Asymmetric dearomatization of benzyl 1-naphthyl ethers *via* [1,3] O-to-C rearrangement

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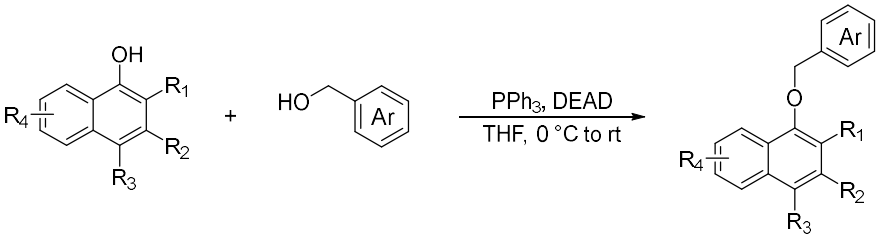
1. General Information

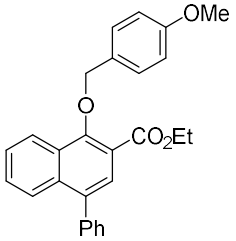
Column chromatography was generally performed on silica gel (300–400 mesh) and reactions were monitored with thin-layer chromatography (TLC) using 254 nm UV light and basic $KMnO_4$ aqueous. NMR characterization data were collected on bruker ASCENDTM operating at 400 MHz and 600 MHz for ^{1}H NMR, 101 MHz and 151 MHz for $^{13}C\{1H\}$ NMR (with complete proton decoupling), and 376 MHz and 565 MHz for $^{19}F\{1H\}$ NMR with complete proton decoupling, and 162 MHz or 243 MHz for $^{31}P\{1H\}$ NMR with complete proton decoupling. ^{1}H NMR chemical shifts δ were recorded in ppm relative to tetramethylsilane (δ = 0.00) and internally referenced to the residual solvent signal (CDC_{l3} = 7.26 ppm). ^{13}C NMR spectra chemical shifts are reported in ppm from the tetramethylsilane with the solvent resonance as internal standard ($CDCl_3$, δ = 77.0). Spectra were reported as follows: chemical shift (δ ppm), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), coupling constants (Hz), integration and assignment. Enantiomeric excesses (ee) were determined by supercritical fluid chromatography (SFC) analysis using the corresponding commercial chiral column as stated in the experimental procedures at 35 ºC. Optical rotations were measured on Rudolph Research Analytic Automatic Polarimeter, and reported as follows: $[\alpha]^{T}_{D}$ (c g/100 mL, in solvent). High-resolution mass spectra (HRMS) were performed on Thermo Q-Exactive Focus (FTMS+c ESI) and data were reported as (m/z). Infrared spectra (IR) were recorded on Bruker Tensor II spectrometer with Plantium ATR accessory and the peaks are reported as absorption maxima (ν, cm^{-1}). Tetrahydrofuran (THF) and toluene were distilled from sodium benzophenone ketyl. 1,1,2,2-TCE, dichloromethane (DCM), and chloroform ($CHCl_3$) were distilled over CaH_2. $Co(BF_4)_2{\cdot}6H_2O$ was purchased from Sigma-Aldrich. The experiments requiring 1-naphthols[1] and chiral *N*,*N*′-dioxide ligands[2] were synthesized according to known procedures.

2. Typical Procedure for the Synthesis of Substrates



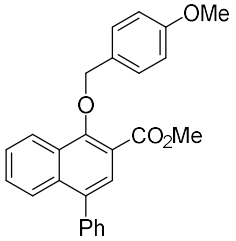
A solution of 1-naphthol (1.0 equiv), benzyl alcohol (1.2 equiv) and PPh_3 (1.5 equiv) in dry THF (4.0 mL/mmol of naphthol) at 0 °C, diethyl azodicarboxylate (DEAD, 1.5 equiv) was added dropwise. The reaction mixture was stirred at room temperature and detected by TLC. After removing the solvent under vacuo, the residue was subjected to flash column chromatography on silica gel and eluted with Pet/EtOAc (40:1 – 20:1, v/v) to afford the product.

Ethyl 1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A1)



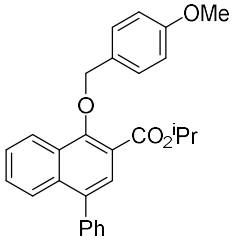
Result: 89% yield, white solid, Mp: 68–70 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.45 – 8.25 (m, 1H), 8.11 – 7.76 (m, 2H), 7.62 – 7.38 (m, 9H), 6.99 (d, *J* = 8.3 Hz, 2H), 5.19 (s, 2H), 4.45 (q, *J* = 7.1 Hz, 2H), 3.86 (s, 3H), 1.41 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.2 , 159.6 , 156.1 , 139.8 , 136.1 , 134. 8 , 130.1 , 129.9 , 129.4 , 129.0 , 128.3 , 128.2 , 127.4 , 127.4 , 126.3 , 126.2 , 124.1 , 119.5 , 113.9 , 77.5 , 61.2 , 55.3 , 14.3 .
HRMS (ESI) Calculated for $C_{27}H_{24}O_4$ ([M]+Na^+) = 435.12567, Found 435.1570.
IR (neat) 2979, 2317, 1720, 1613, 1513, 1412, 1392, 1225, 1151, 1033, 970, 857, 764, 634, 595 cm^{-1}.

Methyl 1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoatev (A2)



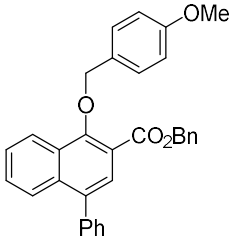
Result: 87% yield, white solid, Mp: 149–151 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.41 – 8.35 (m, 1H), 7.91 (m, 1H), 7.86 (m, 1H), 7.59 – 7.45 (m, 9H), 6.99 (dd, *J* = 8.6, 2.1 Hz, 2H), 5.16 (s, 2H), 3.96 (s, 3H), 3.86 (s, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.6 , 159.7 , 156.2 , 139.8 , 136.2 , 134.9 , 130.1 , 130.1 , 129.3 , 129.1 , 128.3 , 127.5 , 127.4 , 126.4 , 126.3 , 124.1 , 119.1 , 114.0 , 77.7 , 55.3 , 52.3 .
HRMS (ESI) Calculated for $C_{26}H_{22}O_4$ ([M]+Na^+) = 421.1410, Found 421.1411.
IR (neat) 2999, 2836, 1723, 1612, 1512, 1411, 1389, 1227, 1126, 1033, 998, 824, 764, 634, 595 cm^{-1}.

Isopropyl 1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A3)



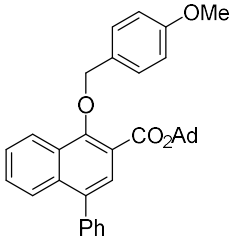
Result: 91% yield, white solid, Mp: 88–90 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.33 (dd, *J* = 7.2, 2.4 Hz, 1H), 7.88 (m, 1H), 7.82 (d, *J* = 2.4 Hz, 1H), 7.59 – 7.45 (m, 9H), 6.98 (dd, *J* = 8.4, 1.4 Hz, 2H), 5.35 (dt, *J* = 12.7, 6.4 Hz, 1H), 5.18 (s, 2H), 3.86 (s, 3H), 1.39 (d, *J* = 6.3 Hz, 6H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 165.8 , 159.6 , 155.9 , 139.9 , 136.0 , 134.7 , 130.1 , 129.8 , 129.5 , 129.0 , 128.3 , 128.1 , 127.4 , 127.4 , 126.3 , 126.2 , 124.1 , 119.9 , 113.9 , 77.4 , 68.6 , 55.3 , 22.0 .
HRMS (ESI) Calculated for $C_{28}H_{26}O_4$ ([M]+Na^+) = 449.1723, Found 449.1725.
IR (neat) 2979, 2278, 1717, 1613, 1513, 1411, 1390, 1227, 1175, 1034, 973, 857, 764, 669, 594 cm^{-1}.

Benzyl 1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A4)



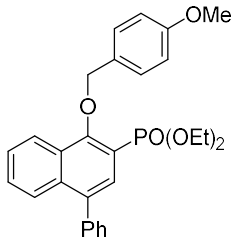
Result: 84% yield, white solid, Mp: 96–98 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.36 (m, 1H), 7.99 – 7.79 (m, 2H), 7.59 – 7.31 (m, 14H), 6.95 (dt, *J* = 8.2, 3.9 Hz, 2H), 5.44 (s, 2H), 5.13 (s, 2H), 3.86 (s, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.1 , 159.6 , 156.3 , 139.8 , 136.2 , 135.9 , 135.0 , 130.1 , 130.0 , 129.3 , 129.1 , 128.6 , 128.5 , 128.4 , 128.3 , 127.5 , 127.4 , 126.4 , 126.3 , 124.1 , 119.2 , 113.9 , 77.6 , 67.0 , 55.3 .
HRMS (ESI) Calculated for $C_{32}H_{26}O_4$ ([M]+Na^+) = 497.1723, Found 497.1731 .
IR (neat) 2953, 2835, 2278, 1721, 1613, 1513, 1412, 1222, 1174, 1033, 970, 857, 764, 636, 593 cm^{-1}.

Adamantan-1-yl 1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A5)



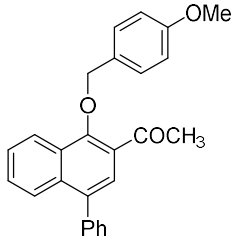
Result: 72% yield, white solid, Mp: 66–68 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.38 – 8.18 (m, 1H), 7.86 (m, 1H), 7.73 (s, 1H), 7.56 – 7.43 (m, 9H), 6.98 (d, *J* = 8.6 Hz, 2H), 5.18 (s, 2H), 3.86 (s, 3H), 2.31 (d, *J* = 2.9 Hz, 6H), 2.23 (s, 3H), 1.80 – 1.62 (m, 6H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 165.5 , 159.5 , 155.3 , 140.0 , 135.8 , 134.4 , 130.1 , 129.8 , 129.7 , 129.0 , 128.3 , 127.9 , 127.5 , 127.3 , 126.1 , 124.0 , 121.2 , 113.9 , 81.8 , 77.2 , 55.3 , 41.4 , 36.2 , 30.9 .
HRMS (ESI) Calculated for $C_{35}H_{34}O_4$ ([M]+Na^+) = 541.2349, Found 541.2322.
IR (neat) 2999, 2283, 1713, 1612, 1512, 1410, 1317, 1227, 1173, 1034, 967, 874, 763, 639, 599 cm^{-1}.

Diethyl (1-((4-methoxybenzyl)oxy)-4-phenylnaphthalen-2-yl)phosphonate (A6)



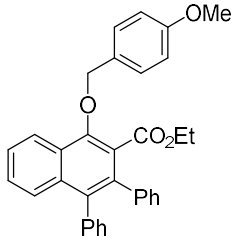
Result: 99% yield, colorless oil.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.35 – 8.26 (m, 1H), 7.93 (dd, *J* = 7.9, 1.6 Hz, 1H), 7.80 (d, *J* = 12.7 Hz, 1H), 7.69 (d, *J* = 8.6 Hz, 2H), 7.57 (m, 2H), 7.50 (m, 4H), 7.47 – 7.41 (m, 1H), 7.01 (d, *J* = 8.6 Hz, 2H), 5.27 (s, 2H), 4.31 – 4.20 (m, 4H), 3.86 (s, 3H), 1.36 (t, *J* = 7.1 Hz, 6H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 159.5 , 158.5 , 158.5 , 139.7 , 136.6 , 136.5 , 135.3 , 135.3 , 130.0 , 130.0 , 129.4 , 129.2 , 129.1 , 128.3 , 128.2 , 127.4 , 126.6 , 126.3 , 123.4 , 118.5 , 116.6 , 113.8 , 77.6 , 62.3 , 62.2 , 55.2 , 16.4 , 16.3 .
^{31}P NMR (162 MHz, Chloroform-*d*) δ 16.75 .
HRMS (ESI) Calculated for $C_{28}H_{29}O_5P$ ([M]+Na^+) = 499.1645, Found 469.1648.
IR (neat) 2981, 2281, 1739, 1613, 1514, 1444, 1355, 1248, 1173, 1050, 962, 873, 765, 682, 542 cm^{-1}.

1-(1-((4-methoxybenzyl)oxy)-4-phenylnaphthalen-2-yl)ethan-1-one (A7)



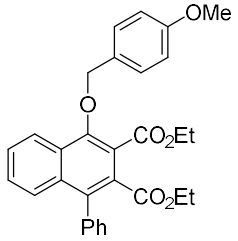
Result: 60% yield, white solid, Mp: 97–99 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.35 (d, *J* = 7.5 Hz, 1H), 7.93 (d, *J* = 8.3 Hz, 1H), 7.68 (d, *J* = 3.2 Hz, 1H), 7.61 – 7.42 (m, 9H), 6.98 (d, *J* = 8.2 Hz, 2H), 5.07 (s, 2H), 3.86 (s, 3H), 2.75 (d, *J* = 1.6 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 200.6 , 159.8 , 155.0 , 139.7 , 136.6 , 134.9 , 130.0 , 129.9 , 128.6 , 128.3 , 128.3 , 128.2 , 127.5 , 126.5 , 126.5 , 126.1 , 123.7 , 114.1 , 78.5 , 55.3 , 31.0 .
HRMS (ESI) Calculated for $C_{26}H_{22}O_3$ ([M]+Na^+) = 405.1461, Found 405.1465
IR (neat) 2933, 2835, 1612, 1513, 1452, 1387, 1248, 1174, 1070, 1032, 960, 856, 765, 641, 567, cm^{-1}.

Ethyl 1-((4-methoxybenzyl)oxy)-3,4-diphenyl-2-naphthoate (A8)



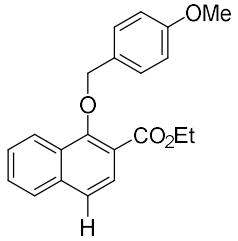
Result: 90% yield, white solid, Mp: 103–105 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.27 (d, *J* = 7.2 Hz, 1H), 7.59 (d, *J* = 8.3 Hz, 1H), 7.51 (d, *J* = 7.3 Hz, 3H), 7.42 (t, *J* = 7.7 Hz, 1H), 7.22 (m, 3H), 7.17 – 7.04 (m, 7H), 6.99 – 6.90 (m, 2H), 5.21 (s, 2H), 4.03 – 3.91 (m, 2H), 3.81 (s, 3H), 0.88 (d, *J* = 5.6 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 167.9 , 159.6 , 151.6 , 138.9 , 138.2 , 136.2 , 135.3 , 134.2 , 131.3 , 130.2 , 129.8 , 129.4 , 127.6 , 127.3 , 127.2 , 127.2 , 127.1 , 126.7 , 126.6 , 126.2 , 125.8 , 122.6 , 113.9 , 77.8 , 61.1 , 55.2 , 13.6 .
HRMS (ESI) Calculated for $C_{33}H_{28}O_4$ ([M]+Na^+) = 511.1880, Found 511.1877.
IR (neat) 2979, 2335, 1725, 1612, 1514, 1442, 1352, 1248, 1175, 1033, 979, 859, 762, 664, 597 cm^{-1}.

Diethyl 1-((4-methoxybenzyl)oxy)-4-phenylnaphthalene-2,3-dicarboxylate (A9)



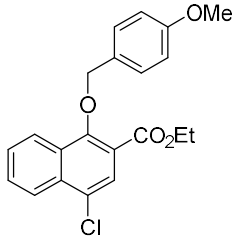
Result: 95% yield, white solid, Mp: 74–76 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.26 (d, *J* = 8.4 Hz, 1H), 7.64 – 7.55 (m, 2H), 7.54 – 7.42 (m, 6H), 7.38 – 7.32 (m, 2H), 6.98 (d, *J* = 8.5 Hz, 2H), 5.20 (s, 2H), 4.38 (q, *J* = 7.0 Hz, 2H), 3.98 (q, *J* = 7.2 Hz, 2H), 3.85 (s, 3H), 1.34 (t, *J* = 7.1 Hz, 3H), 0.91 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 168.0 , 166.7 , 159.7 , 153.6 , 137.6 , 135.4 , 134.3 , 130.2 , 129.9 , 129.8 , 129.1 , 128.8 , 128.2 , 128.0 , 127.7 , 127.6 , 127.5 , 123.1 , 121.4 , 113.9 , 78.0 , 61.8 , 61.2 , 55.3 , 14.0 , 13.5 .
HRMS (ESI) Calculated for $C_{30}H_{28}O_6$ ([M]+Na^+) = 507.1778, Found 507.1783.
IR (neat) 2982, 2836, 1732, 1612, 1513, 1443, 1368, 1245, 1176, 1036, 953, 848, 765, 629, 516 cm^{-1}.

Ethyl 1-((4-methoxybenzyl)oxy)-2-naphthoate (A10)



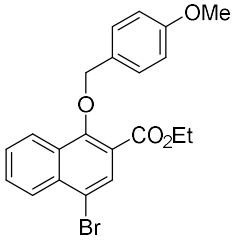
Result: 91% yield, colorless oil.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.27 (d, *J* = 8.4 Hz, 1H), 7.91 (d, *J* = 8.6 Hz, 1H), 7.86 (d, *J* = 7.9 Hz, 1H), 7.64 (d, *J* = 8.6 Hz, 1H), 7.61 – 7.55 (m, 1H), 7.52 (3, 3H), 6.97 (d, *J* = 8.7 Hz, 2H), 5.14 (s, 2H), 4.44 (q, *J* = 7.2 Hz, 2H), 3.84 (s, 3H), 1.42 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.3 , 159.5 , 156.6 , 136.6 , 129.8 , 129.3 , 128.7 , 128.1 , 127.7 , 126.7 , 126.4 , 123.80 , 123.6 , 120.0 , 113.8 , 77.4 , 61.1 , 55.2 , 14.3 .
HRMS (ESI) Calculated for $C_{21}H_{20}O_4$ ([M]+Na^+) = 359.1254, Found 359.1255.
IR (neat) 2980, 2836, 1719, 1612, 1513, 1463, 1365, 1276, 1213, 1174, 1032, 963, 849, 765, 519 cm^{-1}.

Ethyl 4-chloro-1-((4-methoxybenzyl)oxy)-2-naphthoate (A11)



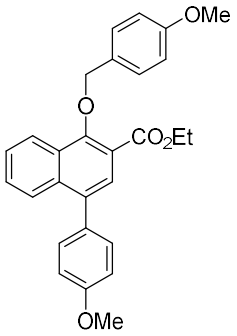
Result: 58% yield, white solid, Mp: 55–57 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.26 (t, *J* = 8.2 Hz, 2H), 8.01 (s, 1H), 7.70 (m, 1H), 7.60 – 7.55 (m, 1H), 7.48 (d, *J* = 8.6 Hz, 2H), 6.95 (d, *J* = 8.5 Hz, 2H), 5.11 (s, 2H), 4.43 (d, *J* = 7.2 Hz, 2H), 3.84 (s, 3H), 1.41 (d, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 165.1 , 159.7 , 155.8 , 133.6 , 130.0 , 129.3 , 129.0 , 127.2 , 126.9 , 126.5 , 124.7 , 124.4 , 120.1 , 113.9 , 77.8 , 61.4 , 55.3 , 14.3 .
HRMS (ESI) Calculated for $C_{21}H_{19}ClO_4$ ([M]+Na^+) = 393.0864, Found 393.0878.
IR (neat) 2980, 2835, 1723, 1613, 1514, 1413, 1350, 1269, 1174, 1034, 969, 856, 763, 697, 555 cm^{-1}.

Ethyl 4-bromo-1-((4-methoxybenzyl)oxy)-2-naphthoate (A12)



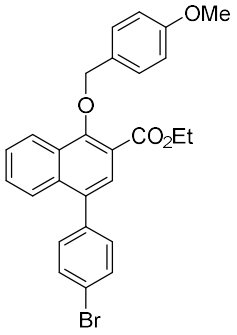
Result: 80% yield, white solid, Mp: 66–68 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.26 (d, *J* = 8.1 Hz, 1H), 8.24 – 8.18 (m, 2H), 7.69 (td, *J* = 8.4, 6.9, 1.3 Hz, 1H), 7.57 (td, *J* = 8.2, 6.9, 1.2 Hz, 1H), 7.47 (d, *J* = 8.6 Hz, 2H), 6.95 (d, *J* = 8.7 Hz, 2H), 5.11 (s, 2H), 4.43 (q, *J* = 7.1 Hz, 2H), 3.84 (s, 3H), 1.42 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 164.9 , 159.7 , 156.5 , 134.8 , 130.2 , 130.1 , 130.0 , 129.6 , 128.9 , 127.3 , 127.2 , 124.4 , 120.5 , 117.2 , 113.9 , 77.8 , 61.4 , 55.3 , 14.3 .
HRMS (ESI) Calculated for $C_{21}H_{19}{}^{79}BrO_4$ ([M]+Na^+) = 437.0359, Found 437.0354.
HRMS (ESI) Calculated for $C_{21}H_{19}{}^{81}BrO_4$ ([M]+Na^+) = 439.0338, Found 439.0331.
IR (neat) 2980, 2835, 2316, 1723, 1613, 1513, 1411, 1325, 1267, 1174, 1034, 964, 855, 762, 582 cm^{-1}.

Ethyl 1-((4-methoxybenzyl)oxy)-4-(4-methoxyphenyl)-2-naphthoate (A13)



Result: 79% yield, white solid, Mp: 115–117 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.34 (dd, *J* = 6.8, 3.0 Hz, 1H), 7.94 – 7.86 (m, 1H), 7.82 (s, 1H), 7.57 – 7.49 (m, 4H), 7.43 (d, *J* = 8.4 Hz, 2H), 7.05 (d, *J* = 8.4 Hz, 2H), 6.98 (d, *J* = 8.4 Hz, 2H), 5.16 (s, 2H), 4.43 (q, *J* = 7.1 Hz, 2H), 3.90 (s, 3H), 3.86 (s, 3H), 1.40 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.3 , 159.6 , 159.0 , 155.8 , 135.8 , 135.0 , 132.2 , 131.2 , 129.9 , 129.4 , 129.1 , 128.2 , 127.4 , 126.3 , 126.2 , 124.1 , 119.5 , 113.9 , 113.8 , 77.5 , 61.2 , 55.4 , 55.3 , 14.4 .
HRMS (ESI) Calculated for $C_{28}H_{26}O_5$ ([M]+Na^+) = 465.1672, Found 465.1680.
IR (neat) 2956, 2835, 2397, 1721, 1611, 1514, 1357, 1274, 1173, 1034, 970, 835, 764, 669, 594 cm^{-1}.

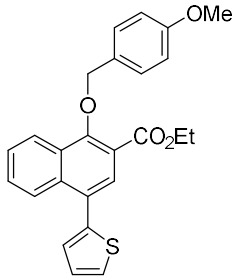
Ethyl 4-(4-bromophenyl)-1-((4-methoxybenzyl)oxy)-2-naphthoate (A14)



Result: 91% yield, white solid, Mp: 158–160 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.41 – 8.28 (m, 1H), 7.93 – 7.74 (m, 2H), 7.64 (d, *J* = 8.3 Hz, 2H), 7.57 – 7.46 (m, 4H), 7.38 (d, *J* = 8.2 Hz, 2H), 6.98 (d, *J* = 8.5 Hz, 2H), 5.16 (s, 2H), 4.44 (q, *J* = 7.1 Hz, 2H), 3.86 (s, 3H), 1.40 (t, *J* = 7.1 Hz, 3H).

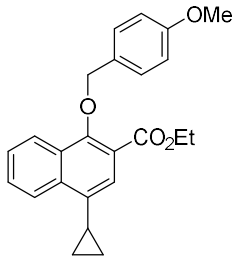
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.1 , 159.7 , 156.4 , 138.7 , 134.8 , 134.5 , 131.7 , 131.5 , 130.0 , 129.3 , 129.1 , 128.5 , 127.5 , 126.5 , 125.9 , 124.2 , 121.7 , 119.5 , 113.9 , 77.6 , 61.3 , 55.3 , 14.4 .
HRMS (ESI) Calculated for $C_{27}H_{23}{}^{79}BrO_4$ ([M]+Na^+) = 513.0672, Found 513.0680.
HRMS (ESI) Calculated for $C_{31}H_{25}{}^{81}BrO_3$ ([M]+Na+) = 515.0651, Found 515.0660.
IR (neat) 2980, 2835, 2280, 1721, 1613, 1513, 1487, 1174, 1034, 970, 857, 764, 593 cm^{-1}.

Ethyl 1-((4-methoxybenzyl)oxy)-4-(thiophen-2-yl)-2-naphthoate (A15)



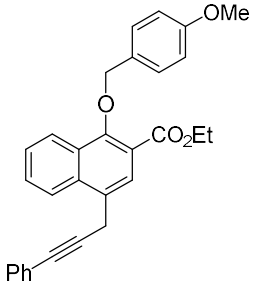
Result: 84% yield, white solid, Mp: 87–89 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.33 (d, *J* = 8.3 Hz, 1H), 8.19 (d, *J* = 7.6 Hz, 1H), 7.99 (s, 1H), 7.63 – 7.51 (m, 4H), 7.45 (dd, *J* = 5.1, 1.2 Hz, 1H), 7.25 (dd, *J* = 3.5, 1.2 Hz, 1H), 7.20 (dd, *J* = 5.1, 3.4 Hz, 1H), 6.97 (d, *J* = 8.6 Hz, 2H), 5.15 (s, 2H), 4.44 (q, *J* = 7.1 Hz, 2H), 3.85 (s, 3H), 1.41 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.0 , 159.7 , 156.6 , 140.7 , 135.1 , 130.0 , 129.2 , 129.2 , 128.8 , 128.7 , 128.4 , 127.6 , 127.3 , 126.5 , 126.0 , 125.9 , 124.2 , 119.5 , 113.9 , 77.7 , 61.3 , 55.3 , 14.4 .
HRMS (ESI) Calculated for $C_{25}H_{22}O_4S$ ([M]+Na^+) = 441.1131, Found 441.1138.
IR (neat) 2983, 2835, 2397, 1721, 1612, 1513, 1357, 1302, 1274, 1033, 963, 826, 763, 605, 554 cm^{-1}.

Ethyl 4-cyclopropyl-1-((4-methoxybenzyl)oxy)-2-naphthoate (A16)



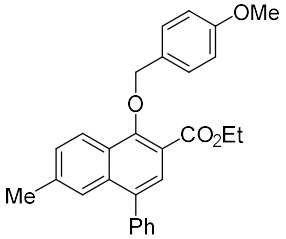
Result: 72% yield, white solid, Mp: 32–34 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.42 (d, *J* = 8.3 Hz, 1H), 8.30 (d, *J* = 8.1 Hz, 1H), 7.69 (s, 1H), 7.65 (m, 1H), 7.57 – 7.50 (m, 3H), 6.97 (d, *J* = 8.6 Hz, 2H), 5.10 (s, 2H), 4.44 (q, *J* = 7.1 Hz, 2H), 3.85 (s, 3H), 2.32 – 2.25 (m, 1H), 1.42 (t, *J* = 7.1 Hz, 3H), 1.12 – 1.06 (m, 2H), 0.81 (td, *J* = 5.9, 4.2 Hz, 2H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.6 , 159.5 , 155.2 , 136.6 , 134.9 , 129.8 , 129.4 , 128.7 , 128.0 , 126.1 , 124.6 , 124.2 , 119.4 , 113.8 , 77.4 , 61.1 , 55.2 , 14.3 , 13.0 , 6.2 .
HRMS (ESI) Calculated for $C_{22}H_{24}O_4$ ([M]+Na^+) = 399.1567, Found 399.1569.
IR (neat) 2998, 2835, 1720, 1613, 1571, 1372, 1269, 1174, 1034, 962, 896, 763, 668, 594 cm^{-1}.

Ethyl 1-((4-methoxybenzyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A17)



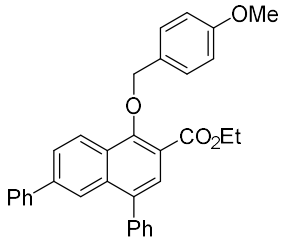
Result: 88% yield, white solid, Mp: 76–78 °C.
^{1}H NMR (600 MHz, Chloroform-*d*) δ 8.33 (d, *J* = 8.4 Hz, 1H), 8.12 (d, *J* = 7.0 Hz, 2H), 7.67 (m, 1H), 7.56 (m, 1H), 7.52 (d, *J* = 8.4 Hz, 2H), 7.48 – 7.43 (m, 2H), 7.34 – 7.27 (m, 3H), 6.96 (d, *J* = 8.4 Hz, 2H), 5.12 (s, 2H), 4.44 (q, *J* = 7.1 Hz, 2H), 4.19 (s, 2H), 3.85 (s, 3H), 1.41 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (151 MHz, Chloroform-*d*) δ 166.1 , 159.6 , 156.2 , 134.6 , 131.6 , 129.9 , 129.4 , 129.1 , 128.5 , 128.3 , 128.2 , 127.9 , 126.5 , 126.3 , 124.6 , 123.7 , 123.5 , 119.5 , 113.9 , 86.8 , 83.7 , 77.6 , 61.1 , 55.3 , 23.5 , 14.3 .
HRMS (ESI) Calculated for $C_{30}H_{26}O_4$ ([M]+Na^+) = 473.1723, Found 473.1725.
IR (neat) 2980, 1719, 1615, 1513, 1459, 1392, 1304, 1274, 1174, 1083, 1031, 959, 823, 759 524 cm^{-1}.

Ethyl 1-((4-methoxybenzyl)oxy)-6-methyl-4-phenyl-2-naphthoate (A18)



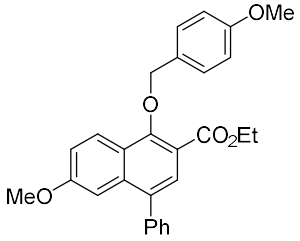
Result: 80% yield, white solid, Mp: 99–100 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.25 (d, *J* = 8.6 Hz, 1H), 7.83 (s, 1H), 7.65 (s, 1H), 7.60 – 7.42 (m, 7H), 7.38 (d, *J* = 8.5 Hz, 1H), 6.99 (d, *J* = 8.4 Hz, 2H), 5.16 (s, 2H), 4.43 (q, *J* = 7.1 Hz, 2H), 3.86 (s, 3H), 2.45 (s, 3H), 1.40 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.2 , 159.6 , 156.3 , 140.0 , 138.5 , 135.4 , 135.1 , 130.1 , 129.9 , 129.5 , 128.5 , 128.3 , 127.7 , 127.3 , 127.2 , 125.2 , 124.0 , 118.5 , 113.9 , 77.5 , 61.1 , 55.3 , 22.0 , 14.4 .
HRMS (ESI) Calculated for $C_{28}H_{26}O_4$ ([M]+Na^+) = 449.1723, Found 449.1730.
IR (neat) 2979, 2835, 1720, 1613, 1570, 1513, 1405, 1375, 1154, 1031, 979, 859, 797, 610, 559 cm^{-1}.

Ethyl 1-((4-methoxybenzyl)oxy)-4,6-diphenyl-2-naphthoate (A19)



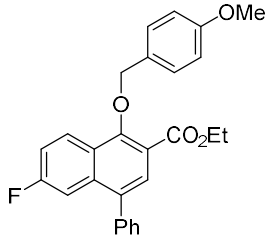
Result: 82% yield, White solid, Mp: 99-101 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.43 (d, *J* = 8.7 Hz, 1H), 8.11 (s, 1H), 7.90 (s, 1H), 7.81 (dd, *J* = 8.7, 1.8 Hz, 1H), 7.63 – 7.51 (m, 8H), 7.46 (m, 3H), 7.37 (m, 1H), 7.00 (d, *J* = 8.4 Hz, 2H), 5.21 (s, 2H), 4.46 (q, *J* = 7.1 Hz, 2H), 3.87 (s, 3H), 1.42 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.1 , 159.6 , 156.1 , 140.9 , 140.6 , 139.8 , 136.3 , 135.1 , 130.1 , 130.0 , 129.4 , 128.9 , 128.4 , 128.2 , 128.1 , 127.7 , 127.5 , 127.5 , 126.0 , 124.8 , 124.1 , 119.4 , 113.94 , 77.6 , 61.2 , 55.3 , 14.4 .
HRMS (ESI) Calculated for $C_{33}H_{28}O_4$ ([M]+Na^+) = 511.1880, Found 511.1880.
IR (neat) 2981, 2835, 1720, 1615, 1513, 1456, 1375, 1249, 1174, 1030, 972, 860, 763, 669, 560 cm^{-1}.

Ethyl 6-methoxy-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A20)



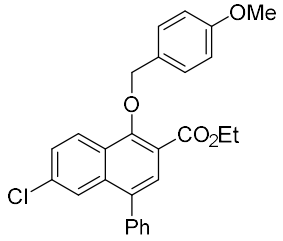
Result: 93% yield, white solid, Mp: 99–101 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.25 (d, *J* = 9.0 Hz, 1H), 7.82 (s, 1H), 7.65 (s, 1H), 7.57 – 7.42 (m, 7H), 7.38 (d, *J* = 8.5 Hz, 1H), 6.99 (d, *J* = 7.4 Hz, 2H), 5.16 (s, 2H), 4.43 (q, *J* = 7.0 Hz, 2H), 3.86 (s, 3H), 2.45 (s, 3H), 1.45 – 1.37 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.2 , 159.6 , 156.3 , 140.1 , 138.5 , 135.4 , 135.1 , 130.1 , 129.9 , 129.5 , 128.5 , 128.3 , 127.7 , 127.3 , 127.2 , 125.2 , 124.0 , 118.54, 113.9 , 77.5 , 61.1 , 55.3 , 22.0 , 14.4 .
HRMS (ESI) Calculated for $C_{28}H_{26}O_5$ ([M]+Na^+) = 465.1672, Found 465.1679.
IR (neat) 2979, 2835, 1720, 1613, 1570, 1513, 1405, 1375, 1249, 1031, 979, 859, 797, 669, 559 cm^{-1}.

Ethyl 6-fluoro-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A21)



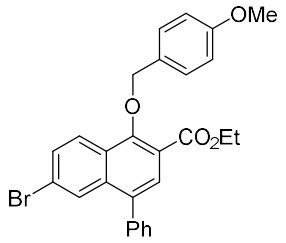
Result: 78% yield, white solid, Mp: 110–112 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.32 (m, 1H), 7.89 (s, 1H), 7.54 – 7.41 (m, 8H), 7.29 (m, 1H), 6.97 (d, *J* = 8.5 Hz, 2H), 5.16 (s, 2H), 4.44 (q, *J* = 7.2 Hz, 2H), 3.86 (s, 3H), 1.41 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-d) δ 166.0 , 163.7 , 161.2 , 159.7 , 156.3 , 139.3 , 136.2 , 135.5 , 130.0 , 129.9 , 129.1 , 128.8 , 128.5 , 127.7 , 127.2 , 127.1 , 126.2 , 118.7 , 116.6 , 116.4 , 113.9 , 110.1 , 109.8 , 77.8 , 61.2 , 55.3 , 14.4 .
^{19}F NMR (377 MHz, Chloroform-*d*) δ -110.35 .
HRMS (ESI) Calculated for $C_{27}H_{23}FO_4$ ([M]+Na^+) = 453.1473, Found 453.1468.
IR (neat) 2980, 2836, 1721, 1622, 1513, 1459, 1353, 1248, 1184, 1031, 984, 863, 795, 609, 550 cm^{-1}.

Ethyl 6-chloro-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A22)



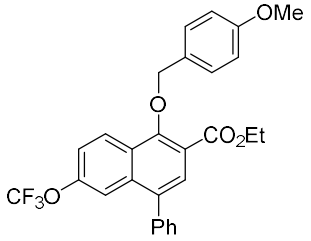
Result: 91% yield, white solid, Mp: 112–114 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.25 (d, *J* = 9.0 Hz, 1H), 7.98 – 7.74 (m, 2H), 7.55 – 7.40 (m, 8H), 6.97 (d, *J* = 8.2 Hz, 2H), 5.15 (d, *J* = 2.4 Hz, 2H), 4.44 (q, *J* = 7.1 Hz, 2H), 3.86 (s, 3H), 1.40 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 165.9 , 159.7 , 156.1 , 139.1 , 135.5 , 135.3 , 134.8 , 130.0 , 123.0 , 129.1 , 128.8 , 128.5 , 127.7 , 127.5 , 127.2 , 126.0 , 125.1 , 119.6 , 114.0 , 77.9 , 61.3 , 55.3 , 14.3 .
HRMS (ESI) Calculated for $C_{27}H_{23}ClO_4$ ([M]+Na^+) = 469.1177, Found 469.1183.
IR (neat) 2980, 2835, 1721, 1611, 1514, 1449, 1352, 1246, 1174, 1030, 973, 883, 794, 608, 559 cm^{-1}.

Ethyl 6-bromo-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A23)



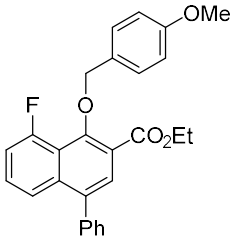
Result: 83% yield, white solid, Mp: 108–110 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.17 (d, *J* = 10.0 Hz, 1H), 8.02 (m, 1H), 7.87 (d, *J* = 3.9 Hz, 1H), 7.59 (d, *J* = 9.0 Hz, 1H), 7.55 – 7.46 (m, 7H), 6.97 (d, *J* = 7.6 Hz, 2H), 5.15 (s, 2H), 4.43 (q, *J* = 7.2 Hz, 2H), 3.85 (s, 3H), 1.40 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 165.9 , 159.7 , 156.2 , 139.1 , 135.8 , 135.2 , 130.0 , 130.0 , 129.8 , 129.1 , 128.8 , 128.6 , 128.4 , 127.7 , 126.0 , 123.4 , 119.7 , 114.0 , 77.9 , 61.3 , 55.3 , 14.3 .
HRMS (ESI) Calculated for $C_{27}H_{23}{}^{79}BrO_4$ ([M]+Na^+) = 513.0672, Found 513.0683.
HRMS (ESI) Calculated for $C_{27}H_{23}{}^{81}BrO_4$ ([M]+Na^+) = 515.0651, Found 515.0662.
IR (neat) 2979, 2834, 1721, 1610, 1514, 1448, 1351, 1246, 1174, 1031, 971, 883, 793, 616, 559 cm^{-1}.

Ethyl 1-((4-methoxybenzyl)oxy)-4-phenyl-6-(trifluoromethoxy)-2-naphthoate (A24)



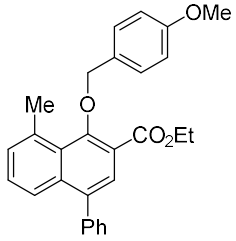
Result: 92% yield, white solid, Mp: 85–87 °C.
^{1}H NMR (400 MHz, Chloroform-d) δ 8.36 (d, J = 9.1 Hz, 1H), 7.92 (s, 1H), 7.71 (s, 1H), 7.56 – 7.44 (m, 7H), 7.39 (d, J = 9.1 Hz, 1H), 6.98 (d, J = 8.4 Hz, 2H), 5.17 (s, 2H), 4.45 (q, J = 7.1 Hz, 2H), 3.86 (s, 3H), 1.41 (t, J = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 165.9 , 159.8 , 156.0 , 148.9 , 139.0 , 135.9 , 135.4 , 130.0 , 129.9 , 129.0 , 129.0 , 128.6 , 127.8 , 127.5 , 126.8 , 120.0 , 119.8 , 116.7 , 114.0 , 77.9 , 61.4 , 55.3 , 14.3 .
^{19}F NMR (377 MHz, Chloroform-*d*) δ -57.51 .
HRMS (ESI) Calculated for $C_{28}H_{23}F_3O_5$ ([M]+Na^+) = 519.1390, Found 519.1396.
IR (neat) 2982, 2837, 1723, 1614, 1514, 1457, 1354, 1246, 1181, 962, 858, 797, 617, 521 cm^{-1}.

Ethyl 8-fluoro-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A25)



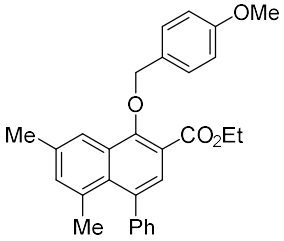
Result: 59% yield, white solid, Mp: 82–84 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.77 (s, 1H), 7.66 (d, *J* = 8.5 Hz, 1H), 7.58 (d, *J* = 8.5 Hz, 2H), 7.51 – 7.40 (m, 6H), 7.22 (m, 1H), 7.00 – 6.94 (m, 2H), 5.14 (s, 2H), 4.39 (q, *J* = 7.1 Hz, 2H), 3.85 (s, 3H), 1.35 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-d) δ 166.2 , 160.6 , 159.5 , 158.1 , 154.2 , 139.7 , 137.0 , 136.3 , 130.3 , 130.2 , 130.0 , 129.3 , 128.4 , 128.3 , 128.0 , 127.9 , 127.6 , 122.7 , 119.4 , 113.8 , 112.3 , 112.1 , 78.1 , 61.4 , 55.3 , 14.3 .
^{19}F NMR (377 MHz, Chloroform-*d*) δ -114.02 .
HRMS (ESI) Calculated for $C_{27}H_{23}FO_4$ ([M]+Na^+) = 453.1473, Found 453.1475.
IR (neat) 2981, 2835, 1725, 1614, 1514, 1463, 1373, 1248, 1176, 1045, 961, 856, 753, 670, 516 cm^{-1}.

Ethyl 1-((4-methoxybenzyl)oxy)-8-methyl-4-phenyl-2-naphthoate (A26)



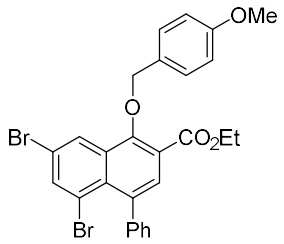
Result: 69% yield, white solid, Mp: 105–107 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.76 (d, *J* = 4.5 Hz, 1H), 7.70 (d, *J* = 7.5 Hz, 1H), 7.53 – 7.41 (m, 7H), 7.36 (t, *J* = 7.7 Hz, 1H), 7.30 (d, *J* = 7.0 Hz, 1H), 6.96 (dd, *J* = 8.7, 2.5 Hz, 2H), 5.01 (s, 2H), 4.39 (q, *J* = 7.0 Hz, 2H), 3.85 (s, 3H), 2.92 (s, 3H), 1.35 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.8 , 159.4 , 157.6 , 140.6 , 136.7 , 136.2 , 136.1 , 130.1 , 129.9 , 129.6 , 129.1 , 128.4 , 128.3 , 127.5 , 127.3 , 124.9 , 121.0 , 113.7 , 78.4 , 61.2 , 55.3 , 24.9 , 14.3 .
HRMS (ESI) Calculated for $C_{28}H_{26}O_4$ ([M]+Na^+) = 449.1723, Found 449.1732.
IR (neat) 2977, 2934, 2835, 1721, 1611, 1513, 1456, 1355, 1246, 1175, 1033, 956, 861, 762, 559, cm^{-1}.

Ethyl 1-((4-methoxybenzyl)oxy)-5,7-dimethyl-4-phenyl-2-naphthoate (A27)



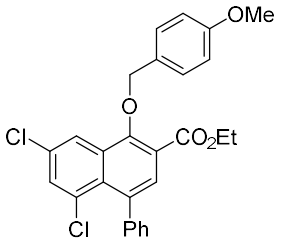
Result: 89% yield, white solid, Mp: 98–100 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.08 (s, 1H), 7.68 (s, 1H), 7.58 (d, *J* = 8.4 Hz, 2H), 7.43 – 7.33 (m, 5H), 7.19 (s, 1H), 7.01 (d, *J* = 8.5 Hz, 2H), 5.15 (s, 2H), 4.42 (q, *J* = 6.8 Hz, 2H), 3.87 (s, 3H), 2.48 (s, 3H), 2.00 (s, 3H), 1.39 (t, *J* = 7.0 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.1 , 159.5 , 155.8 , 144.2 , 136.1 , 135.7 , 135.4 , 134.2 , 132.4 , 130.4 , 129.9 , 129.6 , 129.6 , 128.6 , 127.6 , 126.9 , 121.6 , 118.5 , 113.9 , 77.3 , 61.0 , 55.3 , 24.6 , 21.6 , 14.3 .
HRMS (ESI) Calculated for $C_{29}H_{28}O_4$ ([M]+Na^+) = 463.1880, Found 463.1881.
IR (neat) 2976, 2835, 1721, 1613, 1514, 1455, 1359, 1243, 1174, 1038, 985, 899, 764, 668, 518 cm^{-1}.

Ethyl 5,7-dibromo-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A28)



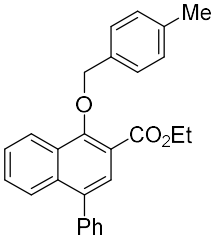
Result: 90% yield, white solid, Mp: 129–131 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.47 (d, *J* = 2.1 Hz, 1H), 7.96 (d, *J* = 2.1 Hz, 1H), 7.84 (s, 1H), 7.48 (d, *J* = 8.4 Hz, 2H), 7.43 – 7.38 (m, 3H), 7.34 – 7.28 (m, 2H), 6.98 (d, *J* = 8.6 Hz, 2H), 5.14 (s, 2H), 4.42 (q, *J* = 7.1 Hz, 2H), 3.86 (s, 3H), 1.39 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 165.3 , 159.9 , 155.0 , 141.5 , 138.1 , 136.2 , 132.4 , 131.7 , 131.0 , 130.2 , 128.6 , 127.6 , 127.4 , 126.7 , 121.1 , 120.4 , 119.9 , 114.0 , 78.2 , 61.5 , 55.3 , 14.3 .
HRMS (ESI) Calculated for $C_{27}H_{22}{}^{79}Br_2O_4$ ([M]+Na^+) = 590.9782, Found 590.0982.
HRMS (ESI) Calculated for $C_{27}H_{22}{}^{81}Br_2O_4$ ([M]+Na^+) = 594.9736, Found 594.9744.
HRMS (ESI) Calculated for $C_{27}H_{22}{}^{79}Br^{81}BrO_4$ ([M]+Na^+) = 592.9757, Found 592.9765.
IR (neat) 2979, 2834, 1723, 1612, 1514, 1465, 1374, 1250, 1186, 1032, 968, 864, 785, 631, 582 cm^{-1}.

Ethyl 5,7-dichloro-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A29)



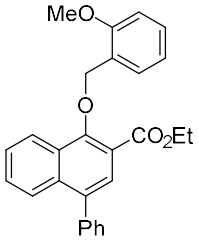
Result: 92% yield, white solid, Mp: 107–109 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.26 (s, 1H), 7.83 – 7.77 (m, 1H), 7.56 (d, *J* = 2.2 Hz, 1H), 7.49 (d, *J* = 8.7 Hz, 2H), 7.39 (m, 3H), 7.34 – 7.29 (m, 2H), 6.97 (d, *J* = 8.6 Hz, 2H), 5.14 (s, 2H), 4.42 (q, *J* = 7.0 Hz, 2H), 3.85 (s, 3H), 1.42 – 1.36 (m, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 165.4 , 159.8 , 155.0 , 142.0 , 135.3 , 132.8 , 132.0 , 131.8 , 131.7 , 131.4 , 130.2 , 129.8 , 129.6 , 128.6 , 127.5 , 127.1 , 122.7 , 120.4 , 114.0 , 78.1 , 61.5 , 55.3 , 14.3 .
HRMS (ESI) Calculated for $C_{27}H_{22}Cl_2O_4$ ([M]+Na^+) = 503.0787, Found 503.0778.
IR (neat) 2980, 2835, 1724, 1612, 1514, 1463, 1373, 1249, 1175, 1032, 956, 864, 764, 633, 592 cm^{-1}.

Ethyl 1-((4-methylbenzyl)oxy)-4-phenyl-2-naphthoate (A30)



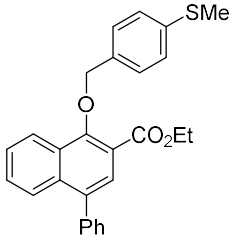
Result: 93% yield, white solid, Mp: 58-61 °C
^{1}H NMR (400 MHz, Chloroform-d) δ 8.38 – 8.32 (m, 1H), 7.91 – 7.86 (m, 1H), 7.84 (s, 1H), 7.54 – 7.48 (m, 8H), 7.46 – 7.41 (m, 1H), 7.27 – 7.24 (m, 2H), 5.19 (s, 2H), 4.42 (q, J = 7.1 Hz, 2H), 2.40 (s, 3H), 1.38 (t, J = 7.2 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.3 , 156.1 , 139.8 , 137.9 , 136.1 , 134.8 , 134.2 , 130.1 , 129.2 , 129.0 , 128.3 , 128.2 , 128.2 , 127.5 , 127.4 , 126.3 , 126.2 , 124.1 , 119.5 , 77.7 , 61.2 , 21.3 , 14.3 .
HRMS (ESI) Calculated for $C_{27}H_{24}O_3$ ([M]+Na^+) = 419.1618, Found 419.1622.
IR (neat) 2980, 2277, 1722, 1617, 1508, 1452, 1414, 1357, 1275, 1249, 1171, 1126, 1021, 975, 805, 762, 611, 549 cm^{-1}.

Ethyl 1-((2-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A31)



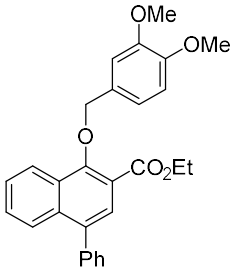
Result: 86% yield, white solid, Mp: 64-66 °C
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.55 – 8.41 (m, 1H), 8.01 – 7.81 (m, 2H), 7.78 – 7.71 (m, 1H), 7.52 (m, 6H), 7.47 (m, 1H), 7.36 (m, 1H), 7.08 (m, 1H), 6.93 (m , 1H), 5.31 (d, *J* = 9.8 Hz, 2H), 4.42 (m, *J* = 7.3 Hz, 2H), 3.80 (d, *J* = 3.0 Hz, 3H), 1.37 (q, *J* = 6.9 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.4 , 157.2 , 156.5, 139.9 , 136.0 , 134.7 , 130.1 , 129.7 , 129.3 , 128.3 , 128.2 , 127.5 , 127.4 , 126.1 , 125.7 , 124.4 , 120.6 , 119. 6 , 110.1 , 73.1 , 61.1 , 55.1 , 14.3 .
HRMS (ESI) Calculated for $C_{31}H_{26}O_4$ ([M]+Na^+) = 435.1567, Found 435.1568.
IR (neat) 2978, 1720, 1597, 1494, 1413, 1359, 1285, 1247, 1153, 1082, 1028, 970, 925, 866, 757, 616 cm^{-1}.

Ethyl 1-((4-(methylthio)benzyl)oxy)-4-phenyl-2-naphthoate (A32)



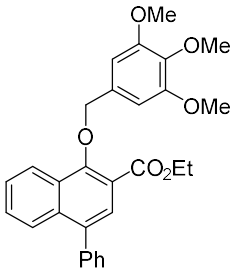
Result: 95% yield, white solid, Mp: 94–96 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.36 – 8.29 (m, 1H), 7.92 – 7.88 (m, 1H), 7.86 (s, 1H), 7.56 – 7.49 (m, 8H), 7.48 – 7.43 (m, 1H), 7.34 (d, *J* = 8.2 Hz, 2H), 5.19 (s, 2H), 4.43 (q, *J* = 7.1 Hz, 2H), 2.53 (s, 3H), 1.39 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.2 , 156.0 , 139.8 , 138.5 , 136.3 , 134.8 , 134.1 , 130.1 , 128.9 , 128.7 , 128.3 , 128.3 , 127.5 , 127.4 , 126.6 , 126.4 , 126.3 , 123.9 , 119.5 , 77.3 , 61.2 , 15.9 , 14.3 .
HRMS (ESI) Calculated for $C_{27}H_{24}O_3S$ ([M]+Na^+) = 451.1338, Found 451.1341.
IR (neat) 2980, 2316, 1720, 1616, 1506, 1443, 1357, 1276, 1171, 1020, 970, 853, 766, 643, 590 cm^{-1}.

Ethyl 1-((3,4-dimethoxybenzyl)oxy)-4-phenyl-2-naphthoate (A33)



Result: 88% yield, white solid, Mp: 108–110 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.38 – 8.32 (m, 1H), 7.95 – 7.87 (m, 1H), 7.85 (s, 1H), 7.55 – 7.44 (m, 7H), 7.20 (s, 1H), 7.11 (dd, *J* = 8.1, 2.0 Hz, 1H), 6.92 (d, *J* = 8.1 Hz, 1H), 5.18 (s, 2H), 4.43 (q, *J* = 7.1 Hz, 2H), 3.94 (d, *J* = 5.6 Hz, 6H), 1.40 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.2 , 156.0 , 149.0 , 139.8 , 136.1 , 134.8 , 130.1 , 129.8 , 129.0 , 128.3 , 128.3 , 127.4 , 127.4 , 126.3 , 126.2 , 124.1 , 120.9 , 119.4 , 111.6 , 110.9 , 77.8 , 61.1 , 55.9 , 55.9 , 14.3 .
HRMS (ESI) Calculated for $C_{28}H_{26}O_5$ ([M]+Na^+) = 465.1672, Found 465.1683.
IR (neat) 2935, 2834, 1720, 1613, 1569, 1462, 1357, 1248, 1156, 1028, 969, 855, 764, 634, 585 cm^{-1}.

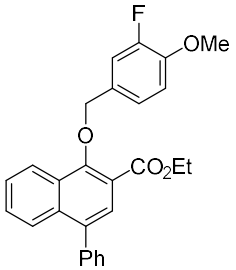
Ethyl 4-phenyl-1-((3,4,5-trimethoxybenzyl)oxy)-2-naphthoate (A34)



Result: 75% yield, white solid, Mp: 76–78 °C
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.37 – 8.31 (m, 1H), 7.93 – 7.88 (m, 1H), 7.85 (s, 1H), 7.56 – 7.44 (m, 7H), 6.84 (s, 2H), 5.18 (s, 2H), 4.43 (q, *J* = 7.1 Hz, 2H), 3.91 (s, 6H), 3.89 (s, 3H), 1.39 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.1 , 155.9 , 153.3 , 139.7 , 137.7 , 136.3 , 134.8 , 132.9 , 130.0 , 129.0 , 128.3 , 128.3 , 127.5 , 127.4 , 126.3 , 126.3 , 124.0 , 119.5 , 105.1 , 77.8 , 61.2 , 60.9 , 56.1 , 14.3 .
HRMS (ESI) Calculated for $C_{29}H_{28}O_6$ ([M]+Na^+) = 495.1778, Found 495.1782.

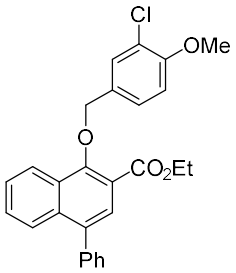
IR (neat) 2931, 2836, 1720, 1507, 1421, 1357, 1247, 1151, 1010, 972, 834, 764, 669, 586 cm^{-1}.

Ethyl 1-((3-fluoro-4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A35)



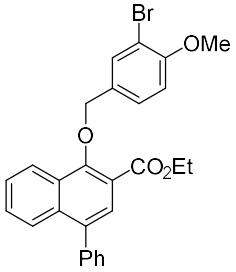
Result: 88% yield, white solid, Mp: 82–84 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.33 (m, 1H), 7.92 – 7.88 (m, 1H), 7.86 (s, 1H), 7.57 – 7.42 (m, 8H), 7.31 (d, *J* = 8.5 Hz, 1H), 7.02 (t, *J* = 8.4 Hz, 1H), 5.16 (s, 2H), 4.44 (q, *J* = 7.1 Hz, 2H), 3.94 (s, 3H), 1.40 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-d) δ 166.0 , 155.8 , 153.5 , 151.1, 147.6 , 147.5 , 139.7 , 136.3 , 134.8 , 130.2 , 130.2 , 130.1 , 128.9 , 128.3 , 128.3 , 127.5 , 127.4 , 126.4 , 126.3 , 124.2 , 124.2 , 123.8 , 119.5 , 116.3 , 116.2 , 113.2 , 113.2 , 76.7 , 61.2 , 56.3 , 14.3 .
^{19}F NMR (377 MHz, Chloroform-d) δ -135.00 .
HRMS (ESI) Calculated for $C_{27}H_{23}FO_4$ ([M]+Na^+) = 453.1473, Found 453.1475.
IR (neat) 2979, 2840, 2279, 1720, 1619, 1519, 1442, 1357, 1277, 1171, 1027, 973, 870, 761, 631 cm^{-1}.

Ethyl 1-((3-chloro-4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A36)



Result: 91% yield, white solid, Mp: 78–80 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.33 (m, 1H), 7.91 (m, 1H), 7.86 (d, *J* = 2.7 Hz, 1H), 7.68 (s, 1H), 7.58 – 7.45 (m, 8H), 7.00 (d, *J* = 8.4 Hz, 1H), 5.15 (s, 2H), 4.44 (q, *J* = 7.2 Hz, 2H), 3.95 (s, 3H), 1.40 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.0 , 155.8 , 154.9 , 139.7 , 136.4 , 134.8 , 130.4 , 130.3 , 130.1 , 128.9 , 128.3 , 127.8 , 127.5 , 127.4 , 126.5 , 126.3 , 123.8 , 122.4 , 119.5 , 111.9 , 76.6 , 61.2 , 56.2 , 14.3 .
HRMS (ESI) Calculated for $C_{27}H_{23}ClO_4$ ([M]+Na^+) = 469.1177, Found 469.1183.
IR (neat) 2978, 2838, 1720, 1607, 1569, 1442, 1384, 1279, 1171, 1023, 973, 876, 739, 620, 564 cm^{-1}.

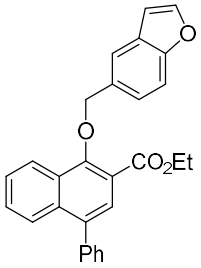
Ethyl 1-((3-bromo-4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A37)



Result: 85% yield, white solid, Mp: 98–100 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.41 – 8.23 (m, 1H), 8.00 – 7.75 (m, 3H), 7.53 (m, 8H), 6.97 (d, *J* = 7.5 Hz, 1H), 5.14 (s, 2H), 4.56 – 4.33 (m, 2H), 3.94 (s, 3H), 1.40 (t, *J* = 5.7 Hz, 3H).

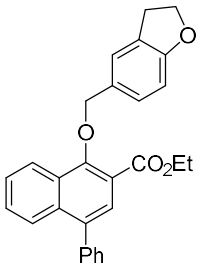
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.1 , 155.7 , 139.7 , 136.4 , 134.8 , 133.4 , 130.9 , 130.1 , 128.9 , 128.6 , 128.3 , 127.5 , 127.4 , 126.5 , 126.3 , 123.8 , 119.5 , 111.8 , 111.6 , 76.5 , 61.2 , 56.3 , 14.3.
HRMS (ESI) Calculated for $C_{27}H_{23}{}^{79}BrO_4$ ([M]+Na^+) = 513.0672, Found 513.0679.
HRMS (ESI) Calculated for $C_{27}H_{23}{}^{79}BrO_4$ ([M]+Na^+) = 513.0672, Found 513.0679.
HRMS (ESI) Calculated for $C_{27}H_{23}{}^{81}BrO_4$ ([M]+Na^+) = 515.0651, Found 515.0659.
IR (neat) 2978, 2837, 2277, 1720, 1604, 1569, 1455, 1355, 1278, 1082, 1021, 973, 899, 763, 673, 555 cm^{-1}.

Ethyl 1-(benzofuran-5-ylmethoxy)-4-phenyl-2-naphthoate (A38)



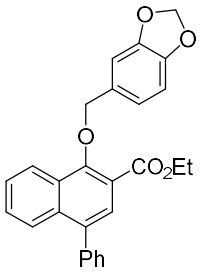
Result: 89% yield, white solid, Mp: 93–95 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.42 – 8.35 (m, 1H), 7.91 (m, 3H), 7.68 (s, 1H), 7.59 (s, 2H), 7.54 (m, 6H), 7.47 (m, 1H), 6.84 (s, 1H), 5.34 (s, 2H), 4.45 (q, *J* = 6.4, 5.6 Hz, 2H), 1.40 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.2 , 156.0 , 154.8 , 145.5 , 139.8 , 136.2 , 134.8 , 131.8 , 130.1 , 129.0 , 128.3 , 128.3 , 127.6 , 127.4 , 126.4 , 126.3 , 124.9 , 124.0 , 121.3 , 119.5 , 111.4 , 106.7 , 78.0 , 61.2 , 14.3 .
HRMS (ESI) Calculated for $C_{28}H_{22}O_4$ ([M]+Na^+) = 445.1410, Found 445.1412.
IR (neat) 2981, 2311, 1720, 1616, 1595, 1444, 1359, 1274, 1152, 1031, 973, 885, 762, 669 cm^{-1}.

Ethyl 1-((2,3-dihydrobenzofuran-5-yl)methoxy)-4-phenyl-2-naphthoate (A39)



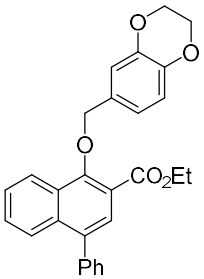
Result: 96% yield, white solid, Mp: 97–99 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.38 (d, *J* = 9.2 Hz, 1H), 8.03 – 7.77 (m, 2H), 7.58 – 7.43 (m, 8H), 7.36 (d, *J* = 8.0 Hz, 1H), 6.86 (d, *J* = 8.0 Hz, 1H), 5.15 (s, 2H), 4.63 (t, *J* = 8.7 Hz, 2H), 4.46 (dd, *J* = 8.7, 5.4 Hz, 2H), 3.28 (t, *J* = 8.7 Hz, 2H), 1.42 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.1 , 160.2 , 156.1 , 139.8 , 136.1 , 134.8 , 130.1 , 129.2 , 129.0 , 128.8 , 128.3 , 128.2 , 127.4 , 127.4 , 126.3 , 126.2 , 125.6 , 124.1 , 119.5 , 109.1 , 77.9 , 71.4 , 61.1 , 29.6 , 14.4 .
HRMS (ESI) Calculated for $C_{28}H_{24}O_4$ ([M]+Na^+) = 447.1567 Found 447.1569.
IR (neat) 2918, 2896, 1720, 1615, 1568, 1444, 1356, 1249, 1171, 1021, 980, 814, 764, 673 cm^{-1}.

Ethyl 1-(benzo[d][1,3]dioxol-5-ylmethoxy)-4-phenyl-2-naphthoate (A40)



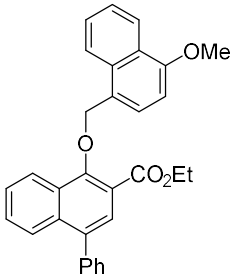
Result: 98% yield, white solid, Mp: 59–61 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.37 – 8.32 (m, 1H), 7.93 – 7.88 (m, 1H), 7.86 (s, 1H), 7.57 – 7.49 (m, 6H), 7.48 – 7.43 (m, 1H), 7.20 (s, 1H), 7.06 (dd, *J* = 7.9, 1.7 Hz, 1H), 6.88 (d, *J* = 7.9 Hz, 1H), 6.01 (s, 2H), 5.13 (s, 2H), 4.45 (q, *J* = 7.1 Hz, 2H), 1.41 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.1 , 155.9 , 147.8 , 147.6 , 139.8 , 136.2 , 134.8 , 131.0 , 130.1 , 129.0 , 128.3 , 128.3 , 127.4 , 126.4 , 126.3 , 124.0 , 122.1 , 119.5 , 109.1 , 108.2 , 101.1 , 77.6 , 61.2 , 14.4 .
HRMS (ESI) Calculated for $C_{27}H_{22}O_5$ ([M]+Na^+) = 449.1359, Found 49.1362.
IR (neat) 2981, 2355, 1720, 1616, 1444, 1369, 1350, 1275, 1151, 1038, 971, 864, 765, 667 cm^{-1}.

Ethyl 1-((2,3-dihydrobenzo[b][1,4]dioxin-6-yl)methoxy)-4-phenyl-2-naphthoate (A41)



Result: 93% yield, colorless oil.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.37 (m, 1H), 7.90 (m, 1H), 7.86 (s, 1H), 7.58 – 7.49 (m, 6H), 7.46 (m, 1H), 7.20 (d, *J* = 2.0 Hz, 1H), 7.11 (m, 1H), 6.95 (d, *J* = 8.2 Hz, 1H), 5.12 (s, 2H), 4.45 (q, *J* = 7.1 Hz, 2H), 4.30 (s, 4H), 1.42 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.2 , 155.9 , 143.6 , 143.5 , 139.8 , 136.1 , 134.8 , 130.4 , 130.1 , 129.0 , 128.3 , 128.2 , 127.4 , 127.4 , 126.3 , 126.2 , 124.0 , 121.6 , 119.5 , 117.5 , 117.3 , 64.4 , 64.3 , 61.2 , 14.4 .
HRMS (ESI) Calculated for $C_{28}H_{24}O_5$ ([M]+Na^+) = 463.1516, Found 463.1516.
IR (neat) 2979, 2875, 2343, 1720, 1617, 1569, 1434, 1355, 1249, 1021, 971, 887, 765, 603, 583 cm^{-1}.

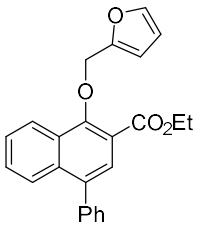
Ethyl 1-((4-methoxynaphthalen-1-yl)methoxy)-4-phenyl-2-naphthoate (A42)



Result: 55% yield, white solid, Mp: 41–43 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.40 – 8.35 (m, 2H), 8.26 (d, *J* = 8.1 Hz, 1H), 7.89 (d, *J* = 8.3 Hz, 1H), 7.86 (s, 1H), 7.66 – 7.61 (m, 1H), 7.57 (d, *J* = 7.9 Hz, 2H), 7.53 – 7.42 (m, 7H), 6.83 (d, *J* = 7.8 Hz, 1H), 5.64 (s, 2H), 4.37 (q, *J* = 7.1 Hz, 2H), 4.05 (s, 3H), 1.37 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.5 , 156.4 , 156.0 , 139.9 , 136.0 , 134.8 , 132.7 , 130.1 , 129.1 , 128.3 , 128.2 , 127.5 , 127.4 , 127.4 , 127.0 , 126.2 , 126.1 , 125.3 , 125.3 , 124.4 , 124.1 , 122.5 , 119.7 , 103.0 , 76.1 , 61.2 , 55.5 , 14.29 .

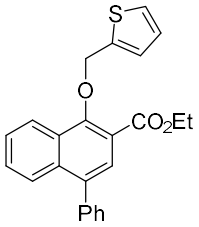
HRMS (ESI) Calculated for $C_{27}H_{22}O_5$ ([M]+Na^+) = 499.1359, Found 499.1362.
IR (neat) 2978, 2343, 1719, 1617, 1511, 1414, 1354, 1250, 1152, 1024, 996, 867, 766, 631, 585 cm^{-1}.

Ethyl 1-(furan-2-ylmethoxy)-4-phenyl-2-naphthoate (A43)



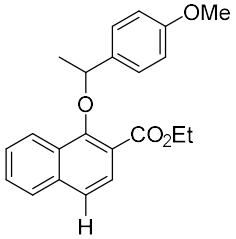
Result: 86% yield, white solid, Mp: 85–87 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.38 (d, *J* = 7.3 Hz, 1H), 7.90 (m, 1H), 7.87 (s, 1H), 7.60 – 7.53 (m, 2H), 7.51 (m, 4H), 7.48 – 7.44 (m, 1H), 7.41 (m, 1H), 7.22 (m, 1H), 7.07 (dd, *J* = 5.1, 3.5 Hz, 1H), 5.40 (s, 2H), 4.47 (q, *J* = 7.2 Hz, 2H), 1.44 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.1 , 155.5 , 139.7 , 139.2 , 136.5 , 134.8 , 130.1 , 129.0 , 128.3 , 127.6 , 127.5 , 127.4 , 126.8 , 126.7 , 126.4 , 126.2 , 124.0 , 119.5 , 71.9 , 61.3 , 14.4 .
HRMS (ESI) Calculated for $C_{24}H_{20}O_4$ ([M]+Na^+) = 395.1254, Found395.1250.
IR (neat) 2980, 2871, 2396, 1719, 1616, 1569, 1413, 1275, 1171, 1021, 971, 856, 761, 669, 581 cm^{-1}.

Ethyl 4-phenyl-1-(thiophen-2-ylmethoxy)-2-naphthoate (A44)



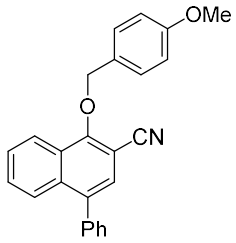
Result: 90% yield, white solid, Mp: 88–90 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.39 (m, 1H), 8.00 – 7.76 (m, 2H), 7.53 (m, 8H), 6.45 (d, *J* = 30.9 Hz, 2H), 5.21 (s, 2H), 4.46 (q, *J* = 7.2 Hz, 2H), 1.45 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.1 , 155.5 , 150.7 , 143.3 , 139.8 , 136.5 , 134.8 , 130.1 , 129.1 , 128.3 , 127.4 , 127.4 , 126.4 , 126.2 , 124.1 , 119.6 , 110.6 , 110.5 , 69.2 , 61.3 , 14.3 .
HRMS (ESI) Calculated for $C_{24}H_{20}O_3S$ ([M]+Na^+) = 411.1025, Found 411.1029.
IR (neat) 2981, 2354, 1720, 1616, 1568, 1413, 1383, 1275, 1152, 1017, 973, 884, 764, 601, 586 cm^{-1}.

Ethyl 1-(1-(4-methoxyphenyl)ethoxy)-2-naphthoate (A45)



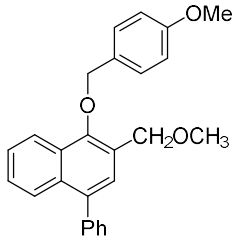
Result: 64% yield, colorless oil.
^{1}H NMR (600 MHz, Chloroform-*d*) δ 8.22 (d, *J* = 8.4 Hz, 1H), 7.90 – 7.68 (m, 2H), 7.56 (d, *J* = 8.6 Hz, 1H), 7.52 (t, *J* = 7.5 Hz, 1H), 7.47 – 7.42 (m, 1H), 7.31 (d, *J* = 8.7 Hz, 2H), 6.83 (d, *J* = 8.6 Hz, 2H), 5.28 (q, *J* = 6.4 Hz, 1H), 4.40 – 4.29 (m, 2H), 3.77 (s, 3H), 1.66 (d, *J* = 6.5 Hz, 3H), 1.36 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (151 MHz, Chloroform-*d*) δ 167.1 , 159.3 , 155.0 , 136.3 , 133.8 , 129.5 , 128.0 , 127.9 , 127.5 , 126.5 , 125.9 , 124.3 , 123.1 , 120.6 , 113.5 , 83.4 , 61.1 , 55.2 , 22.2 , 14.2 .
HRMS (ESI) Calculated for $C_{22}H_{22}O_4$ ([M]+Na^+) = 373.1410, Found 373.1408.
IR (neat) 2978, 1711, 1613, 1566, 1512, 1461, 1371, 1275, 1176, 1078, 1032, 930, 828, 767, 548 cm^{-1}.

1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthonitrile (A46)



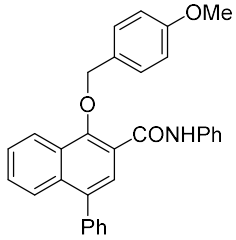
Result: 79% yield, white solid, Mp: 130–112 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.30 (dd, *J* = 6.5, 3.2 Hz, 1H), 7.88 (dd, *J* = 6.4, 3.4 Hz, 1H), 7.64 – 7.39 (m, 10H), 6.98 (d, *J* = 8.7 Hz, 2H), 5.44 (s, 2H), 3.85 (s, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 160.0 , 159.4 , 138.6 , 136.7 , 134.7 , 130.5 , 129.9 , 129.3 , 128.5 , 128.1 , 127.9 , 127.4 , 127.0 , 126.5 , 123.4 , 117.7 , 114.1 , 99.3 , 55.3 .
HRMS (ESI) Calculated for $C_{31}H_{25}NO_3$ ([M]+Na^+) = 482.1727, Found 482.1728.
IR (neat) 3058, 2835, 2223, 1612, 1514, 1411, 1357, 1275, 1169, 1033, 966, 857, 766, 687, 555 cm^{-1}.

1-((4-methoxybenzyl)oxy)-2-(methoxymethyl)-4-phenylnaphthalene (A47)



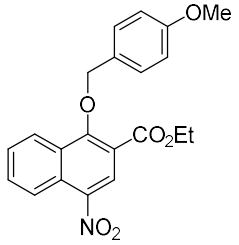
Result: 69% yield, white solid, Mp: 101-103 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.27 (d, *J* = 9.1 Hz, 1H), 7.93 (d, *J* = 8.4 Hz, 1H), 7.58 – 7.41 (m, 10H), 7.01 (d, *J* = 8.6 Hz, 2H), 5.07 (s, 2H), 4.69 (s, 2H), 3.87 (s, 3H), 3.45 (s, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 159.7 , 152.4 , 140.4 , 136.6 , 132.8 , 130.1 , 129.8 , 129.5 , 128.3 , 128.2 , 128.1 , 127.1 , 126.4 , 126.4 , 126.2 , 125.8 , 122.6 , 114.0 , 77.1 , 69.5 , 58.4 , 55.3 .
HRMS (ESI) Calculated for $C_{26}H_{24}O_3$ ([M]+Na^+) = 407.1618, Found 407.1624.
IR (neat) 2929, 2834, 2310, 1611, 1513, 1414, 1363, 1248, 1165, 1033, 972, 892, 764, 668, 569 cm^{-1}.

1-((4-methoxybenzyl)oxy)-N,4-diphenyl-2-naphthamide (A48)



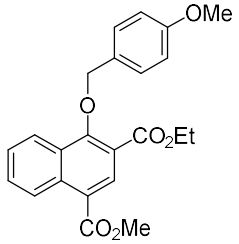
Result: 50% yield, white solid, Mp: 159–161 °C.
^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.97 (s, 1H), 8.40 (d, *J* = 7.6 Hz, 1H), 8.19 (s, 1H), 7.99 (d, *J* = 8.3 Hz, 1H), 7.65 (t, *J* = 7.0 Hz, 1H), 7.60 – 7.49 (m, 7H), 7.44 (m, 3H), 7.33 (t, *J* = 7.7 Hz, 2H), 7.15 – 7.10 (m, 1H), 6.92 (d, *J* = 8.4 Hz, 2H), 5.14 (s, 2H), 3.84 (s, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 163.4 , 160.2 , 153.0 , 139.6 , 138.3 , 137.4 , 134.8 , 130.5 , 130.1 , 128.9 , 128.3 , 128.1 , 128.1 , 127.6 , 127.5 , 126.7 , 126.6 , 124.0 , 123.2 , 122.3 , 119.8 , 114.2 , 78.8 , 55.3 .
HRMS (ESI) Calculated for $C_{31}H_{25}NO_3$ ([M]+Na^+) = 482.1727, Found 482.1728.
IR (neat) 3746, 3006, 2397, 1669, 1514, 1442, 1361, 1275, 1175, 1032, 957, 824, 763, 668, 565 cm^{-1}.

Ethyl 1-((4-methoxybenzyl)oxy)-4-nitro-2-naphthoate (A49)



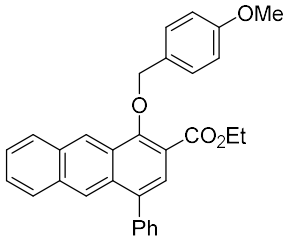
Result: 42% yield, yellow solid, Mp: 60-62 °C
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.78 (s, 1H), 8.64 (dd, *J* = 8.9, 4.1 Hz, 1H), 8.34 (d, *J* = 8.7 Hz, 1H), 7.83 – 7.77 (m, 1H), 7.66 – 7.60 (m, 1H), 7.43 (d, *J* = 8.6 Hz, 2H), 6.93 (d, *J* = 7.8 Hz, 2H), 5.20 (s, 2H), 4.47 (q, *J* = 7.1 Hz, 2H), 3.83 (s, 3H), 1.45 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 164.2 , 161.5 , 159.9 , 141.6 , 131.5 , 130.2 , 129.9 , 128.1 , 128.1 , 127.8 , 126.6 , 124.8 , 123.5 , 117.9 , 114.0 , 78.6 , 61.9 , 55.3 , 14.3 .
HRMS (ESI) Calculated for $C_{21}H_{19}NO_6$ ([M]+Na^+) = 404.1105, Found 404.1109.
IR (neat) 2981, 2837, 2282, 1725, 1613, 1515, 1415, 1272, 1174, 1031, 996, 859, 765, 686, 565 cm^{-1}.

3-Ethyl 1-methyl 4-((4-methoxybenzyl)oxy)naphthalene-1,3-dicarboxylate (A50)



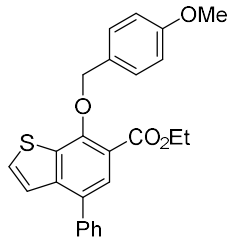
Result: 50% yield, white solid, Mp: 74-76 °C
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.98 (d, *J* = 8.4 Hz, 1H), 8.65 (s, 1H), 8.31 (d, *J* = 8.4 Hz, 1H), 7.70 (m, 1H), 7.58 – 7.53 (m, 1H), 7.45 (d, *J* = 8.6 Hz, 2H), 6.94 (d, *J* = 8.6 Hz, 2H), 5.15 (s, 2H), 4.45 (q, *J* = 7.2 Hz, 2H), 4.01 (s, 3H), 3.83 (s, 3H), 1.43 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 167.1 , 165.6 , 160.4 , 159.8 , 134.5 , 132.1 , 130.0 , 130.0 , 129.4 , 128.7 , 126.7 , 126.0 , 124.3 , 122.5 , 118.6 , 113.9 , 78.0 , 61.5 , 55.3 , 52.2 , 14.4 .
HRMS (ESI) Calculated for $C_{23}H_{22}O_6$ ([M]+Na^+) = 417.1309, Found 417.1310.
IR (neat) 2988, 2349, 1715, 1613, 1514, 1414, 1356, 1277, 1175, 1028, 963, 859, 793, 673, 560 cm^{-1}.

Ethyl 1-((4-methoxybenzyl)oxy)-4-phenylanthracene-2-carboxylate (A51)



Result: 82% yield, yellow solid, Mp: 79-81 °C
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.29 (m, 1H), 7.94 (m, 1H), 7.85 (d, *J* = 7.3 Hz, 1H), 7.78 (m, 2H), 7.58 (d, *J* = 8.4 Hz, 2H), 7.54 – 7.39 (m, 6H), 7.18 – 7.09 (m, 1H), 7.00 (d, *J* = 8.4 Hz, 2H), 5.18 (s, 2H), 4.46 (q, *J* = 7.0 Hz, 2H), 3.87 (s, 3H), 1.42 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.0 , 159.6 , 155.5 , 144.4 , 136.2 , 134.0 , 132.7 , 131.5 , 130.0 , 129.9 , 129.3 , 129.1 , 129.0 , 128.7 , 128.5 , 128.3 , 128.2 , 127.3 , 127.0 , 125.1 , 121.3 , 120.4 , 113.92 , 77.7 , 61.2 , 55.3 , 14.4 .
HRMS (ESI) Calculated for $C_{31}H_{26}O_4$ ([M]+Na^+) = 485.1723, Found 485.1724.
IR (neat) 2979, 2835, 1720, 1612, 1513, 1442, 1354, 1172, 1030, 967, 880, 789, 681, 565 cm^{-1}.

Ethyl 7-((4-methoxybenzyl)oxy)-4-phenylbenzo[b]thiophene-6-carboxylate (A52)



Result: 86% yield, white solid, Mp: 103-105 °C

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.90 (s, 1H), 7.58 (m, 3H), 7.56 – 7.46 (m, 5H), 7.42 (m, 1H), 6.97 (d, *J* = 8.6 Hz, 2H), 5.24 (s, 2H), 4.45 (q, *J* = 7.1 Hz, 2H), 3.85 (s, 3H), 1.42 (t, *J* = 7.1 Hz, 3H).

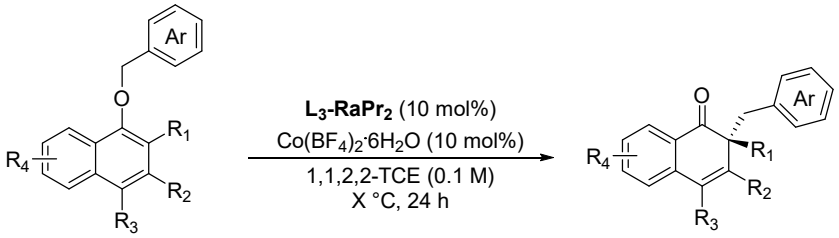
^{13}C NMR (101 MHz, Chloroform-*d*) δ 165.9 , 159.6 , 153.6 , 142.5 , 139.8 , 135.8 , 133.3 , 130.2 , 129.2 , 129.0 , 128.6 , 128.0 , 127.5 , 123.9 , 119.1 , 113.8 , 76.2 , 61.1 , 55.3 , 14.4 .

HRMS (ESI) Calculated for $C_{25}H_{22}O_4S$ ([M]+Na^+) = 411.1131, Found 411.1142.

IR (neat) 2983, 2835, 2397, 1715, 1612, 1514, 1440, 1372, 1274, 1175, 1037, 955, 861, 798, 669, 559 cm^{-1}.

3. General Procedure for the Catalytic Asymmetric dearomatization

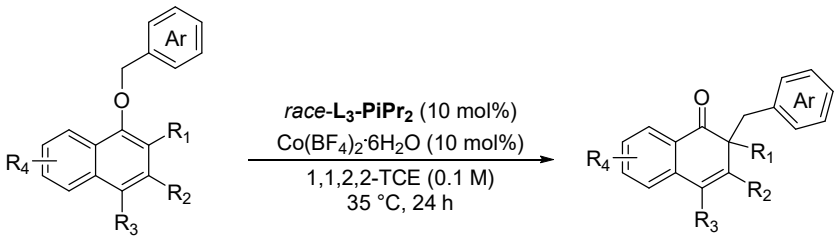
3.1 General procedure for the catalytic asymmetric synthesis



A **B**

A dry reaction tube was charged with **L_3-RaPr$_2$** (7.0 mg, 10 mol%) and $Co(BF_4)_2·6H_2O$ (3.4 mg, 10 mol%) followed by the addition of 1,1,2,2-TCE (1.0 mL). The mixture was stirred at 35 °C for 60 min followed by addition of the substrate **A** (0.1 mmol). The reaction mixture was stirred at indicated temperature for 24 h. The reaction mixture was subjected to column chromatography on silica gel and eluted with petroleum ether/ethyl acetate (20/1 and 10/1, v/v) to afford the corresponding products **B**.

3.2 General procedure for the preparation of the racemic products

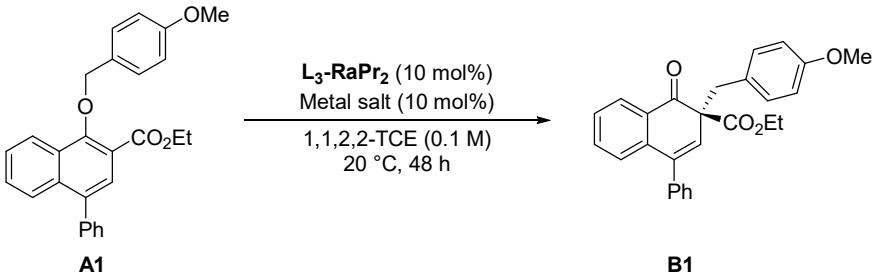


A **B**

A dry reaction tube was charged with *rac*-**L_3-PiPr$_2$** (6.5 mg, 10 mol%), $Co(BF_4)_2·6H_2O$ (3.4 mg, 10 mol%) and substrates **A** (0.1 mmol) followed by the addition of 1,1,2,2-TCE (1.0 mL). The mixture was stirred at 35 °C for 24 h. The reaction mixture was subjected to column chromatography on silica gel and eluted with petroleum ether/ethyl acetate (20/1 and 10/1, v/v) to afford the corresponding racemic products **B**.

4. Optimization of Reaction Conditions

Table S1. Screening of metal salts.

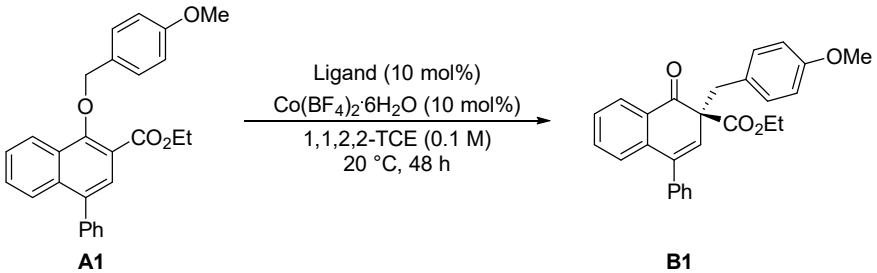


A1 **B1**

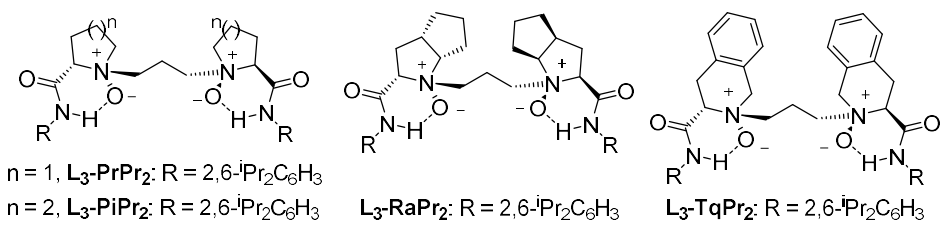
Entry[a]	Metal salt	Yield [%][b]	Ee [%][c]
1	$Cu(OTf)_2$	41	17
2	$Zn(OTf)_2$	35	98
3	$Al(OTf)_3$	Decomposed	--
4	$Ln(OTf)_3$	17	19
5	$Co(OTf)_2$	71	96
6	$Mg(OTf)_2$	69	99
7	$Ni(OTf)_2$	70	96
8	$Fe(OTf)_2$	N.R.	--
9	$Co(BF_4)_2{\cdot}6H_2O$	75	98

[a] Unless otherwise noted, all reactions were carried out with **A1** (0.1 mmol), **L3-RaPr2**/Metal salt (1:1, 10 mol %) in 1,1,2,2-TCE (0.1 M) at 20 ℃ for 48 h. [b] Yield of isolated product. [c] Determined by SFC analysis on a chiral stationary phase. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane. N.R. = No Reaction.

Table S2. Screening of chiral *N,N′*-dioxide ligands.



A1 **B1**

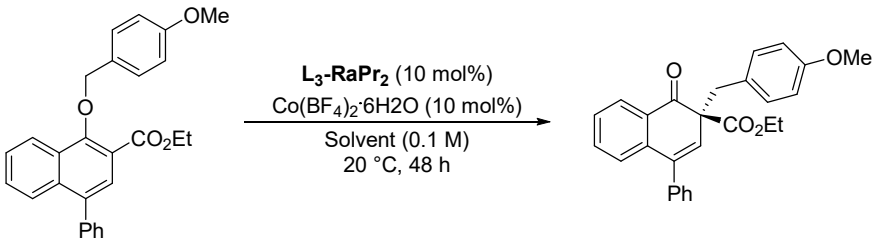


Entry[a]	Ligand	Yield [%][b]	Ee [%][c]

1	**L_3-PiPr$_2$**	65	97
2	**L_3-PrPr$_2$**	50	99
3	**L_3-RaPr$_2$**	75	98
4	**L_3-TqPr$_2$**	60	98

[a] Unless otherwise noted, all reactions were carried out with **A1** (0.1 mmol), **ligand**/$Co(BF_4)_2{\cdot}6H_2O$ (1:1, 10 mol %) in 1,1,2,2-TCE (0.1 M) at 20 °C for 48 h. [b] Yield of isolated product. [c] Determined by SFC analysis on a chiral stationary phase. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane.

Table S3. Screening of the solvent.

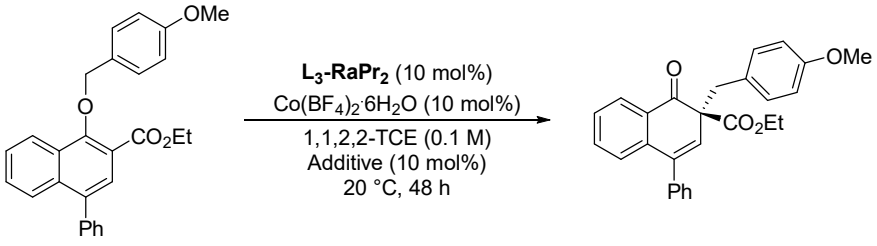


A1 **B1**

Entry[a]	Metal salt	Yield [%][b]	Ee [%][c]
1	1,1,2,2-TCE	75	98
2	DCM	69	97
3	DCE	64	97
4	$CHCl_3$	16	95
5	THF	N.R.	--
6	CH_3CN	44	67
7	$PhCH_3$	N.R.	--

[a] Unless otherwise noted, all reactions were carried out with **A1** (0.1 mmol), **L_3-RaPr$_2$**/$Co(BF_4)_2{\cdot}6H_2O$ (1:1, 10 mol %) in solvent (0.1 M) at 20 °C for 48 h. [b] Yield of isolated product. [c] Determined by SFC analysis on a chiral stationary phase. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane, DCM = Dichloromethane, DCE = 1,2-Dichloroethane, THF = Tetrahydrofuran, $PhCH_3$ = Toluene. N.R. = No Reaction.

Table S4. Screening of the additive.



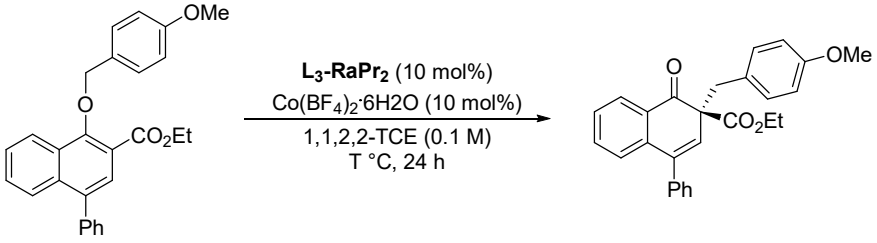
A1 **B1**

Entry[a]	Additive	Yield [%][b]	Ee [%][c]
1	--	75	98

2	H_2O (1.0 equiv.)	56	98
3	4Å MS (20 mg)	70	94
4	$NaBAr^F_4$	37	89
5	K_2CO_3 (20 mol%)	N.R.	--
6	$PhCO_2H$	72	98
7	DMAP	62	98

[a] Unless otherwise noted, all reactions were carried out with **A1** (0.1 mmol), **L_3-RaPr$_2$**/$Co(BF_4)_2{\cdot}6H_2O$ (1:1, 10 mol %) in 1,1,2,2-TCE (0.1 M) at 20 ℃ for 48 h. [b] Yield of isolated product. [c] Determined by SFC analysis on a chiral stationary phase. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane. N.R. = No Reaction.

Table S5. Screening of temperature.

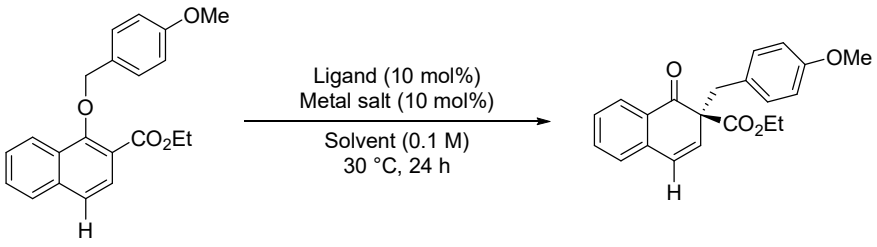


A1 **B1**

Entry[a]	T / ºC	Yield [%][b]	Ee [%][c]
1[d]	20	75	98
2	30	80	98
3	35	73	95
4	40	68	94
5[e]	30	69	98
6[f]	30	7	0

[a] Unless otherwise noted, all reactions were carried out with **A1** (0.1 mmol), **L_3-RaPr$_2$**/$Co(BF_4)_2{\cdot}6H_2O$ (1:1, 10 mol %) in 1,1,2,2-TCE (0.1 M) at 20 ℃ for 48 h. [b] Yield of isolated product. [c] Determined by SFC analysis on a chiral stationary phase. [d] Reaction was performed at 20 ℃ for 48 h. [e] **L_3-RaPr$_2$**/ $Co(BF_4)_2{\cdot}6H_2O$ (1:1, 5 mol %). [f] without **L_3-RaPr$_2$**. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane.

Table S6. Investigation of reaction conditions for B10.



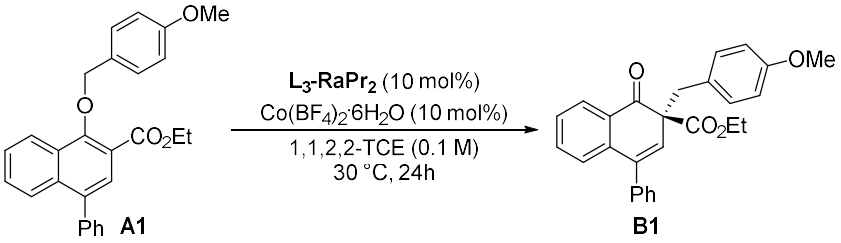
A10 **B10**

Entry[a]	Ligand	Metal salt	Solvent	Yield [%][b]	Ee [%][c]

1	**L_3-RaPr$_2$**	$Co(BF_4)_2{\cdot}6H_2O$	1,1,2,2-TCE	66	98
2	**L_3-RaPr$_2$**	$Mg(OTf)_2$	1,1,2,2-TCE	39	94
3	**L_3-RaPr$_2$**	$Zn(OTf)_2$	1,1,2,2-TCE	57	95
4	**L_3-RaPr$_2$**	$Ni(OTf)_2$	1,1,2,2-TCE	25	95
5	**L_3-PrPr$_2$**	$Co(BF_4)_2{\cdot}6H_2O$	1,1,2,2-TCE	52	91
6	**L_3-PiPr$_2$**	$Co(BF_4)_2{\cdot}6H_2O$	1,1,2,2-TCE	45	97
7	**L_3-RaPr$_2$**	$Co(BF_4)_2{\cdot}6H_2O$	DCM	53	98
8[d]	**L_3-RaPr$_2$**	$Co(BF_4)_2{\cdot}6H_2O$	1,1,2,2-TCE	63	98
9[e]	**L_3-RaPr$_2$**	$Co(BF_4)_2{\cdot}6H_2O$	1,1,2,2-TCE	43	96

[a] Unless otherwise noted, all reactions were carried out with **A10** (0.1 mmol), Ligand/Metal salt (1:1, 10 mol %) in solvent (0.1 M) at 30 ℃ for 24 h. [b] Yield of isolated product. [c] Determined by SFC analysis on a chiral stationary phase. [d] Reaction was performed at 20 ℃ for 48 h. [e] Reaction was performed at 40 ℃ for 24 h. 1,1,2,2-TCE = 1,1,2,2-Tetrachloroethane, DCM = Dichloromethane.

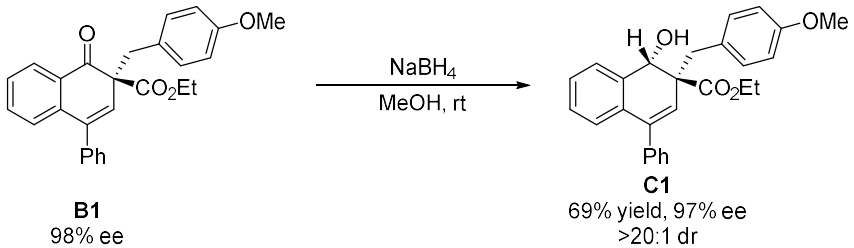
5. Gram-Scale Synthesis of the Product B1



An oven dried round-bottom flask (100 mL) was charged with **L_3-RaPr$_2$** (280.4 mg, 10 mol%) and $Co(BF_4)_2{\cdot}6H_2O$ (136.0 mg, 10 mol%) followed by the addition of 1,1,2,2-TCE (40.0 mL). The mixture was stirred at 35 °C for 60 min followed by addition of the substrate **A1** (1.648 g, 4.0 mmol). The reaction mixture was stirred at 30 °C for 24 h. The reaction mixture was subjected to column chromatography on silica gel and eluted with petroleum ether/ethyl acetate (20/1 and 10/1, v/v) to afford the corresponding product **B1** (1.318 g, 80% yield, 98% ee).

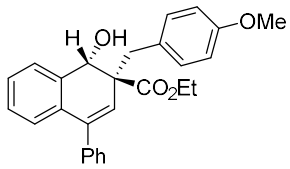
6. Synthetic Transformation

6.1 Experimental procedure for the synthesis of C1



To a solution of **B1** (41.2 mg, 0.1 mmol, 98% ee) in anhydrous MeOH (2 mL) was added $NaBH_4$ (0.12 mmol, 1.2 equiv), and the reaction was then stirred at room temperature. After the reaction was complete (monitored by TLC), the reaction was quenched with H_2O, and extracted with dichloromethane. The organic layers were combined and dried over Na_2SO_4, filtered and concentrated by rotary evaporation. Then the residue was purified by silica gel column chromatography (petroleum

ether /ethyl acetate = 8/1) to afford product **C1** (28.5 mg, 69% yield, 97% ee, >20:1 dr). The absolute configuration of **C1** was determined by NOESY NMR spectra.



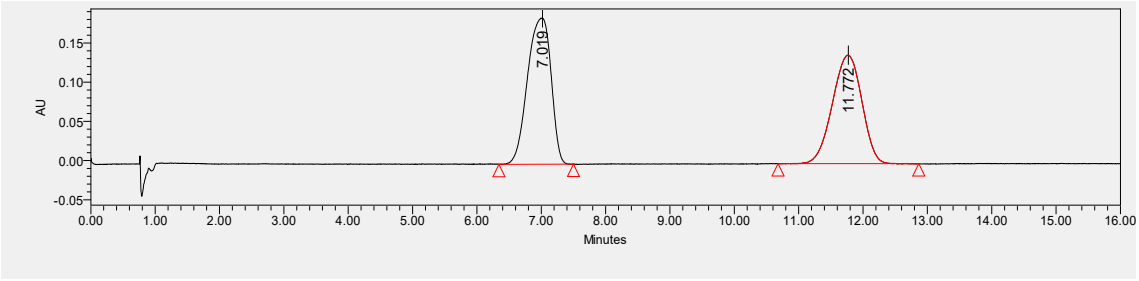
Result: colorless oil, 69% yield, 97% *ee*, >19:1 dr; $[\alpha]^{24.8}$ = -191.3 (*c* = 0.49 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 6.97 min, t_2 = 11.72 min.

^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.75 (d, *J* = 7.6 Hz, 1H), 7.42 – 7.34 (m, 6H), 7.21 (t, *J* = 7.5 Hz, 1H), 7.04 (m, 3H), 6.79 (d, *J* = 8.3 Hz, 2H), 6.01 (s, 1H), 5.27 (s, 1H), 4.13 (q, *J* = 7.1 Hz, 2H), 4.04 (s, 1H), 3.79 (s, 3H), 3.21 (d, *J* = 13.6 Hz, 1H), 2.83 (d, *J* = 13.6 Hz, 1H), 1.15 (t, *J* = 7.1 Hz, 3H).

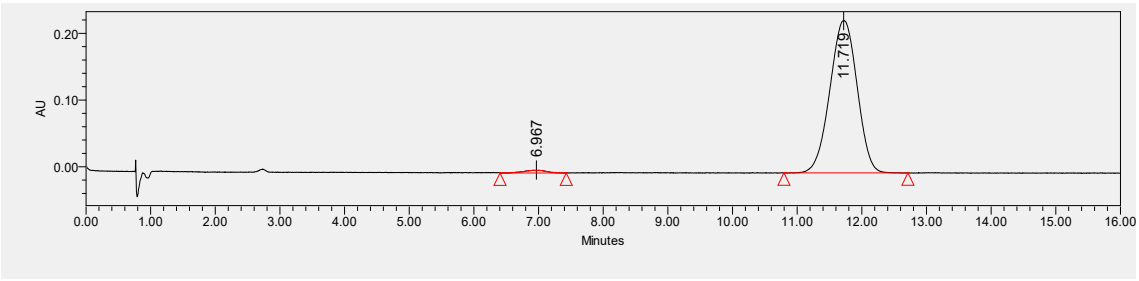
^{13}C NMR (151 MHz, Chloroform-*d*) δ 175.9 , 158.3 , 139.6 , 139.1 , 136.3 , 132.3 , 131.2 , 129.0 , 128.7 , 128.3 , 127.7 , 127.3 , 127.2 , 125.7 , 125.4 , 113.2 , 71.9 , 61.5 , 55.2 , 53.4 , 35.4 , 14.0.

HRMS (ESI) Calculated for $C_{27}H_{26}O_4$ ([M]+Na$^+$) = 437.1723, Found 437.1723.

IR (neat) 3501, 2931, 1702, 1611, 1511, 1446, 1247, 1111, 1035, 833, 771, 703, 553 cm^{-1}.

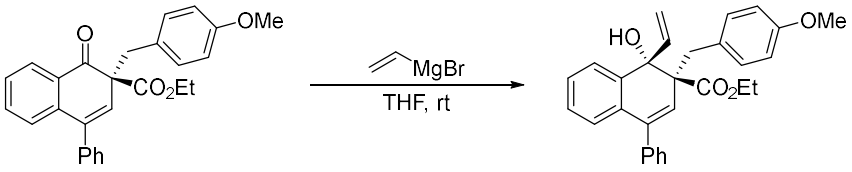


	Retention Time	Area	% Area
1	7.019	4741634	51.91
2	11.772	4392483	48.09



	Retention Time	Area	% Area
1	6.967	102665	1.52
2	11.719	6673271	98.48

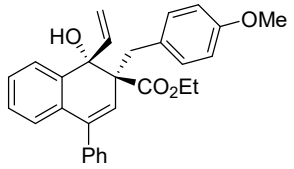
6.2 Experimental procedure for the synthesis of C2



B1
98% ee

C2
90% yield, 98% ee
>20:1 dr

To a solution of **B1** (41.2 mg, 0.1 mmol, 98% ee) in THF (2 mL) was added vinyl magnesium bromide (0.15 mmol, 1.5 equiv) slowly, and the reaction was then stirred at room temperature. After the reaction was complete (monitored by TLC), the reaction was quenched with saturated aqueous $NaHCO_3$, and extracted with dichloromethane. The organic layers were combined and dried over Na_2SO_4, filtered and concentrated by rotary evaporation. Then the residue was purified by silica gel column chromatography (petroleum ether /ethyl acetate = 8/1) to afford product **C2** (3965 mg, 90% yield, 98% ee, >20:1 dr). The absolute configuration of **C2** was determined by NOESY NMR spectra.



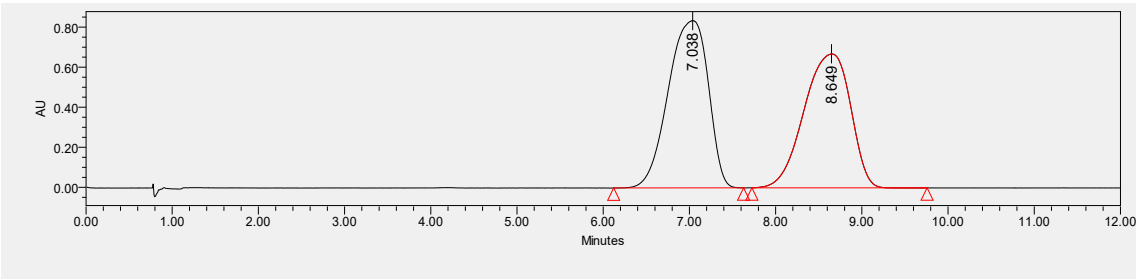
Result: colorless oil, 90% yield, 98% *ee*, >19:1 dr; $[\alpha]^{25.4}$ = -338.5 (*c* = 0.79 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 95/5, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 7.09 min, t_2 = 8.63 min.

^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.75 (d, *J* = 7.6 Hz, 1H), 7.43 – 7.36 (m, 6H), 7.23 (t, *J* = 7.7 Hz, 1H), 7.11 (d, *J* = 7.8 Hz, 1H), 7.00 (d, *J* = 8.6 Hz, 2H), 6.82 (d, *J* = 8.6 Hz, 2H), 6.41 (dd, *J* = 17.0, 10.5 Hz, 1H), 6.04 (s, 1H), 5.46 (d, *J* = 17.0 Hz, 1H), 5.02 (d, *J* = 10.5 Hz, 1H), 4.43 (s, 1H), 4.15 (q, *J* = 7.1 Hz, 2H), 3.81 (s, 3H), 3.45 (d, *J* = 13.3 Hz, 1H), 2.85 (d, *J* = 13.4 Hz, 1H), 1.17 (t, *J* = 7.2 Hz, 3H).

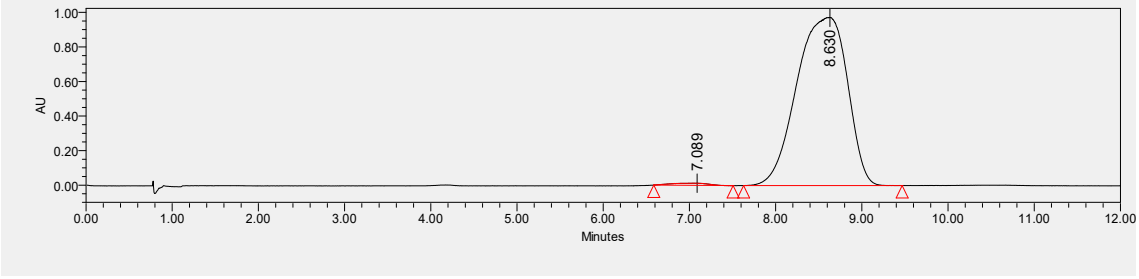
^{13}C NMR (151 MHz, Chloroform-*d*) δ 175.2 , 158.4 , 139.7 , 138.3 , 138.2 , 131.8 , 131.0 , 129.1 , 128.9 , 128.5 , 128.4 , 128.0 , 127.7 , 127.2 , 126.0 , 124.7 , 113.5 , 113.3 , 78.0 , 61.5 , 57.0 , 55.2 , 37.7 , 14.1.

HRMS (ESI) Calculated for $C_{29}H_{28}O_4$ ([M]+Na^+) = 463.1880, Found 463.1881.

IR (neat) 2984, 2361, 1699, 1611, 1511, 1445, 1249, 1179, 1038, 922, 838, 761, 702 cm^{-1}.

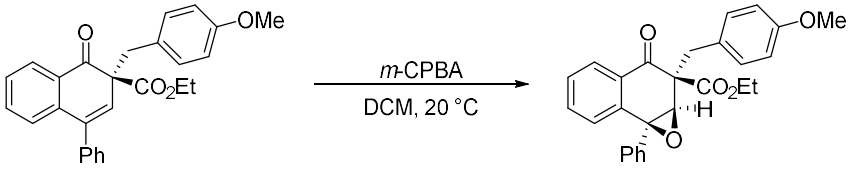


	Retention Time	Area	% Area
1	7.038	26998563	51.93
2	8.649	24988696	48.07



	Retention Time	Area	% Area
1	7.089	366663	0.91
2	8.630	39774999	99.09

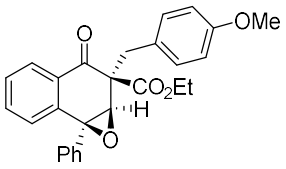
6.3 Experimental procedure for the synthesis of C3



B1
98% ee

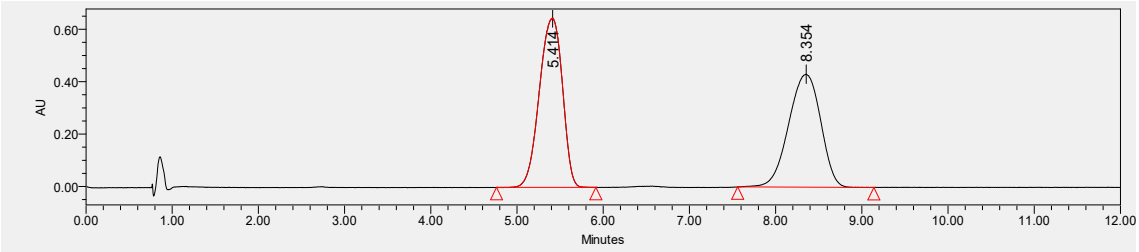
C3
77% yield, 97% ee
>20:1 dr

To a solution of **B1** (41.2 mg, 0.1 mmol, 98% ee) in DCM (1 mL) was added *m*-CPBA (0.20 mmol, 2.0 equiv) slowly, and the reaction was then stirred at 20 ºC. After the reaction was complete (monitored by TLC), the reaction was quenched with aqueous K_2CO_3, and extracted with dichloromethane. The organic layers were combined and dried over Na_2SO_4, filtered and concentrated by rotary evaporation. Then the residue was purified by silica gel column chromatography (petroleum ether /ethyl acetate = 8/1) to afford product **C3** (32.9 mg, 77% yield, 97% ee, >20:1 dr). The absolute configuration of **C3** was determined by NOESY NMR spectra.

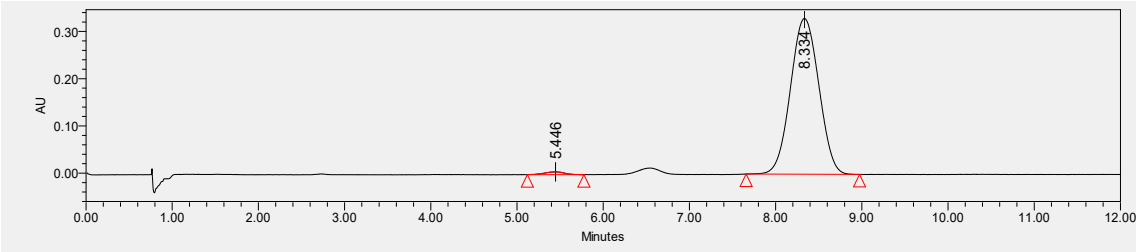


Result: colorless oil, 77% yield, 97% *ee*, >19:1 dr; $[\alpha]^{25.6}$ = -48.8 (*c* = 0.66 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 5.45 min, t_2 = 8.33 min.

^{1}H NMR (600 MHz, Chloroform-*d*) δ 8.02 – 7.91 (m, 1H), 7.54 (s, 2H), 7.45 – 7.38 (m, 5H), 7.22 (d, *J* = 8.6 Hz, 2H), 7.08 – 7.05 (m, 1H), 6.81 (d, *J* = 8.6 Hz, 2H), 4.11 (m, 2H), 3.98 (d, *J* = 14.1 Hz, 1H), 3.86 (s, 1H), 3.76 (s, 3H), 3.23 (d, *J* = 14.1 Hz, 1H), 1.14 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (151 MHz, Chloroform-*d*) δ 190.6 , 167.7 , 158.6 , 141.0 , 136.3 , 133.2 , 131.5 , 131.3 , 129.9 , 129.0 , 128.6 , 128.4 , 127.9 , 127.6 , 113.9 , 62.1 , 62.1 , 61.4 , 60.2 , 55.1 , 36.9 , 14.0.
HRMS (ESI) Calculated for $C_{27}H_{24}O_5$ ([M]+Na^+) = 451.1516, Found 451.1520.
IR (neat) 2983, 1736, 1609, 1512, 1460, 1250, 1109, 1033, 917, 855, 762, 571, 526 cm^{-1}.



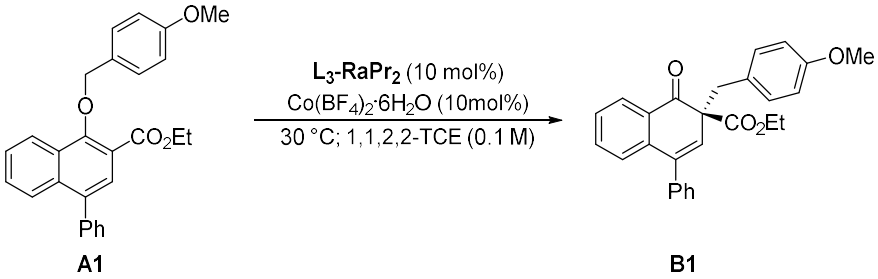
	Retention Time	Area	% Area
1	5.414	11998618	51.88
2	8.354	11130230	48.12



	Retention Time	Area	% Area
1	5.446	93820	1.23
2	8.334	7541601	98.77

7. Kinetic Studies

Procedure of react IR experiment for kinetic studies of **A1** and **L3-RaPr2**/$Co(BF_4)_2 \cdot 6H_2O$ catalyst. Kinetic analysis was performed using in situ attenuated total reflectance Fouriertransform infrared (ATR FTIR) spectroscopy to track the consumption of the reactant **A1** under synthetically relevant conditions. A Mettler Toledo SW License iC IR 701L instrument was treated as main experiment equipment. All the kinetic experiments on each plot were performed using a single batch of reagents.



A1 **B1**

First, the infrared absorption spectra of each reactant **A1** and product **B1** in 1,1,2,2-TCE were collected. The following figure shows the absorption of each participant minus the absorption of solvent. Peak at 1359 cm^{-1} was identified as the characteristic absorption of substrate **A1**. Then **L3-RaPr2** and $Co(BF_4)_2 \cdot 6H_2O$ were added to the test tube and dissolved in 1,1,2,2-TCE (3.0 mL), the mixture was stirred at 35 °C for 60 min. Finally, **A1** (dissolved in 1,1,2,2-TCE (2.0 mL)) was added to the test tube. The reaction mixture was allowed to stir at 30 °C. Reaction progression was monitored by the decreasing absorbance of **A1** at 1359 cm^{-1}.

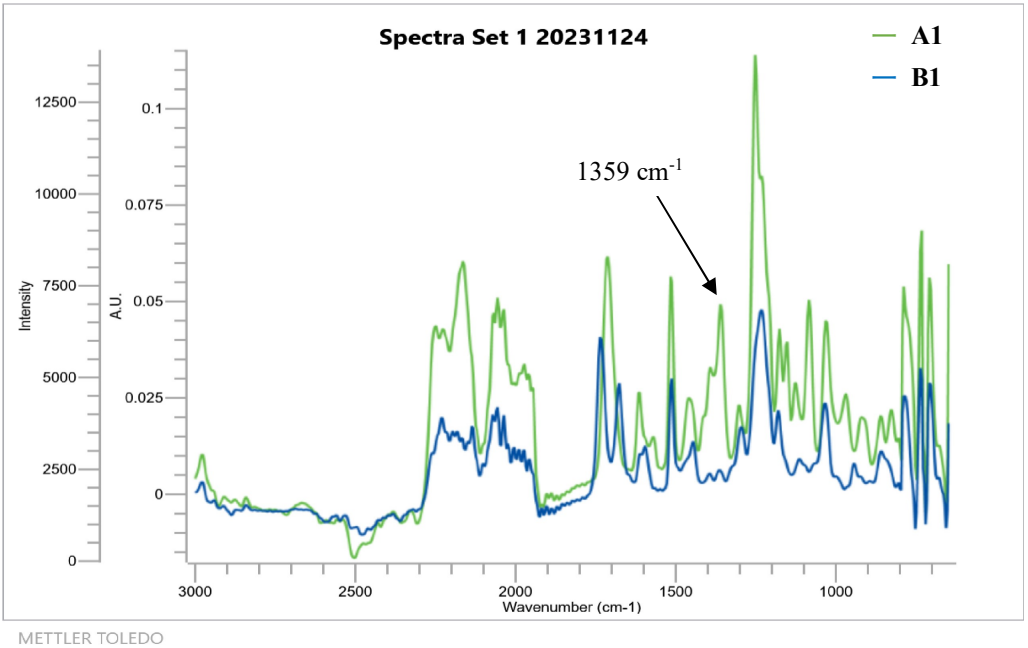
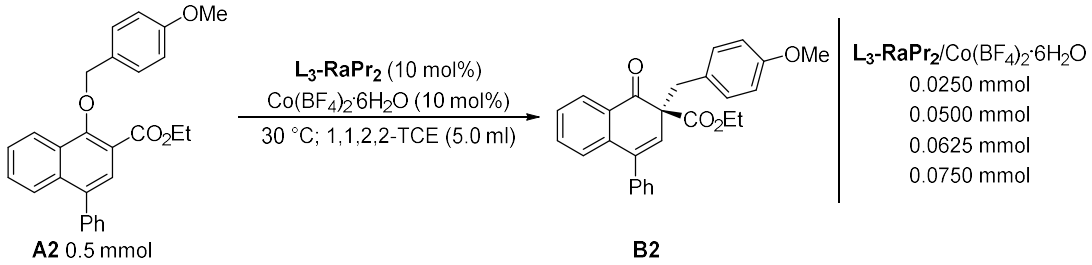


Figure S1. Absorption spectra of **A1** and **B1** in 1,1,2,2-TCE

7.1 Dependence of the reaction rate on concentration of L_3-$RaPr_2$/$Co(BF_4)_2{\cdot}6H_2O$ catalyst.



Kinetic profiles of different initial concentration of **L_3-$RaPr_2$**/$Co(BF_4)_2{\cdot}6H_2O$ (from 0.005 M to 0.015 M), The plot of k_{obs} vs **L_3-$RaPr_2$**/$Co(BF_4)_2{\cdot}6H_2O$ displayed a liner relationship, which indicates a first-order kinetic dependence in **L_3-$RaPr_2$**/$Co(BF_4)_2{\cdot}6H_2O$.

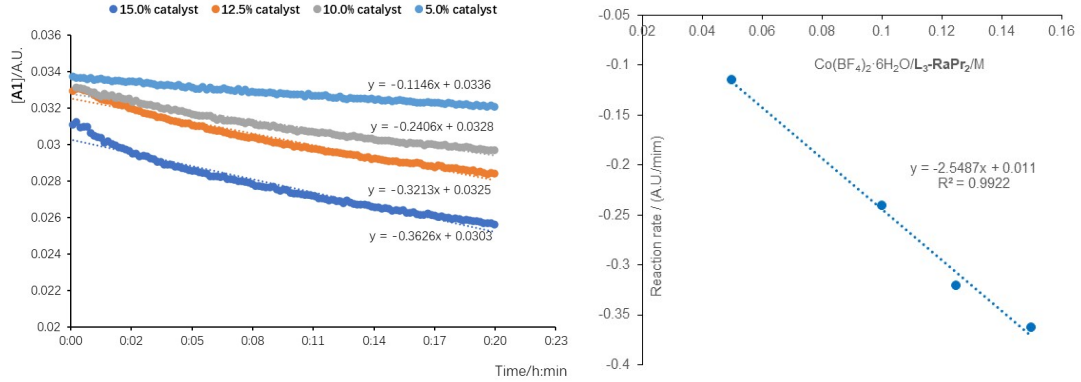
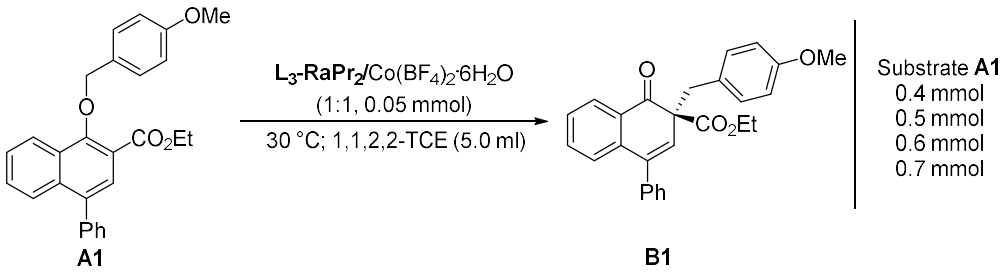


Figure S2. Dependence of the reaction rate on concentration of **L_3-$RaPr_2$**/$Co(BF_4)_2{\cdot}6H_2O$ catalyst

7.2 Dependence of the reaction rate on concentration of A1.



Kinetic profiles of different initial concentration of **A1** (from 0.08 M to 0.14 M), The plot of k_{obs} vs **A1** displayed a liner relationship, which indicates a first-order kinetic dependence in **A1**.

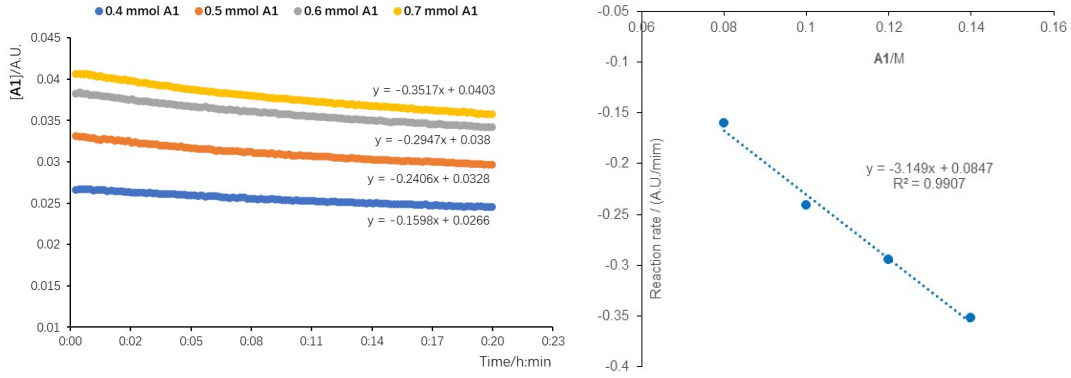
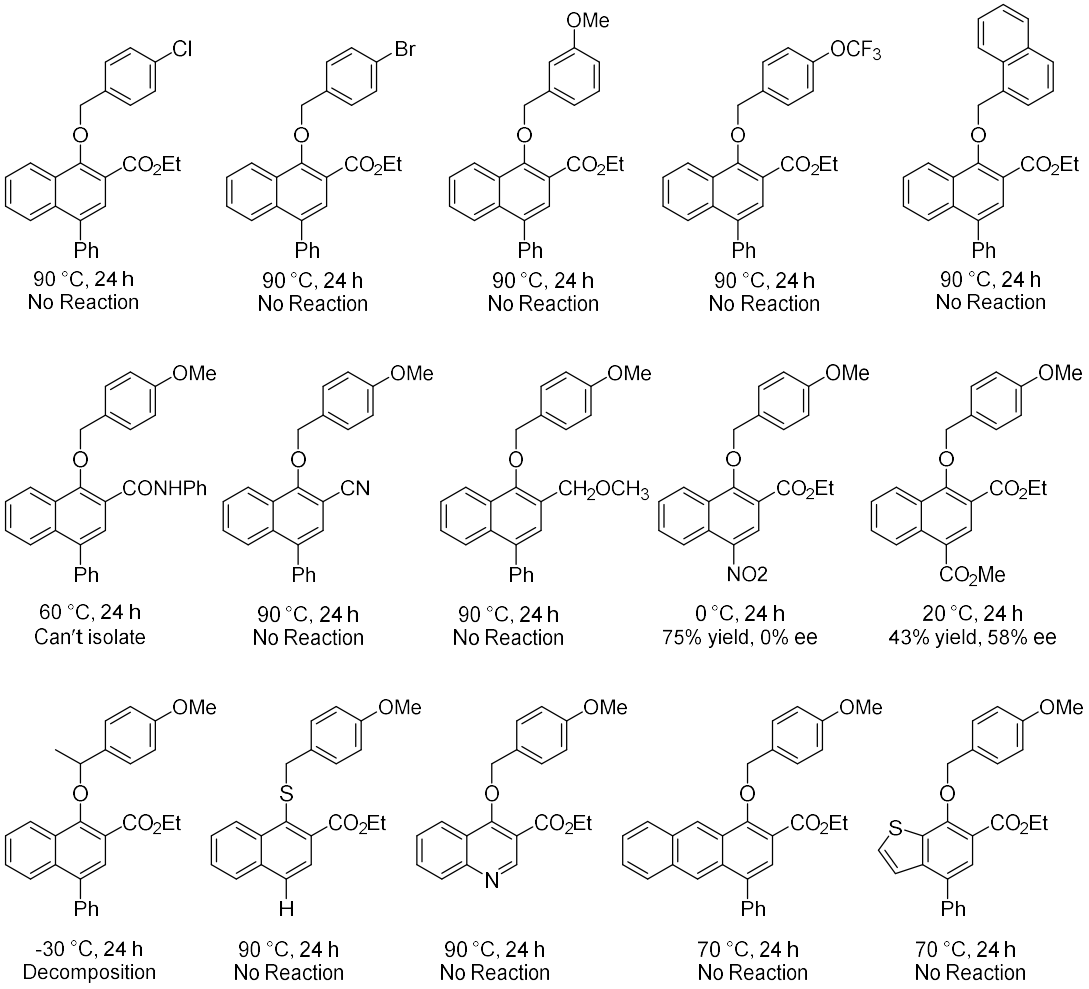


Figure S3. Dependence of the reaction rate on concentration of substrate **A1**

8. Unsuccessful Substrates



9. X-ray Crystal Structures of Product B10 and $Co(BF_4)_2 \cdot 6H_2O/L_3$-$RaPr_2$ Complex

The structure of product **B10** was determined by X-ray chromatography analysis. A single crystal of **B10** was obtained by recrystallization in dichloromethane and petroleum ether at 0 ºC. The crystal data and further details are listed in **Table S7**. CCDC 2283651 contains the supplementary crystallographic data for this paper. These data are provided free of charge by The Cambridge Crystallographic Data Centre.

The colourless crystal in block-shape, with approximate dimensions of 0.224 × 0.336 × 0.495 mm^3, was selected and mounted for the single-crystal X-ray diffraction. The data set was collected by Bruker D8 Venture Photon II diffractometer at 173(2)K equipped with micro-focus Cu radiation source (K_α = 1.54178Å). Applied with face-indexed numerical absorption correction, the structure solution was solved and refinement was processed by SHELXTL (version 6.14) and OLEX 2.3 program package[a, b, c, d]. The structure was analyzed by ADDSYM routine implemented in PLATON suite and no higher symmetry was suggested[e].

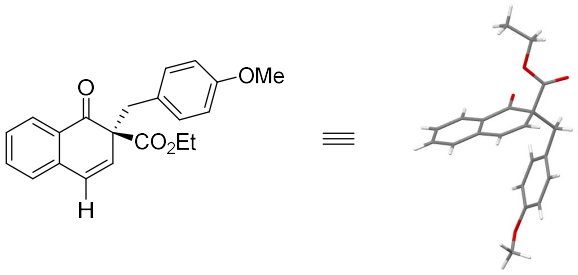


Table S7. Crystallographic Data for $C_{21}H_{20}O_4$ (**B10**).

Formula	$C_{21}H_{20}O_4$
Formula mass (amu)	446.52
Space group	P 21 21 21
a (Å)	8.5423 (2)
b (Å)	12.3659 (2)
c (Å)	16.7686 (3)
α (deg)	90
β (deg)	90
γ (deg)	90
V (Å^3)	1771.32 (6)
Z	4
λ (Å)	1.54178
T (K)	173 K
ρ_{calcd} (g cm^{-3})	1.261
μ (mm^{-1})	0.704
Transmission factors	0.790, 0.928
$2\theta_{max}$ (deg)	68.281
No. of unique data, including $F_o^2 < 0$	3236
No. of unique data, with $F_o^2 > 2\sigma(F_o^2)$	3169
No. of variables	229
$R(F)$ for $F_o^2 > 2\sigma(F_o^2)$ [a]	0.0267
$R_w(F_o^2)$ [b]	0.0705
Goodness of fit	1.030

[a] $R(F) = \sum||F_o| - |F_c|| / \sum|F_o|$.

[b] $R_w(F_o^2) = [\sum[w(F_o^2 - F_c^2)^2] / \sum wF_o^4]^{1/2}$; $w^{-1} = [\sigma^2(F_o^2) + (Ap)^2 + Bp]$, where $p = [\max(F_o^2,0) + 2F_c^2] / 3$.

The structure of $Co(BF_4)_2 \cdot 6H_2O$/**L$_3$-RaPr$_2$** was obtained from its solution in tetrahydrofuran and petroleum ether. The crystal data and further details are listed in **Table S8**. CCDC 2334140 contains the supplementary crystallographic data for this paper. These data are provided free of charge by The Cambridge Crystallographic Data Centre.

The pink crystal in block-shape, with approximate dimensions of 0.406 × 0.758 × 0.792 mm^3, was selected and mounted for the single-crystal X-ray diffraction. The data set was collected by Bruker D8 Venture Photon II diffractometer at 173(2)K equipped with micro-focus Mo radiation source (Kα = 0.71073Å). Applied with face-indexed numerical absorption correction, the structure solution was solved and refinement was processed by SHELXTL (version 6.14) and OLEX 2.3 program package[a, b, c, d]. The value observed herein is indicative of racemic twinning and was accommodated during the refinement (using the SHELXL TWIN instruction). In this case, the relatively large standard uncertainty indicates that the structural data alone should not be used to confirm absolute stereochemistry, but should be used in conjunction with the established stereochemistry of the precursor compound. The structure was analyzed by ADDSYM routine implemented in PLATON suite and no higher symmetry was suggested[e].

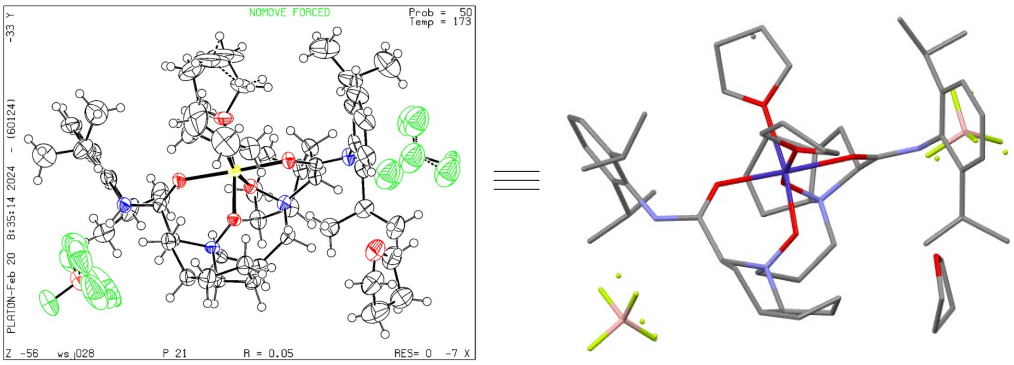


Table S8. Crystallographic Data for $C_{55}H_{88}B_2CoF_8N_4O_7$.

Formula	$C_{55}H_{88}B_2CoF_8N_4O_7$
Formula mass (amu)	1149.84
Space group	P 21
a (Å)	12.6042 (2)
b (Å)	16.7477 (2)
c (Å)	13.9724 (3)
α (deg)	90
β (deg)	90.008 (1)
γ (deg)	90
V (Å^3)	2949.45 (13)
Z	2
λ (Å)	0.71073
T (K)	173 K
ρ_{calcd} (g cm^{-3})	1.295
μ (mm^{-1})	0.368
Transmission factors	0.662, 0.745
$2\theta_{max}$ (deg)	25.376
No. of unique data, including $F_o^2 < 0$	10767
No. of unique data, with $F_o^2 > 2\sigma(F_o^2)$	9937
No. of variables	741
$R(F)$ for $F_o^2 > 2\sigma(F_o^2)$ [a]	0.0453
$R_w(F_o^2)$ [b]	0.1184
Goodness of fit	1.035

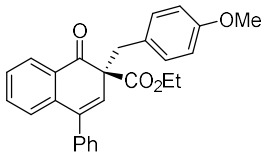
[a] $R(F) = \sum||F_o| - |F_c|| / \sum|F_o|$.
[b] $R_w(F_o^2) = [\sum[w(F_o^2 - F_c^2)^2] / \sum wF_o^4]^{1/2}$; $w^{-1} = [\sigma^2(F_o^2) + (Ap)^2 + Bp]$, where $p = [\max(F_o^2,0) + 2F_c^2] / 3$.

References:

[a] Sheldrick, G. M. *Acta Cryst.* **2008**, *A64*, 112–122.
[b] Sheldrick, G. M. *Acta Cryst.* **2015**, *A71*, 3–8.
[c] Sheldrick, G. M. *Acta Cryst*. **2015**, *C71*, 3–8.
[d] Dolomanov, O.V., Bourhis, L.J., Gildea, R.J., Howard, J. A. K., Puschmann, H. *J. Appl. Cryst*. **2009**, *42*, 339-341.
[e] Spek, A. L. *J. Appl. Cryst.* **2003**, *36*, 7–13.

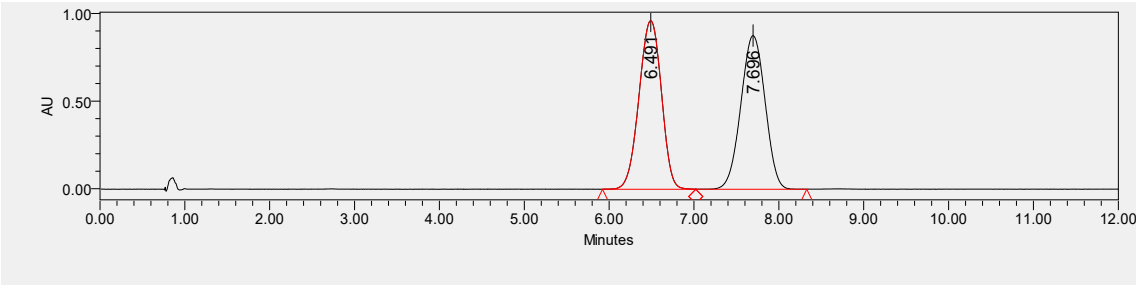
10. Spectral Characterization Data for the Products

Ethyl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B1)

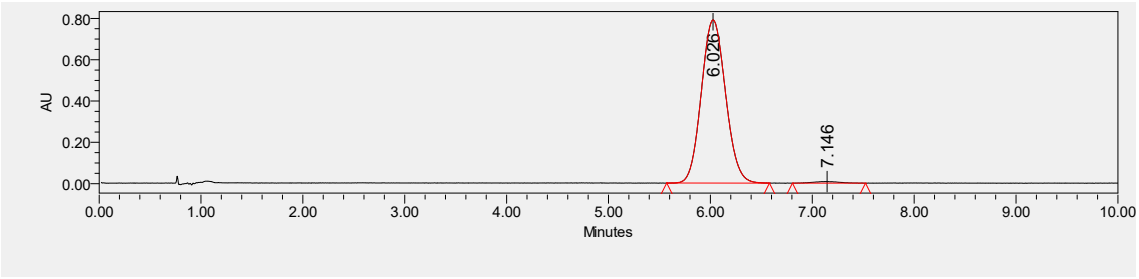


Result: colorless oil, 80% yield, 98% ee; $[\alpha]^{26.6}$ = -72.9 (*c* = 1.12 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 =6.03 min, t_2 = 7.15 min.

^{1}H NMR (400 MHz, Chloroform-d) δ 8.07 (d, J = 7.7 Hz, 1H), 7.41 (m, 4H), 7.32 (m, 1H), 7.25 – 7.20 (m, 2H), 7.04 (d, J = 8.6 Hz, 2H), 6.96 (d, J = 7.7 Hz, 1H), 6.63 (d, J = 8.6 Hz, 2H), 6.04 (s, 1H), 4.19 (q, J = 7.1 Hz, 2H), 3.68 (s, 3H), 3.50 (dd, J = 89.2, 13.4 Hz, 2H), 1.21 (t, J = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.6 , 169.9 , 158.3 , 138.8 , 138.3 , 137.9 , 134.2 , 131.3 , 130.7 , 129.2 , 128.9 , 128.4 , 128.1 , 127.8 , 127.2 , 127.2 , 126.7 , 113.0 , 61.9 , 61.9 , 55.1 , 41.8 , 14.0 .
HRMS (ESI) Calculated for $C_{27}H_{24}O_4$ ([M]+Na^+) = 435.1567, Found 435.1573.
IR (neat) 3746, 3060, 2981, 2328, 2054, 1988, 1738, 1641, 1593, 1443, 1364, 1254, 1217, 1179, 1036, 943, 896, 750, 576 cm^{-1}.

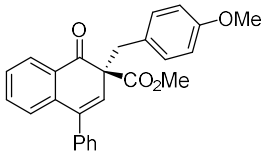


	Retention Time	Area	% Area
1	6.491	17607040	50.29
2	7.696	17407170	49.71



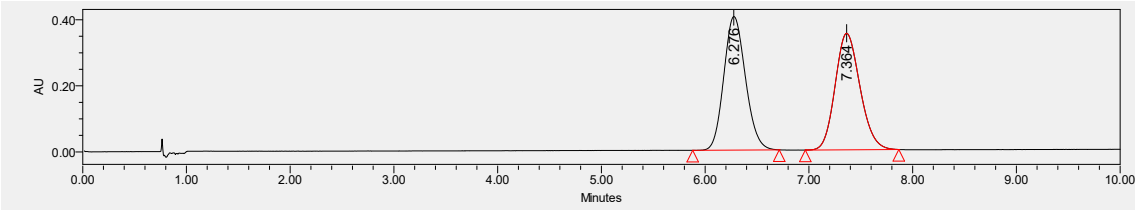
	Retention Time	Area	% Area
1	6.026	13041122	99.03
2	7.146	127971	0.97

Methyl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B2)

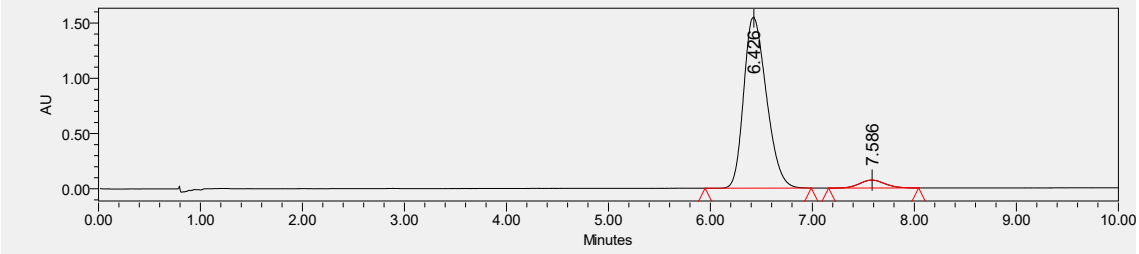


Result: colorless oil, 76% yield, 90% ee; $[\alpha]^{26.7}$ = -80.9 (*c* = 0.77 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 6.43 min, t_2 = 7.59 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.07 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.45 – 7.38 (m, 4H), 7.32 (td, *J* = 7.5, 1.3 Hz, 1H), 7.26 – 7.20 (m, 2H), 7.03 (d, *J* = 8.7 Hz, 2H), 6.97 (d, *J* = 7.5 Hz, 1H), 6.63 (d, *J* = 8.7 Hz, 2H), 6.04 (s, 1H), 3.72 (s, 3H), 3.68 (s, 3H), 3.51 (dd, *J* = 86.2, 13.4 Hz, 2H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.3 , 170.5 , 158.4 , 138.7 , 138.4 , 137.9 , 134.3 , 131.3 , 130.6 , 129.2 , 128.9 , 128.4 , 128.2 , 127.8 , 127.3 , 127.1 , 126.8 , 113.0 , 61.8 , 55.10, 53.0 , 42.0 .
HRMS (ESI) Calculated for $C_{26}H_{22}O_4$ ([M]+Na^+) = 421.1410, Found 421.1411.
IR (neat) 3746, 3059, 3031, 2952, 2055, 1986, 1742, 1641, 1592, 1442, 1355, 1179, 1035, 946, 894, 775, 637, 576 cm^{-1}.

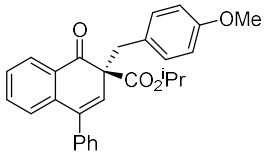


	Retention Time	Area	% Area
1	6.276	5860908	49.98
2	7.364	5866483	50.02



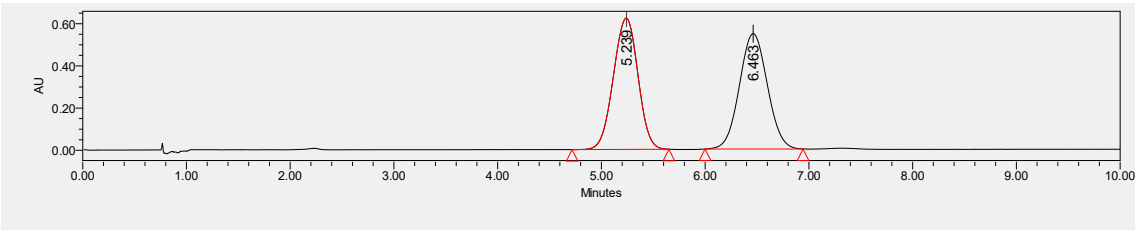
	Retention Time	Area	% Area
1	6.426	23920234	95.07
2	7.586	1240377	4.93

Isopropyl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B3)

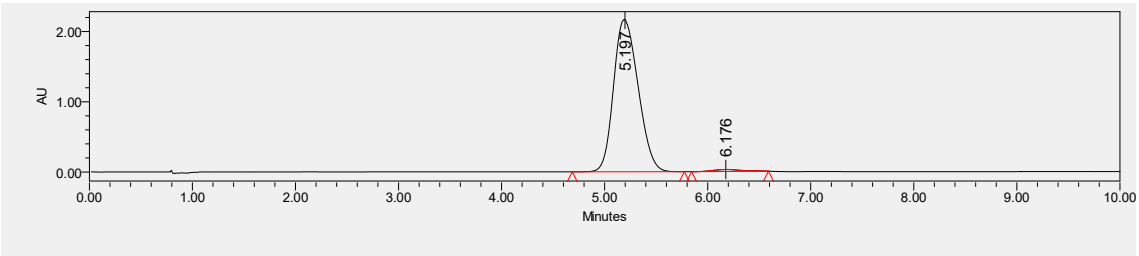


Result: colorless oil, 75% yield, 97% ee; $[\alpha]^{26.7}$ = -36.9 (*c* = 0.71 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 5.20 min, t_2 = 6.18 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.06 (dd, *J* = 7.6, 1.5 Hz, 1H), 7.44 – 7.37 (m, 4H), 7.31 (td, *J* = 7.5, 1.3 Hz, 1H), 7.22 (dd, *J* = 7.7, 1.8 Hz, 2H), 7.04 (d, *J* = 8.6 Hz, 2H), 6.95 (d, *J* = 6.9 Hz, 1H), 6.63 (d, *J* = 8.7 Hz, 2H), 6.03 (s, 1H), 5.06 (hept, *J* = 6.2 Hz, 1H), 3.68 (s, 3H), 3.49 (dd, *J* = 92.0, 13.5 Hz, 2H), 1.18 (t, *J* = 5.9 Hz, 6H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.5 , 169.4 , 158.3 , 138.9 , 138.3 , 137.9 , 134.1 , 131.3 , 130.9 , 129.3 , 128.9 , 128.4 , 128.0 , 127.8 , 127.4 , 127.2 , 126.7 , 113.0 , 69.5 , 62.1 , 55.1 , 41.5 , 21.5 , 21.4 .
HRMS (ESI) Calculated for $C_{28}H_{26}O_4$ ([M]+Na^+) = 449.1723, Found 449.1732.
IR (neat) 3746, 3060, 2982, 2835, 2055, 1736, 1641, 1443, 1374, 1276, 1179, 1035, 943, 864, 763, 637, 576 cm^{-1}.

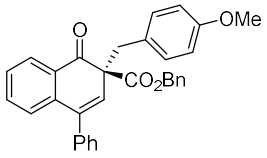


	Retention Time	Area	% Area
1	5.239	10244030	50.05
2	6.463	10222367	49.95



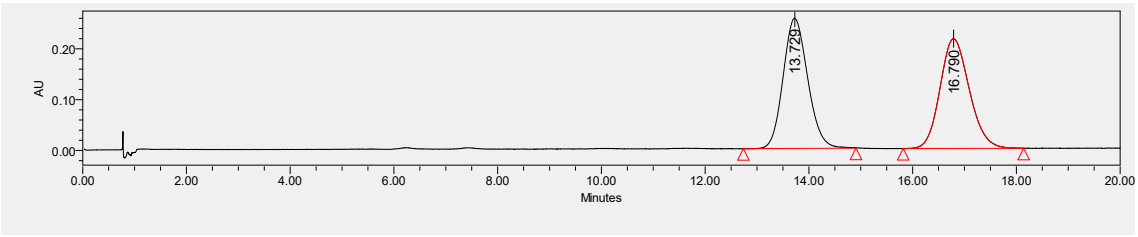
	Retention Time	Area	% Area
1	5.197	35879660	98.49
2	6.176	551938	1.51

Benzyl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B4)

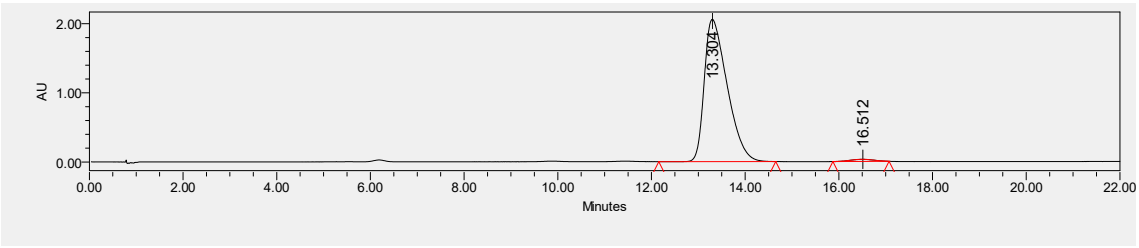


Result: colorless oil, 70% yield, 97% ee; $[\alpha]^{26.1}$ = -9.3 (*c* = 0.78 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 13.30 min, t_2 = 16.52 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.08 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.42 – 7.38 (m, 4H), 7.36 – 7.27 (m, 4H), 7.23 (m, 2H), 7.20 – 7.16 (m, 2H), 7.03 (d, *J* = 8.7 Hz, 2H), 6.96 (d, *J* = 7.5 Hz, 1H), 6.63 (d, *J* = 8.7 Hz, 2H), 6.04 (s, 1H), 5.27 – 5.11 (d, 2H), 3.67 (d, *J* = 12.7 Hz, 4H), 3.41 (d, *J* = 13.5 Hz, 1H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.1 , 169.6 , 158.3 , 138.7 , 138.6 , 137.9 , 135.6 , 134.3 , 131.3 , 130.5 , 129.3 , 128.8 , 128.4 , 128.2 , 128.0 , 127.8 , 127.5 , 127.3 , 127.2 , 126.8 , 113.1 , 67.2 , 62.0 , 55.1 , 41.6 .
HRMS (ESI) Calculated for $C_{32}H_{26}O_4$ ([M]+Na^+) = 497.1723, Found 497.1732.
IR (neat) 3746, 3062, 3006, 2835, 2349, 1990, 1742, 1676, 1512, 1443, 1276, 1178, 1035, 944, 832, 763, 659, 556 cm^{-1}.

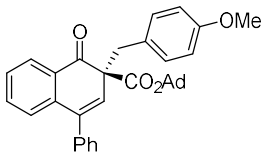


	Retention Time	Area	% Area
1	13.729	8426386	49.99
2	16.790	8429148	50.01



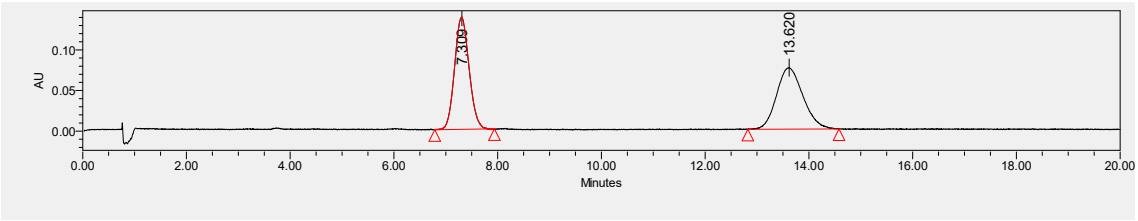
	Retention Time	Area	% Area
1	13.304	69681932	98.50
2	16.512	1063775	1.50

Adamantan-1-yl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B5)

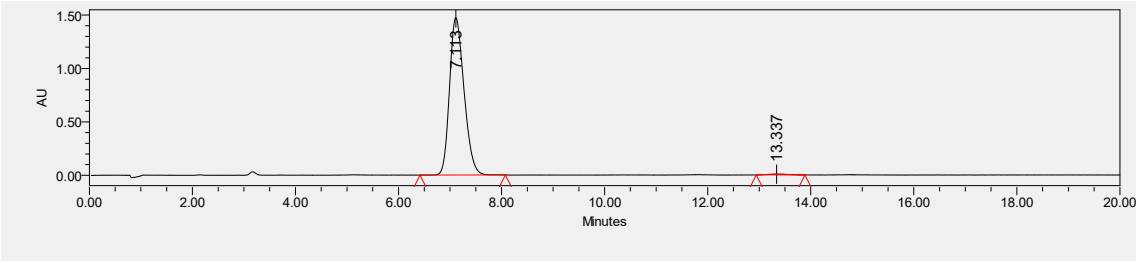


Result: White solid, Mp: 66-68 °C, 70% yield, 99% ee; $[\alpha]^{26.7}$ = 58.4 (*c* = 0.83 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 80/20, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 7.11 min, t_2 = 13.34 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.06 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.44 – 7.35 (m, 4H), 7.31 (td, *J* = 7.5, 1.3 Hz, 1H), 7.22 (dd, *J* = 7.7, 1.8 Hz, 2H), 7.04 (d, *J* = 8.5 Hz, 2H), 6.95 (d, *J* = 9.1 Hz, 1H), 6.64 (d, *J* = 8.6 Hz, 2H), 6.04 (s, 1H), 3.68 (s, 3H), 3.47 (dd, *J* = 115.7, 13.6 Hz, 2H), 2.12 (s, 3H), 2.01 (d, *J* = 2.8 Hz, 6H), 1.61 (s, 6H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.6 , 168.2 , 158.2 , 139.1 , 138.0 , 137.9 , 134.0 , 131.4 , 131.2 , 129.4 , 128.9 , 128.4 , 127.9 , 127.8 , 127.7 , 127.1 , 126.6 , 113.0 , 82.4 , 62.9 , 55.1 , 41.0 , 36.0 , 30.8 .
HRMS (ESI) Calculated for $C_{35}H_{34}O_4$ ([M]+Na^+) = 541.2349, Found 541.2361.
IR (neat) 3746, 3059, 2911, 2835, 2349, 2055, 1989, 1733, 1641, 1593, 1443, 1276, 1179, 1038, 964, 890, 763, 638, 556 cm^{-1}.

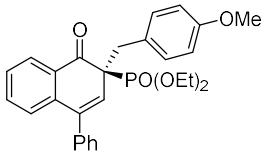


	Retention Time	Area	% Area
1	7.309	2683357	50.07
2	13.620	2676195	49.93



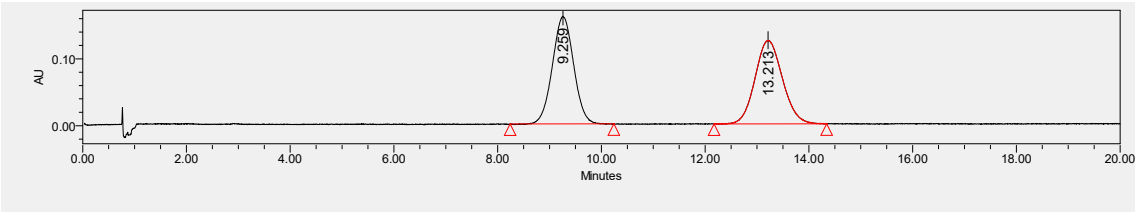
	Retention Time	Area	% Area
1	7.113	28792928	99.40
2	13.337	174067	0.60

Diethyl (S)-(2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalen-2-yl)phosphonate (B6)

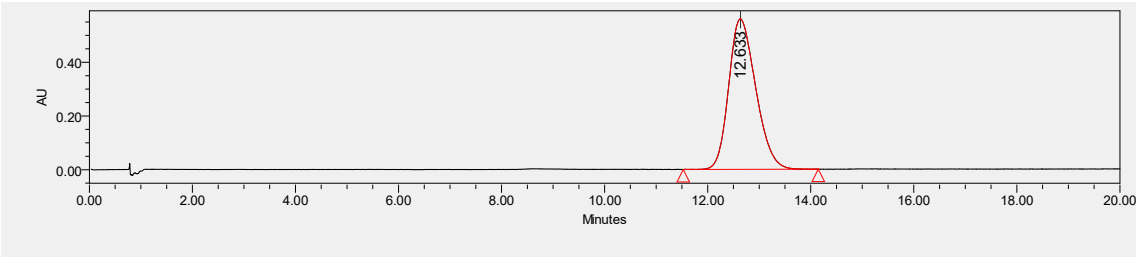


Result: colorless oil, 62% yield, 99% ee; $[\alpha]^{26.5}$ = 101.0 (*c* = 0.60 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_2 = 16.64 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.10 (dd, *J* = 6.7 Hz, 1H), 7.44 – 7.37 (m, 4H), 7.35 – 7.30 (m, 1H), 7.19 (d, *J* = 5.8 Hz, 2H), 7.04 (m, 3H), 6.65 (d, *J* = 8.6 Hz, 2H), 6.24 (d, *J* = 5.4 Hz, 1H), 4.22 – 3.99 (m, 5H), 3.69 (s, 3H), 3.28 (dd, *J* = 13.5, 9.0 Hz, 1H), 1.32 (t, *J* = 7.1 Hz, 3H), 1.09 (t, *J* = 7.0 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 195.3 , 195.2 , 158.2 , 139.0 , 138.9 , 138.0 , 137.9 , 134.1 , 130.9 , 130.2 , 123.0 , 129.8 , 128.9 , 128.9 , 128.6 , 128.4 , 128.0 , 127.7 , 127.2 , 126.6 , 113.3 , 64.1 , 64.0 , 63.8 , 63.7 , 60.3 , 59.1 , 55.1 , 38.3 , 38.3 , 16.4 , 16.4 , 16.3 , 16.2 .
^{31}P NMR (162 MHz, Chloroform-*d*) δ 18.56 .
HRMS (ESI) Calculated for $C_{28}H_{29}O_5P$ ([M]+Na^+) = 499.1645, Found 499.1644.
IR (neat) 3747, 3469, 3060, 2835, 2349, 1988, 1640, 1592, 1443, 1357, 1275, 1179, 966, 880, 777, 659, 583 cm^{-1}.

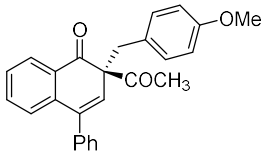


	Retention Time	Area	% Area
1	9.259	4564978	49.99
2	13.213	4566484	50.01



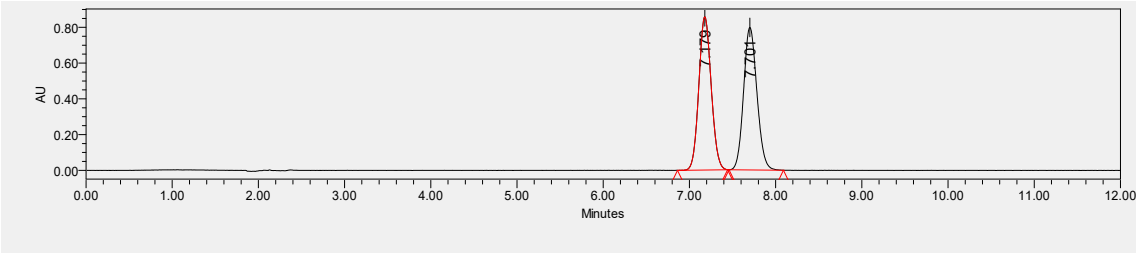
	Retention Time	Area	% Area
1	12.633	20368533	100.00

(R)-2-acetyl-2-(4-methoxybenzyl)-4-phenylnaphthalen-1(2H)-one (B7)

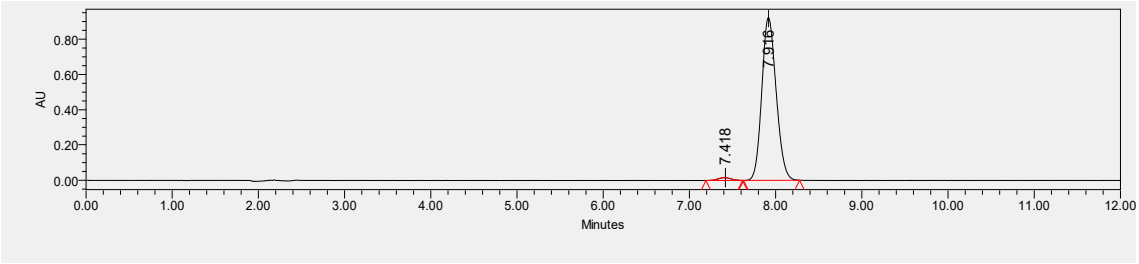


Result: colorless oil, 63% yield, 97% ee; $[\alpha]^{26.7}$ = 102.8 (*c* = 0.39 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel IG-3, CO_2/MeOH = 80/20, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 7.42 min, t_2 = 7.92 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.09 (dd, *J* = 7.7, 1.5 Hz, 1H), 7.46 – 7.40 (m, 4H), 7.35 (m, 1H), 7.24 – 7.19 (m, 2H), 7.01 (m, 1H), 6.97 (m, 2H), 6.61 (d, *J* = 8.7 Hz, 2H), 5.96 (s, 1H), 3.67 (s, 3H), 3.44 (dd, *J* = 100.6, 13.6 Hz, 2H), 2.12 (s, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 201.2 , 197.71 , 158.2 , 139.6 , 138.6 , 138.1 , 134.4 , 131.0 , 130.9 , 129.6 , 128.8 , 128.5 , 128.4 , 128.0 , 127.7 , 127.2 , 127.1 , 113.0 , 69.7 , 55.1 , 41.3 , 27.9 .
HRMS (ESI) Calculated for $C_{26}H_{22}O_3$ ([M]+Na^+) = 405.1461, Found 405.1465.
IR (neat) 3746, 3005, 2835, 2349, 2054, 1988, 1723, 1666, 1592, 1443, 1279, 1176, 1034, 941, 885, 763, 659, 563 cm^{-1}.

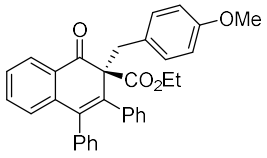


	Retention Time	Area	% Area
1	7.179	8532379	49.88
2	7.701	8574083	50.12



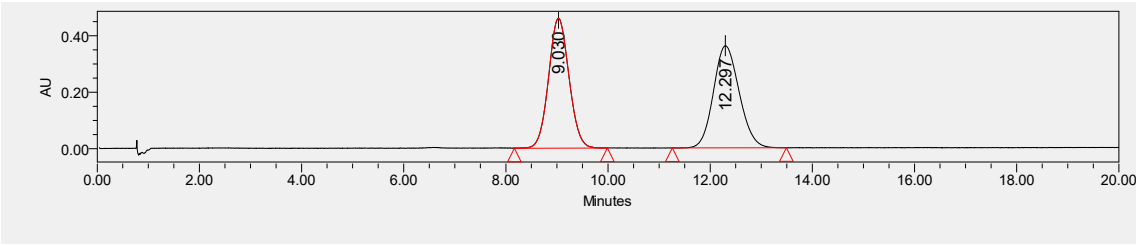
	Retention Time	Area	% Area
1	7.418	167204	1.54
2	7.916	10679816	98.46

Ethyl (S)-2-(4-methoxybenzyl)-1-oxo-3,4-diphenyl-1,2-dihydronaphthalene-2-carboxylate (B8)

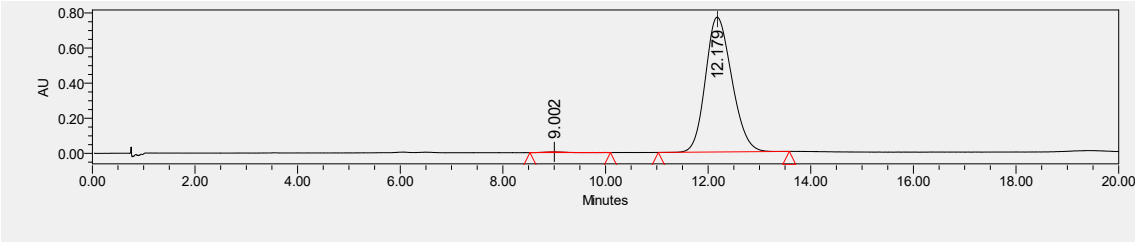


Result: colorless oil, 70% yield, 99% ee; $[\alpha]^{24.5}$ = 31.8 (*c* = 0.59 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 9.00 min, t_2 = 12.18 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.9[26.6] 1H), 6.57 (d, *J* = 8.7 Hz, 2H), 4.13 – 3.99 (m, 2H), 3.74 (d, *J* = 14.3 Hz, 1H), 3.65 (s, 3H), 3.48 (d, *J* = 14.2 Hz, 1H), 1.12 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 197.6 , 170.00 , 158.3 , 139.7 , 139.3 , 137.9 , 137.5 , 134.2 , 131.0 , 130.6 , 130.3 , 123.0 , 128.9 , 127.9 , 127.9 , 127.8 , 127.5 , 127.5 , 127.1 , 127.0 , 126.9 , 126.6 , 112.9 , 66.2 , 61.7 , 55.1 , 41.3 , 13.8 .
HRMS (ESI) Calculated for $C_{33}H_{28}O_4$ ([M]+Na^+) = 511.1880, Found 511.1888.
IR (neat) 3747, 3005, 2988, 2349, 1987, 1744, 1675, 1513, 1442, 1275, 1179, 1035, 923, 844, 763, 660, 574 cm^{-1}.

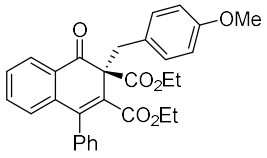


	Retention Time	Area	% Area
1	9.030	12757189	50.25
2	12.297	12627732	49.75



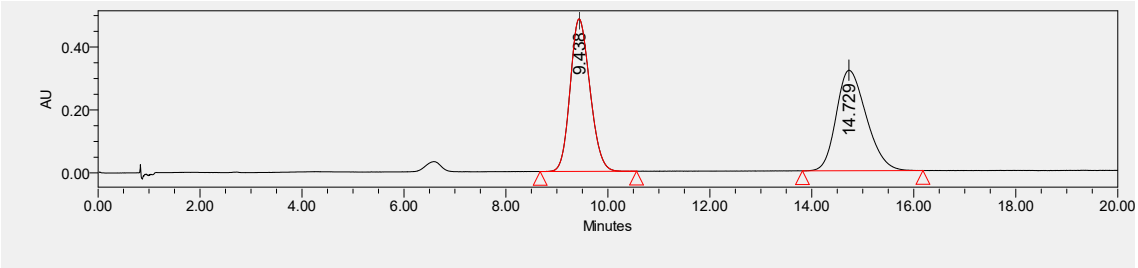
	Retention Time	Area	% Area
1	9.002	91683	0.33
2	12.179	27333223	99.67

Diethyl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2,3-dicarboxylate (B9)

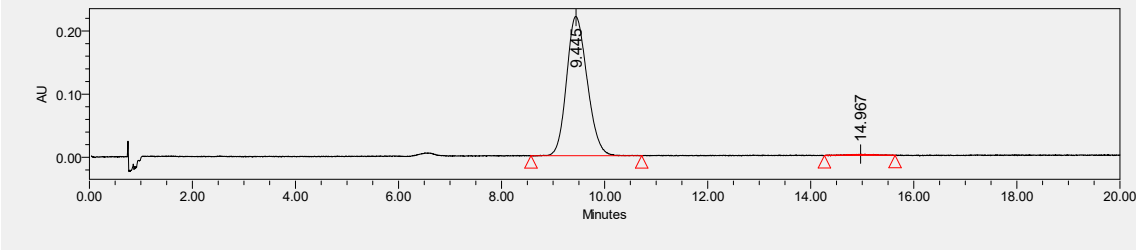


Result: colorless oil, 95% yield, 98% ee; $[\alpha]^{26.8}$ = -134.1 (*c* = 1.01 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 9.45 min, t_2 = 14.97 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.04 – 7.93 (dd, 1H), 7.39 (m, 3H), 7.33 – 7.27 (m, 2H), 7.15 – 7.10 (m, 1H), 7.07 (m, 1H), 6.95 (d, *J* = 8.6 Hz, 2H), 6.63 – 6.58 (dd, 1H), 6.52 (d, *J* = 8.6 Hz, 2H), 4.31 – 4.16 (m, 2H), 3.91 (q, *J* = 7.5, 1.0 Hz, 2H), 3.75 (d, *J* = 13.6 Hz, 1H), 3.62 (s, 4H), 1.22 (t, *J* = 7.1 Hz, 3H), 0.86 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 195.9 , 169.3 , 166.6 , 158.3 , 142.7 , 138.0 , 137.7 , 134.3 , 131.4 , 130.8 , 129.4 , 129.3 , 128.8 , 128.7 , 128.6 , 128.2 , 128.0 , 127.7 , 126.6 , 126.6 , 112.7 , 63.8 , 61.8 , 60.8 , 55.1 , 42.8 , 13.9 , 13.4 .
HRMS (ESI) Calculated for $C_{30}H_{28}O_6$ ([M]+Na^+) = 507.1778, Found 507.1783.
IR (neat) 3747, 3062, 2982, 2836, 1986, 1723, 1612, 1591, 1443, 1367, 1275, 1179, 1073, 929, 864, 764, 660, 599 cm^{-1}.

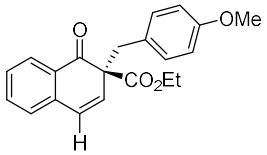


	Retention Time	Area	% Area
1	9.438	13033672	49.95
2	14.729	13057527	50.05



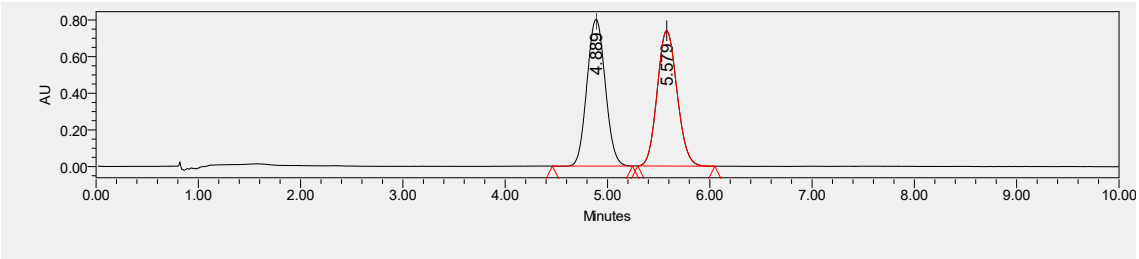
	Retention Time	Area	% Area
1	9.445	6106876	99.00
2	14.967	61766	1.00

Ethyl (S)-2-(4-methoxybenzyl)-1-oxo-1,2-dihydronaphthalene-2-carboxylate (B10)

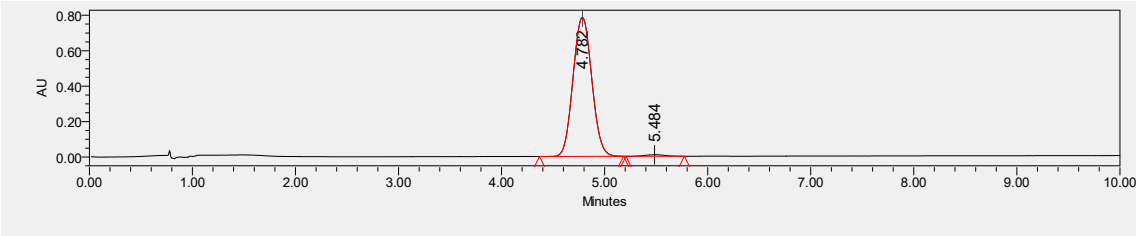


Result: White solid, Mp: 101-103 °C, 66% yield, 98% ee; $[\alpha]^{26.4}$ = -168.8 (*c* = 0.46 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 4.78 min, t_2 = 5.48 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.99 (d, *J* = 8.1 Hz, 1H), 7.48 (td, *J* = 7.5, 1.4 Hz, 1H), 7.31 (td, *J* = 7.6, 1.2 Hz, 1H), 7.11 (d, *J* = 7.5 Hz, 1H), 7.01 (d, *J* = 8.6 Hz, 2H), 6.61 (d, *J* = 8.4 Hz, 3H), 6.13 (d, *J* = 9.8 Hz, 1H), 4.18 – 4.12 (m, 2H), 3.67 (s, 3H), 3.45 (dd, *J* = 87.0, 13.5 Hz, 2H), 1.16 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.3 , 169.8 , 158.3 , 137.5 , 134.6 , 132.0 , 131.2 , 129.0 , 128.3 , 127.6 , 127.3 , 126.9 , 126.8 , 113.1 , 62.0 , 61.9 , 55.0 , 41.3 , 13.9 .
HRMS (ESI) Calculated for $C_{21}H_{20}O_4$ ([M]+Na^+) = 359.1254, Found 359.1256.
IR (neat) 3747, 3034, 2983, 2835, 2349, 1994, 1737, 1642, 1595, 1453, 1365, 1179, 925, 893, 794, 696, 583 cm^{-1}.

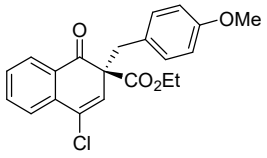


	Retention Time	Area	% Area
1	4.889	9957719	50.06
2	5.579	9932479	49.94



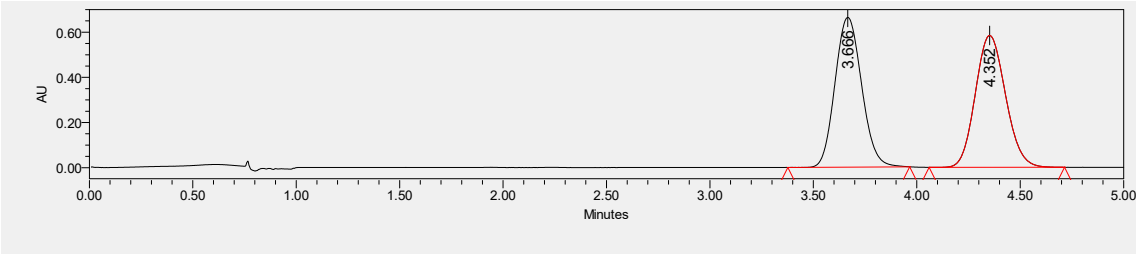
	Retention Time	Area	% Area
1	4.782	9906996	98.86
2	5.484	114608	1.14

Ethyl (S)-4-chloro-2-(4-methoxybenzyl)-1-oxo-1,2-dihydronaphthalene-2-carboxylate (B11)

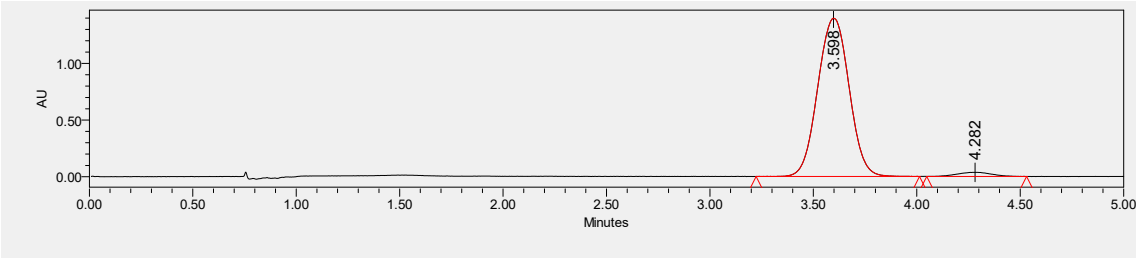


Result: colorless oil, 58% yield, 94% ee; $[\alpha]^{26.8}$ = -105.0 (*c* = 0.42 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 3.60 min, t_2 = 4.23 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.00 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.64 – 7.57 (m, 2H), 7.40 (td, *J* = 7.9, 7.0, 1.6 Hz, 1H), 6.99 (d, *J* = 8.7 Hz, 2H), 6.63 (d, *J* = 8.7 Hz, 2H), 6.32 (s, 1H), 4.17 (qd, *J* = 7.1, 4.8 Hz, 2H), 3.67 (s, 3H), 3.55 – 3.33 (m, 2H), 1.18 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 194.4 , 168.8 , 158.4 , 134.9 , 134.7 , 131.2 , 129.9 , 129.5 , 129.3 , 128.9 , 127.2 , 126.6 , 125.5 , 113.3 , 63.3 , 62.3 , 55.1 , 41.8 , 13.9 .
HRMS (ESI) Calculated for $C_{21}H_{19}ClO_4$ ([M]+Na^+) = 393.0864, Found 393.0865.
IR (neat) 3746, 2985, 2836, 2349, 2055, 1987, 1742, 1632, 1593, 1464, 1276, 1179, 964, 895, 764, 695, 590 cm^{-1}.

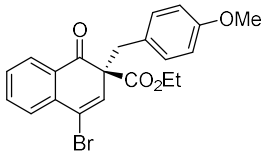


	Retention Time	Area	% Area
1	3.666	5932833	50.05
2	4.352	5920802	49.95



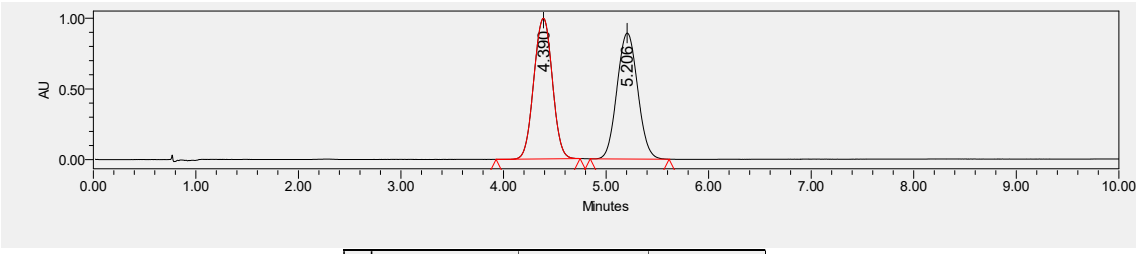
	Retention Time	Area	% Area
1	3.598	14705583	97.25
2	4.282	416097	2.75

Ethyl (S)-4-bromo-2-(4-methoxybenzyl)-1-oxo-1,2-dihydronaphthalene-2-carboxylate (B12)

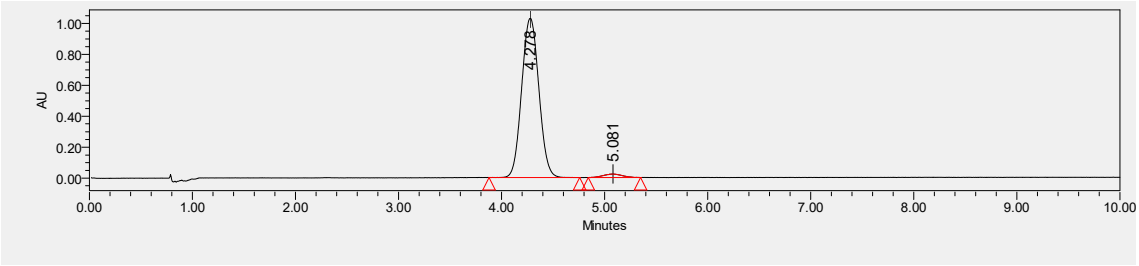


Result: colorless oil, 57% yield, 95% ee; $[\alpha]^{26.8}$ = -75.3 (*c* = 0.55 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 4.28 min, t_2 = 5.08 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.98 (d, *J* = 7.4 Hz, 1H), 7.60 – 7.52 (m, 2H), 7.38 (td, *J* = 8.3, 6.4, 2.3 Hz, 1H), 6.99 (d, *J* = 8.6 Hz, 2H), 6.63 (d, *J* = 8.5 Hz, 2H), 6.58 (s, 1H), 4.21 – 4.14 (m, 2H), 3.67 (s, 3H), 3.53 – 3.33 (m, 2H), 1.19 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 194.5 , 168.5 , 158.5 , 135.6 , 134.8 , 133.2 , 131.2 , 129.6 , 129.4 , 128.3 , 127.1 , 126.5 , 120.7 , 113.3 , 64.5 , 62.3 , 55.1 , 41.7 , 13.9 .
HRMS (ESI) Calculated for $C_{21}H_{19}{}^{79}BrO_4$ ([M]+Na^+) = 437.0359, Found 437.0352.
HRMS (ESI) Calculated for $C_{21}H_{19}{}^{81}BrO_4$ ([M]+Na^+) = 439.0338, Found 437.0345.
IR (neat) 3746, 2988, 2935, 2835, 2343, 1988, 1741, 1590, 1450, 1365, 1276, 1180, 1095, 914, 886, 792, 659 cm^{-1}.

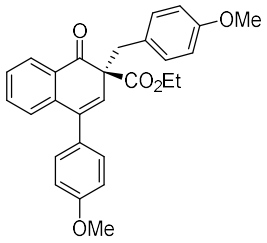


	Retention Time	Area	% Area
1	4.390	12431356	49.99
2	5.206	12434558	50.01



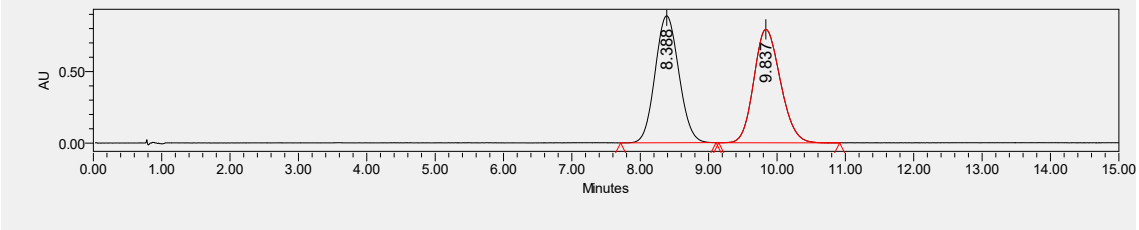
	Retention Time	Area	% Area
1	4.278	11908929	97.65
2	5.081	286085	2.35

Ethyl (S)-2-(4-methoxybenzyl)-4-(4-methoxyphenyl)-1-oxo-1,2-dihydronaphthalene-2-carboxylate (B13)

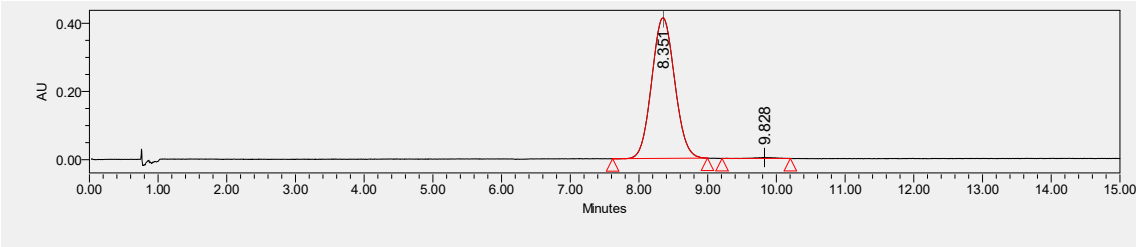


Result: colorless oil, 69% yield, 99% *ee*; $[\alpha]^{26.3}$ = -37.0 (*c* = 0.72 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 8.35 min, t_2 = 9.83 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.05 (dd, *J* = 7.7, 1.5 Hz, 1H), 7.40 (td, *J* = 7.6, 1.5 Hz, 1H), 7.31 (td, *J* = 7.5, 1.2 Hz, 1H), 7.16 (d, *J* = 8.7 Hz, 2H), 7.01 (m, 3H), 6.95 (d, *J* = 8.7 Hz, 2H), 6.62 (d, *J* = 8.7 Hz, 2H), 6.00 (s, 1H), 4.18 (q, *J* = 7.1 Hz, 2H), 3.86 (s, 3H), 3.68 (s, 3H), 3.49 (dd, *J* = 85.3, 13.4 Hz, 2H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.5 , 170.0 , 159.2 , 158.3 , 158.2 , 137.8 , 134.2 , 131.3 , 131.1 , 130.5 , 130.0 , 129.3 , 128.0 , 127.3 , 127.2 , 126.7 , 113.8 , 113.0 , 62.0 , 61.9 , 55.3 , 55.1 , 41.8 , 14.0 .
HRMS (ESI) Calculated for $C_{28}H_{26}O_5$ ([M]+Na^+) = 465.1672, Found 465.1682.
IR (neat) 3746, 2989, 2836, 2054, 1987, 1738, 1676, 1641, 1592, 1389, 1276, 1034, 943, 897, 763, 659, 566 cm^{-1}.

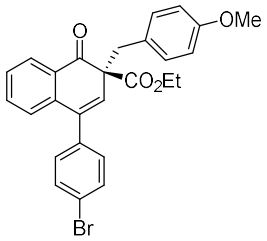


	Retention Time	Area	% Area
1	8.388	21394284	50.06
2	9.837	21340438	49.94



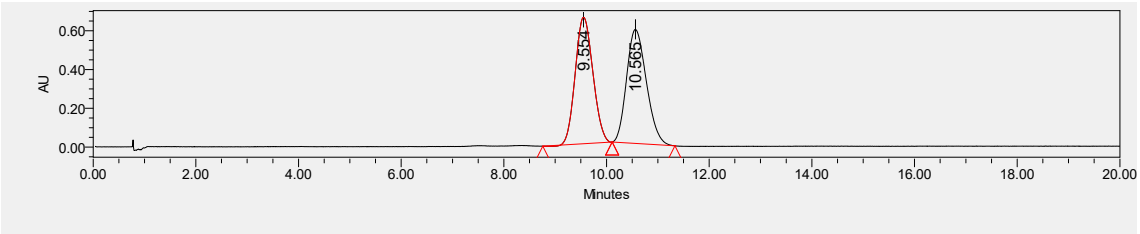
	Retention Time	Area	% Area
1	8.351	9552384	99.45
2	9.828	53017	0.55

Ethyl (S)-4-(4-bromophenyl)-2-(4-methoxybenzyl)-1-oxo-1,2-dihydronaphthalene-2-carboxylate (B14)

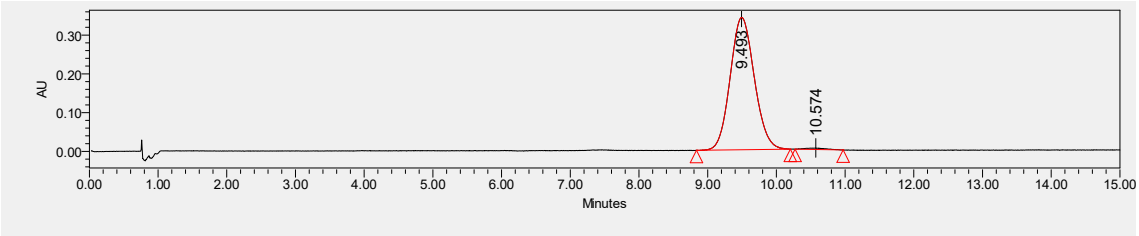


Result: White solid, Mp: 93-95 °C, 76% yield, 98% *ee*; $[\alpha]^{26.7}$ = -29.0 (*c* = 0.78 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 =9.49 min, t_2 = 10.57 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.07 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.55 (d, *J* = 8.5 Hz, 2H), 7.41 (td, *J* = 7.6, 1.6 Hz, 1H), 7.33 (td, *J* = 7.5, 1.3 Hz, 1H), 7.09 (d, *J* = 8.4 Hz, 2H), 7.00 (d, *J* = 8.7 Hz, 2H), 6.91 (d, *J* = 7.5 Hz, 1H), 6.62 (d, *J* = 8.6 Hz, 2H), 6.02 (s, 1H), 4.19 (d, *J* = 7.1 Hz, 2H), 3.68 (s, 3H), 3.49 (dd, *J* = 87.8, 13.4 Hz, 2H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.1 , 169.7 , 158.4 , 137.7 , 137.4 , 137.3 , 134.3 , 131.6 , 131.3 , 131.2 , 130.6 , 129.2 , 128.3 , 127.4 , 127.2 , 126.5 , 121.9 , 113.1 , 62.0 , 61.9 , 55.1 , 41.8 , 14.0 .
HRMS (ESI) Calculated for $C_{27}H_{23}{}^{79}BrO_4$ ([M]+Na^+) = 513.0672, Found 513.0677.
HRMS (ESI) Calculated for $C_{27}H_{23}{}^{81}BrO_4$ ([M]+Na^+) = 515.0651, Found 515.0648.
IR (neat) 3747, 2988, 2835, 2349, 2055, 1988, 1739, 1677, 1591, 1449, 1276, 1179, 1036, 936, 896, 763, 649 cm^{-1}.

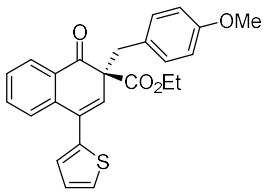


	Retention Time	Area	% Area
1	9.554	15641847	49.79
2	10.565	15774062	50.21



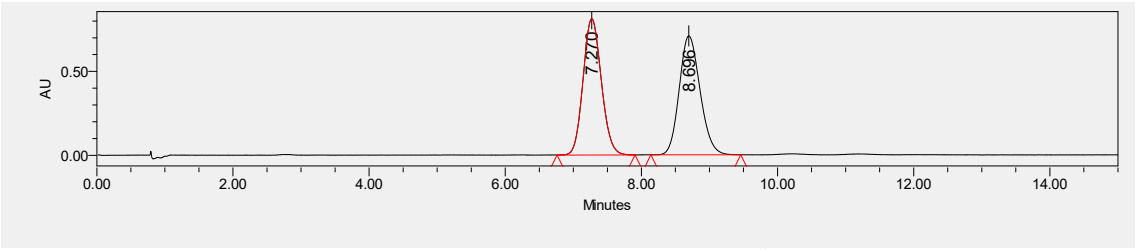
	Retention Time	Area	% Area
1	9.493	8322076	99.10
2	10.574	75383	0.90

Ethyl (S)-2-(4-methoxybenzyl)-1-oxo-4-(thiophen-2-yl)-1,2-dihydronaphthalene-2-carboxylate (B15)

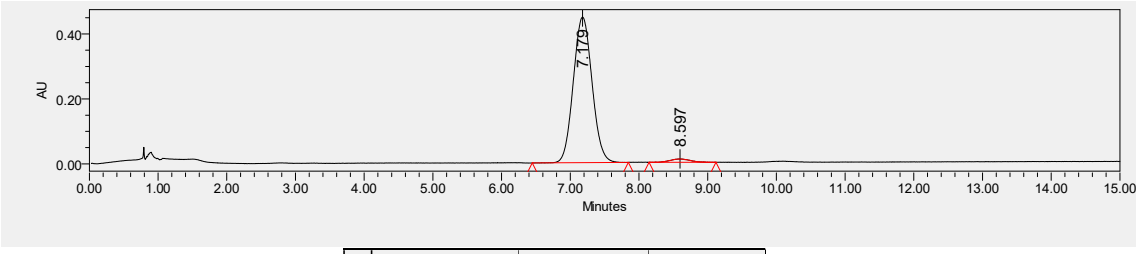


Result: colorless oil, 70% yield, 95% *ee*; $[\alpha]^{26.6}$ = -100.0 (*c* = 0.60 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 7.18 min, t_2 = 8.60 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.05 (dd, *J* = 7.7, 1.5 Hz, 1H), 7.45 (td, *J* = 7.6, 1.5 Hz, 1H), 7.41 – 7.26 (m, 3H), 7.10 (dd, *J* = 5.2, 3.5 Hz, 1H), 7.05 – 7.00 (m, 3H), 6.62 (d, *J* = 8.6 Hz, 2H), 6.24 (s, 1H), 4.19 (qd, *J* = 7.1, 2.1 Hz, 2H), 3.67 (s, 3H), 3.58 – 3.37 (m, 2H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 195.9 , 169.9 , 158.4 , 139.4 , 137.3 , 134.4 , 132.8 , 131.3 , 131.3 , 129.1 , 128.4 , 127.3 , 127.1 , 127.0 , 126.4 , 125.3 , 1131 , 62.3 , 62.0 , 55.1 , 41.9 , 14.0 .
HRMS (ESI) Calculated for $C_{25}H_{22}O_4S$ ([M]+Na^+) = 441.1131, Found 441.1133.
IR (neat) 3747, 3068, 2981, 2835, 2054, 1996, 1739, 1677, 1592, 1449, 1363, 1288, 1179, 1035, 939, 839, 794, 660, 570 cm^{-1}.

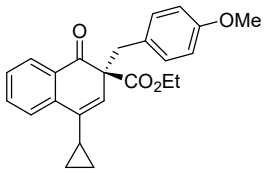


	Retention Time	Area	% Area
1	7.270	15128483	50.08
2	8.696	15077389	49.92



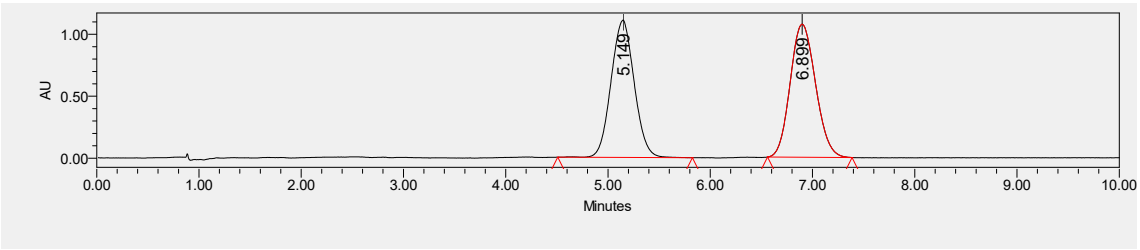
	Retention Time	Area	% Area
1	7.179	8495312	97.69
2	8.597	200503	2.31

Ethyl (S)-4-cyclopropyl-2-(4-methoxybenzyl)-1-oxo-1,2-dihydronaphthalene-2-carboxylate (B16)

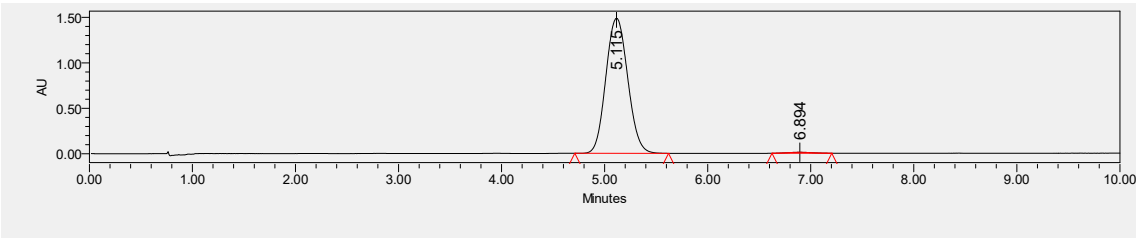


Result: colorless oil, 72% yield, 98% *ee*; $[\alpha]^{26.0}$ = -83.0 (*c* = 0.61 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 5.12 min, t_2 = 6.89 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.01 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.69 (d, *J* = 9.1 Hz, 1H), 7.54 (td, *J* = 7.6, 1.5 Hz, 1H), 7.33 (td, *J* = 7.5, 1.2 Hz, 1H), 6.89 (d, *J* = 8.7 Hz, 2H), 6.56 (d, *J* = 8.6 Hz, 2H), 5.88 (d, *J* = 1.7 Hz, 1H), 4.14 (qd, *J* = 7.1, 3.1 Hz, 2H), 3.65 (s, 3H), 3.39 (dd, *J* = 83.4, 13.4 Hz, 2H), 1.71 – 1.65 (m, 1H), 1.16 (t, *J* = 7.1 Hz, 3H), 0.84 (m, 2H), 0.66 – 0.60 (m, 1H), 0.29 – 0.24 (m, 1H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.8 , 170.3 , 158.2 , 138.7 , 135.9 , 134.4 , 131.2 , 128.9 , 127.8 , 127.7 , 127.3 , 126.9 , 124.7 , 112.9 , 61.8 , 61.3 , 55.1 , 41.8 , 13.9 , 13.2 , 5.7 , 4.6 .
HRMS (ESI) Calculated for $C_{24}H_{24}O_4$ ([M]+Na^+) = 399.1567, Found 399.1572.
IR (neat) 3744, 3004, 2836, 2349, 2055, 1989, 1738, 1675, 1594, 1448, 1387, 1275, 1179, 1036, 934, 844, 763, 750, 561 cm^{-1}.

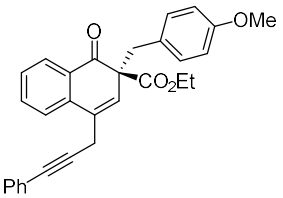


	Retention Time	Area	% Area
1	5.149	17418892	48.53
2	6.899	18472915	51.47



	Retention Time	Area	% Area
1	5.115	21896347	99.18
2	6.894	180491	0.82

ethyl (S)-2-(4-methoxybenzyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,2-dihydronaphthalene-2-carboxylate (B17)



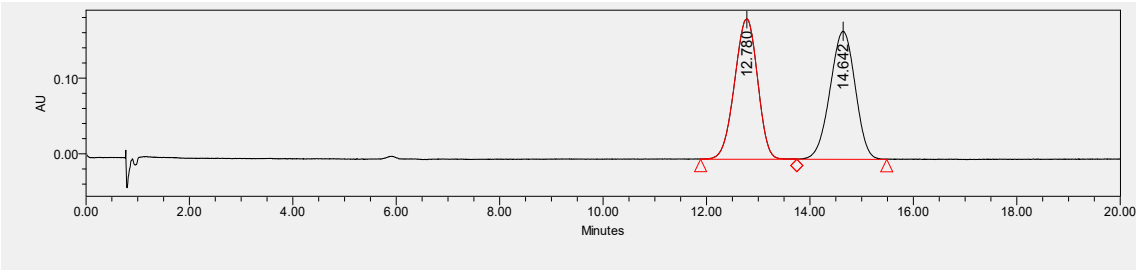
Result: colorless oil, 80% yield, 98% *ee*; $[\alpha]^{25.4}$ = -36.4 (*c* = 0.68 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 12.76 min, t_2 = 16.68 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.04 (dd, *J* = 7.7, 1.5 Hz, 1H), 7.58 – 7.53 (m, 1H), 7.42 (m, 2H), 7.38 – 7.30 (m, 5H), 7.03 (d, *J* = 8.6 Hz, 2H), 6.57 (d, *J* = 8.6 Hz, 2H), 6.38 (s, 1H), 4.17 (m, 2H), 3.61 (s, 2H), 3.58 (s, 3H), 3.53 – 3.36 (m, 2H), 1.17 (t, *J* = 7.1 Hz, 3H).

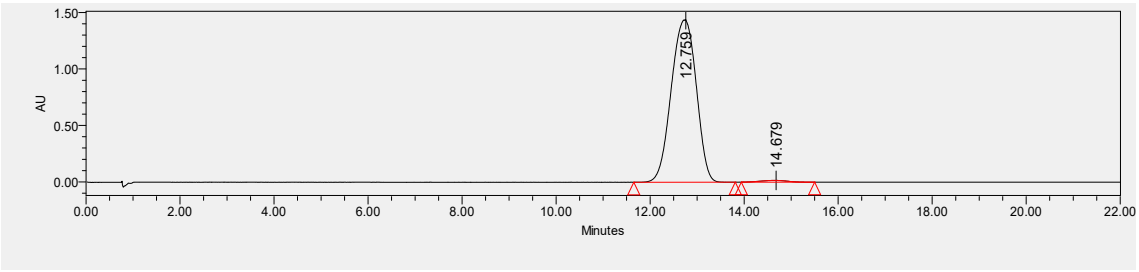
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.3 , 169.8 , 158.2 , 137.0 , 134.5 , 131.6 , 131.4 , 130.0 , 129.9 , 129.1 , 128.3 , 128.2 , 128.1 , 127.4 , 127.1 , 123.7 , 123.3 , 113.0 , 85.5 , 84.3 , 61.9 , 61.8 , 54.9 , 41.7 , 23.5 , 13.9 .

HRMS (ESI) Calculated for $C_{30}H_{26}O_4$ ([M]+Na^+) = 473.1723, Found 473.1725.

IR (neat) 2933, 1738, 1677, 1512, 1444, 1369, 1294, 1209, 1180, 1036, 938, 824, 758, 533 cm^{-1}.

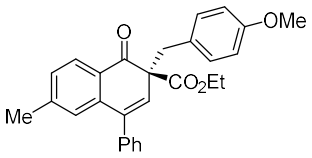


	Retention Time	Area	% Area
1	12.780	5730358	50.08
2	14.642	5711640	49.92



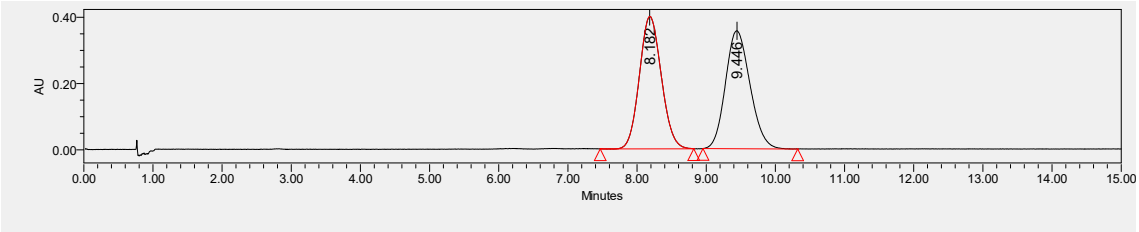
	Retention Time	Area	% Area
1	12.759	53190753	98.87
2	14.679	608007	1.13

Ethyl (S)-2-(4-methoxybenzyl)-6-methyl-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B18)

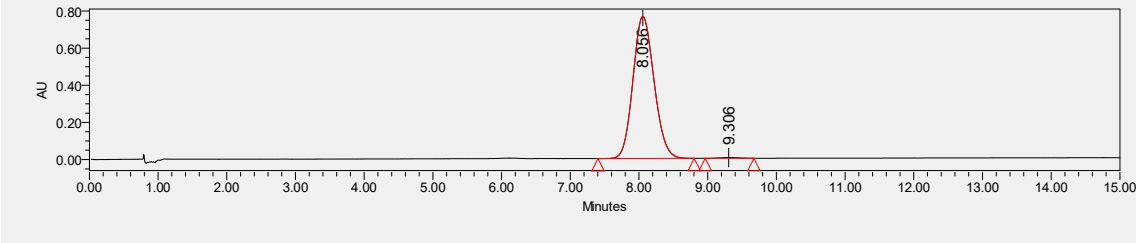


Result: colorless oil, 76% yield, 99% *ee*; $[\alpha]^{26.2}$ = -60.5 (*c* = 0.75 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 8.06 min, t_2 = 9.31 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.98 (dd, *J* = 8.0 Hz, 1H), 7.48 – 7.39 (m, 3H), 7.25 – 7.19 (m, 2H), 7.13 (d, *J* = 7.4 Hz, 1H), 7.03 (d, *J* = 8.6 Hz, 2H), 6.74 (s, 1H), 6.64 (d, *J* = 8.6 Hz, 2H), 6.01 (s, 1H), 4.18 (qd, *J* = 7.1, 1.3 Hz, 2H), 3.69 (s, 3H), 3.49 (dd, *J* = 92.9, 13.4 Hz, 2H), 2.24 (s, 3H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.0 , 170.0 , 158.3 , 145.3 , 139.0 , 138.3 , 137.9 , 131.3 , 131.1 , 129.0 , 128.9 , 128.4 , 127.7 , 127.5 , 127.4 , 127.2 , 127.1 , 113.0 , 61.9 , 61.8 , 55.1 , 41.8 , 21.9 , 14.0 .
HRMS (ESI) Calculated for $C_{28}H_{26}O_4$ ([M]+Na^+) = 449.1723, Found 449.1726.
IR (neat) 3746, 3032, 2980, 2835, 2054, 1996, 1738, 1673, 1599, 1463, 1353, 1289, 1179, 1036, 958, 860, 761, 676, 565 cm^{-1}.

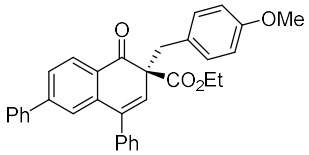


	Retention Time	Area	% Area
1	8.182	8784809	50.07
2	9.446	8761395	49.93



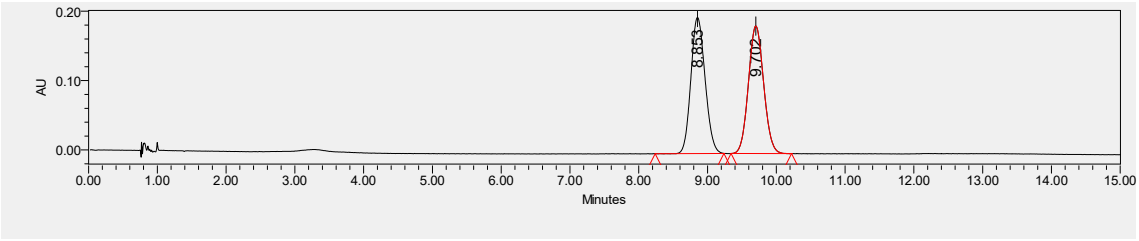
	Retention Time	Area	% Area
1	8.056	16282799	99.46
2	9.306	88313	0.54

Ethyl (S)-2-(4-methoxybenzyl)-1-oxo-4,6-diphenyl-1,2-dihydronaphthalene-2-carboxylate (B19)

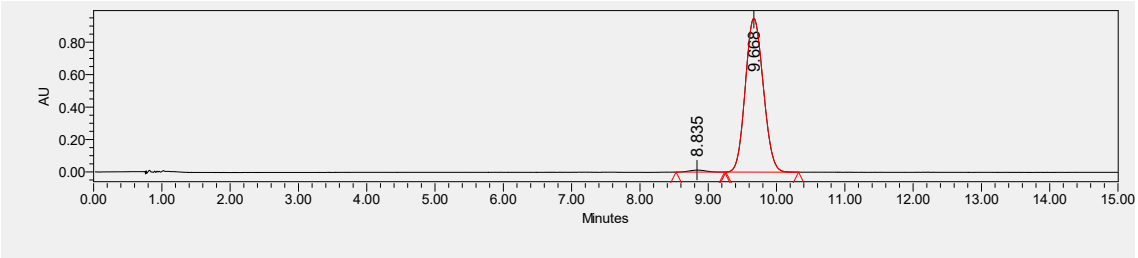


Result: colorless oil, 93% yield, 98% *ee*; $[\alpha]^{26.8}$ = -55.8 (*c* = 0.88 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OD-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 8.84 min, t_2 = 9.67 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.14 (d, *J* = 8.0 Hz, 1H), 7.54 (dd, *J* = 8.1, 1.8 Hz, 1H), 7.47 – 7.32 (m, 8H), 7.30 – 7.25 (m, 2H), 7.18 (d, *J* = 1.8 Hz, 1H), 7.06 (d, *J* = 8.7 Hz, 2H), 6.65 (d, *J* = 8.7 Hz, 2H), 6.08 (s, 1H), 4.20 (q, *J* = 7.1 Hz, 2H), 3.66 (s, 4H), 3.41 (d, *J* = 13.5 Hz, 1H), 1.22 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.0 , 169.9 , 158.4 , 146.9 , 139.7 , 138.8 , 138.4 , 138.3 , 131.4 , 131.3 , 128.8 , 128.5 , 128.3 , 128.0 , 128.0 , 127.9 , 127.3 , 127.2 , 126.8 , 125.4 , 113.1 , 61.99 , 55.1 , 41.8 , 14.0 .
HRMS (ESI) Calculated for $C_{33}H_{28}O_4$ ([M]+Na^+) = 511.1880, Found 511.1872.
IR (neat) 3747, 3058, 2989, 2834, 2343, 2055, 1992, 1739, 1674, 1595, 1443, 1275, 1179, 1036, 944, 849, 763, 659 cm^{-1}.

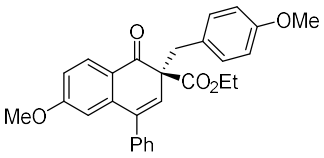


	Retention Time	Area	% Area
1	8.853	2814838	49.95
2	9.702	2820988	50.05



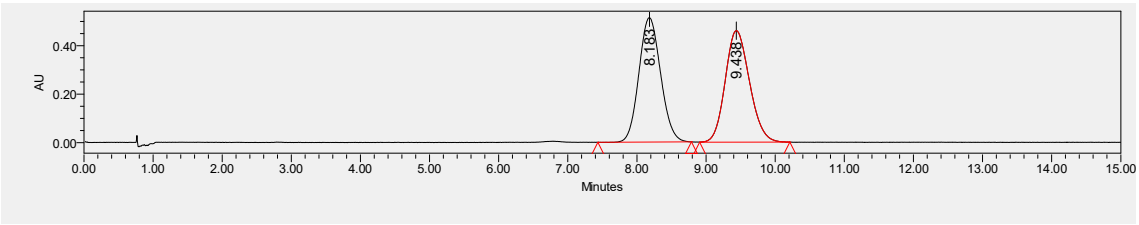
	Retention Time	Area	% Area
1	8.835	206828	1.18
2	9.668	17316018	98.82

Ethyl (S)-6-methoxy-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B20)

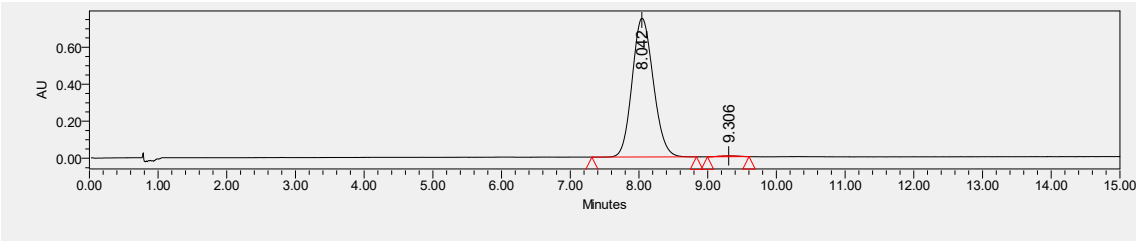


Result: colorless oil, 70% yield, 99% *ee*; $[\alpha]^{26.9}$ = -63.5 (*c* = 0.65 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 =8.04 min, t_2 = 9.31 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.98 (dd, *J* = 7.9 Hz, 1H), 7.46 – 7.39 (m, 3H), 7.22 (dd, *J* = 7.6, 1.9 Hz, 2H), 7.13 (d, *J* = 7.9 Hz, 1H), 7.03 (d, *J* = 8.7 Hz, 2H), 6.74 (s, 1H), 6.64 (d, *J* = 8.7 Hz, 2H), 6.01 (s, 1H), 4.18 (qd, *J* = 7.1, 1.3 Hz, 2H), 3.69 (s, 3H), 3.49 (dd, *J* = 92.9, 13.4 Hz, 2H), 2.24 (s, 3H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.0 , 170.0 , 158.3 , 145.3 , 139.0 , 138.3 , 137.9 , 131.3 , 131.1 , 129.0 , 128.9 , 128.4 , 127.7 , 127.5 , 127.4 , 127.2 , 127.1 , 113.0 , 61.9 , 61.8 , 55.1 , 41.8 , 21.9 , 14.0 .
HRMS (ESI) Calculated for $C_{28}H_{26}O_5$ ([M]+Na^+) = 465.1672, Found 465.1682.
IR (neat) 3746, 2987, 2835, 2349, 2054, 1994, 1738, 1673, 1599, 1443, 1276, 1179, 1036, 958, 899, 763, 649, 565 cm^{-1}.

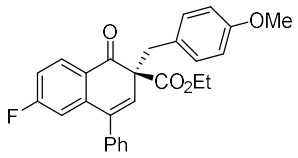


	Retention Time	Area	% Area
1	8.183	11181790	49.98
2	9.438	11188705	50.02



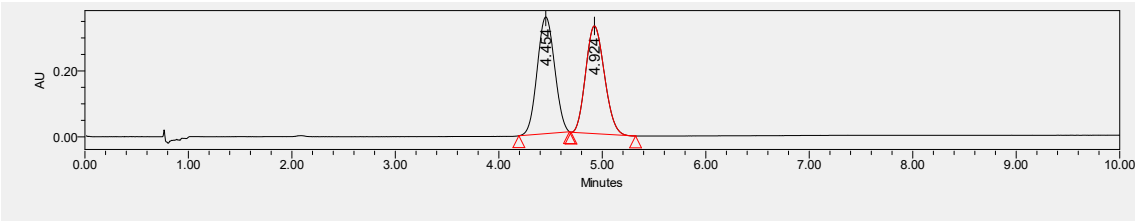
	Retention Time	Area	% Area
1	8.042	16033763	99.47
2	9.306	85292	0.53

Ethyl (S)-6-fluoro-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B21)

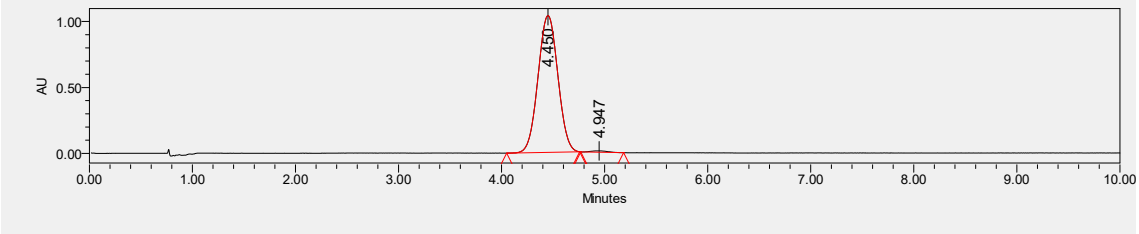


Result: colorless oil, 84% yield, 98% *ee*; $[\alpha]^{26.0}$ = -57.8(*c* = 0.85 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 4.45 min, t_2 = 4.95 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.09 (dd, *J* = 8.7, 6.0 Hz, 1H), 7.46 – 7.40 (m, 3H), 7.21 (dd, *J* = 7.4, 2.1 Hz, 2H), 7.03 – 6.95 (m, 3H), 6.66 – 6.60 (m, 3H), 6.11 (s, 1H), 4.20 (q, *J* = 7.1 Hz, 2H), 3.69 (s, 3H), 3.50 (dd, *J* = 100.0, 13.5 Hz, 2H), 1.21 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 194.9 , 169.6 , 167.8 , 165.3 , 158.4 , 141.0 (d, *J* = 9.4 Hz) , 138.1 , 137.61 (d, *J* = 2.6 Hz) , 132.4 , 131.3 , 131.26 , 130.4 (d, *J* = 9.8 Hz) , 128.7 , 128.6 , 128.1 , 127.0 , 125.9 (d, *J* = 2.8 Hz) , 115.36 (d, *J* = 22.4 Hz), 113.51 (d, *J* = 23.9 Hz) , 113.1 , 62.1 , 61.9 , 55.1 , 41.9 , 14.0 .
^{19}F NMR (377 MHz, Chloroform-*d*) δ -102.14 .
HRMS (ESI) Calculated for $C_{27}H_{23}FO_4$ ([M]+Na^+) = 453.1473, Found 453.1476.
IR (neat) 3745, 2987, 2836, 2349, 2055, 1989, 1741, 1678, 1573, 1443, 1389, 1275, 1179, 1035, 970, 881, 751, 658, 564 cm^{-1}.

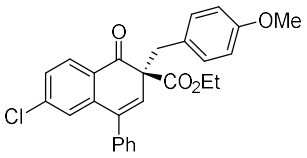


	Retention Time	Area	% Area
1	4.454	4126456	50.15
2	4.924	4101395	49.85



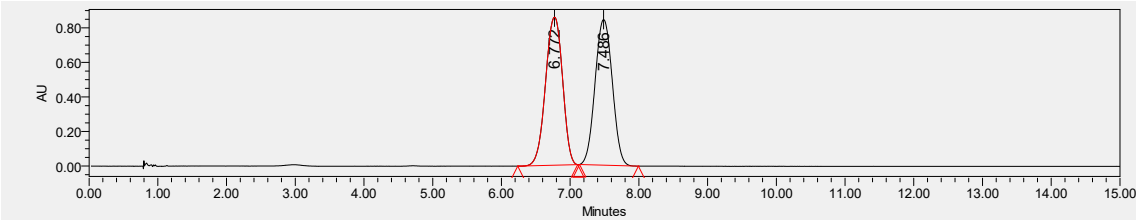
	Retention Time	Area	% Area
1	4.450	13824293	99.17
2	4.947	115972	0.83

Ethyl (S)-6-chloro-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B22)

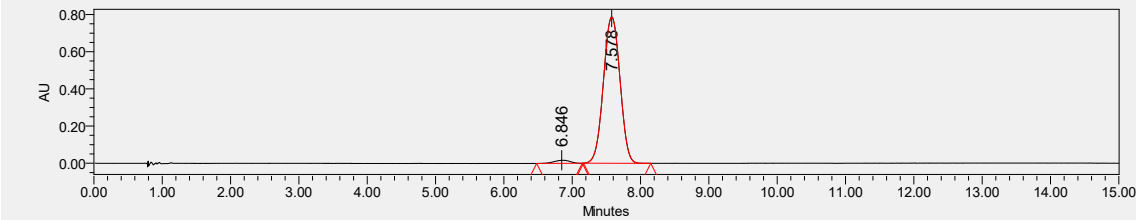


Result: colorless oil, 75% yield, 96% *ee*; $[\alpha]^{26.4}$ = -63.9 (*c* = 0.62 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OD-3, CO_2/MeOH = 95/5, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 6.85 min, t_2 = 7.58 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.00 (d, *J* = 8.4 Hz, 1H), 7.46 – 7.41 (m, 3H), 7.28 (dd, *J* = 8.4, 2.1 Hz, 1H), 7.20 (m, 2H), 7.02 – 6.98 (m, 2H), 6.92 (d, *J* = 2.1 Hz, 1H), 6.64 (d, *J* = 8.7 Hz, 2H), 6.09 (s, 1H), 4.19 (q, *J* = 6.9 Hz, 2H), 3.69 (s, 3H), 3.50 (dd, *J* = 101.9, 13.4 Hz, 2H), 1.21 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 195.4 , 169.5 , 158.4 , 141.0 , 138.0 , 137.5 , 132.4 , 131.2 , 128.9 , 128.7 , 128.7 , 128.3 , 128.1 , 127.5 , 126.9 , 126.7 , 113.1 , 62.1 , 62.0 , 55.1 , 41.9 , 14.0 .
HRMS (ESI) Calculated for $C_{27}H_{23}ClO_4$ ([M]+Na^+) = 469.1177, Found 469.1171.
IR (neat) 3746, 3060, 2981, 2835, 2349, 2056, 1987, 1741, 1678, 1642, 1585, 1442, 1179, 1036, 939, 894, 761, 657 cm^{-1}.

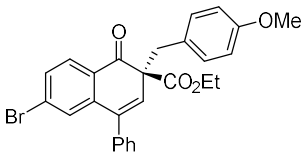


	Retention Time	Area	% Area
1	6.772	14716661	50.07
2	7.486	14674748	49.93



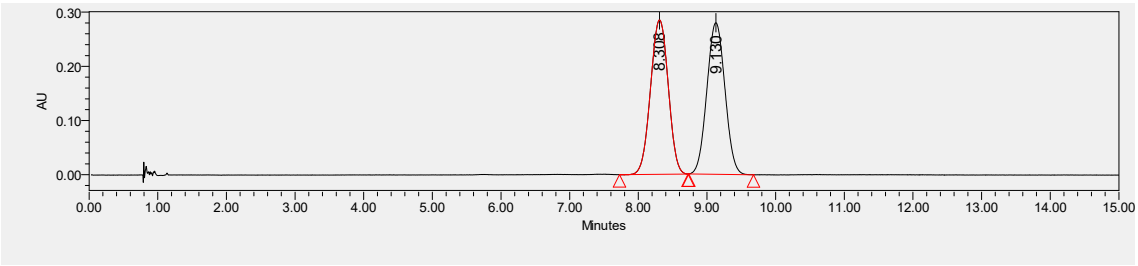
	Retention Time	Area	% Area
1	6.846	266777	1.97
2	7.578	13254145	98.03

Ethyl (S)-6-bromo-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B23)

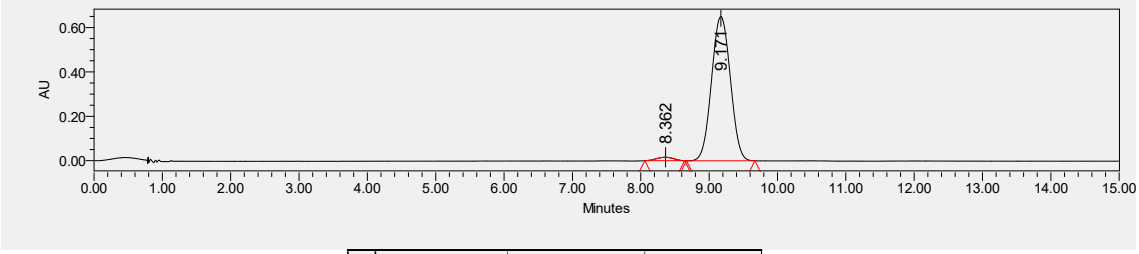


Result: colorless oil, 71% yield, 96% *ee*; $[\alpha]^{26.9}$ = -46.5 (*c* = 0.78 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OD-3, CO_2/MeOH = 95/5, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 8.36 min, t_2 = 9.17 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.91 (d, *J* = 8.3 Hz, 1H), 7.44 (m, 4H), 7.23 – 7.17 (m, 2H), 7.09 (d, *J* = 2.0 Hz, 1H), 7.00 (d, *J* = 8.6 Hz, 2H), 6.64 (d, *J* = 8.7 Hz, 2H), 6.09 (s, 1H), 4.19 (q, *J* = 6.9 Hz, 2H), 3.69 (s, 3H), 3.50 (dd, *J* = 101.8, 13.5 Hz, 2H), 1.21 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 195.6 , 169.5 , 158.4 , 139.5 , 138.0 , 137.4 , 132.5 , 131.3 , 131.2 , 120.0 , 129.6 , 128.9 , 128.7 , 128.7 , 128.1 , 127.9 , 126.9 , 113.1 , 62.1 , 62.0 , 55.1 , 41.9 , 14.0 .
HRMS (ESI) Calculated for $C_{27}H_{23}{}^{79}BrO_4$ ([M]+Na^+) = 513.0672, Found 513.0671.
HRMS (ESI) Calculated for $C_{27}H_{23}{}^{81}BrO_4$ ([M]+Na^+) = 515.0651, Found 515.0651.
IR (neat) 3746, 2988, 2835, 2349, 2054, 1995, 1741, 1678, 1580, 1275, 1179, 1036, 939, 895, 763, 659, 559 cm^{-1}.

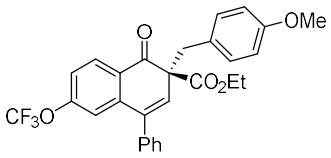


	Retention Time	Area	% Area
1	8.308	5109170	50.01
2	9.130	5107364	49.99



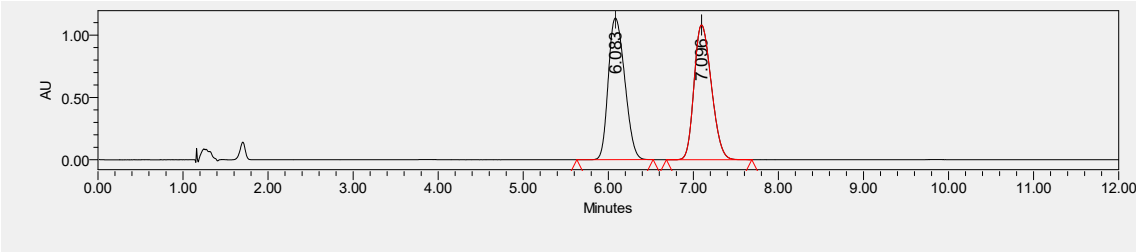
	Retention Time	Area	% Area
1	8.362	268502	2.12
2	9.171	12422845	97.88

Ethyl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-6-(trifluoromethoxy)-1,2-dihydronaphthalene-2-carboxylate (B24)

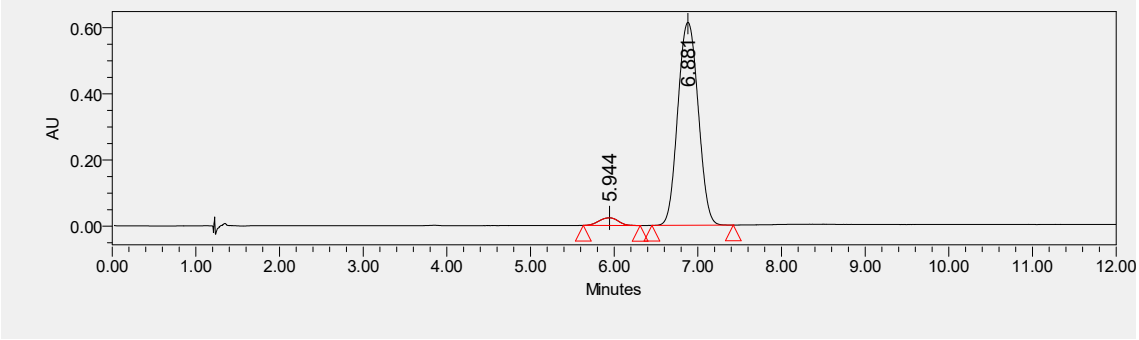


Result: colorless oil, 77% yield, 93% *ee*; $[\alpha]^{25.9}$ = -58.0 (*c* = 0.71 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OD-3, CO_2/^{i}PrOH = 95/5, flow rate = 1.0 mL/min, λ = 254 nm), t_1 = 5.94 min, t_2 = 6.88 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.10 (d, *J* = 8.6 Hz, 1H), 7.47 – 7.41 (m, 3H), 7.24 – 7.20 (m, 2H), 7.13 (m, 1H), 7.01 (d, *J* = 8.7 Hz, 2H), 6.79 – 6.73 (s, 1H), 6.64 (d, *J* = 8.6 Hz, 2H), 6.13 (s, 1H), 4.20 (q, *J* = 7.1 Hz, 2H), 3.68 (s, 3H), 3.50 (dd, *J* = 97.0, 13.5 Hz, 2H), 1.22 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 195.0 , 169.5 , 158.5 , 153.5 , 140.3 , 137.9 , 137.5 , 132.5 , 131.3 , 129.6 , 128.7 , 128.7 , 128.2 , 127.4 , 126.8 , 119.2 , 118.3 , 113.1 , 62.2 , 62.1 , 55.1 , 41.9 , 14.0 .
HRMS (ESI) Calculated for $C_{28}H_{23}F_3O_5$ ([M]+Na^+) = 519.1390, Found 519.1394.
IR (neat) 3747, 2982, 2837, 2348, 1742, 1681, 1644, 1483, 1443, 1177, 1037, 942, 895, 761, 621 cm^{-1}

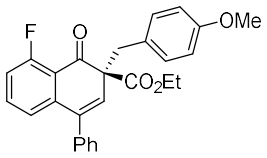


	Retention Time	Area	% Area
1	6.083	15254582	50.03
2	7.096	15234392	49.97



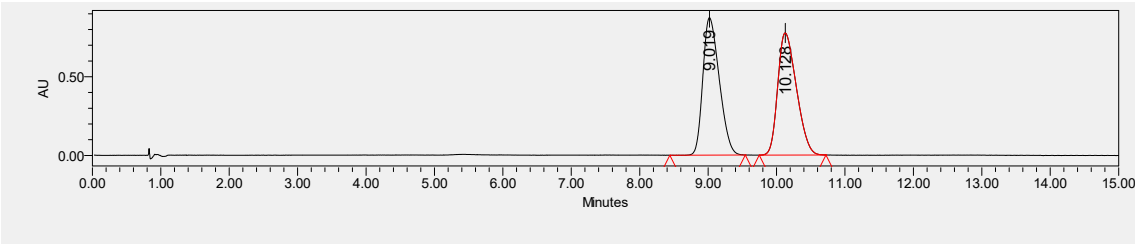
	Retention Time	Area	% Area
1	5.944	369379	3.44
2	6.881	10355235	96.56

Ethyl (S)-8-fluoro-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B25)

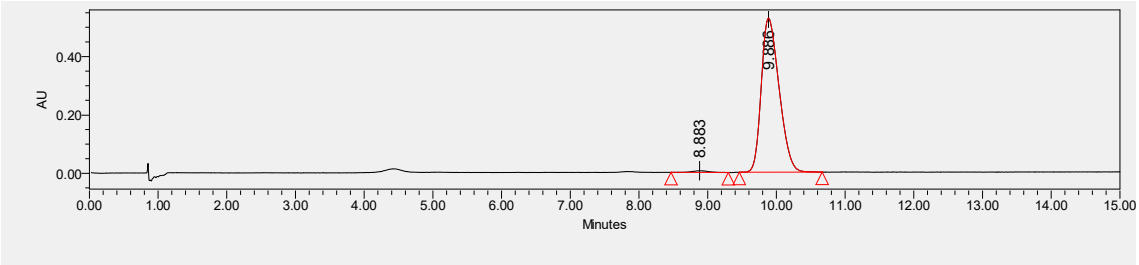


Result: colorless oil, 85% yield, 98% *ee*; $[\alpha]^{26.4}$ = -99.0 (*c* = 0.78 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel IE-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 =8.88 min, t_2 = 9.89 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.46 – 7.37 (m, 3H), 7.32 (td, *J* = 8.1, 5.2 Hz, 1H), 7.25 – 7.19 (m, 2H), 7.07 (d, *J* = 8.6 Hz, 2H), 6.97 (td, *J* = 10.8, 8.3, 1.0 Hz, 1H), 6.72 (d, *J* = 7.9 Hz, 1H), 6.66 (d, *J* = 8.7 Hz, 2H), 6.05 (s, 1H), 4.21 (qd, *J* = 7.2, 2.3 Hz, 2H), 3.69 (s, 3H), 3.48 (dd, *J* = 93.0, 13.5 Hz, 2H), 1.22 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 194.2 , 169.7 , 163.0 , 160.4 , 158.4 , 140.2 , 138.6 , 138.0 , 135.3 , 135.2 , 131.4 , 131.3 , 128.8 , 128.5 , 128.0 , 127.1 , 122.8 , 122.7 , 116.7, 116.4 , 113.1 , 63.0 , 62.0 , 55.1 , 41.3 , 14.0 .
^{19}F NMR (377 MHz, Chloroform-*d*) δ -111.50 .
HRMS (ESI) Calculated for $C_{27}H_{23}FO_4$ ([M]+Na^+) = 453.1473, Found 453.1471.
IR (neat) 3747, 2988, 2836, 2349, 2054, 1986, 1740, 1681, 1642, 1569, 1444, 1389, 1276, 1179, 1037, 922, 897, 798, 659, 559 cm^{-1}.

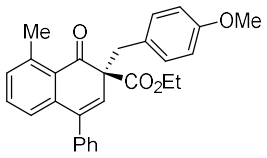


	Retention Time	Area	% Area
1	9.019	14544961	49.81
2	10.128	14657180	50.19



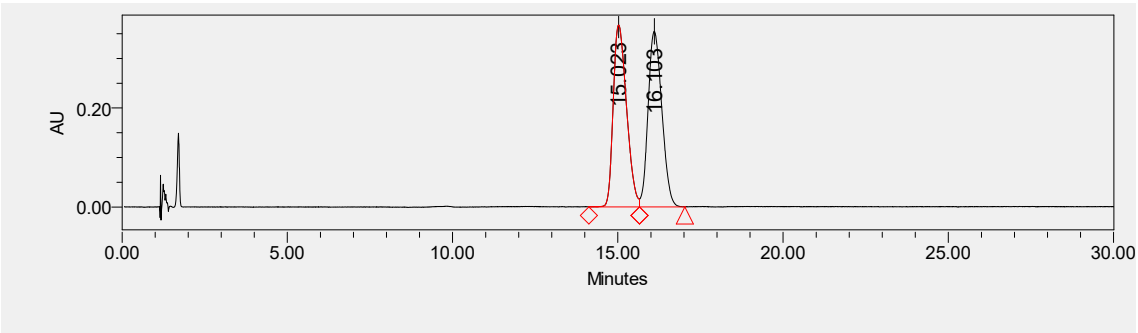
	Retention Time	Area	% Area
1	8.883	89978	0.94
2	9.886	9483498	99.06

Ethyl (S)-2-(4-methoxybenzyl)-8-methyl-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B26)

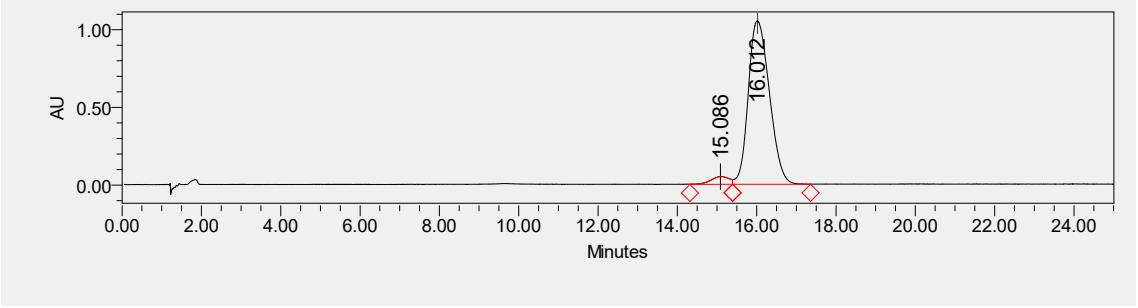


Result: colorless oil, 84% yield, 92% *ee*; $[\alpha]^{26.0}$ = -140.0 (*c* = 0.69 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OD-3, CO_2/^{i}PrOH = 95/5, flow rate = 1.0 mL/min, λ = 254 nm), t_1 = 15.09 min, t_2 = 16.01 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.44 – 7.34 (m, 3H), 7.27 – 7.20 (m, 3H), 7.11 (d, *J* = 7.5 Hz, 1H), 7.06 (d, *J* = 8.6 Hz, 2H), 6.81 (d, *J* = 7.7 Hz, 1H), 6.66 (d, *J* = 8.6 Hz, 2H), 5.99 (s, 1H), 4.19 (qq, *J* = 6.8, 3.6 Hz, 2H), 3.70 (s, 3H), 3.50 – 3.35 (m, 2H), 2.65 (s, 3H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 198.4 , 170.4 , 158.4 , 141.1 , 139.4 , 139.1 , 138.7 , 132.9 , 131.9 , 131.3 , 129.8 , 128.9 , 128.4 , 128.8 , 127.7, 125.2 , 113.1 , 63.2 , 61.8 , 55.1 , 40.9 , 22.8 , 14.0 .
HRMS (ESI) Calculated for $C_{28}H_{26}BrO_4$ ([M]+Na^+) = 449.1723, Found 449.1725.
IR (neat) 3746, 3057, 2987, 2835, 2354, 2055, 1889, 1739, 1671, 1583, 1442, 1381, 1178, 1036, 975, 895, 796, 659, 599 cm^{-1}.

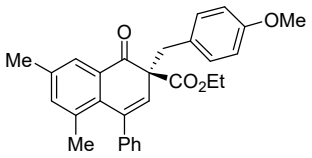


	Retention Time	Area	% Area
1	15.023	10268365	50.01
2	16.103	10265600	49.99



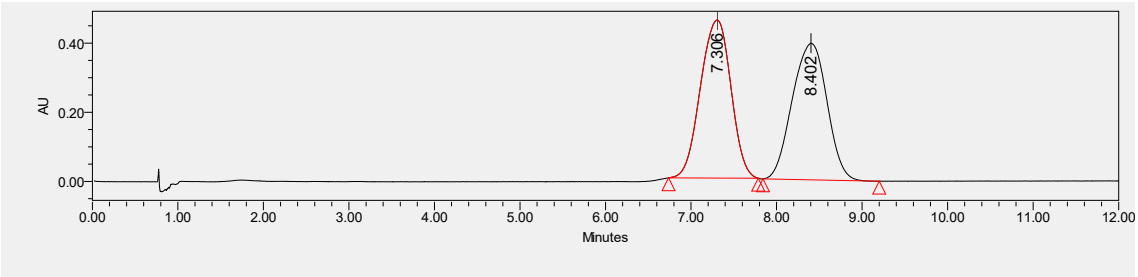
	Retention Time	Area	% Area
1	15.086	1615603	3.97
2	16.012	39037415	96.03

Ethyl (S)-2-(4-methoxybenzyl)-5,7-dimethyl-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B27)

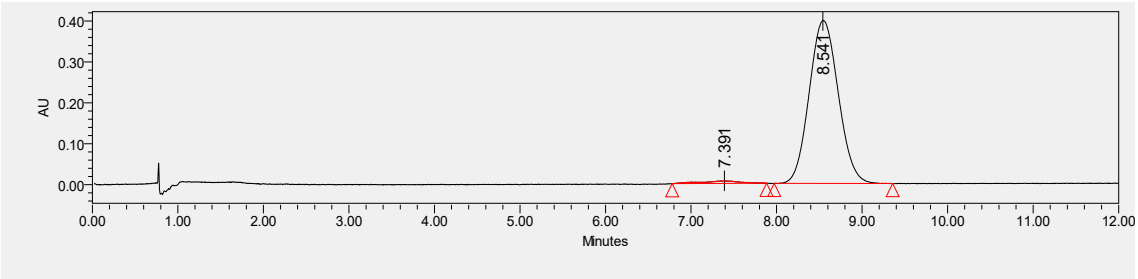


Result: colorless oil, 63% yield, 96% *ee*; $[\alpha]^{25.8}$ = -91.7 (*c* = 1.10 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 7.39 min, t_2 = 8.54 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.68 (s, 1H), 7.33 (d, *J* = 6.1 Hz, 3H), 7.16 (m, 2H), 7.06 – 7.02 (m, 3H), 6.66 (d, *J* = 8.7 Hz, 2H), 5.95 (s, 1H), 4.23 – 4.13 (m, 2H), 3.71 (s, 3H), 3.38 (d, *J* = 5.1 Hz, 2H), 2.33 (s, 3H), 1.58 (s, 3H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 197.6 , 170.3 , 158.3 , 142.7 , 139.1 , 139.0 , 137.9 , 135.8 , 133.4 , 131.4 , 130.8 , 130.3 , 128.4 , 127.7 , 127.7 , 127.2 , 125.9 , 112.9 , 62.1 , 61.8 , 55.1 , 41.0 , 22.8 , 20.8 , 14.0 .
HRMS (ESI) Calculated for $C_{29}H_{28}O_4$ ([M]+Na^+) = 463.1880, Found 463.1880.
IR (neat) 3746, 2988, 2835, 2349, 2055, 1987, 1739, 1675, 1444, 1365, 1276, 1178, 1036, 915, 833, 763, 637, 561 cm^{-1}.

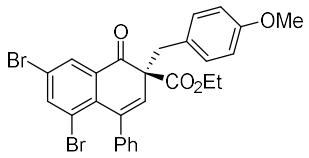


	Retention Time	Area	% Area
1	7.306	11297170	50.36
2	8.402	11135624	49.64



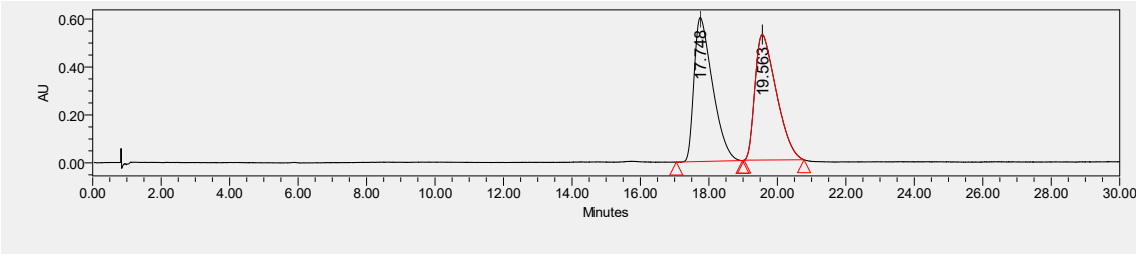
	Retention Time	Area	% Area
1	7.391	195254	2.03
2	8.541	9403144	97.97

Ethyl (S)-5,7-dibromo-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B28)

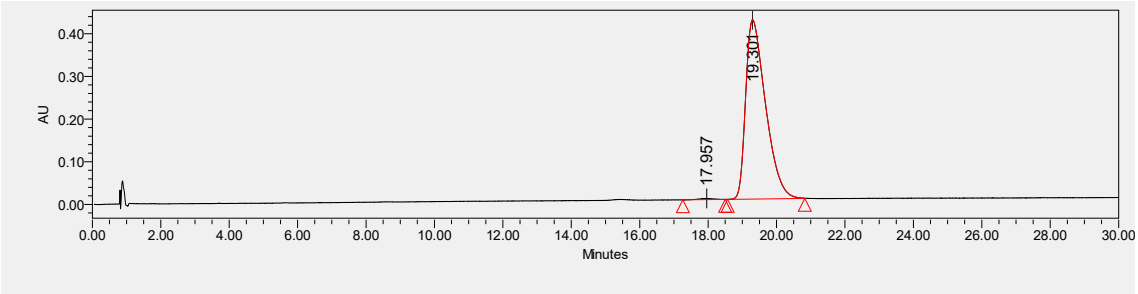


Result: White solid, Mp: 121-123 °C, 60% yield, 99% *ee*; $[\alpha]^{26.6}$ = 32.7 (*c* = 0.66 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel IE-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 17.96 min, t_2 = 19.30 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.16 (s, 1H), 7.92 (s, 1H), 7.54 (s, 1H), 7.36 (m, 3H), 7.23 (d, *J* = 7.2 Hz, 2H), 6.64 (d, *J* = 8.7 Hz, 2H), 6.54 (d, *J* = 8.7 Hz, 2H), 4.51 (d, *J* = 13.3 Hz, 1H), 4.33 – 4.28 (m, 2H), 3.68 (s, 3H), 3.59 (d, *J* = 13.3 Hz, 1H), 1.33 (d, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 178.4 , 163.8 , 160.3 , 158.5 , 141.6 , 141.0 , 139.8 , 137.0 , 130.8 , 129.8 , 129.2 , 127.8 , 127.4 , 126.9 , 126.3 , 122.4 , 113.2 , 61.6 , 55.0 , 52.8 , 38.4 , 14.2 .
HRMS (ESI) Calculated for $C_{27}H_{22}{}^{79}Br_2O_4$ ([M]+Na^+) = 590.9782, Found 590.9782.
HRMS (ESI) Calculated for $C_{27}H_{22}{}^{81}Br_2O_4$ ([M]+Na^+) = 594.9736, Found 594.9758.
HRMS (ESI) Calculated for $C_{27}H_{22}{}^{79}Br^{81}BrO_4$ ([M]+Na^+) = 592.9757, Found 592.9776.
IR (neat) 3746, 3065, 2982, 2835, 2349, 2107, 1989, 1739, 1670, 1572, 1444, 1276, 1180, 1030, 962, 878, 752, 698, 583 cm^{-1}.

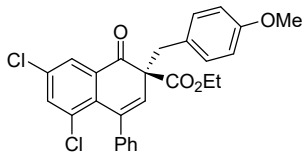


	Retention Time	Area	% Area
1	17.748	22563926	49.94
2	19.563	22616386	50.06



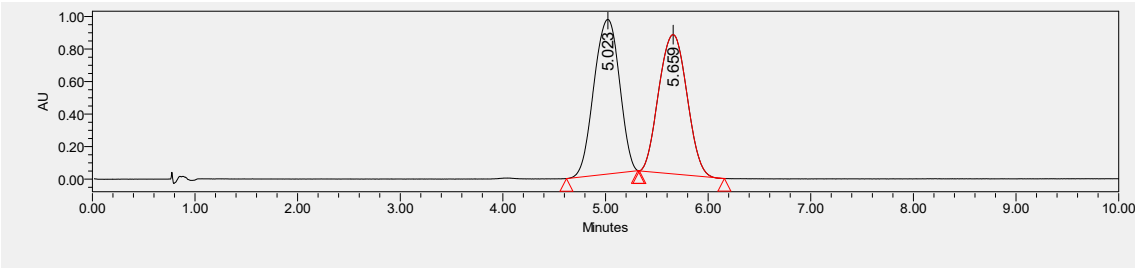
	Retention Time	Area	% Area
1	17.957	71019	0.42
2	19.301	16921386	99.58

Ethyl (S)-5,7-dichloro-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B29)

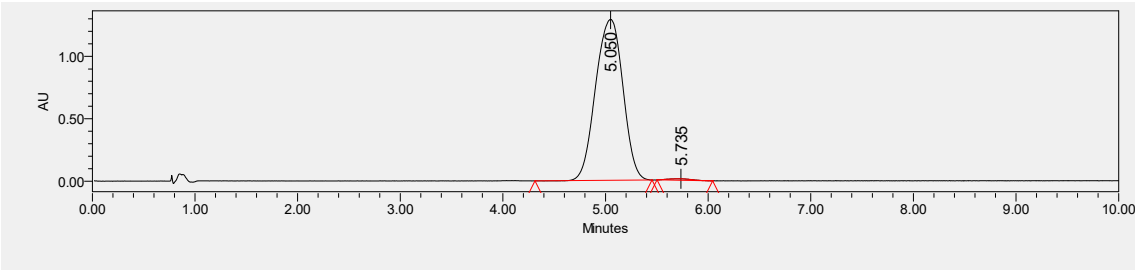


Result: colorless oil, 55% yield, 98% *ee*; $[\alpha]^{26.3}$ = 20.3 (*c* = 0.50 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 5.05 min, t_2 = 5.73 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.97 (d, *J* = 2.4 Hz, 1H), 7.54 (d, *J* = 4.1 Hz, 2H), 7.37 – 7.33 (m, 3H), 7.23 (d, *J* = 6.5 Hz, 2H), 6.63 (d, *J* = 8.7 Hz, 2H), 6.53 (s, 2H), 4.39 (d, *J* = 13.3 Hz, 1H), 4.32 – 4.28 (m, 2H), 3.68 (s, 3H), 3.62 (d, *J* = 13.2 Hz, 1H), 1.34 (s, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 178.5 , 163.9 , 160.3 , 158.5 , 139.8 , 136.3 , 134.8 , 134.5 , 134.4 , 130.7 , 129.2 , 127.7 , 127.2 , 127.1 , 126.4 , 126.2 , 113.3 , 61.6 , 55.0 , 51.8 , 38.7 , 14.2 .
HRMS (ESI) Calculated for $C_{27}H_{22}Cl_2O_4$ ([M]+Na^+) = 503.0787, Found 503.0788.
IR (neat) 3746, 3070, 2984, 2836, 2349, 1988, 1739, 1671, 1582, 1444, 1276, 1029, 964, 878, 762, 698, 645, 589 cm^{-1}.

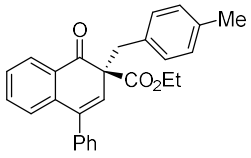


	Retention Time	Area	% Area
1	5.023	16436486	50.22
2	5.659	16295732	49.78



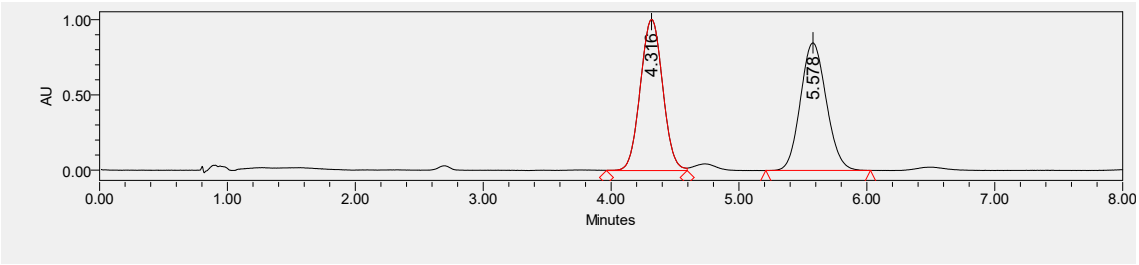
	Retention Time	Area	% Area
1	5.050	23828073	99.23
2	5.735	185531	0.77

Ethyl (S)-2-(4-methylbenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B30)

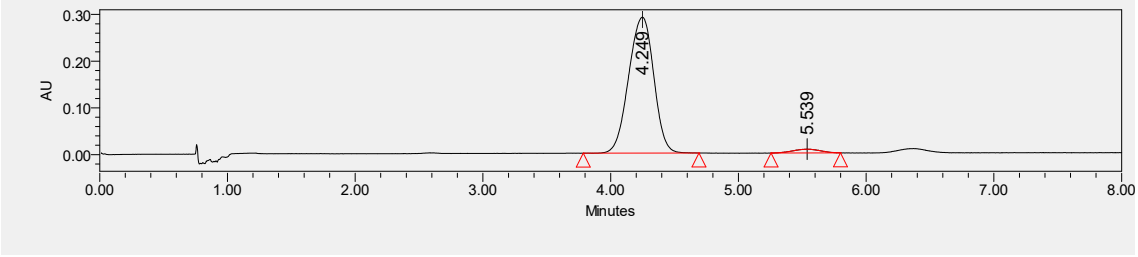


Result: colorless oil, 18% yield, 94% *ee*, $[\alpha]^{26.6}$ = -47.4 (*c* = 0.22 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 4.25 min, t_2 =5.54 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.07 (dd, *J* = 7.6, 1.5 Hz, 1H), 7.45 – 7.38 (m, 4H), 7.32 (m, 1H), 7.22 (m, 2H), 7.00 (d, *J* = 8.0 Hz, 2H), 6.96 (d, *J* = 7.3 Hz, 1H), 6.90 (d, *J* = 7.8 Hz, 2H), 6.03 (s, 1H), 4.19 (q, *J* = 7.1 Hz, 2H), 3.51 (dd, *J* = 80.1, 13.3 Hz, 2H), 2.19 (s, 3H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.4 , 169.9 , 138.9 , 138.2 , 137.9 , 136.2 , 134.2 , 132.1 , 130.8 , 130.2 , 129.3 , 128.9 , 128.4 , 128.4 , 128.1 , 127.8 , 127.3 , 126.7 , 62.0 , 61.8 , 42.1 , 21.0 , 14.0 .
HRMS (ESI) Calculated for $C_{27}H_{24}O_3$ ([M]+Na^+) = 419.1618, Found 419.1620.
IR (neat) 3743, 3057, 2980, 2350, 1987, 1739, 1677, 1644, 1445, 1278, 1037, 943, 895, 751, 679, 576, cm^{-1}.

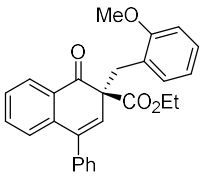


	Retention Time	Area	% Area
1	4.316	12209594	50.69
2	5.578	11875095	49.31



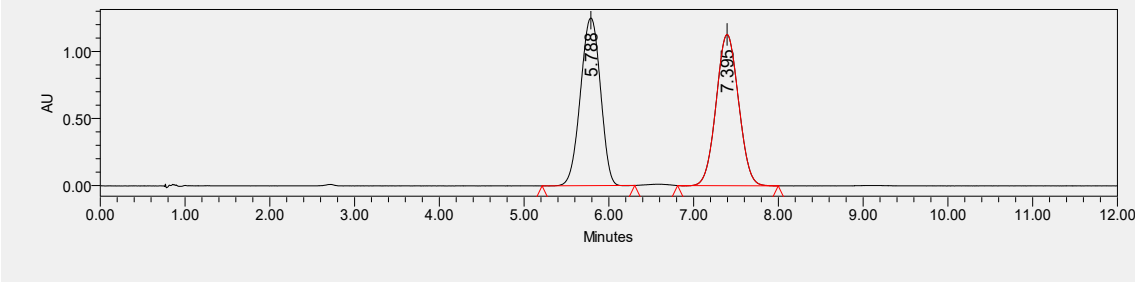
	Retention Time	Area	% Area
1	4.249	3970243	97.15
2	5.539	116655	2.85

Ethyl (S)-2-(2-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B31)

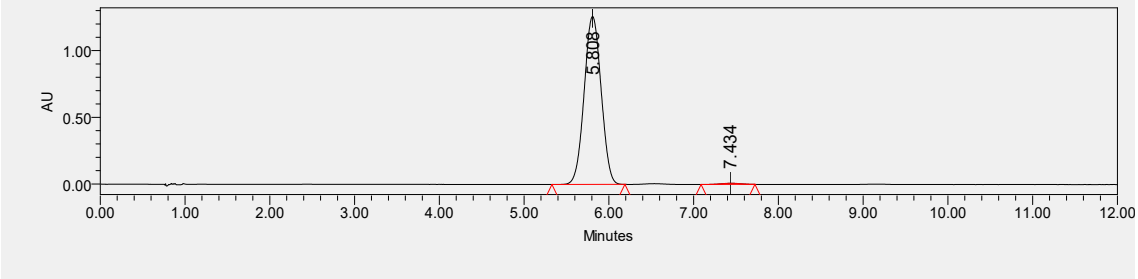


Result: colorless oil, 29% yield, 98% *ee*, $[\alpha]^{17.8}$ = -132 (*c* = 0.20 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 5.81 min, t_2 = 7.43 min.

^{1}H NMR (400 MHz, Chloroform-d) δ 8.16 – 8.05 (m, 1H), 7.39 – 7.30 (m, 5H), 7.09 – 7.02 (m, 4H), 6.92 (m, 1H), 6.67 (m, J = 7.4, 1.1 Hz, 1H), 6.63 (d, J = 8.0 Hz, 1H), 6.01 (s, 1H), 4.20 (q, J = 7.1 Hz, 2H), 3.71 – 3.62 (m, 2H), 3.47 (s, 3H), 1.21 (t, J = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.7 , 170.4 , 157.7 , 139.0 , 137.8 , 137.2 , 134.0 , 131.9 , 131.2 , 129.6 , 128.9 , 128.2 , 128.0 , 127.8 , 127.6 , 127.0 , 126.5 , 124.2 , 119.8 , 109.6 , 61.9 , 61.6 , 54.5 , 36.8 , 14.0 .
HRMS (ESI) Calculated for $C_{27}H_{24}O_4$ ([M]+Na^+) = 435.1567, Found 435.1567.
IR (neat) 3746, 3064, 2937, 1739, 1679, 1449, 1443, 1359, 1290, 1246, 1112, 1031, 941, 860, 755, 570 cm^{-1}.

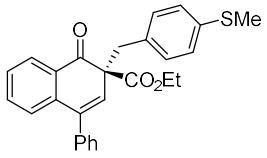


	Retention Time	Area	% Area
1	5.788	20488818	49.78
2	7.395	20672803	50.22



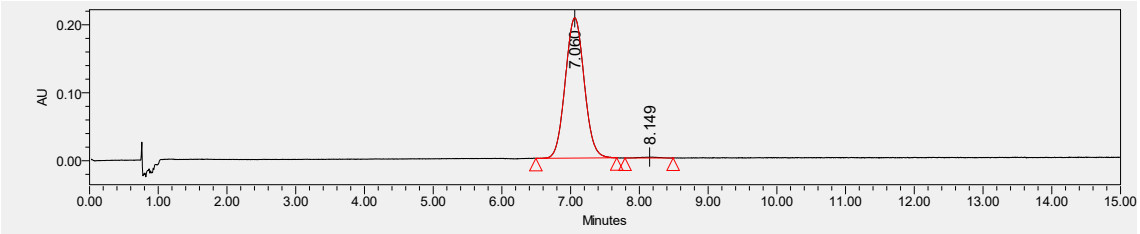
	Retention Time	Area	% Area
1	5.808	17499282	99.24
2	7.434	134508	0.76

Ethyl (S)-2-(4-(methylthio)benzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B32)

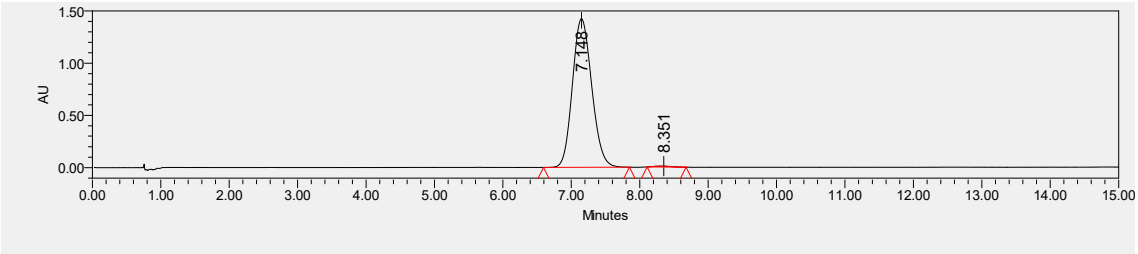


Result: colorless oil, 59% yield, 99% *ee*; $[\alpha]^{26.1}$ = -75.3 (*c* = 0.50 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 7.15 min, t_2 = 8.35 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.06 (dd, *J* = 7.7, 1.5 Hz, 1H), 7.45 – 7.38 (m, 4H), 7.33 (td, *J* = 7.5, 1.3 Hz, 1H), 7.22 (dd, *J* = 7.4, 2.0 Hz, 2H), 7.05 – 6.96 (m, 5H), 6.02 (s, 1H), 4.19 (q, *J* = 7.1 Hz, 2H), 3.51 (dd, *J* = 89.9, 13.4 Hz, 2H), 2.37 (s, 3H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.2 , 169.8 , 138.7 , 138.5 , 136.6 , 134.4 , 132.2 , 130.8 , 130.5 , 129.2 , 128.9 , 128.5 , 128.2 , 127.9 , 127.3 , 126.8 , 126.1 , 62.0 , 61.7 , 42.0 , 15.9 , 14.0 .
HRMS (ESI) Calculated for $C_{27}H_{24}O_3S$ ([M]+Na^+) = 451.1338, Found 451.1340.
IR (neat) 3746, 3059, 2981, 2350, 2054, 1990, 1739, 1677, 1593, 1442, 1277, 1157, 1036, 967, 896, 776, 636 cm^{-1}.

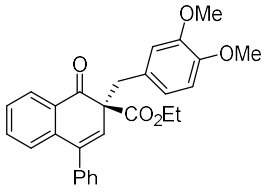


	Retention Time	Area	% Area
1	7.060	3938798	99.43
2	8.149	22433	0.57



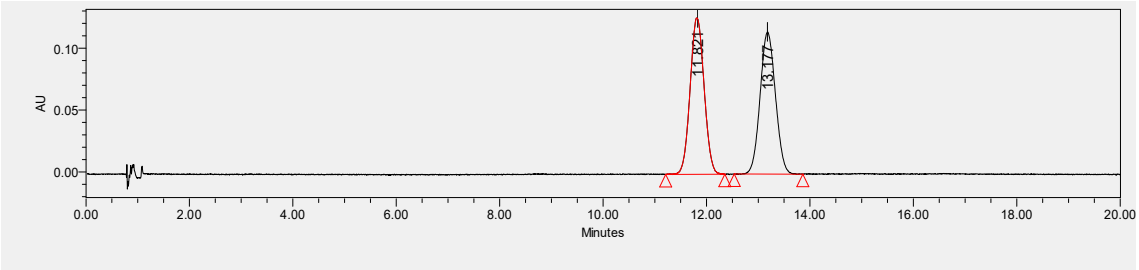
	Retention Time	Area	% Area
1	7.148	27856947	99.49
2	8.351	144117	0.51

Ethyl (S)-2-(3,4-dimethoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B33)

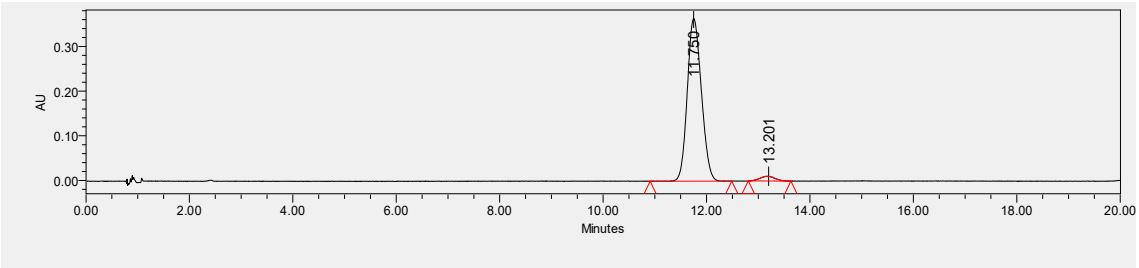


Result: colorless oil, 92% yield, 94% *ee*; $[\alpha]^{26.5}$ = -57.2 (*c* = 0.77 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel IC-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 =11.70 min, t_2 = 13.20 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.09 (dd, *J* = 7.7, 1.5 Hz, 1H), 7.40 (m, 4H), 7.32 (td, *J* = 7.5, 1.2 Hz, 1H), 7.22 – 7.16 (m, 2H), 6.98 (d, *J* = 7.8 Hz, 1H), 6.67 (dd, *J* = 8.2, 2.0 Hz, 1H), 6.64 – 6.56 (m, 2H), 6.03 (s, 1H), 4.19 (q, *J* = 7.1 Hz, 2H), 3.76 (s, 3H), 3.64 (d, *J* = 15.7 Hz, 4H), 3.39 (d, *J* = 13.5 Hz, 1H), 1.21 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.5 , 169.9 , 147.9 , 147.7 , 138.7 , 138.3 , 137.9 , 134.4 , 130.9 , 129.3 , 128.8 , 128.4 , 128.1 , 127.8 , 127.8 , 127.1 , 126.8 , 122.6 , 113.1 , 110.3 , 62.0 , 61.8 , 55.7 , 55.5 , 42.5 , 14.0 .
HRMS (ESI) Calculated for $C_{28}H_{26}O_5$ ([M]+Na^+) = 465.1672, Found 465.1681.
IR (neat) 3747, 3627, 3060, 2981, 2356, 1989, 1739, 1676, 1641, 1591, 1445, 1264, 1029, 942, 897, 763, 647cm^{-1}.

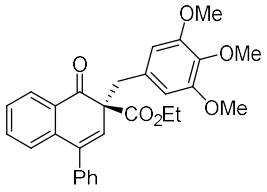


	Retention Time	Area	% Area
1	11.821	2374807	50.08
2	13.177	2367601	49.92



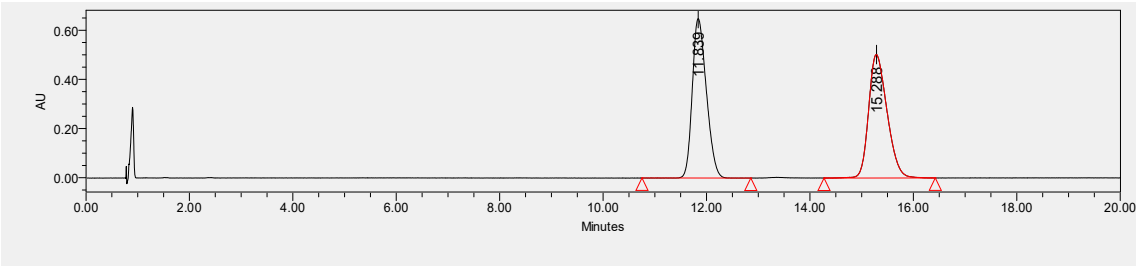
	Retention Time	Area	% Area
1	11.750	6883965	96.99
2	13.201	213499	3.01

Ethyl (S)-1-oxo-4-phenyl-2-(3,4,5-trimethoxybenzyl)-1,2-dihydronaphthalene-2-carboxylate (B34)

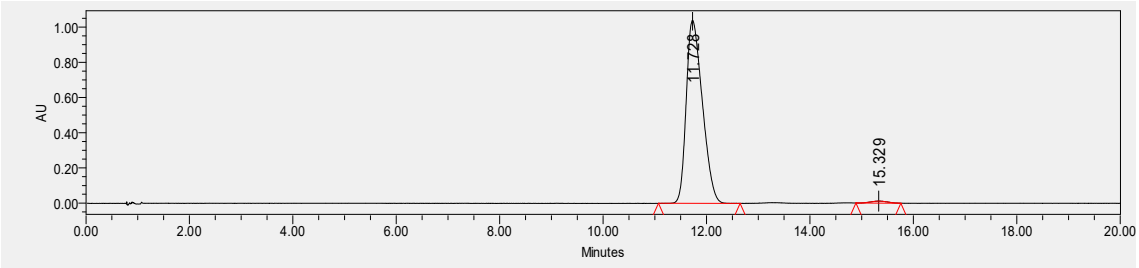


Result: colorless oil, 75% yield, 98% *ee*; $[\alpha]^{26.7}$ = -64.0 (*c* = 0.76 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel IC-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 11.73 min, t_2 = 15.33 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.08 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.44 – 7.37 (m, 4H), 7.33 (td, *J* = 7.5, 1.2 Hz, 1H), 7.16 (m, 2H), 6.98 (dd, *J* = 7.9, 1.2 Hz, 1H), 6.27 (s, 2H), 6.01 (s, 1H), 4.20 (q, *J* = 7.1 Hz, 2H), 3.69 (s, 3H), 3.66 (d, *J* = 13.4 Hz, 1H), 3.62 (s, 6H), 3.38 (d, *J* = 13.4 Hz, 1H), 1.21 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.6 , 169.6 , 152.3 , 138.6 , 138.4 , 137.9 , 136.7 , 134.5 , 131.0 , 130.9 , 129.4 , 128.8 , 128.4 , 128.2 , 127.9 , 127.0 , 126.9 , 107.2 , 62.0 , 61.7 , 60.7 , 55.8 , 43.3 , 14.0 .
HRMS (ESI) Calculated for $C_{29}H_{28}O_6$ ([M]+Na^+) = 495.1778, Found 495.1784.
IR (neat) 3747, 3610, 3060, 2987, 2836, 2350, 1988, 1739, 1676, 1641, 1422, 1276, 1040, 968, 840, 751, 662, 529 cm^{-1}.

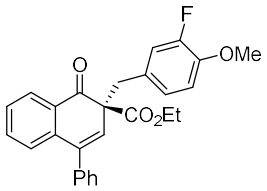


	Retention Time	Area	% Area
1	11.839	12263308	49.69
2	15.288	12418600	50.31



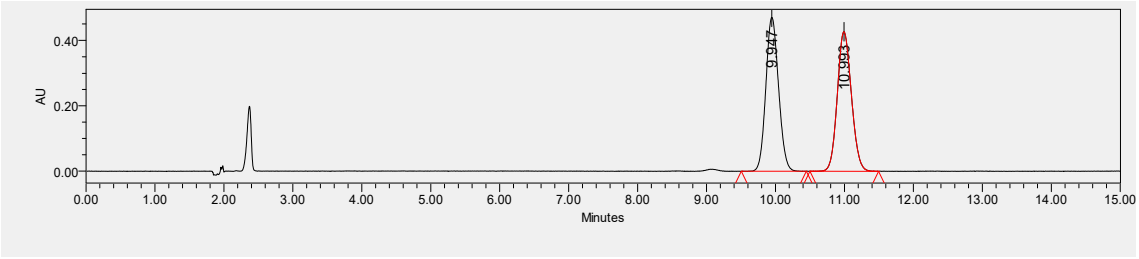
	Retention Time	Area	% Area
1	11.728	22486000	98.83
2	15.329	265424	1.17

Ethyl (S)-2-(3-fluoro-4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B35)

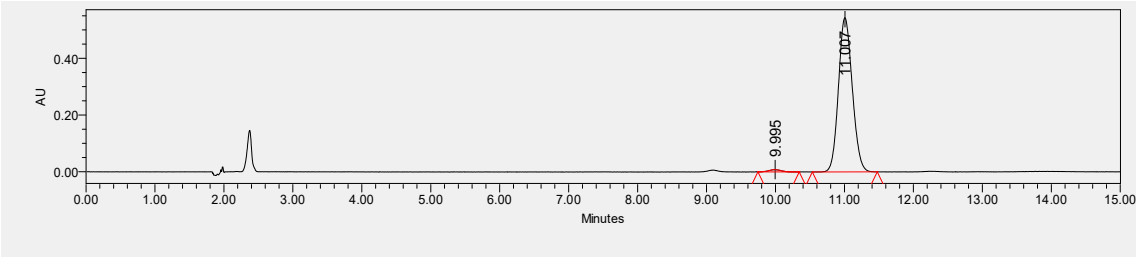


Result: colorless oil, 52% yield, 98% *ee*; $[\alpha]^{26.5}$ = -53.4 (*c* = 0.38 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel IG-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 10.00 min, t_2 = 11.01 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.06 (d, *J* = 8.0 Hz, 1H), 7.46 – 7.38 (m, 4H), 7.33 (m, 1H), 7.23 (m, 2H), 6.98 (m, 1H), 6.87 (m, 1H), 6.81 (m, 1H), 6.67 (t, *J* = 8.6 Hz, 1H), 6.02 (s, 1H), 4.19 (q, *J* = 7.1 Hz, 2H), 3.76 (s, 3H), 3.47 (dd, *J* = 100.5, 13.5 Hz, 2H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.2 , 169.7 , 152.6 , 150.2 , 146.4 , 146.3 , 138.7 , 138.6 , 137.8 , 134.4 , 130.3 , 129.2 , 128.8 , 128.5 , 128.3 , 128.2 , 127.9 , 127.3 , 126.9 , 126.1 , 126.1 , 118.0 , 117.8 , 112.5 , 62.1 , 61.7 , 56.1 , 41.5 , 14.0 .
^{19}F NMR (377 MHz, Chloroform-*d*) δ -136.15 .
HRMS (ESI) Calculated for $C_{27}H_{23}FO_4$ ([M]+Na^+) = 453.1473, Found 453.1482.
IR (neat) 3743, 3061, 2984, 2840, 2055, 1988, 1739, 1676, 1644, 1592, 1444, 1276, 1030, 959, 858, 751, 644, 595 cm^{-1}.

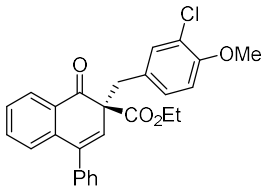


	Retention Time	Area	% Area
1	9.947	6032516	49.94
2	10.993	6047567	50.06



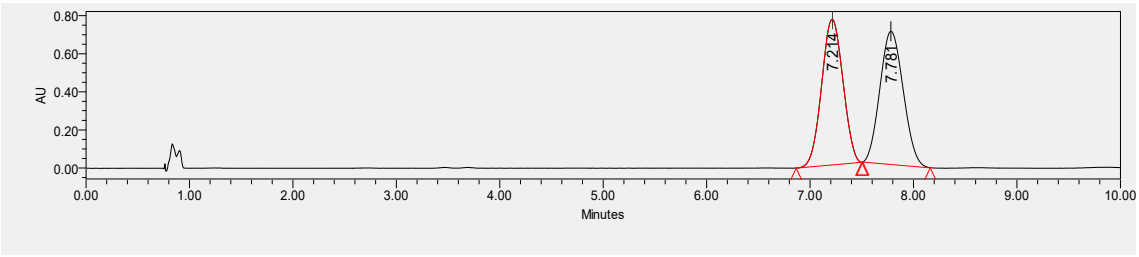
	Retention Time	Area	% Area
1	9.995	98911	1.29
2	11.007	7555895	98.71

Ethyl (S)-2-(3-chloro-4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B36)

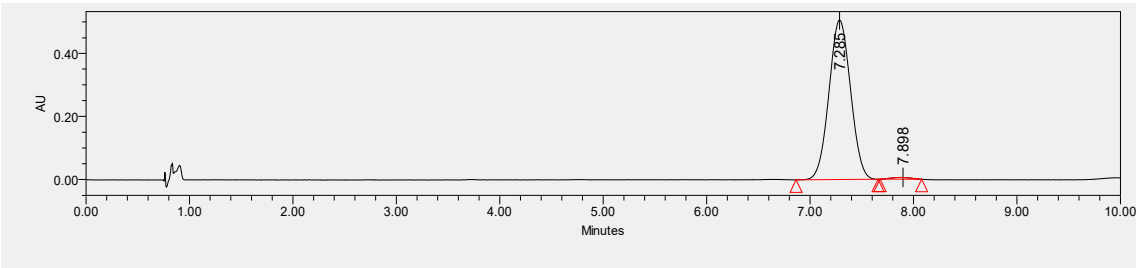


Result: White solid, Mp: 91-93 °C, 67% yield, 98% *ee*; $[\alpha]^{26.4}$ = -73.4 (*c* = 0.68 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 7.29 min, t_2 = 7.90 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.05 (dd, *J* = 7.7, 1.5 Hz, 1H), 7.46 – 7.38 (m, 4H), 7.32 (td, *J* = 7.5, 1.2 Hz, 1H), 7.26 – 7.23 (m, 2H), 7.15 (d, *J* = 2.2 Hz, 1H), 6.98 – 6.93 (m, 2H), 6.62 (d, *J* = 8.4 Hz, 1H), 6.01 (s, 1H), 4.19 (q, *J* = 7.1 Hz, 2H), 3.75 (s, 3H), 3.45 (dd, *J* = 96.3, 13.4 Hz, 2H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.2 , 169.8 , 153.7 , 138.9 , 138.6 , 137.8 , 134.4 , 131.9 , 130.2 , 129.6 , 129.1 , 128.9 , 128.5 , 128.3 , 128.3 , 127.9 , 127.2 , 126.98 , 121.3 , 111.2 , 62.1 , 61.7 , 56.0 , 41.4 , 14.0 .
HRMS (ESI) Calculated for $C_{27}H_{23}ClO_4$ ([M]+Na^+) = 469.1177, Found 469.1186.
IR (neat) 3747, 3061, 2979, 2838, 2055, 1988, 1739, 1676, 1643, 1592, 1442, 1290, 1065, 942, 855, 775, 640, 589 cm^{-1}.

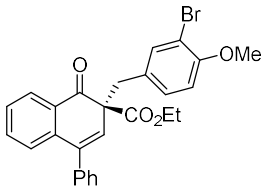


	Retention Time	Area	% Area
1	7.214	10912237	49.92
2	7.781	10946141	50.08



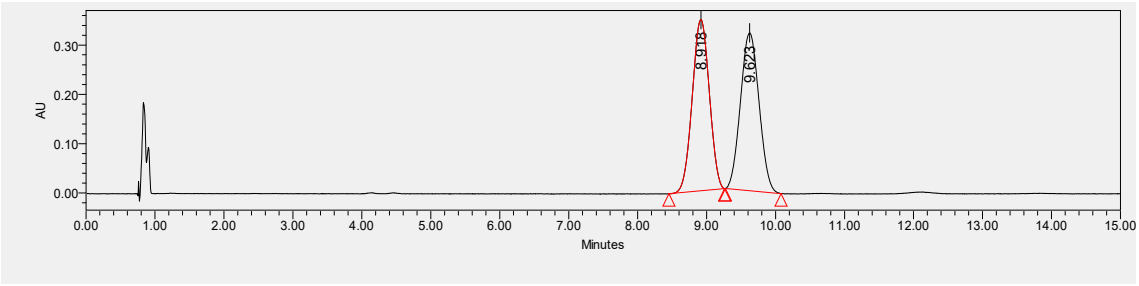
	Retention Time	Area	% Area
1	7.285	7340810	98.99
2	7.898	74850	1.01

Ethyl (S)-2-(3-bromo-4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B37)

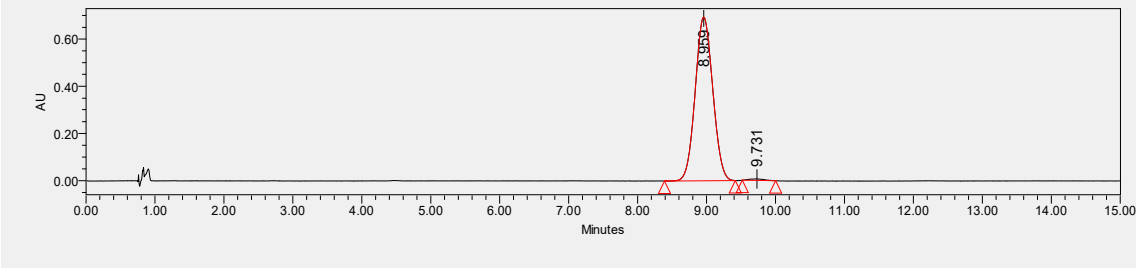


Result: White solid, Mp: 92-94 °C, 61% yield, 98% *ee*; $[\alpha]^{25.9}$ = -91.1 (*c* = 0.66 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 8.96 min, t_2 = 9.73 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.06 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.48 – 7.38 (m, 4H), 7.35 – 7.30 (m, 2H), 7.28 – 7.25 (m, 2H), 7.00 (dd, *J* = 8.4, 2.2 Hz, 1H), 6.97 (d, *J* = 7.8 Hz, 1H), 6.60 (d, *J* = 8.4 Hz, 1H), 6.02 (s, 1H), 4.20 (q, *J* = 7.1 Hz, 2H), 3.75 (s, 3H), 3.45 (dd, *J* = 94.1, 13.5 Hz, 2H), 1.21 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.2 , 169.8 , 154.6 , 138.9 , 138.6 , 137.8 , 135.0 , 134.4 , 130.4 , 130.2 , 129.1 , 129.0 , 128.8 , 128.5 , 128.3 , 127.9 , 127.2 , 126.9 , 111.0 , 110.5 , 62.1 , 61.7 , 56.1 , 41.3 , 14.0 .
HRMS (ESI) Calculated for $C_{27}H_{23}{}^{79}BrO_4$ ([M]+Na^+) = 513.0672, Found 513.0682.
HRMS (ESI) Calculated for $C_{27}H_{23}{}^{81}BrO_4$ ([M]+Na^+) = 515.0651, Found 515.0661.
IR (neat) 3747, 3005, 2982, 2837, 2055, 1987, 1739, 1676, 1593, 1442, 1355, 1277, 1055, 942, 854, 763, 639, 586 cm^{-1}.

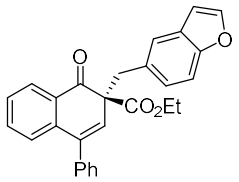


	Retention Time	Area	% Area
1	8.918	5963346	49.90
2	9.623	5988218	50.10



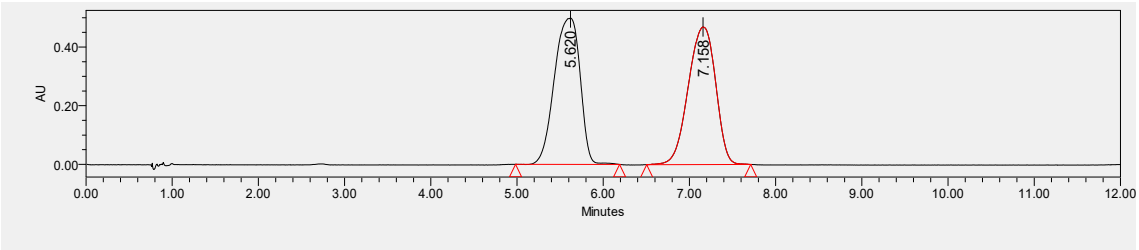
	Retention Time	Area	% Area
1	8.959	12258592	99.24
2	9.731	94046	0.76

Ethyl (S)-2-(benzofuran-5-ylmethyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B38)

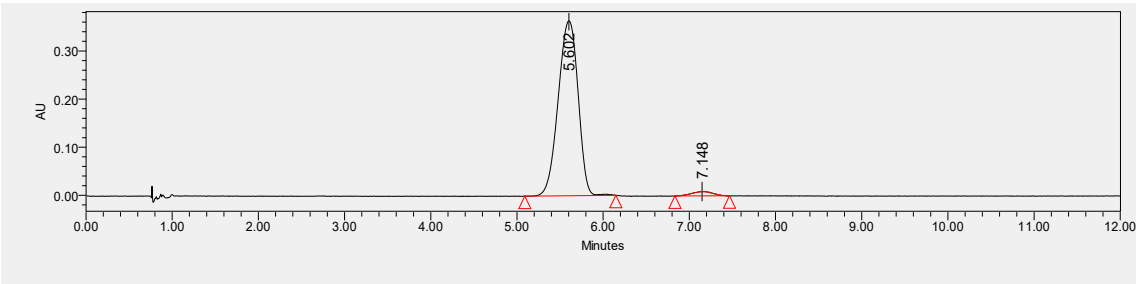


Result: colorless oil, 85% yield, 95% *ee*; $[\alpha]^{26.7}$ = -39.4 (*c* = 0.46 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 5.60 min, t_2 = 7.15 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.06 (d, *J* = 7.2 Hz, 1H), 7.50 (d, *J* = 2.3 Hz, 1H), 7.42 – 7.17 (m, 9H), 7.04 (dd, *J* = 8.5, 1.8 Hz, 1H), 6.89 (d, *J* = 7.2 Hz, 1H), 6.61 (s, 1H), 6.07 (s, 1H), 4.21 (q, *J* = 7.1 Hz, 2H), 3.65 (dd, *J* = 89.9, 13.4 Hz, 2H), 1.21 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.4 , 170.0 , 153.9 , 145.0 , 138.8 , 138.4 , 137.8 , 134.3 , 130.7 , 129.6 , 128.9 , 128.4 , 128.1 , 127.8 , 127.2 , 126.9 , 126.7 , 122.9 , 110.3 , 106.3 , 62.1 , 62.0 , 42.5 , 14.0 .
HRMS (ESI) Calculated for $C_{28}H_{22}O_4$ ([M]+Na^+) = 445.1410, Found 445.1401.
IR (neat) 3747, 3060, 2982, 2849, 2349, 2055, 1987, 1738, 1676, 1593, 1444, 1276, 1157, 1032, 941, 884, 764, 652 cm^{-1}.

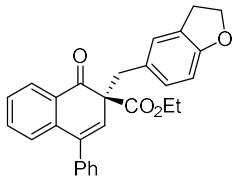


	Retention Time	Area	% Area
1	5.620	10359129	49.98
2	7.158	10368233	50.02



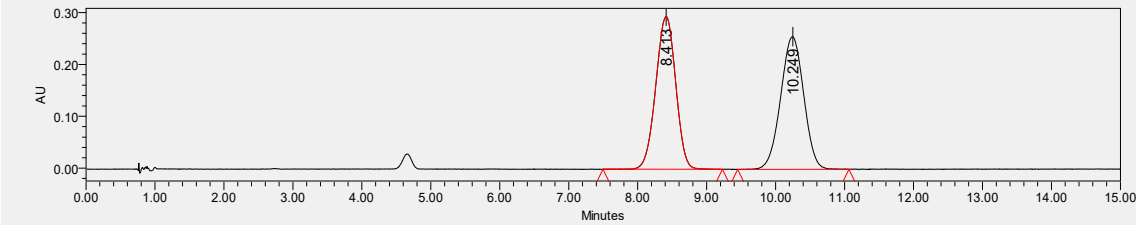
	Retention Time	Area	% Area
1	5.602	5825128	97.45
2	7.148	152385	2.55

Ethyl (S)-2-((2,3-dihydrobenzofuran-5-yl)methyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B39)

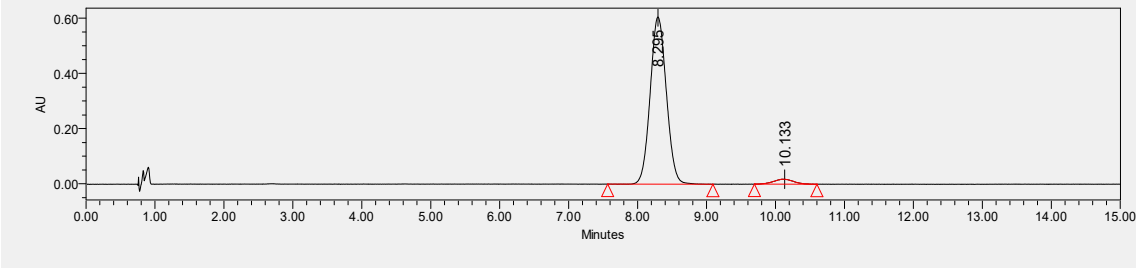


Result: colorless oil, 82% yield, 93% *ee*; $[\alpha]^{26.4}$= -88.8 (*c* = 0.67 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 8.30 min, t_2 = 10.13 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.06 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.45 – 7.38 (m, 4H), 7.32 (td, *J* = 7.6, 1.3 Hz, 1H), 7.23 (m, 2H), 6.98 – 6.93 (m, 2H), 6.84 (d, *J* = 7.7 Hz, 1H), 6.51 (d, *J* = 8.1 Hz, 1H), 6.03 (s, 1H), 4.43 (m, 2H), 4.20 (q, *J* = 7.1 Hz, 2H), 3.48 (dd, *J* = 85.3, 13.4 Hz, 2H), 3.07 – 2.95 (m, 2H), 1.21 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.6 , 170.0 , 158.8 , 138.8 , 138.2 , 137.9 , 134.2 , 130.8 , 130.0 , 129.3 , 128.9 , 128.4 , 128.0 , 127.8 , 127.1 , 127.0 , 126.9 , 126.7 , 126.2 , 108.2 , 71.1 , 62.0 , 61.9 , 42.2 , 29.5 , 14.0 .
HRMS (ESI) Calculated for $C_{28}H_{24}O_4$ ([M]+Na^+) = 447.1567, Found 447.1573.
IR (neat) 3747, 3058, 2979, 2353, 2088, 1993, 1739, 1676, 1593, 1443, 1277, 1156, 1038, 983, 857, 775, 659, 578 cm^{-1}.

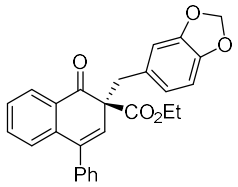


	Retention Time	Area	% Area
1	8.413	5907398	49.86
2	10.249	5940969	50.14



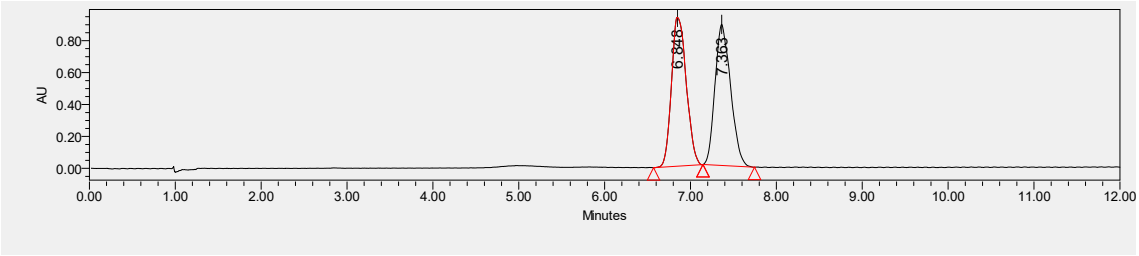
	Retention Time	Area	% Area
1	8.295	9865564	96.46
2	10.133	361870	3.54

Ethyl (S)-2-(benzo[d][1,3]dioxol-5-ylmethyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B40)

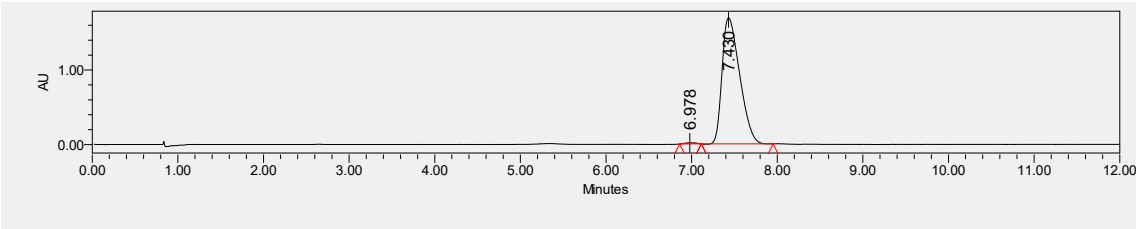


Result: colorless oil, 65% yield, 99% *ee*; $[\alpha]^{25.0}$ = -57.0 (*c* = 0.55 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel IE-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 6.98 min, t_2 = 7.43 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.07 (dd, *J* = 7.7, 1.5 Hz, 1H), 7.47 – 7.39 (m, 4H), 7.33 (td, *J* = 7.5, 1.3 Hz, 1H), 7.24 (m, 2H), 6.99 (d, *J* = 7.5 Hz, 1H), 6.62 (s, 1H), 6.59 – 6.53 (m, 2H), 6.02 (s, 1H), 5.81 (dd, *J* = 9.0, 1.4 Hz, 2H), 4.19 (q, *J* = 7.1 Hz, 2H), 3.47 (dd, *J* = 88.6, 13.4 Hz, 2H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.3 , 169.8 , 146.9 , 146.2 , 138.8, 138.4 , 137.9 , 134.3 , 130.6 , 129.2 , 128.9 , 128.5 , 128. 2 , 127.8 , 127.3 , 126.8 , 123.6 , 110.7 , 107.5 , 100.7 , 62.0 , 61.9 , 42.2 , 14.0 .
HRMS (ESI) Calculated for $C_{27}H_{22}O_5$ ([M]+Na^+) = 449.1359, Found 449.1360.
IR (neat) 3747, 3061, 2980, 2898, 2328, 1738, 1677, 1641, 1593, 1443, 1278, 1157, 1038, 930, 897, 776, 648, 594 cm^{-1}.

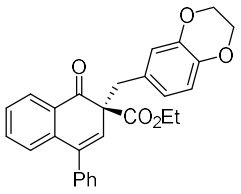


	Retention Time	Area	% Area
1	6.848	11161324	49.96
2	7.363	11179071	50.04



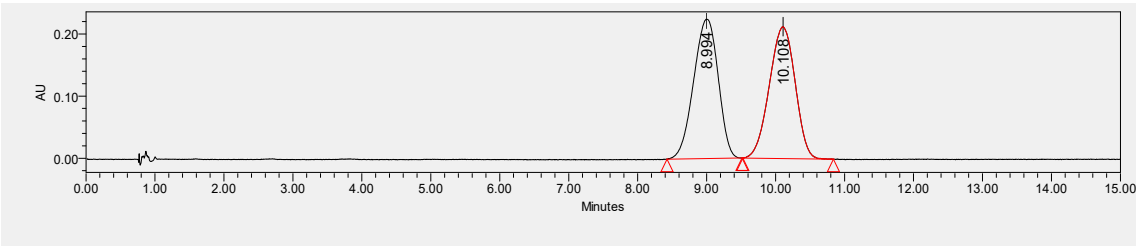
	Retention Time	Area	% Area
1	6.978	133460	0.55
2	7.430	24130924	99.45

Ethyl
(S)-2-((2,3-dihydrobenzo[b][1,4]dioxin-6-yl)methyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B41)

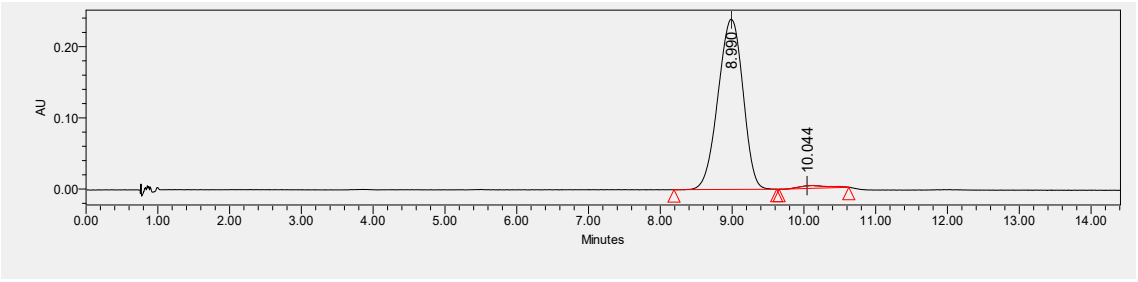


Result: colorless oil, 74% yield, 96% *ee*; $[\alpha]^{25.9}$ = -67.9 (*c* = 0.62 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 8.99 min, t_2 = 10.04 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.06 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.45 – 7.37 (m, 4H), 7.32 (td, *J* = 7.5, 1.3 Hz, 1H), 7.25 (m, 2H), 6.98 (d, *J* = 7.7 Hz, 1H), 6.65 (s, 1H), 6.57 (s, 2H), 6.02 (s, 1H), 4.19 (q, *J* = 7.1 Hz, 2H), 4.12 (s, 4H), 3.44 (dd, *J* = 76.8, 13.4 Hz, 2H), 1.20 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.3 , 169.9 , 142.6 , 142.3 , 138.8 , 138.3 , 137.9 , 134.2 , 130.7 , 129.3 , 128.9 , 128.4 , 128.4 , 128.1 , 127.8 , 127.3 , 126.7 , 123.4 , 119.2 , 116.3 , 64.2 , 64.1 , 62.0 , 61.8 , 41.9 , 14.0 .
HRMS (ESI) Calculated for $C_{28}H_{24}O_5$ ([M]+Na^+) = 463.1516, Found 463.1523.
IR (neat) 3747, 3060, 2980, 2874, 2384, 1985, 1738, 1677, 1642, 1591, 1443, 1259, 1050, 957, 887, 776, 658, 595 cm^{-1}.

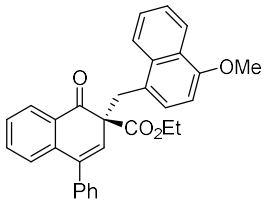


	Retention Time	Area	% Area
1	8.994	5554137	50.18
2	10.108	5513990	49.82



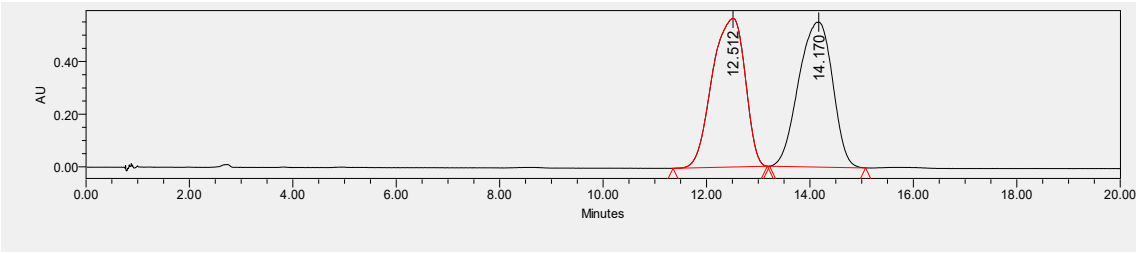
	Retention Time	Area	% Area
1	8.990	5767061	98.15
2	10.044	108702	1.85

Ethyl (S)-2-((4-methoxynaphthalen-1-yl)methyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B42)

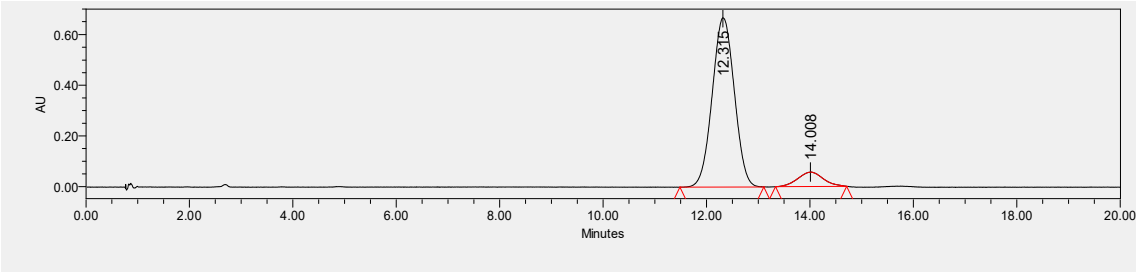


Result: White solid, Mp: 119-121 °C, 52% yield, 82% *ee*; $[\alpha]^{25.8}$= -181.2 (*c* = 0.46 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OZ-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 =12.32 min, t_2 = 14.01 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.19 (d, *J* = 9.1 Hz, 1H), 8.04 – 7.91 (m, 2H), 7.46 – 7.38 (m, 2H), 7.34 – 7.22 (m, 5H), 7.16 (d, *J* = 7.9 Hz, 1H), 6.92 – 6.61 (m, 3H), 6.48 (d, *J* = 7.9 Hz, 1H), 5.98 (s, 1H), 4.22 (qt, *J* = 6.2, 3.2 Hz, 2H), 4.02 (d, *J* = 5.4 Hz, 2H), 3.85 (s, 3H), 1.21 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 197.2 , 170.4 , 154.5 , 138.6 , 137.8 , 137.7 , 134.1 , 133.5 , 130.9 , 129.4 , 128.7 , 128.4 , 128.1 , 127.9 , 127.5 , 127.0 , 126.5 , 126.3 , 125.4 , 124.6 , 124.3 , 123.4 , 122.2 , 102.8 , 62.3 , 62.0 , 55.3 , 37.9 , 14.0 .
HRMS (ESI) Calculated for $C_{31}H_{26}O_4$ ([M]+Na^+) = 485.1723, Found 485.1729.
IR (neat) 3746, 3058, 2979, 2846, 2344, 1984, 1739, 1676, 1641, 1446, 1273, 1070, 942, 893, 767, 633, 598 cm^{-1}.

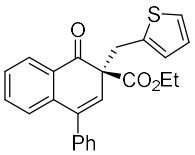


	Retention Time	Area	% Area
1	12.512	24928386	49.85
2	14.170	25074507	50.15



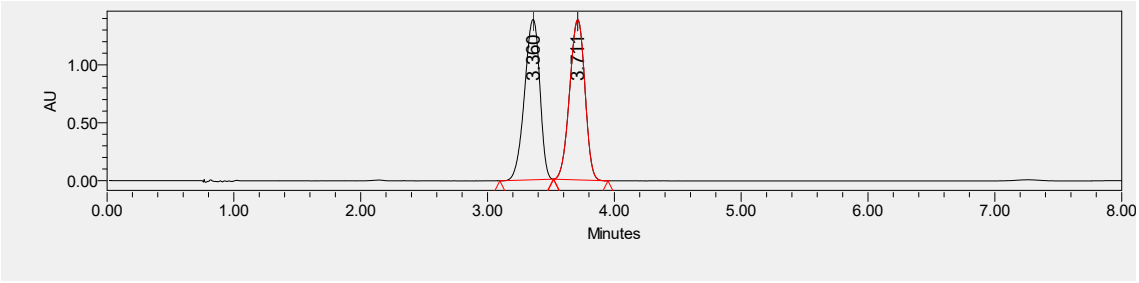
	Retention Time	Area	% Area
1	12.315	19838733	91.09
2	14.008	1939925	8.91

Ethyl (S)-1-oxo-4-phenyl-2-(thiophen-2-ylmethyl)-1,2-dihydronaphthalene-2-carboxylate (B43)

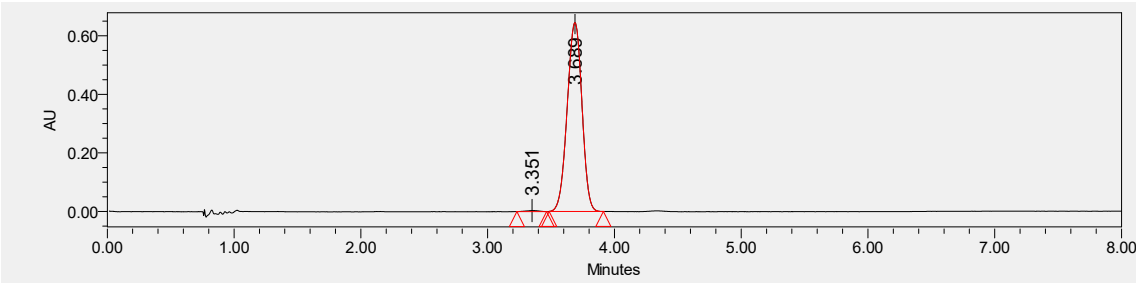


Result: White solid, Mp: 86-88 °C, 84% yield, 99% *ee*; $[\alpha]^{26.2}$ = -17.4 (*c* = 0.74 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OD-3, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 3.35 min, t_2 = 3.69 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.13 (d, *J* = 7.2 Hz, 1H), 7.42 (m, 5H), 7.26 – 7.23 (m, 2H), 7.11 (s, 1H), 7.06 (d, *J* = 7.8 Hz, 1H), 6.13 – 6.10 (m, 1H), 6.01 (s, 1H), 5.98 (d, *J* = 3.2 Hz, 1H), 4.17 (t, *J* = 7.1 Hz, 2H), 3.70 – 3.52 (m, 2H), 1.19 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 195.8 , 169.3 , 150.5 , 141.4 , 138.7 , 138.0 , 137.9 , 134.3 , 130.3 , 129.0 , 129.0 , 128.4 , 128.2 , 127.8 , 127.4 , 126.8 , 110.1 , 108.0 , 62.1 , 60.5 , 34.8 , 13.9 .
HRMS (ESI) Calculated for $C_{24}H_{20}O_3S$ ([M]+Na^+) = 411.1025, Found 411.1029.
IR (neat) 3746, 3060, 2981, 2349, 1985, 1739, 1679, 1642, 1593, 1445, 1276, 1034, 943, 884, 776, 638, 599 cm^{-1}.

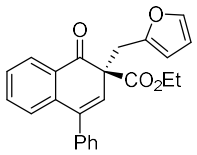


	Retention Time	Area	% Area
1	3.360	11577666	50.01
2	3.711	11572834	49.99



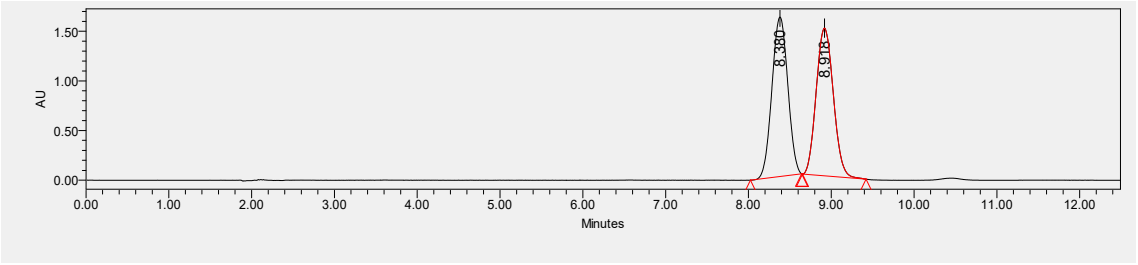
	Retention Time	Area	% Area
1	3.351	24793	0.47
2	3.689	5206908	99.53

Ethyl (S)-2-(furan-2-ylmethyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B44)

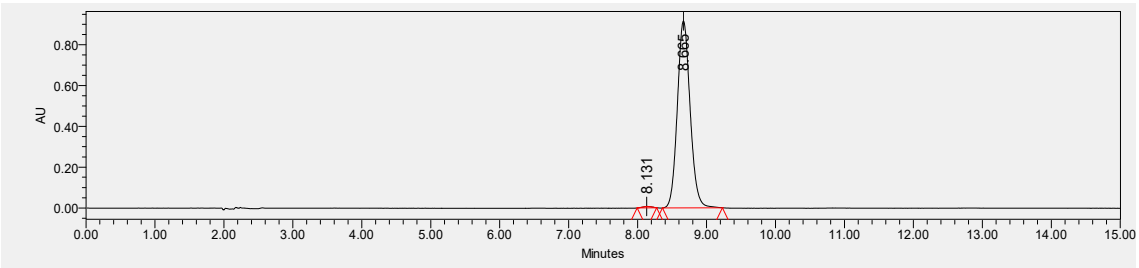


Result: White solid, Mp: 73-75 °C, 76% yield, 99% *ee*; $[\alpha]^{25.8}$ = -26.6 (*c* = 0.64 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel OX-H, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 8.13 min, t_2 = 8.67 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.09 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.46 – 7.41 (m, 4H), 7.38 – 7.34 (m, 1H), 7.30 (m, 2H), 7.06 (d, *J* = 8.5 Hz, 1H), 7.01 (dd, *J* = 4.4, 2.0 Hz, 1H), 6.77 (d, *J* = 4.4 Hz, 2H), 6.06 (s, 1H), 4.22 – 4.17 (m, 2H), 3.92 – 3.64 (m, 2H), 1.19 (d, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 195.9 , 169.4 , 139.1 , 138.7 , 137.9 , 137.2 , 134.4 , 130.4 , 129.2 , 128.9 , 128.4 , 128.3 , 127.9 , 127.5 , 127.4 , 126.9 , 126.4, 124.5 , 62.1 , 61.6 , 36.4 , 14.0 .
HRMS (ESI) Calculated for $C_{24}H_{20}O_4$ ([M]+Na^+) = 395.1254, Found 395.1236.
IR (neat) 3746, 3063, 2985, 2349, 1988, 1738, 1677, 1642, 1593, 1445, 1275, 1033, 941, 895, 763, 642, 588 cm^{-1}.

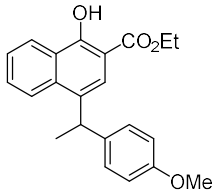


	Retention Time	Area	% Area
1	8.380	21346679	50.00
2	8.918	21343223	50.00



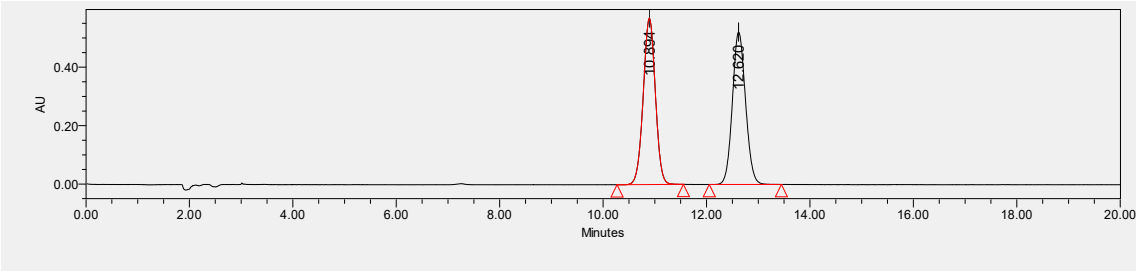
	Retention Time	Area	% Area
1	8.131	62502	0.53
2	8.665	11796054	99.47

Ethyl 1-hydroxy-4-(1-(4-methoxyphenyl)ethyl)-2-naphthoate (B45)

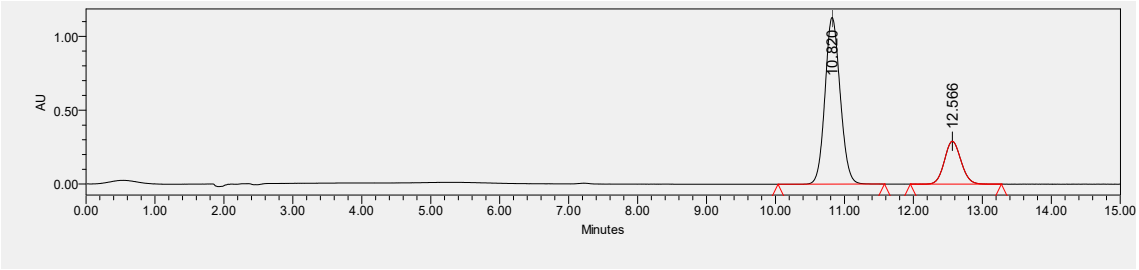


Result: colorless oil, 30% yield, 56% *ee*; $[\alpha]^{26.4}$ = 82.6 (*c* = 0.18 in CH_2Cl_2, λ = 589 nm); SFC (Daicel chiralcel IG, CO_2/MeOH = 90/10, flow rate = 1.5 mL/min, λ = 254 nm), t_1 = 10.82 min, t_2 = 12.57 min.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 12.03 (s, 1H), 8.46 – 8.43 (m, 1H), 7.88 (d, *J* = 7.6 Hz, 1H), 7.78 – 7.77 (m, 1H), 7.52 – 7.46 (m, 2H), 7.12 (d, *J* = 8.7 Hz, 2H), 6.79 (d, *J* = 8.7 Hz, 2H), 4.68 (d, *J* = 7.1 Hz, 1H), 4.51 – 4.46 (m, 2H), 3.75 (s, 3H), 1.73 (d, *J* = 7.1 Hz, 3H), 1.48 (d, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 171.2 , 156.0 , 157.7 , 138.9 , 135.6 , 131.7 , 129.2 , 128.3 , 125.3 , 125.2 , 124.4 , 124.2 , 121.9 , 113.8 , 105.0 , 61.4 , 55.2 , 39.6 , 22.9 , 14.3 .
HRMS (ESI) Calculated for $C_{22}H_{22}O_4$ ([M]+Na^+) = 373.1410, Found 373.1401.
IR (neat) 2930, 1659, 1631, 1510, 1451, 1373, 1337, 1175, 1095, 1033, 831, 768, 557 cm^{-1}.



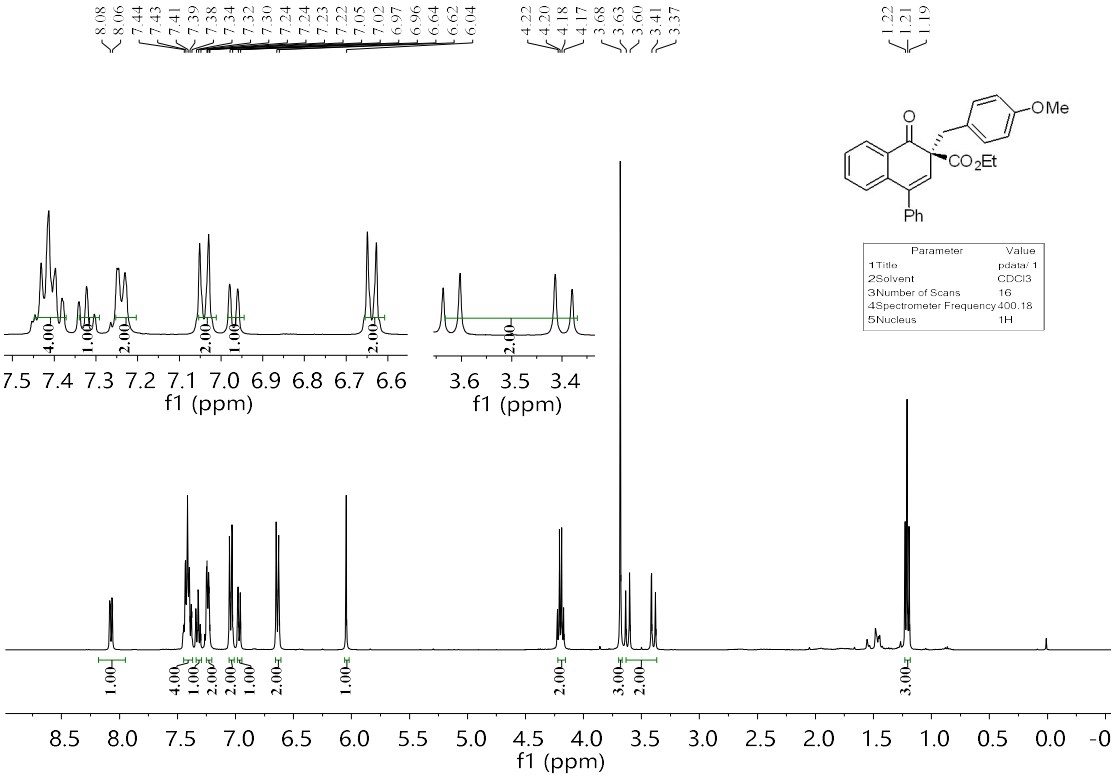
	Retention Time	Area	% Area
1	10.894	9263251	50.15
2	12.620	9206068	49.85

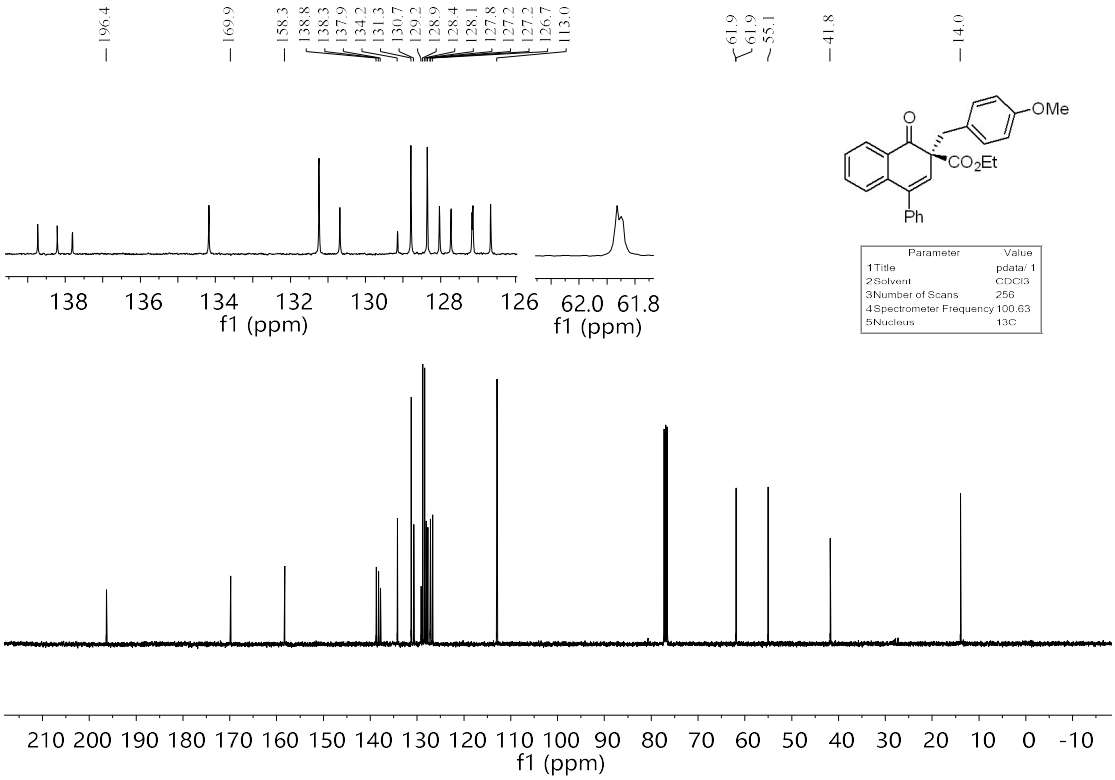


	Retention Time	Area	% Area
1	10.820	17245788	78.00
2	12.566	4865013	22.00

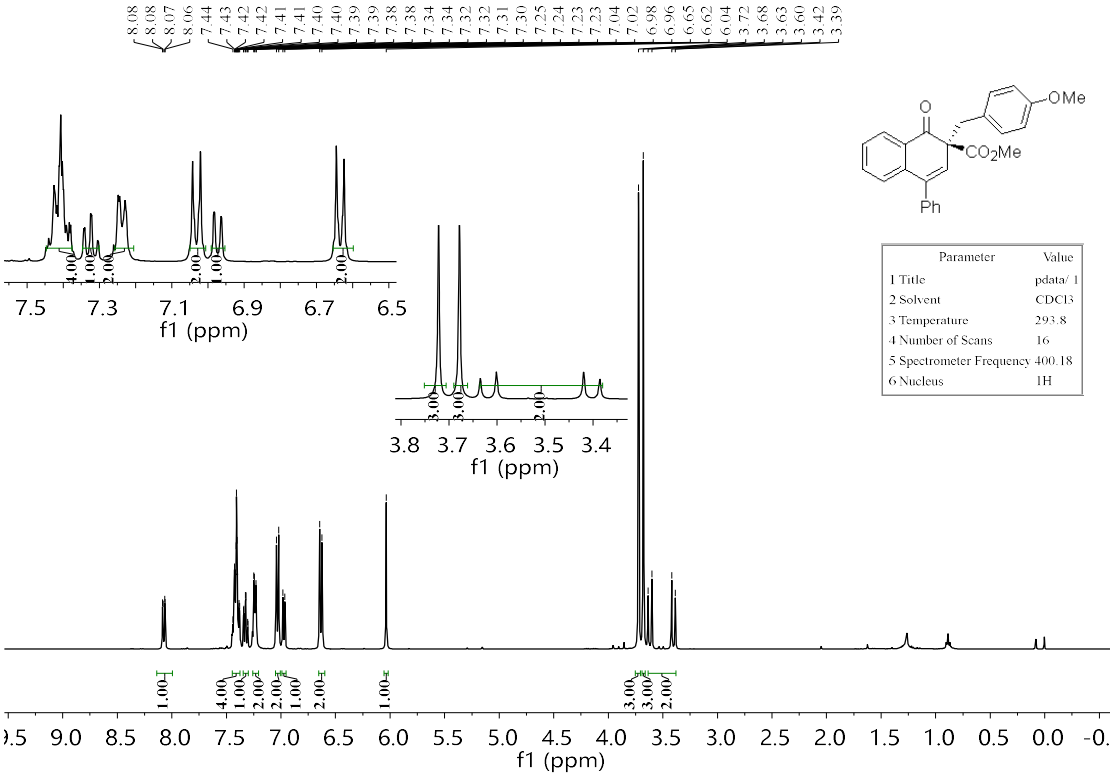
11. Copies of NMR Spectra for the Reaction Products

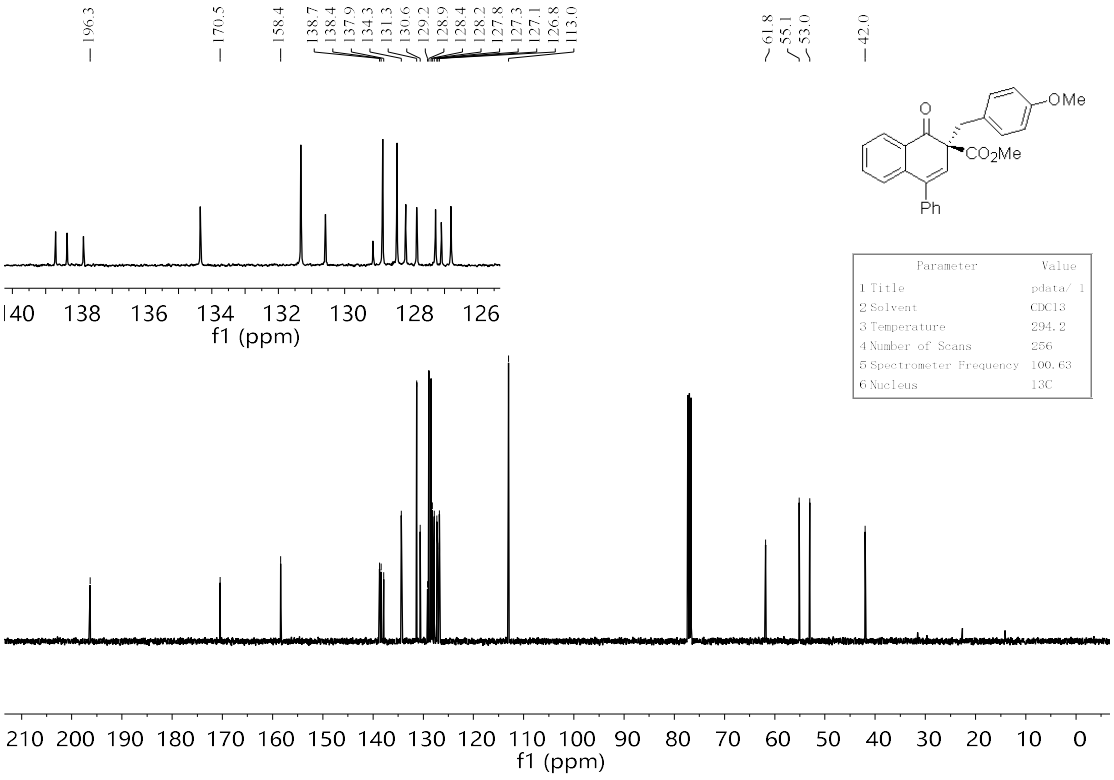
Ethyl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B1)



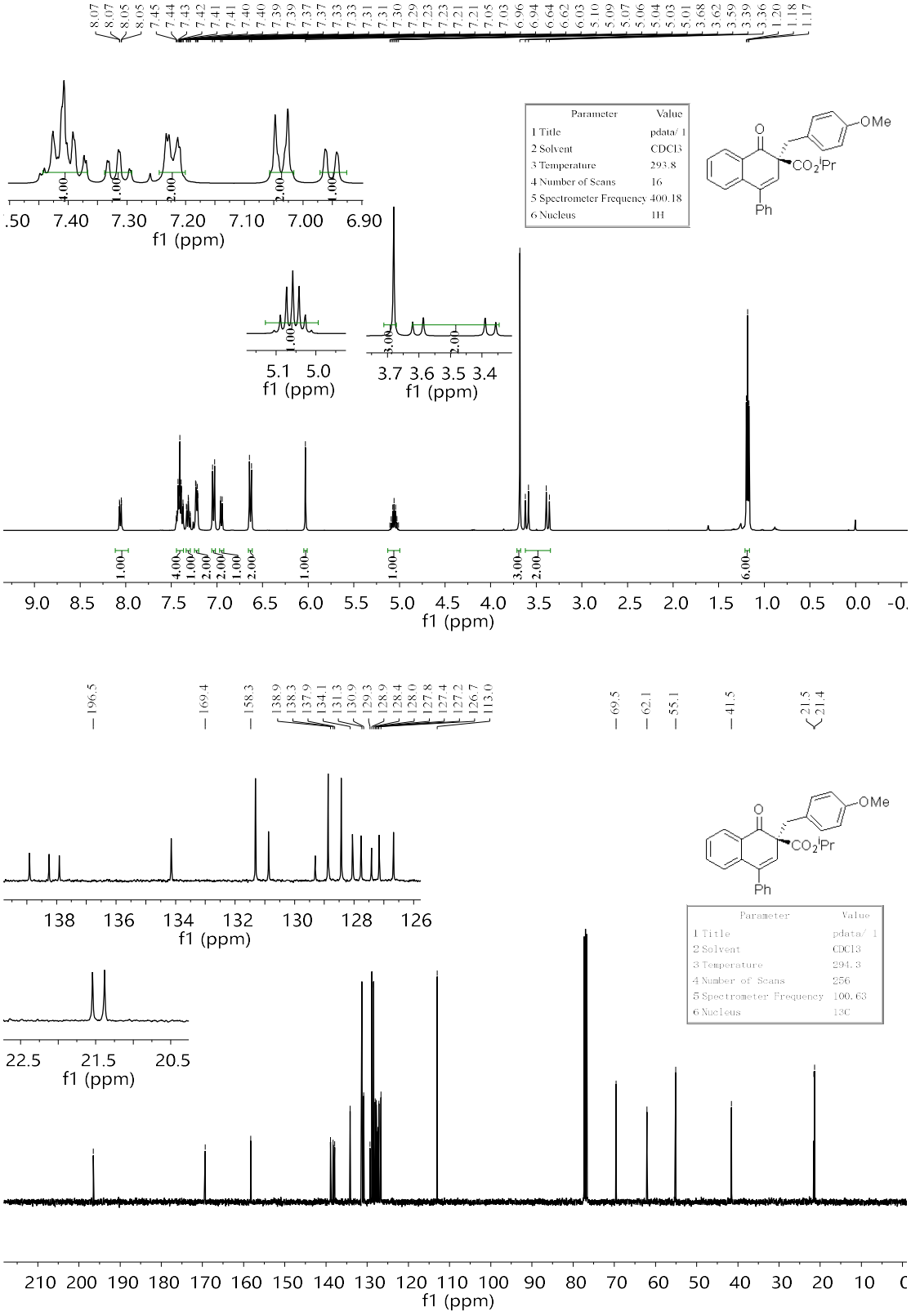


Methyl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B2)

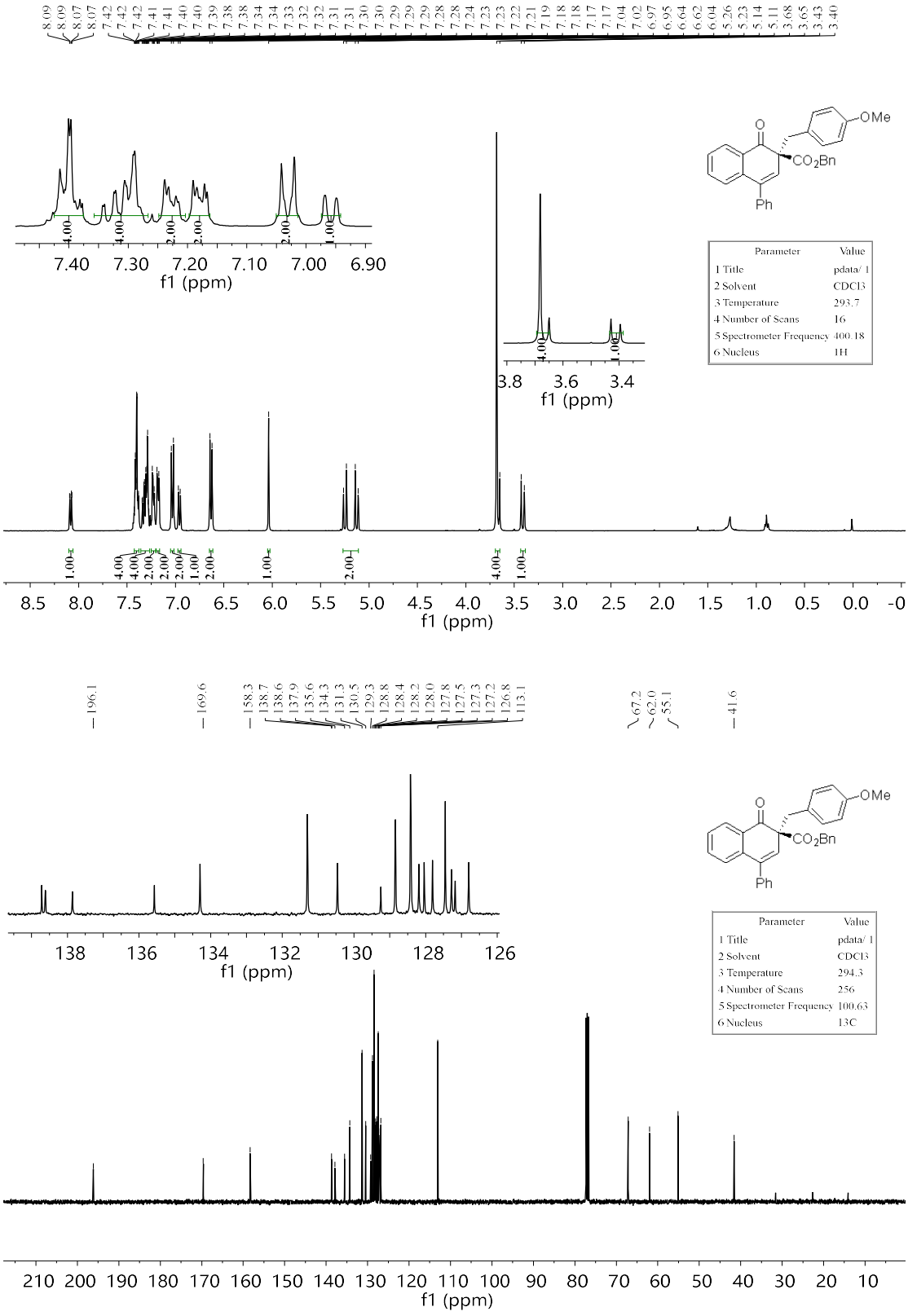




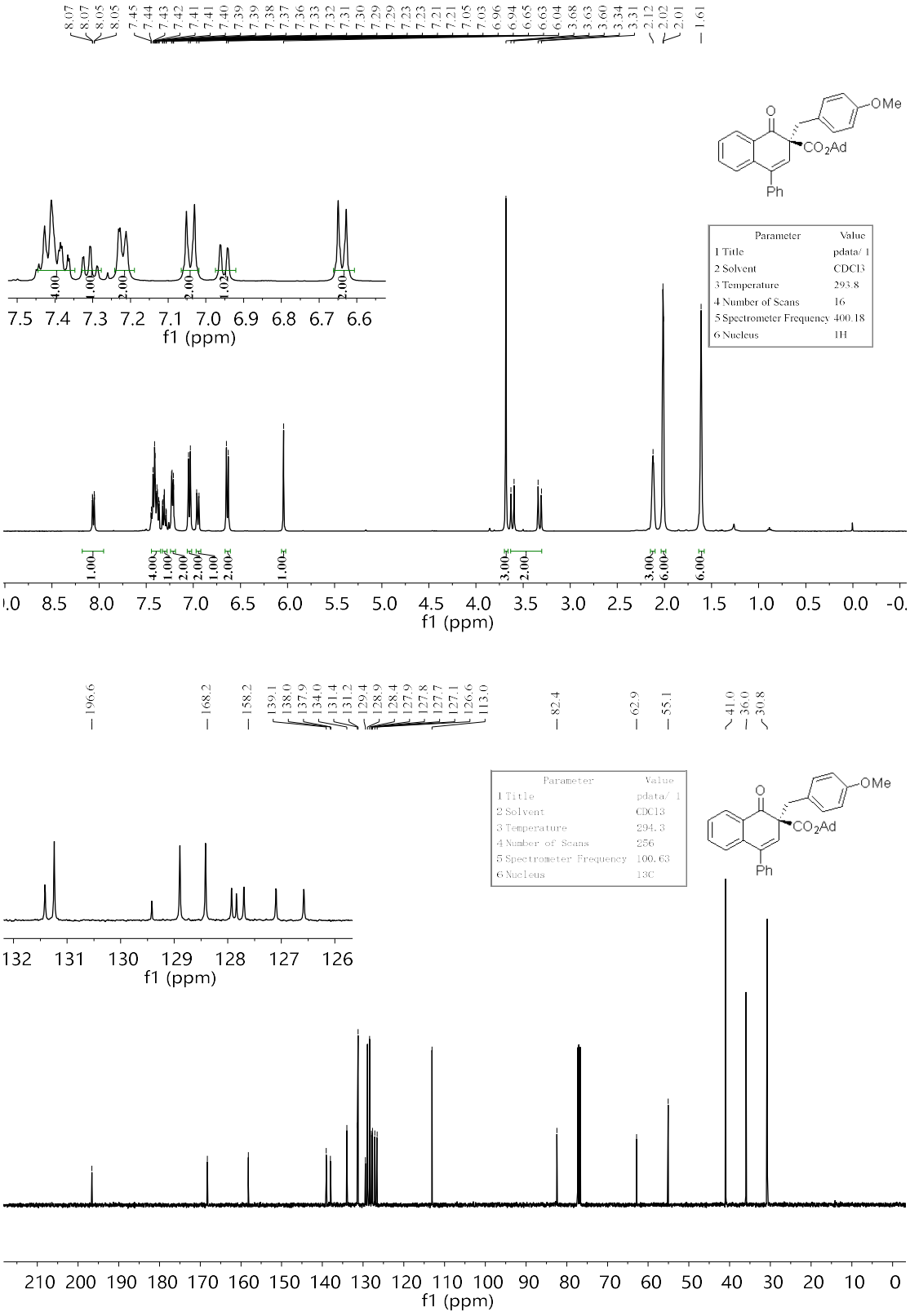
Isopropyl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B3)



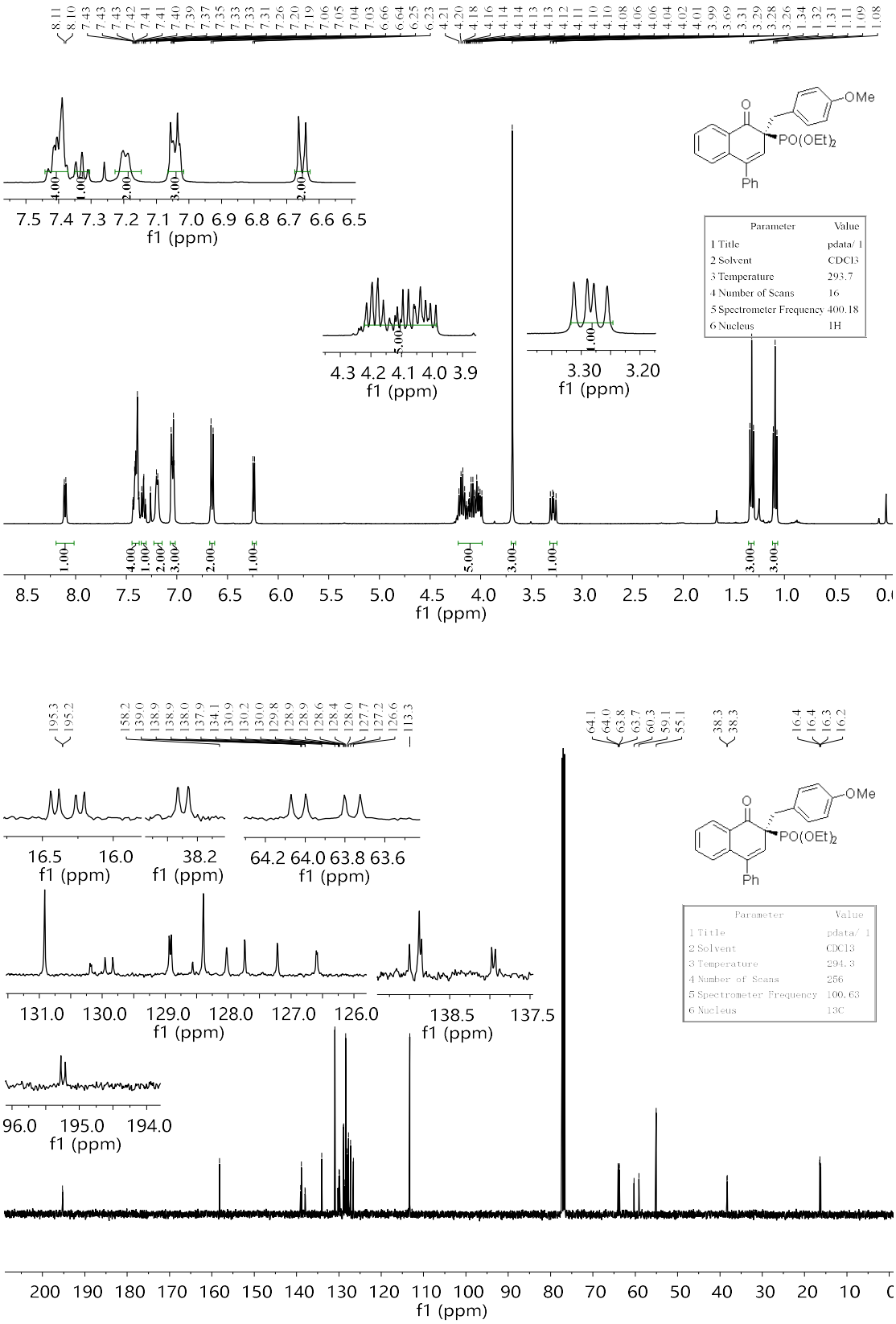
Benzyl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B4)

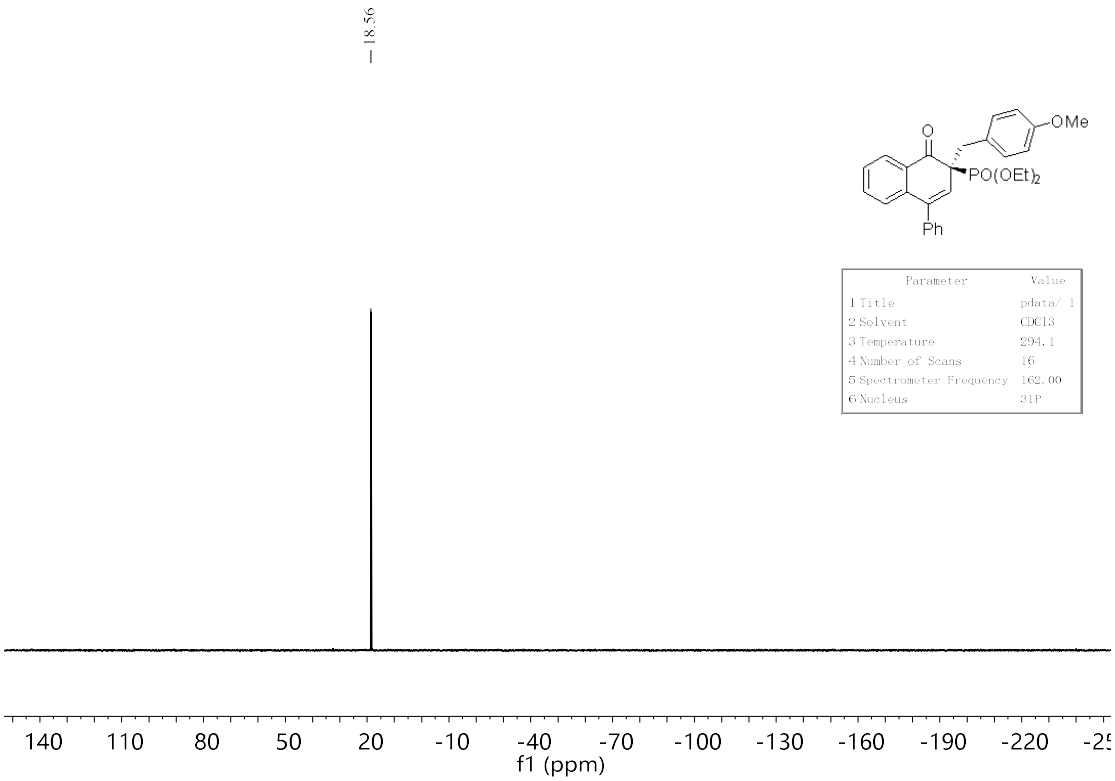


Adamantan-1-yl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B5)

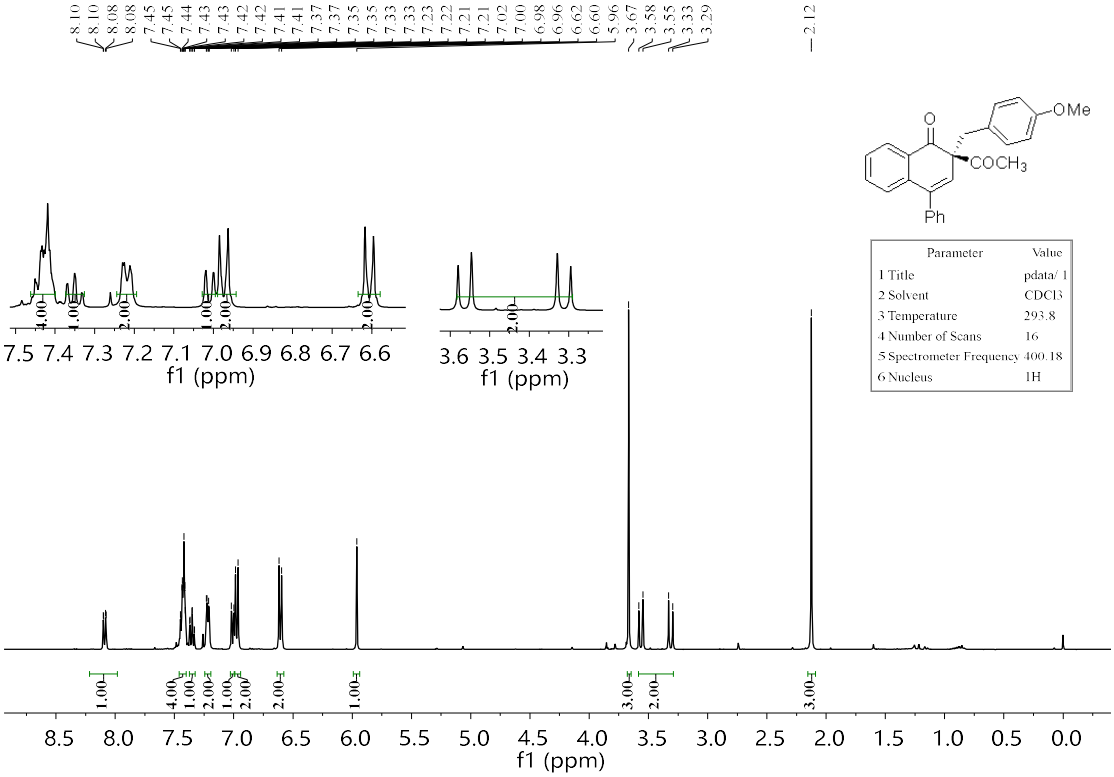


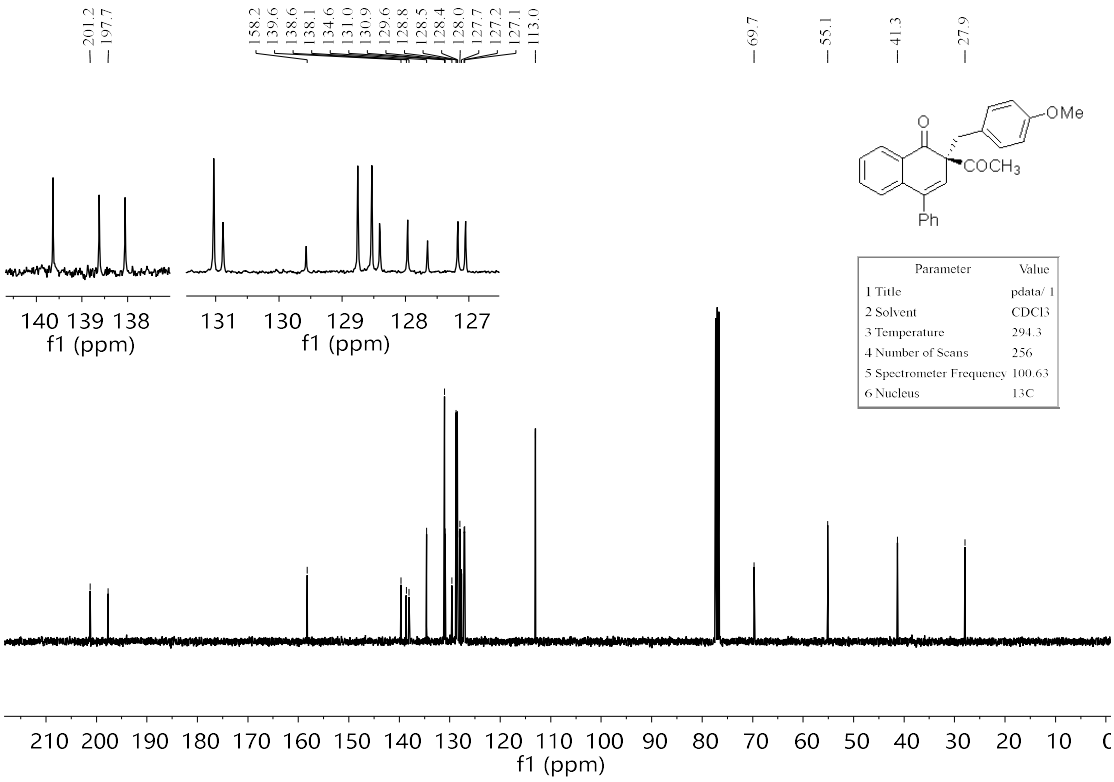
Diethyl (S)-(2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalen-2-yl)phosphonate (B6)



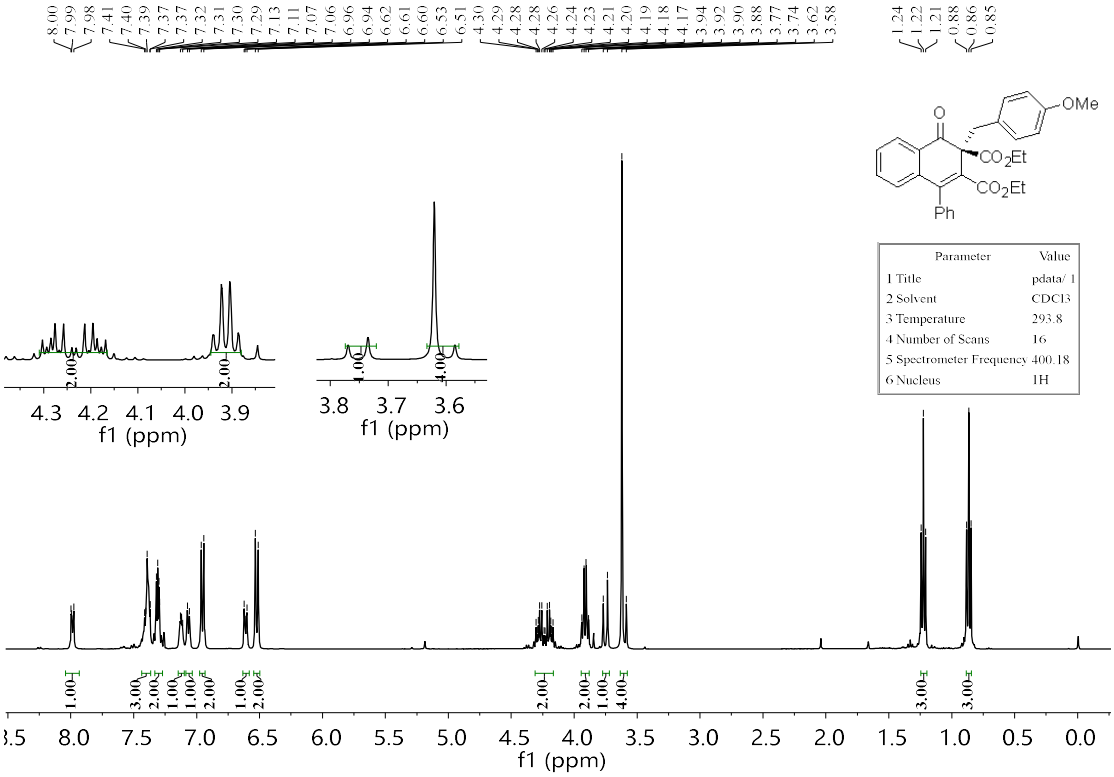

18.56
OMe
PO(OEt)2
Ph
Parameter Value
1 Title pdata/ 1
2 Solvent CDCl3
3 Temperature 294.1
4 Number of Scans 16
5 Spectrometer Frequency 162.00
6 Nucleus 31P
140 110 80 50 20 -10 -40 -70 -100 -130 -160 -190 -220 -25
f1 (ppm)

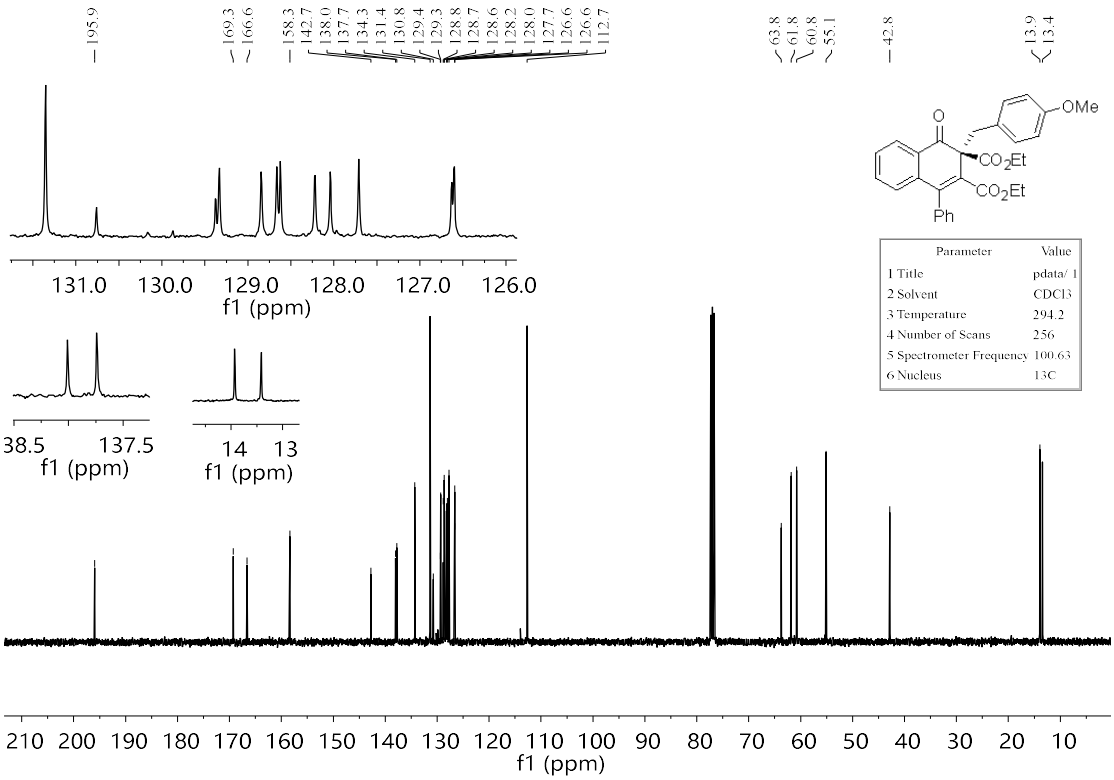
(R)-2-acetyl-2-(4-methoxybenzyl)-4-phenylnaphthalen-1(2H)-one (B7)



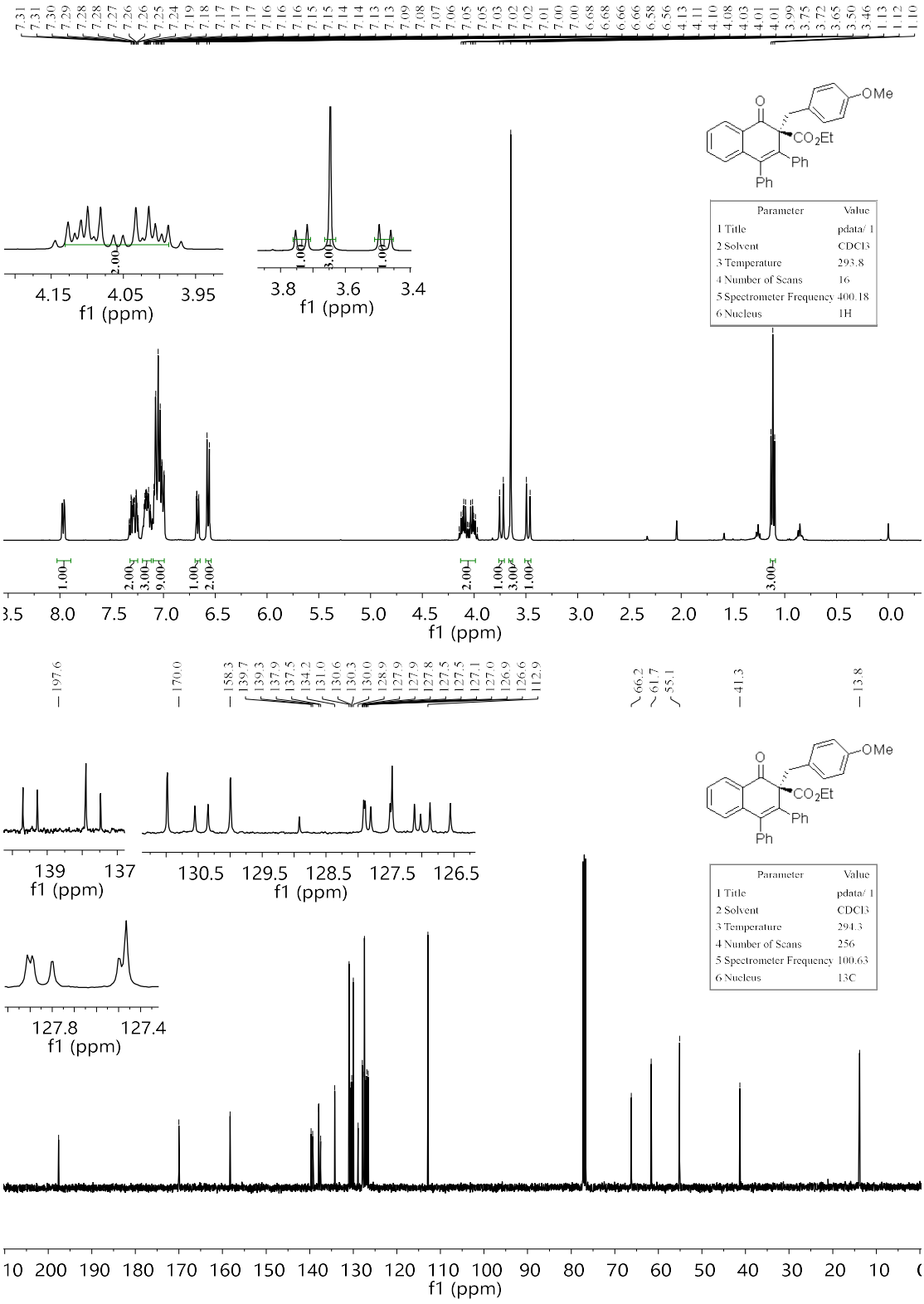


Diethyl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2,3-dicarboxylate (B8)

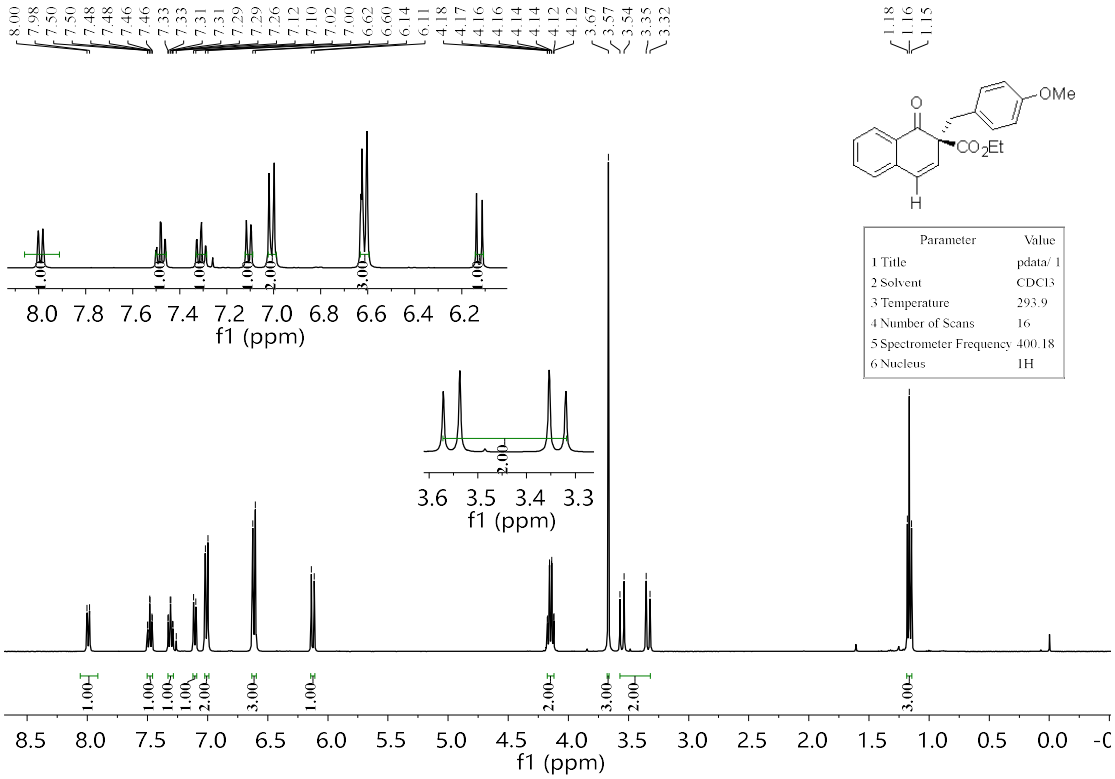


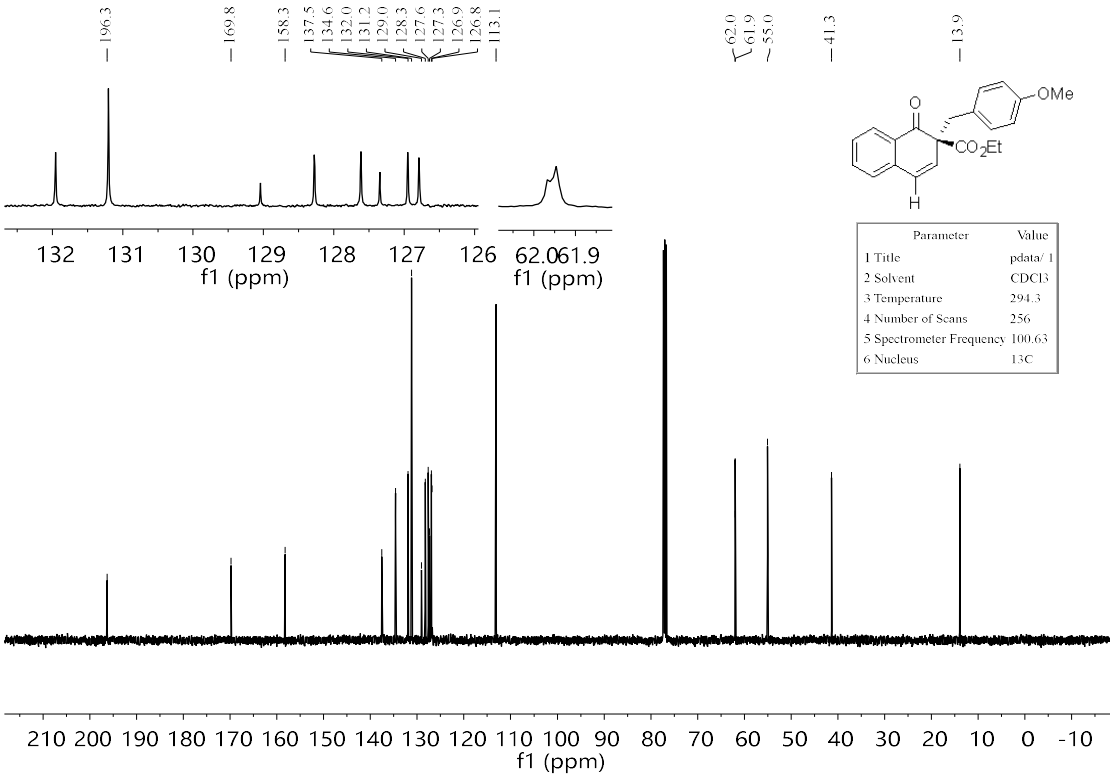


Ethyl (S)-2-(4-methoxybenzyl)-1-oxo-3,4-diphenyl-1,2-dihydronaphthalene-2-carboxylate (B9)

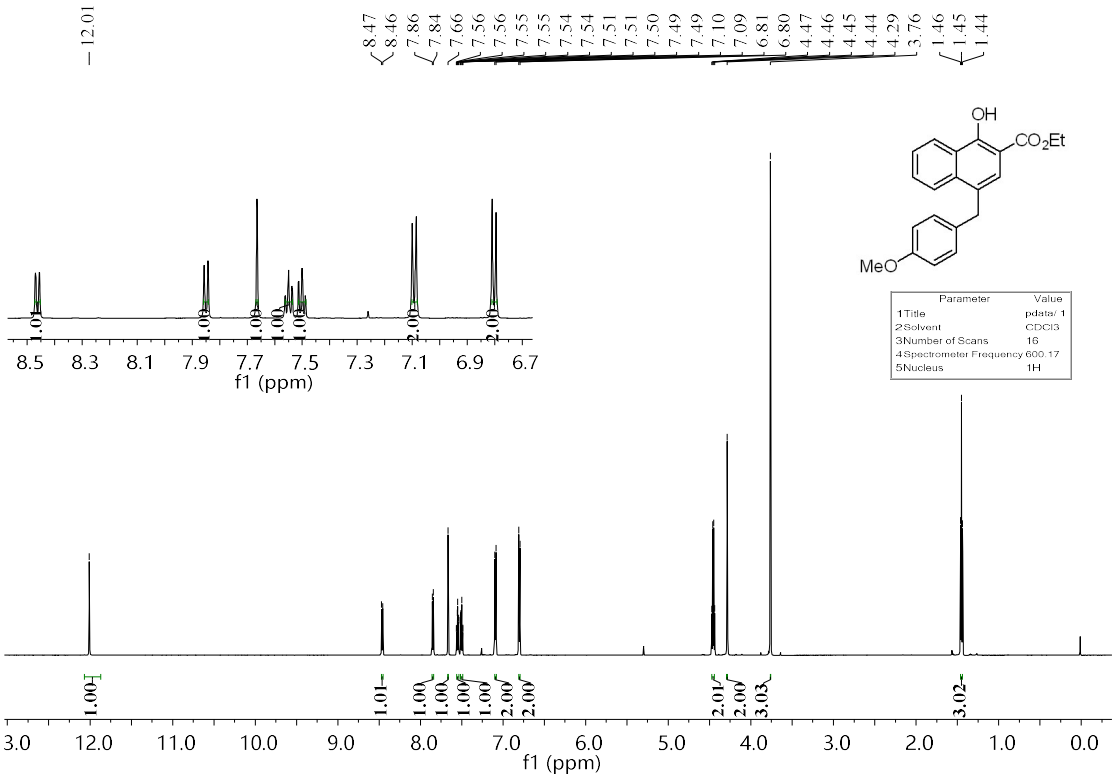


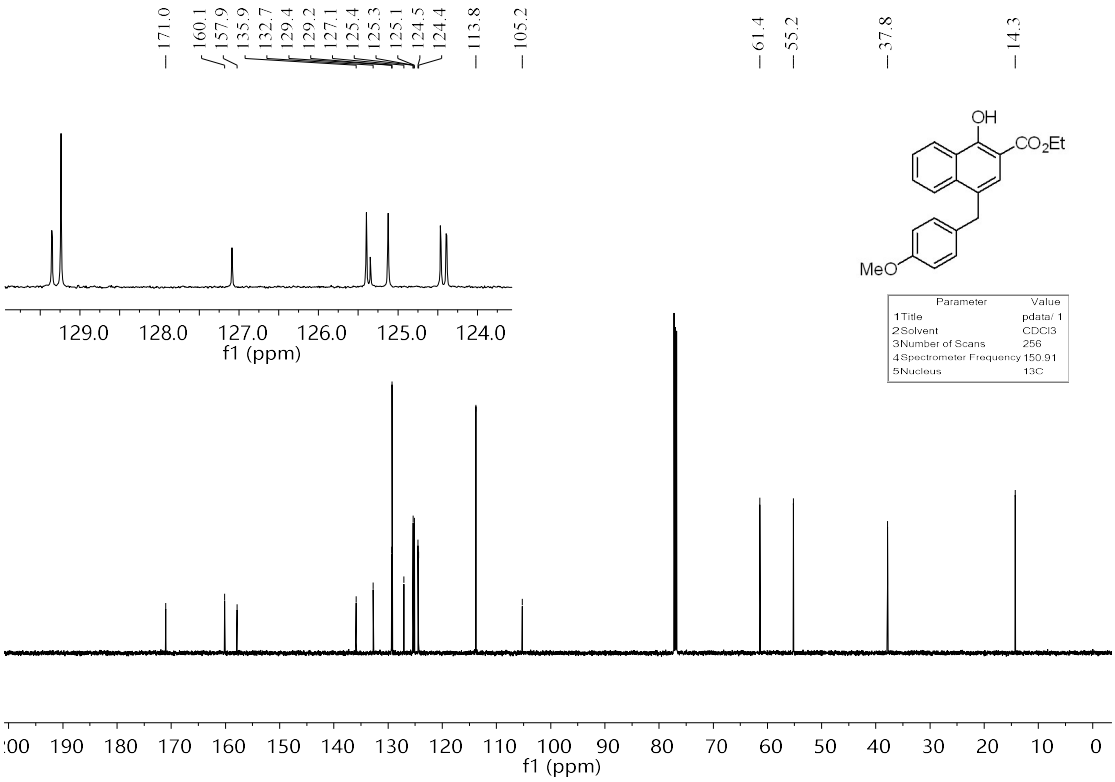
Ethyl (S)-2-(4-methoxybenzyl)-1-oxo-1,2-dihydronaphthalene-2-carboxylate (B10)



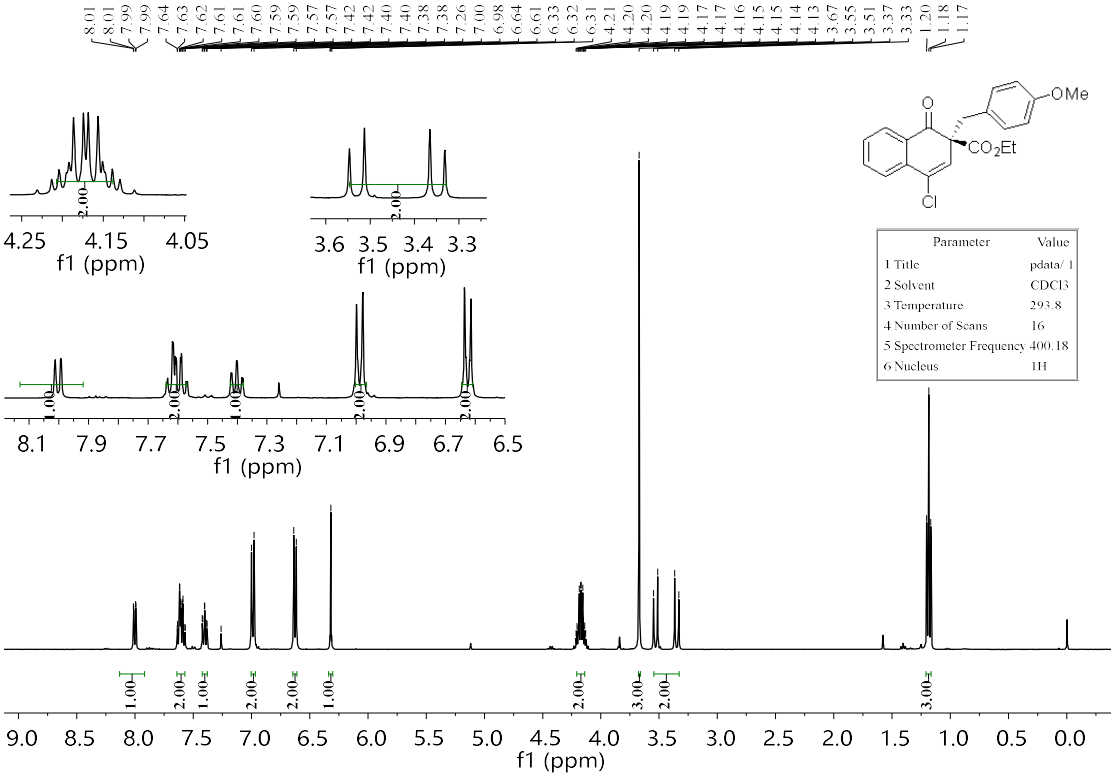


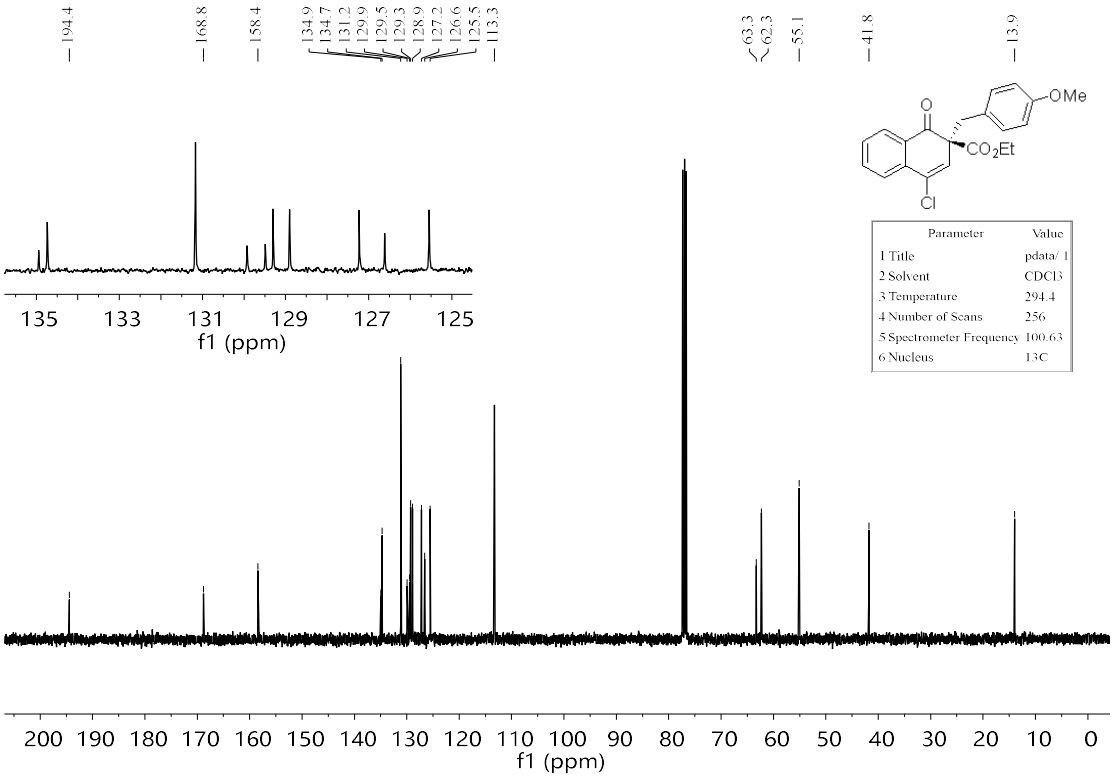
ethyl 1-hydroxy-4-(4-methoxybenzyl)-2-naphthoate (B10')



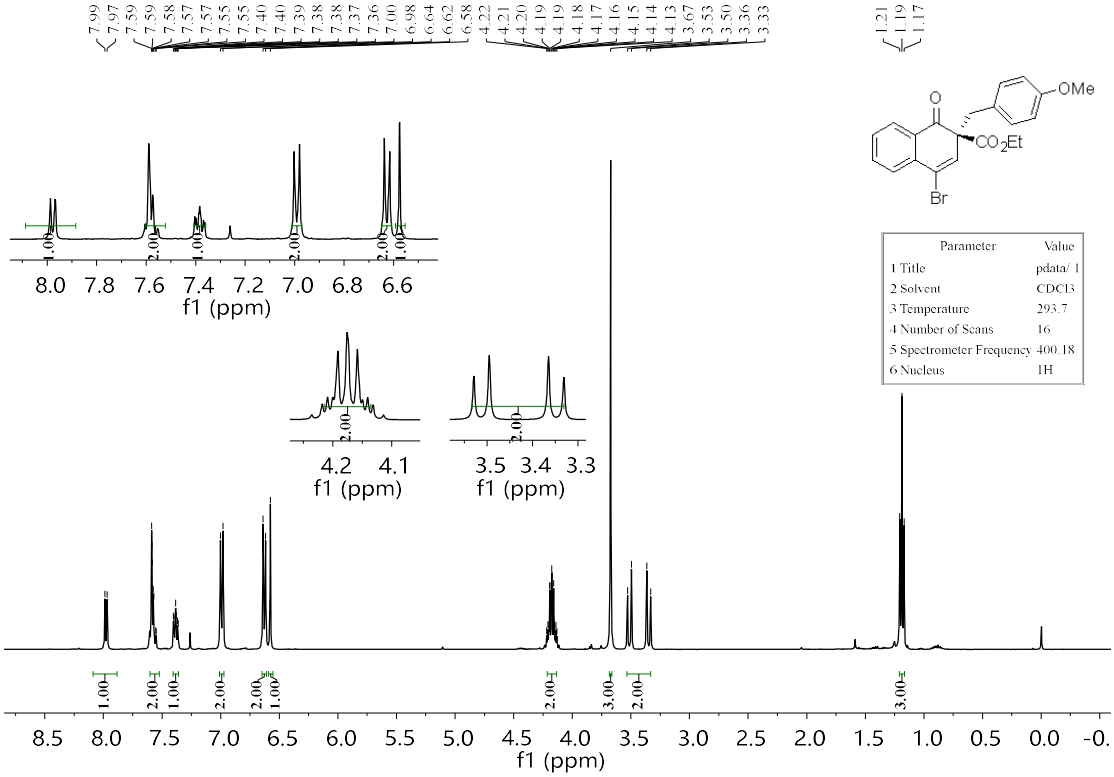


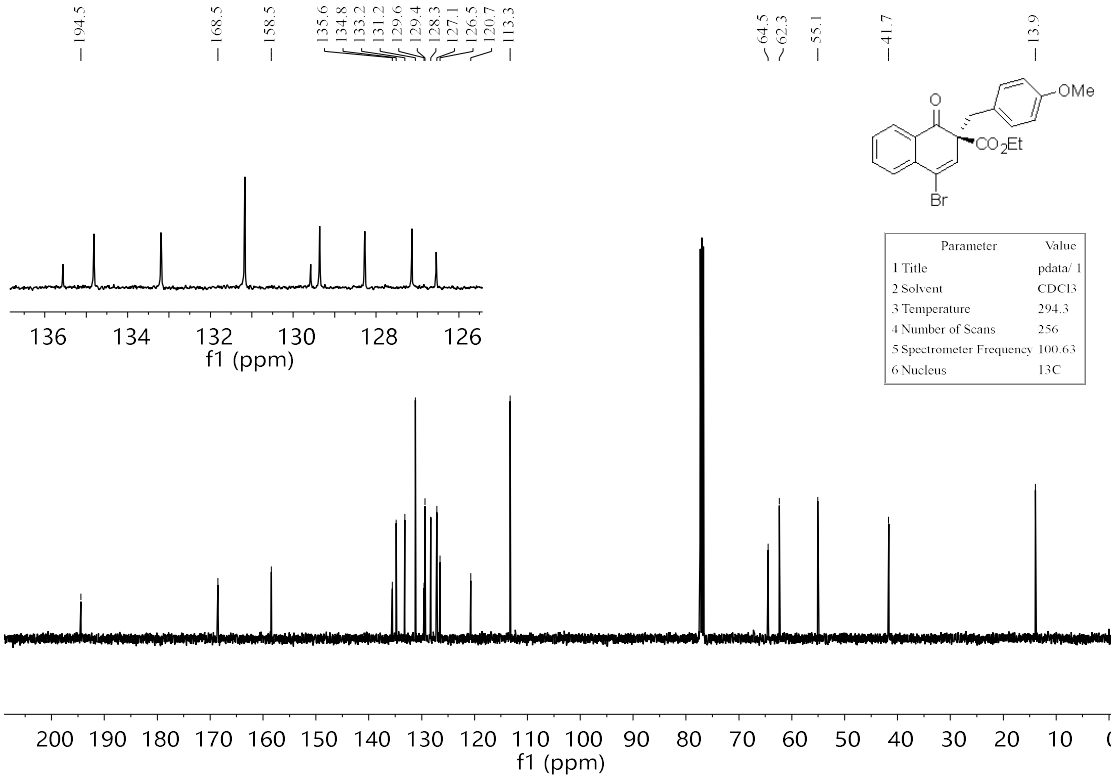
Ethyl (S)-4-chloro-2-(4-methoxybenzyl)-1-oxo-1,2-dihydronaphthalene-2-carboxylate (B11)



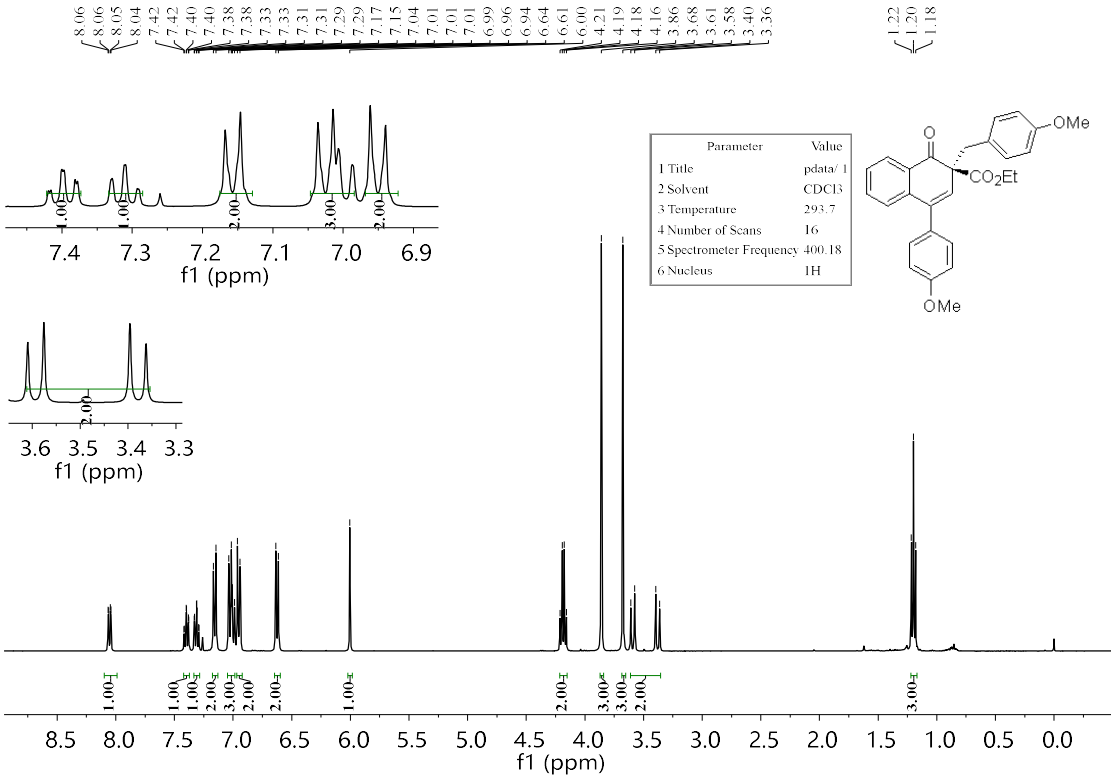


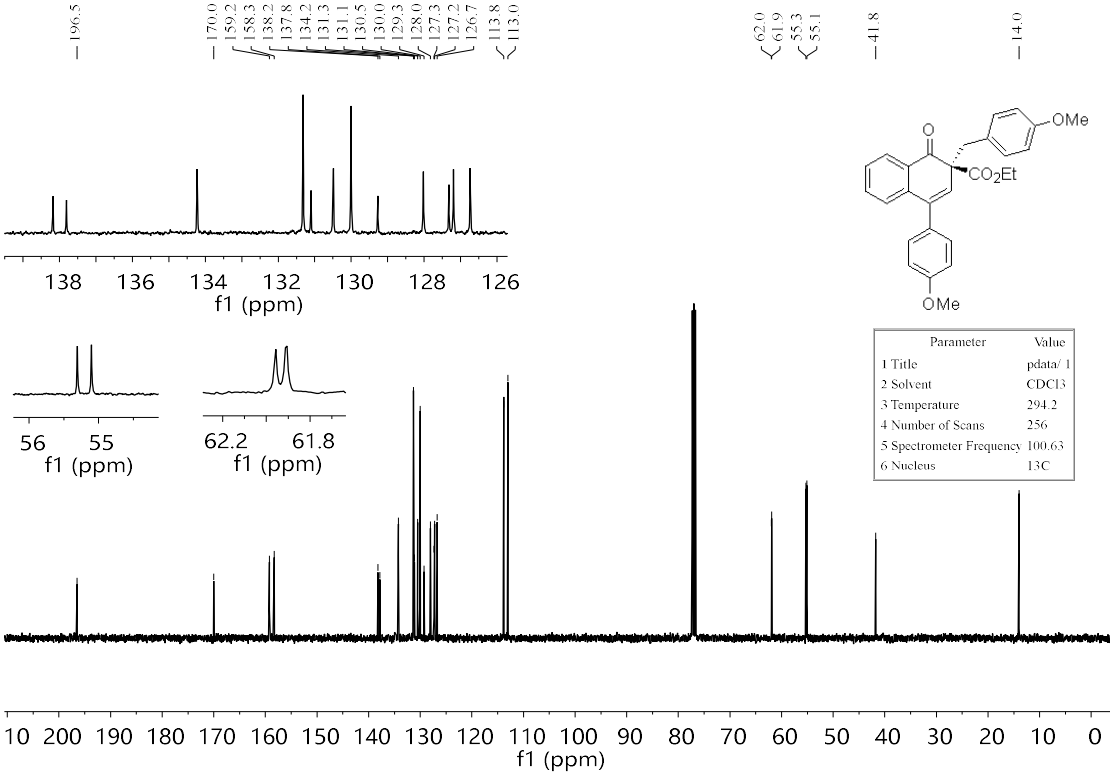
Ethyl (S)-4-bromo-2-(4-methoxybenzyl)-1-oxo-1,2-dihydronaphthalene-2-carboxylate (B12)



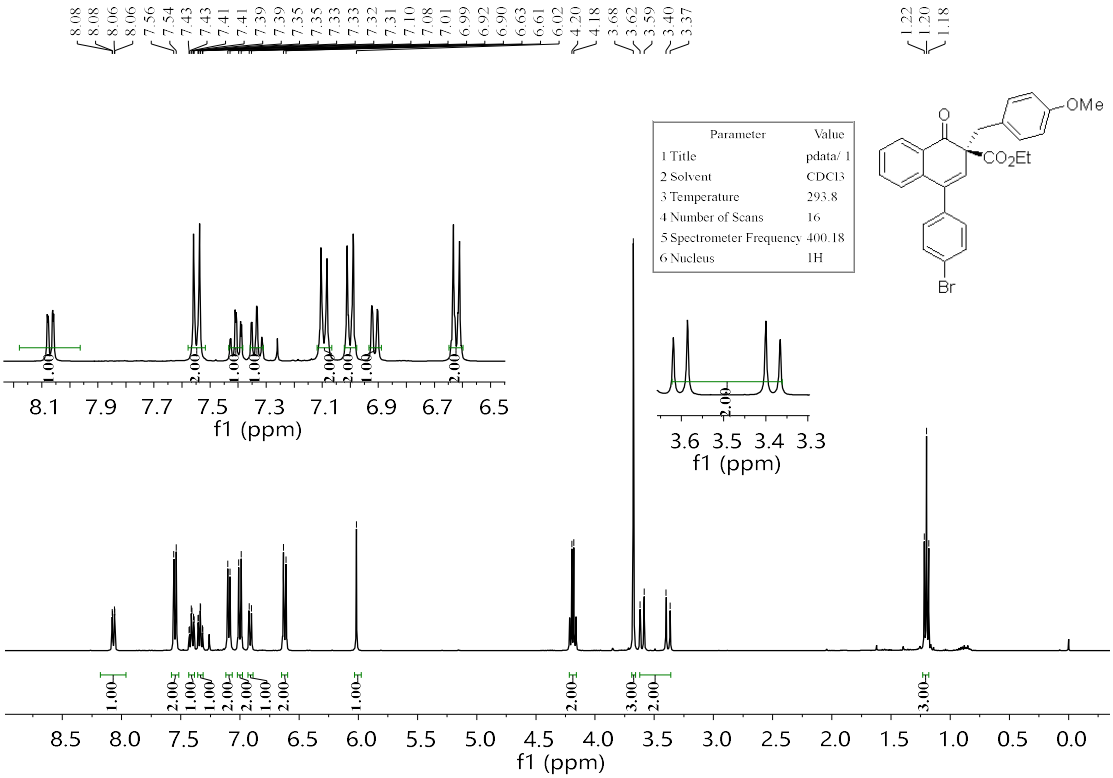


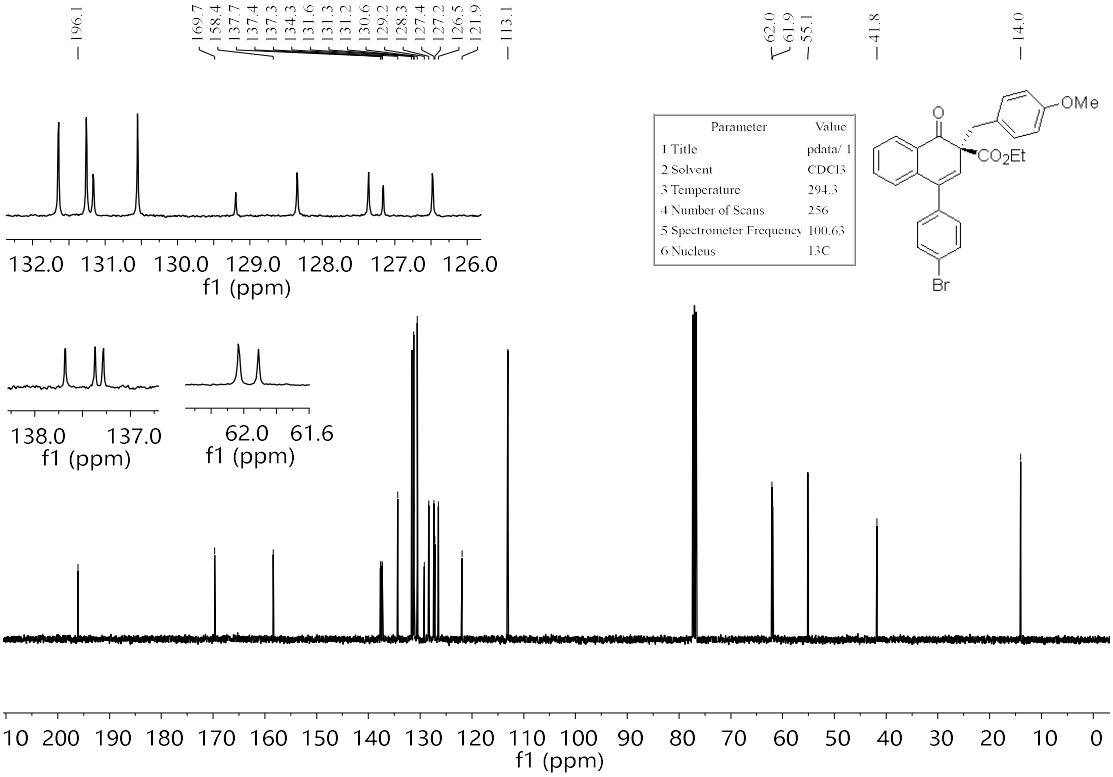
Ethyl (S)-2-(4-methoxybenzyl)-4-(4-methoxyphenyl)-1-oxo-1,2-dihydronaphthalene-2-carboxylate (B13)



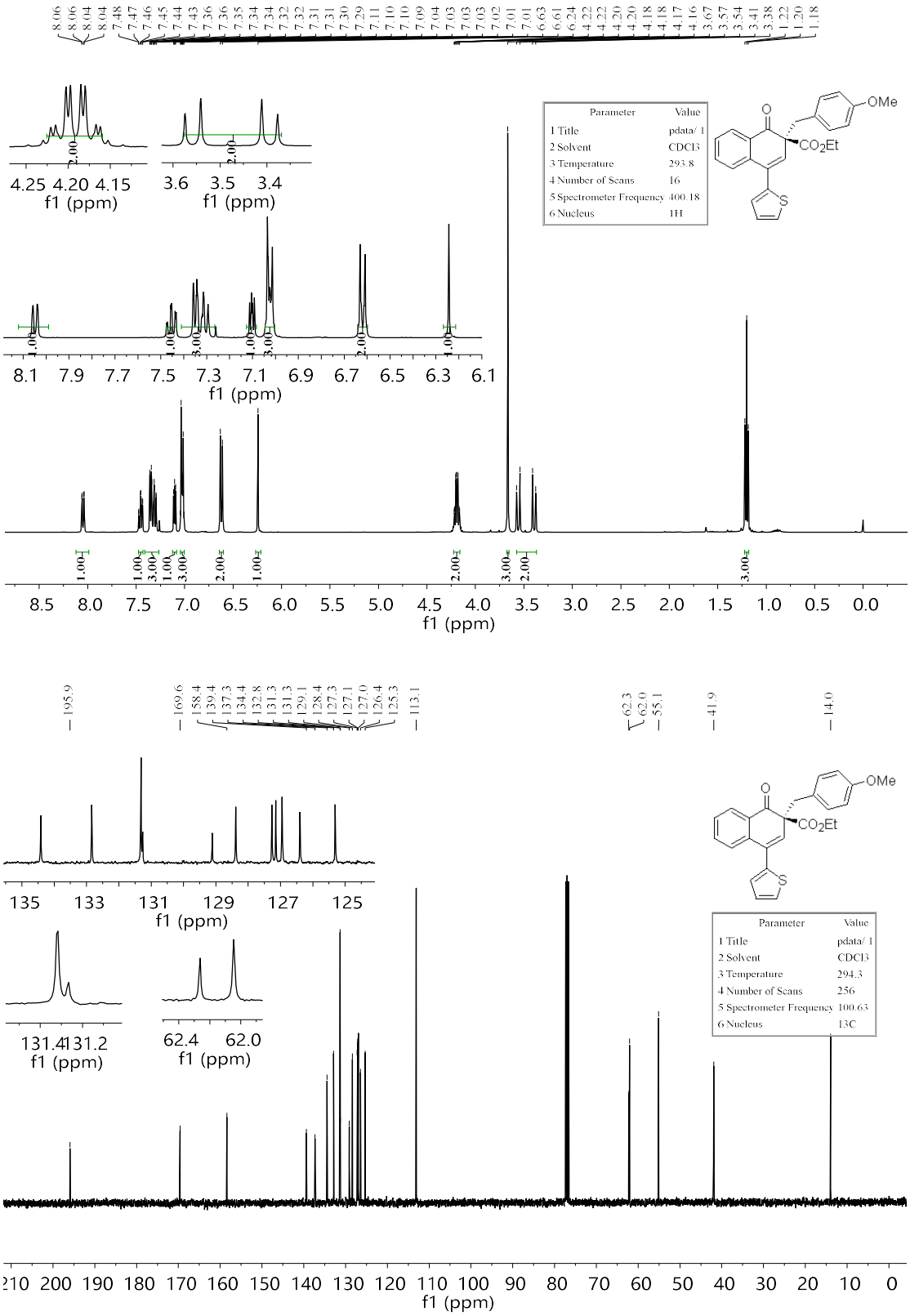


Ethyl (S)-4-(4-bromophenyl)-2-(4-methoxybenzyl)-1-oxo-1,2-dihydronaphthalene-2-carboxylate (B14)

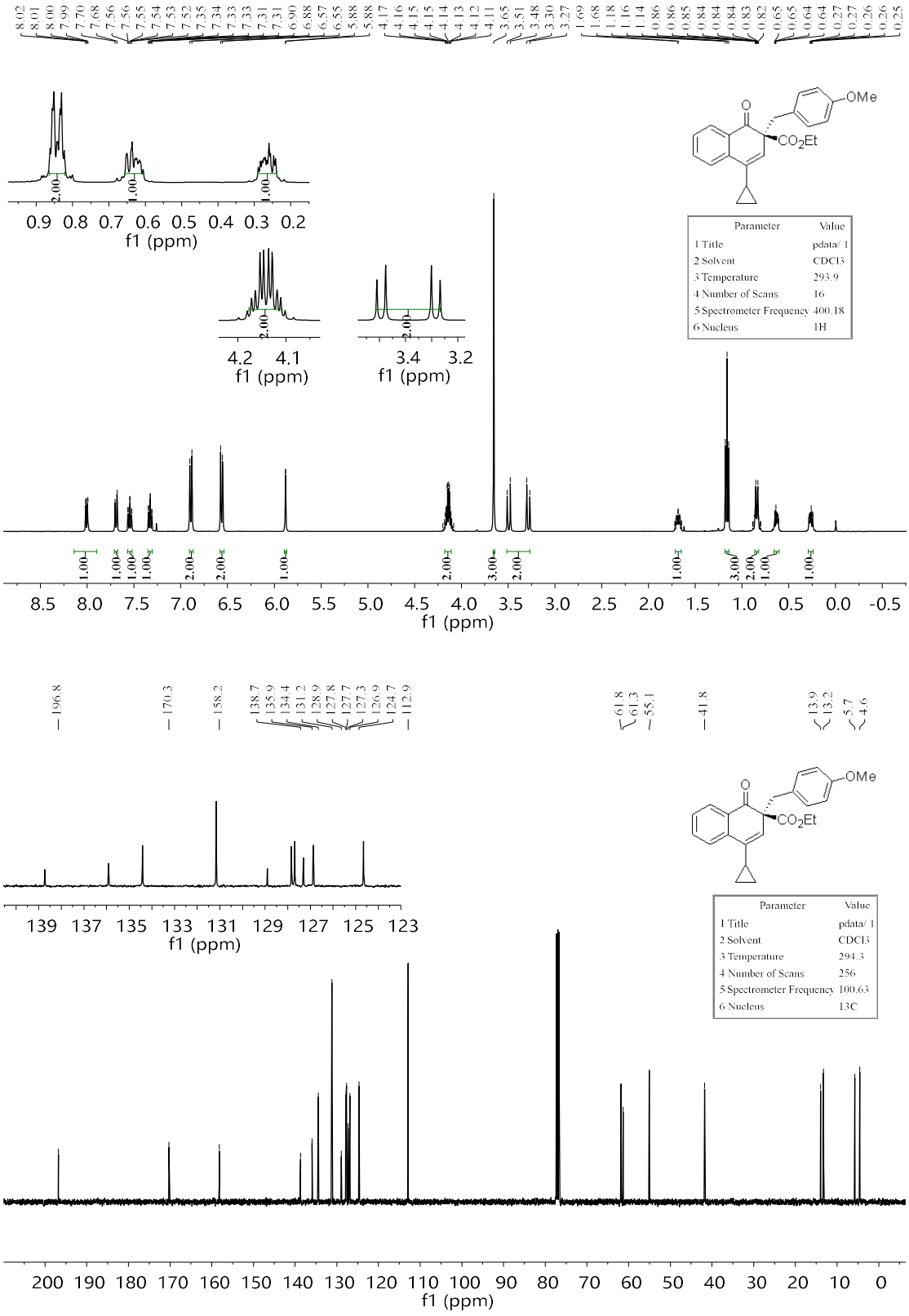




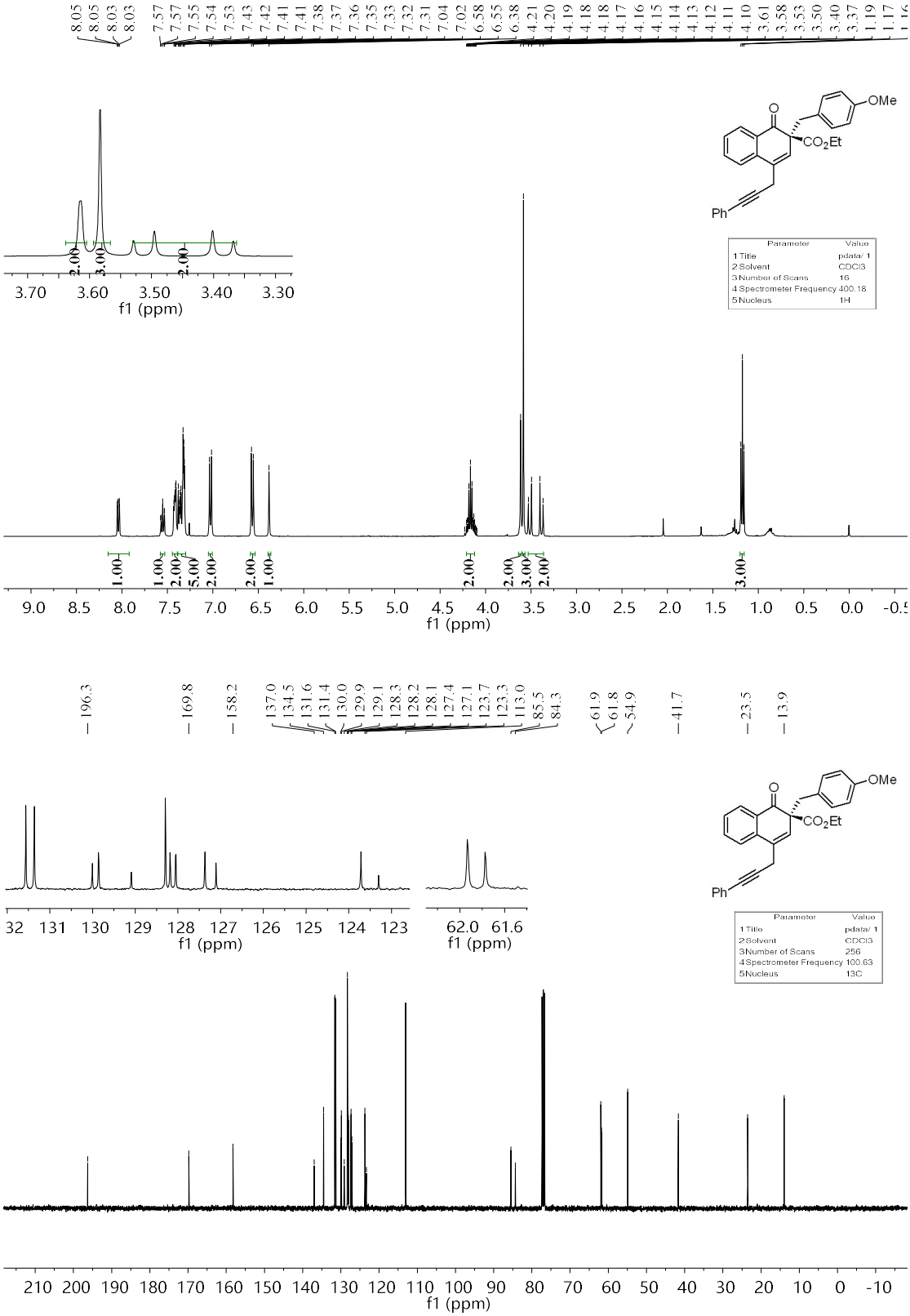
Ethyl (S)-2-(4-methoxybenzyl)-1-oxo-4-(thiophen-2-yl)-1,2-dihydronaphthalene-2-carboxylate (B15)



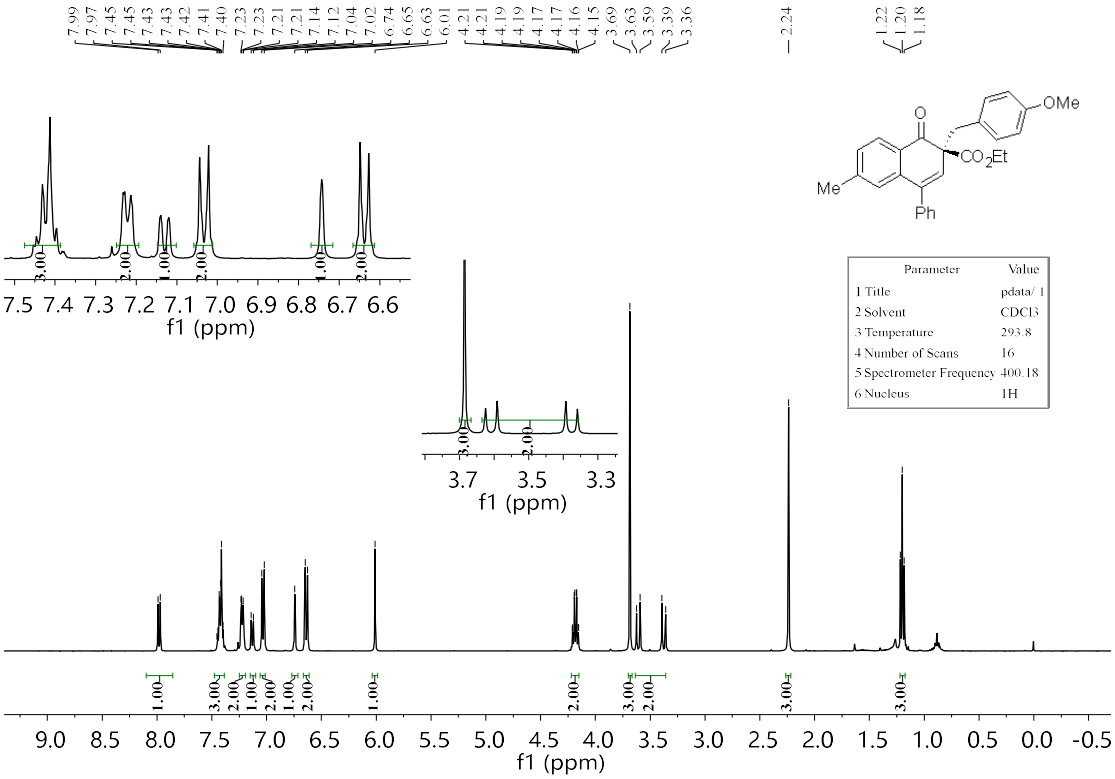
Ethyl (S)-4-cyclopropyl-2-(4-methoxybenzyl)-1-oxo-1,2-dihydronaphthalene-2-carboxylate (B16)

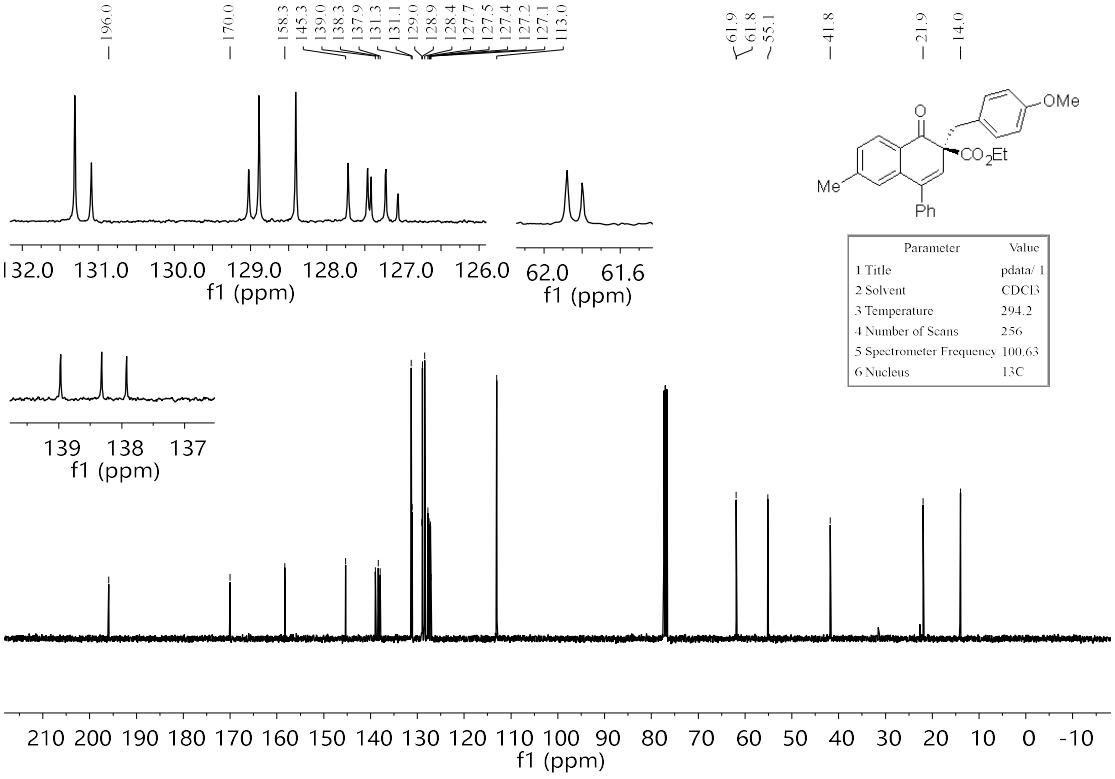


ethyl (S)-2-(4-methoxybenzyl)-1-oxo-4-(3-phenylprop-2-yn-1-yl)-1,2-dihydronaphthalene-2-carboxylate (B17)

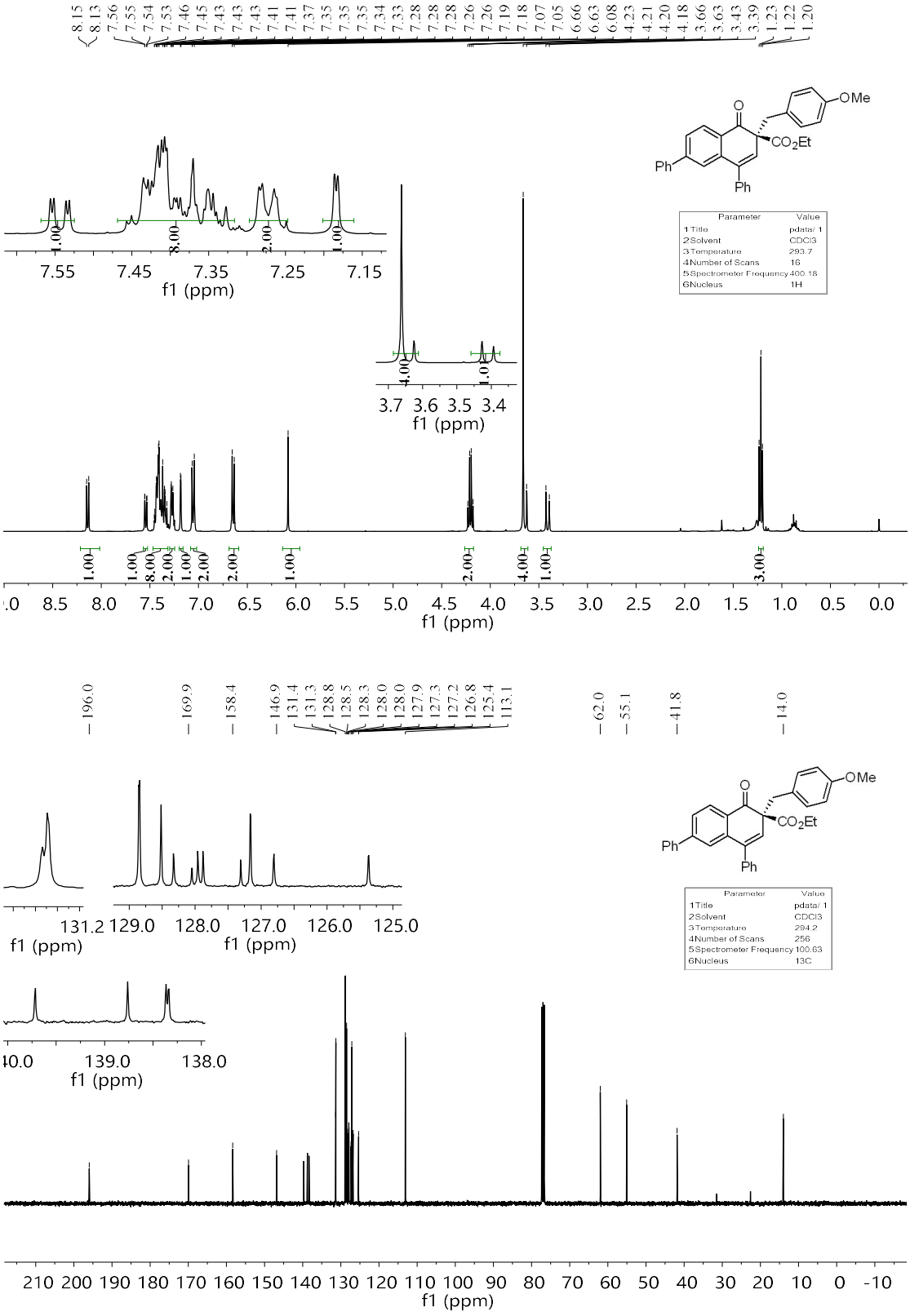


Ethyl (S)-2-(4-methoxybenzyl)-6-methyl-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B18)

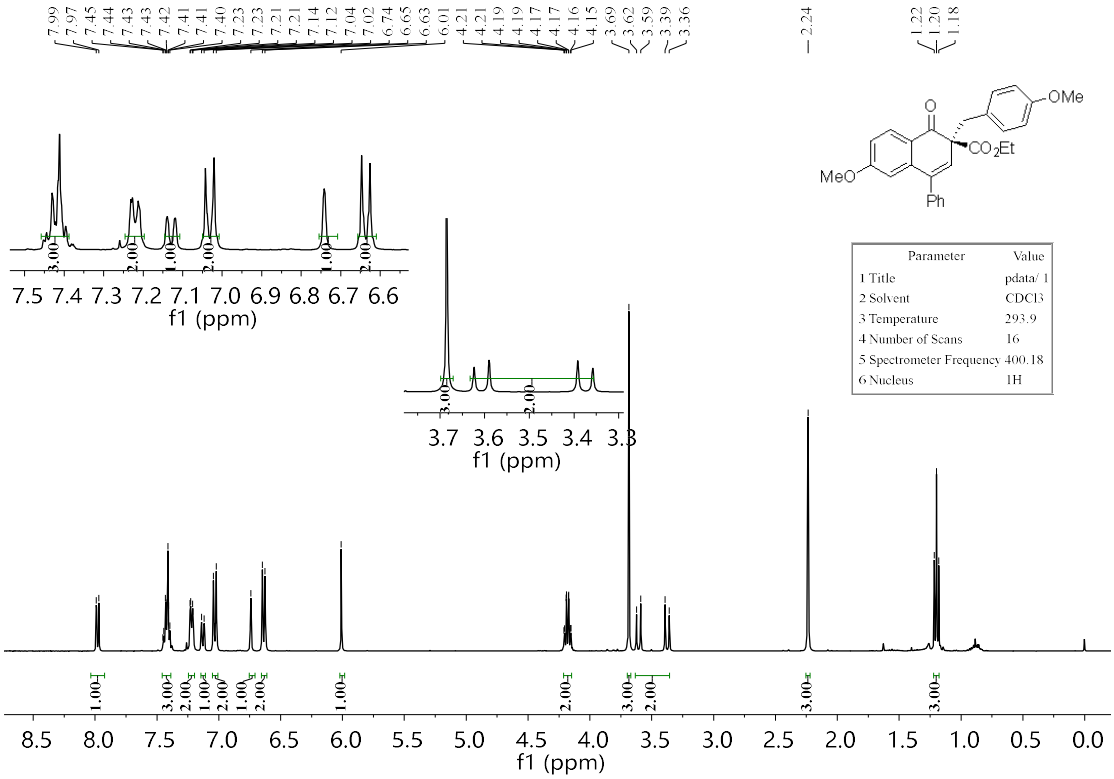


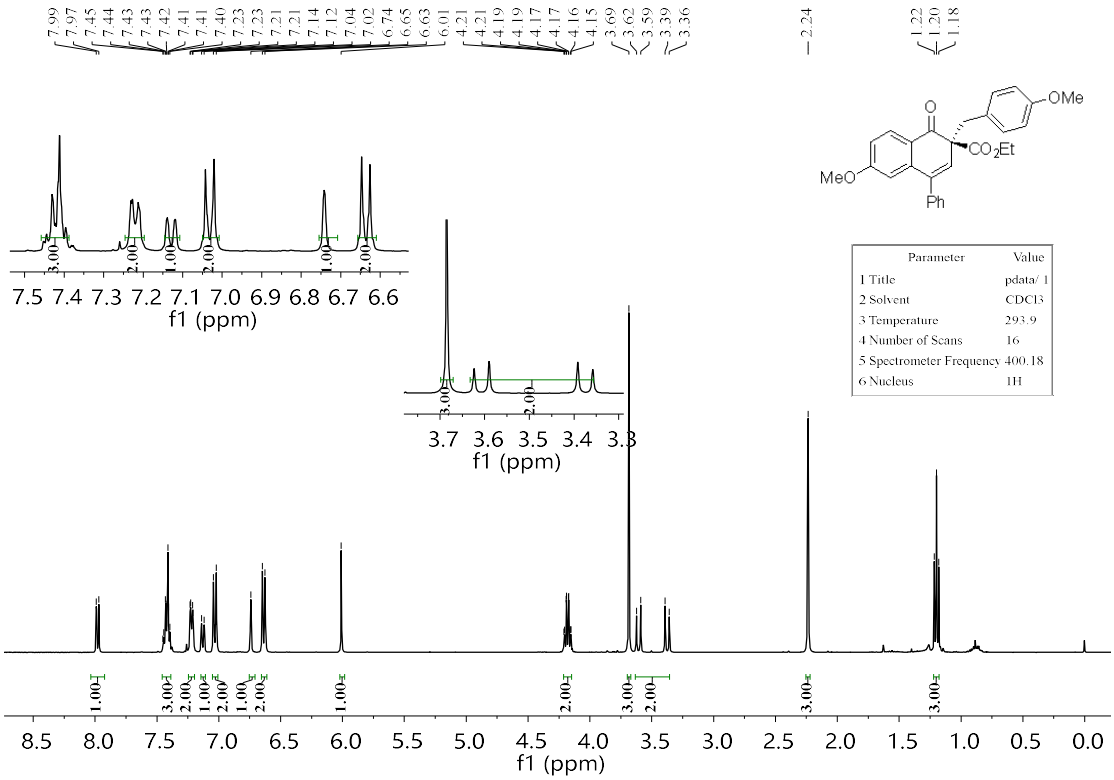


Ethyl (S)-2-(4-methoxybenzyl)-1-oxo-4,6-diphenyl-1,2-dihydronaphthalene-2-carboxylate (B19)

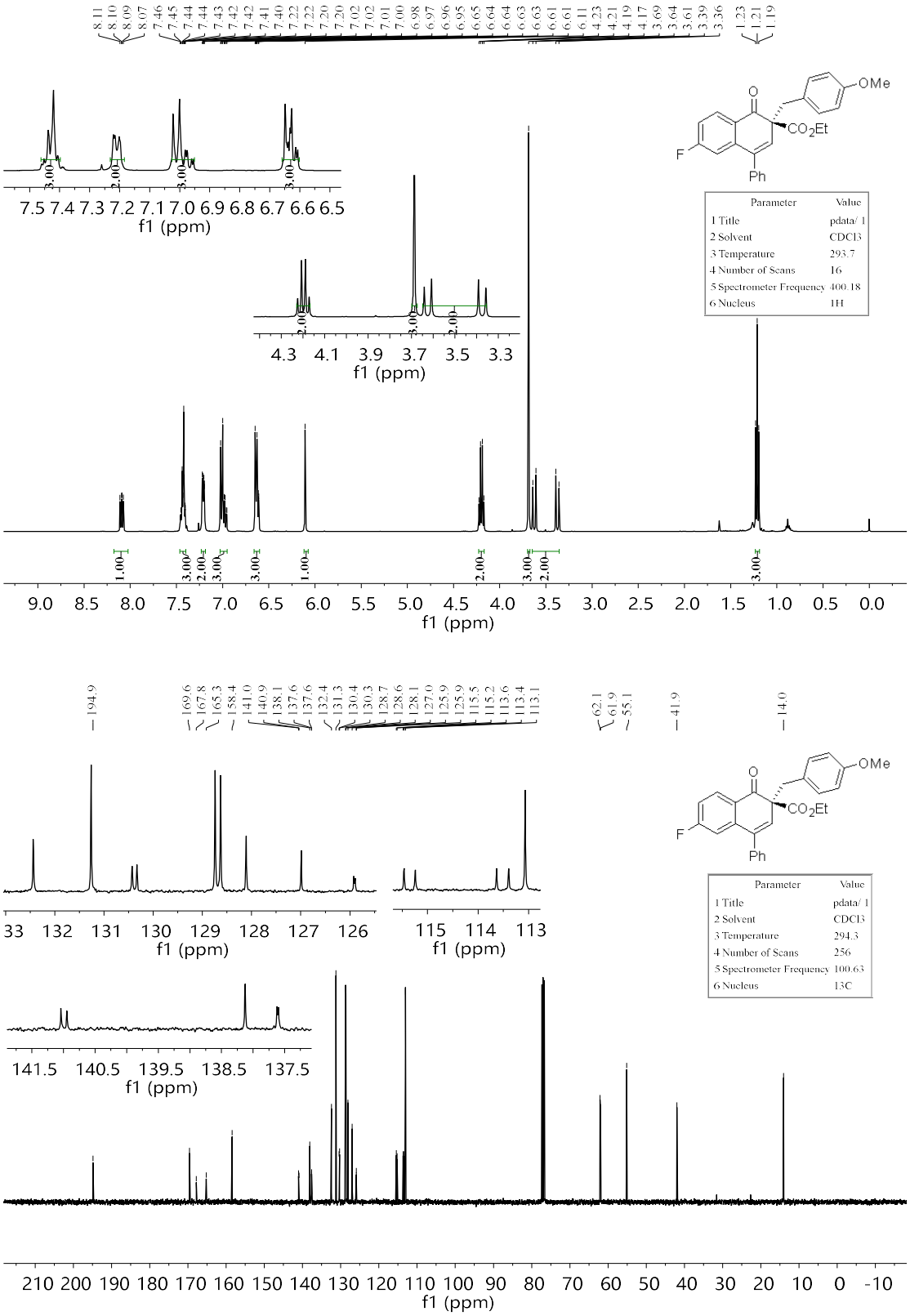


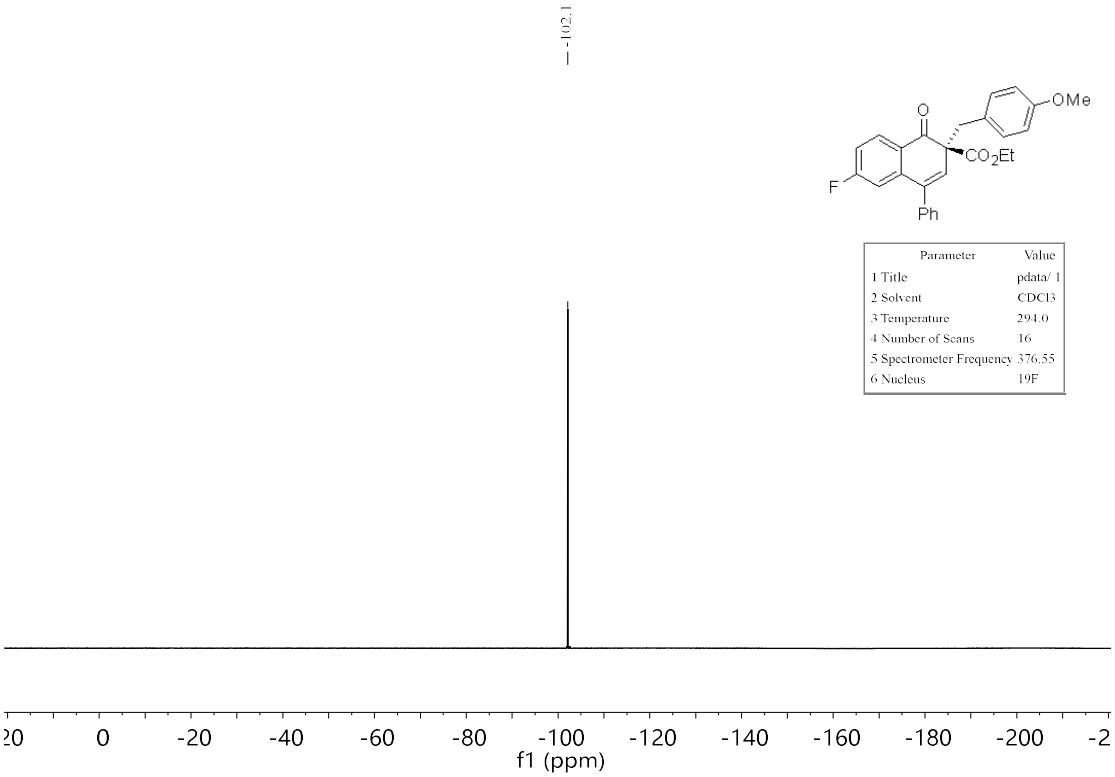
Ethyl (S)-6-methoxy-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B20)





Ethyl (S)-6-fluoro-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B21)




-102.1
O
OMe
CO2Et
F
Ph
Parameter Value
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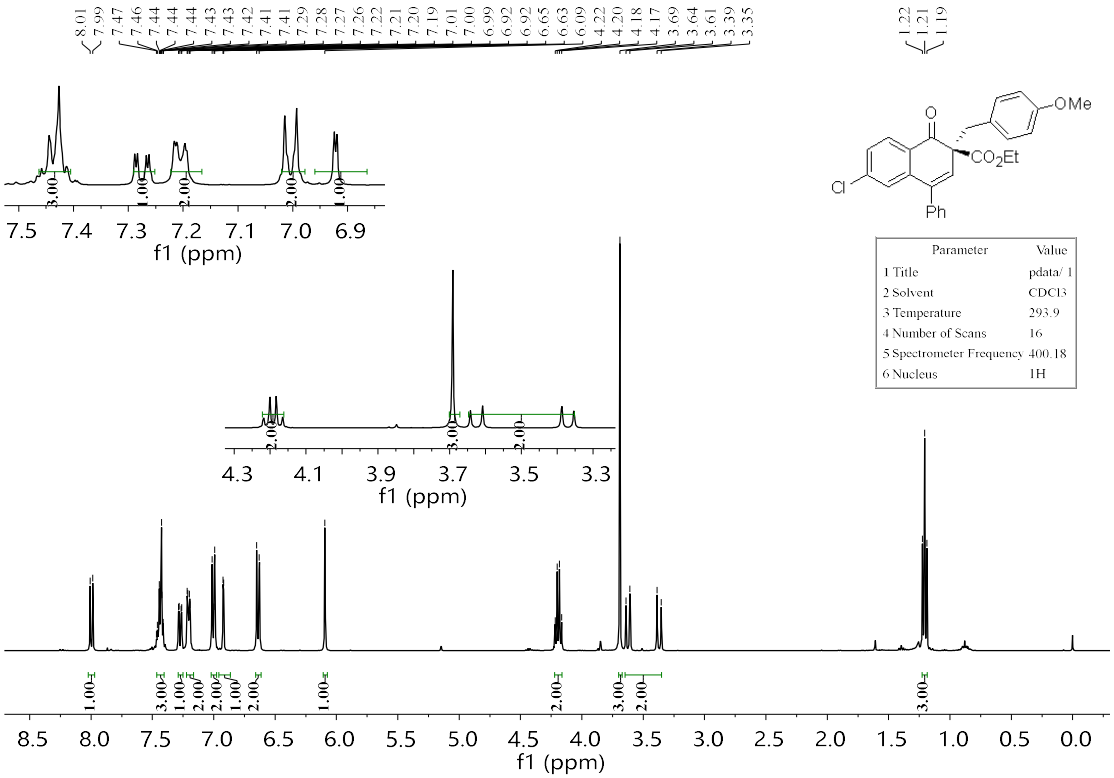
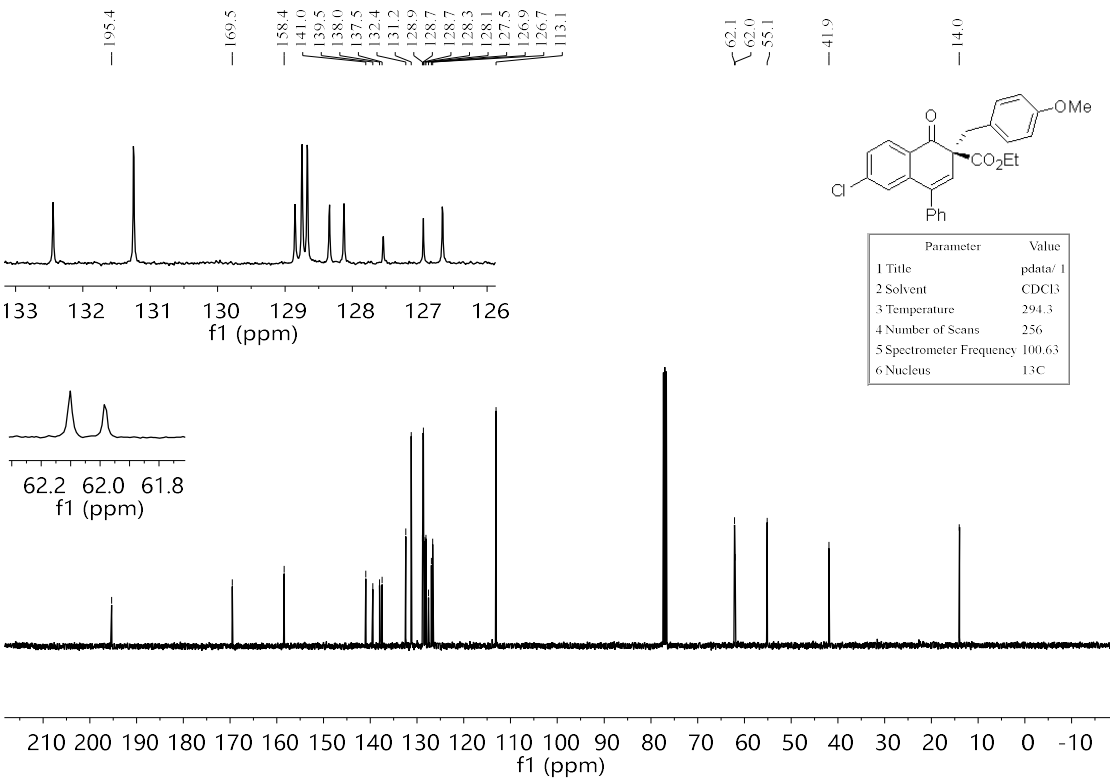
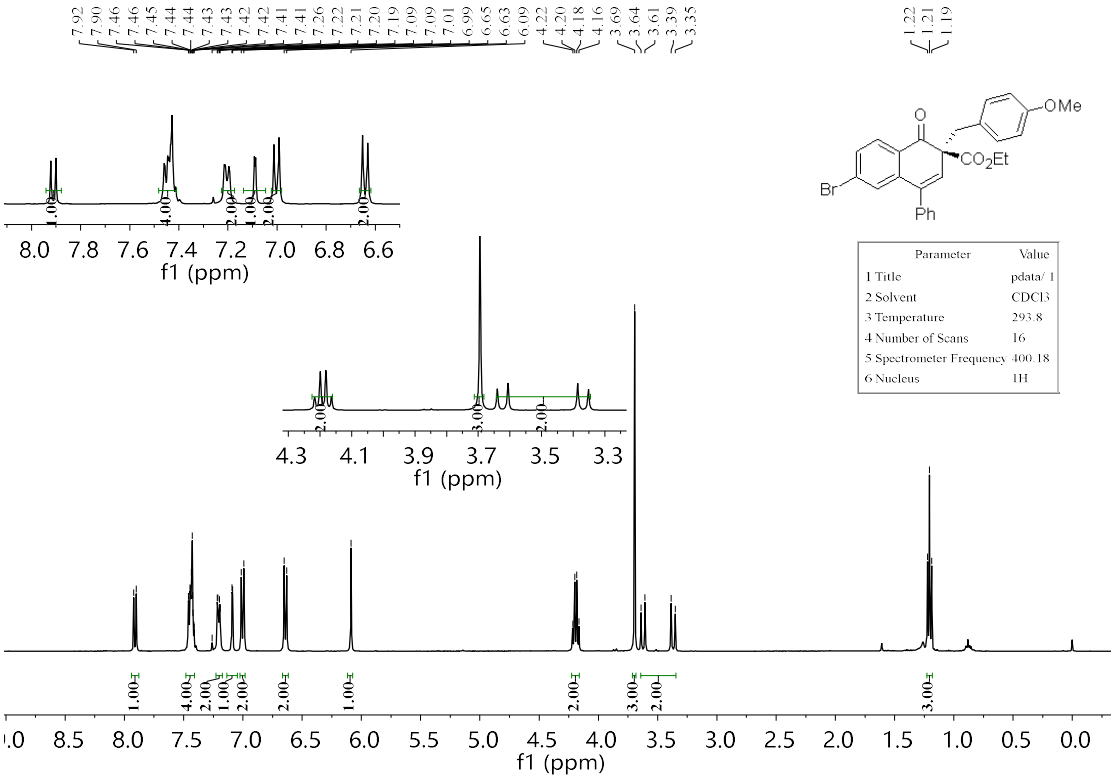
2 Solvent CDCl3
3 Temperature 294.0
4 Number of Scans 16
5 Spectrometer Frequency 376.55
6 Nucleus 19F
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)

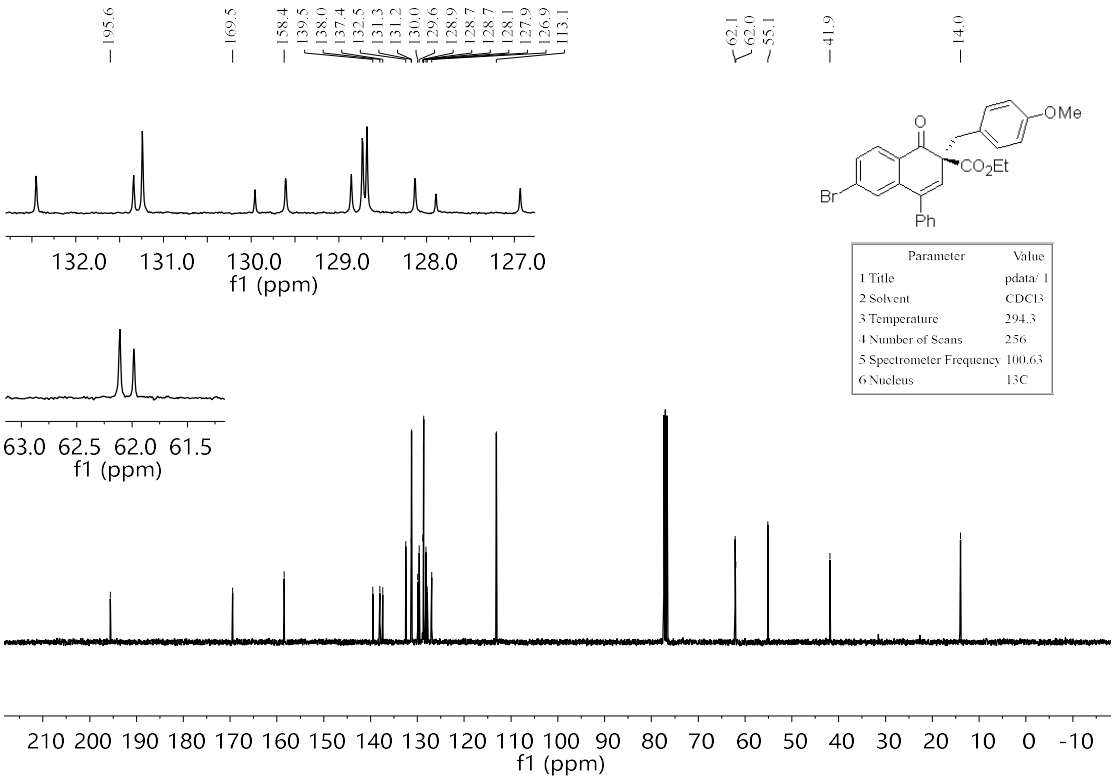
Ethyl (S)-6-chloro-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B22)



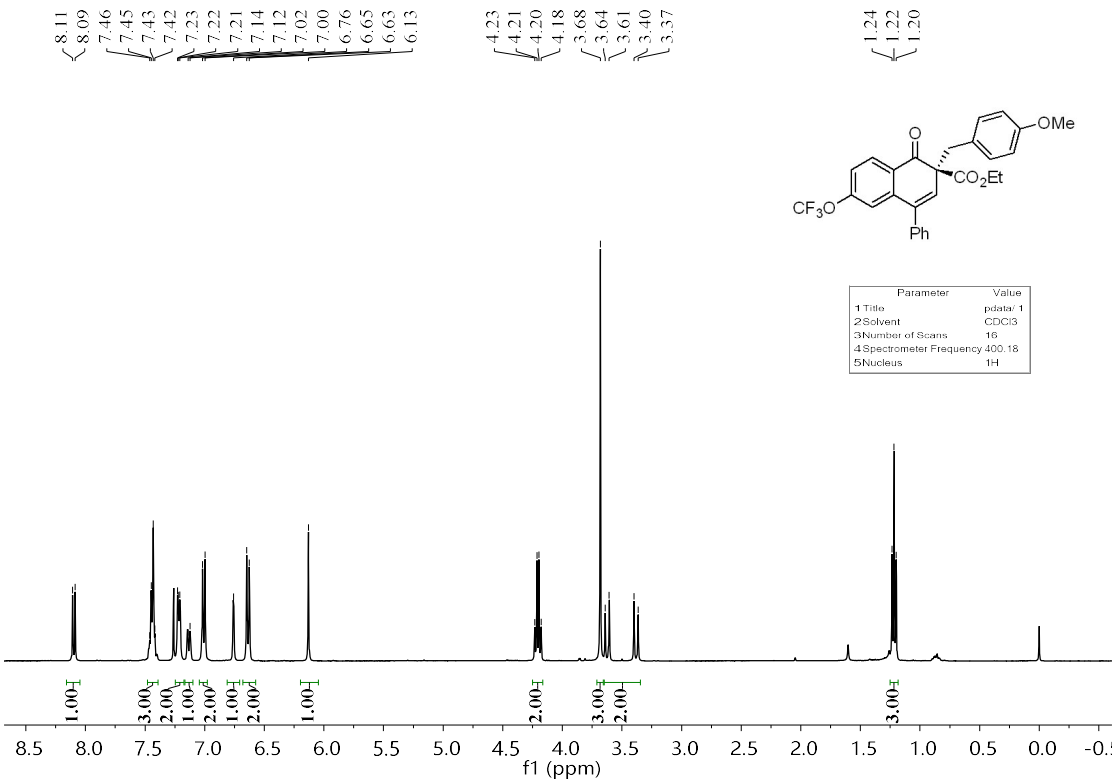


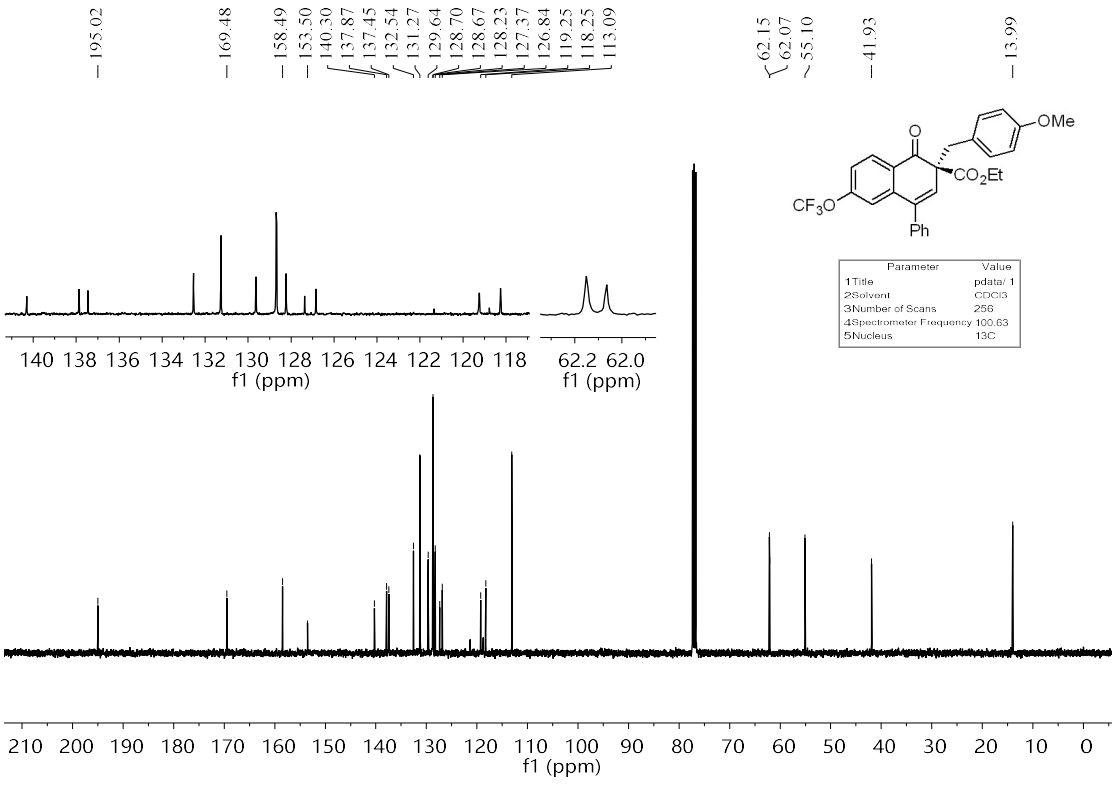
Ethyl (S)-6-bromo-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B23)

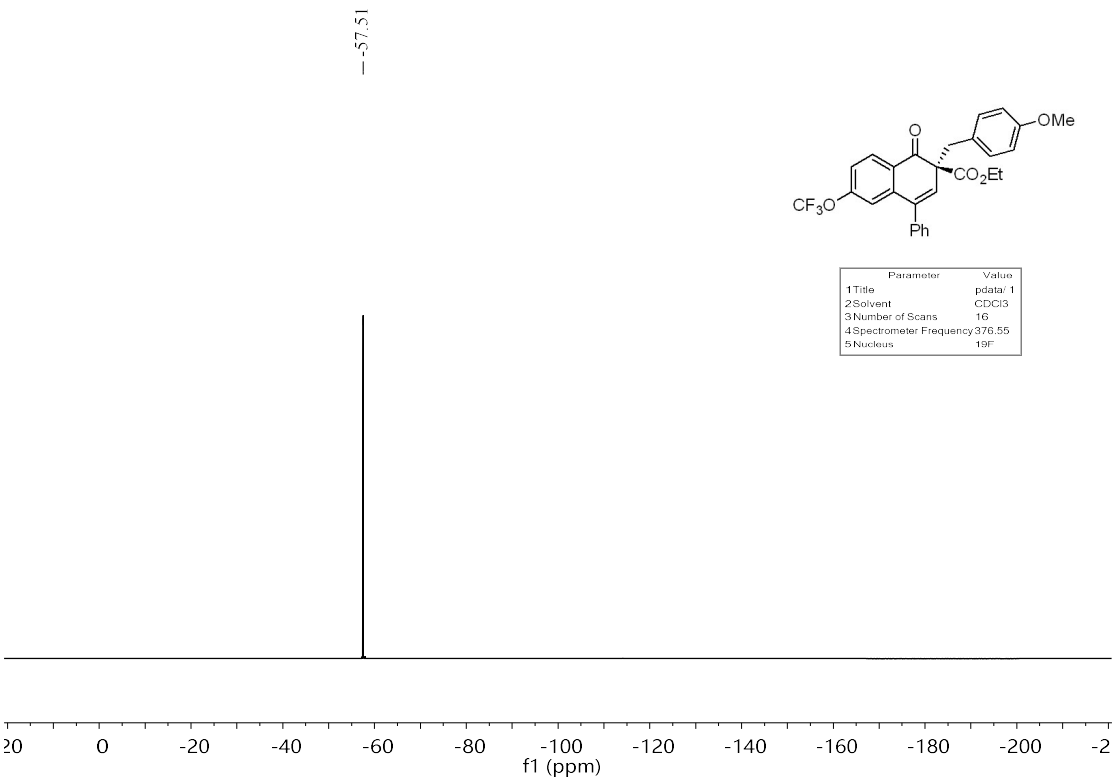




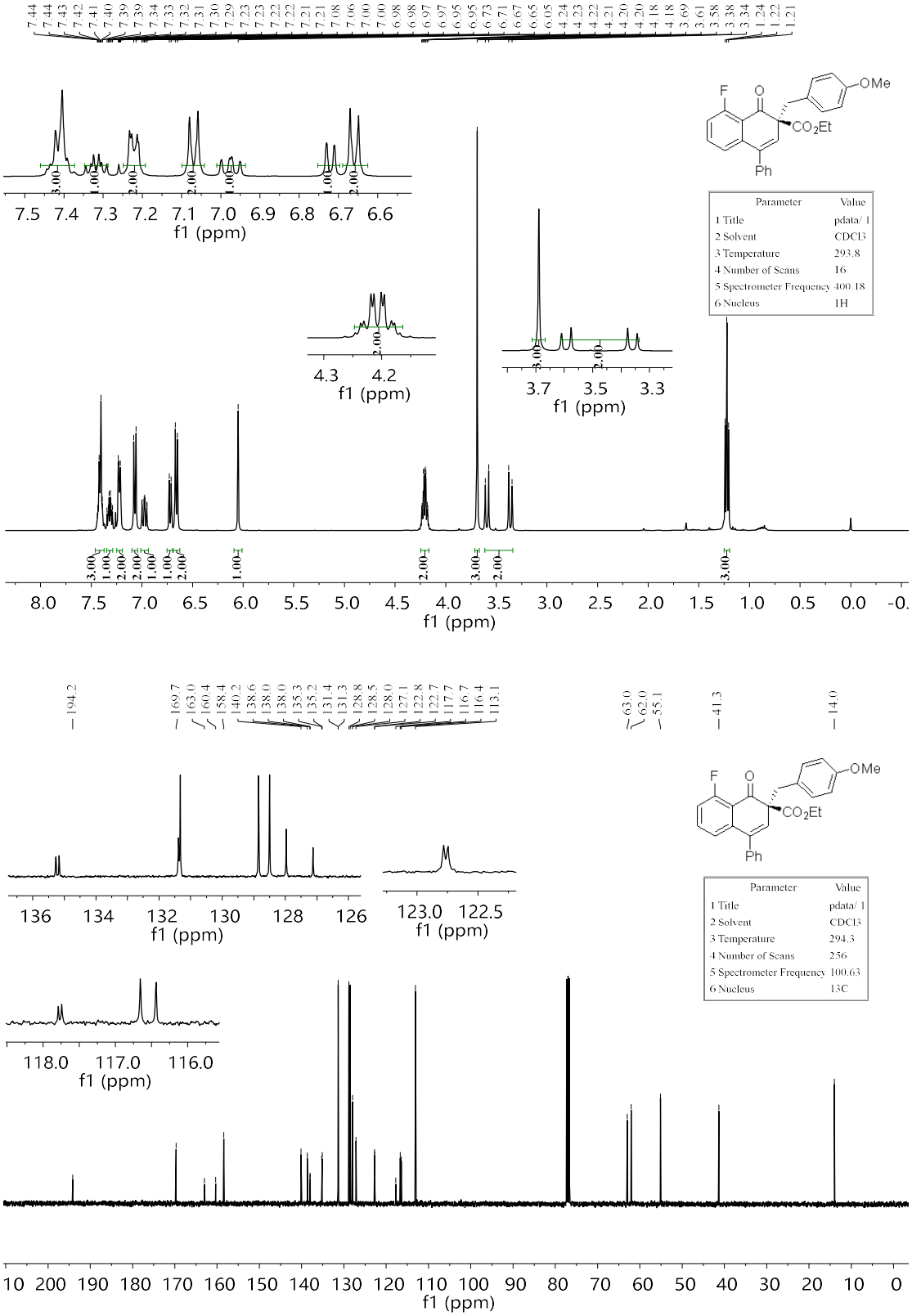
Ethyl (S)-2-(4-methoxybenzyl)-1-oxo-4-phenyl-6-(trifluoromethoxy)-1,2-dihydronaphthalene-2-carboxylate (B24)

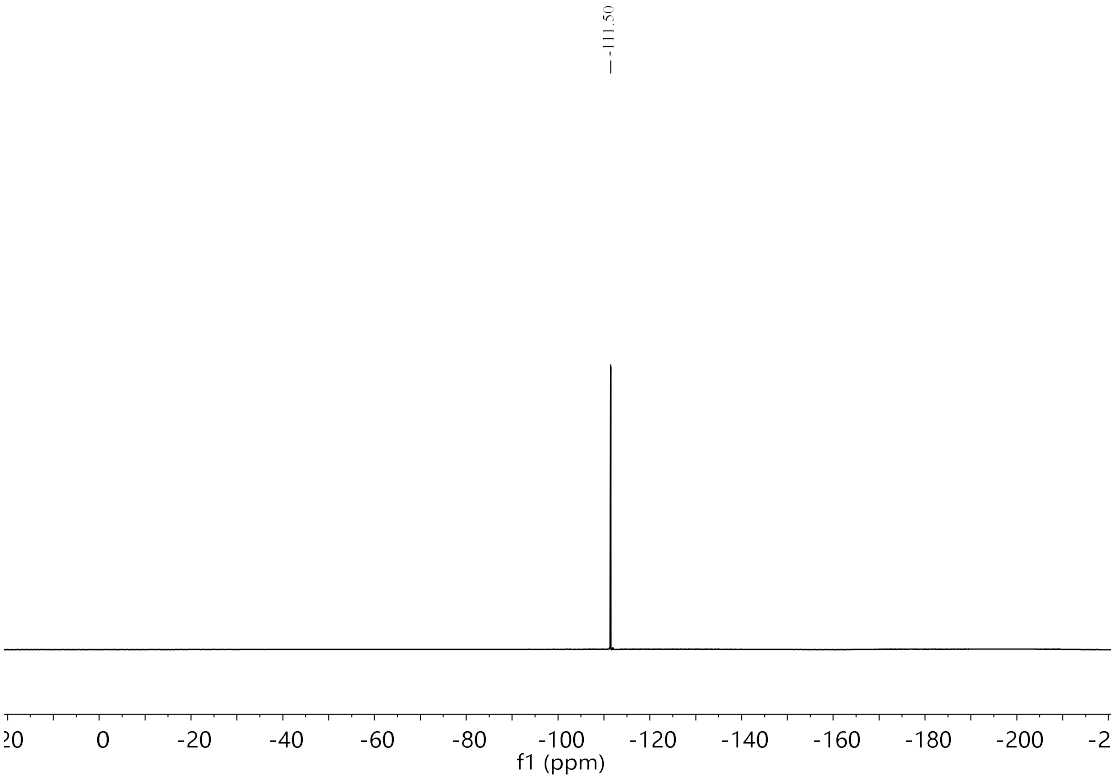




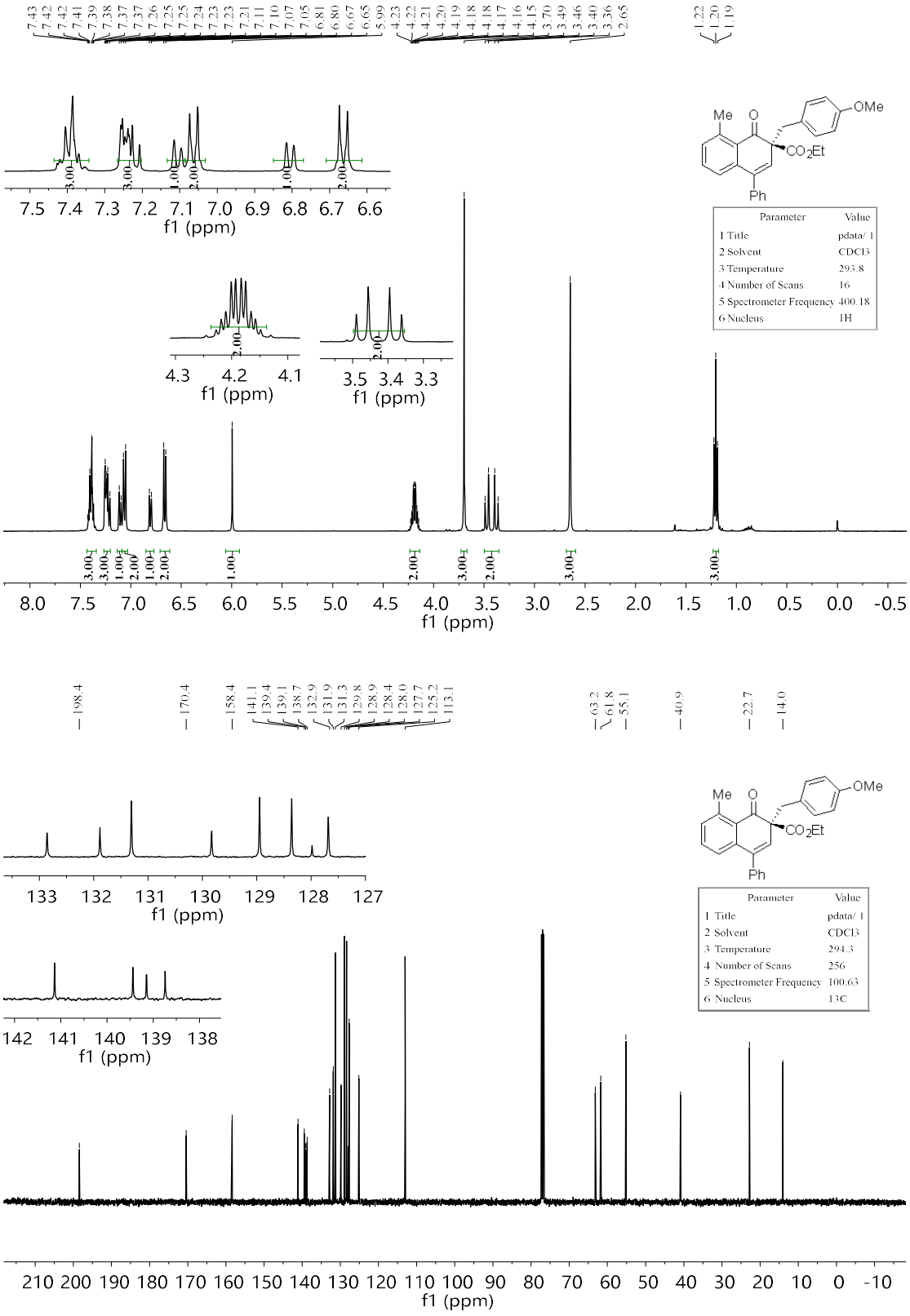

-57.51
OMe
O
CO2Et
CF3O
Ph
Parameter Value
1 Title pdata/ 1
2 Solvent CDCl3
3 Number of Scans 16
4 Spectrometer Frequency 376.55
5 Nucleus 19F
20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -2
f1 (ppm)

Ethyl (S)-8-fluoro-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B25)

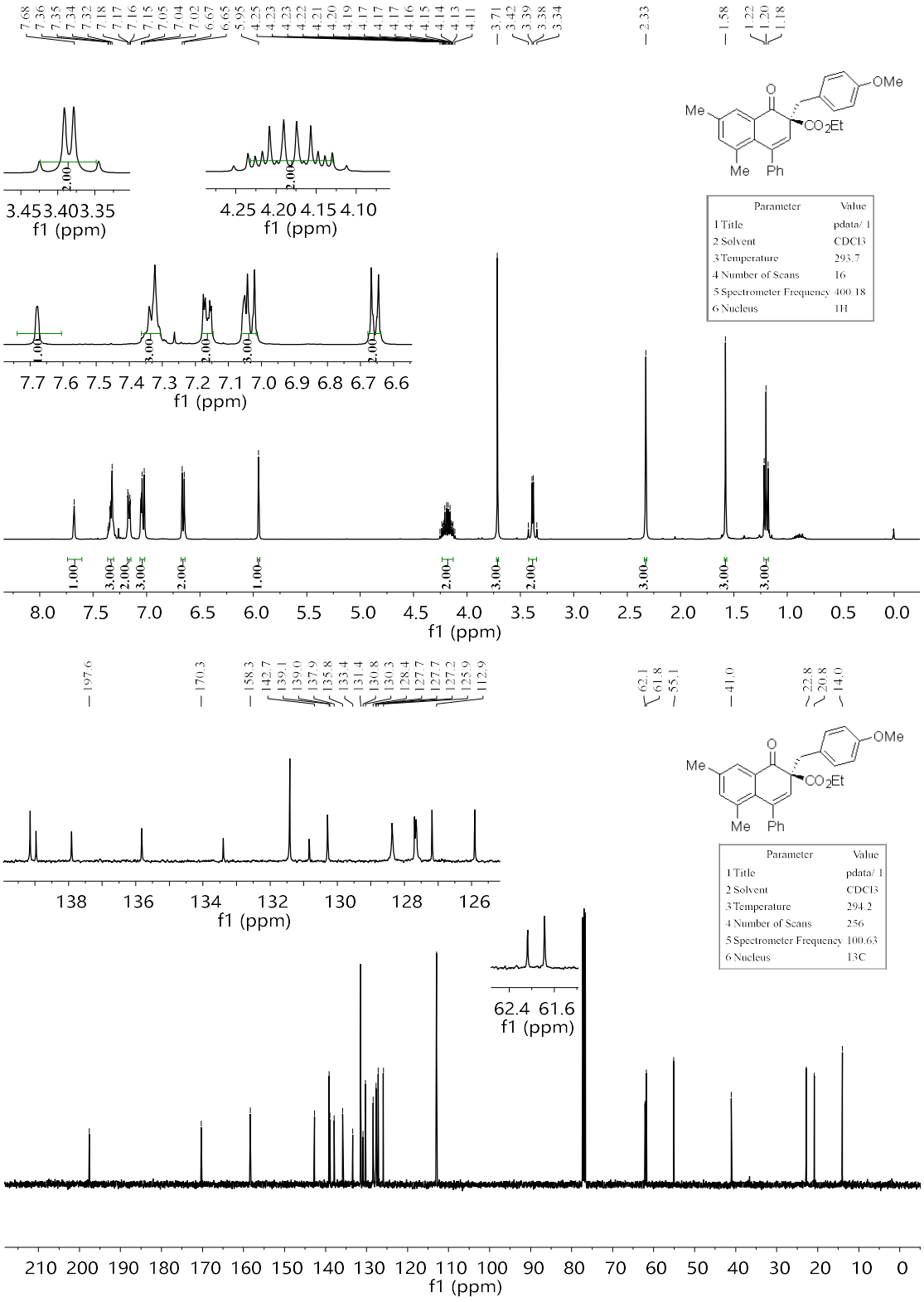



-111.50
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-2
f1 (ppm)

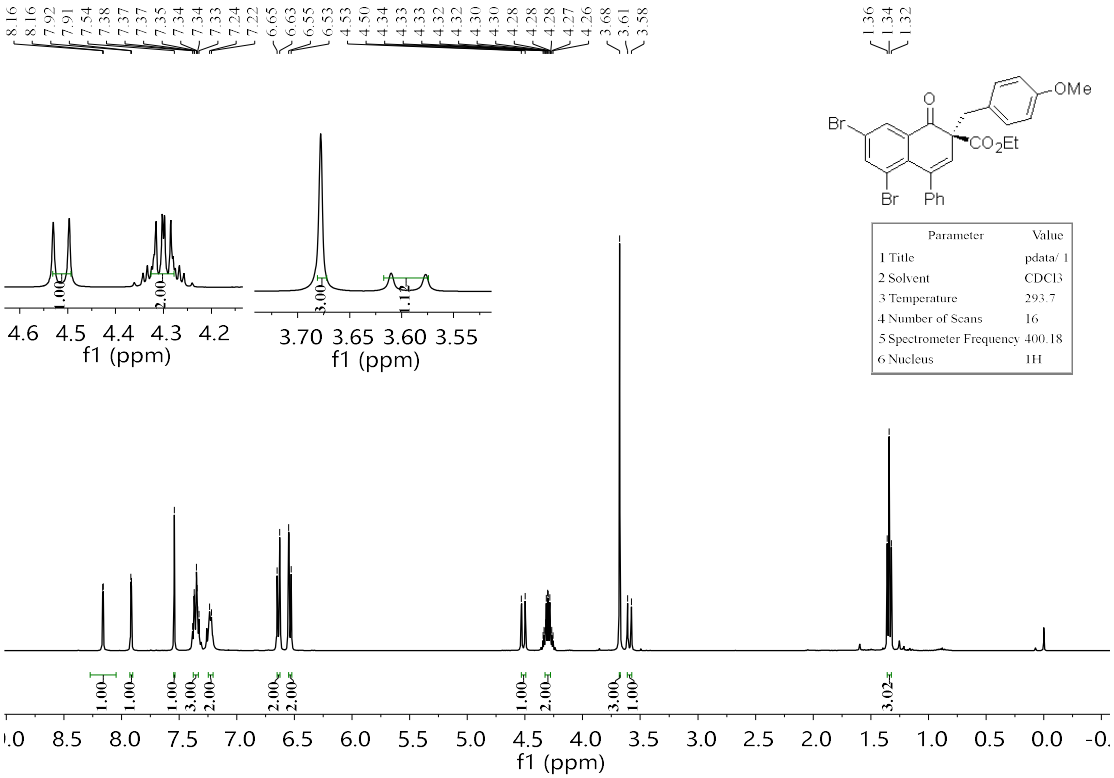
Ethyl (S)-2-(4-methoxybenzyl)-8-methyl-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B26)

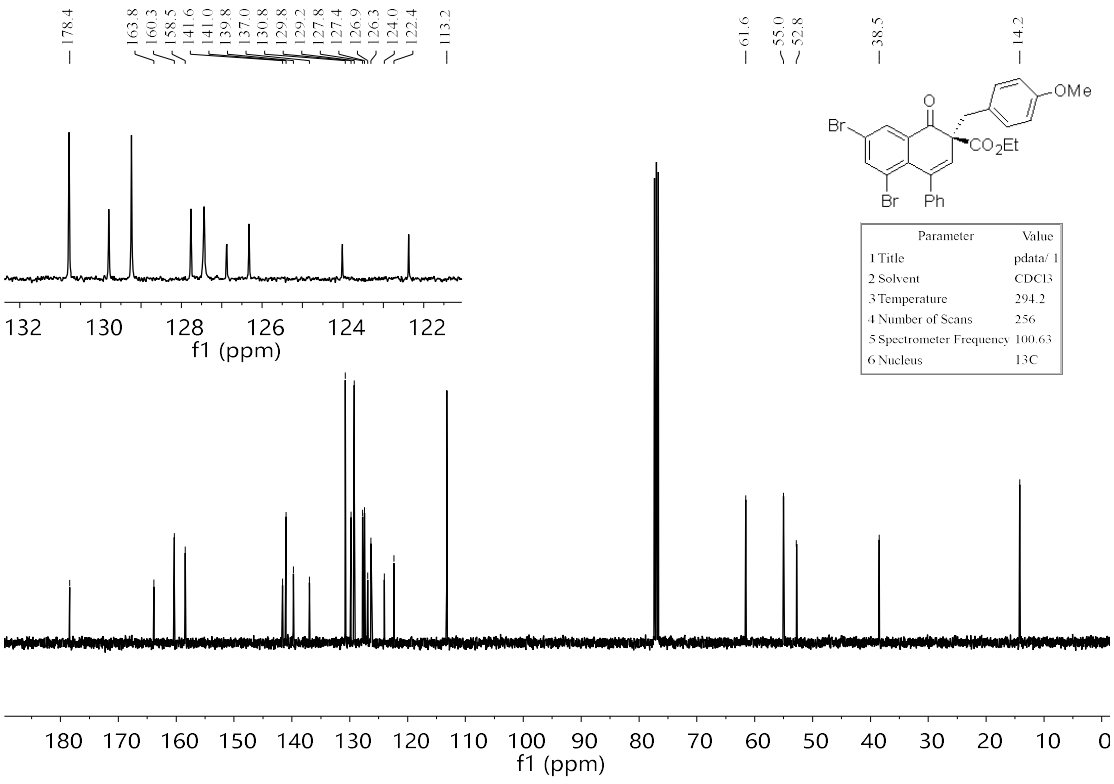


Ethyl (S)-2-(4-methoxybenzyl)-5,7-dimethyl-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B27)

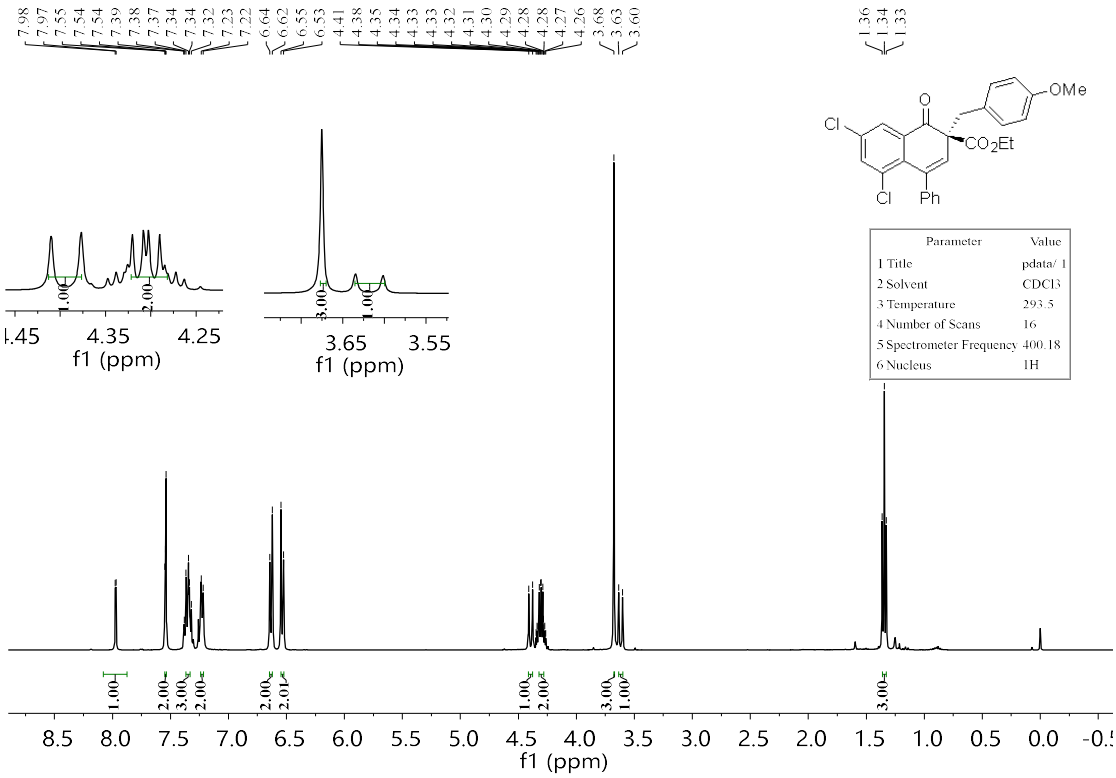


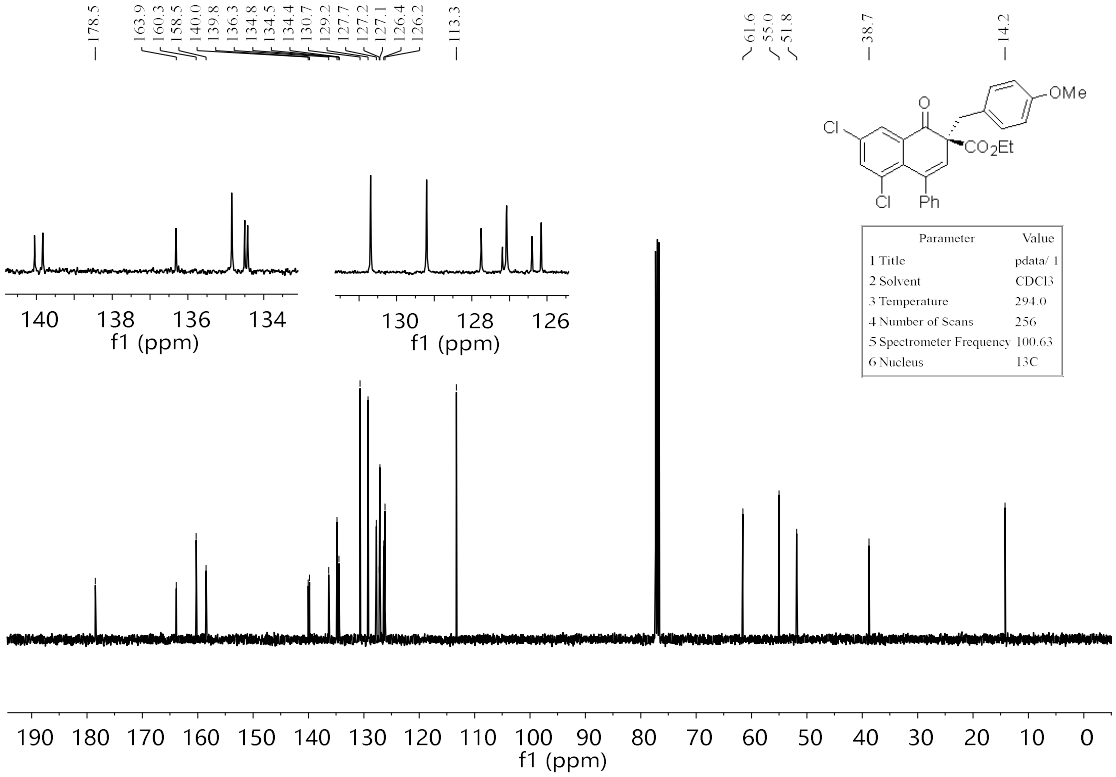
Ethyl (S)-5,7-dibromo-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B28)



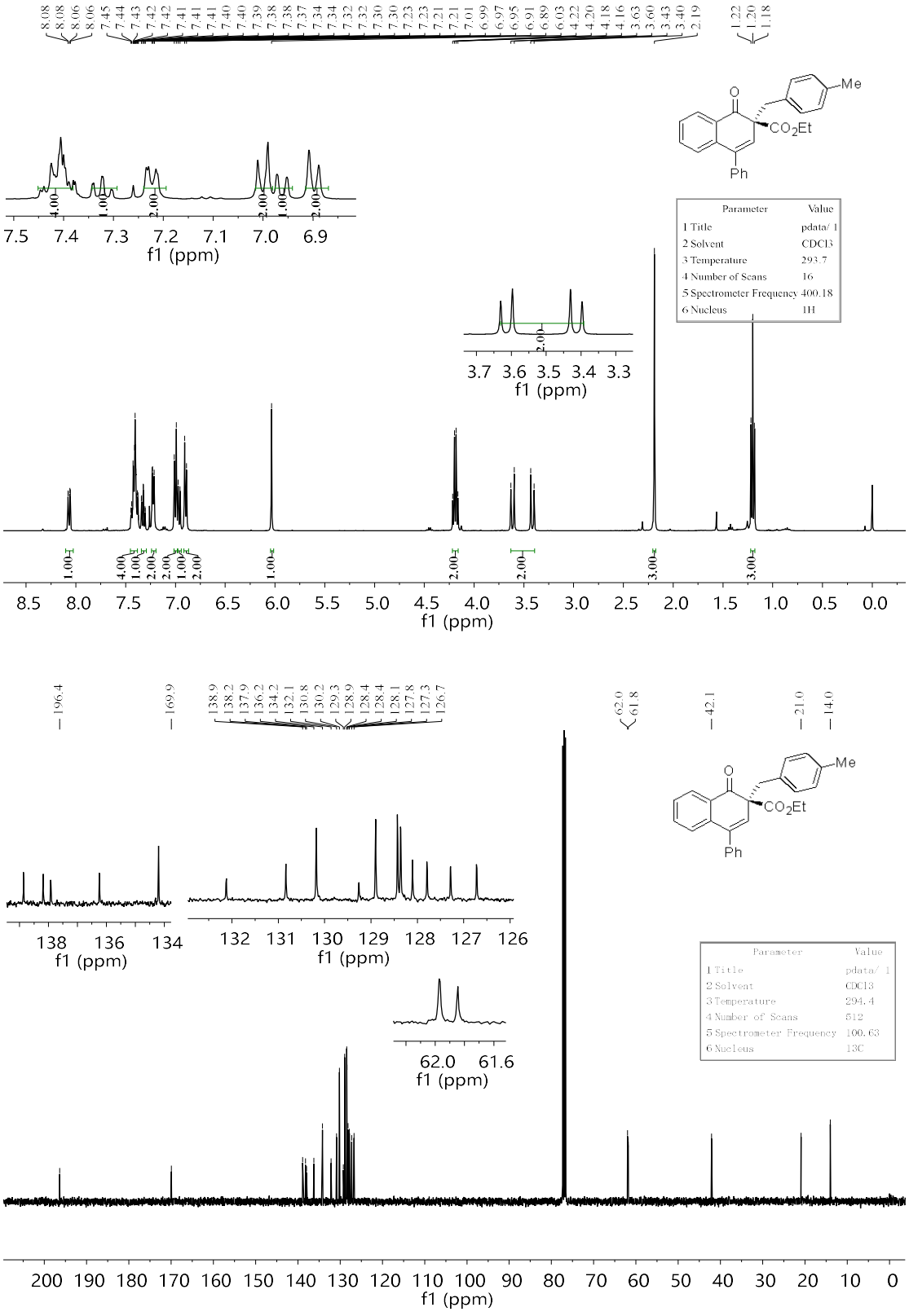


Ethyl (S)-5,7-dichloro-2-(4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B29)

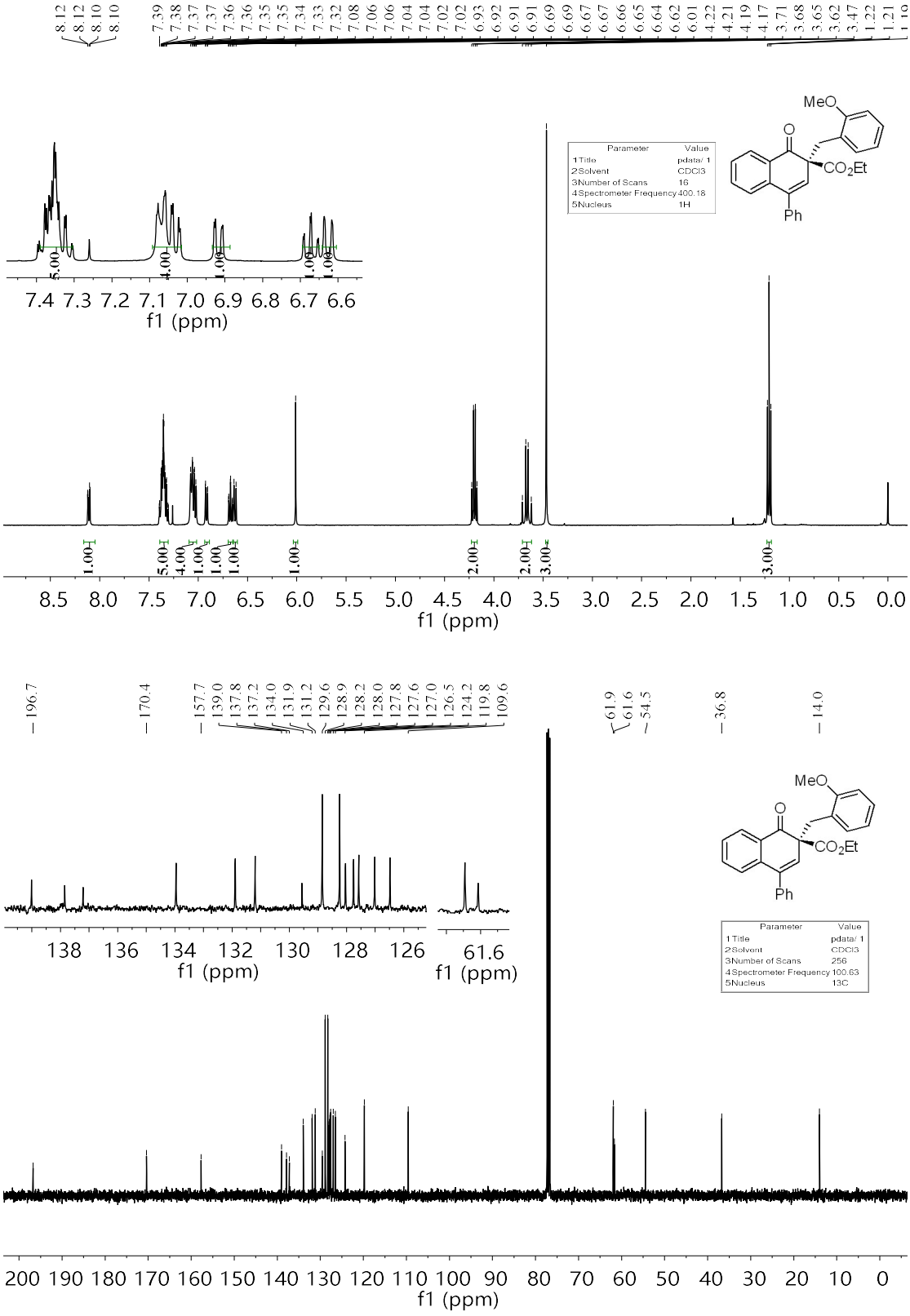




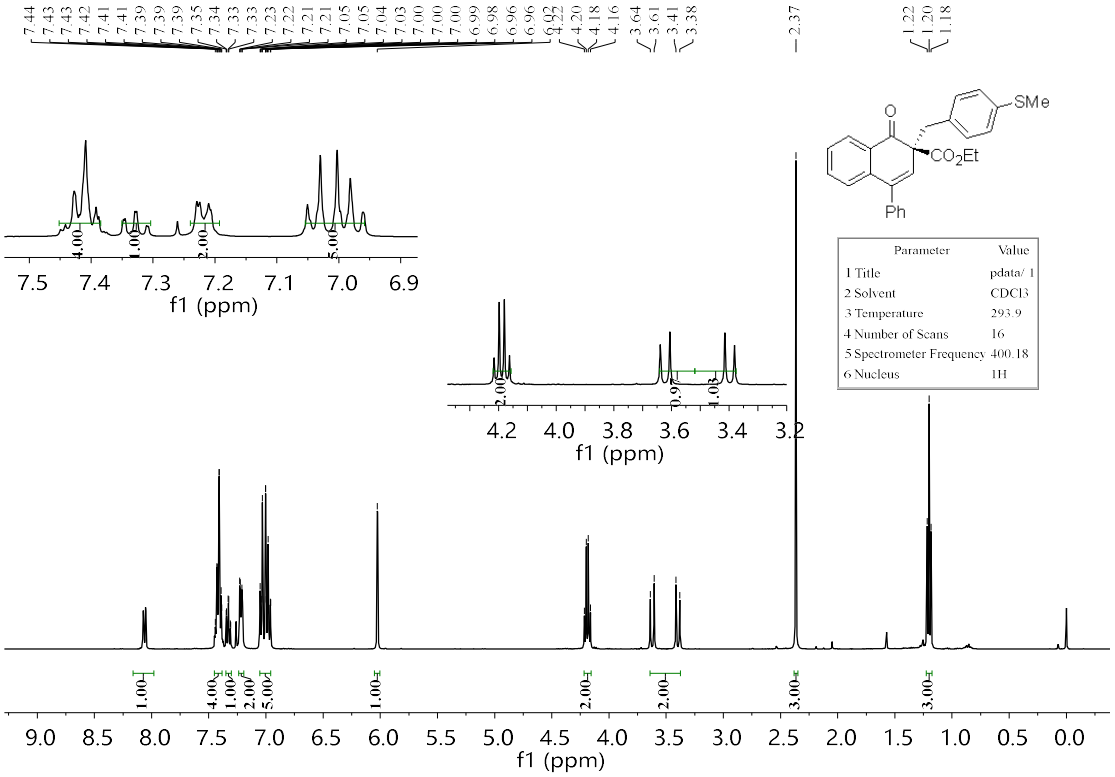
Ethyl (S)-2-(4-methylbenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B30)

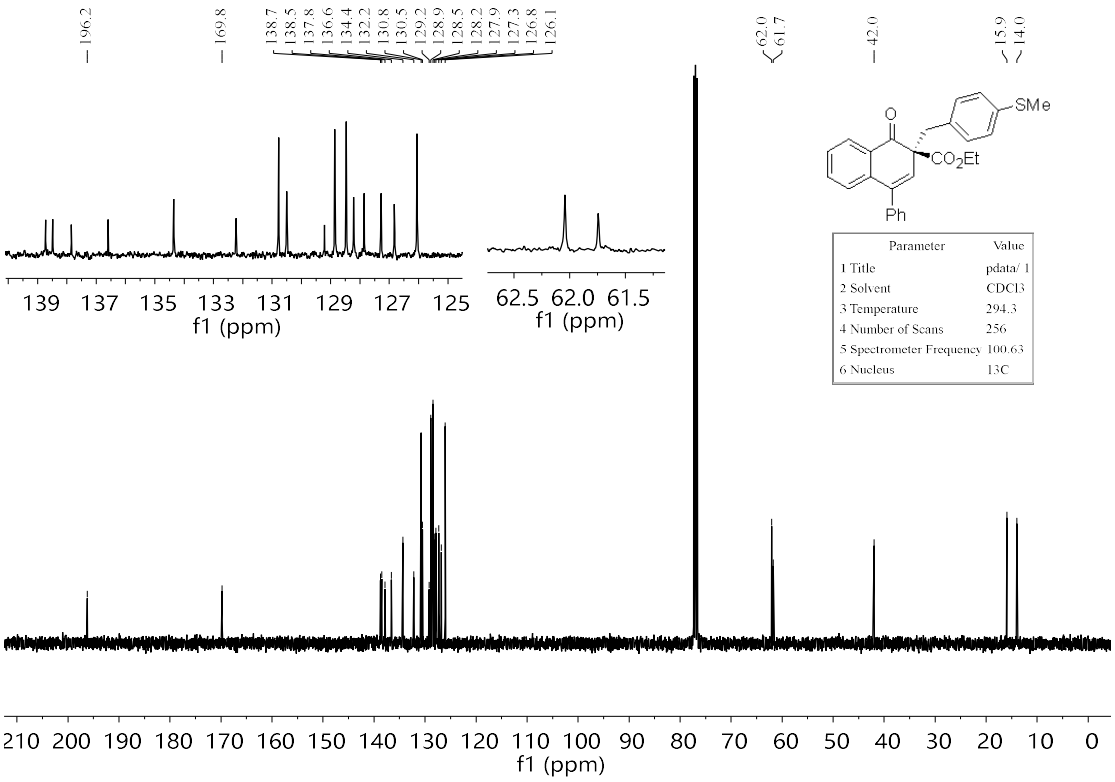


Ethyl (S)-2-(2-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B31)

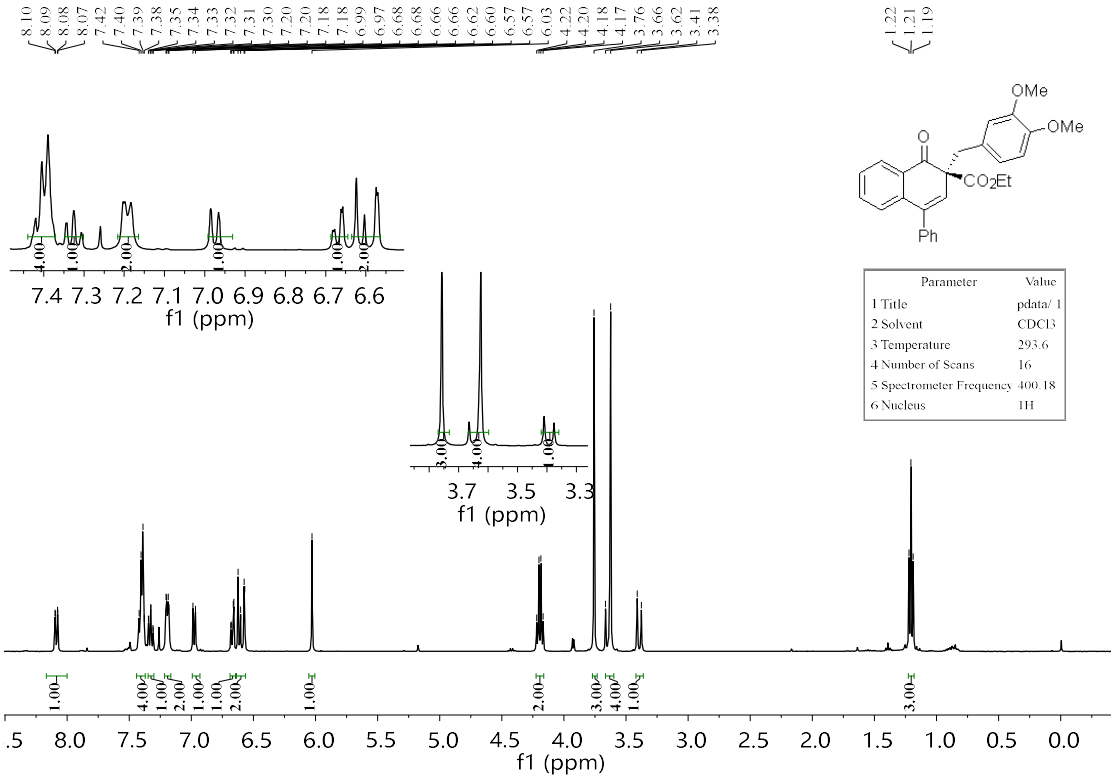


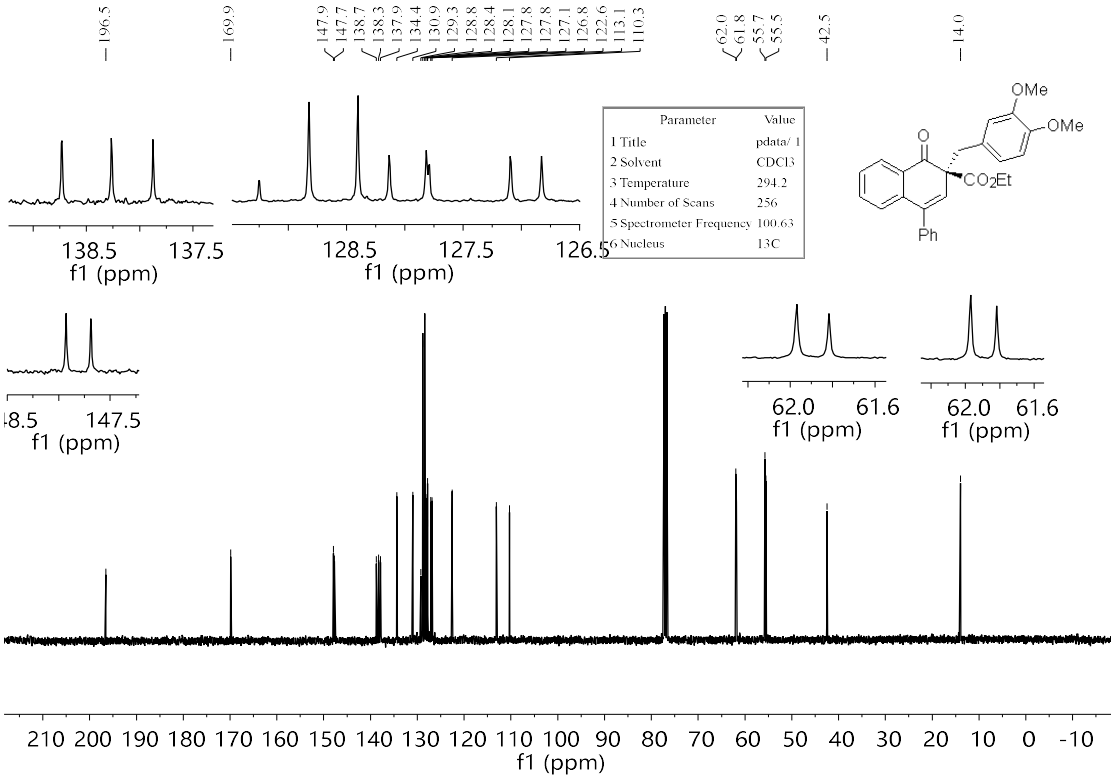
Ethyl (S)-2-(4-(methylthio)benzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B32)



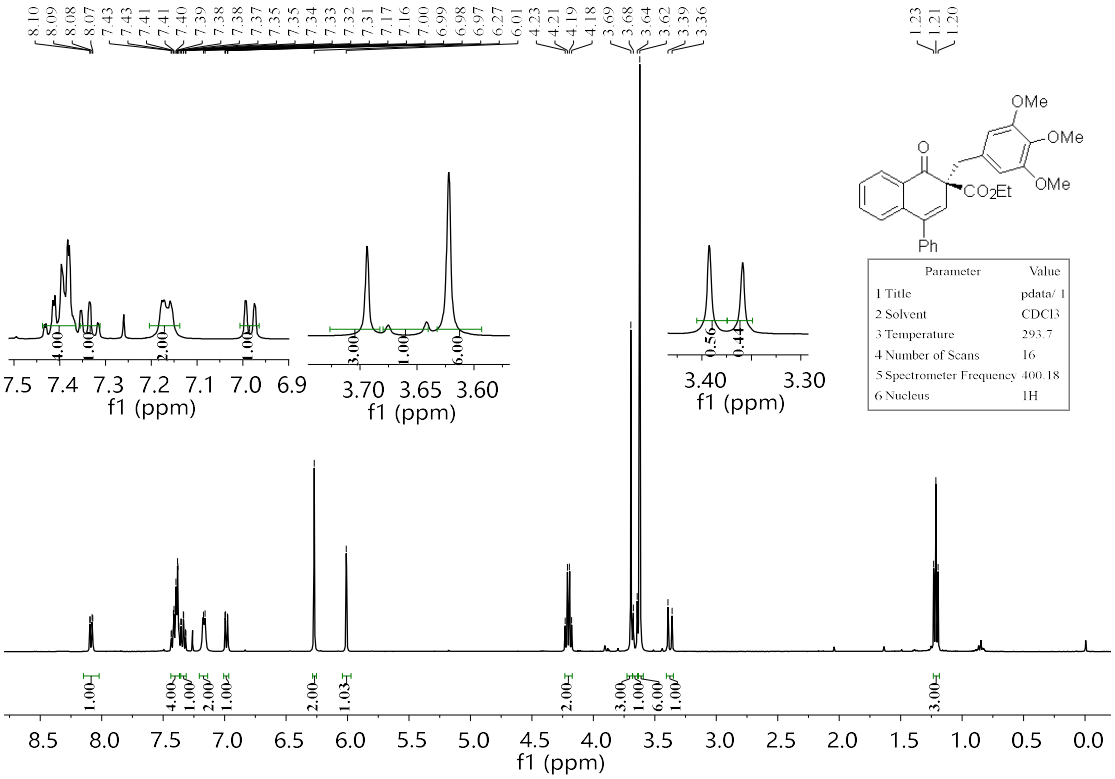


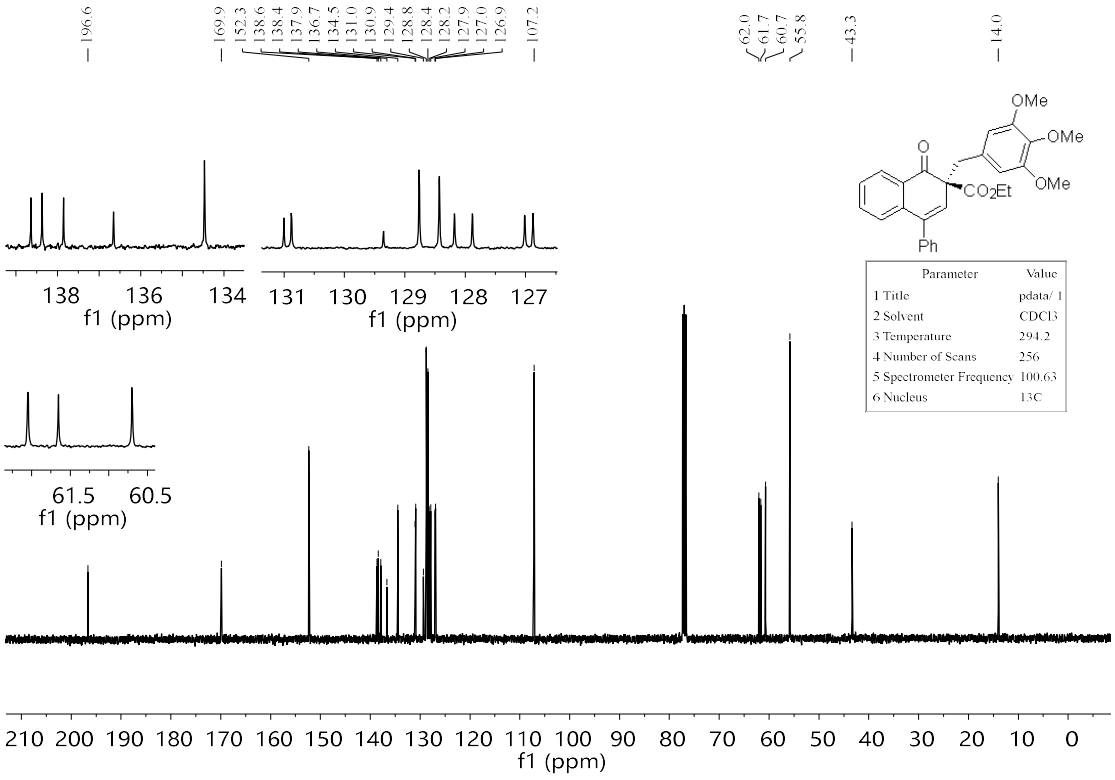
Ethyl (S)-2-(3,4-dimethoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B33)



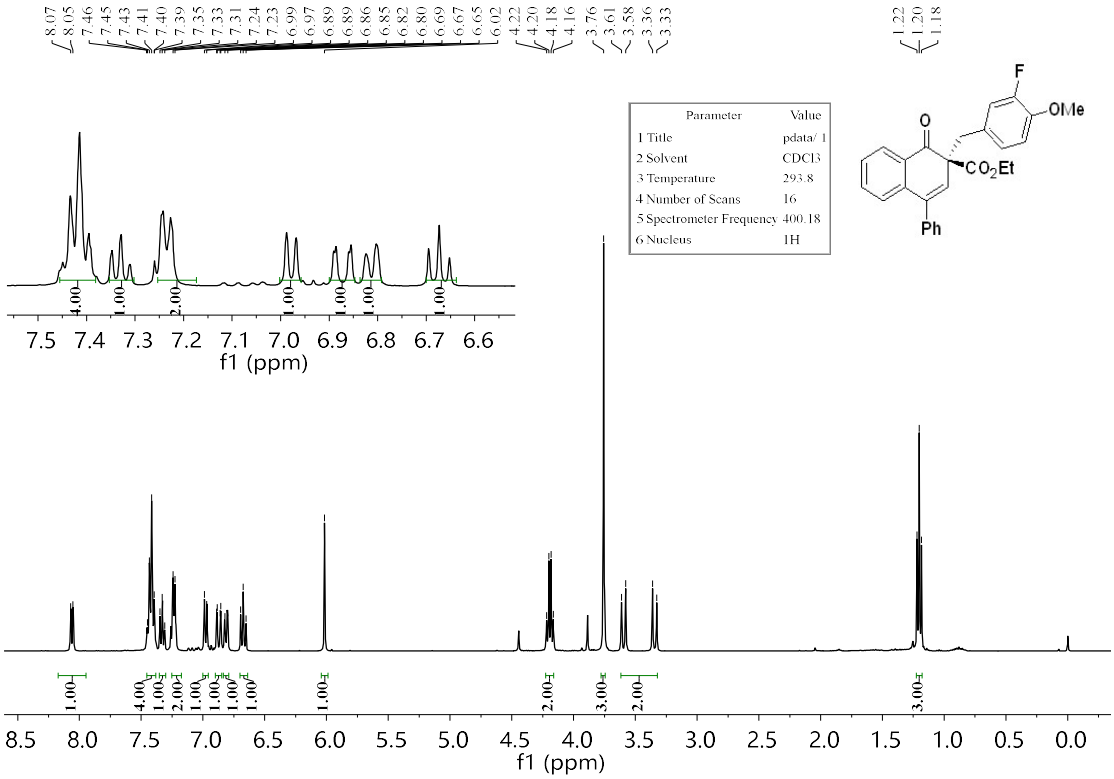


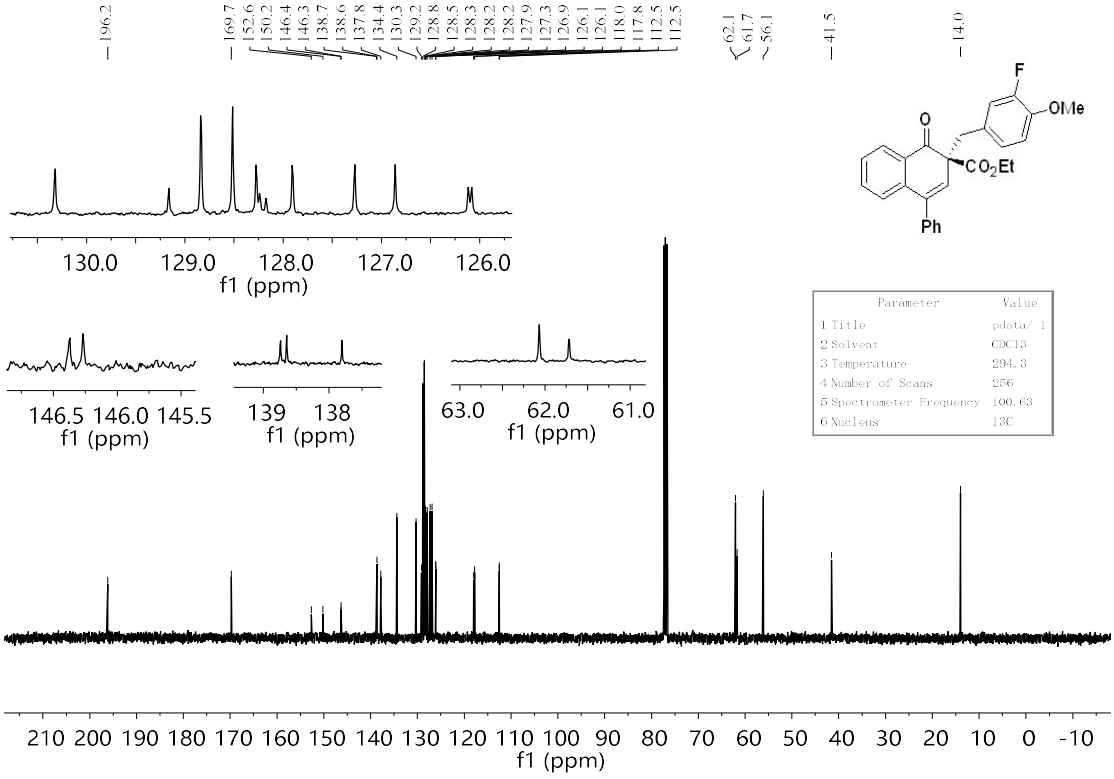
Ethyl (S)-1-oxo-4-phenyl-2-(3,4,5-trimethoxybenzyl)-1,2-dihydronaphthalene-2-carboxylate (B34)

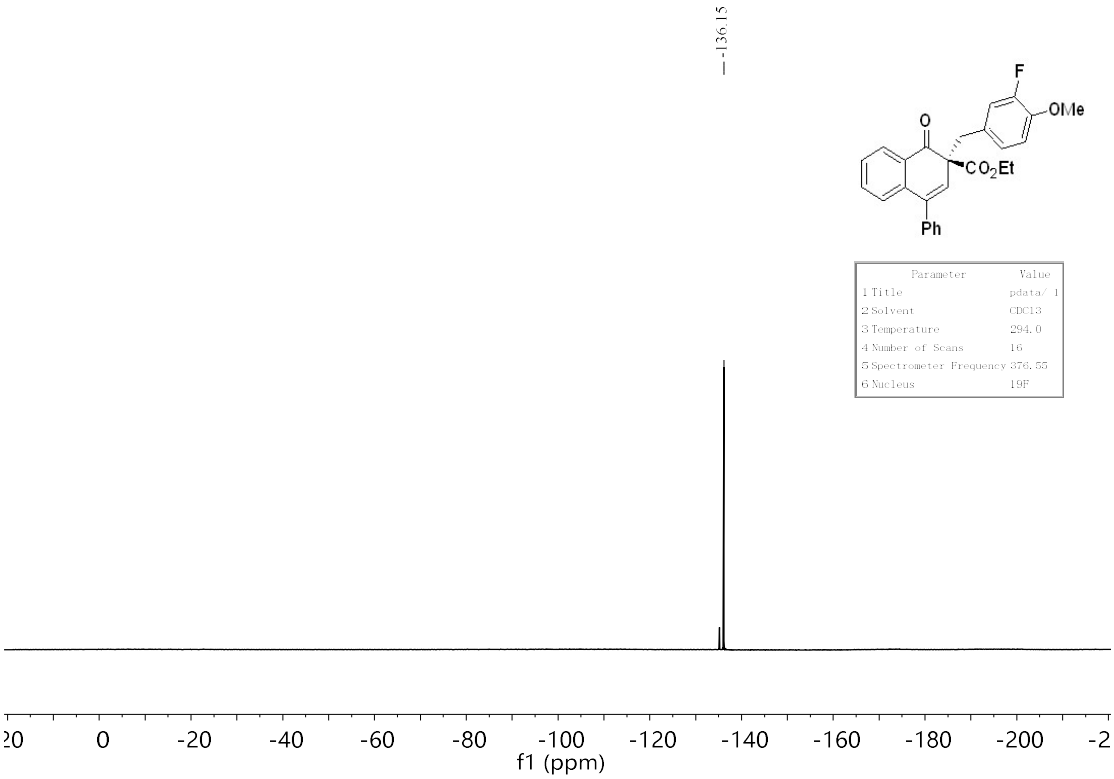




Ethyl (S)-2-(3-fluoro-4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B35)



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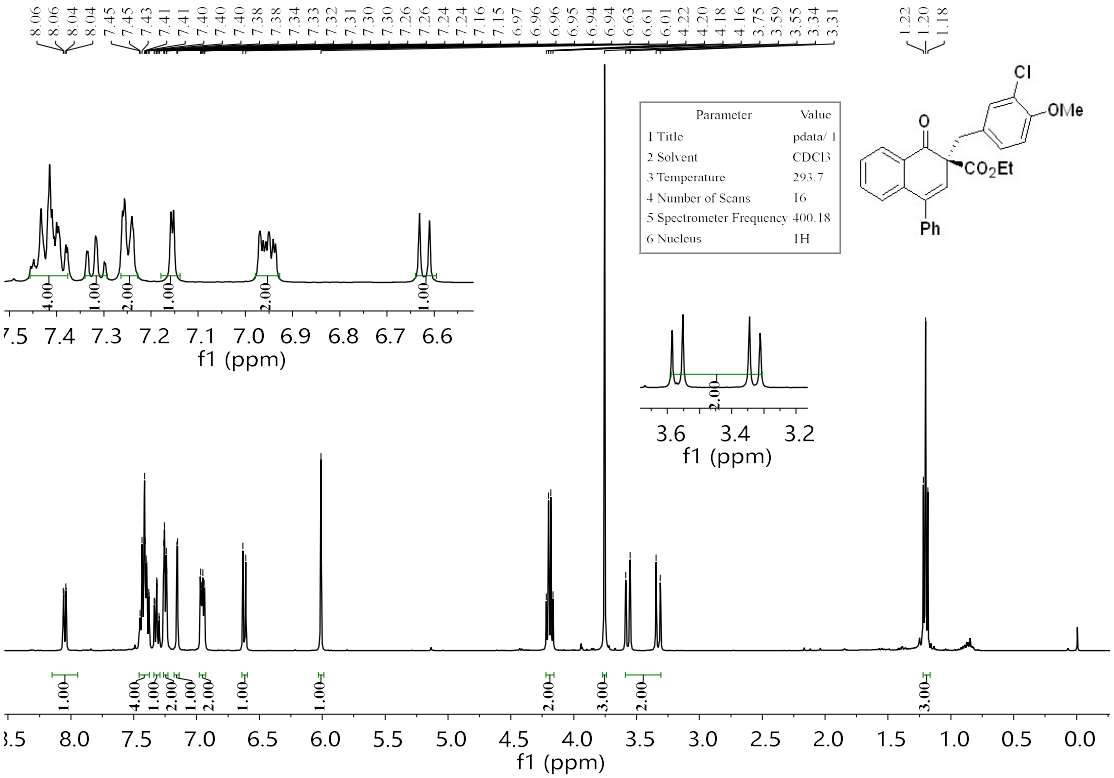
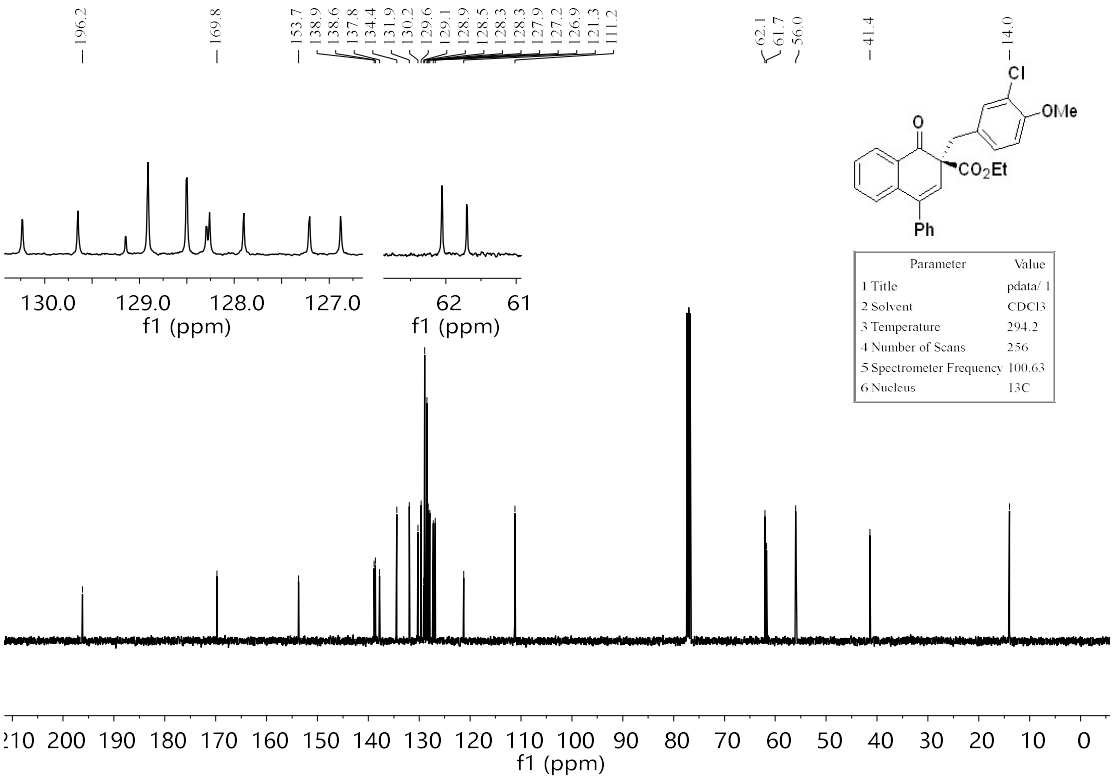
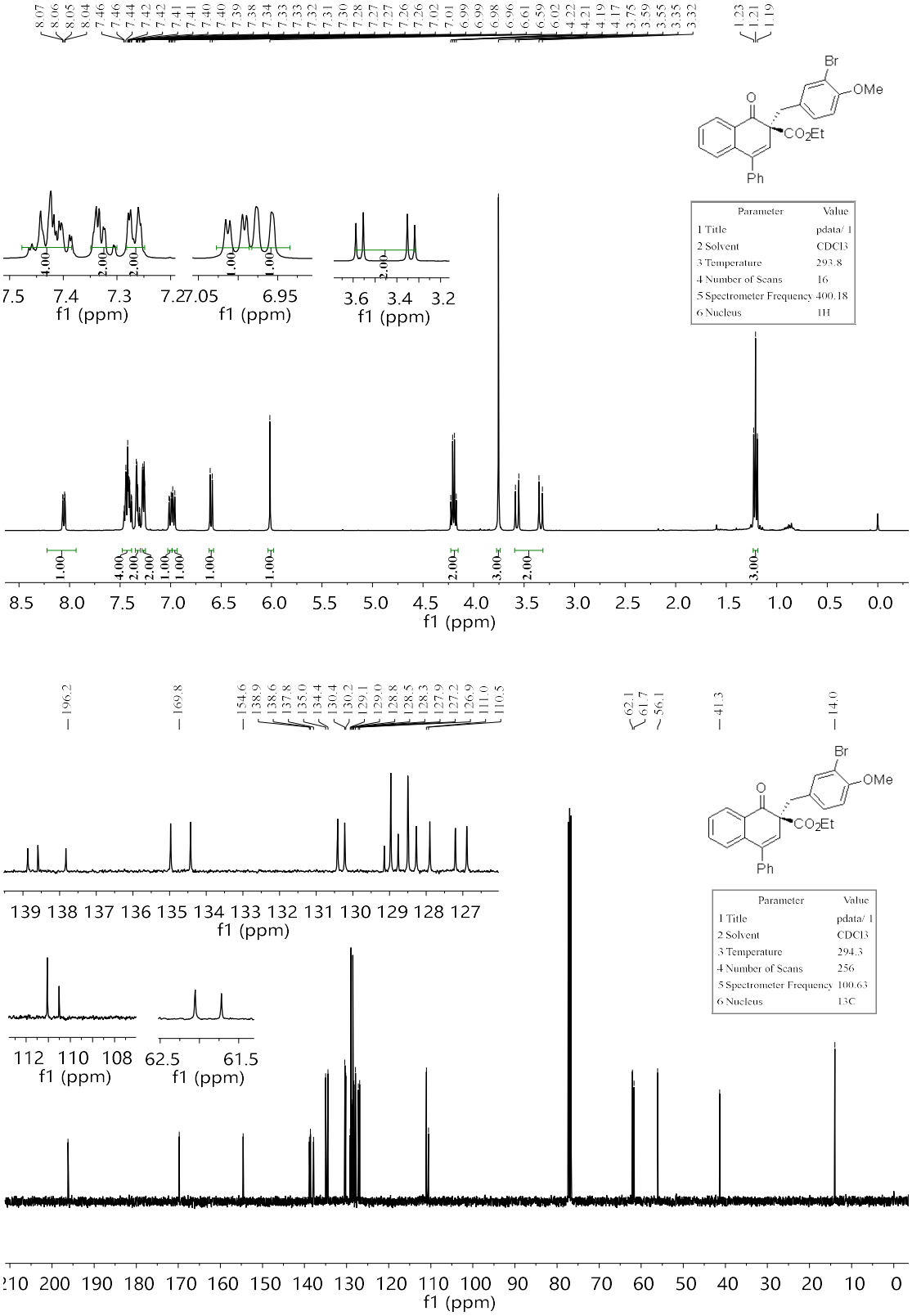
F
OMe
O
CO2Et
Ph
Parameter Value
1 Title pdata/ 1
2 Solvent CDCl3
3 Temperature 294.0
4 Number of Scans 16
5 Spectrometer Frequency 376.55
6 Nucleus 19F
20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -2
f1 (ppm)

Ethyl (S)-2-(3-chloro-4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B36)

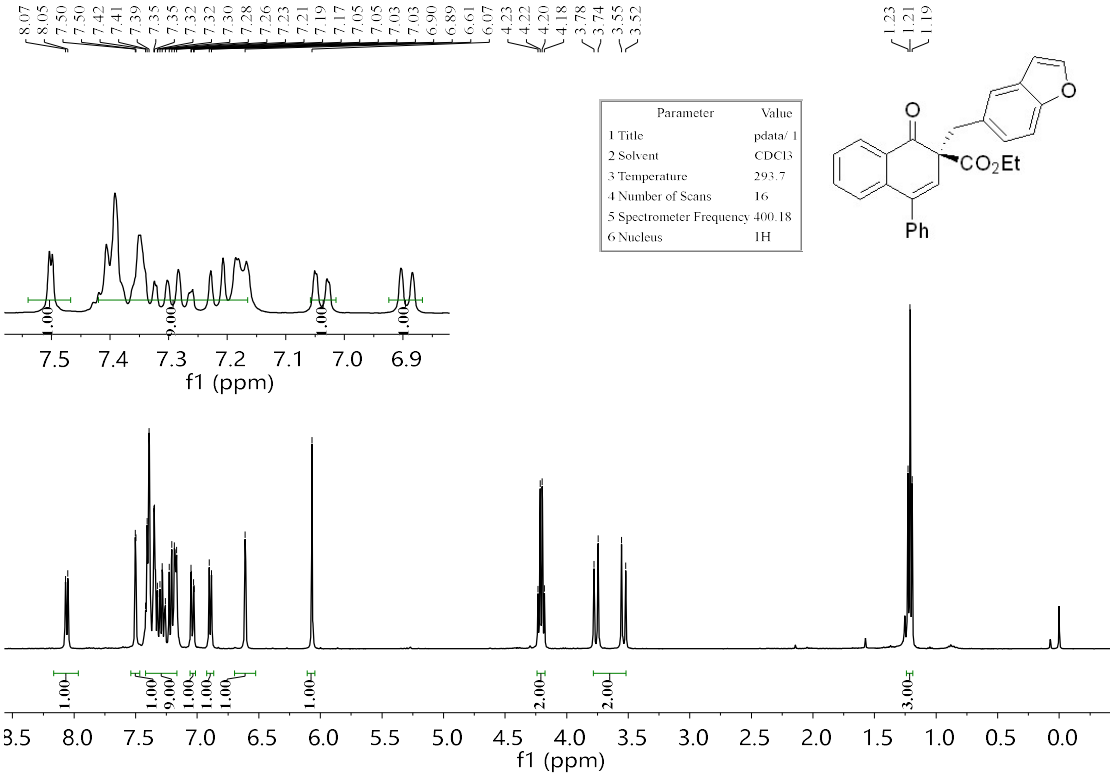


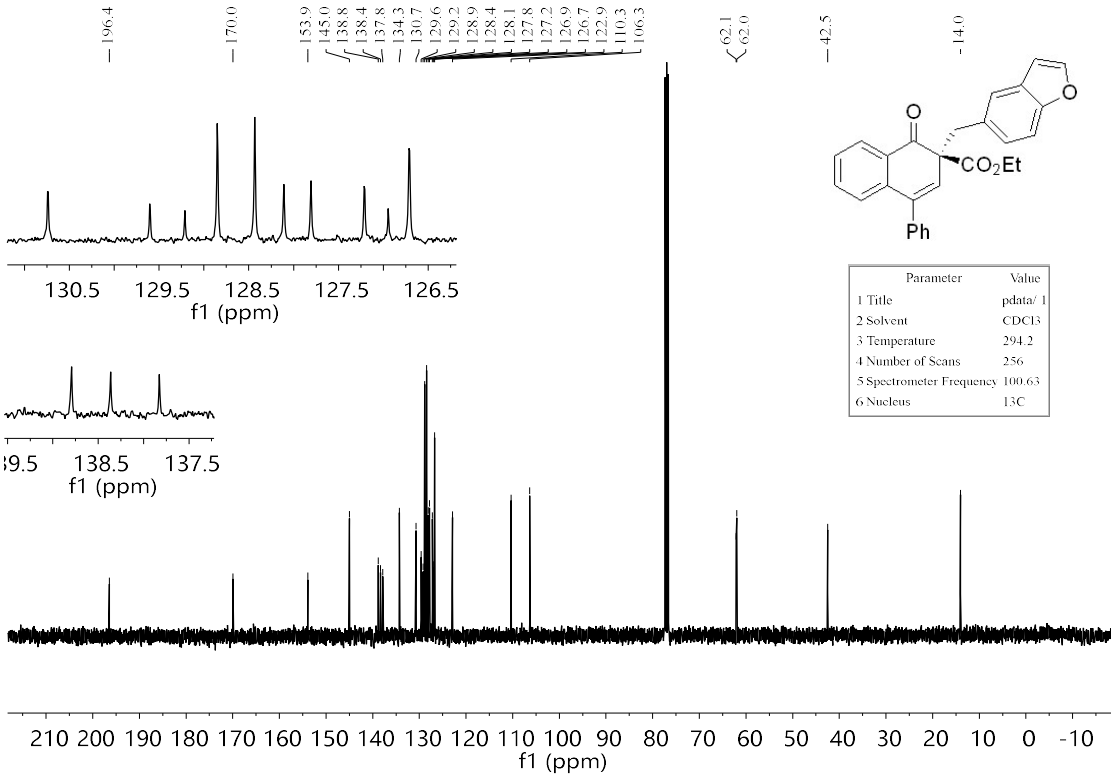


Ethyl (S)-2-(3-bromo-4-methoxybenzyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B37)

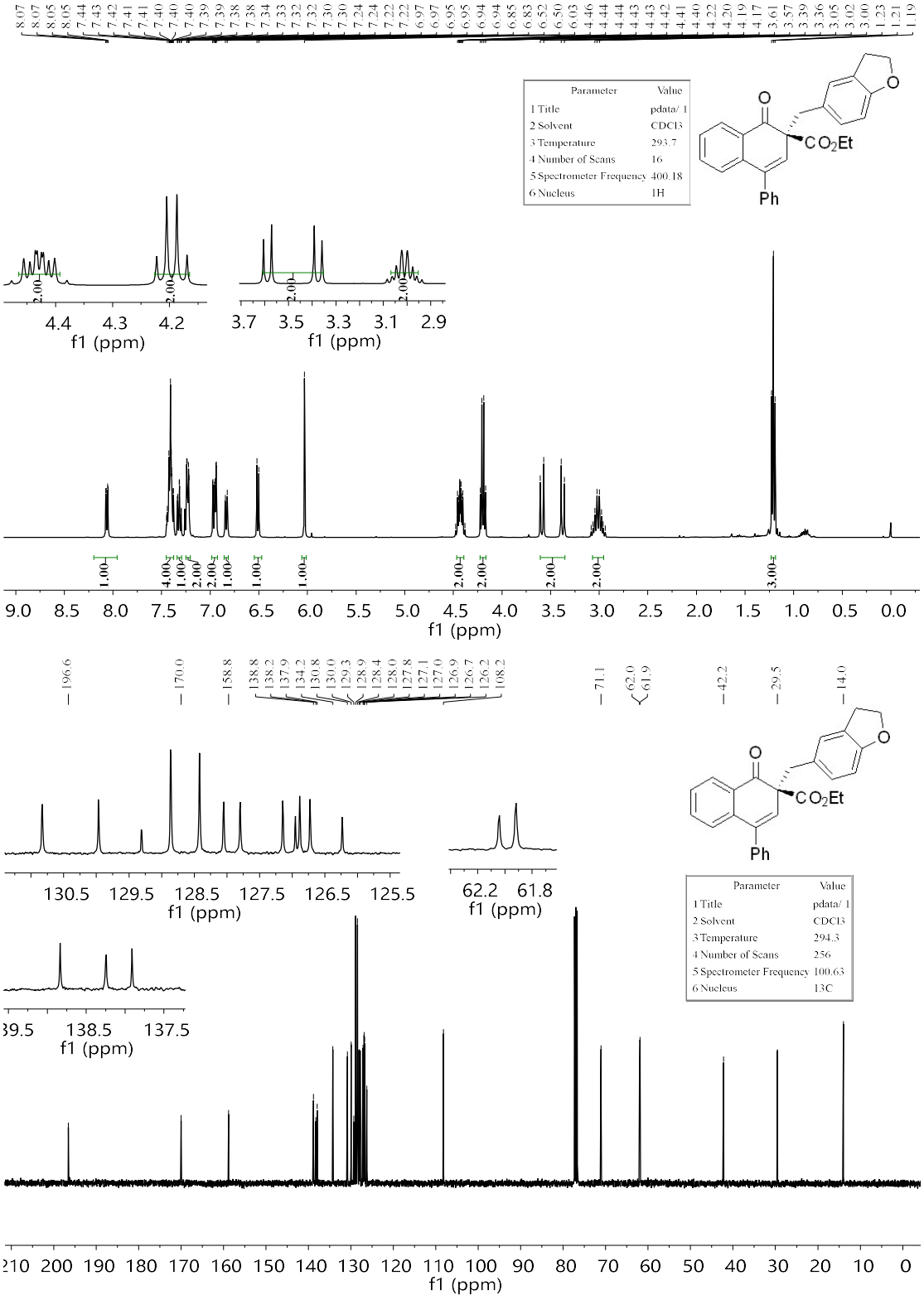


Ethyl (S)-2-(benzofuran-5-ylmethyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B38)

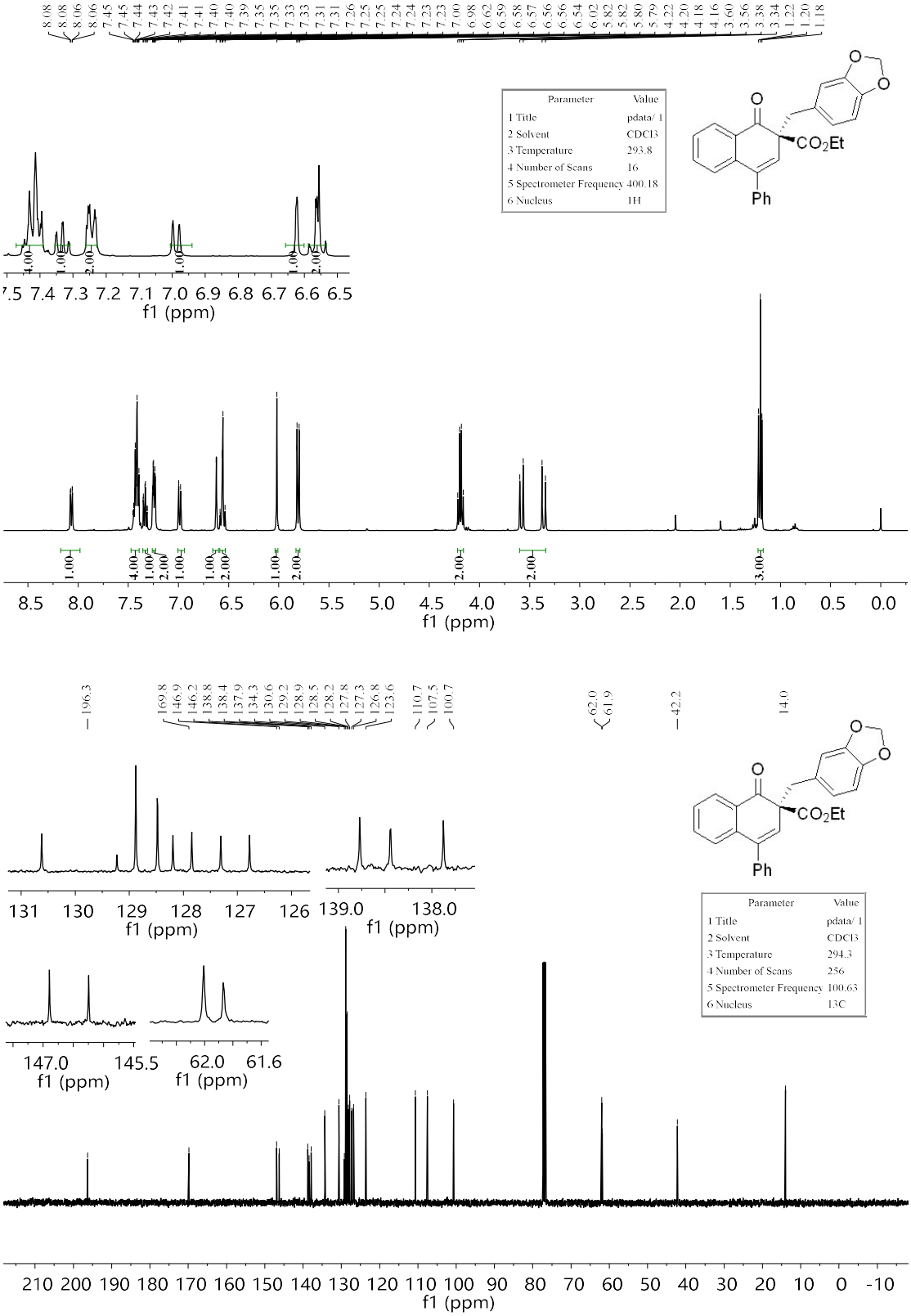




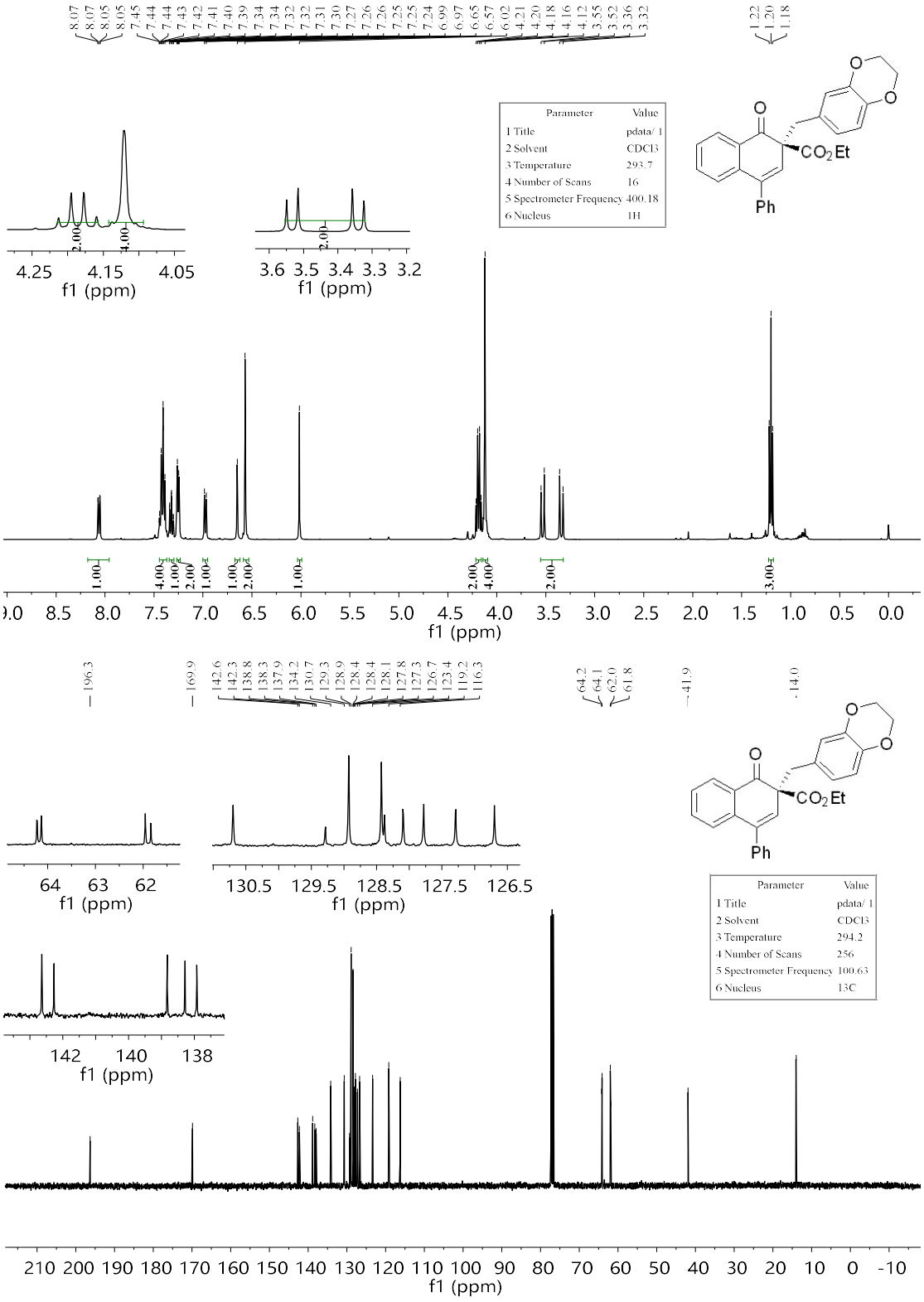
Ethyl (S)-2-((2,3-dihydrobenzofuran-5-yl)methyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B39)



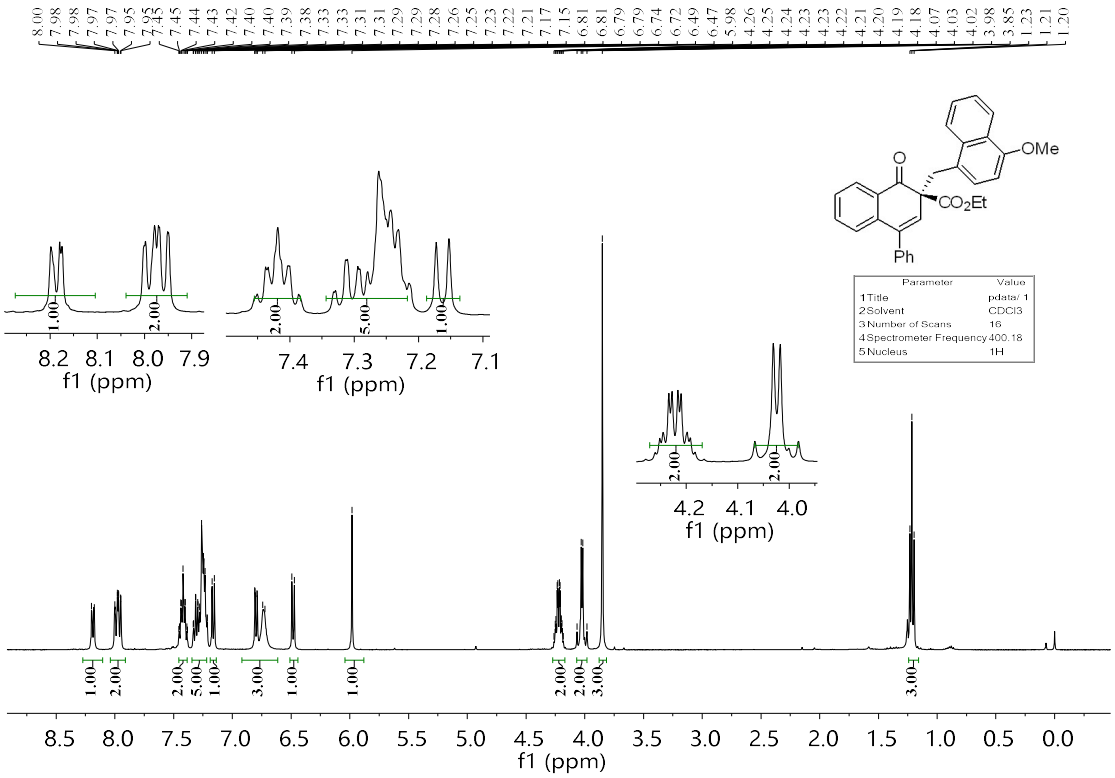
Ethyl (S)-2-(benzo[d][1,3]dioxol-5-ylmethyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B40)

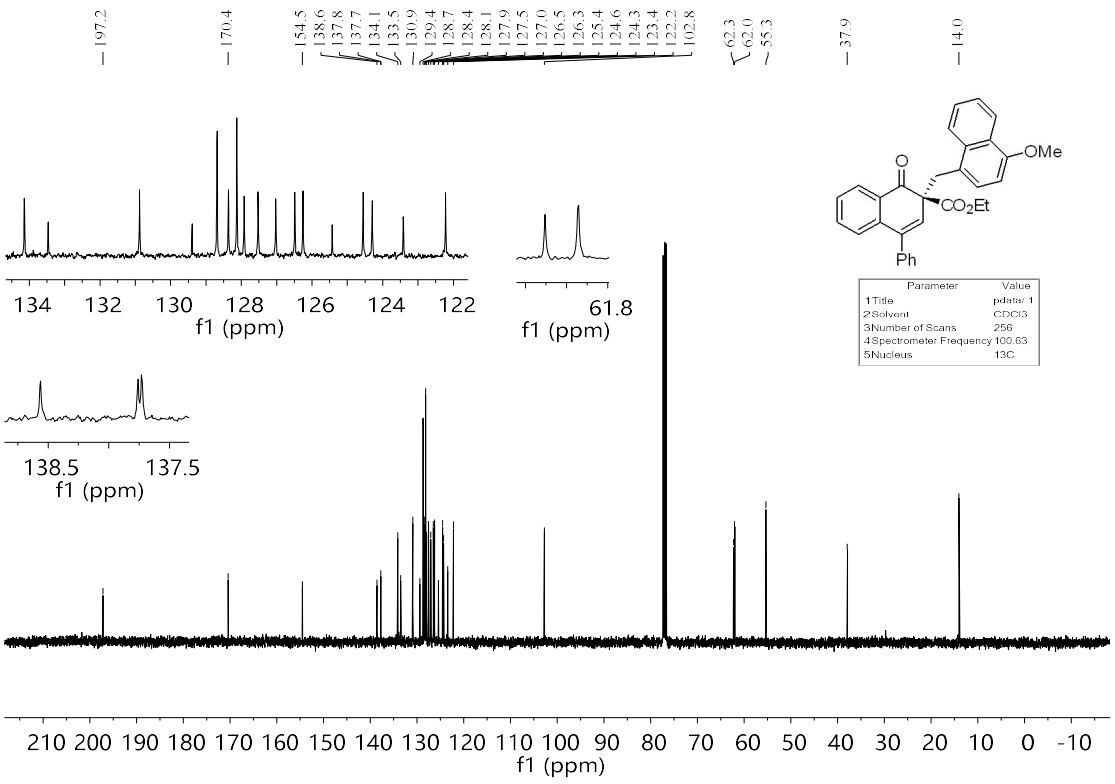


Ethyl (S)-2-((2,3-dihydrobenzo[b][1,4]dioxin-6-yl)methyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2- carboxylate (B41)

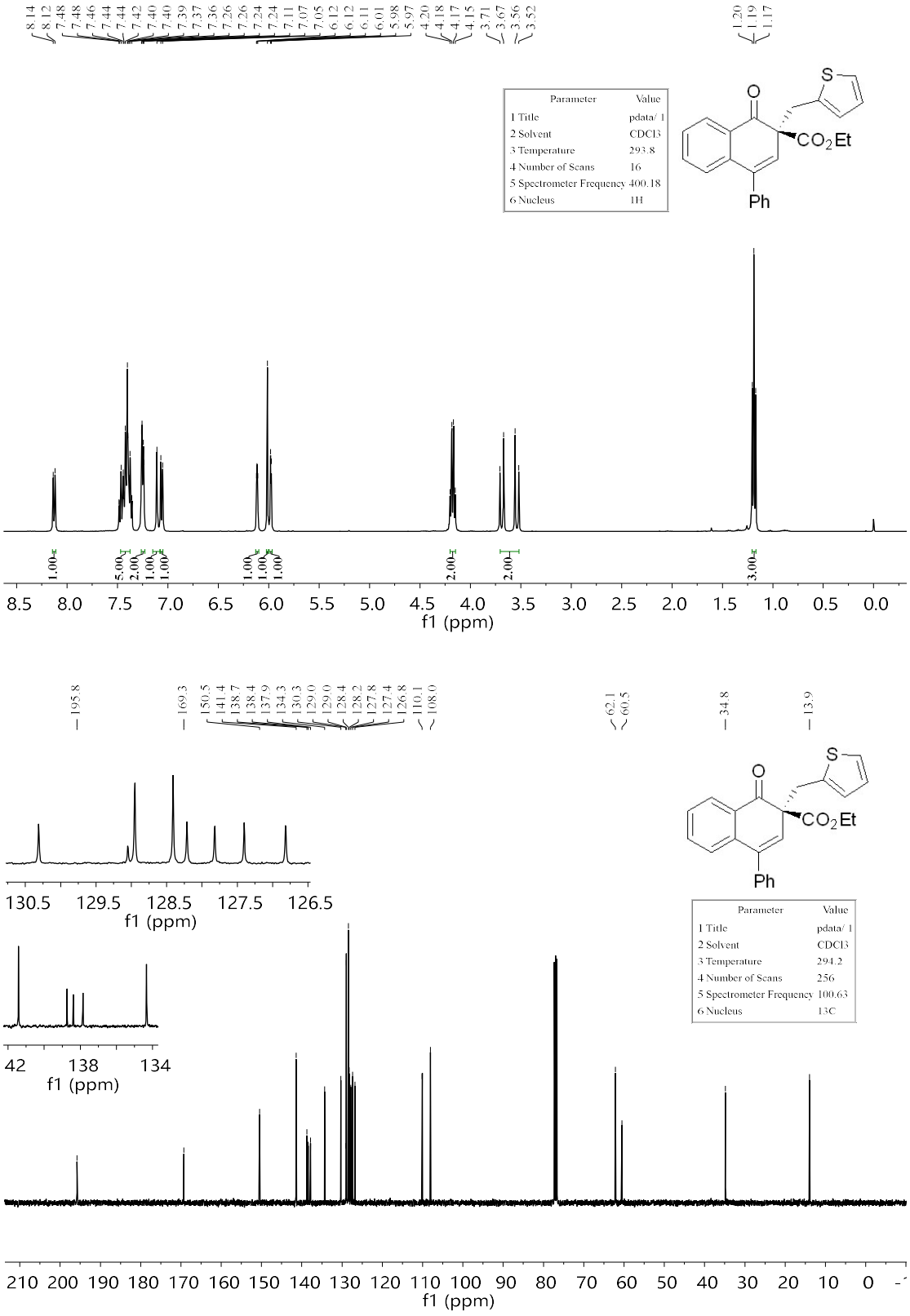


Ethyl (S)-2-((4-methoxynaphthalen-1-yl)methyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B42)

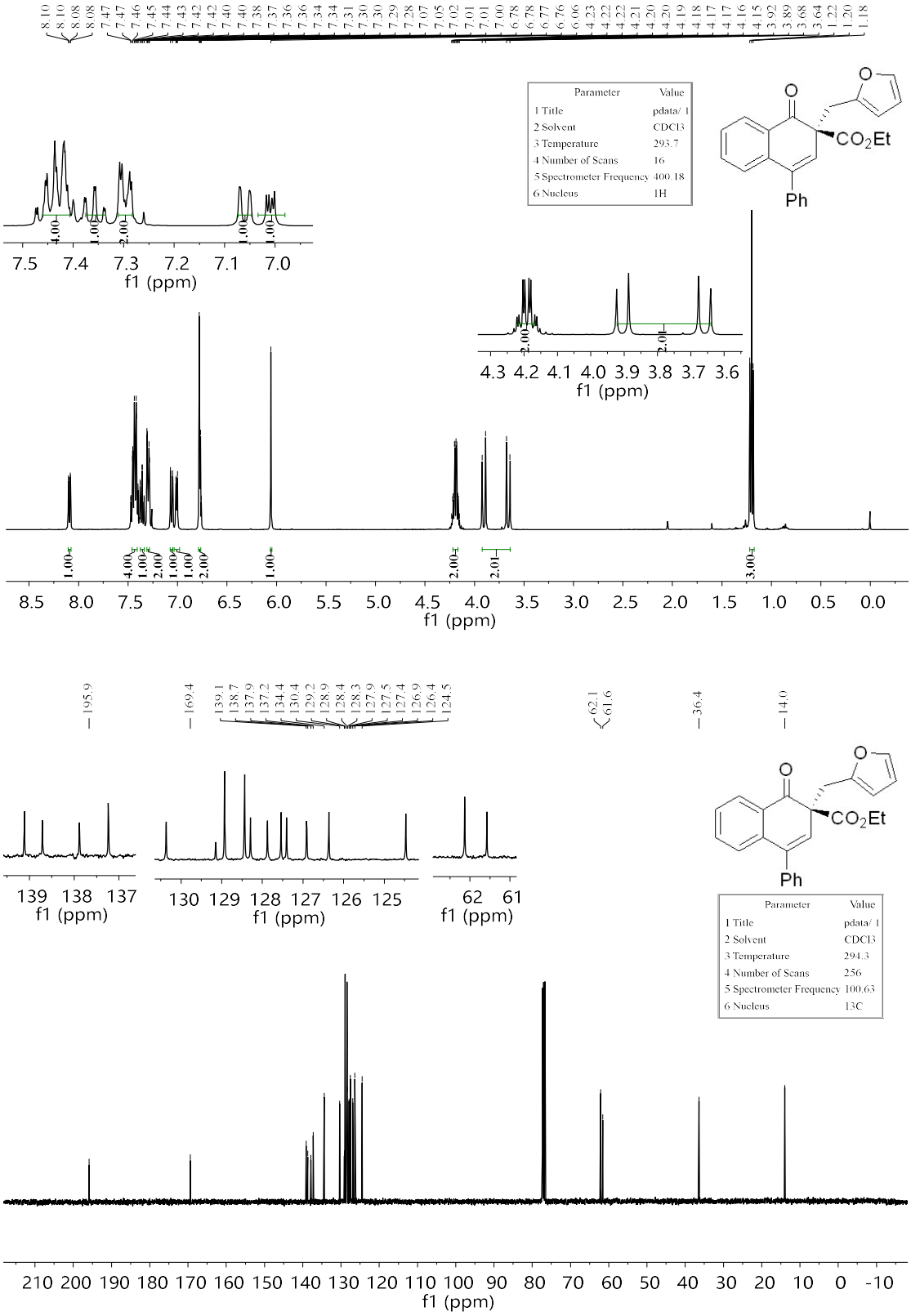




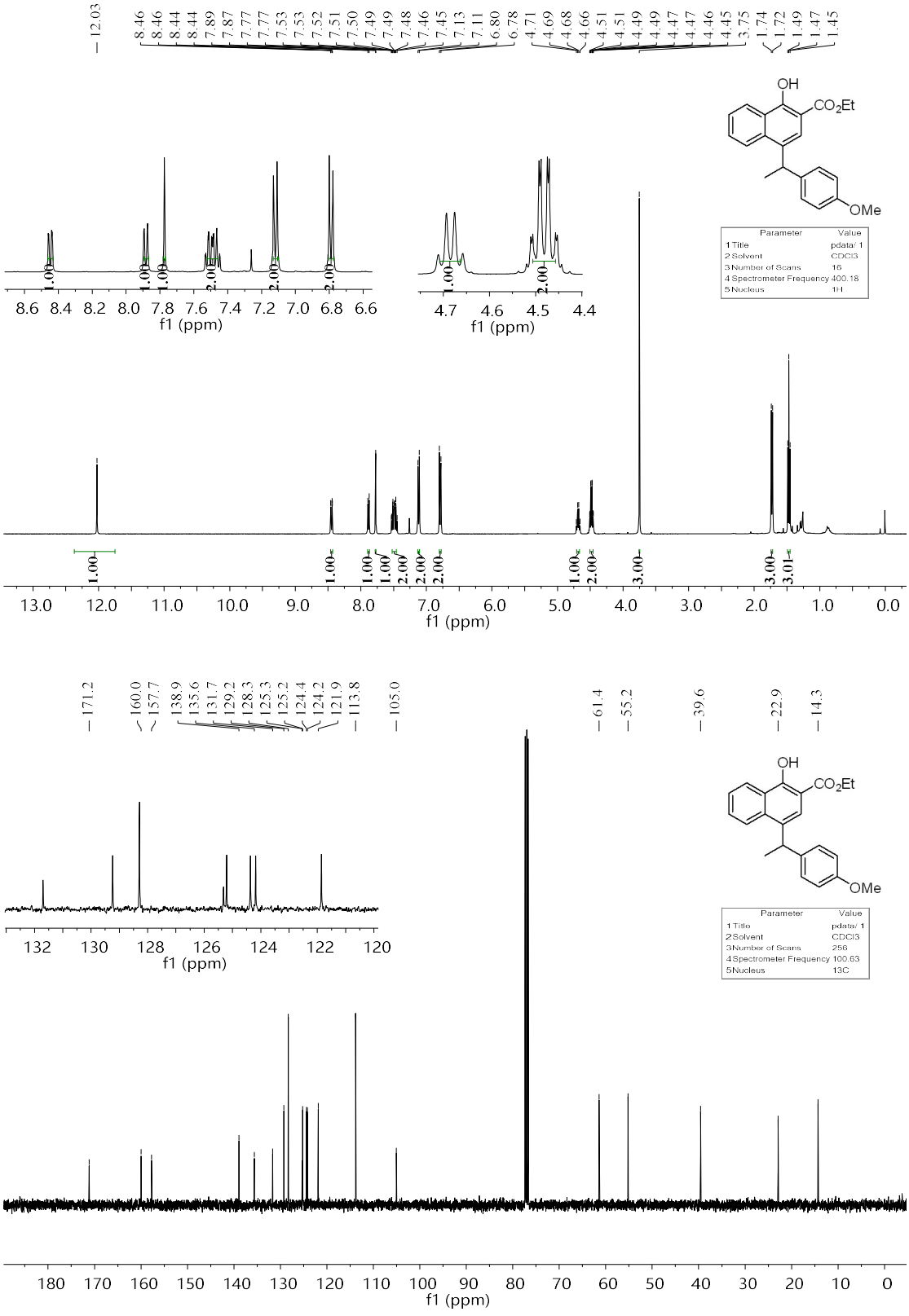
Ethyl (S)-1-oxo-4-phenyl-2-(thiophen-2-ylmethyl)-1,2-dihydronaphthalene-2-carboxylate (B43)



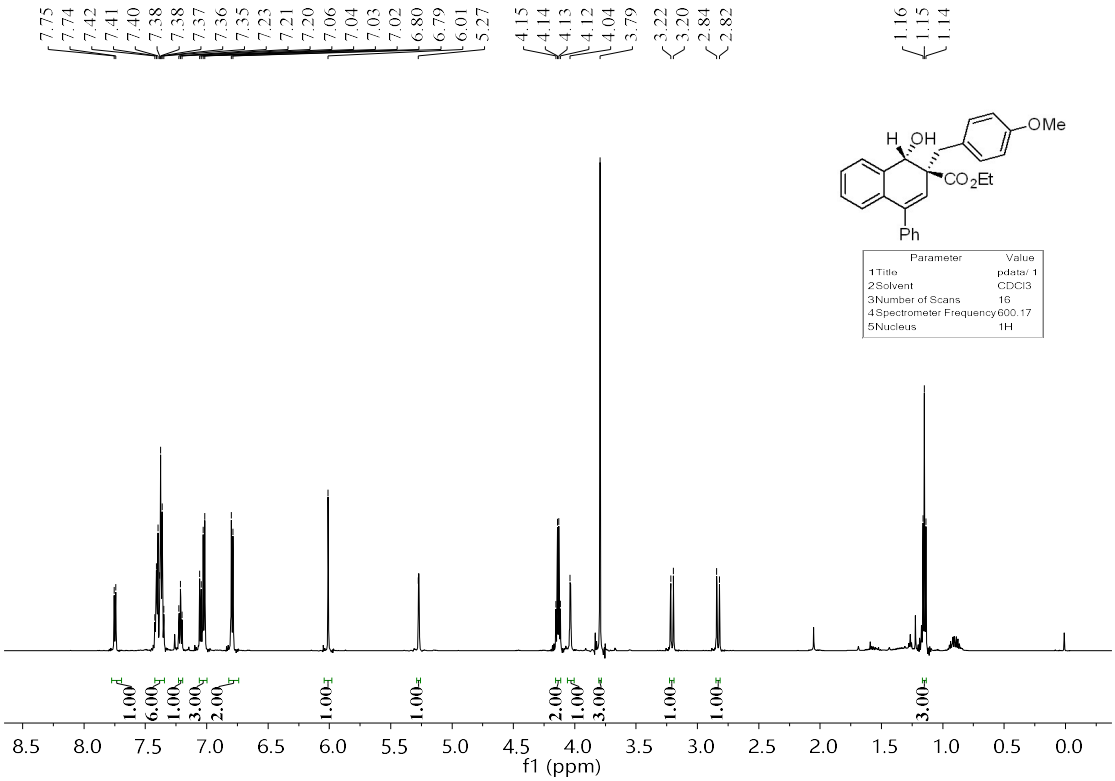
Ethyl (S)-2-(furan-2-ylmethyl)-1-oxo-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (B44)

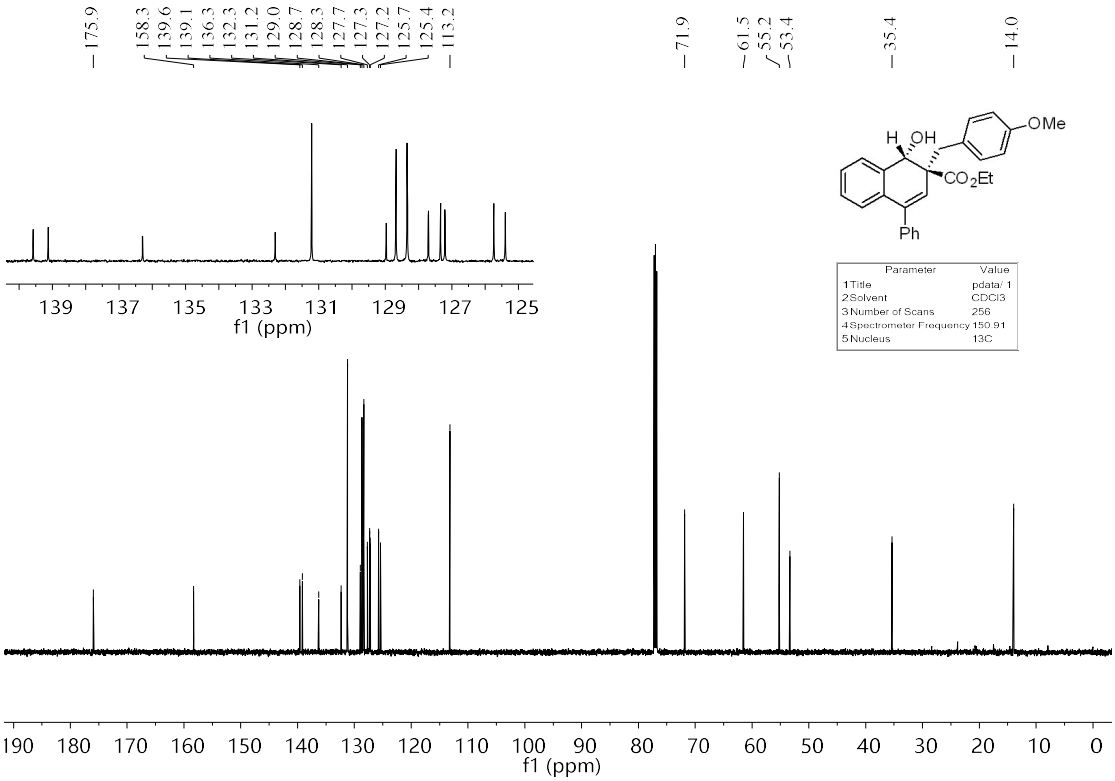


ethyl 1-hydroxy-4-(1-(4-methoxyphenyl)ethyl)-2-naphthoate (B45)

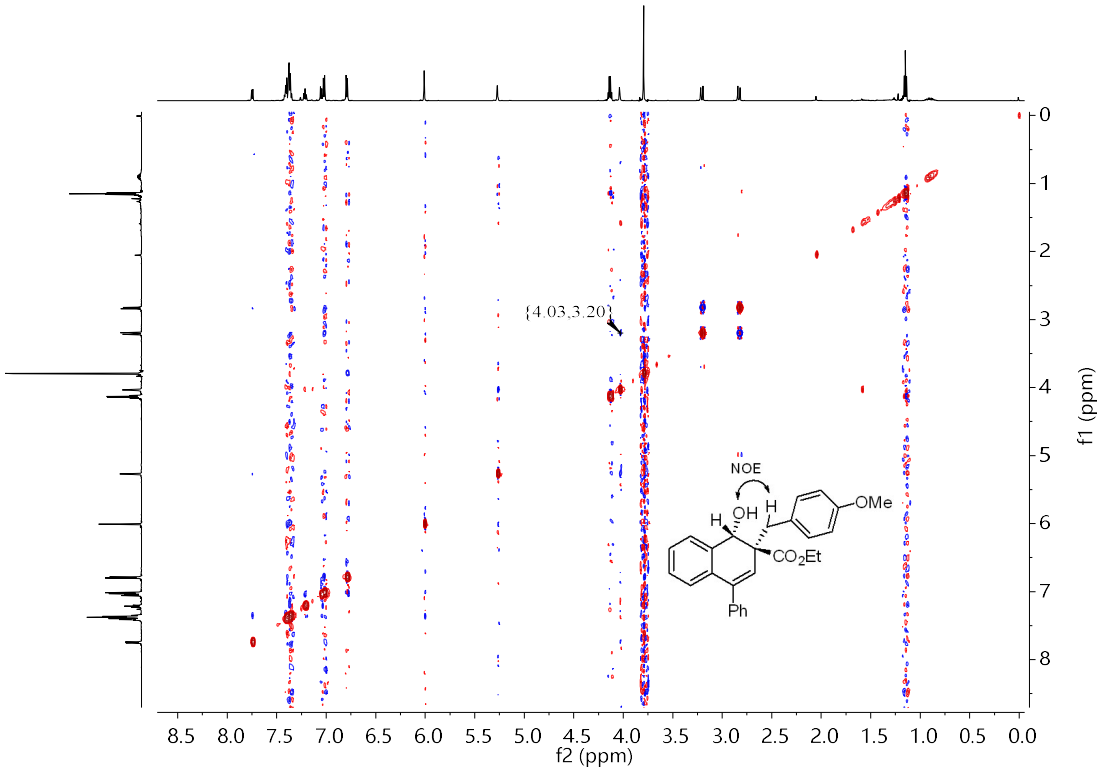


Ethyl (1S,2S)-1-hydroxy-2-(4-methoxybenzyl)-4-phenyl-1,2-dihydronaphthalene-2-carboxylate (C1)

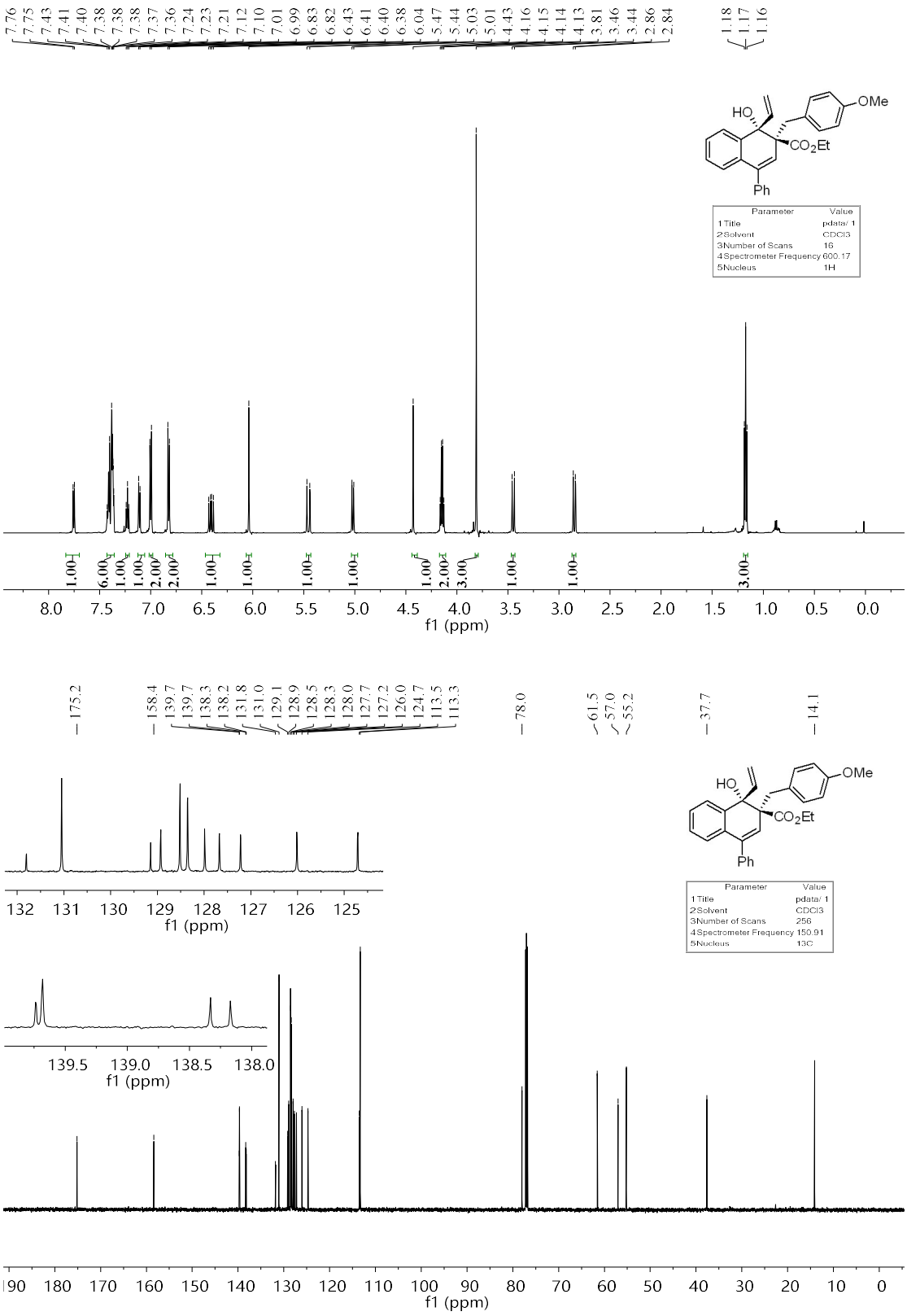




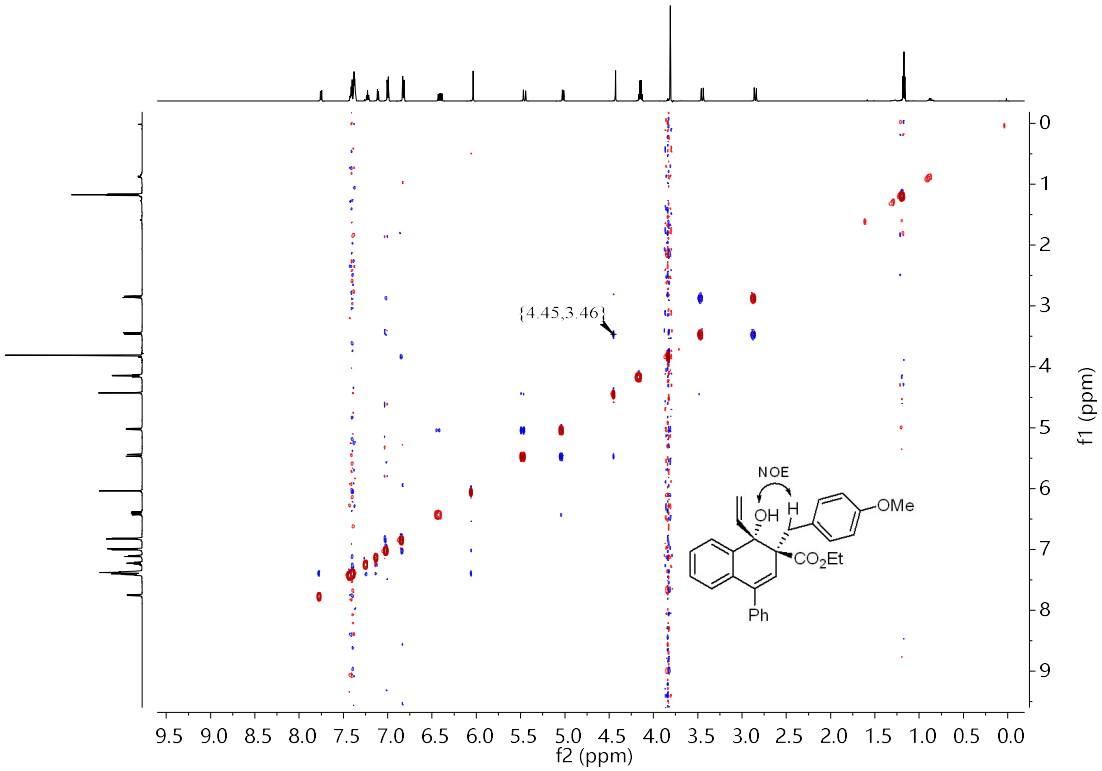
NOESY spectra of C1 in $CDCl_3$ (600 MHz)



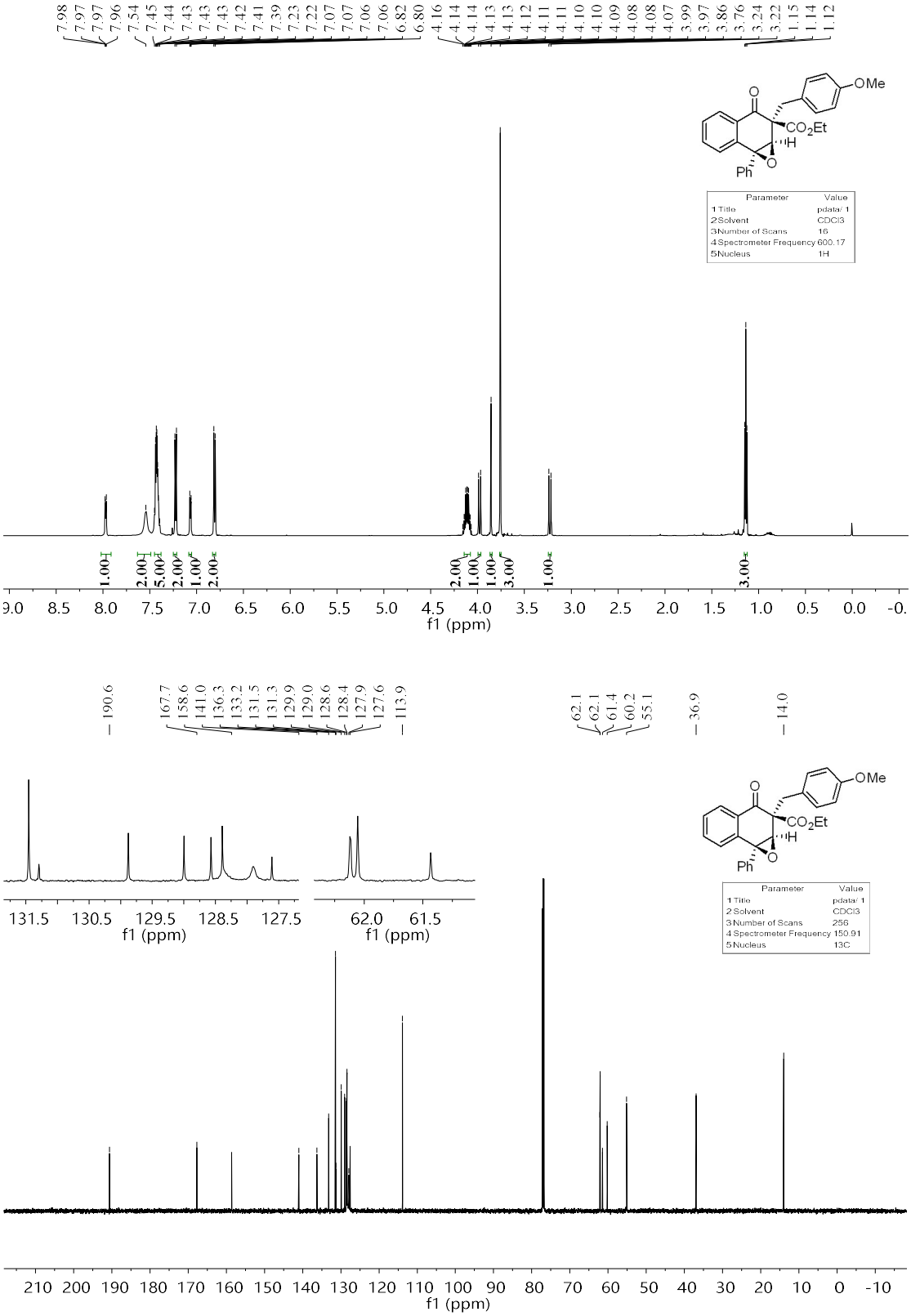
Ethyl (1S,2S)-1-hydroxy-2-(4-methoxybenzyl)-4-phenyl-1-vinyl-1,2-dihydronaphthalene-2-carboxylate (C2)



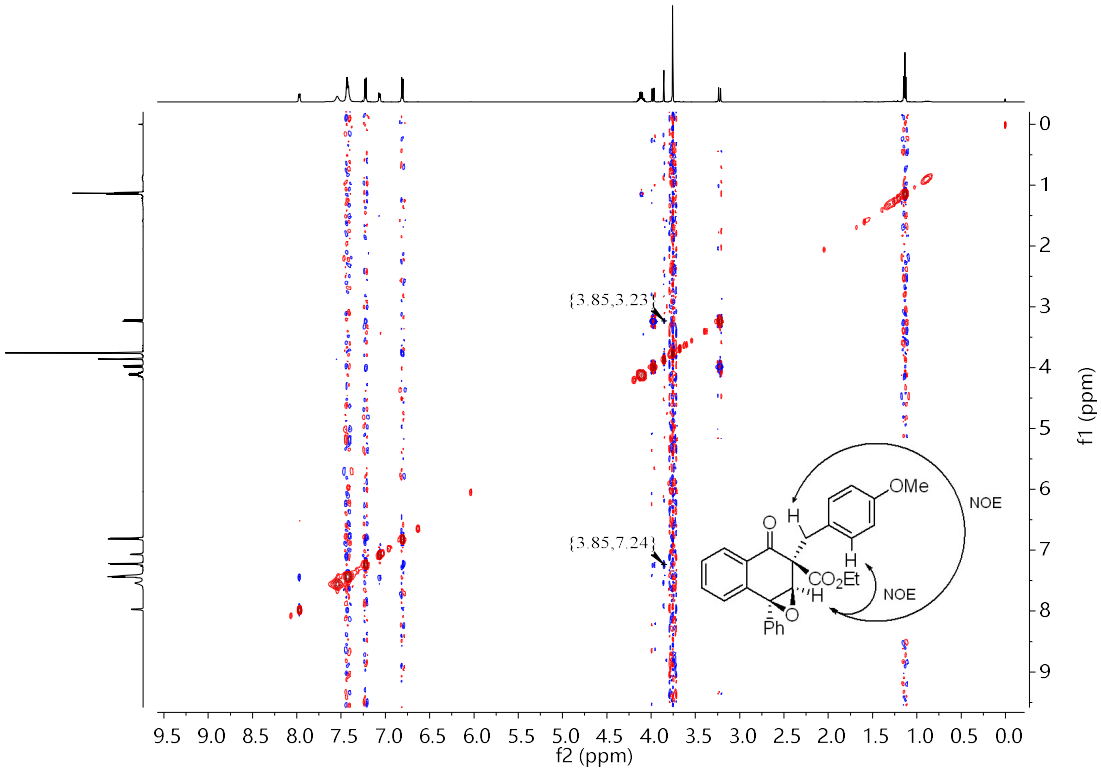
NOESY spectra of C2 in $CDCl_3$ (600 MHz)



Ethyl (1aR,2S,7bS)-2-(4-methoxybenzyl)-3-oxo-7b-phenyl-1a,2,3,7b-tetrahydronaphtho[1,2-b] oxirene-2-carboxylate (C3)

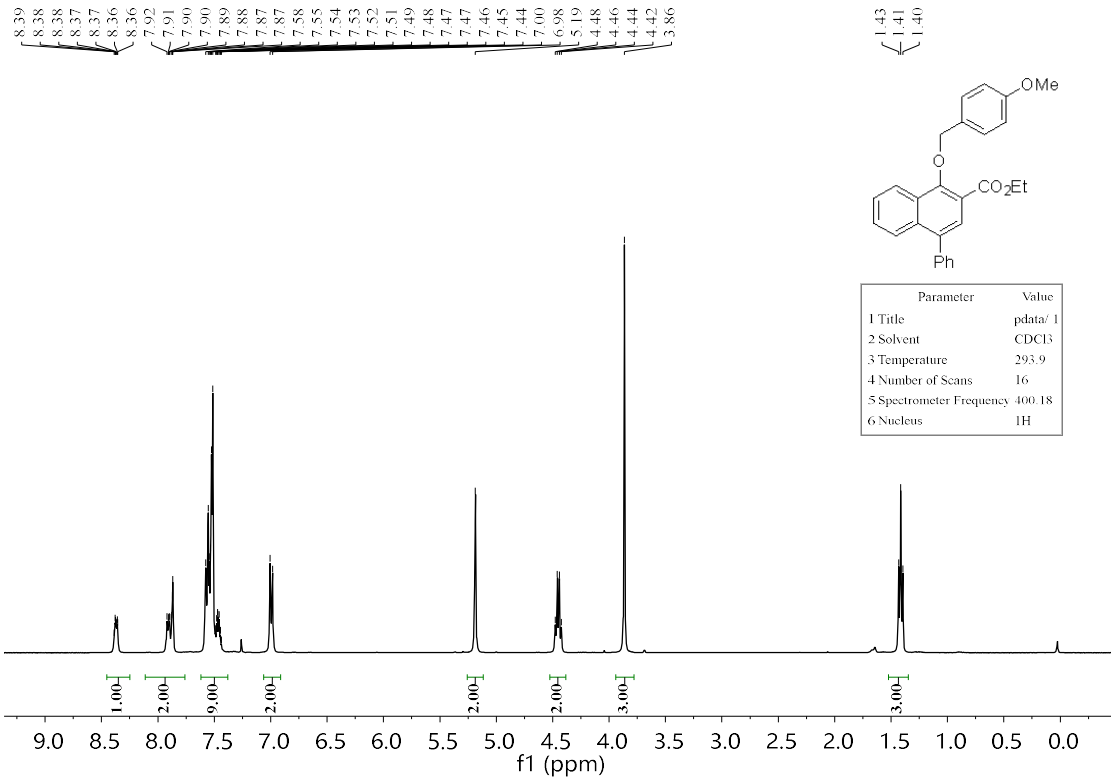


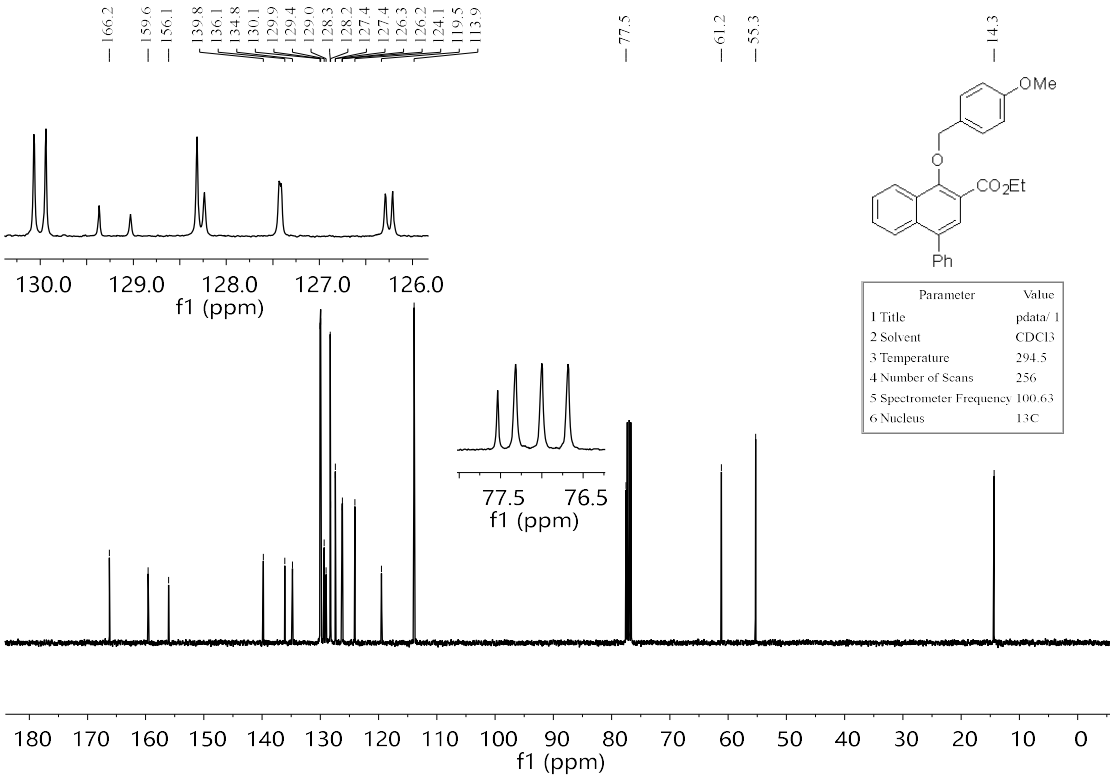
NOESY spectra of C3 in $CDCl_3$ (600 MHz)



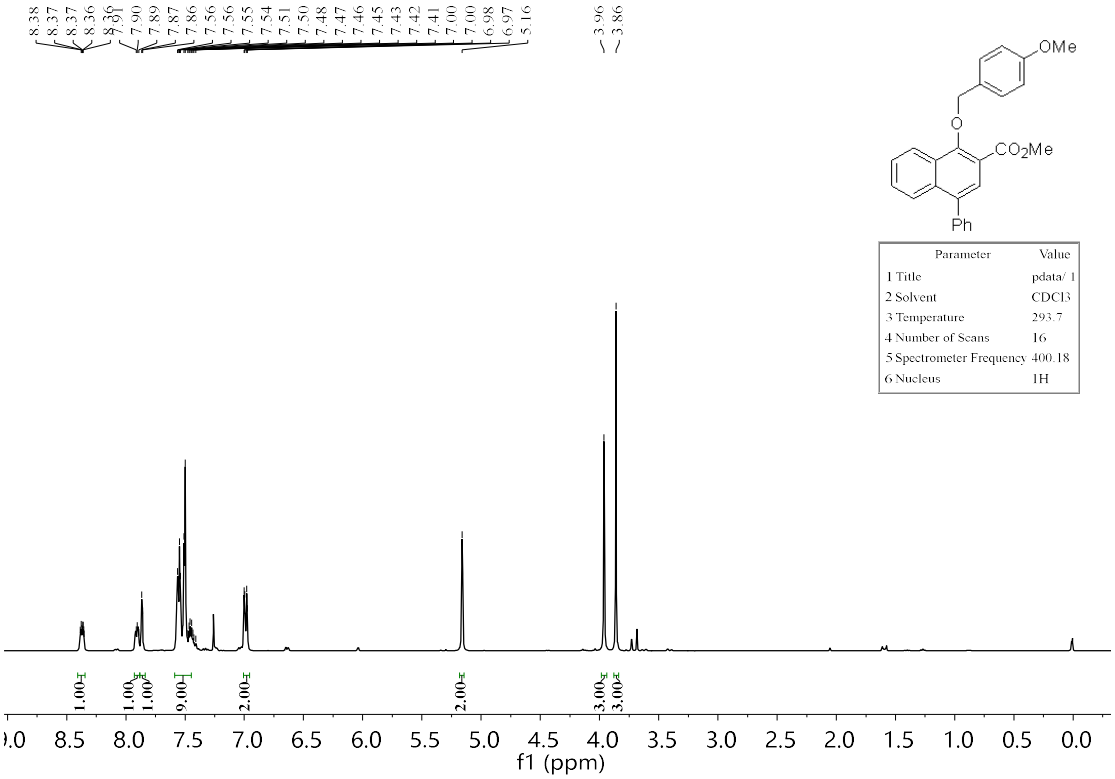
12. Copies of NMR Spectra for the Reaction Substrates

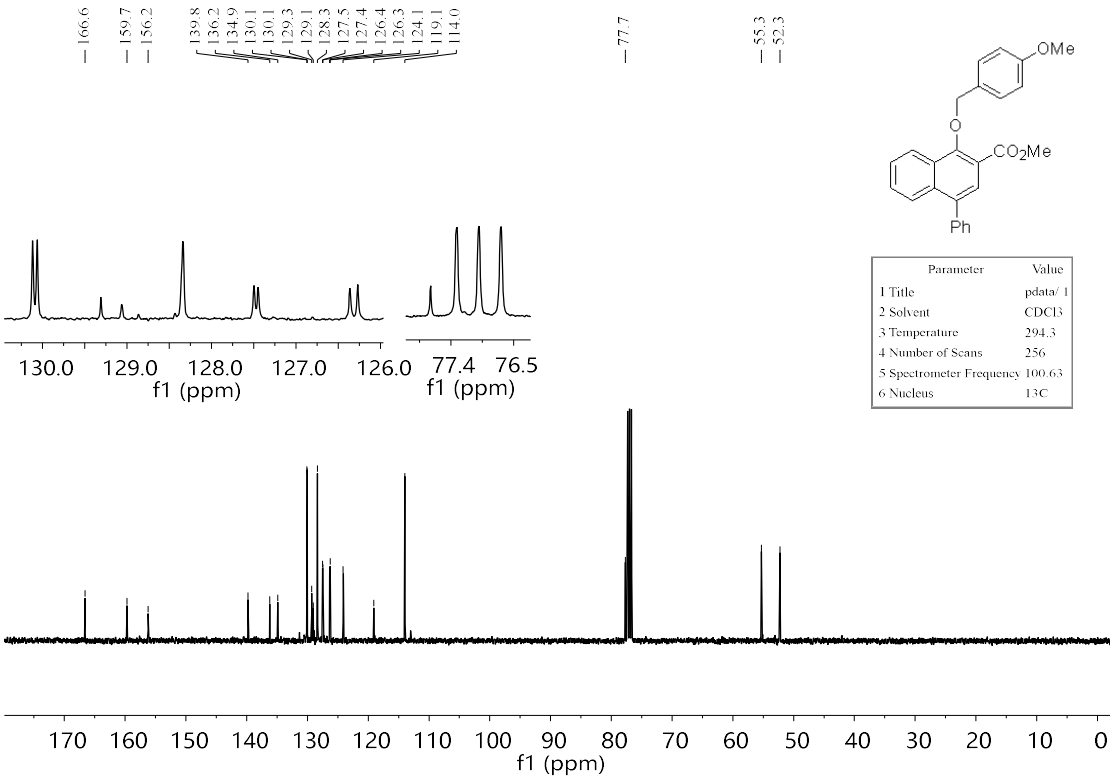
Ethyl 1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A1)



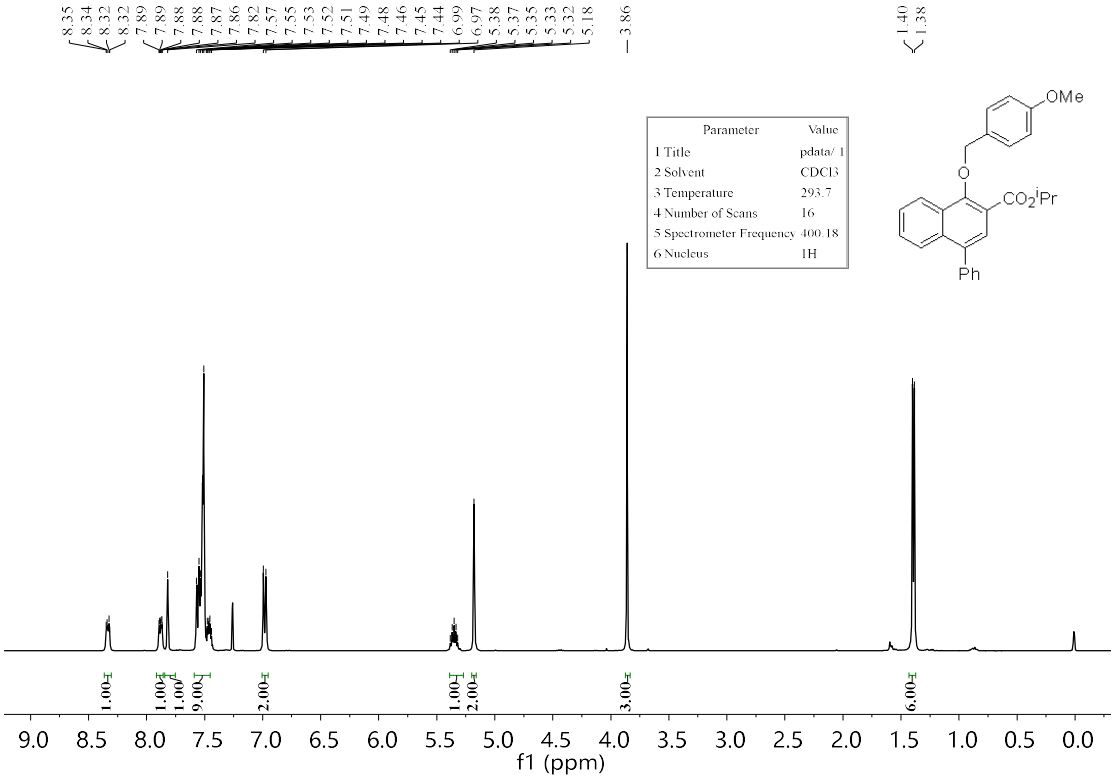


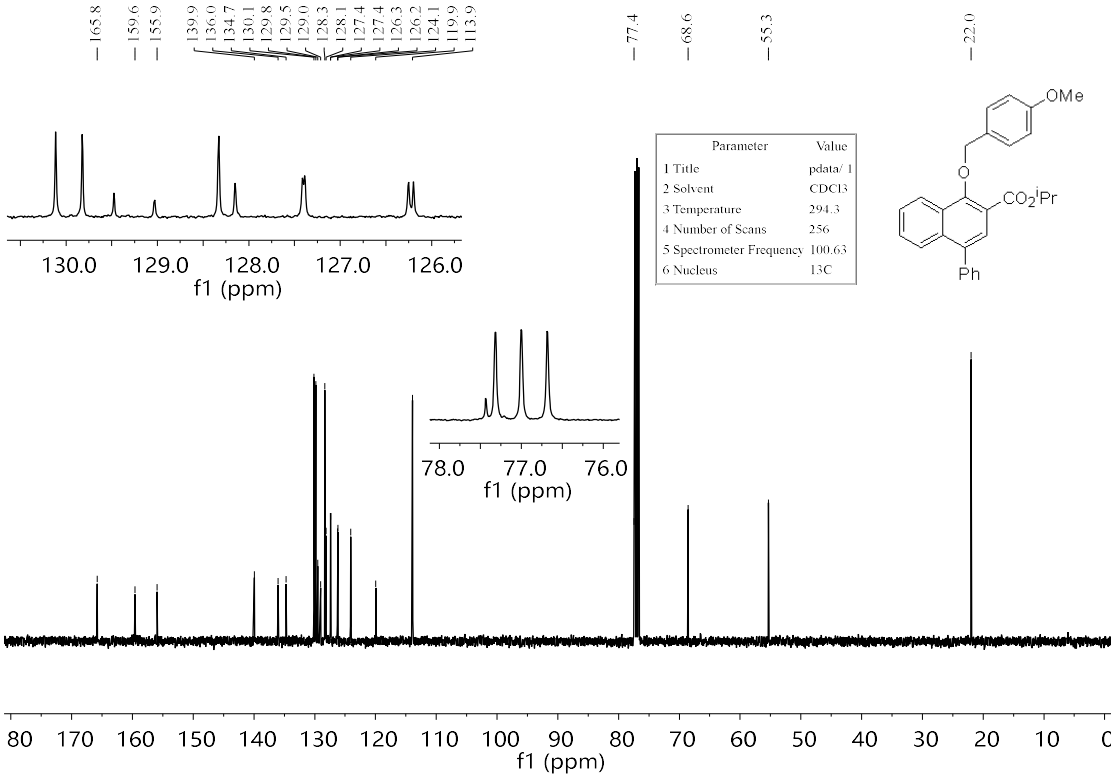
Methyl 1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoatev (A2)



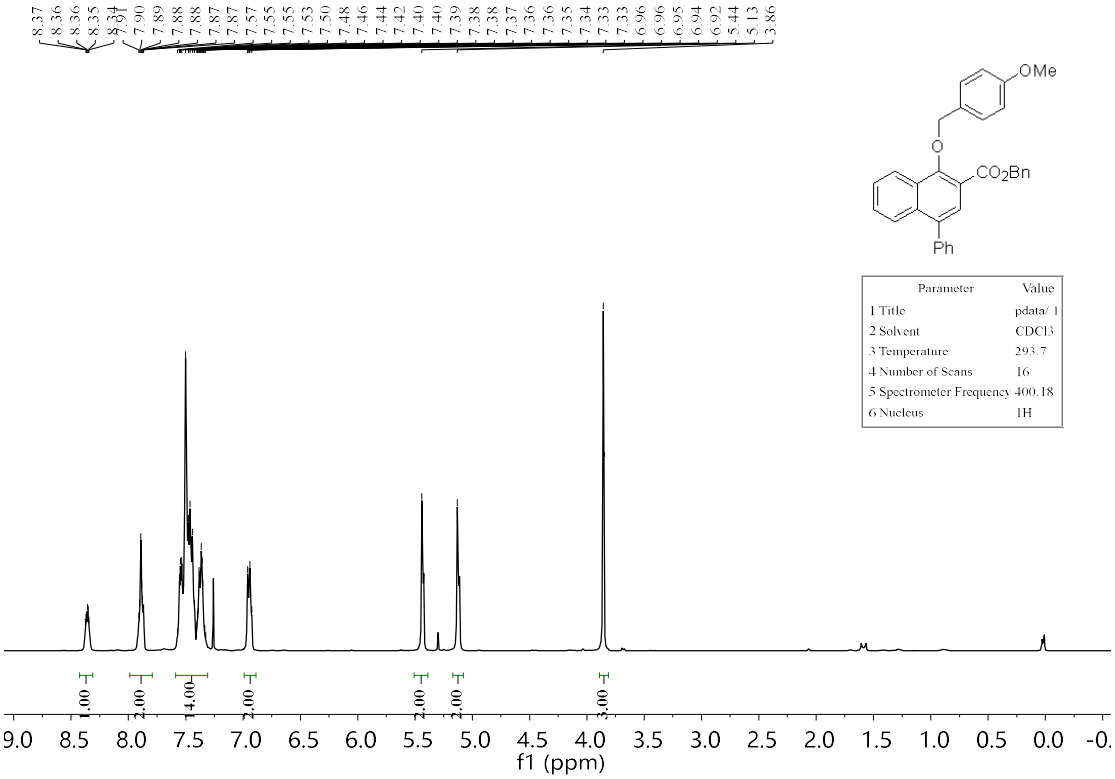


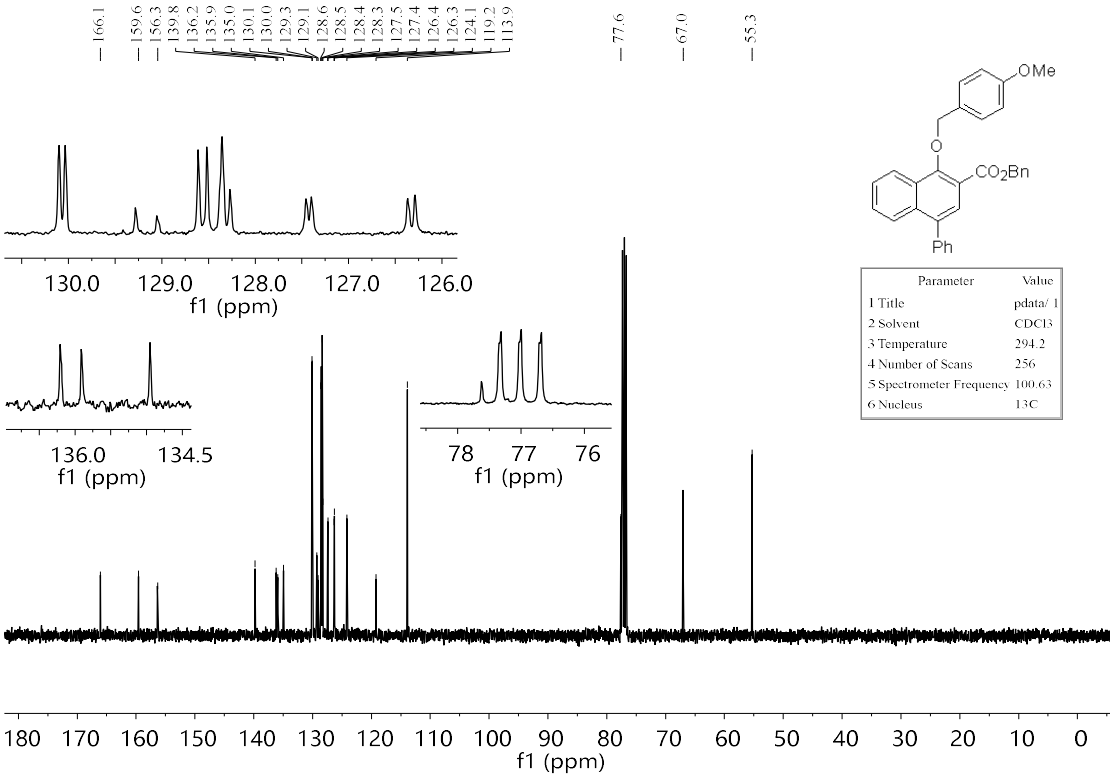
Isopropyl 1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A3)



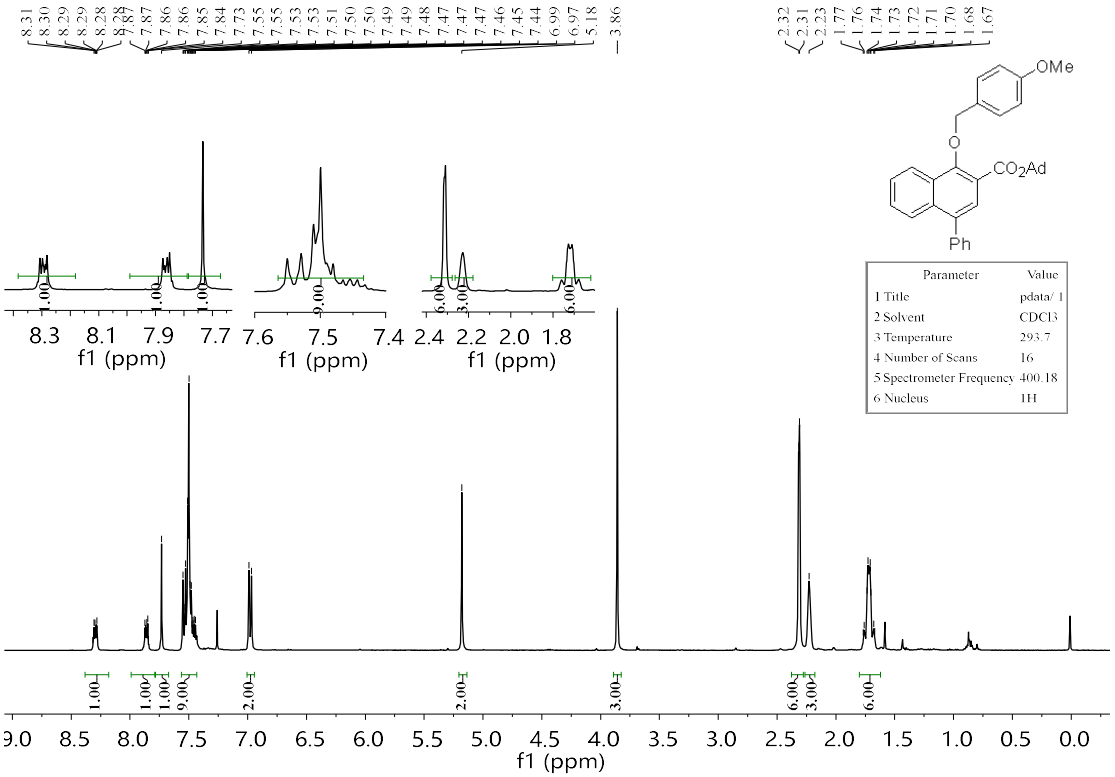


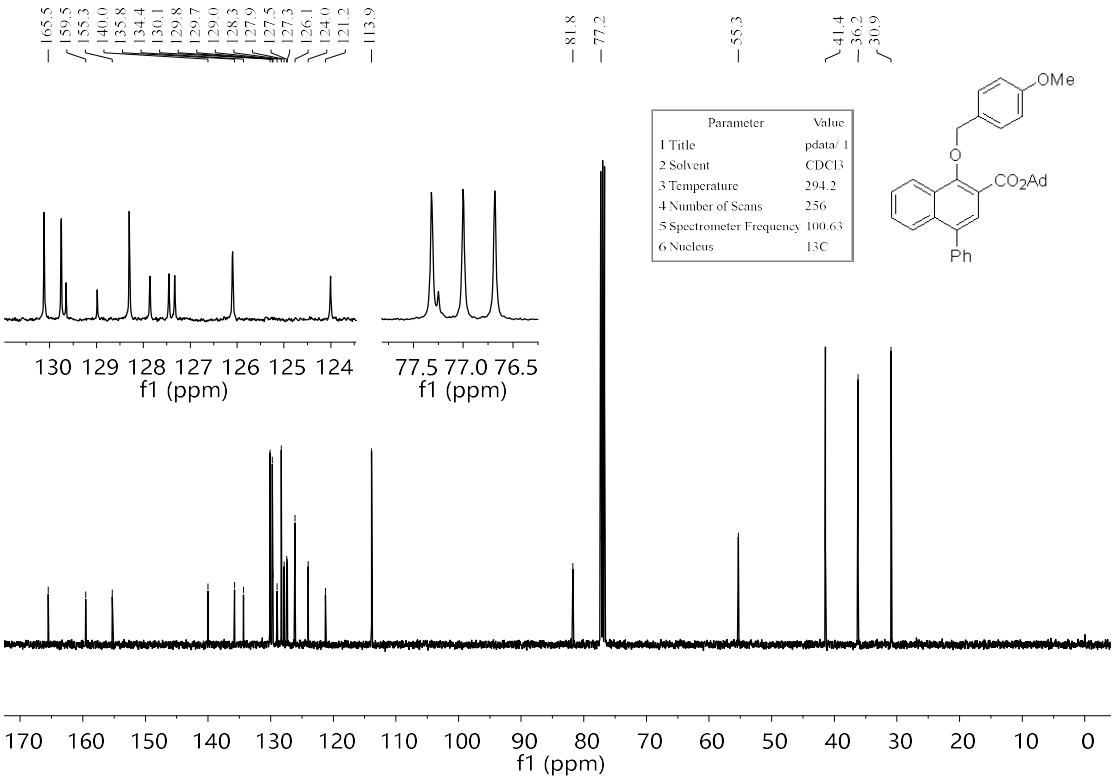
Benzyl 1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A4)



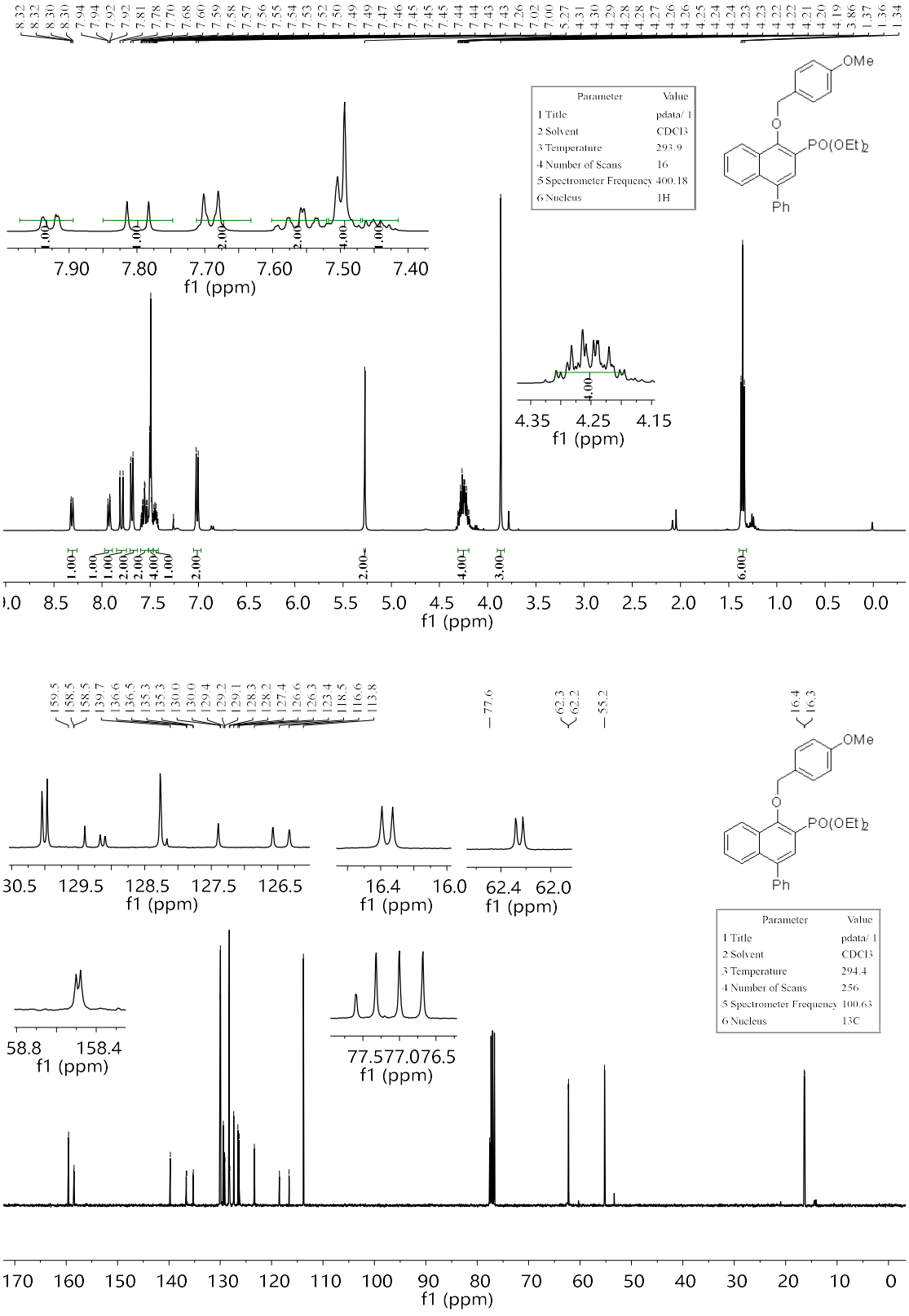


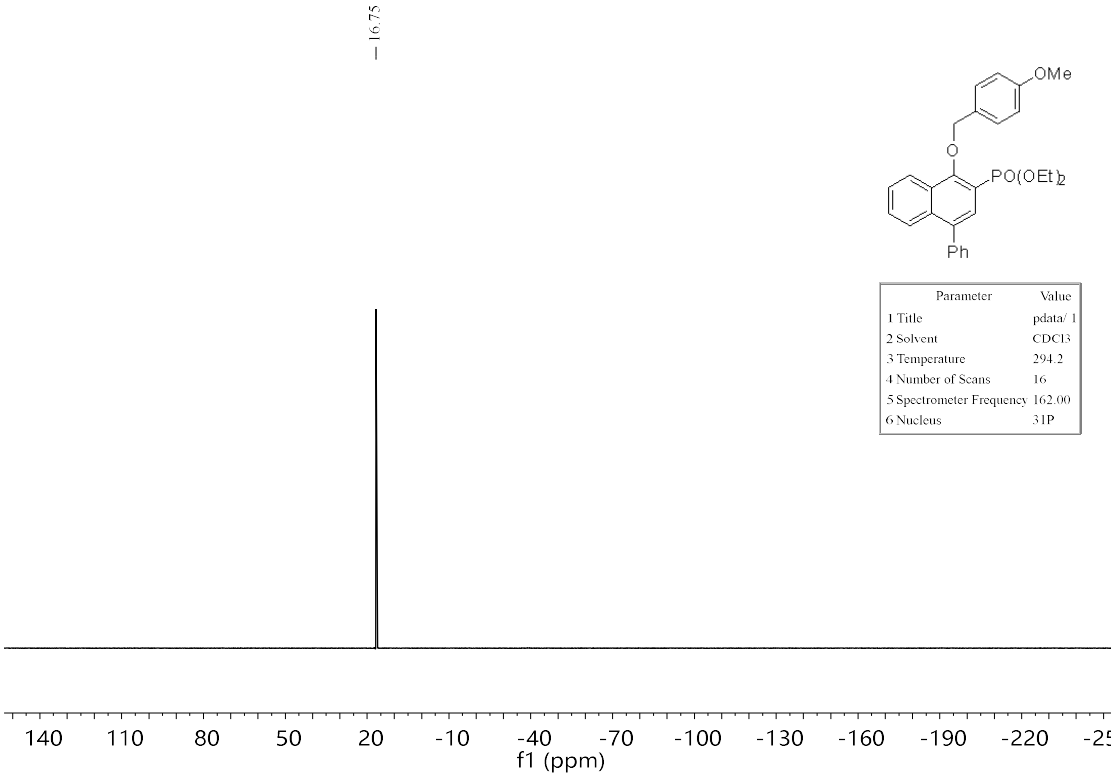
Adamantan-1-yl 1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A5)





Diethyl (1-((4-methoxybenzyl)oxy)-4-phenylnaphthalen-2-yl)phosphonate (A6)




16.75
OMe
O
PO(OEt)2
Ph
Parameter Value
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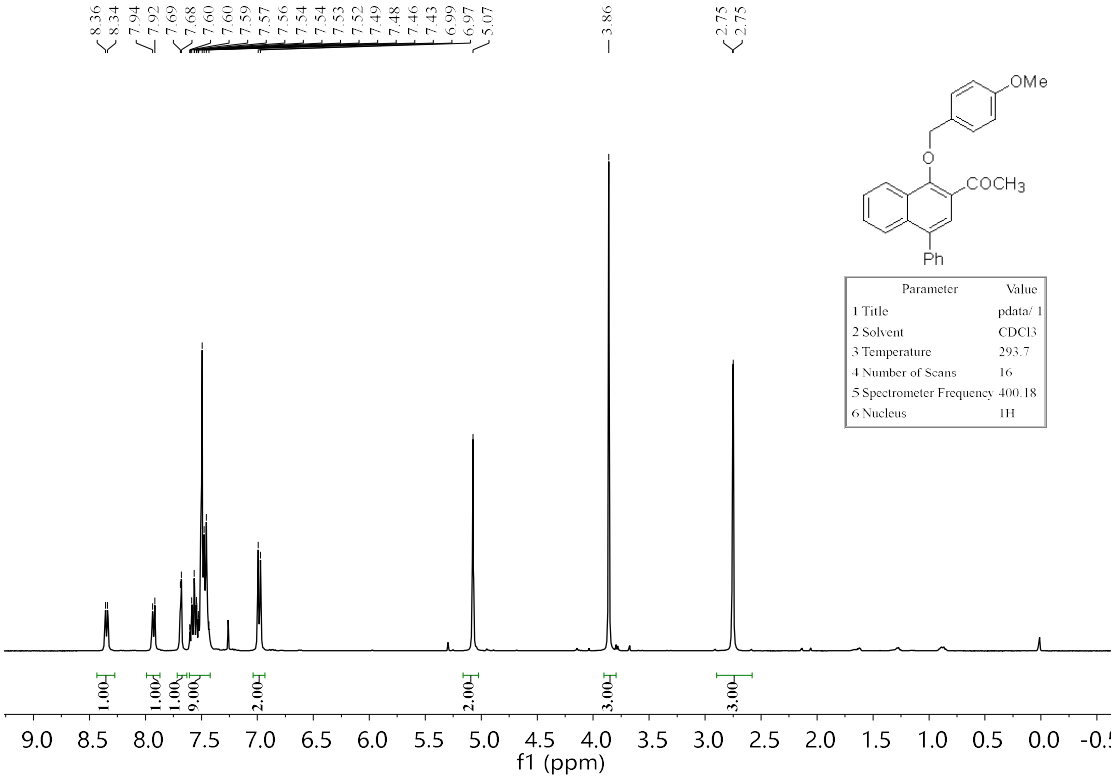
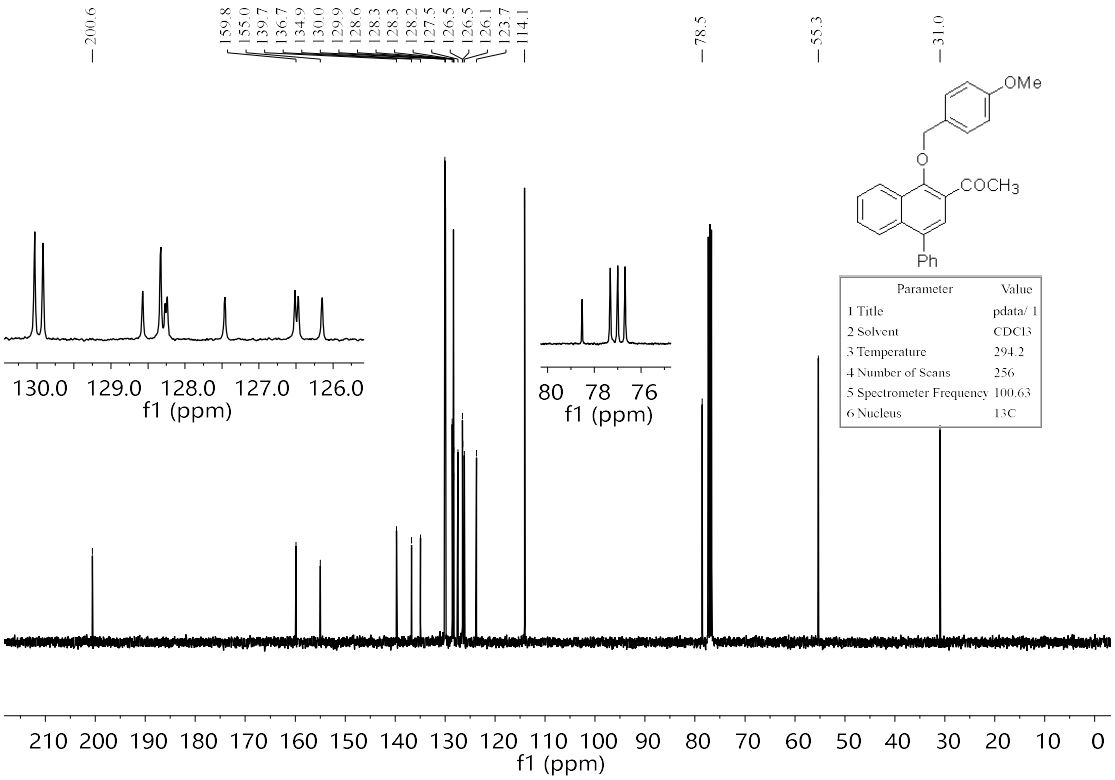
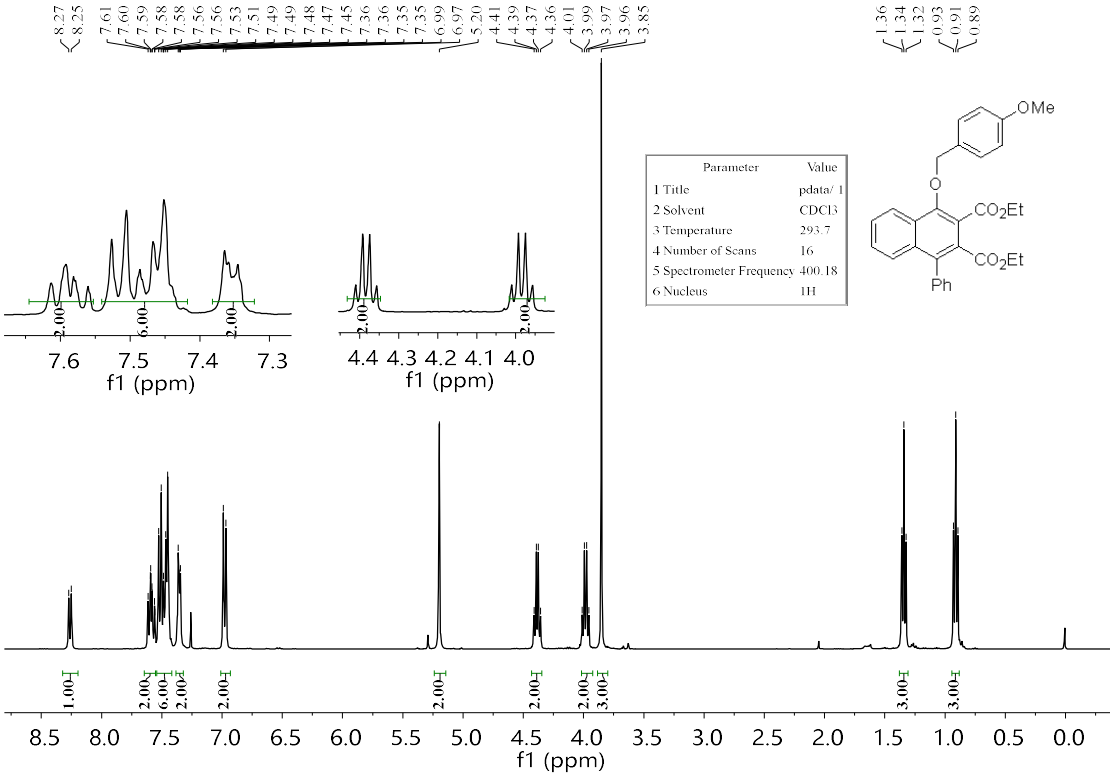
2 Solvent CDCl3
3 Temperature 294.2
4 Number of Scans 16
5 Spectrometer Frequency 162.00
6 Nucleus 31P
140 110 80 50 20 -10 -40 -70 -100 -130 -160 -190 -220 -25
f1 (ppm)

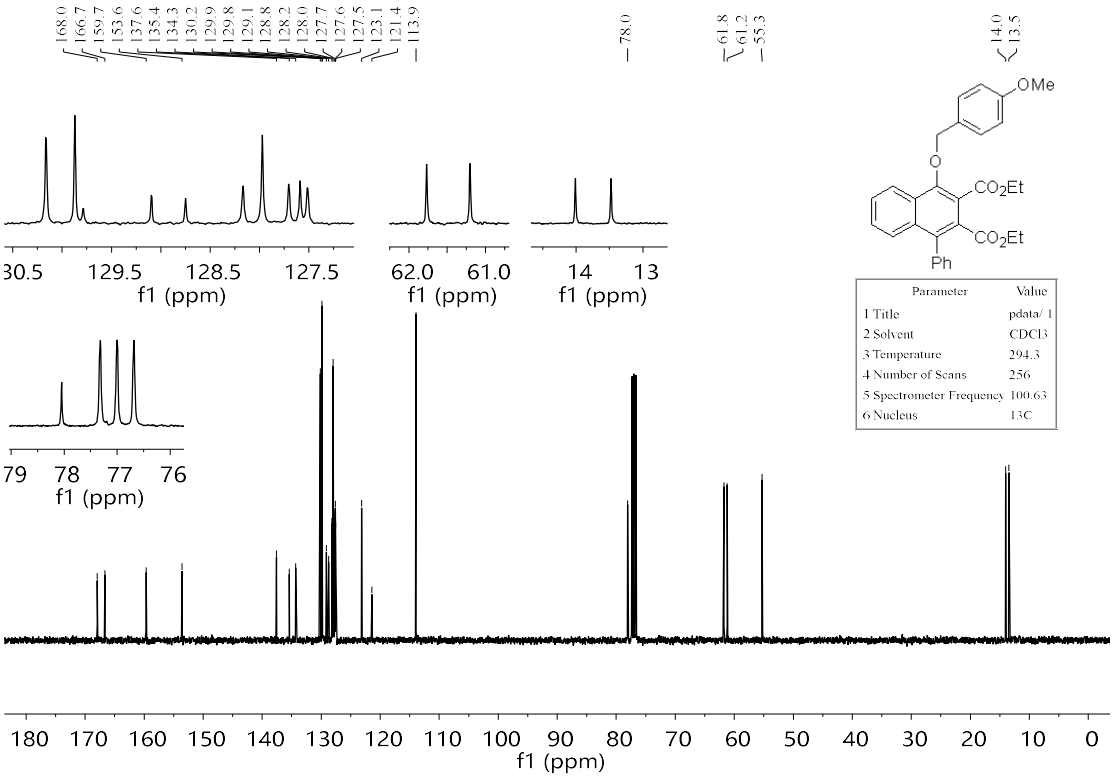
1-(1-((4-methoxybenzyl)oxy)-4-phenylnaphthalen-2-yl)ethan-1-one (A7)



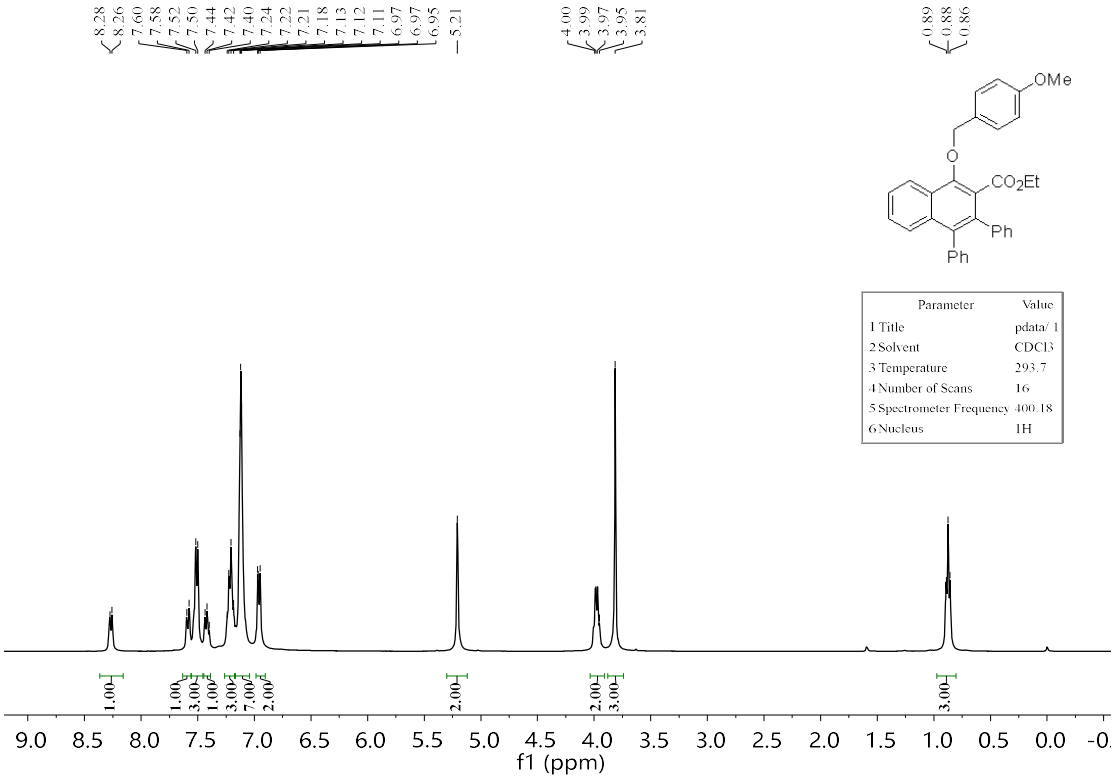


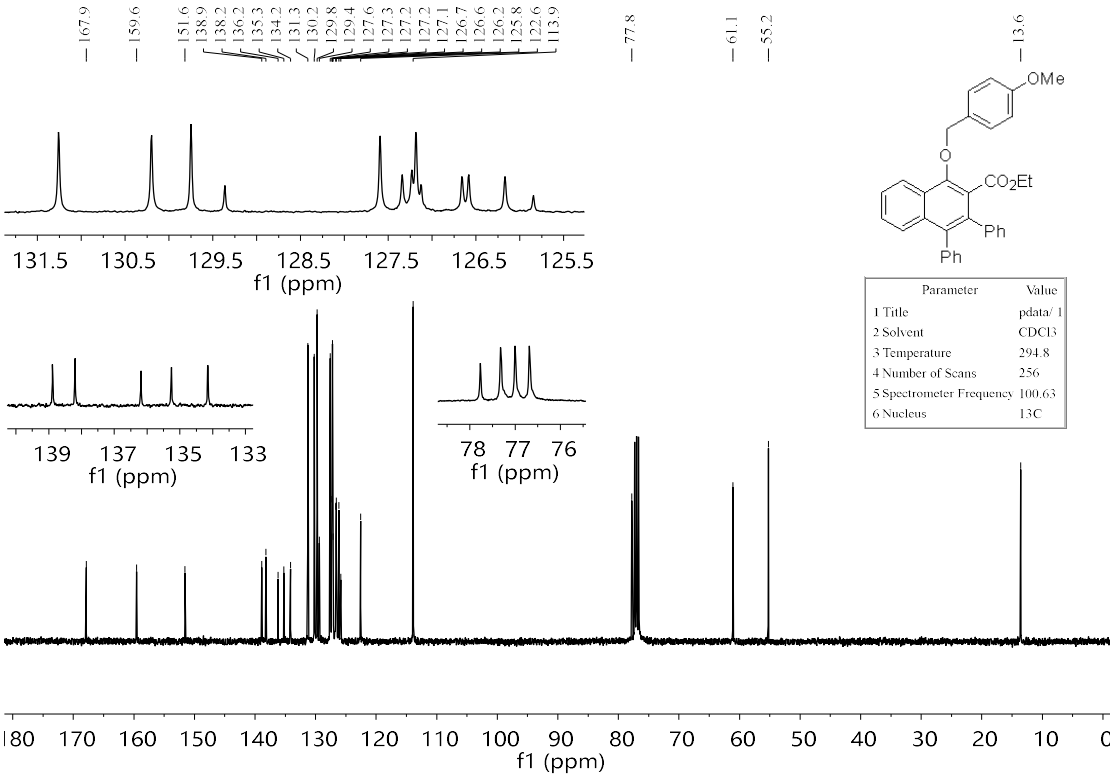
Diethyl 1-((4-methoxybenzyl)oxy)-4-phenylnaphthalene-2,3-dicarboxylate (A8)



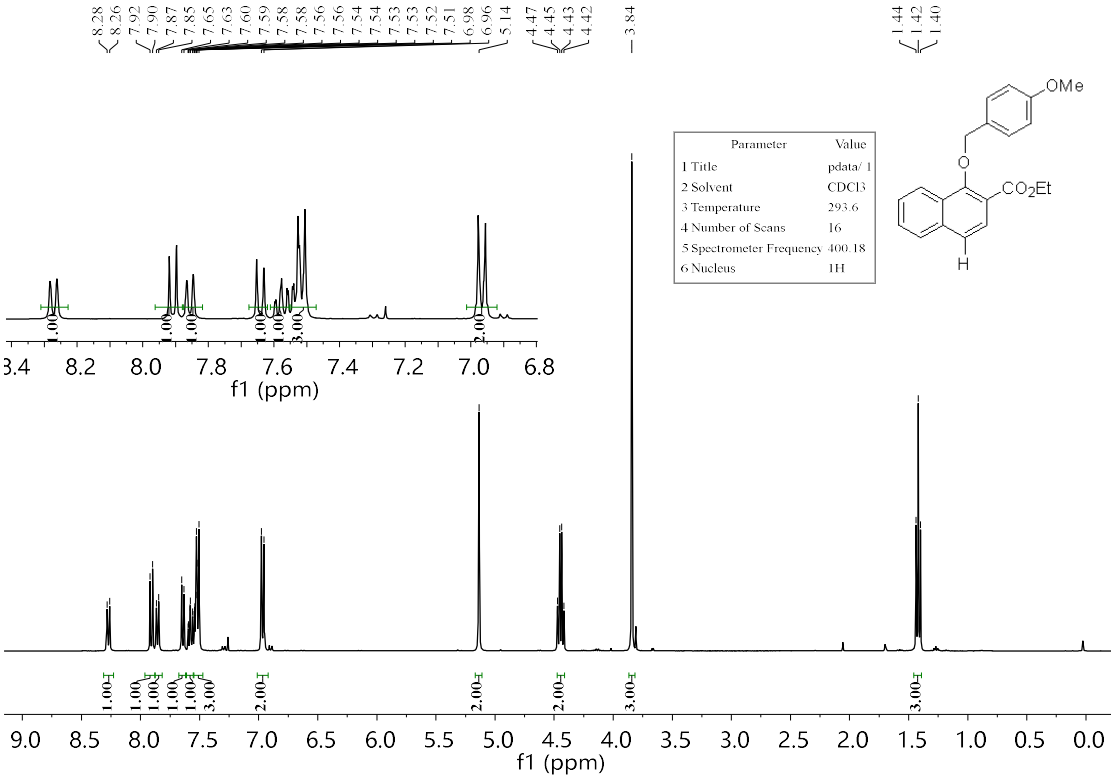


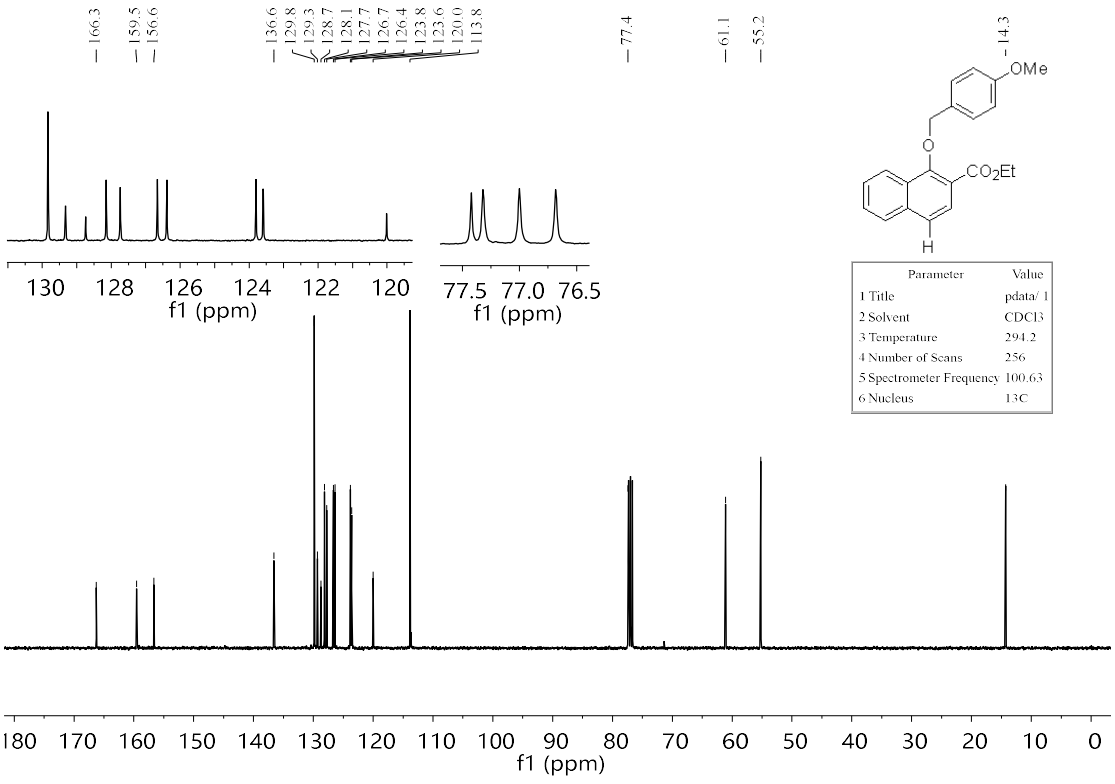
Ethyl 1-((4-methoxybenzyl)oxy)-3,4-diphenyl-2-naphthoate (A9)



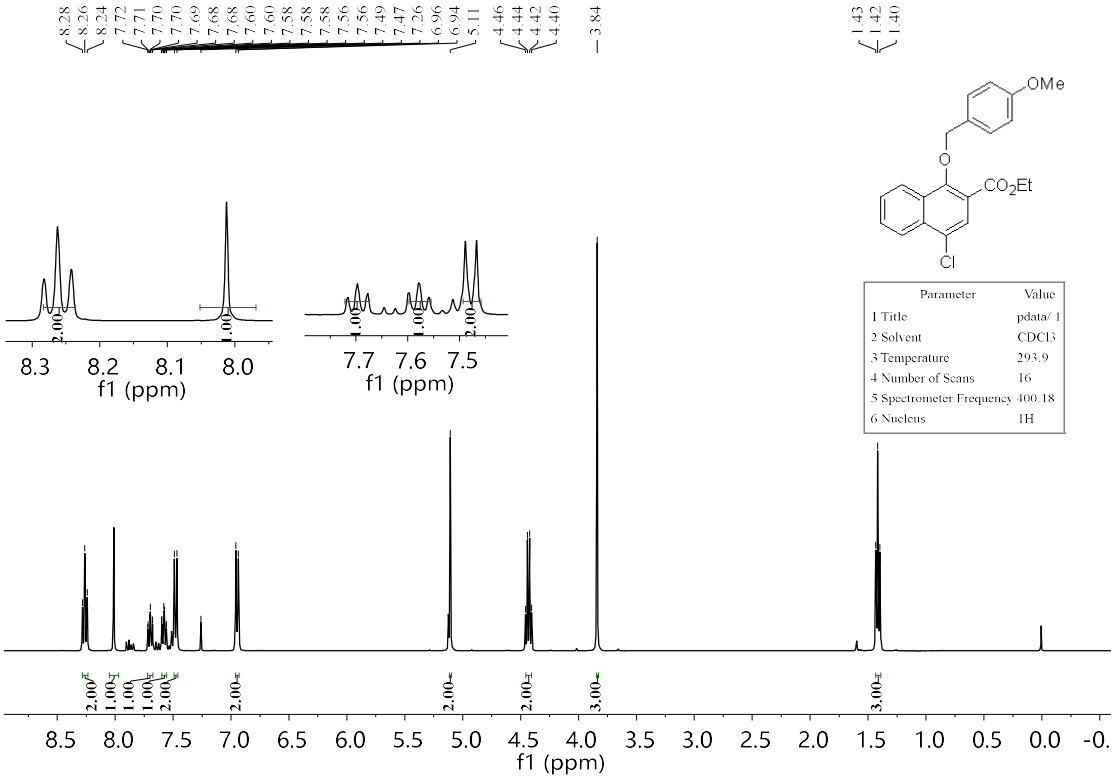


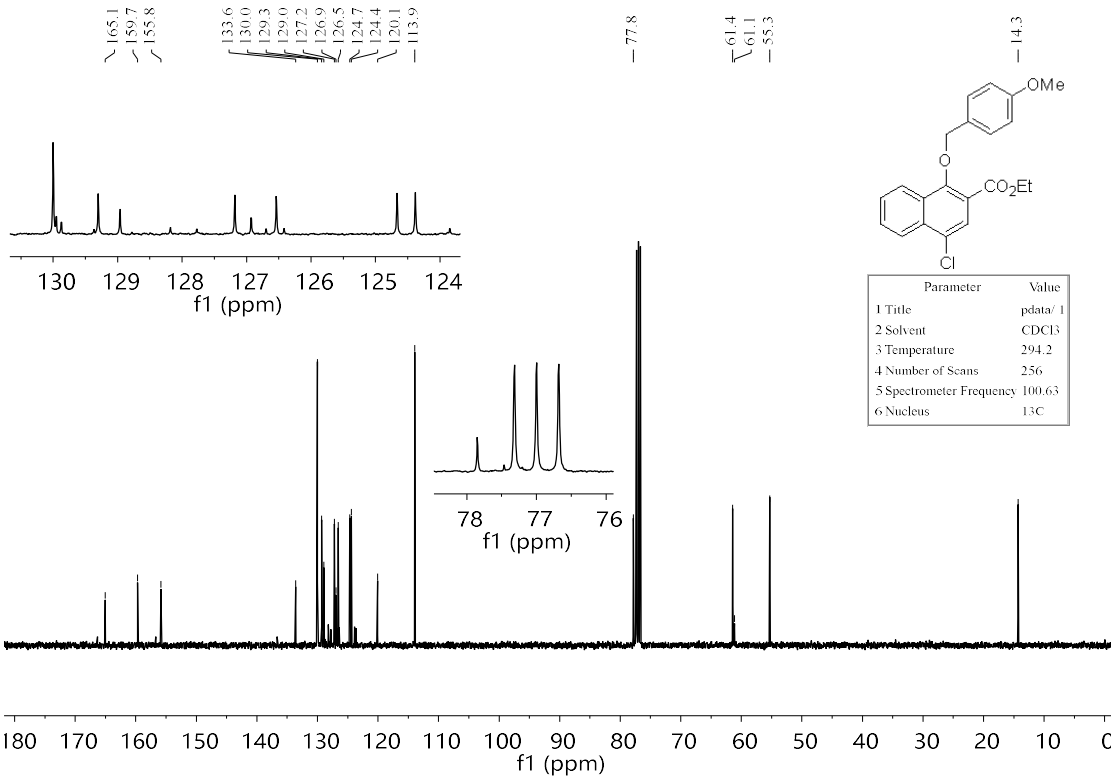
Ethyl 1-((4-methoxybenzyl)oxy)-2-naphthoate (A10)



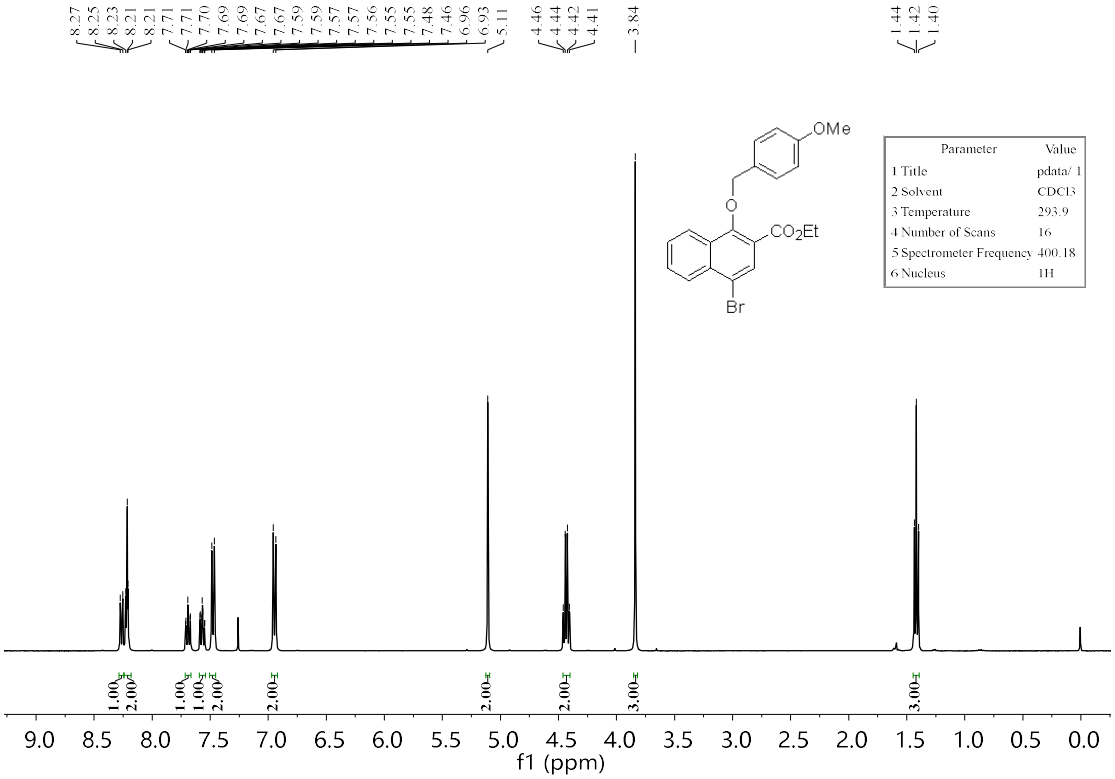


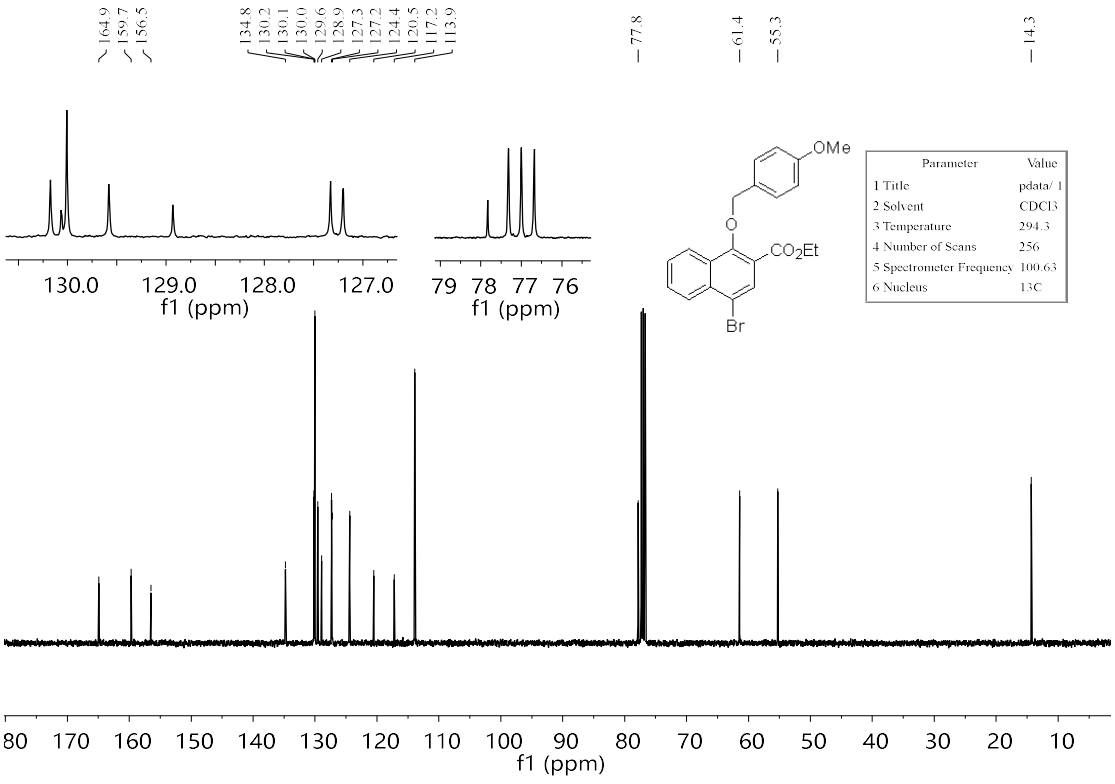
Ethyl 4-chloro-1-((4-methoxybenzyl)oxy)-2-naphthoate (A11)



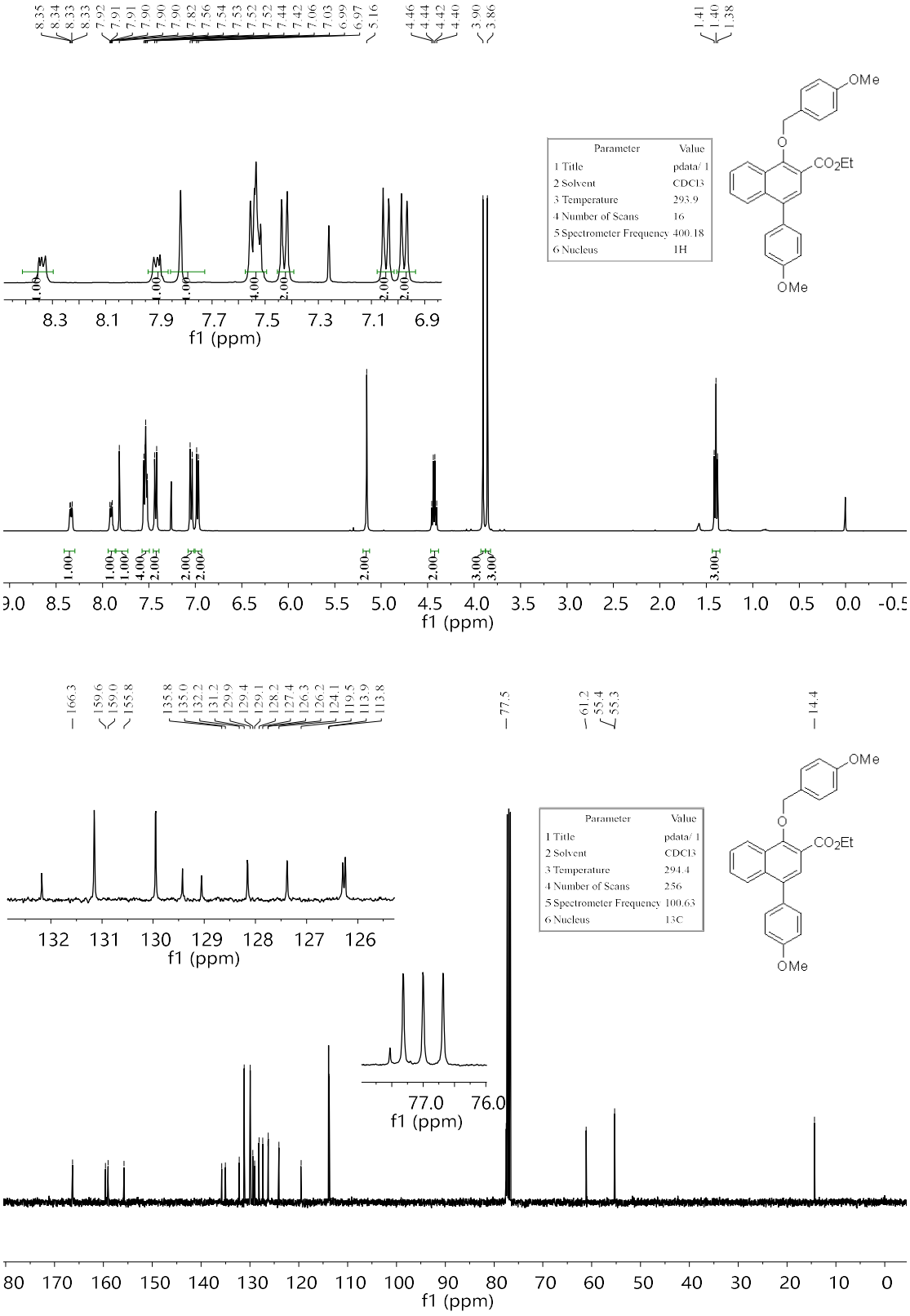


Ethyl 4-bromo-1-((4-methoxybenzyl)oxy)-2-naphthoate (A12)

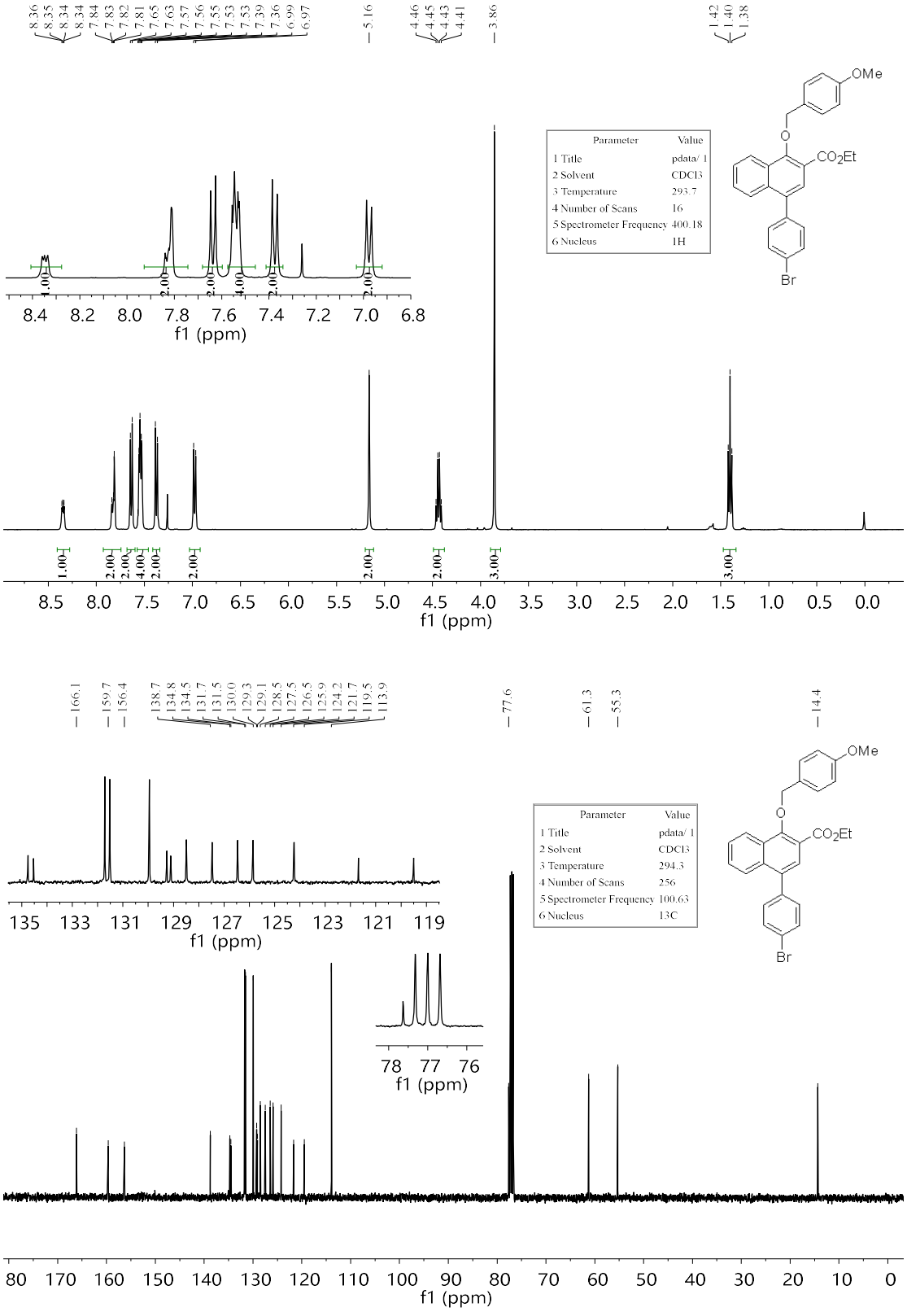




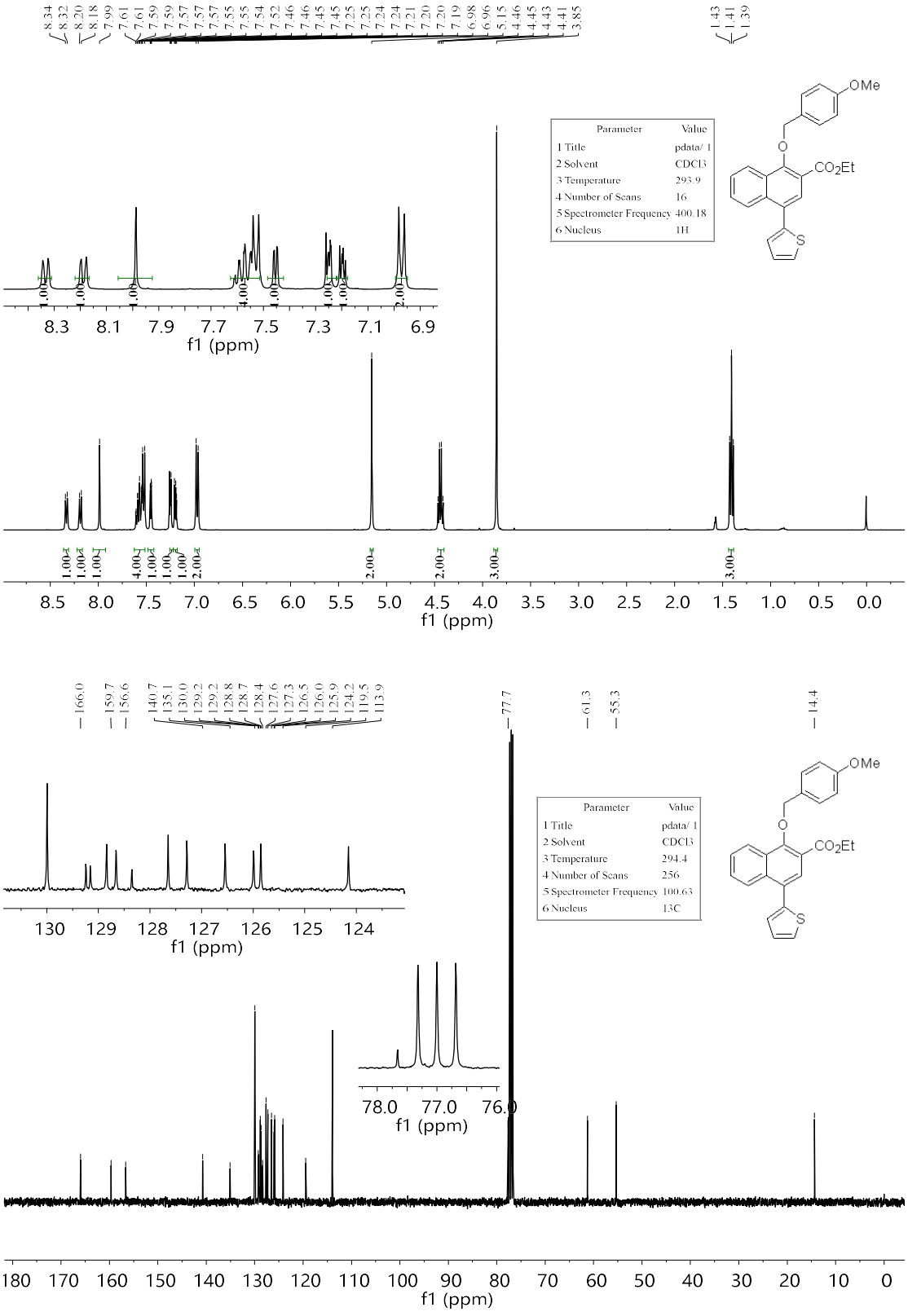
Ethyl 1-((4-methoxybenzyl)oxy)-4-(4-methoxyphenyl)-2-naphthoate (A13)



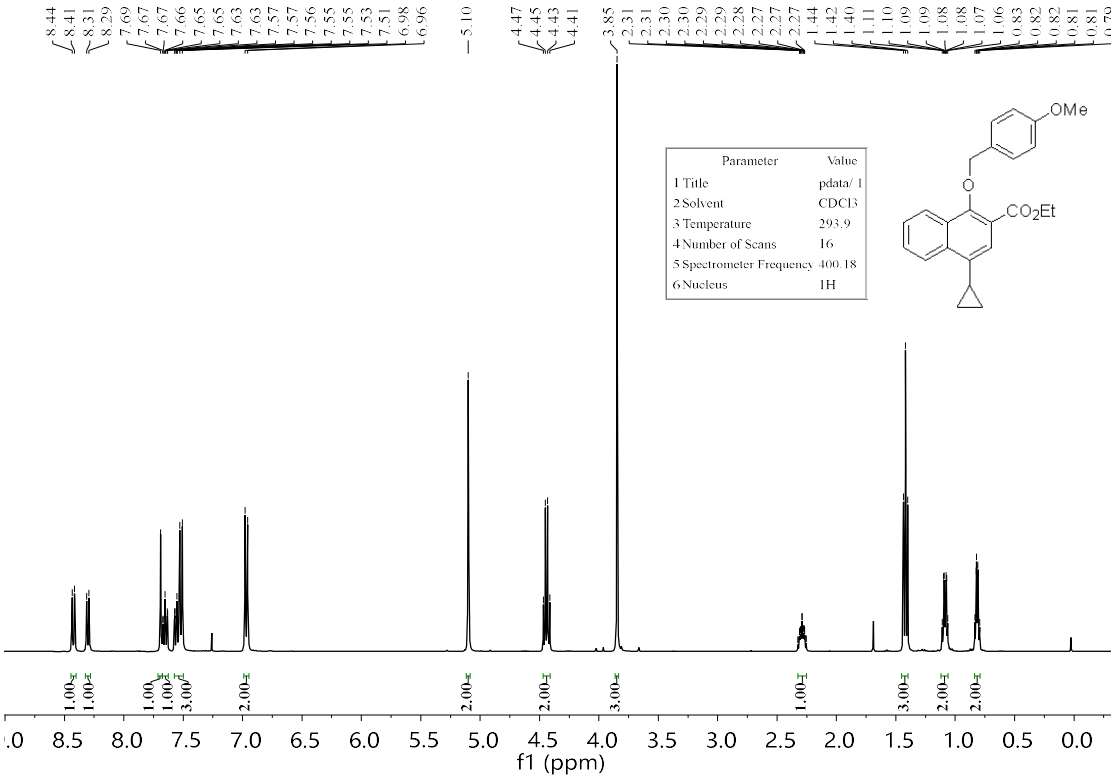
Ethyl 4-(4-bromophenyl)-1-((4-methoxybenzyl)oxy)-2-naphthoate (A14)

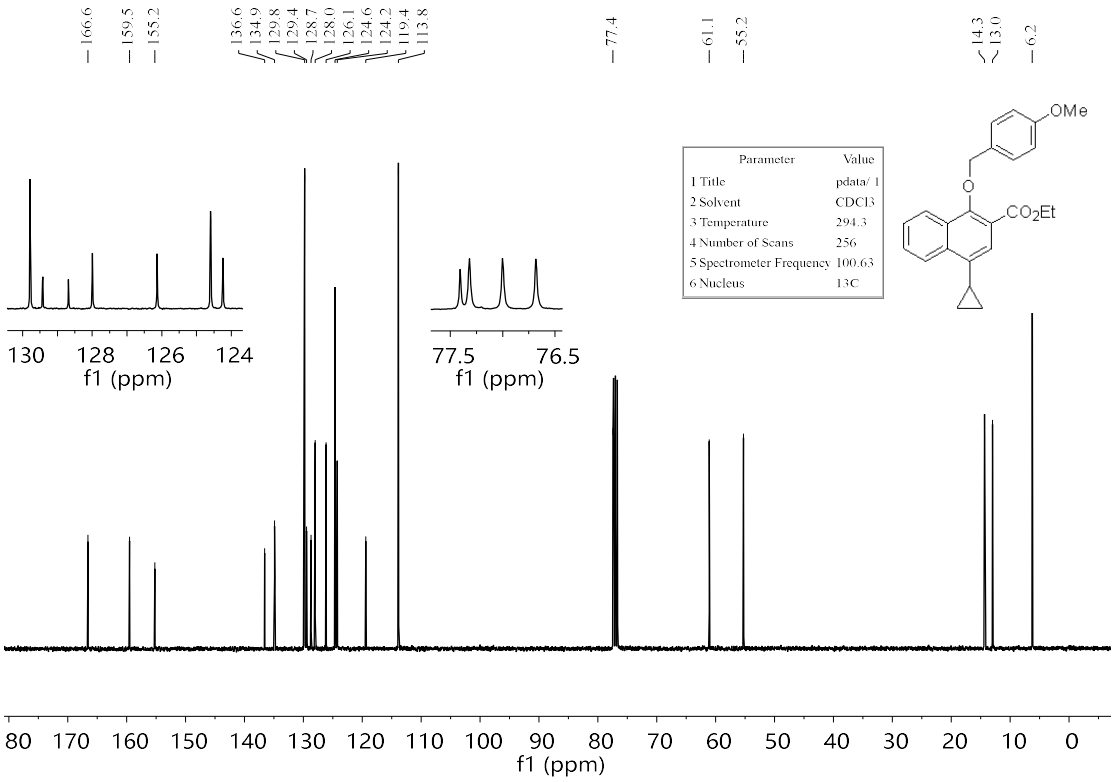


Ethyl 1-((4-methoxybenzyl)oxy)-4-(thiophen-2-yl)-2-naphthoate (A15)

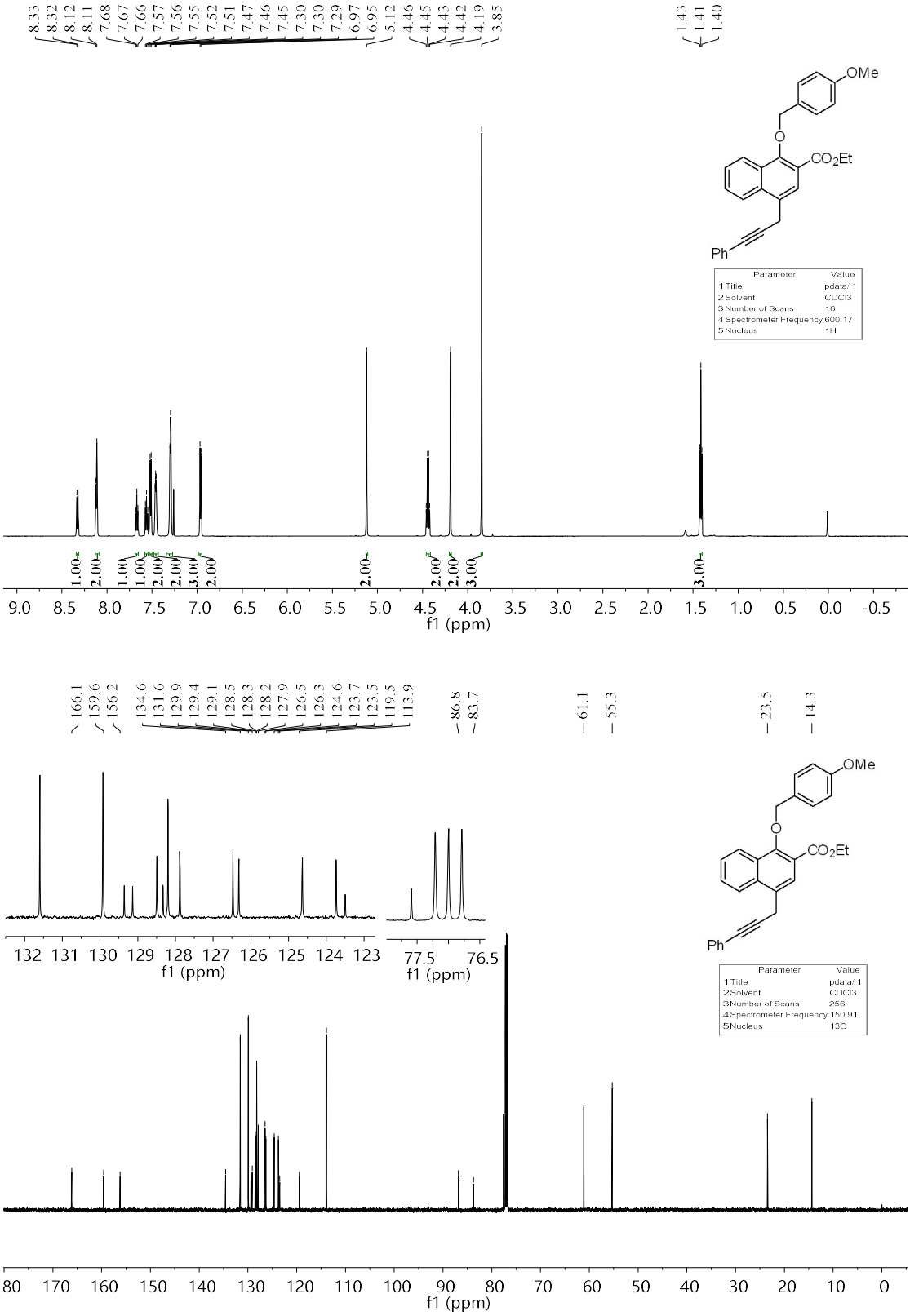


Ethyl 4-cyclopropyl-1-((4-methoxybenzyl)oxy)-2-naphthoate (A16)

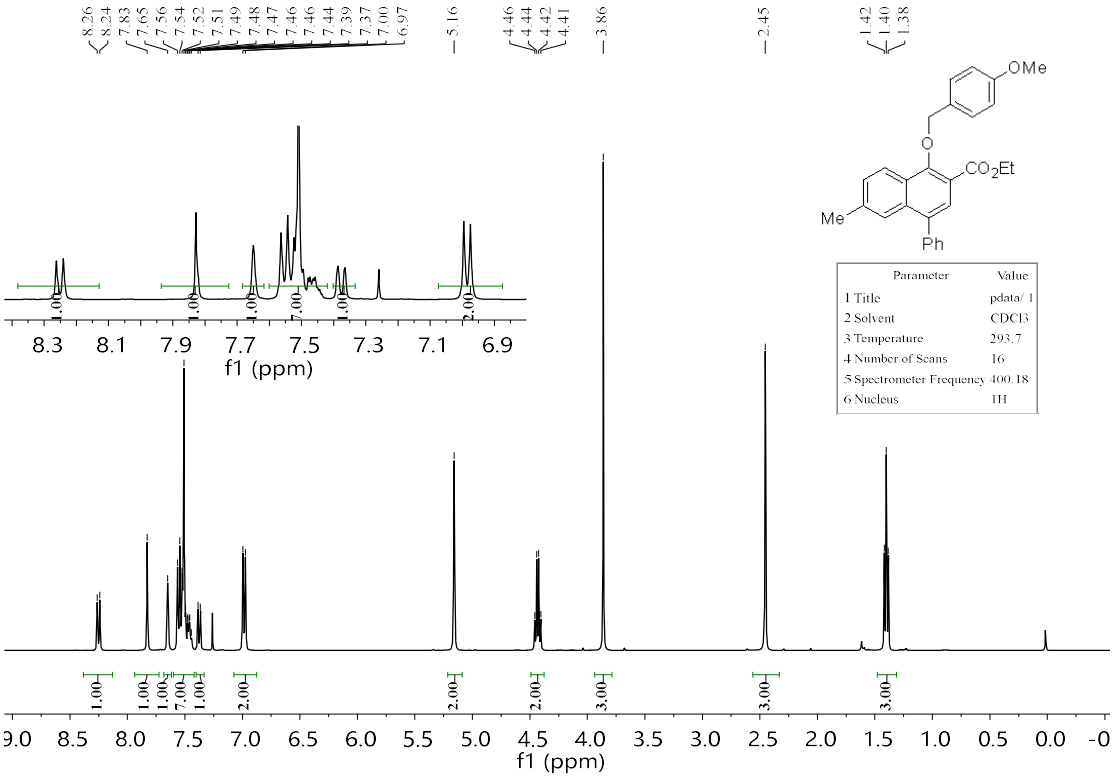


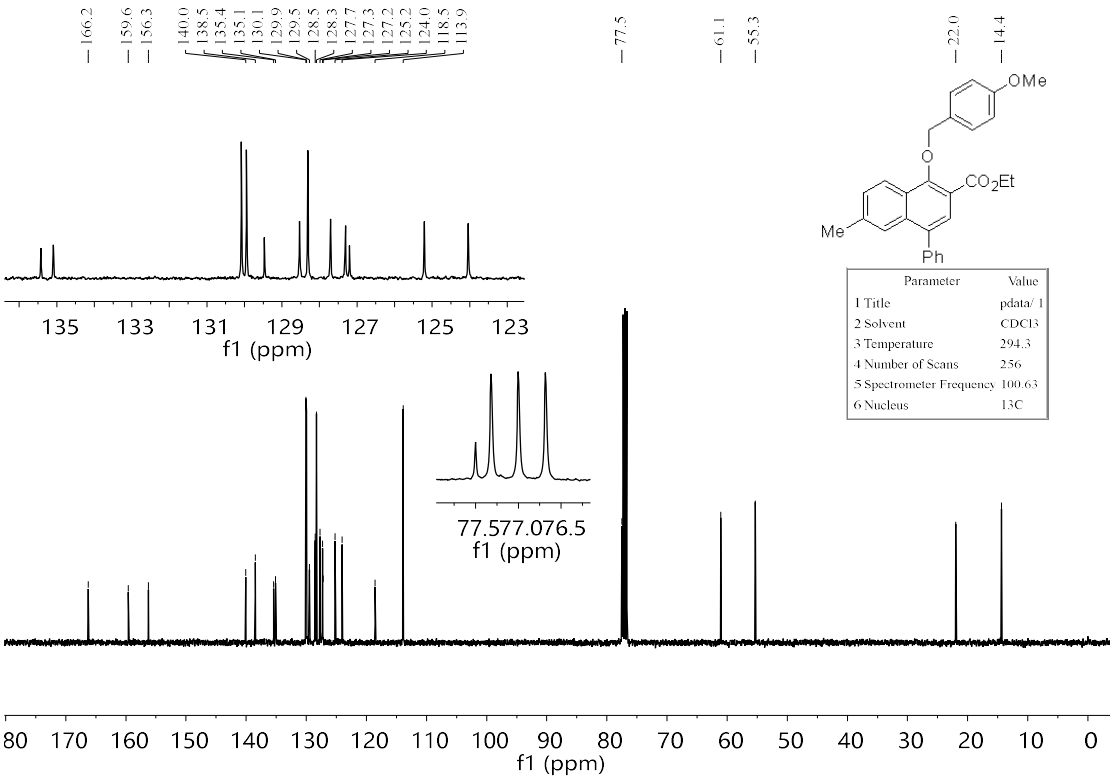


Ethyl 1-((4-methoxybenzyl)oxy)-4-(3-phenylprop-2-yn-1-yl)-2-naphthoate (A17)

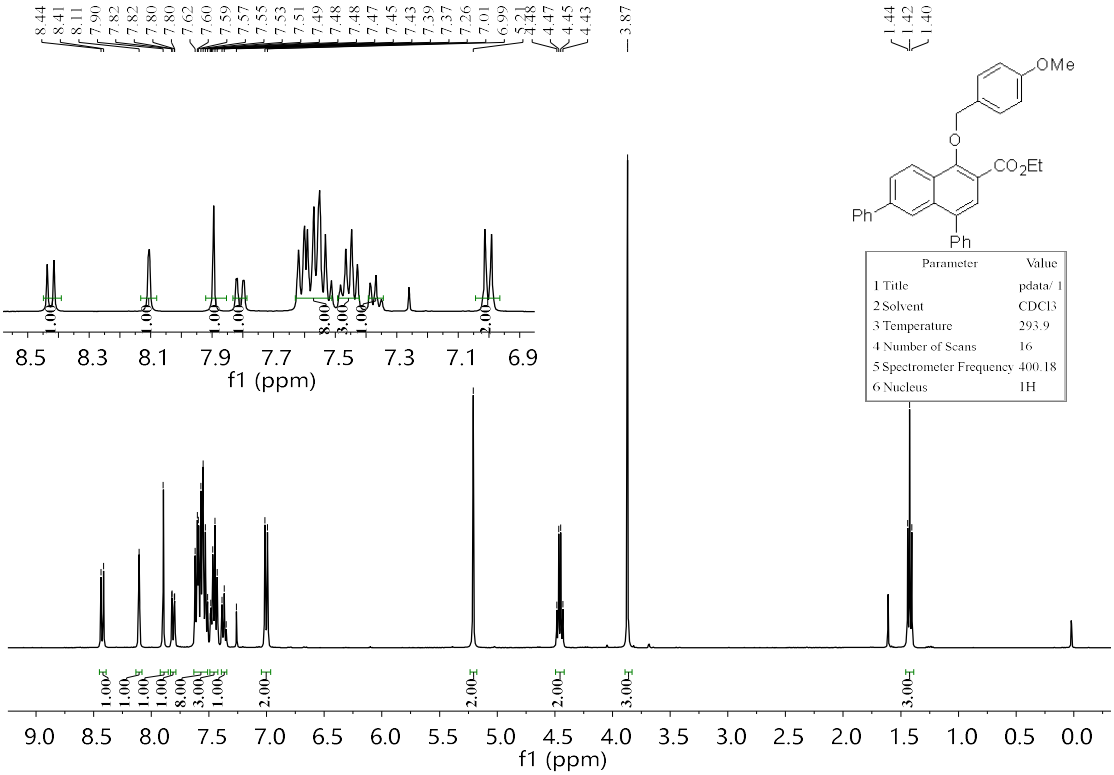


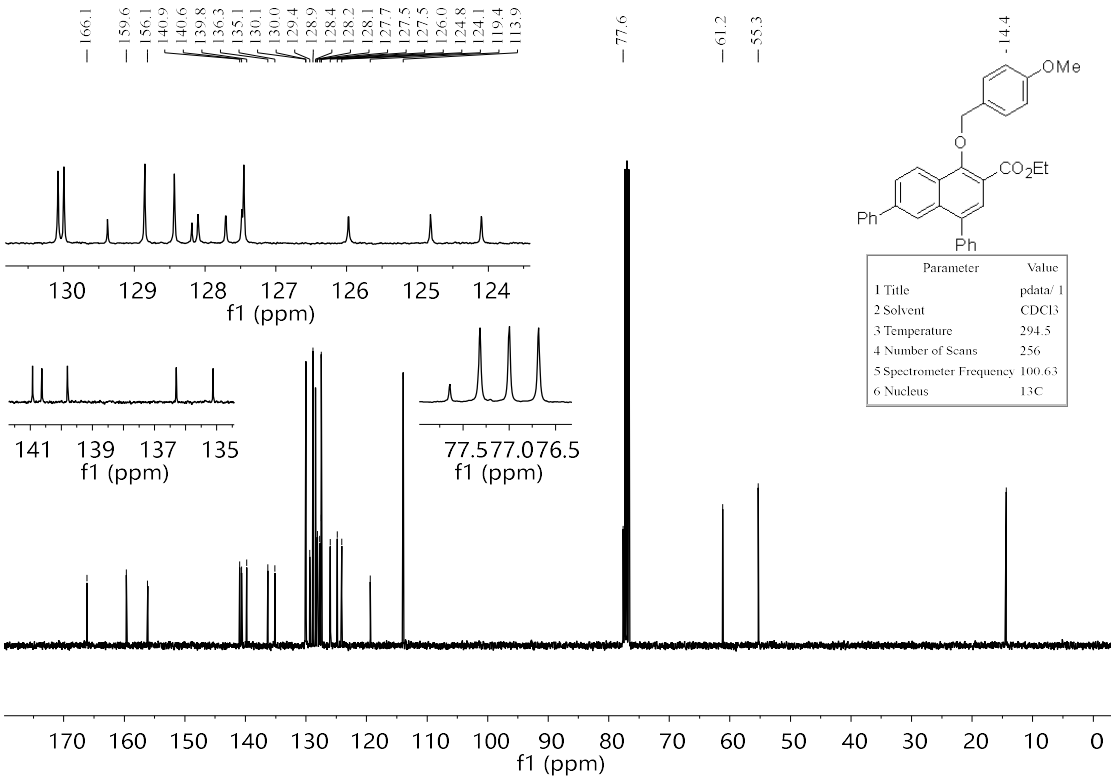
Ethyl 1-((4-methoxybenzyl)oxy)-6-methyl-4-phenyl-2-naphthoate (A18)



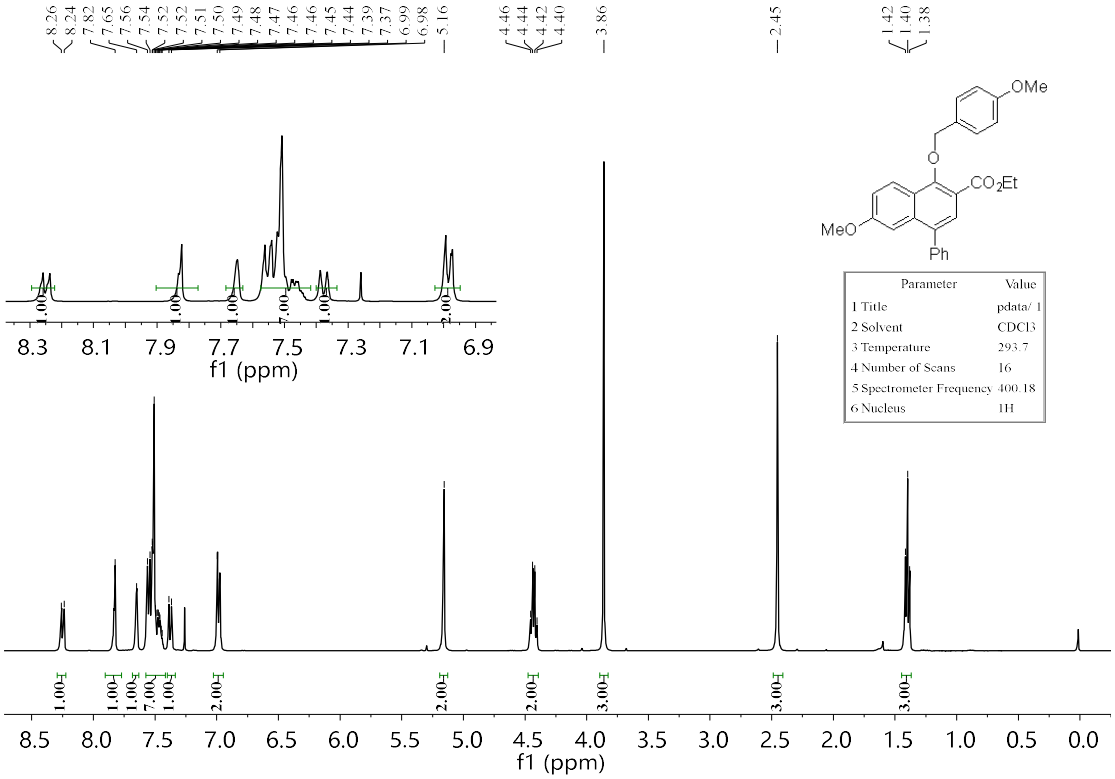


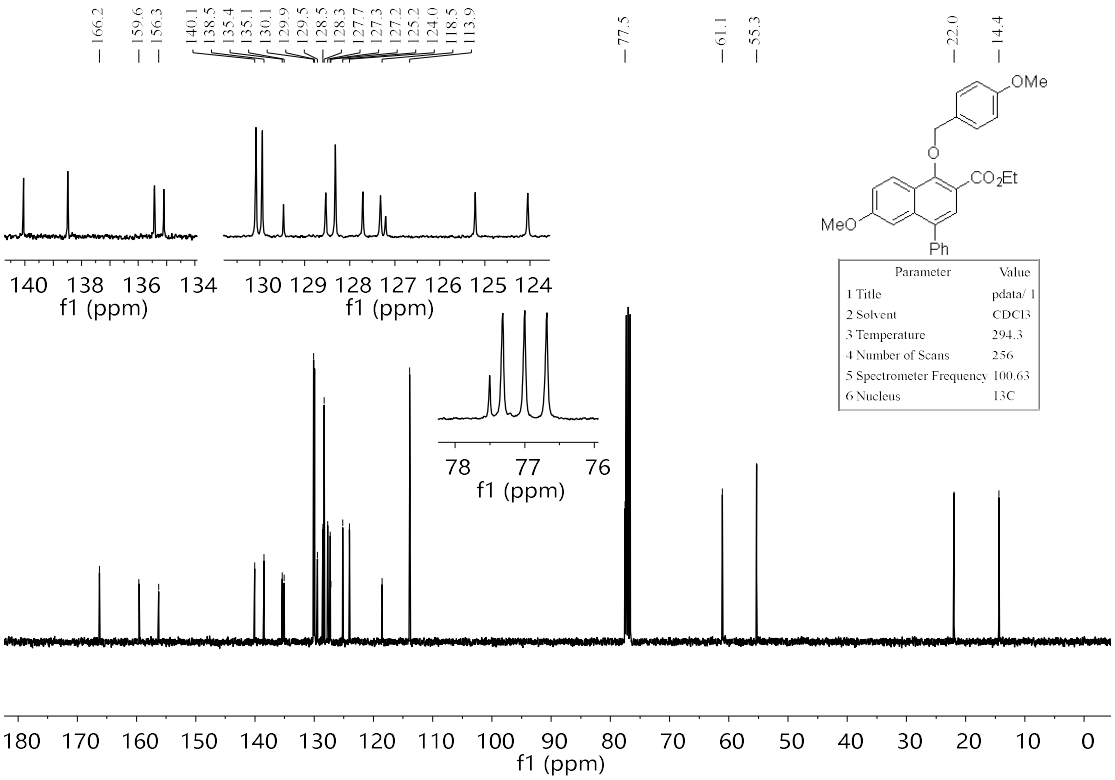
Ethyl 1-((4-methoxybenzyl)oxy)-4,6-diphenyl-2-naphthoate (A19)



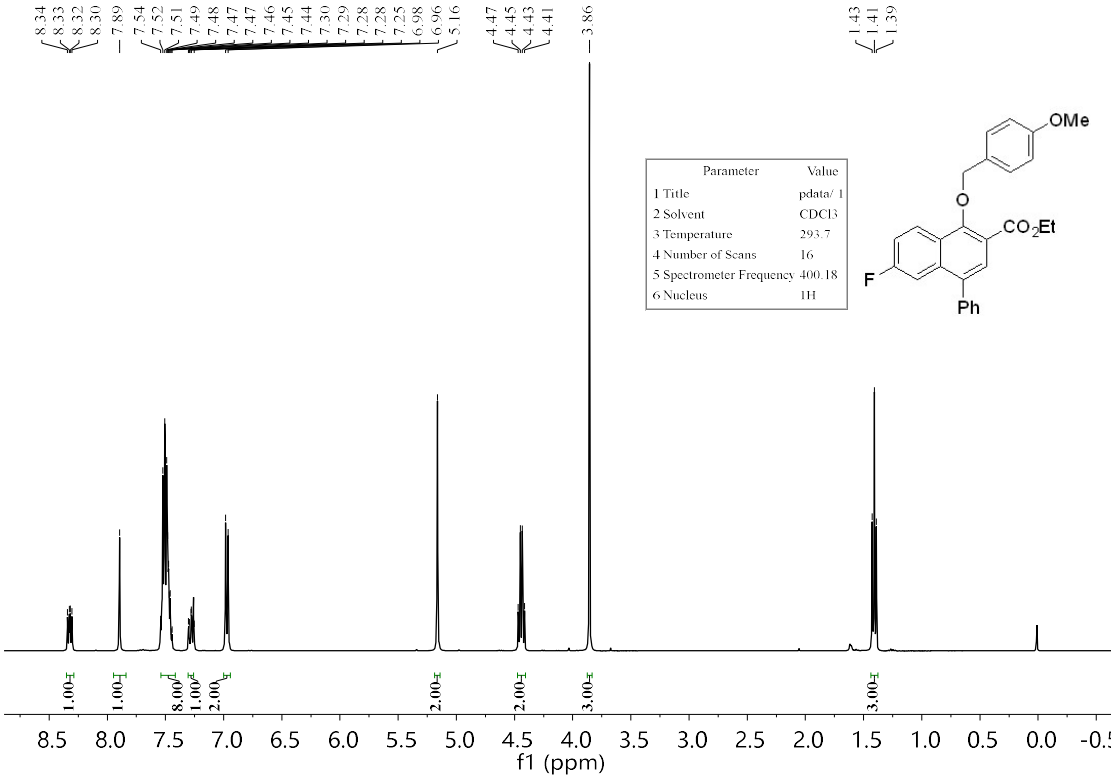


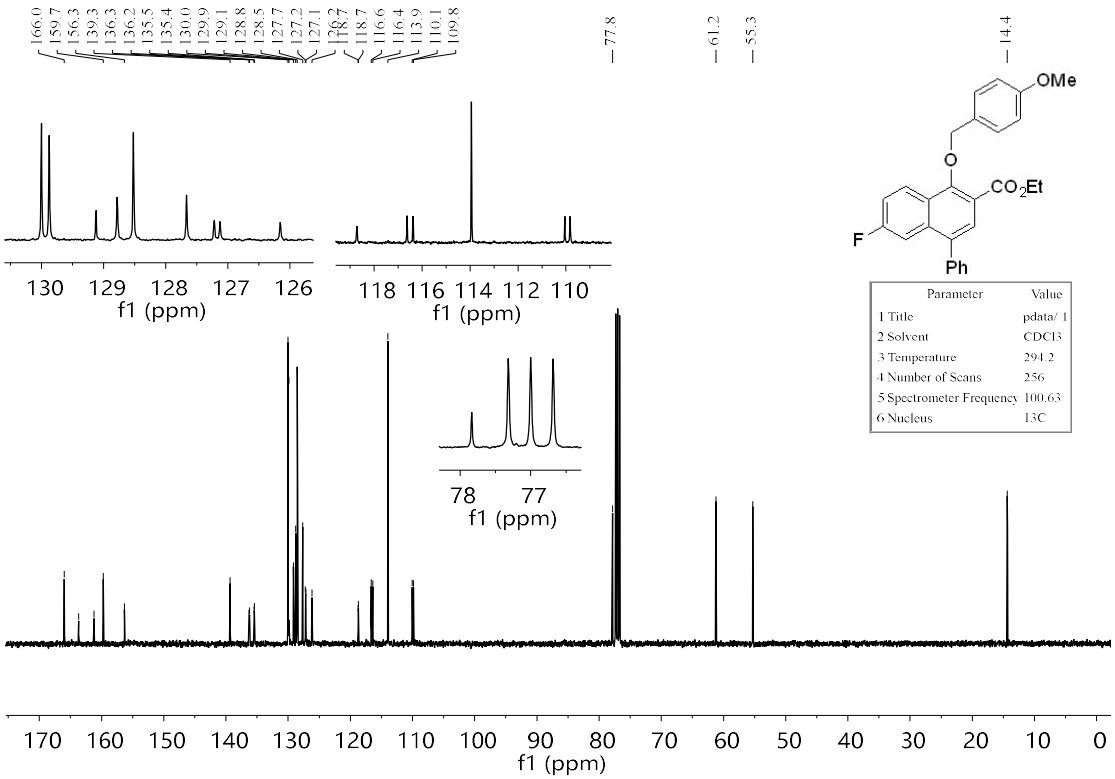
Ethyl 6-methoxy-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A20)



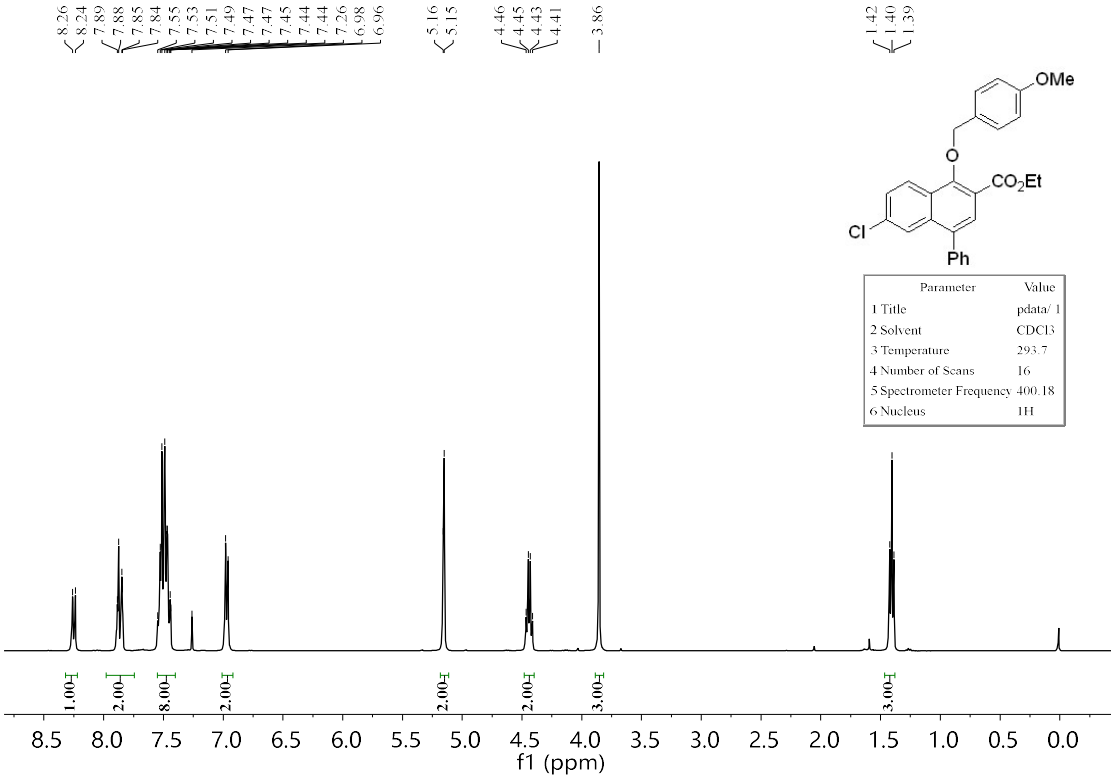


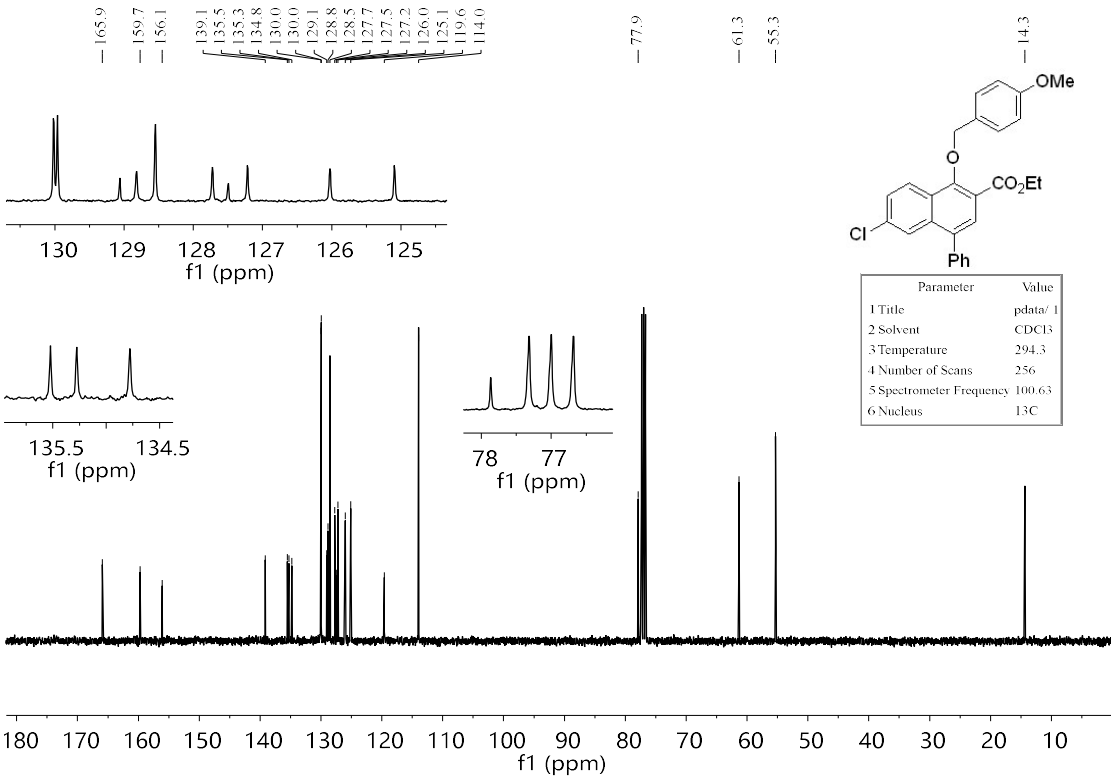
Ethyl 6-fluoro-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A21)



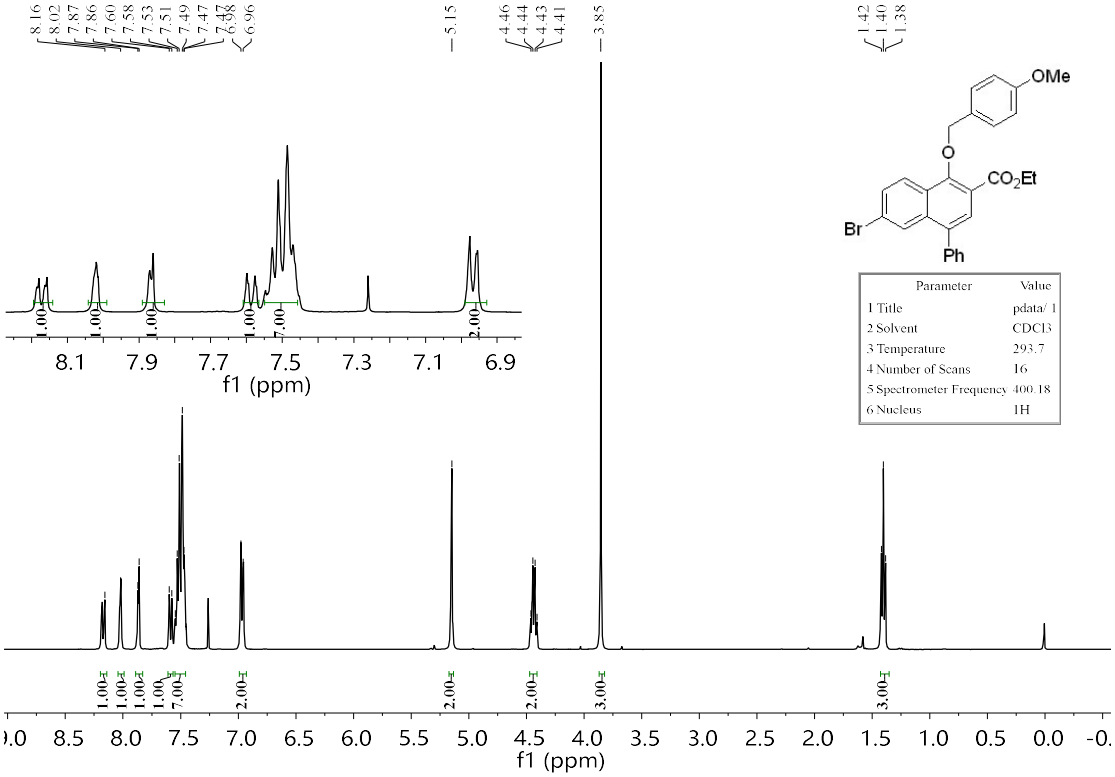


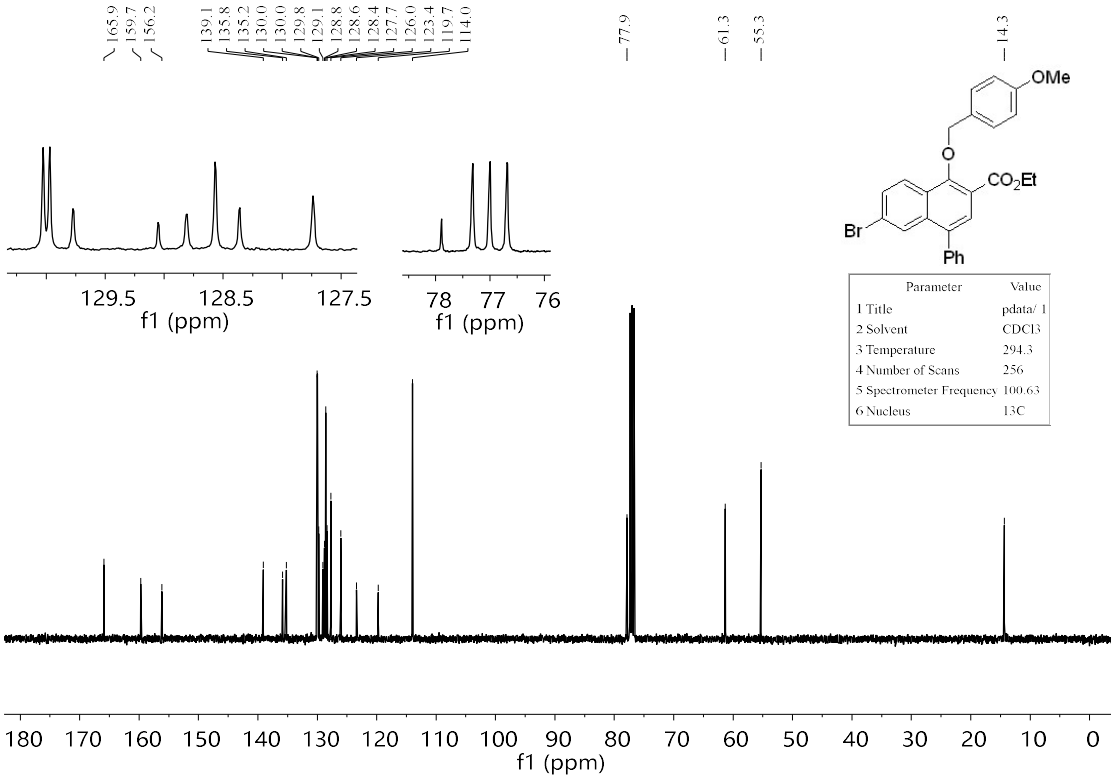
Ethyl 6-chloro-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A22)



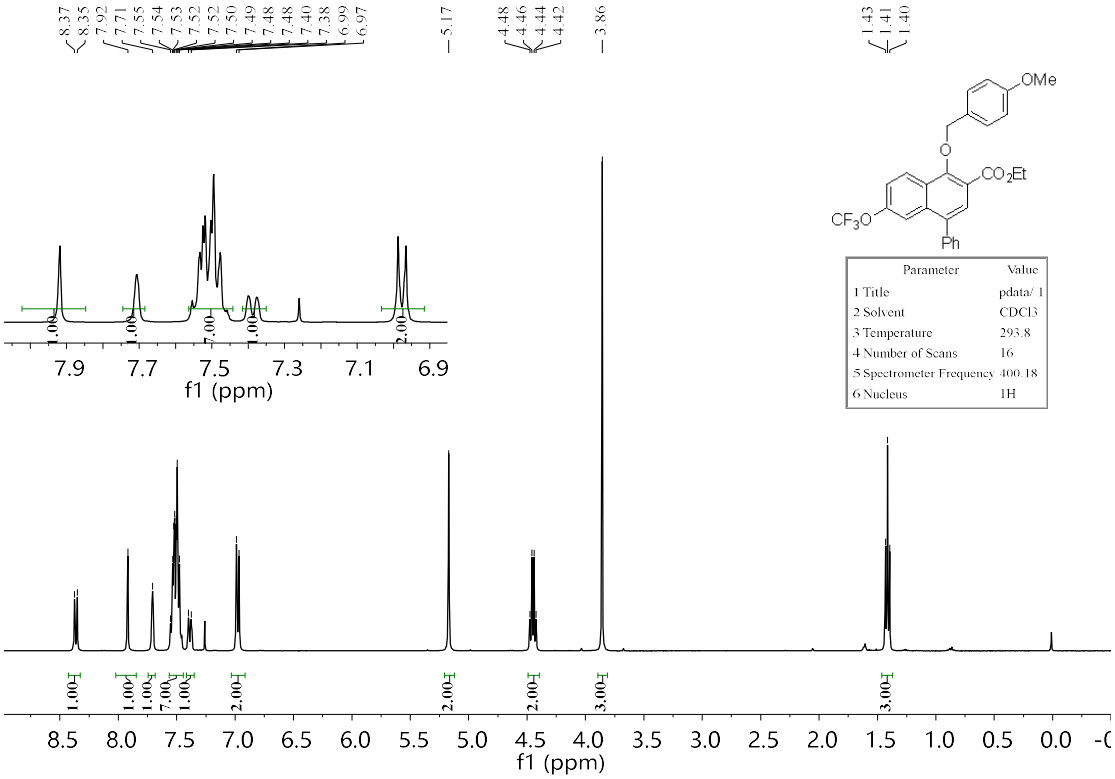


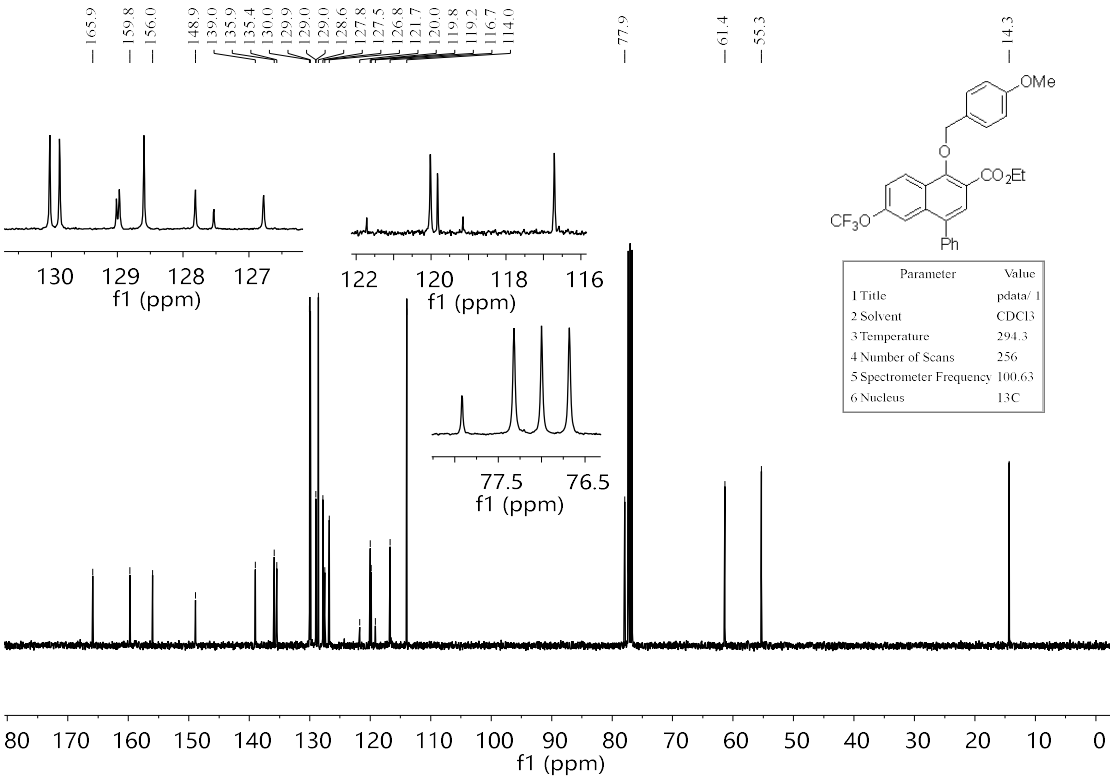
Ethyl 6-bromo-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A23)

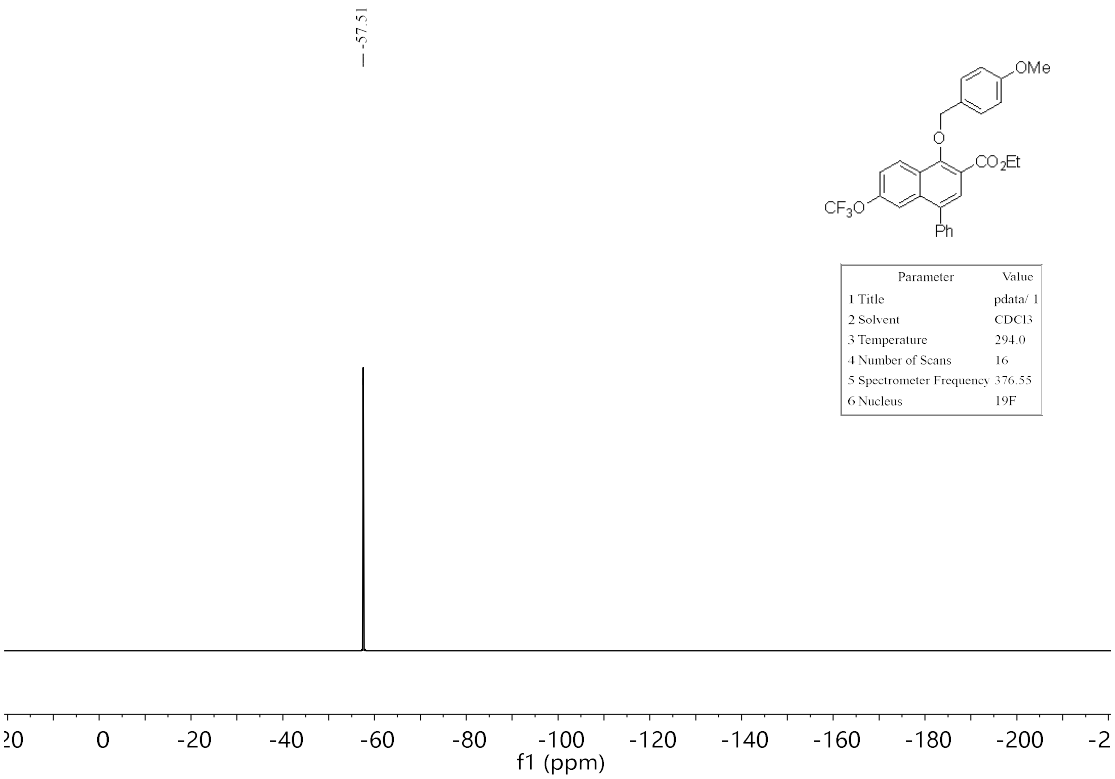




Ethyl 1-((4-methoxybenzyl)oxy)-4-phenyl-6-(trifluoromethoxy)-2-naphthoate (A24)



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CO2Et
CF3O
Ph
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4 Number of Scans 16
5 Spectrometer Frequency 376.55
6 Nucleus 19F
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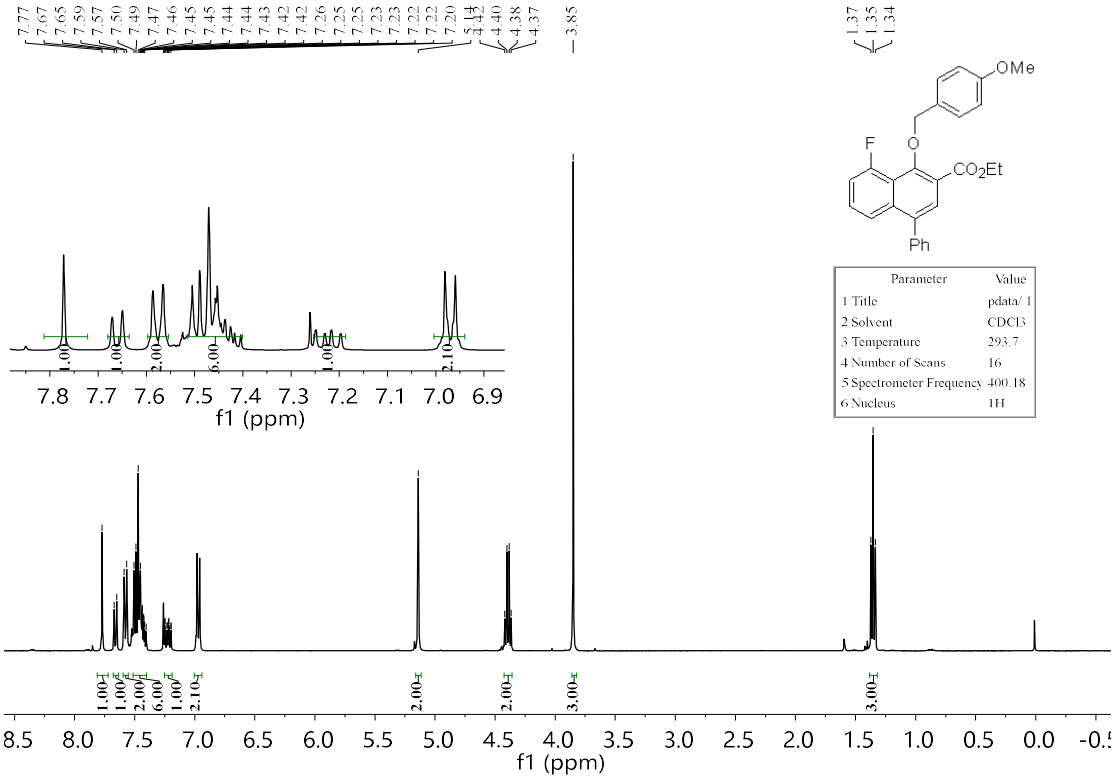
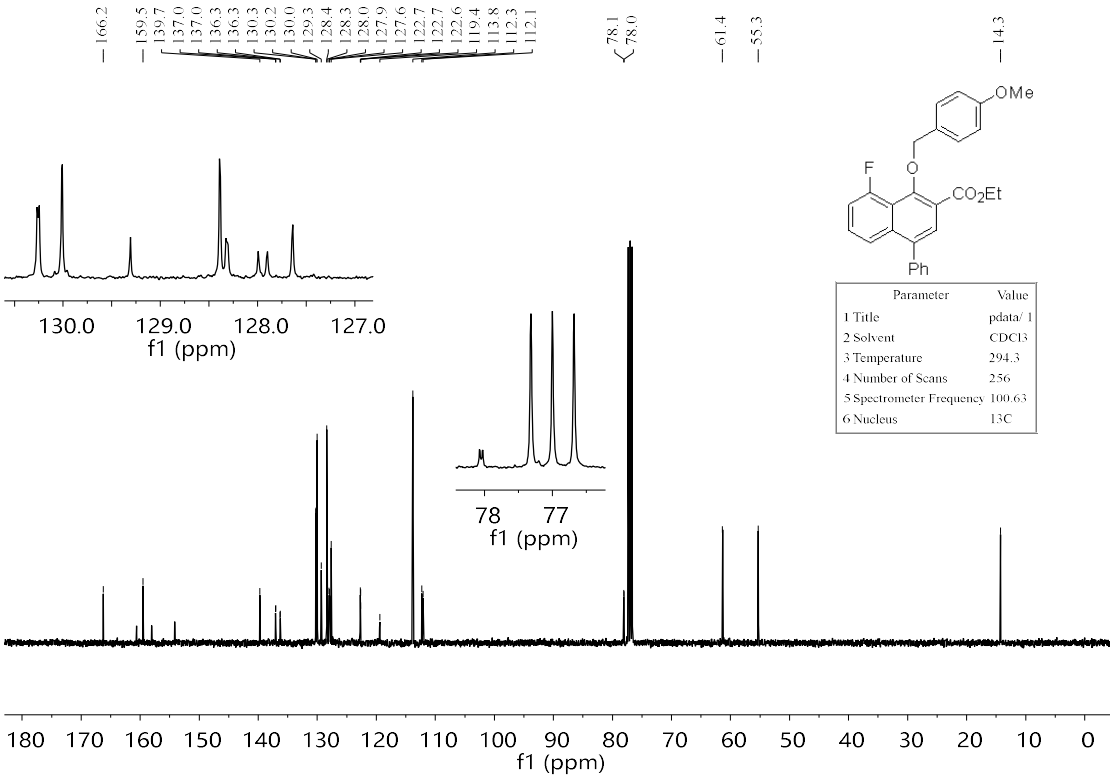
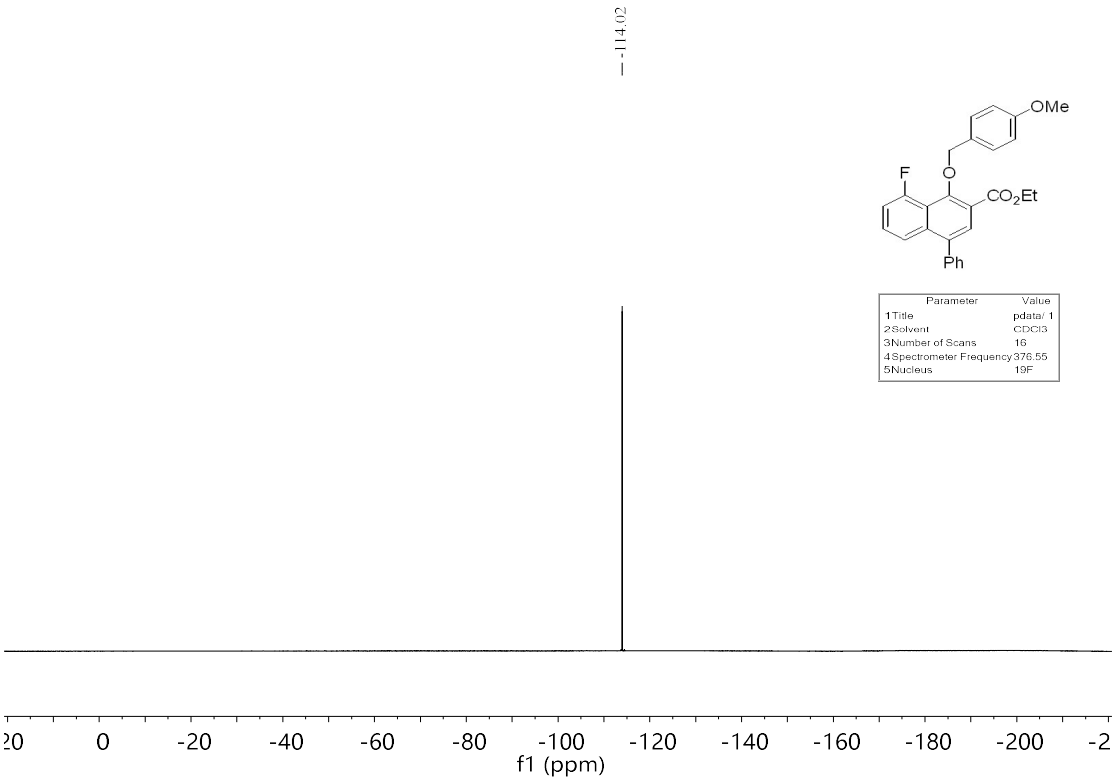
f1 (ppm)

Ethyl 8-fluoro-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A25)



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Ph
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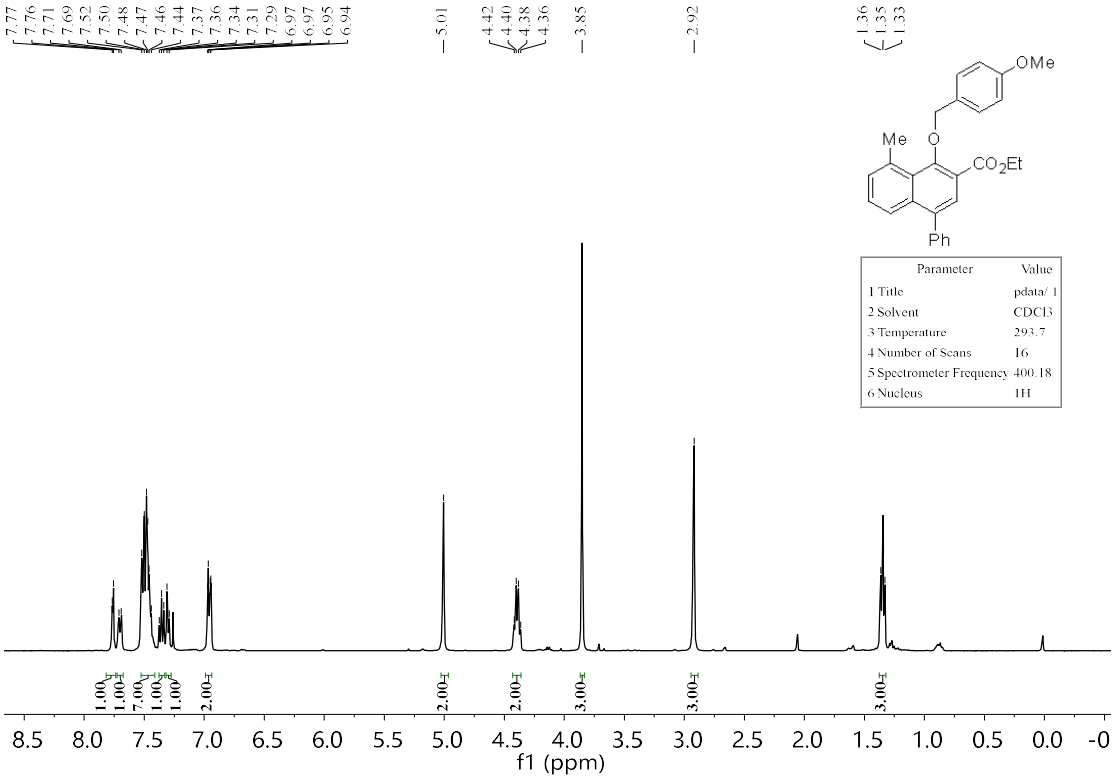
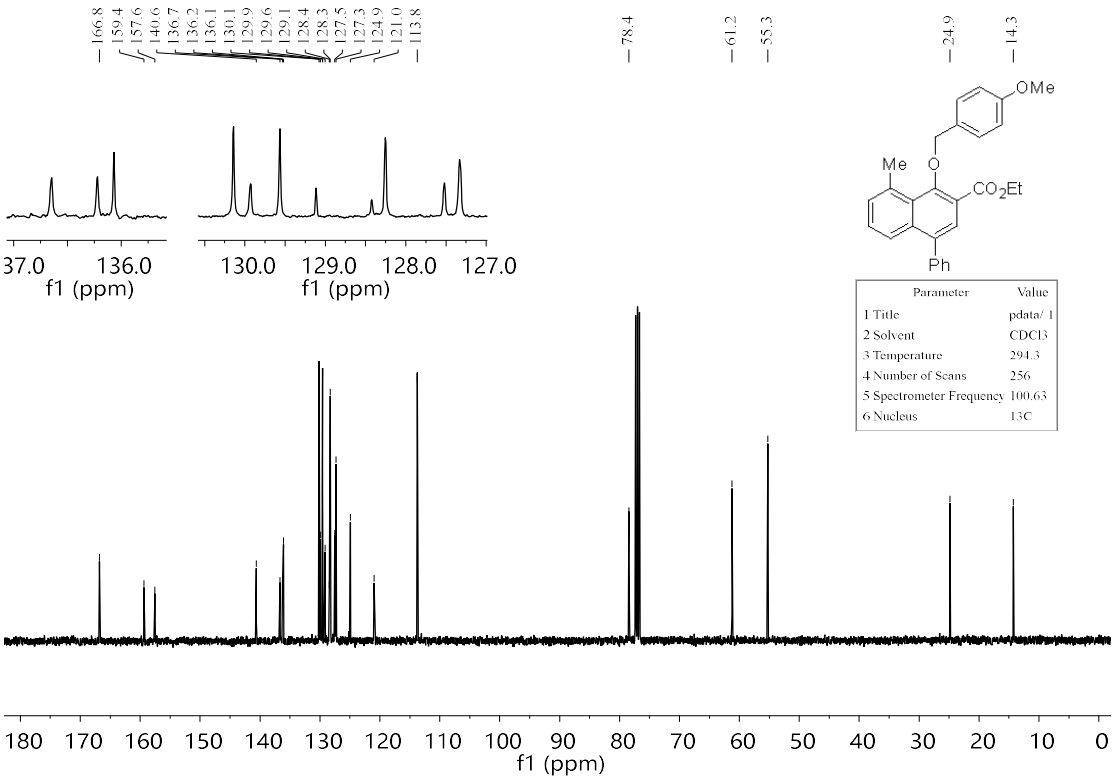
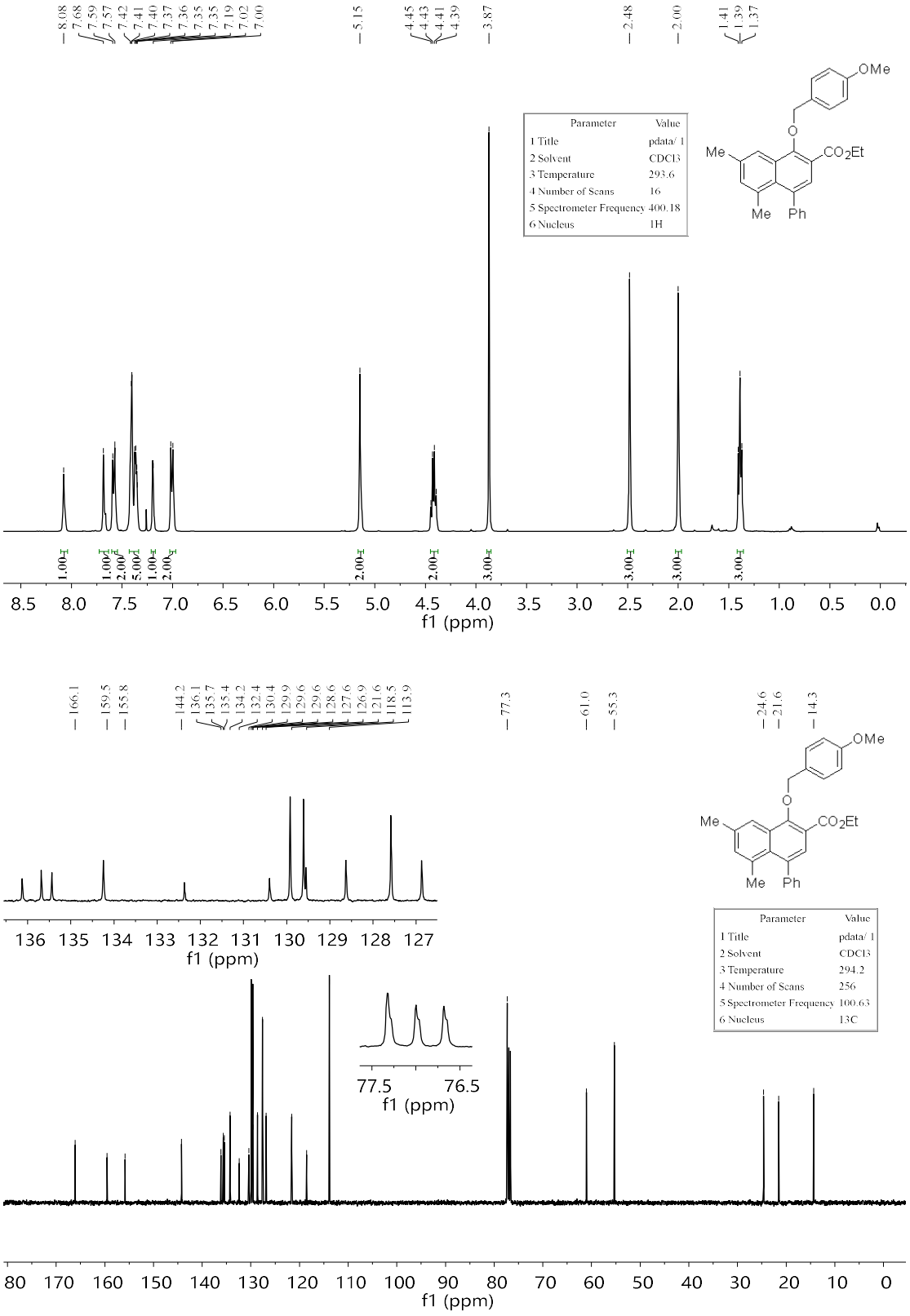
5Nucleus 19F
20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -2
f1 (ppm)

Ethyl 1-((4-methoxybenzyl)oxy)-8-methyl-4-phenyl-2-naphthoate (A26)

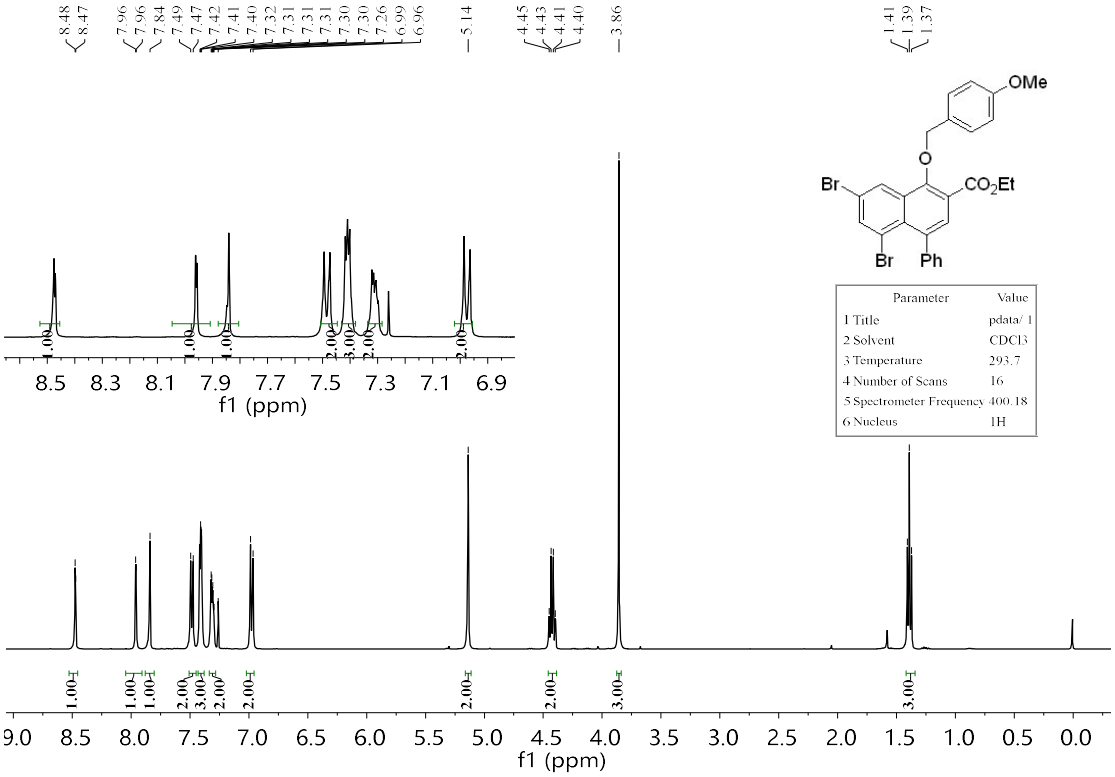


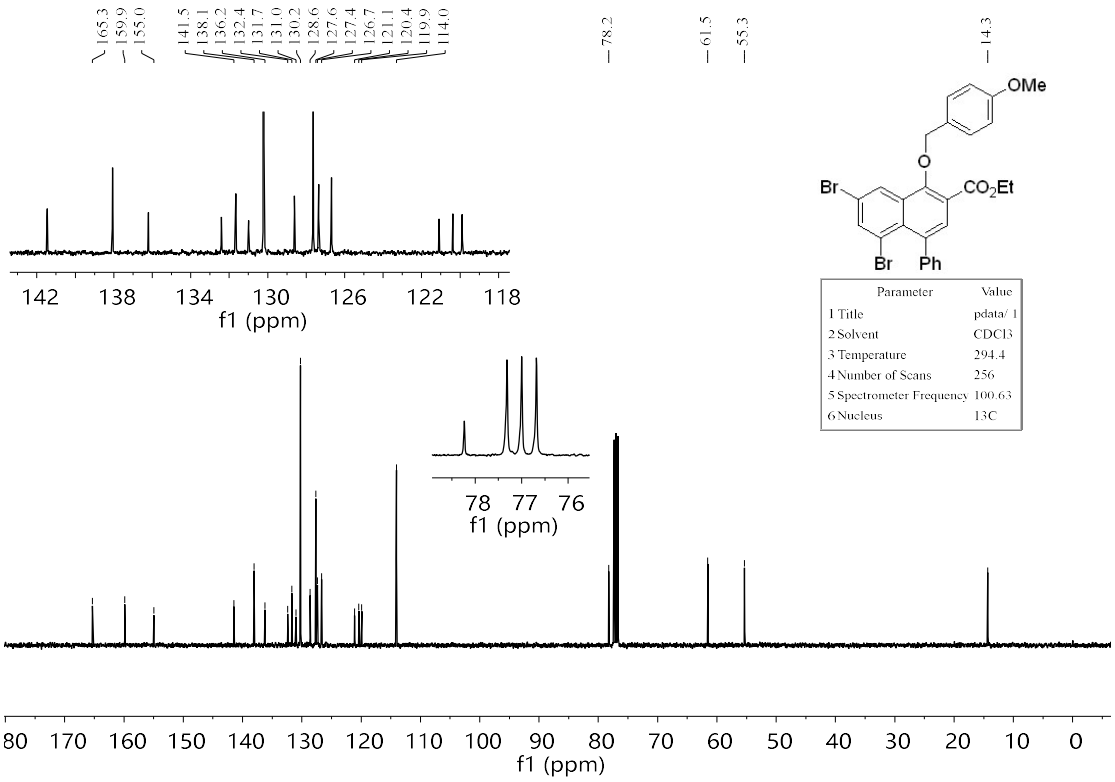


Ethyl 1-((4-methoxybenzyl)oxy)-5,7-dimethyl-4-phenyl-2-naphthoate (A27)

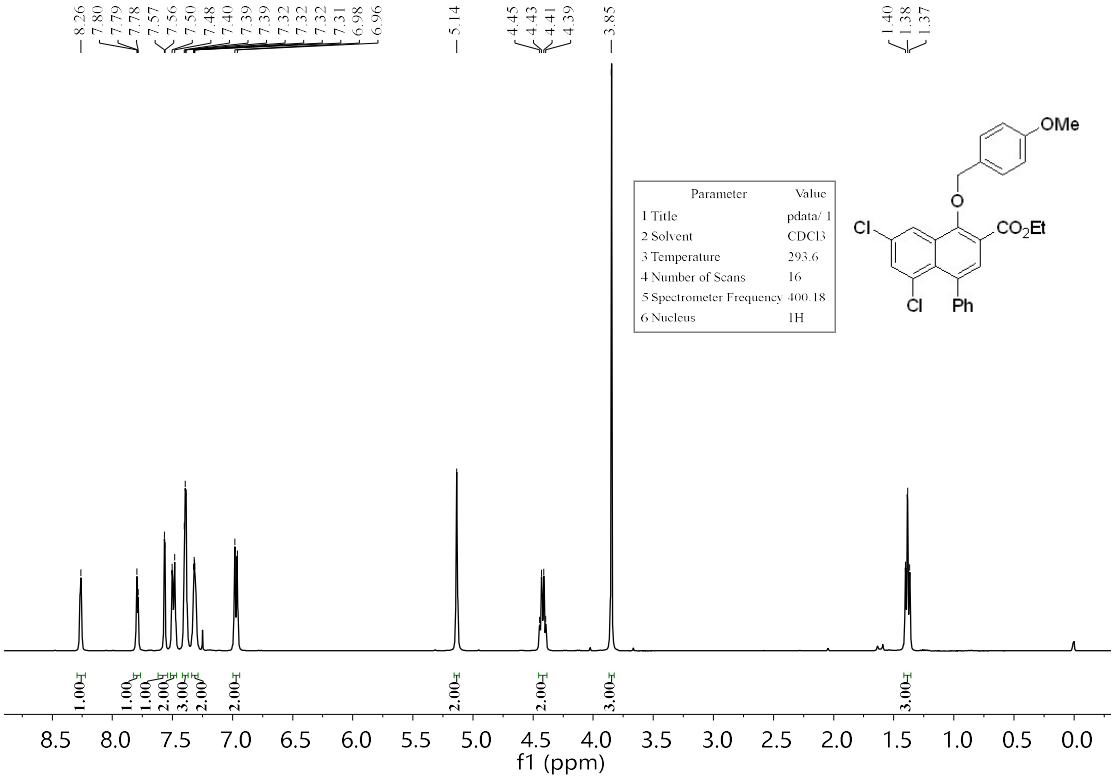


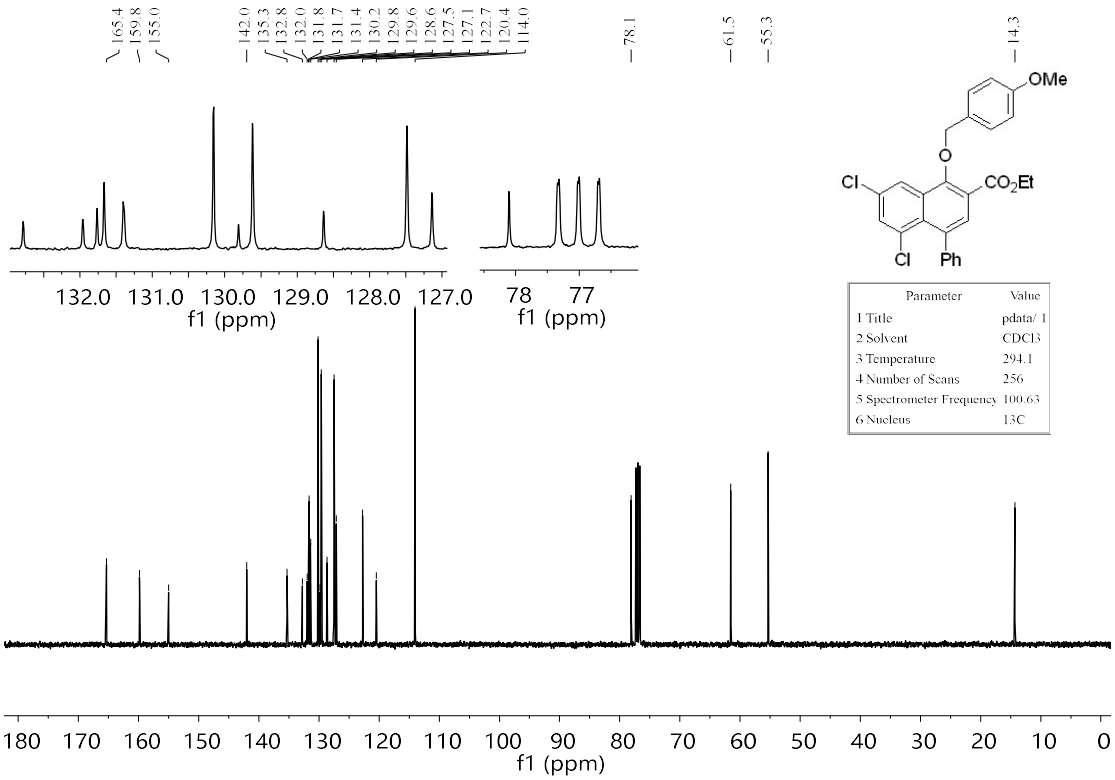
Ethyl 5,7-dibromo-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A28)



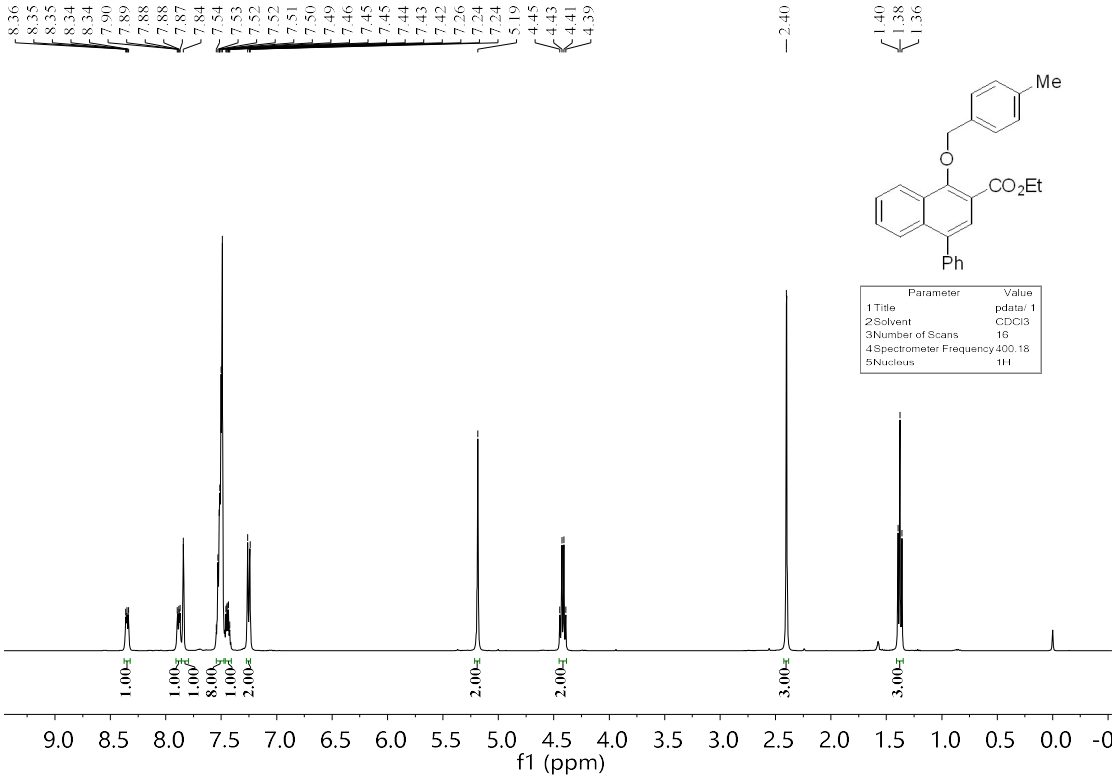


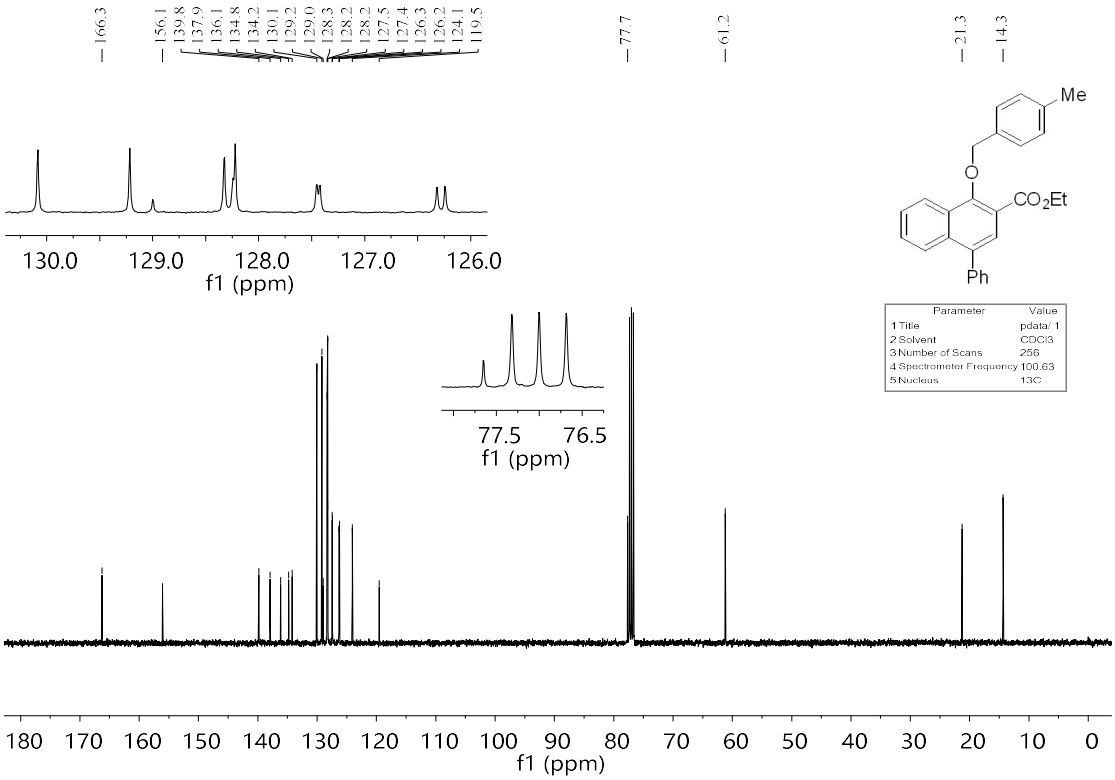
Ethyl 5,7-dichloro-1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A29)



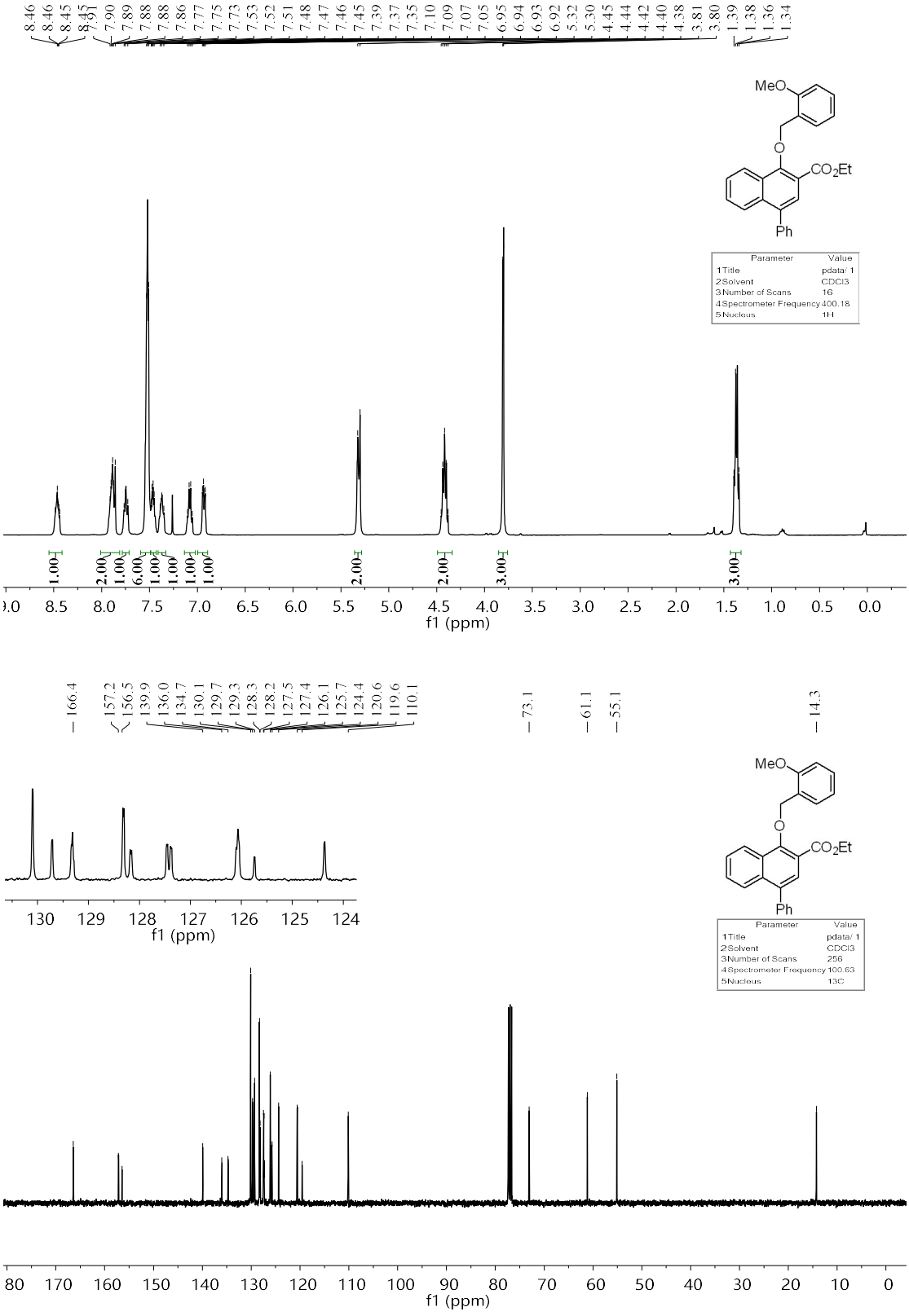


Ethyl 1-((4-methylbenzyl)oxy)-4-phenyl-2-naphthoate (A30)

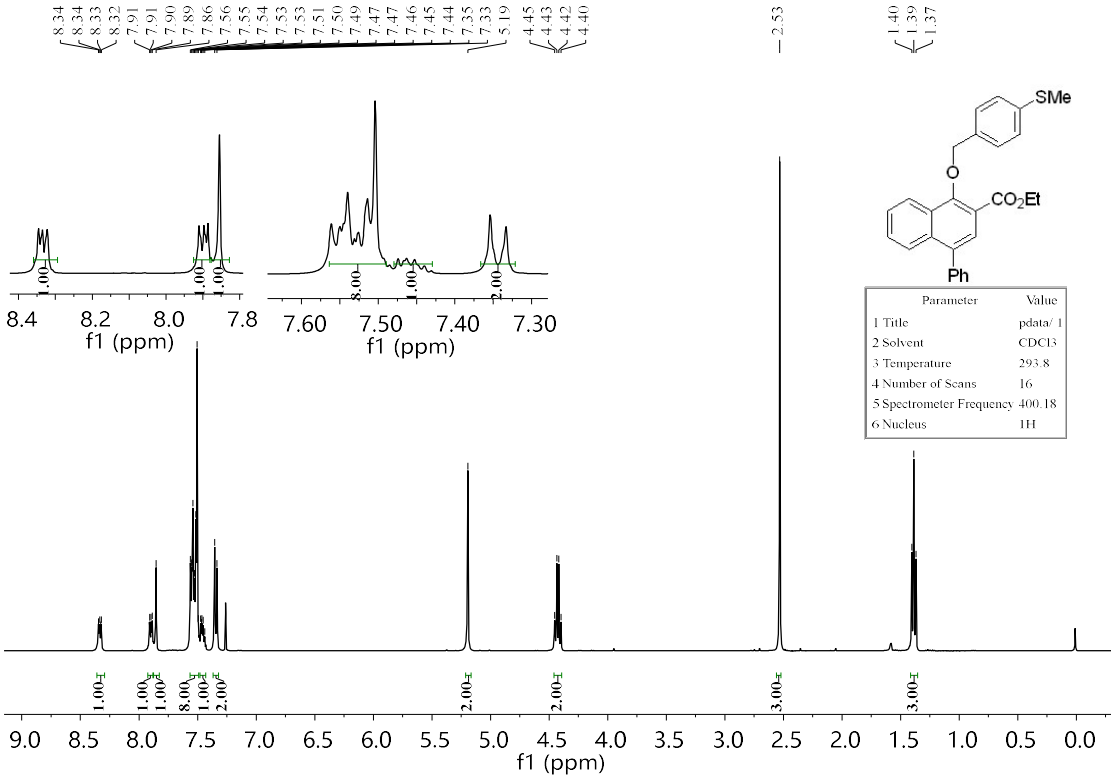


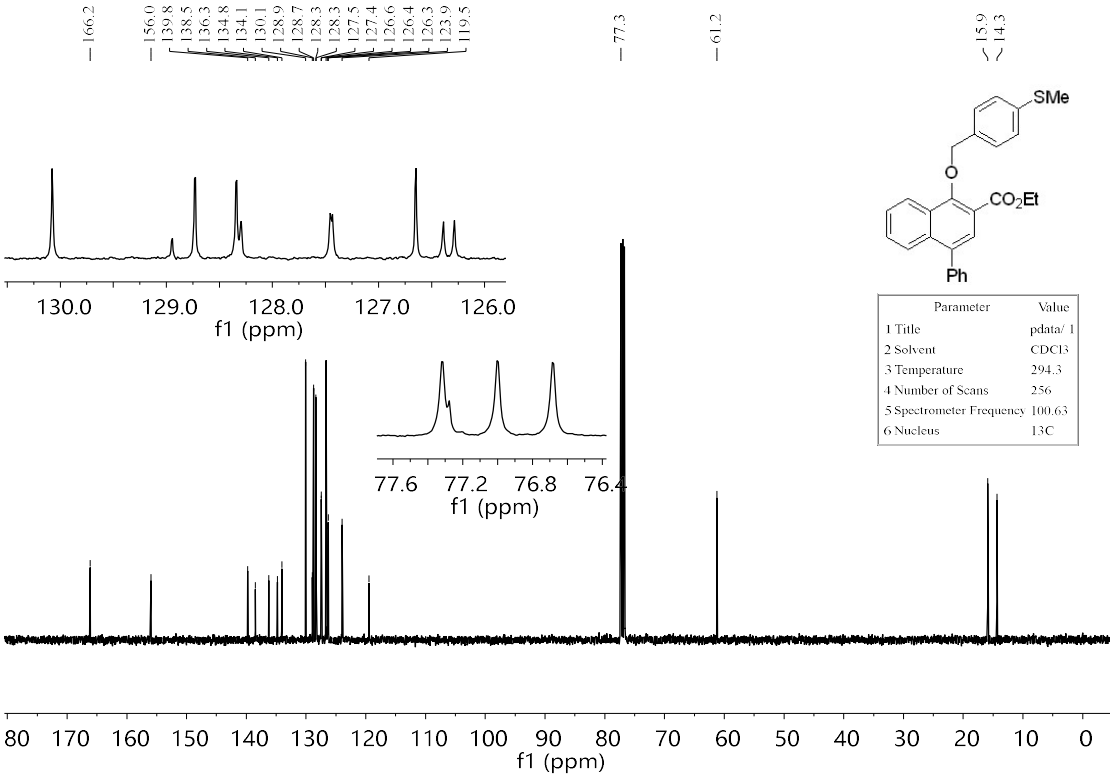


Ethyl 1-((2-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A31)

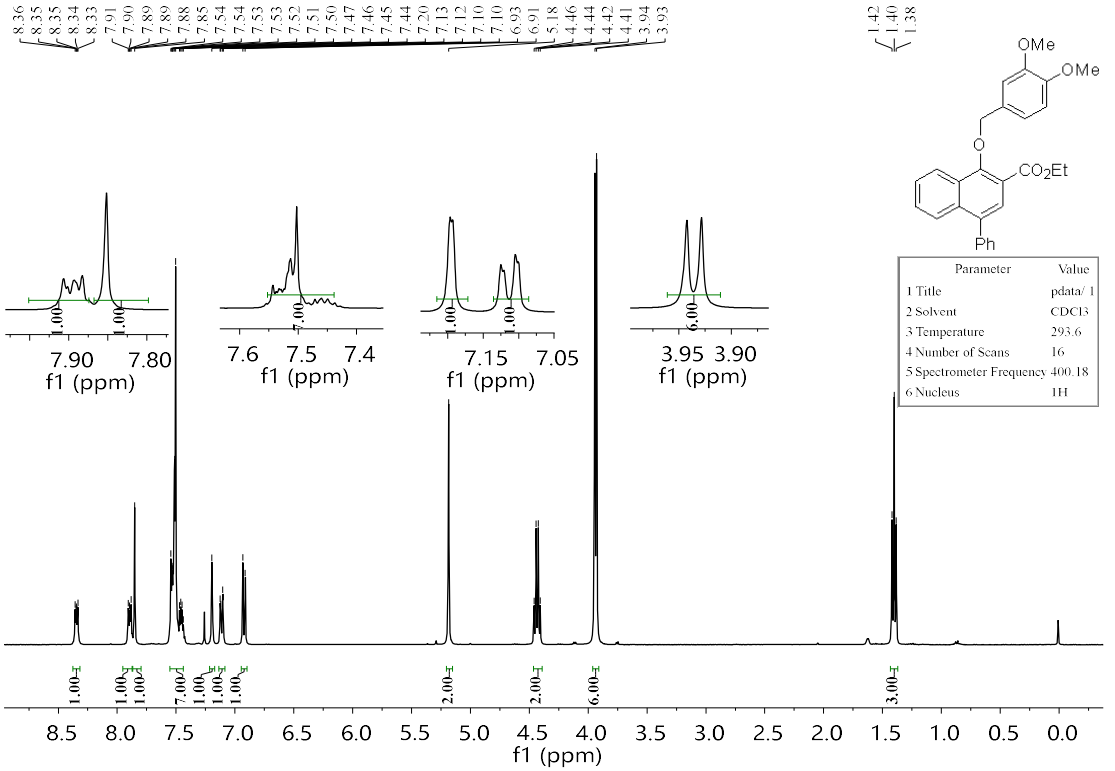


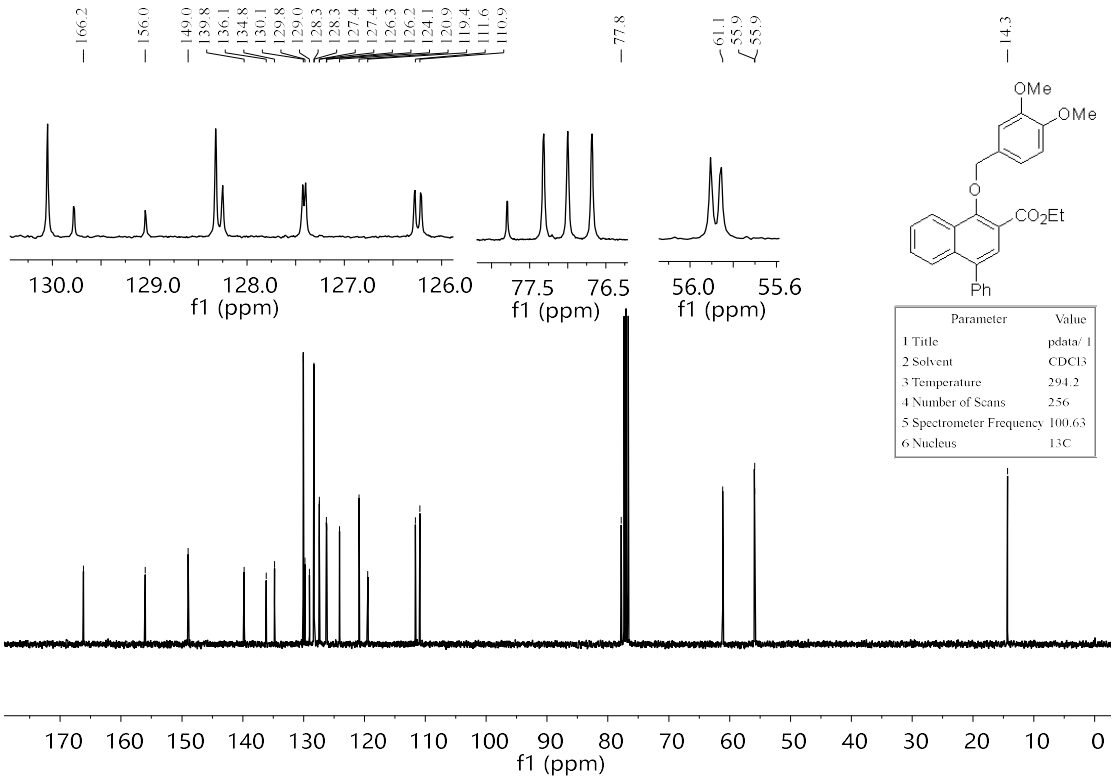
Ethyl 1-((4-(methylthio)benzyl)oxy)-4-phenyl-2-naphthoate (A32)



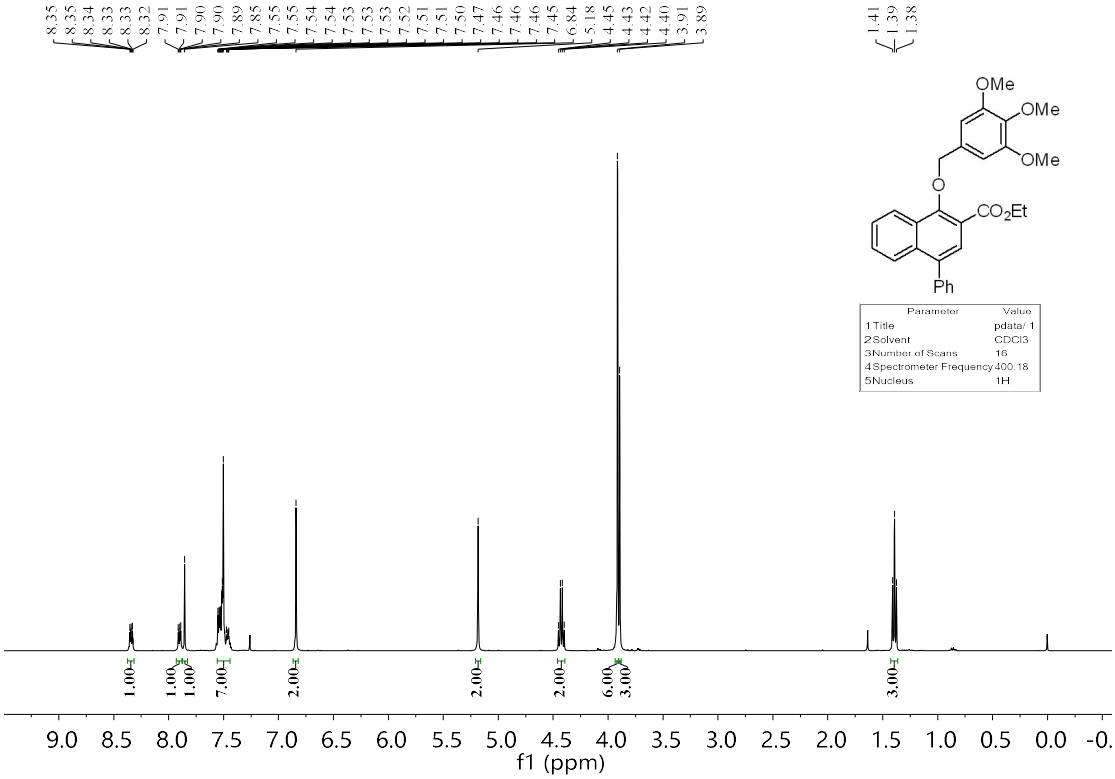


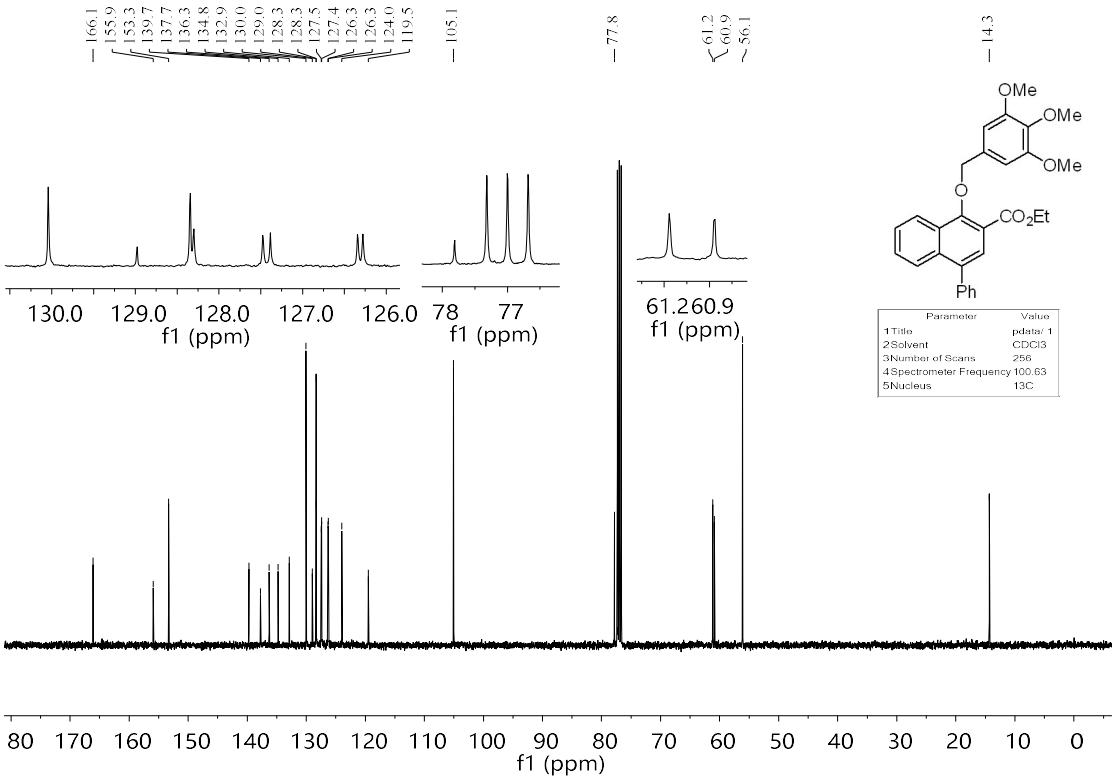
Ethyl 1-((3,4-dimethoxybenzyl)oxy)-4-phenyl-2-naphthoate (A33)



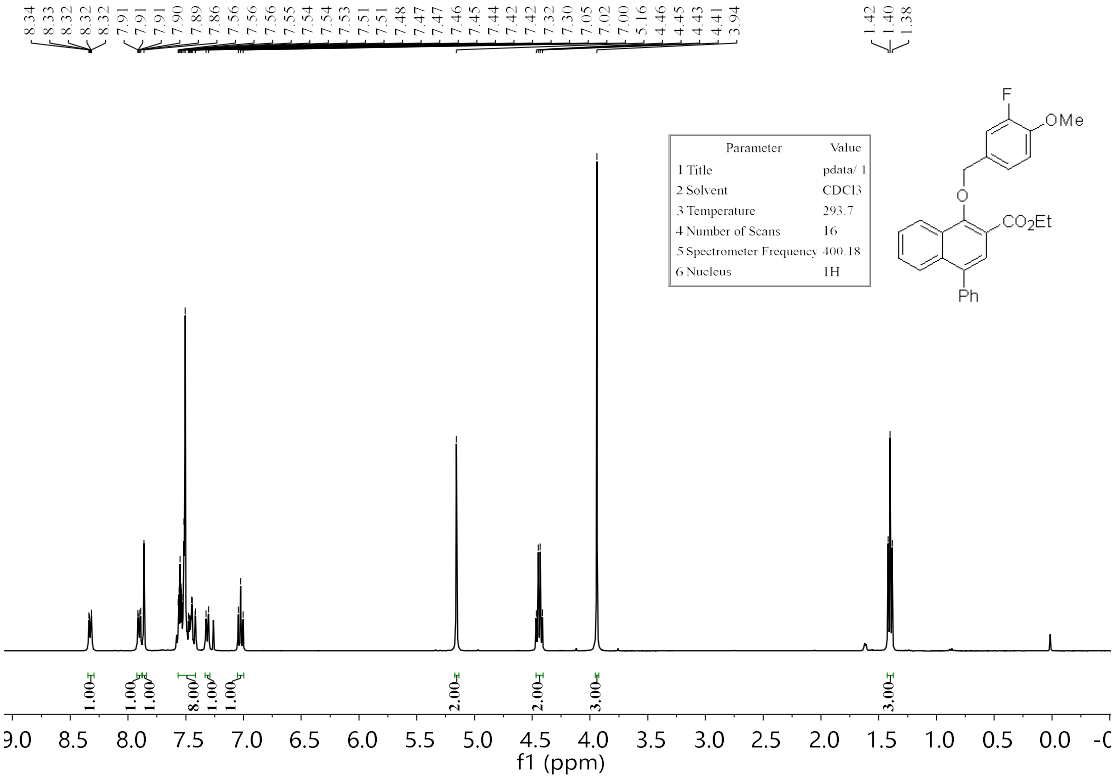


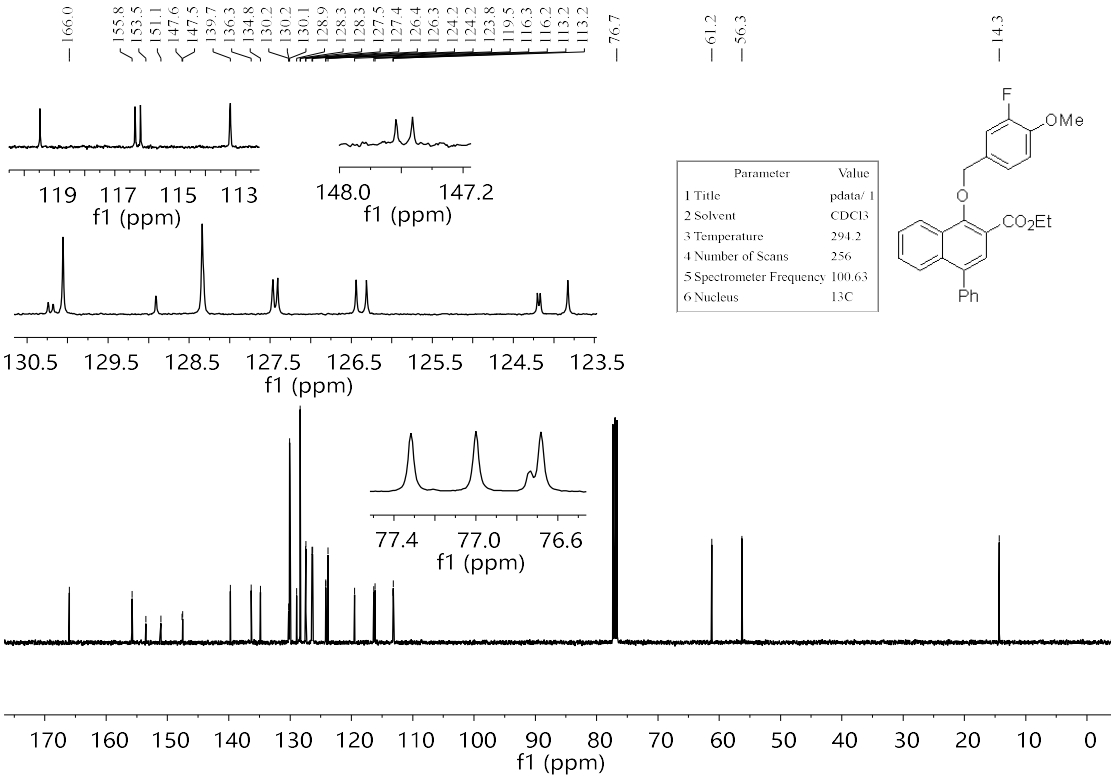
Ethyl 4-phenyl-1-((3,4,5-trimethoxybenzyl)oxy)-2-naphthoate (A34)

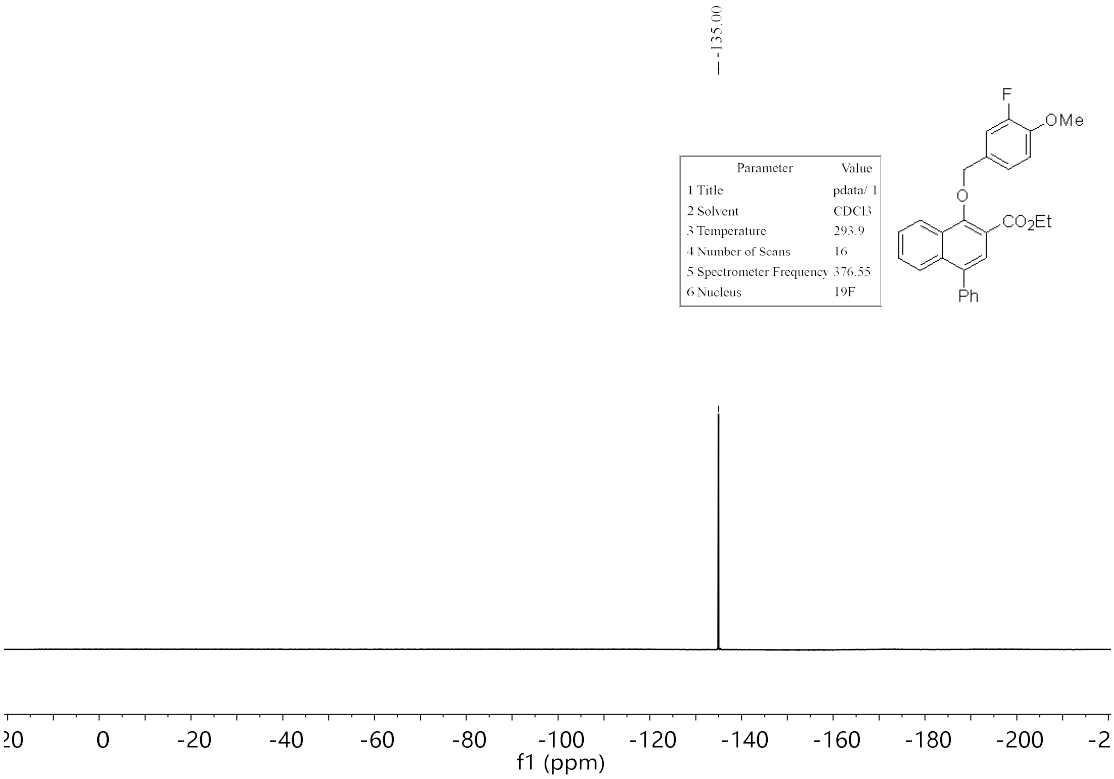




Ethyl 1-((3-fluoro-4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A35)



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F
OMe
O
CO2Et
Ph
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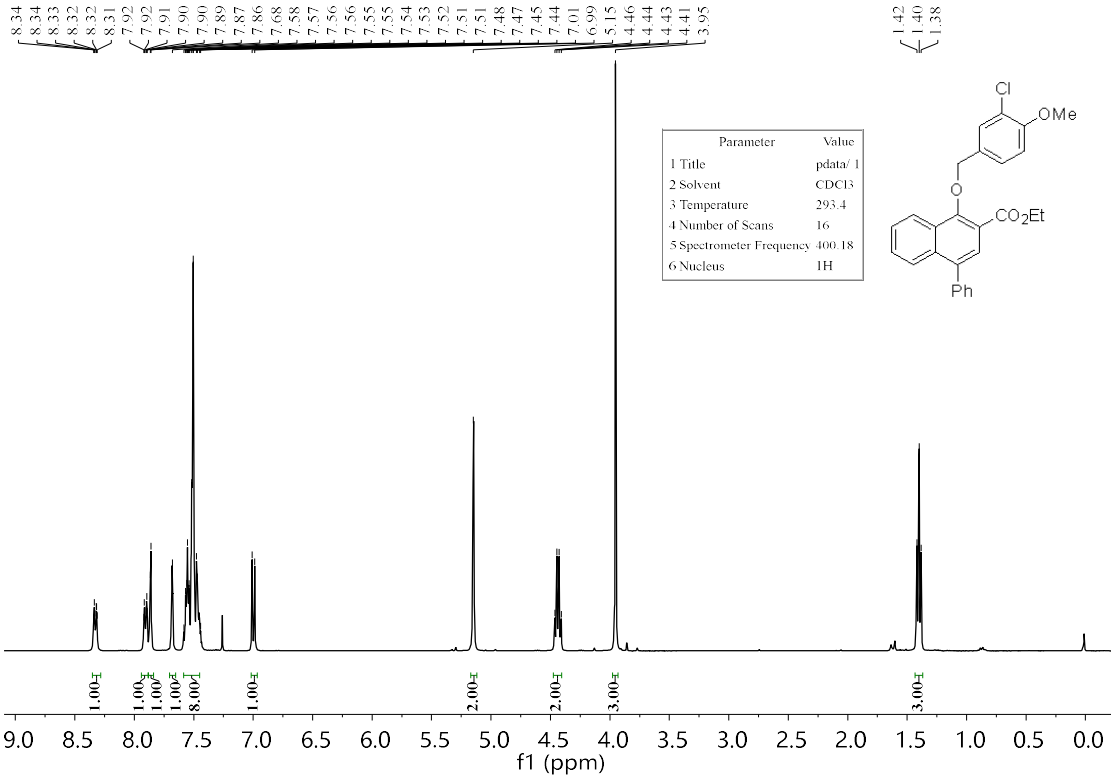
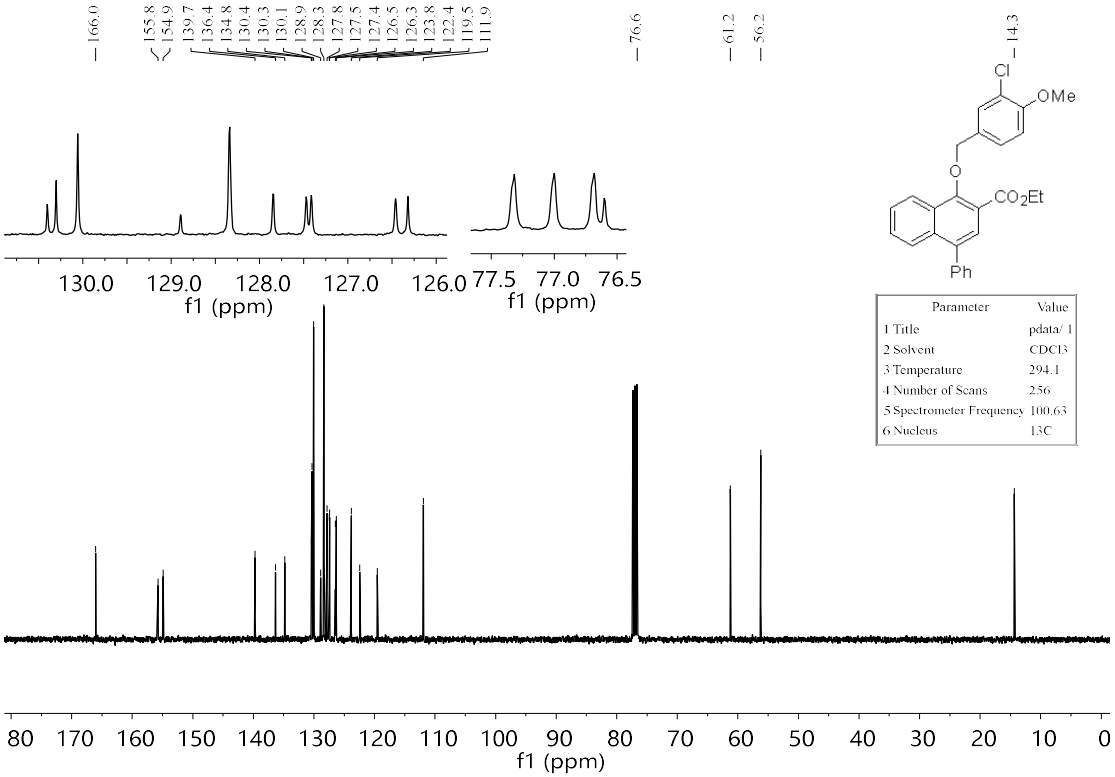
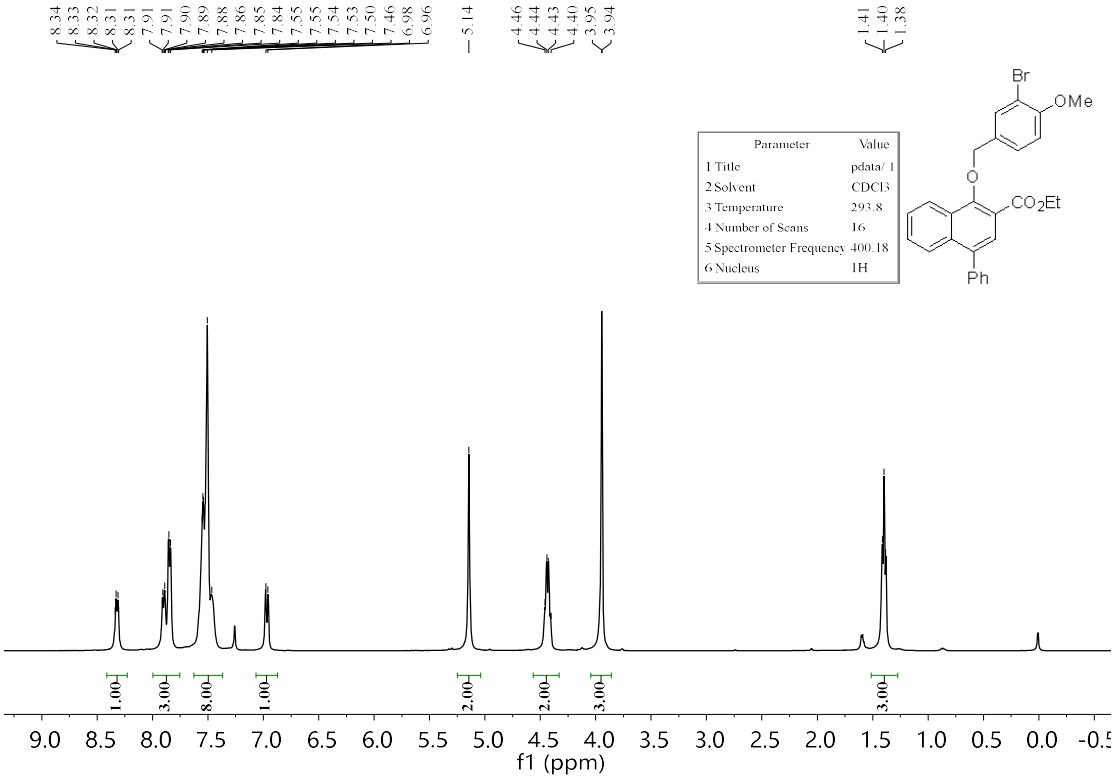
f1 (ppm)

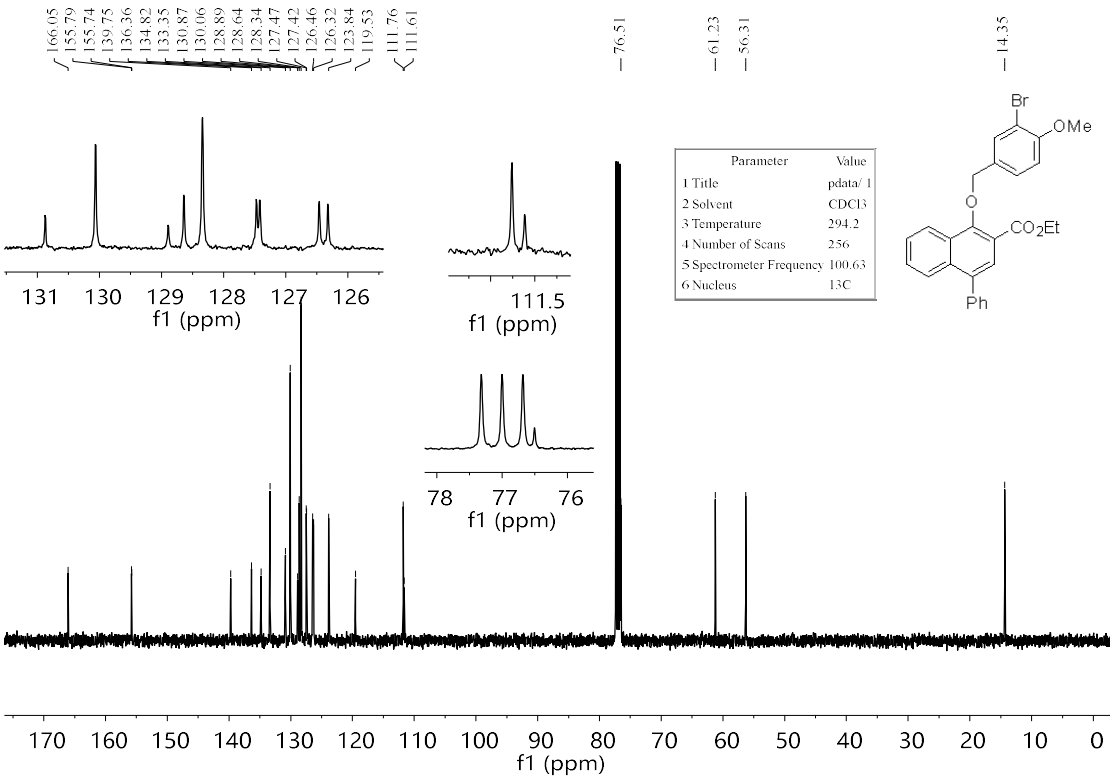
Ethyl 1-((3-chloro-4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A36)



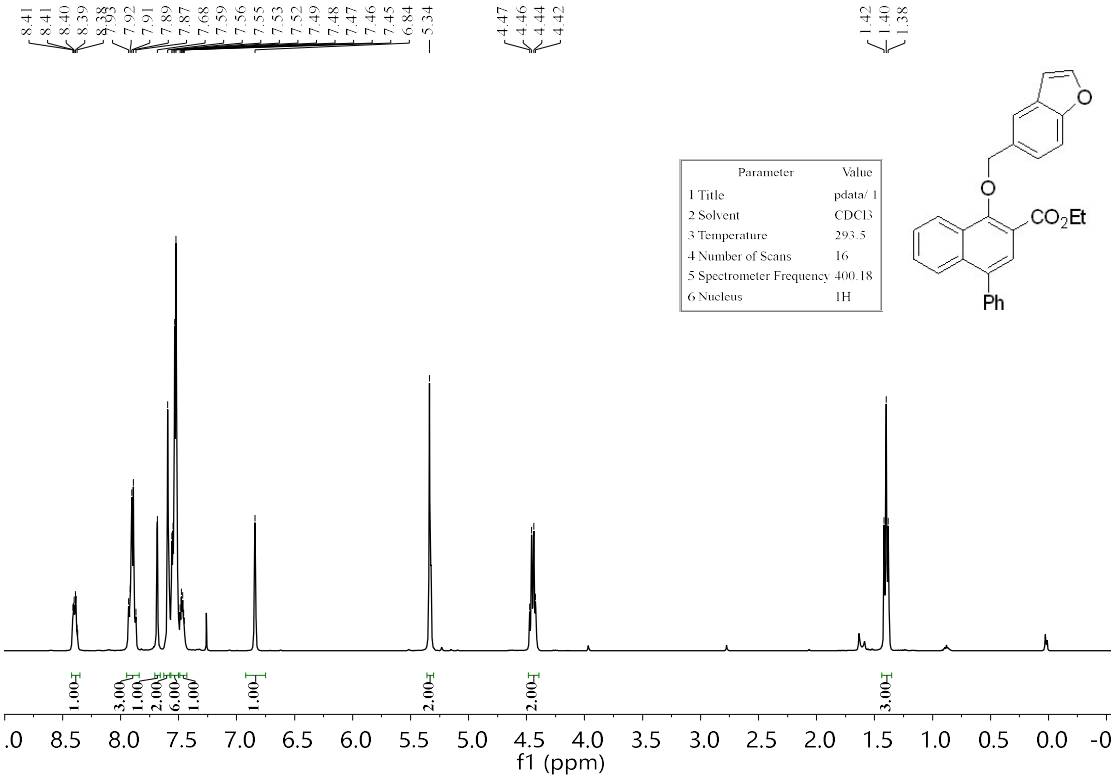


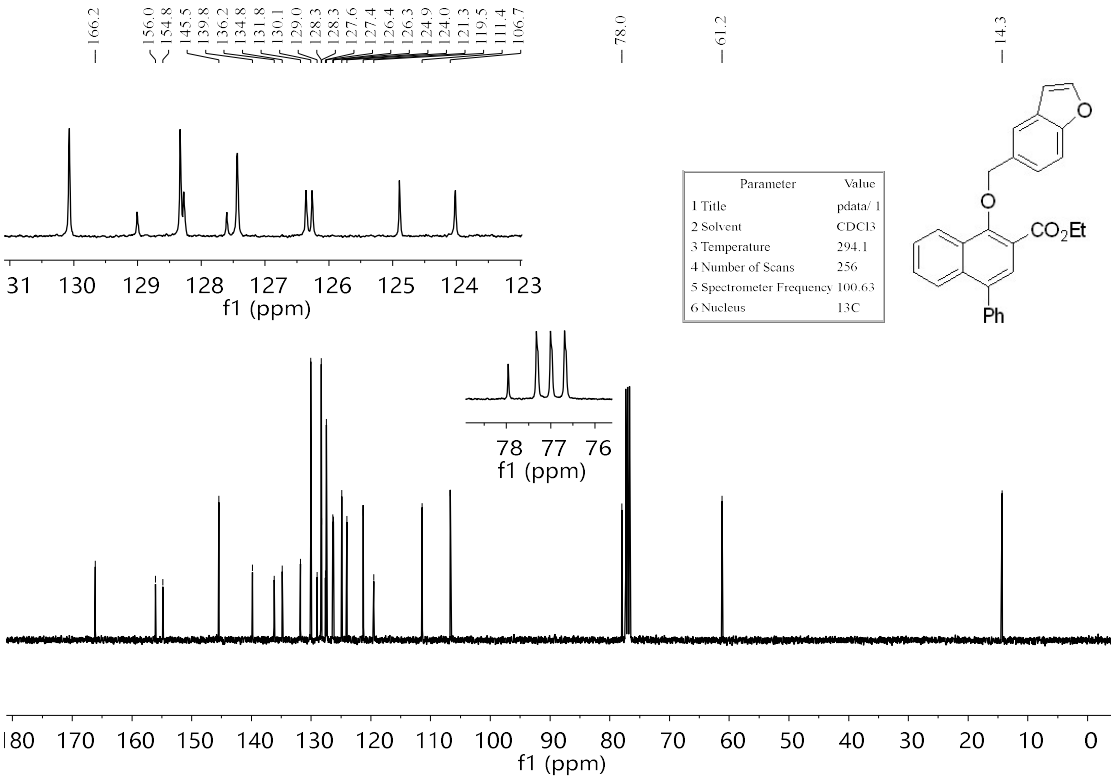
Ethyl 1-((3-bromo-4-methoxybenzyl)oxy)-4-phenyl-2-naphthoate (A37)



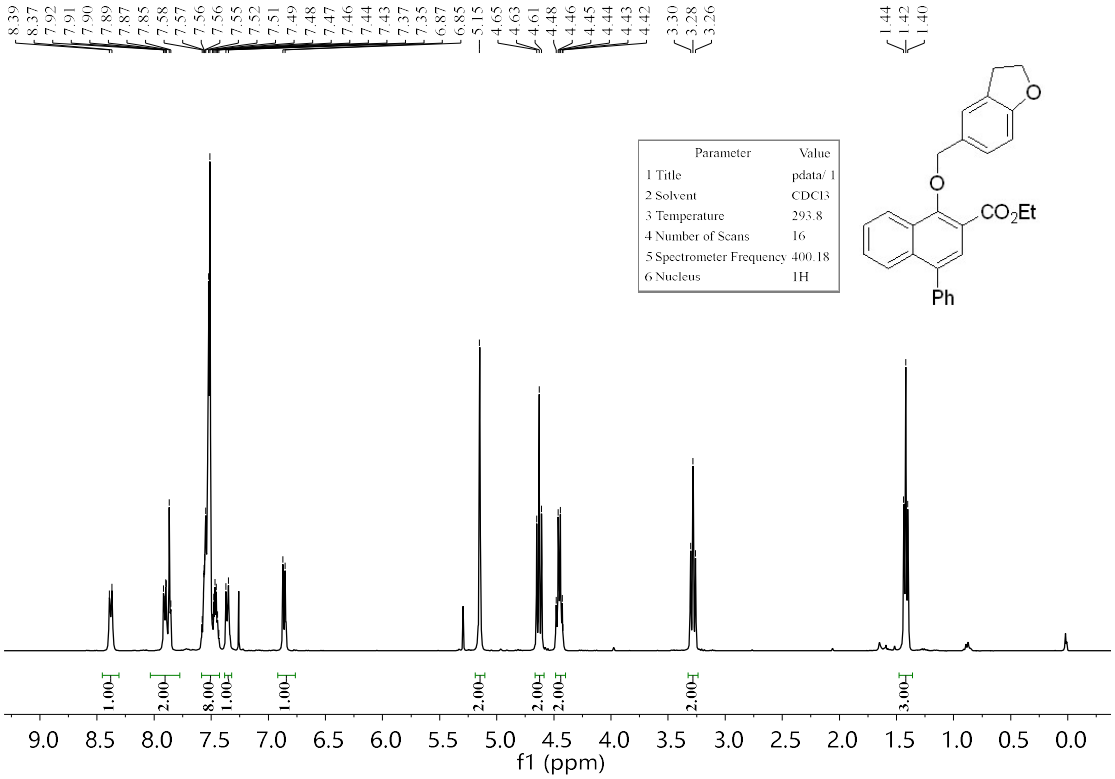


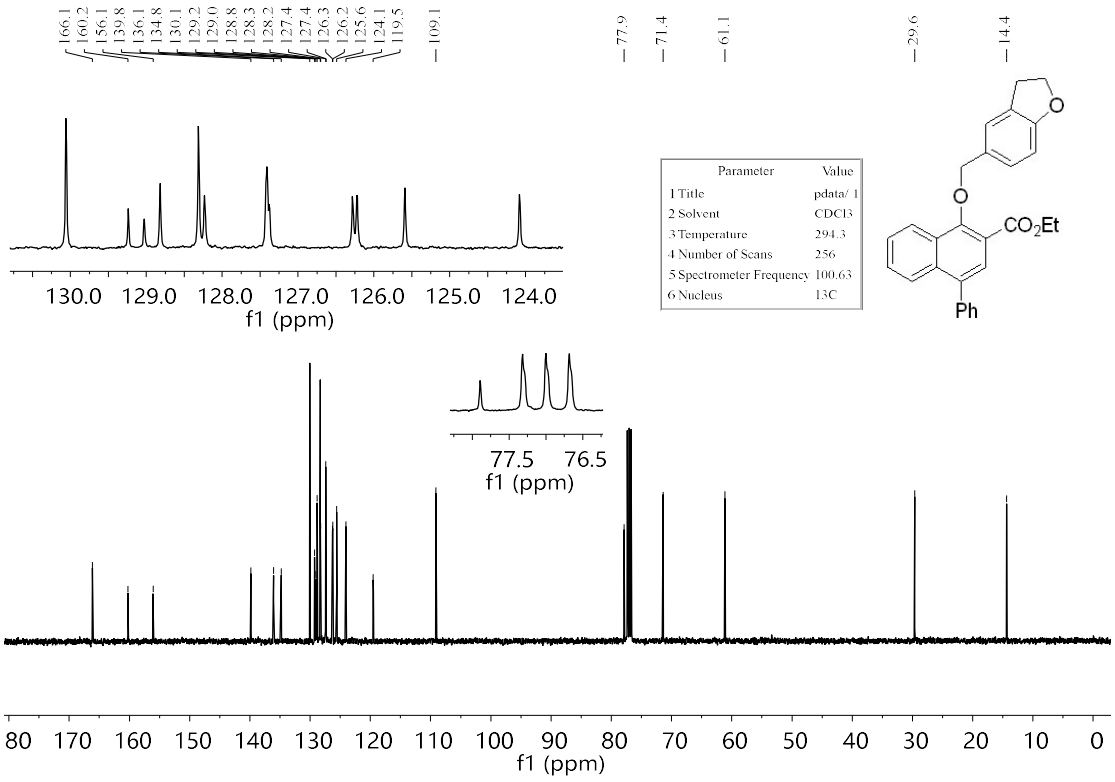
Ethyl 1-(benzofuran-5-ylmethoxy)-4-phenyl-2-naphthoate (A38)



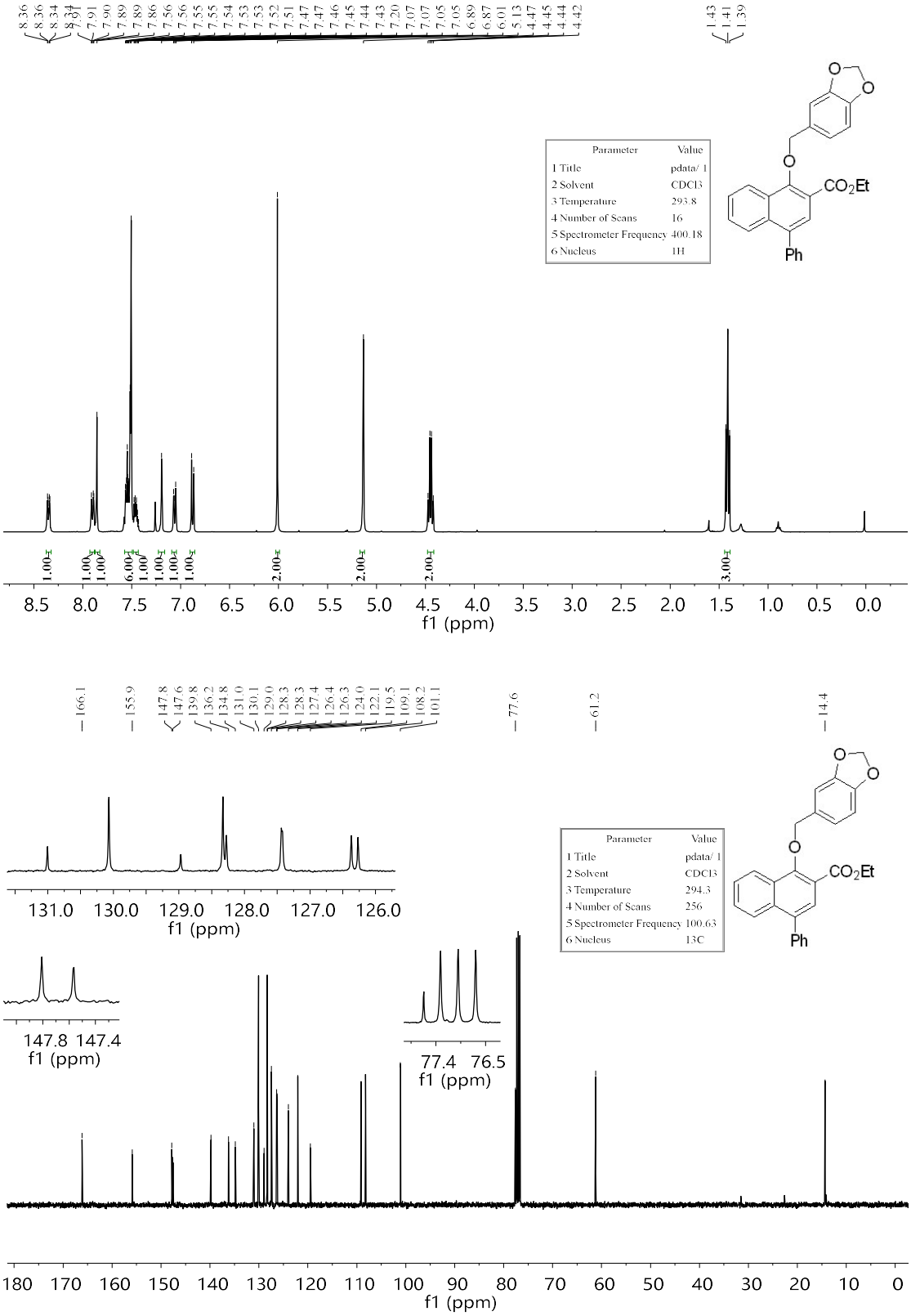


Ethyl 1-((2,3-dihydrobenzofuran-5-yl)methoxy)-4-phenyl-2-naphthoate (A39)

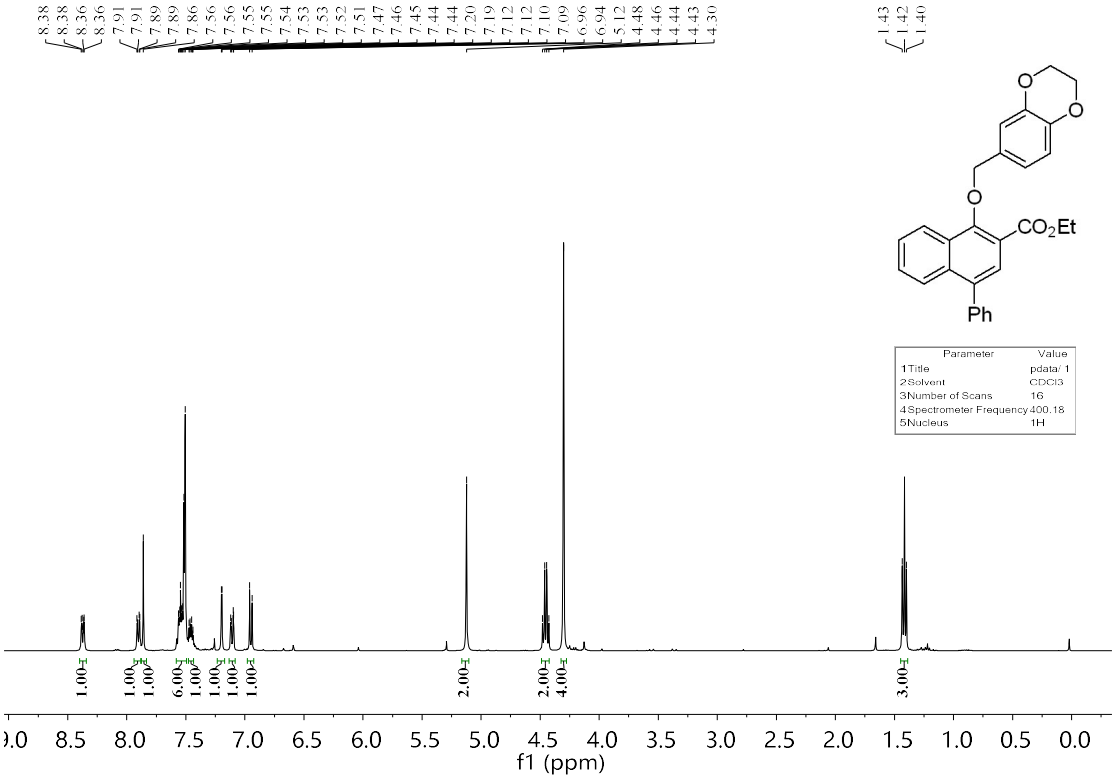


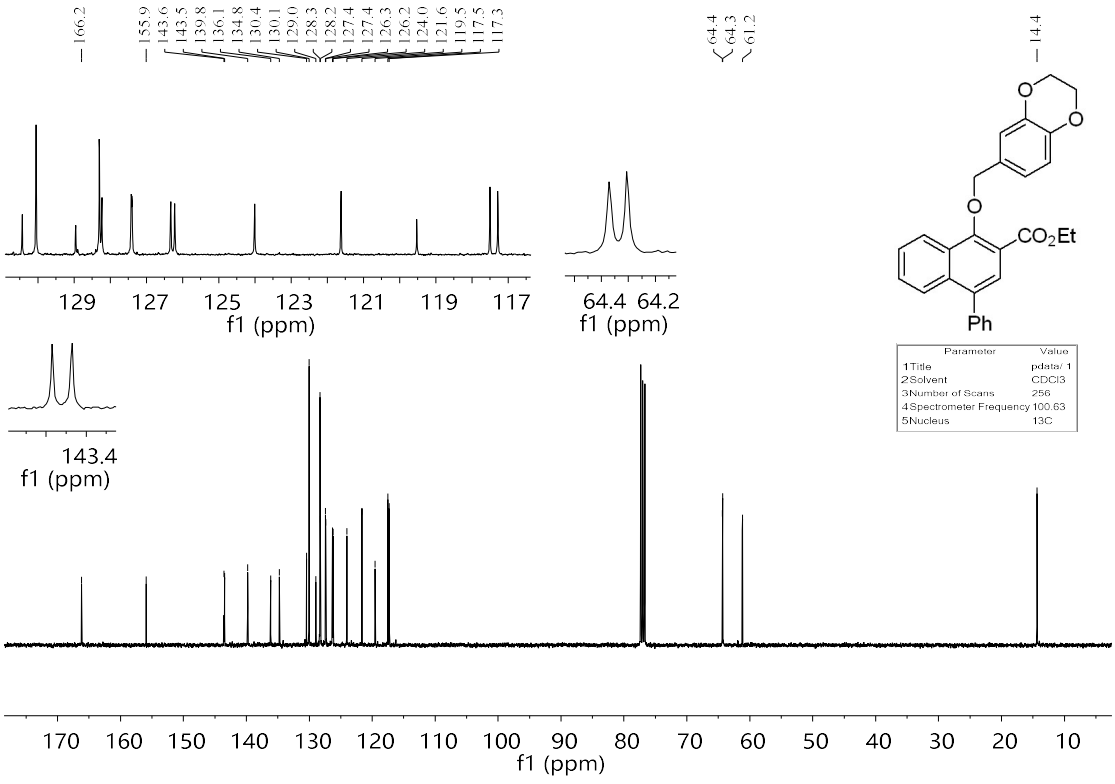


Ethyl 1-(benzo[d][1,3]dioxol-5-ylmethoxy)-4-phenyl-2-naphthoate (A40)

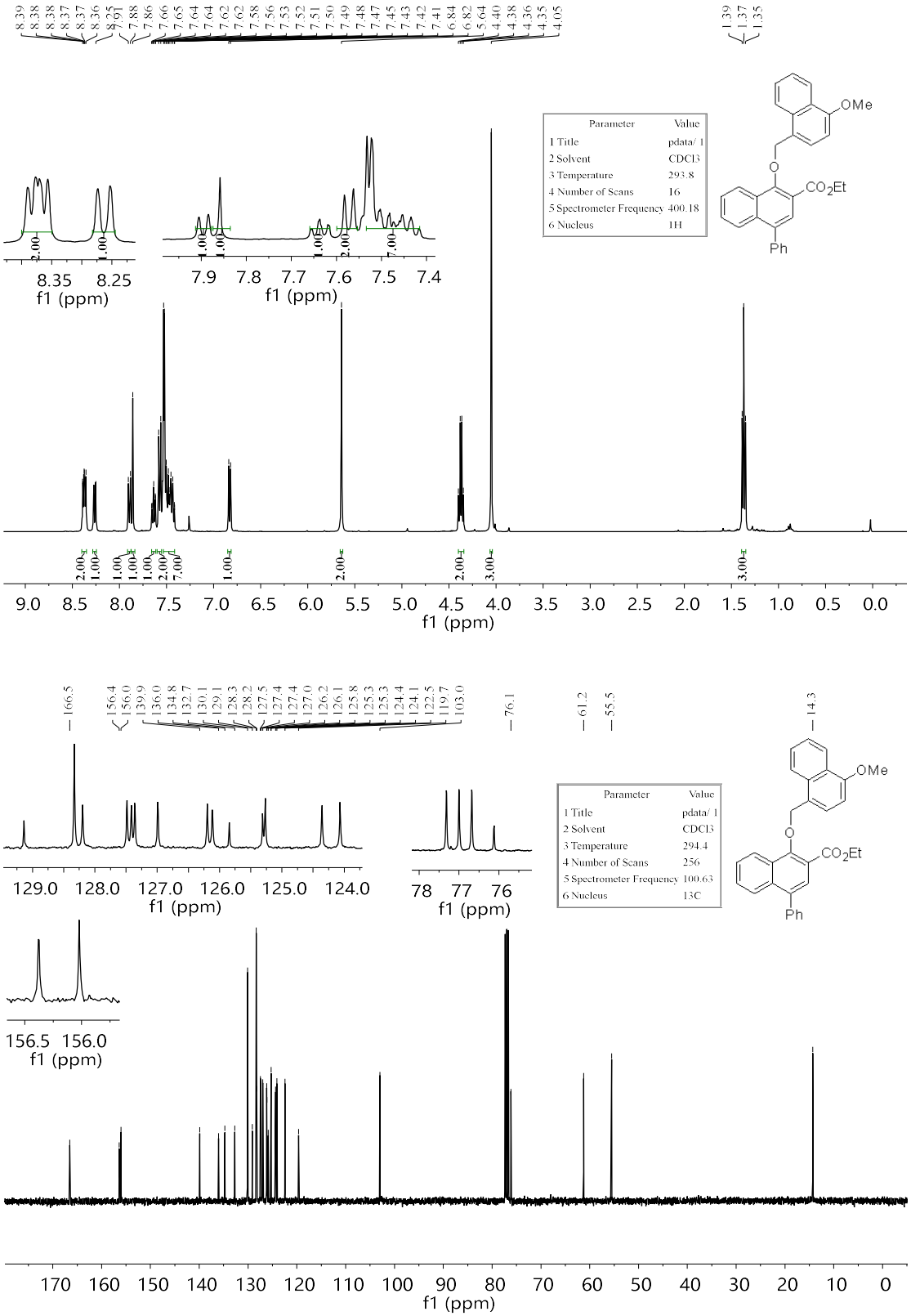


Ethyl 1-((2,3-dihydrobenzo[b][1,4]dioxin-6-yl)methoxy)-4-phenyl-2-naphthoate (A41)

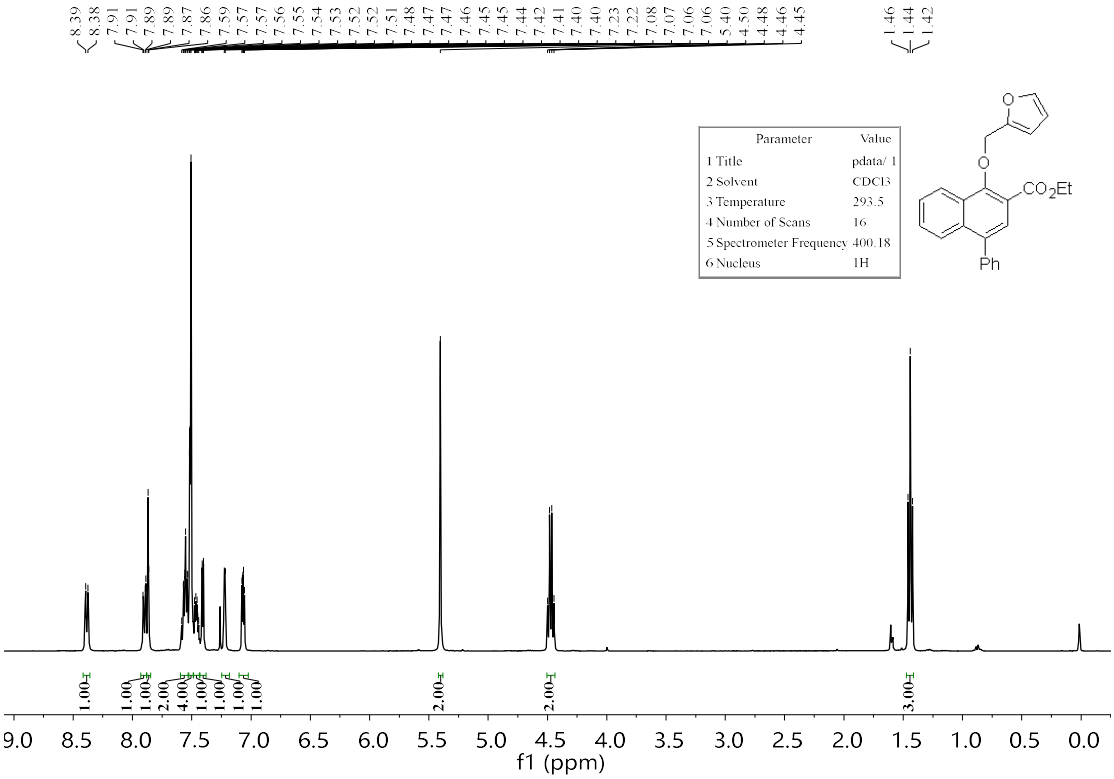


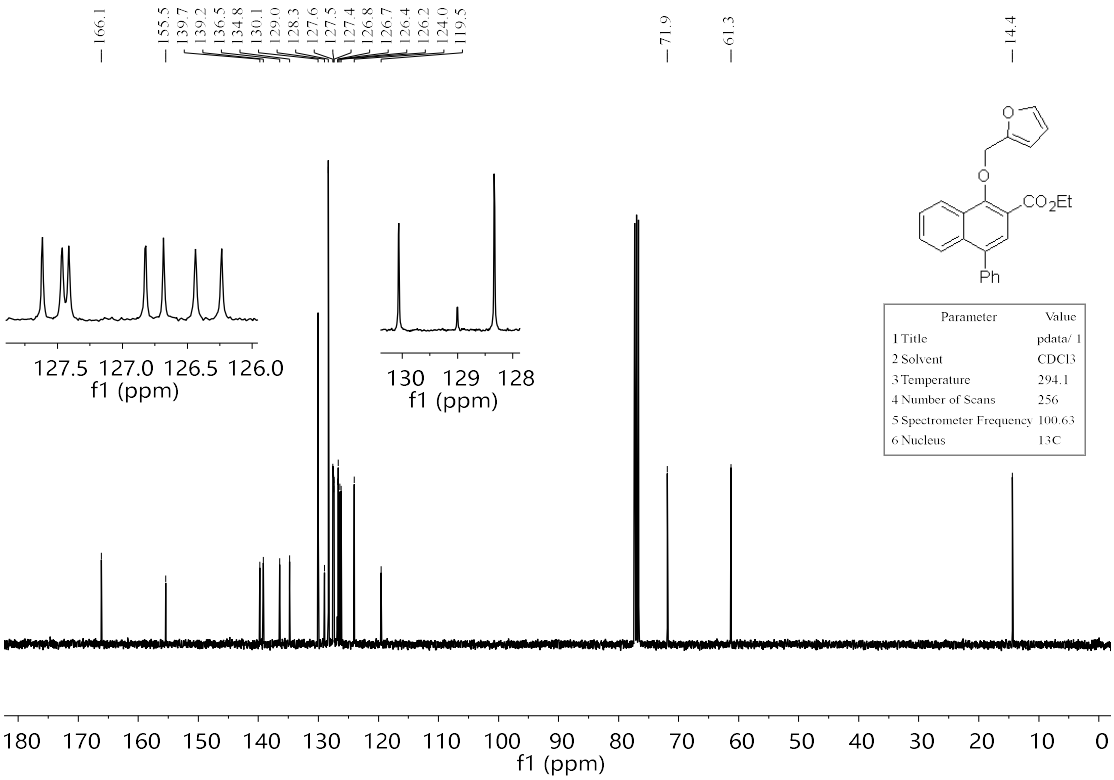


Ethyl 1-((4-methoxynaphthalen-1-yl)methoxy)-4-phenyl-2-naphthoate (A42)

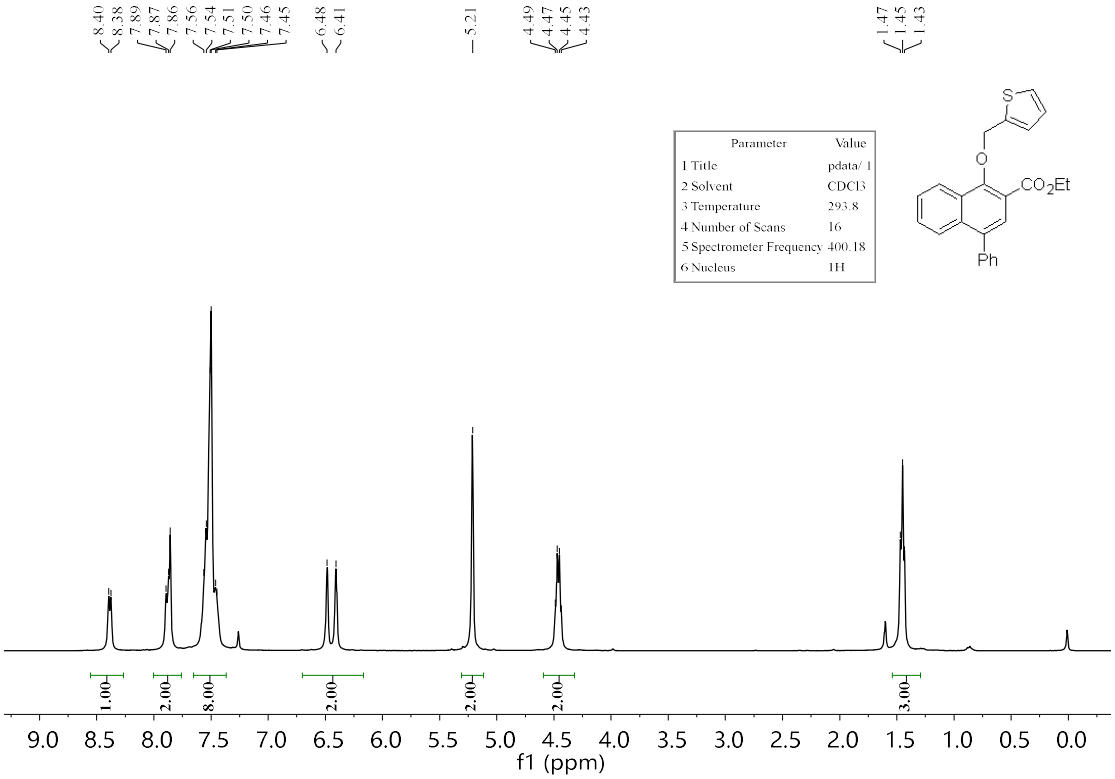


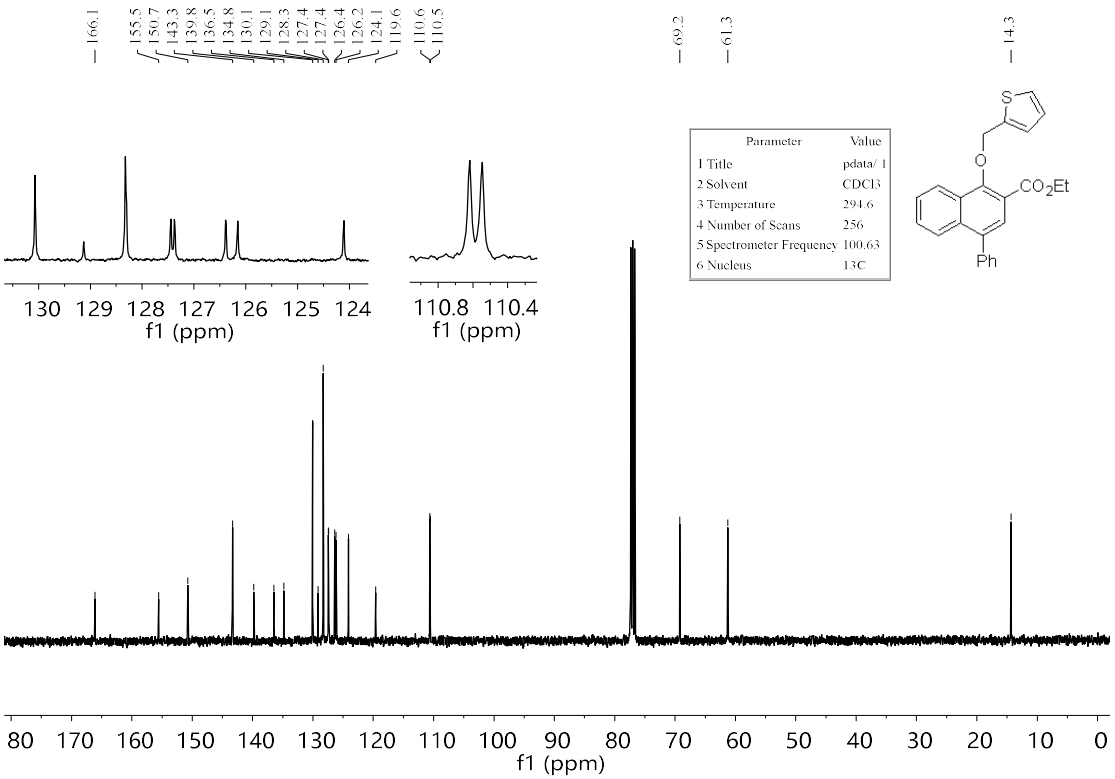
Ethyl 1-(furan-2-ylmethoxy)-4-phenyl-2-naphthoate (A43)



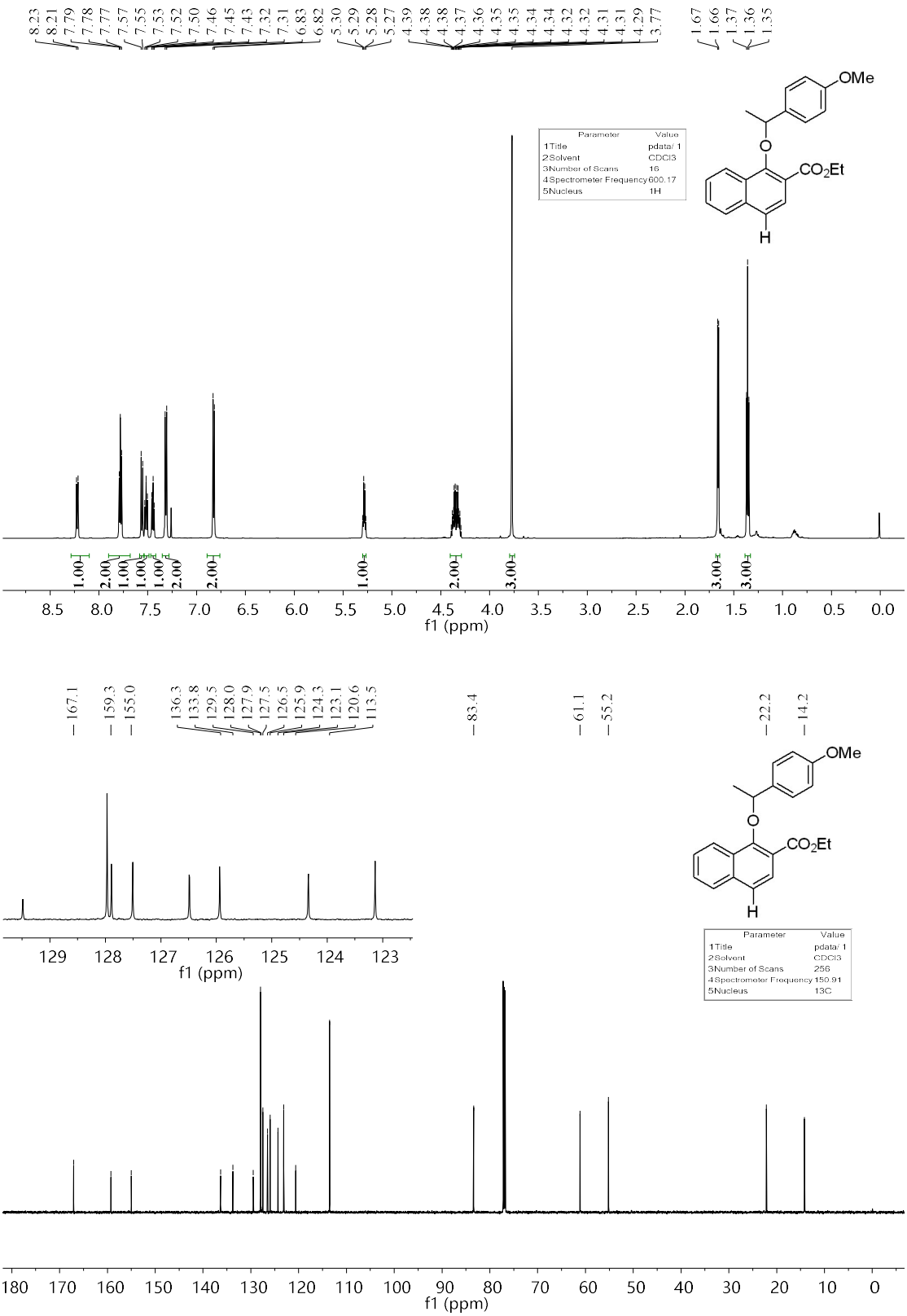


Ethyl 4-phenyl-1-(thiophen-2-ylmethoxy)-2-naphthoate (A44)

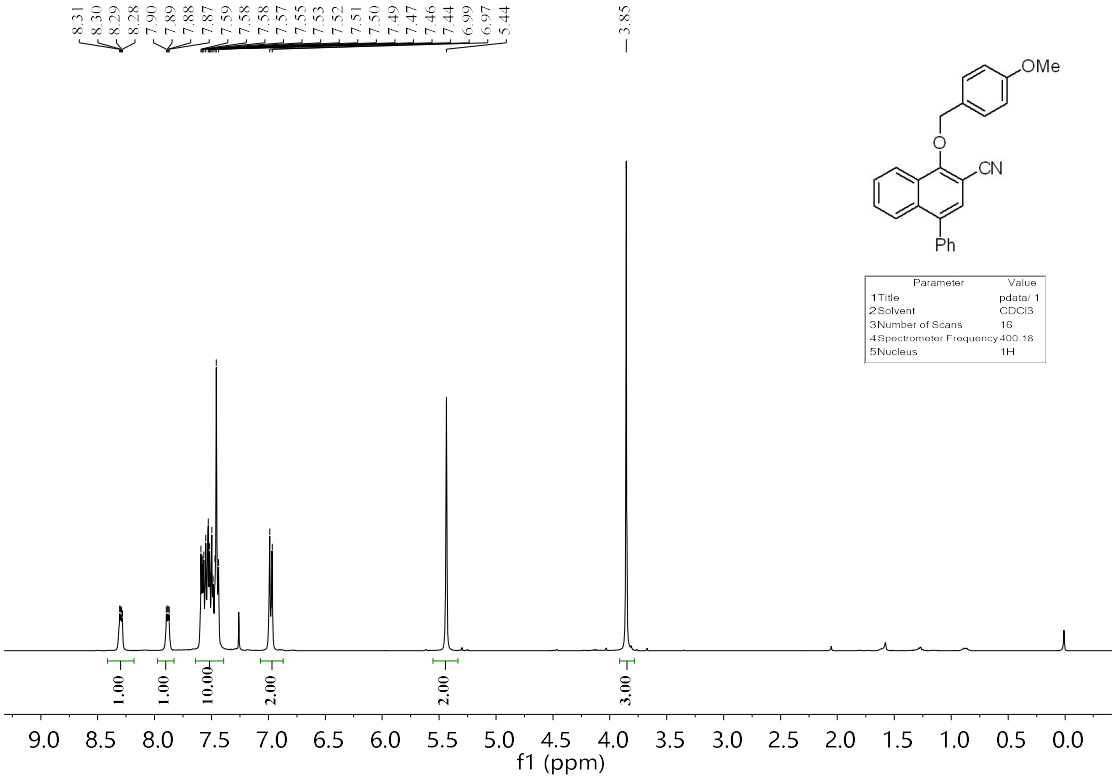


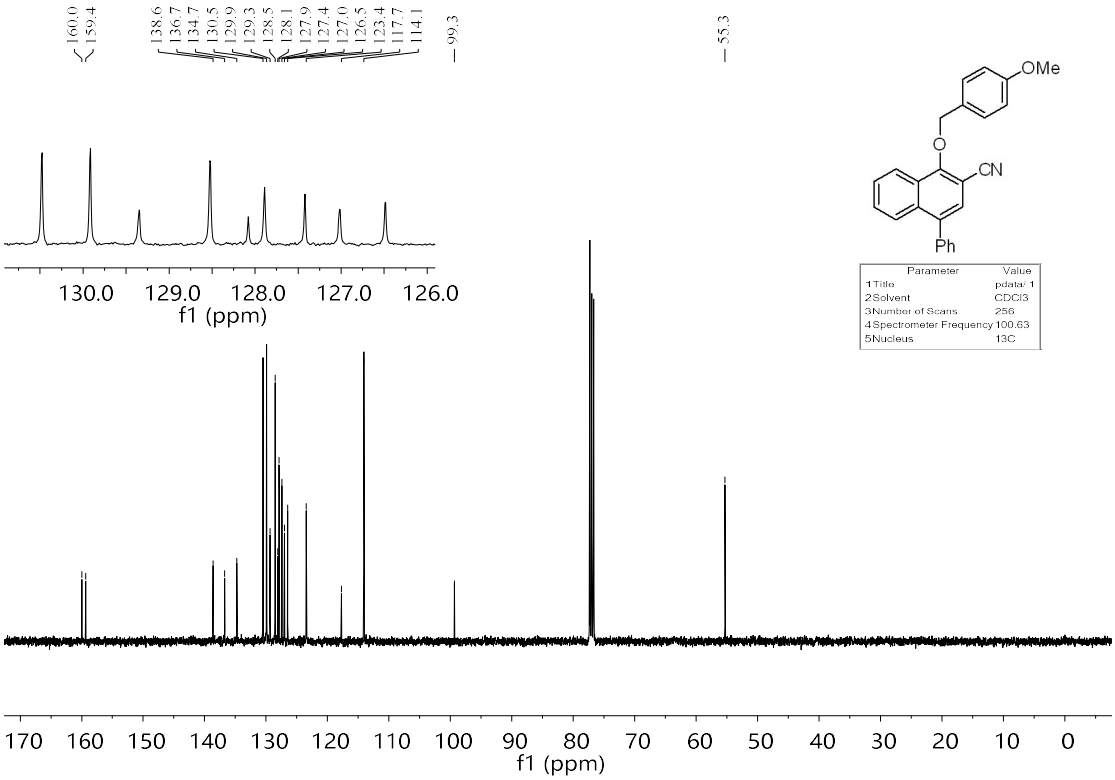


Ethyl 1-(1-(4-methoxyphenyl)ethoxy)-4-phenyl-2-naphthoate (A45)

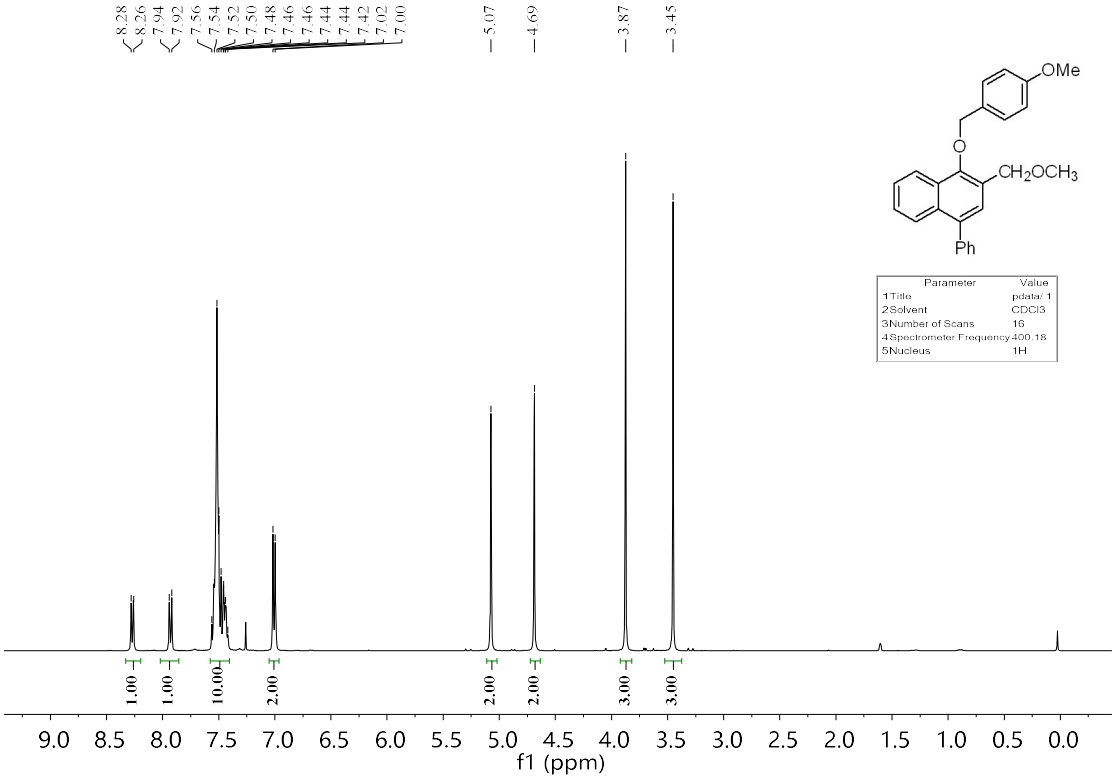


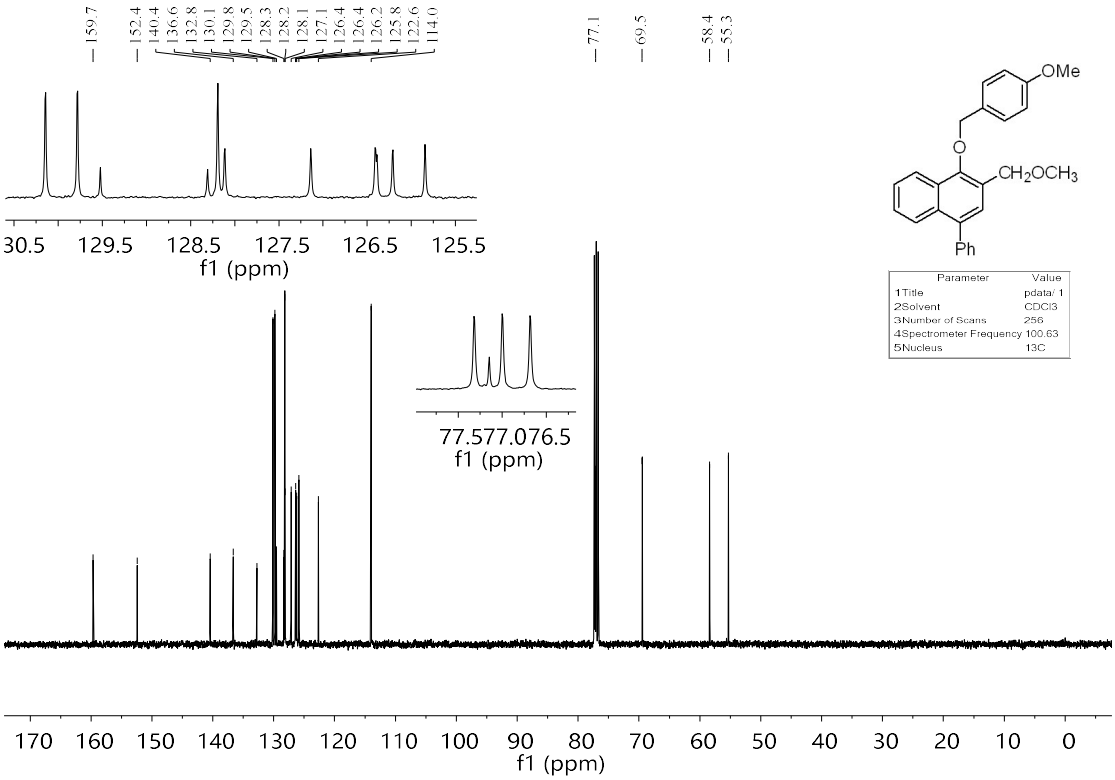
1-((4-methoxybenzyl)oxy)-4-phenyl-2-naphthonitrile (A46)



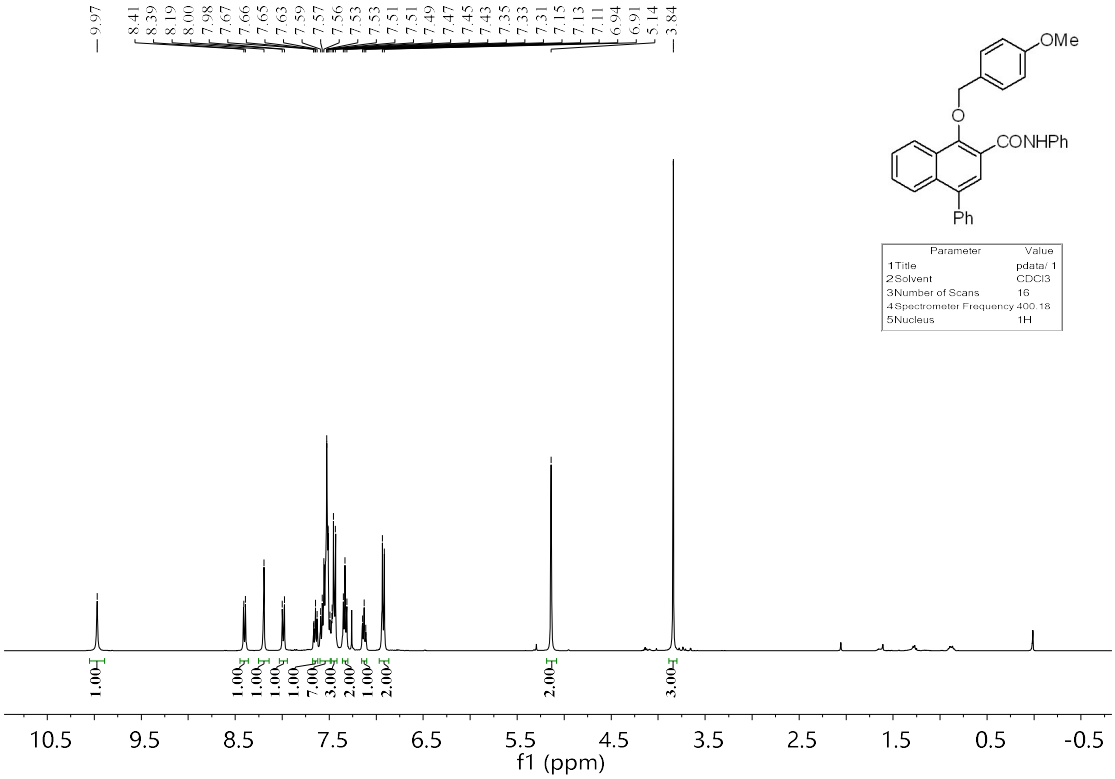


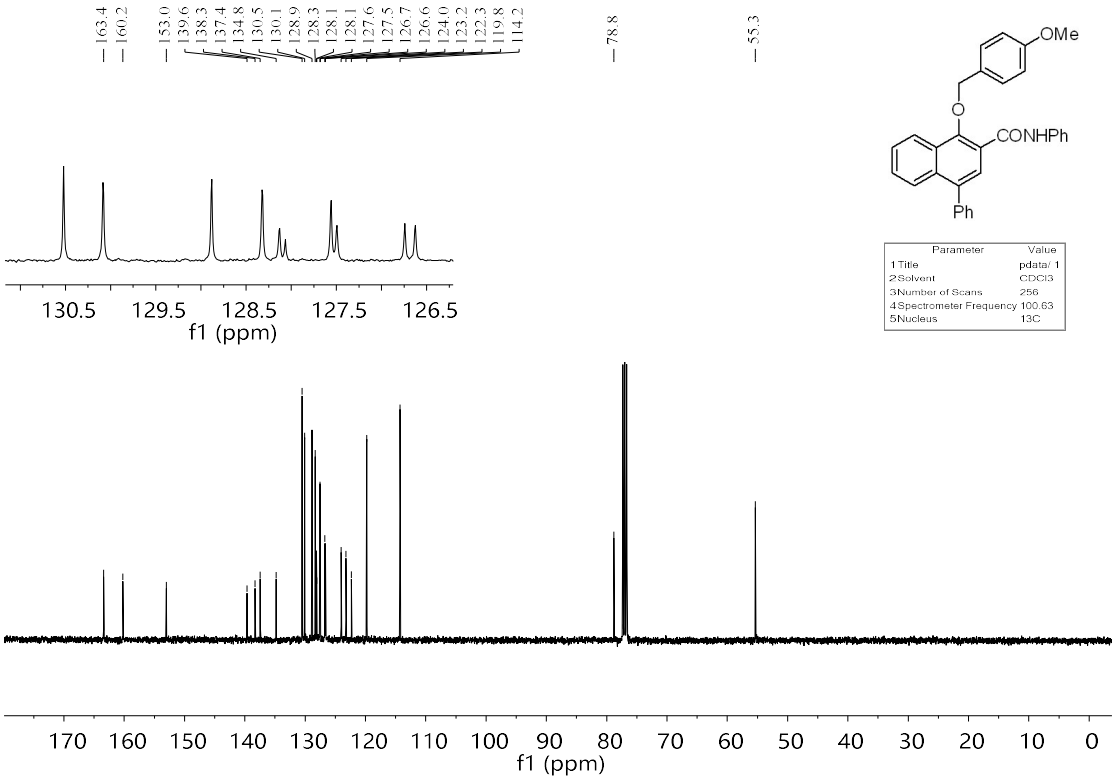
1-((4-methoxybenzyl)oxy)-2-(methoxymethyl)-4-phenylnaphthalene (A47)



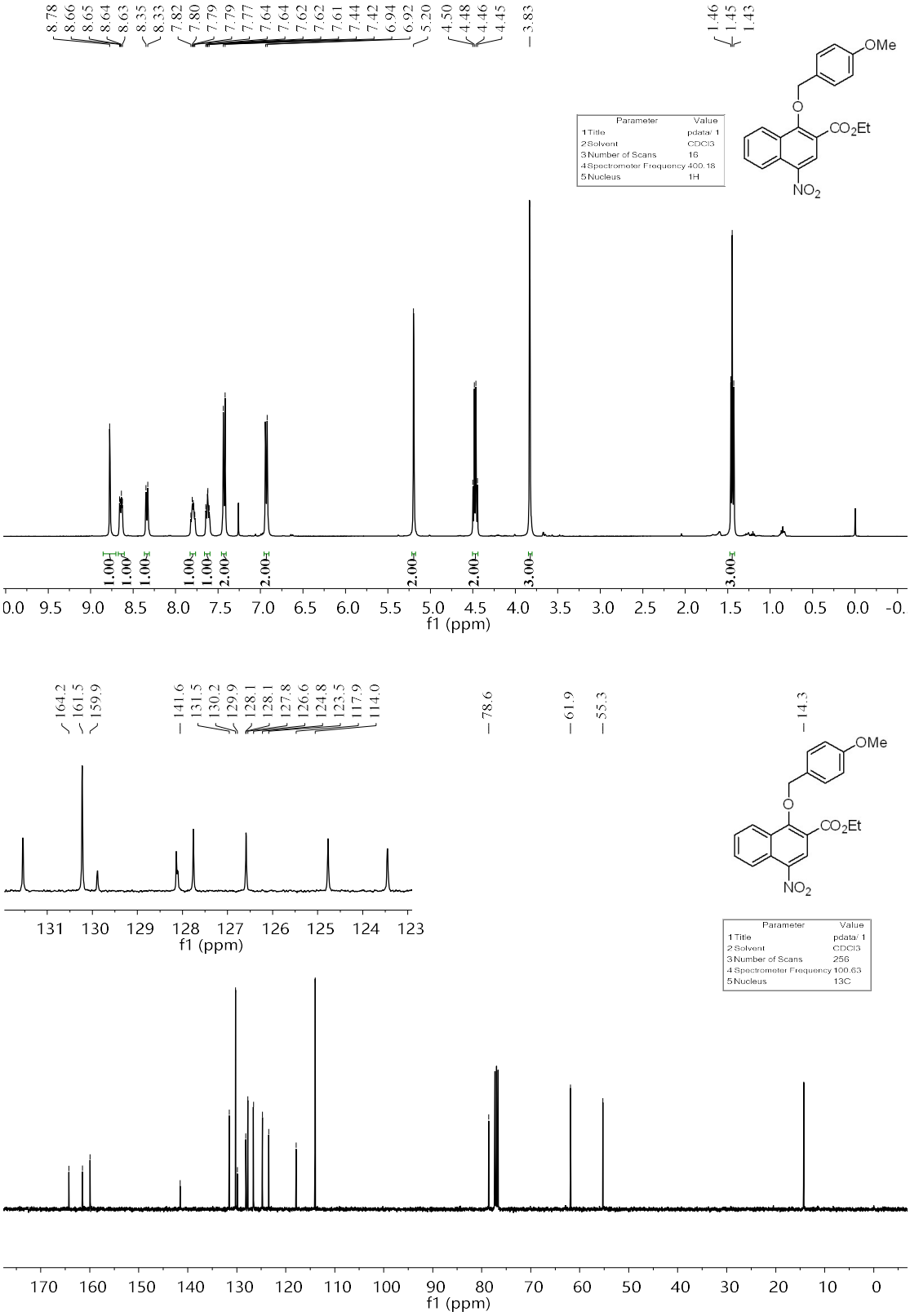


1-((4-methoxybenzyl)oxy)-N,4-diphenyl-2-naphthamide (A48)

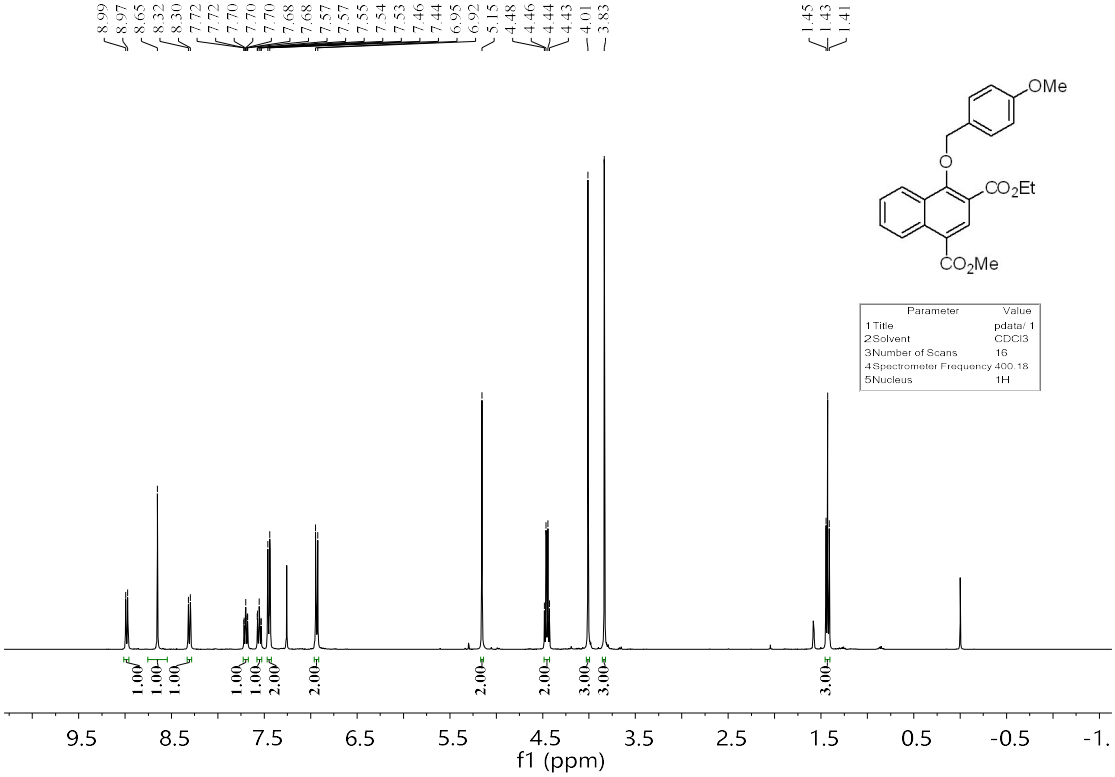


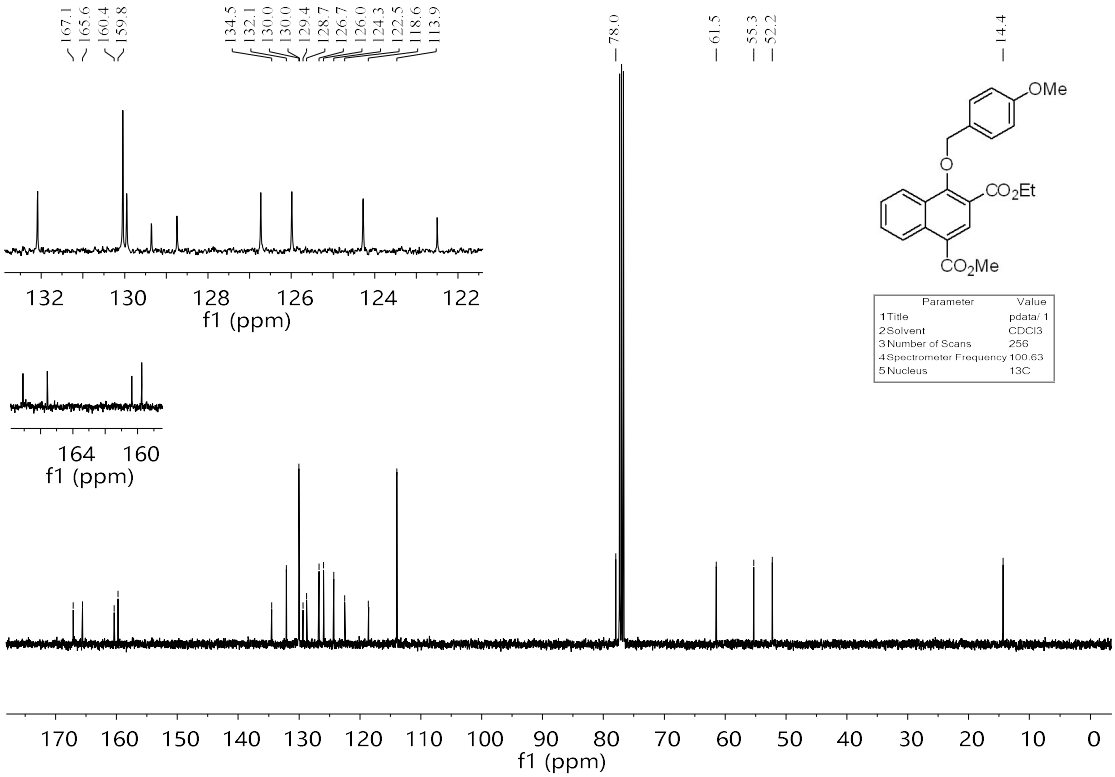


Ethyl 1-((4-methoxybenzyl)oxy)-4-nitro-2-naphthoate (A49)

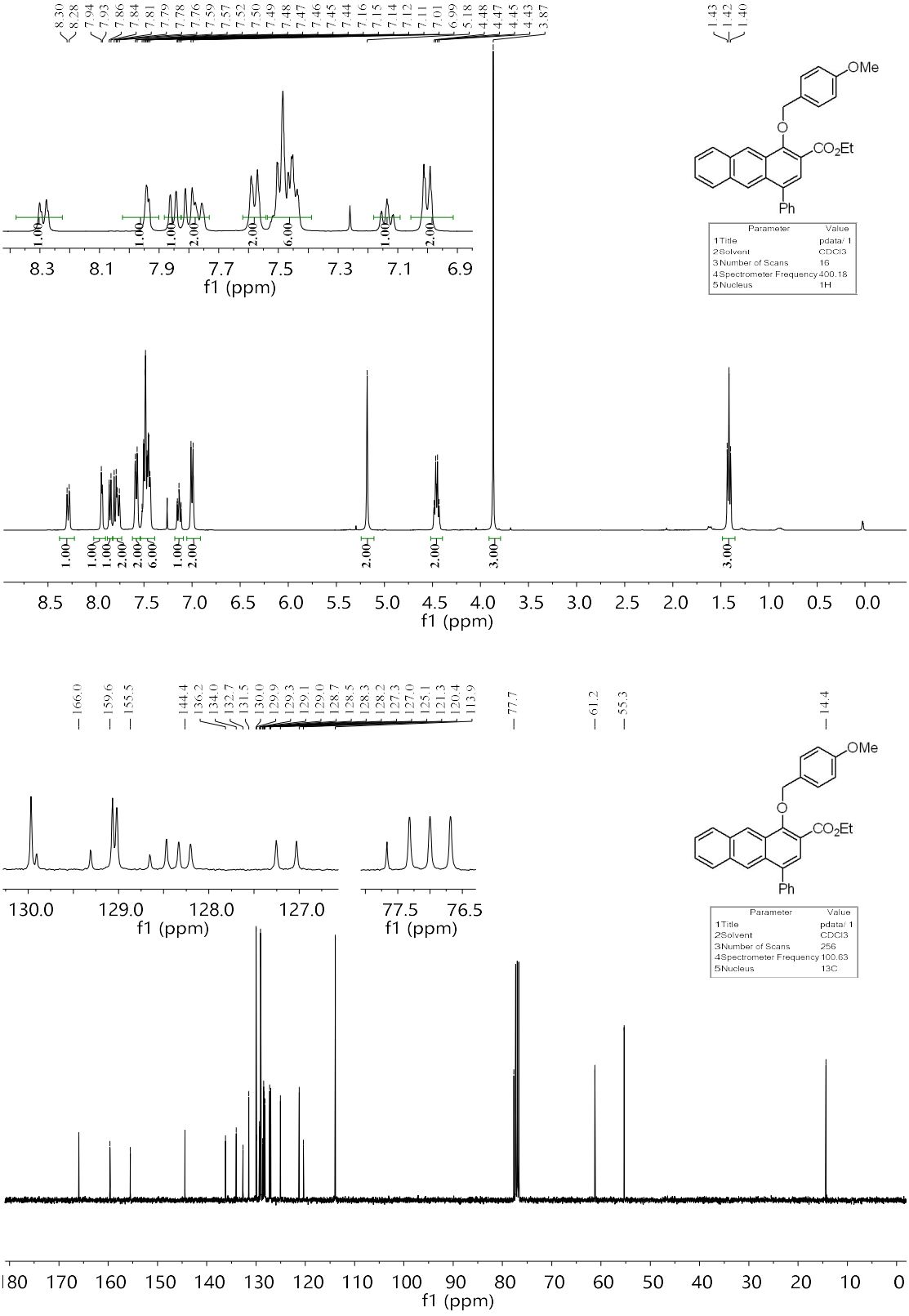


3-Ethyl 1-methyl 4-((4-methoxybenzyl)oxy)naphthalene-1,3-dicarboxylate (A50)

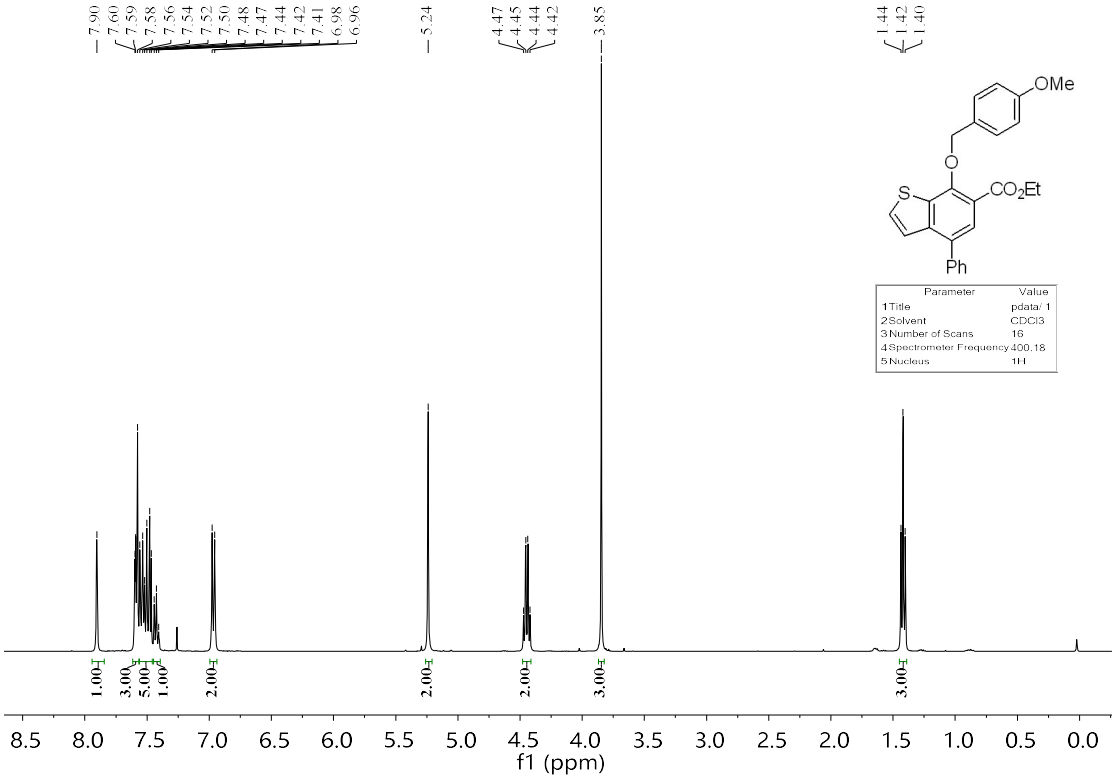


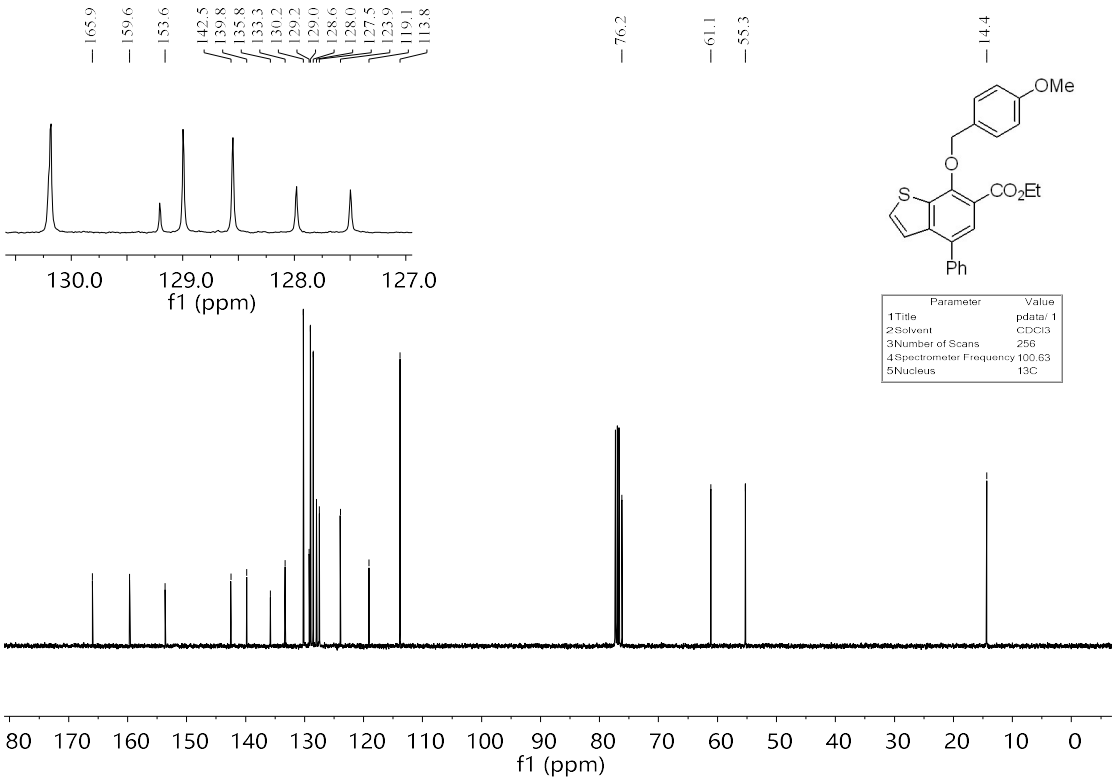


Ethyl 1-((4-methoxybenzyl)oxy)-4-phenylanthracene-2-carboxylate (A51)



Ethyl 7-((4-methoxybenzyl)oxy)-4-phenylbenzo[b]thiophene-6-carboxylate (A52)





13. References

1. a) T. Lu, Y. T. Jiang, F. P. Ma, Z. J. Tang, L. Kuang, Y. X. Wang, B. Wang, *Org. Lett.*, **2017**, *19*, 6344; b) S. Y. Peng, L. Wang, J. Wang, *Chem. Eur. J.*, **2013**, *19*, 13322; c) G. Naresh, R. Kant, T. Narender, *Org. Lett.*, **2015**, *17*, 3446.
2. Y. H. Wen, X. Huang, J. L. Huang, Y. Xiong, B. Qin, X. M. Feng, *Synlett*, **2005**, 2445.