Supporting Information

MOP and EE Protecting Groups in Synthesis of α- or β-Naphthyl-*C*-Glycosides from Glycals

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1. Optimization of the C-1 lithiation

Procedure for lithiation/deuteration experiments:

MOP or EE-protected D-glucal (50 mg, 0.14 mmol, 1 eq) was dissolved under Ar in anhydrous THF. This solution was cooled to -78 °C and then designated amount of *t*-BuLi (1.7 M in pentane) was added dropwise using a syringe pump. The reaction mixture was stirred at -78 °C for 5 min and then at 0 °C for 1 h. After 1 h, D_20 (0.249 mL, 13.79 mmol, 100 eq) was added dropwise at 0 °C and the mixture was stirred for 30 min at 0 °C and for 30 min at RT. The solution was diluted with EtOAc (30 mL) and washed with H_2O (50 mL). The organic layer was dried over $MgSO_4$ and concentrated *in vacuo*.

Deuterated material was subjected to ^{1}H NMR measurement in DMSO-d_6. The extent of deuteration at C1 was assumed from comparison of integral intensity of H1 with other signals in the molecule, as shown in Figures S2 and S3. Outline and results of the optimization are summarized in Figure S1.

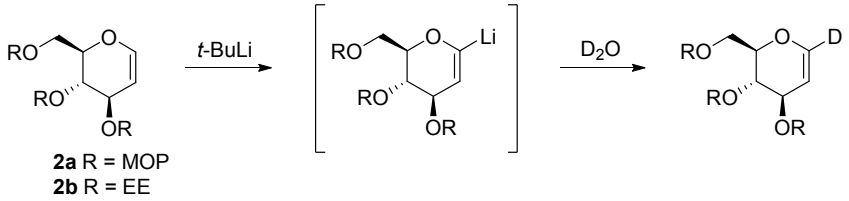
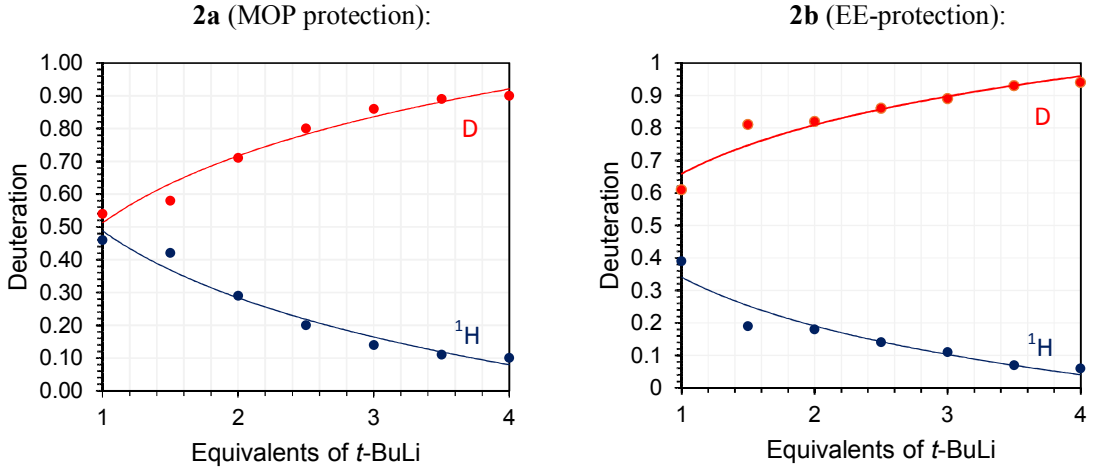


Figure S1. Optimization of the C-1 lithiation of protected glycals **2a** and **2b**.



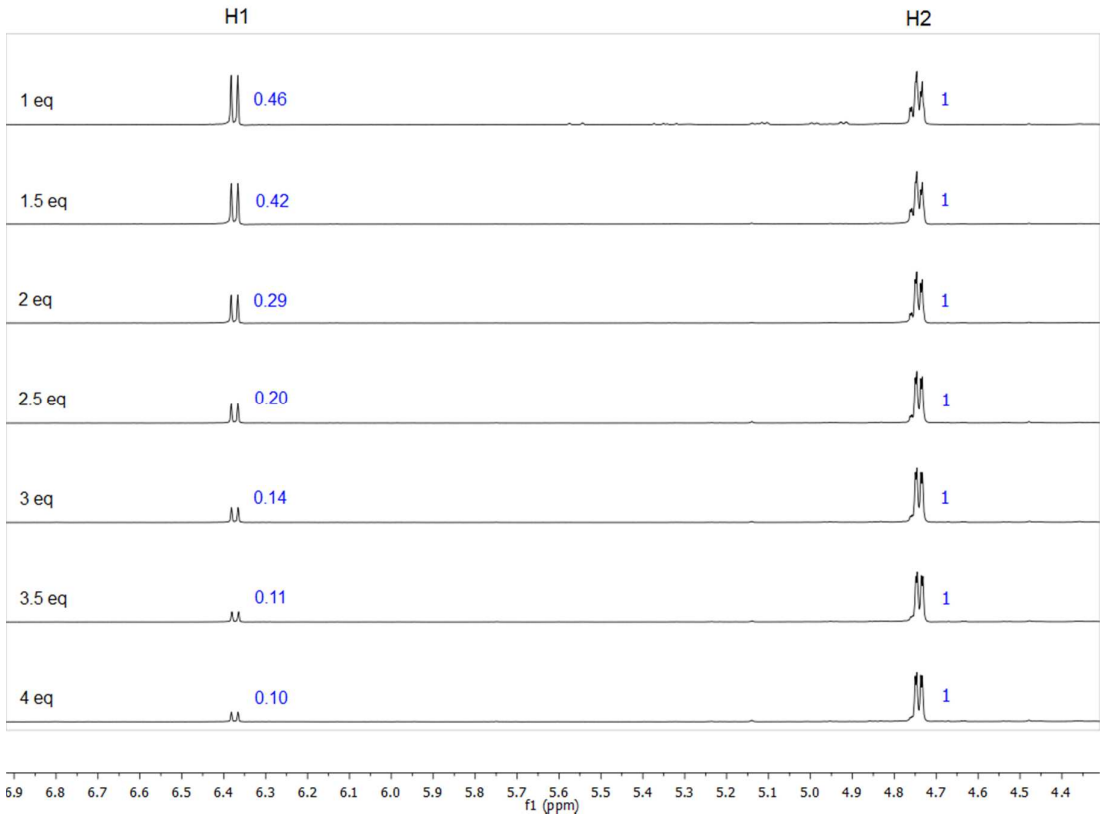


Figure S2. C-1 lithiation of **2a**

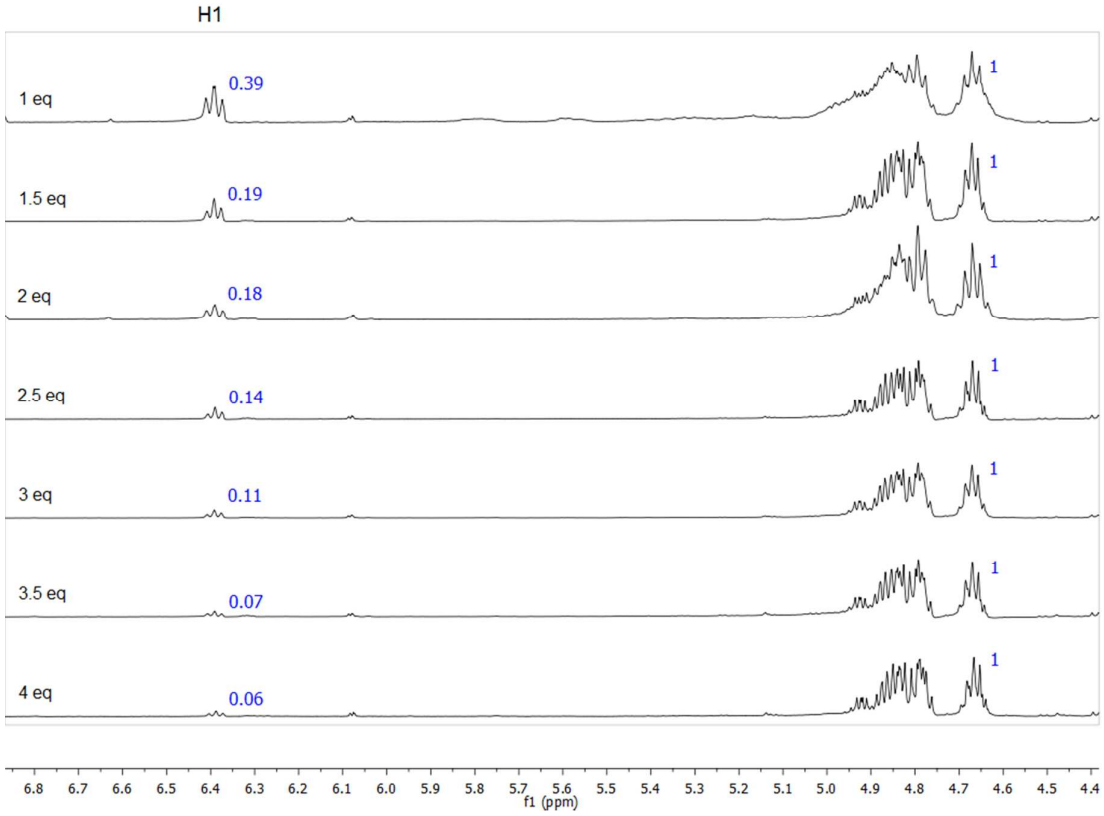
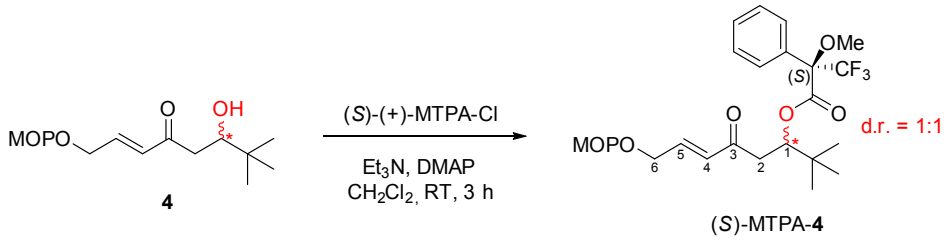


Figure S3. C-1 lithiation of **2b**.

2. Determination of enantiomeric composition of 4



Et_3N (0.04 mL, 290 µmol, 5 eq) and DMAP (709 µg, 6 µmol, 0.1 eq) were added to the solution of enone **4** (15 mg, 58 µmol, 1 eq) in anhydrous CH_2Cl_2 (3 mL). After that, (*S*)-MTPA-Cl (0.02 mL, 116 µmol, 2 eq) was added and the reaction mixture was stirred for 3 h ar RT and then quenched by the addition of sat. aq. NH_4Cl (1 mL). The mixture was diluted with EtOAc (10 mL) and washed with H_2O (2 × 10 mL), dried over $MgSO_4$ and evaporated *in vacuo*.

Diastereomeric composition of the mixture was determined by NMR measurements of the crude (*S*)-MTPA-**4**. Diastereomeric ratio was estimated to be ~ 1:1 based on characteristic ^{13}C NMR signals (Figure S4).

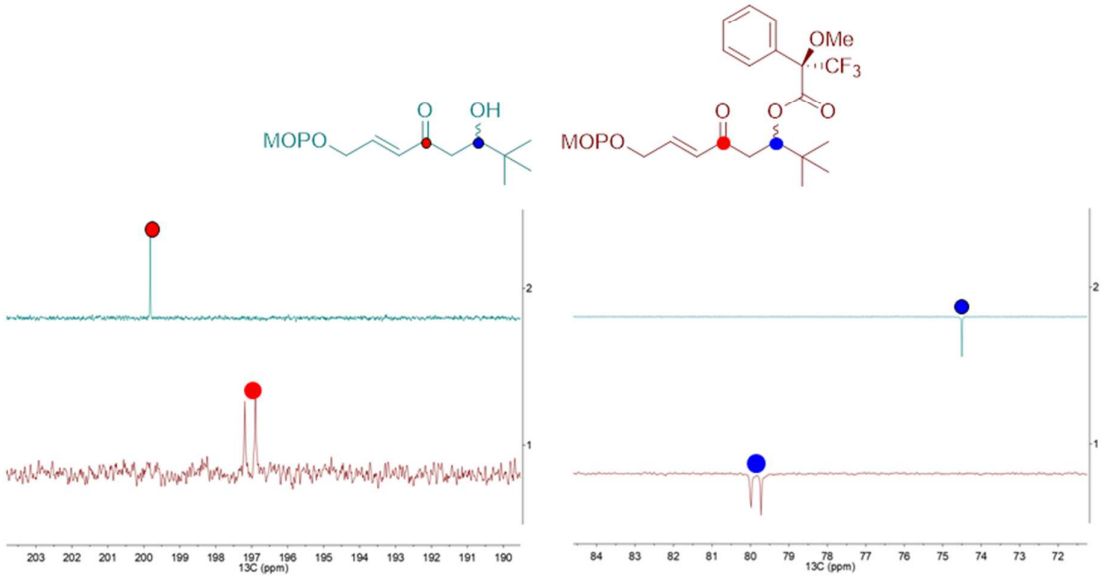
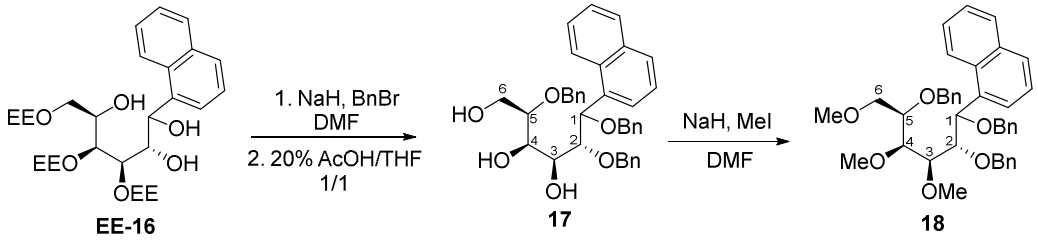


Figure S4. Characteristic ^{13}C NMR signals used for estimation of diastereomeric ratio of (*S*)-MTPA-**4**.

3. Structural assignment of (2*S*,3*R*,4*S*,5*R*)-1-(naphthalen-1-yl)hexane-1,2,3,4,5,6-hexaol (16).

Structure of the intermediate (2*S*,3*R*,4*S*,5*R*)-1-(naphthalen-1-yl)hexane-(3,4,6-tri-*O*-(ethoxyethyl)-1,2,3,4,5,6-hexaol was confirmed by benzylation of the free hydroxyl groups and subsequent cleavage of the EE groups, which gave partially benzylated derivative **17**. The OH groups in positions 3, 4 and 6 were then methylated by the excess of MeI to give the product **18**. The positions of methyl and benzyl groups were then determined by analysis of HMBC spectra.

1-((2*S*,3*S*,4*S*,5*R*)-1,2,5-tris(benzyloxy)-3,4,6-trimethoxyhexyl)naphthalene (18).

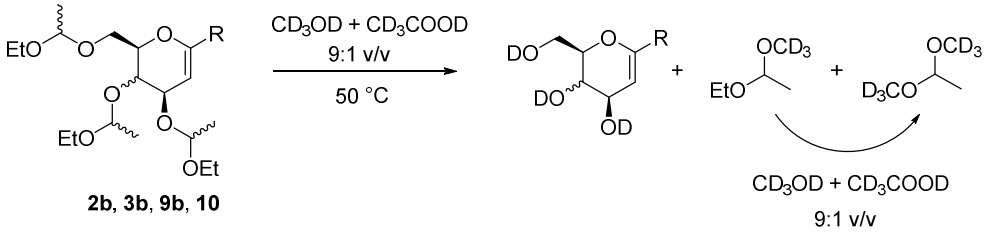


(2*R*,3*R*,4*S*,5*R*)-2,5,6-tris(benzyloxy)-6-(naphthalen-1-yl)hexane-1,3,4-triol (17). To a solution of derivative **EE-16** (50 mg, 95 µmol, 1 eq) in anhydrous DMF (5 mL) at 0 °C was added NaH (22.87 mg, 572 µmol, 60% in mineral oil, 6 eq). The reaction mixture was stirred for 30 min at RT and then BnBr (67.92 µL, 572 µmol, 6 eq) was slowly added dropwise at 0 °C. The resulting solution was stirred for 1 h at 0 °C and then overnight at RT. The reation was quenched by careful addition of MeOH (10 mL) at 0 °C and evaporation *in vacuo*. The residue was taken up in EtOAc (50 mL) and washed with H_2O (3 × 50 mL), dried over $MgSO_4$ and evaporated *in vacuo*. The obtained material containing fully protected derivative was subjected to deprotection procedure **F** using 20% AcOH (5 mL) and THF (5 mL) and stirred overnight at RT. After evaporation, the residue was purified by column chromatography on silica gel ($CHCl_3$/MeOH 8/1 to 5/1), which yielded compound **17** (47 mg, 85 %) as a colorless oil: R_f = 0.36 ($CHCl_3$/MeOH 7/1); ^{1}H NMR (401.0 MHz, $CDCl_3$): 2.55, 3.27, 3.63 (3 × bs, 3 × 1H, OH-3,4,6); 3.66 (dd, 1H, $J_{4,3}$ = 9.5, $J_{4,5}$ = 2.3, H-4); 3.76–3.90 (m, 4H, H-5,6, $CH_a\mathbf{H_b}$Ph-2); 4.09 (d, 1H, $J_{3,4}$ = 9.5, H-3); 4.21 (d, 1H, $J_{2,1}$ = 7.2, H-2); 4.29 (d, 1H, J_{gem} = 10.9, $C\mathbf{H_a}H_b$Ph-2); 4.37, 4.59 (2 × d, 2 × 1H, J_{gem} = 11.6, CH_2Ph-1); 4.64, 4.72 (2 × d, 2 × 1H, J_{gem} = 11.2, CH_2Ph-5); 5.43 (d, 1H, $J_{1,2}$ = 7.2, H-1); 6.76–6.83 (m, 2H, H-*o*-Bn-2); 7.11–7.25 (m, 3H, H-*m,p*-Bn-2); 7.26–7.37 (m, 10H, H-*o,m,p*-Bn-1,5); 7.41 (ddd, 1H, $J_{7,8}$ = 8.4, $J_{7,6}$ = 6.8, $J_{7,5}$ = 1.4, H-7-naphth); 7.49 (ddd, 1H, $J_{6,5}$ = 8.1, $J_{6,7}$ = 6.8, $J_{6,8}$ = 1.2, H-6-naphth); 7.53 (dd, 1H, $J_{3,4}$ = 8.2, $J_{3,2}$ = 7.1, H-3-naphth); 7.78 (dd, 1H, $J_{2,3}$ = 7.1, $J_{2,4}$ = 0.9, H-2-naphth); 7.83 – 7.94 (m, 3H, H-4,5,8-naphth); ^{13}C NMR (100.8 MHz, $CDCl_3$): 63.1 (CH_2-6); 70.5 (CH-3); 71.2 (CH_2Ph-1); 72.5 (CH-4); 73.2 (CH_2Ph-5); 73.9 (CH_2Ph-2); 78.3 (CH-5); 78.7 (br, CH-1); 79.0 (CH-2); 123.6 (CH-8-naphth); 125.3 (CH-3-naphth); 125.7 (CH-2,6-naphth); 126.2 (CH-7-naphth); 127.8, 127.8, 127.9 (CH-*p*-Bn-1,2,5); 128.06, 128.09, 128.2 (CH-*m*-Bn-1,2,5); 128.4, 128.5 (CH-*o*-Bn-1,2,5); 128.7 (CH-4-naphth); 128.8 (CH-5-naphth); 131.9 (C-8a-naphth); 133.8 (C-4a-naphth); 134.6 (C-1-naphth); 137.5, 137.7, 138.0 (C-*i*-Bn-1,2,5); HRMS (ESI) *m/z* $[M+Na]^+$ calcd for $C_{37}H_{38}O_6Na$ 601.2561, found 601.2561.

1-((2*S*,3*S*,4*S*,5*R*)-1,2,5-tris(benzyloxy)-3,4,6-trimethoxyhexyl)naphthalene (18). To a solution of derivative **17** (47 mg, 81 µmol, 1 eq) in anhydrous DMF (5 mL) at 0 °C was added NaH (19 mg, 487 µmol, 60% in mineral oil, 6 eq). The reaction mixture was stirred for 30 min at RT and then MeI (30.34 µL, 487 µmol, 6 eq) was slowly added dropwise at 0 °C. The resulting solution was stirred for 1 h at 0 °C and then overnight at RT. The reaction was quenched by careful addition of MeOH (10 mL) at 0 °C and evaporation *in vacuo*. The residue was taken up in CH_2Cl_2 (30 mL) and washed with H_2O (3 × 30 mL), dried over $MgSO_4$ and evaporated *in vacuo*. The residue was purified by column chromatography on silica gel (Hexane/EtOAc 4/1), which yielded compound **18** (45 mg, 89%) as a colorless oil: R_f = 0.32 (Hexane/EtOAc 4/1); **HRMS** (ESI) *m*/*z* calculated for $C_{40}H_{44}O_6Na$ $[M+Na]^+$ 643.30301, found 643.30292. **^{1}H NMR** (401.0 MHz, $CDCl_3$): 3.13 (d, 1H, J_{gem} = 10.5, $CH_a\mathbf{H_b}$Ph-2); 3.37 (s, 3H, CH_3O-6); 3.39 (s, 3H, CH_3O-4); 3.42 (s, 3H, CH_3O-3); 3.62 – 3.70 (m, 2H, H-4,6b); 3.74 (dd, 1H, $J_{6a,6b}$ = 10.0, $J_{6a,5}$ = 6.4, H-6a); 3.88 (d, 1H, J_{gem} = 10.5, $C\mathbf{H_a}H_b$Ph-2); 3.96 (ddd, 1H, $J_{5,6}$ = 6.4, 5.1, $J_{5,4}$ = 2.5, H-5); 4.15 (bm, 1H, H-2); 4.22 (dd, 1H, $J_{3,4}$ = 8.6, $J_{3,2}$ = 1.4, H-3); 4.31, 4.44 (2 × d, 2 × 1H, J_{gem} = 11.4, CH_2Ph-1); 4.67, 4.86 (2 × d, 2 × 1H, J_{gem} = 11.9, CH_2Ph-5); 5.31 (bm, 1H, H-1); 6.50 – 6.60 (bm, 2H, H-*o*-Bn-2); 6.97 – 7.10 (m, 3H, H-*m,p*-Bn-2); 7.22 – 7.33, 7.33 – 7.42 (2 × m, 10H, H-*o,m,p*-Bn-1,5); 7.45 – 7.55 (m, 3H, H-3,6,7-naphth); 7.78 (bd, 1H, $J_{2,3}$ = 7.2, H-2-naphth); 7.86 – 7.93 (m, 2H, H-4,5-naphth); 8.51 (bm, 1H, H-8-naphth); ^{13}C NMR (100.8 MHz, $CDCl_3$): 58.95 (CH_3O-6); 59.47 (CH_3O-4); 60.47 (CH_3O-3); 69.93 (CH_2Ph-1); 72.35 (CH_2Ph-5); 73.84 (CH_2-6); 73.88 (CH_2Ph-2); 77.81 (CH-5); 78.98 (CH-3); 79.39 (CH-4); 124.71 (CH-8-naphth); 125.31 (CH-2,3-naphth); 125.67 (CH-6-naphth); 126.06 (CH-7-naphth); 127.10, 127.25, 127.42 (CH-*p*-Bn-1,2,5); 127.47, 127.75, 127.77 (CH-*m*-Bn-1,2,5); 128.09, 128.23, 128.25 (CH-*o*-Bn-1,2,5); 128.60 (CH-4-naphth); 128.75 (CH-5-naphth); 132.68 (C-8a-naphth); 133.89 (C-4a-naphth); 135.65 (C-1-naphth); 137.77, 138.18, 138.92 (C-*i*-Bn-1,2,5); HRMS (ESI) *m*/*z* $[M+Na]^+$ calcd for $C_{40}H_{44}O_6Na$ 643.3030, found 643.3029.

4. Characterization of EE-protected compounds by NMR

NMR spectra of EE-protected glycals are complicated by the presence of 8 sets of signals originating from all possible distareoisomers due to asymmetric carbon of EE-group. As result, their ^{1}H and ^{13}C NMR are complex and not easily analyzable due to signal overlap. However, simple *in situ* deprotection using 1:9 (v/v) mixture of CD_3COOD:CD_3OD at 50 °C for 45 – 120 minutes (Figure S5) significantly simplified the spectra and enabled structural characterization of EE-protected glycals by NMR. Simplification of ^{1}H and ^{13}C NMR spectra during *in situ* deprotection for EE-glycals **2b**, **3b**, **9b** and **10** is shown in Figures S6-S9.



EE-glycal	R	reaction time (mins)
2b	H	120
3b	H	75
9b	1-naphthyl	60
10	1-naphthyl	45

Figure S5. *In situ* deprotection of EE-glycals by CD_3COOD + CD_3OD (1:9 (v/v)) in NMR tube at 50 °C.

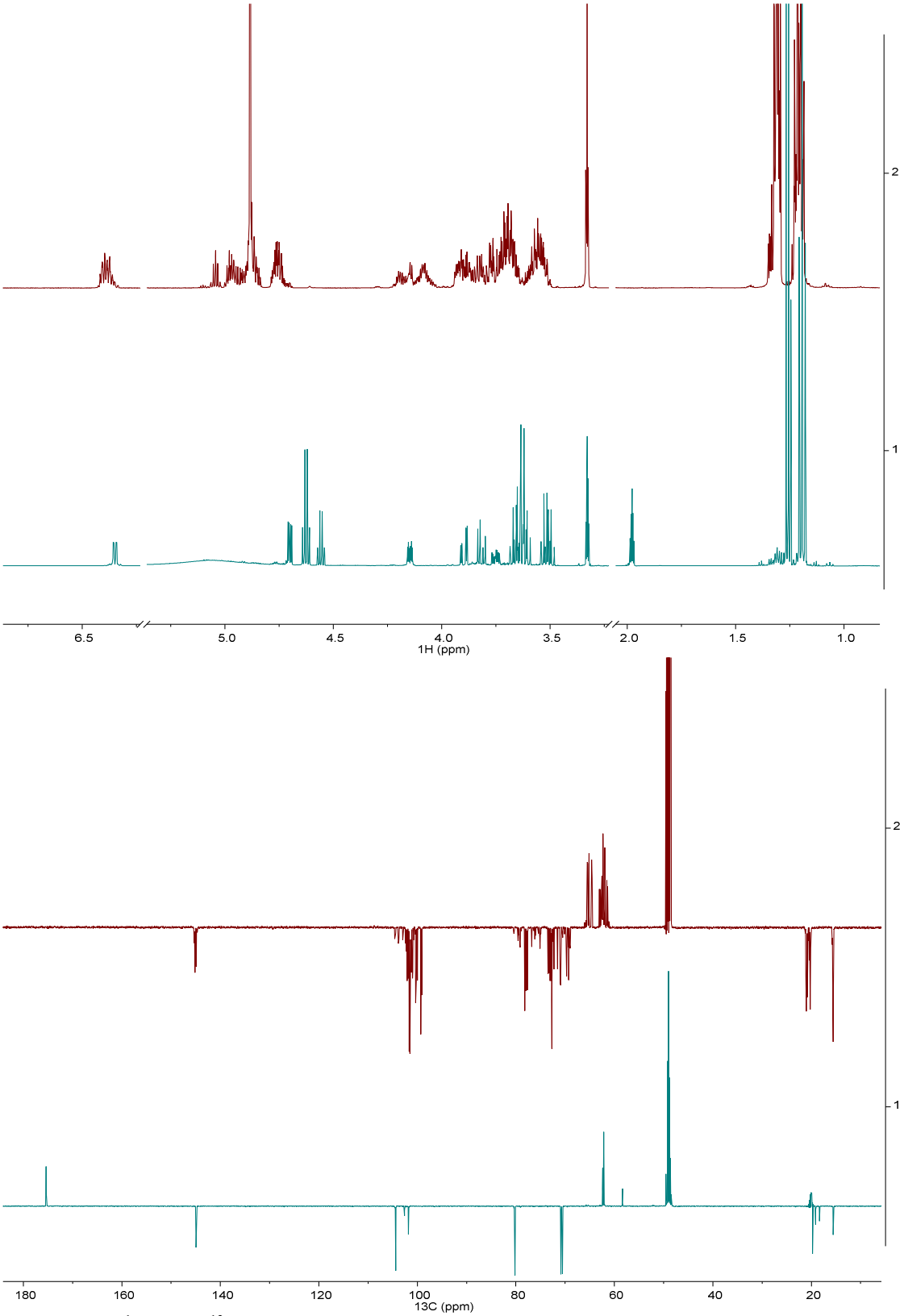


Figure S6. ^{1}H and ^{13}C NMR spectra of EE-glucal **2b** measured in CD_3OD (maroon) and corresponding NMR spectra after deprotection by CD_3COOD (teal).

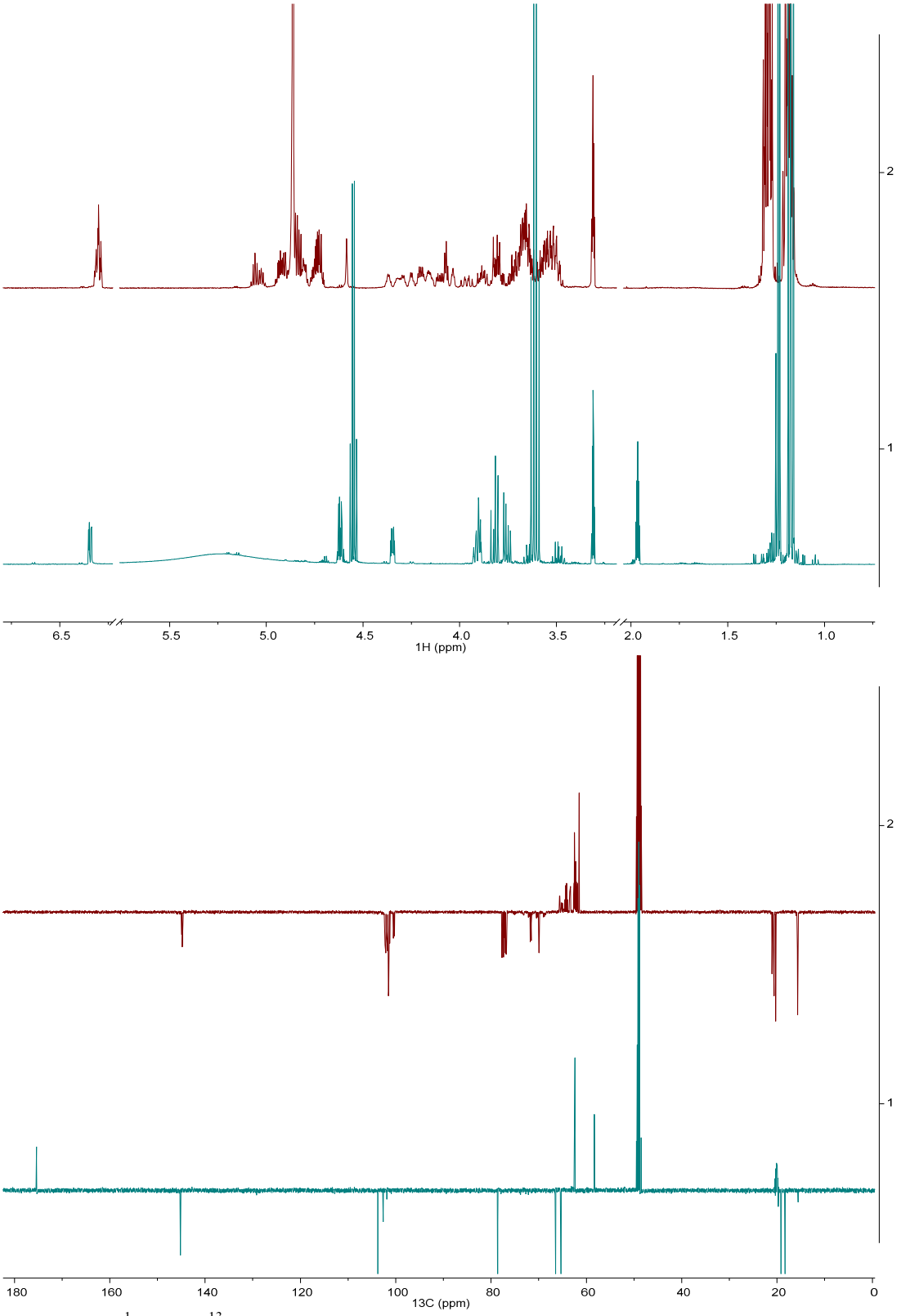


Figure S7. ^{1}H and ^{13}C NMR spectra of EE-galactal **3b** measured in CD_3OD (maroon) and corresponding NMR spectra after deprotection by CD_3COOD (teal).

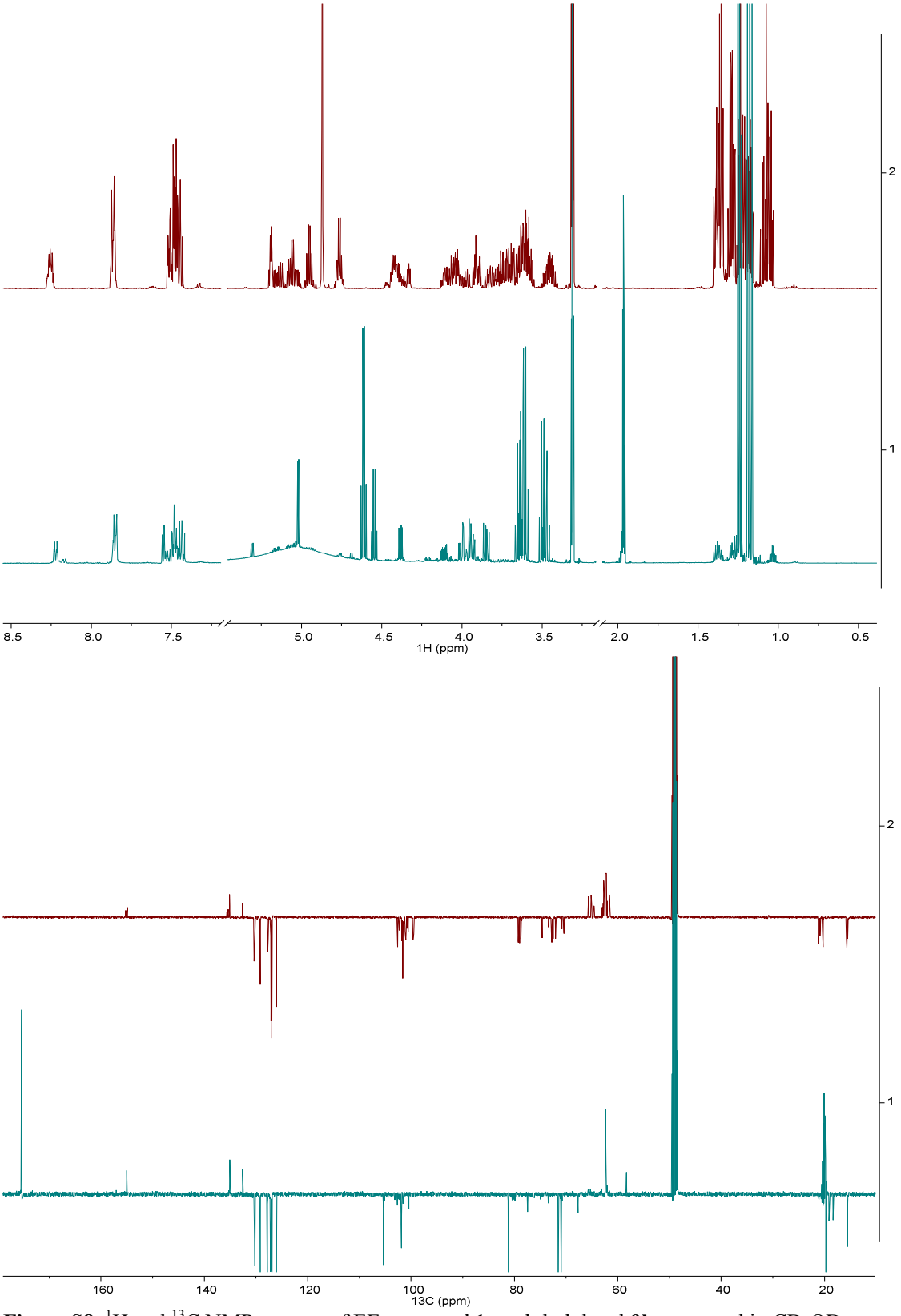


Figure S8. ^{1}H and ^{13}C NMR spectra of EE-protected 1-naphthylglucal **9b** measured in CD_3OD (maroon) and corresponding NMR spectra after deprotection by CD_3COOD (teal).

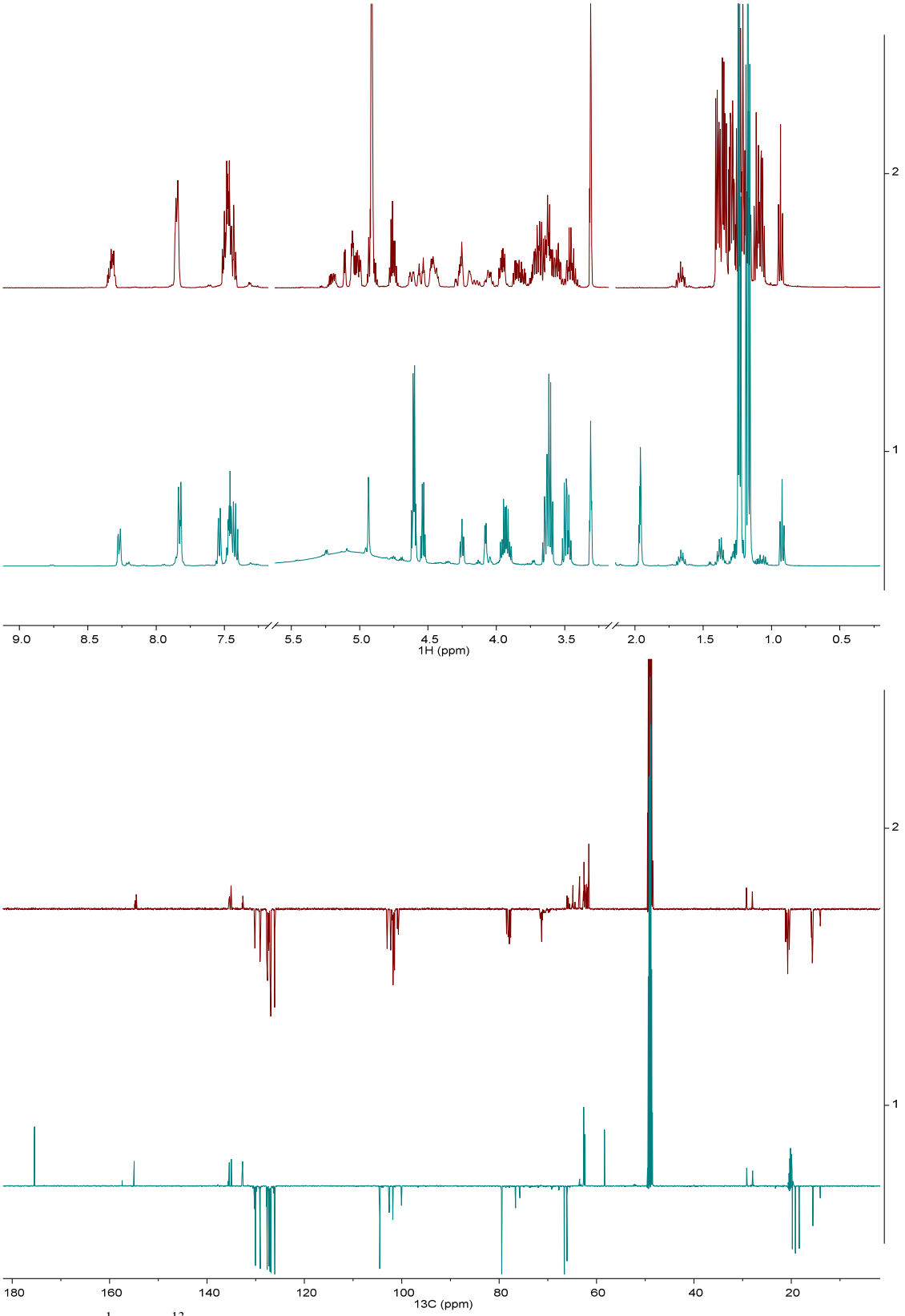
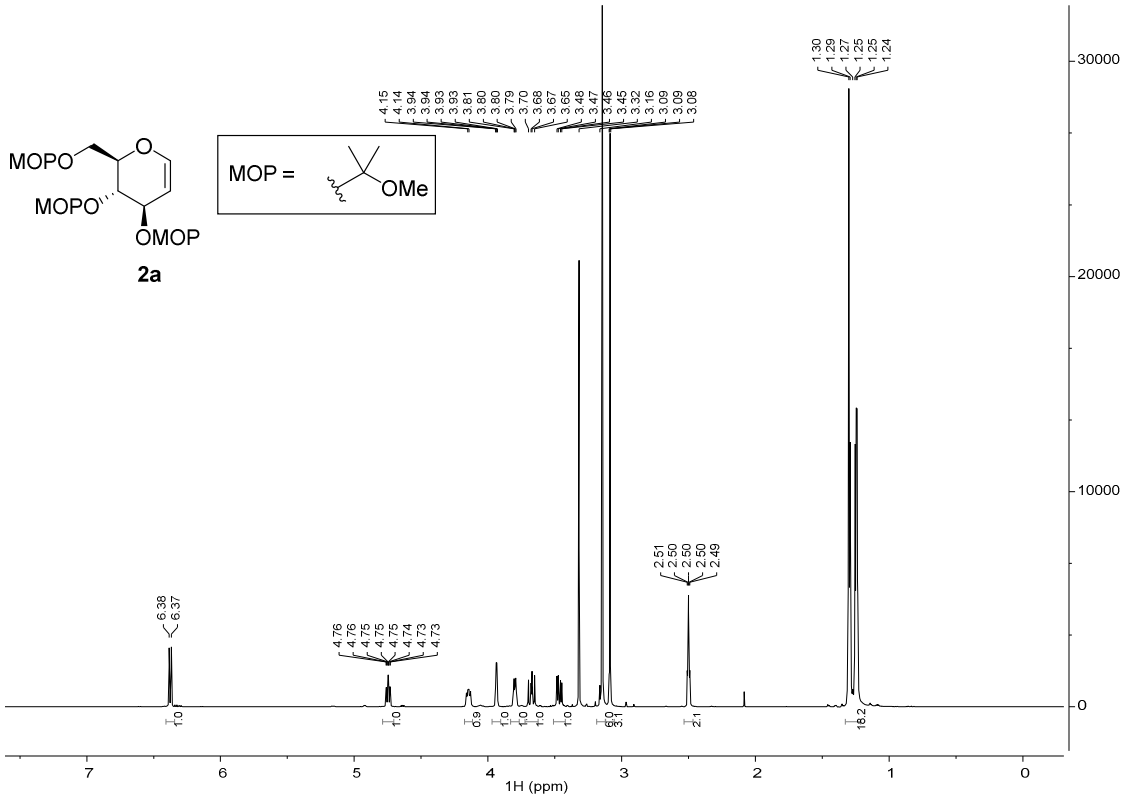
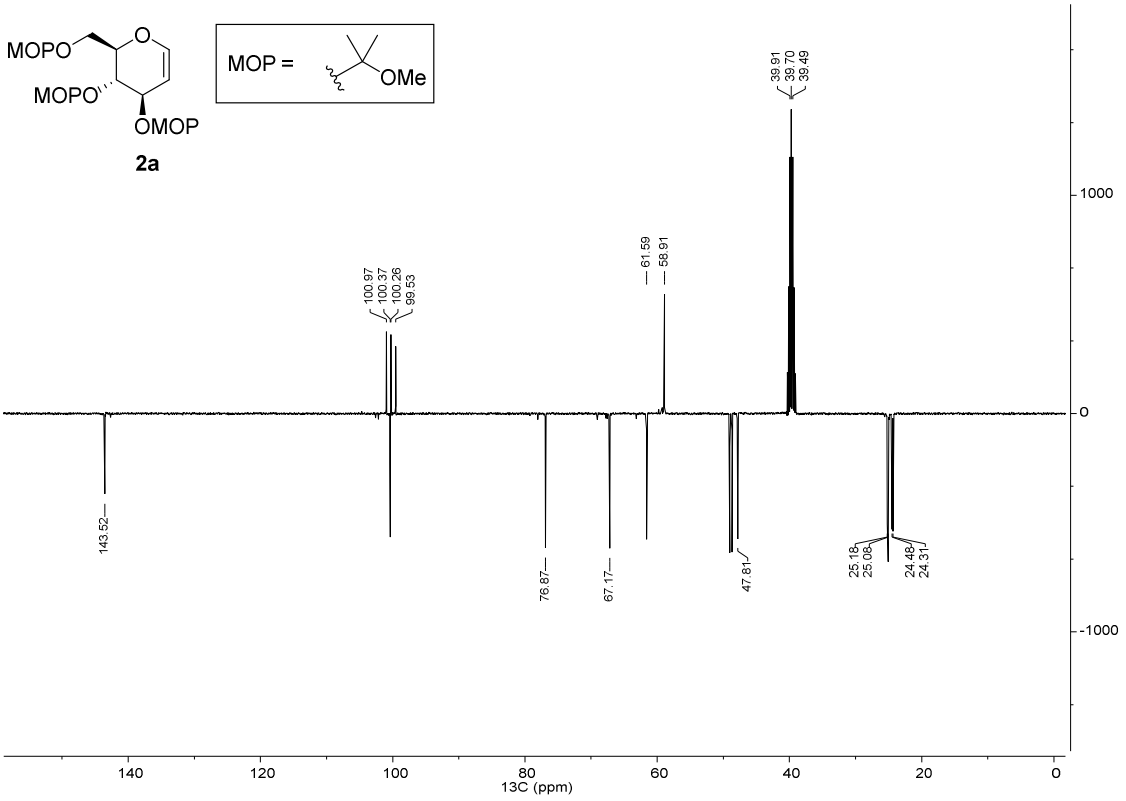


Figure S9. ^{1}H and ^{13}C NMR spectra of EE-protected 1-naphthylgalactal **10** measured in CD_3OD (maroon) and corresponding NMR spectra after deprotection by CD_3COOD (teal).

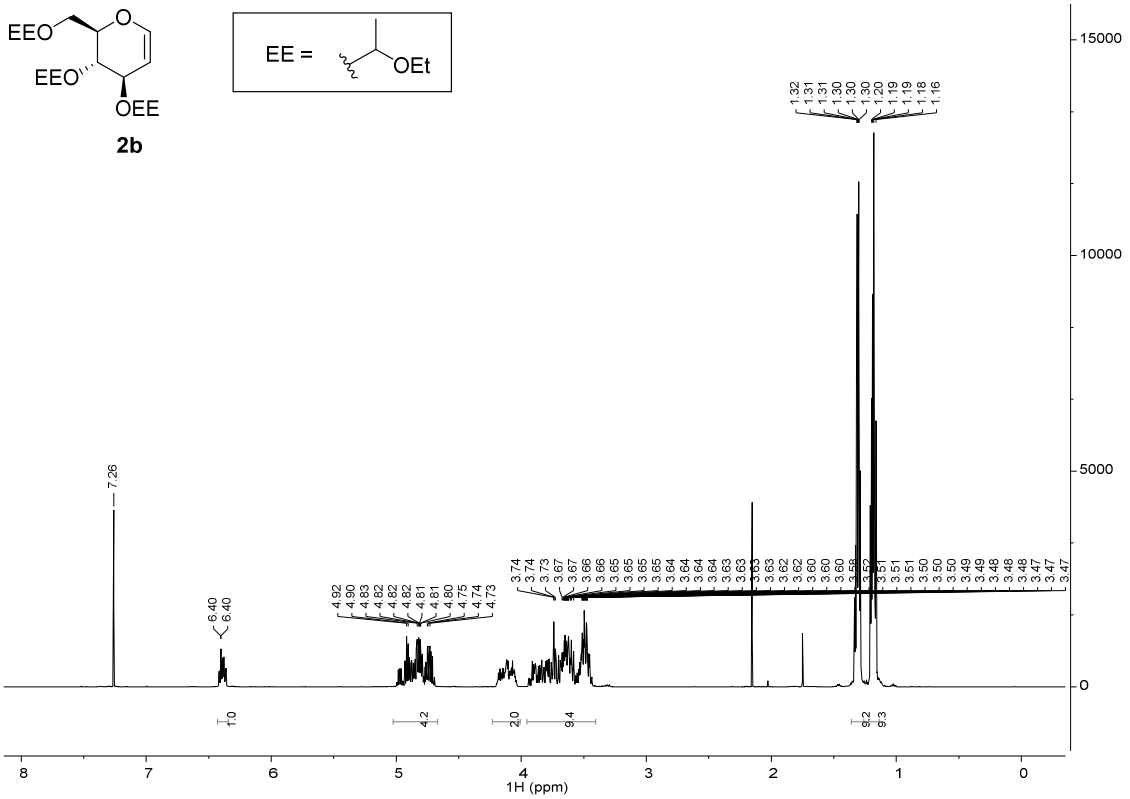
5. ^{1}H NMR and ^{13}C Spectra

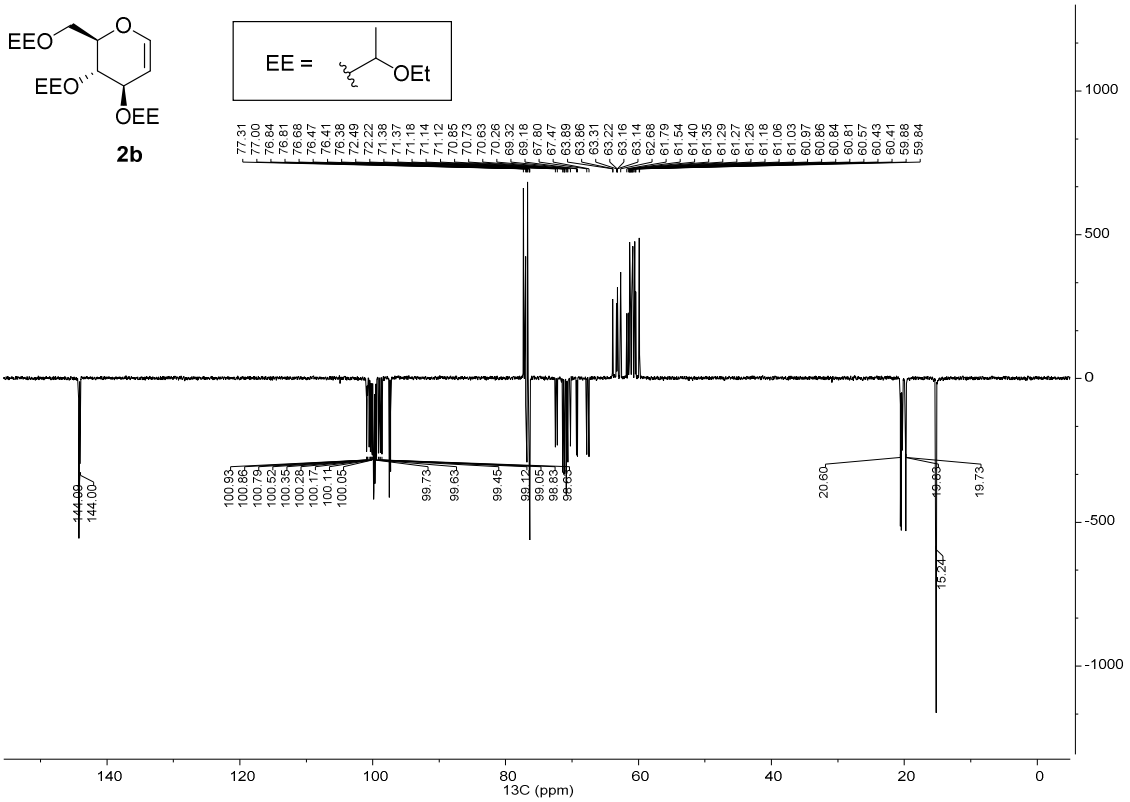
Spectra S1. ^{1}H and ^{13}C NMR of compound **2a**.



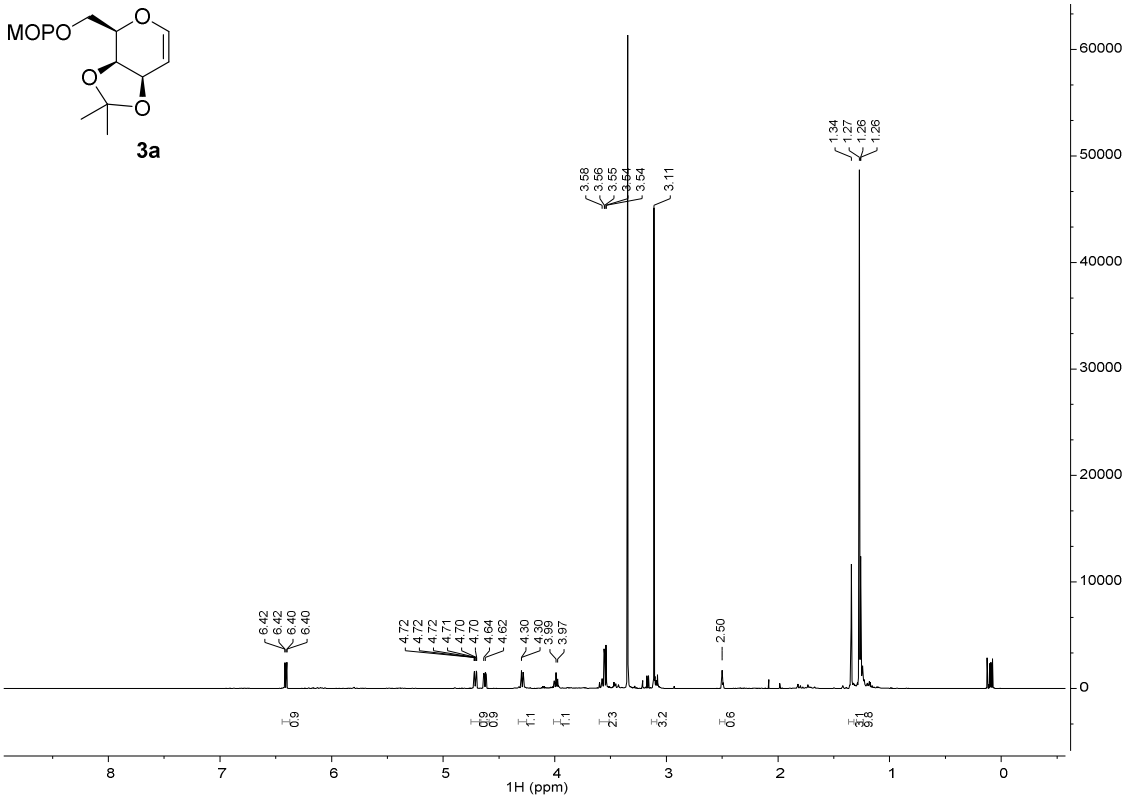


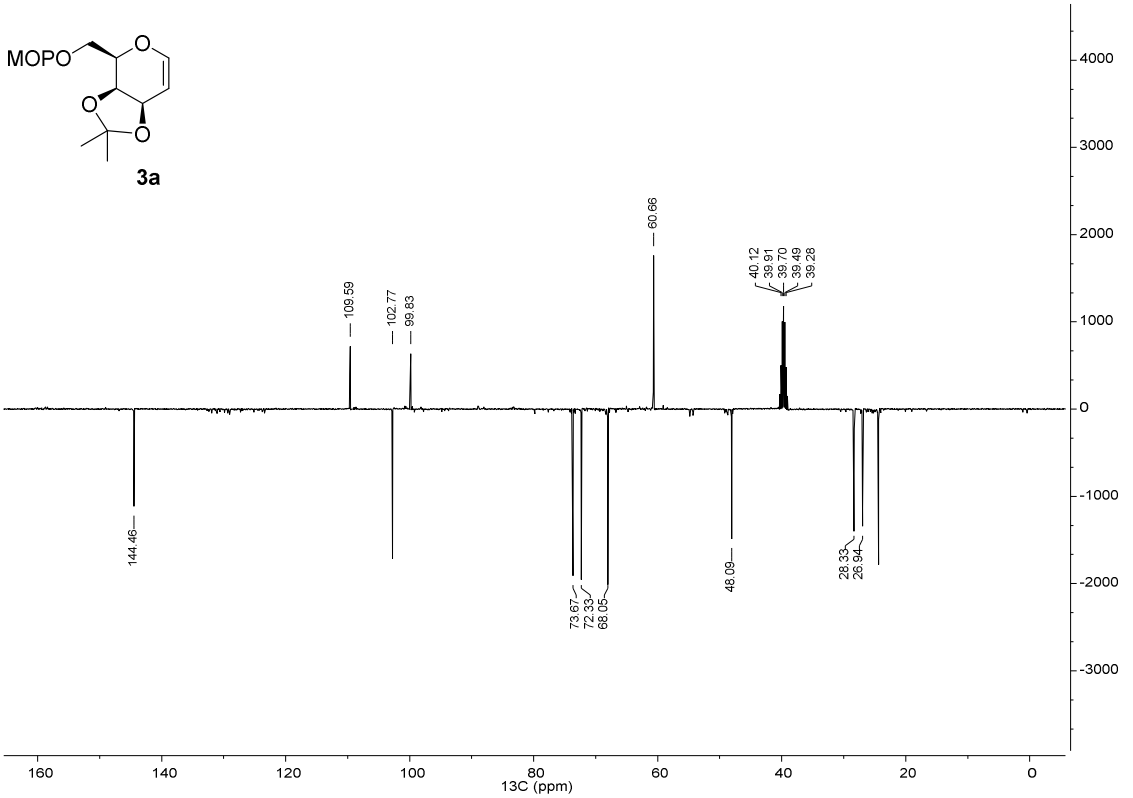
Spectra S2. ^{1}H and ^{13}C NMR of compound **2b.**



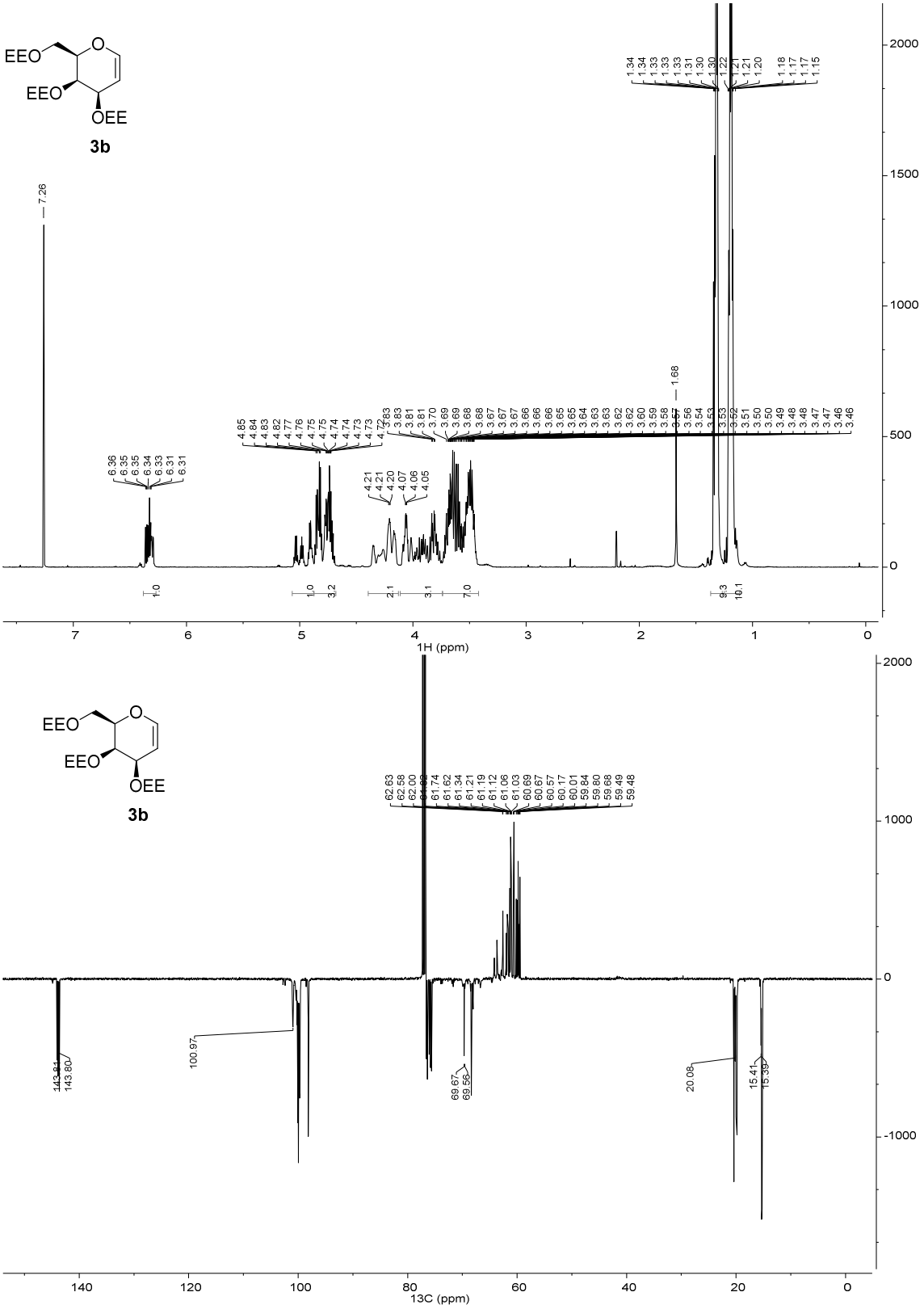


Spectra S3. ^{1}H and ^{13}C NMR of compound **3a.**

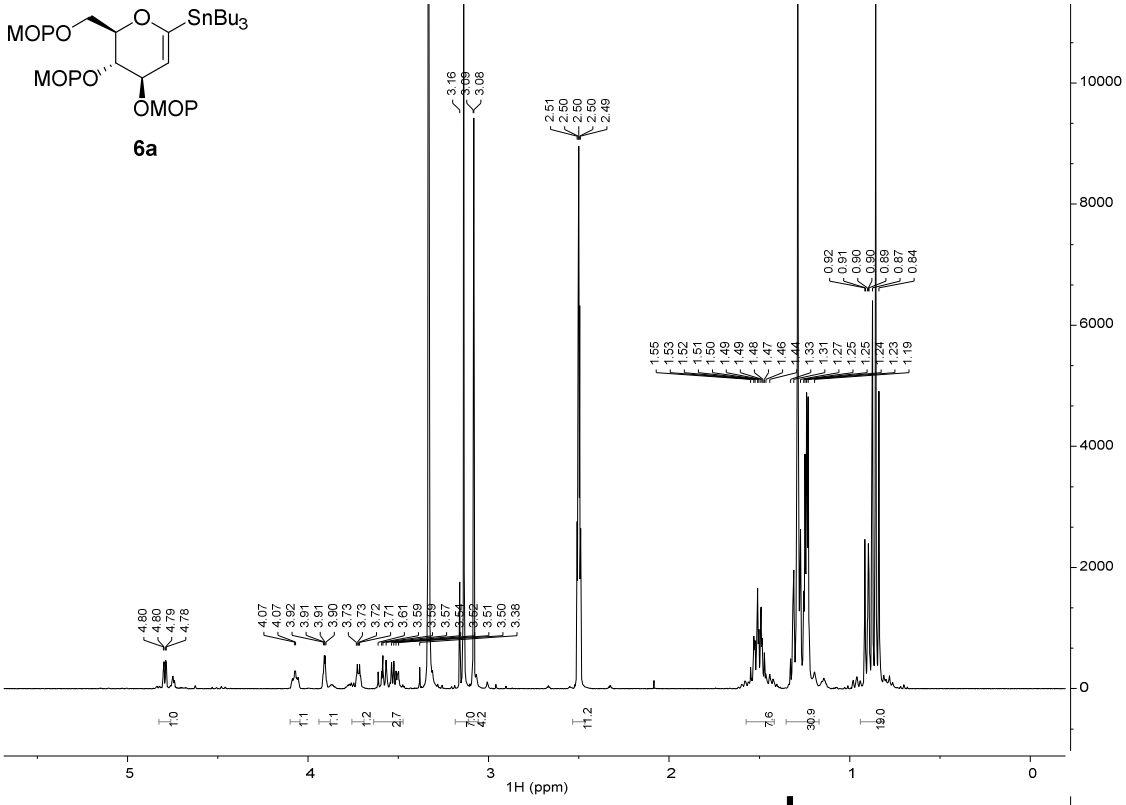


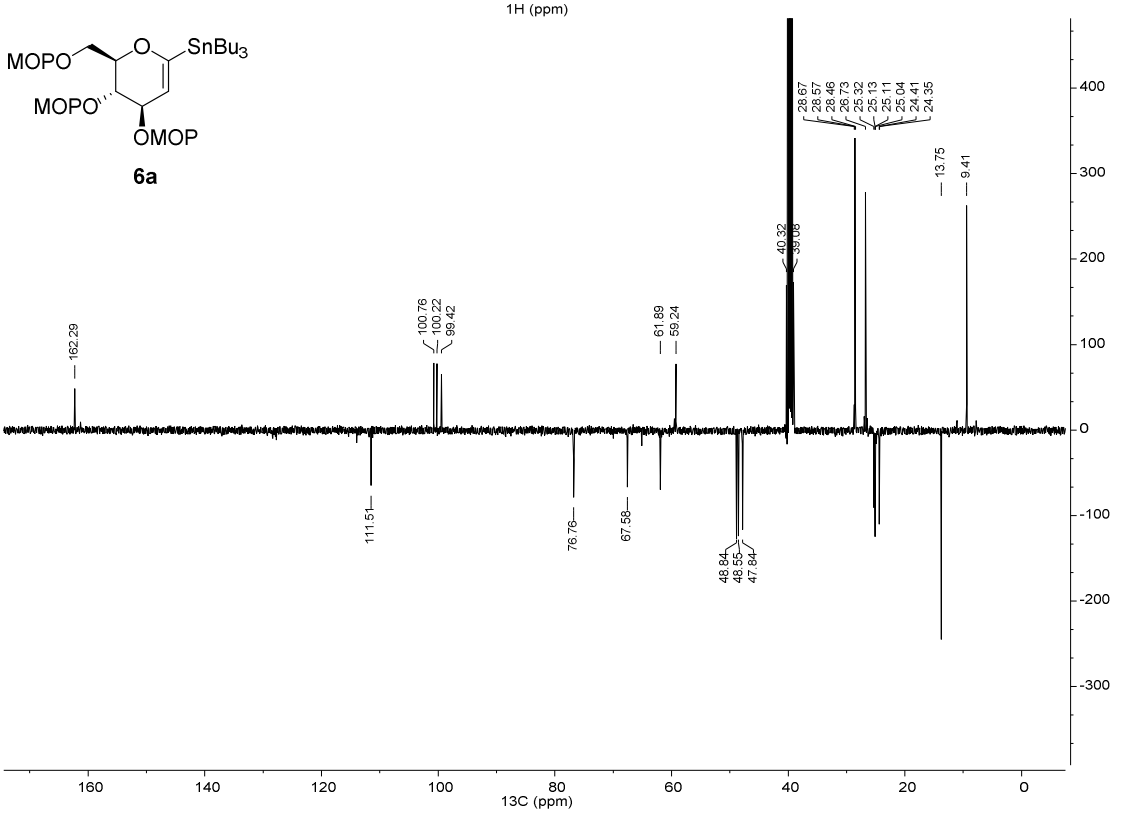


Spectra S4. ^{1}H and ^{13}C NMR of compound **3b.**

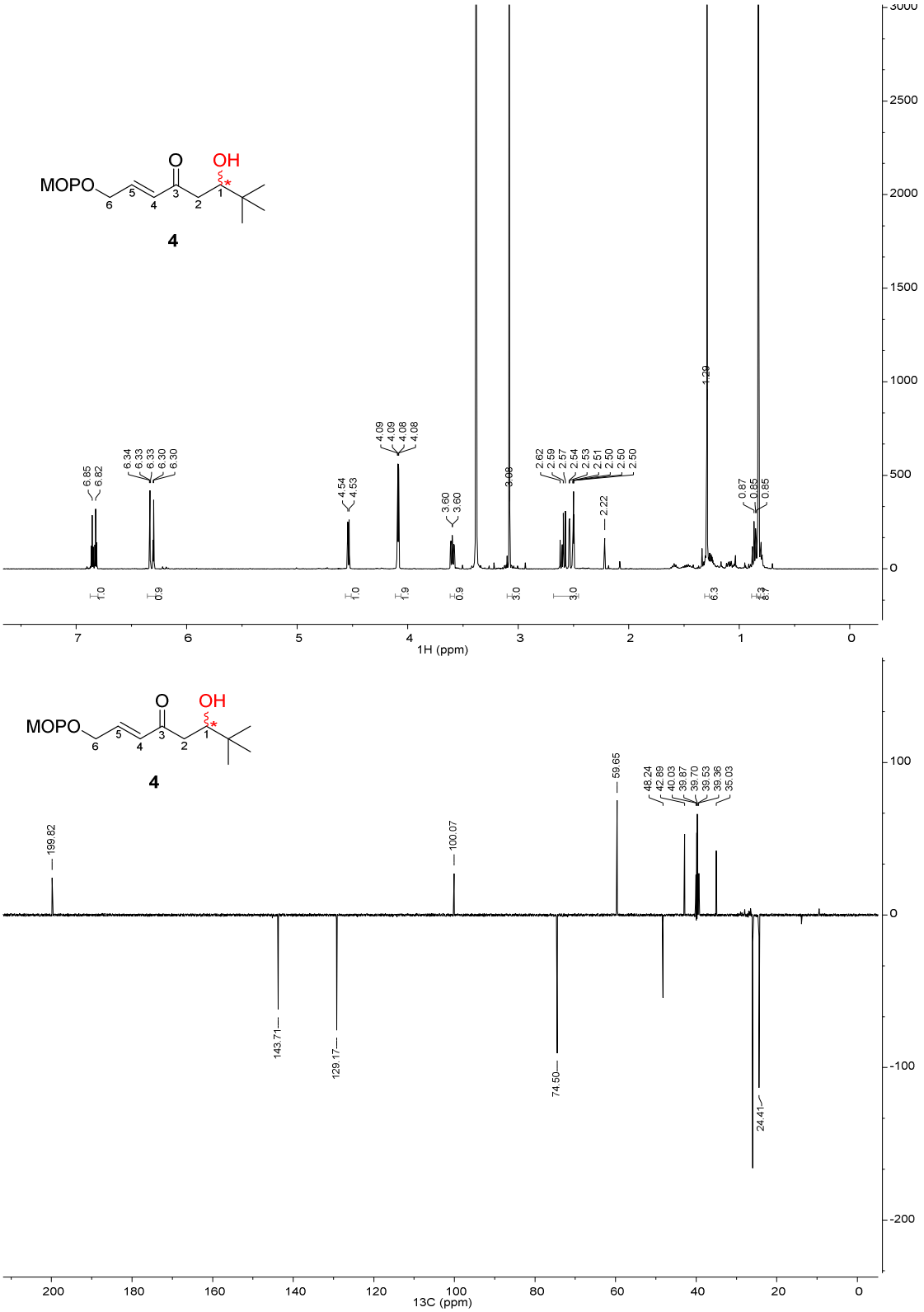


Spectra S5. ^{1}H and ^{13}C NMR of compound **6a.**

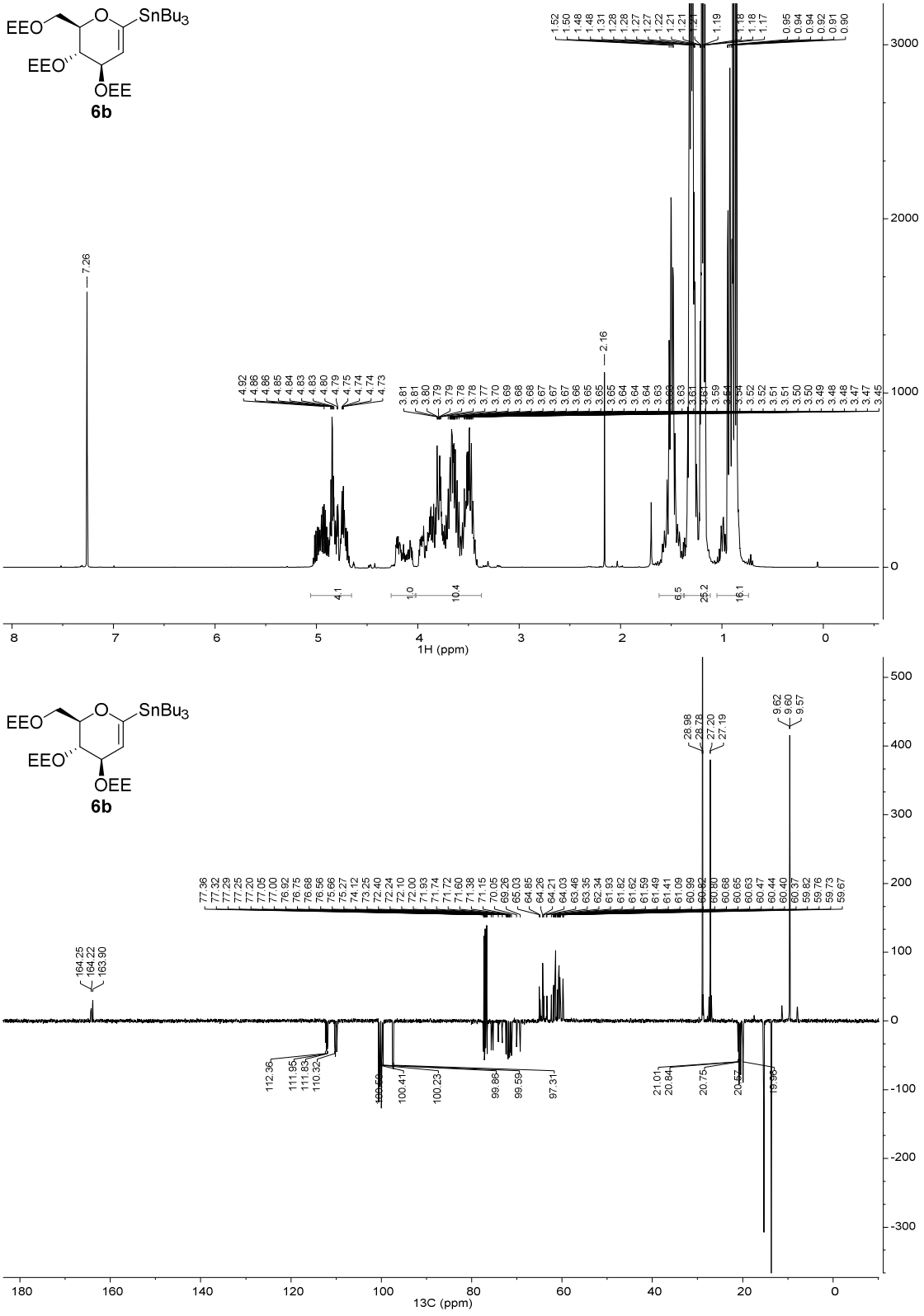




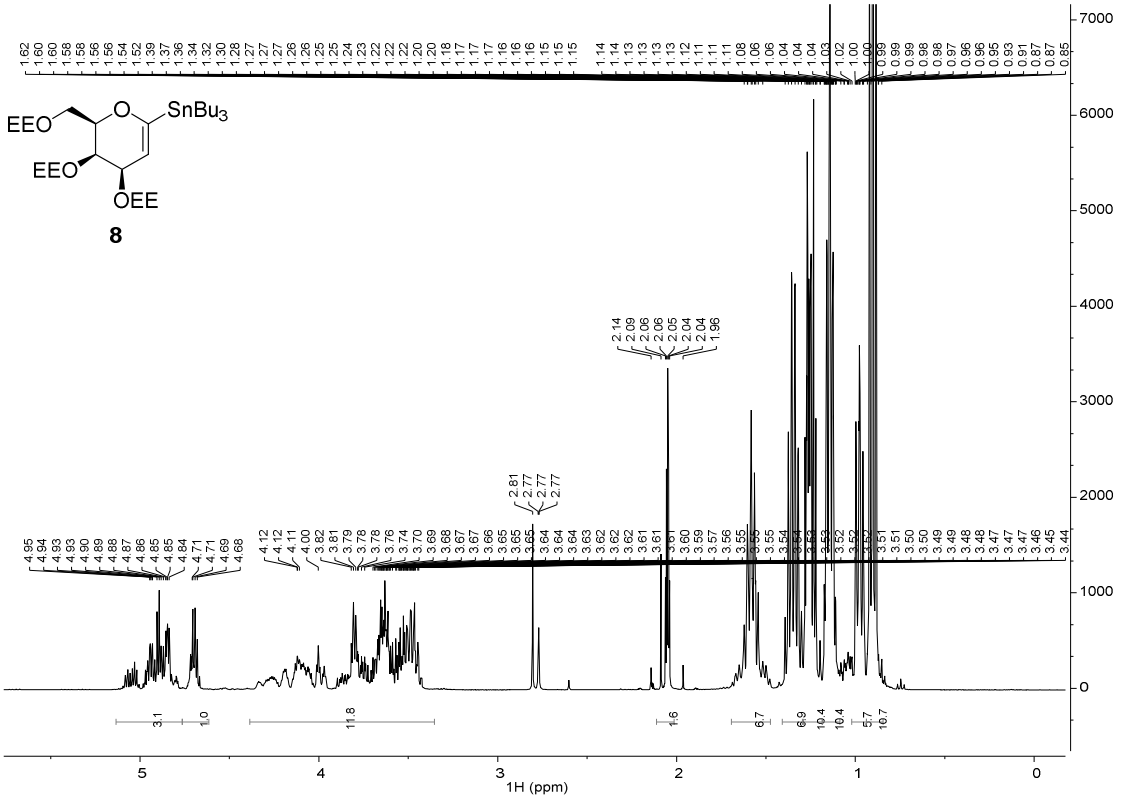
Spectra S6. ^{1}H and ^{13}C NMR of compound **4.**

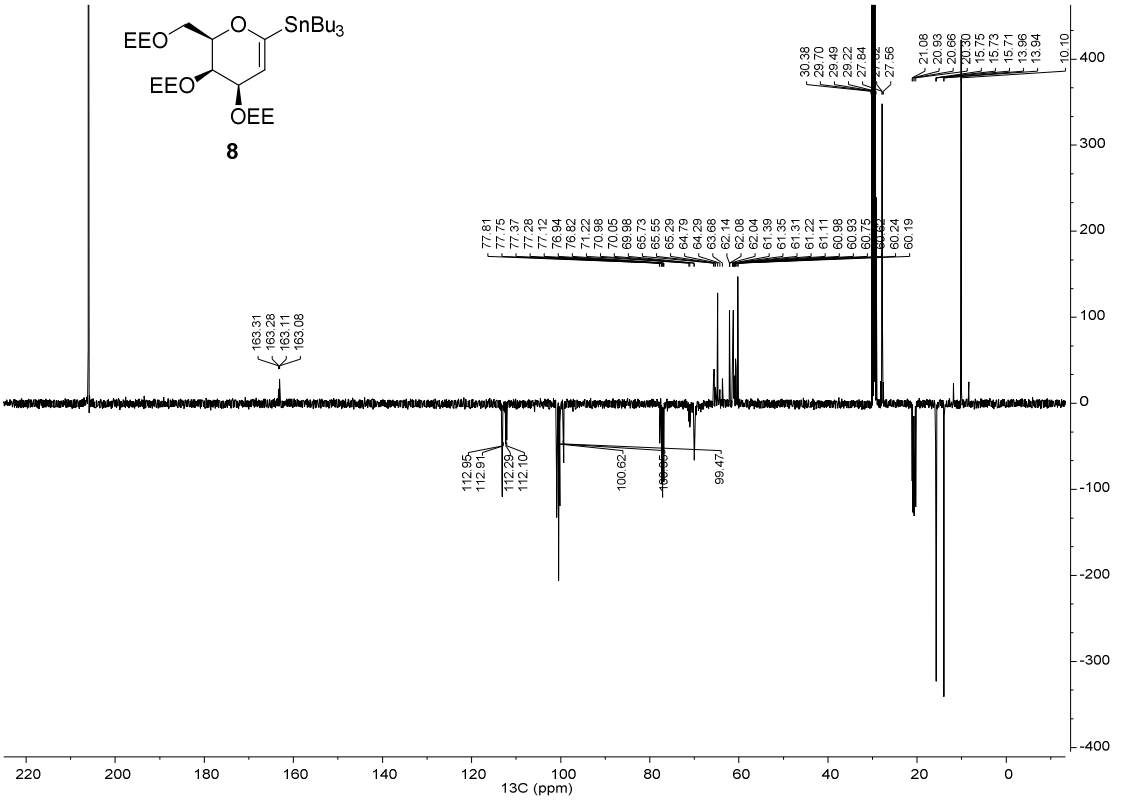


Spectra S7. ^{1}H and ^{13}C NMR of compound **6b.**

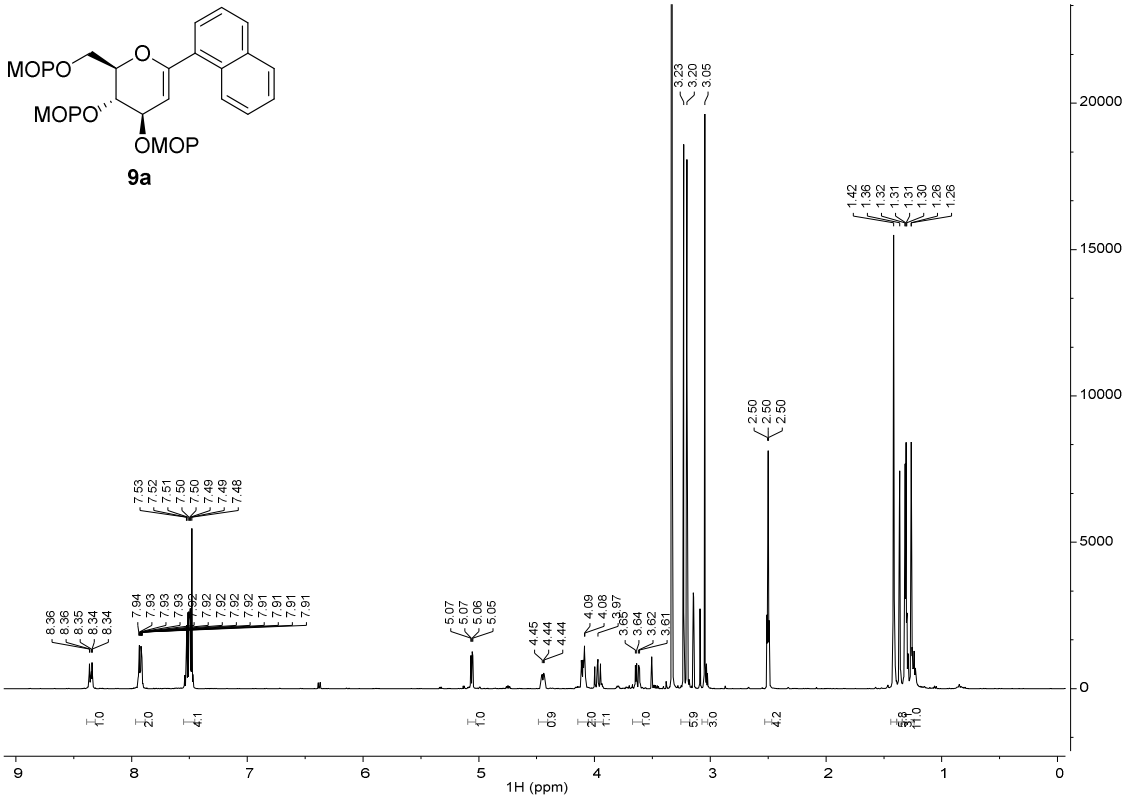


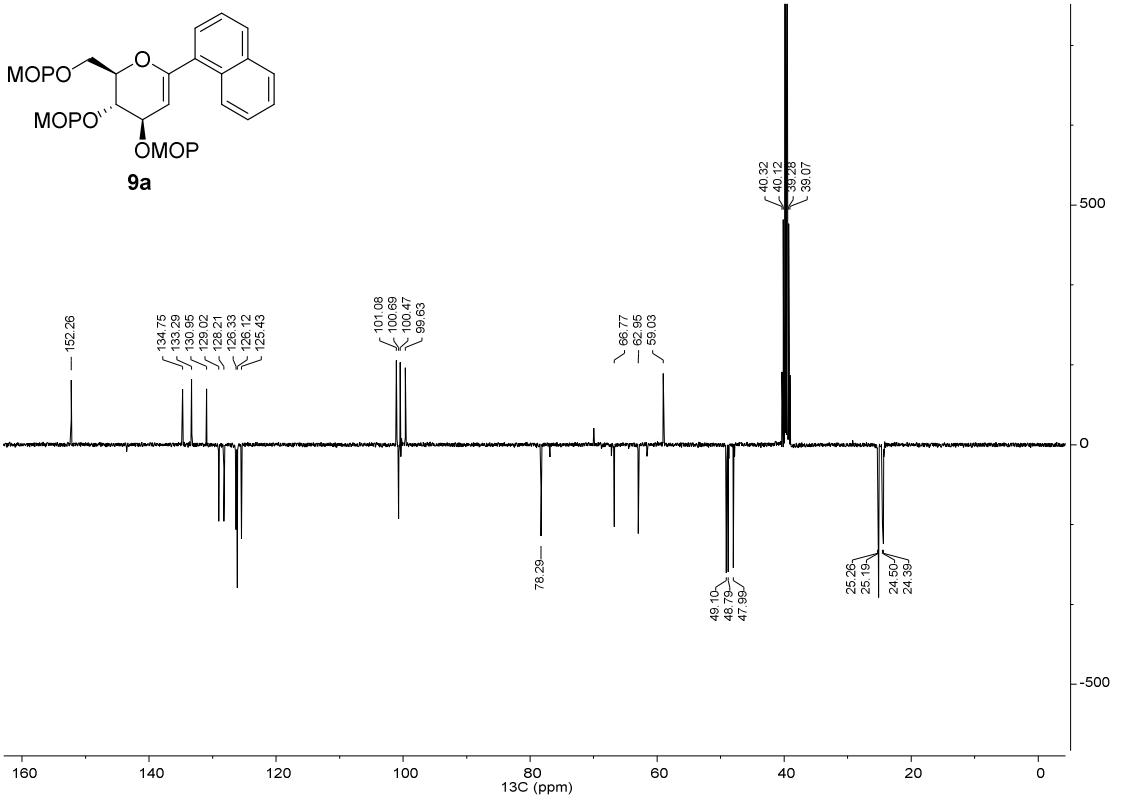
Spectra S8. ^{1}H and ^{13}C NMR of compound **8.**



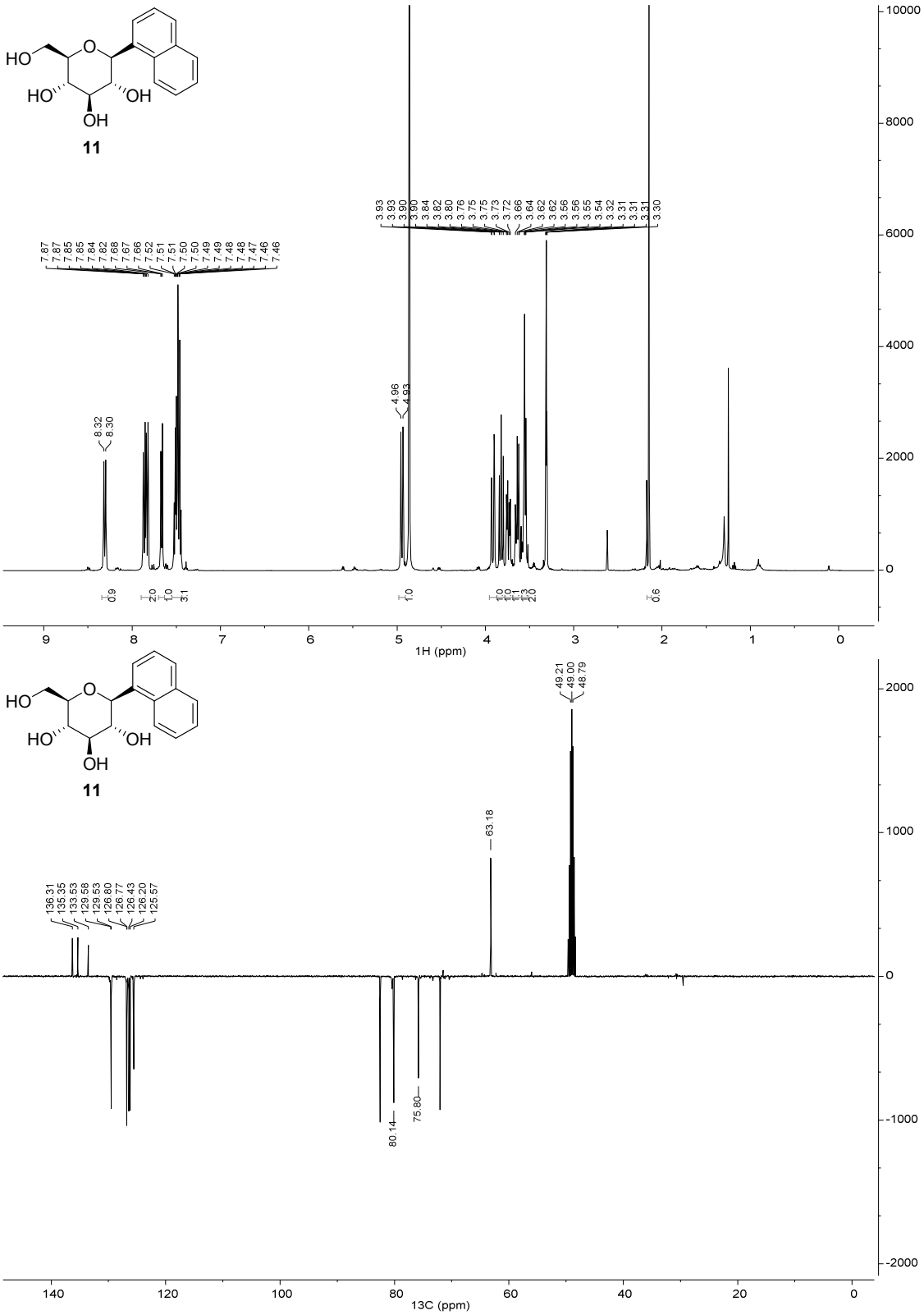


Spectra S9. ^{1}H and ^{13}C NMR of compound **9a.**

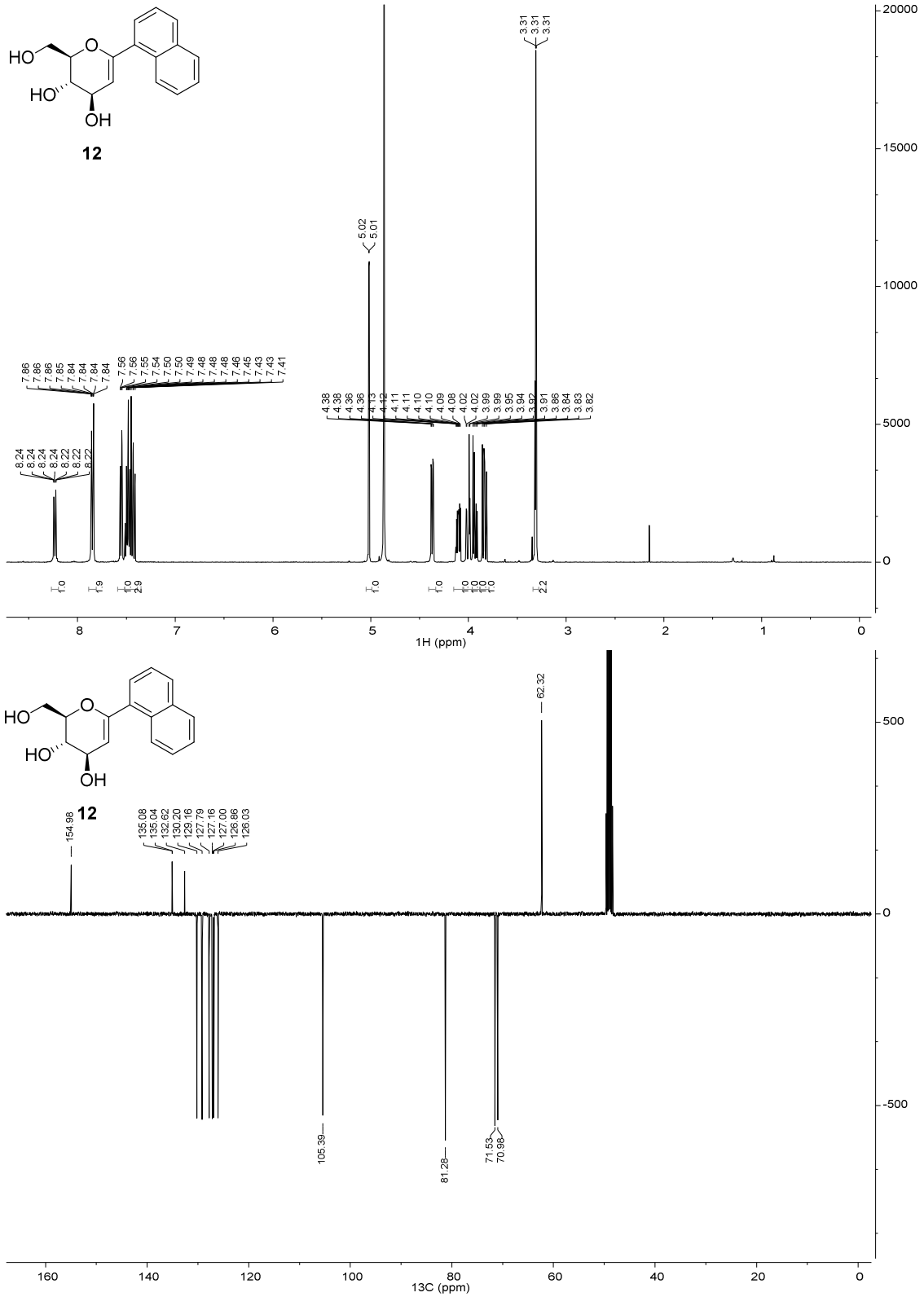




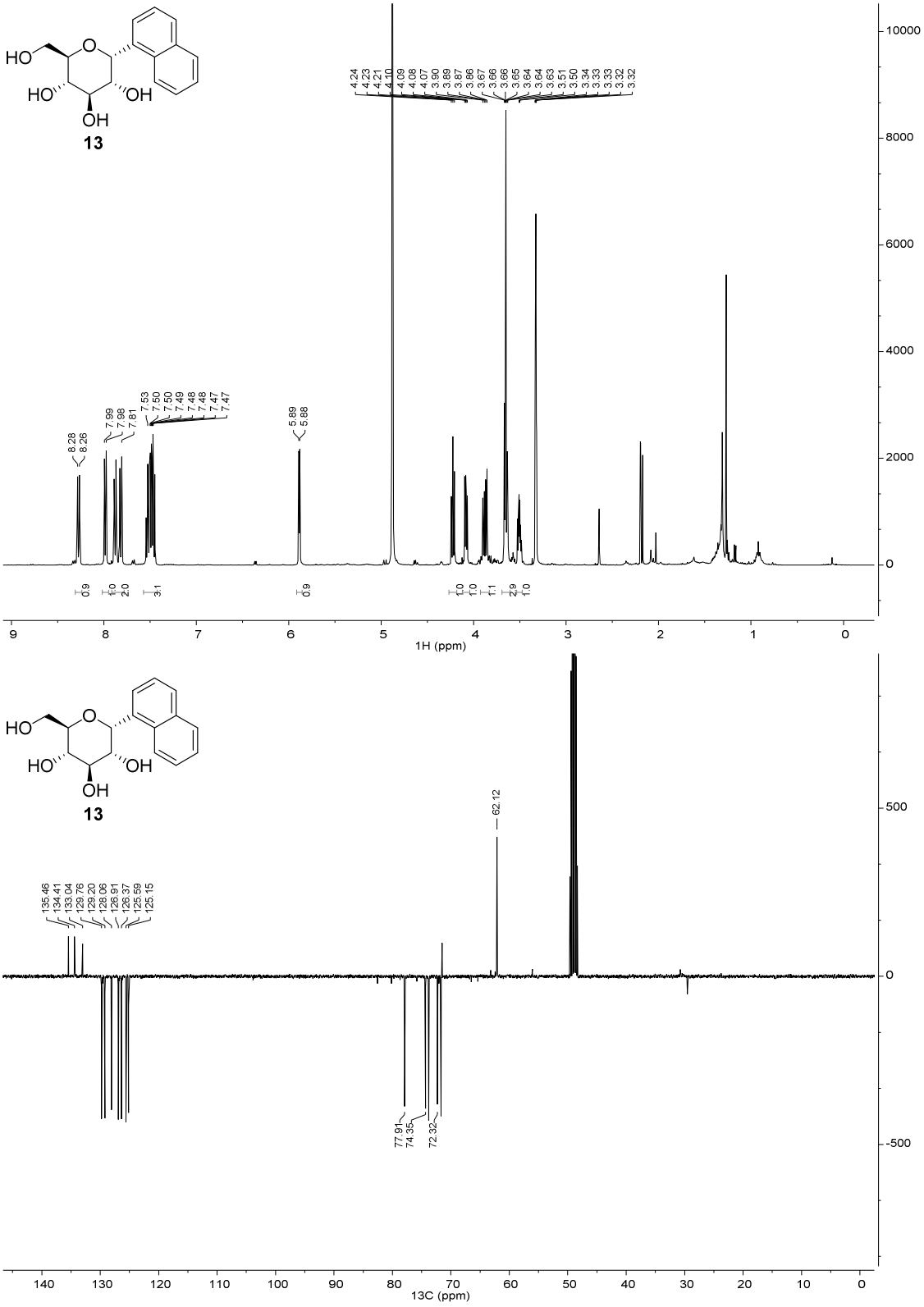
Spectra S10. ^{1}H and ^{13}C NMR of compound **11.**



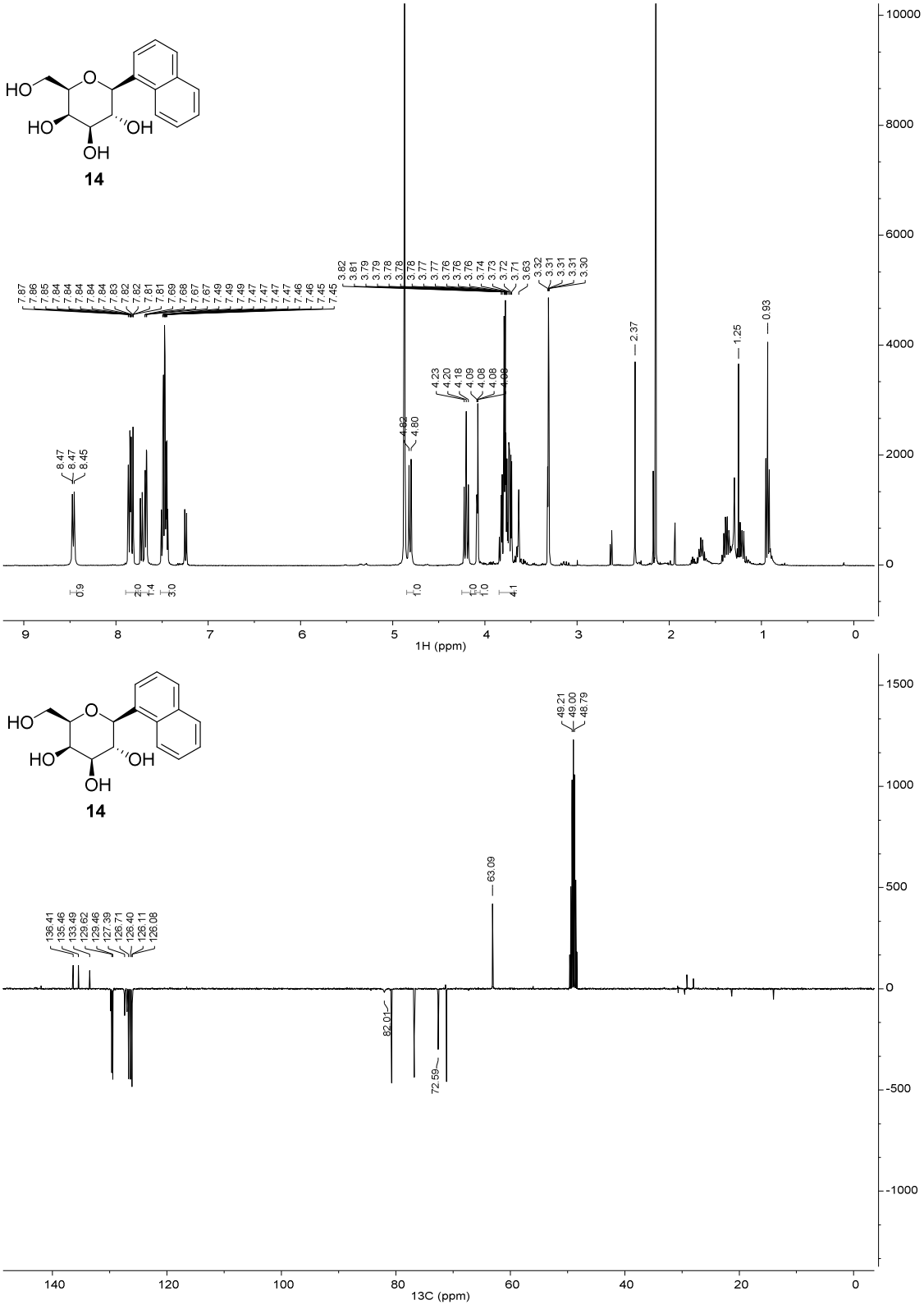
Spectra S11. ^{1}H and ^{13}C NMR of compound **12.**



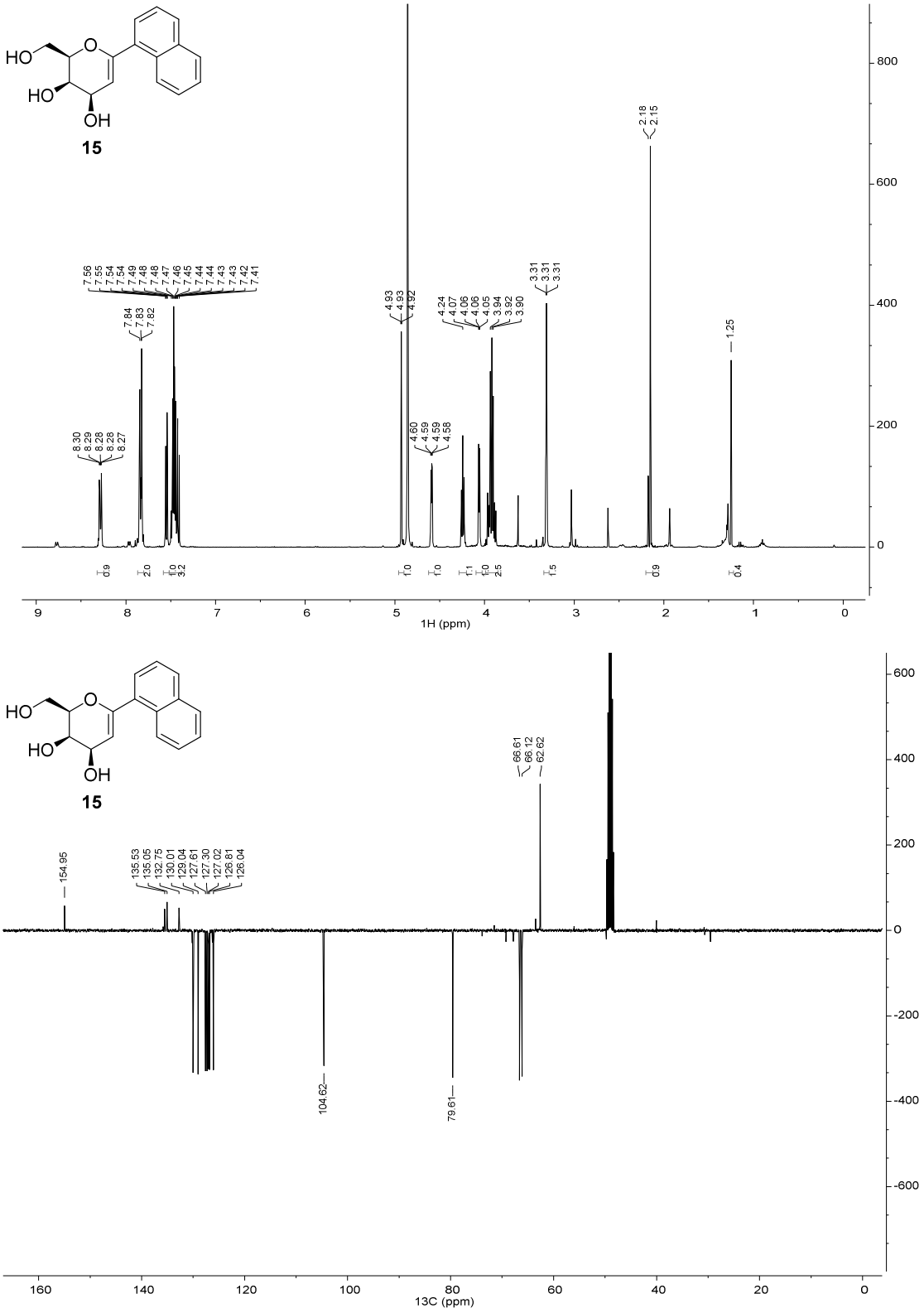
Spectra S12. ^{1}H and ^{13}C NMR of compound **13.**



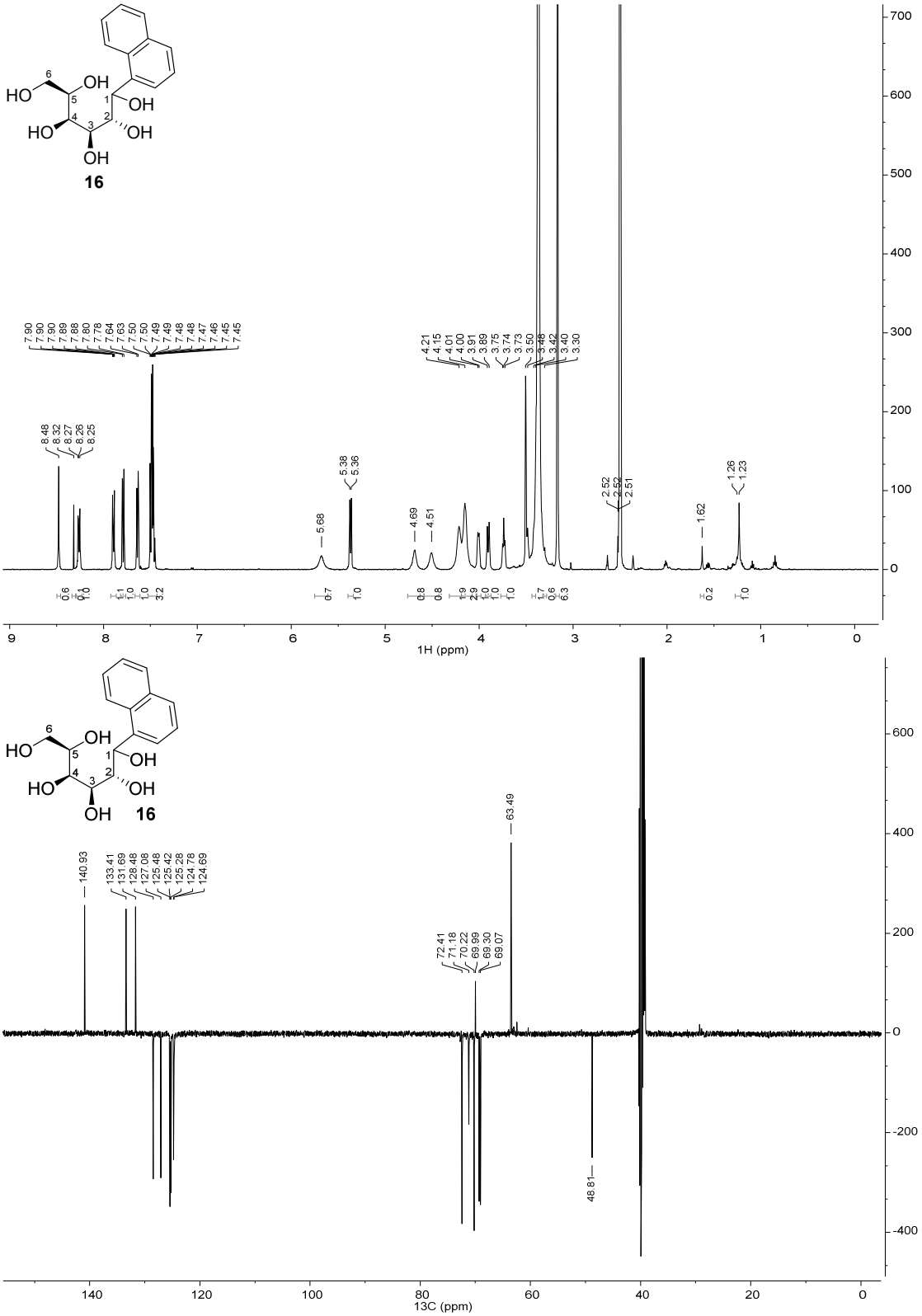
Spectra S13. ^{1}H and ^{13}C NMR of compound **14.**



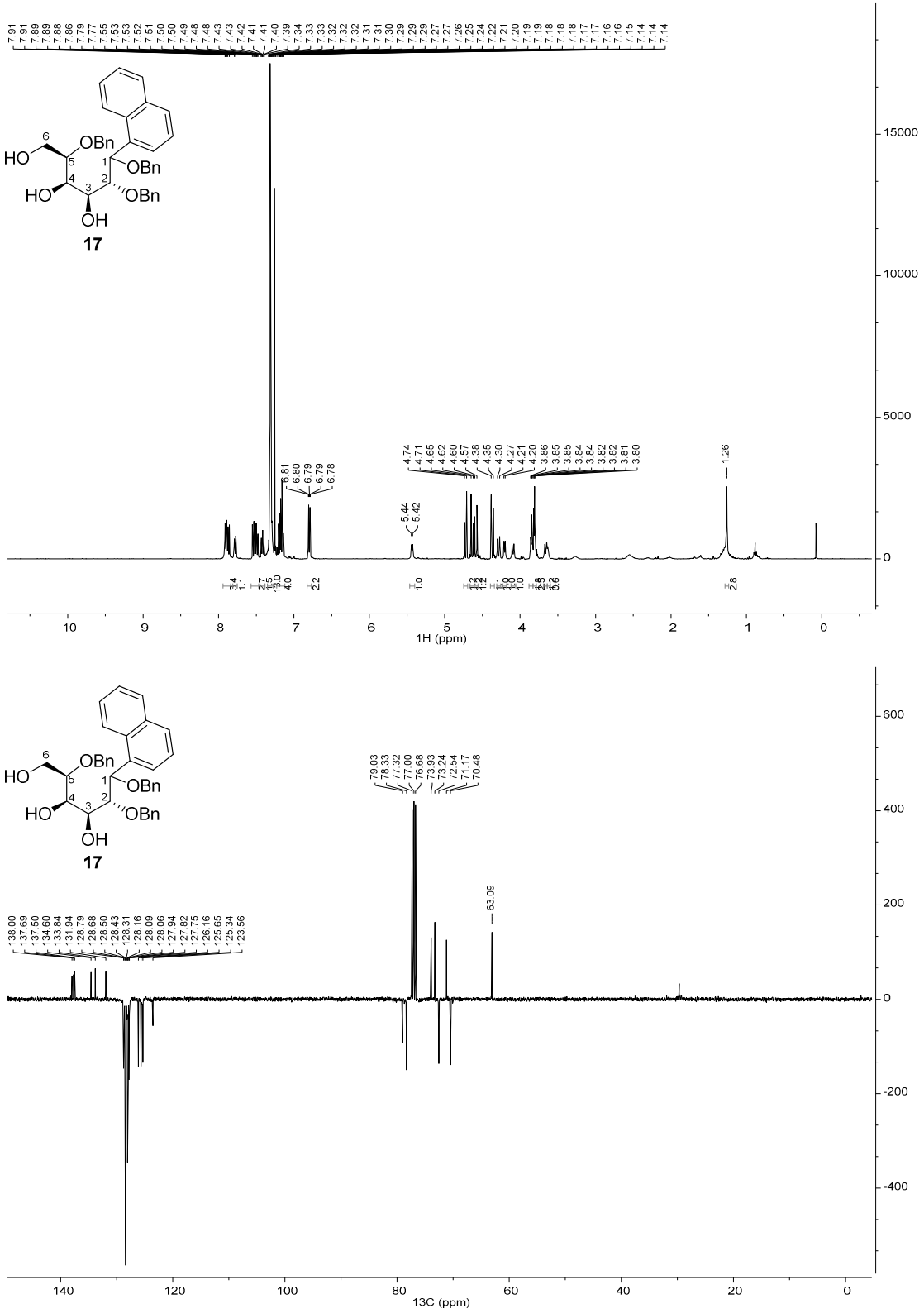
Spectra S14. ^{1}H and ^{13}C NMR of compound **15.**



Spectra S15. ^{1}H and ^{13}C NMR of compound **16.**



Spectra S16. ^{1}H and ^{13}C NMR of compound **17.**



Spectra S17. ^{1}H and ^{13}C NMR of compound **18.**