Chemistry of Heterocyclic Compounds **2024**, *60*(1/2), 58–67

A cascade reaction of 4-amino-substituted 6-hydrazinyl-1,3,5-triazin-2(1*H*)-ones with triethyl orthoacetate

Anna V. Zavodskaya[1], Victor E. Parfenov[1], Olga V. Golovina[1], Vladimir V. Bakharev[1]*

[1] *Samara State Technical University,*
244 Molodogvardeyskaya St., Samara 443100, Russia; e-mail: knilsstu@gmail.com

SUPPLEMENTARY INFORMATION

1. Experimental data

1.1. General methods

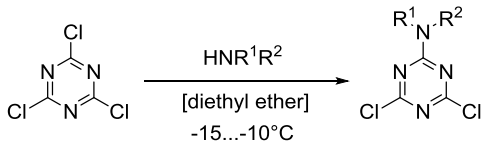
FT-IR spectra were recorded on a Nicolet Avatar 360ESP FT-IR spectrophotometer with ZnSe ATR accessory. ^{1}H and ^{13}C NMR spectra (400 and 100 MHz, respectively), DEPT-135, two-dimensional ^{1}H-^{13}C HMBC NMR spectra were recorded on a JEOL JNM ECX-400 spectrometer in DMSO-d_6, internal standard - residual solvent signal [DMSO-d6, δ = 2.50 ppm (^{1}H), δ = 39.5 ppm (^{13}C)]. Coupling constant (*J*) values are reported in Hertz (Hz). Elemental analysis was performed on a EuroVectorEA 3000 microanalyzer. Melting points of products were determined on a Gallenkamp instrument and were not corrected. The progress of the reactions and the purity of the resulting compounds were monitored by TLC on Merck Silica Gel 60 F254 plates, eluent $CHCl_3$/i-PrOH (95:5), development in UV light and iodine vapor. For column chromatography, silica gel, fraction 0.04–0.063 mm (Merck), eluent AcOEt/EtOH (9:1) was used.

X-ray diffraction analysis was performed at the Institute of Organic Synthesis named I. Postovsky Ural Branch of the Russian Academy of Sciences on a "Xcalibur 3" diffractometer on standart procedure (MoK-irradiation, graphite monochromator, ω-scans with 1^{o} step at T= 295(2) K). Using Olex2 [1], the structure was solved with the ShelXS [2] structure solution program using Direct Methods and refined with the ShelXL [3] refinement package using Least Squares minimization. The non-hydrogen atoms were refined in the anisotropic approximation, hydrogen atoms were refined isotropically in the riding model.

The geometry optimization was performed using Gaussian-09 software [4] using the B3LYP functional and 6-311++G(d,p) Pople's base set. The AIMAll Standard operating mode [5]was used for calculating electron density properties.

All solvents and chemicals used were reagent grade and were used without additional purification. Methods for the synthesis of 6-amino-substituted 4-hydrazinyl-1,3,5-triazin-2(1H)-ones **1a-d** and 5-piperidino[1,2,4]triazolo[1,5-a][1,3,5]triazin-7-one **2e** are described in the work [6].

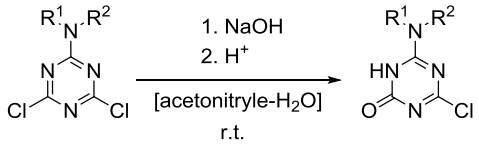
1.2. General procedure for synthesis of 2-amino-substituted 4,6-dichloro[1,3,5]triazines



An amine (20 mmol) (dimethylamine as a 33% aq. solution, other amines as a 10% solution in diethyl ether) was added dropwise to a vigorously stirred suspension of cyanuric chloride (3.69 g, 20 mmol) in diethyl ether (60 mL) at -15…-10°C over 1 h. The resulting mixture was stirred at the same temperature for additional 30-45 min

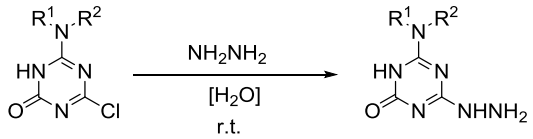
(TLC monitoring for cyanuric chloride, eluent DCE). Diethyl ether was evaporated to dryness, and the residue was treated with water (50 mL). Insoluble white solid was filtered off and dried in air at room temperature.

1.3. General procedure for synthesis of 4-amino-substituted 6-chloro[1,3,5]triazin-2(1*H*)-ones



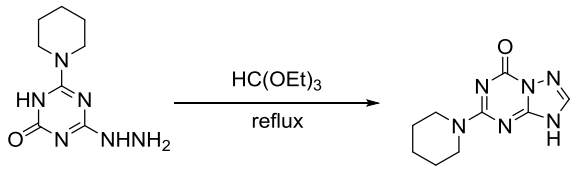
2-Aminosubstituted 4,6-dichloro-1,3,5-triazine (2 mmol) was added to a magnetically stirred mixture of 1.0 M aq. sodium hydroxide (4 mL) and acetonitrile (10 mL) at r.t. The reaction mixture was stirred for 20 min under the same conditions, then 1.0 M aq. sodium hydroxide (4 mL) and 2-aminosubstituted 4,6-dichloro-1,3,5-triazine (2 mmol) were added. After stirring for 20 min, this operation was repeated 3 more times. The reaction mixture was maintained at room temperature, and completion of the reaction was monitored by TLC (eluent DCE). The reaction mixture was filtered off, and the filtrate was acidified with a dilute hydrochloric acid to pH 2-3. The precipitate was filtered off, washed with water (2×30 mL), and dried in air.

1.4. General procedure for synthesis of 4-amino-substituted 6-hydrazinyl[1,3,5]triazin-2(1*H*)-ones



Hydrazine hydrate (6.2 mL, 100 mmol) was added dropwise to a stirred suspension of 4-amino-substituted 6-chloro[1,3,5]triazin-2(1*H*)-one (10 mmol) in water (15 mL) at 20-22 °C. The resulting mixture was stirred at the same temperature for 24 h. Then the mixture was filtered off, washed twice with water (5 mL) and twice with ethanol (5 mL) and dried in air at room temperature for 24 h to give corresponding hydrazine derivatives. No additional purification was required.

1.5. Preparation of 5-piperidino[1,2,4]triazolo[1,5-*a*][1,3,5]triazin-7-one 2e



A suspension of 6-hydrazinyl-4-piperidino-[1,3,5]triazin-2(1*H*)-one (2.1 g, 10 mmol) in ethyl orthoformate (7 mL) was stirred at reflux. After the reaction was complete (TLC), the excess of ethyl orthoformate was removed under reduced pressure, and the solid residue was suspended in water (20 mL), filtered, washed with

acetone (5 mL) and dried at room temp to obtain the crude product. Crude product was recrystallized from 70% aqueous ethanol. Yield 1.92 g (87%).

1.6. Synthesis of 5-amino-substituted 2-methyl[1,2,4]triazolo[1,5-*a*][1,3,5]triazin-7-ones 2a-d

A suspension of **1a-d** (4 mmol) in triethyl orthoacetate (7 mL) was stirred at 85-90 °C for 5-10 hours (control of the starting materials **1a-d** by TLC). Reaction mixture was cooled, the precipitate was filtered off, washed with isopropanol (5 mL) and dried in air.

1.7. Alkylation of 5-aminosubstituted 2-methyl[1,2,4]triazolo[1,5-*a*][1,3,5]triazine-7-ones 2a-d with triethyl orthoacetate

A suspension of **2a-d** (4 mmol) in triethyl orthoacetate (10 mL) was stirred at 95-100 °C for 19-20 hours (control of the starting materials **2a-d** by TLC). The excess of triethyl orthoacetate was removed from the reaction mixture under reduced pressure. The resulting dry mixture was separated by column chromatography (SiO_2, ethyl acetate-ethanol 9:1). Yields of products **3-5a-d** for this reaction are given in Table 1 of the article.

1.8. Alkylation of 5-piperidino[1,2,4]triazolo[1,5-*a*][1,3,5]triazine-7-one 2e with triethyl orthoacetate

A suspension of **2e** (4 mmol) in triethyl orthoacetate (10 mL) was stirred at 95-100 °C for 24 hours (control of the starting materials **2e** by TLC). The excess of triethyl orthoacetate was removed from the reaction mixture under reduced pressure. The resulting dry mixture was separated by column chromatography (SiO_2, ethyl acetate-ethanol 9:1). Yields of products **3-5e** for this reaction are given in Table 1 of the article.

1.9. Alkylation of 2-methyl-5-piperidino[1,2,4]triazolo[1,5-*a*][1,3,5]triazine-7-one 2c with triethyl orthoformate

A suspension of **2c** (4 mmol) in triethyl orthoformate (8 mL) was stirred at 95-100 °C for 70 hours (control of the starting materials **2c** by TLC). The excess of triethyl orthoacetate was removed from the reaction mixture under reduced pressure. The resulting dry mixture was separated by column chromatography (SiO_2, ethyl acetate-ethanol 9:1). Conversion of starting material **2c** and yields of products **3-5c** for this reaction are given in Table 1 of the article.

1.10. Cascade *one pot* reaction of 6-amino-substituted 4-hydrazinyl[1,3,5]triazin-2(1*H*)-ones 1a-d with triethyl orthoacetate

A suspension of **1a-d** (4 mmol) in triethyl orthoacetate (10 mL) was stirred at 95-100 °C for 24-30 hours (control by TLC, till there were traces of intermediate **2a-d**). The excess of triethyl orthoacetate was removed from the reaction mixture under reduced pressure. The resulting dry mixture was separated by column chromatography

(SiO_2, ethyl acetate-ethanol 9:1). Yields of products **3-5a-d** for this reaction are given in Table 2 of the article.

2. Crystallographic data

2.1. X-ray analysis data for compound 2c

Crystal Data. $C_{10}H_{14}N_6O$, M =234.27, orthorhombic, a = 13.6599(5) Å, b = 8.5807(4) Å, c = 19.8344(8) Å, V = 2324.82(17) Å^3, space group Pbca, Z = 8, μ(Mo Kα) = 0.094 mm^{-1}, 7946 reflections measured, 2882 unique (R_{int} = 0.0301) which were used in all calculations. The final wR_2 = 0.1539 (all data) and R_1 = 0.0446 (I>2σ(I)).

Table 1S. X-ray diffraction data for **2c**

Identification code	CCDC 2239695
Empirical formula	$C_{10}H_{14}N_6O$
Formula weight	234.27
Temperature/K	295(2)
Crystal system	orthorhombic
Space group	Pbca
a/Å	13.6599(5)
b/Å	8.5807(4)
c/Å	19.8344(8)
α/°	90.00
β/°	90.00
γ/°	90.00
Volume/Å^3	2324.82(17)
Z	8
ρ_{calc}mg/mm^3	1.339
m/mm^{-1}	0.094
F(000)	992.0
Crystal size/mm^3	0.25 × 0.17 × 0.06
2Θ range for data collection	5.08 to 56.56°
Index ranges	-18 ≤ h ≤ 16, -11 ≤ k ≤ 11, -24 ≤ l ≤ 26
Reflections collected	7946
Independent reflections	2882[R(int) = 0.0301]
Data/restraints/parameters	2882/0/160
Goodness-of-fit on F^2	1.004
Final R indexes [I>=2σ (I)]	R_1 = 0.0446, wR_2 = 0.1344
Final R indexes [all data]	R_1 = 0.0702, wR_2 = 0.1539
Largest diff. peak/hole / ēÅ^{-3}	0.20/-0.18

Table 2S. Fractional Atomic Coordinates (×10^4) and Equivalent Isotropic Displacement Parameters (Å^2×10^3) for **2c**. U_{eq} is defined as 1/3 of of the trace of the orthogonalised U_{IJ} tensor.

Atom	*x*	*y*	*z*	U(eq)
N2	2955.0(8)	-4.5(15)	6740.4(6)	43.3(3)
N1	2567.3(8)	-856.5(15)	7272.7(6)	36.8(3)
C7	2152.3(10)	-2531.2(18)	8336.2(7)	38.0(3)
N6	3122.2(8)	-2256.7(15)	8228.3(6)	40.5(3)
C5	3268.6(9)	-1408.3(17)	7688.4(7)	34.6(3)
N8	1405.4(8)	-2020.1(15)	7956.4(6)	41.0(3)
N10	1931.5(10)	-3383.5(17)	8885.2(7)	51.2(4)
C9	1576.0(9)	-1166.4(19)	7406.6(7)	39.6(4)
N4	4118.3(9)	-894.5(15)	7424.5(6)	39.5(3)
O1	941.1(7)	-648.8(15)	7027.7(6)	56.8(4)
C15	925.0(13)	-3734(2)	9085.0(9)	56.1(5)
C11	2676.8(14)	-4039(2)	9328.9(9)	60.7(5)
C12	2517.9(18)	-3531(2)	10050.6(10)	71.1(6)
C13	1486(2)	-3865(3)	10280.4(10)	81.3(7)
C14	755.5(17)	-3157(2)	9794.5(9)	70.5(6)
C1	4655.9(12)	643(2)	6425.1(9)	55.2(5)
C3	3891.7(10)	-63.0(17)	6855.3(7)	39.4(3)

Table 3S. Anisotropic Displacement Parameters ($Å^2 \times 10^3$) for **2c**. The Anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U_{11}+...+2hka \times b \times U_{12}]$

Atom	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
N2	27.9(6)	61.3(8)	40.7(7)	9.4(6)	2.3(5)	-1.2(5)
N1	20.9(5)	54.5(7)	35.0(6)	4.4(5)	0.4(4)	-1.7(5)
C7	32.1(7)	44.8(7)	37.2(7)	-4.6(6)	7.3(6)	-1.3(6)
N6	27.4(6)	55.9(7)	38.2(6)	5.3(6)	4.0(5)	1.7(5)
C5	21.8(6)	47.0(7)	34.8(7)	-3.4(6)	0.6(5)	1.6(6)
N8	25.1(5)	59.4(7)	38.5(6)	-1.1(6)	4.7(5)	-4.0(5)
N10	42.7(7)	65.0(9)	46.0(7)	11.5(7)	11.0(6)	-2.1(6)
C9	20.2(6)	60.0(9)	38.6(7)	-4.9(7)	1.0(5)	-1.9(6)
N4	20.2(5)	56.6(7)	41.9(7)	6.3(6)	0.7(5)	-1.3(5)
O1	22.9(5)	99(1)	48.4(6)	11.3(6)	-3.3(5)	-0.3(5)
C15	49.1(9)	58.8(9)	60.4(10)	6.0(9)	19.6(8)	-9.7(8)
C11	55.3(10)	71.7(12)	55.1(10)	20.9(9)	10.2(8)	8.1(9)
C12	93.2(16)	63.0(11)	57.1(11)	11.2(10)	-4.7(11)	8.7(11)
C13	109.0(18)	84.4(14)	50.5(10)	9.3(11)	25.5(12)	30.7(14)
C14	76.7(14)	72.0(12)	62.8(11)	6.7(10)	31.2(11)	13.1(11)
C1	34.6(7)	70.2(11)	60.8(10)	17.8(9)	8.7(7)	-4.1(7)
C3	27.3(7)	50.6(8)	40.3(7)	4.2(6)	1.4(6)	-1.1(6)

Table 4S. Bond Lengths for **2c**.

Bond	Length/Å	Bond	Length/Å
N2-N1	1.3890(16)	N10-C15	1.462(2)
N2-C3	1.3006(18)	N10-C11	1.459(2)
N1-C5	1.3496(17)	C9-O1	1.2305(17)
N1-C9	1.4053(16)	N4-C3	1.3709(19)
C7-N6	1.3626(17)	C15-C14	1.510(2)
C7-N8	1.3420(18)	C11-C12	1.512(3)
C7-N10	1.3458(19)	C12-C13	1.509(3)
N6-C5	1.3104(18)	C13-C14	1.515(3)
C5-N4	1.3474(17)	C1-C3	1.478(2)
N8-C9	1.3342(19)		

Table 5S. Bond Angles for **2c**.

Atoms	Angle/°	Atoms	Angle/°
C3-N2-N1	102.81(11)	C11-N10-C15	114.42(14)
N2-N1-C9	127.63(12)	N8-C9-N1	115.26(12)
C5-N1-N2	112.23(11)	O1-C9-N1	119.70(13)
C5-N1-C9	120.14(12)	O1-C9-N8	125.05(12)
N8-C7-N6	126.48(13)	C5-N4-C3	107.20(12)
N8-C7-N10	117.48(13)	N10-C15-C14	109.23(16)
N10-C7-N6	116.04(13)	N10-C11-C12	111.10(16)
C5-N6-C7	111.89(12)	C13-C12-C11	111.44(19)
N6-C5-N1	125.86(12)	C12-C13-C14	110.32(17)
N6-C5-N4	129.10(12)	C15-C14-C13	111.13(16)
N4-C5-N1	105.03(12)	N2-C3-N4	112.73(13)
C9-N8-C7	120.37(11)	N2-C3-C1	125.30(14)
C7-N10-C15	122.81(14)	N4-C3-C1	121.95(13)
C7-N10-C11	122.77(14)		

Table 6S. Torsion Angles for **2c**.

Atoms	Angle/°	Atoms	Angle/°
N2-N1-C5-N6	-179.54(13)	C5-N1-C9-O1	179.45(14)
N2-N1-C5-N4	0.53(16)	C5-N4-C3-N2	0.35(18)
N2-N1-C9-N8	-179.94(13)	C5-N4-C3-C1	-178.43(14)
N2-N1-C9-O1	-0.3(2)	N8-C7-N6-C5	-0.3(2)
N1-N2-C3-N4	-0.03(16)	N8-C7-N10-C15	-1.4(2)
N1-N2-C3-C1	178.71(15)	N8-C7-N10-C11	178.42(16)
N1-C5-N4-C3	-0.52(16)	N10-C7-N6-C5	-179.39(13)
C7-N6-C5-N1	-0.4(2)	N10-C7-N8-C9	179.84(14)
C7-N6-C5-N4	179.52(15)	N10-C15-C14-C13	-56.7(2)
C7-N8-C9-N1	-0.5(2)	N10-C11-C12-C13	52.5(2)
C7-N8-C9-O1	179.92(15)	C9-N1-C5-N6	0.6(2)
C7-N10-C15-C14	-122.95(17)	C9-N1-C5-N4	-179.28(12)
C7-N10-C11-C12	124.71(18)	C15-N10-C11-C12	-55.5(2)
N6-C7-N8-C9	0.8(2)	C11-N10-C15-C14	57.3(2)
N6-C7-N10-C15	177.78(14)	C11-C12-C13-C14	-53.5(2)
N6-C7-N10-C11	-2.4(2)	C12-C13-C14-C15	56.1(3)
N6-C5-N4-C3	179.56(15)	C3-N2-N1-C5	-0.32(16)
C5-N1-C9-N8	-0.2(2)	C3-N2-N1-C9	179.48(14)

Table 7S. Hydrogen Atom Coordinates (Å×10^4) and Isotropic Displacement Parameters (Å^2×10^3) for **2c**.

Atom	*x*	*y*	*z*	U(eq)
H15A	813	-4850	9064	67
H15B	471	-3230	8779	67
H11A	3319	-3702	9180	73
H11B	2655	-5167	9304	73
H12A	2975	-4076	10341	85
H12B	2646	-2423	10089	85
H13A	1386	-3433	10727	98
H13B	1386	-4982	10305	98
H14A	97	-3427	9935	85
H14B	815	-2031	9804	85
H1A	4353	1198	6061	83
H1B	5069	-162	6247	83
H1C	5042	1352	6689	83
H4	4699(16)	-940(20)	7603(9)	60(5)

2.2. X-ray analysis for compound 3c

Crystal Data. $C_{12}H_{18}N_6O$, M =262.32, triclinic, a = 8.3130(6) Å, b = 8.9378(7) Å, c = 9.6496(8) Å, α = 108.448(7)°, β = 91.501(7)°, γ = 104.382(7)°, V = 654.50(9) Å^3, T = 295(2), space group P-1, Z = 2, μ(Mo Kα) = 0.091 mm^{-1}, 6163 reflections measured, 3558 unique (R_{int} = 0.0235) which were used in all calculations. The final wR_2 was 0.1427 (all data) and R_1 was 0.0498 (I>2σ(I)).

Table 8S. X-ray diffraction data for **3c**

Identification code	CCDC 2239693
Empirical formula	$C_{12}H_{18}N_6O$
Formula weight	262.32
Temperature/K	295(2)
Crystal system	triclinic
Space group	P-1
a/Å	8.3130(6)
b/Å	8.9378(7)
c/Å	9.6496(8)
α/°	108.448(7)
β/°	91.501(7)
γ/°	104.382(7)
Volume/Å^3	654.50(9)
Z	2
ρ_{calc}mg/mm^3	1.331
m/mm^{-1}	0.091

F(000)	280.0
Crystal size/mm^3	0.25 × 0.2 × 0.15
2Θ range for data collection	4.48 to 60.98°
Index ranges	-11 ≤ h ≤ 11, -10 ≤ k ≤ 12, -13 ≤ l ≤ 13
Reflections collected	6163
Independent reflections	3558[R(int) = 0.0235]
Data/restraints/parameters	3558/0/174
Goodness-of-fit on F^2	1.009
Final R indexes [I>=2σ (I)]	R_1 = 0.0498, wR_2 = 0.1238
Final R indexes [all data]	R_1 = 0.0727, wR_2 = 0.1427
Largest diff. peak/hole / e Å^{-3}	0.19/-0.28

Table 8S. Fractional Atomic Coordinates (×10^4) and Equivalent Isotropic Displacement Parameters (Å^2×10^3) for **3c**. U_{eq} is defined as 1/3 of of the trace of the orthogonalised U_{IJ} tensor.

Atom	***x***	***y***	***z***	**U(eq)**
O1	-2358.8(13)	1388.3(14)	332.8(12)	53.0(3)
N1	1102.3(15)	1981.6(15)	-101.6(13)	43.4(3)
N3	3019.0(14)	2346.9(14)	1712.0(13)	40.0(3)
N4	1243.1(14)	2160.5(14)	3600.3(13)	39.7(3)
N5	-867.4(15)	1734.3(15)	5041.9(13)	45.6(3)
N6	-1662.3(13)	1586.1(14)	2703.2(13)	40.2(3)
N8	390.9(13)	1955.3(14)	1173.2(12)	37.3(3)
C1	3978(2)	2295(2)	-744.8(19)	55.9(4)
C2	2679.2(17)	2212.8(17)	272.2(16)	42.1(3)
C3	4613.1(17)	2484.9(19)	2486.2(18)	48.3(4)
C4	5732(2)	4188(2)	3001(3)	71.8(5)
C5	-431.5(16)	1837.9(16)	3739.0(15)	36.5(3)
C7	-1337.0(16)	1617.6(16)	1354.3(16)	39.0(3)
C9	1535.5(15)	2161.4(15)	2277.0(15)	35.4(3)
C10	321(2)	2325.6(19)	6363.4(16)	48.3(4)
C11	-23(2)	3828(2)	7442.3(18)	58.0(4)
C12	-1823(3)	3476(2)	7781(2)	66.2(5)
C13	-3017(2)	2784(2)	6390(2)	65.1(5)
C14	-2607(2)	1318(2)	5325.4(19)	55.5(4)

Table 9S. Anisotropic Displacement Parameters ($Å^2 \times 10^3$) for **3c**. The Anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U_{11}+...+2hka \times b \times U_{12}]$.

Atom	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
O1	35.8(5)	77.0(7)	50.4(6)	24.1(5)	1.6(5)	19.4(5)
N1	40.9(6)	54.2(7)	39.5(6)	18.5(5)	11.7(5)	16.1(5)
N3	29.6(5)	50.6(7)	43.2(6)	16.7(5)	10.8(5)	14.8(5)
N4	31.2(5)	51.0(7)	39.4(6)	15.1(5)	7.7(5)	15.1(5)
N5	39.3(6)	60.0(7)	38.2(6)	14.8(5)	12.4(5)	16.1(5)
N6	29.7(5)	51.8(7)	41.2(6)	15.1(5)	9.4(5)	15.1(5)
N8	30.8(5)	48.1(6)	36.6(6)	15.3(5)	8.6(4)	15.0(5)
C1	47.4(8)	70.4(10)	53.1(10)	24.2(8)	23.7(7)	15.1(7)
C2	39.3(7)	47.3(7)	42.7(8)	16.7(6)	13.0(6)	14.0(6)
C3	29.6(6)	64.9(9)	59.5(9)	27.4(7)	10.1(6)	20.0(6)
C4	48.2(10)	69.2(12)	89.9(14)	20.8(10)	-11.7(10)	10.9(8)
C5	32.9(6)	39.1(7)	39.1(7)	11.3(5)	9.6(5)	14.4(5)
C7	29.9(6)	45.4(7)	44.2(8)	14.5(6)	6.4(5)	15.2(5)
C9	28.7(6)	39.5(7)	40.3(7)	13.0(5)	7.7(5)	13.0(5)
C10	50.5(8)	58.0(9)	40.5(8)	18.3(6)	7.5(6)	19.7(7)
C11	74.2(12)	54.6(9)	44.5(9)	15.3(7)	13.9(8)	17.0(8)
C12	87.9(13)	64.1(10)	55.7(10)	20.2(8)	36.3(10)	33.6(9)
C13	59.9(10)	87.6(13)	69.5(12)	40(1)	35.1(9)	37.8(9)
C14	42.9(8)	75.0(11)	51.6(9)	26.3(8)	18.7(7)	13.4(7)

Table 10S. Bond Lengths for **3c**.

Bond	Length/Å	Bond	Length/Å
O1-C7	1.2153(17)	N6-C5	1.3365(18)
N1-N8	1.3831(15)	N6-C7	1.3439(18)
N1-C2	1.2979(18)	N8-C7	1.4199(16)
N3-C2	1.3717(19)	N8-C9	1.3451(17)
N3-C3	1.4623(18)	C1-C2	1.482(2)
N3-C9	1.3552(16)	C3-C4	1.491(2)
N4-C5	1.3689(17)	C10-C11	1.514(2)
N4-C9	1.3063(18)	C11-C12	1.518(3)
N5-C5	1.3421(18)	C12-C13	1.507(3)
N5-C10	1.4594(19)	C13-C14	1.508(2)
N5-C14	1.4565(19)		

Table 11S. Bond Angles for **3c**.

Atoms	Angle/°	Atoms	Angle/°
C2-N1-N8	103.29(11)	N3-C3-C4	112.87(13)
C2-N3-C3	128.28(12)	N5-C5-N4	116.06(12)
C9-N3-C2	106.59(11)	N6-C5-N4	126.57(12)
C9-N3-C3	124.83(12)	N6-C5-N5	117.35(12)
C9-N4-C5	111.51(12)	O1-C7-N6	126.42(13)
C5-N5-C10	123.23(12)	O1-C7-N8	119.77(13)
C5-N5-C14	122.20(13)	N6-C7-N8	113.81(12)
C14-N5-C10	113.55(12)	N4-C9-N3	128.32(12)
C5-N6-C7	121.13(11)	N4-C9-N8	126.32(12)
N1-N8-C7	127.17(11)	N8-C9-N3	105.36(11)
C9-N8-N1	112.03(11)	N5-C10-C11	109.29(13)
C9-N8-C7	120.59(11)	C10-C11-C12	111.17(14)
N1-C2-N3	112.72(12)	C13-C12-C11	110.99(14)
N1-C2-C1	124.04(14)	C12-C13-C14	110.83(15)
N3-C2-C1	123.23(13)	N5-C14-C13	110.65(14)

Table 13S. Torsion Angles for **3c**.

Atoms	Angle/°	Atoms	Angle/°
N1-N8-C7-O1	-3.6(2)	C5-N6-C7-N8	-0.73(19)
N1-N8-C7-N6	176.30(12)	C7-N6-C5-N4	0.6(2)
N1-N8-C9-N3	0.82(15)	C7-N6-C5-N5	-177.93(12)
N1-N8-C9-N4	-178.53(12)	C7-N8-C9-N3	175.93(11)
N5-C10-C11-C12	55.50(18)	C7-N8-C9-N4	-3.4(2)
N8-N1-C2-N3	-0.42(15)	C9-N3-C2-N1	0.94(16)
N8-N1-C2-C1	178.53(14)	C9-N3-C2-C1	-178.02(14)
C2-N1-N8-C7	-174.97(12)	C9-N3-C3-C4	-105.54(18)
C2-N1-N8-C9	-0.26(15)	C9-N4-C5-N5	177.00(12)
C2-N3-C3-C4	81.6(2)	C9-N4-C5-N6	-1.5(2)
C2-N3-C9-N4	178.32(13)	C9-N8-C7-O1	-177.90(12)
C2-N3-C9-N8	-1.02(14)	C9-N8-C7-N6	2.00(18)
C3-N3-C2-N1	174.86(13)	C10-N5-C5-N4	15.4(2)
C3-N3-C2-C1	-4.1(2)	C10-N5-C5-N6	-165.96(12)
C3-N3-C9-N4	4.1(2)	C10-N5-C14-C13	58.62(18)
C3-N3-C9-N8	-175.21(12)	C10-C11-C12-C13	-54.2(2)
C5-N4-C9-N3	-176.25(12)	C11-C12-C13-C14	53.25(19)
C5-N4-C9-N8	2.96(19)	C12-C13-C14-N5	-54.65(19)
C5-N5-C10-C11	110.05(16)	C14-N5-C5-N4	-176.92(13)
C5-N5-C14-C13	-110.19(16)	C14-N5-C5-N6	1.8(2)

C5-N6-C7-O1	179.17(13)	C14-N5-C10-C11	-58.62(17)

Table 14S. Hydrogen Atom Coordinates (Å×10^4) and Isotropic Displacement Parameters (Å^2×10^3) for **3c**.

Atom	*x*	*y*	*z*	U(eq)
H1A	3454	2015	-1725	84
H1B	4612	1537	-724	84
H1C	4710	3385	-444	84
H3A	5179	1764	1836	58
H3B	4398	2123	3327	58
H4A	5989	4538	2170	108
H4B	6748	4215	3517	108
H4C	5181	4909	3648	108
H10A	1453	2597	6109	58
H10B	212	1476	6807	58
H11A	203	4711	7033	70
H11B	720	4182	8346	70
H12A	-2007	2700	8311	79
H12B	-2035	4479	8406	79
H13A	-2951	3619	5935	78
H13B	-4151	2462	6625	78
H14A	-2806	433	5730	67
H14B	-3330	946	4409	67

2.3. X-ray analysis for compound 5d

Crystal Data. $C_{11}H_{16}N_6O_2$, M =264.30, triclinic, a = 8.7595(4) Å, b = 8.8568(5) Å, c = 9.1491(5) Å, α = 76.870(5)°, β = 84.668(4)°, γ = 65.137(5)°, V = 627.16(6) Å^3, T = 295(2), space group P-1, Z = 2, μ(Mo Kα) = 0.102 mm^{-1}, 6034 reflections measured, 3412 unique (R_{int} = 0.0249) which were used in all calculations. The final wR_2 = 0.1713 (all data) and R_1 = 0.0533 (I>2σ(I)).

Table 15S.Crystal data and structure refinement for **5d**.

Identification code	
Empirical formula	$C_{11}H_{16}N_6O_2$
Formula weight	264.30
Temperature/K	295(2)
Crystal system	triclinic
Space group	P-1
a/Å	8.7595(4)
b/Å	8.8568(5)
c/Å	9.1491(5)
α/°	76.870(5)

β/°	84.668(4)
γ/°	65.137(5)
Volume/Å^3	627.16(6)
Z	2
ρ_{calc}mg/mm^3	1.400
m/mm^{-1}	0.102
F(000)	280.0
Crystal size/mm^3	0.25 × 0.2 × 0.15
2Θ range for data collection	4.58 to 61.8°
Index ranges	$-9 \le h \le 12$, $-7 \le k \le 12$, $-12 \le l \le 12$
Reflections collected	6034
Independent reflections	3412[R(int) = 0.0249]
Data/restraints/parameters	3412/0/174
Goodness-of-fit on F^2	1.002
Final R indexes [I>=2σ (I)]	R_1 = 0.0533, wR_2 = 0.1423
Final R indexes [all data]	R_1 = 0.0817, wR_2 = 0.1713
Largest diff. peak/hole / e Å^{-3}	0.26/-0.21

Table 16S. Fractional Atomic Coordinates (×10^4) and Equivalent Isotropic Displacement Parameters (Å^2×10^3) for **5d**. U_{eq} is defined as 1/3 of of the trace of the orthogonalised U_{IJ} tensor.

Atom	*x*	*y*	*z*	U(eq)
O1	6695.7(16)	6855(2)	2150.1(13)	52.0(4)
O2	2915.9(17)	8254(2)	8986.0(17)	70.0(5)
N2	5647.0(17)	6777(2)	7158.3(16)	43.4(4)
N4	10467.6(16)	7255(2)	4904.1(15)	38.8(3)
N6	8090.6(16)	6986.1(19)	6225.3(14)	37.5(3)
N1	8570.9(15)	7044.4(17)	3604.1(14)	33.2(3)
N8	6129.6(16)	6795.2(19)	4650.6(15)	37.9(3)
N3	10890.4(16)	7297.6(18)	3409.0(15)	35.4(3)
C1	9861(3)	7163(3)	1003(2)	58.5(6)
C2	9790.5(18)	7170(2)	2617.8(17)	35.6(4)
C10	5926(2)	7025(3)	8606.2(19)	46.3(4)
C12	2648(2)	8081(3)	7539(2)	58.8(6)
C7	6670.7(18)	6858(2)	5963.4(17)	33.2(3)
C9	7034(2)	6870(2)	3408.2(19)	36.9(4)
C13	4081(2)	6606(3)	7078(2)	45.2(4)
C5	9022.7(18)	7094(2)	4998.0(17)	32.5(3)
C3	12429.7(19)	7529(2)	2897.9(19)	40.4(4)
C4	12209(2)	9308(3)	2836(3)	58.6(5)
C11	4428(2)	8483(3)	9019(2)	57.4(5)

Table 17S. Anisotropic Displacement Parameters ($Å^2 \times 10^3$) for **5d**. The Anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U_{11}+...+2hka \times b \times U_{12}]$.

Atom	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
O1	54.3(7)	79.7(10)	37.9(6)	-12.5(6)	-2.7(5)	-42.3(7)
O2	46.2(8)	113.5(14)	65.5(9)	-49.1(9)	16.9(6)	-35.4(8)
N2	38.3(7)	61(1)	41.9(8)	-18.7(7)	8.7(6)	-28.8(7)
N4	33.8(7)	52.6(9)	36.6(7)	-9.1(6)	1.9(5)	-24.5(6)
N6	34.4(7)	48.0(9)	35.6(7)	-8.3(6)	1.7(5)	-22.9(6)
N1	31.8(6)	37.5(8)	33.6(6)	-4.7(5)	-0.5(5)	-18.8(5)
N8	34.0(7)	47.1(9)	39.0(7)	-10.2(6)	0.8(5)	-22.4(6)
N3	32.5(6)	40.8(8)	37.2(7)	-8.8(6)	2.7(5)	-19.4(6)
C1	55.7(11)	92.7(17)	38.4(9)	-17.3(10)	7.5(8)	-40.9(11)
C2	33.4(8)	38.7(9)	36.4(8)	-5.6(7)	2.4(6)	-18.2(6)
C10	43.6(9)	65.1(13)	36.2(8)	-10.0(8)	1.8(7)	-28.8(9)
C12	39.2(10)	80.5(16)	60.3(12)	-27.0(11)	3.6(8)	-22.6(9)
C7	29.5(7)	31.7(8)	40.3(8)	-6.9(6)	1.4(6)	-15.0(6)
C9	34.5(8)	39.7(9)	41.3(8)	-6.5(7)	-3.1(6)	-20.3(7)
C13	42.0(9)	60.5(12)	48.2(10)	-18.6(9)	10.6(7)	-34.0(9)
C5	31.3(7)	31.6(8)	36.5(8)	-4.0(6)	-2.5(6)	-15.7(6)
C3	31.3(8)	49.6(11)	44.4(9)	-11.4(8)	6.2(6)	-21.0(7)
C4	48.3(11)	51.1(12)	82.1(14)	-9.4(10)	11.8(9)	-30.5(9)
C11	56.2(12)	75.1(15)	53.7(11)	-28.8(10)	8.0(9)	-33.1(10)

Table 18S. Bond Lengths for **5d**.

Bond	Length/Å	Bond	Length/Å
O1-C9	1.2192(19)	N1-C9	1.4491(19)
O2-C12	1.418(2)	N1-C5	1.3851(19)
O2-C11	1.426(2)	N8-C7	1.352(2)
N2-C10	1.449(2)	N8-C9	1.329(2)
N2-C7	1.357(2)	N3-C2	1.313(2)
N2-C13	1.452(2)	N3-C3	1.466(2)
N4-N3	1.3798(18)	C1-C2	1.474(2)
N4-C5	1.3250(19)	C10-C11	1.495(3)
N6-C7	1.3431(19)	C12-C13	1.495(3)
N6-C5	1.3353(19)	C3-C4	1.493(3)
N1-C2	1.3576(19)		

Table 19S. Bond Angles for **5d**.

Atoms	Angle/°	Atoms	Angle/°
C12-O2-C11	110.63(15)	N3-C2-C1	127.45(15)
C10-N2-C13	113.18(13)	N2-C10-C11	109.67(14)
C7-N2-C10	122.99(14)	O2-C12-C13	111.47(16)
C7-N2-C13	123.56(14)	N6-C7-N2	116.43(14)
C5-N4-N3	103.45(12)	N6-C7-N8	128.02(14)
C5-N6-C7	113.35(13)	N8-C7-N2	115.55(13)
C2-N1-C9	131.49(13)	O1-C9-N1	117.80(15)
C2-N1-C5	107.59(12)	O1-C9-N8	127.76(15)
C5-N1-C9	120.91(13)	N8-C9-N1	114.40(14)
C9-N8-C7	120.50(13)	N2-C13-C12	109.84(16)
N4-N3-C3	117.84(13)	N4-C5-N6	127.06(14)
C2-N3-N4	113.51(13)	N4-C5-N1	110.14(13)
C2-N3-C3	128.62(14)	N6-C5-N1	122.80(13)
N1-C2-C1	127.24(15)	N3-C3-C4	111.36(14)
N3-C2-N1	105.31(13)	O2-C11-C10	111.70(18)

Table 20S. Torsion Angles for **5d**.

Atoms	Angle/°	Atoms	Angle/°
O2-C12-C13-N2	-55.5(2)	C7-N8-C9-N1	-0.9(2)
N2-C10-C11-O2	55.1(2)	C9-N1-C2-N3	-179.84(15)
N4-N3-C2-N1	0.32(19)	C9-N1-C2-C1	0.2(3)
N4-N3-C2-C1	-179.69(18)	C9-N1-C5-N4	179.88(14)
N4-N3-C3-C4	-72.5(2)	C9-N1-C5-N6	0.0(2)
N3-N4-C5-N6	179.70(16)	C9-N8-C7-N2	179.82(15)
N3-N4-C5-N1	-0.18(18)	C9-N8-C7-N6	-0.3(3)
C2-N1-C9-O1	-1.5(3)	C13-N2-C10-C11	-53.1(2)
C2-N1-C9-N8	-179.56(16)	C13-N2-C7-N6	-178.88(16)
C2-N1-C5-N4	0.38(18)	C13-N2-C7-N8	1.0(2)
C2-N1-C5-N6	-179.51(15)	C5-N4-N3-C2	-0.09(19)
C2-N3-C3-C4	105.2(2)	C5-N4-N3-C3	177.98(14)
C10-N2-C7-N6	7.5(2)	C5-N6-C7-N2	-178.76(14)
C10-N2-C7-N8	-172.59(15)	C5-N6-C7-N8	1.4(3)
C10-N2-C13-C12	53.4(2)	C5-N1-C2-N3	-0.41(17)
C12-O2-C11-C10	-58.7(2)	C5-N1-C2-C1	179.60(18)
C7-N2-C10-C11	121.08(18)	C5-N1-C9-O1	179.12(15)
C7-N2-C13-C12	-120.76(19)	C5-N1-C9-N8	1.1(2)
C7-N6-C5-N4	178.99(16)	C3-N3-C2-N1	-177.50(15)
C7-N6-C5-N1	-1.1(2)	C3-N3-C2-C1	2.5(3)
C7-N8-C9-O1	-178.73(17)	C11-O2-C12-C13	58.8(3)

Table 21S. Hydrogen Atom Coordinates ($Å \times 10^4$) and Isotropic Displacement Parameters ($Å^2 \times 10^3$) for **5d**.

Atom	*x*	*y*	*z*	U(eq)
H1A	10074	6046	873	88
H1B	10748	7473	544	88
H1C	8807	7967	540	88
H10A	6919	7257	8565	56
H10B	6112	5999	9362	56
H12A	2517	9116	6816	71
H12B	1618	7922	7542	71
H13A	4142	5554	7734	54
H13B	3901	6564	6060	54
H3A	12723	7268	1909	48
H3B	13347	6745	3577	48
H4A	11419	10071	2059	88
H4B	13272	9384	2626	88

H4C	11796	9613	3784	88
H11A	4589	8593	10018	69
H11B	4327	9526	8324	69

3. Calculation details

The geometry optimization was performed with Gaussian-09 software using B3LYP functional and 6-311++G(d,p) Pople's basis set [4]. The AIMAll Standard operating mode [5] was used for calculating electron density properties.

DFT (B3LYP/6-311++G(d,p) calculations of the model structure, bearing dimethylamino-group at the C7 carbon atom instead of morpholino group in **5d**, are in agreement with the X-ray data and show elongated N3-C3 (1.463 Å) and N1-C9 (1.483 Å) bonds and shortened C7-N2 (1.362 Å) bond. Analysis of the electron density by the Bader method indicated that ellipticity of the electron density at the bond critical points confirms a weak π-bond character for N1-C9 bonds (ellipticity of 0.045) and a strong π-bond character for C2-N3, C5-N4, and C7-N2 bonds (ellipticity of 0.304, 0.259, and 0.223 correspondingly). The electron density at the bond critical point for C9-N1 is the lowest, that confirms the ability of the C9-N1 to cleave under the conditions of the observed rearrangements.

The yields of products **3-5** are in agreement with the atoms charge values (electronic factor) and plane angle values (steric factor). It should be taken into account, that plane angles of substituents in planar molecules are equivalent to cone angle in bulk molecules [7]. Some calculated values are given below in this section.

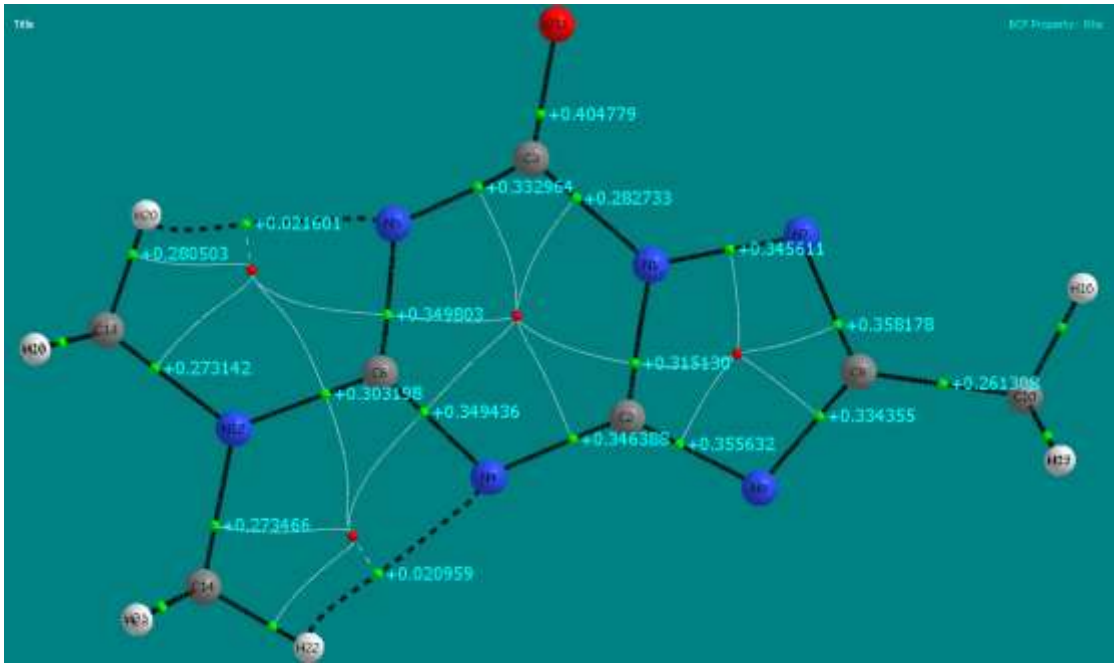


Figure 1S. Charge distribution in the molecule of 5-dimethylamino-2-methyl[1,2,4]triazolo[1,5-a][1,3,5]triazin-7-one.

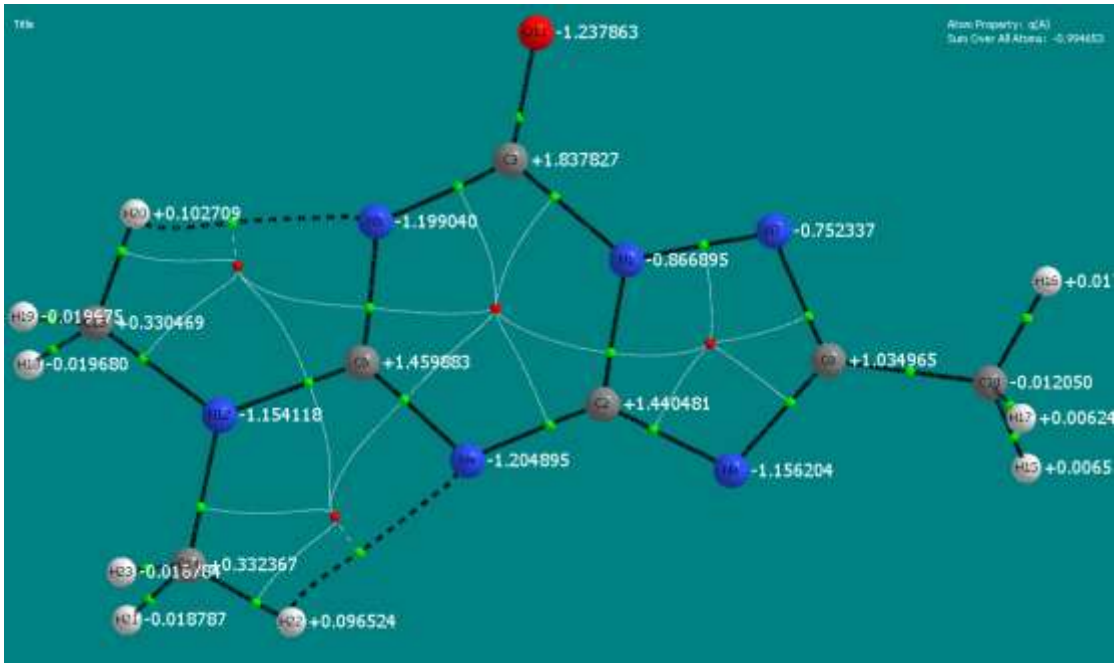


Figure 2S. Charge distribution in the molecule of 5-dimethylamino-2-methyl[1,2,4]triazolo[1,5-a][1,3,5]triazin-7-one.

Table 22S. Calculation results on charge distribution in the model molecule of 5-dimethylamino-2-methyl[1,2,4]triazolo[1,5-a][1,3,5]triazin-7-one.

#	Name	q(A)	L(A)	K(A)	K_Scaled(A)	|Mu_Intra(A)|
1	N1	-0.866895	+0.000680	+54.873503	-55.344614	+0.570451
2	C2	+1.440481	+0.002032	+36.925813	-37.242836	+0.077177
3	C3	+1.837827	+0.002737	+36.542319	-36.856049	+0.305628
4	N4	-1.204895	-0.000068	+54.883132	-55.354325	+0.106158
5	N5	-1.199040	+0.000061	+54.878975	-55.350132	+0.111945
6	C6	+1.459883	+0.000650	+36.850845	-37.167224	+0.103769
7	N7	-0.752337	-0.000498	+54.612527	-55.081397	+0.752330
8	C8	+1.034965	-0.000177	+37.125151	-37.443885	+0.577119
9	N9	-1.156204	+0.000323	+54.837735	-55.308538	+0.145693
10	C10	-0.012050	-0.000218	+37.687229	-38.010788	+0.104062
11	O11	-1.237863	+0.000064	+75.314485	-75.961089	+0.512838
12	N12	-1.154118	+0.001096	+54.886269	-55.357489	+0.119274
13	C13	+0.330469	-0.000006	+37.492822	-37.814713	+0.560454
14	C14	+0.332367	-0.000112	+37.491908	-37.813790	+0.554430
15	H15	+0.006510	+0.000031	+0.606758	-0.611967	+0.158689
16	H16	+0.017696	+0.000040	+0.603323	-0.608503	+0.156271
17	H17	+0.006243	+0.000033	+0.606838	-0.612048	+0.158699
18	H18	-0.019680	+0.000049	+0.619393	-0.624710	+0.170276
19	H19	-0.019675	+0.000049	+0.619391	-0.624709	+0.170275
20	H20	+0.102709	-0.000066	+0.576860	-0.581813	+0.139737

21	H21	-0.018787	+0.000048	+0.619140	-0.624455	+0.170045
22	H22	+0.096524	+0.000134	+0.580095	-0.585076	+0.139584
23	H23	-0.018784	+0.000048	+0.619135	-0.624451	+0.170050
-----	-----	-0.994653	+0.006930	+669.853646	-675.604601	-----

Table 23S. Atom charges and torsions for in the model molecule of 5-dimethylamino-2-methyl[1,2,4]triazolo[1,5-a][1,3,5]triazin-7-one.

Atom	Mulliken	Löwdin	Bader	Torsion, °
N7	-0.34	-0.20	-0.75	210
N9	-0.60	-0.28	-1.16	195
O11	-0.55	-0.34	-1.24	130

4. References

1. Dolomanov, O. V.; Bourhis, L. J.; Gildea, R. J.; Howard, J. A. K.; Puschmann, H. *J. Appl. Cryst.* **2009,** *42* (2), 339–341. doi:10.1107/S0021889808042726

2. Palatinus, L.; Chapuis, G. *J. Appl. Cryst.* **2007,** *40* (4), 786–790. doi:10.1107/S0021889807029238

3. Sheldrick, G. M. *Acta Cryst. A* **2008,** *64* (1), 112–122. doi:10.1107/S0108767307043930

4. Frisch, M. J.; Trucks, G. W.; Schlegel, H. B.; Scuseria, G. E.; Robb, M. A.; Cheeseman, J. R.; Scalmani, G.; Barone, V.; Mennucci, B.; Petersson, G. A.; Nakatsuji, H.; Caricato, M.; Li, X.; Hratchian, H. P.; Izmaylov, A. F.; Bloino, J.; Zheng, G.; Sonnenberg, J. L.; Hada, M.; Ehara, M.; Toyota, K.; Fukuda, R.; Hasegawa, J.; Ishida, M.; Nakajima, T.; Honda, Y.; Kitao, O.; Nakai, H.; Vreven, T.; Montgomery, Jr., J. A.; Peralta, J. E.; Ogliaro, F.; Bearpark, M.; Heyd, J. J.; Brothers, E.; Kudin, K. N.; Staroverov, V. N.; Kobayashi, R.; Normand, J.; Raghavachari, K.; Rendell, A.; Burant, J. C.; Iyengar, S. S.; Tomasi, J.; Cossi, M.; Rega, N.; Millam, N. J.; Klene, M.; Knox, J. E.; Cross, J. B.; Bakken, V.; Adamo, C.; Jaramillo, J.; Gomperts, R.; Stratmann, R. E.; Yazyev, O.; Austin, A. J.; Cammi, R.; Pomelli, C.; Ochterski, J. W.; Martin, R. L.; Morokuma, K.; Zakrzewski, V. G.; Voth, G. A.; Salvador, P.; Dannenberg, J. J.; Dapprich, S.; Daniels, A. D.; Farkas, Ö.; Foresman, J. B.; Ortiz, J. V.; Cioslowski, J.; Fox, D. J. *Gaussian 09, Revision A.1;* Gaussian, Inc.: Wallingford CT, 2009.

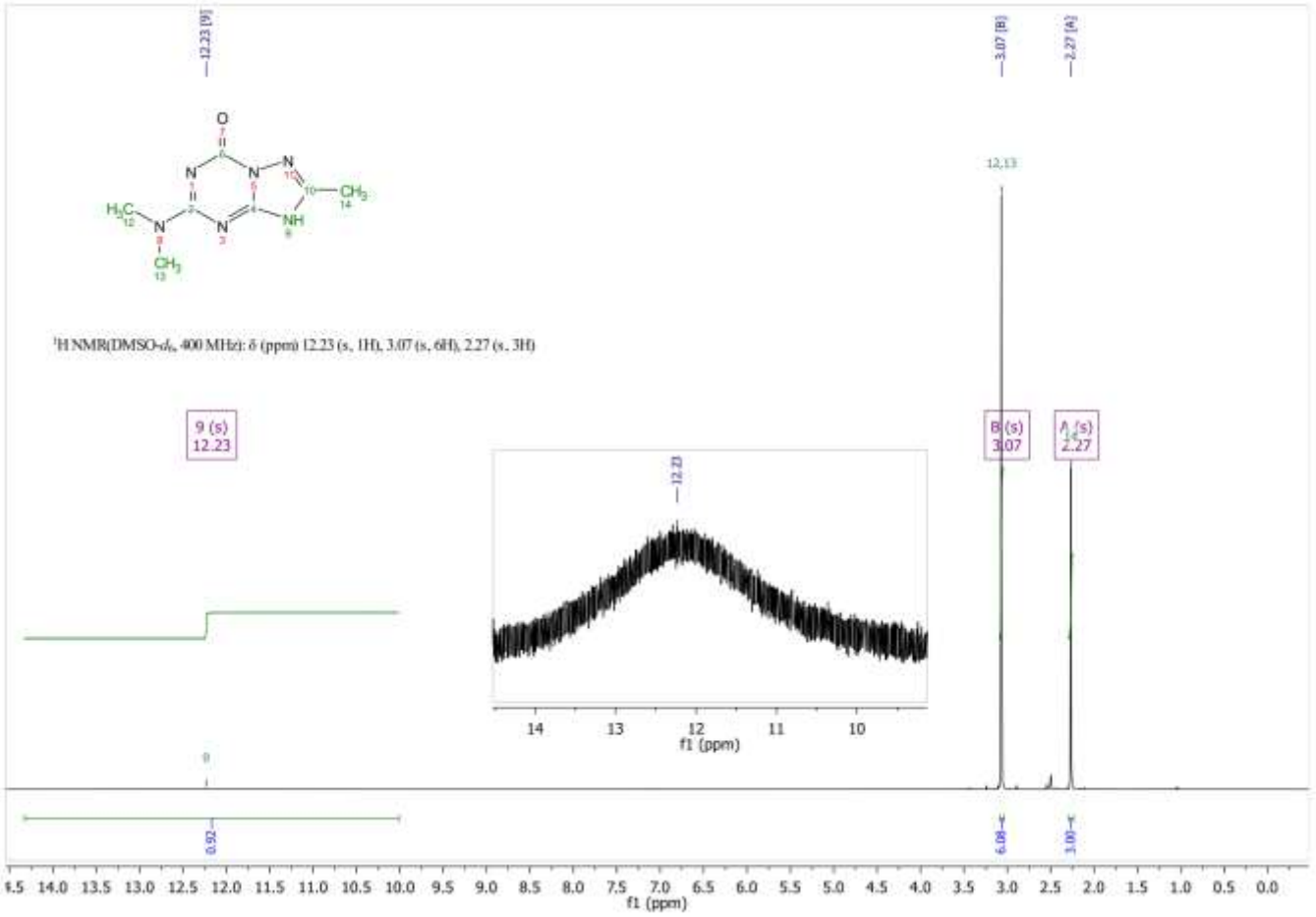
5. Keith, T. A. *AIMAll;* TK Gristmill Software: Overland Park KS, USA, 2016.

6. Bakharev, V. V.; Parfenov, V. E.; Ul'yankina, I. V.; Zavodskaya, A. V.; Selezneva, E. V.; Gidaspov, A. A.; Eltsov, O. S.; Slepukhin, P. A. *Tetrahedron* **2014,** *70* (38), 6825–6830. doi:10.1016/j.tet.2014.07.058

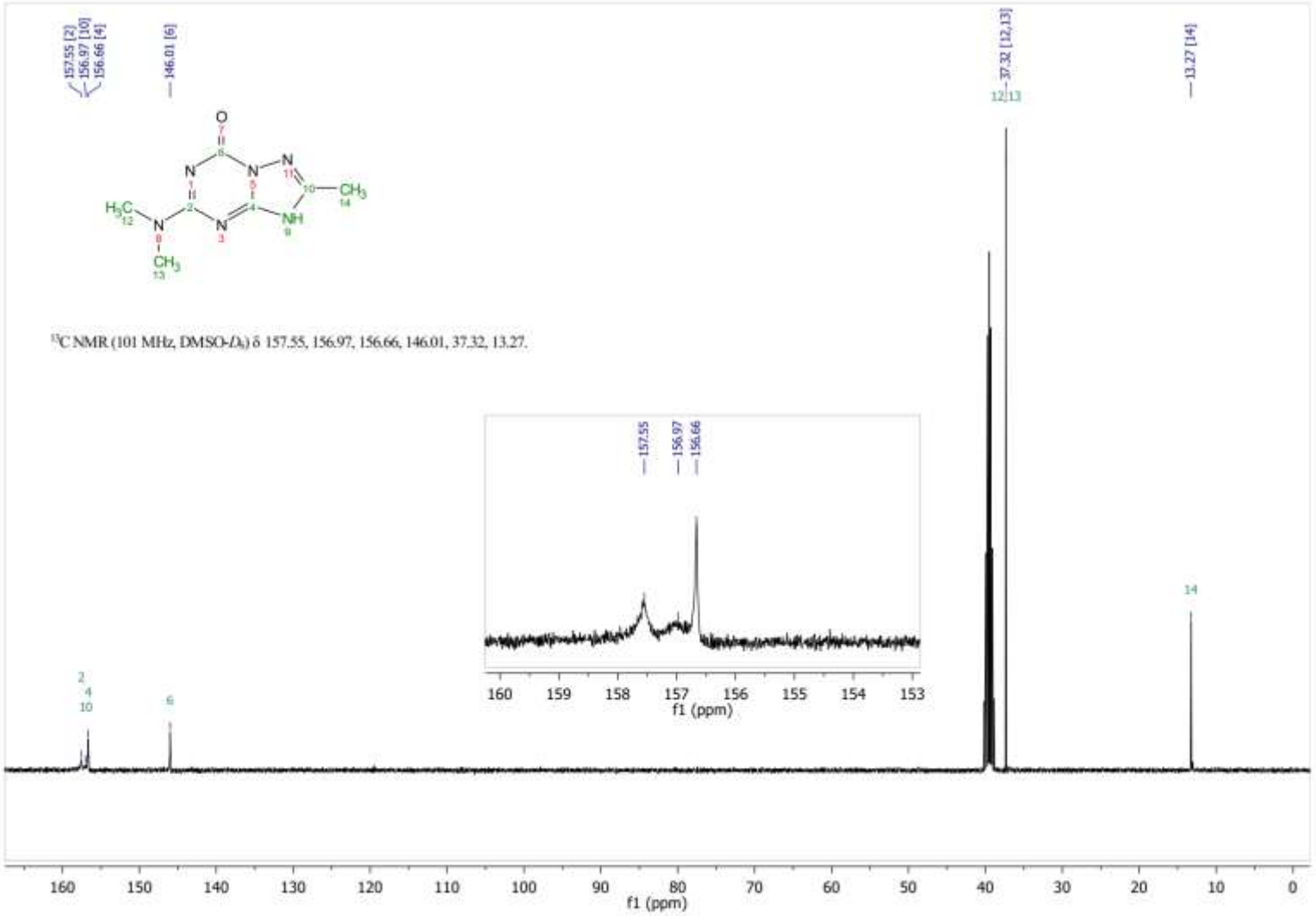
7. White, D. P.; Anthony, J. C.; Oyefeso, A. O. *J. Org. Chem.* **1999,** *64* (21), 7707–7716. doi:10.1021/jo982405w

5. Copies of ^{1}H, ^{13}C and 2D HMBC NMR spectra.

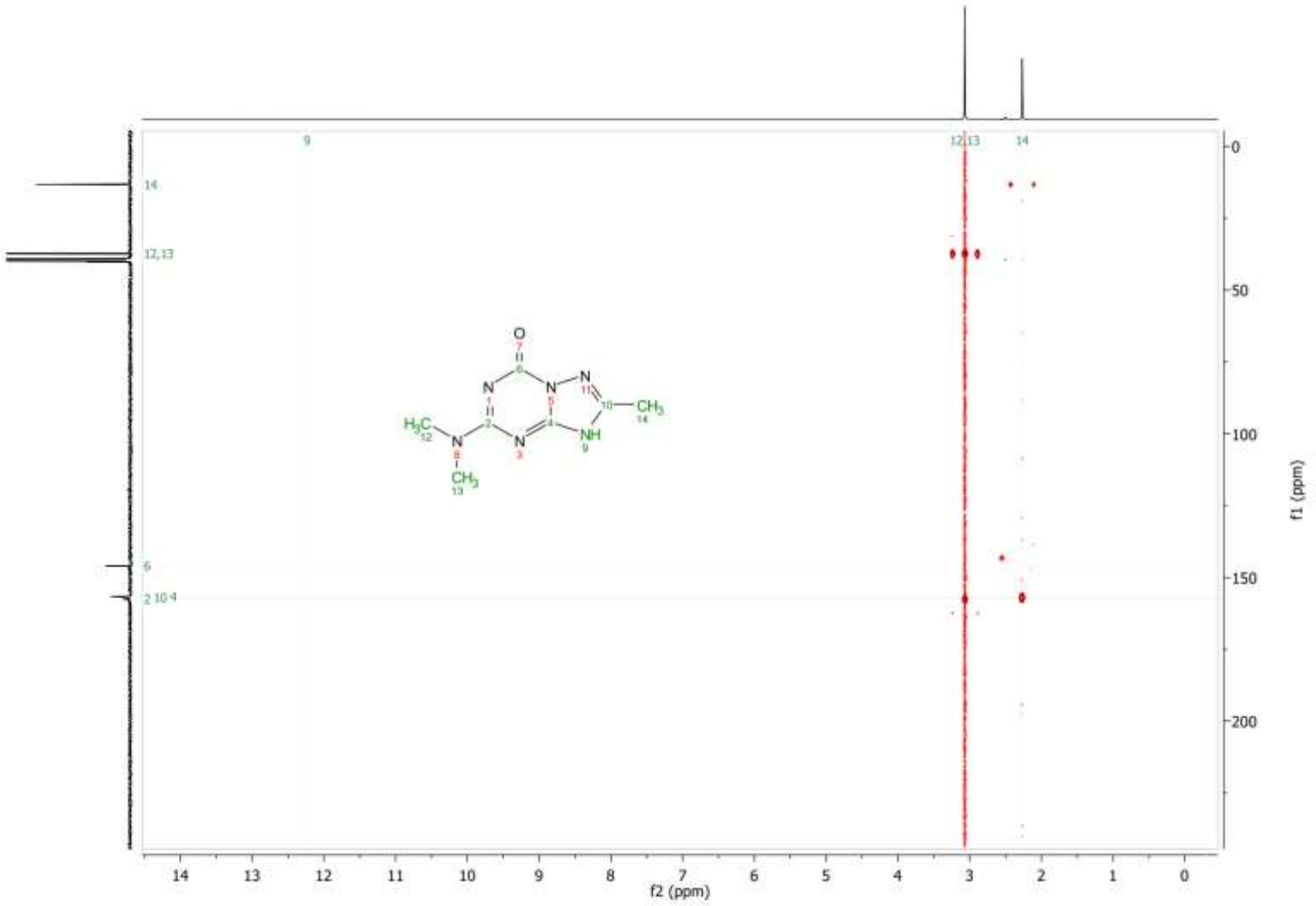
1) ^{1}H, ^{13}C NMR, and 2D HMBC spectra of 2-methyl-5-dimethylamino[1,2,4]triazolo[1,5-a][1,3,5]-triazin-7-one (**2a**)



2a

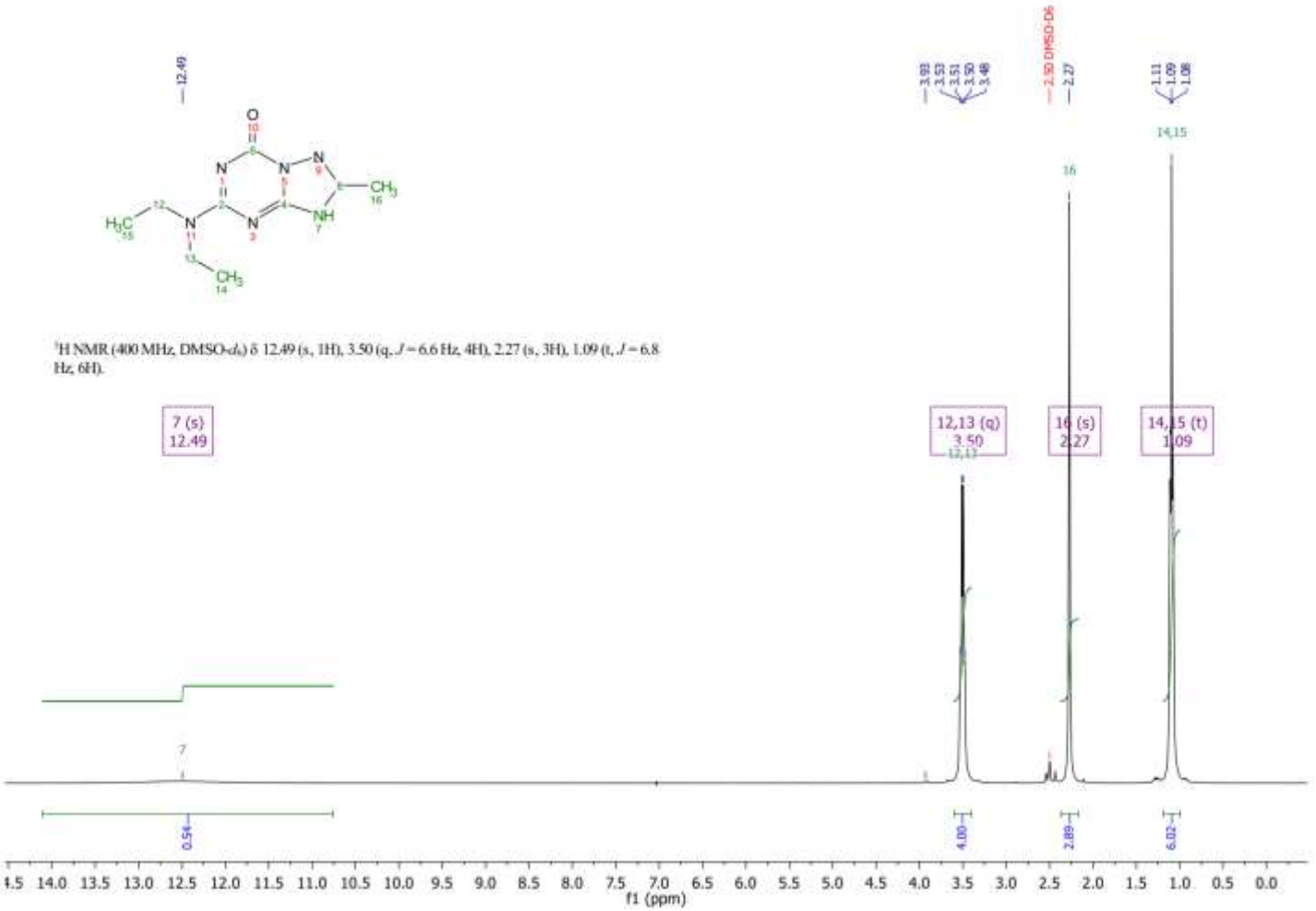

157.55 [2]
156.97 [10]
156.66 [4]
146.01 [6]
37.32 [12,13]
13.27 [14]
^{13}C NMR (101 MHz, DMSO-d_6) δ 157.55, 156.97, 156.66, 146.01, 37.32, 13.27.
f1 (ppm)

2a

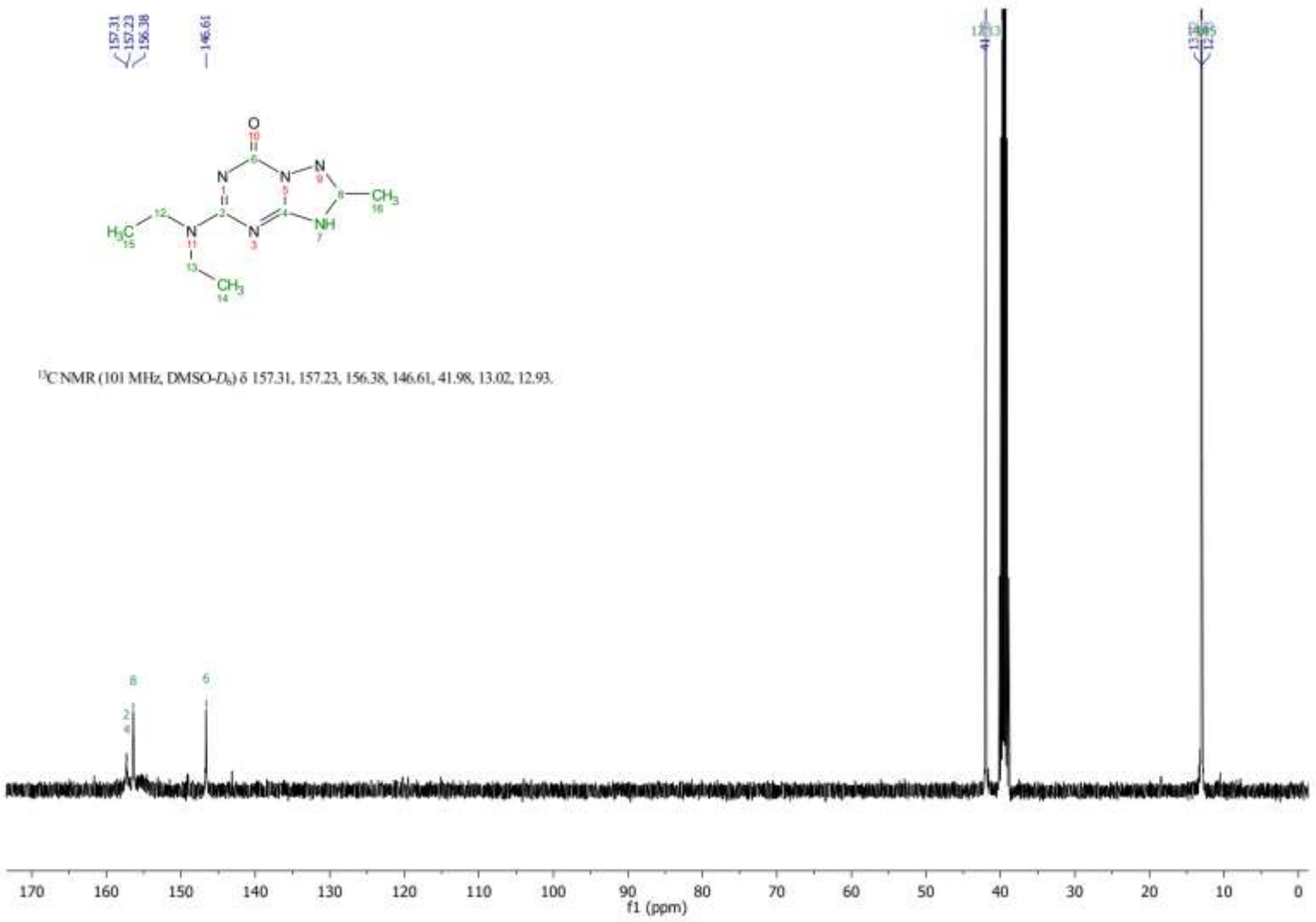


2a

2) ^{1}H, ^{13}C NMR, and 2D HMBC spectra of 2-methyl-5-diethilamino[1,2,4]triazolo[1,5-*a*][1,3,5]triazin-7-one (**2b**)

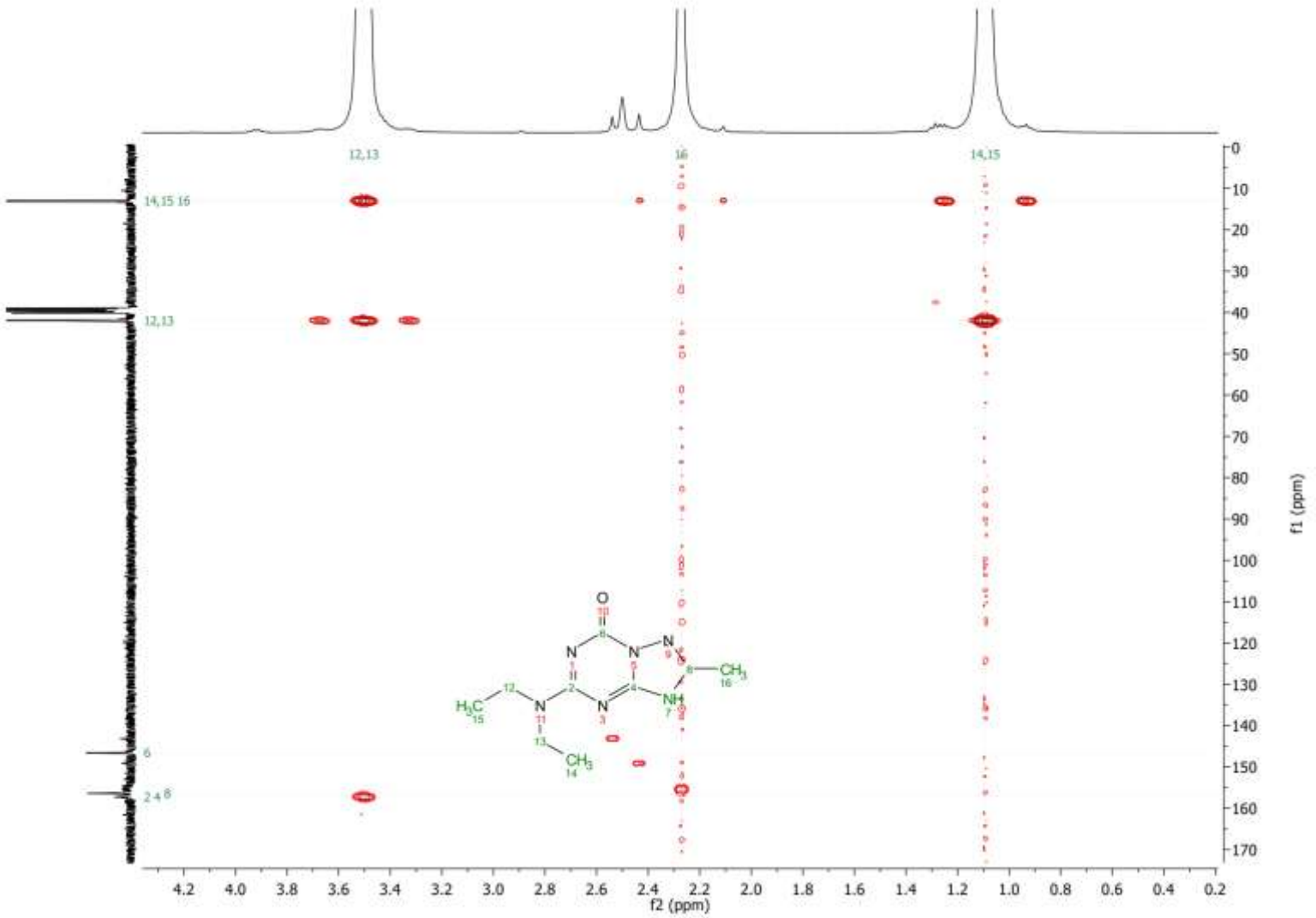


2b



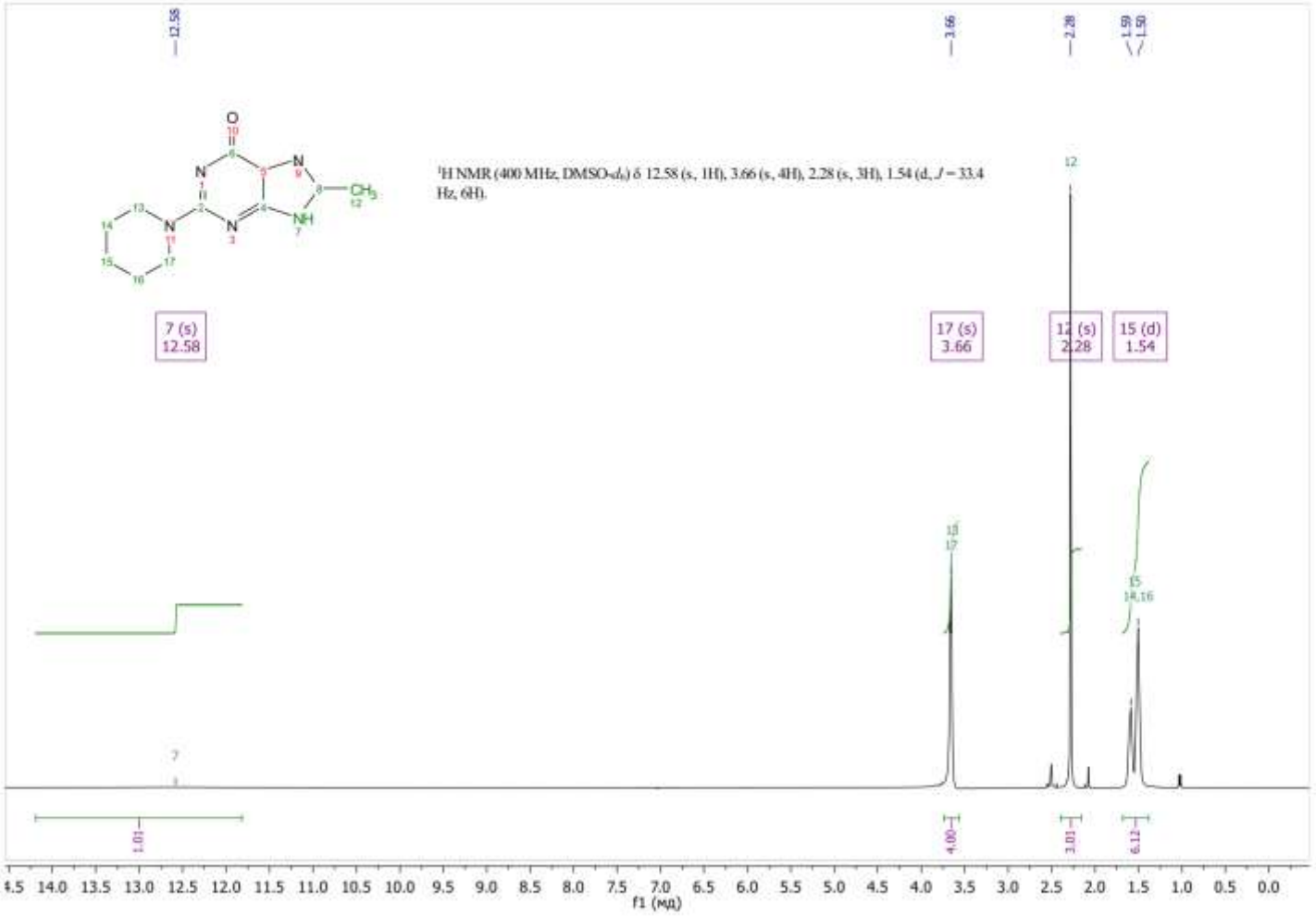
^{13}C NMR (101 MHz, DMSO-D_6) δ 157.31, 157.23, 156.38, 146.61, 41.98, 13.02, 12.93.

2b

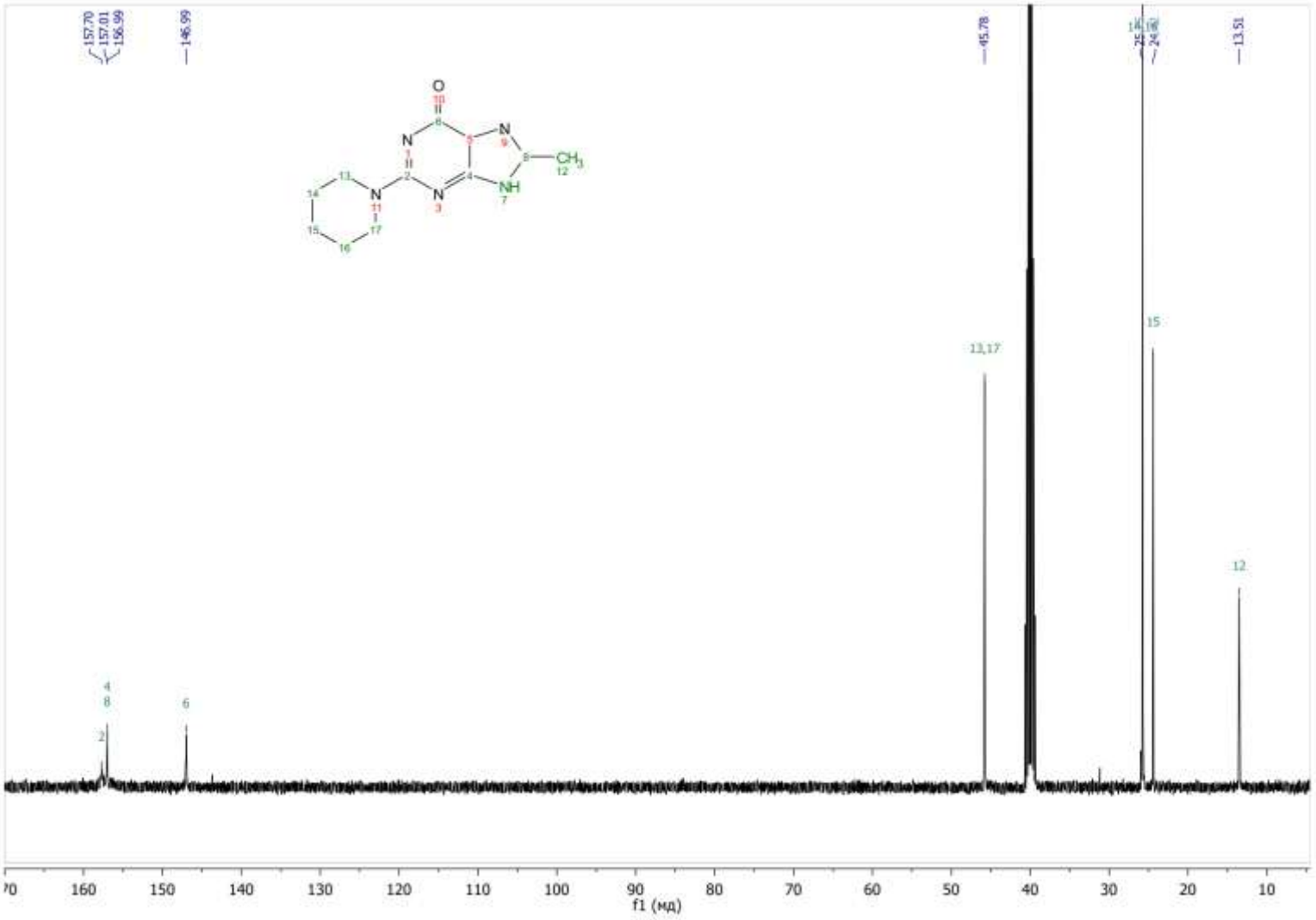


2b

3) ^{1}H and ^{13}C NMR spectra of 2-methyl-5-piperidino[1,2,4]triazolo[1,5-*a*][1,3,5]triazin-7-one (**2c**)

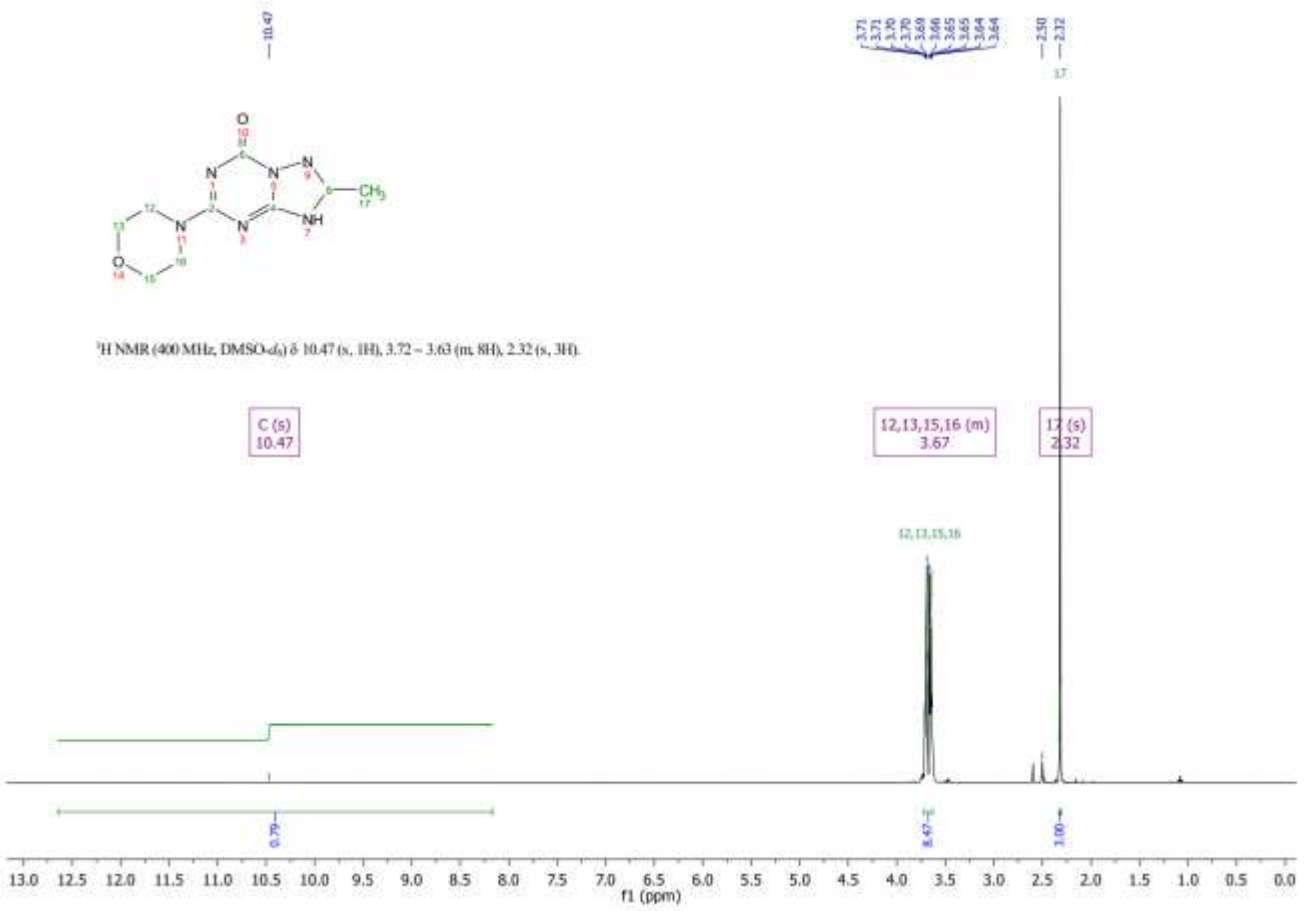


2c

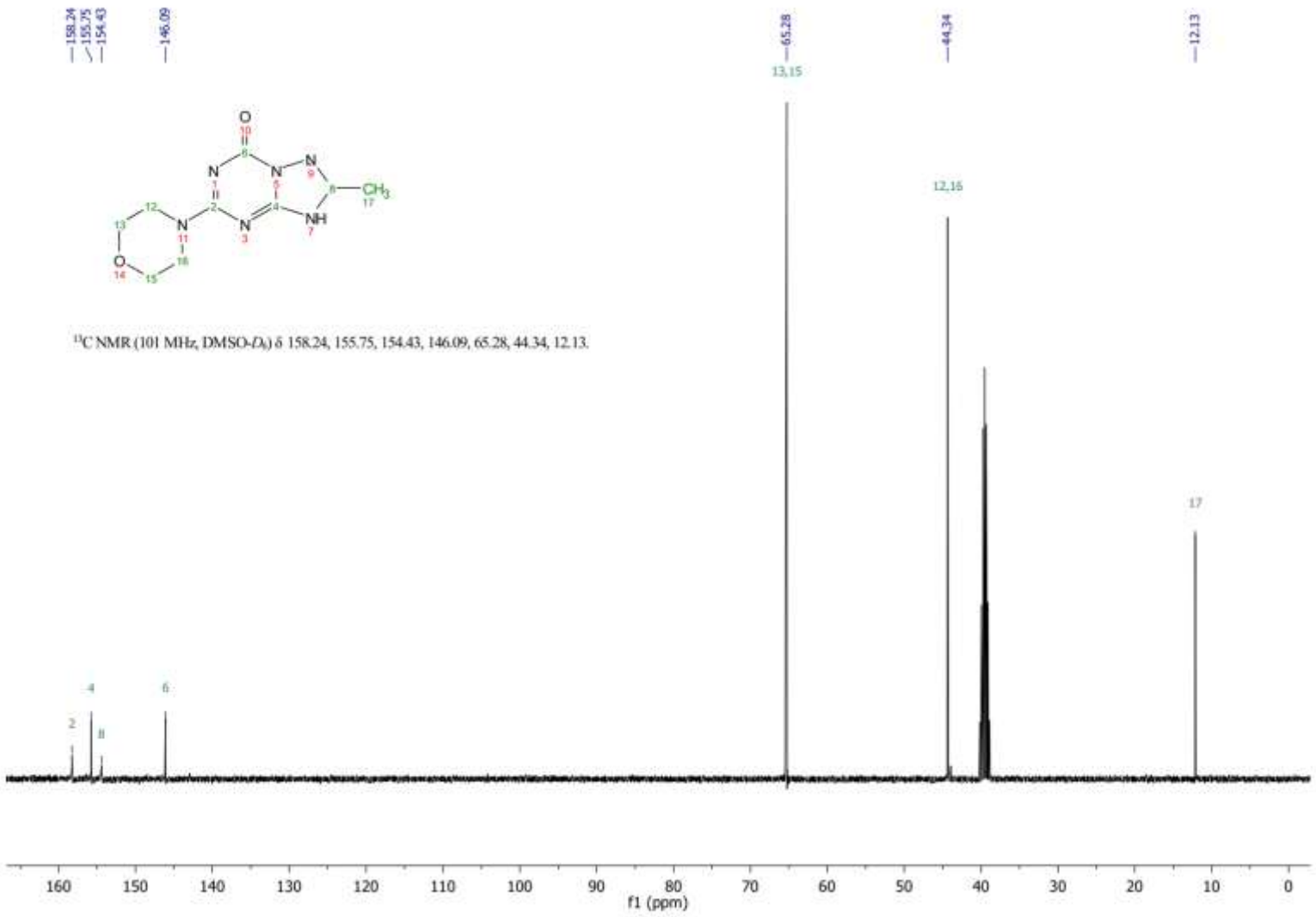

157.70
157.01
156.99
146.99
45.78
25.18
24.98
13.51
13,17
15
12
4
8
6
2
O
10
N
1
6
5
N
9
8
CH3
12
2
4
13
14
N
11
N
3
NH
7
15
16
17
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (мд)

2c

4) ^{1}H, ^{13}C NMR, and 2D HMBC spectra of 2-methyl-5-morpholino[1,2,4]triazolo[1,5-*a*][1,3,5]-triazin-7-one (**2d**)

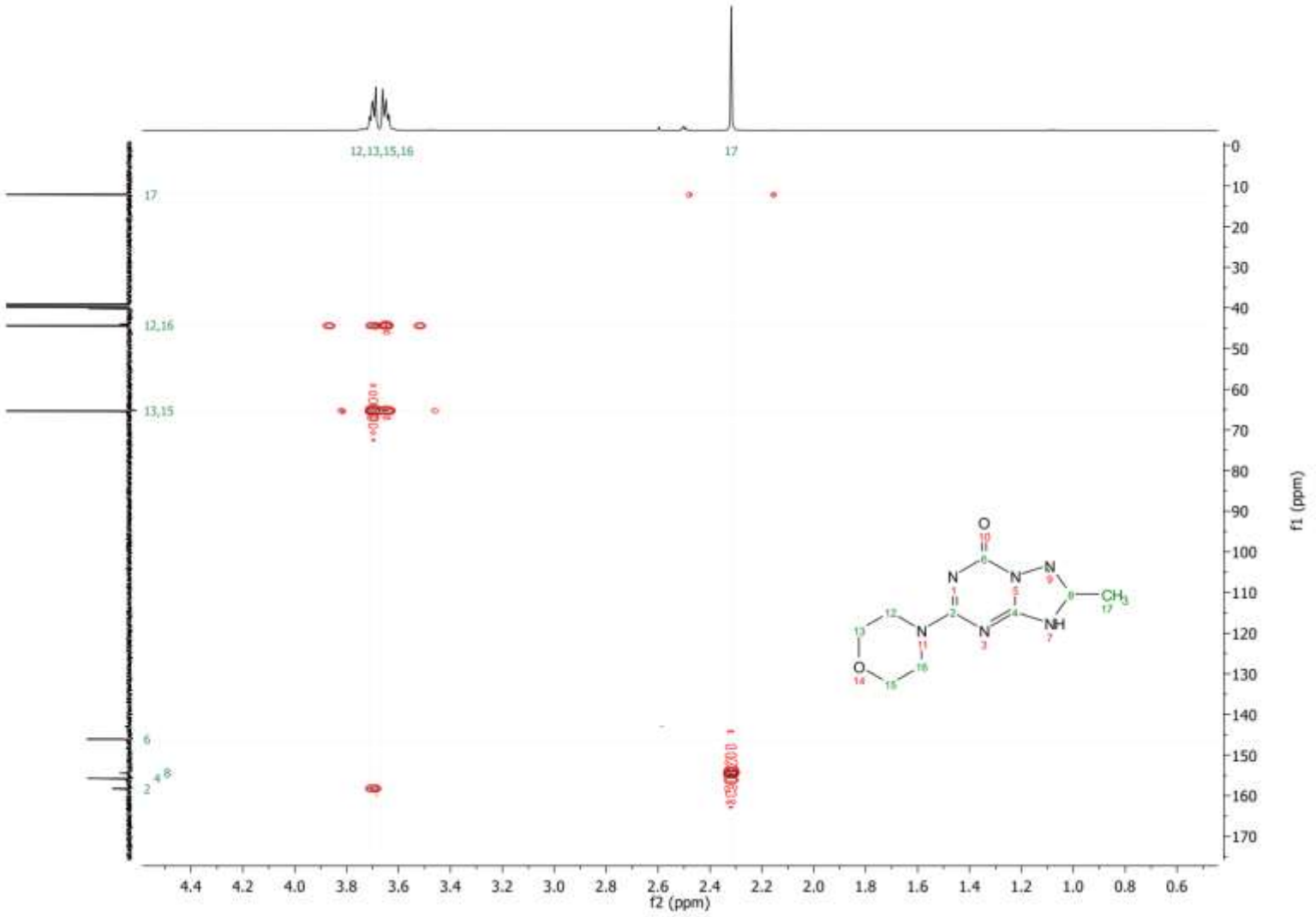


2d



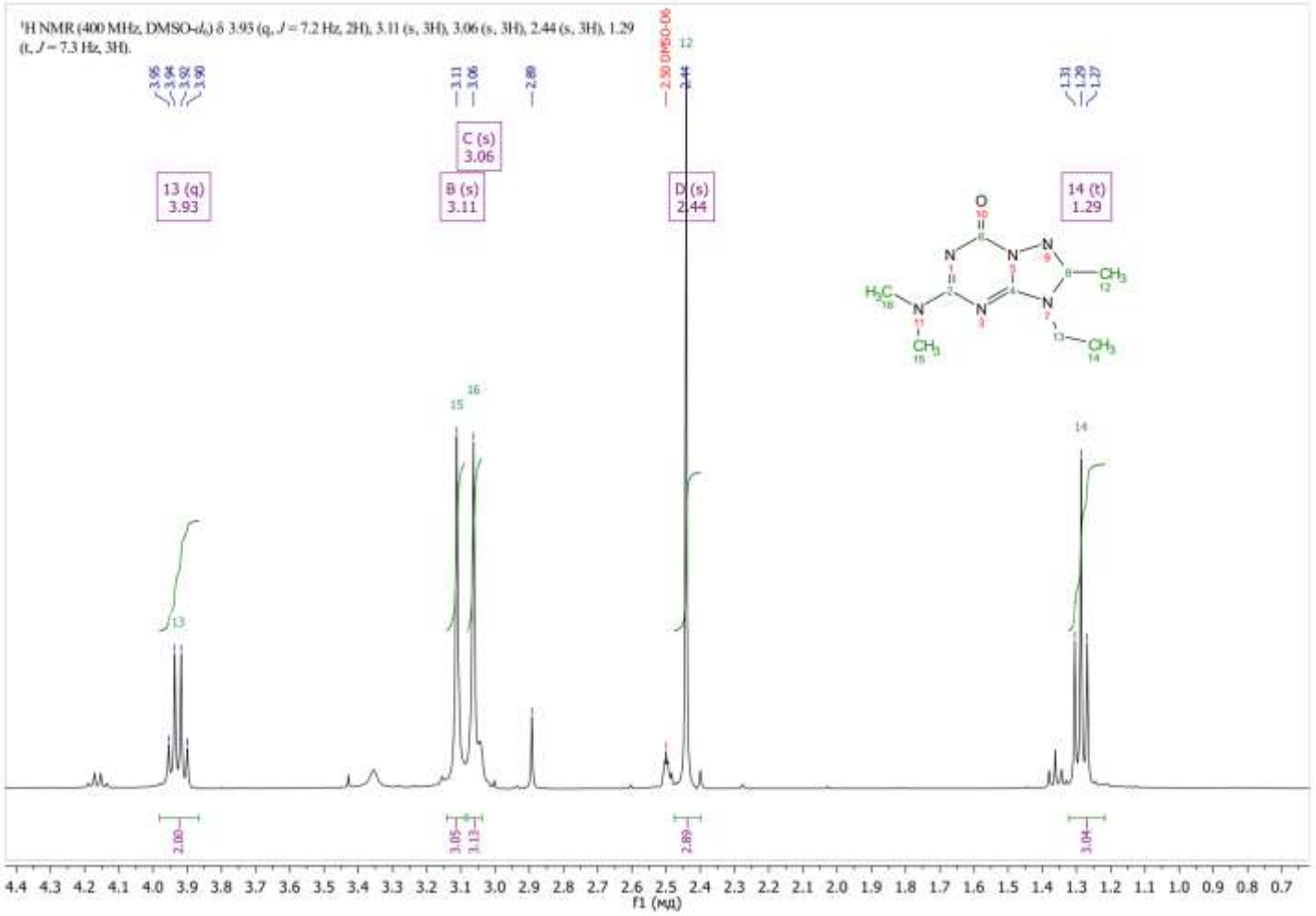
^{13}C NMR (101 MHz, DMSO-d_6) δ 158.24, 155.75, 154.43, 146.09, 65.28, 44.34, 12.13.

2d

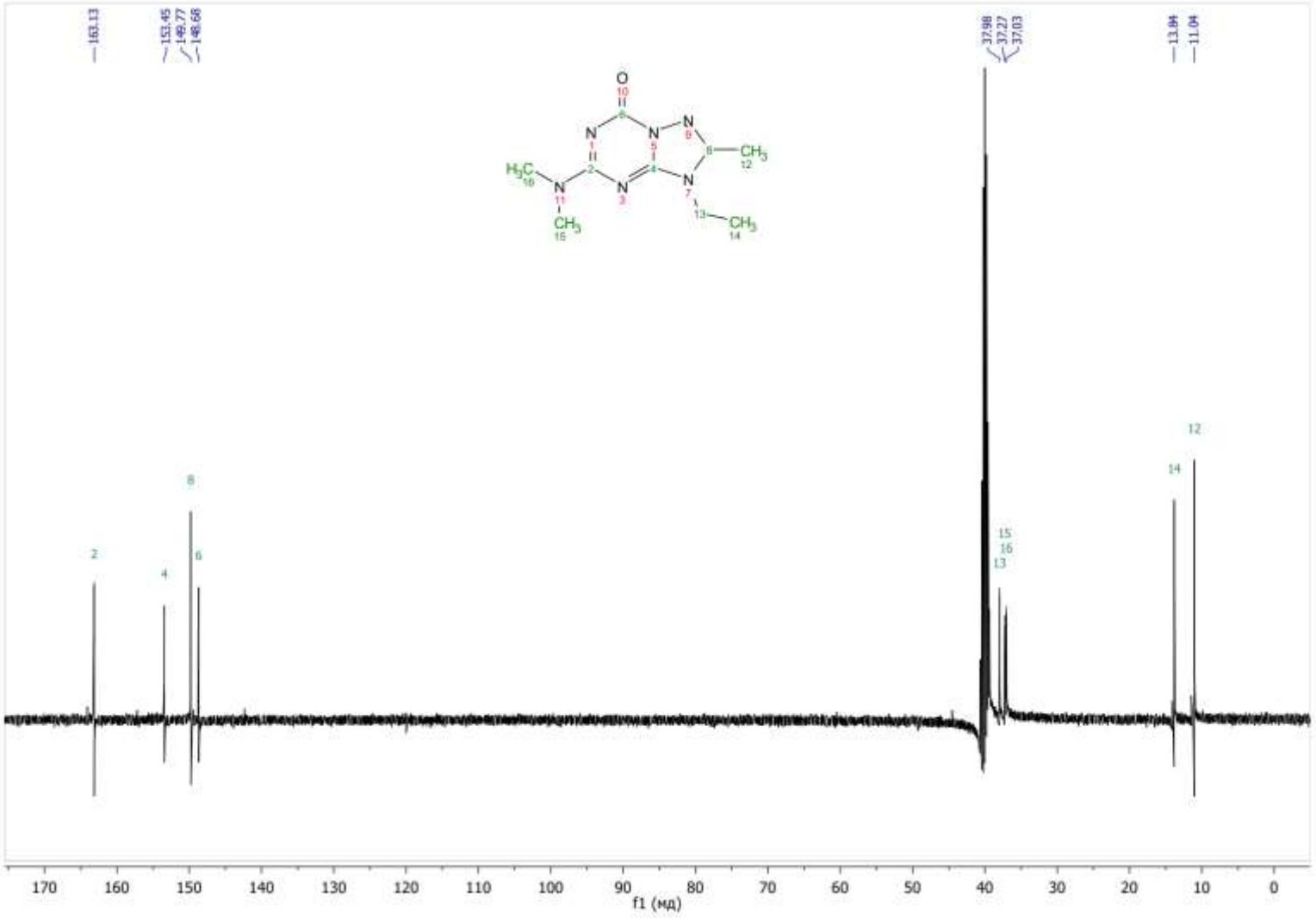


2d

5) ^{1}H, ^{13}C NMR spectra of 3-ethyl-2-methyl-5-dimethylamino[1,2,4]triazolo[1,5-*a*][1,3,5]triazin-7-one (**3a**)

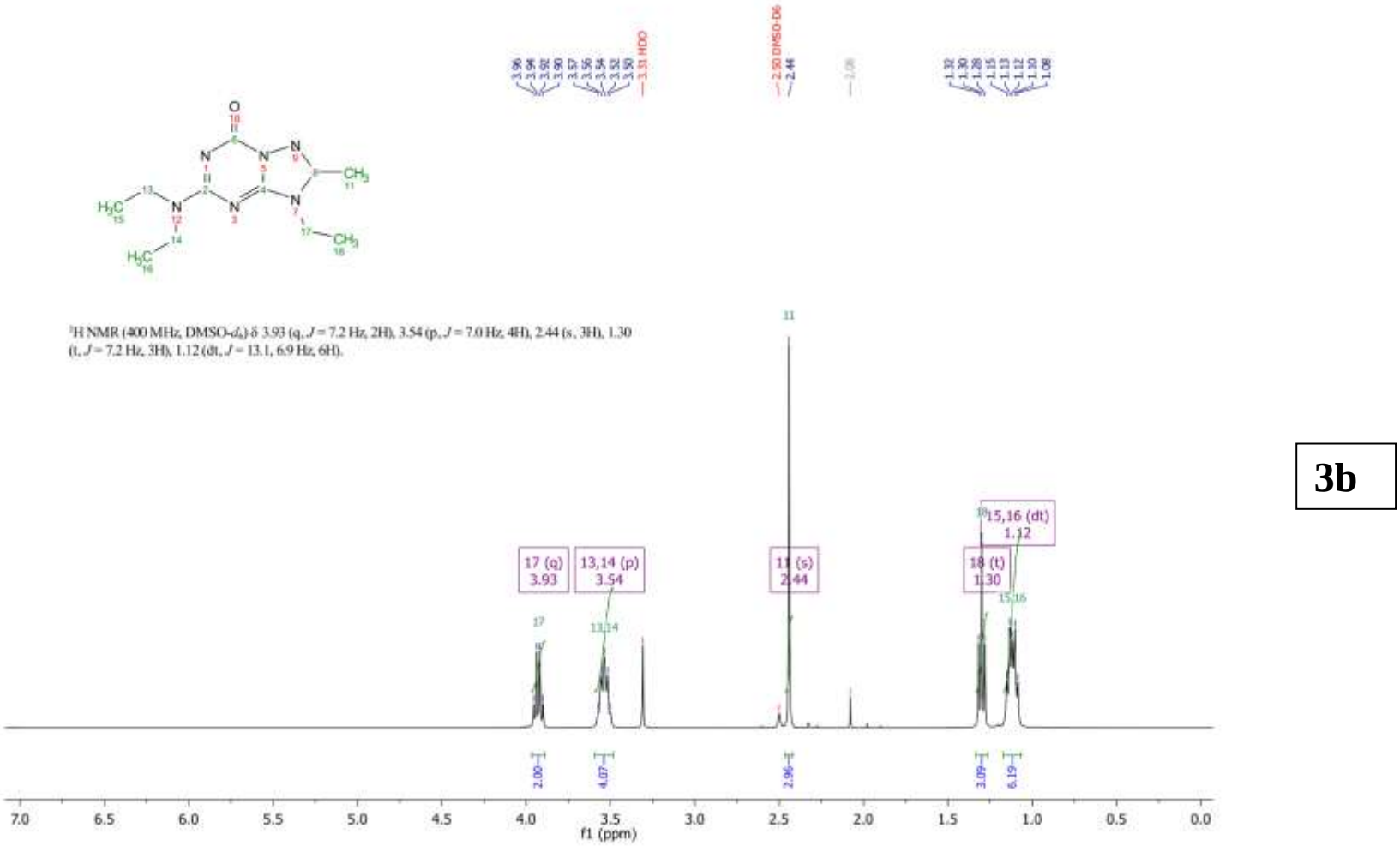


3a

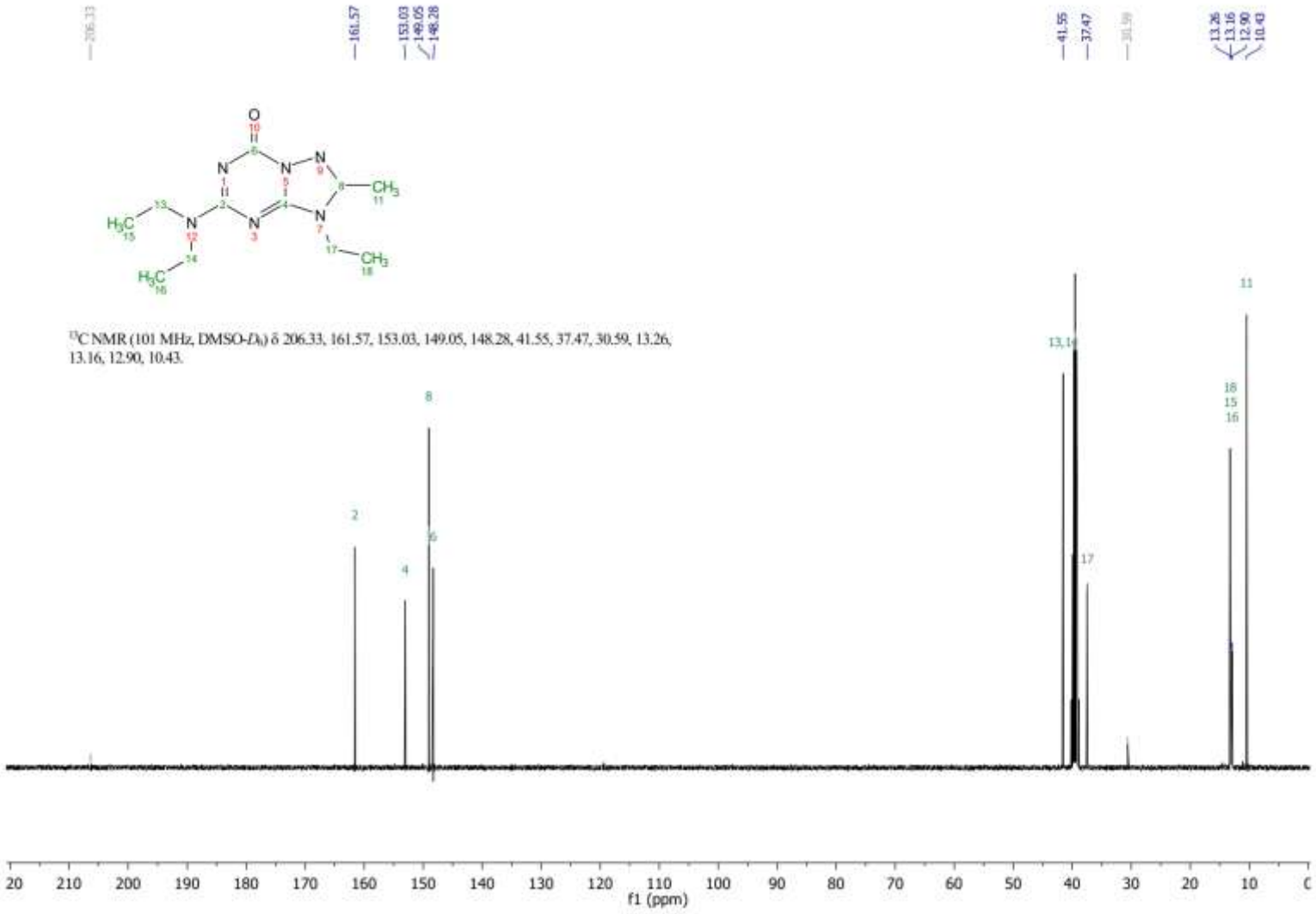

163.13
151.45
149.77
148.66
37.98
37.27
37.03
13.94
11.04
O
N
CH3
H3C
CH3
2
4
8
6
15
16
13
14
12
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (мд)

3a

6) ^{1}H, ^{13}C and 2D HMBC NMR spectra of 3-ethyl-2-methyl-5-diethylamino[1,2,4]triazolo[1,5-*a*][1,3,5]triazin-7-one (**3b**)

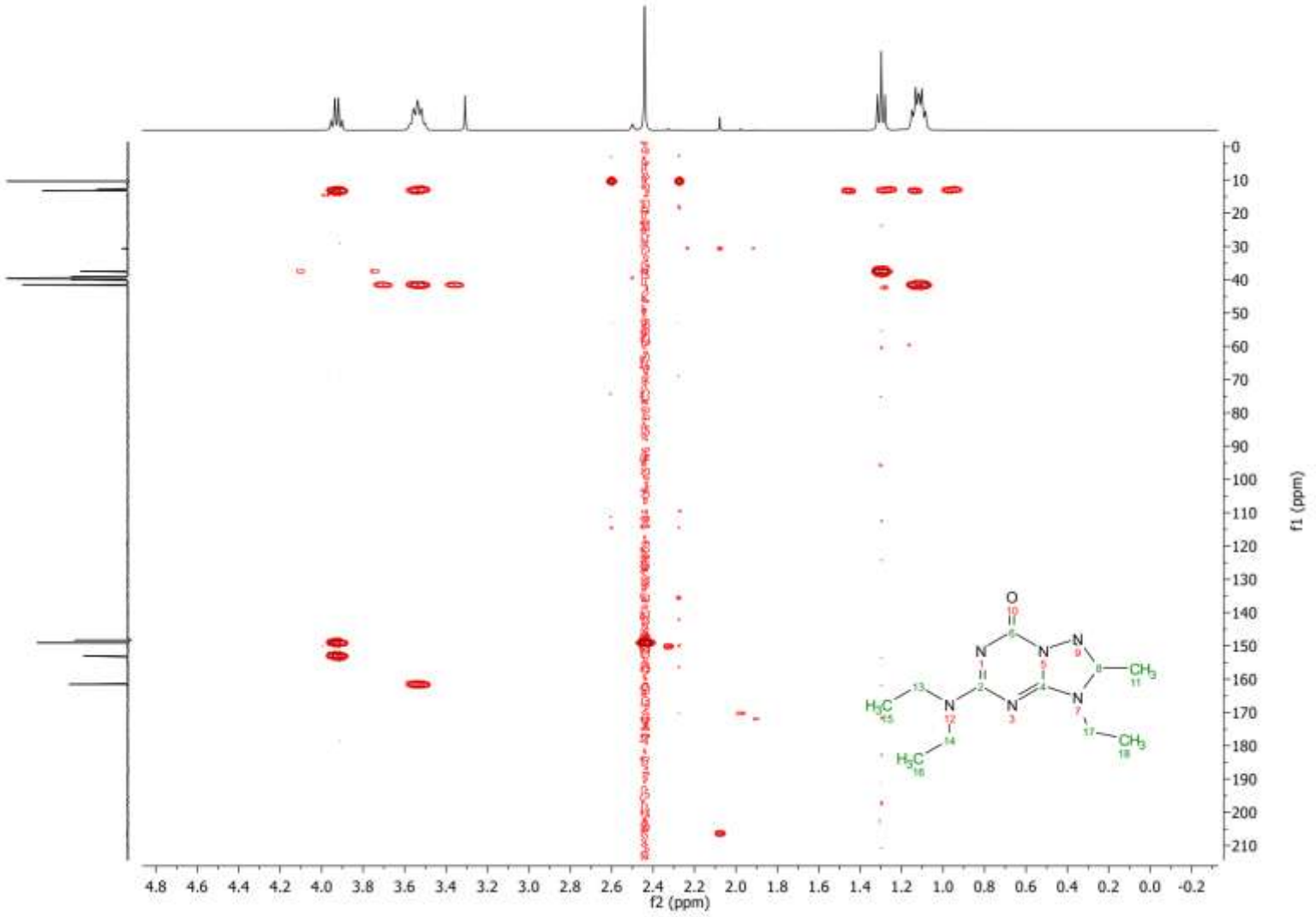


3b



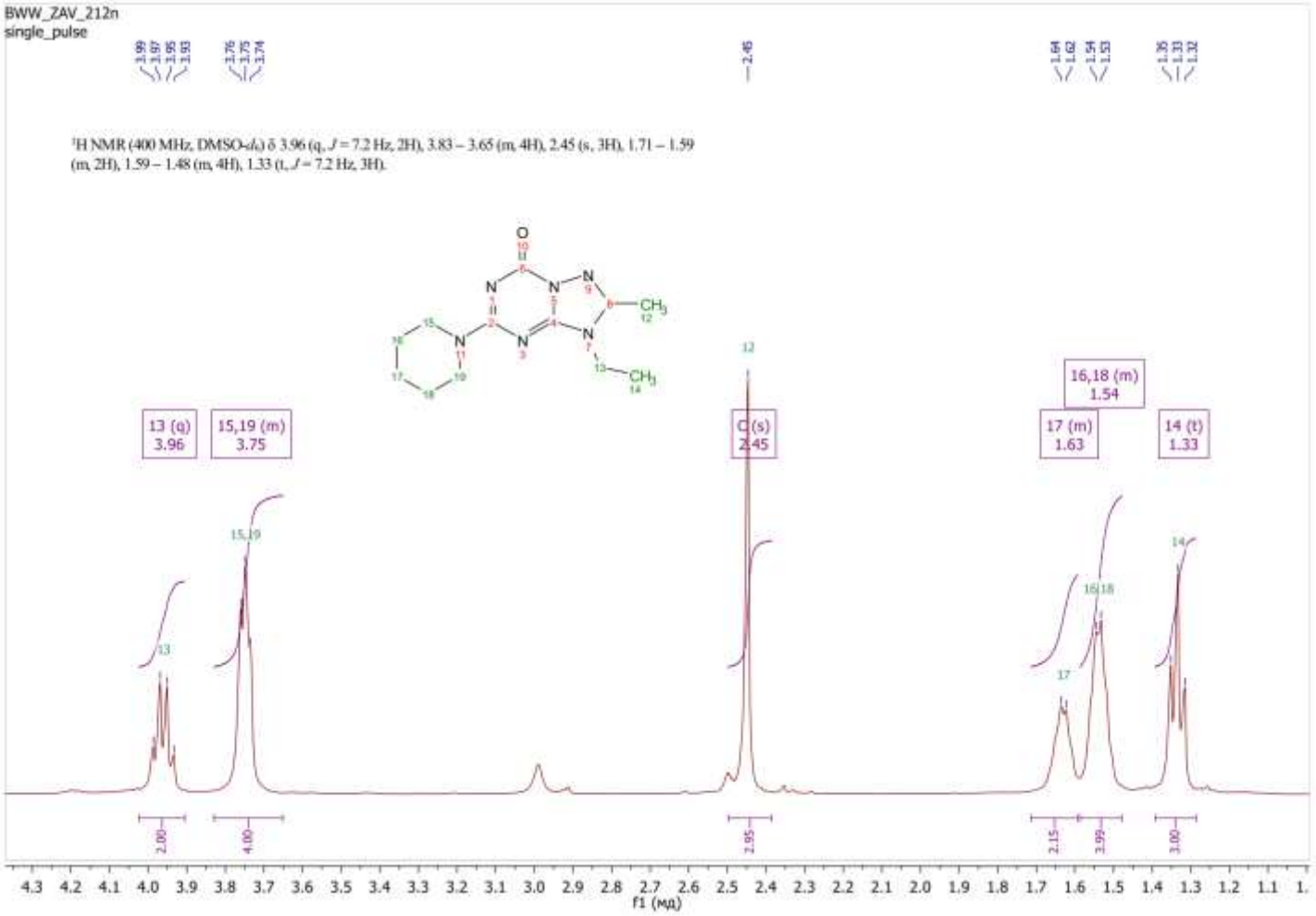
^{13}C NMR (101 MHz, DMSO-d_6) δ 206.33, 161.57, 153.03, 149.05, 148.28, 41.55, 37.47, 30.59, 13.26, 13.16, 12.90, 10.43.

3b

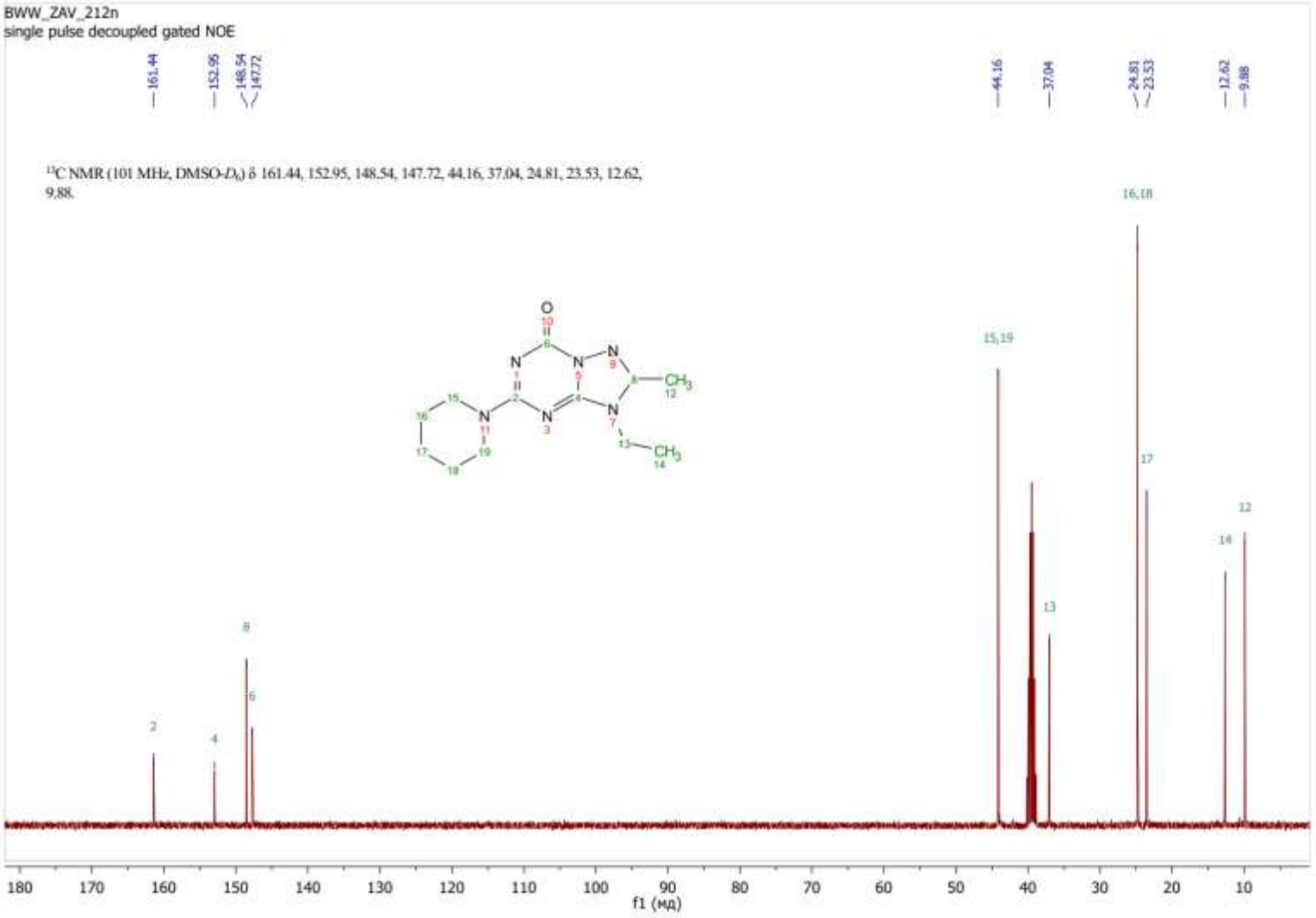


3b

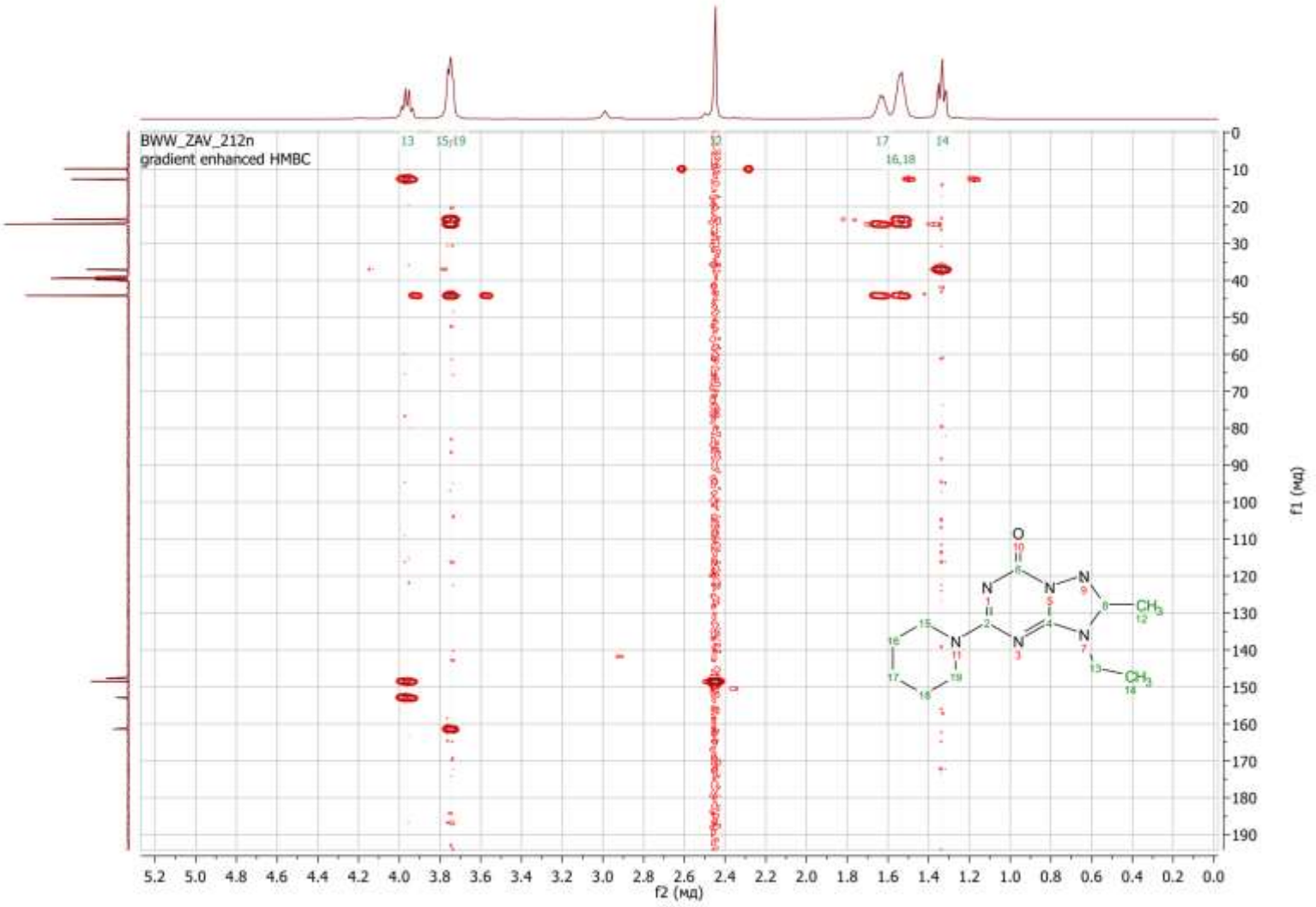
7) ^{1}H, ^{13}C and 2D HMBC NMR spectra of 3-ethyl-2-methyl-5-piperidino[1,2,4]triazolo[1,5-*a*][1,3,5]triazin-7-one (**3b**)



3c

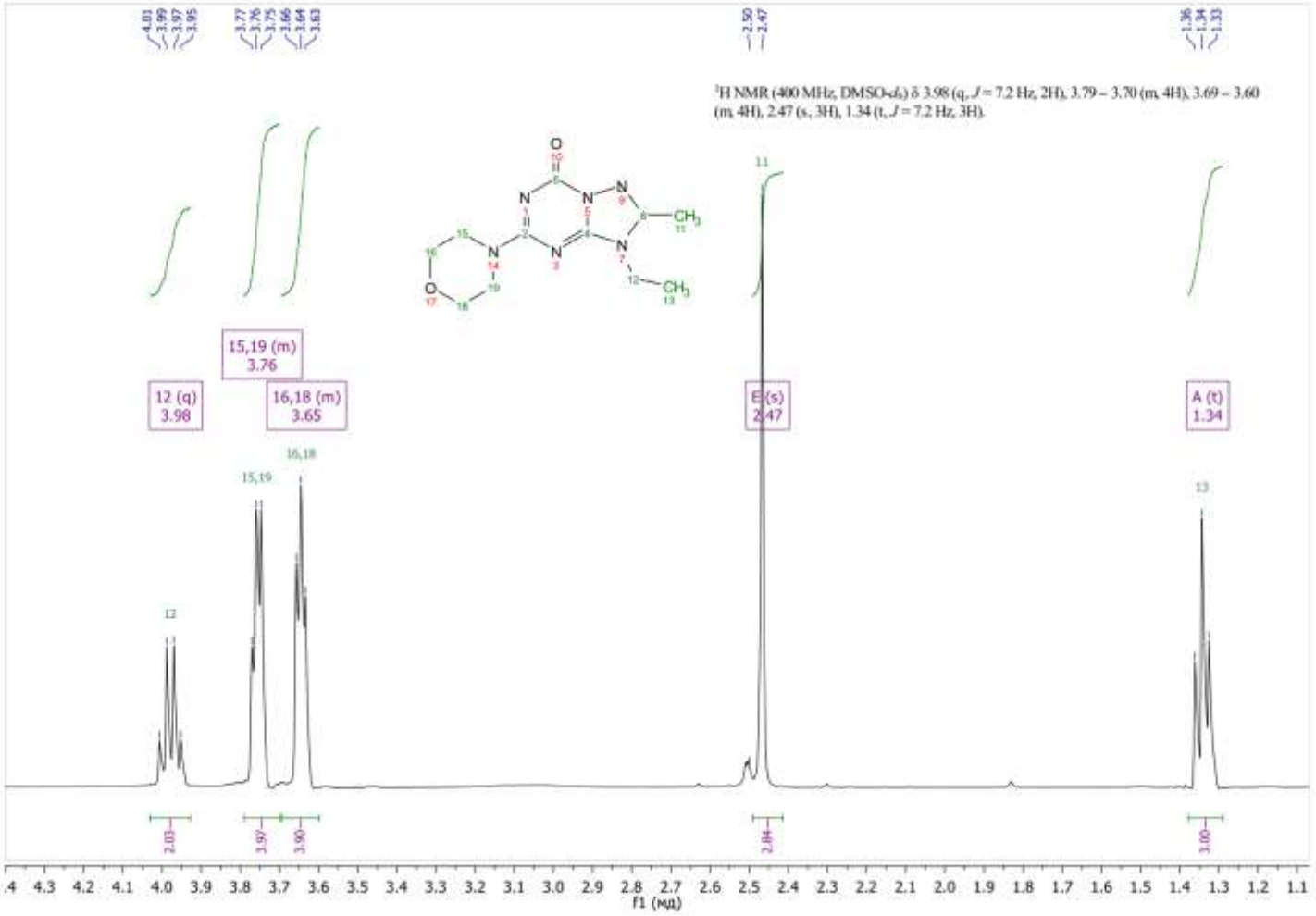

BWW_ZAV_212n
single pulse decoupled gated NOE
161.44
152.95
148.54
147.72
44.16
37.04
24.81
23.53
12.62
9.88
13C NMR (101 MHz, DMSO-D6) δ 161.44, 152.95, 148.54, 147.72, 44.16, 37.04, 24.81, 23.53, 12.62, 9.88.
16,18
15,19
17
12
14
13
8
16
2
4
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (мд)

3c

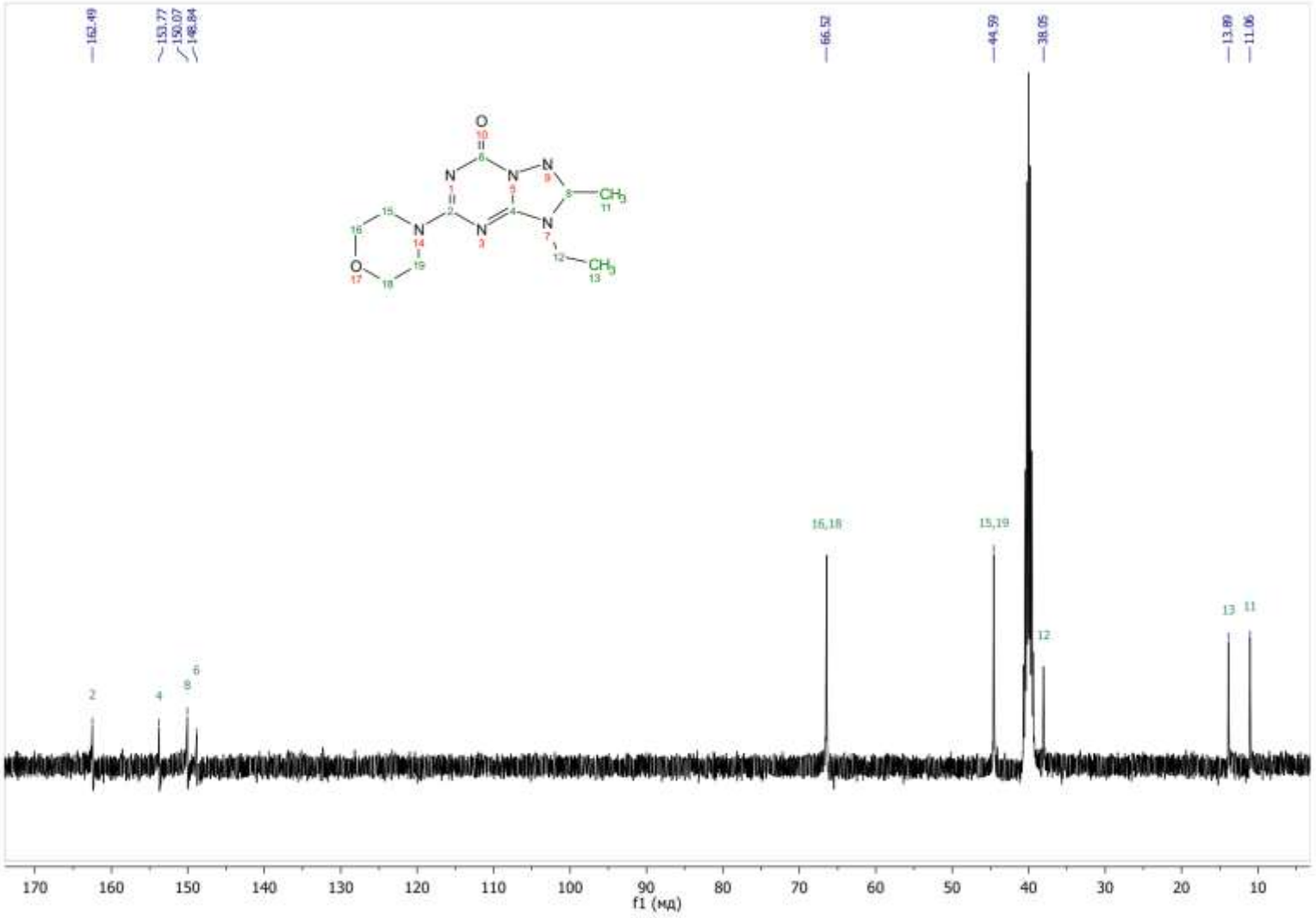

BWW_ZAV_212n
gradient enhanced HMBC
13
15,19
17
16,18
14
f2 (мд)
f1 (мд)

3c

8) ^{1}H, ^{13}C NMR spectra of 3-ethyl-2-methyl-5-morpholino[1,2,4]triazolo[1,5-*a*][1,3,5]triazin-7-one (**3d**)

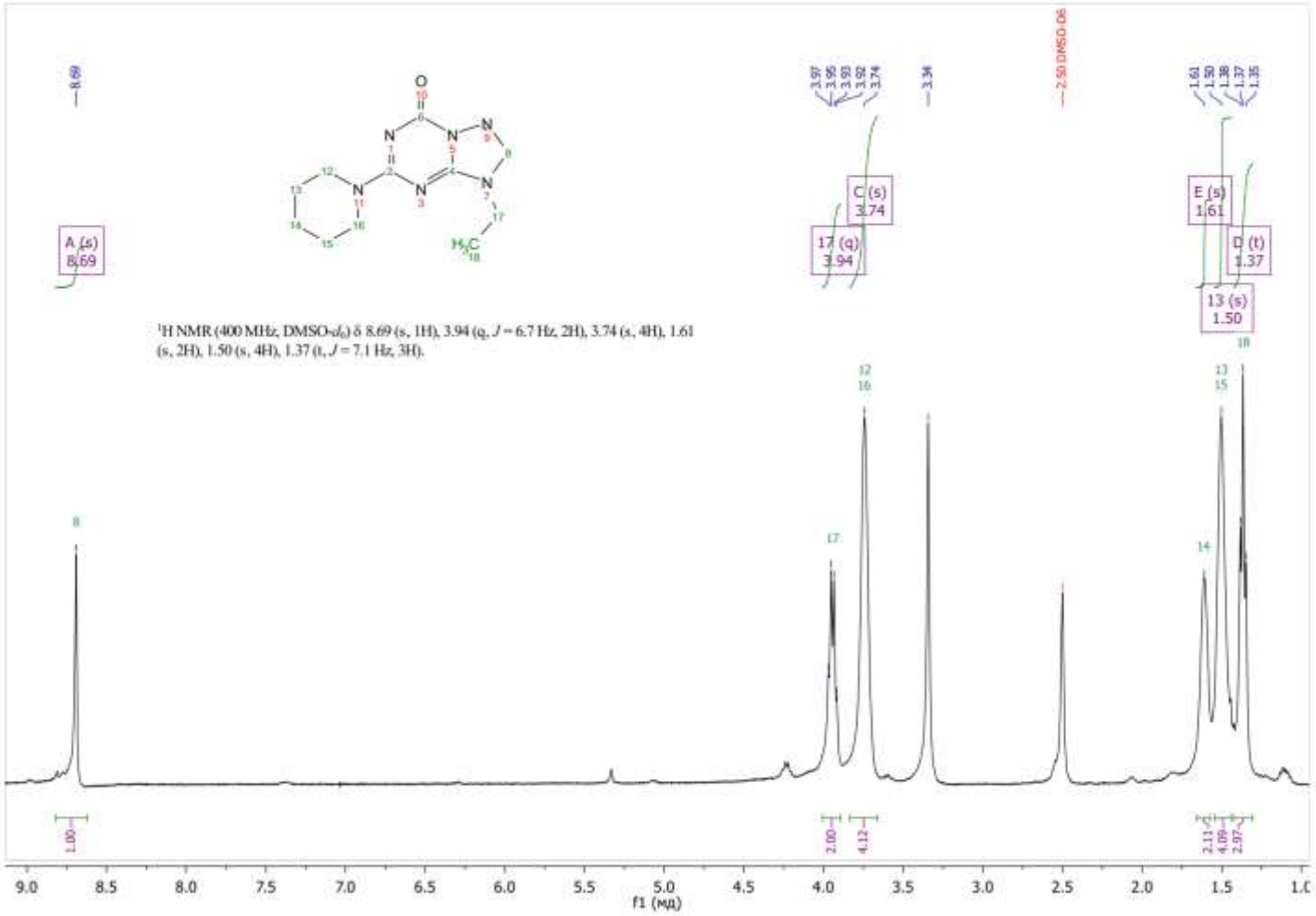


3d

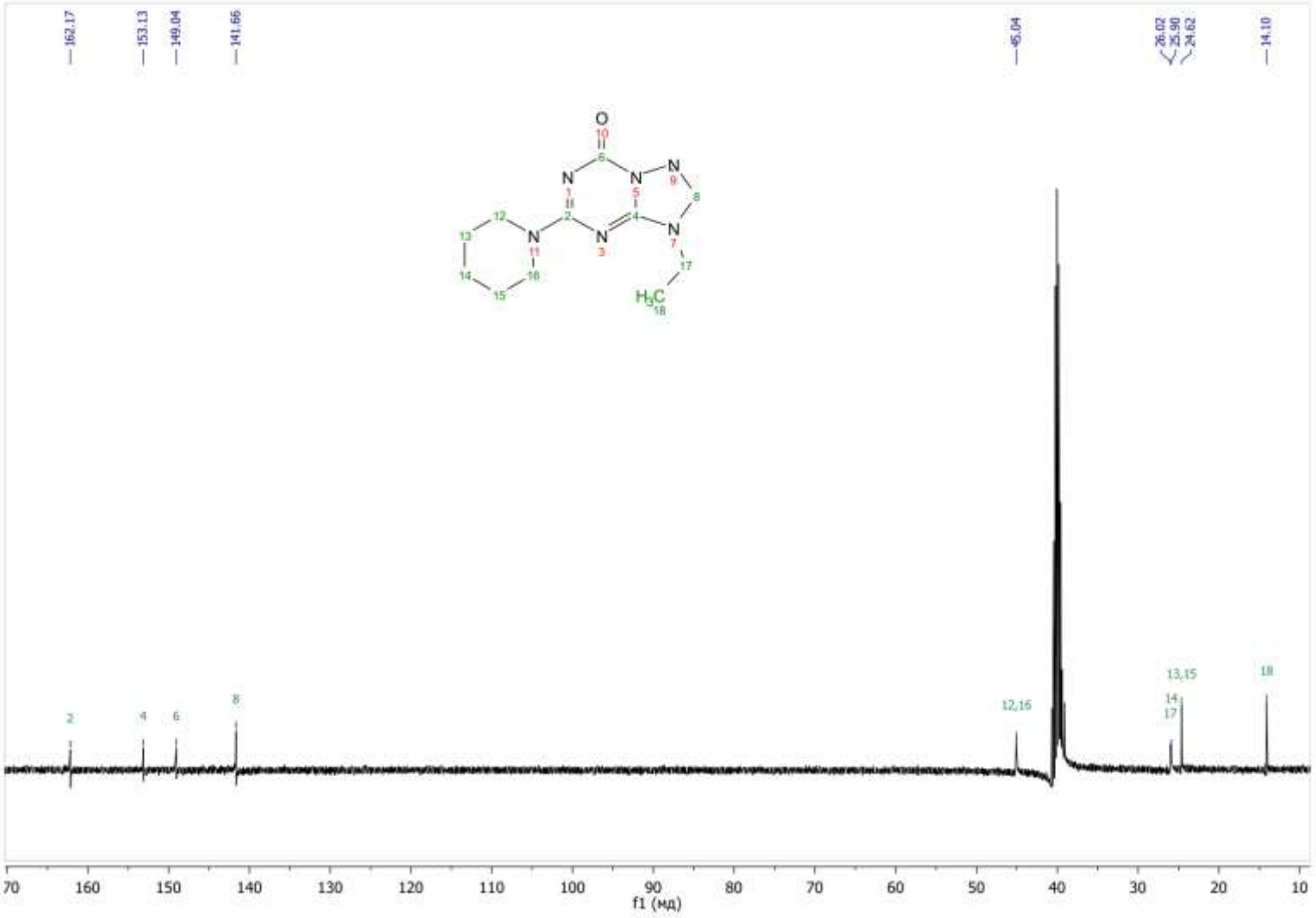

162.49
153.77
150.07
148.84
66.52
44.59
38.05
13.89
11.06
16,18
15,19
13
11
12
2
4
8
6
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (мд)

3d

9) ^{1}H, ^{13}C NMR spectra of 3-ethyl-5-piperidino[1,2,4]triazolo[1,5-*a*][1,3,5]triazin-7-one (**3e**)

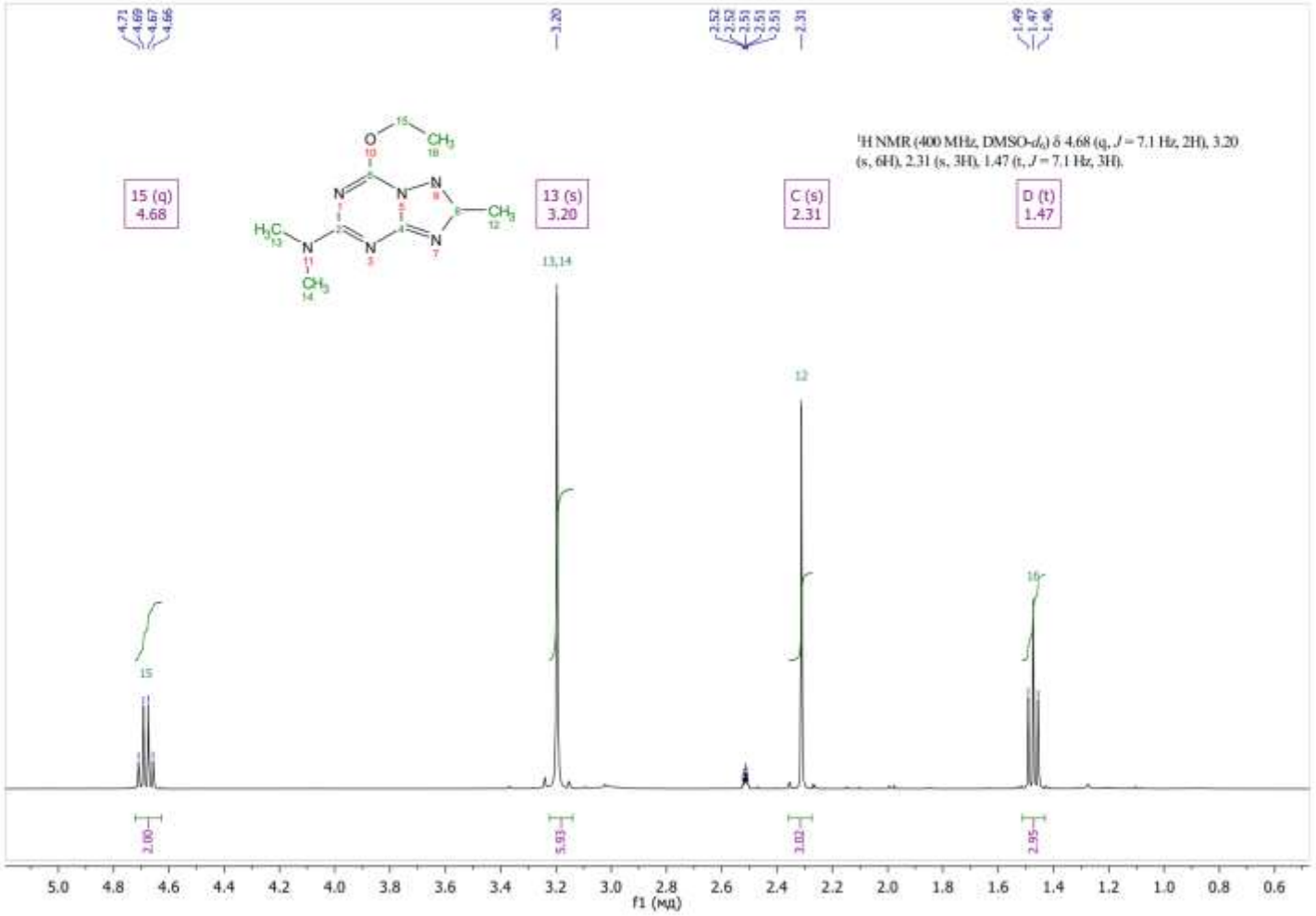


3e

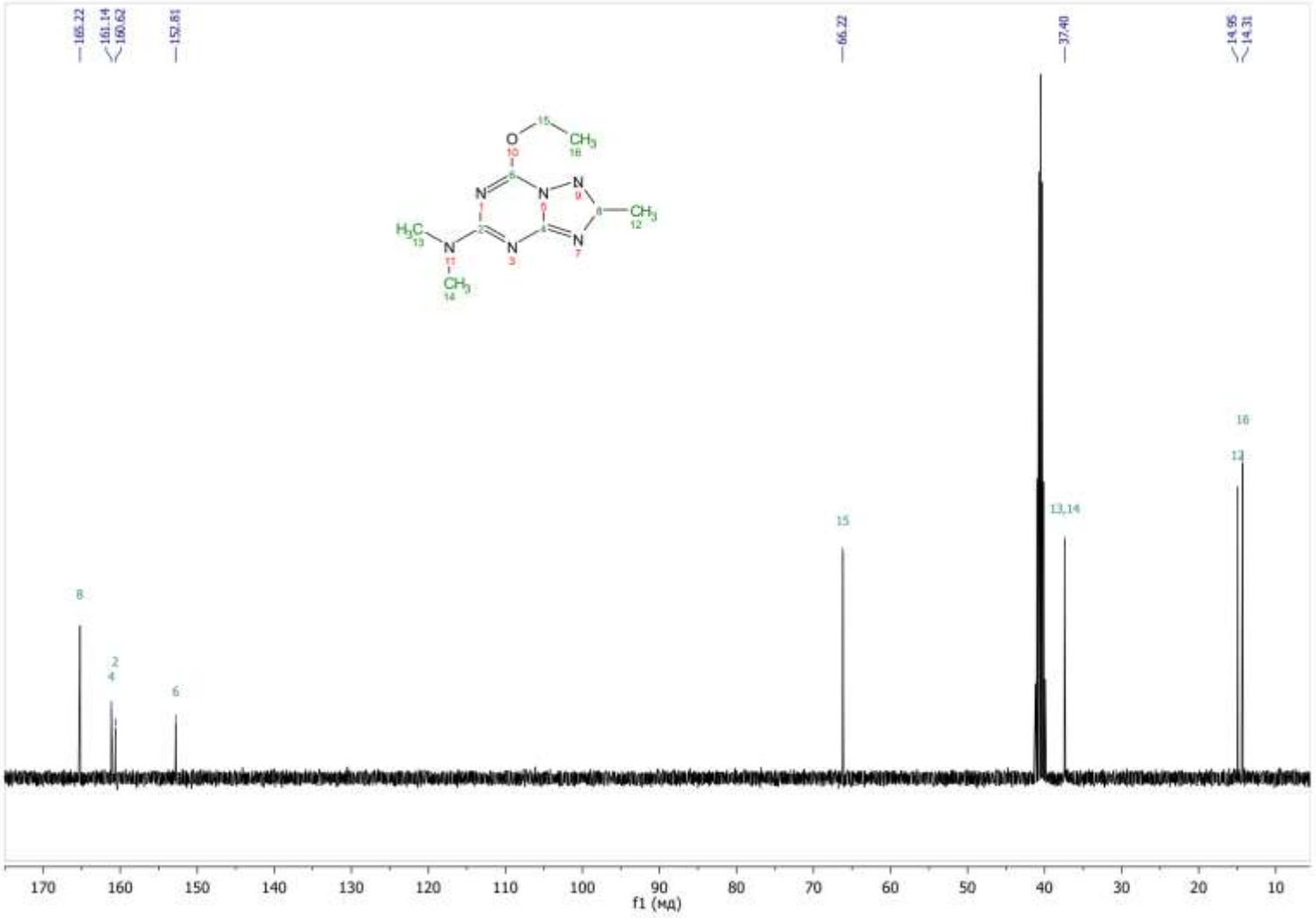

162.17
153.13
149.04
141.66
45.04
26.02
25.90
24.62
14.10
O
10
6
N
1
N
9
8
5
II
2
4
N
N
7
12
13
N
11
3
17
14
16
15
H3C
18
2
4
6
8
12,16
13,15
14
17
18
70
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (мд)

3e

10) ^{1}H, ^{13}C NMR spectra of 7-ethoxy-2-methyl-5-dimethylamino[1,2,4]triazolo[1,5-*a*][1,3,5]triazine (**4a**)

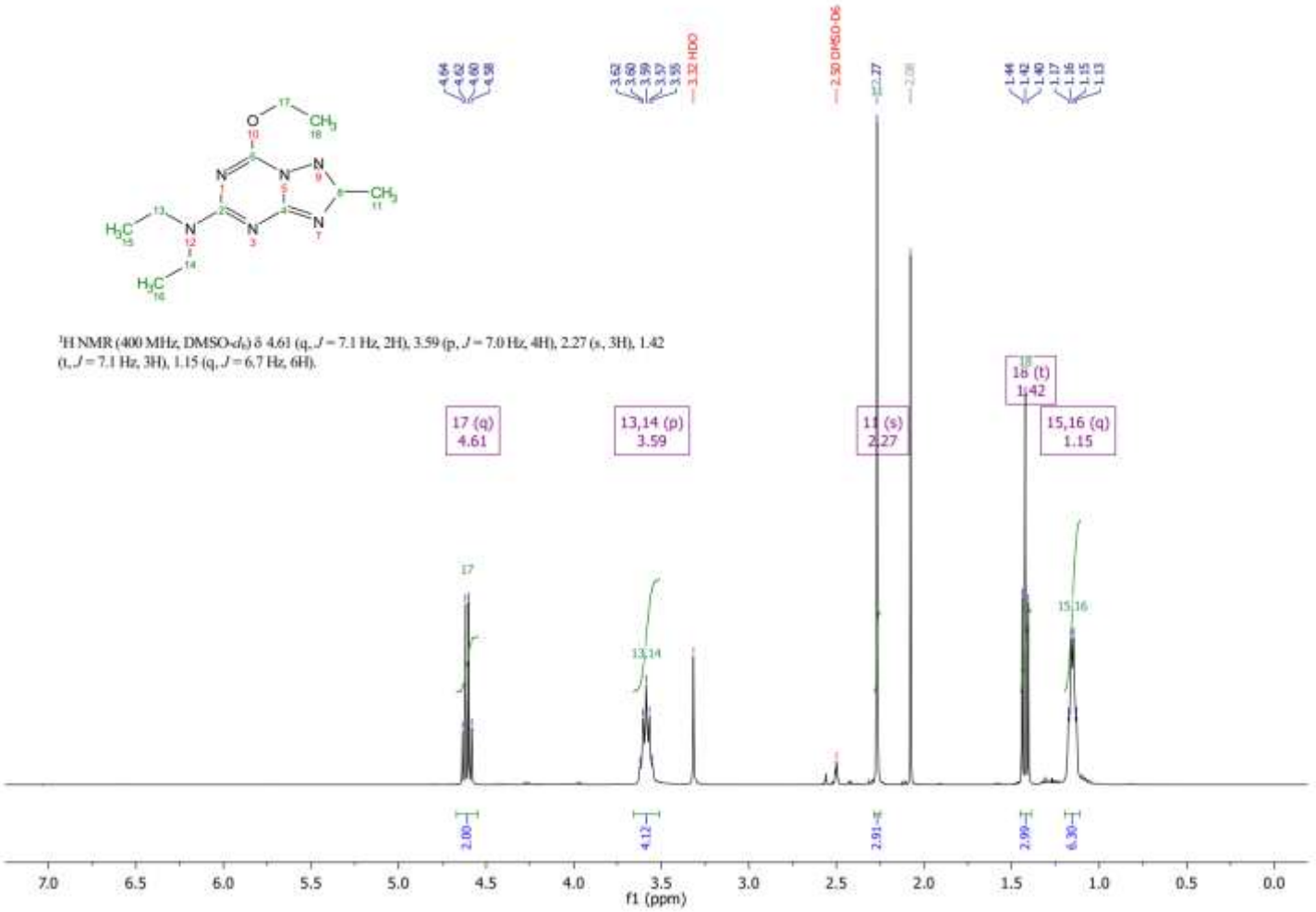


4a

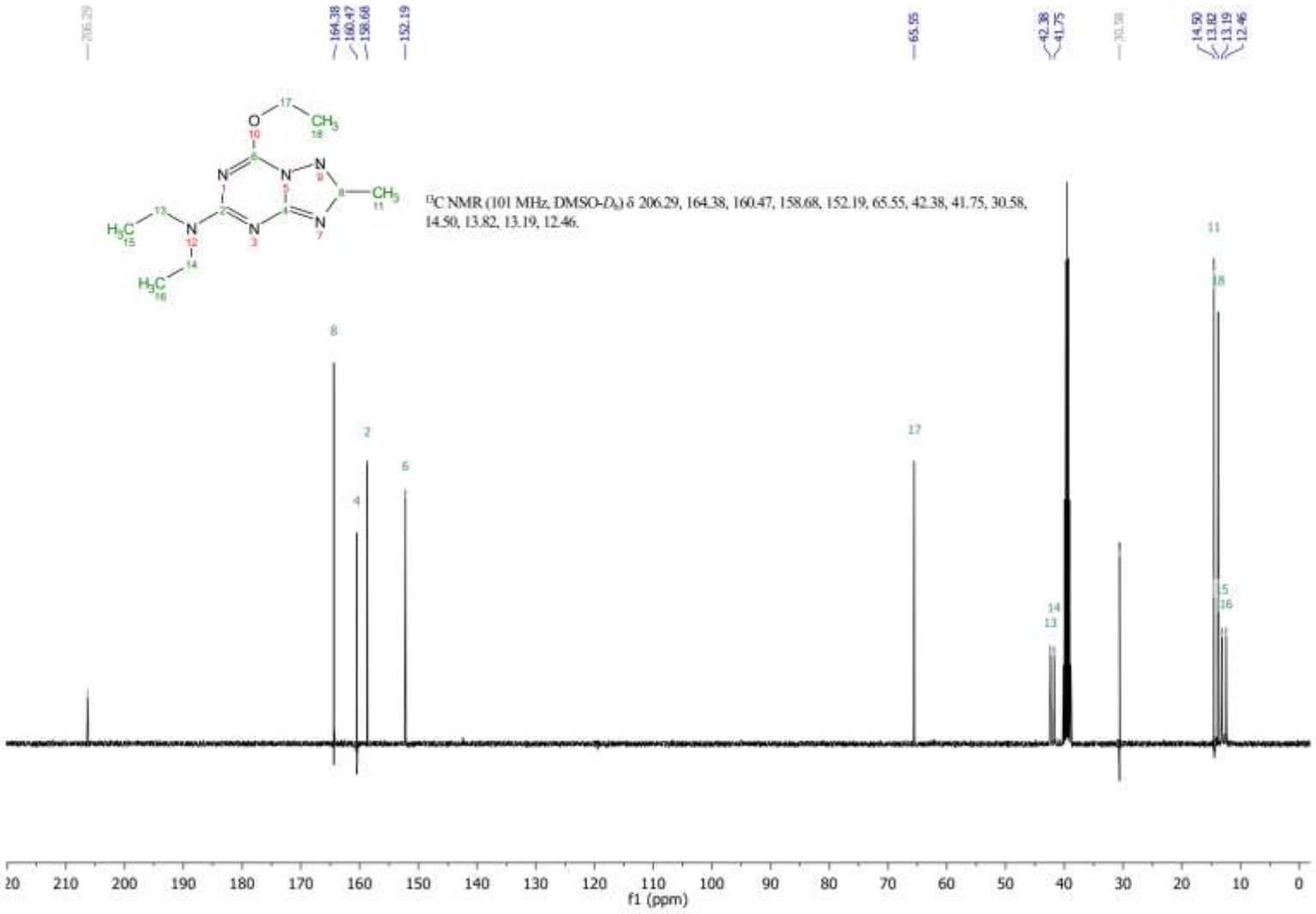

165.22
161.14
160.62
152.61
66.22
37.40
14.95
14.31
8
2
4
6
15
13,14
16
12
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (мд)

4a

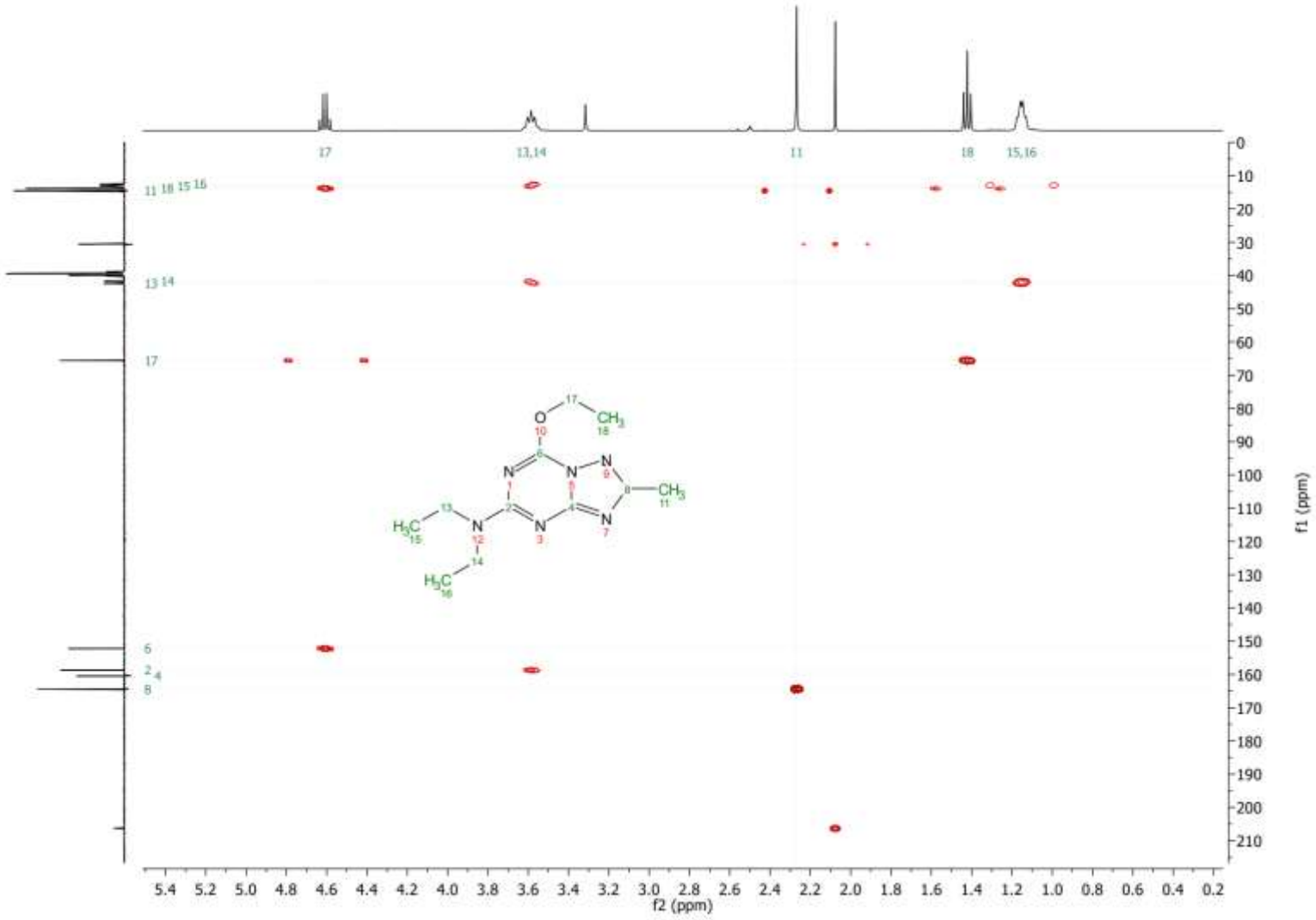
11) ^{1}H, ^{13}C and 2D HMBC NMR spectra of 7-ethoxy-2-methyl-5-diethylamino[1,2,4]triazolo[1,5-*a*][1,3,5]triazine (**4b**)



4b

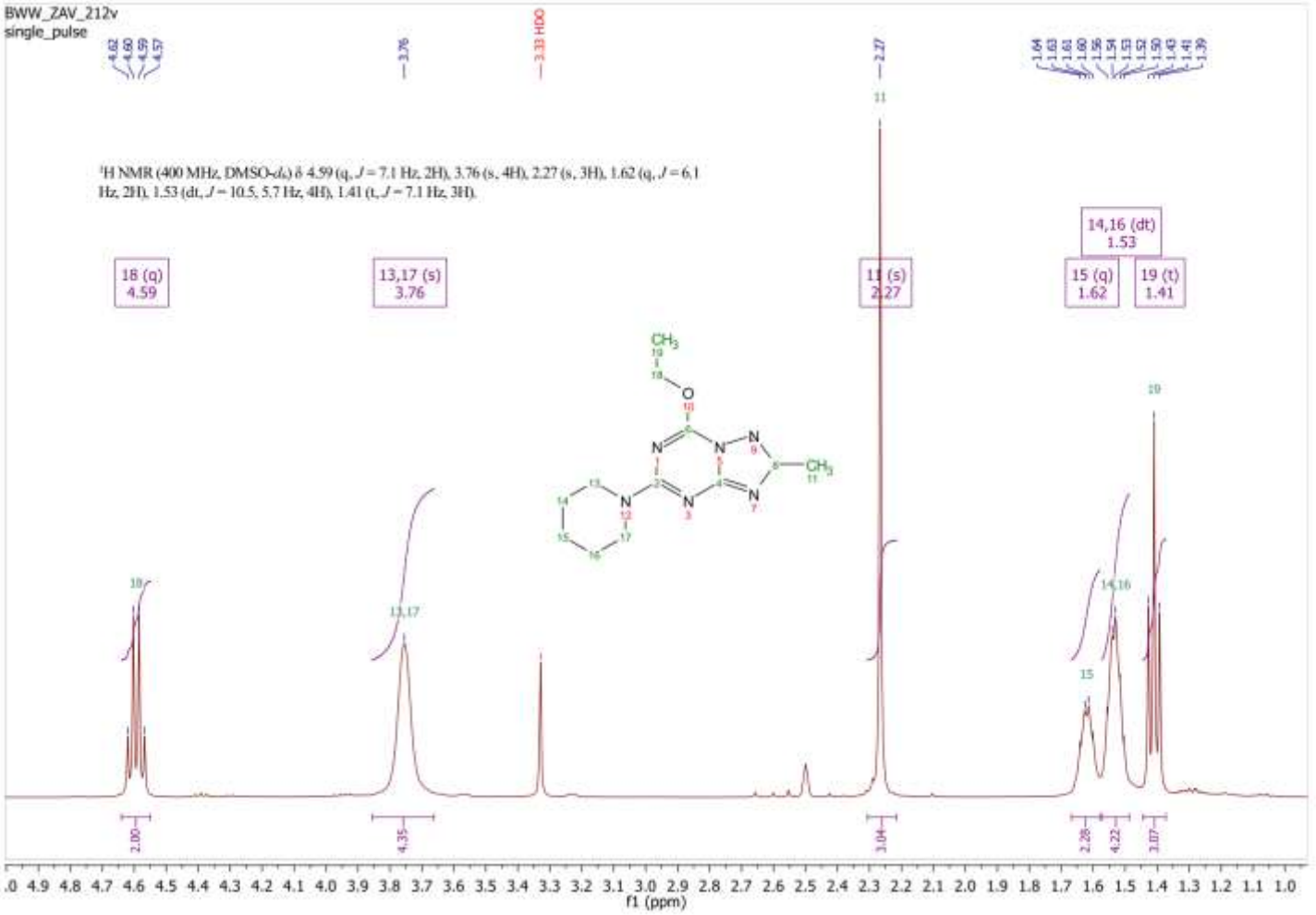

206.29
164.38
160.47
158.68
152.19
65.55
42.38
41.75
30.58
14.50
13.82
13.19
12.46
^{13}C NMR (101 MHz, DMSO-D_6) δ 206.29, 164.38, 160.47, 158.68, 152.19, 65.55, 42.38, 41.75, 30.58, 14.50, 13.82, 13.19, 12.46.
f1 (ppm)

4b

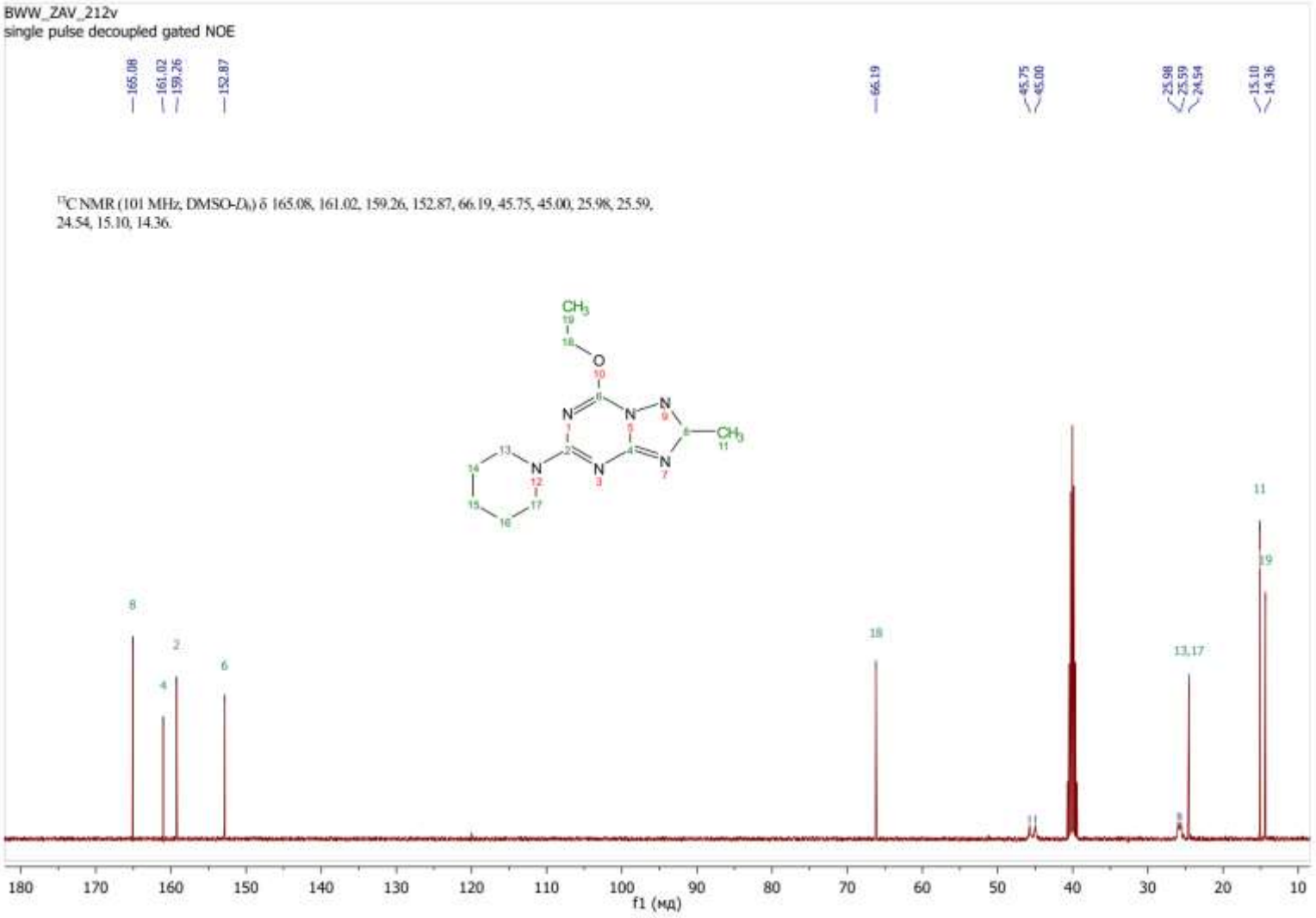


4b

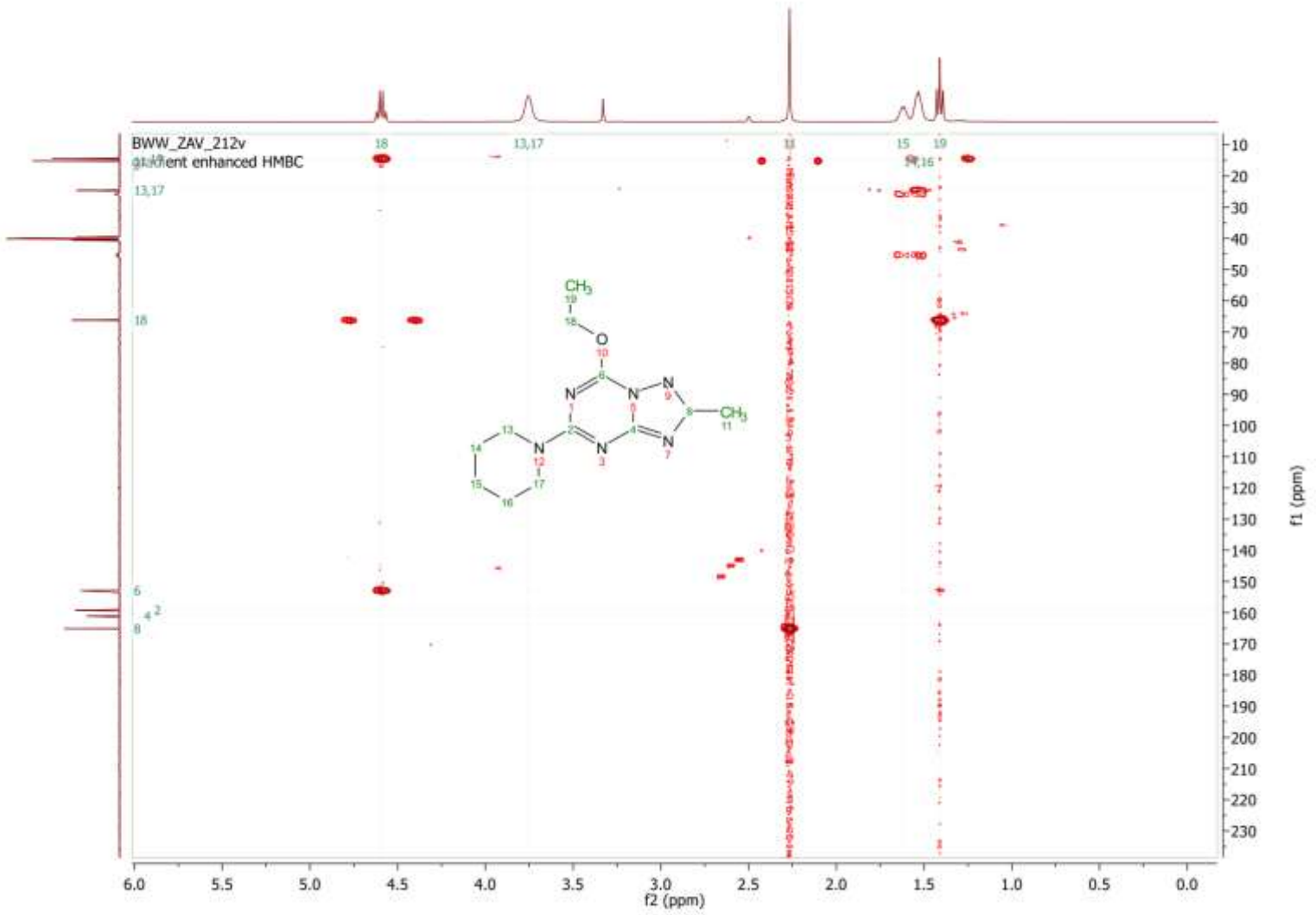
12) ^{1}H, ^{13}C and 2D HMBC NMR spectra of 7-ethoxy-2-methyl-5-piperidino[1,2,4]triazolo[1,5-*a*][1,3,5]triazine (**4c**)



4c

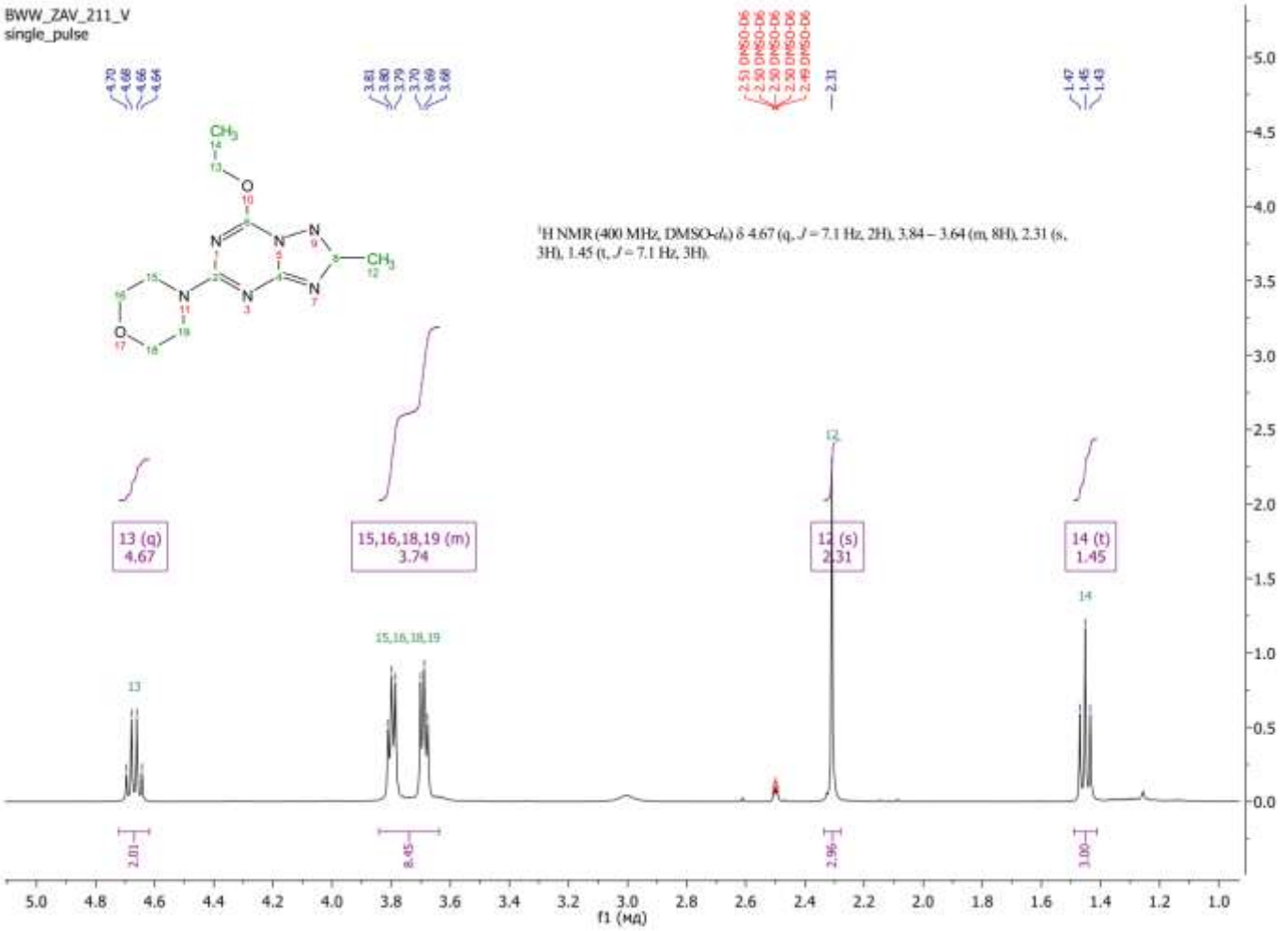

BWW_ZAV_212v
single pulse decoupled gated NOE
165.08
161.02
159.26
152.87
66.19
45.75
45.00
25.98
25.59
24.54
15.10
14.36
^{13}C NMR (101 MHz, DMSO-d_6) δ 165.08, 161.02, 159.26, 152.87, 66.19, 45.75, 45.00, 25.98, 25.59, 24.54, 15.10, 14.36.
8
2
4
6
18
13,17
11
19
f1 (мд)

4c


BWW_ZAV_212v
gradient enhanced HMBC
18
13,17
15
19
15,16
13,17
18
6
4
2
8
CH3
19
18
O
10
6
N
1
N
9
2
9
4
8
CH3
11
13
14
N
12
15
17
16
N
3
N
7
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f2 (ppm)
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
f1 (ppm)

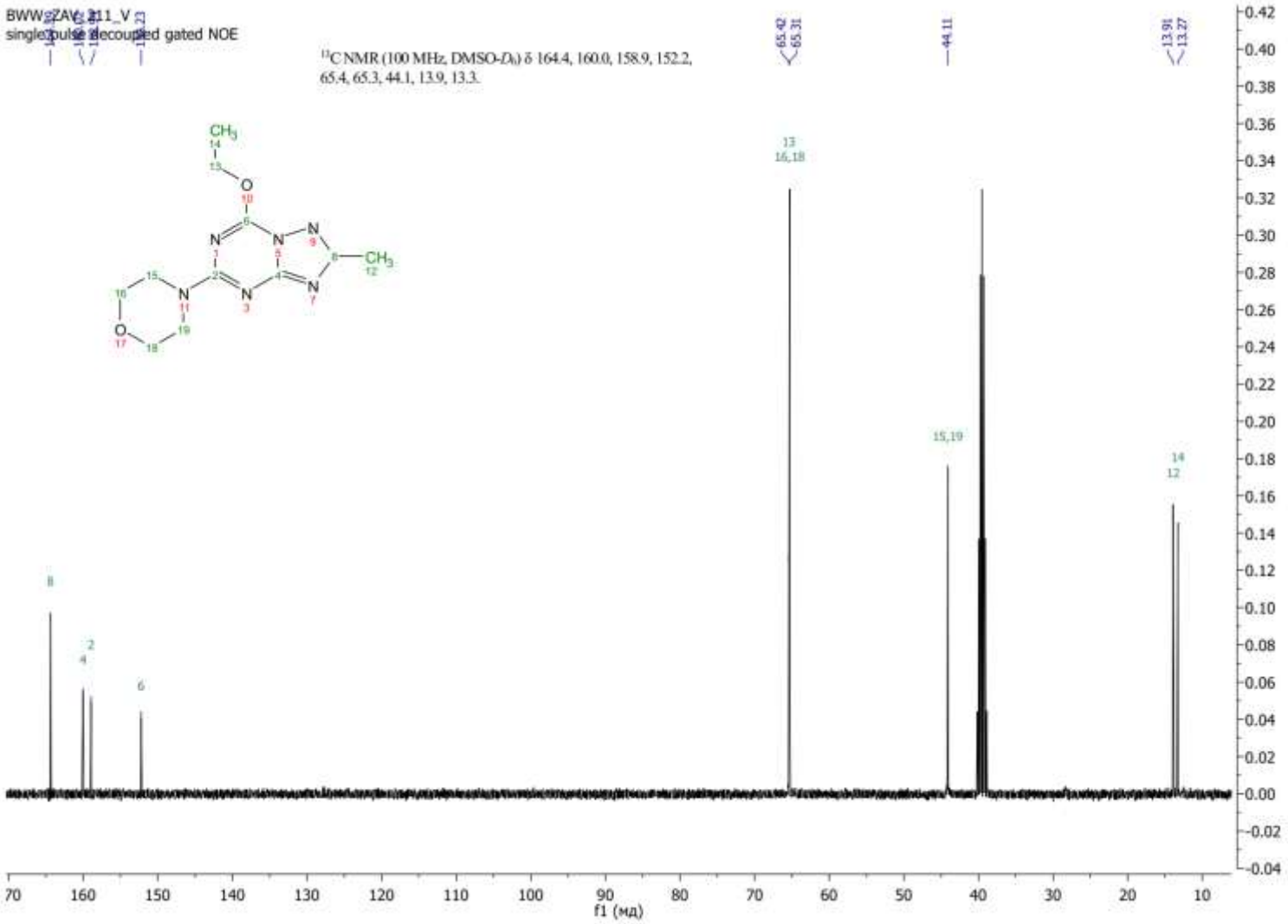
4c

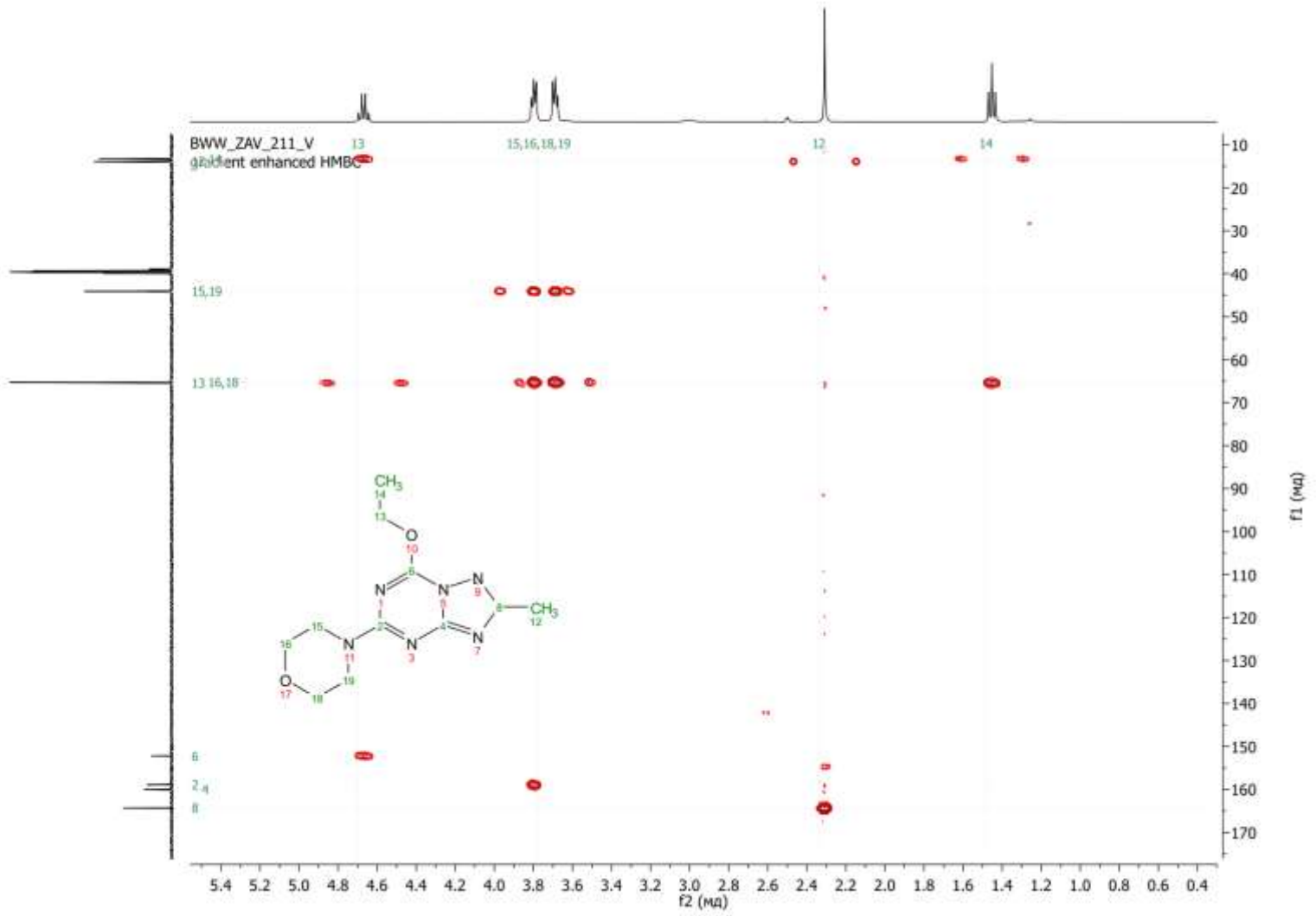
13) ^{1}H, ^{13}C and 2D HMBC NMR spectra of 7-ethoxy-2-methyl-5-morpholino[1,2,4]triazolo[1,5-*a*][1,3,5]triazine (**4d**)



4d

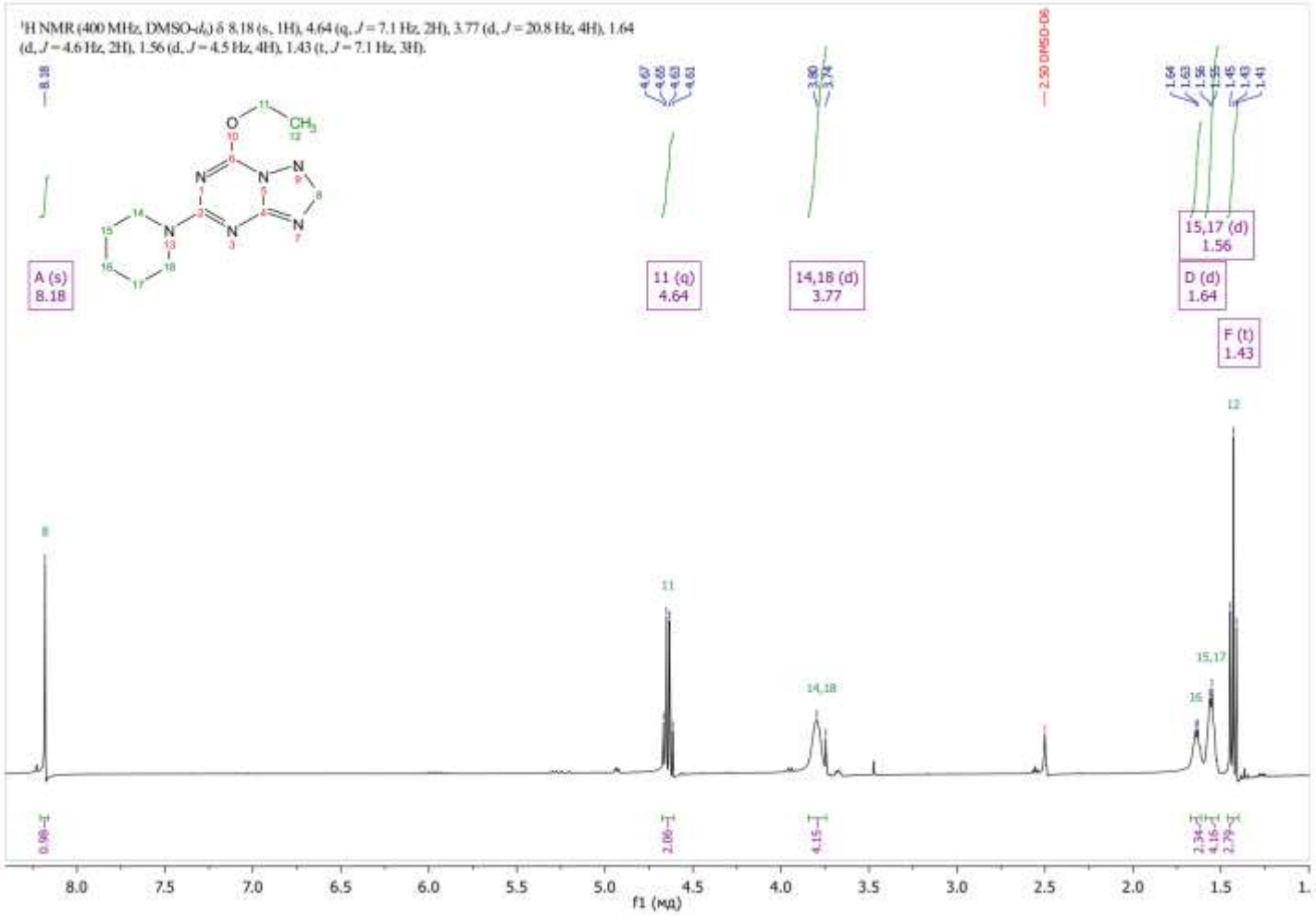
4d


BWW-2AV-211_V
single pulse decoupled gated NOE
^{13}C NMR (100 MHz, DMSO-D_6) δ 164.4, 160.0, 158.9, 152.2, 65.4, 65.3, 44.1, 13.9, 13.3.
65.42
65.31
44.11
13.91
13.27
13
16,18
15,19
14
12
8
2
4
6
f1 (мд)

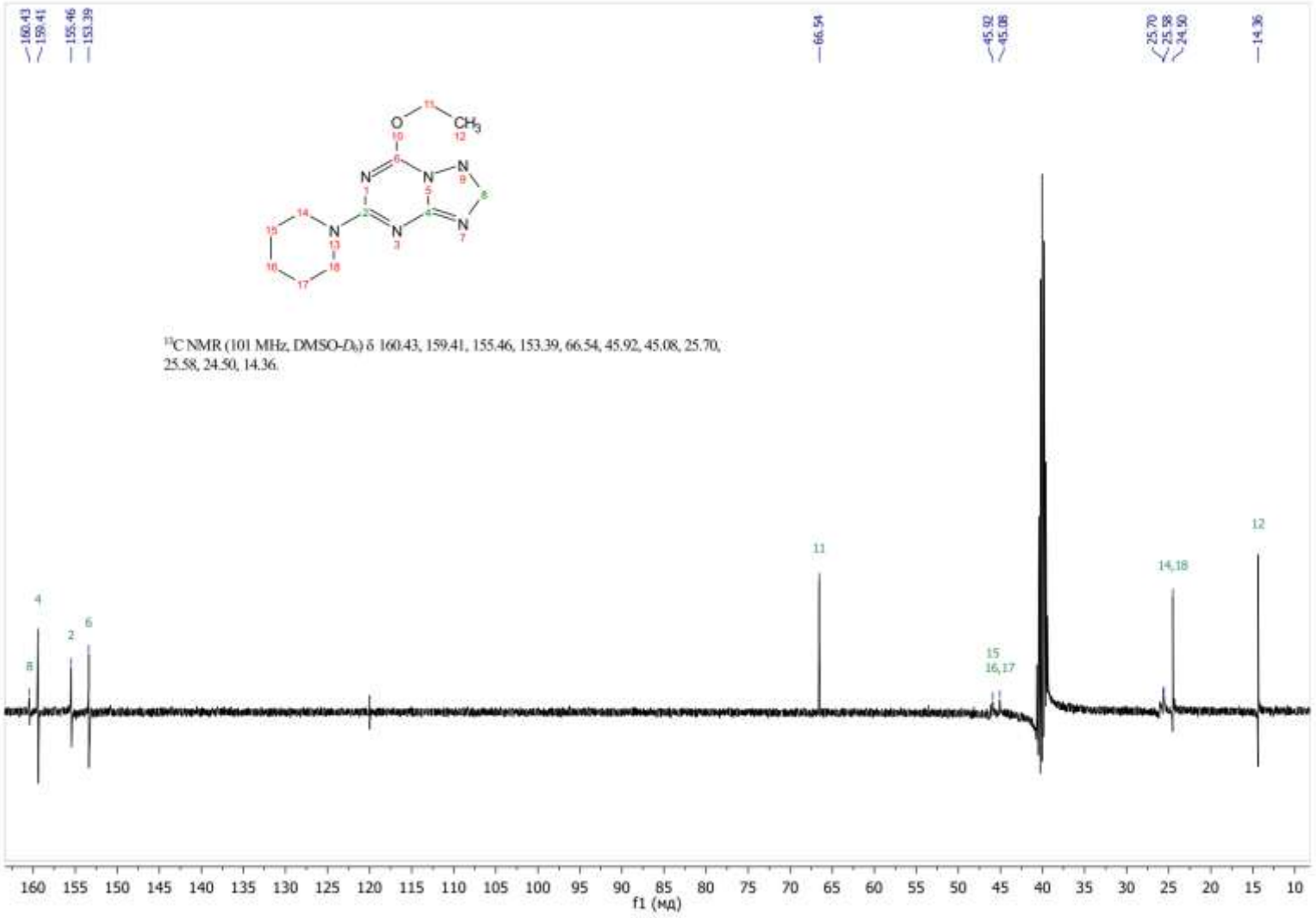

BWW_ZAV_211_V
gradient enhanced HMBC
13
15,16,18,19
12
14
15,19
13 16,18
6
2
8
f2 (мд)
f1 (мд)

4d

14) ^{1}H, ^{13}C NMR spectra of 7-ethoxy-5-piperidino[1,2,4]triazolo[1,5-*a*][1,3,5]triazine (**4e**)

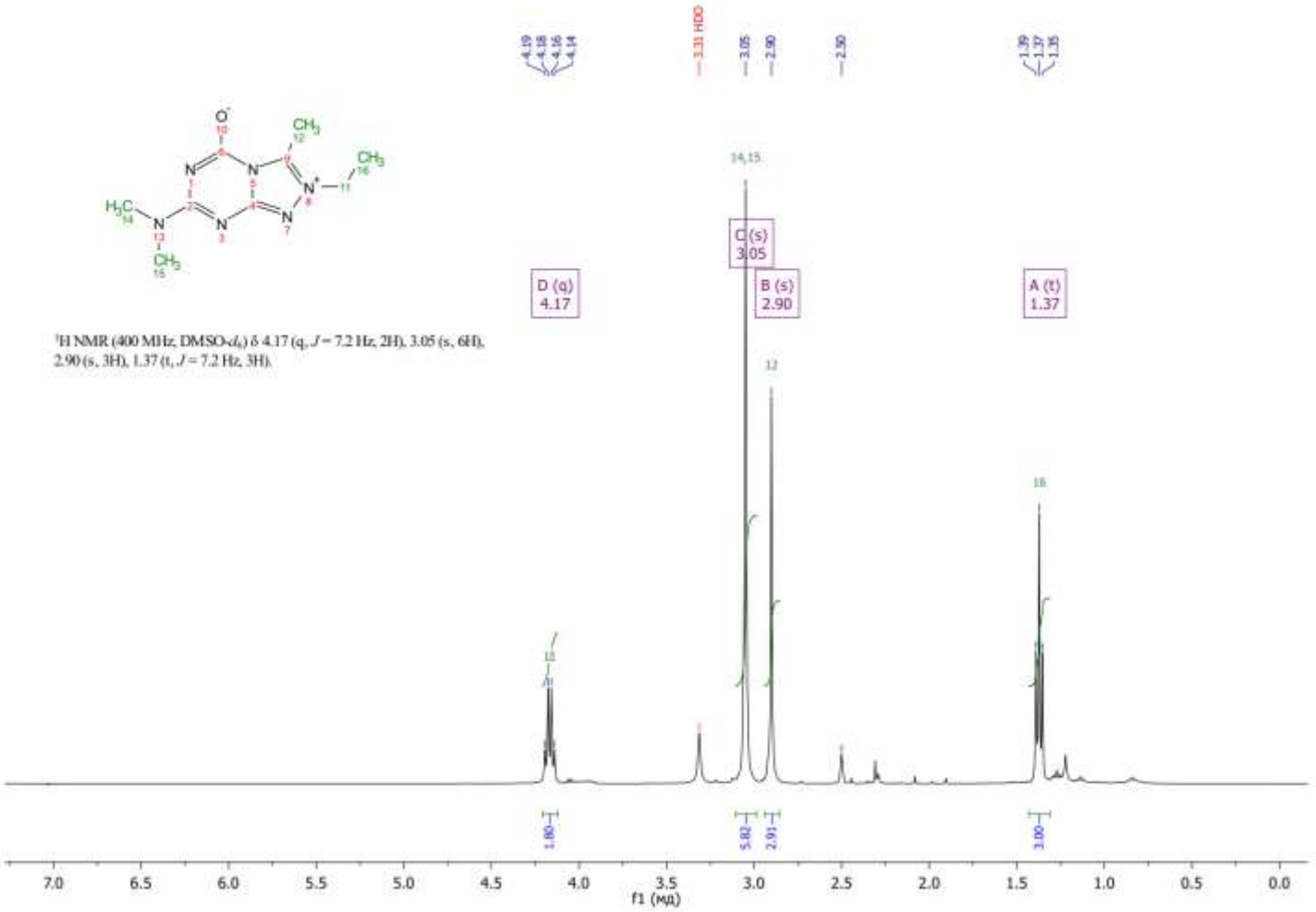


4e


160.43
159.41
155.46
153.39
66.54
45.92
45.08
25.70
25.58
24.50
14.36
^{13}C NMR (101 MHz, DMSO-D_6) δ 160.43, 159.41, 155.46, 153.39, 66.54, 45.92, 45.08, 25.70, 25.58, 24.50, 14.36.
4
2
6
8
11
15
16,17
14,18
12
160 155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10
f1 (мд)

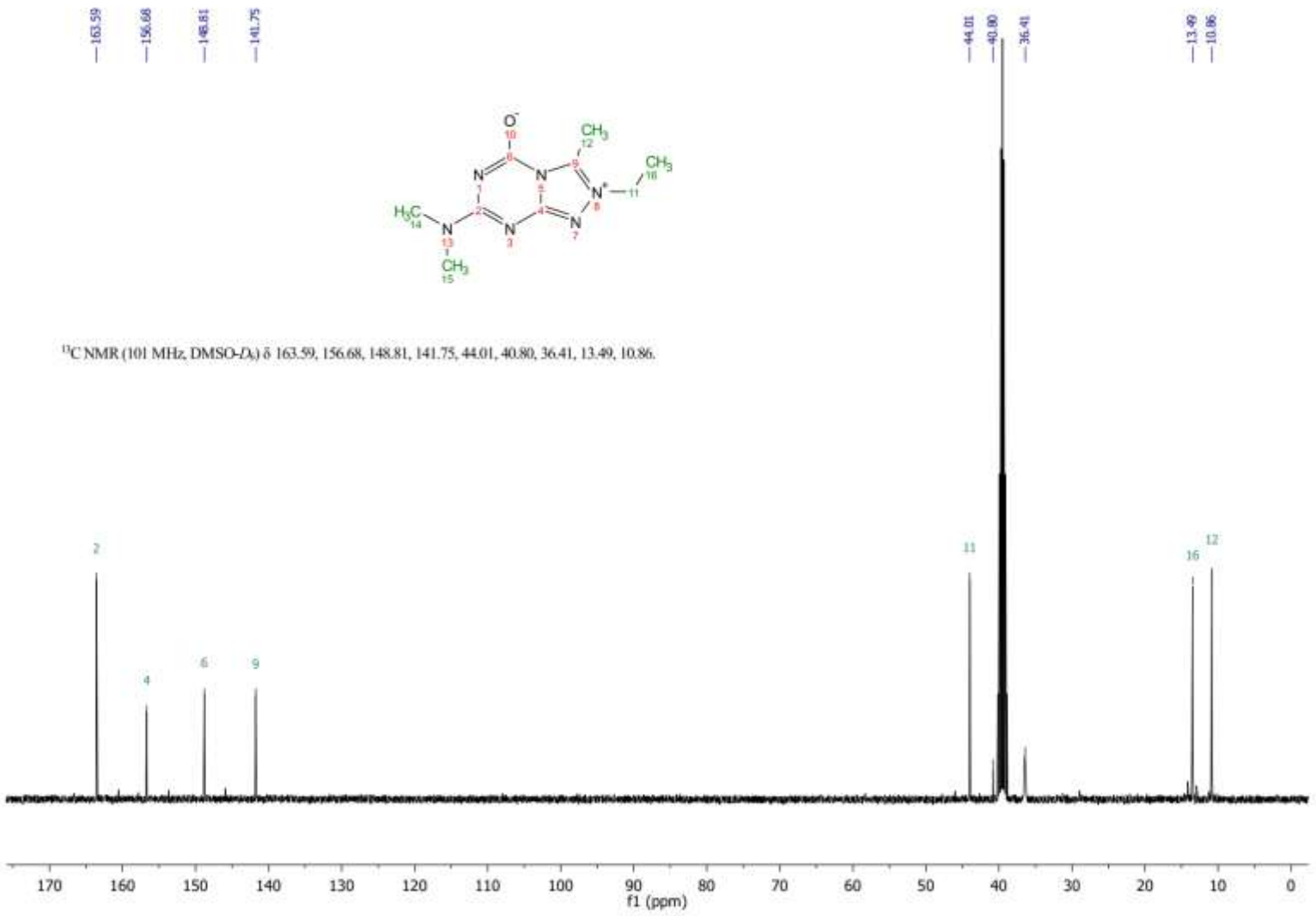
4e

15) ^{1}H, ^{13}C and 2D HMBC NMR spectra of 2-ethyl-3-methyl-7-dimethylamino[1,2,4]triazolo[4,3-*a*][1,3,5]triazin-2-ium-5-olate (**5a**)



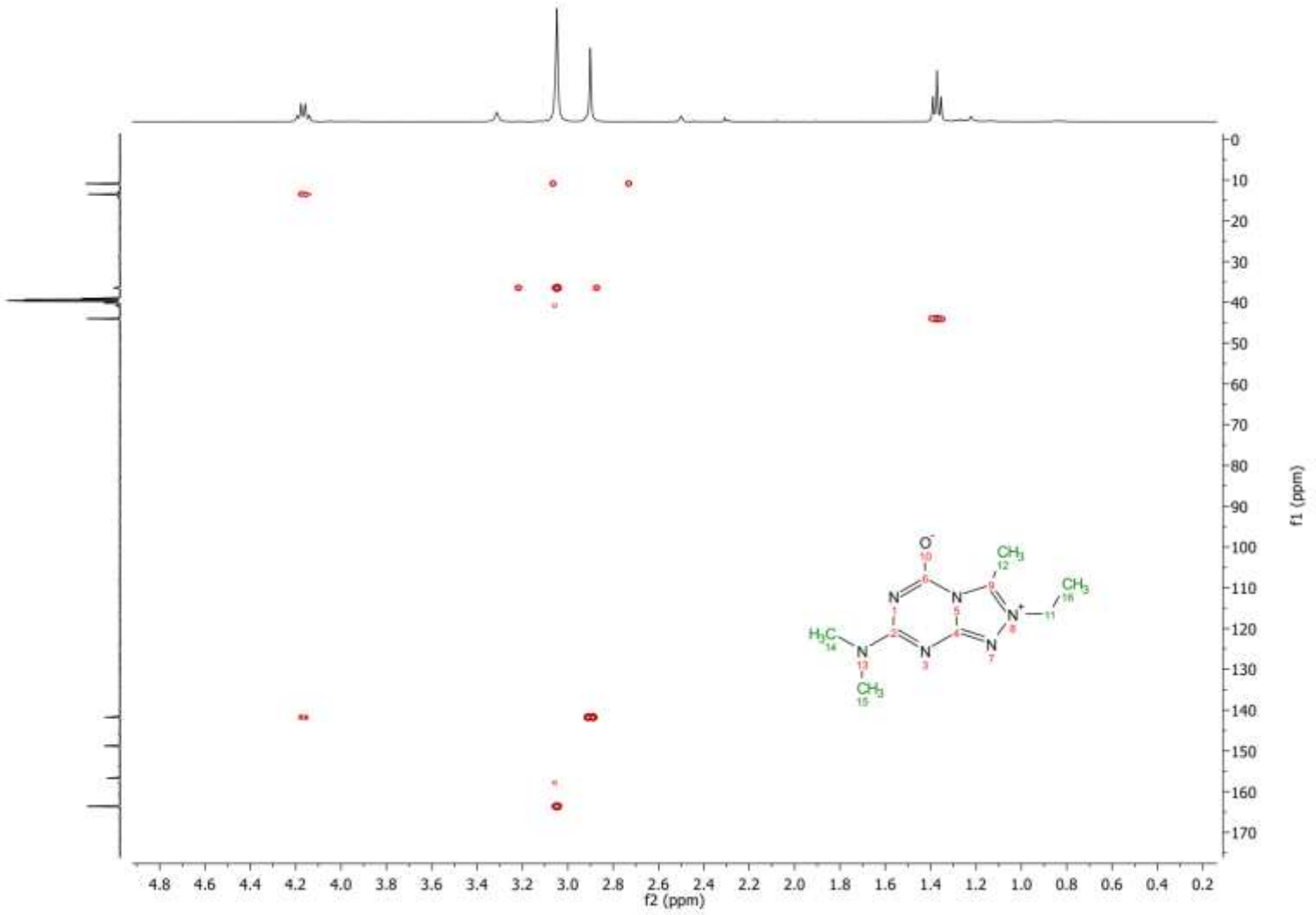
^{1}H NMR (400 MHz, DMSO-d_6) δ 4.17 (q, J = 7.2 Hz, 2H), 3.05 (s, 6H), 2.90 (s, 3H), 1.37 (t, J = 7.2 Hz, 3H).

5a



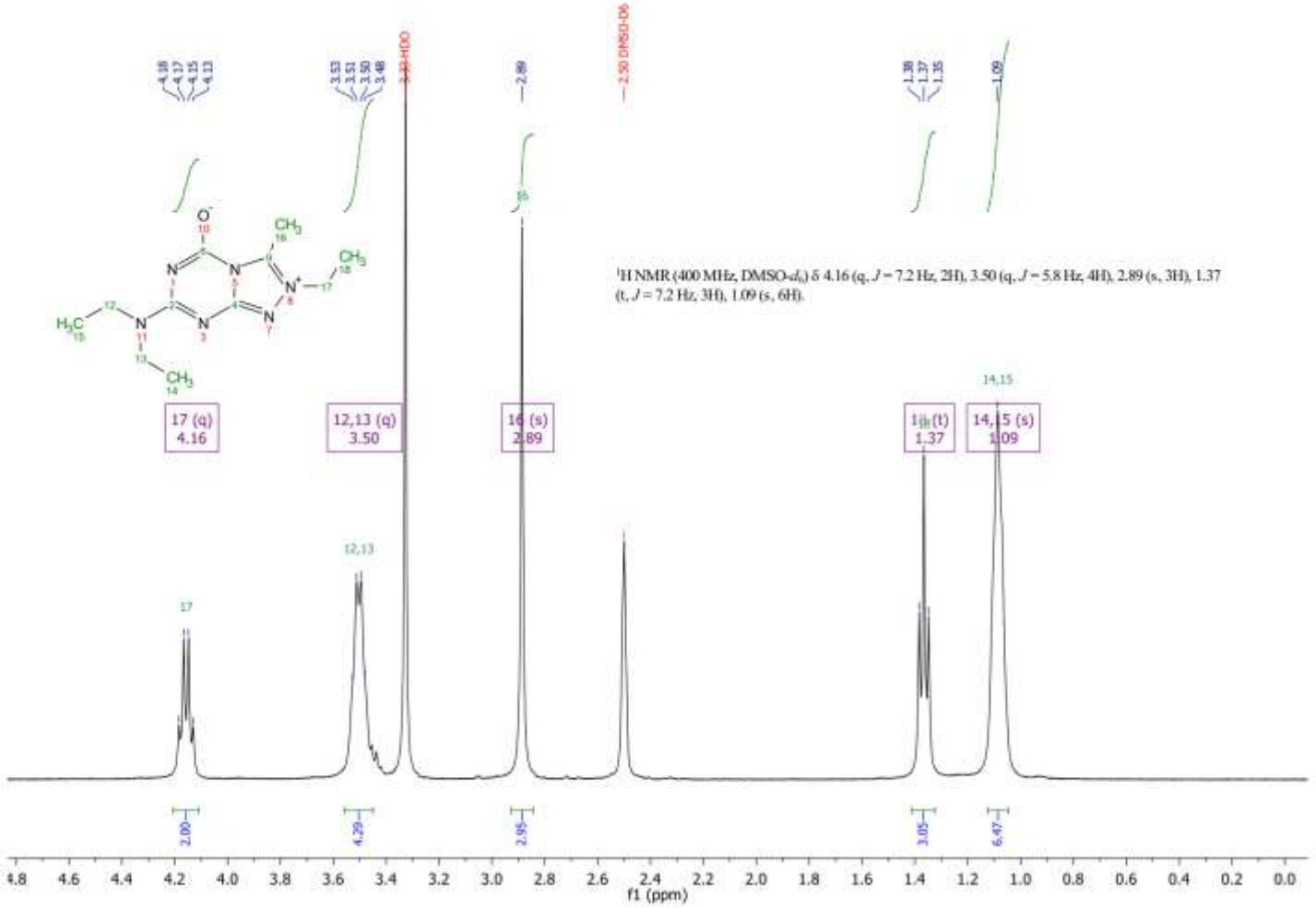
^{13}C NMR (101 MHz, DMSO-D_6) δ 163.59, 156.68, 148.81, 141.75, 44.01, 40.80, 36.41, 13.49, 10.86.

5a

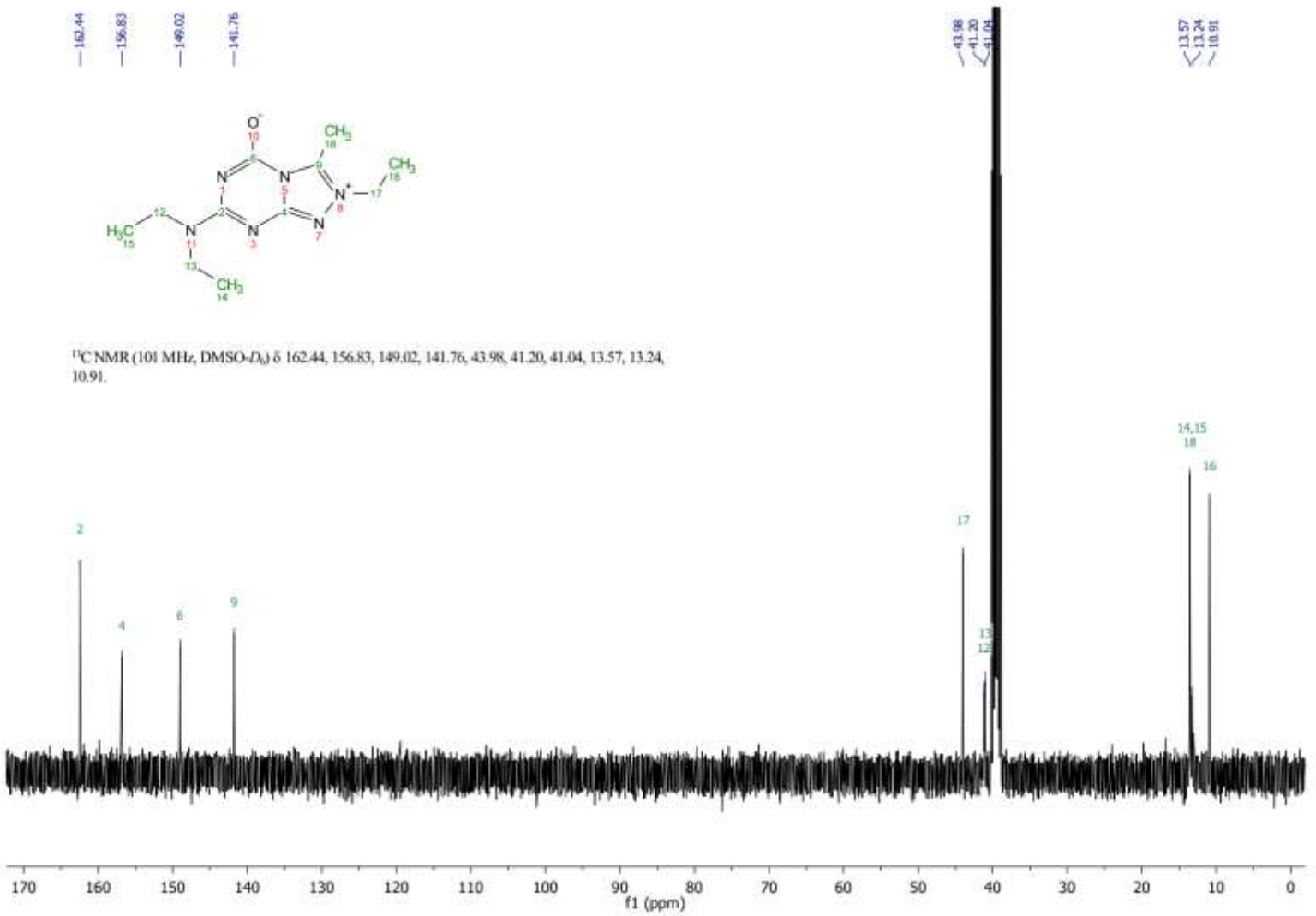


5a

16) ^{1}H, ^{13}C and 2D HMBC NMR spectra of 2-ethyl-3-methyl-7-diethylamino[1,2,4]triazolo[4,3-*a*][1,3,5]triazin-2-ium-5-olate (**5b**)

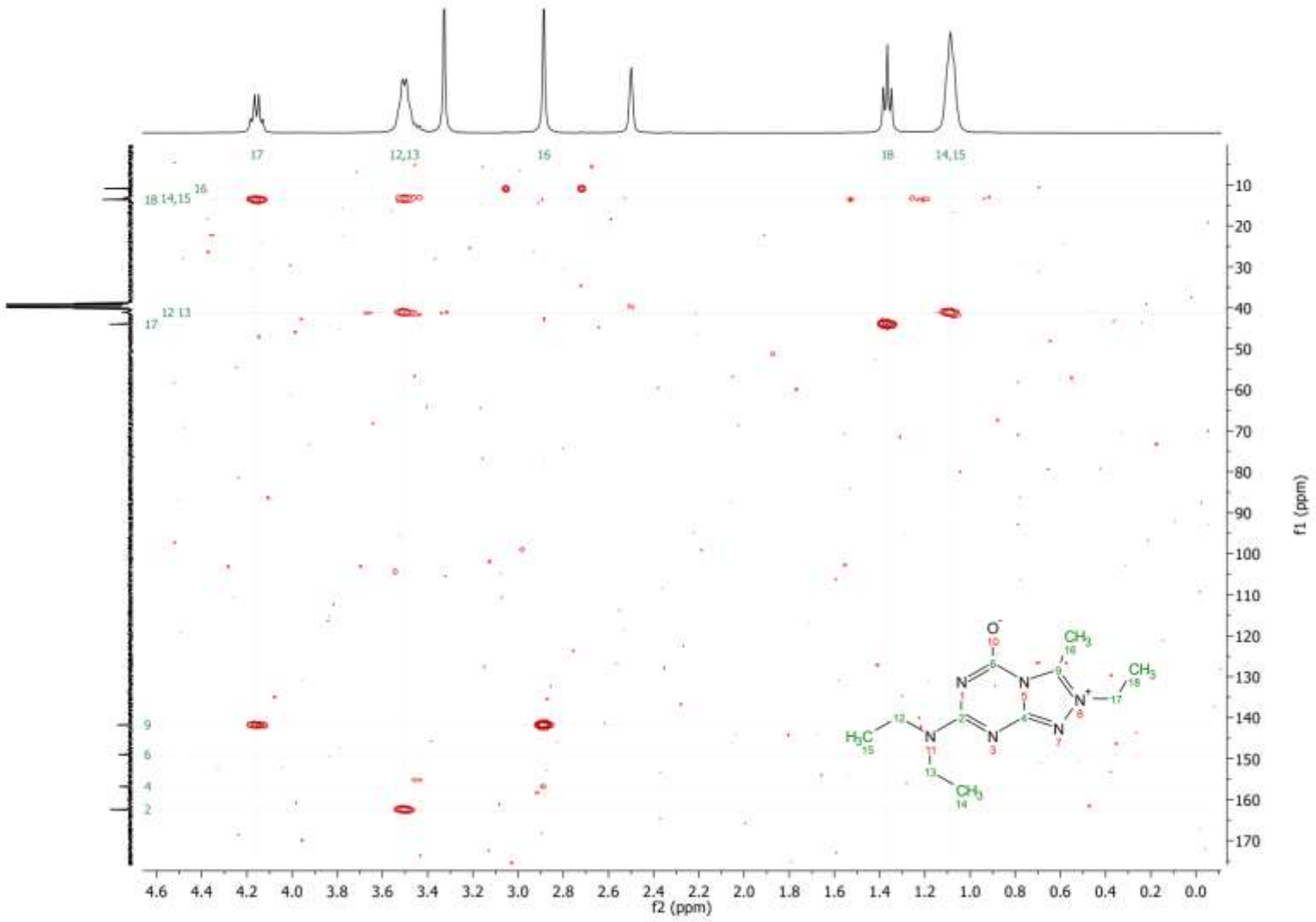


5b



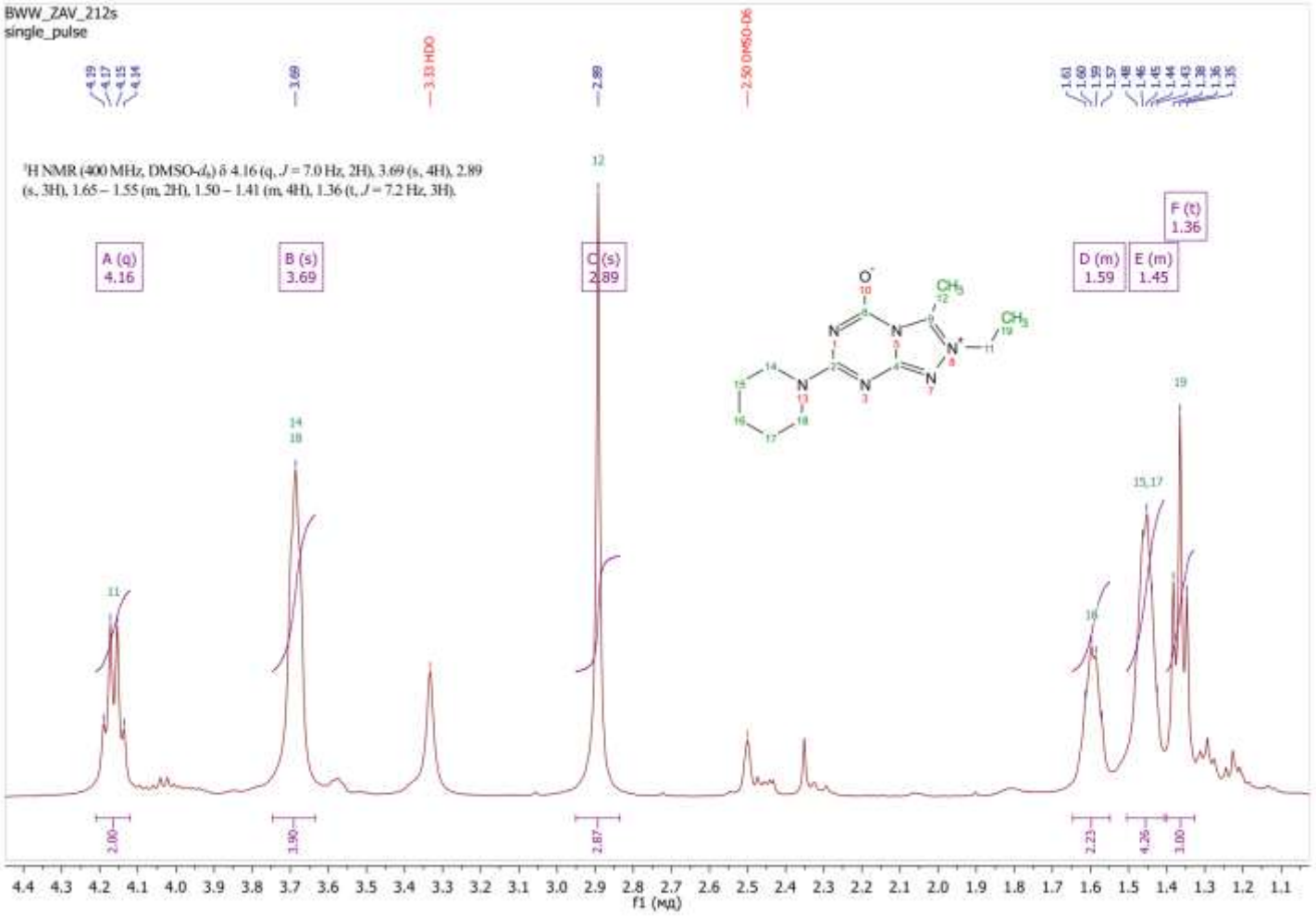
^{13}C NMR (101 MHz, DMSO-D_6) δ 162.44, 156.83, 149.02, 141.76, 43.98, 41.20, 41.04, 13.57, 13.24, 10.91.

5b

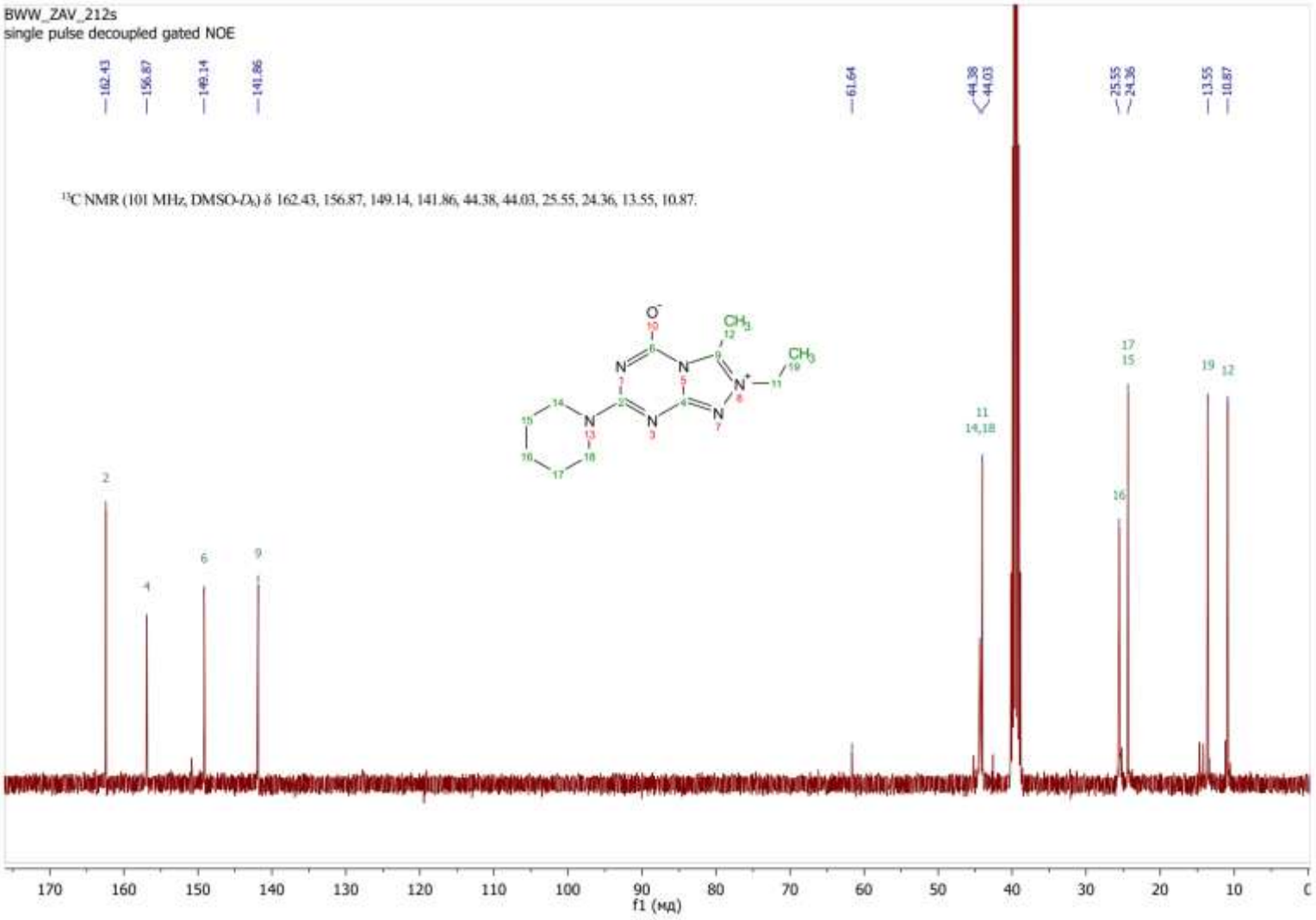


5b

17) ^{1}H, ^{13}C NMR spectra of 2-ethyl-3-methyl-7-piperidino[1,2,4]triazolo[4,3-*a*][1,3,5]triazin-2-ium-5-olate (**5c**)

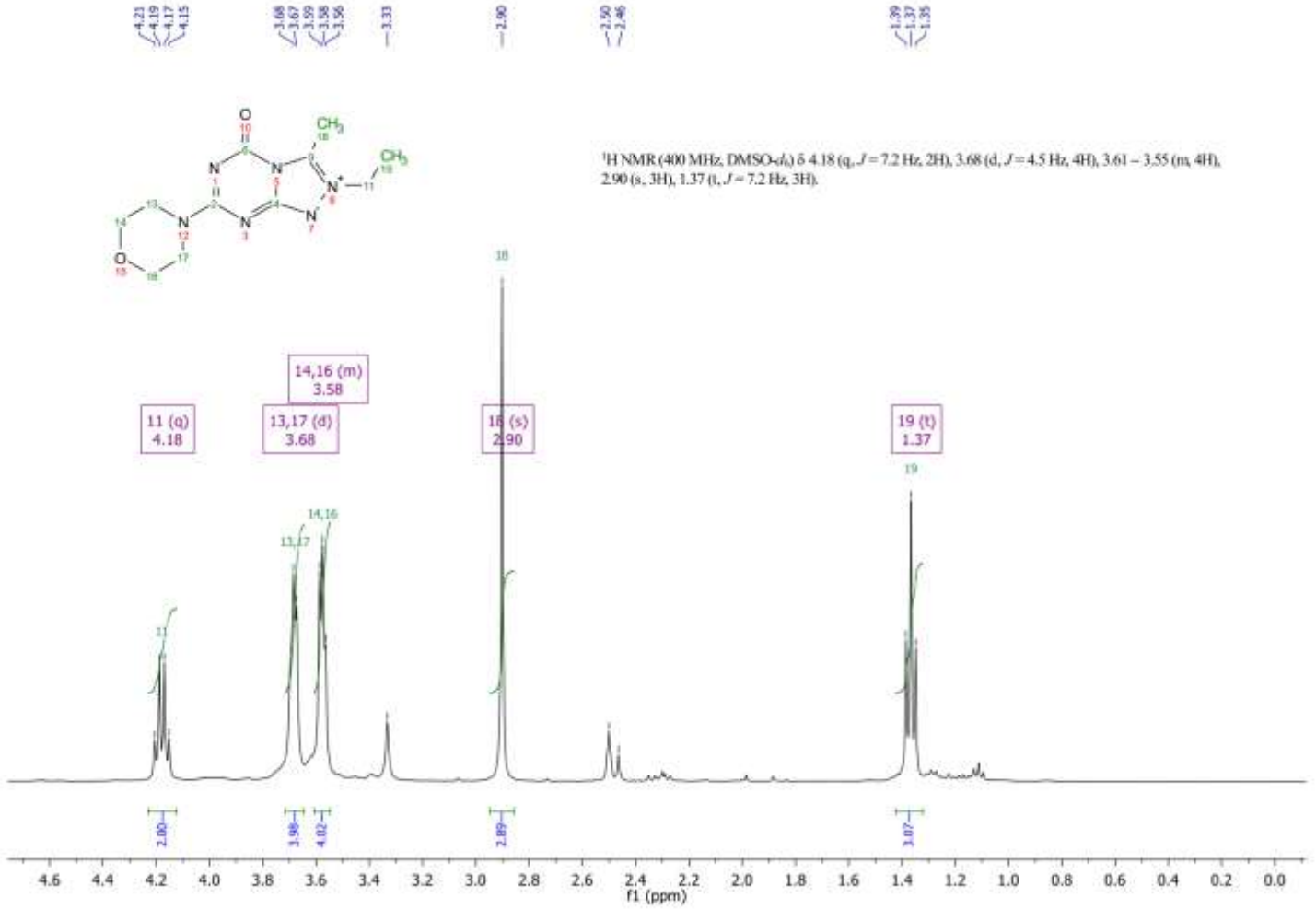


5c

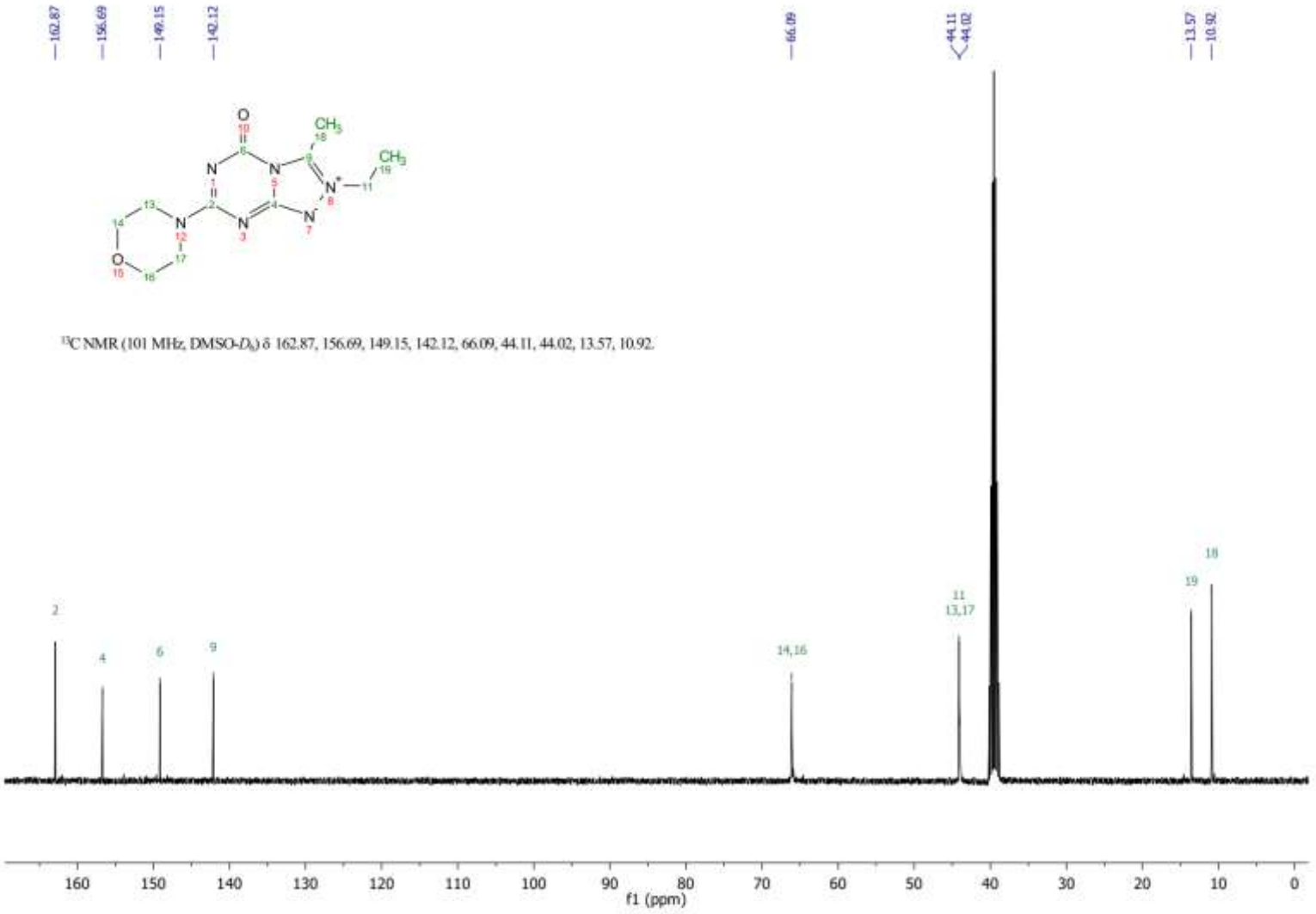

BWW_ZAV_212s
single pulse decoupled gated NOE
162.43
156.87
149.14
141.86
61.64
44.38
44.03
25.55
24.36
13.55
10.87
^{13}C NMR (101 MHz, DMSO-D_6) δ 162.43, 156.87, 149.14, 141.86, 44.38, 44.03, 25.55, 24.36, 13.55, 10.87.
f1 (мд)

5c

18) ^{1}H, ^{13}C and 2D HMBC NMR spectra of 2-ethyl-3-methyl-7-morpholino[1,2,4]triazolo[4,3-*a*][1,3,5]triazin-2-ium-5-olate (**5d**)

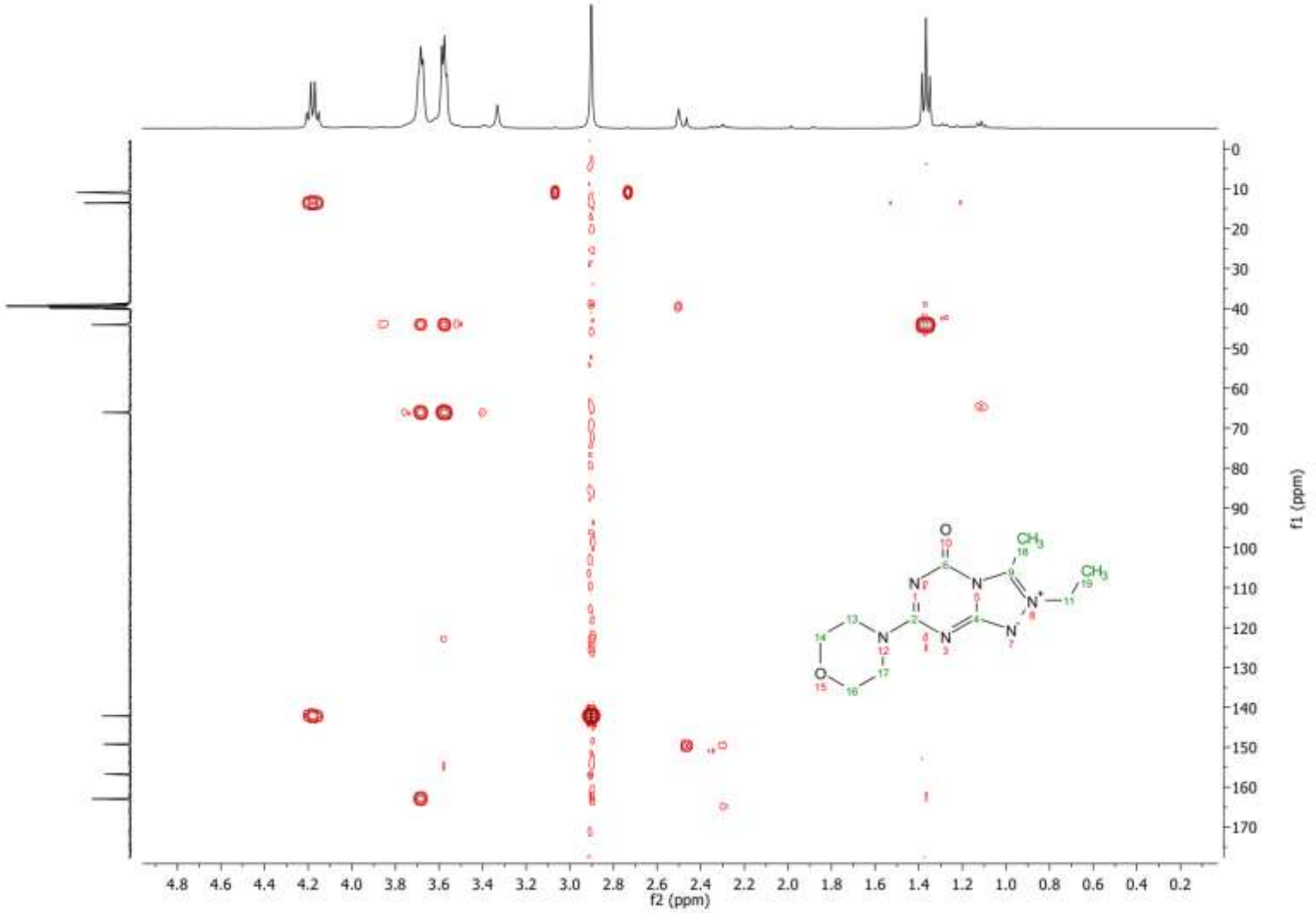


5d



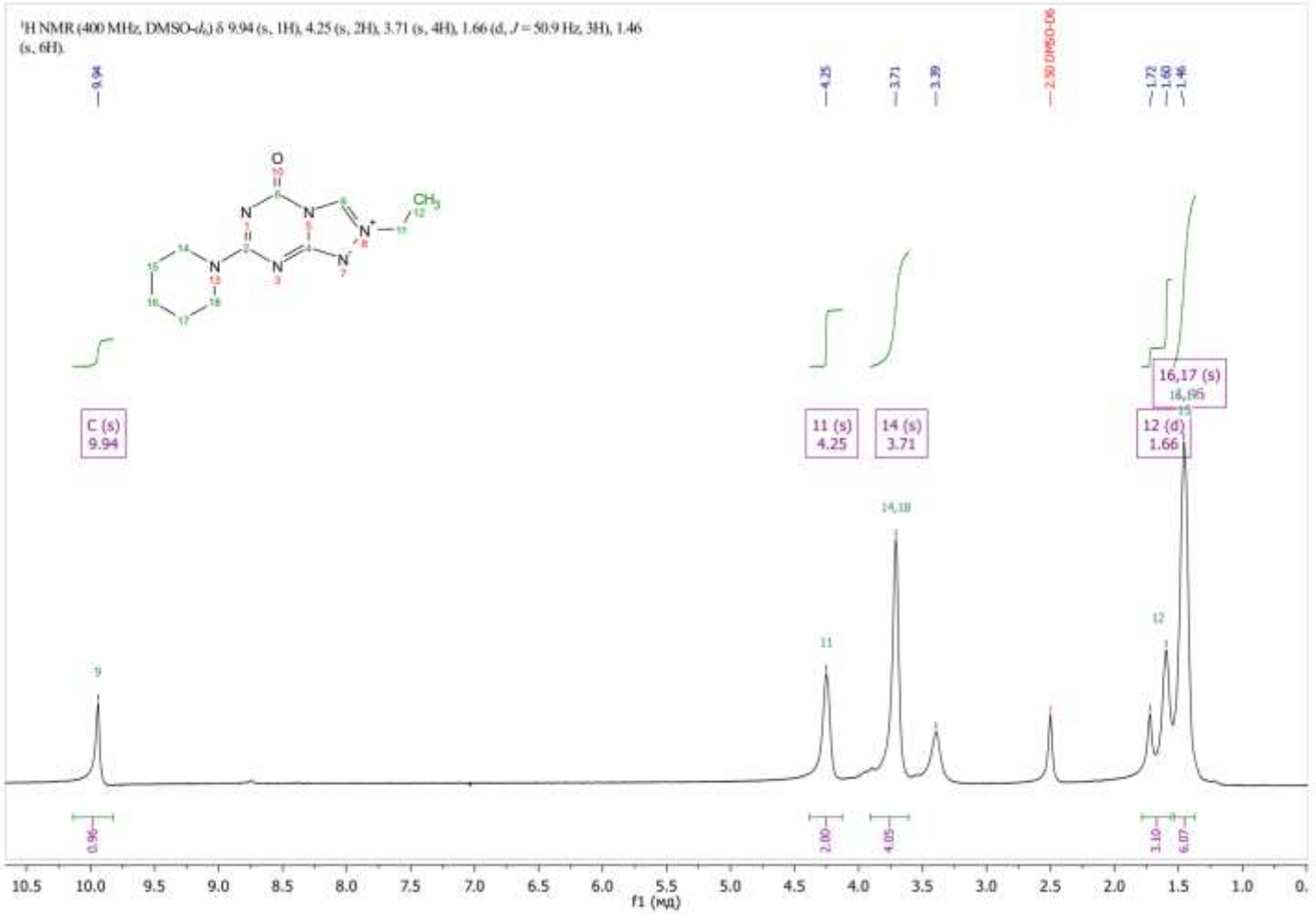
^{13}C NMR (101 MHz, DMSO-D_6) δ 162.87, 156.69, 149.15, 142.12, 66.09, 44.11, 44.02, 13.57, 10.92.

5d

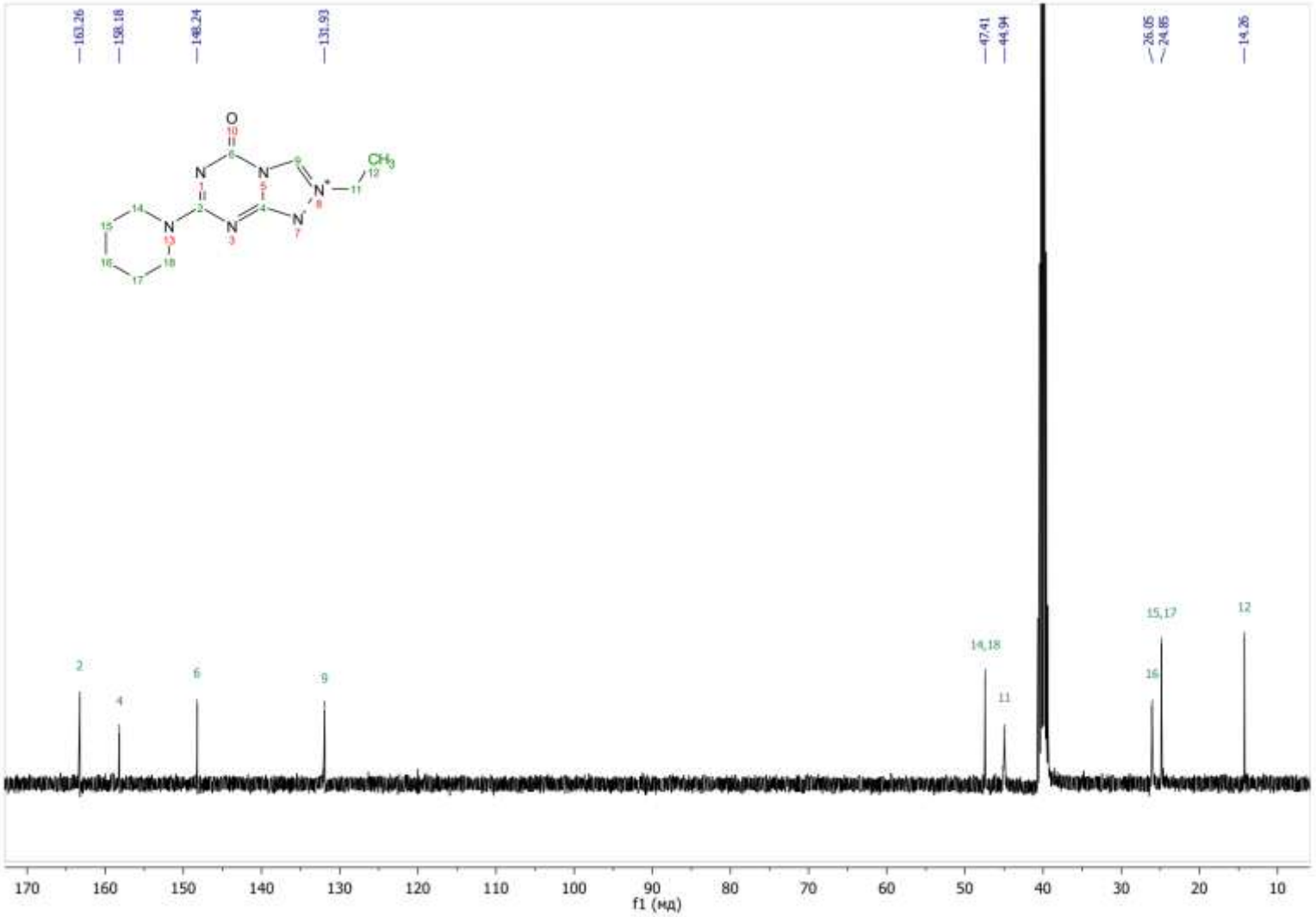


5d

19) ^{1}H, ^{13}C NMR spectra of 2-ethyl-3-methyl-7-morpholino[1,2,4]triazolo[4,3-*a*][1,3,5]triazin-2-ium-5-olate (**5e**)



5e


163.26
158.18
148.24
131.93
47.41
44.94
26.05
24.85
14.26
CH3
2
4
6
9
14,18
11
15,17
16
12
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ид)

5e