Institute of Radio Astronomy of the National Academy of Sciences of Ukraine, Kharkiv, Ukraine
Department of Millimeter Wavelength Radio Astronomy

Ukrainian Monitoring Station of Molecule CO and O3 in the Earth's Atmosphere. First Results.

Valerii Shulga, Valeriy Myshenko, Valeriy Piddyachiy, Alexey Korolev, Oleksandr Antyufeyev, Oleksii Patoka, Dmytro Shulga.

Carbon monoxide is largely inert with respect to other constituents in the middle atmosphere and therefore this species is an excellent tracer of transport processes in this part of the Earth'satmosphere.

115.271 GHz

Due to the less absorption of millimeter waves in the clouds and aerosols of the atmosphere compared with shorter waves it is possible to observing around the clock and almost under all weather conditions.

Study of daily and seasonal variations of CO in the Earth's mesosphere at latitude 50.0N

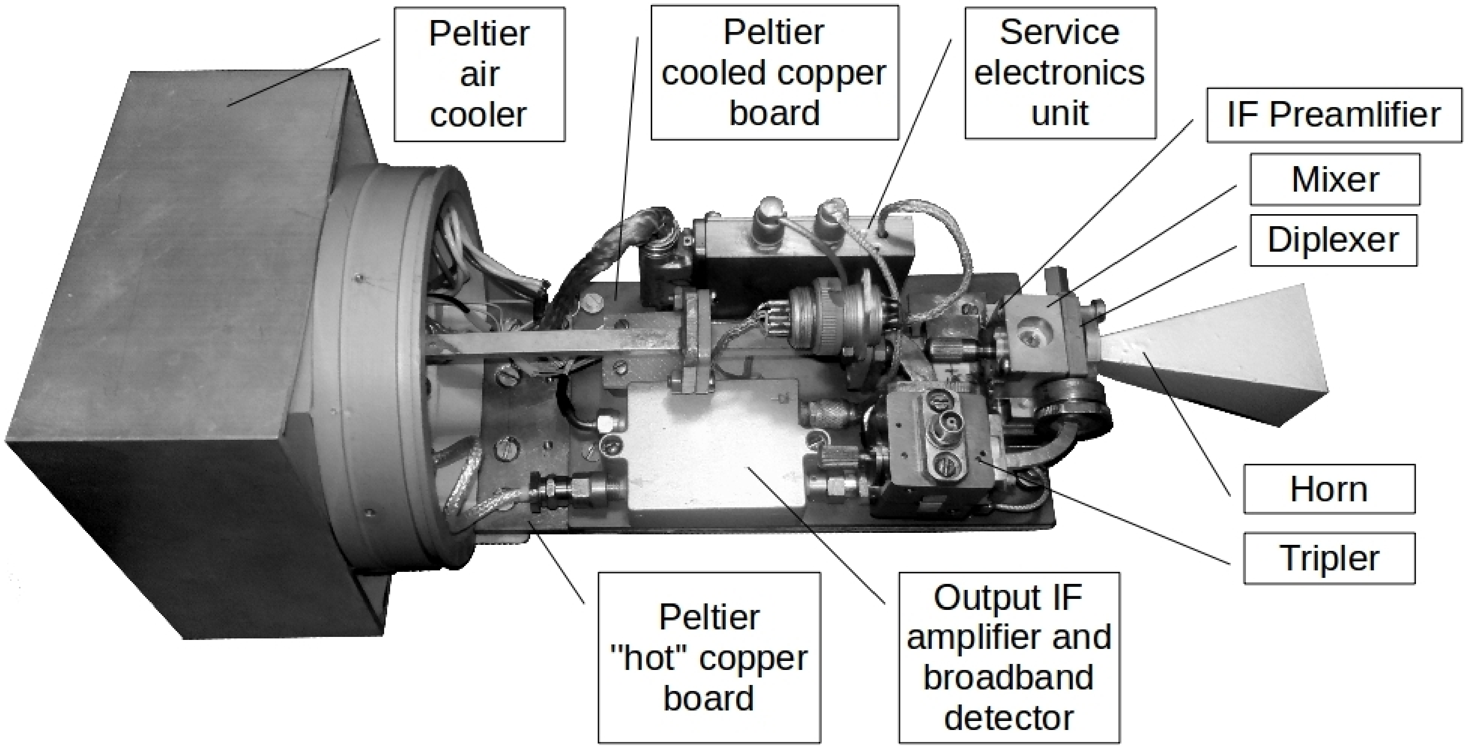
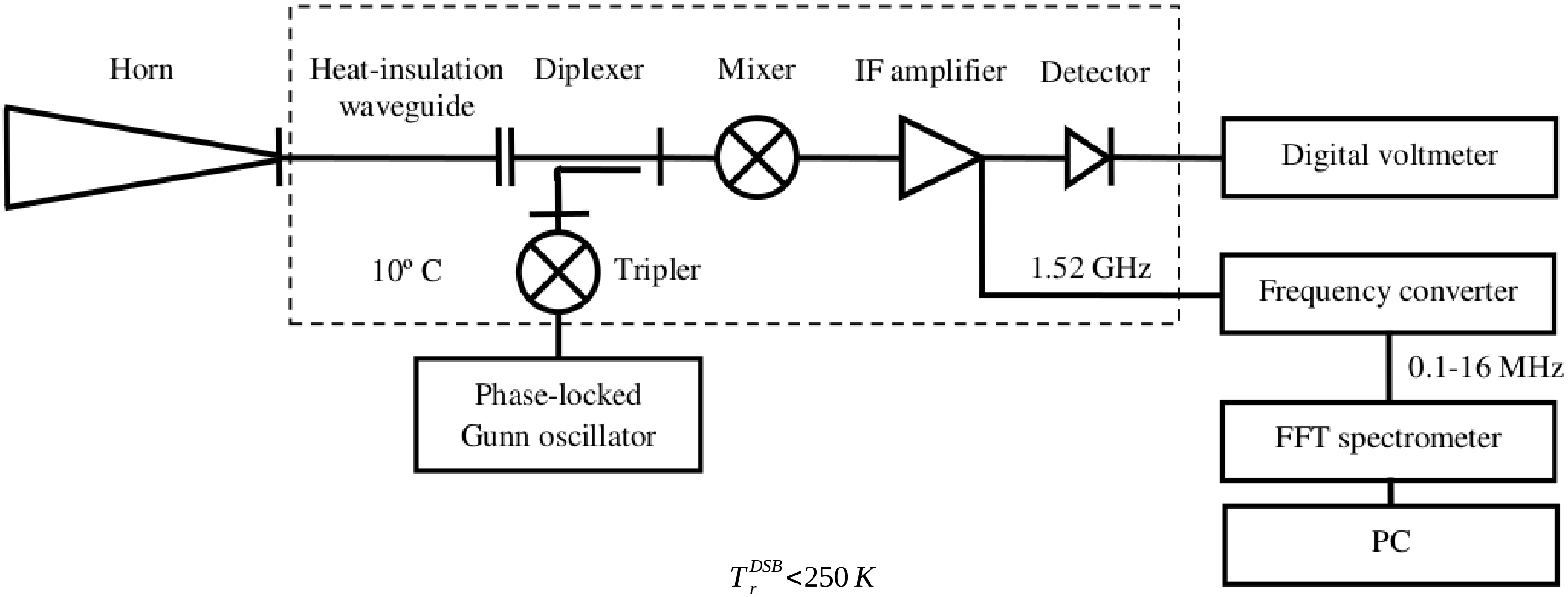


Photo of the internal view of the radiometer without the 37.9-GHz phase-locked Gunn oscillator unit

Temperature-stabilized at a temperature of 10 ± 0.5°C

Total double-sideband conversion loss of the receiver is 2.5 dB



$T_r^{DSB} < 250\,K$

Block diagram of the receiver system

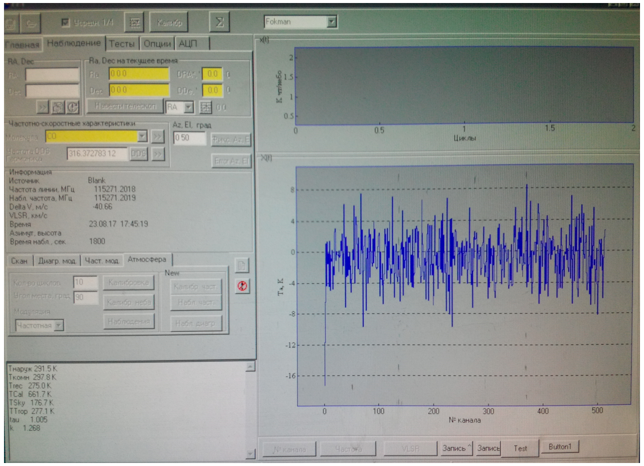
CO

115.271 GHz

IF frequency 1.52 GHz

LO frequency 113.751 GHz

DSB receiver noise temperature do not exceed 250 K



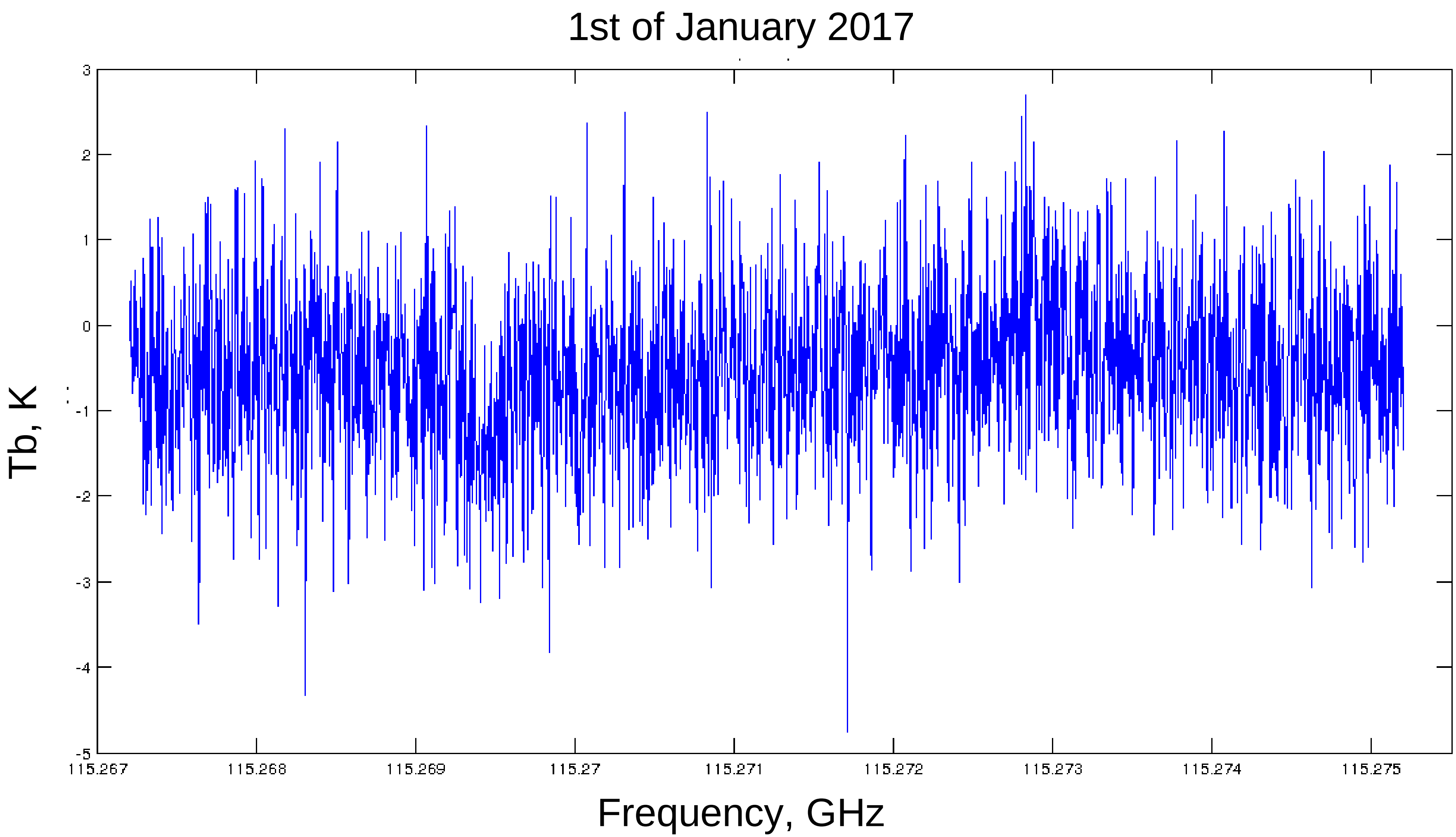
Калибр
Fokman
Главная
Наблюдение
Тесты
Опции
АЦП
RA, Dec
Ra, Dec на текущее время
Частотно-скоростные характеристики
Az, El, град
Информация
Источник Blank
Частота линии, МГц 115271.2018
Набл. частота, МГц 115271.2019
Delta V, м/с -40.66
VLSR, км/с
Время 23.08.17 17:45:19
Азимут, высота
Время набл., сек 1800
Скан
Диагр. мод.
Част. мод.
Атмосфера
New
Тнаруж 291.5 K
Ткомн 297.8 K
Trec 275.0 K
TCal 661.7 K
TSky 176.7 K
TTrop 277.1 K
tau 1.005
k 1.268
Циклы
Ta, K
№ канала
Запись
Test
Button1

J Infrared Milli Terahz Waves
DOI 10.1007/s10762-016-0334-1

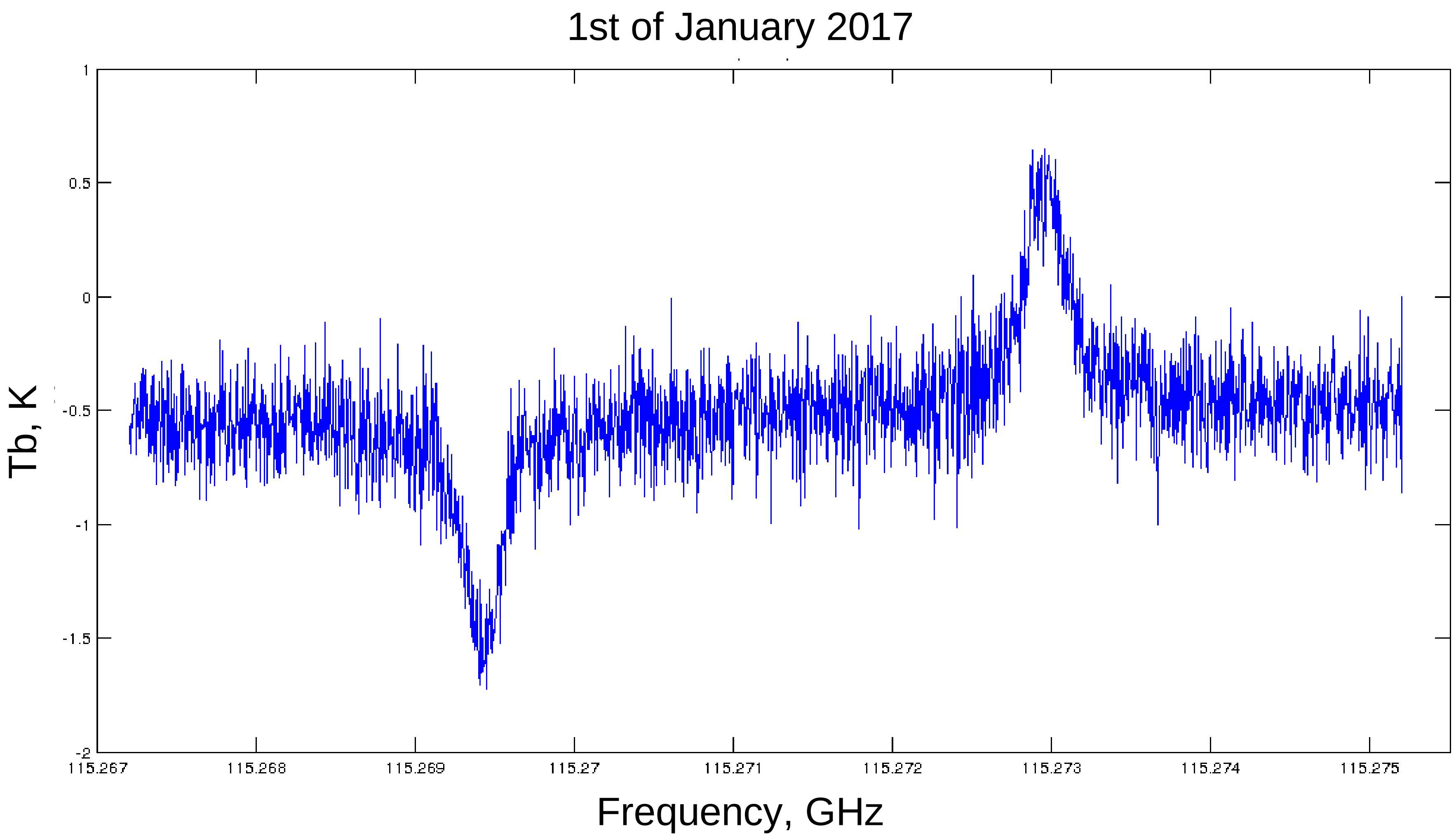
Microwave Radiometer for Spectral Observations of Mesospheric Carbon Monoxide at 115 GHz Over Kharkiv, Ukraine

Valeriy Piddyachiy[1] · Valerii Shulga[1,2] · Valeriy Myshenko[1] · Alexey Korolev[1] · Oleksandr Antyufeyev[1] · Dmytro Shulga[1] · Peter Forkman[3]

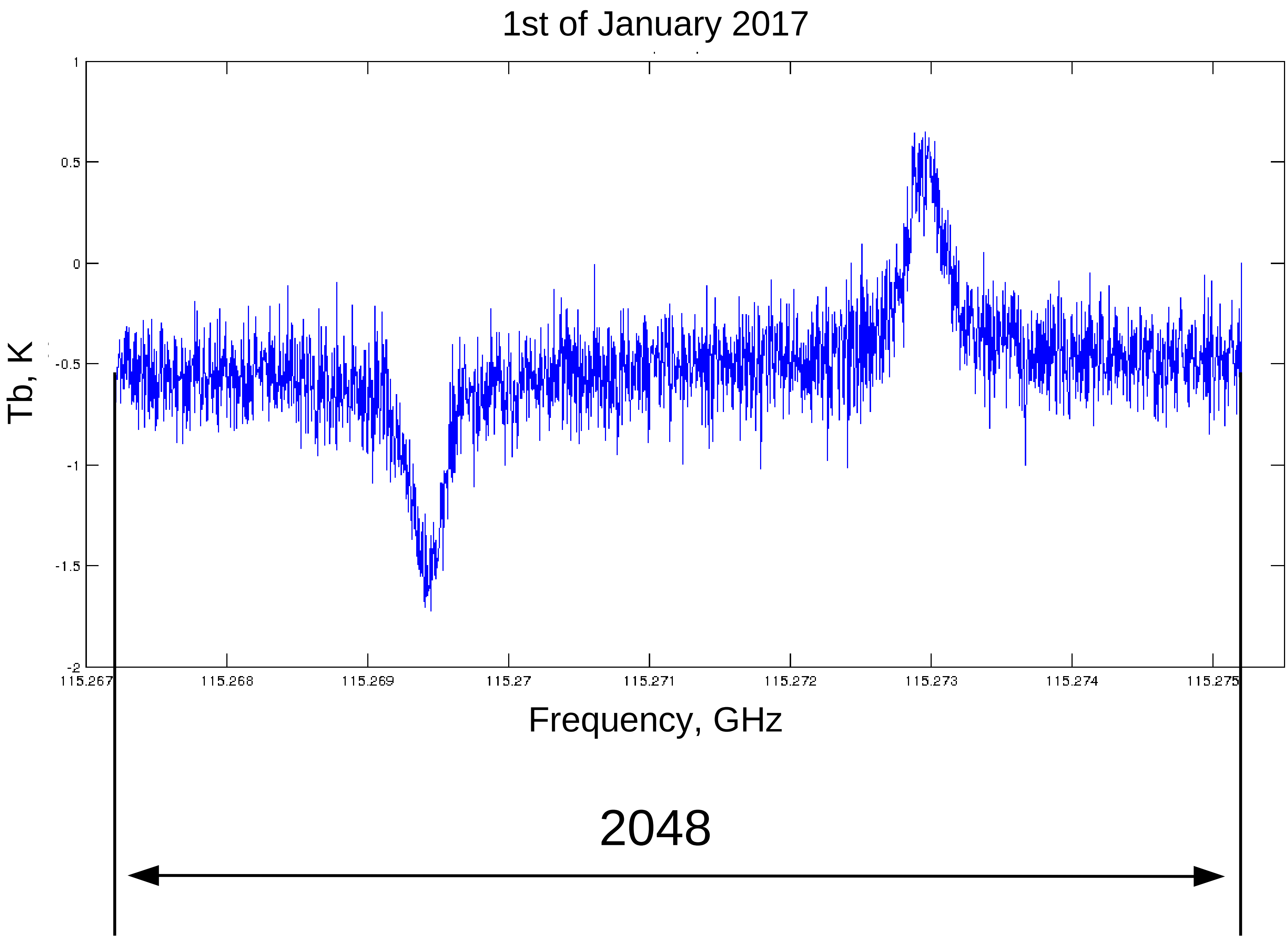
Received: 6 July 2016 / Accepted: 3 November 2016



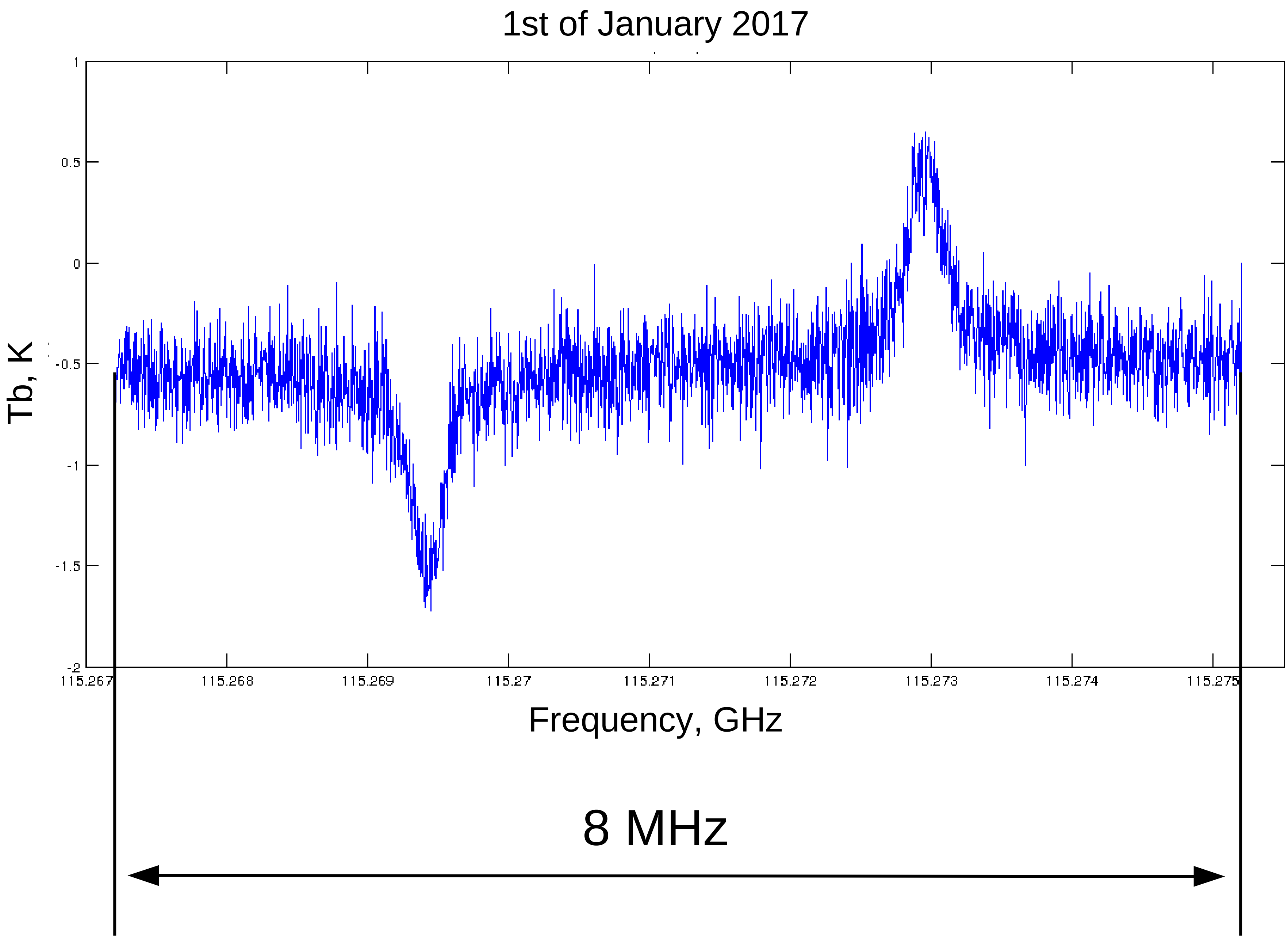
An example of spectrum.
One measurement.



An example of spectrum.
One day averaged.

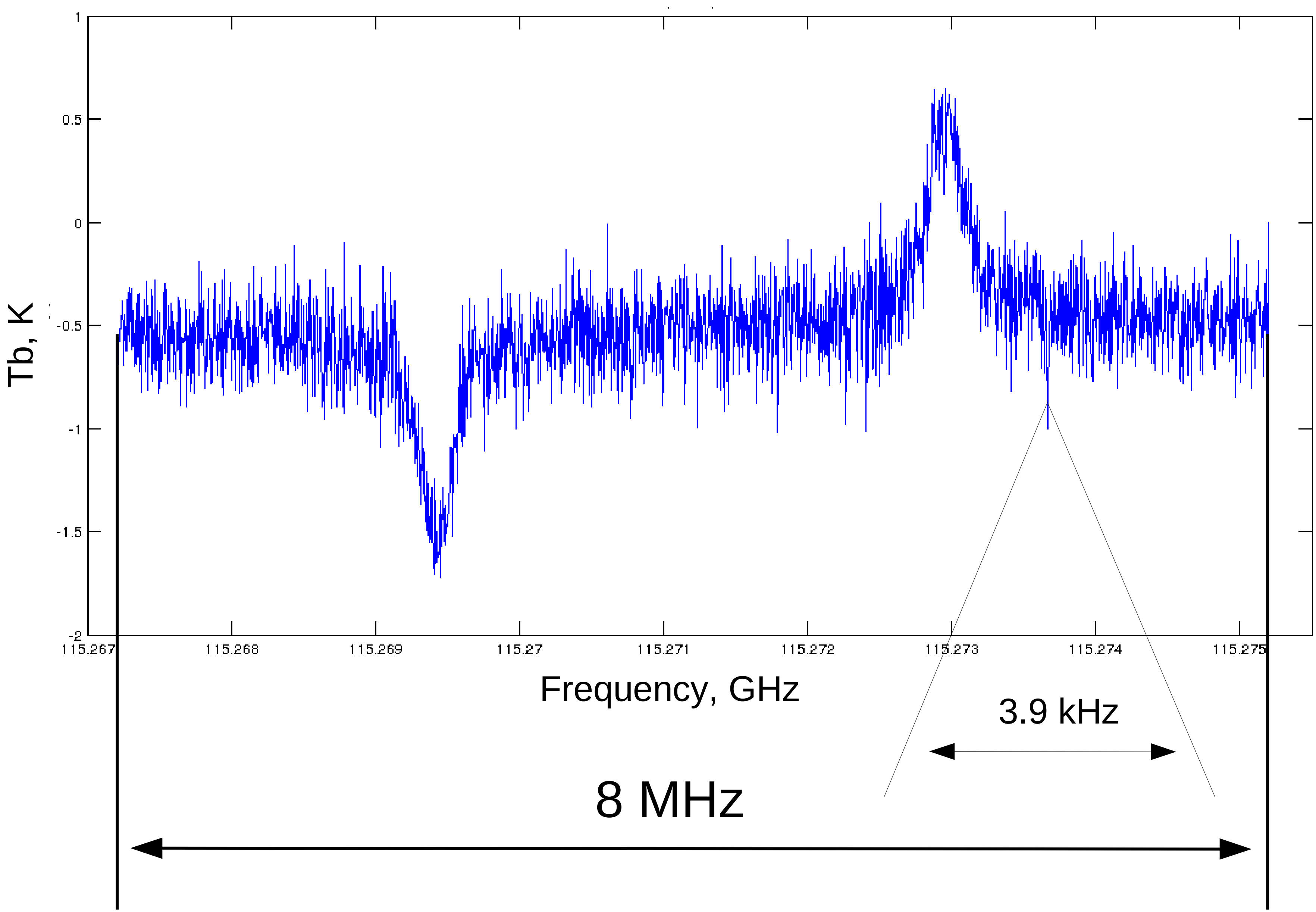


FFT spectrometer



FFT spectrometer

1st of January 2017

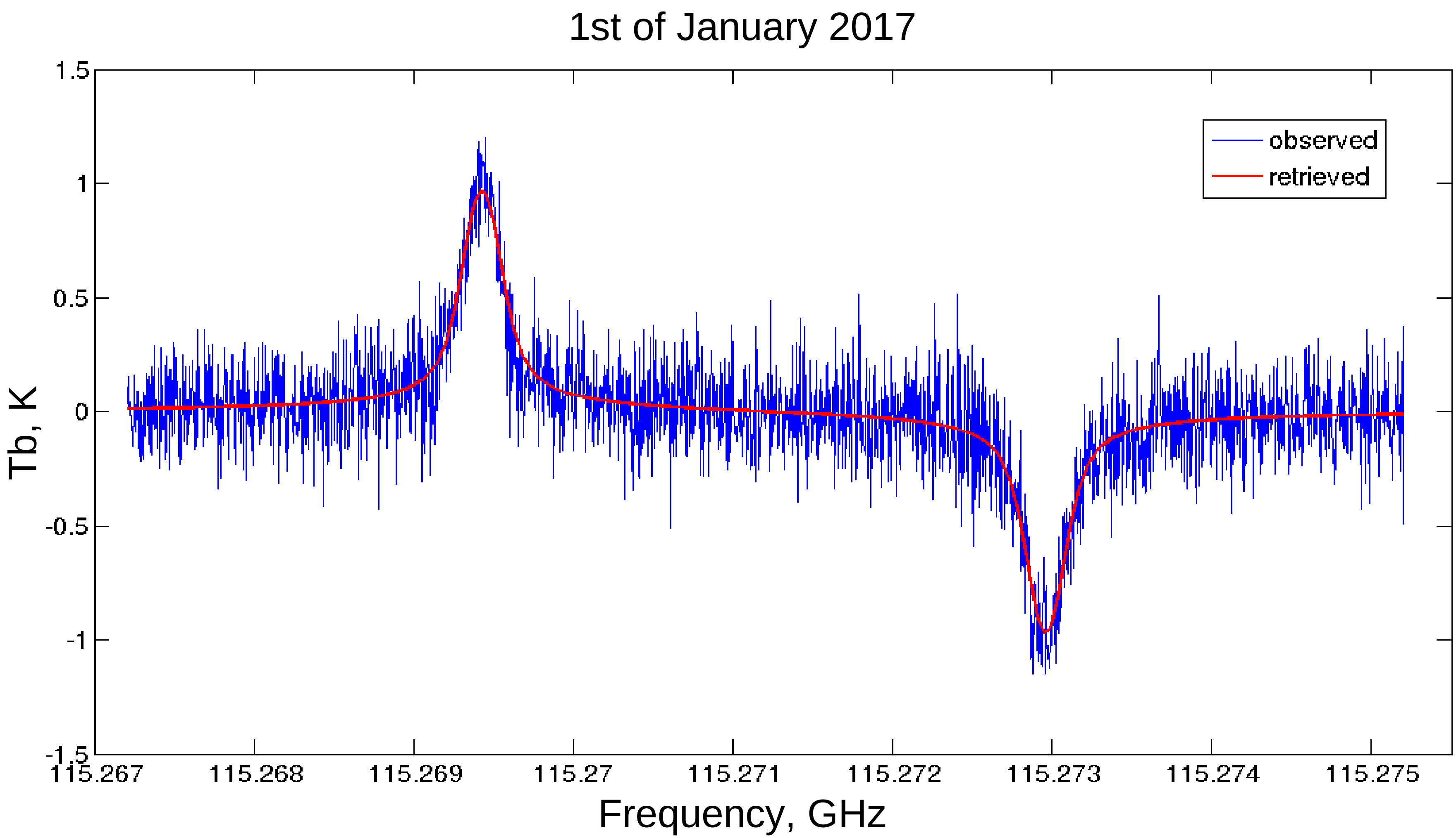


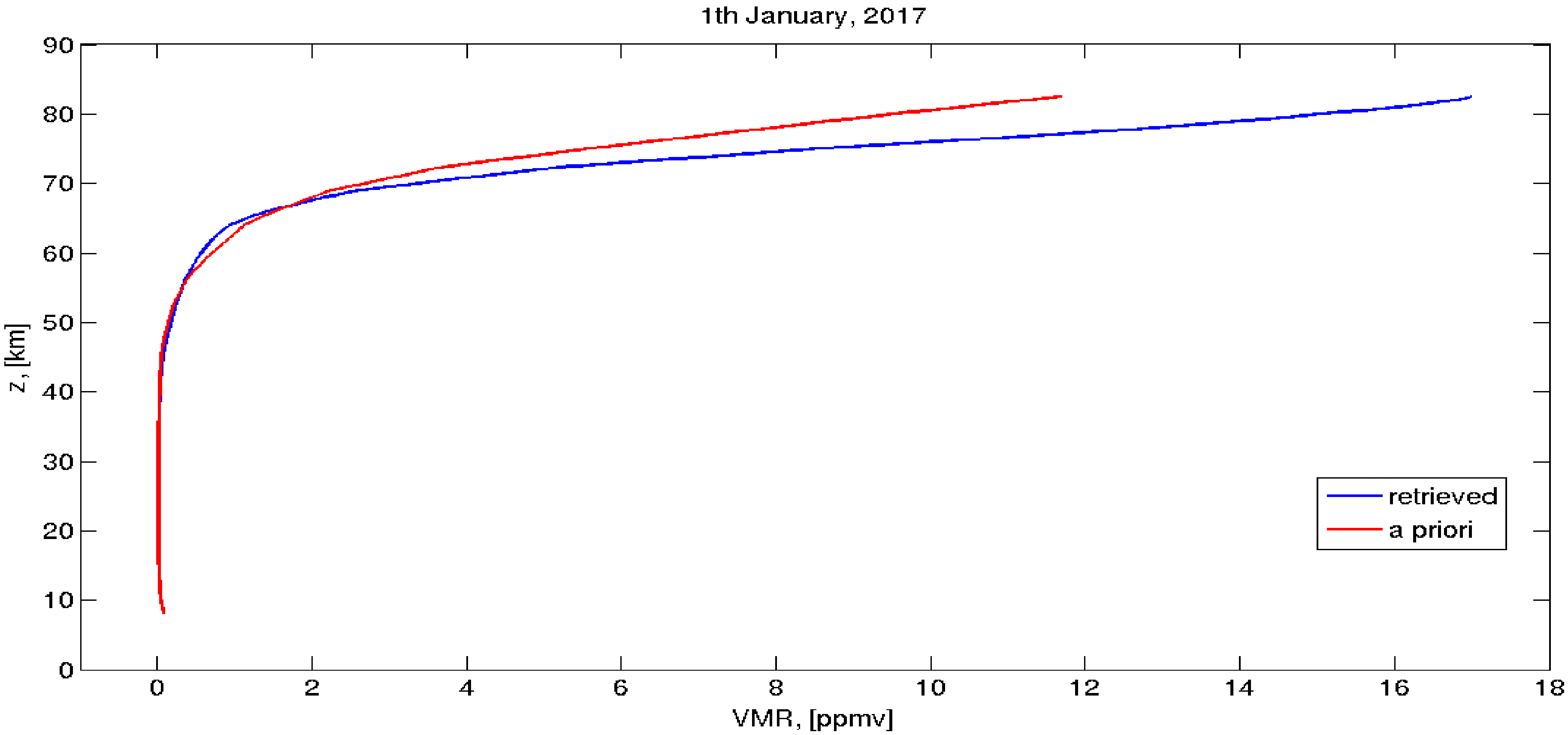
FFT spectrometer

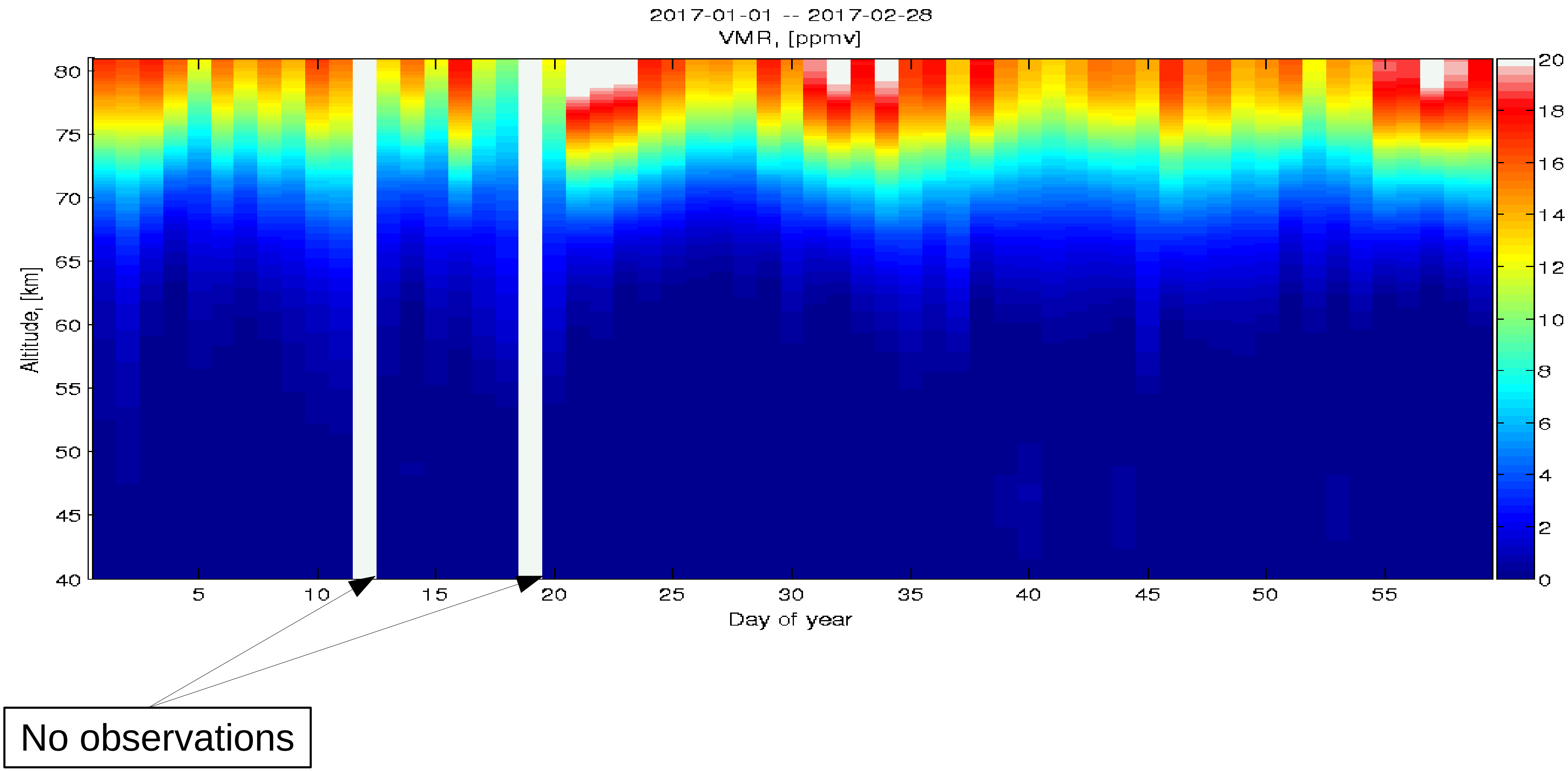
ACE-FTS Climatology - Version 3.5

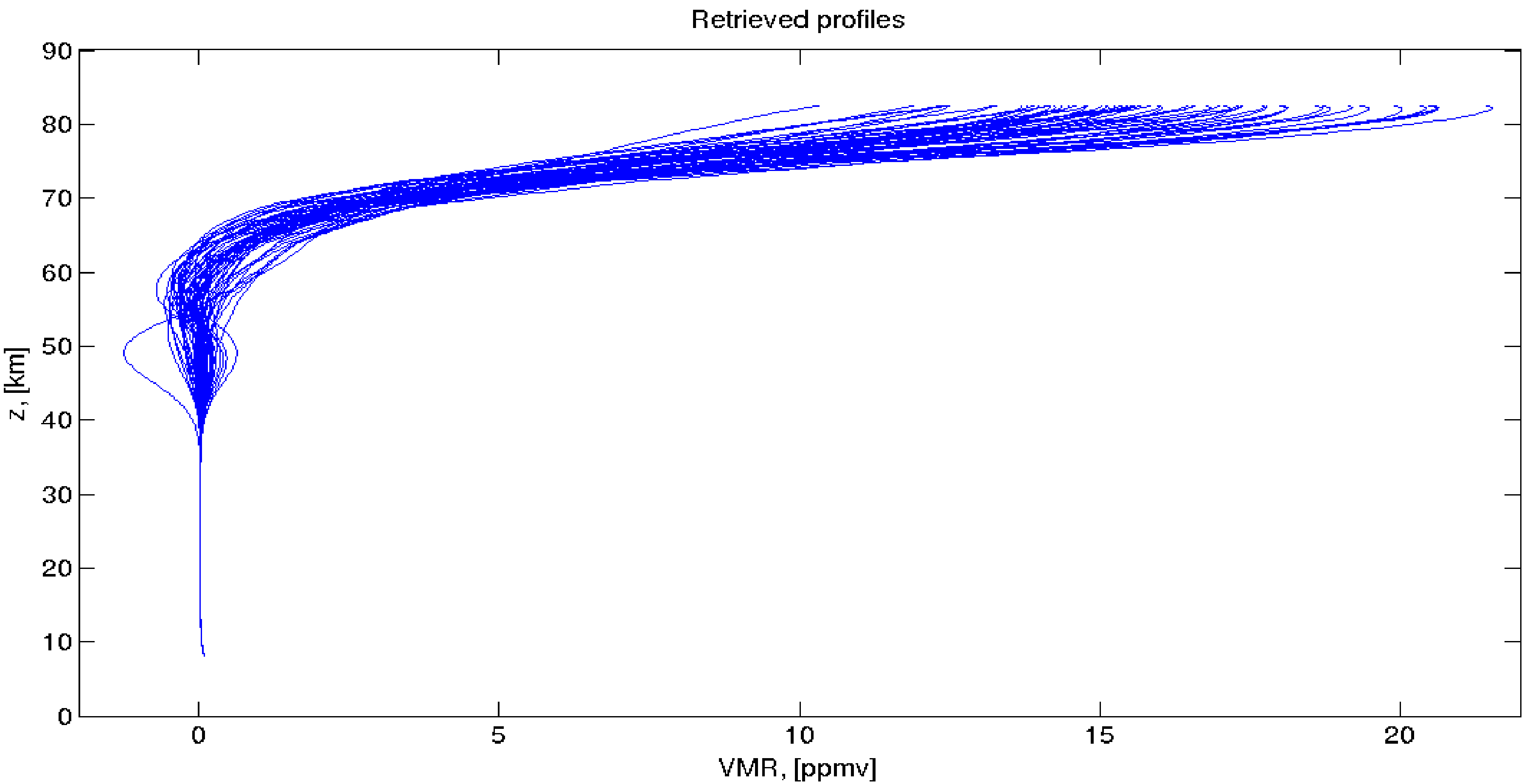
The Atmospheric Chemistry Experiment (ACE), also known as SCISAT, is a Canadian-led mission mainly supported by the Canadian Space Agency (CSA).

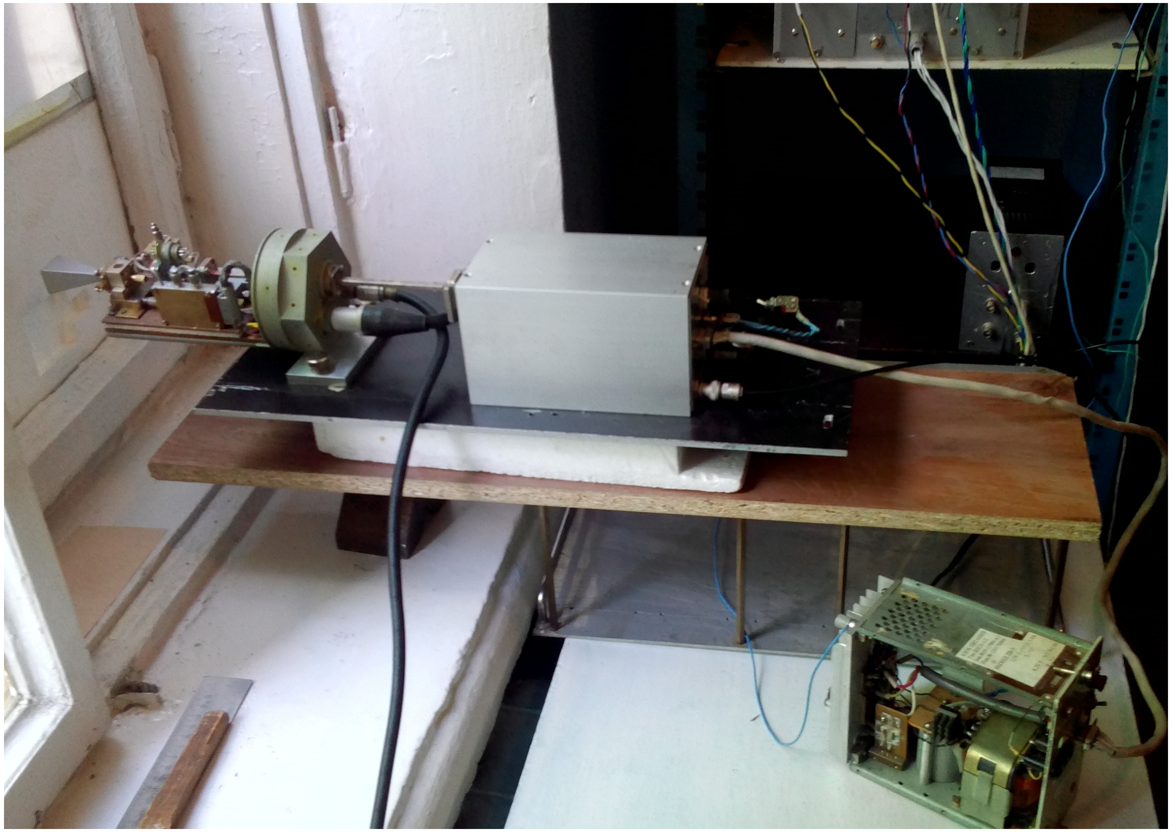
Koo, Ja-Ho, Walker, Kaley A., Jones, Ashely, Sheese, Patrick E., Boone, Chris D., Bernath, Peter F., Manney, Gloria L. (2017), **Global climatology based on the ACE-FTS version 3.5 data set: Addition of mesospheric levels and carbon-containing species in the UTLS**, Journal of Quantitative Spectroscopy and Radiative Transfer, 12, 52-62, doi:10.1016/j.jqsrt.2016.07.003


1st of January 2017
Tb, K
Frequency, GHz
observed
retrieved
1.5
1
0.5
0
-0.5
-1
-1.5
115.267
115.268
115.269
115.27
115.271
115.272
115.273
115.274
115.275


1th January, 2017
z, [km]
VMR, [ppmv]
retrieved
a priori
0
10
20
30
40
50
60
70
80
90
0
2
4
6
8
10
12
14
16
18


2017-01-01 -- 2017-02-28
VMR, [ppmv]
Altitude, [km]
Day of year
80
75
70
65
60
55
50
45
40
5
10
15
20
25
30
35
40
45
50
55
20
18
16
14
12
10
8
6
4
2
0
No observations


Retrieved profiles
z, [km]
VMR, [ppmv]
0
10
20
30
40
50
60
70
80
90
5
15

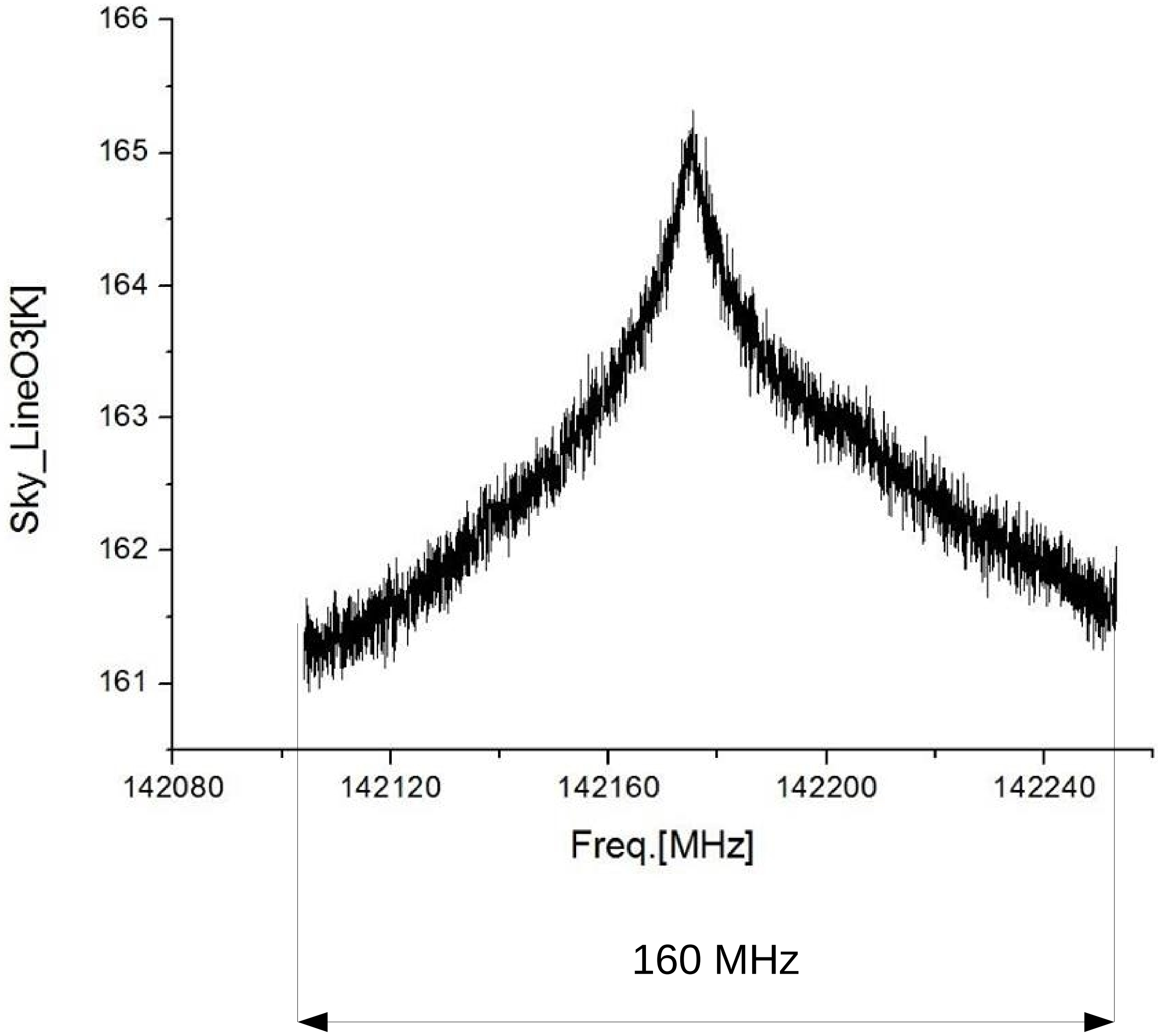


O_3

142.2 GHz

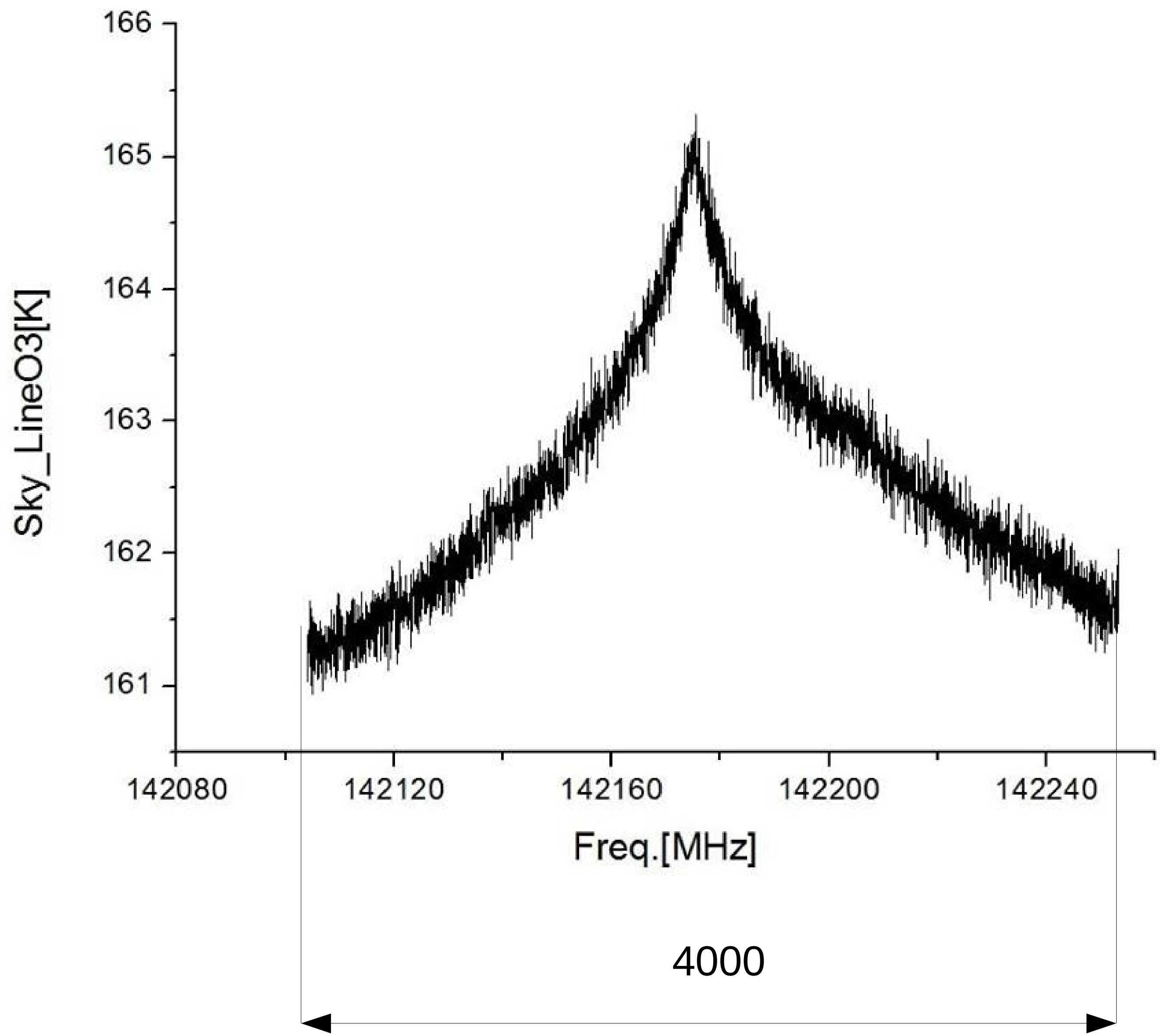
DSB receiver noise temperature ~ 550 K

Tms_sky=10min*6=60min, Tms_BB300K=2min*6=12min

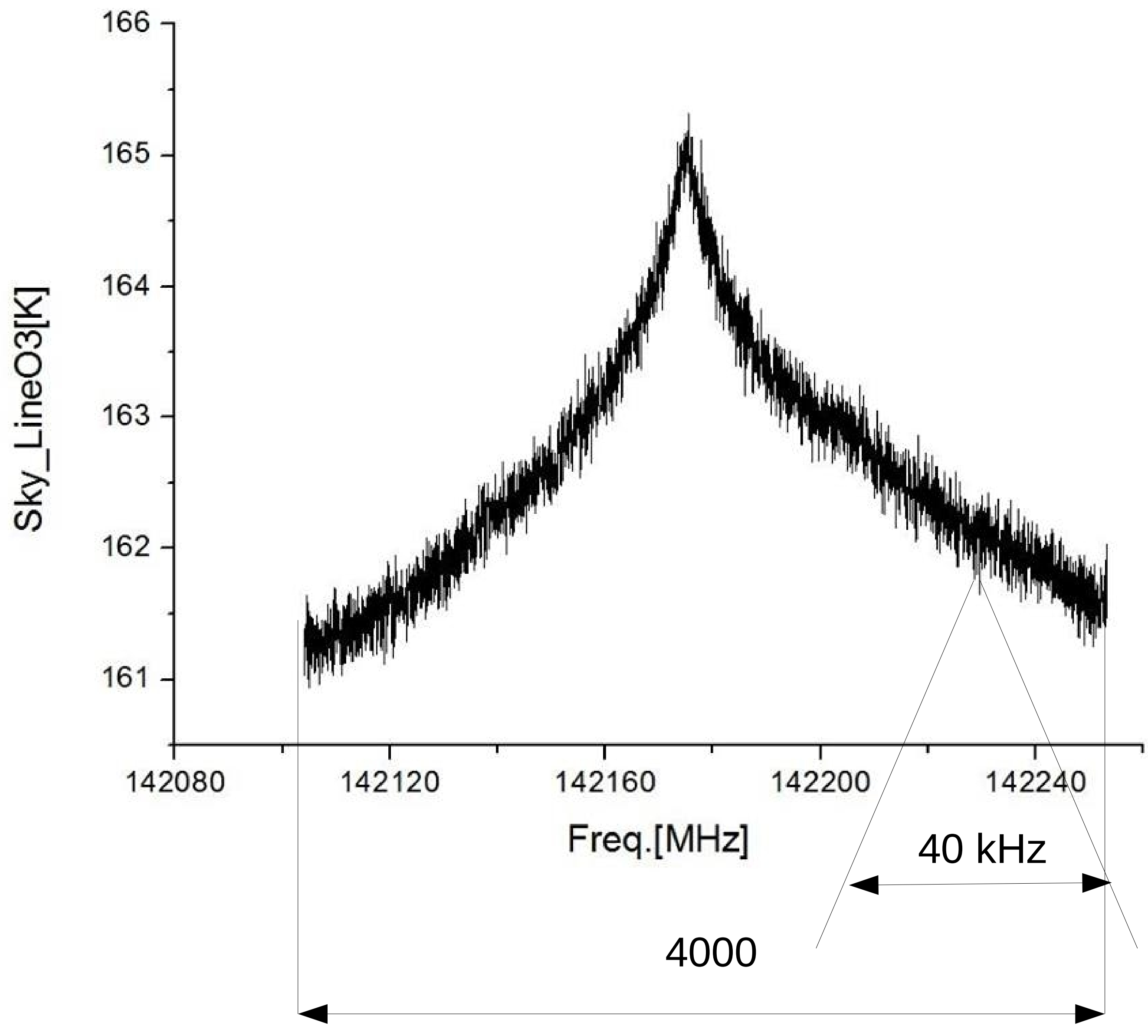


1

Tms_sky=10min*6=60min, Tms_BB300K=2min*6=12min



Tms_sky=10min*6=60min, Tms_BB300K=2min*6=12min



Thank you for attention

In our work, the difference between the hot load and sky temperatures is used for the data calibration.

Case of blackbody calibration

$$P_{hot}^{1} \sim g_s(T_{rec}^{1}+T_{hot})+g_i(T_{rec}^{1}+T_{hot}) \qquad P_{hot}^{2} \sim g_s(T_{rec}^{2}+T_{hot})+g_i(T_{rec}^{2}+T_{hot})$$

Case of sky calibration

$$P_{sky}^{1} \sim g_s(\Delta T_b(z0) + T_{rec}^{1}+T_b^{1}(z0))+g_i(T_{rec}^{1}+ T_b^{1}(z0))$$

$$P_{sky}^{2} \sim g_s(T_{rec}^{2}+T_b^{2}(z0))+g_i(T_{rec}^{2}+ T_b^{2}(z0))$$

T_{rec} — system noise temperature of receiver (dual sideband)

T_{hot} — black body temperature (in the room)

$T_b(z0)$ – brightness temperature of the sky (at ground level)

$\Delta T_b(z0)$ - is the difference in brightness temperatures between the two frequencies without tropospheric correction

<u>“underground of presentation”</u>

$$g_s = g_i = 0.5$$

$$P_{hot} = (P_{hot}^{1} + P_{hot}^{2})/2$$

$$P_{sky} = (P_{sky}^{1} + P_{sky}^{2})/2$$

$$T_{rec}^{1} = T_{rec}^{2}$$

$$T_b^{1}(z0) = T_b^{2}(z0) = T_b(z0)$$

$$\Delta T_b(z0) = 2\,(P_{sky}^{1} - P_{sky}^{2})/(P_{hot} - P_{sky})*(T_{hot} - T_b(z0))$$

<u>“underground of presentation”</u>

$$T_{\rm b}(z_0) = T_{\rm b}(z_{\rm trop})e^{-\tau} + T_{\rm trop}(1 - e^{-\tau}),$$

$$\Delta T_{\rm b}(z_{\rm trop}) = \frac{\Delta T_{\rm b}(z_0)}{e^{-\tau}}. \qquad \tau = -\ln\left(\frac{T_{\rm trop} - T_{\rm b}(z_0)}{T_{\rm trop} - T_{\rm bg}}\right).$$

where

$T_b(z0)$ – is the brightness temperature of the sky (at ground level),

T_{trop} – is the effective brightness temperature of the troposphere

$$\Delta T_b(z0) = 2\frac{\left(P_{sky}^1 - P_{sky}^2\right)}{\left(P_{hot} - P_{sky}\right)}\left(T_{hot} - T_b(z0)\right)\frac{T_{trop} - T_{bg}}{T_{trop} - T_b(z0)}$$

$$T_b(z0) = \frac{1}{k}\left(T_{rec} + T_{hot}\right) - T_{rec} \qquad k = \frac{P_{hot}}{P_{sky}}$$

$$T_{trop}(\nu) = \alpha T_{gr} + \beta T_b(z_0, \nu), \quad \alpha = 0.89, \beta = 0.1 \; for \; \nu = 115\, GHz$$

<u>“underground of presentation”</u>