Activities at Thule (76.5°N, 68.8°W), Greenland (and at the lab in Rome)

G. Muscari[1], P. P. Bertagnolio[1], I. Fiorucci[1], R. de Zafra[2]
[1]Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy
[2]Dept. of Physics and Astronomy, Stony Brook University, N.Y., U.S.A.

NCAR FTIR

Univ. Rome/ENEA lidar

DMI ozonesonde

Main features of GBMS

- DSB receiver tunable between 230 and 280 GHz

- SIS mixer (13 years old, need backup!) with Trec = 230-330K [Trec=2 * (Thot *(Vcold-Voff)-Tcold*(Vhot-Voff))/(Vhot-Vcold)]

- hot/cold calibration with Eccosorb CV-3 material and LN2

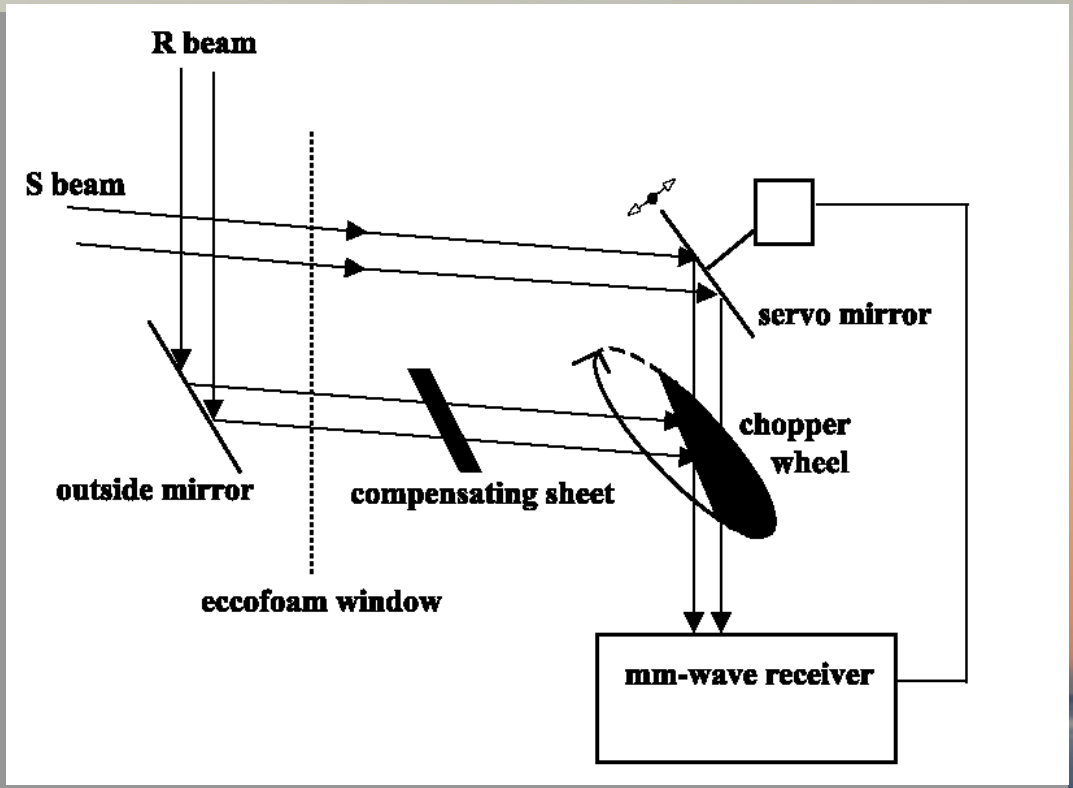
- Double AOS: a) 600 MHz/1.2 MHz; b) 50 MHz/65 kHz

- Balanced beam receiver (S btw 10° and 15° above horizon, R at zenith)

- Observed chemical species: O_3 (S+M), CO (S+M), HNO_3 (S), N_2O (S), HCN (S)

- Optimal Estimation retrieval algorithm for all species

$$\frac{S - R}{R} = \frac{T_S(\nu) - T_R(\nu)}{T_R(\nu)}$$



$$T_S^*(\nu) = T_z^*(\nu) A_S e^{-A_S\tau_z} e^{-\tau_p} e^{-\tau_w} + 2T_{atm}\left(1 - e^{-A_S\tau_z}\right) e^{-\tau_w} +$$

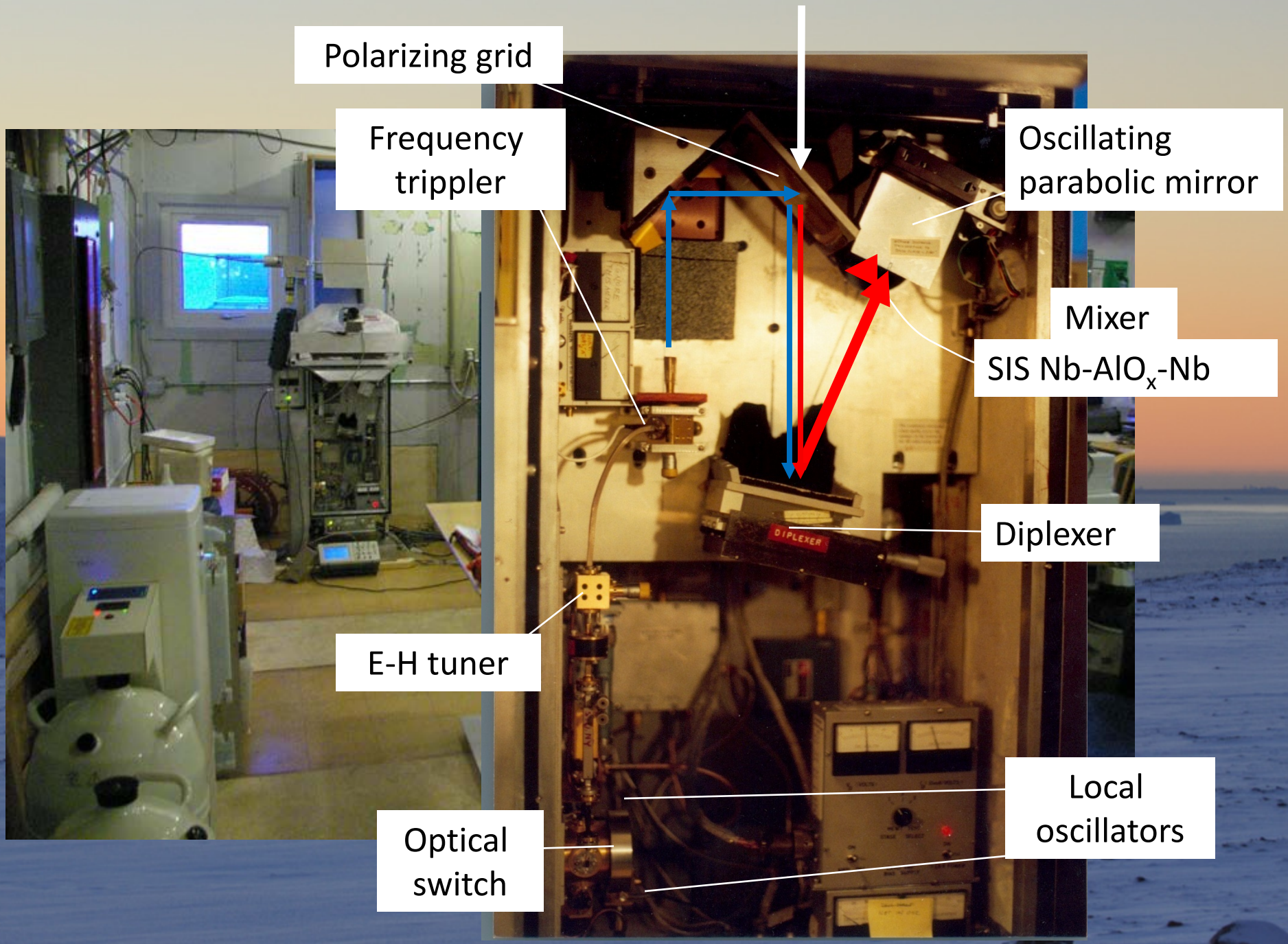
$$+ 2T_{atm}\left(1 - e^{-A_R\tau_z}\right) e^{-\tau_p} e^{-\tau_w} + 2T_w\left(1 - e^{-\tau_w}\right) e^{-\tau_p} +$$

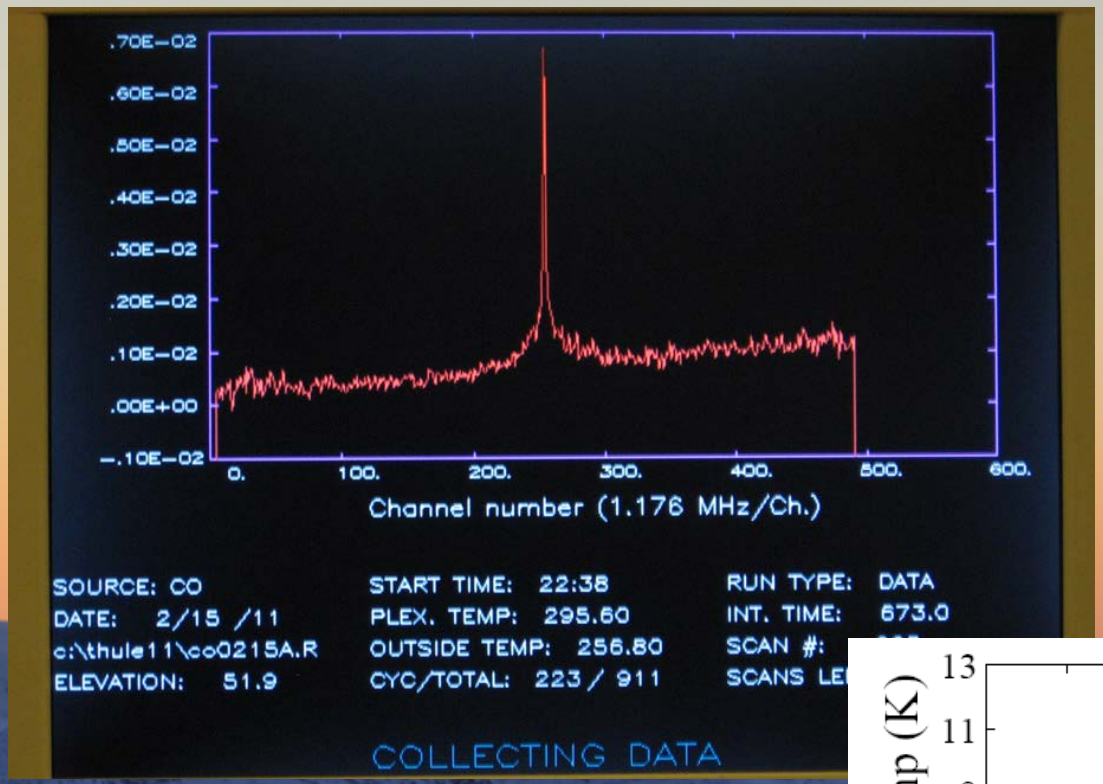
$$+ 2T_p\left(1 - e^{-\tau_p}\right) + T_{rec}(\nu)$$

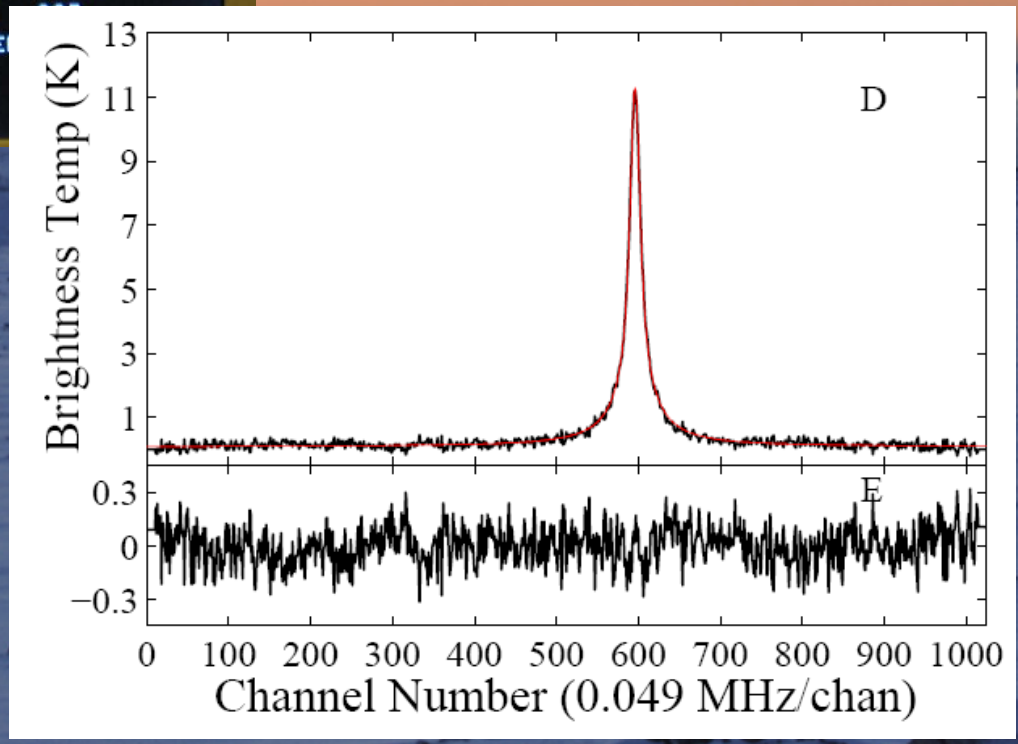
$$T^{*}_{z}(\nu) = SF(\nu)\frac{T_S(\nu) - T_R(\nu)}{T_R(\nu)}$$

where

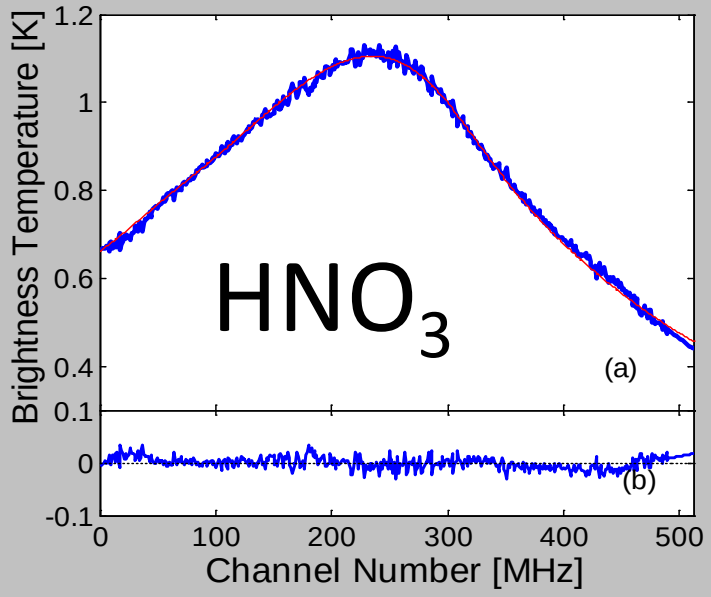
$$SF(\nu) = \frac{2T_{atm}\left(1 - e^{-A_S\tau_z}\right)e^{-\tau_w} + 2T_w\left(1 - e^{-\tau_w}\right) + T_{rec}(\nu)}{\left(A_S^{'}e^{-A_S\tau_z} - A_R^{'}e^{-A_R\tau_z}e^{-\tau_p}\right)e^{-\tau_w}}$$

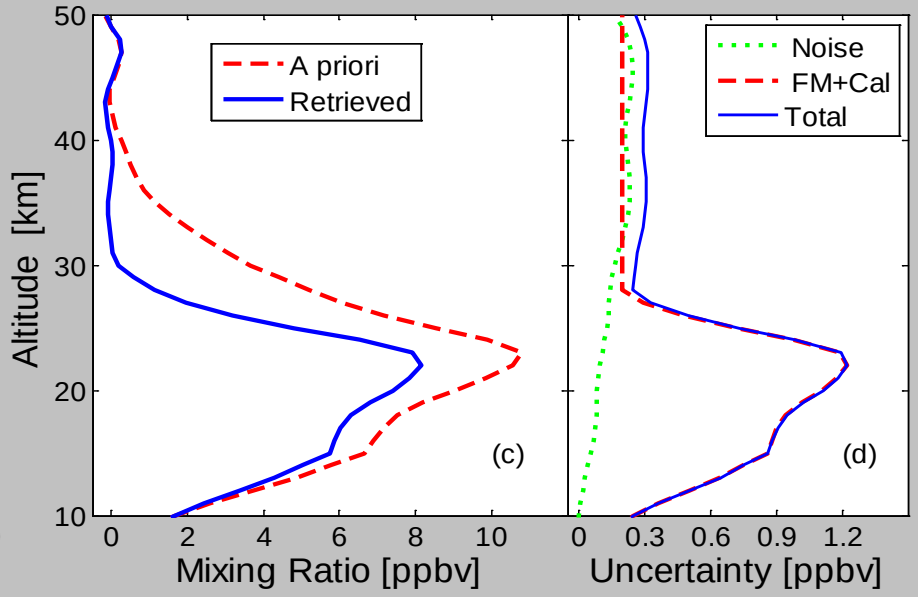

Polarizing grid
Frequency trippler
Oscillating parabolic mirror
Mixer
SIS Nb-AlO$_x$-Nb
Diplexer
E-H tuner
Local oscillators
Optical switch

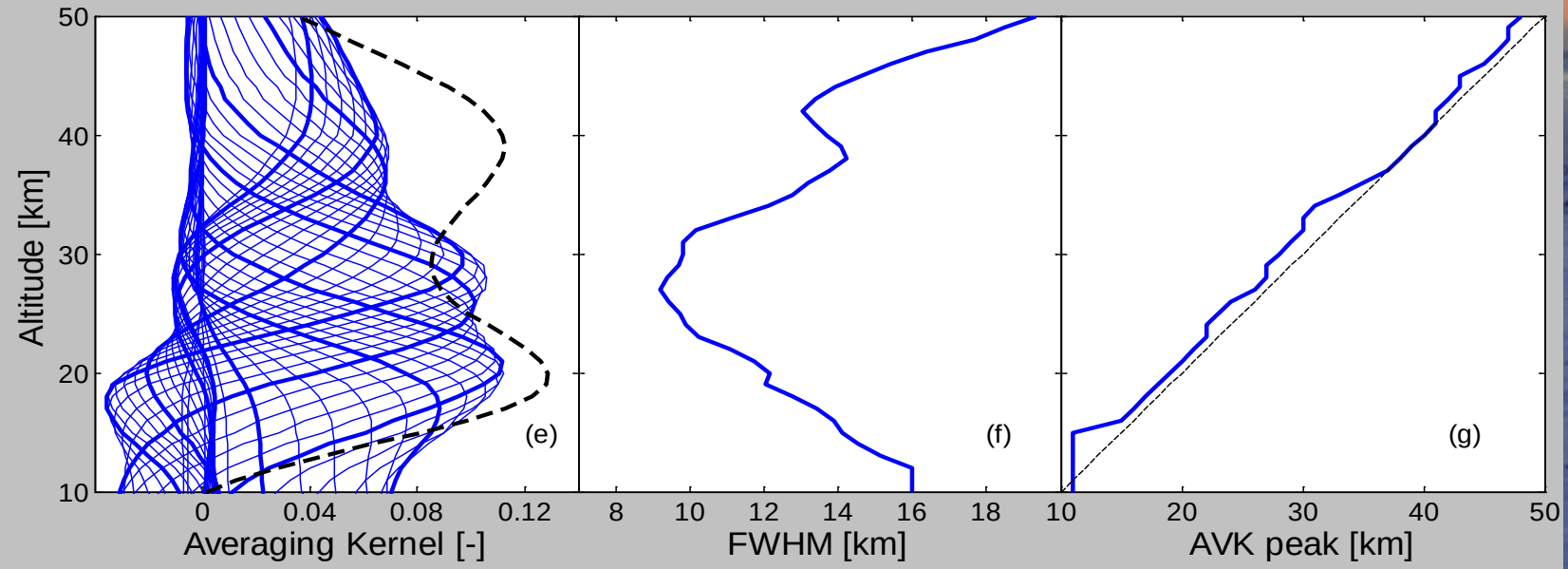

.70E-02
.60E-02
.50E-02
.40E-02
.30E-02
.20E-02
.10E-02
.00E+00
-.10E-02
0.
100.
200.
300.
400.
500.
600.
Channel number (1.176 MHz/Ch.)
SOURCE: CO
DATE: 2/15 /11
c:\thule11\co0215A.R
ELEVATION: 51.9
START TIME: 22:38
PLEX. TEMP: 295.60
OUTSIDE TEMP: 256.80
CYC/TOTAL: 223 / 911
RUN TYPE: DATA
INT. TIME: 673.0
SCAN #:
COLLECTING DATA


Brightness Temp (K)
13
11
9
7
5
3
1
D
0.3
0
−0.3
E
0
100
200
300
400
500
600
700
800
900
1000
Channel Number (0.049 MHz/chan)

1.5 mm PWV, 5-hour integration

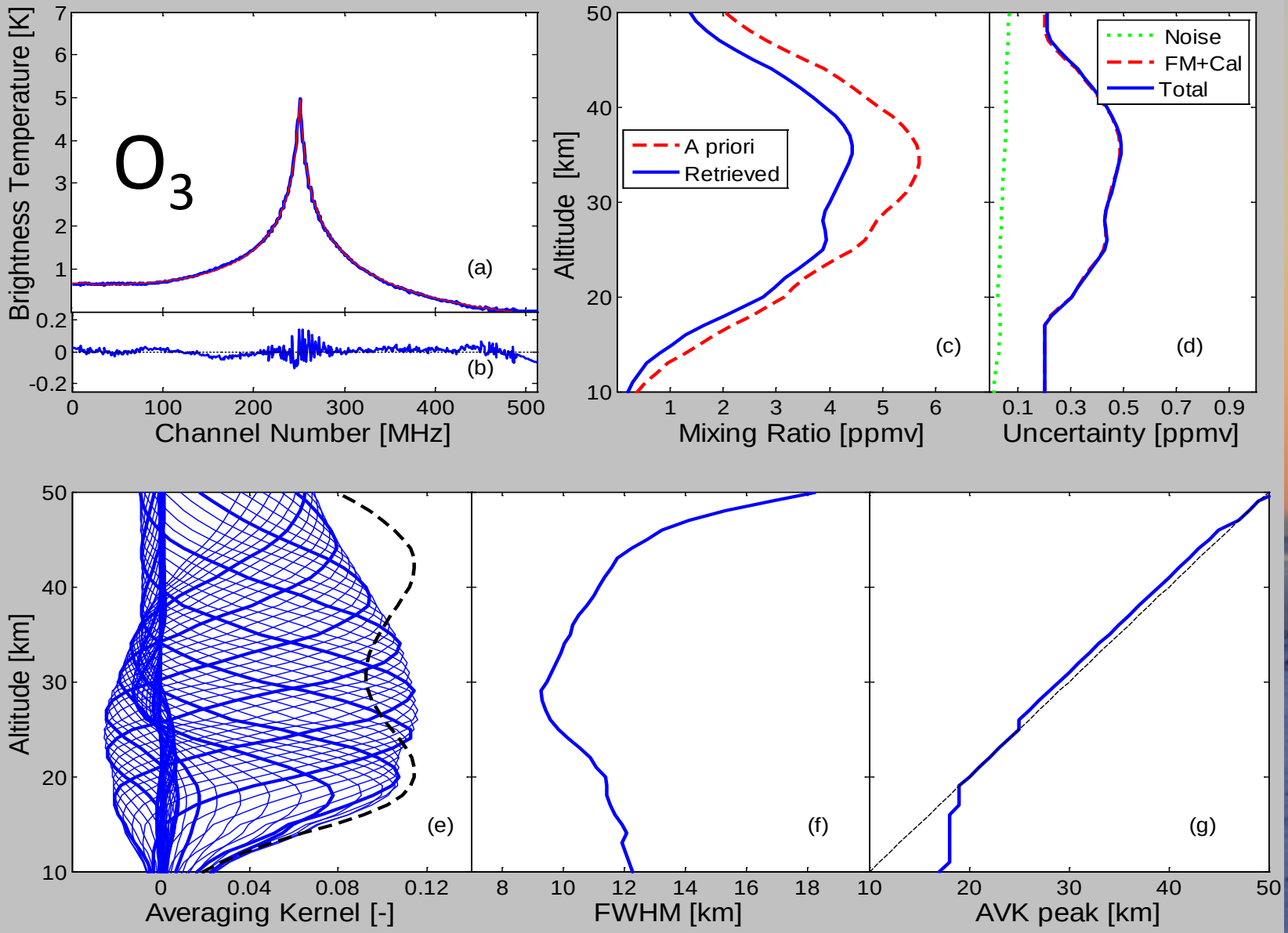




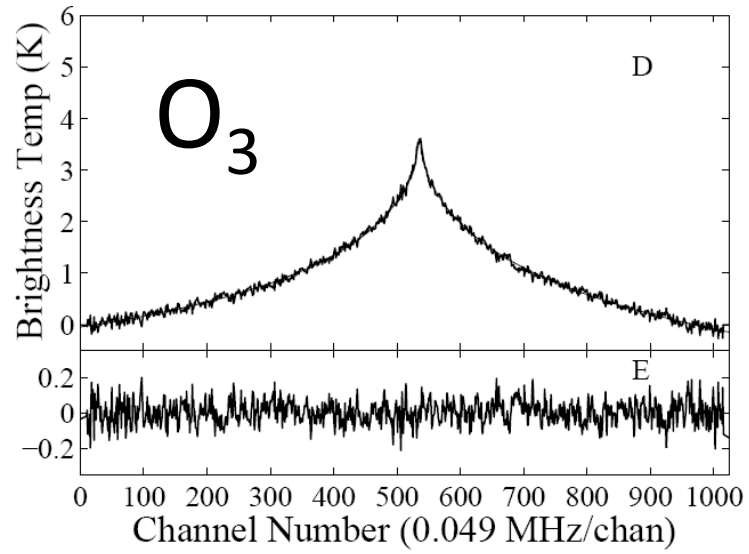


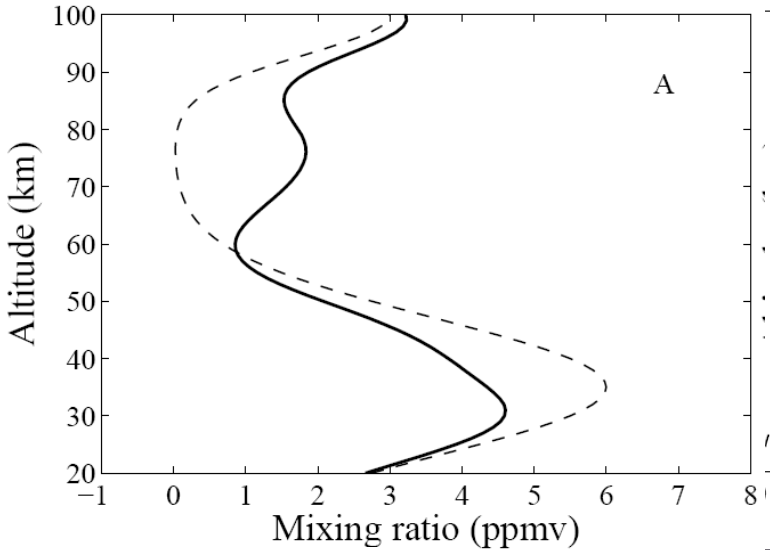
HNO3 AVKs are well peaked and centered close to their correct altitude level in the vertical range 17-45 km, with their sensitivity close to 1

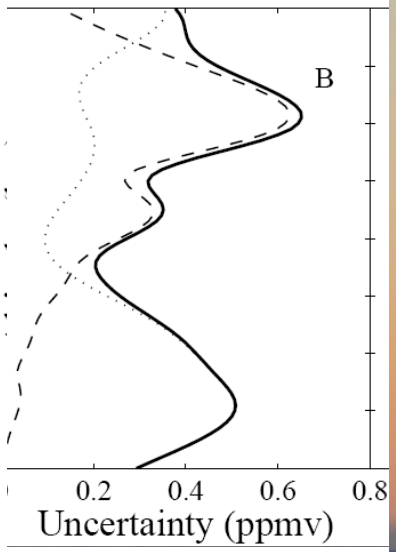
1.5 mm PWV, 1-hour integration

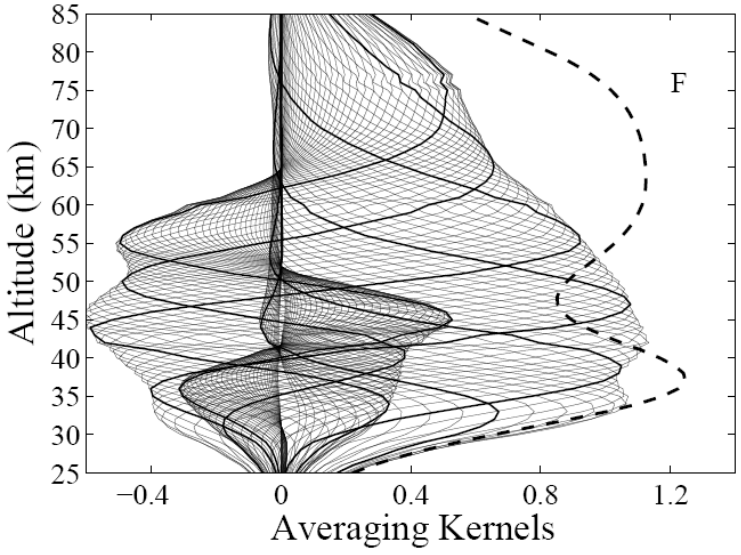


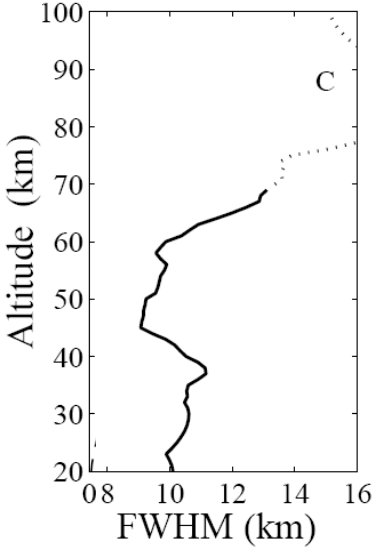
Good sensitivity (>80%) in the vertical range ~17-50 km, where the difference between the nominal and the peak height of the AVKs does not exceed 3 km







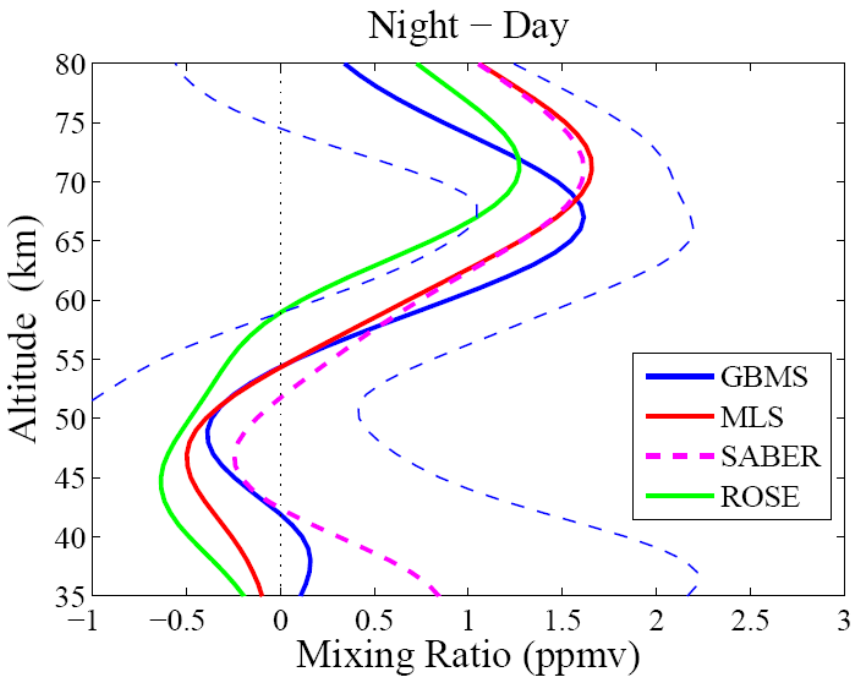




1.5 mm PWV

15-minute integration

Mesospheric O_3 diurnal change

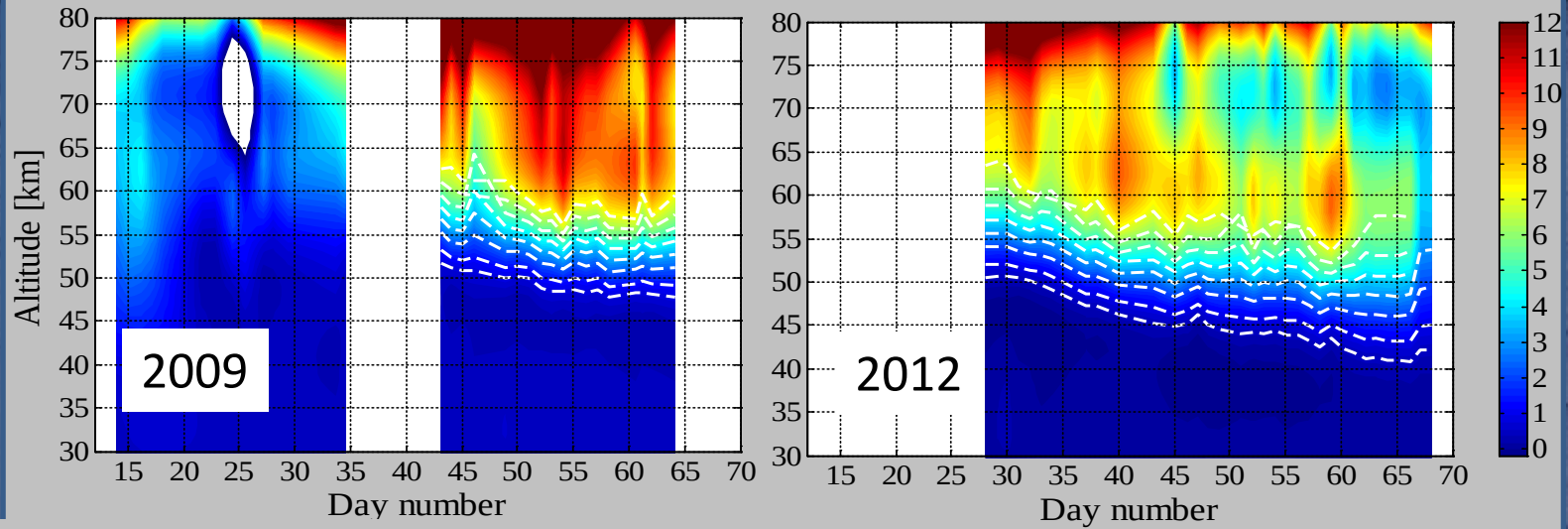


17 +17 MLS coincidences
18+2 SABER coincidences

apriori with no peak at 71 km

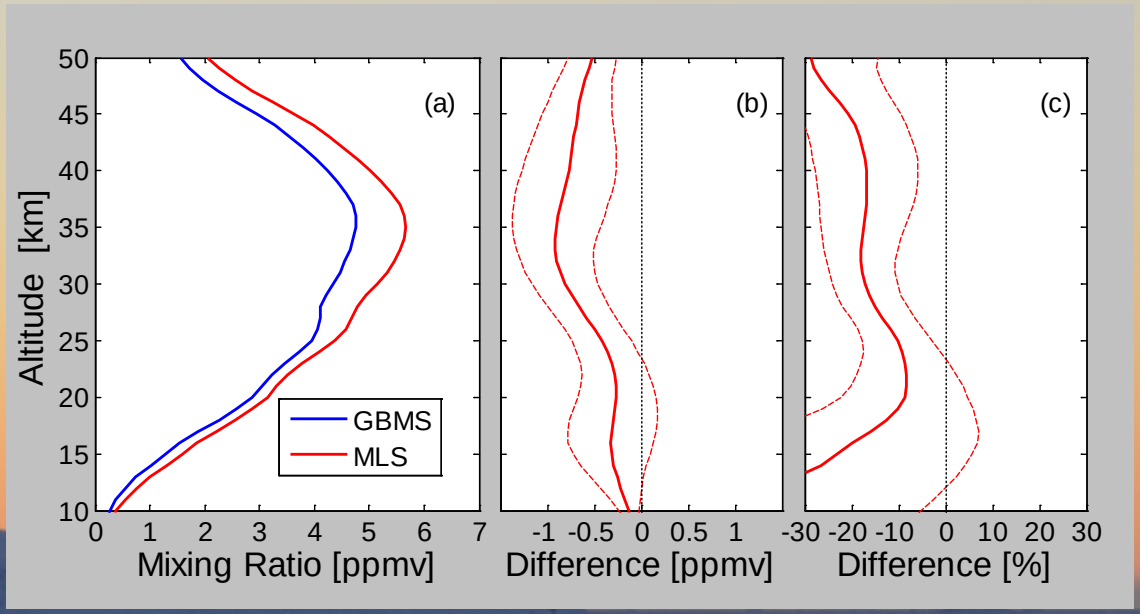
Muscari, G., et al., JGR , doi:10.1029/2011JD016863, 2012

CO to estimate vertical descent for air starting at 50-60 km.



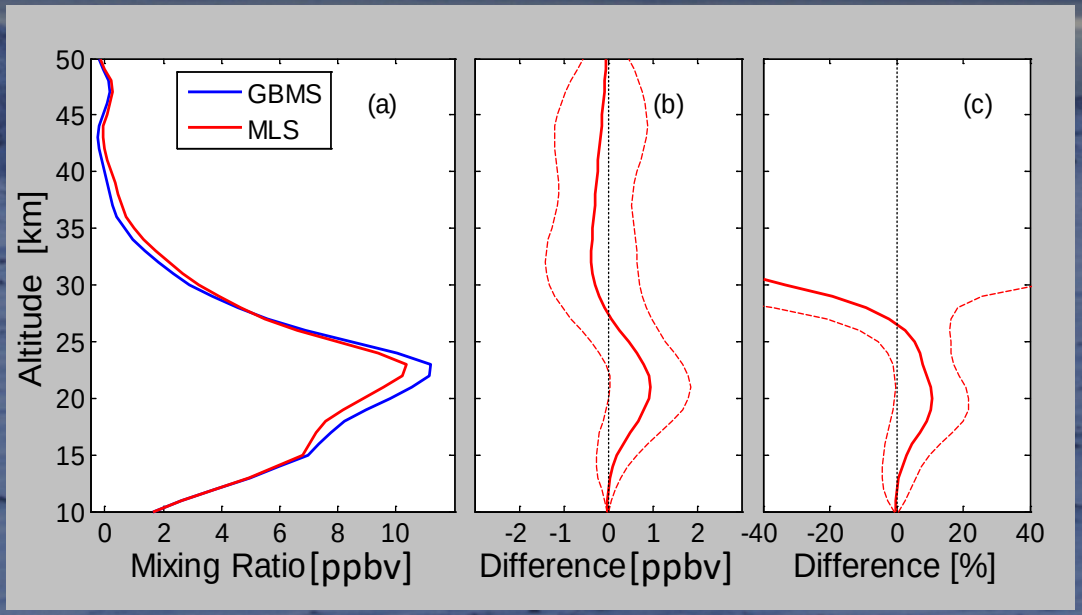
Di Biagio, C., et al., JGR, doi:10.1029/2010JD014070, 2010

GBMS (blue) and MLS convolved (red) mean profiles.



O_3 during the two winters 2011 and 2012.
54 coincidences.

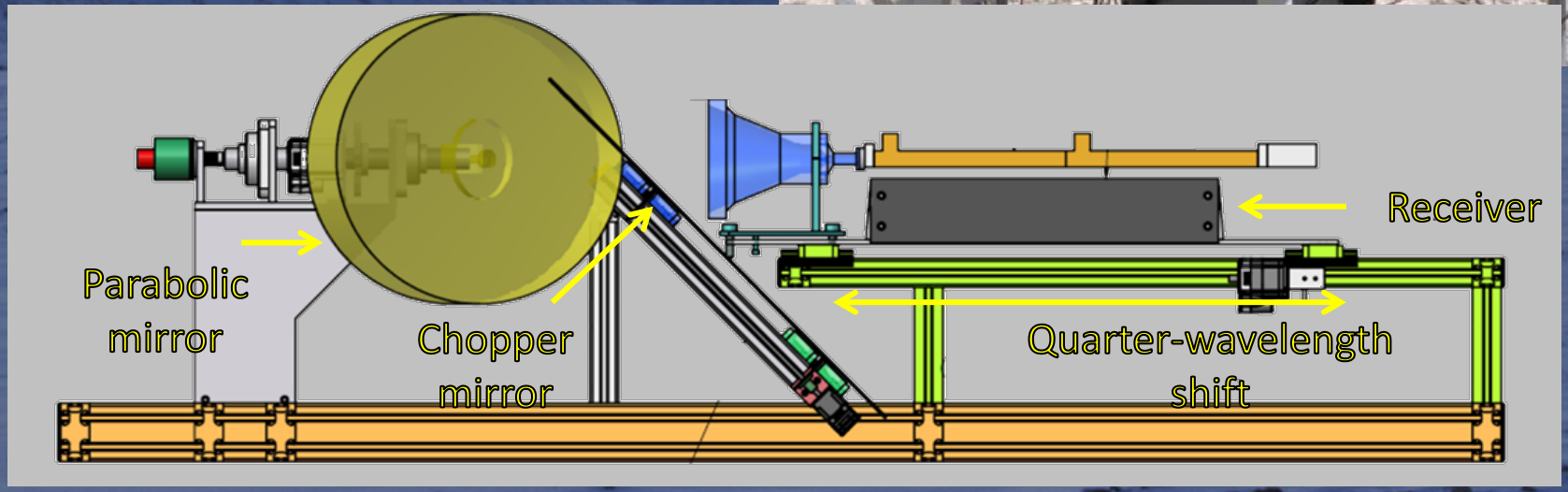
HNO_3 during winters 2010, 2011, and 2012 .
43 coincidences.



Fiorucci, I., et al., Atmos. Meas. Tech., submitted, 2012.

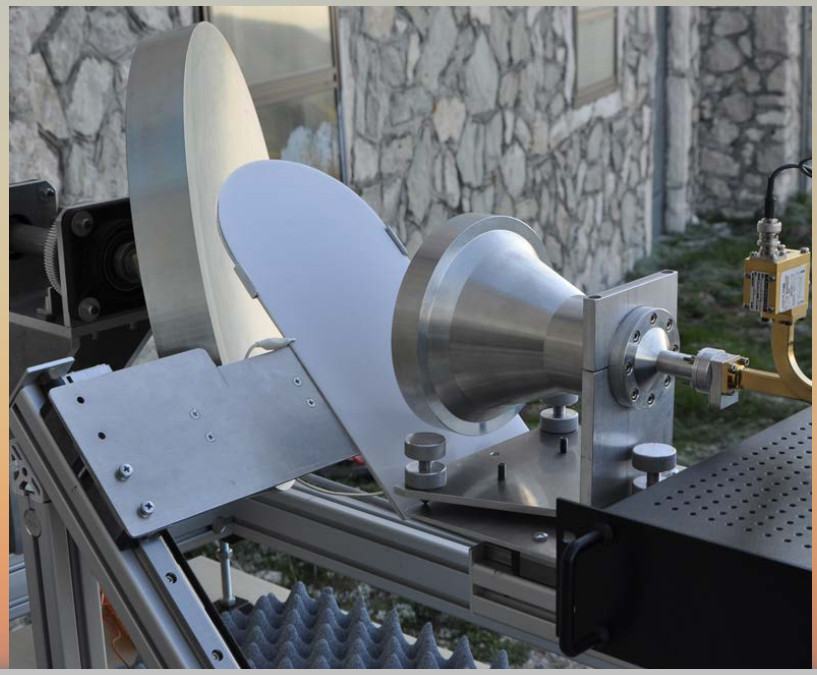
VESPA22

(water Vapor Emission Spectrometer for Polar Atmospheres at 22 GHz)



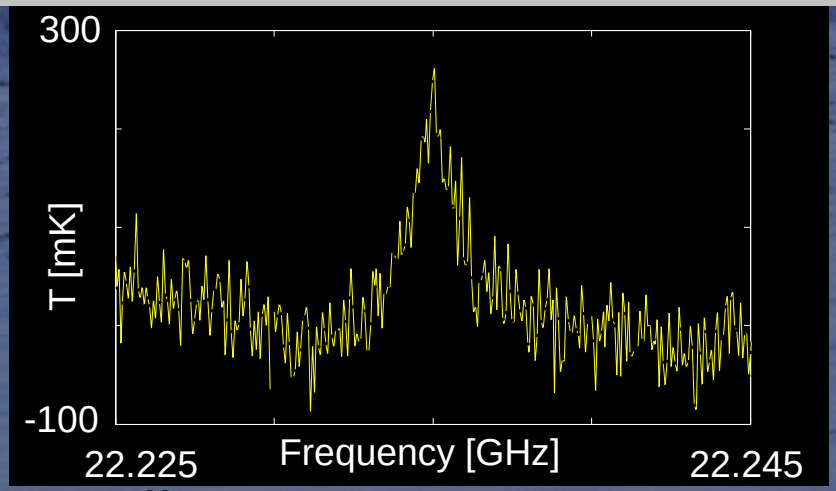
Main features of VESPA22

- Designed for indoors (polar regions)
- Balancing technique (signal > 15°, reference at 90°)
- Front-end:
  - Parabolic reflector + compact feedhorn (HPBW=3.5°)
  - SSB uncooled heterodyne receiver (Trec ~ 200 K)
  - chopper with dielectric sheet (Tint = 3+3 s)
- Back-end:
  - Acqiris/Agilent U1080A FFT spectrometer
- Calibration:
  - on-line with two calibrated noise diodes
  - Hot/Cold (LN2) loads of eccosorb CV-3 for abs. calibration



$$T_H - T_C = T_{ND} * (V_H - V_C) / (V_{ND+C} - V_C)$$

First H_2O spectrum (Rome, 04/2012)



Effective integration time: 6h (3+3)