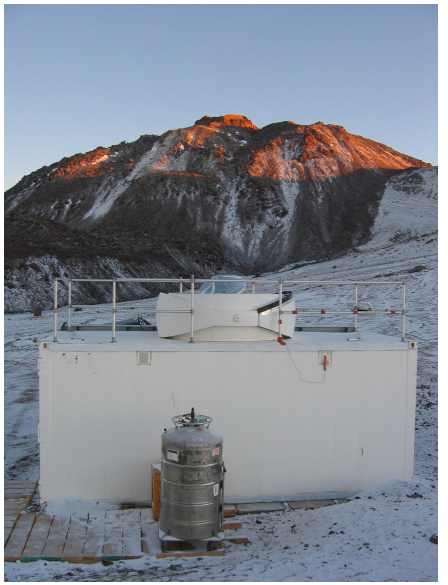
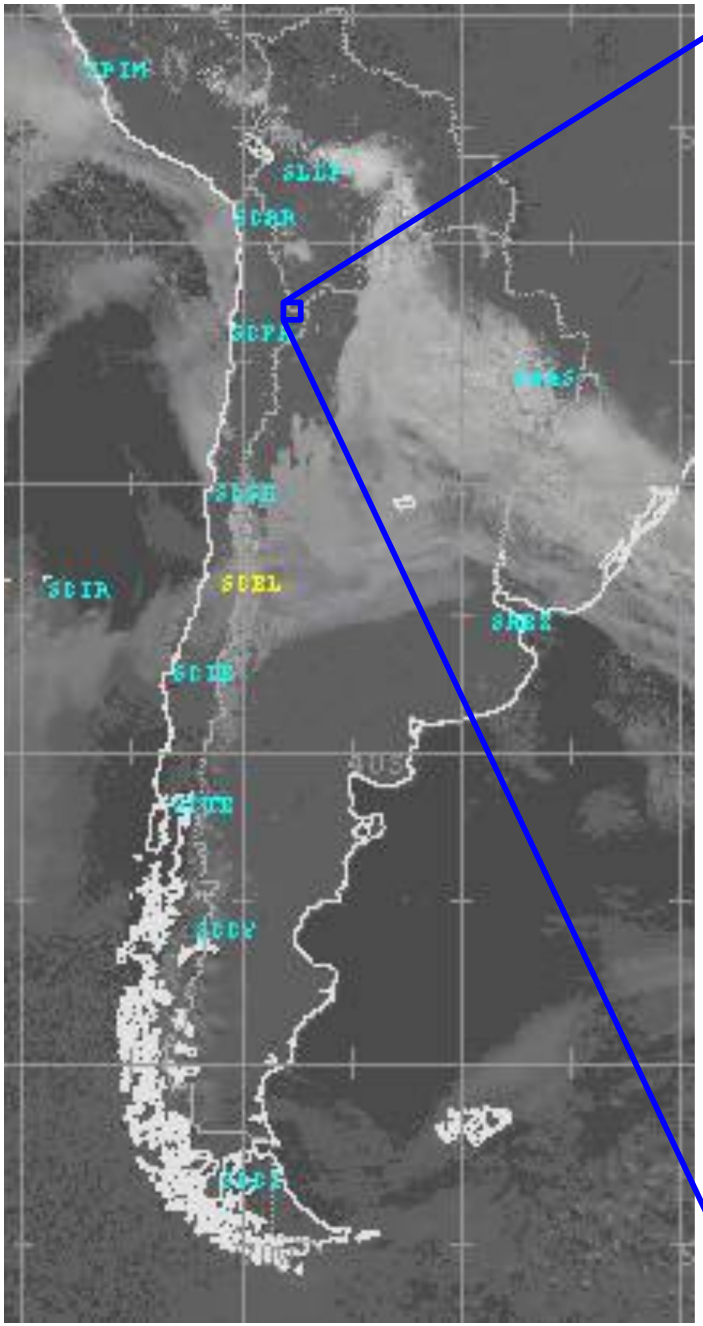
The RLT on Sairecabur



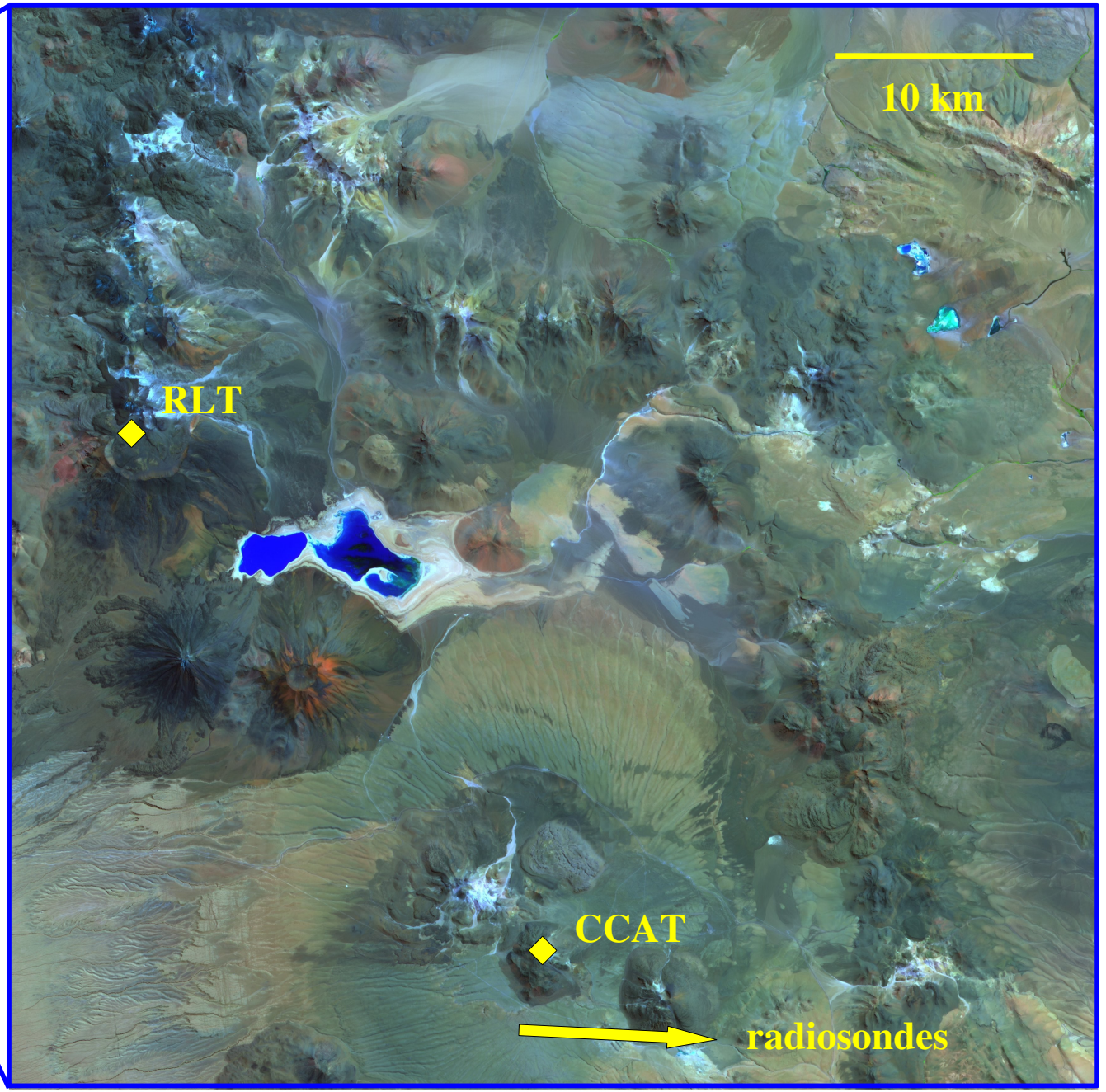
R. Blundell, S. Paine, D. Marrone, E. Tong, D. C. Papa, T. Hunter, M. Smith, R. Plante, J. Battat, S. Leiker, T.K. Sridharan (CfA); J. Kawamura, J. Pearson, J. Stern, H. Yorke, I. Mehdi, J. Ward, S. Lord (JPL/Caltech), J. May, L. Bronfman, D. Luhr, C. Barrientos, W. Moerback (U. Chile); H. Gibson (RPG); B. Voronov, G. Goltsman (MSPU); M. Diaz (BU); D. Loudkov (Delft), D.Meledin (Chalmers), F. Bensch (Bonn); C. Groppi (NRAO); S. Radford (Caltech); A. Otarola, R. Rivera (ESO)

Outline

- Site testing
  - FTS observations
  - Radiosondes
- The Receiver Lab Telescope (RLT)
  - Goals
  - Examples of observations
- Lessons learned and future plans



NOAA GOES-12 / Direccion Meteorologica de Chile



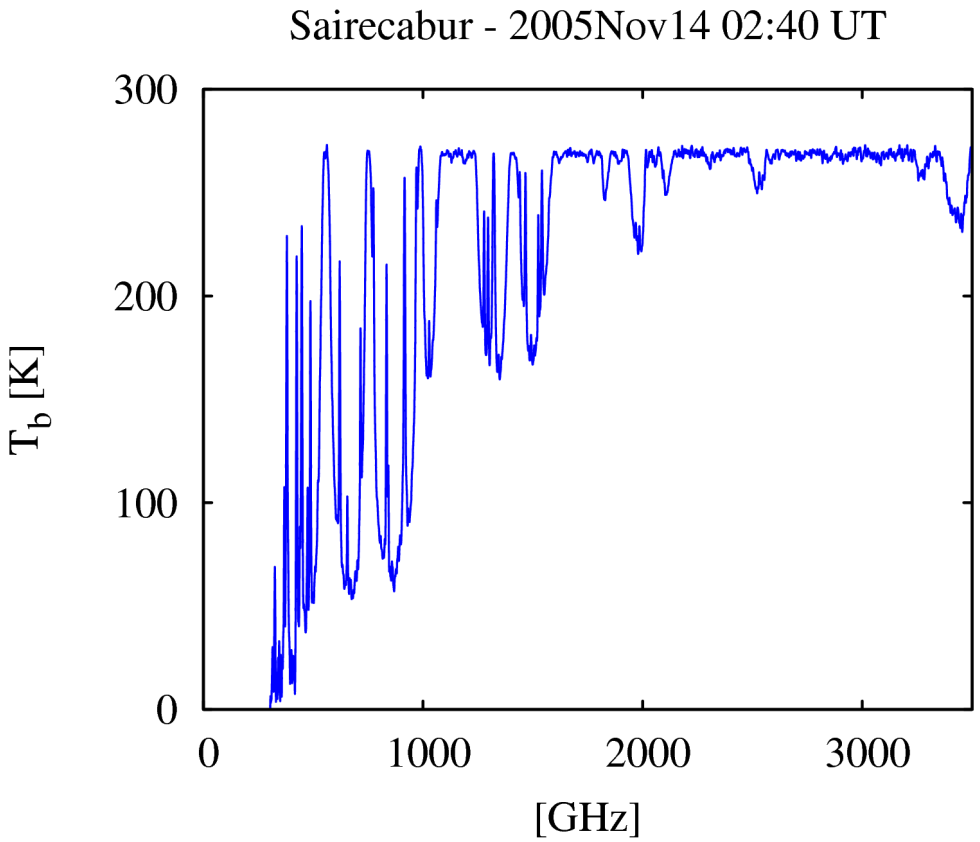
NASA/GSFC/METI/ERSDAC/JAROS and U.S./Japan ASTER Science Team

FTS Observations

- Chajnantor (5050 m) – 1997 Oct - 1999 Dec
  - Hosted by NRAO, ESO for site studies
- Sairecabur (5525 m) – 2000 Nov - present
  - Comparison with Chajnantor
  - RLT calibration
  - Model validation

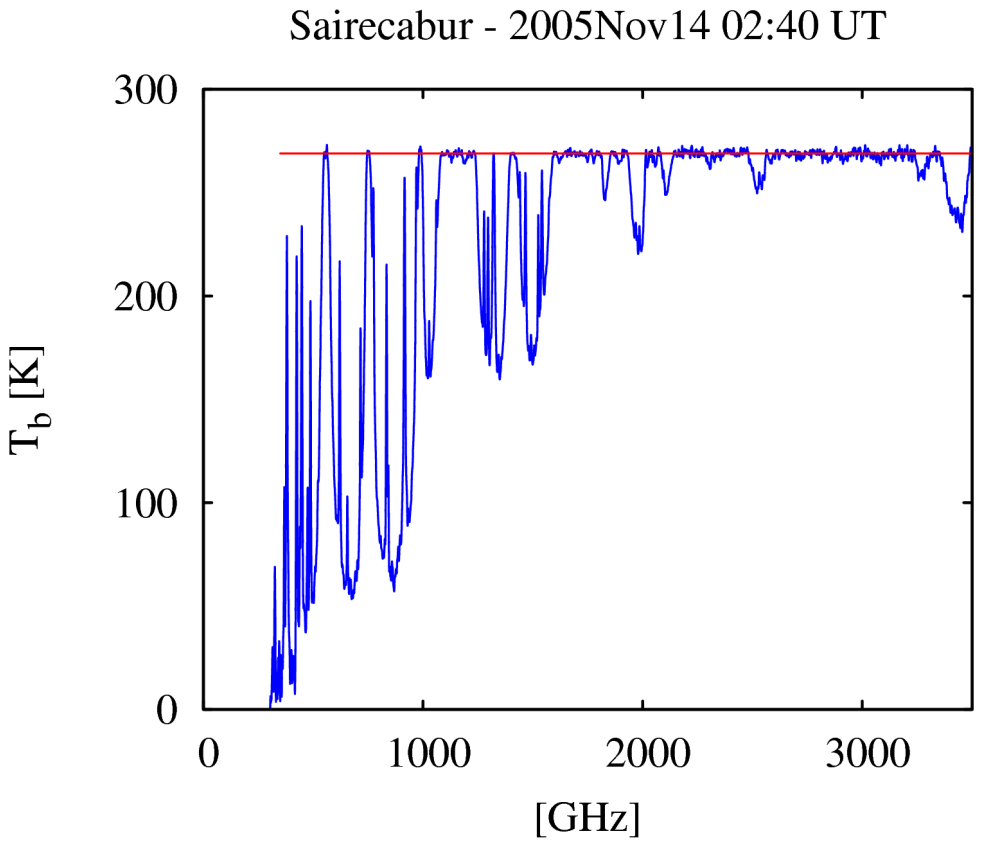
FTS Spectra

- Calibrated data product is T_b



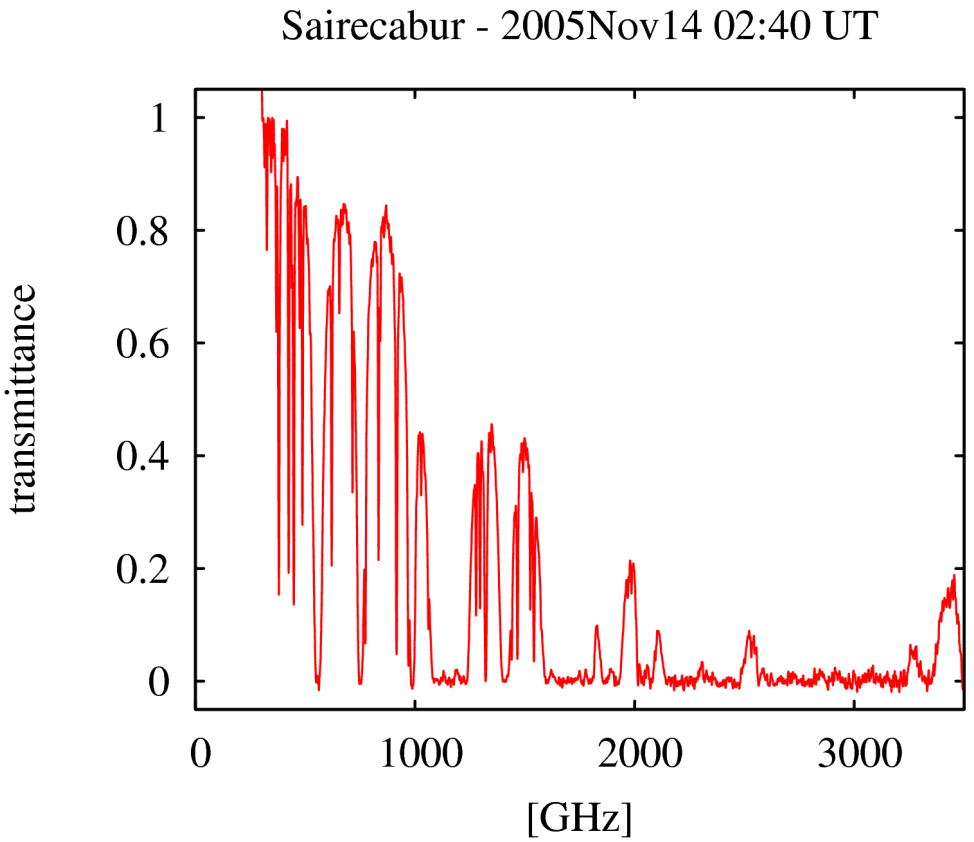
FTS Spectra

- Calibrated data product is T_b
- Simple transmittance
  - T_{atm} from baseline



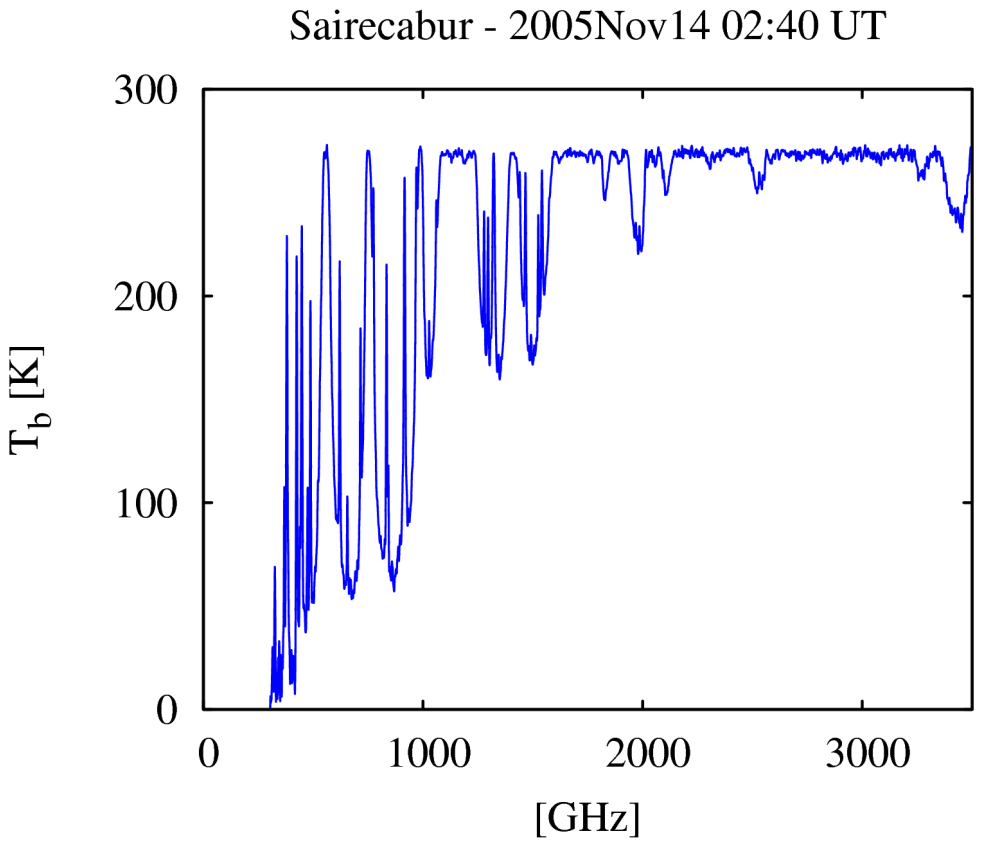
FTS Spectra

- Calibrated data product is T_b
- Simple transmittance
  - Effective T_{atm} from baseline
  - Isothermal transmittance



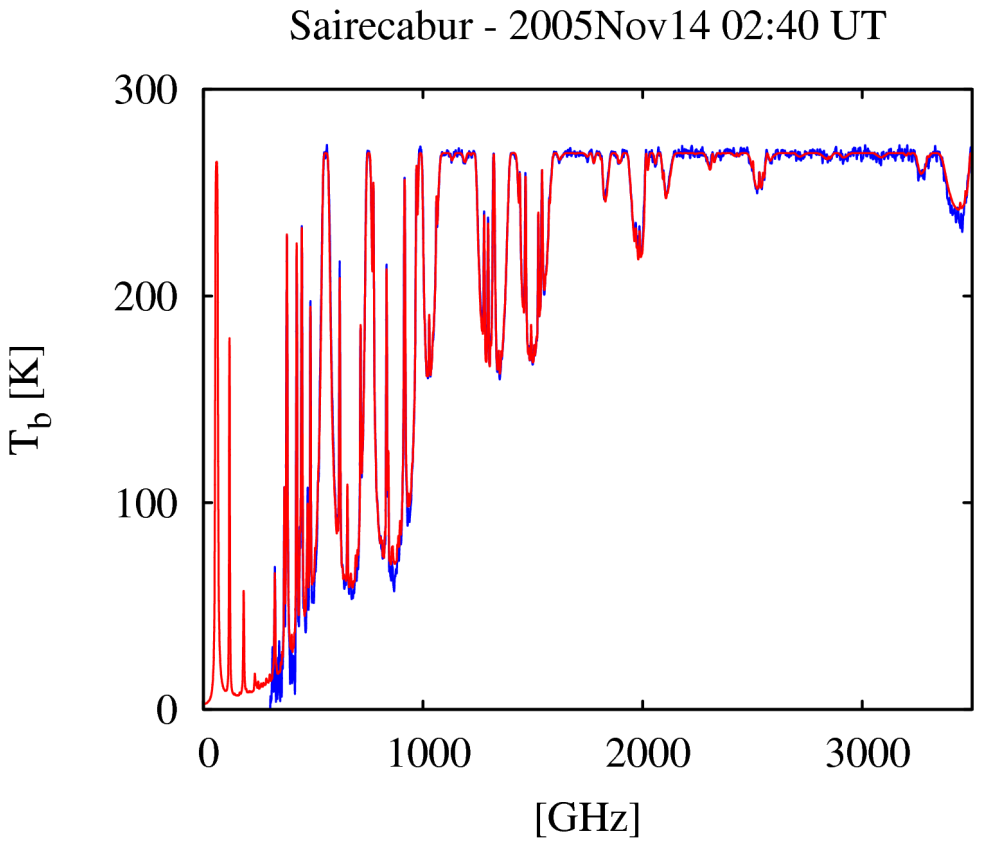
FTS Spectra

- Calibrated data product is T_b
- Simple transmittance
  - Effective T_{atm} from baseline
  - Isothermal transmittance
- Model transmittance



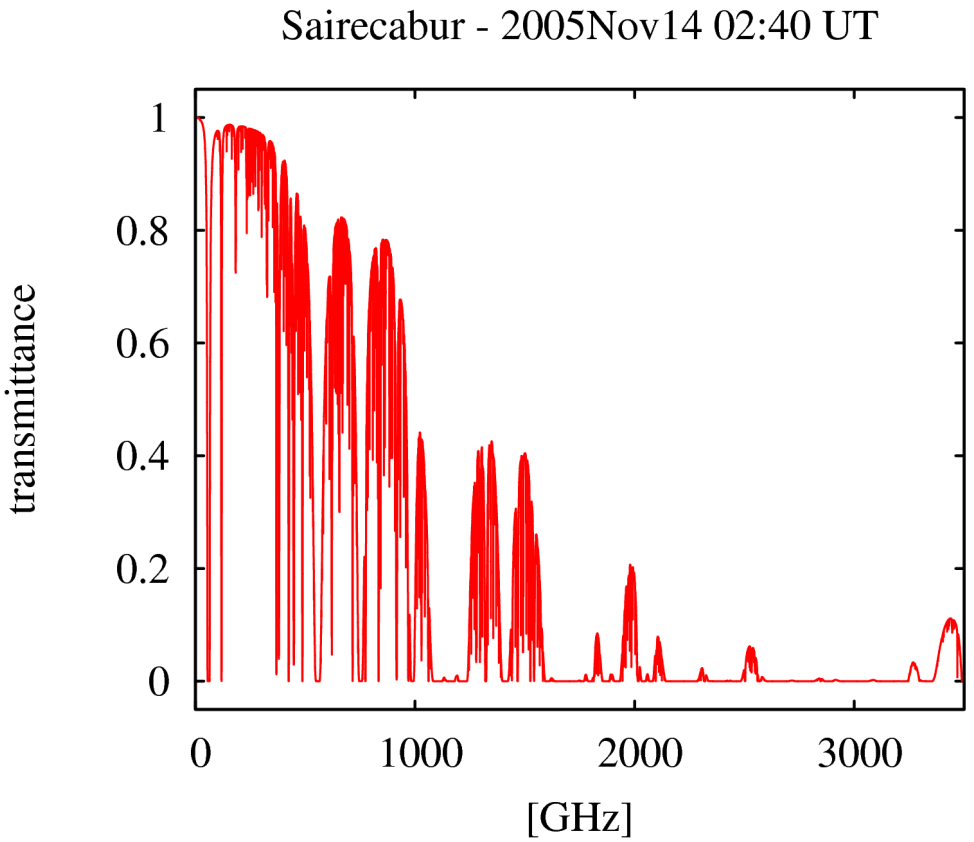
FTS Spectra

- Calibrated data product is T_b
- Simple transmittance
  - Effective T_{atm} from baseline
  - Isothermal transmittance
- Model transmittance
  - *am* fit to T_b



FTS Spectra

- Calibrated data product is T_b
- Simple transmittance
  - Effective T_{atm} from baseline
  - Isothermal transmittance
- Model transmittance
  - *am* fit to T_b
  - Fully-resolved model transmittance



FTS Spectra

- Calibrated data product is T_b
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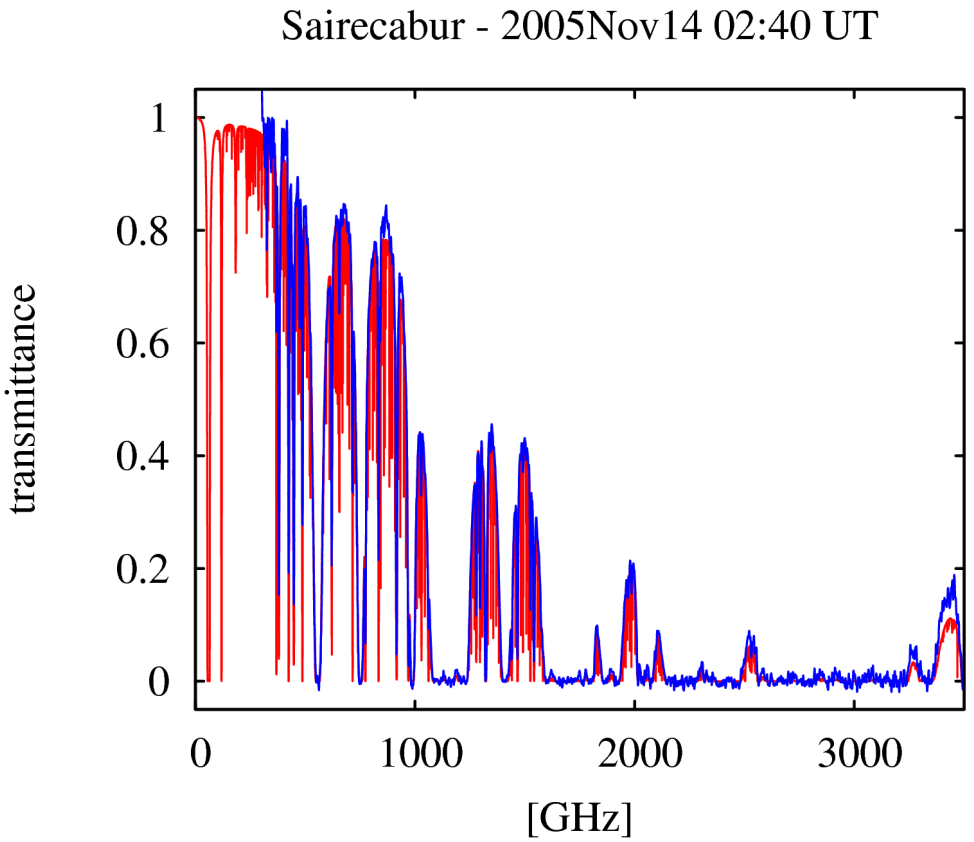
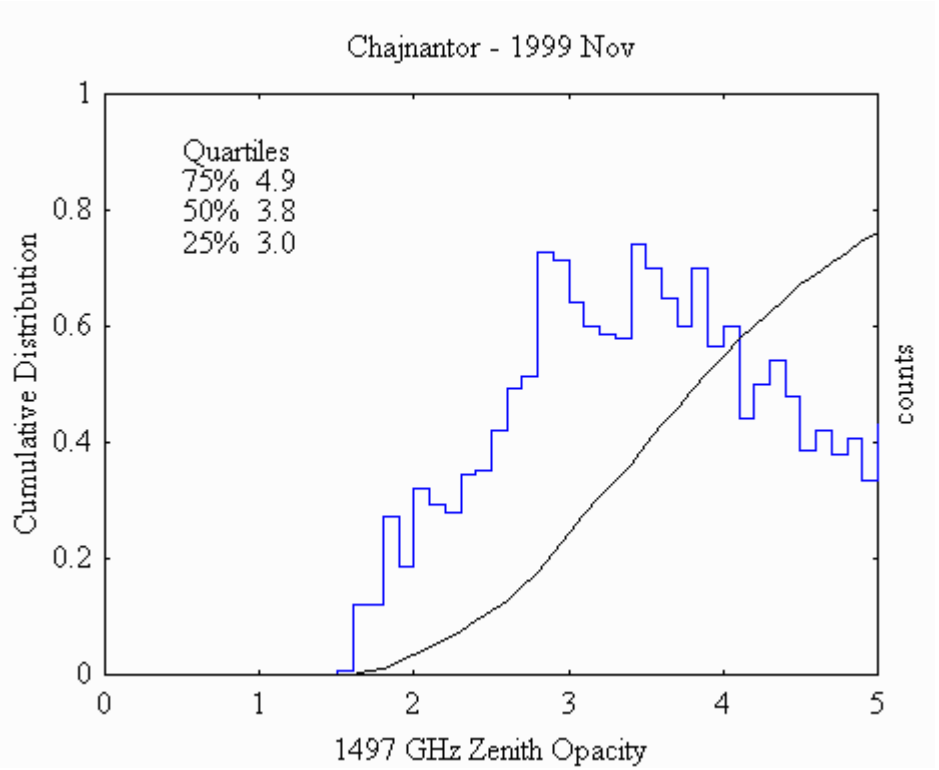
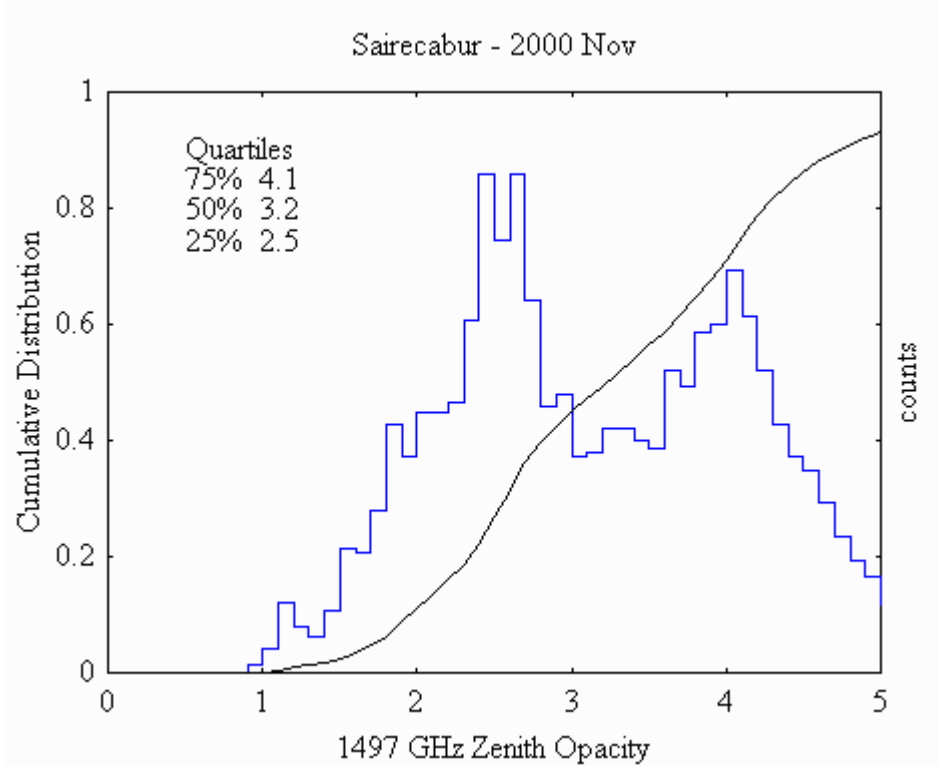


Llano de Chajnantor vs. Sairecabur

- Only one FTS, so comparison is indirect
- Use 1999 Nov and 2000 Nov, which had similar τ_{225} quartiles at Chajnantor
  - 1999 Nov: 0.026 / 0.035 / 0.049
  - 2000Nov: 0.027 / 0.037 / 0.054
- 2000 Nov was slightly worse

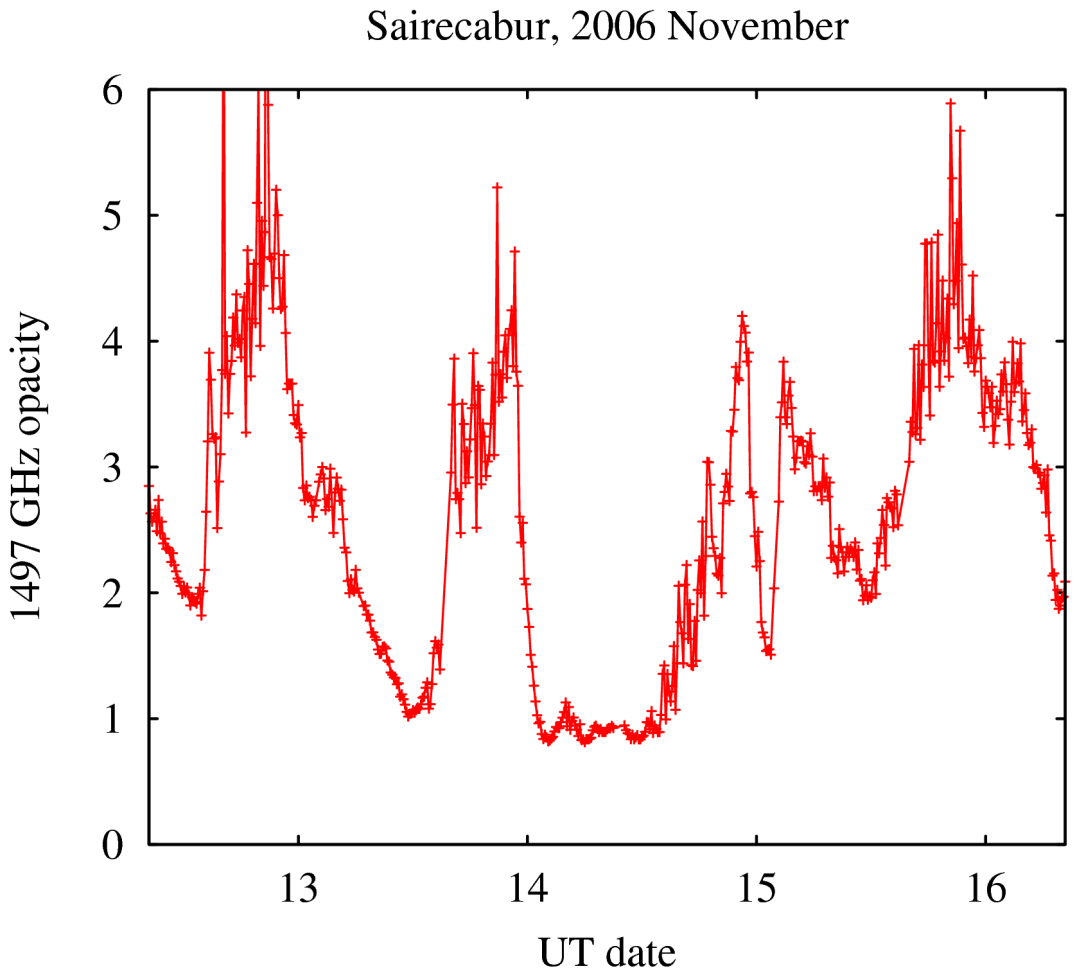
Llano de Chajnantor vs. Sairecabur





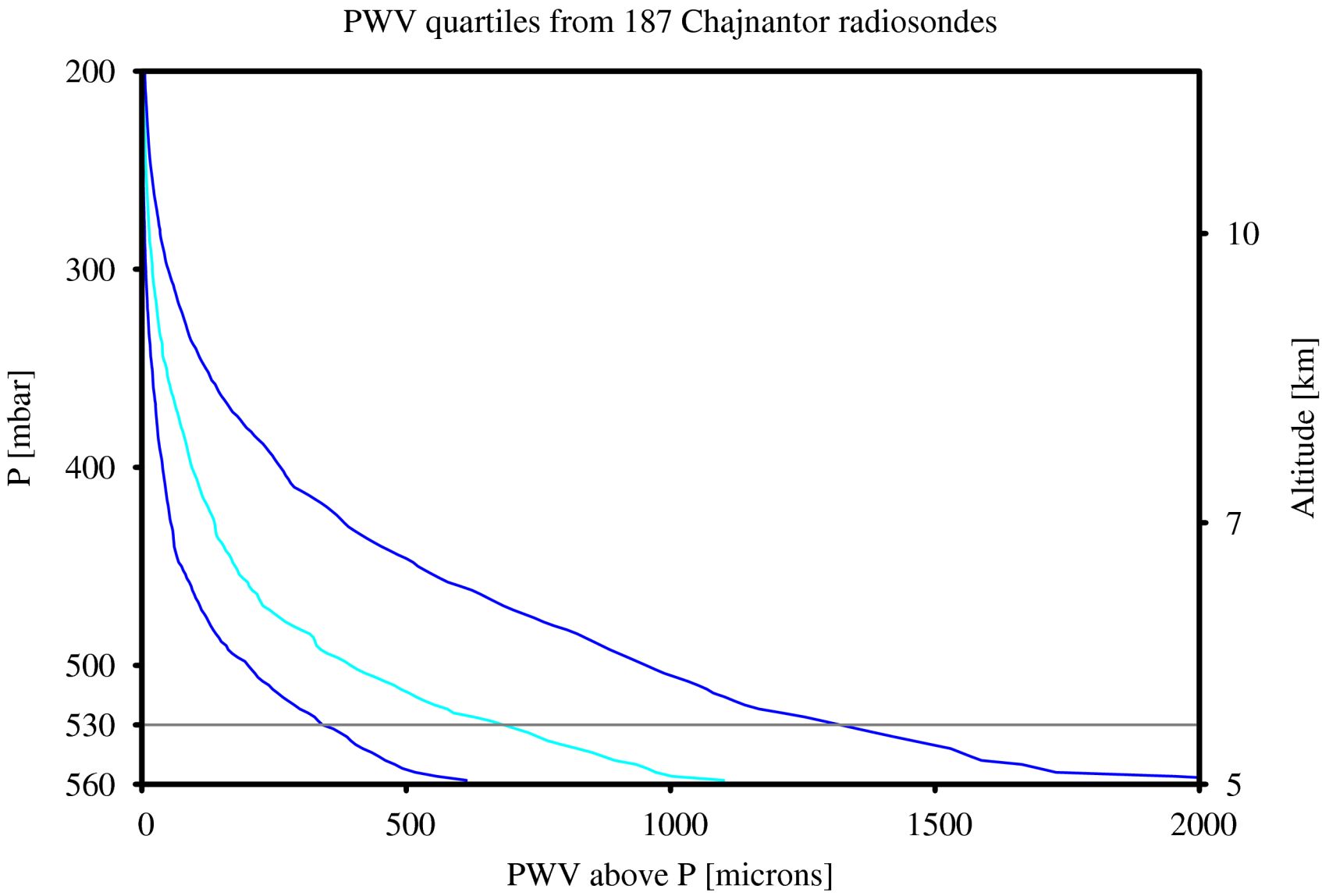
200 μm opacity lower by about 0.6, down to endpoint

Typical Diurnal Variability (good weather)

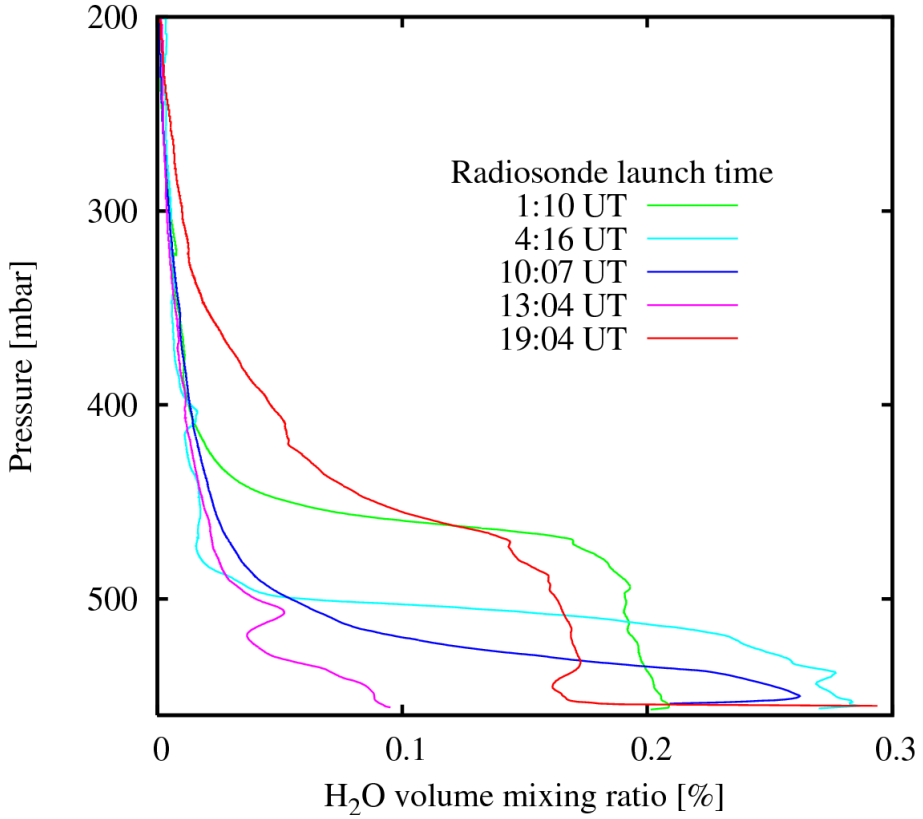


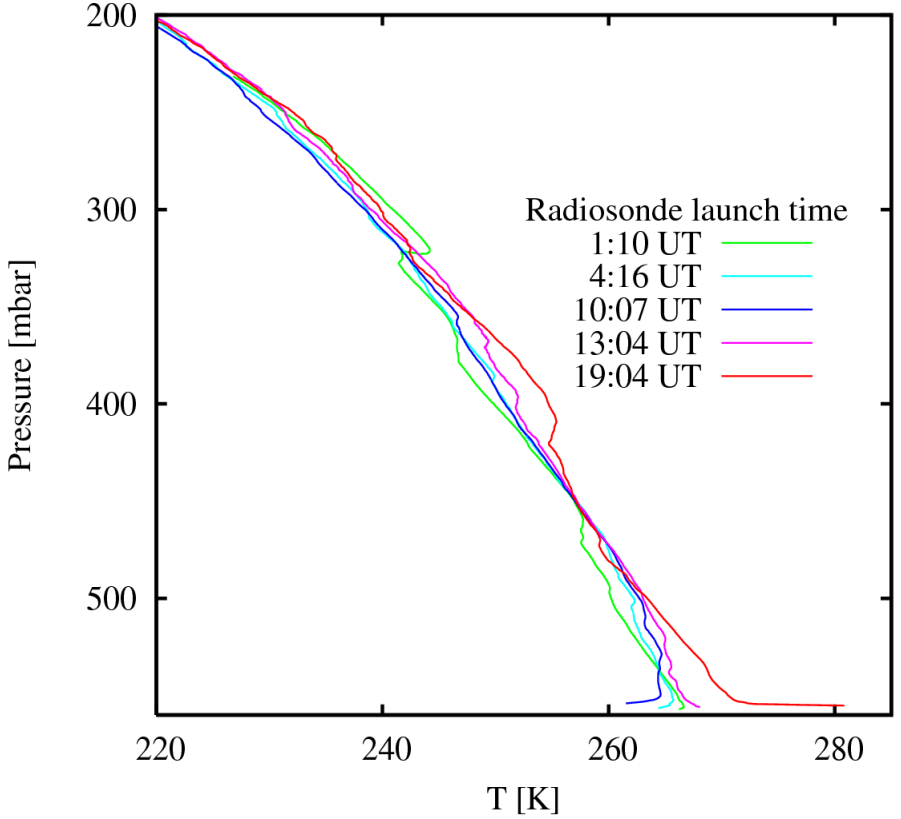
Chajnantor Radiosondes

- Initiated in 1998 by Cornell, NRAO, ESO, SAO
- Irregular time sample, but median pwv (1.1 mm) agrees well with median τ_{225} for Chajnantor (0.061)


PWV quartiles from 187 Chajnantor radiosondes
200
300
400
500
530
560
P [mbar]
0
500
1000
1500
2000
PWV above P [microns]
10
7
5
Altitude [km]

Radiosondes – diurnal cycle (1999 Nov 10)



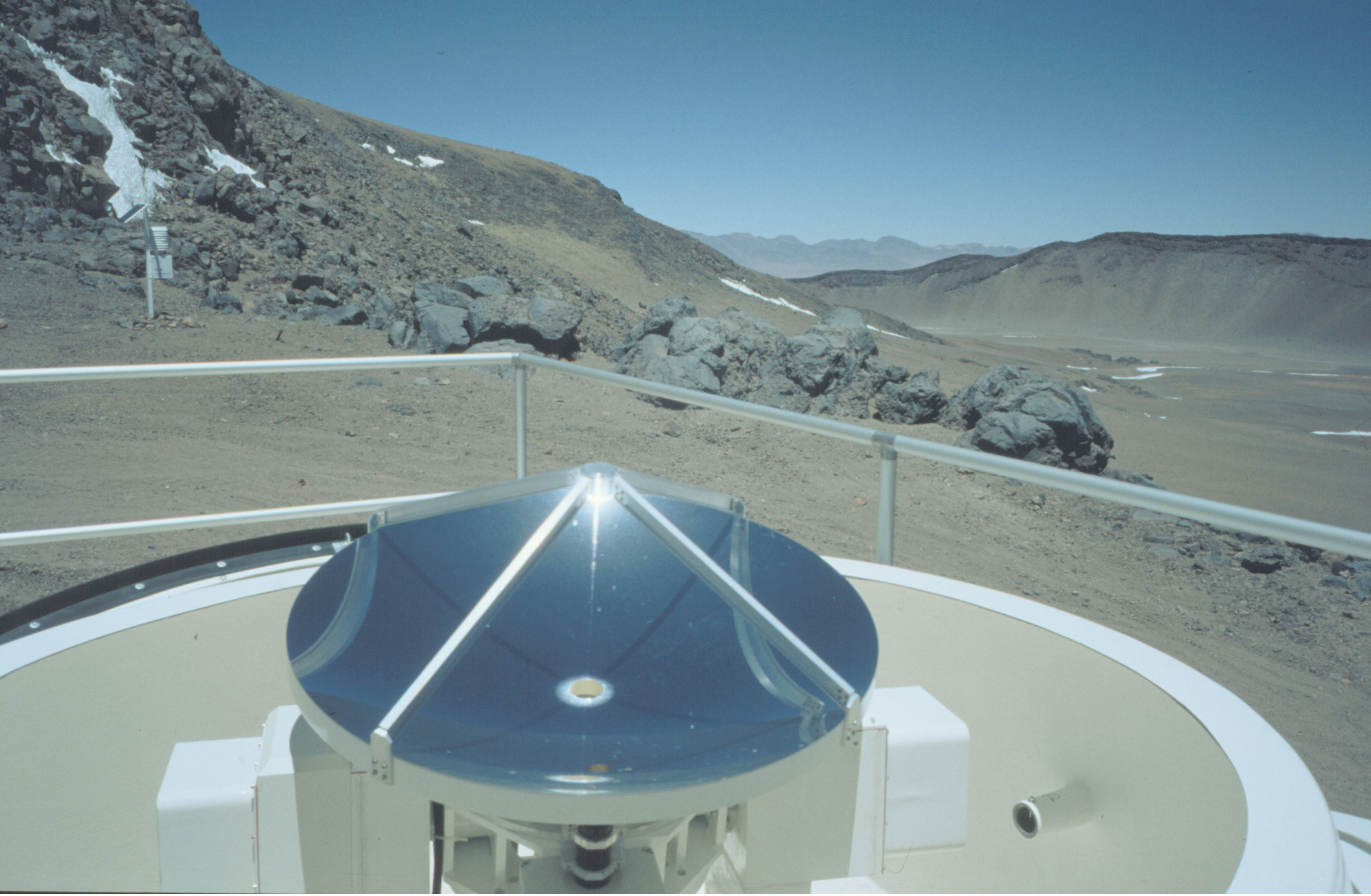


The RLT

- Encouraged by radiosonde and FTS data
- Goals
  - Test bed for THz receivers using HEB mixers
  - Spectroscopy – CO and isotopologues, N+
  - THz observing techniques
  - Propagation studies
- Deployed Nov 2002

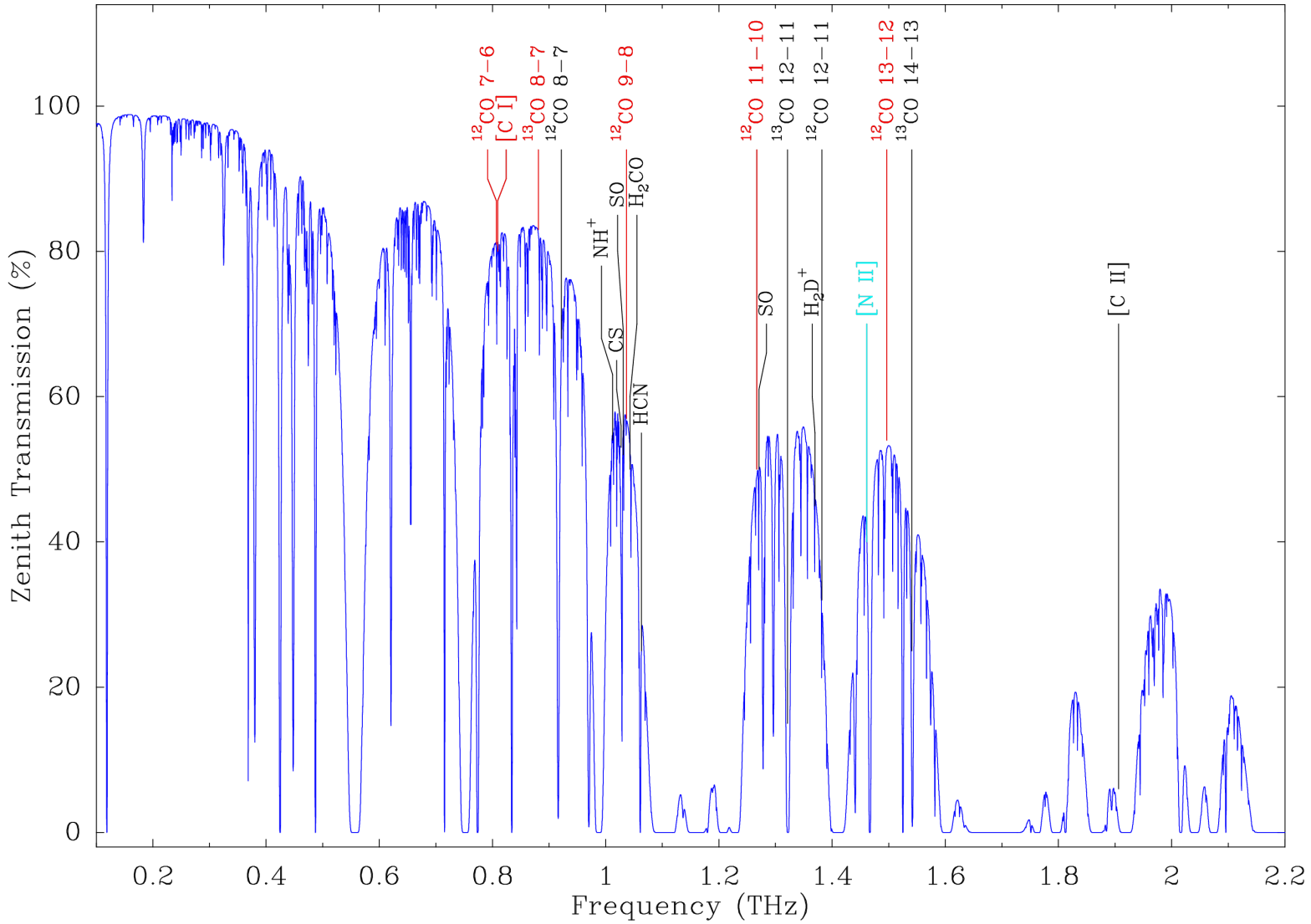
RLT specifications

- 800 mm primary (1' at 1.5 THz)
- HEB mixer receivers
  - 850 GHz, ~900 K
  - 1.03 THz
  - 1.3 THz
  - 1.5 THz, ~ 1900 K
- Autocorrelating spectrometer, 1 GHz BW



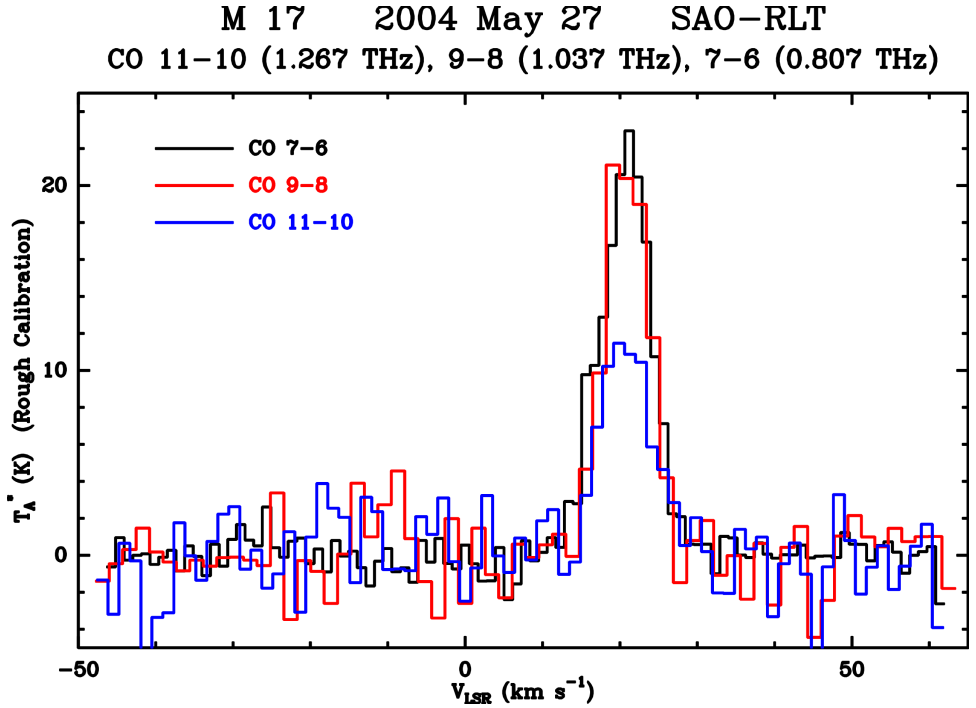
2006 July 19 CCAT Partnership Meeting

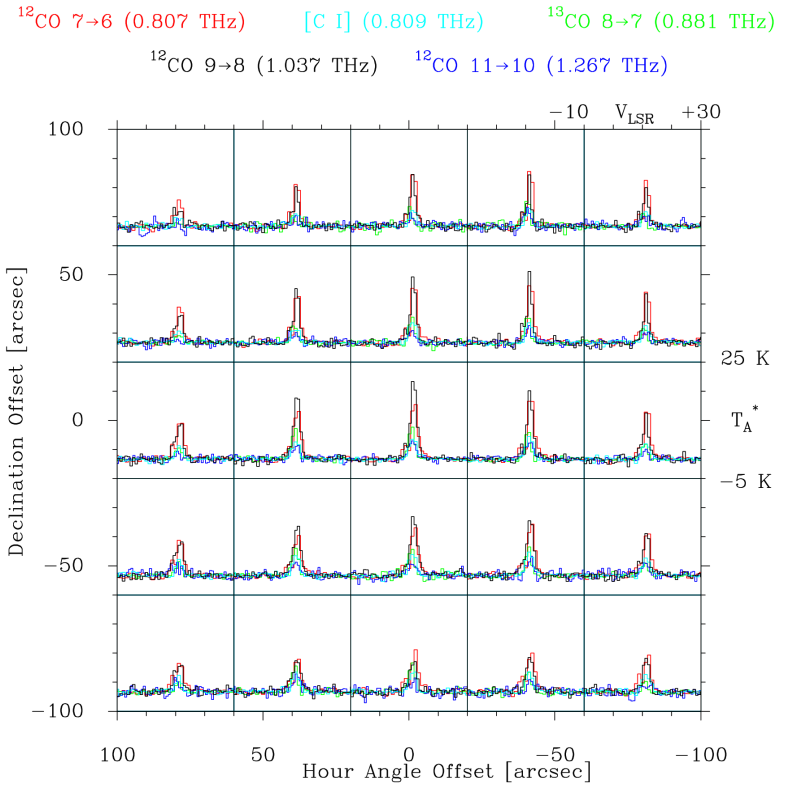
RLT Target Species



Multi-band observations

M 17

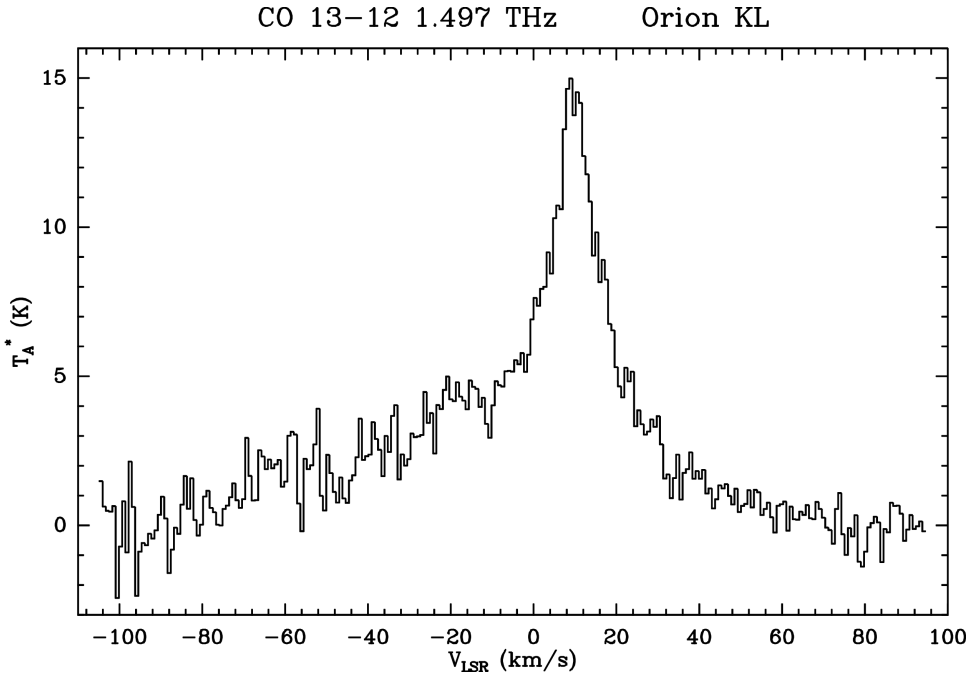


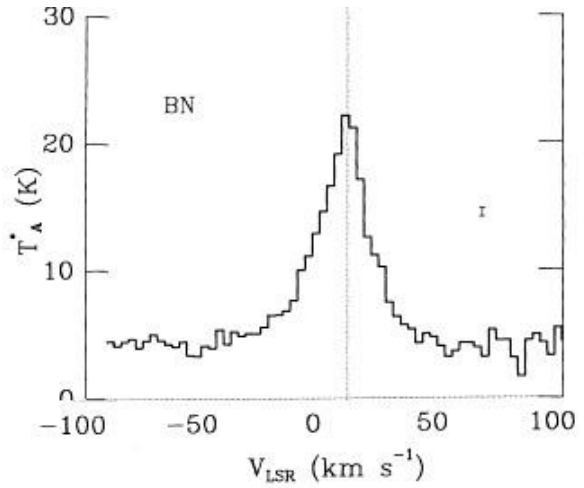


NGC 2024

1.5 THz band

- 1.5 THz LO on loan from JPL since 2004 December



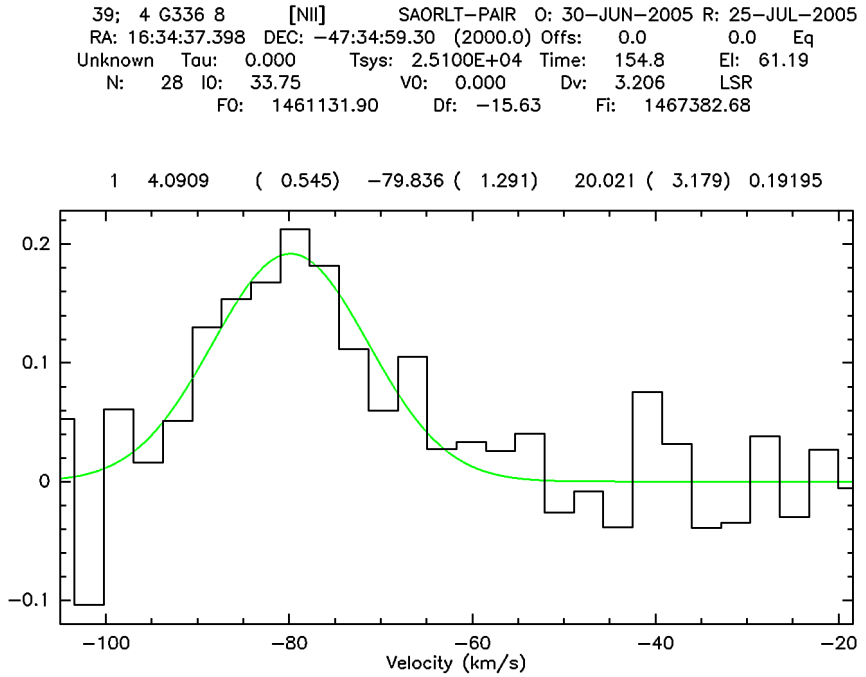


cf. CO 17-16 from KAO (Boreiko, Betz & Zmuidzinas 1989)

(D. Marrone)

N+ Observations (1461.1 GHz)

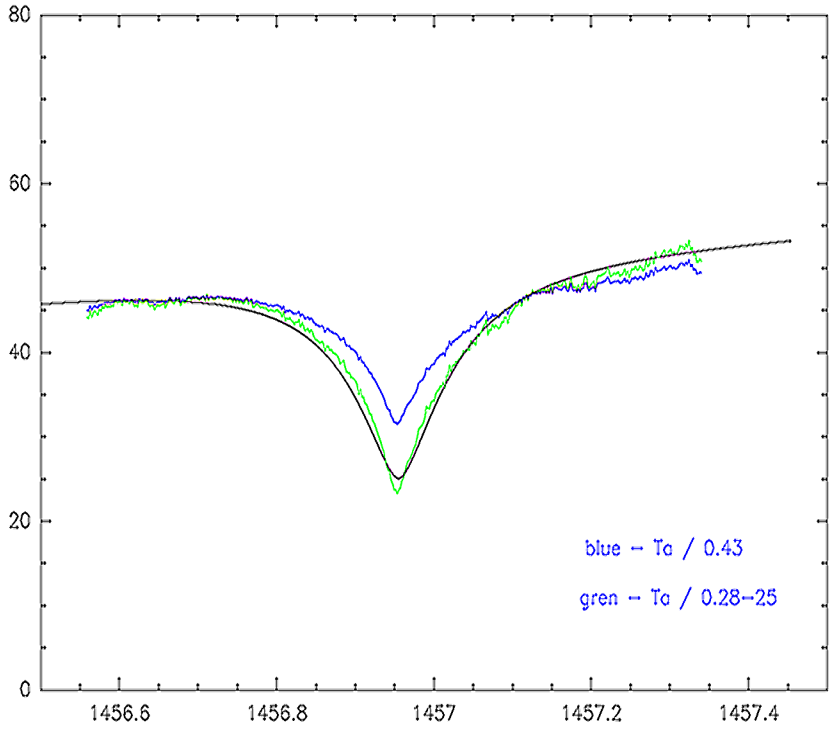
- Transmittance about 50% of window peak (O_2 line at 1466.8 GHz)
- Sources weak
- System inefficient



G336.84+0.05 Jun-Jul 2005 (D. Marrone)

Evaluating system efficiency

- Look at stratospheric O_3 on/off Moon
- FTS calibrates foreground tropospheric absorption
- Reduction in expected line contrast measures efficiency
- Optical efficiency ~30%



Lessons learned

- Ground-based THz observations feasible, but difficult
- Need agile observing strategy
- FTS essential for calibration
- HEB mixers sensitive to LO power, bias (Touchy operation under field conditions)

Future Plans

- Two-band receiver, SIS / HEB
- New analog correlating spectrometer
- Move to Chajnantor?