Site testing: some data from atmospheric and meteorological studies

L. Valenziano

on behalf of 'the collaboration'

The collaboration

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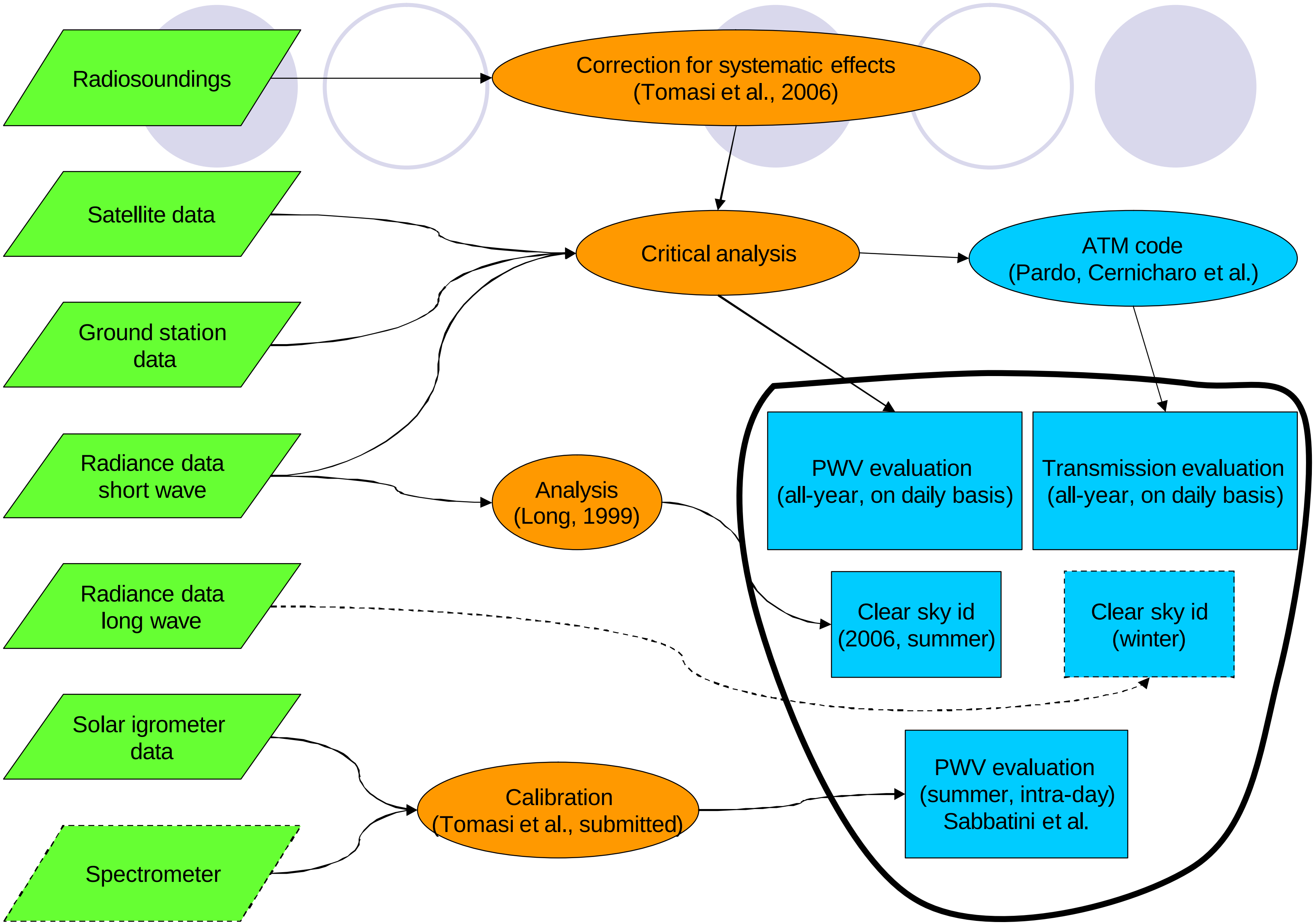


Radiosoundings

Satellite data

Ground station data

Radiance data short wave

Radiance data long wave

Solar igrometer data

Spectrometer

Correction for systematic effects (Tomasi et al., 2006)

Critical analysis

ATM code (Pardo, Cernicharo et al.)

Analysis (Long, 1999)

Calibration (Tomasi et al., submitted)

PWV evaluation (all-year, on daily basis)

Transmission evaluation (all-year, on daily basis)

Clear sky id (2006, summer)

Clear sky id (winter)

PWV evaluation (summer, intra-day) Sabbatini et al.

Next steps for our study

- Cloud coverage detection
  - Percentage of clear sky
  - Cloud type detection
- New atmospheric data
  - LW radiance data: clear sky analysis in winter
- Merge radiosoundings with cloud coverage data
- ISAC sky radiometer data
  - PWV intra-day monitoring (daytime) -> stability
- ISAC LIDAR
  - Cloud detection
  - Ice cristal study (polarization)

Conclusions

- Radiosoundings **data** results:
    - *mm* observations are well assessed
    - Atmospheric *window* at 200 *mm* is open at DomeC
    - PWV value variability over some days is also present
    - Transmission stability (short term) is not assessed (some data from Sabbatini talk)
- Detailed predictions from ATM need model validation for DomeC
    - CASPER is an opportunity
- PWV monitoring: 183 GHz radiometer (?)
- Further critical analysis of radiosounding data is in progress
- Radiance data still to be completely injested in our study
    - It will allow to disentangle between clear and cloudy conditions

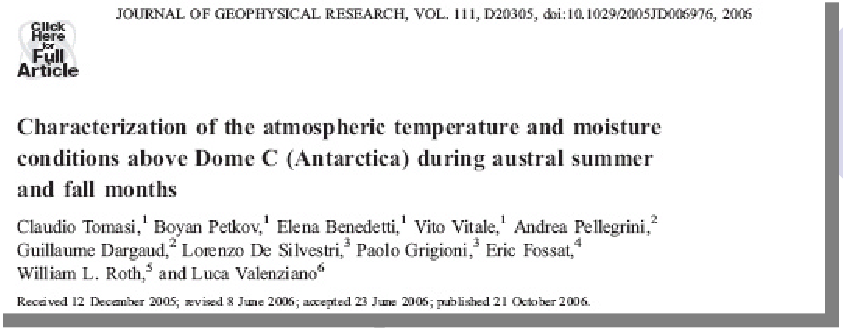
We squeezed meteorology data almost completely.
It is time to start a *real* site testing in the sub-mm range.
Transition from *possible* observations to robust project proposals.

High accuracy radiosoundings data real data!

- Radiosoundings accuracy is reduced at very low temperature (see also Chamberlin, 2001 for South Pole)

- Vaisala sensors used at Dome C
  - RS80-A, RS80-H, RS90,RS92
- Thermocap sensor data corrected for heat exchange effects (Vaisala procedure)
- Barocap sensors corrected for lag effects (Tomasi et al, 2004)
- Humicap sensor raw data are affected by errors (Wang, 2002)
  - Temperature dependence
  - Basic calibration model
  - Sensor aging
  - Chemical contamination
  - Sensor arm heating
  - Ground check
- Lag errors (Miloshevich, 2004)
- RH corrected using a custom procedure (Tomasi et al., 2006)

Systematic effects in radiosoundings



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Characterization of the atmospheric temperature and moisture conditions above Dome C (Antarctica) during austral summer and fall months

Claudio Tomasi,[1] Boyan Petkov,[1] Elena Benedetti,[1] Vito Vitale,[1] Andrea Pellegrini,[2] Guillaume Dargaud,[2] Lorenzo De Silvestri,[3] Paolo Grigioni,[3] Eric Fossat,[4] William L. Roth,[5] and Luca Valenziano[6]

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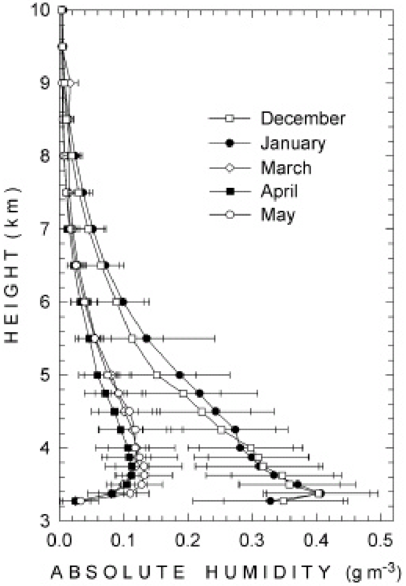


Figure 5. Mean monthly vertical profiles of absolute humidity q (g m^{-3}) obtained from the monthly data sets of q relative to December (open squares), January (solid circles), March (open diamonds), April (solid squares), and May (open circles). The bars represent the standard deviations obtained at some fixed levels, giving a measure of the dispersion of the monthly data.

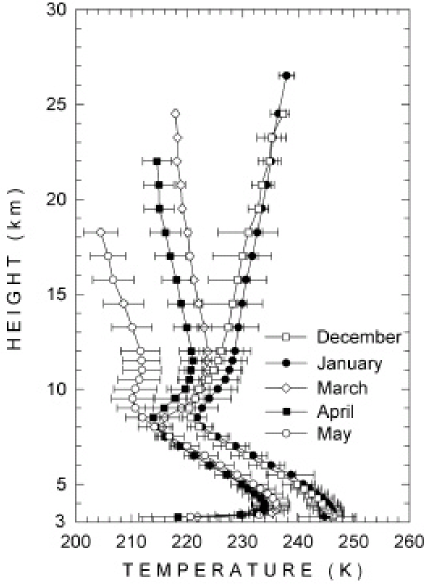
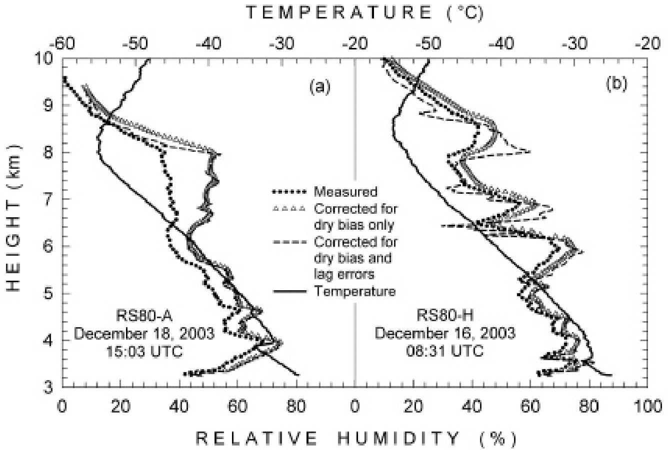
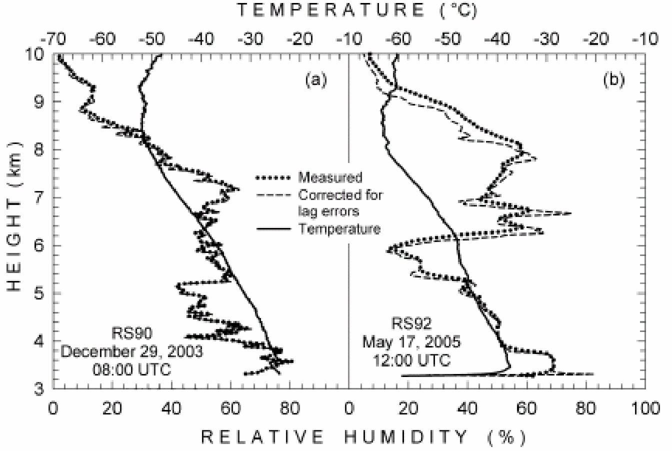
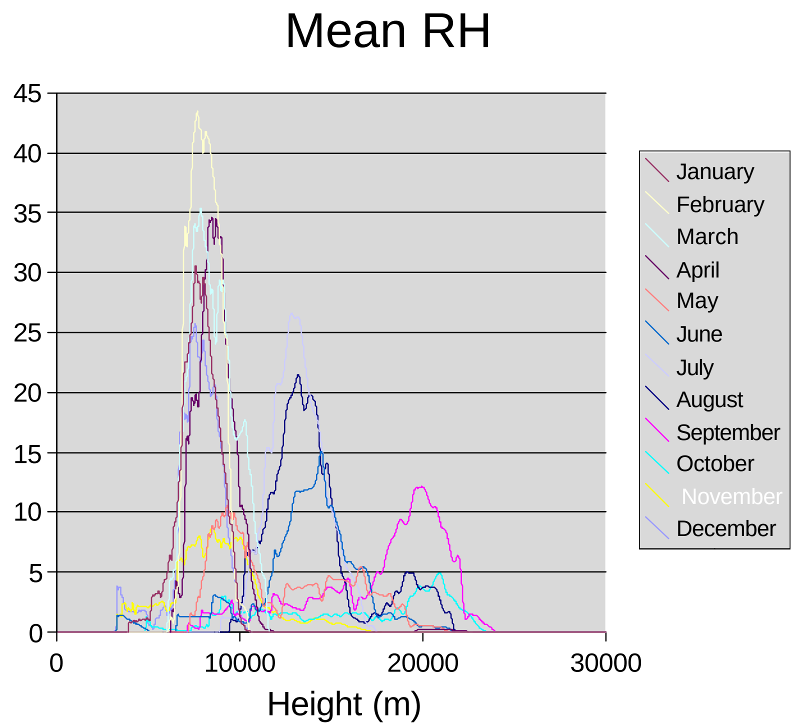


Figure 4. Mean monthly vertical profiles of air temperature T (K) obtained from the monthly data sets relative to December (open squares), January (solid circles), March (open diamonds), April (solid squares), and May (open circles). The bars represent the standard deviations obtained at some fixed levels, giving a measure of the dispersion of the monthly data.





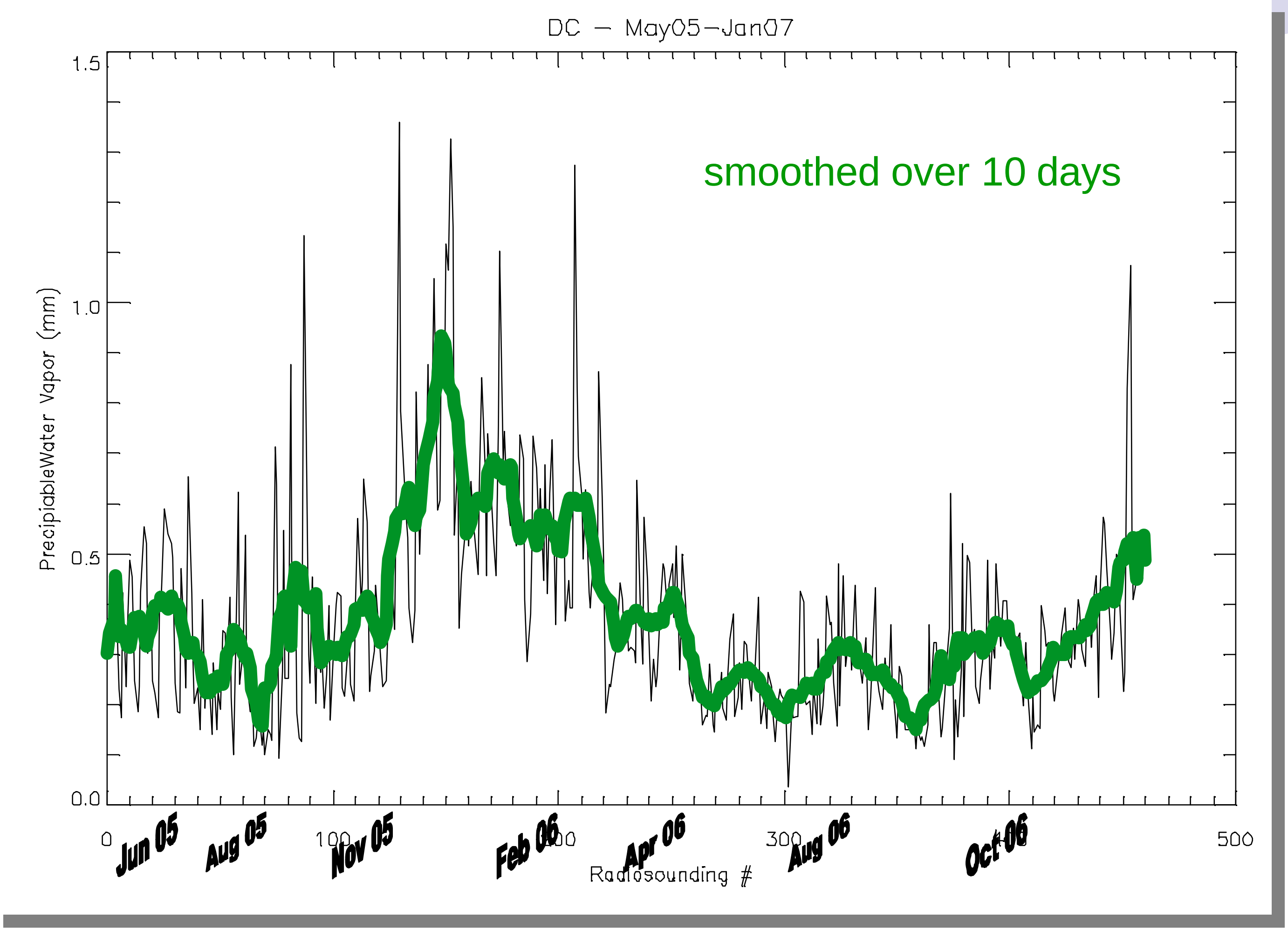
2nd data set



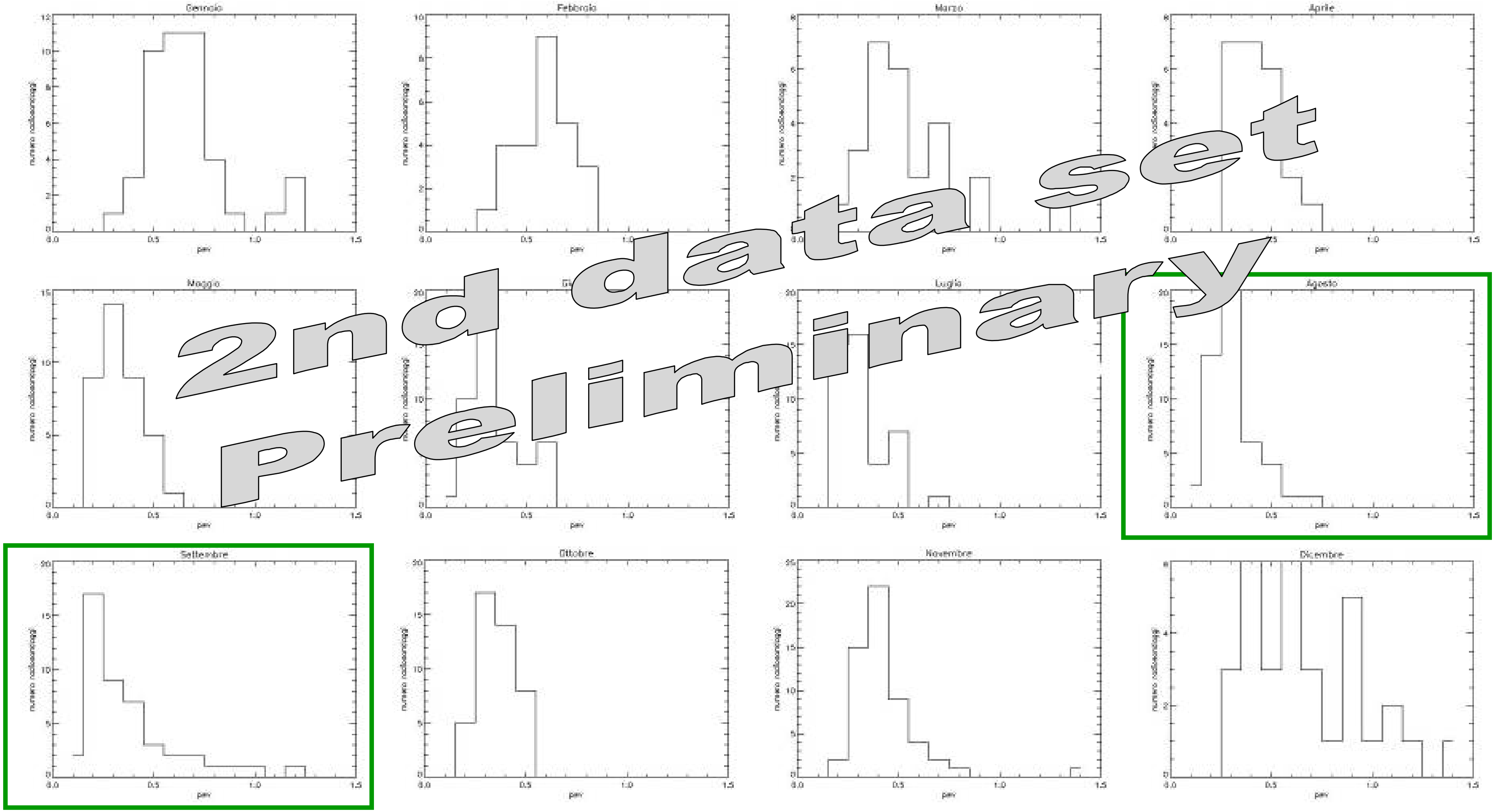
April 2005 – January 2007 - 471

Month	***number of radiosounding***
january	*45*
february	*26*
march	*26*
april	*23*
may	*38*
june	*44*
july	*43*
august	*48*
september	*46*
october	*44*
november	*56*
december	*32*

PWV vs. time

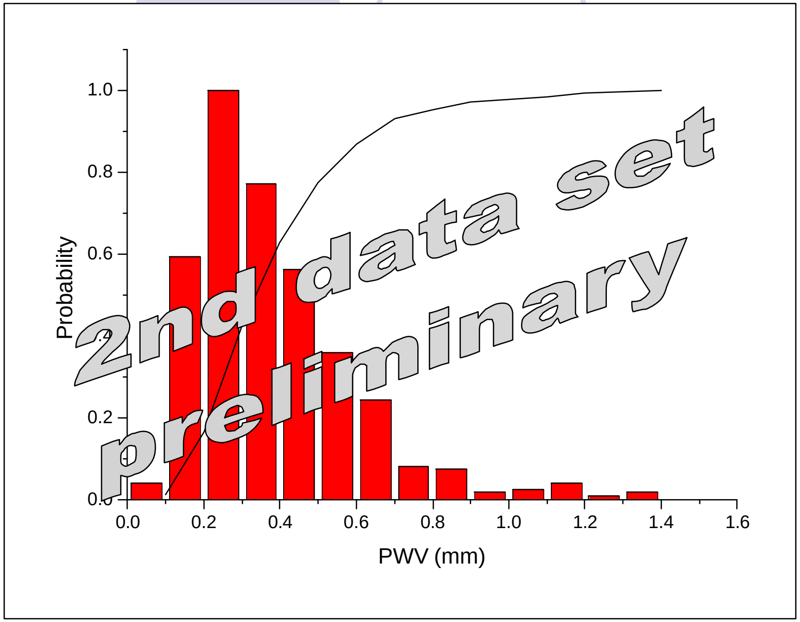

DC — May05–Jan07
smoothed over 10 days
PrecipiableWater Vapor (mm)
1.5
1.0
0.5
0.0
0
100
200
300
400
500
Radiosounding #
Jun 05
Aug 05
Nov 05
Feb 06
Apr 06
Aug 06
Oct 06

Monthly distribution



2nd data set

Preliminary



0.23
0.33
0.48

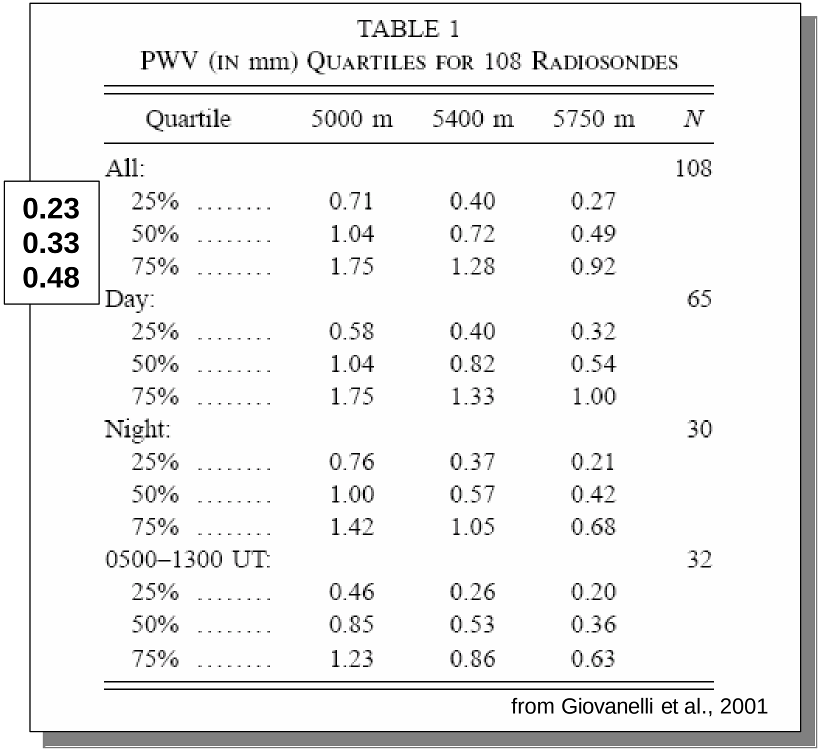
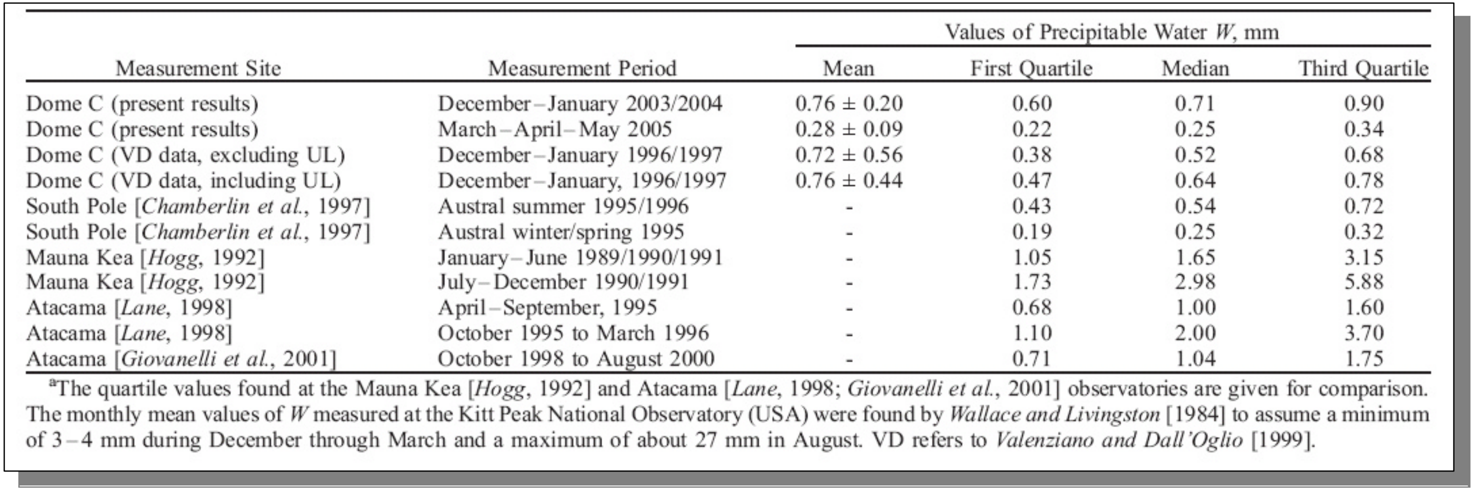


TABLE 1
PWV (IN mm) QUARTILES FOR 108 RADIOSONDES

Quartile	5000 m	5400 m	5750 m	*N*
All:				108
25%	0.71	0.40	0.27	
50%	1.04	0.72	0.49	
75%	1.75	1.28	0.92	
Day:				65
25%	0.58	0.40	0.32	
50%	1.04	0.82	0.54	
75%	1.75	1.33	1.00	
Night:				30
25%	0.76	0.37	0.21	
50%	1.00	0.57	0.42	
75%	1.42	1.05	0.68	
0500–1300 UT:				32
25%	0.46	0.26	0.20	
50%	0.85	0.53	0.36	
75%	1.23	0.86	0.63	

from Giovanelli et al., 2001



		Values of Precipitable Water *W*, mm			
Measurement Site	Measurement Period	Mean	First Quartile	Median	Third Quartile
Dome C (present results)	December–January 2003/2004	0.76 ± 0.20	0.60	0.71	0.90
Dome C (present results)	March–April–May 2005	0.28 ± 0.09	0.22	0.25	0.34
Dome C (VD data, excluding UL)	December–January 1996/1997	0.72 ± 0.56	0.38	0.52	0.68
Dome C (VD data, including UL)	December–January, 1996/1997	0.76 ± 0.44	0.47	0.64	0.78
South Pole [*Chamberlin et al.*, 1997]	Austral summer 1995/1996	-	0.43	0.54	0.72
South Pole [*Chamberlin et al.*, 1997]	Austral winter/spring 1995	-	0.19	0.25	0.32
Mauna Kea [*Hogg*, 1992]	January–June 1989/1990/1991	-	1.05	1.65	3.15
Mauna Kea [*Hogg*, 1992]	July–December 1990/1991	-	1.73	2.98	5.88
Atacama [*Lane*, 1998]	April–September, 1995	-	0.68	1.00	1.60
Atacama [*Lane*, 1998]	October 1995 to March 1996	-	1.10	2.00	3.70
Atacama [*Giovanelli et al.*, 2001]	October 1998 to August 2000	-	0.71	1.04	1.75

[a] The quartile values found at the Mauna Kea [*Hogg*, 1992] and Atacama [*Lane*, 1998; *Giovanelli et al.*, 2001] observatories are given for comparison. The monthly mean values of *W* measured at the Kitt Peak National Observatory (USA) were found by *Wallace and Livingston* [1984] to assume a minimum of 3–4 mm during December through March and a maximum of about 27 mm in August. VD refers to *Valenziano and Dall'Oglio* [1999].

Radiosounding data

(Dec. 2003, Jan. 2003-2004, Apr.-Mar.2005, May 2005)

+ Correction procedures

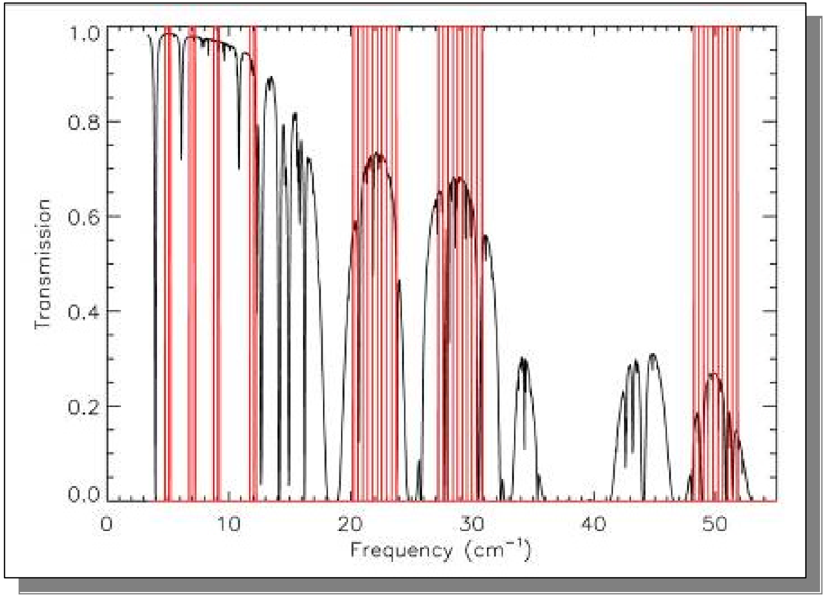
(C. Tomasi et al. 2006)

+ Derived synthetic atmospheric emission spectra

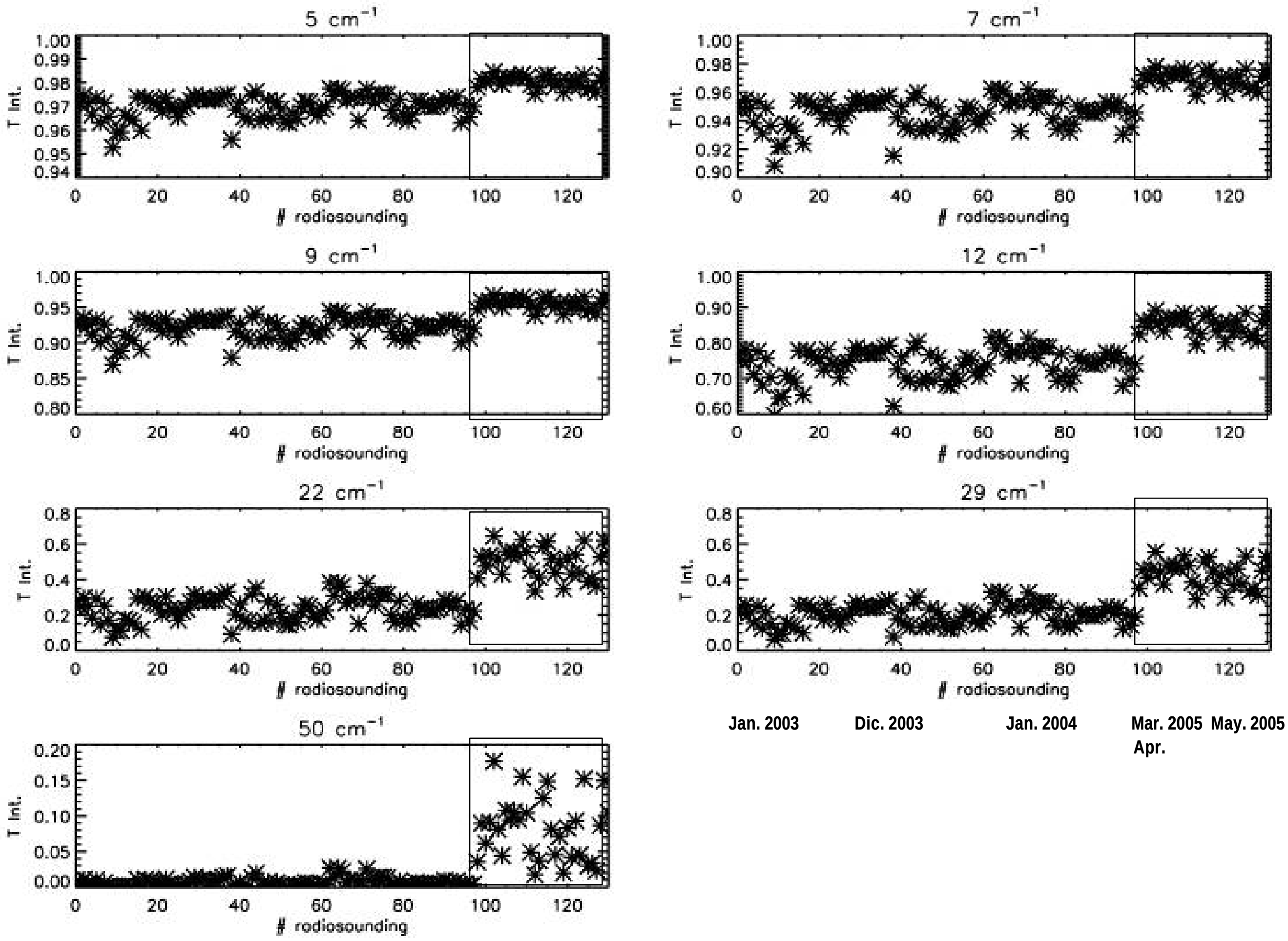
(J. Pardo et al., 2001, ATM)

= Estimated mm/sub-mm atmospherical performances @ astrophysical bands

Freq (GHz)	wave# (cm^{-1})	BW (%)
150	5	10
210	7	7
270	9	5
360	12	4
660	22	16
870	29	12
1500	50	7



In band Transmission as estimated by simulated ATM-spectra -1st data set



450µm

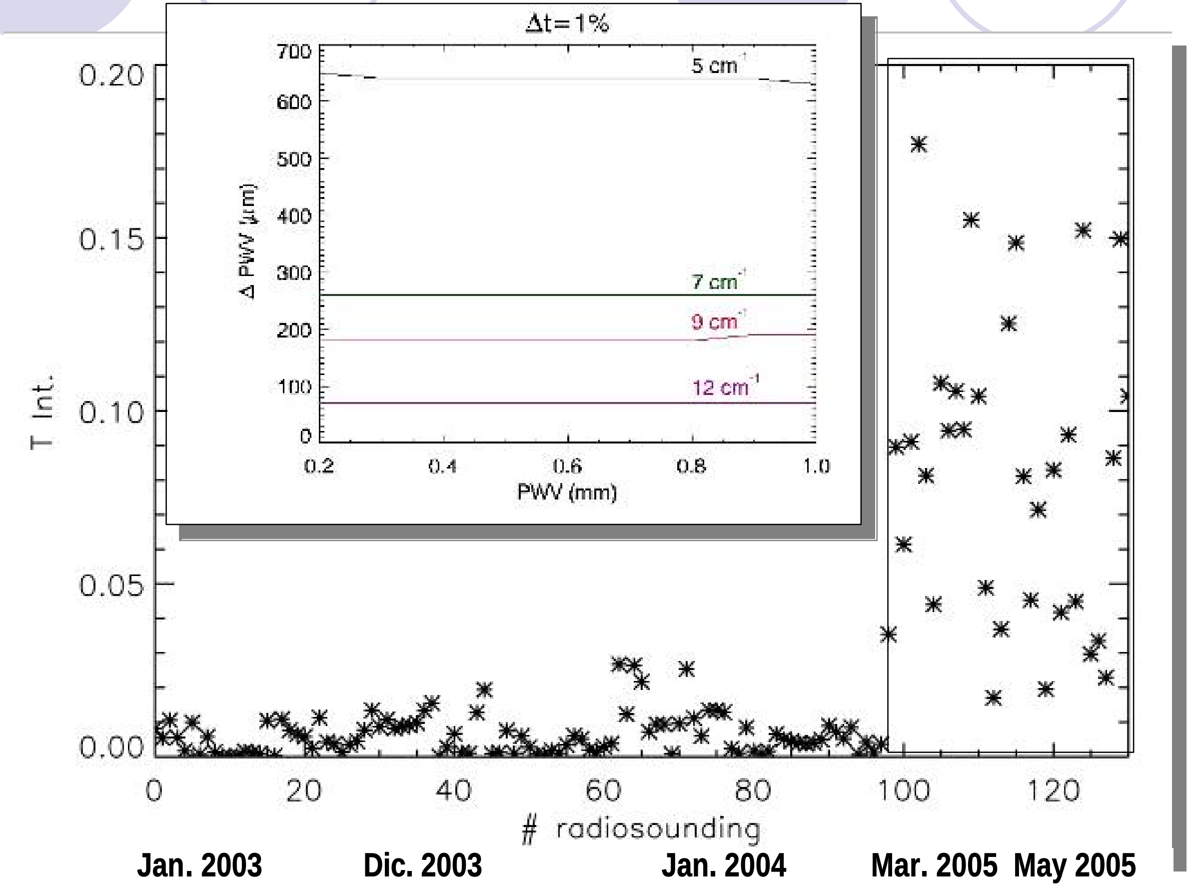
350µm

200µm

Jan. 2003 **Dic. 2003** **Jan. 2004** **Mar. 2005** **May. 2005**
Apr.

Jan. 2003 **Dic. 2003** **Jan. 2004** **Mar. 2005** **May. 2005**
Apr.

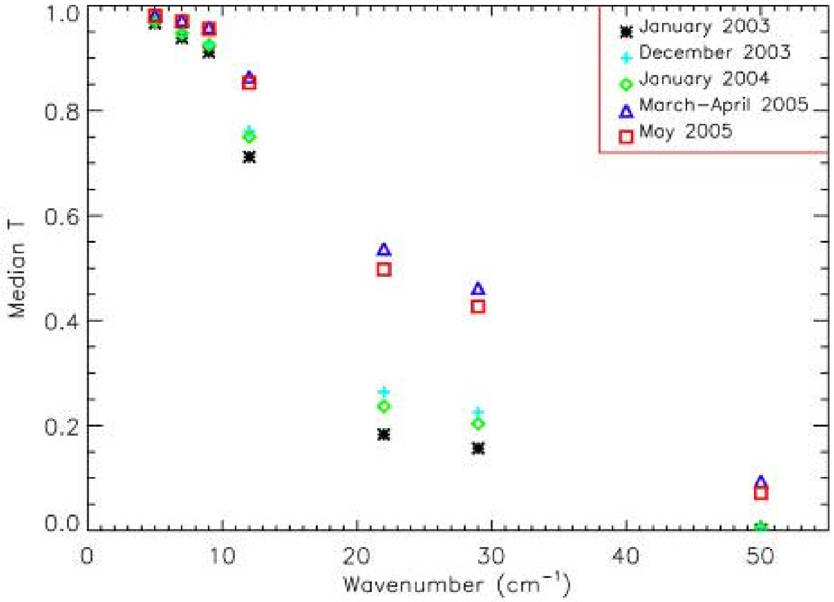
200μm/1.5 THz-window



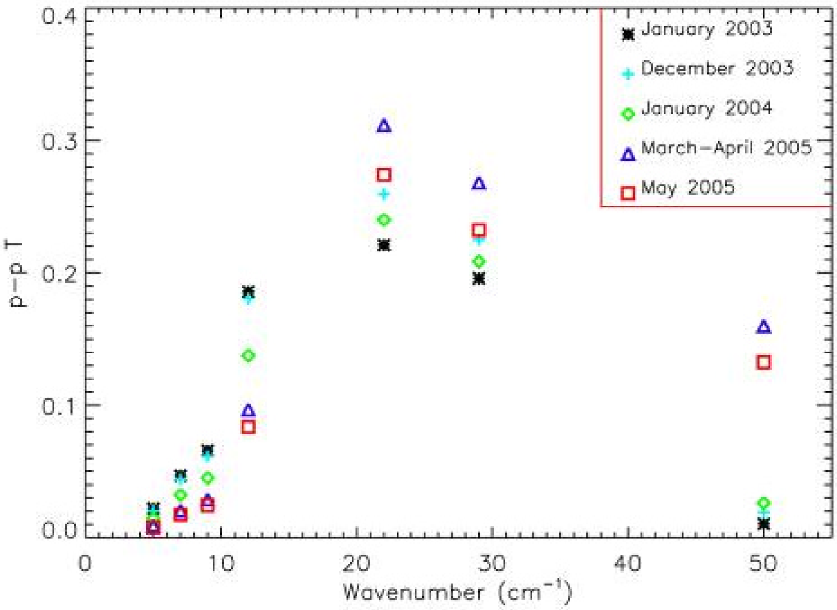
Jan. 2003 **Dic. 2003** **Jan. 2004** **Mar. 2005 May 2005**

Apr.

Average in band Transmissions and rms vs. wave#s



Peak-to-Peak *vs* wave#s



Low freqs @ fall : high mean transmission – low fluctuations
High freqs @ fall : low mean transmission – high fluctuations

CASPER

***C**oncordia **A**tmospheric **SP**ectroscopy of **E**mitted **R**adiation*

Italian & International Collaborations @ PNRA 2003 proposal:

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+ Universita' di Milano, INAF/IASF-sezione di Milano, INAF-Osservatorio Astronomico di Trieste

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School of Physics and Astronomy - University of Wales, Cardiff, UK
J.R. Pardo, J. Cernicharo
Inst. Estructura de la Materia, Dpto. Astrofisica Molecular e IR, Madrid, Spain

CASPER's peculiarities & goals:

- low resolution spectra of atmospheric emission between 3 mm and 180 micron (resolving power: 15<R<275) producing an estimate of transmission value within 1%, adeguate for accurate broad-band photometric observations

  Alternative approach: transmission measurements in band by observations of known calibrated sources (probs: source spectra, visibility, ..) or tau measurements by skydips (prob: loosing obs-time)

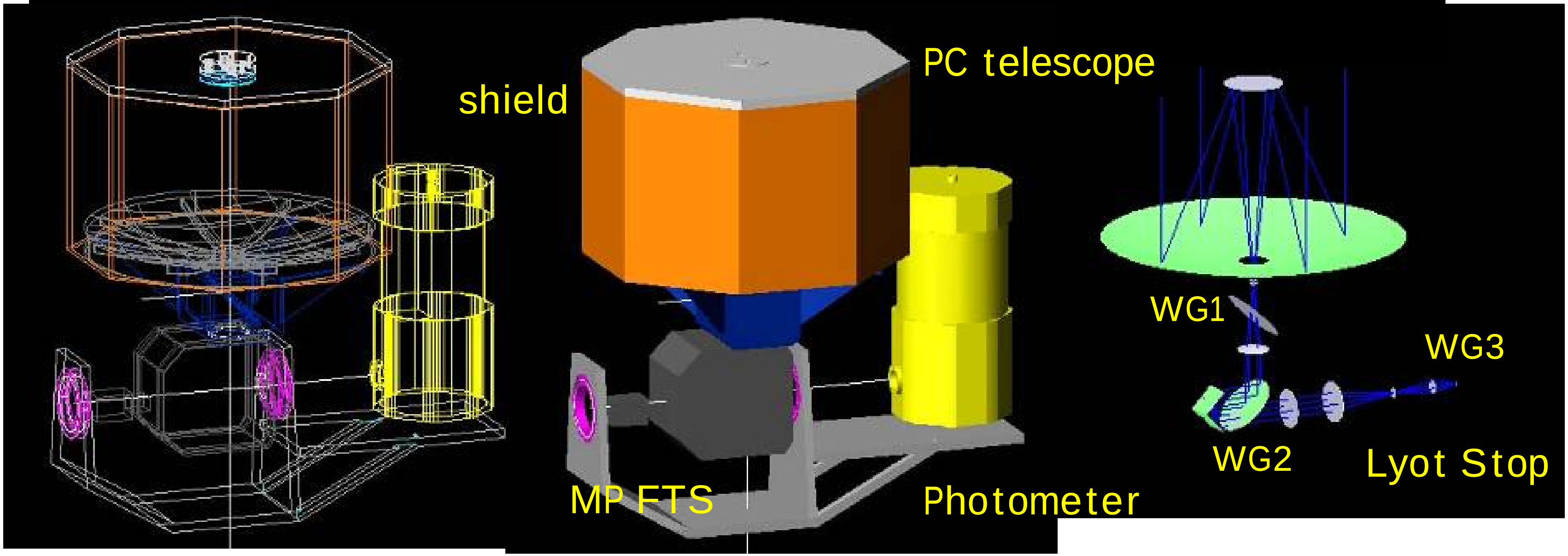
- wide frequency coverage allowing good estimate of N_{H_2O} and continuum opacity ($\nu_{max}/\nu_{min}=3$) (see Pardo et al.)

- optimization of observing procedures for FIR/mm telescopes at Dome C (hereafter master telescope) avoiding observational time losing with skydips and permitting the necessary atmospheric corrections to produce accurate calibrations towards known sources

- pointing system for co-allignment with master telescope f.o.v exploring in this way the same atmospheric path

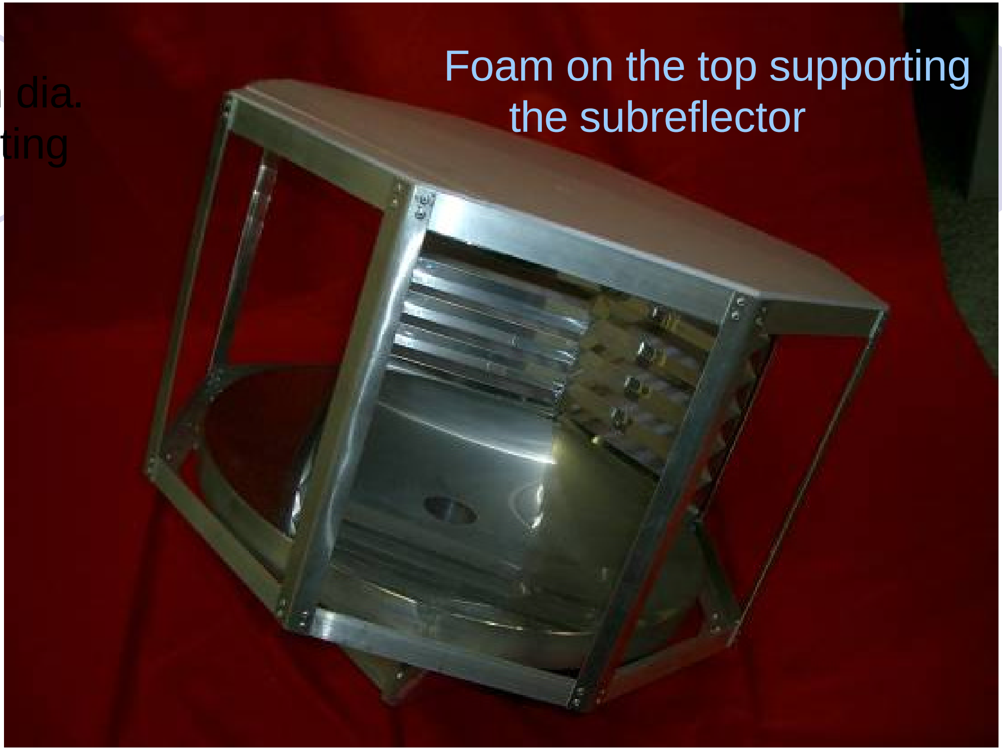
The spectrometer is based on 4 main subsystems:

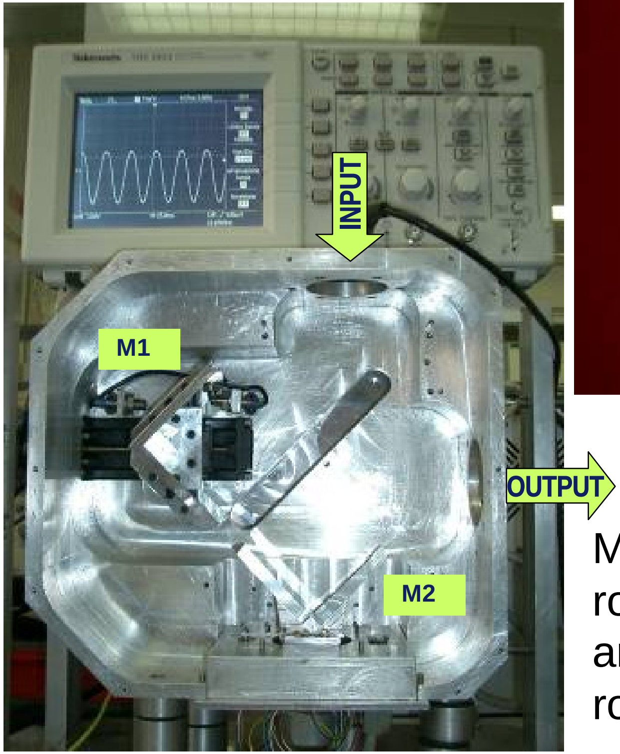
I. Martin-Puplett Fourier Trasform Spectrometer enriched by a fast scan & phase modulator
II. Sky radiation collector (Pressman-Camichel 62-cm in dia. telescope) with altaz mount
III. He^4/N$_2$ cryostat with detectors cooled down to He$_L$ @ 0.3K
IV. Acquisition system, data handling and pointing control



CAD: S. De Gregori

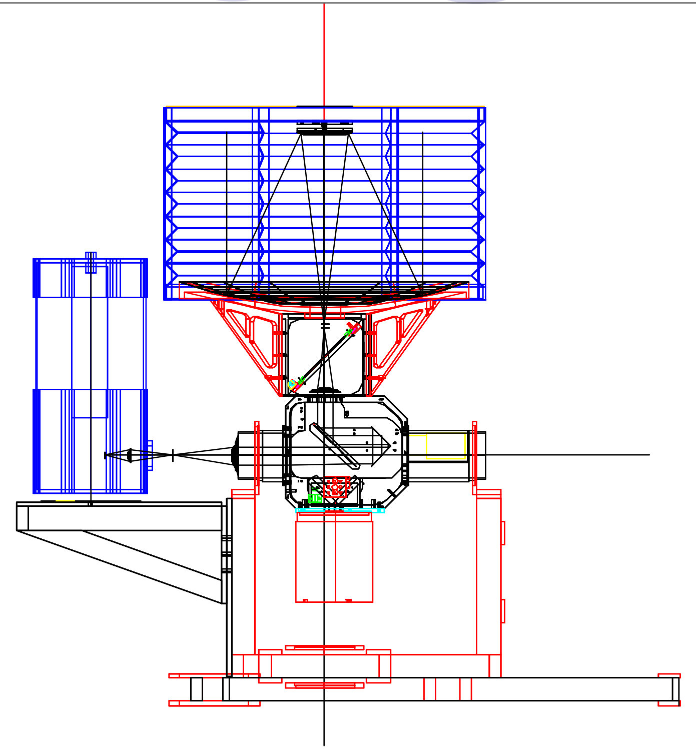
Pressman-Camichel 62-cm in dia. telescope shielded with reflecting vanes
(only 2 panels in the photo)


Foam on the top supporting the subreflector



MP interferometer with:
roof mirror on the left (M1) for fast scan + step & integrate
and
roof mirror on the bottom (M2) as phase modulator

CASPER2 first ligth on July 2006 at MITO



CASPER