



Radiative Heating in Underexplored Bands Campaign (RHUBC-II) in Chile

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¹ University of Wisconsin – Madison

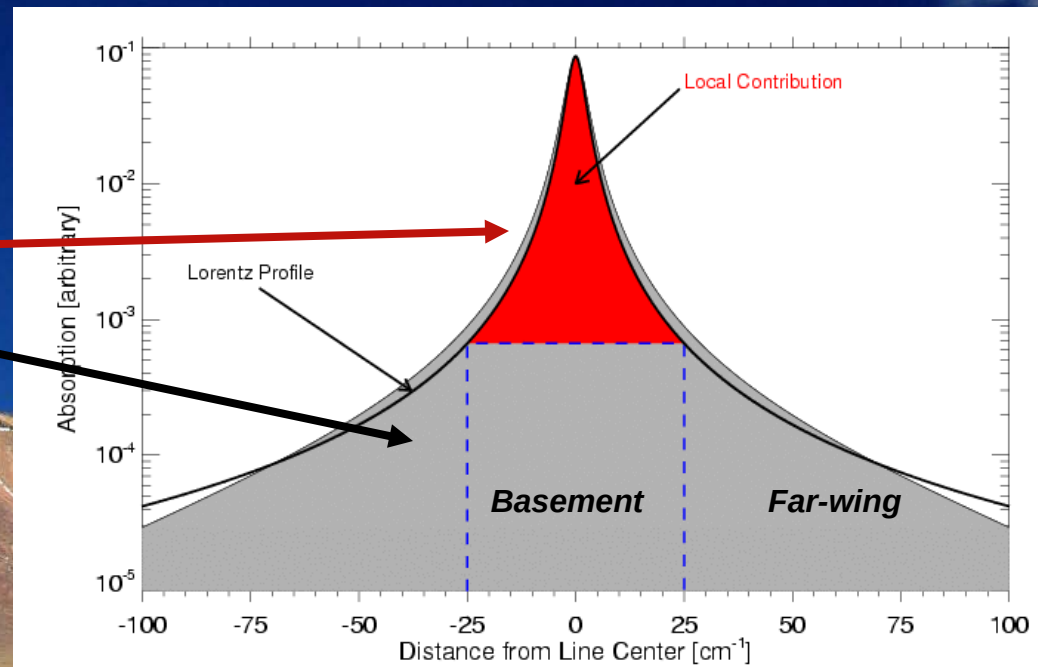
² Atmospheric and Environmental Research, Inc.



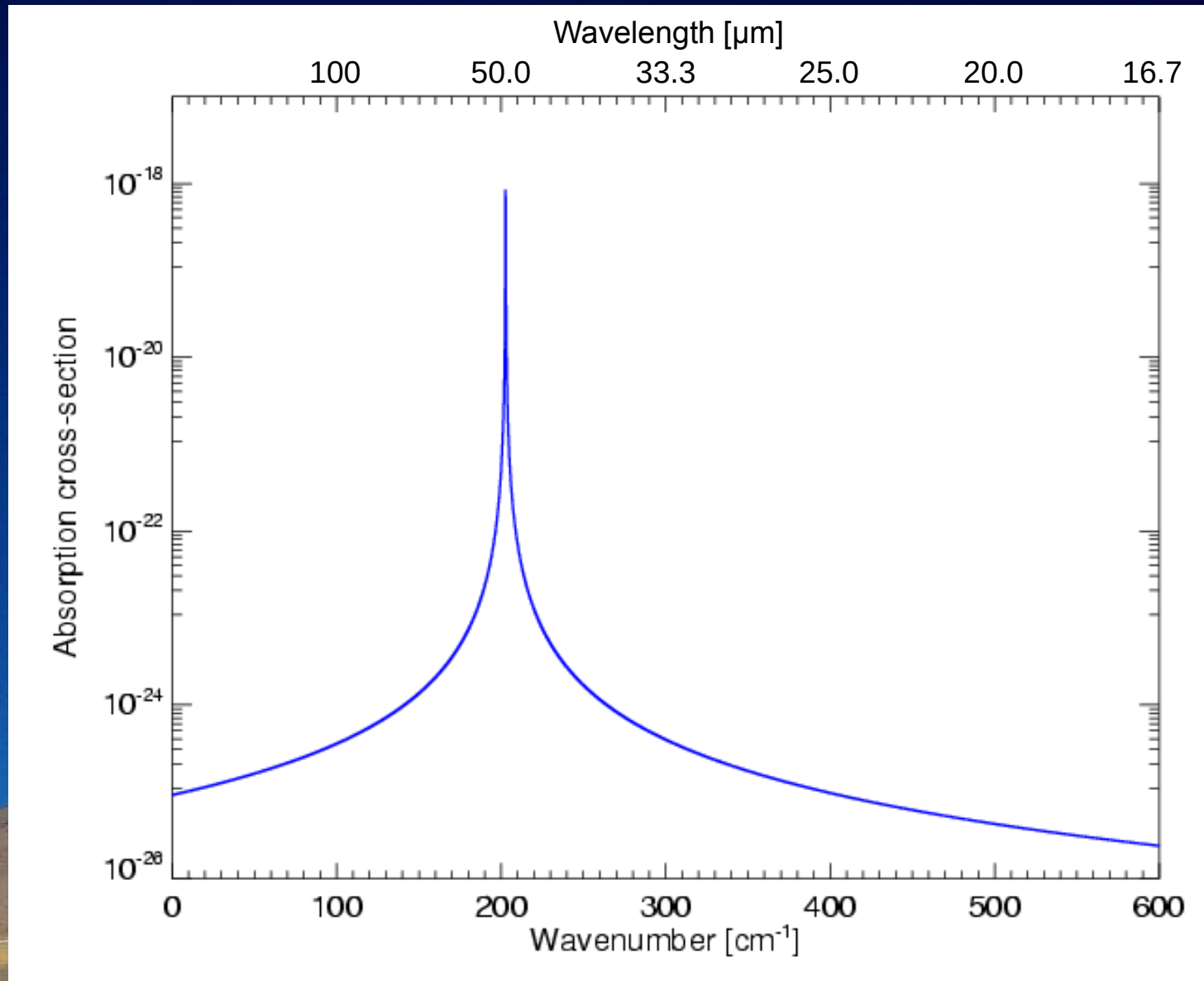
RHUBC-II Breakout Session
ASR 1st Annual Science Team Meeting
Bethesda, Maryland
15 March 2010

What is the Water Vapor Continuum?

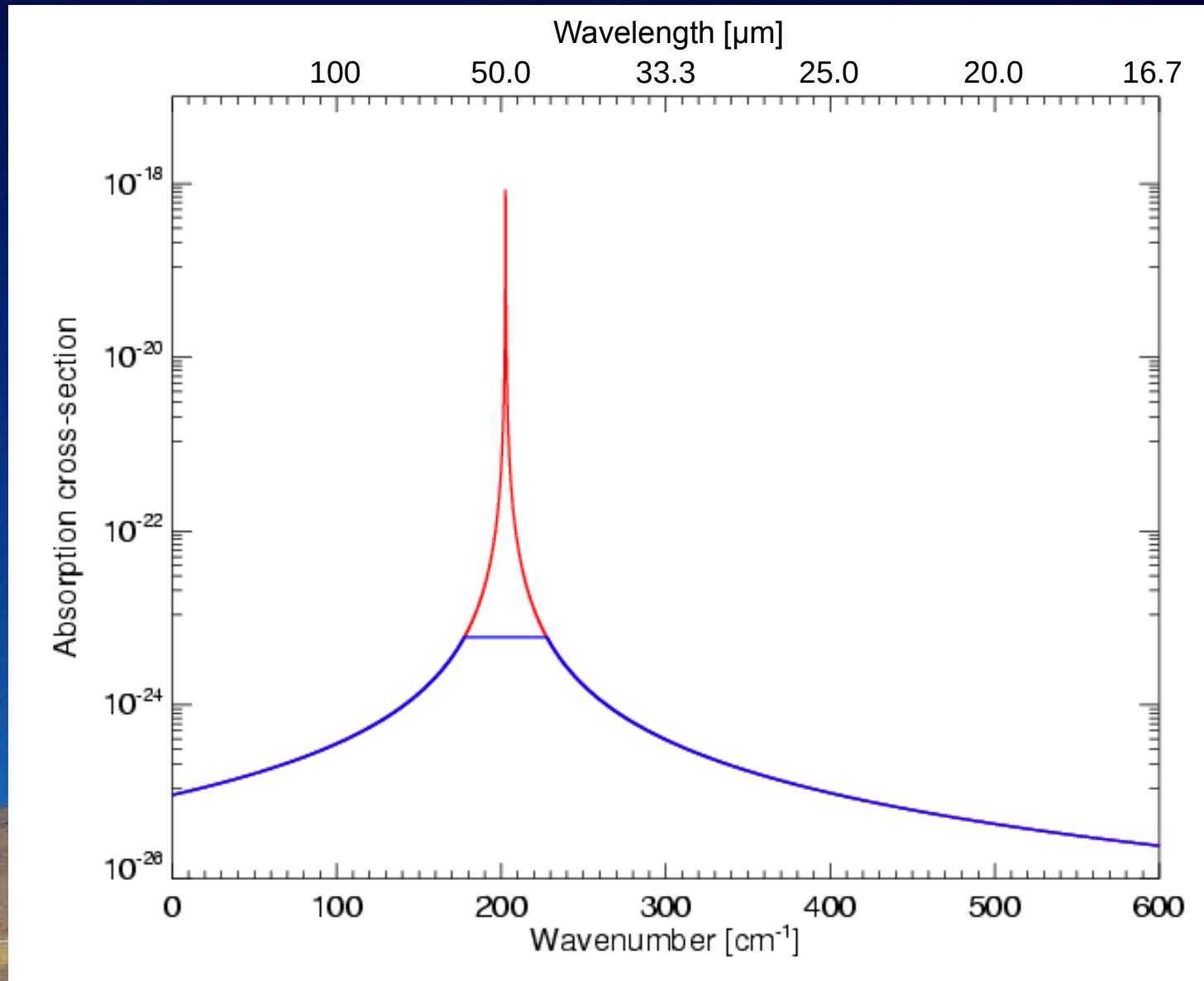
- Computing the radiative contribution for a given molecule requires that the shape of the absorption line is well-known
- The H₂O line shape is not well-known
 - Assuming a Lorentzian line shape (impact approximation) grossly over-estimates the radiative contribution in the wings
- Current state-of-art parameterizations treats the contribution from each H₂O line as two components:
 - Local contribution
 - Continuum
- H₂O continuum models are semi-empirical fits to lab and atmospheric data



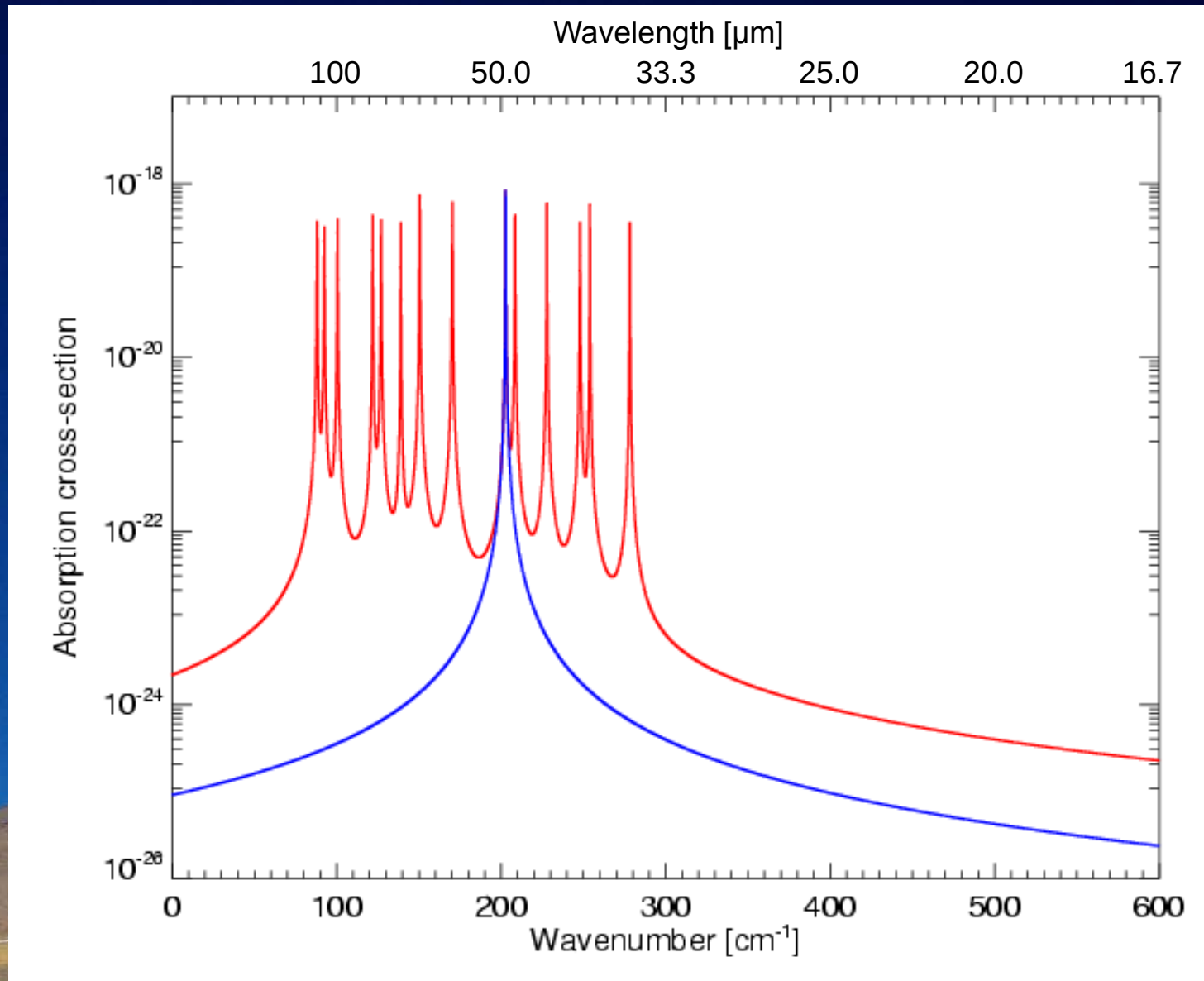
Water Vapor Continuum Tutorial (1)



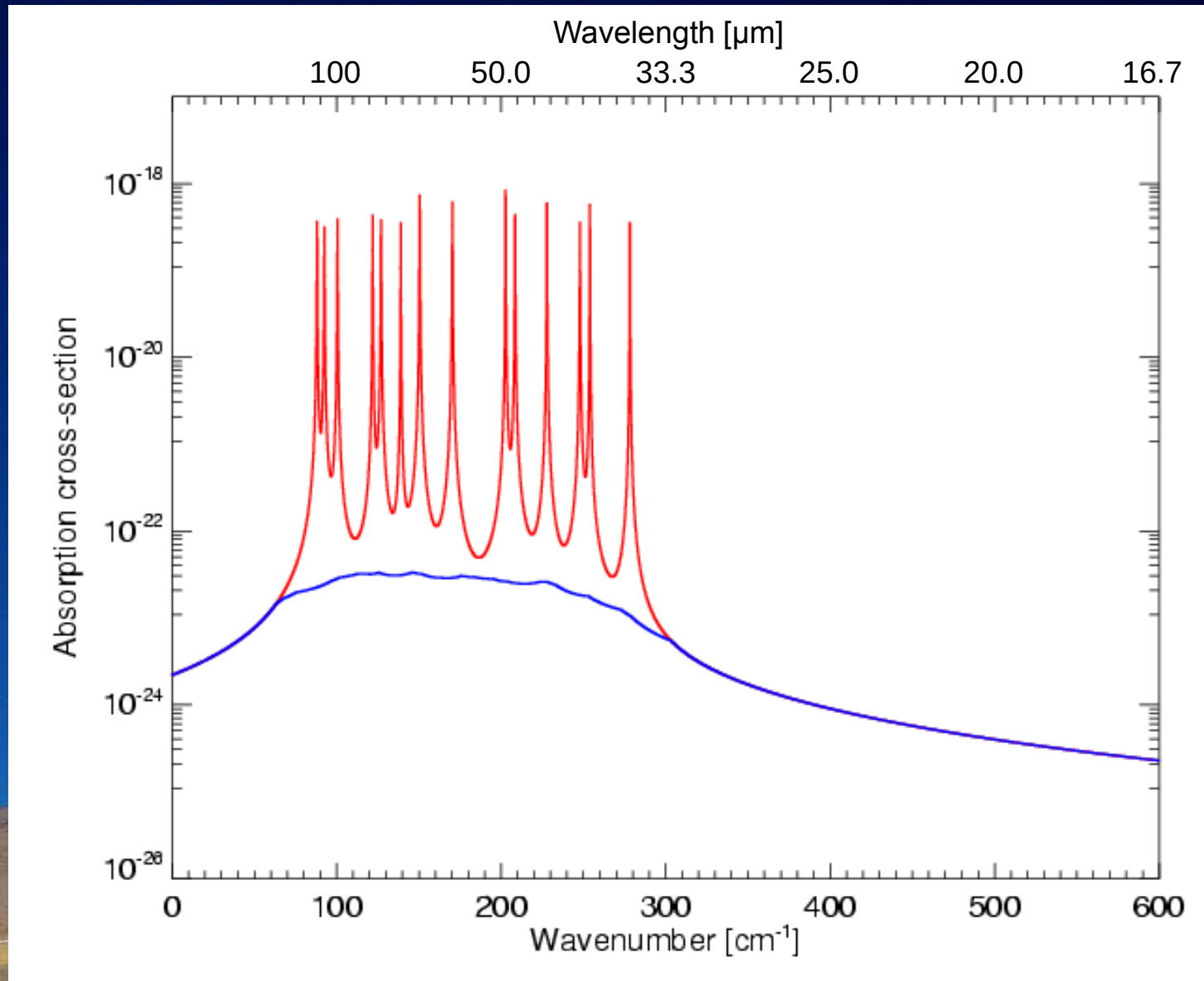
Water Vapor Continuum Tutorial (2)



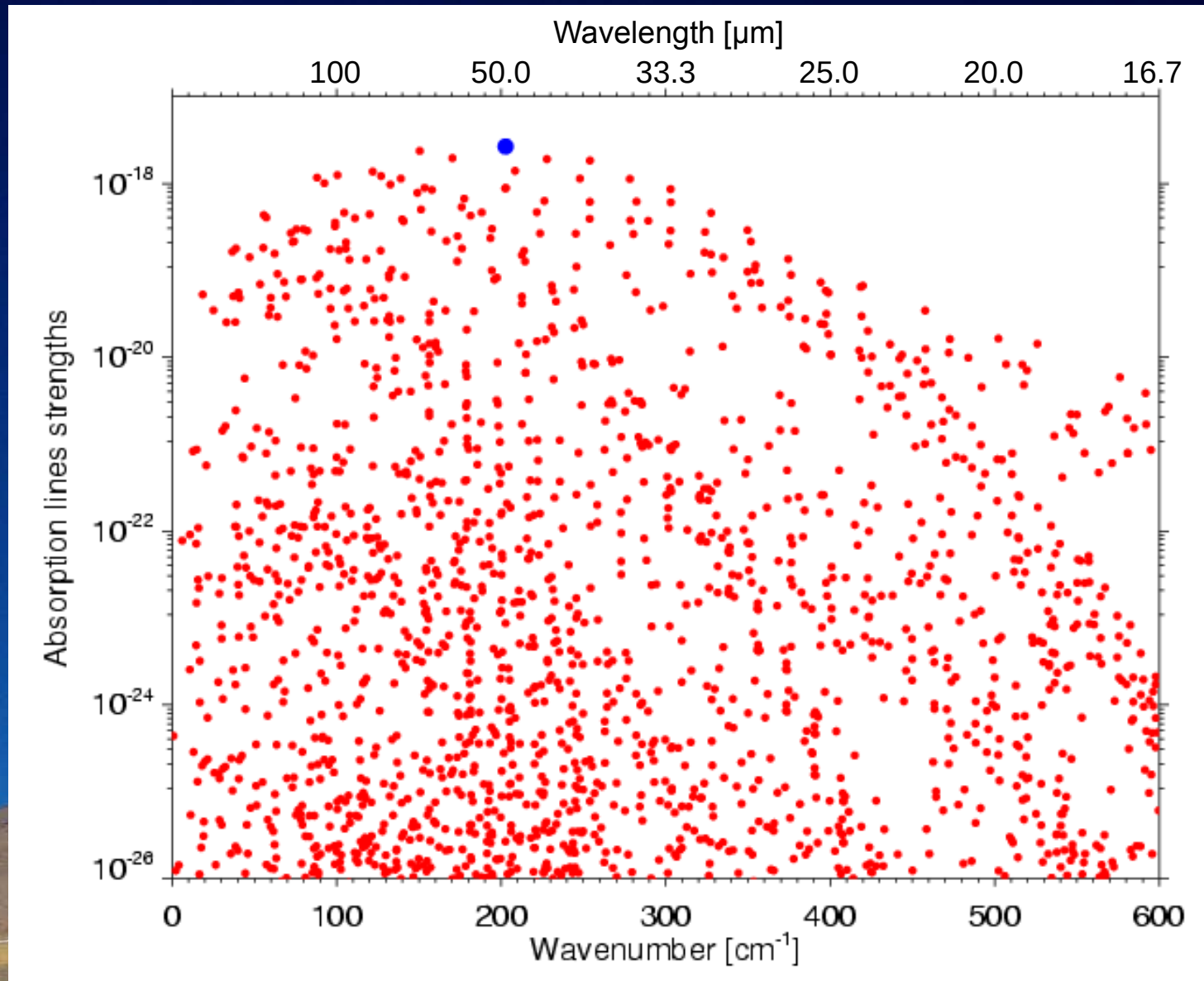
Water Vapor Continuum Tutorial (3)



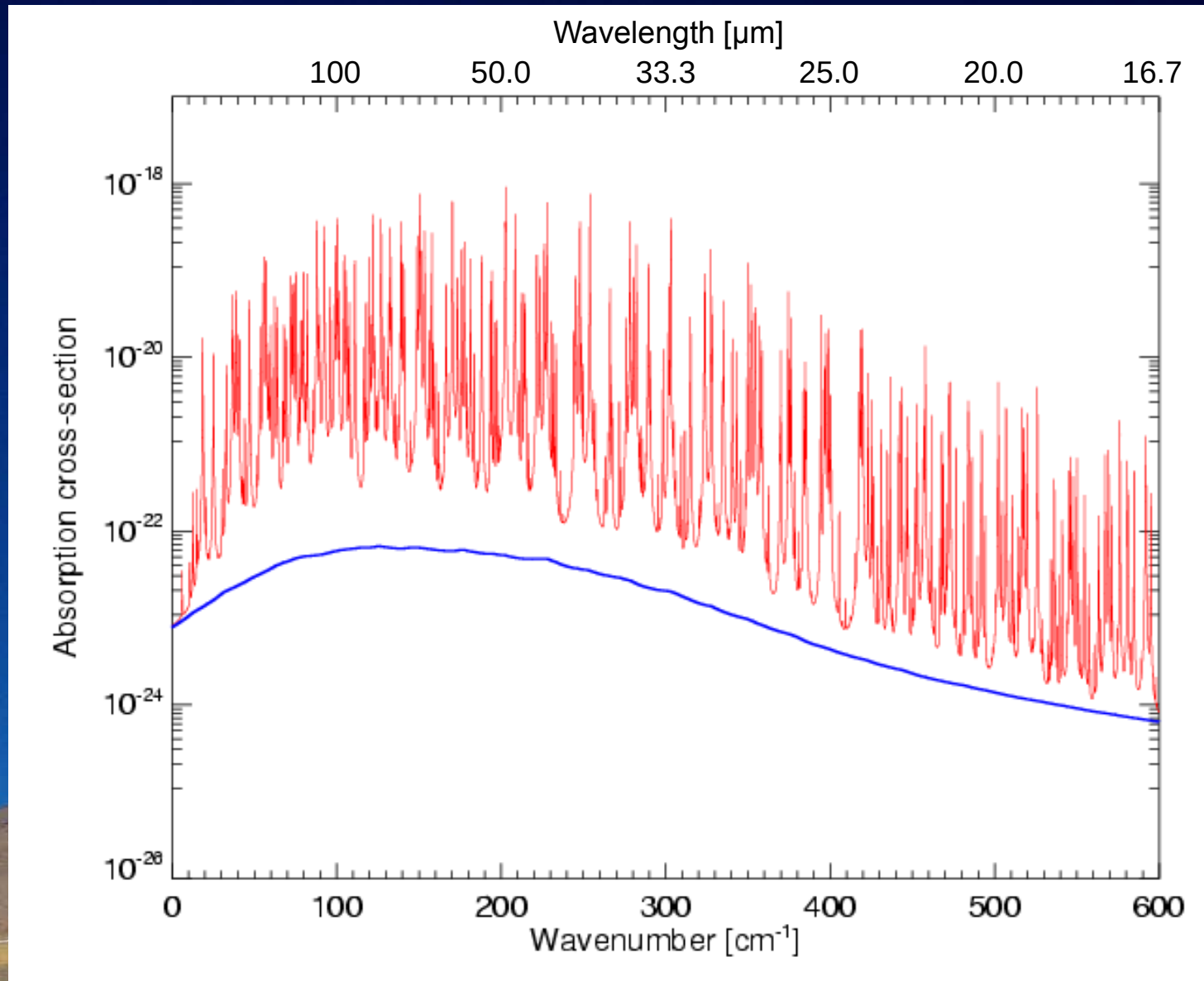
Water Vapor Continuum Tutorial (4)



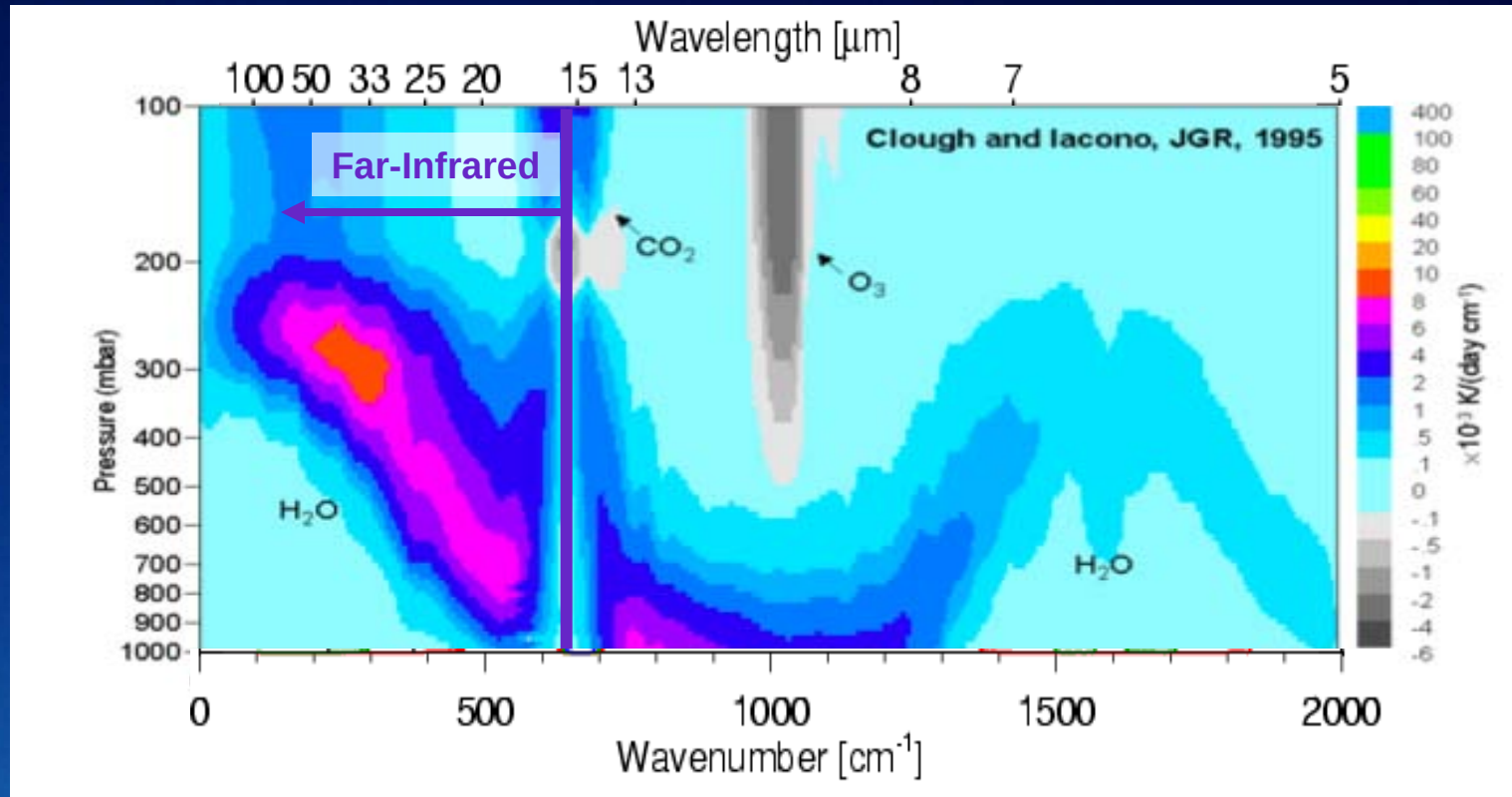
Water Vapor Continuum Tutorial (5)



Water Vapor Continuum Tutorial (6)



Typical Spectral Heating Rate Profiles in the Infrared



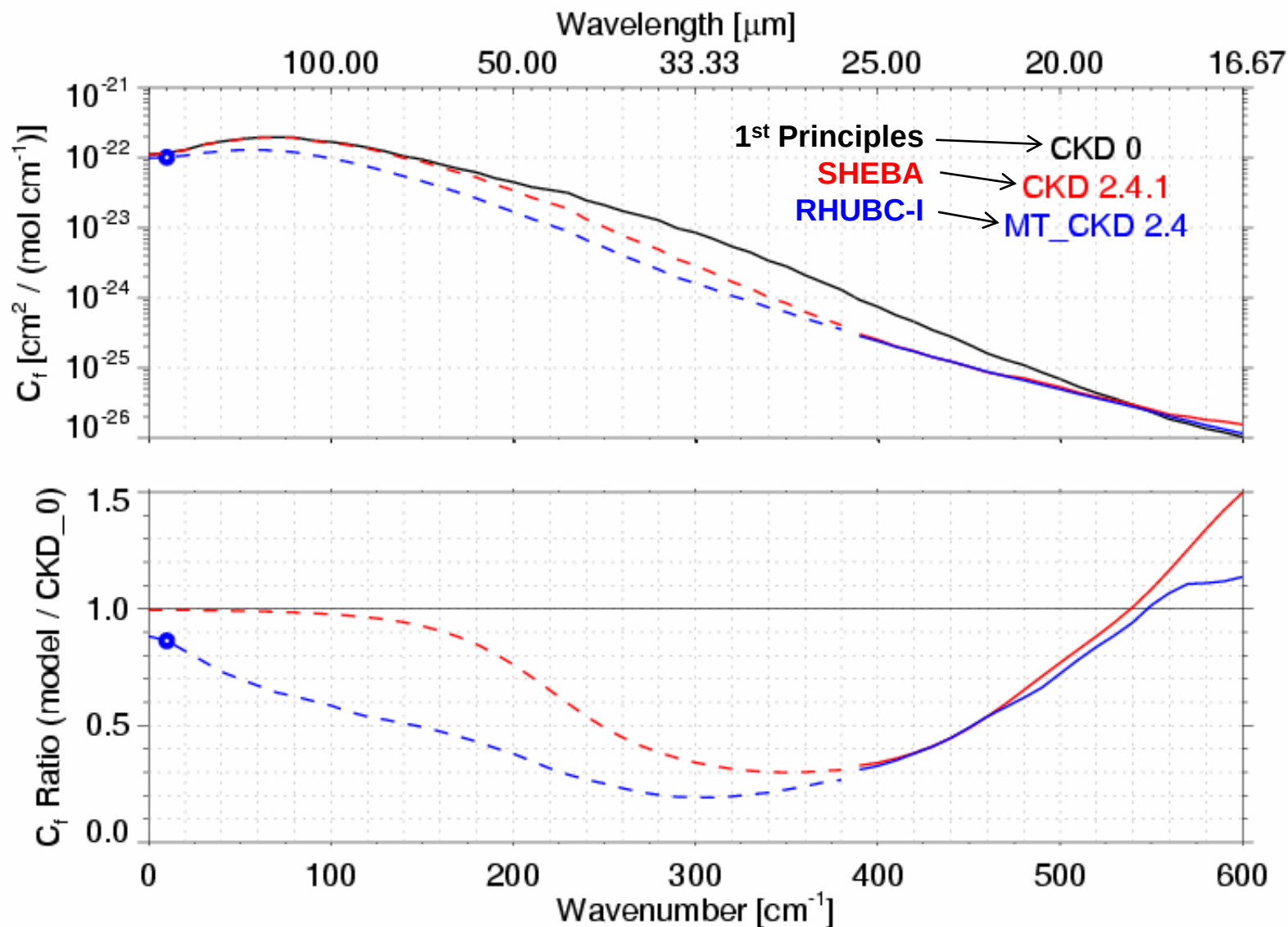
Cooling

Warming

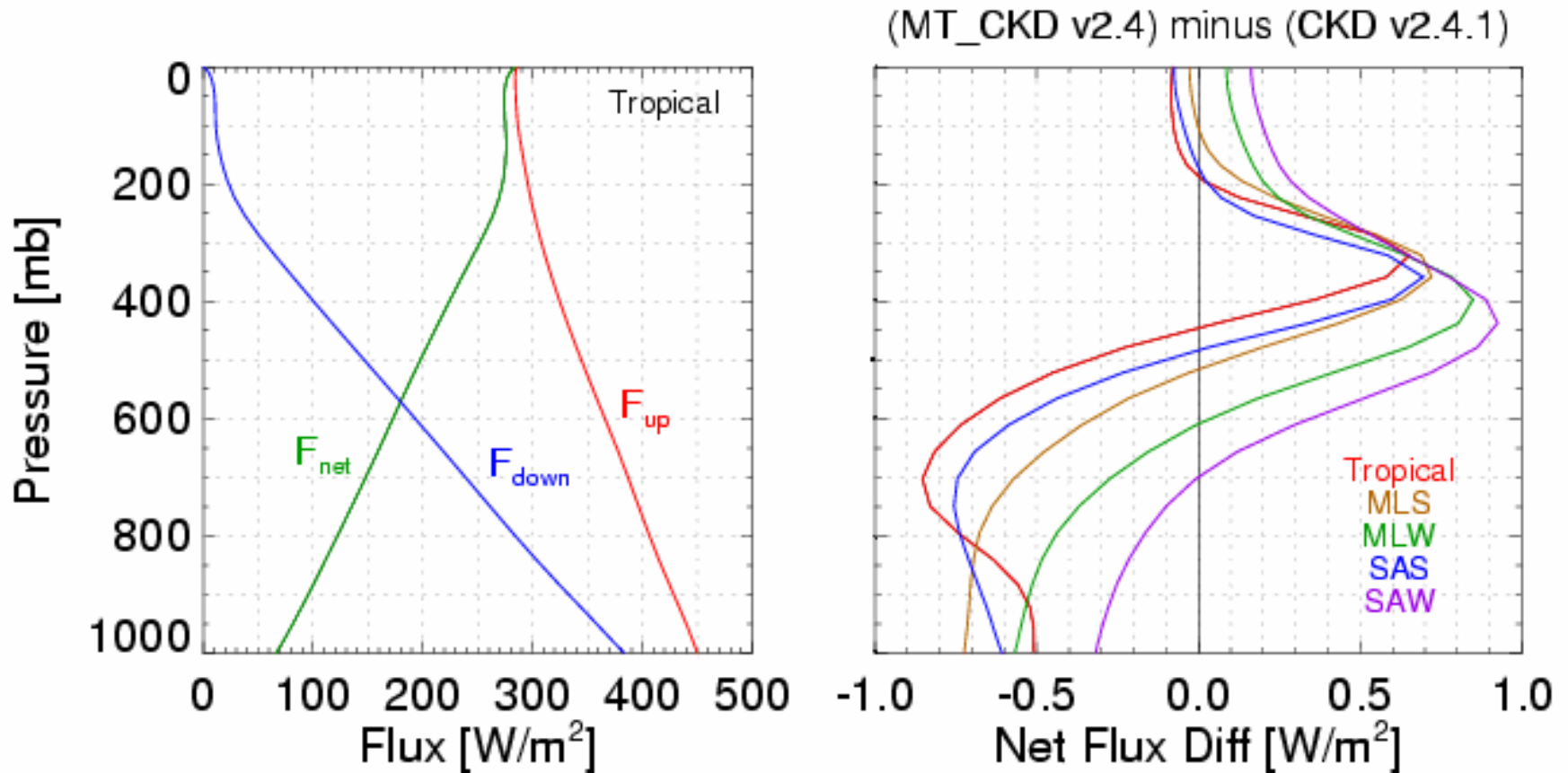
$$\frac{dT}{dt} = \frac{-1}{\rho C_p} \frac{dF_{net}}{dz}$$

- Spectral line absorption by different species
- Vertical concentration and gradient of absorbers
- T-dependence of the Planck function

Uncertainty in the WV Cntnm in Far-IR



Impact on Net Flux Profiles



This translates into a very important (i.e., huge!) difference in radiative heating rates!

RHUBC Details

- RHUBC-I
 - ARM North Slope of Alaska Site, Barrow, AK (71°N, 157°E, 8 m MSL)
 - February - March 2007, 70 radiosondes launched
 - Minimum PWV: 0.95 mm (observed)
 - 2 far-IR / IR interferometers
 - 3 sub-millimeter radiometers for PWV observations
 - Lidar for cirrus detection
- RHUBC-II
 - Cerro Toco, Chile (23°S, 68°E, 5340 m MSL)
 - August - October 2009, 144 radiosondes were launched
 - Minimum PWV: ~0.2 mm
 - 3 far-IR / IR interferometers
 - 1 sub-millimeter radiometer for PWV
 - 1 sub-millimeter FTS
 - 1 near-IR FTS
 - High-spectral resolution from 1.0 μm to 3000 μm !
 - Lidar for cirrus detection

Additional support from:

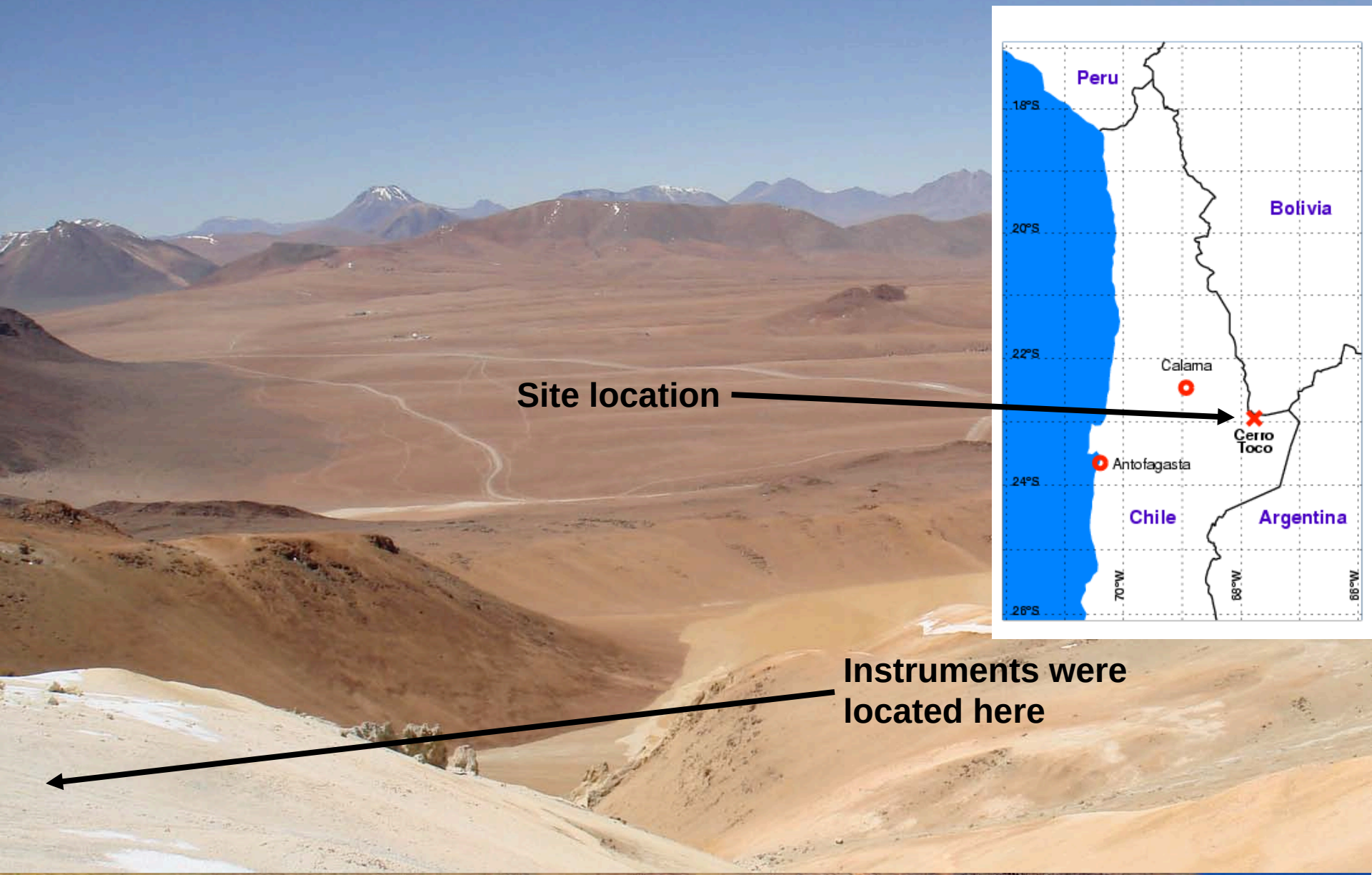
NASA

Italian Research Foundation

Smithsonian

BAMS paper accepted

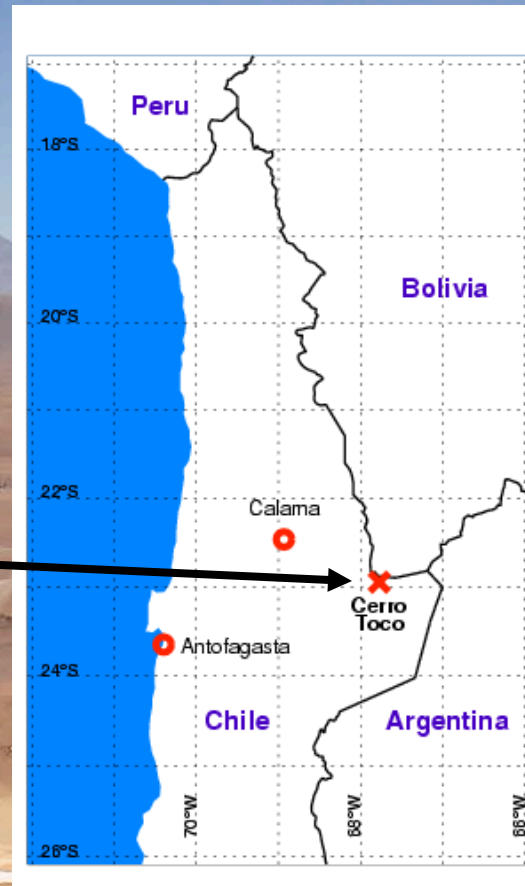
View from Cerro Toco Location



Site location



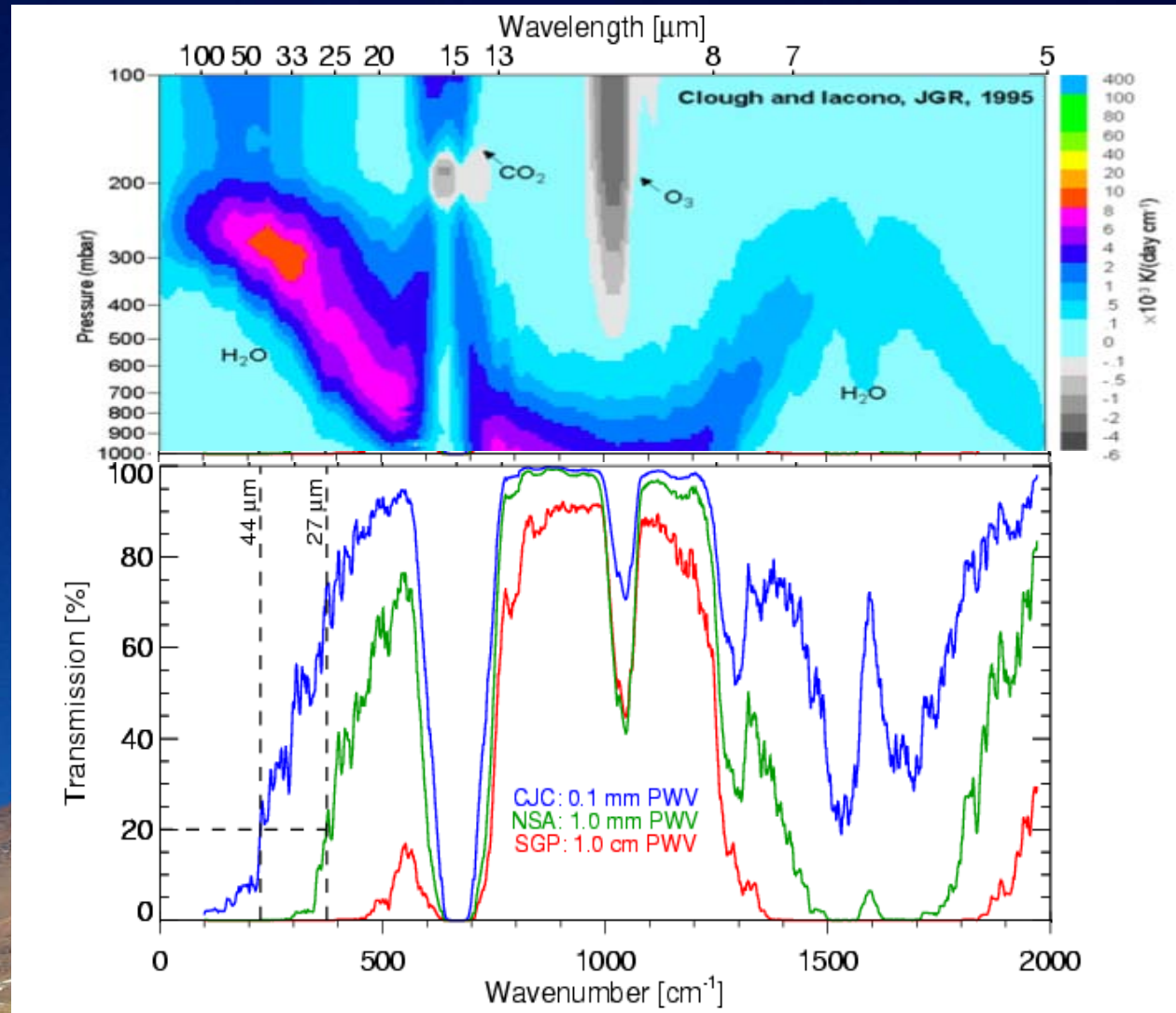
Instruments were
located here



RHUBC-II Field Site



Transmission in the Infrared



Challenges

- Export issue with AERI component
- Chilean gov'n't request at the 23rd hour
- Local contractor issues
- Unheard of weather (twice!)
- “Speed of Chile”
- Generator problems
- Instruments not behaving
- Oxygen impacts
- Nonetheless, good data was collected!



Radiosondes



AERI



LN₂ dewar

New insulating box

2nd FOV

ABB in nadir
position

Deck weight

REFIR-PAD



FIRST



Sub-mm FTS



GVRP

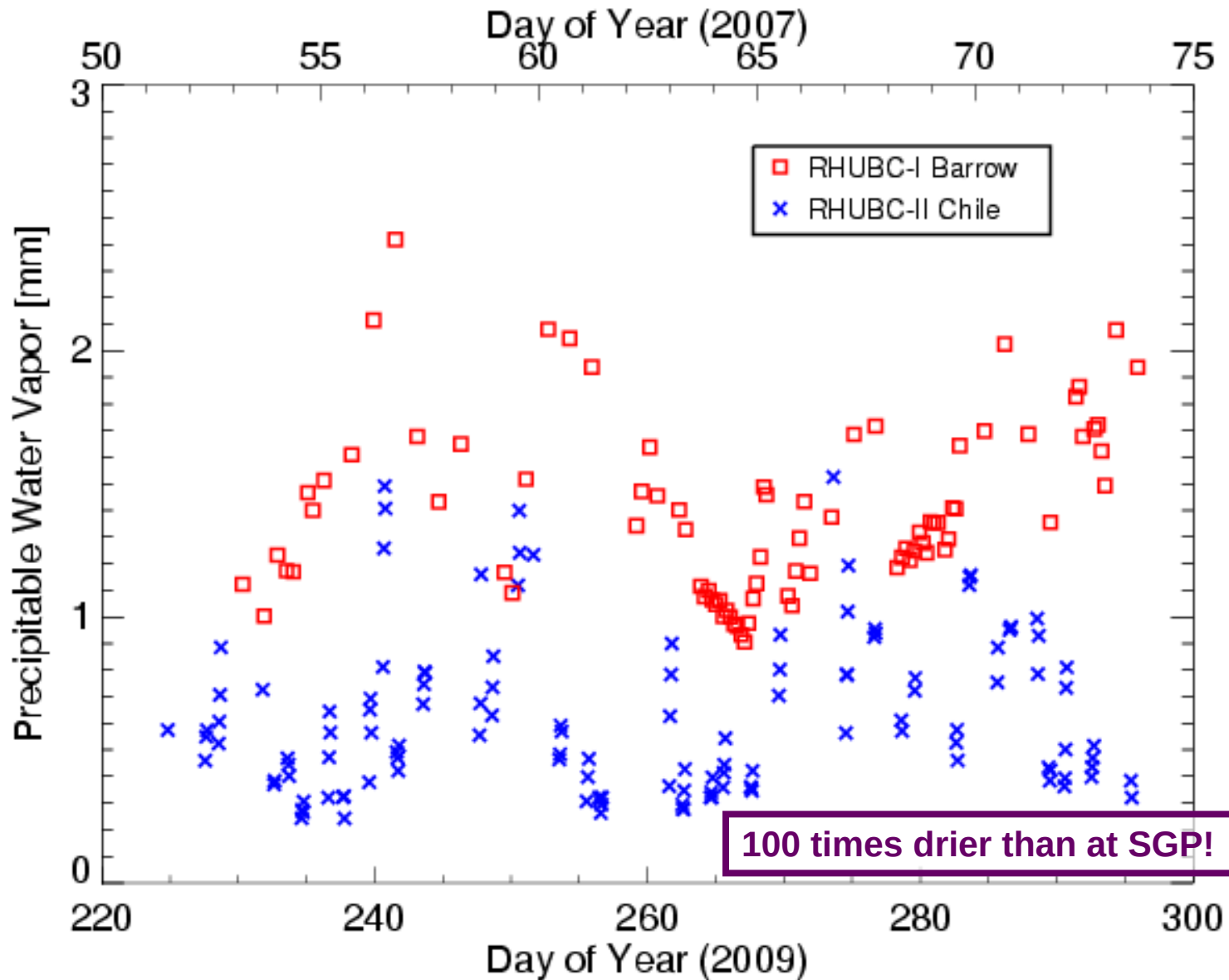


On-Site Lead

Time Period	Lead
22 Jul – 31 Jul	Troy Culgan (BOM)
1 Aug – 19 Aug	Dave Turner (UW)
20 Aug – 30 Aug	Luca Palchetti (IFAC-CNR)
31 Aug – 11 Sep	Jen Delamere (AER)
12 Sep – 23 Sep	Tim Wagner (UW)
24 Sep – 5 Oct	Dave Tobin (UW)
6 Oct – 24 Oct	Eli Mlawer (AER)
25 Oct – 31 Oct	Troy Culgan (BOM)

Planned start date: 10 August
Actual start date: 15 August
End date: 24 October

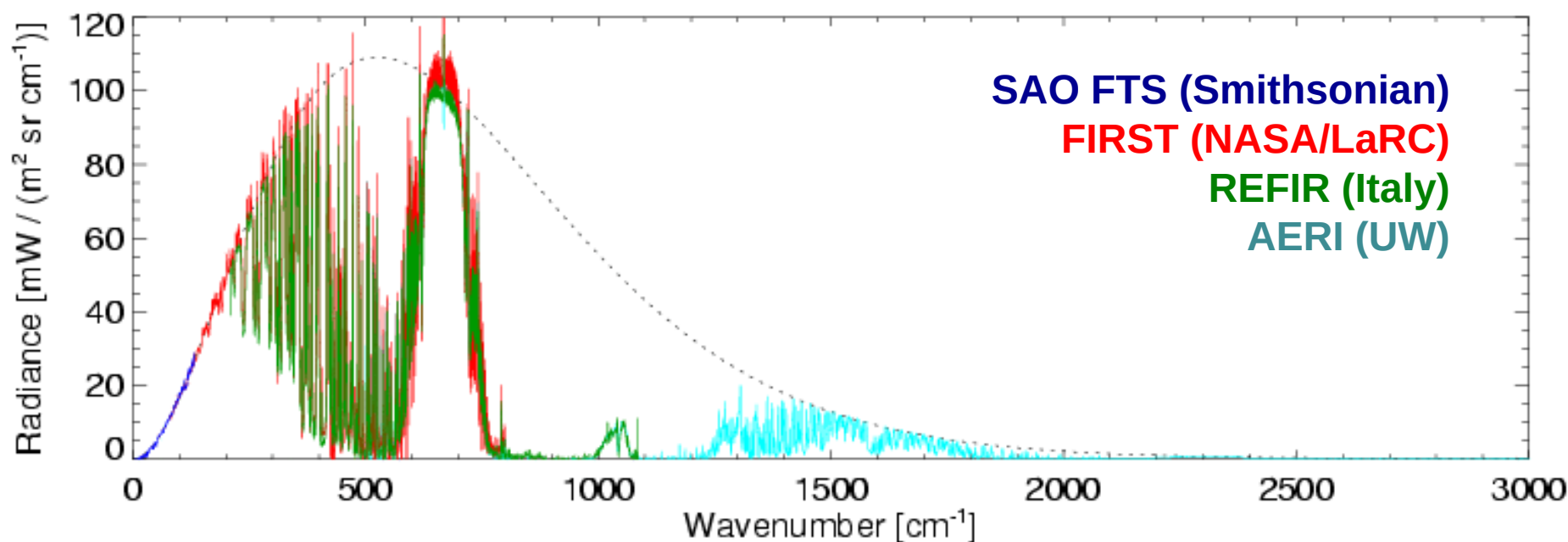
Radiosonde Observed PWV



Spectral Observations

170 GHz (5.6 cm^{-1}) to $3 \text{ }\mu\text{m}$ (3000 cm^{-1})

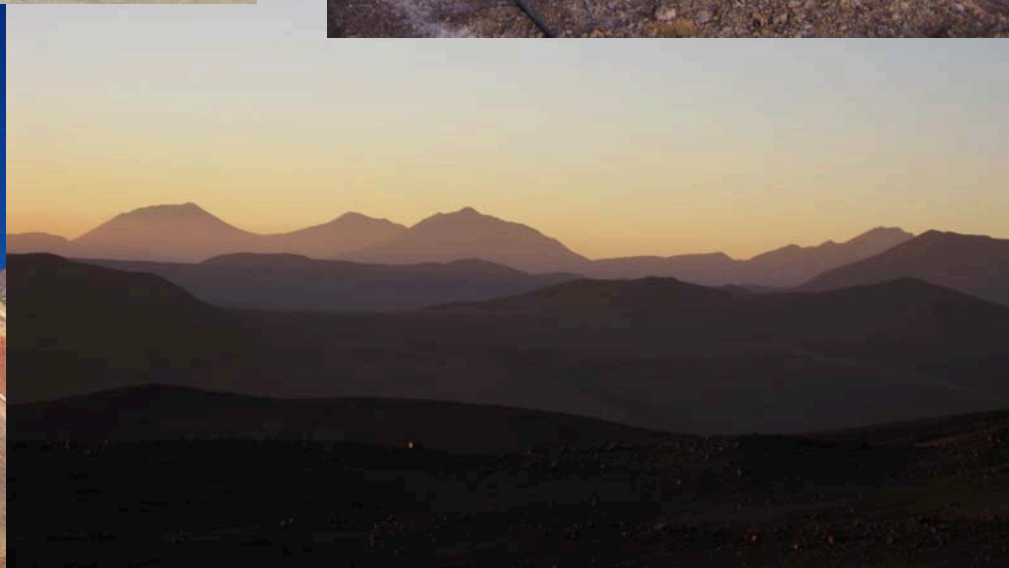
First ever measurement of the entire
infrared spectrum from 3 to 1780 μm !



PRELIMINARY DATA

Tim's Lemma regarding the fundamental RHUBC relationship:
"sky ugliness for science equals sky awesomeness for pictures"



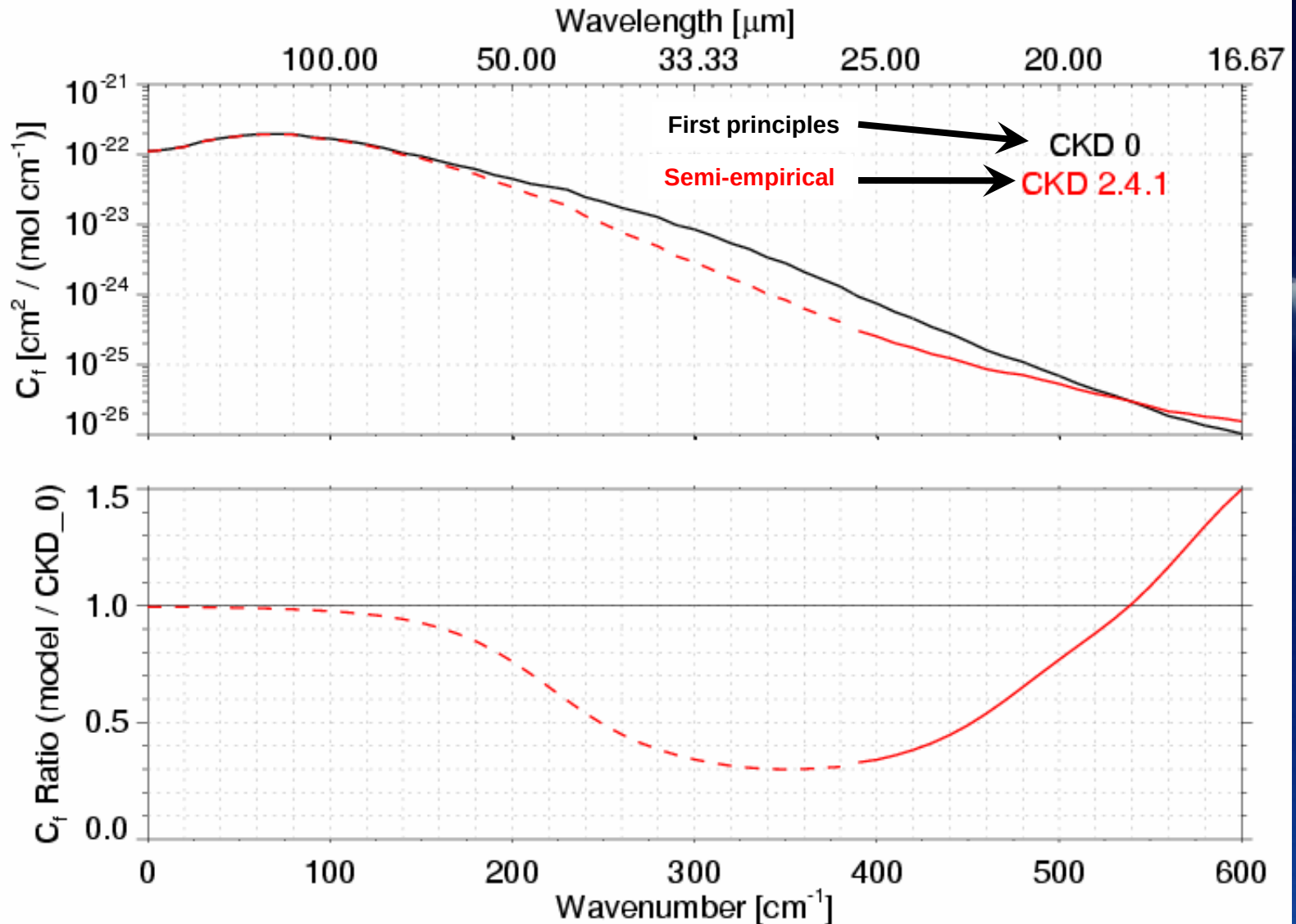


Agenda for this Breakout Session

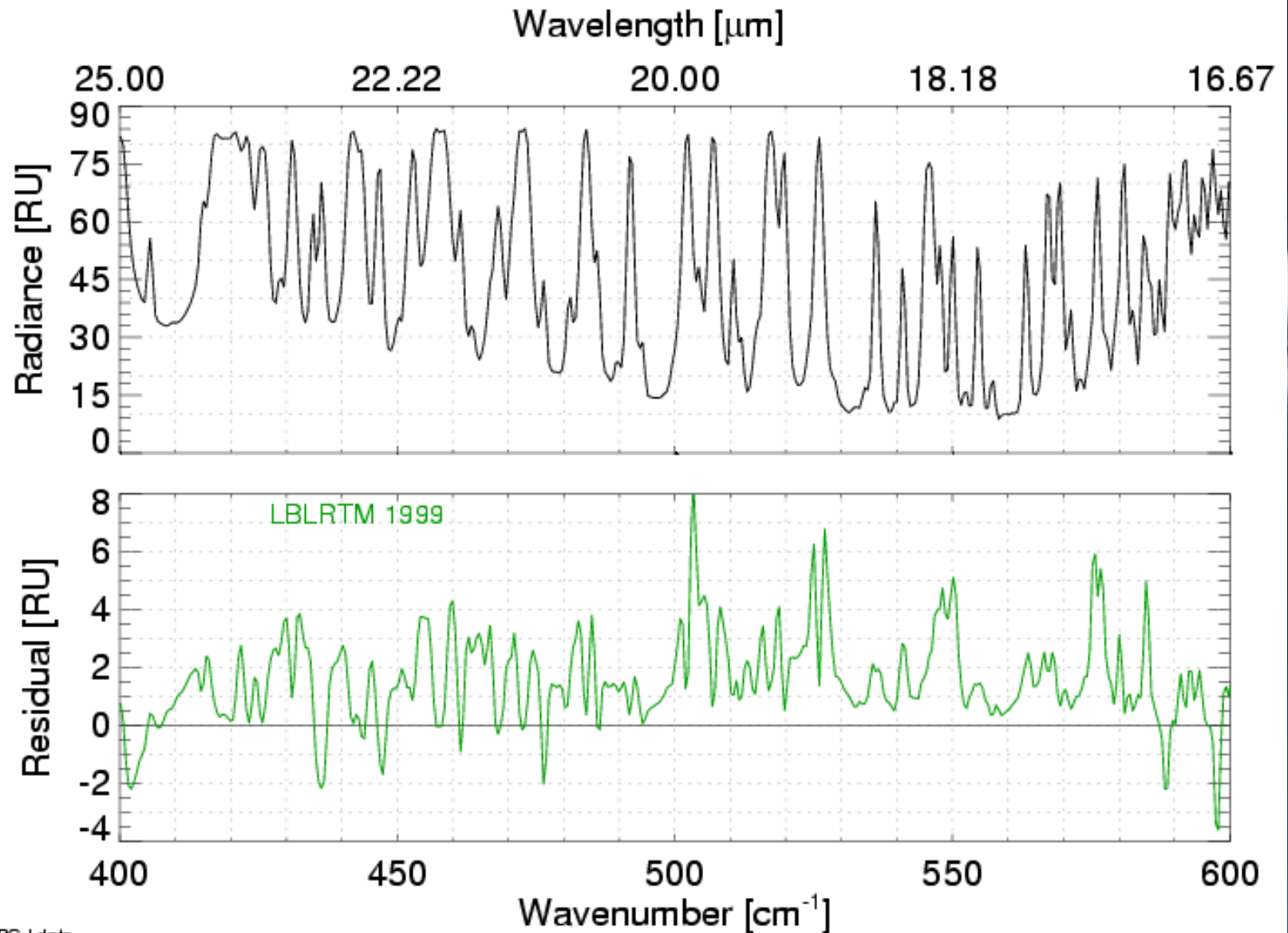
3:00 – 3:20	Turner	RHUBC introduction and background
3:20 – 3:35	Delamere	Summary of RHUBC-I accomplishments
3:35 – 3:50	Mlawer	Initial analysis of water vapor and PWV data
3:50 – 4:05	Mlynczak	Initial analysis of FIRST data
4:05 – 4:20	Turner (for Tobin and Palchetti)	Initial analysis of AERI and REFIR-PAD data
4:20 – 4:35	Mlawer (for Marin and Pozo)	WRF modeling results in the RHUBC-II region
4:35 – 5:00		Open discussion



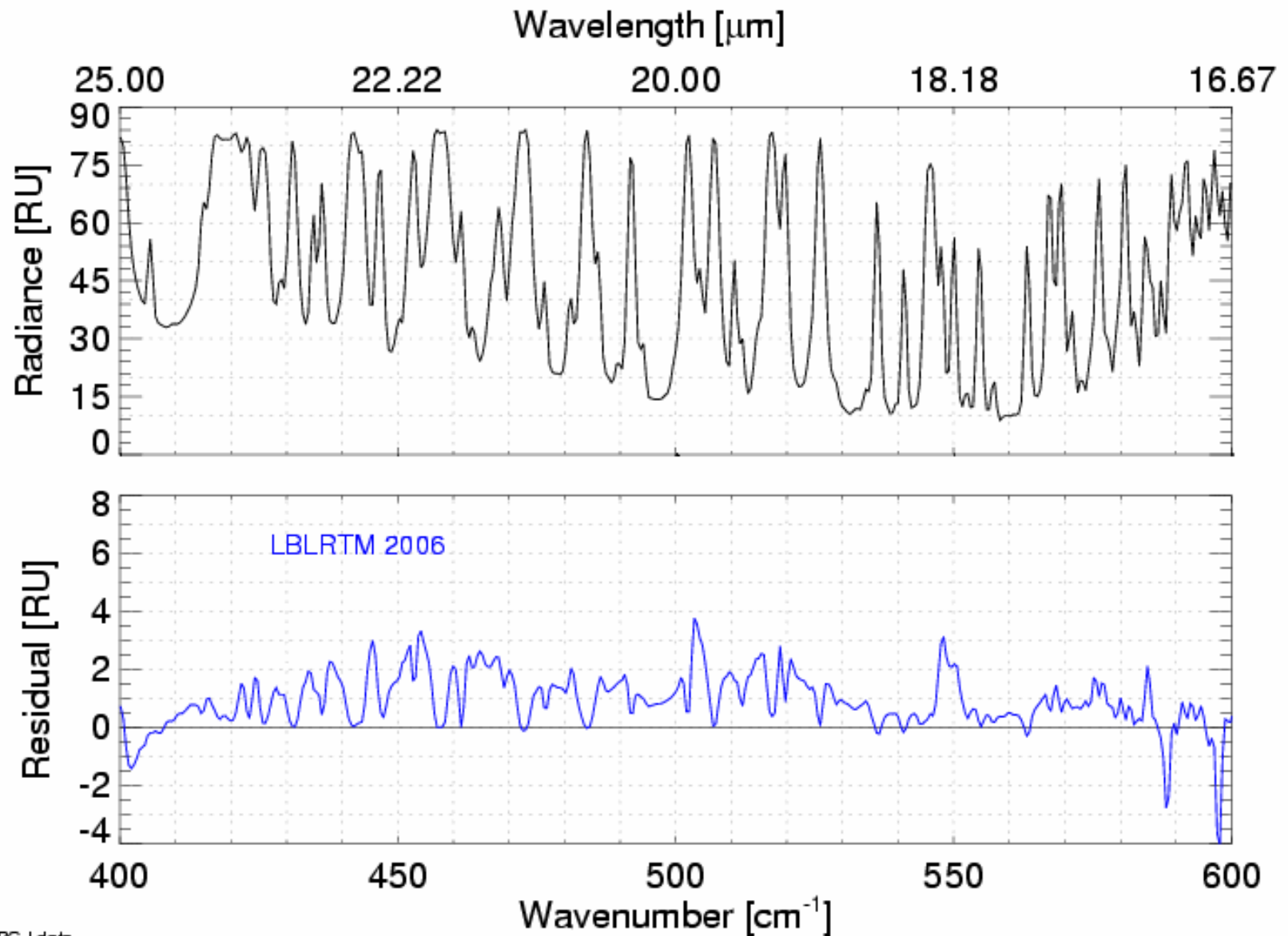
Water Vapor Continuum Circa 1999



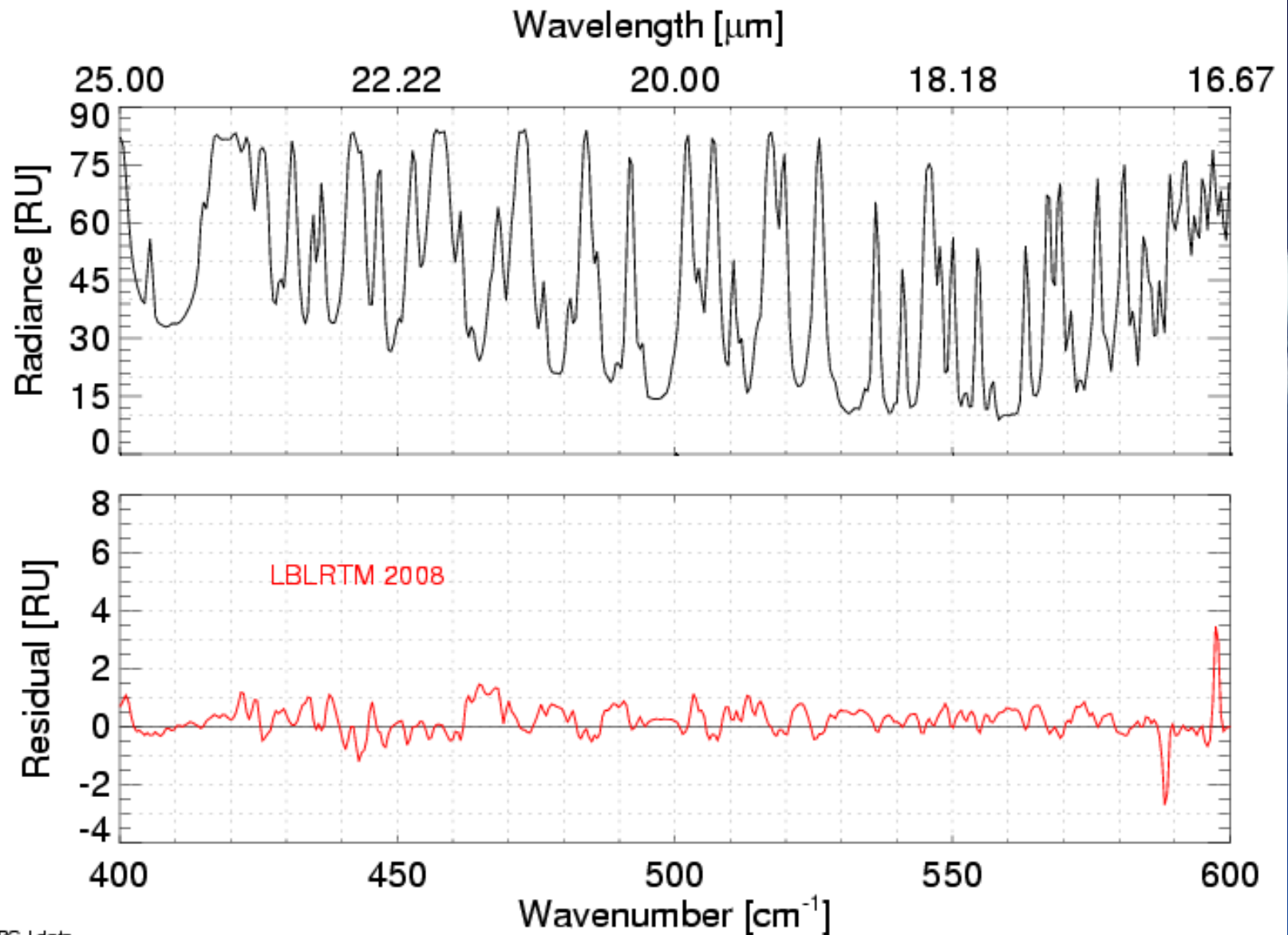
State-of-Art in Far-IR: Circa 1999



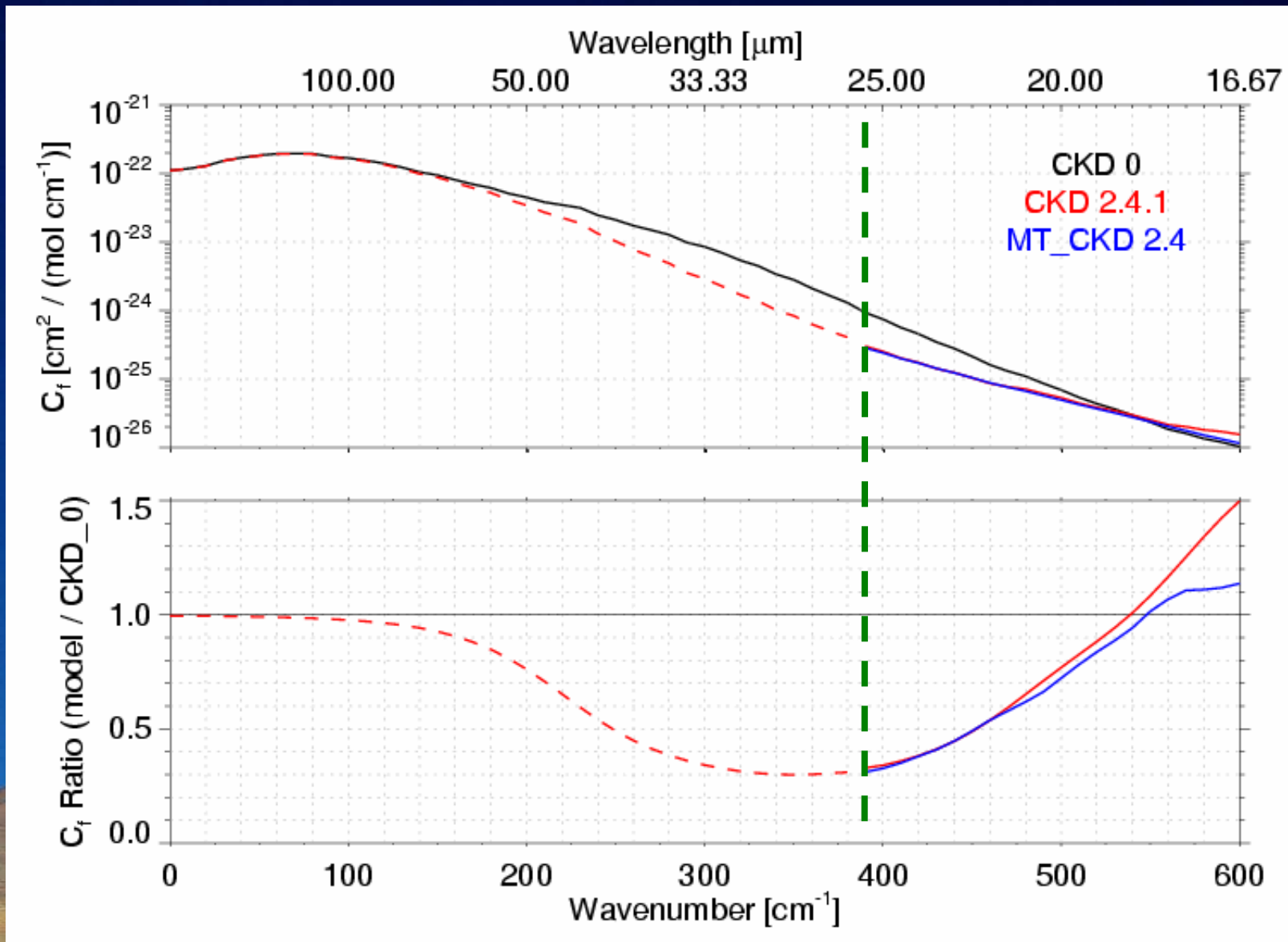
State-of-Art in Far-IR: Circa 2006



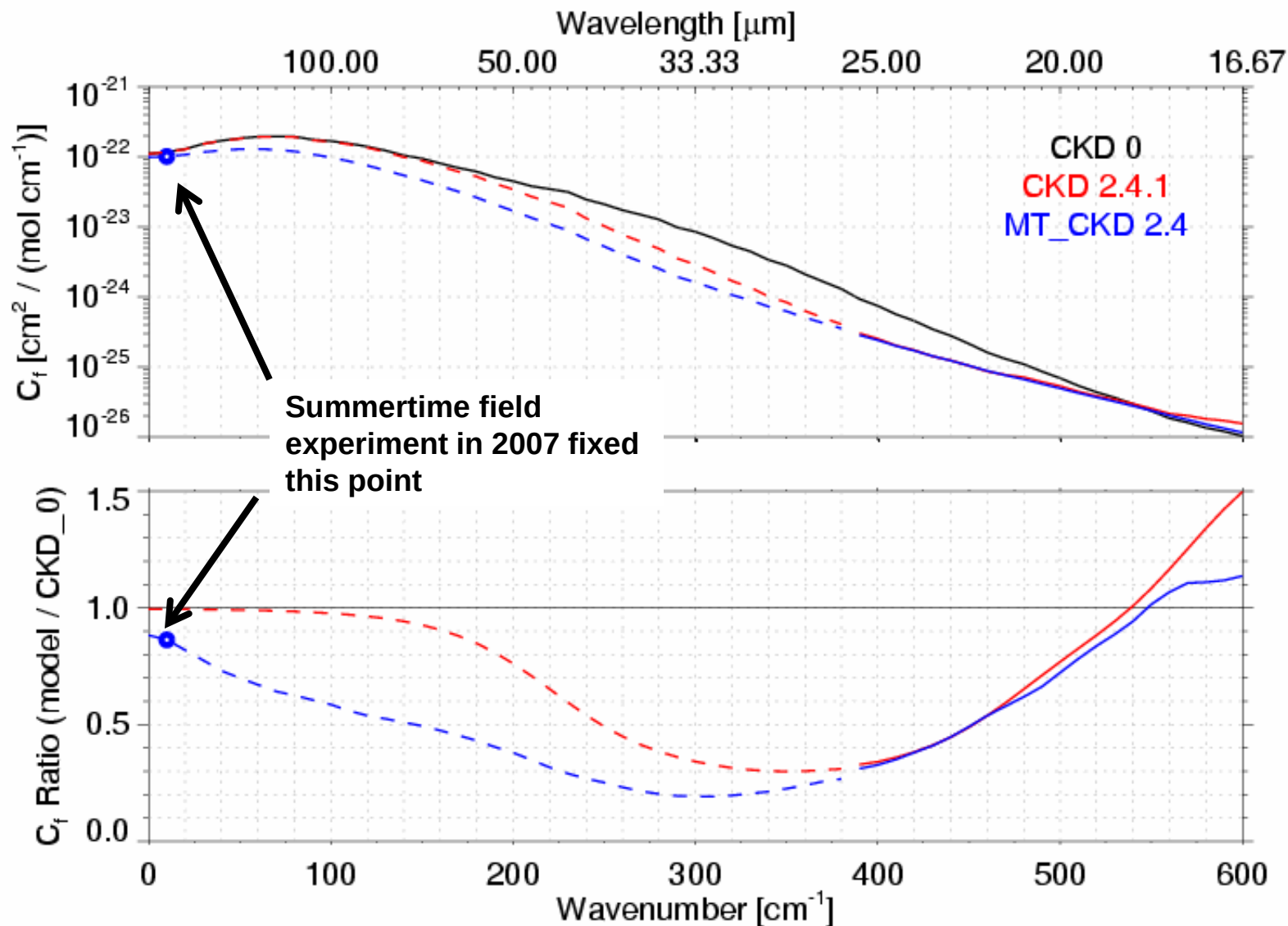
State-of-Art in Far-IR: After RHUBC-I

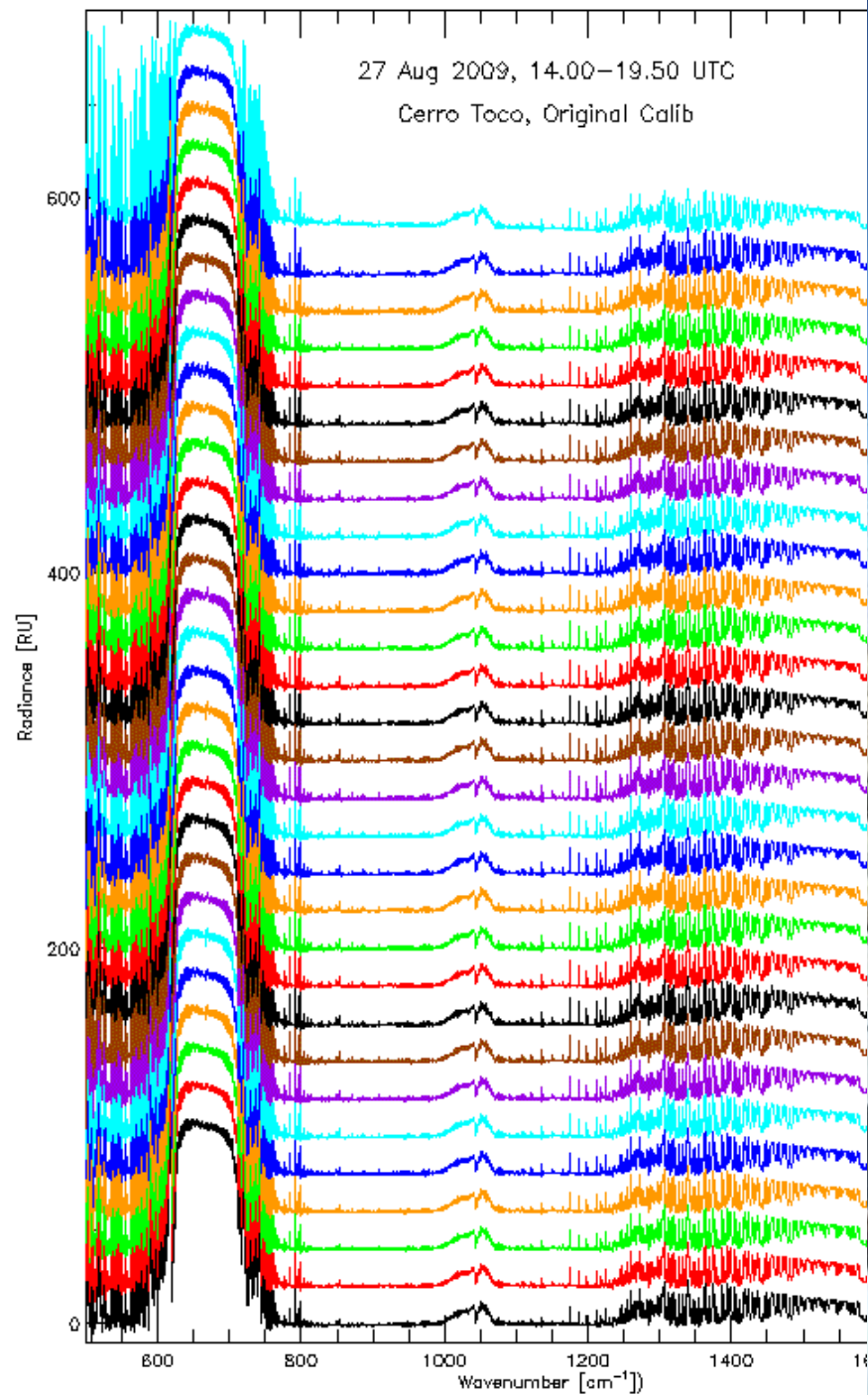


Water Vapor Continuum After RHUBC-I



WV Continuum after Work at 5 cm⁻¹



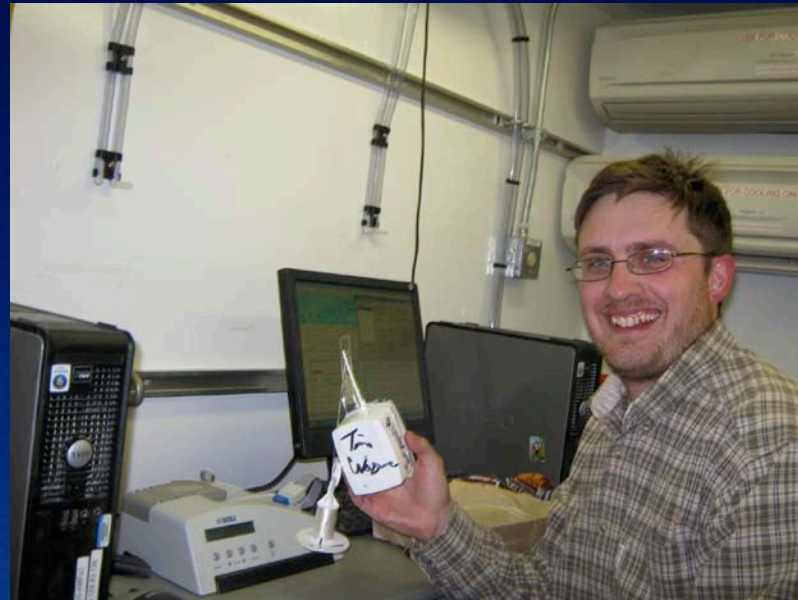


An UW / SSEC AERI



SSEC people hard at RHUBC-II

Tim Wagner



Dave Tobin



Dave Turner



Site Tours

Bob Wilson!

