

Winter/Spring 2007 North Slope of Alaska

Radiative Closure Studies

J. Delamere, V. Payne, E. Mlawer, S. Clough (*AER, Inc.*)

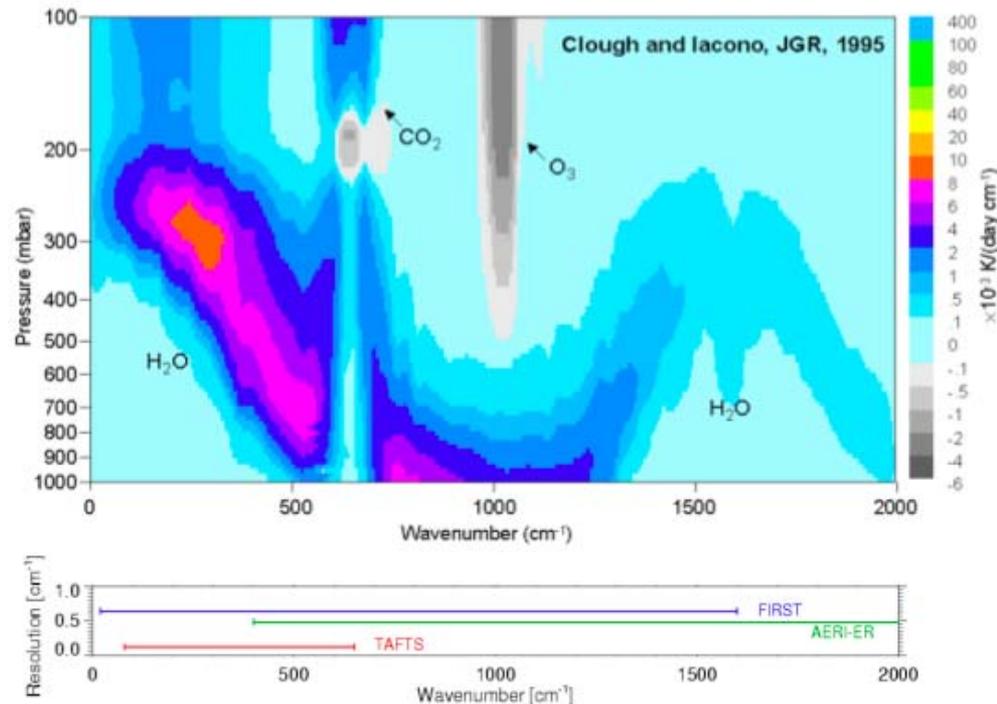
D. Turner \square (*University of Wisconsin*)

R. Gamache (*University of Massachusetts - Lowell*)

& The RHUBC Crew

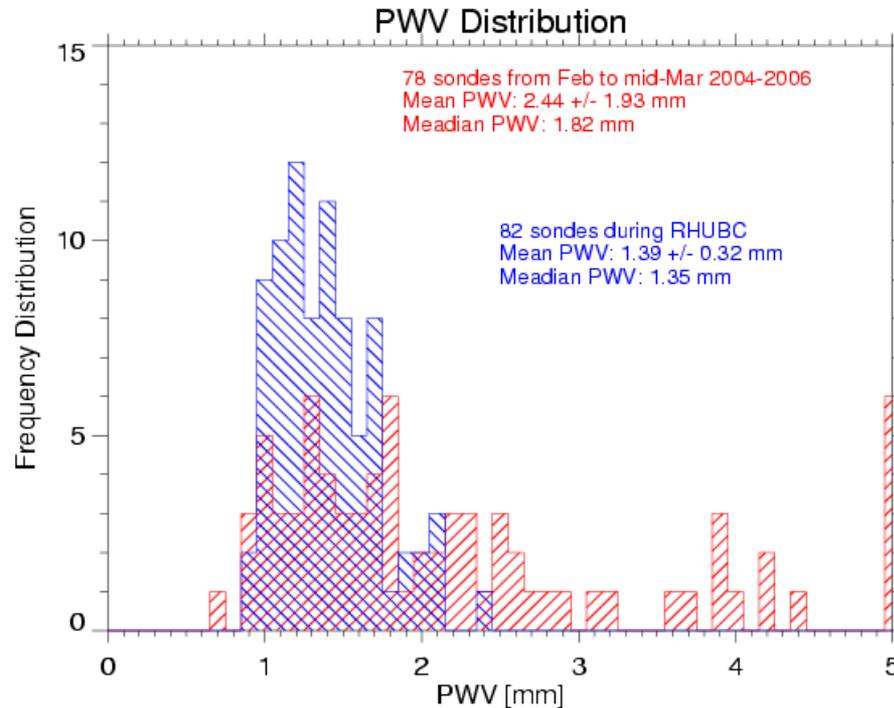


- The far-infrared (far-IR) spectral region is crucially important for the determination of polar surface fluxes and global cooling rates in the mid to upper troposphere.
- So important but understudied.....
- Conduct a clear sky radiative closure exercise in the far-IR to reduce uncertainties in water vapor continuum and absorption line parameter

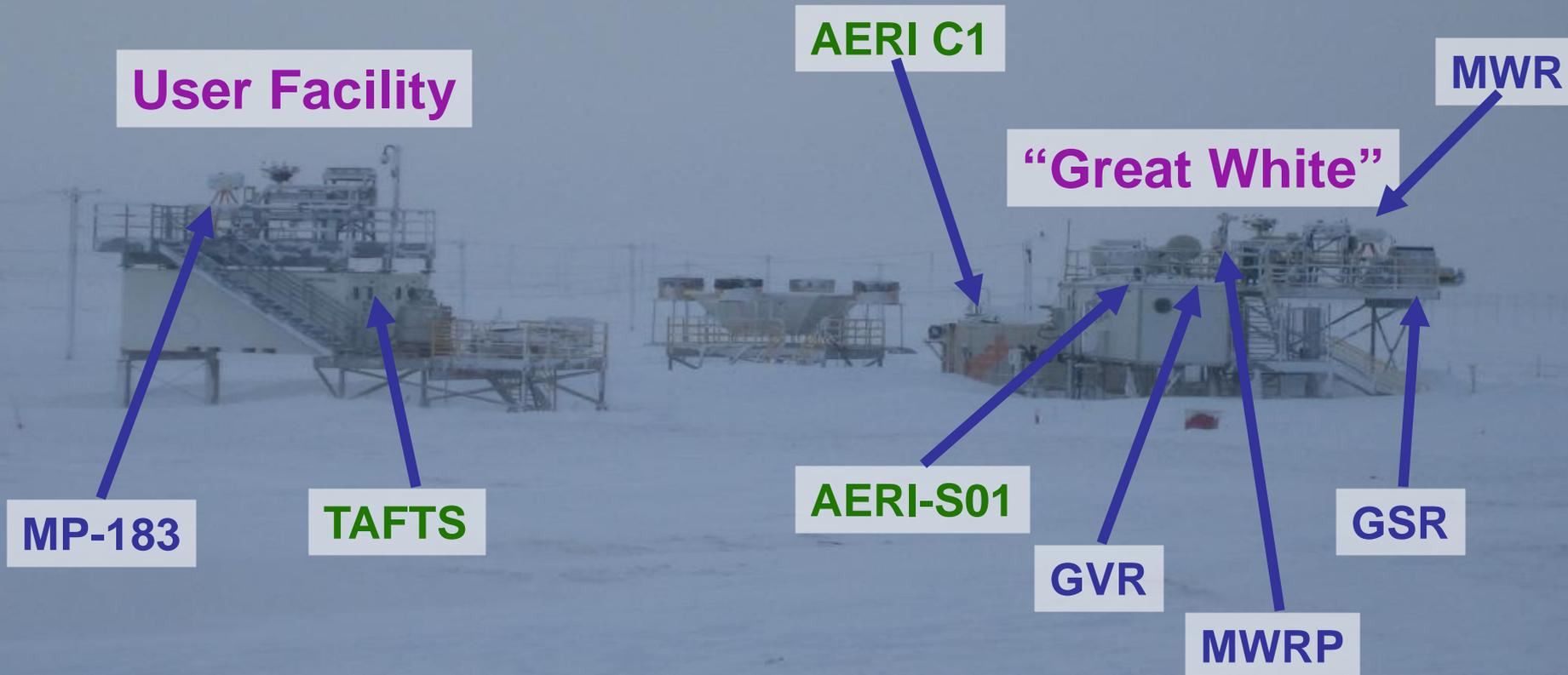


RHUBC 2007 @ NSA

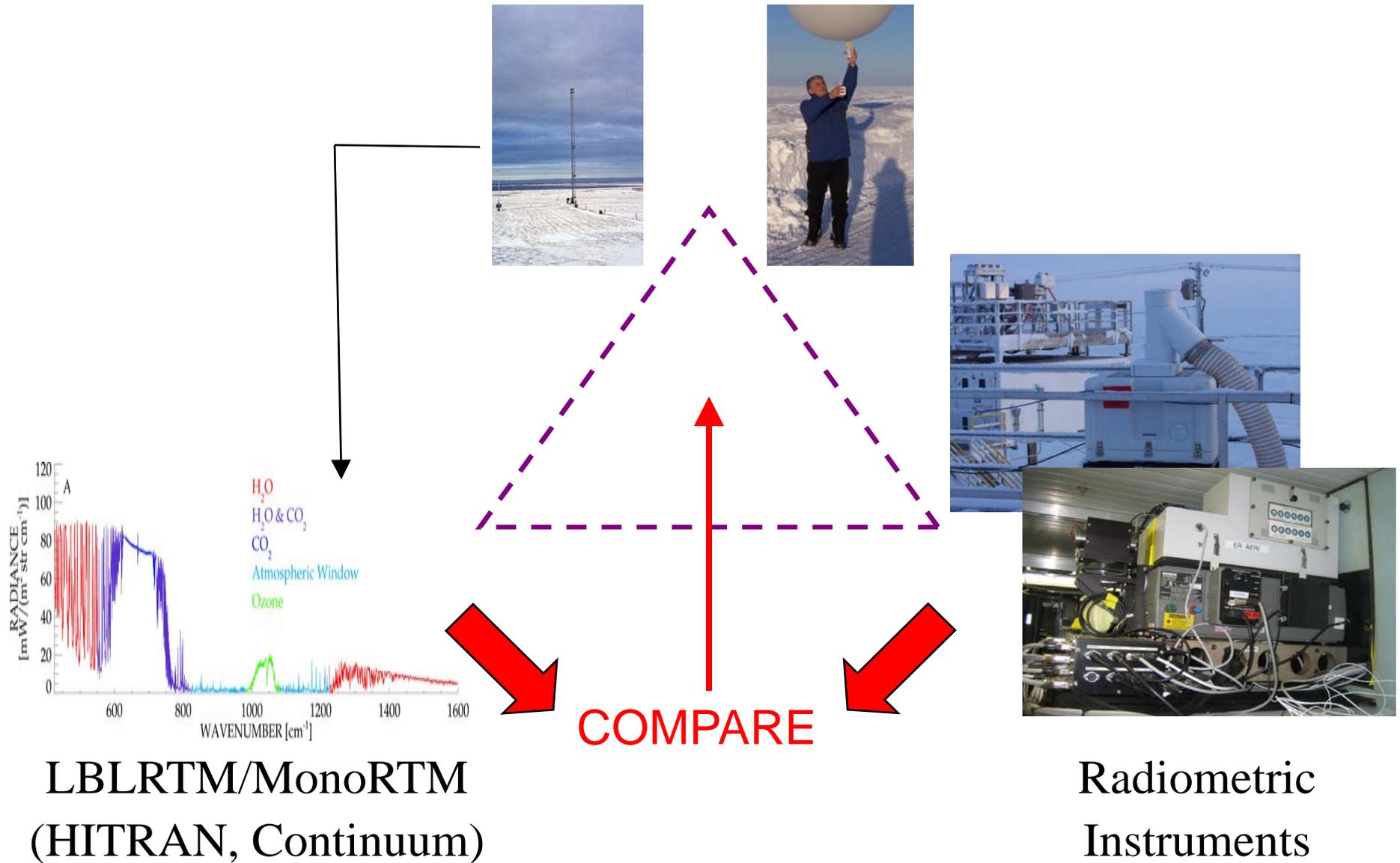
- Conduct a clear sky radiative closure exercise in the far-IR to reduce uncertainties in water vapor continuum and absorption line parameter
- Comparison between radiosonde total water vapor column versus that retrieved from 183 GHz radiometers
 - 183 GHz microwave radiometers (GSR, GVR, MP-183)



NSA Site Layout Looking WNW



Radiative Closure Technique



Consistency between IR & MW?

Microwave (MW) measurements v. radiative transfer model (MonoRTM) comparisons @ 183 GHz.

Assessment and improvement of MW spectroscopy in MonoRTM.

Improved estimates of total atmospheric water content (PWV) from a MW retrieval algorithm with improved MonoRTM.

Far-IR measurements v. model (LBLRTM) comparisons from 400 - 600 cm^{-1} using MW-retrieved PWV estimates. Assess and improve far-IR spectroscopy.

Demonstrate consistency between MW and far-IR by comparing MW-retrieved PWV and an additional far-IR retrieved PWV

Air-broadened Half-Widths of the 22 GHz and 183 GHz Water Vapor Lines

(Submitted to IEEE TGRS, 2007)

V. Payne, S. Clough, J. Delamere, K. Cady-Pereira, J.
Moncet, E. Mlawer

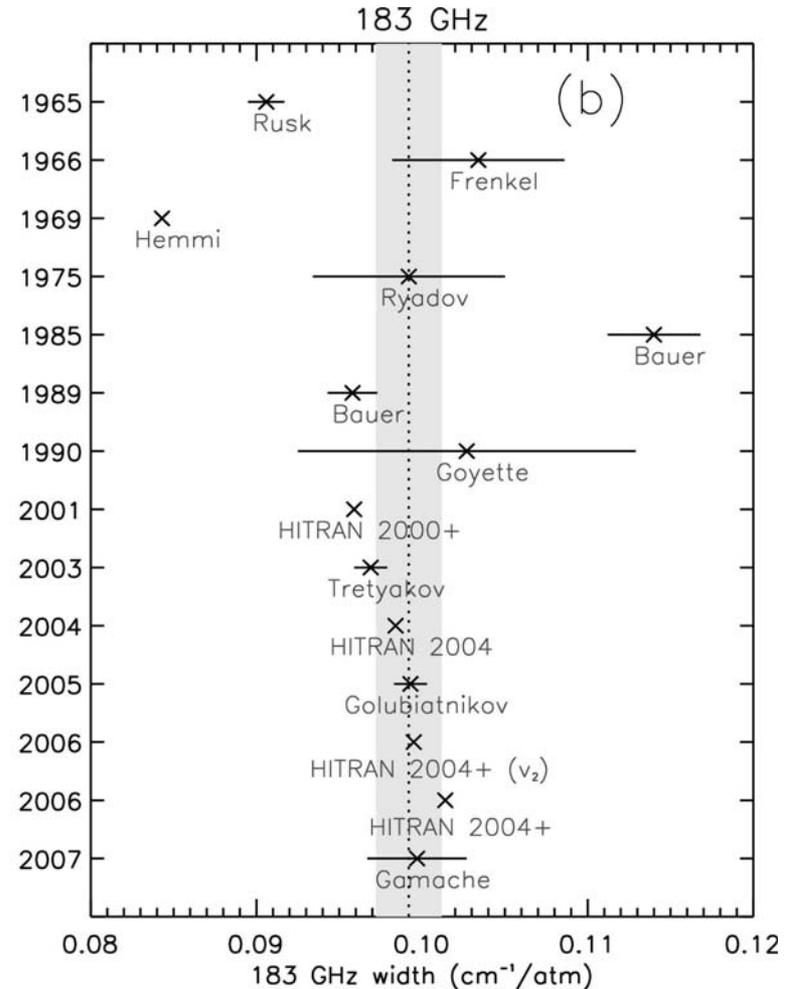
(AER, Inc.)

R. Gamache

(University of Massachusetts - Lowell)

183 GHz Summary

- Width value: $0.0992 \text{ cm}^{-1}/\text{atm}$
 - Estimated uncertainty: 2%
- Improved and *continuous* estimates of atmospheric water vapor for dry conditions
- Do we achieve consistency with other spectral regions...such as the **far-infrared**....



A far-infrared radiative closure experiment in low precipitable water vapor conditions

J. Delamere, E. Mlawer, S. Clough, V. Payne

(AER, Inc.)

D. Turner

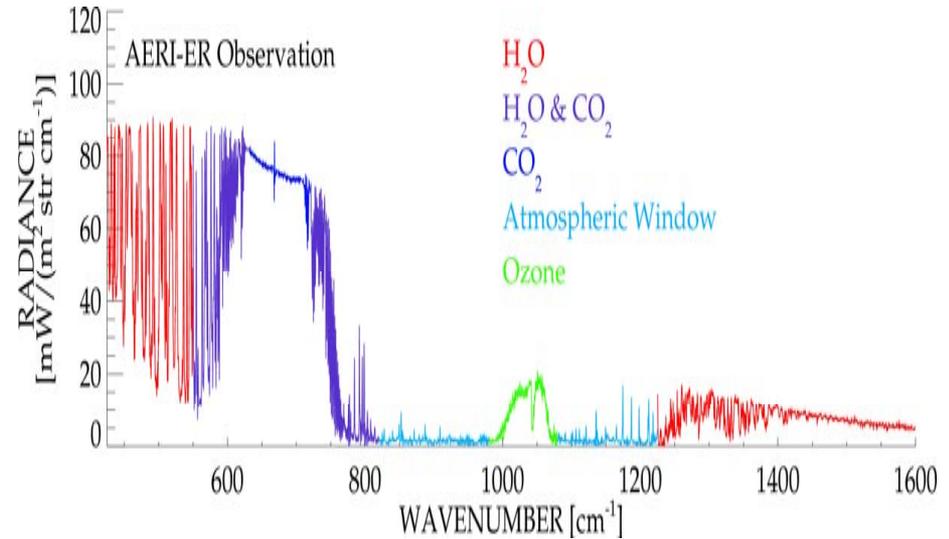
(University of Wisconsin)

R. Gamache

(University of Massachusetts - Lowell)

2007 LBLRTM (IR Studies)

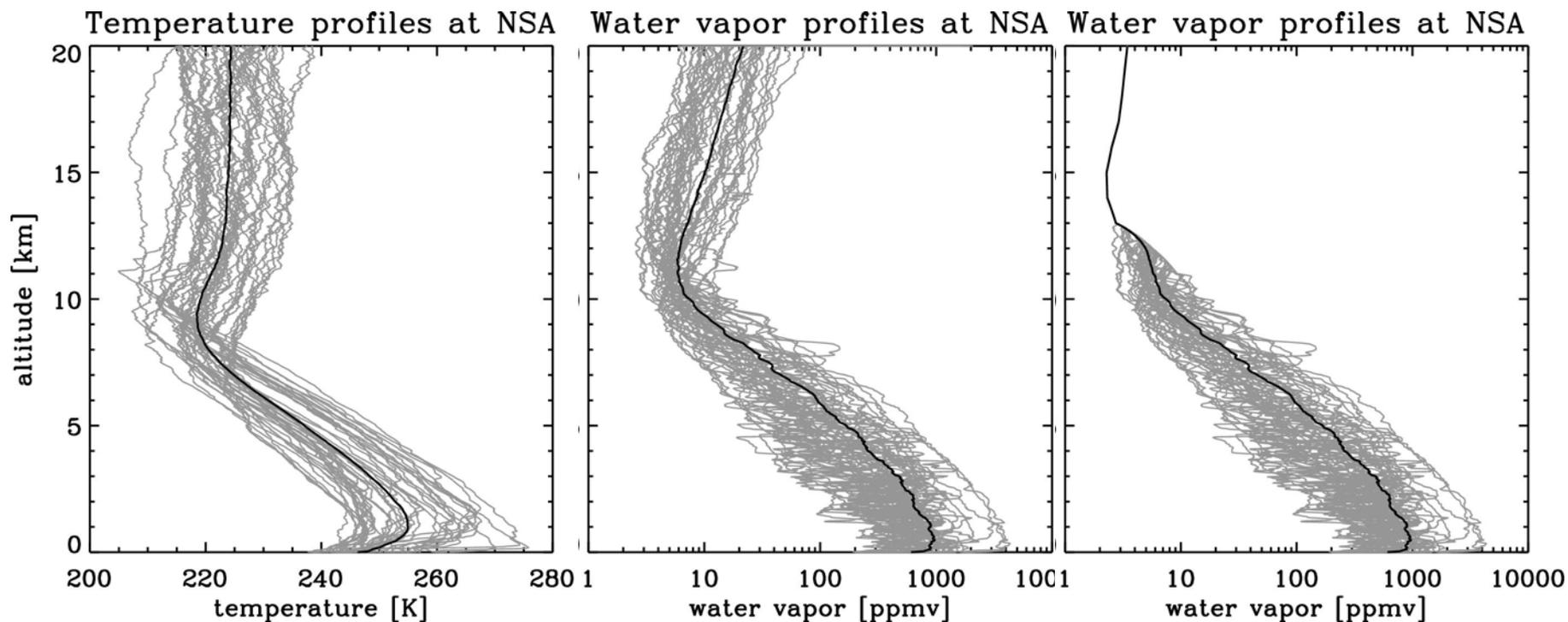
- **Line intensities**
 - HITRAN 2004 with Updates
- **Widths & Temperature Dependence**
 - HITRAN 2004 with Updates
 - Recently calculated WV line-widths (R. Gamache)
- **WV Continuum**
 - MT_CKD_2.0
- **Improved CO₂**
 - Line-coupling (Niro et al., 2005)
 - Modified CO₂ Continuum
- Use model/measurement comparisons
- Assess current spectroscopy down to 400 cm⁻¹
- Retrieve PWV scaling factor
- **Measurements: AERI-ER at NSA**



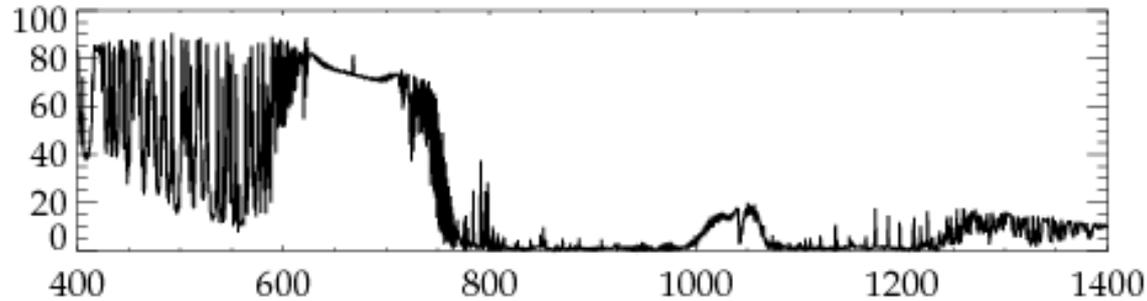
- Extended Range Atmospheric Emitted Radiance Interferometer:
 - Operating continuously at the NSA
 - Range 3.3 - 25 μm with 0.5 cm^{-1} resolution
 - 3-min (normal) or 20-s sky (rapid-sample) averages
 - Accuracy better than 1% ambient radiance
 - *Offset applied* to data
- Date range used: January/February 2007
 - 14 clear cases
 - Includes early RHUBC cases
- Atmospheric Profile
 - Radiosonde (T, RH)
 - PWV scaled to match GVR retrieval



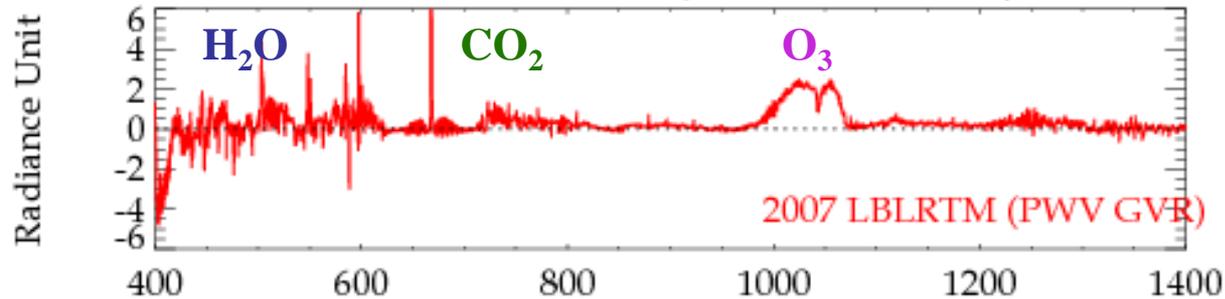
- **PWV range: 0.07 to 0.8 cm**
- Sonde RH values “bottom out” at 10-12 km
 - Leads to unrealistic H₂O values in stratosphere
 - Stratospheric values set to climatological values
- 40-m Meteorological Tower data



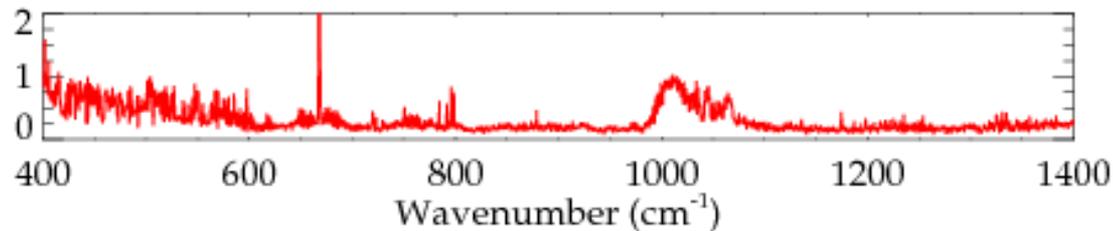
14 North Slope of Alaska Cases



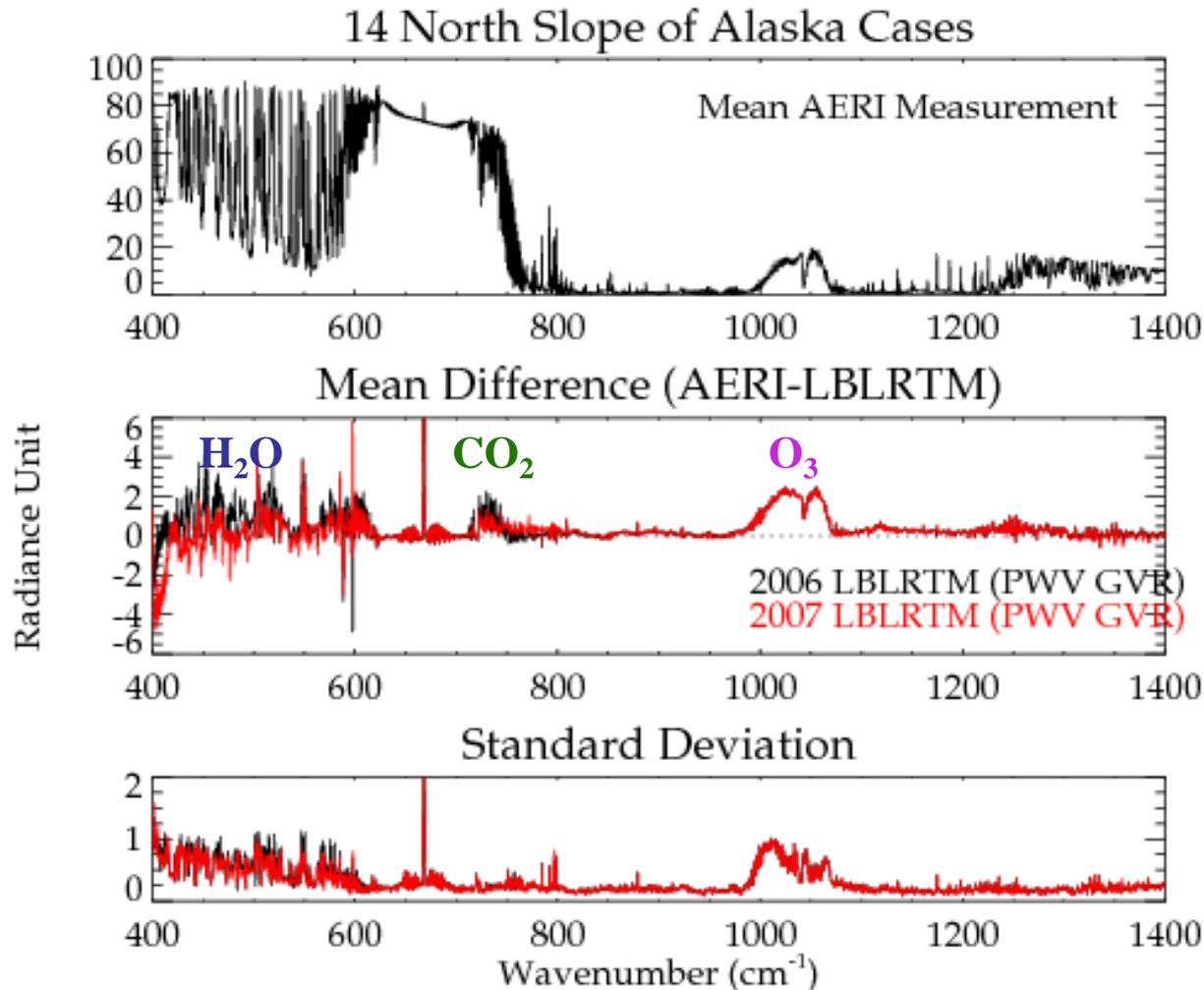
Mean Difference (AERI-LBLRTM)



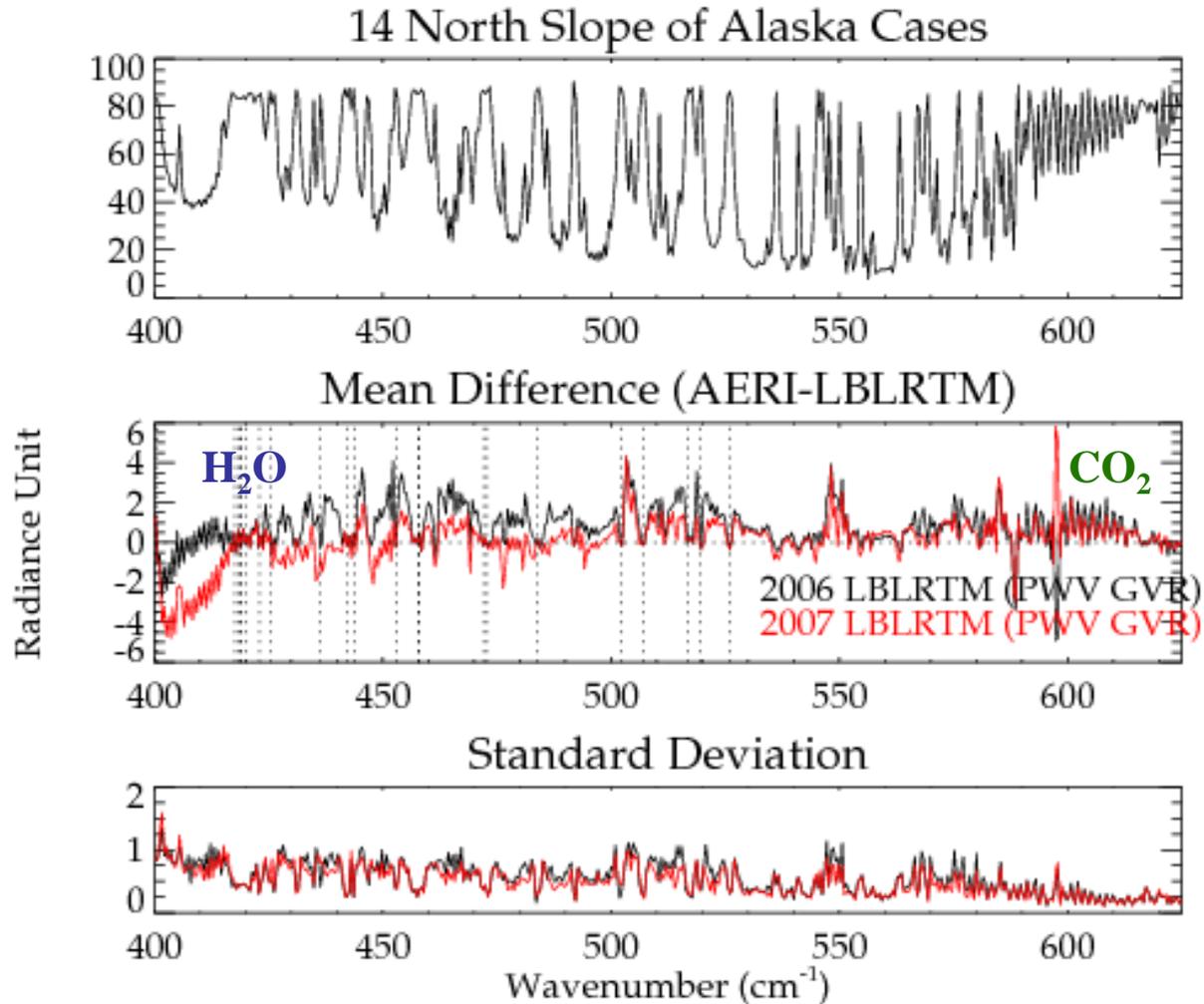
Standard Deviation

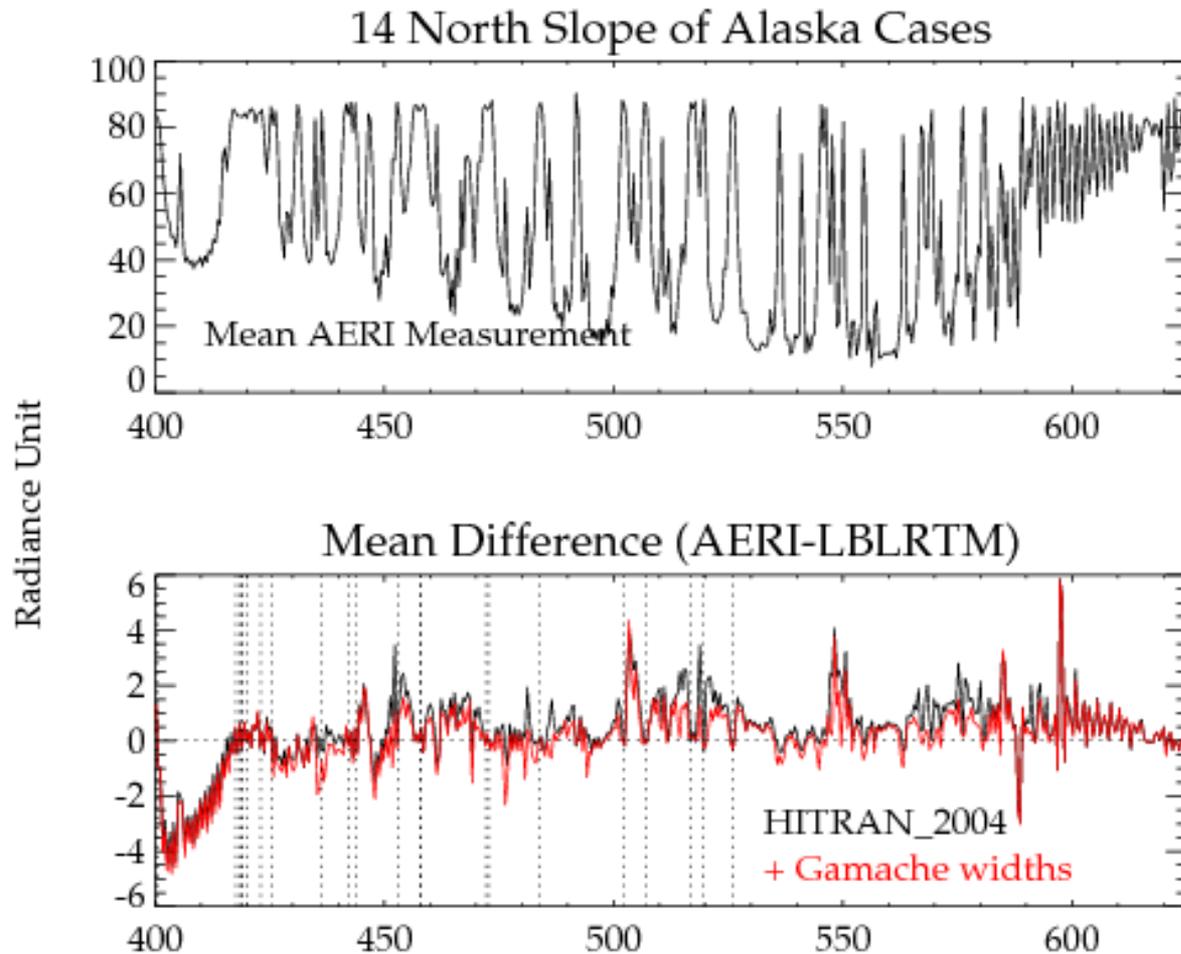


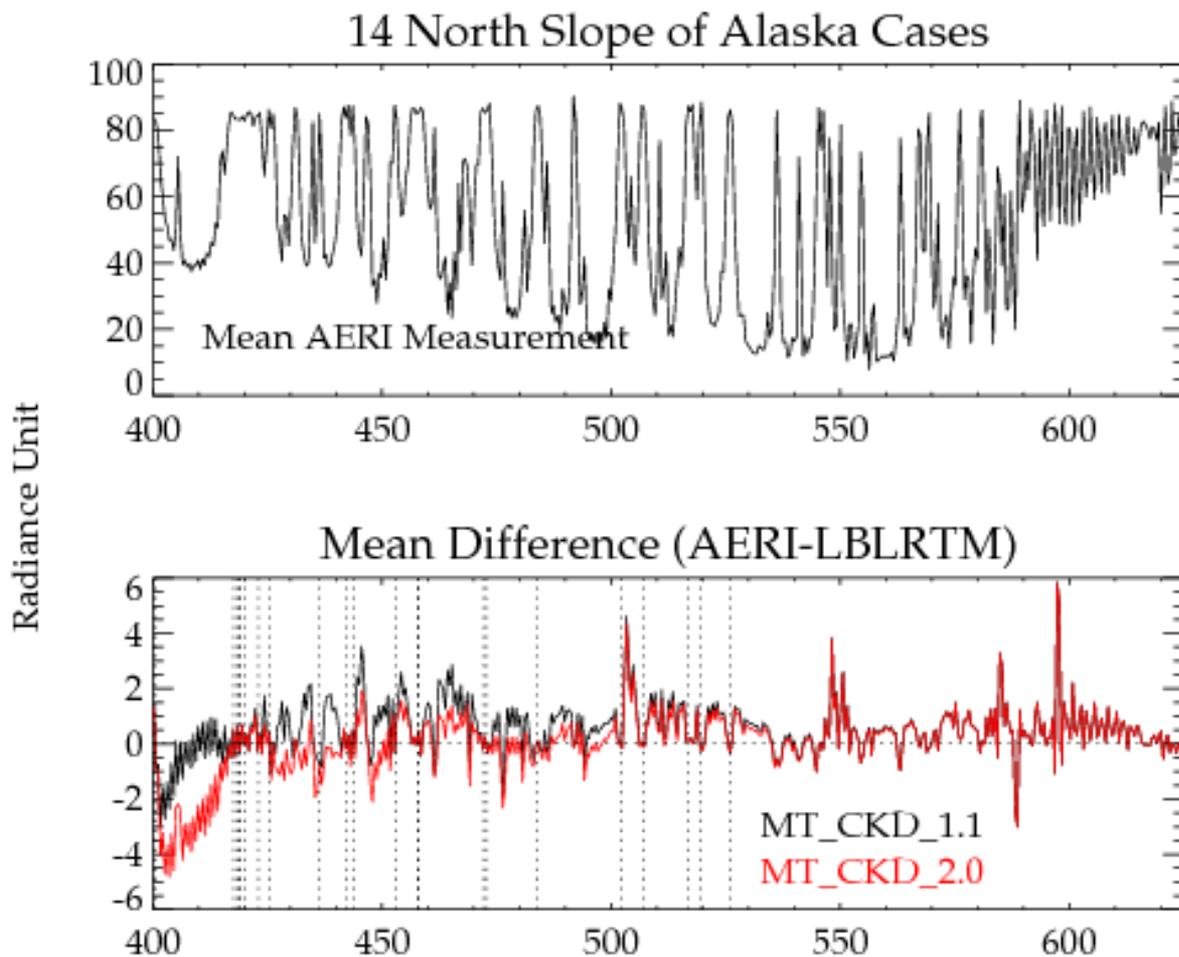
AERI-ER Spectral Comparisons



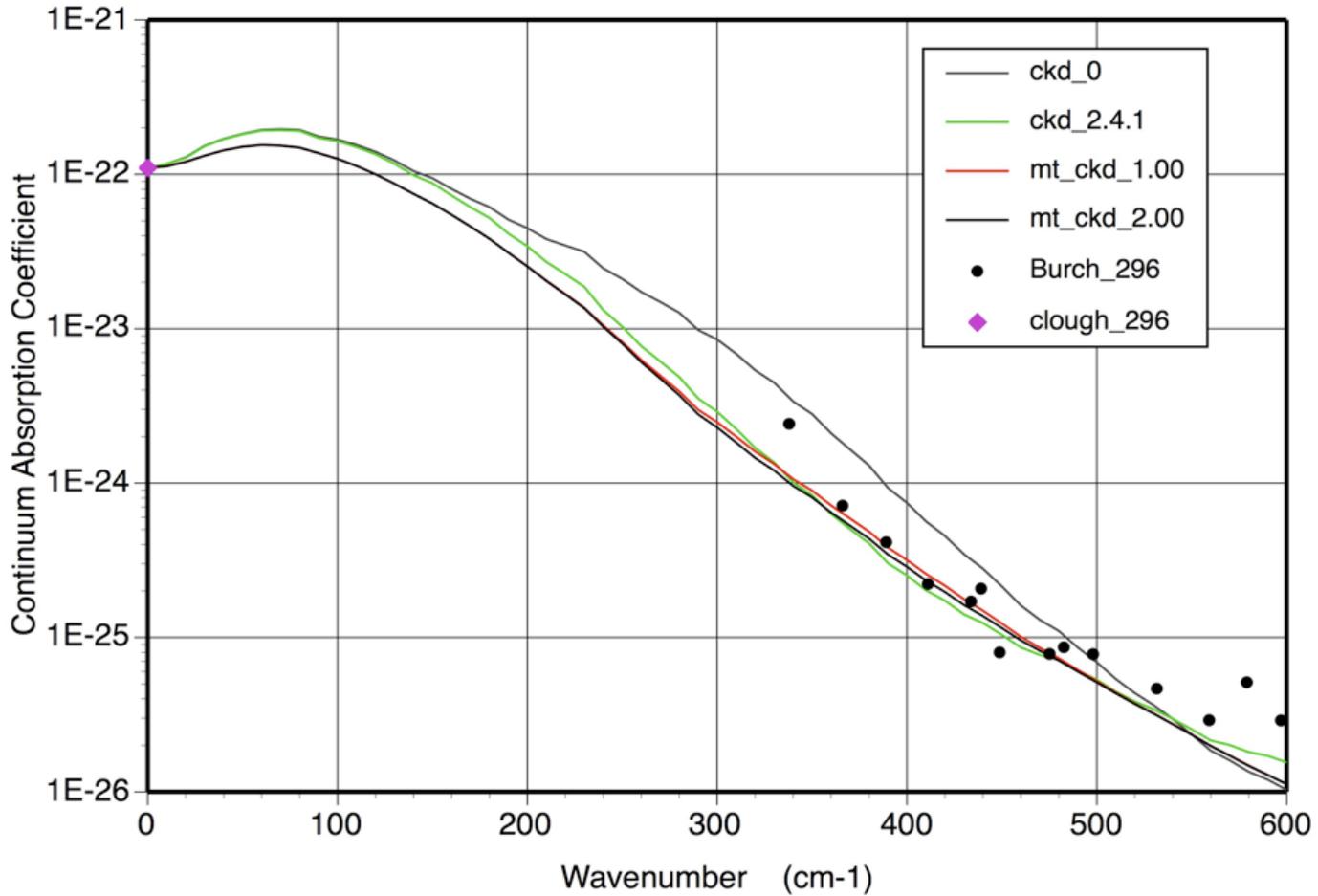
Far-IR Spectral Comparisons

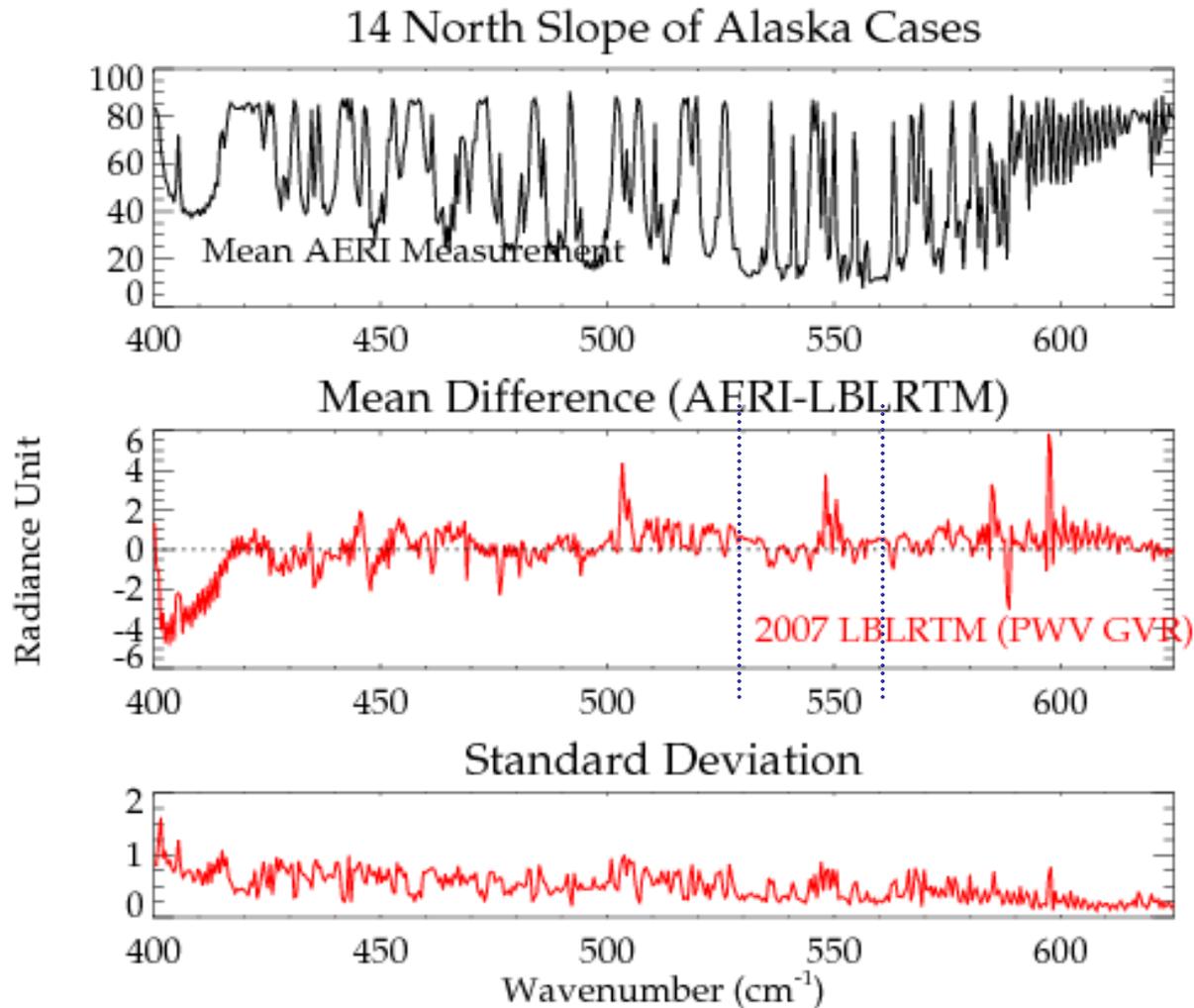


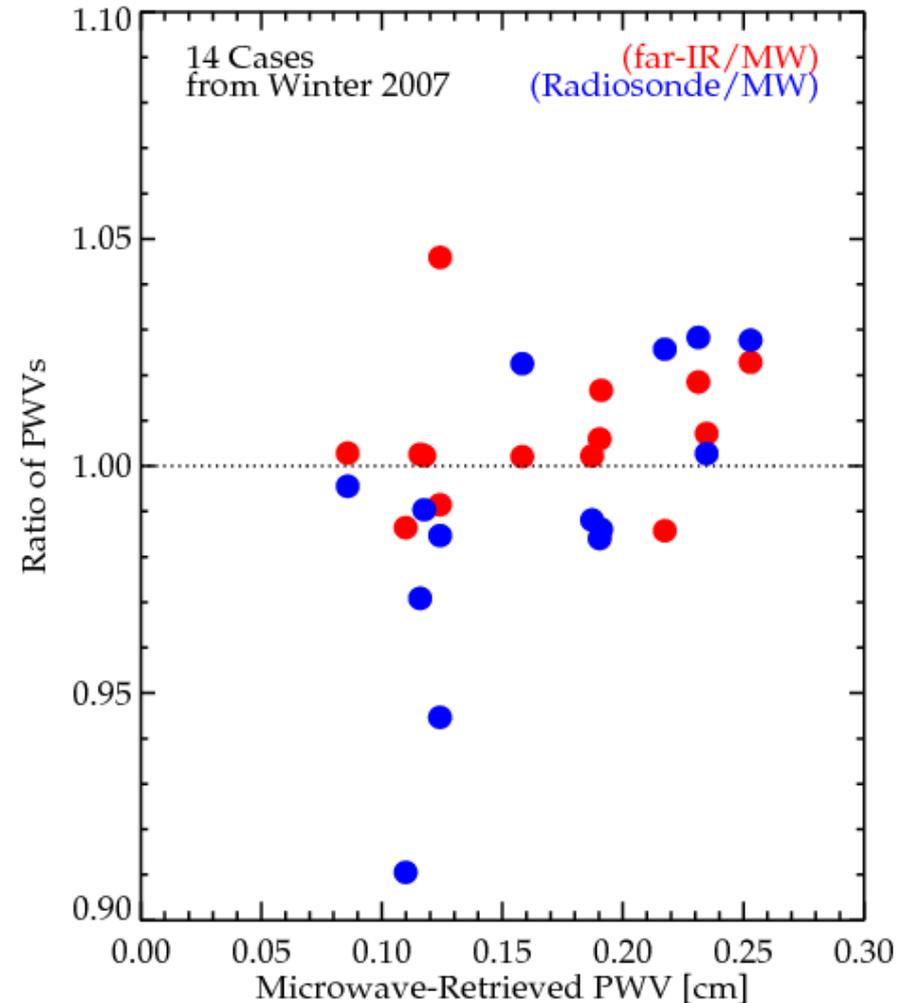
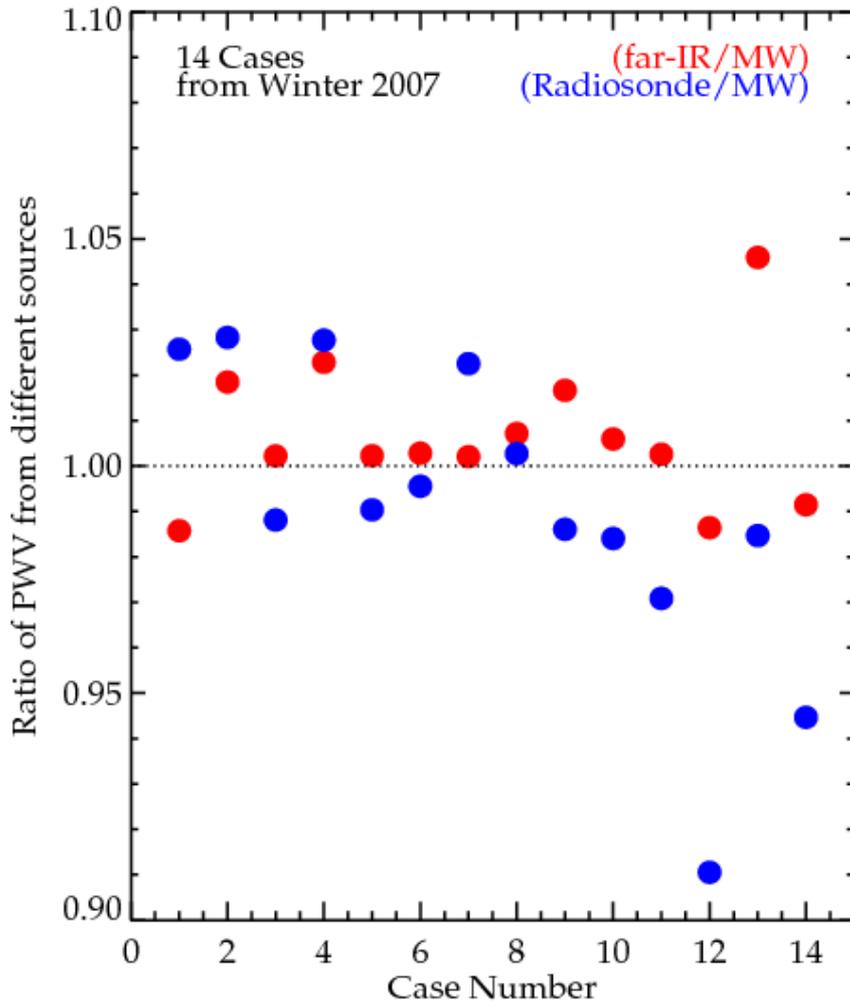


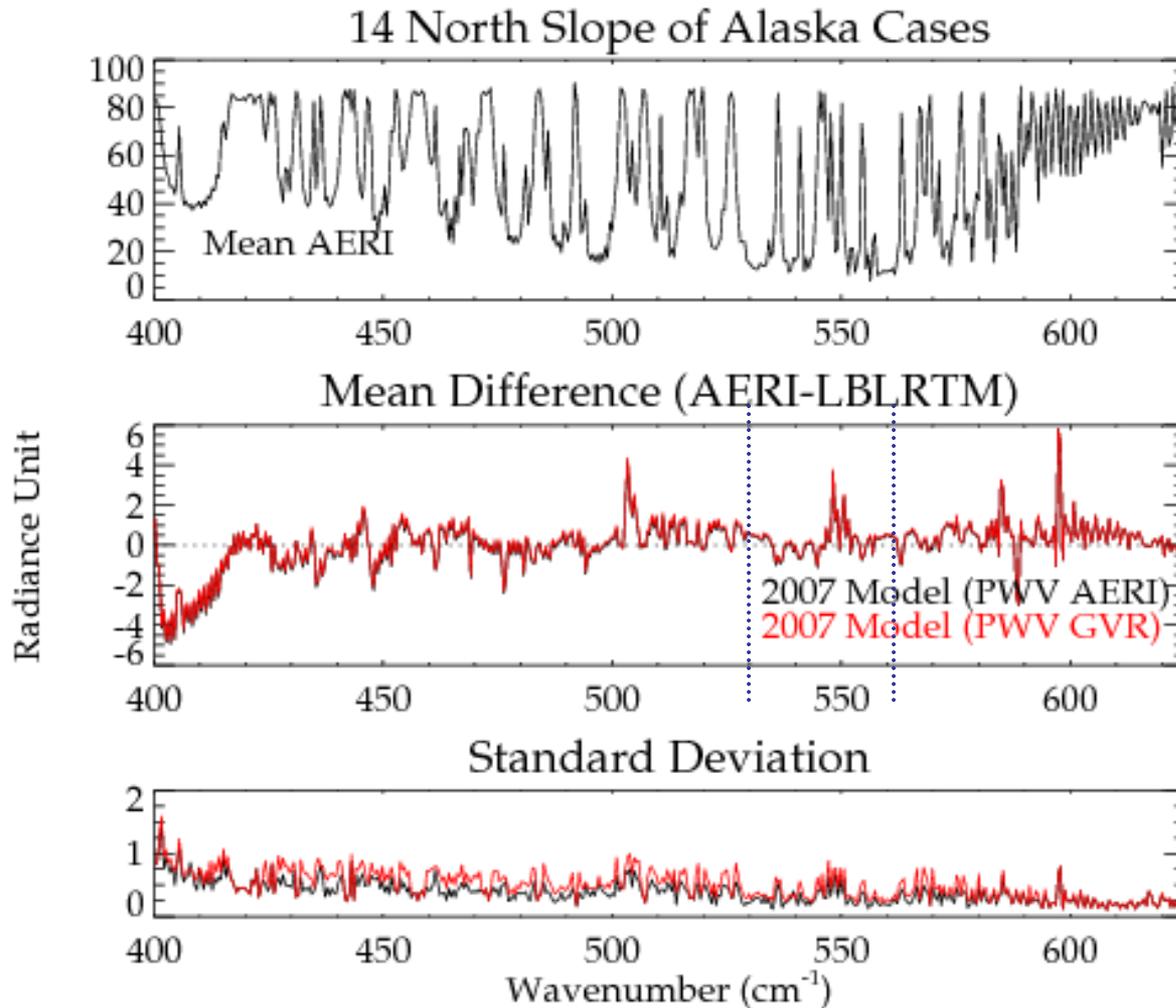


Foreign Continuum Coefficients

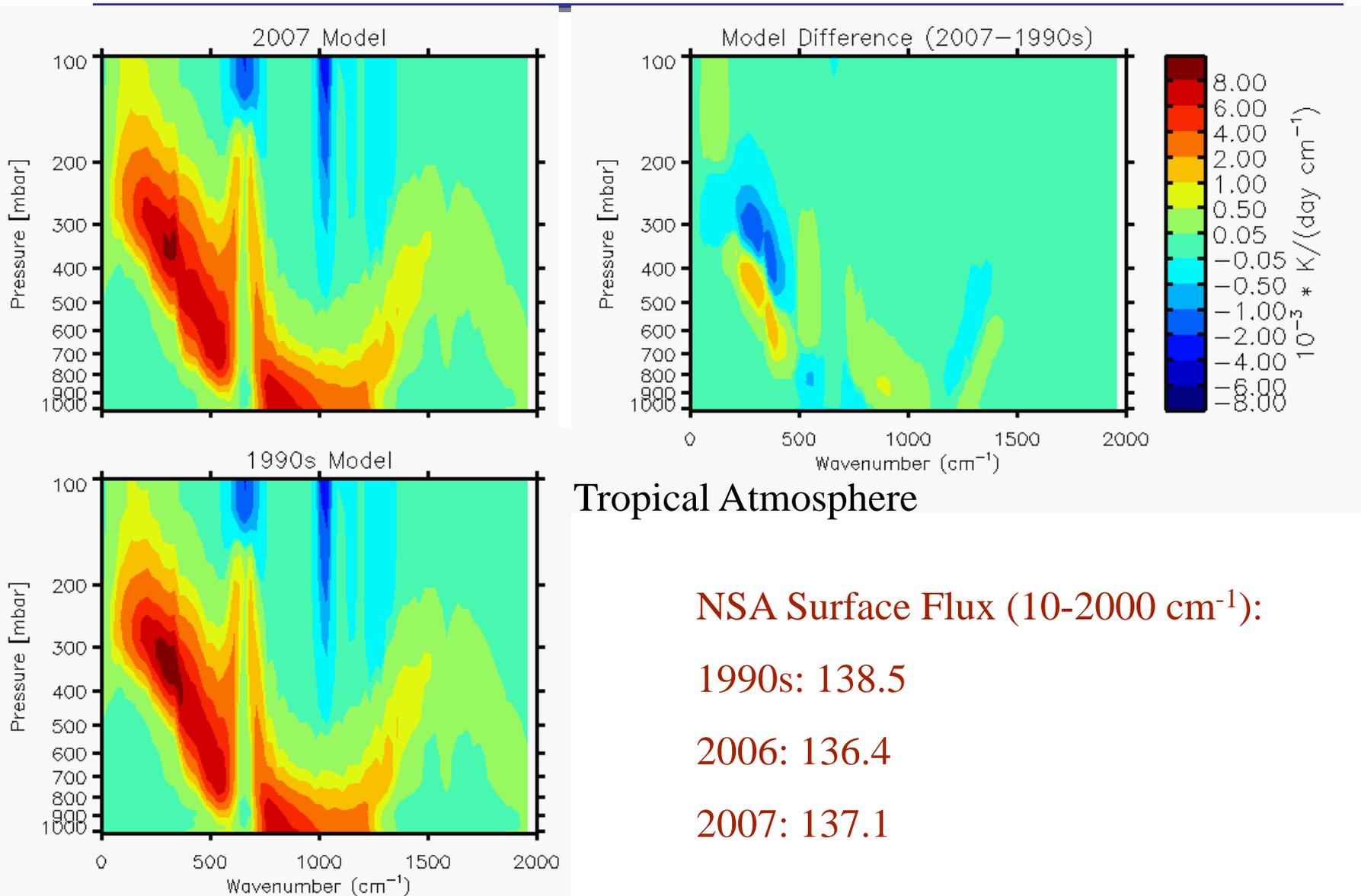








From ~1990s to 2007



Tropical Atmosphere

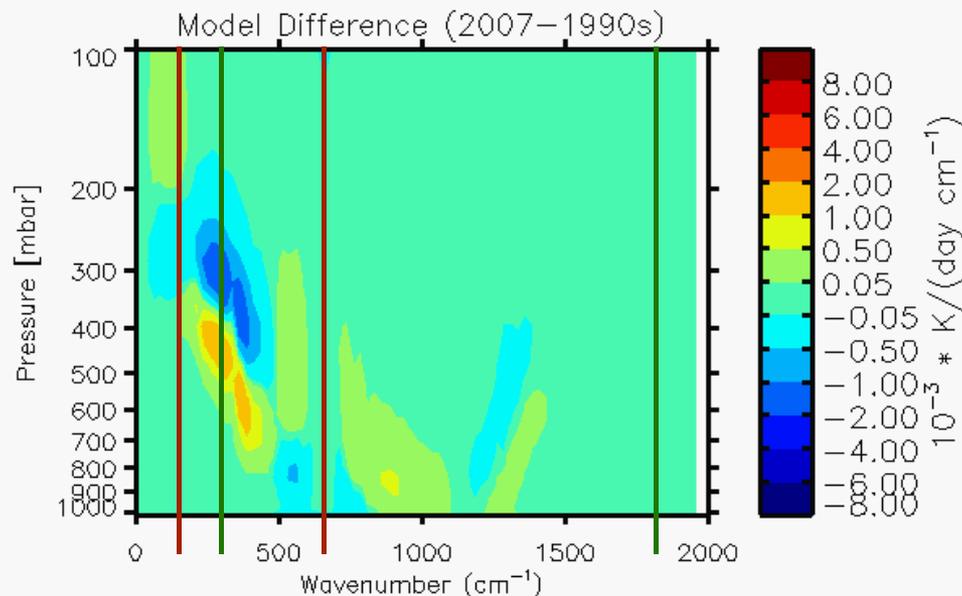
NSA Surface Flux (10-2000 cm^{-1}):

1990s: 138.5

2006: 136.4

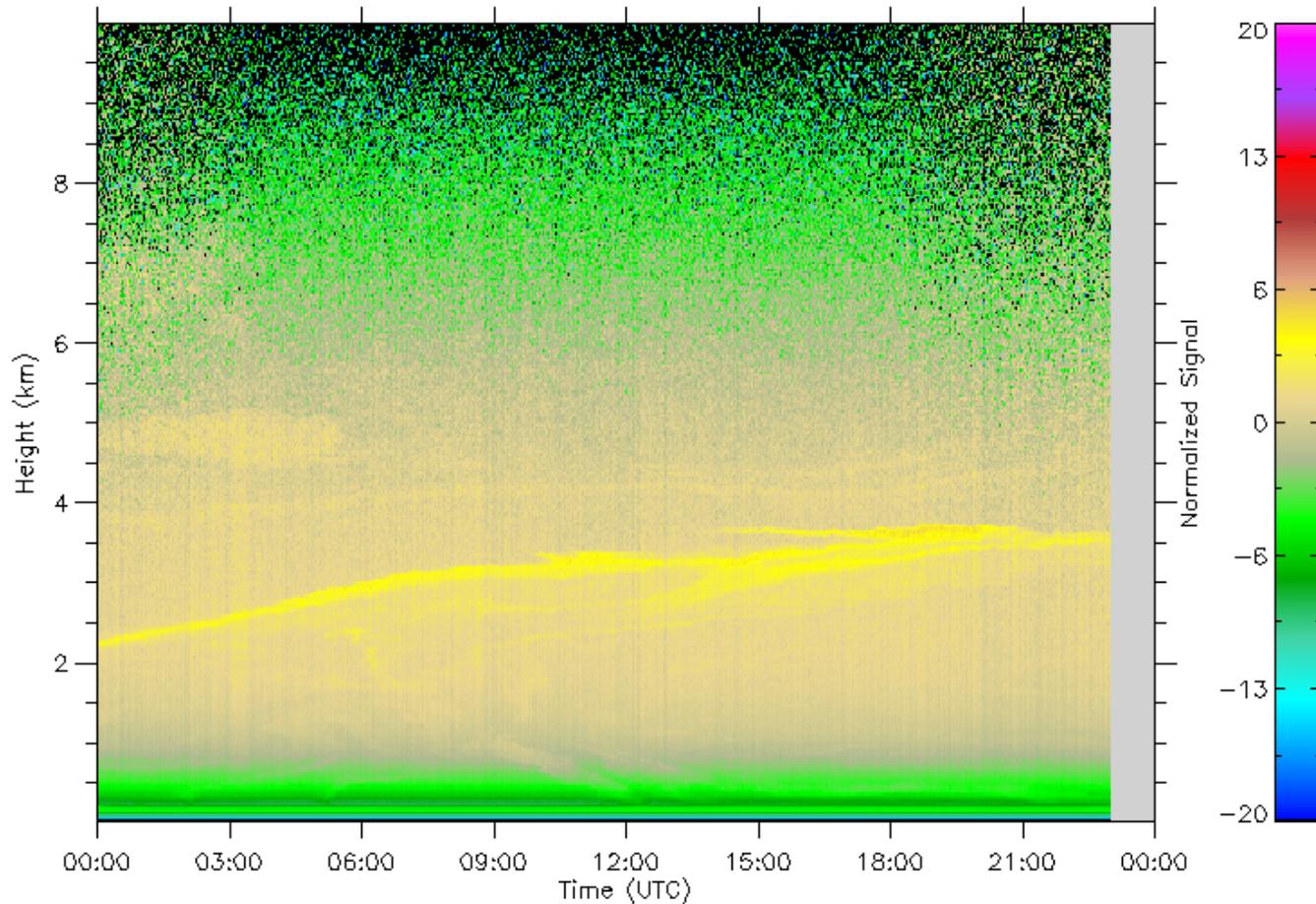
2007: 137.1

- Use remaining RHUBC sondes for control and improvement in far-IR radiative closure studies with AERI-ER
- TAFTS Data: Arriving at the end of September
- Continued update of AER models from our line-by-line to our rapid radiative transfer model (RRTM) \Rightarrow
- Continue examination of the microwave using three 183 GHz instruments at NSA



Just when you think it is clear...

March 4, 2007





- Spectral Residuals are Key!
- Consistency **within a band system**
- Consistency **between bands**
 - AIRS: ν_2 and ν_3 bands to investigate consistency for CO₂
- Consistency **between species**
 - TES: temperature from O₃ and H₂O consistent with CO₂; N₂O
- Consistency **between instruments**
- Consistency **between infrared and microwave**
 - AERI-ER & GVR: low water vapor conditions