

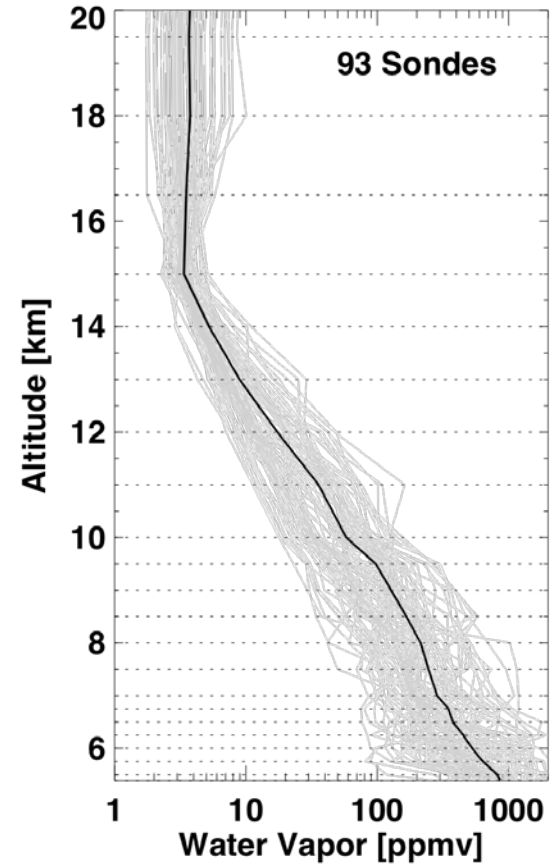
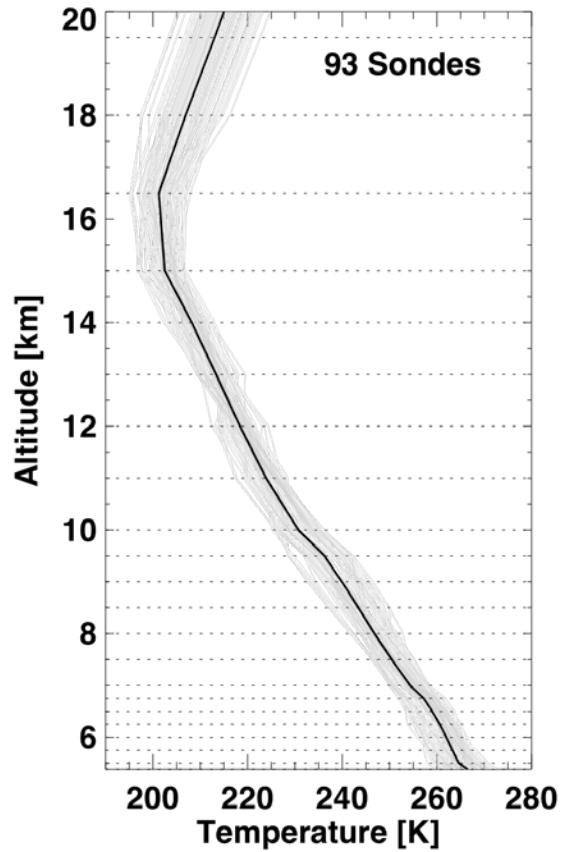
The RHUBC Campaign: Analysis of Water Vapor Profiles

**Eli Mlawer, Jennifer Delamere, Dave Turner, Scott Paine,
Vivienne Payne, Maria Cadeddu, Karen Cady_Pereira**

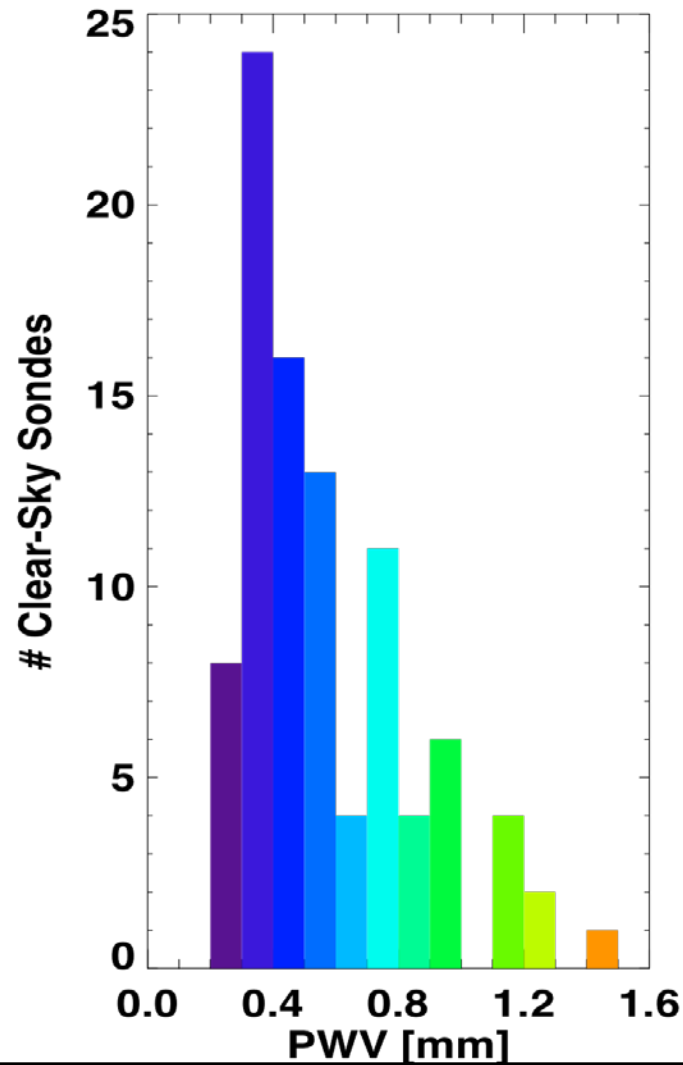
- Water vapor is a key greenhouse gas
- Many years of ARM radiative closure studies have been aimed at improving WV spectroscopy
 - Led to improvements in specification of water vapor profile in atmospheric column above radiometric instruments
- Standard approach used for typical ($PWV > \sim 5$ mm) cases
 - Constant scaling of WV profile to agree with PWV retrieved from 23.8 channel of MWR (channel not sensitive to WV profile)
 - Improves spectral radiative closure agreement in infrared
- For lower PWV such as in RHUBC-I and -II, 22 GHz line is too weak
 - Can use stronger 183 GHz line -- sensitive to WV profile
- Progress has been made in characterizing WV profiles biases
 - Miloshevich et al. (2009)

Preliminary: Analysis is still in early stages

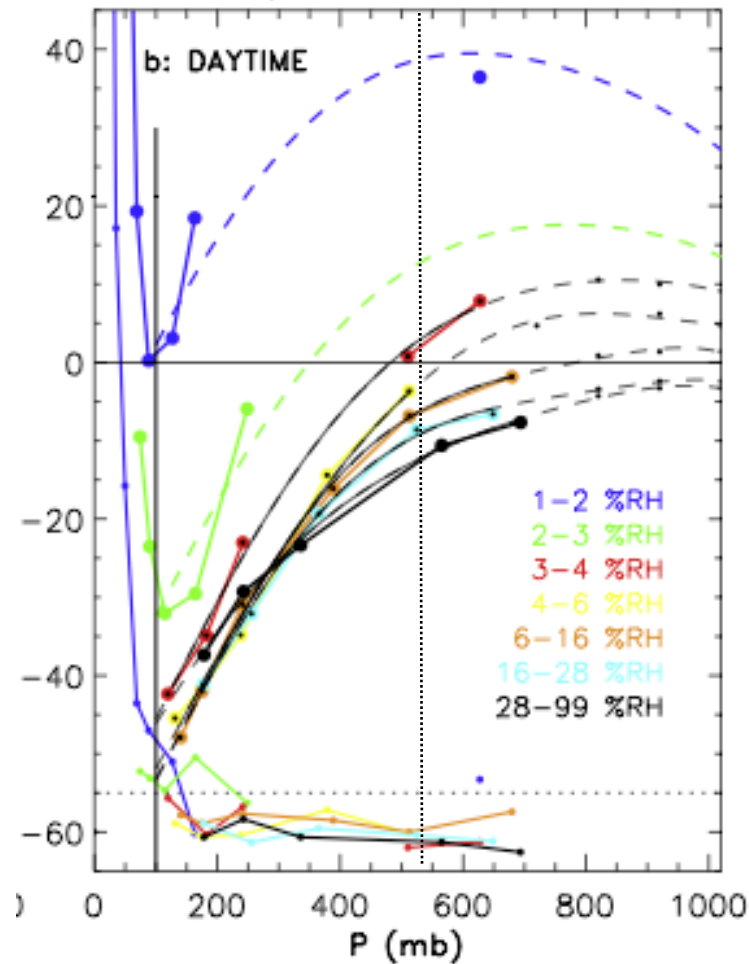
Temperature and WV Profiles during RHUBC-II



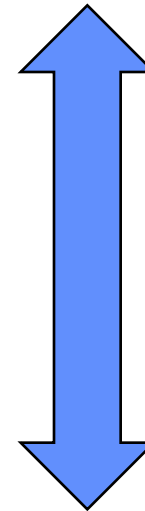
Water Vapor Column Amounts (PWV)



Daytime sonde biases from Miloshevich et al. 2009

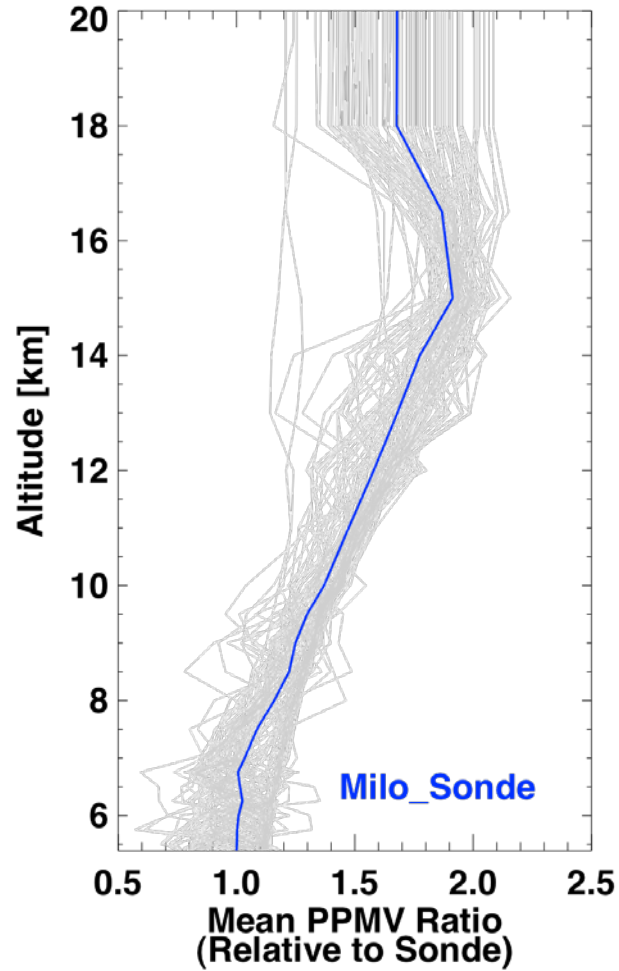


Sonde too moist



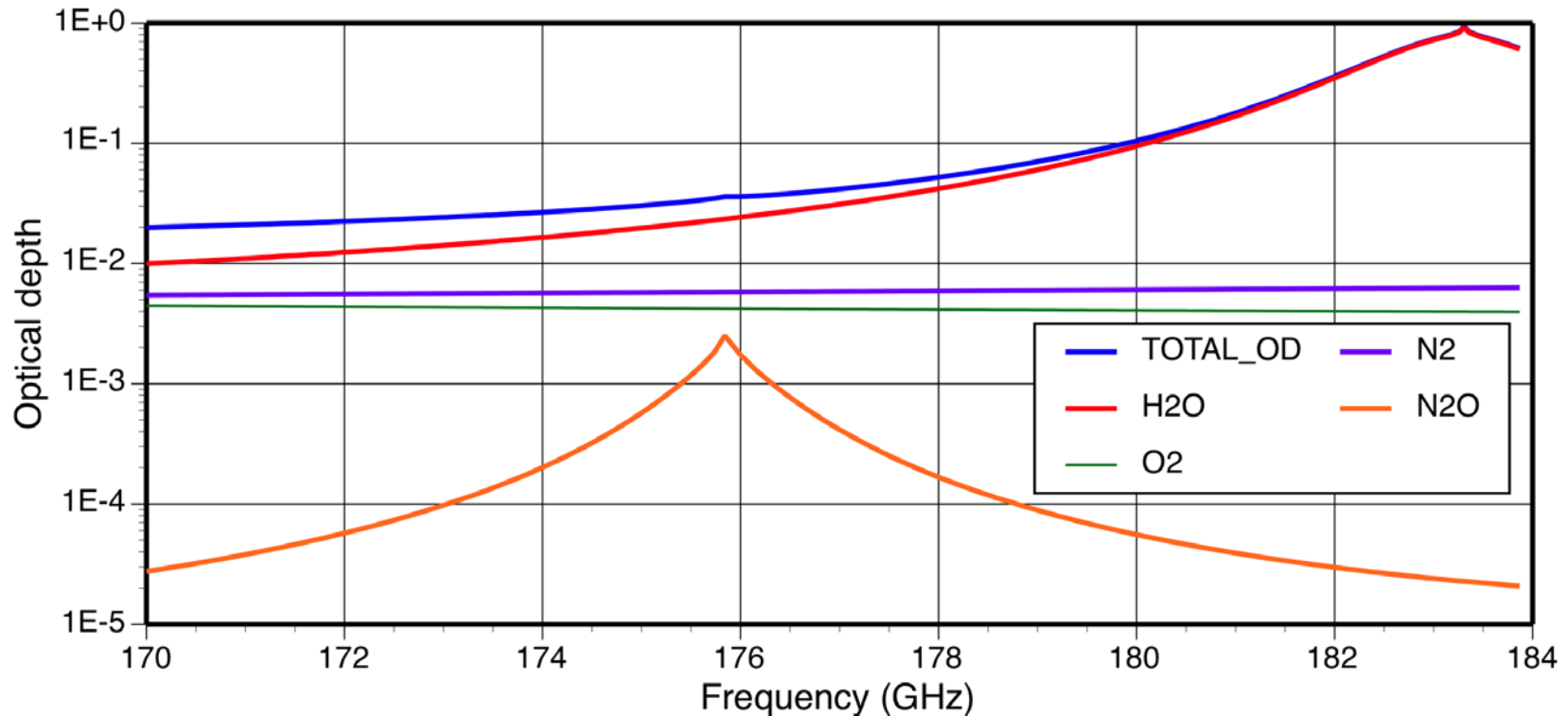
Sonde too dry

Impact of Miloshevich adjustment on RHUBC-II Sonde WV



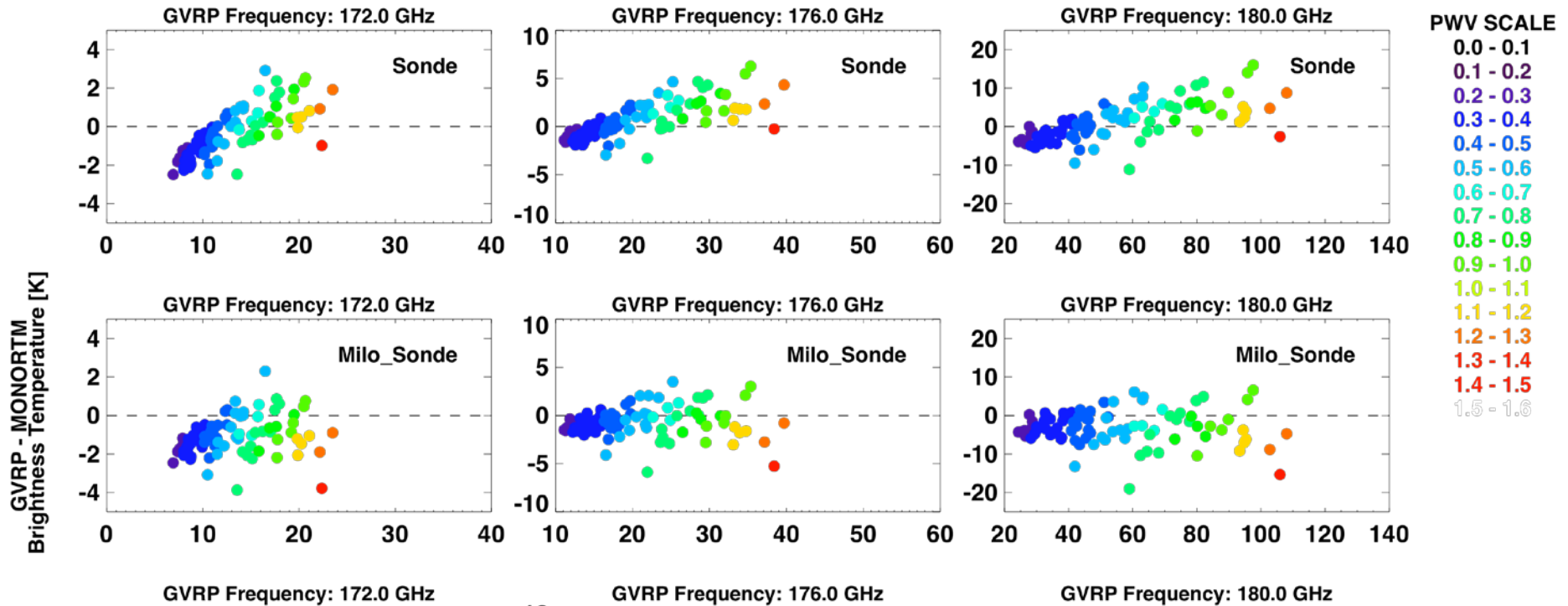
Optical depths in GVRP Spectral Region

9/19, 1530 – 0.28 PWV

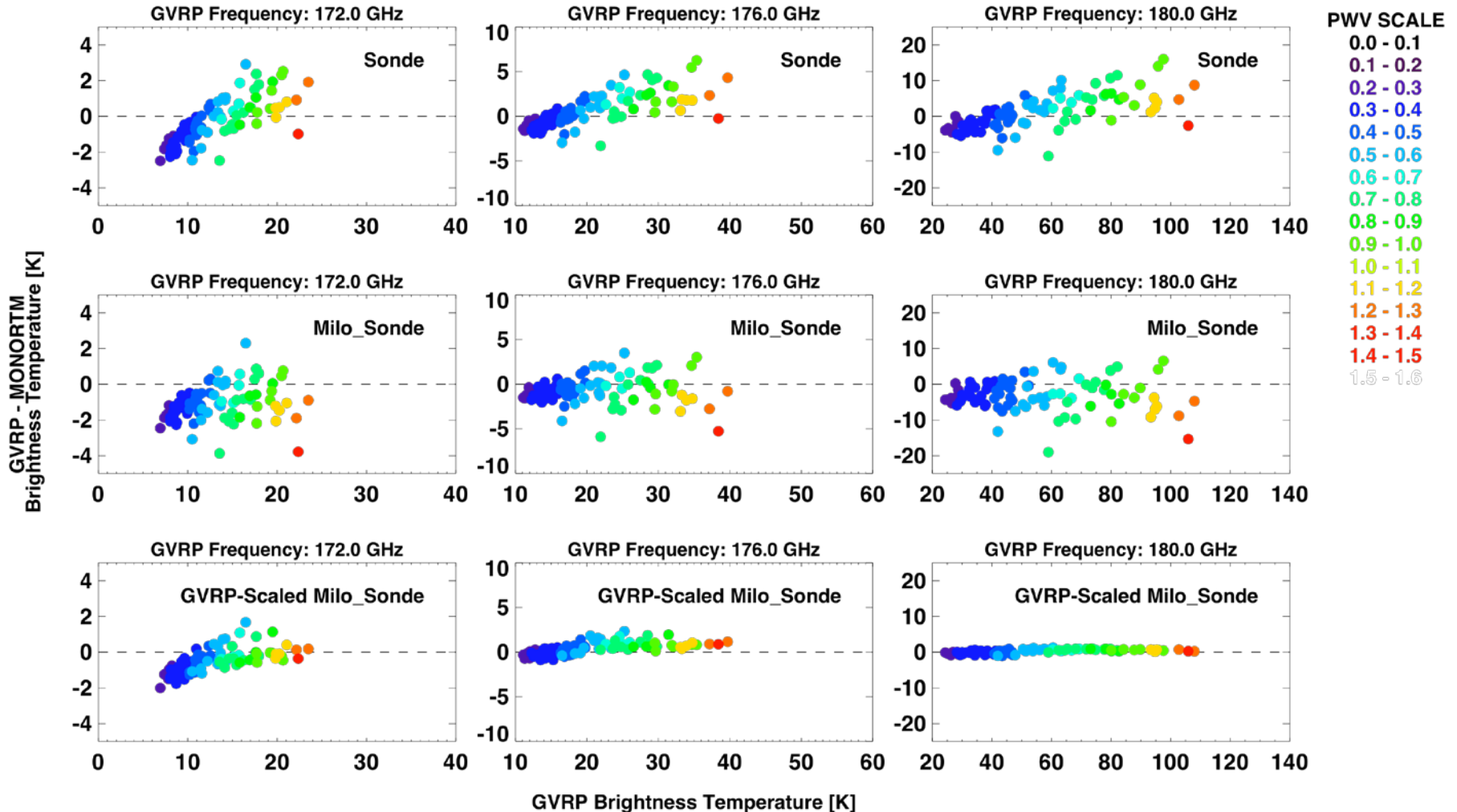


GVRP channels centered at 170, 171, ..., 183, 183.3 GHz

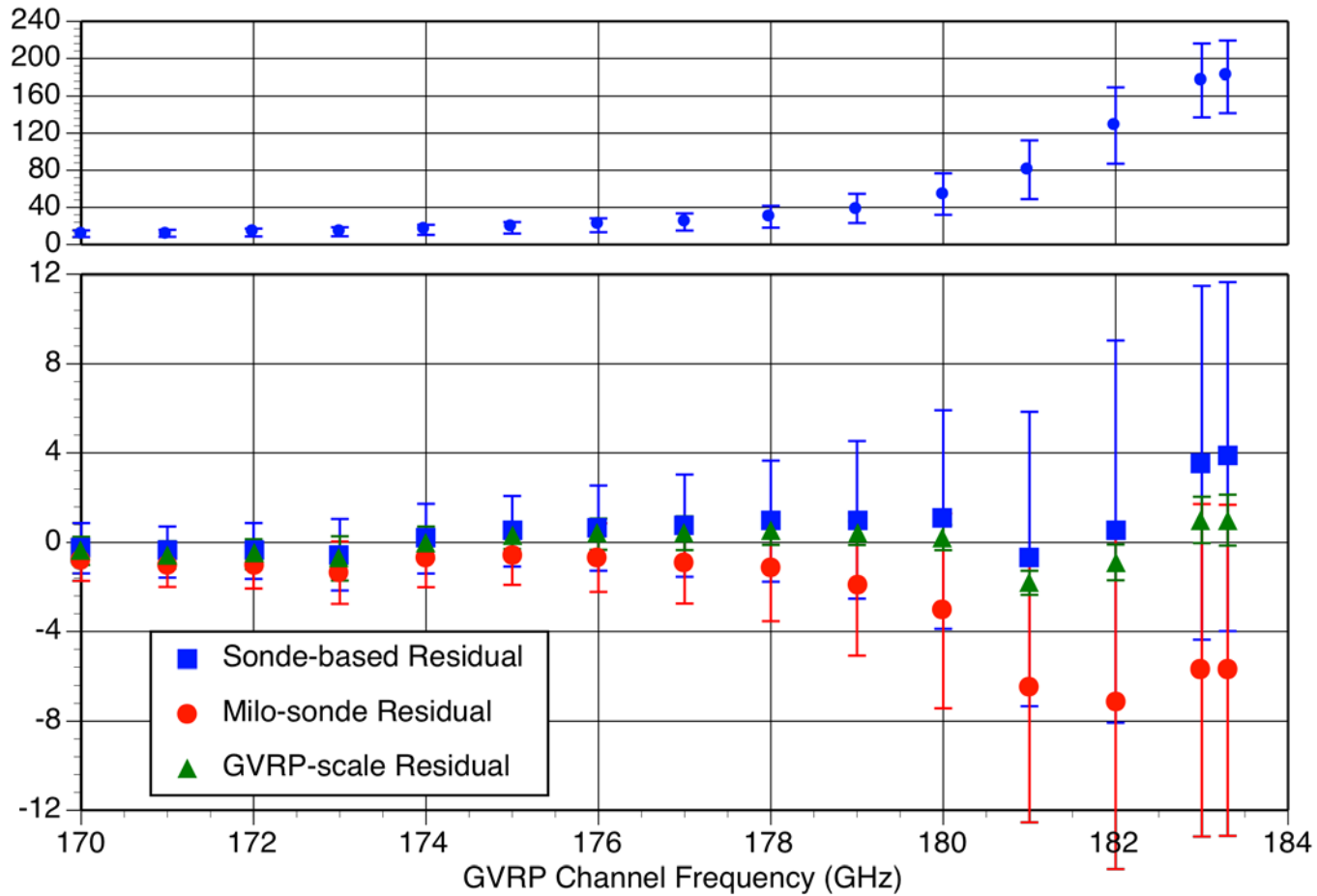
Impact of Miloshevich adjustment on GVRP Residuals



Constant scaling of WV Profiles Using GVRP



Scaling the WV Profiles Using GVRP Channels



Scaling the WV Profiles Using GVRP Channels

From Cimini
et al. (2008)

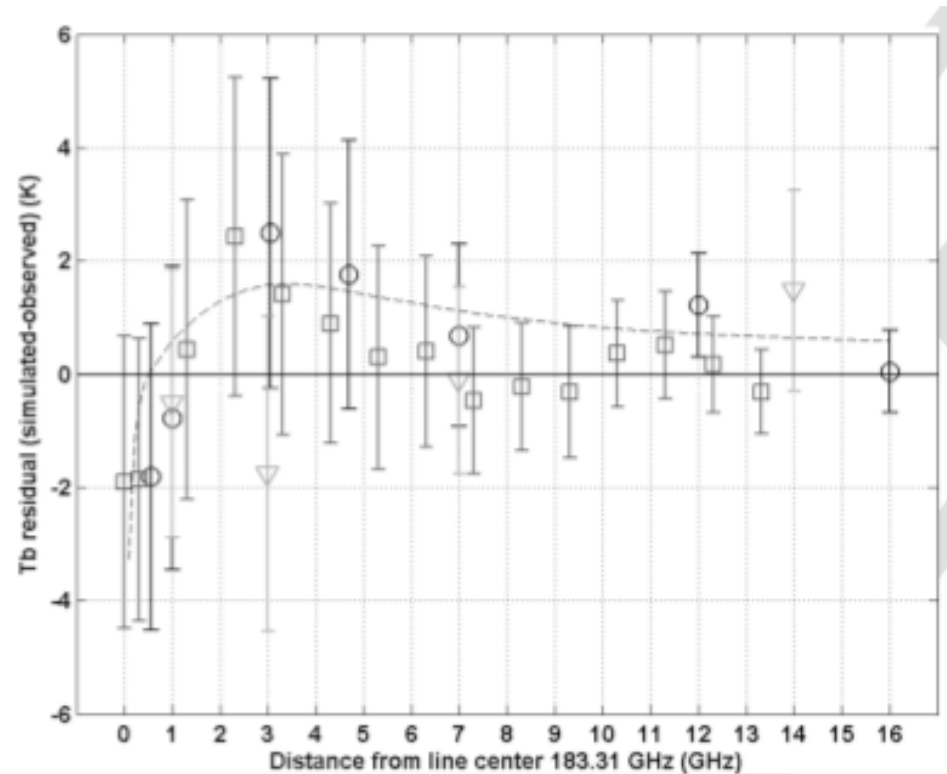
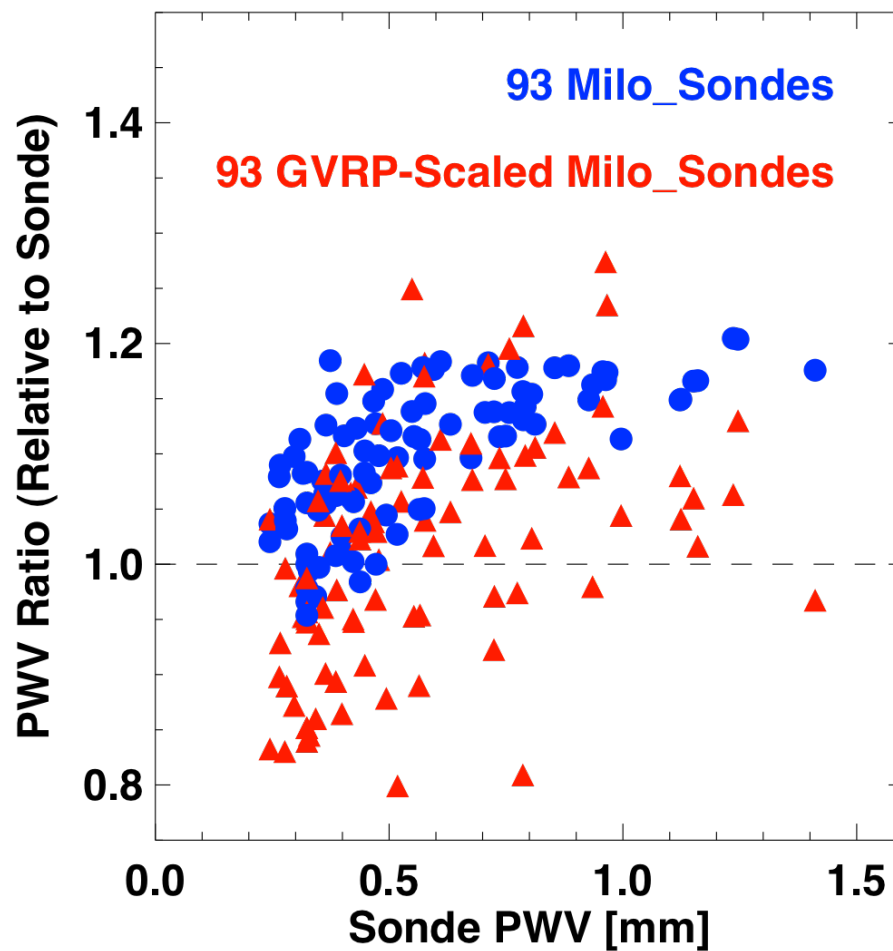
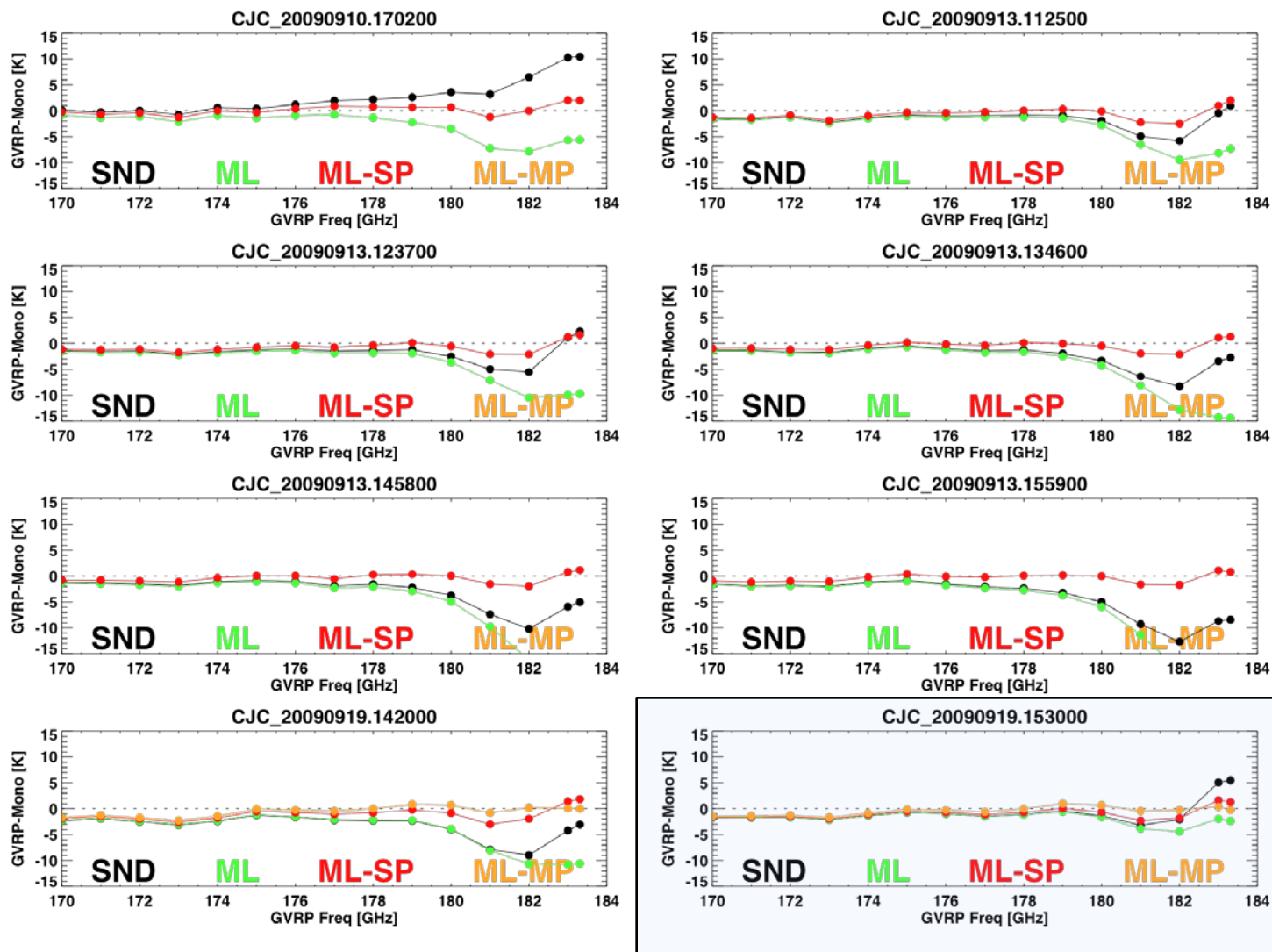


Fig. 5. Tb residuals (simulated minus observed) for (circles) GSR, (triangles) GVR, and (squares) MP-183A versus channels' spectral displacement from line center (183.31 GHz). Markers show the mean residual while error bars indicate ± 1 standard (computed over the set of 38 clear-sky RAOBs). The dashed line indicates calculated Tb differences associated with realistic sensor humidity uncertainty affecting the sounding in an opposite way at lower and upper levels (5% drier above and wetter below a reference level fixed arbitrarily to 3 km).

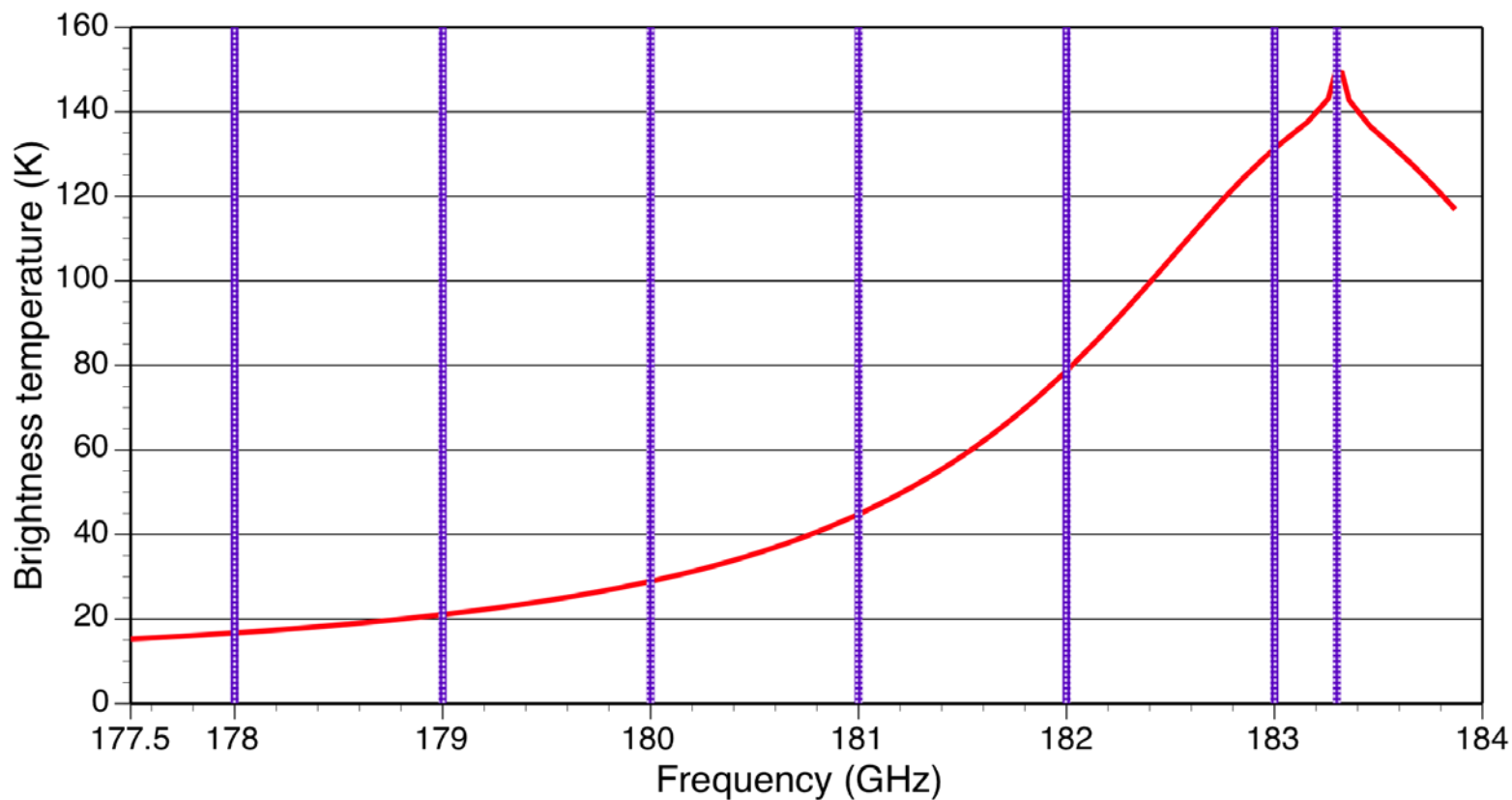
PWV Scale Factors



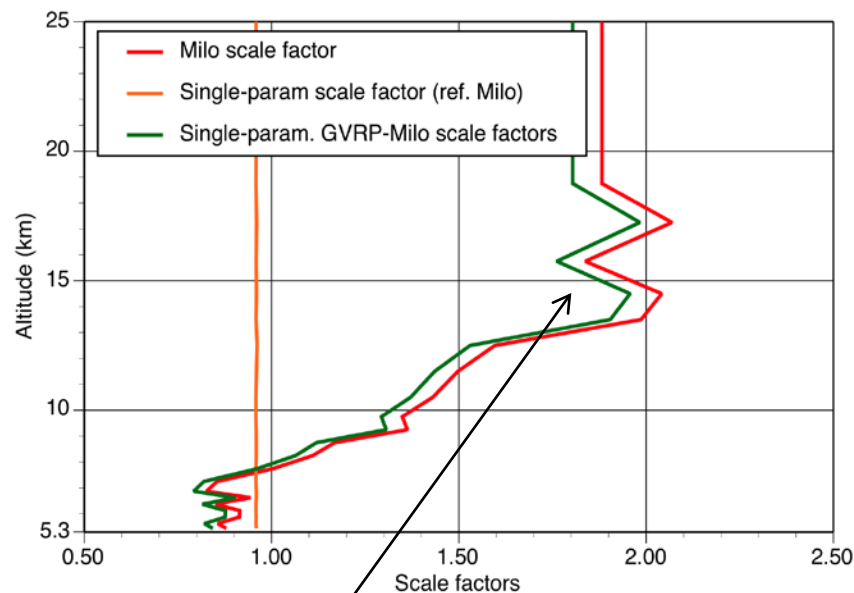
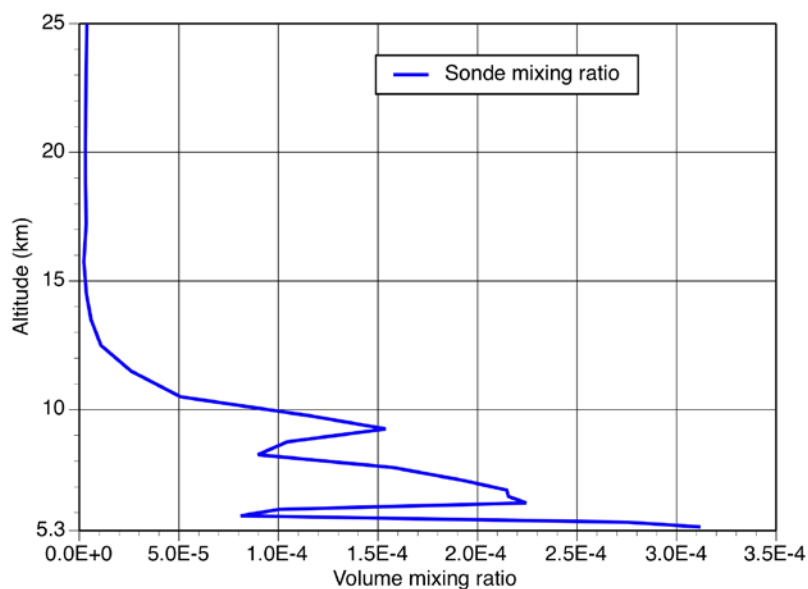
GVRP Residuals from Various WV Profiles



9/19, 1530 UT - GVRP Channels Near Line Center

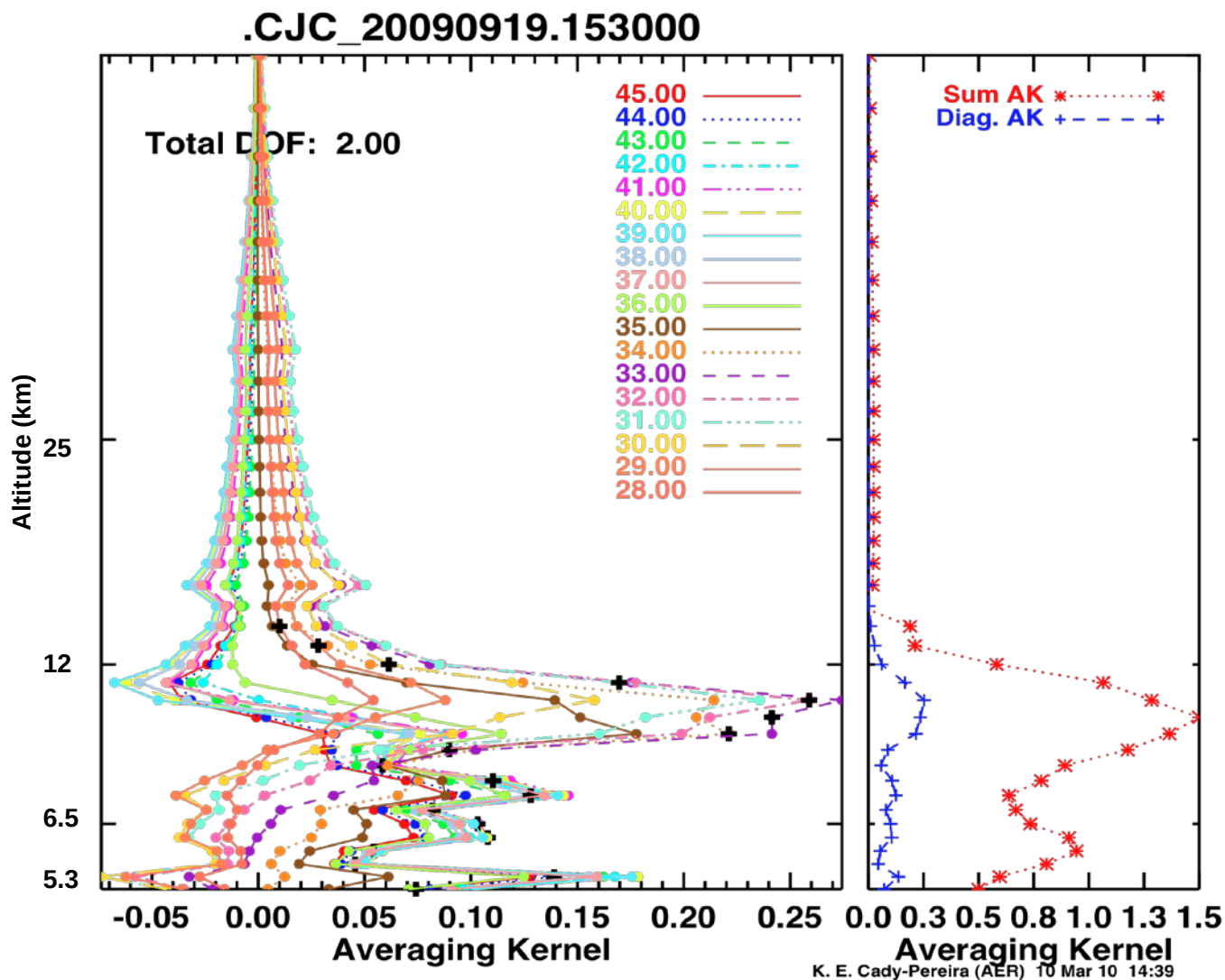


9/19 – 1530UT, PWV ~ 0.27 mm – WV Profiles

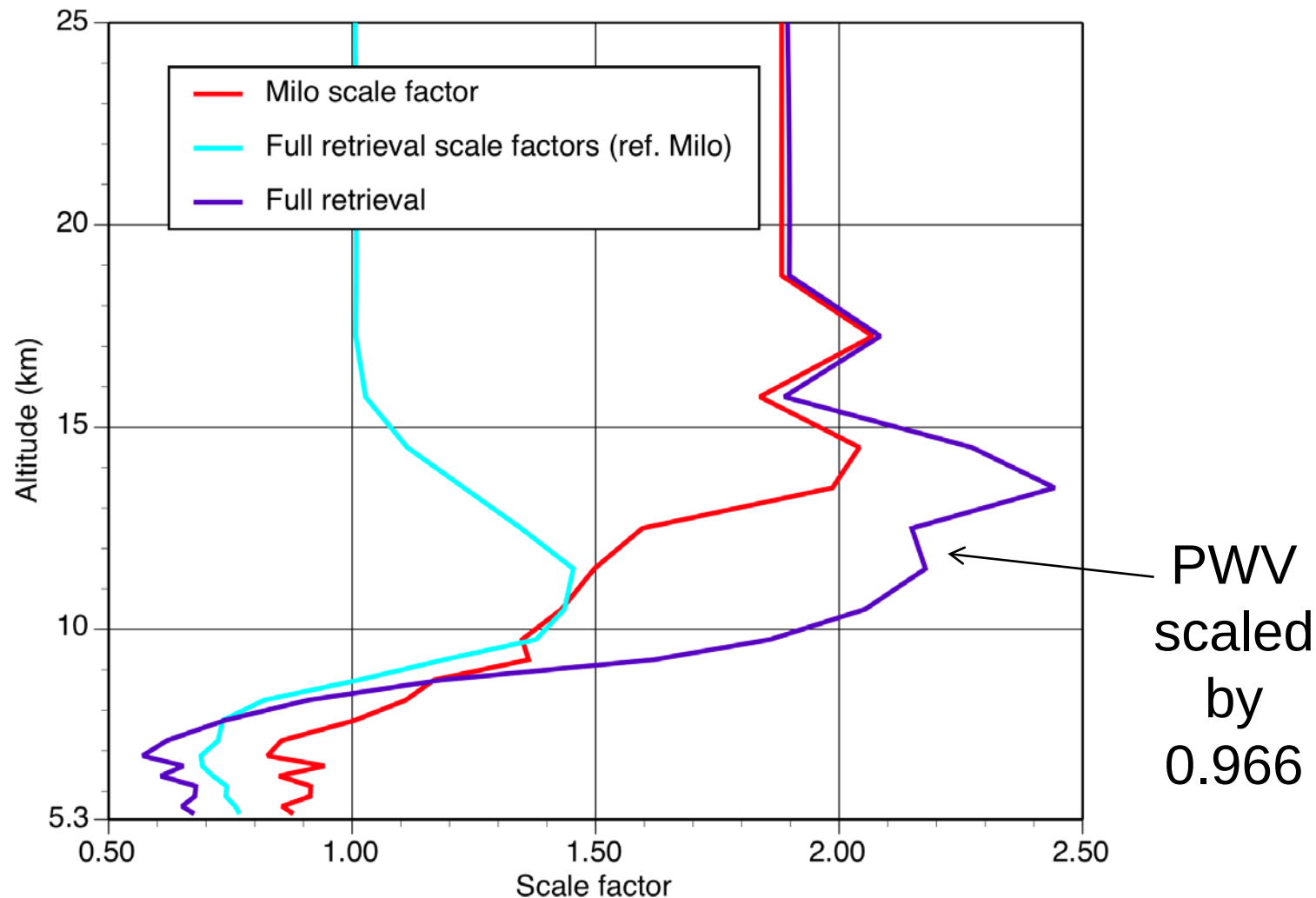


PWV scaled by 0.96

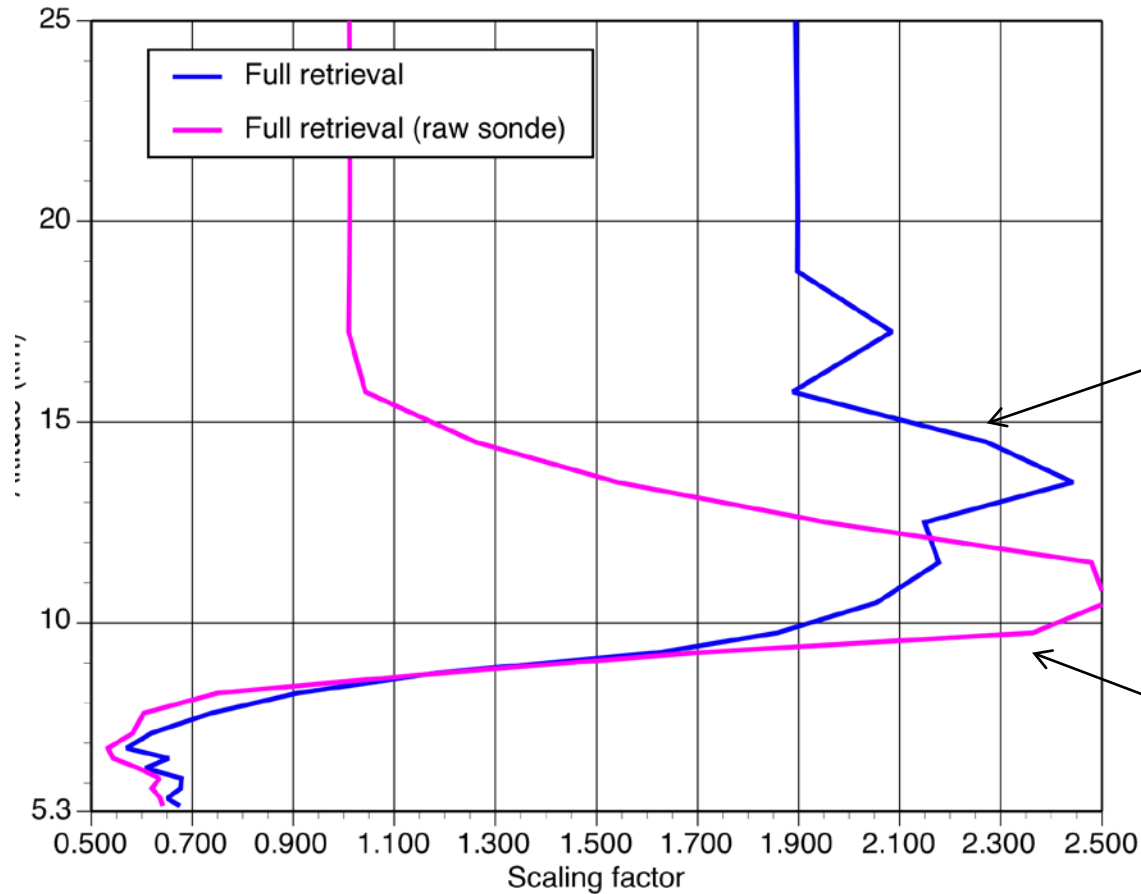
Averaging Kernel from Multi-level Retrieval – 9/19, 1530



Multi-level WV Retrieval – 9/19, 1530

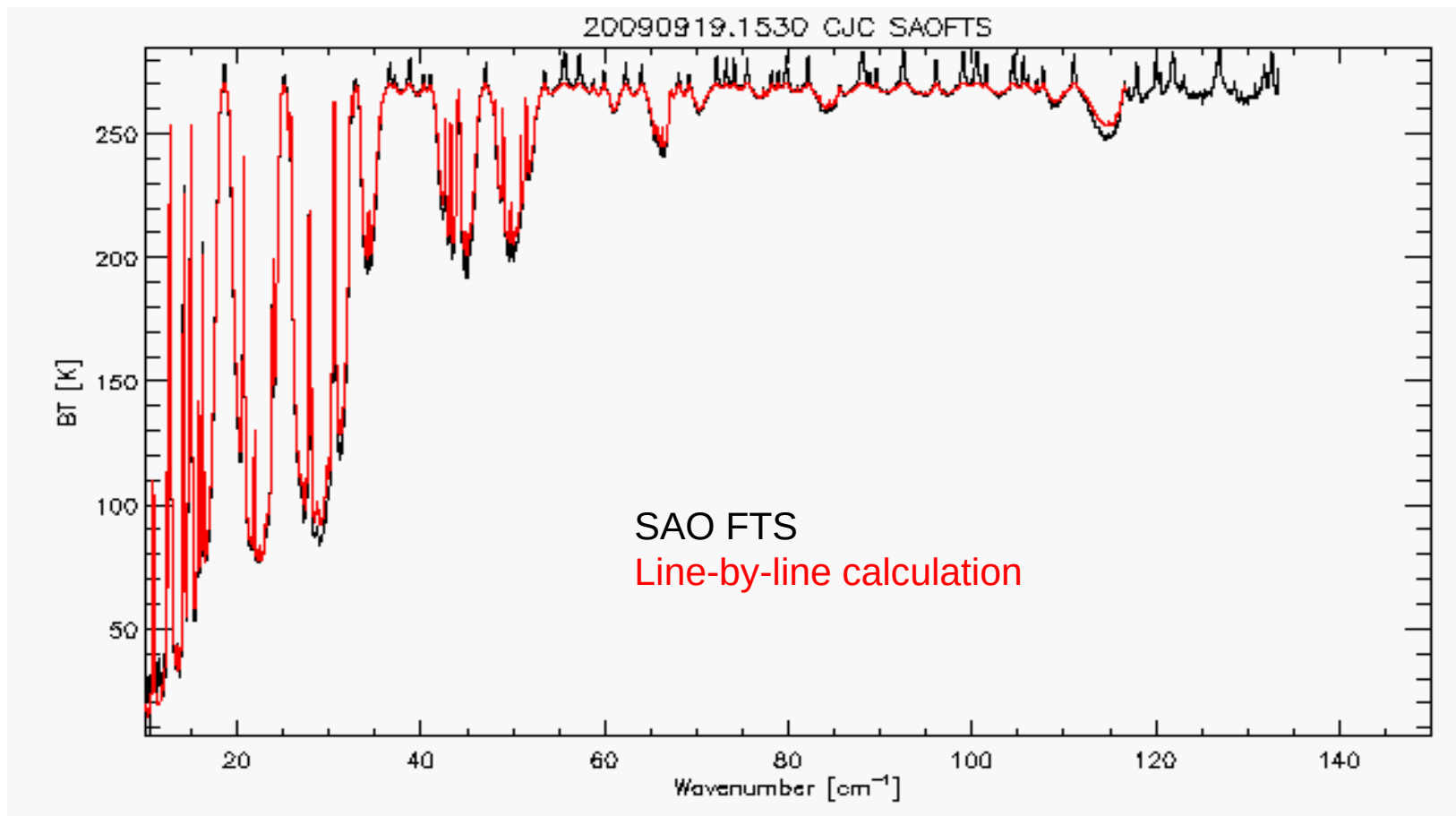


Multi-level WV Retrieval with Different Initial Guess/A Priori – 9/19, 1530

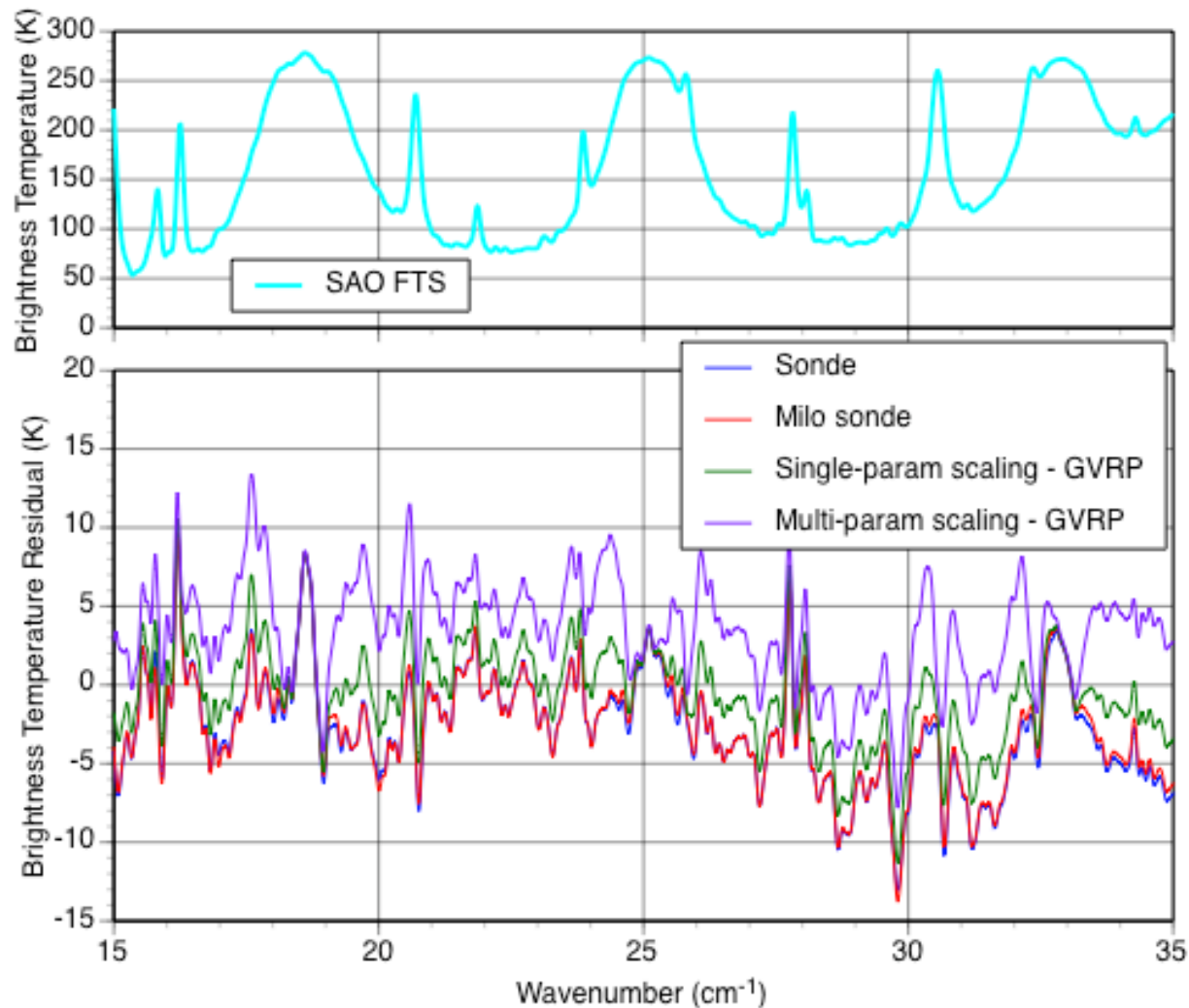


First look at Radiative Closure – 9/19, 1530

SAO FTS – zenith radiance from 300-3500 GHz (resolution 3 GHz)



First look at Radiative Closure – 9/19, 1530



Summary

- **Water vapor profile important for radiative closure analysis in sub-mm and far-IR**
 - **determination of WV continuum, other spectroscopic parameters**
- **Miloshevich et al. adjustments improved GVRP agreement for higher PWV cases**
- **Spectral GVRP-model residuals show consistent pattern**
 - **Consistent with results of RHUBC-I**
 - **WV retrievals show large decreases near surface and large increases in mid-troposphere**
 - **Cause under investigation**