An Update on the AERIoe Retrieval Algorithm

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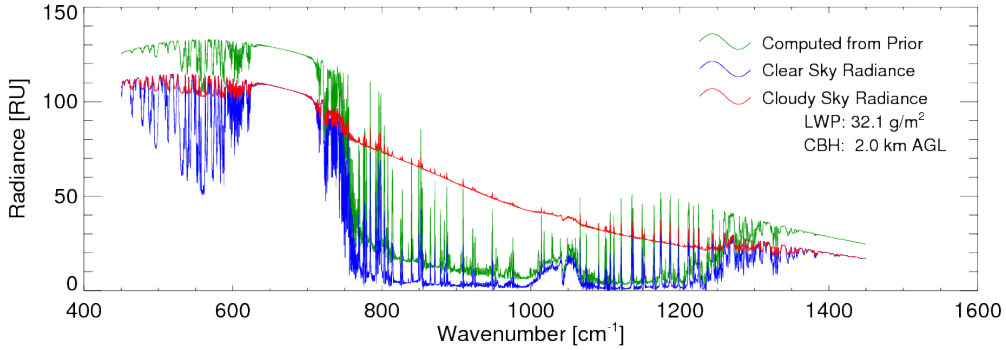
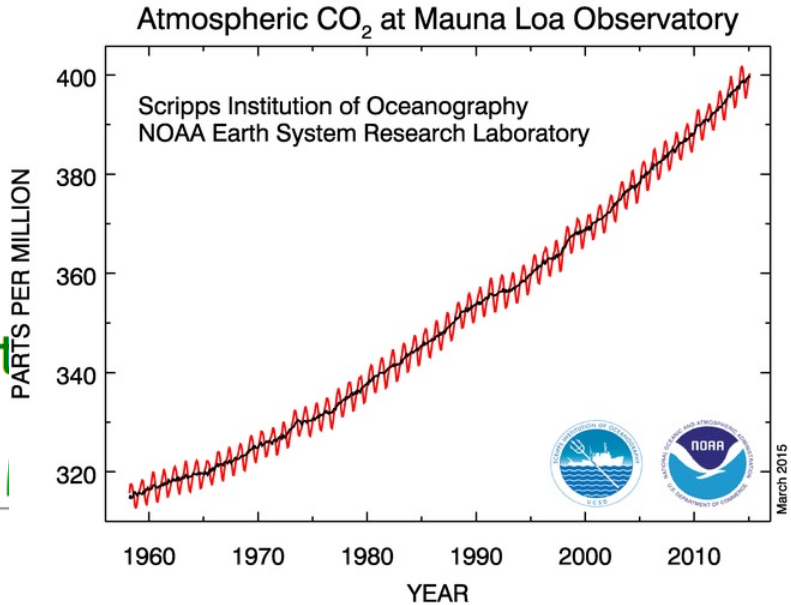
AERI Thermodynamic Retrieval Background

- AERI observes downwelling infrared radiance at high temporal (30-s) and spectral (1 cm^{-1}) resolution



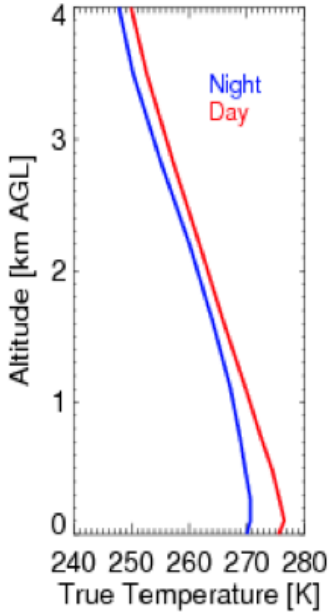
- IR radiance has information on the profile of temperature (T) and humidity (q), as well as cloud properties
- Current AERI retrieval algorithm (AERIprof) developed in early 2000s, and has limitations:
  - Only able to retrieve T/q in cases with no cloud overhead
  - No uncertainty analysis provided with each retrieval
  - Carbon dioxide concentration fixed to 380 ppm (and unable to change)
  - Fixed fast RT model; unable to change for improved spectroscopy

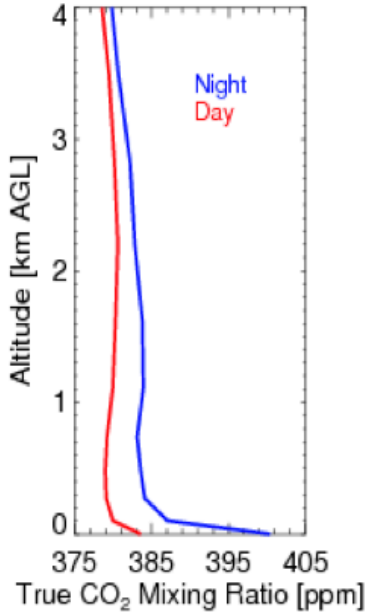
Sensitivity of Retrieved T Profile to CO_2 Concentration

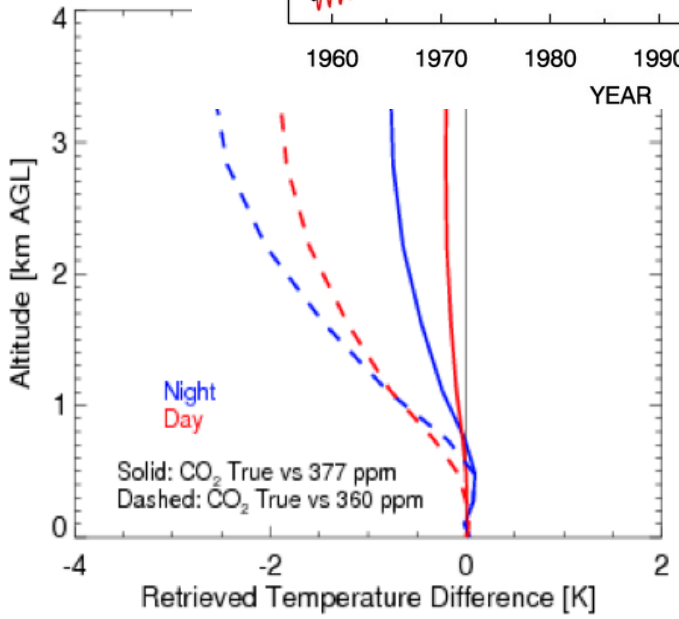


Impact Using Assumed vs. True CO_2 Profile

Constant







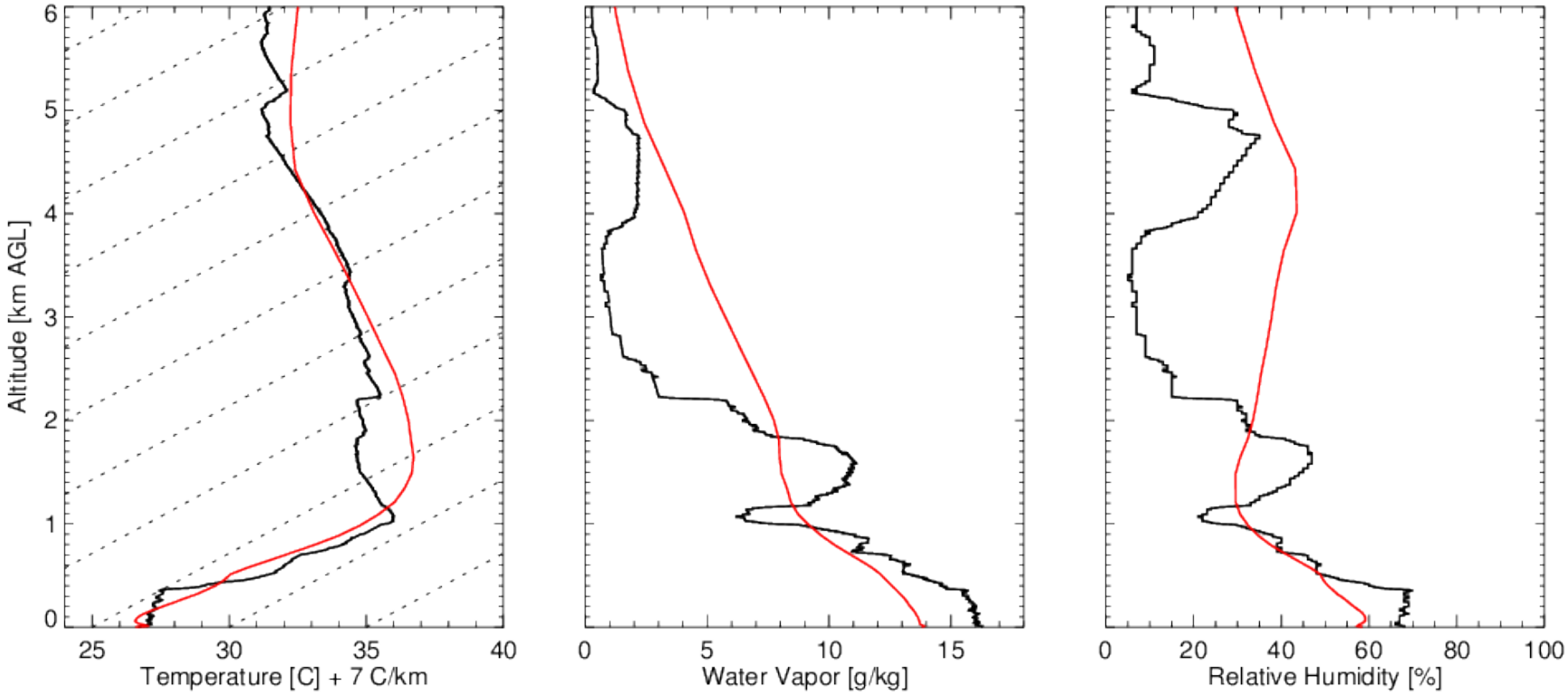
AERIoe Retrieval Background

- A physical-iterative method (like AERIprof)
- Use the LBLRTM as the forward model
  - Always have latest spectroscopy
  - Can use any trace gas (e.g., CO_2) amounts desired
- Use optimal-estimation framework
  - Propagate uncertainties into retrieved solution
  - Uses prior information (climatology of sonde data) to constrain solution (as retrieval is an ill-posed problem)
- Retrieves cloud properties and thermodynamic profiles simultaneously
  - Developed method to overcome bad first guess
    - Method converges and provides solution over 95% of the time
  - Able to also retrieve trace gas amounts (CO_2, CH_4, N_20)
- Ultimate goal: To replace AERIprof and MIXCRA

T(z)
q(z)
LWP
$R_{eff,liq}$
Tau_{ice}
$R_{eff,ice}$

AERIoe Example Profile

- Example from PECAN
  - Ellis, KS on 22 June 2015 at 0600 UTC
- Inputs: AERI radiances, CBH from lidar



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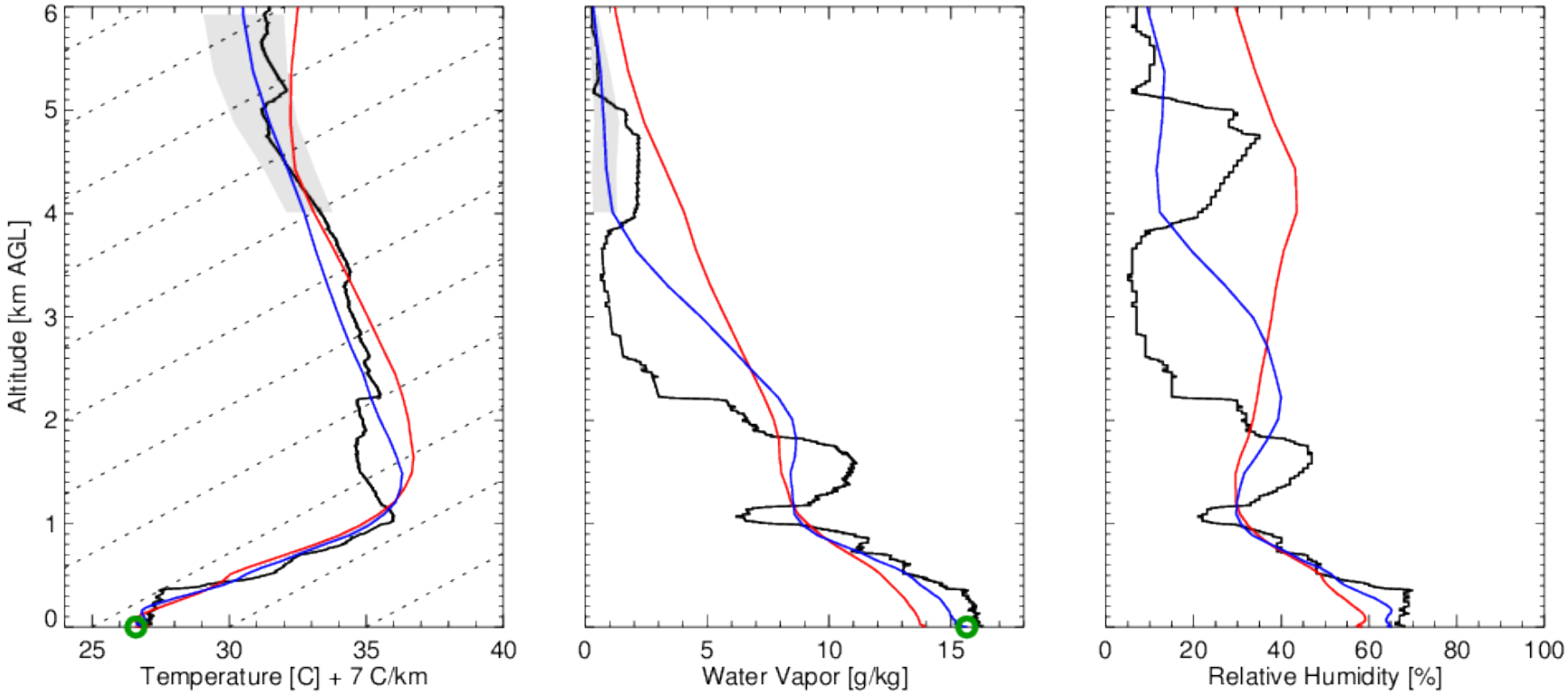

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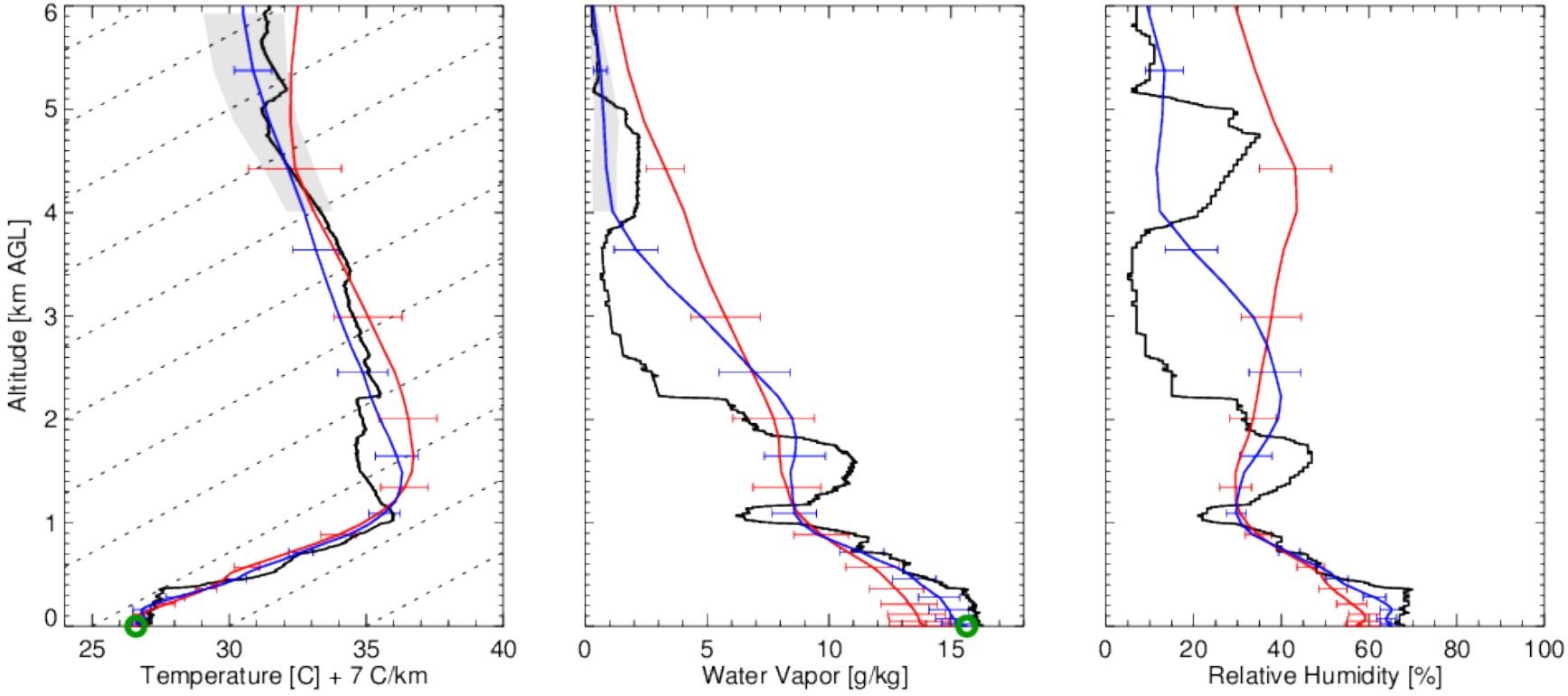


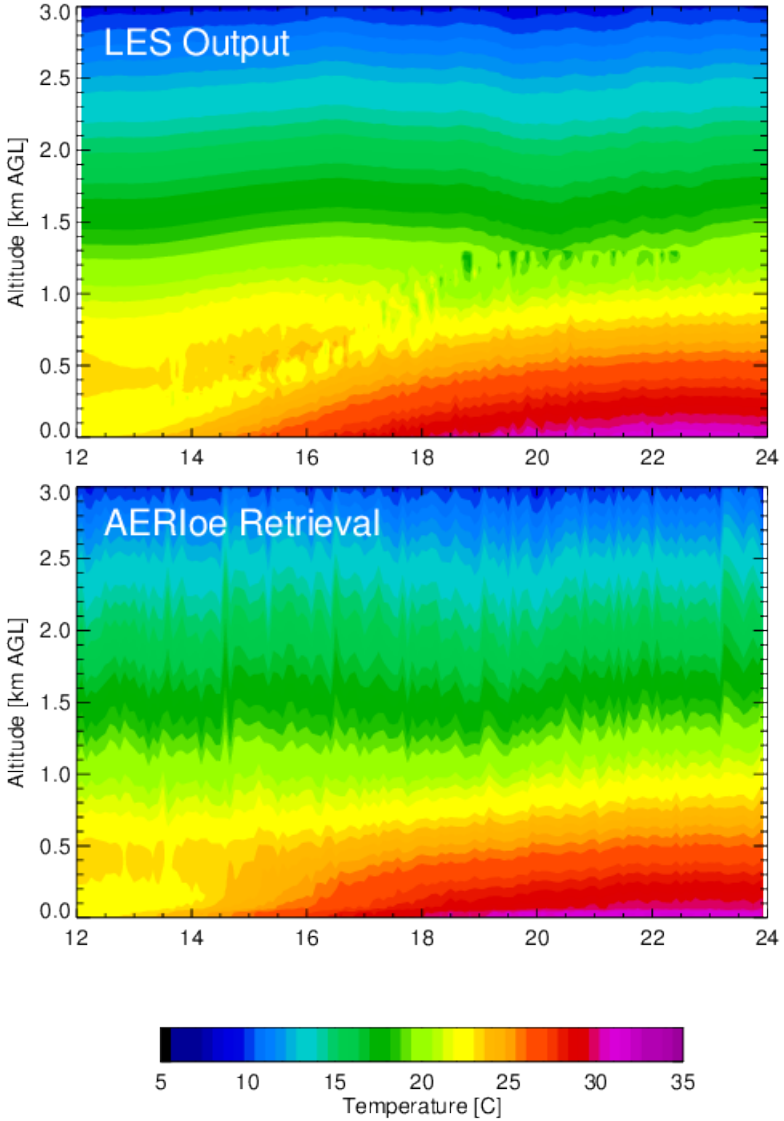
LES-based OSSE

(Observation System Simulation Experiment)

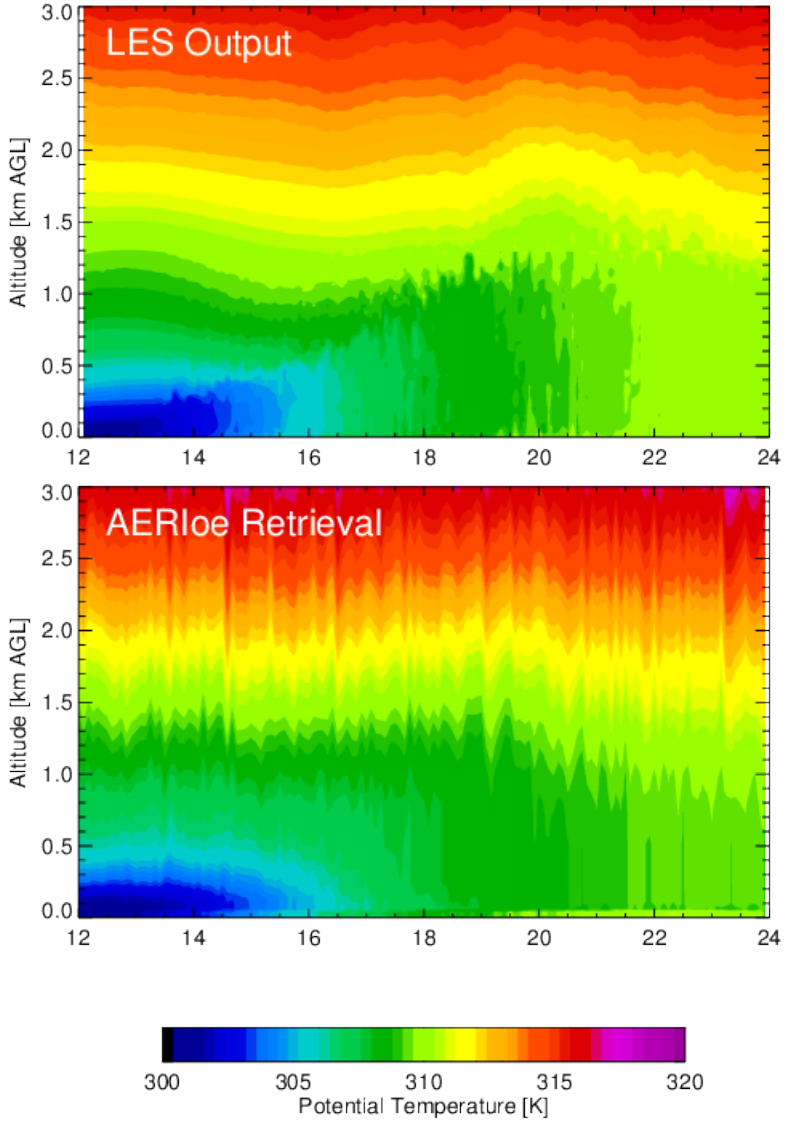
- Used LES to simulate a convective boundary layer
  - Case is 24 July 2008 (Thijs Heus presentation on Wednesday)
- Simulate AERI observations
  - Compute downwelling IR radiance at 30-s resolution
  - Convolve with AERI instrument function
  - Added random noise
- Apply the PCA-based noise filter
  - Principal components derived from real AERI obs at SGP in July 2015
- Run AERIoe retrieval
  - Use prior dataset derived from SGP radiosondes for July
- Compare retrieved profiles with LES truth profiles

OSSE Results

Ambient Temperature

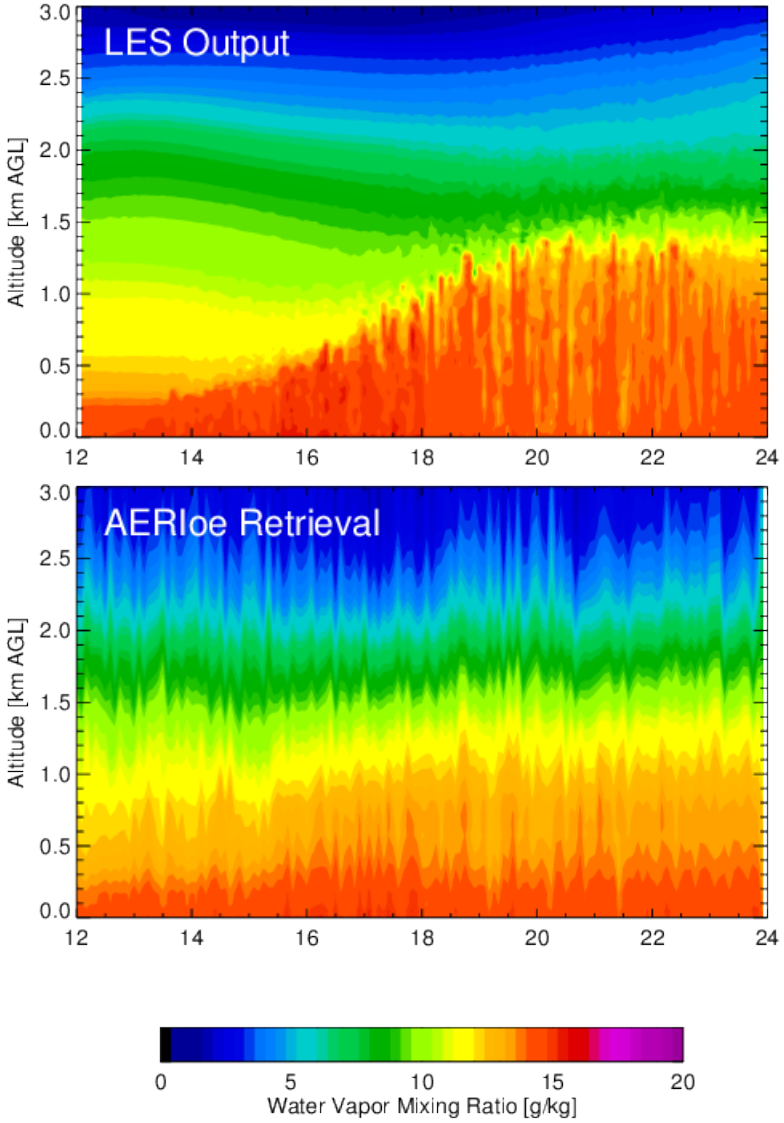


Potential Temperature (θ_v)

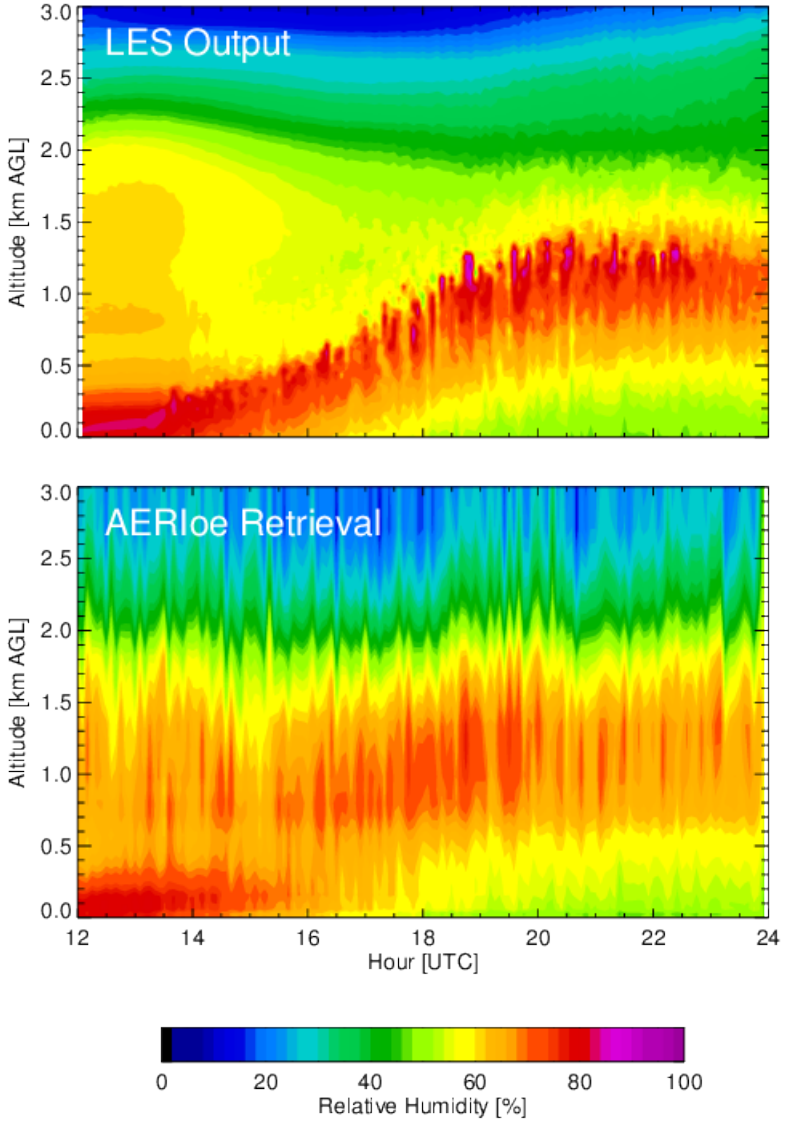


OSSE Results

Water Vapor Mixing Ratio

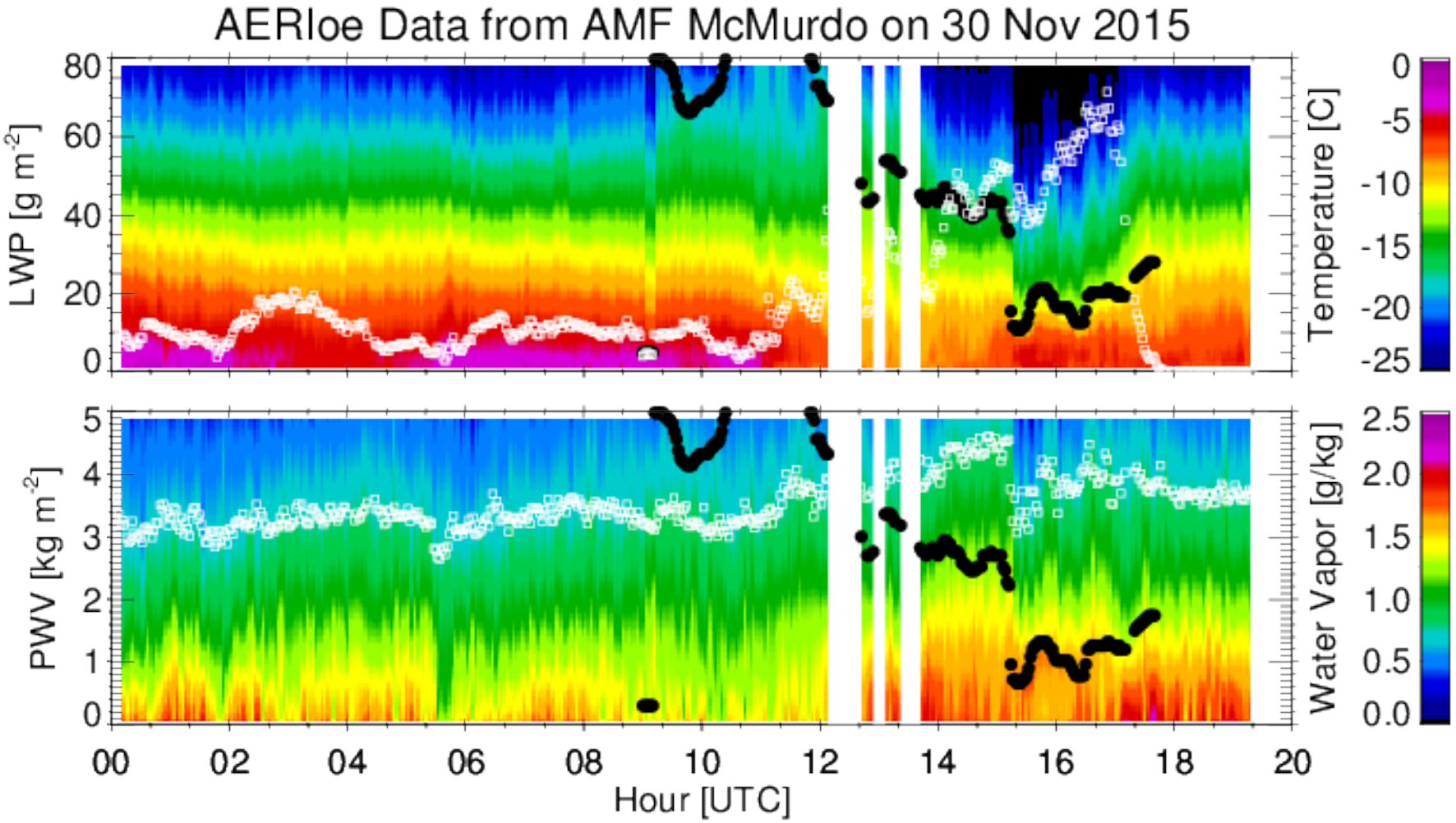


Relative Humidity



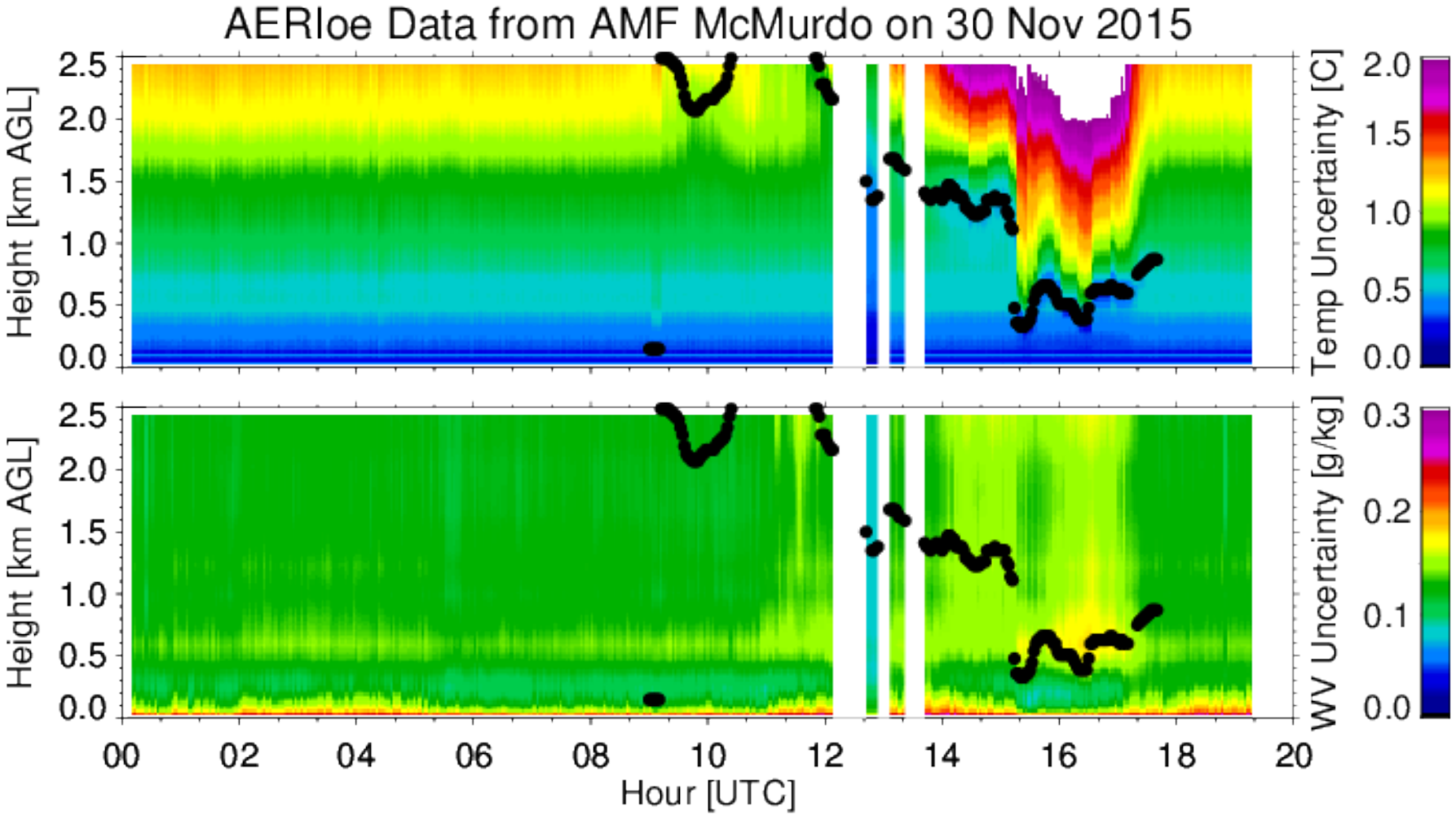
AERIoe Results from AWARE

- Computed new prior constraint dataset
- Ran retrieval



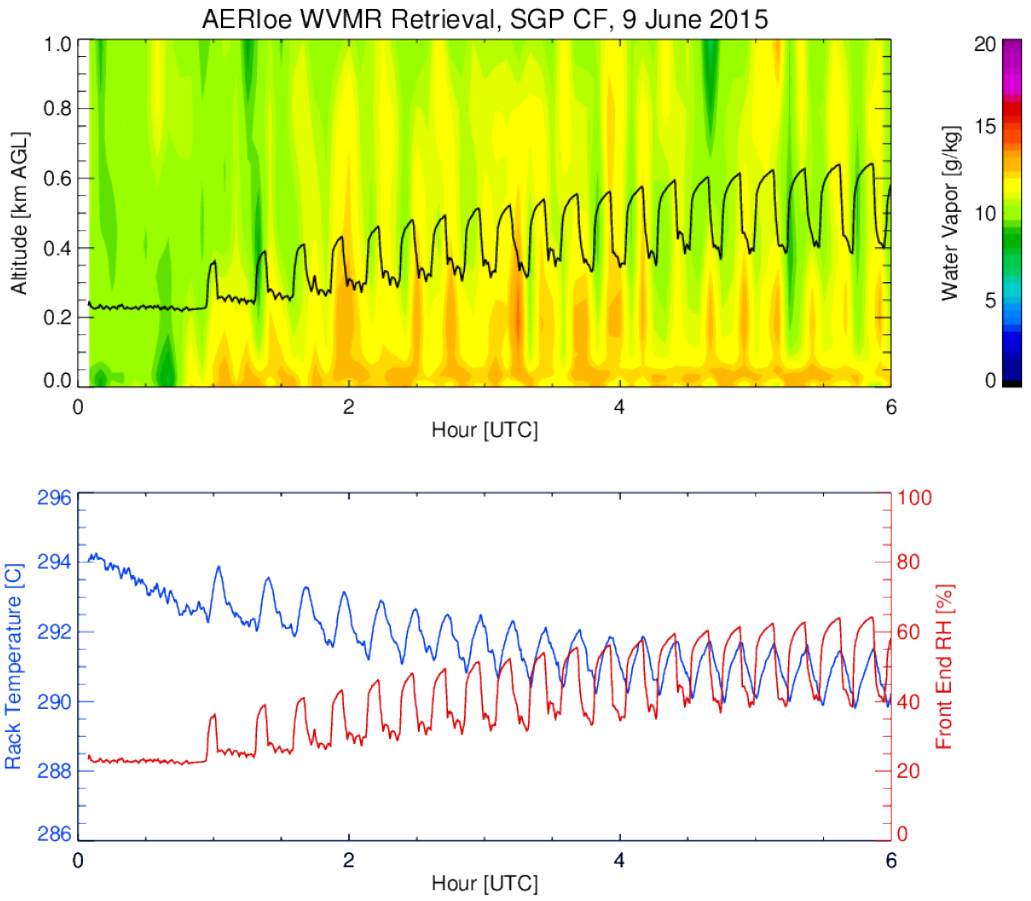
AERIoe Results from AWARE

- Uncertainties provided automatically
- Always be careful of retrieved profiles above cloud base

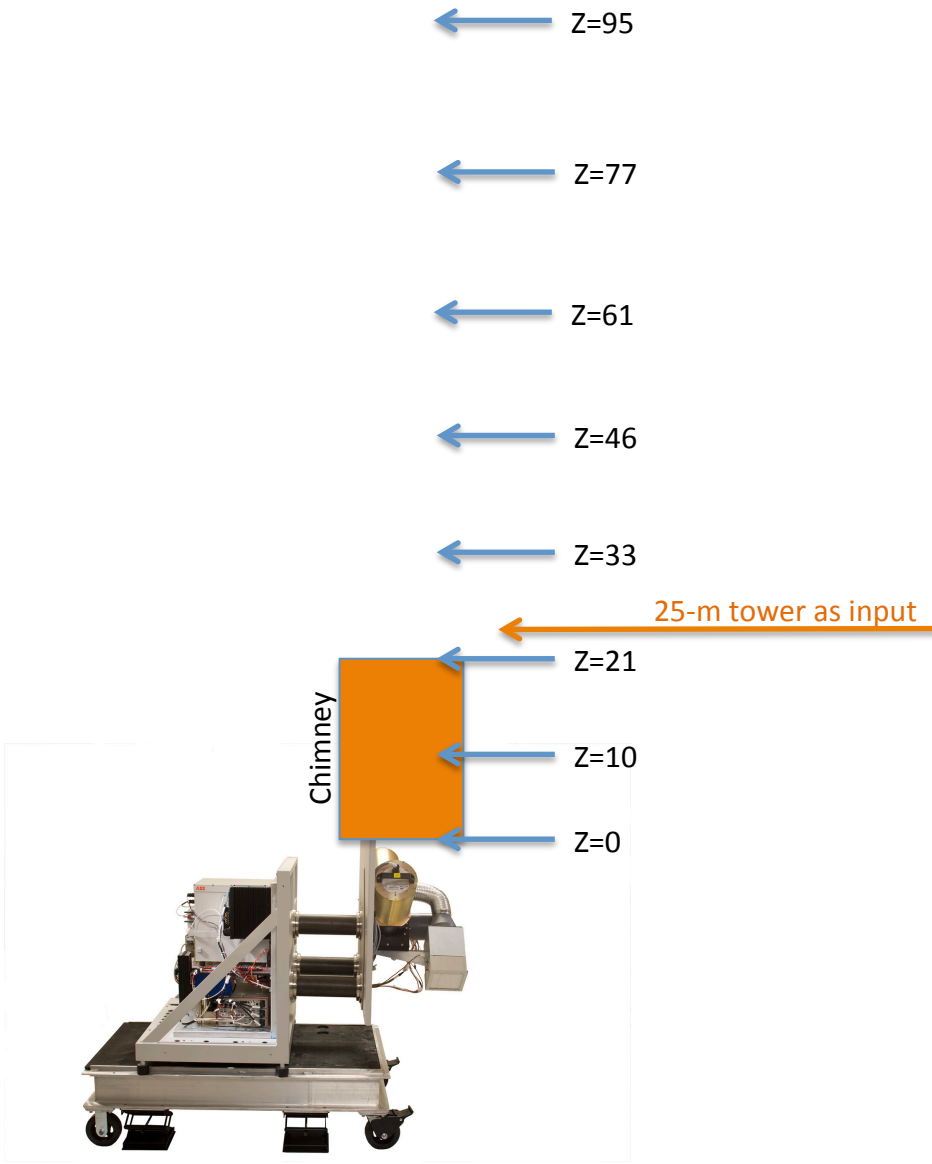


A Challenge at SGP Central Facility

- Oscillations noted in AERI radiance data occasionally
  - Seen in both the v4 AERI and the AERI-01
- Oscillations in radiance result in oscillations in retrieved profiles (esp water vapor)
- Mentor has traced problem to air “leaking” from optical trailer into the AERI front end
- Problem resolved Feb 2016, but need to handle historical data



Possible Approach: Insert a Chimney



SGP's 60-m tower (with obs at 25-m also)

Summary

- AERIoe algorithm becomes more mature by the day
- One last major modification to make: incorporating MWR brightness temperature observations
  - Improved LWP retrieval over entire dynamic range
  - Excellent constraint on the PWV
- Older version (Release_1_5) was implemented in the ARM Data Management Facility
  - Used to process some examples for LASSO
  - Used to process data from PECAN (in archive)
- New version (Release_2_1) should be provided to ARM by early summer
- Processing is still slow: takes ~2 min per spectrum. However, easily distributed to multiple processors (ARM linux cluster!)