

# VAP Highlights for the CAPI WG

Laura Riihimaki, Chitra Sivaraman, Krista Gaustad, Tim Shippert, Yan Shi, Elaine Chapman, Sri Nikhil Gupta Gourisetti, Jennifer Comstock, Rob Newsom, Chuck Long



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## Summary of selected CAPI-related ARM VAPs in development or operation with recent progress highlighted in more detail.

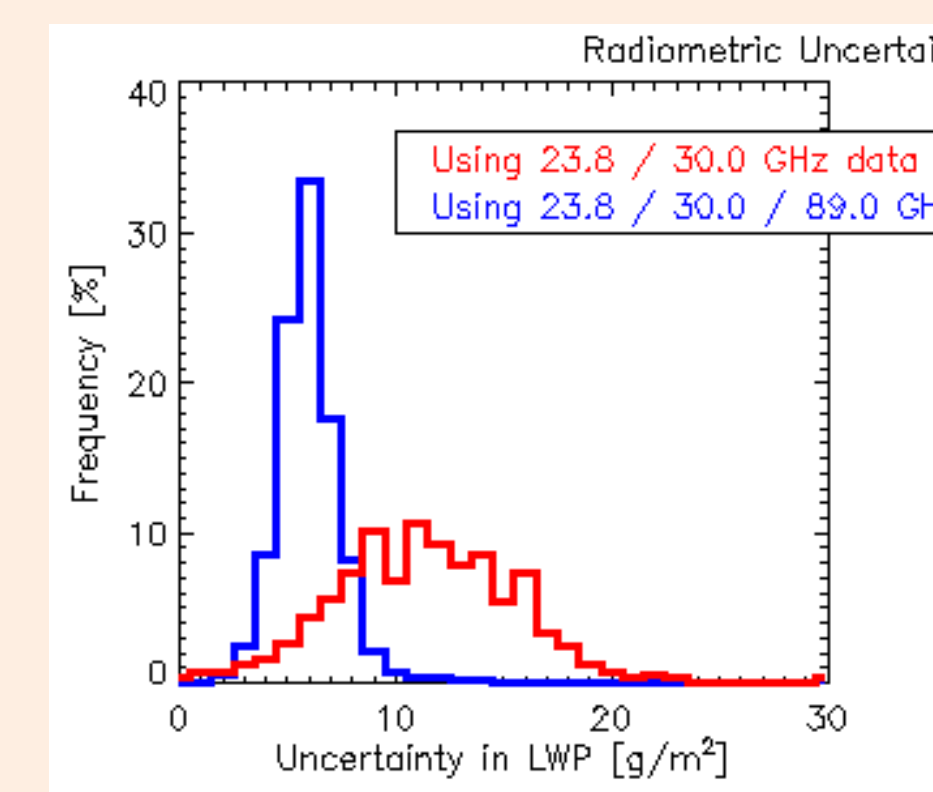
### Cloud and Aerosol Retrievals:

VAP name	Scientific Variables	Instrument	Status	Notes
MWRRET	precipitable water vapor, liquid water path	2-channel microwave radiometer	Operational at all sites; c2 level processing	Calculates PWV and LWP using optimal estimation method of physical retrieval.
MWRRETv2	precipitable water vapor, liquid water path	3-channel microwave radiometer	Final bias corrections being made; evaluation data soon available at SGP	Similar methodology to original MWRRET but applicable to 3-channel mwr.
NDROP	cloud adiabaticity, droplet number concentration	mwr, mfrsr, ARSCL	Soon to be operational at SGP; waiting on WACRARSCL at GRW	Calculates adiabaticity by comparing a calculated and measured lwp, and droplet number concentration from cloud base (ARSCL), lwp (MWRRET), and optical depth (MFRSRCLDOD).
MFRSRCLDOD	cloud optical depth, effective radius	multi-filter rotating shadowband radiometer	Operational at all SGP/TWP sites and many AMF sites. NSA data in eval area	Uses Min & Harrison (1996), GRL method. Only applicable for overcast, liquid clouds.
MPLCOD	column cloud optical depth	micropulse lidar	Evaluation product at SGP	Based on Comstock & Sassen (2001), J. Tech. method.
CCNPROF	CCN profiles below clouds	Raman Lidar, AOS	Operational at SGP	Scales surface CCN properties to dehumidified Raman lidar aerosol extinction profiles. Assumes aerosol properties at surface and cloud base are the same.

### \*New VAP\* Physical retrievals of LWP and PWV from 3-channel microwave radiometers

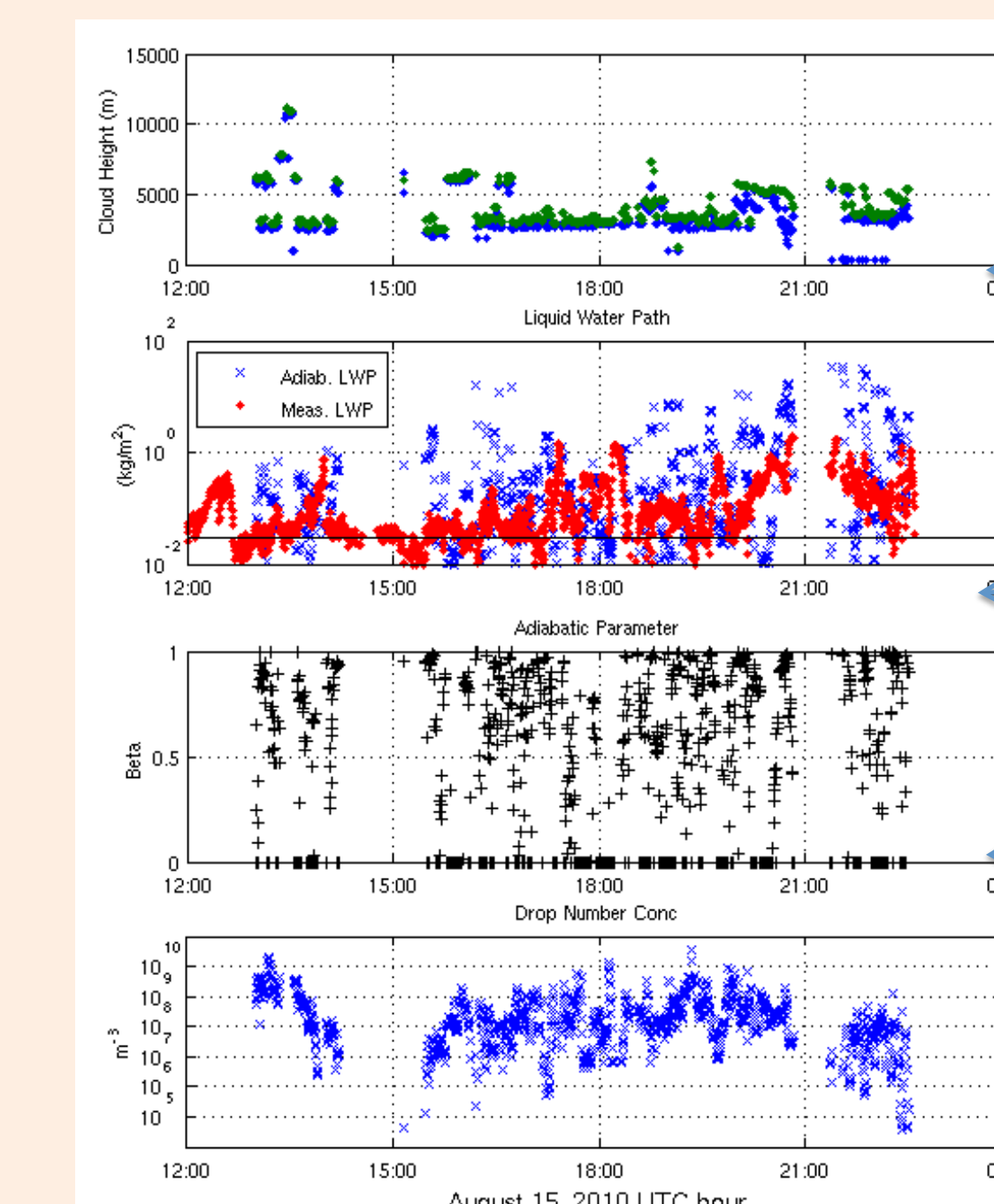
Update to the MWRRET VAP that calculates physical retrievals from microwave radiometer brightness temperatures. MWRRETv2 will operate on the 3-channel MWRs, which are more sensitive to LWP in thin clouds.

SGP data is currently being evaluated to make sure bias correction is adequate. Data will soon be in evaluation area.



Decrease in LWP uncertainty from 3 channel MWR retrieval compared to 2 channel

### Droplet Number Concentration & Adiabaticity



Currently run at SGP. Will be expanded to Azores when ARSCL input data is ready.

Calculated and measured liquid water path:

$$LWP_{adiab} = \frac{1}{2} C_w H^2$$

Adiabatic parameter from meas/calc LWP:

$$\beta = 1 - \frac{LWP_{meas}}{LWP_{adiab}}$$

Calculated Drop Number Concentration

$$N_d = C_1 k^{-1} \rho^2 \tau^3 LWP^{-2.5} [(1 - \beta) C_w]^{0.5}$$

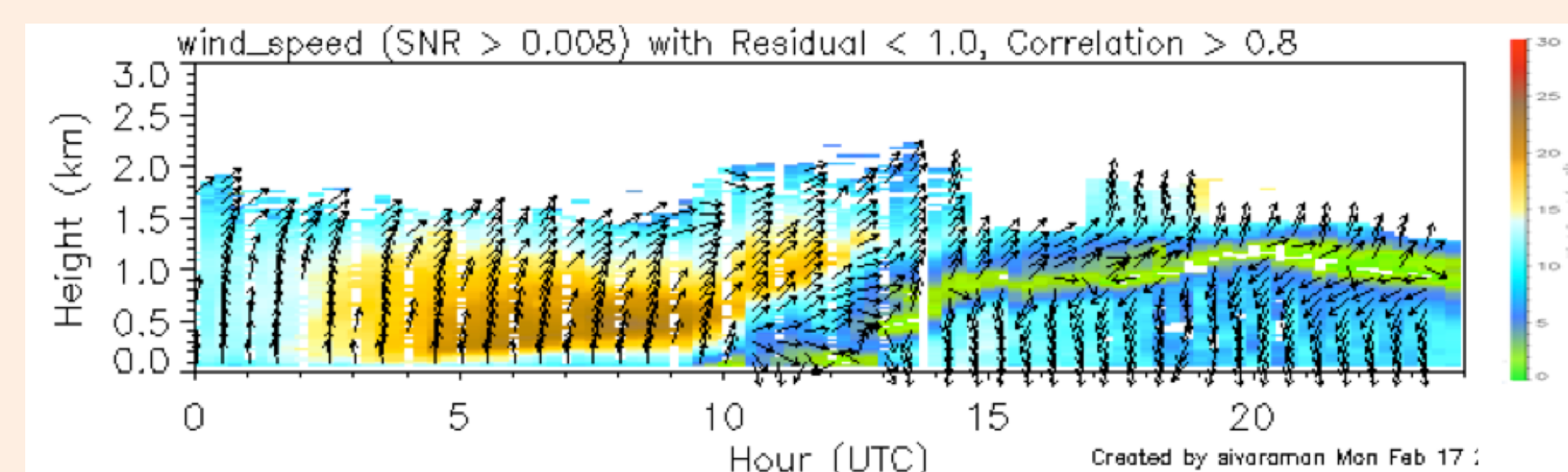
where,  
 $C_w$  = adiabatic condensation rate  
 $H$  = cloud height  
 $k$  = (volume radius/effective radius)<sup>3</sup>  
 $\rho$  = density of water  
 $\tau$  = optical depth

### Atmospheric State:

VAP name	Scientific Variables	Instrument	Status	Notes
AERIPROF	vertical profiles of temperature and humidity	spectral infrared (AERI)	Operational at SGP	Iterative forward modeling to match profiles with spectral infrared irradiance.
DLWINDPROF	vertical profiles of winds beneath lowest cloud base	doppler lidar	Data in evaluation area for SGP, TWP, TCAP, and GVAX	Calculate wind profiles from doppler lidar PPI scans.
PBLHT SONDE	planetary boundary layer height	radiosonde	Operational at all sites with sondes including field campaigns!	Three methods calculate PBL height from thermodynamic and wind profiles.
PBLHT MPL	planetary boundary layer height	micropulse lidar	Currently under development	Will be based on method from Sawyer & Li (2013) Atmos. Env.

### \*New VAP\* Doppler Lidar Wind Profiles

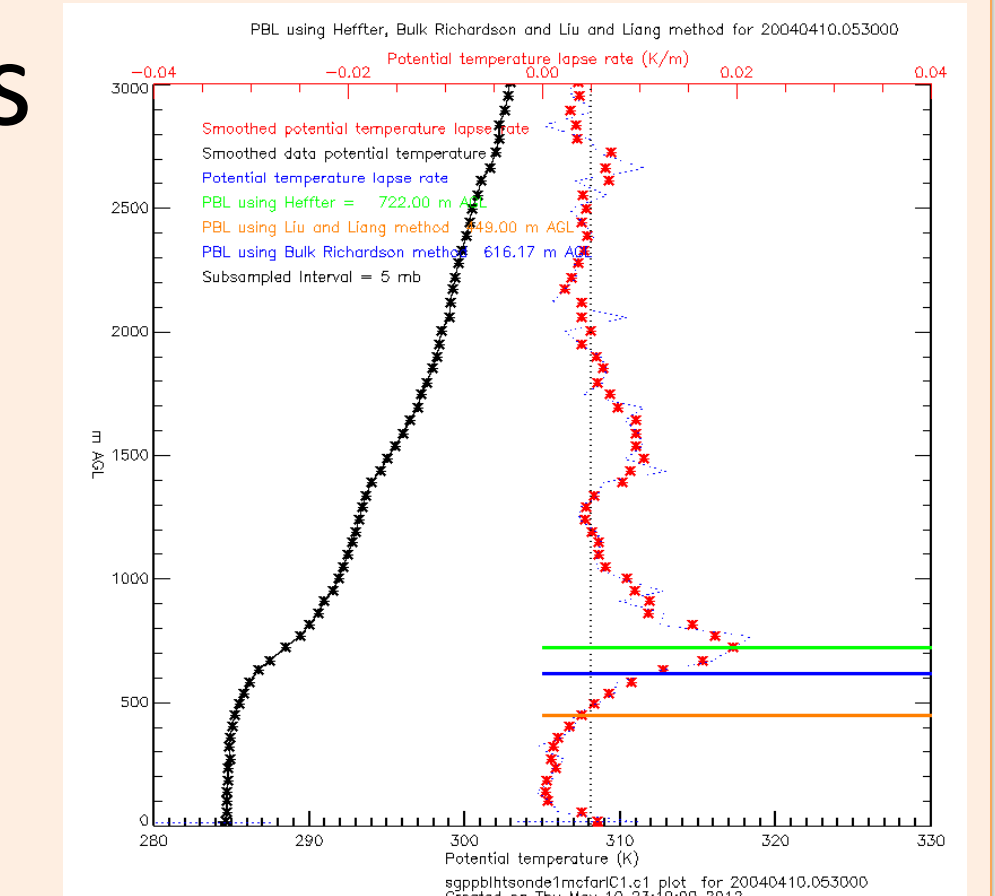
New Doppler Lidar Wind Profile VAP computes vertical profiles of horizontal wind speed and direction using a modified version of the traditional velocity-azimuth-display algorithm (Browning and Wexler 1968). Wind profiles are obtained within the lowest 3 km of the atmosphere with nominal height and time resolutions of 26 m and 15 minutes, respectively. Data are available in the evaluation area.



Wind speed (colors) and direction (arrows) from the Doppler lidar at SGP for 4 October 2012.

### Planetary Boundary Layer Heights

The sonde-based product calculates PBL height using three different methods, which are not expected to agree as the PBL height is not a well-defined parameter, but dependent on meteorological conditions.



Example of three PBLHT calculations:

- Heffer—inversion layer with  $\Delta\theta > 2$  K
- Liu-Liang—first classifies as convective, stable, or neutral residual layer then uses appropriate definition
- Bulk-Richardson—Richardson number below threshold, measure of turbulence, best for stable, low wind speed conditions

Sonde product operational at all sites. MPL product under development.

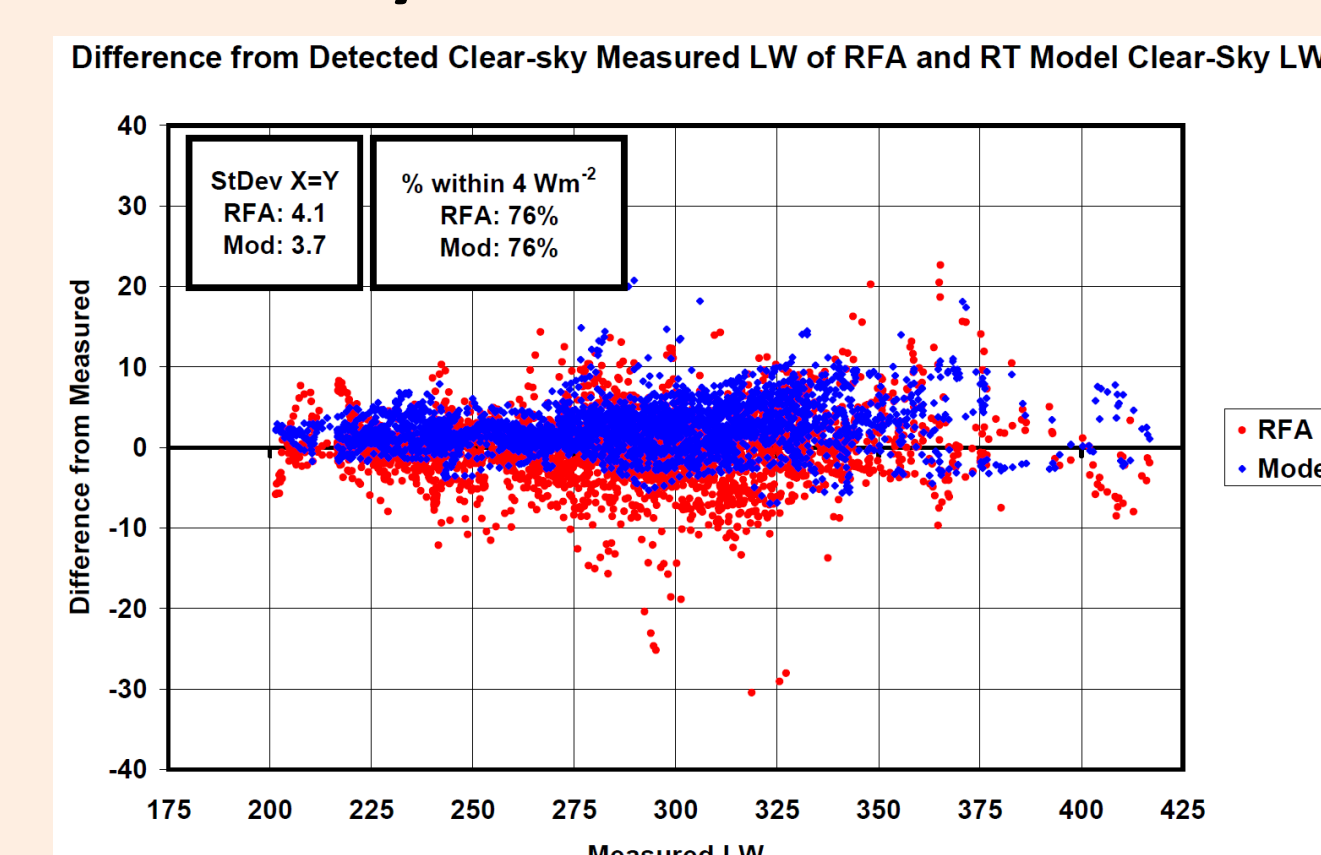
### Radiation:

VAP name	Scientific Variables	Instrument	Status	Notes
QCRAD	upwelling/downwelling broadband irradiances	broadband radiometers	Operational at all sites. C2 level data recently processed	This is the recommended ARM data stream for broadband irradiance data!
RIPBE	all needed inputs for radiative transfer calculations	many	2002-2007 and MC3E data available at SGP central facility	Collects all needed inputs to radiative transfer calculations--aerosol, clouds, albedo, trace gas concentrations, etc.
BBHRP	calculated broadband heating rates/fluxes	--	SGP 2002-2007 and MC3E periods from RIPBE in evaluation area	In addition to VAP output, a beta version of a user-run BBHRP has been developed.
FluxAnalysis	shortwave and longwave cloud radiative forcing	broadband radiometers	Evaluation data available at SGP central facility	Extends SWFLUXANAL VAP to include both LW and SW calculated clear sky and measured all sky irradiances and derived quantities
SSST	Sea Surface Skin Temperature	IRTs	Under development for MAGIC--data available by request	Dual-IRT method corrects sea surface measurements for reflected sky irradiance.

### \*New VAP\* Radiative Flux Analysis

Update to the Shortwave Flux Analysis VAP to also estimate LW clear sky irradiance, and use better quality controlled input data. With measured all sky and estimated clear sky LW and SW irradiance a variety of parameters can be derived including cloud radiative effects.

SGP data will soon be in evaluation area.



Difference between measured & calculated clear sky LW irradiance calculated from (blue) radiative transfer model and (red) RFA empirically-estimated values (Long & Turner, 2008).

### Adjust BBHRP to be user-run

In response to ASR requests to make BBHRP a user-run retrieval evaluation tool, updates have been made to allow users to calculate fluxes/heating rates with RIPBE-like files.

- Implemented RRTM\_G as radiative transfer code to speed up processing
- Installed on ARM BDS system for user access
- Wrote documentation and adjustable user run script

