The Doppler Lidar Boundary-Layer Turbulence Statistics Value-Added Product
(aka the BLTS VAP)

Rob K. Newsom, *Pacific Northwest National Laboratory, Richland, WA*
Virendra P. Ghate, *Rutgers University, New Brunswick, NJ*
Pavlos Kollias, *McGill University, Montreal, Quebec*
Larry K. Berg, *Pacific Northwest National Laboratory, Richland, WA*
Jennifer M. Comstock, *Pacific Northwest National Laboratory, Richland, WA*

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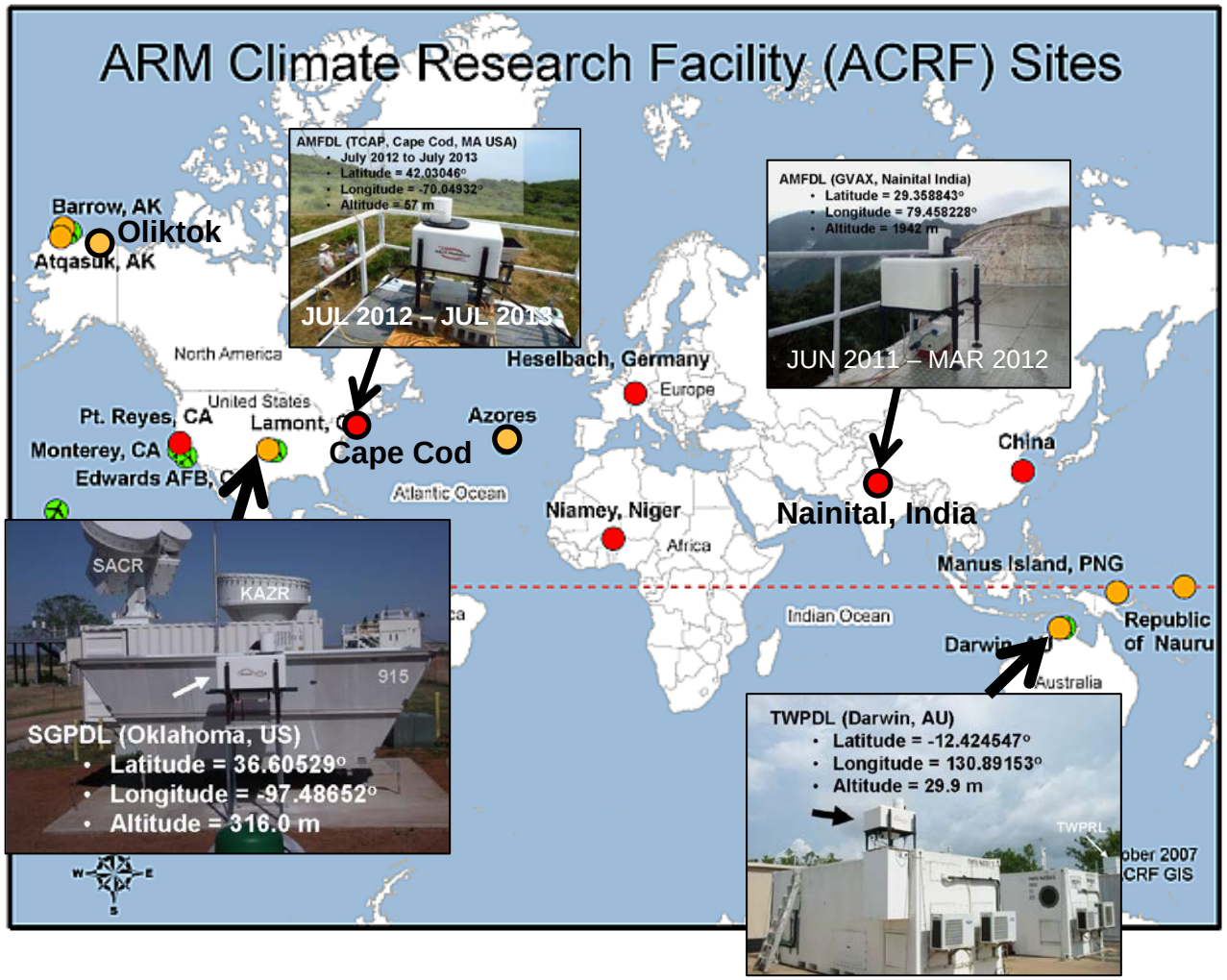
Background and Goals

- Doppler lidars (DLs) were recently added to the suite of ARM instrumentation in order to fill a long-standing measurement gap, i.e. vertical velocities in clear-air and sub-cloud layers. These measurements are important for …
  - Understanding mixing processes
  - Understanding cloud lifecycles
  - Development and validation of parameterization scheme in models
- The ARM DLs provide height and time resolved measurements of vertical velocity (and aerosol backscatter)
- The Boundary-Layer Turbulence Statistics (BLTS) VAP uses data from the DLs and other instruments to provide estimates of
  - Clear-air boundary-layer vertical velocity statistics
  - Cloud properties

ARM Doppler Lidars

- Manufacturer: Halo Photonics (UK)
- Specs
  - Wavelength: 1.5 μm
  - Pulse width: 150ns (22.5m)
  - Pulse Energy: ~100 μJ
  - Pulse repetition Frequency: 15 kHz
  - Max Measurement Range: 10 km
  - Typical range: ~2-4 km
  - Velocity precision: ~10cm s^{-1}
- Full upper hemispheric scanning capability
- Sensitive to aerosol backscatter
- Measurements:
  - Radial Velocity
  - Attenuated aerosol backscatter

Deployment Locations



- Currently 3 systems
  - Fixed Sites (2)
    - Southern Great Plains
    - Tropical Western Pacific – Darwin
  - Mobile Facility (1)
    - GVAX (June 2011 to March 2012)
    - TCAP (July 2012 to July 2013)
- Future
  - Oliktok AK (1)
  - Azores (1)

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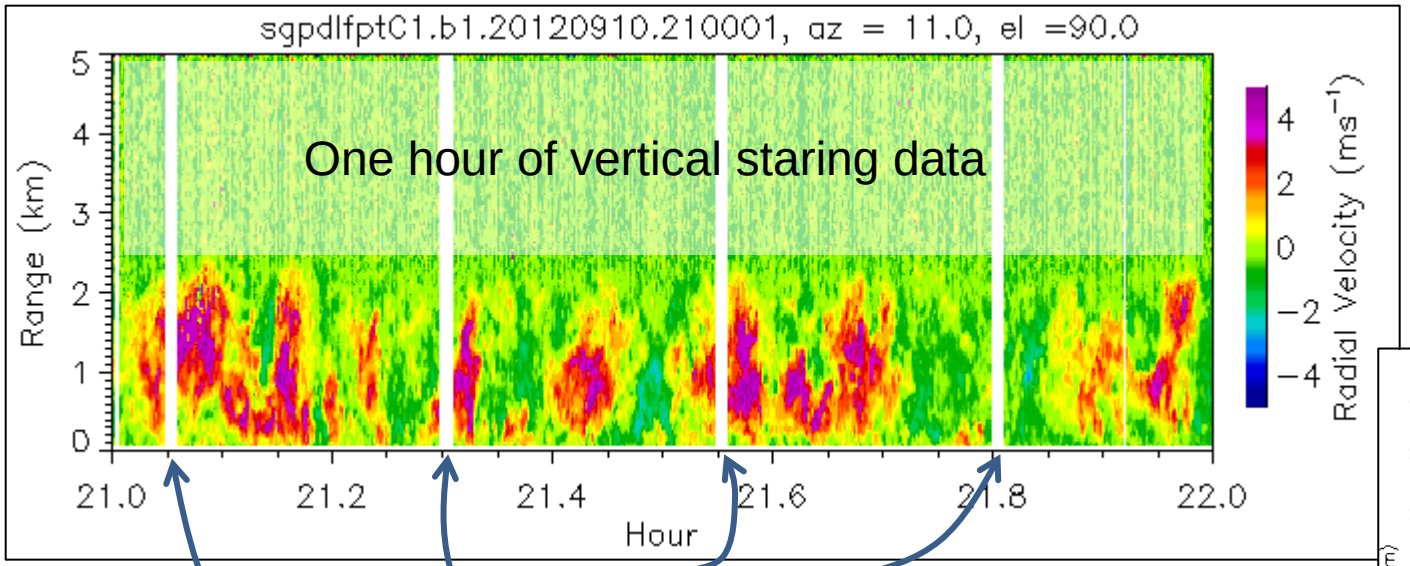
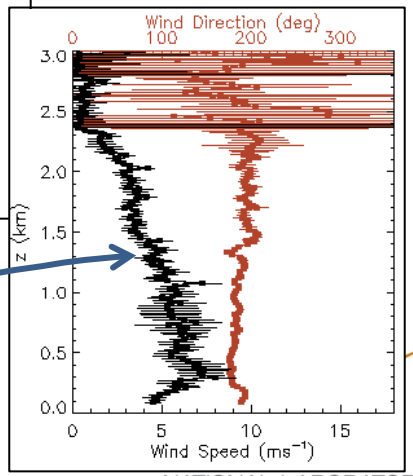
Operational Configuration for the ARM Doppler Lidars

- Vertical stare most of the time
- PPI scan once every 15 minutes (~40 seconds per scan)
- 30 m range gate, 1 second pulse integration time
- Duty cycle = ~82% → 1 profile per 1.22 seconds





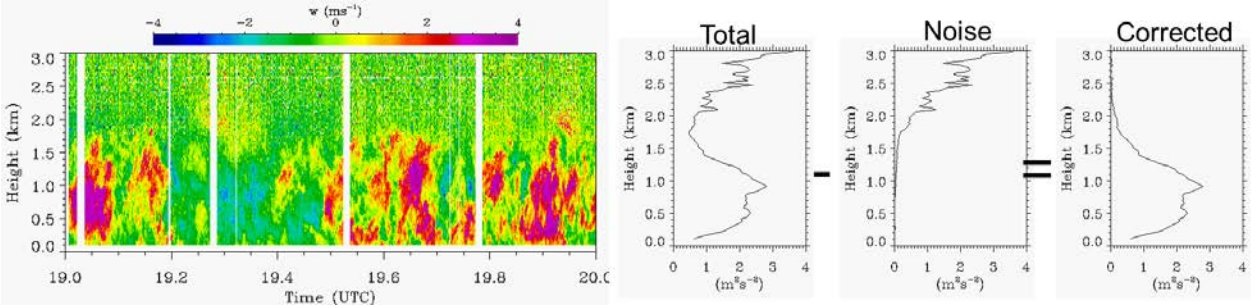
Gaps are PPI scans for computing horizontal wind profiles

BLTS VAP Output

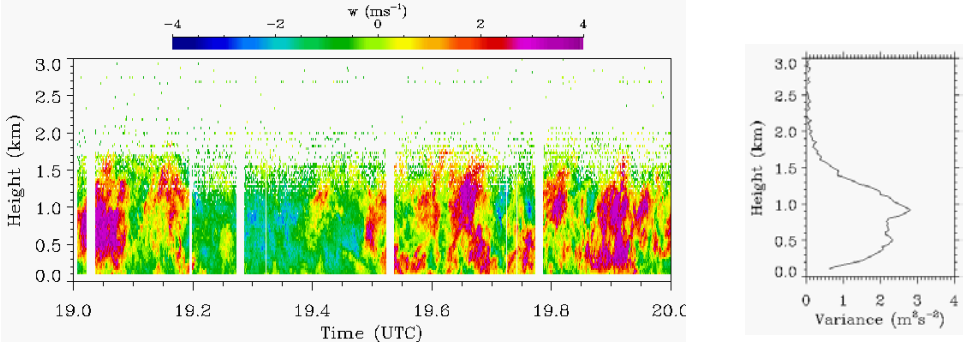
- Daily files, 30-minute average, 30m vertical resolution
- DL-derived quantities
  - Profiles (clear-air) of w stats from 100m to 4 km AGL
    - median w
    - Updraft fraction
    - Moments: Variance, Skewness, Kurtosis
    - Dissipation rate
  - Profiles of median SNR from 100m to 4km AGL
  - Profiles of horizontal winds resampled from DL VAD VAP
  - Cloud properties from 100m to 9.6 km AGL
    - Cloud base height (CBH)
    - Cloud fraction
    - Cloud base w stats
      - Median
      - Updraft fraction
- Quantities derived from other instruments
  - Surface fluxes (ECOR) and met
  - Precipitation Flag
  - CBH from ceilometer

Dealing with Noise

- Noise compensation technique
  - Lenschow, Wulfmeyer, Senff, 2000: Measuring Second- through Fourth-Order Moments in Noisy Data, *JTECH*, **17**, 1330-1347.
  - Noise variance is estimated from time series analysis
    - Frequency domain
    - Time domain
  - Atmospheric variance = (Uncorrected variance) – (noise variance)



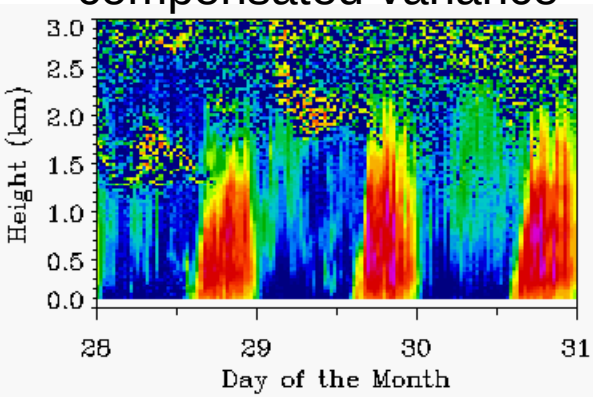
- SNR threshold technique
  - Statistics are computed using only radial velocities above a prescribed SNR threshold.



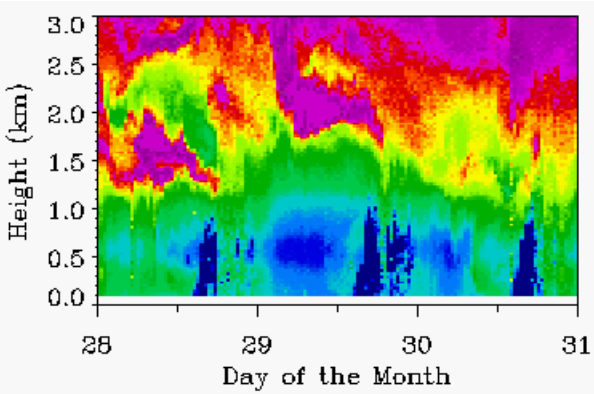
Noise Variance for Quality Control

- The noise variance is used as a quality control field
  - Threshold set at 1 m^2s^{-2}

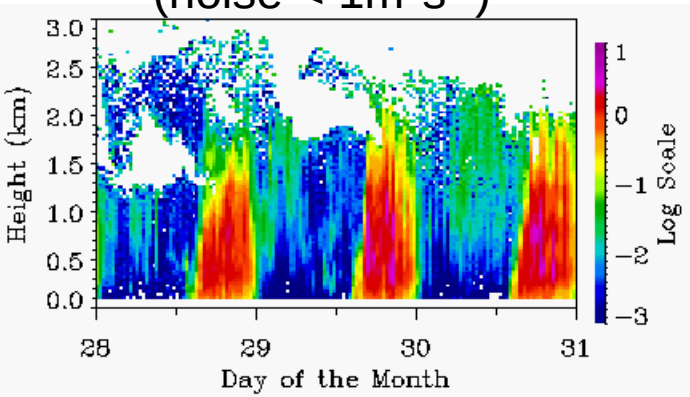
Unfiltered noise-compensated variance



Noise variance



Filtered noise-compensated variance (noise < 1m^2s^{-2})



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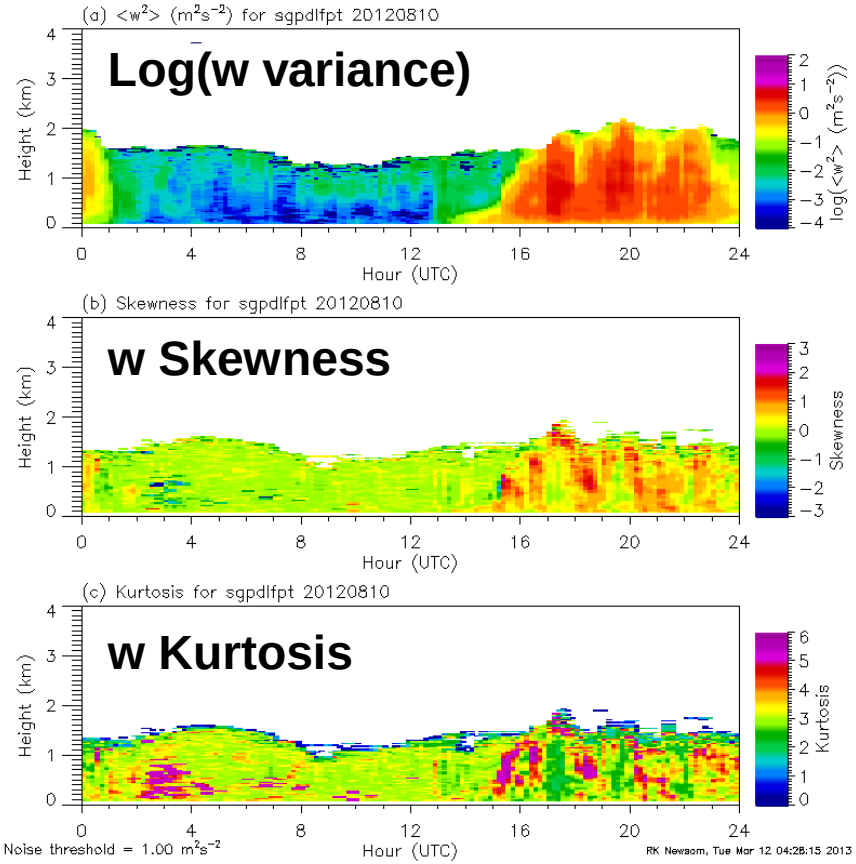
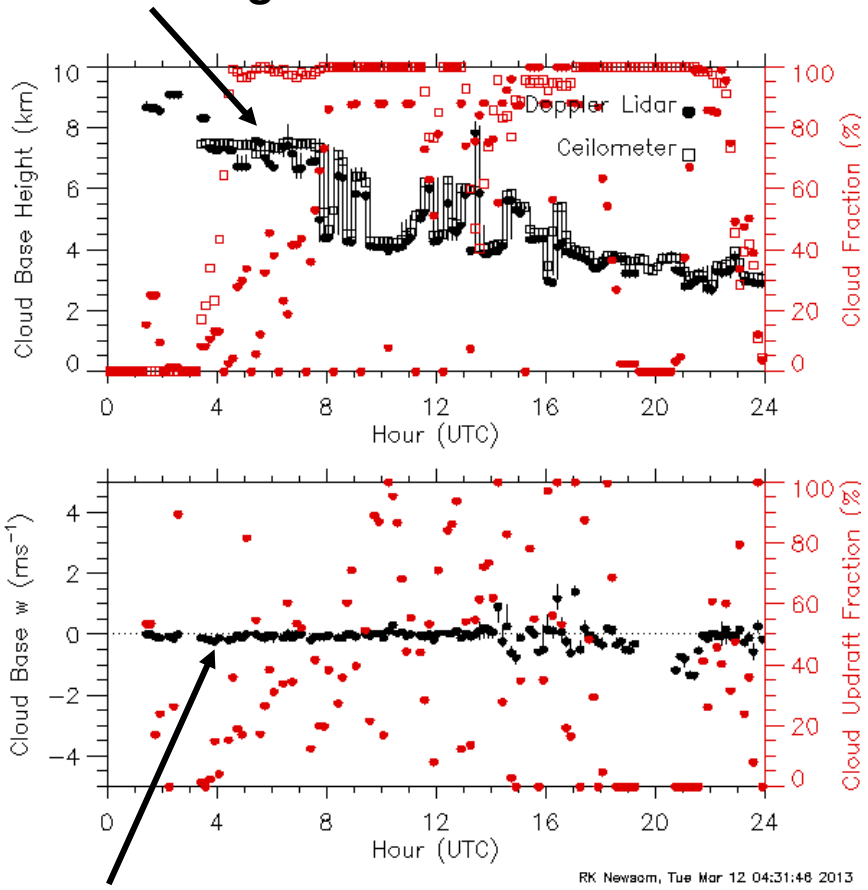
BLTS Sample Quicklooks



Cloud Base Heights



Cloud Base w

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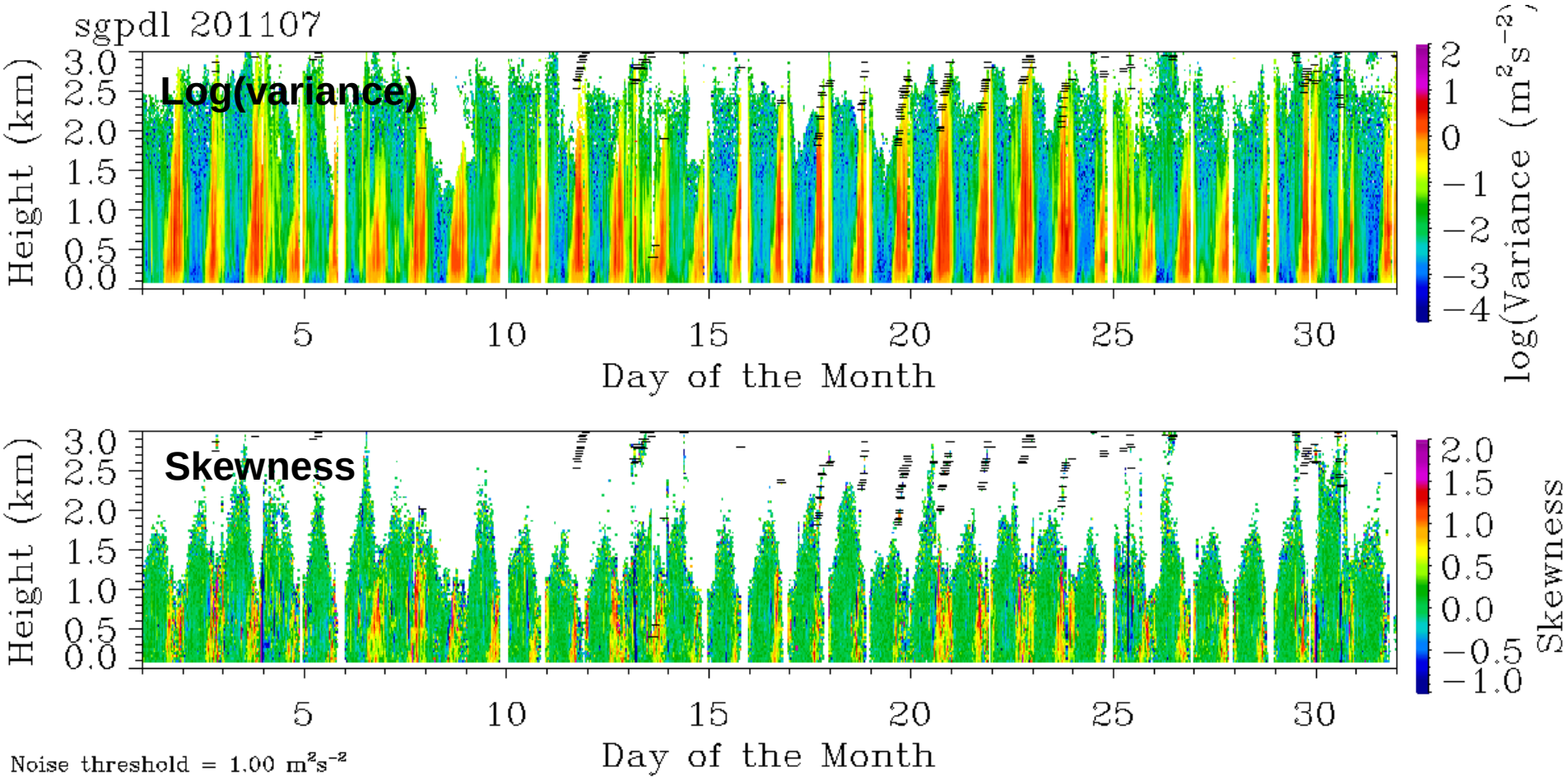
Variance and Skewness at SGP During July 2011



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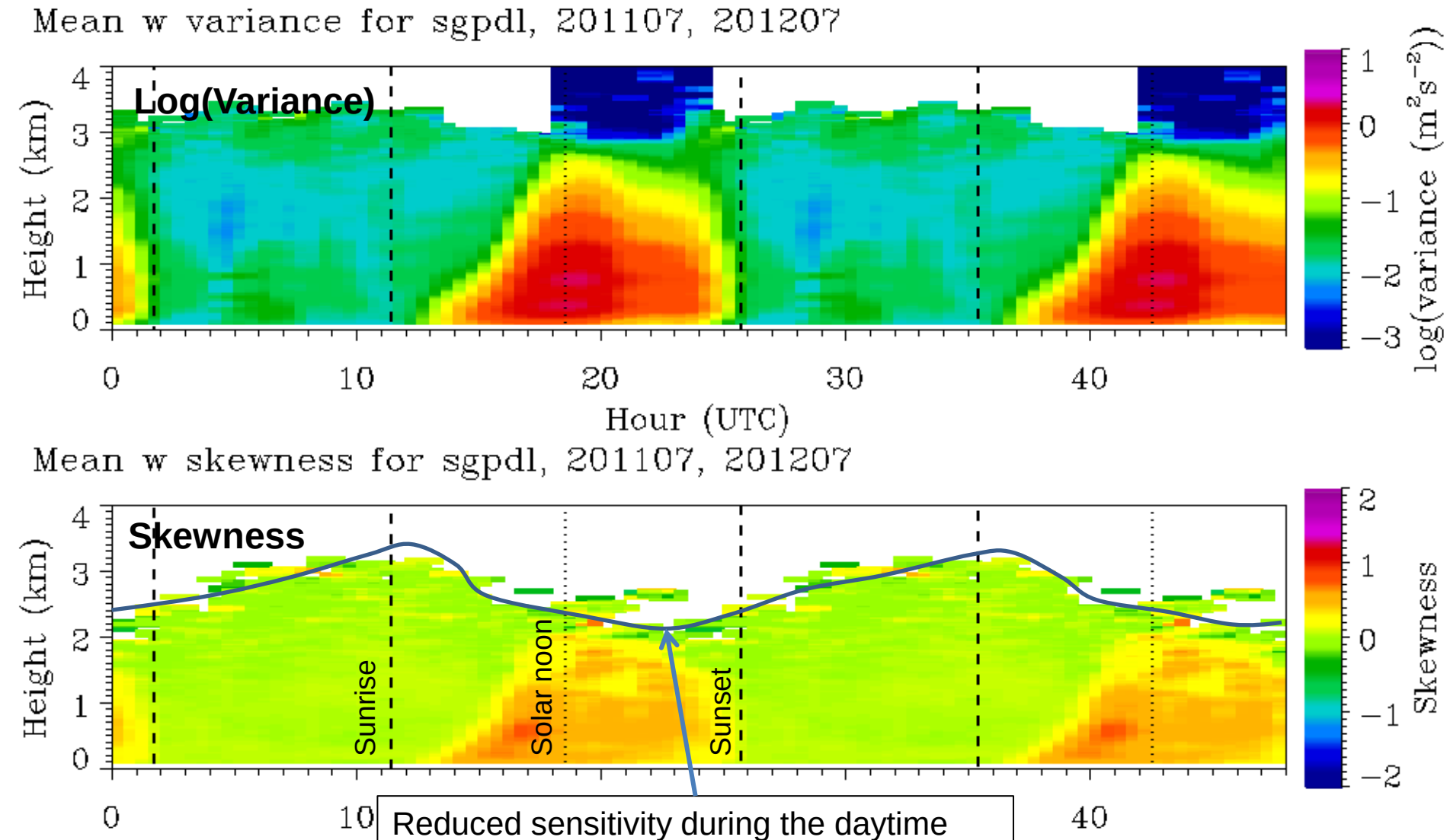
Mean Diurnal Variance and Skewness at SGP for July 2012 and July 2011



Future Work

- BLTS VAP is currently under development. Most of the development effort is complete.
- Still need to finalize the Data Object Design (DOD), and create QC flags for each of the primary output variables.
- As of March 2013, the release data is TBD; however, preliminary results can be viewed at https://engineering.arm.gov/~newsom/