ARM Vertical Velocity Best Estimate Product

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Vertical Velocity Focus Group Breakout Session
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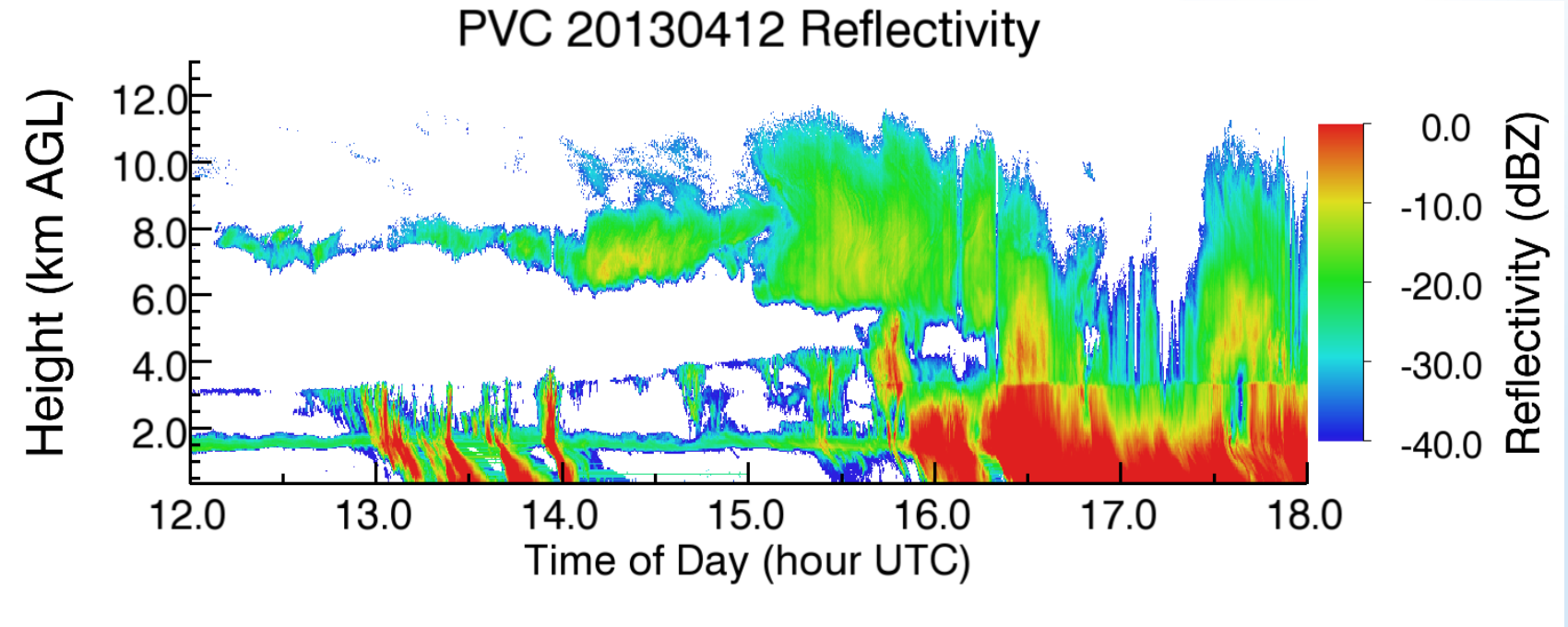
BROOKHAVEN NATIONAL LABORATORY
a passion for discovery

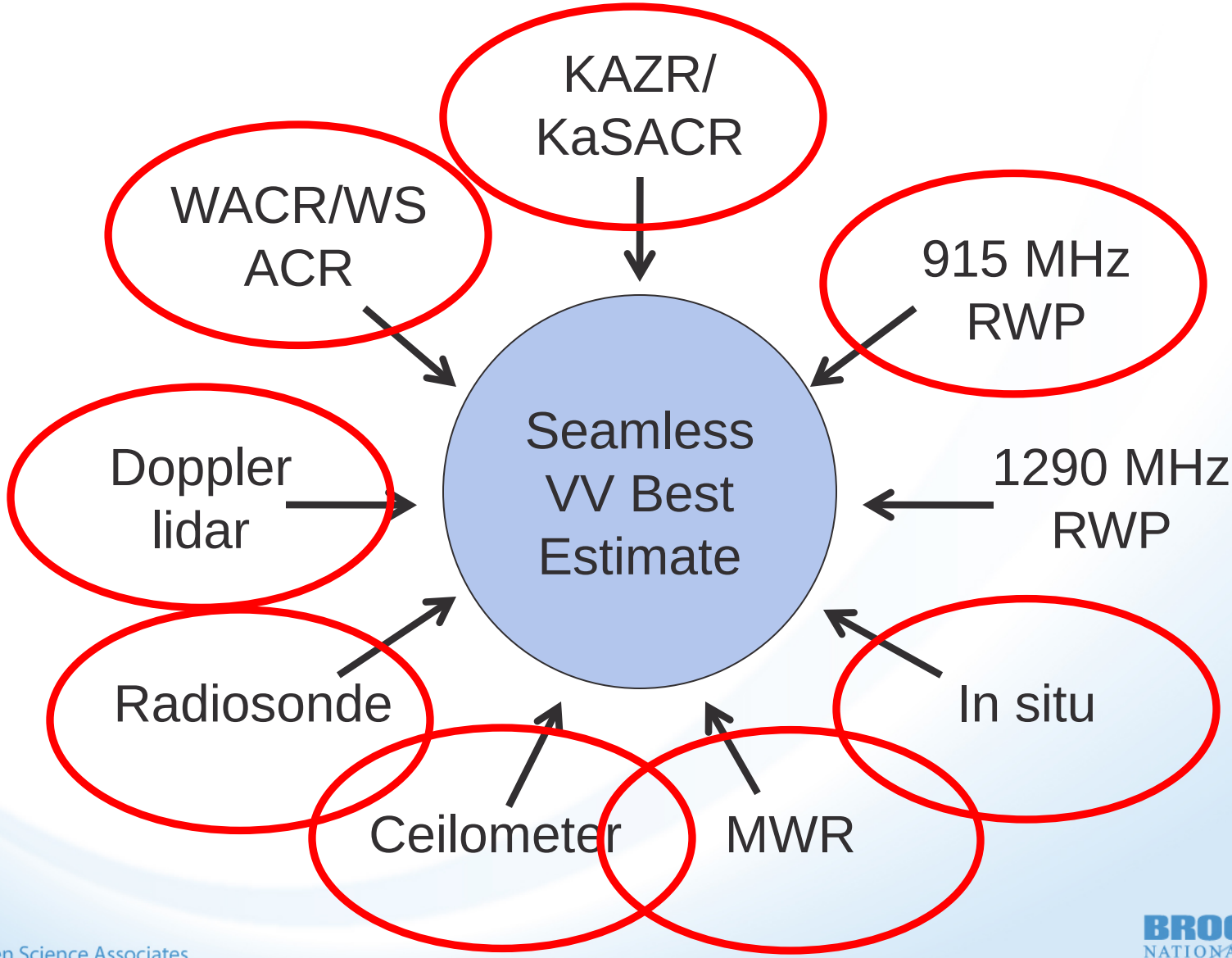
Office of Science
U.S. DEPARTMENT OF ENERGY

Objective

Produce a comprehensive column vertical air velocity product, with uncertainty estimates, based on sensor fusion of all ARM assets, minimizing data gaps to the fullest extent possible.

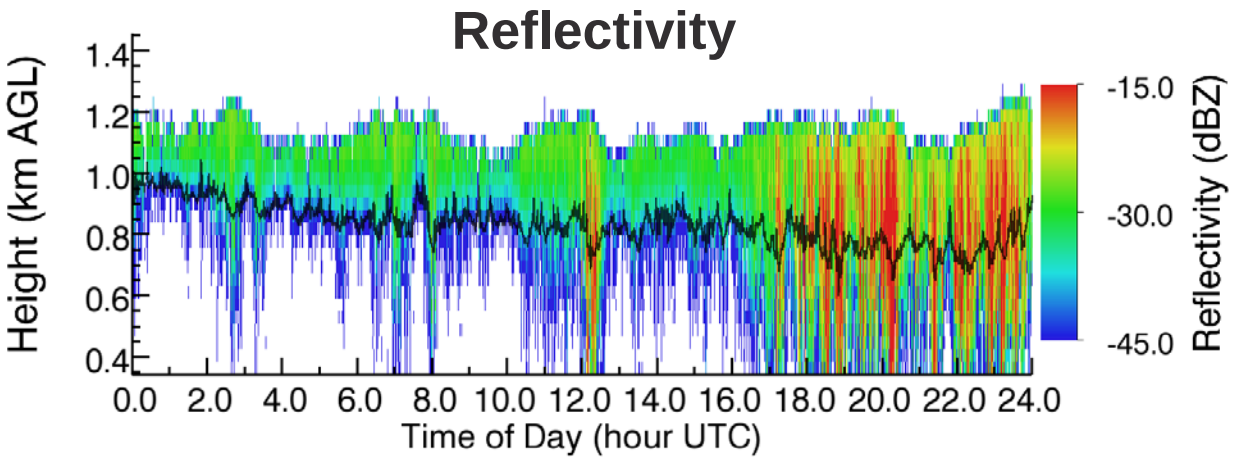


Sensor fusion of all relevant ARM assets

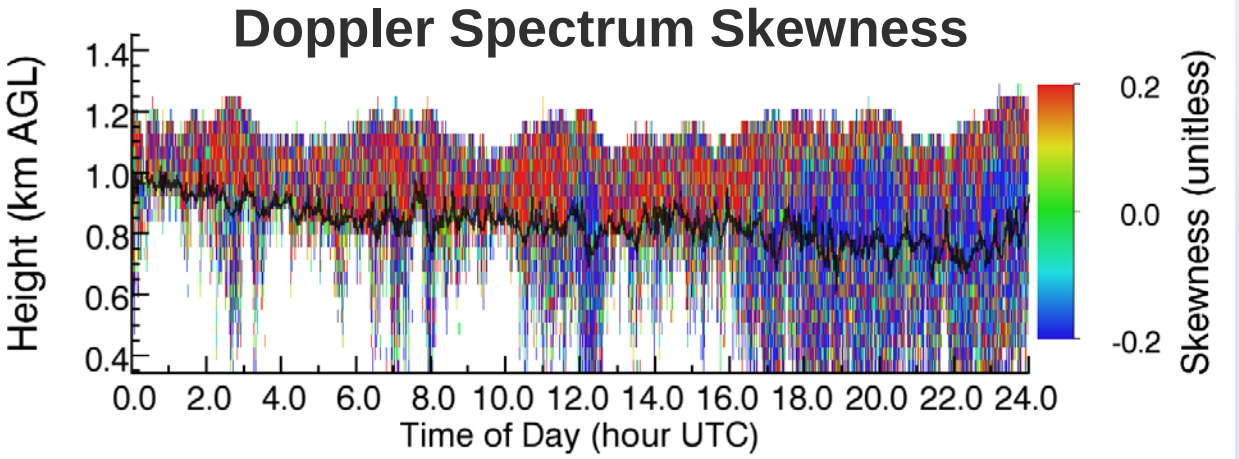


Lightly drizzling stratocumulus

Reflectivity at 95 GHz of **lightly drizzling** StCu cloud observed by the DOE ARM Mobile Facility in the Azores.

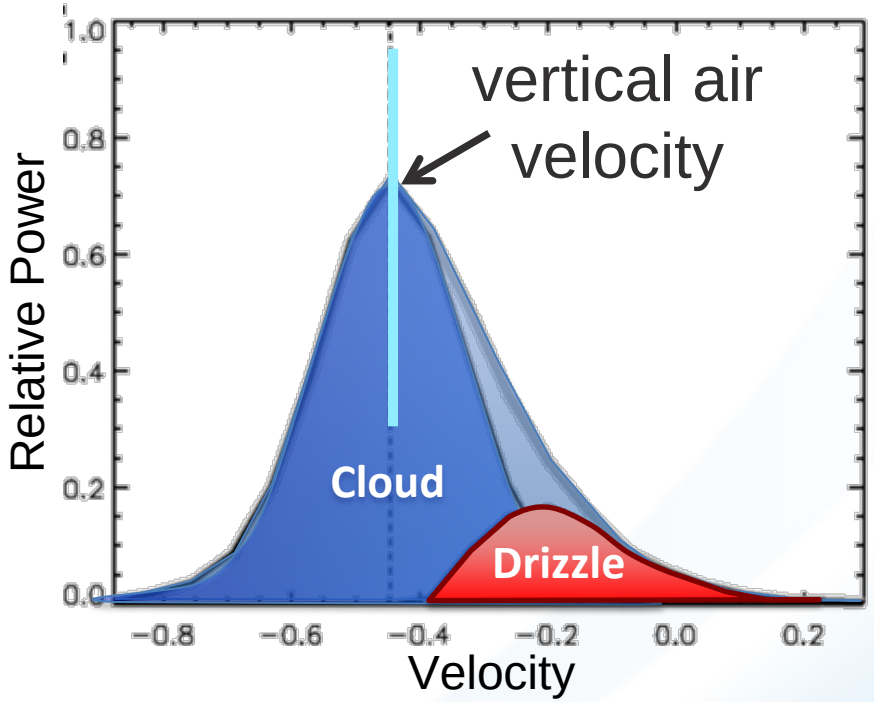


The areas of **positive** spectrum skewness (red) are candidates for spectral decomposition retrievals.



Radar Doppler spectrum decomposition

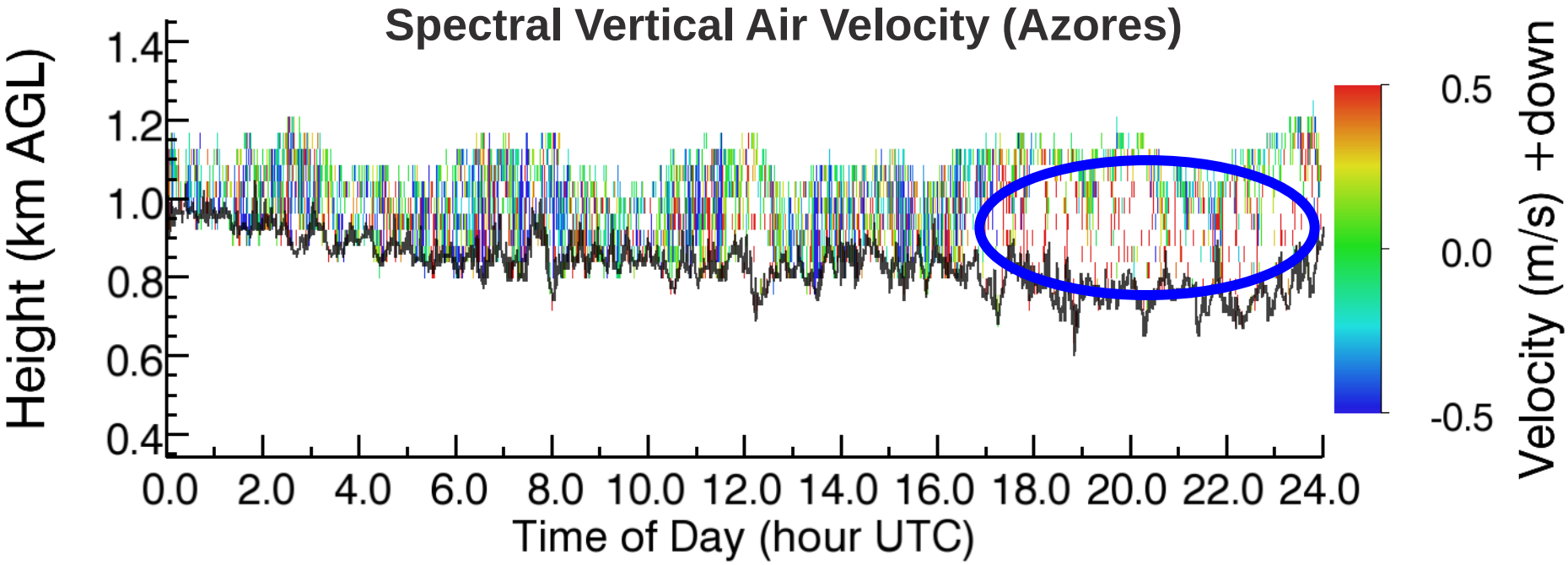
A positively skewed radar Doppler spectrum is decomposed into cloud and drizzle components using Luke and Kollias (2013). The **center** of the cloud component indicates the **vertical air velocity**.



Luke and Kollias, 2013: Separating Cloud and Drizzle Radar Moments during Precipitation Onset Using Doppler Spectra. *J. Atmos. Oceanic Technol.*, **30**, 1656–1671.

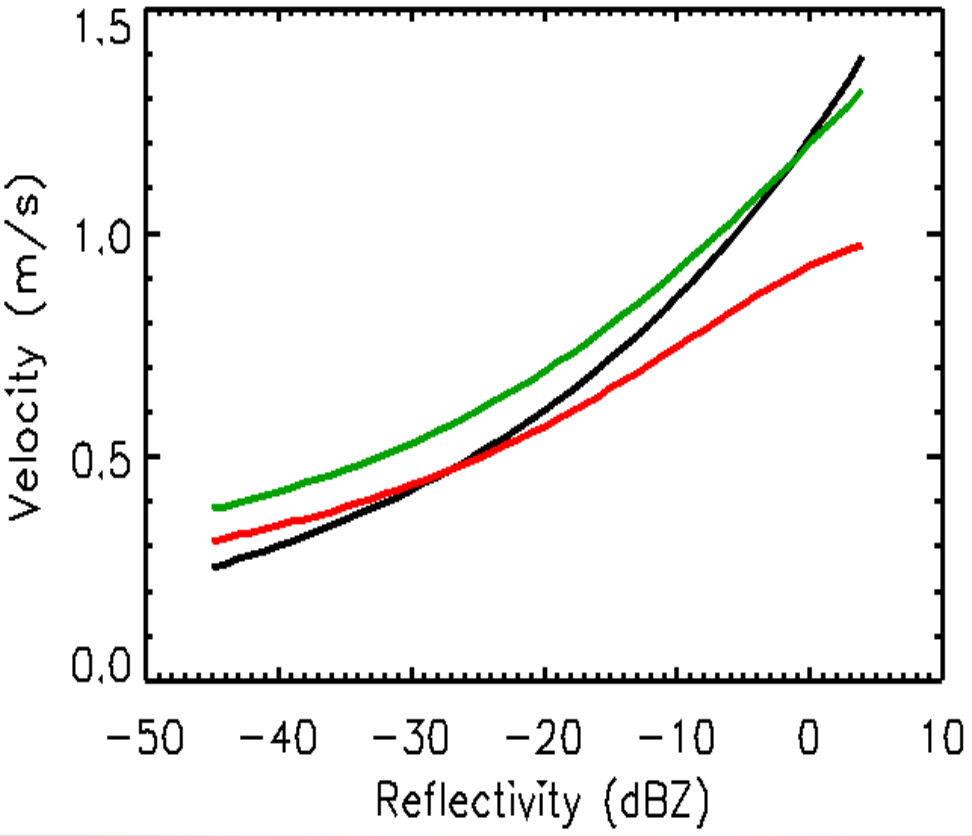
Radar spectral velocity retrievals

These vertical air velocity retrievals were produced by radar spectrum decompositions. The black line indicates cloud base. In the white gaps, spectrum decomposition is not successful.



Reflectivity to V Map Techniques

Z-V power law



Reflectivity to V Map Techniques

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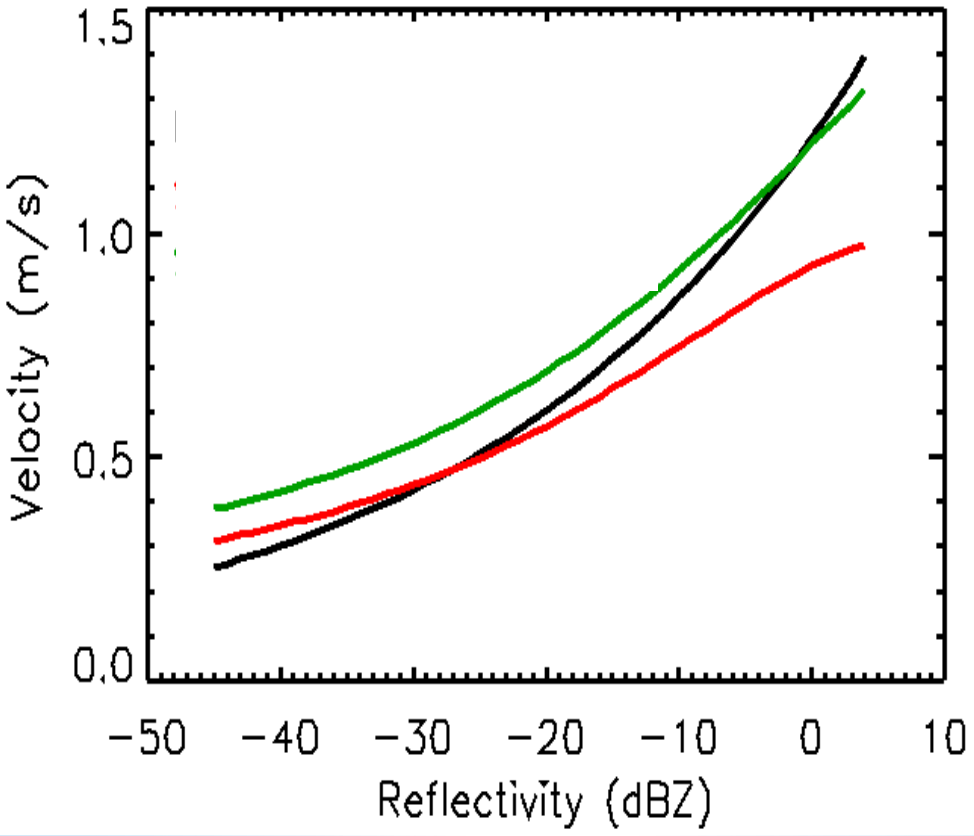
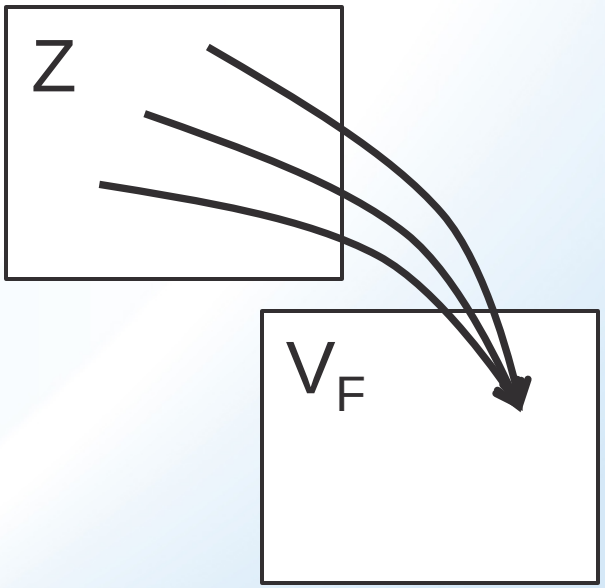
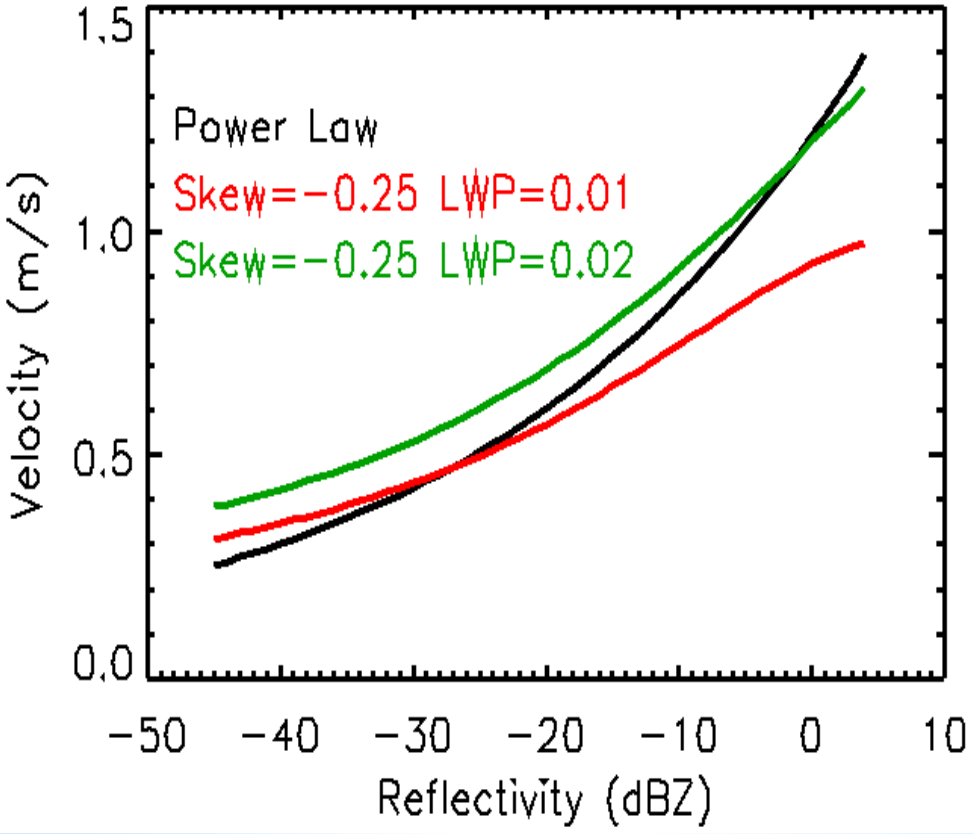
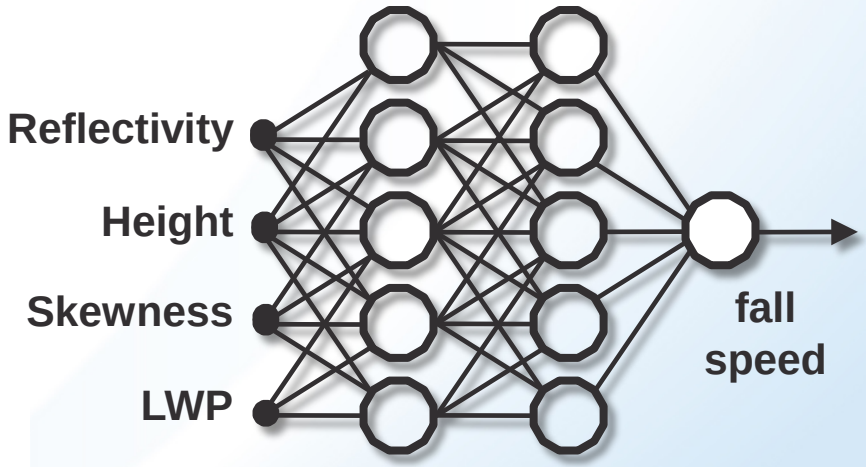




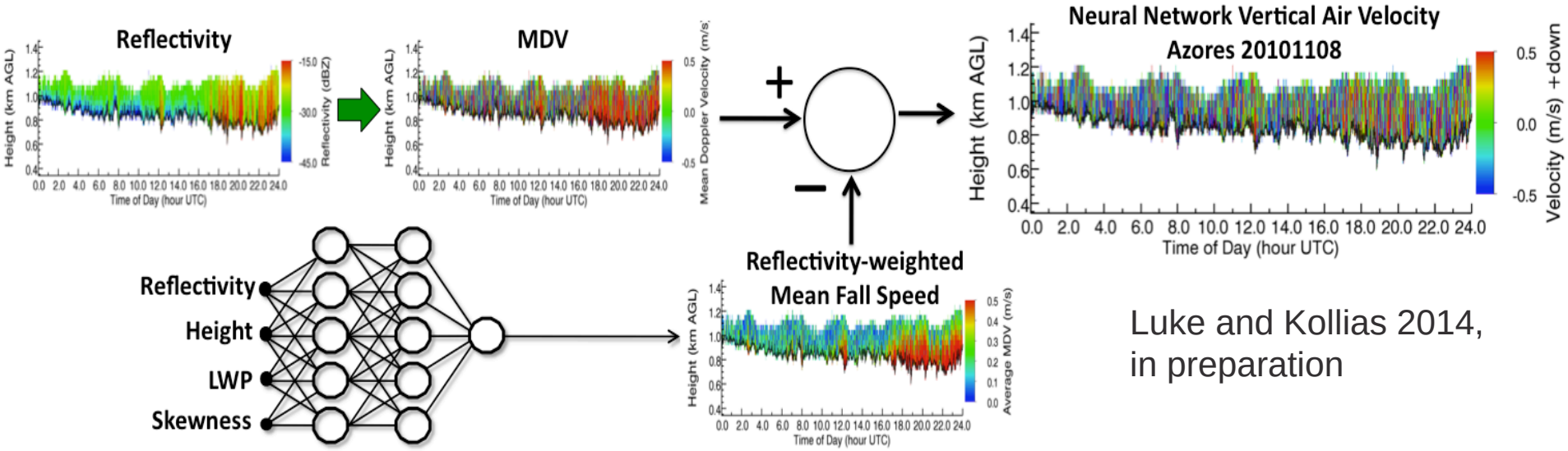
Multi-parameter to V Map Technique

Neural Network

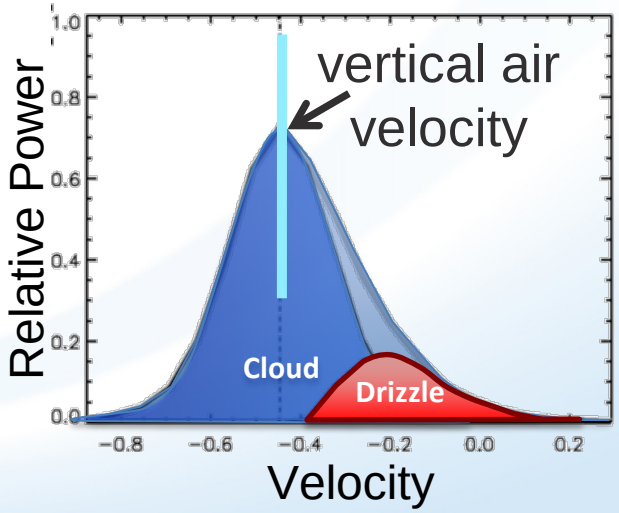




Neural Network Methodology

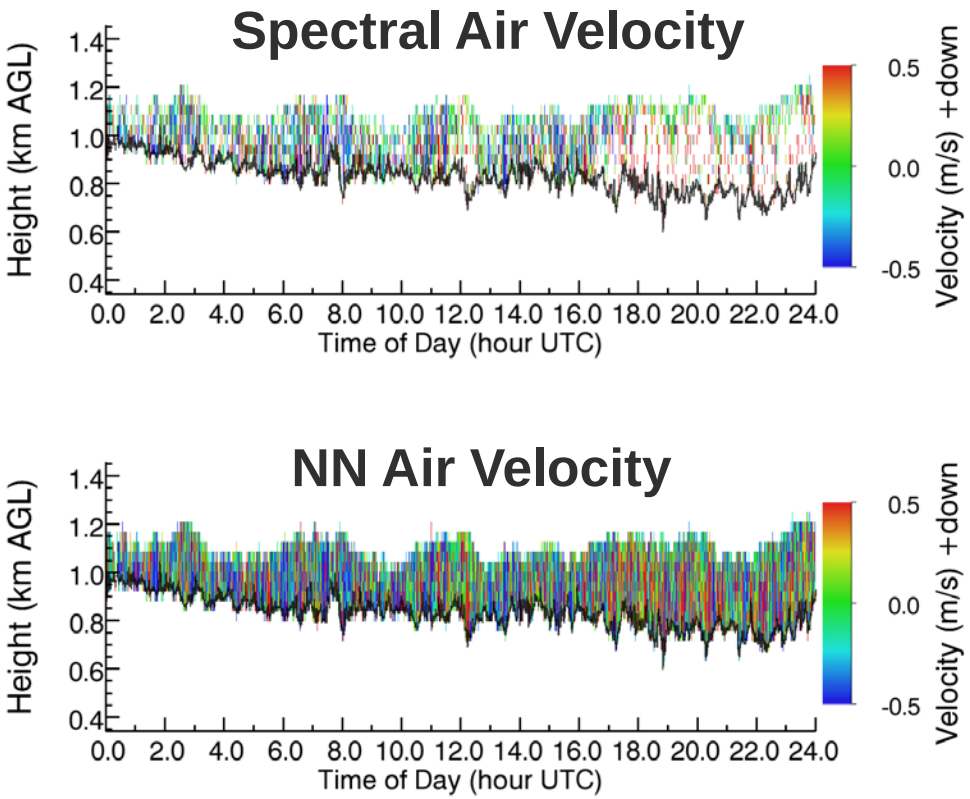


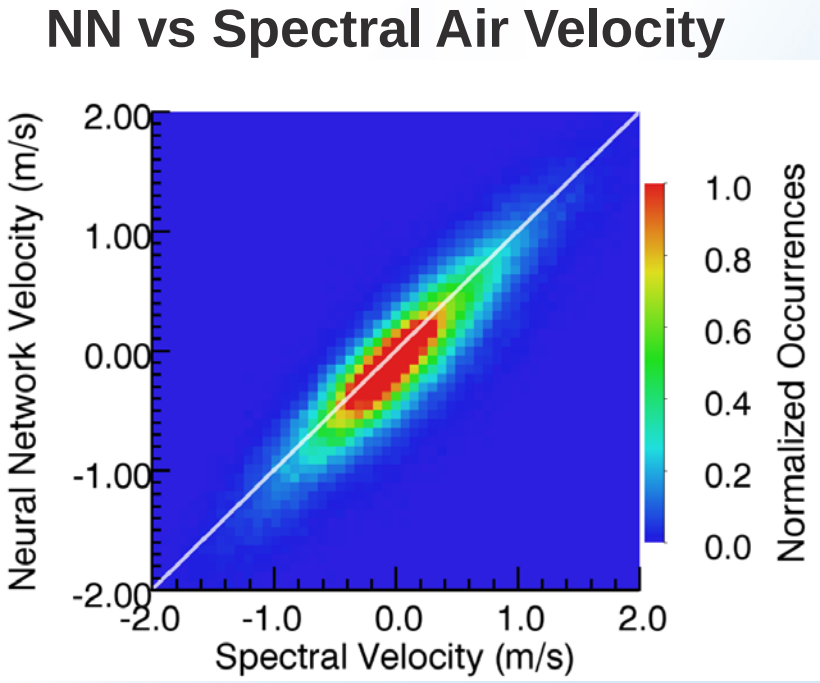
Luke and Kollias 2014, in preparation



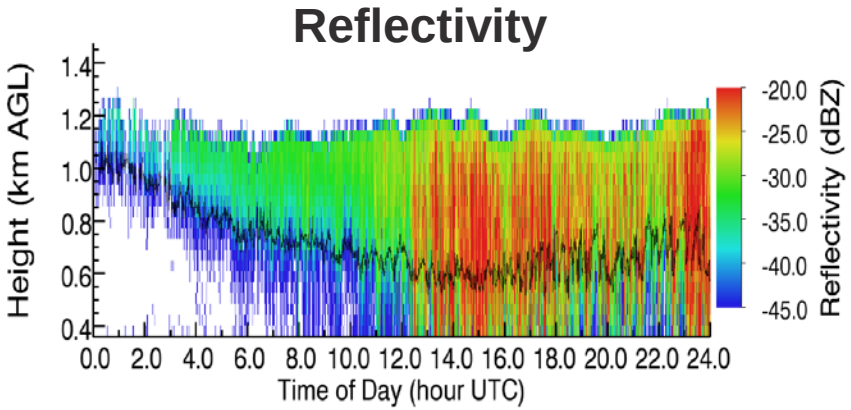
Radar Doppler spectrum decomposition

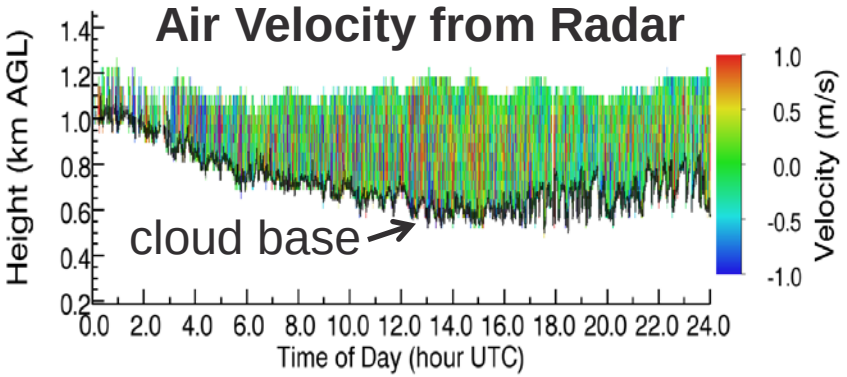
Comparisons of spectral and moments-based NN vertical air velocity retrievals are shown below. The mean spectral velocity is **2.5 cm/s** and the mean neural network velocity is **0.5 cm/s**.

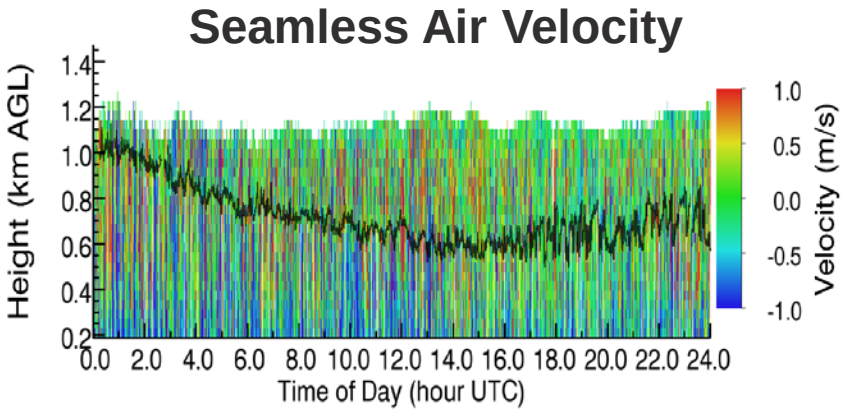


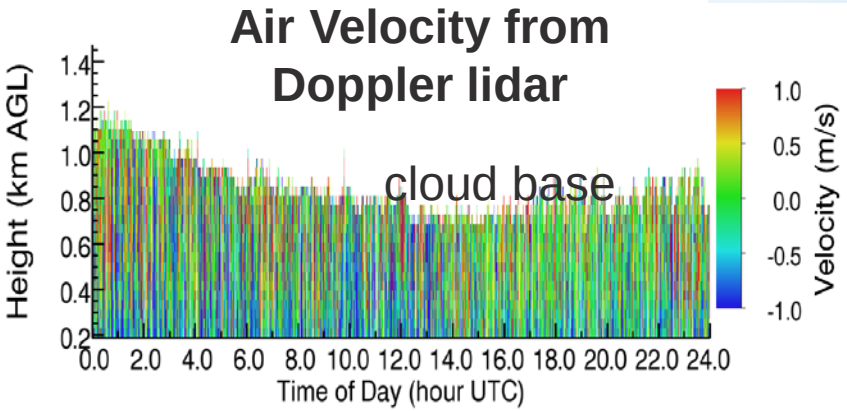


Seamless cloud/precip/clear velocity

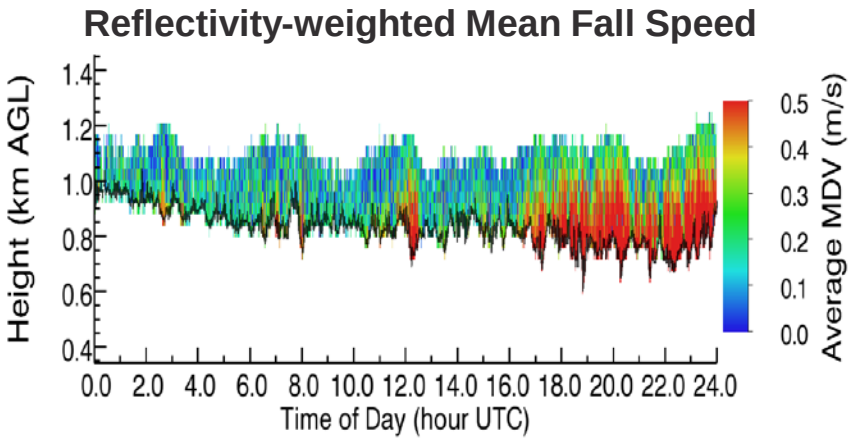


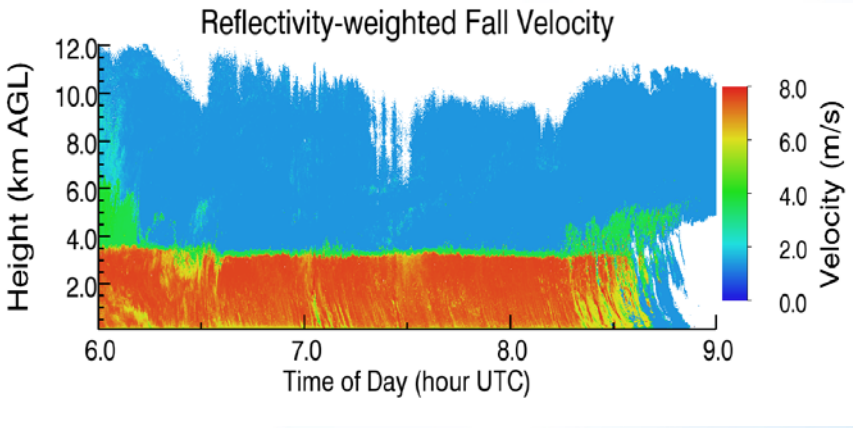


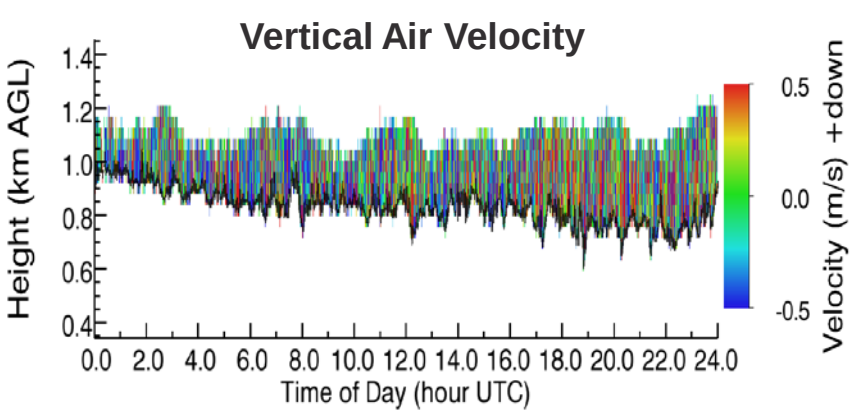


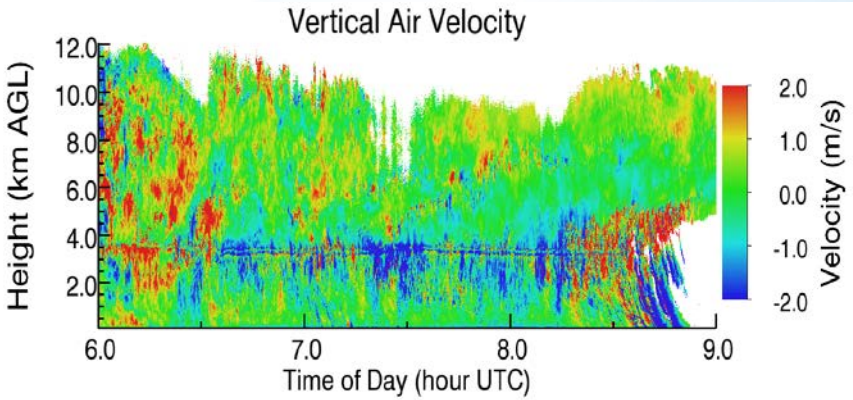


Generalizing to all stratiform precip.

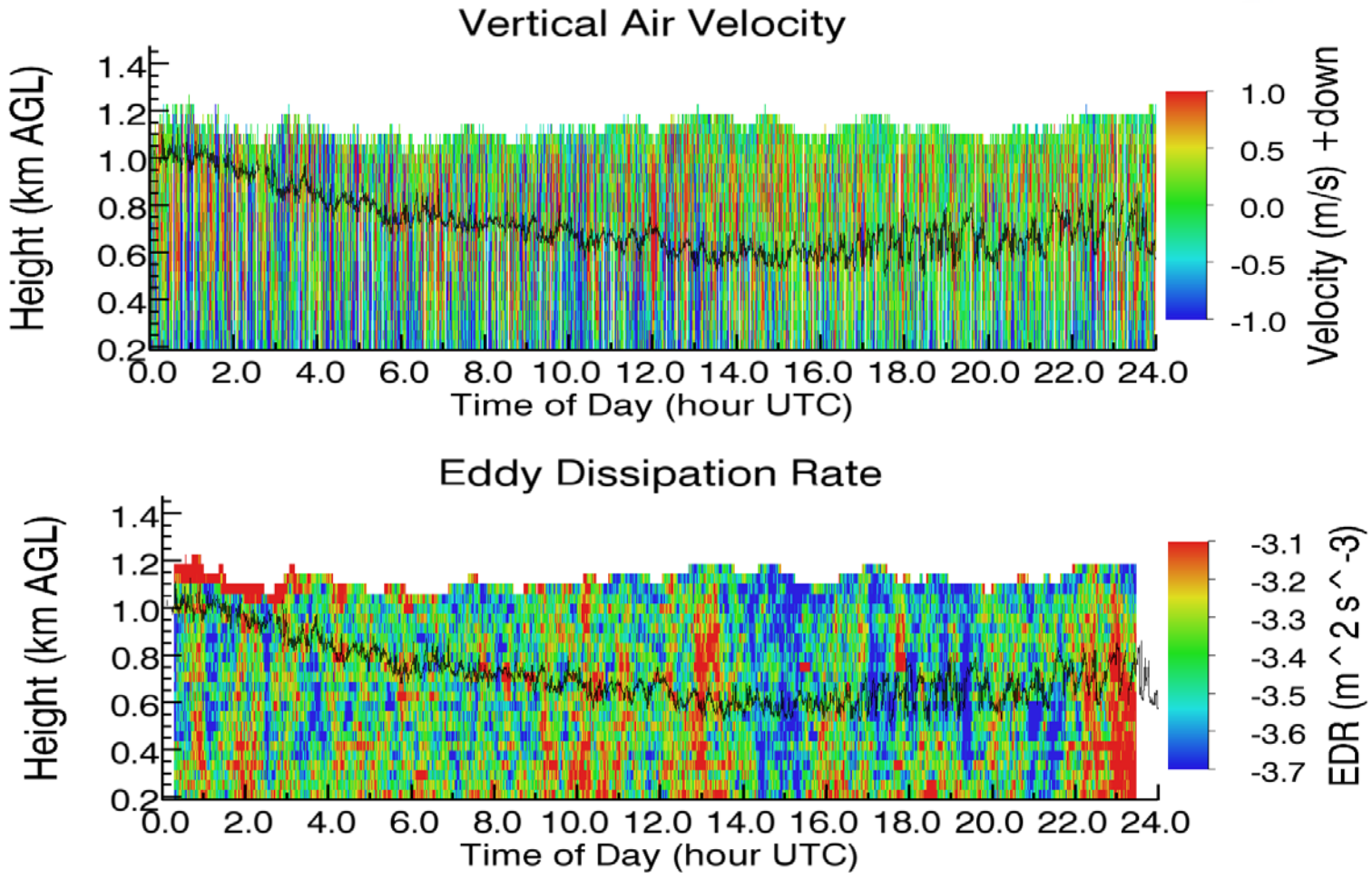




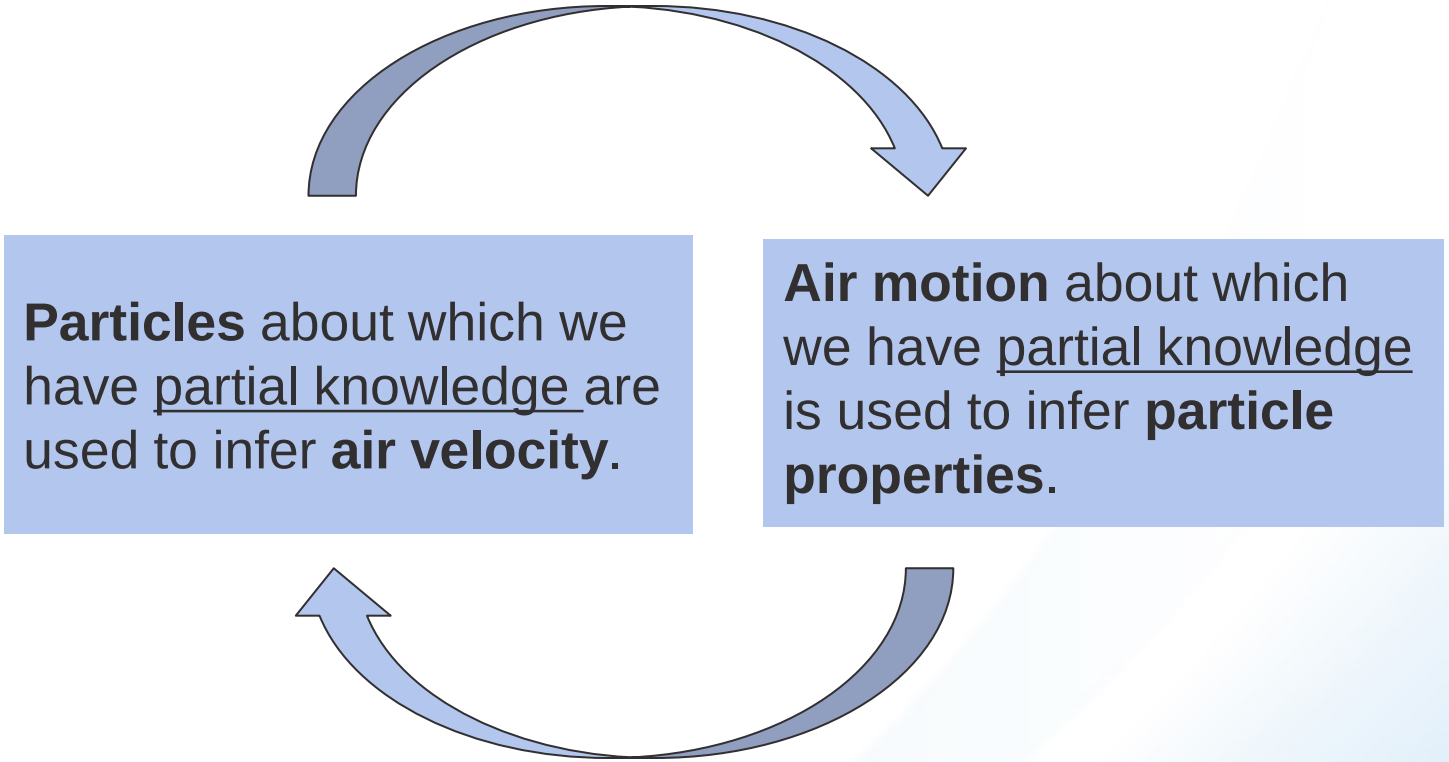




Crosswind needed for turbulence retrievals

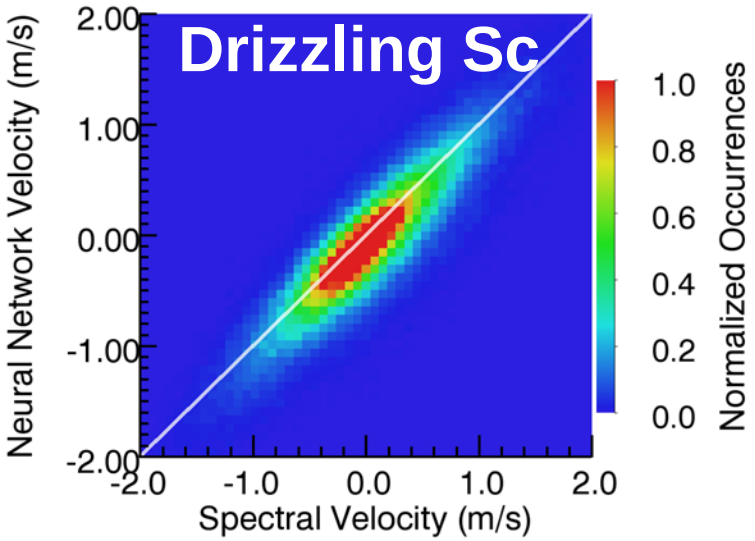


Sedimentation velocity retrievals

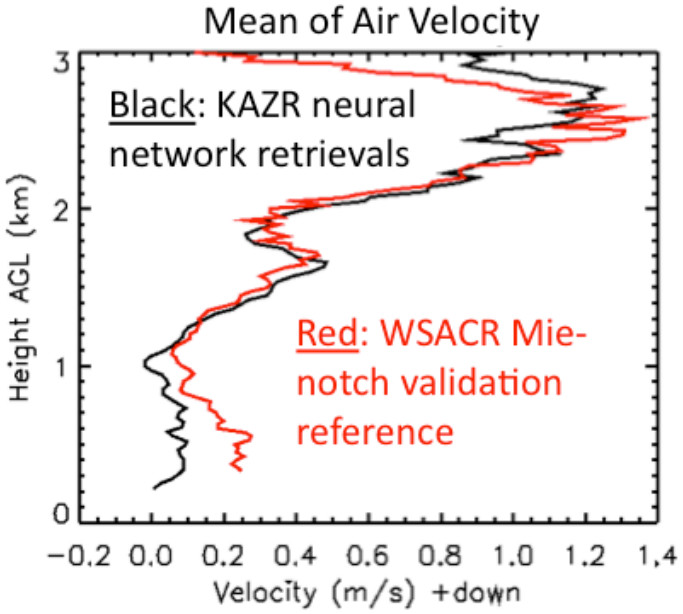


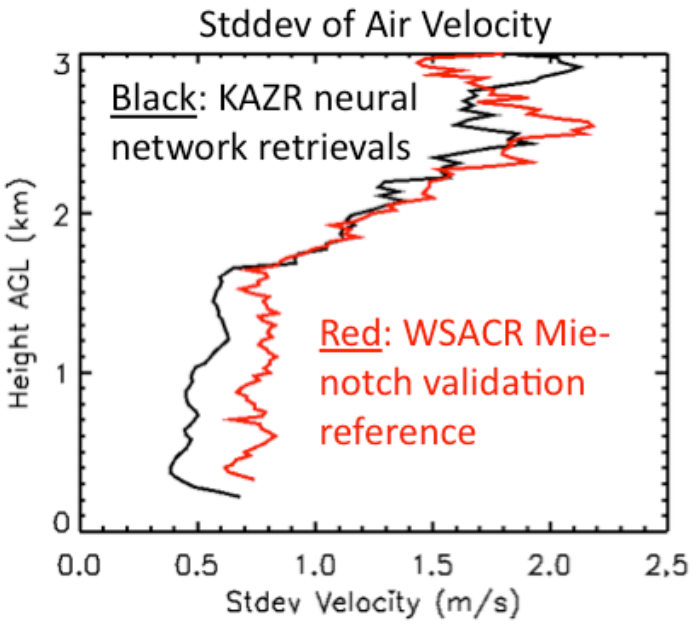
Many vertical air velocity retrievals are inherently sedimentation rate retrievals as well.

VV Uncertainty



Stratiform rain





Site/Regime priorities

- SGP
- NSA
- Azores
- Amazon
- other

- Clear sky
- Fair weather Cu
- Continental/marine Sc
- Mixed-phase
- Mid-level convection
- Deep convection
- Cirrus
- Sub-cloud
- Above cloud

Summary

- Progress has been made on a seamless vertical velocity best estimate product.

- Drizzling stratocumulus above and below cloud base is at PI-product level

- Stratiform rain is showing promising results

- Ice cloud results are the most recent, and also encouraging

- Deep convection work to start in the near future.