

Vertical Motions and Microphysics in Arctic Mixed-Phase Stratus

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With contributions from

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ARM Science Team Meeting 2007

Topics

Status of Ground-Based
Observational Methods

Cloud Classification

M-PACE
Vertical Motions &
Microphysics

A Conceptual Model

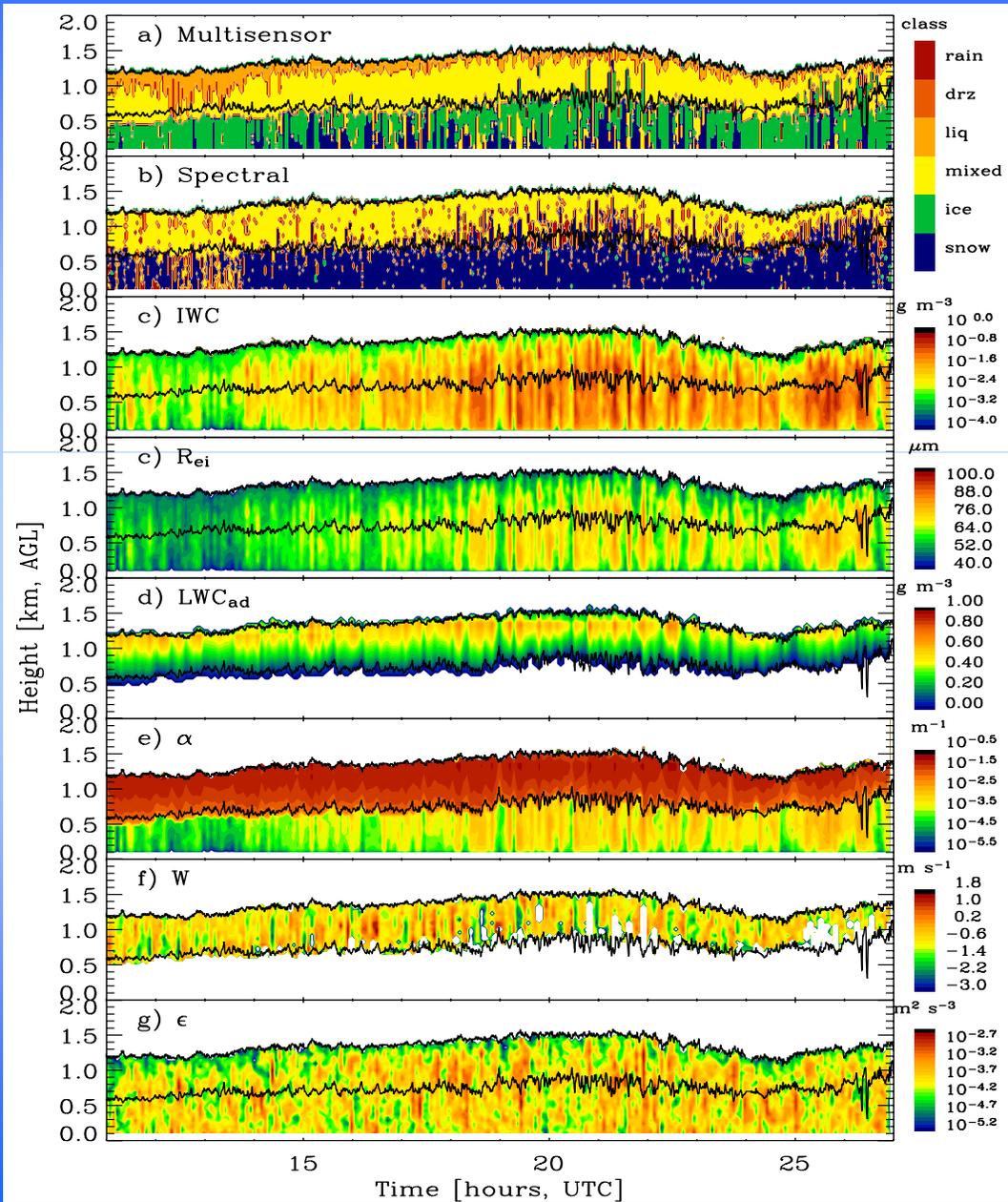
Status of Ground-based Retrievals

Phase
Classification

Microphysics

Radiation

Dynamics



Status of Ground-based Retrievals

Boundaries

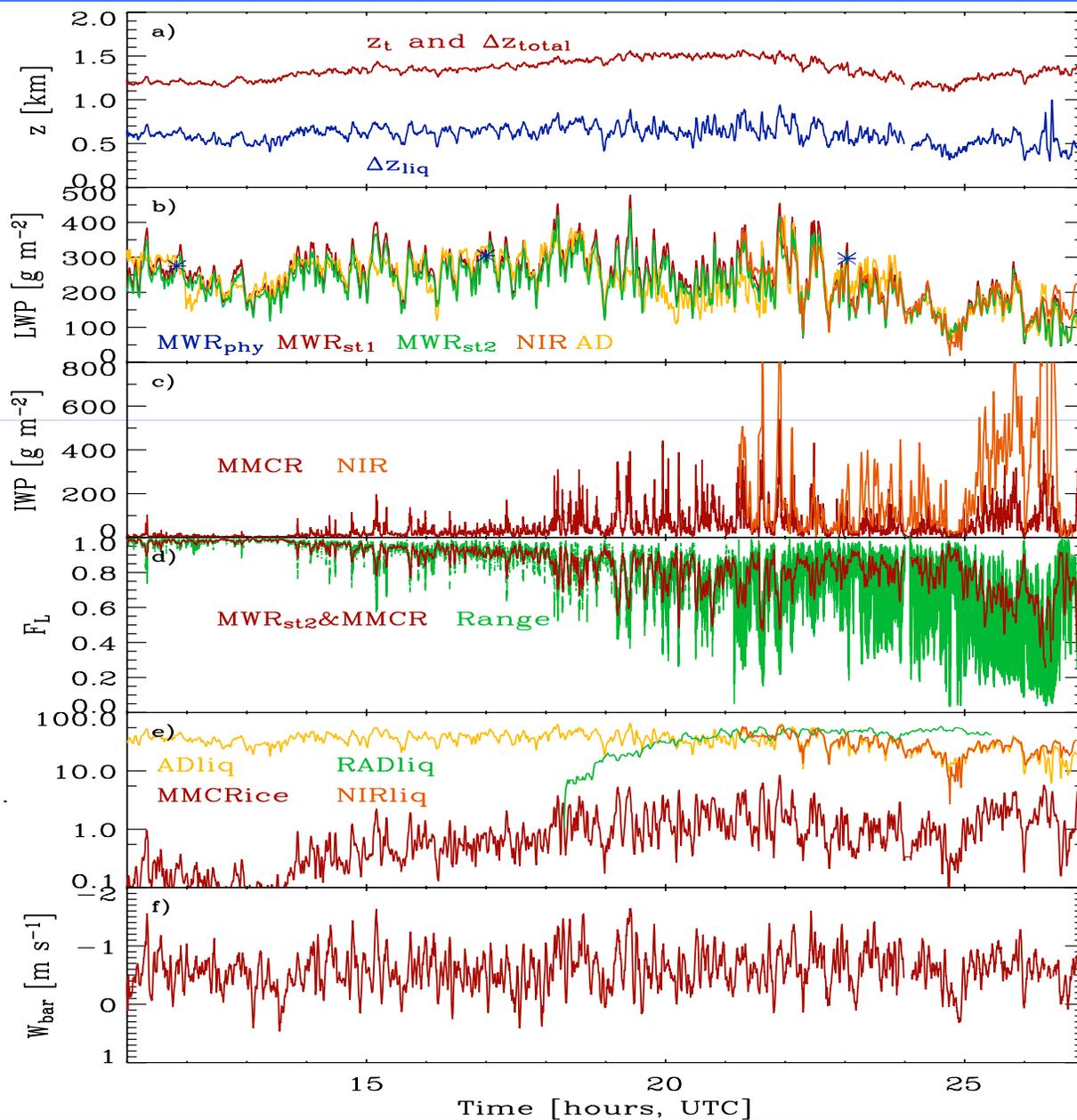
LWP

IWP

Phase
Balance

Optical
Depth

Vertical
Velocity



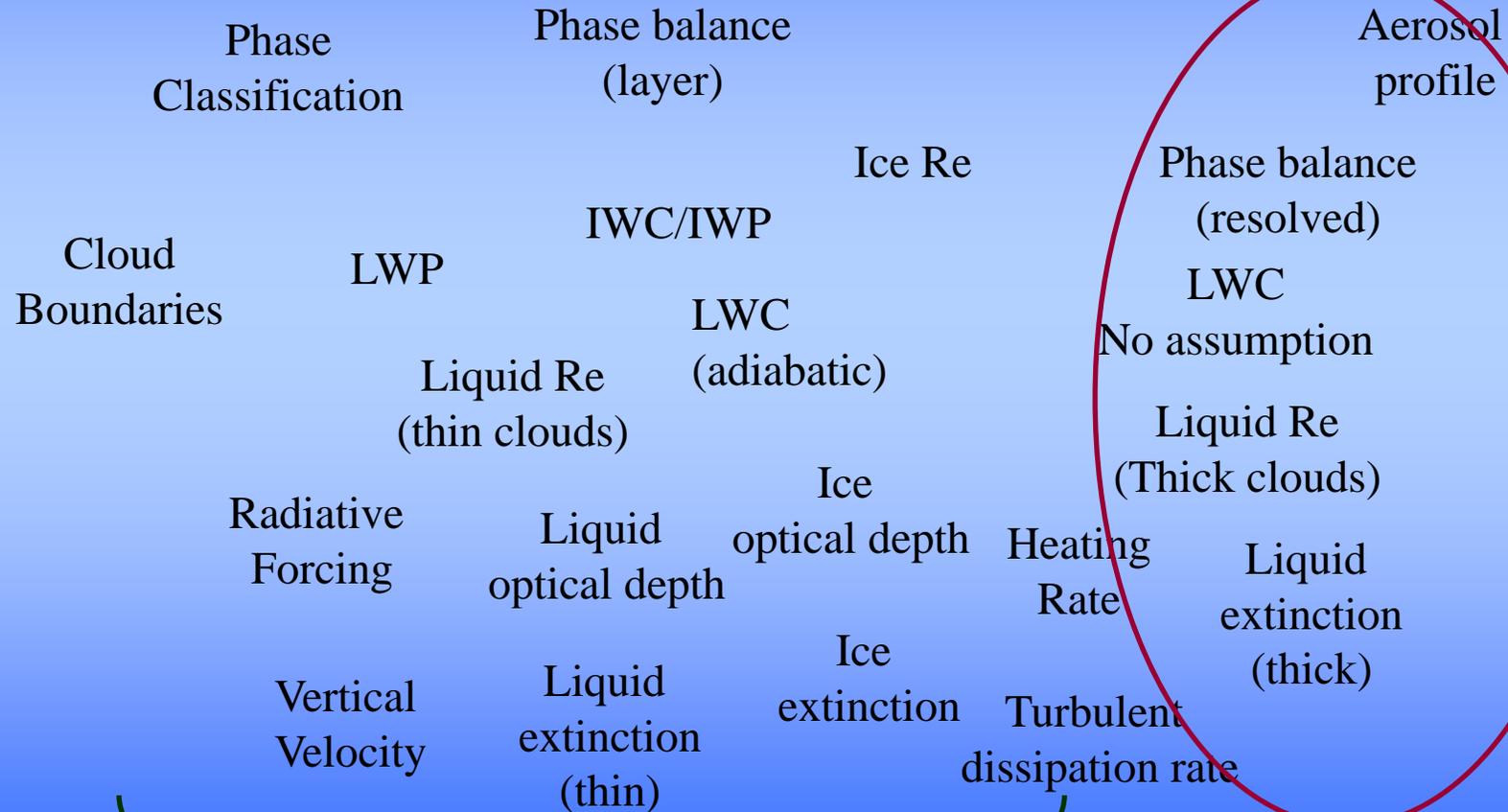
The Spectrum of our Knowledge

From Ground-based Sensors

← Certain

“Known”

Unknown

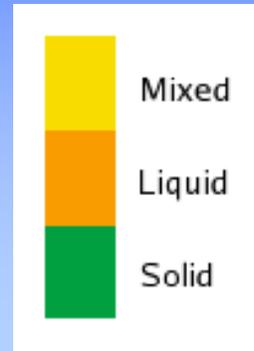
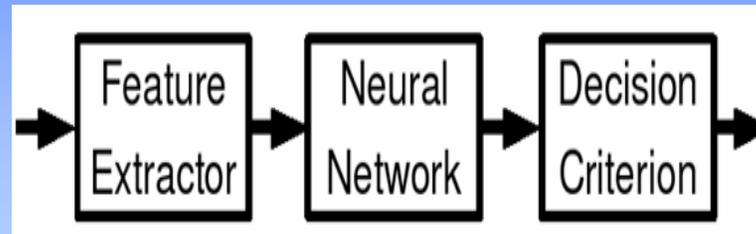
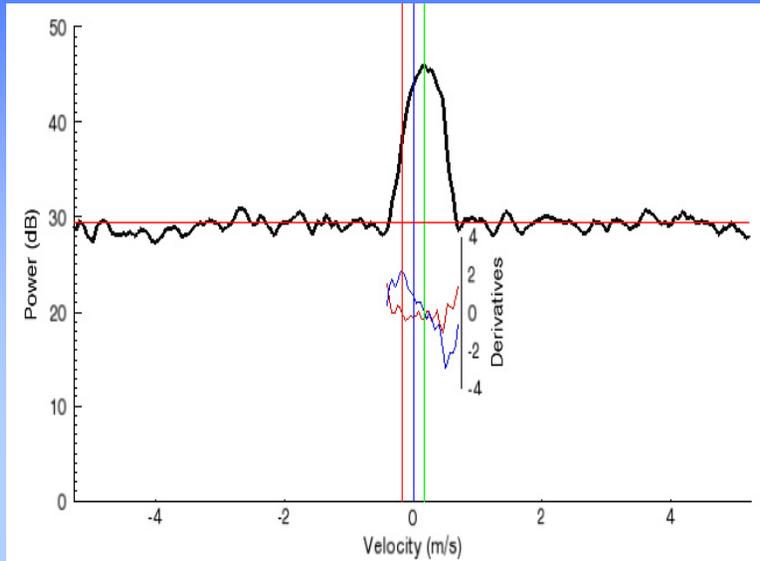


Need new methods

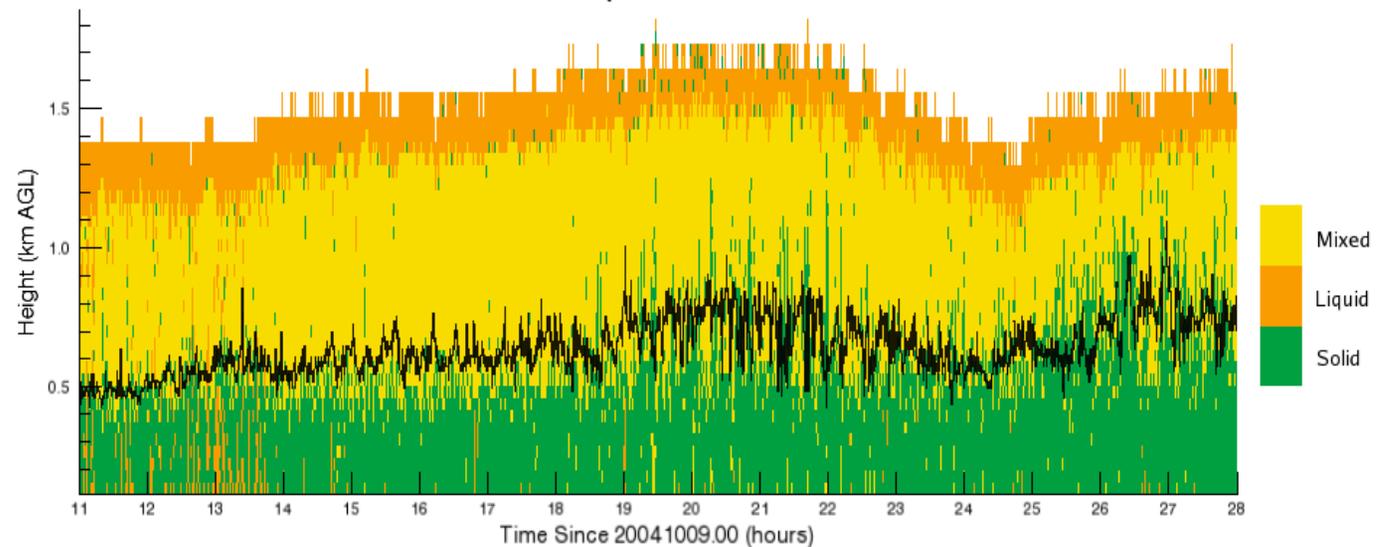
Need further validation

Cloud Phase Classification

MMCR Doppler spectra-based technique



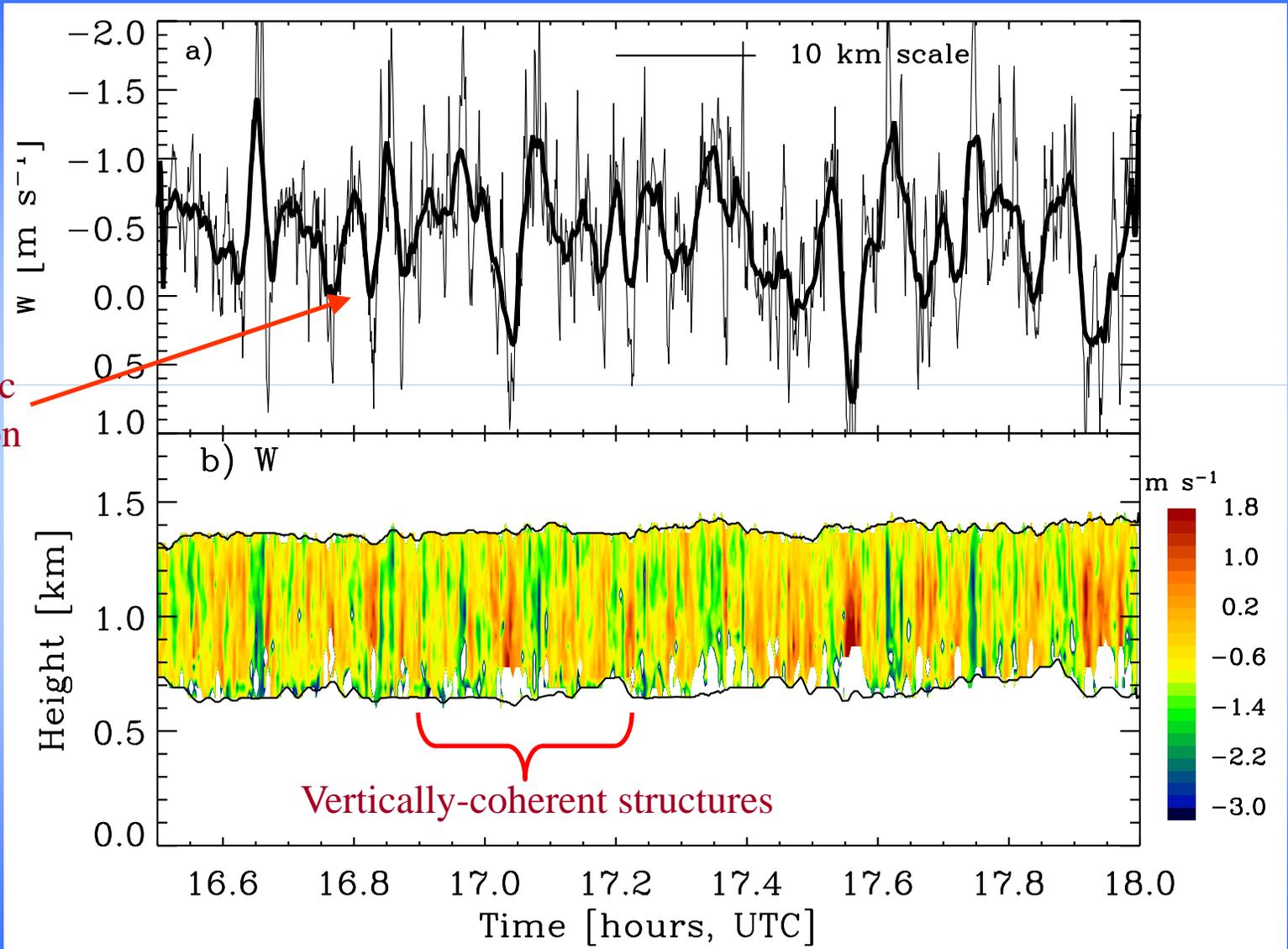
NSA 20041009-20041010 Spectra-based Phase Classifications



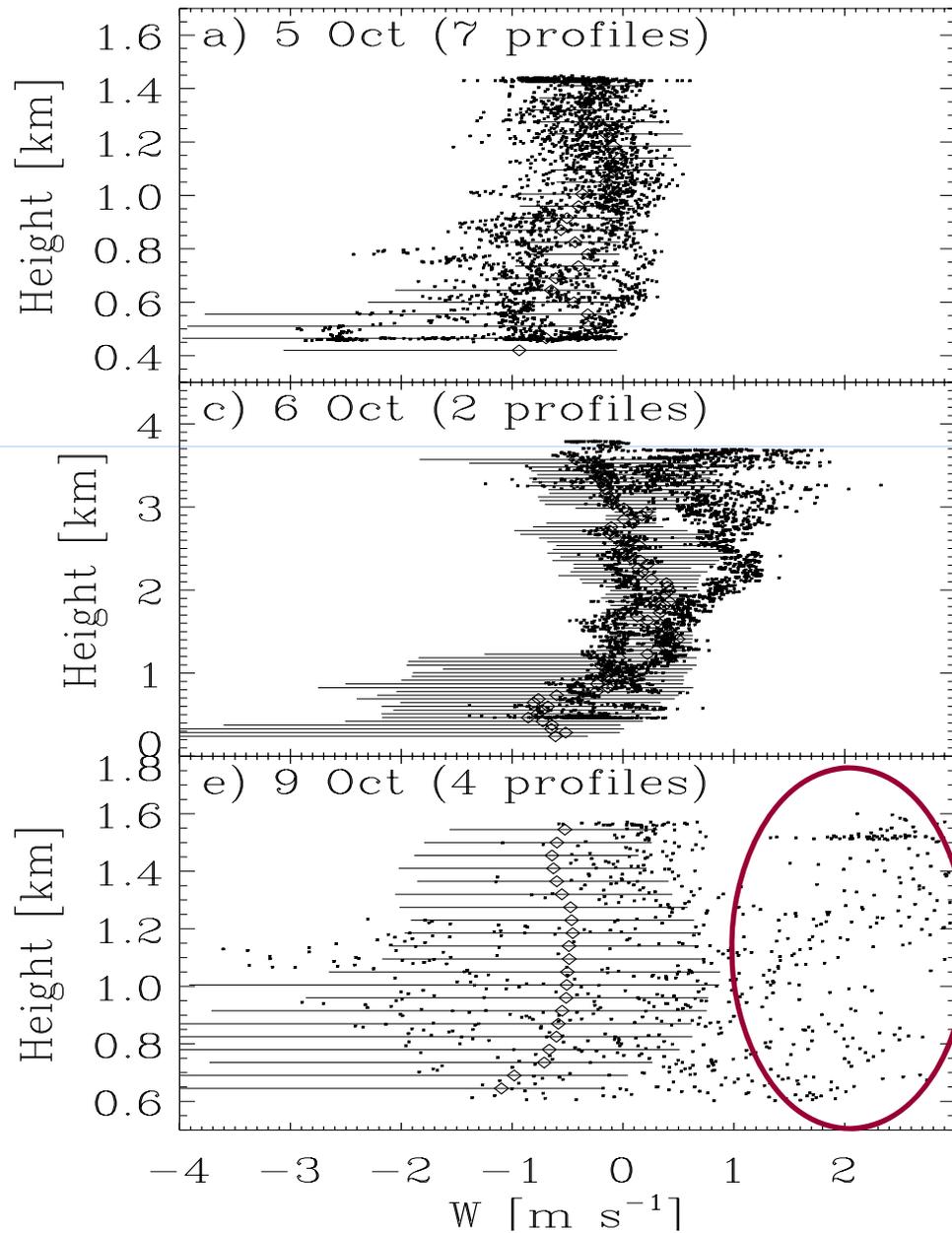
Slide from P. Kollias & E. Luke

An Example

Various periodic scales-of-motion

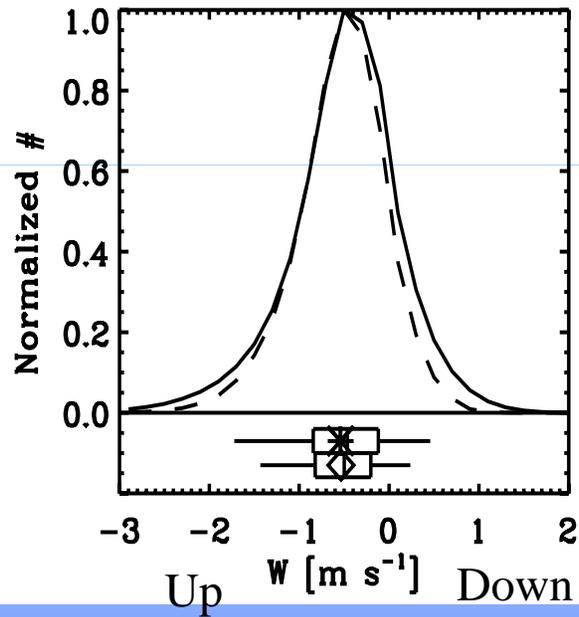


Aircraft Comparisons at M-PACE

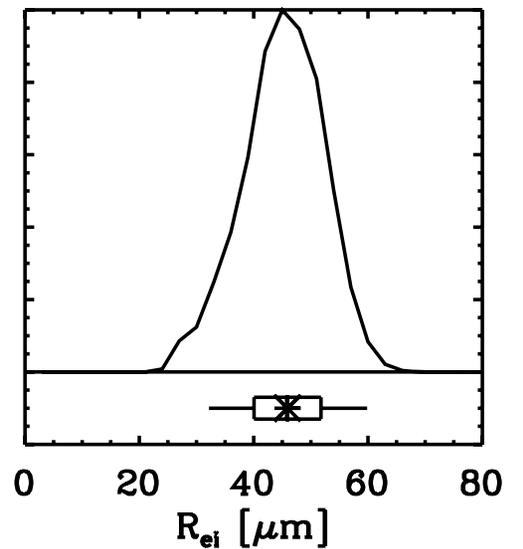
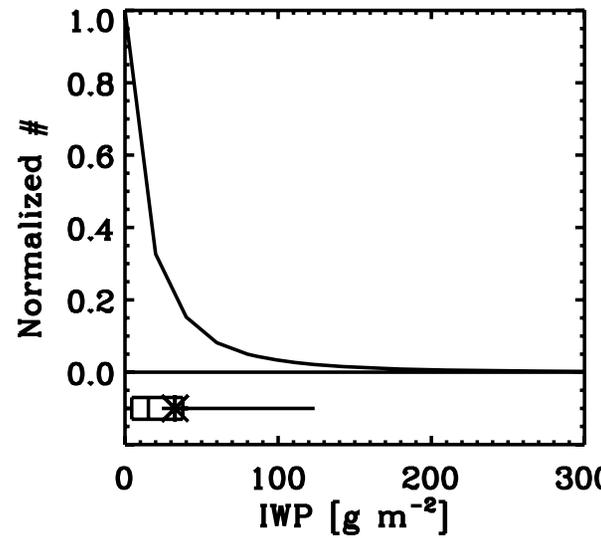
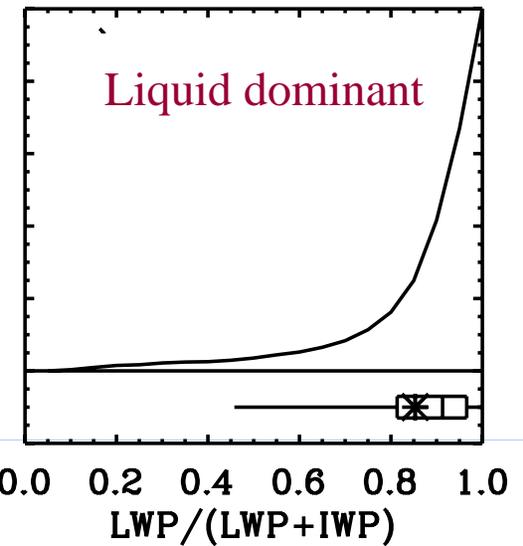
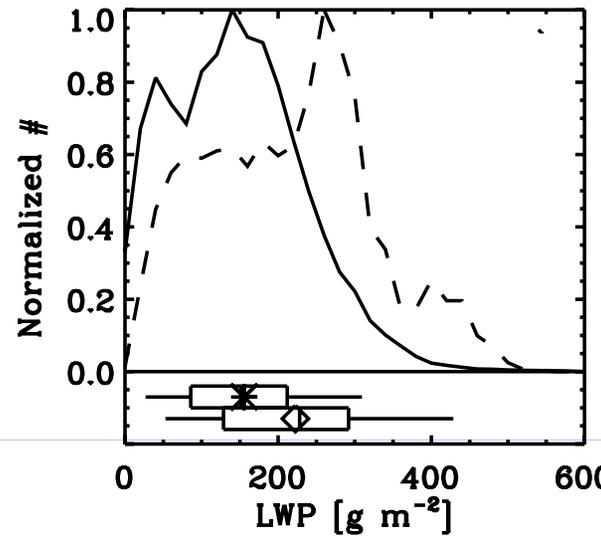


Different
Air mass?

Results from M-PACE: Single layer stratus

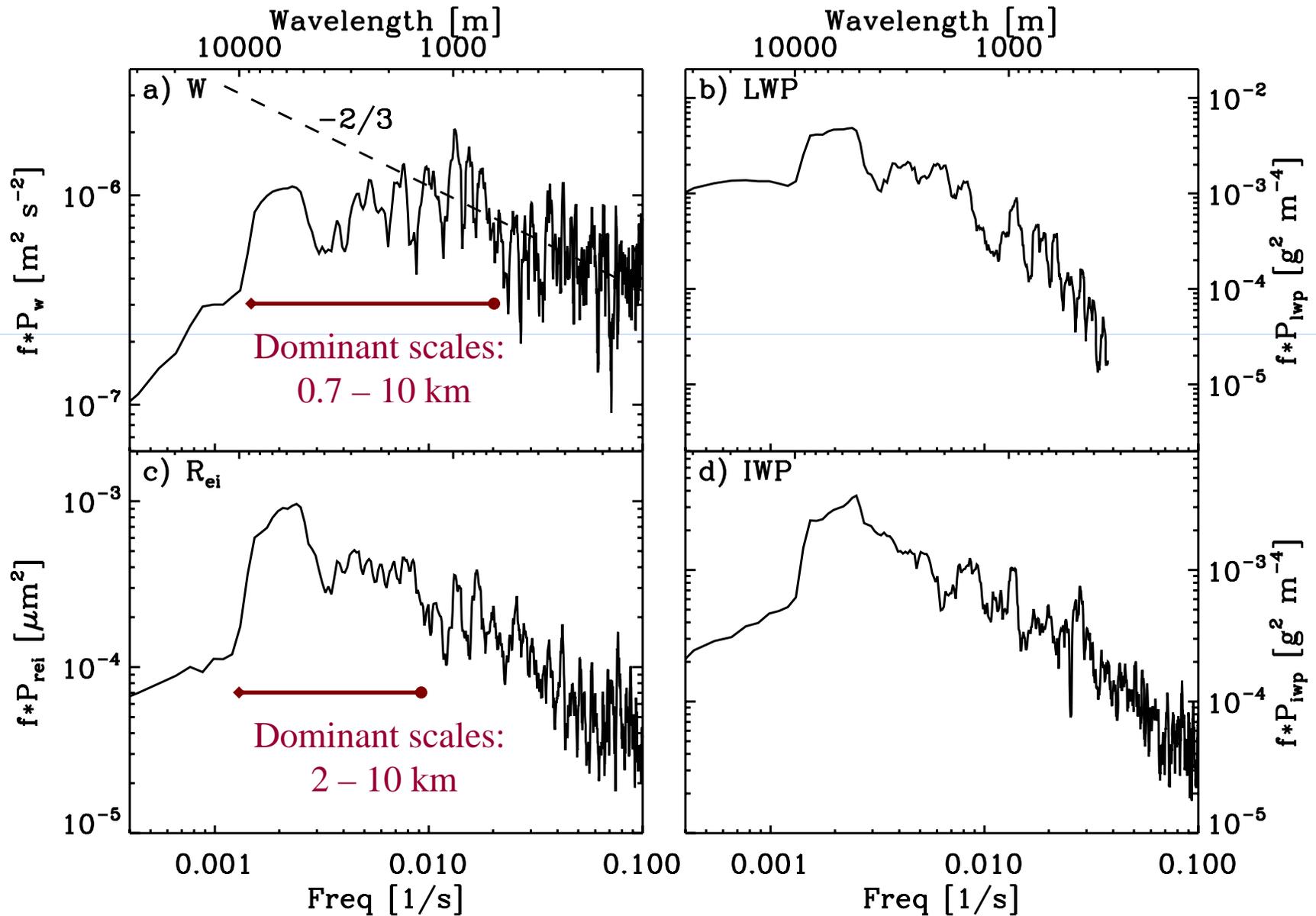


Mean upward motion in cloud

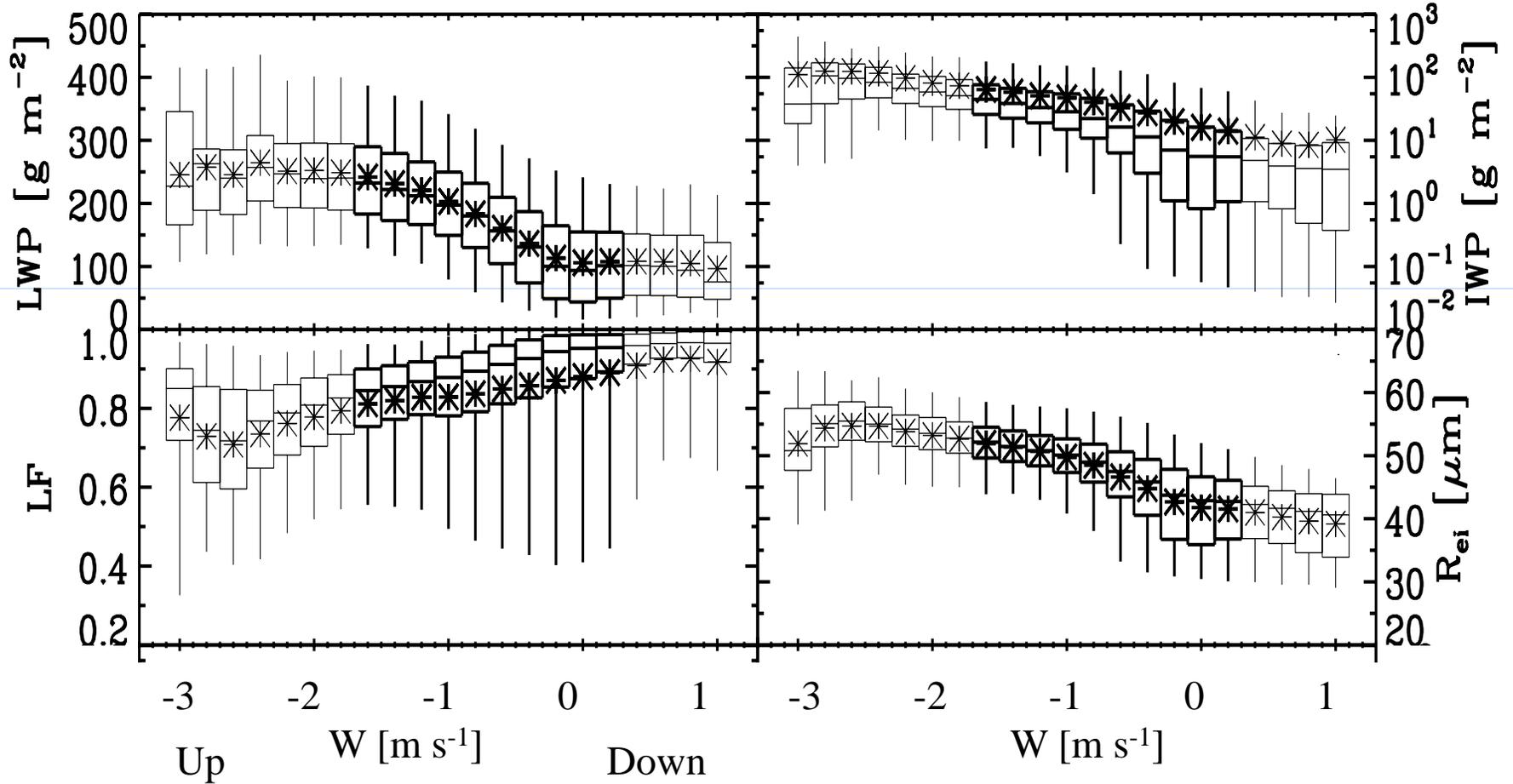


More liquid and less ice than SHEBA

Time Series Analysis



Cloud Response to Vertical Motions

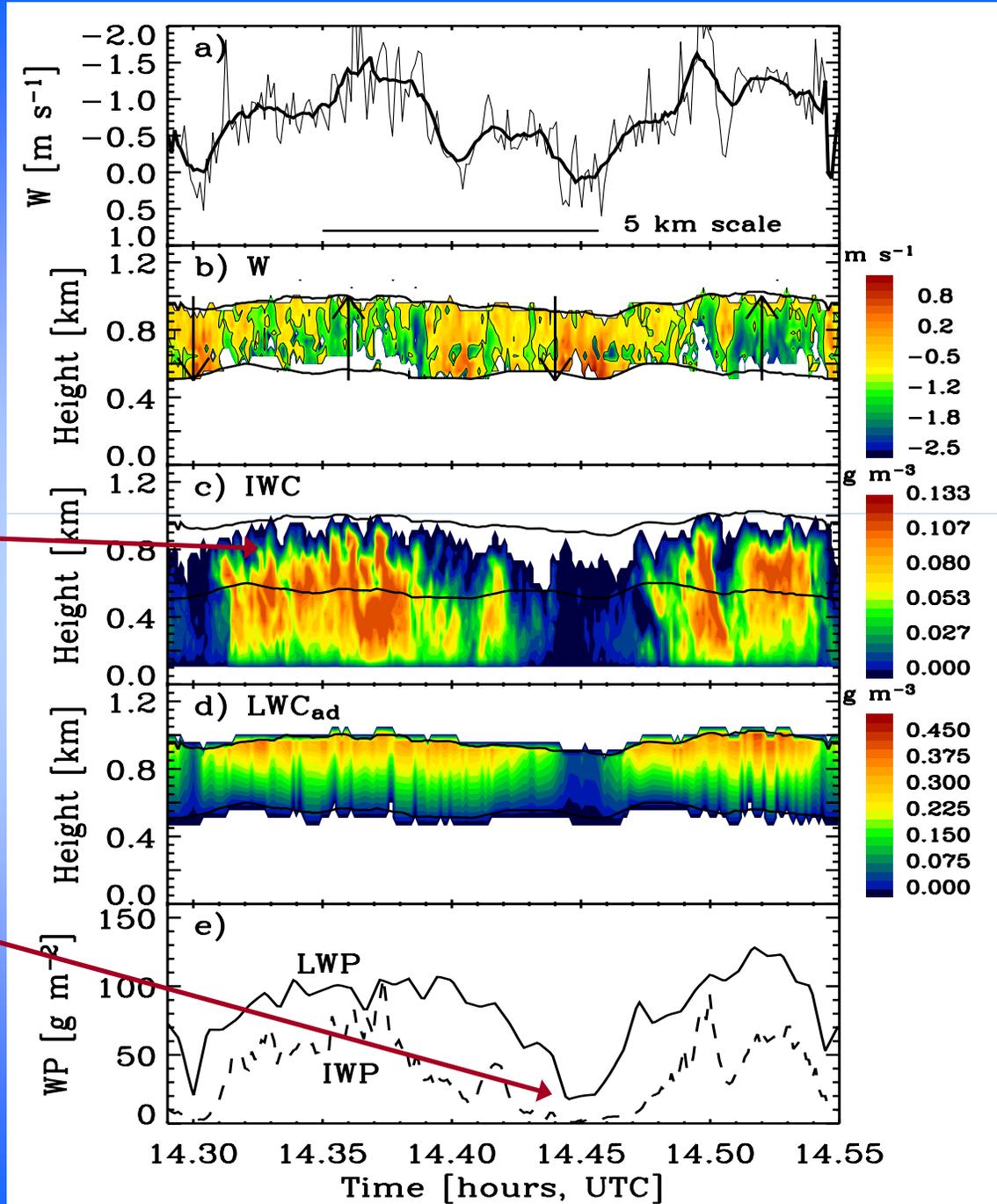


In Focus

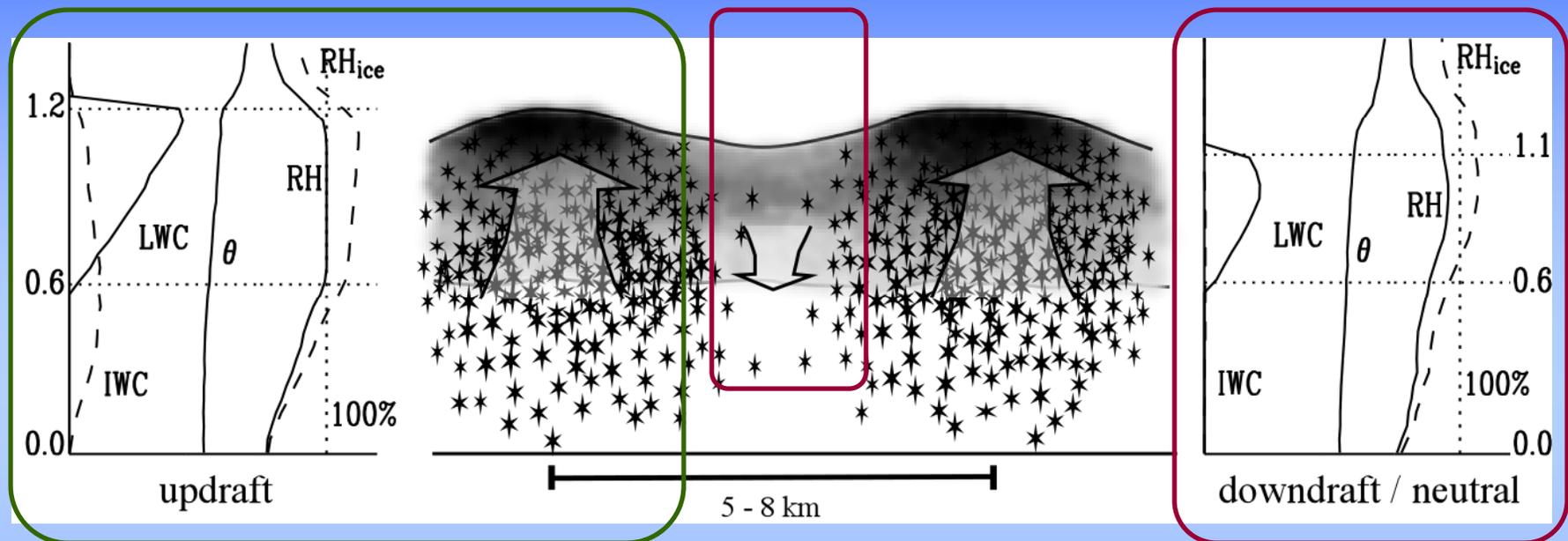
Motions at 7, 2, and 0.5 km wavelengths

Ice forms in updrafts near cloud top, falls out.

Liquid persists throughout cycle, supported by almost complete ice fallout



A Conceptual Model



Updraft

- Cloud top lifts
- LWC near adiabatic
- Ice particle nucleation
- Limited ice concentration
- IWC maximum near liquid base
- $RH \sim 100\%$ in cloud layer

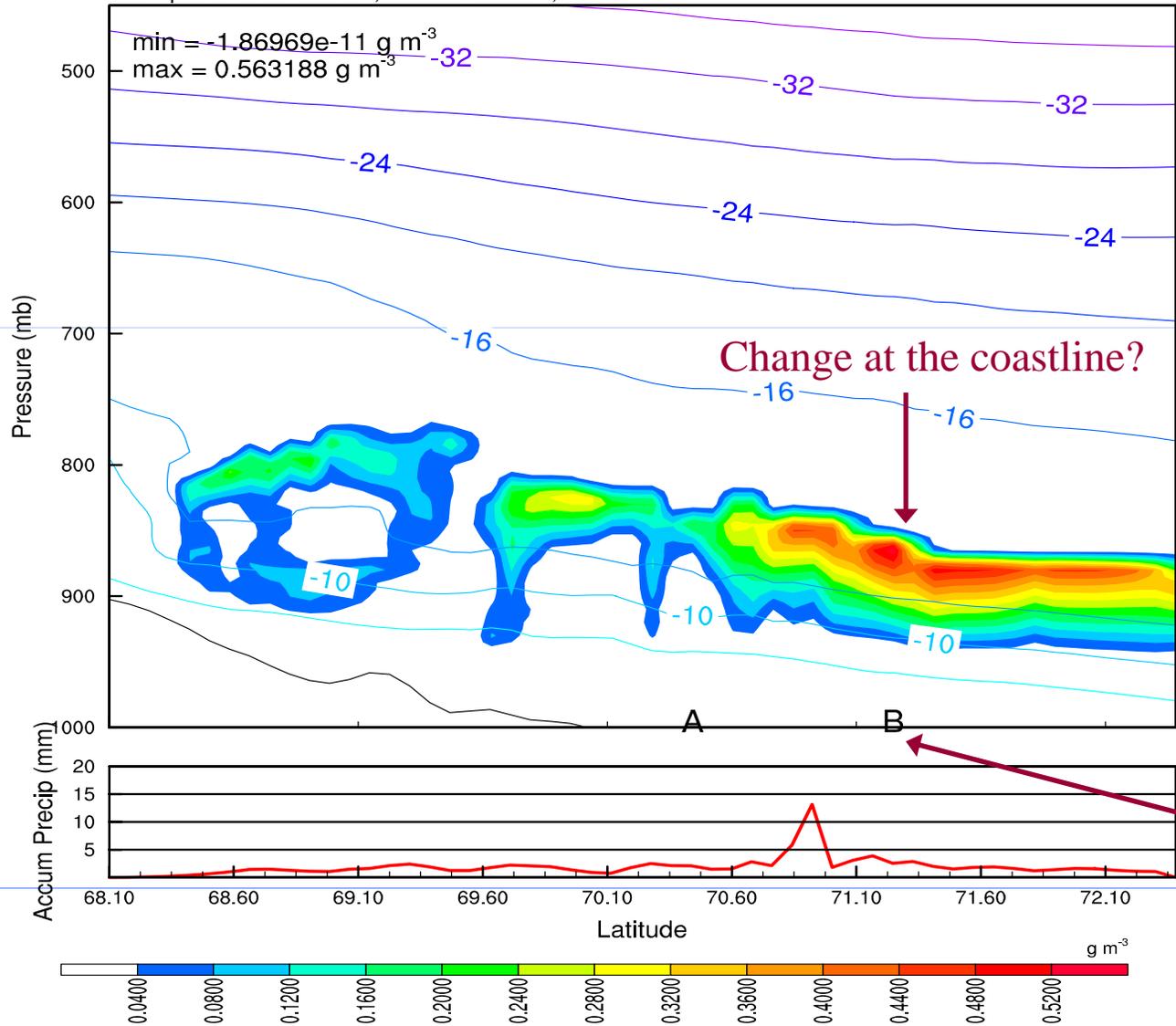
Downdraft / neutral

- Cloud top descends
- LWC sub-adiabatic (evaporation)
- Ice particles fall out
- IWC negligible
- $RH < 100\%$ in cloud layer

Representative?

Cloud water mixing ratio (g m^{-3})

Thompson Barrow 71.3N, Oct 10 2004 0Z, 156.7W



Conclusions

- *Still some gaps in our abilities:*

Most importantly the vertical dist'n of liquid properties

- *New classification methods:*

Radar Doppler spectra are rich with information

- *Vertical velocity retrievals:*

Provide for a better understanding of microphysical-dynamical processes

- *Conceptual model:*

Describes cloud structure in autumn at Barrow