Analysis of Vertical Velocity Measured During RACORO ^

A work in progress

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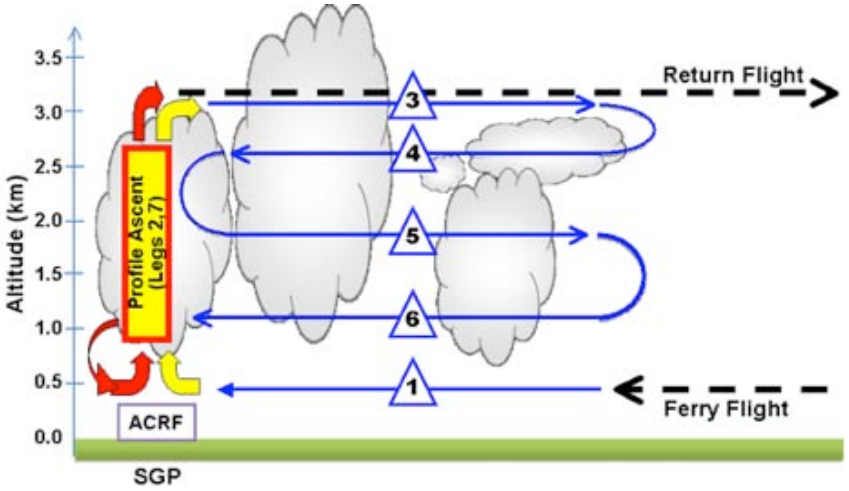
RACORO Overview

- January-June 2009
- Routine flights in BL & liquid clouds
- Measurements
  - Optical and microphysical properties of clouds and aerosols
  - Radiative fluxes
  - *Dynamic* and thermodynamic atmospheric state
- Platform: CIRPAS – Twin Otter

RACORO:
Routine AVP CLOWD, Optical, Radiative, Observations

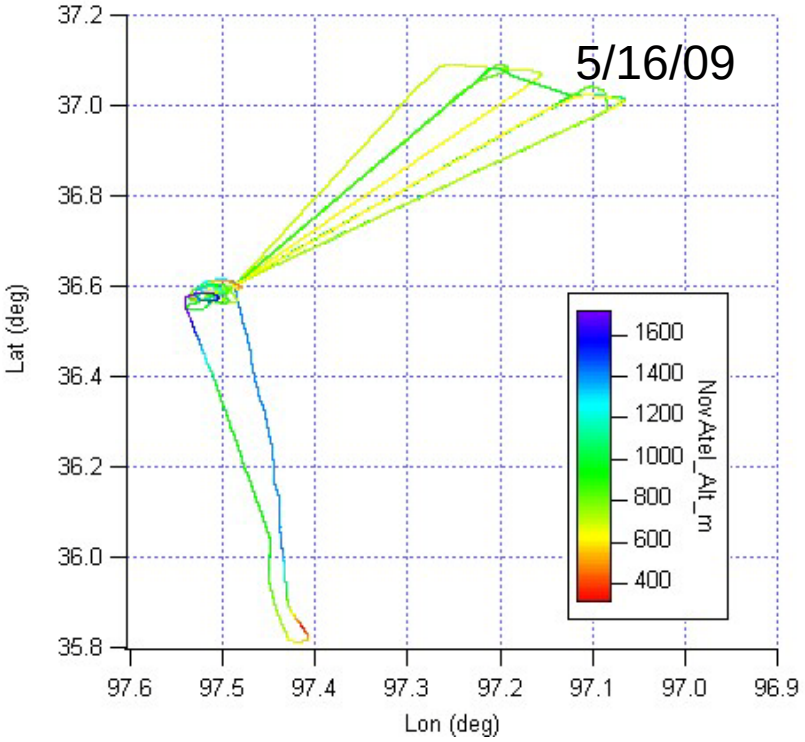
RACORO Flight Plans

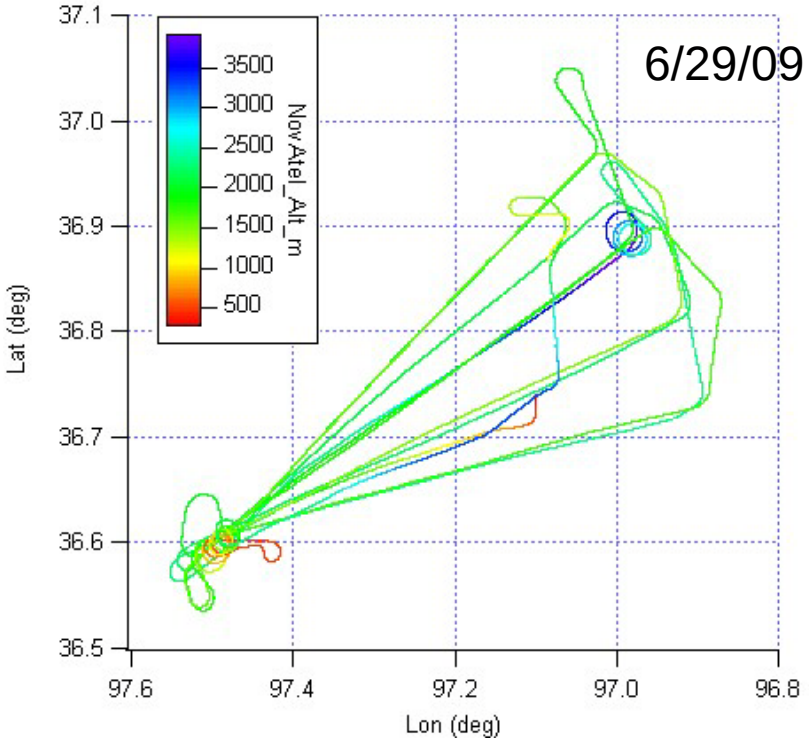
- Cloud Flights
- Clear sky flights
  - *Turbulence: long level legs in BL*
  - Surface albedo
  - Radiometer tilt characterization



Turbulence Legs

- 17 flights with turbulence legs
  - Flown through clear air (cloud free days)



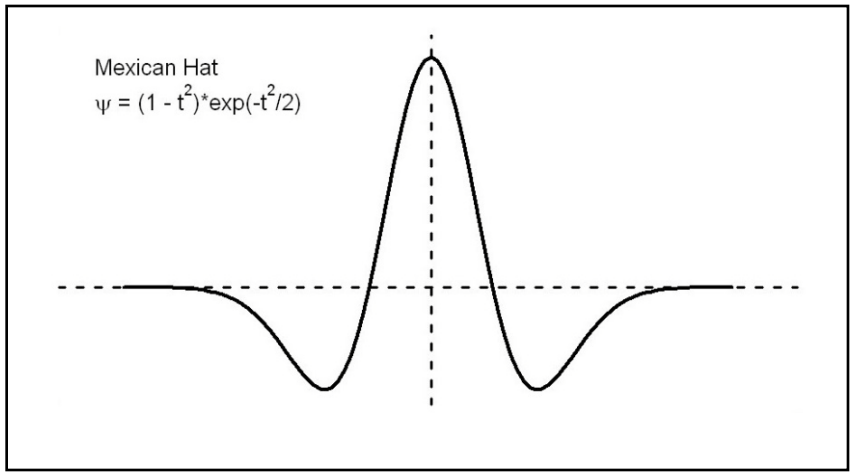


Data Processing

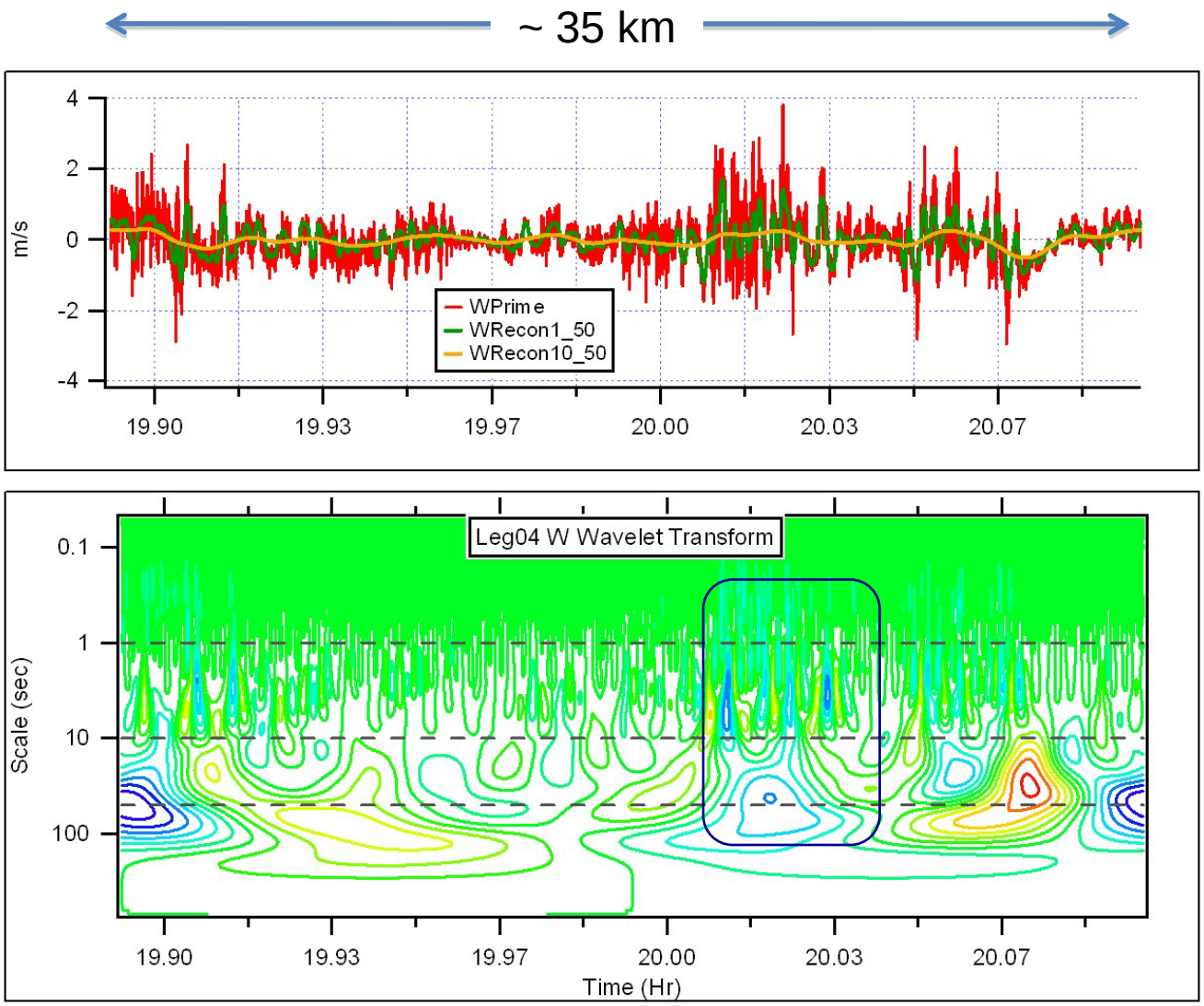
- Velocity data available at 10 Hz
- First steps
  - Remove mean and trend
  - Remove outliers
  - Replace missing values
- Filter to focus on length/time scales of interest
  - Large scale features may not be well represented
  - Instruments might not be collocated—gust probe and cloud microphysics

Filtering: Wavelets

- Why not FFT?
- Wavelets to describe events in high-frequency data
  - Localized in both frequency and time
  - Translate a “mother” wavelet in time
  - Dilate at each time
- Mexican-hat mother wavelet used in this study
- Can filter data to desired scale — useful for comparison with remote sensing platforms



Example: 29 June 2009



- Near BL top $z/z_i \sim 0.98$
- Original w' in red
- Used wavelet transform to filter data
  - 1-50 sec (50-250 m)
  - 10-50 sec (500-2500 m)

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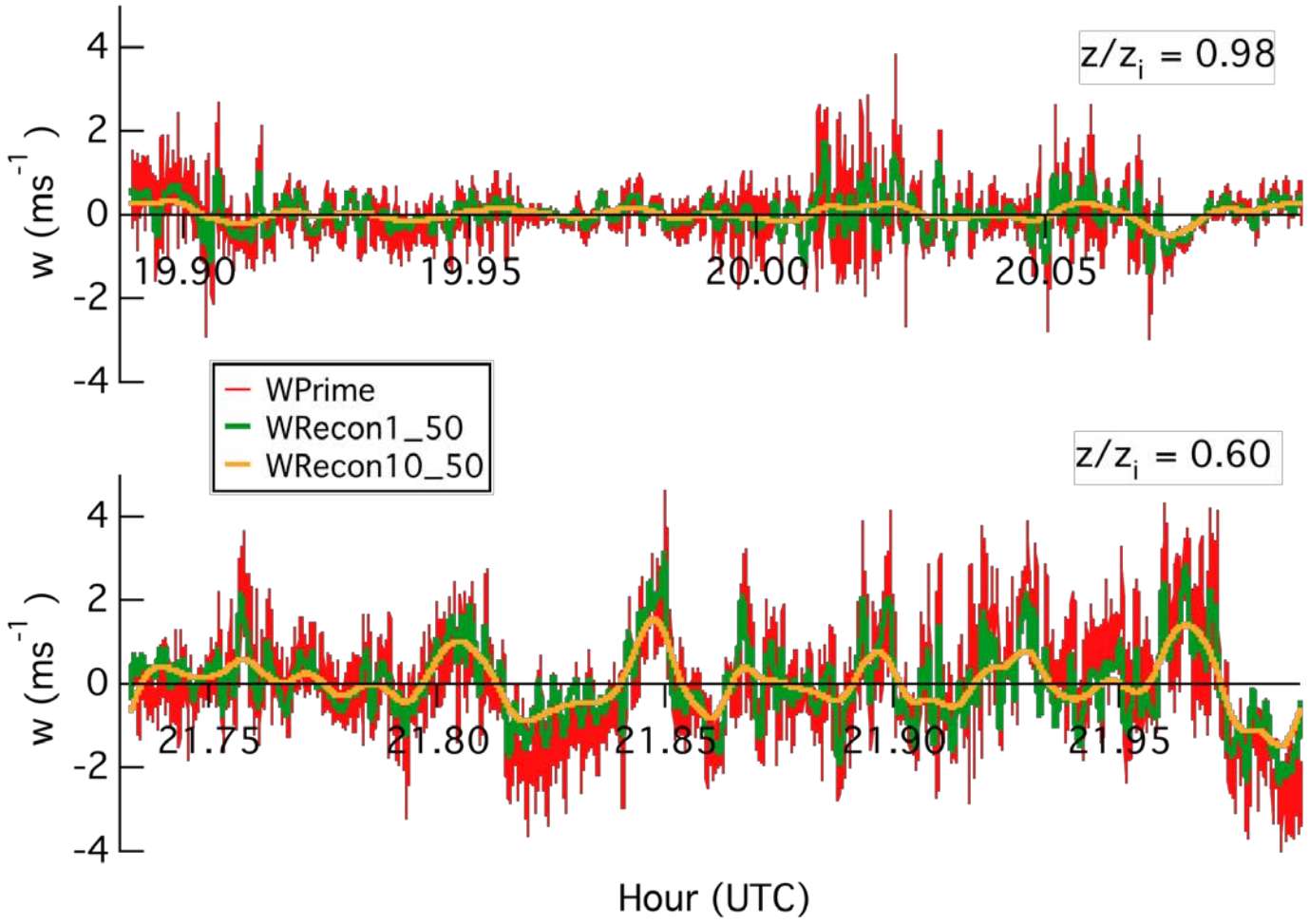
Vertical Velocity: Changes with Height



- Reduced turbulence near BL top

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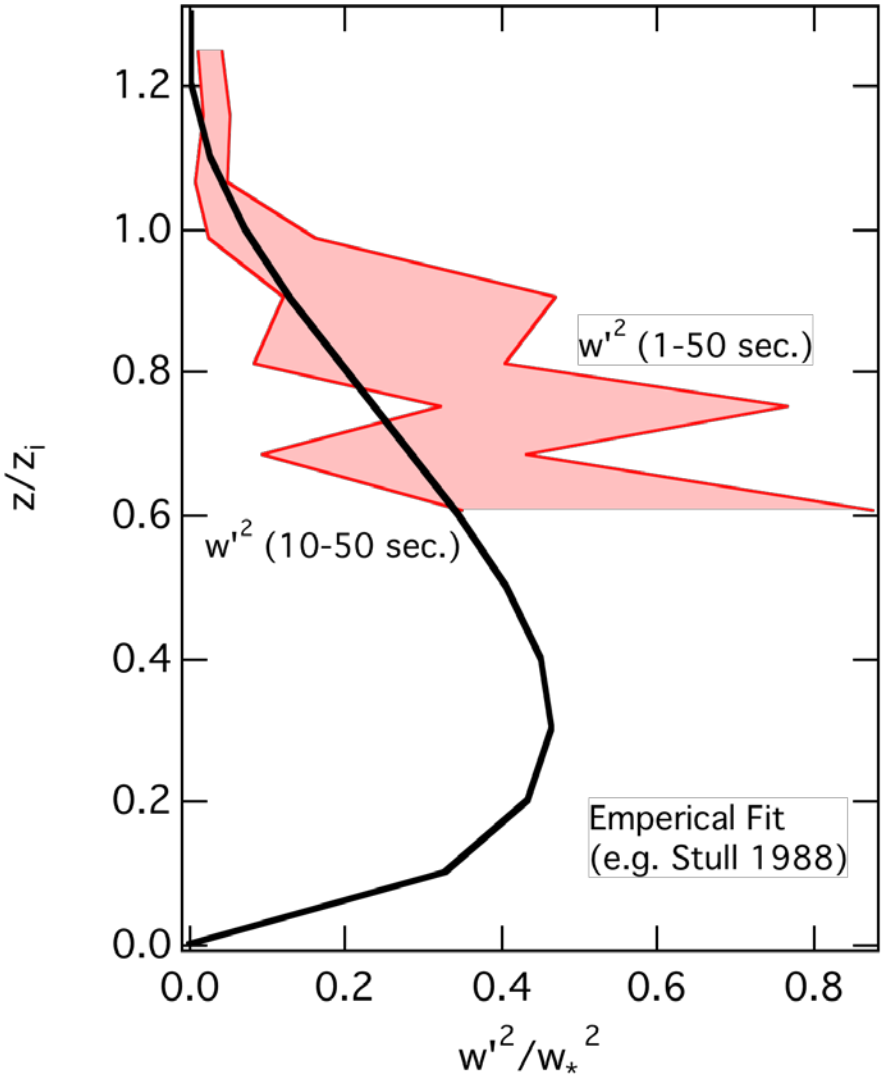
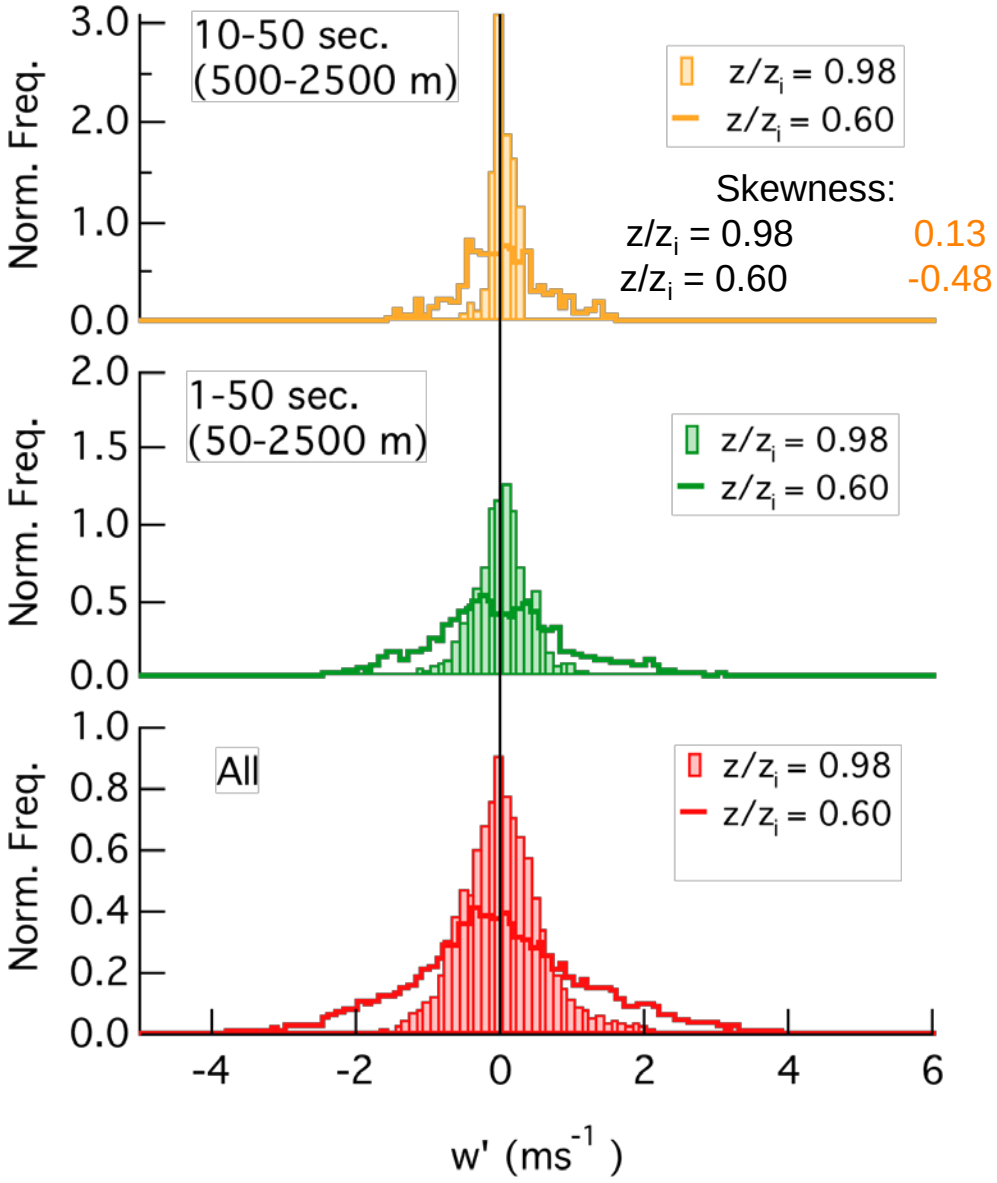
Velocity Variance



- RACORO results similar to past studies
- Range of scales are important
  - Scales between 1 and 10 seconds (50-500 m) contain a significant amount of energy

Histograms of w’



- Decrease in spread of distribution with height and filtering
- Distributions become less Gaussian with removal of shorter scales

Skewness:

$z/z_i = 0.98$ 0.16

$z/z_i = 0.60$ 0.55

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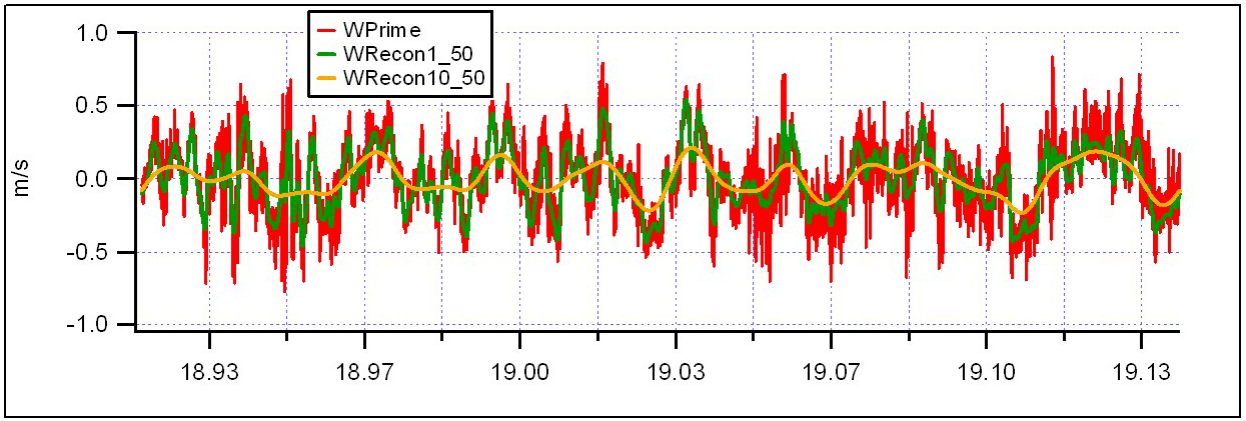
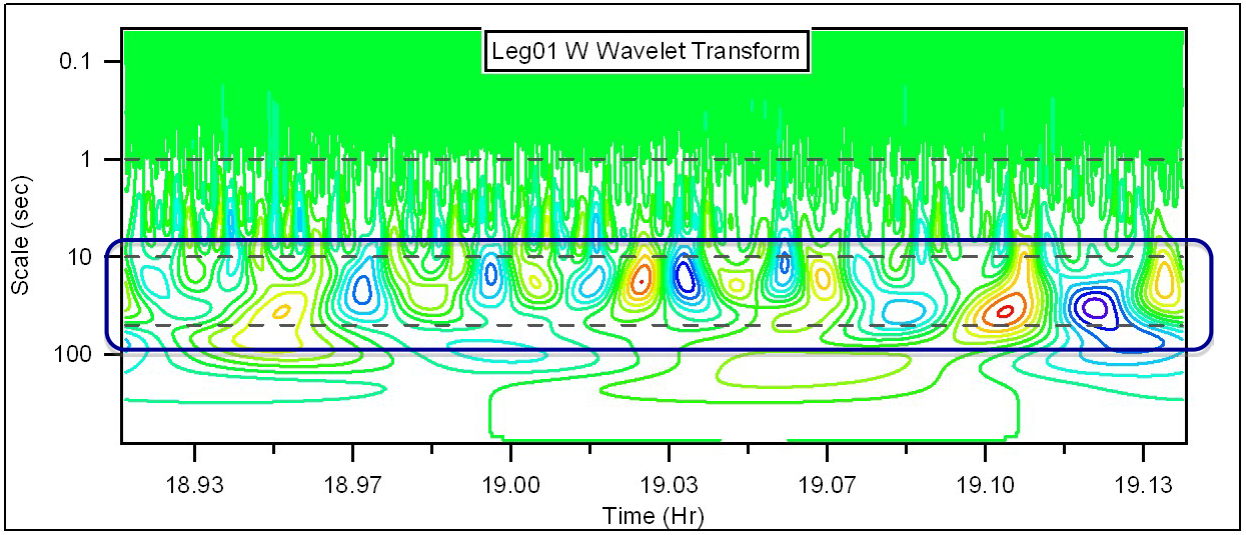
On Going & Future Work

- Additional analysis of turbulence legs
- Extension to days with clouds
  - Main reason for using wavelet analysis
  - Prepare detailed analysis of vertical velocity for comparison with parameterizations and remote sensors
  - Coupling with cloud microphysical measurements
- Make data set available for community use

Example: 6/29/09





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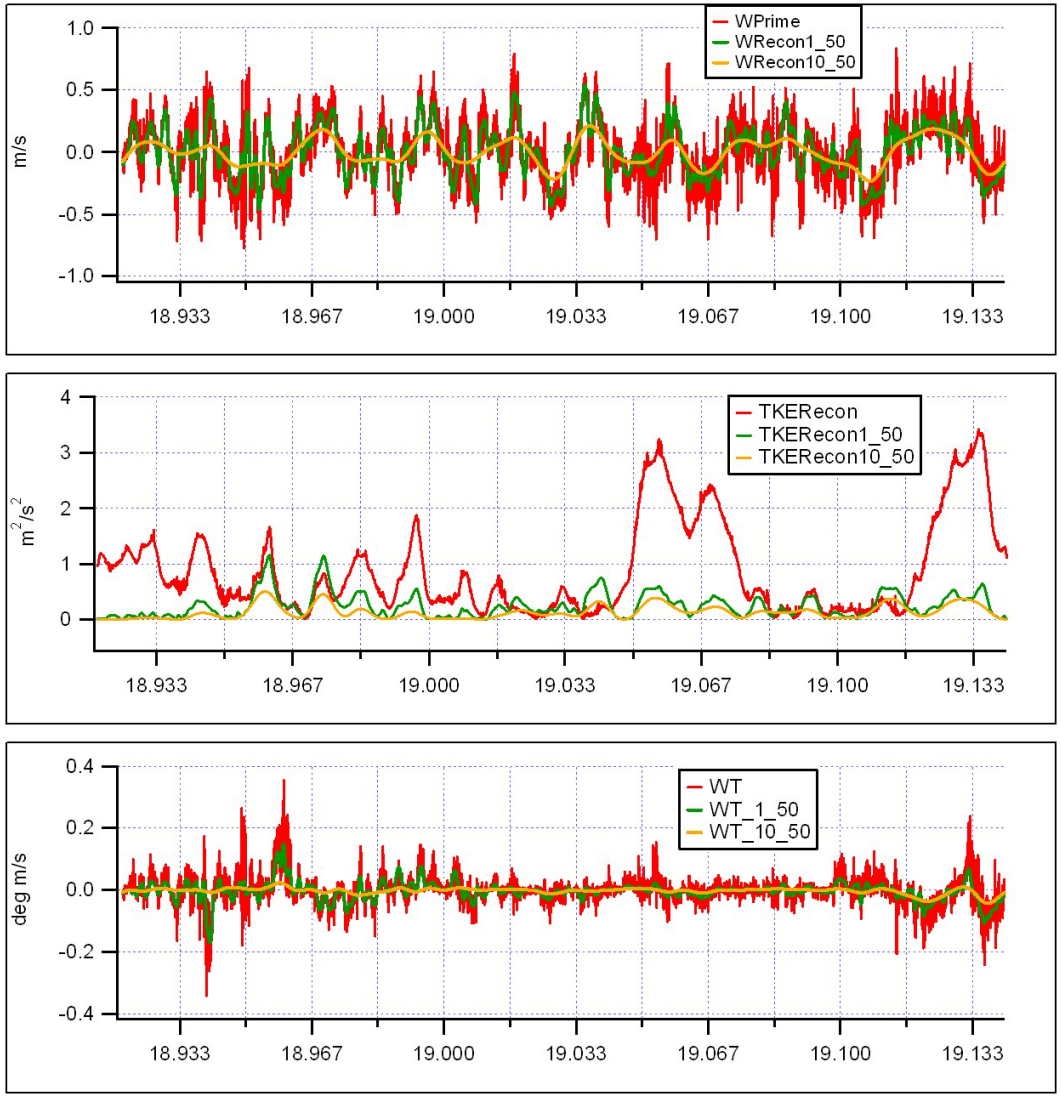
Vertical Velocity, TKE, & Heat Flux: 06/29/09



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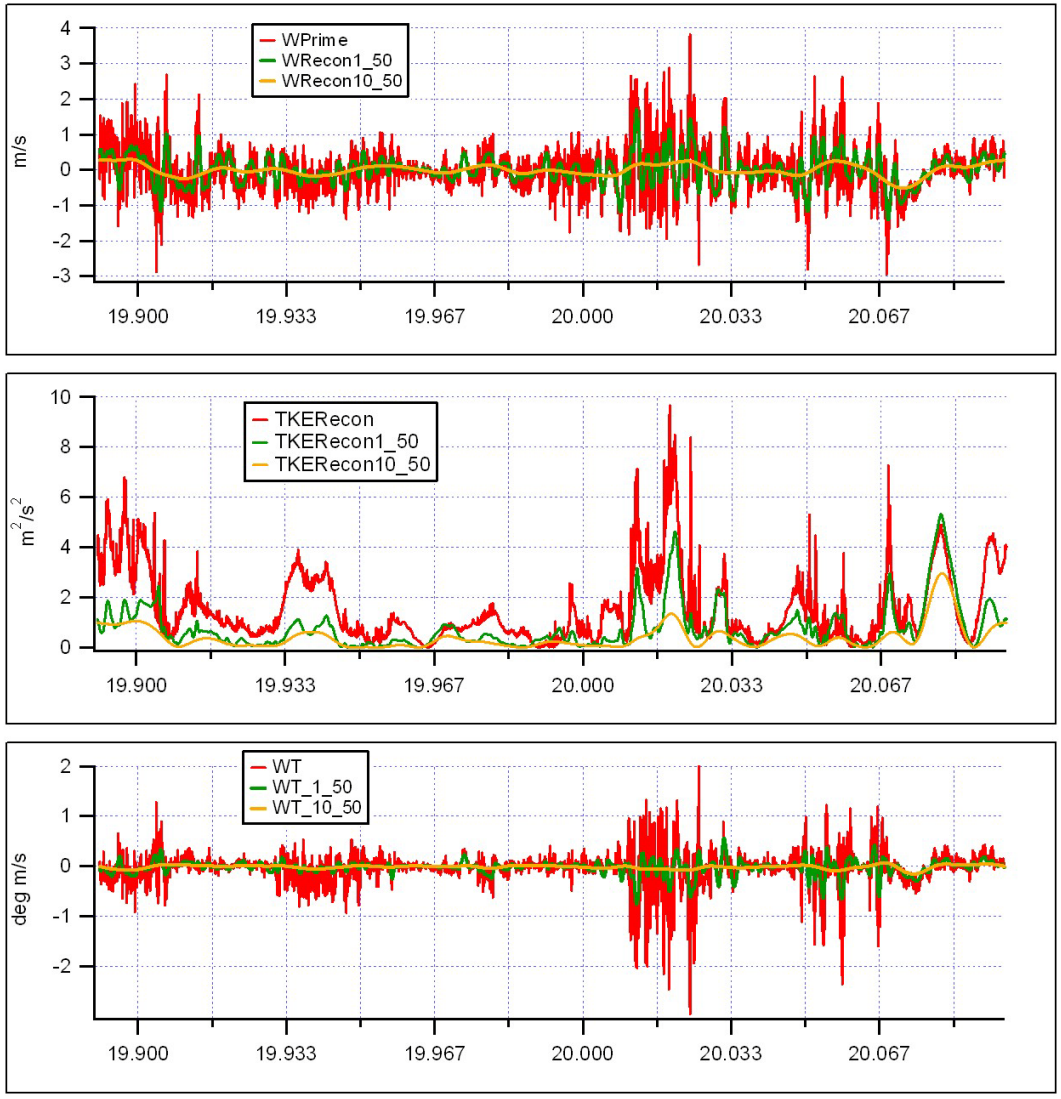

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Vertical Velocity Histograms

- Histograms of w’ have been constructed
  - Leg 1: near BL top
  - Leg 4: