High Resolution Radar/RASS measurements
Validation and preliminary results

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UNIVERSITY OF MASSACHUSETTS
M I R S L
MICROWAVE REMOTE SENSING LABORATORY

Outline

- Experimental setup.
- RASS implementation.
- Data example and RASS validation.
- Space-time statistics.

TEP setup

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Objectives:

- Validate RASS operation. Explore horizontal temperature imaging capabilities.

- Study space-time statistics of signals under a rande of stability conditions.

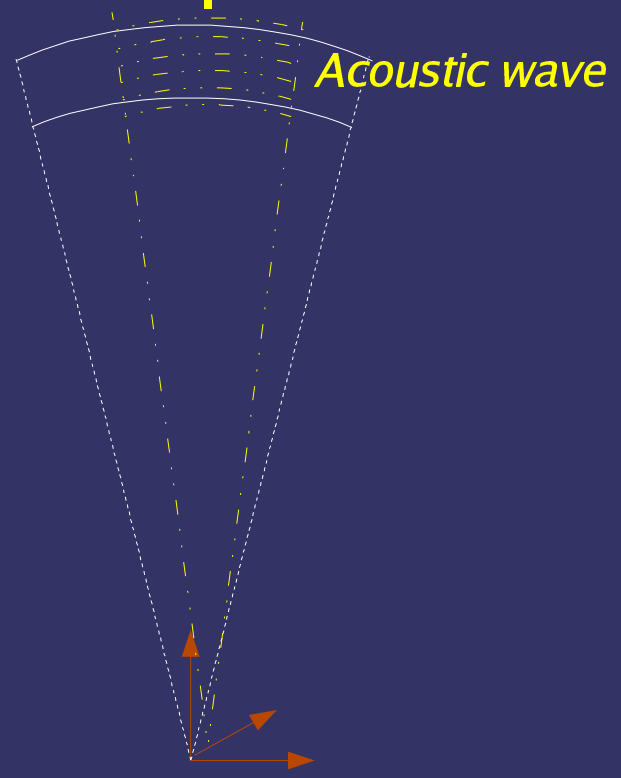
Experiment conditions:

- Low/moderate winds.

- Moderate boundary layer depth.

Radio Acoustic Sounding (reminder)

$$c_a = 20.047\sqrt{T_v}$$



RASS uses radar to measure speed of accoustic wave, with $\lambda_a = \lambda_e/2$ (for Bragg-ressonance).

Speed of sound depends on virtual temperature

↓

RASS measures temperature

TEP has been modified to operate in RASS mode. Appart from vertical temperature profiles...

Can we measure horizontal temperature fields?

RASS-TEP specifics

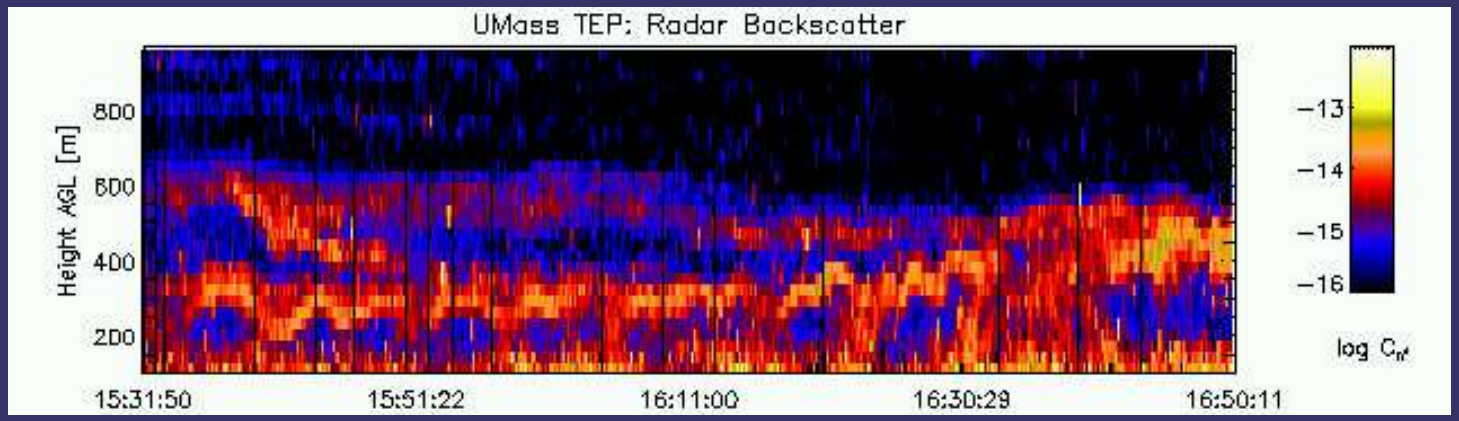
- During RASS operations TEP switches between *normal* mode and RASS mode every approximately 2.5 seconds.

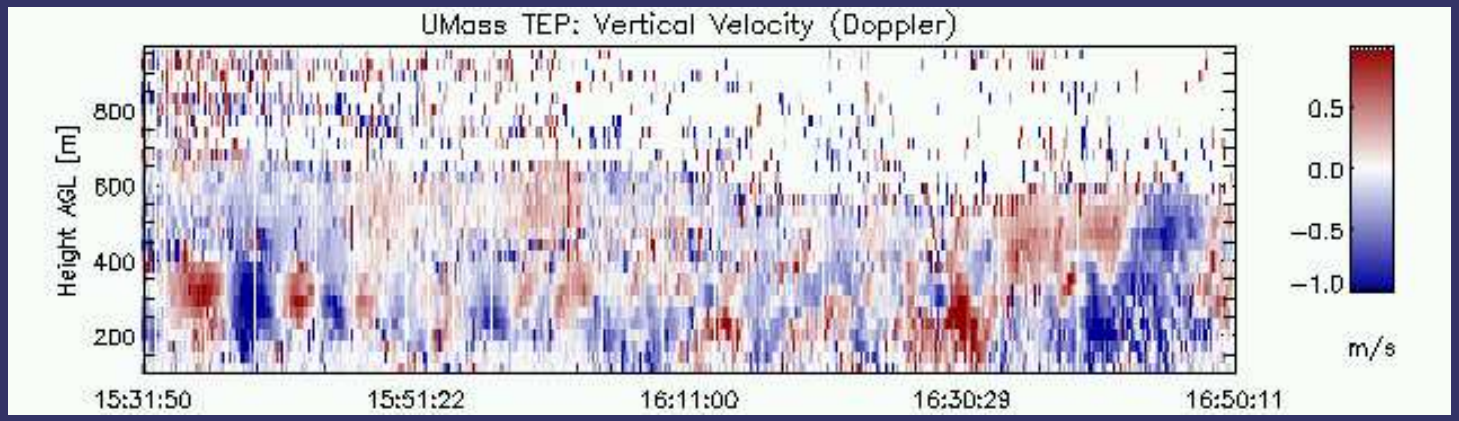
- Speed of sound is obtained substracting measured radial wind-component from the apparent speed of sound measured in RASS-mode.

- Bandpass *noise* acoustic waveform.

Center-beam C_n^2 and w time-height profiles

Morning Transition



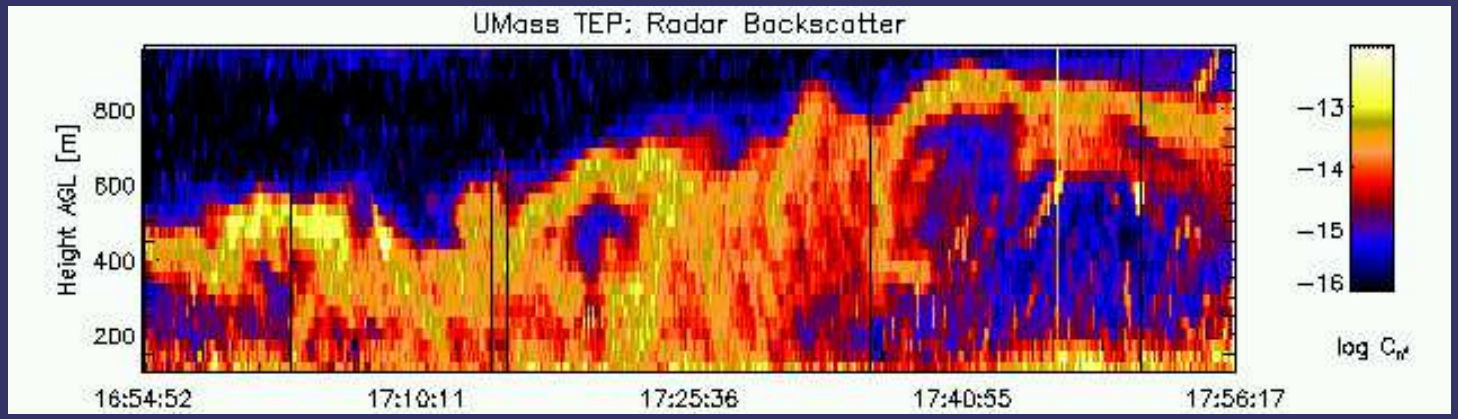


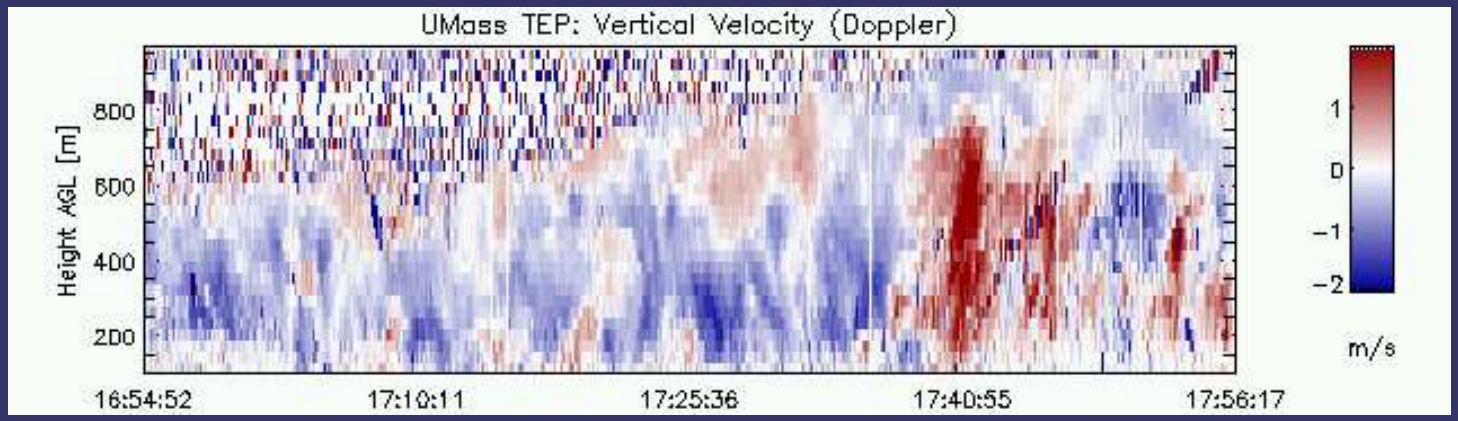
9/7/2002 11:30-12:50 (local)

RASS mode

Center-beam C_n^2 and w time-height profiles

CBL growth

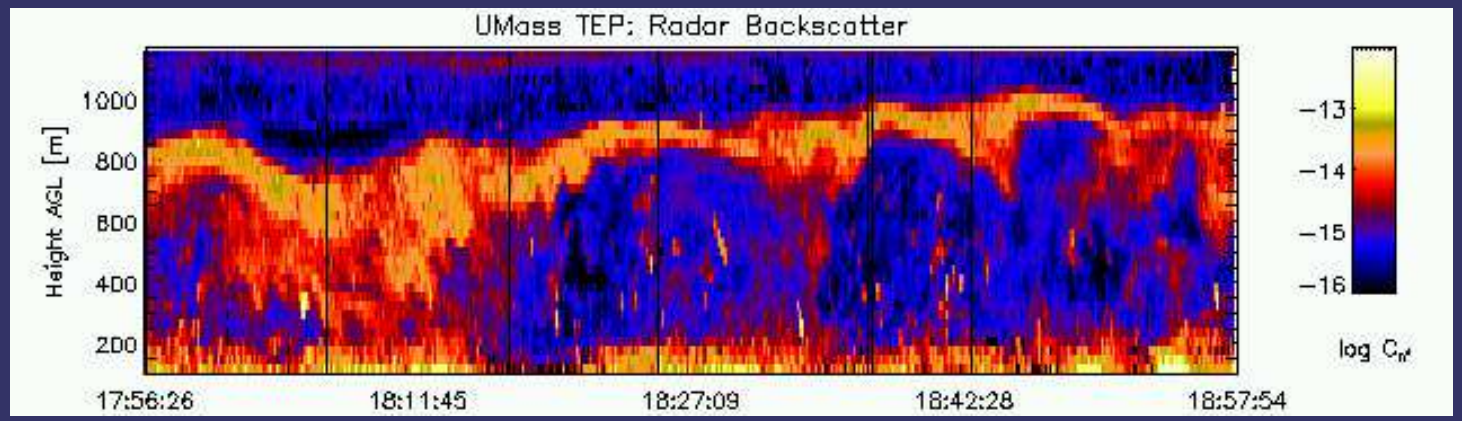


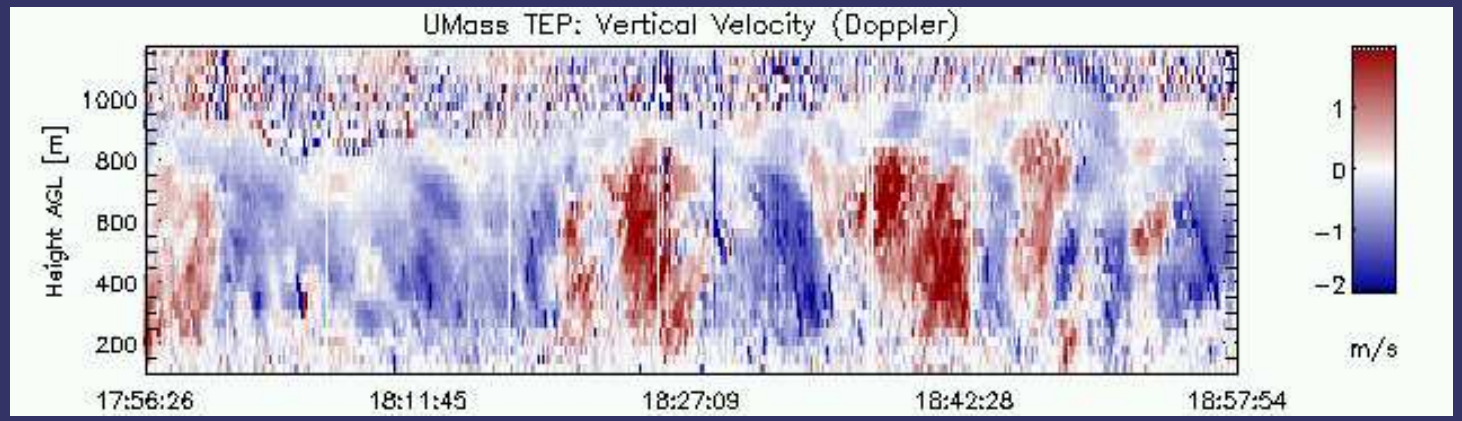


9/7/2002 12:54-13:56 (local)

Center-beam C_n^2 and w time-height profiles

CBL. Up/down-drafts

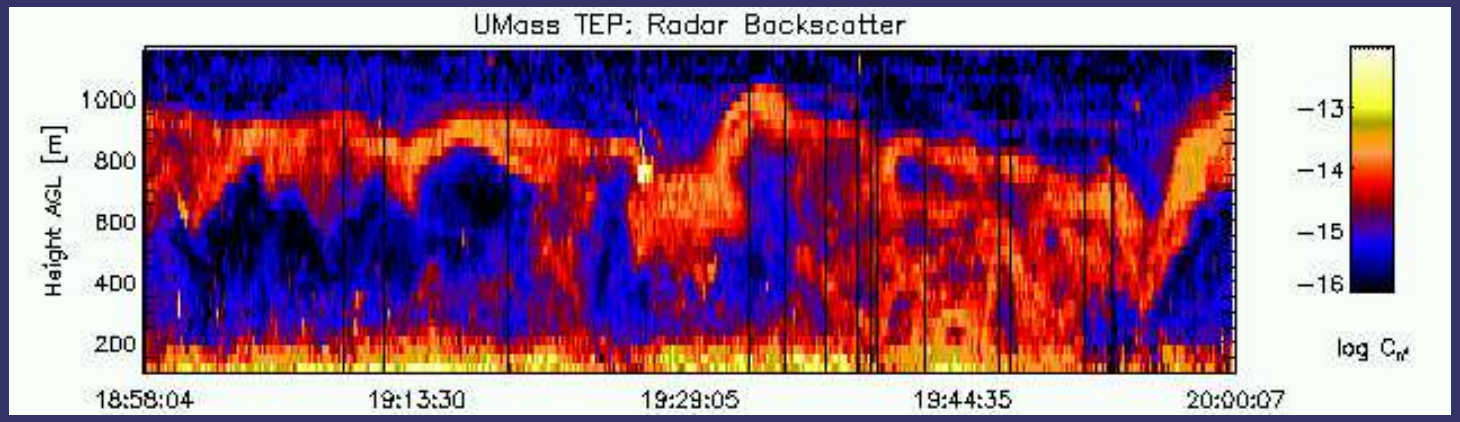


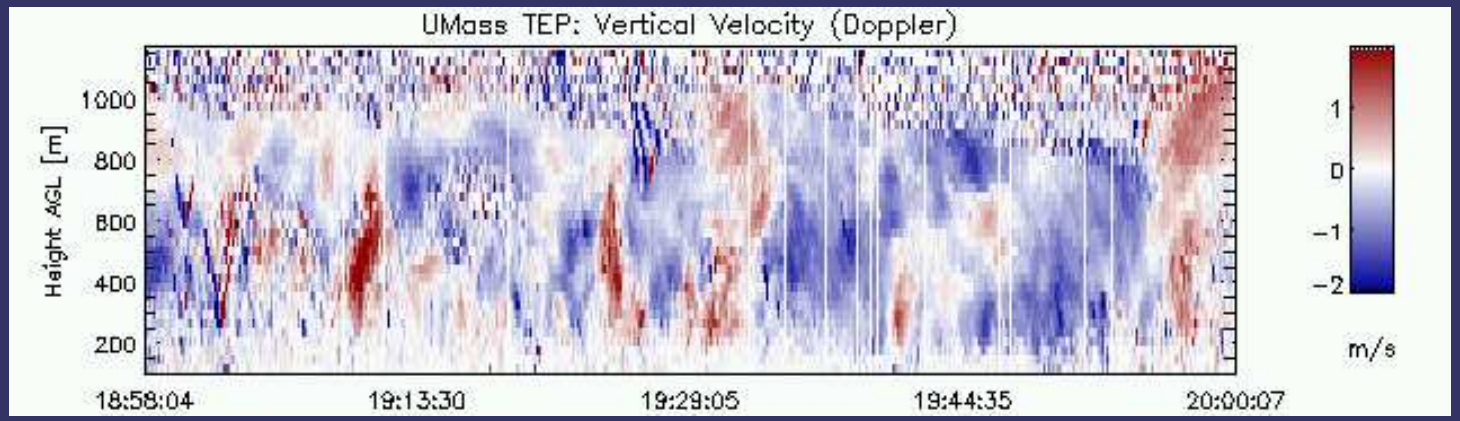


9/7/2002 13:56-14:58 (local)

Center-beam C_n^2 and w time-height profiles

CBL

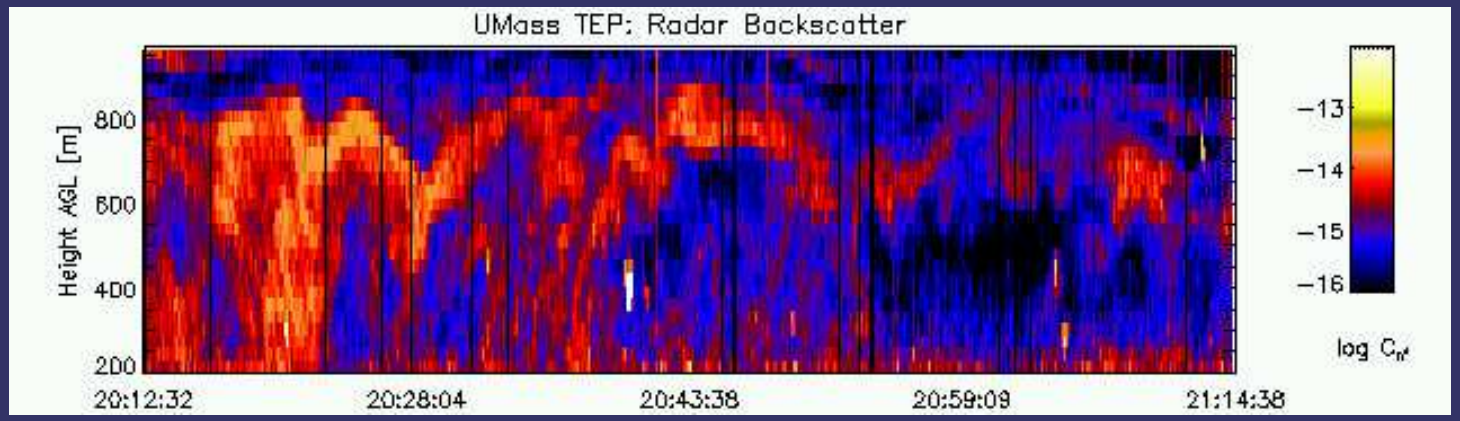


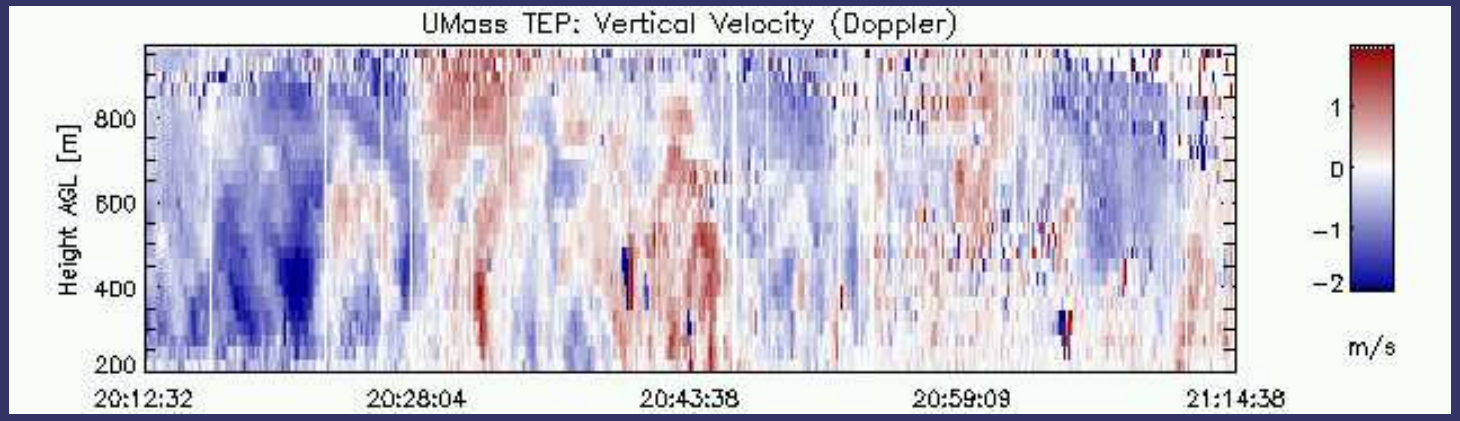


9/7/2002 14:58-16:00 (local)

Center-beam C_n^2 and w time-height profiles

Evening transition?



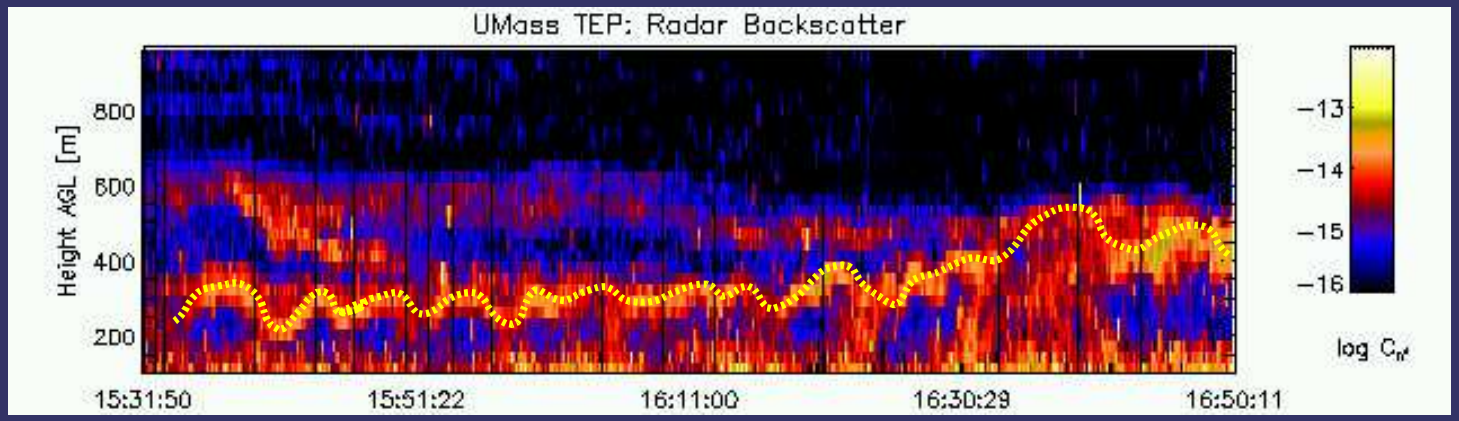


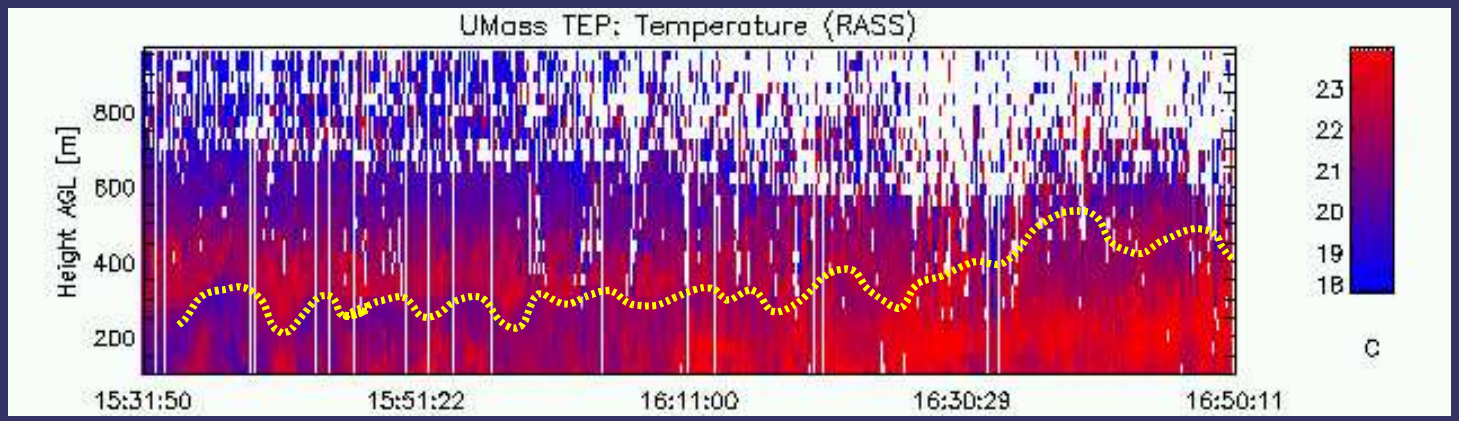
9/7/2002 16:12-17:14 (local)

RASS mode

Center-beam C_n^2 and T_v time-height profiles

Morning Transition revisited

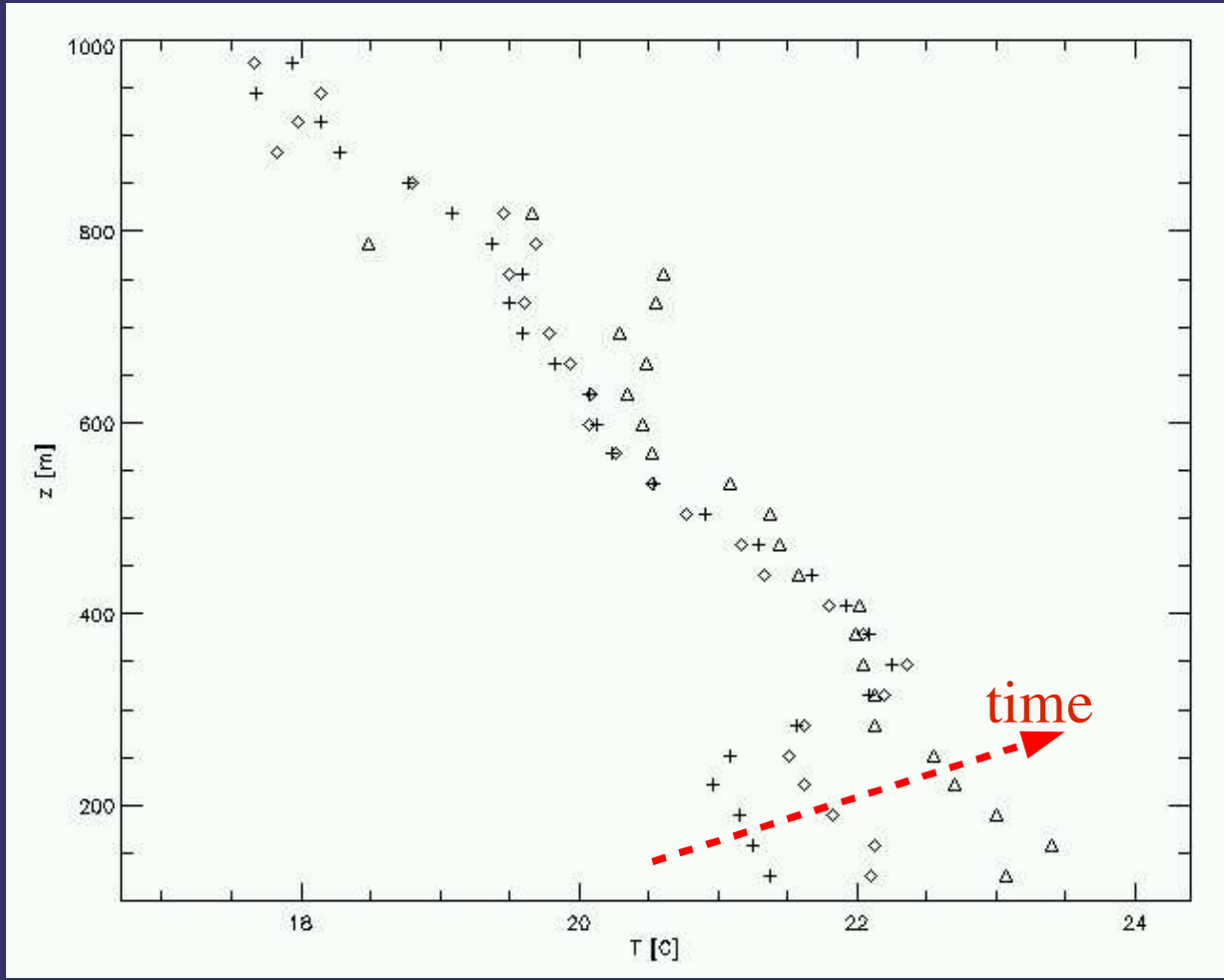




9/7/2002 11:30-12:50 (local)

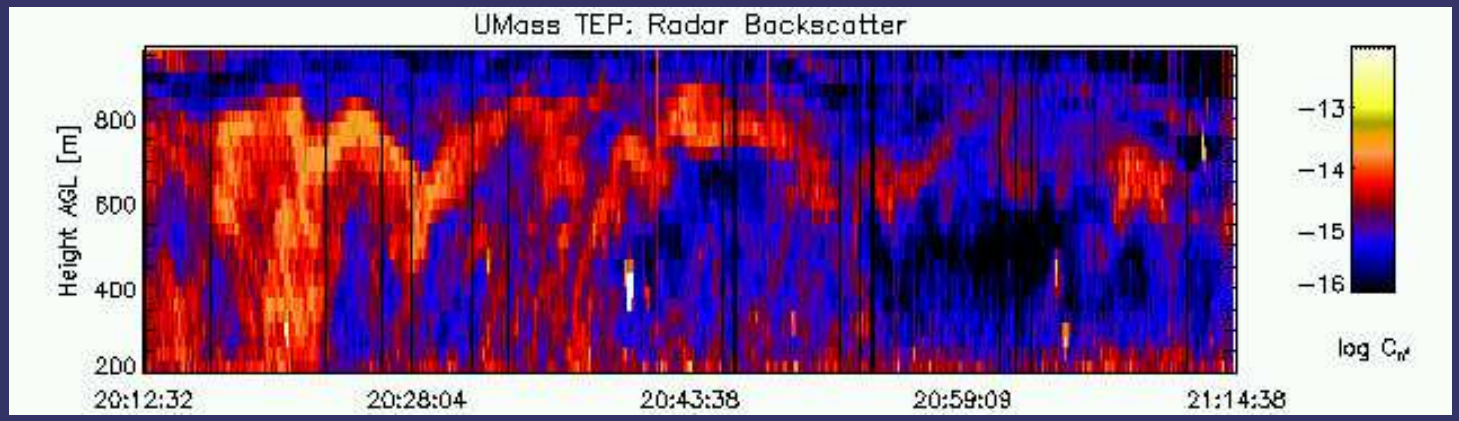
RASS mode

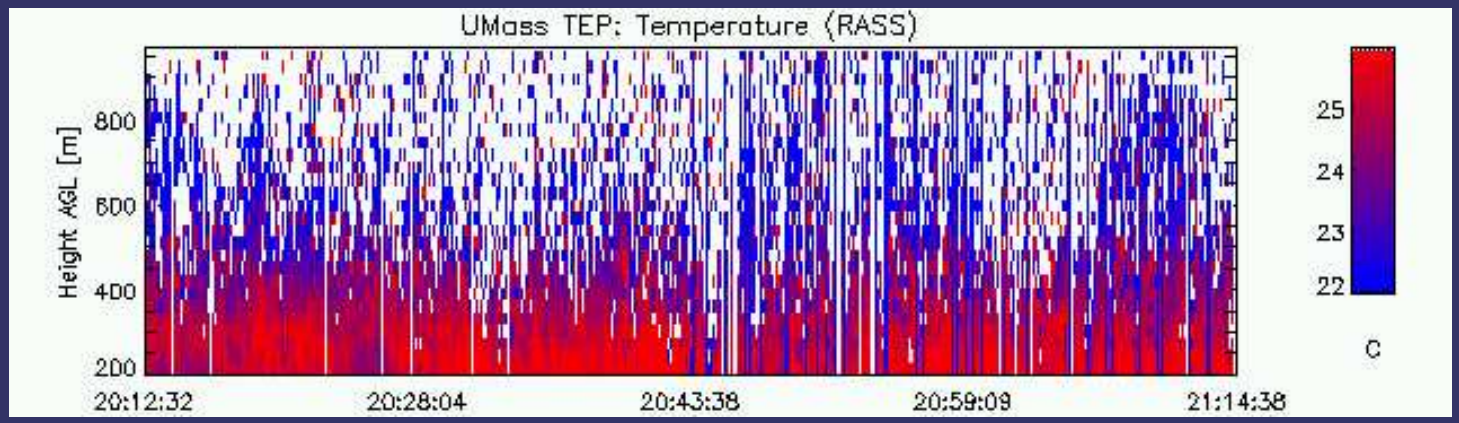
20-minute averaged temperature profiles
Morning Transition



Center-beam C_n^2 and T_v time-height profiles

Evening transition revisited

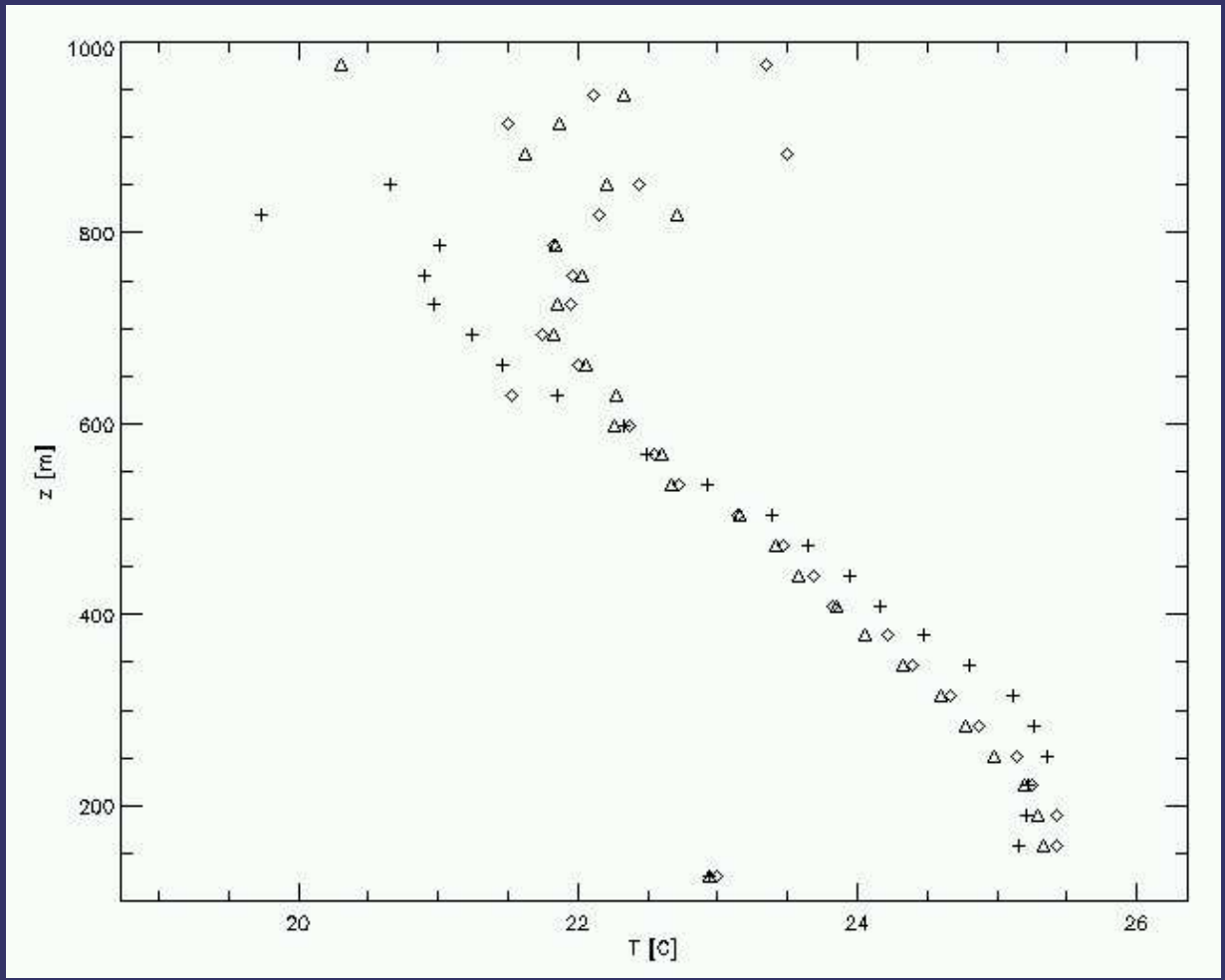




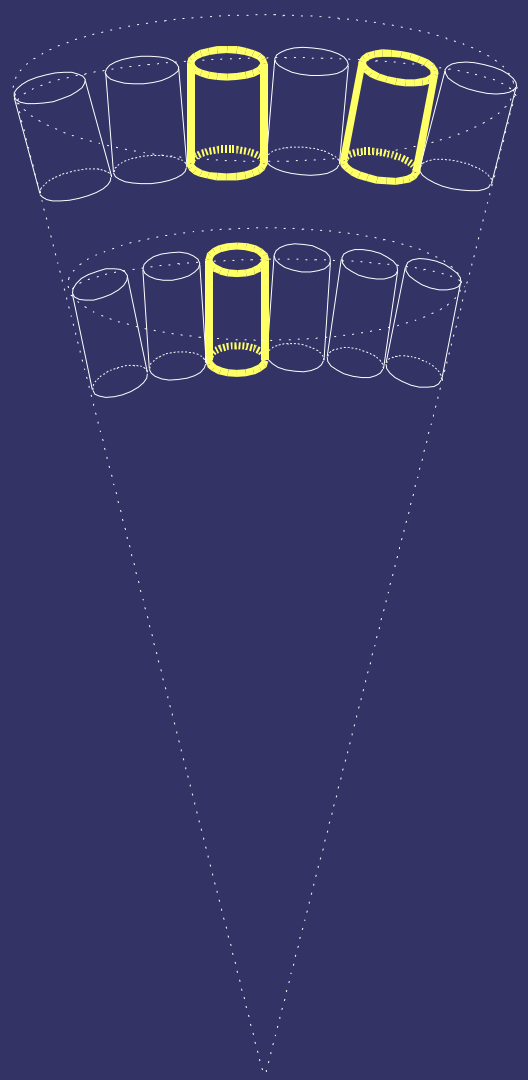
9/7/2002 16:12-17:14 (local)

RASS mode

20-minute averaged temperature profiles
Evening Transition?



Spatial statistics with TEP data: concept



For each resolution-volume TEP provides *filtered* measurements of C_n^2, v_r (≈ w), and T_v. This allows computation of various space-time statistics, e.g.:

- C_{Tv}^2.

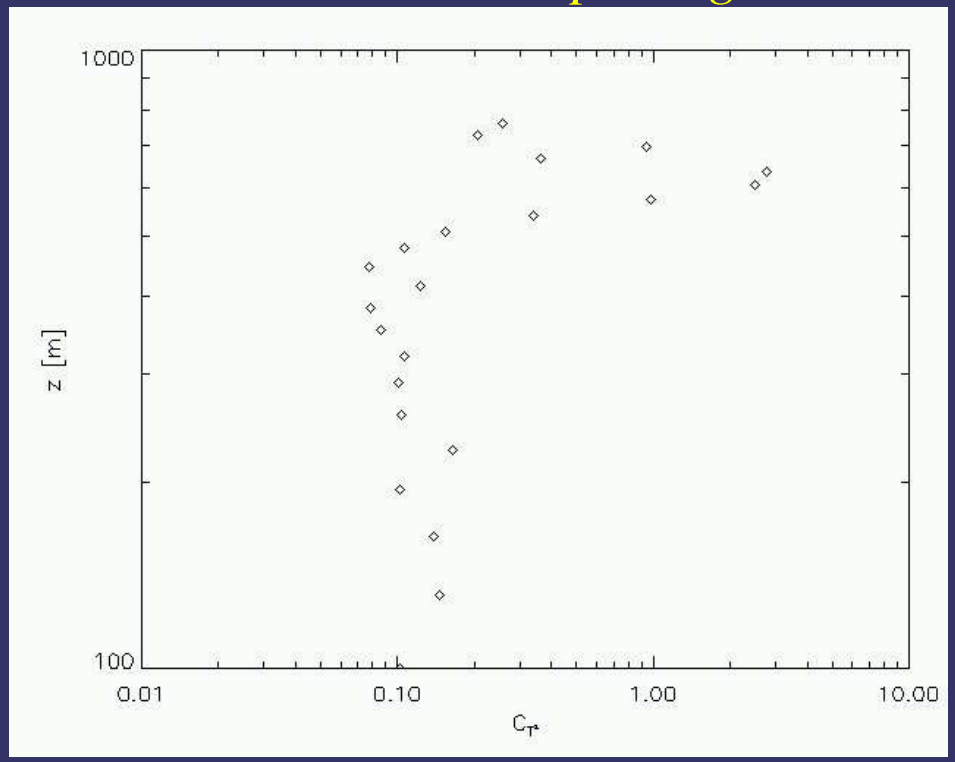
$$C_{T_v^2} = \frac{\overline{(T_{v,i} - T_{v,j})^2}}{r^{2/3}}$$

- Spectral coherences (following Kristensen, Mayor) of w'.

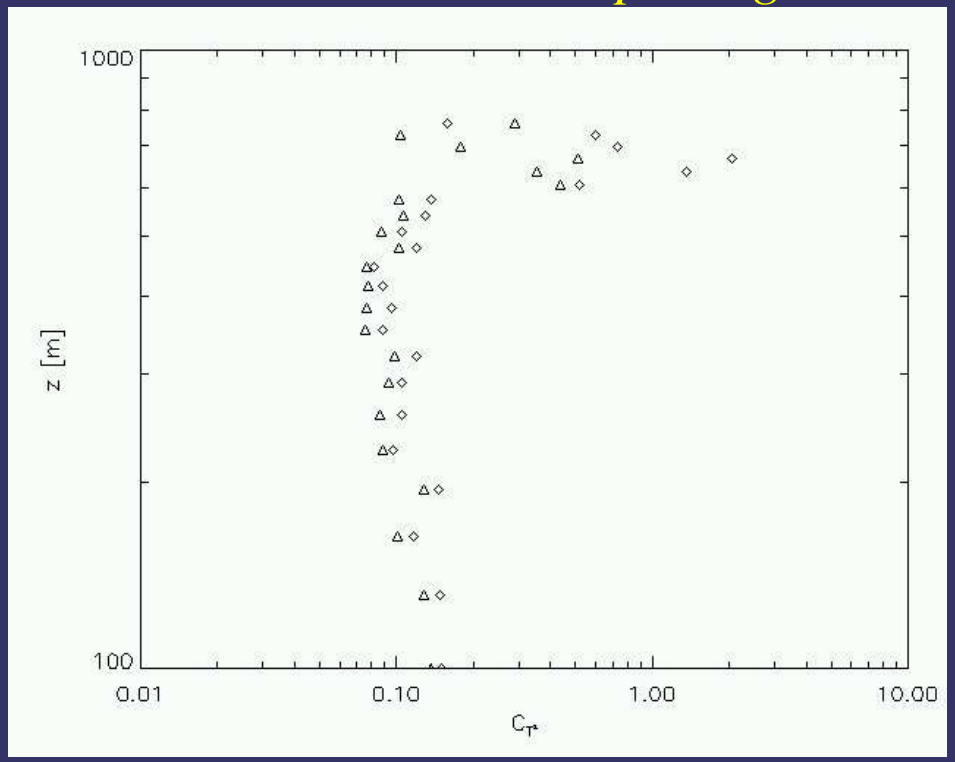
$$coh_w(D, \kappa) = \frac{|S_{w_i w_j}(\kappa)|^2}{S_{w_i}(\kappa) S_{w_j}(\kappa)}$$

Explicit calculation of $C_{T_v}^2$
9/7/2002 12:30pm local

With vertical spacing

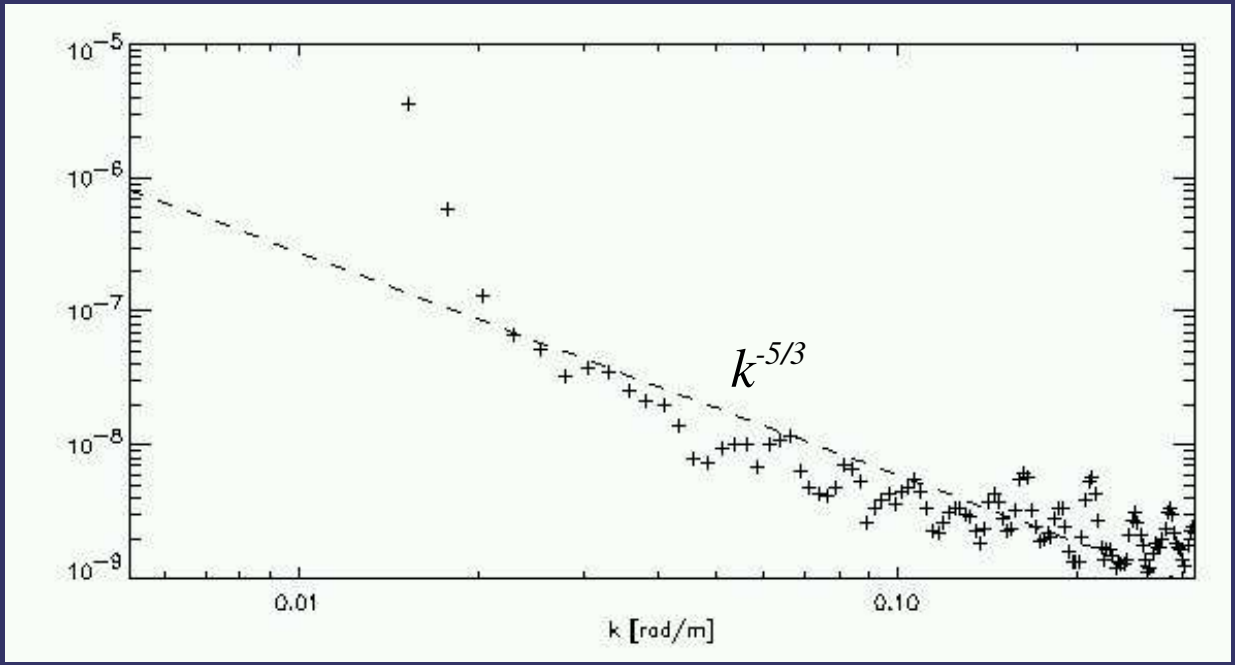


With horizontal spacing

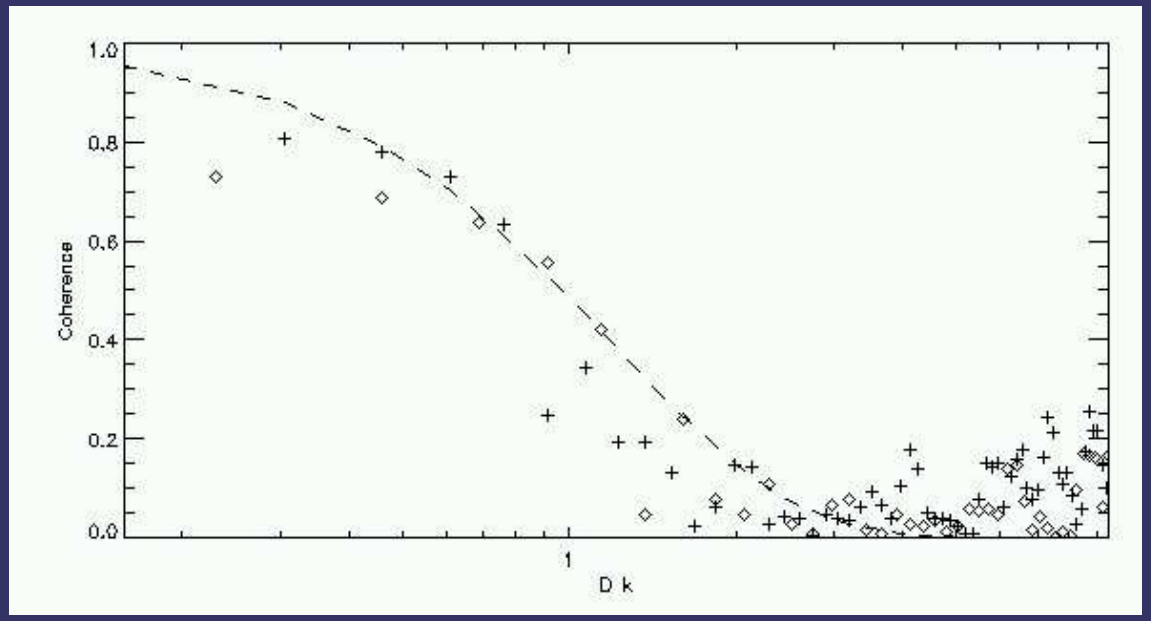


Plots are self-consistent, but are they valid?

Power spectrum of w'
9/7/2002 11:30am, 300m AGL

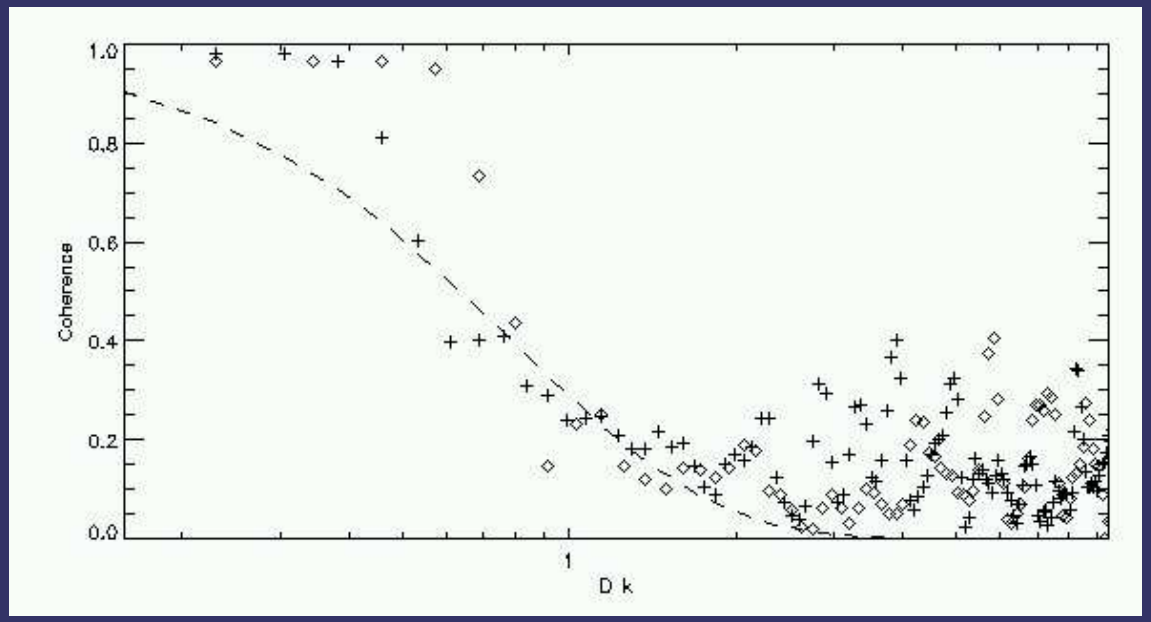


Spectral coherences



<u>Vertical spacing.</u>

Height: 200-350 meter.
Spacing: 60, 90 meter.
Wind-speed: 2 m/s



<u>Horizontal spacing</u>
(cross-stream).

Height: 200-350 meter.
Spacing: ≈ 30, 45 meter.
Wind-speed: 2 m/s

Outlook

- Quite extensive data-set gathered during “TABLE2002”.
- Rigorous analysis of spatial statitics needed: have to account for particularities of Radar/RASS data before comparing to theory.
- Comparisons of TEP data with LES data (in collabortion with PSU) planned for the near future.
- With some luck, this is my last VTMX talk as a graduate student!