*Santa Fe, NM, June 19-24, 2016*

# CEDAR-GEM Workshop 2016

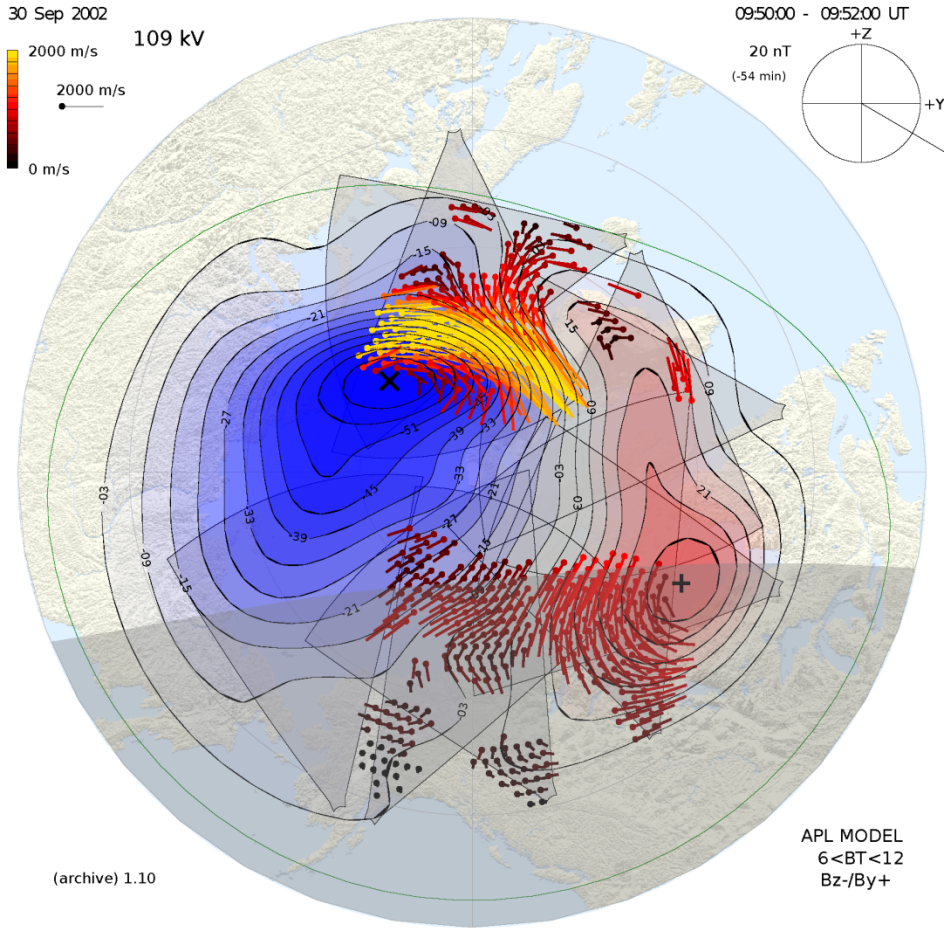
## *Joint Data Fusion Workshop*

## *SuperDARN Uncertainties*

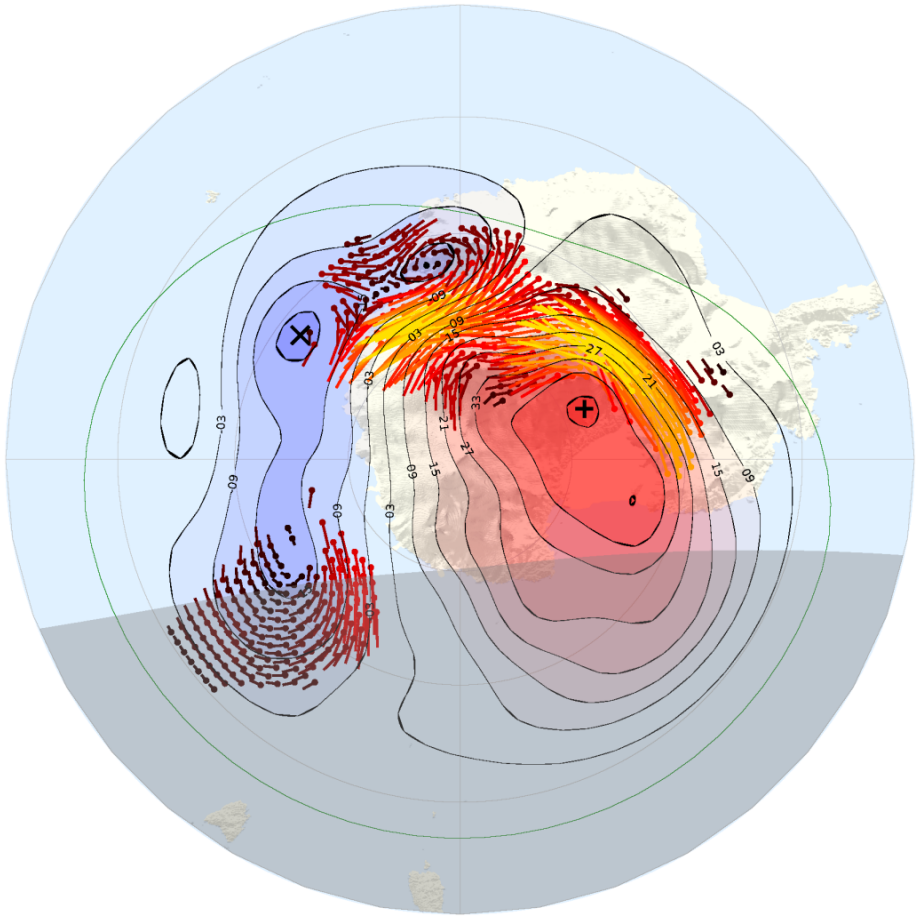
# Global-Scale Mapping of Ionospheric Plasma Convection

Assimilation of observational and model data into maps [*Ruohoniemi and Baker*, 1998]

September 30, 2002: 09:50 – 09:52 UT



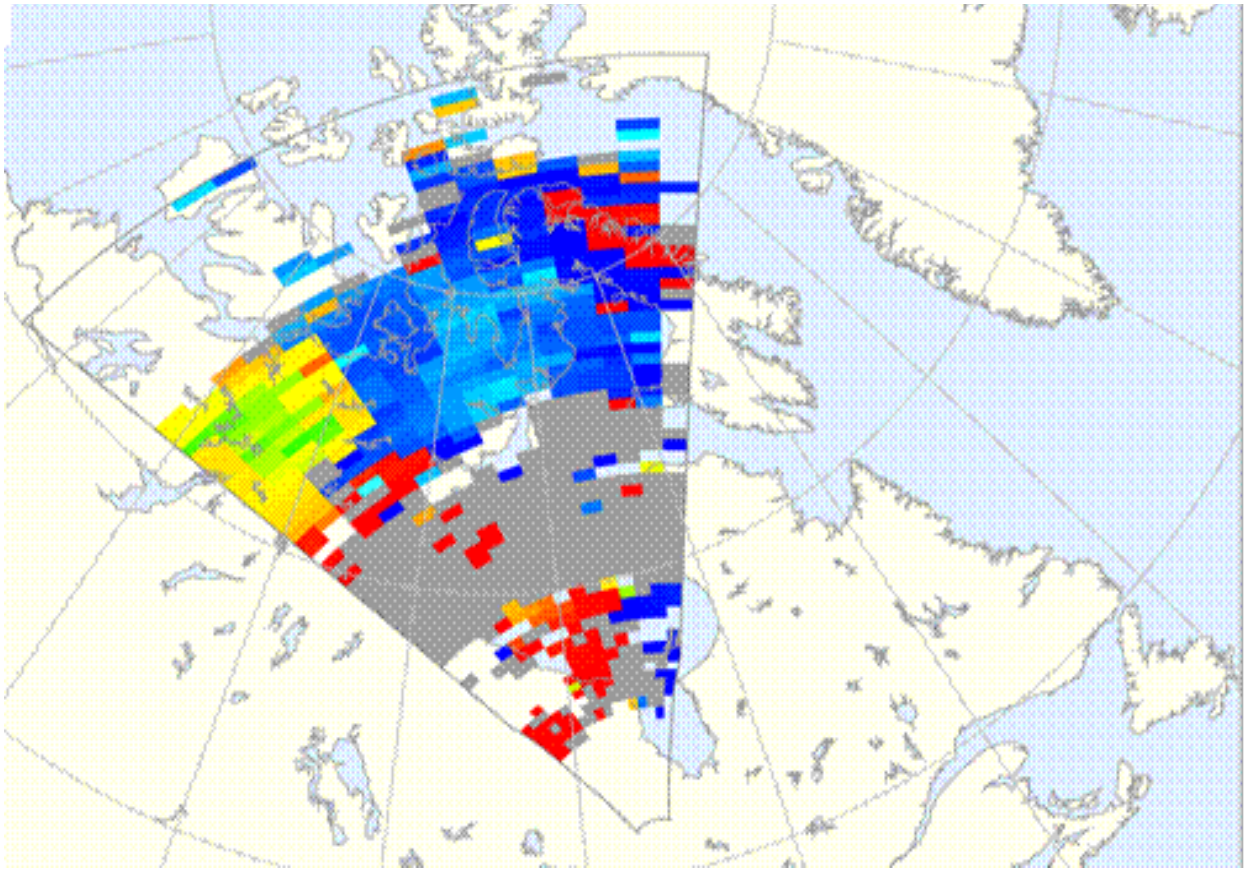

Northern Hemisphere



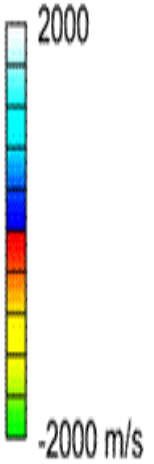
Southern Hemisphere

# Observing Plasma Convection in the F region

Map of ‘raw’ line-of-sight velocity obtained from a single 2-min radar scan



Velocity magnitude




Blue - towards
Red - away

January 11, 2001 0110 – 0112 UT: Kapuskasing radar

**Levels of SuperDARN data (descending order)**

- Global convection maps (resolution of several hundreds of km, depending on the order of the fitting)
- Gridded line-of-sight velocity (square cells, resolution of ~ 150 km)
- Median-filtered line-of-sight velocity data (resolution of ~90 km)
- Raw line-of-sight velocity measurements (resolution of 45 km)

**Points:**

- Each level has associated variabilities in time and space
- Some of this variability is due to measurement error and some of it is geophysical

*Philosophical aim >>*

**Measure the 2-D ExB plasma drift velocity in the ionospheric F region:**

- with arbitrarily high precision in magnitude (m/s) and direction ($\theta$,$\phi$)
- with exact knowledge of position (lat,lon,alt)
- with arbitrarily high spatial resolution (~m)
- with arbitrarily high temporal resolution (~s)

….. these are the desired conditions on **granularity**

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….. these are the desired conditions on **granularity**

**And measure it:**

- everywhere
- simultaneously
- continuously

….. these are the desired conditions on **globality**

*Philosophical aim >>*

**Points:**

- We could relax some of these conditions if we had knowledge of:

- the lowest scales of spatial structure and temporal variability (granularity)
- the limits of spatial and temporal coherence (globality)

but we don't!

- More conditions could be stipulated such as:

- arbitrary precision and consistency in mapping the velocity data into the representational coordinate system (usually geomagnetic: mlon, mlat, MLT)
- ideal experimental conditions including the complete absence of false and interfering signals

# Variability in SuperDARN Velocity Measurements



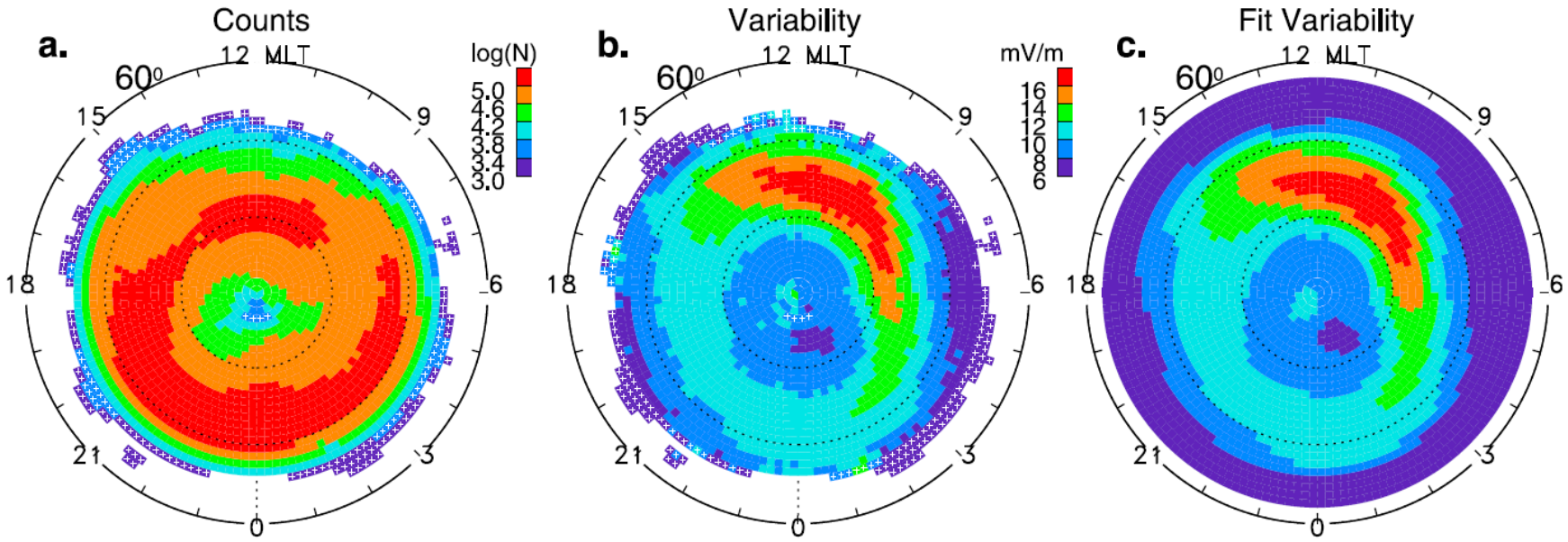
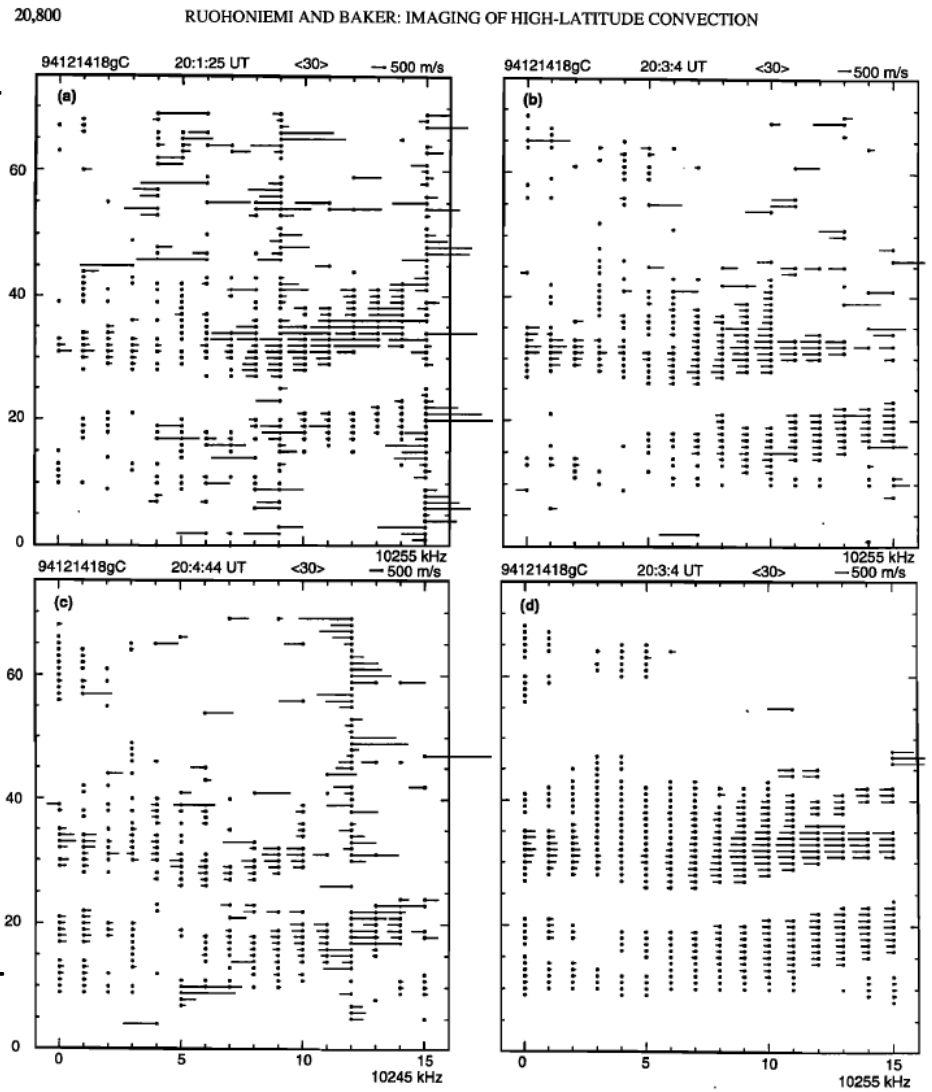



**Figure 1.** Maps of (a) the number of data points (on a logarithmic scale), (b) the mean variability value, and (c) the fit variability value in ~110 × 110 km grid cells for negative tilt, IMF $B_y$+ conditions in the Northern Hemisphere. The maps are plotted in geomagnetic coordinates.

# Sequence of beam-range velocity plots

2001:25 UT

2003:04 UT




Demonstration of processing of raw line-of-sight velocity to prepare for gridding

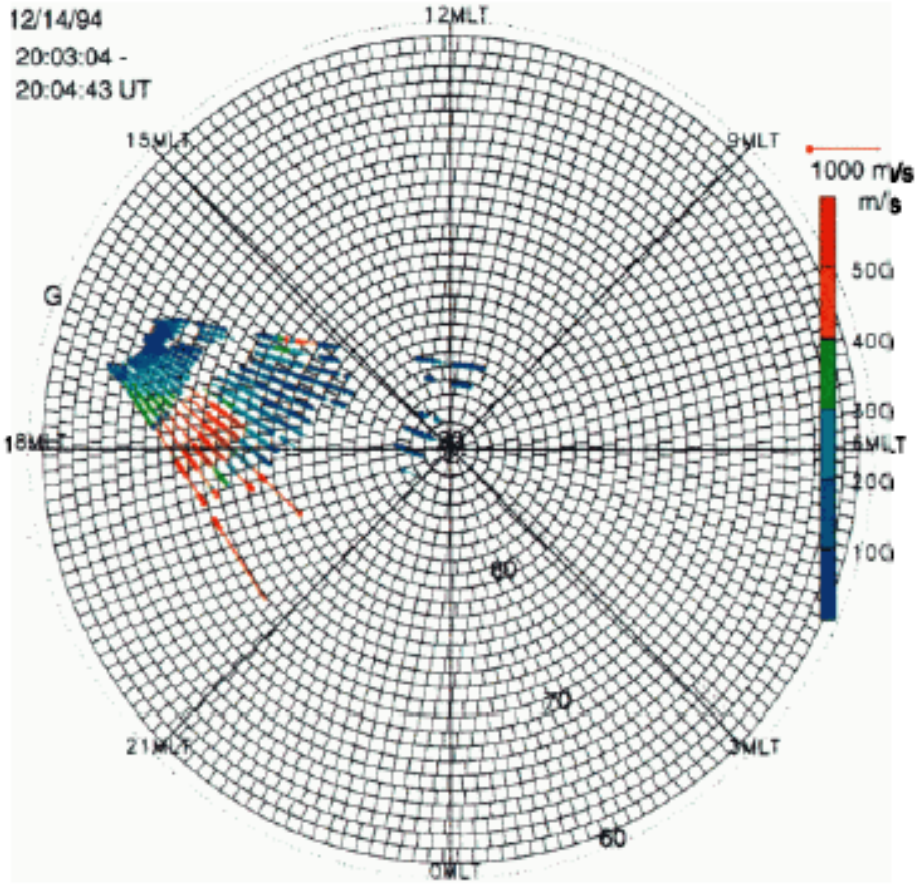
Point-to-point and scan-to-scan variabilities are pronounced

2004:44 UT

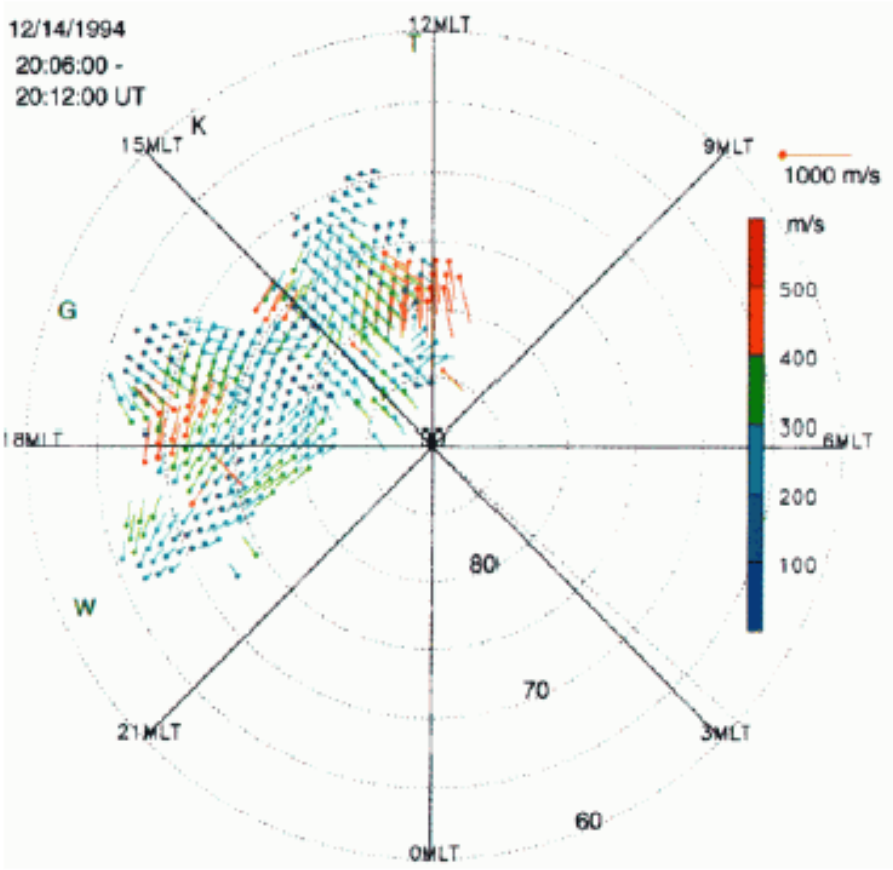
< 2003:04 UT >

**Figure 1.** (a)–(c) A sequence of line-of-sight velocity data collected during successive scans with the Goose Bay HF radar on December 14, 1994. The scans start at 2001:25, 2003:04, and 2004:44 UT. The plotting coordinates are beam number (0–15) and range gate (0–74), and the line-of-sight velocity vectors are rotated to the horizontal for clarity; the leftward directed arrows correspond to motions toward the radar. (d) The filtered velocity data obtained for the scan beginning at 2003:04 UT as explained in the text.

# Processing to gridded velocities

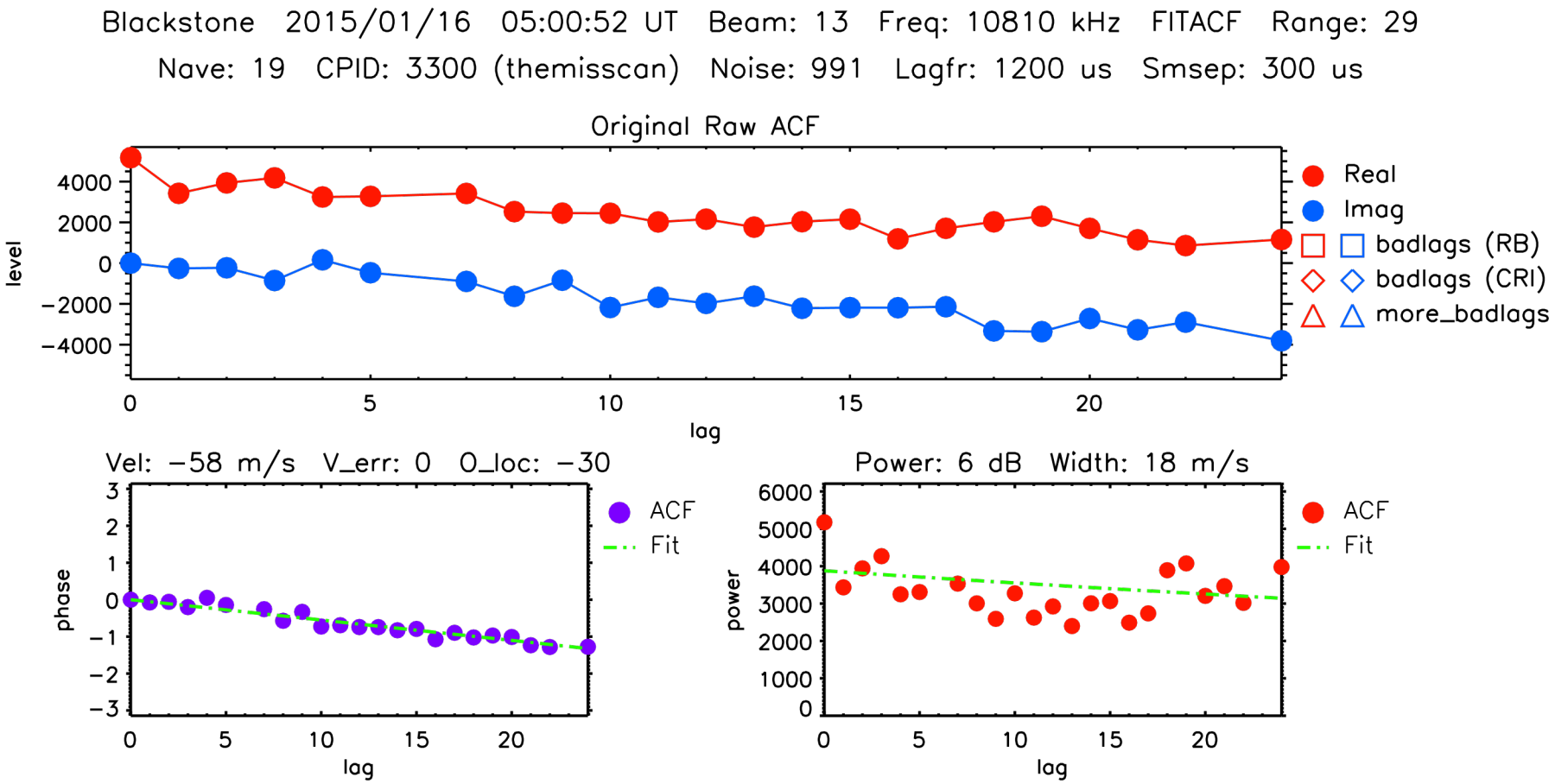



Raw line-of-sight velocities from Goose Bay radar plotted on equal-area grid



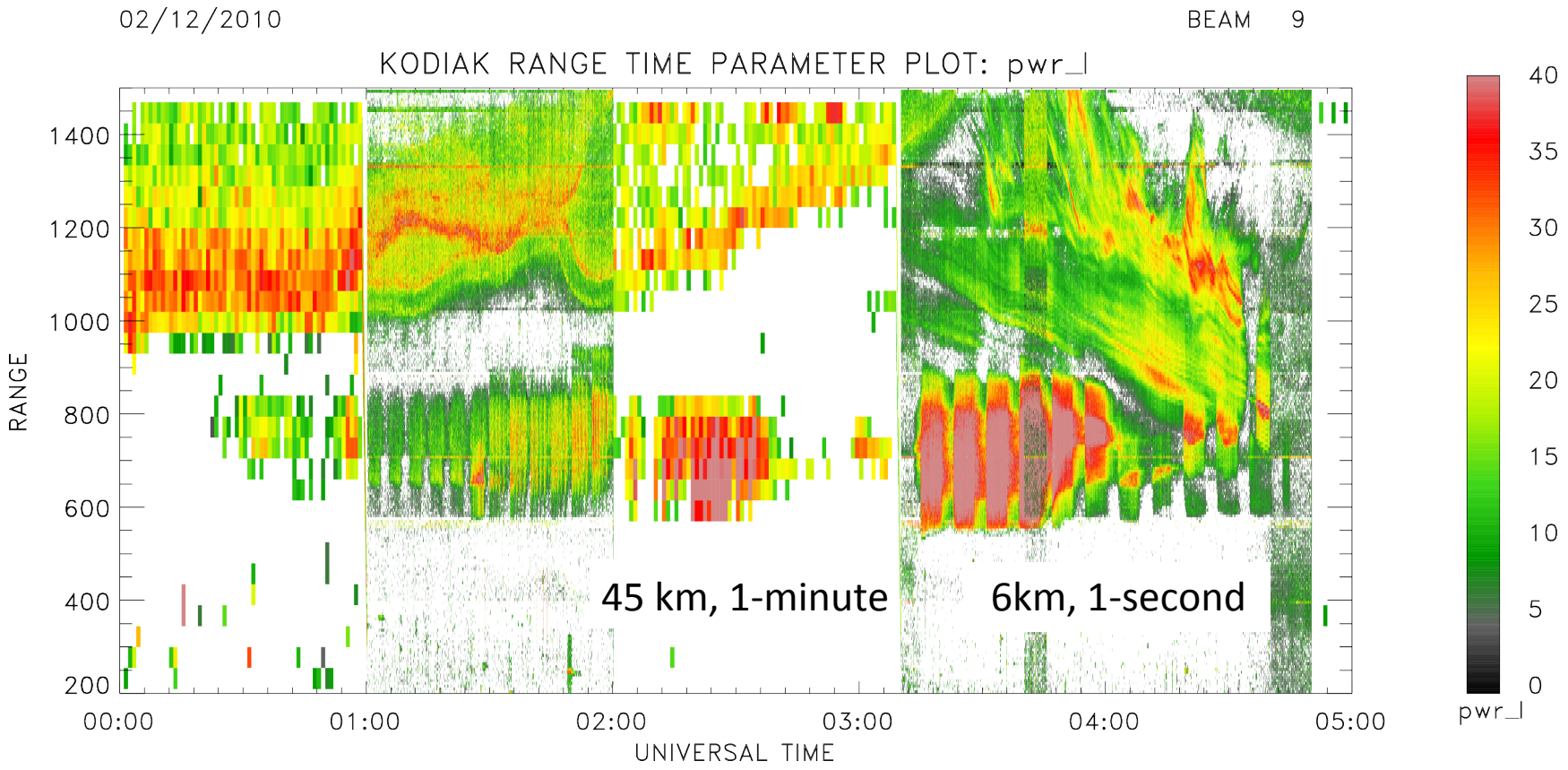

Filtered and gridded line-of-sight velocities from four radars including Goose Bay

# Fitting the ACF to obtain a velocity estimate




Close fitting of the variation of phase with lag time to a straight line indicates small error on the velocity

# What's missed?




Structure exists at ~km spatial scales and sub-second time scales

*Philosophical aim >>*

Should we despair?

No! The science questions under consideration should be used to determine the data requirements

- And we can making progress in:

- improving measurement capabilities and coverage
- understanding variability and coherence
- developing techniques that are optimized for particular types of research