



PHYSICS AND ENGINEERING PHYSICS

Three way validation of Rankin velocity measurements: Saskatoon radar, Resolute CADI and DMSP

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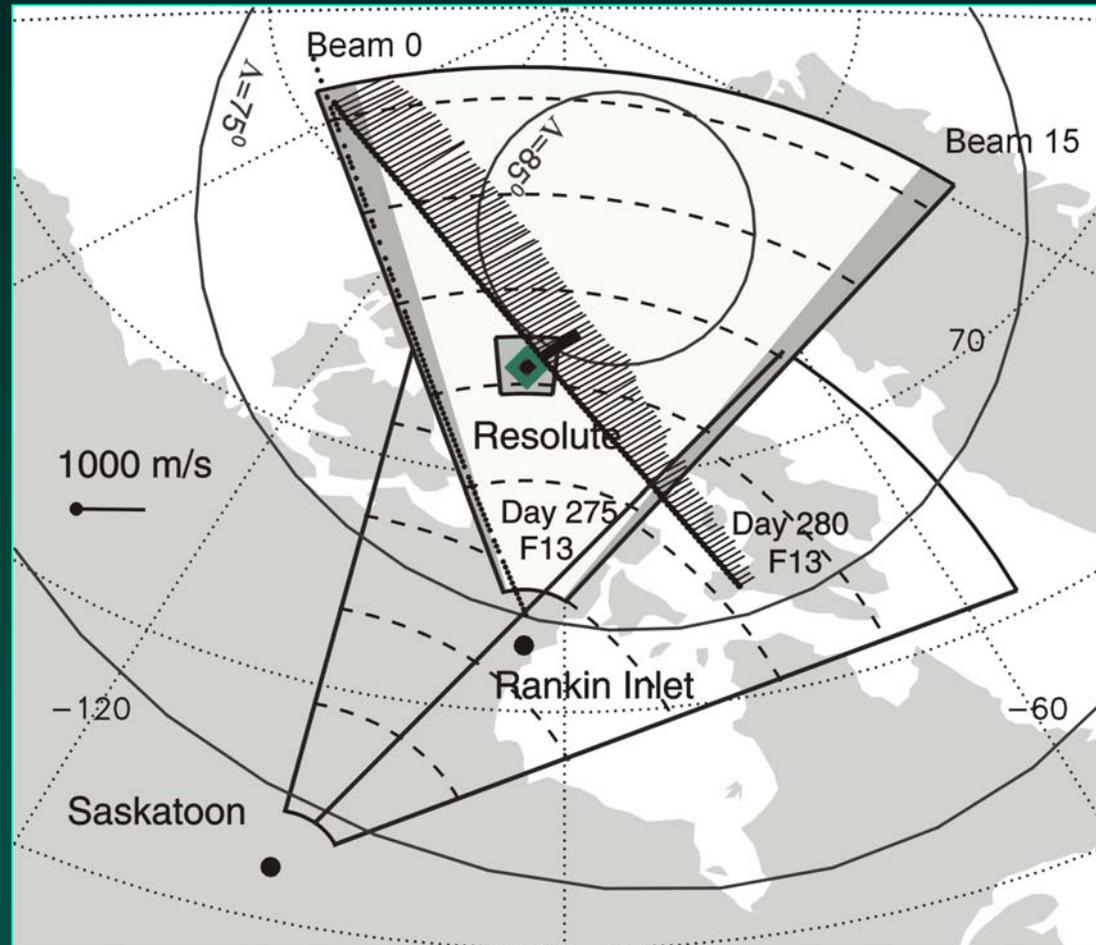
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Institute of **S**pace and **A**tmospheric **S**tudies

Rankin: Reasoning behind the work

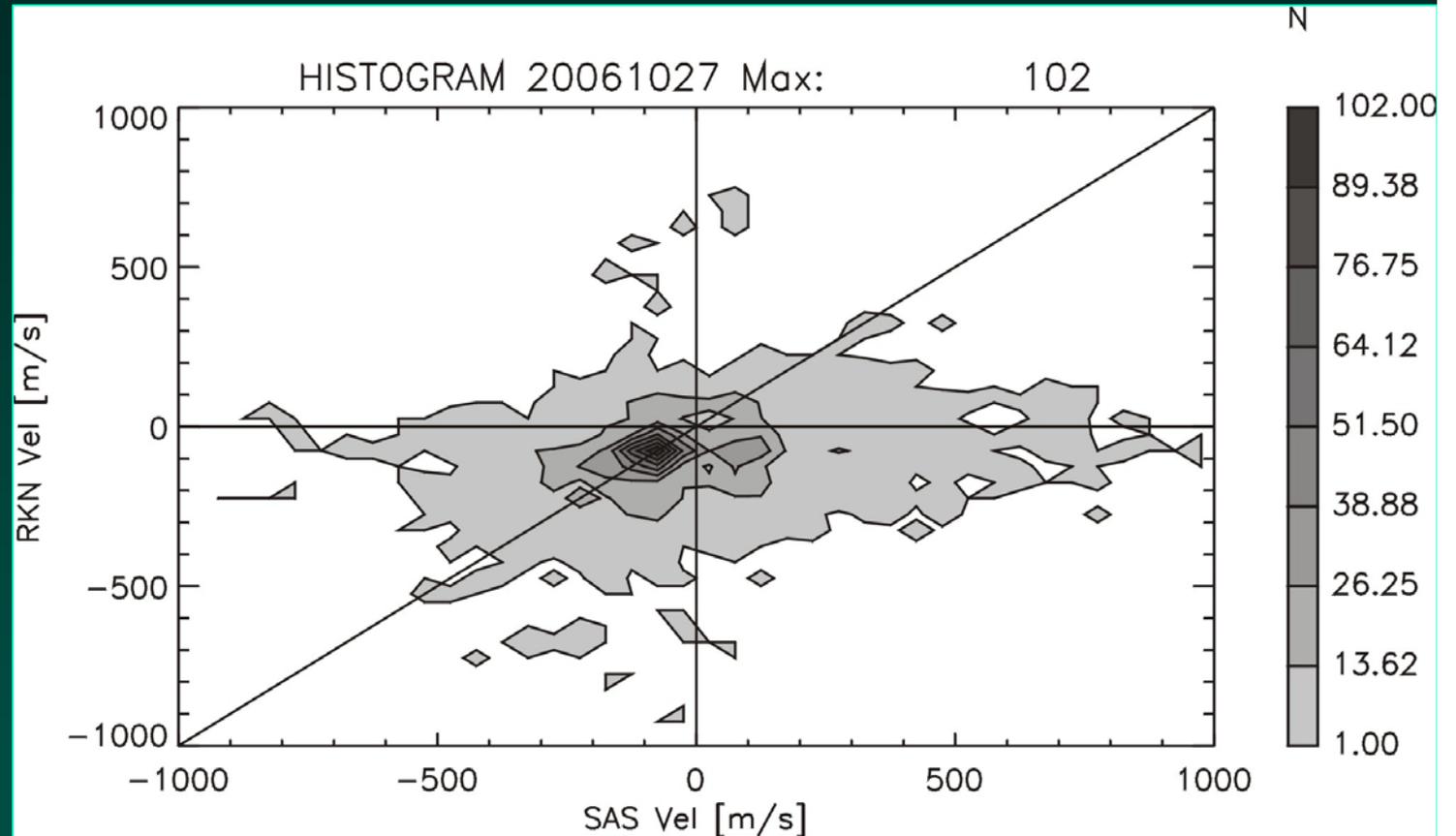
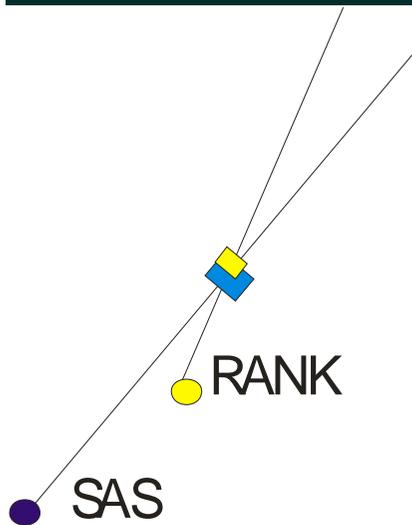
1. We have antennae back and side lobes. Contrary to the auroral zone radars (located low in latitude), effect might be significant as irregularities are available everywhere around
2. My personal perception is that variability of Rankin velocity is above a typical auroral zone radar. I do not have numbers, but it is extremely difficult to find periods with stable (of course +/-) Rankin velocity. Are there any extra “clutter” signals?
3. We have a combination of instruments measuring ExB in one place. Intercomparison is important as a general assessment of their performance
4. Comparison CADI-DMSP showed reasonable agreement

Rankin and Saskatoon Radar FoVs, Resolute CADI and DMSP Crossings



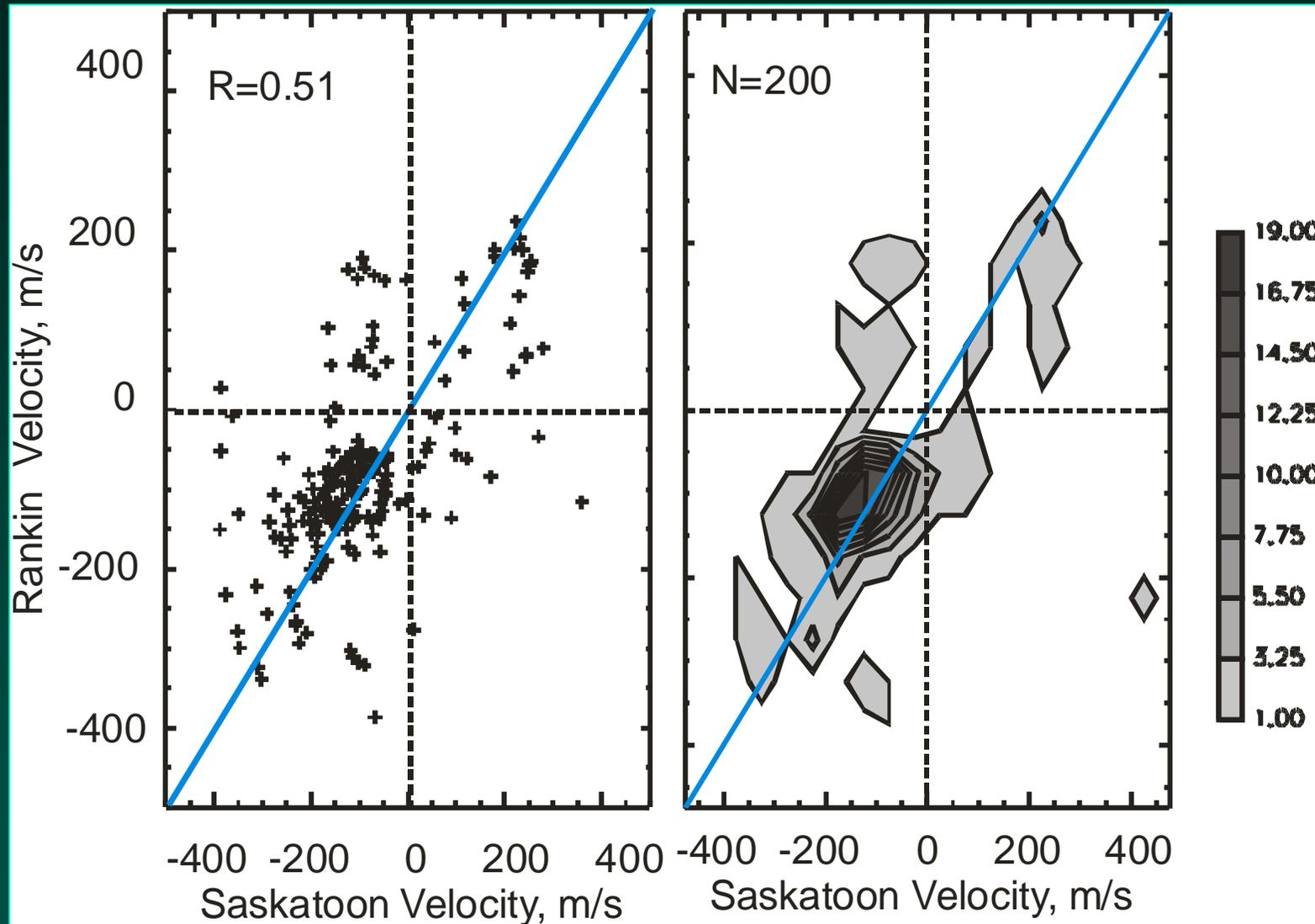
Some beams overlap with small misalignment. One can compare velocities of SAS F echoes with Rank either F or E region echoes. There is CADI at Resolute, and DMSPs around

Cell-by-cell Comparison (Dieter)



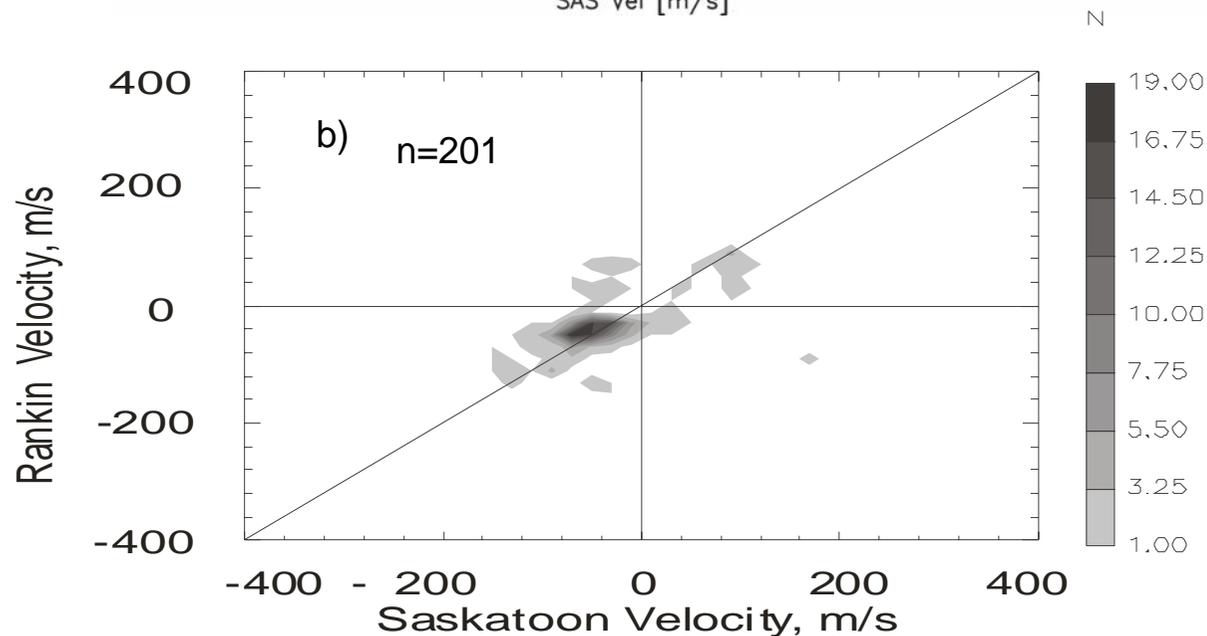
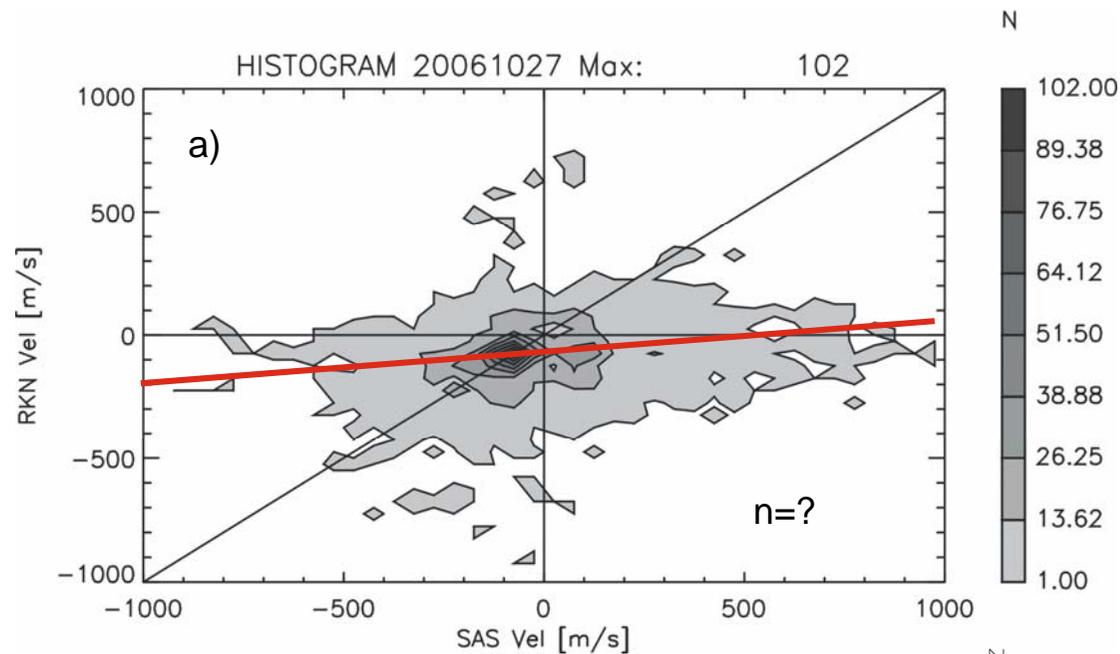
Velocity in one SAS gate vs RANK velocity for overlapping cell(s).
First attempt.

Comparison at Grid Points (Robyn)



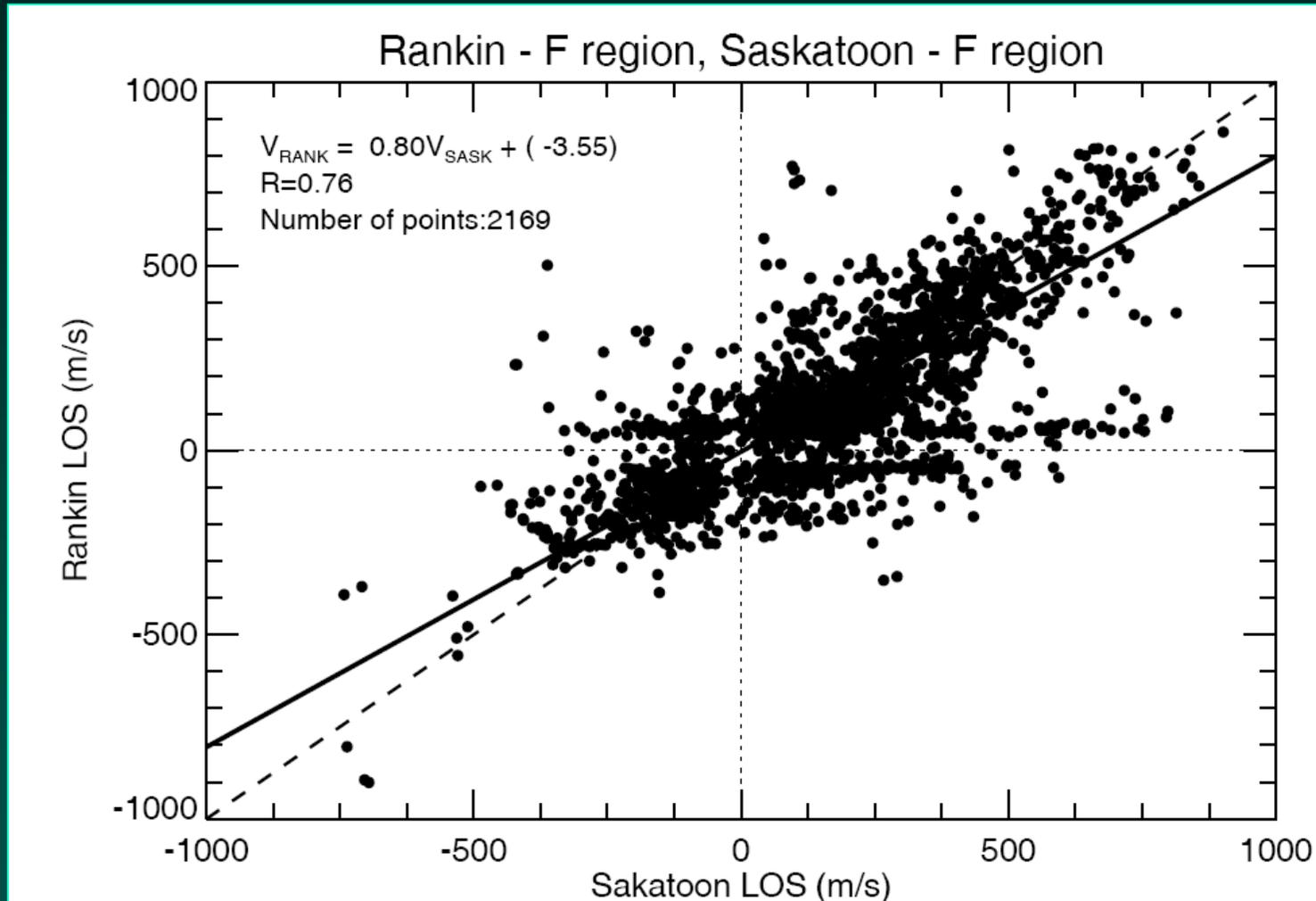
Velocity for one SAS grid point vs RANK velocity for the same grid point, beam misalignment of <10 deg

Grid and Cell-by-cell Comparisons for 27 October 2006



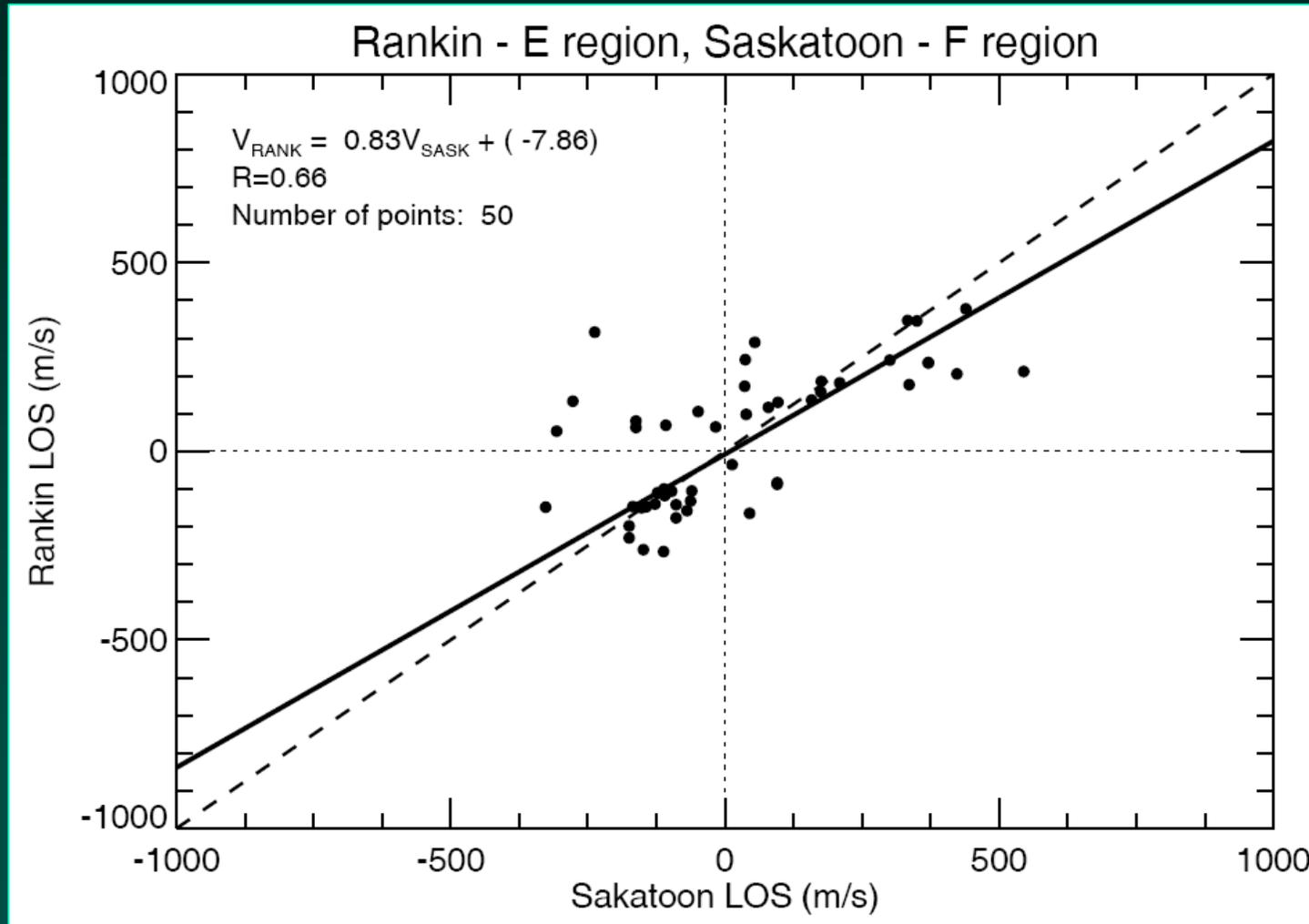
**Comparison for
grid points shows
better agreement**

Extended Comparison at Grid Points (Robyn)



10 events in October 2006. Beam misalignment of <10 deg.

Grid Point Comparison, E region RANK (Robyn)

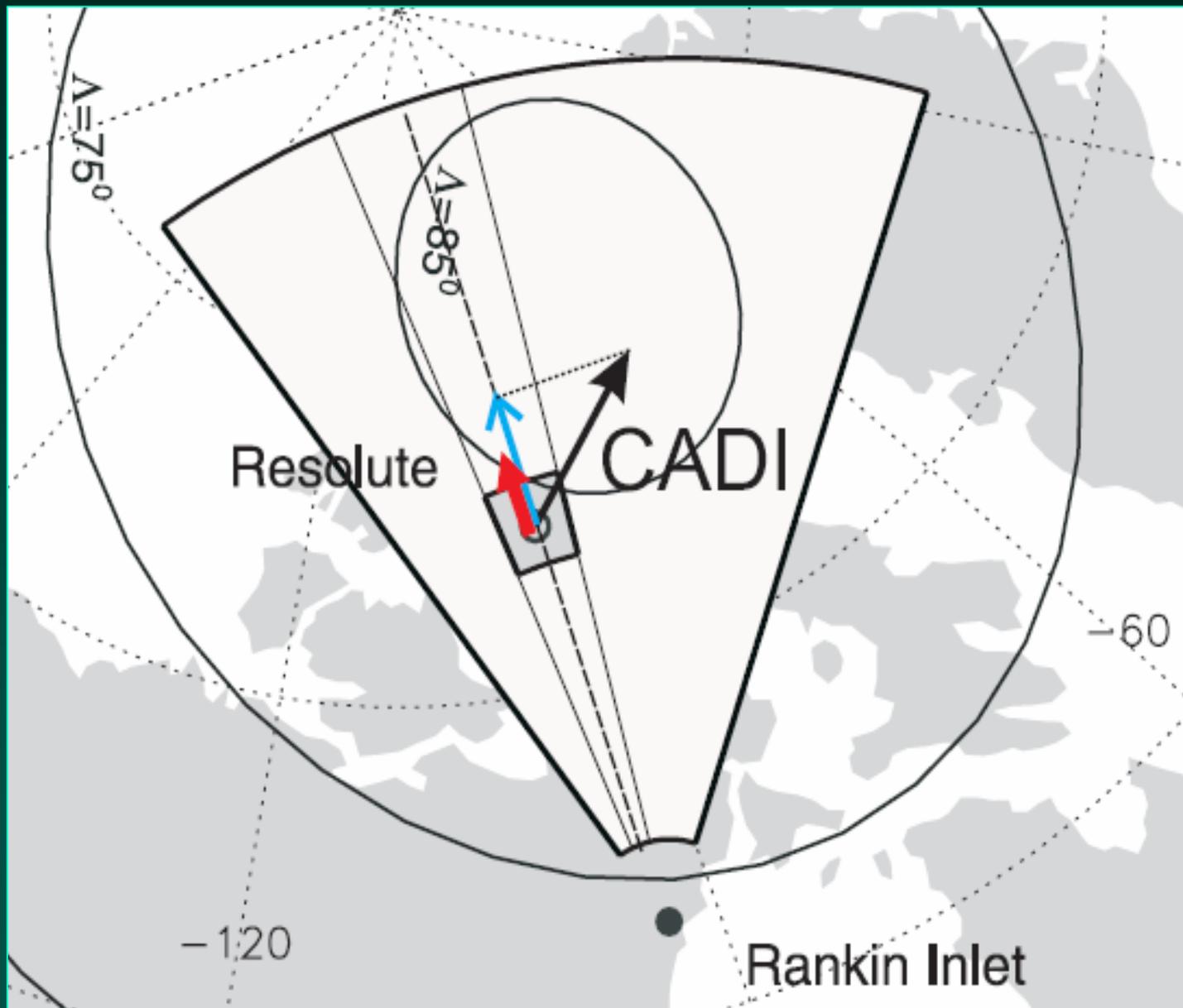


10 events in October 2006. Beam misalignment of <10 deg.

Conclusions for RANK-SAS Comparisons

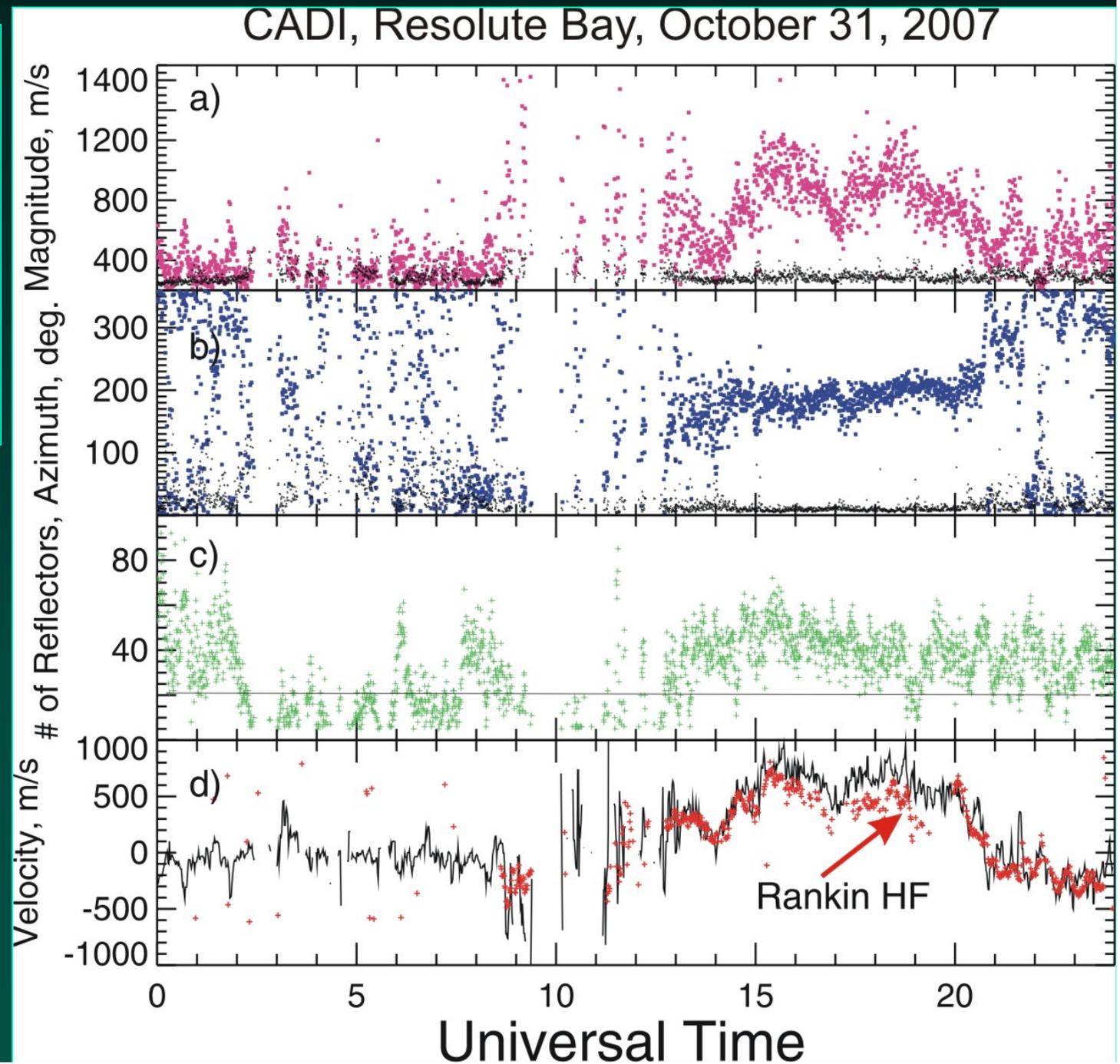
- 1) Cell-by-cell comparison shows significant amount of points with different polarities. If these are not counted, overall agreement is OK.**
- 2) Reasons for different polarities would be interesting to investigate. Not clear how.**
- 2) Ground scatter is still present at Rankin, clearly seen for “grided” velocities; patches of low-velocity Rankin echoes are affecting the results. What do they signify?**
- 3) More significant statistics would be interesting, especially for F_Saskatoon - E_Rankin case**

CADI-Rankin: Projection Comparison

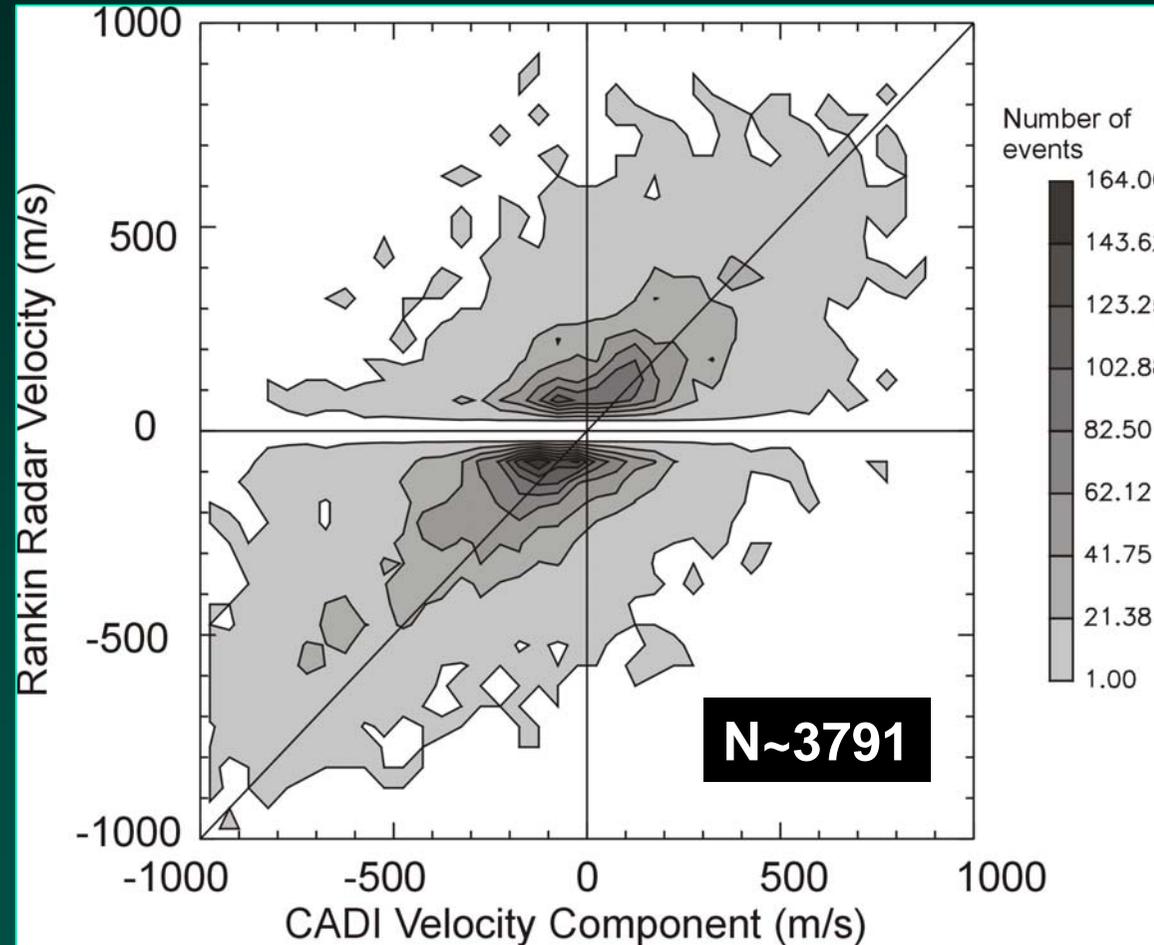


CADI and Rankin observations

Case of reasonable agreement



RANK-CADI Comparison



Reasons for disagreements

(a) Presence of E region echo for CADI

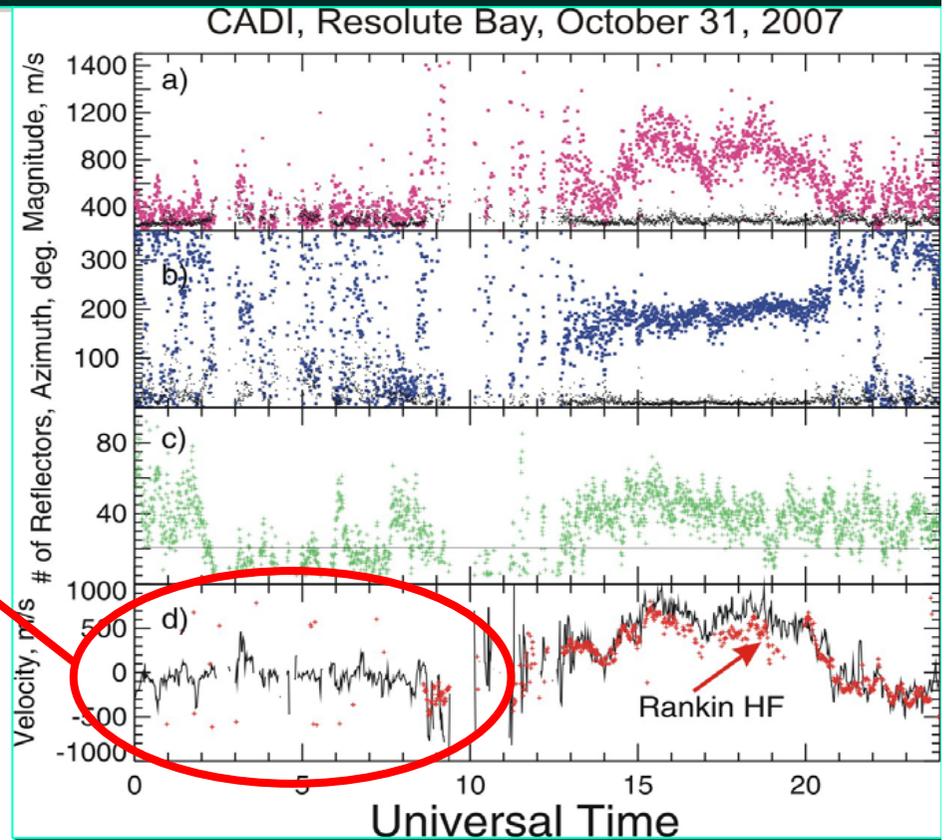
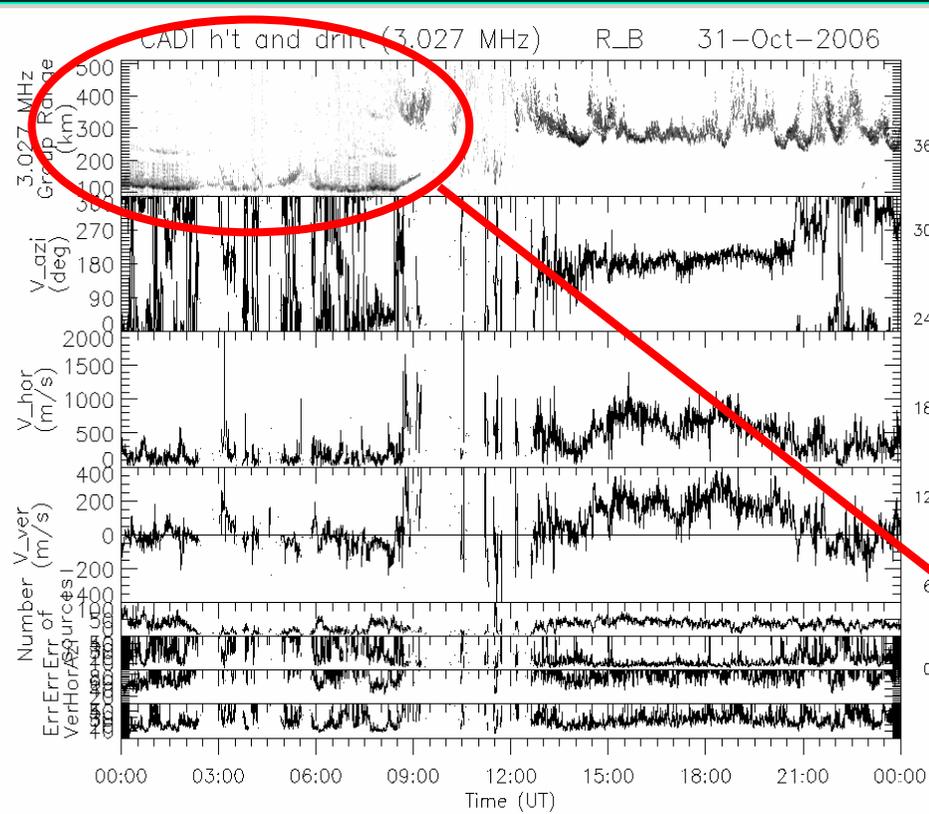
(b) Low number of CADI scatterers

(c) Ground scatter contamination for Rankin

(d) Fast changes of convection pattern

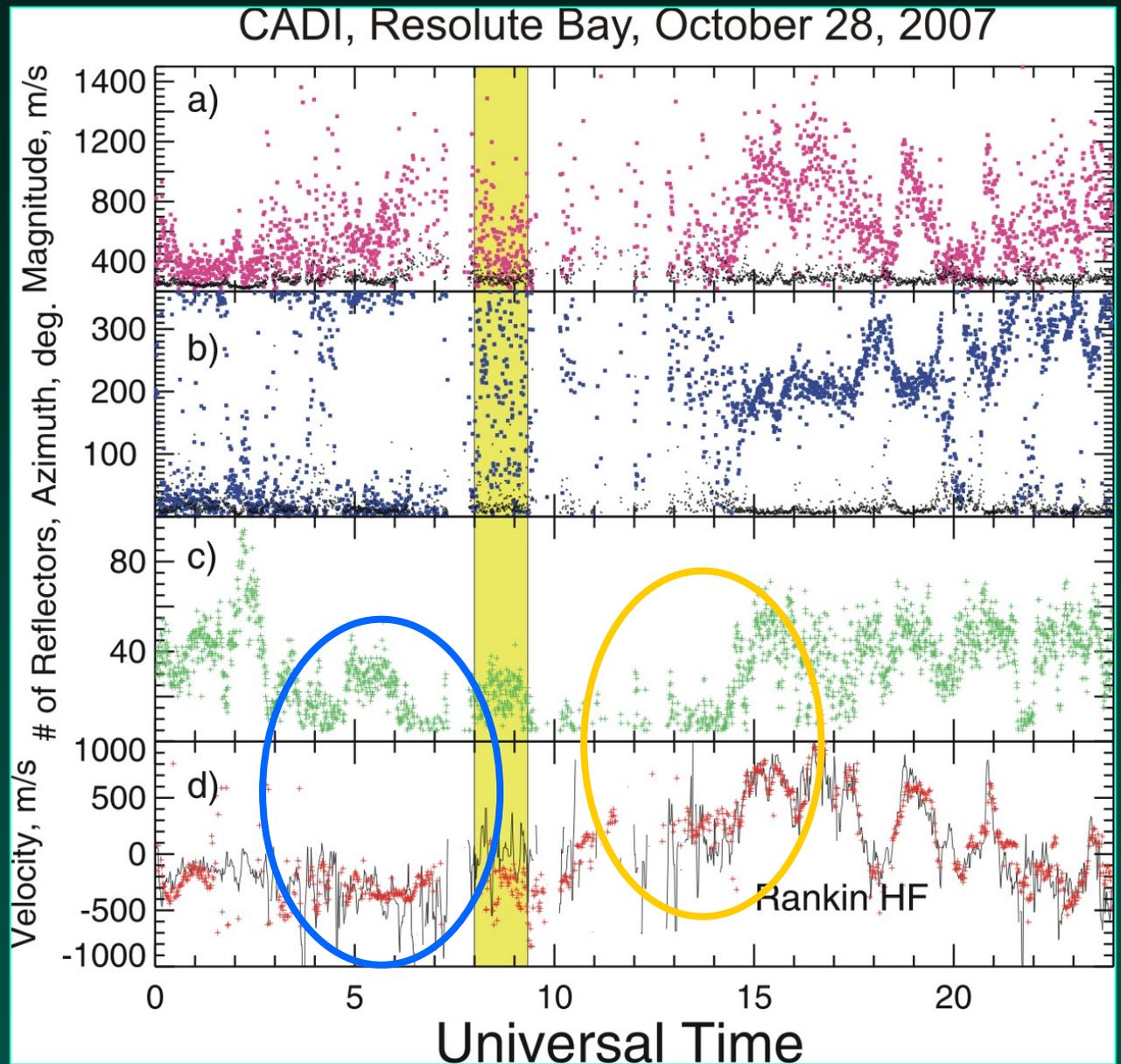
- **CADI velocity magnitude fast changes**
- **CADI velocity vector azimuth fast changes**

CADI limitations



Sometimes, CADI sees echoes from both E and F regions; for these periods agreement is generally poor

CADI limitations



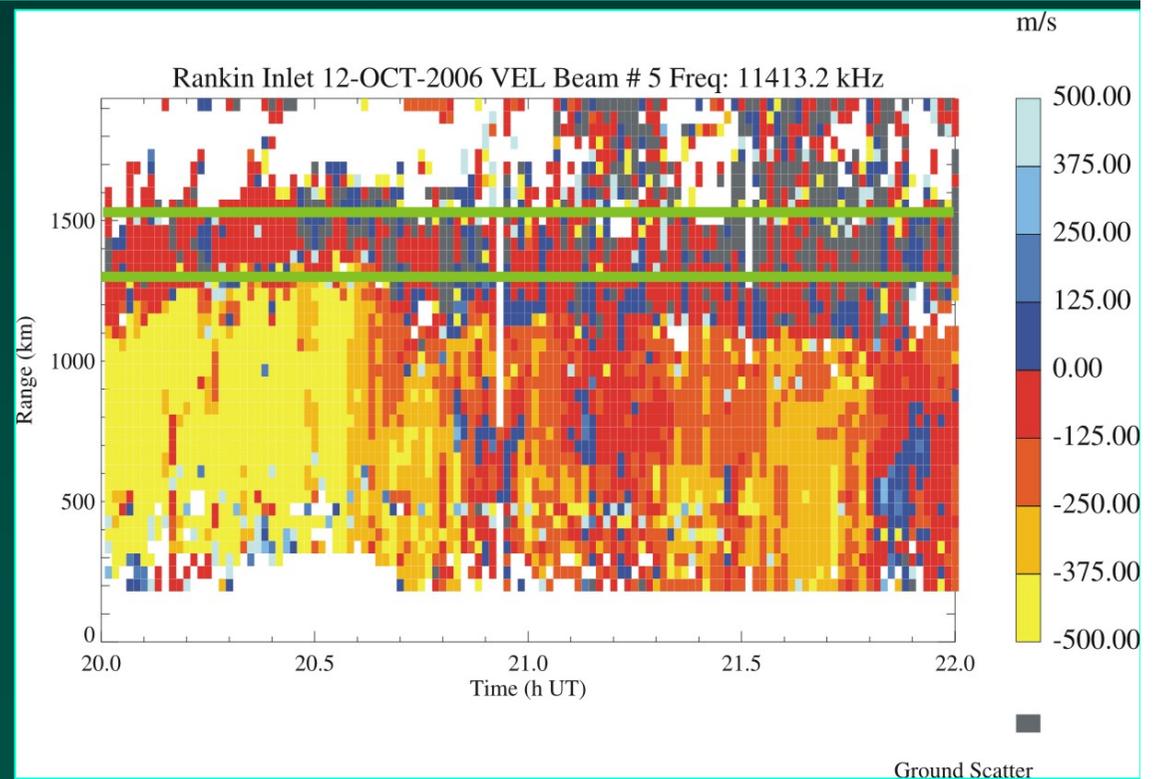
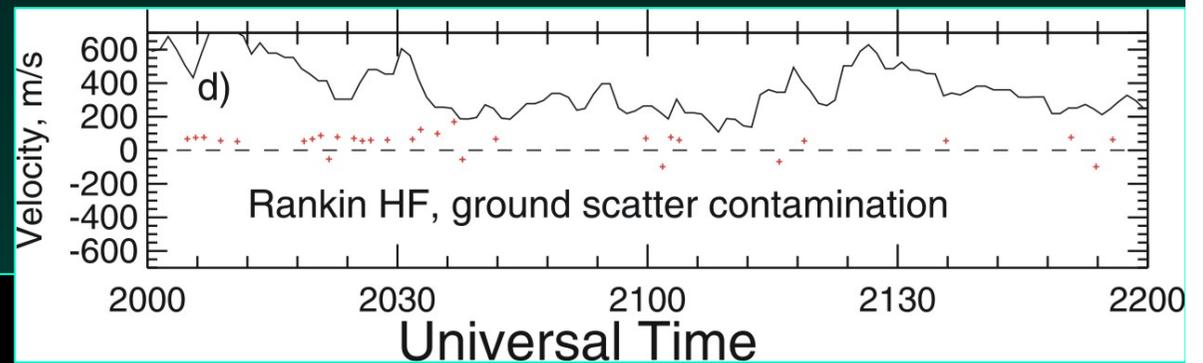
Sometimes, number of CADI scatterers within the entire sky is low, below 20; for these periods agreement is generally poor

Rankin HF radar limitations

October 12, 2006

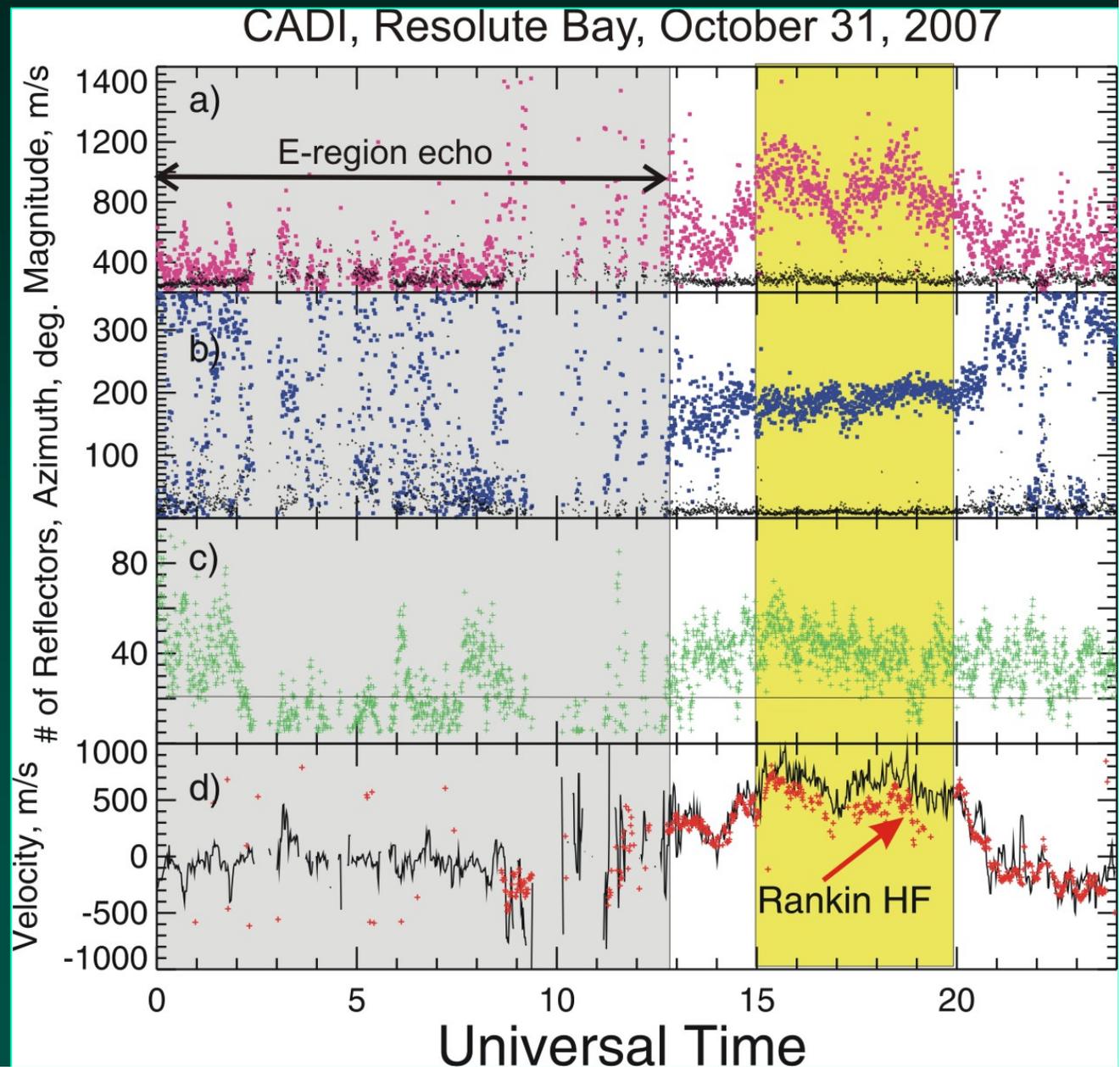
Sometimes, HF radar sees echoes contaminated with ground scatter; this gives obvious underestimation of the true convection velocity

Other possibility – “wrong” reported ranges Rankin velocities at “shorter” ranges agree with CADI



Geophysical reasons for discrepancies

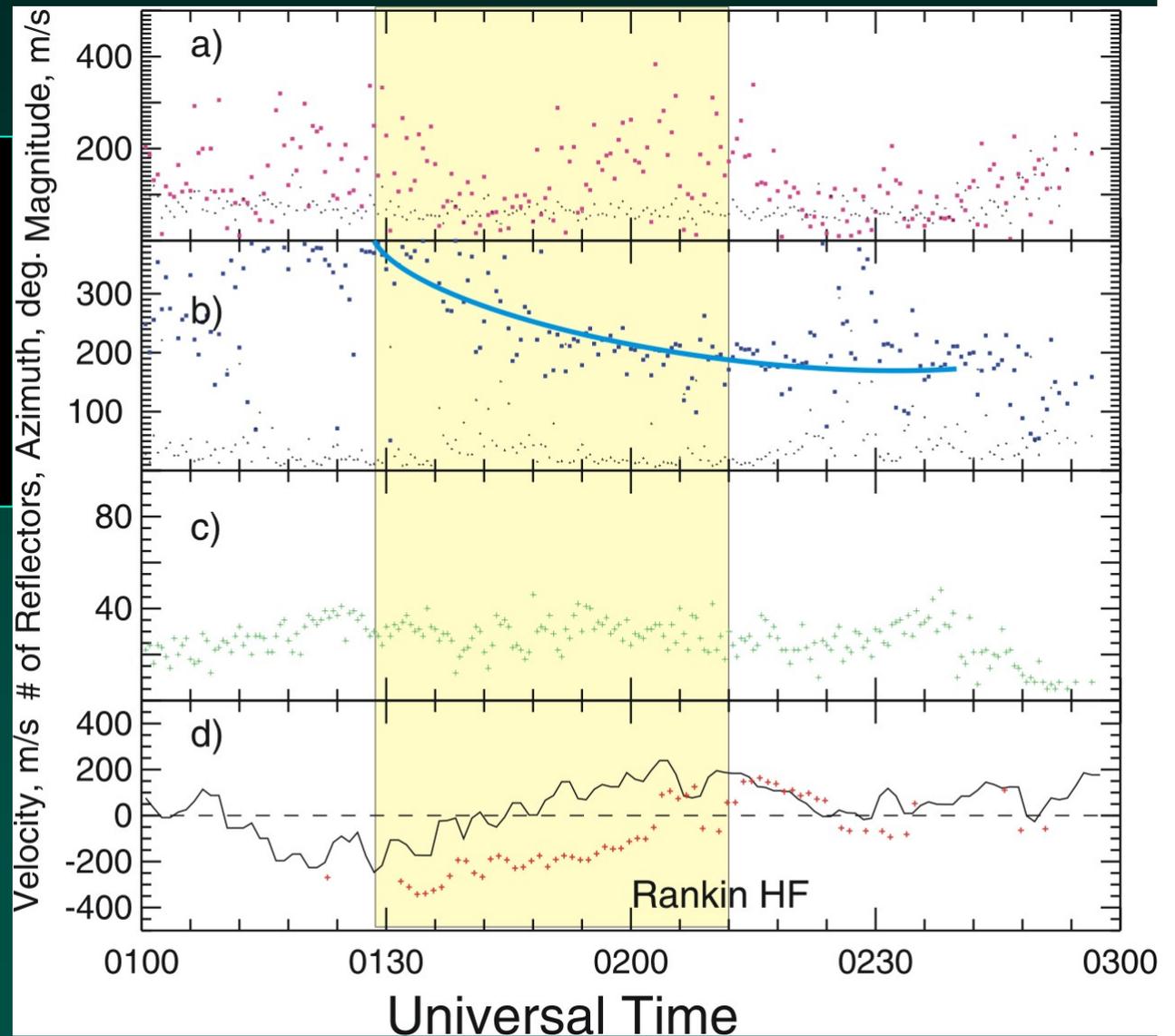
When convection is changing fast in magnitude, as indicated by the CADI magnitude, CADI-Rankin differences increase.



Geophysical reasons for discrepancies

Oct 12, 2006 event

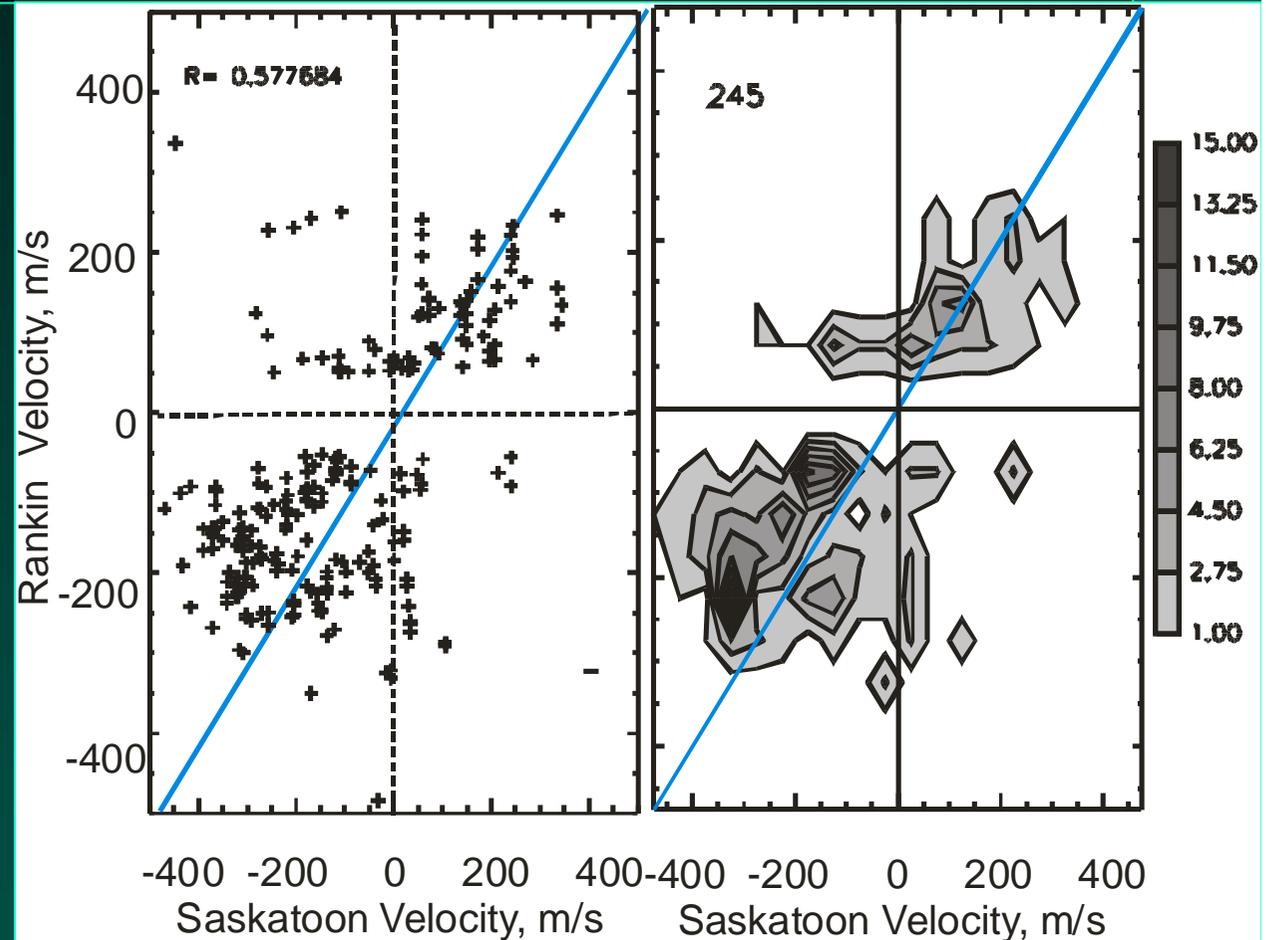
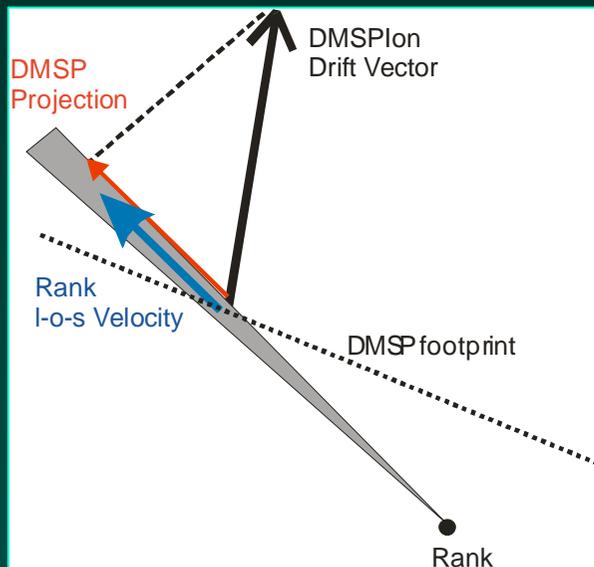
When convection is changing fast in direction, as indicated by the azimuth, CADI-Rankin differences are significant.



Conclusions for RANK-CADI Comparison

1. Rankin Inlet radar velocity for observations at ~1400 km (direct propagation mode) agrees well with measurement by the CADI instrument at Resolute Bay
2. Discrepancy increases when CADI F-region signals are contaminated by scattering from the E region or when there are less than 20 scatterers within CADI sky map.
3. Discrepancy increases when Rankin F-region velocity data are contaminated by the ground scatter
4. Discrepancy increases whenever the magnitude and/or the direction of ionospheric convection change in time

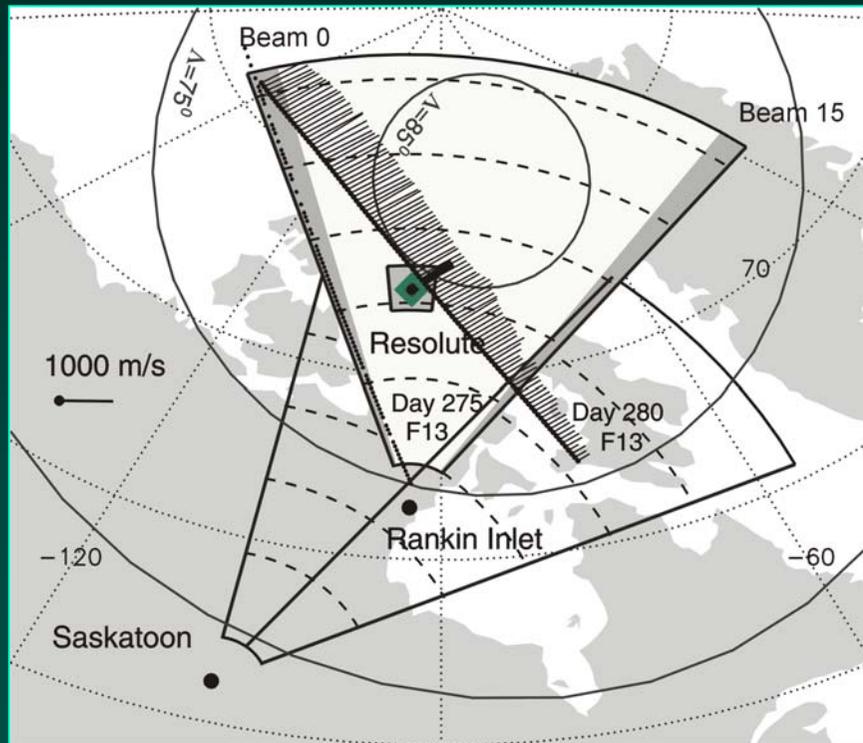
DMSP (Vector)-Rankin (I-o-s) Comparison (Robyn)



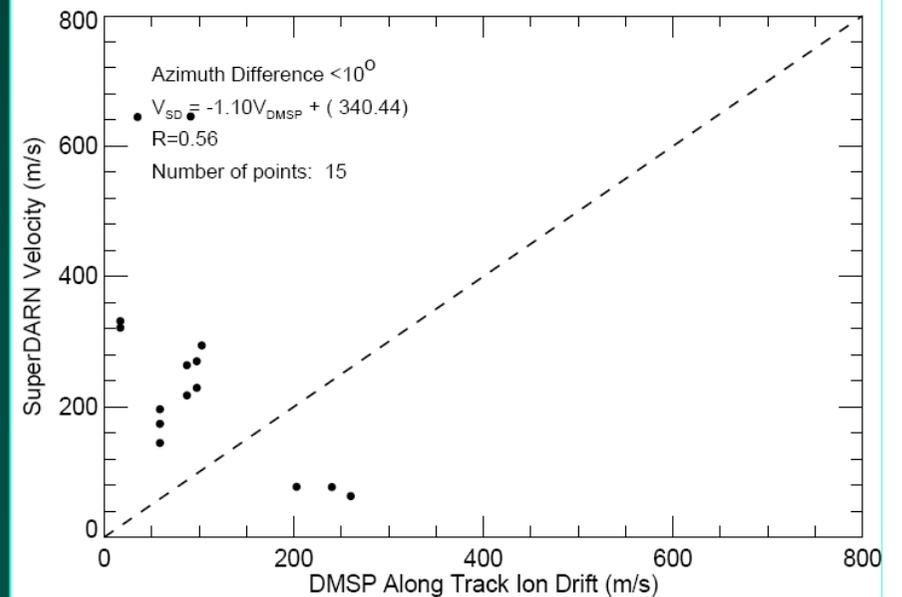
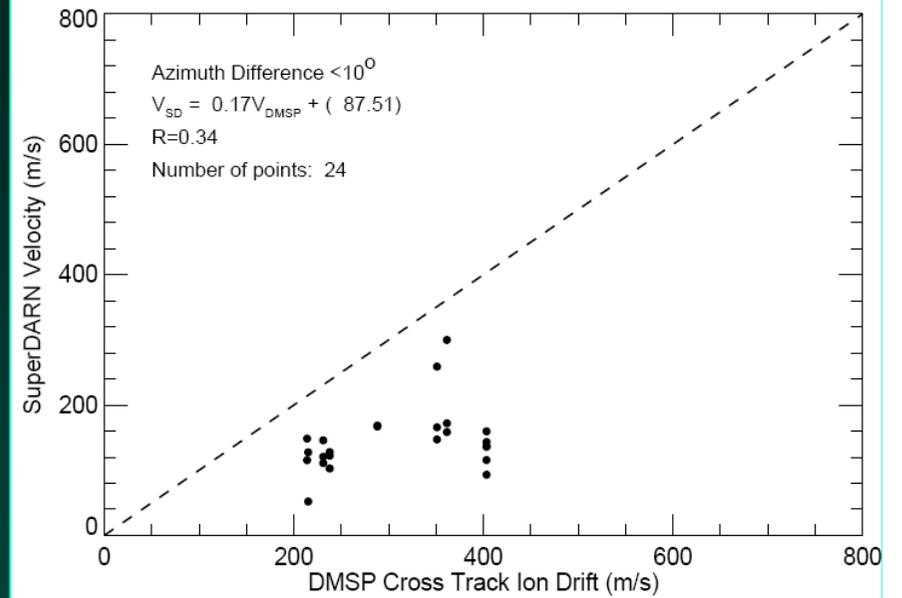
The DMSP ion drift vector was projected onto the direction of respective beam at closest radar cell and compared with the I-o-s velocity

Unsuccessful attempt of 1-D comparison:

RANK I-o-s and DMSP cross-track ion drift, misalignment of 10 deg



RANK I-o-s and DMSP along-track ion drift, misalignment of 10 deg



Conclusions for RANK-DMSP Comparison

1. Rankin Inlet radar velocity is, statistically speaking, somewhat smaller than the DMSP ion drift, consistent with the past results for other radars
2. Cases of different polarity DMSP-Rankin are not rare

Overall Conclusions

1. Overall, we are doing OK at Rankin in terms of the l-o-s velocity for observations at ~1000-1500 km (direct propagation mode).
2. There are quite a few cases when the polarity of the convection is different for individual instruments. I cannot say for sure who is right and who is wrong.
3. Identification of events with three or even four instruments measuring “almost” simultaneously is the way to dig deeper.