Improving Space-based Data for Data Assimilation

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Overview

- Defense Meteorological Satellite Program Data
  - Particles
  - Magnetic Field
  - Electric Field
- AMPERE and ST5 (in preparation for SWARM)
  - Compare satellite dB's in common reference frame
- Determine agreement between and weightings for various data sets
- Space-based data assimilation: AMIENext
- Geospace Response

DMSP

- Data “clean-up” and baseline removal for data archived at NGDC
  - Most recent 15 years of data archived at NGDC
  - Close cooperation with data experts

- Particle Data
  - Provide satellite location on 1 second basis
  - Remove background radiation contamination
  - Place in VO this year

- Magnetometer Data
  - Provide satellite location on 1 second basis
  - Improve high latitude baseline removal
  - Inter-compare with other satellite mags
  - Place in VO next year

- Ion Drift and RPA Data
  - Provide satellite location on 1 second basis
  - Address Quality flag issue
  - Inter-compare with other data
  - Place in VO in ?? years

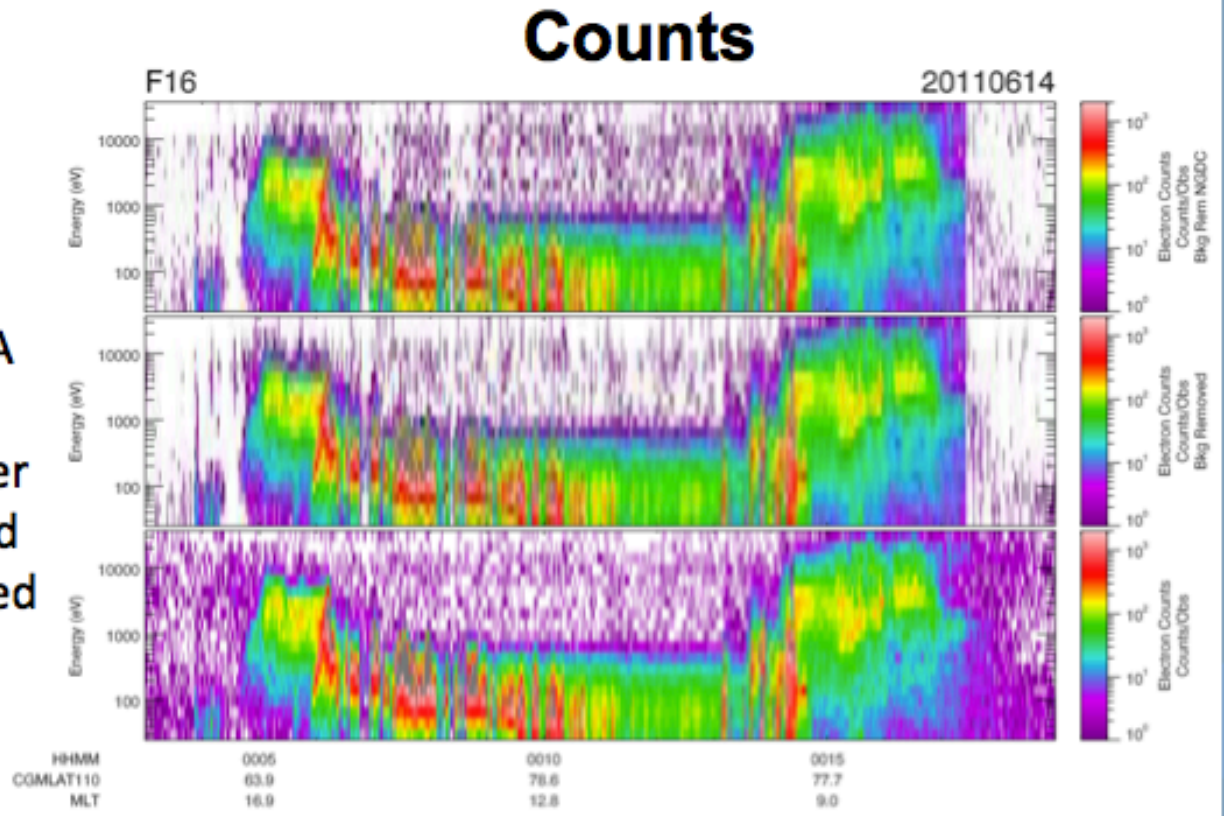
SSJ Background Estimation and Contamination Removal Uncertainty Estimates

R. Redmon, G. Wilson and D. Ober

Counts Comparison:

- Top to bottom:

  NGDC, SSDP, Obs
- Both remove CPS and SAA (not shown)
- NGDC initially looks noisier
  - |counts| < 0 retained
  - ~ 53 "spikes" removed



SSJ Error Propagation
R. Redmon, G. Wilson and D. Ober

- Relative or Absolute Uncertainties?
- Differential Energy Flux Relative Uncertainty

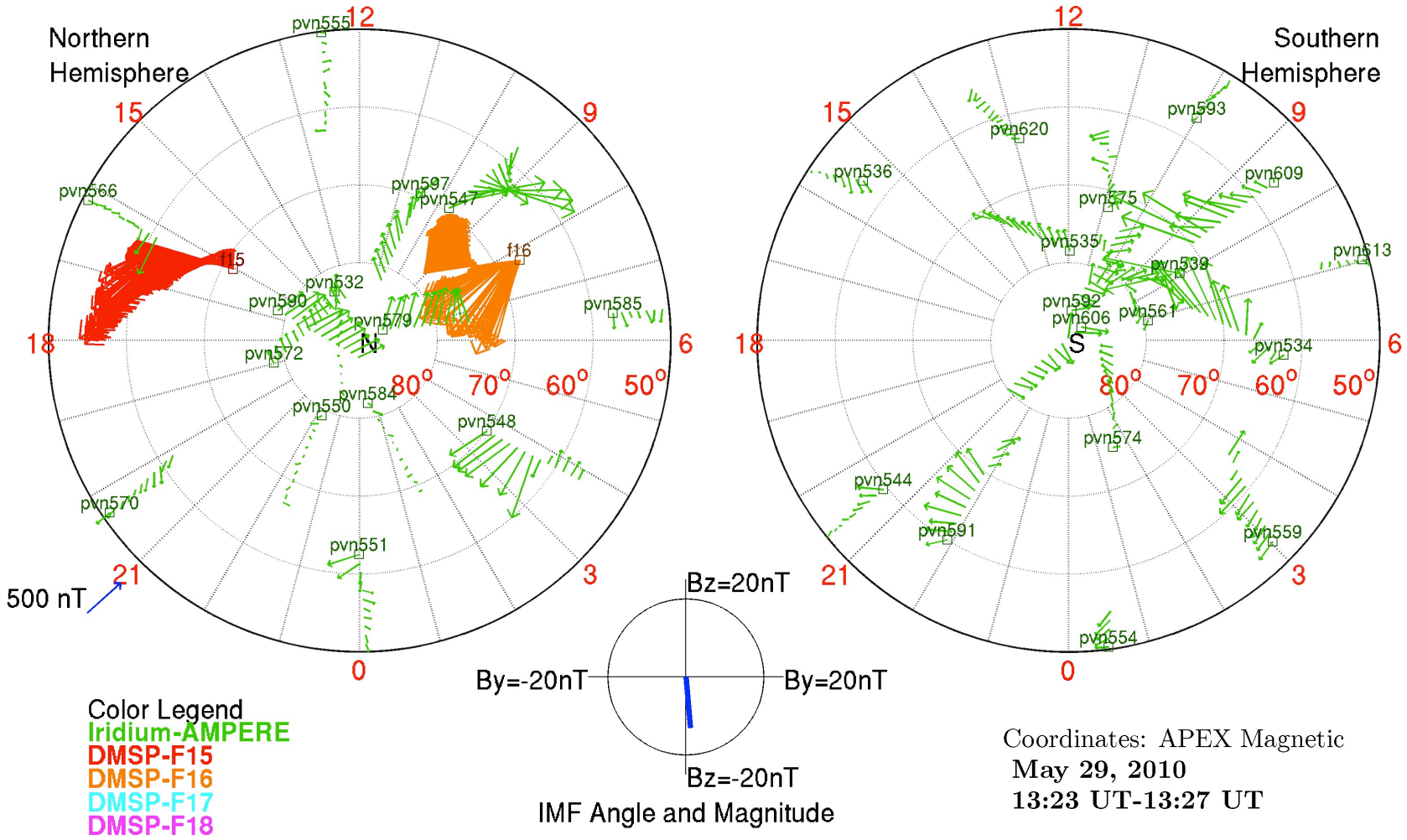
$$\frac{\sigma_{j_E(E_i,\Omega)}}{j_E(E_i,\Omega)} = \pm\sqrt{\left(\frac{\sigma_C}{Counts}\right)^2 + \left(\frac{\sigma_{GF}}{GF}\right)^2 + \left(\frac{\sigma_{\eta(E_i)}}{\eta(E_i)}\right)^2 + \left(\frac{\sigma_{\Delta E_i}}{\Delta E_i}\right)^2}$$

- Total Energy Flux Relative Uncertainty

$$\frac{\sigma_{JE_{Total}(\Omega)}}{JE_{Total}(\Omega)} = \pm\frac{1}{\Delta E_{Total}}\sqrt{\sum_{i=1}^{19}\left(\Delta E_i \sigma_{j_E(E_i,\Omega)}\right)^2} \Big/ JE_{Total}(\Omega)$$

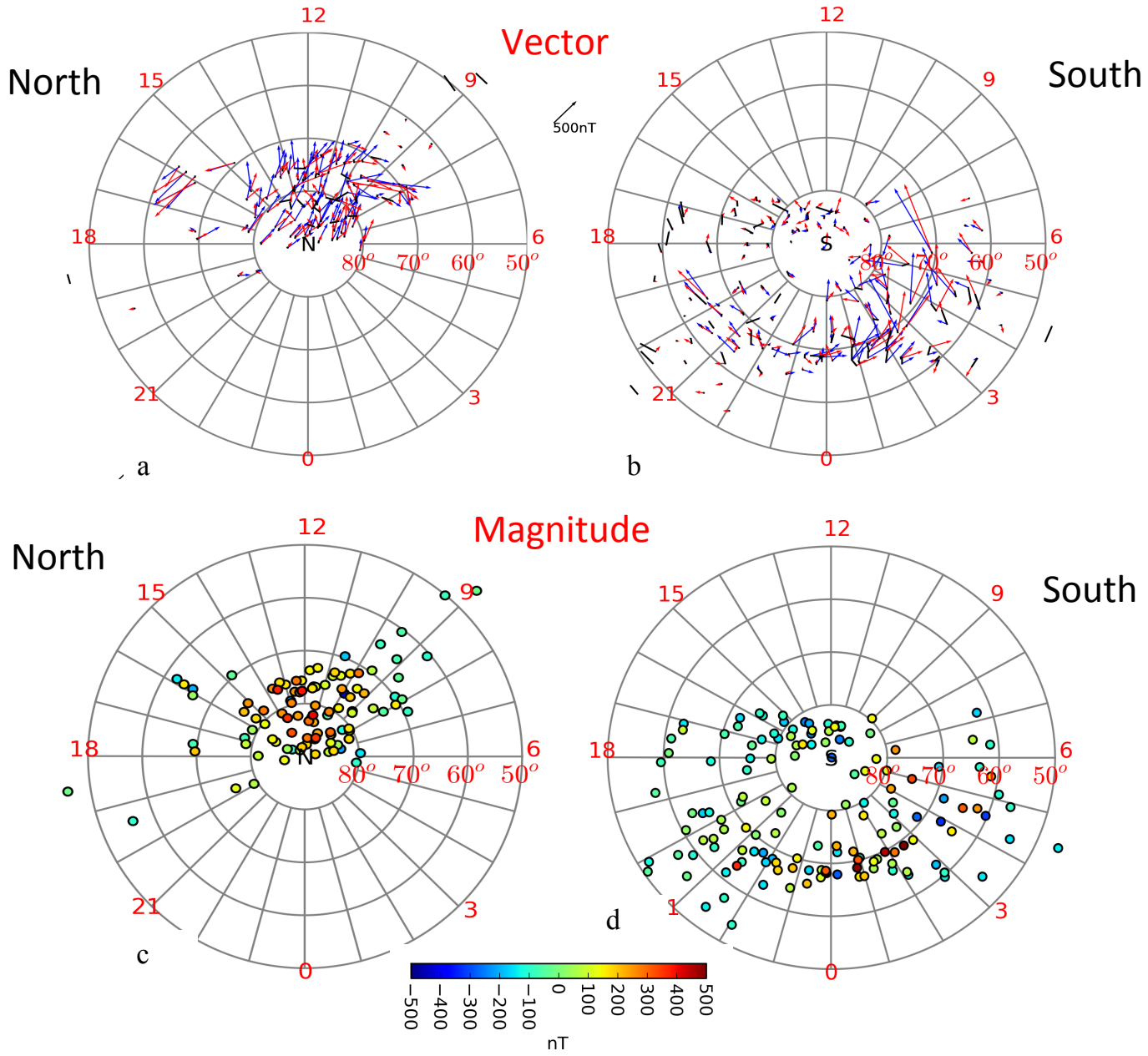
Provide Error Estimates with Original and “Decontaminated” Data

AMPERE-DMSP perturbations @ 110 km in Modified Apex Coordinates



Knipp et al., Accepted, *Space Weather*

29 May DMSP-AMPERE dB's during Magnetic Conjunctions (within 3°, +/- 90 s)



Conjunctions calculated in APEX Coordinates

Blue –DMSP
Red- AMPERE

Significant discrepancies In NH polar cap and cusp
DMSP > AMPERE
Larger during high activity

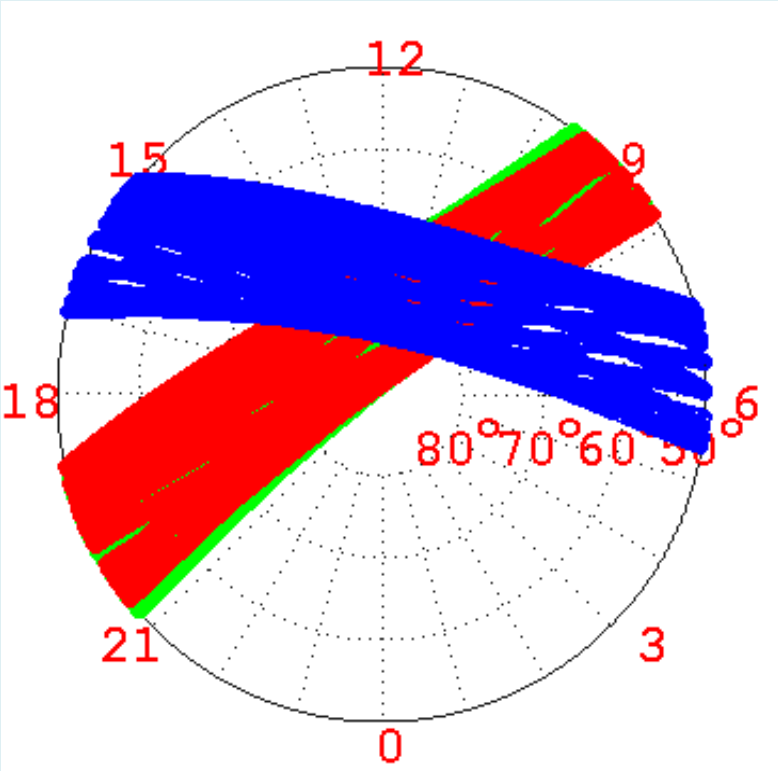
Some discrepancies in SH high-lat auroral zone

Knipp et al., Accepted, *Space Weather*

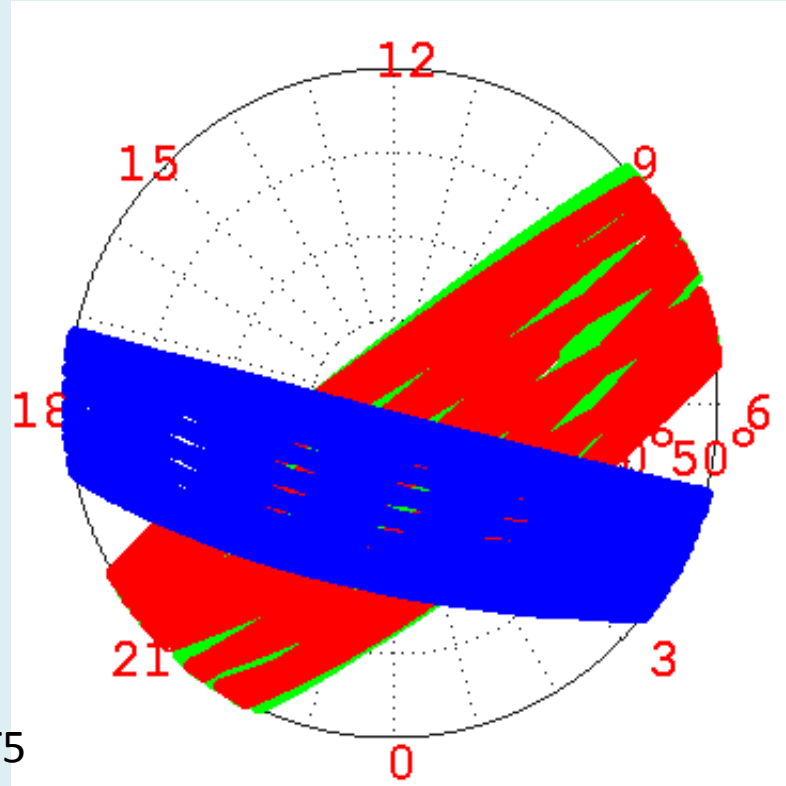
Determine/Describe the Quality of DMSP Mag Data

Choose interval with overlap of quality magnetic measurements
ST5 Constellation mid March-Mid June 2006

North



South

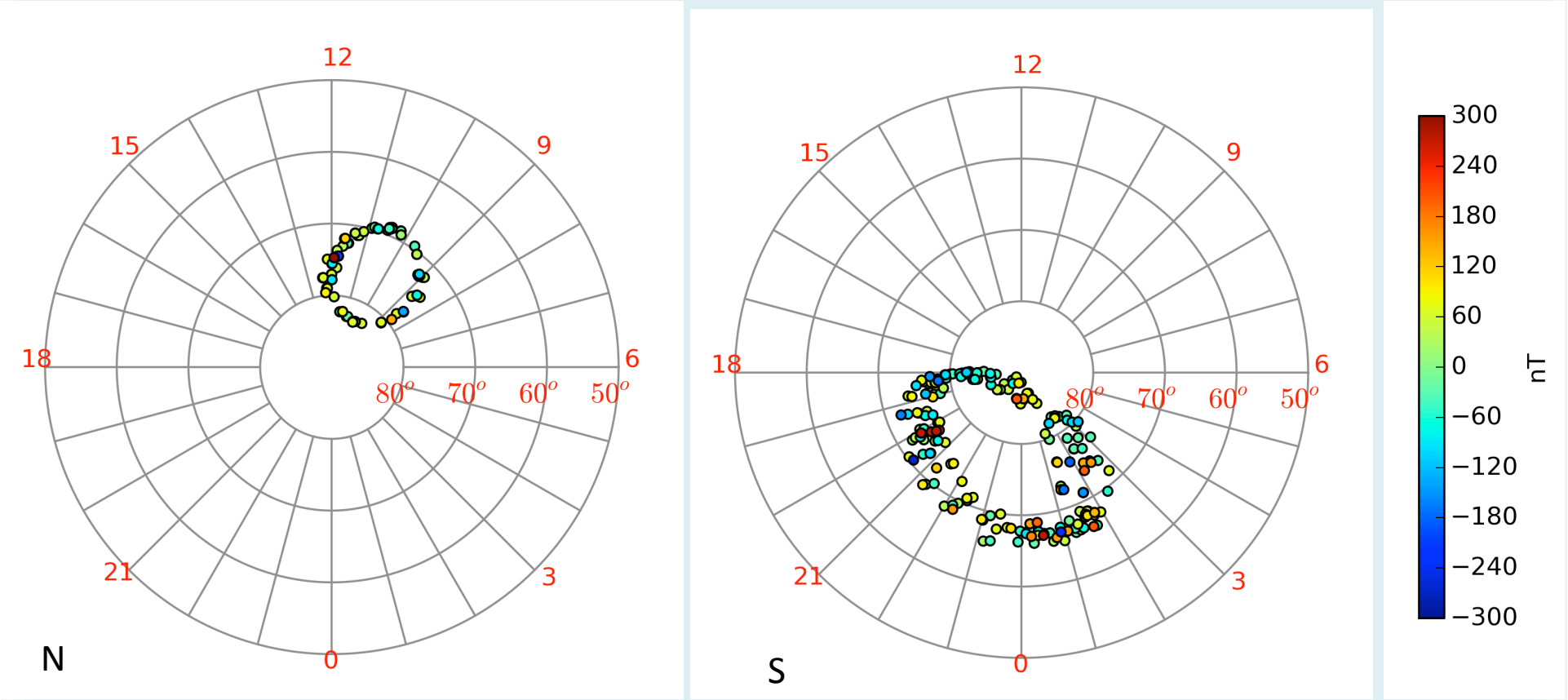


Blue ST5
Red/Green DMSP

Knipp et al., work in progress, 2014

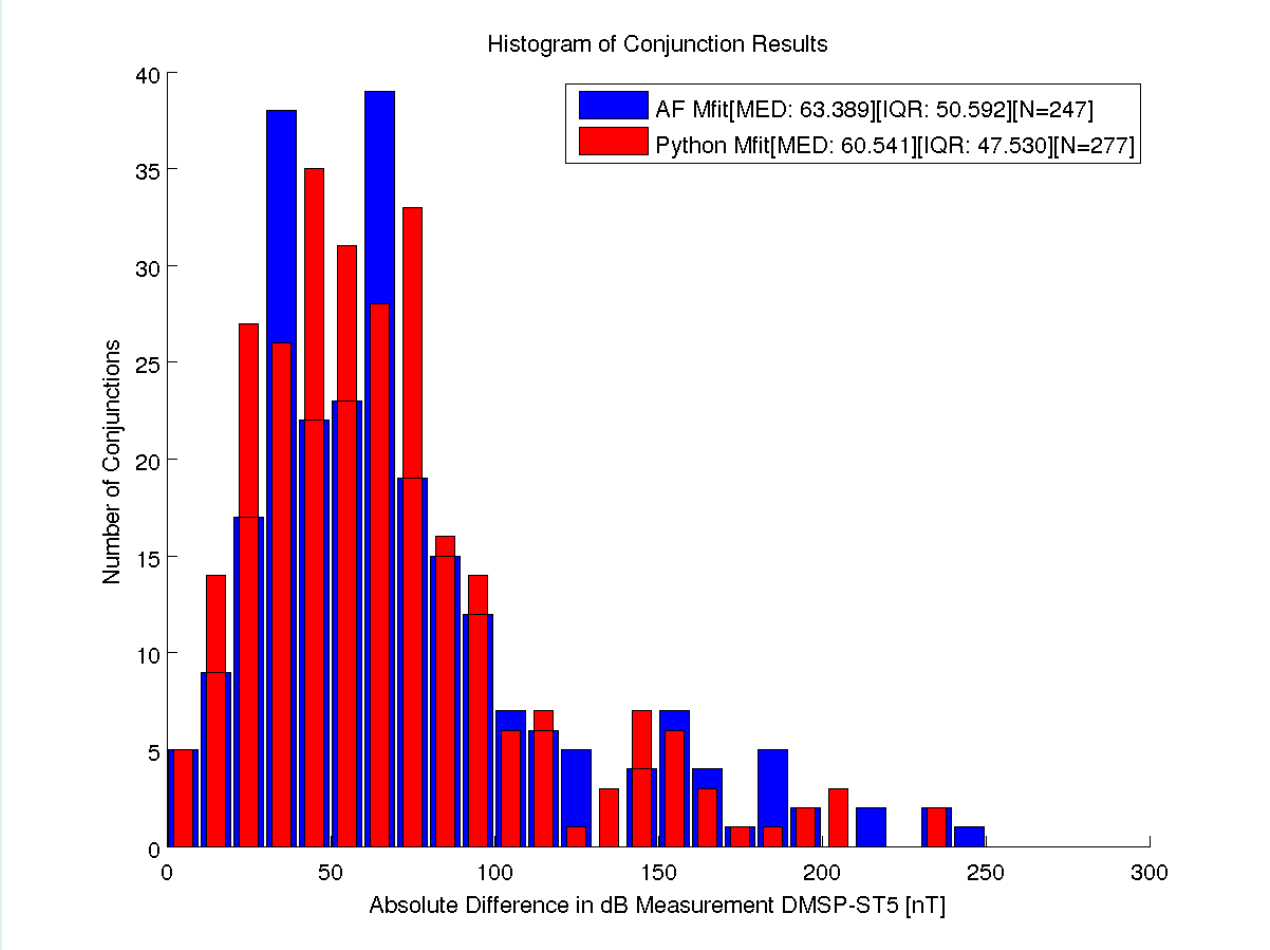
Find Conjunctions between Magnetometers on Different Spacecraft

277 Conjunctions: Do the Measurements Agree? If not: Why not



Knipp et al., work in progress, 2014

Reduce Disagreement by Improving Baseline Removal



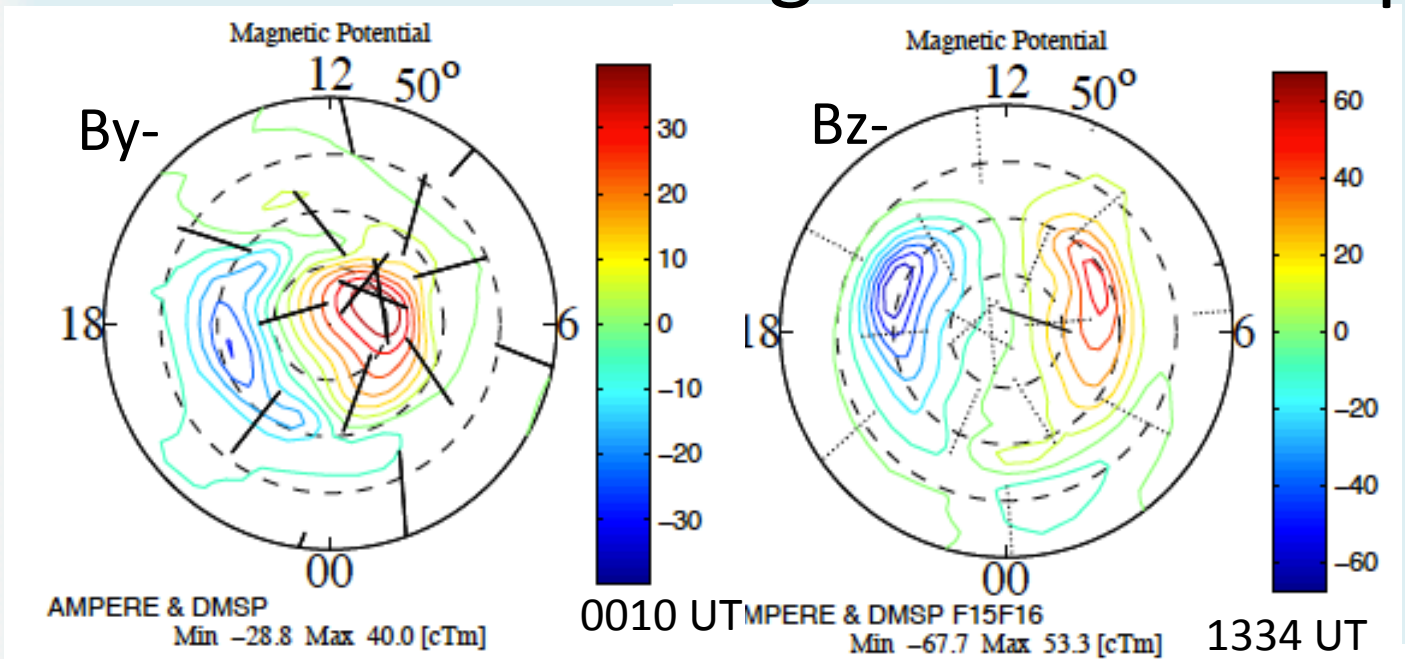
Reduce agreement be ~ 20 nT

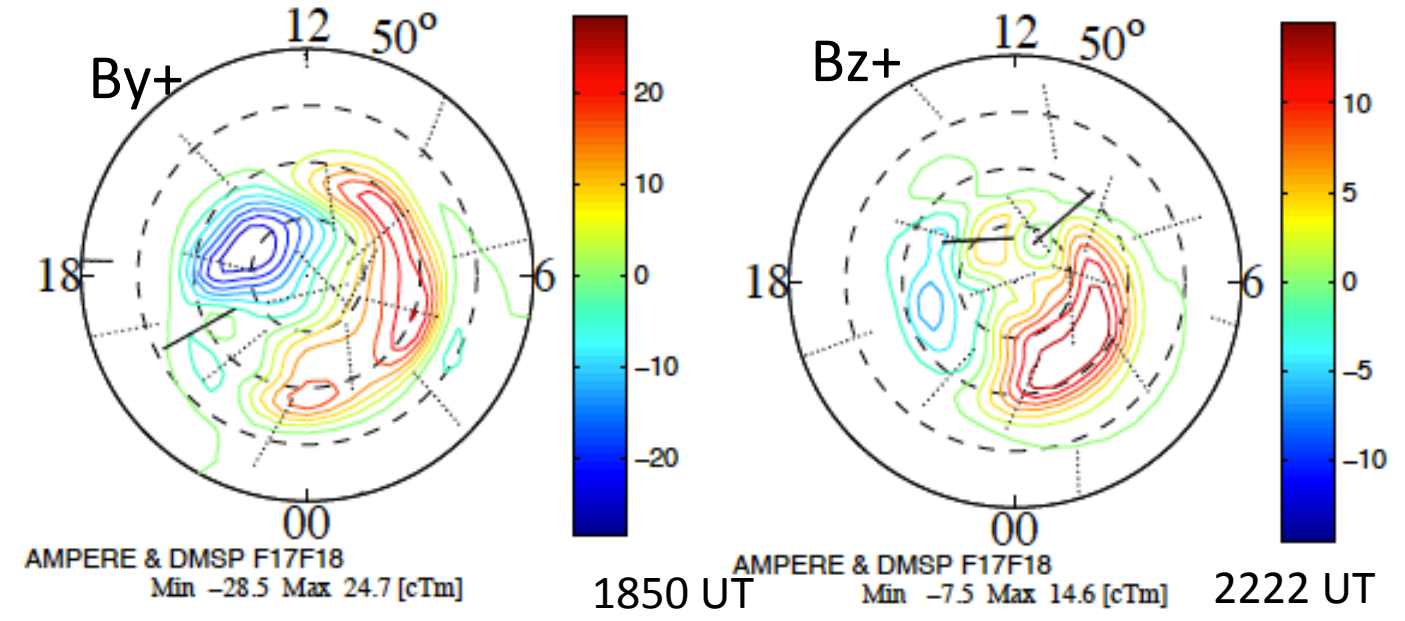
Median disagreement now at 60 nT for measurements within 3° and 90 sec

Growing confidence in revised DMSP mag observations

Knipp et al., work in progress, 2014

AMIENext Mag Potential Morphology



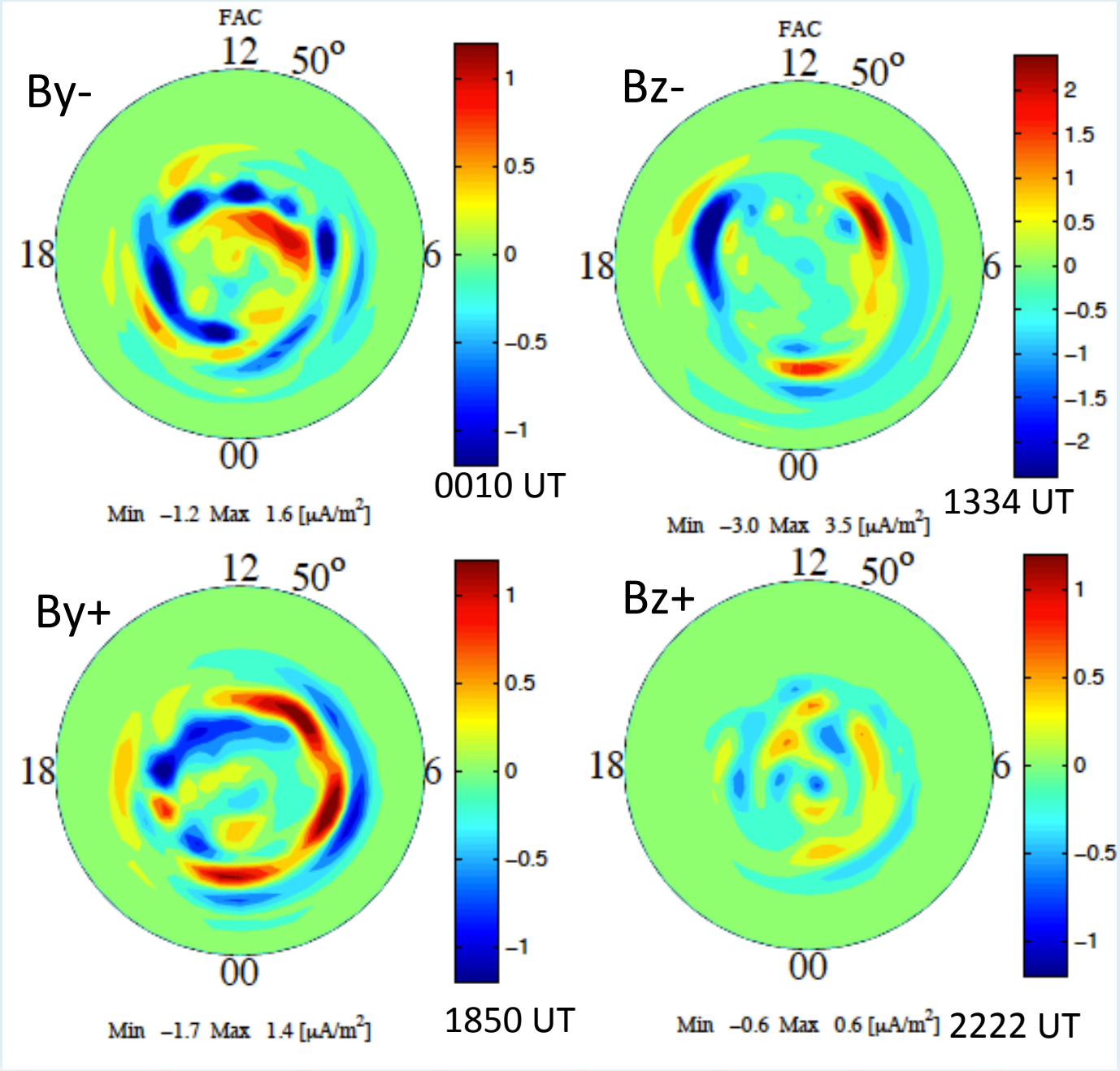


Left Colum:
Expected twist of potential for IMF By changes

Right Column
Bz- Two Cell
Bz+ Four Cell

View from above north geomagnetic pole; noon at top

AMIENext FAC Morphology



Left Colum:
Expected shift in FAC morphology for IMF By changes

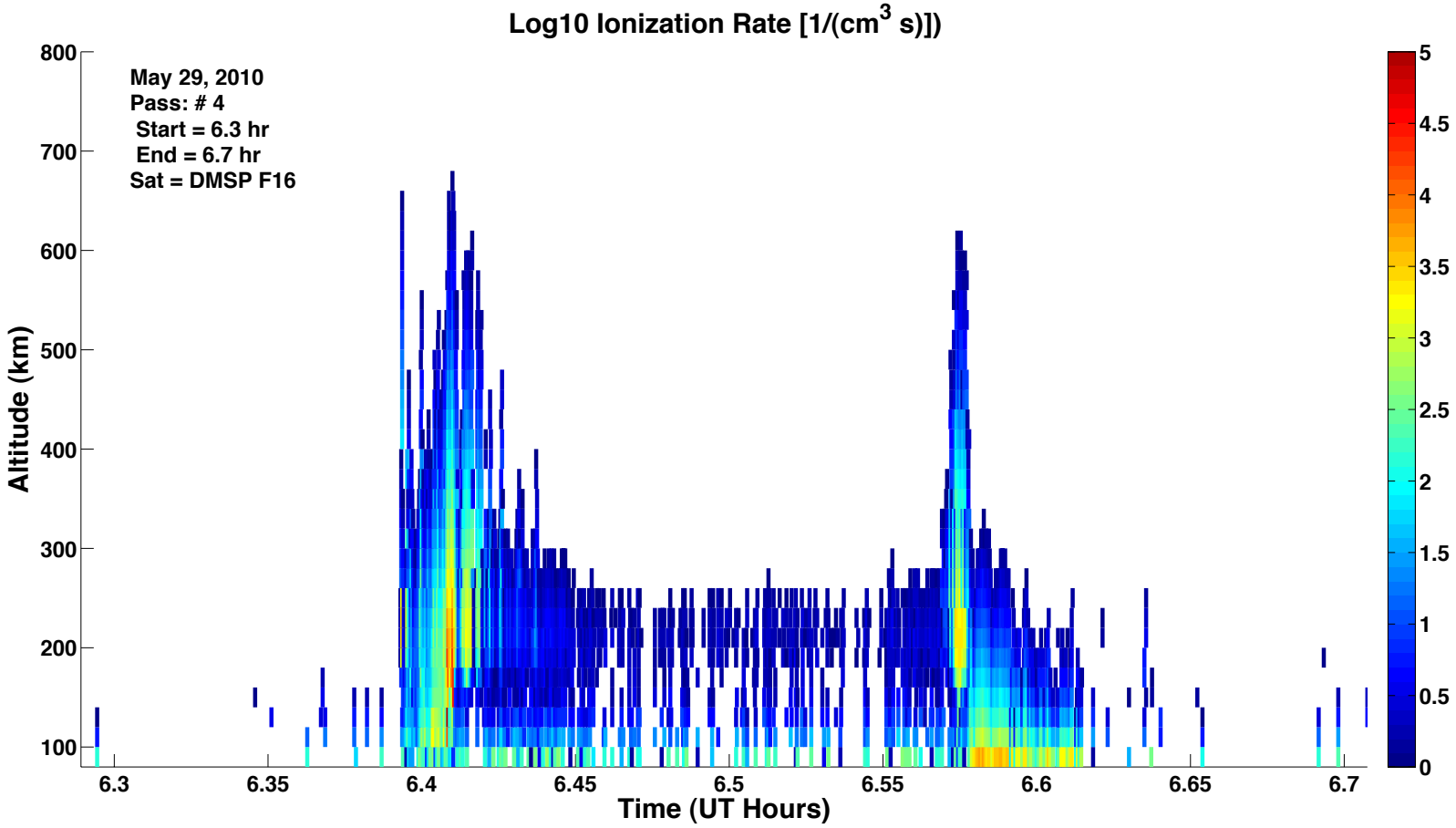
Right Column:
Bz- Strong Region 1 and 2 currents
Bz+ Weak Reversed NBZ current

View from above north geomagnetic pole; noon at top

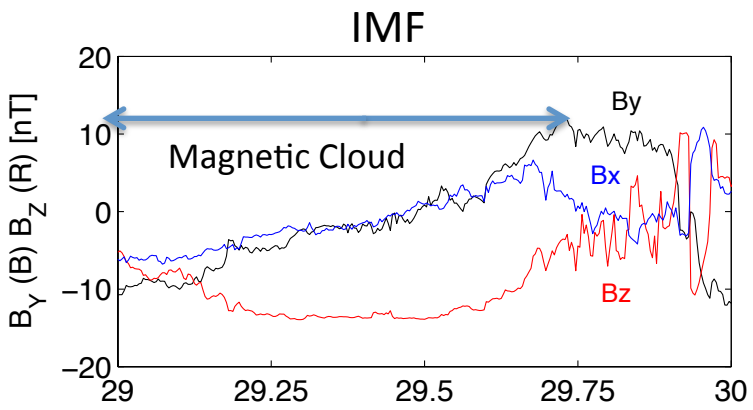
Blue Downward FAC
Red Upward FAC

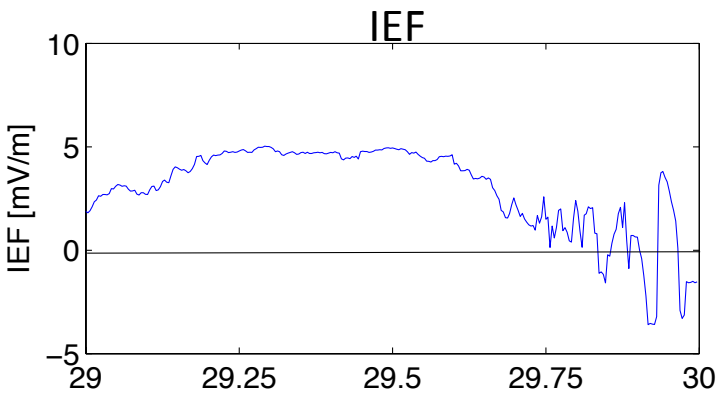
Note scale difference to Bz-

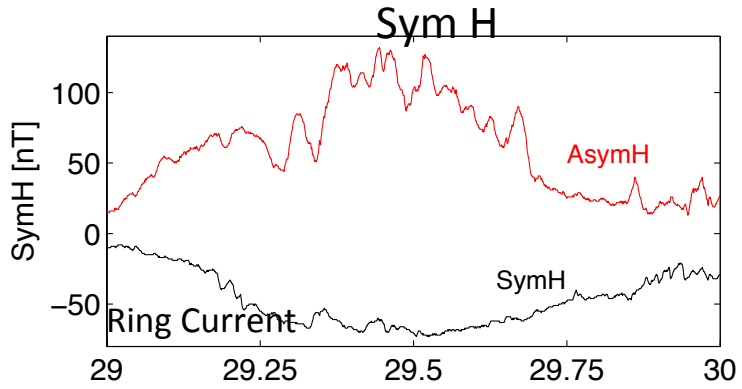
Two Dimension Conductance

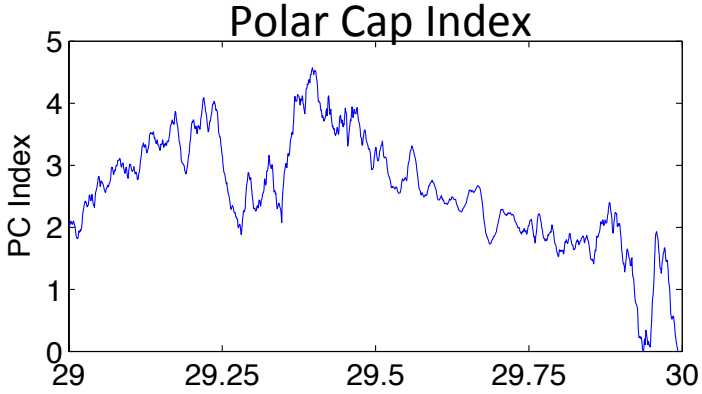


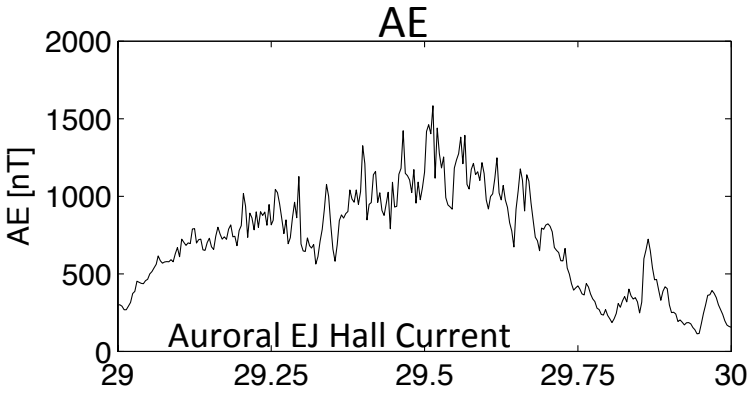
Geospace Response

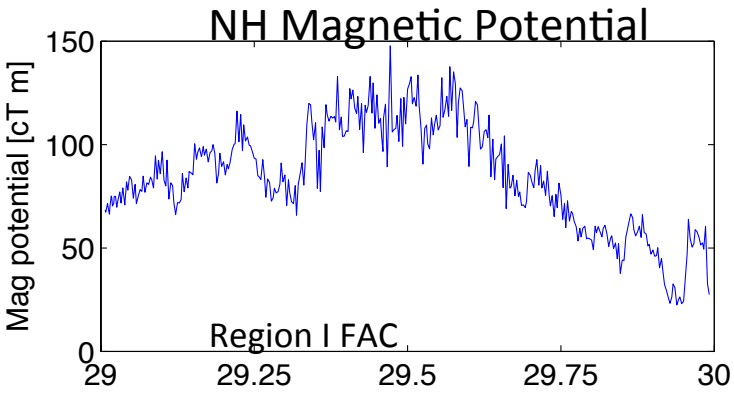












Summary

- Significant progress in improving accessibility and utility of DMSP particle data
  - Solar Cycle + worth of data headed to VO
- Good progress in baseline removal and comparison of DMSP mag data
- Data merging, comparison and assimilation for mag data are underway
- Challenges remain for recent decade of DMSP electric field data