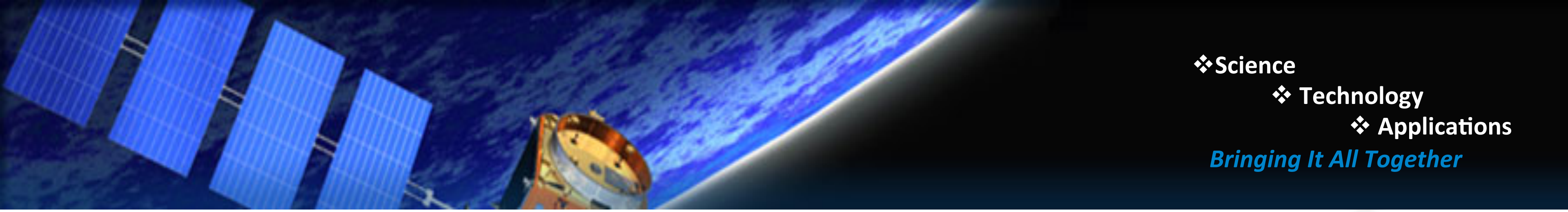


High Latitude Drivers

G. Crowley, M. Pilinski, I. Azeem

Atmospheric and Space Technology Research Associates (ASTRA LLC.)

ASTRA Modeling Capabilities

Model	Inputs	Outputs
TIME-GCM Thermosphere-Ionosphere Mesosphere-Electrodynamics General Circulation Model	• Electric Potential (AMIE) or empirical high-latitude potential patterns driven by ACE solar wind information or magnetic indices • Solar flux at 57 key wavelengths or F10.7 • Tides and planetary waves (optional) from empirical or other models (e.g. WACCM, NCEP, NOGAPS etc.)	• **Global Neutral** and Ion **Density** • **Global Neutral** and Ion **Temperature** • **Global Neutral** and Ion **Composition** • **Global Neutral Vector Winds** • Global Ion Vector Drifts
AMIE Assimilative Mapping of Ionospheric Electrodynamics	• Magnetometer Data (Ground and Space) • Incoherent Scatter Radar Electric Field Data • In-Situ DMSP Drift Data • SuperDARN Radar Drifts • AMPERE perturbations due to Field Aligned Currents	• **Auroral Boundaries (>40° mag. Lat.)** • **Electric Potential distribution (>40° mag. lat.)** • Electric Fields (>40° mag. Lat.) • Field Aligned Currents (>40° mag. Lat.) • Ionospheric Conductance, Σ_p Σ_{II} (>40° mag. Lat.) • Joule Heating (>40° mag. Lat.)

<u>Caution:</u>

There is not one “AMIE”

There is not one data set from magnetometers, SuperDARN, DMSP

There is not one “Background Model” such as Weimer

Quality controls on datasets

TIMEGCM and AMIE Transition to Realtime

Modeling

Data Assimilation

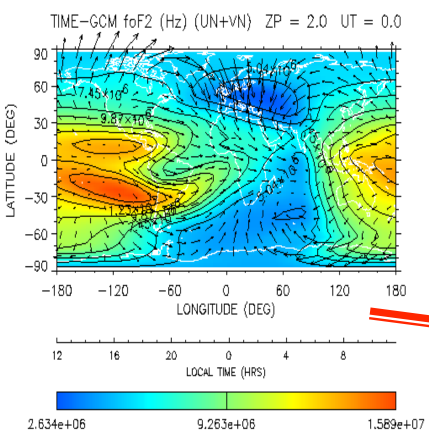
Data Analysis

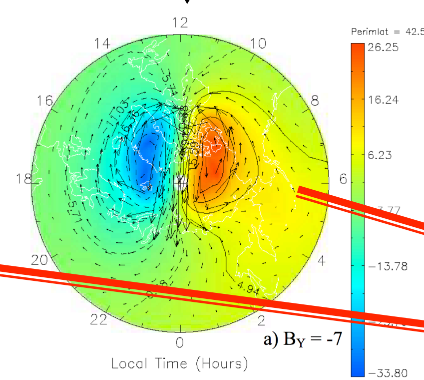
Space Based Data

Ground Based Data

AMIE

TIMEGCM



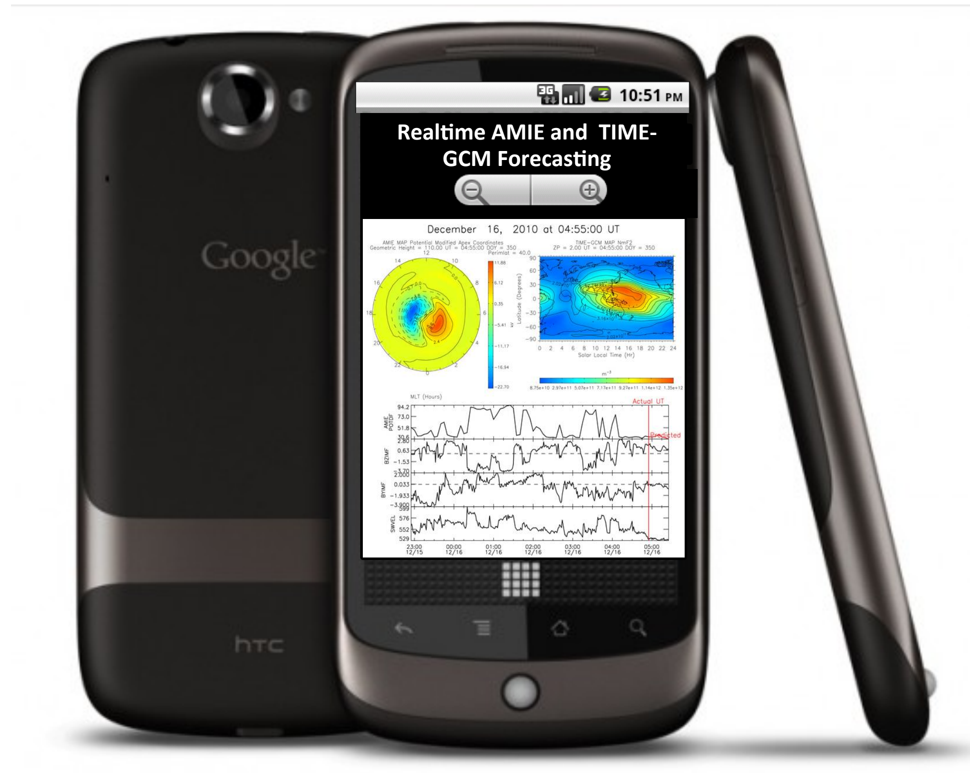


android market

www.astraspace.net

AMIE and TIMEGCM Models

on the ASTRA Space Weather App!

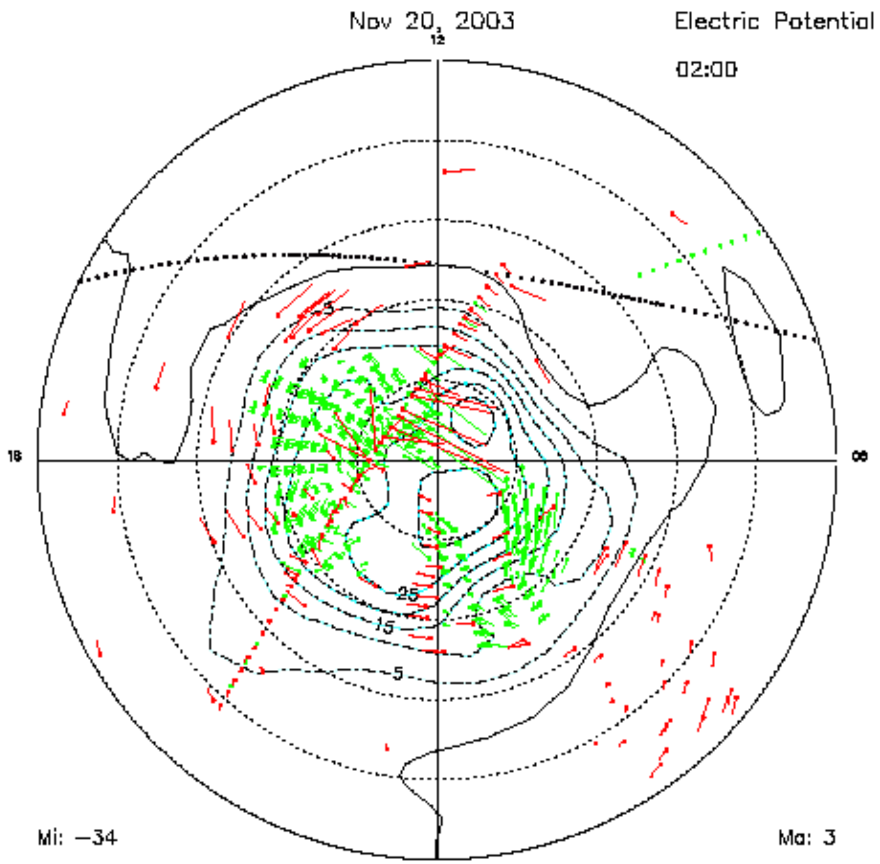


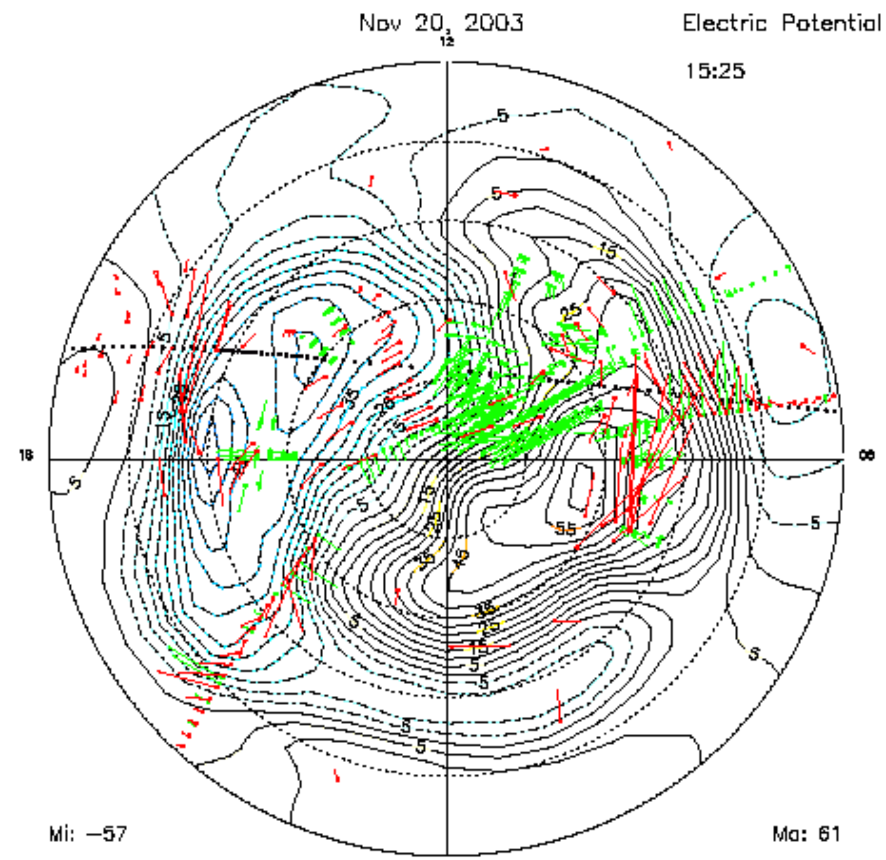
Get Realtime AMIE and TIME-GCM Model data on your mobile phone with the **Astra Space Weather App.**

Use barcode scanner application on your phone and scan the QR code on the right to download from Google Marketplace!

High Latitude Forcing: Electric Potentials

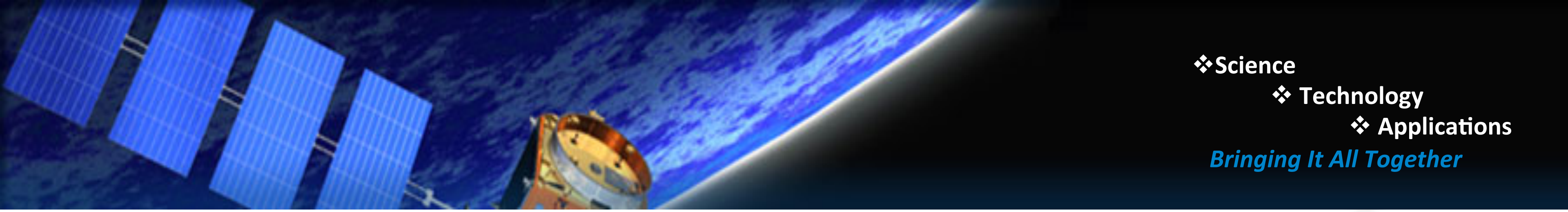
AMIE Potentials: More Realistic Inputs



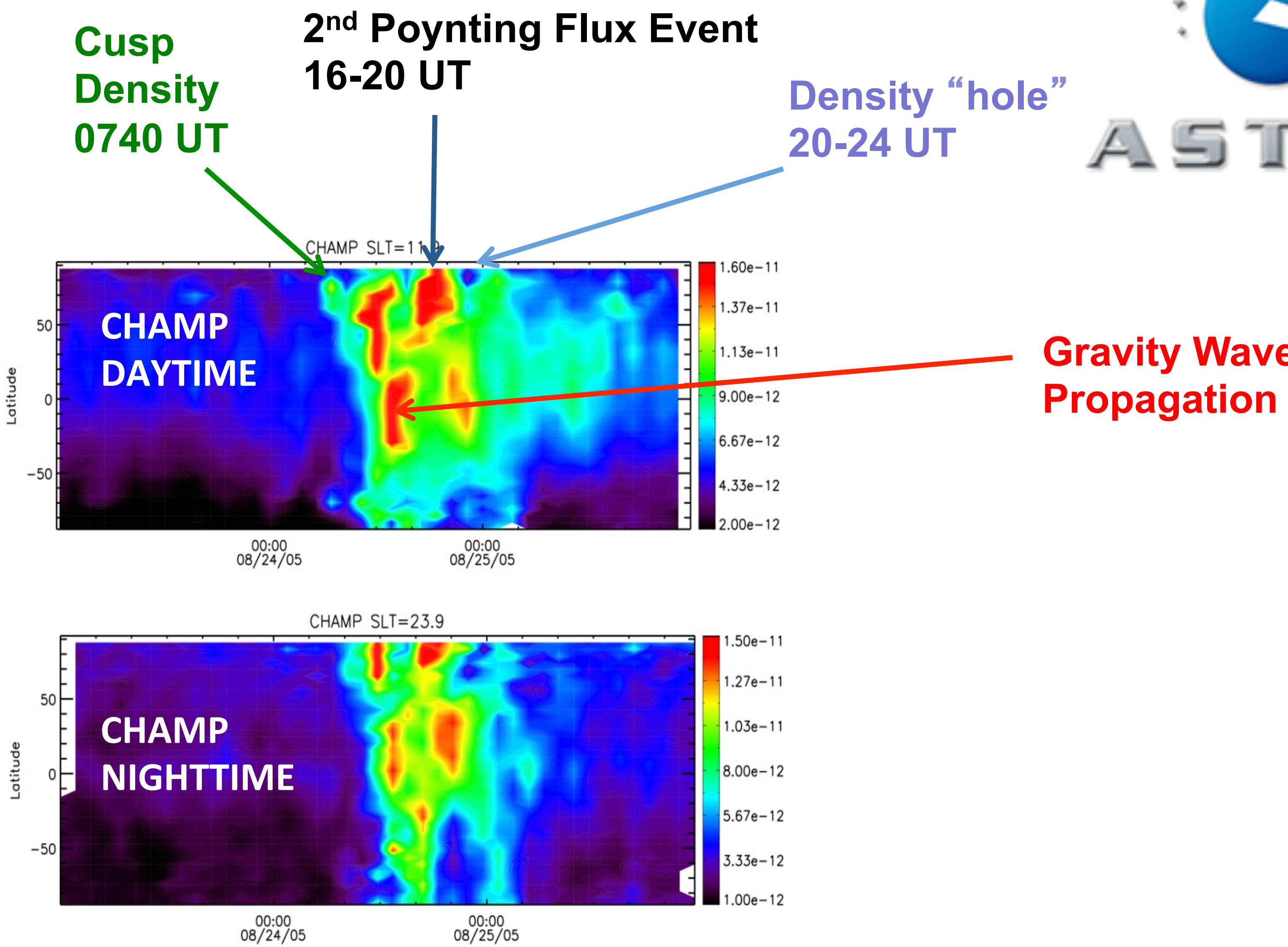


Data Inputs: **180 ground magnetometers**
3 DMSP satellites
10 SuperDARN radars
Satellite Magnetometer – NEW!

NSF's AMPERE Mission: Measures Field Aligned Currents



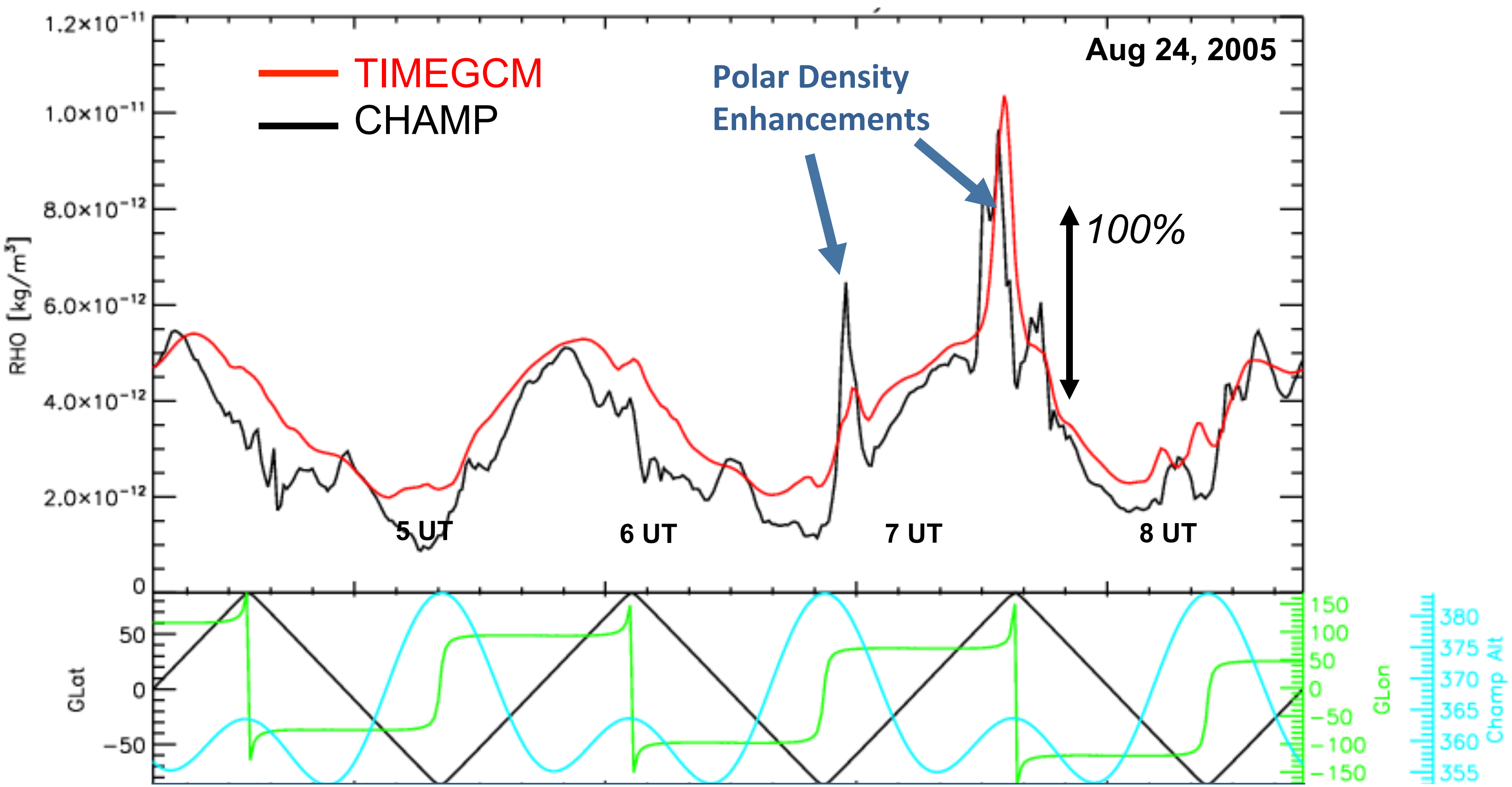
High Latitude Density Structure



Cusp Density
0740 UT
2nd Poynting Flux Event
16-20 UT
Density "hole"
20-24 UT
Gravity Wave Propagation
CHAMP SLT=11.9
CHAMP DAYTIME
Latitude
50
0
-50
00:00
08/24/05
00:00
08/25/05
1.60e-11
1.37e-11
1.13e-11
9.00e-12
6.67e-12
4.33e-12
2.00e-12
CHAMP SLT=23.9
CHAMP NIGHTTIME
Latitude
50
0
-50
00:00
08/24/05
00:00
08/25/05
1.50e-11
1.27e-11
1.03e-11
8.00e-12
5.67e-12
3.33e-12
1.00e-12

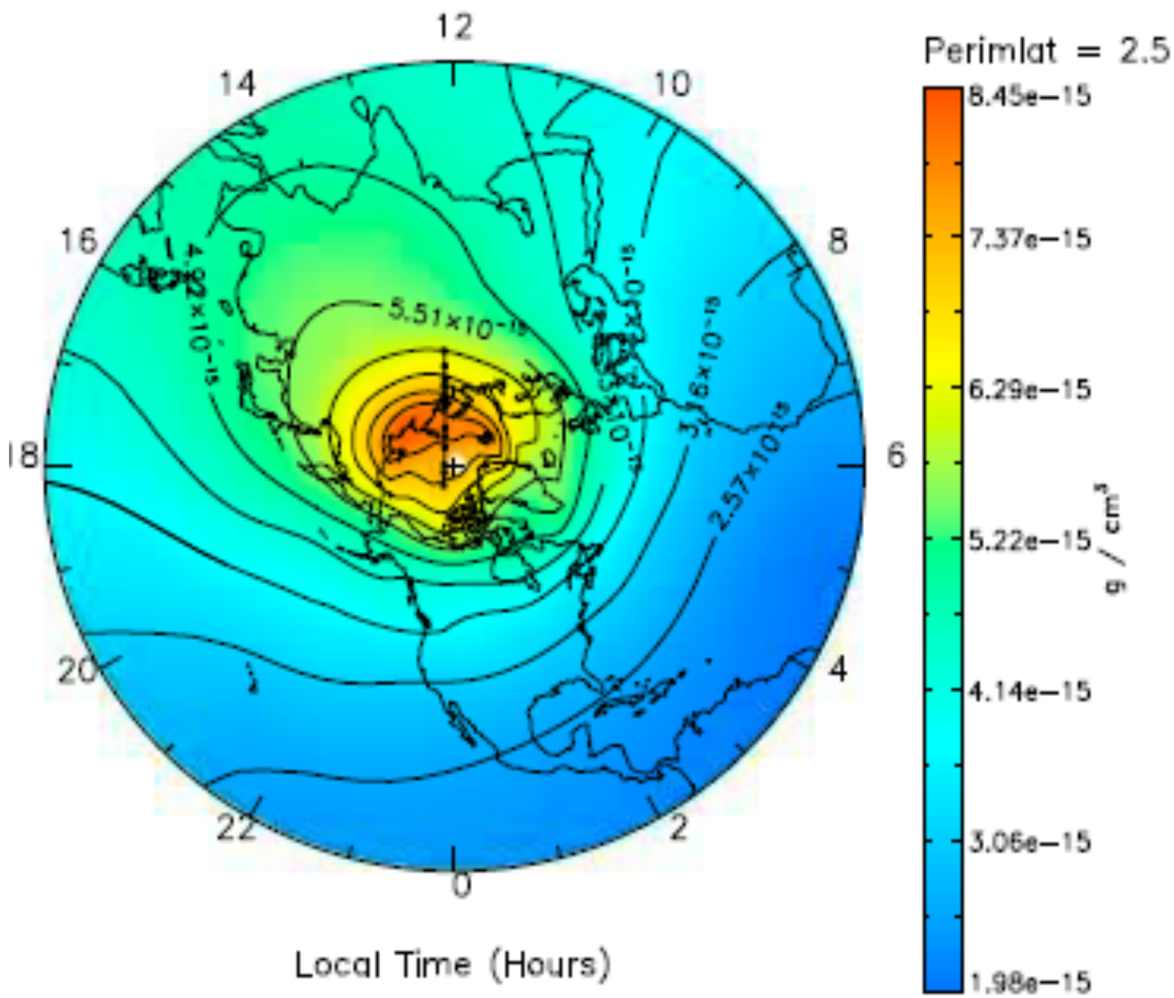
Mysterious Cusp Density Enhancements

(CHAMP, Herman Luhr)

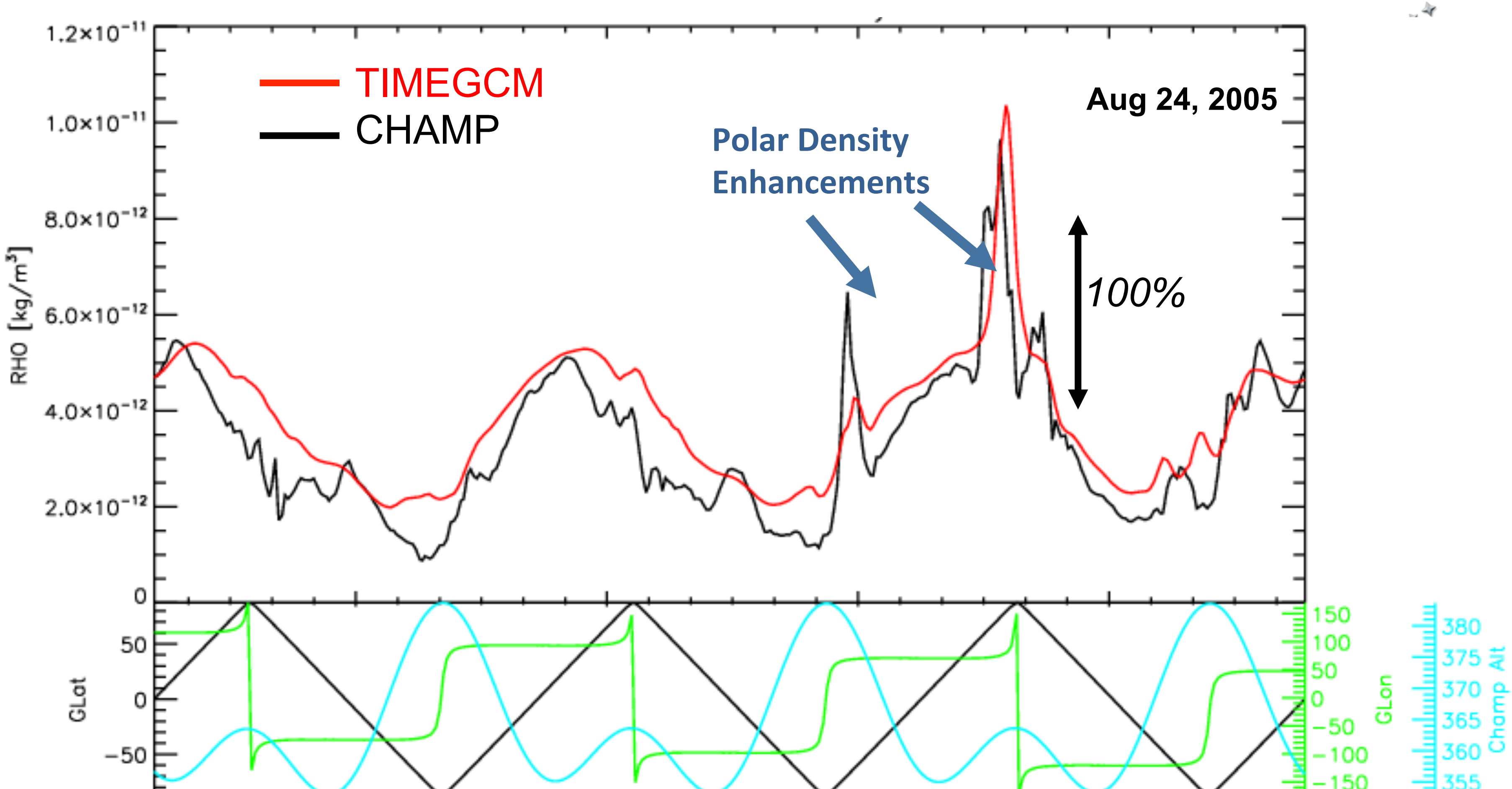


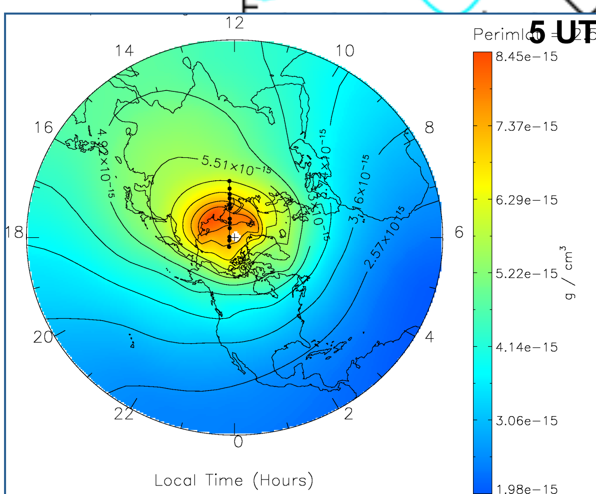
High Latitude Forcing is Crucial for Accurate Global Density Modeling

TIME-GCM Neutral Density



From Crowley et al. [2010]





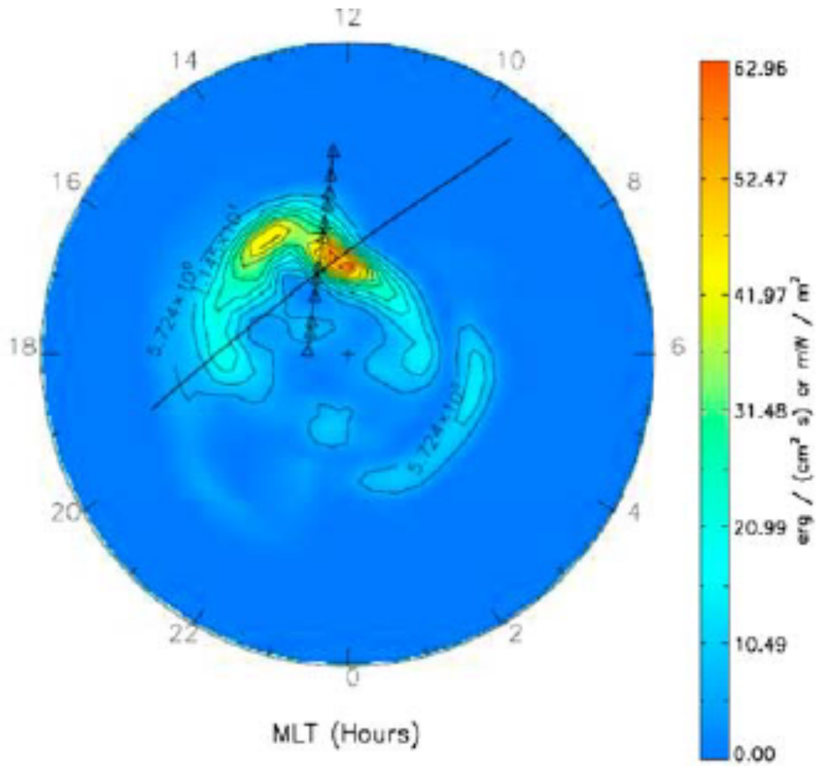
Accomplishment:

- CHAMP Density 100% enhancements near 75° (cusp)
- Unexplained for 10 yrs
- Density enhancements not captured by AF models
- First simulation of CHAMP high latitude density enhancements
- Uses high fidelity AMIE runs with TIMEGCM

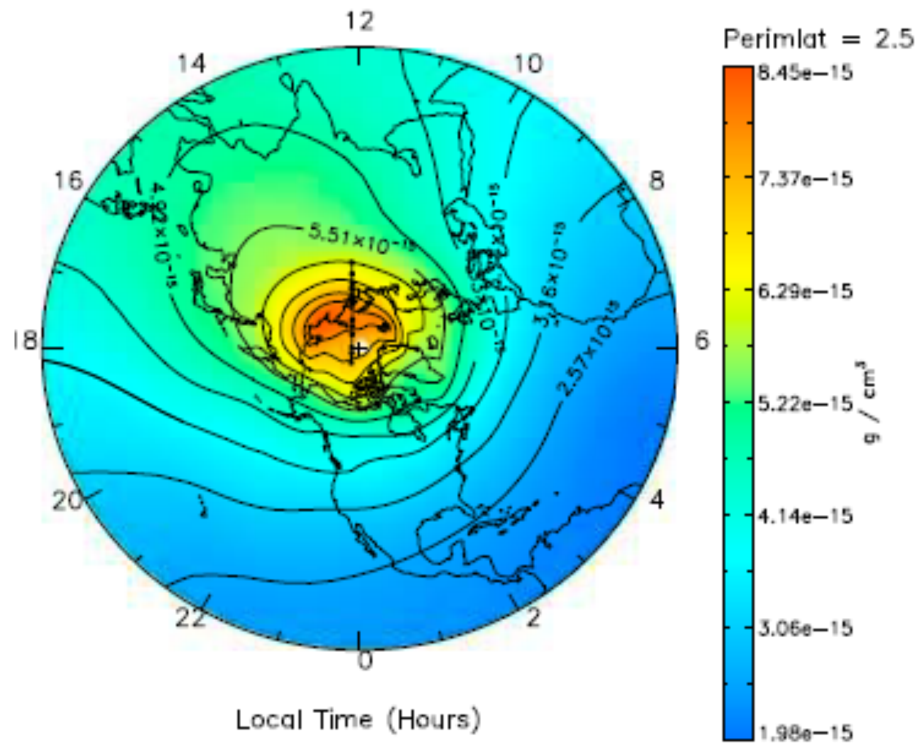
Crowley et al., Geophys. Res. Lett., 37, L07110, doi:10.1029/2009GL042143

High Latitude Forcing is Crucial for Accurate Global Density Modeling

AMIE Joule Heating (Magnetic Coords)



TIME-GCM Neutral Density (Geographic Coords)

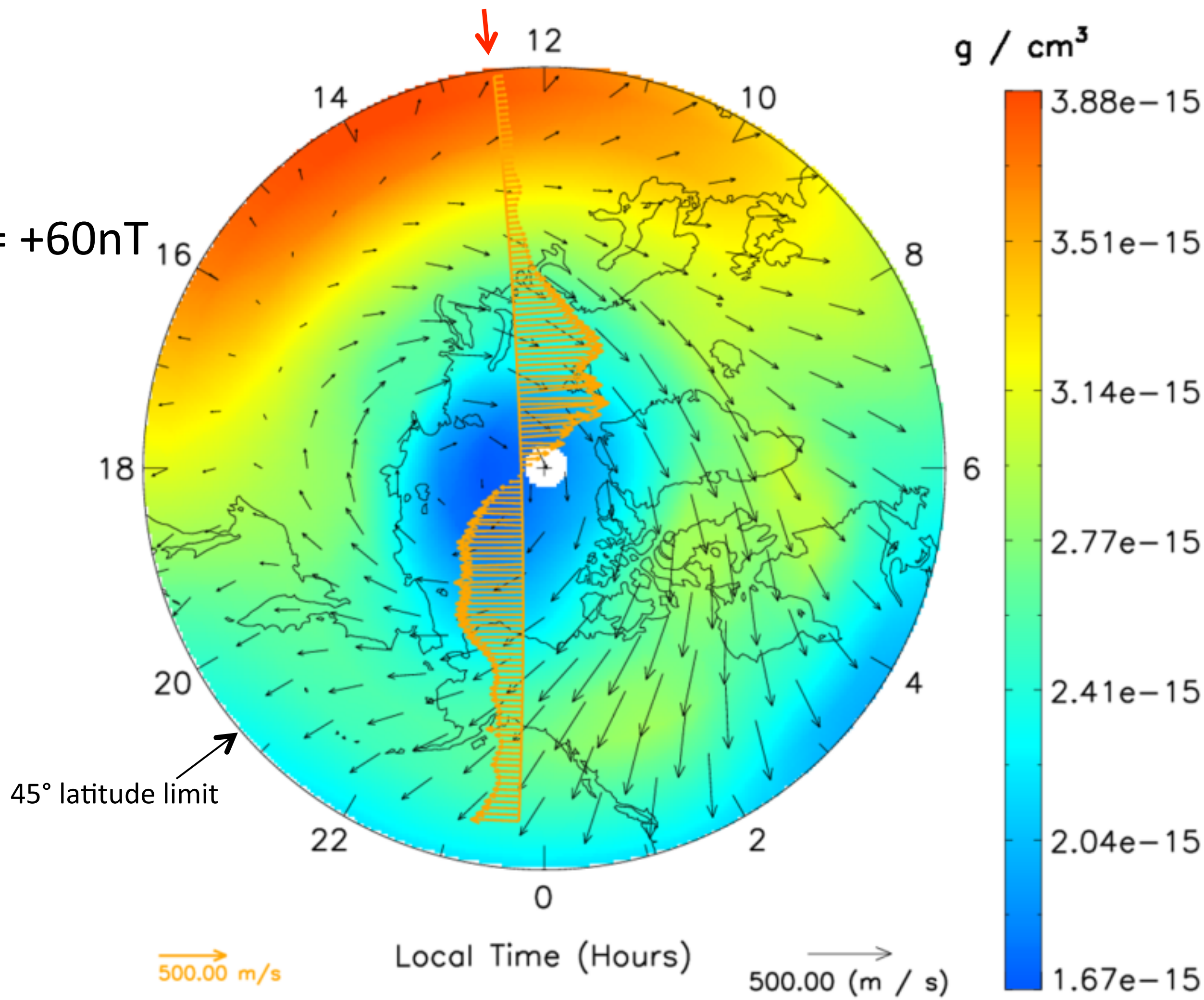


From Crowley et al. [2010]

Large Density Hole with Winds
9:20 UT, 8/24/2005

CHAMP
365 km

IMF BY = +60nT

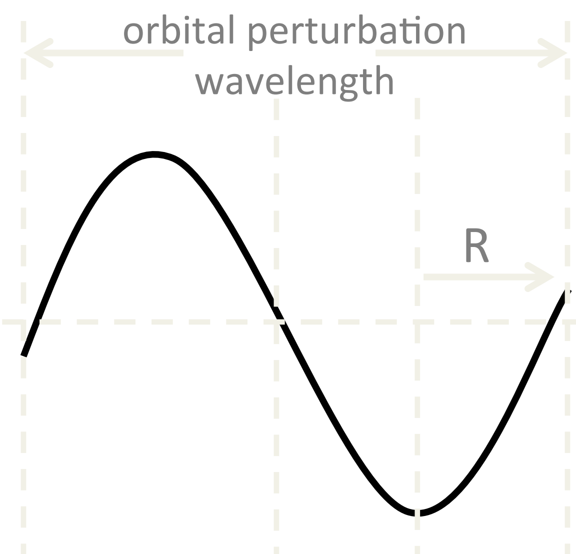


M. Pilinski, G. Crowley, E. Doornbos, R. Walterscheid

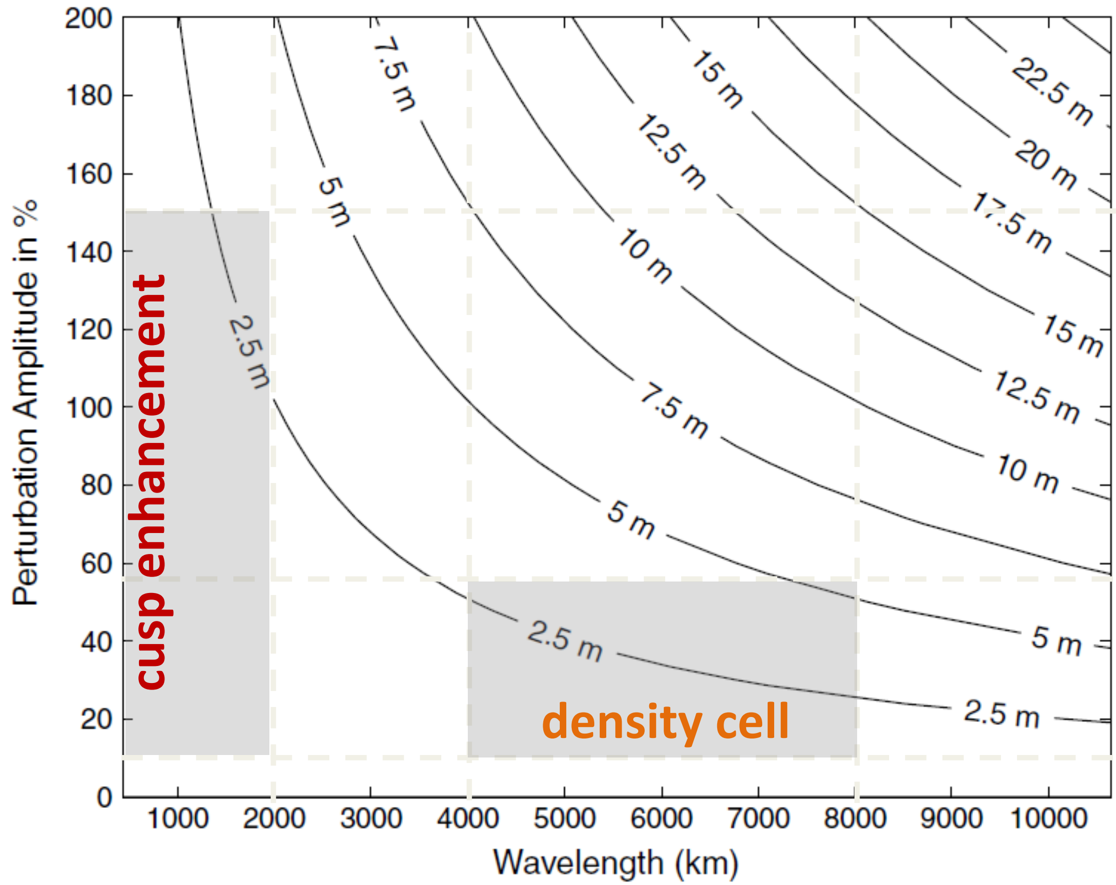
What are the effects of different scale-sizes ?
(i.e. how long do we have to integrate before we see an effect?)

From Anderson paper (400 km effect)

- Large scale perturbations can be misrepresented in empirical models
- It takes long-wavelength perturbations to cause significant position errors



R – density cell radius



[Anderson et al. 2009]

AMIE Runs Provided to CCMC

- **2006 December event**
  - **Magnetometers only**
  - **Mags + SuperDARN**
  - **Mags + SuperDARN + DMSP**

- **Other Events**
- **GEM-CEDAR events**
- 08/30 - 09/02, 2001
- 10/28 - 10/31, 2003
- 05/14 - 05/17, 2005
- 07/08 - 07/13, 2005
- 08/30 - 09/02, 2005
- 04/04 - 04/07, 2010
- 08/04 - 08/09, 2011

- **CEDAR events**
- 03/19 - 03/23, 2007
- 03/31 - 04/03, 2007
- 05/21 - 05/26, 2007
- 07/08 - 07/11, 2007
- 12/06 - 12/10, 2007
- 02/27 - 03/02, 2008

- **Recent events**
- 03/08 - 03/11, 2012
- 06/16 - 06/20, 2012
- 07/14 - 07/20, 2012
- 09/30 - 10/03, 2012
- 11/13 - 11/16, 2012

Conclusions

- To obtain 5% RHO accuracy, need First-Principles (Physics-based) Models
- Several first-principles models available

- 1st Order Inputs: High latitude inputs and Solar inputs
- 1.5th Order Inputs: Tides propagating from lower atmosphere
- Gravity waves

AMIE High Latitude Drivers:

Magnetometers
SuperDARN
DMSP
Iridium/AMPERE Magnetometers

Each group runs AMIE differently

- different background models (e.g. modified Weimer)
- different datasets included (e.g. number of magnetometers)
- different quality control programs
- need to talk about particle precipitation quantity and location

Caution is needed in comparing different high latitude forcings

Questions

ASTRA

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