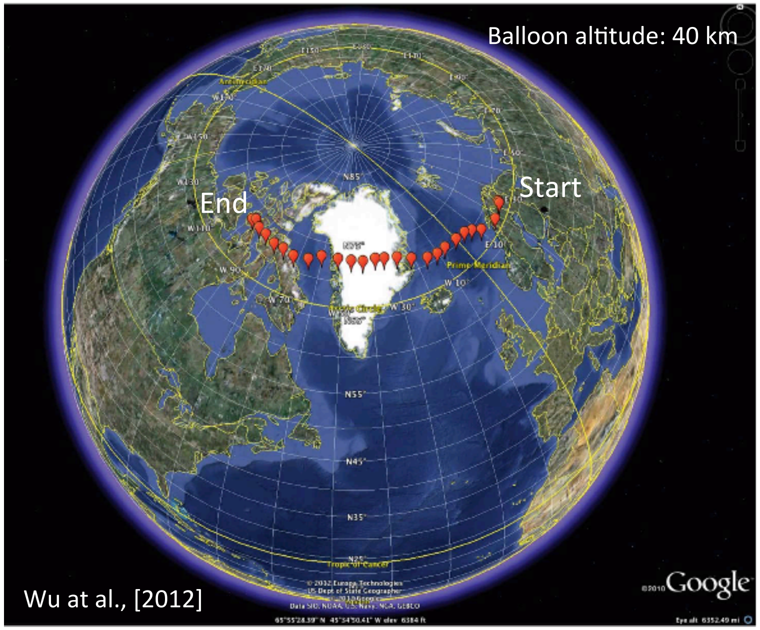
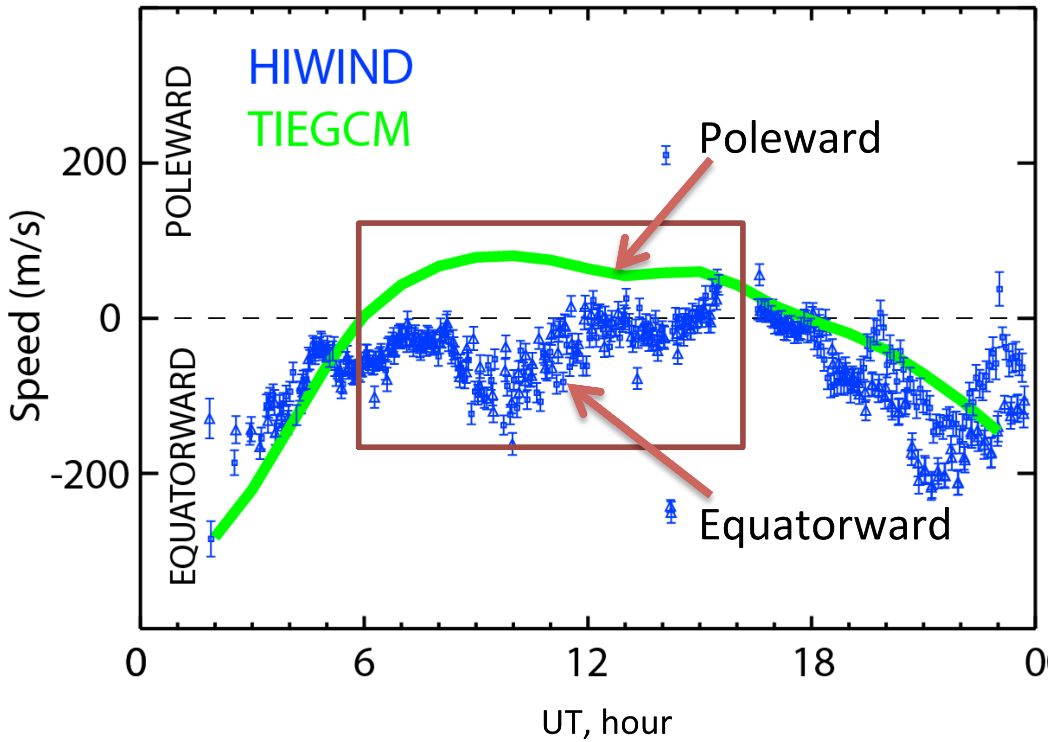
The "Unexpected" Quiet-Time Thermospheric Wind

The High Latitude Wind Balloon (HIWIND) Experiment

Balloon Trajectory



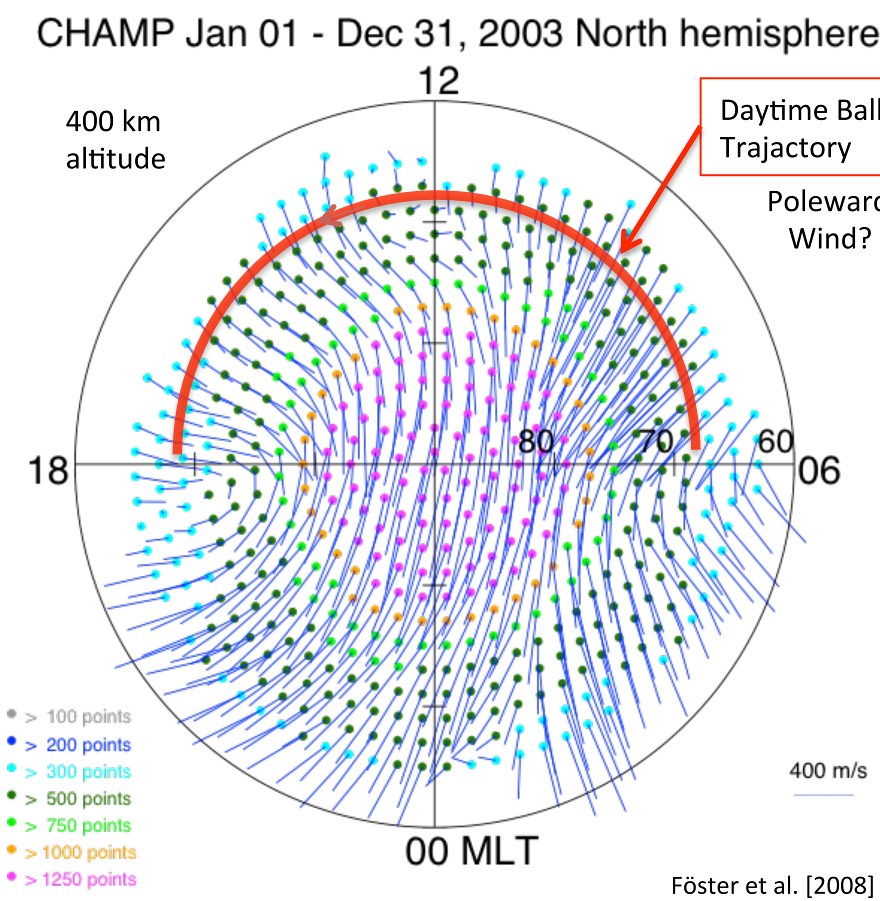
MERIDIONAL WIND ON JUN 14, 2011



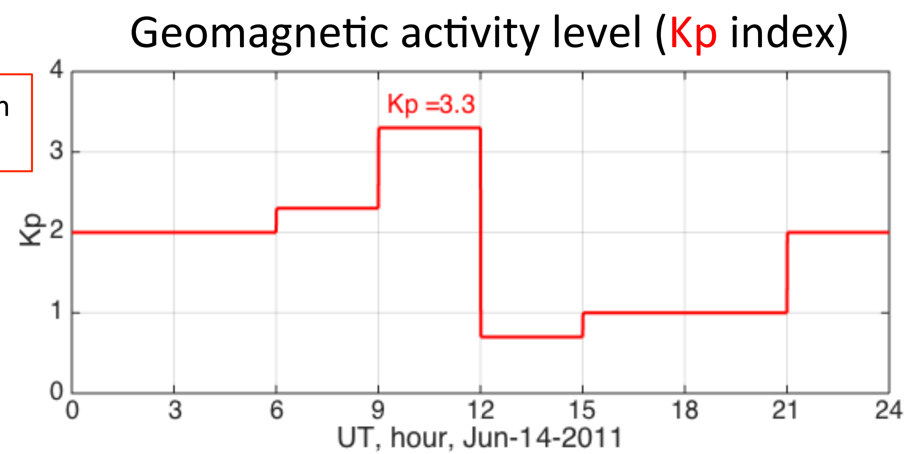
- HIWIND Balloon launched on Jun-14, 2011 in the northern hemisphere, summer time;
- The dayside thermospheric winds at 250 km altitudes were measured using FPI

Question: What drives the equatorward wind in the dayside polar region?

The "Expected" Thermospheric Wind Patterns



Statistically, upper thermospheric winds are mostly poleward on the dayside



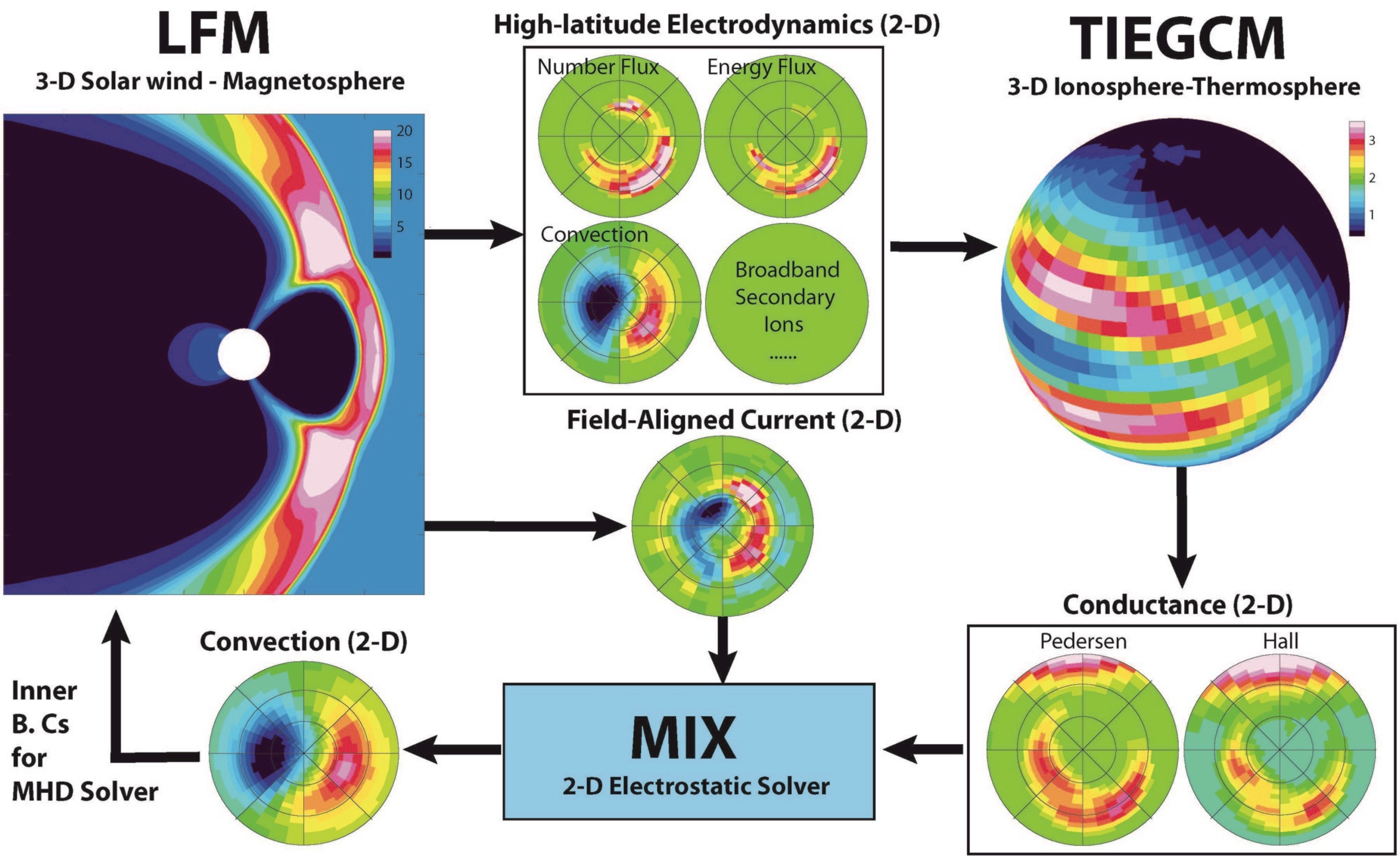
Summary of SW/IMF driving conditions

- Solar minimum conditions
- Summer time in N. hemisphere
- Average Kp = 2
- SW velocity around 450 km/s
- IMF By ~ +5 nT
- IMF Bz mostly northward (little SW-M coupling – not much energy input)

Question: Can CMIT reproduce the observed equatorward?

The Coupled M-I-T (CMIT) Model

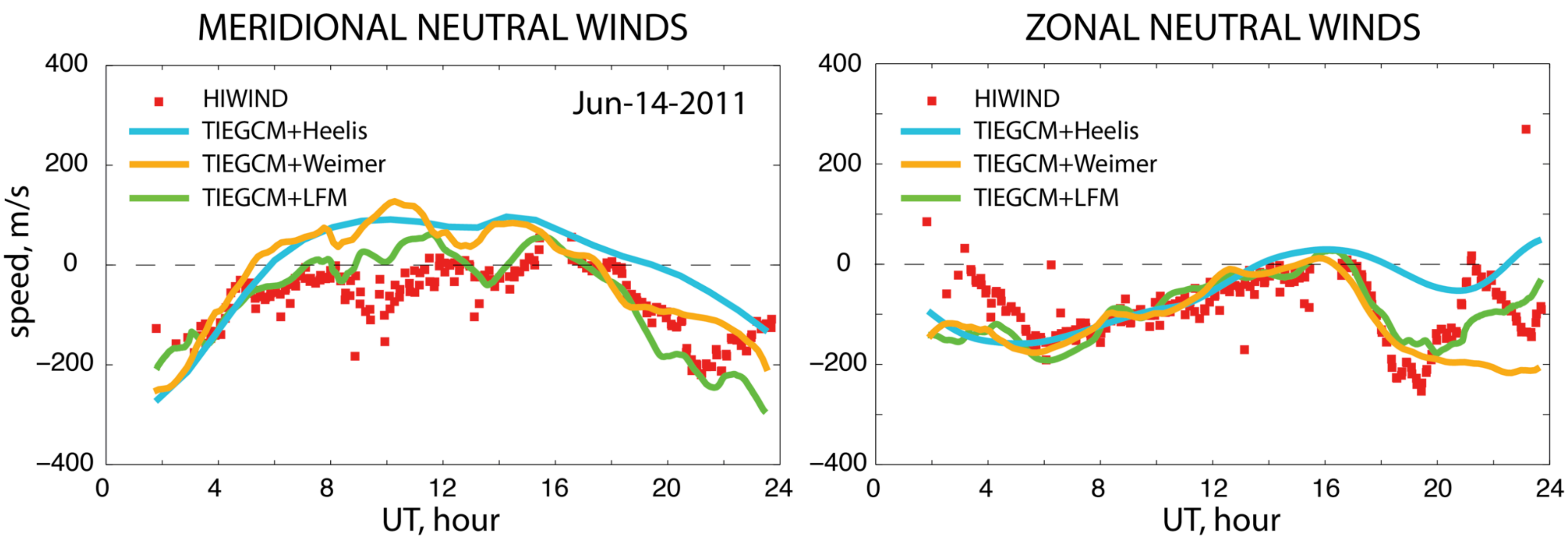
Coupling LFM with TIEGCM



CMIT is now a community model available at NASA-CCMC

Simulated Neutral Winds in TIEGCM

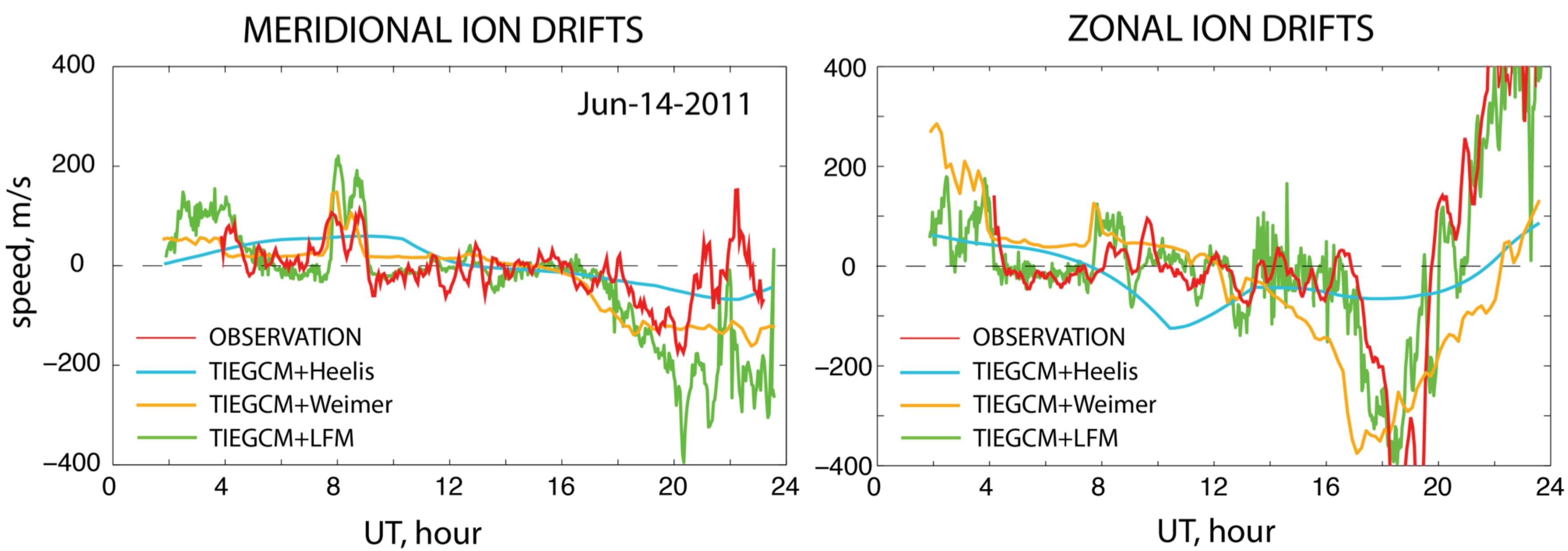
TIEGCM driven by Heelis, Weimer and LFM



- The TIEGCM+Heelis and TIEGCM+Weimer show poleward wind between 6-18 UT;
- The TIEGCM+LFM exhibits equatorward wind between 6-8 UT and 12-15 UT;
- The TIEGCM+LFM shows the best agreement with HIWIND data among the three runs;
- Zonal neutral winds are not significantly influenced by high-latitude forcing (6-16 UT);
- Evident discrepancy still exists in the TIEGCM+LFM simulation between 9-12 UT, could be possibly related to the additional heating mechanism.

Simulated Ion Drifts in TIEGCM

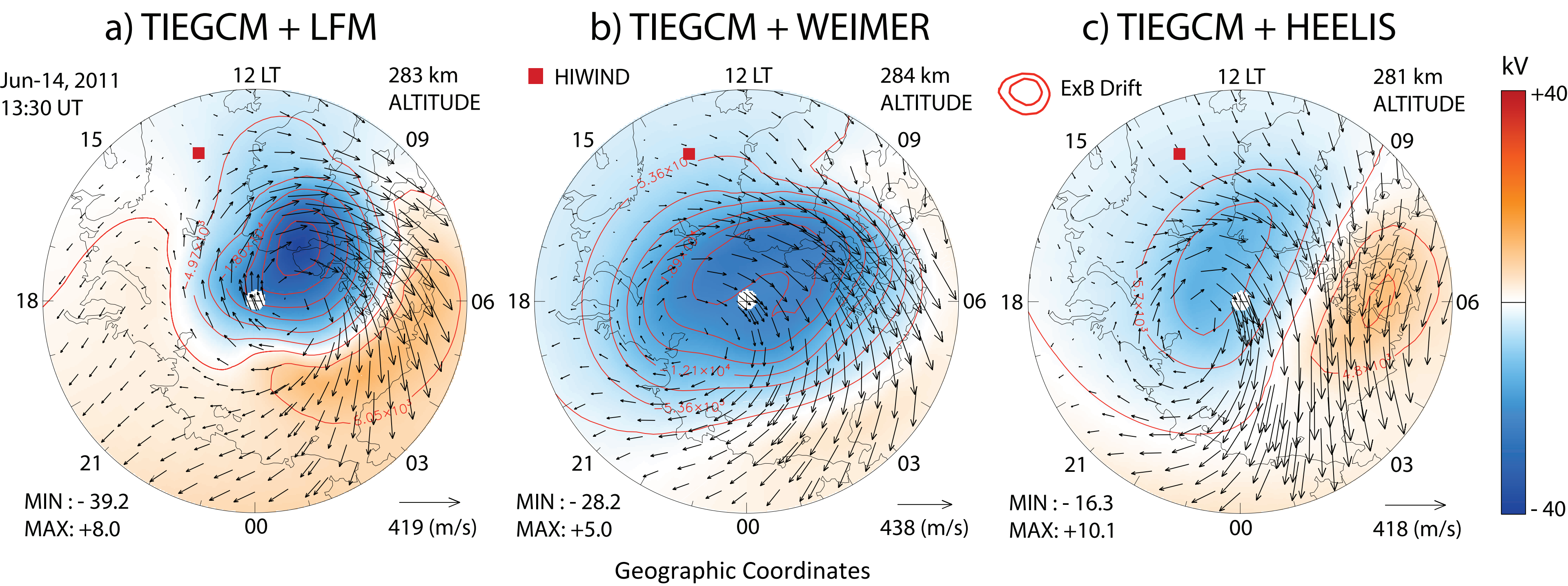
TIEGCM driven by Heelis, Weimer and LFM



- The TIEGCM+Heelis shows little variations in ion drift (kp-driven);
- The TIEGCM+Weimer shows good agreement with data (IMF-driven); but the temporal variation is smeared (15-min average input) especially during night time;
- The TIEGCM+LFM shows the best agreement with ion drift data among the three runs; however, the magnitude in the auroral zone might be overestimated (Bz-driven);
- Overall, LFM possibly provides more realistic ion drifts among the three simulations.

The Impacts of High-latitude driving

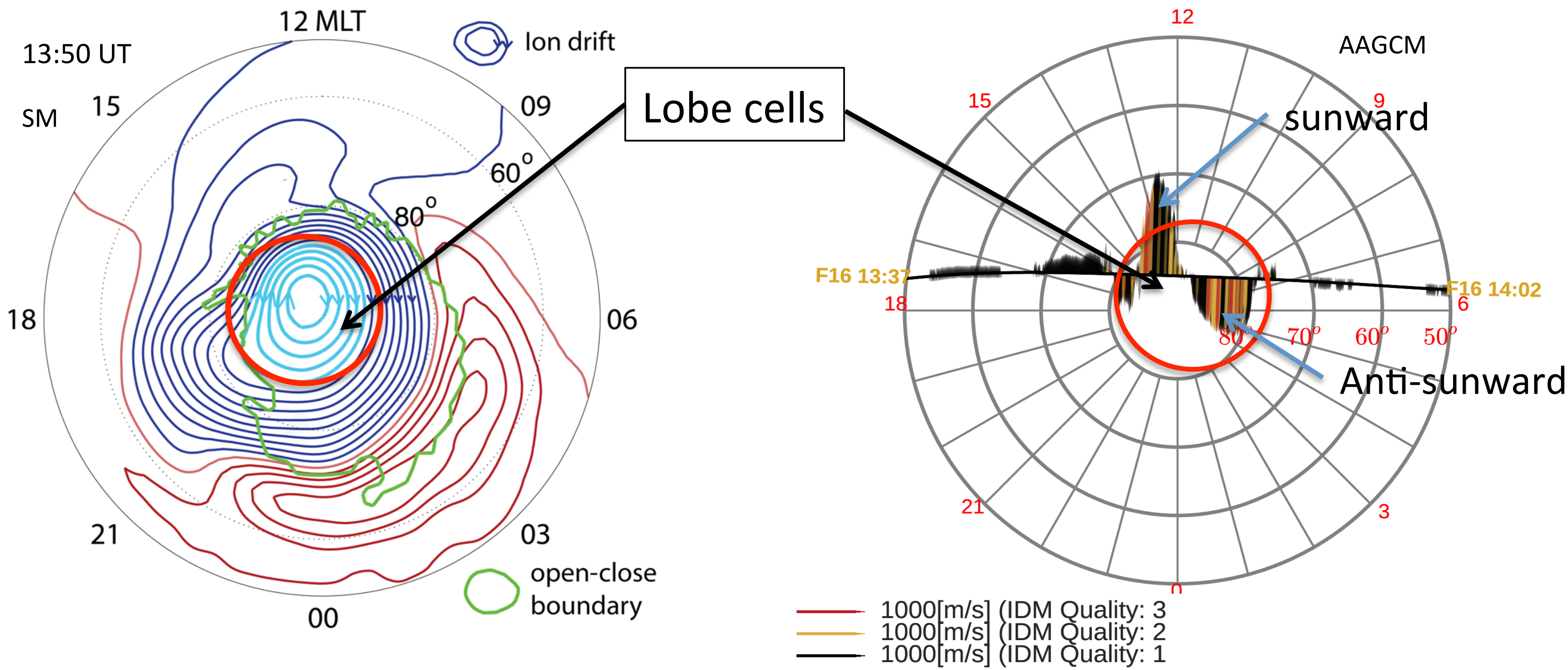
Empirical versus Physics-based convection during By+ period



- The TIEGCM+Heelis and TIEGCM+Weimer show poleward wind in the noon sector;
- The LFM convection pattern shows the formation of a lobe cell on the dayside;
- The Weimer convection pattern is similar to LFM with much larger spatial extensions;
- The Heelis convection pattern always shows two-cell convection regardless of IMF By;
- The TIEGCM+LFM simulation exhibits equatorward wind in the noon sector;

Data-model Comparison on ion drift

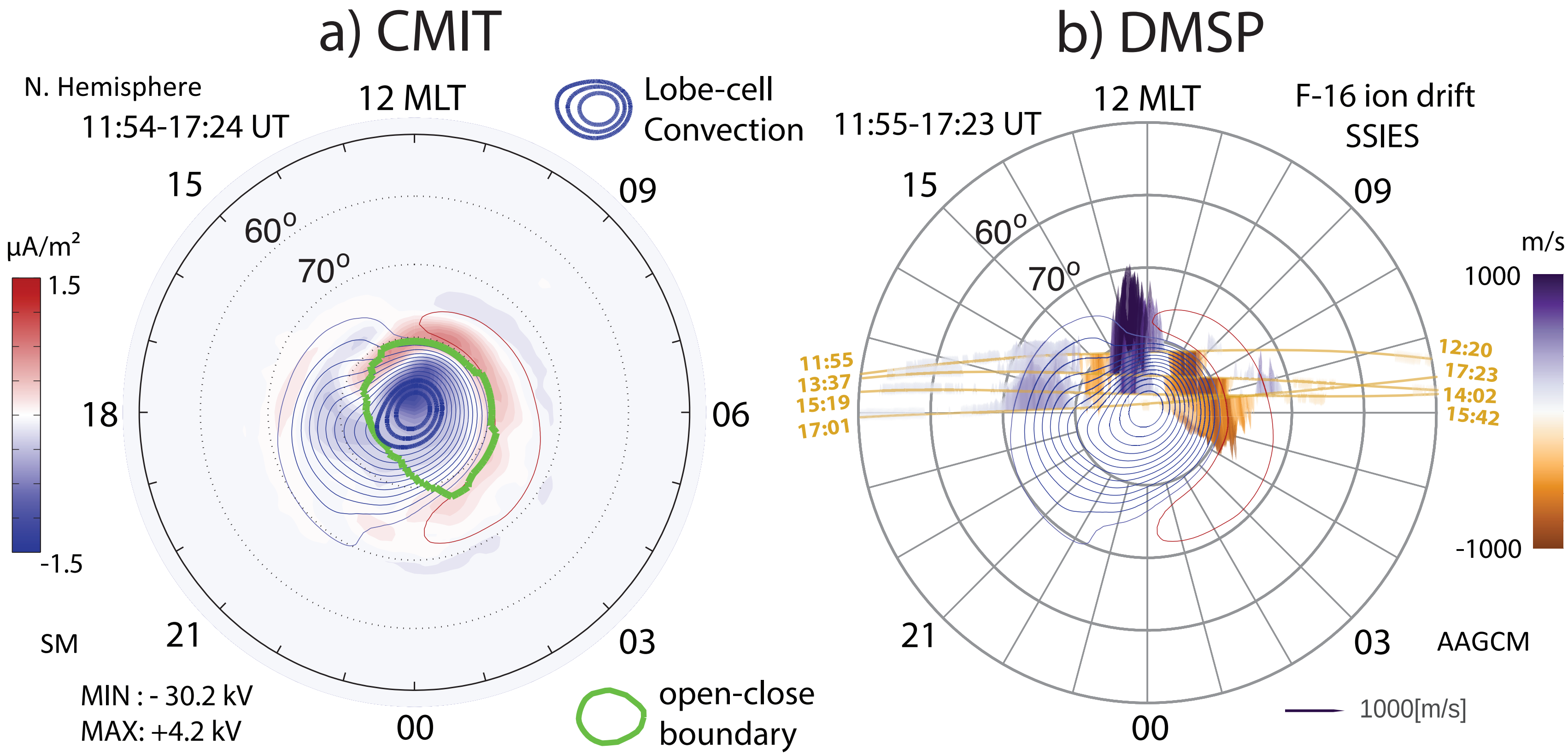
CMIT at 13:50 UT　　　　　AAGCM　　　　　One DMSP-F16 pass, 13:24-14:02 UT



SW-M-I-T coupling loop

Solar Wind IMF By+, Bz+ → Magnetospheric Lobe Cell → Ionospheric Sunward Convection → Thermospheric equatorward wind

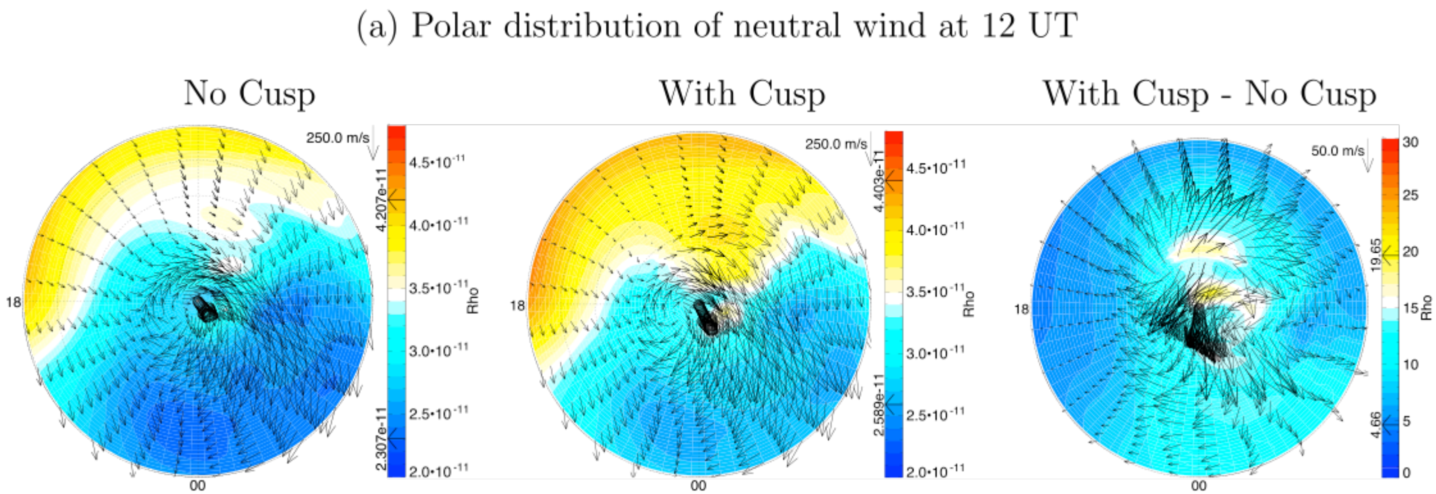
Lobe-cell convection between 12-18 UT



- SSIES data from F16 passes show sunward plasma drift in the dayside polar cap, suggesting the possible existence of magnetospheric lobe cells between 12-18 UT, Jun-14-2011
- The spatial extensions of the sunward convection on the dusk side is less than the anti-sunward convection on the dawn side, consistent with simulated lobe-cells in CMIT driven by IMF By+
- DMSP satellites also show intense, small-scale electromagnetic and particle energy that are not included in the CMIT simulation (may explain the discrepancy between 8-12 UT)

Cusp Heating Mechanisms

Sheng et al. [2015], GITM simulations w/ fixed cusp



Cusp Location

3° LAT centered at 73.5 N
6-hour LT Centred at 12 LT

Cusp Heating

20 mW/m² Poynting flux
1 mW/m² soft electron flux

High-latitude driving

Weimer empirical model

With the additional energy specified near the polar cusp region, GITM does show promising results of reproducing the observed equatorward wind on the dayside. Future investigations are need to justify the source location and determine the amount of energy deposition in the cusp region for this event.