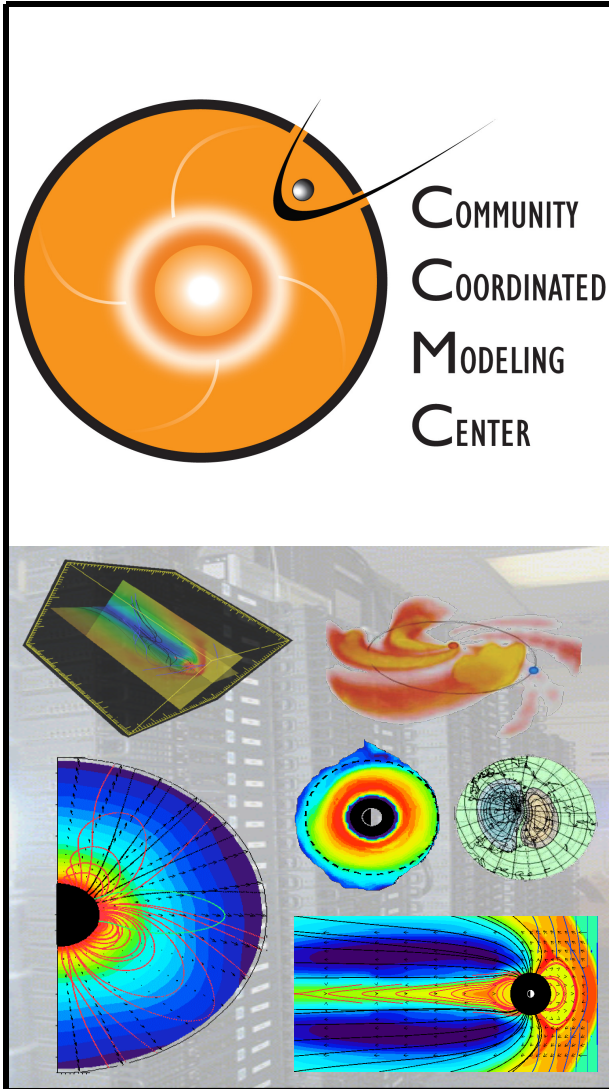


CEDAR ETI Challenge



CCMC : J. Shim, M. Kuznetsova, L. Rastätter, M. Hesse, A. Chulaki, and A. Pulkkinen

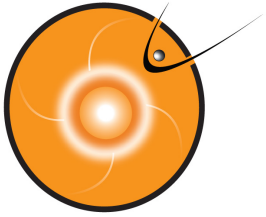
Modelers : D. Bilitza, M. Codrescu, B. Emery, B. Foster, T. Fuller-Rowell, J. Huba, A. Ridley, R. Schunk, D. C. Thompson

Data providers : D. Anderson, J. Chau, J. M. Forbes, J. Sojka, E. Sutton, B. Rideout

<http://ccmc.gsfc.nasa.gov>

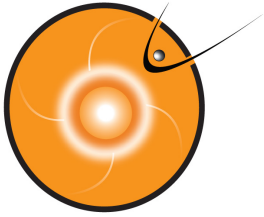
NASA Goddard Space Flight Center





Overview

- Challenge Setup
 - Events
 - Physical parameters
 - Model Submissions
 - Results
 - Summary
-



Challenge Setup : Events

GEM storms

- E.2006.348: 2006/12/14(doy 348) 12:00 UT - 12/16 (doy 350) 00:00 UT (Kp_max = 8)
- E.2001.243: 2001/08/31(doy 243) 00:00 UT - 09/01 (doy 244) 00:00 UT (Kp_max = 4)
- E.2005.243: 2005/08/31 (doy 243) 10:00 UT - 09/01 (doy 244) 12:00 UT (Kp_max = 7)

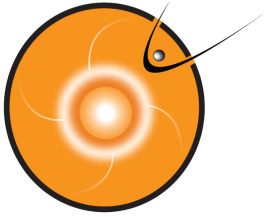
Year of incoherent scatter radar (ISR) observations from 2007/03/01 (doy 060) – 2008/03/31 (doy 091)

Moderate storms

- E.2007.091: 2007/04/01 (doy 091) 00:00 UT - 04/02 (doy 092) 12:00 UT (Kp_max = 5)
- E.2007.142: 2007/05/22 (doy 142) 12:00 UT - 05/25 (doy 145) 00:00 UT (Kp_max = 5.7)
- E.2008.059: 2008/02/28 (doy 059) 12:00 UT - 03/01 (doy 061) 12:00 UT (Kp_max = 5.3)

Quiet periods

- E.2007.079: 2007/03/20 (doy 079) 00:00 UT - 03/22 (doy 081) 00:00 UT (Kp_max = 0.7)
 - E.2007.190: 2007/07/09 (doy 190) 00:00 UT - 07/10 (doy 191) 00:00 UT (Kp_max = 0.3)
 - E.2007.341: 2007/12/07 (doy 341) 00:00 UT - 12/09 (doy 343) 00:00 UT (Kp_max = 1.0)
-



Challenge Setup : Physical Parameters

1. Vertical and horizontal drifts at Jicamarca (V_{perpN} and V_{perpE})
2. Neutral density at CHAMP orbit (N_{den})
3. Electron density at CHAMP orbit (E_{den})
4. NmF2 from LEO satellites (CHAMP and COSMIC) and ISRs
5. HmF2 from LEO satellites (CHAMP and COSMIC) and ISRs

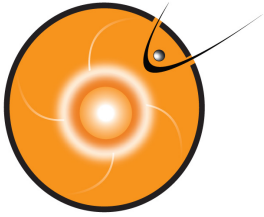
Millstone Hill (42.62 N, 288.51 E)

EISCAT Svalbard (78.09 N, 16.02 E)

Poker Flat (65.13 N, 212.53 E)

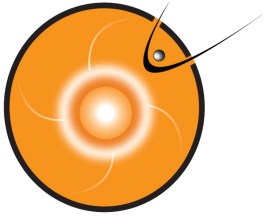
Sondrestrom (66.99 N, 309.05 E)

6. Global TEC
-



Measurements

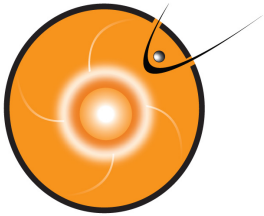
- Vertical and horizontal drifts at Jicamarca (VperpN and VperpE):
 - Vertical Drifts obtained from Jicamarca-Piura dH Magnetometer measurements
 - Vertical and horizontal drifts from the 150-km echoes measured by the 50 MHz JULIA radar
 - Neutral density at CHAMP orbit (Nden)
 - : Estimated values obtained using accelerometer measurements from the CHAMP
(Univ. of Colorado, <http://sisko.colorado.edu/sutton/index.html>)
 - Electron density at CHAMP orbit (Eden)
 - : PLP (Planar Langmuir Probe Data) measurements from CHAMP
(GFZ German Research Centre for Geosciences, <http://isdc.gfz-potsdam.de/user.php>)
 - NmF2 from LEO satellites (CHAMP and COSMIC) and ISRs
 - HmF2 from LEO satellites (CHAMP and COSMIC) and ISRs
 - Millstone Hill (42.62 N, 288.51 E)
 - EISCAT Svalbard (78.09 N, 16.02 E)
 - Poker Flat (65.13 N, 212.53 E)
 - Sondrestrom (66.99 N, 309.05 E)
-



Model Submissions

Model Setting ID	Model Description
1_SAMI3_HWM07	SAMI3_MPI-1.68+HWM07; resolution: 120 (lat) x 160 (alt) x 90 (lon)
1_SAMI3_HWM93	SAMI3_MPI-1.68+HWM93; resolution: 120 (lat) x 160 (alt) x 90 (lon) (for $-60 < \text{magnetic latitude} < 60$, $90\text{km} < \text{altitude} < 20,000 \text{ km}$)
1_TIE-GCM*	TIE-GCM1.92; Heelis electric potential model at high latitudes at high latitudes above a critical co-latitude
2_TIE-GCM	TIE-GCM1.93; Weimer electric potential model at high latitudes, dynamic critical co-latitudes, constant eddy diffusion coefficient at the lower boundary
3_TIE-GCM	TIE-GCM1.93; Weimer electric potential model, dynamic critical co-latitude, seasonally variable eddy diffusion coefficient at the lower boundary
1_CTIPe*	
1_USU-IFM*	
1_USU-GAIM*	
1_IRI	IRI-2007
1_GITM	

* Runs performed at the CCMC



Metrics Examples

- Metrics based on RMS

Model Skill Score :

$$\left(1 - \frac{\text{Model Score}}{\text{Reference Model Score}}\right)$$

Model Score against the observation :

$$\sqrt{\frac{\sum (x_{obs} - x_{mod})^2}{N}}$$

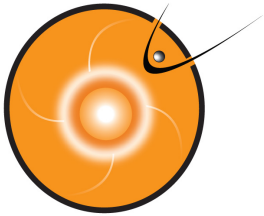
Reference Model : IRI-2007, NRLMSISe00

- > 0 : better than reference model,
- < 0 : worse than reference model

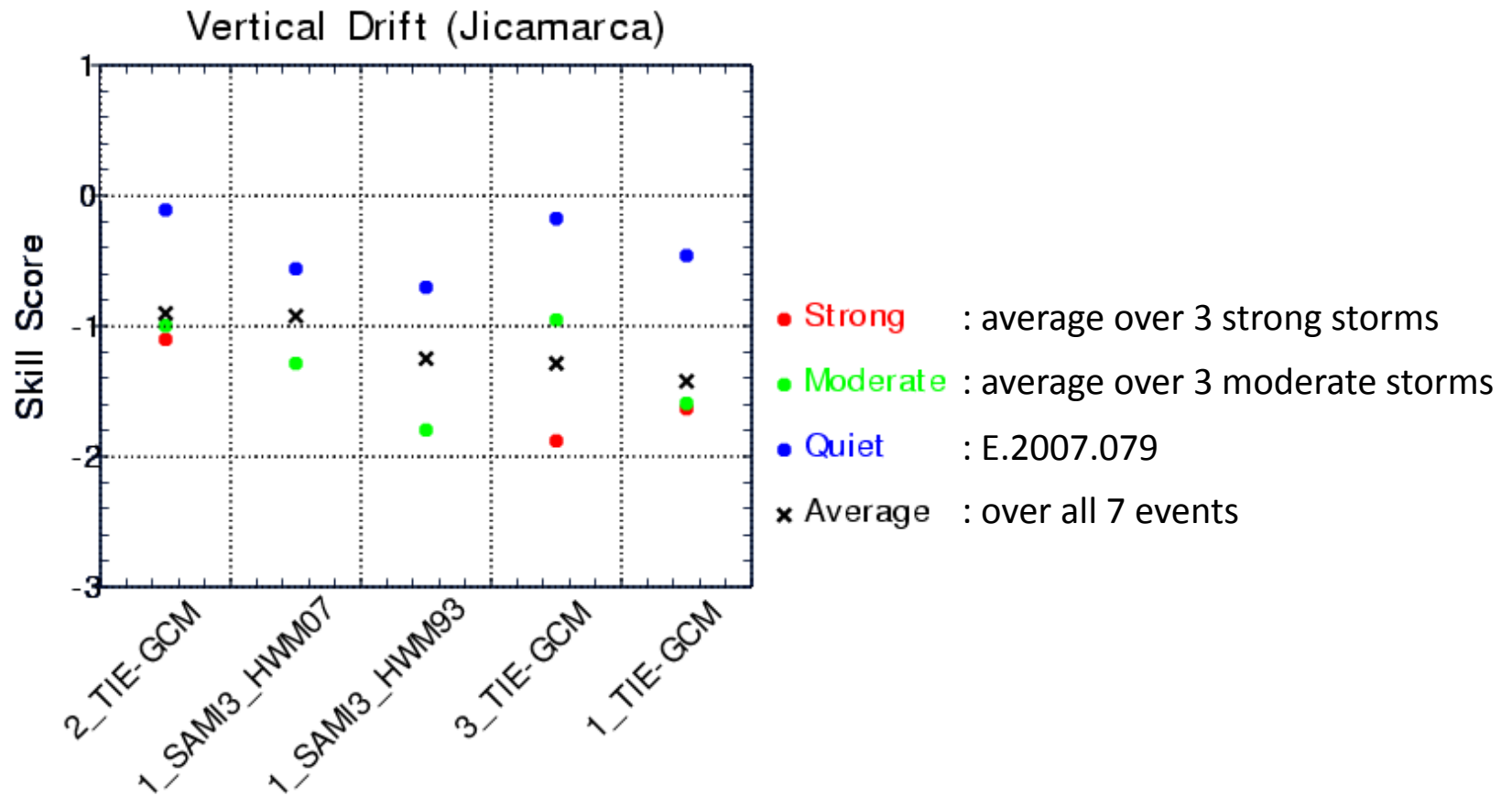
- Metrics based on ratio of the difference between maximum and minimum values during an event:

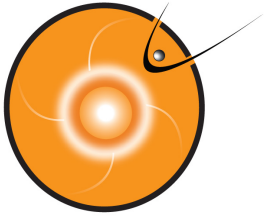
$$\frac{(x_{mod})_{\max} - (x_{mod})_{\min}}{(x_{obs})_{\max} - (x_{obs})_{\min}}$$

- > 1 : over estimate,
 - < 1 : under estimate
-

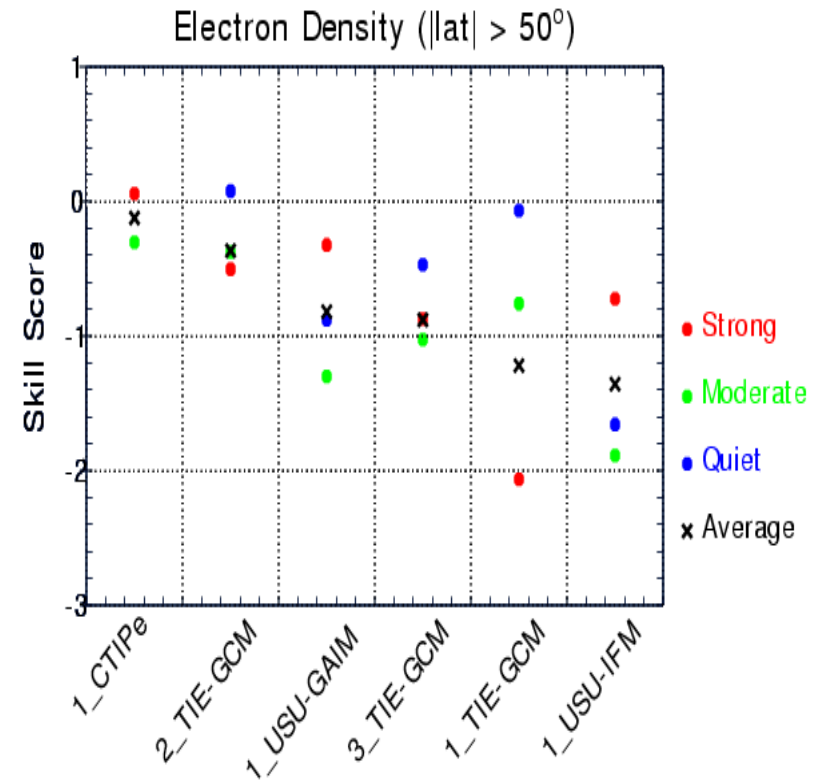
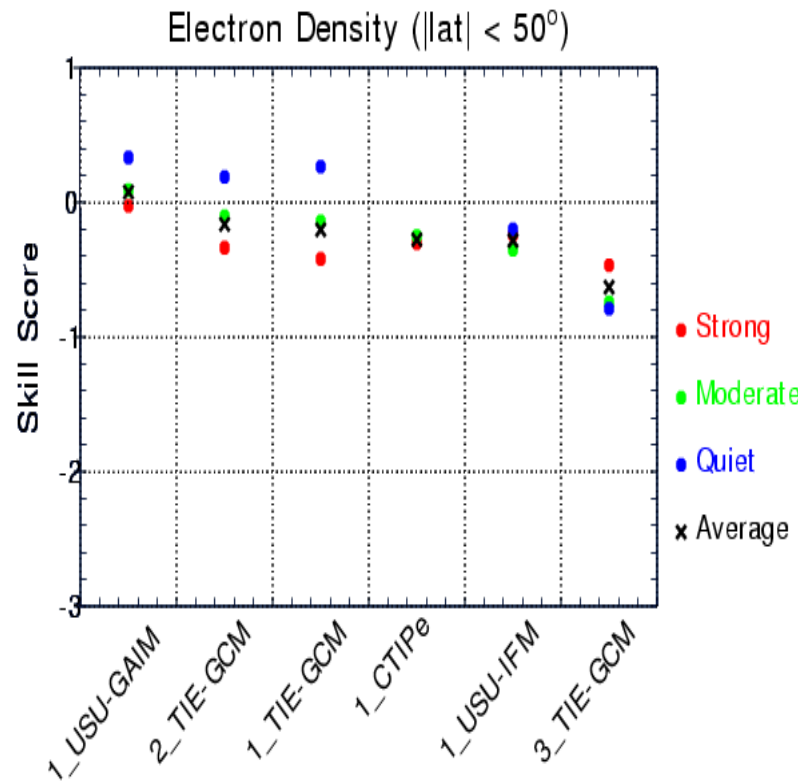


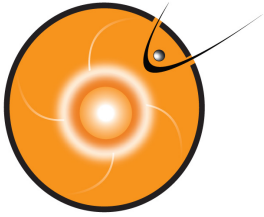
Vertical Drift



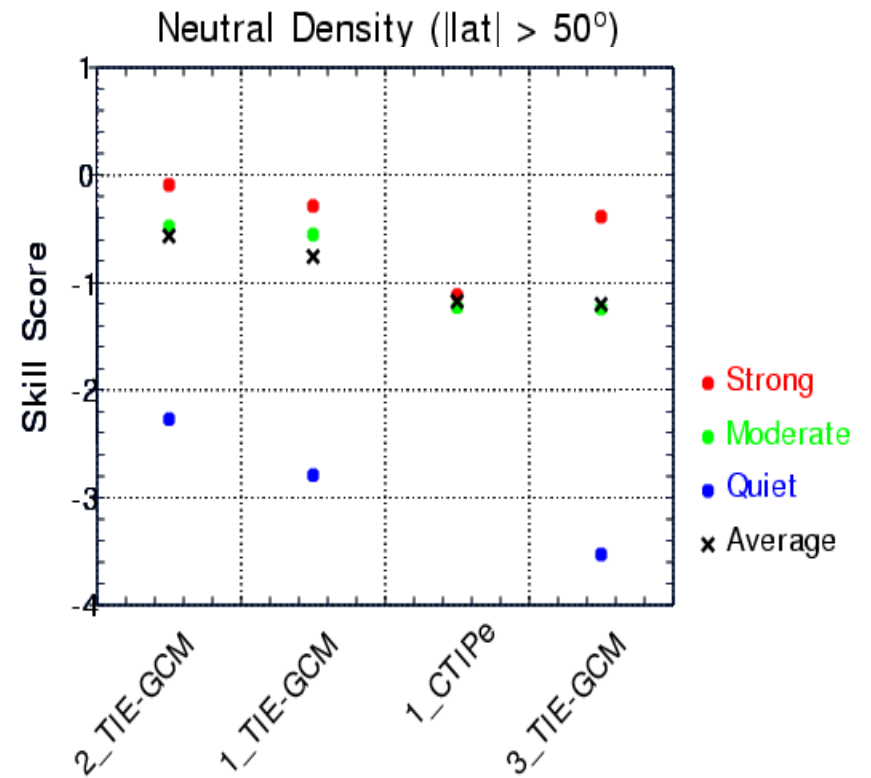
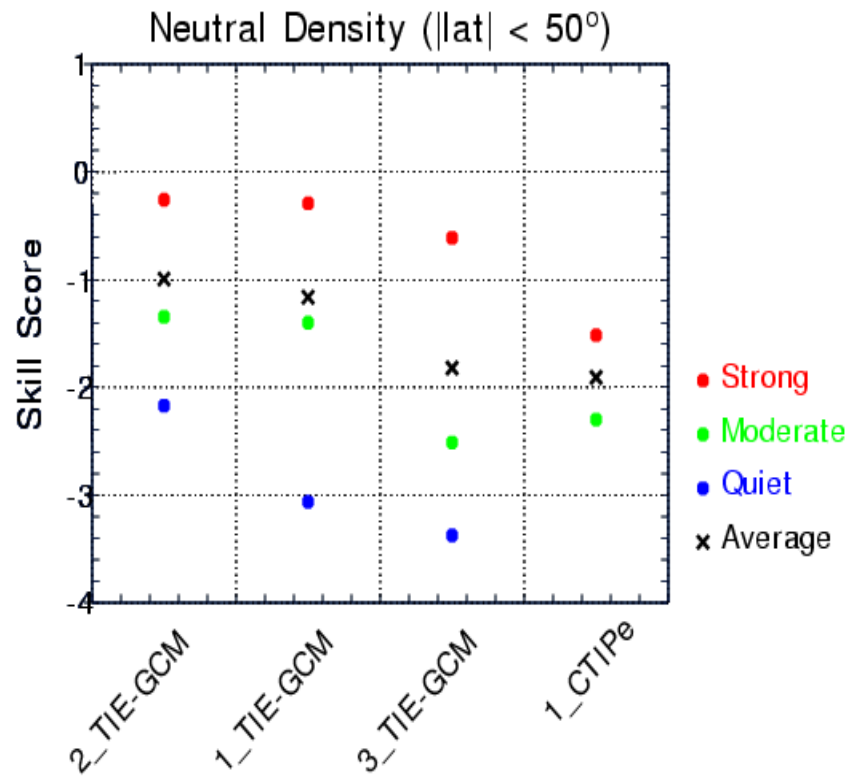


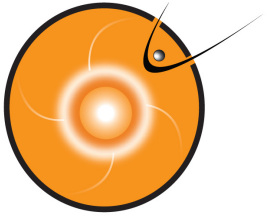
Electron Density



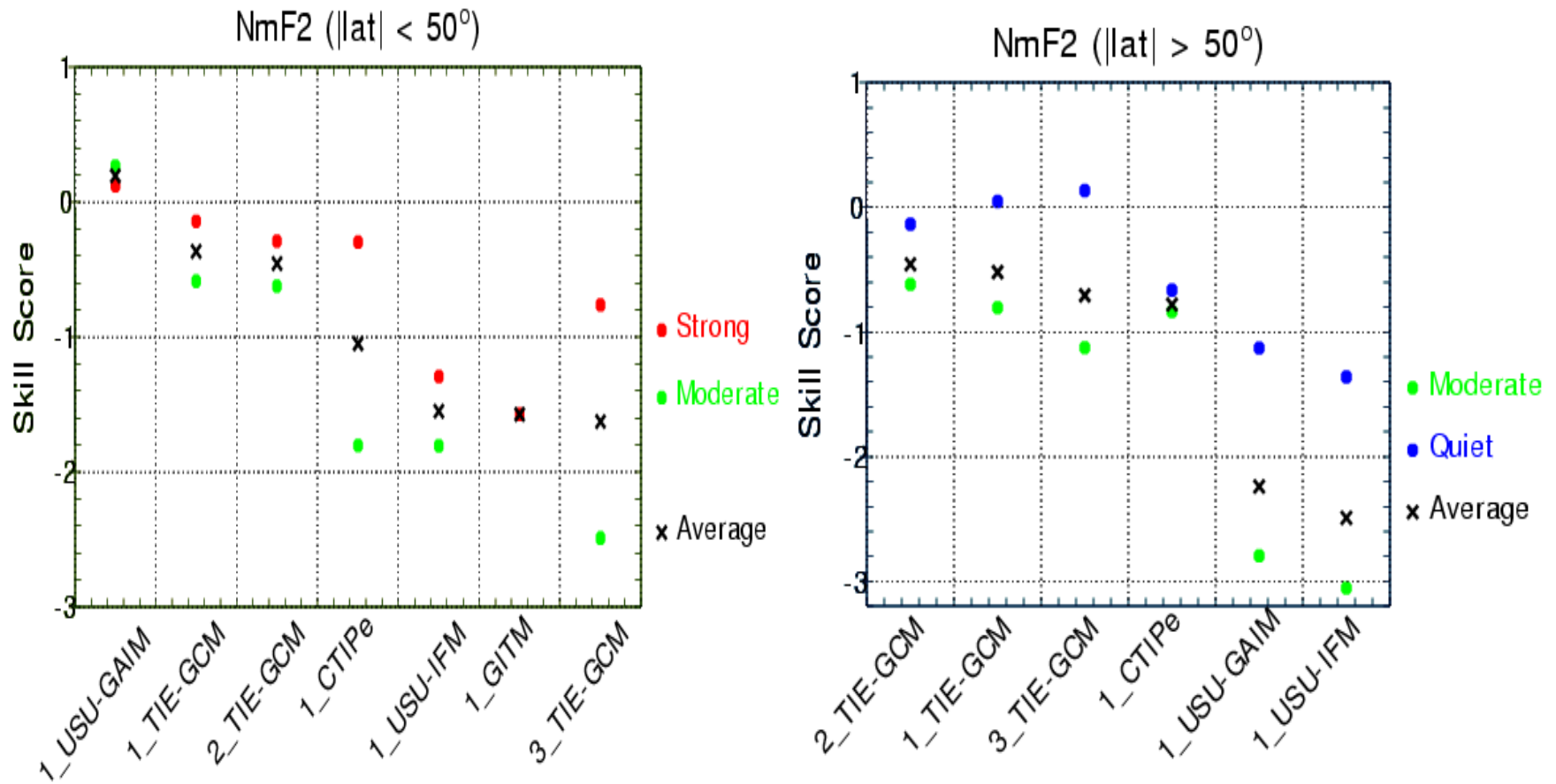


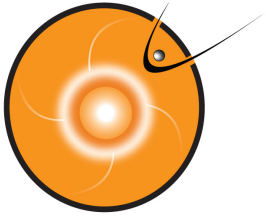
Neutral Density



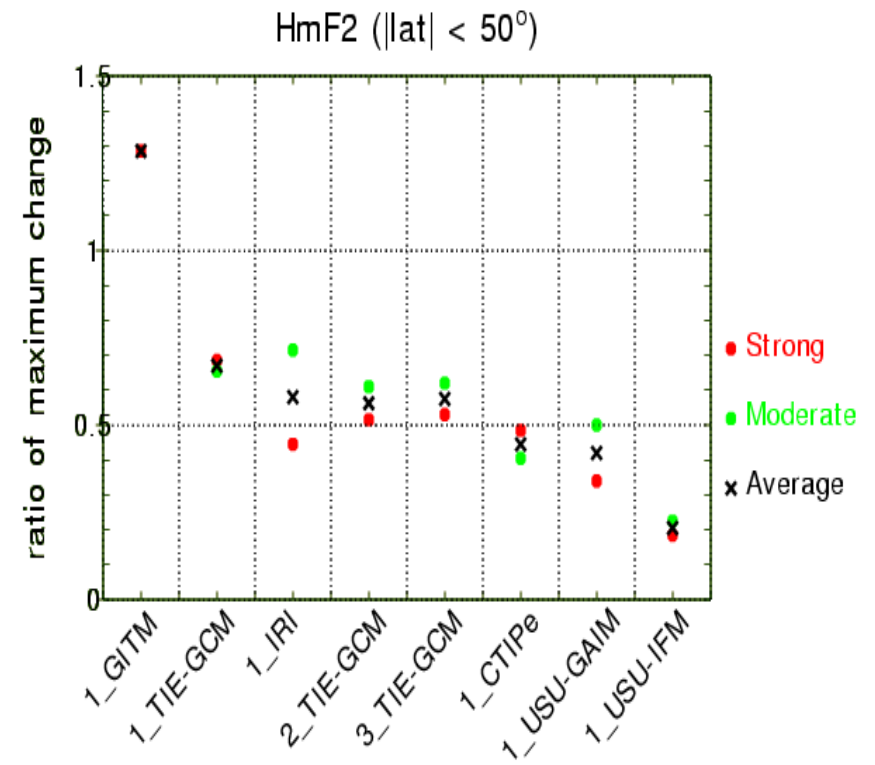
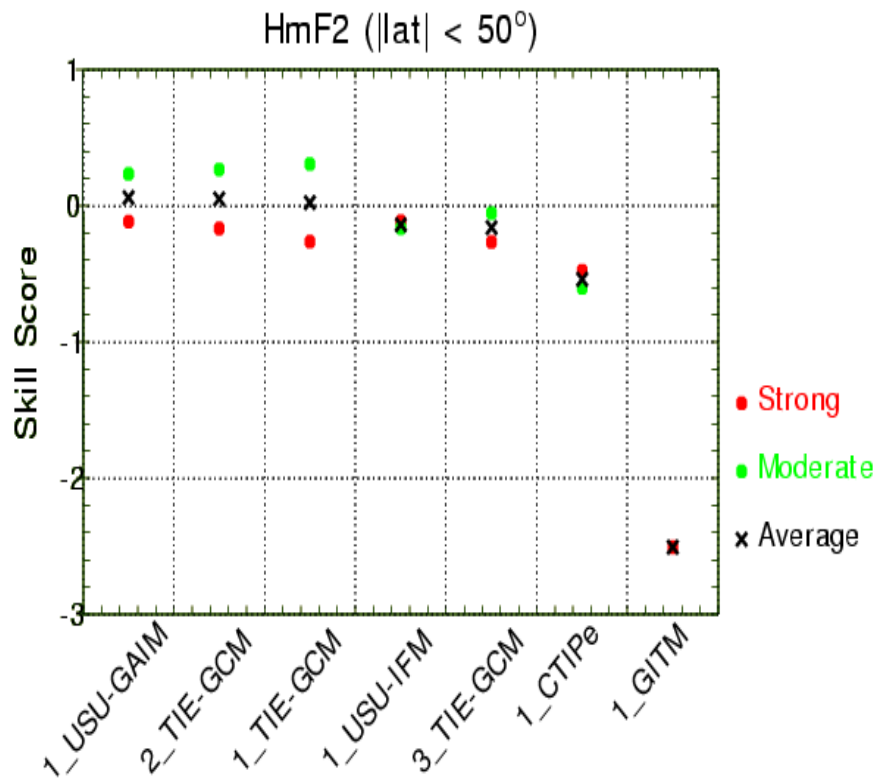


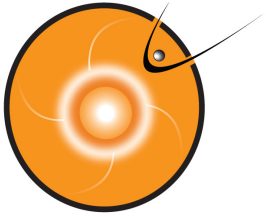
NmF2



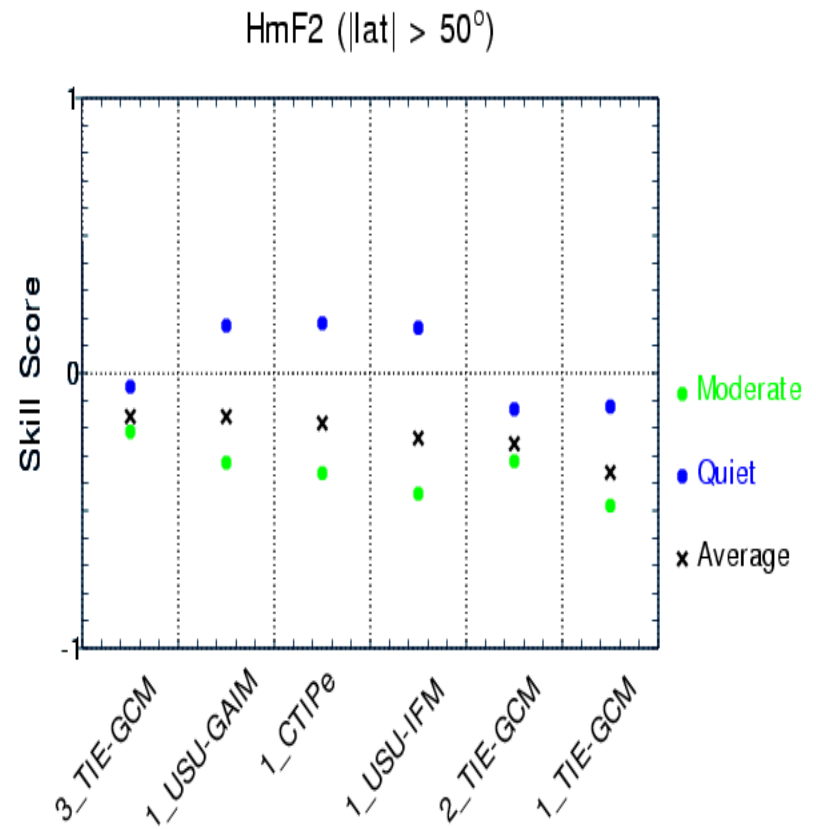
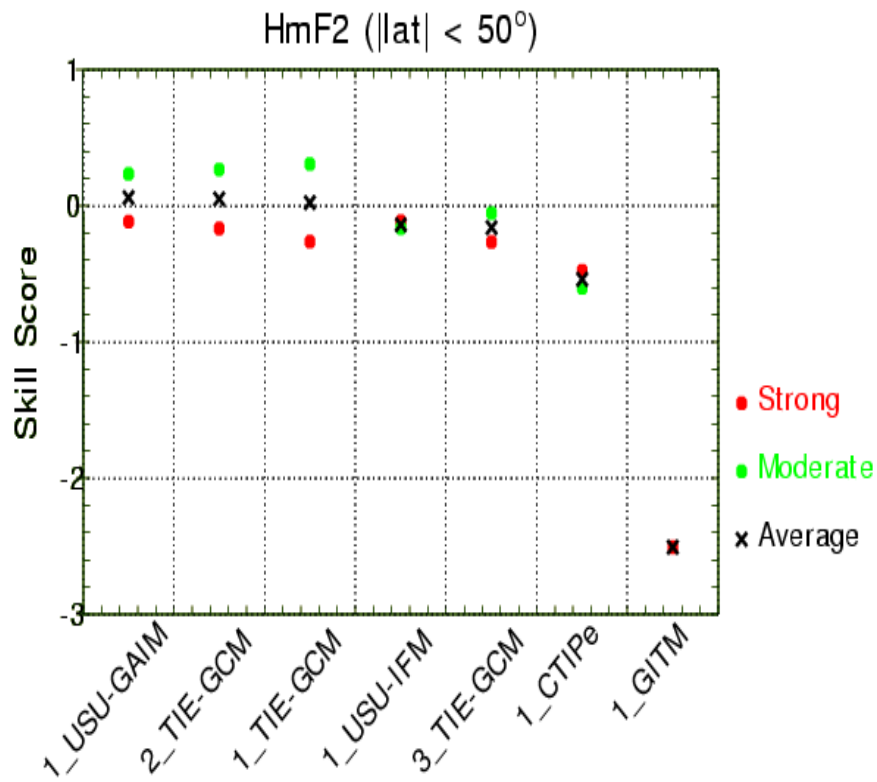


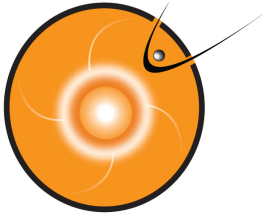
HmF2





HmF2





Summary

Model performance depends on

- geomagnetic activity
 - latitude
 - metrics selection
-