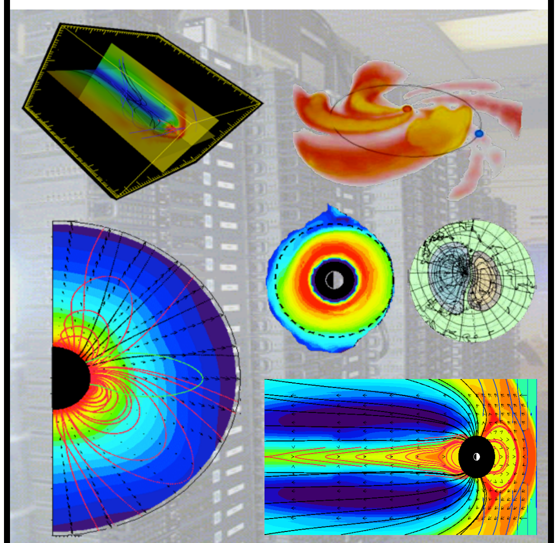
Community Coordinated Modeling Center



Highlights of the CEDAR Electrodynamics Thermosphere Ionosphere Challenge (CETIC) results and recent advances

CCMC : J. Shim, M. Kuznetsova, L. Rastätter, M. Hesse

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

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

CEDAR ETI Challenge

Events

GEM events

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

Moderate storms

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

Quiet periods

E.2007.079: 2007/03/20 00:00 UT - 03/22 00:00 UT (Kp_max = 0.7)
E.2007.190: 2007/07/09 00:00 UT - 07/10 00:00 UT (Kp_max = 0.3)
E.2007.341: 2007/12/07 00:00 UT - 12/09 00:00 UT (Kp_max = 1.0)

Physical Parameters

- Vertical drifts at Jicamarca
- Neutral density at CHAMP orbit (Nden)
- Electron density at CHAMP orbit (Eden)
- 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)

* http://ccmc.gsfc.nasa.gov/support/CETI2010/

http://ccmc.gsfc.nasa.gov/support/CETI2010/metrics_results.php

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CEDAR ETI Challenge

CEDAR ETI challenge results: Online time series plotting tool

	VperpN/VperpE	Nden	Eden	NmF2	HmF2
E.2006.348	Jicamarca	CHAMP	CHAMP	CHAMP COSMIC1 COSMIC2 COSMIC3 COSMIC4 COSMIC5 Millstone_Hill	CHAMP COSMIC1 COSMIC2 COSMIC3 COSMIC4 COSMIC5 Millstone_Hill Sondrestrom
E.2001.243	Jicamarca	CHAMP	CHAMP	no data available	no data available
E.2005.243	Jicamarca	CHAMP	CHAMP	CHAMP Millstone_Hill	CHAMP Millstone_Hill
E.2007.091	Jicamarca	CHAMP	CHAMP	CHAMP COSMIC1 COSMIC2 COSMIC3 COSMIC4 COSMIC5 COSMIC6 EISCAT-Svalbard Poker_Flat	CHAMP COSMIC1 COSMIC2 COSMIC3 COSMIC4 COSMIC5 COSMIC6 EISCAT-Svalbard Poker_Flat
E.2007.142	Jicamarca	CHAMP	CHAMP	CHAMP COSMIC1 COSMIC2 COSMIC3 COSMIC4 COSMIC5 COSMIC6 Millstone_Hill EISCAT-Svalbard Poker_Flat Sondrestrom	CHAMP COSMIC1 COSMIC2 COSMIC3 COSMIC4 COSMIC5 COSMIC6 Millstone_Hill EISCAT-Svalbard Poker_Flat Sondrestrom
E.2008.059	Jicamarca	CHAMP	CHAMP	CHAMP COSMIC2 COSMIC3 COSMIC4 COSMIC6 Millstone_Hill Sondrestrom	CHAMP COSMIC2 COSMIC3 COSMIC4 COSMIC6 Millstone_Hill Sondrestrom
E.2007.079	Jicamarca	CHAMP	CHAMP	CHAMP COSMIC1 COSMIC2 COSMIC3 COSMIC5 COSMIC6 EISCAT-Svalbard Poker_Flat Sondrestrom	CHAMP COSMIC1 COSMIC2 COSMIC3 COSMIC5 COSMIC6 EISCAT-Svalbard Poker_Flat Sondrestrom
E.2007.190	Jicamarca	CHAMP	CHAMP	CHAMP COSMIC1 COSMIC2 COSMIC4 COSMIC6 EISCAT-Svalbard	CHAMP COSMIC1 COSMIC2 COSMIC4 COSMIC6 EISCAT-Svalbard
E.2007.341	Jicamarca	CHAMP	CHAMP	CHAMP COSMIC1 COSMIC2 COSMIC3 COSMIC4 COSMIC6 Millstone_Hill Poker_Flat Sondrestrom	CHAMP COSMIC1 COSMIC2 COSMIC3 COSMIC4 COSMIC6 Millstone_Hill Poker_Flat Sondrestrom

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About | Models at CCMC | Request A Run | View Results | Instant Run | Metrics and Validation | Education | RT Simulations

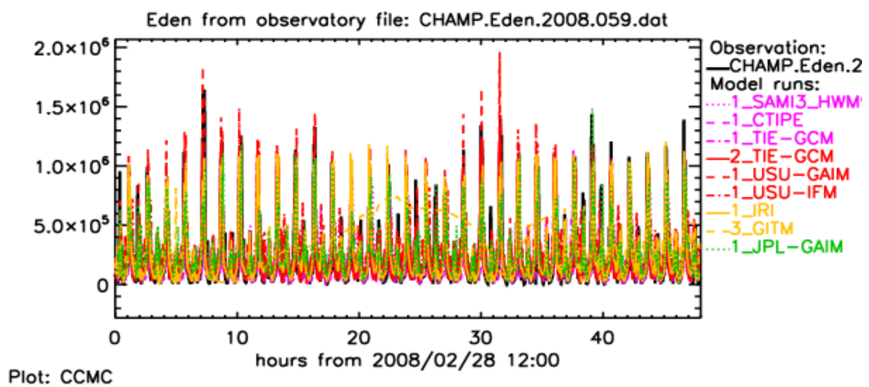


Figure: Eden from observatory CHAMP and model runs
Campaign: CETI2010
Metric study: Eden - electron density at 400 km altitude
Event: February 28, 2008 12 00 UT - March 1, 2008 12 00 UT

To track usage for our government sponsors, we ask that you notify CCMC staff whenever you use CCMC results in a scientific publication or presentation. Thank you.
Go back to metrics challenge table

Update Plot *Update Plot* will update (generate) the plot with the chosen time and plot parameters below.
This will take some time (typically 10-30s) as data is read in and processed.

Start: Year: 2008 Month: 2 Day: 28 Hour: 12 Minute: 0 Second: 0

Metrics

- RMS error : $\sqrt{\dfrac{\sum (x_{obs} - x_{mod})^2}{N}}$

- Prediction efficiency against the mean of observations:

$$1 - \frac{\sqrt{\sum (x_{obs} - x_{mod})^2 / N}}{\sqrt{\sum (x_{obs} - < x_{obs} >)^2 / N}}$$

- Ratio of maximum change : $\dfrac{(x_{mod})_{\max} - (x_{mod})_{\min}}{(x_{obs})_{\max} - (x_{obs})_{\min}}$

- Ratio of maximum : $\dfrac{(x_{mod})_{\max}}{(x_{obs})_{\max}}$

Model Submissions

	Model Setting ID	
1	1_IRI*	IRI-2007, empirical ionospheric model
2	1_MSIS	NRLMSISe0, empirical model : http://sisko.colorado.edu
3	1_JB2008	JB2008 empirical thermospheric density model by Bruce Bowman, Kent Tobiska, et al.
4	2_JB2008	JB2008 with temperature correction derived from W05 total Poynting fluxes
5	1_SAMI3_HWM07	SAMI3 with the neutral wind model HWM07
6	1_SAMI3_HWM93*	SAMI3 with the neutral wind model HWM93
7	1_USU-IFM*	IFM driven by F10.7, Kp and empirical inputs for the thermosphere parameters
8	1_CTIPE*	CTIPe driven by Weimer electric potential model, 2°×18°, 15 levels in logarithm of pressure
9	1_GITM	GITM, 25x50x13
10	3_GITM	GITM, 25x50x13, with the equatorial electrojet and potential solver
11	1_TIE-GCM*	TIE-GCM1.93 driven by Heelis electric potential model
12	2_TIE-GCM	TIE-GCM1.94 driven by Weimer electric potential model with dynamic critical co-latitudes
13	1_JPL-GAIM	USC/JPL GAIM with gound based gps sites and cosmic data
14	1_USU-GAIM*	USU-GAIM23 with GPS TEC observations from up to 400 ground stations

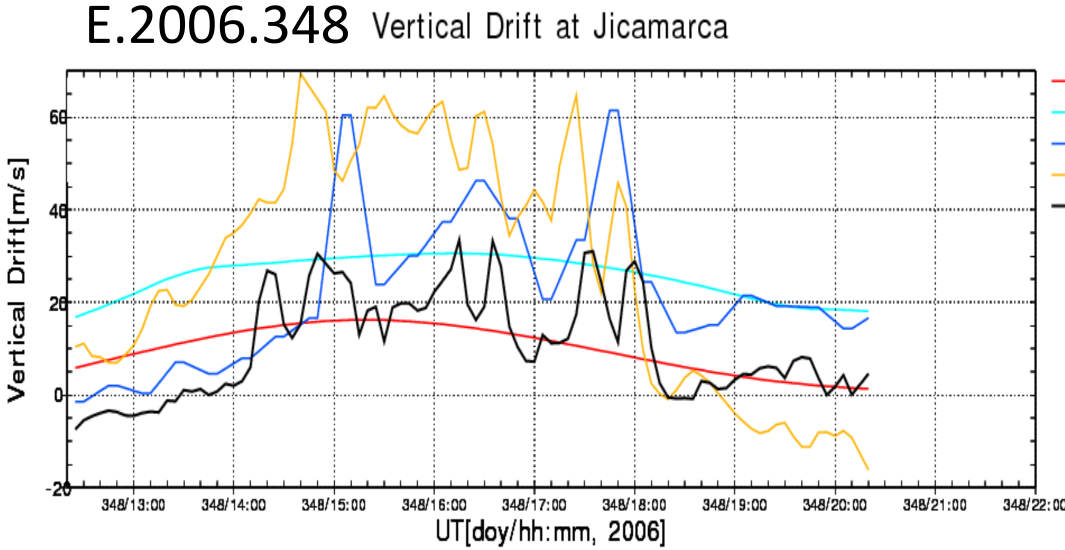
* Runs performed at the CCMC

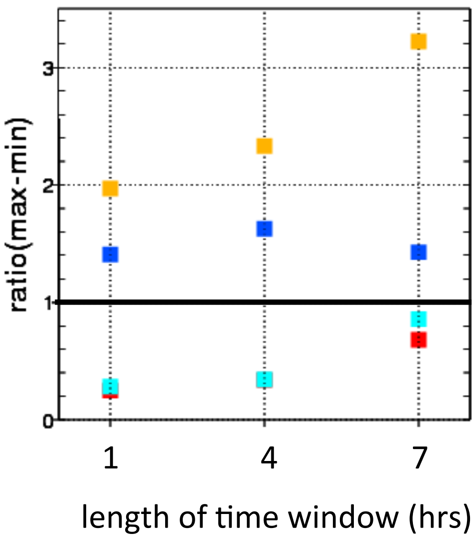
Vertical Drift

• Vertical drifts at Jicamarca :

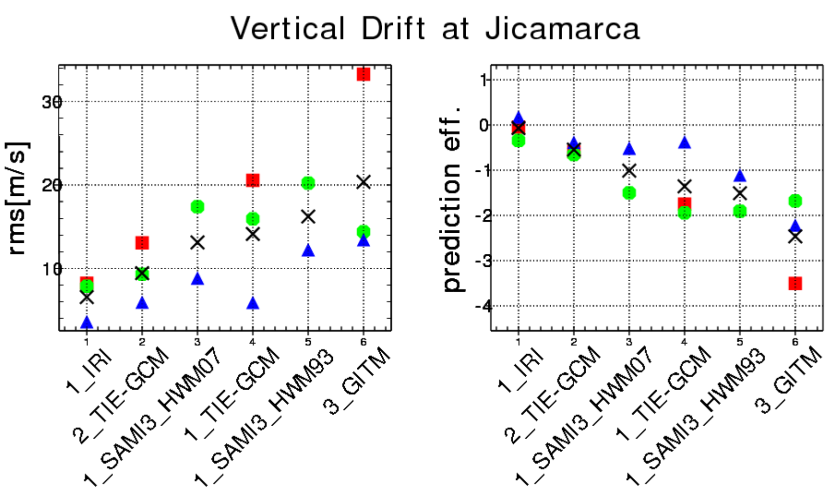
- measured by the 50 MHz JULIA radar : 0700-1800 LT (1200 - 2300 UT)
- obtained from Jicamarca-Piura dH magnetometer measurements

E.2006.348





Vertical Drift

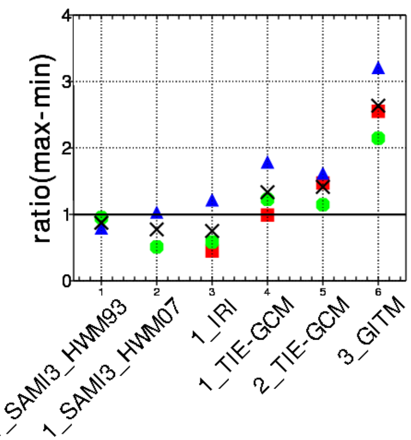


RMS

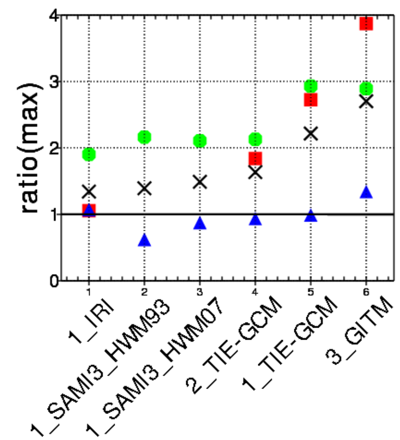
PE

- not all models have data for all events
- model performance depends on geomagnetic activity level

Ratio(max-min)



Ratio(max)



■ : strong storms

● : moderate storms

▲ : quiet periods

✖ : average over all events

NmF2 and hmF2 from CHAMP and COSMIC

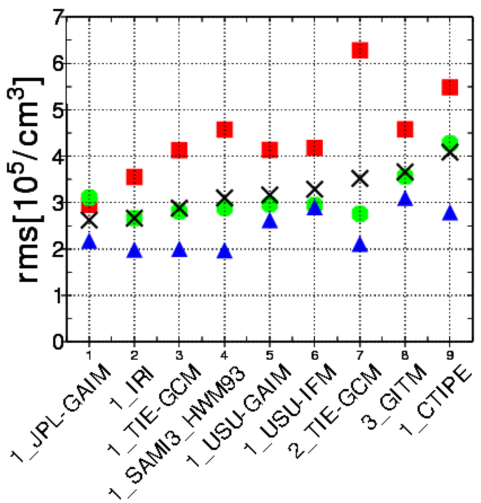
- NmF2 and hmF2 from LEO satellites (CHAMP and COSMIC)
  : CDAAC (COSMIC Data Analysis and Archive Center,
  http://cdaac-www.cosmic.ucar.edu/cdaac/)

- 3 latitude regions :
  - low : |lat| < 25°
  - middle : 25° < |lat| < 50°
  - high : |lat| > 50°

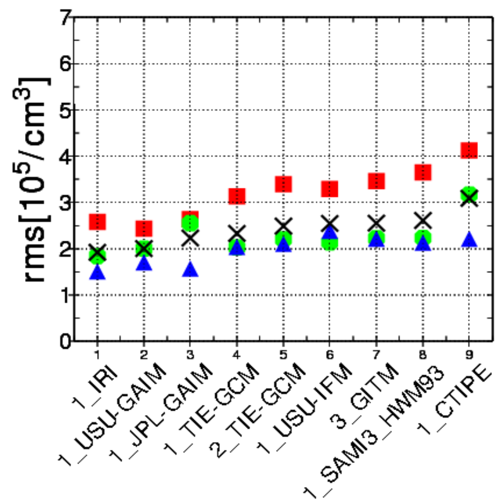
- 90 min time window

NmF2 from CHAMP and COSMIC : RMS

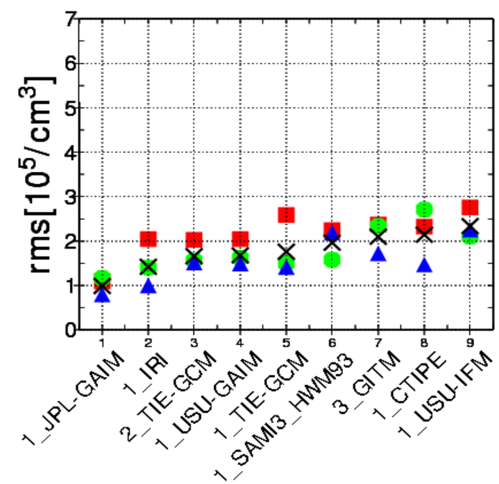
low (|lat| < 25°)



middle (25° < |lat| < 50°)



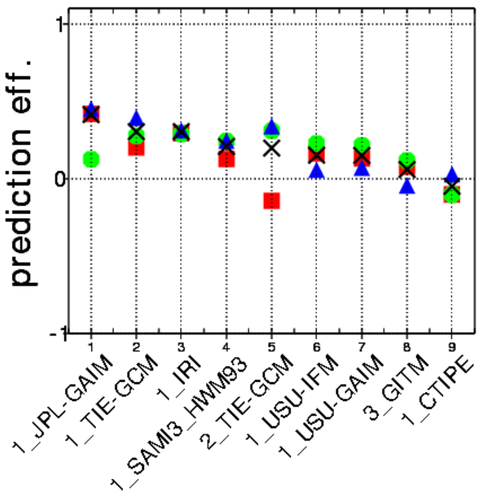
high (|lat| > 50°)



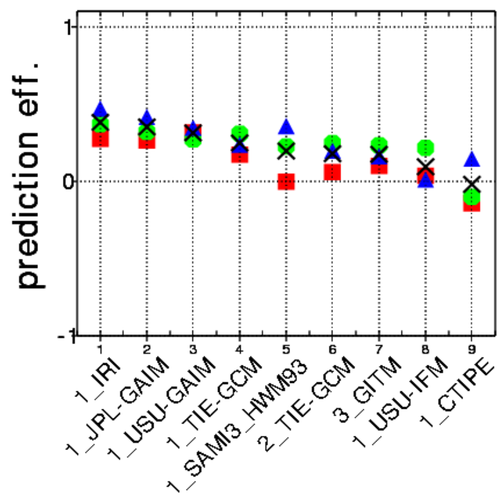
- no big difference in RMS error between models on the average
- largest RMS error during the storm events in the low latitudes
- data assimilation and empirical models < physics based models

NmF2 from CHAMP and COSMIC : PE

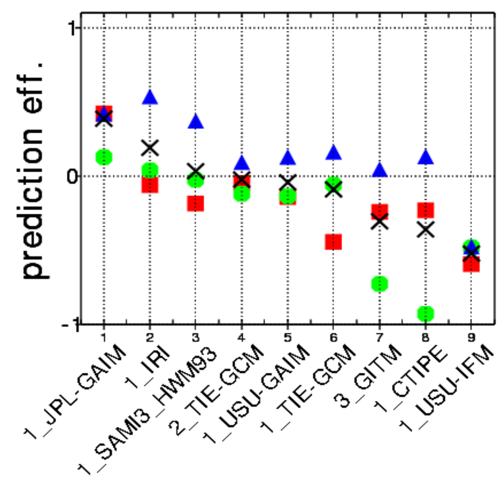
low (|lat| < 25°)



middle (25° < |lat| < 50°)



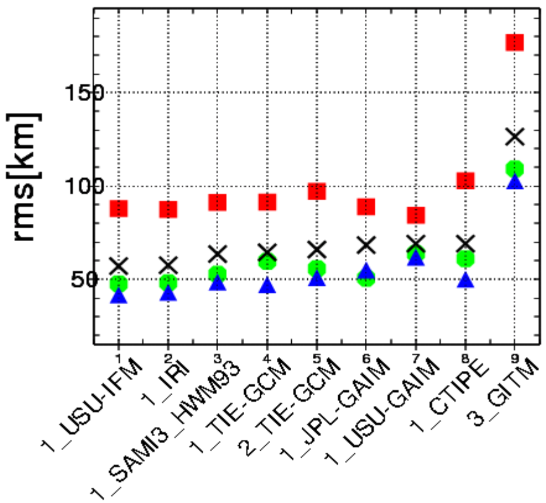
high (|lat| > 50°)



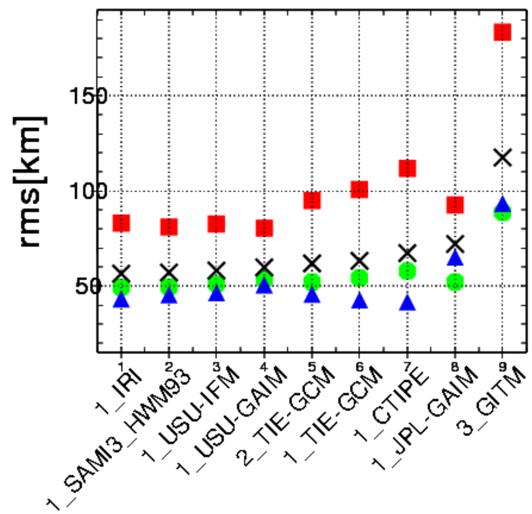
- negative PE during the storm events in the high latitudes
- no big difference in PE between models and between geomagnetic activities in low and middle latitudes

HmF2 from CHAMP and COSMIC : RMS

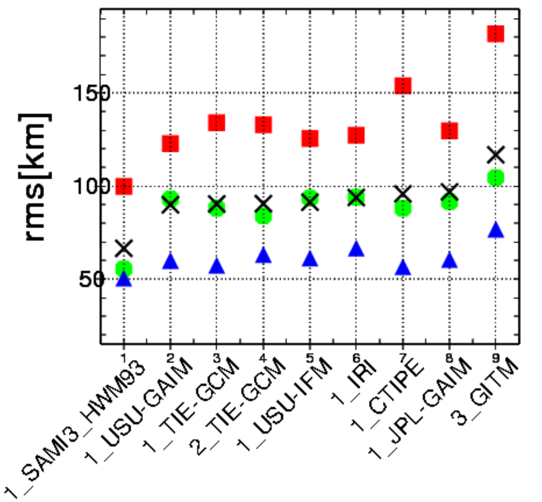
low (|lat| < 25°)



middle (25° < |lat| < 50°)



high (|lat| > 50°)



- similar RMS error for all three latitudes and for all three geomagnetic levels
- similar PE close to 0 (not shown here)
- score based on ratio ~ 1 (not shown here)

Summary of CETIC

- model performance depends on
  - geomagnetic activity
  - latitude
  - metrics selection

- model performance varies from event to event.

- none of models ranks at the top for all used metrics.
  - empirical models : ranked high on the average or during the quiet time
  - physics based models : better represent dynamics

- first step to establish a baseline for future versions and models

- paper to be submitted

Preliminary Results of GEM-CEDAR Challenge

GEM-CEDAR Modeling Challenge

Events :

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

- E.2005.135: 2005/05/15 00:00 UT - 05/16 00:00 UT (Kp_max = 8)
- E.2005.190: 2005/07/09 00:00 UT – 07/12 00:00 UT (Kp_max = 6)

Physical Parameters :

- Ne, Te, and Ti at 300 km from ISR
  (Millstone Hill, Sondrestrom, EISCAT, EICAT-Svalbard ISRs)

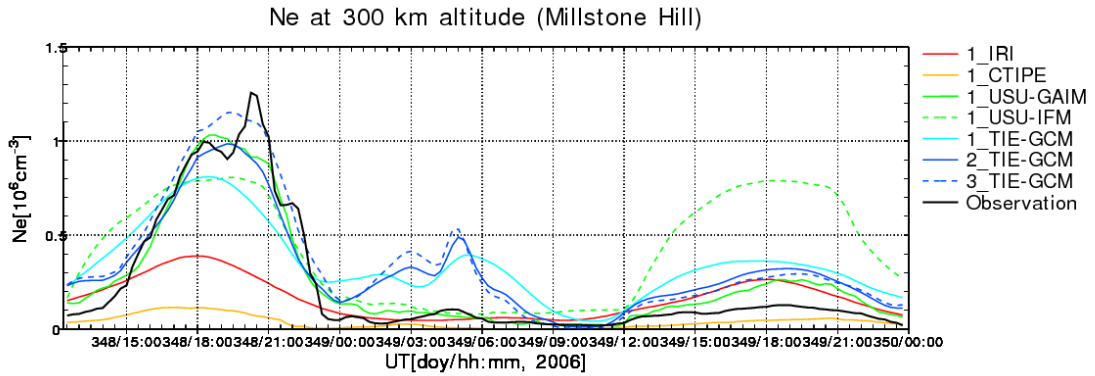
- Tn and neutral winds at 250 km from Fabry-Perot Spectrometer
  (Arrival heights, Resolute Bay)

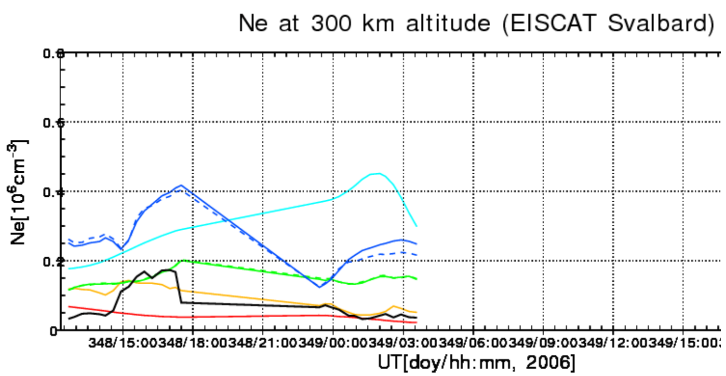
- Ion vertical velocity at 300 km from ISR (Sonderstrom)

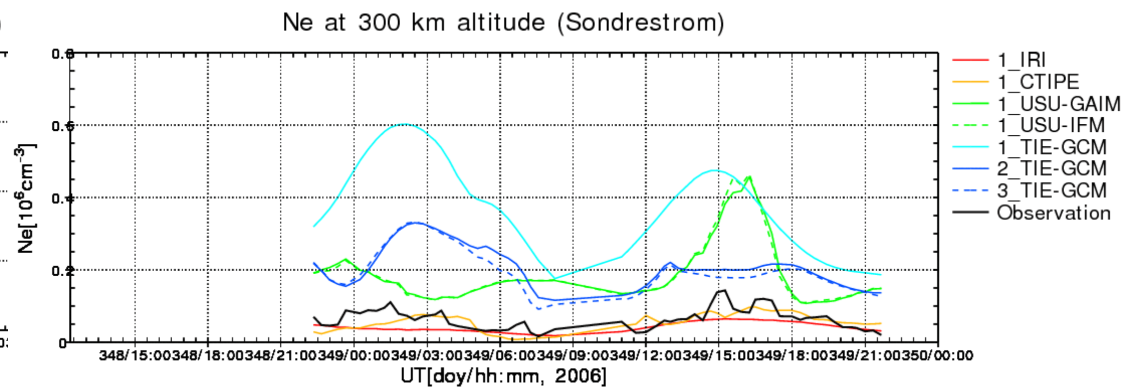
Ne at 300 km height from ISRs

- Millstone Hill (42.62 N, 288.51 E)
- EISCAT Svalbard (78.09 N, 16.02 E)
- EISCAT (69.58 N, 19.23 E)
- Sondrestrom (66.99 N, 309.05 E)

E.2006.348

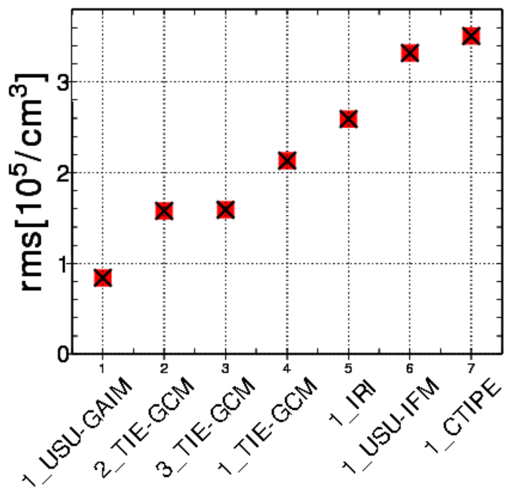




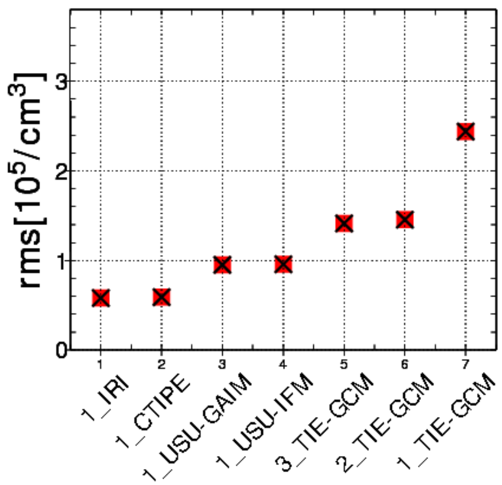


Ne at 300 km height from ISRs : RMS

Millstone Hill

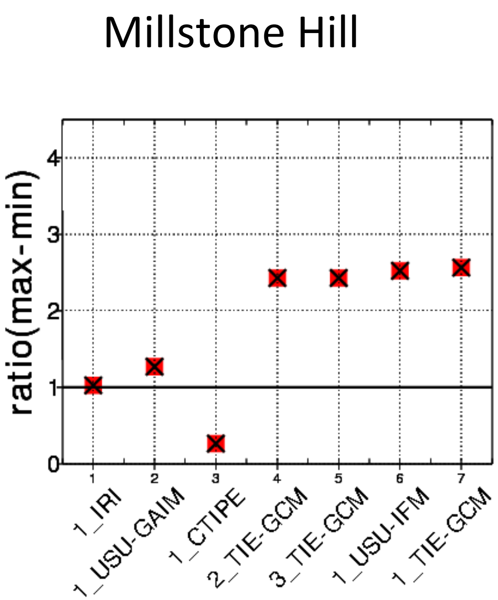


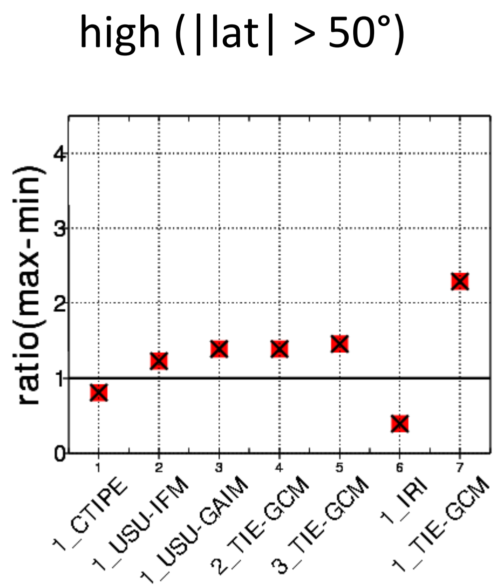
high (|lat| > 50°)



- only for E.2006.348 event
- data assimilation model ranks higher than physics based models and empirical model in the middle latitudes
- empirical model ranks higher than data assimilation model and physics based models in the high latitudes

Ne at 300 km height from ISRs : Ratio (max-min)





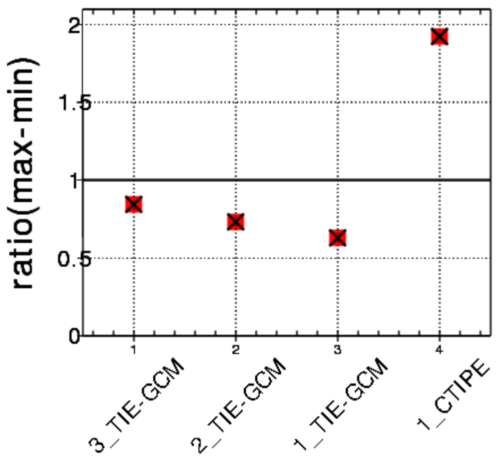
- only for E.2006.348 event
- empirical and data assimilation model rank higher than physics based models in the mid-latitudes
- data assimilation and physics based models rank higher than empirical model in the high latitudes

Tn at 250 km height from FPI

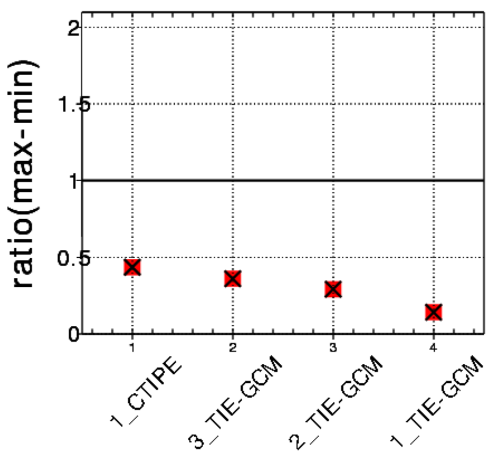
- Resolute Bay in Canada (74.41° S, 194.52° W) :
  provided by Qian Wu (E.2006.348)
- Arrival Heights in Antarctica (77.82° S, 166.65° E) :
  provided by Gonzalo Hernandez (E.2005.190)
- Data from five looking directions
- Relative values
- 2 hr time window

Tn at 250 km height from FPI: Ratio(max-min)

Resolute Bay



Arrival Heights



- average over five looking directions (E, W, N, S, Z)