Quantitative Assessment of the Storm Time Performances of IT Models for the Orbit Averaged Neutral Densities on CHAMP orbit

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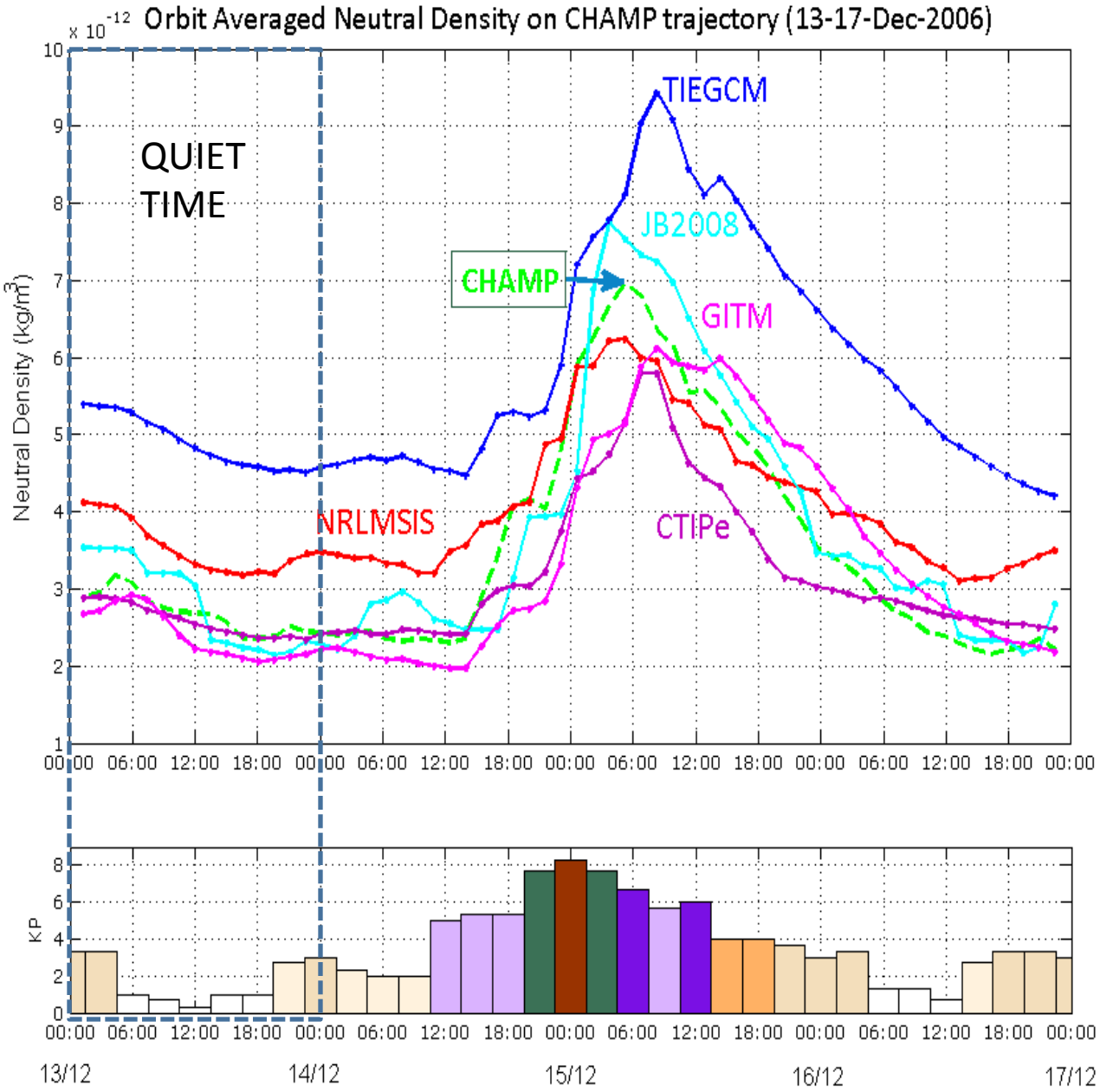
PURPOSE

- Quantify the storm time performances of IT models for the orbit averaged neutral densities on CHAMP satellite track
- Select metrics for satellite drag applications

DATA AND METHODOLOGY



EVENT:

December 2006 geomagnetic storm. $Kp_{max}>8$

Latest model versions at the CCMC : Driven with Weimer potentials

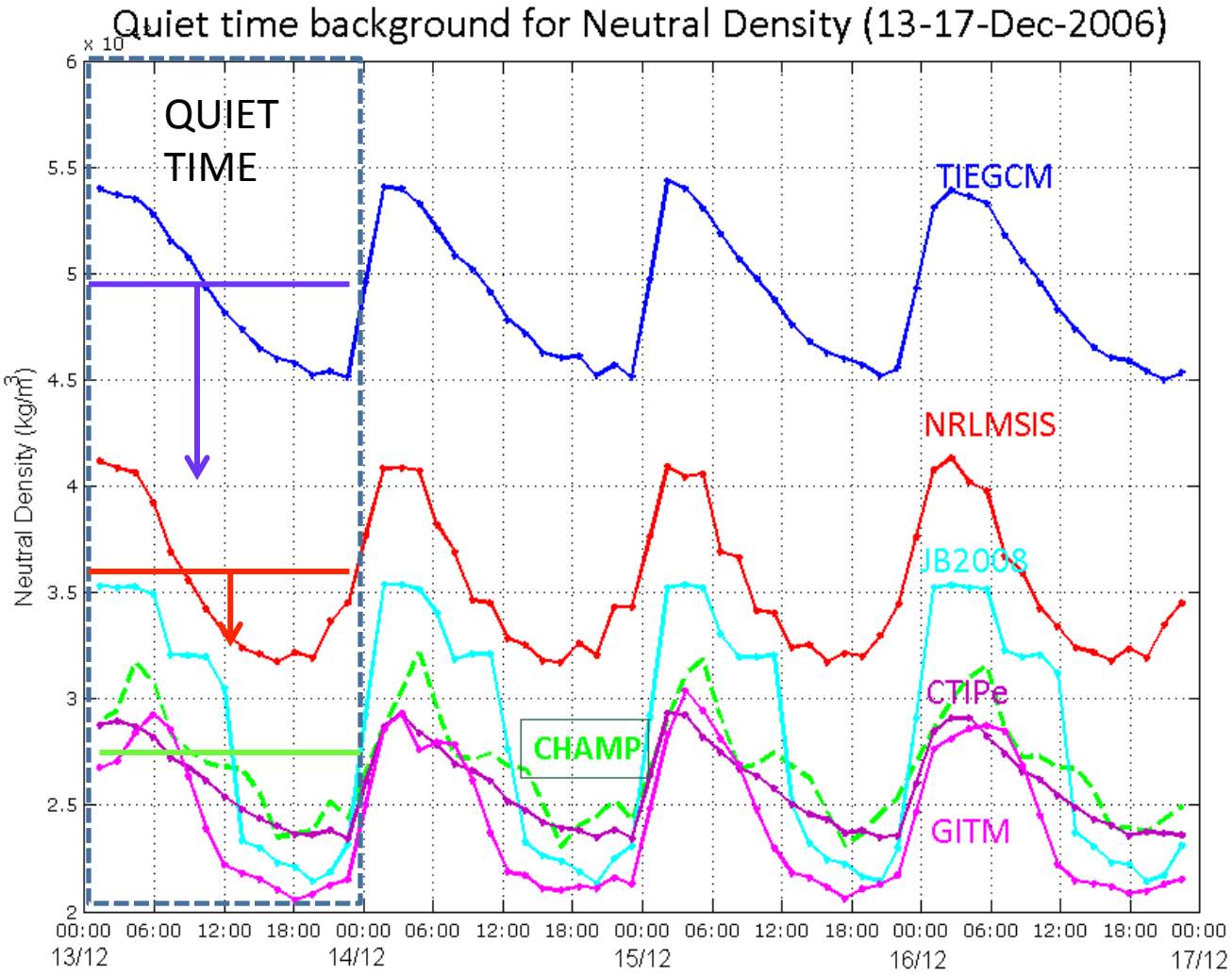
Problem: How to assess the storm time performances of the models?

Suggestion: Removing the background climatology

HOW?

1. Quick and Dirty: Using the quiet time mean
2. Persistent: Using the background run

SHIFTING METHODS



HOW?

1.Quick and Dirty: Using the mean

a)Shift to CHAMP levels

b)Shift to zero

2. Persistent: Doing point to point subtraction

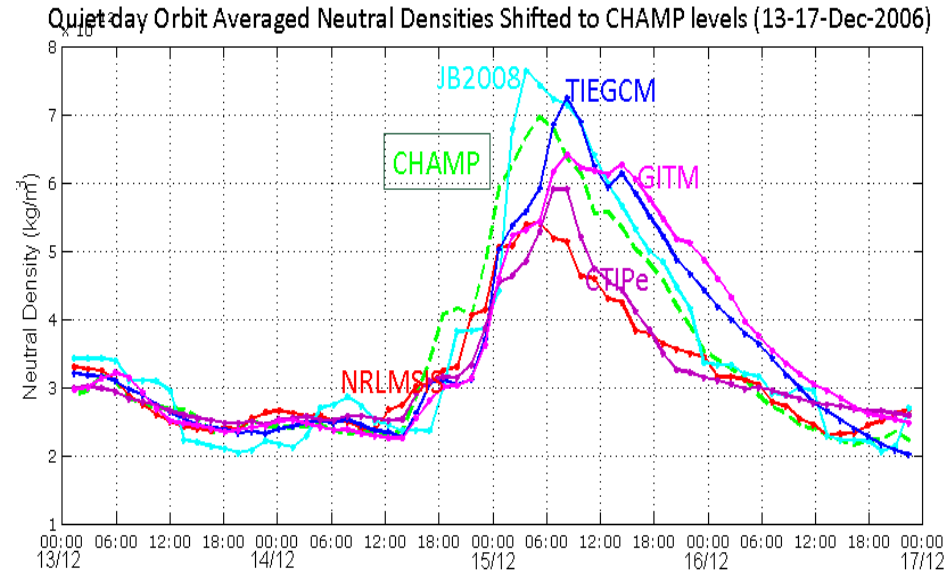
a)Shift to CHAMP

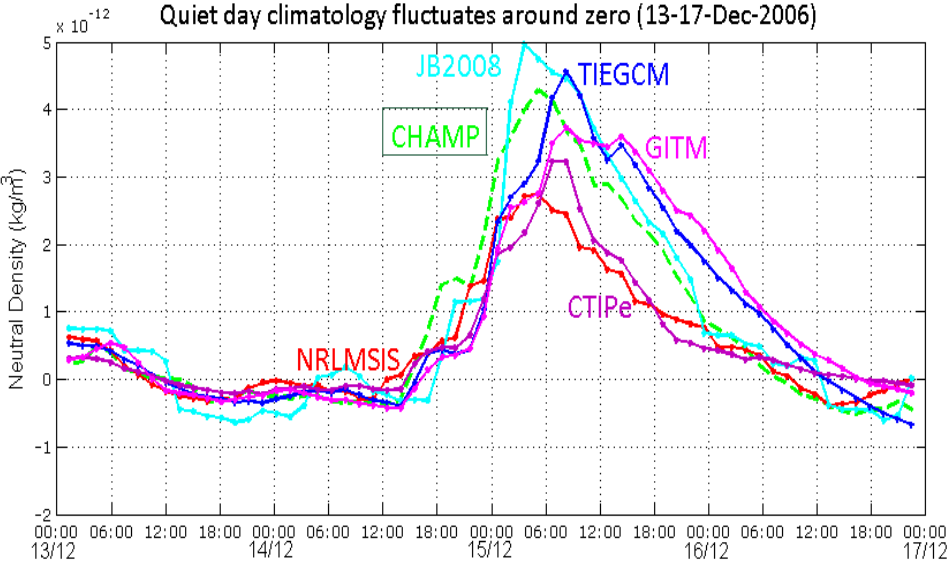
b)Shift to zero

Assumption: The following day neutral density variations would have been the same with the quite day neutral density variations if there weren't any geomagnetic storms.

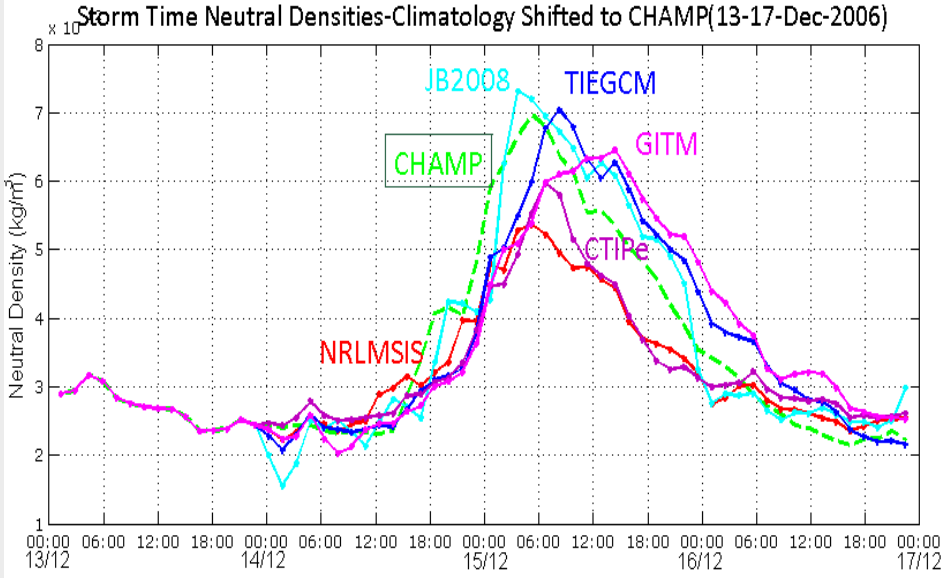
RESULTS

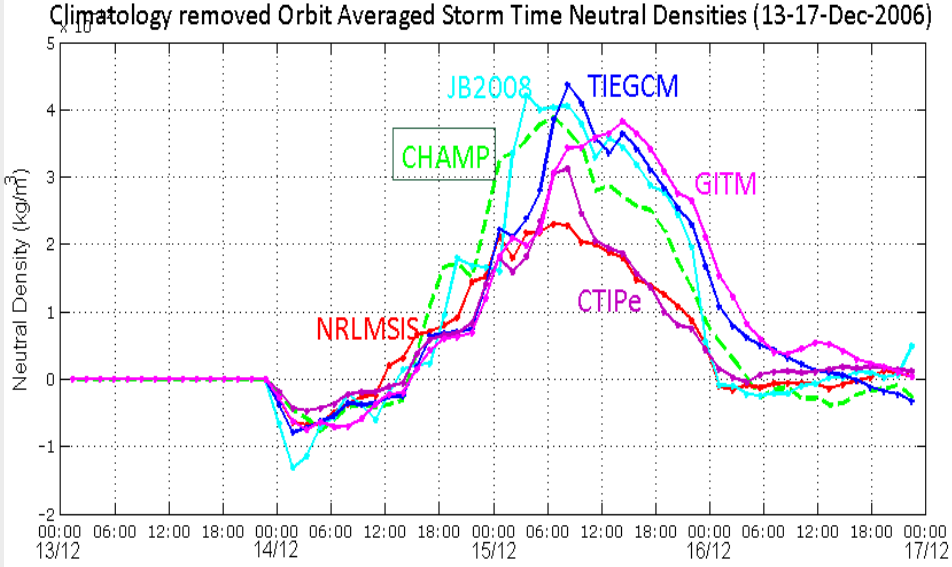
Quick and Dirty: Shift using the mean



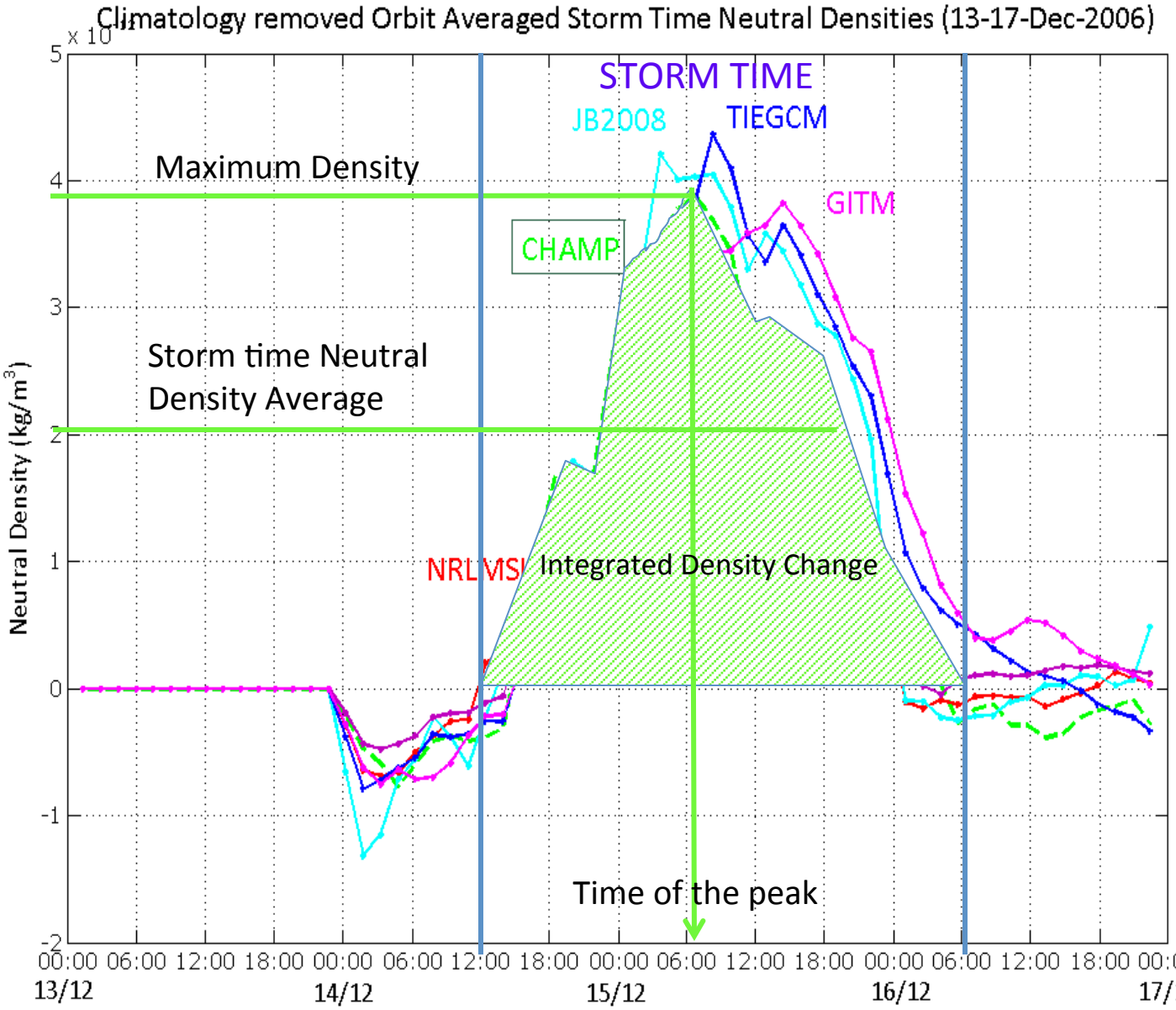


Persistent: Shift by point to point subtraction





ASSESSMENT OF MODEL PERFORMANCES



All calculations are done for the storm time interval which is determined based on the CHAMP neutral density levels.

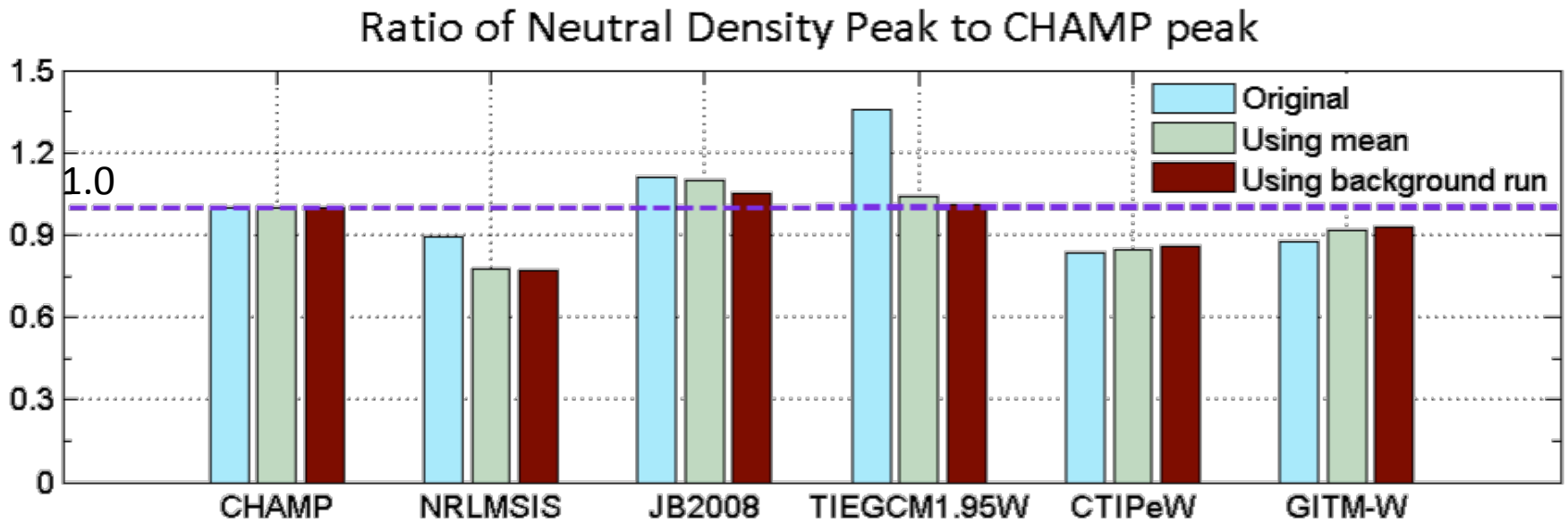
Selected Metrics:

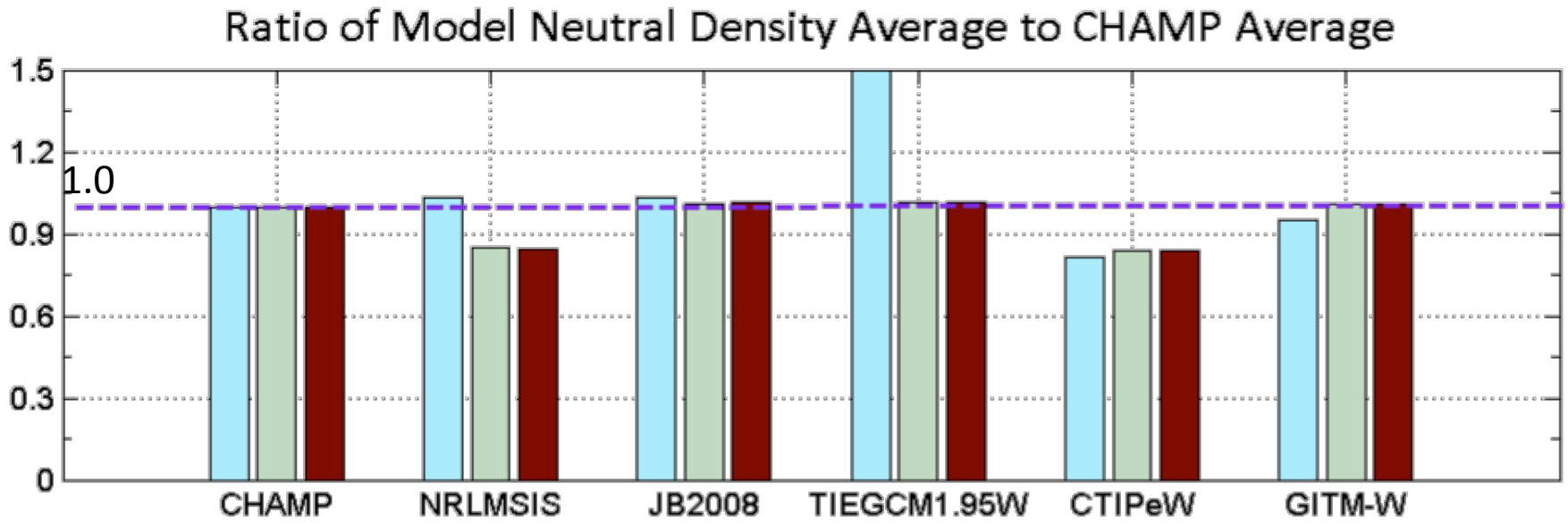
1. Neutral Density Average
2. Neutral density maximum
3. Time of the maximum
4. Integrated density change

Skill Scores:
MAE: Mean Absolute Error
RMSE: Root mean square error

METRICS

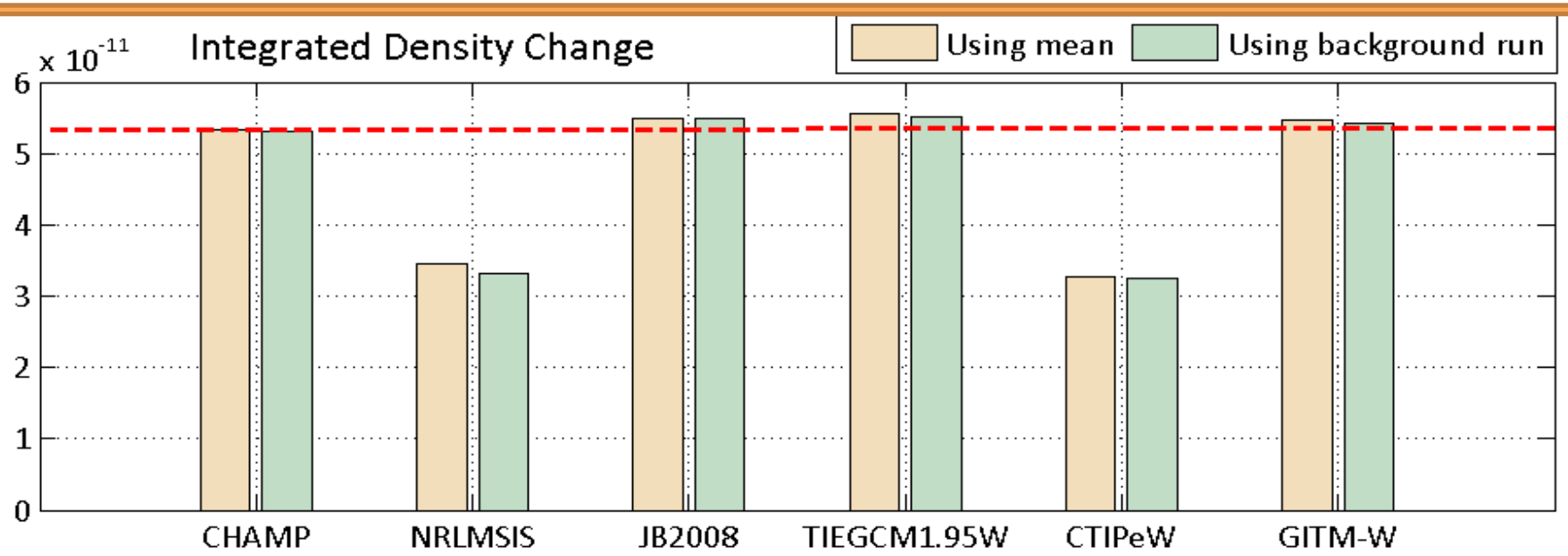
$$Ratio_{max} = \frac{n_{model,max}}{n_{CHAMP,max}} \qquad Ratio_{avg} = \frac{n_{model,avg}}{n_{CHAMP,avg}}$$

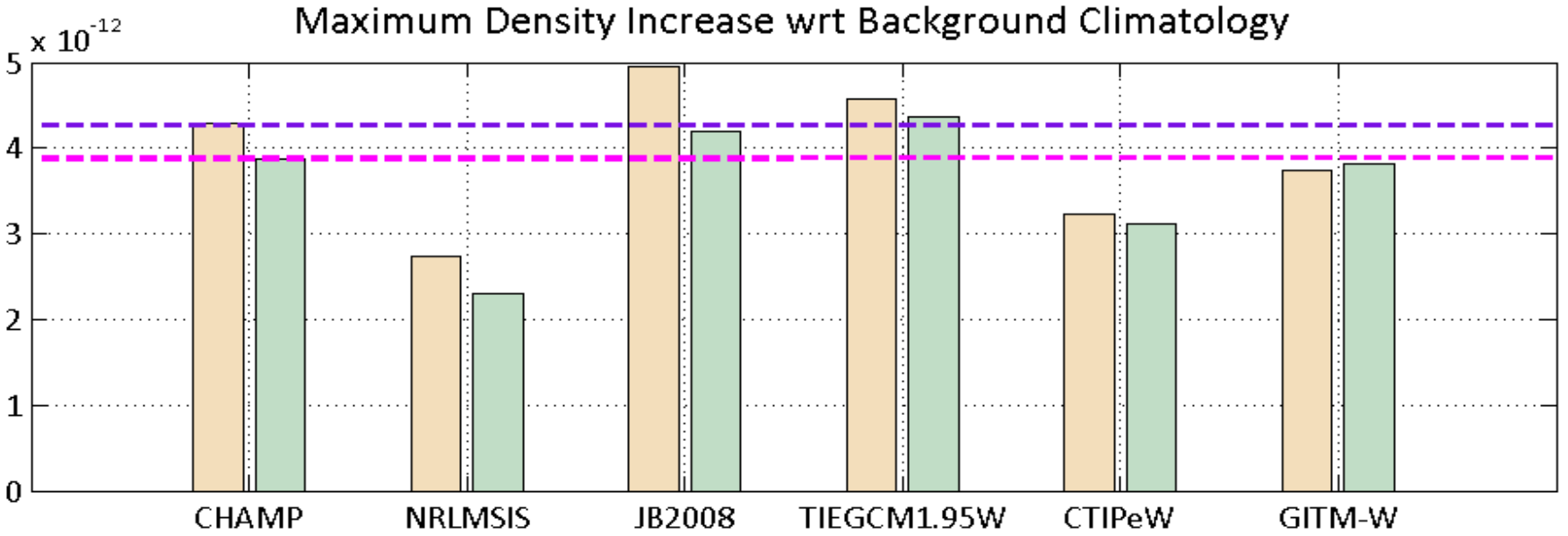




METRICS

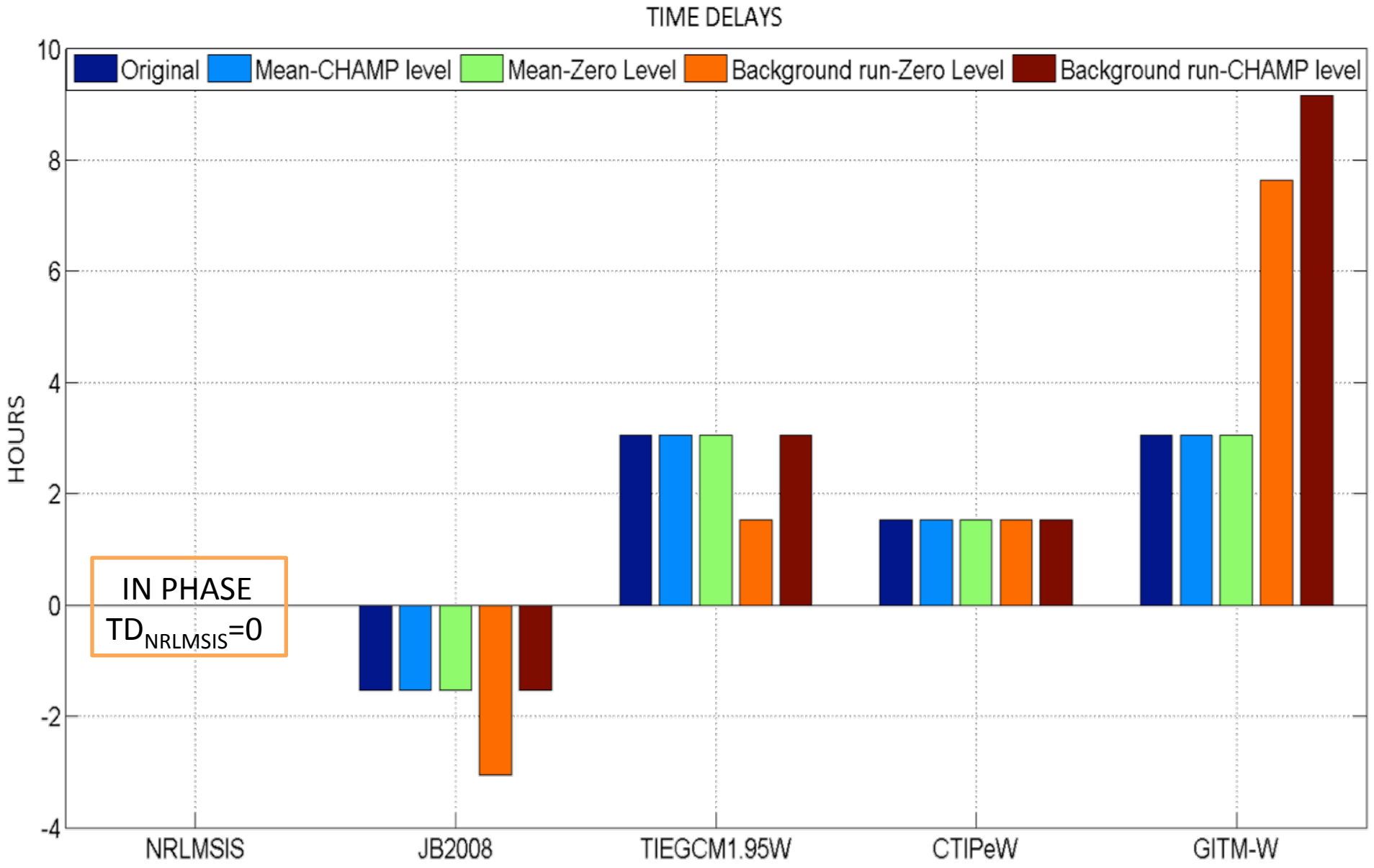
$$Sum(n) = \sum (n_{CHAMP} - n_{background})$$





METRICS

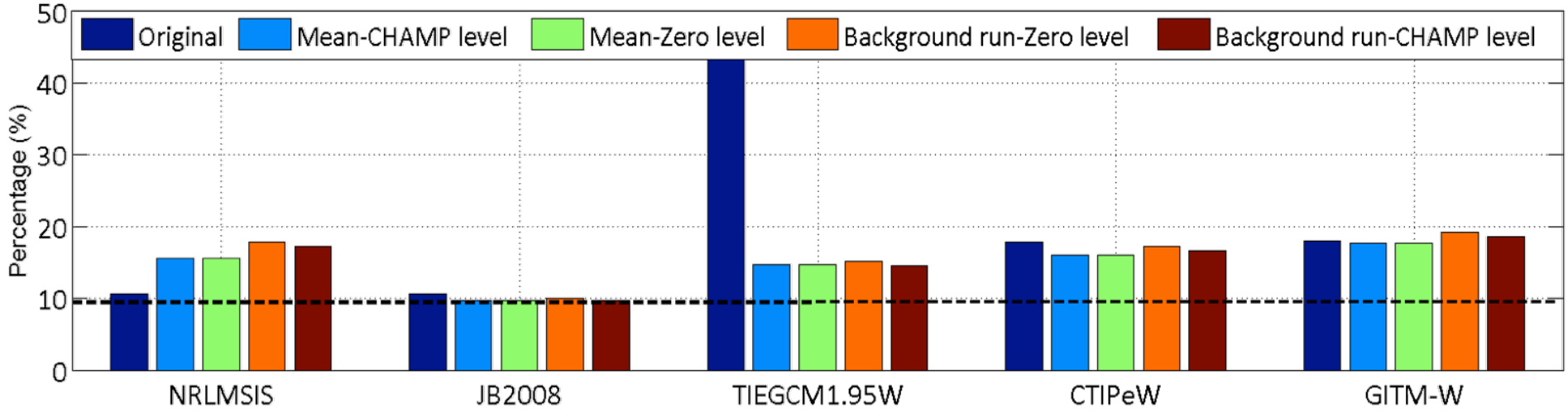
$$TD = t_{MODEL,max} - t_{CHAMP,max}$$



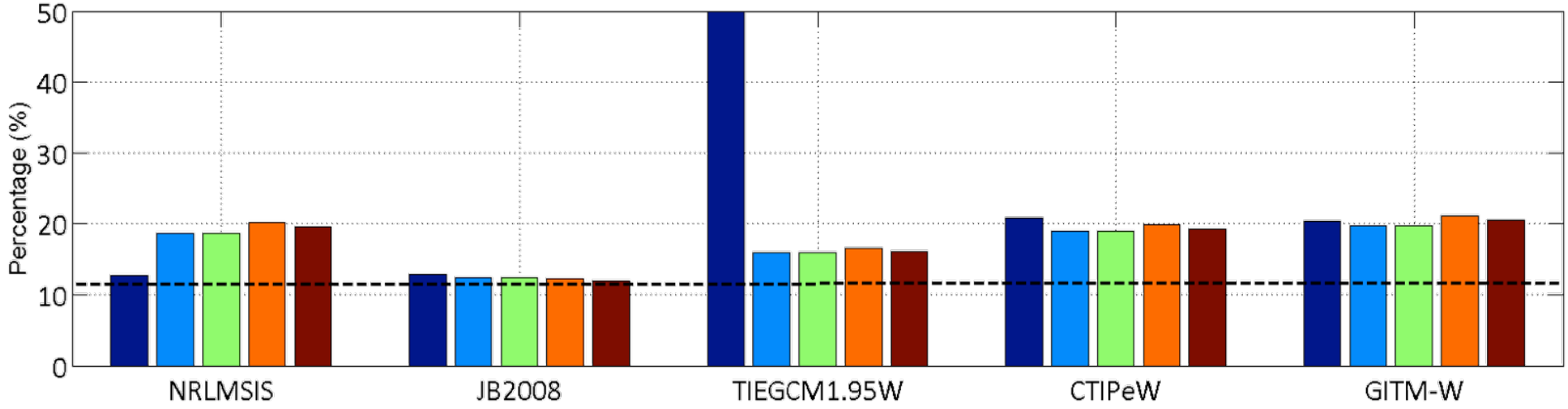
SKILL SCORES

$$NMAE = \frac{1}{N}\sum \frac{(n_{CHAMP} - n_{MODEL})}{(n_{CHAMP,max} - n_{CHAMP,min})} \qquad NRMSE = \frac{1}{N}\sqrt{\sum \frac{(n_{CHAMP} - n_{MODEL})^2}{(n_{CHAMP,max} - n_{CHAMP,min})}}$$

NORMALIZED MEAN ABSOLUTE ERROR



NORMALIZED ROOT MEAN SQUARE ERROR



Conclusion

- Background climatology removal is essential in assessing the storm time performances of the models correctly. Otherwise, climatology gets in the way during the storm time performance calculations
- Physics based and empirical models' storm time performances are comparable
- Time delay is an effective error source for the models even when model neutral density average and peak values are similar to CHAMP observations.
- All metrics and skill scores are in agreement with each other after the background removal for this event.

MORE COMMENTS AND QUESTIONS ARE ALSO WELCOME DURING THE POSTER SESSION

TUESDAY, JUNE 24, SOLA-01

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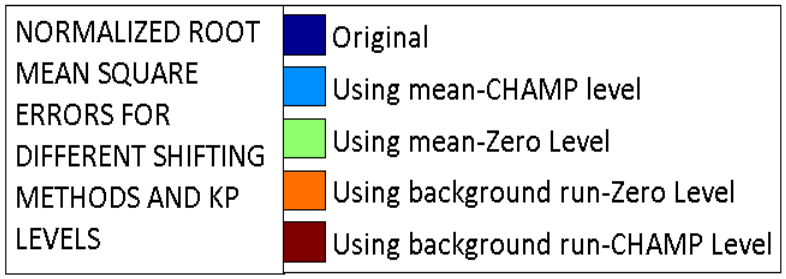
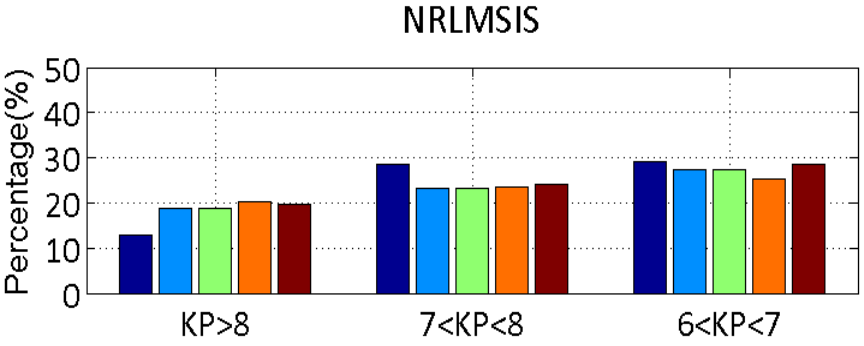
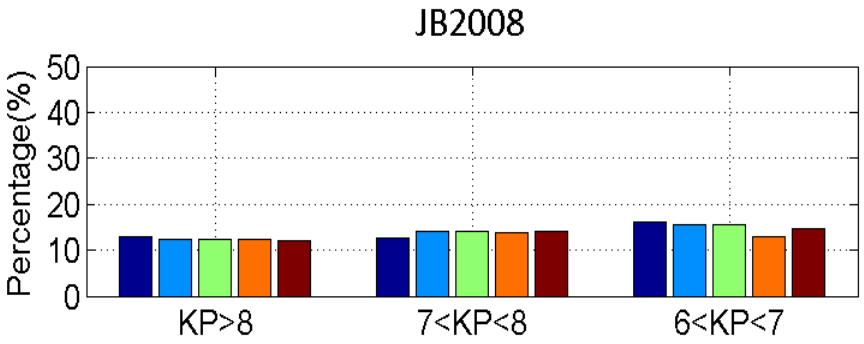
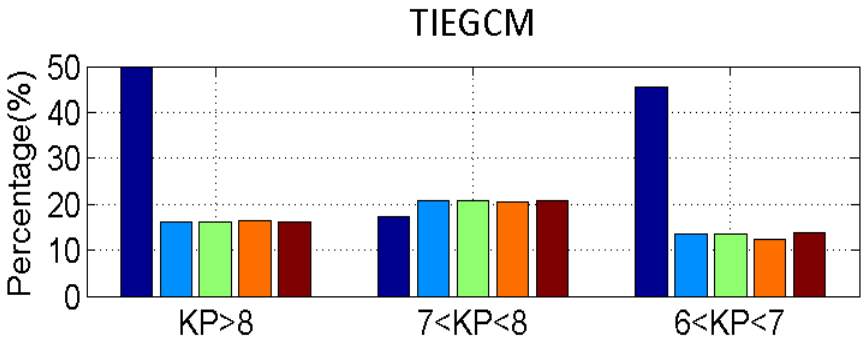
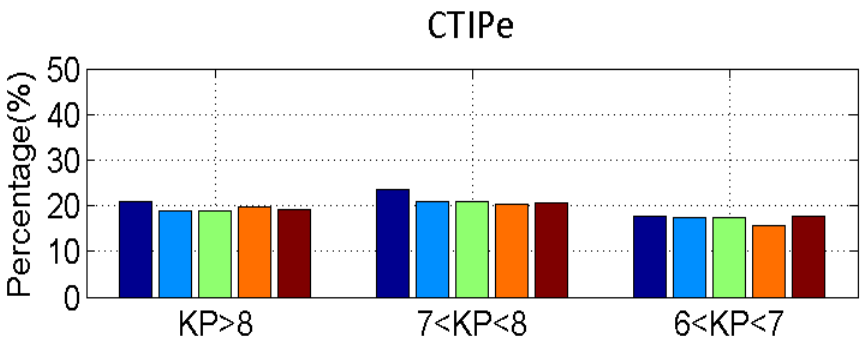
Extra Slide: Model Performances with respect to Kp

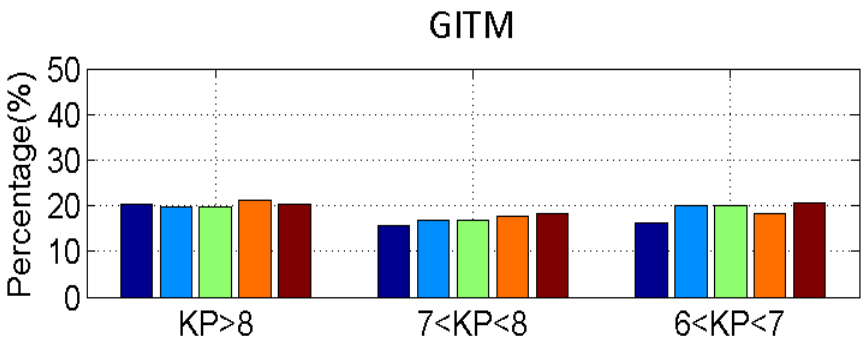




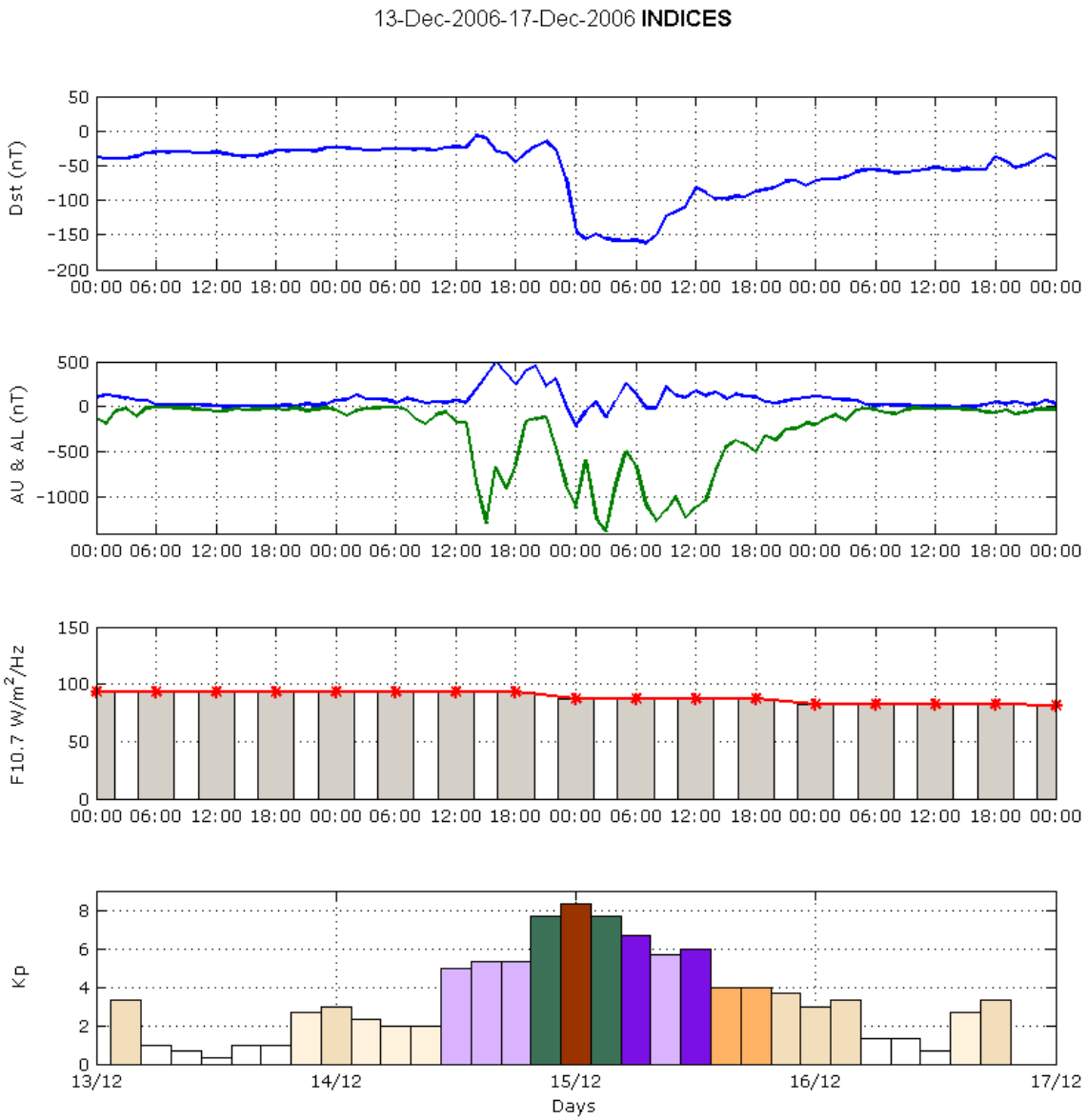








Extra Slide- In case it is needed: Indices during the Storm



Extra Slide: Skill Scores-Not Normalized