Jet Propulsion Laboratory
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Forecasting ionospheric total electron content: a case study of the June 2012 geomagnetic storm

X. Meng, A. J. Mannucci, O. P. Verkhoglyadova, and B. T. Tsurutani

Jet Propulsion Laboratory, California Institute of Technology

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Background

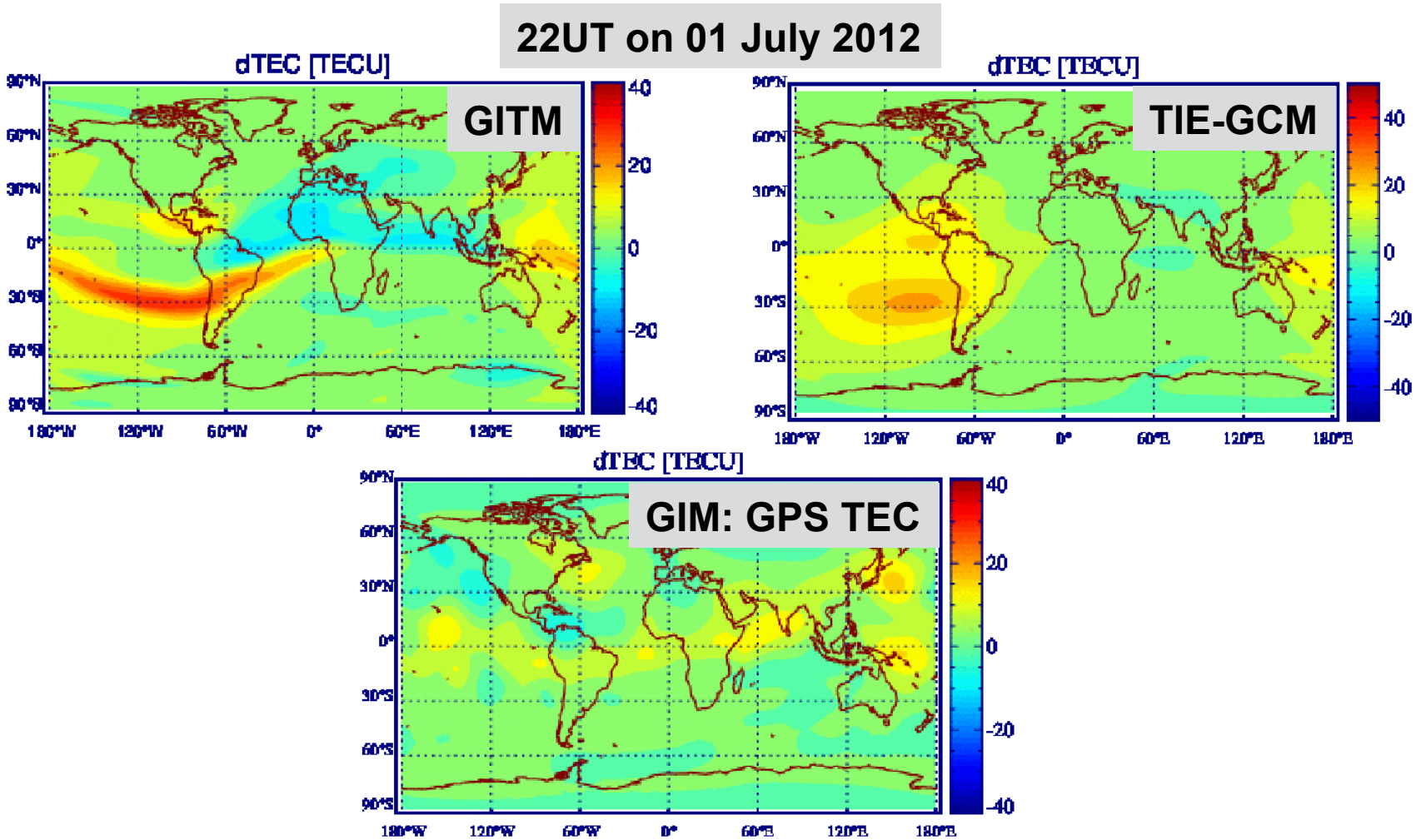
- We have performed forecast-mode ionospheric-thermospheric model runs for 20+ CIR/HSS and CME storms.

- Models
  - Global Ionosphere-Thermosphere Model (GITM)
  - Thermosphere Ionosphere Electrodynamics General Circulation Model (TIE-GCM)
  - Coupled Thermosphere Ionosphere Plasmasphere Electrodynamics Model (CTIPe)

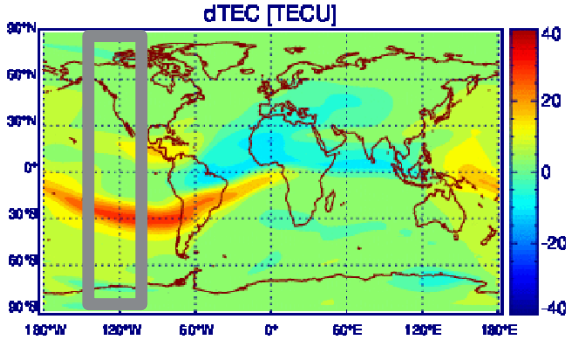
- Forecast-mode run inputs are predictable: solar wind, F10.7 flux
  - 60 runs with actual solar wind and **forecasted** F10.7 (via CCMC)
  - 20 runs with actual solar wind and **actual** F10.7
  - More runs planned

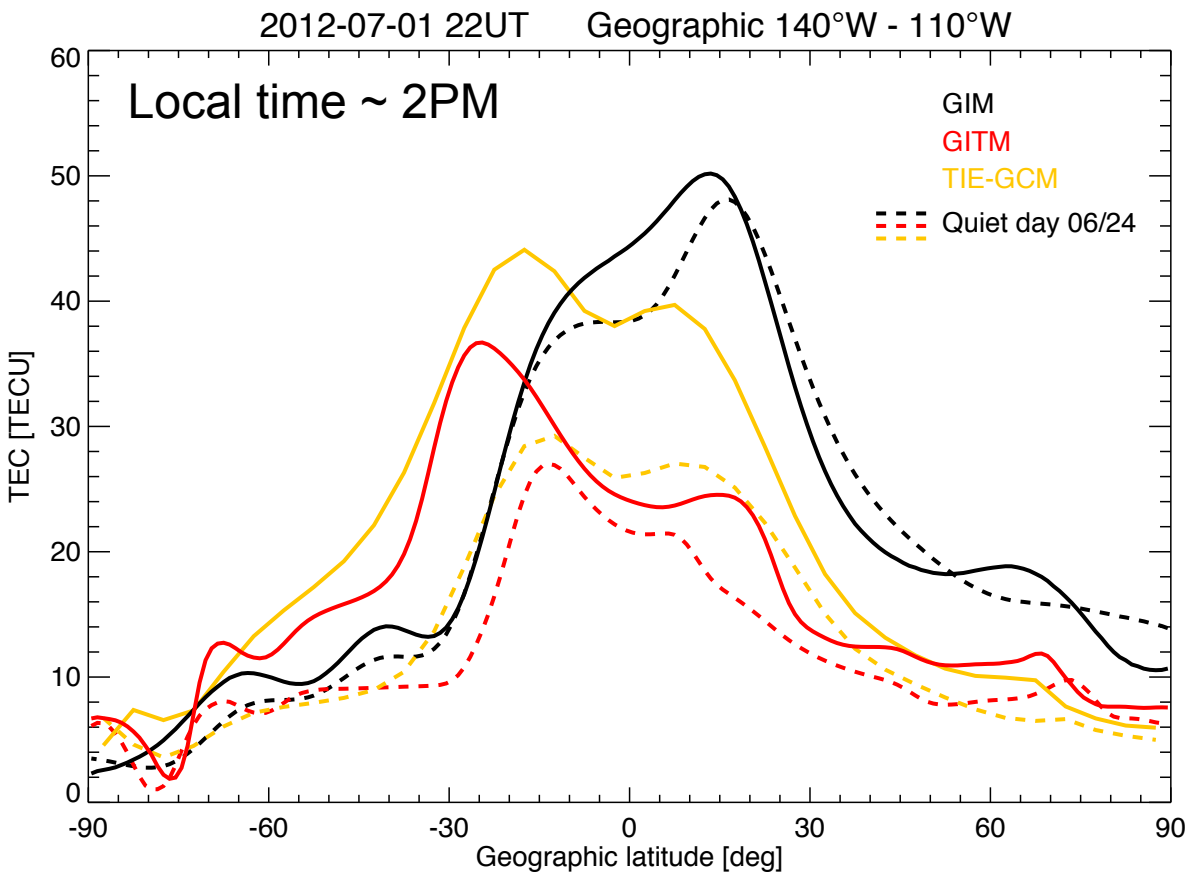
Motivation

- GITM and TIE-GCM overestimate the June 2012 CIR/HSS storm response in similar regions.



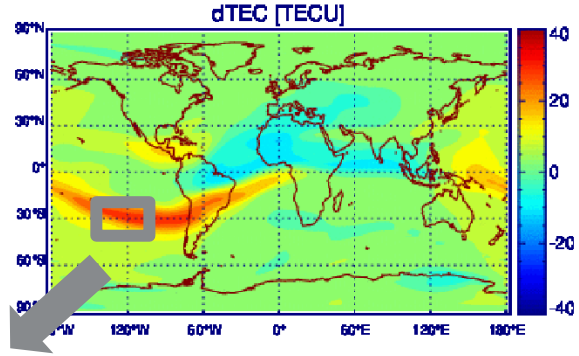
Motivation

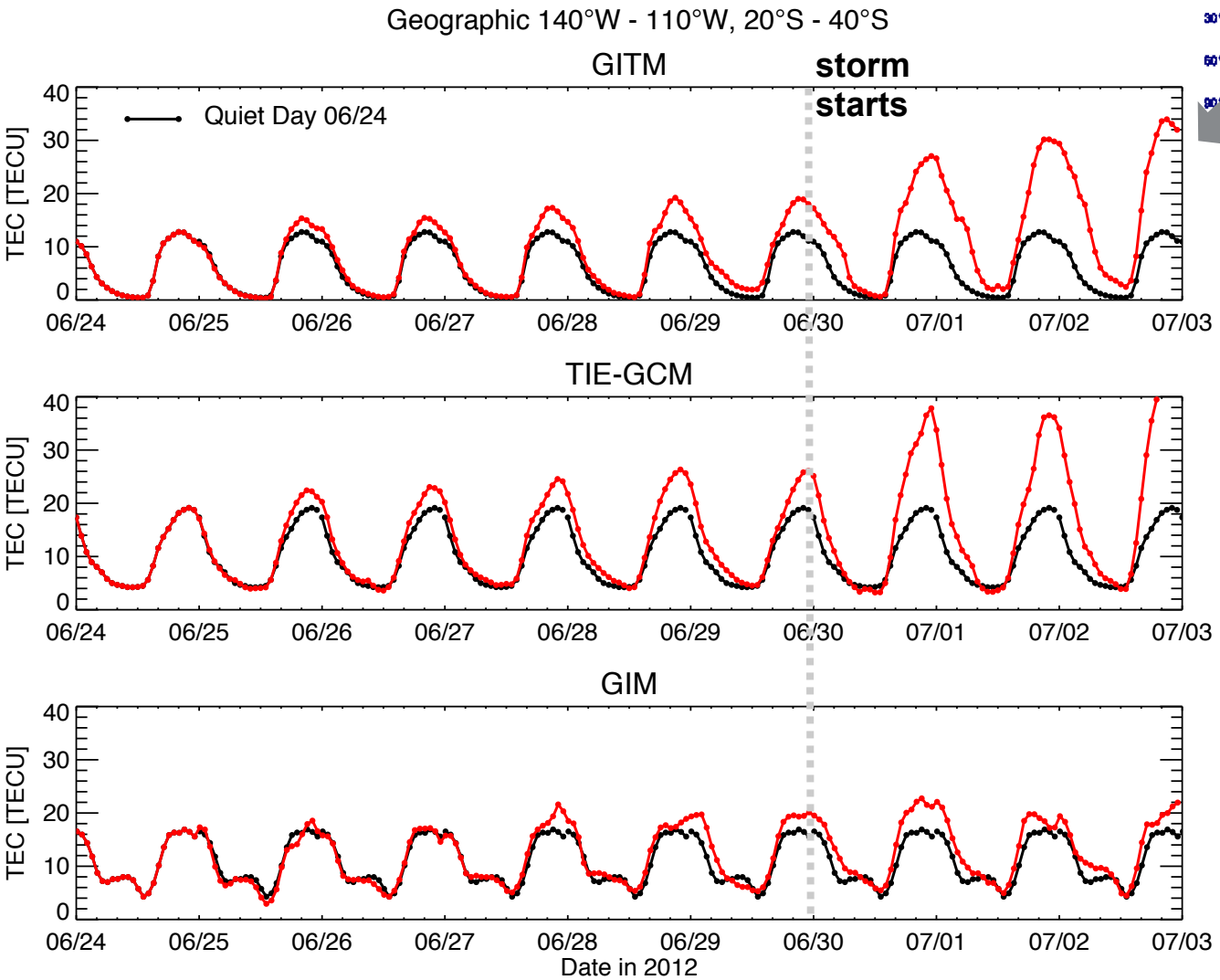




- Extended equatorial anomaly region

Motivation

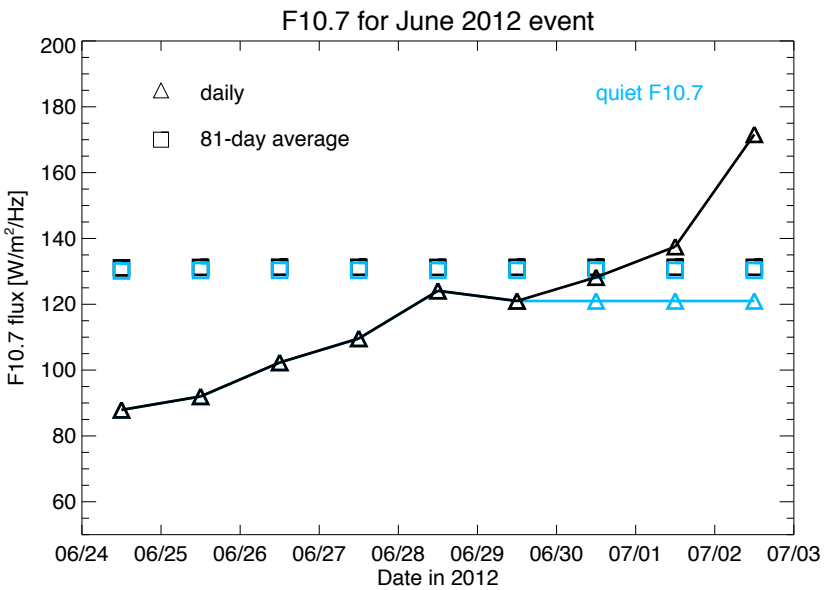


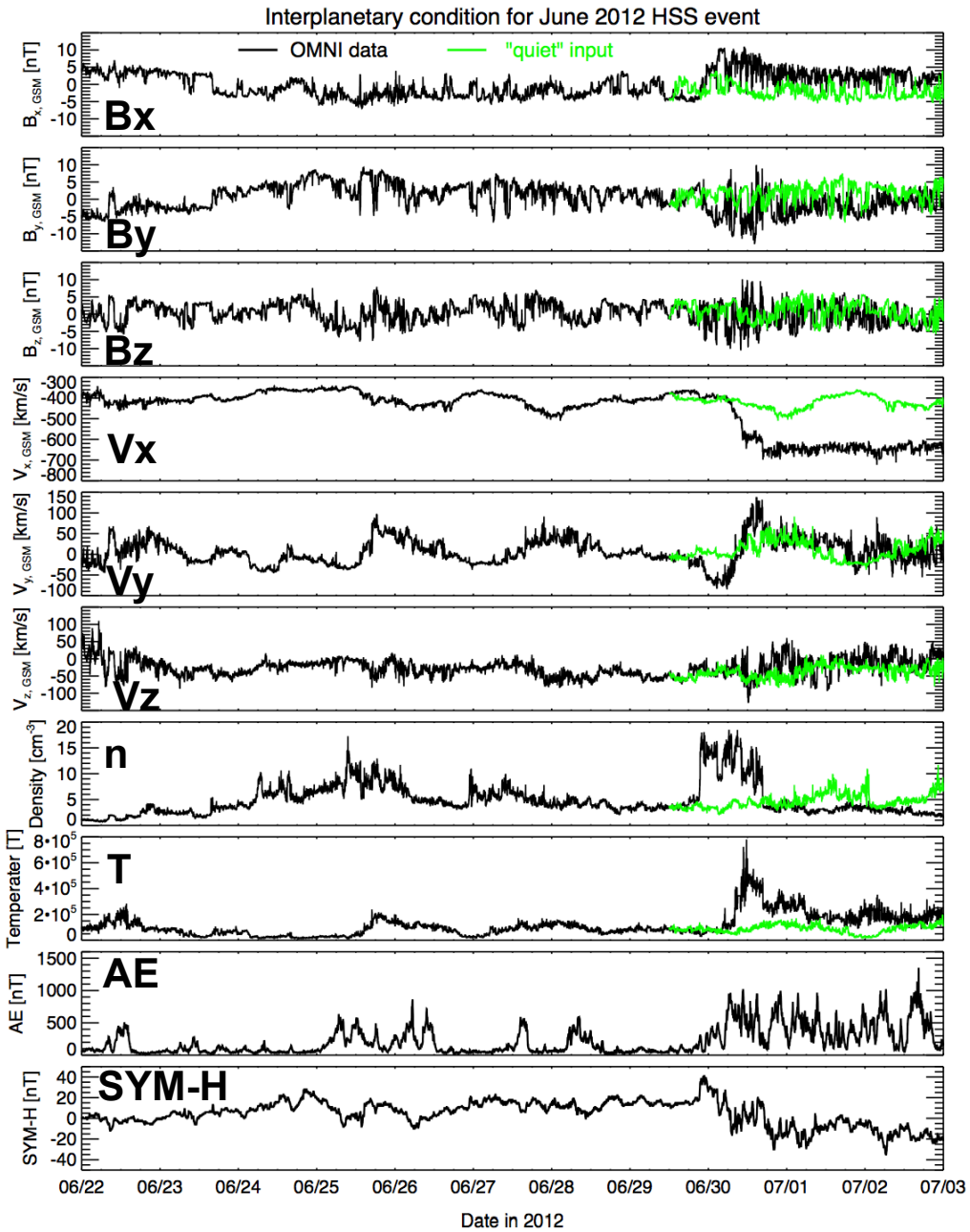


- Enhanced TEC

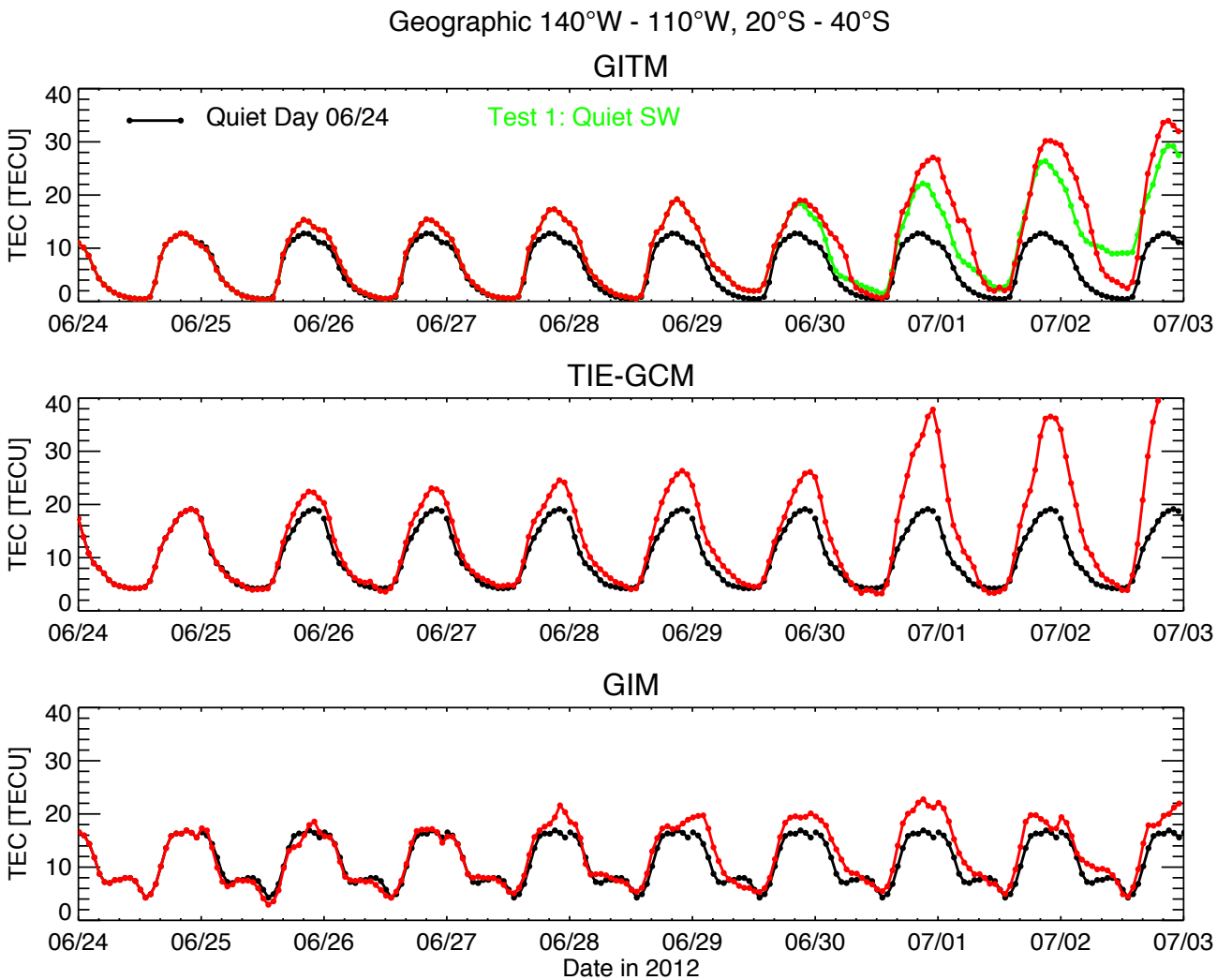
Modeling Experiment Set-up

- **GITM Test 1**: "quiet" solar wind + actual F10.7
- **GITM Test 2**: "quiet" solar wind + "quiet" F10.7





Modeling Experiment Results



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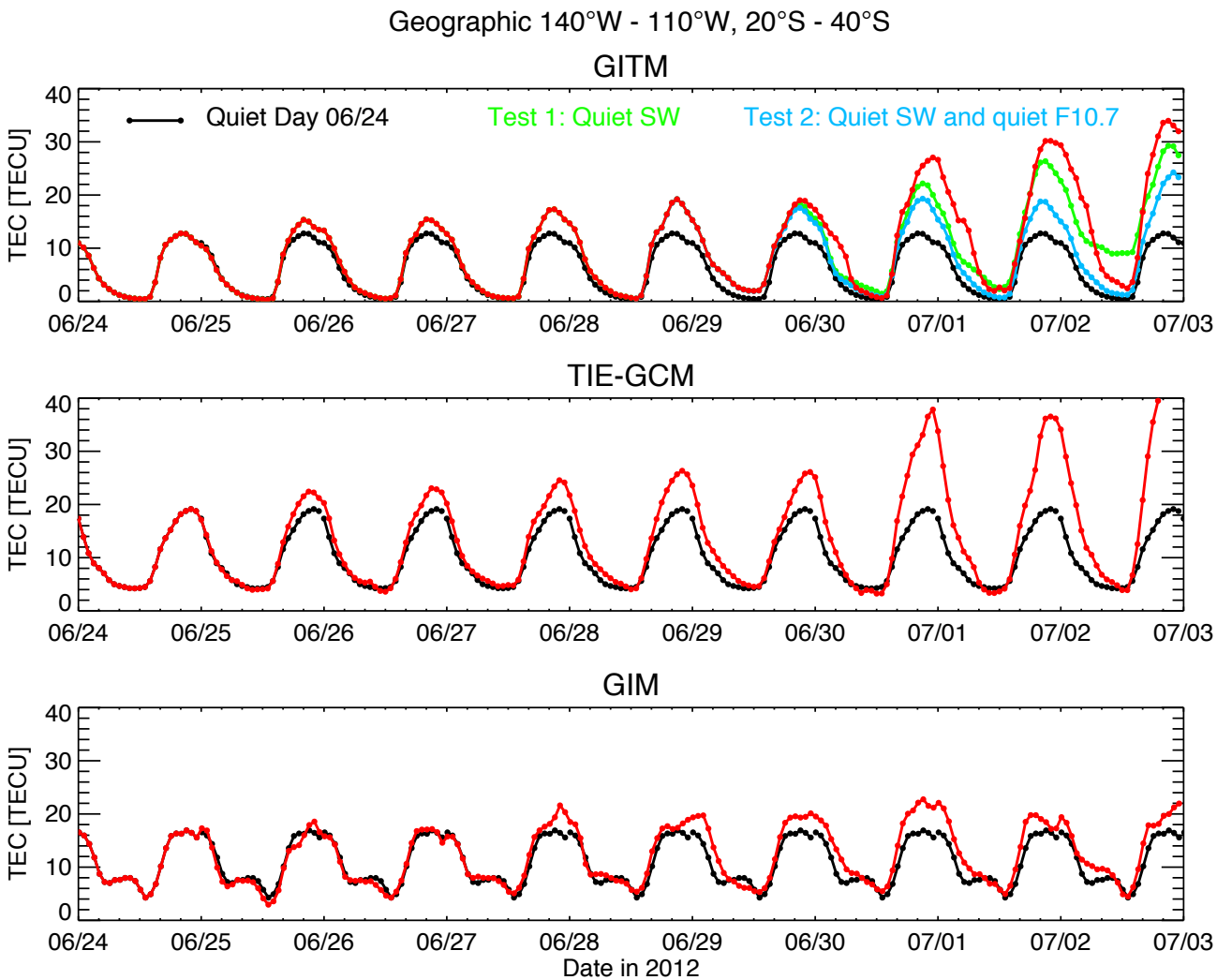

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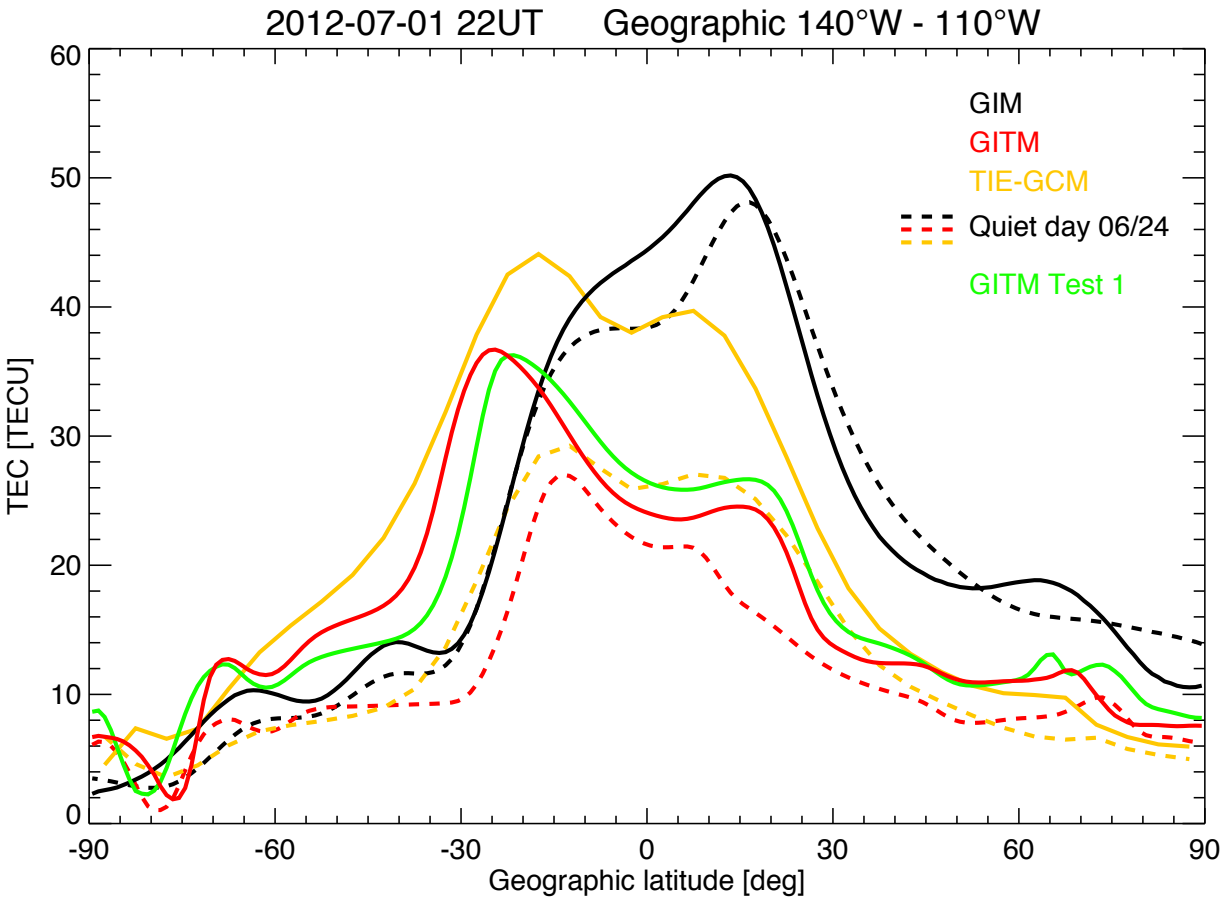

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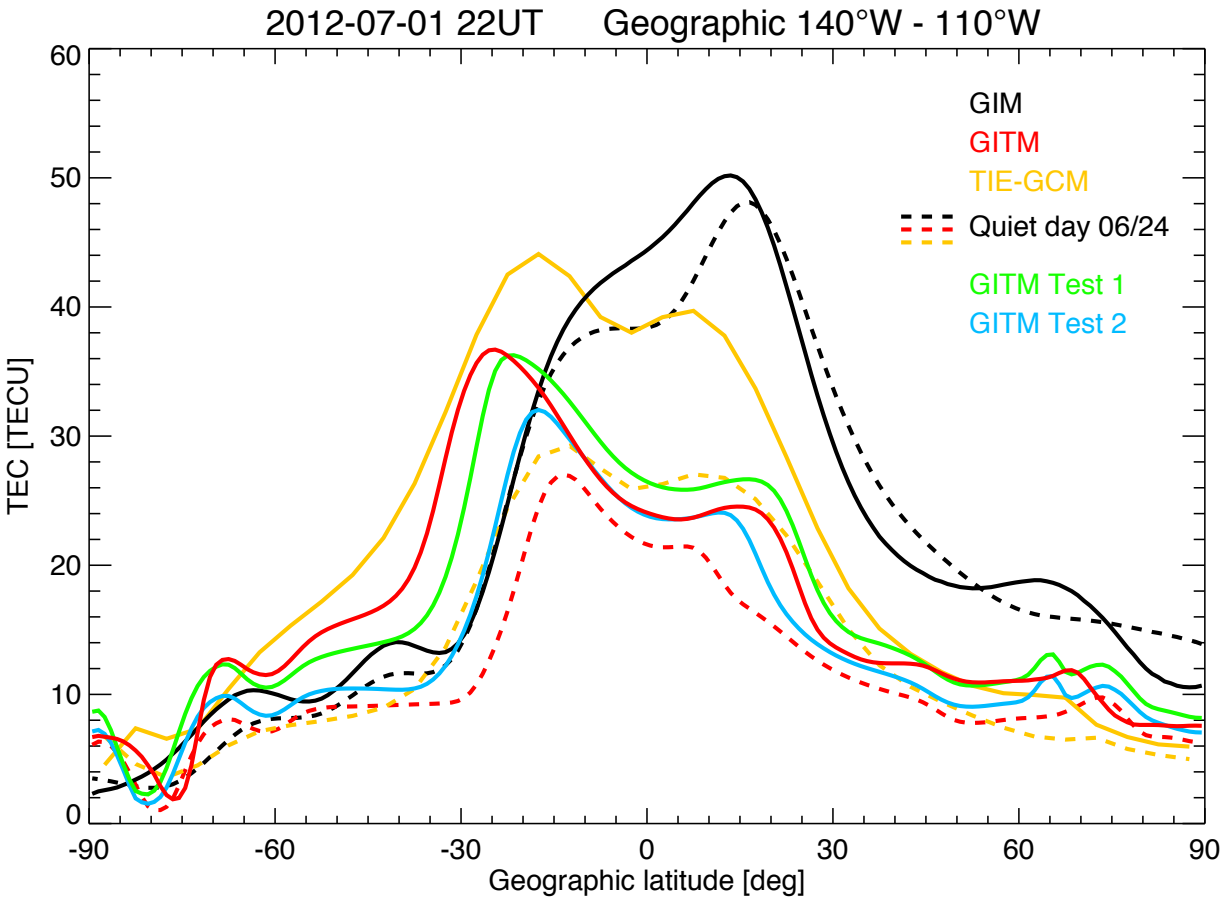


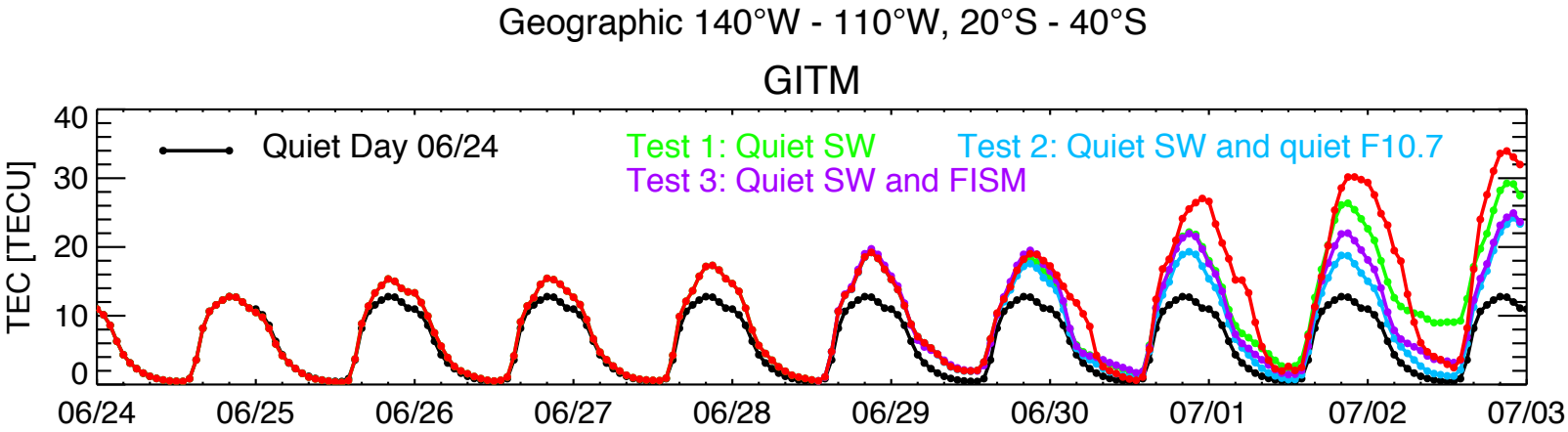
Questions

- Model accuracy degrades when solar irradiance is large?

- Model gets wrong solar irradiance from F10.7?

Another Test

- **GITM Test 3**: Quiet solar wind + Flare Irradiance Spectral Model (FISM)



Answers

- Model accuracy degrades when solar irradiance is strong?

  Not evident based on GITM experiments

- Model gets wrong solar irradiance from F10.7?

  Very likely!

  F10.7 → EUVAC solar flux model → GITM/TIE-GCM

  [Richards et al., JGR, 1994]

Discussion and Future Work

- Modeled TEC response to the June 2012 event depends much more on the F10.7 flux than the interplanetary conditions.

- The EUVAC solar flux model and/or F10.7 index can fail to provide accurate solar irradiance and induce significant TEC forecast errors.

- Next steps
  - Similar modeling experiments with TIE-GCM.
  - Understanding EUVAC model/F10.7 “fail”

Acknowledgement

- Living With A Star Targeted Research and Technology NASA/NSF Partnership for Collaborative Space Weather Modeling Program

- Model developers: A. J. Ridley et al. (GITM), R. G. Roble et al. (TIE-GCM)

- CCMC for conducting the TIE-GCM run

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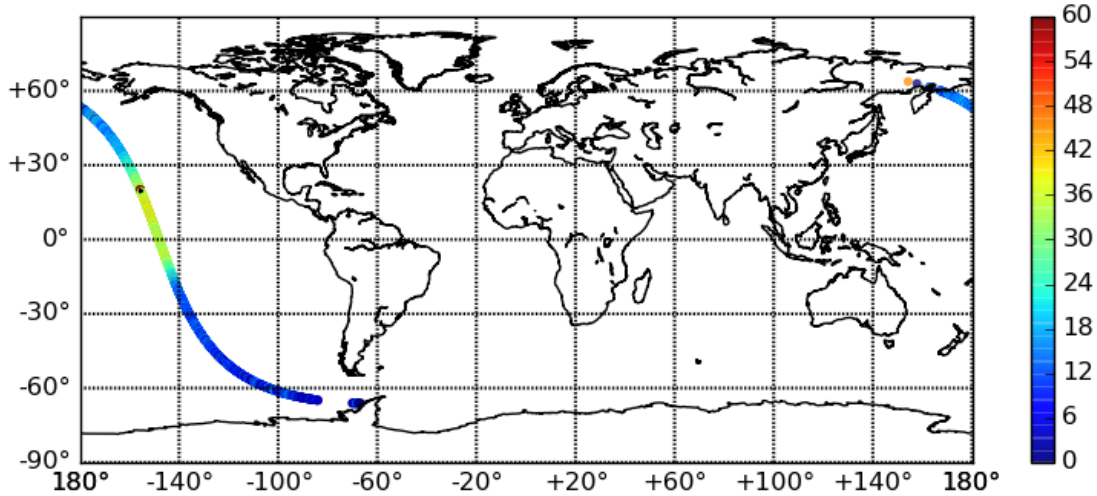
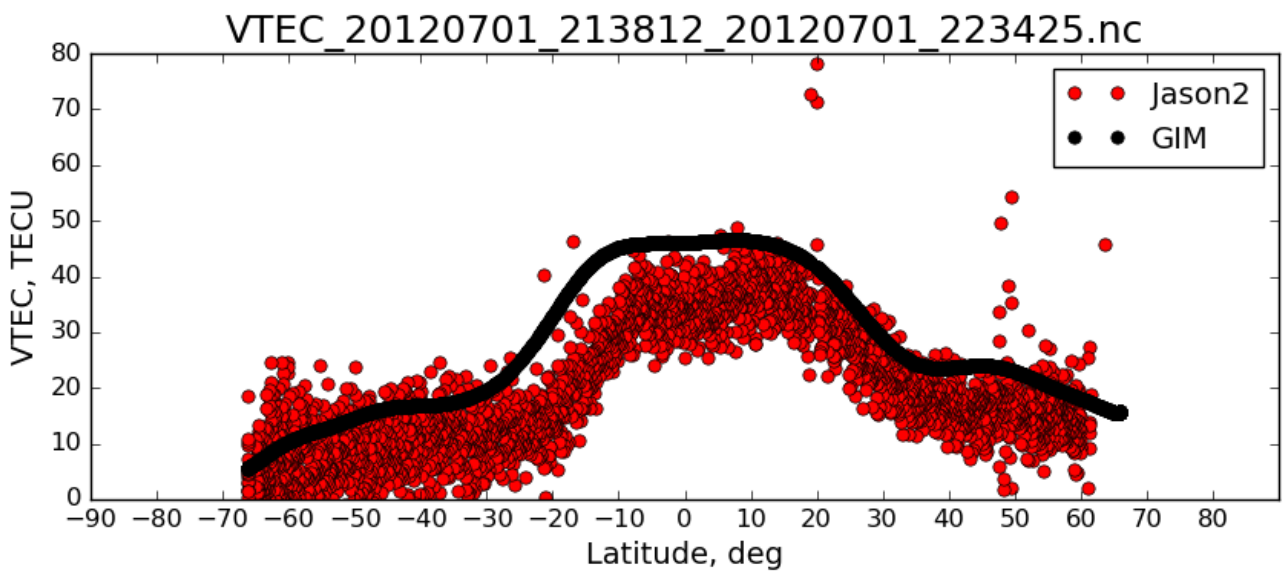
Backup I

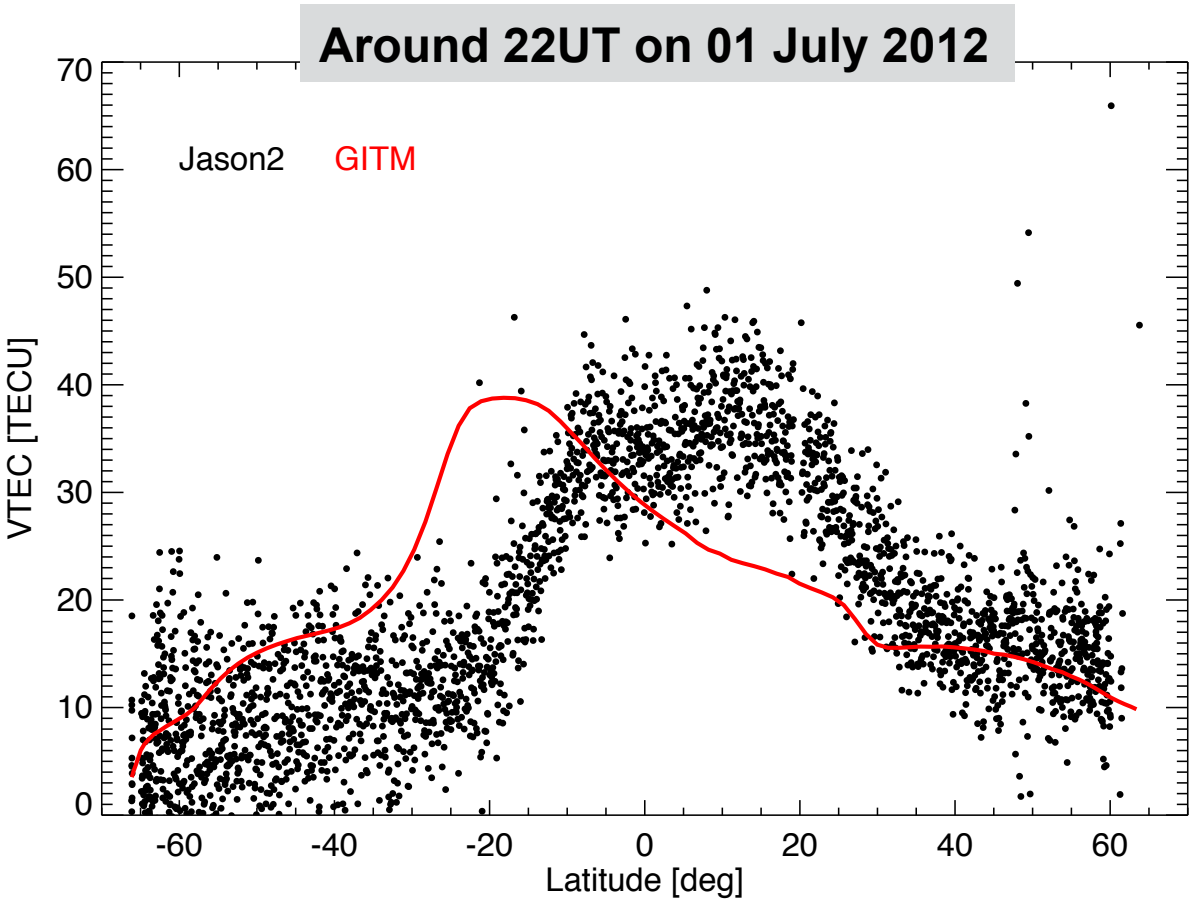
- Jason TEC vs. GIM TEC

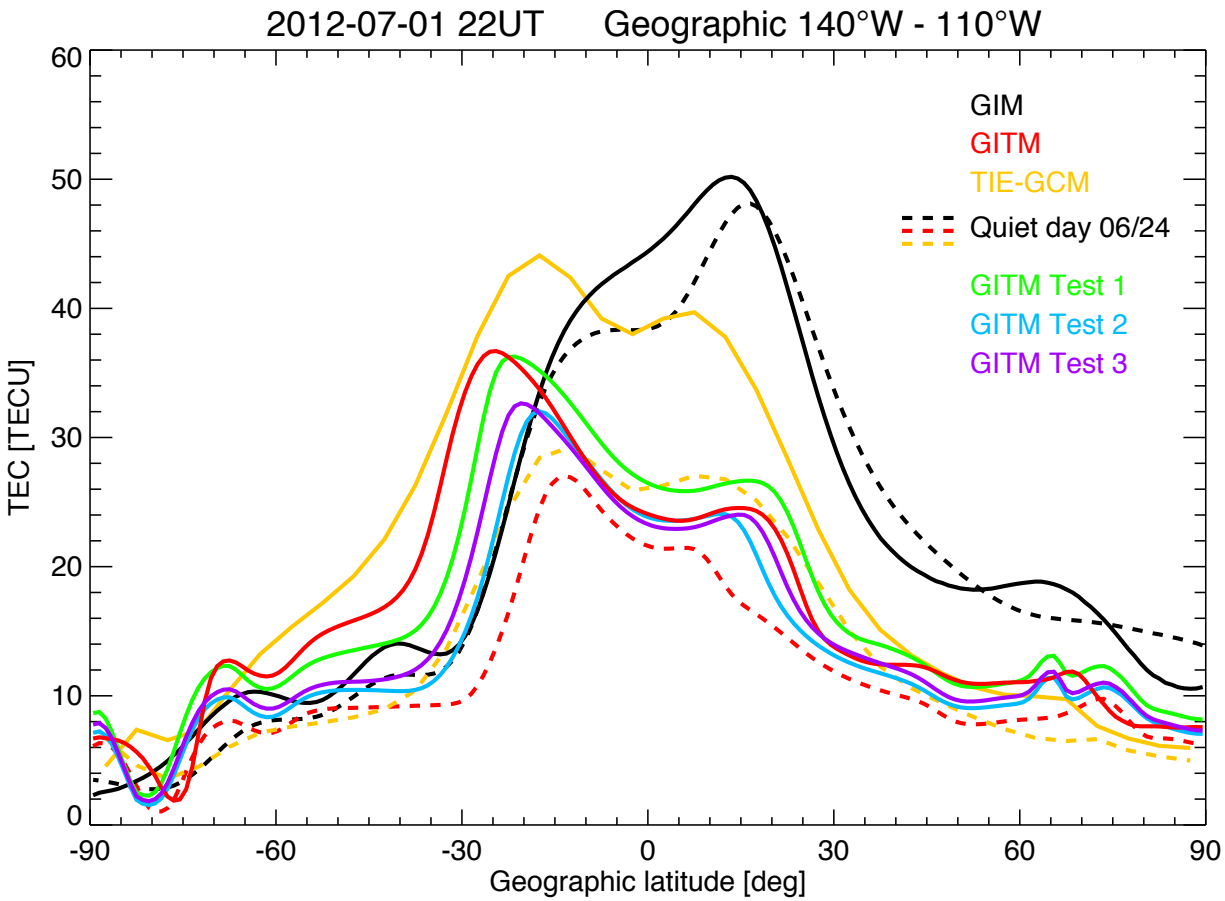




Backup II

- Jason TEC vs. GITM TEC



Backup III

- GITM Test 3