

SAMI3/WACCM-X Simulations of the Ionosphere during 2009

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Ionospheric Weather

- Direct solar radiation is the primary driver of ionospheric variation
- But lower-atmospheric weather accounts for a significant portion of the day-to-day variability observed in the ionosphere

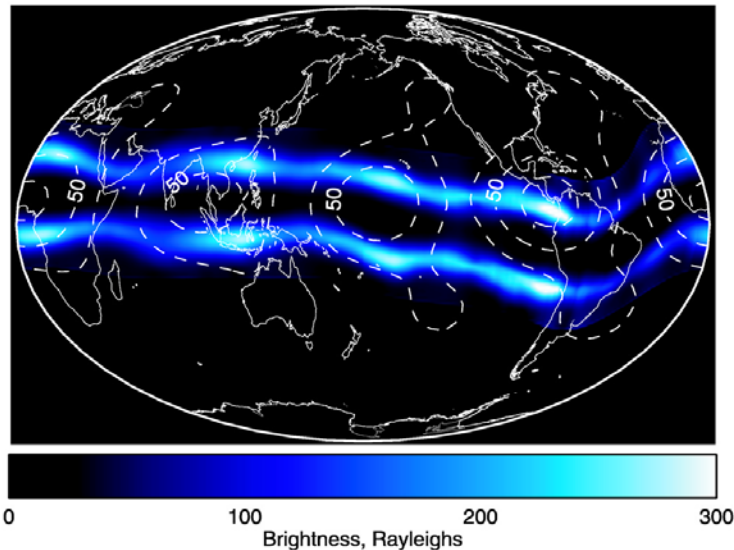
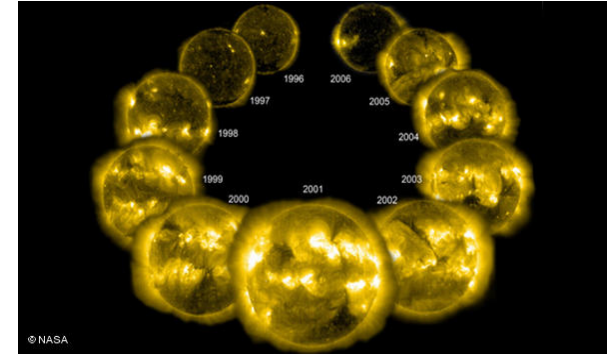
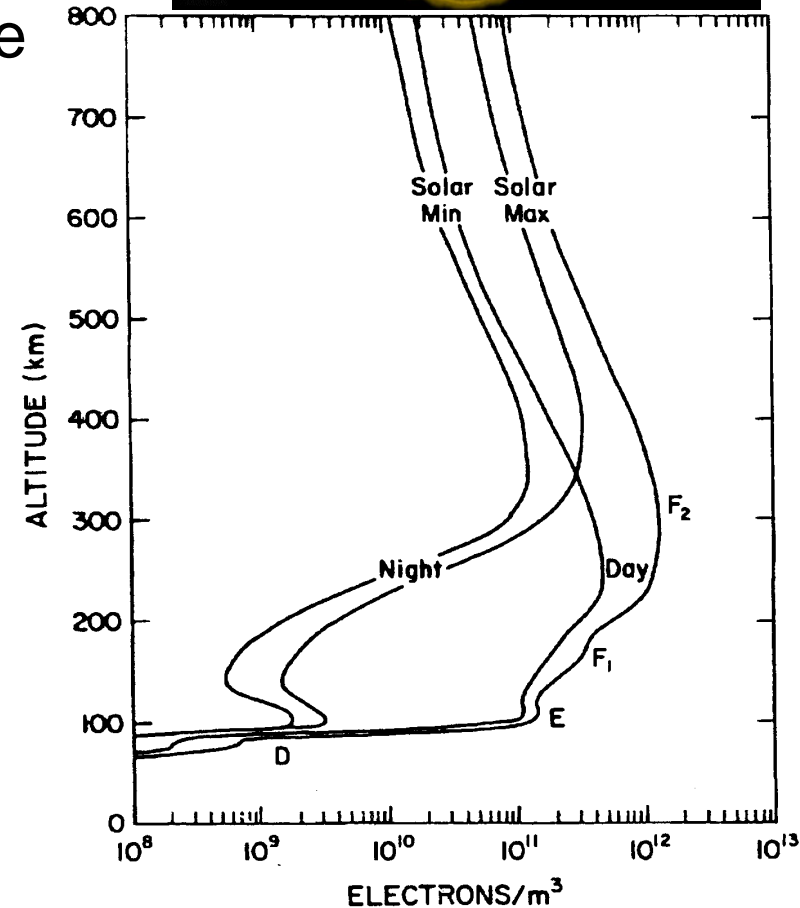
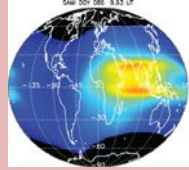


IMAGE composite of 135.6-nm O airglow (350-400 km) for March-April 2002 at 20:00 LT and magnitude of tidal temperature oscillations at 115 km due to upward-propagating lower atmospheric tides (*Immel et al., 2006*).



Models

NRLSSI Solar Irradiance Model



SAMI3

Physics based model of the ionosphere
Models dynamics and chemistry of
7 ion species from 85 km to 8 R_E



NRLMSIS

Thermospheric Composition
Neutral Winds
Temperature

Ion and electron density,
temperature, velocity,
Thermospheric Composition
Temperature



WACCM

Whole Atmosphere Community Climate Model

Global climate-chemistry model
Solves dynamics, physics and chemistry
globally from ground to ~500 km

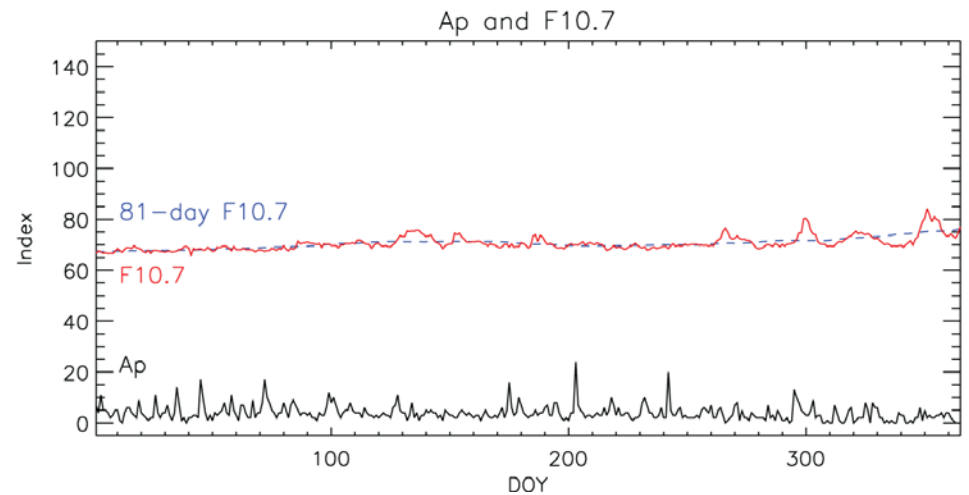
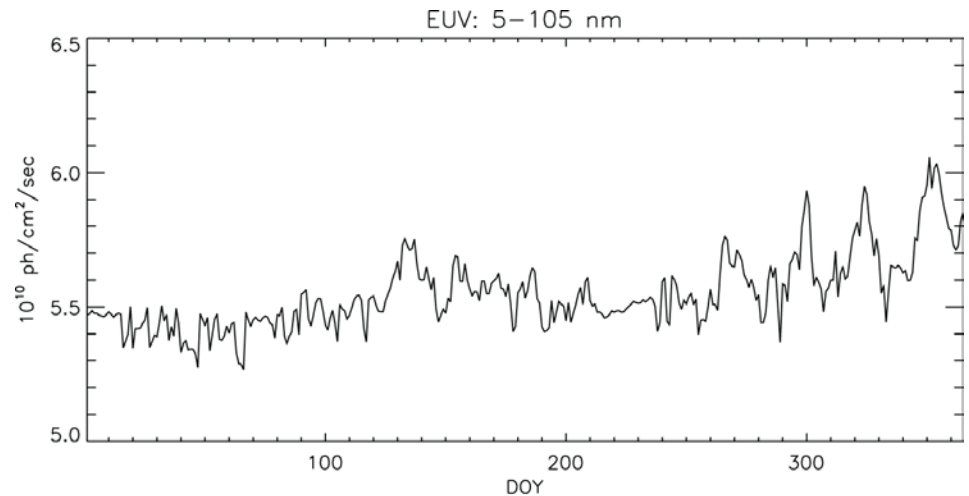


NAVGEM: Operational Navy Analysis (ground to
~92 km)
4DVAR data assimilation products (NASA/MERRA)

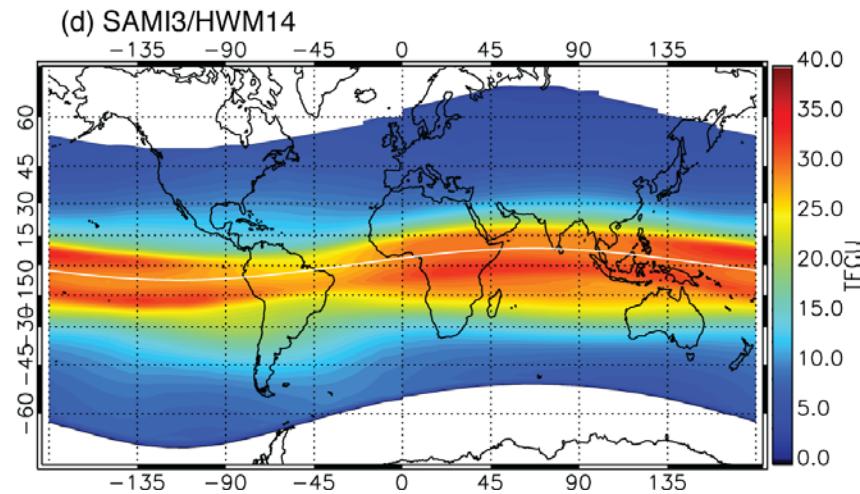
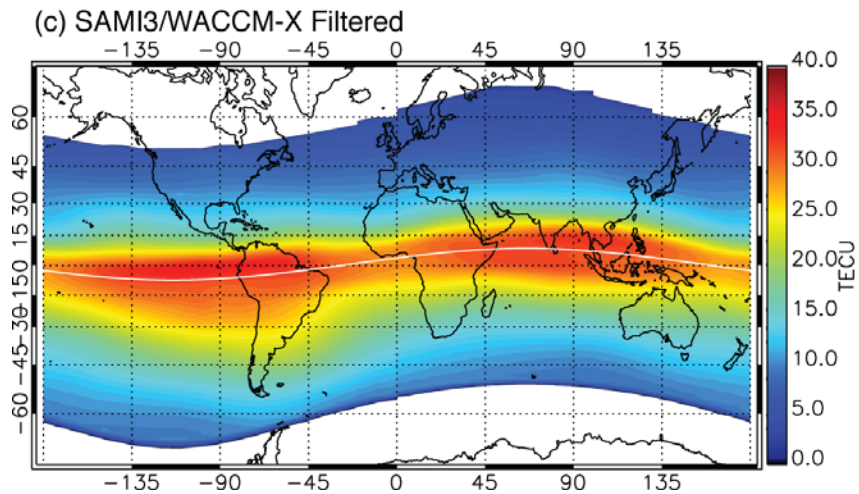
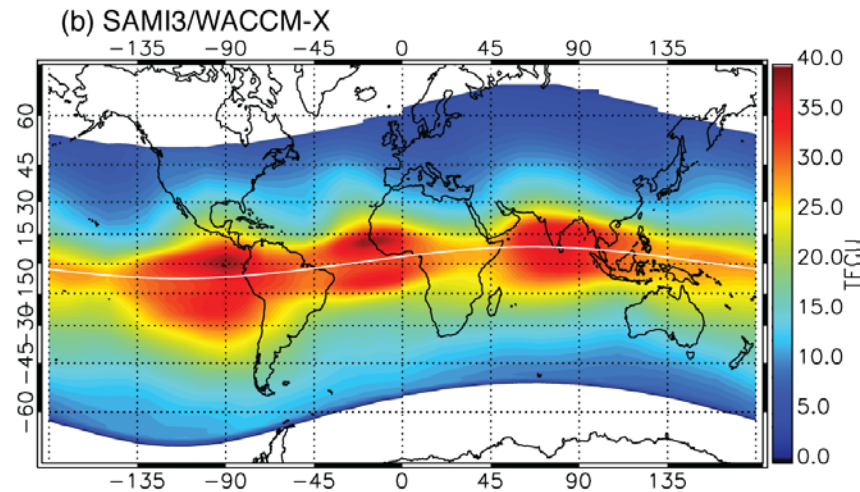
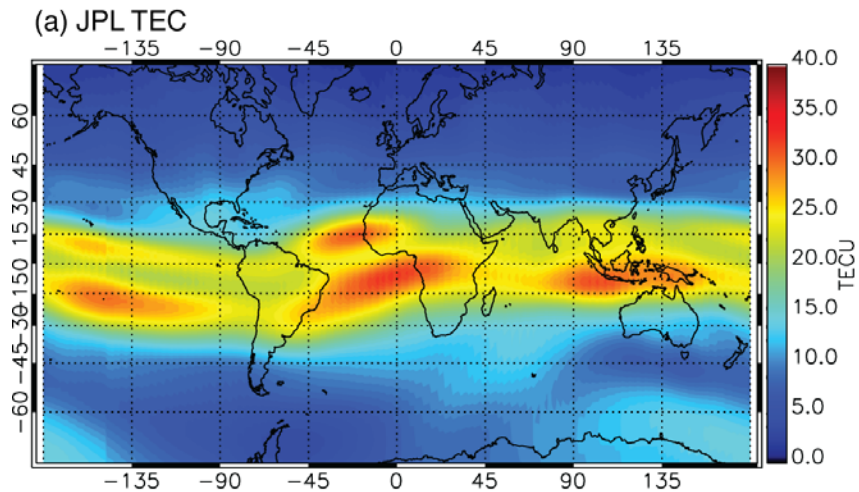
SD-WACCM-X

SAMI3 Simulations

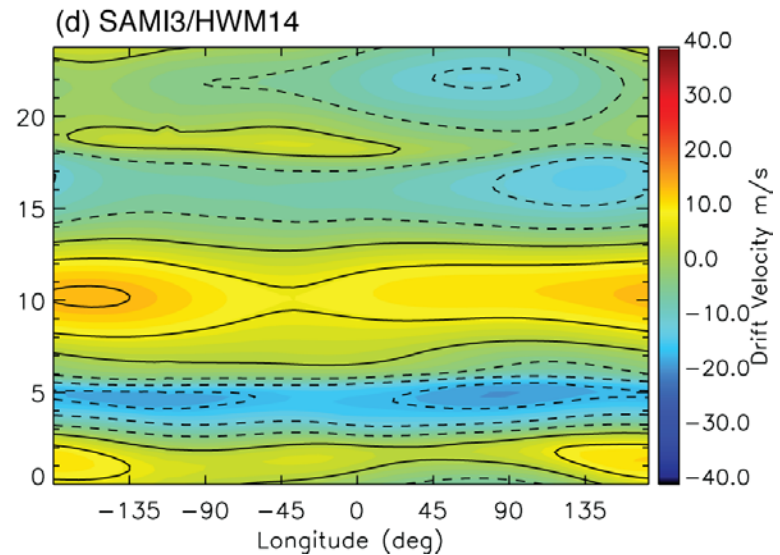
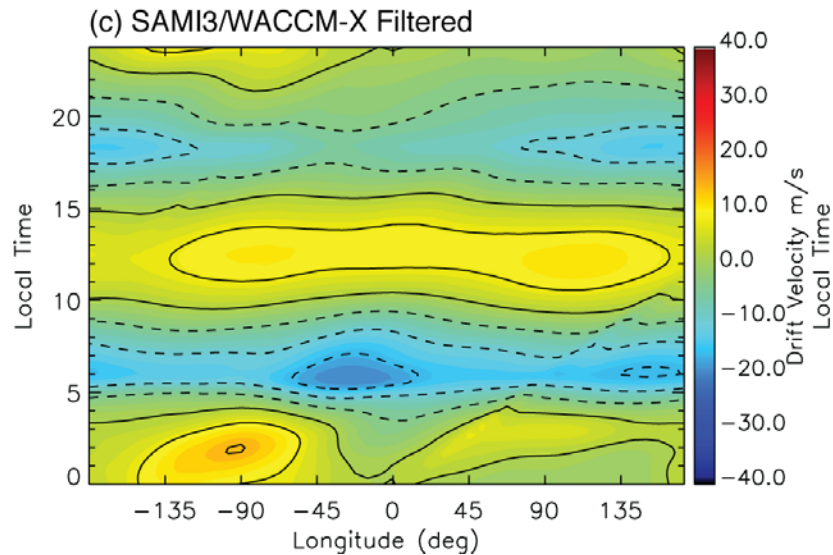
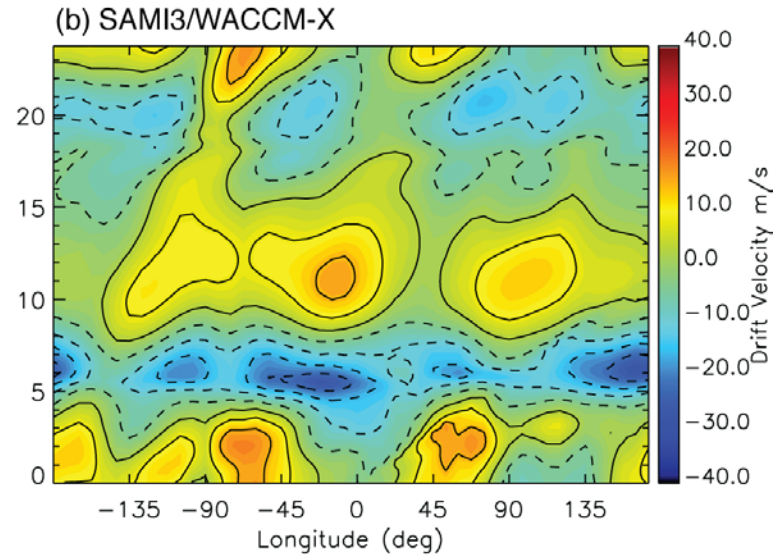
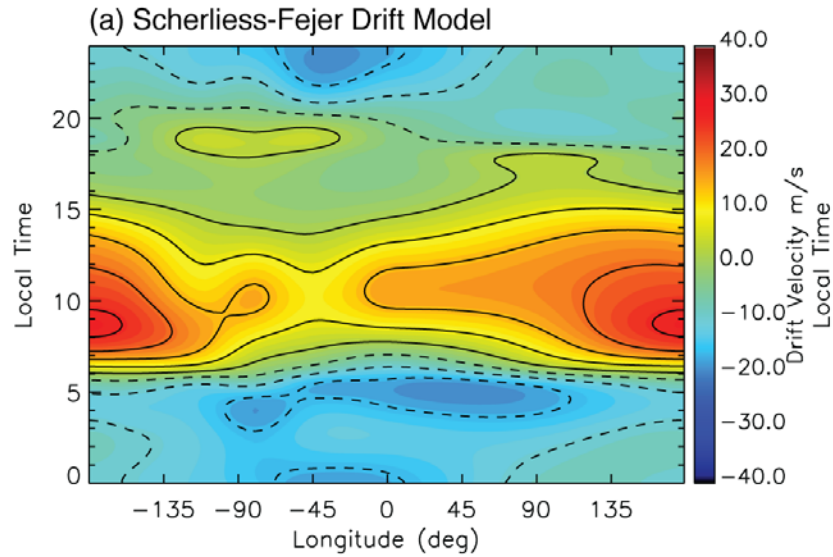
- 2009: January-February, April, July, October
 - SD-WACCM-X winds
 - With and without non-migrating tides
 - HWM14 (empirical model) winds
- Comparison with observations:
 - JPL Global Ionosphere Maps of total electron content (TEC)



Average Total Electron Content 14:00 LT, 6-15 January 2009



Mean Vertical ExB Drifts 6-15 January 2009



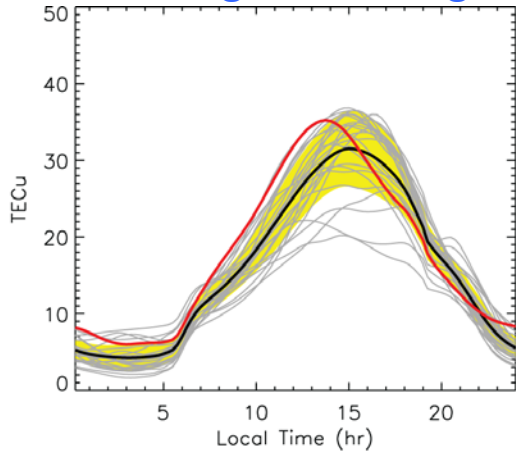
Day to Day Variability

January 6-31, 2009

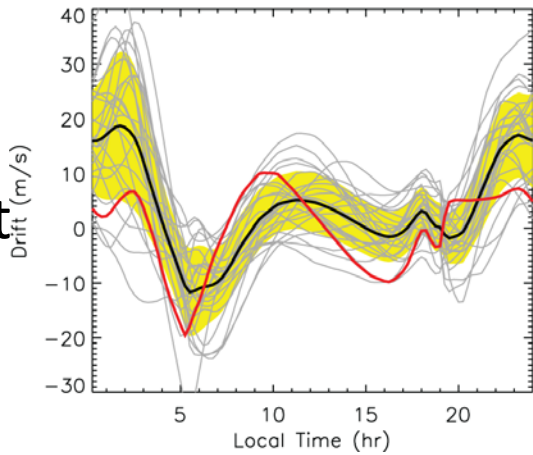
285° Lon, 0° Lat

SD-WACCM-X
Mig & Non-Mig

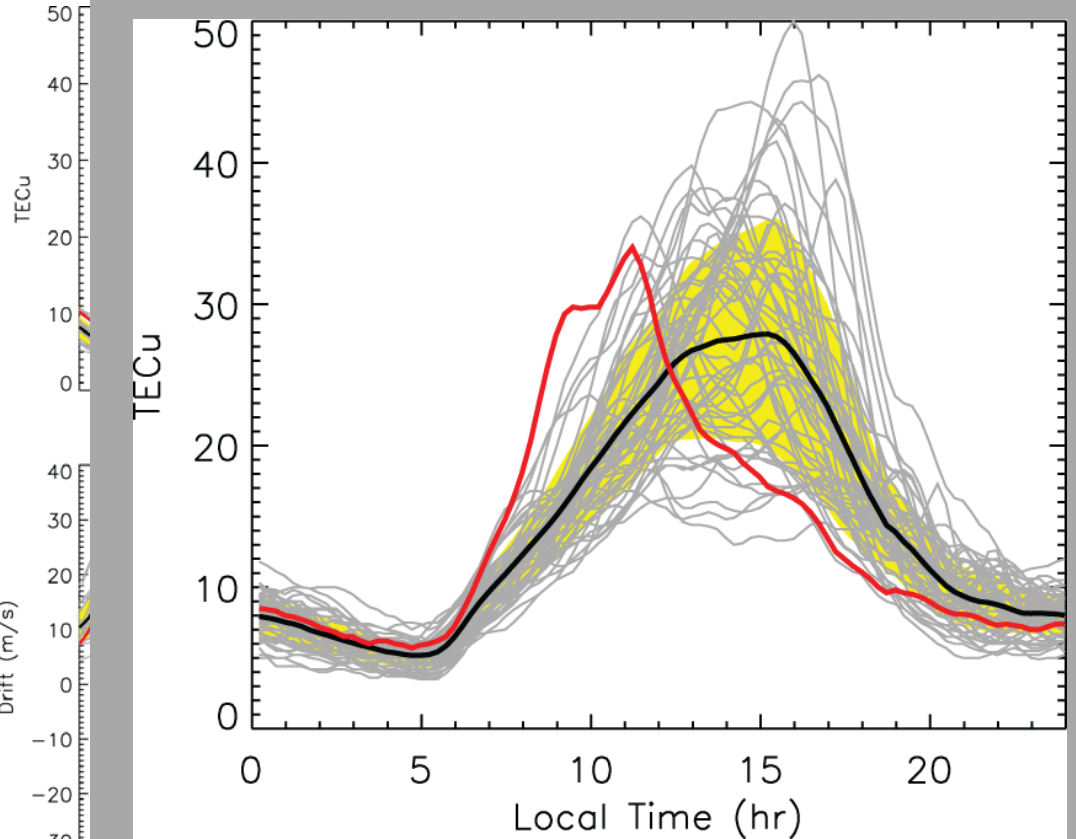
TEC



ExB
Drift



JPL TEC



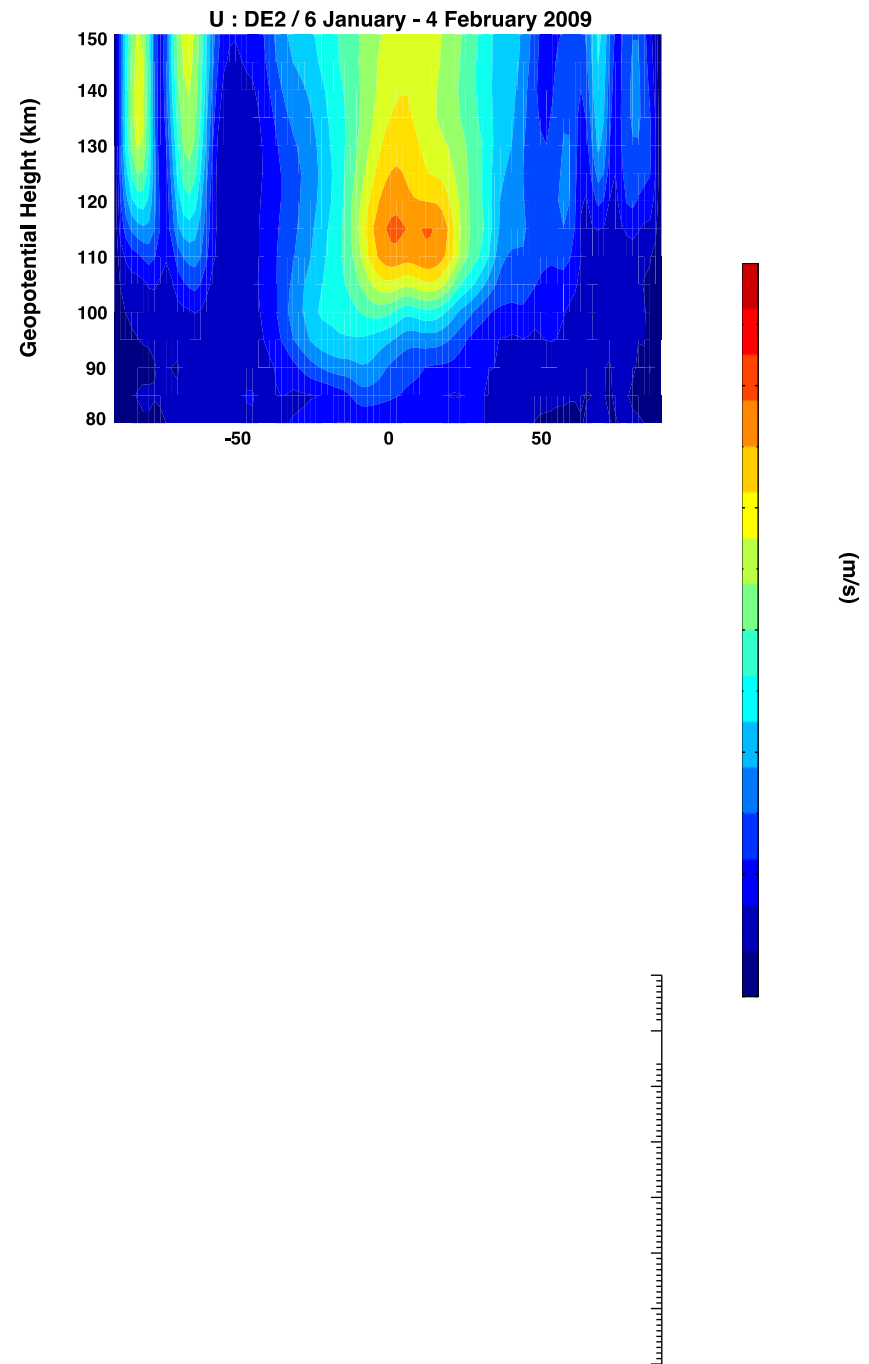
— Daily value

— Mean value

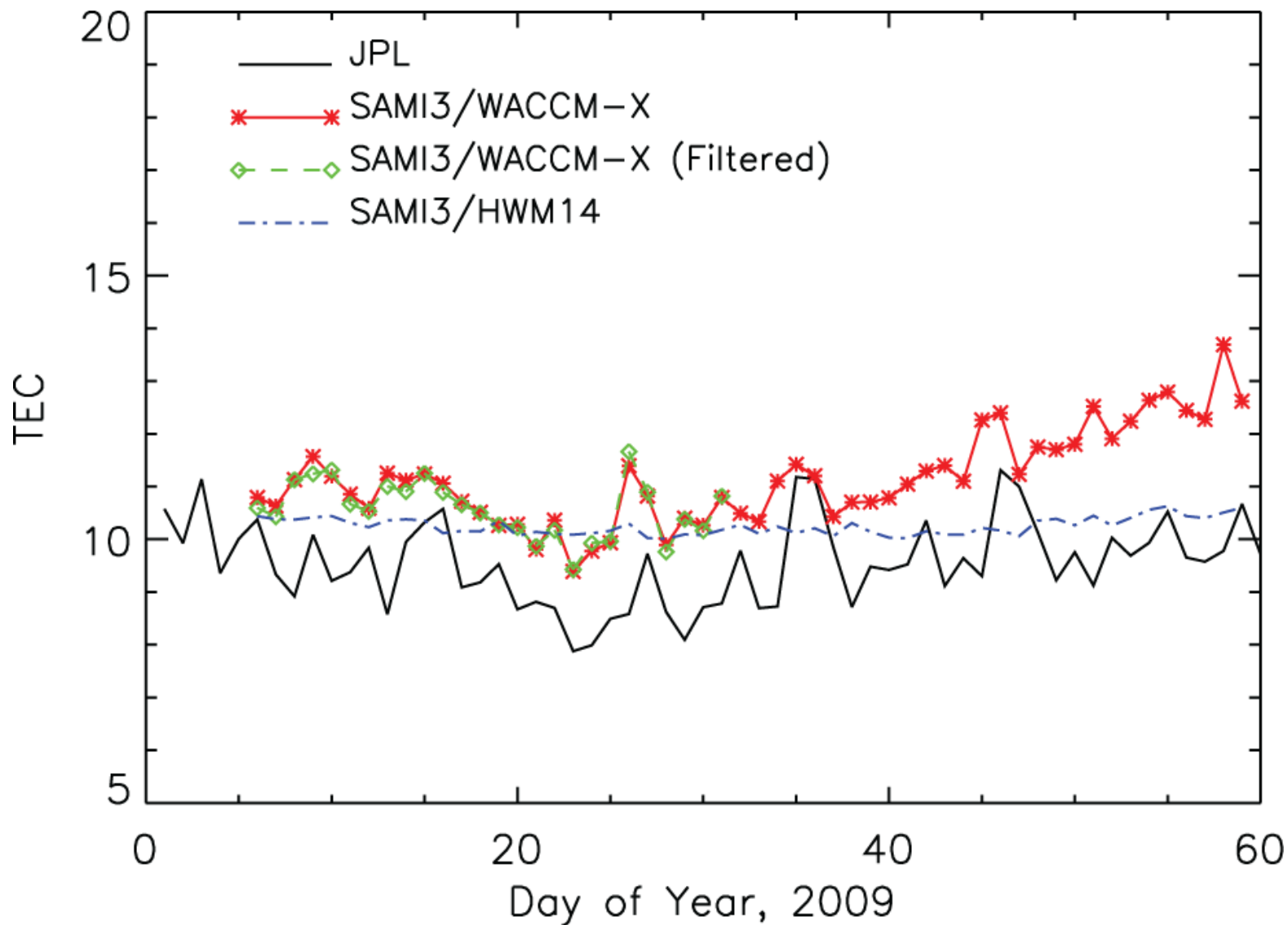
— 27 January (after SSW event)

SD-WACCM-X Average Non-migrating Tides in the Zonal Wind (6 January – 4 February 2009)

- DE2, SE2, DE3 – nonmigrating tides with large amplitudes in WACCM-X
- DE2 and DE3 generated by latent heat release in the tropical troposphere and generate wave-3 and wave-4 longitudinal patterns when observed at constant local time



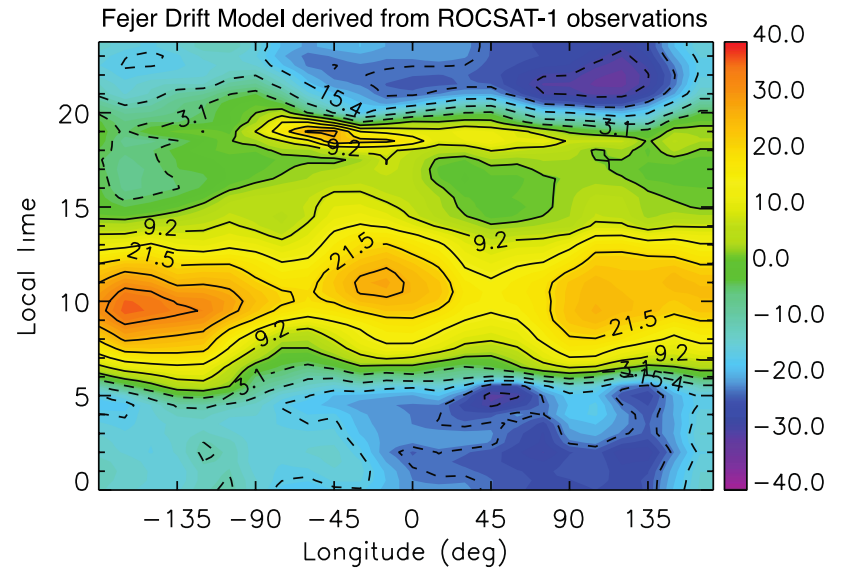
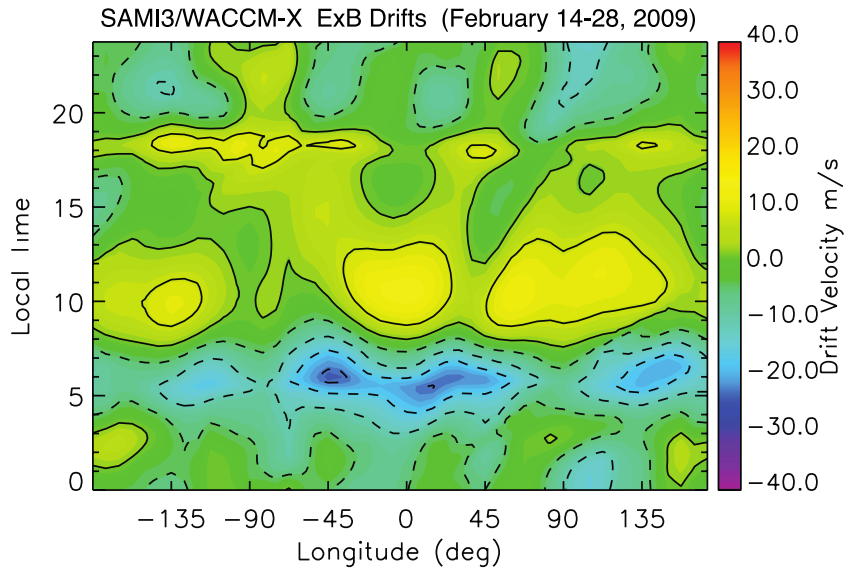
Global Mean TEC (January – February 2009)



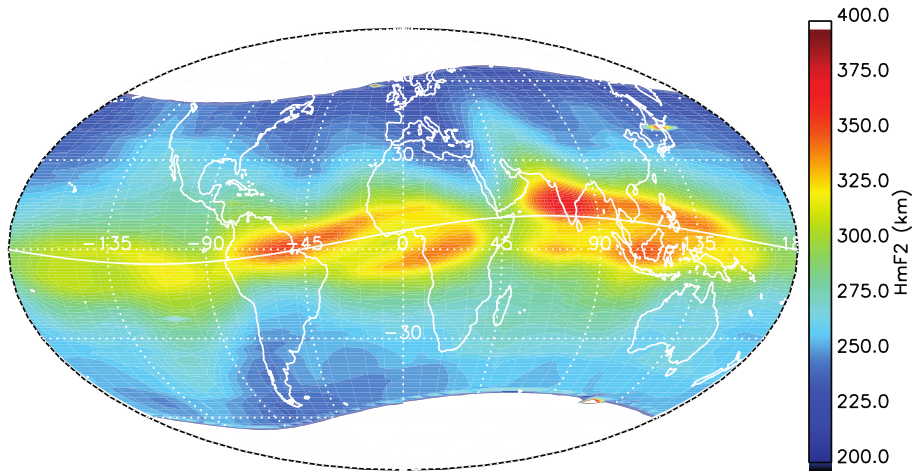
Summary

- Initial results of one-way coupling of SAMI3 to SD-WACCM-X winds
- Longitudinal and Day-to-day variations consistent with observations (but room for improvement...)
 - Longitudinal variations due to non-migrating tides
 - Evidence of Stratospheric Warming event on 27 January in non-migrating tides (possibly SE2)
 - Day-to-Day global mean variation due to migrating tides
- Future plans
 - Fully couple SAMI3/WACCM-X

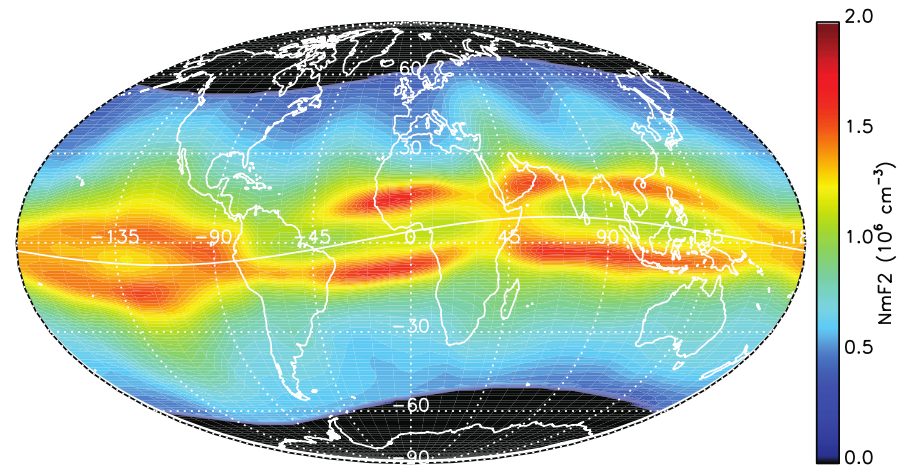
February 14-28, 2009



SAMI3/WACCM-X hmF2 at 1500 LT (February 14-28, 2009)



SAMI3/WACCM-X NmF2 at 1500 LT (February 14-28, 2009)



- January 2009 Stratospheric Warming
- Strong daytime ionospheric response in EIA
- Semi-diurnal feature with phase shifting to later times each day
- Perturbations lasting up to 3 weeks
- Observed 50 – 150% increase in TEC

