# LWS TR&T Recommended Strategic Science Areas

- **SSA-1, Physics-based Geomagnetic Forecasting Capability:** 15-30 min (short lead-time) and 1-3 day (long lead-time) predictions of pending extreme GIC events
- **SSA-2, Physics-based Satellite Drag Forecasting Capability:** global neutral density in low Earth orbit with a lead-time of at least one hour as well as longer-term predictions out to at least three days and preferably to seven days or longer
- **SSA-3, Physics-based Solar Energetic Particle Forecasting Capability:** probabilistic prediction of the intensity of SEP events, and increased time periods for all-clear forecasts with higher confidence level
- **SSA-4, Physics-based TEC Forecasting Capability:** specification of the global ion density in the ionosphere and plasmasphere with a lead time of at least one hour, as well as longer-term predictions
- **SSA-5, Physics-based Scintillation Forecasting Capability:** predict scintillation occurrence and ascertain how radio signals are degraded by ionospheric irregularities
- **SSA-6, Physics-based Radiation Environment Forecasting Capability:** predictive capability for the radiation environment and its effective dose as well as dose rates based on GCR, SEP, cutoff rigidity, atmosphere density, and gamma-ray/X-ray inputs

# The science the CCMC infrastructure is designed to do well:

Sun-to-Earth Modeling for traditional SW "scales" (3 flavors: solar radiation, solar energetic particles, geomagnetic activity,

- Tracing the flow of plasma from the Sun (ENLIL, etc.)
- How the magnetosphere responds (OpenGGCM, etc.)
- Quantifying drivers and energy input to the upper atmosphere
- Neutral density and large-scale ionospheric response to solar and geomagnetic activity (CTIPe, TIEGCM, GITM, etc.)

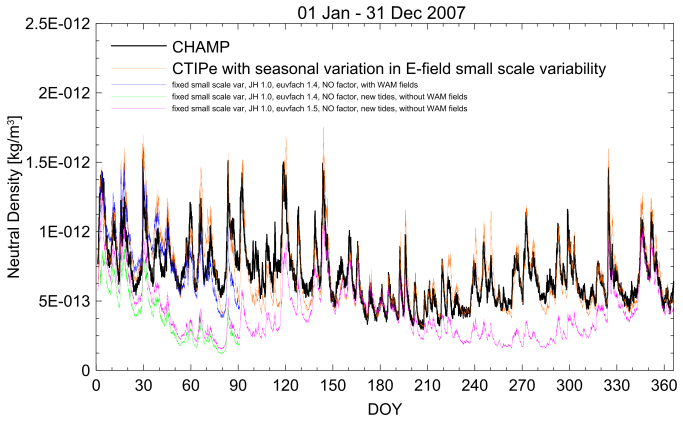
Doesn't mean we have all the models, understanding, or expertise to predict solar and geomagnetic activity and the geospace response (some missing pieces)

- Connection between magnetospheric MHD and iono flux tube models
- How the magnetospheric energy is dissipated
- Exosphere
- Mass loading
- EUV prediction

Still need improved models, validation, etc. but the CCMC structure is designed and built around this objective and paradigm

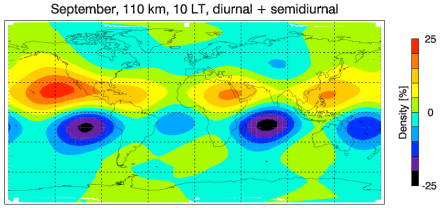
# Science the CCMC infrastructure is not designed for:

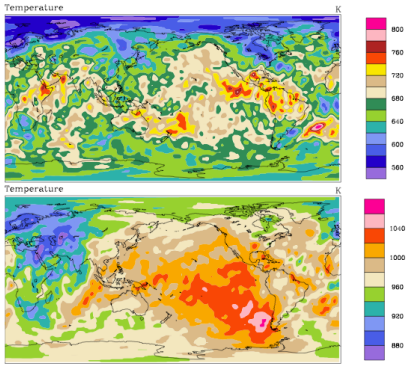
- SSA-2 Neutral density variation not driven by solar variability – semi-annual variation, tidal/planetary/gravity wave response



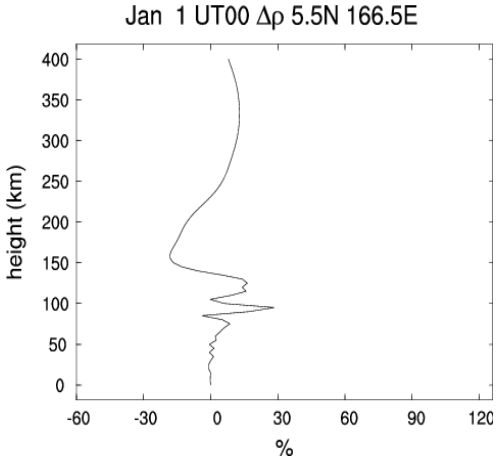

neutral density compared with CHAMP

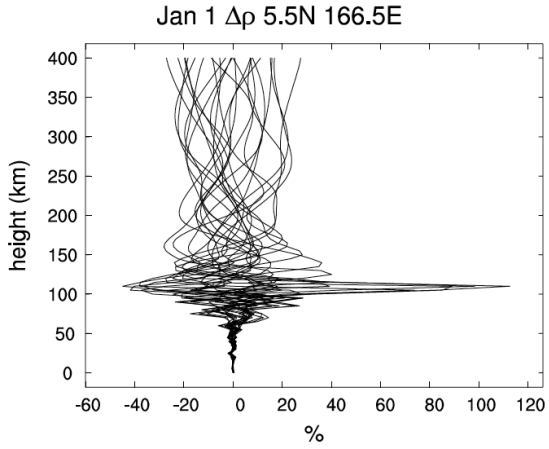
Variability in the thermosphere and ionosphere

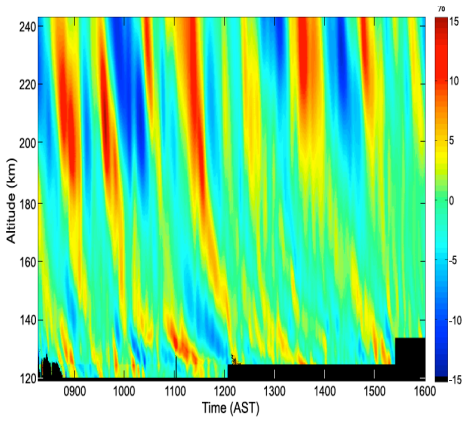


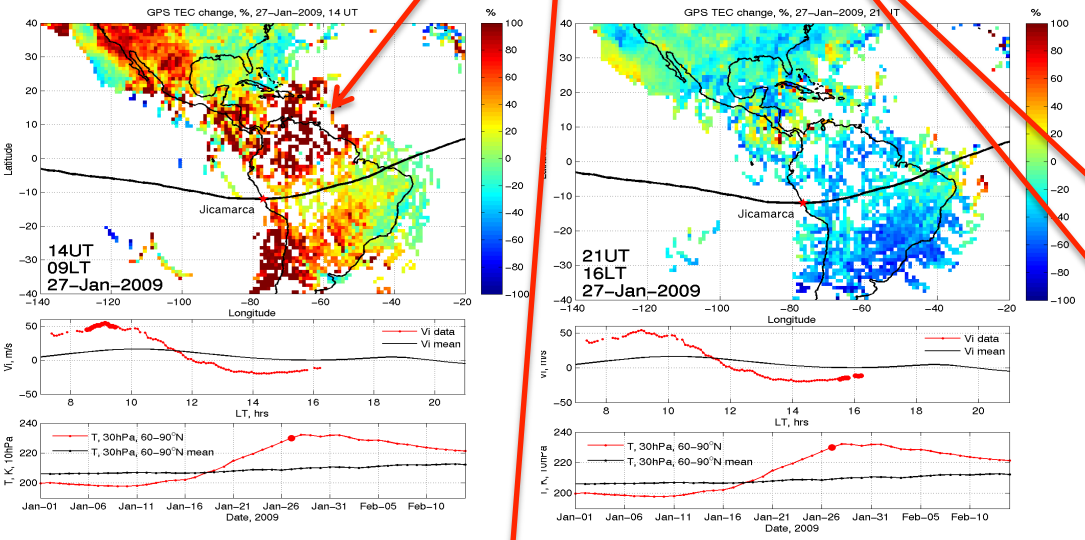

- SSA-2 Neutral density (and ionospheric) variability in the lower thermosphere sub-orbital and re-entry region



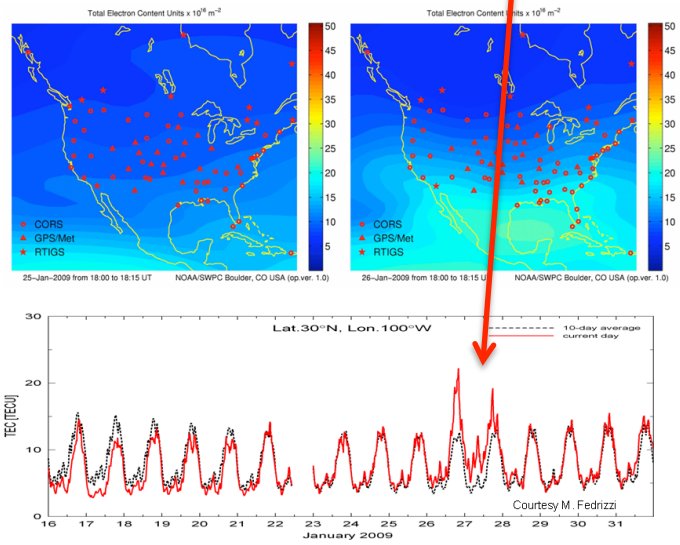



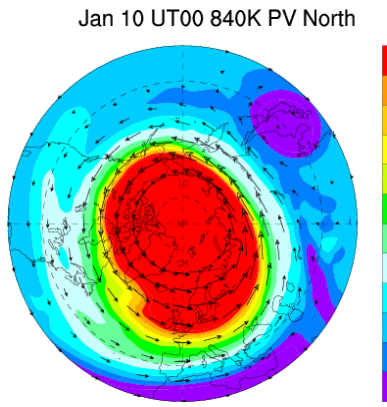
SSA-4 50-100% changes in plasma content (TEC) during breakup of stratospheric polar vortex (unrelated to solar or geomagnetic activity?




Goncharenko et al., 2010




NOAA US-TEC




Whole Atmosphere Model (WAM) simulation

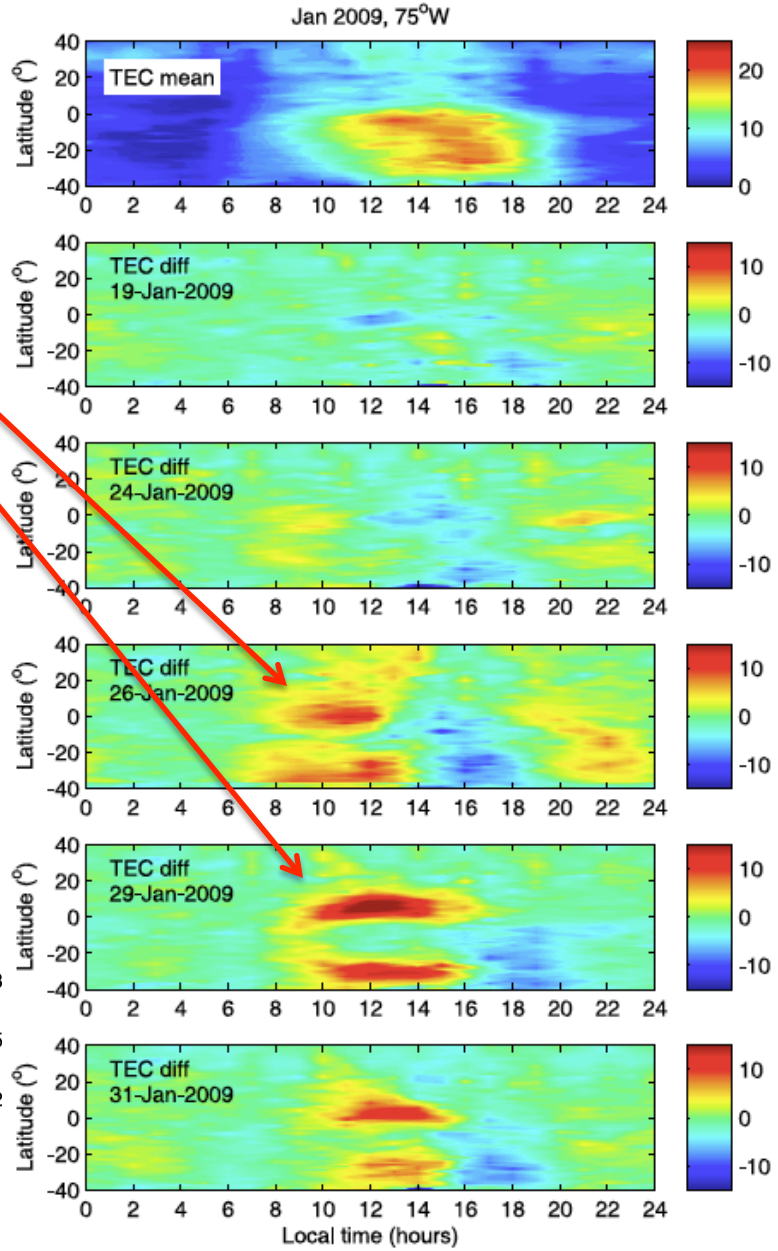
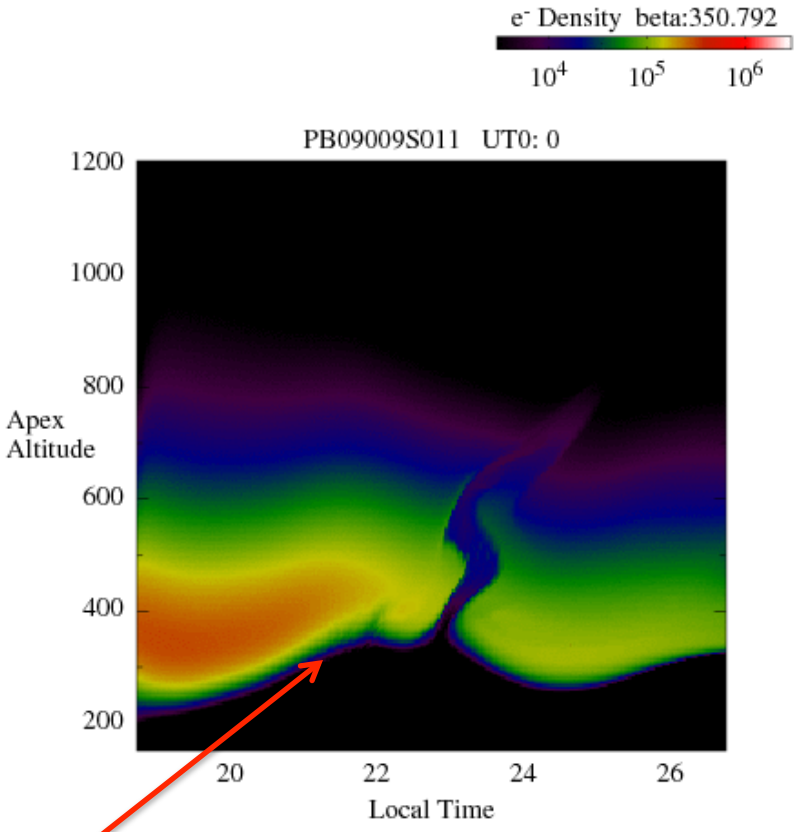
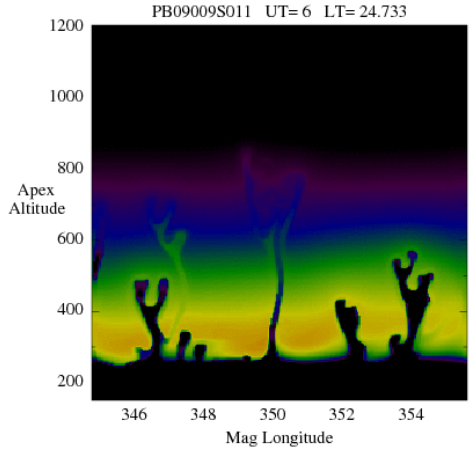


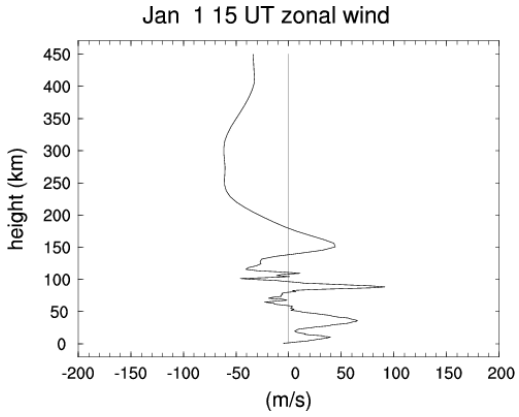

**Figure 3.** TEC variation at 75°W in local time and latitude during the January 2009 SSW. (top) The 10 day mean TEC prior to SSW. (lower) Differences in TEC from the mean state during the SSW.

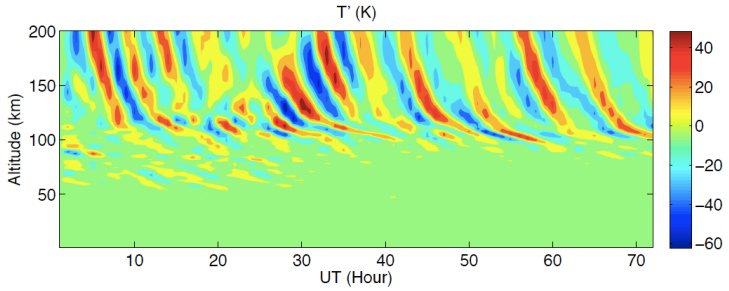
SSA-5 Day-to-day changes in occurrence of ionospheric irregularities and small-scale structure, again unrelated to solar and geomagnetic activity

Bubble development in physics-based irregularity model (PBMOD) with WAM fields at 180 km horizontal resolution with no additional seeding Retterer et al.

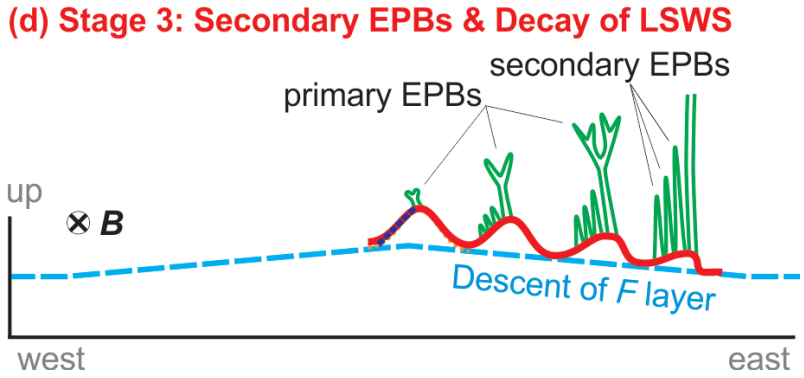



forecasting large scale wave structure, (LSWS) on bottomside




Roland Tsunoda

# Possible changes in CCMC infrastructure to address these new science challenges

- Expand CCMC to include connection between space weather with terrestrial weather (whole atmosphere-ionosphere models can examine the fourth flavor of space weather)

- Data assimilation as a science tool (not just for space weather applications), CCMC can provide the infrastructure to get the most out of satellite missions – GOLD, ICON, COSMIC-II, SWARM, SSULI/ SSUSI, etc.

- Need an expanded infrastructure of CCMC to mirror terrestrial weather capabilities – MERRA (retrospective analysis for science), GMAO (NASA's assimilation center), etc.

- JCSDA (Joint Center for Satellite Data Assimilation) - develop a common assimilation infrastructure at NOAA and NASA