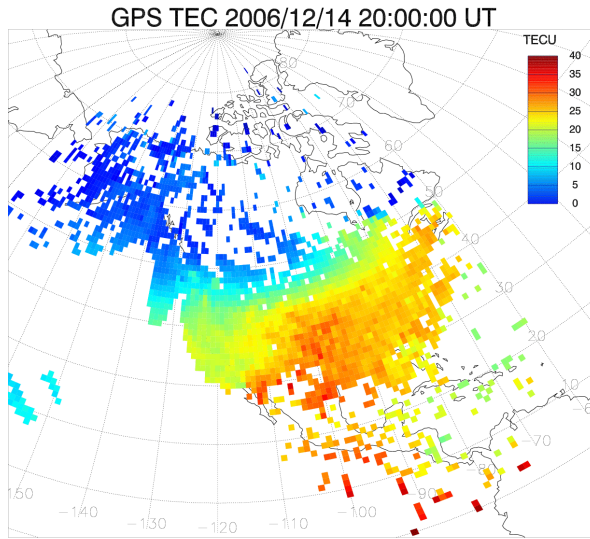


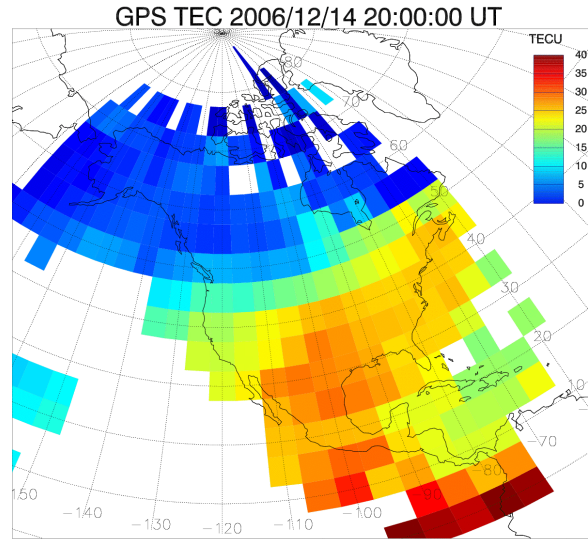
On-going Community-wide Projects to Assess Capabilities to Quantify Storm-driven Ionospheric Disturbances

- Quantification of the storm effects on Ionosphere-Thermosphere
 - TEC
 - Neutral density
 - foF2
- Challenges in model/data comparison for validation of TEC disturbances

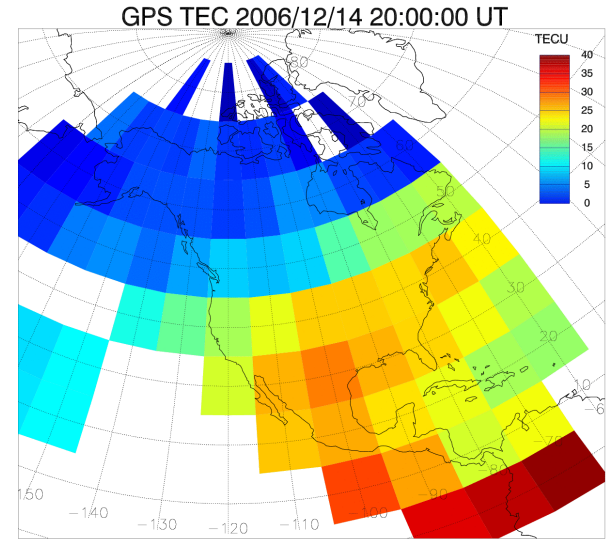
What is the optimal resolution?



1° lat × 1° lon

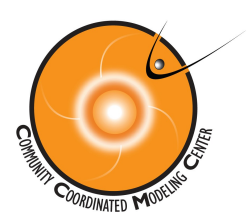


5° lat × 5° lon



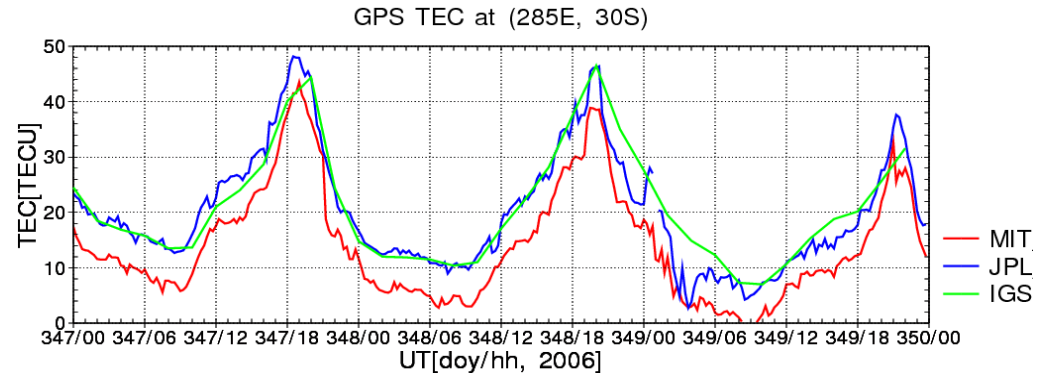
10° lat × 10° lon

- resolution of measured TEC ↑, number of data points ↓, TEC error ↑
- 2.5° lat × 5° lon x 5 min

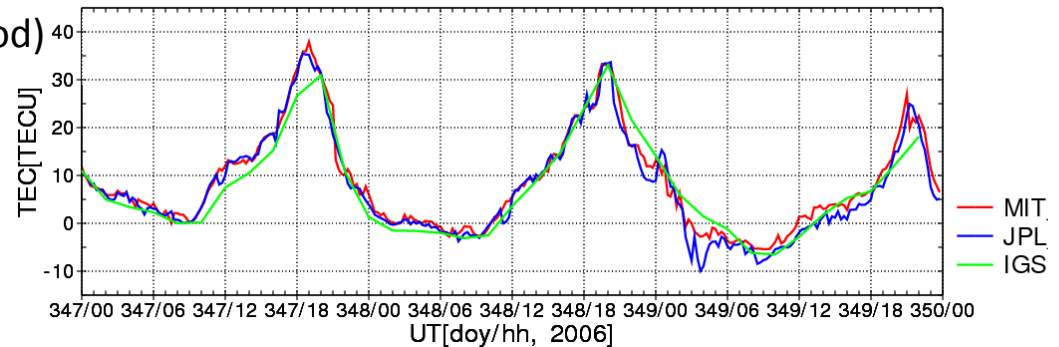


Biases/Baselines in TEC Measurements

- Difference between GPS TEC data sets



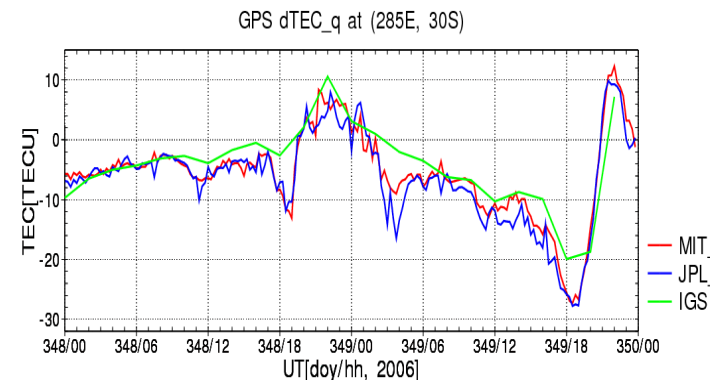
- $TEC - TEC_{min}(\text{pre-storm period})$

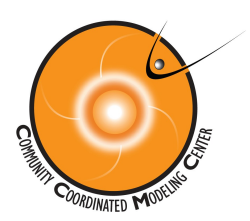


- $TEC - TEC_{quiet}$:

What is the best quiet time reference?

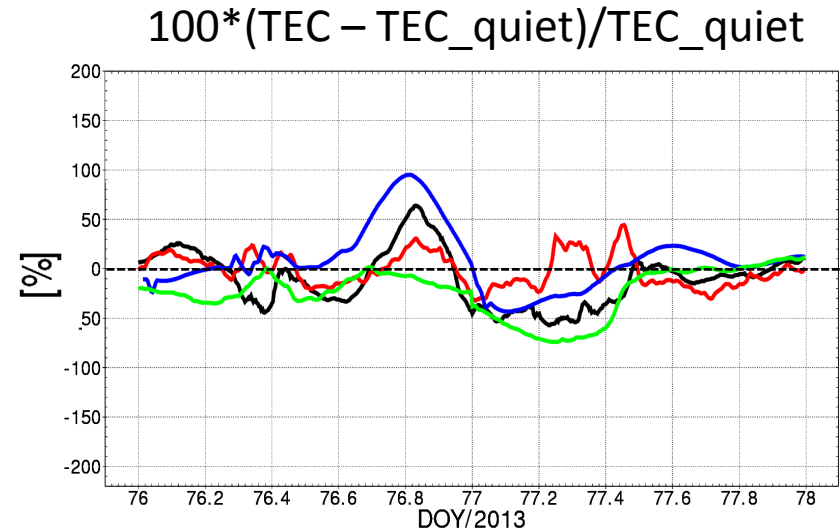
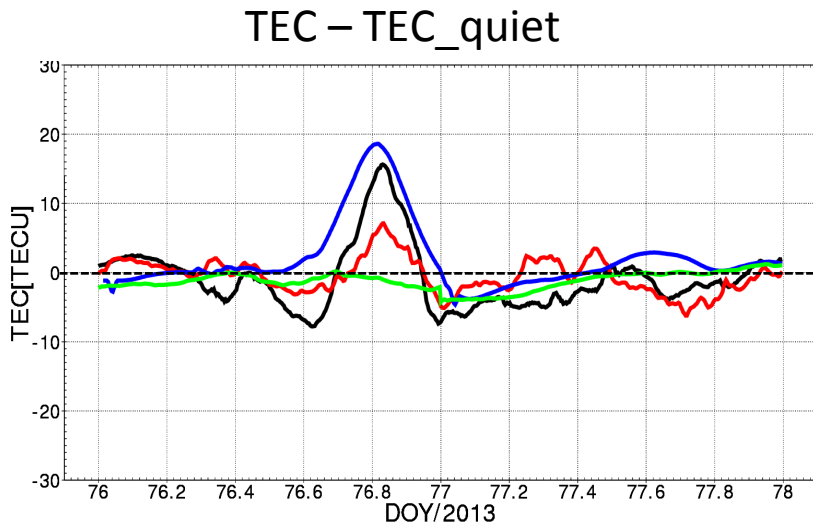
- TEC of one day prior to storm events
- median for the 30 days prior to storms



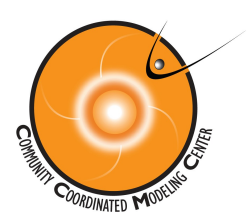


TEC Changes & Percentage Changes

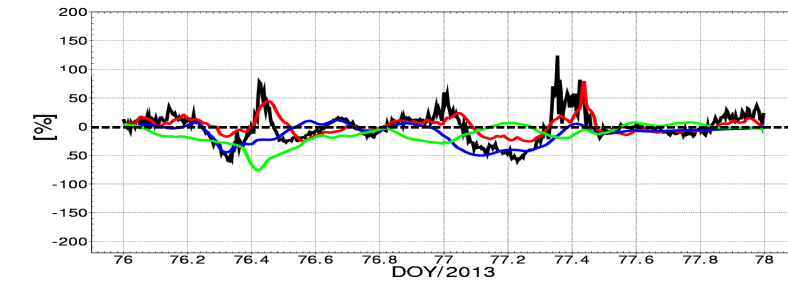
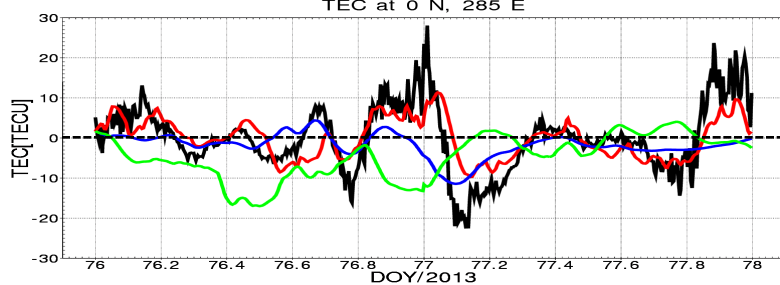
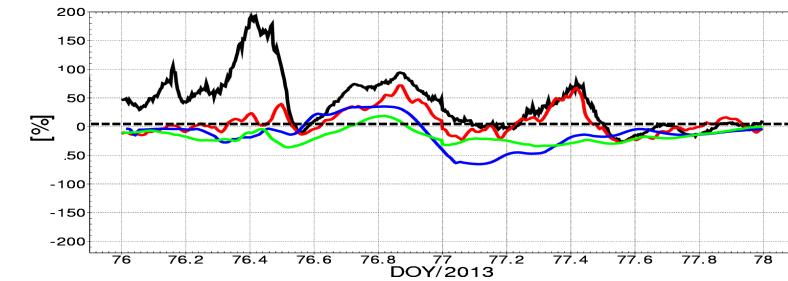
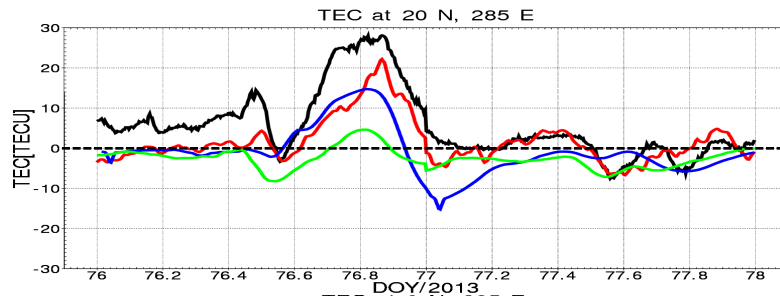
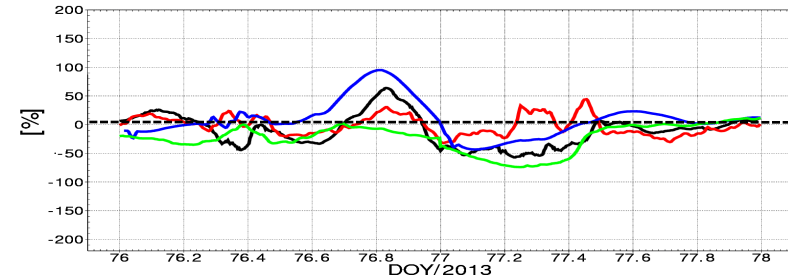
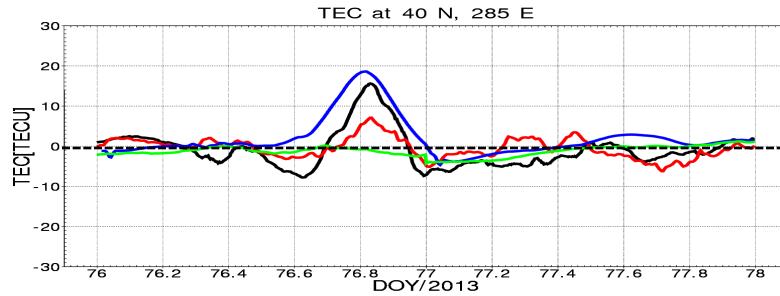
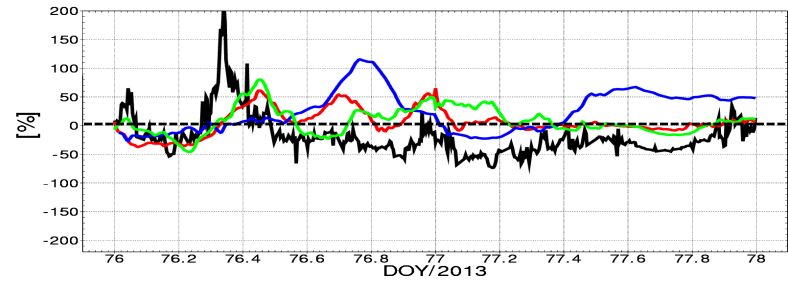
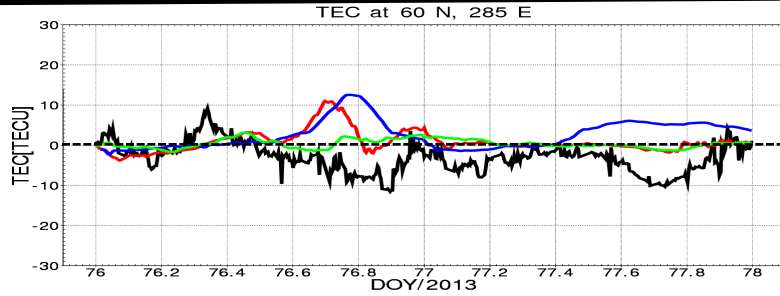
at (40°N, 285°E)

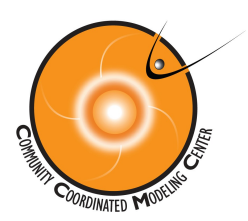


- during 2013 Mar. event (03/17, DOY 076)
- black: GPS TEC
- colored lines: modeled TEC

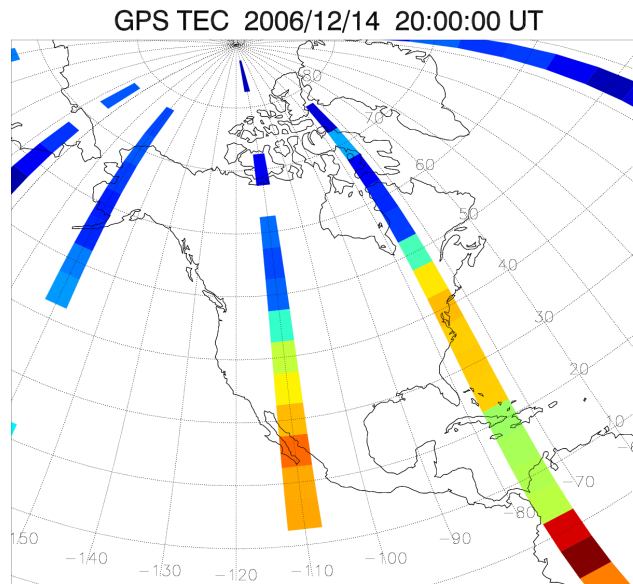


TEC Changes & Percentage Changes at 285°E

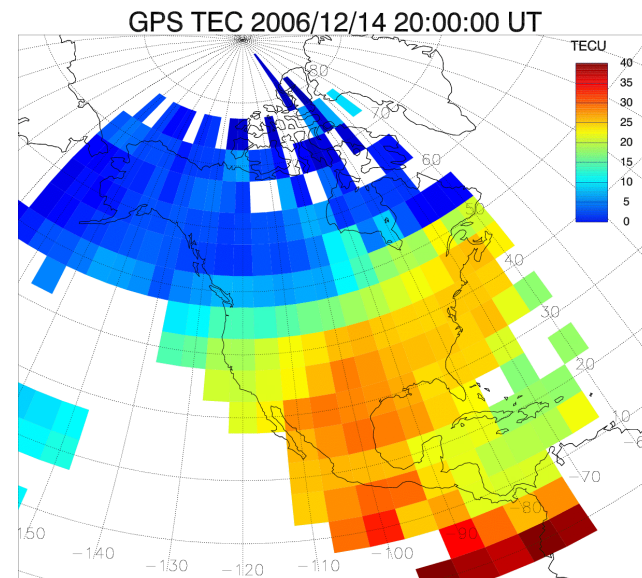




Global vs Regional TEC Study

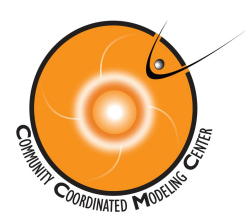


5° lat × 5° lon × 15 min, weighted mean



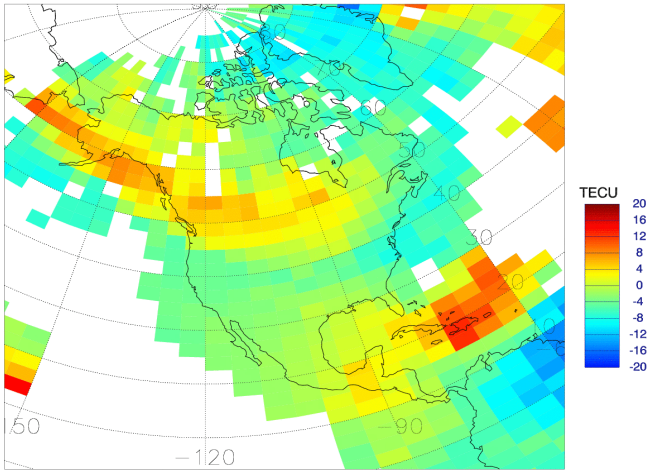
2.5° lat × 5° lon × 5 min

- Started with 8 longitude sectors
- Extend to regional study

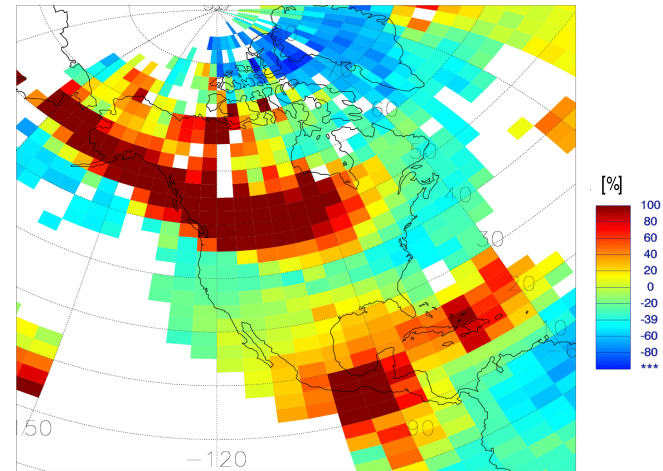


TEC Changes vs Percentage Changes

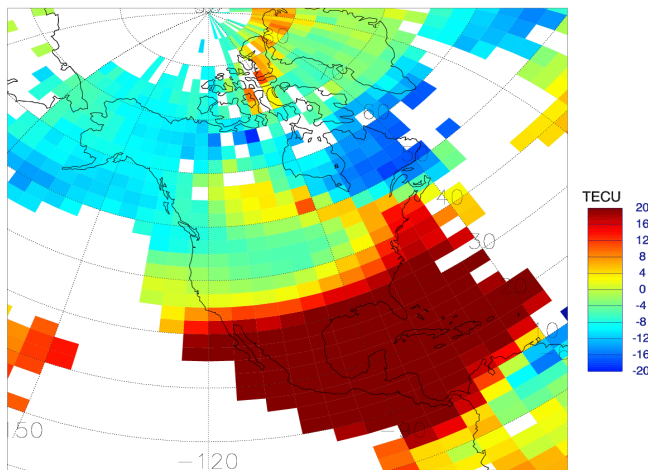
MIT_0002 d_TEC 2013/03/17 12:00:00 UT



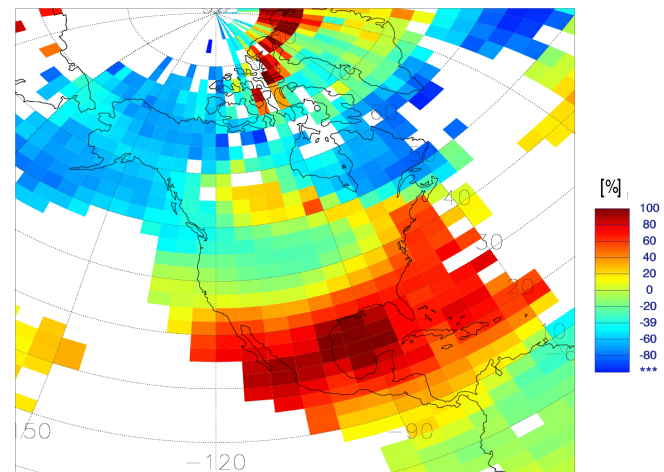
MIT_0002 d_TEC 2013/03/17 12:00:00 UT

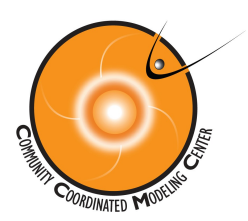


MIT_0002 d_TEC 2013/03/17 20:00:00 UT



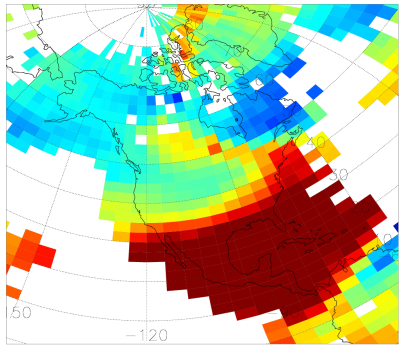
MIT_0002 d_TEC 2013/03/17 20:00:00 UT



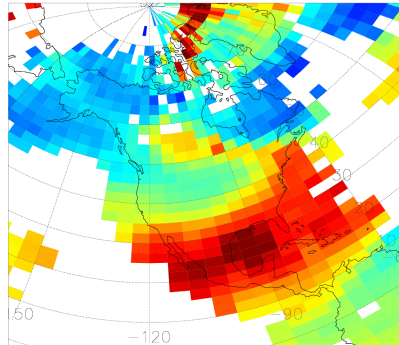


GPS TEC & Modeled TEC Changes

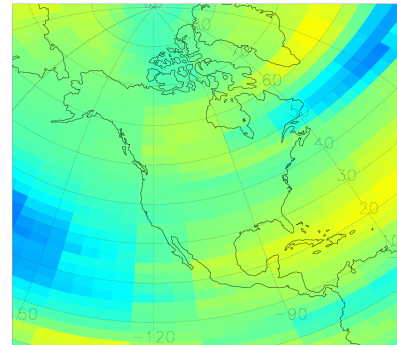
MIT_0002 d_TEC 2013/03/17 20:00:00 UT



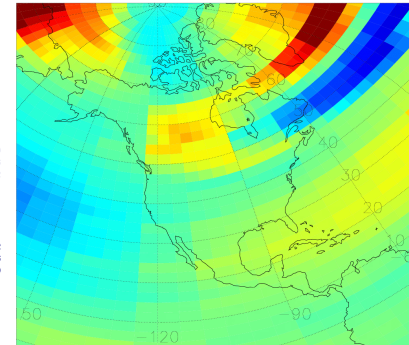
MIT_0002 d_TEC 2013/03/17 20:00:00 UT



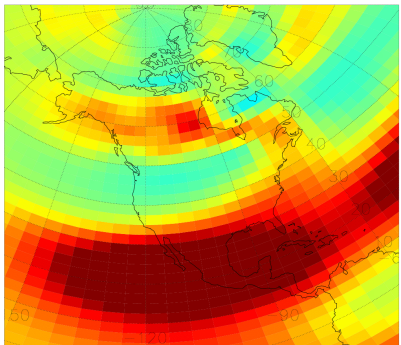
CTIPE_0001 d_TEC 2013/03/17 20:00:00 UT



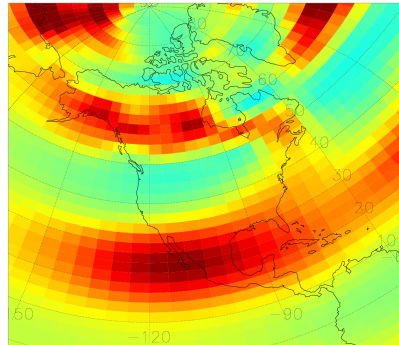
CTIPE_0001 d_TEC 2013/03/17 20:00:00 UT



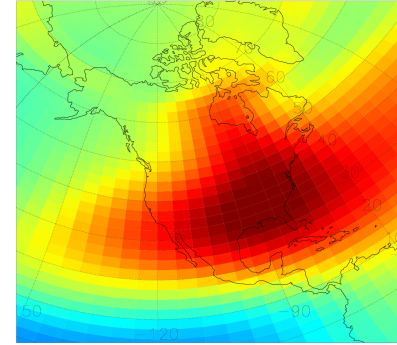
GAIM_0001 d_TEC 2013/03/17 20:00:00 UT



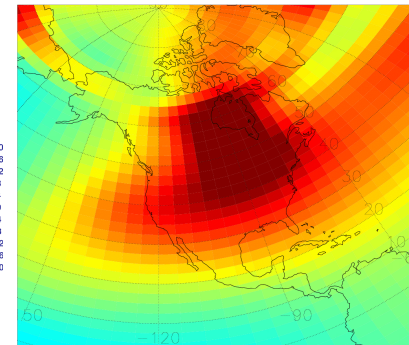
GAIM_0001 d_TEC 2013/03/17 20:00:00 UT

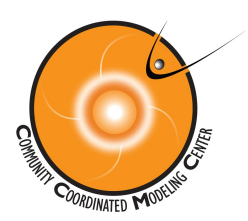


TIEGCM_0004 d_TEC 2013/03/17 20:00:00 UT



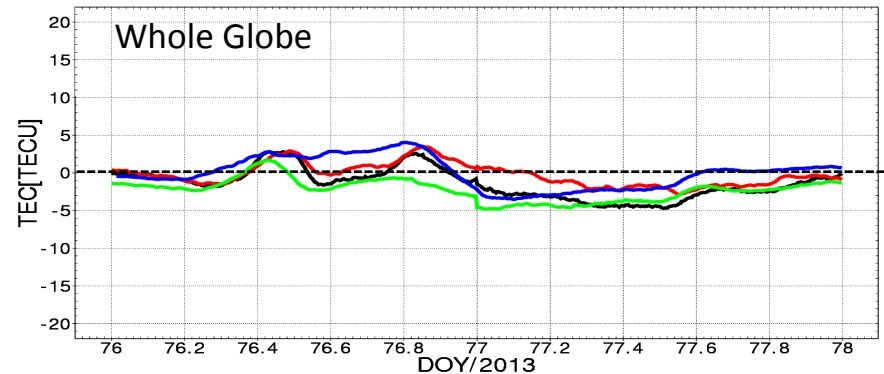
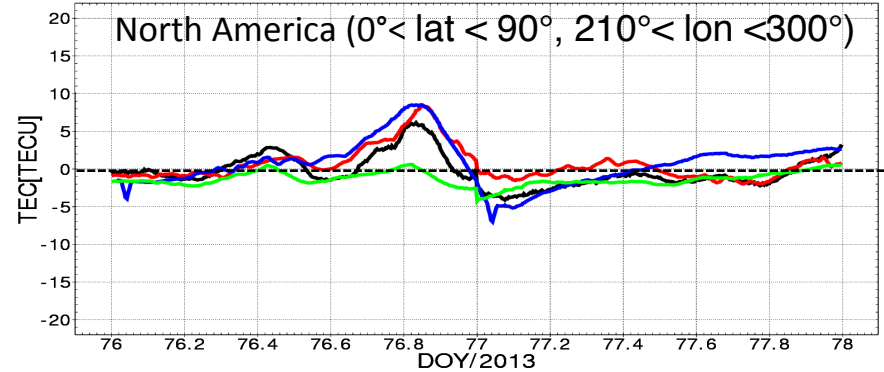
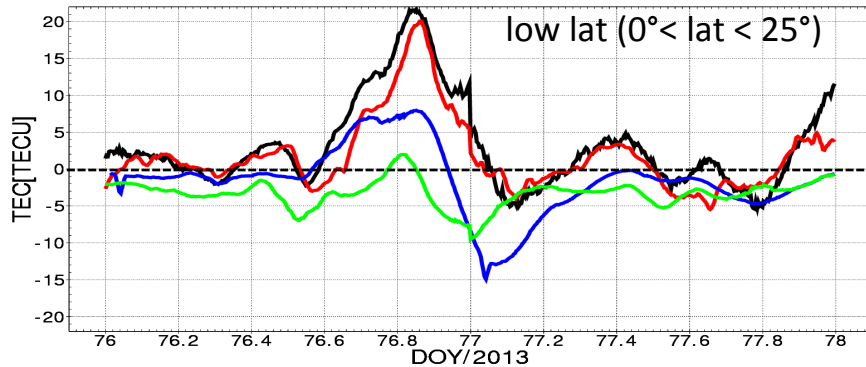
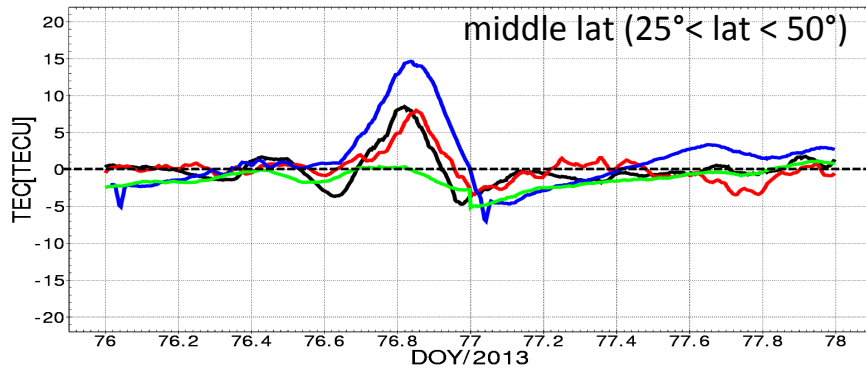
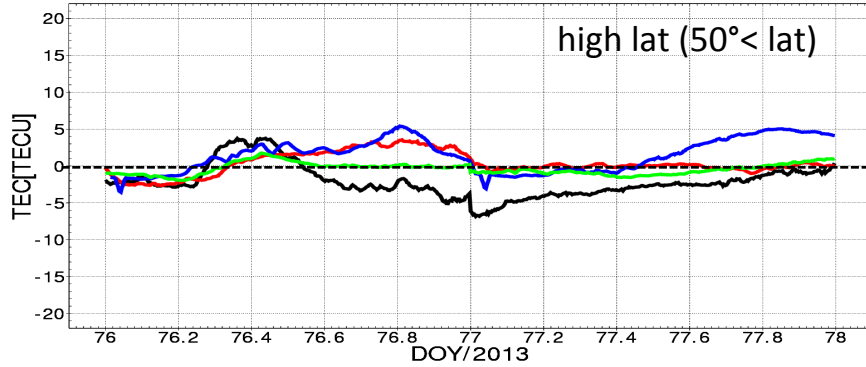
TIEGCM_0004 d_TEC 2013/03/17 20:00:00 UT





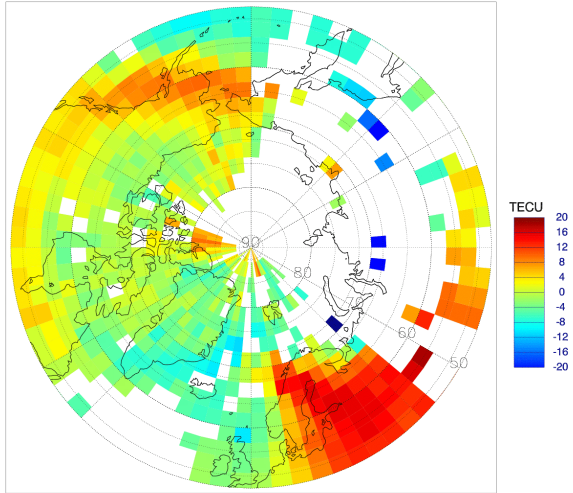
Averaged TEC?

- Latitudinal
- Regional
- Over the whole globe

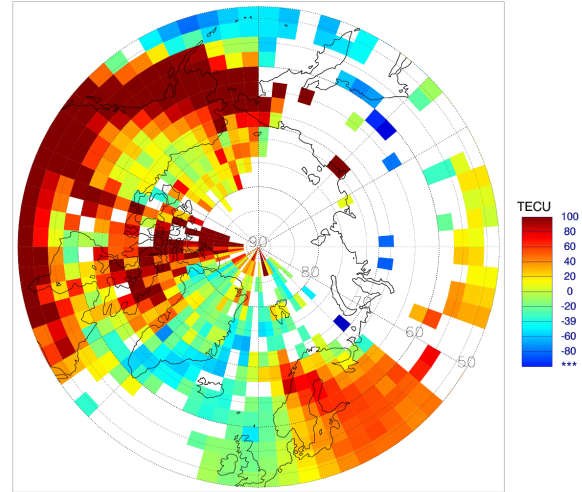


TEC Changes in Polar Regions

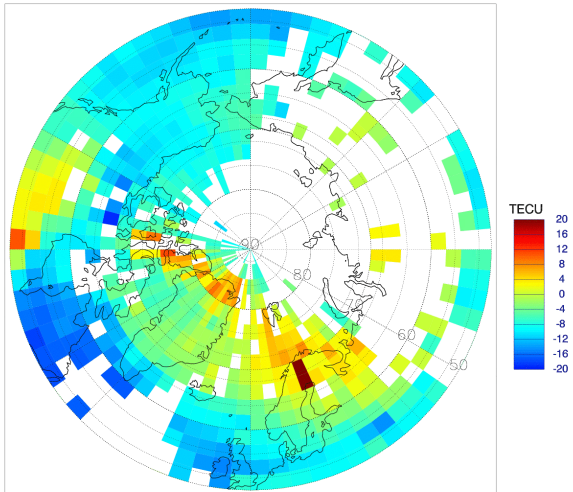
MIT_0002 d_TEC 2013/03/17 10:00:00 UT



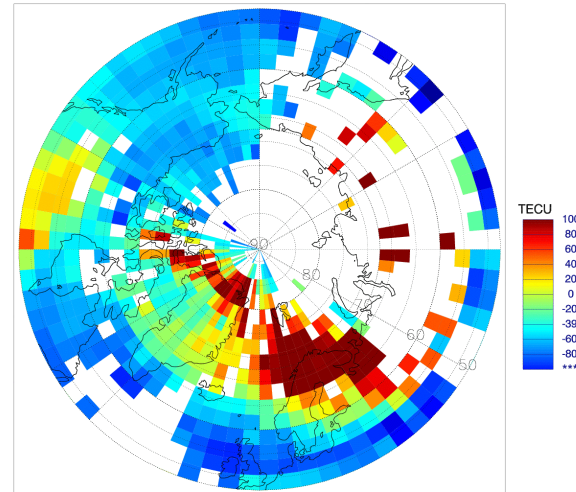
MIT_0002 d_TEC 2013/03/17 10:00:00 UT

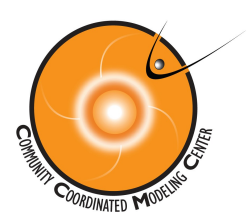


MIT_0002 d_TEC 2013/03/17 20:00:00 UT



MIT_0002 d_TEC 2013/03/17 20:00:00 UT

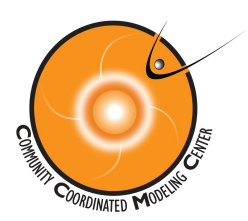




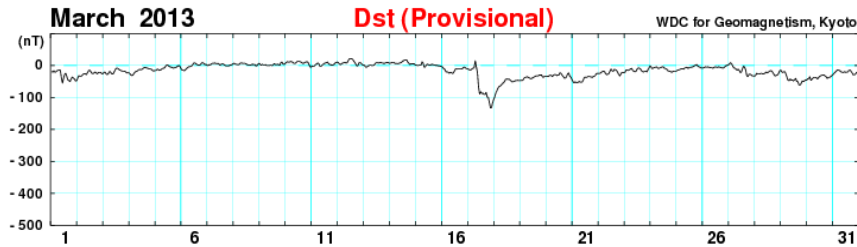
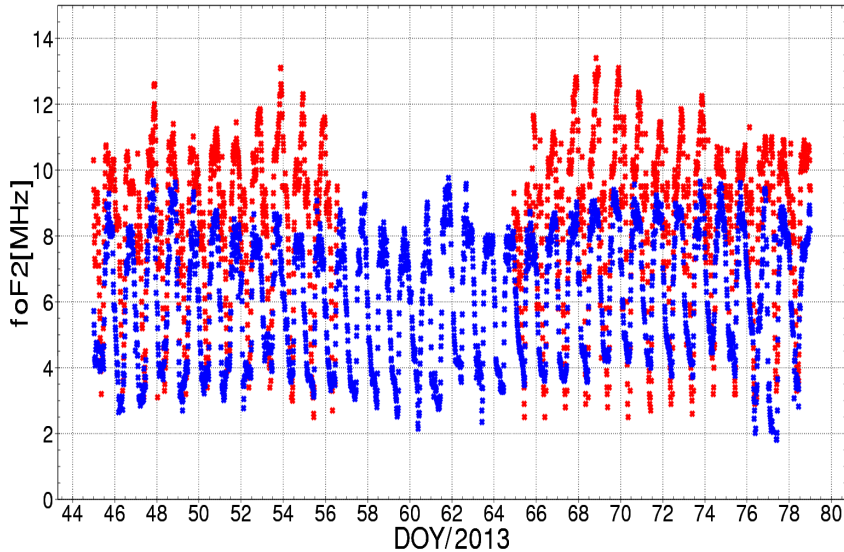
foF2 from GIRO



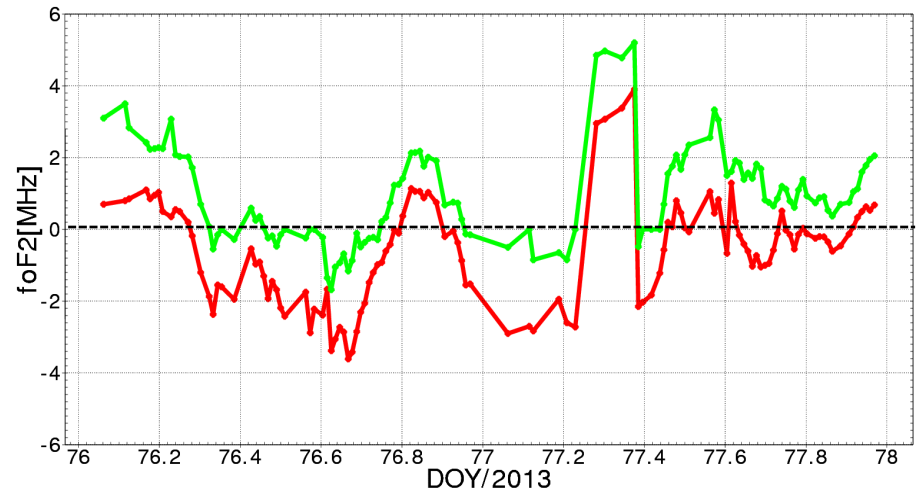
- GIRO (Global Ionospheric Radio Observatory) provides accurate specification of electron density in the Earth's ionosphere at > 60 locations in the world



foF2 for 35 days including 2013 Mar. Storm (doy 076) at Millstone Hill (blue)

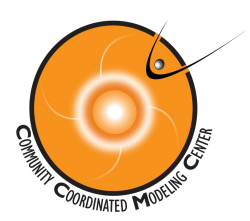


foF2 Changes

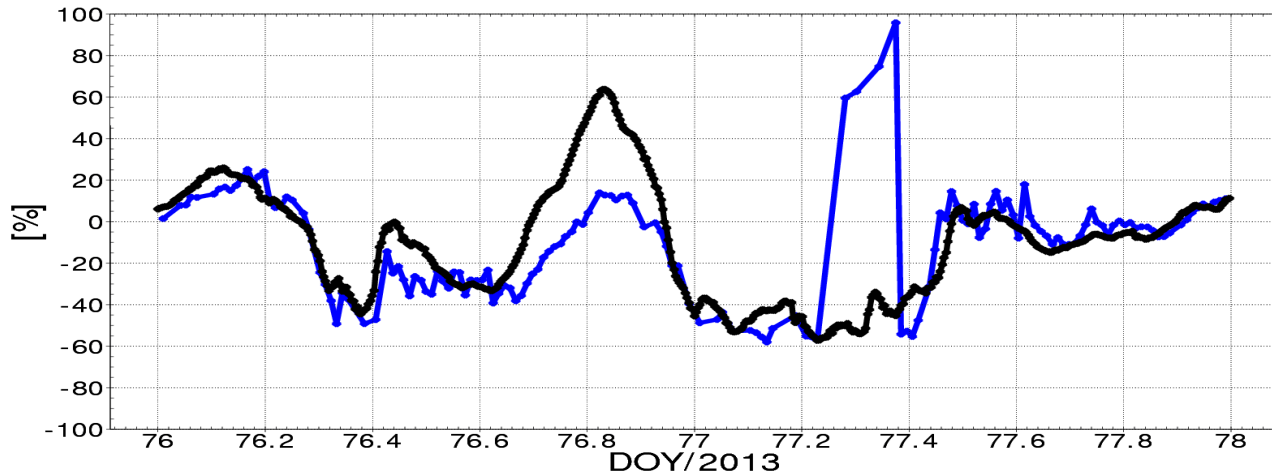


red: foF2 - foF2_{quiet}(doy 075)

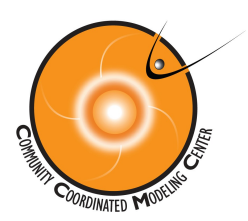
green: foF2 - foF2_{quiet}(30-day median)



TEC and foF2 Percentage Changes



- $TEC \sim (foF2)^2$
- Percentage changes of foF2 and TEC mostly correlate.
- Big difference (DOY 77.2~77.4) due to bad quality of foF2 data



Challenges in

- quantification of TEC disturbances during storms
 - quiet time reference:
 - TEC of one day prior to storm events
 - median for the 30 days prior to storms
 - ?
 - how to measure the disturbances
 - difference
 - ratio, percentage change
 - ?
- model/data comparison for validation of TEC disturbances
 - biases/baseline in measurements
 - bin size:
 - e.g., 1x1, 5x5, 10x10, 2.5x5
 - regional vs global
 - point vs averaged