Global Ionospheric Maps and Magnetosphere-Ionosphere Coupling Science

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Others…

Outline

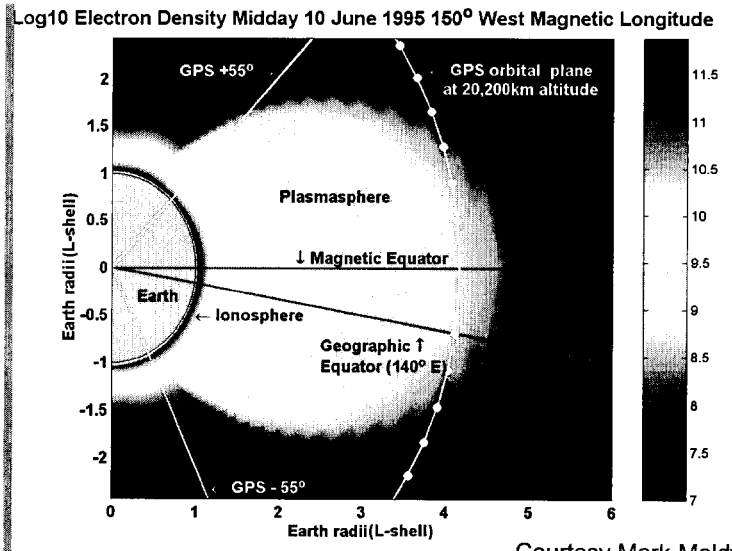
What is a Global Ionospheric Map?

Why are such TEC maps useful for understanding MI coupling?

Aspects of GPS TEC data and maps

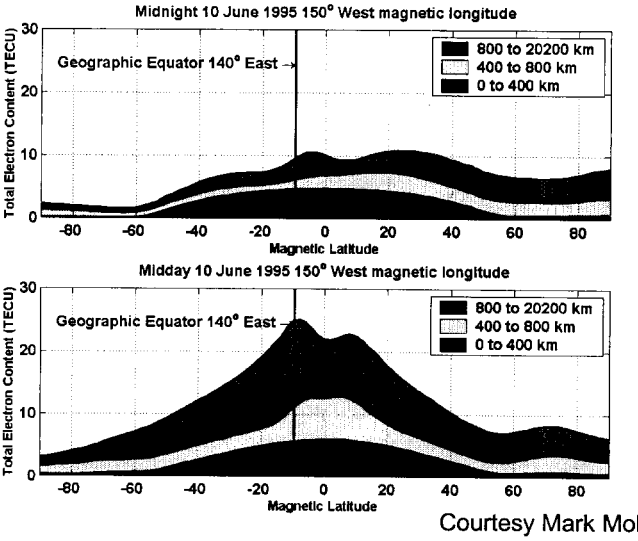
Ionospheric remote sensing with the GPS signal of opportunity and other sensors

Total Electron Content w/ GPS



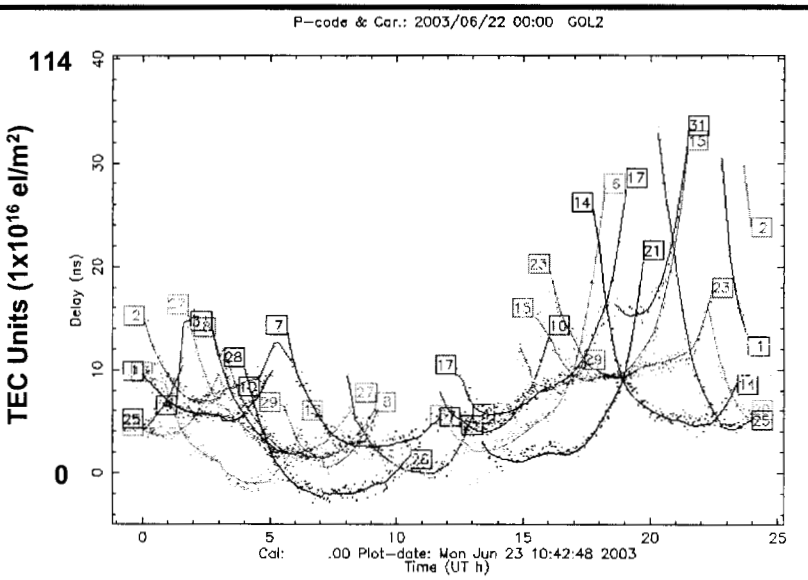
Courtesy Mark Moldwin, UCLA

TEC in Parts



Courtesy Mark Moldwin, UCLA

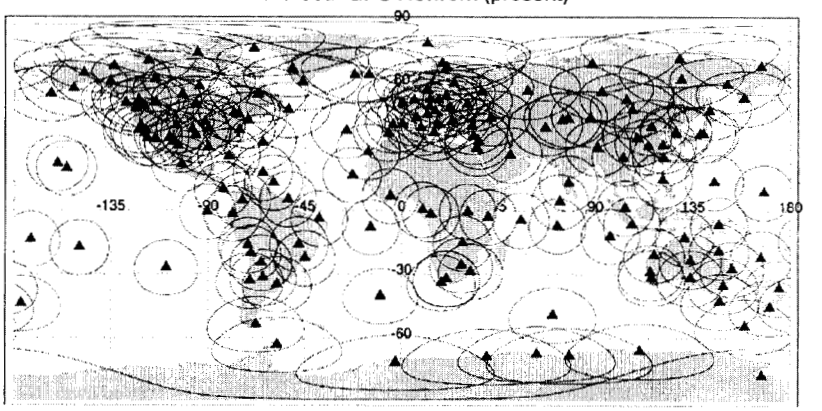
TEC Data From Goldstone CA



Global GPS Network

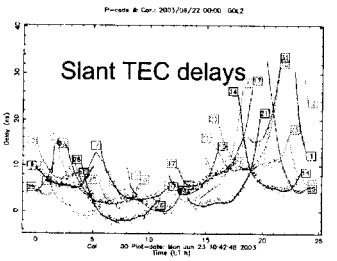
IGS Global GPS Receiver Network

IGS Global GPS Network (present)

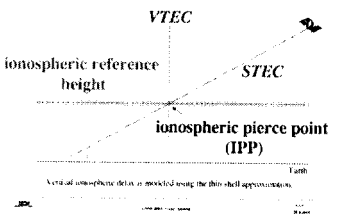


10 degree elevation mask. Subionospheric height at 450 km.

What is a Global TEC Map?



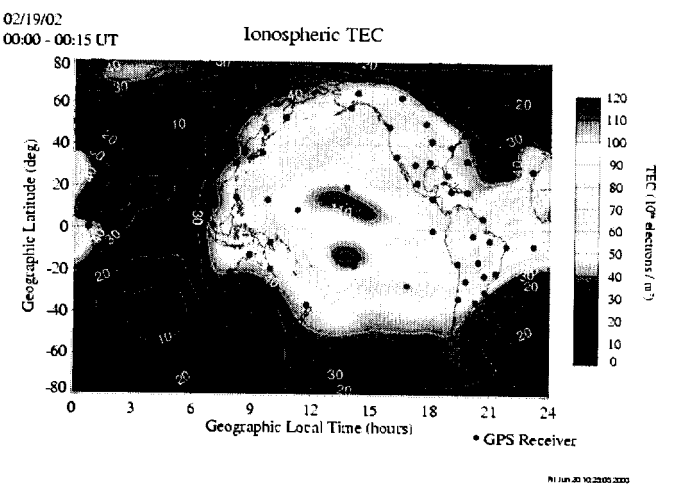
Scale to vertical TEC



Satellite and receiver bias estimation and removal

- Spatial interpolation using basis function fitting
- Sequential estimation assuming persistence in Solar-Geomagnetic coordinates
- Temporal smoothing assuming vertical delay is a "random walk" process

Global Map Animation



Global TEC Data and MI Coupling

- Magnetosphere drives ionosphere
- Global and mesoscale changes
- Dynamics
  - Large-scale convection electric field prior to shielding
  - Thermospheric wind dynamo electric fields
  - Thermospheric O/N_2 ratio changes
  - Sructure due to polarization jets
  - Longitudinal/local time coverage
  - Detection of plasma turbulence
  - Plasmasphere studies
- Pluses
  - Continuous, instantaneous global coverage, always on
  - Mesoscale structure over each site
- Minuses
  - TEC is an integrated quantity

Coordinate TEC with other observations and models

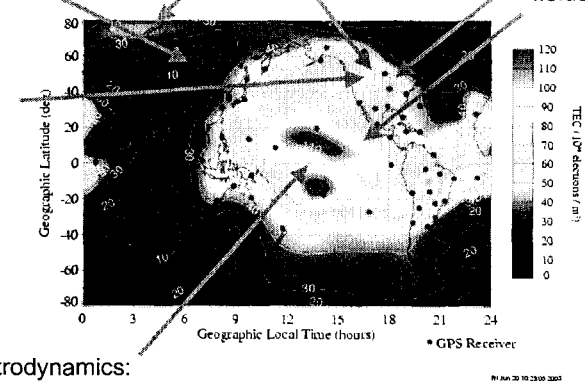
TEC Science

Transport of plasma blobs or patches

Thermospheric composition changes and dynamo electric fields

Mid-latitude trough
Plasmaspause

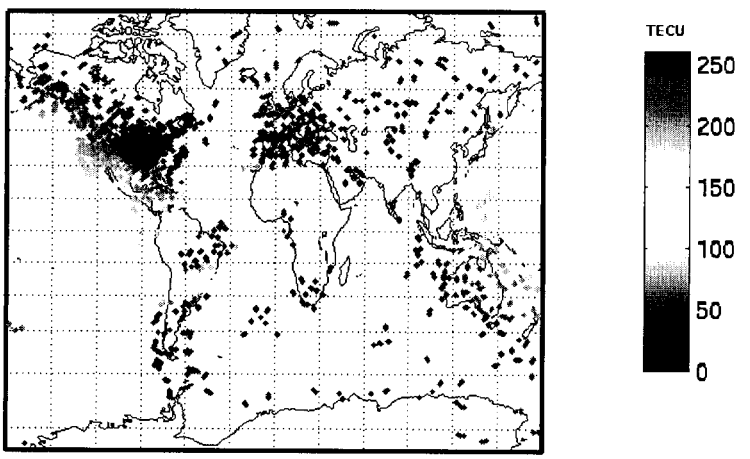
SAPS, SAID, (Polarization jets?)



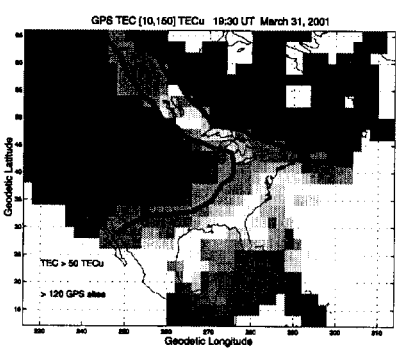
Equatorial electrodynamics: magnetospheric, thermospheric

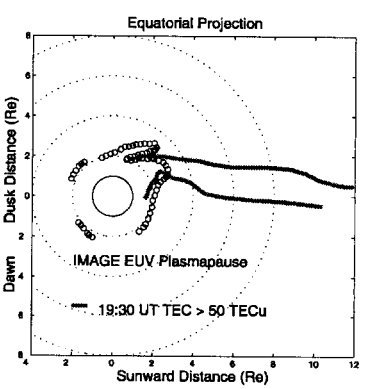
Point Plots

Vertical TEC for 31 March 01 at UT 10331 0000



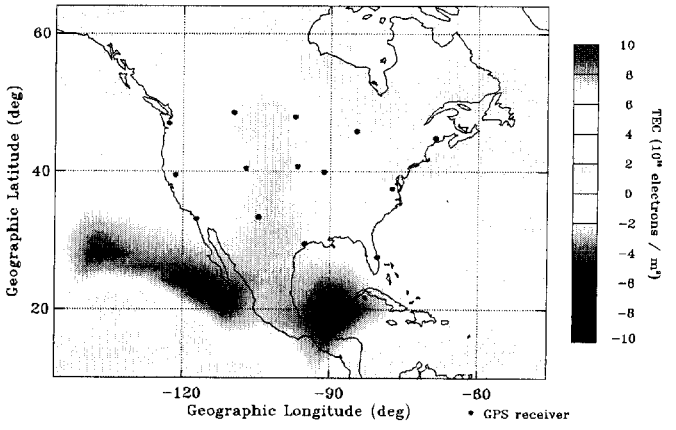
Foster's Tails





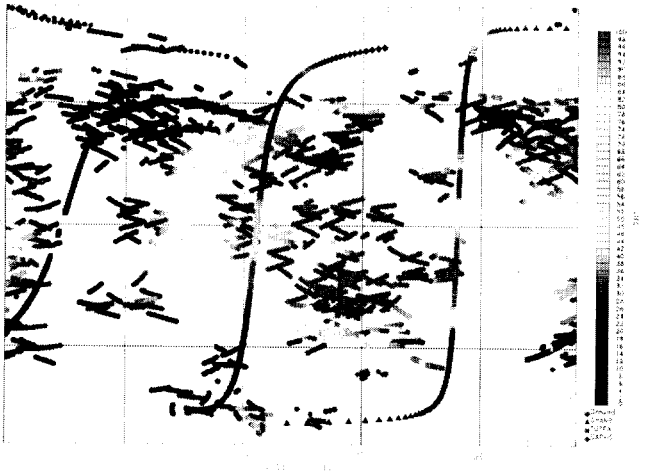
Solar Minimum Storm

Absolute Deviation of TEC from
Time-Averaged Distribution



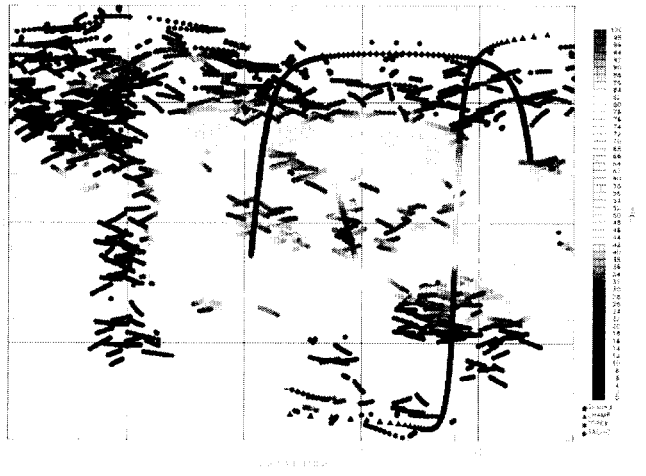
November 6 Event Study I

04:14 to 05:00 UT

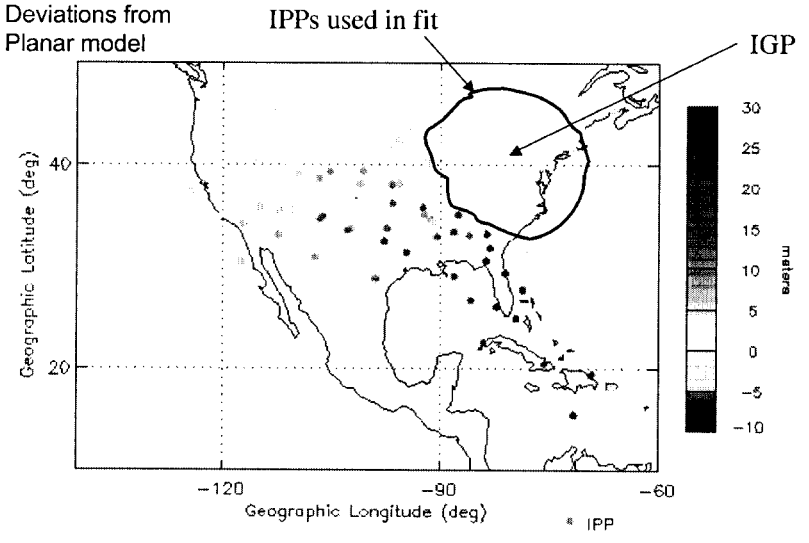


November 6 Event II

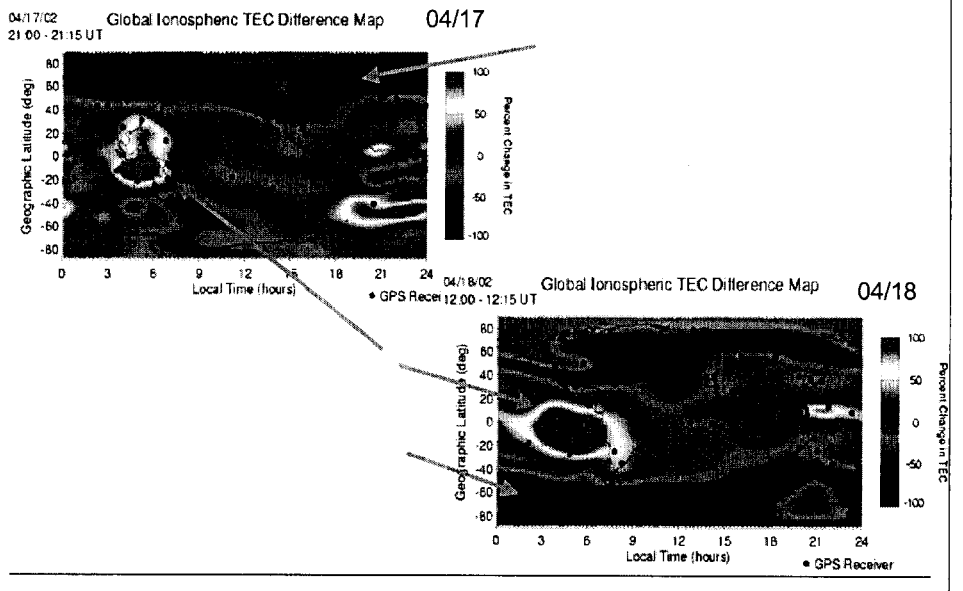
08:53 to 09:39 UT



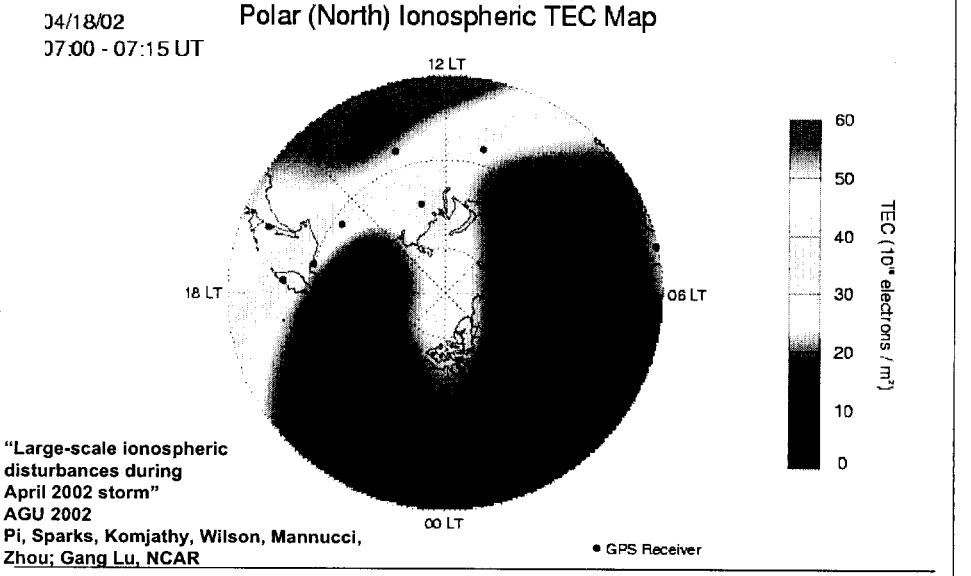
Space Weather Hazard July 15, 2000



April 2002 Event – Global

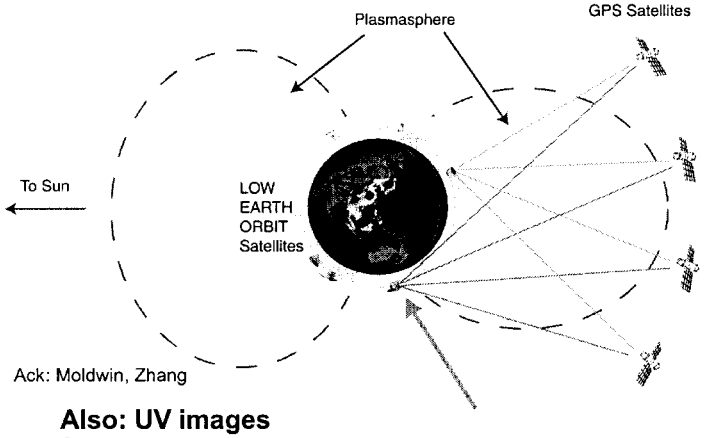


April 2002 Event – High Latitude



"Large-scale ionospheric disturbances during April 2002 storm"
AGU 2002
Pi, Sparks, Komjathy, Wilson, Mannucci, Zhou; Gang Lu, NCAR

Ionospheric Remote Sensing

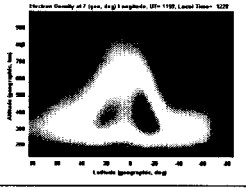


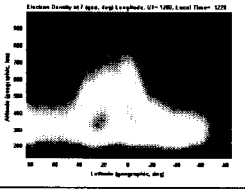
Ack: Moldwin, Zhang

Also: UV images from GUVI/TIMED, DMSP Satellite, Ground-based imagers

Global Assimilative Ionosphere Model

- **Numerical space weather prediction for the *ionosphere***
- **Mathematical framework used by weather models**
- **Model update algorithm, based on data, closely tied to underlying physics**
- **Ideal for data fusion**
- **New tools for sensitivity studies**
- **Long-term: must be integrated with the coupled space weather models**





Summary

- Global TEC maps are a mature resource for investigations of MI coupling
- Scientific use is in the early stages
- Instantaneous global coverage is usefull for investigating magnetospheric footprints on the ionosphere
- Well suited for studying coupled models
- Recommendation: do not blindly trust global TEC maps, but use as a guide
- Ionospheric remote sensing (data and models) continues to develop