Total electron content (TEC) variability of low latitude ionosphere and role of dynamical coupling: quiet and storm-time characteristics

Gebregiorgis Abraha
and

Gizaw Mengistu

03 March 2015

Table of contents

Introduction

- Ionosphere is layers of Earths atmosphere where solar radiation has ionized particles
- ionosphere is highly variable.
- Magnetosphere- Ionosphere Coupling refers to the processes which interconnect the lower-altitude, solar produced, ionospheric plasma with the energized plasmas and mechanisms of the high-altitude magnetosphere.
- Magnetospheric variability is a result of Ejecta from the sun

Energy dissipation in the ionosphere

- Joule heating: Raises neutral and plasma temperatures
- Momentum Exchange: Imparts ion motion to neutral gas, Modifies neutral winds
- Poynting Vector: Transfers electromagnetic energy flux to ionosphere from magnetosphere

Cont...

- Atmospheric tides, planetary waves and gravity waves play significant role in dynamic features of the MLT region.
- Atmospheric tides are the global response of the atmosphere to the periodic forcing of solar heating;
- propagate westward following the motion of the Sun with periodicities equal to the solar day and its sub-harmonics.
- Tides are classified as migrating and non-migrating.
- The non-migrating tides lead to strong longitudinal variations in amplitude and phase of diurnal tide, but Migrating do not
- The diurnal tide is mainly excited by the direct absorption of the sun light by water vapor in the troposphere and the stratosphere
- The migrating tides contain diurnal, semidiurnal, terdiurnal and other higher harmonics.

Results and Discusions: TEC diurnal variability

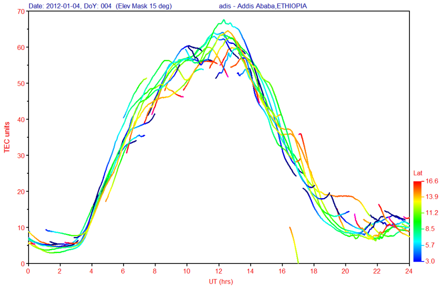

Figure: Mass plot of TEC from SCINDA GPS station at Addis Ababa

Results and Discusion: contd.

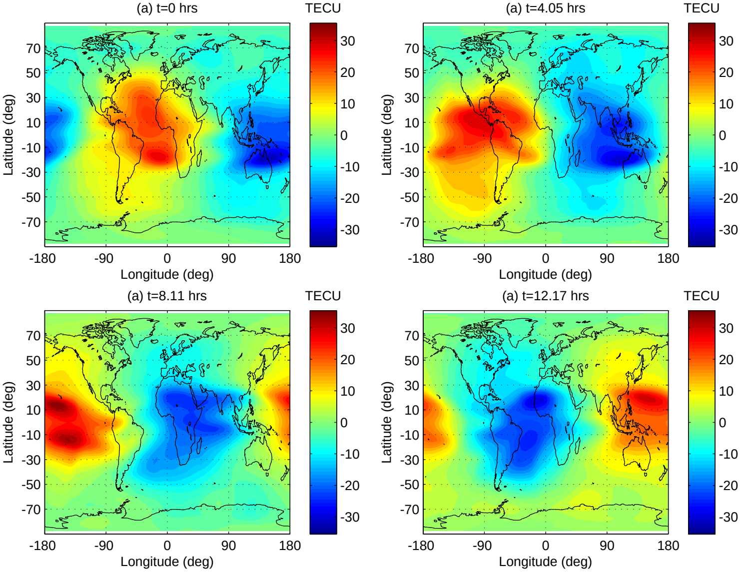

Figure: Diurnal TEC variation as a function of time within 24-hr cycle.

Results and Discusion: The geomagnetic storms of January 22-25, 2012

- Geomagnetic activity is caused by transfer of energy and momentum from solar wind to the magnetosphere that occurs in response to the southward interplanetary magnetic field.
- can also becaused by CIR-driven
- can be identified using different indicators

Results and Discusion: contd.

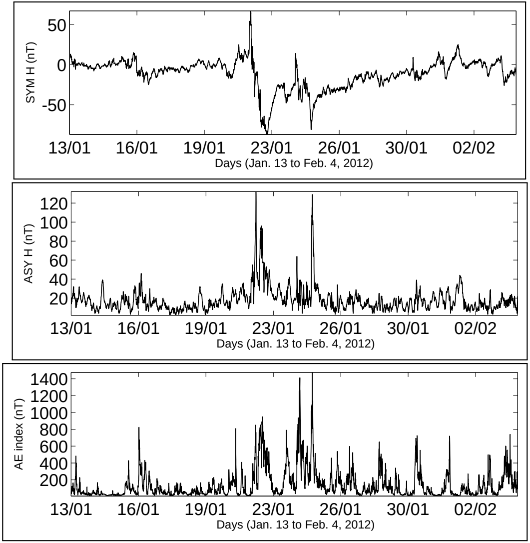

Figure: $SYM - H$, ASY and AE index time series during January 13-February 4, 2012.

Results and Discusion: contd.

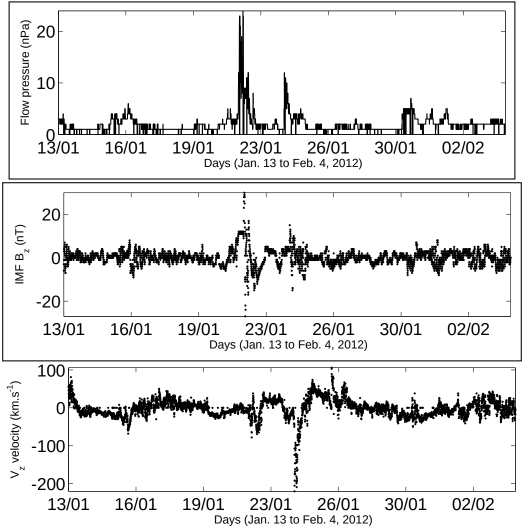

Figure: The variation of solar wind dynamic pressure in nPa (top), IMF B_z (middle) and solar wind velocity during 21 days encompassing the storm events.

Results and Discusion: contd.

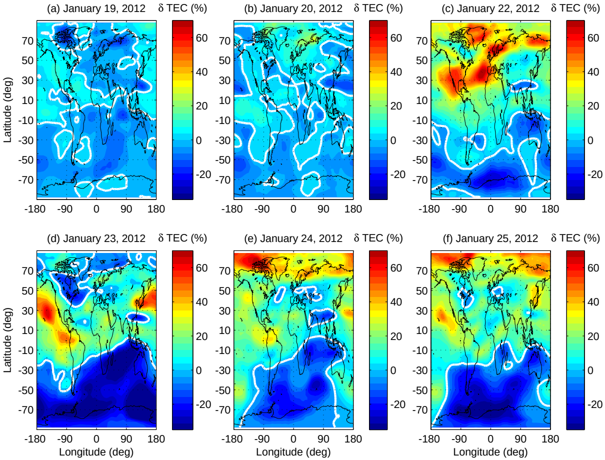

Figure: GPS-delta TEC daily mean in TECU

Results and Discusion: contd.

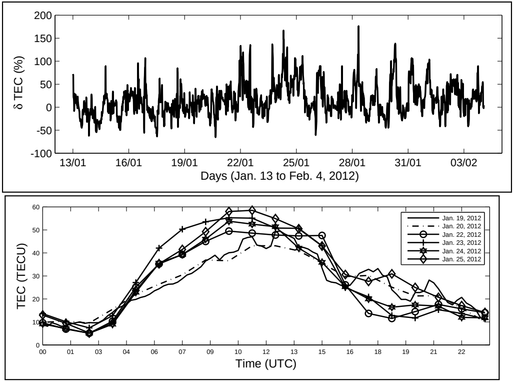

Figure: Relative change in GPS TEC values in percentage(top) and GPS-TEC extracted from global TEC at location close to Addis Ababa, Ethiopia. The median TEC is estimated for TEC observation from January 13-20, 2012

Results and Discusion: contd.

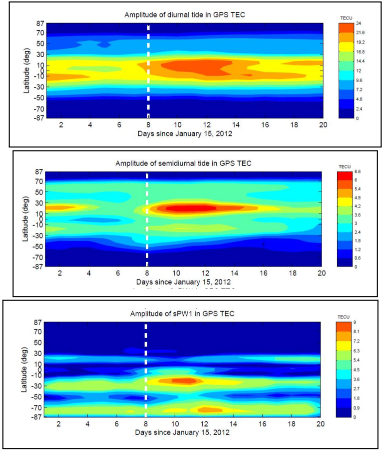

Figure: The amplitude of diurnal (top), semidiurnal (bottom) migrating tides and stationary planetary wavenumber 1 from January 15 to February 3, 2012.

Results and Discusion: contd.

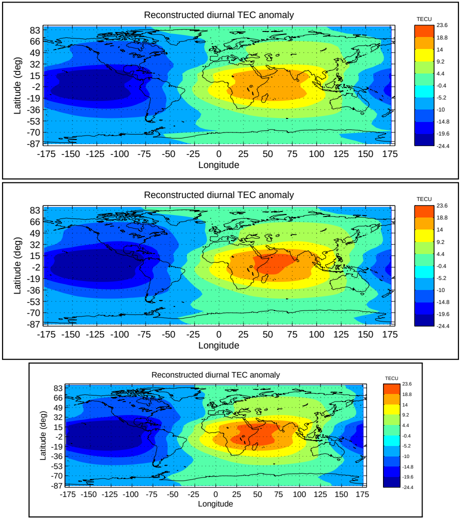

Figure: The variation of TEC due to diurnal tide at 12 UTC on January 19 (top), 22 (middle) and 25 (bottom).

Results and Discussion: contd.

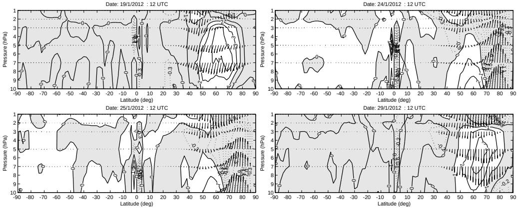

Figure: EP flux (vector) and divergence (contour). The negative EP flux divergence is shown by gray shade and dashed contours while positive values are shown by solid contours for January 19, 24, 25 and 29, 2012.

Conclusions

- The short recovery period, unlike that of CIR driven geomagnetic storms, implies the geomagnetic storm is a CME-driven
- During the disturbed days especially on January 23, the southern hemisphere TEC is highly depleted while TEC is accumulated over the northern hemisphere;
- The abrupt changes in amplitudes, in response to the geomagnetic storms, of diurnal (upto 5 TECU) and semidirinal (upto 2 TECU) migrating tides, of SPW1 is in the order of 3 TECU
- The impact of the geomagnetic storm on the major wave components in the ionosphere and MLT regions as well as on the coupling between them are investigated.

Acknowlegments

Many thanks to

- United Nation and Japan Government