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Publication date:
2013

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Kotsiaros, S., Stolle, C., Friis-Christensen, E., & Matzka, J. (2013). *A climatological assessment of ionospheric travelling convection vortices using an automatic detection algorithm*. Poster session presented at AGU Fall Meeting 2013, San Francisco, United States.

A climatological assessment of ionospheric travelling convection vortices using an automatic detection algorithm

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Poster SM31A-2116

Introduction

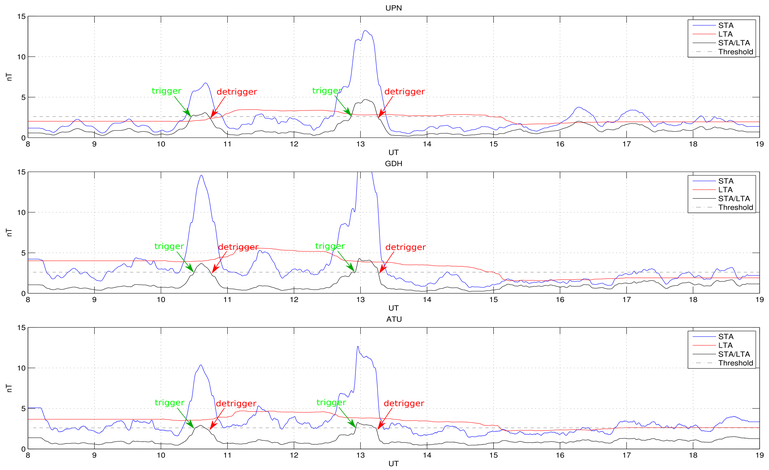
- The Greenland magnetometer array continuously provides geomagnetic variometer data since the early eighties. With the polar cusp passing over it almost every day, the array is suitable to detect ionospheric traveling convection vortices (TCVs).
- TCVs have been first detected by *Friis-Christensen et al. [1988]* and are commonly believed to be generated by:
  - compression or decompression of the magnetopause by changes in the solar wind dynamic pressure,
  - flux transfer events, or
  - magnetospheric Kelvin-Helmholtz instabilities.
- TCVs are receiving growing attention mainly due to the benefit from the increasing conjugate ground stations and satellite data availability, e.g. *Kim et al. [2013]* and *Engebretson et al. [2013]*.
- A climatological assessment of occurrence properties of TCVs using Greenland data in 1996 has been presented by Clauer and Petrov [2002].

Data

- Data span the period between 01/01/2011 and 01/05/2013 with a sampling rate of 1 second.
- The coordinates used are local magnetic north (H), local magnetic east (E) and vertical down (Z).
- Spikes are removed, daily means are subtracted and daily variations such as Sq are suppressed using a high-pass filter with a 30 minute cuttoff.

Detection of TCVs

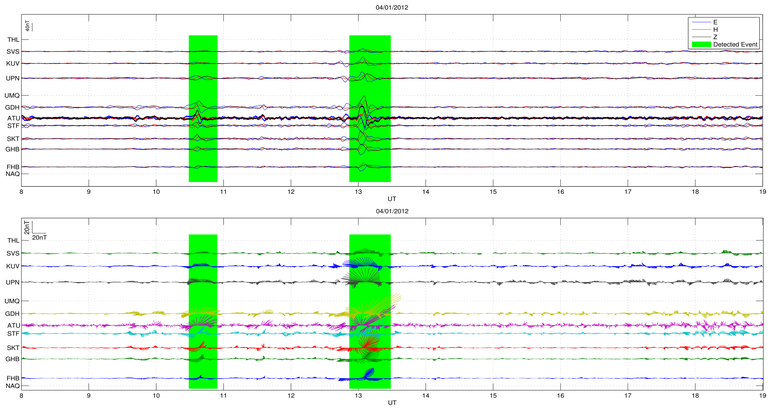
- The automated algorithm is based on the short-time-average through long-time-average trigger (STA/LTA) broadly used in weak-motion seismology.



Function and variables of STA/LTA calculations using the H-component from Upernavik (top), Qeqertarsuaq (middle) and Attu (bottom).

Example of detected TCVs

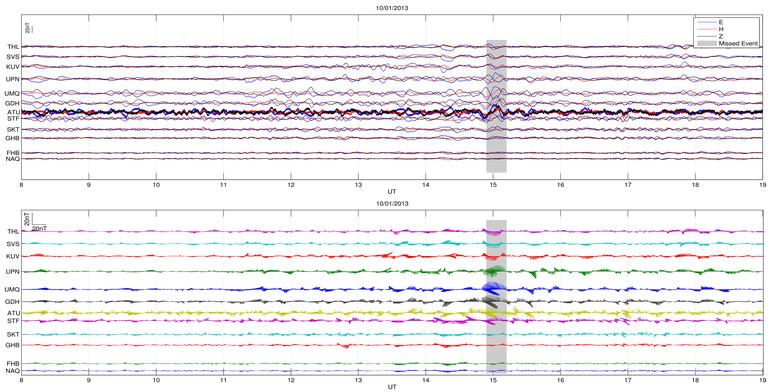
- Spike-like disturbance at nearly all stations when TCVs occur.
- Horizontal perturbation vectors show a rotational pattern.
- The source moves across the line of stations with time.



Top: Time series of magnetic variations recorded by stations at the West coast of Greenland.
Bottom: Total horizontal magnetic perturbation vectors corresponding to the variations shown on the top panel.

Limitations

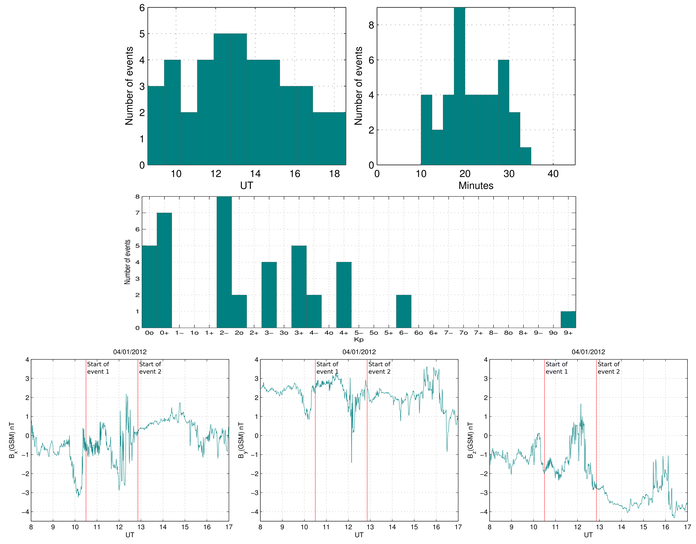
- Not easy to isolate TCV event during disturbed times.
- The sensitivity of the detection algorithm can be increased (i.e. more true negatives); however, the specificity will be decreased (i.e. more false positives).
- Mathematical approach rather than physical approach.



Top: Time series of magnetic variations recorded by stations at the West coast of Greenland.
Bottom: Total horizontal magnetic perturbation vectors corresponding to the variations shown on the top panel.

Characteristics of TCVs

- Detected events are visually checked in order to eliminate false positives.
- 41 TCV events collected.



Occurrence frequency of the TCVs as a function of local time (top left), duration (top right) and geomagnetic activity as indicated by the Kp index (middle). Bottom, the interplanetary magnetic field components in GSM coordinates B_x (left), B_y (middle) and B_z (right) on 04/01/2012.

Conclusions

- TCVs occur usually around magnetic local noon with a typical duration of approximately 20 minutes.
- TCV detection is facilitated during times of low geomagnetic background activity.
- Large sudden fluctuations in the interplanetary magnetic field are proximate to TCV events.

Outlook

- Further tests and optimization of the detection-algorithm's specificity.
- Isolate TCVs using all available Greenland data, provide a catalogue of events and make a statistical investigation.

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