Main conclusions:

1. Dayside convection throat rotates towards afternoon sector before main phase

2. Then electric potential increases and dayside throat rotates back towards noon

3. Average large-scale morphological changes in the electric field during storms happen on dayside

Average Ionospheric Electric Field Morphologies during Geomagnetic Storm Phases

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Motivation
• SuperDARN was built to study high-latitude ionospheric convection
• Radio signals are back-scattered by moving ionised particles (extrinsic)
• SuperDARN is used to calculate convection velocities

Method
• Extract and quantify dominant morphologies (patterns) from each dataset
• Use a quantitative assessment
• Use principal component analysis to build improved model

Principal Component Analysis
• Each original dataset maps $X_i$ can be expressed as (reconstructed) in terms of eigenvectors of the covariance matrix of $X_i$ and their eigenvalues $\sigma_i$:

\[ \sigma_i = \Phi_i \cdot X_i \] (1)

\[ \Phi_i = \sum_{i=1}^{n} \sigma_i \] (2)

• We use the Householder method and Householder's method to achieve this (see Press et al. 2007)
• We scale each storm phase duration to the SuperDARN data period
• We perform a superposed epoch analysis (see also Ampère's Law) on normalised time scale $o(m)$
• We use the principal component analysis to extract and quantify dominant morphologies from each day

Eigenvectors:

• $\sigma_1$ is the electric potential increases throughout main phase and decreases as soon as recovery phase starts
• $\sigma_2$ is the dayside convection pattern

Eigenvectors:

• Most variability is on the dayside

SuperDARN* coverage, Jan. 2016

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SuperDARN network:

SuperDARN's mid-latitude (SuperDARN) maps (normalised by storm phase duration)

Example average SuperDARN maps (normalised by storm phase duration):

Example geometric storm:

Geometric storm event list (is available to download in part of supporting information to Walach & Grocott, 2019 in JGR: Space Physics)

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