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PiB and Airglow Bursts during Strong Storm-Time Geomagnetic Disturbances

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INTRODUCTION

We report on the novel features of stormtime, midlatitude PiB/PiC geomagnetic pulsations, ionospheric and field-aligned currents, and oxygen, O1S and O1D, emissions at 557.7 and 630.0 nm, respectively. The distinct characteristic of the super substorm or SSS (AE < –2500 nT) was the presence of bay-like geomagnetic variations with the X and Z components with the opposite signs in the northern and southern sections of the IMAGE chain near 18 MLT. Using the magnetogram inversion technique (ISTP MIT) we obtained the MLT-MLAT distribution (map) of equivalent and field-aligned currents (FACs) revealing an additional westward electrojet to the north of the usual eastward current. For the first time we have shown that such a current system provides the observed distribution of geomagnetic variations along the 18 MLT meridian. We also revealed a localized geomagnetic event during which the magnitudes of the H geomagnetic component, PiB/PiC pulsations, and oxygen emissions at mid latitudes were more than twice greater than during the super substorm.

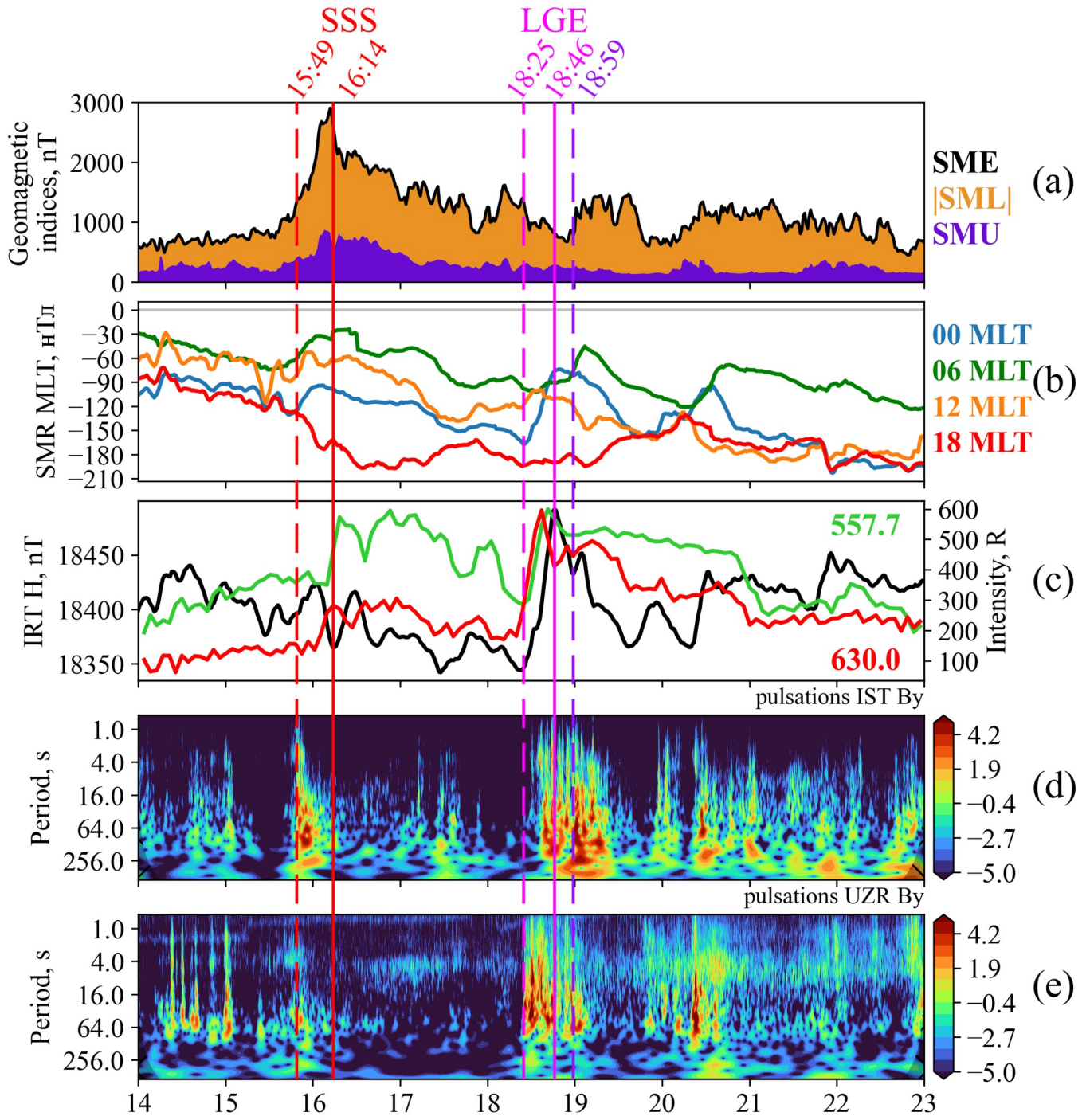
Fig. 1. 20 Dec 2015 storm, variations in:

a) **SME**, **SMU** and **|SML|** indices of geomagnetic activity;

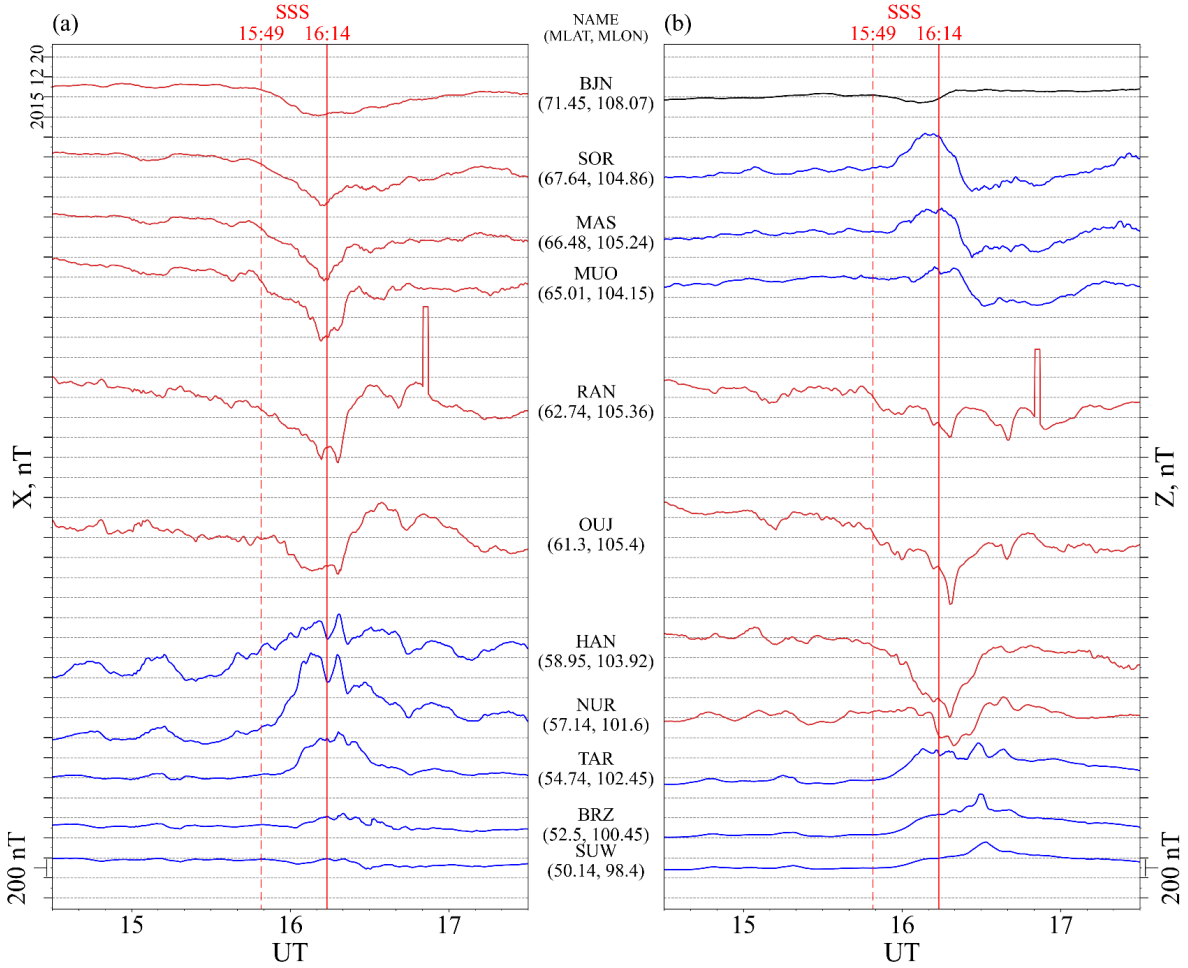
b) **SMR00**, **SMR06**, **SMR12**, **SMR18** indices for the ring current (mean index, in the midnight and in the dawn sectors)

c) Geomagnetic field **H-component at the IRK (1-min data)** and the [OI] **557.7 nm** and **630.0 nm** emission intensities at Tory station;

d) and e) are dynamic spectra for the **By-component of geomagnetic pulsations** at the IST (CGM: 66.28°) and UZR (CGM: 48.5°); shown is the amplitude variation dependence (color scale on the right in relative unities)



SUPER SUBSTORM



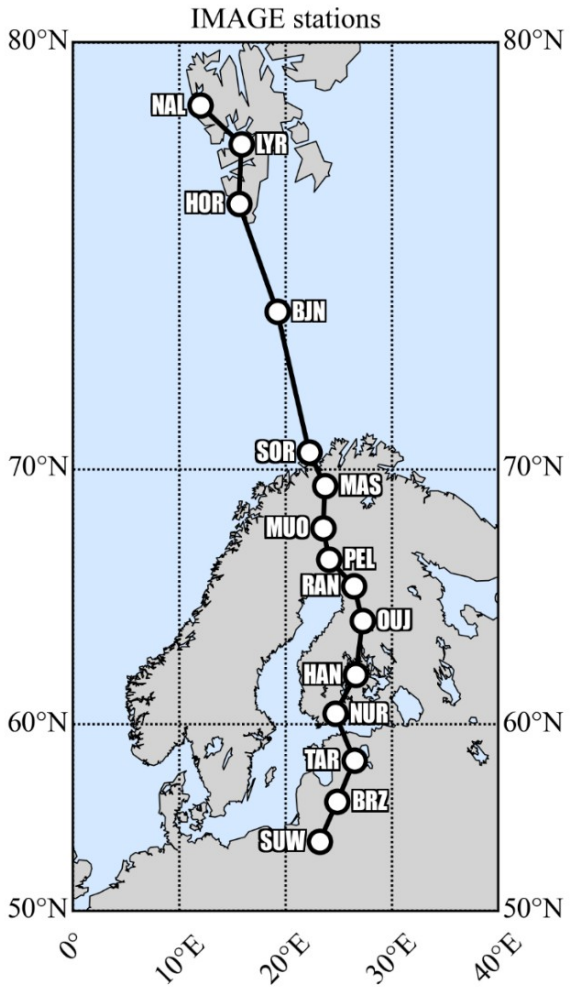


Fig. 3. IMAGE Magnetometer network

↑ **Fig. 2.** Variations in the geomagnetic field X- (a) and Z- (b) components from the IMAGE magnetometer network during the SSS. **The blue (red) color shows positive (negative) bays.**

SUPER SUBSTORM

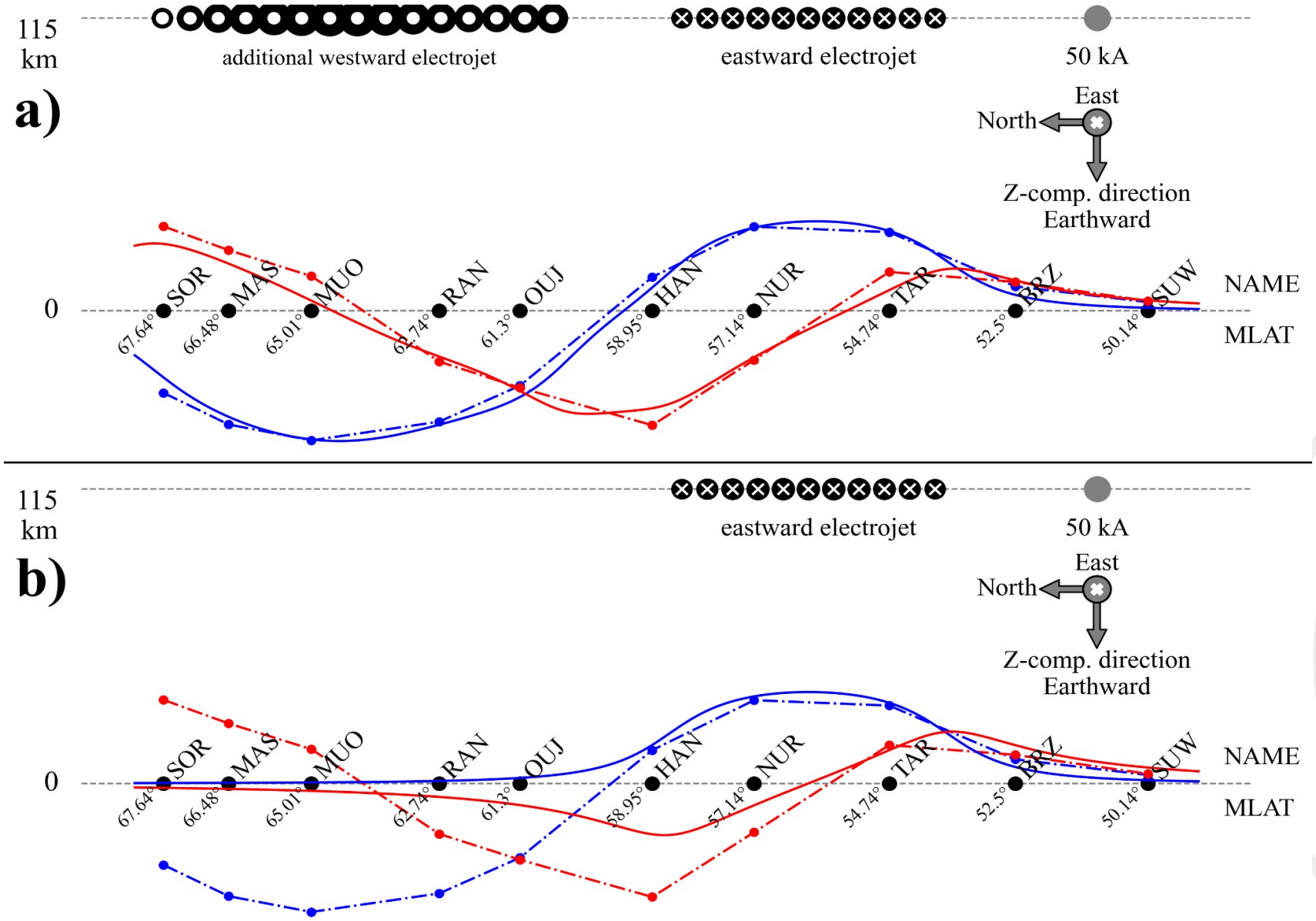


Fig. 4. Modeling the **X**- and **Z**-components on the Earth surface along the IMAGE meridian in the presence of:

a) the eastward electrojet (EEJ), additional westward eletrojet (WEJ);

b) the eastward electrojet only. The solid lines represent the simulated field; the intermittent line shows the field observed at the IMAGE stations at 16:14 UT.

SUPER SUBSTORM

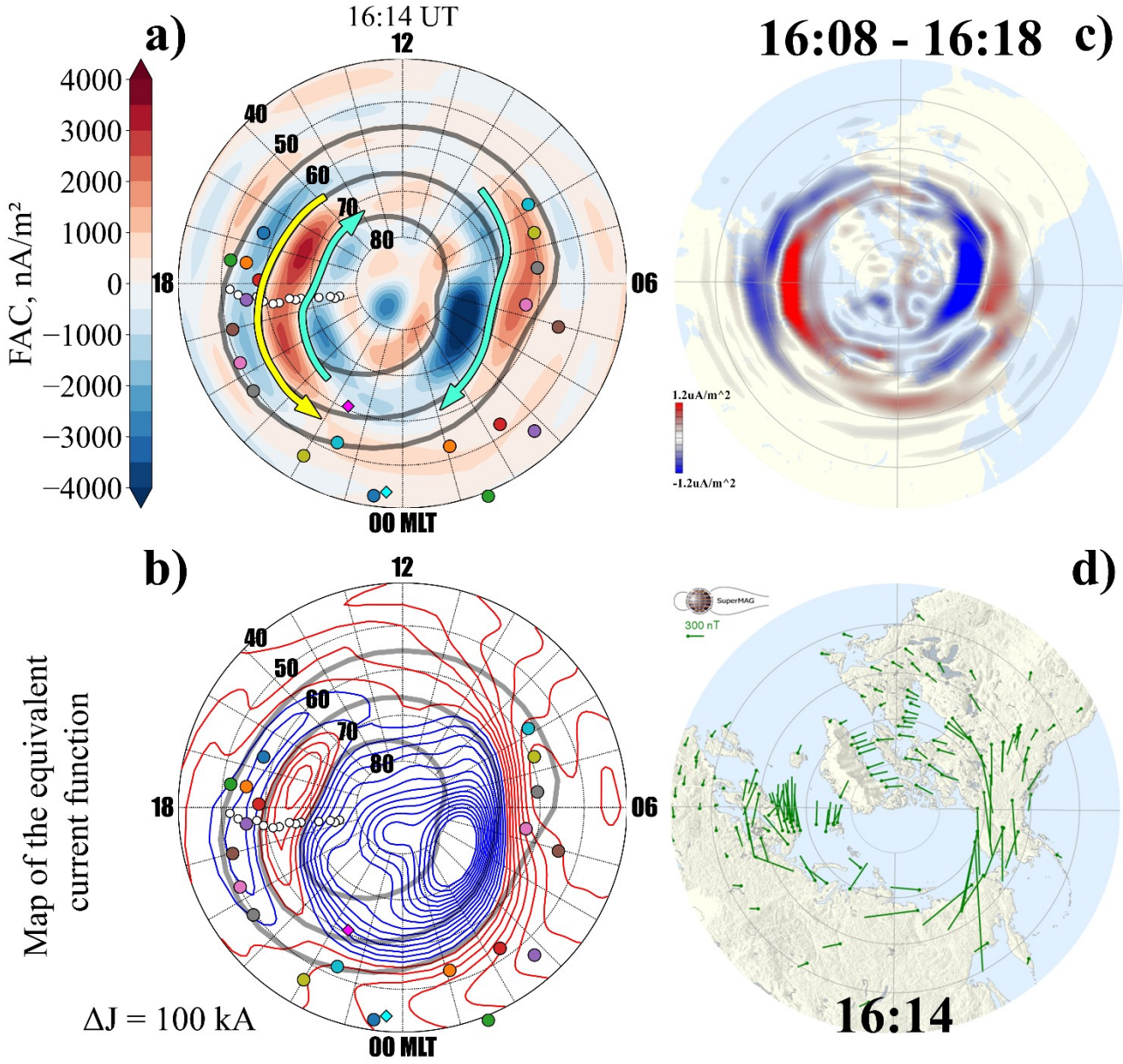


Fig. 5. Maps for SSS :

a) Field Aligned Current (FAC) map was constructed using the magnetogram inversion technique (MIT). The **red** (**dark blue**) color denotes the ***upward*** (**downward**) currents. fat grey lines are boundaries of FAC regions R0, R1, R2 (from the pole). Thick lines with arrows show ionospheric currents: **yellow (eastward)** and **cyan (westward);**

b) MIT built map for equivalent currents;

c) AMPERE FAC map;

d) SuperMAG map for the magnetic field variations. **Magnetic field vectors** are rotated 90° clockwise, showing the direction of equivalent ionospheric currents

LOCALIZED GEOMAGNETIC EVENT

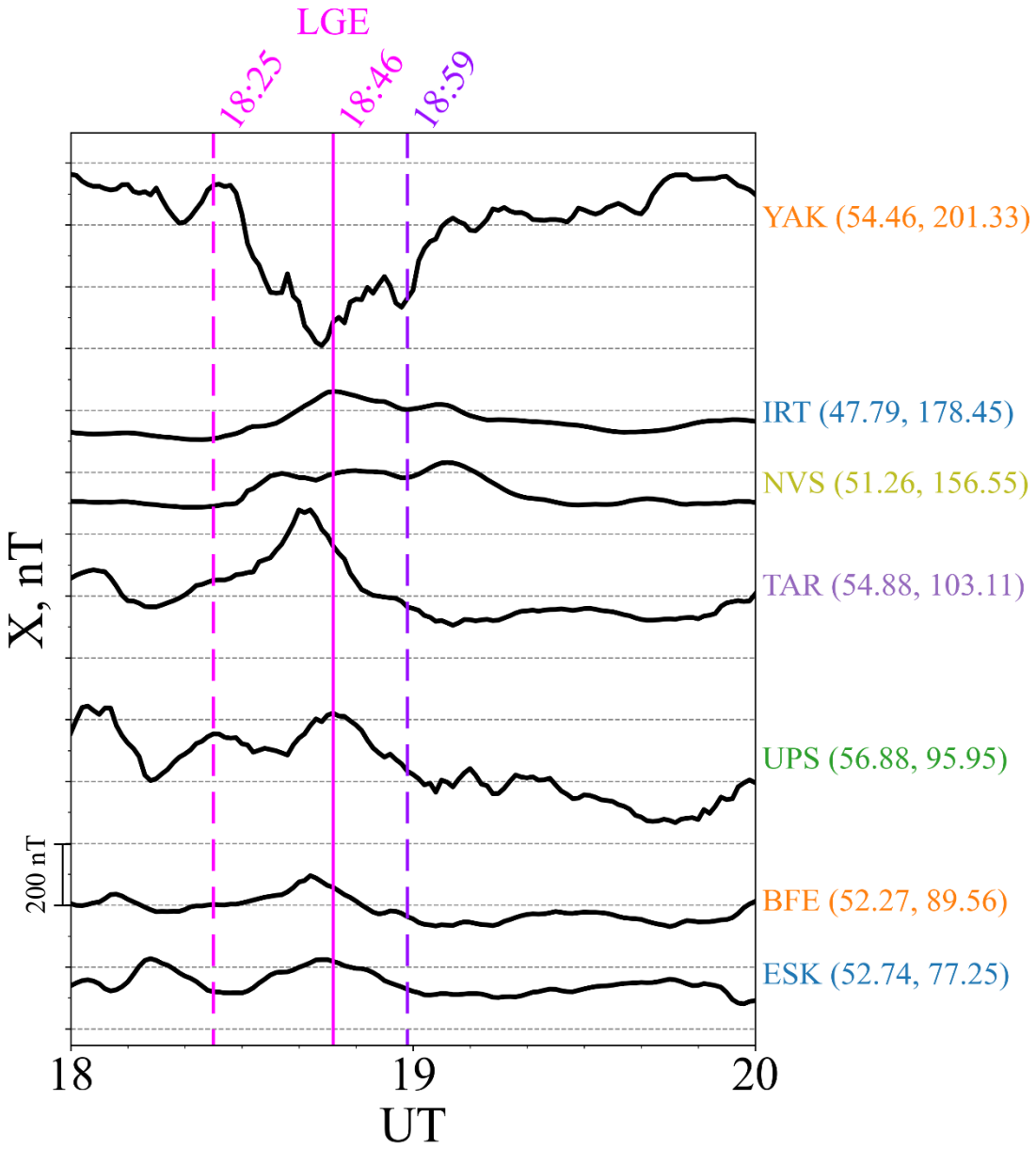


Fig. 6. Same as Fig. 2 for 18 – 20 UT

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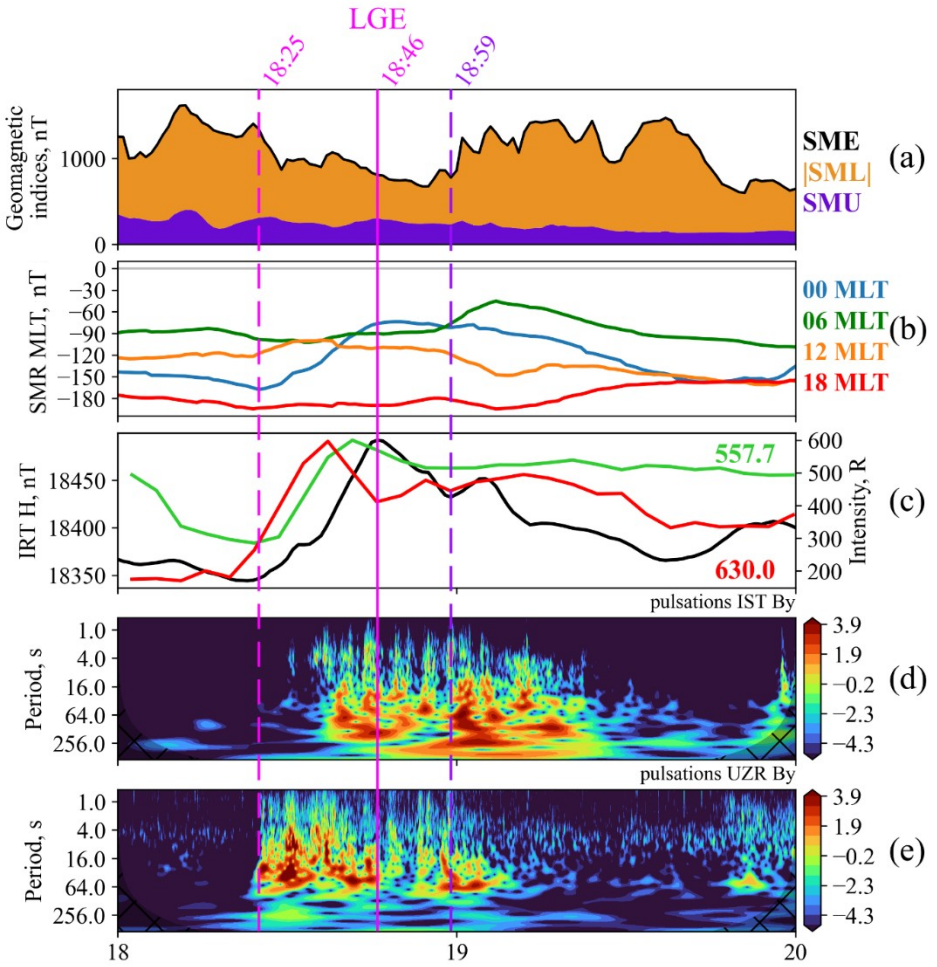
a) indices of geomagnetic activity

b) Sector indices for the ring current

c) **H-component** and the [OI] **557.7 nm** and **630.0 nm** emission intensities

d) dynamic spectra for the geomagnetic pulsations



← **Fig. 7. Variations of X component on the longitude network of stations: Yakutsk, Irkutsk, Novosibirsk, Tartu, Uppsala, Brorfelde, Eskdalemuir**

RESULTS

- The formation of an additional westward electrojet (AWEJ) north of the eastward one (EEJ) during the 20 Dec 2015 super substorm causes the sign change in the X- and Z-components at the IMAGE chain of stations. It is obvious from the ISTP MIT and SuperMAG FAC maps.
- We built a simple model of a location of both electrojets (AWEJ and EEJ) in one dusk sector that demonstrates that the MIT FAC maps corresponds to the observed distribution of geomagnetic variations.
- Using data from ISTP observatories, we addressed the evolution of a previously unobserved localized geomagnetic event in the near-midnight sector. During the LGE, we observed attenuations in the PiB power at high-latitudes. We assume that there is a relation between the LGE and the ring current and/or particle injection from BBFs.
- At mid-latitudes, the growth in the [OI] 557.7 and 630.0 nm emission intensities is followed by an increase in the SME during an SSS and by a positive bays in the H-component of the geomagnetic field at the IRK observatory during the LGE.

THANKS FOR YOUR ATTENTION