2018 Space Weather Activities in Ukraine

1. Operational activities

Ukraine is determined to contribute to the worldwide effort to protect the humankind from threats posed by space weather by developing its own operational capabilities in close cooperation with other nations and in the context of global activities.

According to this determination, the Main Center of Special Monitoring, a branch of the National Space Facilities Control and Test Center, subordinate to State Space Agency of Ukraine, in cooperation with Ukrainian research institutions, began daily Space Weather operations starting in February 2018. These operations benefit from 60 years worth of experience in operational geophysical monitoring the Main Center of Special Monitoring, which also has a history of contributing to world peace and international security by providing real-time geophysical data on behalf of Ukraine to the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization since the signature of the Treaty in 1996. Work is underway to modernize and expand the Center's infrastructure for its updated mission by procuring modern measurement equipment, upgrading some of the older analog equipment to provide digital data, and constructing a new larger operational room. It is foreseen that a large share of operational data will be provided through domestic and international collaboration. Preliminary agreements were reached with most national data providers.

Currently these operations include relaying translated NOAA/NWS Space Weather Prediction Center alerts, kindly made publicly available by the USA, with a correction of expected effects for geomagnetic latitude, and post-event analysis based on local geomagnetic data from the network of magnetometers operated by the Main Center of Special Monitoring and other organizations. The localized alerts and analysis of notable events are included in a daily brief to the Main Situational Center of Ukraine, which provides critical data on the current situation to top government officials and emergency services. It is planned to make these and most of the future products publicly available upon reaching maturity.

2. Development of operational services

The capacity building, described above, is complimented by development of new services. Ukraine has an excellent scientific record in heliophysics, particularly in ionospheric physics, but this research was never transited to operations.

The two services, closest to achieving operational readiness, are the Central Europe Regional Ionospheric Model by the Institute of the Ionosphere, and local geomagnetic forecasts by the Space Research Institute of the National Academy of Sciences of Ukraine and State Space Agency of Ukraine.

2.1 Central Europe Regional Ionospheric Model

This model is based on more than 30 years of data from Kharkiv Incoherent Scatter Radar, the only mid-latitude ISR in Europe, and describes the spatial and temporal distribution of electron density, electron and ion temperatures, and the vertical component of plasma drift velocity over Central and Eastern Europe in the altitude range from 200 to 750 km. It is planned to calibrate this model using *in situ* measurements by the Microsat mission, scheduled for launch in 2021. The operational version is limited to determining the background noon and midnight values of the 3 basic parameters of the F2 layer: the critical frequency *foF2*, the peak electron density *NmF2*, and the corresponding altitude *hmF2* depending on the month and the mean *F10.7* solar radio flux.

2.2 Local geomagnetic forecast

This is a new product with no known alternatives. In contrast to state-of-the-art geomagnetic forecast products, which offer predictions of some geomagnetic index, this product directly predicts the components of the geomagnetic field at the location of some magnetometer. Prediction models for 3 magnetic observatories were developed: Lviv (LVV) in Ukraine, Chambon-la-Forêt (CLF) in France, and Boulder (BOU) in Colorado, USA. The lead time in each case equals 3 hours + propagation time from L1. The plots in Figure 1 below show a retrospective forecast for the storm of March 17-18, 2015 for each geomagnetic element at Chambon-la-Forêt and Boulder magnetic observatories. The operational version will deliver forecasts for Lviv magnetic observatory as soon as it will be upgraded to provide data in real time (current delay is about 3 hours).

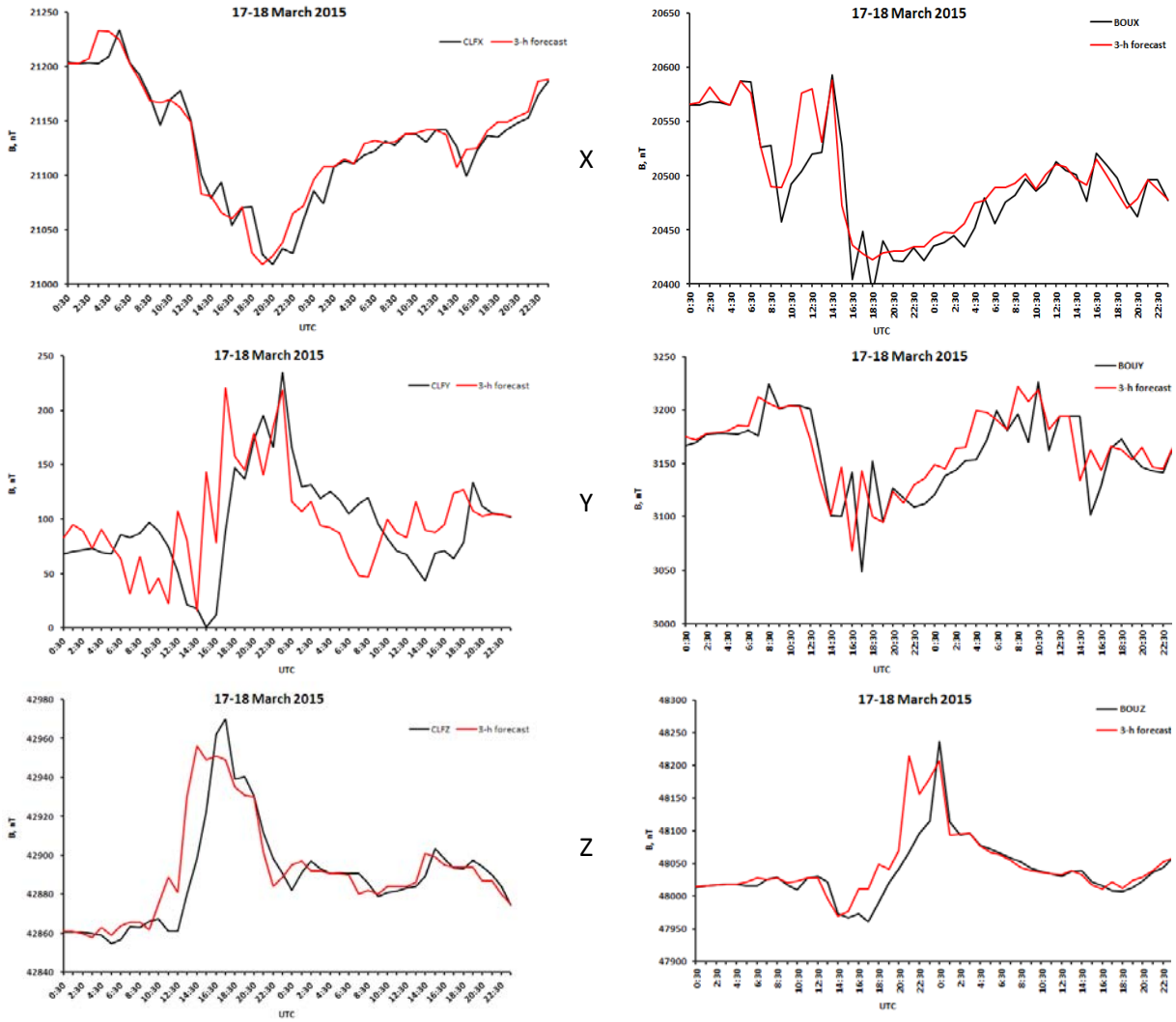

Figure 1. Predicted (red) and measured (black) values of X (top), Y (middle), and Z (bottom) geomagnetic elements at Chambon-la-Forêt (left) and Boulder (right) magnetic observatories during the geomagnetic storm of March 17-18, 2015. Magnetic units are nanoteslas (absolute), time is UTC. Lead time of the retrospective forecast is 3 hours + propagation time from L1 (variable).

3. Development of ground network

A new digital ionosonde developed jointly by the Institute of Radio Astronomy and the Institute of the Ionosphere was installed at the Vernadsky Antarctic station. It currently works side-by-side with the older analog ionosonde to ensure proper cross-calibration.

A similar digital ionosonde operates in test mode at the Institute of the Ionosphere near Kharkiv with another digital ionosonde awaiting deployment.

A set of 1 flux-gate (LEMI-025) and 2 induction (LEMI-112) magnetometers developed and produced by Lviv Center of Space Research Institute was also delivered to the Vernadsky Antarctic station. They are scheduled to be installed in the end of March.

2 magnetotelluric stations developed and produced by Lviv Center of Space Research Institute were procured for the Main Center of Special Monitoring.

2 VLF receivers near Kiev and Chernivtsi were retrieved from storage and will be upgraded to provide digital data.