NOVEMBER 2004 SPACE WEATHER EVENTS
REAL TIME OBSERVATIONS AND FORECASTS

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Monitoring Space Weather events on the basis of real-time observations is an important tool for forecasting needs as well as for scientific purposes. This poster is a collective work based on the materials presented at the Spulpher Sessions during the 1st ESWW in November 2004.

The complexity of the November 2004 Space Weather events was predefined by the 9 central main structures forming two geo-effective interplanetary structures. Rapid extensive expansion of the auroral oval to 55 degrees in geomagnetic latitude and the great variability of the ionosphere became the sources of difficulties for forecasters.

INTERPLANETARY PROPAGATION REAL-TIME DATA

Four CMEs of 14 November (see the table) interacted on their way producing a complex ICME, which passed the ACE location on 4 Nov. CMEs 312-315 demonstrated 3 different and magnetic cloud (MCG) structures.

Three CMEs of 6-7 November (see Table) gave a complex ICME of 9-10 Nov. (CMEs 314-315) at the L1 location with 2 shocks and MCG structures.

Both CMEs contained long periods of strong (~3-39m/s) southward ambient magnetic field (ARF). CMEs of 9 November produced a not well-defined structure on 13-14 November with one small shock. CME of 10 November did not reach the L1 location.

Daily proton flares at GOES experienced abrupt increase due to X2.8 flare on 7th November and stopped until November 17th.

Polar Energetic Protons and OEEs Proton Fluence Data

Indications of the oncoming storms started to appear on ACE solar wind data on 02:39 UT on November 7. In addition to the strong solar wind CME, a near solar pitch of increased intensity can be noticed. This feature gives us an idea and propagates southward over the night side.

During the night and morning hours of 8th November, the ionosphere was severely perturbed with extremely high polar TEC over 4000s at 08:30 - 09:00 UT.

The development of the ionosphere started around 08:00 UT and intensified the recovery phase of this first storm.

GLOBAL SST MAPS

The complex signatures of the perturbed SST were observed in Europe, Japan and Australian regions. They are presented in black-colored maps of the critical frequency of F2 layer (f0F2). The maps of forecasted f0F2 (yellow-colored) are shown for European continent.

These maps were prepared by B&V Warsaw.

7 November: 00:00 UT "storm-at-sea" f0F2 leaves then predicted 12:00 UT increased f0F2 in Northern Europe due to the solar activity增强 storm, night-time (Japan and Australia) show regular patterns.

8 November: 00:00 UT Decreased night-time f0F2, 12:00 UT increased day-time f0F2 with complex pattern, increased night-time equatorial (Japan) and still complicated Australian region.

9 November: 00:00 UT Increased day-time f0F2 12:00 UT small structures for European region (UK), increased night-time equatorial (Japan) and complex patterns over Australian region.

10 November: 00:00 UT Decreased night-time f0F2, 12:00 UT small structures for European region (UK), increased night-time equatorial (Japan) and complex patterns over Australian region.

Forecast for most of the time shows quite different from data and can serve only as an average pattern.

GLOBAL GEOMAGNETIC FIELD

The first complex ICME of 8th November produced 2.5 Sd and turning IMF continued followed by the strong geomagnetic storm. It started at the day side with earthward normal current system and changed to the night side, reversed normal electrojet system located between 41 and 73.5° geomagnetic latitudes. Auroral activity influence lower latitude stations and can be seen at NOG, Europe (in America sector the expansion of auroral oval can be seen almost down to 59°).

The next night of 9-10 Nov. shows enhanced activity in traditional auroral zone due to the high speed solar wind passage.

The second complex ICME of 9-10 Nov. caused the second geomagnetic storm, with its main phase started right after midnight when IMF first turned negative for a long period of time. It is characterized by an enhanced earthward electrojet system at night side. Prior to that, sharp short negative IMF turning at 10:00. 11 Nov. produced short duration earthward electrojet near OTF and equator at AE and reversed between ICC and NDR. The activity continues through the daytime (10 Nov. night time) in several zones due to the continuously high speed of the solar wind.

ICME ORIENTATION AND MOVEMENT FORECAST

The main neutral line in the active region AR 0094 shows East-West direction (being in its current through the solar disk) and passes the high-latitude end of the ICME (left panel) with positive polarity on northern side. Therefore, southward orientation of the large scale magnetic field of the flux rope, with northward edge was expected for the second partial halo CME of 11 November (right panel) and confirmed by SMM orientation of the first ICME seen at ACE.

The second ICME was expected to have a similar orientation of the magnetic field as being produced by the same AR, but showed either a NWS direction (see ACE plots). This can be the result of more complicated magnetic field orientation (see the difference in the top right panel) with disappearing filament below larger loops connecting AR 0094 and AR 0095. The orientation of the magnetic field of the filament flux rope was most likely NWS, with 43° inclination to the X-direction which later was encountered by ACE. Prediction in this case was impossible.

North Pole hourly TEC maps for 7 and 8 November (http://www.kn.nao.ac.jp/daily/tec-np)

For fal3 hourly TEC maps produced by AR 0096 in November 2004

The large geomagnetic bays observed in Australia were accompanied by the large solar events in solar latitude (~150°) jet streams, taking their way outside the operational range (top panel). These events were more studied by B&V Australia.