

Review of 4th to 15th September Space Weather Activity

Content Provided by UK Met Office and ESA SSA Programme Office

Active region (AR) 12673 was a dormant alpha Hsx spot which developed into a simple β (Dsi) then rapidly developed into a $\beta\gamma\delta$ (Dkc) complex sunspot region between September 3rd and 5th

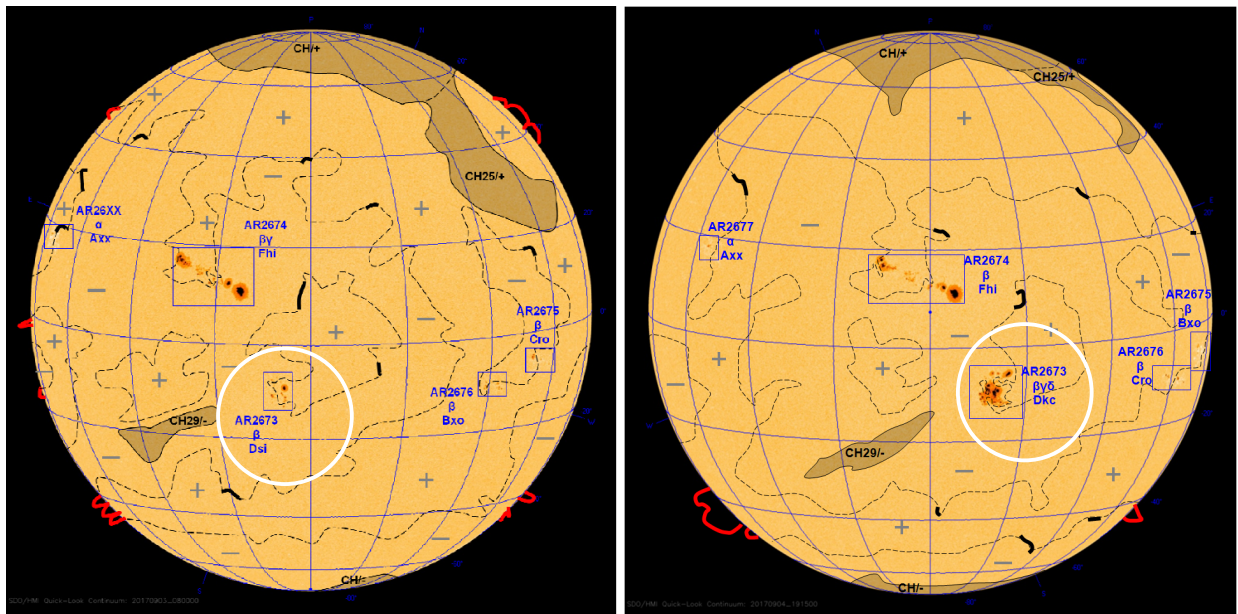


Figure 1: 3rd Sept (left) and 5th Sept (right) solar synoptic maps with AR12673 circled showing its rapid development.

The first major X-class flare was recorded at 08:57 UT on 6th September. This was followed by a period of continued flaring which lasted until the region rotated out of view on 11th September. A total of 4 X-class flares were produced. The largest events were as follows:

X9.3: 11:53 UT 6th September 2017

X8.2: 15:35 UT 10th September 2017

These constitute the 2 largest flares of the current solar cycle.

The solar events also resulted in an enhanced radiation environment for several days including a small Ground Level Enhancement (GLE) on 10th Sept and a Kp8 geomagnetic storm on the 8th.

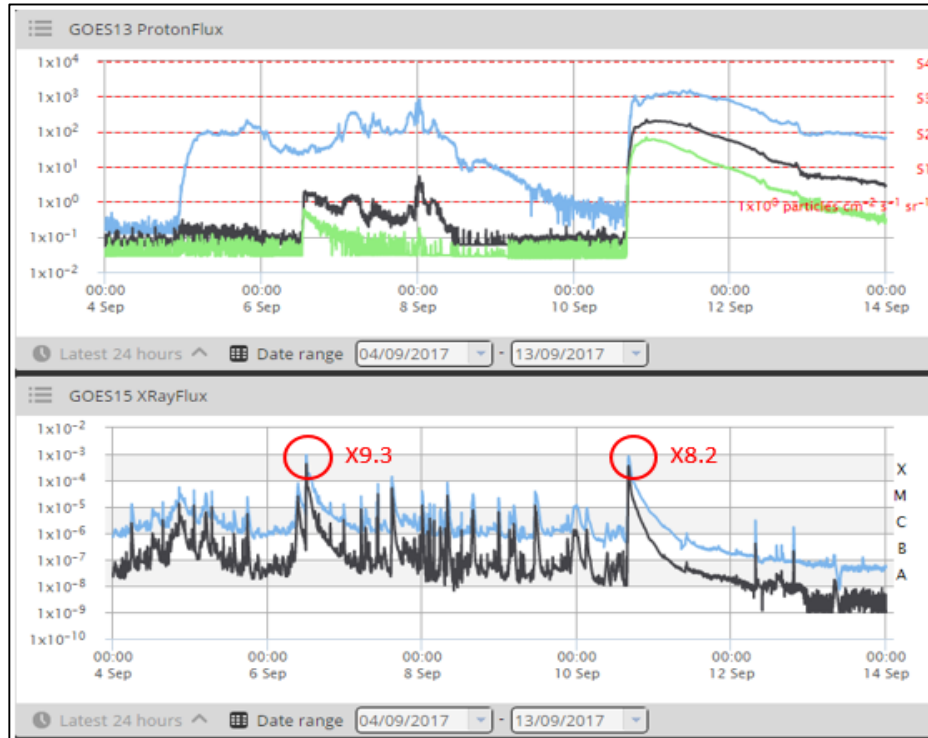


Figure 2: GOES-13 proton flux plot (top) and GOES-15 X-ray flux plot with the 2 largest flares circled

The two largest flares produced significant degradation of HF communications over the Atlantic and the radiation storms also produced HF communications issues over polar regions and high latitudes.

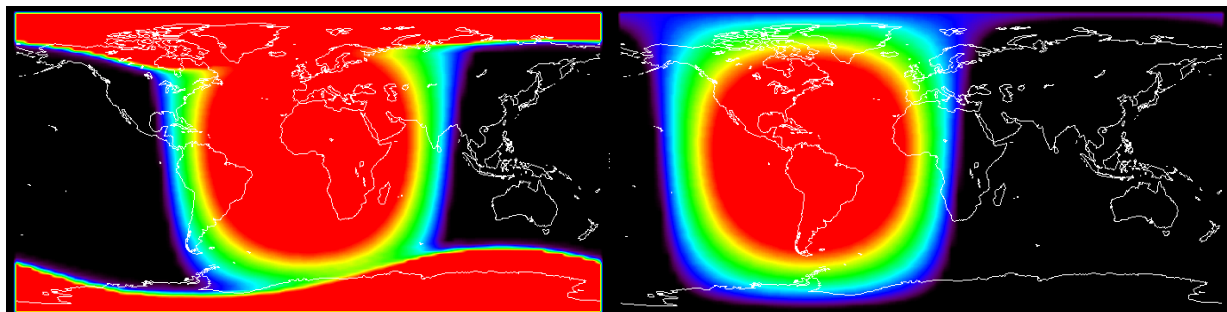


Figure 3: D Region Absorption Prediction (DRAP) indicating areas of >1db absorption by frequency (purple 5MHz & red 35MHz) for the X9.3 flare, 6 Sept (left) and X8.2 flare 10 Sept (right)

The X8.2 flare generated an SEP event with a 'hard' spectrum which resulted in a small GLE of between 5 & 6% at mostly high latitude sites (Inuvik, Kergulen (S Atlantic), South Pole, Terra (Antarctica), Thule)

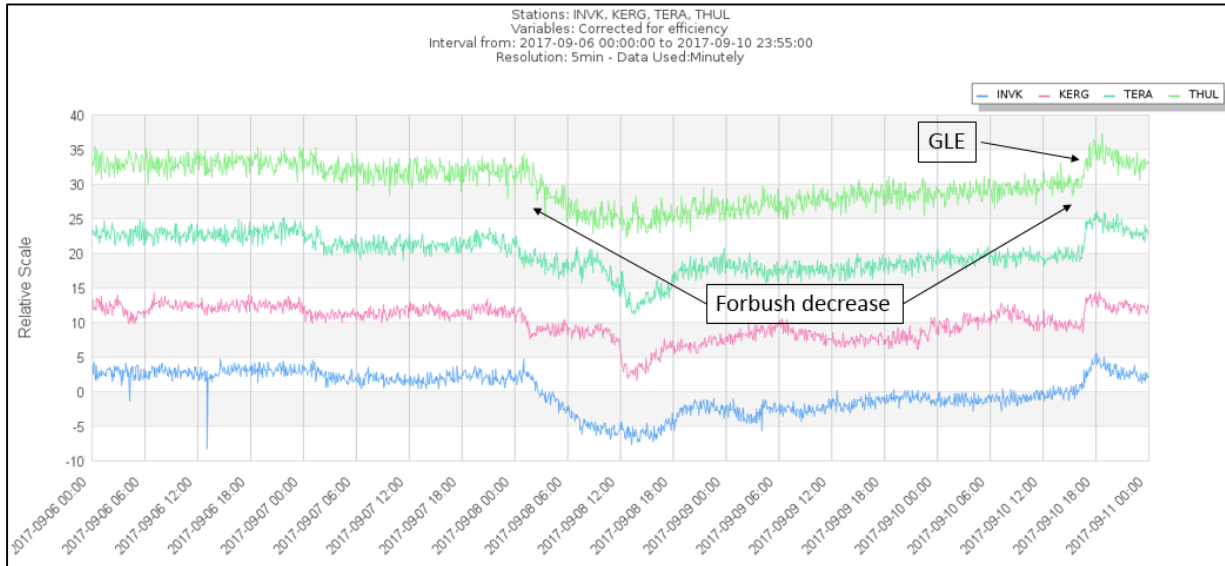


Figure 4: Plotted data for Inuvik, Kergulen, Terra & Thule neutron monitors from the NMBD for 6th to 10th Sept.

The plotted neutron monitor data clearly shows the reduction in galactic cosmic rays (Forbush decrease) that began on the 8th due to geomagnetic activity and the GLE that occurred on the 10th shown to the right of the plot.

Both flares were associated with halo Coronal Mass Ejections. The first CME was launched in an Earth facing direction due to the source region being close to disk centre. The CME arrival was initially detected at the L1 Lagrange point at 22:34UT on 7th September. The interplanetary magnetic field Bz component was strongly and persistently negative for the 3 hours following this.

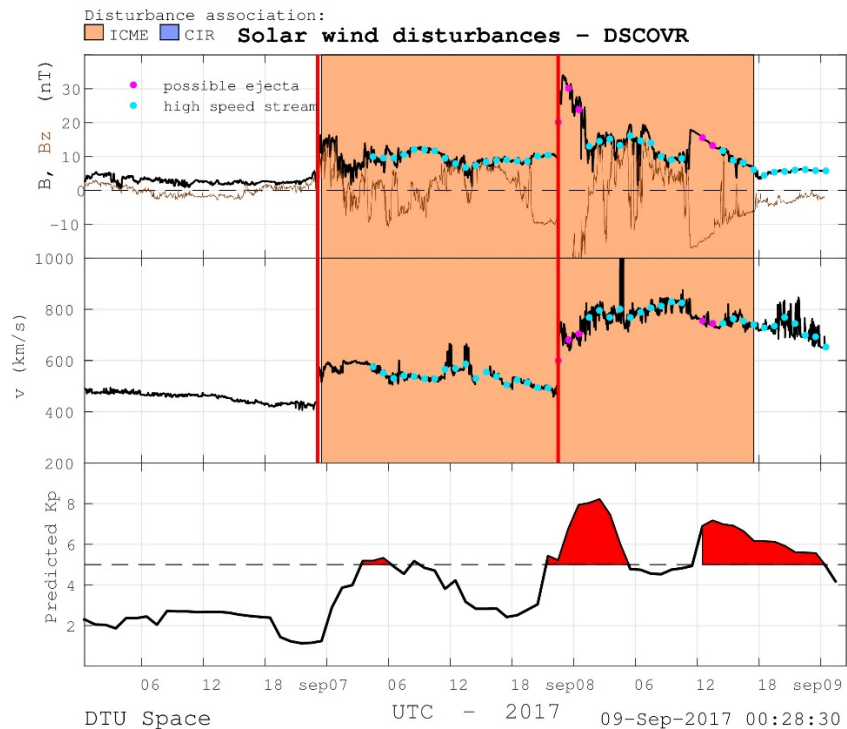


Figure 6. Illustrates the solar wind conditions on 7-8th September 2017 and their interpretation by the AWARE automated near Earth alerts product (<http://swe.ssa.esa.int/web/guest/dtu-aware-federated>). CME arrival was detected late on 7th September corresponding to a sharp increase in predicted Kp.

Strong to severe geomagnetic storming as illustrated the planetary Kp geomagnetic index was consequently recorded between 00:00 UT and 03:00 UT, and conditions remained disturbed for several hours. A further increase to severe disturbance levels took place later in the afternoon as the magnetic field within the CME again turned southward. This lasted for between 3 and 6 hours following which conditions gradually returned to quiet levels. Enhanced aurora were also observed during the evenings of 7th and 8th September.

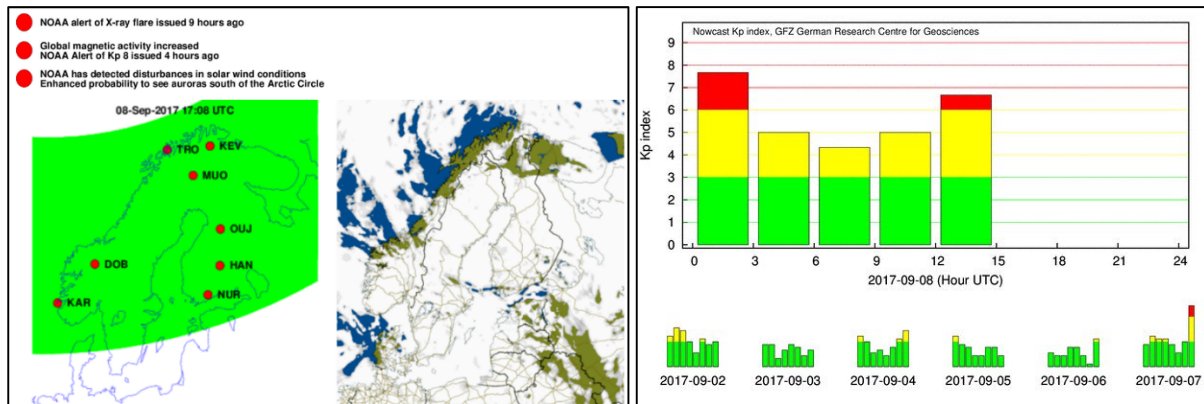


Figure 7: Extracts from the FMI RAF regional auroral forecast (<http://swe.ssa.esa.int/web/guest/fmi-federated>) and GFZ Kp nowcast products (<http://swe.ssa.esa.int/web/guest/potsdam-federated>), as available on the 8th September 2017 illustrating strongly disturbed conditions.

The CME associated with the X.8.2 flare on 10th September was primarily launched to the West of the Earth resulting in a glancing blow from the ICME which reached the Earth on 12th evening and led to moderate (Kp6) geomagnetic storming only.