

## Ionospheric weather risk mitigation challenges in deleterious impacts on ground and space based operational systems and infrastructure

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Several procedures for mitigating the risk of ionospheric weather effects on ground and space operating systems and infrastructure are discussed. The work was limited to radiocommunication - absorption in region D; loss of HF; scintillation of the radio signal in the HF / UHF / L band, for aviation - loss of HF communication; GPS position error for expansion systems. User domain service based on EGNOS, WAAS is extremely useful.

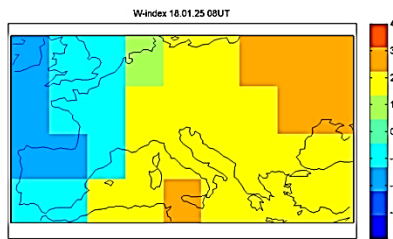


Figure 1. An example for W-index disturbance map computed based on SBAS messages (every 3 minutes) and W-index disturbance computed based on correction EGNOS messages are shown. EGNOS provides online the regional maps of the vertical total electron content in timely, continuous regime.

This application presents commonly used techniques in services. Impact of the state of troposphere with tropospheric return delay and attenuation is described by modelling of the current situation and the forecast is discussed, as well.

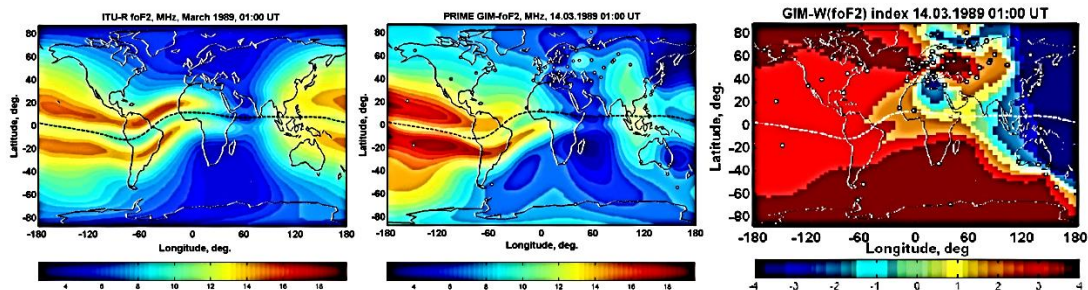


Figure 2. An example: ITU-R (CCIR) prediction of reference quiet monthly foF2 map (left), instant PRIME GIM-foF2 map (middle) and W(foF2) map (right) at the peak of super-storm 14.03.1989 at 01 h UT.

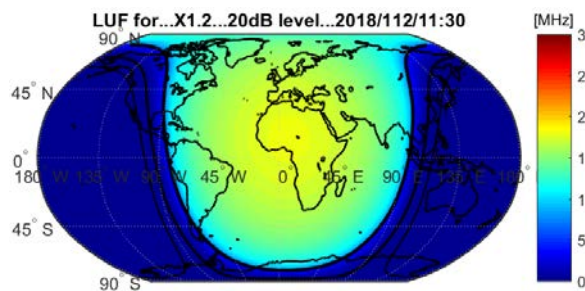


Figure 3. X-ray solar activity can have a significant effect on LUF as presented below.

Commonly used and new techniques in services have both their usefulness, and their pitfalls. and the accuracy they produce can be of key importance for, for example for the frequencies to transmit over nearby mountains, the forecast of usable frequencies, recommendation of available frequencies to global operators or determination of available HF frequencies for Emergency Responders.

The definition of a suite of space weather products for HF radio-communication is key to obtaining quite impressive and reliable results.

It seems that the future challenges discussed, such as new services providing online estimation of the degree of TEC disturbance with a defined resolution, TEC perturbation expressed by a disturbance index (DIX, W or other) at each point of the map grid, or how infrastructure upgrading can be a credible route to providing better and more efficient services for different space weather conditions.

Future challenges will be needed in almost real time to deliver forecasts, alerts and warnings about space weather events and their potential effects.