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Ionospheric Space Weather and Impacts on Technological Systems

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It is well understood that space weather effects on the ionosphere impact a number of technological systems such as High-Frequency (HF) radio communications, satellite navigation and communication systems, over-the-horizon radar, and radio astronomy signals. These impacts occur primarily due to changes in the refractive index of the ionosphere caused by space weather. For example, changes in the refraction of HF radio signals due to variations in the electron density during ionospheric storms causes changes in the propagation path of HF communications and radar signals; variations in electron density due to space weather leads to pseudo-range errors in satellite navigation systems; large gradients in electron density can impact GNSS augmentation systems used for precision navigation; small-scale electron density anomalies cause fluctuations in the ionospheric refractive index resulting in scintillation of transiting radio signals; and vertical drift motion of the ionosphere caused by interaction with downward propagating magnetospheric hydromagnetic waves can introduce Doppler clutter in radar signals. In addition, ionospheric current systems can impact long grounded conductors such as power networks and resource pipelines. For example, rapid variations in ionospheric current systems such as the Equatorial and Auroral Electrojets can induce hazardous currents in power network transformers in those regions, whilst diurnal variations in current systems such as the Sq-current can potentially impact corrosion rates of resource pipelines.

The Australian Bureau of Meteorology's Space Weather Service (formerly known as The Ionospheric Prediction Service or IPS) has been providing services to owners and operators of technological systems impacted by ionospheric space weather for over seven decades, primarily for HF radio operations. Over recent decades the Bureau has been providing increasing support for other technologies such as satellite navigation and communication systems, power networks and resource pipelines. This presentation will briefly review some of the impacts highlighted above and services provided by the Bureau of Meteorology to support operators of affected technologies mitigate ionospheric space weather impacts.