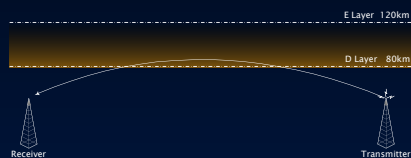
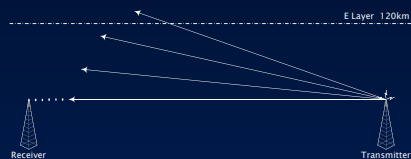


British Astronomical Association Radio Astronomy Group

Sudden Ionospheric Disturbances



Very Low Frequency (VLF) radio signals (3...30kHz) are guided between the conducting ground and the D-layer. The D-layer is a region of the ionosphere that is ionised directly by solar radiation. It is present only during the day, and responds quickly to changes in solar radiation.

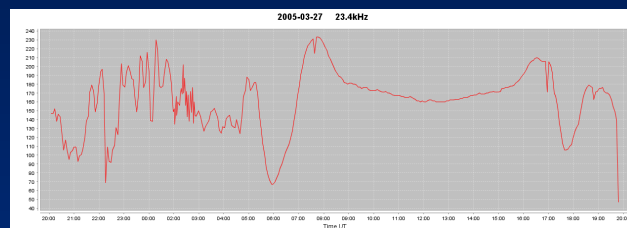


At night, solar radiation cannot ionise the D-layer. VLF radio signals cannot propagate efficiently. The E-layer is responsible for reflecting higher frequency radio signals, which often rise in strength at night.

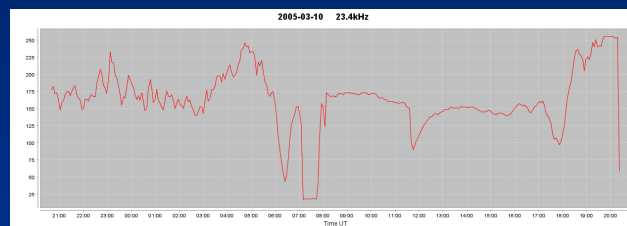


Solar flares produce UV and X-rays, increasing the ionisation (electron density) of the D-layer. The Sudden Ionospheric Disturbances (SIDs) alter VLF propagation, producing rapid and distinctive changes in received signal strength.

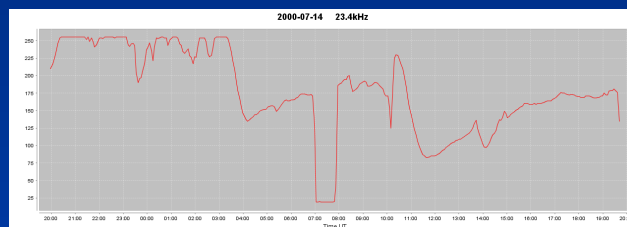
Recorded at 23.4kHz, from a transmitter in North Germany. The graph shows signal strength against time over a 24 hour period. It shows random variation in signal strength at night, followed by a dip as the rising sun recreates the D-layer. During the day, signal strength varies with the altitude of the Sun. At sunset, the D-layer recombines and is lost, producing another dip in signal strength.



A C-class flare at 11:39UT disturbs the D-layer sufficiently to produce a distinctive change in signal strength, recorded as a SID. Note the sudden drop followed by a much slower recovery. SIDs can also show as a sudden increase in signal strength followed by the slow recovery. The transmitter was off-air between 07:10 and 07:50UT.



This X-class flare recorded at 10:04UT had a more dramatic effect on the D-layer, as well as causing havoc to satellites and short-wave communications. The signal received from any transmitter is a combination of waves that have travelled slightly different paths and thus interfere with each other. Large D-layer disturbances can show this multiple-dip pattern as the interference pattern moves over the receiver. The slow recovery phase lasts for several hours.



This work is funded in part by a BAA Ridley Grant