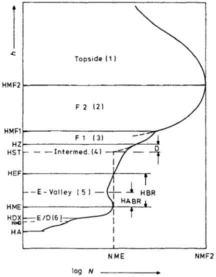
Ionospheric observations from Dourbes during the Mother Day storm

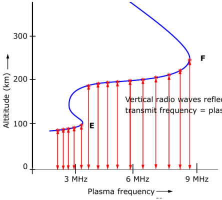
Tobias G.W. Verhulst

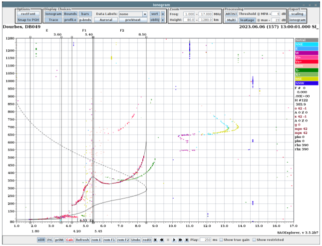
STCE – Royal Meteorological Institute of Belgium

STCE annual meeting, 2024 June 27

We will mostly look at ionosonde data.

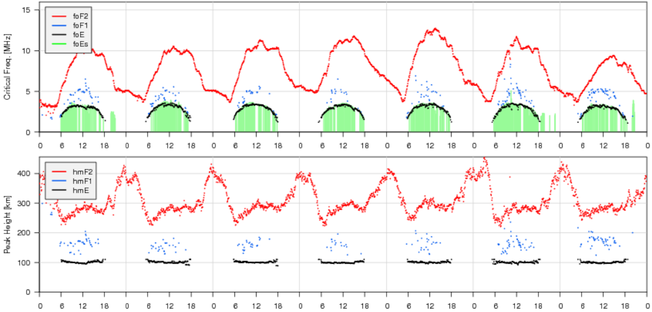






The ionogram shows radar reflection of ionospheric layers up to the highest electron density.

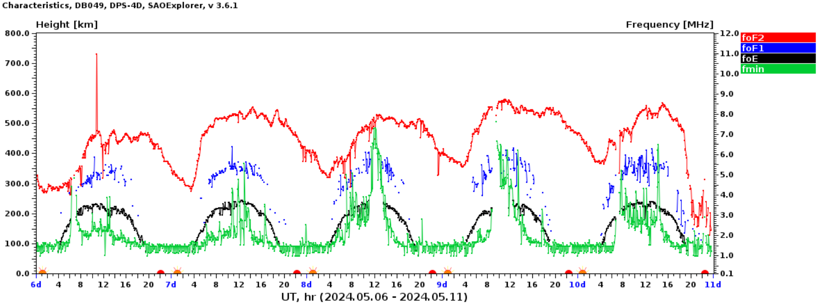
Quiet-time variations



Various ionospheric layers show characteristic diurnal variations.
E & F_1 layers exist only during day; F_2 also at night but with lower density, higher altitude.

Solar flare effects

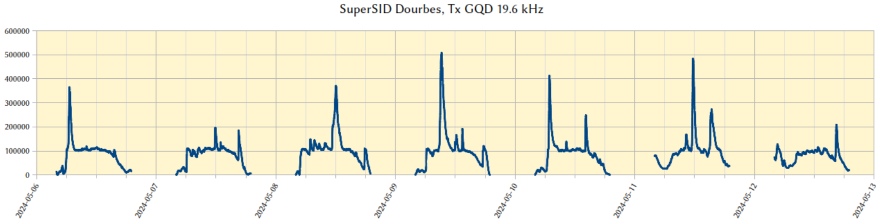
X-rays from solar flares produce ionisation in the *D* region (around 80 m). Ionisation at this altitude causes absorption of HF-waves rather than reflection.



f_{min} is the lowest frequency at which any reflection is seen in an ionogram.

VLF observations

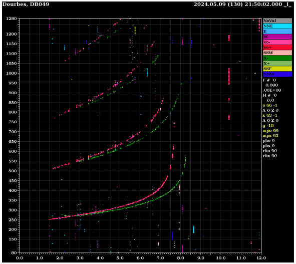
VLF propagate by ducting in a waveguide between earth and ionosphere. Thus: propagation increases with solar flare.

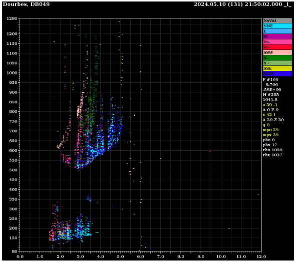


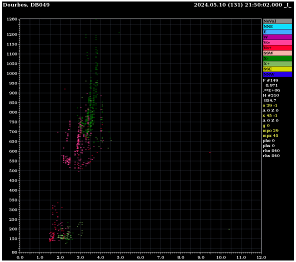
SuperSID instrument monitors signal intensity from various VLF transmitters. Here, Tx is GQD (Anthorn, UK), 550 kW, 19.6 kHz.

Geomagnetic storm: main phase disturbances

The main geomagnetic storm arrived the night of 10 – 11 May.

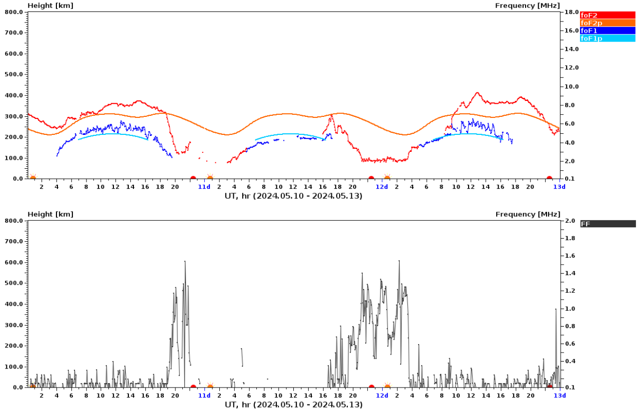






- *F* layer depletion: lower peak density and higher altitude (no positive phase was seen).
- Spread of *F*-layer trace, plus oblique reflections (expanding auroral oval $\rightarrow$ GNSS scintillation).
- *E* layer appearance at night (particle precipitation $\rightarrow$ auroras).

Geomagnetic storm: recovery phase



- Severe depletion lasted (only) until around noon on May 12.
- F_2 density below F_1 density for most of 11 and early 12 May.
- F_1 shows little depletion.
- Still strong spread-F the night after the storm.

Summary

1. During the solar flares, HF signals absorbed so no ionogram data (but good VLF reception).
2. Strong spread-F during the main phase, also during the next night(s) (auroral scintillation expected).
3. Particle precipitation causes night-time E layer (and auroras).
4. Strong post-storm depletion, F_2 disappeared behind F_1 layer.
5. Not shown, investigation still ongoing: plasma drift & travelling disturbances.
6. Additional flares and sporadic-E complicate analysis.

The end!

Questions?