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Extraction of spatially confined small-scale waves from high-resolution all-sky airglow images based on machine learning

Since June 2019, a scanning OH*airglow camera (passive remote sensing) is running operationally every night at DLR Oberpfaffenhofen (48.09°N, 11.28°E), Germany. It provides nearly all-sky images (diameter 500 km) of the OH* airglow layer (height ca. 85–87 km) with an average spatial resolution of ca. 150 m and a temporal resolution of ca. 2 min.

We analyse about three years (941 nights between October 2020 and September 2023) of these images for spatially confined wave structures with horizontal wavelengths of ca. 20 km and smaller. Such structures are often referred to as ripples and are considered to be instability structures. However, Li et al. (2017) showed that they could also be secondary waves.

To identify small-scale and spatially confined structures, we adapt and train YOLOv7 (You Only Look Once, version 7), a machine learning approach, to provide their position and extent on the sky as well as their horizontal wavelength. We analyse the seasonal variations of these parameters and deduce that instability signatures are observed above Oberpfaffenhofen especially in summer.

Finally, we introduce a concept for "operating-on-demand"in order to derive energy dissipation rates from our measurements.

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