Geophysical Research Abstracts
Vol. 19, EGU2017-12782, 2017
EGU General Assembly 2017

High resolution observations of small-scale gravity waves and turbulence features in the OH airglow layer

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A new version of the Fast Airglow Imager (FAIM) for the detection of atmospheric waves in the OH airglow layer has been set up at the German Remote Sensing Data Centre (DFD) of the German Aerospace Centre (DLR) at Oberpfaffenhofen (48.09 ° N, 11.28 ° E), Germany. The spatial resolution of the instrument is 17 m/pixel in zenith direction with a field of view (FOV) of 11.1 km x 9.0 km at the OH layer height of ca. 87 km. Since November 2015, the system has been in operation in two different setups (zenith angles 46 ° and 0 °) with a temporal resolution of 2.5 to 2.8 s.

In a first case study we present observations of two small wave-like features that might be attributed to gravity wave instabilities. In order to spectrally analyse harmonic structures even on small spatial scales down to 550 m horizontal wavelength, we made use of the Maximum Entropy Method (MEM) since this method exhibits an excellent wavelength resolution. MEM further allows analysing relatively short data series, which considerably helps to reduce problems such as stationarity of the underlying data series from a statistical point of view. We present an observation of the subsequent decay of well-organized wave fronts into eddies, which we tentatively interpret in terms of an indication for the onset of turbulence.

Another remarkable event which demonstrates the technical capabilities of the instrument was observed during the night of 4th to 5th April 2016. It reveals the disintegration of a rather homogenous brightness variation into several filaments moving in different directions and with different speeds. It resembles the formation of a vortex with a horizontal axis of rotation likely related to a vertical wind shear. This case shows a notable similarity to what is expected from theoretical modelling of Kelvin-Helmholtz instabilities (KHIs).

The comparatively high spatial resolution of the presented new version of the FAIM airglow imager provides new insights into the structure of atmospheric wave instability and turbulent processes. Infrared imaging of wave dynamics on the sub-kilometre scale in the airglow layer supports the findings of theoretical simulations and modellings.

Parts of this research received funding from the Bavarian State Ministry of the Environment and Consumer Protection.