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Case study of stationary orographic gravity waves in the middle atmosphere observed by wind and temperature lidars at Observatoire de Haute-Provence in January 2019

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An intensive campaign of stratospheric wind observation took place in January 2019 at Observatoire de Haute-Provence, one of the main instrumental ARISE sites. The goal was to validate the wind profiles obtained by the Aladin Doppler lidar on board ESA ADM-Aeolus satellite. The OHP ground-based Doppler lidar was operated during up to 14 hours for each clear-sky night together with NDACC stratospheric ozone and the temperature lidars. Temperature profiles were also retrieved using the channel non-absorbed by ozone (355 nm) of the ozone lidar.

On 6-9 January the meteorological situation was favourable to the generation of orographic gravity waves (GWs) above Alps Mountains and upward propagation to the stratosphere, with the wind blowing from North from the ground up to 30 km. The evolution of meridional wind and temperature profiles during the three nights from 6-7 to 8-9 January showed stationary structures between 15 and 35 km with a dominant vertical wavelength of 5-6 km, in agreement with theoretical estimation for a stationary wave and an observed average wind speed of about 20 ms-1. Several characteristics of the GWs may be extracted from these observations: phase relation between wind and temperature fluctuations, ratio between potential and kinetic energy, altitude of energy and momentum flux deposition. For the determination of the momentum flux, the knowledge of horizontal wavelength is also needed. It is not determined directly by the lidars but it can be estimated using high-resolution ECMWF temperature and wind fields in which the scale of such orographic waves are relatively well simulated. The comparison of GW amplitude in observations and ECMWF data will also inform us about the capability of numerical weather prediction models to explicitly resolve these waves. Additionally the impact of GWs on stratospheric ozone profiles will be presented.