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Gravity waves in simultaneous wind and temperature measurements in the strato- and mesosphere with a twin Doppler lidar

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Wind and temperature measurements are fundamental to understand atmospheric dynamics. However, a wide altitude range of the middle atmosphere from about 15 to 70 km is hard to access by remote sensing instruments: the absence of free electrons prevents radar measurements, and the optical depth prevents satellite remote sensing over the whole altitude range. In-situ measurements by rockets allow only sporadic snapshots, while balloons are not able to ascent high enough. Our Rayleigh/Mie/Raman lidar at the Arctic Lidar Observatory for Middle Atmosphere Research (ALOMAR) in Northern Norway (69° N, 16° E) allows to measure temperatures, aerosols, and wind speed simultaneously. By applying two independently steerable telescopes we are able to measure altitude profiles of two wind components at once. The wind retrieval currently allows wind measurements in aerosol free parts of the middle atmosphere up to 80 km altitude without external calibration. The temporal and spatial resolution is 1 h and 3 km, respectively. We present case studies which include data recorded during stratospheric warmings and during periods of enhanced wave activity. Wave signatures are clearly visible in time-height sections of temperature and horizontal wind and can be combined to deduce parameters of the wave, like propagation and energy density. We present also mean temperatures and winds from lidar measurements performed during the winter seasons 2009–2012 and discuss their importance for wave propagation.