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Investigation of the short- and medium-term variability of OH airglow at Cerro Paranal, Chile within the project AirMon-VLT, using statistical and artificial intelligence methods

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Gravity waves are a significant driver of middle atmosphere dynamics with various excitation sources, e.g. the jet stream, convection zones, flow over orography and natural hazards such as tsunamis. OH-airglow measurements allow continuous night-time observations of gravity waves and various other wave types including singular events like bores and wall events at an altitude of about 86 km.

Their respective signals are subject to the measurement system “Observations of Airglow with Spectrometer and Imager Systems” (OASIS). Imager systems allow the derivation of wave parameters such as the horizontal wavelength and the propagation direction. Data from spectrometers complement this information with wave amplitudes derived in temperature and absolute OH radiance.

Since November 2022, the measurement system OASIS started routine observations at the Very Large Telescope (VLT) in the Atacama Desert at Cerro Paranal, Chile (24.6°S, 70.4°W) in cooperation with the European Southern Observatory (ESO). It is composed of two Fast Airglow Imagers (FAIM) and one Ground-based infrared P-branch Spectrometer (GRIPS) with high temporal resolution (1 image every 1/2 seconds, 1 spectrum every 15 seconds). Currently, over three years of data with nearly 100% night-time data coverage have been acquired. One of the goals of the observation site beside the general investigation of atmospheric dynamics is the investigation of tsunami-induced signals in OH airglow.

Monitoring the OH airglow provides a unique opportunity to make continuous night-time observations of the middle atmosphere with high temporal and spatial resolution. However, the OH airglow causes noise in ground-based astronomical observations in the short-wave infrared like performed with the VLT due to its emissions in this spectral range. The project AirMon-VLT (“Airglow Monitor at the VLT”) brings together the interests of atmospheric scientists to understand middle atmosphere dynamics even better and astronomers who want to precisely

know about the OH airglow variability and radiance. With this detailed knowledge an improved scheduling of deep sky observations for example at times with low OH airglow variability and radiance could be achieved. Also, precise and highly temporally resolved information about the change of OH airglow radiance can help to improve the correction of astronomical spectra.

Within AirMon-VLT, the short and medium-term variability of OH airglow is investigated with statistical methods answering questions like which changes in airglow radiance could typically be expected within minutes/hours/days/etc., e.g. due to infrasound, gravity waves, tides, planetary waves, and by singular events like bore or wall events. With methods from the field of artificial intelligence predictions of the airglow variability will be made into the near and medium future (nowcasting and forecasting) to allow for a better scheduling of the astronomical targets. Also, additional data like ERA5 reanalysis data will be investigated for a more comprehensive understanding of causes of the variability from lower atmospheric layers.

We present the project AirMon-VLT and the measurement system OASIS. We show first results of statistical evaluations about typical changes of airglow radiances related to various wave phenomena, including singular events like a potential wall event with an exceptional high radiance change of 60% within only one hour.