EP 3: Clouds in Planetary Atmospheres (joint session EP/UP)

Time: Tuesday 16:45–18:00 Location: ZEU/0160

EP 3.1 Tue 16:45 ZEU/0160

Wellen und Wolken in der Atmosphäre über den südlichen Anden gemessen mit einem Rayleigh-Lidar — •Natalie Kaifler, Bernd Kaifler, Andreas Dörnbrack und Markus Rapp — Deutsches Zentrum für Luft- und Raumfahrt e.V., Institut für Physik der Atmosphäre

Das CORAL-Lidar misst seit November 2017 in Tierra del Fuego, Argentinien (54°S) die Temperatur der Atmosphäre bis in 100 km Höhe. In der Stratosphäre treten über den südlichen Anden durch Gebirgswellen verursachte Temperaturstörungen von über 20 K Amplitude auf. In den kalten Phasen der Wellen können auf diese Weise polare Stratosphärenwolken auch in mittleren Breiten entstehen. In größeren Höhen, am oberen Rand der Mesosphäre, ist die Temperatur im Sommer kalt genug für die Bildung von Eiswolken, den sogenannten leuchtenden Nachtwolken. Sie werden durch die Gezeitenwinde beeinflusst, sind stark durch Schwerewellen moduliert, und treten in der Südhemisphäre nicht seltener auf als in der Nordhemisphäre, was man aufgrund der höheren Hintergrundtemperatur der südlichen polaren Mesosphäre erwarten könnte. Wir zeigen eine Übersicht und ausgewählte Beobachtungen von Wellen und Wolken in der mittleren Atmosphäre aus mehr als fünf Jahren Lidar-Messungen.

EP 3.2 Tue 17:00 ZEU/0160

Preferential adsorption of para and ortho water molecules on charged nanoparticles in planetary ice clouds — •Johanna Weidelt[1], Thomas Dresch[2], Denis Duft[2], and Thomas Leisner[2,3] — [1]Ultrafast Science Research Unit, University of Bielefeld, Germany — [2]Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology, Germany — [3]Institute of Environmental Physics, University of Heidelberg, Germany

In the Earth mesopause, nanometer-size singly charged particles form by condensation of evaporated meteorite material. They exhibit an enhanced water adsorption cross section due to the strong charge-dipole-interaction. In this work, we study how the nuclear spin state of water molecules affects this enhancement and whether there are conditions that could lead to the formation of spin-polarized ice. Due to symmetry constraints on the total molecular wavefunction, ortho (proton spins parallel) and para (spins antiparallel) water occupy different rotational states, resulting in a different average dipole orientation in electric fields. Therefore, we expect ortho and para water to exhibit distinct adsorption enhancement factors onto charged nanoparticles. Based on Stark-shifts of individual rotational states of water, average dipole orientations of a molecular ensemble and the resulting collision cross section was calculated for various temperatures and particle sizes. We found that in the mesosphere of the Earth (T~150K) the adsorption enhancement of ortho- and para- water is approximately equal while at lower temperatures prevailing around ice giant planets and their moons, significant spin polarizations up to 15% occur.

EP 3.3 Tue 17:15 ZEU/0160

On the colour of noctilucent clouds — •Christian von Savigny[1], Anna Lange[1], Gerd Baumgarten[2], and Alexei Rozanov[3] — [1]Institute of Phyics, University of Greifswald, Greifswald, Germany — [2]Leibniz Institute of Atmospheric Physics, Kühlungsborn, Germany — [3]Institute of Environmental Physics, University of Bremen, Bremen, Germany

Noctilucent clouds, also known as polar mesospheric clouds, are a polar summer mesopause phenomenon and they are typically characterised by a silvery-blue or pale blue colour. In this contribution, we investigate the reasons for this colour using the radiative transfer model SCIATRAN in combination with the CIE (International Commission on Illumination) colour-matching functions in order to the determine the resulting colour impression in an objective way. Different processes and parameters potentially affecting the colour of NLCs are investigated, i.e. the size of the NLC particles, the abundance of middle atmospheric O3 and the importance of multiply scattered solar radiation. We confirm earlier studies indicating that absorption of solar radiation in the O3 Chappuis bands can have a significant effect on the colour of the NLCs. It is, however, found that for sufficiently large NLC optical depths O3 plays only a minor role for the blueish colour. The simulations also show that the size of NLC particles affects the colour of the clouds. Cloud particles of unrealistically large sizes can lead to a reddish colour. Furthermore, the simulations show that the contribution of multiple scattering to the total scattering is only of minor importance, providing additional justification for the earlier studies on this topic, which were all based on the single-scattering approximation.

EP 3.4 Tue 17:30 ZEU/0160

Exoplanetary clouds: The potential of high-precision polarimetry — •Moritz Lietzow and Sebastian Wolf — Institute of Theoretical Physics and Astrophysics, Kiel University, Germany

The reflected flux from planets is polarized due to scattering in their atmosphere. While polarimetry is used to study objects in the Solar System, it has also been proposed for detection and characterization of extrasolar planets. In particular, the reflected polarized flux depends not only on the planetary phase angle and observed wavelength, but also on the atmospheric composition, allowing to distinguish between various cloud compositions. Given the accuracy of existing high-precision polarimeters, scattered light polarimetry indeed has the potential to become a powerful tool to characterize exoplanetary atmospheres. First measurements of planet-induced polarization were reported during recent years. To provide the basis for theoretical studies and the interpretation of dedicated polarization measurements, we developed a radiative transfer simulation software that contains all relevant continuum polarization mechanisms for the comprehensive analysis of the polarized flux resulting from the scattering in the atmosphere, on the surface, and in the local planetary environment. In addition, we investigated the impact of the cloud composition and exoplanetary rings on the scattered light polarization.

EP 3.5 Tue 17:45 ZEU/0160

Retrieval of cloud properties using spectropolarimetric simulations of Earthshine — •Orsolya Pari[1], Claudia Emde[1], Michael Sterzik[2], and Mihail Manev[1] — [1]Ludwig-Maximilians-Universität, München, Germany — [2]European Southern Observatory, Garching bei München, Germany

In order to be able to interpret future observations of the atmospheres of Earth-like planets and detect signatures of life, it is important to understand Earth's atmospheric and surface properties. Observations of Earthshine, which is sunlight scattered by Earth to the Moon, and then reflected back to Earth, make it possible to study Earth as an exoplanet.

We use the Monte Carlo radiative transfer model MYSTIC to simulate polarized spectra in the atmosphere of the Earth for Ocean and Lambertian surfaces. A water or an ice cloud layer is included and we vary the cloud parameters (cloud altitude, cloud optical thickness, effective droplet radius).

The focus is on the $O_2 - A$ and H_2O bands, where the degree of polarization can be higher or lower than the adjacent continuum. To quantify this behavior we use the equivalent width, which is the area in the passband between the absorption line and the simulated spectrum without absorption across a specific spectral region.

We find that the equivalent width is highly sensitive to cloud altitude and cloud optical thickness.The simulations are compared to the observations of Earthshine obtained by FORS2 at the VLT for different Sun-Earth-Moon phase angles.