Symposium Strange Clouds – from the Earth to Exoplanets (SYSC)

jointly organised by
the Environmental Physics Division (UP) and
the Extraterrestrial Physics Division (EP)

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Clouds serve an essential purpose in the Earth's lower atmosphere due to their impact on the radiative balance of the atmosphere. Clouds are found also in other planetary atmospheres throughout the solar system and even on exoplanets, and those clouds can differ strongly in their chemical composition from Earth's water/ice clouds. This session provides a forum on the fascinating properties of these "strange clouds": clouds in planetary atmospheres that differ from the ordinary clouds in the Earth's troposphere.

Overview of Invited Talks and Sessions

(Lecture hall HSZ/0004)

Invited Talks

SYSC 1.1	Tue	11:00–11:20	HSZ/0004	**Not all clouds are created equal – strange clouds in our solar system** — •Thomas Leisner
SYSC 1.2	Tue	11:20–11:45	HSZ/0004	**Clouds to the Edge of Space** — •Gerd Baumgarten, Ronald Eixmann, Jens Fiedler, Michael Gerding, Mykhaylo Grygalashvyly, Franz-Josef Lübken, Ashique Vellalassery, Christian von Savigny, Robin Wing
SYSC 1.3	Tue	11:45–12:10	HSZ/0004	**The dynamic clouds of Venus** — •Javier Peralta
SYSC 1.4	Tue	12:10–12:35	HSZ/0004	**Observational constraints of exoplanet clouds** — •Nicolas Iro
SYSC 1.5	Tue	12:35–13:00	HSZ/0004	**Gemstone clouds in JWST target exoplanets** — •Dominic Samra, Christiane Helling

Sessions

SYSC 1.1–1.5	Tue	11:00–13:00	HSZ/0004	**Strange Clouds – From the Earth to Exoplanets**

SYSC 1: Strange Clouds – From the Earth to Exoplanets

Time: Tuesday 11:00–13:00 Location: HSZ/0004

Invited Talk SYSC 1.1 Tue 11:00 HSZ/0004

Not all clouds are created equal – strange clouds in our solar system — •Thomas Leisner — Institut für Meteorologie und Klimaforschung, Karlsruher Institut für Technologie — Institut für Umweltphysik, Universität Heidelberg

We are accustomed to the appearance of liquid water and ice clouds in the Earth's atmosphere. This contribution introduces clouds in other parts of the solar system and discusses how their appearance and optical properties are shaped by the thermodynamic and microphysical boundary conditions in these worlds.

Invited Talk SYSC 1.2 Tue 11:20 HSZ/0004

Clouds to the Edge of Space — •Gerd Baumgarten[1], Ronald Eixmann[1], Jens Fiedler[1], Michael Gerding[1], Mykhaylo Grygalashvyly[1], Franz-Josef Lübken[1], Ashique Vellalassery[1], Christian von Savigny[2], and Robin Wing[1] — [1]Leibniz Institute of Atmospheric Physics at the University of Rostock — [2]Institute of Physics, University of Greifswald

While the troposphere is rich of clouds, the stratosphere and mesosphere is virtually free of clouds. Two examples of strange clouds above the troposphere are Polar Stratospheric Clouds (PSC) and Noctilucent Clouds (NLC). Extraterrestrial sources or space traffic may lead to cases of clouds that quickly disappear. Because of their importance to society, these strange clouds have attracted great interest. For example, PSC are responsible for Ozone destruction following polar winter, ultimately leading to the Ozone hole. NLC are a one-of-a-kind source of information from the Edge of Space, at an altitude of 85 km, dating back to 1885. Only a few lidar instruments are capable of observing NLC, and only the RMR lidar at the ALOMAR observatory in northern Norway is using three different wavelengths. We make use of these multicolor observations to understand microphysical processes in clouds. A new instrument setup in Kühlungsborn allows studying NLC with subsecond resolution and in 3 different directions, allowing to investigate their morphology which reveals atmospheric motion in the transition region of waves to turbulence. We will present strange clouds observed by lidars above Northern Norway and Kühlungsborn. The importance of these observations is investigated using model simulations of NLC from 1885 to 2100.

Invited Talk SYSC 1.3 Tue 11:45 HSZ/0004

The dynamic clouds of Venus — •Javier Peralta — Facultad de Fisica (Universidad de Sevilla), Sevilla, Spain

Venus is an excellent laboratory to study terrestrial planets permanently covered by clouds. In fact, Venus exhibits a thick cloudy layer which extends along an altitude range of 20 km, these clouds being mainly composed of sulphuric acid droplets and hiding a mysterious absorber proven to be a main driver of its atmospheric dynamics. The spectroscopic and imagery data set acquired during the last 15 years thanks to the space missions Venus Express (ESA) and Akatsuki (JAXA) not only have allowed us to better understand their composition and the prevailing atmospheric dynamics, but the clouds of Venus have also proven their potential to study the generation and impact of the thermal tides, characterize diverse planetary-scale waves and atmospheric instabilities, confirm the vertical propagation of waves generated at the surface, and discover new atmospheric phenomena yet without explanation. The clouds of Venus have also been shown to represent a false positive when inferring surface properties from time-series measurements of reflected starlight on exoplanets.

Invited Talk SYSC 1.4 Tue 12:10 HSZ/0004

Observational constraints of exoplanet clouds — •Nicolas Iro — German Aerospace Centre (DLR), Berlin, Germany

We entered a new era in extrasolar planets characterisation. We are indeed given access to constraints on their meteorology.

New facilities have been designed specifically for exoplanet atmospheric characterisation. Higher spectral resolution of exoplanet atmosphere observations allow us to infer atmospheric properties with unprecedented details, including the presence of clouds.

Moreover, time varying observations could in principle study the variability of exoplanet atmospheres, such as climate and cloud coverage temporal variations.

Here we will review the recent observational constraints relative to clouds in exoplanet atmospheres, as well as discuss the exciting prospects for the near future.

Invited Talk SYSC 1.5 Tue 12:35 HSZ/0004

Gemstone clouds in JWST target exoplanets — •Dominic Samra[1] and Christiane Helling[1,2] — [1]Space Research Institute, Austrian Academy of Sciences, Schmiedlstrasse 6, A-8042 Graz, Austria — [2]Institute for Theoretical Physics and Computational Physics, Graz University of Technology, Petersgasse 16, A-8010 Graz, Austria

Exoplanets provide excellent test-beds for exploring the diversity of atmospheric physics. However, clouds remain a key challenge in observations by altering the local atmospheric composition through condensation, as well as obscuring deeper atmospheric layers. State-of-the-art instruments (e.g. JWST) will make spectral features of cloud particle composition observable. Cloud formation in exoplanet atmospheres traces local thermodynamic conditions. Microphysical cloud modelling is a powerful tool which provides the details of cloud formation processes (nucleation, growth, collisions, settling and mixing) necessary for understanding observations over a wide wavelength range. Gas-giant atmospheres condense clouds formed from a diverse range of materials, such as silicates, metal oxides and salts. We model cloud formation for 1D atmosphere profiles using a kinetic cloud formation model consistently combined with equilibrium gas-chemistry. Using results from 3D general circulation models as input to our model allows us to study cloud formation in JWST targets, such as WASP-96b. We find a significant gap between known theory and retrieved results from observations. However, additional processes could reconcile these differences and yield a greater understanding of the reality of cloud formation on such planets.