EP 7: Exoplanets and Astrobiology II

Time: Thursday 14:00–14:45 Location: H8

EP 7.1 Thu 14:00 H8

Hidden water in magma oceans — •Caroline Dorn[1] and Tim Lichtenberg[2] — [1]University of Zürich, Zürich, Switzerland — [2]University of Oxford, Oxford, United Kingdom

Over the past years, there has been huge progress in our understanding of the bulk properties of Super-Earth and Sub-Neptune exoplanets. Because hot and close-in planets are abundant in the exoplanet population, phase transitions in the interiors of small, dominantly rocky planets have come into sharper focus. Here, we use coupled structural models of the interior and atmosphere of up to super-Earth-sized exoplanets to explore the effect of water partitioning into the interiors of rocky planets inside the runaway greenhouse transition and calculate the effect on the total radius of planets compared to recent models that ignore this effect. The two end-member assumptions lead to a deviation in total planet radius on the order of 5-10%, which is within current accuracy limits for individual systems and will be statistically testable with next-generation transit surveys. In consequence, the inferred water content for a given observed radius of a specific planet may be underestimated by up to two orders of magnitude if volatile partitioning between planetary sub-reservoirs is not accounted for.

EP 7.2 Thu 14:15 H8

Modeling the permittivity profile of Enceladus' tiger stripe region to a simulate radar exploration with an autonomous melting probe — •Alexander Kyriacou, Pia Friend, Gianluca Boccarella, and Klaus Helbing — University of Wuppertal, Gaußstr. 20, 42119 Wuppertal, Germany

Enceladus possibly hosts extra-terrestrial life, due to the presence of a subsurface ocean. Plumes containing microscopic ice particles erupt from geysers into space, the latter of which mostly fall onto the surface and create a layer of deposited material. The geysers are fed by water-filled fractures connected to the ocean. These aquifers are a target for a future lander mission, Enceladus Explorer, carrying a self-navigating melting probe, using an integrated orbital, surface and subsurface radar system to map the intervening ice and localize the water pockets and potential hazards. The deposition of ice particles results in an in-homogeneous permittivity profile, and we quantify the effect this has on the positional uncertainty of radar. First, we predict the density, temperature and impurity level of Enceladus' surface ice. Using data from the Cassini mission deposition of ice particles is modelled, as well as densification processes such as sintering in the presence of heat from the geysers. We find that the ice grains remain unconsolidated on most of the surface and will only experience sintering within 1 km of active geysers. With the derived profile, we simulate radar propagation through the surface using ray-tracing and parabolic equation methods and reconstruct target positions. We compare the results with simulations of terrestrial glacier ice and field measurements.

EP 7.3 Thu 14:30 H8

Response of a coupled climate-chemistry column model to step by step increases in insolation: Towards the simulation of a giant steam atmosphere at the close of the magma ocean period — •Alexander Esau[1], Fabian Wunderlich[2], John L. Grenfell[2], and Heike Rauer[1,2,3] — [1]Centre for Astronomy and Astrophysics (ZAA), Berlin Institute of Technology (TUB), Hardenbergstr., 10623 Berlin, Germany — [2]Department of Extrasolar Planets and Atmospheres (EPA), Institute for Planetary Research (PF), German Aerospace Centre (DLR), Rutherfordstr. 2, 12489 Berlin, Germany — [3]Institut für Geologische Wissenschaften, Freie Universität Berlin, Malteserstr. 74-100, 12249 Berlin, Germany

Using the coupled climate-photochemical column model 1D-TERRA, we perform 11 scenarios varying the net, top-of-atmosphere incoming insolation (S) with values of S = 1 to S = 1.5. Results suggest surface temperature increases to 356 K mainly due to increasing insolation and associated greenhouse heating from enhanced water vapor via ocean evaporation. Surface pressure increases as a result from 1.02 bar (control) up to 1.54 bar in scenario 11 with the highest insolation. Near the tropopause, results suggest a warming of the cold trap and a weakening of the temperature inversion with increasing insolation. The cold trap and temperature inversion are no longer evident in the lower stratosphere in scenario 11, where a penetration of H2O into the stratosphere occurs consistent with tropospheric greenhouse heating and weakened upwards vertical mixing. We plan to investigate the photochemical and H-escape responses with our extensive chemical scheme.