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On the Importance of Producing and Characterizing Laboratory Analogs of Planetary Atmospheric Aerosols and Clouds and Their Use to Interpret Observations

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Clouds and hazes play a major role in (exo)planetary atmospheres. They can absorb and reflect light from UV to thermal infrared wavelengths, changing the atmospheric emission, reflection, and transmission spectra dramatically. The organic aerosols forming the haze can act as cloud condensation nuclei. Then can also settle down onto the surface, hence participating in its composition. Dedicated laboratory experiments have been developed to produce solid materials that are analogs of haze and cloud particles, under different experimental conditions (molecular precursors, temperature, pressure, energy source…). These experimental studies are key to investigating the physical and chemical processes that drive the formation of solid particles from gas and solid phase molecular precursors in planetary environments. These experiments also allow the characterization of the physical, optical and chemical properties of the laboratory-generated haze and cloud particle analogs, hence providing critical information that can be used as input parameters in models for the analysis and interpretation of observational data (e.g. optical constants, vapor pressures, spectral features, grain morphology, etc).

Here, as examples of these laboratory efforts, we will present various studies that combine (1) experiments performed to produce analogs of Titan and Pluto atmospheric aerosols from gas phase molecular precursors, (2) experiments conducted to simulate the formation of benzene ice cloud particles in Titan's stratosphere, and (3) experiments carried out to characterize the haze and cloud particle analogs to provide, in particular, optical constants and vapor pressures. We will show how important these studies are for the interpretation of observational data from past, current and future (exo)planetary missions. We will also introduce the newly funded NASA Center for Optical Constants whose overarching goal is to support a stable, long-term, synergistic laboratory effort to address a critical need throughout the broader planetary science community for the development of a comprehensive database containing complex refractive indices (optical constants) of laboratory-

generated analogs of organic refractory materials, and ices present in planetary atmospheres and surfaces.

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