Geophysical Research Abstracts
Vol. 19, EGU2017-1179, 2017
EGU General Assembly 2017

Laboratory experiments on the microphysical formation process of Noctilucent Clouds

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Ablated meteoric material condensates in the upper atmosphere to nanometer sized meteoric smoke particles (MSPs). These particles are believed to be the major kind of nuclei for the formation of so called NoctiLucent Clouds (NLCs) in the polar summer mesosphere. However, describing the formation process of these clouds is flawed with large uncertainties mainly due to a lack of experimental data on their microphysical formation process.
To investigate these processes, we produce single charged nanometer sized (1-3 nm) MSP analogues in a microwave plasma particle source. The particles are suspended in a carrier gas and transferred to a vacuum setup where they are stored in a linear ion trap (MICE). The trap allows us to apply realistic mesopause conditions in terms of temperature, background pressure and water vapor concentration. By using a time-of-flight mass spectrometer, we are able to observe adsorption and, if nucleation occurs, subsequent deposition of water vapor on the MSP analogues as a function of saturation and residence time in MICE. From these experiments, we determine critical saturations needed to activate cloud formation. However, NLCs occur during polar summer and therefore are exposed to sunlight. At the low pressures of the mesopause, MSPs may heat up with respect to the background gas temperature which significantly influences the critical saturation needed to activate cloud formation. We expose the MSP analogues trapped in MICE to laser light of a known radiation profile in order to determine the heat up of the particles as well as the resulting influence on the nucleation process. The results of our experiments describe the microphysical H_2O nucleation process on MSPs at realistic mesopause conditions and therefore can be used in models to describe the formation of NLCs and countercheck the results with observational cloud properties.