Geophysical Research Abstracts
Vol. 18, EGU2016-9738, 2016
EGU General Assembly 2016

Atmospheric aging of dust ice nucleating particles – a combined laboratory and field approach

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We present INP data measured in-situ at two mostly free tropospheric locations: the High Altitude Research Station Jungfraujoch (JFJ) in the Swiss Alps, located at 3580 m above sea level (asl) and the Izaña observatory on Tenerife, off the West African shore (2373 m asl). INP concentrations were measured online with the Portable Ice Nucleation Chamber, PINC, at the Jungfraujoch in the winters of 2012, 2013 and 2014 and at Izaña in the summers of 2013 and 2014. Each measurement period lasted between 2 to 6 weeks. During summer, Izaña is frequently within the Saharan Air Layer and thus often exposed to Saharan dust events. Saharan dust also reaches the Jungfraujoch mainly during spring. For offline ice nucleation analysis in the laboratory under similar thermodynamic conditions, airborne dust was collected a) at Izaña with a cyclone directly from the air and b) collected from the surface of the Aletsch glacier close to the JFJ after deposition. Supporting measurements of aerosol particle size distributions and fluorescence were conducted at both locations, as well as cloud water isotope analysis at the Jungfraujoch and aerosol chemistry at Izaña. For both locations the origin of the INPs was investigated with a focus on dust and biological particles using back trajectories and chemical signature.
Results show that dust aerosol is the dominant INP type at both locations at a temperature of 241 K. In addition to Saharan dust, also more local, basaltic dust is found at the Jungfraujoch. Biological particles are not observed to play a role for ice nucleation in clouds during winter at Jungfraujoch but are enriched in INP compared to the total aerosol at Izaña also during dust events. The comparison of the laboratory and the field measurements at Izaña indicates a good reproducibility of the field data by the collected dust samples. Field and laboratory data of the dust samples from both locations show that the dust arriving at JFJ is less ice nucleation active than the rather fresh dust at Izaña. This suggests that atmospheric aging and processing decreases the ice nucleation efficiency of Saharan dust during advection to Central Europe.