Interaction between aerosols to rain clouds as a function of aerosols type and source (ASTCI-2015)

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- **Introduction and motivation:**

Precipitation forming processes can be divided into two categories: Warm processes, where the rain forms mainly from the liquid phase in the cloud, and cold processes, where the rain forms mainly from the ice phase in the cloud (Rogers and Yau, 1989). In order for cold processes to occur in temperatures higher than -38^{0}C (homogeneous freezing temperature), ice nuclei (IN) are needed to be present in the cloud (heterogenic freezing) (Szyrmer and Isztar, 1997; Rogers and Yau, 1989). Heterogenic freezing enables ice crystals to grow at the expanse of liquid droplets in a process called Wegener–Bergeron–Findeisen Mechanism (Rogers and Yau, 1989). This is the primary process which initiates precipitation in the mid latitudes (Pruppacher and Klett, 1977; Gagin, 1975). Quantifying aerosol-cloud interactions involves large uncertainty, both at the micro-scale (e.g., the influence of aerosols on precipitation forming processes) and at the global scale (e.g., aerosol influence on the energy budget and on the hydrological cycle). Therefore the interest in this subject has been growing (Menon et al, 2002; Lohmann and Feichter, 2005; Rosenfeld, 2007; Kaufman and Koren, 2006).
The influence of aerosol's size on cloud processes is well recognized, and the conventional wisdom is that larger aerosols (diameter>0.5 μm) are better cloud condensation nuclei (CCN) and better ice nuclei (IN). In contrast, the influence of the chemical composition of aerosols on cloud processes is still not as important to their CCN activity (Dusek et al. 2006; Andreae and Rosenfeld 2008).
Aerosols can originate from natural (desert dust, sea spray, etc) or anthropogenic (industrial, transport, fossil-fuel power plant emissions) sources. As can be imagined, each aerosol type has different chemical composition, for example, desert dust contains high concentrations of terrestrial elements, while sea spray contains sea salt (mostly Na, Cl, and a few other elements) and has a distinguish Strontium isotopic ratio ($^{87}Sr/^{86}Sr$=0.7092; Faure 1986).
It should be mentioned that the largest sources on IN that were recorded are mainly terrestrial (Schnell and Vali, 1976). The existing knowledge on marine IN links between IN concentrations and biological activity. In addition, there are very few evidence for marine IN in terrestrial environment (Bigg 1973; Saxena, 1983; Creamean et al, 2013).

- **Scientific objectives:**

In this work I aim to characterize aerosols' sources according to their chemical composition and isotopic ratios of Strontium and Lead. Aerosols sources also will be verified by HYSPLIT back trajectory calculations. In addition, my chemical data will be compared with data from the HINC (Horizontal Ice Nucleation Chamber) which measures IN concentrations, cloud microphysical properties will be examined using a cloud condensation nuclei counter (operated by PSI). Whenever possible, the polar satellite Soumi MPP (spatial resolution of 375m) will be used to analyze cloud top microphysical properties (i.e. cloud top temperature and composition).

My results might help constraining aerosol-cloud interaction models by using different IN efficiencies for different sources and chemical compositions.

I plan to analyze the chemical composition of cloud samples collected at Jungfraujoch (JFJ). My results will be used to investigate cloud-aerosol interactions and the influence of different air masses on aerosols' composition, and in turn, its effect on ice formation in clouds. The JFJ's remote location, high altitude and state-of-the-art instruments provides a great advantage for studying cloud-aerosol interactions and precipitation forming processes.

My objectives are:

To examine the influence of different aerosol sources and types on cloud properties. The identification of aerosols' sources will be done by chemical and isotopic analyses cloud samples. Back trajectories will be used to verify these findings. After classification of the aerosol sources, the relationships between cloud chemical composition, IN concentration (from HINC) and the microphysical properties of the cloud will be examined.

Results from last year's CLACE campaign indicates that marine aerosols reaching to the research station and can initiate ice through condensation freezing. In addition, Saharan dust was found to be an effective IN within deposition freezing. The results from this year measurements will be combined with the existing data in order to clarify the results obtained from CLACE 2014 regarding the influence of different aerosols on cloud properties, ice formation in clouds, and precipitation forming processes.

- **Reason for choosing station:**

I chose to do my measurements in the JFJ research station since its high altitude and remote location are instrumental for studying cloud-aerosol interactions. In addition to its unique location, additional instruments will be operating at the research station, generating a high quality data set that can be used.

- **Method and experimental set-up:**

Cloud sampling: Cloud samples were collected using a two Teflon impact surfaces that are placed at the Sphinx's lower terrace. As super cooled droplets hit the impact surface and freeze into rimed ice. Every few hours (depending on the sample size), I took the impact surface with the cloud sample, and using a plastic spatula, scratched the rimed ice into a clean zip-lock bag. After the rimed ice melted, it was collected into 50ml tubes.

- **Preliminary results and conclusions:**

During my stay at the research station, I collected 12 different cloud samples. I also showed Larisa Lacher (PhD student from ETH) the sampling procedure and she will continue to sample until February 14th.

Our preliminary results from last year indicates that marine aerosol reaching to JFJ can serve as IN through condensation freezing. In addition, our results indicate that the ability of a given aerosol to serve as IN in condensation freezing increases as the Sr isotopic ratio ($^{87}Sr/^{86}Sr$) is closer to the marine isotopic ratio (0.7092; Faure, 1986). In contrast, in the deposition mode, IN concentration and efficiency increases as the Sr isotopic ratio becomes less maritime and more of a terrestrial type.

- **Outcome and future studies:**

The future studies that are based on the collected data in the campaign are described in detail above.

- **References:**

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