Title	Improving our understanding of Arctic clouds: multi-instrument, multi-frequency, and combined modeling-observation approaches

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Arctic clouds are still challenging for both observations and modeling. High quality observations are needed to better understand the processes related to Arctic clouds and their role in affecting the Arctic climate. Only a few sites exist in the Arctic, where continuous cloud observations with a high vertical resolution are performed. One of these sites is the French - German Arctic Research Base AWIPEV at Ny-Ålesund / Svalbard, where a cloud radar has been installed as part of the Transregional Collaborative Research Centre TR172 on Arctic Amplification (AC)[3] (www.ac3-tr.de) in 2016. In this

presentation, we will highlight ongoing and upcoming (AC)[3] cloud research activities at Ny-Ålesund and the need to tackle the cloud problem by various means.

Each remote sensor, e.g. a single-frequency cloud radar, already provides valuable information on cloud properties such as cloud occurrence or vertical structure. However, more complex properties such as cloud phase, ice particle habit, detection of rimed or aggregated particles, require the combined use of different approaches. Sensor synergy is thus crucial to get a much more comprehensive picture of Arctic clouds and the related microphysical processes. In particular, the combination of different frequencies (combined 94 GHz and 35 GHz cloud radar), radar polarimetry, and lidar will provide the necessary observational constraint for processes in Arctic mixed-phase clouds which is needed to evaluate and improve numerical models.

Using a high-resolution model, we can perform sensitivity experiments and test different microphysical parametrizations relevevant for Arctic cloud processes. In order to link observations with models, we also need a forward operator which simulates synthetic observations based on the model output. In this way, we can better understand the sensitivities of our observations and the role of specific microphysical processes. Long-term model-observation statistics will be combined with detailed analyses of specific case studies.