ARKTINEN TUTKIMUSOHJELMA
ARCTIC RESEARCH PROGRAMME

ICINA

UNIVERSITY OF HELSINKI
UNIVERSITY OF EASTERN FINLAND
TAMPERE UNIVERSITY OF TECHNOLOGY
FINNISH METEOROLOGICAL INSTITUTE

Ice Clouds and Ice Nucleation in Arctic

FROM AEROSOLS TO ICE IN CLOUDS

COMBINING DIFFERENT ASPECTS OF EXPERIMENT AND THEORY

AFFECTING THE ARCTIC CLIMATE

How aerosols are affecting the cloud phase?

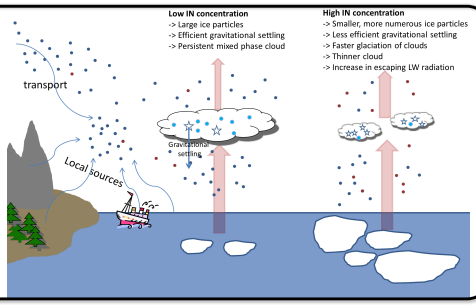
What are the radiative properties of Arctic atmosphere?

Representation of clouds in global models

Feedback mechanisms relevant for the Arctic climate

Wintertime Arctic atmosphere has two typical states:

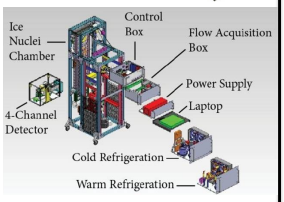
- mixed phase clouds (thick cloud cover, warming)
- radiatively clear state (~40-60 W/m^2 more LW radiation out)



ICE NUCLEATION EXPERIMENTS

Determining the ice nucleation activity of the most important aerosol types in the Arctic, studying how condensation and aging affects properties, determining particle composition, comparison to theory for simple test systems

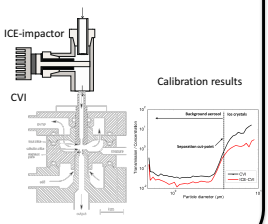
SPIN: a portable ice nucleus counter, based on a continuous flow diffusion chamber – laser, two light-scattering detectors and two polarized light detectors allow discrimination of ice particles from other particles



Ice nuclei separation interface module (INSIM) after the SPIN has been designed and built and is under laboratory testing. INSIM separates ice nuclei from ice crystals and nuclei properties can be studied with different instruments.

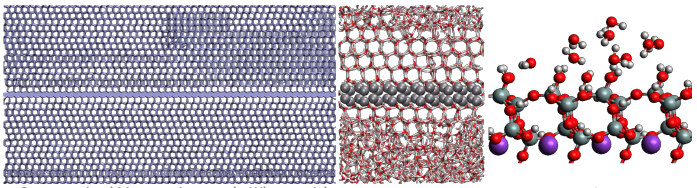
Laser induced fluorescence (LIF) is a candidate to study the origin of the ice nuclei particles. Biological and non-living particles can be detected with LIF.

INSIM



MODELLING ICE NUCLEATION

State-of-the-art molecular-level modelling tools for fundamental understanding on ice nucleation and to construct a molecular level theoretical framework describing the nucleation processes.



Coarse-grained Monatomic water (mW) potential ~ 100 000 'H_2O' molecules

All-atom TIP4P/2005 ~ 1000 H_2O

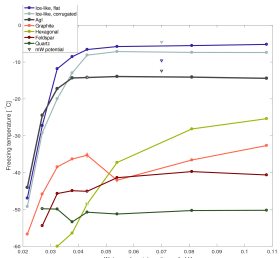
Quantum chemistry a few H_2O molecules

QM/MM method development

Direct comparison to laboratory experiments for test substances and for atmospherically relevant aerosols

Bridging the gap between all-atom simulations and macroscopic models, such as CNT

Generating a realistic description of the ice nucleation process for global models



Ice nucleation temperatures for different aerosol surfaces in MD simulation

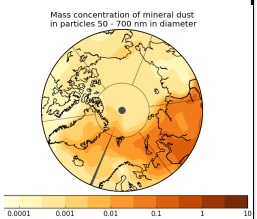
ORIGIN AND PROPERTIES OF ARCTIC AEROSOLS

Ground station measurements of ice nuclei (IN) concentrations and types in the Arctic and sub-Arctic

Satellite observations and modelling reanalysis of dust transport into Arctic

Analysis of relative contribution of local sources *vs* long range transport on IN active particles

Modelling the change in aerosol IN properties during atmospheric aging



PROPERTIES OF CLOUDS & GLOBAL MODELS

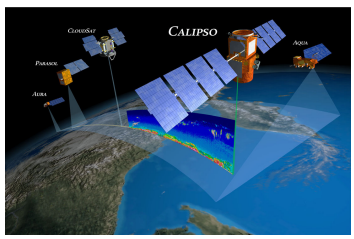
Remote sensing by ground and satellite based LIDARs and cloud radar

Cloud droplet & ice particle residue measurements

Cloud scale process modeling of cloud dynamics and phase

New parameterizations for mixed and ice phase cloud dynamics in global climate model

Better simulations for radiative properties of Arctic atmosphere



NASA Afternoon Train group of satellites with LIDAR equipped Calipso and RADAR equipped CloudSat

PROJECT OUTCOMES

New tools for measuring and modelling of key processes related to Arctic ice and mixed phase cloud formation

Predicting how formation and properties of Arctic clouds change in the future

Improving regional climate and air quality predictions, help target climate change mitigation and adaptation

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