Overview of Ice Processes Focus Group (IcePro)

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Mission Statement

- Better characterize ice physical properties & processes by
  - Establishing linkage between observed ice properties (means, distributions) & models (covering variety of scales) used to investigate how cloud physical properties change with environmental conditions
- IcePro focuses on
  1. Quantifying ice properties & their uncertainties & how they affect modeled processes.
  2. Quantifying uncertainties from in-situ data that serve as basis for model parameterizations of mass- and area-based ice crystal properties

Motivation

- Response of clouds to climate change is major source of uncertainty for future scenarios (IPCC)
  - Need to know what controls physical & radiative properties of clouds to represent how cloud radiative impact responds to changes in environment
  - Key to understanding & predicting microphysical & radiative properties lies in characterizing cloud physical properties

Available Data on Ice μphysics

- Large database exists (in-situ, lab, remote sensing) with varying degrees of accuracy
  - Not known how properties vary by location, cloud type, formation mechanism, vertical motion, dynamics, meteorology, etc.
  - Such knowledge needed to develop process-oriented understanding and accurate parameterizations
- Additional data in variety of conditions needed
  - properties of individual crystals & global populations
  - Need uncertainties associated with properties
  - Need to investigate optimal representations in models with variety of scales

Representations of ice μphysics

- M-D & A-D relations used in μphysics & optics
- How does surface roughness affect optics?
- Size distributions, $N(D)=N_0 D^{\mu} e^{-\lambda} D$
- What are fall velocities, scattering properties, D_e?
  - How well do they describe processes (e.g., riming, sedimentation, aggregation, break-up, sublimation, fall-out, etc.) & radiative properties?
  - How do uncertainties in such relations cascade to larger scales?
  - Not known how properties vary by location, cloud type, formation mechanism, vertical motion, dynamics, meteorology, etc.

Objectives of IcePro

1. Use in-situ observations to derive statistical databases (individual crystals & populations)
2. Utilize new ground-based scanning radar to develop retrieval techniques for crystal habits
3. Conduct spectral radiative closure to constrain ice particle physical & optical properties
4. Conduct model studies to assess sensitivity of modeled cloud properties to representation of ice properties

UNCERTAINTY IMPORTANT FOR ALL ACTIVITIES

Milestones

- Deliver a database of single particle properties to ARM archive as PI products

- Deliver m-D and A-D relations, and SD attributes, to ARM archive that will be useful for model & remote retrieval studies

Performance Metrics

- Develop framework for determining how well physical properties need to be known

- Develop framework for evaluating degree to which candidate parameterizations fulfill established goals based on analysis of observations and simulation

Synergy with QUICR

1. Provide QUICR with ice physical properties to improve QUICR retrievals.
2. Analysis of in-situ observations provides crucial dataset for evaluating ground-based retrievals and their uncertainties
3. Spectral radiative closure may help constrain ice particle physical & optical properties and their uncertainties that are used in retrievals

NOT DIRECTLY IMPROVING OR EVALUATING RETRIEVALS—THAT WILL BE LEFT TO QUICR

End Result

- Identify gaps that still exist in ice cloud property database and parameterization, and possibly recommend additional field experiments needed to fill these gaps