ISDAC LES Intercomparison:

Setup overview and preliminary results

(**Mikhail Ovchinnikov**)

- Ideas introduced at ASR STM 2011, refined at the working group meeting Sept 2011.
- Setup released (Dec. 1, 2011)
- First round of simulations (March 1, 2012) and ongoing.
- Additional simulations are likely, so

  … *IT'S NOT TOO LATE TO JOIN*

Arctic mixed-phase clouds: ISDAC flight 31

A case description for LES intercomparison

DOE Atmospheric System Research (ASR) Program, Cloud-Aerosol-Precipitation Interactions (CAPI) Working Group;
Global Atmospheric System Studies (GASS);
WMO Cloud Modeling Workshop (CMW)

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1. Background and motivation

The goal of this intercomparison is to assess factors controlling the stability of shallow mixed-phase Arctic clouds and examine the sensitivity of cloud parameters simulated by high-resolution numerical models to ice particle properties, such as number concentration, growth rate, and sedimentation velocity. Because liquid-ice partitioning is tightly coupled with the intensity of vertical motions, the analysis will specifically target interactions of micr

https://engineering.arm.gov/~mikhail/ISDAC_F31.html

Two se Arctic clouds provi

A joi ud Experiment (MPA single-layer mixed-phase cloud during the Arctic fall. Models differed widely in simulated properties of a cloud layer formed over open ocean with large surface turbulent fluxes, cloud top temperatures around -15°C, and low aerosol number concentrations [*Klein et al.,* 2009]. Liquid water path (LWP) and ice water path (IWP) from several cloud-resolving models were scattered across two orders of magnitude. An even wider range of results was obtained when single column models were included. Perhaps the most striking differences were seen in ice number concentration predicted by the models using available ice nucleation parameterizations.

In a follow-up intercomparison based on a case from the Surface Heat Budget of the Arctic Ocean (SHEBA) and First ISCCP Regional Experiment – Arctic Clouds Experiment (FIRE-ACE) ice particle number concentration was constrained uniformly across models [*Morrison et al.,* 2011]. The cloud system consisted of a persistent mixed-phase cloud that

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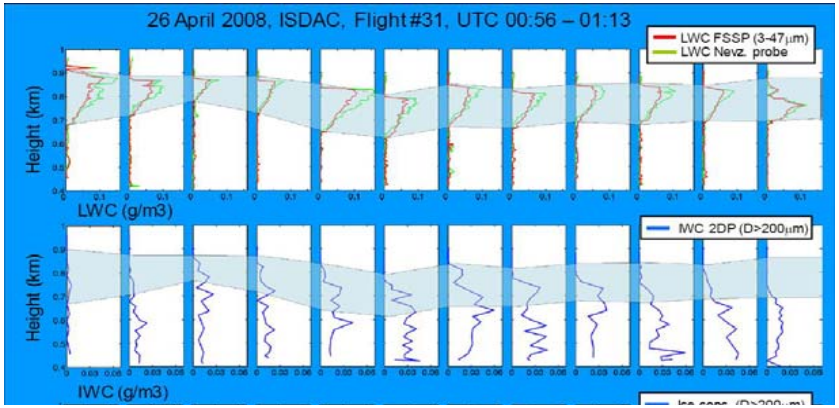
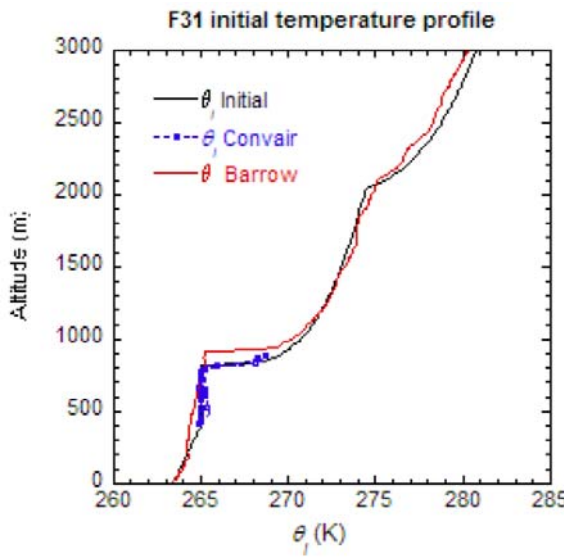
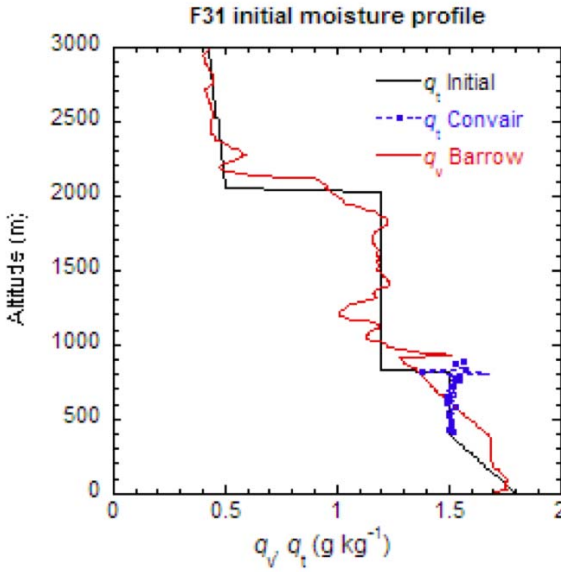
Setup options



- Semi-idealized case based on ISDAC Flight 31.
- LES, 50-m horizontal and 10-m vertical grid size, 128x128x120+ domain.
- 8-hr simulations, liquid-only dynamics spin-up for 2 hrs.
- Elevated mixed-layer, temperature inversion above and slightly stable & moist layer below.
- Nudged horizontal wind profiles and temperature & moisture above the inversion





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Setup options

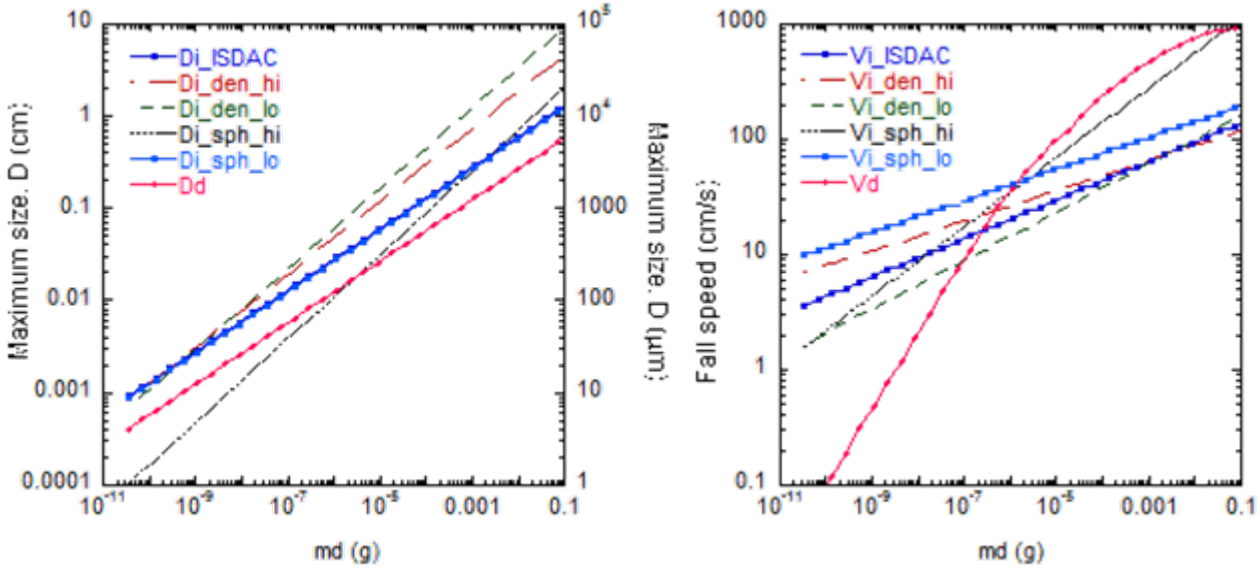
Ice nucleation:

- Constrained IN / N_i concentrations (3 runs **ICE0**, **ICE1**, **ICE4**, for N_i=0,1,4 L^{-1})

$$\left(\frac{\partial N_i}{\partial t}\right) = \max\left(0, \frac{N_{i0} - N_i}{\Delta t}\right), \quad S_i \geq 0.05 \text{ AND } q_l \geq 0.001\, g\, kg^{-1}$$

Ice microphysics:

- Prescribed/parameterized ice properties for deposition & sedimentation



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Setup options

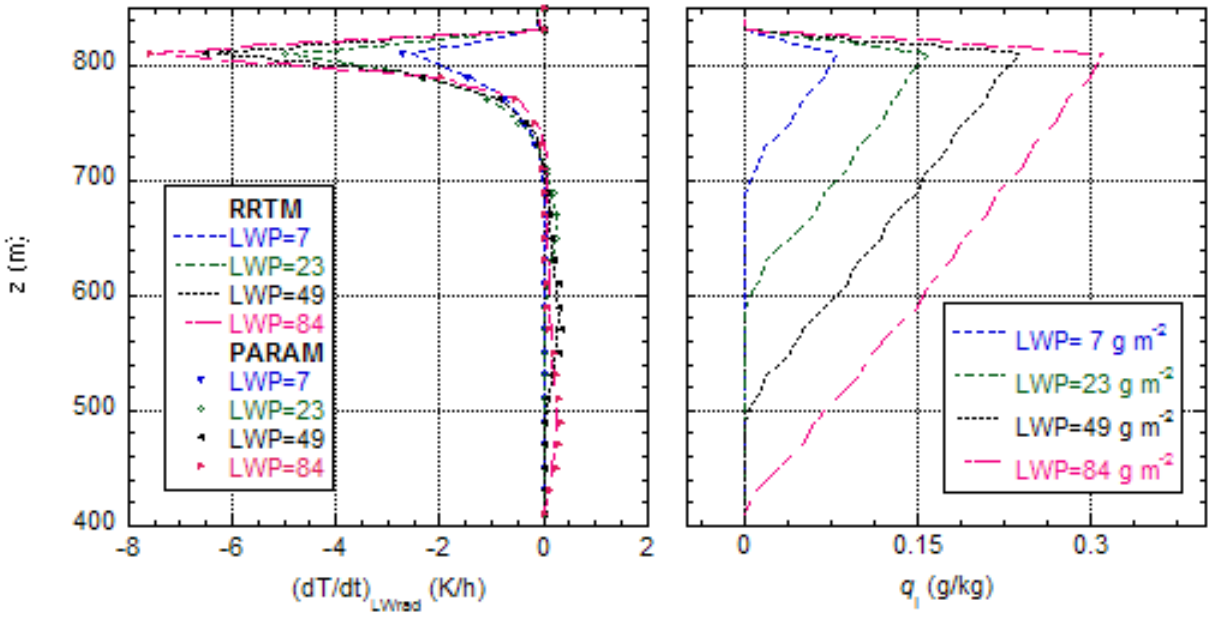
Parameterized radiation:

- Net longwave flux as a function of liquid water profile

$$F(z) = F_0 \exp\left(-k\left[LWP(z_t) - LWP(z)\right]\right) + F_1 \exp\left(-k\, LWP(z)\right)$$

Parameter:	F_0 (W m^{-2})	F_1 (W m^{-2})	k (m^2 kg^{-1})
Value:	72	15	170

$$LWP(z) = \int_0^z \rho(z')\, q_l(z')\, dz'$$



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Preliminary results

(2 models x 3 runs)

DHARMA-2M:

- 3D, two-moment (modified Morrison) microphysics

SAM-SBM:

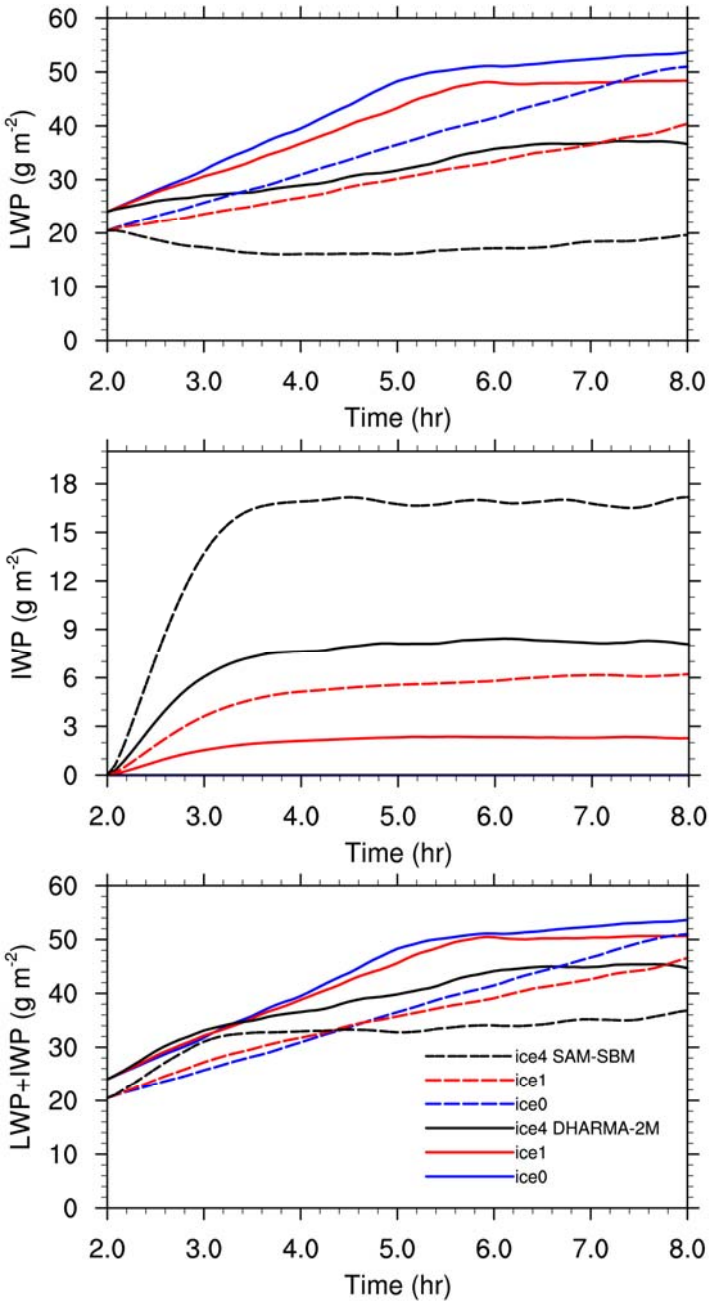
- 3D, size resolved (spectral bin) Microphysics

Runs: ICE0, ICE1, ICE4

Differences in ICE0 runs after the spinup

(initialization, dynamics, entrainment, turbulence, etc.)

Sensitivities to *N*i are similar.



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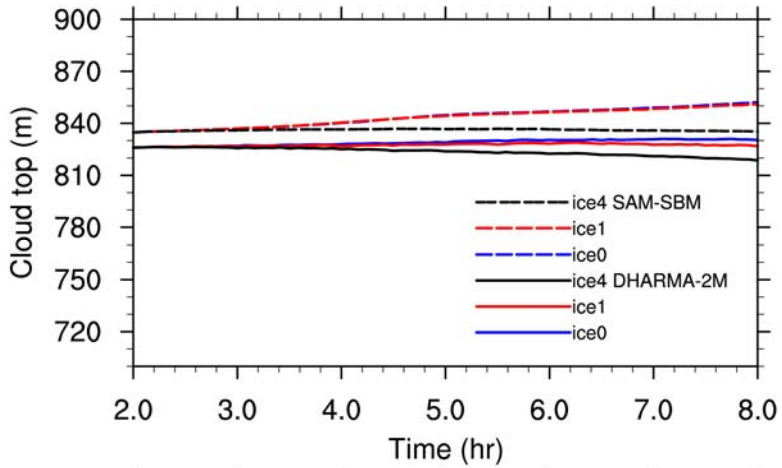
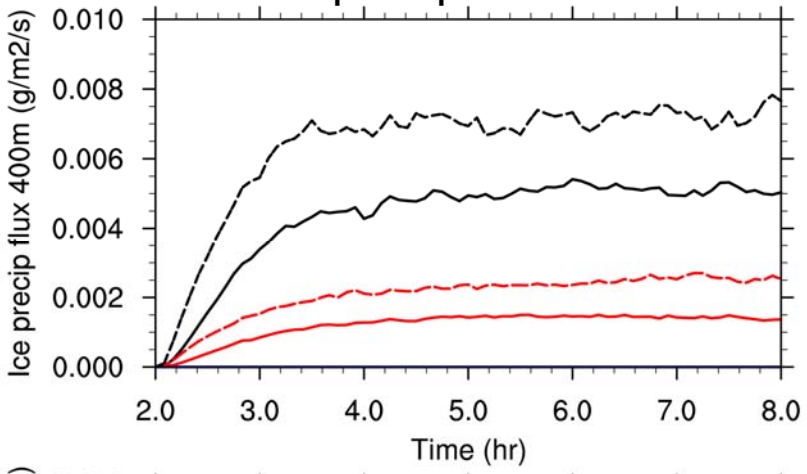
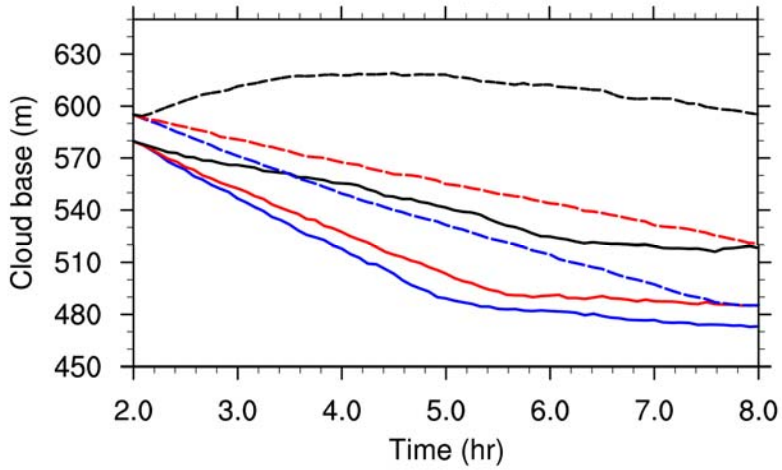
Preliminary results

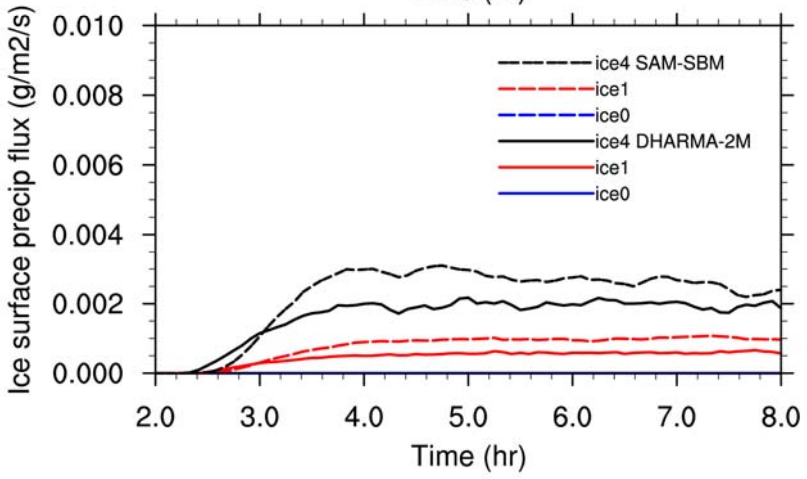
- Cloud top is relatively stable
- Mixed layer is deepening downward

Quasi-steady state IWP and precipitation









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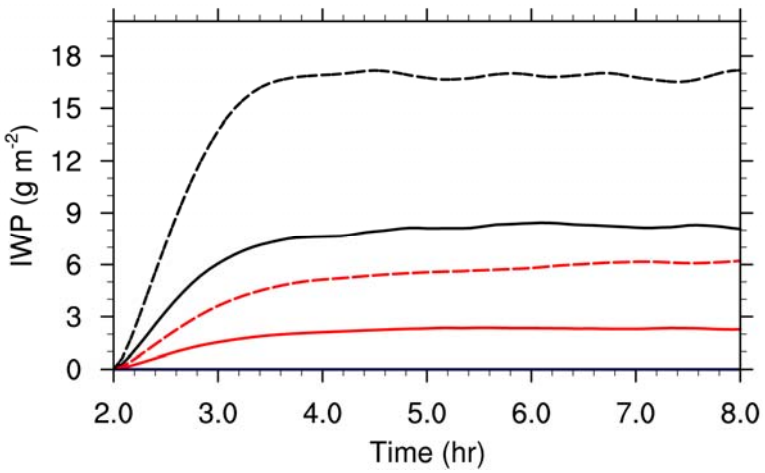
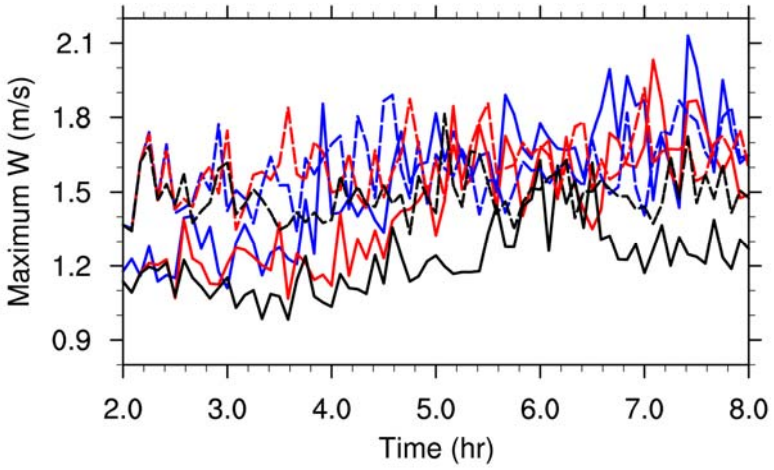
Preliminary results

Effect of dynamics: stronger updrafts seem to support higher ice water content.





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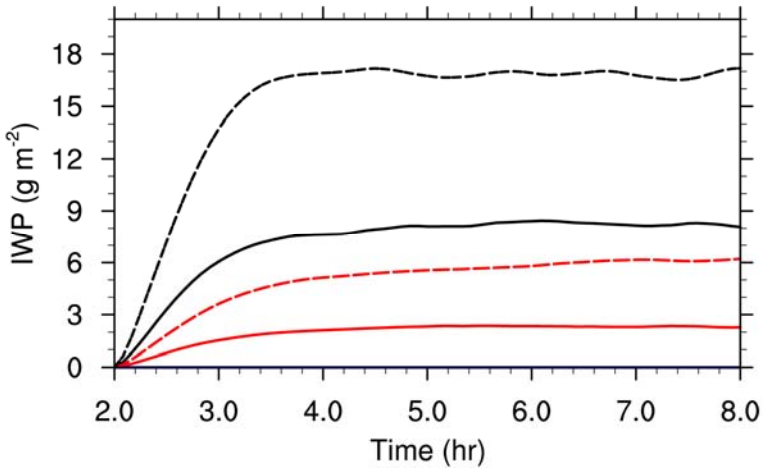
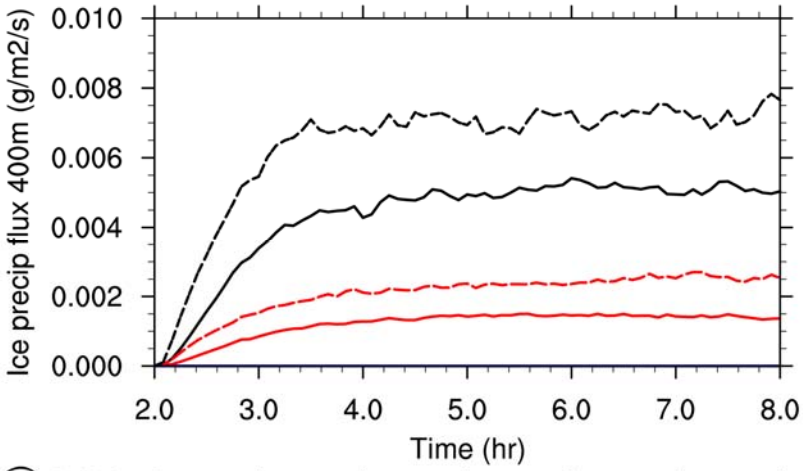
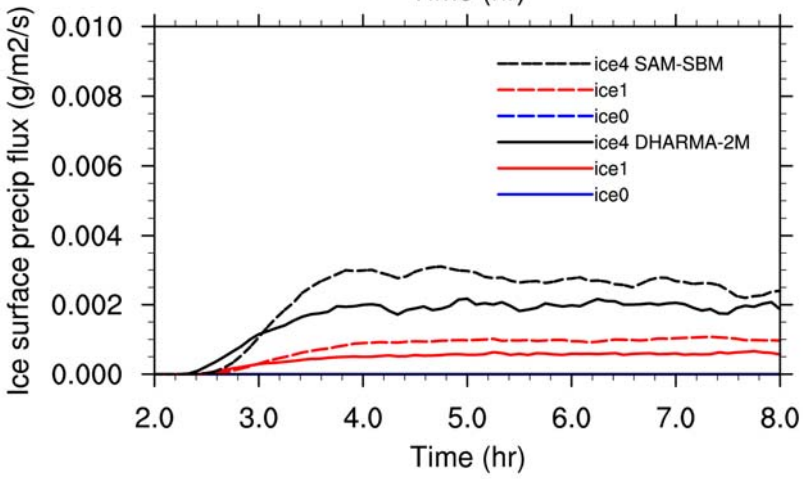
Preliminary results

Effect of microphysics: Differences in precipitation between the models are smaller than in IWP. Different size distributions?







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Next steps

- Make adjustments to the setup and requested output statistics.
- Collect and analyze results from more models.
- Conduct more sensitivity runs with the different dynamics and/or microphysics within the same model(s).
- New deadline TBD: late spring – early summer.
- A dedicated session at the 8th International Cloud Modeling Workshop in Warsaw, Poland in July 23-27, 2012.

  http://www.atmos.washington.edu/~andreasm/workshop2012

- Polar Cloud Processes session at the 1st Pan-GASS Conference 10-14 Sept. 2012, Boulder, Colorado USA