Aerosol indirect effect on cold clouds

Xiaohong Liu
(Pacific Northwest National Laboratory)
Paul DeMott
(Colorado State University)

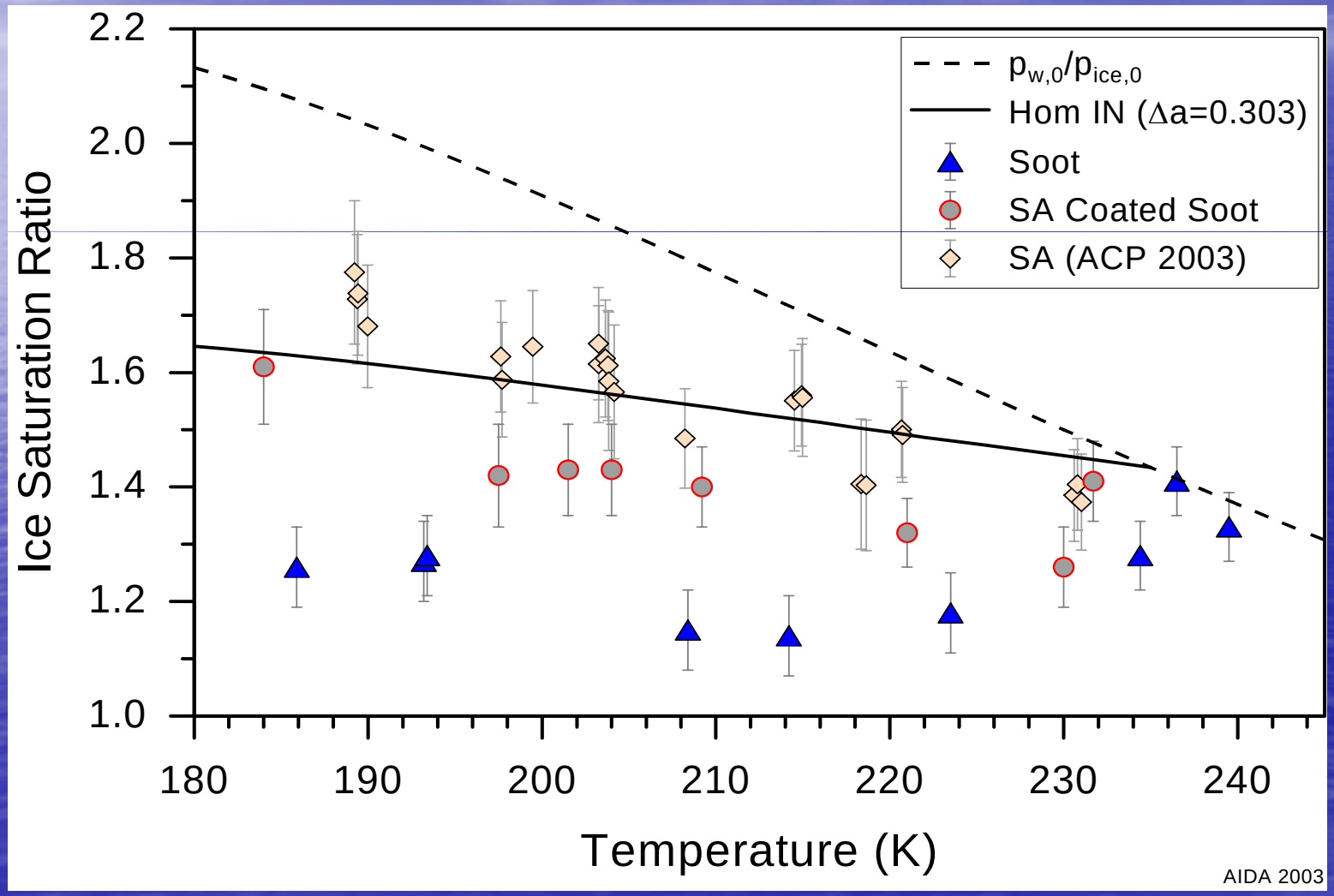
Some evidence for alteration of ice clouds by aircraft emissions

- Soot associated with increasing ice concentrations in regions of enhanced soot most probably due to aircraft (Ström and Ohlsson, 1998); Ice effective radius reduced by 10-30% perturbed by aircraft (Kristensson et al., 2000)

- Trend difference in high clouds observed over regions with computed contrail cover > 0.5% was 3.5%/decade (land) and 1.6%/decade (ocean) between 1984 and 1990 (ISCCP data) (Fahey and Schumann et al., 2001)

- Regional climate changes due to aircraft emissions (e.g., U.S. after 9/11 grounding according to Travis et al., 2002)

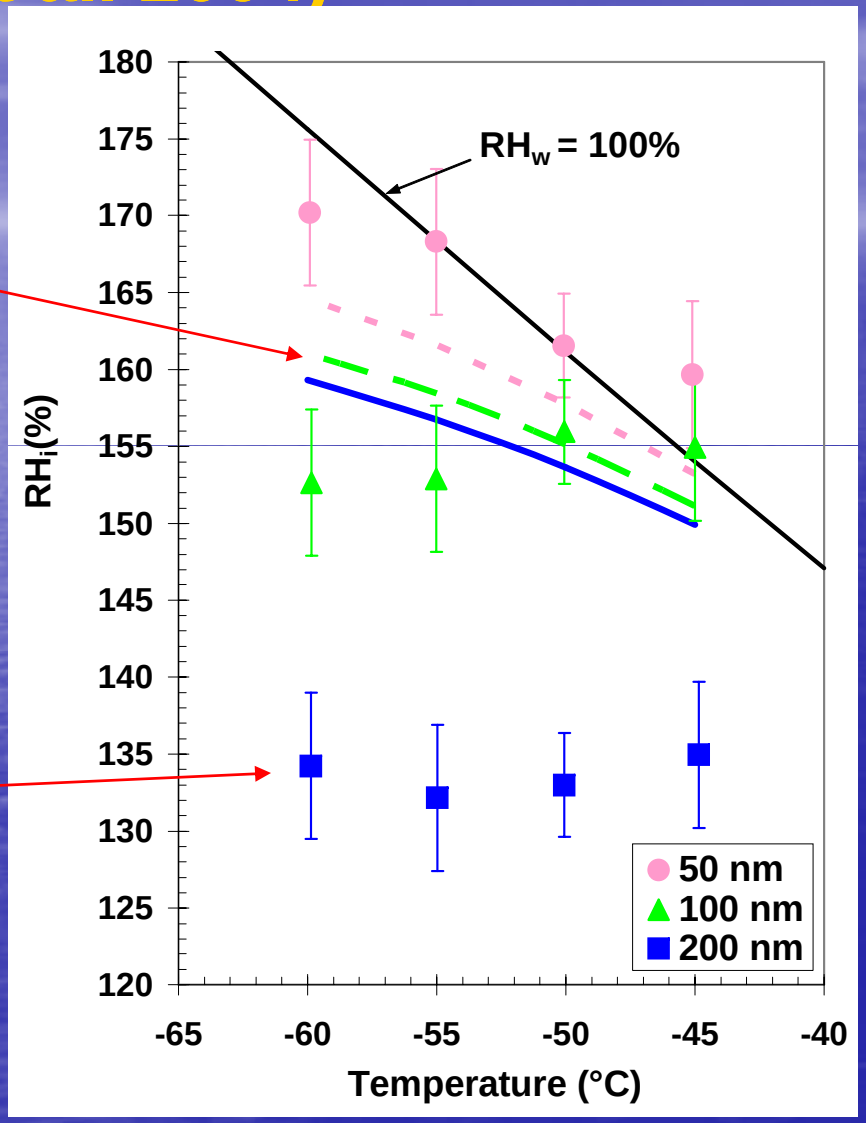
Combustion soot as an ice nucleus (Moller et al. 2005) suggesting morphology, surface properties, chemistry are important.



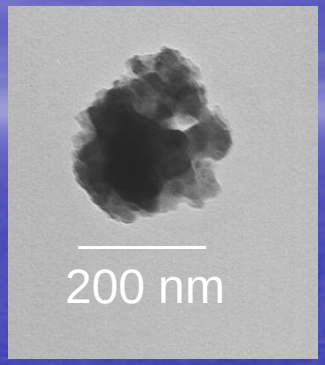
Resuspending actual dust samples (Asian dust – Archuleta et al. 2004)

Homogeneous freezing points of sulfuric acid aerosols

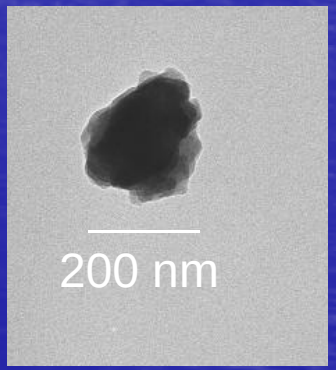
Heterogeneous nucleation by dust

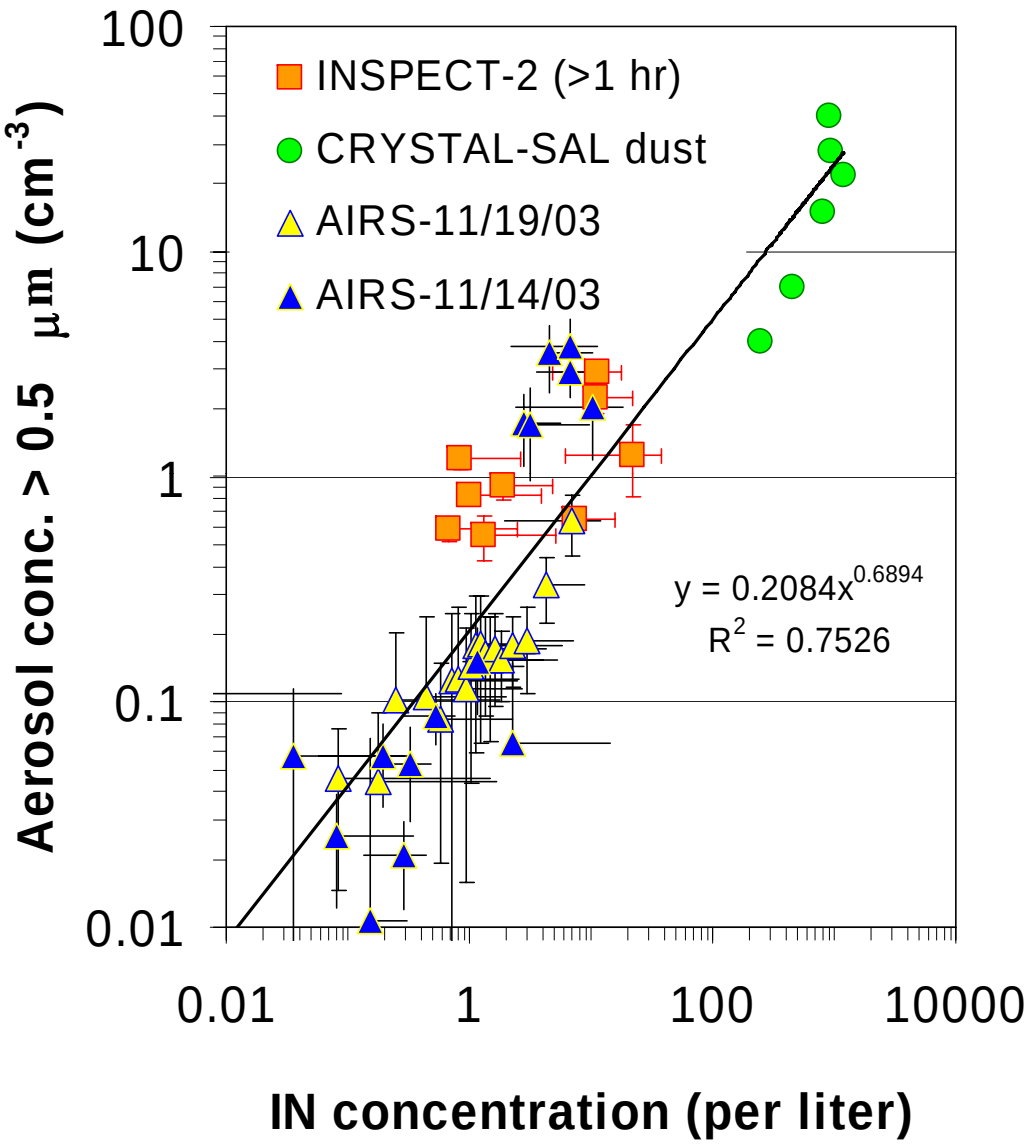


Ca, Si, S, Mg



Si, Al, Fe

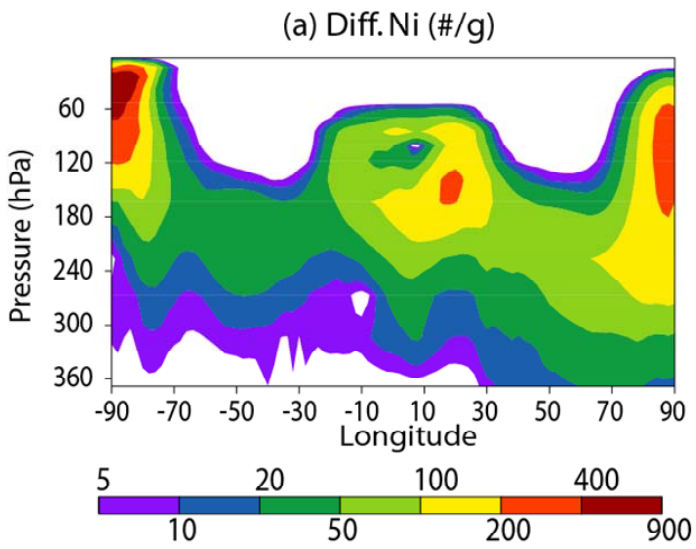


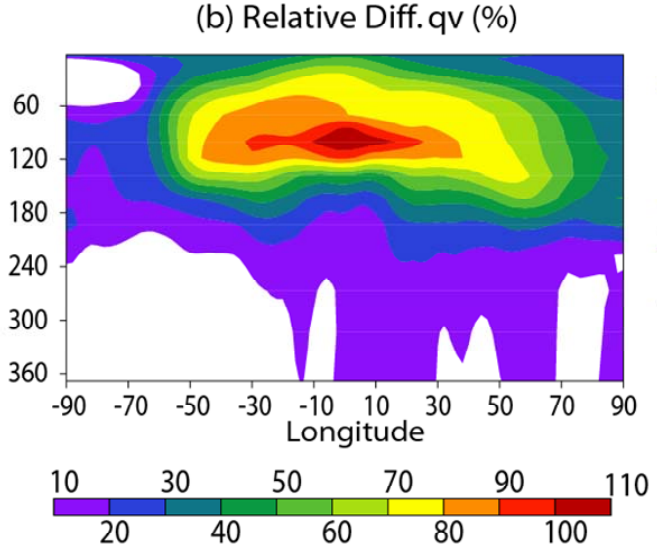


Paul DeMott and Anthony Prenni
(DOE Grant DE-FG02-06ER64176

Effect of ice nucleation on UT/LS temperature and water vapor using NCAR CAM3 (Liu et al., 2007)

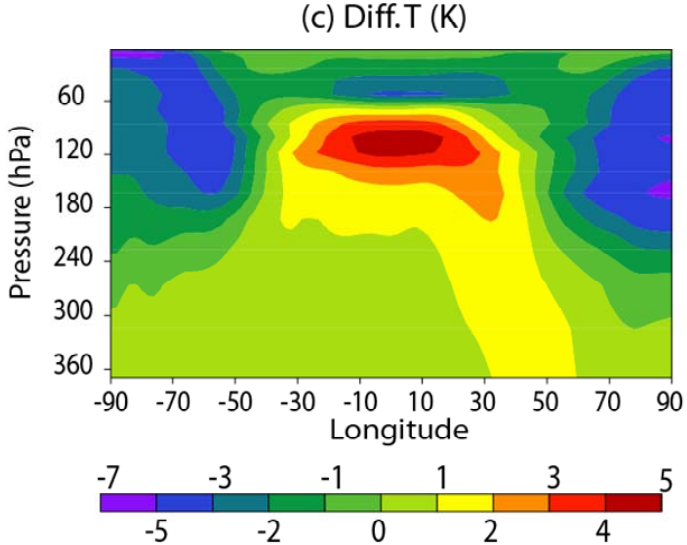
Diff. Ni





Diff. qv

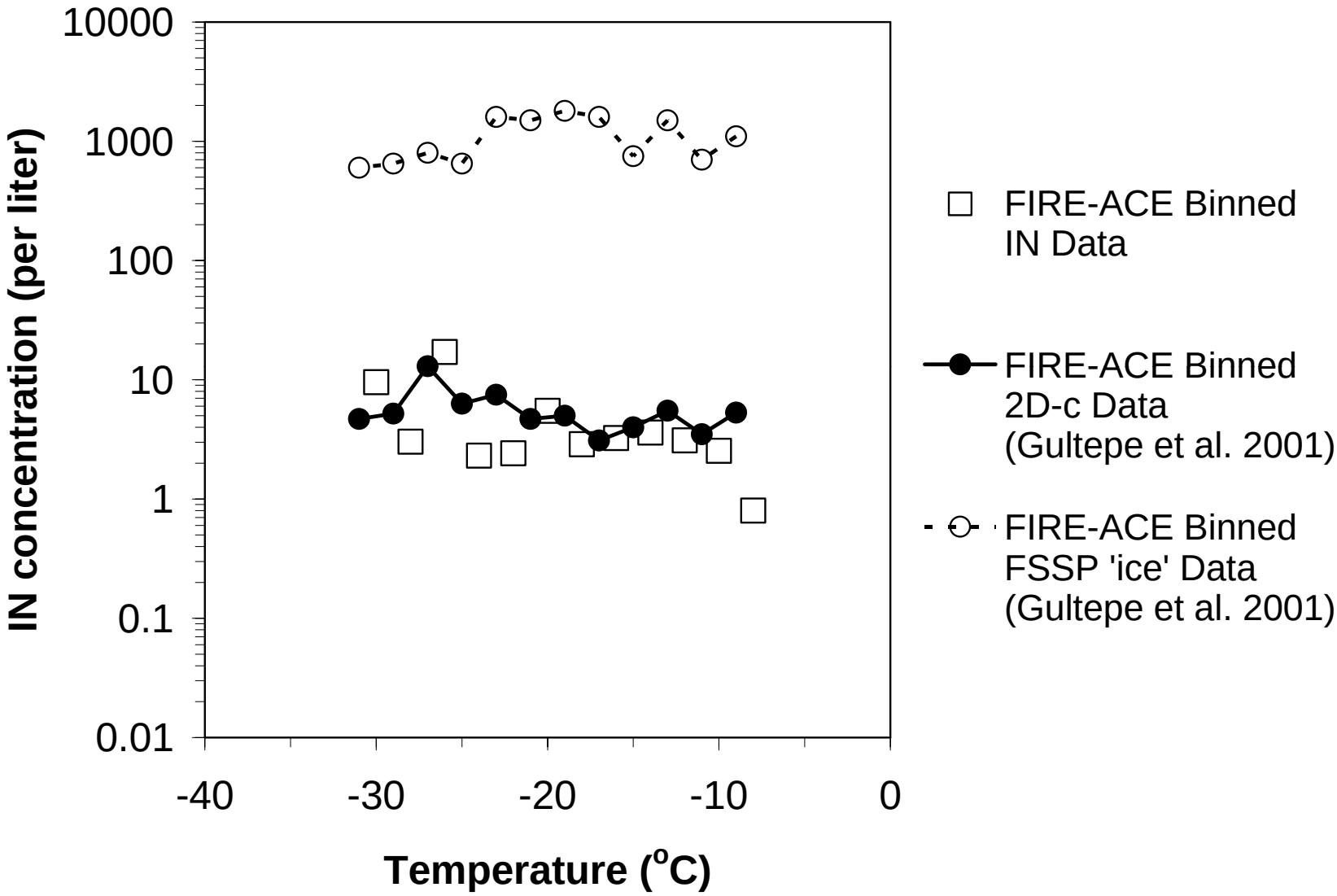
Diff. T



threshold RHi for heter. ice nucleation changing from 125 to 105%

Challenges

- Laboratory measurements and fields campaign urgently needed to understand ice nucleation properties of aerosols as related to aerosol sizes and composition, and to understand ice nucleation mechanisms
- Constrain ice nucleation theory and improve parameterization.
- Improve ice microphysics in the GCMs.
- Evaluation of models with field campaign data and NASA satellite data (e.g., CLOUDSAT, CALIPSO).



Paul DeMott and Anthony Prenni
(DOE Grant DE-FG02-06ER64176