Investigations of ice nucleating particles from sea spray

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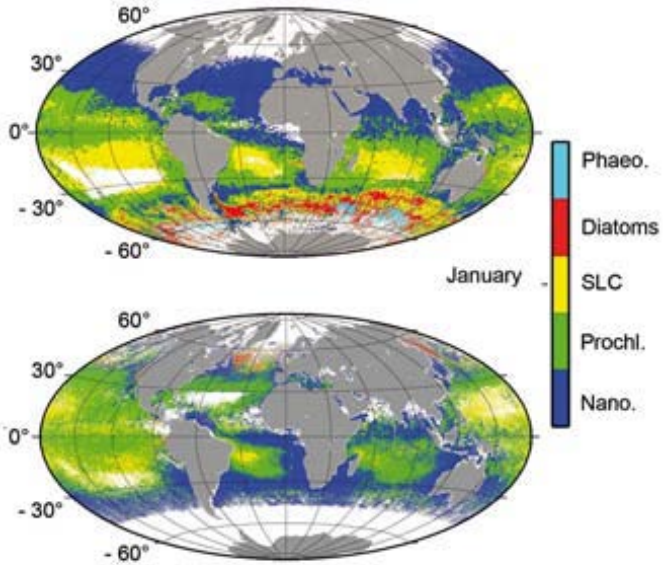
(+ many collaborators)

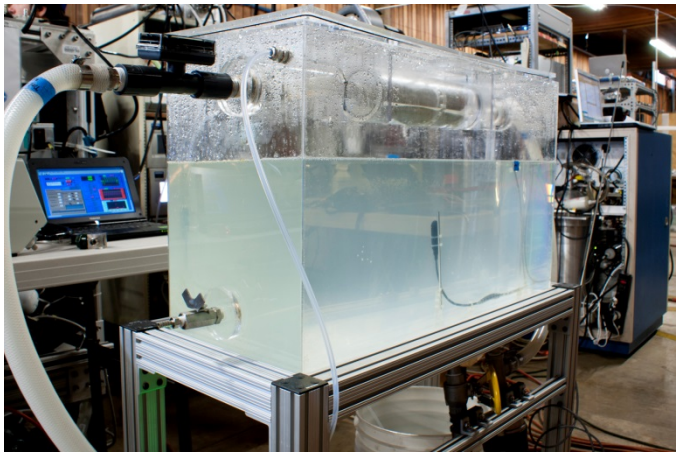
- To what extent are oceans sources of the nuclei for ice cloud formation?
- Are marine ice nuclei of biological origin (bacteria, virus, algal, diatoms) or mediated by their action and byproducts?
- Long term goal: assisting modeling objectives. Can variations in sources help to explain marine cloud differences (frequency and phase) over oceans detected by satellites versus simulated by global models?

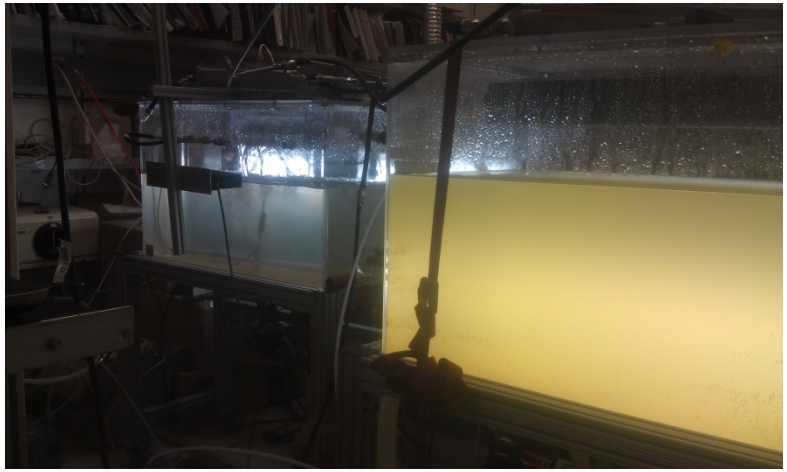


Alvain et al. 2012

CAICE (Center for Aerosol Impacts on Climate and the Environment) Lab Studies

Glass Wave Channel





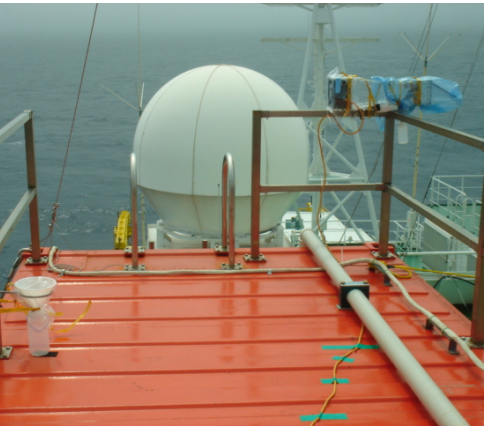
Marine Aerosol Reference Tank (MART)

Method: Filter-based aerosol collection, offline analysis of IN concentration from marine regions

Preloaded, sterilized, filters collected once per day (~8k-15k liters)

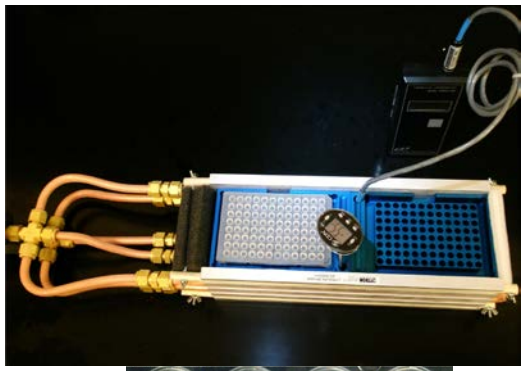
Cold storage

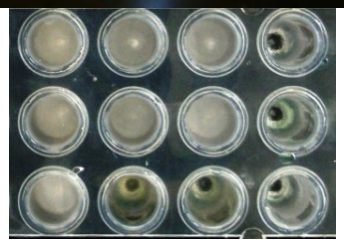
Washing of thawed filters



Heat/chemical treatment for selective removal of fungi, bacteria, all biologicals, all organics

Ice spectrometer analysis of freezing portion of subdivided liquid (~ 3 ml) in 96 wells

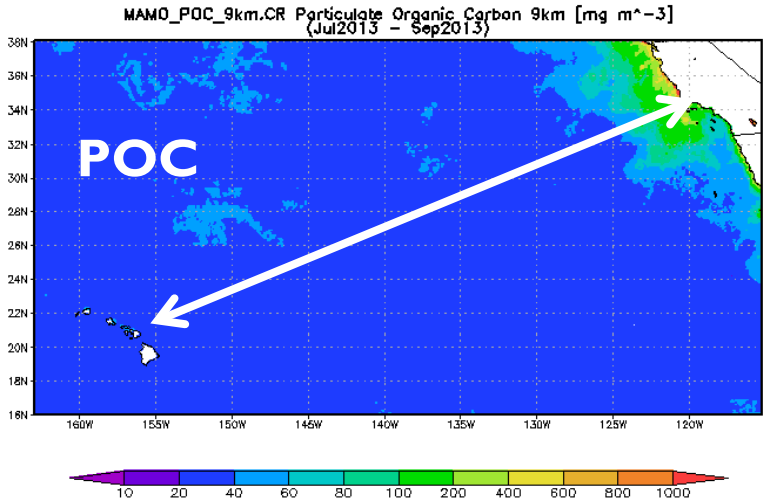


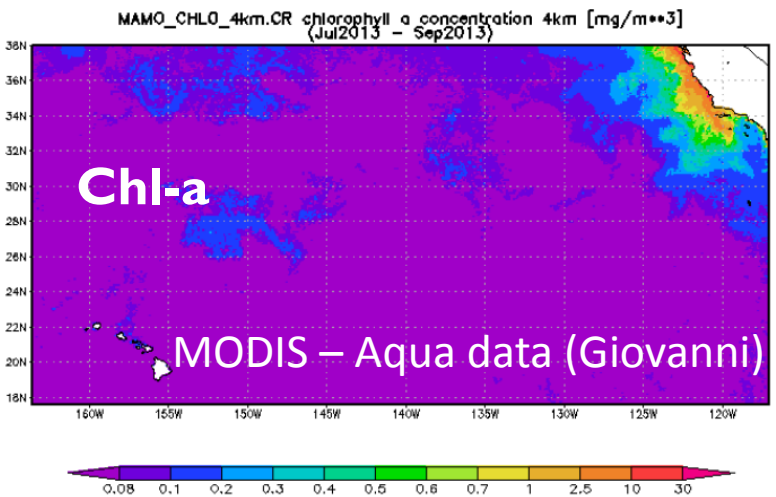


DNA extracted from portion of liquid for PCR analyses, pyrosequencing, and comparison to seawater

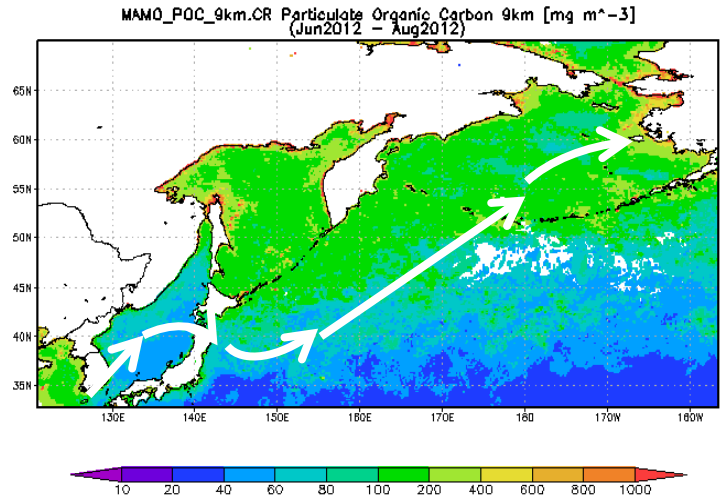
Two distinctly different ocean transects (MAGIC LA-Honolulu versus SHIPPO Incheon to Nome)

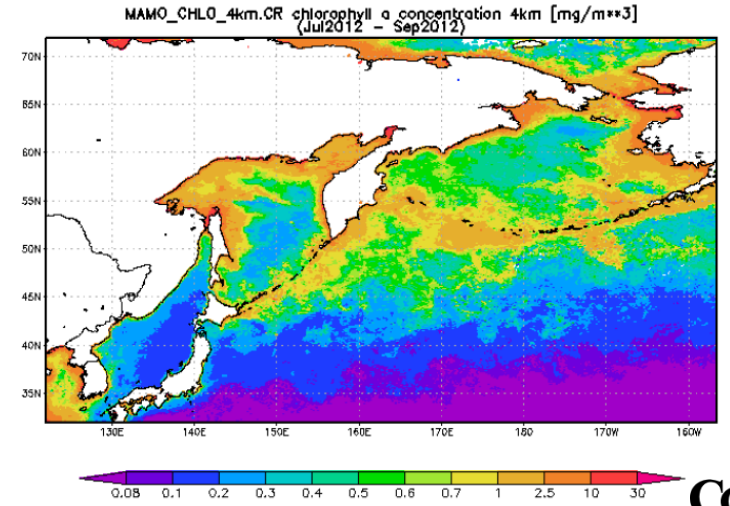
MAGIC-IN (July-Sept 2013)





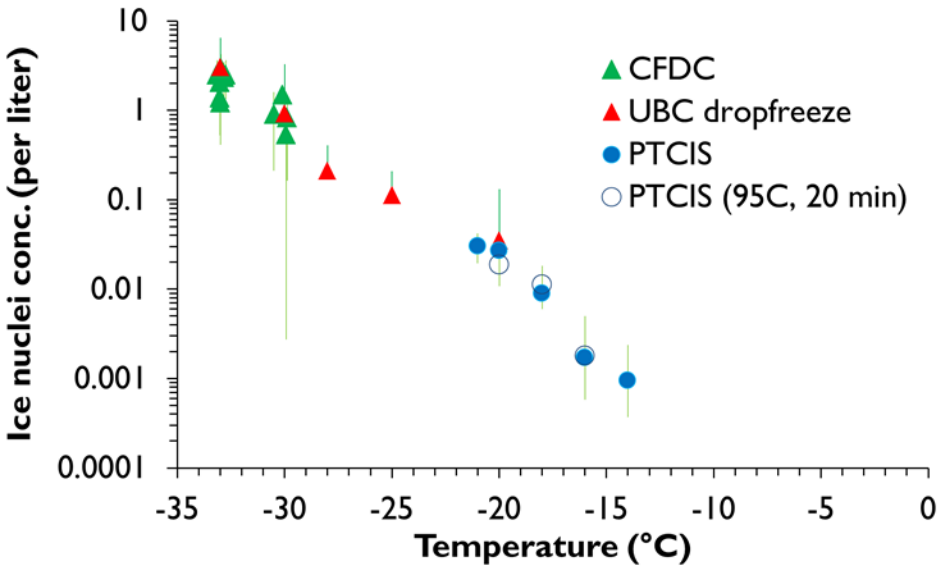
SHIPPO (July 2012)



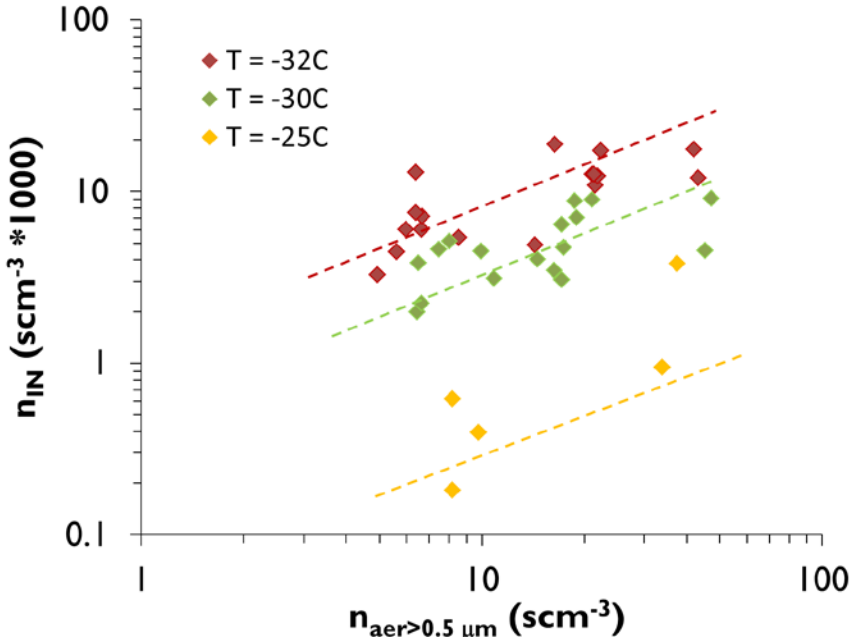


CAICE fresh seawater (Scripps pier) wave-breaking experiments

Basic IN-T spectrum with overlap of methods

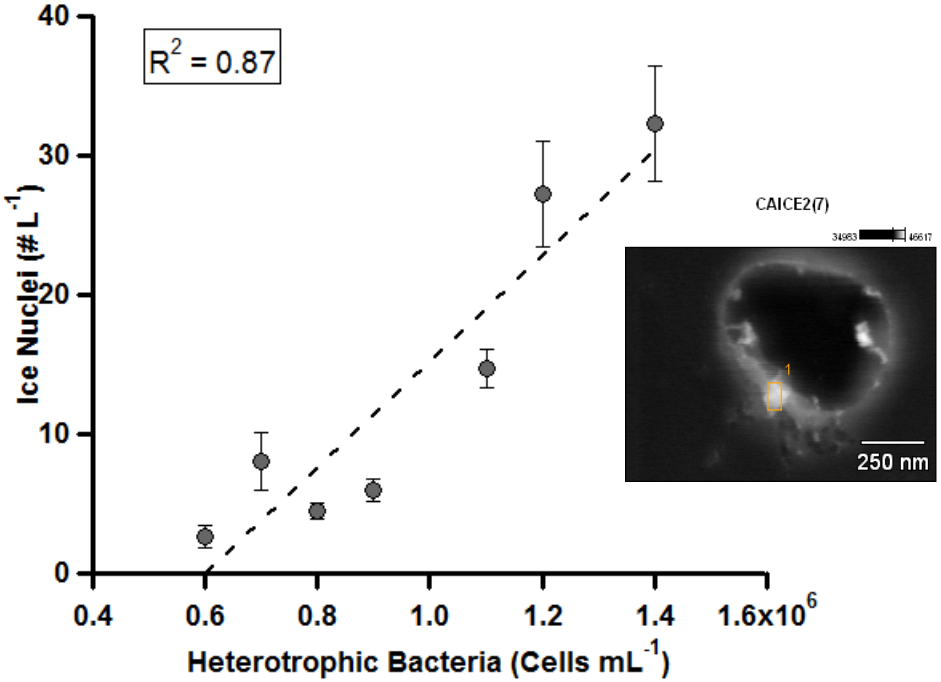


Modest dependence on n>0.5μm (mimics airborne inorganic IN)

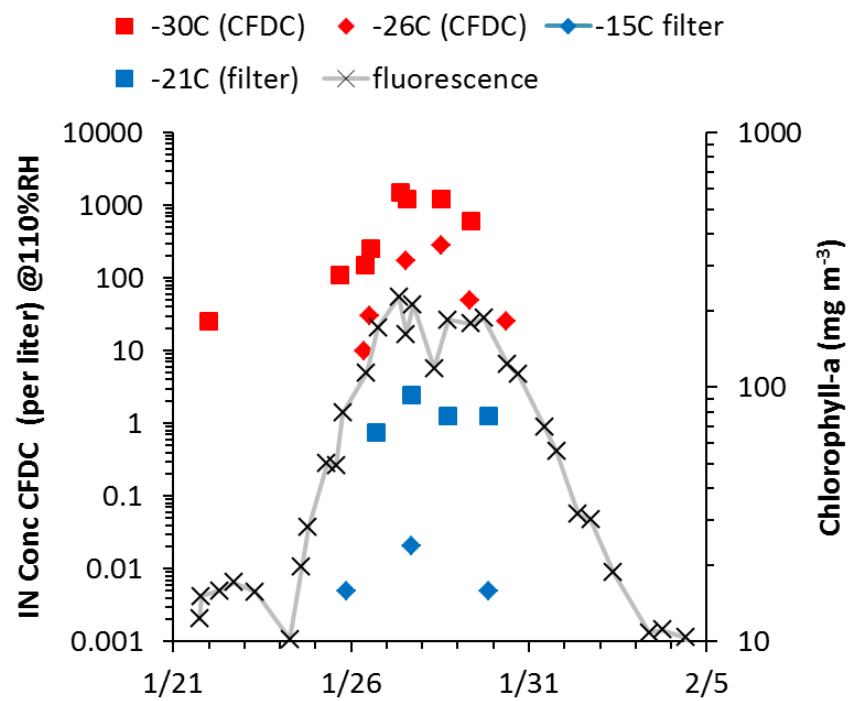


CAICE Lab studies – marine biological influences on IN released from sea spray

Wave Channel mesocosm experiment (11/2011) – Bacteria fed organics (T = -30˚C)



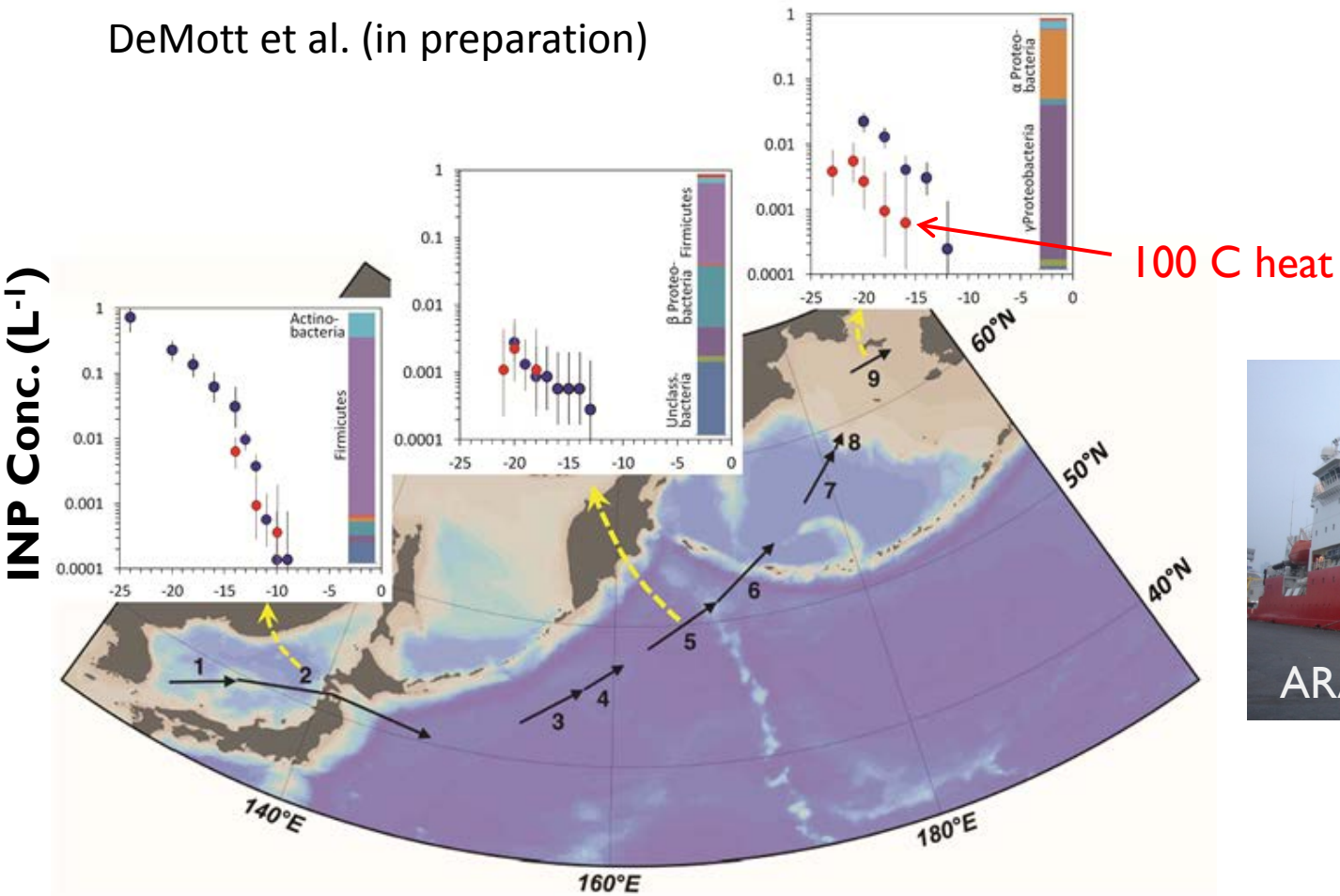
Sea spray studies in UCSD MART (1/2013) – Phytoplankton fed inorganics



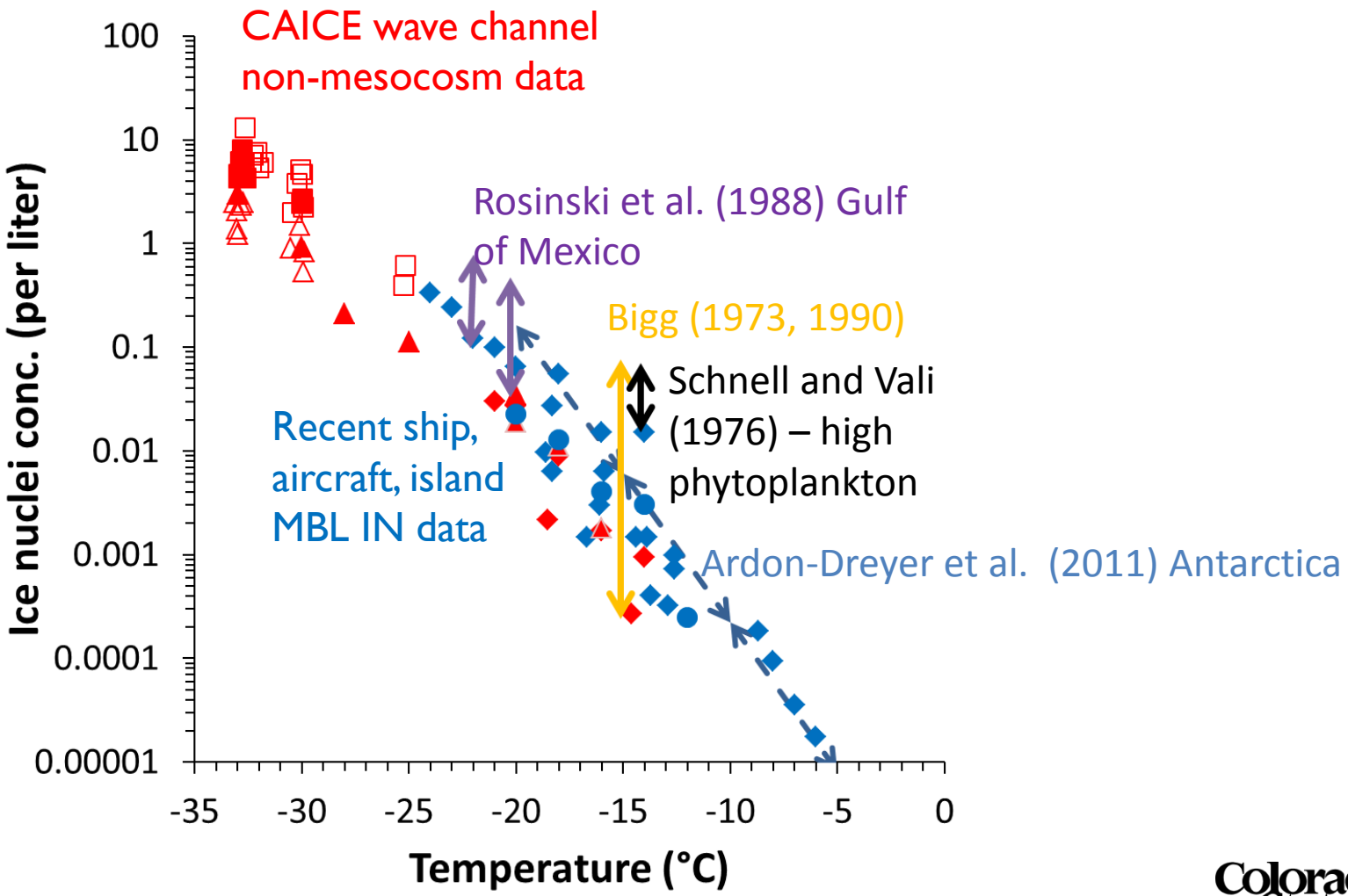
Ice nucleating particles and aerosol biodiversity measured from ambient marine boundary layer filter collections

Korea Polar Research Institute's (KOPRI) Summer 2012
SHIPPO (SHIp-borne Pole-to-Pole Observations)

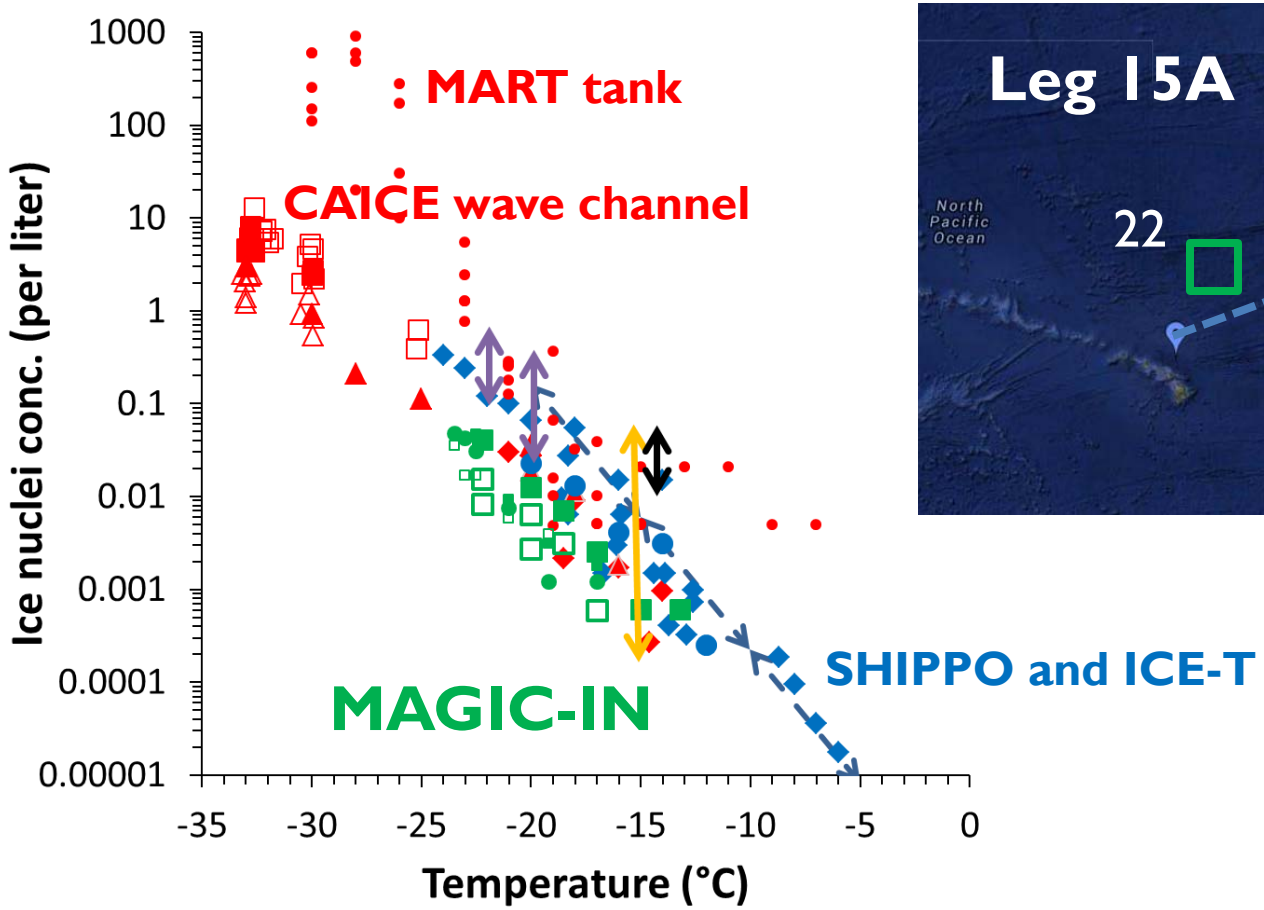
DeMott et al. (in preparation)

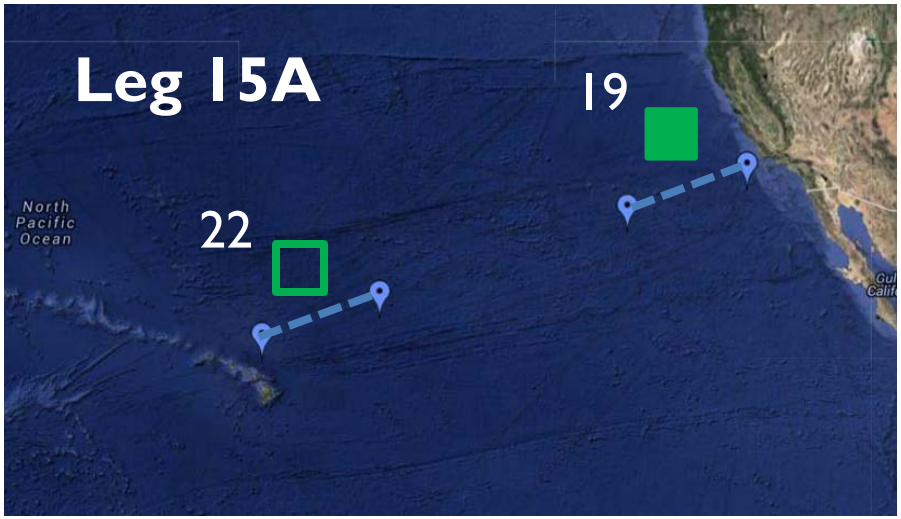


Measurements (real-time CFDC and filters) in line with sparse historical IN data over oceans



Comparison for a few recent MAGIC samples





What's next?

- ASR proposal in review
  - Further processing of frozen MAGIC samples for IN.
  - Pyrosequencing relating these measurements ocean microbial communities.
  - Relation to various satellite data (POC, chl-a, phytoplankton type, etc…) and other MAGIC aerosol and Met. data
  - Comparison and contrast N-S cruises to polar regions in Pacific and Atlantic basins.
- Possible participation in Western Atlantic Climate Study II (WACS II), SIO Bay of Bengal cruises
- CAICE Phase 2 studies (funded), single particle mass spectrometry of seaspray IN to isolate composition. Study possible sample collection impacts on sea spray IN
- Collaboration with modeling groups (Burrows, PNNL)
- Planning for SOCRATES, if it moves forward