Potential impacts of mineral dust aerosol on cold cloud formation

Kirsten Koehler

S.M. Kreidenweis, P.J. DeMott, A.J. Prenni, M.D. Petters

Colorado State University

Fort Collins, CO, USA

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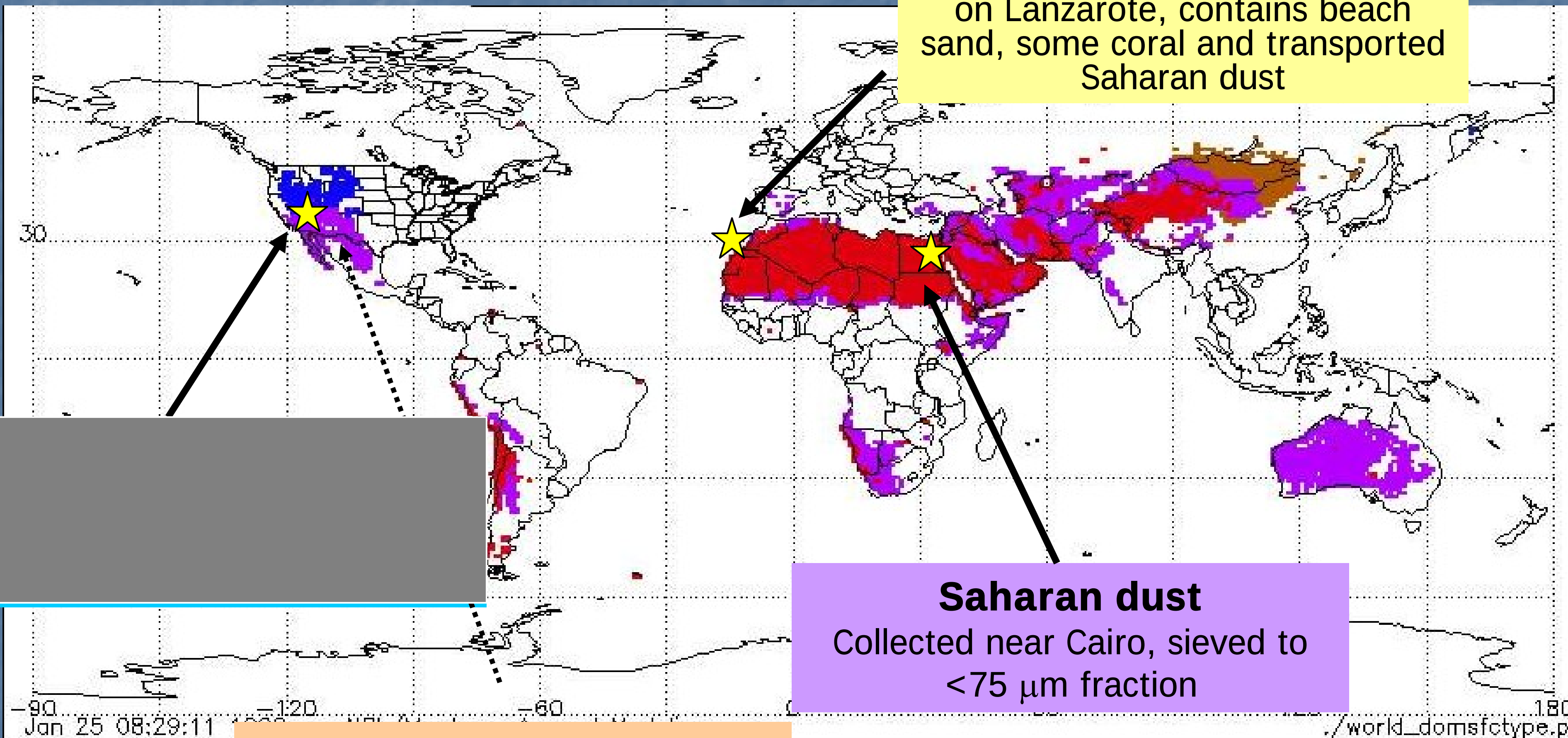
Motivation

- Atmospheric mineral dust is one of the largest unknowns in determining the role of aerosols in the global climate process (IPCC, 2001)
  - Mostly natural but can have anthropogenic contributions
- "Indirect effect" highly uncertain
  - Warm cloud indirect effects mostly focus on sulfates and organics
    - Can mineral dust contribute to CCN concentrations?
  - Aerosols may impact frequency, altitude, and microphysics of cirrus clouds
    - Perturb Earth's radiation budget (more cirrus → warming)
- Previous laboratory experiments and aircraft campaigns have indicated that dust particles initiate ice formation at relatively warm and dry conditions in the atmosphere
  - Observed in Saharan dust plume (DeMott et al., 2003)

Dust samples

Erodible surfaces
From NAAPS model

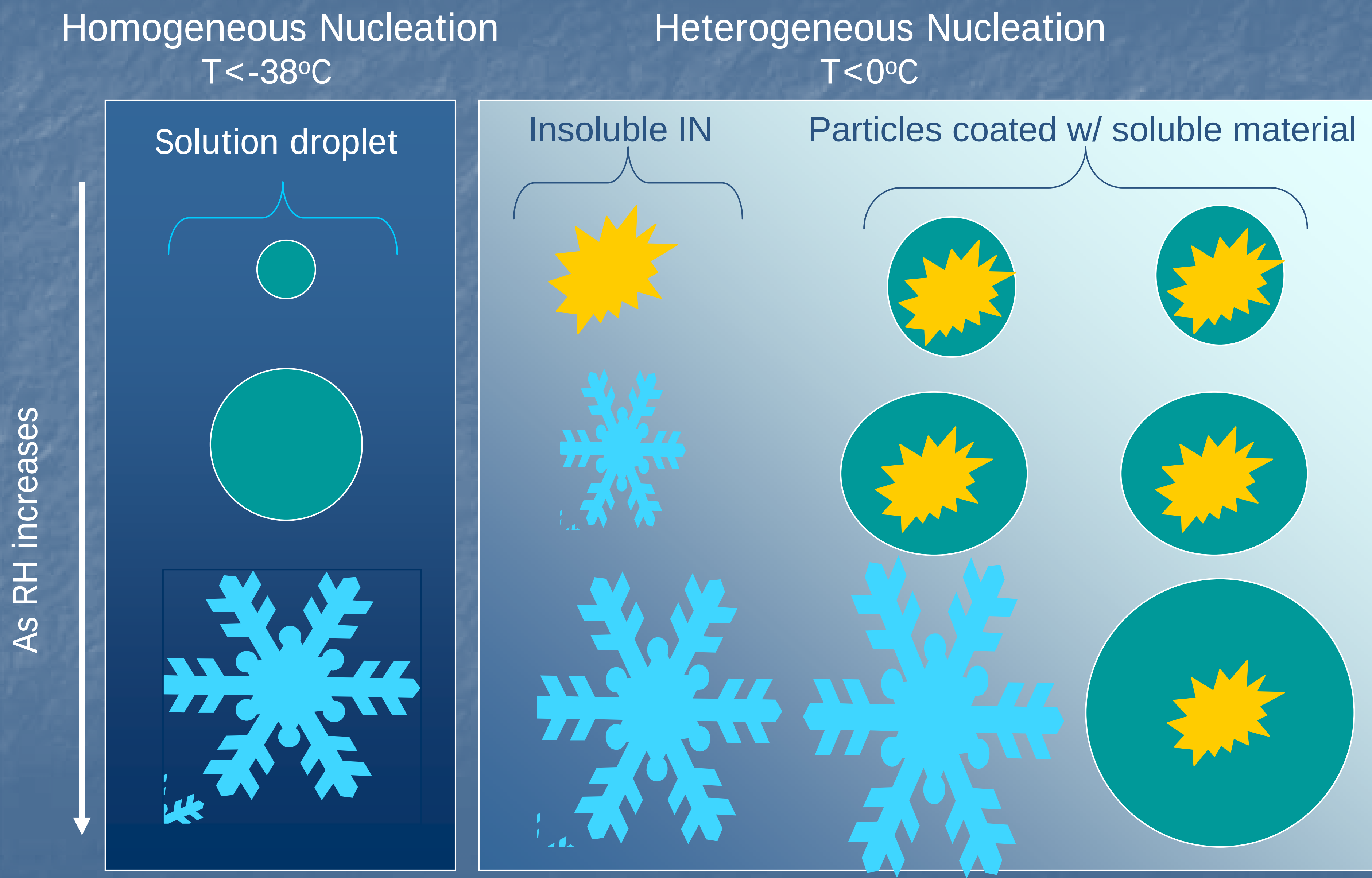


Canary Island dust
Unsieved, collected near surface on Lanzarote, contains beach sand, some coral and transported Saharan dust

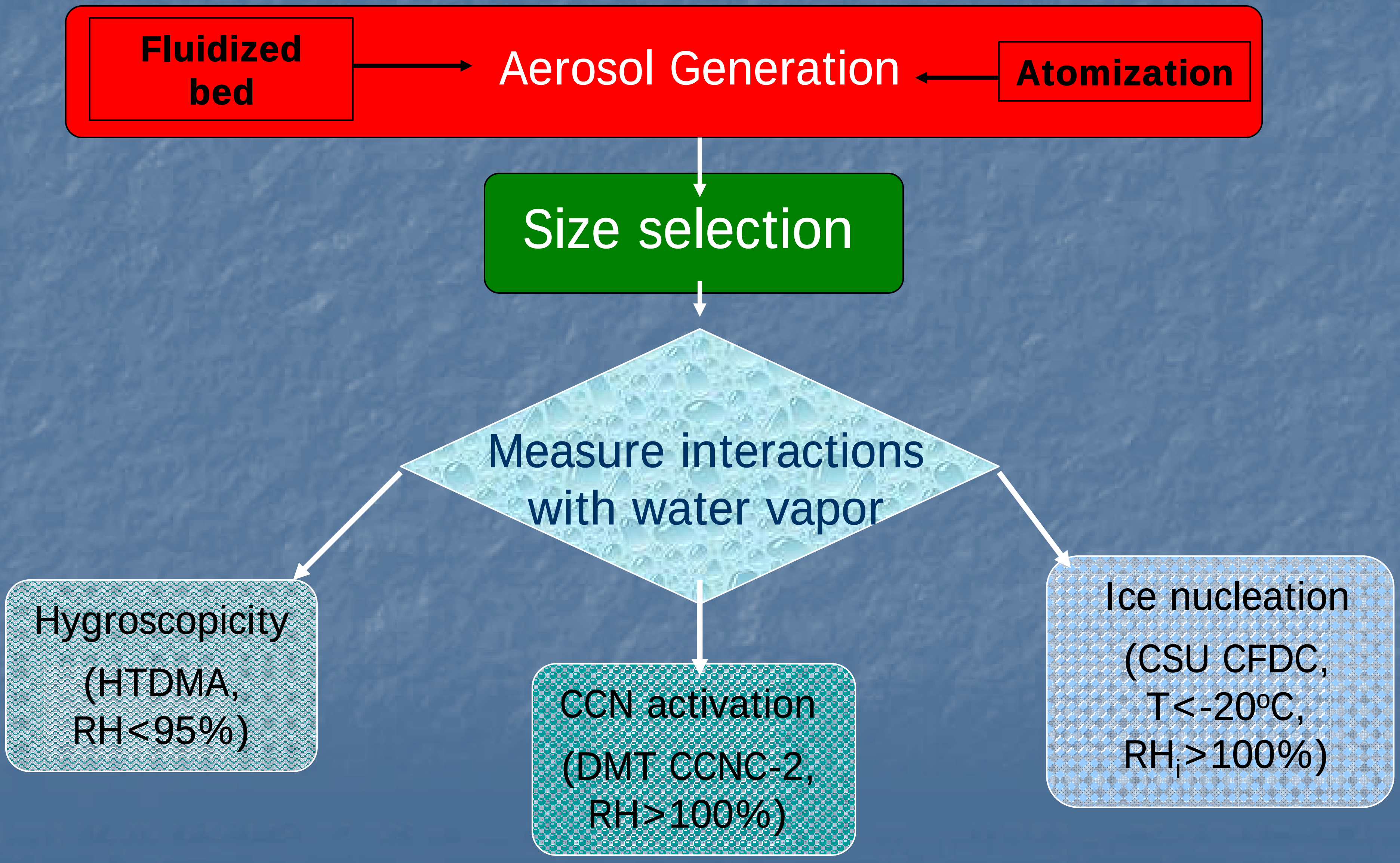
Saharan dust
Collected near Cairo, sieved to <75 μm fraction

Arizona Test dust
Commercially produced, milled product. Expected to be representative of dust in SW U.S.

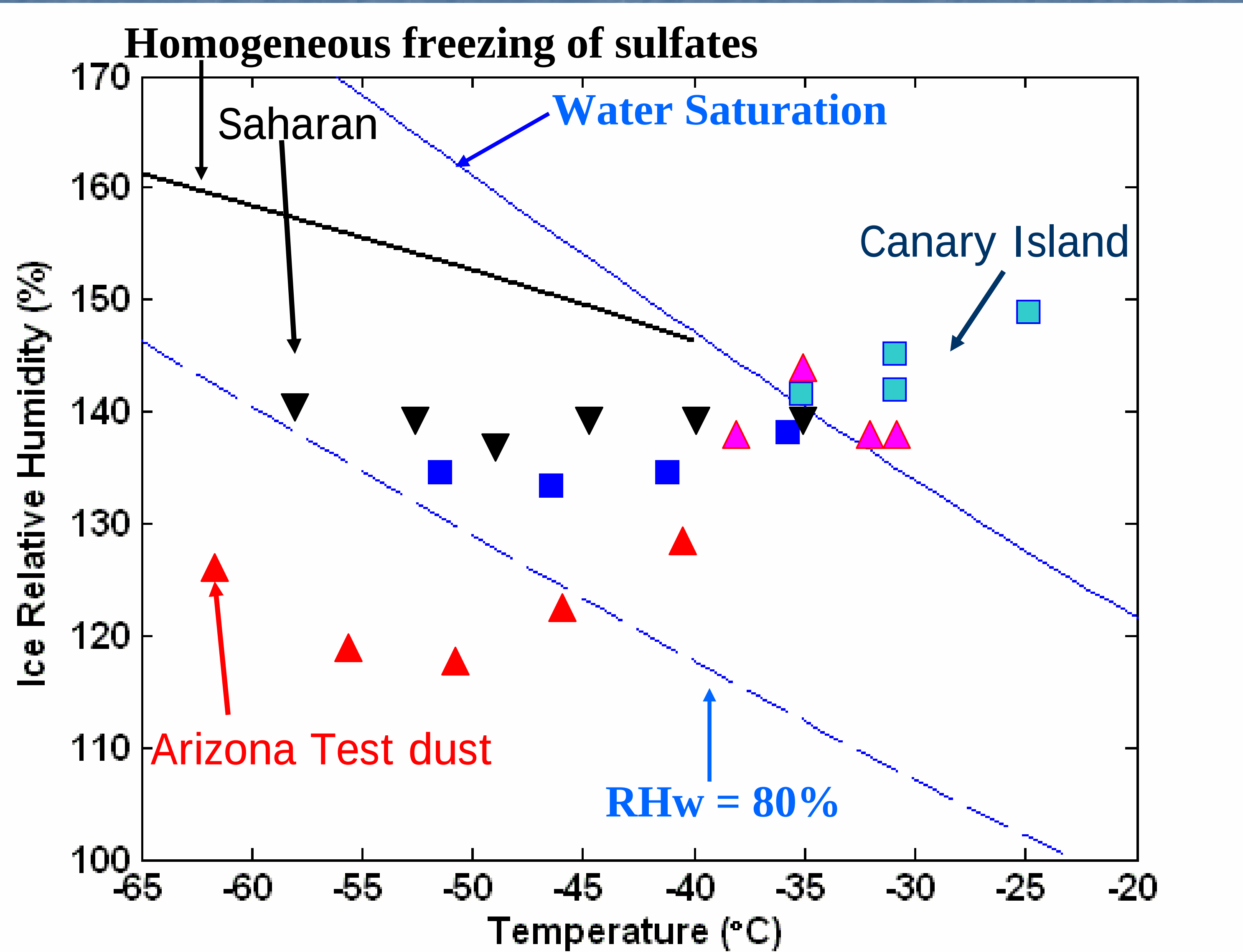
Ice Formation



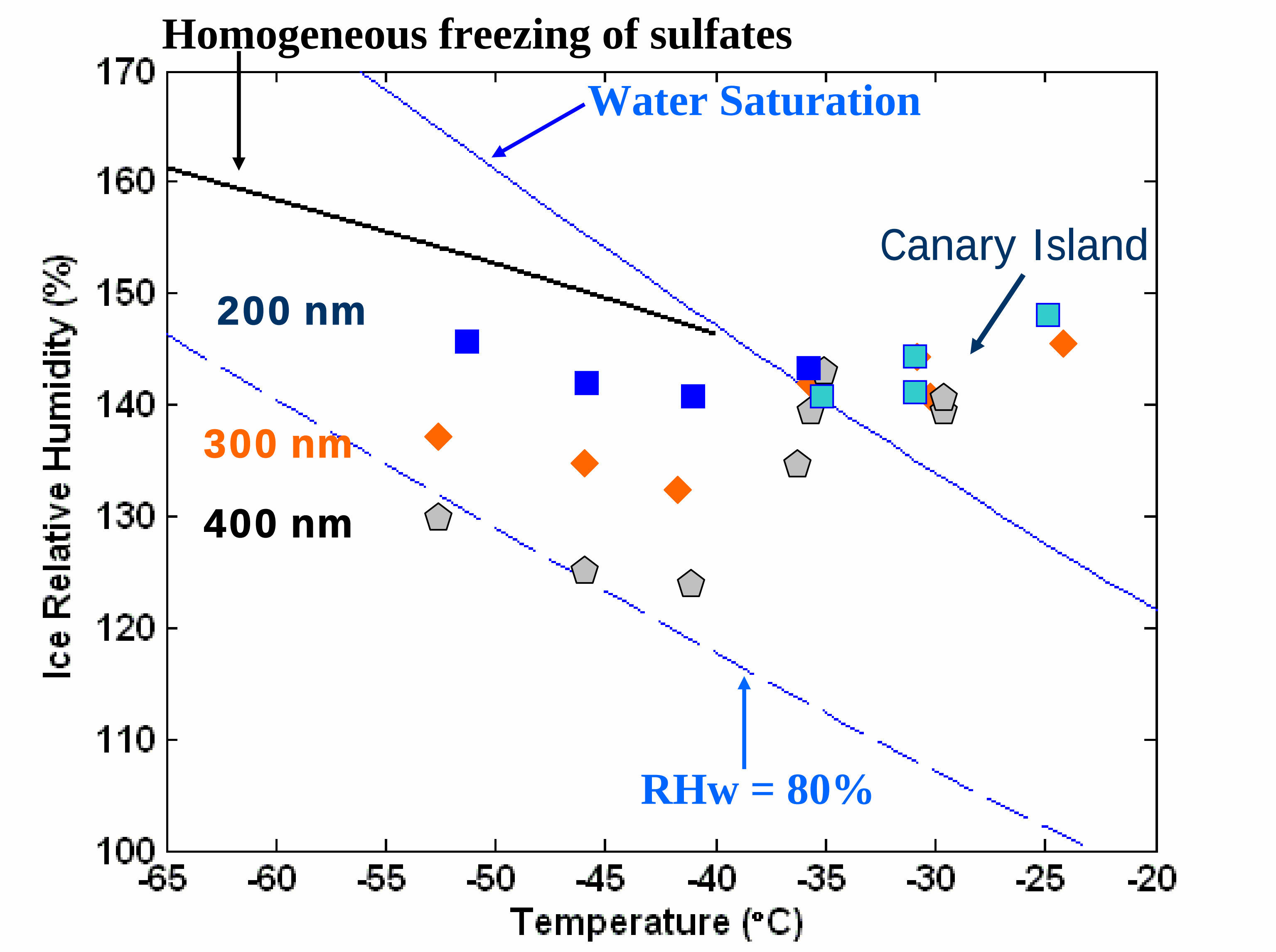
Measurement Strategy



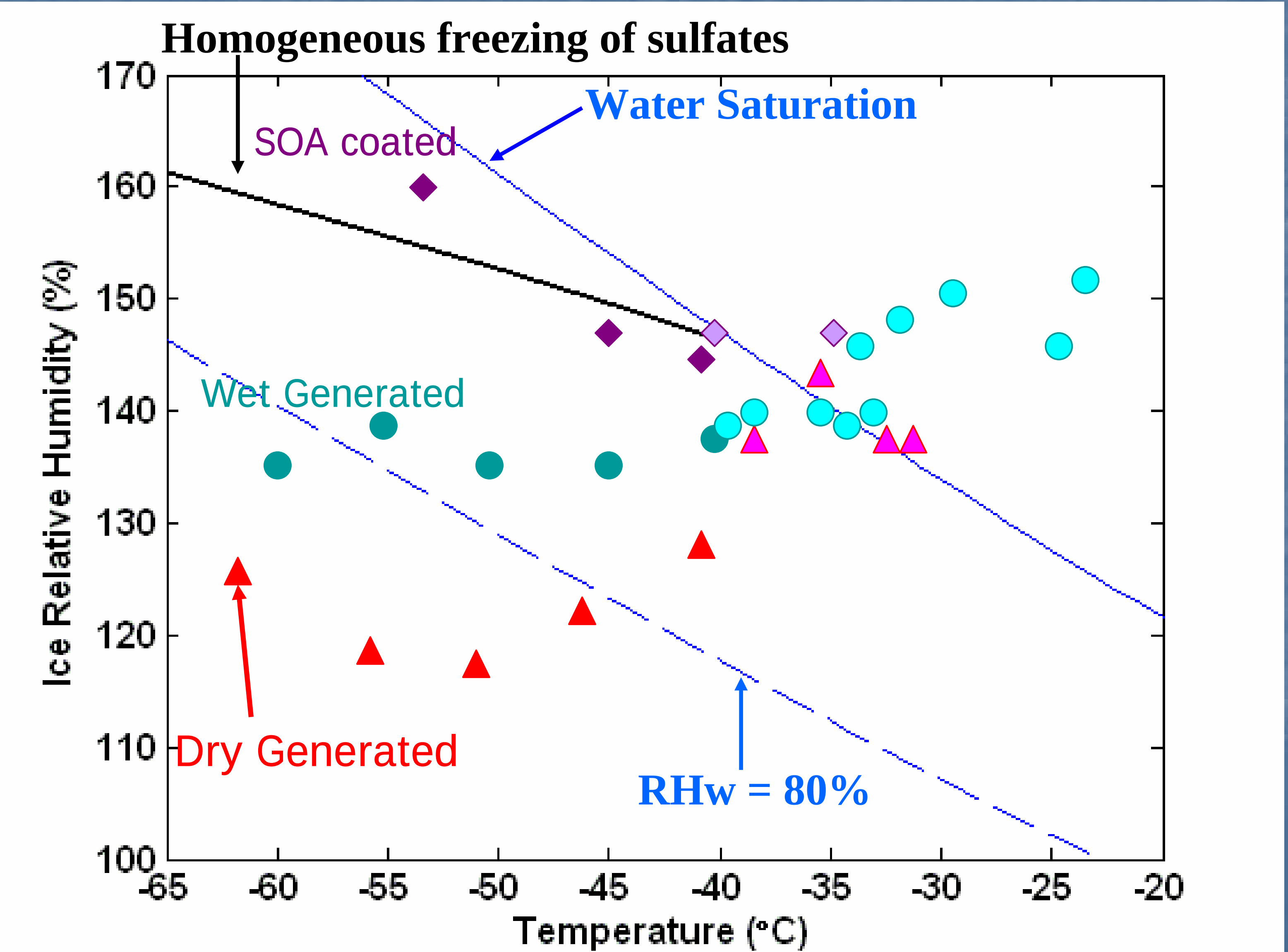
Ice Nucleation Results ~200 nm, 1% activation



Size effect (Canary Island dust 5% activation)



Generation/coating effects (ATD, 1% activation)



Conclusions

- Dusts from different regions nucleate ice at different RHis and possibly via different modes
  - Effect of composition
  - depends on particle soluble fraction
  - Hygroscopic coatings increase the required RHi for nucleation- appear homogeneous, at least for SOA coatings
- Size effects can be important in ice nucleation onset

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Particles exposed to low T, high RHice in the Continuous Flow Diffusion Chamber