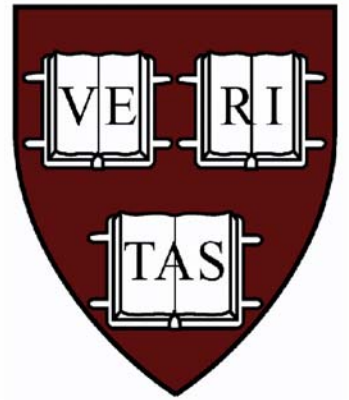
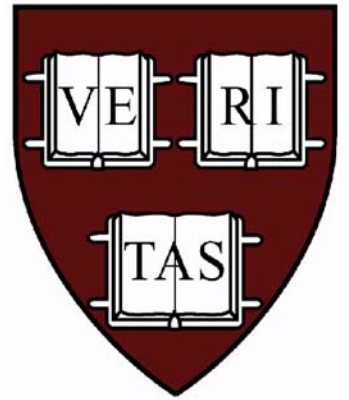


Atmospheric Nanoparticles

Scot T. Martin
Associate Professor of Environmental Chemistry

Division of Engineering and Applied Sciences
Harvard University

http://www.deas.harvard.edu/~smartin



Critical Research Needs for Nanoparticles

- New particle formation and growth
- Particle composition and morphology
- Chemical and photochemical reactions
- Health effects

8 Atmospheric Nanoparticles

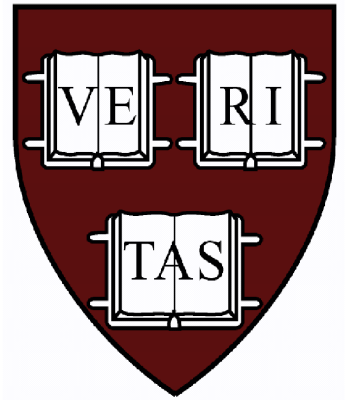
Cort Anastasio

Atmospheric Science Program
Department of Land, Air & Water Resources
University of California-Davis
One Shields Avenue
Davis, California 95616

Scot T. Martin

Division of Engineering and Applied Sciences
29 Oxford Street, Pierce Hall
Harvard University
Cambridge, Massachusetts 02138

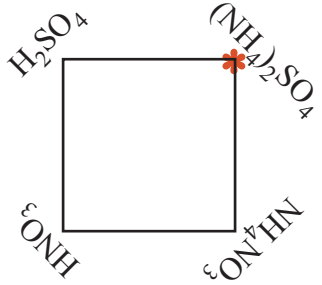
Anastasio, C.; Martin, S. T. "Atmospheric Nanoparticles." In Nanoparticles and the Environment; Banfield, J. F., Navrotsky, A., Eds.; Mineralogical Society of America: Washington, D.C., 2001; Vol. 44; Pages 293-349.

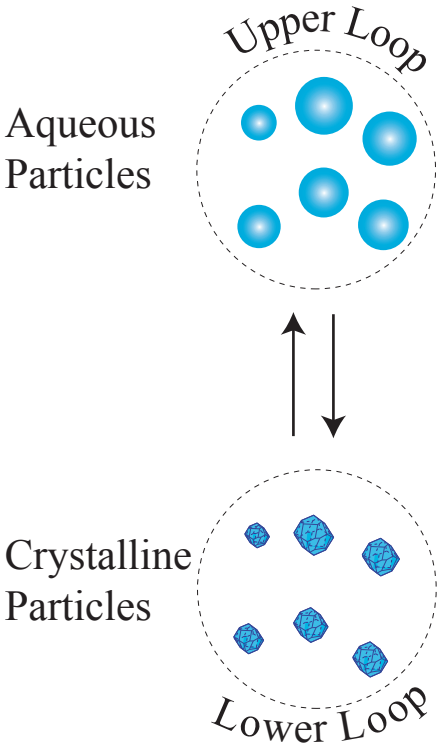


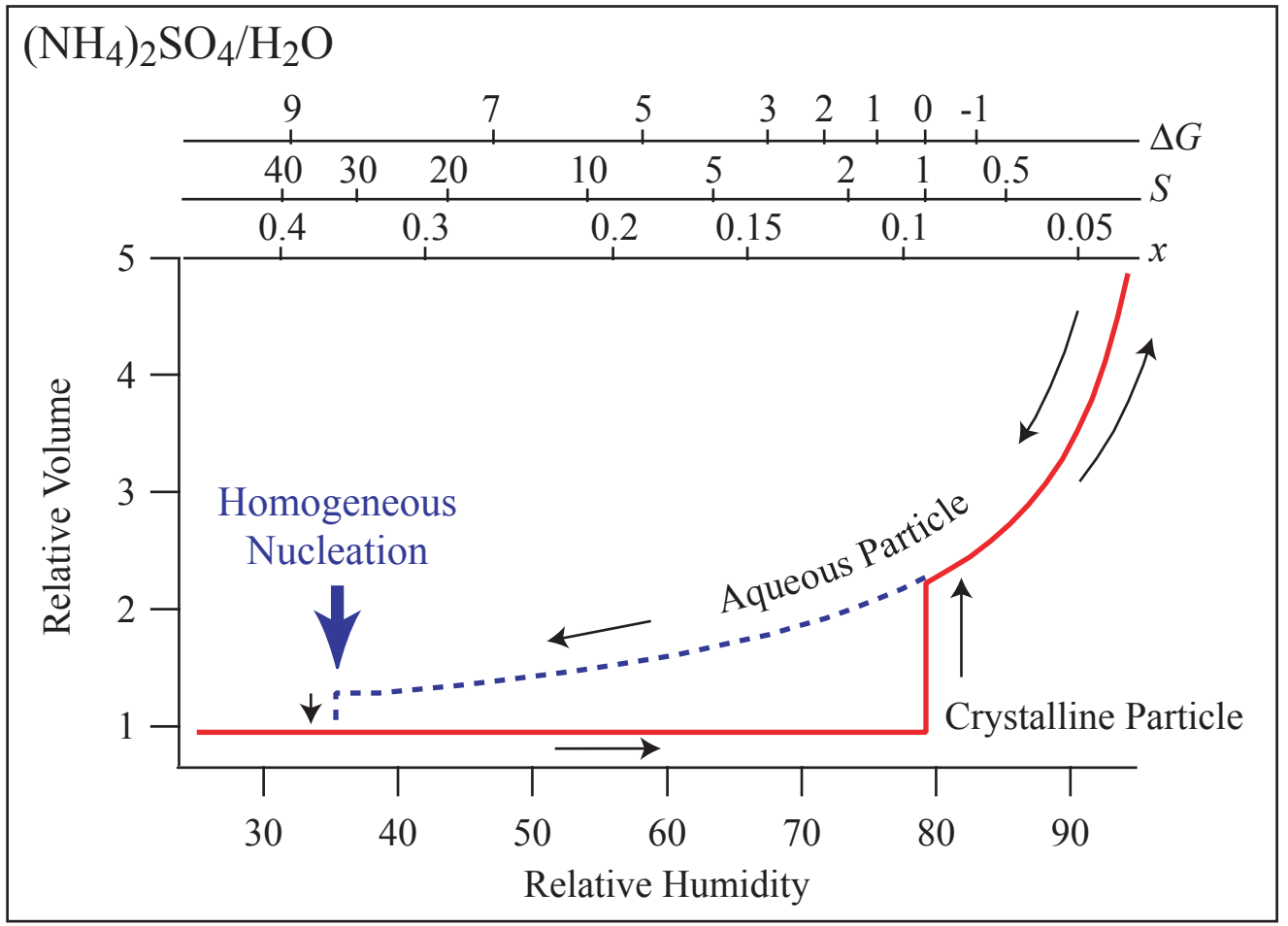
Nano-Properties

Effect of particle diameter on deliquescence relative humidity

Hysteresis Effect: *Particle Phase Depends on Relative Humidity History*







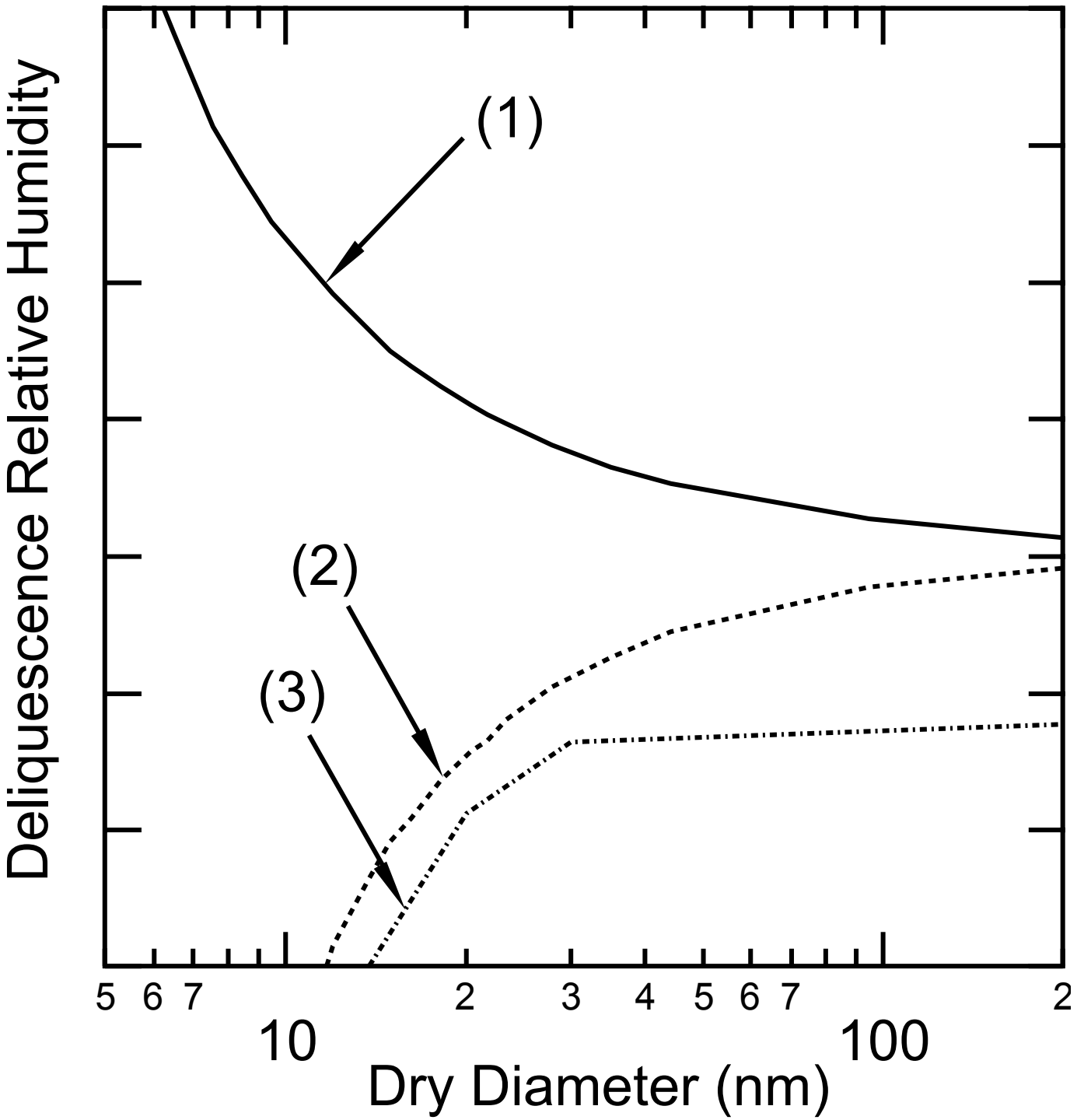


Figure 2. Comparison of models for DRH(x) of NaCl.
(1) Russell and Ming[16]
(2) Mirabel et al.[14]
(3) Djikaev et al.[15]

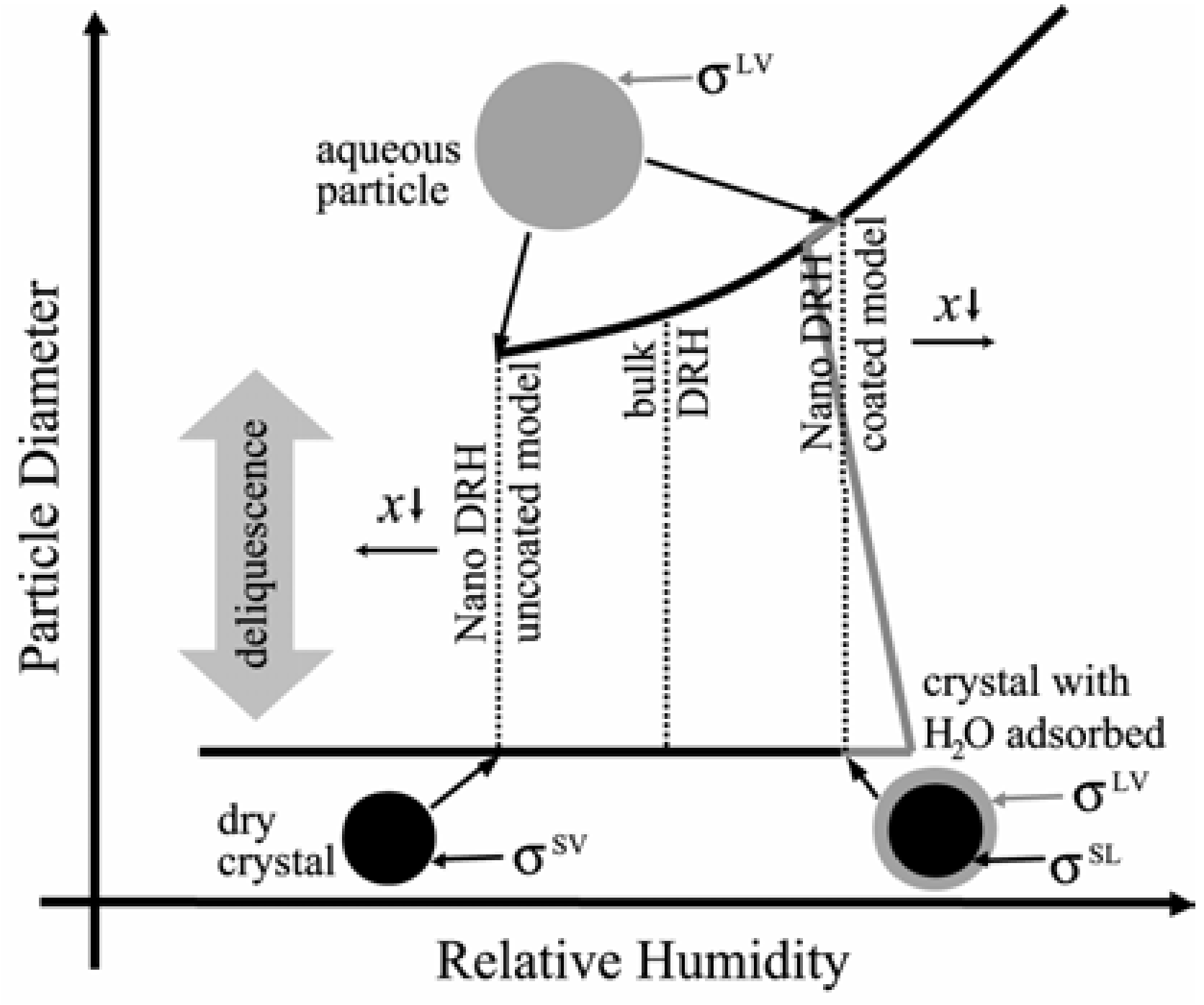
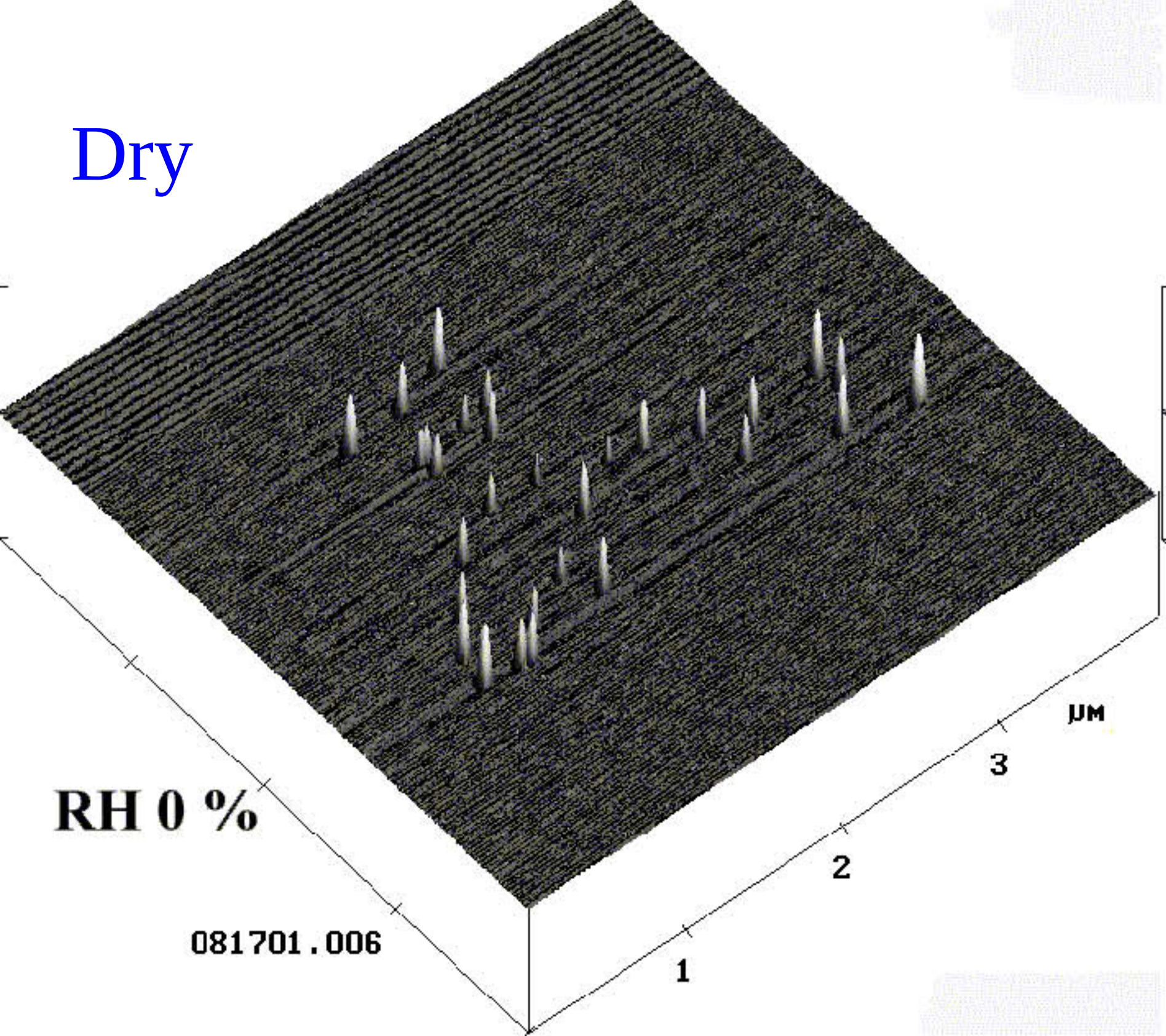
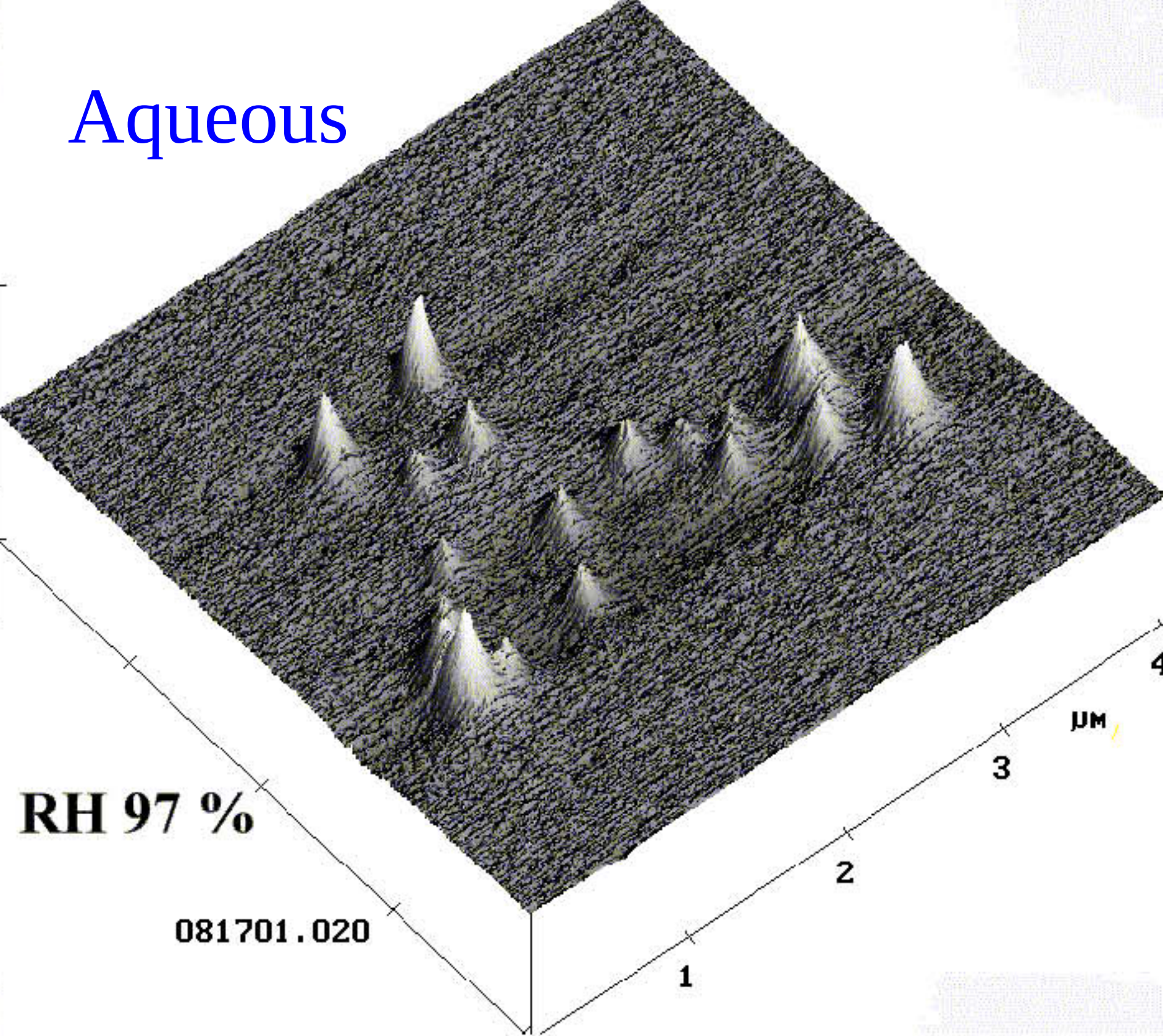
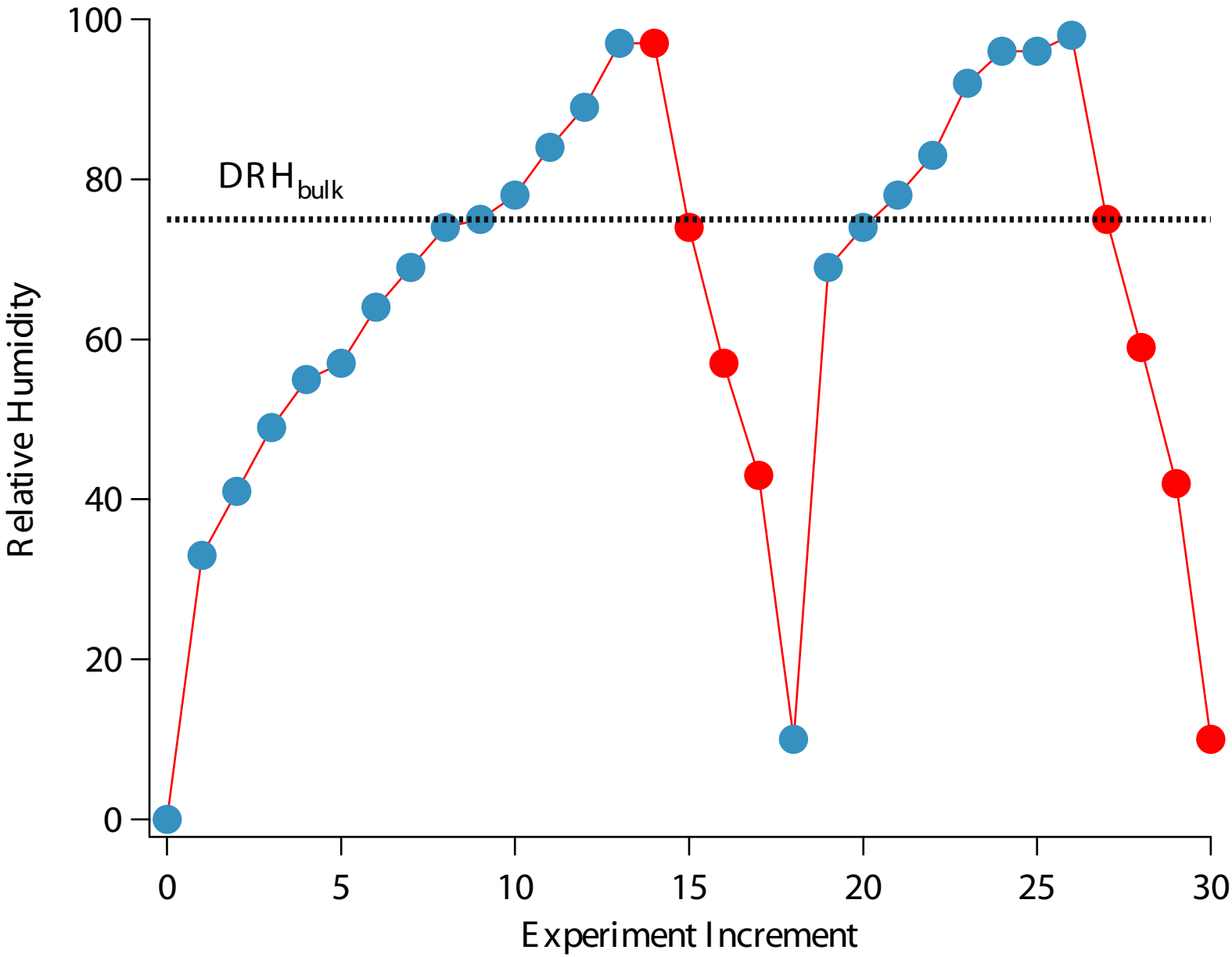


Figure 1. Schematic illustration of coated[16] and uncoated[14] models for nano-deliquescence. An opposite dependence of DRH on *x* is shown.


Dry
RH 0 %
081701.006
1
2
3
µm

Aqueous

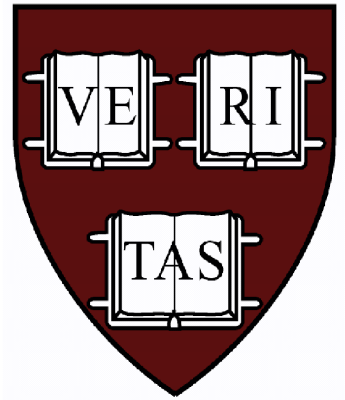



100
80
60
40
20
0
Relative Humidity
DRH bulk
0
5
10
15
20
25
30
Experiment Increment

$$92 < \mathrm{DRH}_{60\mathrm{nm}} < 96\%$$

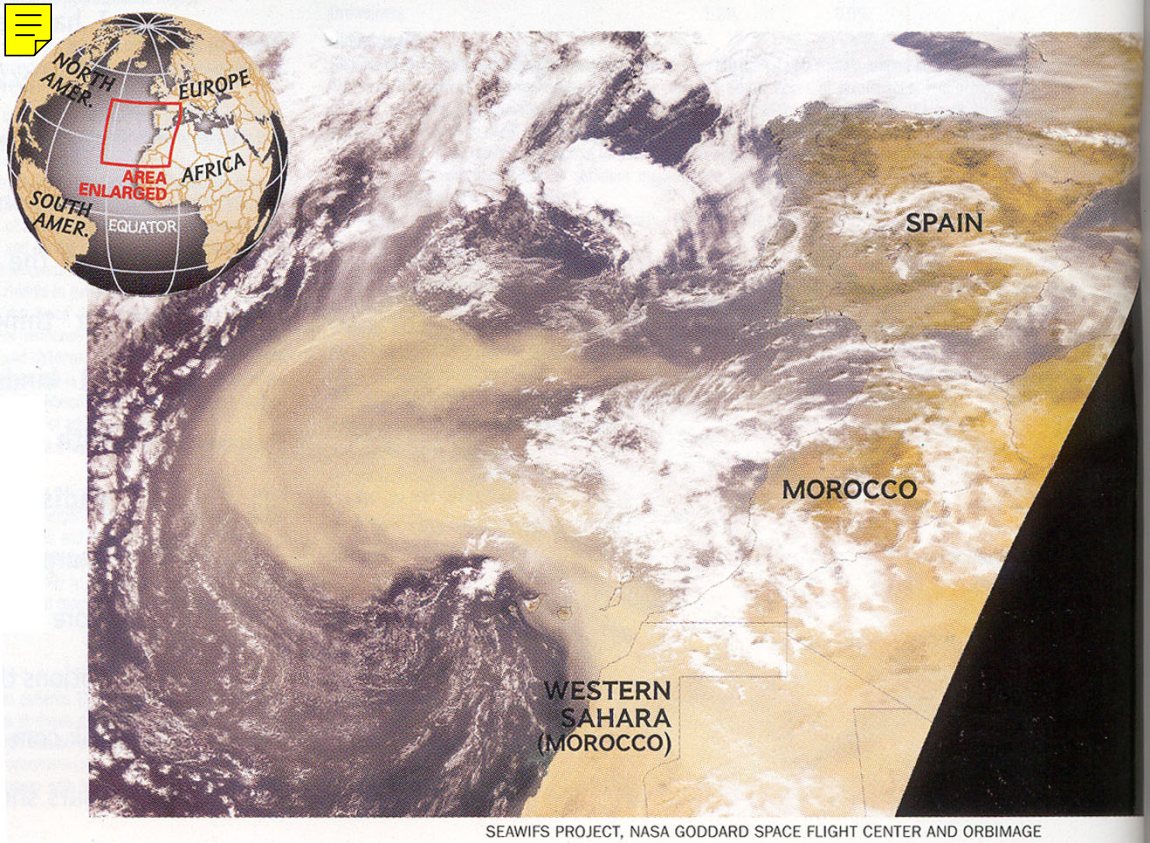
$$\mathrm{DRH}_{\mathrm{bulk}} = 75.3\% @ 298\ \mathrm{K}$$

…continue work onto other diameter particles

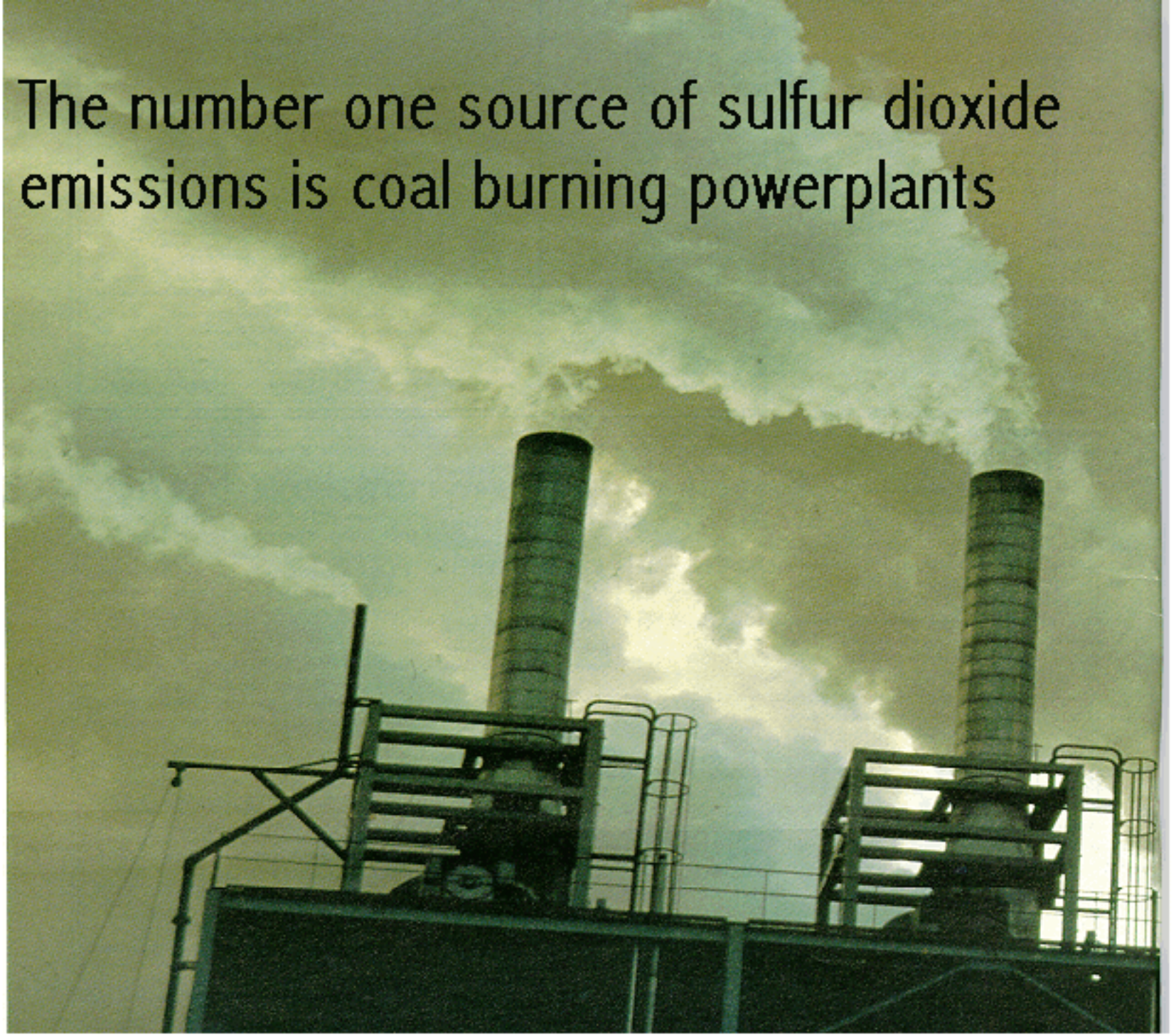


Nano-Structures

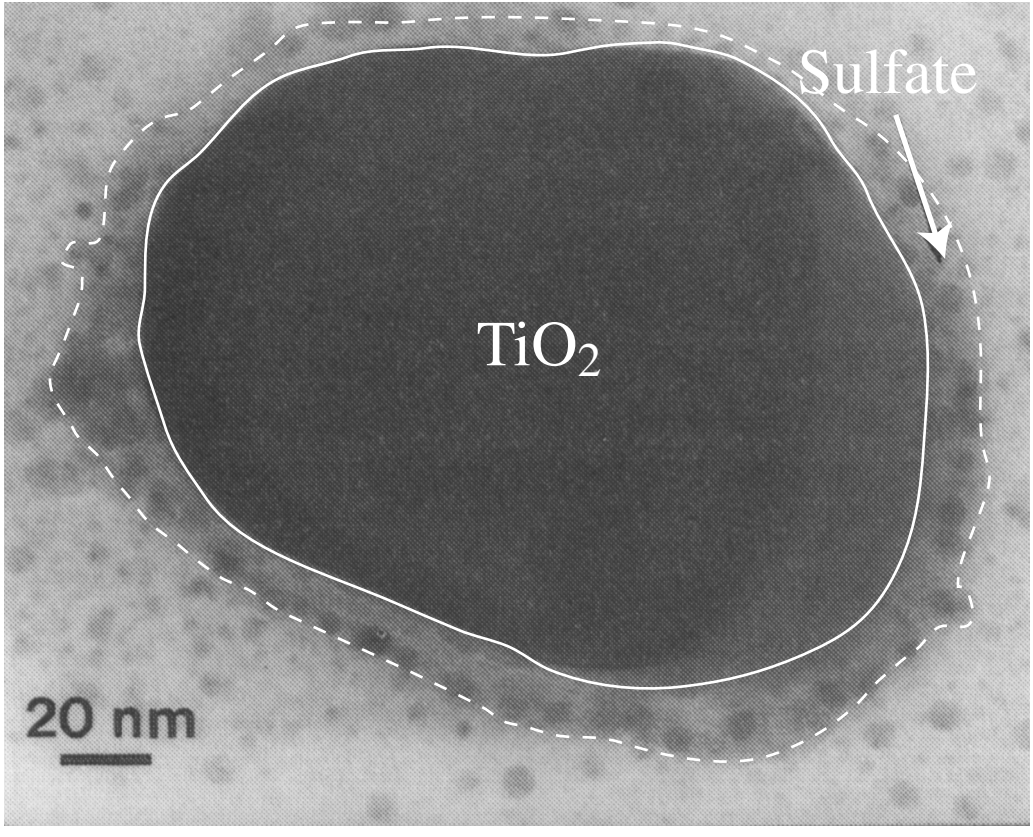
Effect of inclusion diameter on crystallization relative humidity



SEAWIFS PROJECT, NASA GODDARD SPACE FLIGHT CENTER AND ORBIMAGE

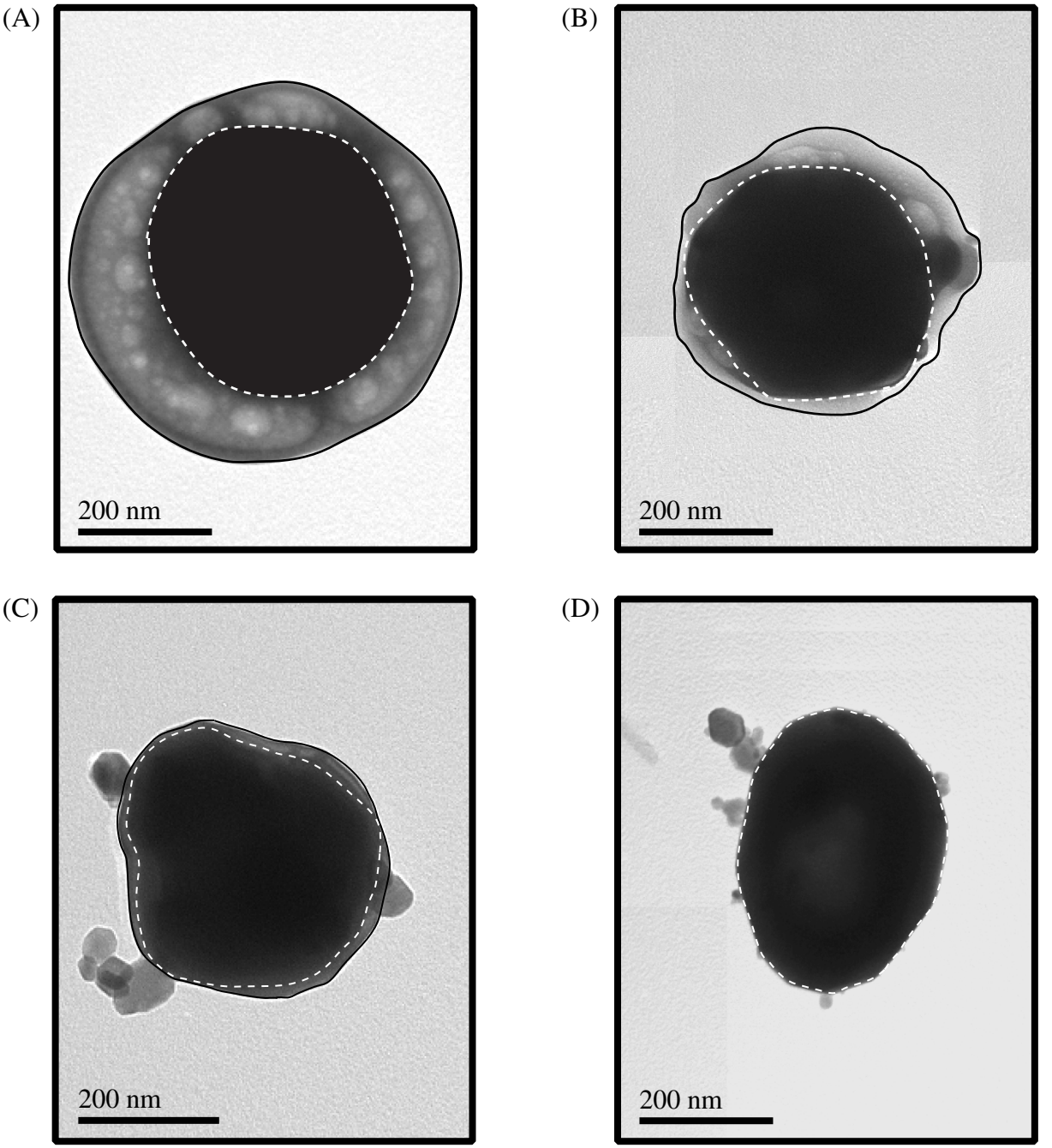

The number one source of sulfur dioxide
emissions is coal burning powerplants

Marine Aerosols from the Equatorial Pacific
1990 FeLINE-1 cruise

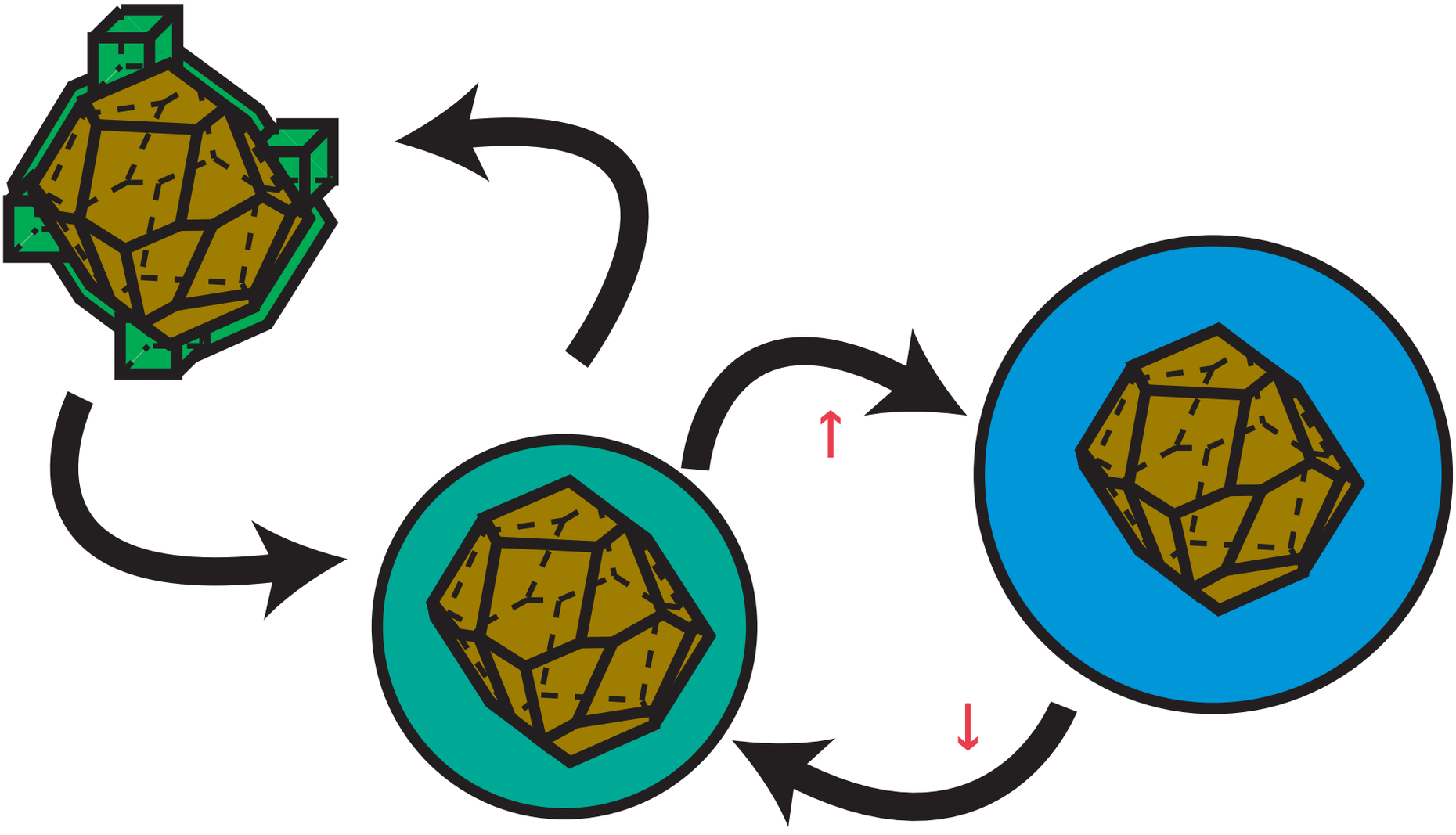


Posfai et al., 1994

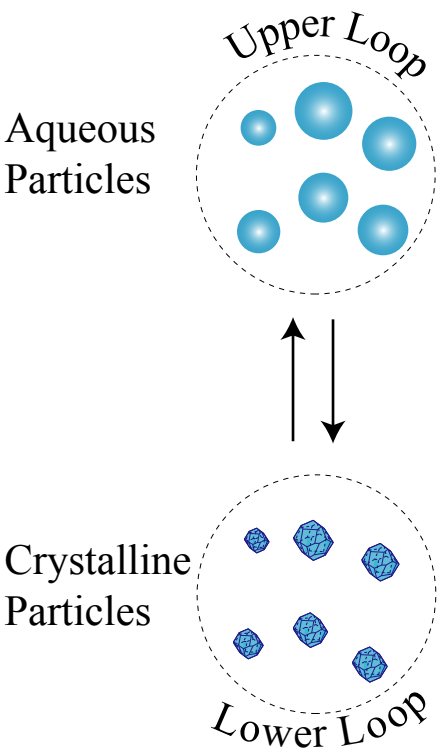
TEM images of Lab Test Aerosols

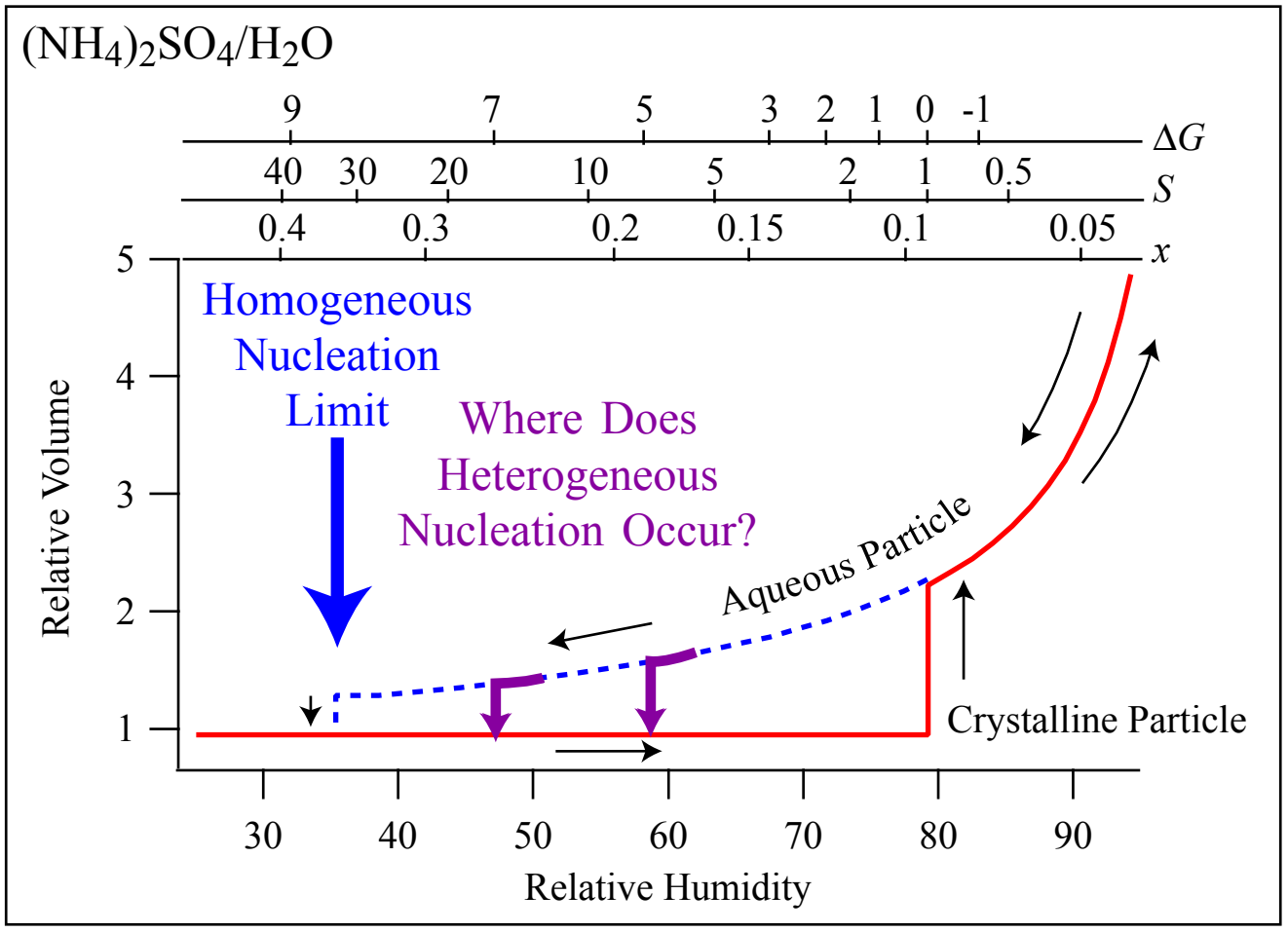


Deliquescence
Efflorescence

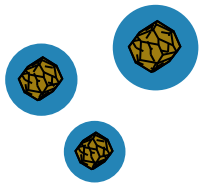


Hysteresis Effect

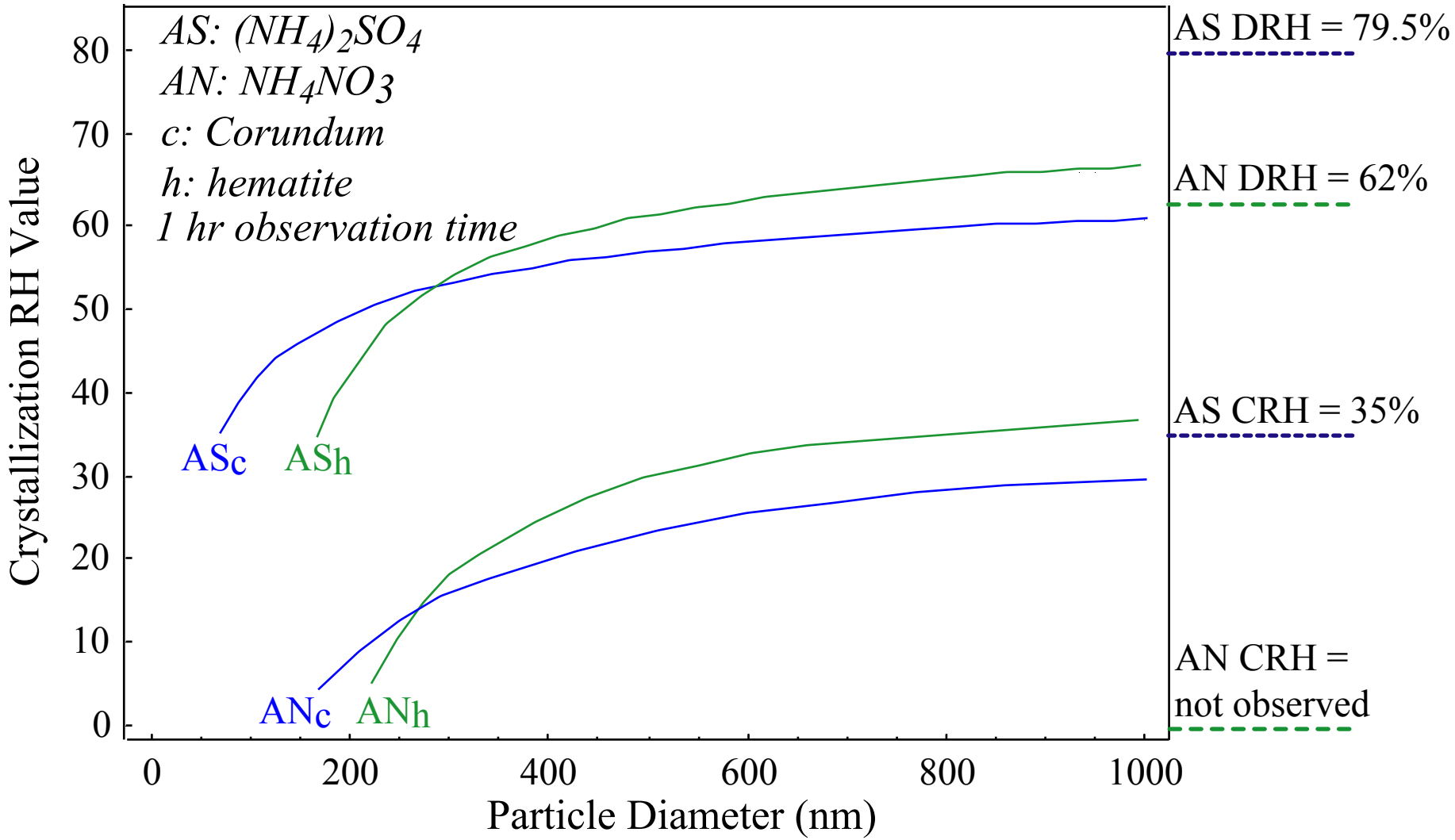




Dependence of Crystallization Relative Humidity of Aqueous $(NH_4)_2SO_4$ and NH_4NO_3 Outer Layers as a Function of Inclusion Size

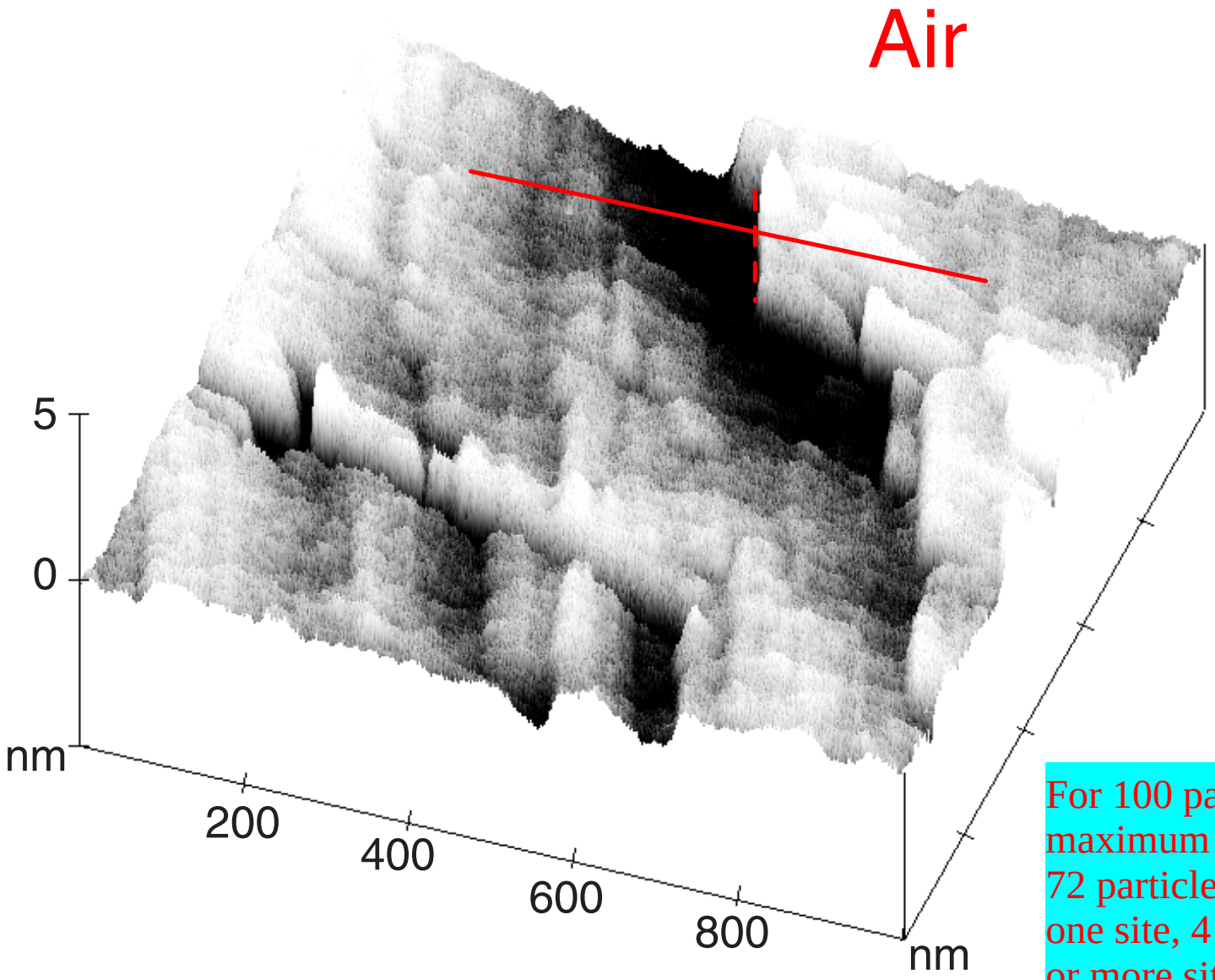


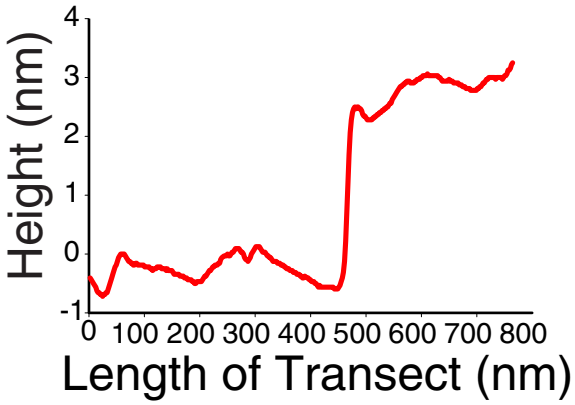
Active site model



(110) Face of Synthetic α-Fe_2O_3

imaged by contact under air before exposure to water or oxalate





For 100 particles of 10-nm diameter, the maximum likelihood distribution is that 72 particles have no active sites, 23 have one site, 4 have two sites, and 1 has three or more sites.

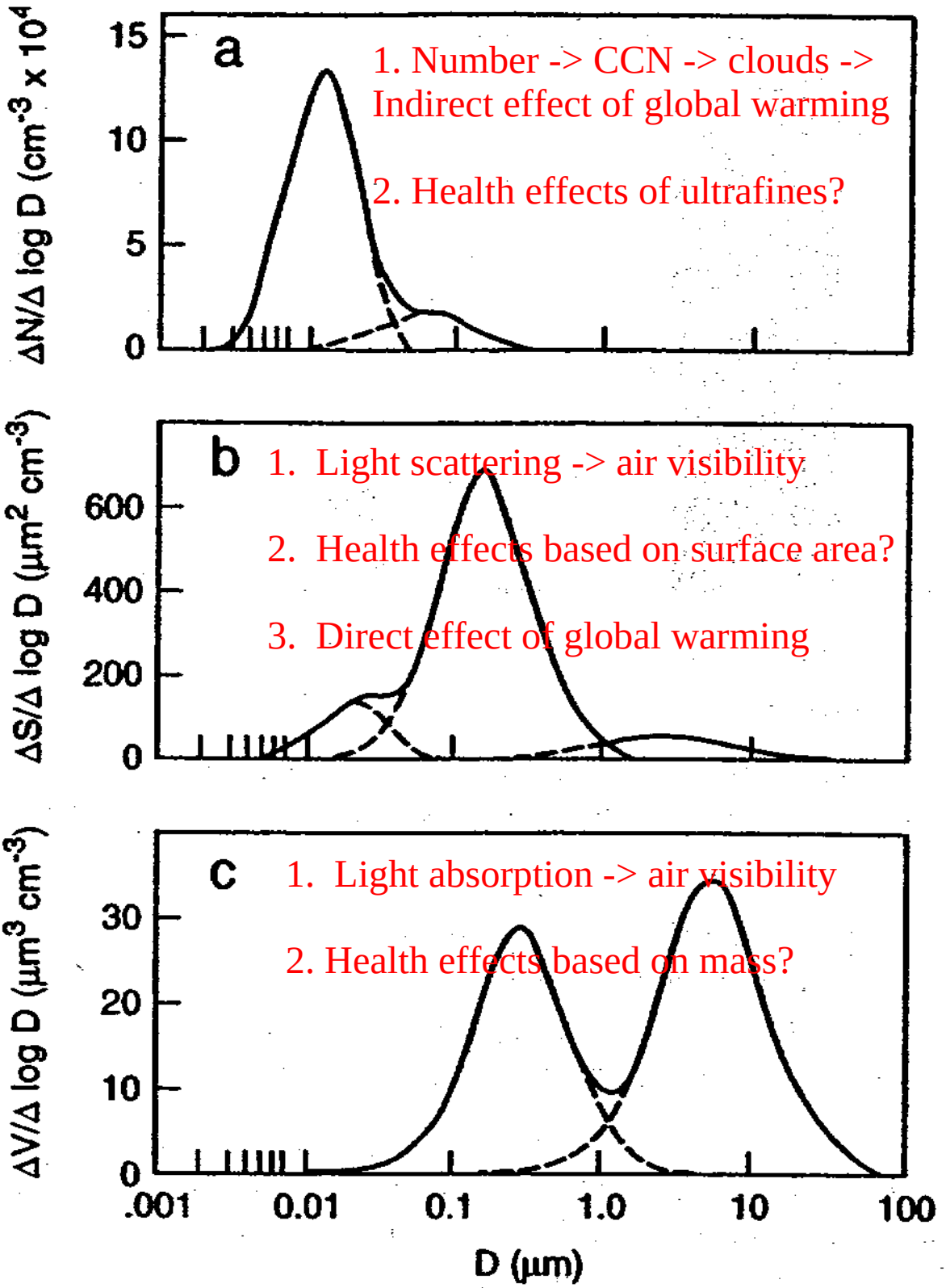
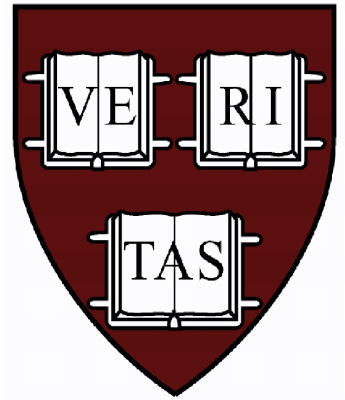


Figure 1. Number (ΔN/Δlog D), surface area (ΔS/Δlog D), and volume (ΔV/Δlog D) distributions for a typical urban aerosol. The solid lines are the size distributions, while the dashed lines show the tails between intersecting modes. The total number concentration, surface area, and volume equal the areas under the curves of each mode. From Finlayson-Pitts and Pitts (2000). Used by permission of Academic Press.



Acknowledgments

Dr. Hui-Ming Hung

Dr. Jeong-Ho Han (now at Brookhaven)

Mr. Adam Malinowski

Dr. Akiko Fillinger (now at Oberlin)

Ms. Julie Schlenker

National Science Foundation

Atmospheric Chemistry Program (ATM)

Nanoscale Interdisciplinary Research Team (NIRT)

Petroleum Research Fund

http://www.deas.harvard.edu/~smartin