Summary of Modifications for C6 Ice Cloud Models

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Microphysical data:

a. more field campaigns (ARM, TRMM, SCOUT, ACTIVE, pre-AVE, midCiX, CRYSTAL-FACE)
b. mitigation of contribution from shattered ice particles
c. data are being provided by new probes; new insight regarding small particles
d. now have ~13,000 individual PSDs, previously had about 1,100
e. IWC now ranges from 1.E-6 to 1 g m^{-3} (lower limit previously 1.E-3 g m^{-3})
f. development of new habit distribution

Ice particle single scattering libraries now include:

a. new habits, e.g., hollow bullet rosette and aggregate of plates
b. both roughened and smooth particles
c. full phase matrix
d. increased resolution in particle size
e. host of improvements to light scattering calculations
f. updated ice index of refraction (Warren and Brandt, JGR, 2008)
g. models will include same properties as before except for delta-transmission energy

New database of single-scattering properties is under development that will cover spectrum from UV through Far-IR with no spectral gaps

A preliminary database provides what is needed for MODIS Collection 6

Use of models with particle roughening will result in lower t and higher D_{eff}

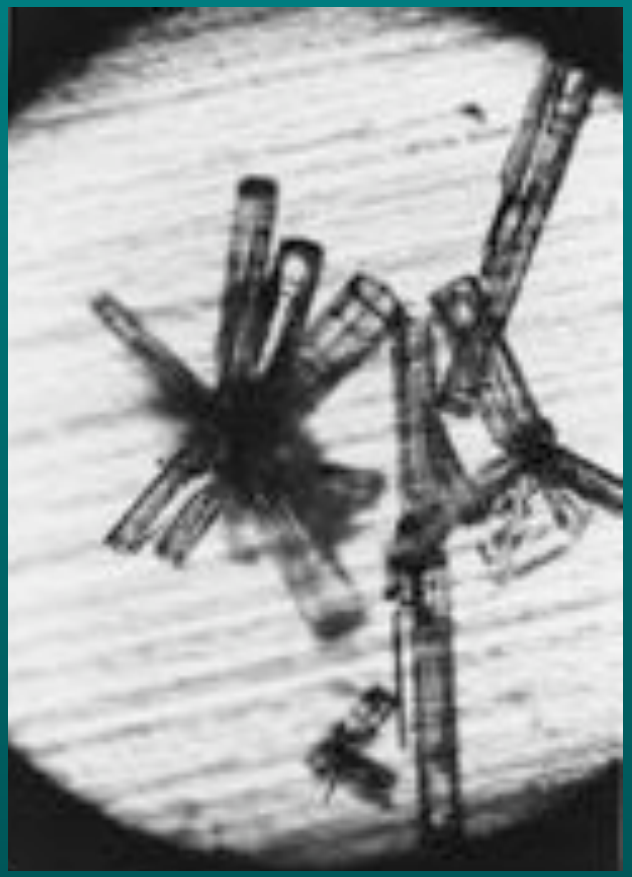
Expanded Set of Microphysical Data Available

IWC range: 1.E-6 to 1 g m^{-3}

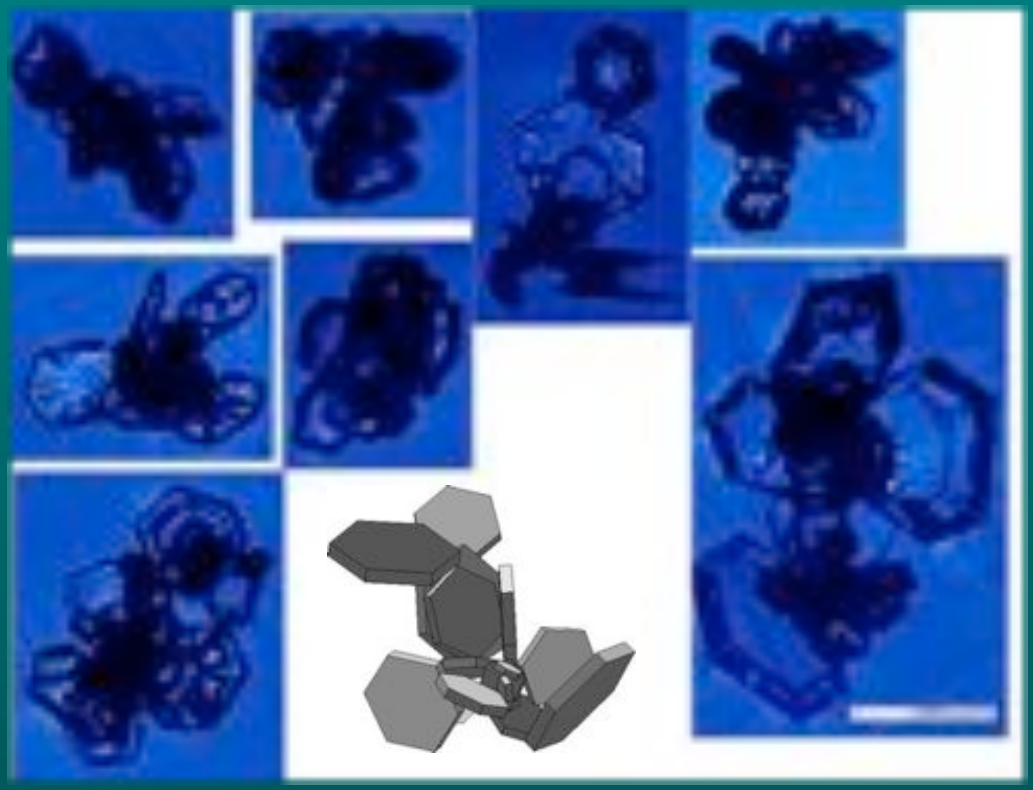
Field Campaign	Location	Instruments	# PSDs
ARM-IOP (UND Citation)	Oklahoma, USA 2000	2D-C, 2D-P, CPI, CVI, FSSP	1420
TRMM-KWAJEX (UND Citation)	Kwajalein, Marshall Islands, 1999	2D-C, HVPS, FSSP	201
CRYSTAL-FACE (NSA WB-57F)	SE Florida/Caribbean 2002	CAPS (CIP, CAS), VIPS	62
SCOUT (Geophysica)	Darwin, Australia 2005	FSSP, CIP	553
ACTIVE - Monsoons (Egrett)	Darwin, Australia 2005	CAPS (CIP, CAS)	4268
ACTIVE- Squall Lines (Egrett)	Darwin, Australia 2005	CAPS (CIP, CAS)	740
ACTIVE- Hectors (Egrett)	Darwin, Australia 2005	CAPS (CIP, CAS)	2583
MidCiX (NASA WB-57F)	Oklahoma, USA 2004	CAPS (CIP, CAS), VIPS, FSSP	2968
Pre-AVE (NASA WB-57F)	Houston,Texas, USA 2004	VIPS, CAPS	20

Number of particle size distributions for each field campaign. The total sample set has been filtered by the requirement that the cloud temperature be colder than –40°C, leading to a total of 12,815 PSDs.

New Habits

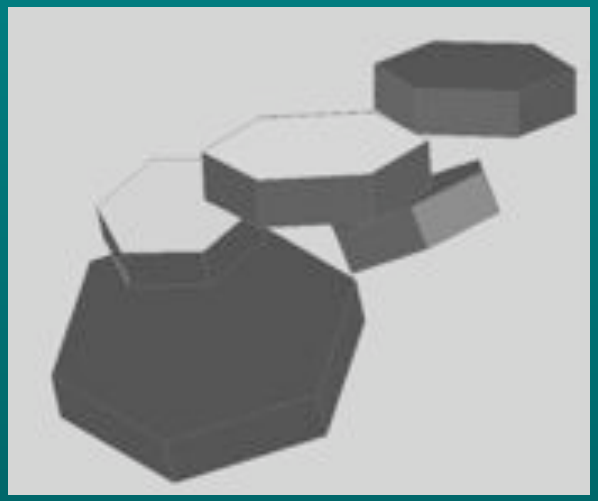


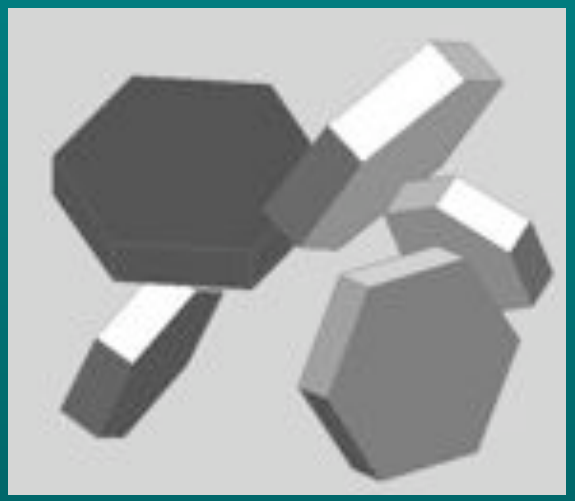
Photomicrograph of snow particles falling at the South Pole Station, 18 August, 1992, at ambient temperature -54°C. The scale bar is 1 mm. Photograph by Stephen Warren.

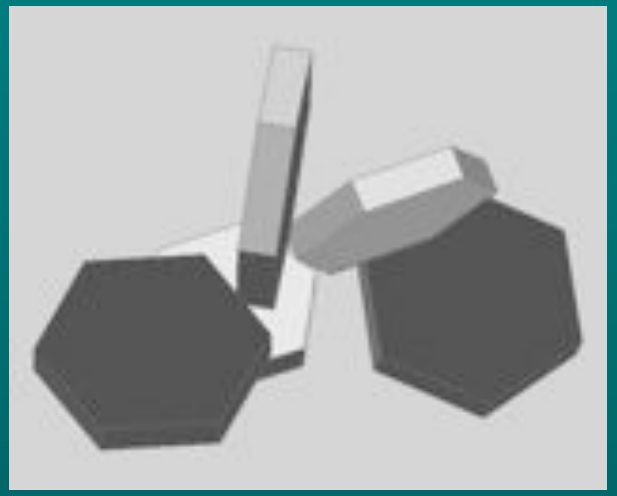


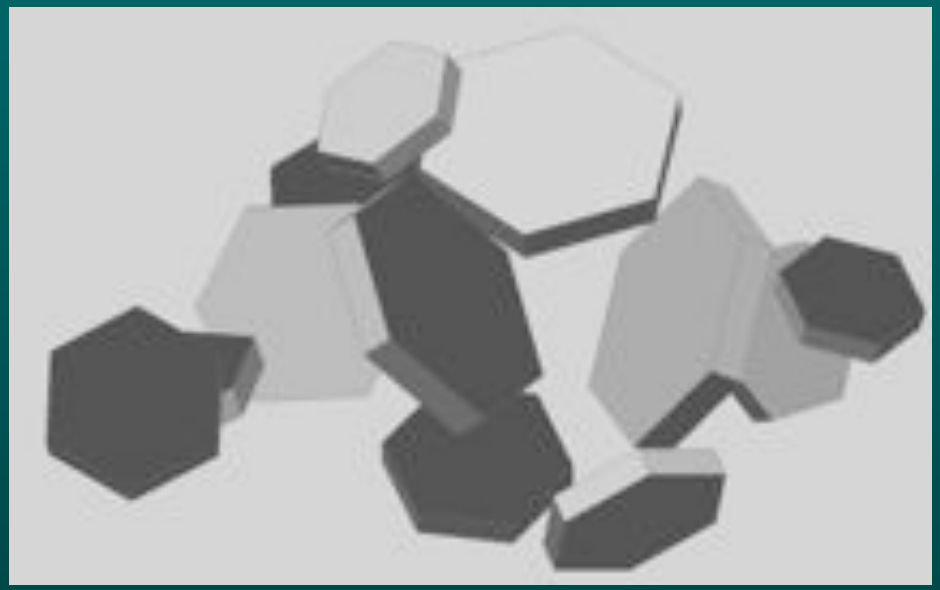
Images of aggregates of plates provided by A. Heymsfield and C. Schmitt (NCAR). Also shown is a realization of an aggregate of plates used for calculating single scattering properties.

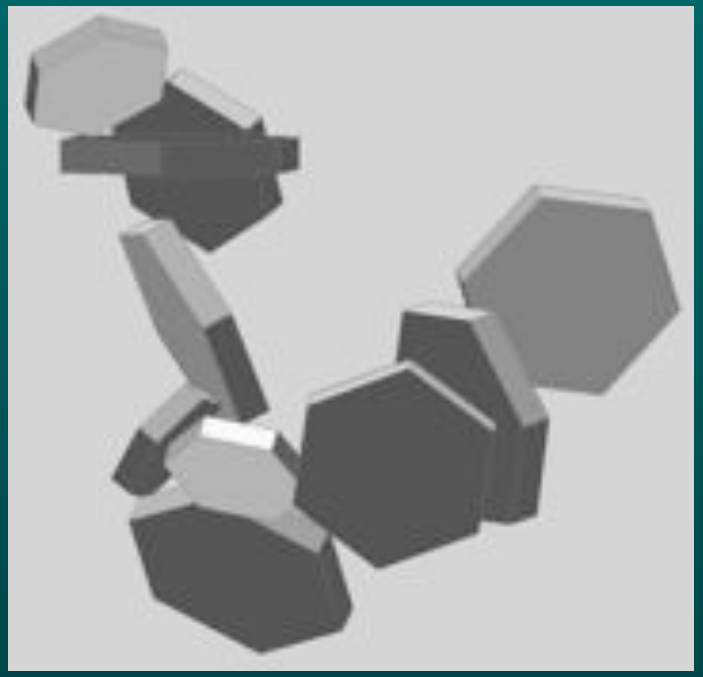
Different Realizations for the Aggregate of Plates



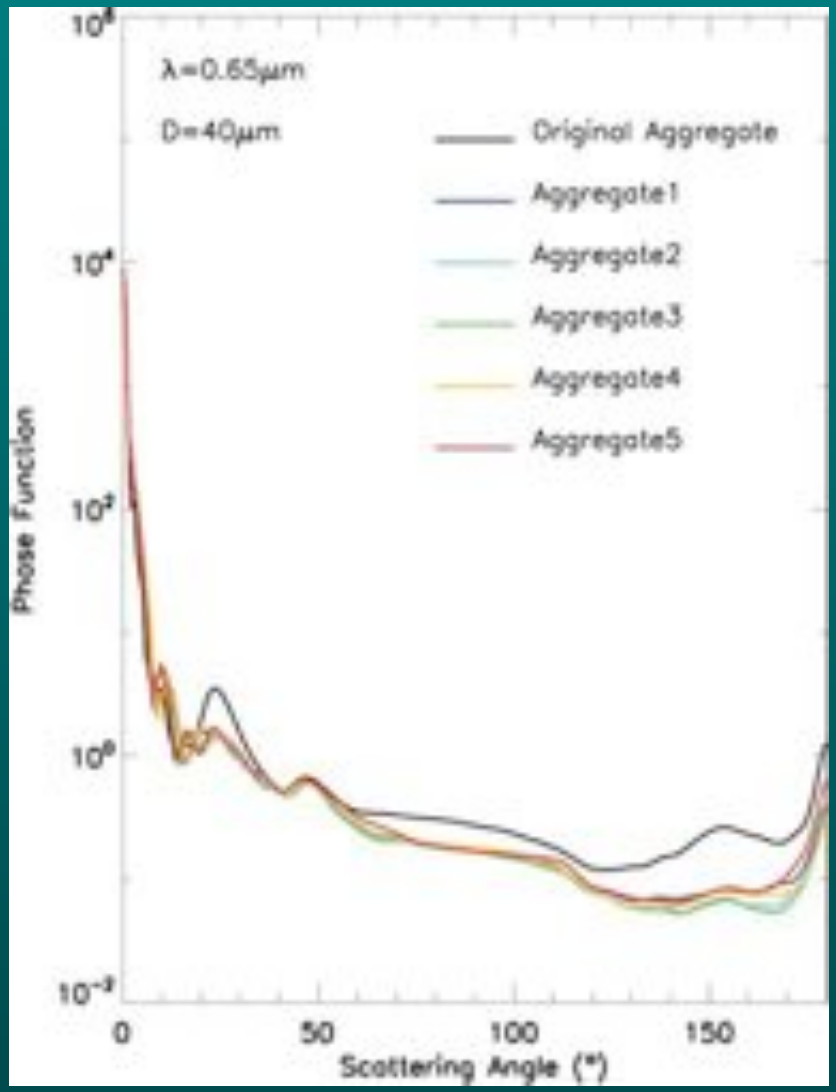




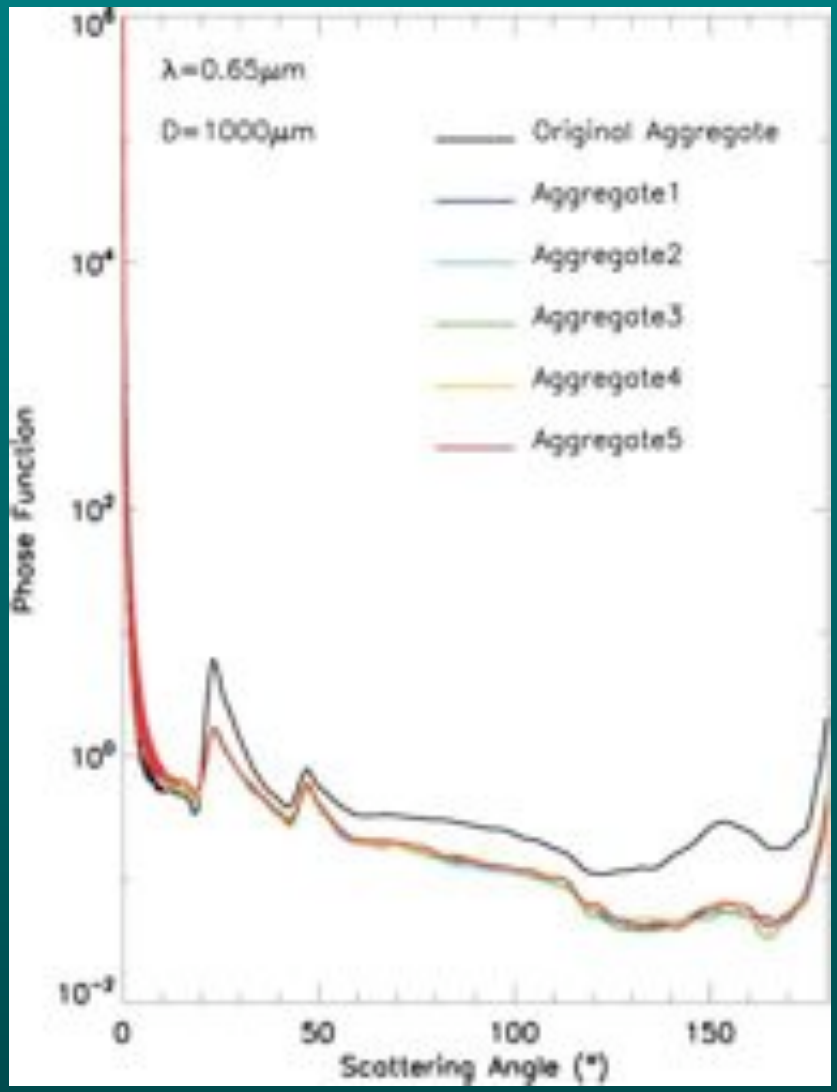




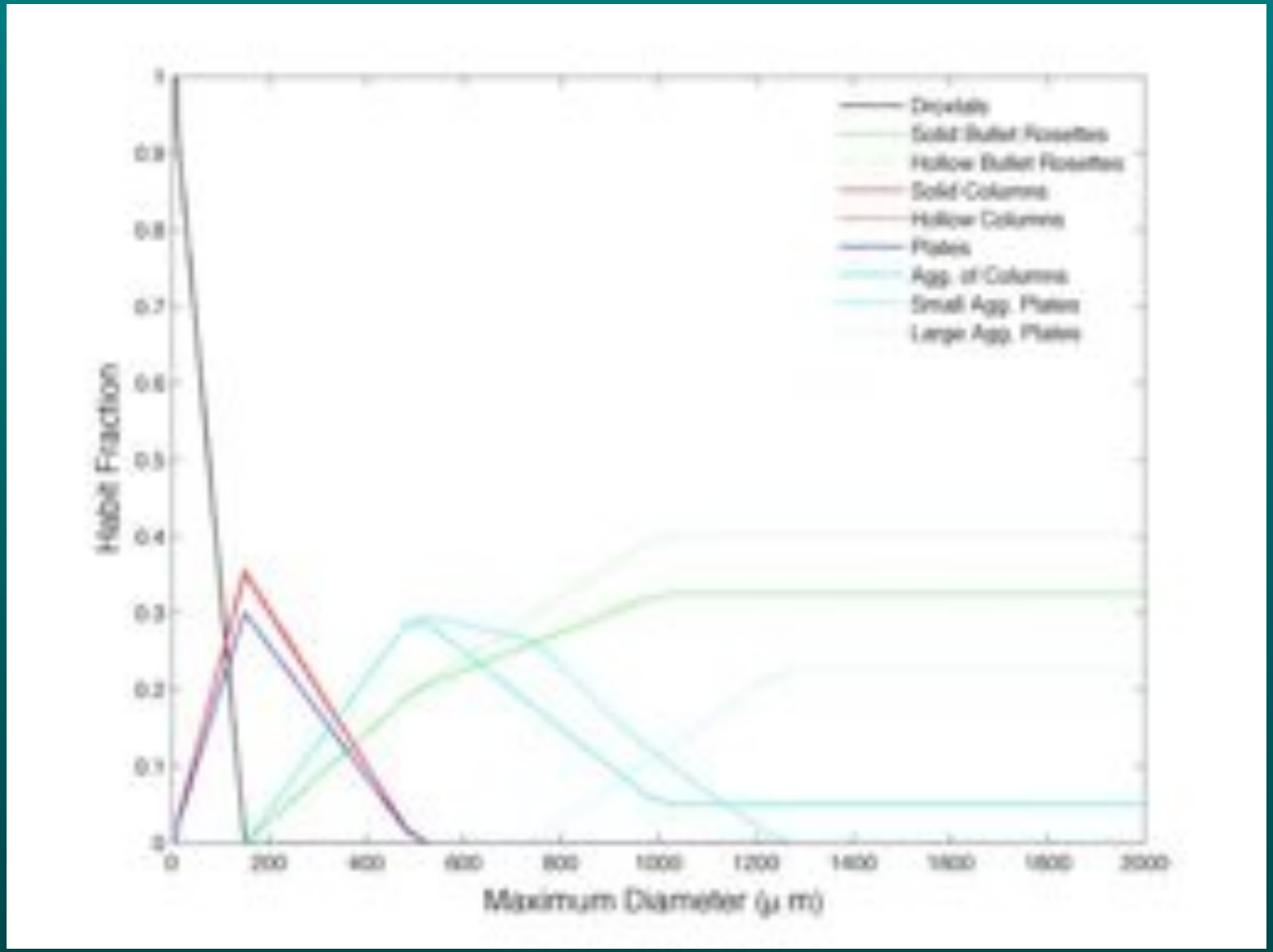
Our models will use properties based on an average of 5 different aggregate particles

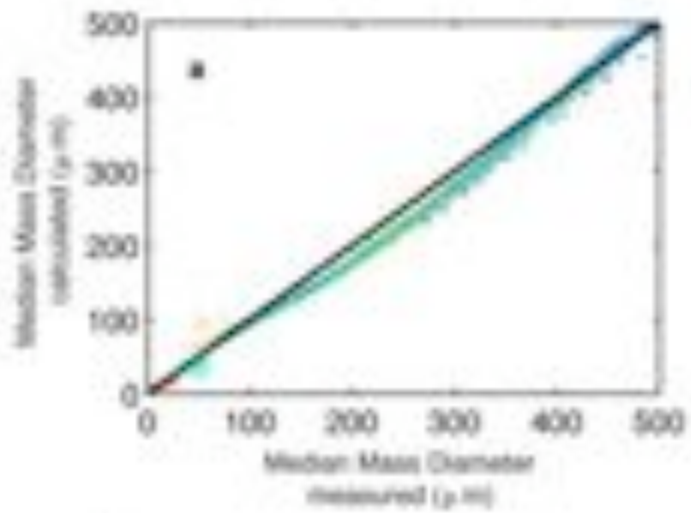


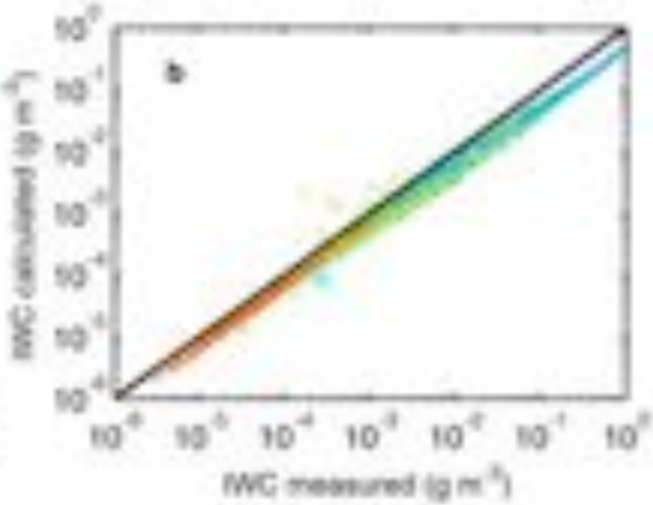
Small aggregates

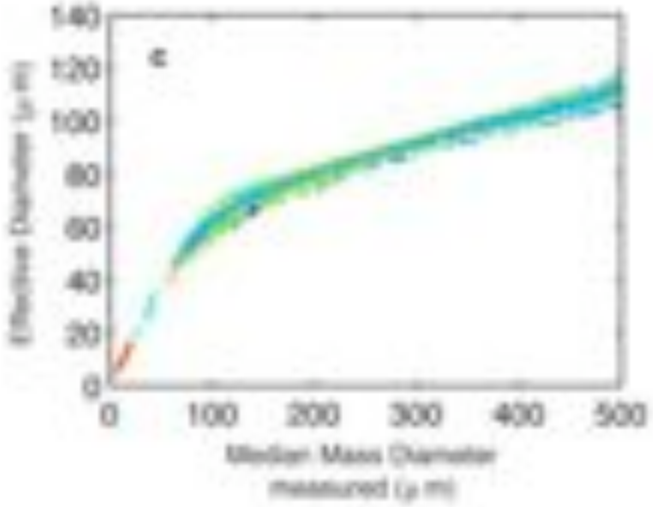


Large aggregates


Habit Fraction
Maximum Diameter (μ m)
Droplets
Solid Bullet Rosettes
Hollow Bullet Rosettes
Solid Columns
Hollow Columns
Plates
Agg. of Columns
Small Agg. Plates
Large Agg. Plates







- ARM-ICP
- TRMM
- CRYSTAL-FACE
- pre-AVE
- MidCiX
- ACTIVE Hector
- ACTIVE Monsoon
- ACTIVE Squall Line
- SCOUT

Improvements to Light Scattering Models

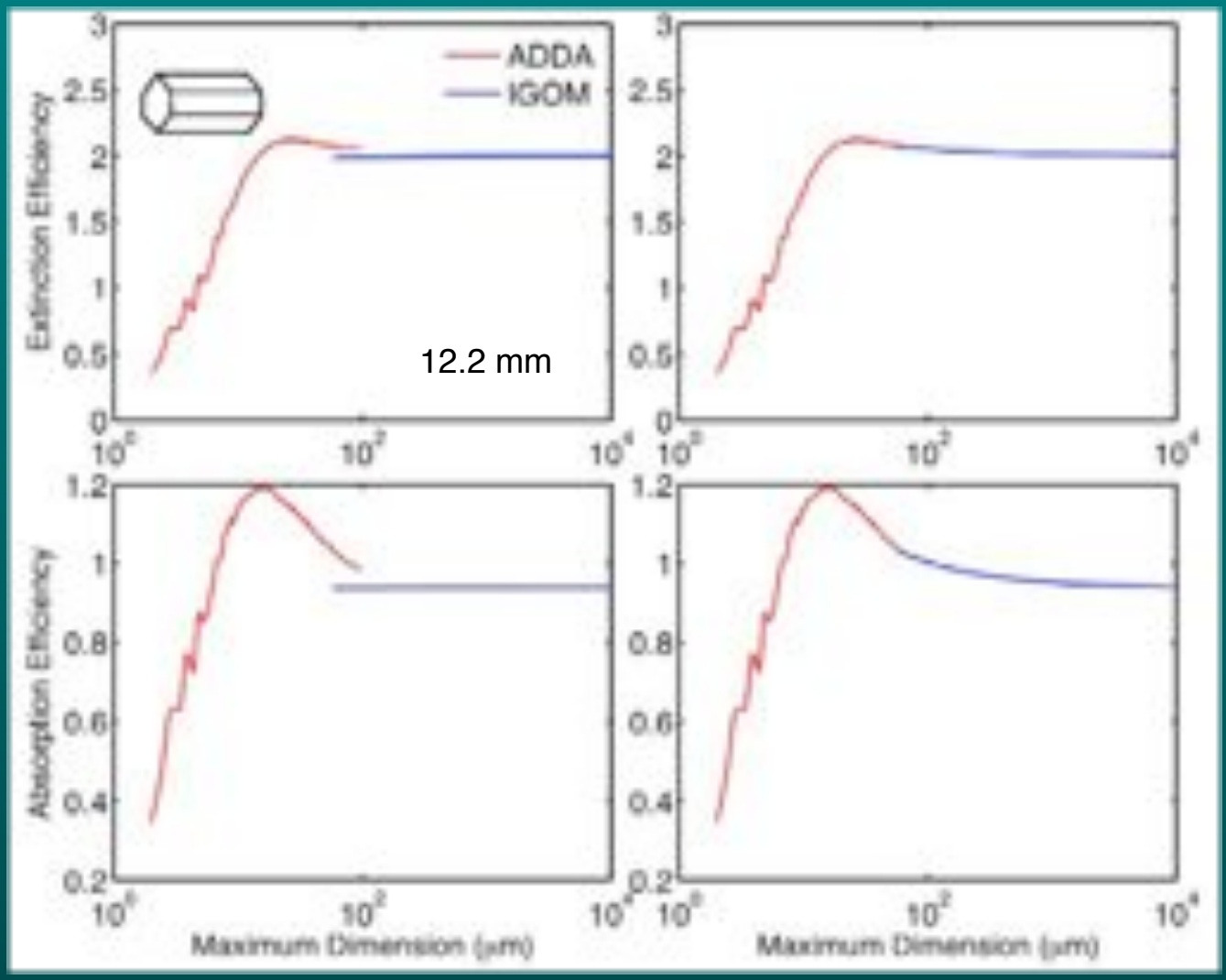
New treatment of ray-spreading results in the removal of the term relating to delta-transmission energy at the forward scattering angle.

Improved the mapping algorithm: the single-scattering properties from the new algorithm smoothly transition to those from the conventional geometric optics method at large size parameters.

Semi-analytical method developed to improve the accuracy of the first-order scattering (diffraction and external reflection).

Semi-empirical method is developed to incorporate the edge effect on the extinction efficiency and the above/below-edge effects on the absorption efficiency.

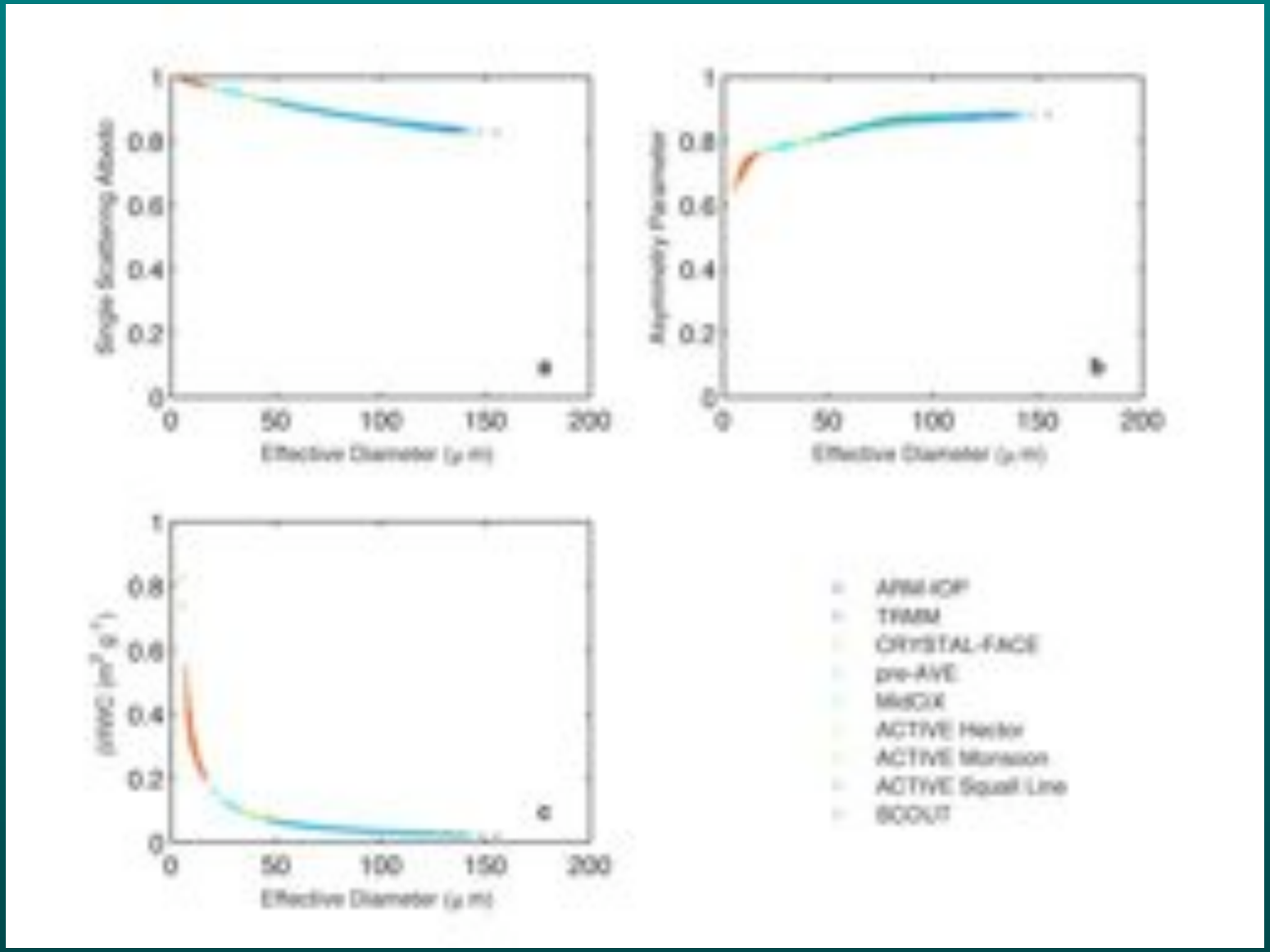
Better transition of extinction/absorption efficiencies between IGOM and ADDA models



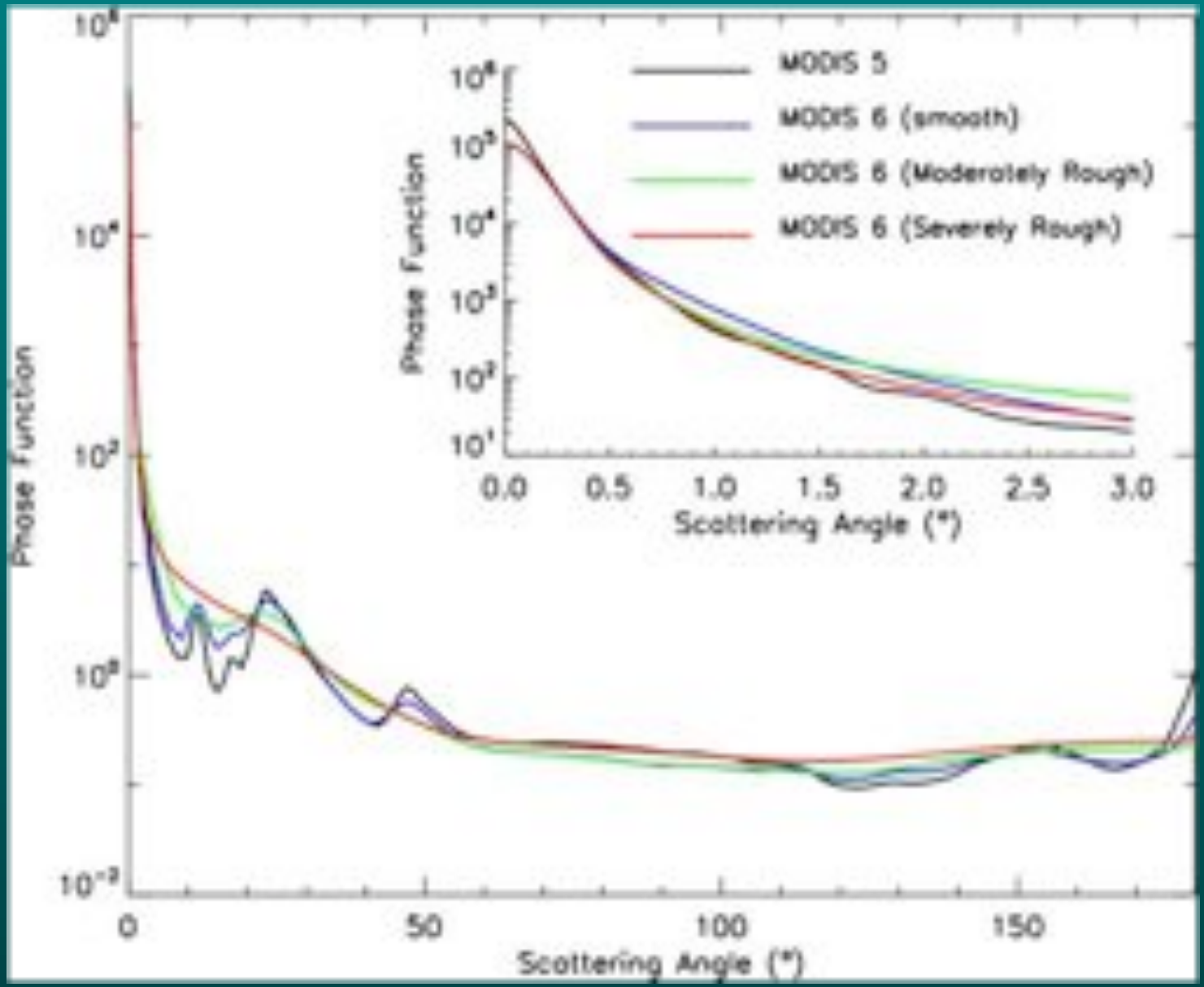
Left column: not considering edge effects

Right column: considering edge effects

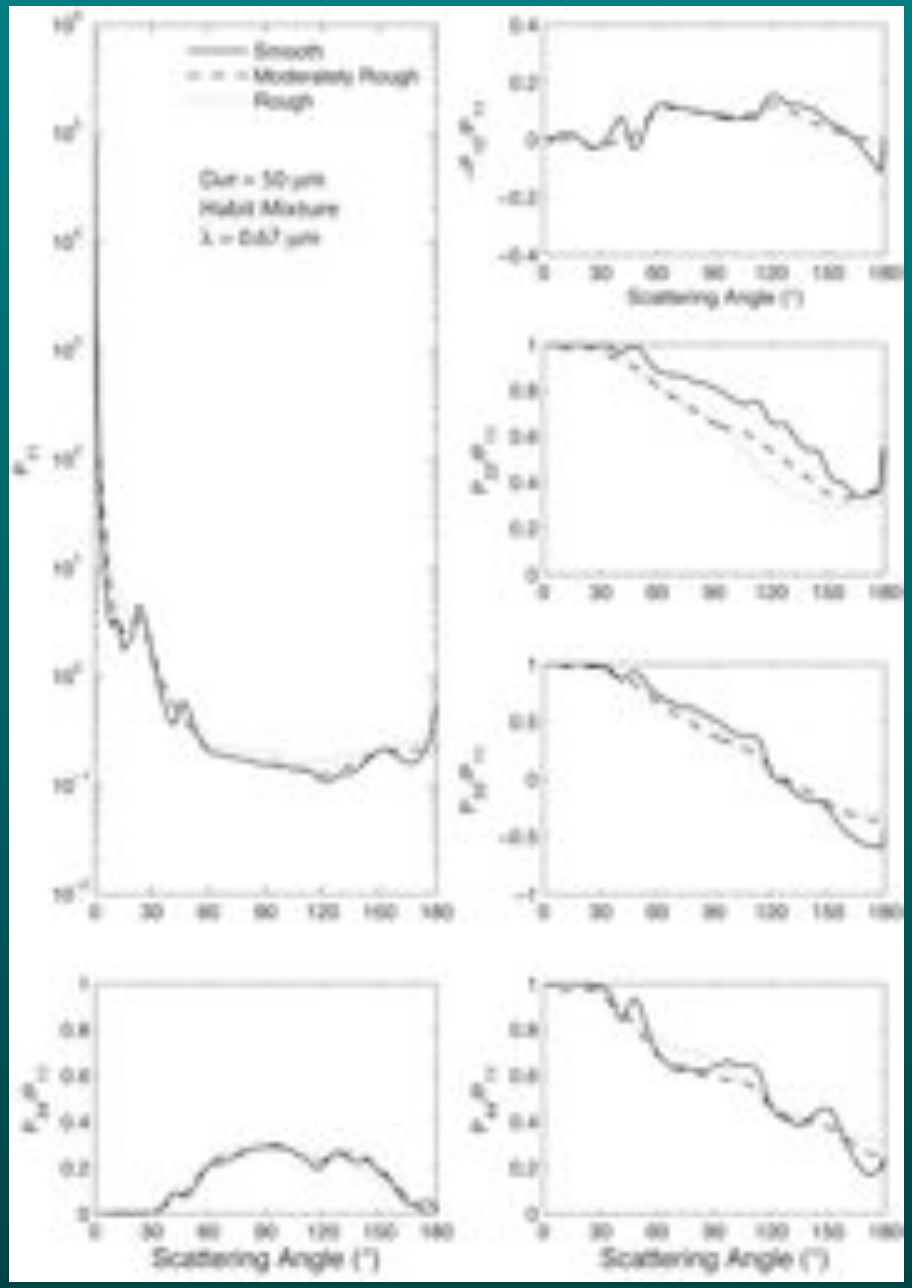
MODIS Band 7, severely roughened particles

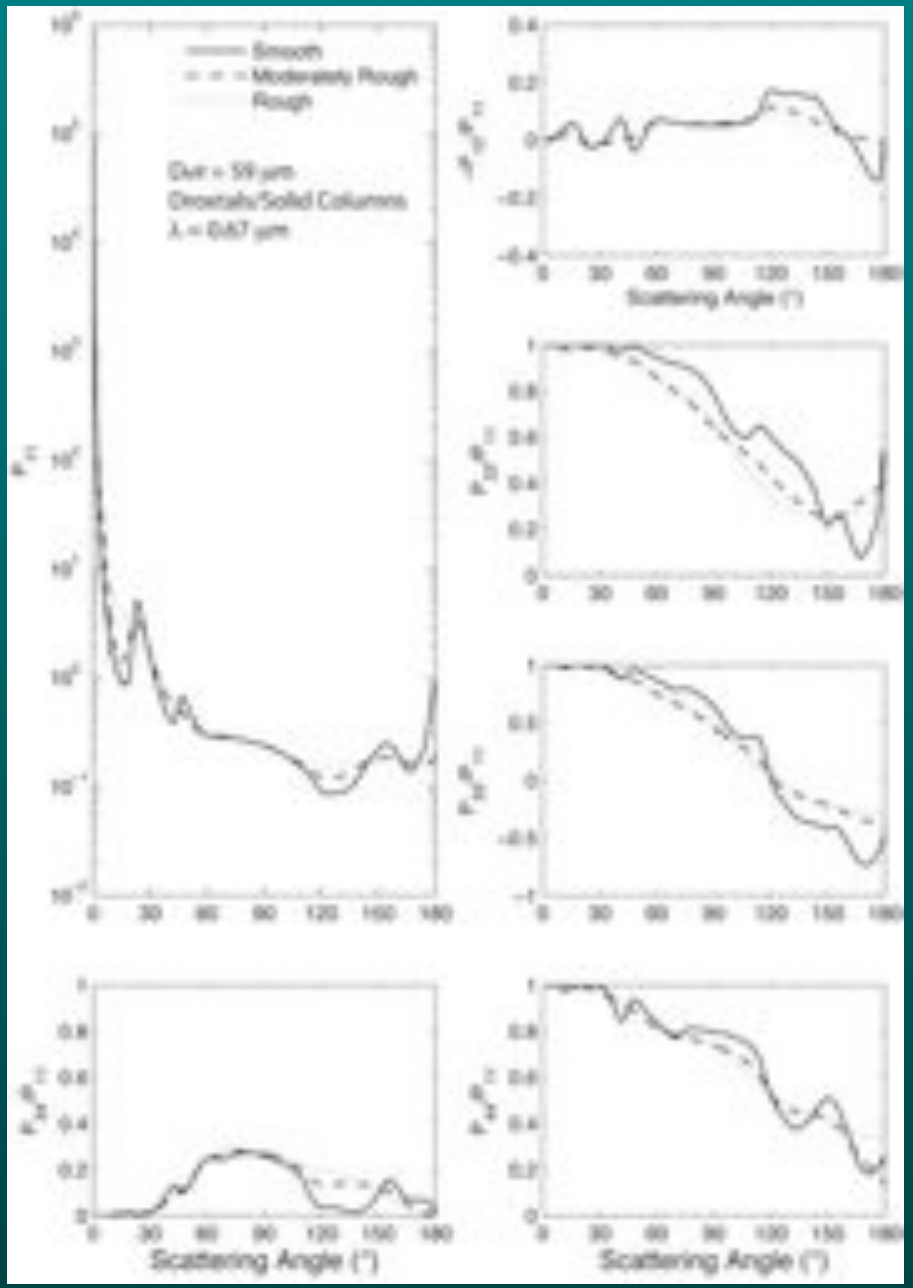


Comparison of MODIS C5 to Potential C6 Phase Functions
MODIS Band 1 (l = 0.65 mm)



Effect of habit and roughness on the phase matrix
C5 habit mixture versus solid columns





Effect of habit and roughness on the phase matrix
C5 habit mixture versus hollow bullet rosettes