Multi-spectral consistency check of the two-habit model

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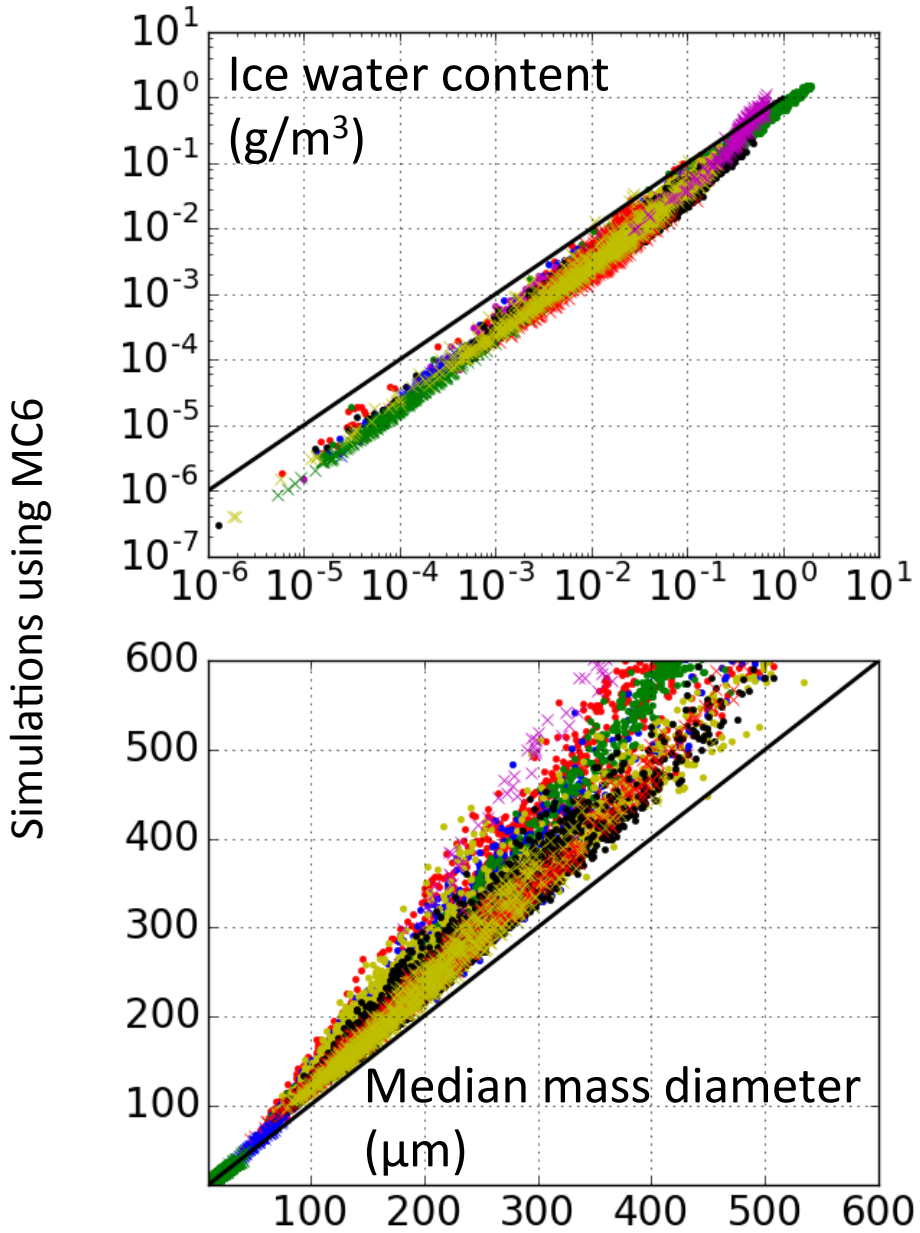
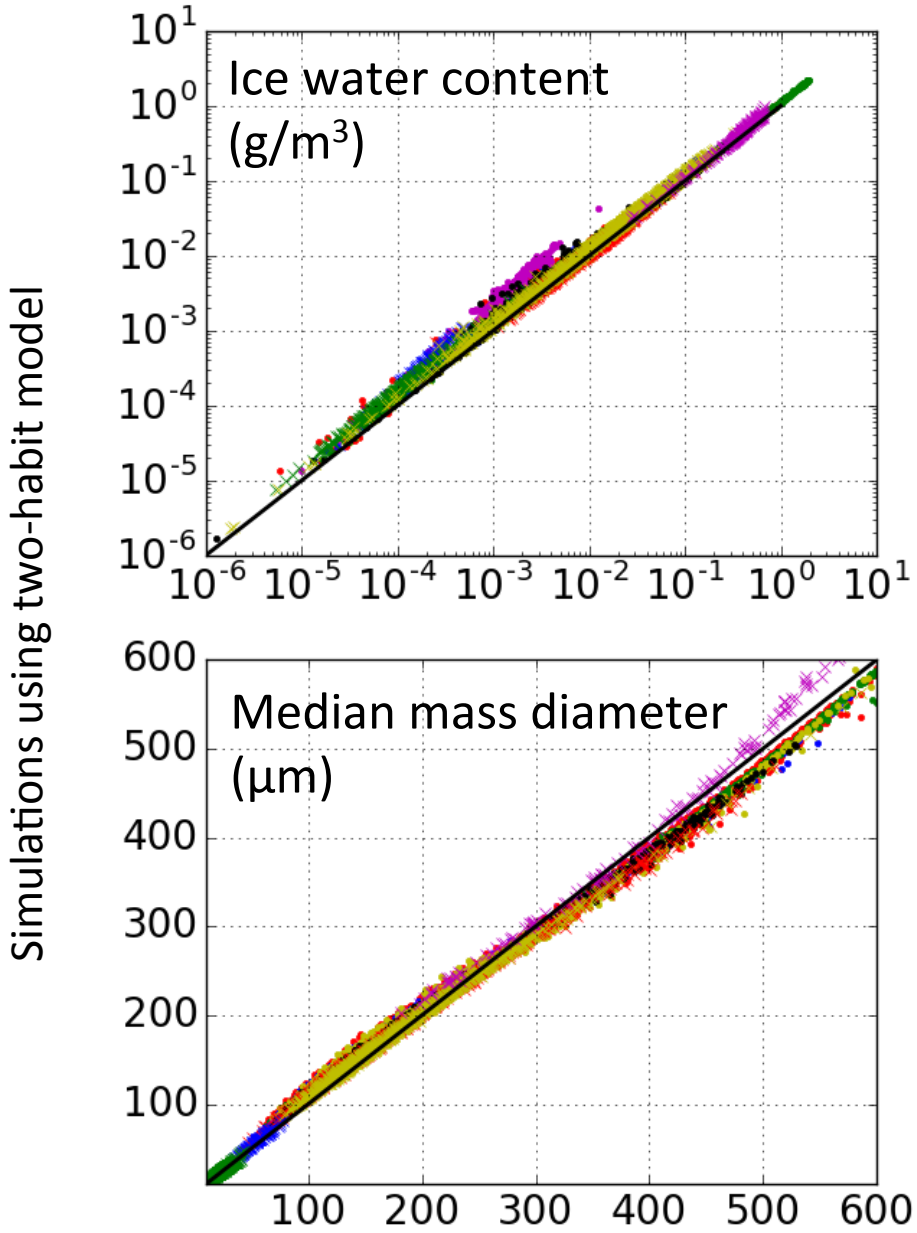
Compare MC6 with in-situ measurement



- ACTIVE Hector
- ACTIVE Monsoon
- ACTIVE SquallLine
- ARM-IOP
- CRYSTAL
- MIDCIX
- MPACE
- preAVE
- SCOUT
- TC4
- TRMM

Consistency of THM with in-situ microphysics measurement



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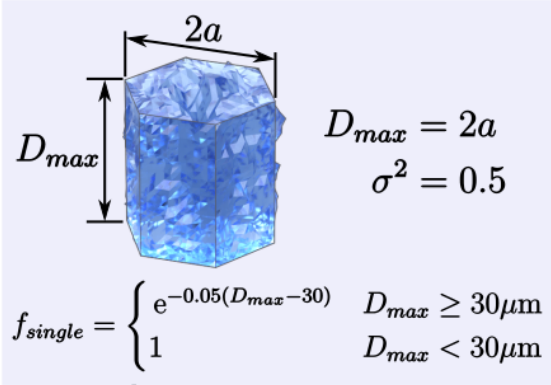
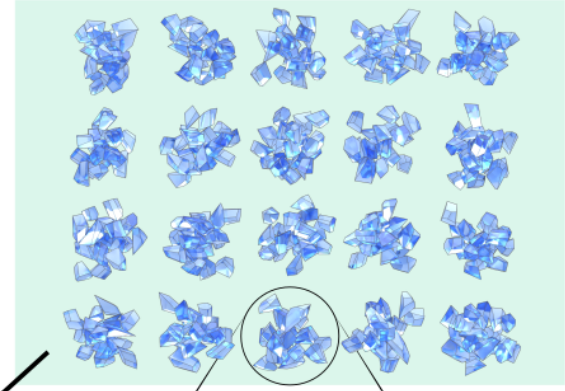
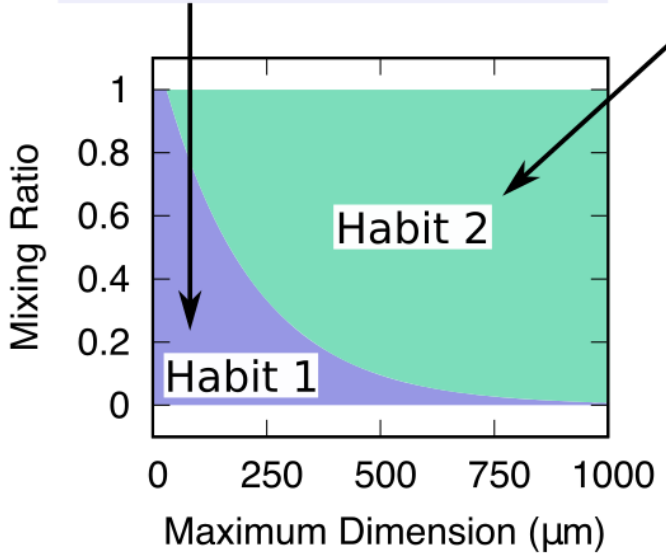
Two-Habit model

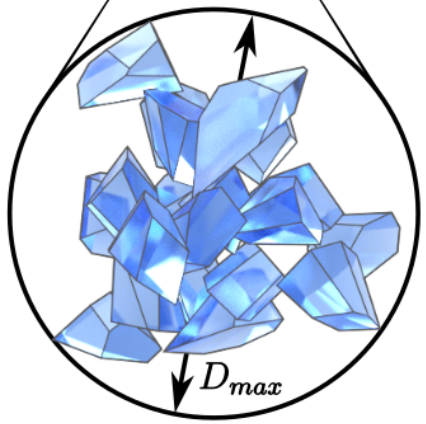
Habit 1:
Single Column



Habit 2:
Ensemble of Aggregates



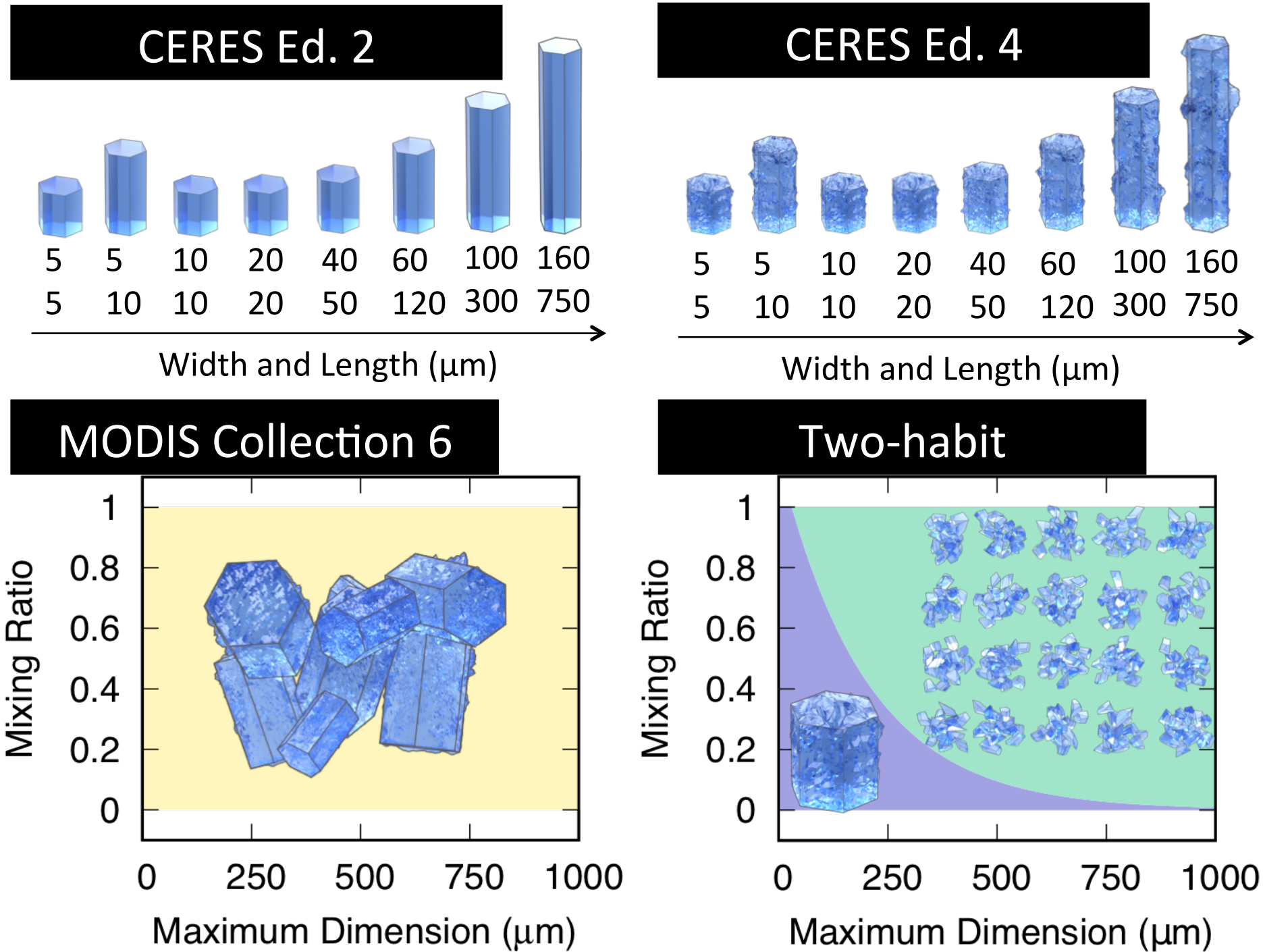




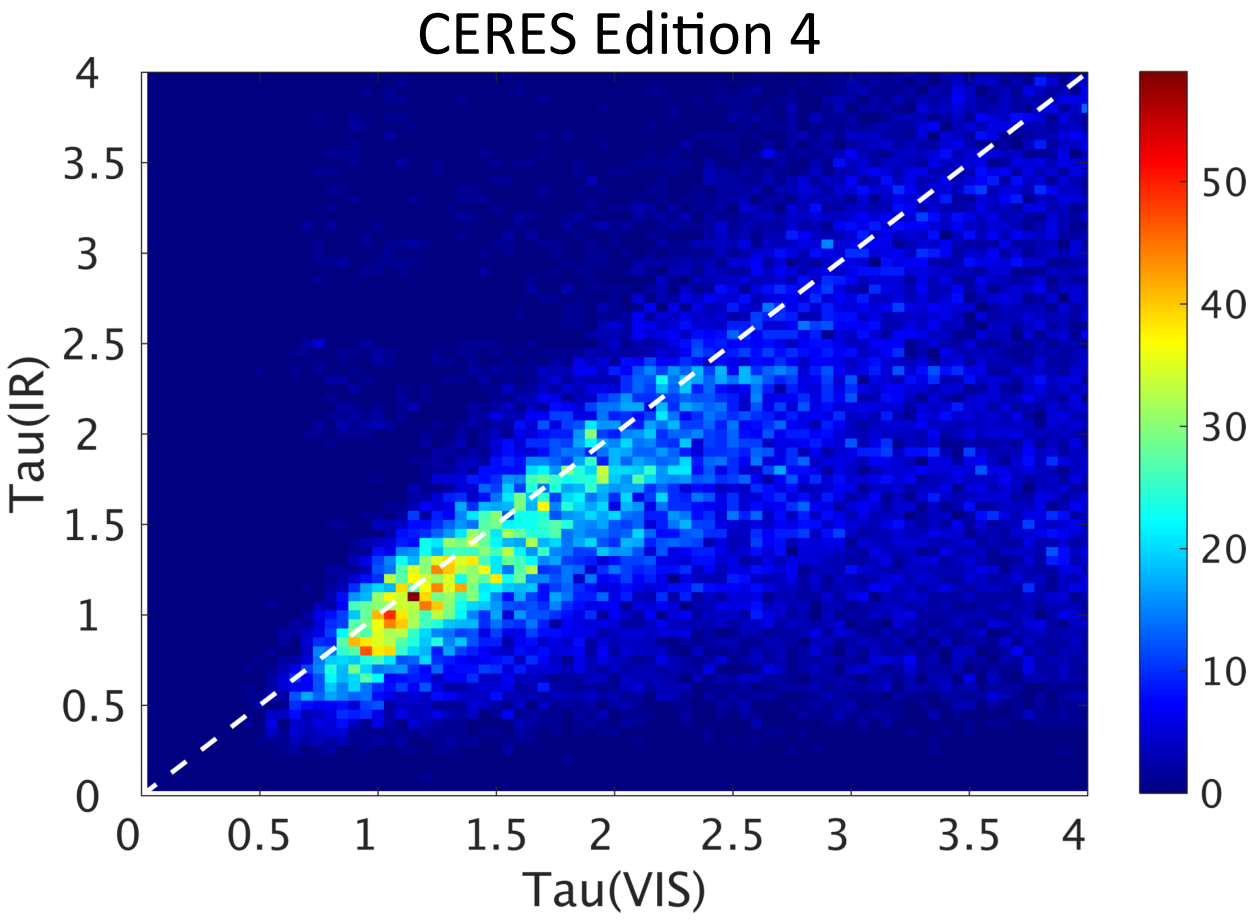
Aggregate of 20 distorted hexagonal columns, $\sigma^2 = 0.5$

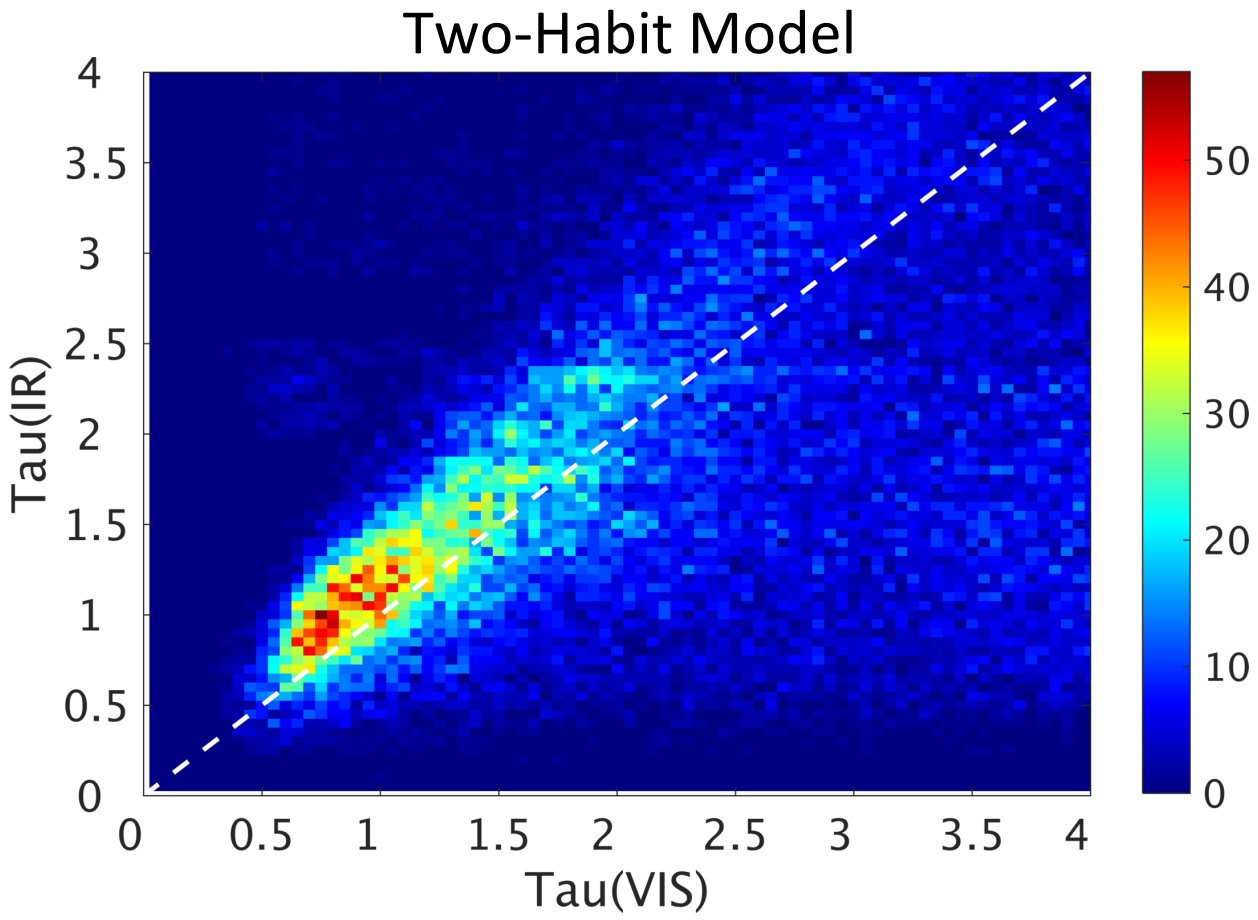
Courtesy of S. Hioki

- GOAL: develop an ice cloud model that provides a better representation of natural clouds.
- Mixture of a roughened single column and an aggregate of 20 distorted hexagonal columns.
- The absorption, scattering, and polarization properties are calculated over an entire practical range of particle sizes.
- Specific habit fractions are given at each size bin.


CERES Ed. 2
5 5 10 20 40 60 100 160
5 10 10 20 50 120 300 750
Width and Length (µm)
CERES Ed. 4
5 5 10 20 40 60 100 160
5 10 10 20 50 120 300 750
Width and Length (µm)
MODIS Collection 6
Mixing Ratio
1
0.8
0.6
0.4
0.2
0
0 250 500 750 1000
Maximum Dimension (µm)
Two-habit
Mixing Ratio
1
0.8
0.6
0.4
0.2
0
0 250 500 750 1000
Maximum Dimension (µm)

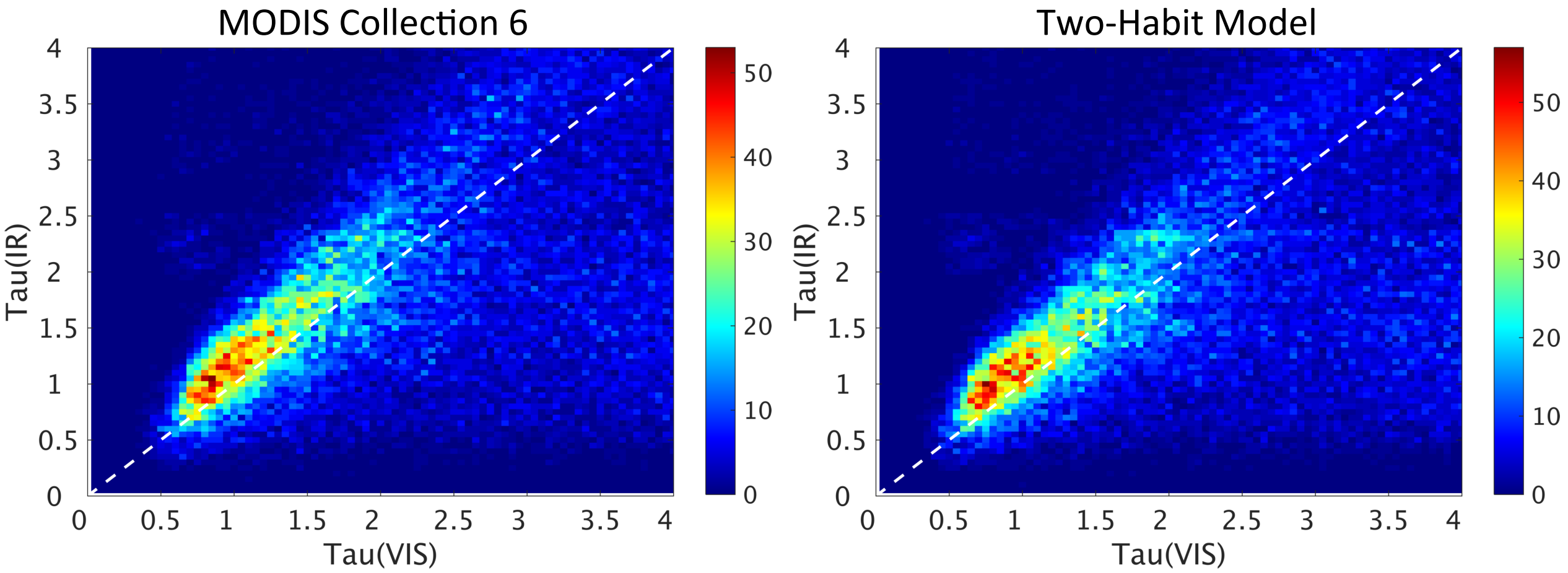
VIS/IR Optical Thickness Retrieval





Courtesy of C.-P. Kuo

VIS/IR Optical Thickness Retrieval



Courtesy of C.-P. Kuo

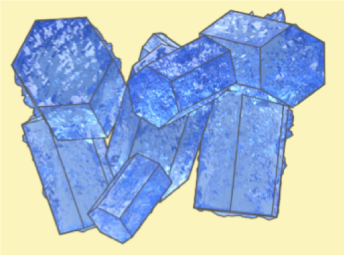
Shortwave Retrieval

- **One month of MODIS Aqua Data**
  - May, 2012
  - Level 2 Reflectivity with atmospheric correction
- **Shortwave bi-spectral retrieval**
  - Band 2 (0.86 µm) and Band 7 (2.13 µm)
  - Effective radius and optical thickness are retrieved

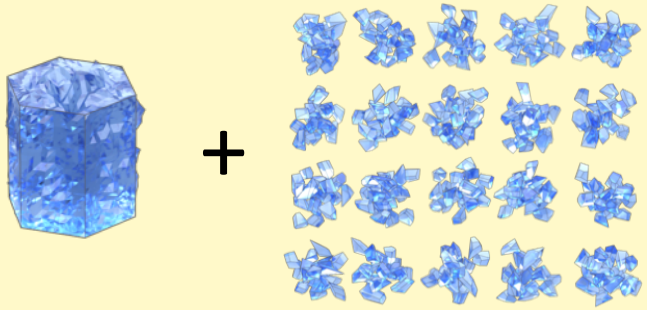
4 Assumed Particle Shapes

CERES Edition 2

CERES Edition 4



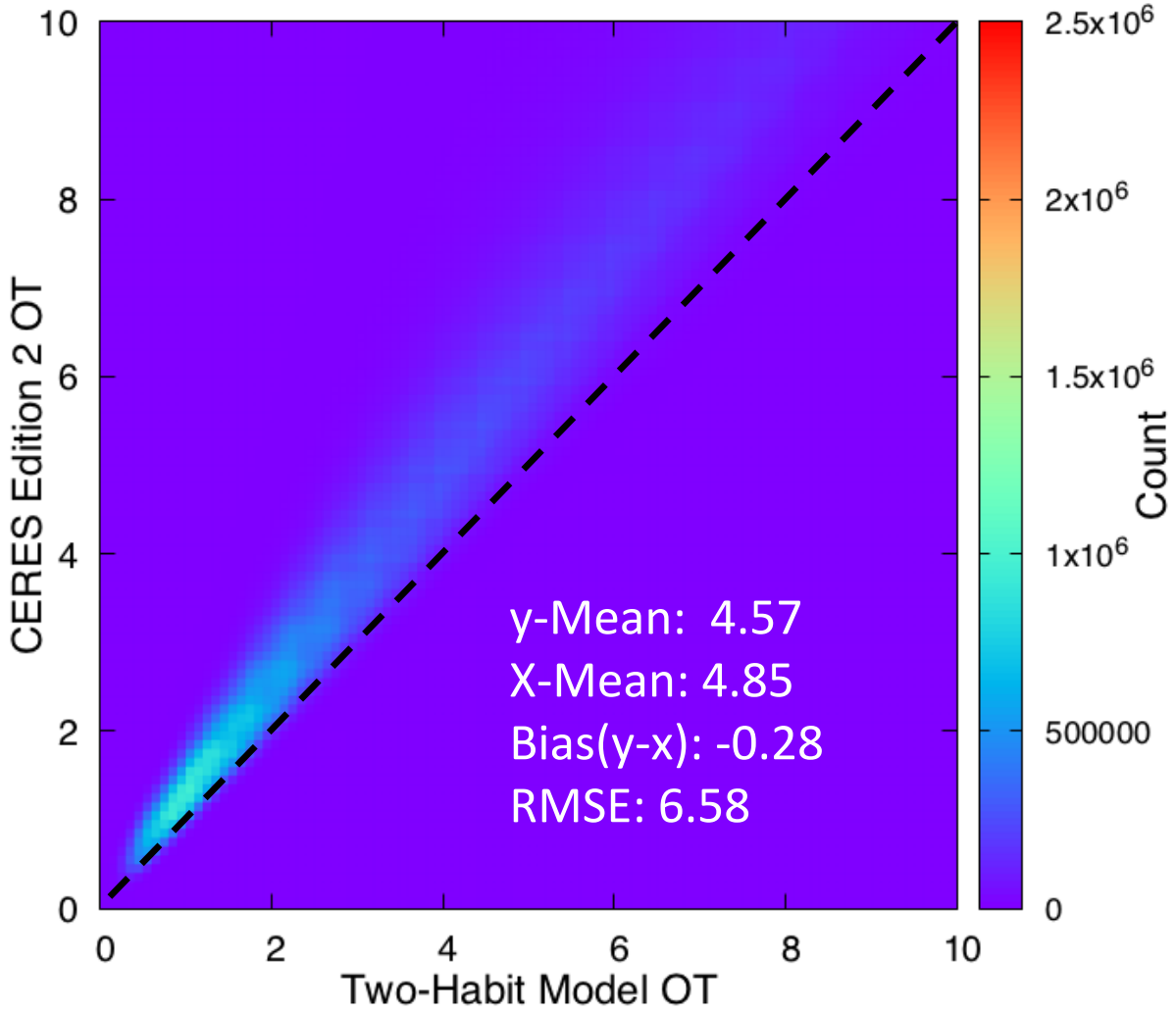
MODIS Collection 6 (C6)



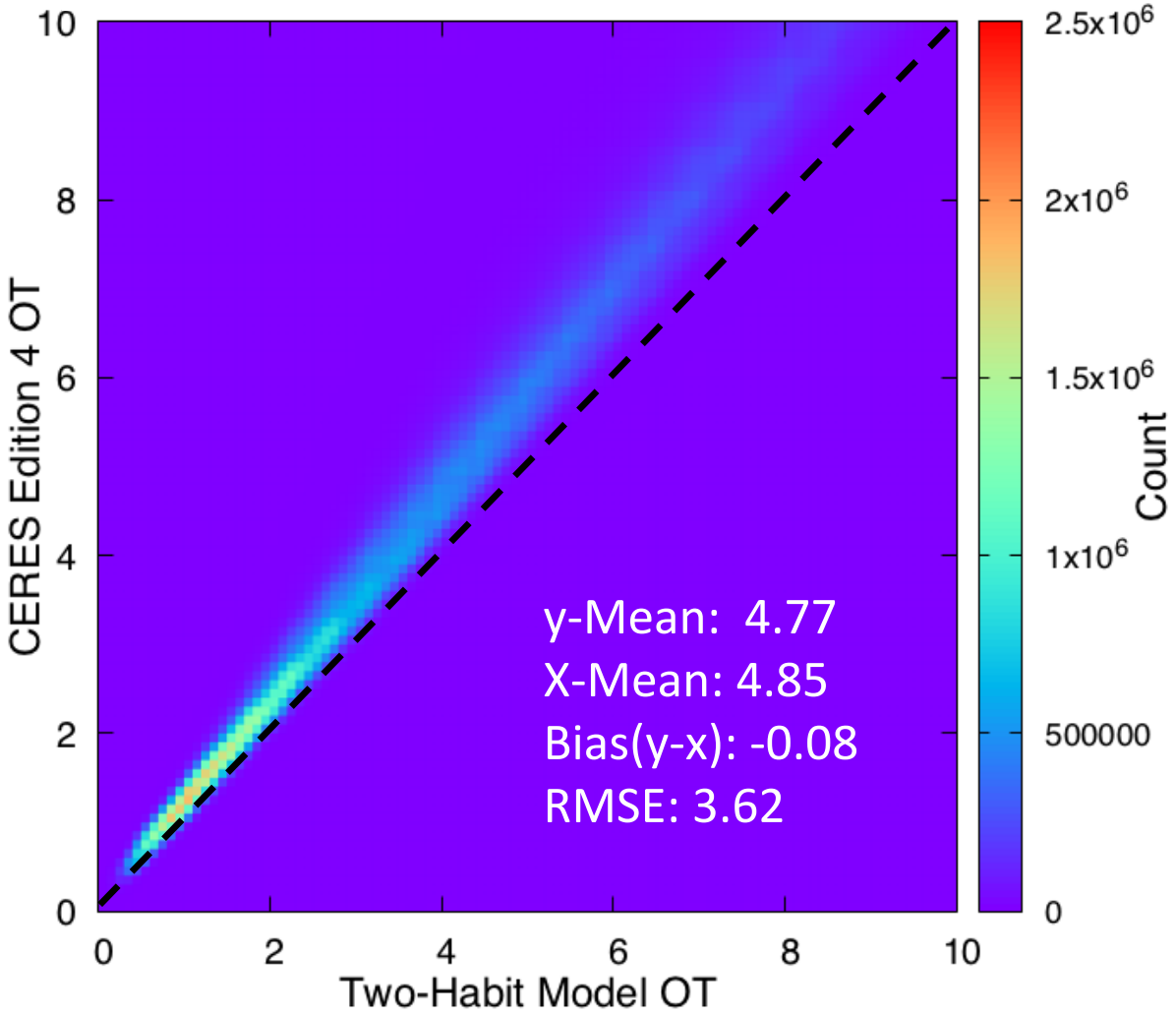
Two-Habit Model

Comparison of two-habit model and CERES Editions 2, 4

Two-Habit Model vs CERES Edition 2

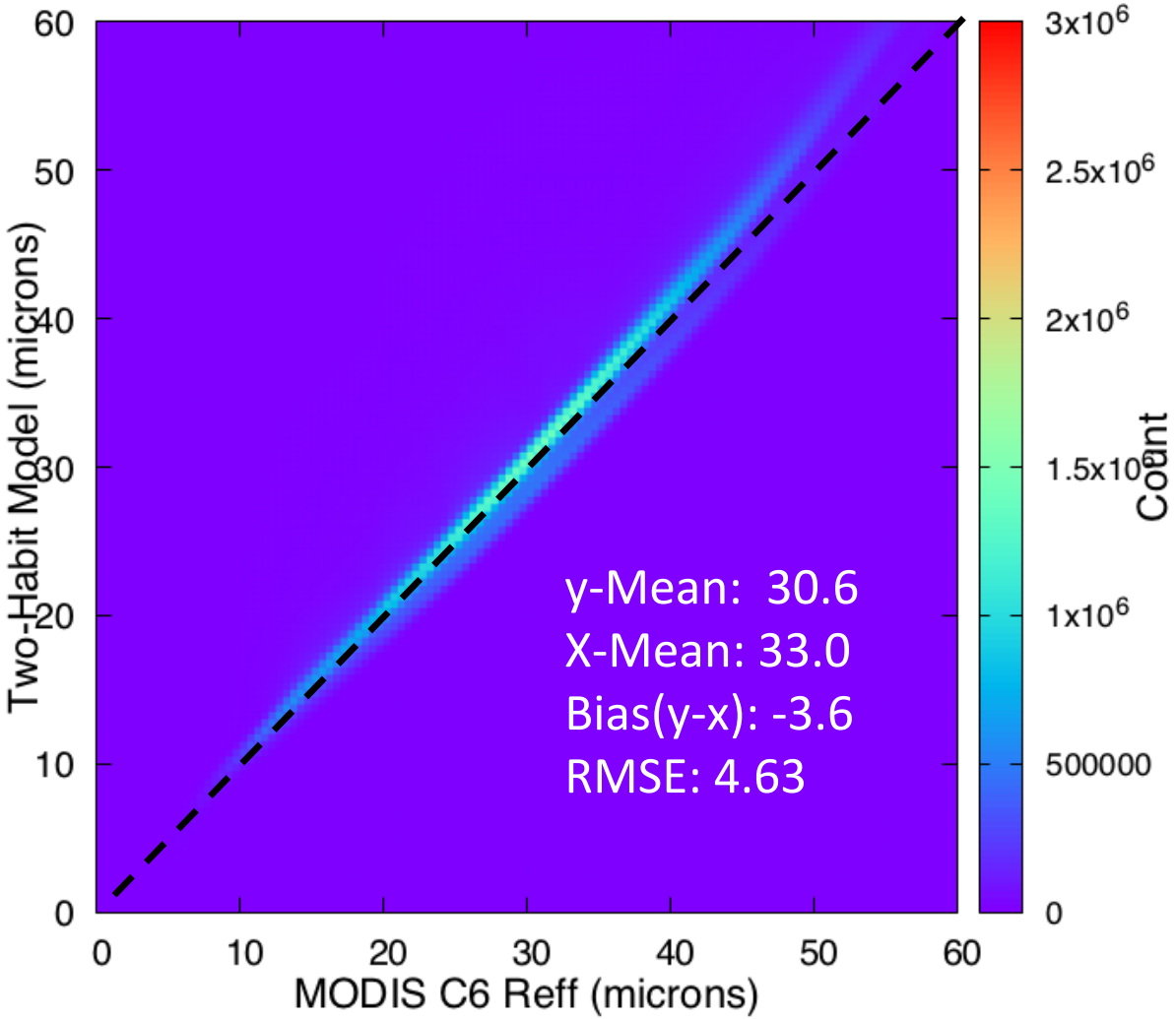


Two-Habit Model vs CERES Edition 4

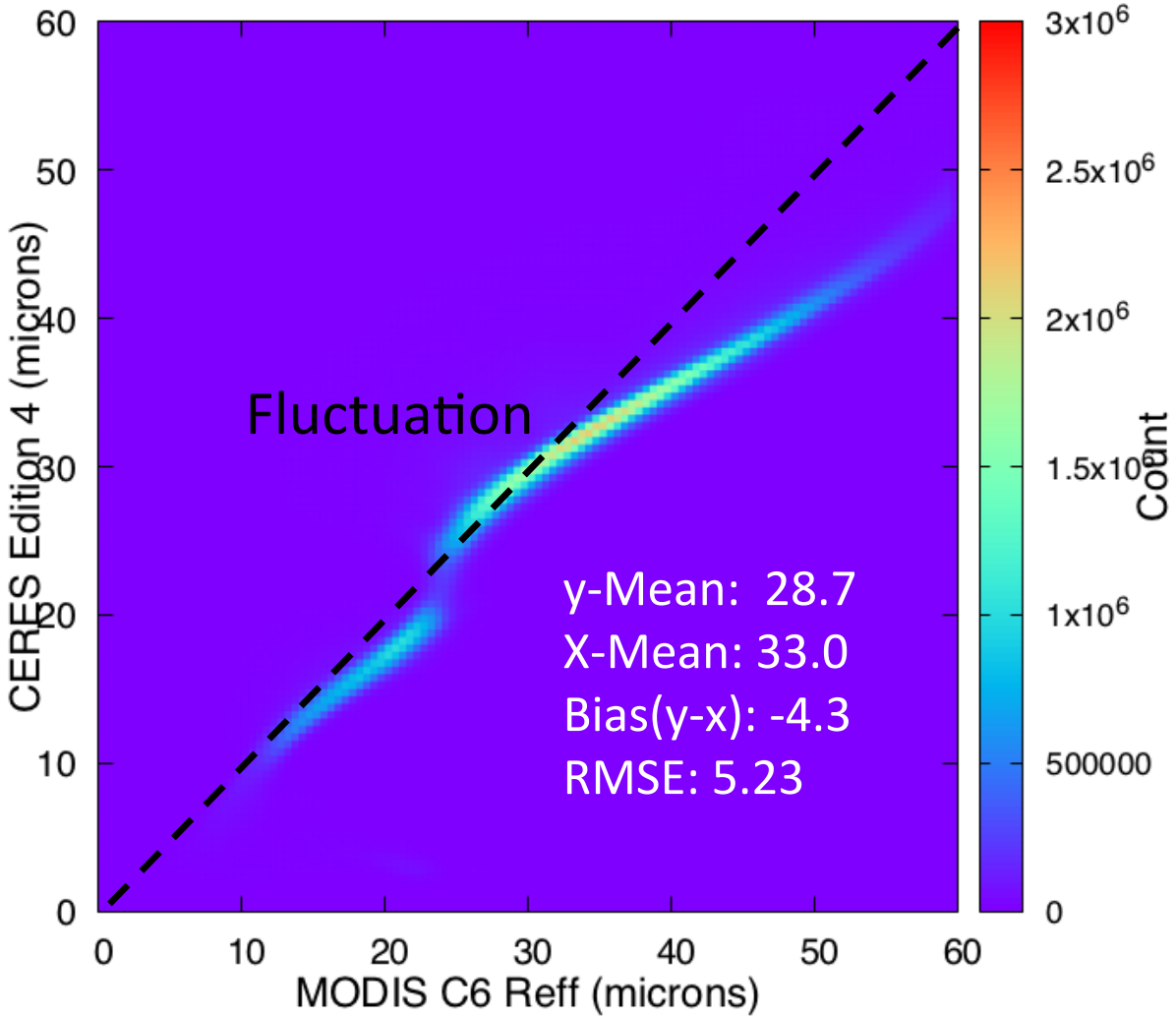


Shortwave Retrieval: Effective Radius

MODIS C6 vs Two-Habit Model

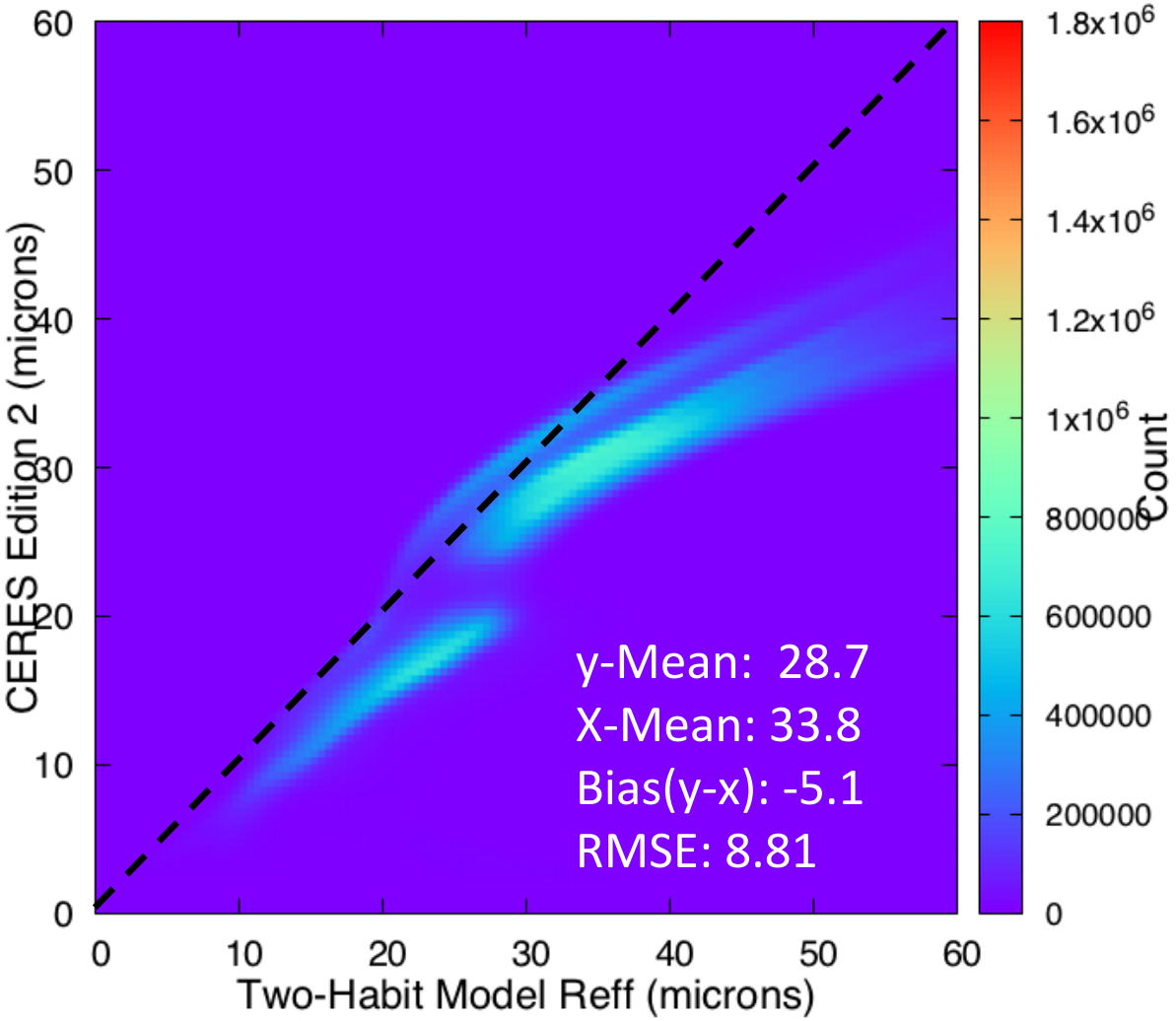


MODIS C6 vs CERES Edition 4

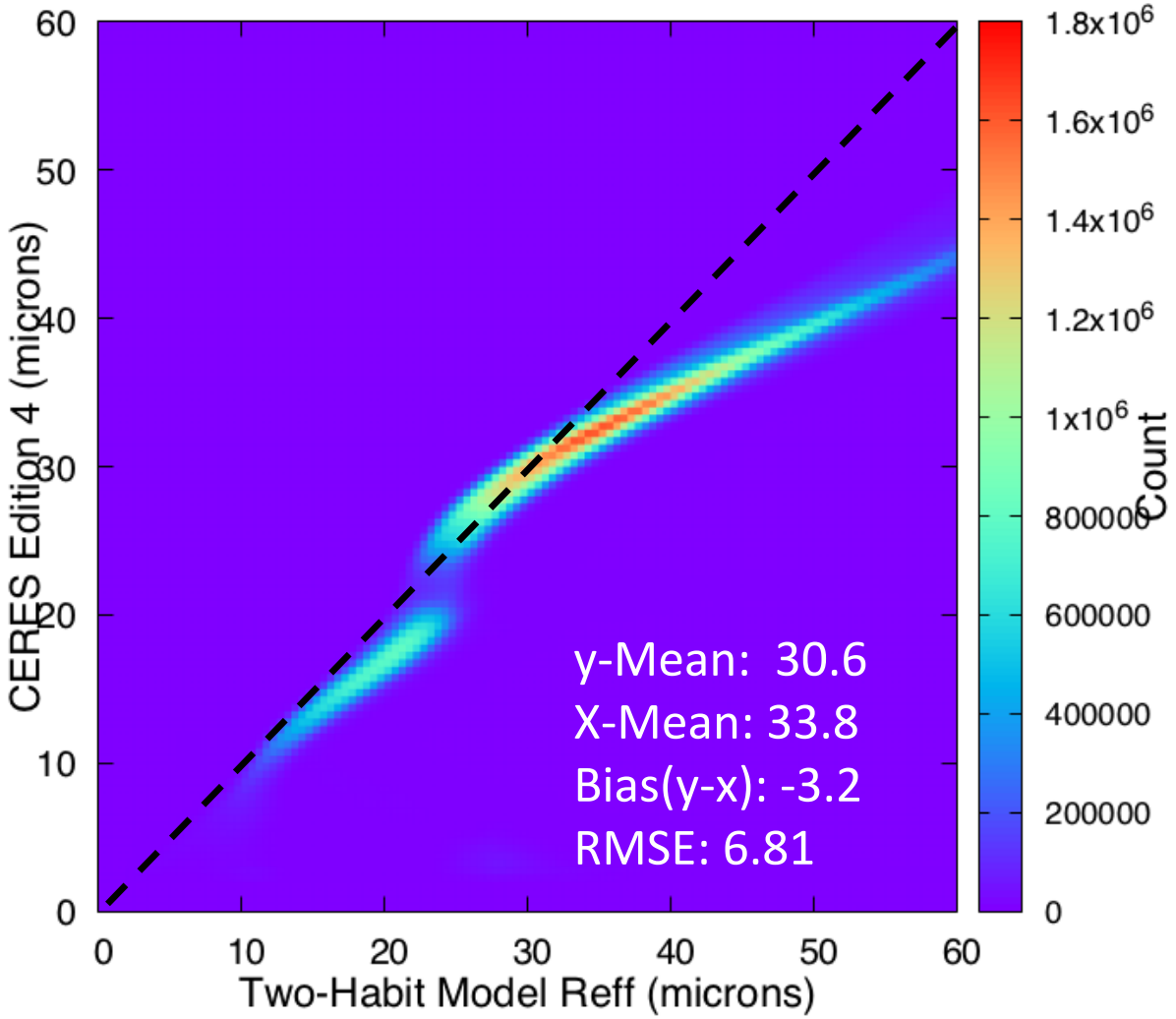


Shortwave Retrieval: Effective Radius

Two-Habit Model vs CERES Edition 2



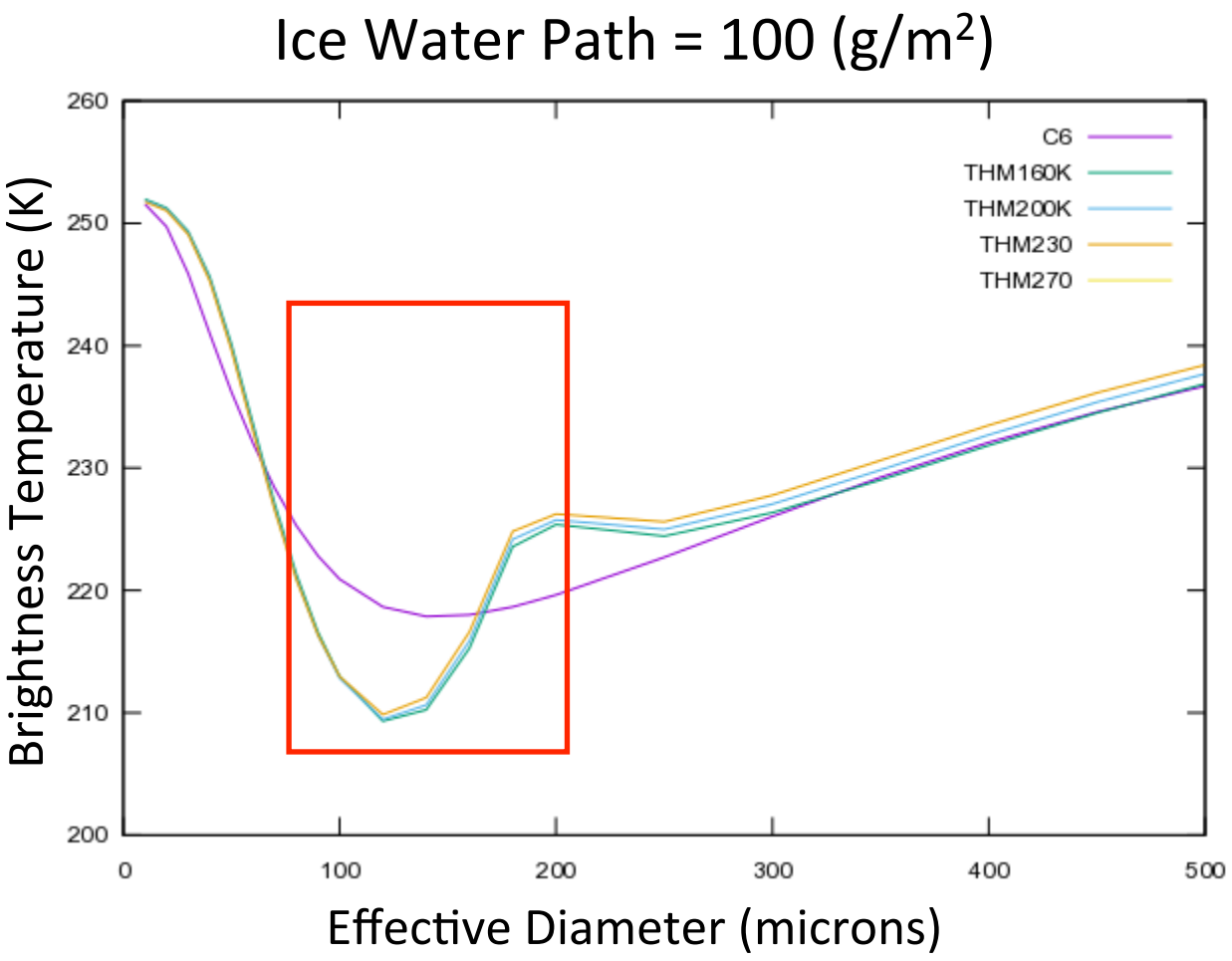
Two-Habit Model vs CERES Edition 4

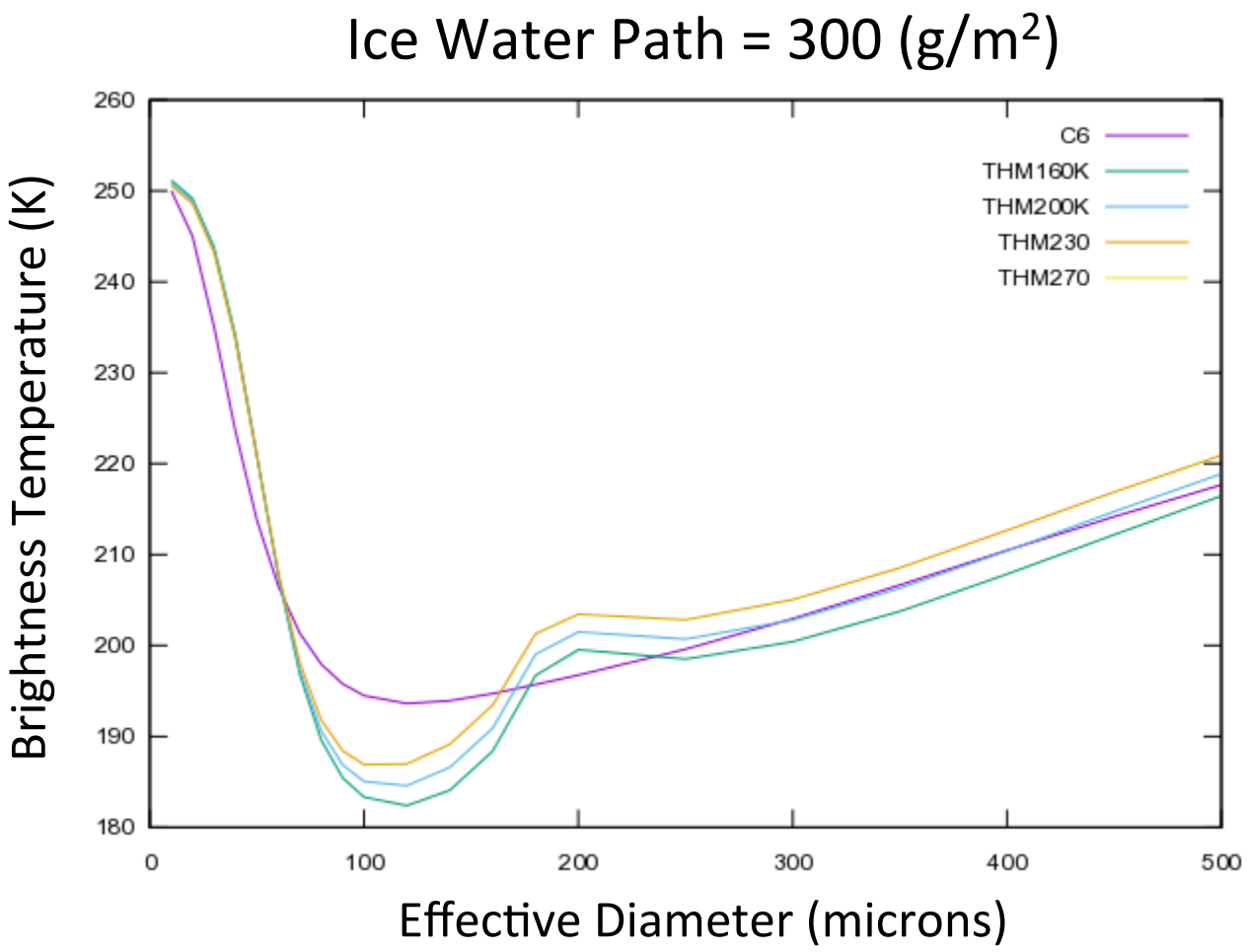


Comparison of Two-Habit Model and MODIS C6

- **Radiative Transfer Calculations Performed with Atmospheric Radiative Transfer Simulator (ARTS)**
  - 53.5˚ assumed viewing zenith direction
  - Radiances and associated brightness temperatures (TB) are computed at **874 GHz (343 µm)**
- Refractive index of ice is sensitive to temperature in this frequency
  - Optical properties are computed for a range of **160-270K**

Spectral Consistency :





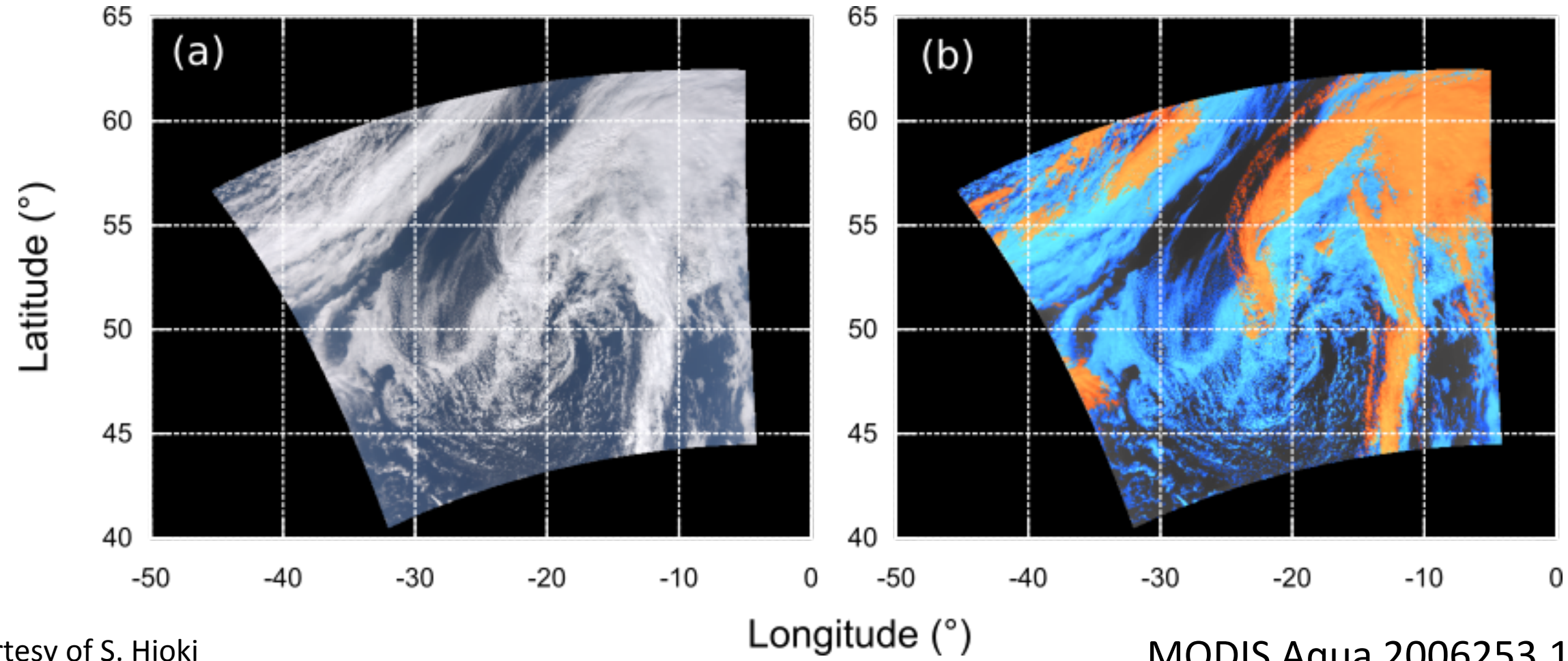
- Brightness Temperatures (BT) for a range of Ice Water Paths (IWP)
- Particle types: MODIS Collection 6 (C6) and Two-Habit Model
- Interesting fluctuation around 100-200 µm

Flux difference due to particle shape

Visible Composite

Cloud Phase

Orange: Ice Blue: Water



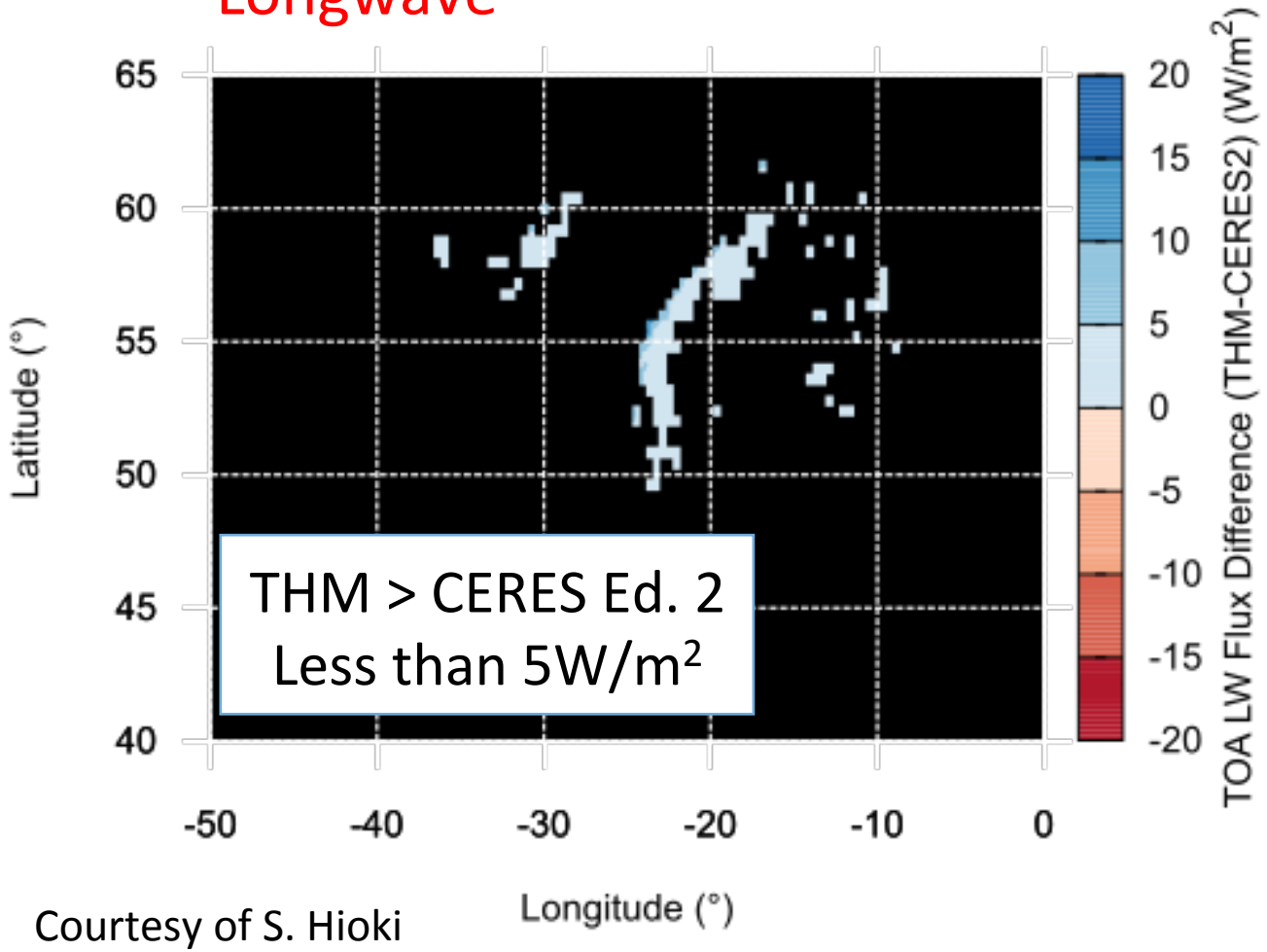
Courtesy of S. Hioki

MODIS Aqua 2006253.1420

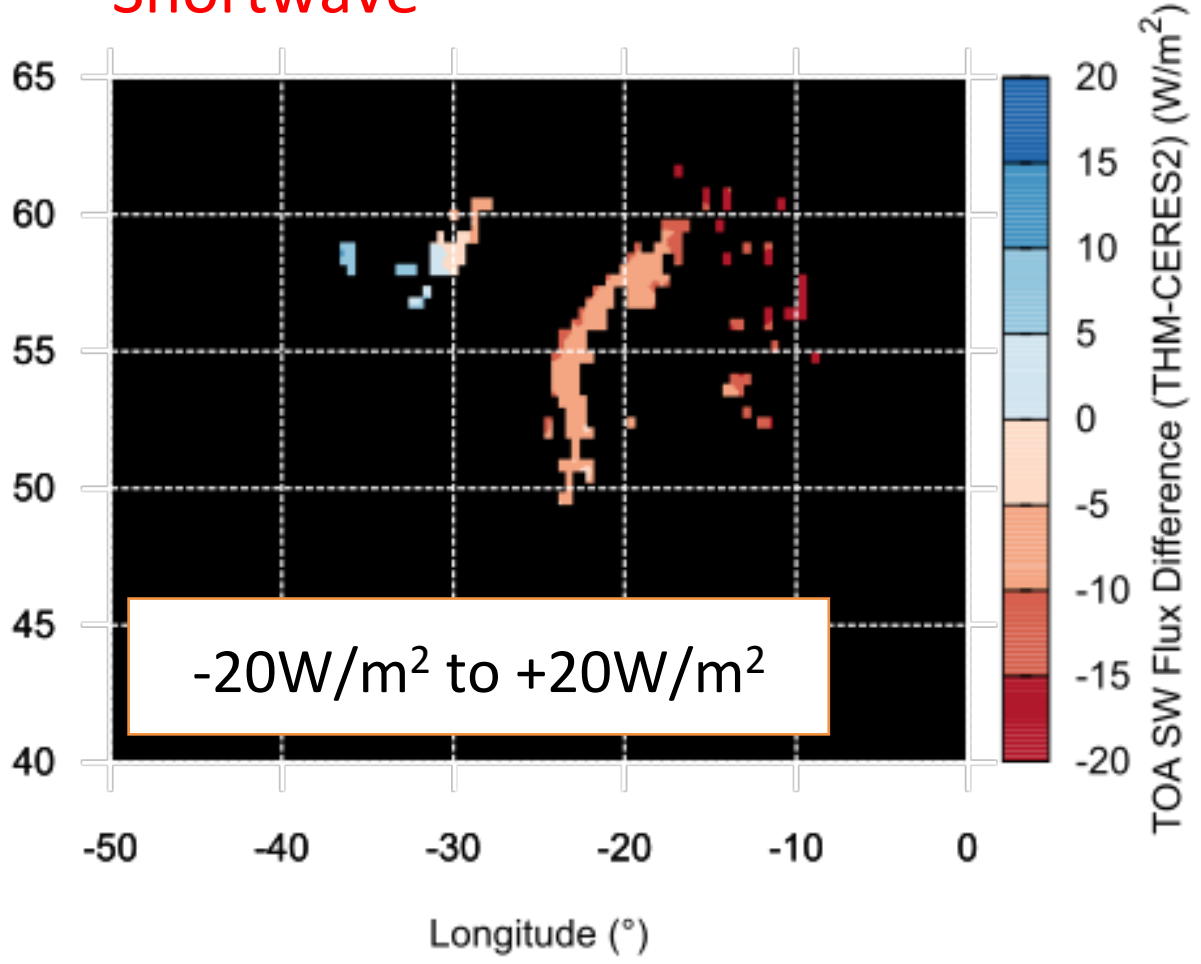
Flux difference due to particle shape

Two-habit model – CERES Ed. 2

Longwave



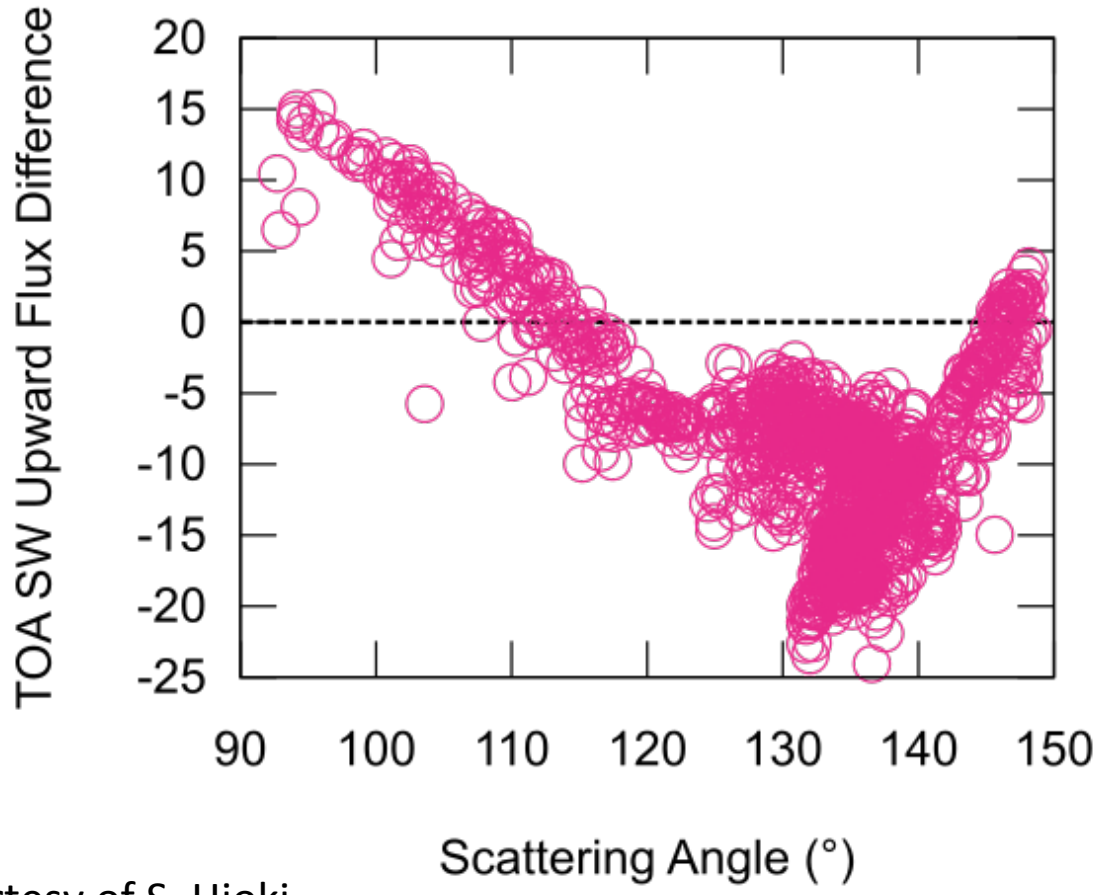
Shortwave



Courtesy of S. Hioki

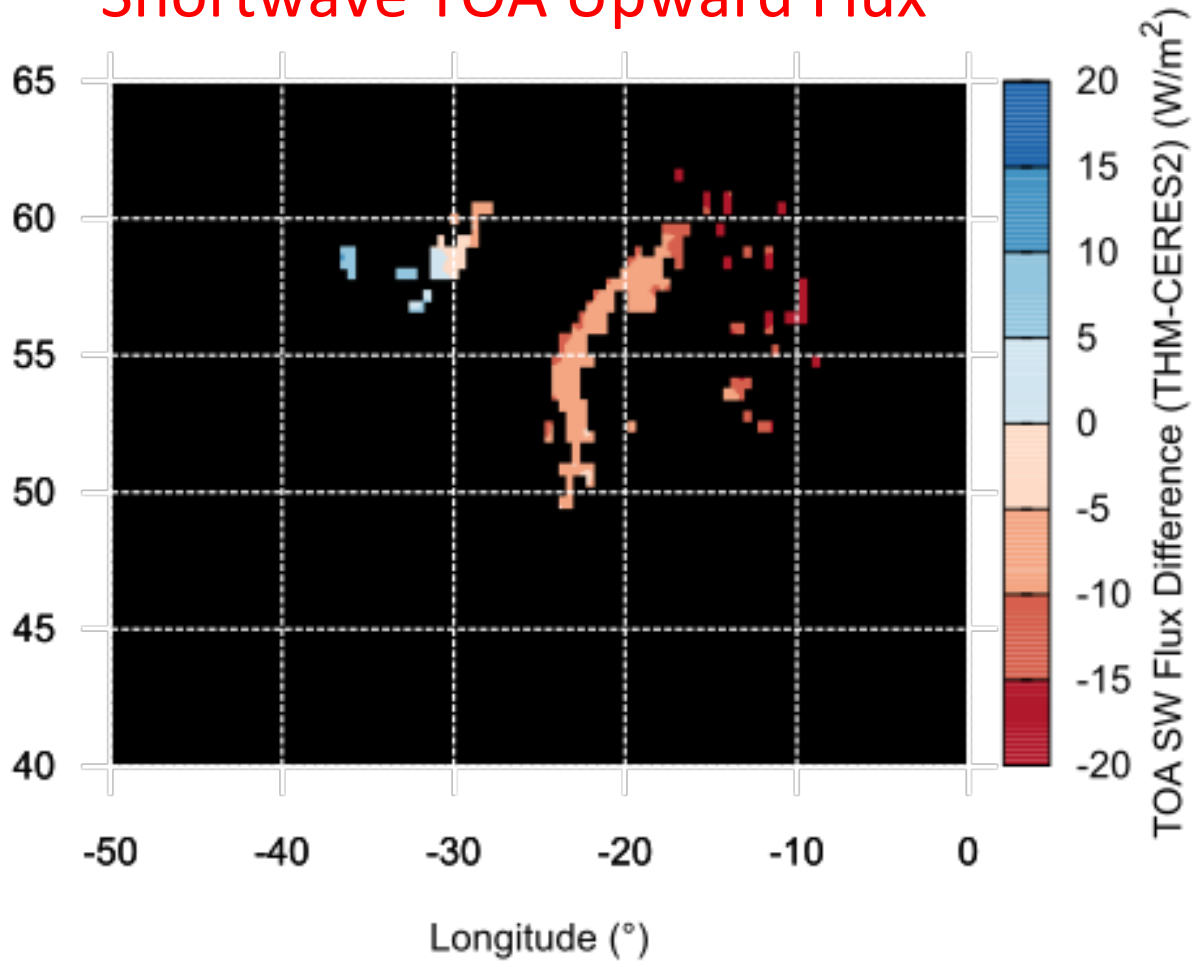
Flux difference due to particle shape

Shortwave TOA flux difference depends on the scattering angle



Two-habit model – CERES Ed. 2

Shortwave TOA Upward Flux



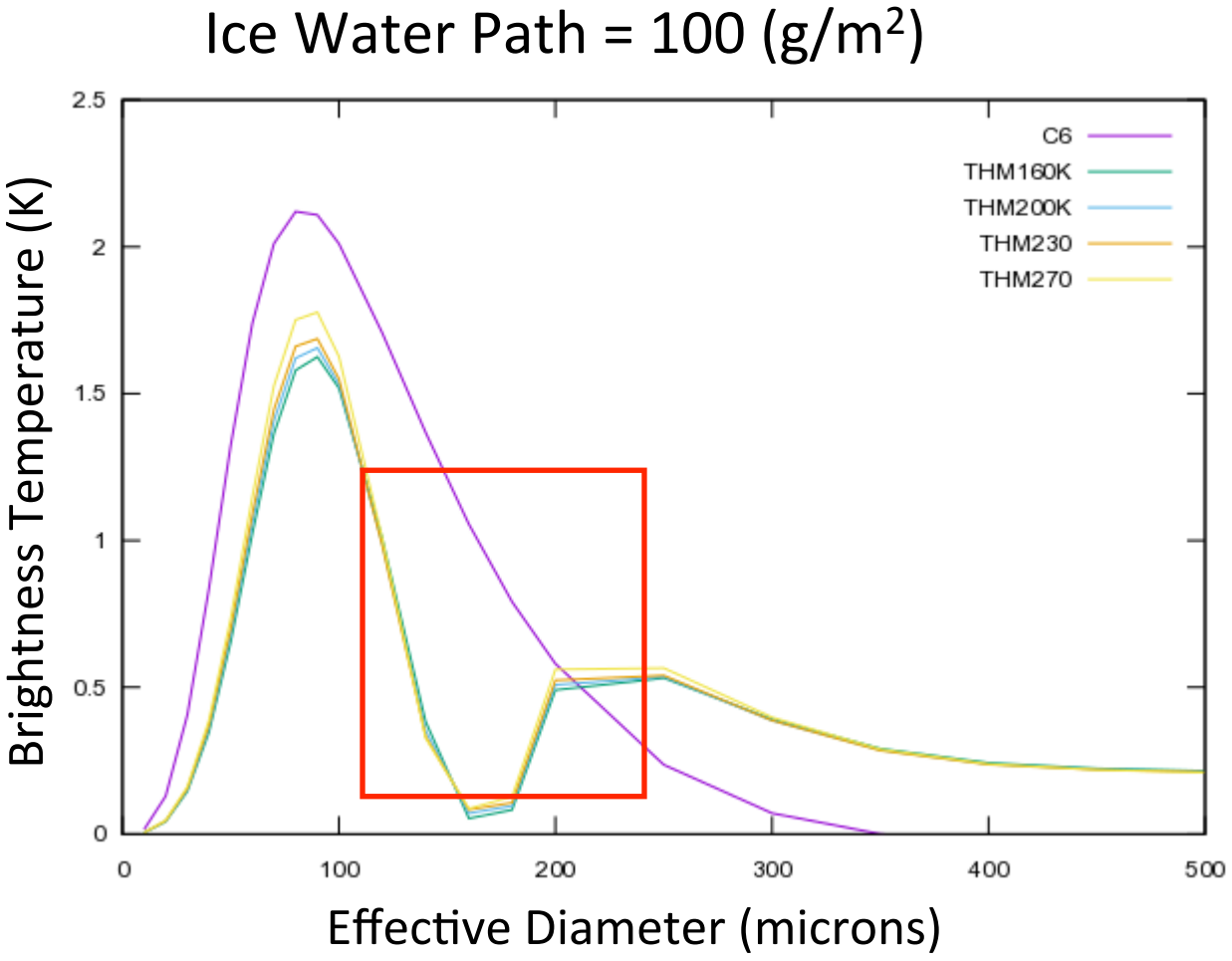
Courtesy of S. Hioki

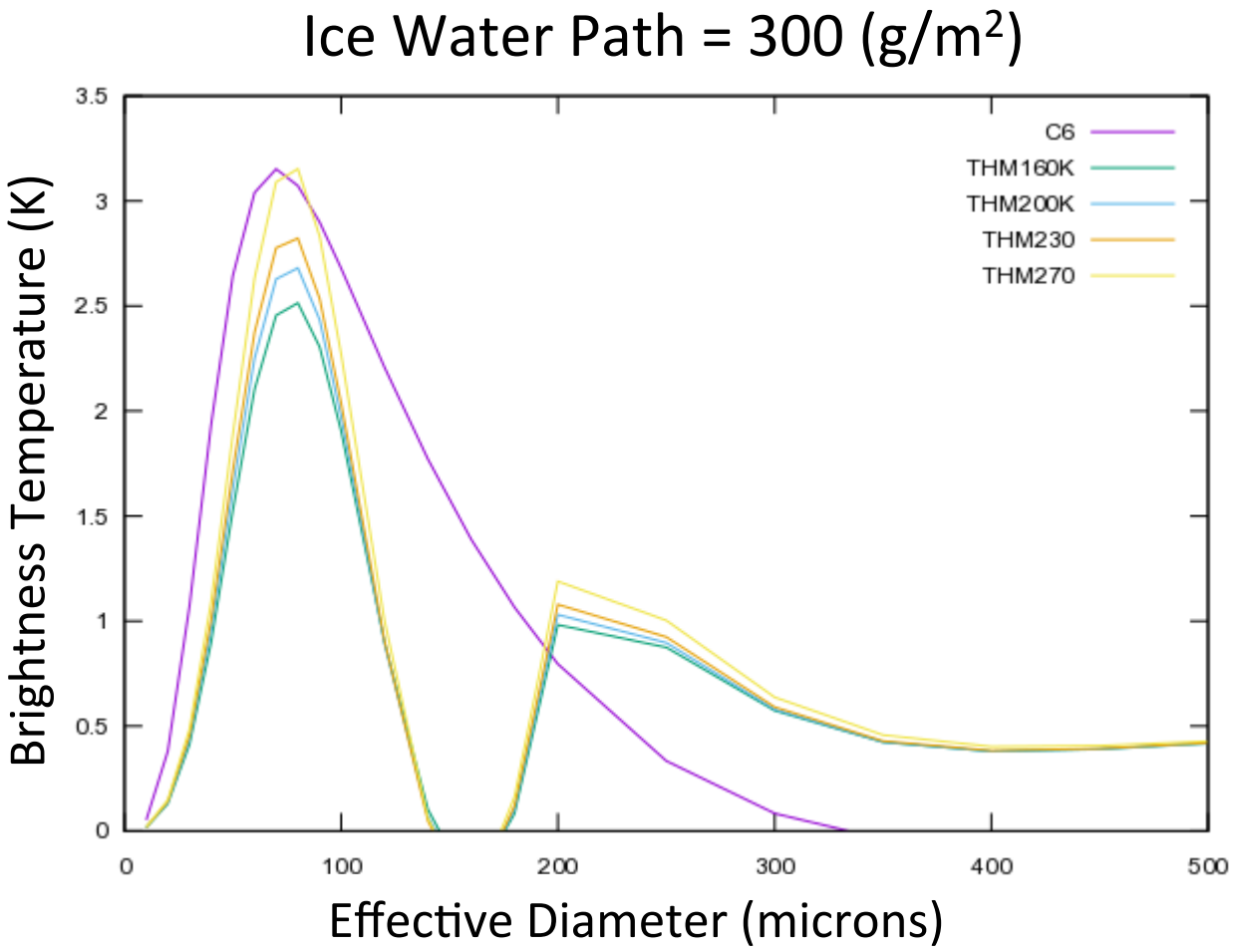
Conclusions

- **VIS/IR retrieval** of optical thickness are consistent when using the Two-Habit Model, MODIS Collection 6, and CERES Edition 4
- The **shortwave retrieval** with the Two-Habit Model has higher consistency with CERES Edition 4 than previous Edition 2 in optical thickness retrievals
  - The two-habit model retrieves **smaller effective diameter**
- In **874 GHz microwave** simulations, there is an interesting fluctuation of brightness temperatures for the Two-Habit Model as compared with MODIS Collection 6
- **Flux calculations** show total **LW TOA flux difference** to be less than 5W/m^2 (THM > CERES Edition 2)
- **SW TOA flux difference** ranges from -20W/m^2 to +20 5W/m^2 and is dependent on scattering angle

Backup Slides

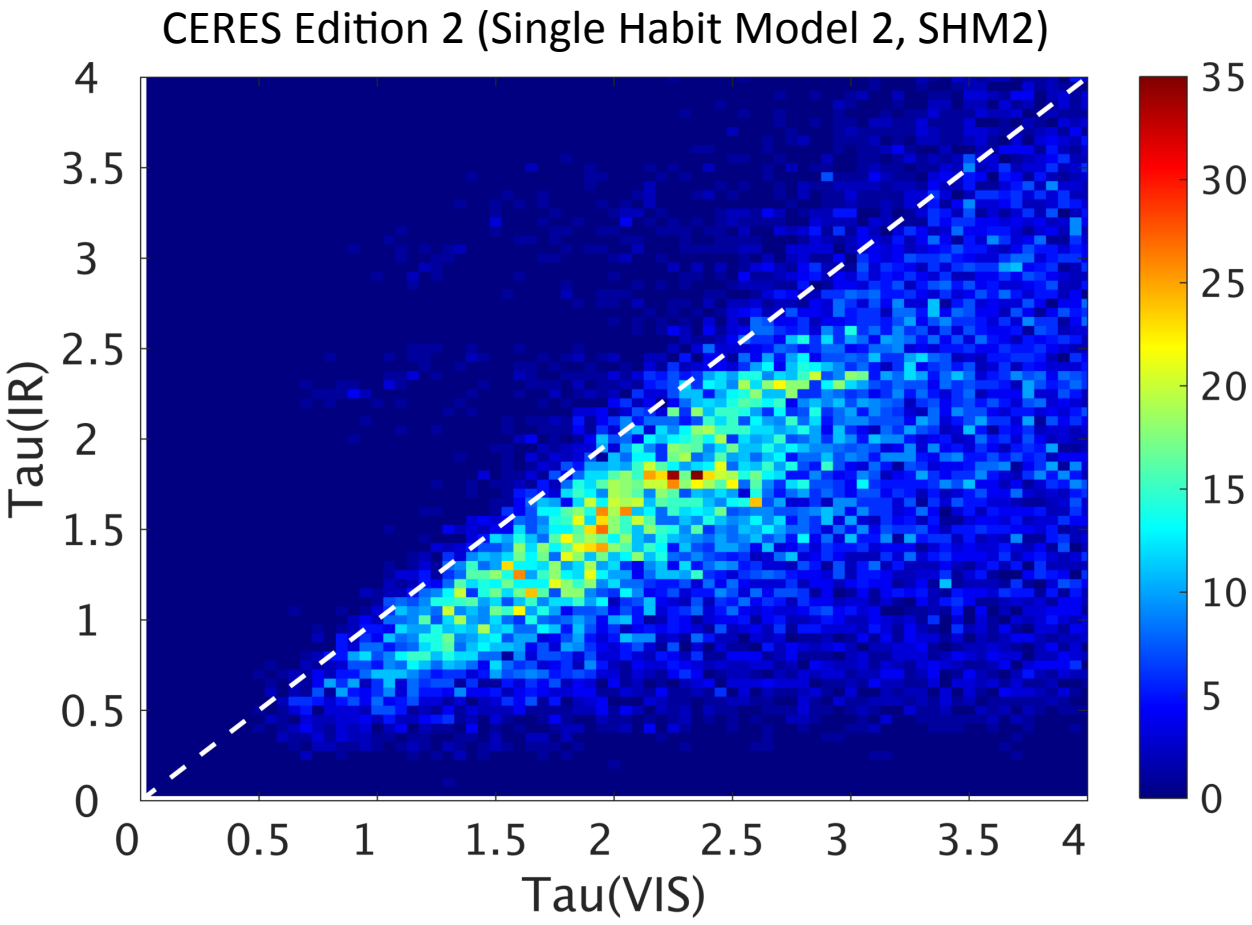
Spectral Consistency :

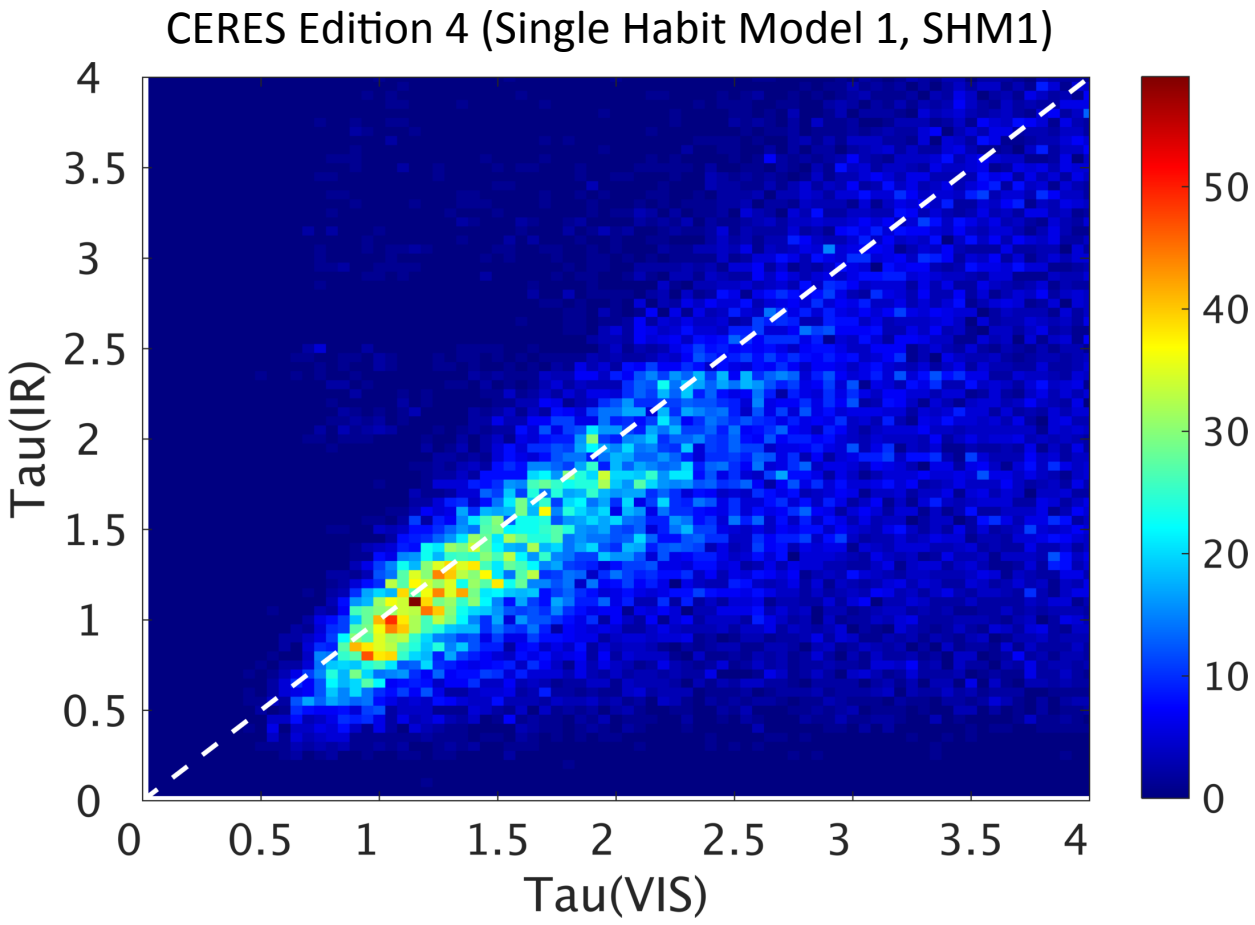




- Polarization Difference (PD)
  - PD = BTv - BTh
- Particle types: MODIS Collection 6 (C6) and Two-Habit Model THM

VIS/IR Optical Thickness Retrieval





Courtesy of C.-P. Kuo