# Aggregate Model

UCL

**Table A1**
*Projects*

| Acronym | Acronym expanded | Primary sponsor(s) |
|---|---|---|
| ACTIVE | Aerosol and Chemical Transport in Tropical Convection | UK NERC |
| ATTREX | Airborne Tropical Tropopause Experiment | NASA |
| CCOPE | Cooperative Convective Precipitation Experiment | NSF/BOR |
| CR-AVE | Costa Rica AURA Validation Experiment | NASA |
| CRYSTAL-FACE | Cirrus Regional Study of Tropical Anvils and Cirrus Layers-Florida Area Cumulus Experiment | NASA |
| DC3 | Deep Convective Clouds and Chemistry Project | NASA/NSF |
| EOS | Earth Observing System | DOE |
| EMERALD-I & II | Egrett Microphysics Experiment with Radiation, Lidar, and Dynamics | UK NERC |
| FIRE.ACE | First ISCCP Regional Experiment Arctic Cloud Experiment | NASA/DOE |
| FIRE-II | First ISCCP Regional Experiment | NASA |
| ICE-T | Ice in Clouds Experiment-Tropical | NSF |
| ISDAC | Indirect and Semi-Direct Aerosol Campaign | DOE, NASA |
| MIDCIX | Midlatitude Cirrus Cloud Experiment | DOE |
| POSIDON | Pacific Oxidants, Sulfur, Ice, Dehydration, and Convection Experiment | NASA |
| SEAC4RS | Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys | NASA |
| SCCP | Sierra Cooperative Pilot Project | BOR |
| SPARTICUS | Small Particles in Cirrus Project | DOE |
| TC4 | Tropical Composition, Cloud and Climate Coupling | NASA |
| TRMM KWAJEX | Tropical Rain Measurement Mission Kwajalein Experiment | NASA |
| TRMM TEFLUN-A | TRMM Texas and Florida Under Flights – A (Texas) | NASA |
| TRMM TEFLUN-B | TRMM Texas and Florida Under Flights – B (Florida) | NASA |
| TWP-ICE | Tropical Warm Pool – International Cloud Experiment | DOE |

- The study grouped together more than 107 CPI images.
- Goal: to see if the ice crystal shape distributions differ from varying ice cloud regimes.
- Which shape distribution should we initially use for the microwave and sub-mm (i.e. sizes 100 – 10000 $\mu m$) ?

RP Lawson et al. (2019). "A Review of Ice Particle Shapes in Cirrus formed In Situ and in Anvils". In: *Journal of Geophysical Research: Atmospheres* 124.17-18, pp. 10049–10090

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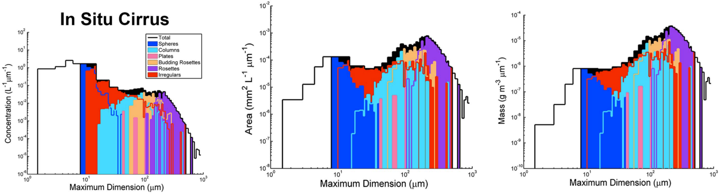



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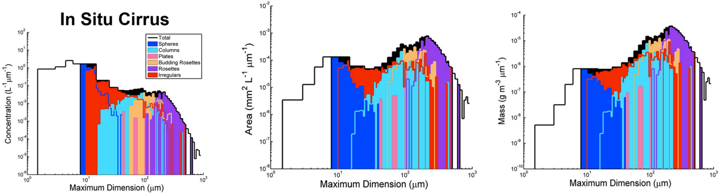


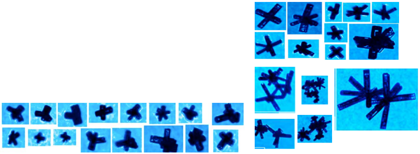

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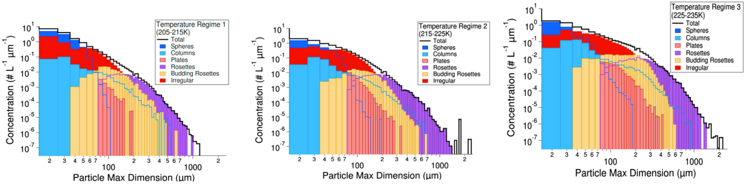



RP Lawson et al. (2019). "A Review of Ice Particle Shapes in Cirrus formed In Situ and in Anvils". In: *Journal of Geophysical Research: Atmospheres* 124.17-18, pp. 10049–10090

RJ Cotton et al. (2013). "The effective density of small ice particles obtained from in situ aircraft observations of mid-latitude cirrus". In: *Quarterly Journal of the Royal Meteorological Society* 139.676, pp. 1923–1934

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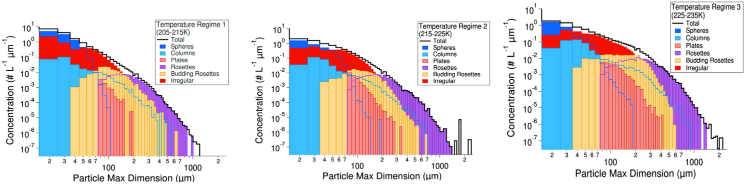


For an initial shape distribution to represent scattering in *mm*-wave and sub-*mm*-wave, the rosettes and aggregates of these seem reasonable to assume. Construct rosette mass models such that:

- mass $\approx D^3$, for budding rosettes
- mass $= 0.0257D^2$, for rosette aggregates, following Cotton et al. (2013) within $\pm 30\%$

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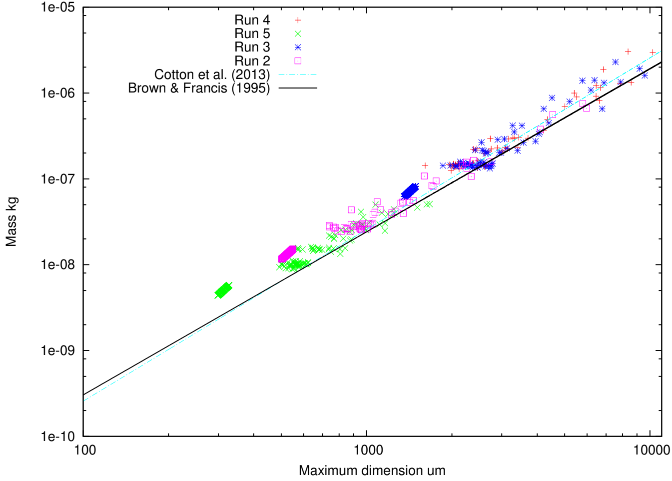
# Aggregate Model

In collaboration with Chris Westbrook, University of Reading.



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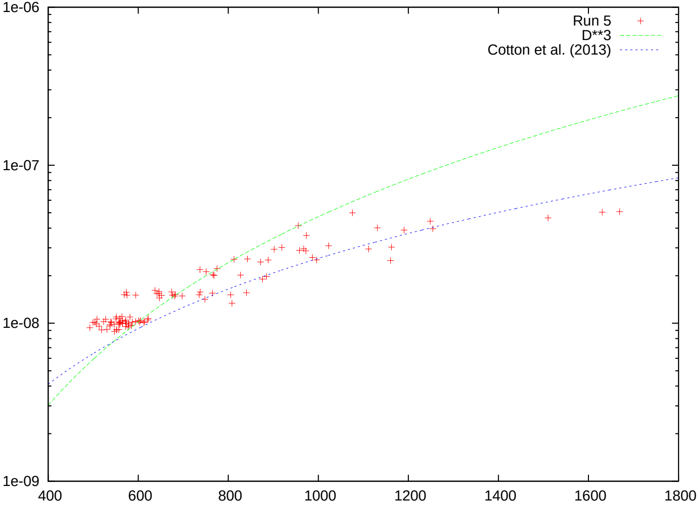

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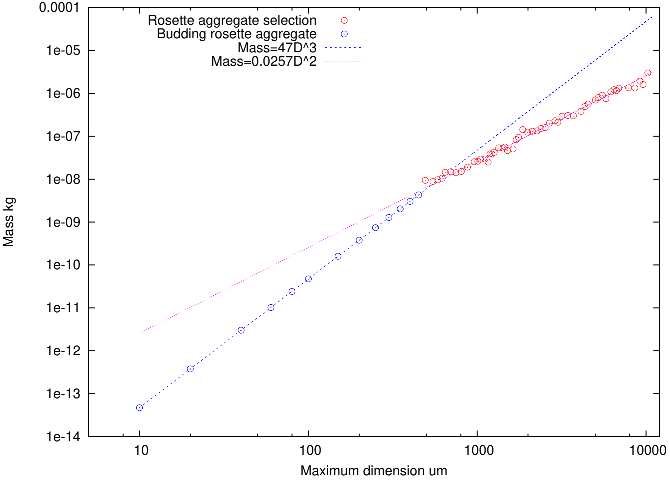

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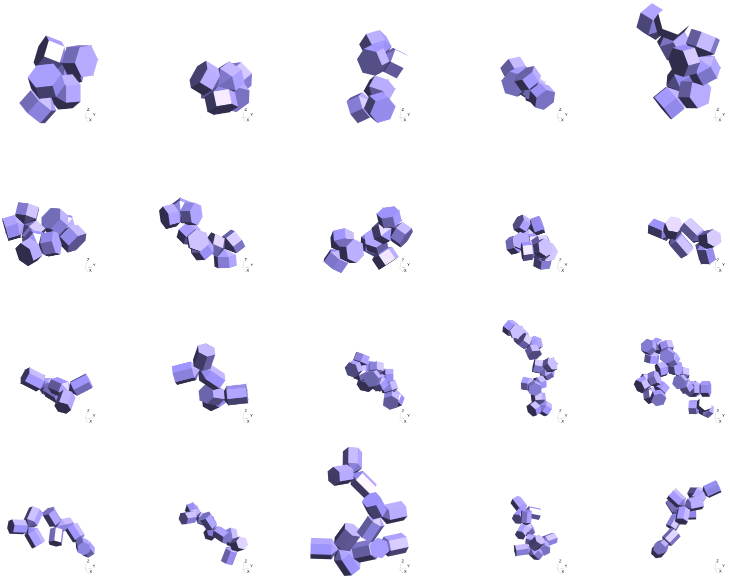

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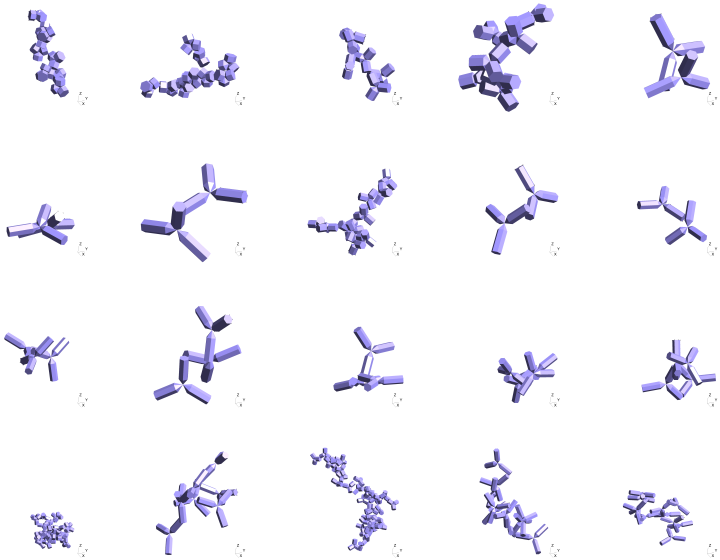

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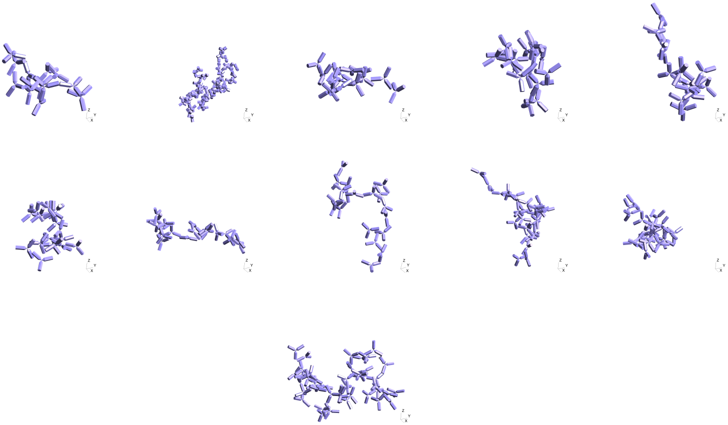

# Simulating random orientation

- Usually the orientational average of a quantity $Q$ is calculated by

$$\langle Q \rangle = \frac{1}{8\pi^2} \int_0^{2\pi} d\beta \int_{-1}^{1} d\cos\theta \int_0^{2\pi} d\phi Q(\beta, \theta, \phi)$$

where $\beta, \theta, \phi$ are the three angles that describe the orientation of the particle.

- In terms of BEM, that would require a new matrix $\mathbf{A}$ in the system $\mathbf{Ax} = \mathbf{b}$, for each orientation.
- Instead, we fix the orientation and consider different incident waves. That way $\mathbf{A}$ remains the same, only $\mathbf{b}$ changes saving computational time and memory.

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Bruce T Draine and Piotr J Flatau (2000). "User guide for the discrete dipole approximation code DDSCAT (Version 5a10)". In: *arXiv preprint astro-ph/0008151*