Community Active Sensor Module (CASM)

Simulated aggregates with their constituent base shapes (top row) [Image courtesy of K.-S. Kuo]

Dendrite aggregate showing the onset of melting, from 0 to 0.15 melt fraction.

Dendrite aggregate showing the full range of melting, from 0 to 1.0 melt fraction.

CASM Capabilities:
(1) Forward-model various active sensor platforms (currently, only, extending to scattering, extinction, and radar)
(2) Provides a physical basis for 1-D variational retrievals (e.g., MASP) of active observations;
(3) Enhance data assimilation capabilities by providing increased access to active sensor datasets;
(4) Provides an independent forward model for radar to compare with ARTS approach for MIIST;
(5) For use as a testbed for physics testing in combined radar/radiometer algorithms.

CASM Goals:
(1) Simulation of multi-frequency radar reflectivities
(2) Simulation of coincident passive microwave TBs
(3) New scattering database for ARTS
(4) Development of database associated scattering and extinction properties
(5) Note: this will use ARTS, and CASM will be implemented in ARTS for MIIST

Hydrometeor Model

- Electric Const.
- Single-particle
- Shape/Density, Scat.
- Extinct.
- Dielectric Const.
- ASD: Scat. + Extinct.
- DFR
- Multitude
- T, q, wind
- Dielectric Const.
- Precip. Ice/Liquid
- Aerosol/Molecules
- P-type Absorption
- Attenuation, Corrections:
  - Attenuation and extinction properties
  - Derivation and Surface NRCS

CASM Forward Model

- DFR: Scat. + Extinct.
- Sensor Specific: Radar Simulation & Extinction, and Cloud
- CRTM/ARTS
- Output:
  - Precip. Ice/Liquid
  - Aerosol/Molecules
  - P-type Absorption
  - Attenuation and Surface NRCS

CASM Research Goals:
1. Forward-model various active sensor platforms
2. Simulation of coincident passive microwave TBs
3. Derivation of database associated scattering and extinction properties
4. Development of database associated scattering and extinction properties
5. Note: this will use ARTS, and CASM will be implemented in ARTS for MIIST

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Research Goals:
1. Provide a physical basis for 1-D variational retrievals using radar observations
2. Simulate active sensor platforms within CRTM/ARTS
3. Enhance all-sky data assimilation capabilities by providing increased access to active sensor dataset
4. Development of database of realistically shaped hydrometeors and associated scattering and extinction properties

Status and Scope:
1. Presently covers satellite-based radar simulations with path-integrated attenuation
2. Working on complete integration into CRTM
3. New scattering database interface layer under development for CRTM, also within ARTS for MIIST
4. Updated single particle melting model (SPMM) to provide more realistic melting-layer simulations

Planning Flowchart (work in progress)

- Atmospheric Path
- Microwave Path
- Cloudy Sky
- Rainy, Cloudy
- Single-particle
- Scat. + Extinct.
- Dielectric Const.
- Precip. Ice/Liquid
- Aerosol/Molecules
- P-type Absorption
- Attenuation, Corrections:
  - Attenuation and extinction properties
  - Derivation and Surface NRCS

Forward Operation

- DFR: Scat. + Extinct.
- Sensor Specific: Radar Simulation & Extinction, and Cloud
- CRTM/ARTS
- Output:
  - Precip. Ice/Liquid
  - Aerosol/Molecules
  - P-type Absorption
  - Attenuation and Surface NRCS

CASM Capabilities:
- Single Particle Melting Model (SPMM):
  - Neutrino melting algorithm: 2 iterative operations: melt mode and movement mode.
  - Can be easily run on any desktop computer, requiring at most a few hours to simulate the entire melting process.

    Melt Mode: Nearest neighbor approach, similar to cellular automatia; fixed ice points having the fewest ice neighbors melt first -- iterate.
    Movement: Liquid points having only liquid neighbors are free to move, subject to the following constraints: (i) Can only move to locations having other water neighbors, (ii) movement must always be toward the center of mass (parallel movements allowed).

Downloaded and processed. Following the previous approach, the Nw, Dm, temperature, and reflectivity information was obtained from each DPR file -- only the nadir beam was selected. Promising these variables using CASM, the figure below shows CFADs of attenuation-corrected reflectivities (Zc) for GPM DPR observed Ku- and Ka-band reflectivities in panels (a) and (b), respectively, and for the CASM simulations at Ku- and Ka-band panels (c) and (d), respectively.

Note: this will use ARTS, and CASM will be implemented in ARTS for MIIST.