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# Vertical Velocity in Storms (Proposal 60799)



2<sup>nd</sup> ESA EarthCARE Validation Workshop

25-28 May 2021 (online)

- Overview of Cloud-Microphysics and Ascent
- Planned Use of Aerosol-Cloud Model for Validation of EarthCARE
- Scientific Problems to Address with AC-vs-EarthCARE Synergy
- Summary



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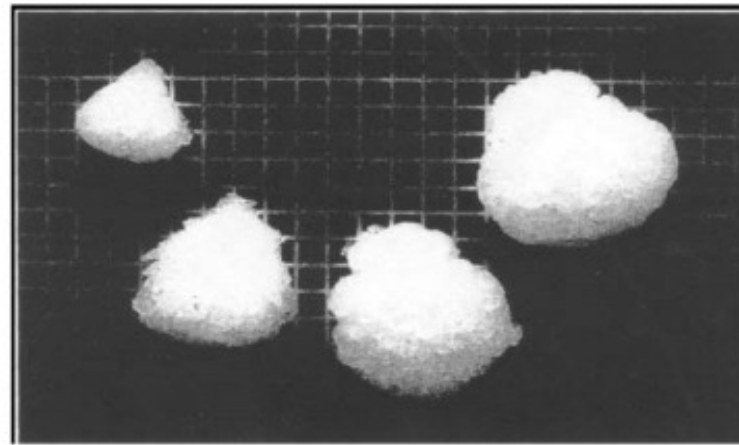
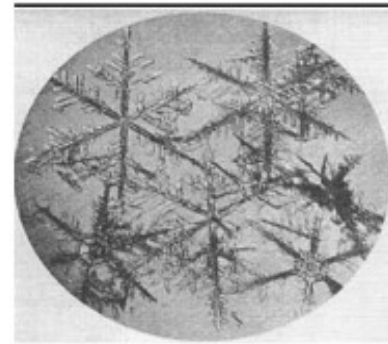
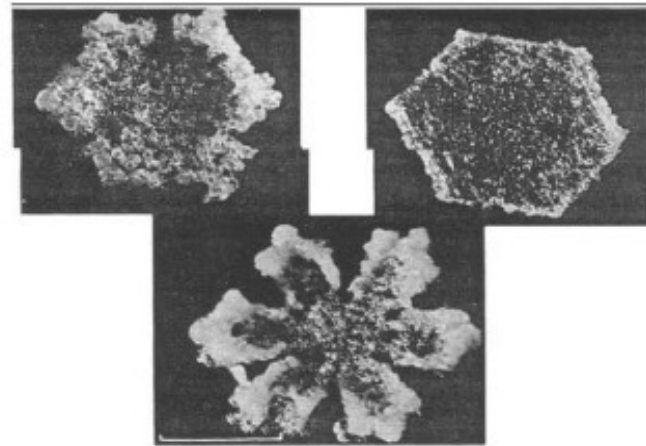




# Complexity of ice

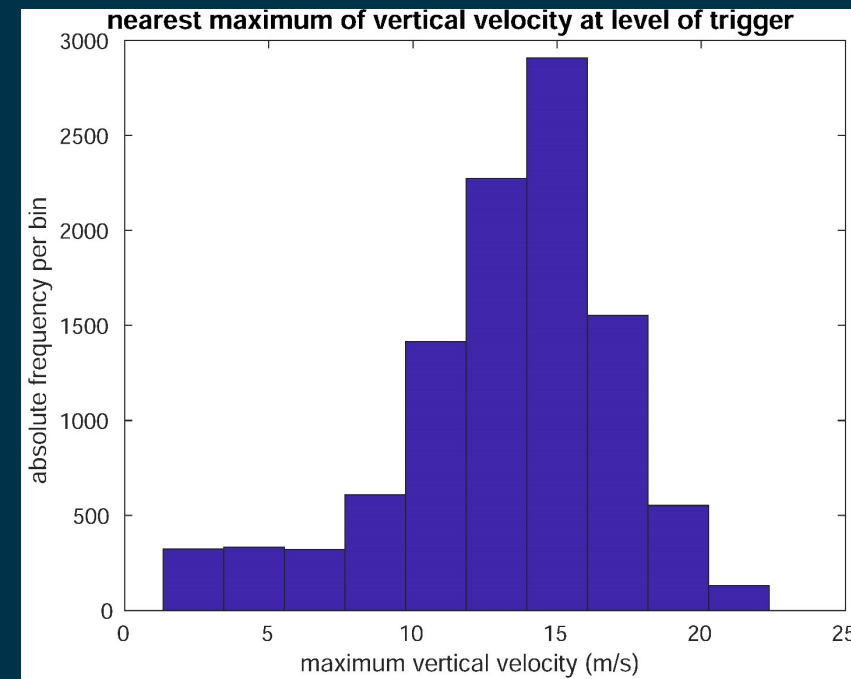
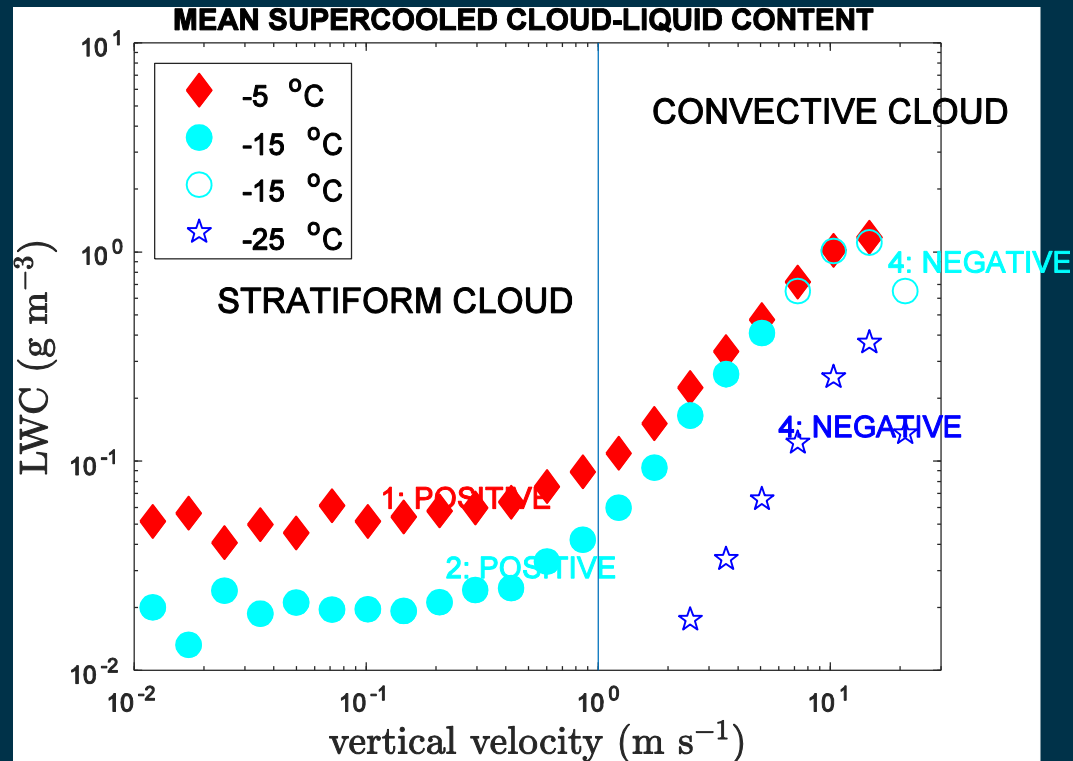
Many types of ice are possible:

- Riming (0.1 – 0.9 g cm<sup>-3</sup>):
  - Graupel, hail
- Aggregation (0.01 – 0.2 ? g cm<sup>-3</sup>)
  - Snowflakes
- Vapour deposition (0.2 – 0.8 g cm<sup>-3</sup>)
  - Crystals
    - Bullet-rosettes
    - Planar polycrystals
    - Columns
    - Dendrites
    - Plates



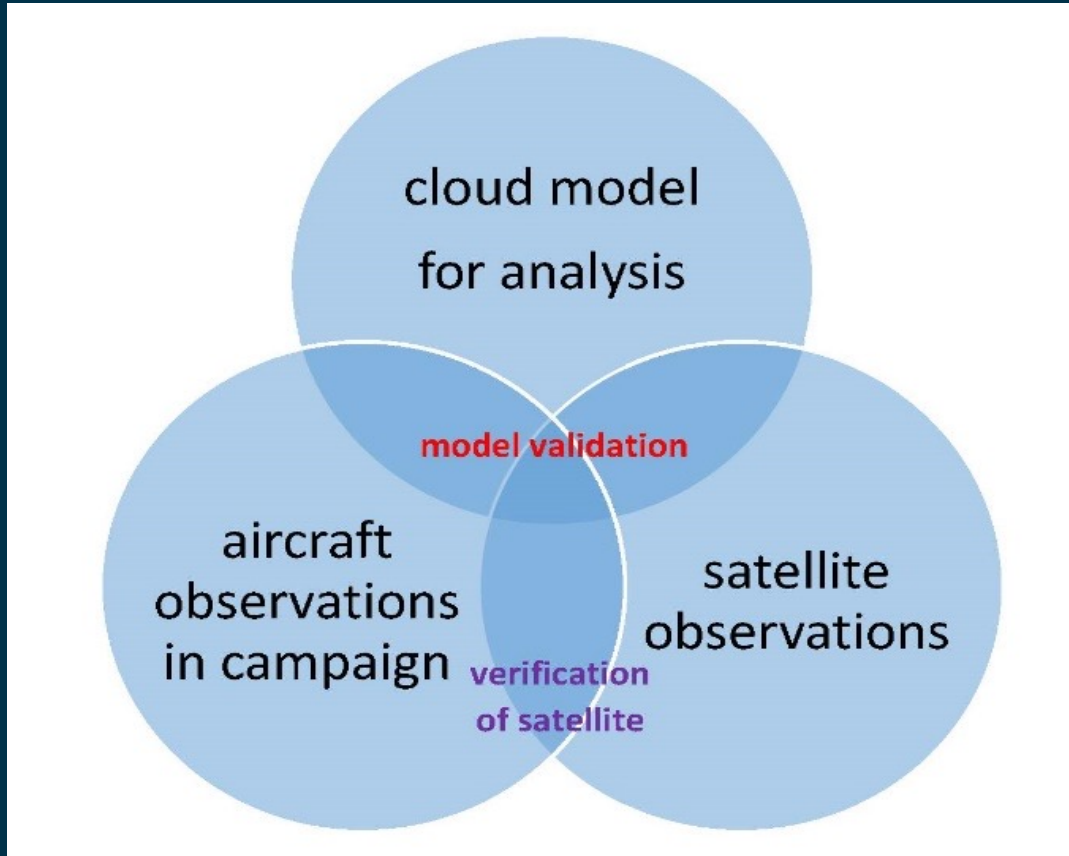
# Ascent is the forcing for microphysics

- Fast ascent => fast condensation + 2ndary droplet activation => high supercooled LWC
- Convective clouds have much rimed ice precipitation
- Charging ?

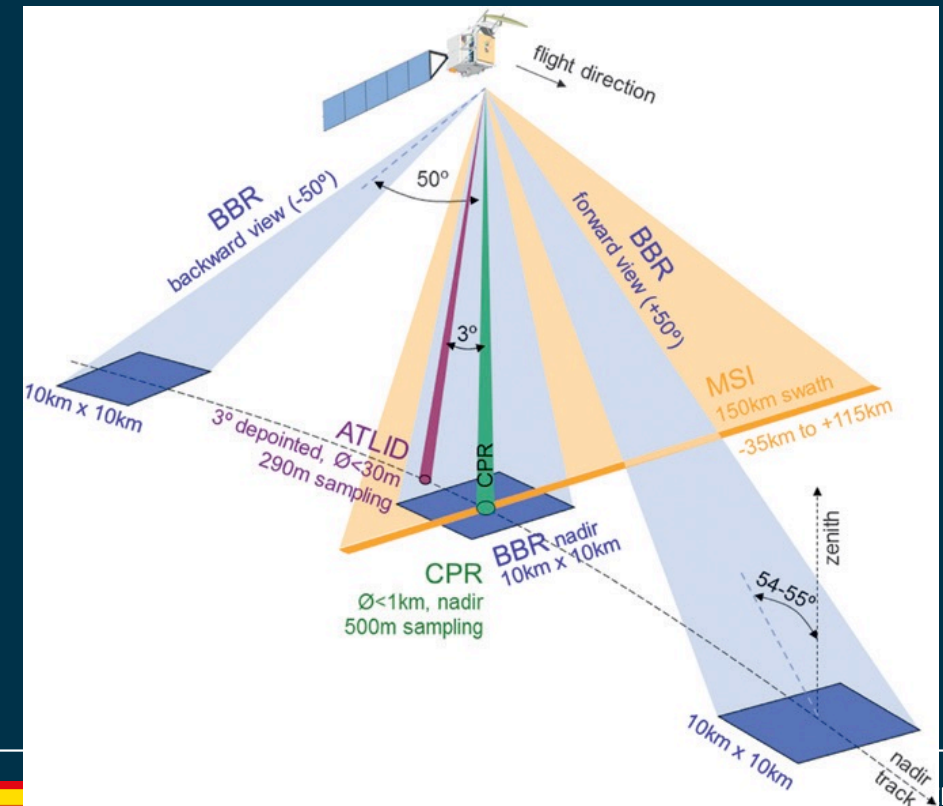


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Venn diagram illustrating the synergy of three tools in analysis of thunderstorms.



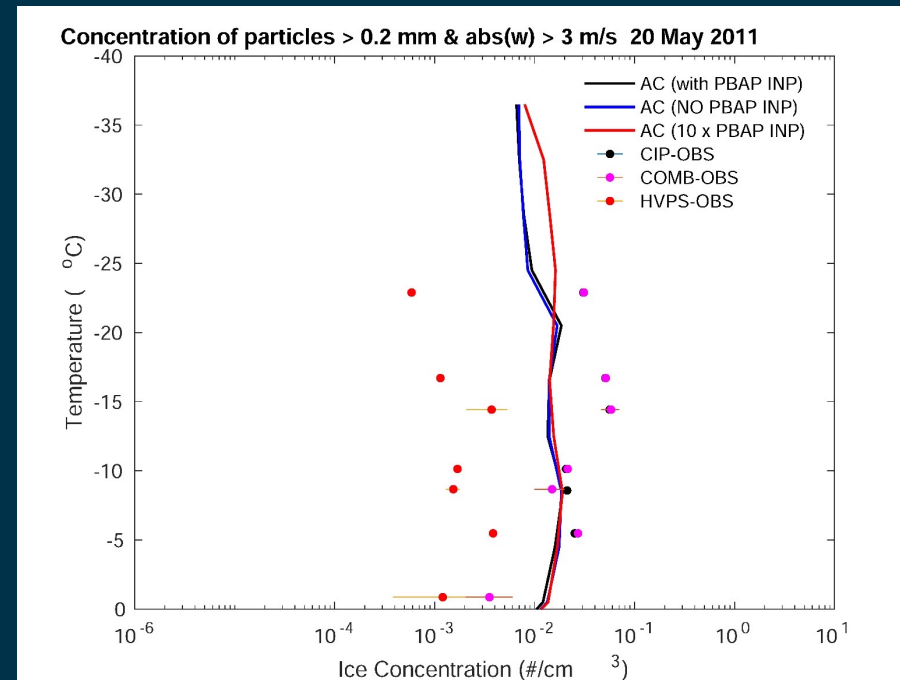


# Choose aircraft campaign sampling deep convection in Tropics in 2023 or 2024

- Ocean - blind zone

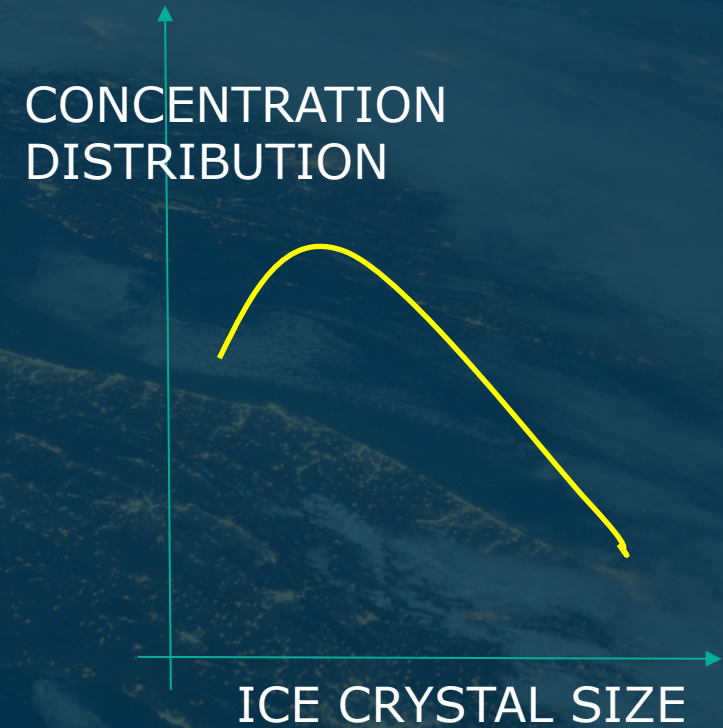
## Simulate with AC model

- Hybrid bin/bulk microphysics
- Recent schemes for secondary ice
- 7+ aerosol species
- Validate simulation of ice concentrations, Z, LWC etc against aircraft



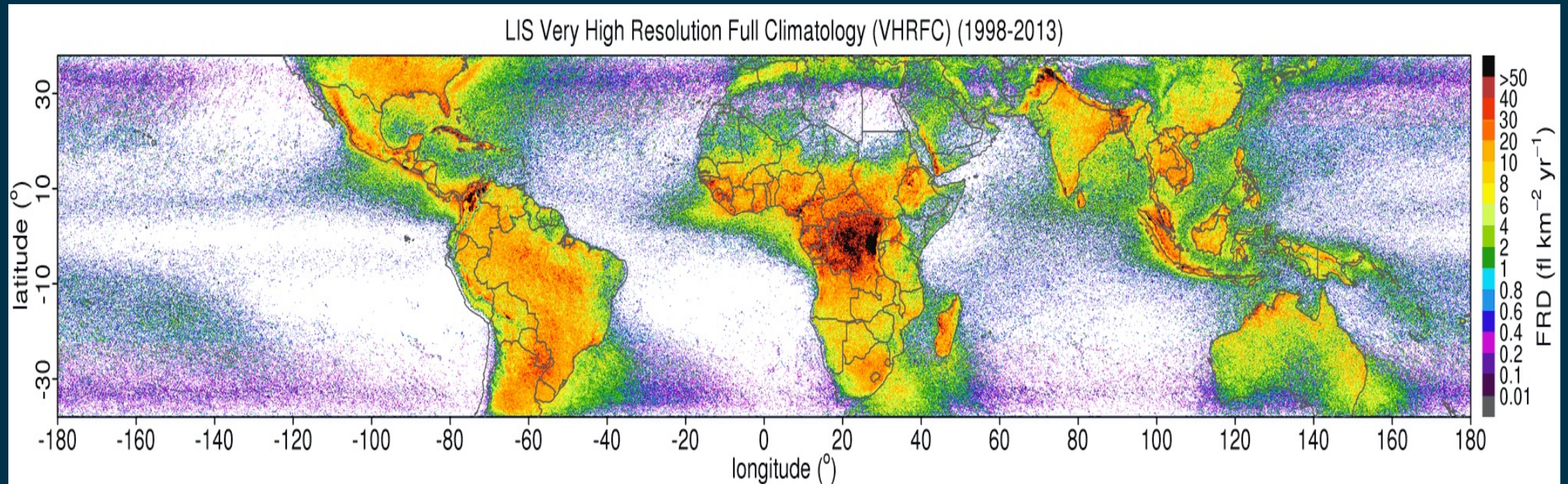
# VALIDATION OF EARTHCARE: ASCENT, ICE PROPERTIES ...

- Coincident flights through cirriform cloud during overpasses by the satellite (from OPOT)
- Optical probes on aircraft characterise size distributions and morphology of ice particles
  - Estimate of reflectivity-weighted fallspeed of ice
  - Compare with model and EarthCARE
- Vertical air velocity statistics etc from EarthCARE compared with aircraft and AC model



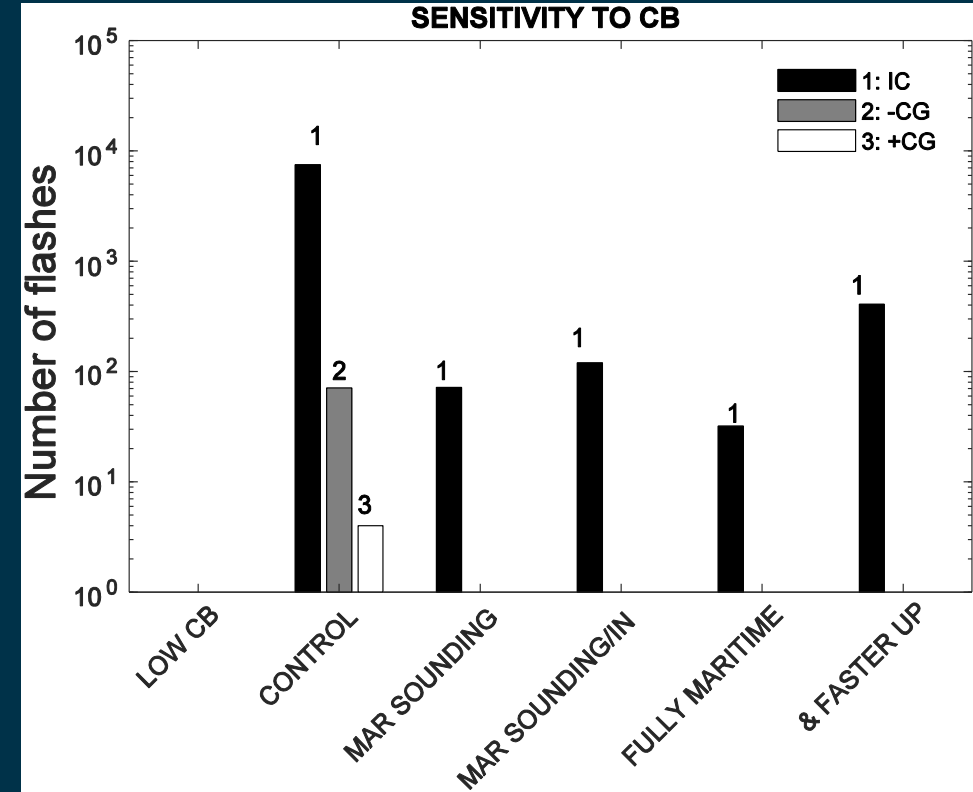
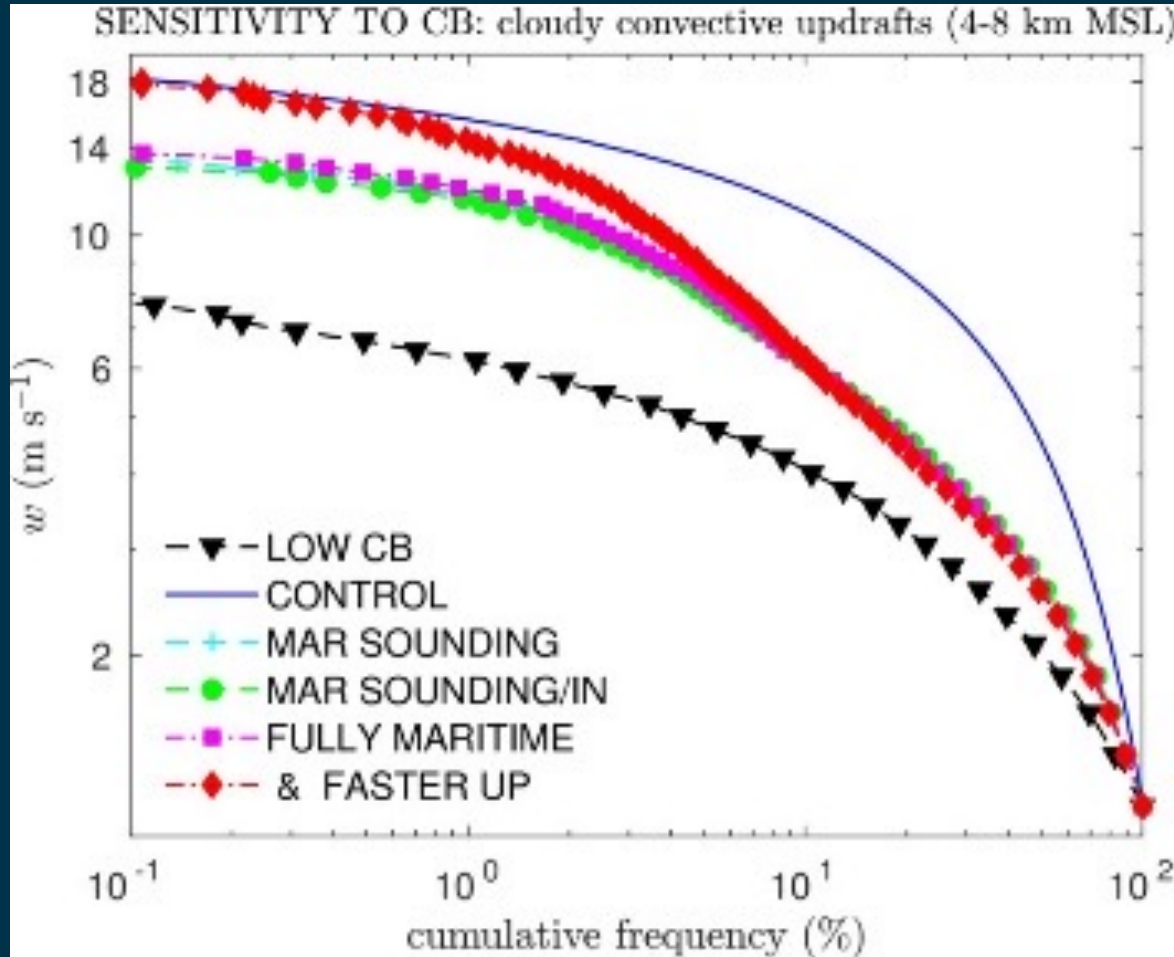
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**Figure 1:** Map of 16 years of observations of total lightning frequencies from the Lightning Imaging Sensor (LIS) on NASA's Tropical Rainfall Monitoring Mission (TRMM) satellite (Albrecht et al. 2016).

# Can EarthCARE detect the land-ocean contrast in cloud properties simulated ?



Phillips et al. (2021, in review at JAS)

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- Detailed cloud model in conjunction with aircraft data
  - validate EarthCARE products of ascent, fallspeeds, ice concentrations, cloud phase etc
- Study land-ocean contrast in deep convection with AC: ascent, lightning etc
  - Extend survey of contrast with EarthCARE to globe

