

CloudSat Cal/Val Lessons Learned & Summary of ACCP Suborbital Discussions with Emphasis on Cloud and Precipitation Cal/Val

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Contributions from
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- Prelaunch Campaigns: TWP-ICE, AMMA, C3VP
- April 28, 2006: CloudSat and CALIPSO Launches from Vandenberg AFB
- Summer 2006: Data collection begins for both with formation flying
 - July-August 2006: CloudSat-CALIPSO Validation Experiment (CCVEX)
- September 2007: CALIPSO swings to 3 ° from nadir
 - July-August 2007: TC4 Campaign (ER2, DC8, WB57) Eastern Tropical Pacific (Costa Rica)
 - July 2010-June 2011: DOE-Funded SPartICus Campaign
 - March-April 2011: NASA Midlat Airborne Cirrus Prop. Exp. (MACPEX)
- April 2011: CloudSat Experiences Battery Anomaly
- February 2012: CloudSat returns to A-Train in Do-Op Mode
 - April-June 2014: Integrated Precipitation and Hydrology Exp (IPHEX)
 - Nov-Dec 2015: Olympic Mountains Ground Validation Exp (OLYMPEX)
- February 2018: CloudSat Leaves A-Train (Reaction wheel anomaly Summer 2020...)
 - August-October 2019: NASA CAMP2Ex, Philippines
- May 2021: ACCP enters Pre-Phase A for late 2020's launch(es)



Early Flight data from ER2 was critical in developing the Radar-Lidar Geometrical Profile Product

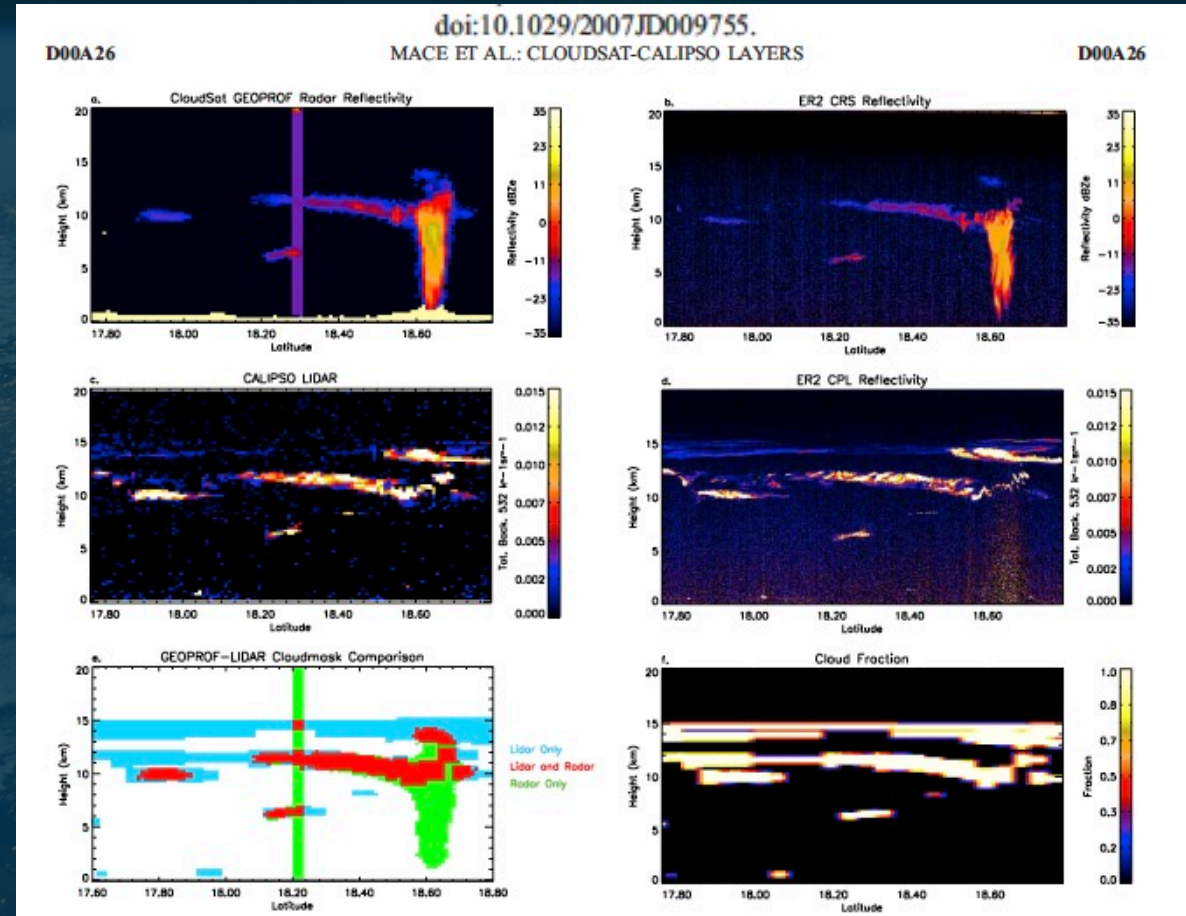
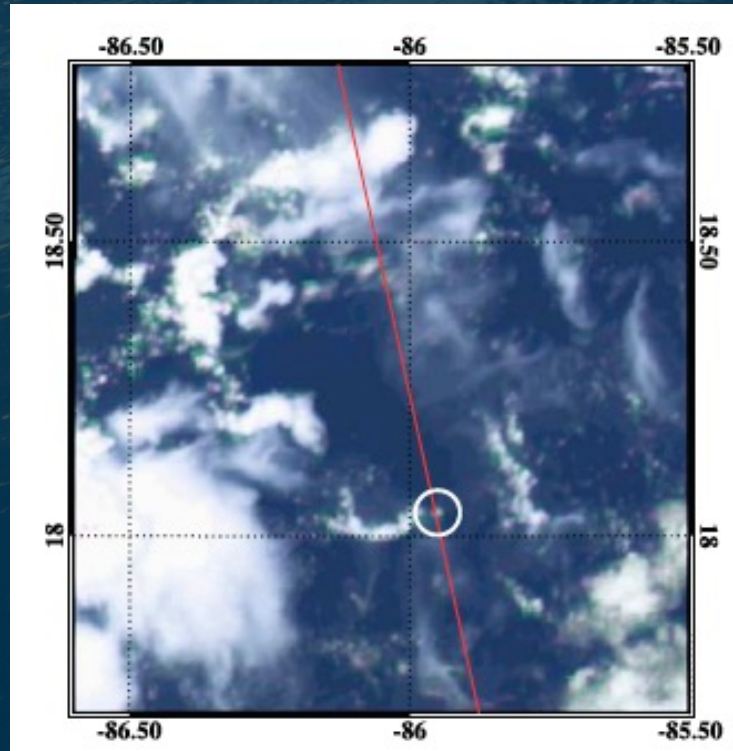


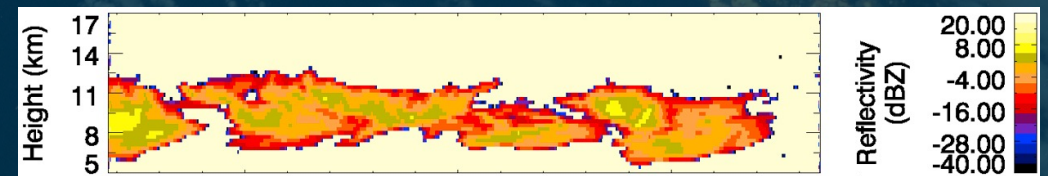
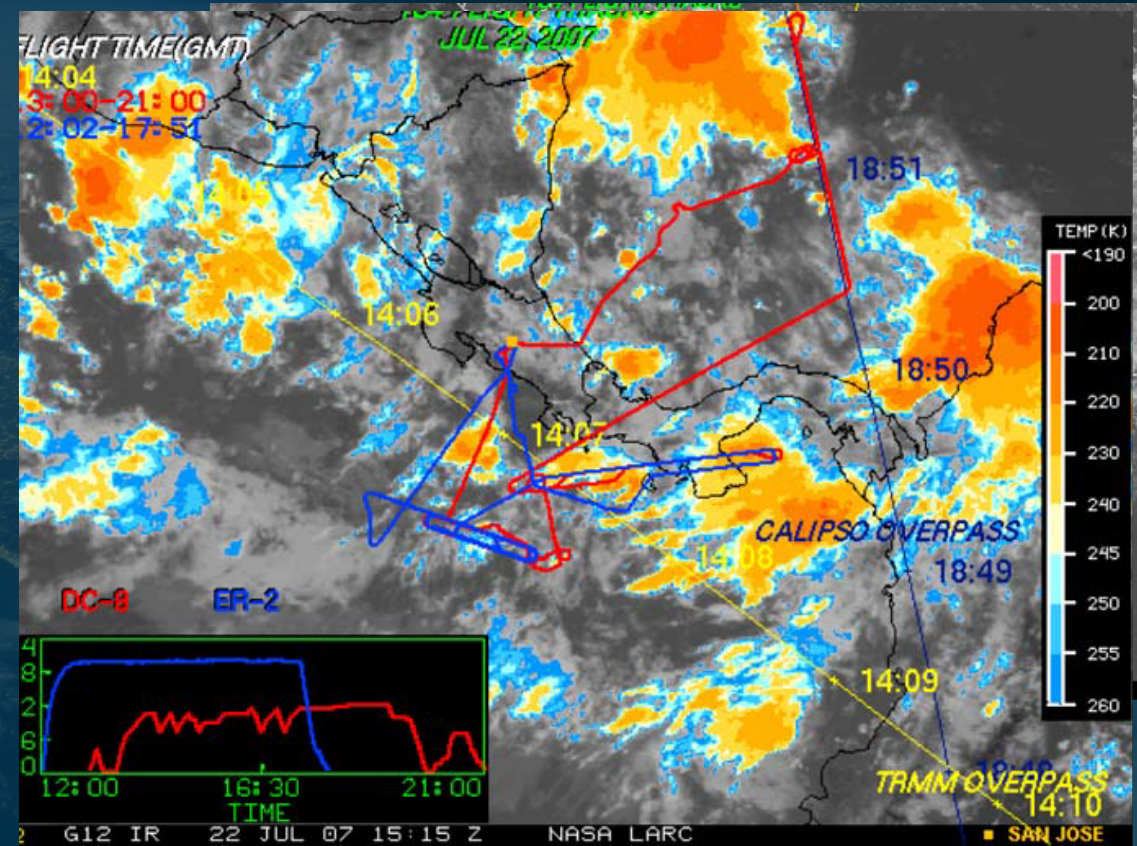
Figure 2. Radar and lidar data collected along the track depicted in Figure 1. (a) Radar Reflectivity Factor (dBZe) from the CPR on Cloudsat. (b) As in Figure 2a, except data collected by the CRS on the ER2. (c) 532 nm attenuated backscatter data collected by the CALIOP on CALIPSO. (d) As in Figure 2c, except data collected by the CPL on the ER2. (e) Mask depicting identified hydrometeor boundaries in terms of the observing instruments. (f) The Lfrac array depicting the fraction of CALIOP volumes within the CPR volumes that observed cloud.

ER2: Carried an A-Train Simulator Package that included CPL, CSR, EDOP, AMPR, COSSIR, MAS

DC8: In situ cloud, aerosol microphysics and chemistry...

TC4 was the first experiment that used emerging technology for extraordinarily good coordination of very diverse aircraft.

TC4 allowed for development and validation of 2C-ICE (Deng et al. 2010 doi:10.1029/2009JD013104)



TC4 Anticipated the ACCP Era...

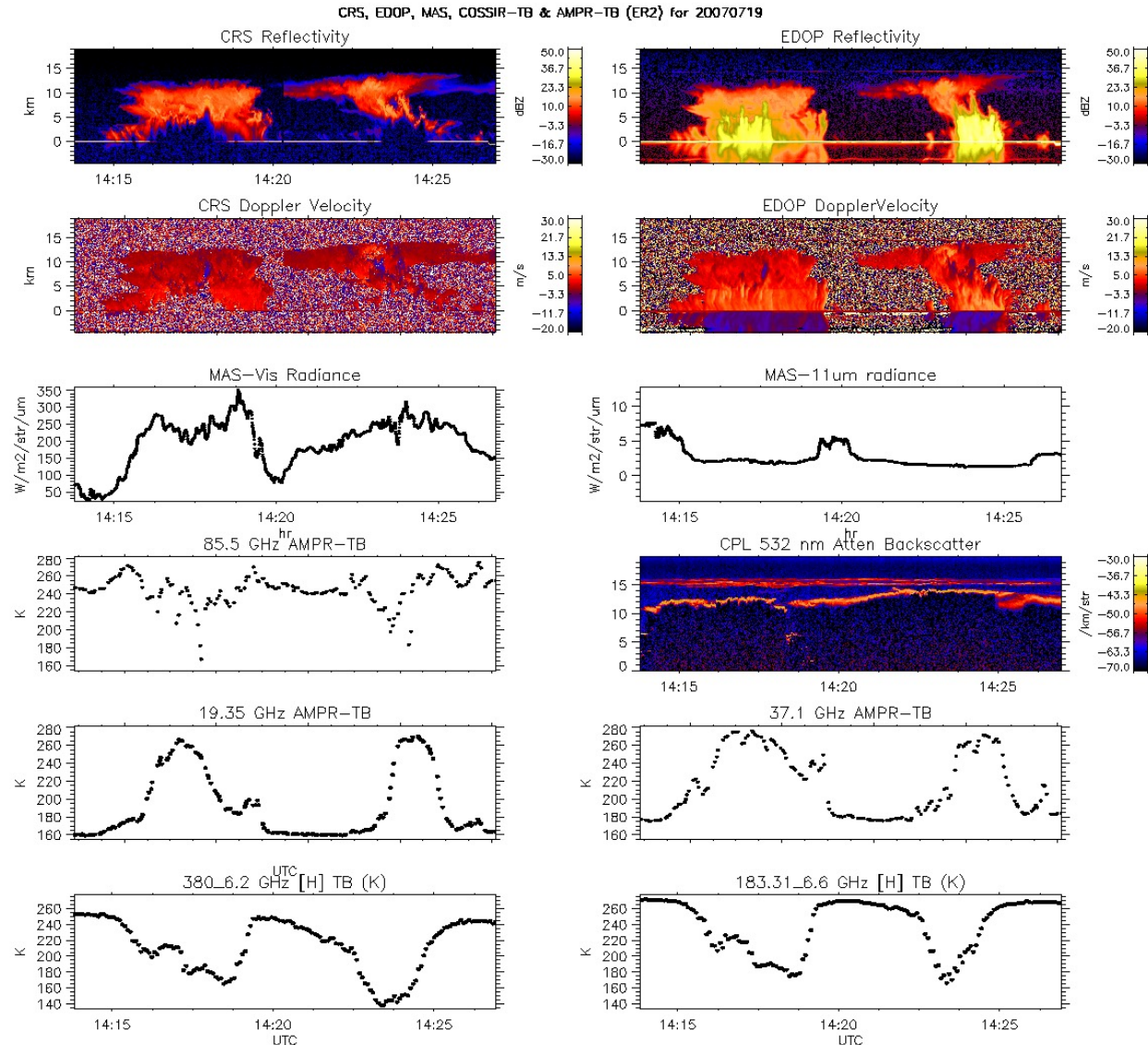
Z and V at two freq constrain profile of precip, cloud, and vertical motion

Reflectance and Lidar backscatter constrain cloud near top

Ice scattering signatures at 85 GHz constrains cross sectional area of large ice

Low Freq Microwave constrains the liquid water path

Submm constrains ice water path

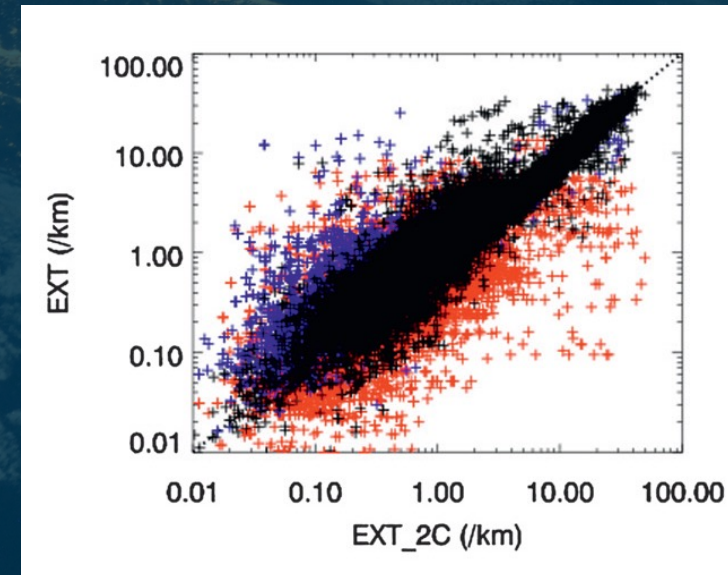


**Routine aircraft in situ
measurements in cirrus over SGP**

**Total Hours: 200 hr (190 research /
10 test flight)**

47 Flight Days (1-3 flights per day)

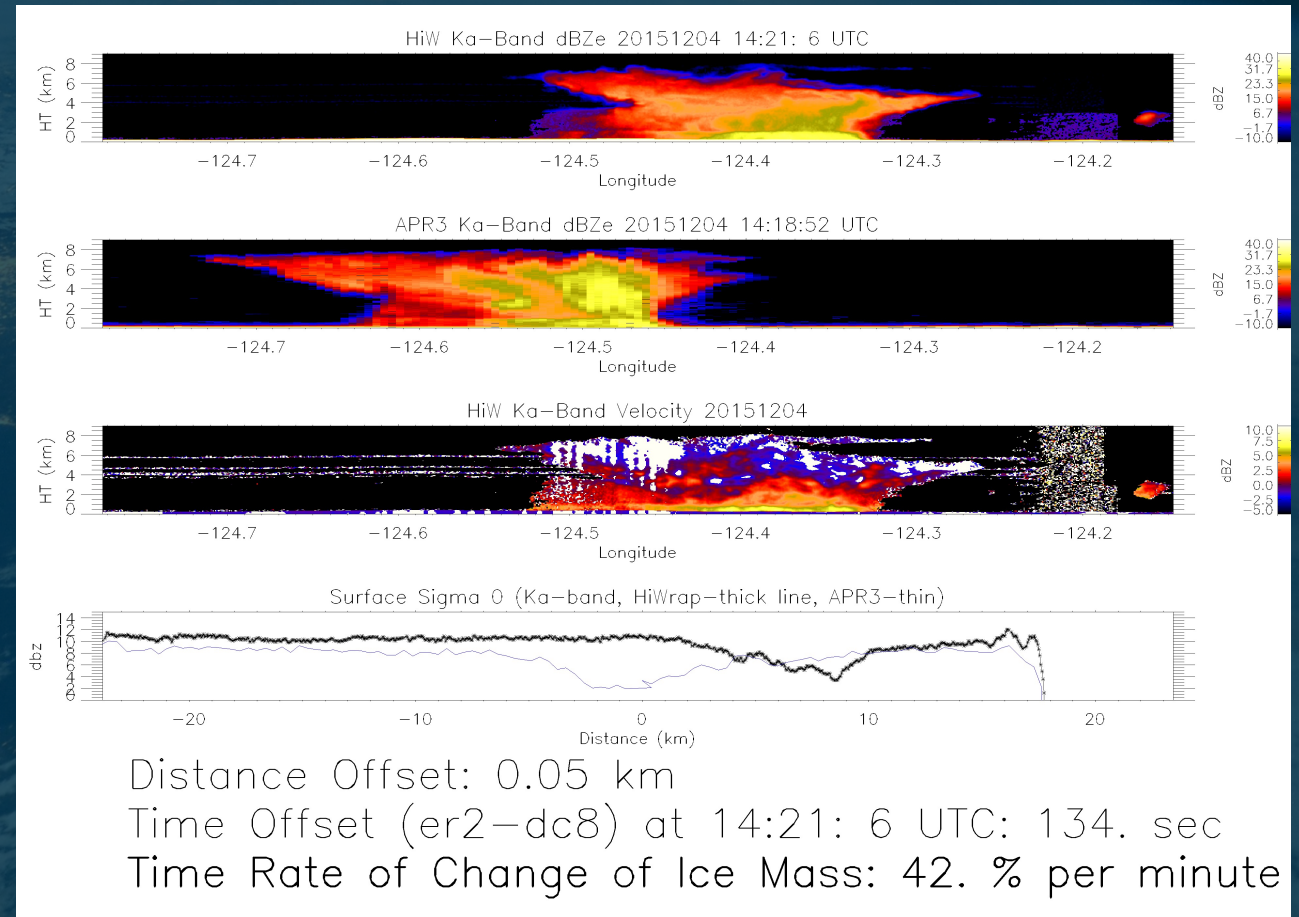
- 23 SGP Flights
- 21 CALIPSO/CloudSat Flights (9 combined with SGP flights)
- 3 TERRA
- 8 Orographic, wave clouds, or other cirrus not associated with remote sensors



NASA ACE Program collaborated very fruitfully with GPM Ground Validation Campaigns in 2014 (IPHEX) and 2015 (Olympex)

Learned that pooling resources and collaboration among programs could multiply science results.

Example of Radar delta-t During Olympex



- In response to 2017 NAS Decadal Survey, Aerosol and Clouds, Convection, Precipitation were deemed to be “Designated Observables” for the coming decade
- An ~18 month study was undertaken that resulted in the ACCP concept
- The ACCP Study has concluded with recommendation to NASA HQ and a Project Authorization Letter has been received.
- Suborbital including Cal/Val and integrated science has been a significant part of the ACCP study

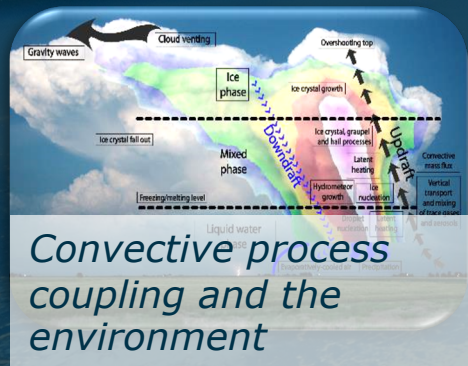
Suborbital will be an integral component of ACCP



ACCP Suborbital Science Motivation

Modules →
Themes ↓

Convection and High Clouds



Convective process coupling and the environment



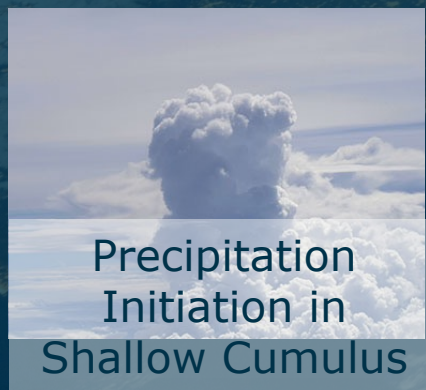
Convective core detrainment and anvil growth- character and process



Anvil to cirrus evolution, lifecycle, and feedbacks

Low Clouds/ACI

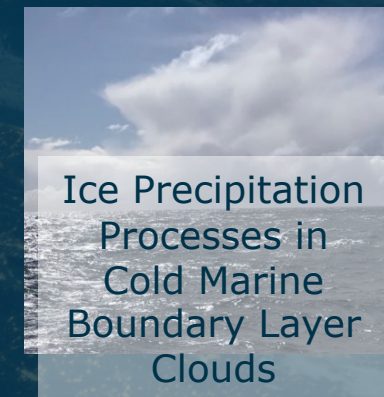
Cloud & Aerosol lifecycle and radiative processes



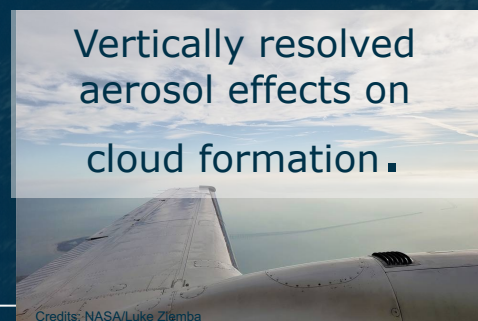
Precipitation Initiation in Shallow Cumulus



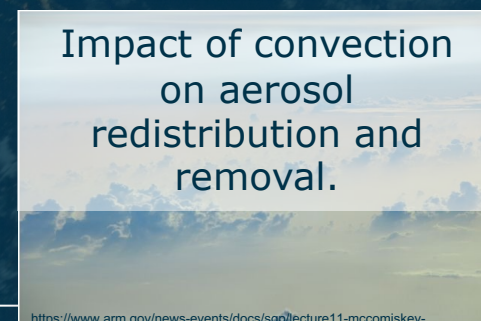
Open-Closed Cell Transition in marine Stratocumulus



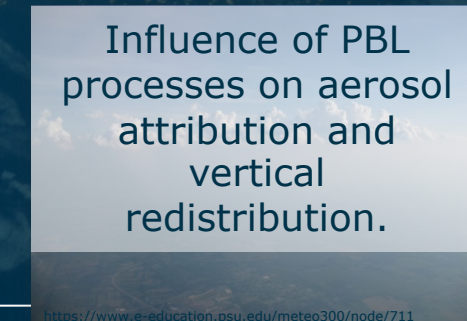
Ice Precipitation Processes in Cold Marine Boundary Layer Clouds



Vertically resolved aerosol effects on cloud formation.



Impact of convection on aerosol redistribution and removal.



Influence of PBL processes on aerosol attribution and vertical redistribution.

Building on nearly 2 decades of supporting orbital science with suborbital assets, ACCP is anticipating working closely with international partners to meet science and Cal/Val goals

While EarthCare will come before ACCP, EarthCare's Cal/Val program will overlap with the pre-launch phase of ACCP.

Pre-launch Investments in Sub Orbital efforts are likely

