Low orbiting space-borne high IWC retrievals in the framework of the European HAIC project: from case studies to regional and seasonal distributions

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1. Objectives
- Characterize the properties and frequency of occurrence of high IWC cloud systems from space-borne passive and active remote sensing instruments onboard low orbit (LEO) missions
- Support MSG-based day-time products with polar orbiting satellite observations in the perspective of the EarthCare mission
- Develop a reference global-scale climatology of high IWC frequency of occurrence

2. Strategy and methodology
- A multiple approach and observational-based strategy
  - Satellite-based characterization of cloud properties during AIRBUS in-service events
  - Satellite-based characterization of cloud properties during past AIRBUS field campaign and HAIC campaigns
  - Satellite-based characterization of clouds with high IWC detected from the A-Train active sensors (Figure 1)
  - Development of High IWC detection schemes
  - Evaluation/validation of now service events and other convective cores S2. The 10°x10° train mission is composed of several satellites distributed along the same orbit and sampling within few minutes the same atmosphere.

3. Space-based observations exploited
- The A-Train mission: various remote sensing instruments on-board different platforms (see Figure 1)
  - the cloud radar CPR on-board CLOUDSAT,
  - the lidar CALIOP on-board CALIPSO,
  - the VIS/NIR imager POLIDER on-board PARASOL,
  - the VIS/IR imager MODIS on-board AQUA,
  - and the microwave imager AMSRE on-board AQUA.

4. Cloud properties during in-service events
- Analysis of LEO and GEO IR imagery suggests that in-service event can occur in four different categories of convective systems:
  - large-scale long-duration tropical storms,
  - long-live convective lines,
  - young convective clouds (see Figure 2),
  - thick high-altitude clouds not connected to any apparent convective cells

5. High IWC climatology
- Use of Cloudsat DARDAR IWC profiles and MODIS High IWC mask over the Tropics (independent profiles/pixels; Figure 3)
- Seasonal and regional High IWC distributions consistent with locations of in-service events (not shown)

Figure 2: Cloud properties for an in-service AIRBUS event recorded on the 28th of October 2009. The properties are retrieved from MODIS (a-d), AMSRE (e), and CPR-CALIP (f-h). The A-train sampled the area 7 min after the occurrence of the in-service event. The 10°x10° images are centered on the location of the in-service event. The black segment shows the direction from where the aircraft was coming. In (a) the white dashed line corresponds to the track of CPR and CALIP. S1 and S2 are the two storms analyzed. The in-service event occurred close to the convective core S1 (about 50km west) and after at least 50km exposure to ice conditions. Different histogram and transsects (not shown here) confirm the rather homogeneous upper part of the cloud S1 above the location of the in-service event. As shown in (f) to (h) the active sensors did not sample S1 but another convective core S2.

Figure 3: High IWC climatology in the Tropics based on DARDAR (full 2008 year and every five days for the period 2009-2014) and MODIS High IWC mask for 2008 only (i) for daytime overpasses.