



## **The use of combined airborne and satellite active remote sensing in preparation for future EarthCARE mission**

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Once launched the ESA/JAXA EarthCARE (Earth Cloud Aerosol Radiation Explorer) will be the largest and most complex Earth Explorer mission. Its core instruments the high spectral resolution lidar (HSRL) at 355 nm and the Doppler cloud radar at 95 GHz will be the most advanced cloud instruments in space providing simultaneous profiles of aerosol and clouds. To fully exploit the capability of this future satellite mission great effort was undertaken within the last years to scientifically prepare and develop methods dedicated to EarthCARE's unique payload. Especially airborne measurements with similar instruments as the future satellite greatly help in preparing for EarthCARE as they provide real data sets to test and further develop algorithms for future satellite application. Additionally underpasses below NASA's A-Train satellite constellation provide information crucial for investigating the benefit and limitations that can be expected from future EarthCARE measurements.

With its so called NARVAL (Next-generation aircraft remote sensing for validation studies) payload the German research aircraft HALO (High Altitude and Long-range) is equipped with an EarthCARE-like payload. Active remote sensing measurements of simultaneous aerosol and cloud profiles are provided by the combined differential absorption and high spectral resolution lidar (532 nm) system WALES and a METEK cloud radar (35 GHz). Additional passive remote sensing instruments complement the active remote sensing measurements. This payload was employed during the NARVAL-I mission over the tropical and extra-tropical North Atlantic region in December 2013 and January 2014 and again during the NARVAL-II over the tropical North Atlantic in August 2016 and NAWDEX (North Atlantic Waveguide and Downstream Experiment) in the extra-tropical North Atlantic region in September/October 2016. During all these flight experiments a major focus was set on underpasses below NASA's CALIPSO (Cloud Aerosol Lidar Infrared Pathfinder Observation) and CloudSAT satellites. We use these measurements to test and further develop synergistic algorithms, as well as to study possible effects occurring from the limitation of spatial and temporal resolution of the satellite measurements. Additionally, during the NAWDEX coordinated flights with a second aircraft (French Falcon) equipped with similar payload as HALO but at different wavelength (HSRL at 355 nm and Doppler cloud radar at 95 GHz) were performed. These coordinated measurements provide information on the effects of different wavelengths on the retrieved properties. This is crucial to prepare for and interpret future validation measurements as well as to build the bridge from current satellite lidar measurements at 532 nm to future EarthCARE measurements at 355 nm.

In our presentation we will introduce the EarthCARE-like measurements on board HALO, and we will show first results in comparing airborne and spaceborne active remote sensing measurements, as well as in the use of different wavelengths.