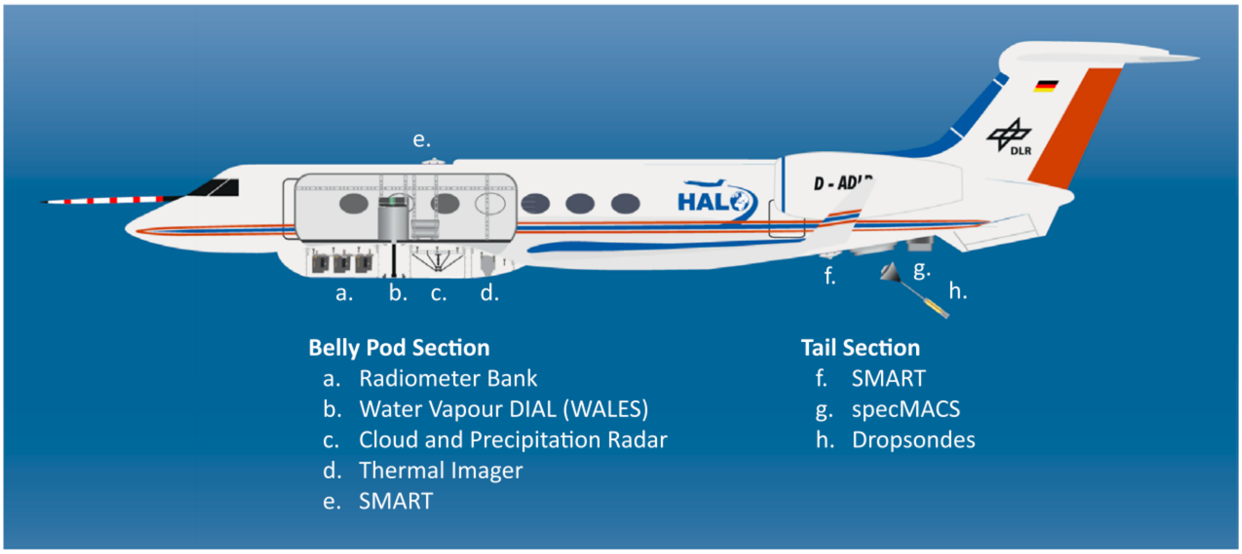
HALO as a Cloud Observatory



HALO is configured to function as an airborne cloud observatory with a great variety of remote-sensing instruments on board along with a dropsonde launching system. For greater detail, refer to Stevens et al (2019). The instruments have been listed in the table below.

Name	Instrument	Quantities measured & derived products	Type	Detailed description of instrument	Campaigns
BAHAMAS (not shown in image)	Multiple sensors all over the aircraft fuselage such as five hole probe on boom, diode laser, etc.	Aircraft state variables, position, three-dimensional turbulent winds, humidity, temperature and pressure	In-situ	DLR website	All
Dropsondes	Vaisala RD-94 sondes with AVAPS receiver on HALO (EUREC^{4}A used RD-41)	**Vertical profiles of:** Temperature Relative Humidity Horizontal wind speed and direction **Derived Products:** Divergence Vorticity Vertical velocity Moist static energy Integrated water vapour (Precipitable water)	In-situ	Wang et al (2015)	8-channel receiver for EUREC^{4}A; 4-channel for campaigns earlier

Name	Instrument	Quantities measured & derived products	Type	Detailed description of instrument	Campaigns
HAMP Cloud Radar	**Ka-band** (35 GHz) mono-static, pulsed magnetron radar	**Vertical profiles of:** Radar reflectivity Linear Depolarization ratio [1)] **Derived products:** Cloud objects Cloud fraction	Active remote-sensing	Ewald et al (2019)	All
HAMP Radiometers	Microwave radiometers in: **K-band** (22- 31 GHz) **V-band** (50 - 58 GHz) **W-band** (90 GHz) **F-band** (119 GHz) and **G-band** (183 GHz)	Brightness Temperature **Derived products:** Liquid water path Rain water path Water vapour profiling Water condensate (liquid/ice) path Temperature profiling	Passive remote-sensing	Mech et al (2014)	All
SMART	**Visible and near-infrared (300 to 1000 nm)** 2- to 3-nm spectral resolution [full width half maximum (FWHM)] **Shortwave infrared (1000 to 2200 nm)** 10- to 15-nm spectral resolution (FWHM)	Downwelling irradiance Upwelling radiance and irradiance **Derived products:** Cloud fraction Cloud droplet density	Passive remote-sensing	Wendisch et al (2016)	NARVAL2, NAWDEX, EUREC^{4}A
specMACS	Cameras: **Visible and near-infrared** (400 to 1,000 nm) **Shortwave infrared** (1,000 to 2,500 nm) **2D polarized** (RGGB + polarization Bayer Pattern)	Spectrally resolved line image **Derived products:** Cloud top temperature Cloud mask (cloud fraction) 3D cloud field along flight path	Passive remote-sensing	Ewald et al (2016)	NARVAL2, NAWDEX; Two lens-system with FoV overlap for EUREC^{4}A

Name	Instrument	Quantities measured & derived products	Type	Detailed description of instrument	Campaigns
WALES	High spectral resolution lidar **Multi-wavelength water vapor differential absorption lidar (DIAL)** Four wavelengths near 935 nm **Aerosol channels** 532 and 1064 nm with depolarization	**Vertical profiles of:** Backscatter Extinction **Derived products:** Water vapour mixing ratio profiles Cloud top mask Aerosol optical depth Ice water content	Active remote-sensing	Wirth et al (2009)	All
Velox	Thermal Infrared Wavelength Imager		Passive Remote-sensing		EUREC⁴A

N.B.: The list of derived products is not an exhaustive list, and most of the listed ones are not from a single instrument, but are estimates of quantities using synergistic measurements from the various instruments on board.

Campaigns and Data

Campaigns

For campaigns see Observation Campaigns in the Tropics

Data Access

Unified Dataset

There is a unified dataset, developed by Konow et al (2018), available for all NARVAL campaigns and the NAWDEX campaign together, which integrates the data from the HAMP instruments along with the dropsonde data, over a uniform grid of 30 m resolution in the vertical. The dataset also includes auxiliary data from BAHAMAS. Along with the data, quick looks for all flights have been uploaded to the CERA database as auxiliary data. These datasets are available at:

1. NARVAL1 South
2. NARVAL1 North
3. NARVAL2
4. NAWDEX

Liquid water path

Using the microwave measurements on board HALO, in combination with the cloud radar and lidar measurements, Jacob et al (2019) have calculated the liquid water path (LWP) and rain water path (RWP), using artificial neural network techniques for the NARVAL1 South and NARVAL2 campaigns. The dataset also includes integrated water vapor (IWV), along with auxiliary data from the radar and lidar. These are also available through the CERA database at:

1. NARVAL1 South
2. NARVAL2

WALES Data

All WALES data is available through the DLR Institute for Atmospheric Physics in the HALO database at:
German Aerospace Center (2016).

SpecMACS Data

Although the data is not published yet, data from SpecMACS is available at the MACS-LMU server. Please contact Tobias Kölling (LMU) regarding any queries about these data.

1. NARVAL2
2. NAWDEX
3. Cloud Mask product for NARVAL2
4. EUREC4A

SMART Data

Available from the HALO database here

[1] The radar also measures Doppler velocity. However, due to slight fluctuations in the aircraft's altitude, these estimations are not very reliable, as the order of magnitude of measured values is about the same as that of the uncertainty.