EUREC^{4}A: Overview of LIM contributions

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Summary: From 17 January to 19 February 2020, the EUREC^{4}A campaign was carried out in the trade-wind region of the Atlantic Ocean, in the Caribbean Sea just off the East Coast of Barbados. With several research platforms, including research vessels and aircraft, each containing various types of instrumentation, the goal of the campaign was to acquire observations of cloud properties as well as information about the large-scale environment and interactions therein. Scientists from LIM contributed active and passive remote sensing instrumentation aboard the research vessel Meteor and the High Altitude and Long Range research aircraft (HALO). EUREC^{4}A uses the multi-platform approach, which provides synergy from the observations to research trade-wind clouds and dynamics. An overview of the contribution of LIM to EUREC^{4}A and first preliminary results are given here.

Zusammenfassung: Von 17. Januar bis 19. Februar 2020 fand die groß angelegte EUREC^{4}A Feldkampagne im Osten von Barbados im Karibischen Meer statt. In der vom Passatwind geprägten Region wurden mehrere Forschungsschiffe sowie -flugzeuge genutzt, um klimarelevante Prozesse in der Atmosphäre und im Ozean zu charakterisieren. Ziel war es mit Hilfe unterschiedliche Messstrategien und -instrumenten das Zusammenspiel der Wolken, der Meeresströmungen und der globalen Zirkulation umfassend zu dokumentieren. Ein Beitrag der Wissenschaftler:Innen des Leipziger Instituts für Meteorologie waren flugzeuggetragene Fernerkundungsmessungen, welche vom deutschen Forschungsflugzeug HALO aus in einer Höhe von bis zu 10 km gemacht wurden. Gleichzeitig wurden Fernerkundungsmessungen der Atmosphäre vom Forschungsschiff Meteor durchgeführt. Mit Hilfe eines Wolkenradars, eines Mikorwellenradiometers, und spektraler Messungen solarer Strahlung wurden von der FS Meteor aus die Passatwindwolken untersucht. Die Vielfalt an Messinstrumenten und -platformen ermöglicht dabei eine ganzheitliche Sicht auf die klimarelevanten Passatwindwolken und deren Dynamik in der Atmosphäre.

1 Introduction

The ElUcidating the RolE of Cloud-Circulation Coupling in ClimAte, or for short EUREC^{4}A, campaign in January and February of 2020 was one of the largest atmospheric and oceanic research campaigns ever to be conducted, comprising four research vessels, five aircraft, one remote sensing station on Barbados and many unmanned research crafts. As stated in Bony et al. (2017) and Stevens et al. (2021), the primary objectives of the campaign were:

- To quantify macrophysical and microphysical properties of trade-wind cumuli as a function of the large-scale environment, and
- To provide a reference data set that can be used as a benchmark for the modeling and satellite observation of shallow clouds and circulation

With the combination of the many platforms that employ a variety of measurement techniques and objectives, a broad view of trade-wind clouds is provided. The strategy for tackling this challenge was largely based on a synergistic approach. The research domain was centered just east of Barbados in the Caribbean Sea and focused on "Tradewind Alley", the central measurement area in a semi-circle defined by the Barbados-based Polarized C-Band Radar, POLDIRAD (Fig. 1, green area). Additional research vessels contributed to these measurements while also exploring the influence and evolution of ocean eddies that frequently ramble toward Barbados from the southeast, along the "Boulevard des Tourbillons" (Stevens et al., 2021). Among the many platforms were the German Research Vessel Meteor and the High Altitude LOng range research aircraft (HALO) operated by the DLR (Deutsches Zentrum für Luft- und Raumfahrt), which specifically included instruments operated by scientists from the Leipzig Institute for Meteorology (LIM). The following sections describe in more detail how observations from LIM-operated instrumentation contributed to capturing the broader cloud picture from various perspectives.

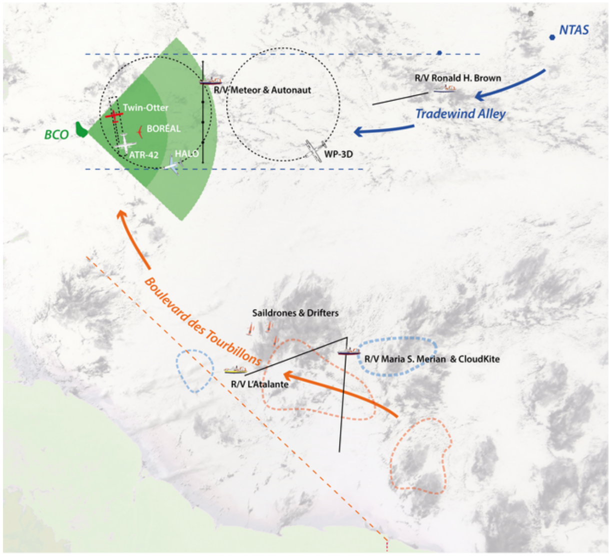

Figure 1: *Schematic illustration of the area of field operations during EUREC^{4}A. Green denotes the field of view of the C-Band Radar POLDIRAD (http://eurec4a.eu/overview/eurec4a).*

Table 1: *Overview of instrument specifications.*

Instrument	Time resolution	FOV	Wavelength range	Vertical resolution	Measured quantity	Derived/retrieved parameters	Platform
BACARDI	0.1 s	180°	0.2 – 3.6 µm (pyranometer); 4.5 – 42 µm (pyrgeometer)	integrated	Broadband solar (pyranometer) and terrestrial (pyrgeometer) irradiance	Albedo, net irradiance, heating rate profiles	HALO
VELOX	1 s	35° x 29°	7.7 – 12 µm	integrated	Emitted upward radiance, brightness temperature	Liquid water path, effective radius, cloud top and sea surface temperatures, surface type, 2D cloud mask	HALO
KT19	1 s	2.3°	9.6 – 11.5 µm	integrated	Emitted upward radiance, brightness temperature	Cloud top and sea surface temperatures, 1D cloud mask	HALO
SMART	1 s	180°	0.3 – 2.2 µm	integrated	Downward spectral irradiance	Cloud top reflectivity	HALO
LIMRAD	1.5 s	HPBW[a]: 0.56°	94 GHz (active); 89 GHz (passive)	22.4 m (0.3 – 3 km); 37.7 m (3 – 6.2 km); 42.1 m (6.2 – 13 km)	Radar reflectivtiy factor, Doppler velocity, polarimetric variables, brightness temperature at 89 GHz	Liquid water path, cloud top height, cloud mask, hydrometeor fraction	RV Meteor
LIMHAT	1 s	HPBW: 1.8° – 3.5° frequency dependent	22.2 – 31.4 GHz; 51.2 – 58.0 GHz	100 – 500 m parameter and height dependent	Brightness Temperature	Liquid water path, integrated water vapour	RV Meteor
CORAS	~6 s	2°	300 – 2200 nm	integrated	spectral solar downward radiance	Cloud optical thickness, effective radius	RV Meteor

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[a] Half Power Beam Width

2 Platforms and LIM instrumentation

Clouds, dynamics and the interactions therein are a multi-dimensional challenge to observe and comprehensively capture. Overcoming this challenge therefore requires the use of multiple platforms and instruments. The participating LIM scientists contributed to this effort on two such platforms – HALO and the RV Meteor. Descriptions of the instrumentation and the observations during EUREC^{4}A are summarized in the following section and in Table 1.

2.1 HALO

The HALO aircraft flew with an instrument payload known as the cloud-observatory configuration (Stevens et al., 2019). With these instruments, the cloud population as well as their environment (i.e. dynamic and thermodynamic) can be simultaneously observed. Active and passive sensors were used to obtain a characterization of cloud field properties – microphyiscal, macrophysical and radiative – while dropsondes were used to collect in situ measurements of the vertical atmospheric profile. The flight track for HALO was carefully designed to observe the clouds as they develop and change while moving across the Atlantic trade-wind region but also with the intention of capturing the vertical thermodynamic motion. To this end, HALO flew in a pattern defined by large circles (approximately 220 km in diameter, one circle per hour) repeated in the same location over the course of each flight (see Fig. 1). Other flight patterns in this same measurement domain were also flown as well as flight maneuvers dedicated to the calibration of specific instruments. A total of 13 local research flights were performed throughout the course of the campaign, with an additional two ferry flights between Barbados and Germany. Most flights were approximately 9 hours in duration. Further information can be found in Bony et al. (2017), Stevens et al. (2021) and an article submitted to Earth System Science Data, "EUREC^{4}A's HALO", by Konow et al., which describe the results from the EUREC^{4}A campaign and the data product contributions from the HALO aircraft, respectively.

The LIM team operated three passive sensors on board HALO, two of which are new additions to this cloud-observatory configuration – a broadband radiometer package and a thermal infrared camera system. Each instrument is described in the following subsections and their respective positions on the aircraft can be seen in Fig. 2.

2.1.1 BACARDI

The new radiometer package on HALO, the Broadband AirCrAft RaDiometer Instrumentation (BACARDI), consists of two sets of Kipp and Zonen pyranometers (CMP 22) and pyrgeometers (CGR-4) mounted to the fuselage of the aircraft. With these four instruments, the upward and downward solar (0.2 – 3.6 µm) and terrestrial (4.5 – 42 µm) irradiances at flight level can be measured. Measurements from these broadband radiometers are necessary for quantifying the radiative forcing of the clouds in Tradewind Alley. It should be noted that this instrument is operated by colleagues at the DLR, and data processing is handled by the LIM team. A more detailed description of the instrument as well as a discussion concerning corrections applied in post-processing

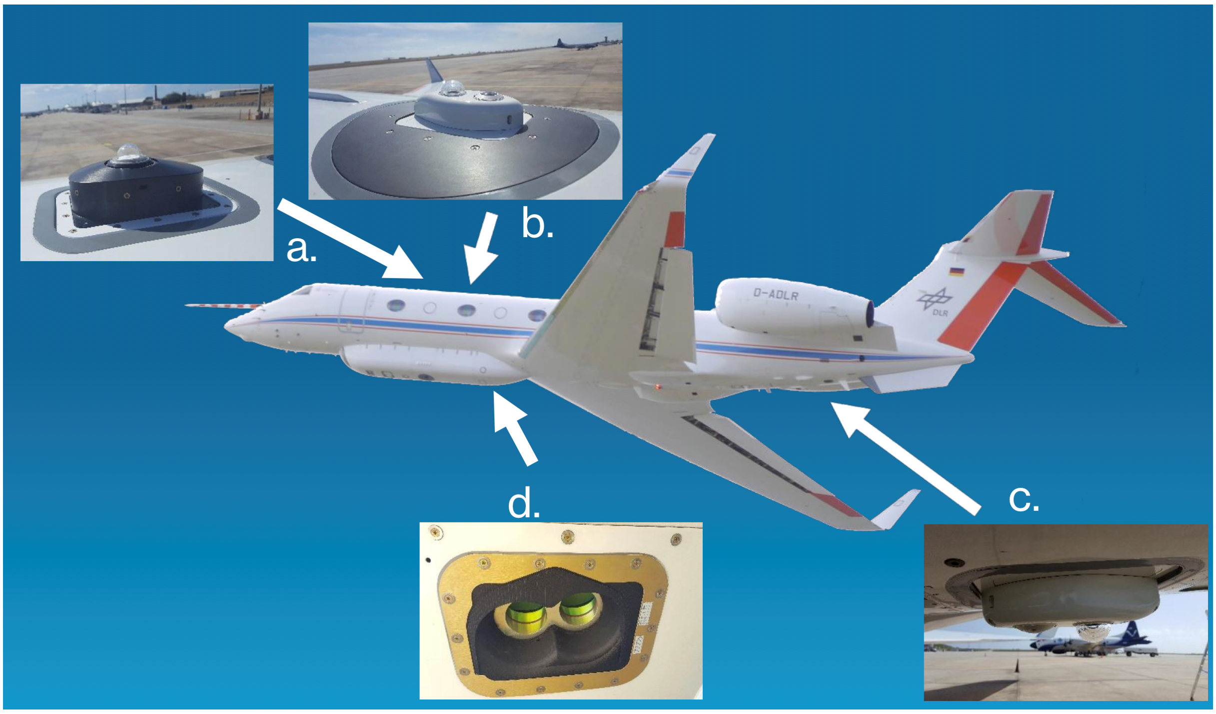


Figure 2: *Schematic depicting the position of LIM instruments on board HALO during the EUREC*^{4}*A campaign. Clockwise: a. SMART-Albedometer (downward spectral irradiance), b. BACARDI (downward broadband irradiance), c. BACARDI (upward broadband irradiance), d. VELOX.*

with respect to sensor response time, temperature dependence of the sensor and aircraft attitude can be found in an upcoming publication from Zöger et al., "A new efficient method to correct for the thermal offset of airborne broadband radiometer". BACARDI data has been published in the AERIS database (Ehrlich et al., 2021).

2.1.2 VELOX and KT19

The VELOX (Video airbornE Longwave Observations within siX channels) system consists of a thermal infrared (TIR) imager VELOX327k veL, manufactured by IR-CAM GmbH, Erlangen, Germany, and a KT19.85II infrared pyrometer, manufactured by HEITRONICS Infrarot Messtechnik, Wiesbaden, Germany, which serves as an additional reference. Both instruments are mounted together on the aircraft in a nadir-viewing position, where they observe the upward TIR radiance emitted by the clouds and surfaces below in two-dimensional images. At a typical cruising altitude of 10 km, VELOX has a field of view of 6.4 km x 5.1 km with a spatial resolution of 10 m. The observed radiance, or brightness temperature, can be used in retrievals of cloud properties such as liquid water path (LWP), effective radius (r_{eff}) and cloud top temperature (T_{ct}) as well as sea-surface temperature (T_{sea}) and surface type discrimination.

In order to carry out these retrievals, observations within various wavelength bands are needed. Basically, VELOX provides broadband measurements in the spectral wavelength range between 7.7 and 12 µm. However, this system contains a synchronously rotating filter wheel with six slots for bandpass and longpass filters; four of the slots are used for specific wavelength bands (8.648±0.55 µm, 10.74±0.39 µm, 11.66±0.81 µm and

11.50±0.20 µm; the two latter bands are cutoff at 12 µm based on the detector range), which correspond to different features of interest and are comparable to those used by MODIS (MODerate resolution Imaging Spectroradiometer) on the Terra and Aqua satellites, while the two remaining slots are for broadband (7.70 – 12.00 µm) observations. For further information about the VELOX system including calibrations and corrections to the data, please see the upcoming publication from Schäfer et al., "Introduction to the new airborne thermal infrared imager VELOX for remote sensing of cloud and surface properties".

Thus far, cloud masks were derived from the brightness temperature observations of both VELOX and KT19, respectively. Both are based on whether the measured brightness temperature meets a certain threshold relative to the brightness temperature of simulated cloud-free conditions. The measurement, or individual pixel in the case of VELOX, is then flagged as cloud-free, probably cloudy, or most-likely cloudy. The cloud mask data set is described and published in the AERIS database (Schäfer et al., 2021a,b) and is further explored alongside cloud mask products from other HALO instruments in the upcoming Konow et al. publication.

2.1.3 SMART

During EUREC^{4}A, the Spectral Modular Airborne Radiation measurement sysTem (SMART) measured downward irradiance in the spectral range between 0.3 µm and 2.2 µm. The spectral resolution (FWHM) of the instrument is 2 – 3 nm for wavelengths below 1.0 µm and 10 –15 nm for longer wavelengths. Notably, the instrument is mounted to a leveling platform to actively maintain a horizontal position. The irradiance measurements are used to calculate the cloud top reflectivity in combination with measurements by the spectral imager specMACS (Ewald et al., 2016). The data is also used in retrievals of cloud optical properties such as cloud optical thickness, effective diameter and thermodynamic phase. Wendisch et al. (2001) and Wendisch et al. (2016) provide further information. Data from the campaign is published in the AERIS database (Ehrlich, 2021).

2.2 RV Meteor

The RV Meteor's objective during the campaign was to measure along the same cross section of the HALO circle during the whole campaign to derive statistics of clouds inside this area (see Fig. 1). For this, the ship was steaming on a north-south transect between $\sim 12^\circ$ N and $\sim 14^\circ 30'$ N. It was equipped with a suite of in situ and remote sensing systems, of which only a few are mentioned here. For further details please refer to the cruise report (Mohr et al., 2020).

2.2.1 Remote sensing measurements

LIM contributed with remote sensing measurements to the atmospheric observations on Meteor. The LIM instruments on board the RV Meteor are shown in Fig. 3. They were placed on the starboard side of the 5th superstructure deck of the vessel to limit obstructions in the field of view of the instruments.

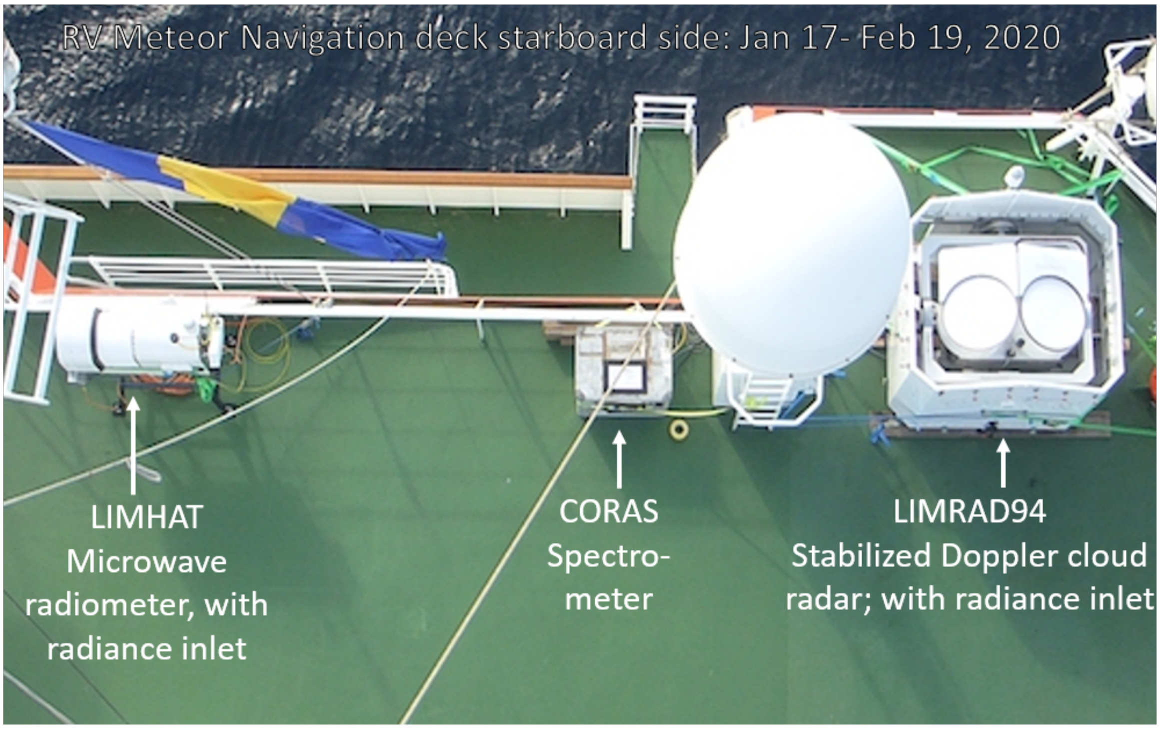


Figure 3: *Instrument setup on board the RV Meteor on the 5th superstructure deck from 17. Jan 2020 to 19. Feb 2020. From left to right: LIMHAT microwave radiometer with a radiance inlet, CORAS spectrometer, LIMRAD94 Doppler cloud radar inside a passive stabilization platform with a stabilized radiance inlet.*

Starting from the bow, the first instrument is the humidity and temperature profiler, HATPRO (LIMHAT) manufactured by Radiometer Physics GmbH (RPG), Meckenheim, Germany. LIMHAT uses a passive approach to retrieve profiles of relative humidity and temperature by measuring brightness temperatures in 14 channels around the water and oxygen absorption line in the atmosphere (Rose et al., 2005; Foth et al., 2015). From these measurements the liquid water path (LWP) as well as the integrated water vapour (IWV) in the atmospheric column above the instrument can be retrieved.

The second instrument is the spectral radiometer CORAS (COmpact RAdiation measurements System, Brückner et al. (2014)). During this cruise it was configured to measure zenith radiances transmitted through clouds to derive the cloud optical thickness as well as the effective cloud particle radius and cloud droplet number concentration by applying a retrieval method based on radiative transfer calculations.

The passive remote sensing was complemented by active remote sensing from a stabilized frequency modulated continuous wave (FMCW) W-band cloud radar (LIMRAD) manufactured by RPG (Küchler et al., 2017). It was placed inside a custom made cardanic mount, which reduces the impact of the roll and pitch motion of the ship on the vertical alignment of the radar. For off-zenith measurements, the horizontal wind would contaminate the retrieved vertical cloud particle velocity as this is derived from the measured Doppler velocity of the cloud particles. The radar samples the atmosphere by sending out three consecutive chirps. In each chirp, the frequency is slightly modulated to allow for a precise height measurement of the return signal. Thus, the vertical resolution of the radar changes with height (see Table 1). The sensitivity of the radar during the campaign has been determined to be around −38 dBZ at 5 km. Sensitivity increases with decreasing height and thus, the cloud radar is able to detect very thin liquid clouds such as the trade-wind cumulus clouds, which were the main object of interest during the campaign. The LIMHAT and LIMRAD data sets have been published in the AERIS database (Kalesse-Los et al., 2020, 2021).

The remote sensing suite on board the RV Meteor was extended by a ceilometer on the 6th superstructure deck operated by the Max Planck Institute for Meteorology, Hamburg, which measured the backscatter at 1064 nm and is used to detect cloud base height. The ceilometer data set has also been published in the AERIS database (Jansen, 2020).

2.3 In situ and oceanic measurements

The ship was also equipped with in situ measurement instrumentation, such as the Mini Max Planck CloudKite operated by the Max Planck Institute for Dynamics and Self-Organization, Goettingen. It was used to fly a sonde into the clouds that provided measurements of the atmospheric state variables at sonde height and of cloud microphysical parameters such as the cloud droplet number concentration and cloud droplet size (Stevens et al., 2021). Another in situ measurement system on board was the Wide Range Aerosol Spectrometer EDM 665 (WRAS) which sampled the air at ship level to retrieve aerosol number concentrations in different size ranges.

In addition to atmospheric measurements, the ship routinely stopped to conduct oceanic measurements with the help of a Conductivity Temperature Depth (CTD) device. Thereby, profiles of conductivity, temperature and depth/pressure were retrieved as well as water samples from different depths. These water samples were then collected by the biologists from the Max Planck Institute for Marine Microbiology, Bremen, on board and prepared for further sampling on land.

3 Case study of collocated measurements

The following case study from 9 February 2020 illustrates the measurement capabilities for a cloud situation encountered during the campaign. For this case study we use a near HALO overpass with the RV Meteor at approximately 16:05 UTC, and thereby offer two perspectives - one view looking down onto the cloud with the VELOX instrument on board HALO and the other view looking up at the clouds with the cloud radar and ceilometer from RV Meteor. Due to the high ground speed of HALO compared to the RV Meteor, the temporal and spatial overlap between the two measurements is relatively small. While this is partly balanced by the larger field of view of VELOX, the radar samples only a narrow column above the ship, again reducing the potential overlap of the two measurements.

3.1 Ground-based remote sensing

An impression of the cloud condition as seen from Meteor is given in Fig. 4a. This gives a first impression of what an observer from the ground witnessed. Expanding the observation into the vertical cloud structure, Fig. 4c shows a time-height plot of radar reflectivity combined with the first ceilometer cloud base up to 3 km. The scene starts with a few small broken clouds, followed by a more vertically extensive cloud with higher reflectivity. The ceilometer suggests a cloud base at around 800 m. Cloud top for the small scattered clouds is around 1600 m rising close to 3000 m for the larger cloud.

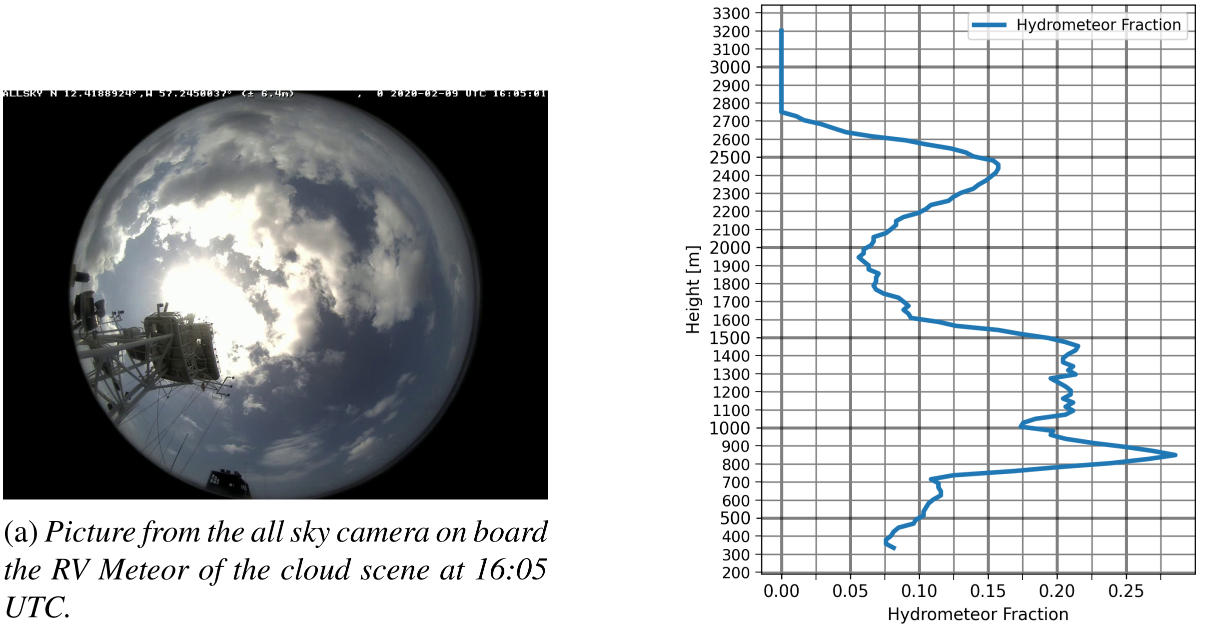
To characterize the cloud vertical structure with a statistical approach, the hydrometeor fraction is derived, which is the fraction of radar pixels with a measurement observed in each height bin for the specified time period, here 15:58 to 16:15 UTC on 9 February 2020. Figure 4b shows this hydrometeor fraction. The first thing to notice is that the maximum hydrometeor fraction during the observation period is below 30 %. This means that during the 17 minutes of observation, the radar only observed a cloud for about 5 minutes.

Furthermore, there are two cloud layers as can be seen by the drop of the hydrometeor fraction back to 6 % at 1950 m. Looking at Fig. 4c this corresponds to the vertically extensive cloud, whose top part is only loosely connected to the one below. Another prominent feature is shown in the lower part of the plot. It can be observed that hydrometeor fraction does not reach zero in the lowest radar range gates. Instead, it slowly rises, starting at 7.5 % and reaching about 11 % at 700 m. At this point a sharp increase towards the maximum value can be observed. The maximum value at 850 m corresponds with the cloud base also observed by the ceilometer. The signal seen below this height can be classified as virga, which is precipitation that does not reach the ground. The ceilometer is not able to detect these small rain particles, but the radar can. This synergy between the two instruments can therefore be used to detect virga events in an automated fashion, as has been done in Fig. 4c with the pink box. Finally, the hydrometeor fraction shows us that the maximum cloud top lies at 2700 m.

3.2 Airborne remote sensing

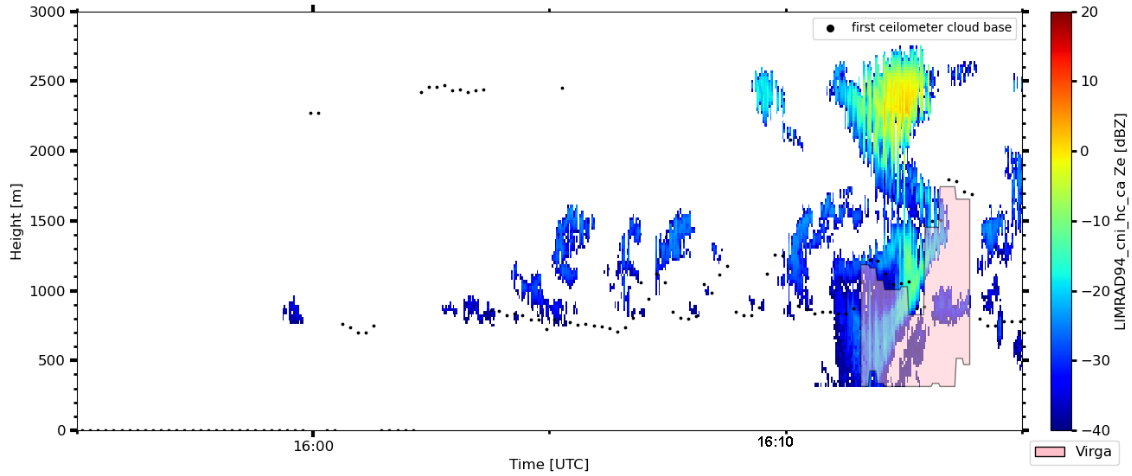
The same cloud scene is also observed by the airborne remote sensing instruments on HALO as it flies over the RV Meteor from east to west. As shown in Fig. 5, the VELOX imager captures the clouds observed by the radar on the RV Meteor as well as the surrounding cloud field. The cloud mask retrieval in this figure is based on three brightness temperature thresholds – 1 K, 1.5 K and 2 K – representing the difference of the brightness temperature of each pixel to cloud-free air. If only one threshold is reached, the pixel is flagged as *probably cloudy*, while if all are reached, the pixel is flagged as *most likely cloudy*. The scene shown in Fig. 5 reveals that the clouds in the vicinity of the RV Meteor fall mainly into the *most likely cloudy* category. Also, based on the image of the cloud field, the brokenness of the cloud deck agrees with the assessment from the radar that the observation of clouds during this period of time would be limited.

As mentioned, the overpass is relatively brief, with the RV Meteor remaining within VELOX's view for only about 30 seconds. Nevertheless, in the same way that the radar is able to provide a hydrometeor fraction over the vertical profile of the observed cloud, VELOX offers a cloud fraction for the two-dimensional scenes that it observes over the broader measurement domain, which is shown in Fig. 6. This particular time series takes place before, during and after the overpass, corresponding to the same duration of time shown in Figs. 4b and 4c. From this short example, the heterogeniety of the domain becomes clear. At the time of the overpass, the cloud field from the perspective of HALO rapidly shifts from a cloudy to a more clear field, with reported cloud fractions of the



(a) *Picture from the all sky camera on board the RV Meteor of the cloud scene at 16:05 UTC.*

(b) *Hydrometeor Fraction in the lower Troposphere from 15:58 to 16:15 UTC.*



(c) *Time height plot of radar reflectivity and the lowest ceilometer cloud base (black dots). Radar signal below the ceilometer cloud base can be classified as virga (pink box).*

Figure 4: *RV Meteor viewpoint of the cloud scene on 9 February 2020.*

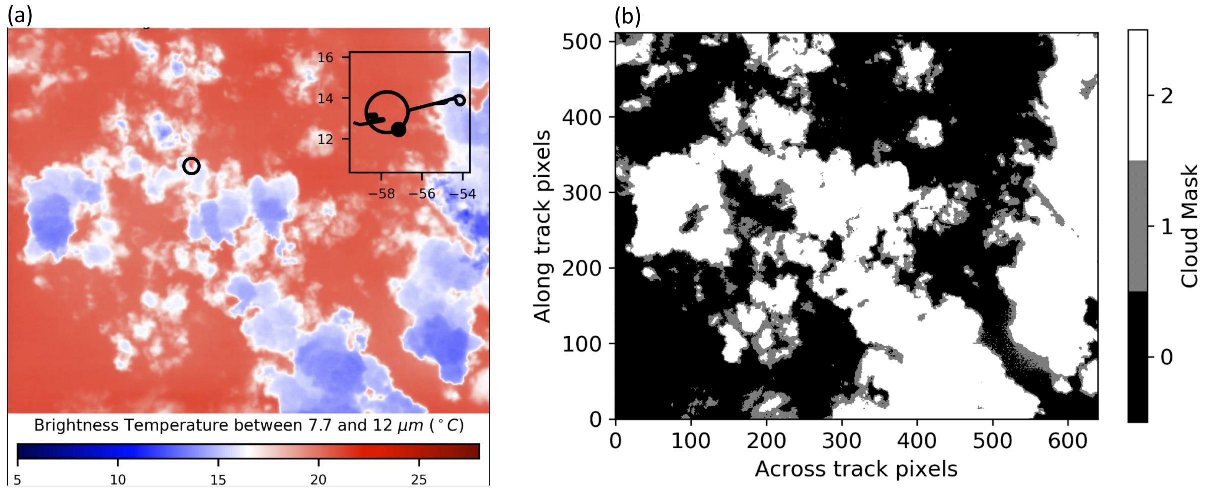


Figure 5: *Cloud images from VELOX at the time of the overpass (16:05:16 UTC shown here). a. Image with brightness temperature observations from the broadband channel. The flight track can be seen in the upper right corner, with the location of HALO marked as a filled, black circle. The smaller open circle in black in the center of the image indicates the position of the RV Meteor at this time. b. The cloud mask retrieved from the brightness temperature image at the same time. 0: no cloud, 1: probably cloudy, 2: most likely cloudy.*

scene between 21 % and 75 %.

Using this case study, we can discuss a common challenge in cloud research – how to define cloudiness. The sensitivities of the different instruments are a key point in that discussion. A cloud radar like the one on RV Meteor is most sensitive to large droplets, whereas an IR thermal imager like VELOX is sensitive to any amount of liquid water, including water vapor, independent of cloud particle size. Thus, in a case of clouds with low LWP, which also typically have small droplets, VELOX has the necessary sensitivity to detect them. On the other hand, the radar measurement technique is ideally suited to characterizing the vertical structure of the clouds and precipitation, whereas VELOX can define the cloudy versus cloud-free areas, based on emitted radiation, and the horizontal distribution of cloud properties across a broader field of view. Furthermore, the way in which the respective platforms travel relative to the movement of the cloud field also leads to differences in the spatial representation of the different measurements. While seemingly complex, having both perspectives, as well as the perspectives of the numerous other instruments involved in the campaign, ultimately serves the purpose of providing a more complete picture. Thus, the merits of a multi-platform campaign are clear.

4 Conclusions & Outlook

The EUREC^{4}A campaign in early 2020 mobilized a number of research aircraft and vessels, and took advantage of the Barbados Cloud Observatory nearby, to sample the clouds and large-scale dynamic structure of the Atlantic trade-wind region. Scientists from LIM were involved in this effort with instruments aboard the HALO aircraft and the RV Meteor. The utilization of instruments viewing from above and below as well

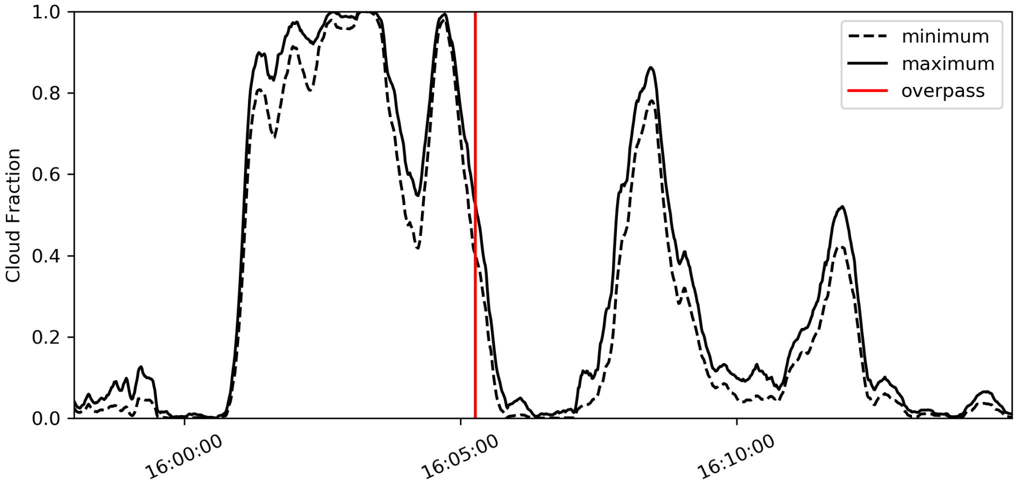


Figure 6: *Cloud fraction as derived from the VELOX camera, showing the minimum and maximum cloud fraction depending on brightness temperature differences to clear-sky. The minimum includes only "most likely cloudy" pixels, while the maximum also includes "probably cloudy" pixels.*

as employing complementary remote sensing techniques offers a unique and comprehensive view of these clouds. Specifically, the observations allow for studies of cloud imagery, profiles of the vertical hydrometeor structure, the radiative impact of the clouds, information and statistics on the macrophysical properties of the clouds as well as the potential for further retrievals revealing other microphysical properties.

This rich dataset is central to many current analyses as well as future work. The following provides a brief description of the activities at LIM specific to EUREC^{4}A data.

- In addition to the cloud mask data product from VELOX, which will continue to be fine-tuned, there is continuing work on retrievals of the cloud properties described in Sec. 2.1.2.

- An analysis to determine whether the cloud radiative forcing of trade wind cumuli is driven by the macrophysical or microphysical properties of the clouds, the mesoscale organization of the cloud field or some combination is in progress. By determining the sensitivity of the cloud radiative forcing to these quantities, the representation of these clouds in models can be assessed. The analysis includes cloud albedo, which has been calculated from the irradiance measurements of BACARDI in combination with radiative transfer simulations using libRadtran (Mayer and Kylling, 2005), and domain averaged cloud properties from GOES16 satellite observations during the campaign period. Future work on this topic will include use of the cloud mask and additional cloud properties derived from VELOX.

- A synergistic approach utilizing the obtained microphysical and macrophysical cloud properties from active and passive remote sensing on board the RV Meteor to derive cloud droplet number concentrations is also currently being worked on. The joint application, which includes solar zenith radiances, is currently being tested for homogeneous stratocumulus in the absence of drizzle, assuming the adiabatic theory. The heterogeneous nature of the observed trade wind cumuli, as illustrated in Sec. 3, poses the inevitable problem of 3D radiative effects, which complicate or restrict microphysical radiance retrievals without the knowledge of the 2D/3D cloud fields. Further improvement for homogeneous cloud scenes, as suggested in the literature, can be achieved by combined forward modeling of radar reflectivity and solar zenith radiances.

- By combining the radar, ceilometer and HATPRO on board the RV Meteor, a couple of synergistic retrievals can be applied, which have been developed within the Cloudnet framework (Illingworth et al., 2007). The retrievals include a hydrometeor classification and a radar and lidar detection status, which can then be used to derive further statistics of the observed hydrometeors. The measurements can be compared to the measurements at the Barbados Cloud Observatory, which also operates as a Cloudnet site to study cloud evolution.
- The performance of the radar stabilization platform and the impact on the radar observation and derived products will be analyzed.
- Using the remote sensing observations on board the RV Meteor, the macrophysical characteristics of the trade wind cumulus clouds are being investigated.

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