

# CAESAR

## Cold-Air outbreak Experiment in the Sub-Arctic Region



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### Areas of contribution

Polar atmospheric processes

Modelling and forecasting

Polar-lower latitude linkages

### Summary

CAESAR (Cold-Air outbreak Experiment in the Sub-Arctic Region) will deploy the US National Science Foundation NCAR C-130 aircraft to document convective clouds in the marine boundary layer (MBL) during cold-air outbreaks in the far northern Atlantic Ocean, in a region stretching from the Fram strait to the Barents Sea. The NCAR C-130 will be based in Kiruna, Sweden (KRN), and conduct research flights between 23 Feb and 7 April 2021. The payload will include dropsondes, the Wyoming Cloud Radar (WCR, three antennas, up/down and slant back), the Ka-band Profiling Radar (KPR), the Wyoming Cloud Lidar (WCL, up-looking), the (Multi-function Airborne Raman Lidar (MARLi), a microwave radiometer, a number of Optical Array Probes for precipitation particles, cloud particle spectrometers and total liquid/ice probes, the VCSEL water vapor sensor, several probes to measure the concentration and size distribution of aerosol, including cloud-active aerosol, several trace gas probes, as well as meteorological and eddy correlation flux sensors. CAESAR is expected to improve the understanding of aerosol-cloud-precipitation processes in mixed phase clouds, and its representation in regional and global climate models. These data are sorely needed since MBL clouds represent a significant challenge to NWP and climate models, especially in the high-latitude regions, as they generally are sub-grid-scale and fall in the gray zone where boundary-layer processes and convection are tightly coupled and cannot be parameterized independently.

## **Description**

CAESAR (Cold-Air outbreak Experiment in the Sub-Arctic Region) is a "Large Campaign" proposal that will be submitted to the US National Science Foundation on 15 January 2019. It focuses specifically on convective clouds in the marine boundary layer (MBL) during cold-air outbreaks (CAOs), including mesocyclones (polar lows) that commonly form in this environment. It will deploy the NSF/NCAR C-130 aircraft from Kiruna, Sweden (KRN) to the far northern Atlantic Ocean, in a region stretching from the ice edge in the Fram strait and the Barents Sea, down to the Norwegian shore, between 23 Feb and 7 April 2021. The NCAR C-130 payload will include dropsondes, the Wyoming Cloud Radar (WCR, three antennas, up/down and slant back), the Ka-band Profiling Radar (KPR), the Wyoming Cloud Lidar (WCL, up-looking), the (Multi-function Airborne Raman Lidar (MARLi), a microwave radiometer, a number of Optical Array Probes for precipitation particles, cloud particle spectrometers and total liquid/ice probes, the VCSEL water vapor sensor, several probes to measure the concentration and size distribution of aerosol, including cloud-active aerosol, several trace gas probes (including oxygen isotope ratios), as well as meteorological and eddy correlation flux sensors. The CAESAR large campaign proposal includes 16 letters of intent from investigators planning to submit research proposals to NSF or elsewhere, if the C-130 deployment is approved. (A decision on this is expected by July 2019.)

CAESAR is expected to improve fundamental understanding of aerosol-cloud-precipitation processes in mixed-phase clouds. Several CAESAR research proposals will focus on the representation of these processes in regional and global climate models. These data are sorely needed since MBL clouds represent a significant challenge to NWP and climate models, especially in the high-latitude regions, as they generally are sub-grid-scale and fall in the gray zone where boundary-layer processes and convection are tightly coupled and cannot be parameterized independently.

Mutual benefits are expected between CAESAR and a synchronous, YOPP-endorsed, field campaign that is part of the German Arctic Amplification project [(AC)3]. The HALO aircraft will be based in Kiruna as well, with a series of active and passive remote sensors (Ka band radar, radiometer, multi-spectral lidar ...). We hope that DLR HALO / NCAR C-130 flights can be coordinated during CAO events. The CAESAR data collection effort will be linked tightly to a modelling effort, aimed towards better representation of shallow, precipitating convection in a hierarchy of models, from Large Eddy Simulations to global climate models, through the evaluation and improvement of shallow convection and boundary layer parameterizations.

## **Timeline**

2021-02-23 - 2021-04-07

## **Regional emphasis**

Northern hemisphere: Yes

Southern hemisphere: No

## Further specification

The far northern Atlantic Ocean. More specifically, a region stretching from the Arctic ice edge, the Fram strait, the Barents Sea, to the Norwegian Sea.

## Key project deliverables

A strategy is presented for both the creation of a real-time publically-accessible Field Catalog needed for mission planning and post-project reference, and for the long-term open-access archival of CAESAR data at NCAR.

Data for CAESAR will also be collected by ships and ground facilities funded by other U.S. and other government agencies. These data will be subject to data archival and access requirements of the individual funding agencies. However, to our knowledge, all these agencies typically require that data be made public after some limited time period, usually between 6-18 months. The strategy below follows mostly standard procedures followed on previous NSF C-130 projects.

NCAR EOL will implement a real-time Field Catalog, as they have done for a number of previous field campaigns (an example is found at <http://catalog.eol.ucar.edu/SOCRATES/>), to assist in the planning and operational phase, and to serve as post-project reference. The Field Catalog will include the following:

- Catalog Map, allowing an overlay of the C-130 track with satellite and radar imagery, with minimal latency (hopefully the Polar 5 and Polar 6 tracks can be included);
- daily flight plans, mission reports, facility status updates, project planning documents, completed by participants during the field campaign;
- images of preliminary field data, collected on C-130 flights, again completed by participants after each flight;
- daily weather forecasts, completed by the forecast team led by MET Norway;
- satellite imagery (e.g., GOES-16 and MeteoSat geostationary satellites, AVHRR, MODIS, MISR, GPM, CloudSat, CALIPSO, SSMI/I, AMSR2), and derived products produced from the satellite data (e.g., cloud cover, top/height, optical depth, effective radius, presence of mixed-phase cloud or supercooled water), uploaded by NCAR;
- sounding data, plotted on skew Ts, from the C-130 dropsondes, from the Polarstern, Ny-Ålesund, Bear Island, Andenes, plus operational sites in the CAESAR operations area, uploaded by NCAR;
- radar imagery (MET Norway composite low-level radar reflectivity, plus Bear Island radar imagery if available) uploaded by EOL;
- images of select model output (ECMWF, GFS, AROME-MetCoOp, AROME-Arctic, and any real-time regional model run by CAESAR participants during the field campaign) uploaded by NCAR.

The Field Catalog has its own tested image animation tool. A low-bandwidth version of the Field Catalog may need to be made available for access from aboard the C-130. AVAPS dropsonde data will be uploaded in real-time to the WMO WIS/GTS system, from where they are incorporated into operational models and plotted on Skew Ts for access from the Field Catalog. The Field Catalog will be publicly accessible at all times, even during the field phase. It should remain up for at least 5 years.

NCAR will also implement and maintain a CAESAR long-term data archive, as done for other projects (e.g., [http://data.eol.ucar.edu/master\\_list/?project=PECAN](http://data.eol.ucar.edu/master_list/?project=PECAN)), which includes a Master List of all archived data and products regardless of archive location, all datasets collected aboard the C-130, a link to the Field Catalog, a

link to the AC3 HALO dataset archived by DLR, and the array of operational data accessible on the Field Catalog in image form. We expect the CAESAR participants to provide their final, quality-controlled data sets, associated metadata and products to the EOL Data Archive as soon possible, and no later than 6 months after the completion of the campaign. We will also require that all funded P/Is include sufficient documentation with their submitted data products. NCAR will notify the CAESAR community of the procedures for the submission of data and metadata to the archive, thus ensuring long-term integrity of the data.

NCAR will further assist in planning and implementing a CAESAR data management strategy that is consistent with NSF guidelines (e.g., data policy, data submission deadlines, attribution guidelines, Digital Object Identifier). The NCAR CAESAR Data Archive will also be linked to other archive locations, in particular the DLR AC3 data.

CAESAR will abide by the NCAR data policy in effect at the time of the campaign (in 2021). Unless the policy changes, the complete long-term archive will be made publicly available within one year (12 months) of the completion of the campaign. In short, we expect six months for quality control and six months for internal team use

### **Data management**

A long-term data archive will be implemented and maintained by NCAR at this site:

[http://data.eol.ucar.edu/master\\_list/?project=CAESAR](http://data.eol.ucar.edu/master_list/?project=CAESAR). All data must be final (fully processed and quality-controlled) and become publicly no later than 12 months after the end of the field phase.

### **Is data provided to WMO Global Telecommunication System**

Yes

### **Real-time provision**

As discussed above, the Field Catalog will be openly accessible in real time, and will be found at <http://catalog.eol.ucar.edu/CAESAR/>. It will be used to assist in the planning and operational phase, and to serve as post-project reference.

### **Timelines**

<b>Location</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Start date</b>	<b>End date</b>	<b>Activity</b>
CAESAR field campaign			2021-02-23	2021-04-07	NCAR C-130 flights