NAUKA O KLIMACIE
DLA SCEPTYCZNYCH

# Chasing marine convective clouds in subtropics: the EUREC4A/ATOMIC research campaign


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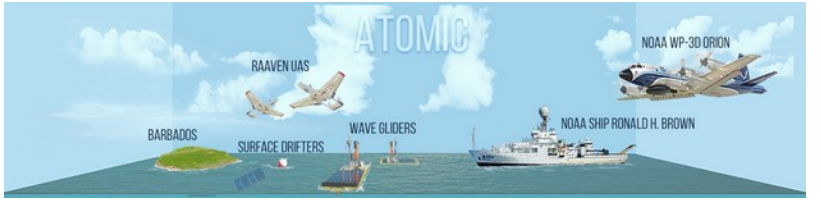
Wydział Fizyki Uniwersytetu Warszawskiego

2020-10-23

UNIWERSYTET WARSZAWSKI

# Over 100 research institutions involved, more than 1200 researchers and staff participating in situ.

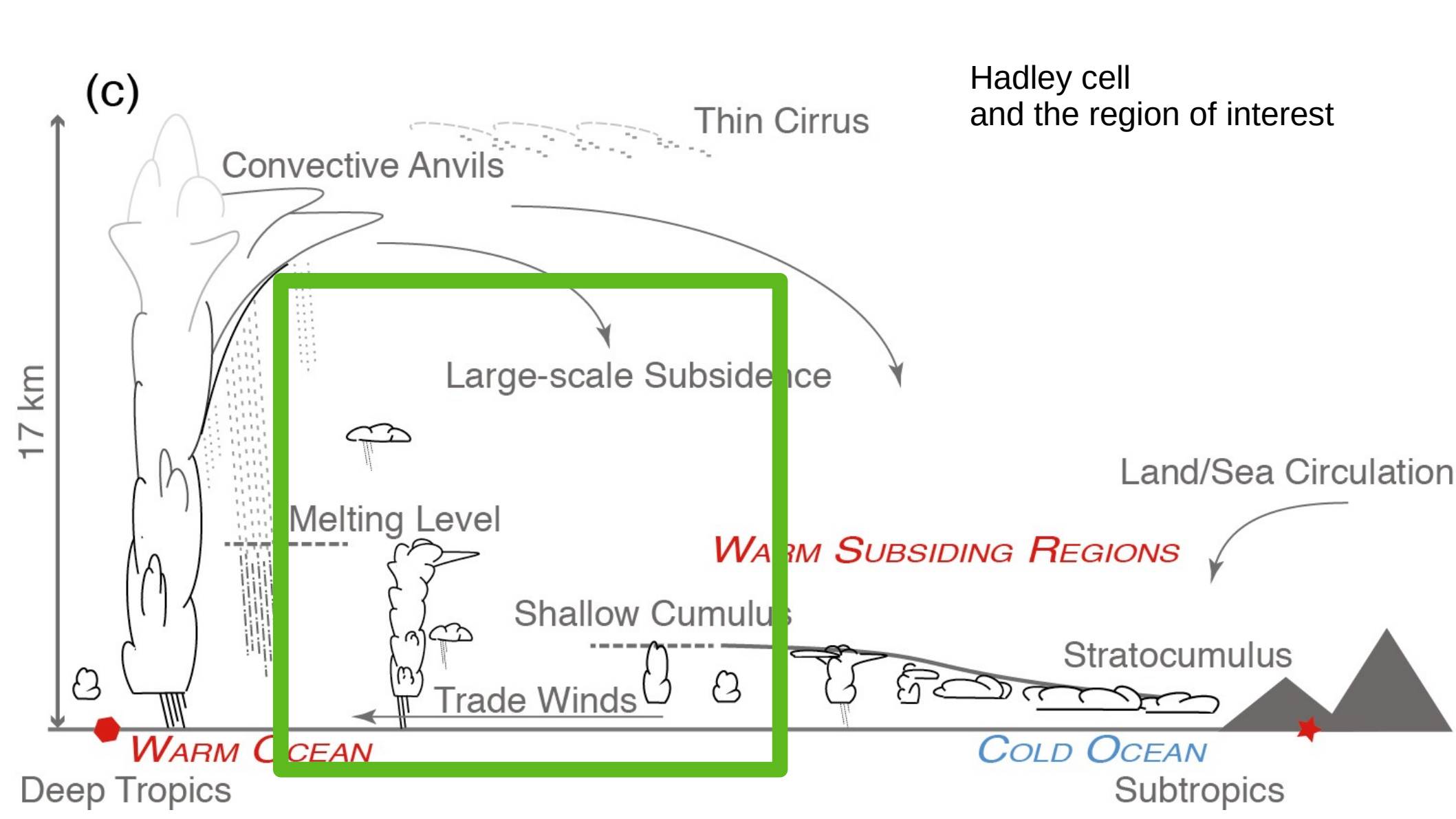



AERIS ( https://en.aeris-data.fr)
British Antarctic Surve, BAS (https://www.bas.ac.uk/)
Caribbean Institute for Meteorology and Hydrology, Bridgetown, Barbados ( http://www.cimh.edu.bb)
Centre National de Recherches Météorologiques (CNRM, http://www.cnrm.fr)
Centre Nationnal de la Recherche Scientifique (CNRS, http://www.cnrs.fr)
CNES (French Space Agency, www.cnes.fr)
Delft University of Technology (TU Delft, https://www.tudelft.nl/en/ceg/about-faculty/departments/geoscience-remote-sensing)
Deutsche Luft- und Raumfahrt Flight Experiments (DLR-FX, http://www.dlr.de/fb)
Deutsche Luft- und Raumfahrt Institut für Physik der Atmosphäre (DLR-IPA, http://www.dlr.de/ipa)
École Normale Supérieure, (ENS http://www.ens.fr/departements-sciences/geosciences.html)
ETH Zürich ( http://www.iac.ethz.ch/)
European Centre for Medium Range Forecasts (ECMWF, http://www.ecmwf.int)
GEOMAR, Helmholtz Zentrum für Ozeanforschung Kiel, Kiel, ( www.geomar.de/en)
Geoscience and Remote Sensing, Delft University of Technology ( http://www.citg.tudelft.nl/en/about-faculty/departments/geoscience-and-remote-sensing/)
Hans Ertel Center for Weather Research, Deutscher Wetterdienst ( https://www.hans-ertel-zentrum.de/en/index.html)
Helmholtz-Zentrum Geesthacht, Centre for Material and Coastal Research ( https://www.hzg.de/index.php.en)
IFREMER, French National Institute for Ocean Science ( https://wwz.ifremer.fr/en)
Laboratoire Atmosphères, Milieux, Observations Spatiales (LATMOS/IPSL, https://www.latmos.ipsl.fr/index.php/en/)
Laboratoire d'Aérologie (LA, aero.obs-mip.fr )
**Laboratoire de Météorologie Dynamique (LMD/IPSL, UPMC, Paris, http://www.lmd.jussieu.fr)**
Laboratoire de Météorologie Physique (LAMP, Clermont-Ferrand, http://wwwobs.univ-bpclermont.fr/atmos/)
Laboratoire d'Océanographie et du Climat, Paris (LOCEAN www.locean-ipsl.upmc.fr/index.php?lang=en)
Laboratoire des Sciences du Climat et de l'Environment (LSCE, https://www.lsce.ipsl.fr/en/index.php)
Laboratory of Atmospheric Optics (LOA, Lille, https://www-loa.univ-lille1.fr)
Leibniz Institute for Tropospheric Research (TROPOS www.tropos.de)
Leipziger Institut für Meteorologie, Universität Leipzig ( http://meteo.physgeo.uni-leipzig.de/de/index.php)
Leitstelle Deutsche Forschungsschiffe ( https://www.ldf.uni-hamburg.de)
Max Planck Society (MPG, https://www.mpg.de/de)
Max Planck Institute for Dynamics & Self-Organization, Göttingen (MPI-DS www.mpsd.mpg.de/en)
Max Planck Institute for Marine Microbiology, Bremen (MPI-MM www.mpi-bremen.de/en/)
**Max Planck Institute for Meteorology, Hamburg, (MPI-M http://www.mpimet.mpg.de)**
Met Office, Exeter UK ( www.metoffice.gov.uk)
Météo-France ( www.meteofrance.fr)
Meteorological Institute Munich (MIM) at LMU Munich ( http://www.meteo.physik.uni-muenchen.de)
SAFIRE, CNRS, Toulouse ( http://www.safire.fr/web/index.php)
National Centre for Atmospheric Science (NCAS), United Kingdom ( https://www.ncas.ac.uk/en/)
NERC (Natural Environment Research Council), which is part of UK Research and Innovation, UKRI ( https://nerc.ukri.org/)
University of Bergen ( https://www.uib.no/en)
University of East Anglia (UEA), Centre for Ocean and Atmospheric Sciences, Norwich, UK (https://www.uea.ac.uk/environmental-sciences/coas-people)
University of Hamburg, Meteorological Institute ( https://www.mi.uni-hamburg.de/en.html)
University of Hohenheim, Institute of Physics and Meteorology ( https://physik-meteorologie.uni-hohenheim.de )
University of Leeds, Institute for Climate and Atmospheric Science, ICAS ( https://environment.leeds.ac.uk/institute-climate-atmospheric-science)
University of Manchester, Centre for Atmospheric Science (CAS), Department of Environmental Sciences ( http://www.cas.manchester.ac.uk/)
**University of Warsaw, Institute of Geophysics ( https://www.igf.fuw.edu.pl/en/)**
Universität zu Köln, Institut für Geophysik und Meteorologie ( http://www.geomet.uni-koeln.de)

ATOMIC is supported by the **NOAA Climate Program Office Climate Variability and Predictability Program**, NOAA UAS Program, and NOAA Physical Sciences Laboratory (PSL), with additional participation from the National Aeronautics and Space Administration (NASA) Physical Oceanography program.

It involves scientists from PSL, NOAA's Chemical Sciences Laboratory, Atlantic Oceanographic and Meteorological Laboratory, Pacific Marine Environmental Laboratory, University of Colorado (CIRES and IRISS), University of Washington several other U.S. universities, Caribbean Institute for Meteorology and Hydrology, pilots and crew from the NOAA Office of Marine and Aviation Operations.

Campaign focused on mutual interactions (feedbacks) between warm convective clouds in subtropics and ocean top layers.




Hadley cell
and the region of interest

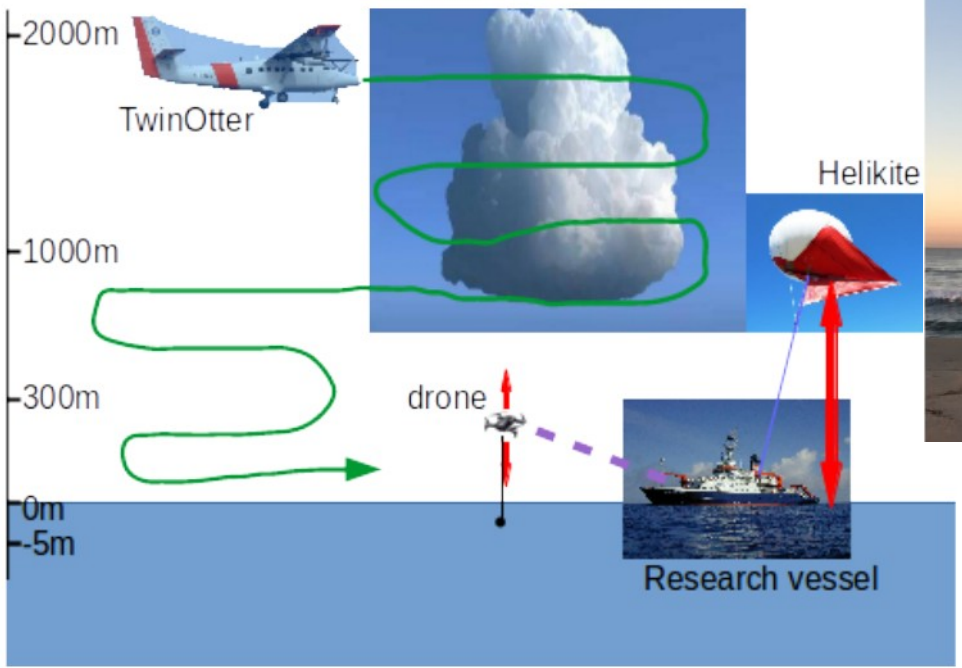
High resolution temperature measurements: investigations of ocean-atmosphere turbulent exchange in the course of EUREC4A-ATOMIC campaign.
Narodowe Centrum Nauki, HARMONIA,

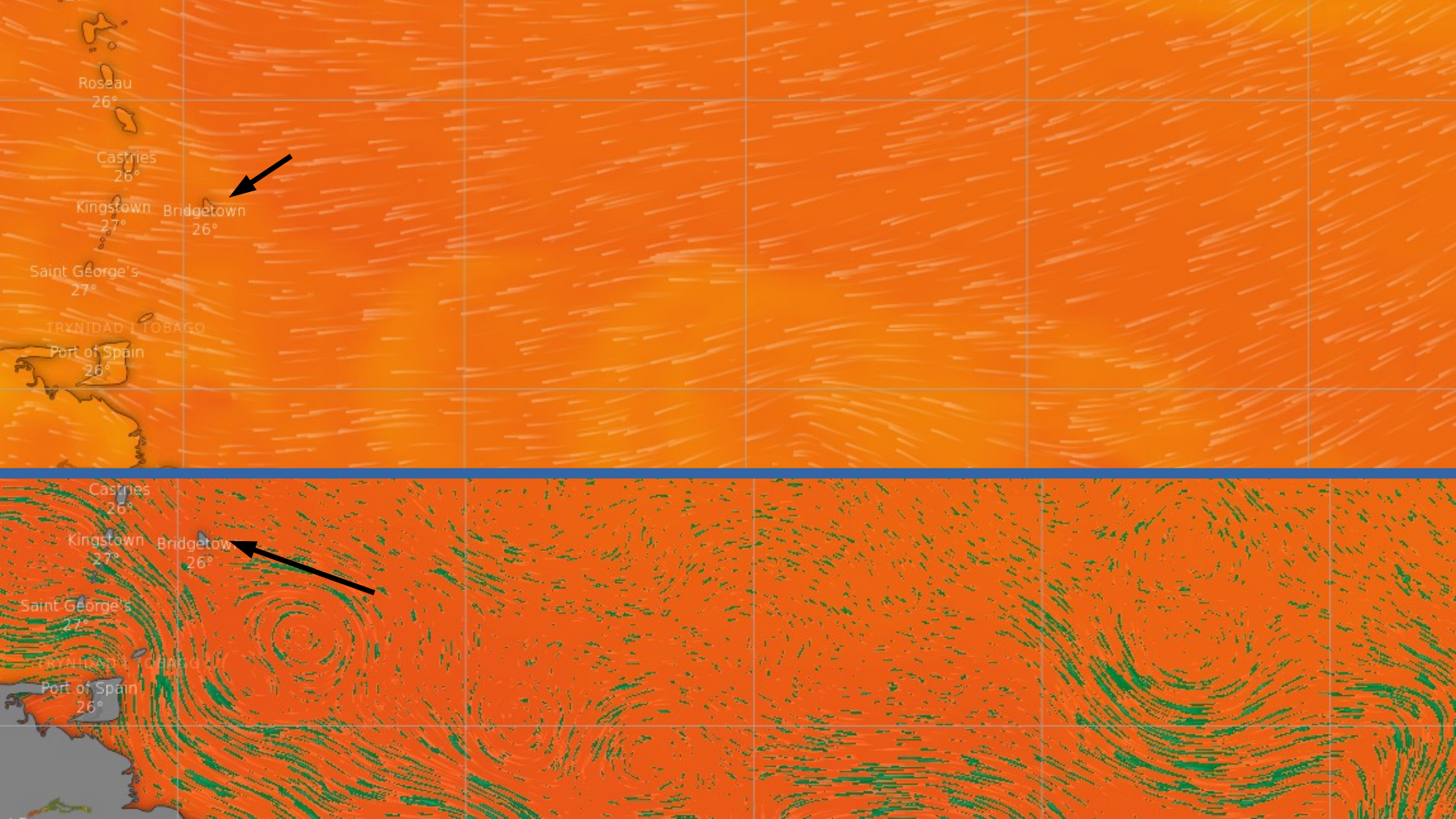
Project type: Research project
Affiliation: Institute of Geophysics, Atmospheric Physics Department
April 17, 2019 - April 16, 2021

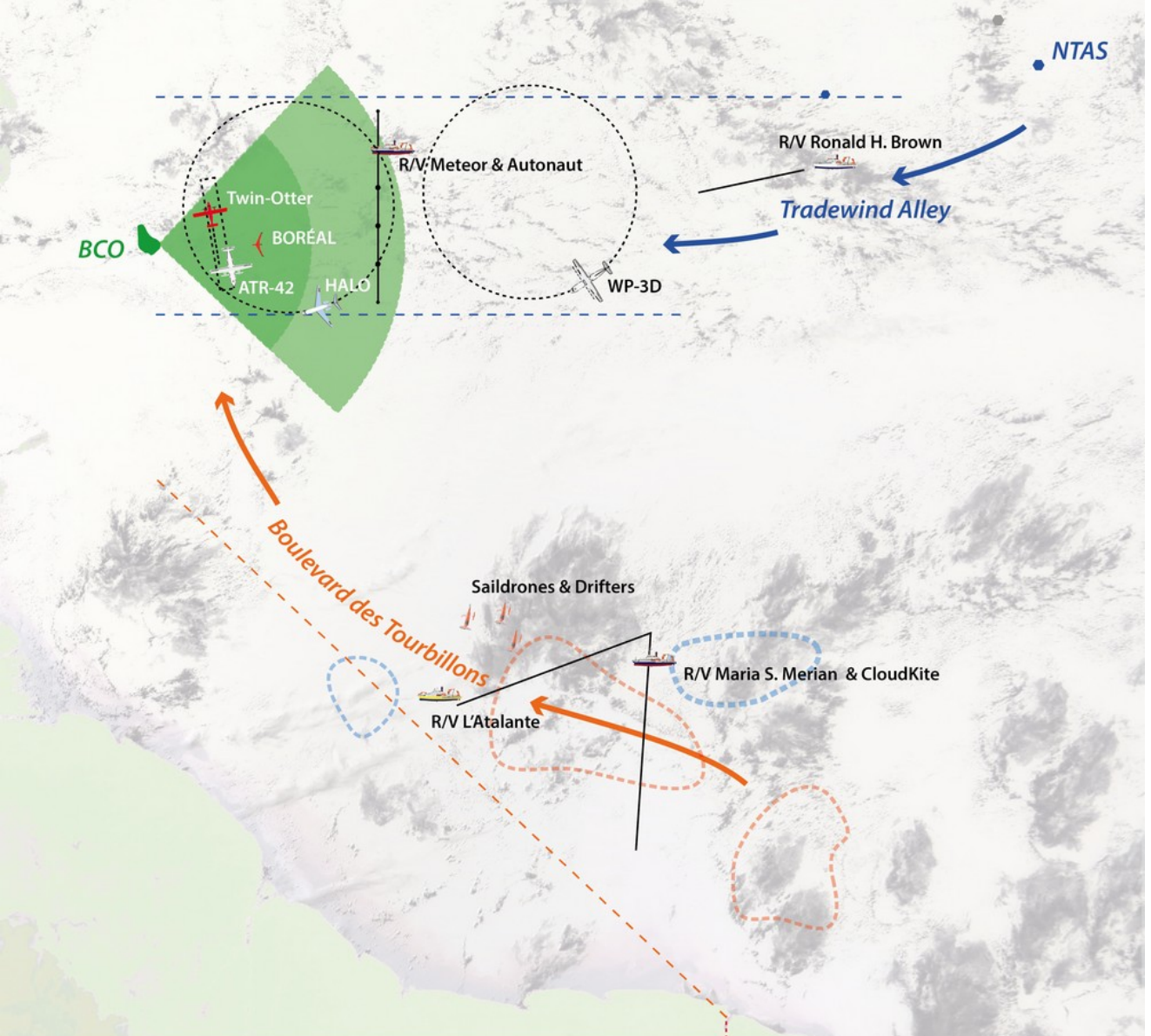

Szymon P. Malinowski – leader
Dariusz Baranowski - principal investigator
Krzysztof Markowicz - co-investigator
Jakub Nowak - investigator
Wojciech Kumala - investigator

Collaborators:

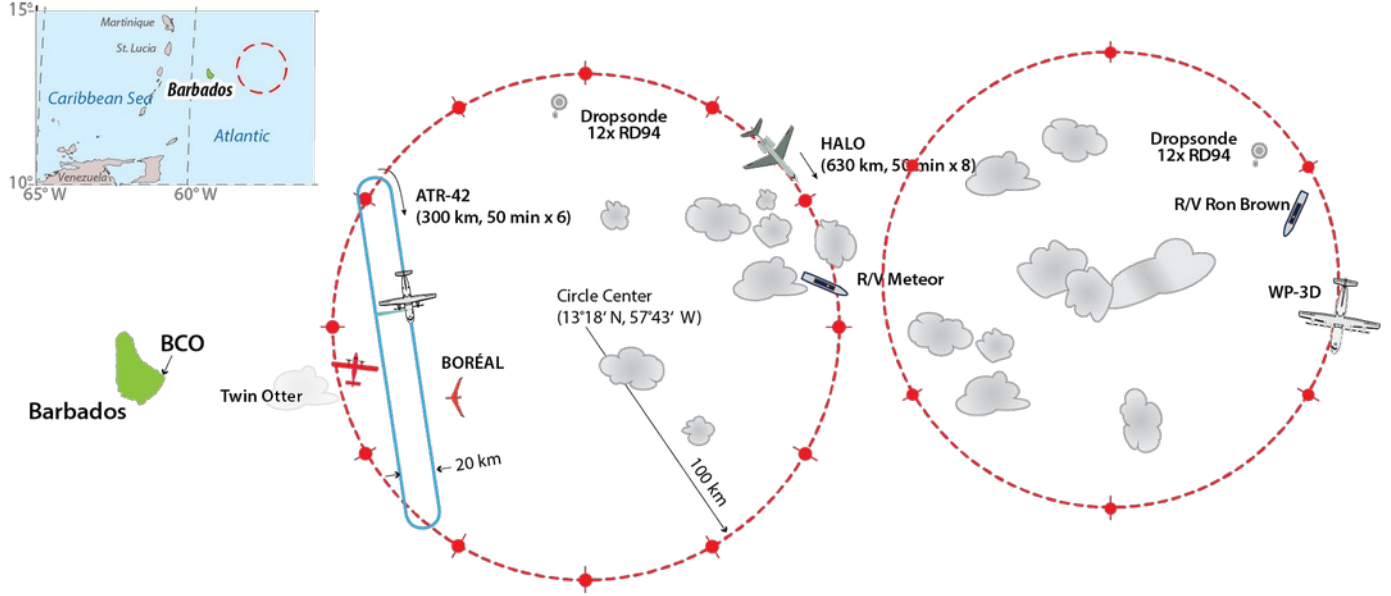
Michał Brennek
Michał Posyniak
Wojciech Szkółka
Michał Chiliński

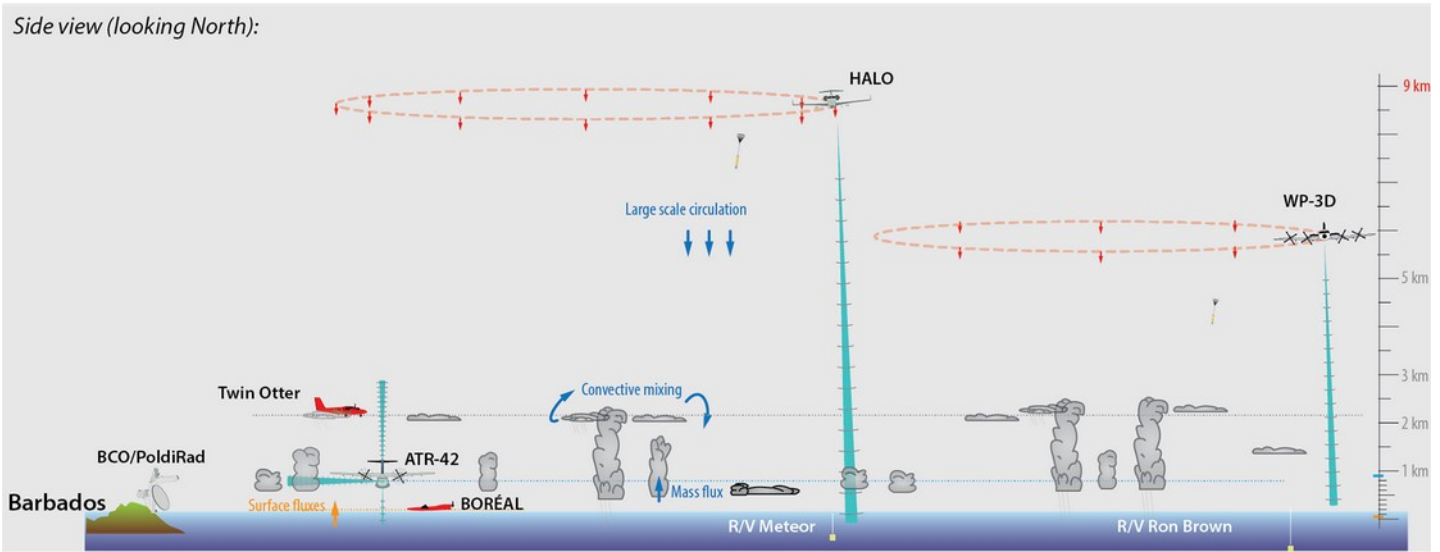


Roseau
26°
Castries
26°
Kingstown
27°
Bridgetown
26°
Saint George's
27°
TRYNIDAD | TOBAGO
Port of Spain
26°
Castries
26°
Kingstown
27°
Bridgetown
26°
Saint George's
27°
Port of Spain
26°

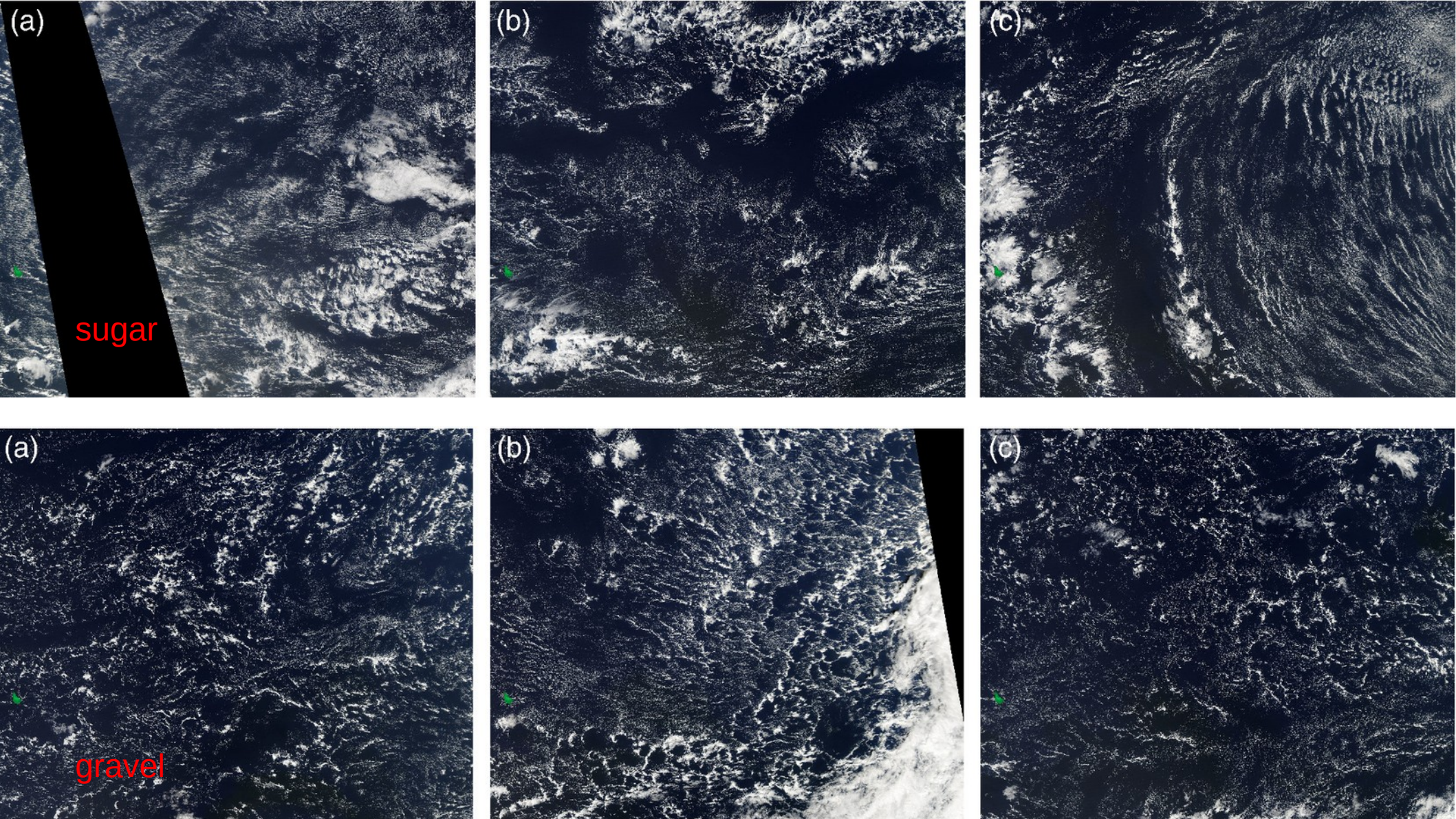


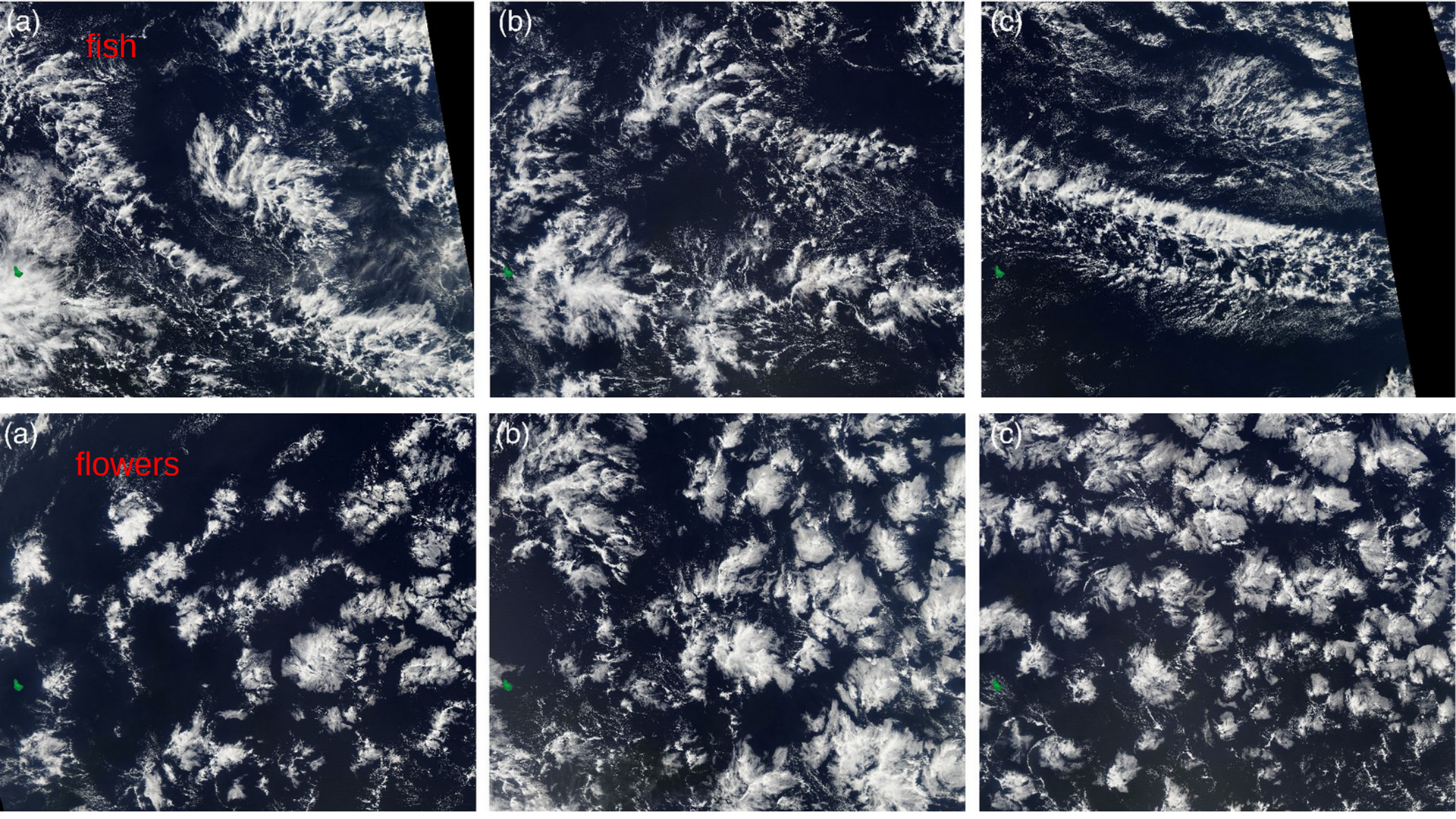

Scheme of the campaign - map




Scheme of the campaign – details of major atmospheric operations




(a)
sugar
(b)
(c)
(a)
gravel
(b)
(c)


(a)
fish
(b)
(c)
(a)
flowers
(b)
(c)

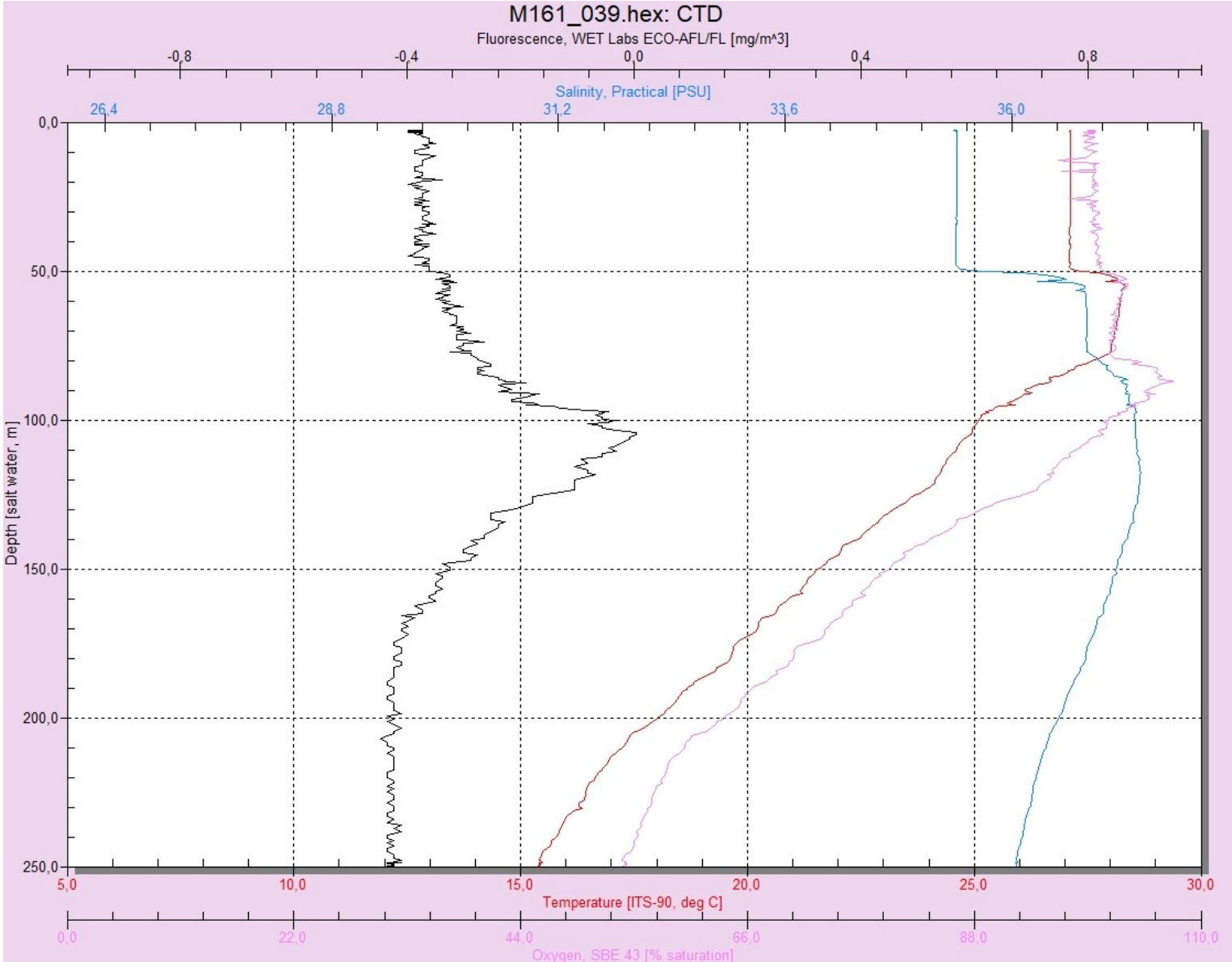
# Major research platforms

On the Island:
Barbados Cloud Observatory (BCO)
and
Ragged Point Observatory

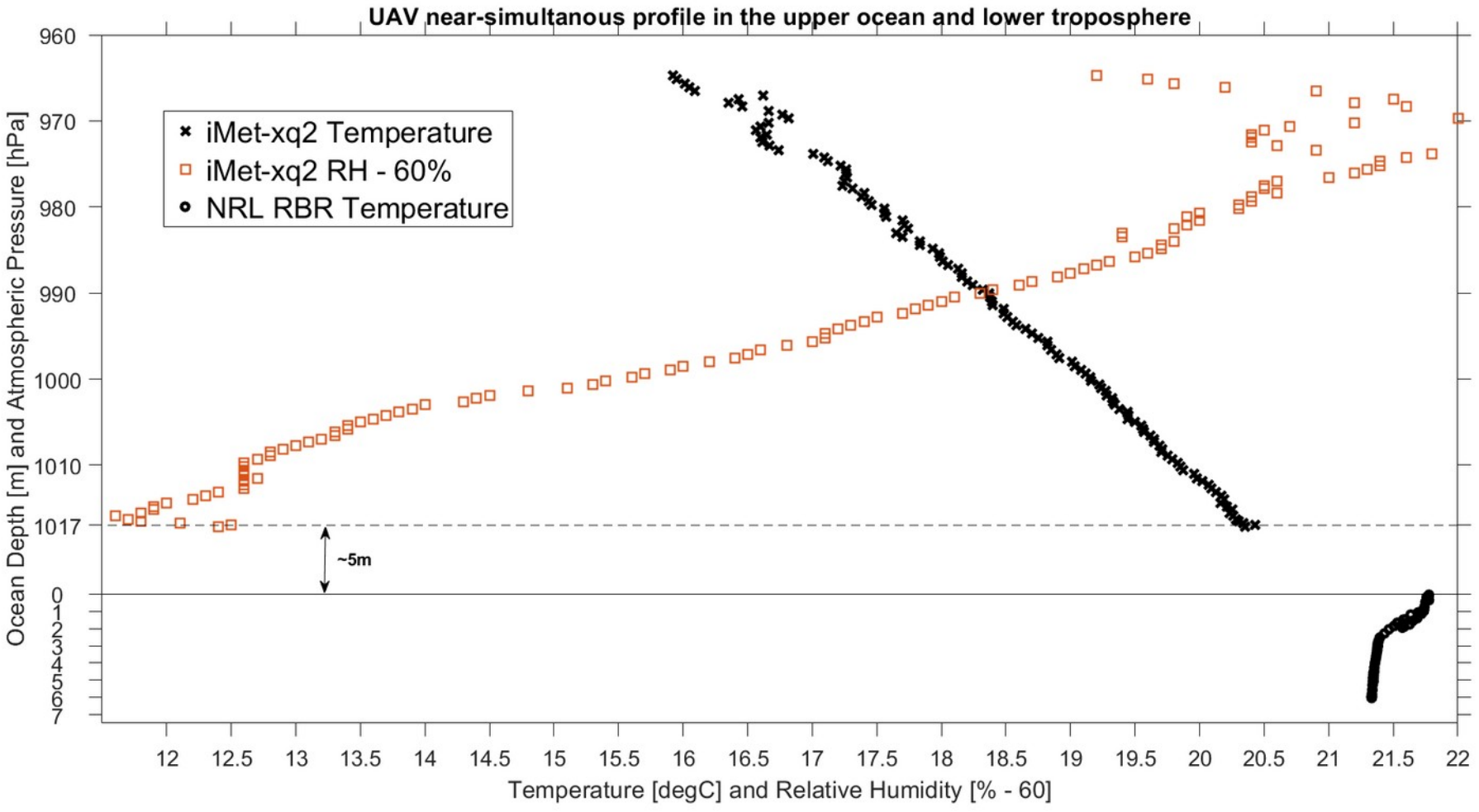
# Barbados: radar POLDIRAD



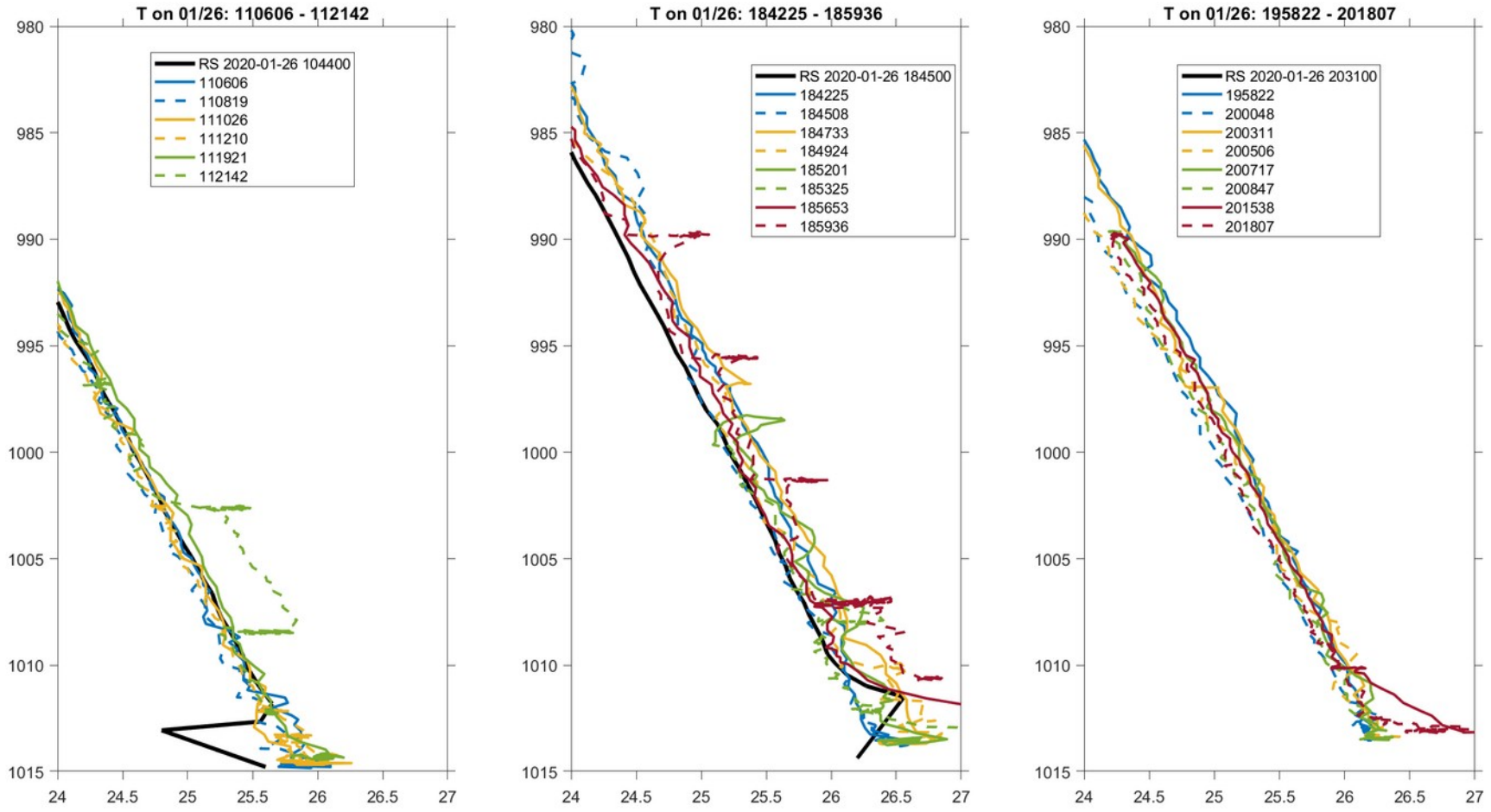
R/V Meteor stopped for a series of  multiple measurements: CTD, cloudkite and quadcopter drone.


M161_039.hex: CTD
Fluorescence, WET Labs ECO-AFL/FL [mg/m^3]
-0,8
-0,4
0,0
0,4
0,8
Salinity, Practical [PSU]
26,4
28,8
31,2
33,6
36,0
0,0
50,0
100,0
150,0
200,0
250,0
Depth [salt water, m]
5,0
10,0
15,0
20,0
25,0
30,0
Temperature [ITS-90, deg C]
0,0
22,0
44,0
66,0
88,0
110,0
Oxygen, SBE 43 [% saturation]

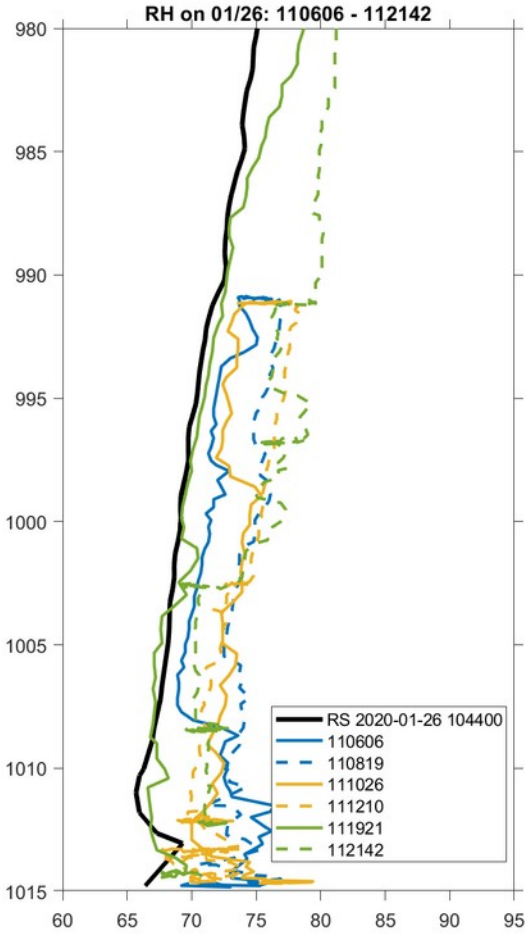
Quadcopter drone (left) and small cloudkite (right) operating from R/V METEOR

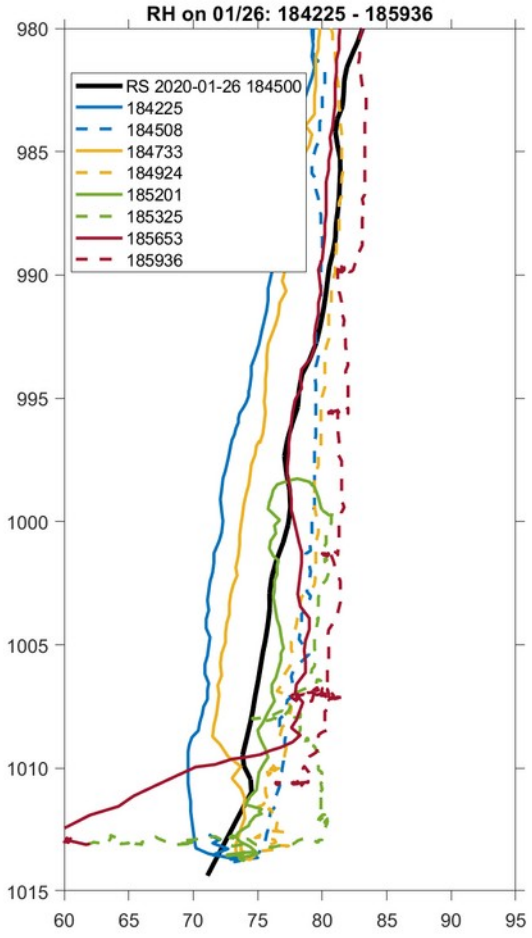

UAV near-simultanous profile in the upper ocean and lower troposphere
iMet-xq2 Temperature
iMet-xq2 RH - 60%
NRL RBR Temperature
~5m
Ocean Depth [m] and Atmospheric Pressure [hPa]
960
970
980
990
1000
1010
1017
0
1
2
3
4
5
6
7
12
12.5
13
13.5
14
14.5
15
15.5
16
16.5
17
17.5
18
18.5
19
19.5
20
20.5
21
21.5
22
Temperature [degC] and Relative Humidity [% - 60]

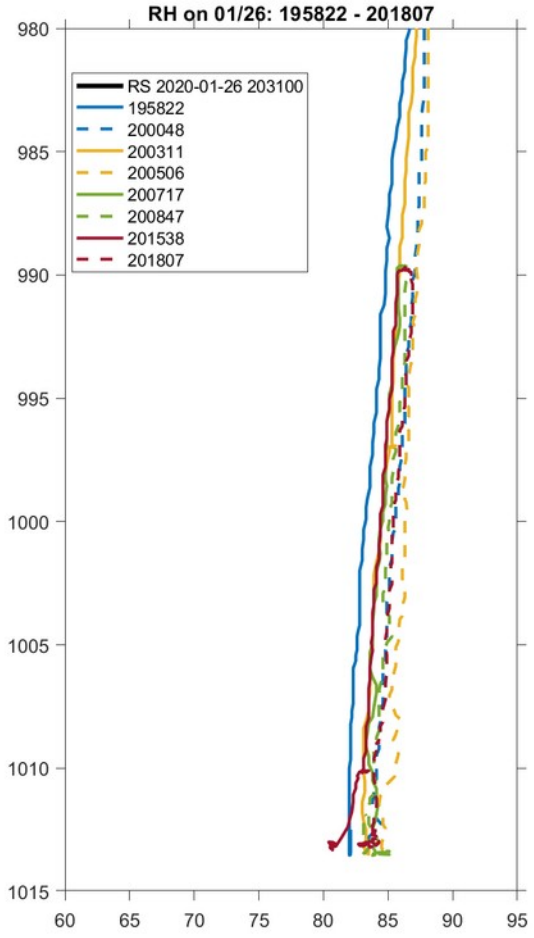
# BL profiling by quadcopter - temperature



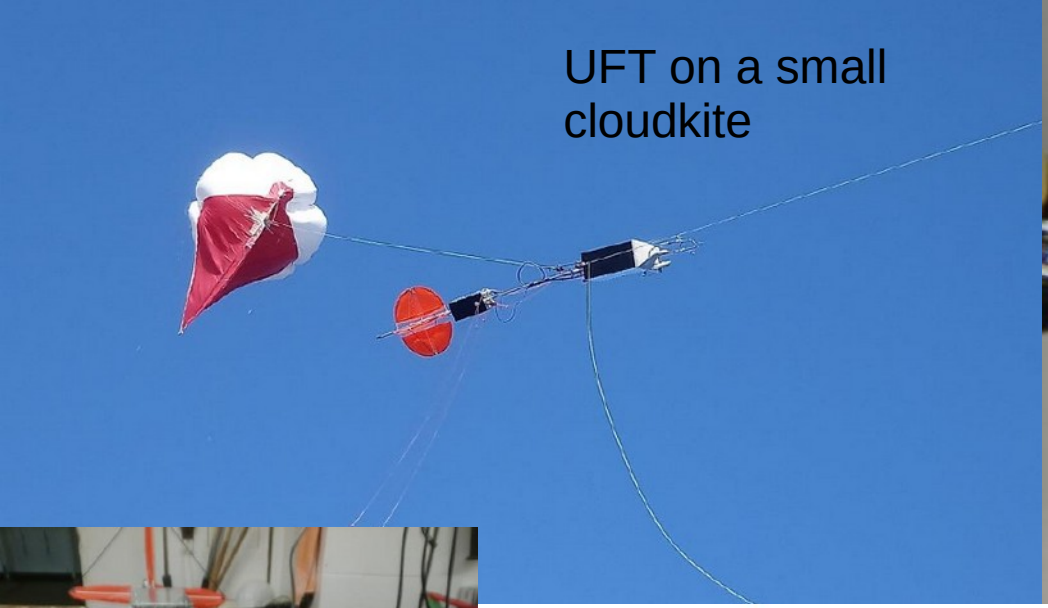
# BL profiling by quadcopter – relative humidity

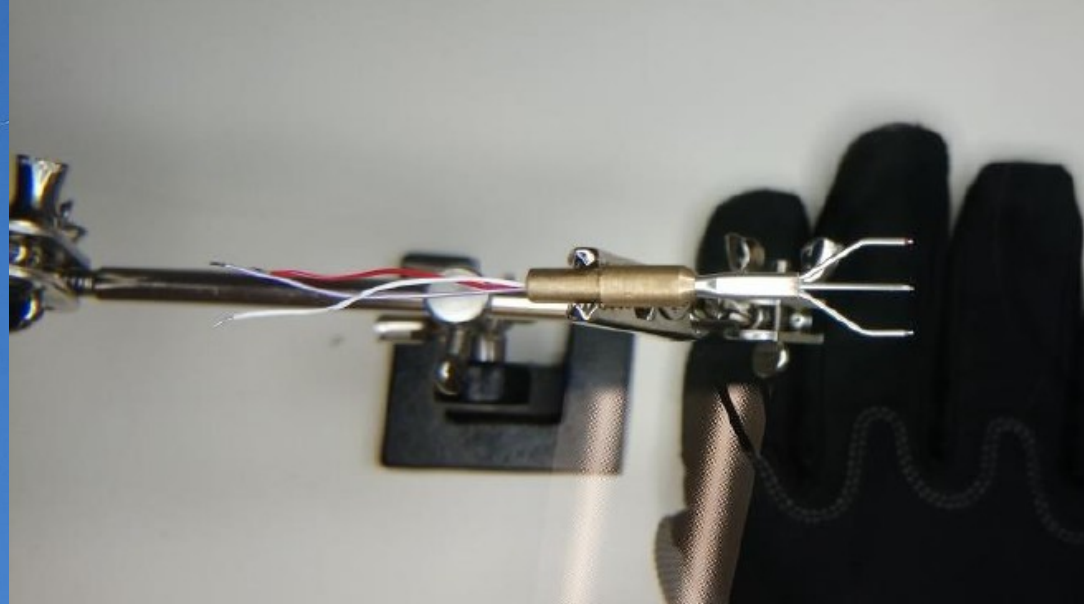


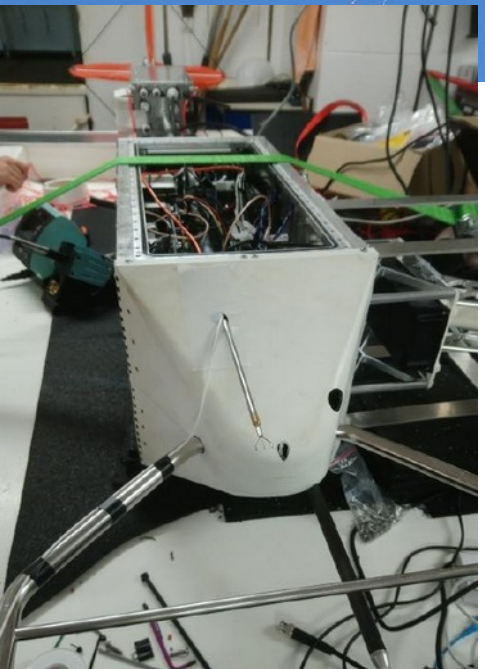



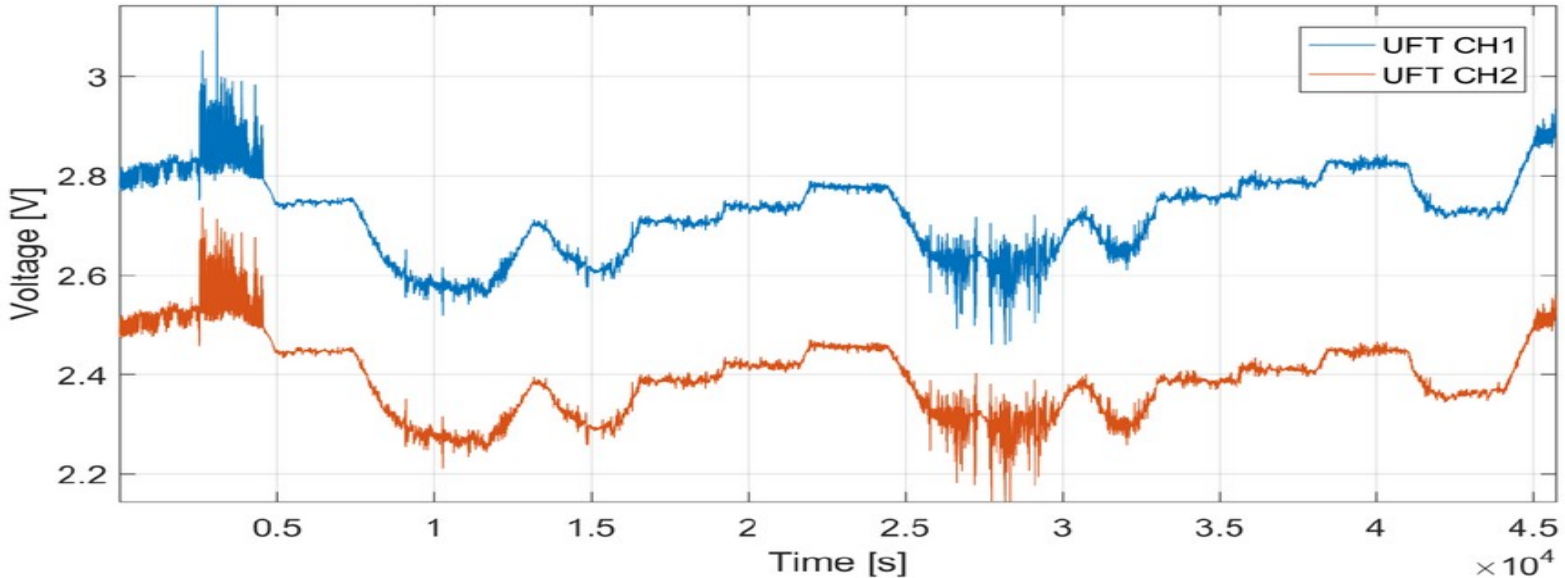



UFT on a small cloudkite



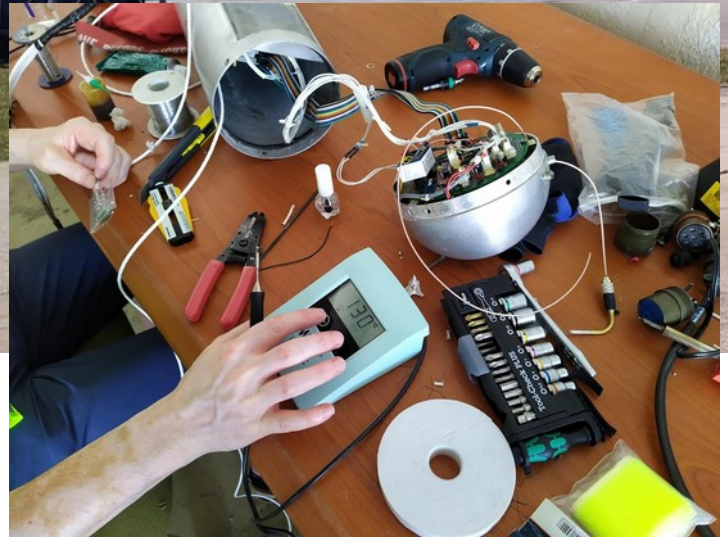




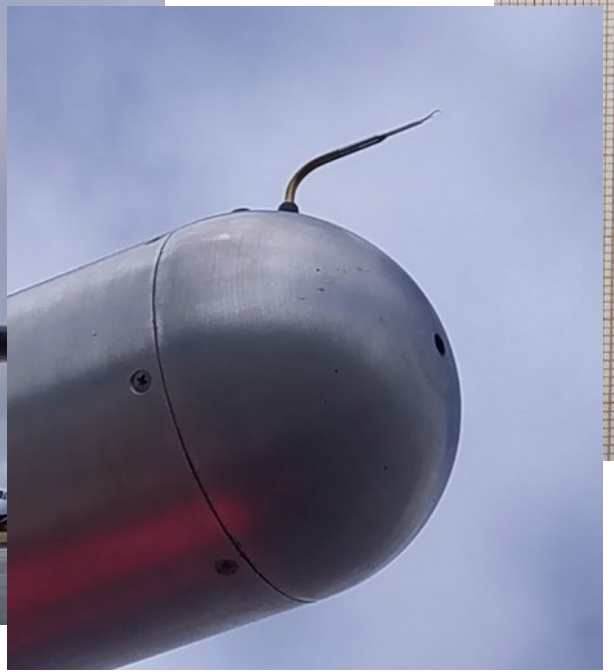


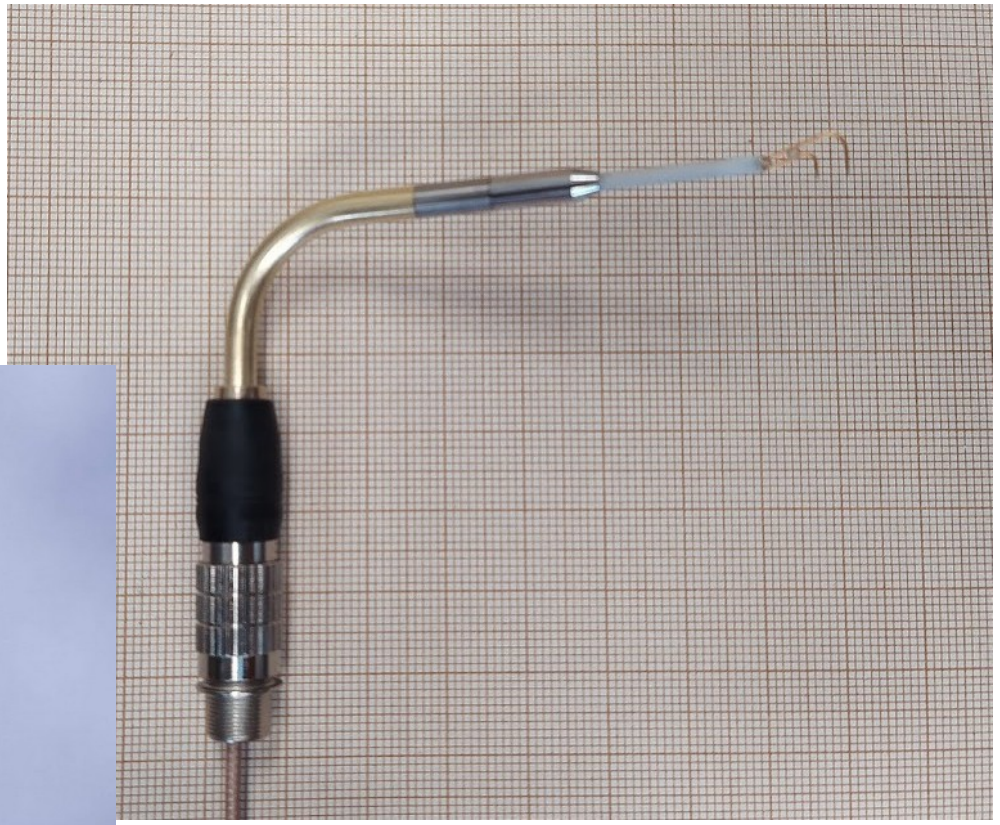
Long range aircraft:

DLR HALO
and NOAA P3



French  ATR-42 and British Twin Otter – preparations at the airport.

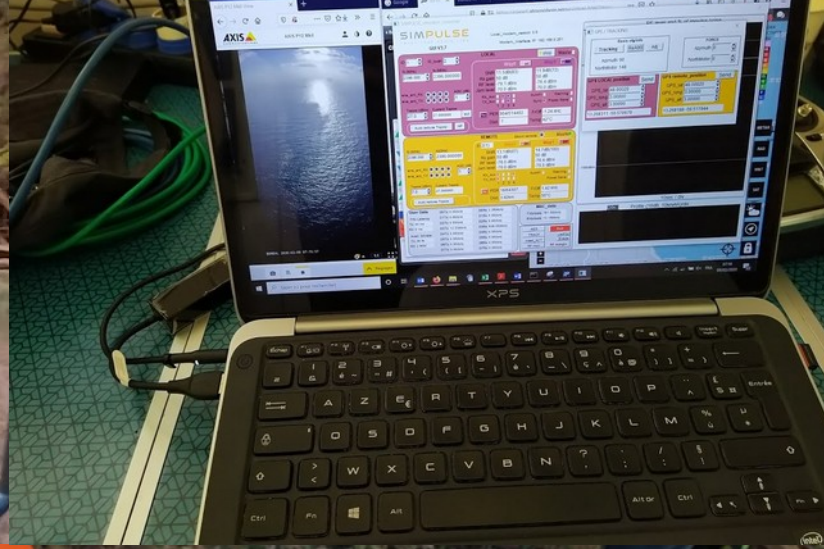




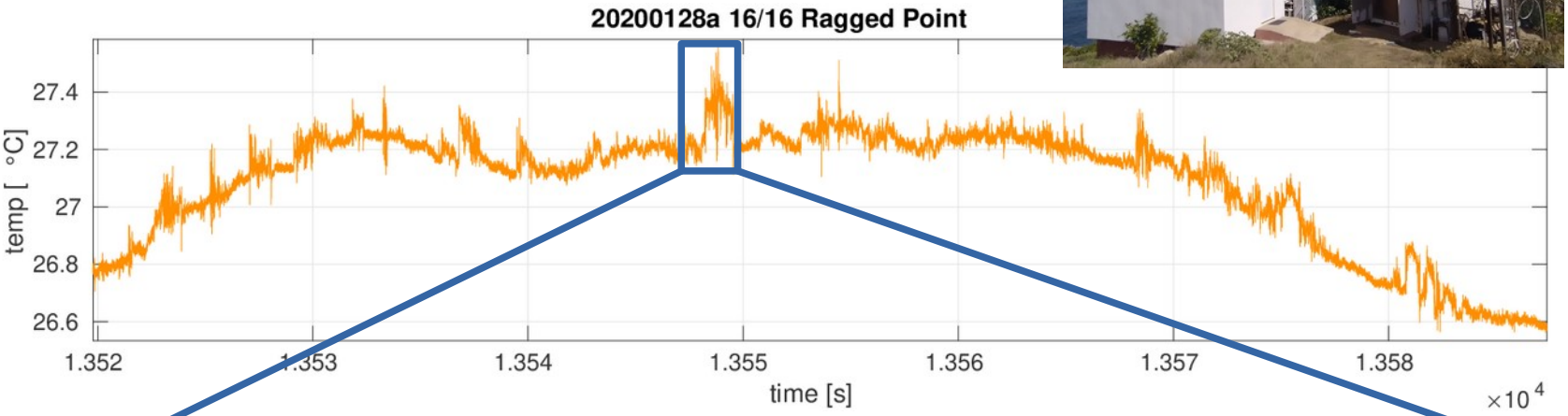
A special version of the UFT mounted on the turbulence probe of BAS Twin Otter

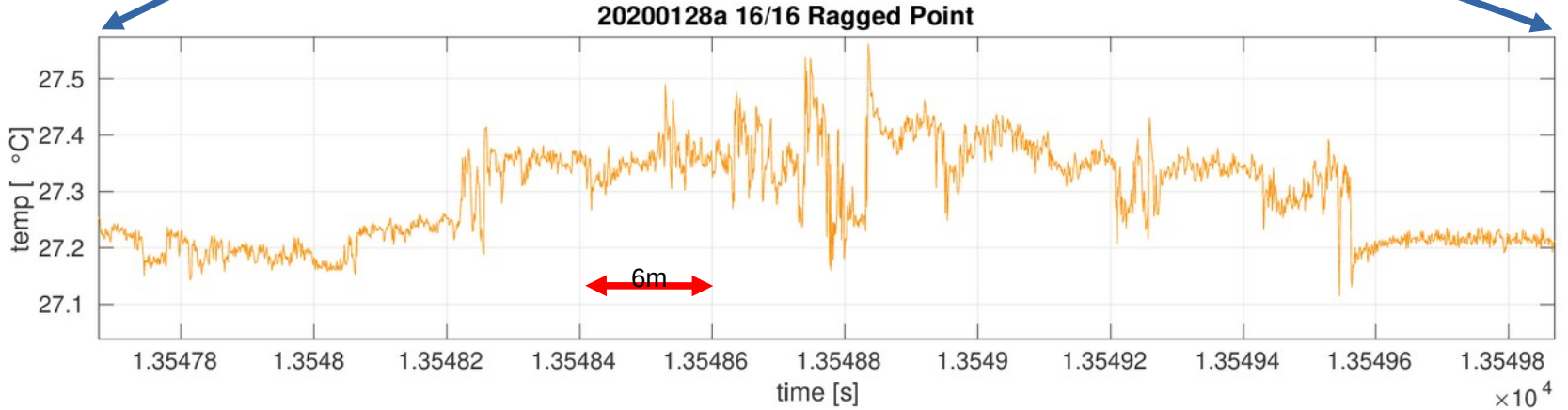
# Mounting of the UFT on BAS Twin Otter

UFT on BOREAL drone

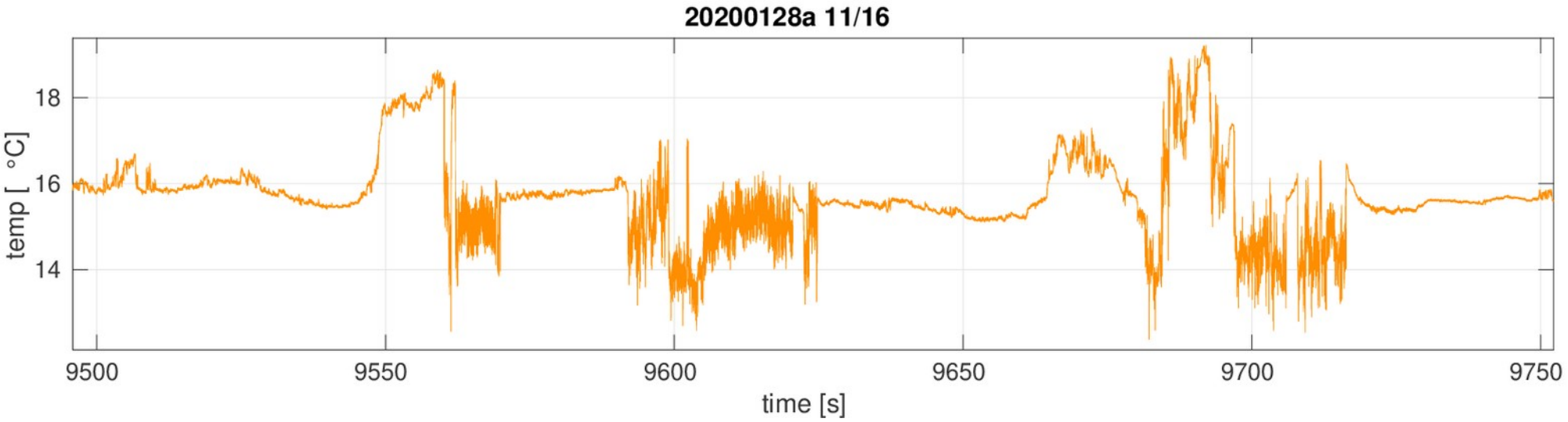


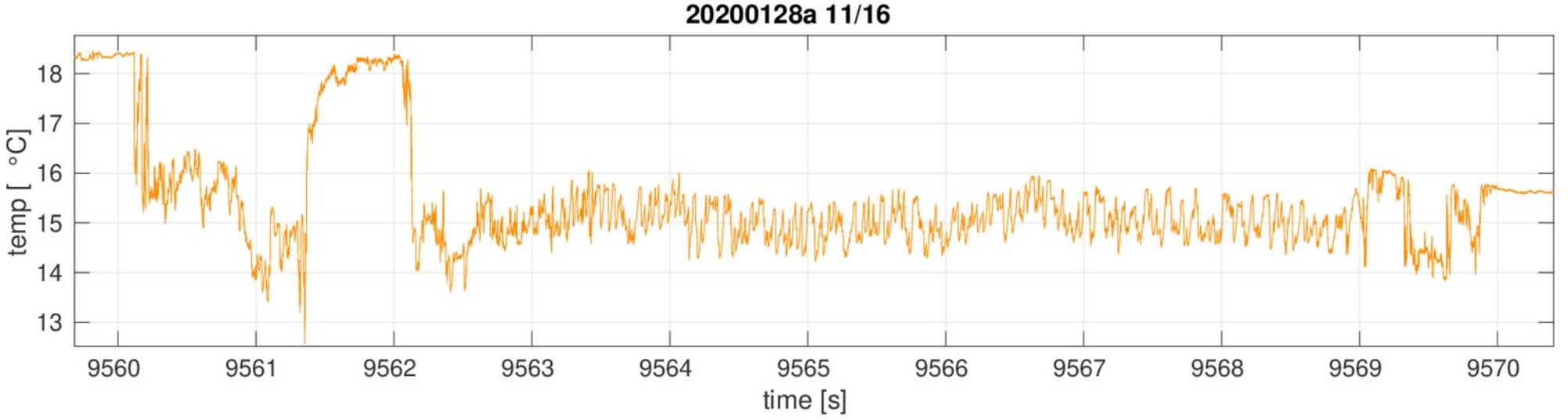

# UFT-2, BAS Twin Otter, 30 m above the sea next to Ragged Point / BCO observatories



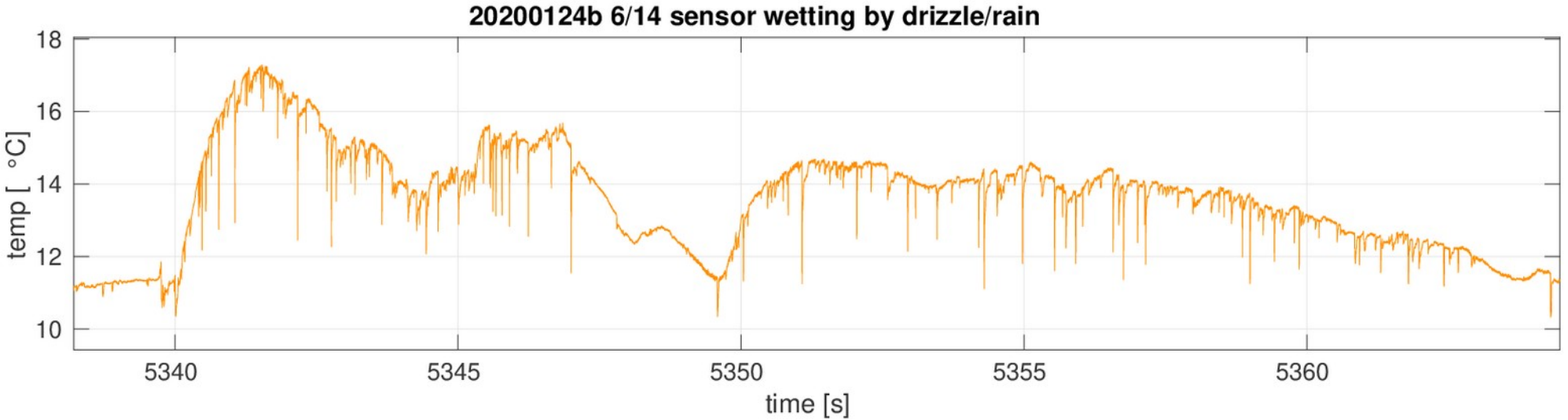



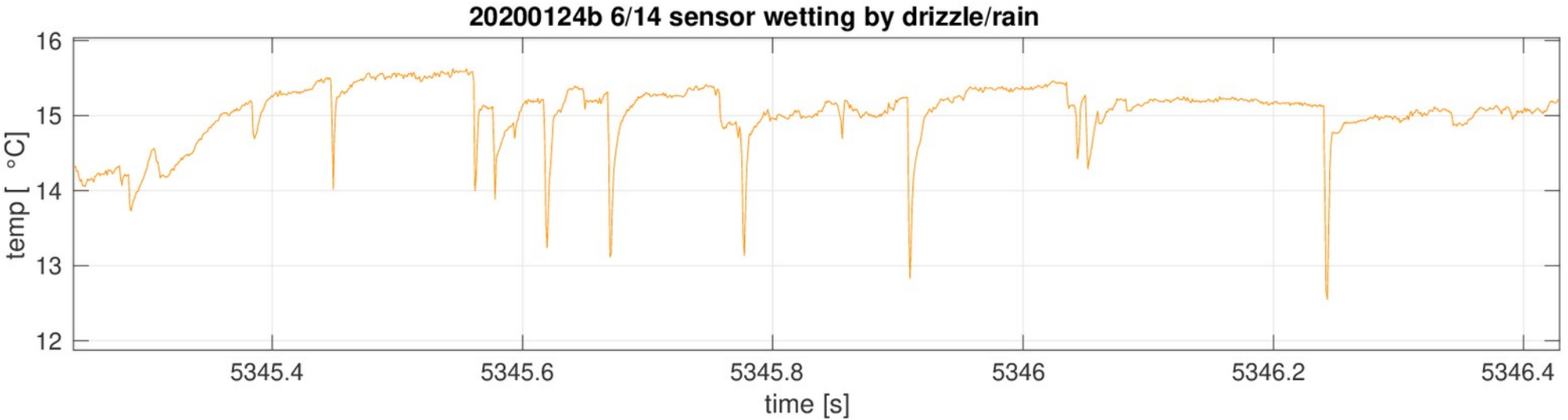
UFT-2, BAS Twin Otter, penetration of successive clouds (upper panel) and blow-up (lower panel)

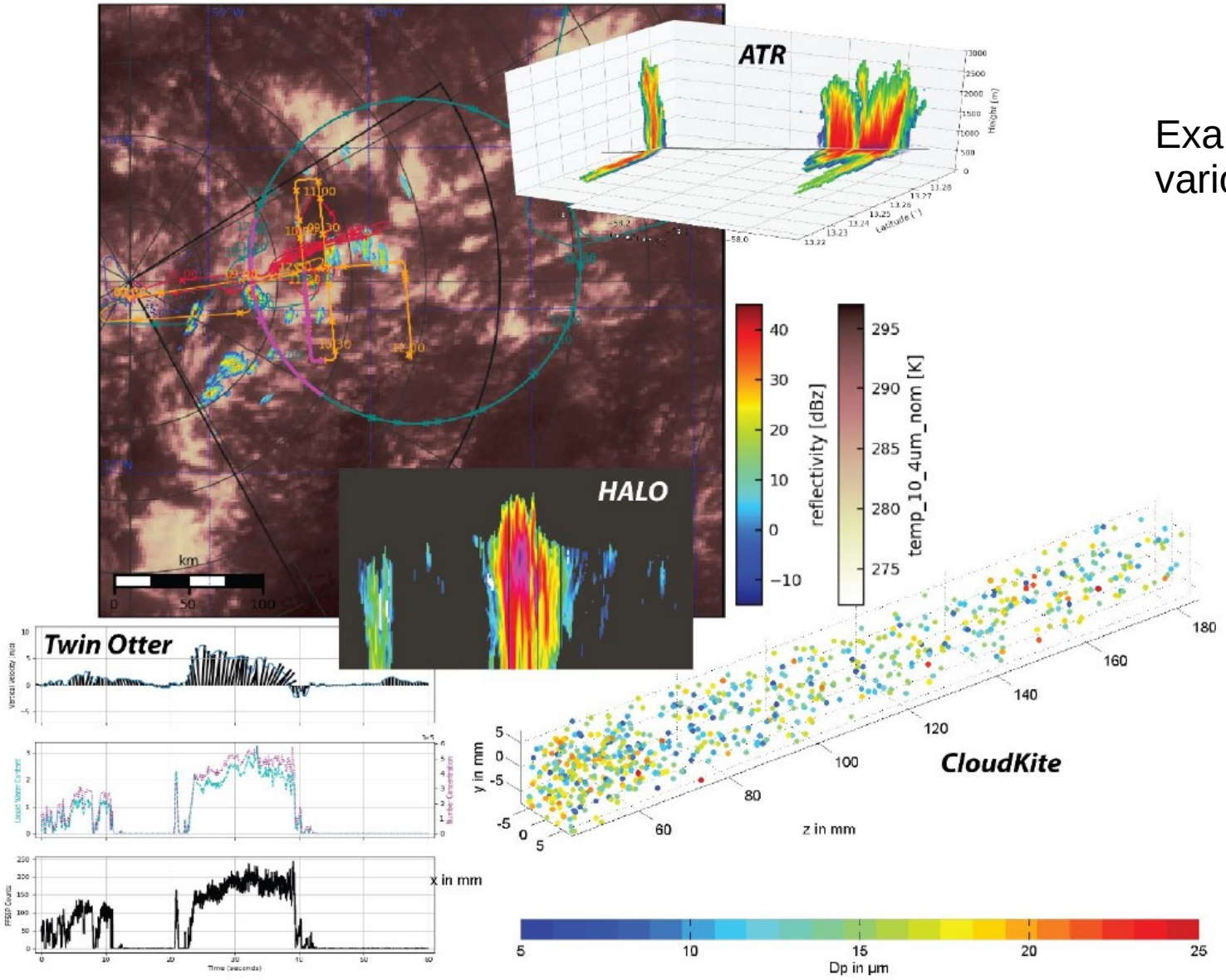


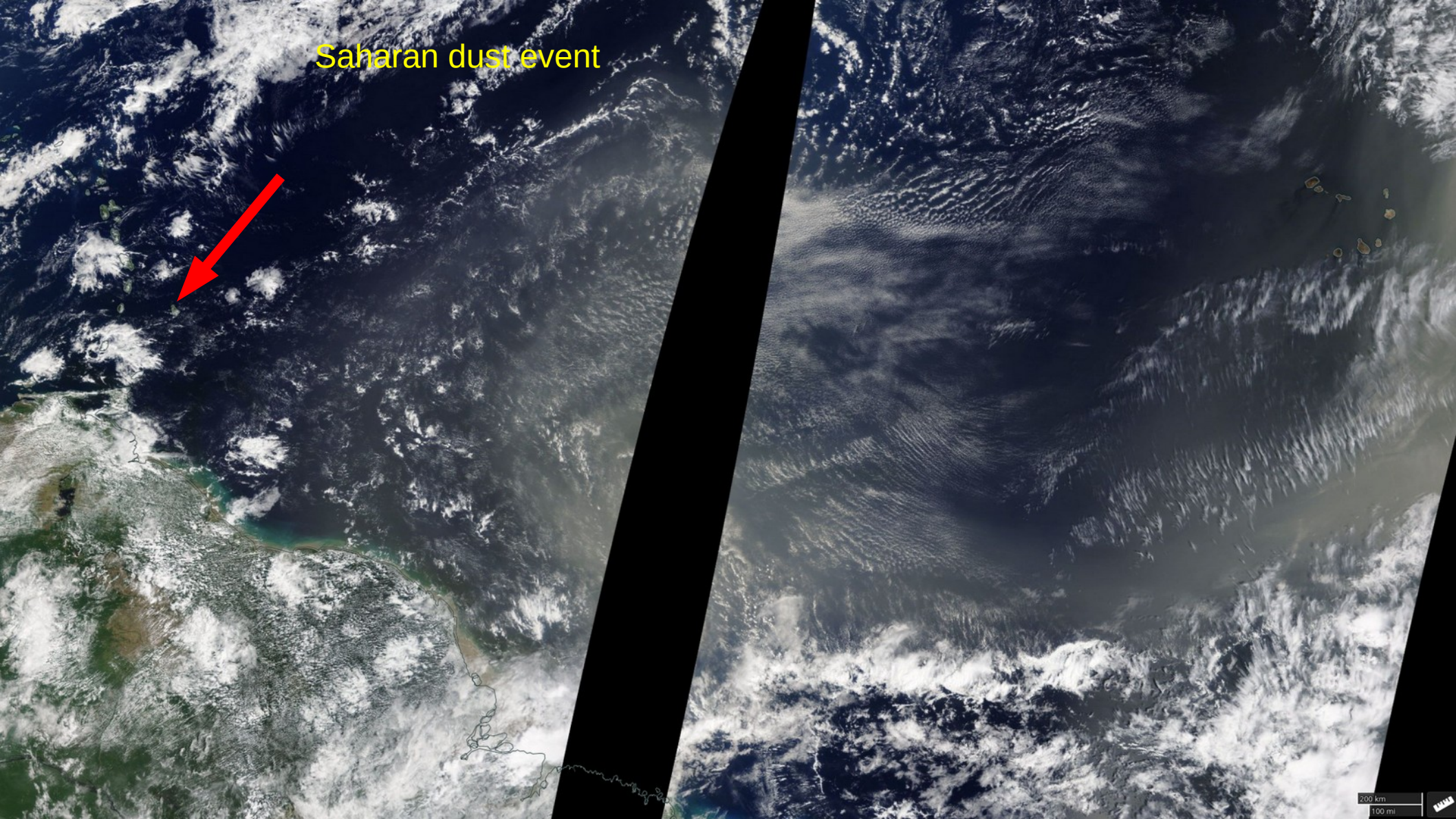
UFT-2, BAS Twin Otter, in clouds

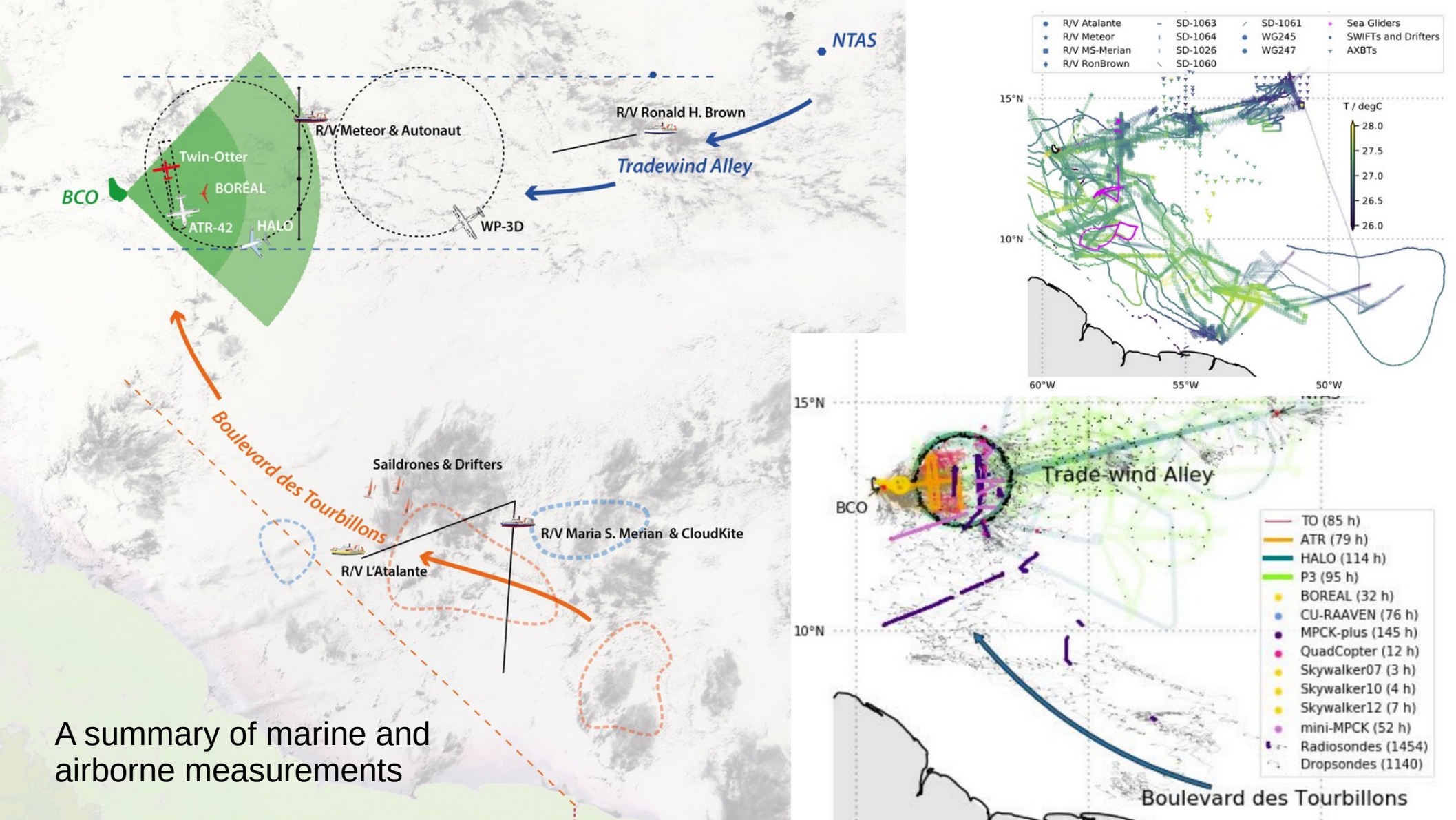




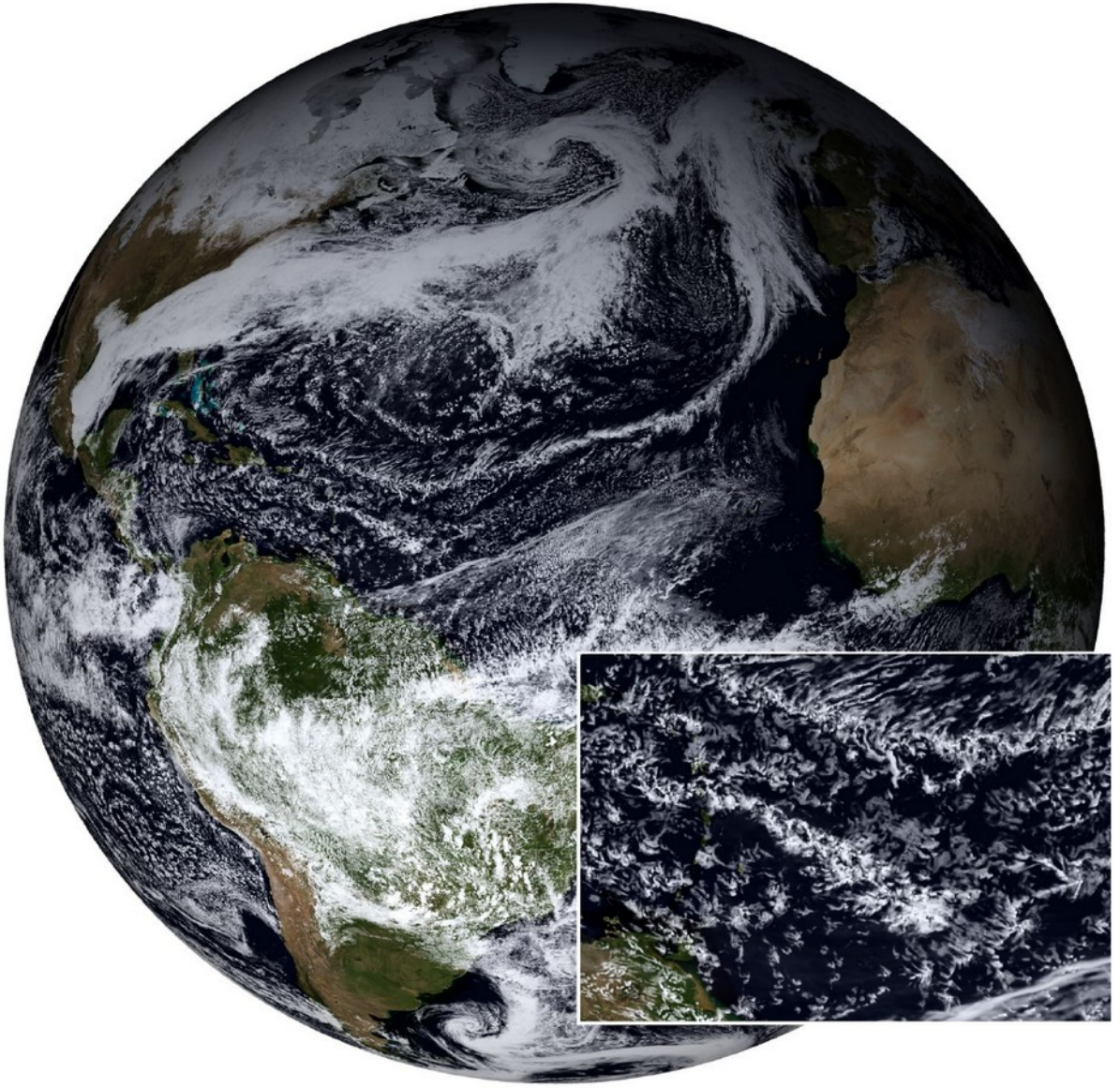

Example records from various aircraft


Saharan dust event
200 km
100 mi




A summary of marine and airborne measurements

Associated numerical simulation,
global 2.5km resolution,
initialized,January, 20,
snapshot February, 2.



From an overview paper (in preparation):

„At this time we can report that the execution of EUREC4 A was successful. All of the measurements we set out to make have been made. In retrospect, with the worldwide spread of the COVID-19 Pandemic shortly after field operations concluded, this ends up being a stroke of even greater fortune.
For some key measurements, such as those of the mean mesoscale vertical motion field, preliminary analyses  suggest that they have the desired information content. The analysis of other measurements, such as those that aim to quantify clouds, is more delicate and ongoing.
Together we anticipate that at the conclusion of this analysis we will have learned a great deal more about the ways of clouds, how they couple to circulation systems on different scales, how they influence and are influenced by the upper ocean and the extent to which they are susceptible to perturbations in the aerosol environment.  A better quantification of these sensitivities will help us understand to what extent a warmer world will express the majesty of clouds less markedly.”

*B. Stevens, S. Bony and coauthors*

ACKNOWLEDGMENT:

Polish participation in The EYREC4A/ATOMIC campaign was supported by Poland’s National Science Centre grant under agreement UMO-2018/30/M/ST10/00674