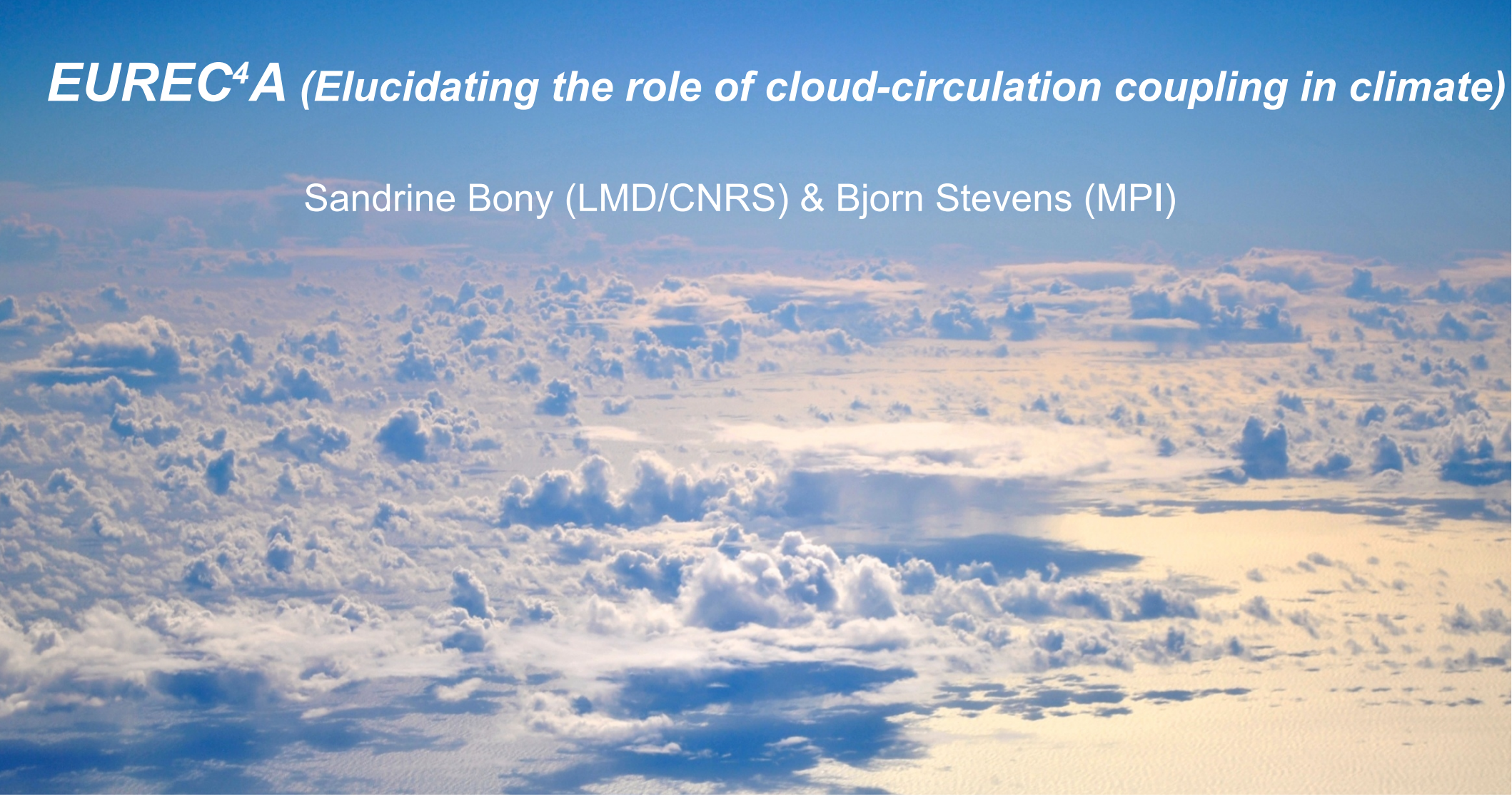
EUREC^{4}A *(Elucidating the role of cloud-circulation coupling in climate)*

Sandrine Bony (LMD/CNRS) & Bjorn Stevens (MPI)



A multi-platform international field campaign (French-German led) in support of the WCRP Grand Science Challenge on Clouds, Circulation and Climate Sensitivity.

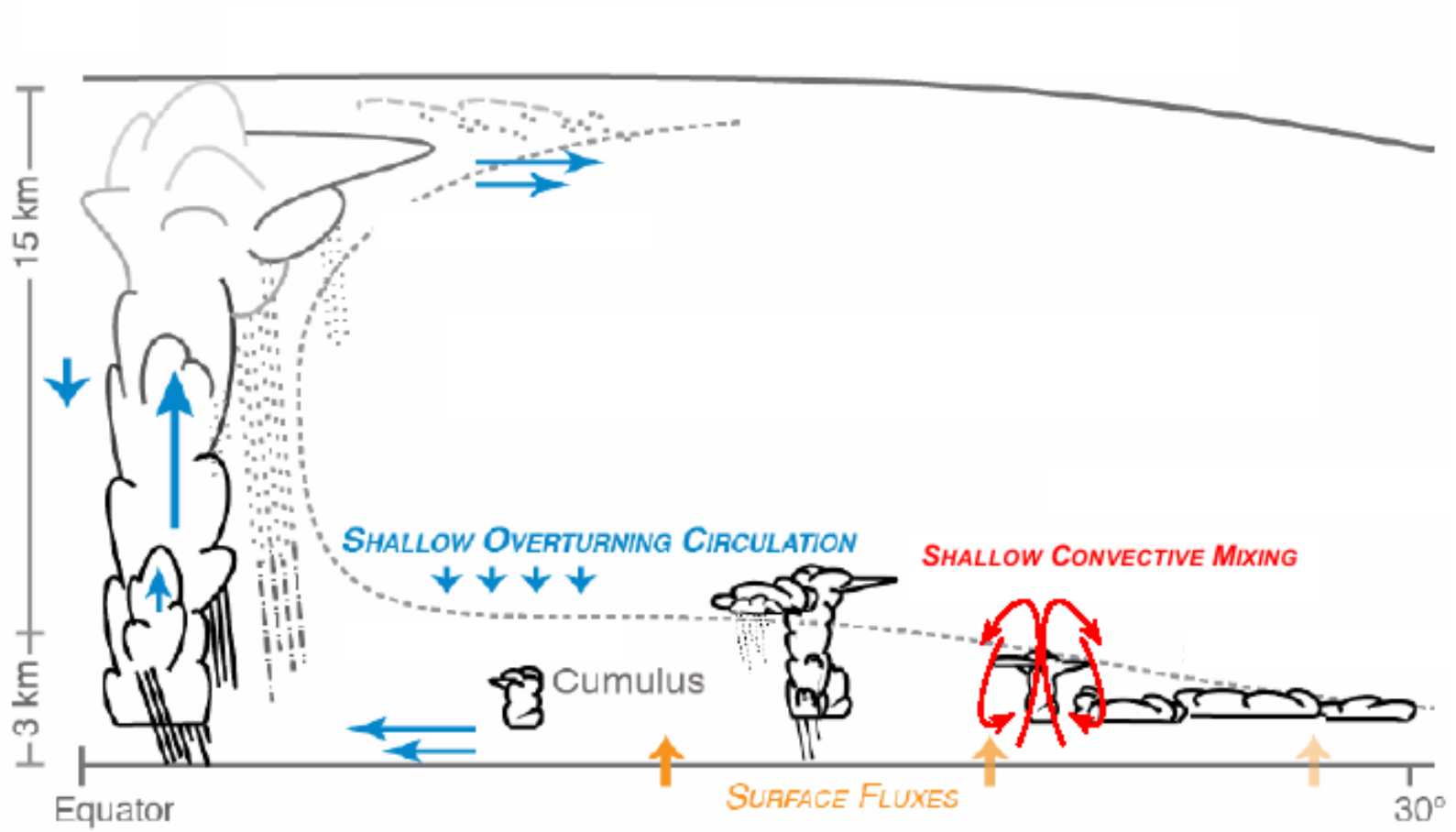
http://www.mpimet.mpg.de/en/science/the-atmosphere-in-the-earth-system/narval-eurec4a/

WCRP World Climate Research Programme

erc

DFG

Low-cloud feedbacks remain the primary cause of uncertainty in model estimates of climate sensitivity



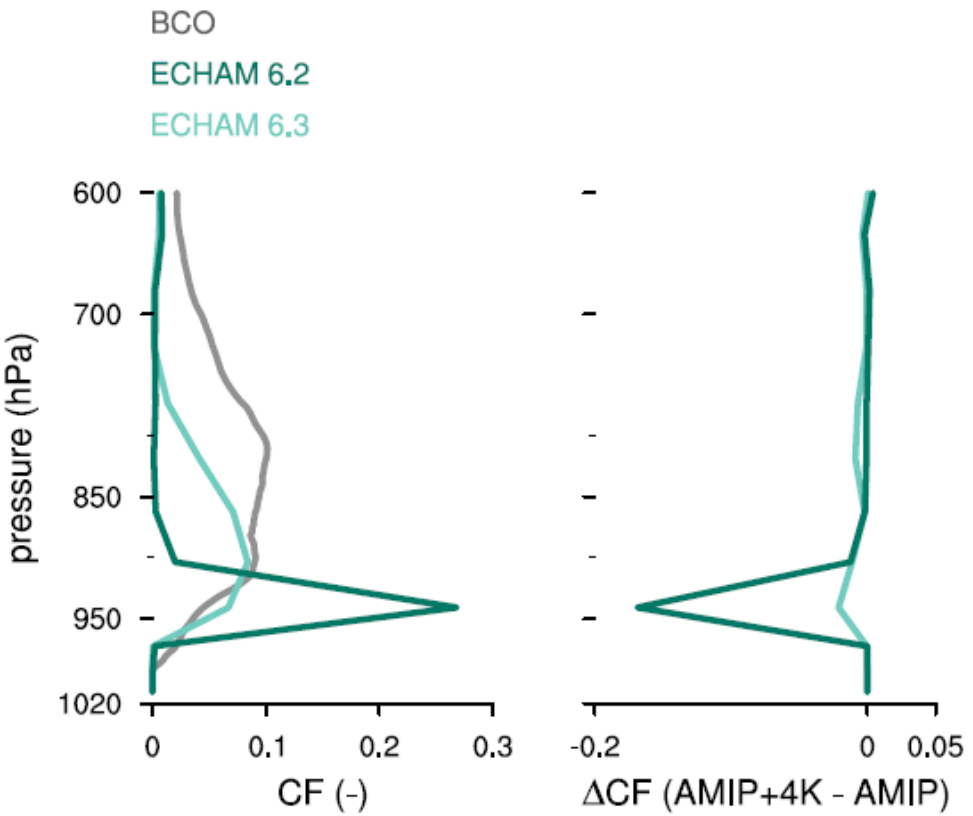
Key processes:

- surface turbulent fluxes
- lower-tropospheric mixing (by shallow convection and large-scale circulations)
- atmospheric cloud-radiative effects

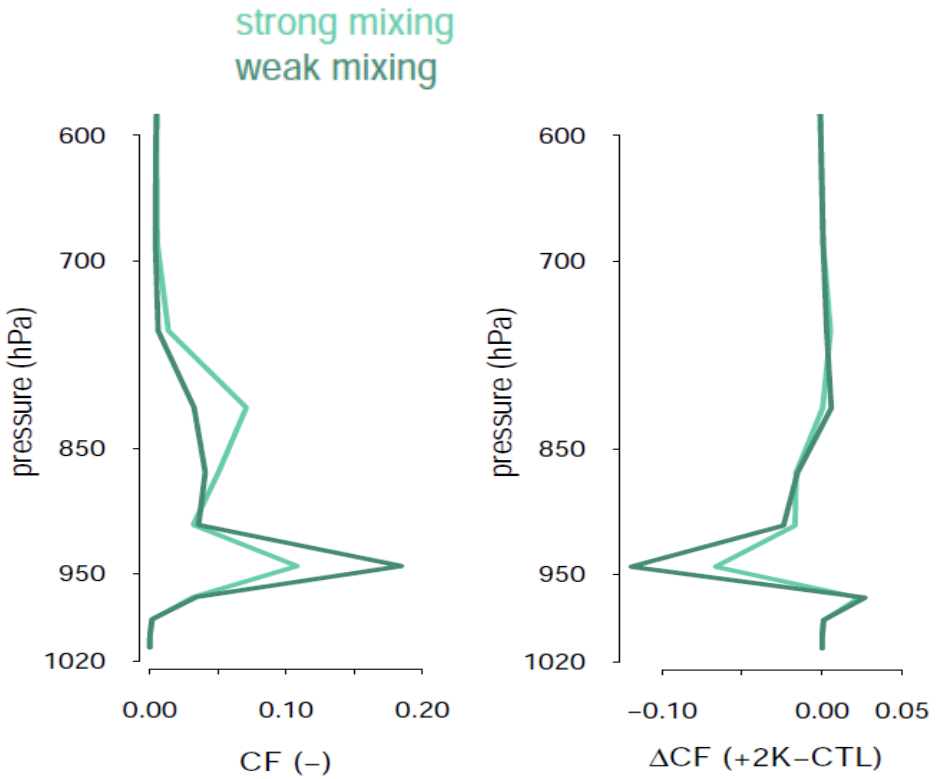
\+ mesoscale organization?

Low-cloud feedback and lower-tropospheric mixing in GCMs

MPI GCM:



IPSL GCM:



Stevens et al, BAMS (2015); Vial et al. (submitted)

EUREC^{4}A (Elucidating the role of cloud-circulation coupling in climate)

EUREC^{4}A is planned to take place east of Barbados (13N, 59W) and involve two research aircrafts equipped with advanced instrumentation for characterizing clouds (lidar and radar) and their large-scale environment (extensive dropsondes) in 2019 or early 2020.

EUREC^{4}A will build on results from NARVAL-II and observations at the Barbados Cloud Observatory to:

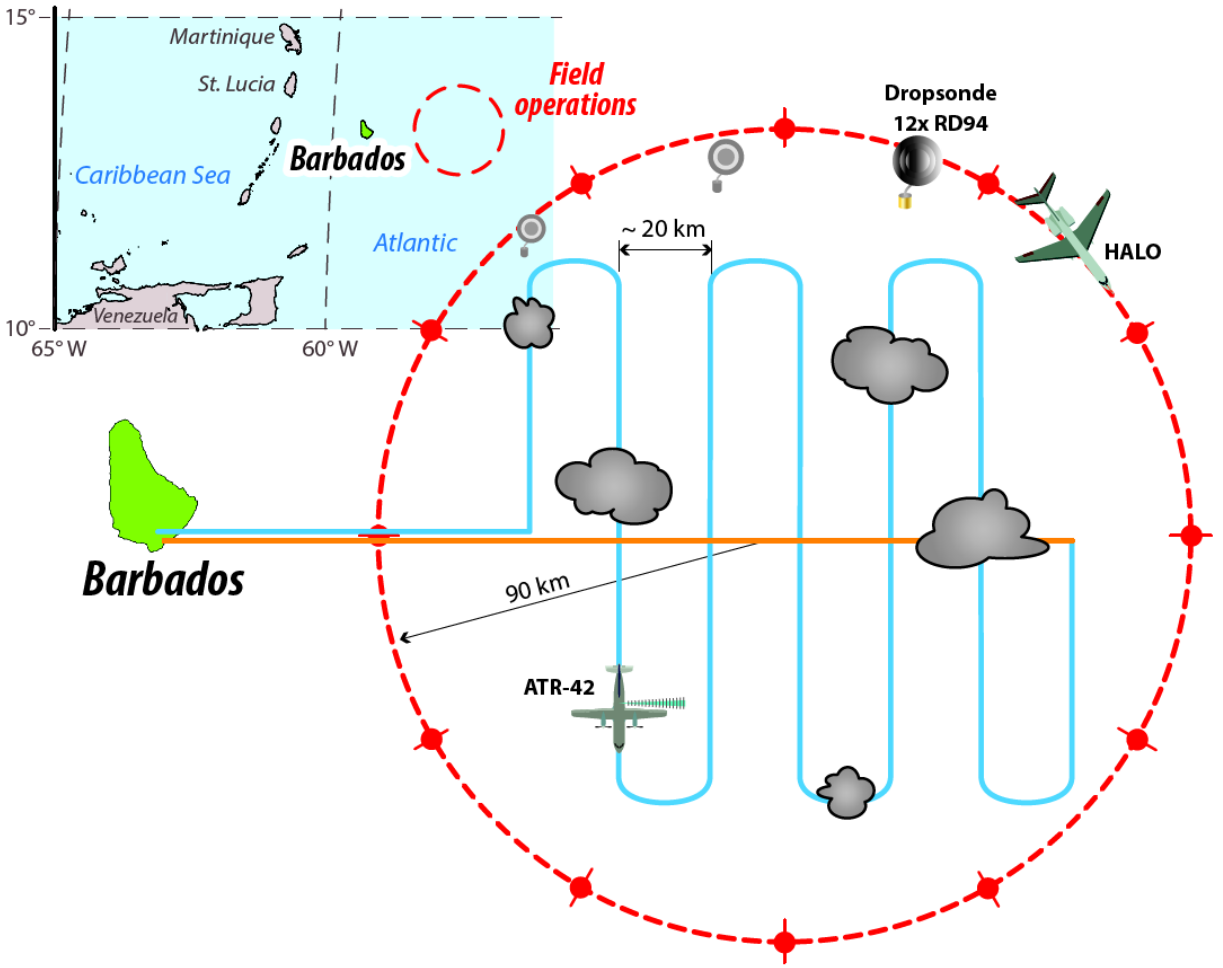
- Investigate, for the first time, **how the shallow cumulus cloud field** (including the cloud fraction and its spatial organization) **relates to convective-scale and large-scale circulations**

- Close the heat, mass and moisture budgets within the sub-cloud layer to infer the convective mass flux (and its coupling to surface fluxes, radiative cooling and cloud fraction), and thus **test leading hypotheses for how low-level clouds respond to warming**

- **Investigate the processes that drive the mesoscale organization of shallow convection**, and the impact of this organization on the cloud fraction and atmospheric properties

- **Provide validation for a new generation of space-based remote sensing**, e.g. ADM-AEOLUS, EarthCare, water-vapor profiling, surface fluxes retrievals

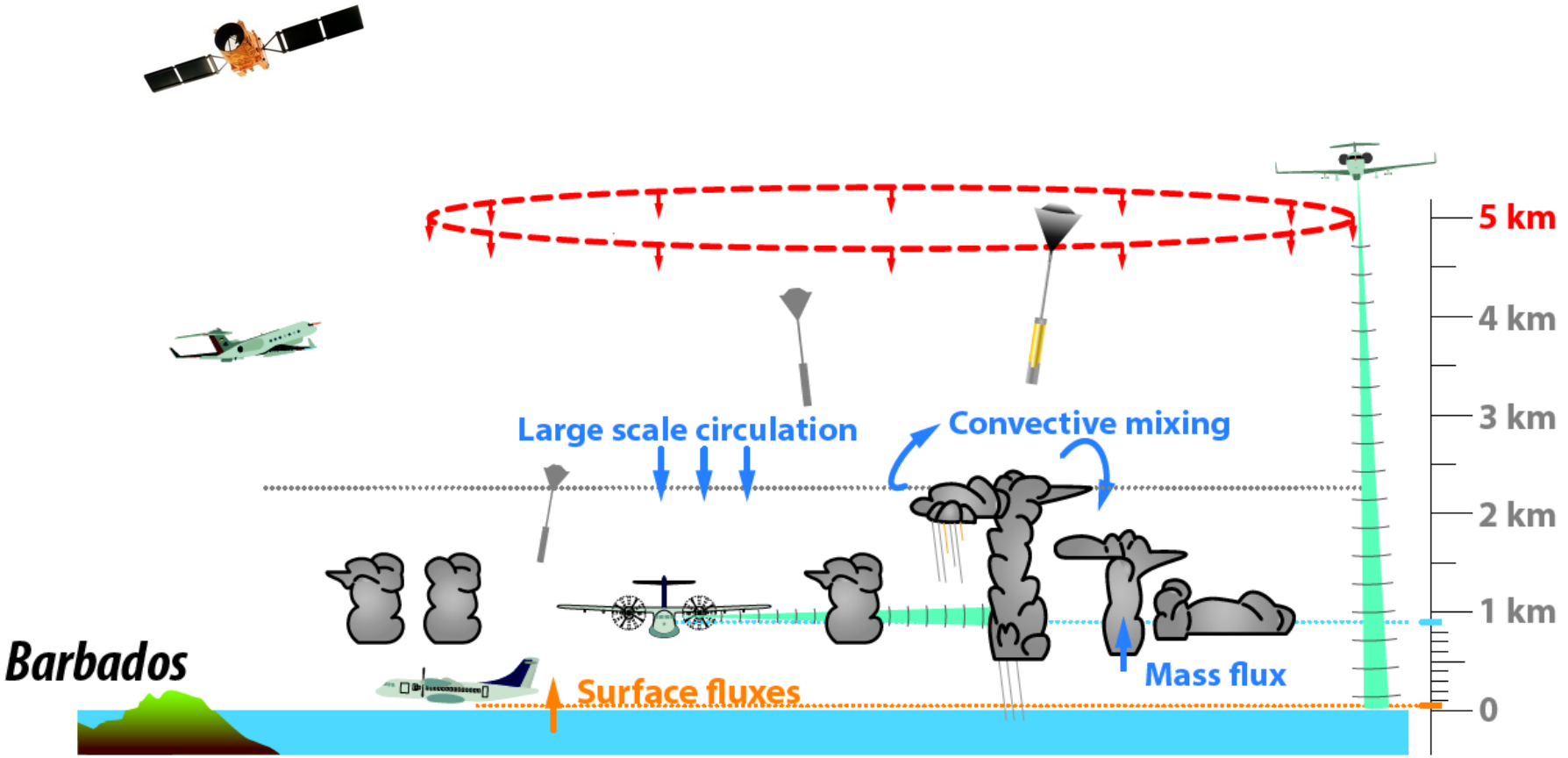
EUREC⁴A (Elucidating the role of cloud-circulation coupling in climate)



- Shallow cumulus cloud cover and boundary-layer properties measured through a series of low-level legs flown either just above cloud base (~1 km) or near the surface.

- Large-scale subsidence and vertical structure of the atmosphere measured through higher-level flights describing large circles (~ 500 km) at 5 km altitude.

EUREC^{4}A *(Elucidating the role of cloud-circulation coupling in climate)*



- A sideways-staring lidar on board the ATR will measure the cloud fraction near cloud base.

- Large-scale vertical velocity from the surface to the mid-troposphere will be measured by launching a dense array of dropsondes along the HALO circles and measuring the divergence profile of the horizontal wind.

- The convective mass flux at cloud base will be inferred from the mass budget of the mixed subcloud layer.

Status and developments (1)

- Timing: 2019 vs 2020?
  - Measurements in undisturbed conditions, i.e., December to May preferred
  - Launch ADM-Aeolus and EarthCare uncertain; 2020 probably better for EarthCare

- Aircraft:
  - ATR-42 supported for a month deployment in 2019 or early 2020 (flexible).
  - Support from the MPG (Hamburg) for HALO component, proposal pending.

- EUREC^{4}A ideas and methodologies will be tested through:
  - Narval2 (measurement of omega through a large array of dropsondes)
  - lidar simulator (looking sideways) applied to LES simulations
  - analysis of satellite observations, Narval and BCO data

- Efforts to further strengthen surface-based and atmospheric remote sensing measurements:
  - DLR Falcon (wind lidar) – opportunity for the validation of ADM-Aeolus measurements in the tropics
  - secure a supporting ship array: Ketch (MPI for Chemistry), Meteor?
  - buoys? barge? research vessel Flip?
  - ARM Mobile Facility?

Status and developments (2)

• Strong link to high-resolution modeling efforts (e.g.through HD(CP)2) and GCM modeling efforts

• Developing link to satellites through ISSI international science team (pending proposal)

• Opportunity to address additional science questions, e.g.:
  - influence of cloud microphysics on cloud macrostructure (e.g. aerosols)
  - tracer release experiment in the shallow waters off Barbados (ocean mixing)
  - investigation of interactions between the atmosphere and ocean eddies
  - trades/ITCZ (or shallow/deep) transition and interaction
  - added value of water isotopic measurements
  - validation of specific satellite retrievals
  - biogeochemical processes

• Growing interest within the US (Zuidema/Emanuel/Wing/Ferrari), UK (Blyth/Holloway), France (Flamant/Delanoe/Speich/Flossman)