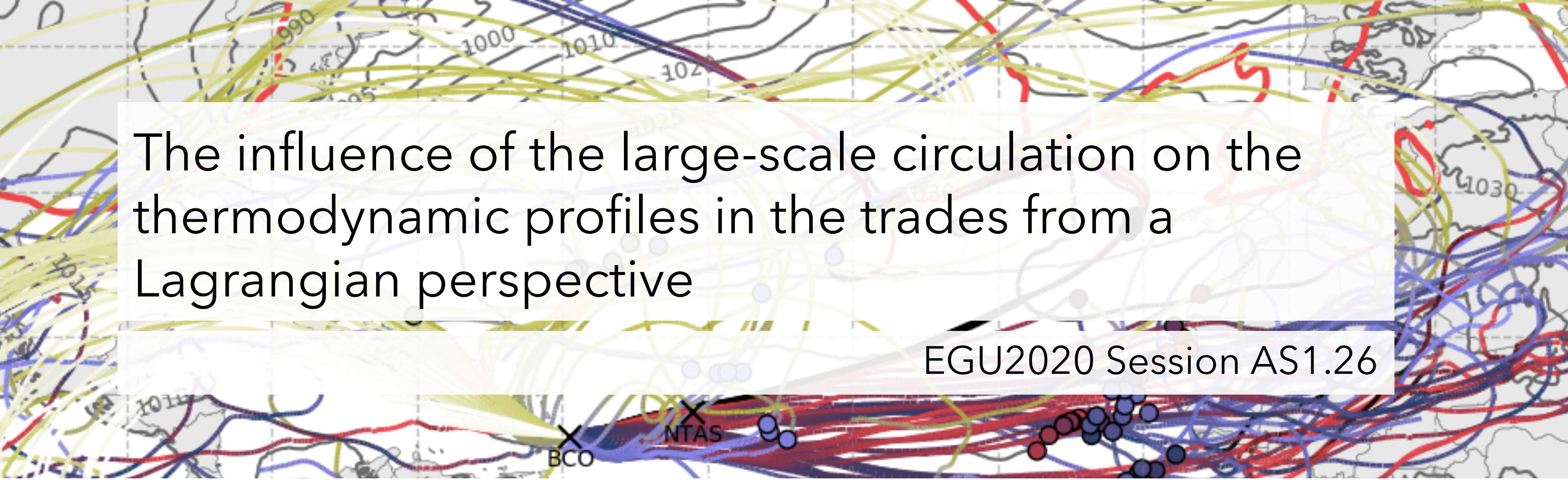

The influence of the large-scale circulation on the thermodynamic profiles in the trades from a Lagrangian perspective

EGU2020 Session AS1.26

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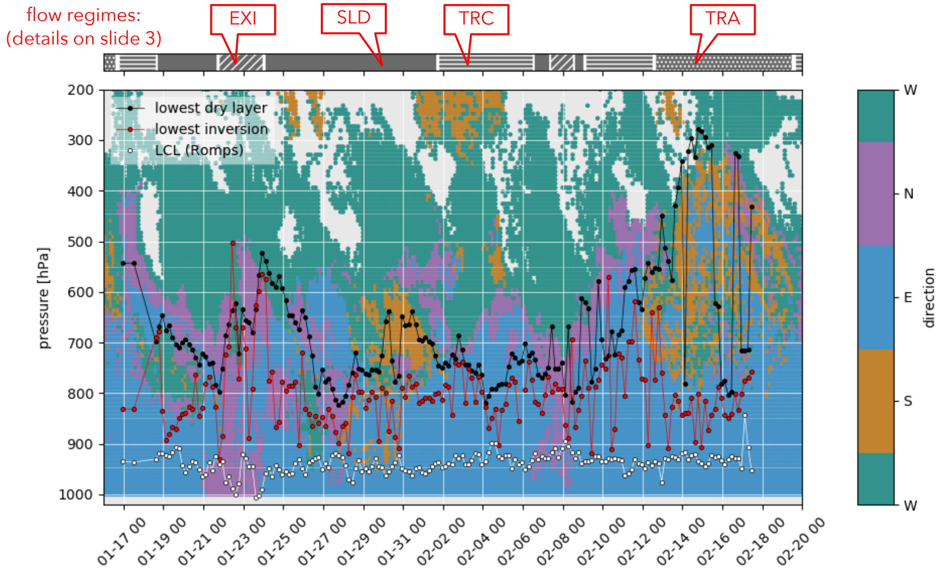
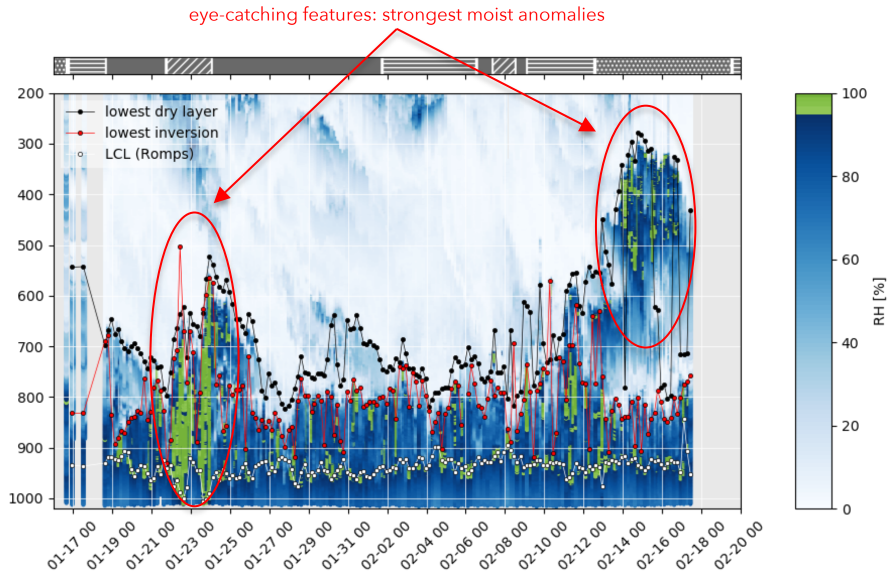
Q1 Which flow regimes can be identified during EUREC^{4}A[1], based on RDFs* from LAGRANTO[2,3] backward trajectories arriving above the BCO[4]?

Q2 Does the large-scale circulation leave an imprint on the local thermodynamic profiles measured by the BCO balloon soundings[5]?

*Reverse Domain Filling



Direction of advection Flow regimes (top) and RDF of the trajectory position (bottom) four days before arrival, shown as compass direction seen from the BCO, overlayed with parameters (LCL[6], lowest inversion, lowest dry layer, i.e. RH<20%) extracted from the sounding ascents. Missing values at upper levels result from trajectories that exit the computational domain. Trajectories were calculated each 8hPa between 1000 and 200hPa and are based on 3 hourly IFS analysis (0.2° x 0.2° hor. res., 137 levels) data.



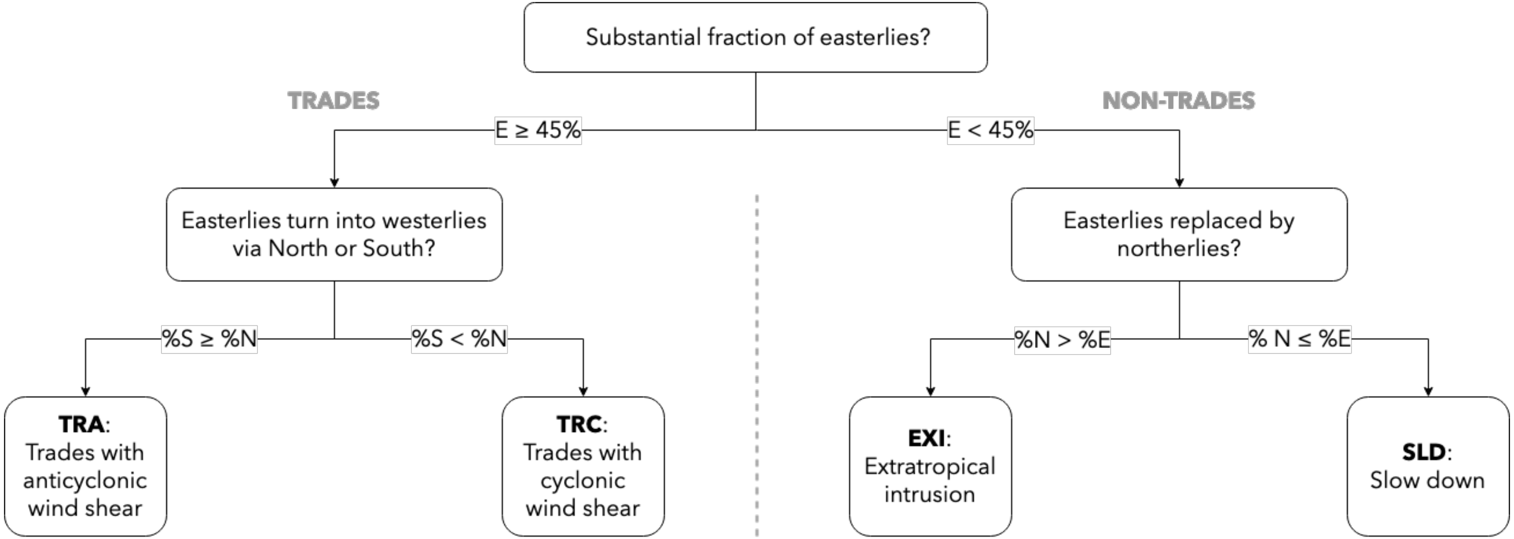
Sounding data Flow regimes (top) and relative humidity (bottom) from all BCO soundings, cloud layers (RH>95%) shown in green and overlayed with parameters (LCL[6], lowest inversion, lowest dry layer, i.e. RH<20%) extracted from the sounding ascents.

C1 The EUREC^{4}A trajectories outline four distinct flow regimes for the air parcels arriving above the BCO.

C2 Different properties, such as the location of the dry layer above the lowest inversion and the presence of upper-level moist layers, relate to the origin and history of air parcels arriving above the BCO.

Q1 Which flow regimes can be identified during EUREC⁴A[1], based on RDFs* from LAGRANTO [2,3] backward trajectories arriving above the BCO[4]?

Flow regimes are defined by the percentage of trajectories (1000-400hPa) located East, North and South relative to the BCO 4 days before arrival (consistent results with 6 days before arrival).



deep layer of low level easterlies that turn into upper level westerlies via South

deep layer of low level easterlies that turn into upper level westerlies via North

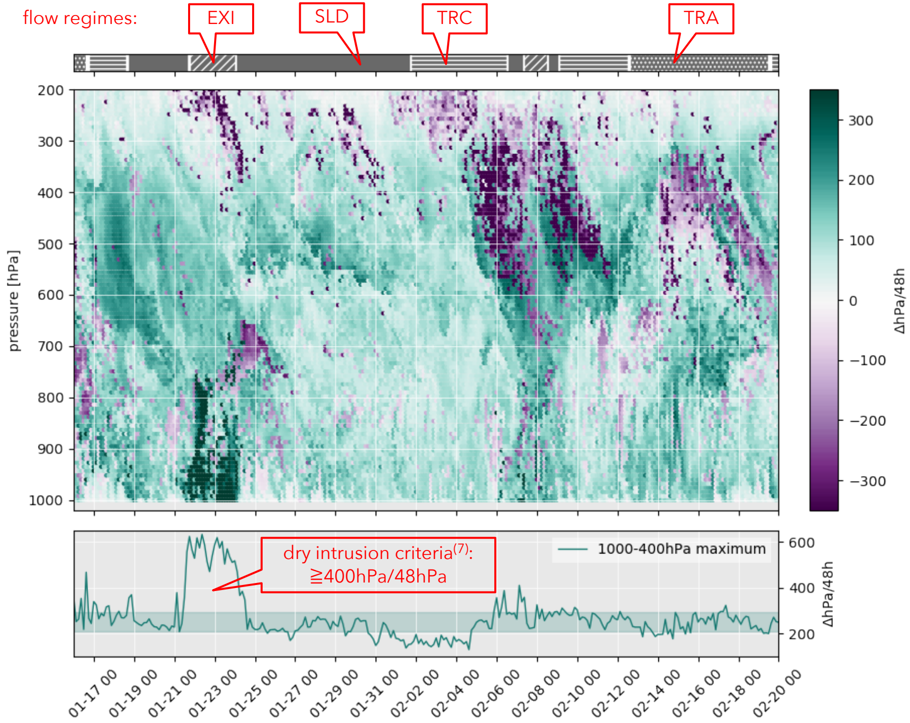
low level easterlies to great extent replaced by northerlies

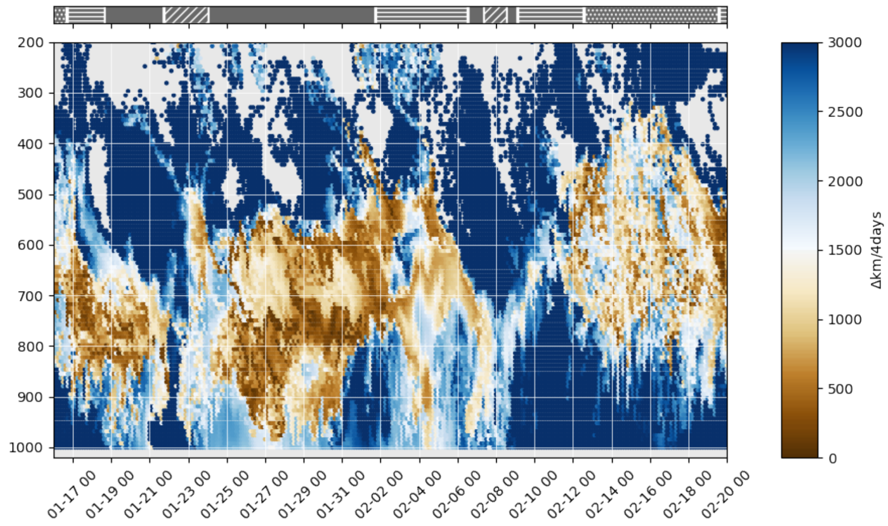
low level easterlies interrupted by multiple other directions

Q1 Which flow regimes can be identified during EUREC⁴A[1], based on RDFs* from LAGRANTO[2,3] backward trajectories arriving above the BCO[4]?

The flow regimes differ not only in the direction of advection, but also regarding vertical displacement and covered distance:

- **EXI** (01-21 to 01-23) → 1000-800hPa air parcels that have experienced a strong descent and were transported over large distances
- **TRA** (02-13 to 02-19) → 800-400hPa advection of local air parcels, partially collocated with air parcels that have experienced a strong ascent
- **SLD** (01-24 to 02-01) → 1000-550hPa reduced vertical displacement, advection of local air parcels

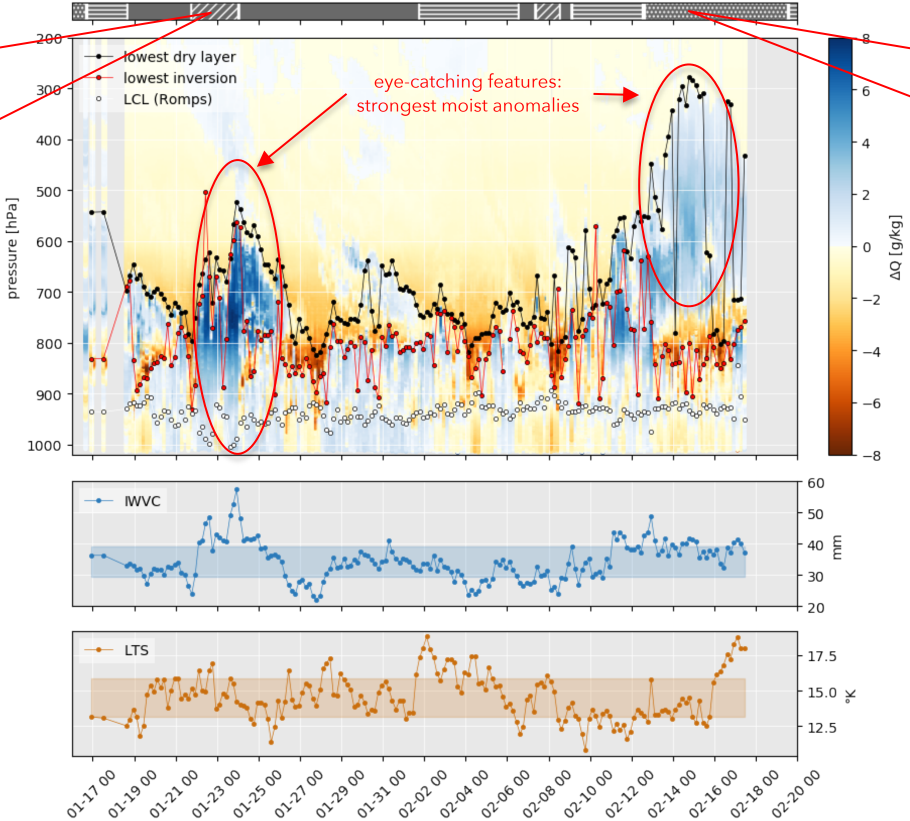




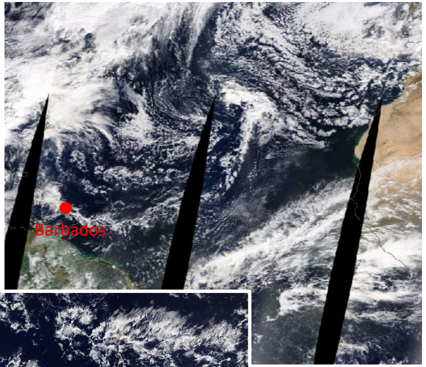
Trajectory parameters Flow regimes (top) and RDF of the maximum absolute descent or ascent per 48 hours from which the trajectories exited within 4 days before arrival (left, middle) and the maximum of it from the trajectories with arrival pressure 1000-400 hPa (left, bottom) together with the 25th and 75th quantile (shading). The RDF of the distance to the BCO 4 days before arrival is shown on the right side.

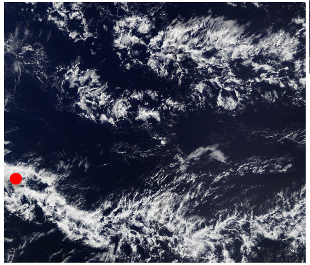
Q2 Does the large-scale circulation leave an imprint on the local thermodynamic profiles measured by the BCO balloon soundings[5]?

EXI (01-22 to 01-24):
- high IWVC, elevated inversion and dry layer, low LCL
- two peaks in IWVC correspond passage of fish-like clouds
- large variability in IWVC, first dry then wet anomaly due to the passage of first the dry band, then the wet band



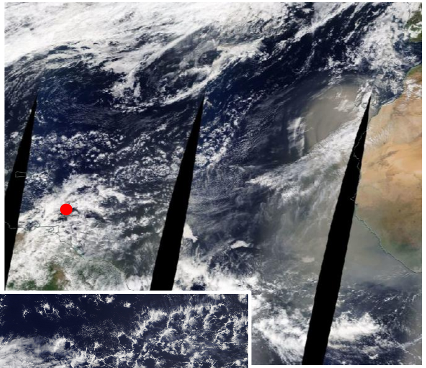
TRA (02-13 to 02-19):
- moist layer of great vertical extent above lowest inversion is connected to southerly flow
- associated with altostratus/-cumulus

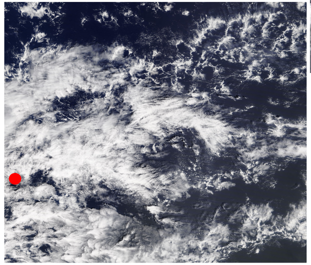




MODIS Terra
22th Jan 2020

Sounding data Flow regimes (top) and specific humidity anomaly relative to the pressure level mean (upper middle) from all BCO soundings, overlayed with parameters extracted from the sounding ascents. Integrated water vapor content (IWVC; lower middle) and lower tropospheric stability (LTS; bottom) of the sounding ascents are shown together with the 20th and and 80th quantile (shading).

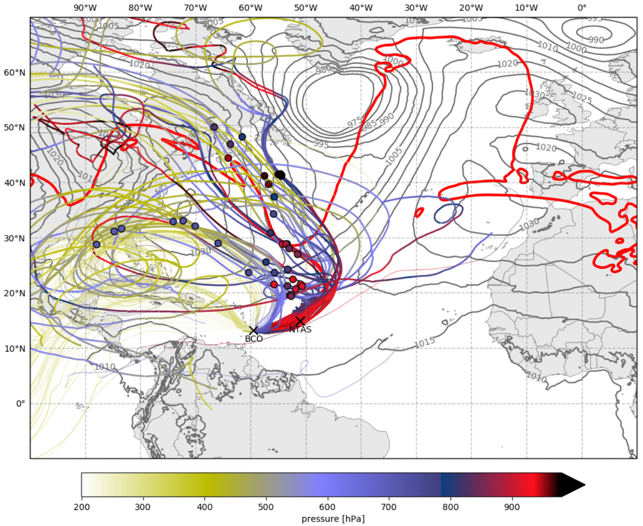




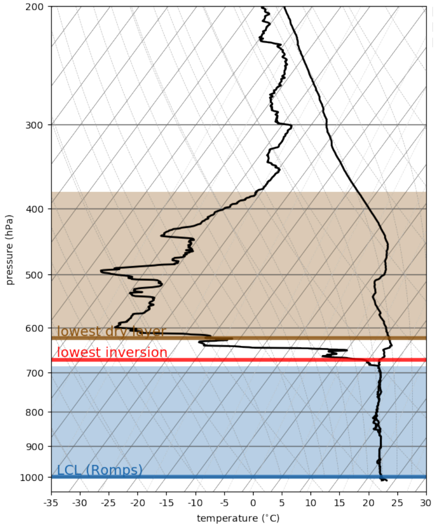
MODIS Terra
14th Feb 2020

EXI: 01-22 15UTC (sounding 14:44UTC)

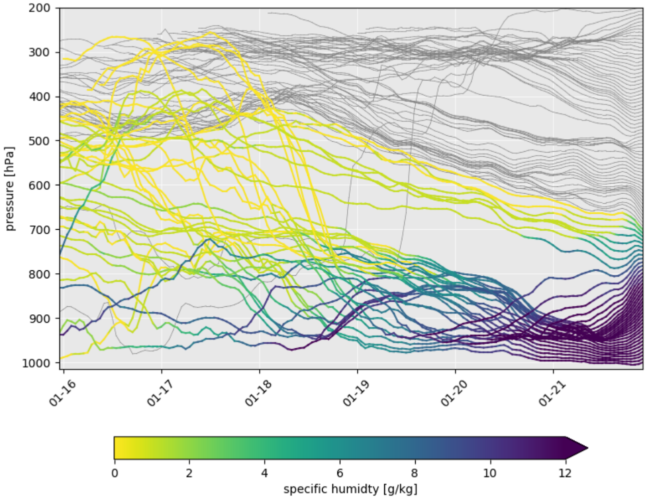
Air parcels arriving at 1000-700 hPa above the BCO are transported from high latitudes towards the BCO by an extratropical surface cyclone/upper level trough. The initially dry air parcels descend from upper-levels into the boundary layer, where they experience a rapid moistening, before arriving at the BCO as anomalously humid. During this period Barbados is affected by continuous rainfall from a fishbone-like cloud structure along a dissolving cold front.



Trajectory data Trajectories arriving above the BCO on 22th Jan 2020 15:00 UTC shown together with their position (dots coloured in arrival pressure), SLP (grey) and 2 pvu at 320 K (red) four days before arrival for the trajectories arriving at 1000-700 hPa. The remaining trajectories are shown as thin, more transparent lines.



Sounding data BCO profile, balloon launched 22th Jan 2020 14:44 UTC, indicated are dry and moist ($RH_{smoothed}$ < 20 % and > 80 %) layers (brown and blue), lowest dry layer, lowest inversion and LCL (lines).

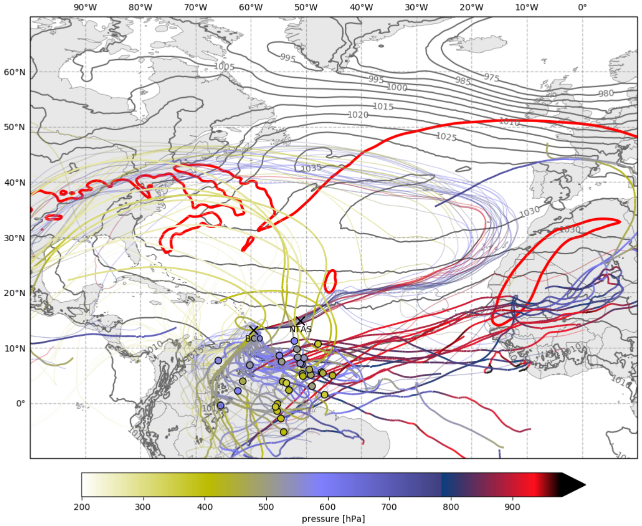


Moistening along trajectories Height of trajectories, arriving above the BCO on 22th Jan 2020 15:00 UTC, during the 6 days before arrival, coloured according to the specific humidity for the trajectories arriving at 1000-700 hPa. The remaining trajectories are shown in grey.

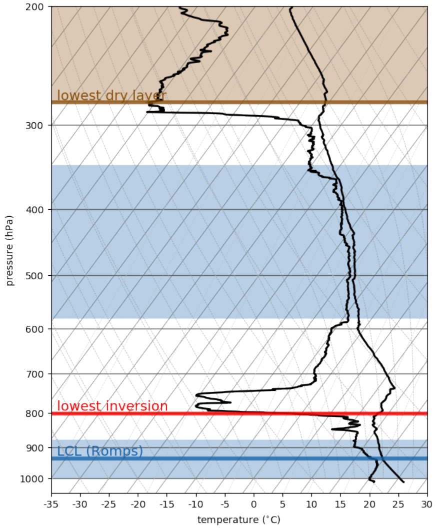
Q2 Does the large-scale circulation leave an imprint on the local thermodynamic profiles measured by the BCO balloon soundings(5)? *CASE 2*

TRA: 02-14 18UTC (sounding 18:44UTC)

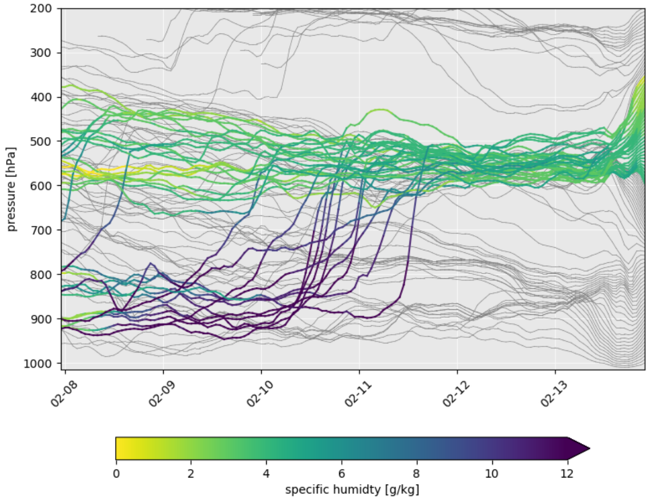
Part of the air parcels arriving at 600-350 hPa above the BCO cross the North Atlantic at low latitudes, within the moist boundary layer, before being lifted due to the topography of South America. There, they mix with local air parcels and travel isobarically towards the BCO, causing a humid layer at unusually high altitudes.



Trajectory data Trajectories arriving above the BCO on 14th Feb 2020 18:00 UTC shown together with their position (dots coloured in arrival pressure), SLP (grey) and 2 pvu at 320 K (red) four days before arrival for the trajectories arriving at 600-350 hPa. The remaining trajectories are shown as thin, more transparent lines.



Sounding data BCO profile, balloon launched 14th Feb 2020 18:44 UTC, indicated are dry and moist ($RH_{smoothed}$ < 20 % and > 80 %) layers (brown and blue), lowest dry layer, lowest inversion and LCL (lines).



Moistening along trajectories Height of trajectories, arriving above the BCO on 14th Feb 2020 18:00 UTC, during the 6 days before arrival, coloured according to the specific humidity for the trajectories arriving at 600-350 hPa. The remaining trajectories are shown in grey.

OUTLOOK

- Repeat analysis for other platforms with sounding data available to check robustness of flow regimes and linkage to thermodynamic profiles
- Assess January and February flow regime climatology with ERA5 over period 2009-2020
- Further deepen the analysis of the two case studies (EXI and TRA) with evident linkage between large-scale circulation and thermodynamic profile

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SOURCES

Satellite images MODIS Terra. URL:https://wvs.earthdata.nasa.gov/?LAYERS=MODIS_Terra_CorrectedReflectance_TrueColor Accessed:03/2020.

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