Impact of dry intrutions on the Marine Boundary layer

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Motivation and methodology

Dry air intrusions (DIs) are coherent airstreams, which descend slantwise over thousands of kilometers from the vicinity of the tropopause to the middle and low tropospheric levels. DIs travel equatorward from the mid-latitudes, mainly in the winter. DIs were shown to influence the Planetary Boundary Layer (PBL) by inducing static instability and convection, contributing to rises of sensible and latent heat fluxes into the PBL and increased PBL height.

However, the detailed influence of DIs on the dynamic, thermodynamic and chemical characteristics of the PBL has not been addressed so far. Here we focus on addressing the following questions:
1) What is the climatology of DIs over the Azores?
2) What is impact of DIs on the anomaly of thermodynamics variables?
3) Does the DIs penetrate into the PBL? Does this process impact the local PBL?

DI Lagrangian criterion: >400-hPa descent in 48 h (Raveh-Rubin 2017)

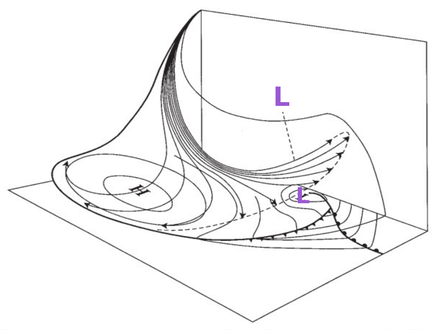


Figure 1: Conceptual DI (Browning 1997)

Climatology of DIs over the Azores Islands

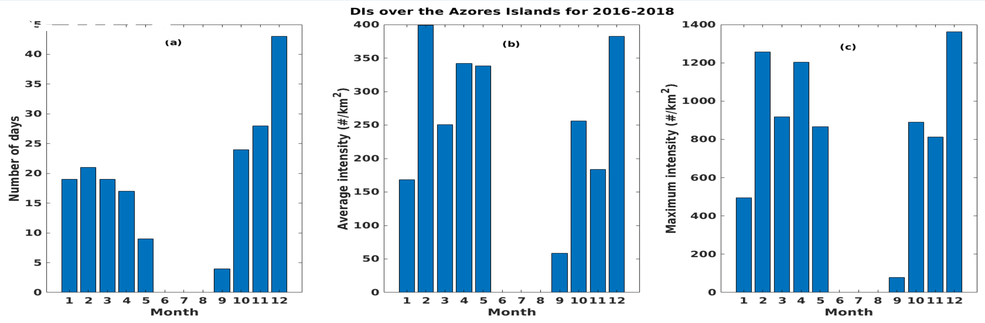
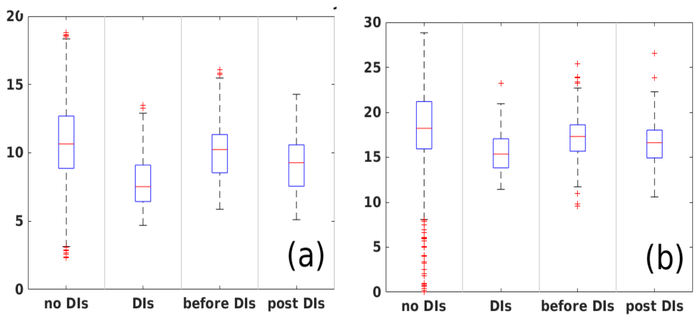


Figure 2: The number of DI days (a), The average intensity (b) and the maximum intensity (c) over the Azores for each month.

Figure 3: Distributions of surface water vapor mixing ratio [g/kg] (a) and temperature [C] (b) measurements at surface in different DIs classes categories. The thick vertical line marks the median value of distributions. The lower and upper boundaries correspond to 25th and 75th percentiles of the distributions. The measurements were conducted in the Azores islands between 2016-2018.



Case study: 29-31 DEC. 2017

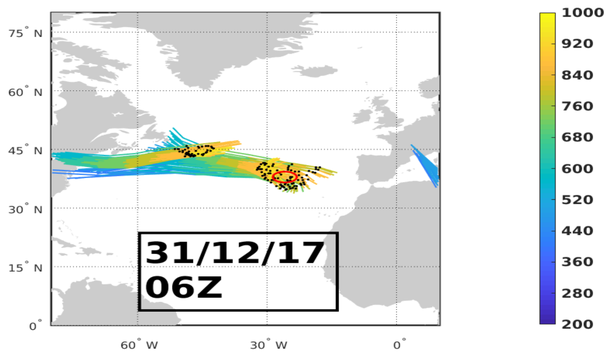


Figure 4: A selected set of DI trajectories starting their descent at 18 UTC 29/12/17 (initial time) for 48h, colored according to their pressure (hPa). The black dots mark the location of the trajectories after 36h. The trajectories penetrated into the PBL in the area of the campaign (red ellipse).

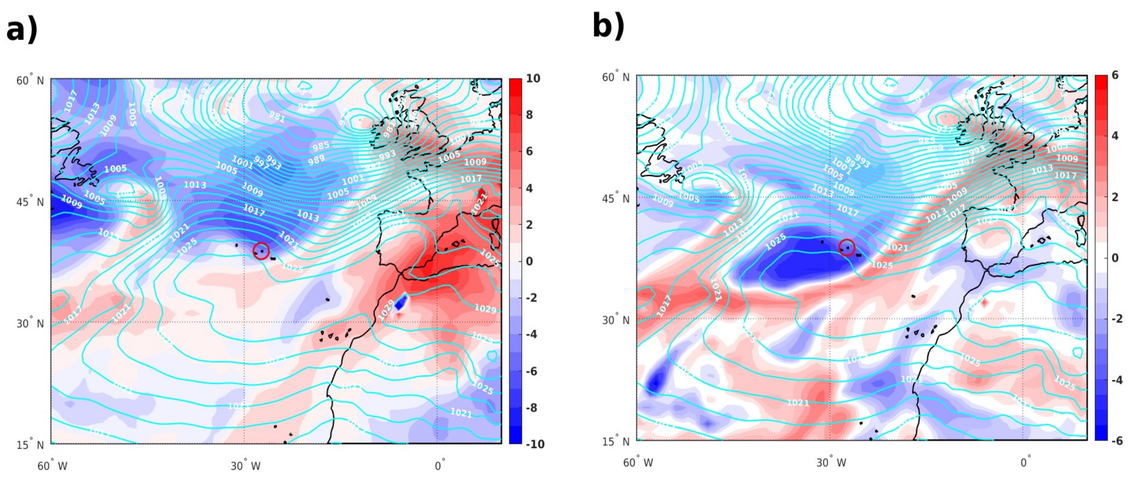


Figure 5: Anomaly of potential temperature [K] (a) and specific humidity [g/kg] (b) at 850 hPa during DIs event. Sea level pressure contours (interval of 2mb) at 00 UTC 31/12/17. The Azores islands are in red ellipse.

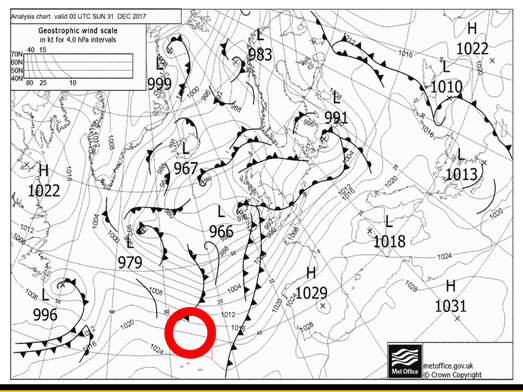
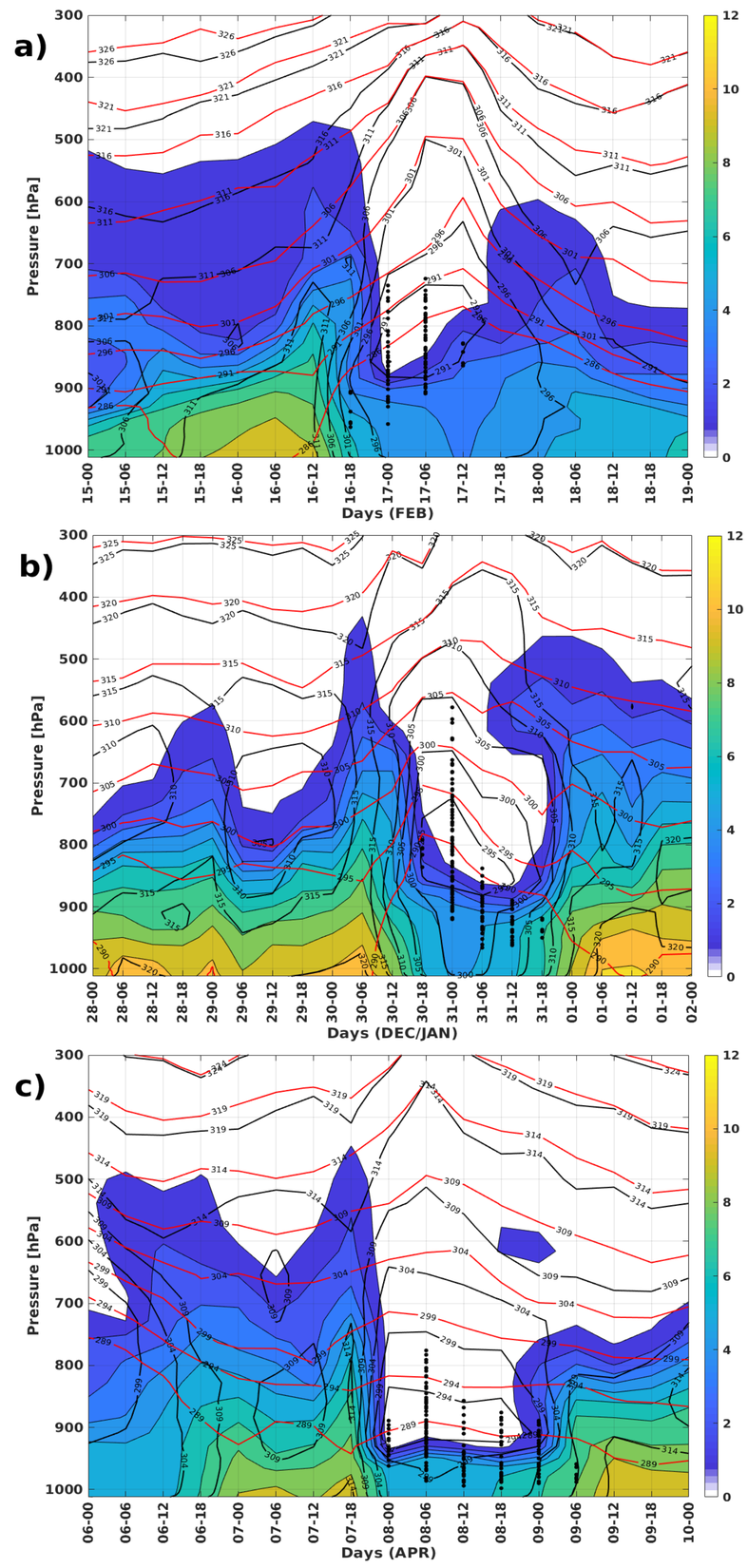


Figure 6: Surface analysis from DWD website. Cold front passes over the Azores islands (red ellipse) at 00 UTC 31/12/17.

Local impact at ACE-ENA site



FEB 2016

DEC 2017 – JAN 2018

APR 2018

Figure 7: Time-height cross sections of Era Interim specific humidity (g/kg), in the campaign location (Lat=39.092N, Lon=28.03W) for three representation cases. The red contours show the potential temperature and the black contours are the equivalent potential temperature [K]. The black points mark the DI trajectories vertical position. The trajectories were identified according to data from ERA-Interim within the radius of 1 degree around the campaign.

Conclusions

- DIs over the Azores Islands occur in the extended winter season.
- Shown here by reanalysis and observational data, DIs impact the lower troposphere and Marine boundary layer by sharply lowering the temperature, and moisture content. The arrival of DI air from the free troposphere downwards induces lower-tropospheric potential instability.
- Relationships between DI events and additional thermodynamical variables will be explored over the campaign in the Azores for the 3 years 2016-2018. Specifically, the impact of DIs on the local marine boundary layer height, surface fluxes and cloud cover will be investigated.

References

Browning, K. A., 1997: The dry intrusion perspective of extra-tropical cyclone development. *Meteorol. Appl.,* **4**, 317-324.

Raveh-Rubin, S., 2017: Dry Intrusions: Lagrangian Climatology and Dynamical Impact on the Planerary Boundary Layer. *J. Climate.,* **30**, 6661-6682, doi:10.1175/JCLI-D-16-0782.1.