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How is the marine atmospheric boundary layer turbulence organized in the trades ?

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Tradewind clouds can exhibit a wide diversity of mesoscale organizations, and the turbulence of marine atmospheric boundary layer (MABL) can exhibit coherent structures and mesoscale circulations. One of the objectives of the EUREC4A (Elucidating the role of cloud-circulation coupling in climate) field experiment was to better understand the tight interplay between the mesoscale organization of clouds, boundary-layer processes, and the large-scale environment.

During the experiment, that took place East of Barbados over the Western Tropical Atlantic Ocean in Jan-Feb 2020, the French ATR-42 research aircraft was devoted to the characterization of the cloud amount and of the subcoud layer structure. During its 17 research flights, it sampled a large diversity of large scale conditions and cloud patterns. Multiple sensors onboard the aircraft measured high-frequency fluctuations of potential temperature, water vapour mixing ratio and wind , allowing for an extensive characterization of the turbulence within the subcloud layer. A quality-controled and calibrated turbulence dataset was produced on the basis of these measurements, which is now available on the EUREC4A AERIS data portal.

The MABL turbulent structure is studied using this dataset, through a spectral analysis of the vertical velocity. Vertical profiles of characteristic length scales reveal a non-isotropic structure with a stretching of the eddies along the mean wind. The organization strength of the turbulent field is also explored by defining a diagnostic based on the shape of the vertical velocity spectrum. The structure and the degree of organization of the subcloud layer are characterized for different types of mesoscale convective pattern and as a function of the large-scale environment, including near-surface wind and lower-tropospheric stability conditions.