

Radiative budget in the lower tropical stratosphere from the combination of balloonborne lidar and radiometric measurements

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The atmospheric layer near the tropical tropopause (14-18.5 km), referred to as the Tropical Tropopause Layer (TTL), is a key region of the Earth's atmosphere and the gateway to the stratosphere. Along their ascent through the extremely cold TTL (<200 K), air parcels undergo ice formation and freeze-drying, which is ultimately responsible for the dryness of the stratosphere, of dramatic importance for stratospheric chemistry and the Earth's radiative balance. TTL ice clouds (cirrus) also directly affect the Earth's radiative budget.

The Strateole-2 project is an international effort led by French scientists aiming at in situ and remote-sensing observations of the TTL using long-duration balloons (SPBs) developed by the French Space Agency (CNES). The balloons drift with the wind for several months at targeted altitudes, enabling quasi-Lagrangian measurements. This is well-suited to characterize cirrus life cycle and convective overshoot topography. During the Strateole-2 measurement campaign three nadir looking backscatter lidars were flown in the lower stratosphere, in combination with a bolometer. These three flights, from October 20 2021 to January 9 2022, correspond to 679 hours of nighttime measurements, with a vertical sampling of 15 meters, a temporal resolution of 1 minute and a horizontal resolution ranging from 0.1 to 1 km. The bolometer gives an estimate of the upward broadband longwave radiation.

Nighttime profiles of cloud distributions and optical properties measured by the three Balloonborne Cirrus and convective overshoot Lidars (BeCOOL) are analyzed and compared to satellite observations. Combining balloonborne lidar and radiometric measurements, the variability of upward longwave radiation is also discussed. Using a radiative transfer model forced or validated by these observations, the radiative impact of cirrus on the budget and stability of the lower tropical stratosphere is finally assessed.