Southeast Pacific stratocumulus clouds, precipitation and boundary layer structure sampled along 20° S during VOCALS-REx

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Multiplatform airborne, ship-based, and land-based observations from 16 October–15 November 2008 during the VOCALS Regional Experiment (REx) are used to document the typical structure of the Southeast Pacific stratocumulus-topped boundary layer and lower free troposphere on a~transect along 20° S between the coast of Northern Chile and a buoy 1500 km offshore. Strong systematic gradients in clouds, precipitation and vertical structure are modulated by synoptically and diurnally-driven variability. The boundary layer is generally capped by a strong (10–12 K), sharp inversion. In the coastal zone, the boundary layer is typically 1 km deep, fairly well mixed, and topped by thin, nondrizzling stratocumulus with accumulation-mode aerosol and cloud droplet concentrations exceeding 200 cm−3. Far offshore, the boundary layer depth is typically deeper (1600 m) and more variable, and the vertical structure is usually decoupled. The offshore stratocumulus typically have strong mesoscale organization, much higher peak liquid water paths, extensive drizzle, and cloud droplet concentrations below 100 cm−3, sometimes with embedded pockets of open cells with lower droplet concentrations. The lack of drizzle near the coast is not just a microphysical response to high droplet concentrations; smaller cloud depth and liquid water path than further offshore appear comparably important.

Moist boundary layer air is heated and mixed up along the Andean slopes, then advected out over the top of the boundary layer above adjacent coastal ocean regions. Well offshore, the lower free troposphere is typically much drier. This promotes strong cloud-top radiative cooling and stronger turbulence in the clouds offshore. In conjunction with a slightly cooler free troposphere, this may promote stronger entrainment that maintains the deeper boundary layer seen offshore.

Winds from ECMWF and NCEP operational analyses have an rms difference of only 1 m s−1 from collocated airborne leg-mean observations in the boundary layer and 2 m s−1 above the boundary layer. This supports the use of trajectory analysis for interpreting REx observations. Two-day back-trajectories from the 20° S transect suggest that eastward of 75° W, boundary layer (and often free-tropospheric) air has usually been exposed to South American coastal aerosol sources, while at 85° W, neither boundary-layer or free-tropospheric air has typically had such contact.

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