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GOFOS, Ground Optical Fog Observation System for monitoring the vertical stratocumulus dynamic in the coastal Atacama Desert, Chile

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The vertical variability of the stratocumulus (Sc) cloud in the interface ocean-land at the coastal Atacama Desert ($\sim$20°S) has been well described, but in its interaction with the local topography it has been roughly characterized, conditioning our understanding of the atmospheric conditions under which the fog occurs. Our aim is to analyze and characterize the vertical variability of fog at a local scale and the vertical structure of atmospheric boundary layer (ABL) by using a Ground Optical Fog Observation System (GOFOS). A database every 10 minutes by the year 2017 is obtained from GOFOS, which is based in two time lapse cameras located at altitudes that regularly lie above the thermal inversion layer and under the lower cloud base altitude respectively, and observing an altitudinal profile of autonomous LED solar lights allowed to characterize the fog vertical variability. These measurements are validated by using a transect of weather stations located at 50, 750 and 1.200 m a.s.l to determine the ABL regimes established by Lobos et al (2018). The GOFOS measurements are compared with the ABL regimes which estimate the fog presence-dissipation through a well-mixed/stratified regime. We characterize the daily, monthly and seasonally fog cloud top (CT), cloud base (CB) and cloud depth (CD). The CT, CB and CD, show marked seasonal and daily variations. In addition, the altitudes and depths are inversely related with the fog frequency presence (FFP). The highest CT and CB altitude occur during summer ($\sim$1.230 and 970 m a.s.l. respectively). Summer also record, the thickest CD ($\sim$315 m) when the FFP is at its minimum (seasonal mean of $\sim$3,5 %). The CT and CB reach their minimum mean altitude in winter ($\sim$1.040 and 850 m a.s.l., respectively), as well the thinnest CD ($\sim$220 m), this season coinciding with the maximum FFP ($\sim$50 %). From a daily perspective, the relation between cloud altitude and depth with FFP is also inverse, with maximum CT, CB and CW during the afternoon and minimum during night-dawn. In presence of fog, the ABL is well-mixed and the proposed regimes of specific humidity(q) agree above 90%, while the potential temperature (θ) reaches 70%. Summer and daylight time shows a deep ABL, which is related to a high stratification within the ABL, thus lower FFP, oppositely, during winter and night-dawn the ABL is shallower and under well-mixed conditions, thus higher FFP. The new fog monitoring system (GOFOS) allow us to characterize accurately the vertical fog variability at coastal Atacama Desert, as well as to validate and adjust the atmospheric regimes proposed, both key indicators for future fog harvesting forecast.