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Laboratory of Atmospheric Microphysics and Radiation (LAMAR): a set of sensors for the study of extreme meteorological events in the Central Andes of Peru.

Daniel Martinez[1,2], Yamina Silva[1], Rene Estevan[1], Jose Luis Flores[1], Luis Suarez[1], Aldo Moya[1], Jairo Valdivia[1], and Miguel Saavedra[1]

[1]Instituto Geofisico del Perú, Division of Atmospheric and Hidrologyc Sciences, Lima, Peru (danielmartinezc53@gmail.com)
[2]Instituto de Meteorología de Cuba. Centro de Física de la Atmósfera. La Habana, Cuba

A set of instruments to measure several atmospheric physical, microphysical and radiative properties of the atmosphere and clouds is essential to understand the conditions of formation and development, and eventually, the effects of extreme meteorological events, like severe rainfall, hailstorms and frost events that occur with some regularity in the central Andes of Peru. With this purpose, the Geophysical Institute of Peru has installed a set of specialized sensors in the Huancayo observatory (12.04°S,75.32°W, 3313 m ASL) including sub-sets dedicated to the measurements of near-surface and low boundary layer turbulent flows (turbulence and gradients subset), measurement of precipitation and its structure (precipitation subset)and the measurement of aerosols and their interaction with radiation in the atmosphere (radiation subset). Additionally, a proper open area is reserved for upper air soundings. The turbulence subset consists of a set of thermohygrometers (HMP60 probe of Campbell Scientific) placed in two towers, one of 1 m and another of 30 m high, two wind sentry sets (03002 of Campbell Scientific), five tensiometers (Decagon 5TM VWC) to measure soil temperatures and moistures and a soil heat flux plate (HFP01 of Campbell scientific). The radiation subset consists of three pyranometers (CMP10 of Kipp & Zonen), to measure short-wave solar irradiance components, for(global, diffuse and reflected) and a pyrheliometer (CHP1 of Kipp & Zonen) to measure direct solar irradiance. A small black sphere mounted on an articulated shading assembly in a two-axis automatic sun tracker (Kipp & Zonen 2AP) blocked direct solar irradiance and allows to measure diffuse solar irradiance. To measure long-wave terrestrial irradiance components, two pyrgeometers are used (CGR4 of Kipp & Zonen). All these radiative sensors are installed in a tower of 6 m high. The precipitation subset includes A Ka-band cloud profiler (MIRA-35c), a disdrometer (PARSIVEL2) and two rain gauges pluviometers. A UHF wind profiler (CLAIRE), and a VHF wind profiler (BLTR) complement the precipitation subset, as they can detect turbulent low-level wind turbulence, associated with precipitation events. . The upper-air sounding system consists of two stations: Windsond, for model S1H3) and Meteo-modem, for model M10 radiosondes. All these sensors have been used to study the surface-atmosphere interactions, including the behavior of surface boundary layer, the components of surface energy budget and the microphysics properties or rainfall during the occurrence of extreme meteorological events, and to validate numerical model

simulations. To show practical applications of LAMAR instrumentation we present a detailed analysis of two events: a severe rainfall event occurred on 17 January 2018 and a frost event occurred on 08 July 2018.