Geophysical Research Abstracts
Vol. 21, EGU2019-1413, 2019
EGU General Assembly 2019

Assessment of the variability of the thermodynamic structure of the atmosphere and its influence on the pollutant concentration in the Aburrá Valley, Colombia

Alejandra Isaza (1,2), Carlos D. Hoyos (1,2), Laura Herrera (1,2)

(1) Universidad Nacional de Colombia, Medellin, Colombia, (2) Sistema de Alerta Temprana de Medellín y el Valle de Aburrá (SIATA)

In the Aburrá Valley, located in the central Colombian Andes, the interaction between meteorological and anthropic factors modulating atmospheric pollutant concentration is non-linear. Medellín, settled within the valley, has experienced critical air quality episodes, with mean daily concentrations of fine particulate matter (PM2.5) reaching 116 $\mu g/m^3$, more than three times the national regulation. Evidence suggests that one of the crucial factors affecting air pollution is the radiative forcing that modifies the local thermodynamic vertical structure, hence controlling the atmospheric stability conditions. This work focuses on studying the temporal variability of the thermodynamic structure of the atmosphere in relation to air quality, using information from the metropolitan air quality monitoring network, in-situ meteorological data and radiosonde campaigns, local data from a Microwave Radiometer (MWR), data from GOES-R, AIRS, and WRF simulations. The evidence suggests the behavior of pollutants in the valley is affected both by climate and weather conditions, in different temporal and spatial scales. PM2.5, for example, exhibits a bimodal diurnal cycle with maximum concentrations in the morning hours and a smaller peak at night. This behavior is mainly determined by the local emissions and the evolution of atmospheric stability as revealed by different thermodynamic indices including CINE, CAPE, and in particular, lower troposphere potential temperature vertical gradients ($\Delta\Theta$). The local thermodynamic structure is also used to explain the annual cycle of PM2.5, focusing on the critical periods during 2016 to 2018, especially in March which has been identified as a critical month regarding air quality. WRF simulations capture reasonably well the evolution of atmospheric stability within the valley. Satellite and reanalysis data show evidence of global and regional forcing modulating local atmospheric stability, including an essential role of the ZCIT migration and the associated changes in cloudiness and precipitation, and anomalies in the global zonal circulation as a response to the different ENSO phases. The relationship between pollutant concentration and atmospheric stability has been used for environmental decision making during critical air quality episodes by limiting pollutant emissions.