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An assessment of the role of surface sensible heat flux and the atmosphere inversion on the breakup time in a highly complex terrain

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The Aburrá Valley is a narrow highly complex mountainous terrain located in the Colombian Andes. The particular topographic features of this region limit the atmospheric pollutant dispersion almost entirely to thermodynamically driven processes. According to this, understanding when and under which conditions the nocturnal inversion breakup occurs, is highly relevant because it corresponds to the time when the exchanges between the surface and the free atmosphere intensify and reach their maximum, resulting in a more efficient pollutant vertical transport. Particularly in the Aburrá Valley, this mechanism must be strong enough for pollutants to exceed the top of the mountain ranges. Several factors determine the time of the breakup, including both the characteristics of the initially stably stratified atmosphere and the external forcing, defined as the total energy provided to the system in the form of the surface sensible heat flux. The goal of this work is to study the relationship between both processes, and determine which one influences the most the initiation of the convective dynamics, under the Aburrá valley conditions.

We analyze the thermodynamic profiles from a Microwave Radiometer to infer through different thermodynamic indexes, how much energy is required to erode the stably stratified boundary layer until the breakup occurs. The surface sensible heat flux was estimated by the eddy covariance technique from CSAT3 - 20Hz data. We use datasets from February to November 2018 and calculate the Convective Inhibition Energy (CIN) at different levels and the difference between the Potential Temperature ($\Delta\Theta$) of different layers in the valley atmosphere. $\Delta\Theta$ 800, the difference between 800m and the first available level, appears to be the index that better represents the characteristics of the stable valley atmosphere, and allows the better understanding of the relationship between the energy provided, and the energy required to break the existent nocturnal inversion. This approach has some restrictions related to the spatial representativeness of the measurements; being one of the main reasons why similar studies in the literature follow modeling-based approaches. The results also evidence that many additional factors can disturb the behavior of the system, such as changes in the synoptic forcing. For example, the reversal of trade winds has significative consequences in the dynamics inside the valley.