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Characterizing the mesoscale and synoptic circulations in relation to crop dynamics: belg-2017 in the Gamo highlands, Ethiopia

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The Gamo highlands, Ethiopia, are characterized by steep elevation (1,100 to 3,600 m asl.) with nearby large water masses (lake Abaya and lake Chamo). The valleys are dominated by dry crops and the mountain slopes by wetter crops and forest patches. These landscape features strongly determine how the diurnal evolution of the state variables are modulate by both the mesoscale flows (e.g. lake-breezes, orographic) and synoptic region weather dynamics (driven by the ITCZ position). In this study, we analyse the temporal and spatial variations in weather as function of topography and mesoscale circulations; and their impact on potato crop growth during belg-2017 crop season. Following a strategy to determine the crop growth zoning, we installed a network of six automatic weather stations in two-transects of the highlands. This dense network covers a radius of 15 kilometre with an elevation difference of 2000 meters. In addition, we monitored variables related to the potato crop dynamics in the vicinity of the stations. The observed weather during the belg was ingested to the genotype-by-environment crop model (GECROS).

The weather data analysis showed strong diurnal cycles in temperature, wind direction and precipitation as well as large variations between the lowland (1,200 m) and the highlands (3,000 m asl); and significant variations between the beginning (Feb) and the end (May) of the belg months. We identified the February month to be more dominated by mesoscale circulations, associated with local features such as lakes during day and mountains/valleys during night-time. In contrast, May weather is explained by synoptic dynamics (e.g., ITCZ) with superimposed topography induced flows. GECROS model results, using the observed weather input, predicts satisfactorily the crop yield observations in different elevations, in particular the more relevant variables LAI and yield. By shifting the precipitation from May till March, we found that the crop growth is very sensitive to the order of weather situations. We conclude that our stations network in this complex terrain enables us to quantify the role of weather scales (diurnal, mesoscale and synoptic), providing an improved understanding and quantification of the potato crop dynamics.

Key words: Crop-yield, diurnal cycle, lake-breeze, orographic flows, potato, terrain.