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# A novel framework to investigate atmospheric boundary layer dynamics from balloon soundings worldwide: CLASS4GL

Hendrik Wouters (1), Irina Y. Petrova (1), Chiel C. van Heerwaarden (2), Jordi Vilà-Guerau de Arellano (2), Adriaan J. Teuling (2), Joseph A. Santanello (3), Vicky Meulenberg (2), and Diego G. Miralles (1)

(1) Ghent University, Department of Forest and Water Management, Ghent, Belgium (hendrik.wouters@kuleuven.be), (2) Wageningen University and Research, Department of Environmental Sciences, Wageningen, The Netherlands (chiel.vanheerwaarden@wur.ml, (3) National Aeronautics and Space Administration, Hydrological Sciences Laboratory, United States of America (joseph.a.santanello@nasa.gov)

The coupling between soil, vegetation and atmosphere is thought to be crucial in the development and intensification of weather extremes, especially meteorological droughts, heat waves and severe storms. Therefore, understanding evolution of the atmospheric boundary layer (ABL) and the role of land–atmosphere feedbacks in that behaviour is necessary for earlier warnings, better climate projection and timely societal adaptation. However, this understanding is hampered by (a) the difficulties to attribute cause–effect relationships from complex coupled models, and (b) the irregular space-time distribution of in situ observations of the land–atmosphere system. As such, there is a need for simple deterministic appraisals that systematically discriminate land–atmosphere interactions from observed weather phenomena over large domains and climatological time spans. Here, we present a new interactive data platform to study the behaviour the ABL and land–atmosphere interactions based on global weather balloon soundings. This software tool, referred to as CLASS4GL, is developed with the objectives to (a) mine appropriate global observational data from over 2 million weather balloon soundings since 1981 together with satellite and reanalysis data into a single database, and (b) constrain and initialize a numerical model of the daytime evolution of the ABL that serves as a tool to interpret these observations mechanistically and deterministically. The suitability of the existing observations, model formulations, and surface parameter databases employed by CLASS4GL is extensively validated. In most cases, the framework is able to realistically reproduce the observed daytime response of the ABL height, potential temperature and specific humidity from the balloon soundings. The virtual tool is open-source and remains in continuous development. The software infrastructure allows the research community to easily employ extensive global sensitivity experiments for addressing the effect of land conditions and atmosphere dynamics on the ABL evolution. As such, it should foster a better process-understanding of the drivers of the ABL evolution and its global and climatological distribution, including the onset and amplification of weather extremes. Finally, it can be used to study the representation of land–atmosphere feedbacks and ABL dynamics in Earth System Models, reanalysis data and remote sensing products, with the ultimate goal to improve local climate projections, to provide earlier warnings of extreme weather, and to foster a more effective development of climate adaptation strategies.