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Conference Abstract

From Leaf to Label: A robust automated workflow for stomata detection

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Abstract

Leaf stomata are microscopic pores on the leaves of plants which control the balance between water loss and CO_2 uptake by the plant. As plants adapt their stomatal traits in response to environmental parameters such as water availability, temperature and atmospheric carbon dioxide concentrations, stomatal size and density of preserved leaves have allowed for reconstruction of past climates. Stomata serve as ‘gates’ between deep-soil water reservoirs and the atmosphere and are a key determinant of transpiration in models for operational predictions of the near-climate. It is well known that stomatal size and density vary widely across plant species and even though efforts have mapped stomatal behavior globally, more detail is needed as including more interspecific trait variation in climate models could significantly reduce the error in model predictions. Despite their important function, no standardized methodology has yet been described to measure stomatal traits which is widely considered to be labour-intensive and time-consuming and to this day mostly performed manually.

Herbaria contain a treasure of unique ecological data covering large temporal scales. We used the African Herbarium of Meise Botanic Garden which contains over 1.2 million African specimens with a very good coverage of the Congo Basin (dating back to 1880) to develop a workflow for extracting stomatal trait data starting from the herbarium specimen, involving the automatic detection of stomata using a deep learning approach. The purpose of developing this workflow is to generate a large amount of data on stomatal traits on an

easy, cost- and time- efficient manner. Here, we will present the leaf-to-label workflow and demonstrate how it was used to study the effect of global change on leaf adaptation in central African rainforest over the past 100 years.

Keywords

Herbaria, deep learning, stomata, Meise Botanic Garden

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