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A soil moisture and crop yield diagnostic system for tropics

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In tropics and sub-tropics, millions of people live in poverty, and rely on maintaining agriculture for their food and income. However, food security in these regions is declining; supply is strongly dependent on local production affected by unreliable rainfall and poor soils, while economic development is closely tied to local crop yield stability. Increasing climate extremes, drought and high temperatures, threaten food security further. A large number of stakeholders can benefit from improved and prompt information on soil water resources, and their links to crop yield.

We use a model-data framework to analyse agro-ecosystem states and processes. The framework combines a simple crop-soil model of carbon-water interactions with climate reanalyses, soil maps, satellite remote sensing of vegetation states, land use and soil moisture. Recent developments on coupling our current carbon cycle model with hydrological component provide a tool to analyse the spatial and temporal correlation between retrieved soil moisture, leaf area index, and plant production. During drought stress periods in agricultural areas this approach will identify the critical thresholds around carbon allocation above and below ground that lead to resilience or crop failure. The use of a simple model allows very large ensemble simulations to produce probabilistic retrievals of model parameters and states across landscapes, and has the capacity to develop into an operational system.

Our aim is to produce key information: mapping the crop yield gap attributable to drought stress, mapping inter-annual variation in yield gaps, and quantifying benefits to yield of targeted irrigation and soil improvements. The benefits of this information are particularly strong in sub-Saharan Africa where current data are sparse, drought is a major factor in agricultural production, and where smartphone availability is now widespread for access to such data.