PhD Program in Computer Science and Systems Engineering

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DIBRIS, University of Genova

Proposal of Research Theme

Title: The role of vegetation in hydrological modelling

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Research area(s): Hydrology, Climate Change

Description

Vegetation is a dynamic component that, through its physiological and structural characteristics (e.g. stomatal conductance, leaf density, plant age, etc.), affects primarily the partitioning of incoming solar energy into latent and sensible heat fluxes and the amount of rainfall into runoff, canopy interception, evapotranspiration (ET) and soil infiltration. Besides, by the photosynthesis and respiration processes necessary to growth and maintain plant tissues, vegetation acts as sink or source of carbon. For this reason, vegetation is known to play an important role in the spatial distribution and temporal variation of the energy, water and carbon fluxes at the land surface.

How vegetation affects these fluxes in a future climate is currently a central problem of earth system sciences.

Dynamic Vegetation Models (DVMs) were developed to incorporate into a model framework, the physiological and structural processes that describes the time evolution of vegetation functions and distribution. DVM includes processes based on ecological and physiological knowledge of the factors influencing individual plant demography.

Ecological and physiological processes comprise photosynthesis, autotrophic respiration, allocation, Nitrogen (N) cycle and plant competition.

Coupled with hydrological or Soil Vegetation Atmosphere Transfer scheme (SVAT, model that represents the interactions between vegetation and climate), DVMs have been largely applied at the global scale, to investigate the feedbacks among vegetation, climate and hydrological cycle under a rapid increase of atmospheric CO2 concentration.

Understanding the variations of ET caused by structural and physiological changes of vegetation is extremely relevant to flood and drought estimations because evapotranspiration represents for some 60% of terrestrial precipitation and can approach 100% of annual rainfall in water-limited ecosystem.

The main goal of the research is to develop a prognostic DVM coupled with a hydrological model for water management, flood forecasting and climate studies.

The model should adopt a robust and parsimonious approach to prognostically derive LAI and stomatal conductance, two fundamental plant characteristics that influence the evapotranspiration flux. Robust in the sense that should be capable to reproduce the inter-seasonal and intra-seasonal variations of water and energy fluxes in diverse climates and regions while parsimonious because the parameterization should be reduced at minimum. For instance, sensitivity analyses should be conducted to test the advantage, if any, of using a more sophisticated scheme for modeling the exchange of ET among soil, vegetation and atmosphere (e.g.: two sources vs. one source scheme).

In addition, the water scarcity impacts on the abiotic and biotic plant functions deserve be investigated (e.g. use of specific soil moisture stress functions for each Plant Functional Type).

The model should be able properly work in data scarce environment and to fully use and benefits from satellite data especially the new high-resolution from the Sentinel constellation.

Link to the group or personal Webpage

http://www.cimafoundation.org/

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