EMERGING BEHAVIOR IN COMPLEX SOIL BIOGEOCHEMICAL PROCESSES

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The soil-plant-atmosphere system is characterized by a large number of interacting processes with high degree of nonlinearity. These elements of complexity, while making a full modeling effort daunting, may also be responsible for the emergence of universal behavior. Based on extensive experimental observations, we explain such emerging patterns by using nonlinear dynamical systems, describing the main deterministic components, coupled to suitable stochastic terms, surrogating the high dimensional and unpredictable components.

We show how the interplay of stochastic and nonlinear components in the soil water balance explains ecosystem response to water stress caused by changes in timing and frequency of rainfall, and gives rise to a universal partitioning of rainfall into evapotranspiration and losses by percolation and runoff in agreement with the semi-empirical Budyko's curve. We also discuss how hydrologic forcing affects the dynamics of soil nutrient and show that separating biochemical from physical impacts on soil organic matter decomposition results in universal curves describing data of litter decomposition and nutrient mineralization across the globe. Future extensions to larger spatial scales and managed ecosystems are briefly outlined.

BIO – AMILCARE PORPORATO

Amilcare Porporato earned a Master Degree in Civil Engineering (summa cum laude) in 1992 from Polytechnic of Turin and his Ph.D. in 1996 from Polytechnic of Milan. He was appointed Assistant Professor in the Department of Hydraulics of the Polytechnic of Turin in 1995 and received tenure in 1998. He moved to Duke University in 2003, where he is Full Professor in the Department of Civil and Environmental Engineering with a secondary appointment with the Nicholas School of the Environment.

In June 1996, Porporato received the Arturo Parisatti International Price, awarded by the Istituto Veneto di Scienze, Lettere e Arti. He was Research Associate at the Texas A&M University (USA) in 1998 and Visiting Scholar at Princeton University (USA), Department of Civil and Environmental Engineering, from 1999 to 2001. In 2008-2009 he was the first Landolt & Cie Visiting Chair in "Innovative Strategies for a sustainable Future" at Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland.

His main research interests regard nonlinear and stochastic dynamical systems, hydrometeorology and soil-atmosphere interaction, soil moisture and plant dynamics, soil biogeochemistry, and ecohydrology.

Porporato has been Editor of Water Resources Research (AGU) (2004-2009), and he is member of the editorial board of Advances in Water Resources and Hydrological Processes. Among other things, he was chairman and convener of the Ecohydrology sessions of the AGU Spring Meeting in 2001 and 2002 and of the EGU in 2004-2006. Porporato has been part of the Italian research groups of Turbulence and Vorticity and of Climate, Soil and Vegetation Interaction, an adviser for real-time forecasting in the Piedmont Region (Italy), and ecohydrology (US National Academy).

Porporato's didactic experience comprises courses in Environmental Fluid Mechanics, Hydraulics, Hydraulic Constructions, Statistical and Physical Hydrology, Ecohydrology, Nonlinear Dynamics and Stochastic Processes. He has also been the didactic coordinator for the International School "Hydroaid:

Water for Development", co-organized by the Polytechnic of Turin and the Italian Ministry of Foreign Affairs.

Porporato is author of more than 100 peer-reviewed papers, several publications presented at national and international conferences and invited talks. He is also co-author of the book "Ecohydrology of water controlled ecosystems" (Cambridge Univ. Press, 2004) and the edited the book "Dryland Ecohydrology" (Springer, 2005).