Geophysical Research Abstracts
Vol. 13, EGU2011-13079, 2011
EGU General Assembly 2011

Environmental observatories and environmental gradients: challenges and opportunities for exploring the Earth's critical zone

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The living skin of the terrestrial Earth – the "Critical Zone" – is characterized by spatial heterogeneity and process complexity, posing challenges to the research community. Several so-called Critical Zone Observatories have recently been launched, in which multidisciplinary teams of researchers focus their combined efforts on an individual piece of landscape, typically a small catchment. Such observatories offer opportunities to study process linkages that might otherwise go unnoticed if individual researchers worked in separate locations. The processes and properties of the critical zone are also increasingly explored using networks of sites along environmental gradients. Such gradients can provide natural "experiments" in which individual environmental factors vary while others remain relatively constant. Here I will illustrate how both observatory data and gradient inter-comparisons can illuminate coupled physical, chemical, and biological processes in the Critical Zone, and I will outline key challenges facing Critical Zone research.