Geophysical Research Abstracts
Vol. 14, EGU2012-10825, 2012
EGU General Assembly 2012

On Budyko curve as a consequence of climate-soil-vegetation equilibrium hypothesis

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A hypothesis that Budyko curve is a consequence of stable equilibriums of climate-soil-vegetation co-evolution is tested at biome scale. We assume that i) distribution of vegetation, soil and climate within a biome is a distribution of equilibriums of similar soil-vegetation dynamics and that this dynamics is different across different biomes and ii) soil and vegetation are in dynamic equilibrium with climate while in static equilibrium with each other. In order to test the hypothesis, a two stage regression is considered using MOPEX/Hydrologic Synthesis Project dataset for basins in eastern United States. In the first stage, multivariate regression (Seemingly Unrelated Regression) is performed for each biome with soil (estimated porosity and slope of soil water retention curve) and vegetation characteristics (5-week NDVI gradient) as dependent variables and aridity index, vegetation and soil characteristics as independent variables for respective dependent variables. The regression residuals of the first stage along with aridity index then serve as second stage independent variables while actual vaporization to precipitation ratio (vapor index) serving as dependent variable. Insignificance, if revealed, of a first stage parameter allows us to reject the role of corresponding soil or vegetation characteristics in the co-evolution hypothesis. Meanwhile the significance of second stage regression parameter corresponding to a first stage residual allow us to reject the hypothesis that Budyko curve is a locus "solely" of climate-soil-vegetation co-evolution equilibrium points. Results suggest lack of evidence for soil-vegetation co-evolution in Prairies and Mixed/SouthEast Forests (unlike in Deciduous Forests) though climate plays a dominant role in explaining within biome soil and vegetation characteristics across all the biomes. Preliminary results indicate absence of effects beyond climate-soil-vegetation co-evolution in explaining the ratio of annual total minimum monthly flows to precipitation in Deciduous Forests though other three biome types show presence of effects beyond co-evolutionary. Such an analysis can yield insights into the nature of hydrologic change when assessed along the Budyko curve as well as non co-evolutionary effects such as anthropogenic effects on basin scale annual water balances.