

The hydrological in East Asia: Correlations, memory and a Granger causality analysis

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Variability of the Yangtze catchment hydrology is closely linked with the Tibetan Plateau snow cover and the large scale atmospheric circulation in East Asia. These connections are analyzed in a control simulation (2800 years) of the atmosphere ocean general circulation model (ECHAM5/MPIOM) coupled to vegetation and ocean biogeochemistry modules. Up to decadal time scales, runoff, soil wetness, and temperature show inter-annual memory while precipitation, snow depth, and snow melt reveal no memory. On the annual time scale, the correlations of the Hadley cell and ENSO on precipitation, temperature and snow melt are weak but significant. Temperature is anticorrelated with precipitation and soil wetness in the Yangtze catchment. Singular spectrum analysis highlights the 3-4 year ENSO mode in the monsoon indices, precipitation, and snow depth, explaining their high correlations. Projecting snow depth on ENSO shows long term variations explaining conflicting results obtained from correlations in short data sets. To retrieve possible causal relationships between the climatic components, a Granger causality analysis is performed. This method determines causality by an error analysis in predictions. The results reveal a mutual causality between monsoons and the hydrology in the catchment on an annual basis. Thus the climate in the catchment is subject to complex interactions and predictability cannot be attributed to the inter-annual memory of a few individual components.