Geophysical Research Abstracts
Vol. 12, EGU2010-9426, 2010
EGU General Assembly 2010

An Evaluation, Diagnostic and Correction approach to parsimonious model building for dryland areas

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This paper deals with building a parsimonious water balance model at monthly time steps for dryland areas. The study area is in western parts of India where data available is scarce. The overriding motivation for such a parsimonious modeling approach is to study how hydrology controls the effectiveness of adaptation strategies such as water trade in dryland areas. The process of model development is stepwise where the study area is first delineated into (interconnected) subbasins. Each subbasin is then represented by a linear reservoir model conceptualizing two dominant processes in semi-arid/arid areas: evaporation and subsurface flows. However, representation of the two fluxes simultaneously within a subbasin poses an issue of parameter nonidentifiability. Parameterization of these fluxes is therefore "evaluated" using GRACE and MERRA2D data simultaneously (rather than using either of them one at a time). These two data sets allow orthogonalization of information on the two fluxes, thereby controlling for parameter interactions (and hence identifiability). Parsimony in parameters of the overall model of interconnected linear reservoirs is achieved by regionalizing recession parameters in terms of soil characteristics of the study area.

The parsimonious model is then "diagnosed" by comparing its storage change behavior with GRACE storage change data. The developed model‘s inability to reproduce storage change signature in dry parts of the year and to wet slower during the beginning of the wet period is detected; thereby emphasizing the need to "correct" the model structure. Consequently the model structure is corrected by including a second (nonlinear) reservoir for each subbasin while maintaining parsimony in overall model parameterization. Interestingly, in the process of model correction, a nonlinear storage-discharge relationship is discovered in the monthly time steps model (at coarse spatial resolution). However this nonlinear relationship is not in readily estimable power-law relationship. A simple mechanistic approach is therefore proposed to further conceptualize nonlinear storage discharge relationship thus detected and is incorporated in the corrected model. Finally the corrected model structure is compared with its initial form and challenges posed by their structures and data needs are discussed.