Geophysical Research Abstracts, Vol. 7, 10689, 2005
SRef-ID: 1607-7962/gra/EGU05-A-10689

Common patterns in spatially dirstibuted groundwater series

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Since the introduction of time series modeling in groundwater hydrology, an enormous amount of groundwater time series has been modeled. Often, transfer function-noise (TFN) models are applied to determine the 'natural part' of groundwater fluctuations, i.e. fluctuations caused by precipitation and evaporation. The residual part of the groundwater fluctuations is modeled by a noise model. This part contains errors resulting from input uncertainty, errors due to model assumptions, but also fluctuations caused by unknown, non-natural influences. The last one in particular is of interest to the hydrologist: are there, e.g., any trends or structural changes in groundwater regimes? A major issue in the assessment of 'non-natural' groundwater fluctuations is the spatial pattern of these fluctuations. If groundwater levels are measured at different locations, such spatial patterns can be estimated using a multiple time series model. This presentation provides an approach to model multiple time series of groundwater level simultaneously. The approach is based on the vector transfer-function noise (VTFN) model. The residual part of the VTFN model - the noise model - has the form of a common dynamic factor (CDF) model. A CDF model describes a set of n time series by one or more common factors accounting for the communality of the residual series, and n specific factors describing the unique component of each residual series. In hydrological applications the common factors can be interpreted as regional components and the specific factors as local components of the residual series. Both regional and local component provide useful information of the groundwater system. The regional component describes common patterns in the observed groundwater fluctuations. Local components describe deviations from the regional component. In addition, they are a measure of uniqueness of the observed groundwater fluctuations, which can be used in the optimization of monitoring networks. The multiple

time series model is illustrated with a real world case. In this case, ten time series of groundwater fluctuations are modeled simultaneously. Two common factors are used to describe the communality of the residual part. One of the common factors describes a temporal trend caused by groundwater extractions.