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Variability of basin scale water resources indicators derived from global hydrological and land surface models

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Global hydrological and land-surface models are becoming increasingly available, and as the resolution of these improves, as well how hydrological processes are represented, so does their potential. These offer consistent datasets at the global scale, which can be used to establish water balances and derive policy relevant indicators in medium to large basins, including those that are poorly gauged. However, differences in model structure, model parameterisation, and model forcing may result in quite different indicator values being derived, depending on the model used.

In this paper we explore indicators developed using four land surface models (LSM) and five global hydrological models (GHM). Results from these models have been made available through the Earth2Observe project, a recent research initiative funded by the European Union 7th Research Framework. All models have a resolution of 0.5 arc degrees, and are forced using the same WATCH-ERA-Interim (WFDEI) meteorological re-analysis data at a daily time step for the 32 year period from 1979 to 2012. We explore three water resources indicators; an aridity index, a simplified water exploitation index; and an indicator that calculates the frequency of occurrence of root zone stress. We compare indicators derived over selected areas/basins in Europe, Colombia, Southern Africa, the Indian Subcontinent and Australia/New Zealand.

The hydrological fluxes calculated show quite significant differences between the nine models, despite the common forcing dataset, with these differences reflected in the indicators subsequently derived. The results show that the variability between models is related to the different climates types, with that variability quite logically depending largely on the availability of water. Patterns are also found in the type of models that dominate different parts of the distribution of the indicator values, with LSM models providing lower values, and GHM models providing higher values in some climates, and vice versa in others. How important this variability is in supporting a policy decision, depends largely on how a decision thresholds are set. For example in the case of the aridity index, with areas being denoted as arid with an index of 0.6 or above, we show that the variability is primarily of interest in transitional climates, such as the Mediterranean

The analysis shows that while both LSM's and GHM's provide useful data, indices derived to support water resources management planning may differ substantially, depending on the model used. The analysis also identifies in which climates improvements to the models are particularly relevant to support the confidence with which decisions can be taken based on derived indicators.