Large-scale simulation of karst processes - parameter estimation

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PARAMETER ESTIMATION SCHEME

1. Initial model parameter ranges

A newly developed parameter estimation scheme is applied to derive pa-

per model parameter sets and remaining parameter uncertainty for four karst land-

scape parameters using KF (Fluxnet) and soil moisture (SSM) observations for

2002-2012.

Initial parameter ranges are the same for all karst landscapes. They are as-

sessed by prior experience with the model at the catchment scale.

1.1 Bias rule: retain only the parameter sets that produce a bias between observed and simulated actual evaporation lower than 15%.

1.2 Correlation rule: retain only the parameter sets that produce a positive coefficient of correlation between observations and simulations of both actual evaporation and soil moisture.

2. Definition of karst landscapes

We sample 25,000 parameter sets within the initial parameter ranges and apply them to the model to obtain 25,000 simulated time series for each of our observation sites. For each of the four karst landscapes we apply three, soft rules to confine the initial parameter set:

2.1.2 Correlation rule: retain only the parameter sets that produce a positive coefficient of correlation between observations and simulations of both actual evaporation and soil moisture.

3. Confined of parameter ranges

1. A priori information: retain only parameter sets, in which the soil parameterVect falls within the feasible range for the chosen karst landscape.

DATA

<table>
<thead>
<tr>
<th>Variable</th>
<th>Spatial resolution</th>
<th>Time period</th>
<th>Frequency</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation</td>
<td>0.25°</td>
<td>2002-2012</td>
<td>daily</td>
<td>DIVA-5.1</td>
</tr>
</tbody>
</table>
| Temperature               | 0.25°              | 2002-2012   | daily     | DIVA-5.1
| Snow water equivalent     | 0.25°              | 2002-2012   | daily     | NPGS | NOAA/NOGEO-I2 |
| Soil moisture             | 0.25°              | 2002-2012   | daily     | SMBT V3.2 |
| Vegetation                | 0.25°              | 2002-2012   | daily     | FRAXET |
| Actual evaporation        | individual locations | individual periods | daily | FLUXNET |
| Soil moisture             | individual locations | individual periods | daily | ERMH |

RESULTS

The simulations show high annual recharge rates in Northern Europe and in the high-mountain areas, very high recharge for Southern Europe and Northern Africa. Parameter uncertainty due to the limited data availability remains low in most of the study domains.

EVALUATION

Comparison with recharge volumes assessed from the literature shows that although there is a considerable spread across the simulations, their bulk trends will adhere to the 1:1 line.

Another comparison with simulated recharge volumes of 2 other large-scale models we find a strong tendency of under-estimation, in particular at the MTN and HUM regions.

SYNTHESIS

Our novel parameter estimation scheme allowed to set up a large-scale karst recharge model over all karst regions in Europe, Northern Africa and the Middle East. The simulated pattern of recharge rates and comparison to independent observations indicate an overall realism of the model. Consequently, the model can be used to derive relevant measures of the climate sensitivity of recharge to support present and future water management.

Acknowledgments

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Reference: