JULES’ VALIDATION AND FLUX PARTITIONING FOR LARGE-SCALE BASINS

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Prof. Ioannis Tsanis

JULES meeting
1-2 of July 2014
Leicester
Introduction

Motivation:
- Simulation of the water cycle at the global, continental or basin scale
- Need for model validation → basin scale

Scope:
- Evaluate model performance
- Identify model deficiencies comparing performance at different basins

Data & Simulations
- JULES version 3.4.1., default mode
- WFDEI forcing data
- 0.5° x 0.5° grid resolution
- Global runs, Simulation period: 1979-2010
- Outputs: Precipitation, Surface & Subsurface runoff production, Evaporation from soil, Canopy evaporation
- Watershed delineation using TRIP river routing scheme (flow direction template)
- Location of the gauging station is set as river pour point
- The cells into the boundaries of the watershed are extracted from the global output
Runoff routing

Model output: **surface and subsurface runoff production** per gridbox

✓ Required output for model validation: river **discharge**

✓ Conversion using a **conceptual lumped routing approach**

- \( \times \) gridbox area
- Sum all gridboxes

- Apply triangular filters
- Longer filter (slower response) for subsurface runoff
- 3 steps for surface runoff
- 10-50 steps for subsurface runoff

- Surface discharge production in the basin
- Subsurface discharge production in the basin

- Delayed surface discharge
- Delayed subsurface discharge

- Total response (discharge)
- Allows validation at daily time-scale
Evaluation (daily time-scale)

- The model shows more “peaky” response.
- Overestimates peaks and underestimates lower flows.

I. Danube
- Data
- Model(3,10)

II. Volga
- Data
- Model(3,50)

III. Ganges
- Data
- Model(3,10)

IV. Mississippi
- Data
- Model(3,10)

V. Amazon (Madeira)
- Data
- Model(3,50)
### Evaluation (daily time-scale)

<table>
<thead>
<tr>
<th>Daily</th>
<th>NSE</th>
<th>PBIAS(%)</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Danube</td>
<td>-1.57</td>
<td>-38.44</td>
<td>0.566</td>
</tr>
<tr>
<td>II. Volga</td>
<td>-0.2</td>
<td>-20.25</td>
<td>0.61</td>
</tr>
<tr>
<td>III. Ganges</td>
<td>0.68</td>
<td>-4.04</td>
<td>0.75</td>
</tr>
<tr>
<td>IV. Mississippi</td>
<td>0.24</td>
<td>6</td>
<td>0.63</td>
</tr>
<tr>
<td>V. Amazon</td>
<td>0.06</td>
<td>18.76</td>
<td>0.57</td>
</tr>
</tbody>
</table>

- Model performance varies between the basins.
- NSE and PBIAS vary significantly but all basins exhibit sufficient linear correlation.
Evaluation (monthly time-scale)

- Model behaviour is clearer at the monthly time-scale.
- High flows are overestimated in most basins. Time of peaking is correct but the simulated discharge values are much higher.
Model performance is better when evaluated at the monthly time-scale.
Evaluation (annual time-scale)

<table>
<thead>
<tr>
<th>River</th>
<th>Data</th>
<th>Model(3,10)</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Danube</td>
<td></td>
<td></td>
<td>0.87</td>
</tr>
<tr>
<td>II. Volga</td>
<td></td>
<td></td>
<td>0.73</td>
</tr>
<tr>
<td>III. Ganges</td>
<td></td>
<td></td>
<td>0.58</td>
</tr>
<tr>
<td>IV. Mississippi</td>
<td></td>
<td></td>
<td>0.88</td>
</tr>
<tr>
<td>V. Amazon (Madeira)</td>
<td></td>
<td></td>
<td>0.08</td>
</tr>
</tbody>
</table>
## Comparing performance at different time-scales

<table>
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<tr>
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<td>0.57</td>
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</tbody>
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<tr>
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<th>Monthly NSE</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Danube</td>
<td>-1.18</td>
<td>0.71</td>
</tr>
<tr>
<td>II. Volga</td>
<td>-0.28</td>
<td>0.67</td>
</tr>
<tr>
<td>III. Ganges</td>
<td>0.87</td>
<td>0.86</td>
</tr>
<tr>
<td>IV. Mississippi</td>
<td>0.57</td>
<td>0.81</td>
</tr>
<tr>
<td>V. Amazon</td>
<td>0.07</td>
<td>0.59</td>
</tr>
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</table>
- Averages per month for all years
- Model deficiencies can be identified
- Differences in the performance between the basins and throughout the year

## I. Danube

### Data Model (3,10)

- Discharge [m³/s]

## II. Volga

### Data Model (3,10)

- Discharge [m³/s]

## III. Ganges

### Data Model (3,10)

- Discharge [m³/s]

## IV. Mississippi

### Data Model (3,10)

- Discharge [m³/s]

## V. Amazon (Madeira)

### Data Model (3,50)

- Discharge [m³/s]
Partitioning water cycle fluxes

- Partitions seem to follow the same pattern in all basins.
- Surface runoff production is very small compared to the other fluxes. Discharge is practically governed only by subsurface runoff production.
For Danube and Volga, evaporation from soil and from canopy (ET) are the largest components during the wet seasons.

Ganges exhibits higher subsurface runoff during the wet season compared to the dry season.
### Seasonal flux partitioning

**IV. Mississippi**

- **Subsurface Runoff**
- **Surface Runoff**
- **Evap. from soil**
- **Evap. from canopy**
- **Precipitation**

For **Mississippi** the governing partition is evaporation from soil, especially during the wet season. The subsurface runoff component is small all year round.

**V. Amazon (Madeira)**

Amazon exhibits the smallest soil evaporation partition and the largest subsurface runoff partition compared to the other basins, especially for the wet months.
Concluding remarks

• For the same run, model performance varies between different basins.

• Simulations are more robust at larger time-scales.

• Surface runoff production (in the default model version) is a very small part of the water balance, almost negligible for discharge calculation.

...and some questions to be answered

- Can we calibrate? Which parameters can improve model performance in terms of the simulation of the water cycle components? Which parameters would affect flux partitioning?

- Is it possible to calibrate at the global scale?
Thank you!
Any questions?

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