Joint assimilation of streamflow and downscaled satellite soil moisture observations to improve large-scale hydrological modelling.

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OzEWEX – 2nd National Workshop
2nd December 2015
Introduction

Large-scale hydrological models

VIC

Global water balance: historical variations, human uses of water, impact on availability, etc.

HTESSEL

Assessment of global hydrological extremes: floods and droughts

PCR-GLOBWB

Climate change impact on water resources

ETC, …
Introduction

Large-scale hydrological models

BUT

Local water resources management

Coarse spatial resolution

River basin scale features
Introduction

Large-scale hydrological models

BUT

Coarse spatial resolution

High resolution meteorological forcing data
Introduction

Large-scale hydrological models

BUT

Coarse spatial resolution

High resolution meteorological forcing data

Assimilation of observations
Approach

**Meteorological forcing data**
- Global forcing data (WFDEI)
- Local forcing data (AWAP)

**Hydrological model**
- Large-scale model: PCR-GLOBWB
- Local-scale model: OpenStreams wflow_sbm

**Data assimilation**
- Downscaled AMSR-E soil moisture (0.08°/day) and discharge (selected stations/day)

**Validation**
- Soil moisture/Streamflow estimates
Meteorological forcing data

Precipitation [mm d⁻¹]

Local (AWAP)

Global (WFDEI)

Difference (Global - Local)

Temperature [°C]

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Meteorological forcing data

**Precipitation bias (Global-Local)**

**Temperature bias (Global-Local)**

<table>
<thead>
<tr>
<th></th>
<th>P [mm d$^{-1}$]</th>
<th>T [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSE</td>
<td>-0.203</td>
<td>0.693</td>
</tr>
<tr>
<td>r</td>
<td>0.378</td>
<td>0.985</td>
</tr>
<tr>
<td>MAE</td>
<td>1.739</td>
<td>3.527</td>
</tr>
<tr>
<td>RMSE</td>
<td>3.817</td>
<td>3.794</td>
</tr>
<tr>
<td>mean E2O</td>
<td>1.708</td>
<td>15.598</td>
</tr>
<tr>
<td>mean AWAP</td>
<td>1.573</td>
<td>19.122</td>
</tr>
<tr>
<td>bias</td>
<td>0.135</td>
<td>-3.525</td>
</tr>
</tbody>
</table>
PCR-GLOBWB and OpenStreams wflow_sbm models

- Large-scale hydrological model
  - Temporal resolution: daily
  - Spatial resolution: ~10 km (0.08° x 0.08°)
  - Soil schematization → 3 layers: 0 – 5 cm, 5 – 30 cm, 30 – 150 cm

- Local-scale hydrological model
  - Temporal resolution: daily
  - Spatial resolution: ~1 km (0.01° x 0.01°)
  - Soil schematization (topog_sbm) → 2 layers: UZ, SZ
Data assimilation

- **Observations:**
  - SM (AMSR-E)
  - Q (BoM and CSIRO)

- **Assimilation period:** 2007 – 2010

- **Ensemble Kalman Filter**
  - (100 ensemble members)

- Model and observations uncertainty
Impact on runoff estimates

LOCAL

GLOBAL

Time [month-year]

Discharge [m³·s⁻¹]

PCR-GLOBWB OSWS

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Impact on streamflow estimates

LOCAL

GLOBAL

PCR-GLOBWB  OSWS

MAE [m$^3$ s$^{-1}$]

RMSE [m$^3$ s$^{-1}$]

$\Delta$ [°]

NSE [-]

410001  410005  410078  410136  Average

410001  410005  410078  410136  Average

Workshop – 2015
Conclusions

1. Assimilating downscaled soil moisture observations produces the largest improvement on the streamflow model estimates, compared with the independent discharge assimilation.

2. The joint assimilation of both discharge and downscaled soil moisture observations leads to further improvement on streamflow estimates, mainly for upstream catchments (20% reduction in RMSE).

3. The higher spatial resolution of the local forcing data results in higher models performances on both soil moisture and streamflow estimates.

4. The additional contribution of data assimilation, for any considered scenario, is more pronounced when global meteorological data are used to force the models.

5. Data assimilation of high resolution soil moisture can partly overcome the difference in model performance between a large-scale hydrological model driven by coarse resolution forcing data and a local-scale model forced with higher resolution meteorological data.

Thank you
Questions