AWRA-CMS: A hydrological modelling system

November 2019

Australian Government
Bureau of Meteorology
Overview

Background
What is the AWRA-CMS

Roadmap
• Goal: Seamless Water Service
• Retrospective
• Forecasts
• Projections
• Model development

Enabled by HPC + good software design
• FAST
• FLEXIBLE
• ROBUST
What is the AWRA-CMS?

- Operational framework for the Bureau's national hydrological model

- Products:
  - Soil moisture
  - Runoff
  - ET
  - Deep drainage

- Wider community:
  - Reduced feature public package on GitHub
Retrospective:

Fig 1. Overview of the soon to be released, expanded Australian Landscape Water Services
Example products:
Retrospective workflow:
Forecasts:

Fig 1. Overview of the soon to be released, expanded Australian Landscape Water Services
Example products:

Data assimilation framework

Seasonal forecast

<table>
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<th>Month</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
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</tbody>
</table>
Forecast workflow:

Seasonal forecast

Data assimilation framework

Upper SM

Lower SM

Oct

Nov

Feb

Mar

Integration of initial conditions

Validation

Ensemble

Forecast

Observations

Long range

Ensemble

Observations

Data assimilation

Validation

Model

Weather conditions

Observations
Projections:

Fig 1. Overview of the soon to be released, expanded Australian Landscape Water Services.
Example products:

Bias corrected met forcing from GCMs

Projected change in hydrological fields
Projections workflow:

Bias corrected met forcing from GCMs

Projected change in hydrological fields
All products supported by continuous model development:
Model development workflow:

1. Ingestion of data from remote
2. Metadata check
3. Preprocessing
4. Validation
5. Model calibration
6. Model run with DA
7. Post-model processes
8. Validation
9. Analysis
Enabled by HPC and good software design: FAST

How?

• Use of
  – Vectorisation
  – Parallel compute across and within nodes
  – Parallel IO
  – Big data: use of next generation Python data science libs

• On the fly
  – Data transformation
  – Templating and compilation
  – Model coupling (e.g. model to routing)

Enabled by HPC and good software design: FLEXIBLE

How?

• Workflow schedulers
  – Cylc/Rose
  – Built in redundancies, dependencies and polling

• Modular workflow design
  – Plug and play
  – Infrastructure for connecting new hydrological models
  – Reuse core components / inheritance

Source: [https://docplayer.net/17345454-Rose-cylc-introduction.html](https://docplayer.net/17345454-Rose-cylc-introduction.html)
Enabled by HPC and good software design: ROBUST

How?
• Continuous integration
  – Training notebooks, plus tests are part of a continuous integration pipeline
  – Metrics collected for performance, stability etc
  – Linting
  – Check for security vulnerabilities
  – Run on multiple platforms including HPC

• Testing
  Ensure adequate test coverage
  Stress testing

Source: https://www.hurricanelabs.com/splunk-tutorials/splunk-app-development-continuous-integration
Summary

To be able to agilely deliver high value products to customers we need:

• A fast, flexible and robust modelling system
  – Build your own modular workflows and use of workflow schedulers
  – Flexibility for model implementation and development
  – Good software design (optimisation, parallelism, load balancing etc.)

• High performance computing and high performance data
  – Large compute > 100 ensemble members
  – Big-ish data >200 TBs of data
Thanks for listening

CREDITS:
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