C-SCALE

Copernicus - eoSC AnaLytics Engine

# Use case 4: High-resolution Land Surface (Drought) Analysis

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# Objectives

*Deliver accurate and reliable information, readily available, easily understandable and with high resolution*

**HRLSDA solution**

- Provide **high resolution** regional forecasts of hydrological droughts
- Develop operational **Copernicus-based downstream information services**
- **Scalable and easy to extend** to other regions
- Holds the potential to **improve operation, planning and management** of agricultural and other drought affected activities

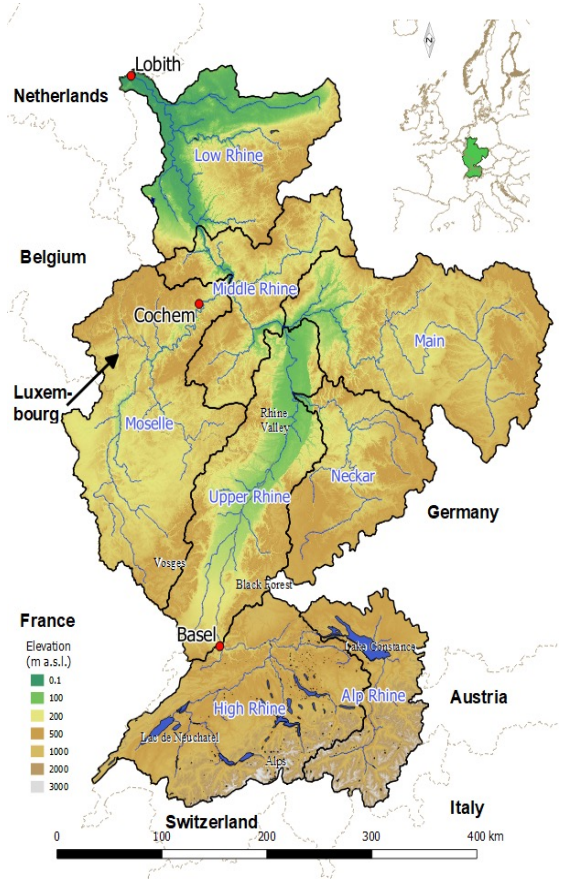
**HRLSA services**

- Early warning drought detection and forecasting service
- Information for planning operations

# Specific objective

- Development of high-resolution drought forecasts for the Rhine Basin and a second country on the C-SCALE compute facilities

*Relevance: Summer 2018 drought*



# Wflow_sbm (wflow.readthedocs.io)

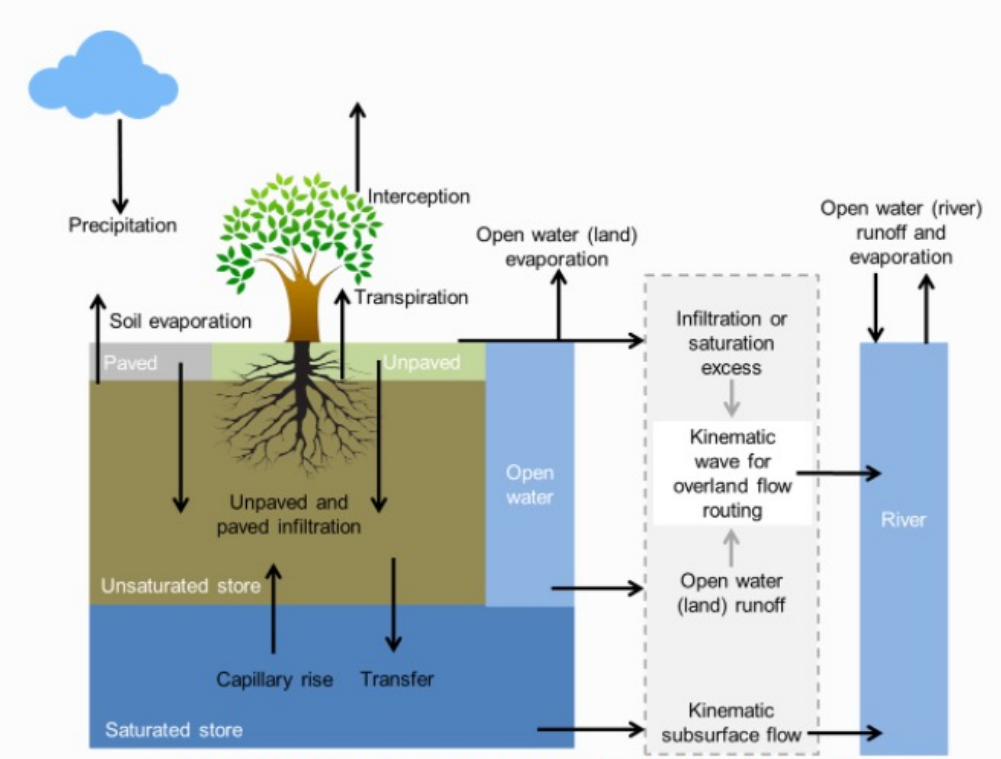
- Fully distributed – grid based model
- Runs on hourly / daily time-step
- Resolutions 100 m – 5 km
- Mainly applied at catchment / river basin scale

***Oppertunities***

- Grid-based model
- Open Source
- Pedo-transfer functions for parameterization based on global datasets

***Limitations***

- Simple bucket model
- Simplified represenation of soil water flow / saturated zone



*Overview of the different processes and fluxes in the wflow_sbm model.*

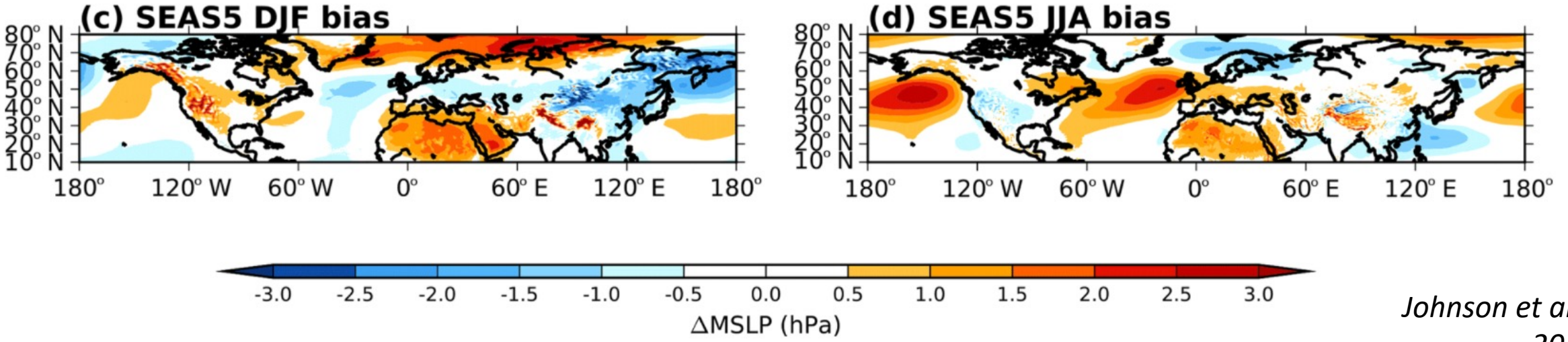
# Data and modelling challenges

***Data assimilation***

- Seasonal forecast performance highly influenced by initial conditions
- Soil moisture influences both the simulation of floods and low flows
- Need to correlate satellite soil moisture to wflow variable for assimilation
    - vertical.satwaterdepth [mm] (saturated store)
    - vertical.zi [mm] (depth of pseudo water table)
    - vertical.runoff [mm] (amount of water in to the overland flow kinematic wave)
    - vertical.wc [-] (volumetric water content per soil layer)
    - vertical.wc_perc [%] (volumetric water content per soil layer)
    - vertical.wc_root [-] (volumetric water content in root zone)
    - vertical.wc_percroot [%] (volumetric water content in root zone)
    - vertical.ustoredepth [mm] (total amount of available water in the unsaturated zone)
- OpenDA (openda.org) is used for data assimilation – first time connected to Wflow Julia

# Data and modelling challenges

***Seasonal forecasts tend to be biased***




*Johnson et al., 2019*

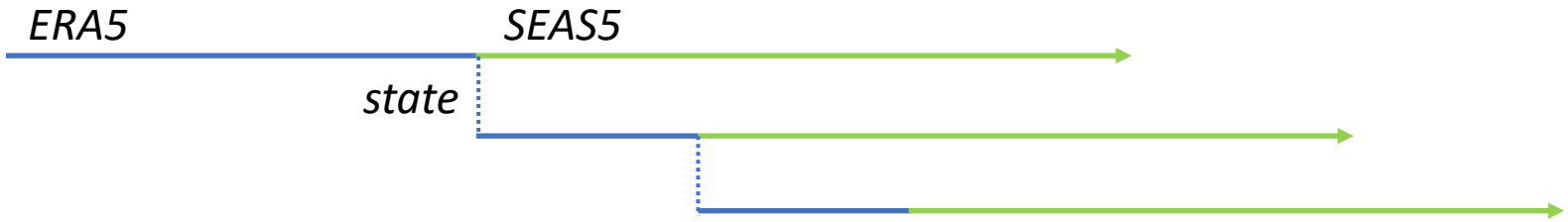
→Each month need for state updating with wflow run based on ERA5 re-analysis data

→Bias correction with ERA5 data ?

# Seasonal forecasts

- SEAS5 data from ECMWF – data ranges 6 months ahead in time. Reasonable skill for western Europe ~ upto 3 months, 50 members:
  - *Precipitation, temperature, pressure and radiation*

- Use of hydrological model to convert meteo into hydrological variables: discharge, soil moisture, lake storages etc



# Workflow description

ERA5 re-analysis

SEAS5 forecast

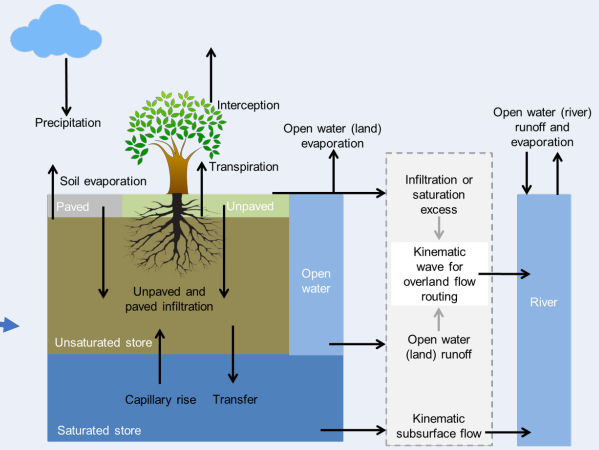
*COPERNICUS DataStore*

Meteorological forcing

Pre-processing for Wflow

Soil moisture assimilation

OpenDA




Monthly drought forecasts

*C-SCALE compute federation*

Sentinel-1

*Copernicus Global Land Service*

# Requirements

| Use case | HRLSDA | |
|---|---|---|
| End Product | Viewer with forecasted drought indicators upto 3 months ahead | |
| Provider | SURF (SPIDER platform) | |
| Area of Interest | Rhine + a additinal basin | |
| Data requirements | SEAS5<br>ERA5<br>Sentinel-1 L2 soil moisture | Current month<br>Latest week<br>Near real-time |
| Code base | Python, Julia, wflow_sbm, hydromt | |
| Resource requirements | HTC, 20TB storage, 8 GB RAM, parallel running | |

# Architecture

SURF

**Data download**

- ERA-5 (historical) ✓
- SEAS5 (seasonal forecast ✓

Copernicus Europe's eyes on Earth — Implemented by ECMWF

- Satellite soil moisture

Copernicus Global Land Service
*Providing bio-geophysical products of global land surface*

**Pre-processing**

- Meteo forcing on wflow grid ✓
- Enable ensemble runs ⏳
- Soil moisture on wflow grid

**Model running**

- Wflow_SBM Julia ✓
- OpenDA for data assimilation

OpenDA

**Post-processing**

- Assess drought indicators for visualization

# Activities – with SURFSara

1. Access to SURFSara HTC arranged
2. Helpdesk ticket system for support questions
3. For the basic workflow all scripting and model preparations nearly completed
5. Completion of docker – Wflow Julia
6. Set-up singularity for Python scripts
7. *Testing and uploading to the platform*

# Challenges

- Multiple data sources (different formats, time spans, sources etc.)
- Multiple data processing algorithms (Python, Wflow Julia, OpenDA)
- Need for development of dockers and singularity
- Selection of platform