Improved early warnings through Earth Observation Data Assimilation and Hydrological Retrospective forecasts (EODAHR)

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Kluisbergen, BEODay 28/11/2019

Context

Research hypothesis:

Assimilation of microwave-based satellite data related to soil moisture and vegetation allows reducing the impact of errors in the initial conditions for the provision of reliable post-processed hydrological ensemble predictions.

Need for reliable hydrological predictions (floods, drought)

May 21, 2012, Tubize

July 22, 2018, Brussels

Hydrological Ensemble Predictions

Limited use of medium range weather forecasts in operational flood forecasts in Belgium

The RMI is issuing probabilistic forecasts up to nine days ahead with its **Hydrological Ensemble Prediction System** (HEPS)

Efforts so far to improve reliability of hydrological simulations through **remote sensing data assimilation**:

- Soil moisture data
- Combined soil moisture and vegetation data (very new and only with Level 2 products in the literature)

Still reliability needs to be improved through better data-assimilation systems and post-processing

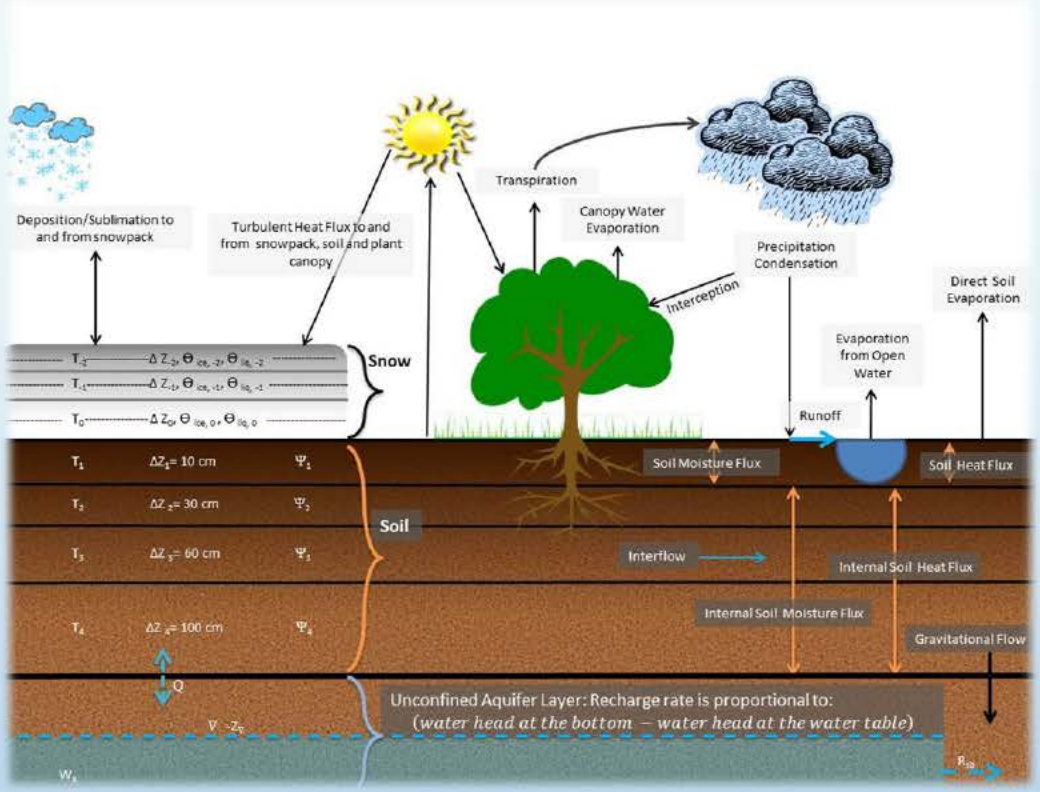
Scientific objectives of EODAHR

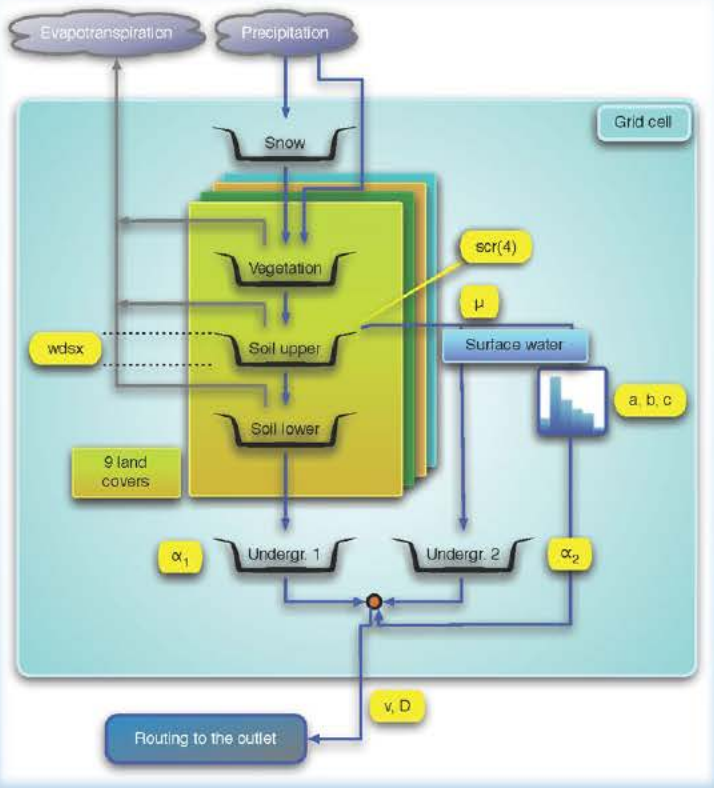
In summary:

- Implementation of satellite data assimilation for soil moisture and vegetation estimation
- Combination of the assimilation system with the **medium-range hydrological ensemble prediction system** in the context of **statistical post-processing**, based on **hydrological reforecasts**

Specifically:

- Prepare both a Hydrological Model (HM) and Land Surface Model (LSM), as well as an observation operator, for Level 1 active microwave data assimilation over Belgium – observation operator: a microwave backscatter model, first to be tested for the LSM and then to be transferred to the HM system
- Develop an **innovative assimilation system to use Level 1 microwave data for joint soil moisture and vegetation** estimation – vegetation in LSM is a prognostic variable while in the HM is a parameter set; more advanced data assimilation methods are required
- Produce streamflow **forecasts** with updated initial conditions – verification by comparing the forecasts with the corresponding streamflow observations
- Improve hydrological ensemble predictions by **post-processing** – calibration and application of a statistical correction model based on streamflow forecasts for past situations (**hydrological reforecasts**), with and without data assimilation





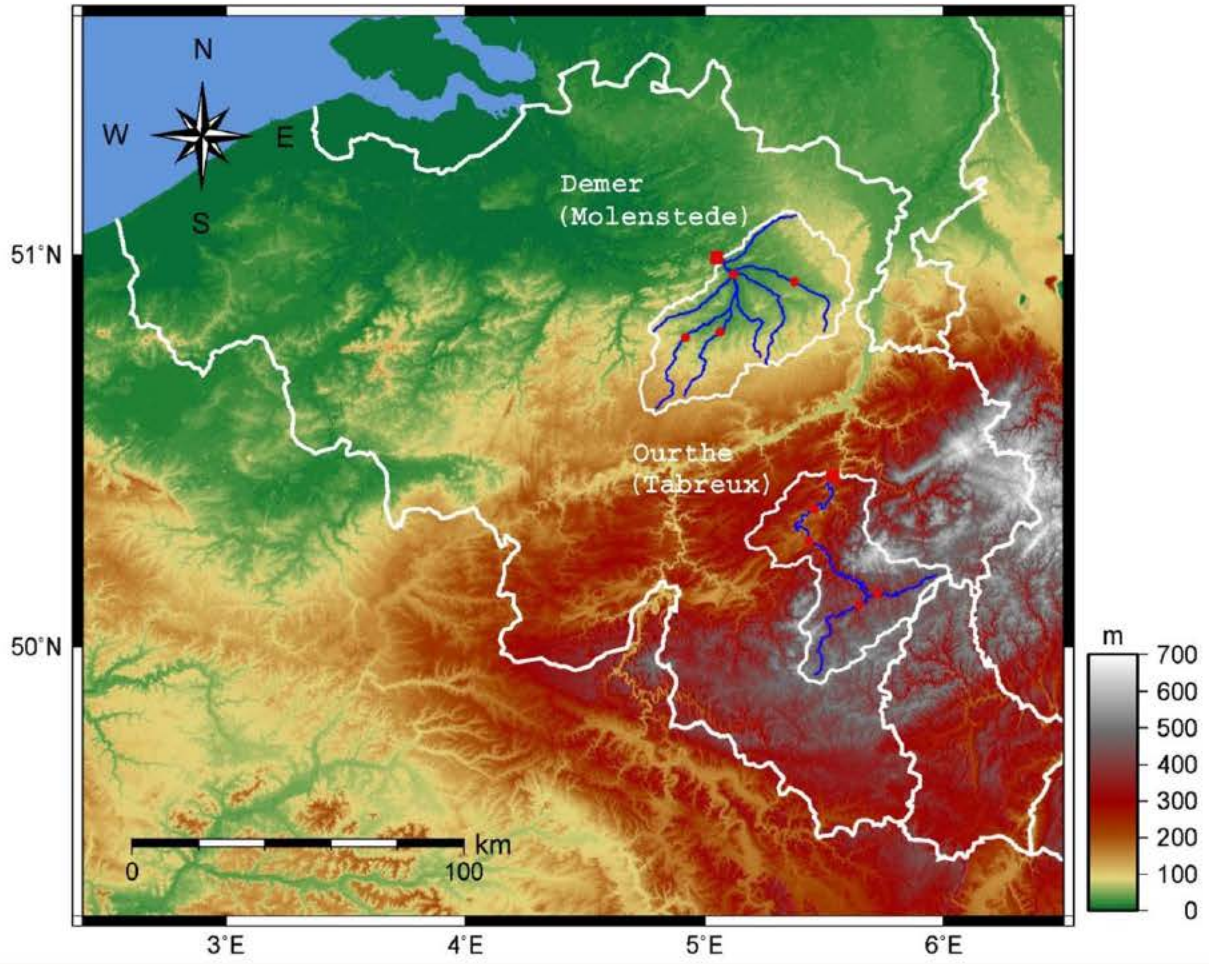
Noah-MP Land Surface Model

- Separate vegetation canopy defined by a canopy top and bottom, crown radius, and leaves with prescribed dimensions, orientation, density, and radiometric properties
- Multi-layer snow pack with liquid water storage and melt/refreeze capability and a snow-interception model
- Multiple options for surface water infiltration and runoff and groundwater transfer and storage

SCHEME Hydrological Model

- Daily time step, 7km x 7km
- 9 land covers
- Conceptual water reservoirs
- Calibration of parameters
- Regionalization
- Routing from cells to outlet

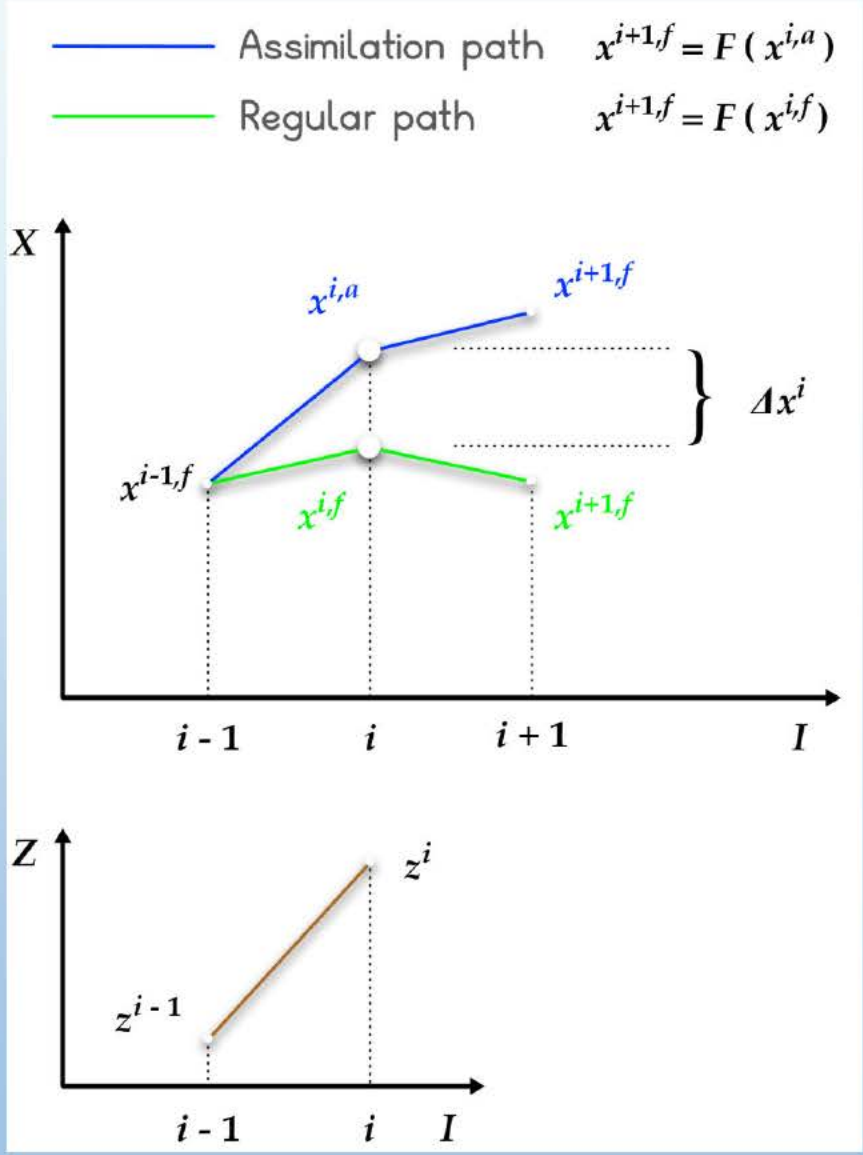
Location of test sites



The Demer catchment intersects with most of the BELAIR site HESBANIA in the Grote and Kleine Gete tributaries

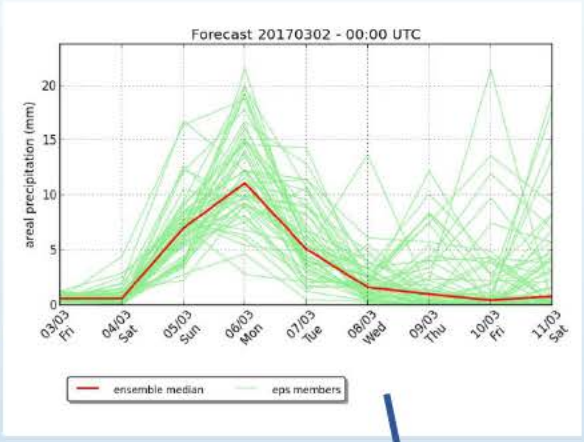
Data assimilation

F: model
x: model state
Δx: correction
z: observation
i: time step
f: forecast
a: analysis

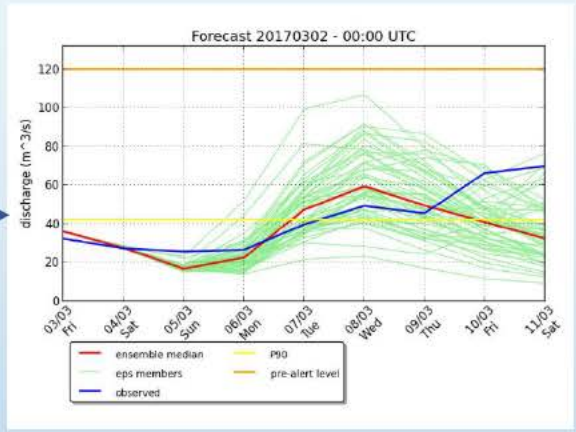


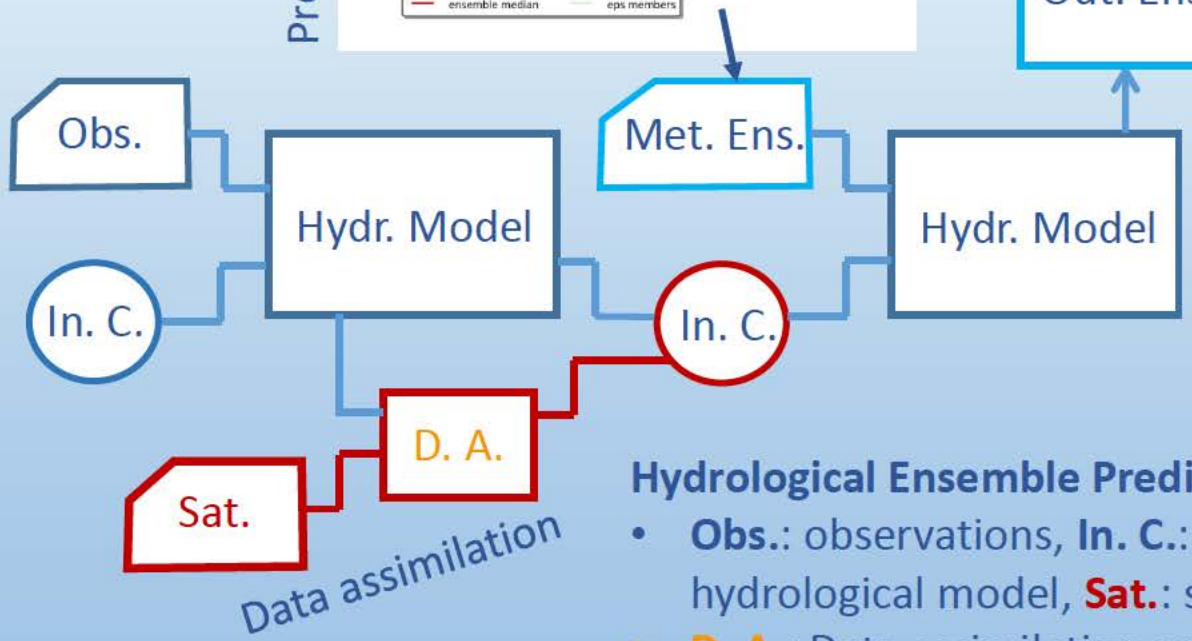
Data assimilation and forecast uncertainty

Precipitation forecast



Runoff forecast

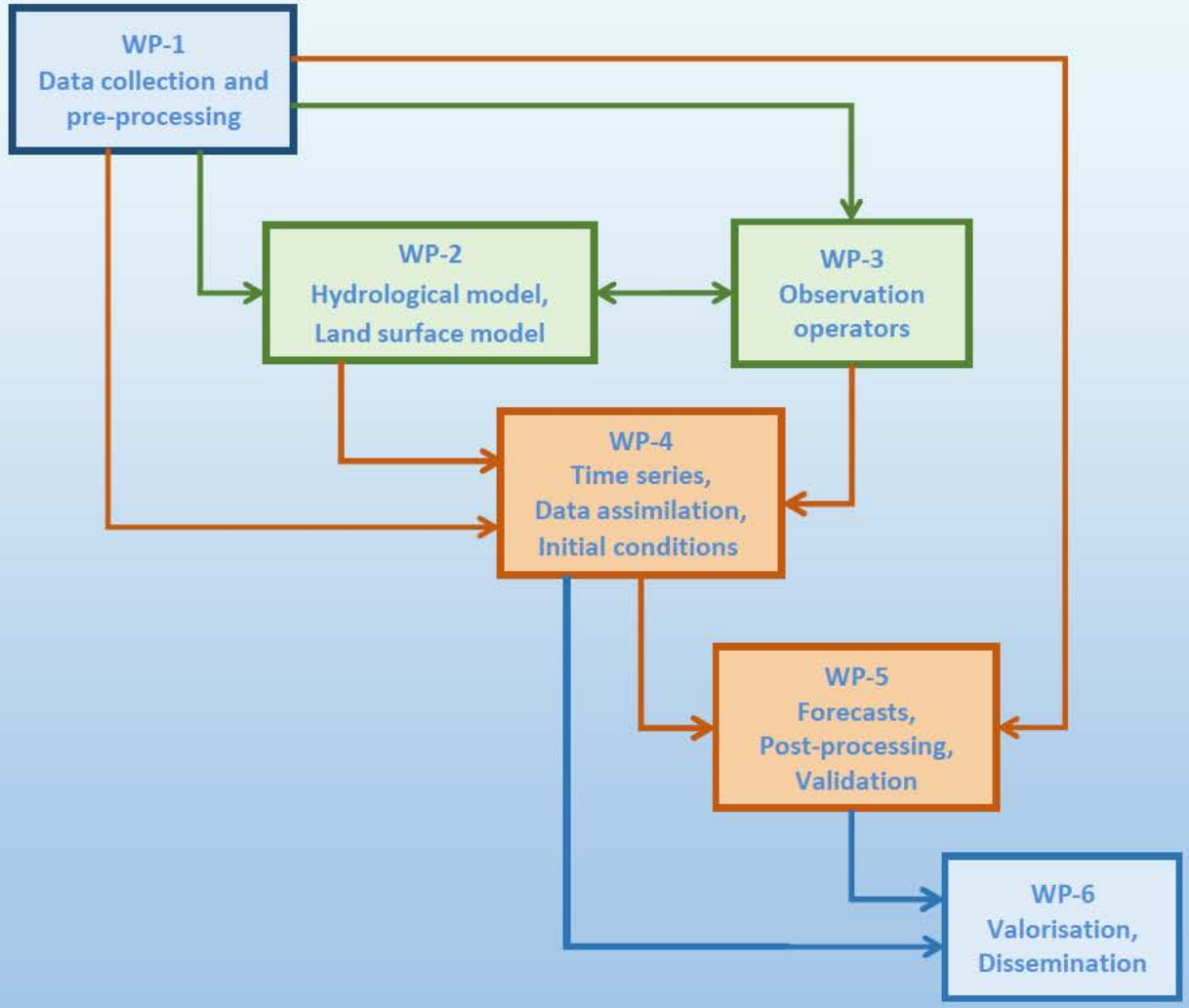




Hydrological Ensemble Prediction System

- **Obs.**: observations, **In. C.**: initial conditions for the hydrological model, **Sat.**: satellite data
- **D. A.**: Data assimilation system
- **Met. Ens.**: ensemble of meteorological forecasts, **Out. Ens.**: ensemble of model output

Work packages - At a glance



Thank you!

Innovation project started in July 2019
Duration: 30 months
http://eo-dahr.meteo.be