Hydrological features of the SURFEX-CTRIP model driven by the MESCAN surface reanalysis

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METEO-FRANCE   -   CNRM-UMR3589

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Outline

❑ Context and motivation

❑ Principle of modelling system

❑ Water and Energy balance components

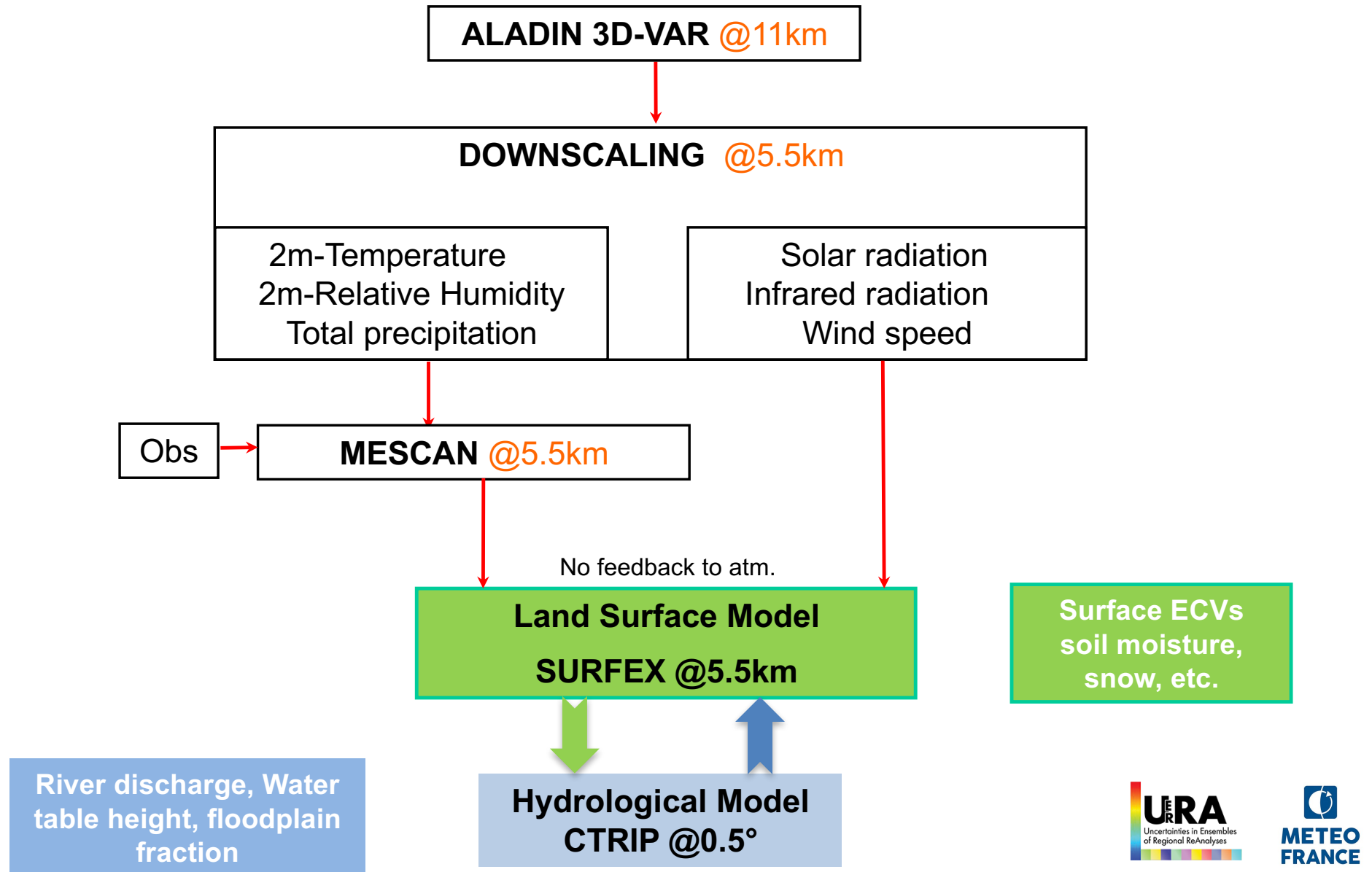❑ Hydrological evaluation

Context and Motivation

❑ UERRA

    – Development and production of an ensemble system of regional reanalysis

    – Estimation of ECVs and their uncertainties
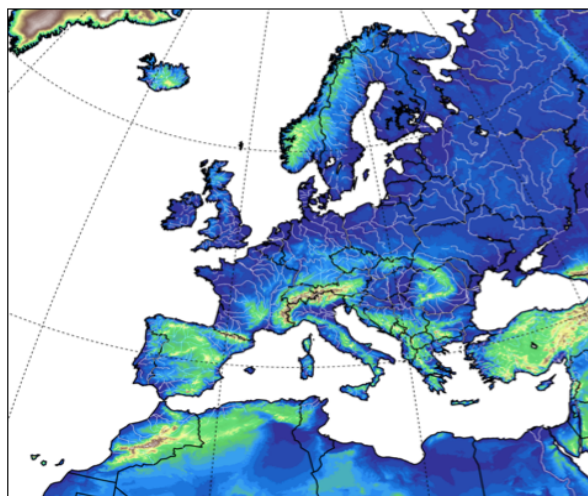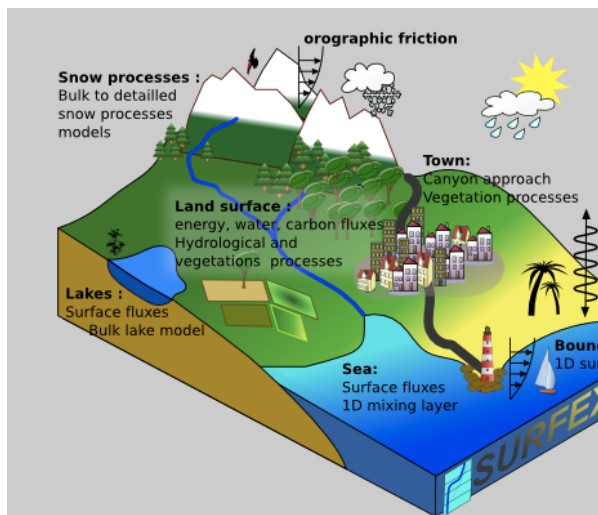
❑ Motivation of the study

    – To use the 50-yr high-resolution reanalysis over Europe

    – To setup a coupled hydro-meteorological modelling system

        • To assess the reanalysis quality among discharges (independent variables)

            – For the main European rivers

        • To provide the users:

            – An estimate of land surface water balance components

                » Applications: agriculture, droughts, irrigation, …

            – An evaluation of the simulated discharged against measurements

                » To be compared to existing systems like EU-HYPE, EFAS for floods, …
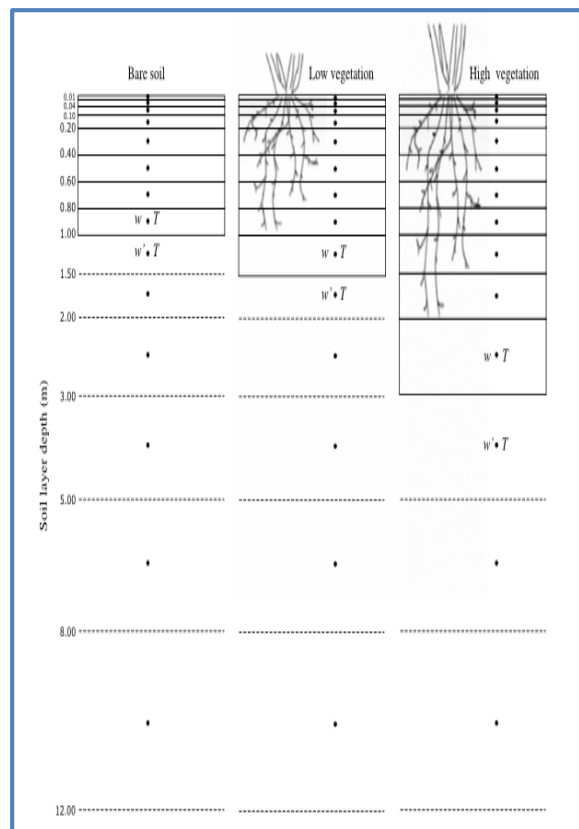
Hydro-meteorological Modelling System

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                    ┌─────────────────────────────────┐
                    │   ALADIN 3D-VAR @11km           │
                    └─────────────────────────────────┘
                                   │
                                   ▼
        ┌──────────────────────────────────────────────────────┐
        │   DOWNSCALING  @5.5km                                 │
        │  ┌──────────────────────┐  ┌──────────────────────┐  │
        │  │ 2m-Temperature       │  │ Solar radiation      │  │
        │  │ 2m-Relative Humidity │  │ Infrared radiation   │  │
        │  │ Total precipitation  │  │ Wind speed           │  │
        │  └──────────────────────┘  └──────────────────────┘  │
        └──────────────────────────────────────────────────────┘
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Obs → **MESCAN @5.5km**

No feedback to atm.

Land Surface Model

SURFEX @5.5km

Surface ECVs soil moisture, snow, etc.

River discharge, Water table height, floodplain fraction

Hydrological Model CTRIP @0.5°

UERA — Uncertainties in Ensembles of Regional ReAnalyses
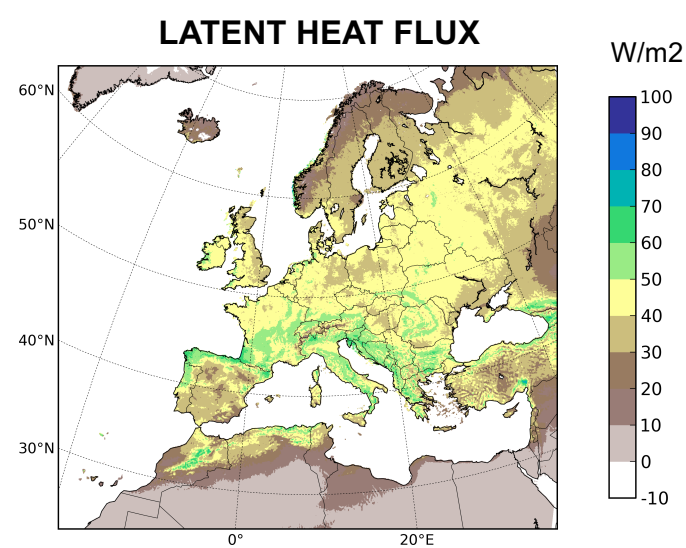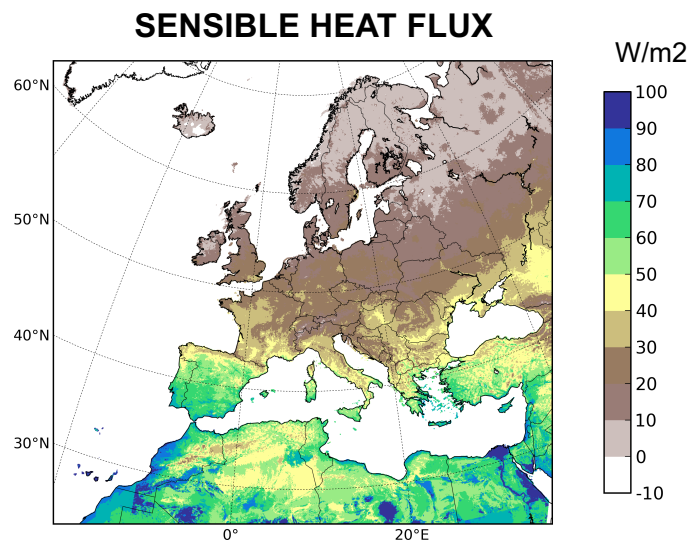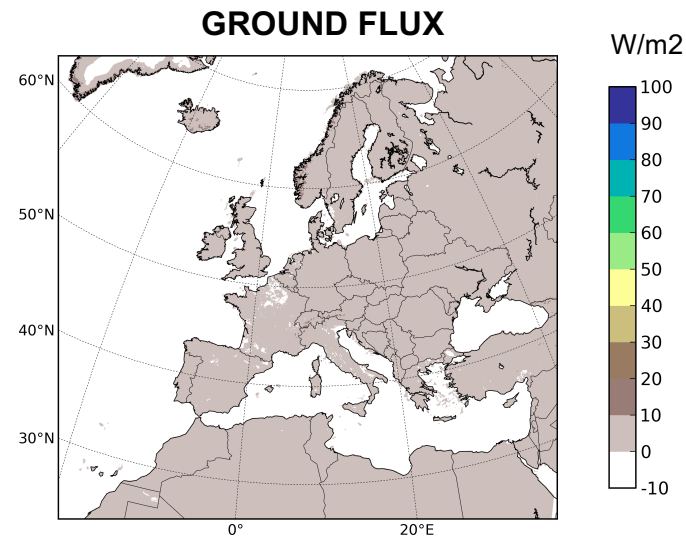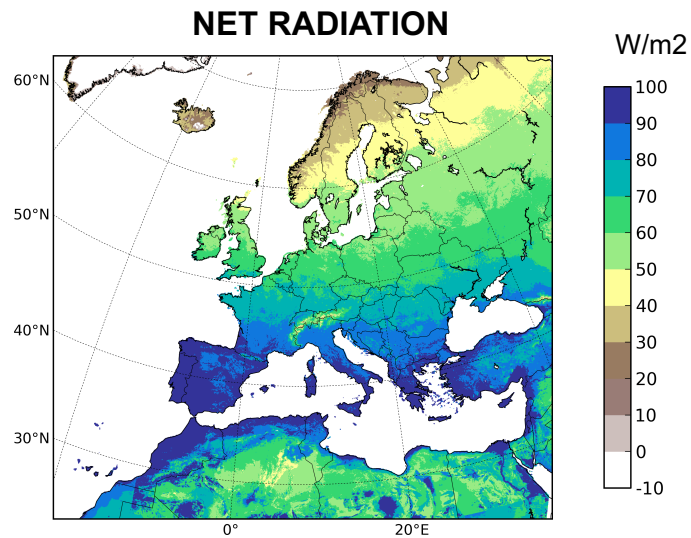
METEO FRANCE

Land Surface Model SURFEX

Tiling approach

Soil vertical discretization
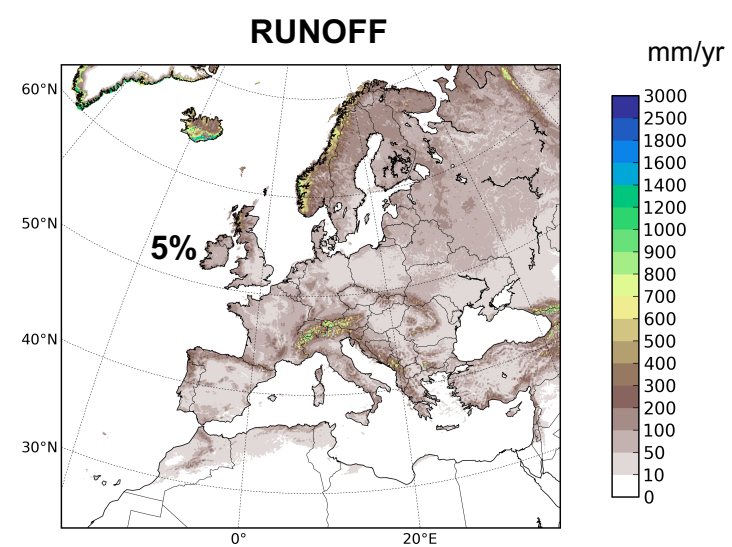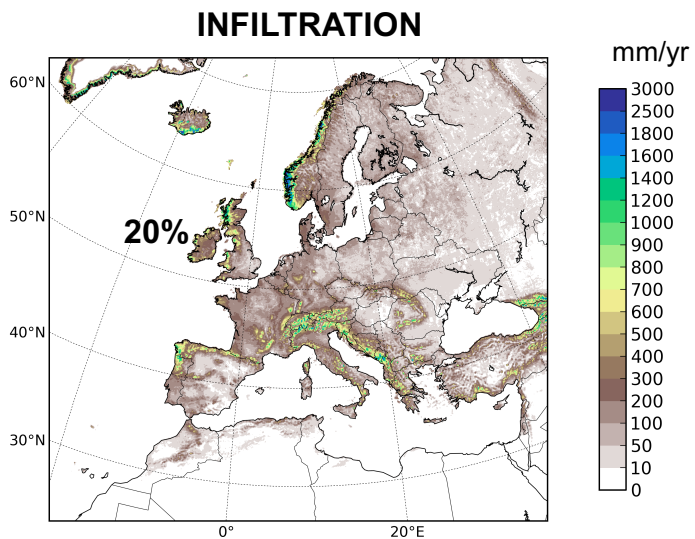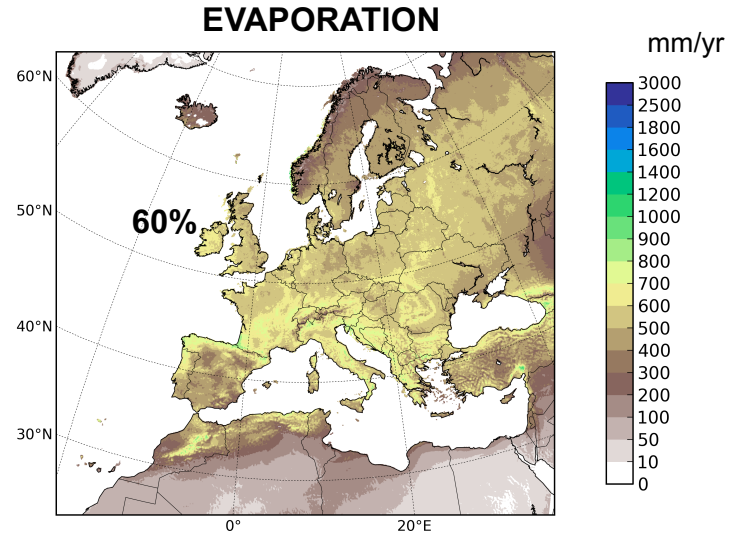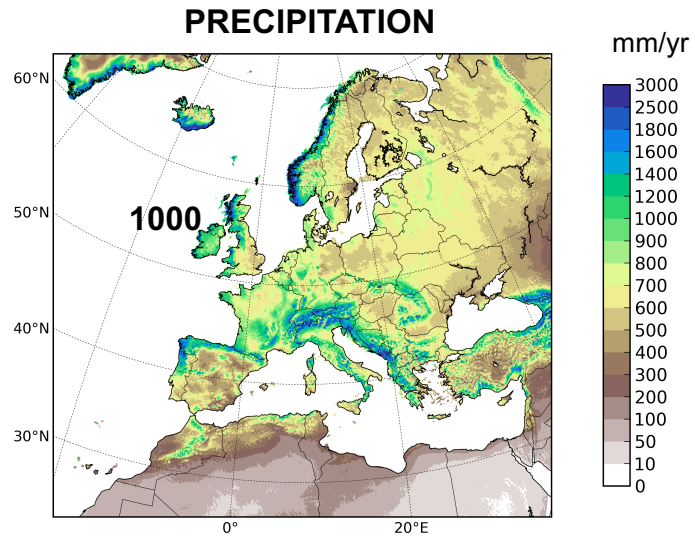
Rooting and soil depths According to PFTs
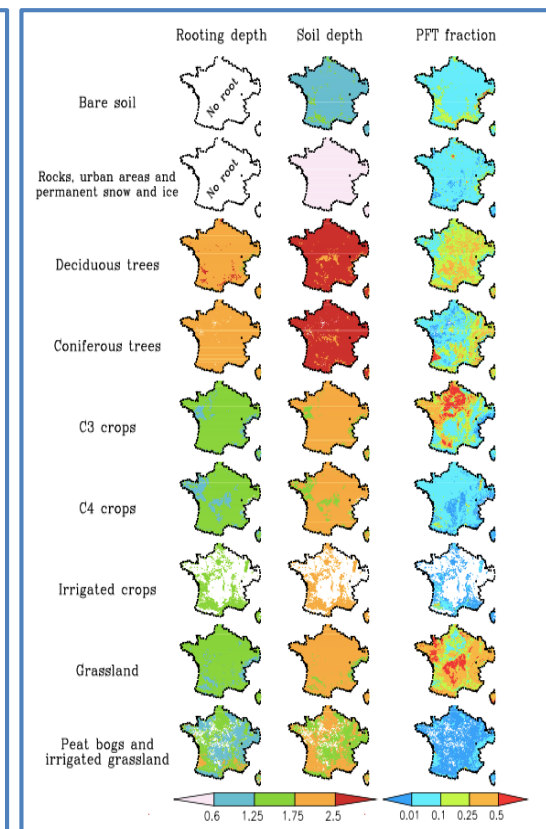
In UERRA computations are performed for each vegetation type and aggregated over the tile "nature" before being archived
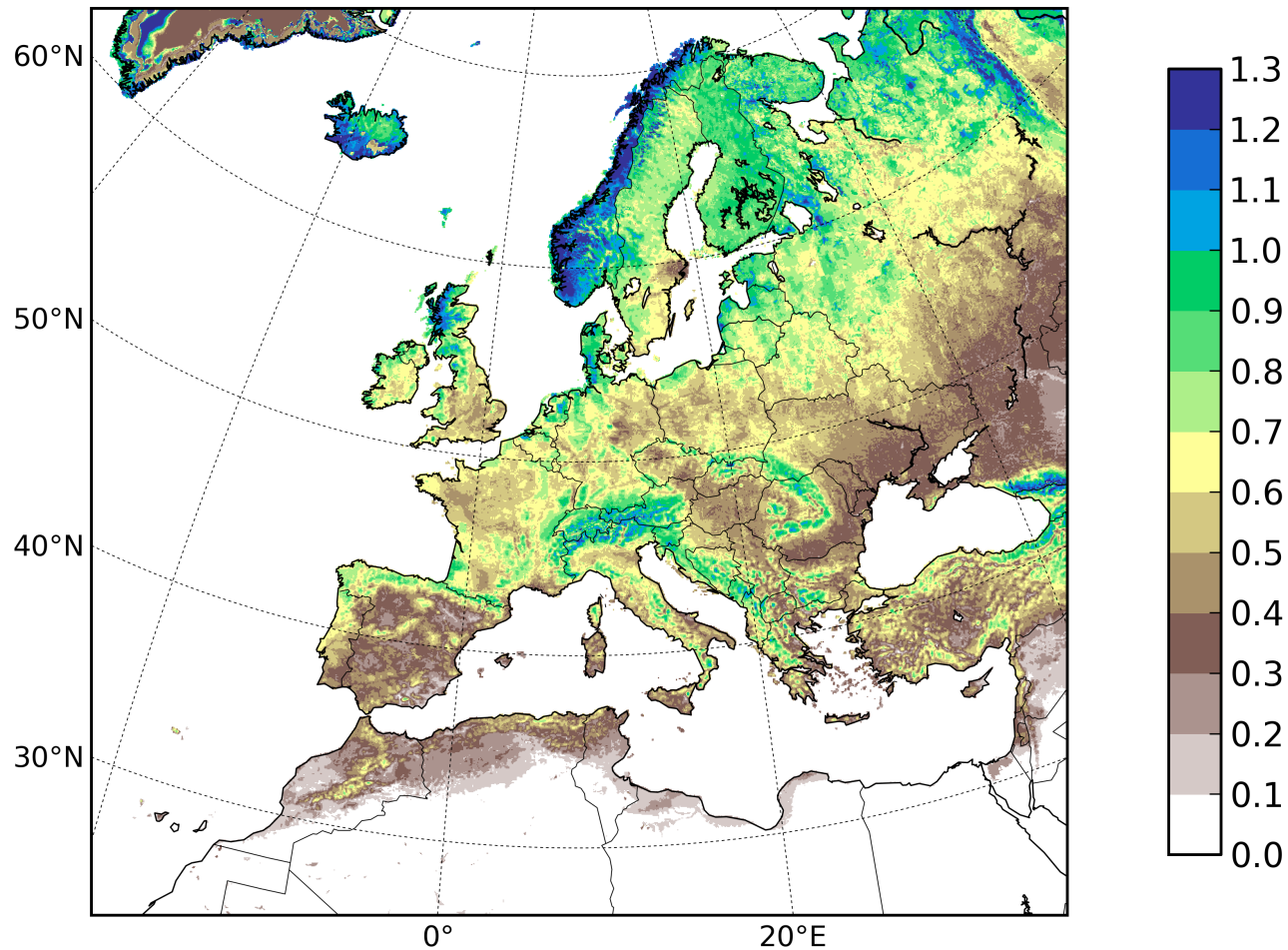
Energy Balance Components: 1961-1995

Water Balance Components: 1961-2010

PRECIPITATION mm/yr

1000

EVAPORATION mm/yr

60%
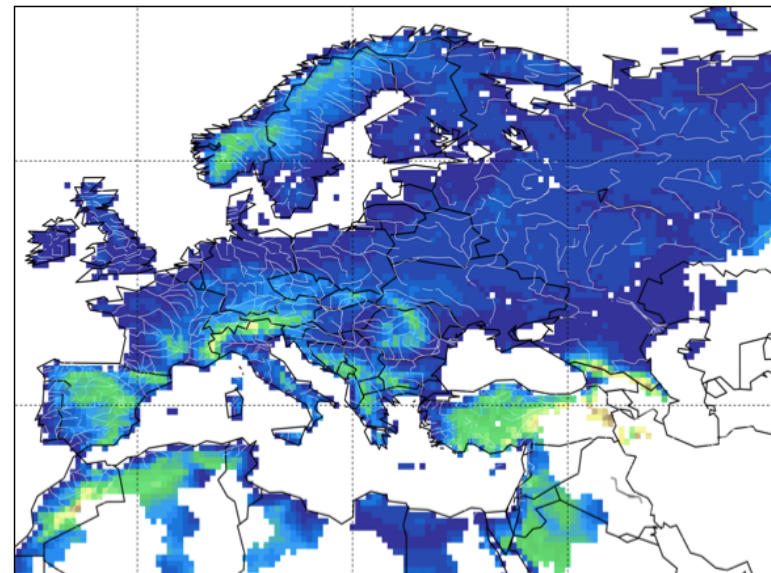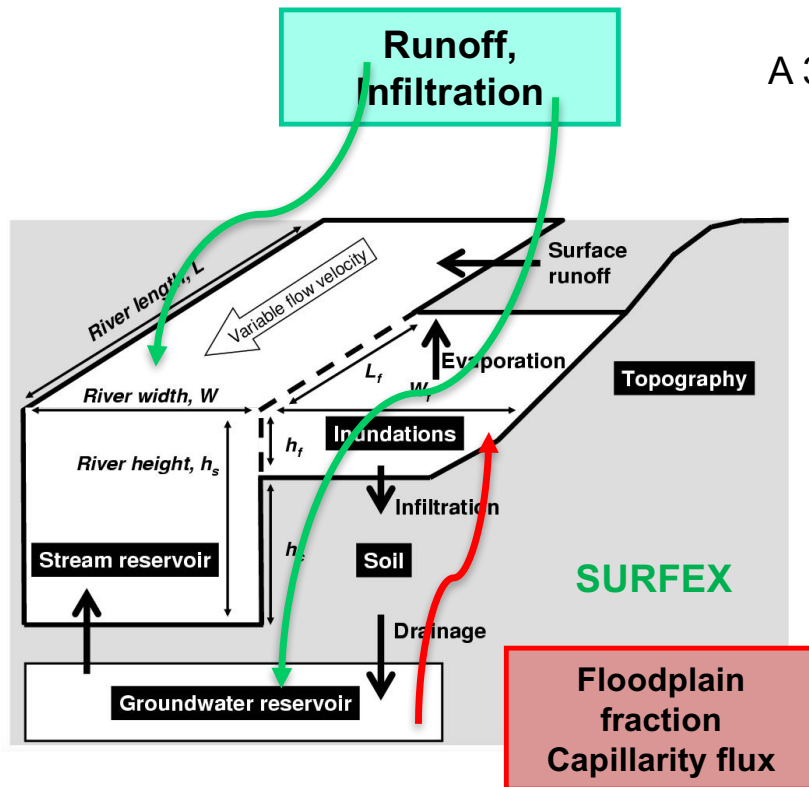
INFILTRATION mm/yr

20%

RUNOFF mm/yr

5%

Soil Wetness Index: 1961-2010

Water storage = Precip – Evap – Runoff – Infiltration

$SWI = (Wg - Wwilt) / (Wfc - Wwilt)$

Coupling SURFEX to CTRIP Hydrological Model

A 3-hr coupling

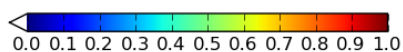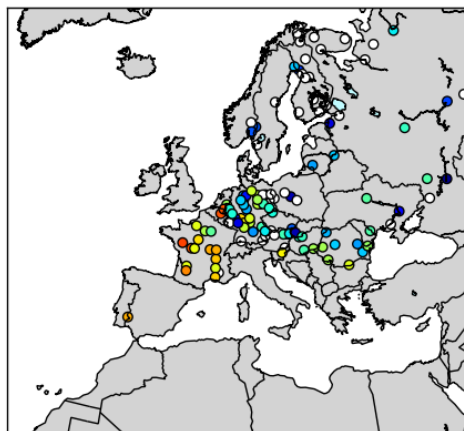**Runoff, Infiltration**

Floodplain fraction Capillarity flux

CTRIP computes: River discharge, Water table height, floodplain fraction
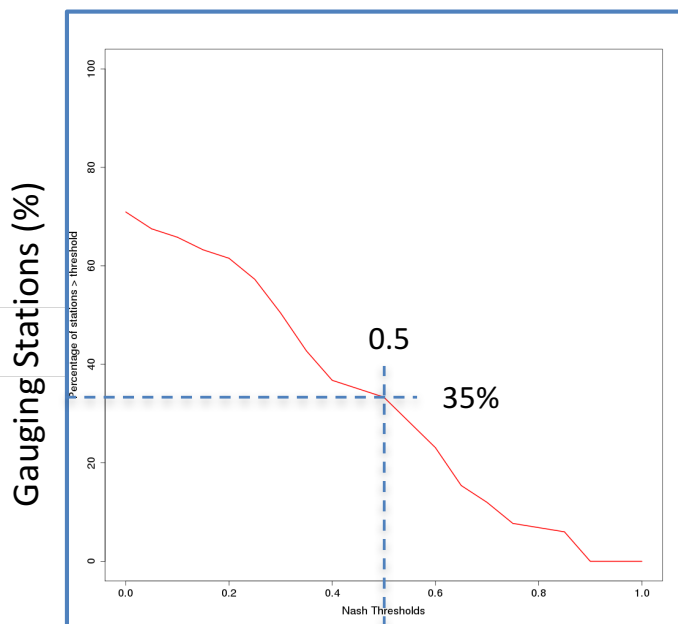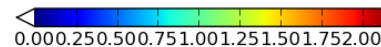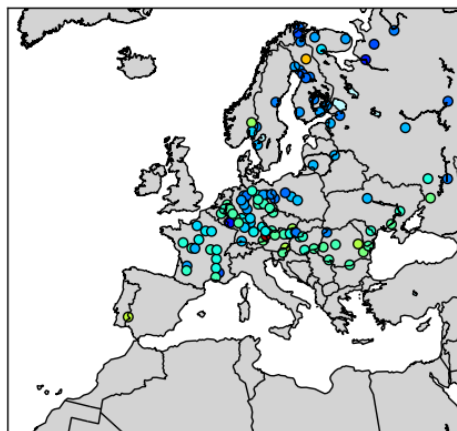
CTRIP aquifers @ 0.5°

River Discharges: 1961-2010
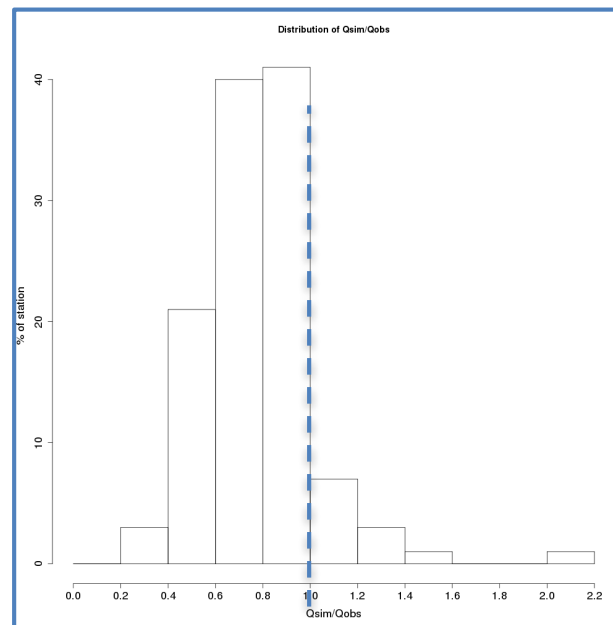
120 GRDC gauging stations

Nash Efficiency

Discharge ratio
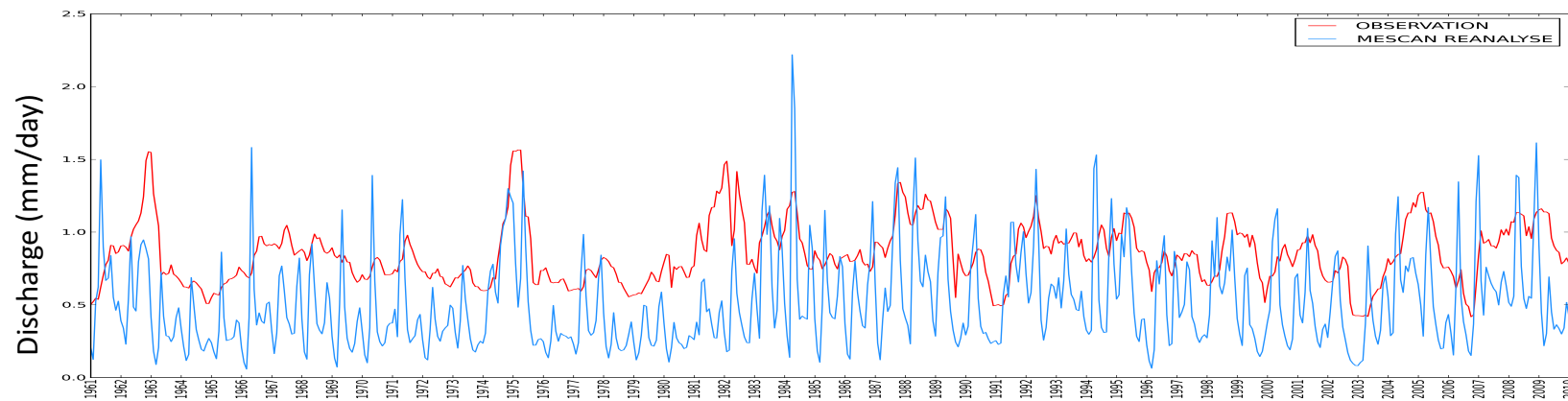

Nash Efficiency

Discharge ratio

River Discharges: 1961-2010

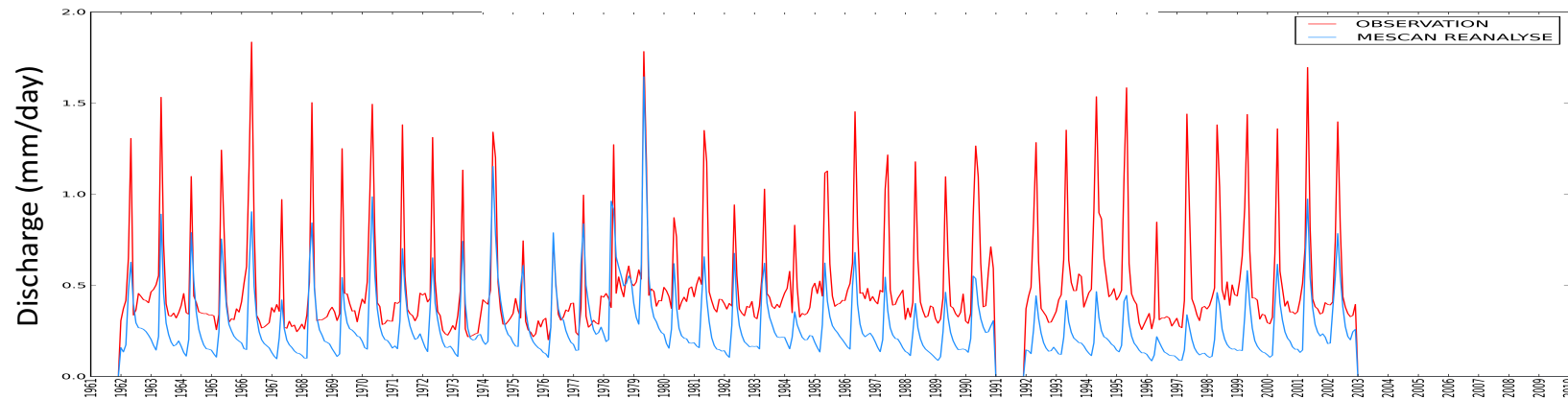How to explain discharge underestimation?

     Physics of the system: Radiation overestimation, Underestimation of precipitation

     Human activity not accounted for in the model: Presence of dams
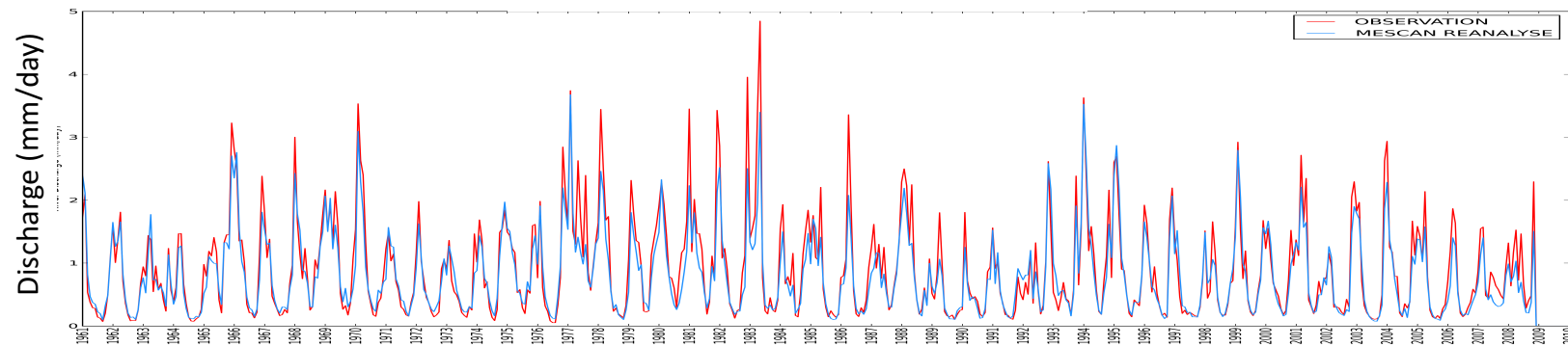
Vuoksi river @ Tainionkoski station (Finland)

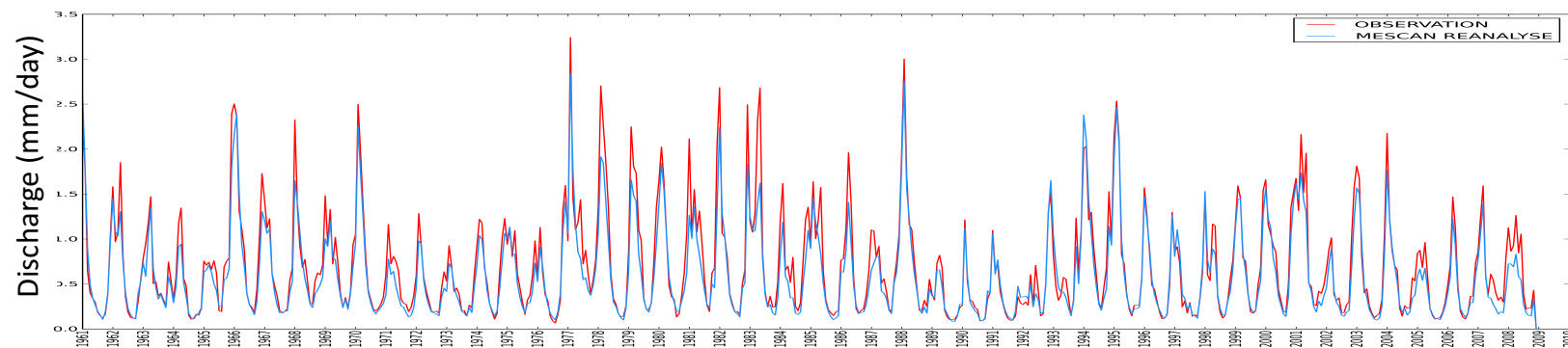
Volga river @ Volgograd Power Plant (Russia)

La Loire River in France

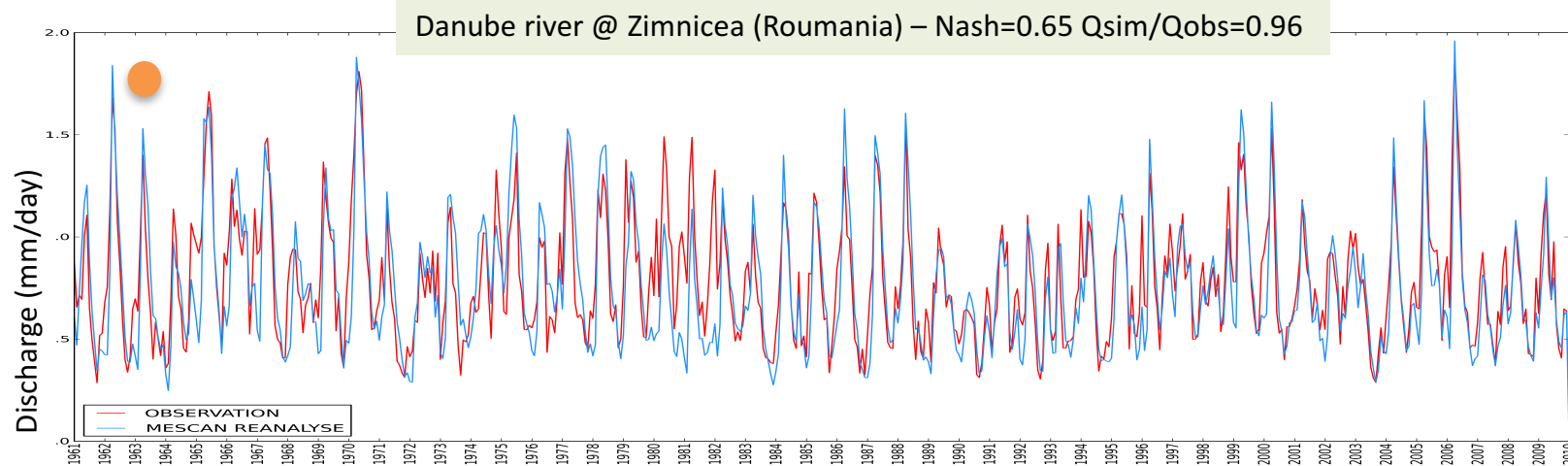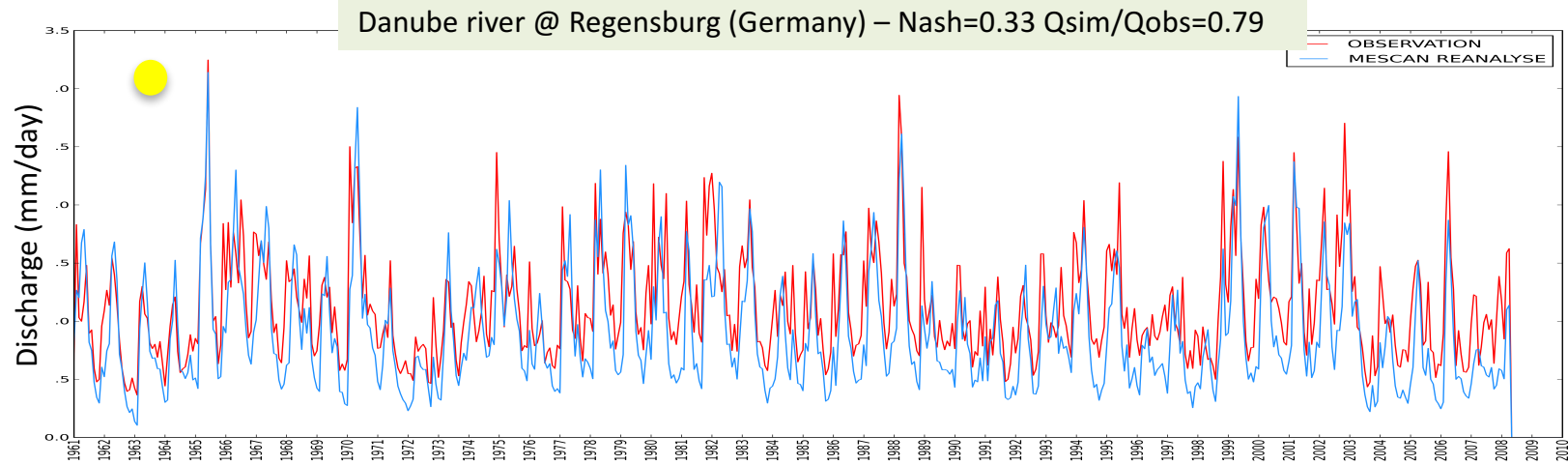La Loire @ Nevers station – Nash=0.86

La Loire @ Montjean station – Nash=0.89

The Danube River

A complex catchment area in terms of climate, morphology, human practices, etc.

Danube river @ Regensburg (Germany) – Nash=0.33 Qsim/Qobs=0.79

Danube river @ Zimnicea (Roumania) – Nash=0.65 Qsim/Qobs=0.96

The Danube River
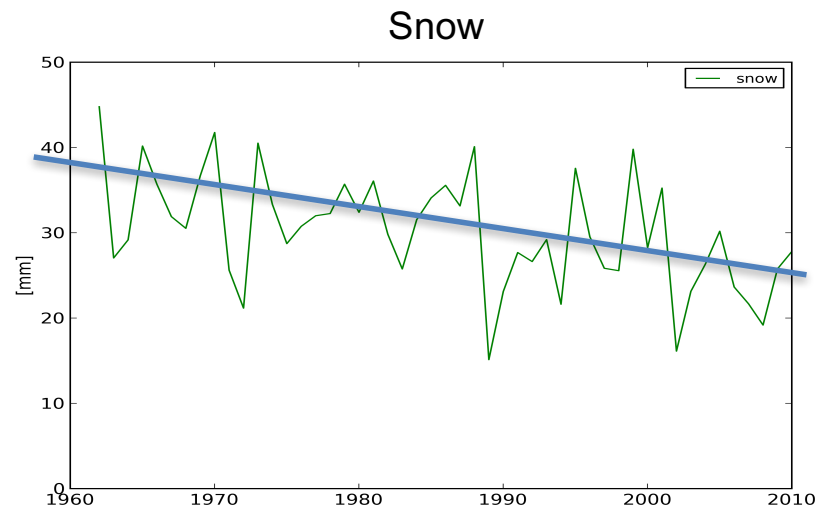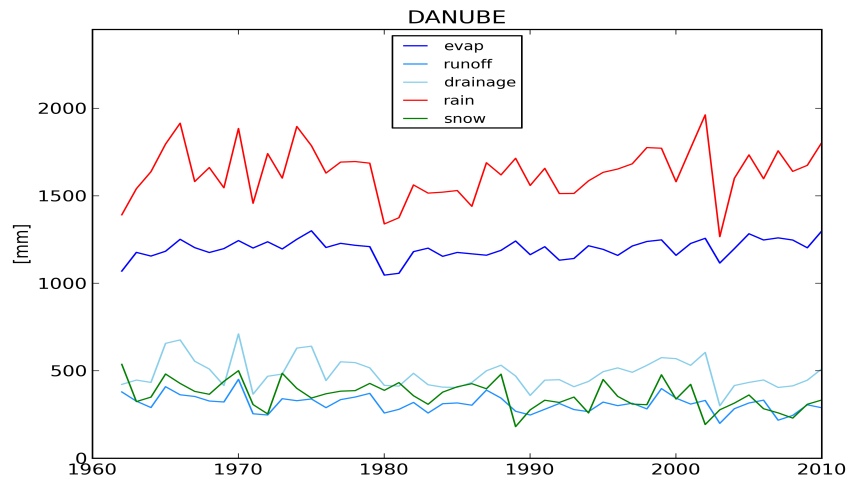
Danube catchment area

Typical of a mountainous area with a balance between rain and evaporation during summer, snow in winter, and increasing runoff and infiltration after melting

Summary

- A hydro-meteorological modelling system was set up to assess the UERRA reanalysis performance over Europe using independent variables

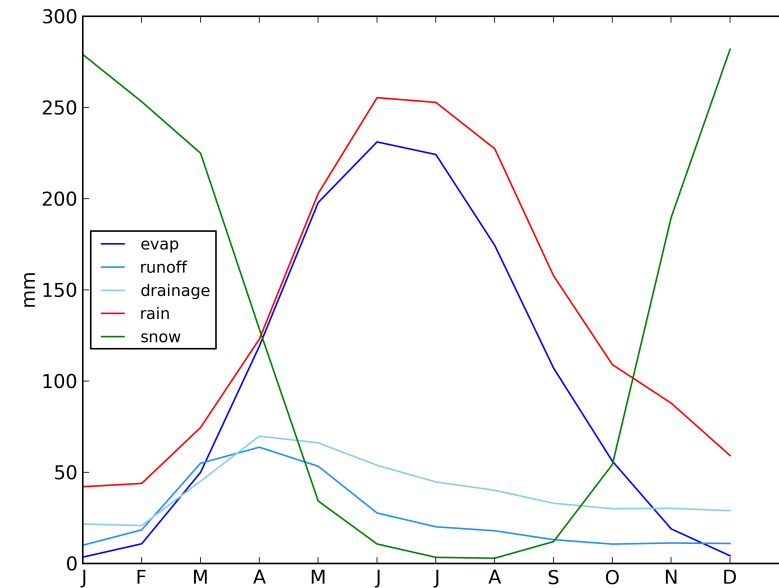- Production of a climatology of the water balance components: surface runoff, soil deep infiltration, soil moisture, evaporation, etc.

- Comparisons over Europe highlight discharge underestimation, that can be attributed to human activity and system errors

- Studying the 55-yr reanalysis will help understanding inter-annual variability of river discharge

- SURFEX-CTRIP is a valuable dataset for users to study droughts, floods, etc.

- 1961-2015 data will be available in ECMWF MARS archiving system

- A draft report is available (D4.8). Final version will be delivered in December.

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Thanks for your attention!