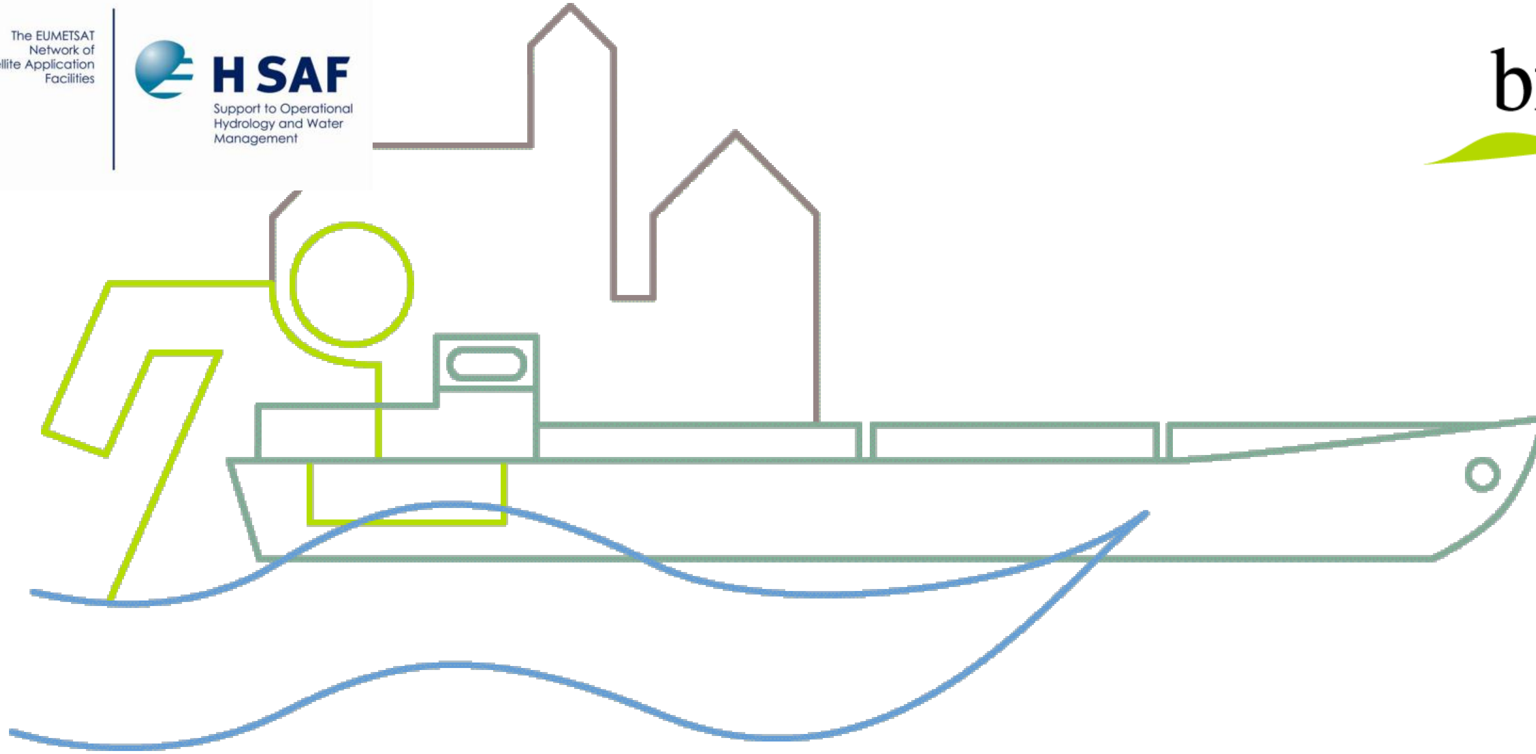

Hydrometeorological and Hydrological Validation of Satellite derived Snow data

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Federal Institute of Hydrology, Koblenz, Germany

Introduction

The Federal Institute of Hydrology (*BfG*) is ...

- **a higher authority of the Federal Republic of Germany under the jurisdiction of the Federal Ministry of Transport, Building and Housing (BMVBS)**
- **run by approximately 300 members of staff (1/3 scientists)**

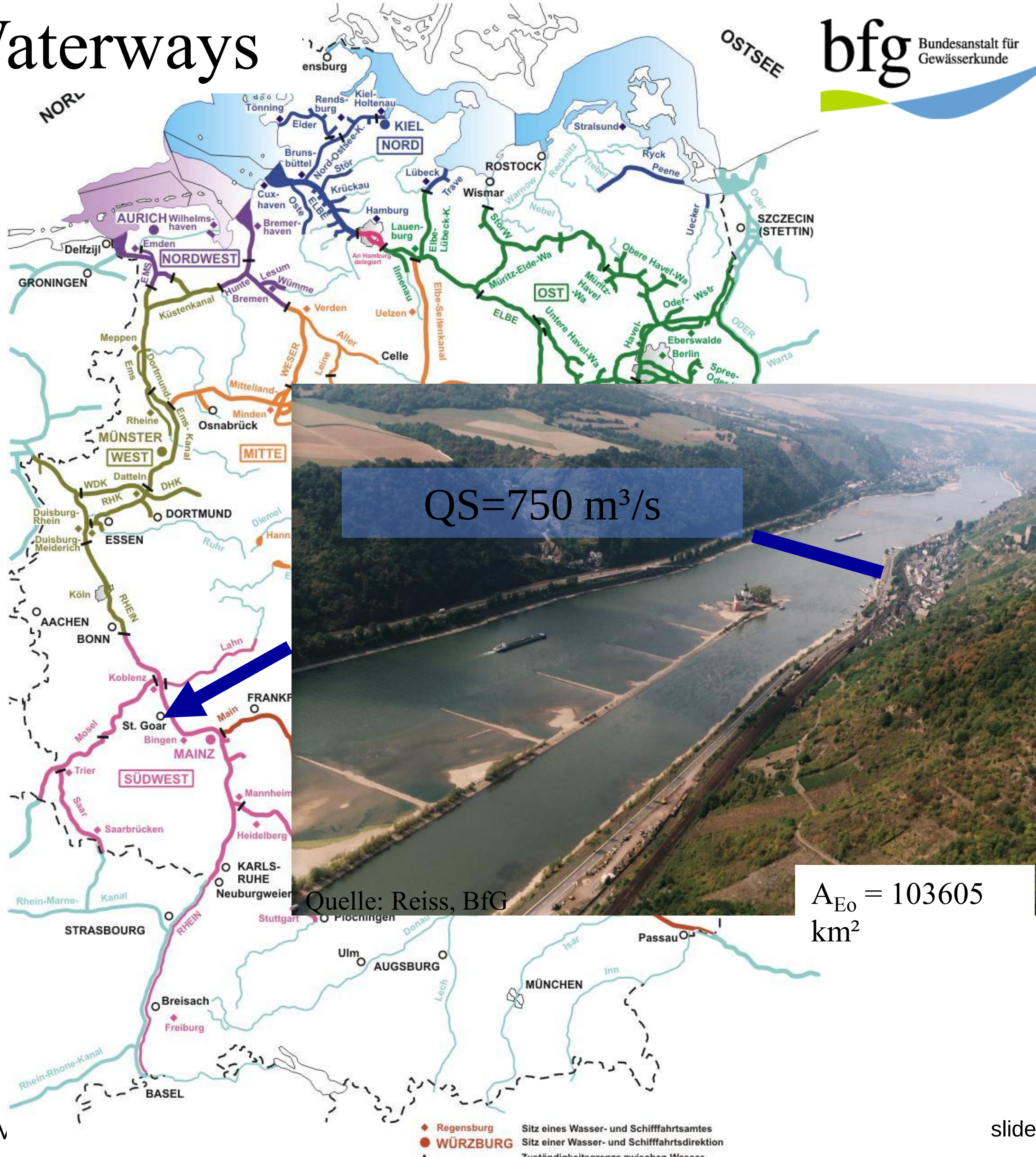
The Federal Waterways

bfg Bundesanstalt für Gewässerkunde

Water quantity

Water quality

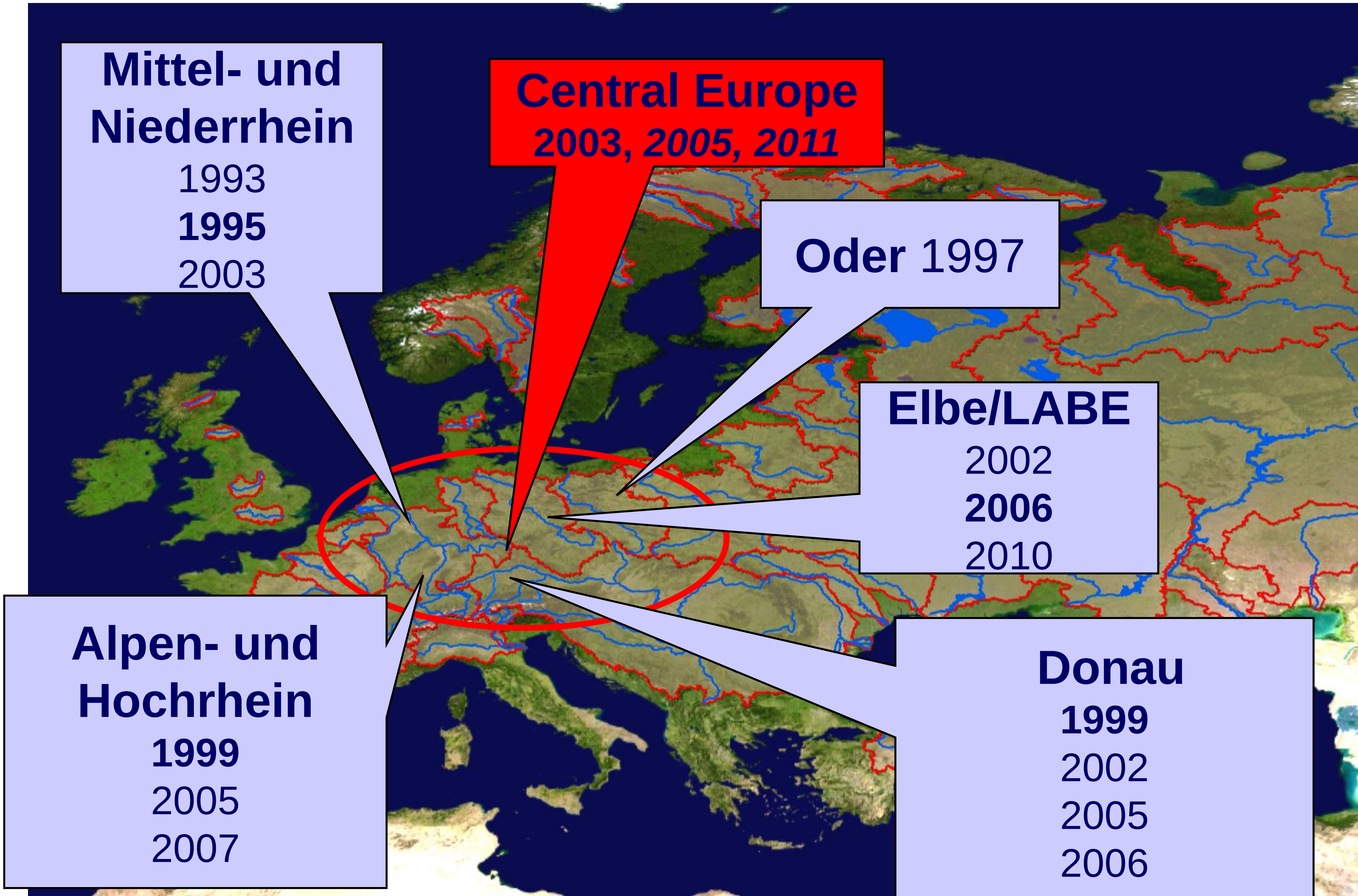
Ecology



A_{Eo} = 103605 km²

Hydrological Extremes in Central Europe River basins

bfg Bundesanstalt für Gewässerkunde



Objectives – Water Quantity

Bundesanstalt für Gewässerkunde

Monitoring of water resources

Climate impact studies

Short to medium range forecasts (low water)

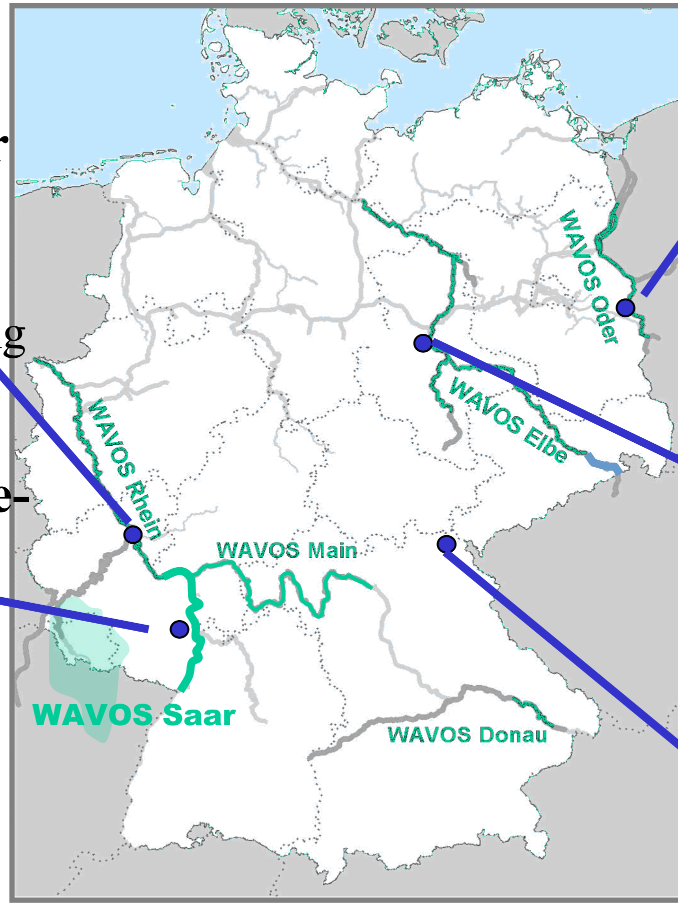
Seasonal predictions

Understanding hydrological processes

Forecasting Systems BfG

Bundesanstalt für Gewässerkunde, Koblenz
Low flow Forecasting Rhein und Donau

Hochwassermelde-zentrum Rhein, Mainz (WSV + RLP)
Flood forecasting Rhein



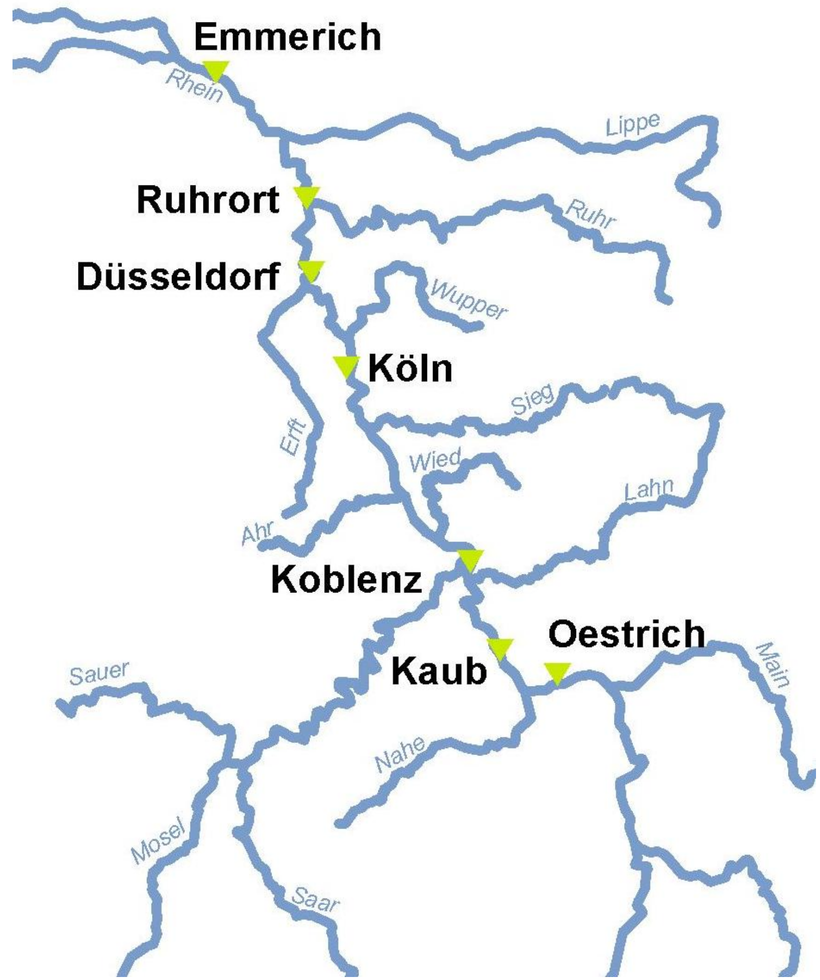
Hochwasser-Vorhersagezentrale Frankfurt (Oder) (BB)
HW- + werktägliche Vorhersage Grenzoder

Vorhersagezentrale Elbe, Magdeburg (WSV + ST)
NW-/MW- und HW-Vorhersage Elbe u.

Hochwasser-Vorhersagezentrale Main, Hof (BY)
HW- + werktägliche Vorhersage Main

Background: Operational Service

- 7 gauging stations
- Forecasting horizon: +96 hours
  (since 2008)
- Forecasting time: 7:00
- Daily Forecast: Water level at gauge Duisburg-Ruhrort ≤ 400cm
  (begin of severe restrictions for navigation)
- Dissemination via email and Internet (ELWIS) till 08:30



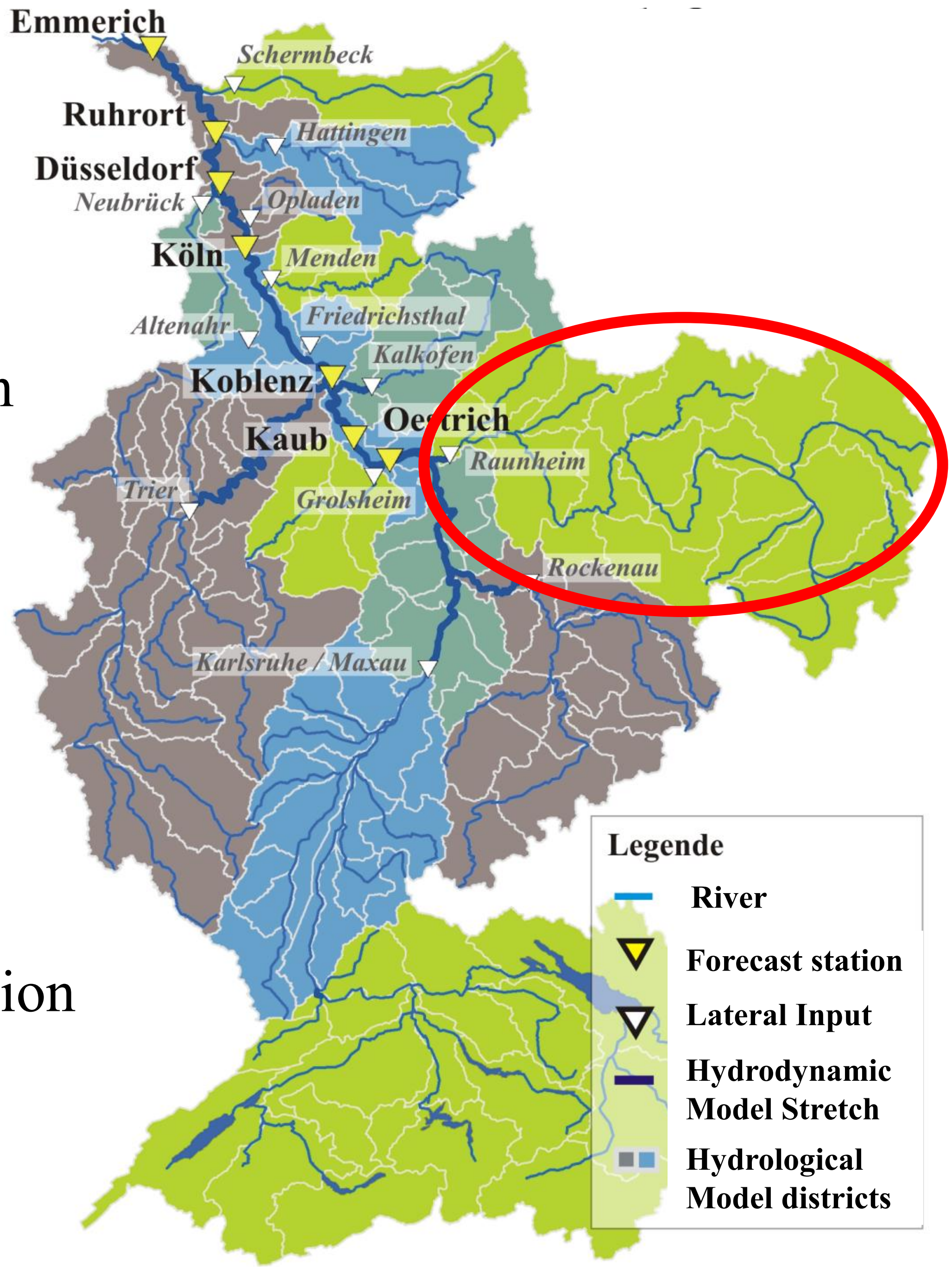
Background: Forecasting System

<u>HBV-Model (in FEWS)</u>

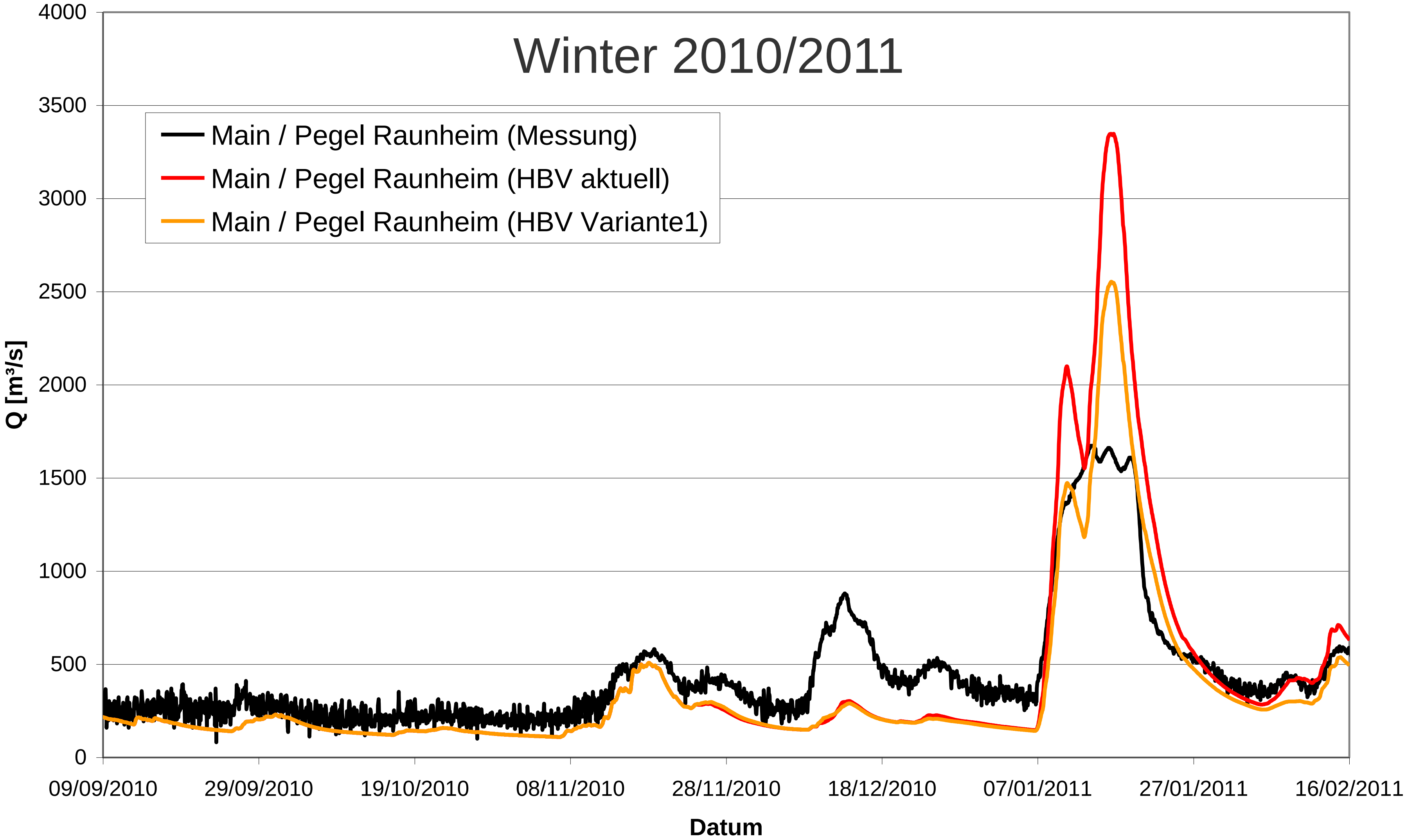
- Hourly model, new calibration
- operated in FEWS-BfG
- export at 14 locations (lateral input to SOBEK)

<u>SOBEK-Model (in WAVOS)</u>

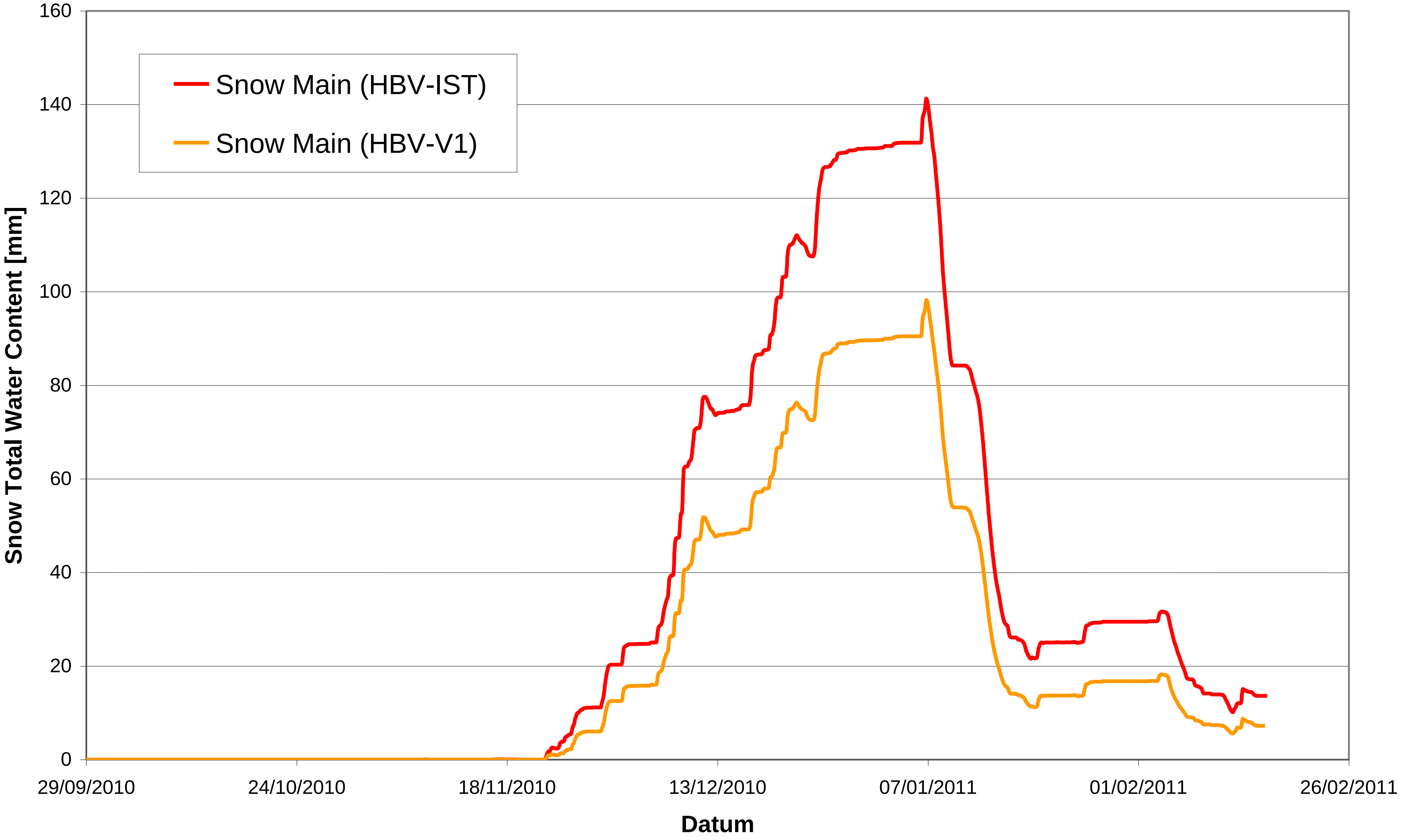
- new calibration, current retention measures
- no dike overtopping



Shortcomings/Points of action: Uncertainties of snow modelling



Shortcomings/Points of action: Uncertainties of snow modelling



H-SAF

- Production of satellite derived estimates of

  rainfall

  snow

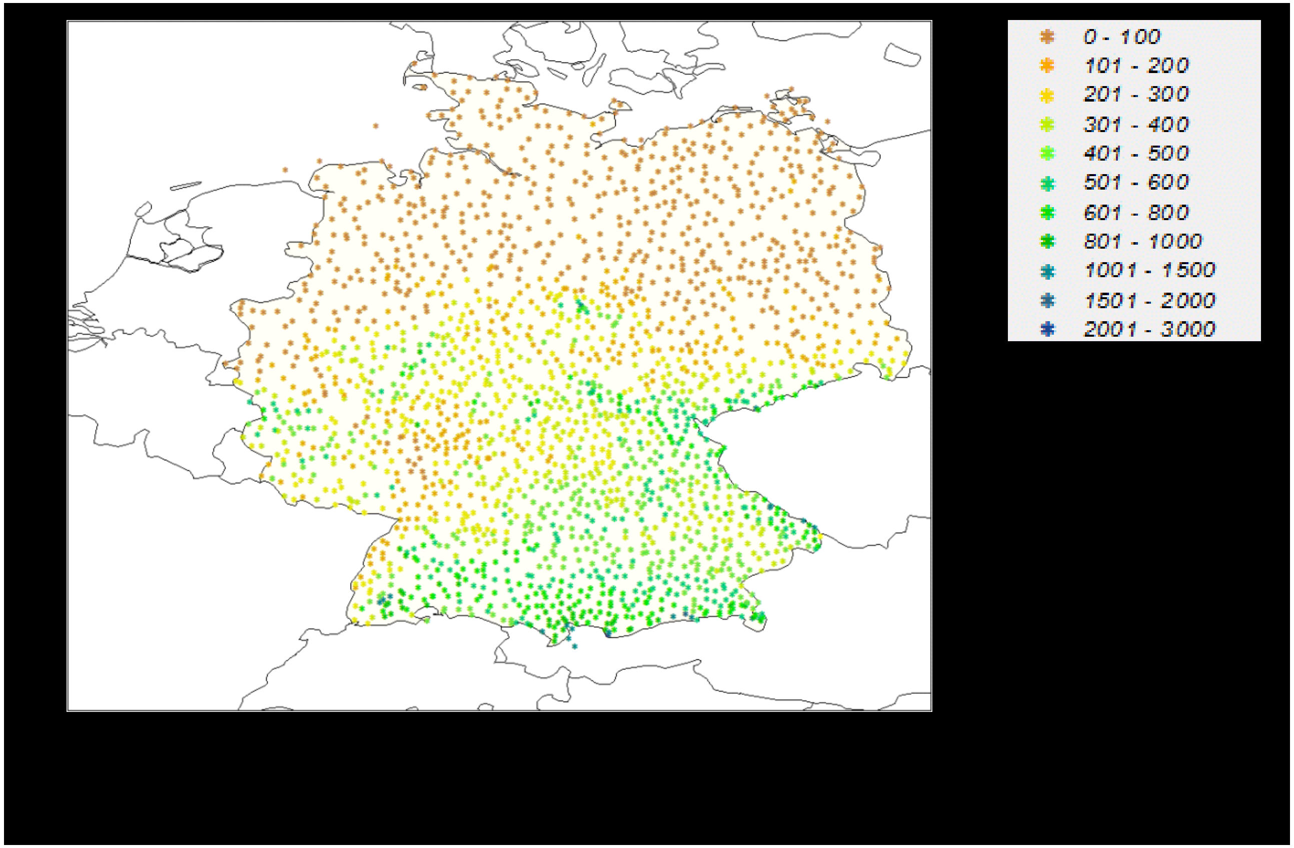
  soil moisture

- Validation of H-SAF products versus in situ measurements
- Hydrological Validation of H-SAF products by data assimilation & hydrological modelling

H-SAF SNOW Products

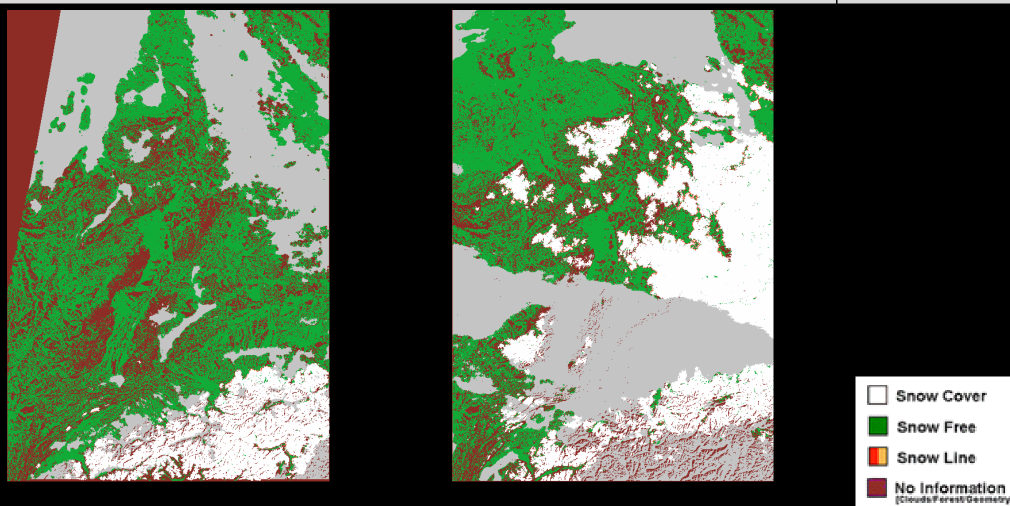
Name	Content	Geometry & resolution	Data source	Format	Period
SN-OBS-1 H-SAF H10	Snow detection by VIS/IR	Meteosat projection 5 km	H-SAF FTP	HDF5	10/2010 – 10/2011 (OR)
SN-OBS-2 H-SAF H11	Snow status (dry/wet) by MW	Lat./long. 0.25 deg	H-SAF FTP	grib	10/2010 – 10/2011 (OR)
SN-OBS-3 H-SAF H12	Effective snow cover by VIS/IR	Lat./long. 0.05 deg	H-SAF FTP	grib	10/2009 – 09/2010 (ORR)
SN-OBS-4 H-SAF H13	Snow water equivalent by MW	Lat./long. 0.25 deg	H-SAF FTP	grib	10/2009 – 09/2010 (ORR)

Station data (DWD)



- Snow depth (n ~1000 +1000)
- Snow water equivalent (n ~600)
- Air temperature for delineation of **snow status (dry / wet)**

Polar View Products

Products Name and description	Examples (image product available via Polar View User FTP)	Geometry and Resolution
		

Operational products:

River Rhine coverage (2010-2011)

Additional products:

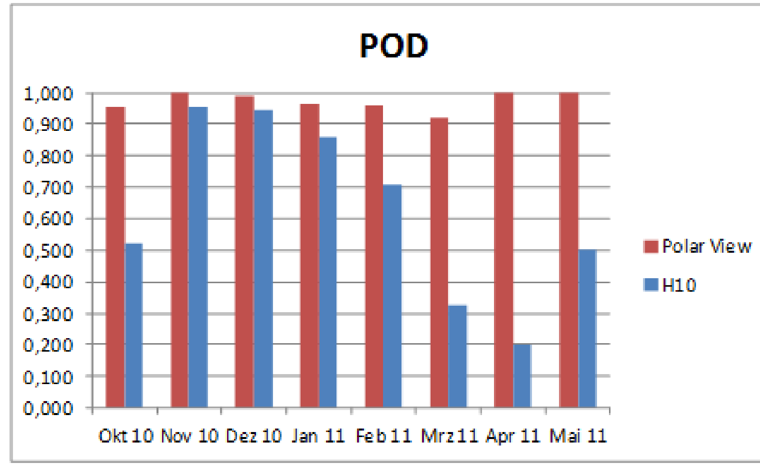
- SWE results „Upper Danube"
- WET-snow detection Demo Germany

Polar View

Comparision H10 & Polar View

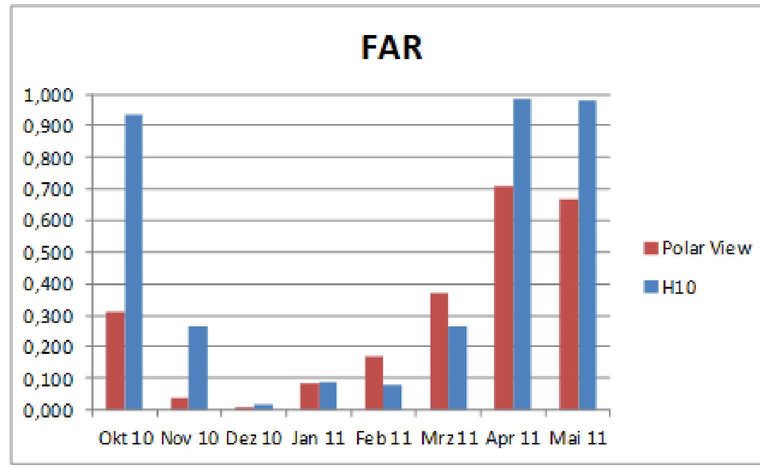
Probability of detection

A value of 1 is best.



False alarm ratio

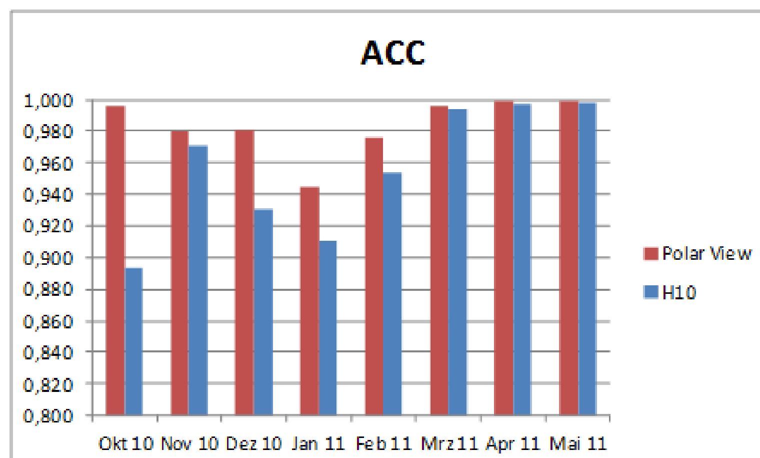
A value of 0 is best.



	H10 Flat and Mountain	Polar View Flat and Mountain
POD	0.861	0.971
FAR	0.183	0.100
POFD	0.016	0.008
ACC	0.975	0.991
CSI	0.722	0.876
HSS	0.825	0.929

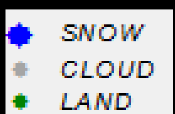
to 1)

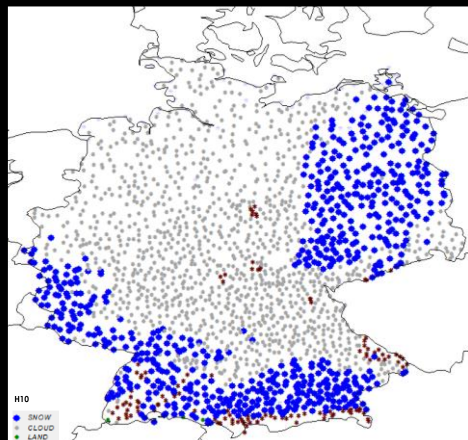
best.

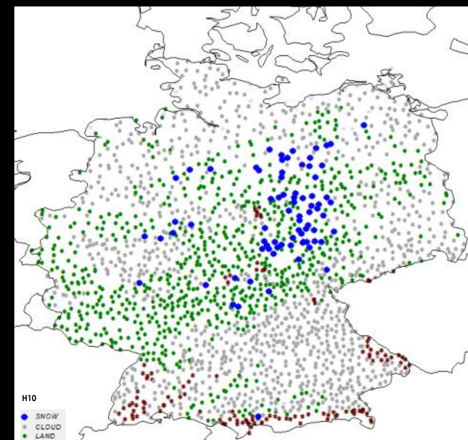


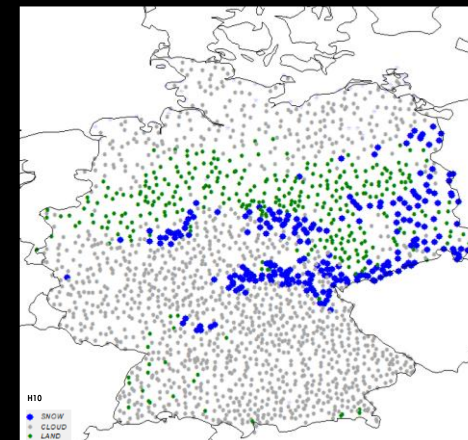
Example Case Studies

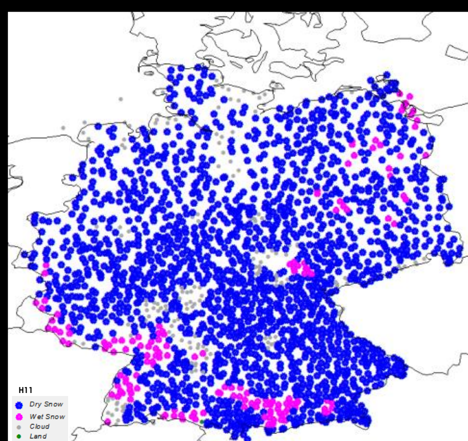
Date	5.1.2011	8.1.2011	10.1.2011

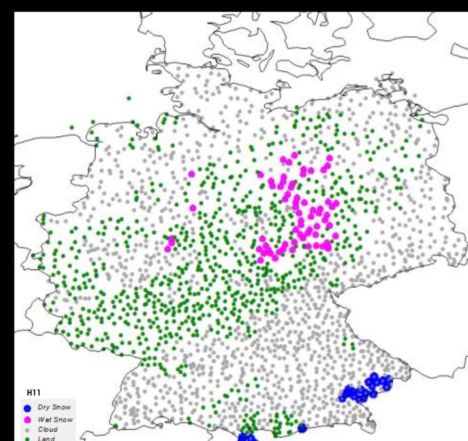


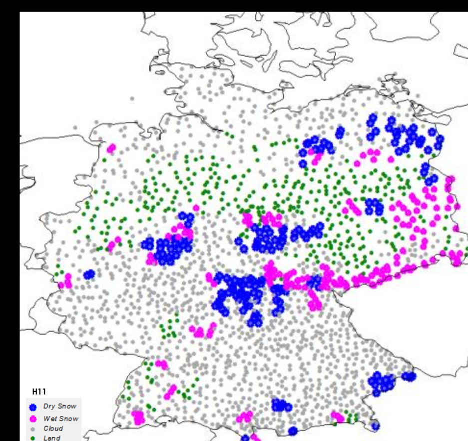






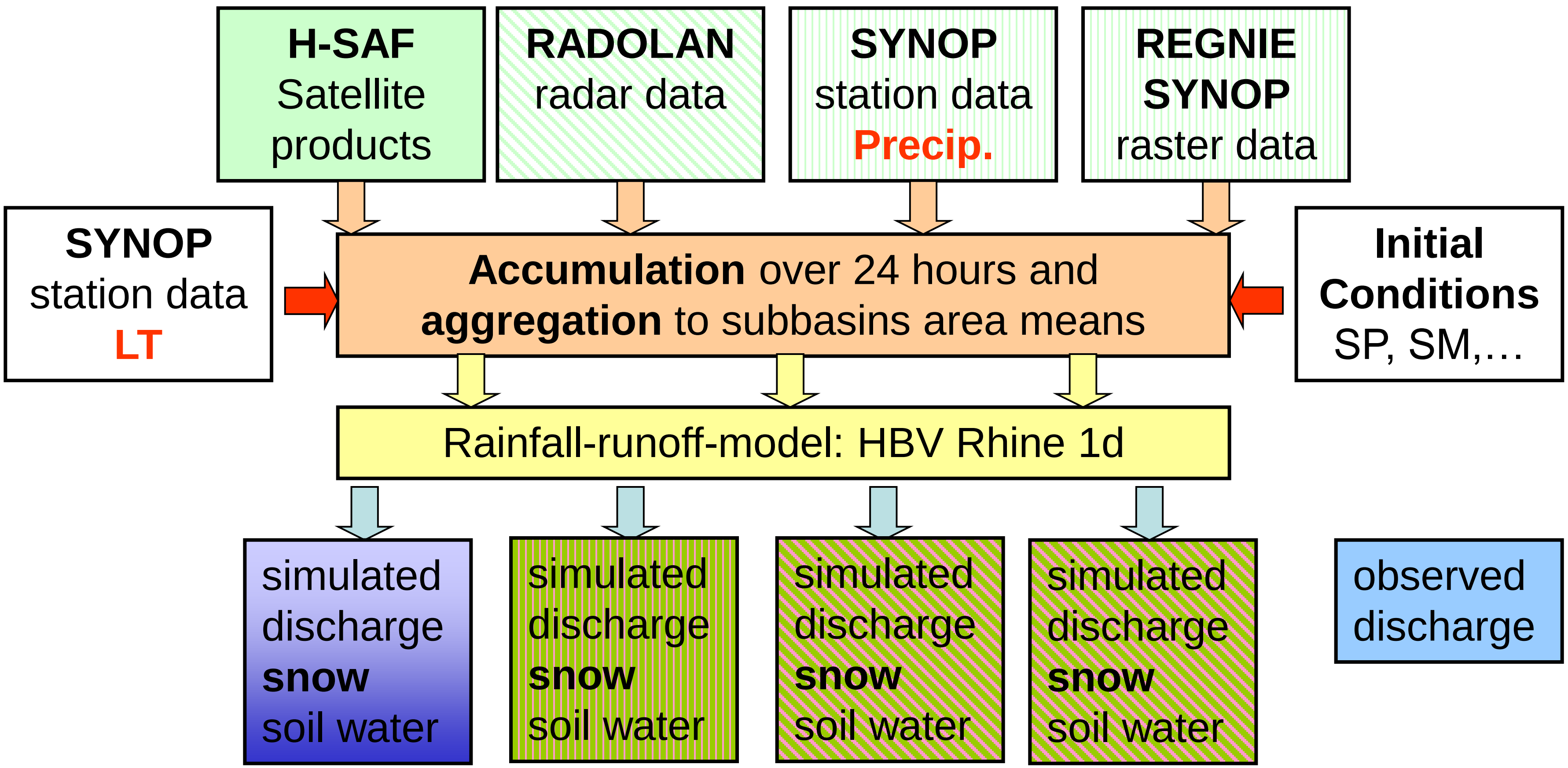






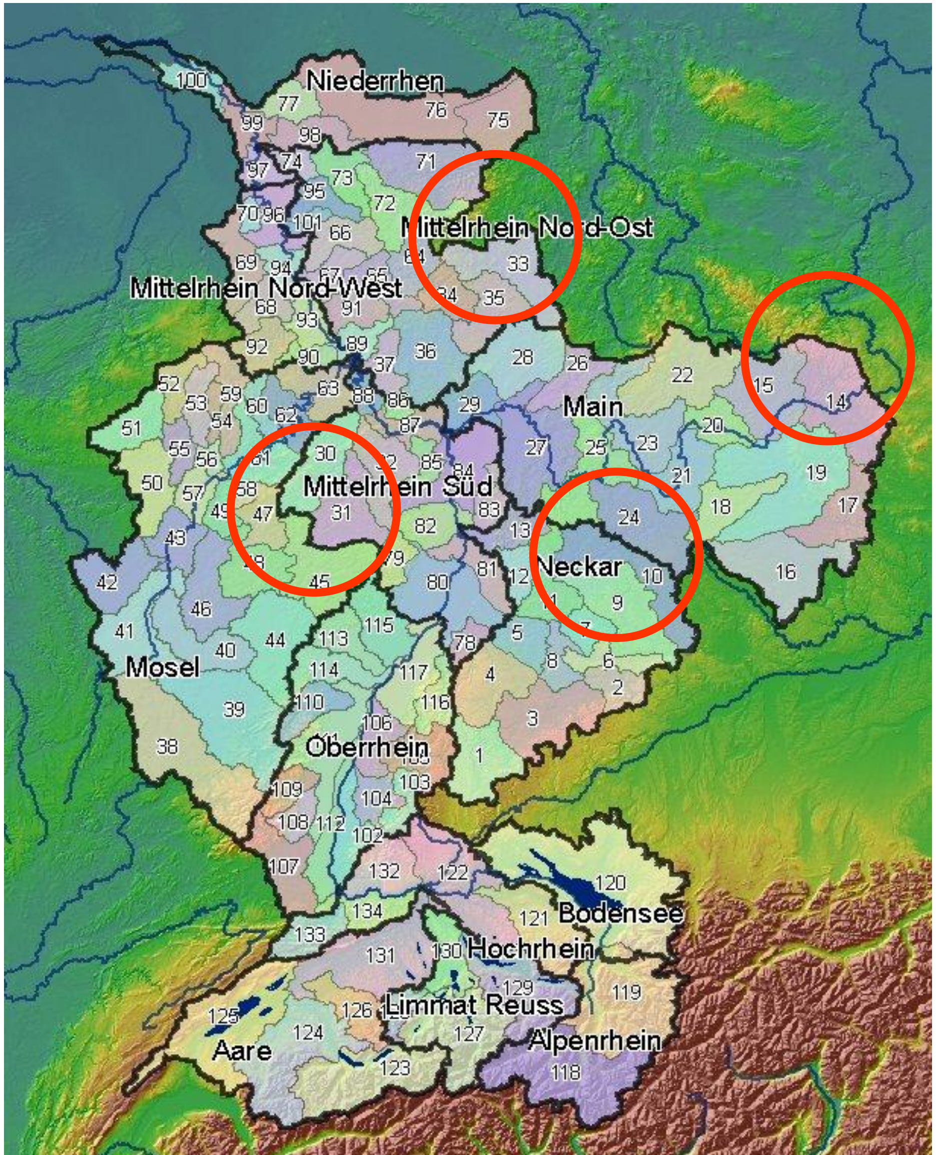
Hydrological Validation

***Precipitation** (different time and spatial scales)*



H-SAF derived and in situ measured precipitation data-sets were cumulated over 24h and aggregated to subbasin area means as forcing for the HBV conceptual hydrological model operated in daily mode

Hydrological Validation



Catchment: **River Rhine**

Area: 185,300 km²

Length: 1233 km

Elevations: 100 to 3600 m a.s.l.

Land cover:

- forest (33%)
- meadows & agricultural crop lands (28%)
- pasture (27%)
- built-up areas & roads (6%)
- water, vineyards & fruit growing, fallow & bare ground and glaciers (< 5%)

Hydrological Validation

Hydrological Model: e.g. HBV-SMHI

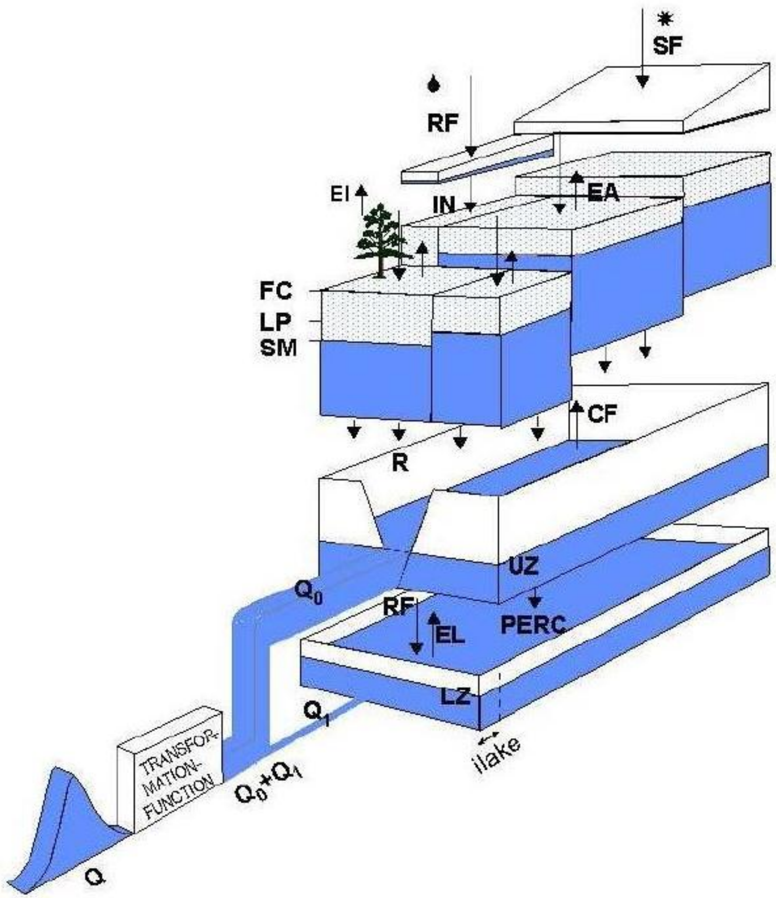
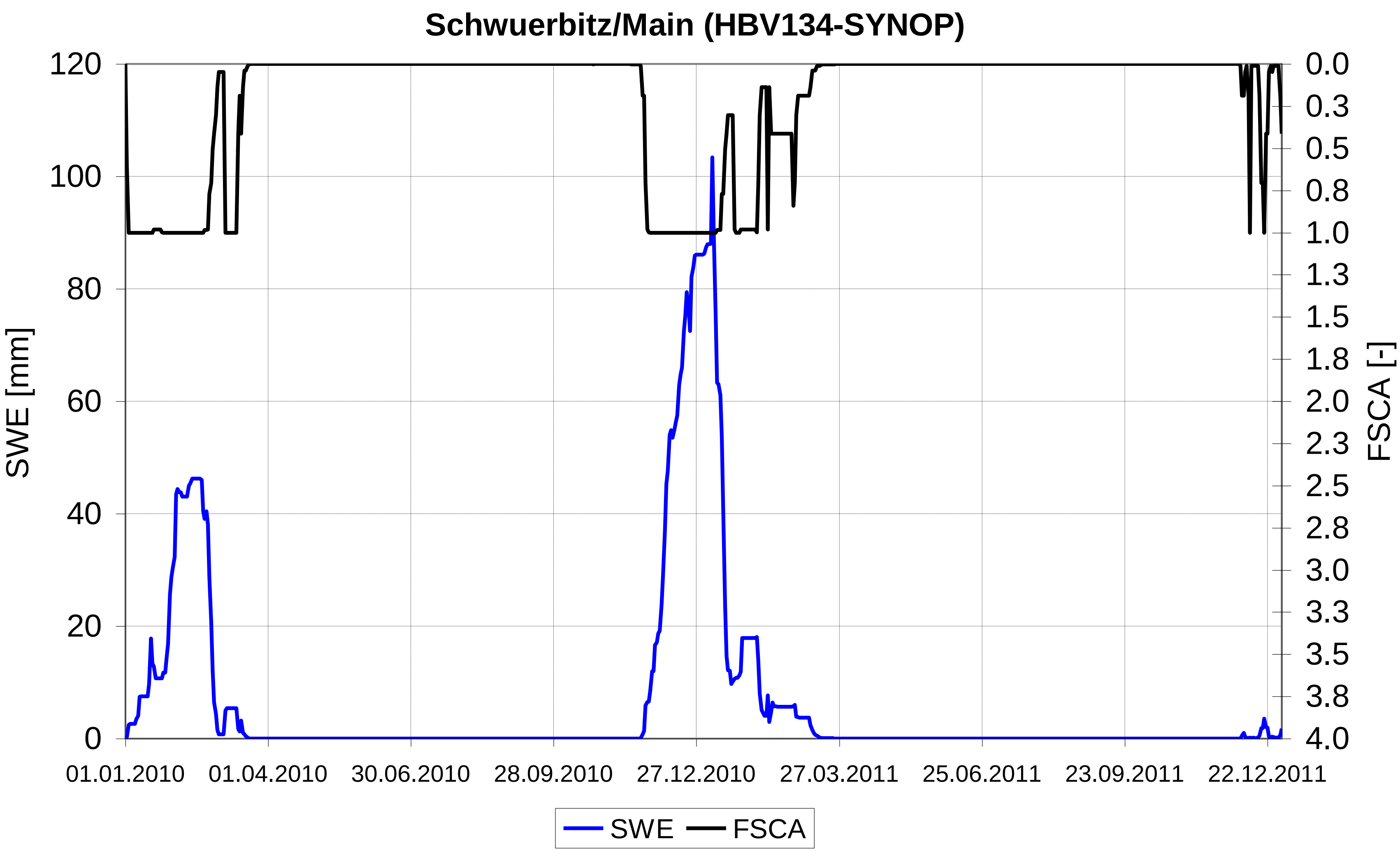


Figure 2-1. Schematic presentation of the HBV model for one subbasin.

$$P - E - R = \frac{d}{dt}\left[\mathrm{SWE} + SM + UZ + LZ\right]$$

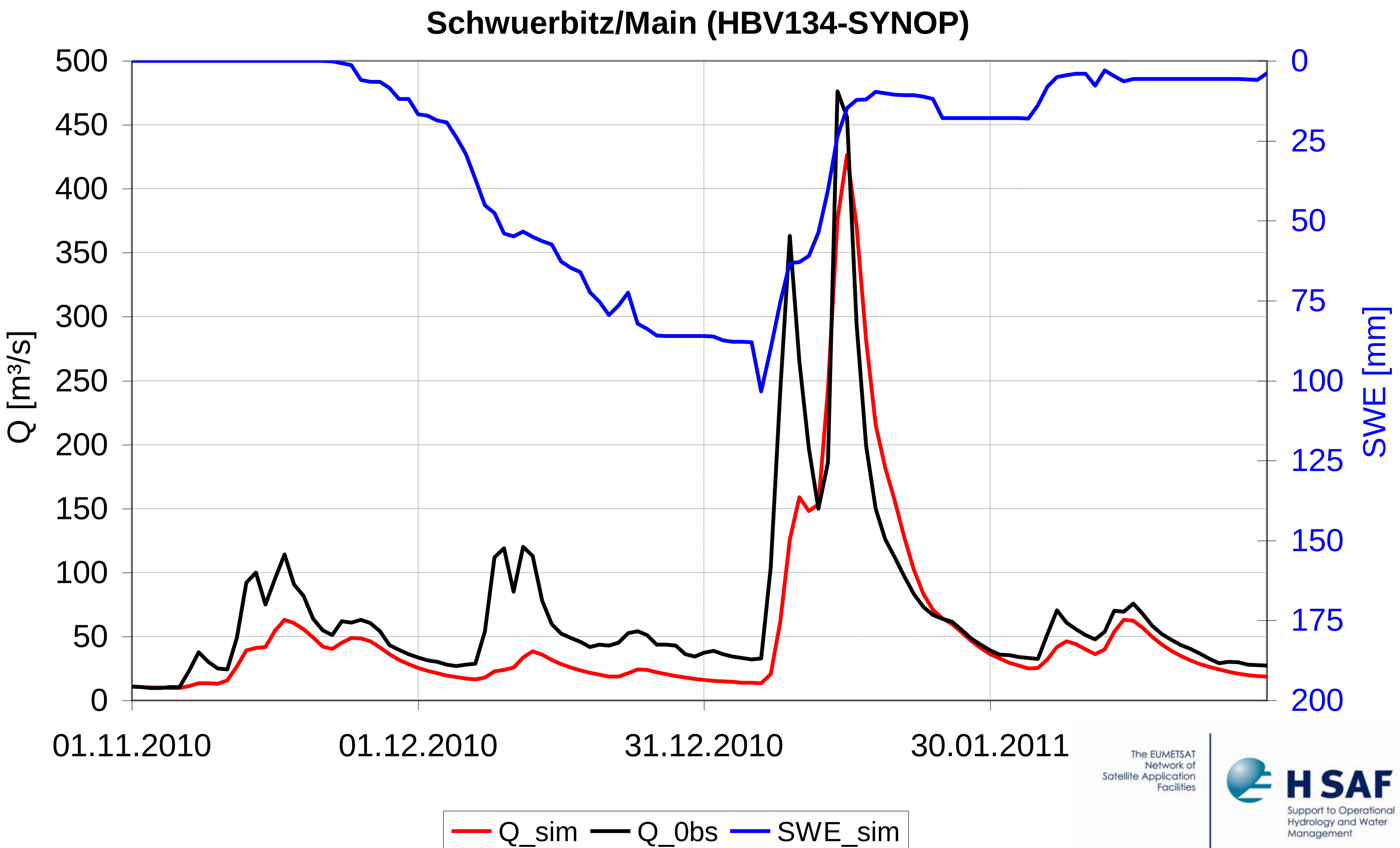
P	**precipitation**
E	evapotranspiration
R	runoff
SWE	**snow water equivalent**
SM	soil moisture
UZ	upper runoff zone
LZ	lower runoff zone
lakes	lake volume

Example Reference run



Next Step DA (station and sat. data)

Bundesanstalt für Gewässerkunde



The EUMETSAT Network of Satellite Application Facilities

H SAF Support to Operational Hydrology and Water Management

User Requirements

- Define generic user groups and identify general requirements e.g.
  - Advanced User (quantitative use, proc. level 1)
  - Intermediate User (quantitative & qualitative use, processing level 2)
  - Informative User (qualitative use, proc. level 3)
- Further general requirements

physical feasible products

spatial & temporal resolution

availability (e. g. cloud coverage) & thematic issue

Thank you
for your attention

Outlook

From HBV134 to LARSIM-ME

From daily to hourly model

Framework for Assimilating

- Discharge (gauging stations)
- Soil moisture data
- **Snow data**

Large **A**rea **SIM**ulation Model

Hydrological Validation H-SAF Products

134 subbasins → ~100 basins

Selection of basins and sub basins

7 gauges at River Rhine river

(~ 100,000 km²)

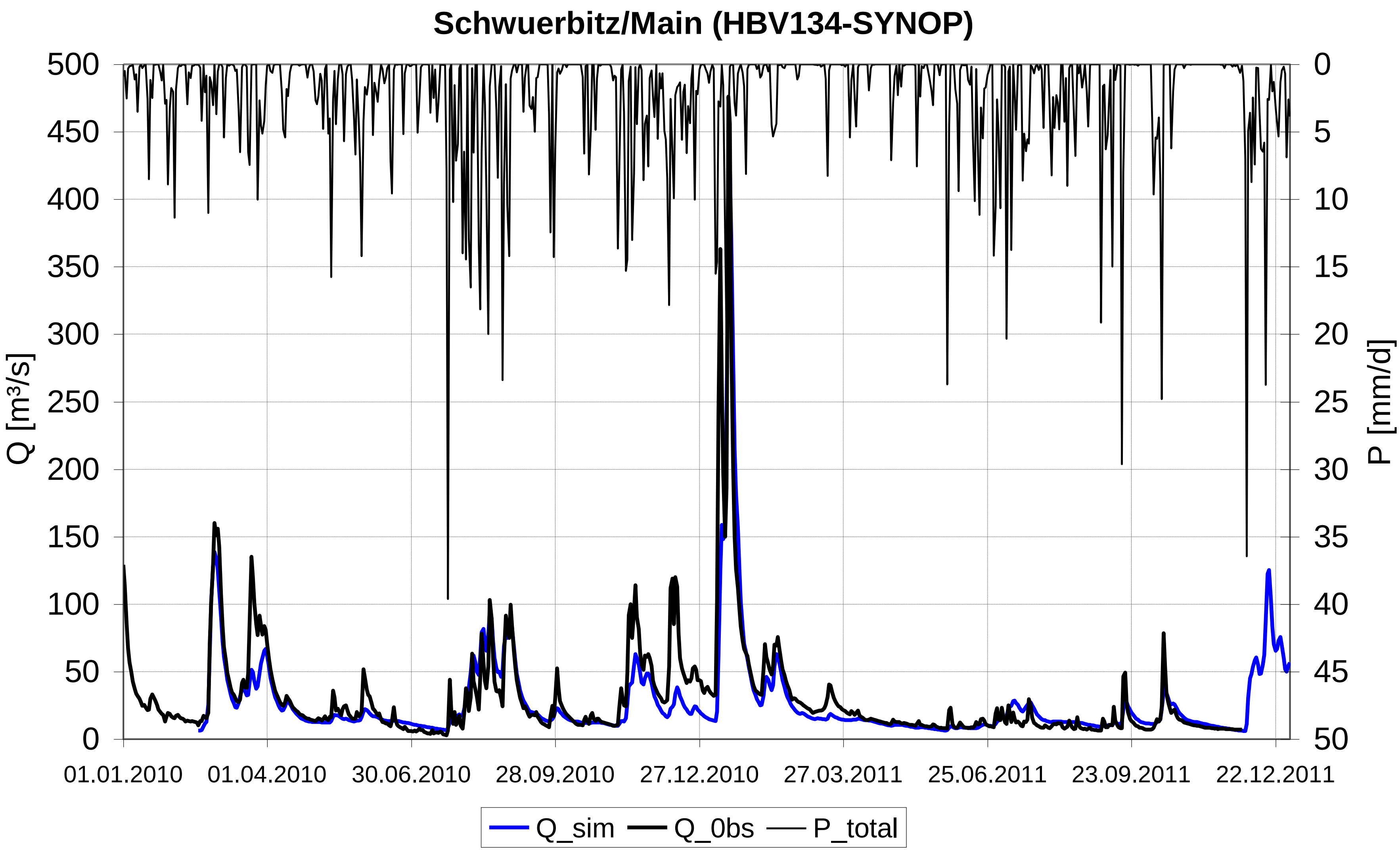
11 gauges of Rhine river tributaries

(~ 20,000 km²)

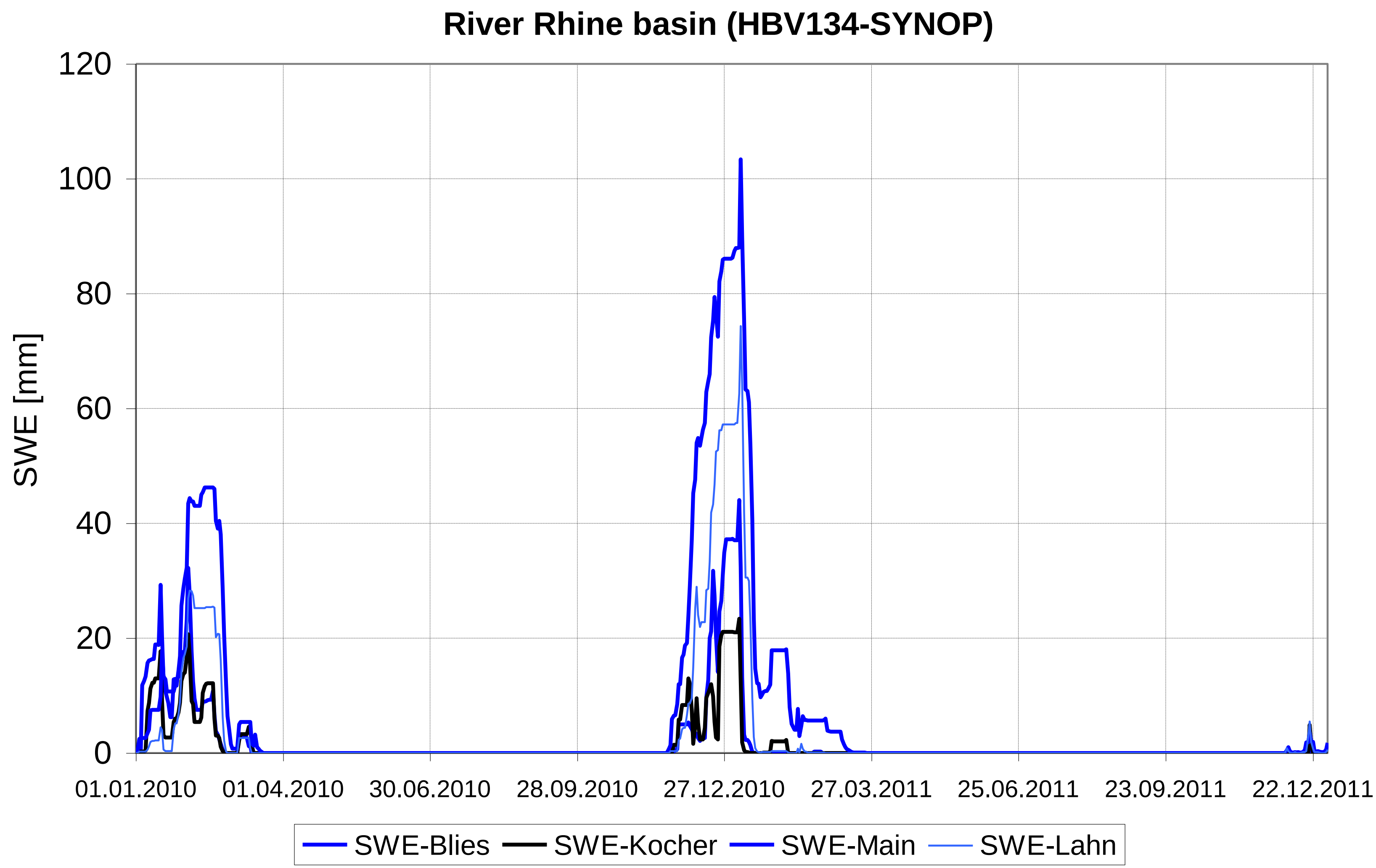
48 gauges head water catchments

(~ 1,500 km²)

Reference run



Reference run



River basins of Central Europe