Delft FEWS based flood forecasting system for Czech Hydrometeorological institute

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Agenda

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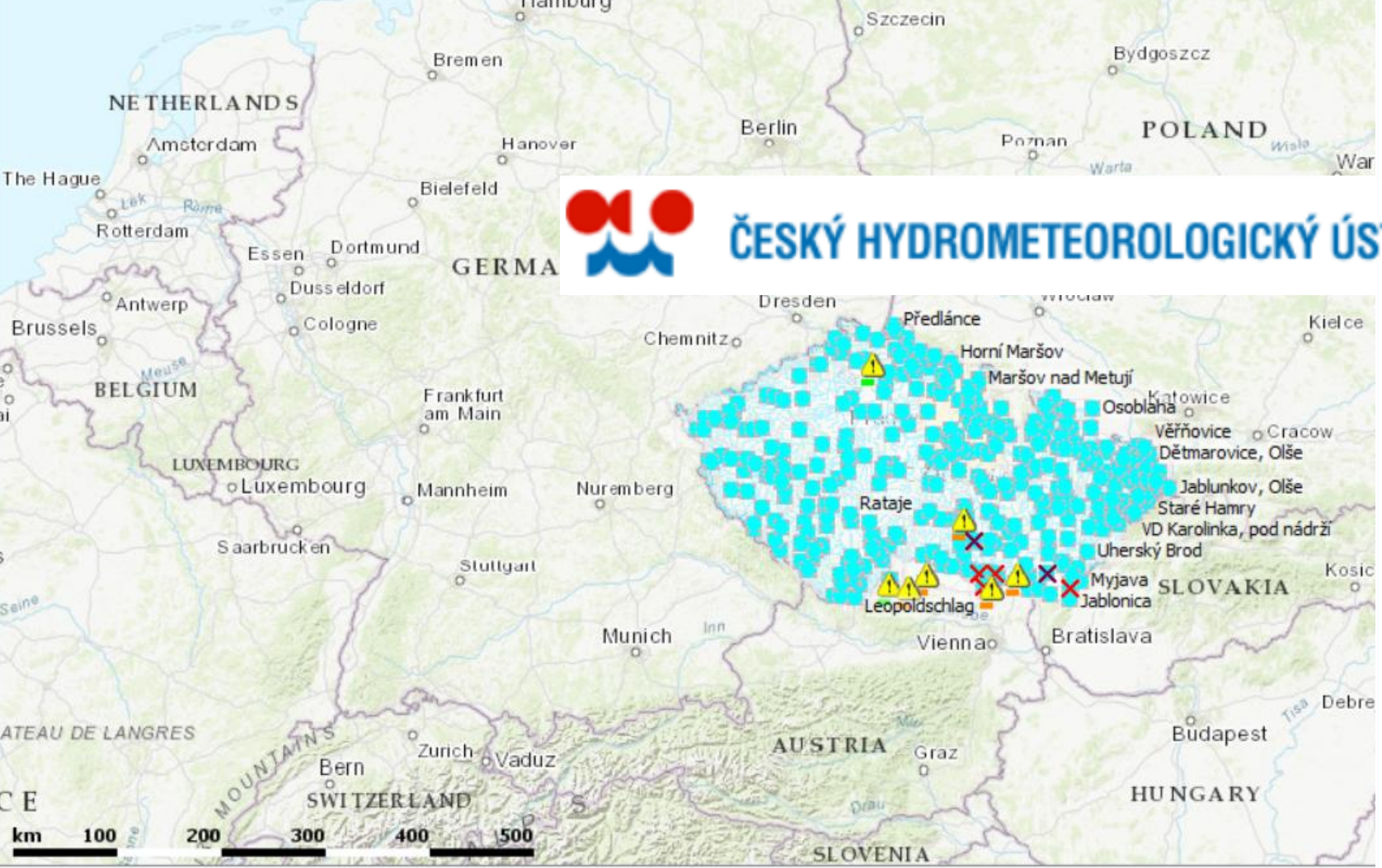

ČESKÝ HYDROMETEOROLOGICKÝ ÚSTAV
Předlánce
Horní Maršov
Maršov nad Metují
Osoblaha
Věřňovice
Dětmarovice, Olše
Jablunkov, Olše
Staré Hamry
VD Karolinka, pod nádrží
Uherský Brod
Myjava
Jablonica
Leopoldschlag
Rataje
NETHERLANDS
Amsterdam
The Hague
Rotterdam
Bremen
Hanover
Bielefeld
Berlin
POLAND
Poznan
Szczecin
Bydgoszcz
Essen
Dortmund
Dusseldorf
Cologne
Antwerp
Brussels
BELGIUM
LUXEMBOURG
Luxembourg
Frankfurt am Main
Mannheim
Nuremberg
Saarbrucken
Stuttgart
Munich
Dresden
Chemnitz
Katowice
Cracow
Kielce
Wroclaw
Vienna
Bratislava
SLOVAKIA
Kosice
AUSTRIA
Graz
Budapest
HUNGARY
Debrecen
SLOVENIA
Zurich
Vaduz
Bern
SWITZERLAND
km 100 200 300 400 500

01.

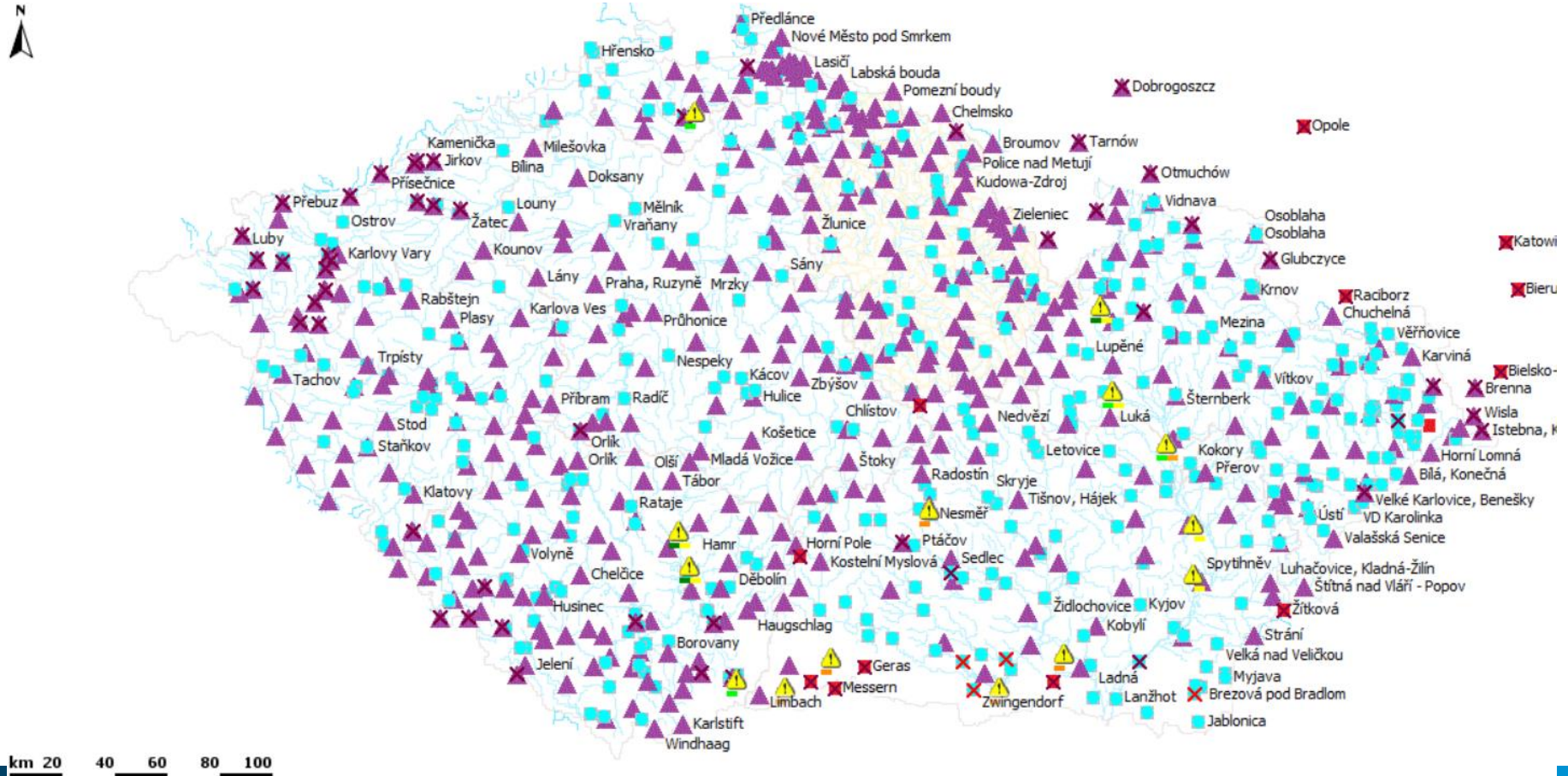
Basics

about flood forecasting systém implementation at CHMI

About CHMI flood forecasting

- 7 branches completing flood forecast usually 2x per day (process not fully unified)
- about 600 climatic stations, 400 water lever gauges, 300-400 forecasting stations
- 2 proprietary rainfall-runoff models used: Aqualog, Hydrog
  (conceptual lumped linear-reservoir type: Sacramento / event based kinem. vawe)
- 1 hour time step
- variety of data sources (stations, databases, radars, meteo models, external)
- publishing to web and to customers

Precipitation stations + flow gauges



Aims of the project

- system covering whole flood forecasting process in CHMI
- implementation to 7 branches (CZ territory about 79 000 km^2)
- mimic current approach and procedures
- full integration of 2 proprietary R-R models
- automated data import from several sources
- overall options for forecast process:
    - deterministic manual calibration
    - variants of automated deterministic forecast
    - ensemble automated forecast

Project basics

- 9/2017 – 11/2019
- CHMI required Delft FEWS software
- DHI CZ office won the tender and implemented system
- tight cooperation with client
- tight cooperation with models developers
- several substantial changes in architecture according to clients request
- tested by CHMI staff per-partes during implementation
- now full system in testing period
- future CHMI aim: system fully operated, managed and further developed by CHMI staff

02.

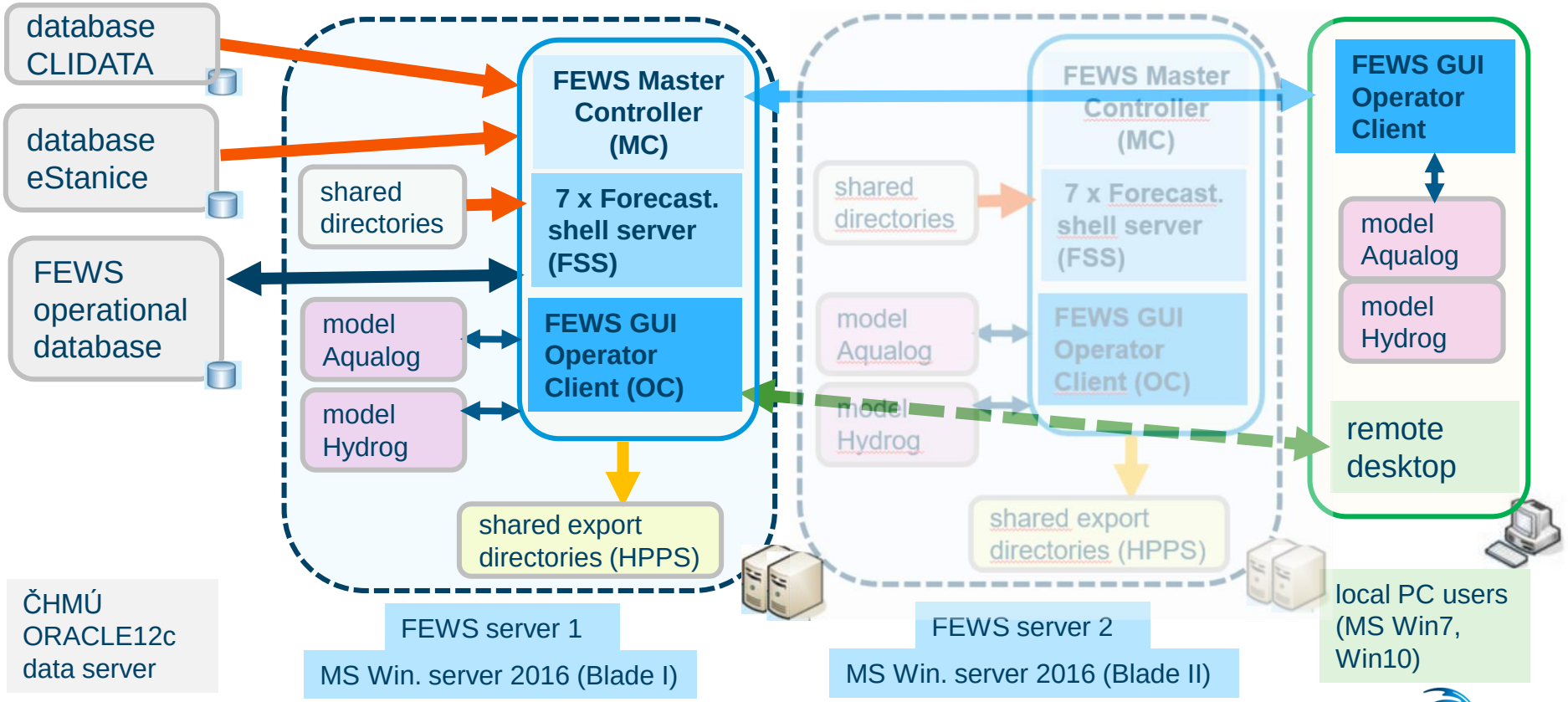
General scheme

of Delft FEWS system implemented at CHMI

Technical info

- system running at 2 CHMI servers (racks) + more than 10 local PCs
- Microsoft Windows Server 2016 (local: Win 7, Win 10)
- FEWS database: ORACLE 12c
- developed at Delft FEWS 2017.2, will be updated soon
- 2 levels of user access, branches restrictions
- 3 ways of system use: OC, RDP, SA
- prepared for manual forecast, scenarios automated deterministic and ensemble forecast process

General scheme of CHMI flood forec. system architecture



03.

Forecasting process steps

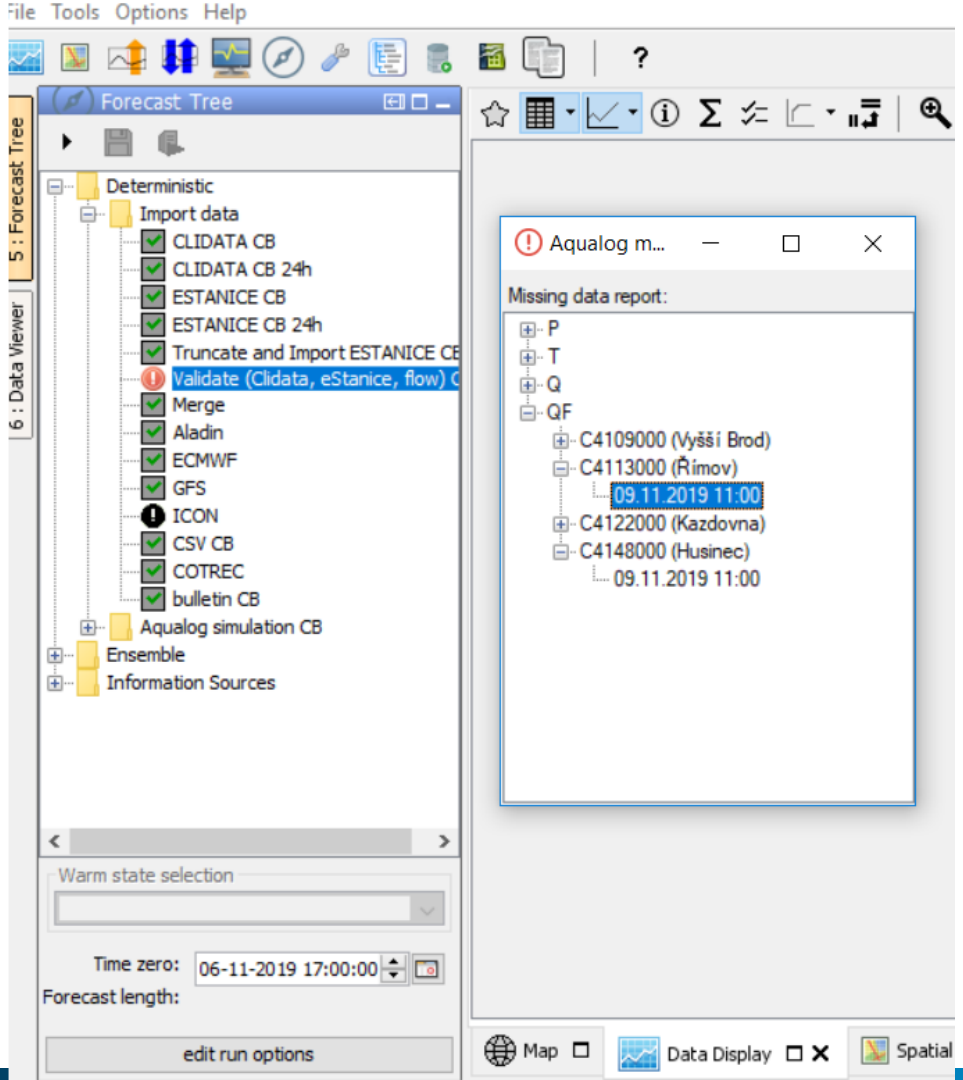
implemented to the Delft FEWS system at CHMI

Flood forecasting process

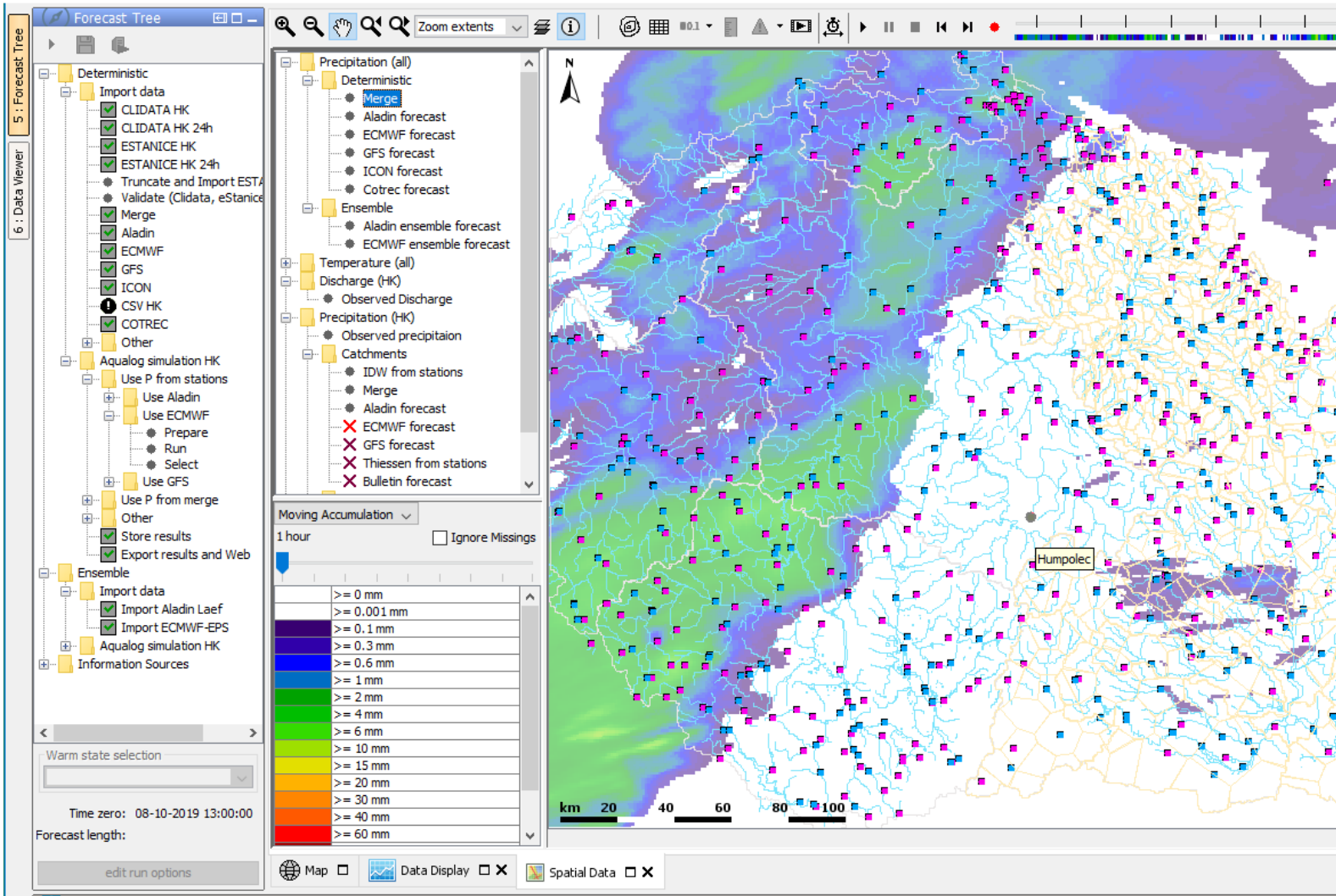
- Import of station data, meteoradar interpretations, meteomodels (ALADIN, ECMWF, ICON, GFS)
- Validation of station data (list of missing values)
- Selection of input data combination
- Prepare and checking of inputs for models
- Running of model: manual calibration using model interface
- Final model forecast stored to FEWS database
- Model setup sent to server for automated ensemble simulation
- Water levels calculation (Q/h curves)
- Automated simulation of ensembles sets
- Export of approved forecast to customers, publishing on CHMI web

Data validation tool

- list of missing values (P, T, Q, QF) in stations



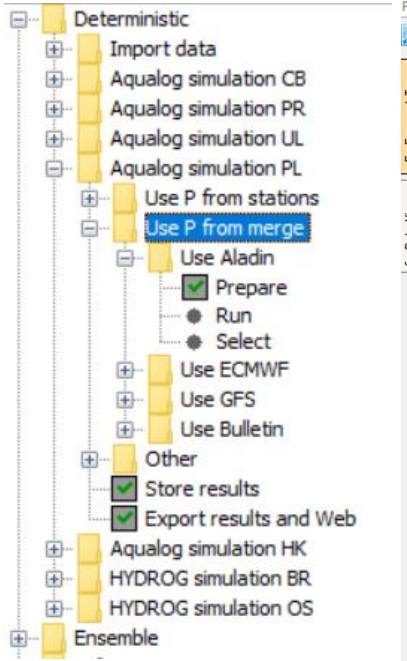
Interface

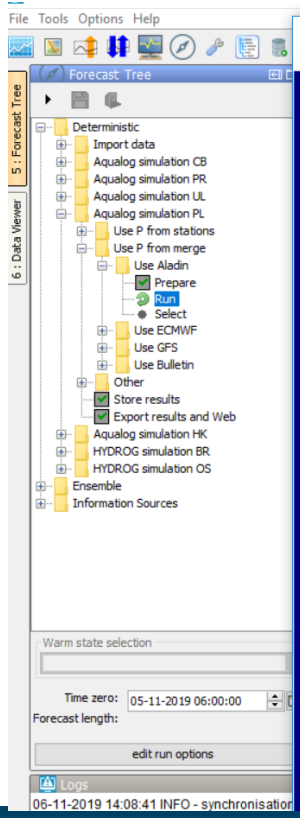


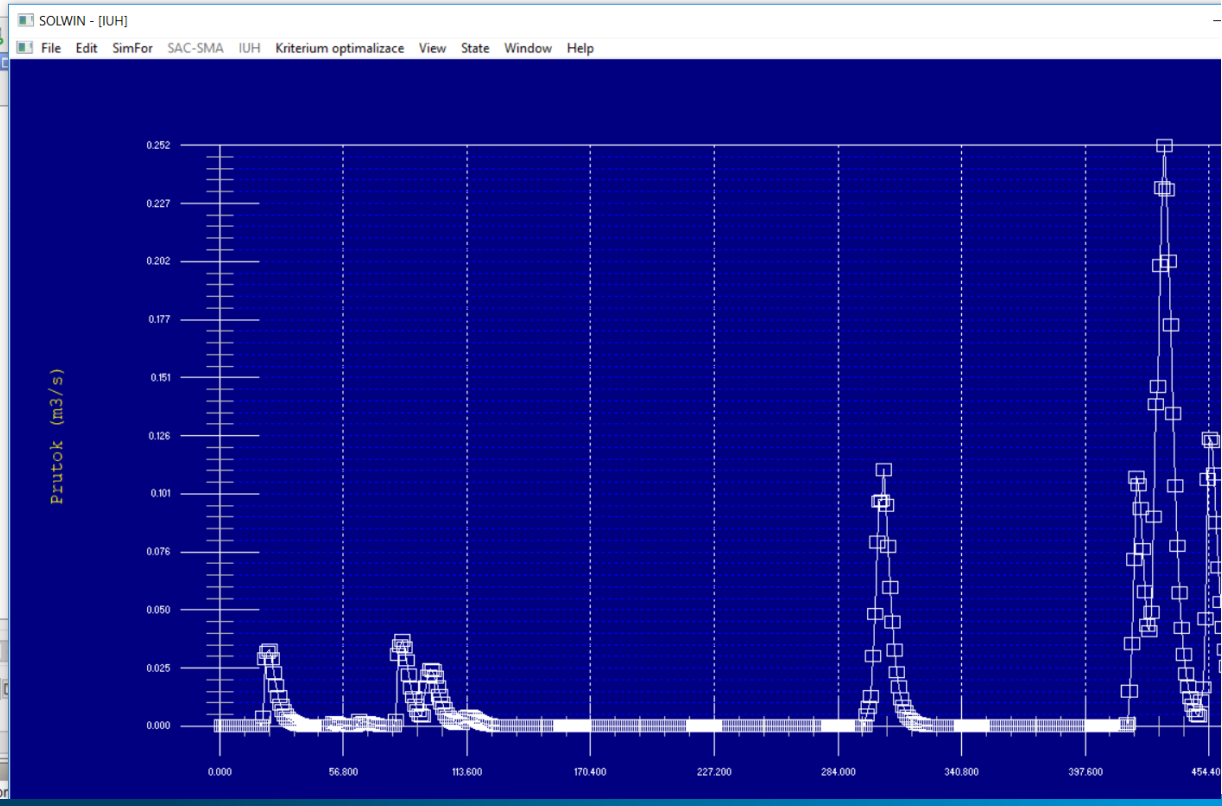
Working with Aqualog model interface

- calibrating all Q gauges stepwise for whole region

- 8 options for calibration



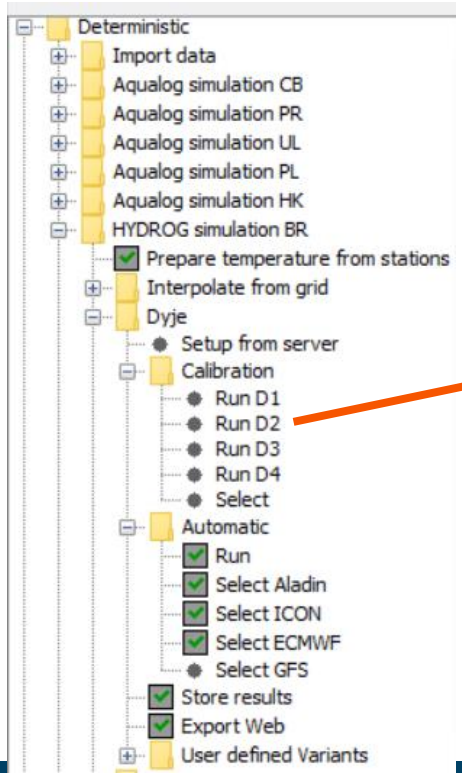


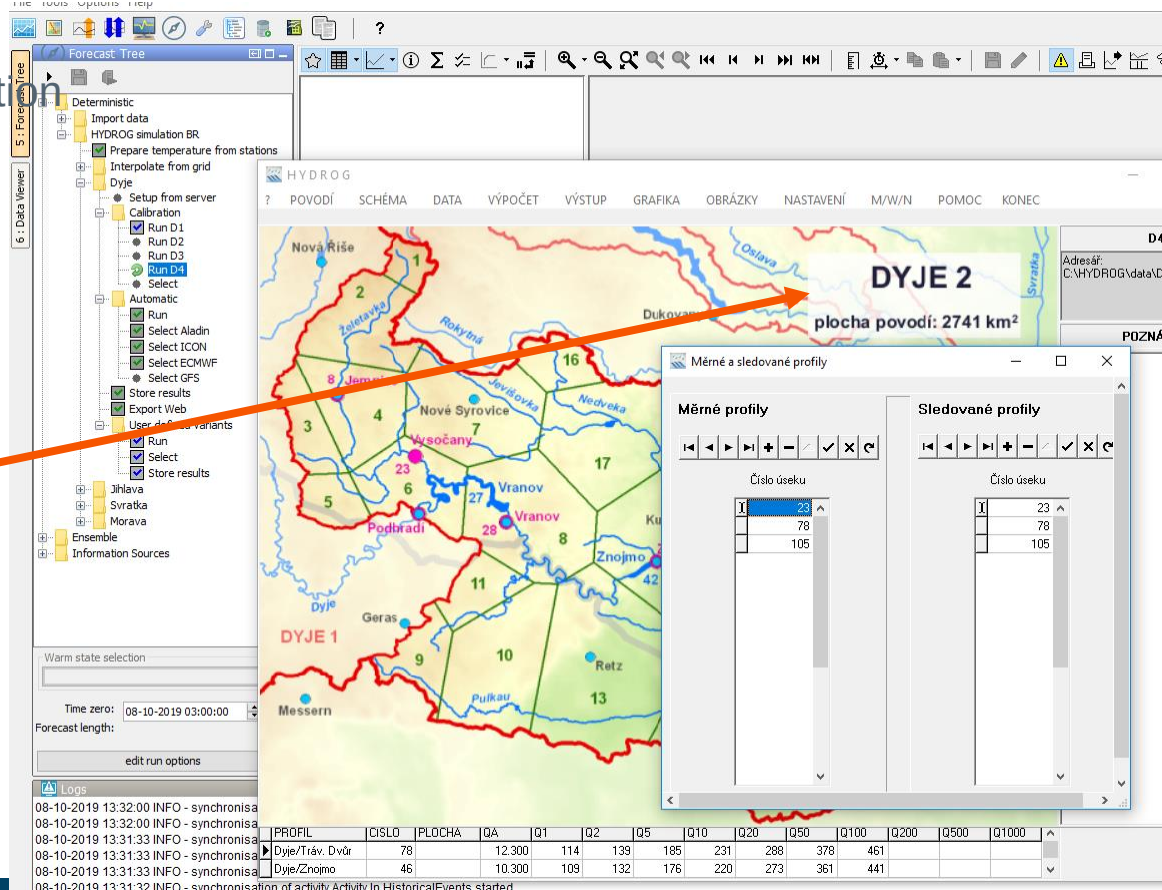


Working with HYDROG model interface

- running individually computational model catchments (22+21)

- 3 options for calibration
- + 5 variants for automated calculation





04.

FEWS system configuration

Data preparation

- Data inputs
  - SQL view to the Oracle database
  - Time series text files
  - Manual inputs of the dam operation data
  - Raster from different file formats including ensemble datasets
- Raster
  - Interpolation from stations
  - Aggregation to catchments
- Basic data validation

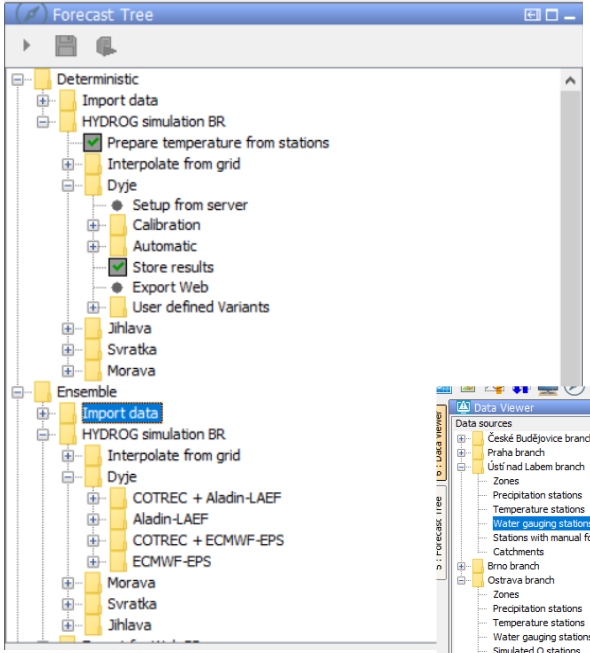
Model execution

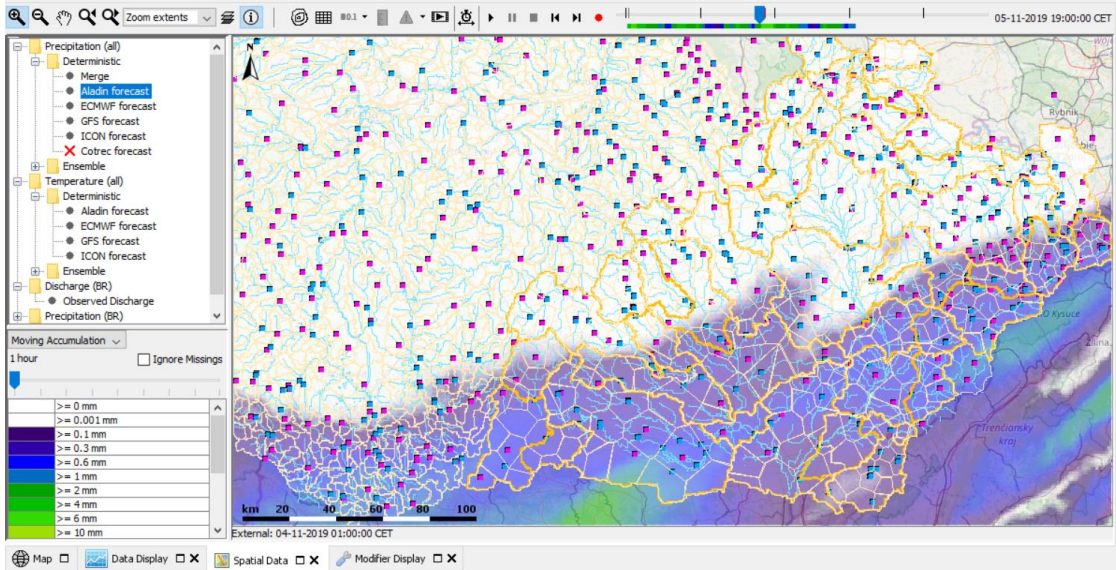
- Transfer of the last calibrated model from server to client computer
- Modifiers used for some parameters setup
- Run model on local computer using model (Aqualog, Hydrog) GUI. Calibration using different combination of the input data.
- Final selection of the calibrated model. Copy setup (selected files) to the server + loading result to database
- Model runs in server using calibrated data + different predefined input data combinations
- Ensemble runs

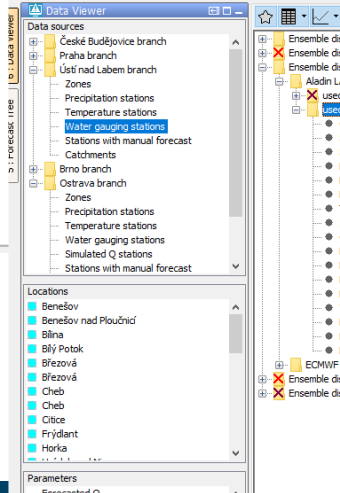
Data post processing

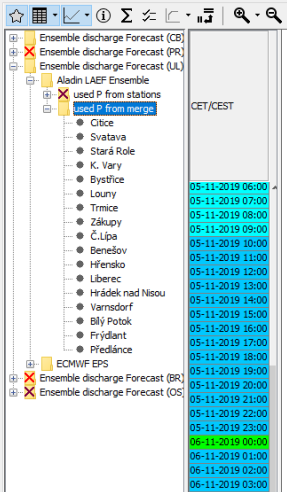
- H computed from Q using Q/H curves
- Ensemble statistic
- CSV results send to the other organization (waterboards, …) using FTP
- Data prepared for Web

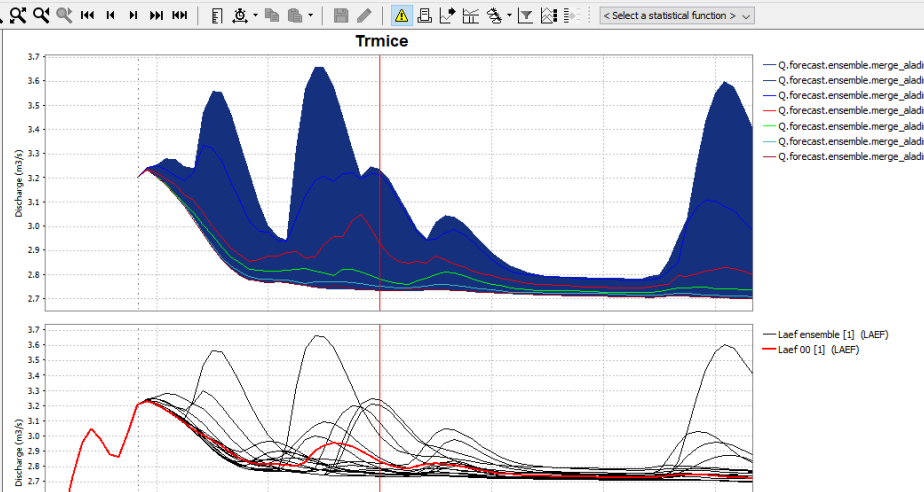
GUI - examples











GUI in FEWS

- Data View, Spatial Vies and Forecast tree configured differently for 7 branches.
  - Created by common part + branch specific part
  - Model run part divided to Calibration, Automatic runs in server and Ensembles
- Shortcuts used for the ensemble presentation in predefined profiles

Configuration

- Module configuration files intensively use variables
  - Global variables from global settings
  - Variables defined in workflow
- User request functionality replicating current status, having possibility to execute individual steps. As result – big amount of workflows created. Many workflows call the same modules using different variable values.

05.

Wrapper

Wrappers

- Written in C#
- Advance logs for debugging and problem reports
- RR wrappers
  - Individual wrappers for two different RR models (Aqualog and Hydrog)
  - Wrapper can be executed in two modes
    - Using model GUI on local computer
    - Using model batch run on server
  - Prepare input TS
  - Modify input files based on parameters prepared in module
  - Read results

Wrappers – supporting functionality

- Data import – from specific formats
- Data and model setup transfer between local computer and server computers
- Export results (deterministic and ensemble) to existing data structures for Web presentation
- Other small supporting items

Summary

System developed in tight cooperation with client, to fulfill their needs

Covering whole process: from data import to publishing forecast

Variants of models and data combinations – high system complexity

Deterministic manual calibration and automated ensemble calculation

Full intergration of 2 proprietary models

Functionality for finding time series gaps

Thank you

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