MicroStep-MIS

Your friends in every weather

HYDROLOGICAL FORECASTING MODELS AND SYSTEMS

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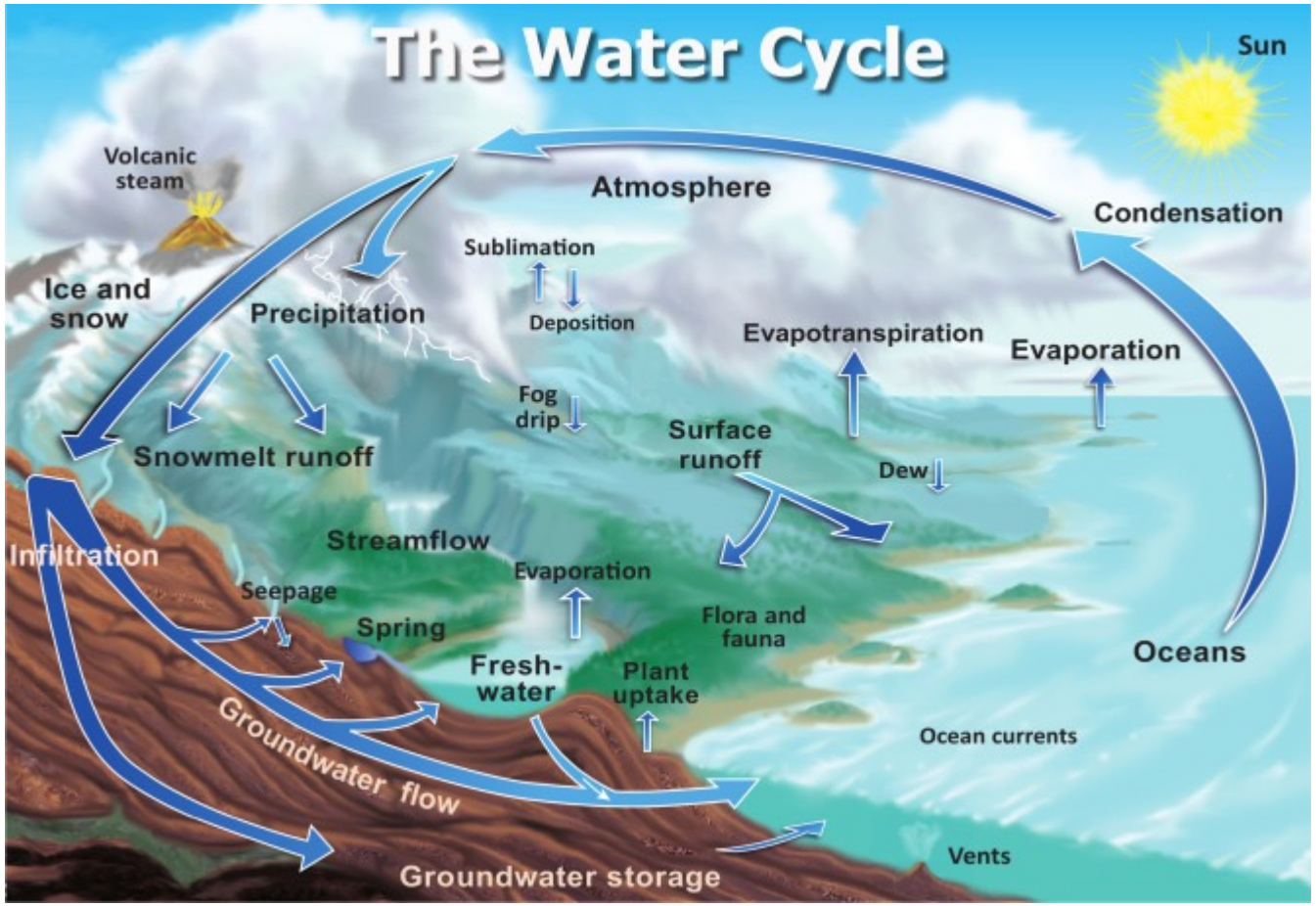
HYDROLOGICAL MODELLING

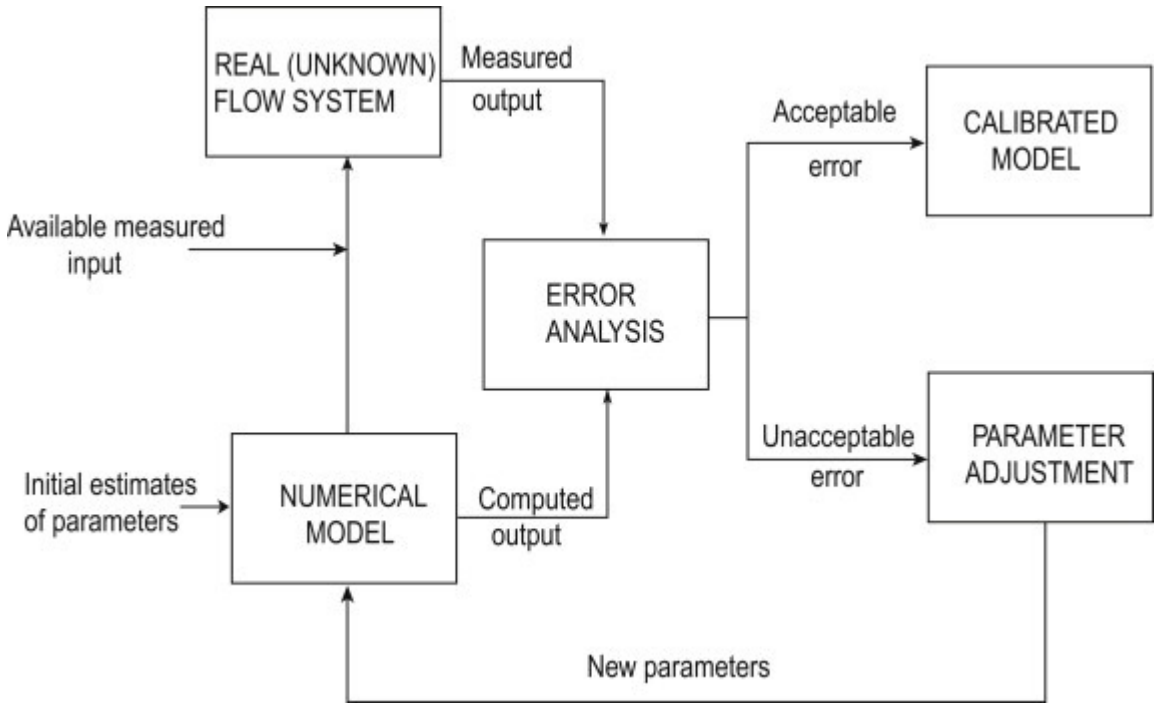
- Hydrologic modeling is used to answer questions where water excess, scarcity, or dissolved or solid content is of primary importance (Burges, 1986)
- many plausible solutions, depending on purpose and needed complexity - wide variety of different hydrologic models
- uncertainties in process and the overwhelming influence of heterogeneities
- poorly understood and ill-described natural phenomena



Water cycle is the complex of processes in the real watersheds

HYDROLOGICAL MODEL

- Tool for simulation of natural processes via mathematical functions
- Preparing of model for operation is long distance run:
  - Data collection
  - Calibration of model
  - Validation (verification) of model
  - Set –up of model for daily use
  - Regular real time QC
  - Visualization of model outputs
- Calibrated model is not forever, but has to be updated

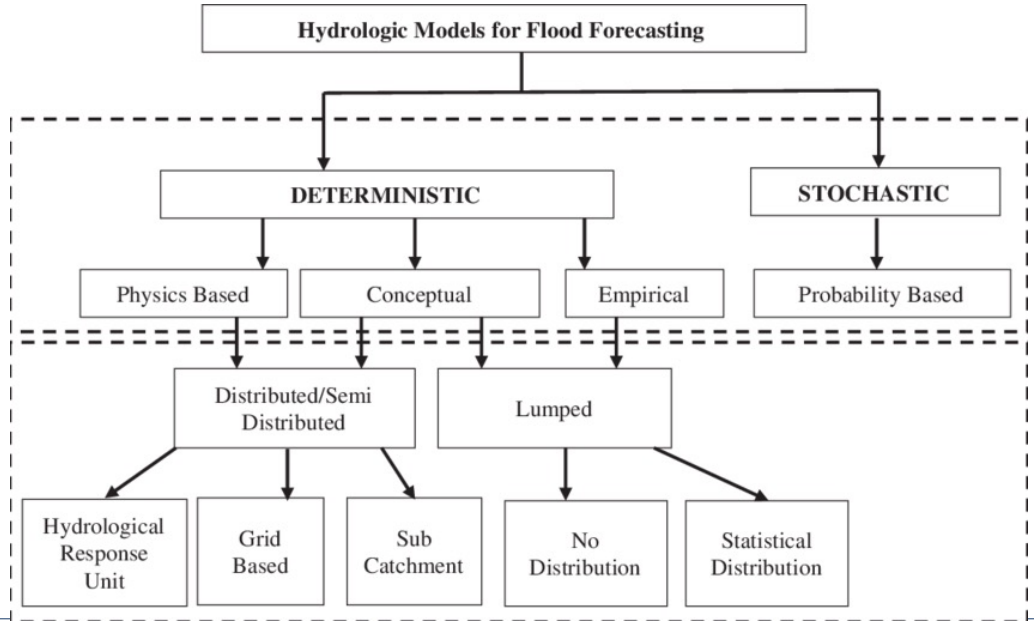


Calibration of hydrological model is sophisticated and complex process. Positive results is not ensured.

TYPES OF HYDROLOGICAL MODEL

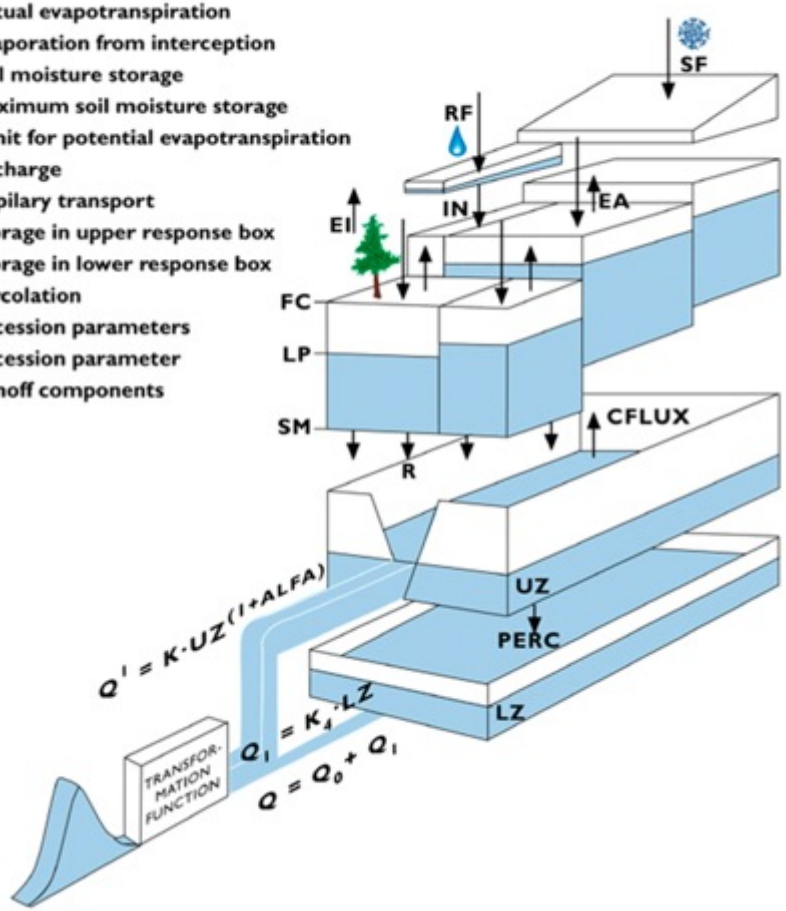
- Principle of model:
  - black box,
  - grey box,
  - white box
- Spatial heterogeneity:
  - lumped parameters
  - spatially distributed
- Complexity:
  - complex models
  - models of parts of hydrological cycle
- Purpose:
  - operational
  - event based
  - research

- Purpose of the model:
  - Rainfall –runoff m.
  - HD, flow m.
  - UGW m.
  - Pollution spread / sedimentation models m.
  - M. of parts of hydrological cycle

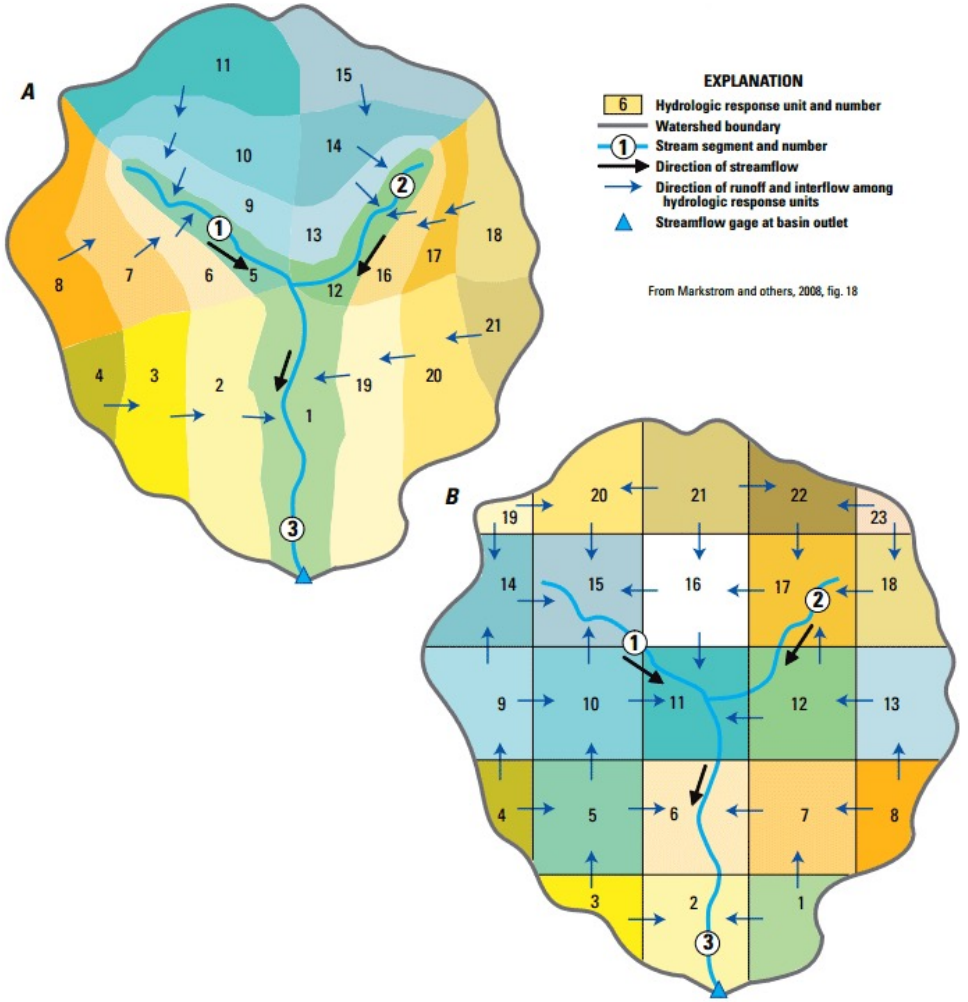


SPATIAL HETEROGENEITY

SF = Snow
RF = Rain
IN = Infiltration
EA = Actual evapotranspiration
EI = Evaporation from interception
SM = Soil moisture storage
FC = Maximum soil moisture storage
LP = Limit for potential evapotranspiration
R = Recharge
CFLUX = Capilary transport
UZ = Storage in upper response box
LZ = Storage in lower response box
PERC = Percolation
K,K4 = Recession parameters
ALFA = Recession parameter
Q0,Q1 = Runoff components



Lumped parameters



Spatially distributed parameters

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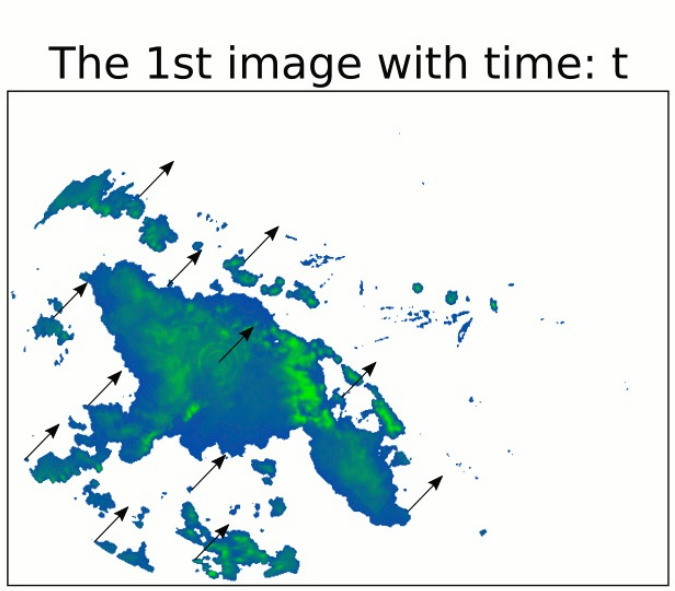
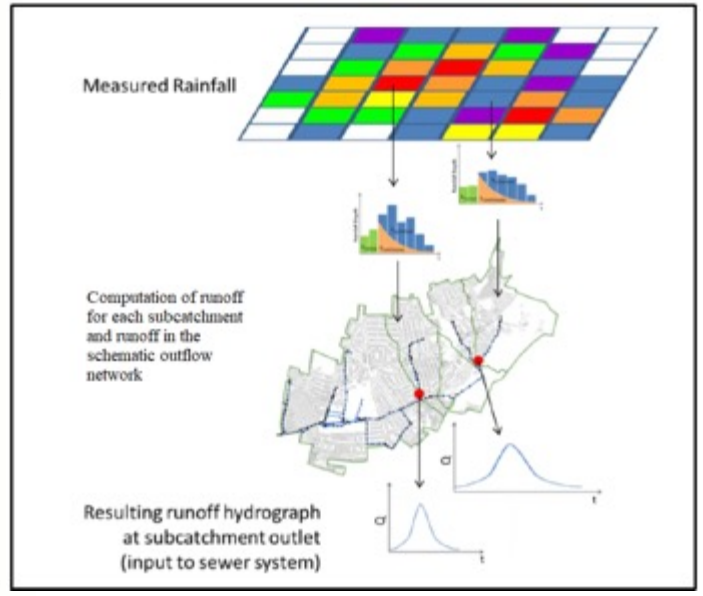
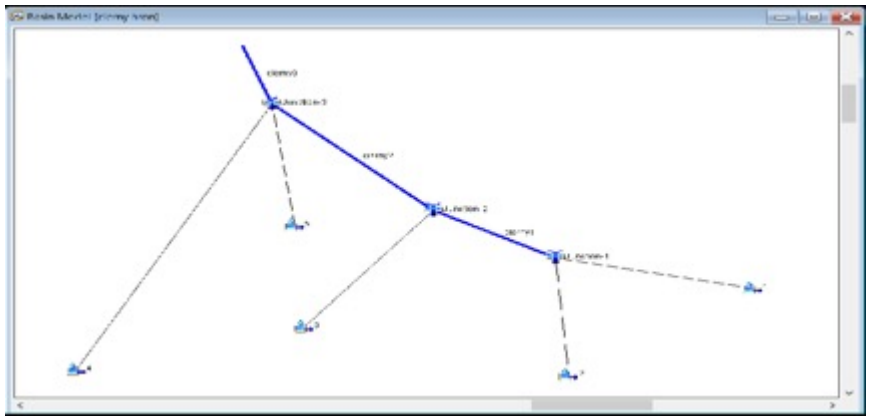
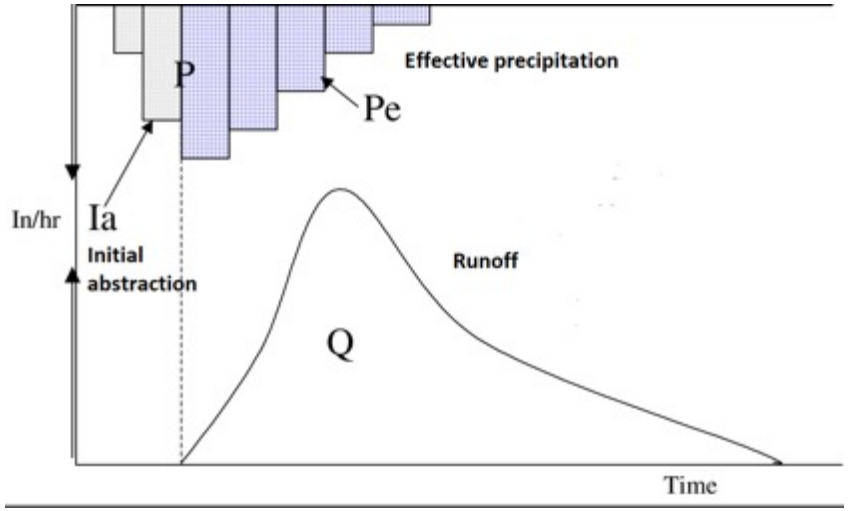
RAINFALL – RUNOFF MODEL

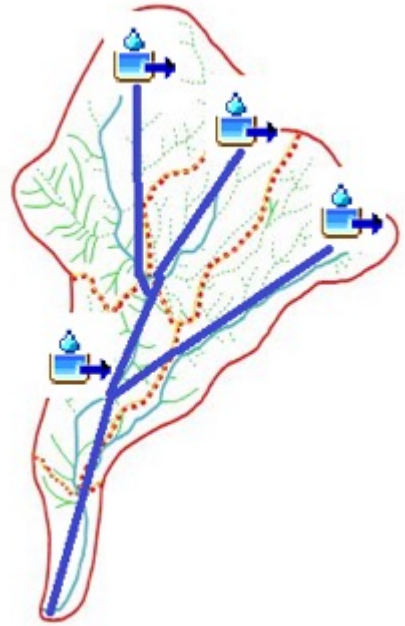
- Transformation of precipitation to runoff
- Input data: precipitation, temperature, soil, land cover, DEM
- Precipitation measured / predicted - NWP
- Transformation function is the set of parameters of watersheds properties
- Distrubition of runoff in space and time





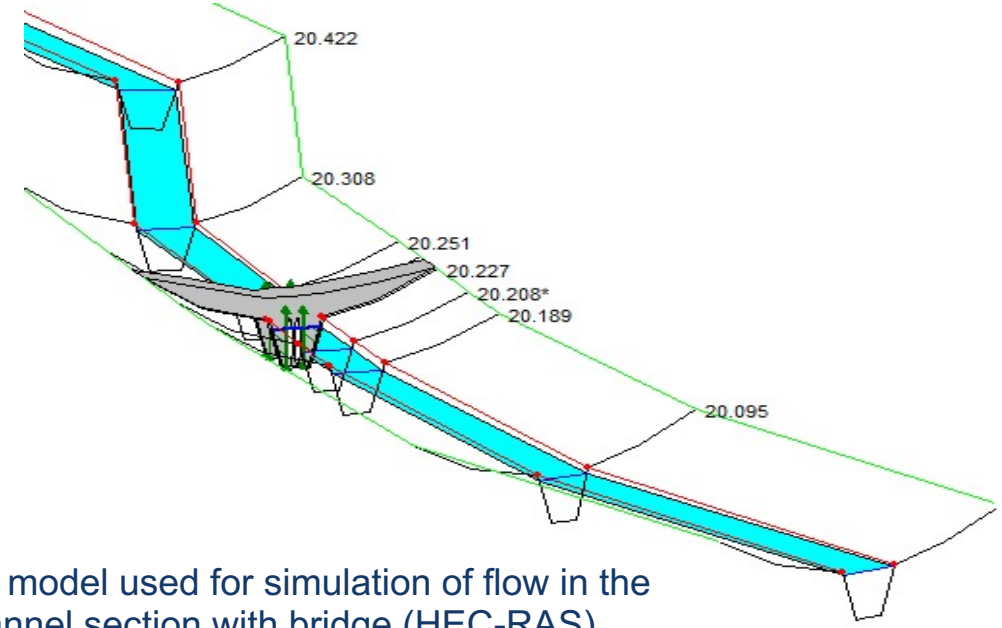




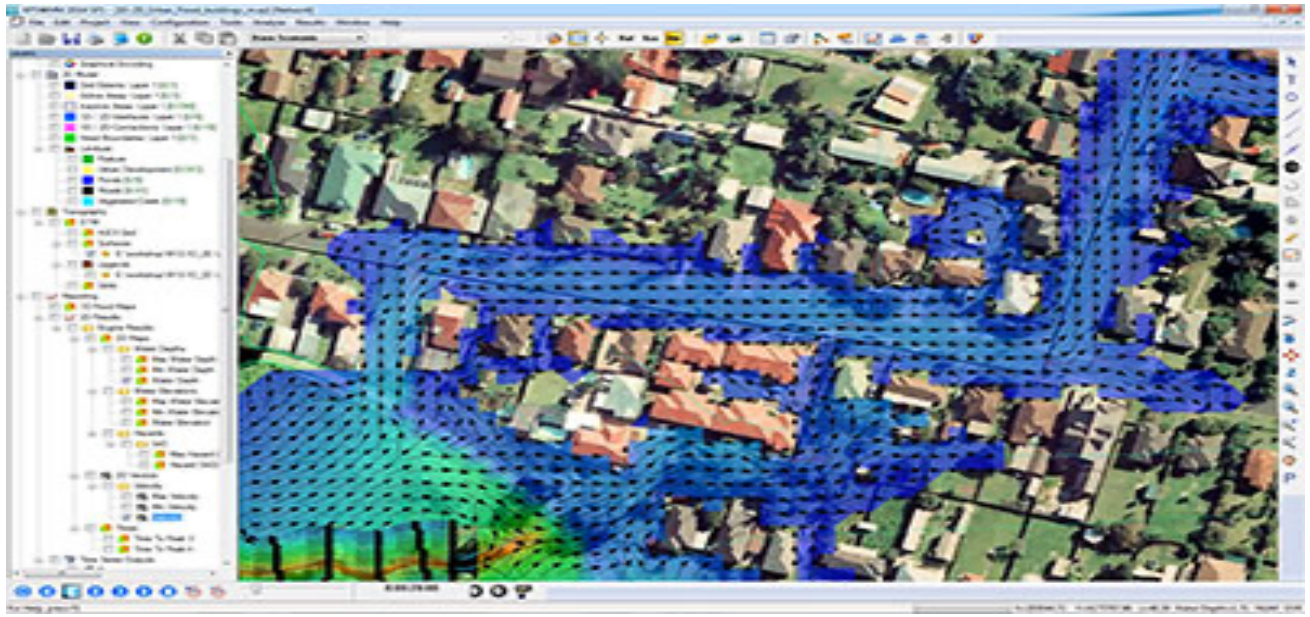


HYDRODYNAMIC AND FLOW MODELLING

- Transformation (Attenuation) of outflow wave in the river channel (in inundation)
- Input is the value of inflow on the beginning of the modeled section
- Output is the value of outflow in the outflow section / map of inundated area
- 1D model – high of water in the channel in time
- 2D model computing of spatial relations (used for flood risk mapping)
- 3D spatial aspect (used for simulation of flooding in the real time / event simulation)



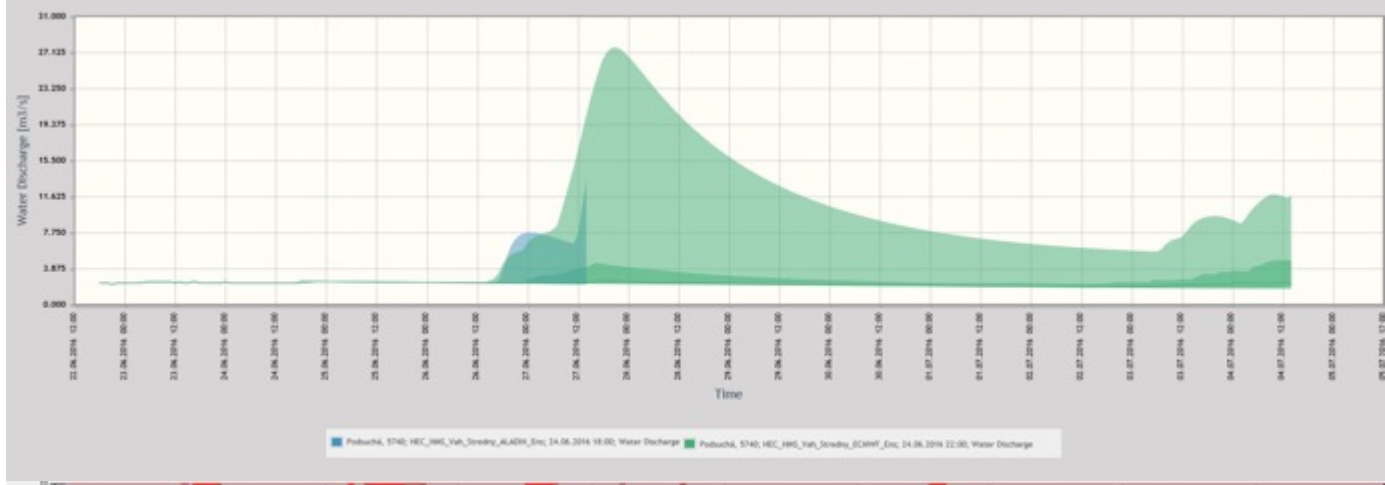
HD model used for simulation of flow in the channel section with bridge (HEC-RAS).

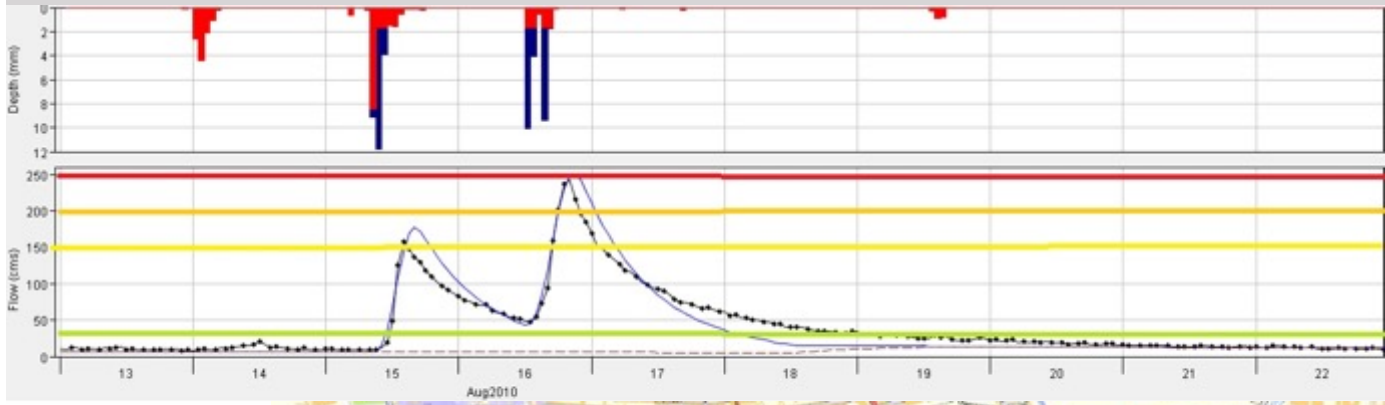


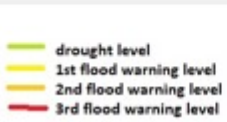
Simulation of flow in the city streets (HEC-RAS+GIS)

USING OF HYDROLOGICAL MODELS

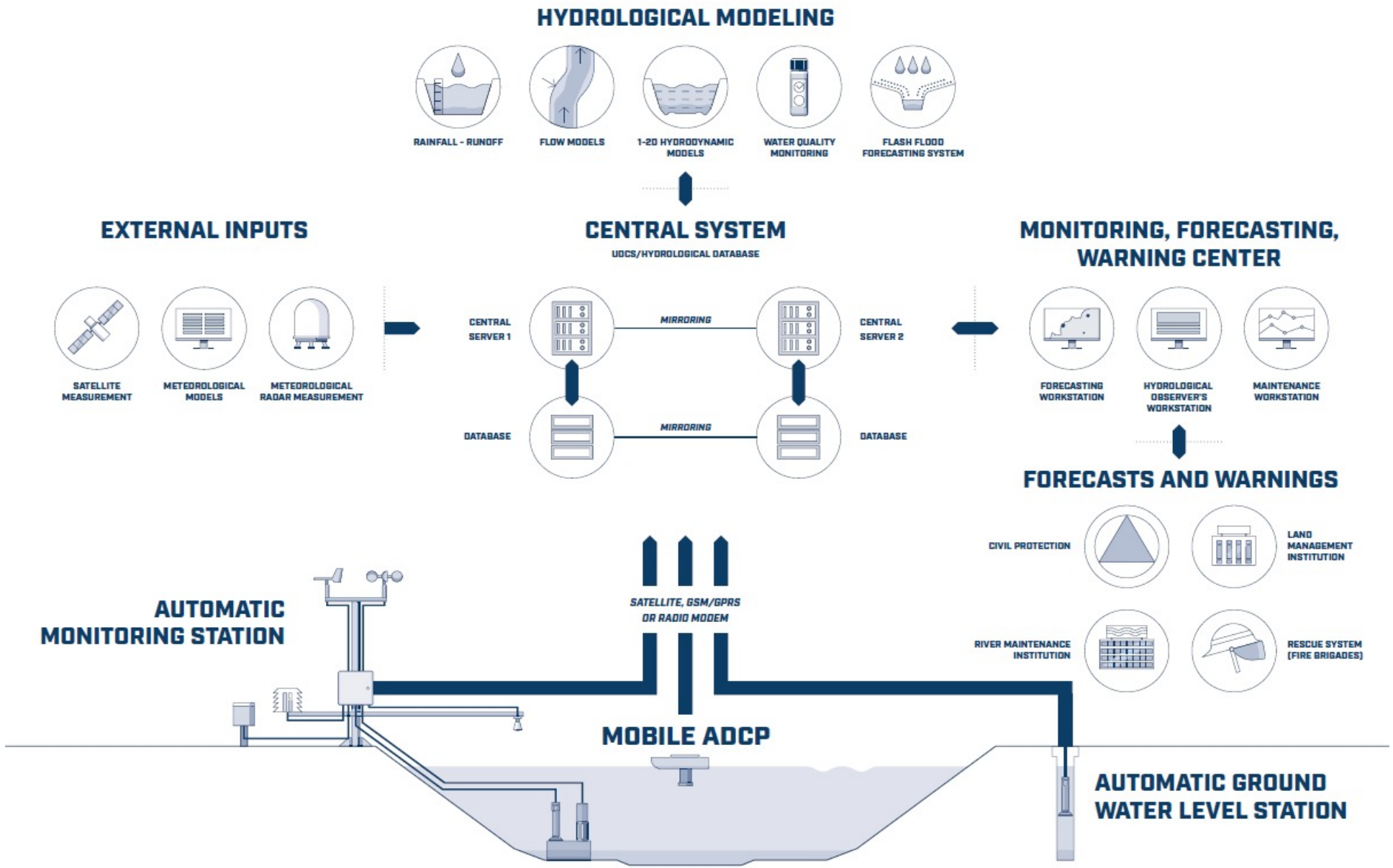
- Forecasting and warning services – daily operation
- Daily operation of dams/ other hydrological structures (monitoring, prediction, warning)
- Planning purposes
- Flood Hazard and Flood Risk mapping
- Hind – casting and re- simulations – event based
- Research and development purposes







COMPLEX HYDROLOGICAL MONITORING & FORECASTING SYSTEM



INPUT DATA FOR HYDROMODELS

Data for model calibration and for operative usage

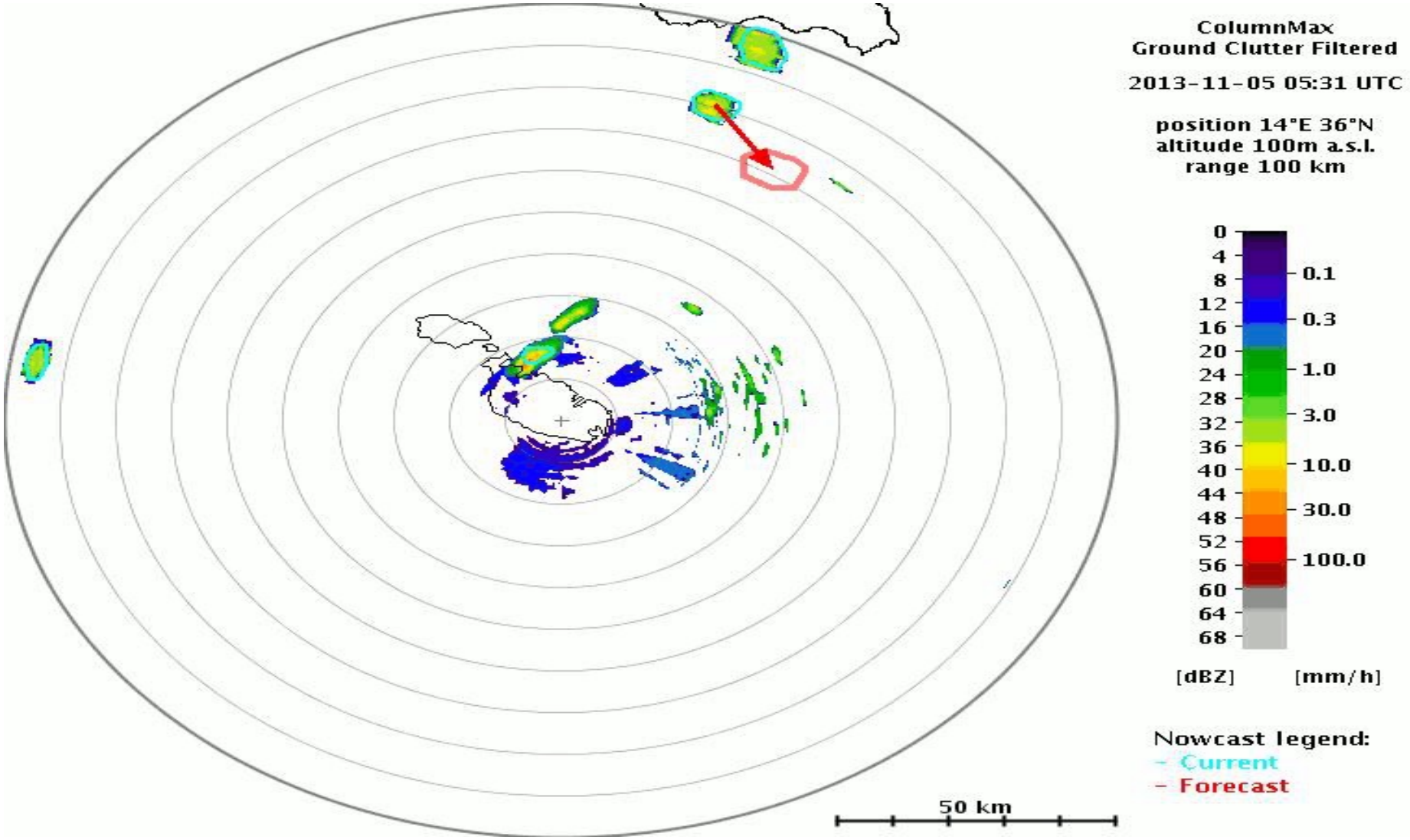
Calibration data:

- Meteo input data (temperature, precipitation)
- Hydrological data
- Land parameters - elevation bands
  - Infiltration and retention potential (soil, UGW, Land cover)
- Channel parameters – length, width, roughness
- Reservoir and storage object parameters
- Other (sinks, water sources)

Operation data

- Precipitation incl. snow – station based, meteorological radar
- Temperature – station based – extra and interpolation methods
- Satellite data
- NWP + short prediction methods (nowcasting)
- Hydrological data – water level in crucial points, discharge data
- Other (dam operation data, irregular water releases)

RADAR BASED NOWCASTING

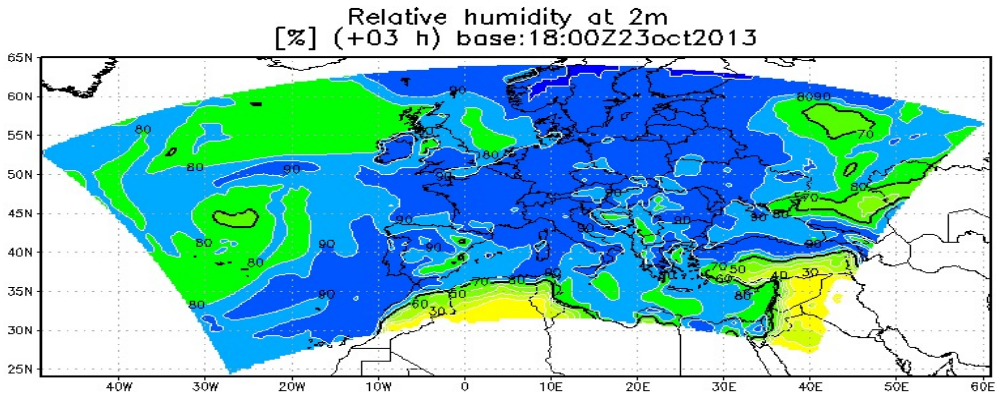


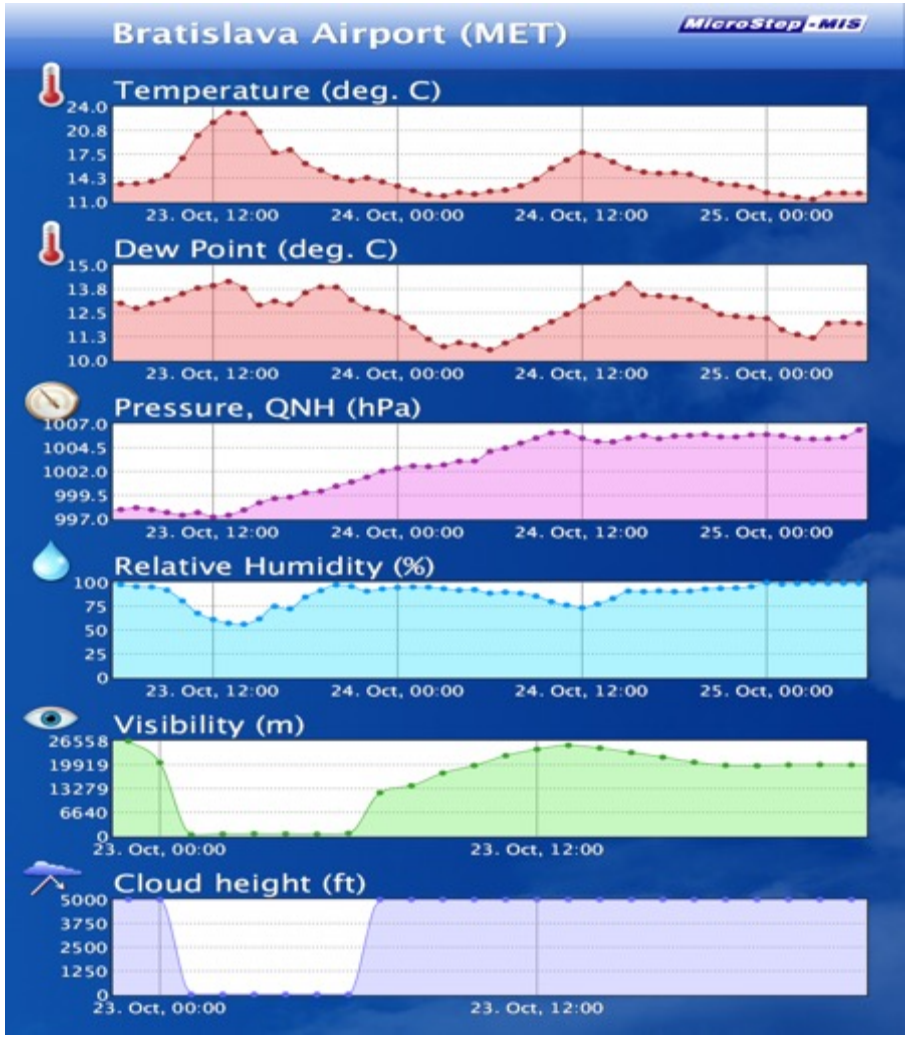
NUMERIC WEATHER PREDICTION MODEL

Purpose:
Modeling of basic meteo parameters
Input to other subsystems

System Configuration:
Access to global model data (via internet, etc.)
NWP limited area model (existing or MicroStep-MIS supplied)

AWDSS Output:
Meteograms
Weather forecasts
Vertical profiles
Weather charts
Turbulence index
Icing index





CENTRAL SYSTEM

Integration of all hydrological and meteorological data

IMS Central Computer Rack

- Single or dual hot-failover system
- Powerful servers (HP, IBM, Fujitsu Siemens)
- Main communication hub (modems, radiomodems, LAN switch)
- Data input, processing, verification
- Configurable interfaces to 3rd party systems
- Measurement, report, event database
- Models and warning
- Maintenance utilities
- Server for thin or thick clients
- Linux or Windows XP/2003/Windows7,8,10

Rack installation is recommended, but small systems can run on the standard PC.

IMS Workstations

- Real time access to hydrological data
- Thin or thick clients
- Linux (SuSE, RedHat, CentOS) or Windows XP/2003/Windows 7/8/10

IMS4 – APPLICATION SOFTWARE

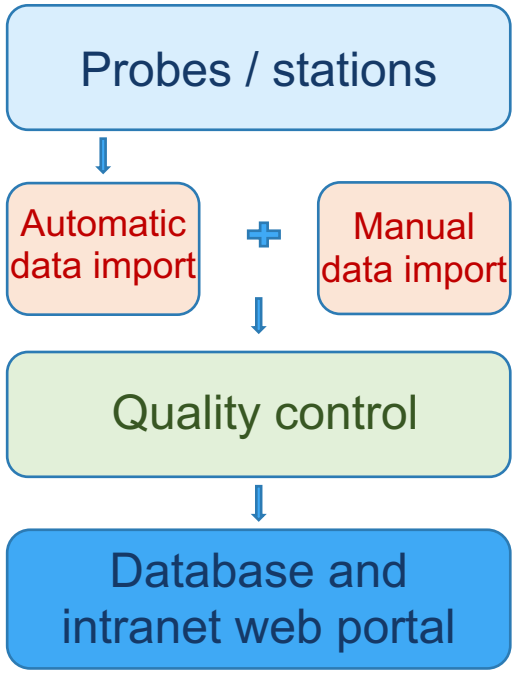
4th generation of Integrated Meteorological System

Being developed since 1993.
Designed for 24 x 7 unattended operation.
More than 200 installations in various countries of Europe, Middle East, Asia, Africa.
Compliant with applicable regulations and recommendations (WMO, EU, OGC, ISO, OASIS), open for adjustment for compatibility with national practices.
Complex multipurpose software:

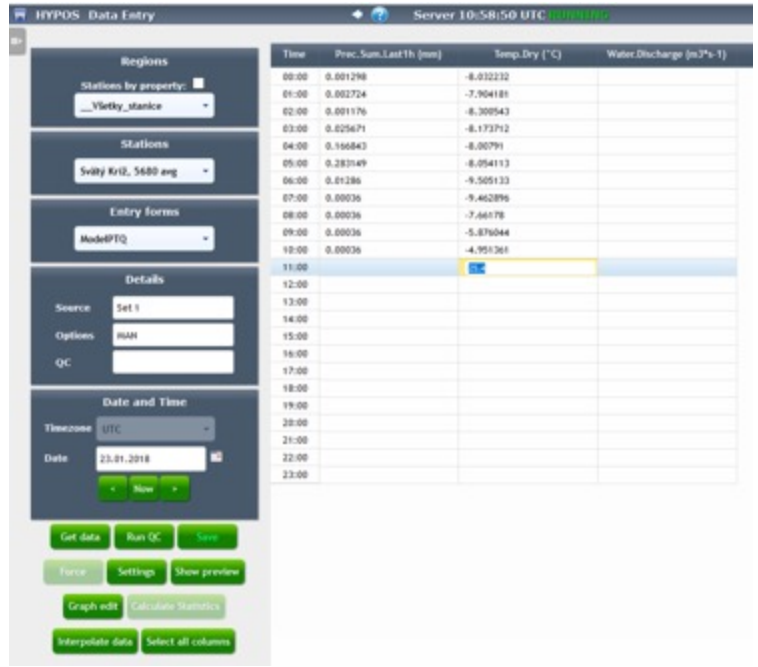
- Hydrological systems
- Marine meteorology
- Synoptic and Climatological monitoring
- Aviation Systems
- Gamma radiation monitoring

DATABASE

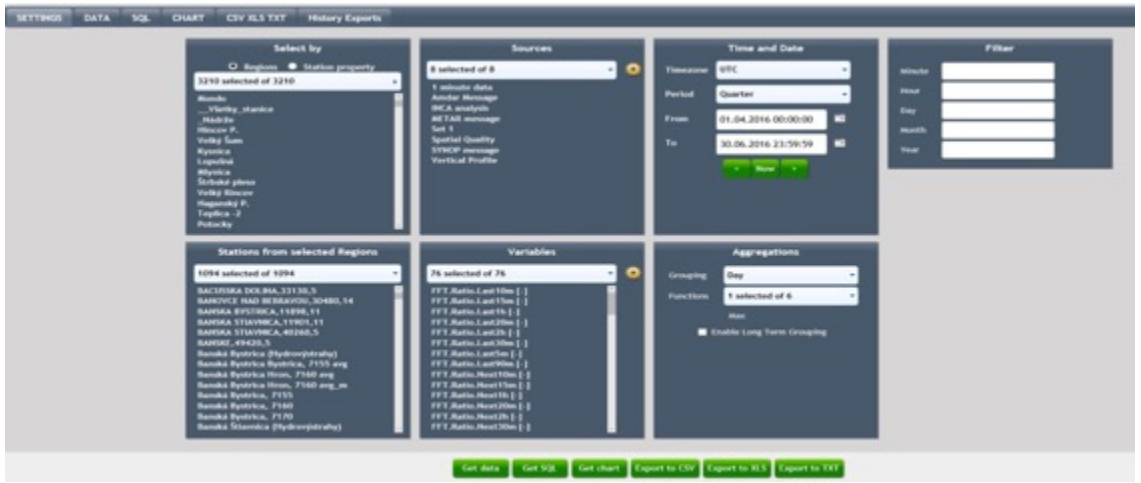
- Heart of the system
- Data from various sources in various formats – from weather and hydrostations, buoys, modelling systems
- Data tables in various formats (.csv, .txt, Microsoft Excel)
- Data charts in various formats (Microsoft Excel, .jpg, .png)
- Excel, PDF reports
- DQC (Data Quality control)
- Ability of manual control and change of data in DB. Automatic labeling of manually changed values
- Selection and grouping tools
- Reports, statistics
- Import of data from external sources – other DBs



Data flow scheme



Manual data entry



Data selection and aggregation

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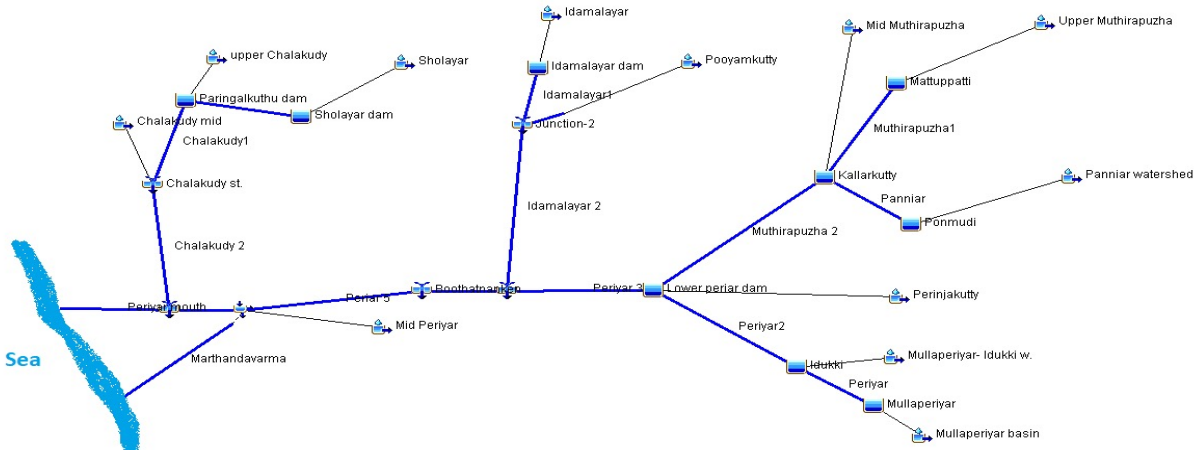
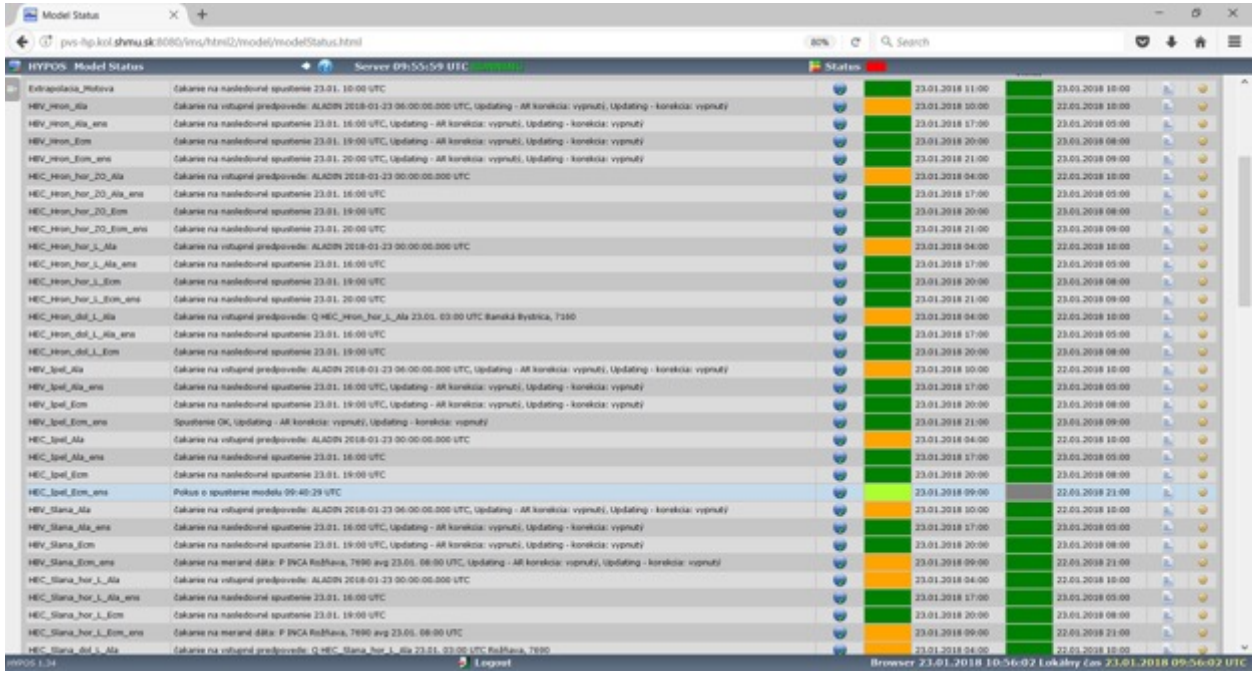
HYDROLOGICAL MODELING SYSTEM

- **Complexity** - combination of RR, HD, flow models and reservoir management models
- **Automatization** – all inputs and outputs are automatically processed by the system, no need of human input to comp. process
- **Actuality** – all data are available in the real time
- **Correctness** – automatic QC on input and output
- **Visualization** – overview of inputs and outputs is available in the form of tabs, graphs and maps



System of hydrological models – RR+flow model in the watershed network scheme (HEC-HMS)

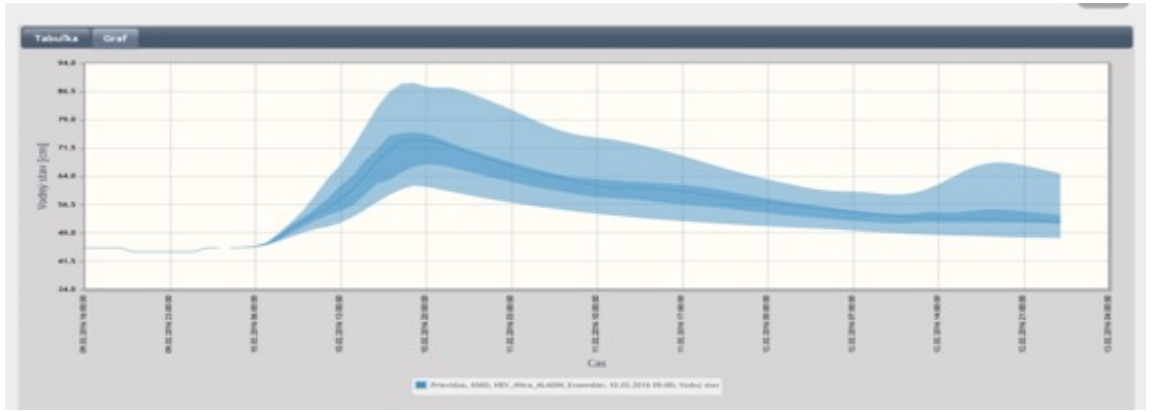


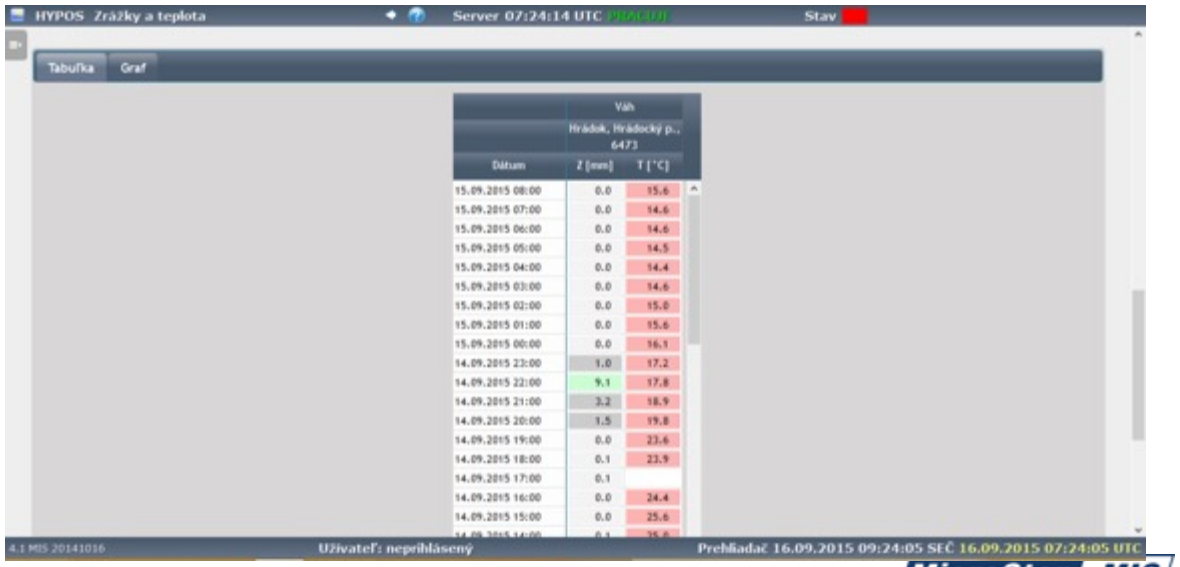
Model inventory: operator has overview of actual status of models

Outputs of modeling system

DATA VISUALIZATION

- In the form of tabs, graphs and maps
- **Map server**
- OGC Web Services
- Station data layer
- Forecast layer
- Meteo data layer – gridded data (models, radars, satellite images)
- Topographic data
- Soil properties data
- Geographic data
- “Movie” mode





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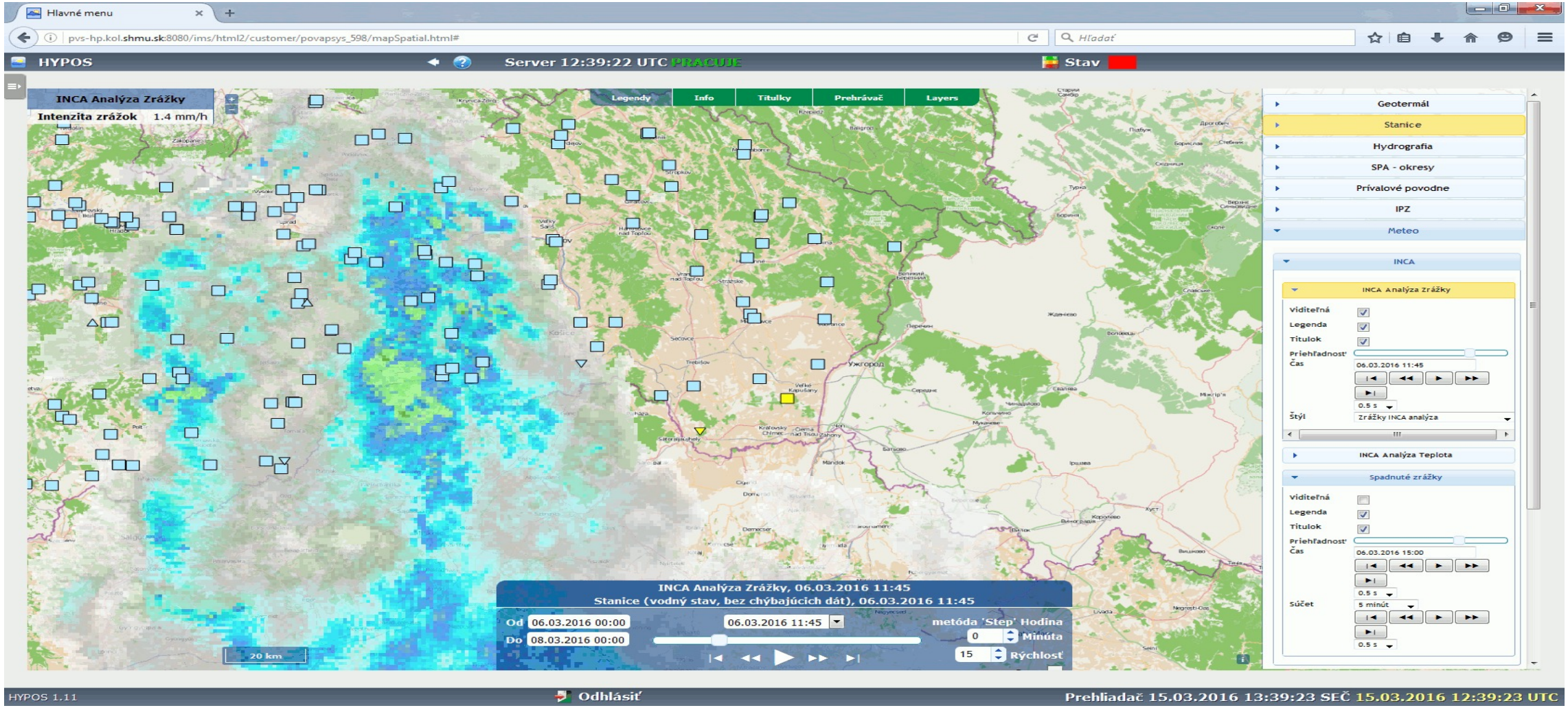
HYPOS MAP SERVER - ANIMATIONS



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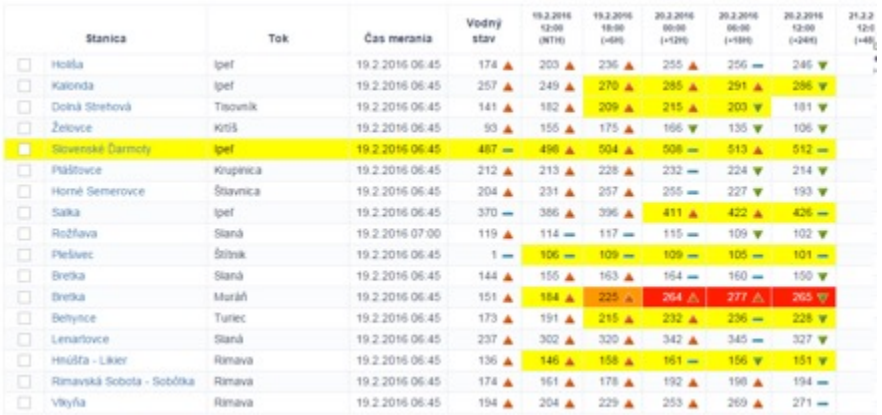
USING OF THE OUTPUTS OF MODEL SYSTEM

- Hydrological forecasts for public – Hydromet institutes, responsible organisations
- Hydro forecasts for partner institutions
- Comercial forecasts (insurence comp.)
- Hydrological warnings (for public, partner, commercial)
- DSS (Decission Support system) – management of reservoir operation
- Sharing of info via:
  - ➢ internal links (ftp),
  - ➢ public links (internet),
  - ➢ standard media (TV, radio, newspaper)
  - ➢ Mobile apps



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