Application of ALADIN/AROME at the Hungarian Meteorological Service

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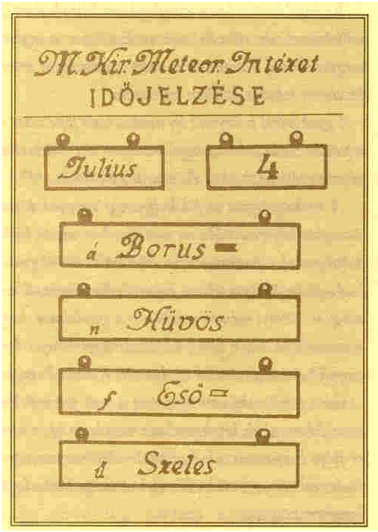
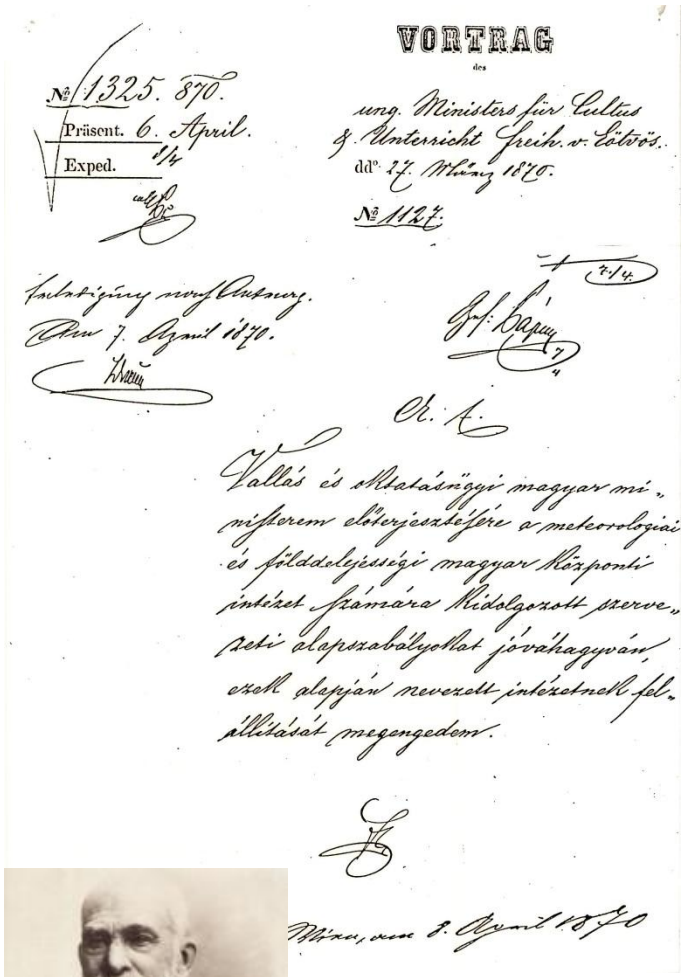
Host presentation at the ALADIN 20th General Assembly
9–10 February 2016, Budapest, Hungary

Alapítva: 1870

Short history

established as Royal Hungarian Institute for Meteorology and Geomagnetism in 1870, 8 April





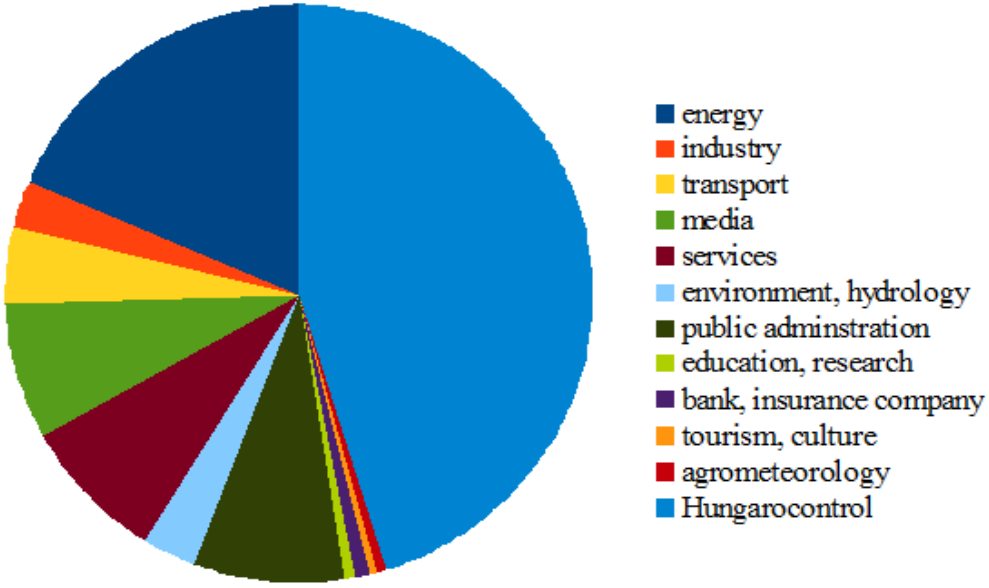
Early years

1870 establishment
1891 first daily reports
1900 about 1400 station
1910 today's central building
1925 upper air observation

in 1870 by Franz Josef I.

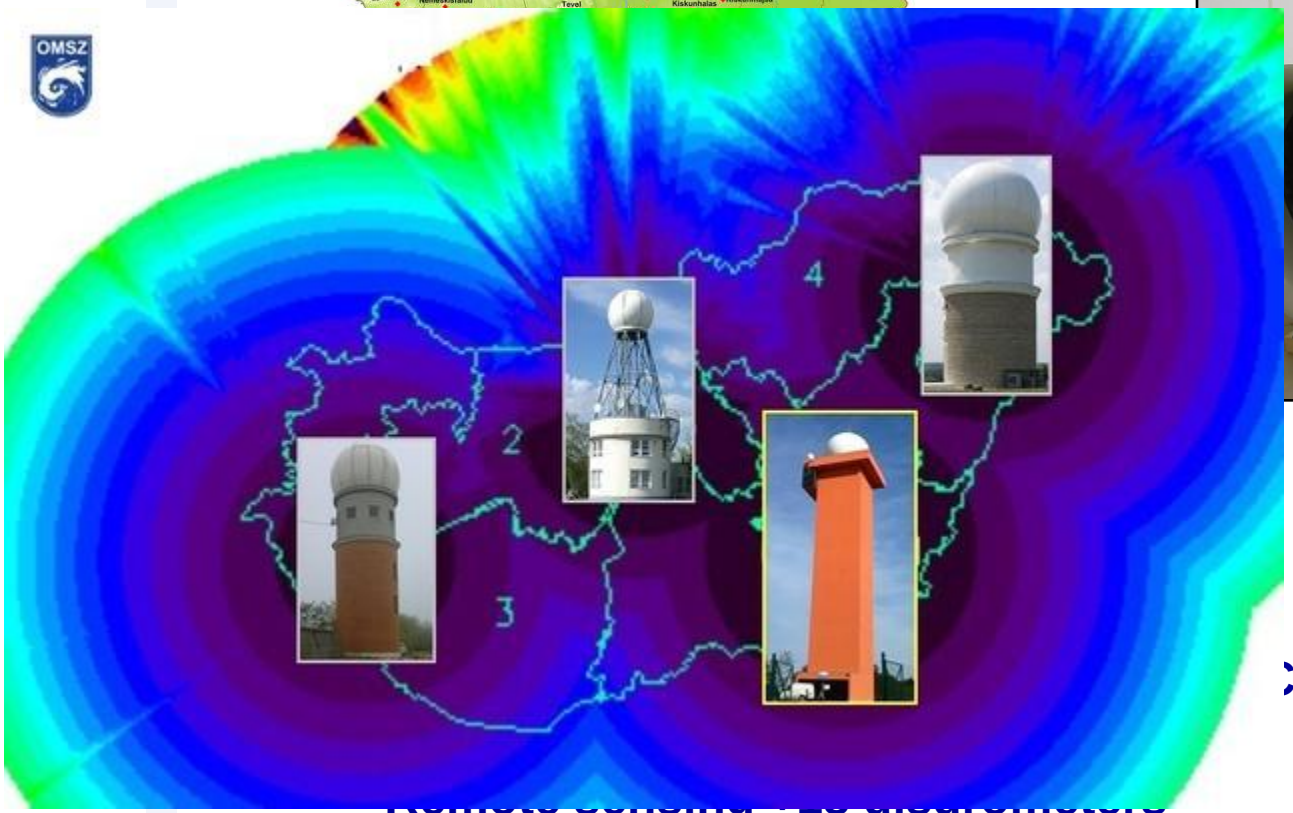
Governance

- under the Ministry of Agriculture since June 2014
- total budget 7 380 000 EUR
- number of staff 195, state budget support 34% in 2015
- current pursuits: full membership to ECMWF and acceptance of the act on meteorology



Observations

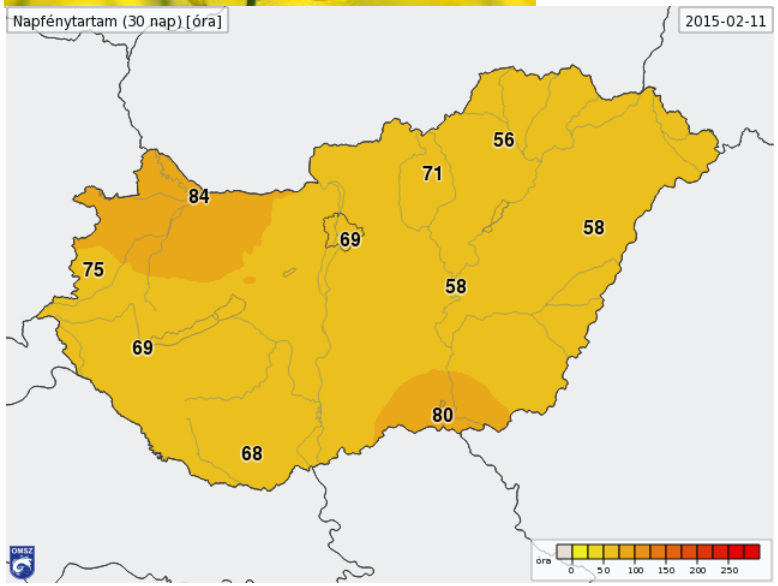
Surface observations



Calibration

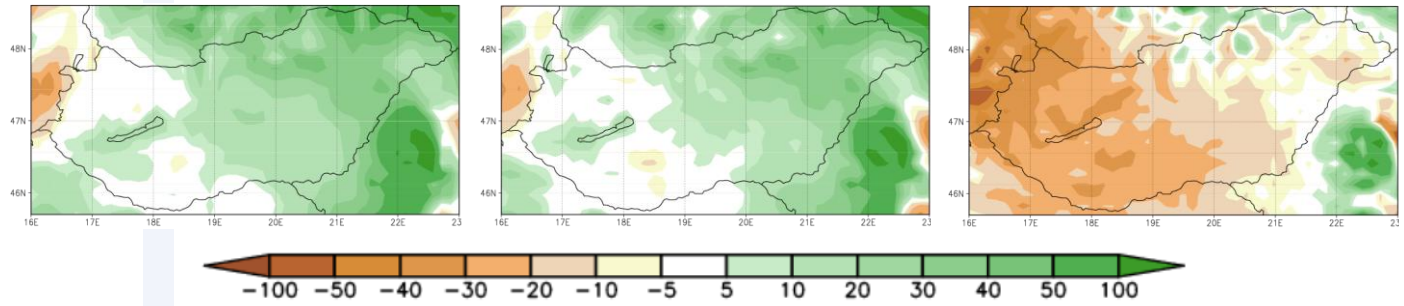
Activities: weather, climate and air quality

Sunshine duration for 30 days



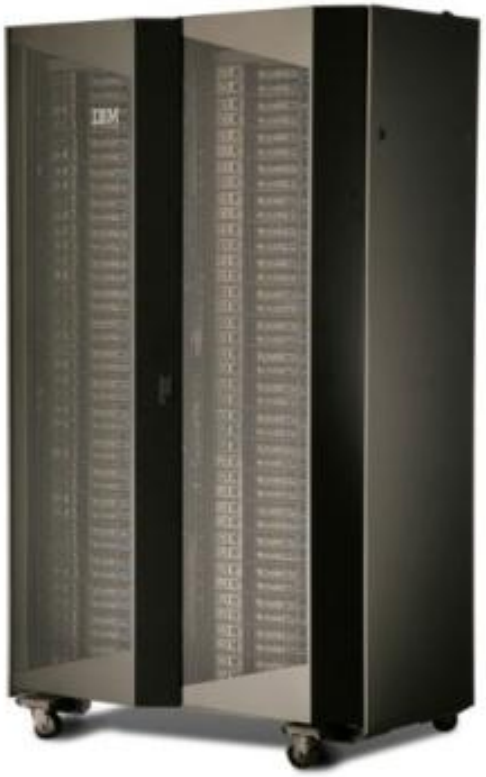
- **Weather forecasting and warnings:**
  - Agriculture
  - Aviation: Hungarocontrol
  - Highway/motorway operation
  - Energy sector
  - Insurance companies
- **Support to climate adaptation:**
  - Climate database, MISH/MASH
  - interpolation method developped at OMSZ
  - Aladin-Climate and REMO study climate change characteristics

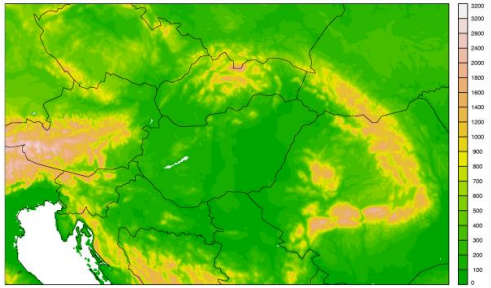
HARMONIE-Climate 15 km | **HARMONIE-Climate 6 km** | **ALADIN-Climate 10 km**

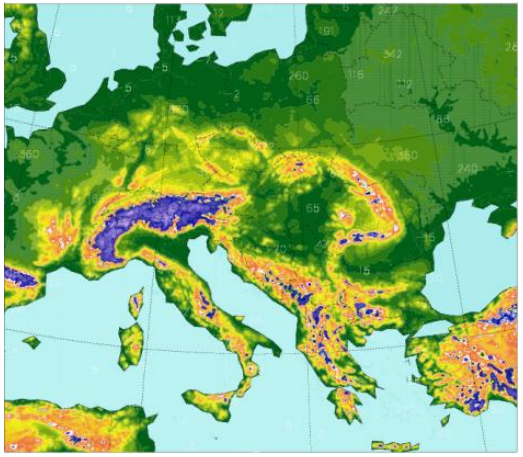


- **Air quality services:**
  - Air Quality Reference Centre
  - Air Quality Modeling
  - Greenhouse Gas Inventory

Operational ALADIN/AROME NWP system







	AROME	ALADIN	ALADIN-EPS
h	2.5 km	8 km	8 km
	60	49	49
	500x320	360x320	360x320
s	ECMWF deterministic (1h coupling)	ECMWF deterministic (3h coupling)	PEARP (6h coupling)
	00 (+48h), 06 (+39h), 12 (+48h), 18 (+39h)	00 (+54h), 06 (+48h), 12 (+48h), 18 (+36h)	18 (+60h)
	3 hourly (SYNOP, TEMP, AMDAR)	6 hourly (SYNOP, TEMP, AMDAR, SEVIRI, AMV, ATOVS)	-
	-	-	11

IBM iDataplex supercomputer

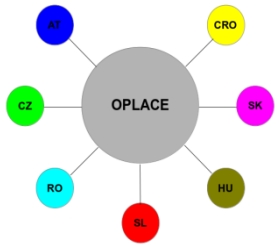
560 cores

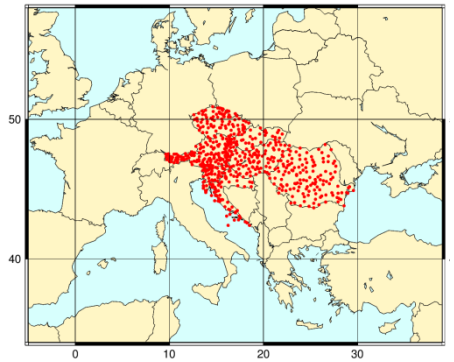
since December 2010

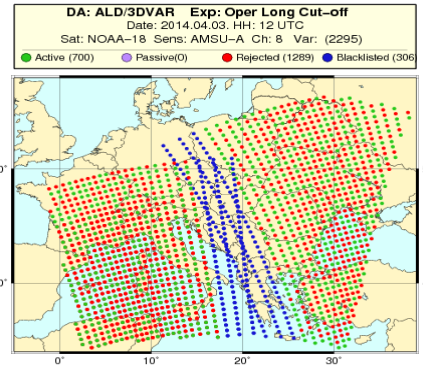
Data assimilation activities

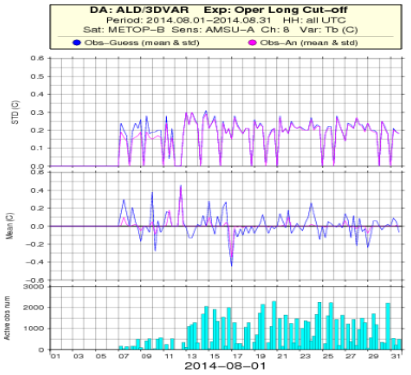
- **Common research plan and collaboration** with ALADIN/HIRLAM and closely with LACE countries

- Observation pre-processing for LACE countries (**OPLACE**) i.e. common pre-processing, maintenance and e.g. migration issues of the observations. **The system is running at OMSZ.**





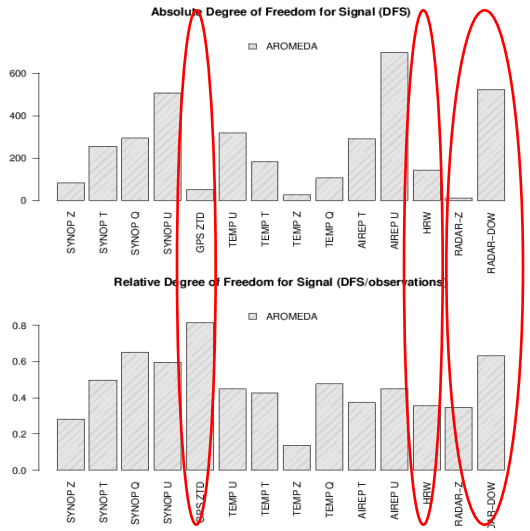




- AROME DA system is developed more extensively than ALARO.

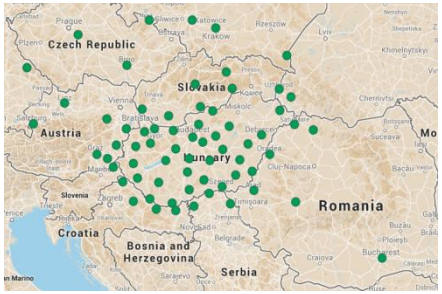
- **Main areas of developments:**

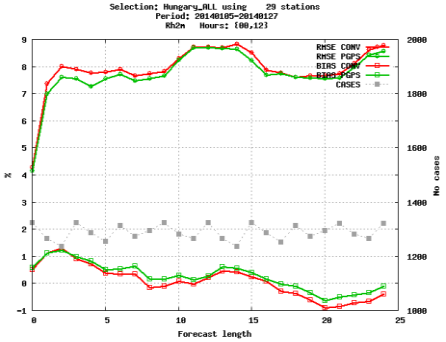
  - Rapid Update Cycle approach 3 hourly → 1 hourly
  - Surface assimilation using Extended Kalman-Filter
  - The use of non-conventional observations:
    - GNSS Zenith Total Delay
    - RADAR reflectivity and radial wind
    - Meteosat radiances and AMVs

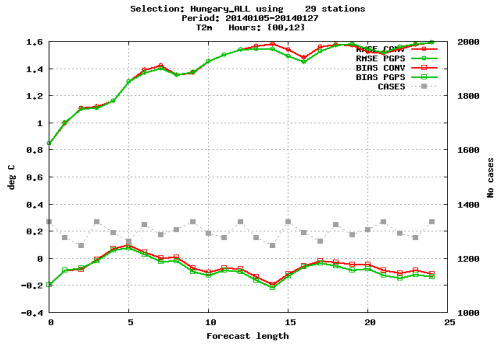


Data assimilation activities

- **GNSS Zenith Total Delay** – EGVAP Network SGOB (Satellite Geodetic Observatory Penc) provides good coverage of ZTD measurements for AROME-Hungary



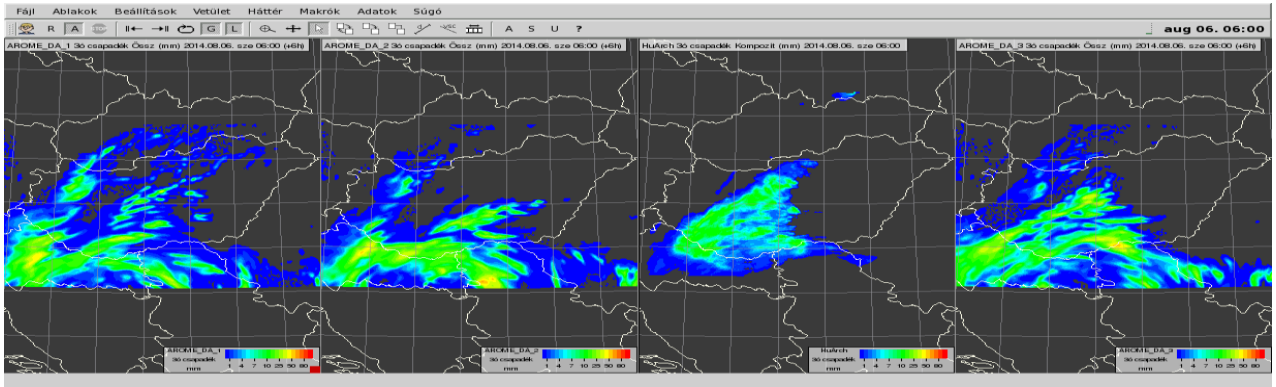




RMSE-BIAS

OPER – Red
GPS – Green

- **Meteosat SEVIRI radiance and AMV observations** are experimentally assimilated in AROME DA system. Two types of AMVs have been tested, the standard MPEF or Geowind AMVs and the NWCSAF produced High Resolution Winds AMV as well.

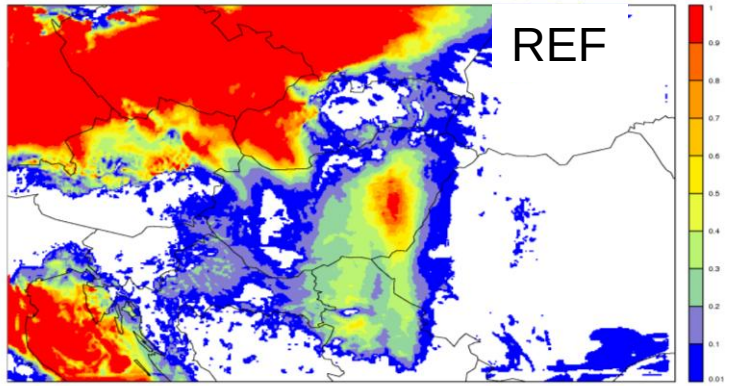


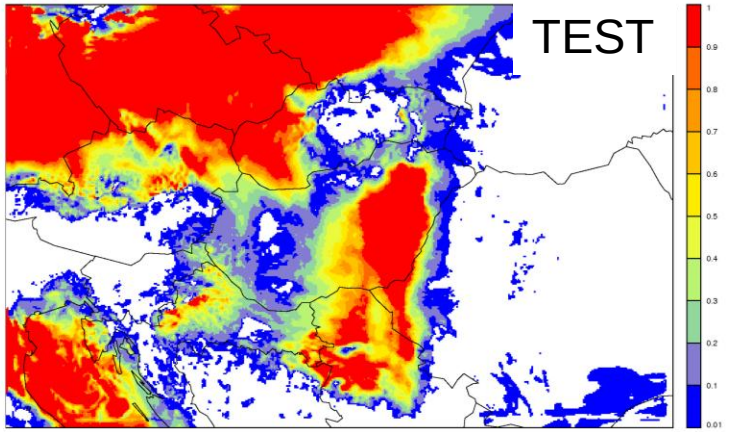
3h AROME/Hungary precipitation forecasts for 6th of August, 2014. 1.panel: Without AMV, 2.: with MPEF AMV, 3.: RADAR observation, 4.: with HRW AMV

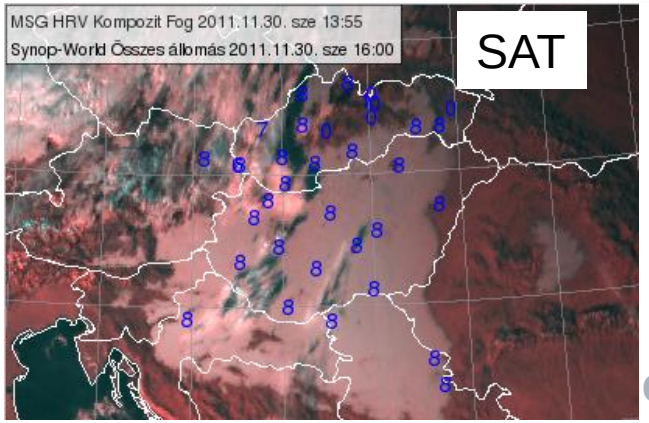
- **RADAR reflectivity and radial wind observations** from the RADAR network of OMSZ are under investigation in AROME DA system.

Microphysics developments in AROME

- Stratus cases: winter anticyclonic cases; low mixing, fog is formed during the night, which does not dissolve during the day, elevates and forms a stratus layer
- The cloud top radiates out considerably → CTT can decrease even during day → condensation at cloud top → fog elevates
- Complex process: radiation, turbulence, microphysics
- Operational models often give wrong forecasts (too less low clouds)
- By increasing the critical value for autoconversion → snowfall decreases → stratus does not dissolve



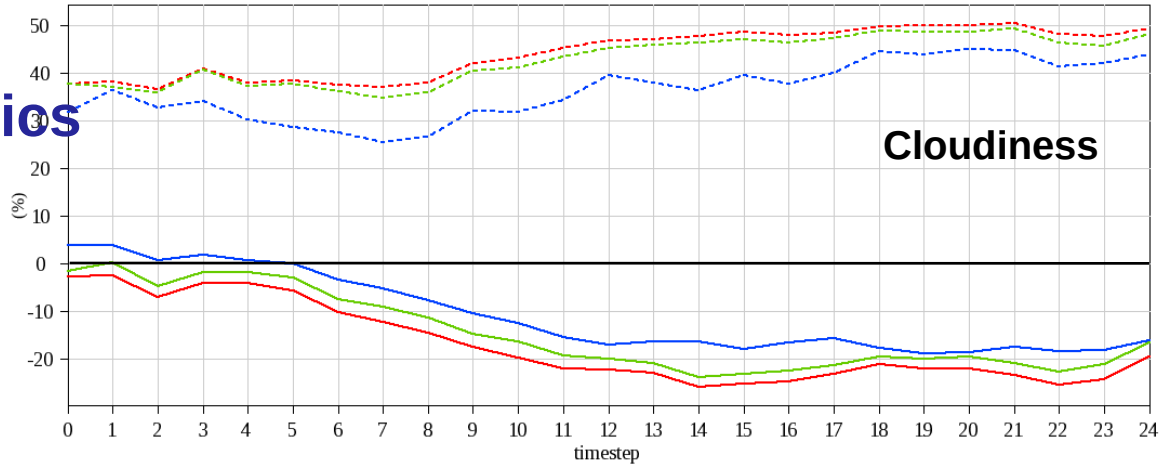


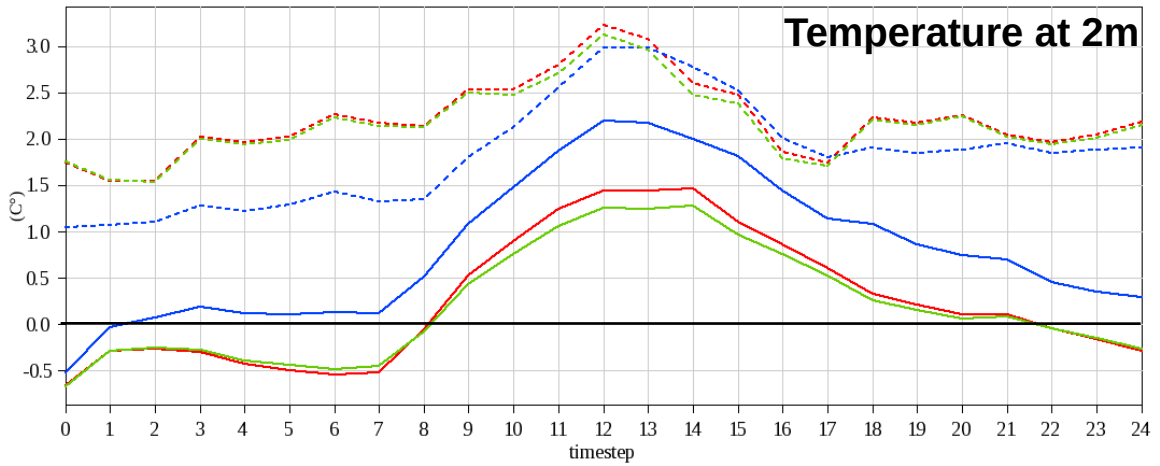


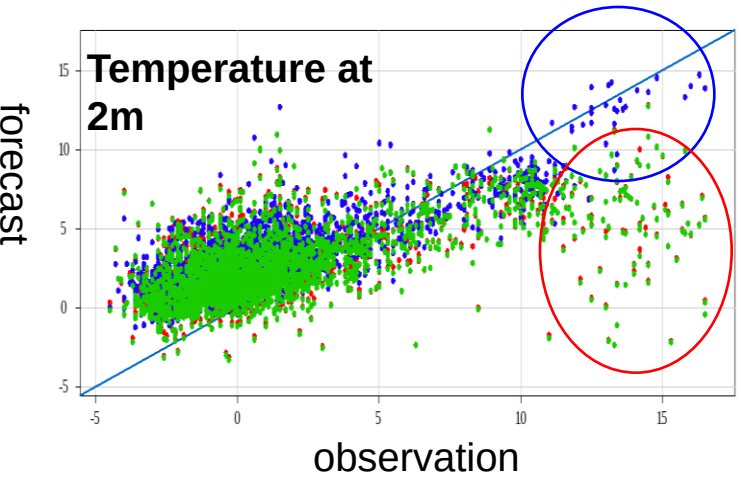
Experiments with modified microphysics in AROME

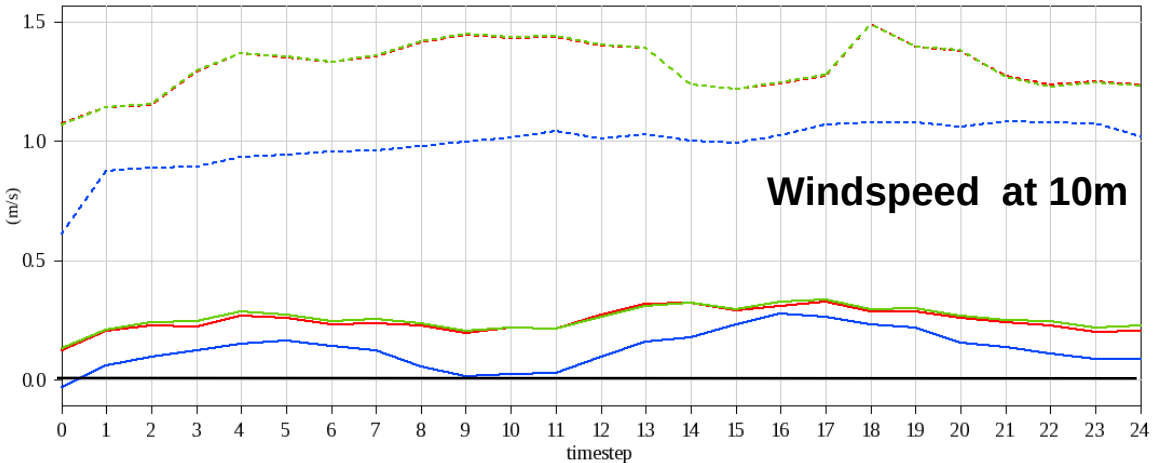
- OCND2: mods by Karl-Ivar Ivarsson + AUTIS: mods by Balázs Szintai
- Winter period (anticyclone → fog, stratus): 18/11/2011 – 02/12/2011
- Each day 00 UTC +24 h forecasts

– reference run
— BIAS **– AUTIS only**
---- RMSE **– OCND2 (+ AUTIS)**



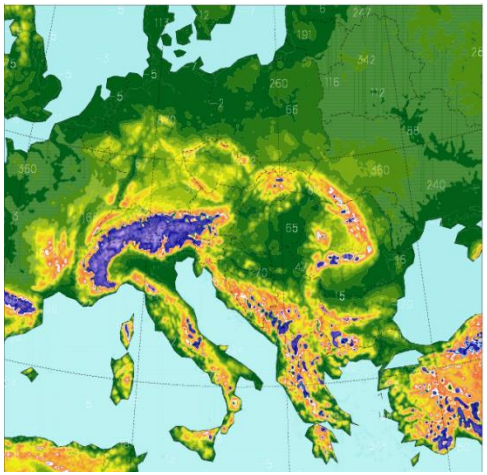


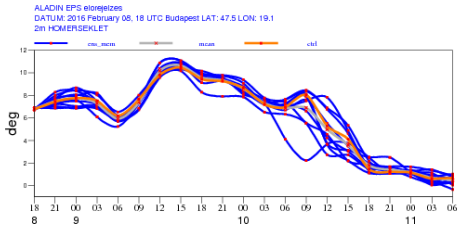


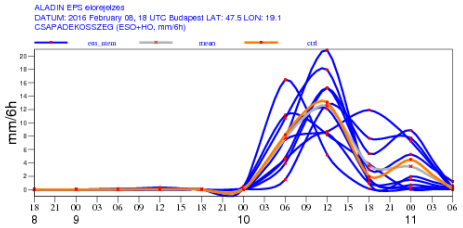


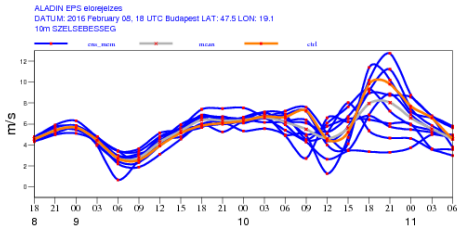
Operational LAMEPS at OMSZ

- Our **current LAMEPS:**
  - contains **11 members**,
  - runs for +60hours every day once at 18UTC,
  - the dynamical downscaling of the French ARPEGE-EPS (**PEARP**),
  - based on **ALADIN** model (with **ALARO** physics),
  - runs with **8km** horizontal resolution in **hydrostatic** mode.
- **Developments** in test phase:
  - LBCs from **ECMWF ENS**,
  - Ensemble Data Assimilation (**EDA**) system for the better IC perturbations,
  - Stochastically Perturbed Parametrized Tendencies (**SPPT**) method for the better model error estimation.



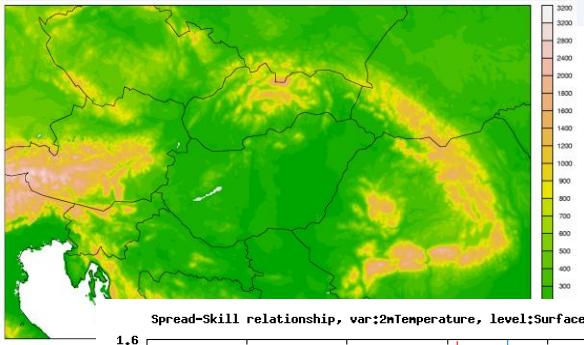


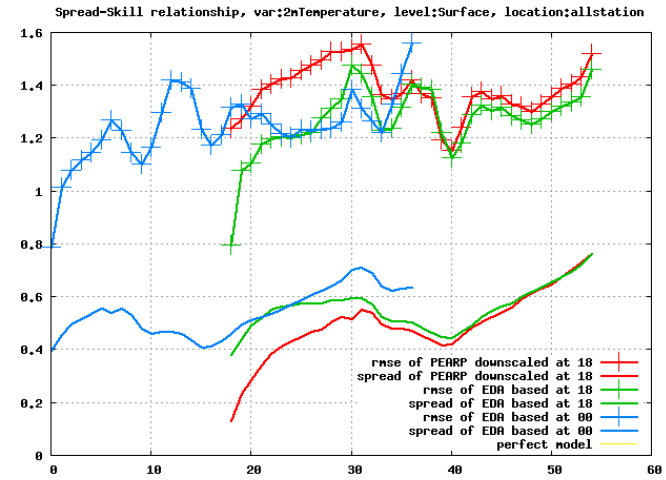


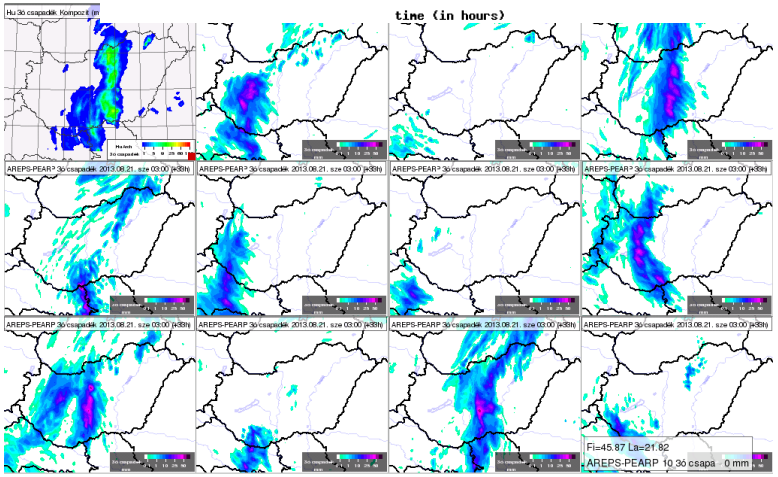


Convection-permitting test EPS

- Our **test LAMEPS:**
  - contains **11 members**,
  - runs for +36-48 hours,
  - based on **non-hydrostatic AROME** model,
  - runs with **2.5km** horizontal resolution
- **Developments and tests** in the new system:
  - LBCs from ARPEGE-EPS (**PEARP**) or from **ECMWF ENS**,
  - **EDA** for the better IC perturbations, **SPPT** for the better model error estimation,
  - evaluation of the **probability products** of a convction-permitting system.



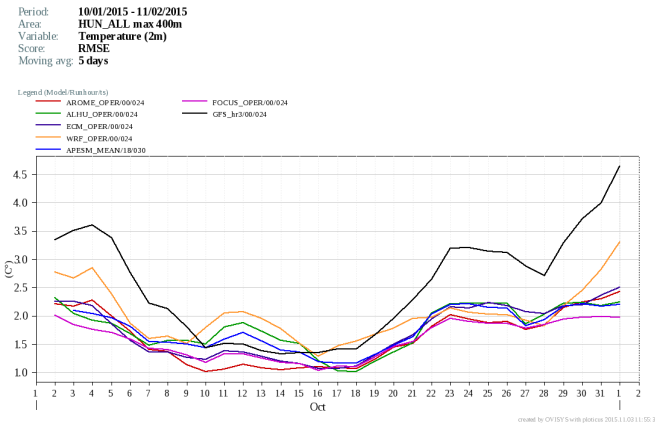


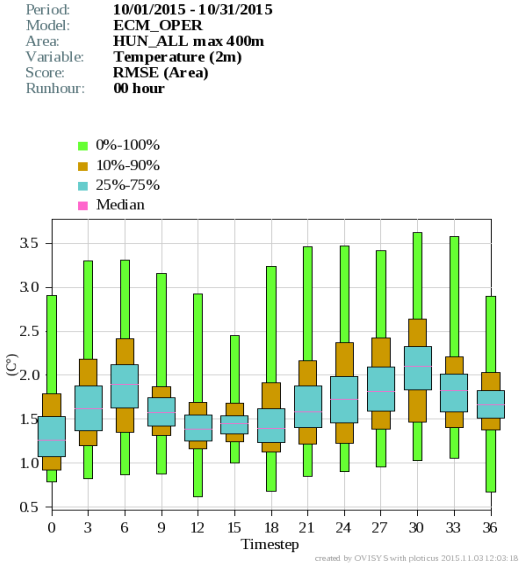


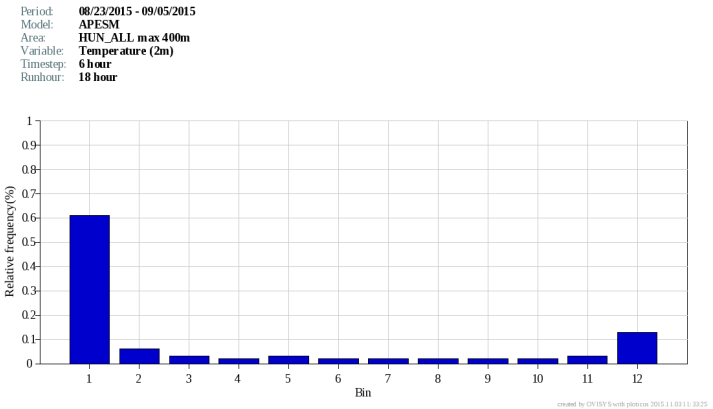
Verification

Objective VerIfication SYStem

- 8 operational models and many experiments
- Standard system (C language)
- Same file format and construction for all models and observations (NetCDF)
- Ploticus plotting system and GMT
- Verification based on points or areas
- Many figure types: time-t, time-ts, scatterplot, map, PDF, threshold figure type, contingency table, etc.
- EPS verification (base methods and scores)
- Web page for easy manageability







Visualisation at OMSZ

Own developed systems for maps and diagrams: HAWK

Current version: HAWK-3

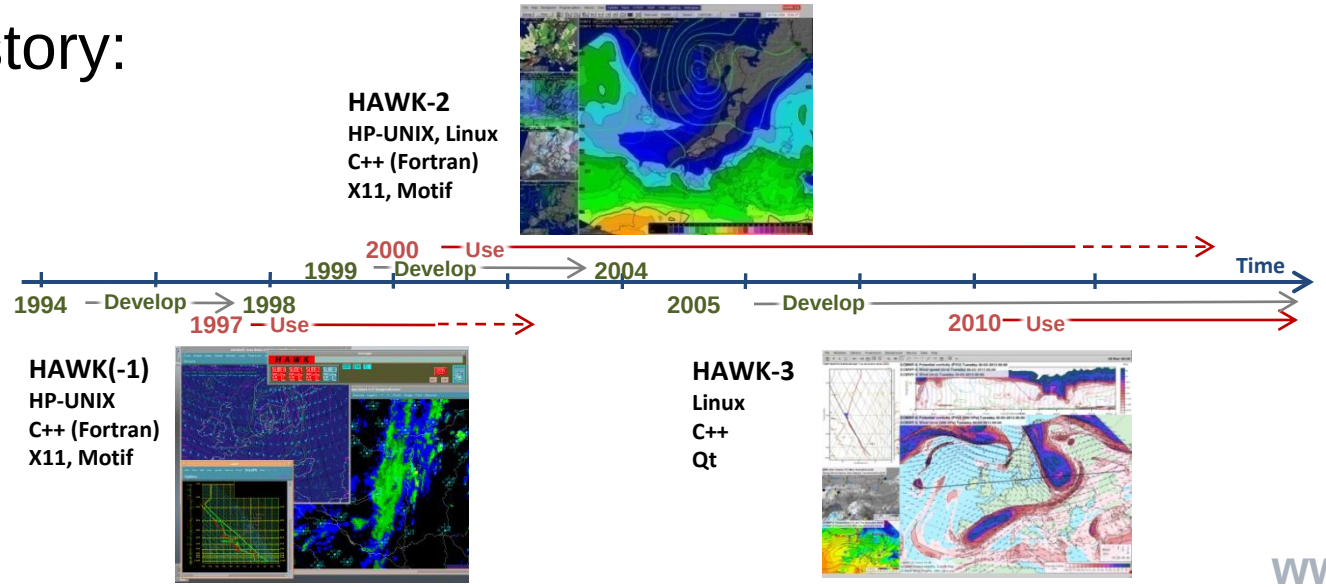
Written in C++, Qt – runs: Linux on PC & workstation

Purpose: - basic forecaster tool

- for research (case studies, publications)

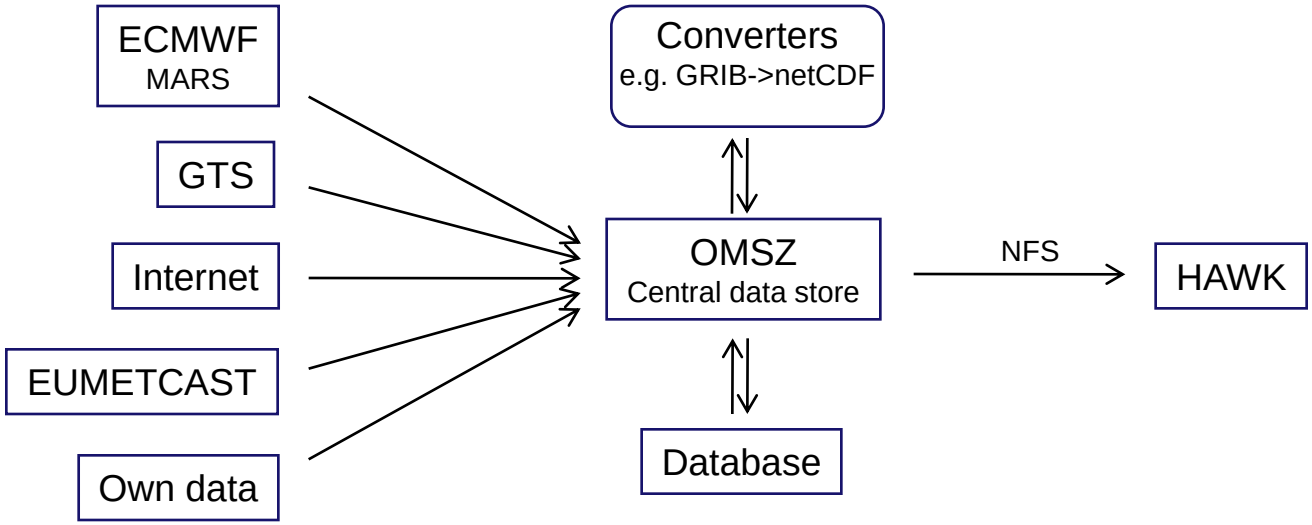
- automated image generation (to the web)

History:



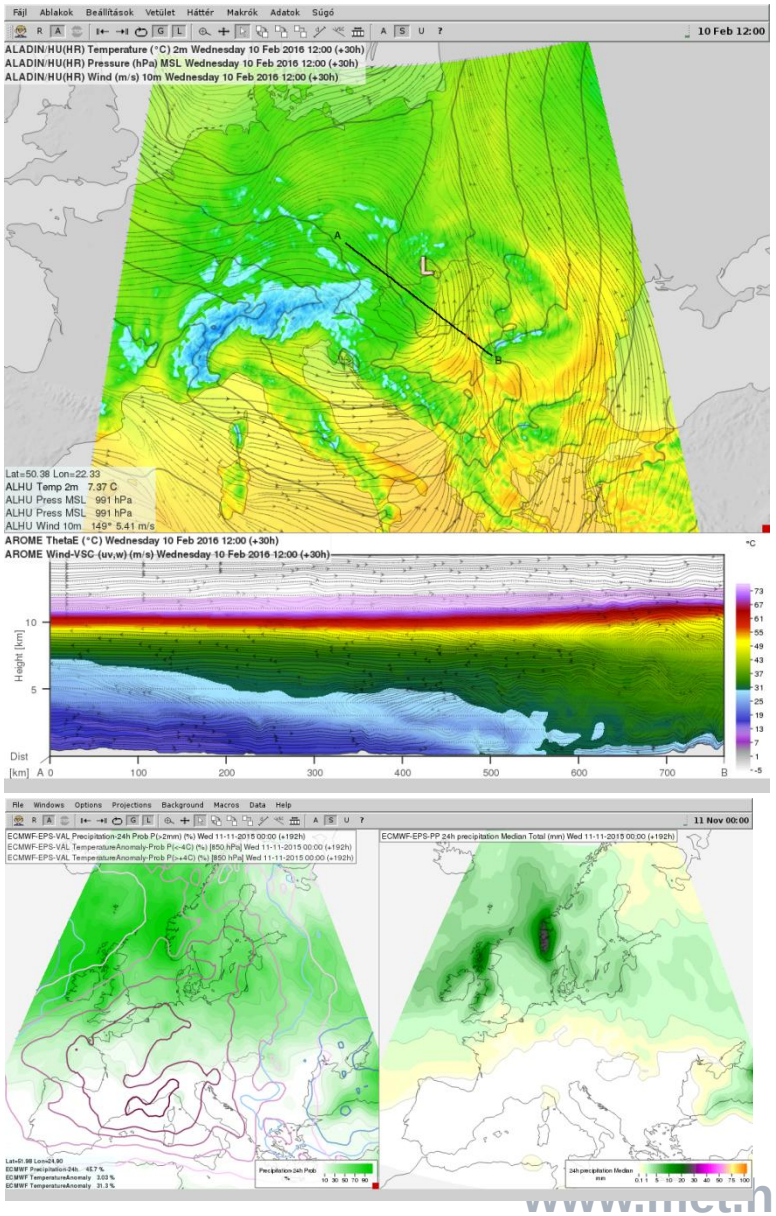
Visualisation at OMSZ

- Standalone visualising software (no database, no interoperability)
- Simple files as input (netCDF, GRIB (grib_api), HDF-5, simple binary, text, BUFR)
- Various data types (grid, satellite, radar, SYNOP, radiosonde, AMDAR, lightning, frontline, SAF-NWC prods, images, trajectory, SIGWX)



Visualisation at OMSZ

- Various drawing modes
  raster images, contours, wind barbs, streamlines, numbers, texts, symbols
- Various views
  maps, vertical spatial & temporal section, thermodynamic diagrams, hodograph
- Data layer deriving
  Basic math operations, various functions
  → new variables
  → comparison of different NWP models
  → basic statistical fields of EPS members



Thank you for your attention!

Alapítva: 1870