Application and Verification of ECMWF Products 2021

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1. Summary of major highlights

It is expected that a more detailed description of any items included here will appear in section(s) below.

ECMWF products and products produced at ECMWF infrastructure (A-LAEF system) are the main source of information for preparation of medium and long range weather forecasts at SHMU.
In the case when our customer requires weather forecast for more than 72h ahead, we use ECMWF products as the main source to cover required forecast range.
We have developed the processing software to compute statistics over EPS data (quantiles, median, mean), and we produce our own EPS meteograms based on those statistics (see Figure 1). For this reason we download for some parameters all ensamble members.
ECMWF data are used as input for rainfall-runoff models in our hydrological forecasting department.
Air quality department uses ad-hoc ECMWF model data for their dispersion model.

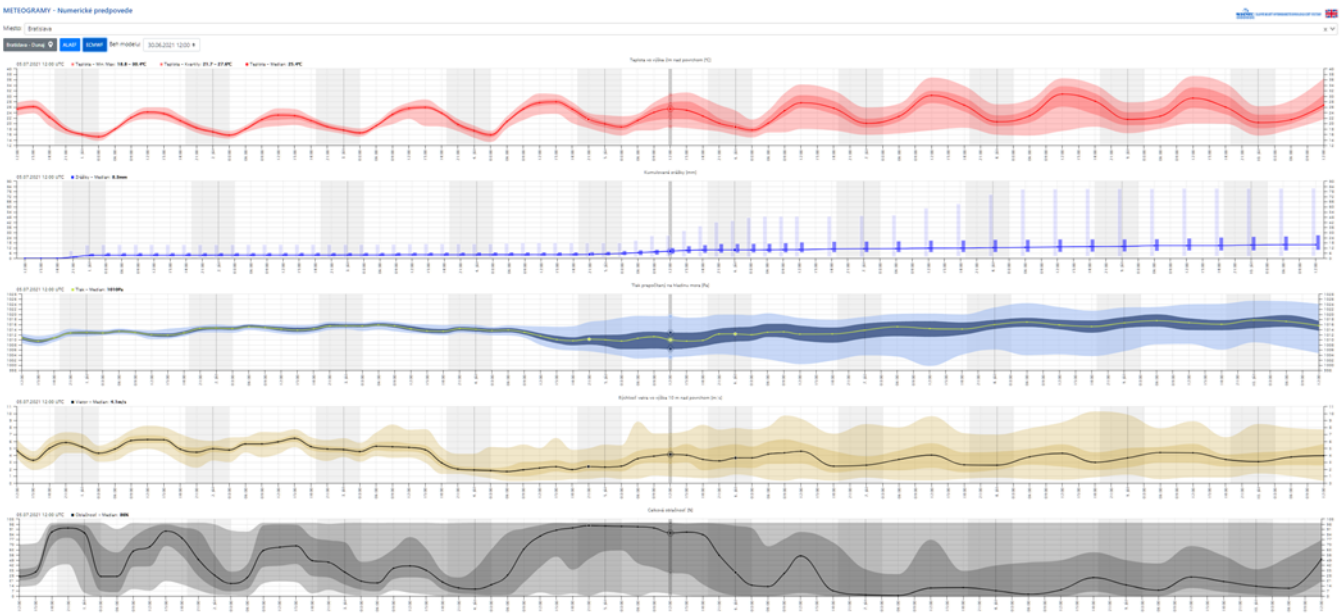

Figure 1

2. Use and application of products

Include, as appropriate, medium-range high-resolution (HRES) and ensemble (ENS) forecasts, monthly forecasts, seasonal forecasts.

2.1 Direct Use of ECMWF Products

Describe how ECMWF products are used directly in operational duties, e.g. for severe weather situations.

At this time (2021) we would particularly welcome comments on this recent ECMWF initiative:

- "Open Charts" products introduced in October 2020 (new web layout, free-to-access).

Our forecaster use:
a) basic HRES products at levels like 500, 700, 800, 850, 900, 925 hPa, MSLP, 10 m, 2m (geopotential, wind, temperature, humidity), cloud cover, precipitation maps, precipitation type, CAPE, wind shear,

lapse rate and other convection parameters – some of them are computed by software package Visual Weather
b) some ENS products – ENS meteograms, ENS means and spreads (mainly for temperature at different levels, precipitation amount), precipitation type, wind, probability of precipitation, ENS vertical profiles, EFI 2 m Maximum temperature, EFI precipitation
c) a few extended range products – weekly anomaly and weekly probability anomaly
Our forecasters do appreciate the product description below the EFI charts, and think, the "open charts" are great source of meteorological forecasts for people interested in meteorology but not as a professional forecasters.
From commercial point of view we did not notice any change as a result of "open chart" (decrease or increase of demands for ECMWF products from old or new customers) yet.

2.2 Other uses of ECMWF output

Describe the different ways in which you use ECMWF forecasts indirectly, in the following categories:

2.2.1 Post-processing

Statistical adaptation - include post-processing strategies for standard HRES and ENS output. Any details of products which are created using Artificial Intelligence (AI) and/or Machine Learning (ML) techniques would be particularly welcome at this time.

ECMWF HRES forecasts are used to generate specific products for our customers for the ranges longer than ALADIN/SHMU LAM forecasts (3 days). Those are mostly screen level data (temperature, wind, precipitation, cloudiness) for particular locations or regions. New software was developed to compute derived statistics from EPS products.

2.2.2 Derived fields

Include modified ENS output e.g. regimes, clustering, probabilities.

2.2.3 Modelling

Include limited-area models, hydrological models, dispersion models etc. that use ECMWF model data (HRES and/or ENS) as input (e.g. for initial conditions / boundary conditions etc.)

ECMWF HRES and ENS data are used by SHMU hydrological forecasting department as an input for hydrological rainfall-runoff models to compute the expected discharge for cca 200 river profiles twice per day.
Air quality department uses ad-hoc ECMWF model data as input for WRF model and results are input for CMAQ model
We also use operationally ECMWF deterministic forecast as LBCs for experimental convection permitting model at SHMU (2km resolution).
A-LAEF EPS system was developed in a frame of RC LACE cooperation. This system is running at HPC of ECMWF, is coupled to ECMWF ENS system, uses first 16 members as a source of LBC. Results are shared among RC LACE members and partners. Some results for Slovakia are published on our webpage (see Figure 2)

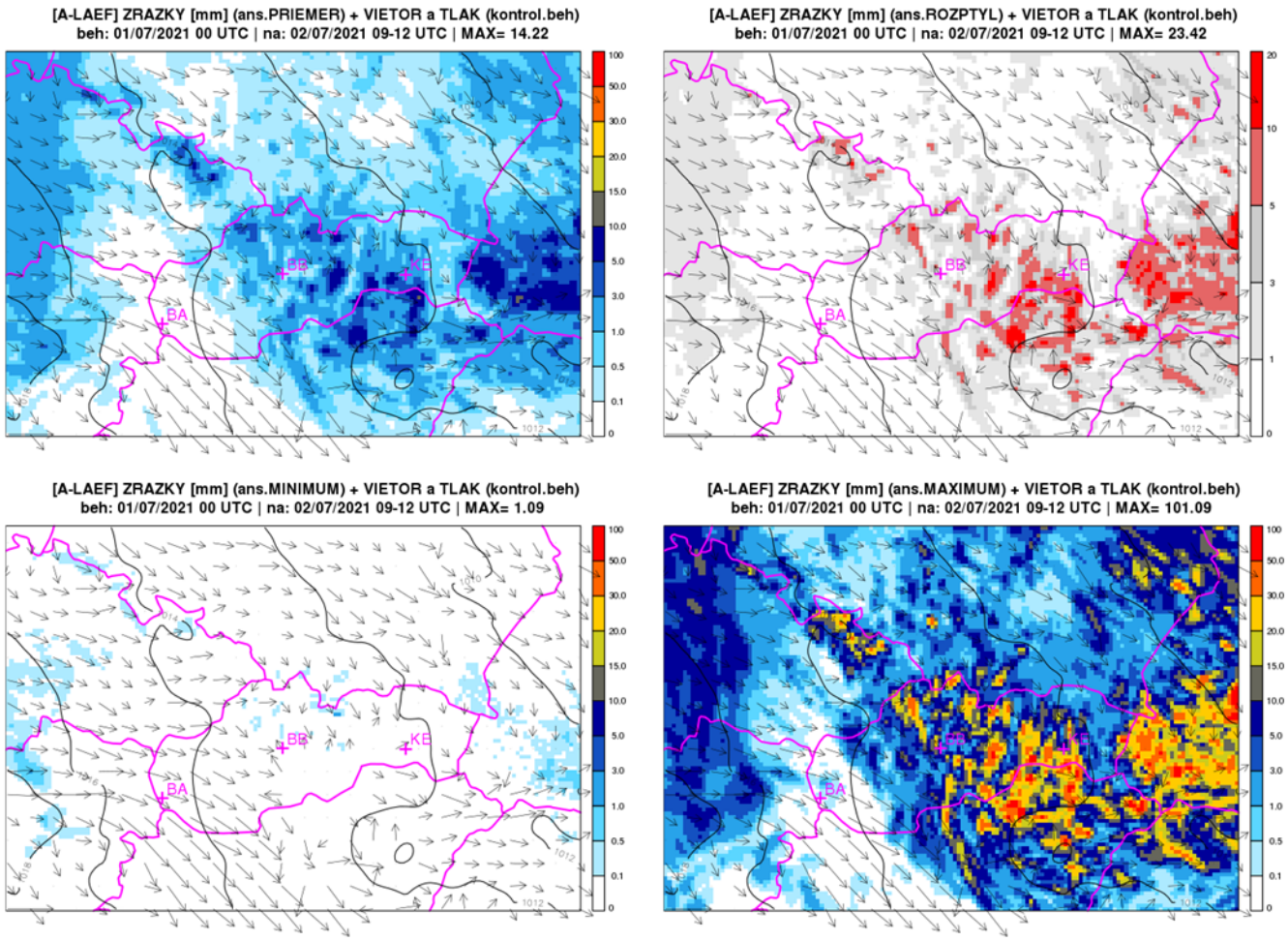

Figure 2

3. Verification of ECMWF products

HRES, ENS, monthly and seasonal forecasts are all within scope. ECMWF does extensive verification of its products in the free atmosphere. However, verification of surface parameters is in general limited to using synoptic observations. More detailed verification of these weather parameters by National Services is always valuable to us. We are most interested in results for the last 1 or 2 years.

At this time (2021) ECMWF would particularly welcome:

- Conditional verification results (e.g. 10m wind bias stratified by topographical aspects/cloud cover)
- Comparisons between ECMWF ENS and external LAM-EPS systems (for probabilistic forecasts)

3.1 Objective verification

Describe verification activities and show and discuss related scores.

3.1.1 Direct ECMWF model output (both HRES and ENS), and other NWP models

Focus on local weather parameters verified for locations that are of interest to your service, including comparisons, where possible, with other NWP models used by your service. For lead times up to day 15.

ECMWF deterministic forecasts are occasionally verified against the automatic weather station network over Slovakia for screen level parameters. The scores are compared with short-range high resolution LAM models operationally exploited by SHMU to check their overall performance. For the time being there are no regular verification activities performed. Active implementation of HARP verification system is ongoing, and we plan to include ECMWF EPS system into it (near future plan).

3.1.2 Post-processed products and end products delivered to users

e.g. Calibrated ENS probabilities, etc. For lead times up to day 15.

3.1.3 Monthly and Seasonal forecasts

Focus on lead times beyond day 15.

3.2 Subjective verification

3.2.1 Subjective scores

Include evaluation of confidence indices when available.

3.2.2 Case studies

Severe weather events/non-events are of particular interest. Include an evaluation of the behaviour of the model(s). Reference to major forecast errors, even if they are not in a "severe weather" category, are also very welcome.

LBC from ECMWF deterministic forecast were recently used for case studies and results submitted into Idojaras journal.

4. Requests for additional output

Include here any particular requests you may have for new or modified ECMWF products.

5. References to relevant publications

(Copies of relevant internal papers may be attached)

Smith, W. and **C. Jones**, 2005: Whatever the name of the article is. *Mon. Wea. Rev.*, **20**, 134–148