Application and Verification of ECMWF Products 2019

This report should be a maximum of 6 pages and reach ECMWF by the **31 July 2019** via email to Sue Dunning (sue.dunning@ecmwf.int).

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1. Summary of major highlights

The ECMWF products are used extensively in the operational work of LEGMC in fields of meteorology and hydrology, as well as in the frame of climatological analysis. ECMWF model output data are integrated in forecaster workstation SmartMet (FMI), where analysis and editing (half-automatic post processing) of information is done, followed by generation of products for clients. For hydrological purposes, data is used in the hydrological model HBV and the hydrological simulation and forecasting system WSFS. Data is assembled and visualized in the internal web portal. Furthermore, ECMWF website and ecCharts are used for general analysis, quick data overview and specific products. Yearly, quarterly and monthly verification results of ECMWF products for average air temperature, average wind speed, maximum wind gusts, precipitation, relative humidity and visibility have been added. Additionally, direct comparison between ECMWF and HIRLAM/HARMONIE (FMI) verification results has been provided.

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

Direct ECMWF products from website and ecCharts are used for general overview of synoptic situation and as source of information for products not provided in forecaster workstation (for instance EFI, some probabilities products). In the beginning of warm season 2019 forecasters' attention were focused on possibilities to use new products available on website and ecChars, especially vertical profiles.
Direct products from ECMWF website and ecCharts are used as back up source of information for the critical products to be provided to clients in cases of local technical issues (included in training exercises).

2.2 Other uses of ECMWF output

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

The ECMWF output are the basis for LEGMC medium-range meteorological and hydrological forecasts for up to 14 days, and the only data source used for long range forecasts (up to 12 months ahead), Intensively used for short-term forecasts together with HIRLAM and HARMONIE models outputs.

2.2.1 Post-processing

For operational purposes, ECMWF model data outputs from HRES, EPS and HRES-WAM are routinely provided to forecasters work station, where it is analysed together with observational data (ground observations, soundings, satellite and radar data), climate data and other available models (for instance GFS) and edited for a period of up to 10 days. Maps, time series and vertical cross sections are used for a wide range of hydrometeorological parameters. Forecasters are not only provided with the single level (ground level) data – they also have access to pressure level and model level data. From these data sets, stability indexes, wind shear and other parameters are calculated.

Together with HIRLAM and HARMONIE data (provided by FMI) ECMWF data is extensively used for short-range forecasts and warnings for both meteorological and hydrological phenomena. ENS is the only source of probabilities for our products at the moment. ECMWF Extreme forecast index and ENS clustering and plumes products are used from ECMWF web page and are partially available in our internal web portal.

At the beginning of winter, ECMWF data (mainly air temperature and precipitation) is used to predict the formation of ice cover in rivers, while in spring, forecasts are used to predict ice break-up, maximum levels and discharges of spring floods.

2.2.2 Derived fields

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

Ensemble mean and probabilities of defined thresholds are calculated for a wide range of parameters (e.g. air temperature, maximum wind gusts, total precipitation, snow fall and snow depth, total cloud cover and cloud base height). Information is accessible to forecasters in their work stations for further editing of data and generation of products.

For extended and long-term forecasts, air temperature and precipitation ensemble means, anomalies and terciles are provided to forecasters together with climate data from LEGMC observational stations in the form of maps, graphs and tables.

In various climatological analysis at LEGMC besides historical observations also ECMWF climatological reanalysis data is used. In studies mainly are used ERA-Interim daily fields for surface level, yet recently also ERA5 data for different model levels was taken into account while analysing wind speeds.

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 (daily average air temperature and sum of the precipitation) is used by the hydrological model to simulate river runoff for the next 14 days and twice a week LEGMC performs such simulation for the next 4 weeks. Since 2018 a 12 months hydrological simulations are prepared based on ECMWF seasonal forecasts (SEAS5).

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 particularly valuable.

At this point in time (2019) ECMWF would particularly welcome:

- Evaluation of systematic errors in near-surface parameters
- Evaluations related to visibility, humidity, clouds, precipitation type
- 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

Verification of ECMWF HRES model runs at 00 and 12 UTC is performed yearly and quarterly (January-March, April-June, July-September, October-December) for a time period of maximum 228 h (lead time). Verification methodology used for the continuous forecasts of average air temperature, average wind speed and maximum wind gusts consists of calculating mean error (ME), mean absolute error (MAE) and root mean square error (RMSE), while for the dichotomous forecasts of precipitation, false alarm ratio (FAR) and probability of detection (POD) methods were used.

Verification results are presented by parameters – average air temperature (Fig. 1), average wind speed (Fig. 2), maximum wind gusts (Fig. 3), precipitation (FAR - Fig. 4; POD – Fig. 5) and visibility (Fig. 6).

A data point at the i^{th} lead time hour represents all data between *i-1* hour (included) and i^{th} hour (not included).

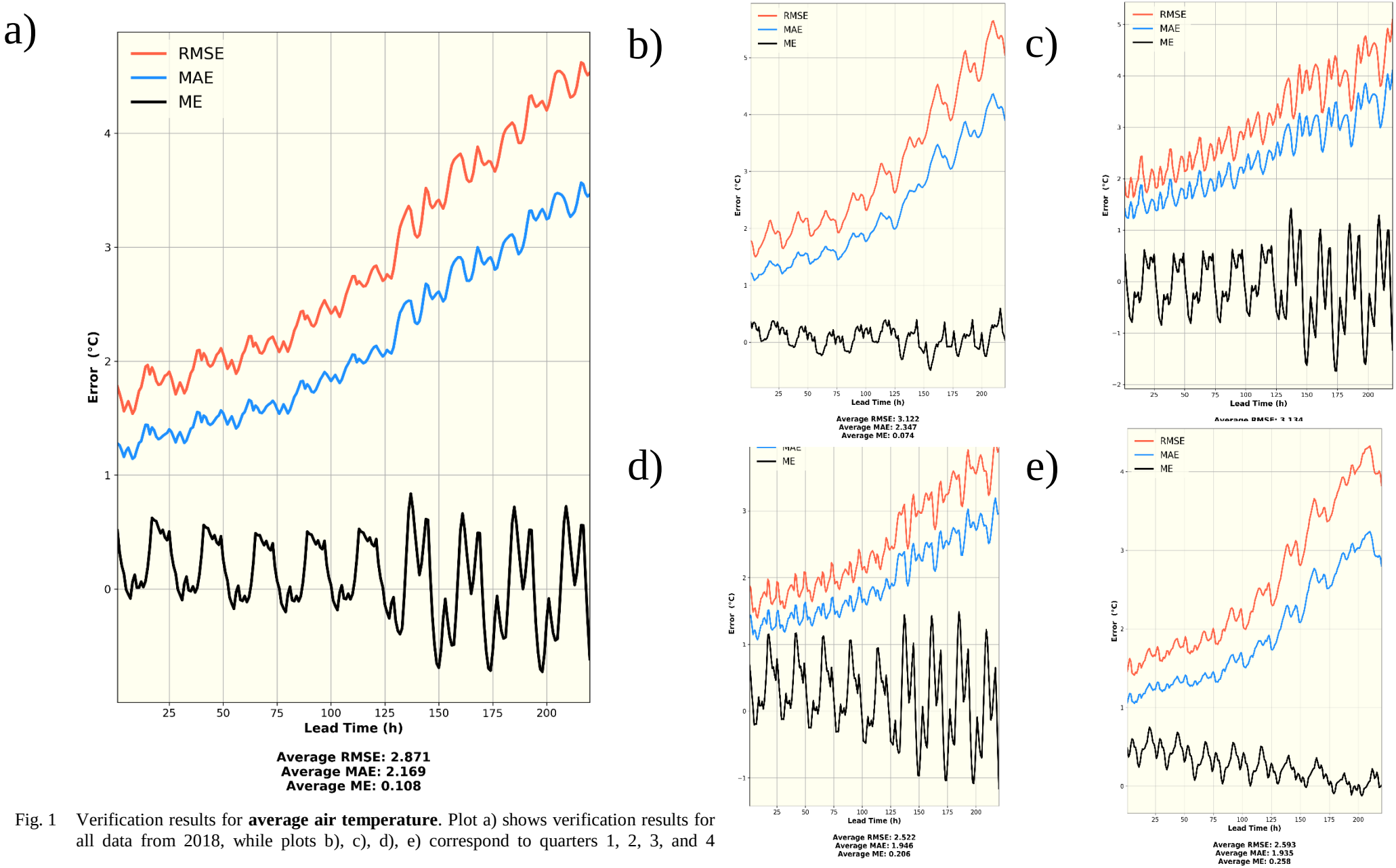

Fig. 1 Verification results for **average air temperature**. Plot a) shows verification results for all data from 2018, while plots b), c), d), e) correspond to quarters 1, 2, 3, and 4

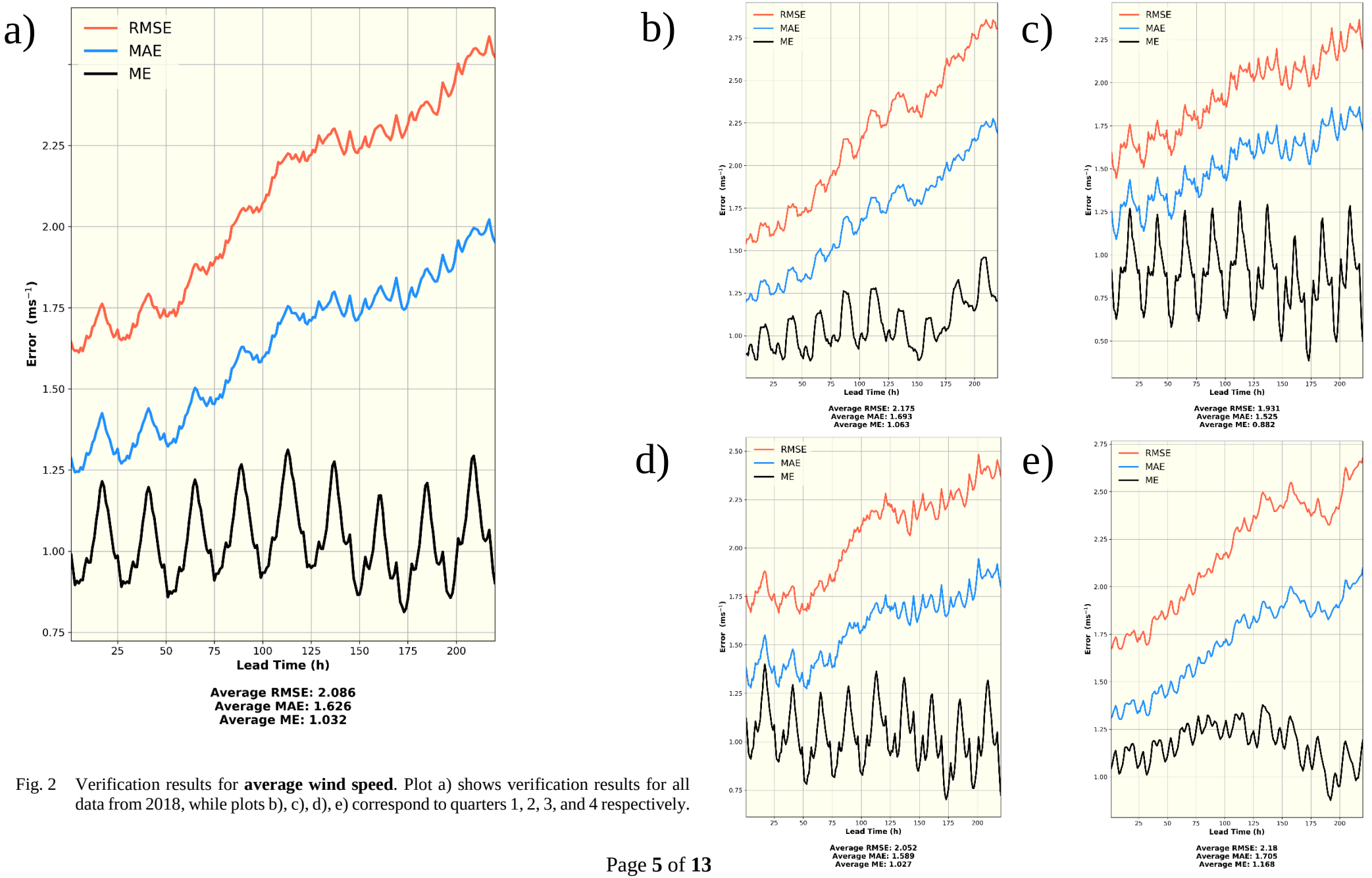

Fig. 2 Verification results for **average wind speed**. Plot a) shows verification results for all data from 2018, while plots b), c), d), e) correspond to quarters 1, 2, 3, and 4 respectively.

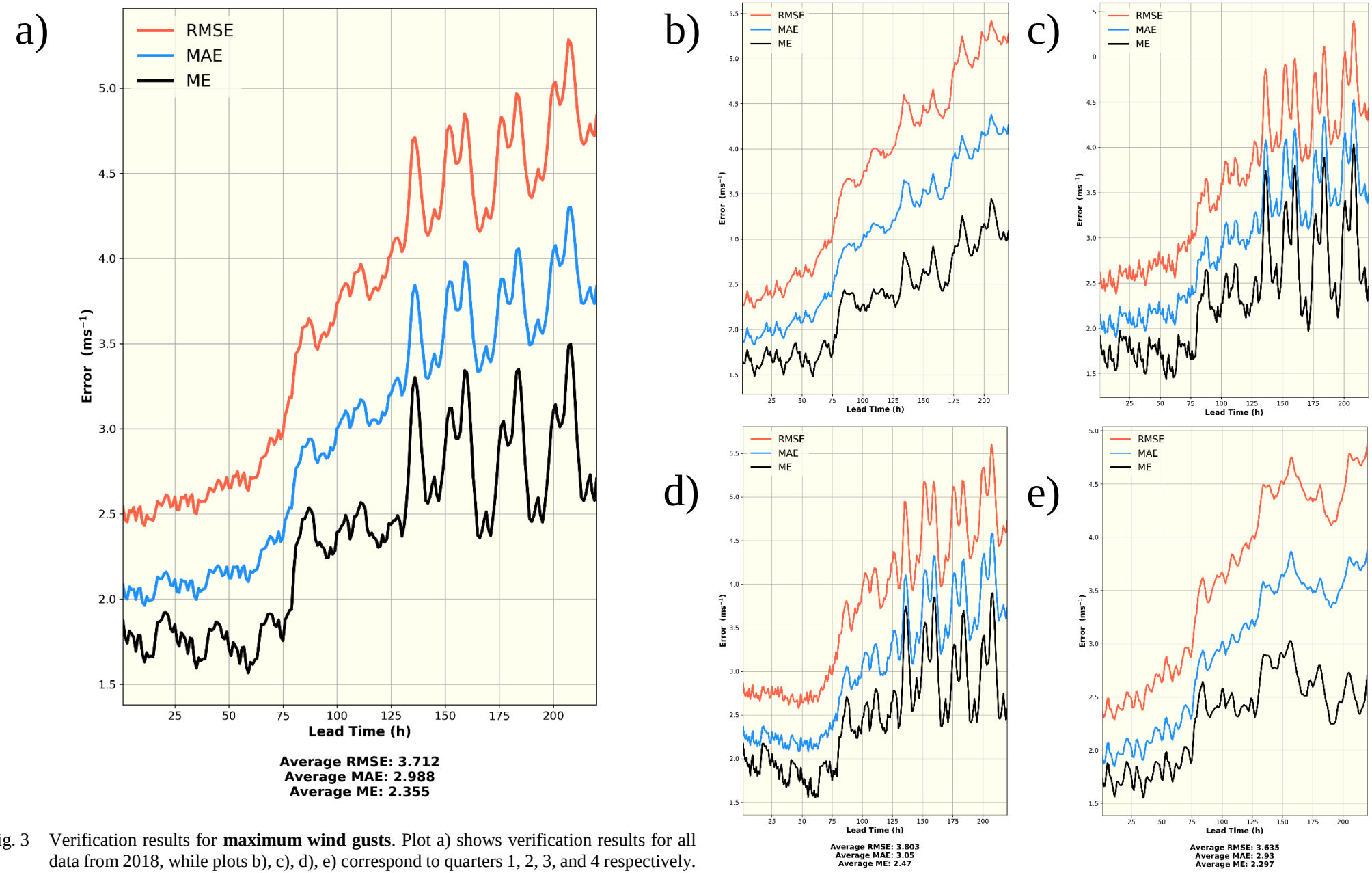

Fig. 3 Verification results for **maximum wind gusts**. Plot a) shows verification results for all data from 2018, while plots b), c), d), e) correspond to quarters 1, 2, 3, and 4 respectively.

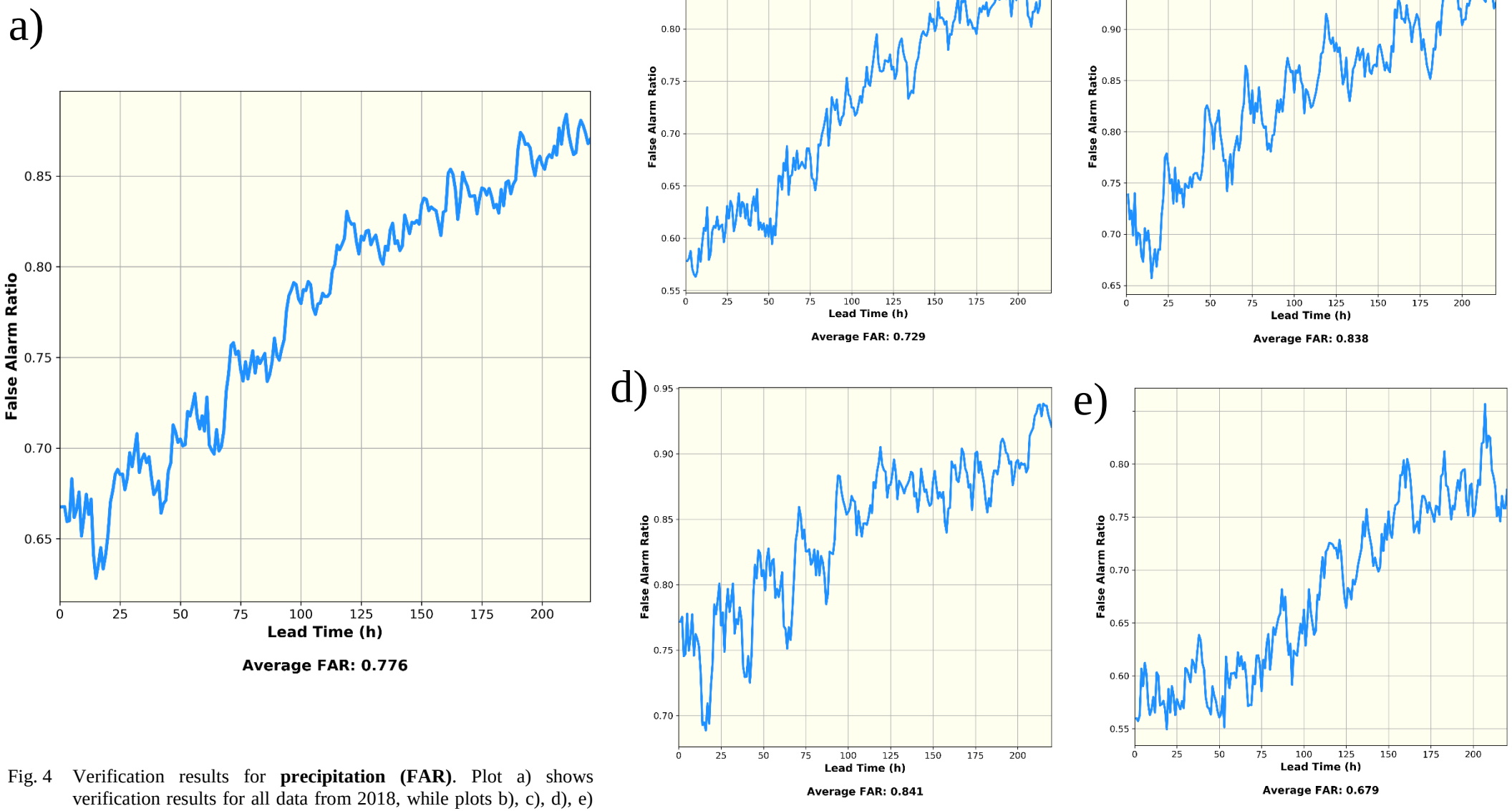

Fig. 4 Verification results for **precipitation (FAR)**. Plot a) shows verification results for all data from 2018, while plots b), c), d), e) correspond to quarters 1, 2, 3, and 4 respectively.

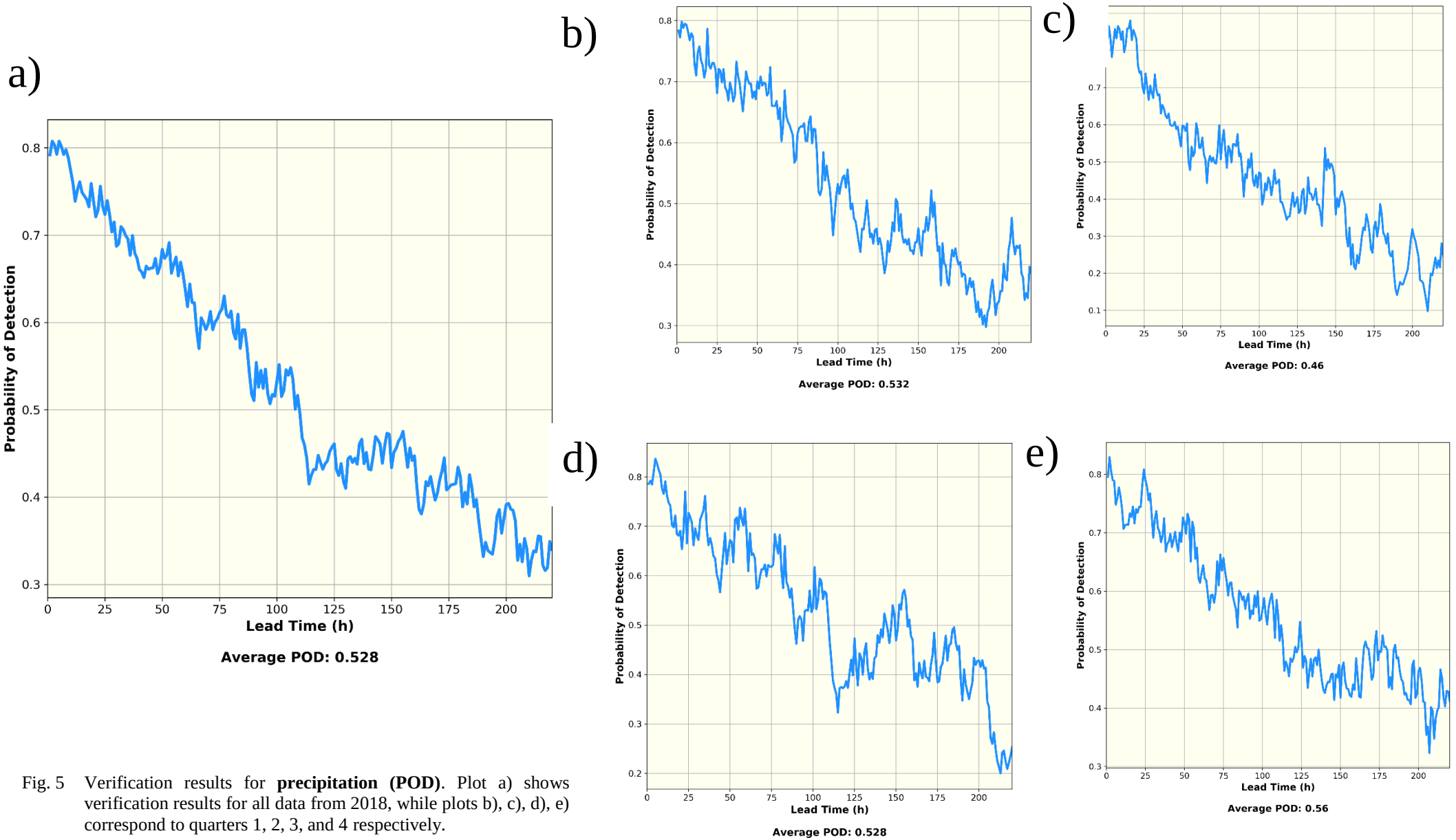

Fig. 5 Verification results for **precipitation (POD)**. Plot a) shows verification results for all data from 2018, while plots b), c), d), e) correspond to quarters 1, 2, 3, and 4 respectively.

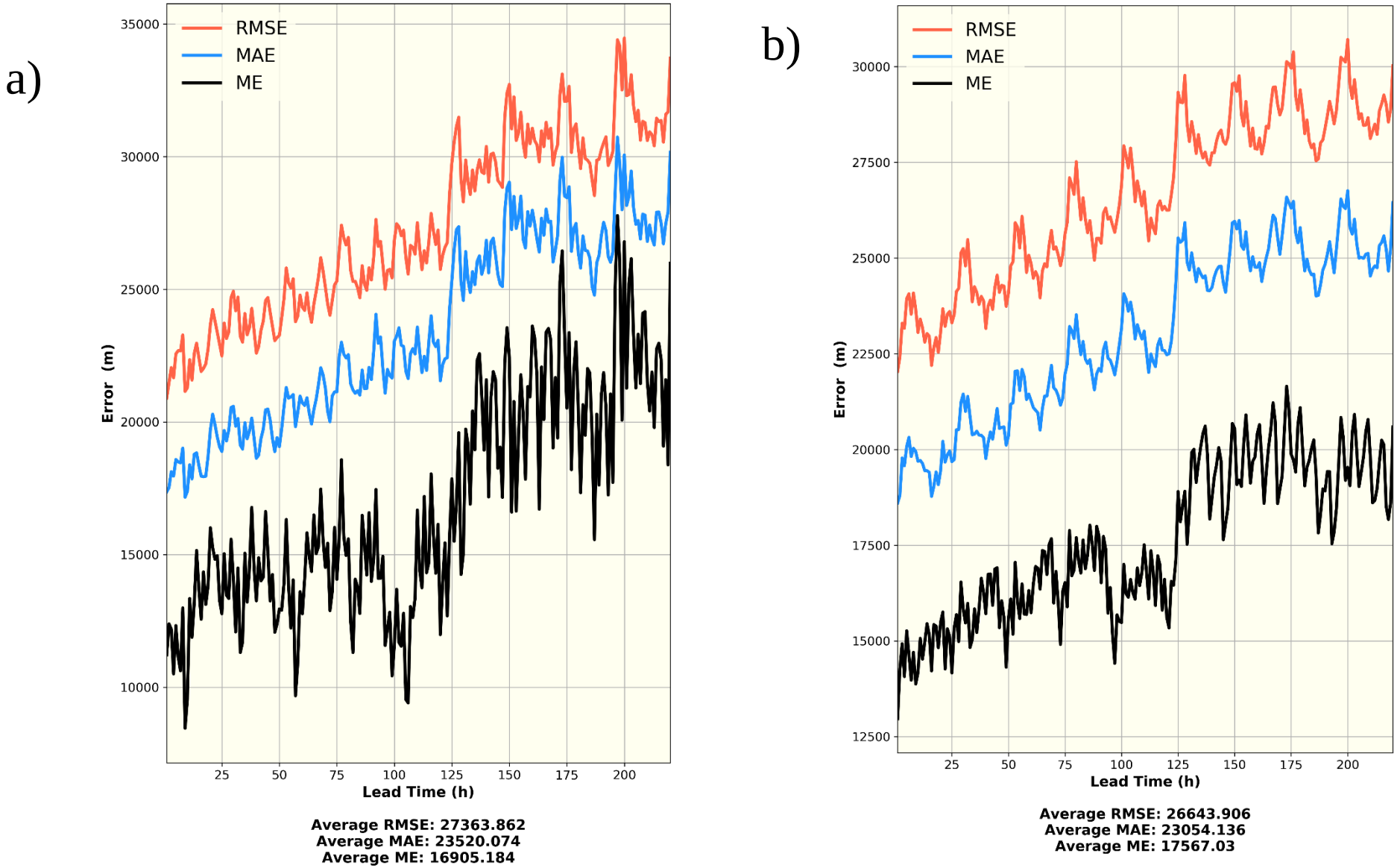

Fig. 6 Verification results for **visibility for all data from 2018**. Plot a) shows verification results for visibility data limited to 0-2 km range, while plot b) correspond visibility limited to 0-10 km range respectively. For verification selected points where visibility observed or predicted within defined range

A direct comparison of the ME, MAE and RMSE for ECMWF and HIRLAM/HARMONIE models is done regularly for the period up to 40 hours. Verification results are presented by parameters – average air temperature (Fig. 7), average wind speed (Fig. 8), maximum wind gusts (Fig. 9), and visibility: to 0-2 km range (Fig. 10) and 0-10 km range (Fig.11).

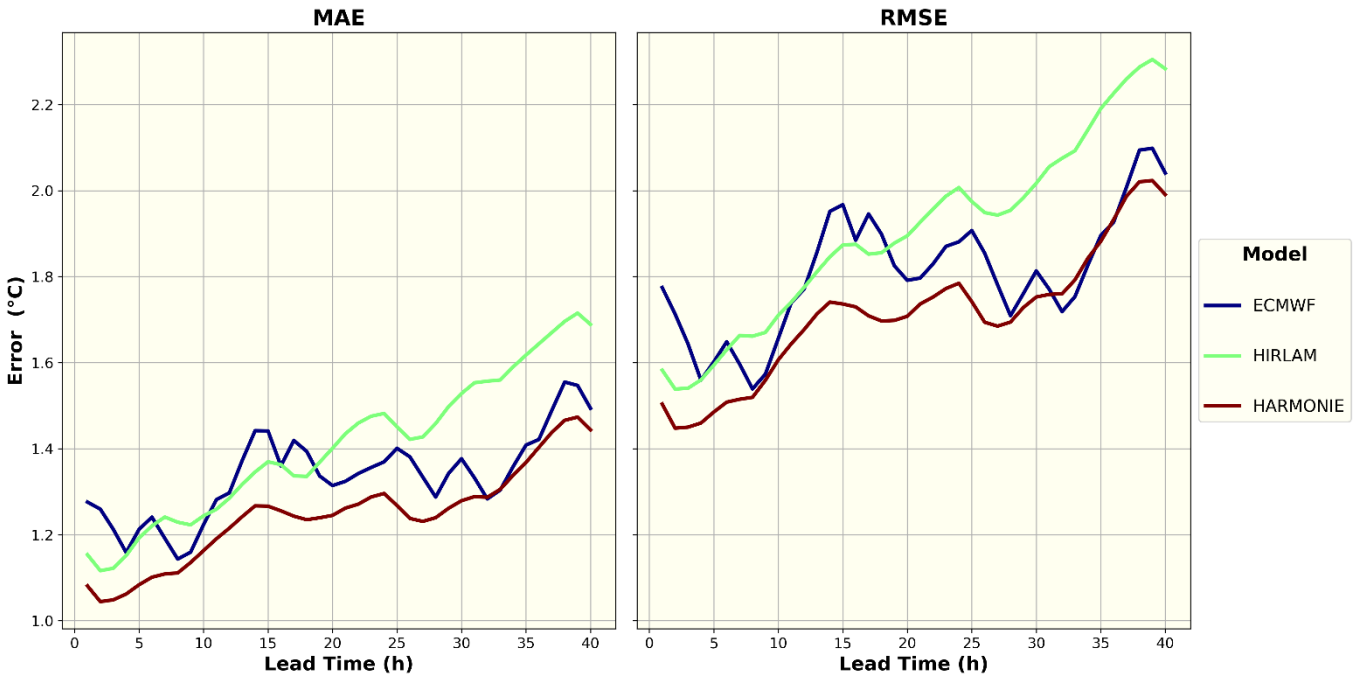

Fig. 7 Verification results for average air temperature for all data from 2018

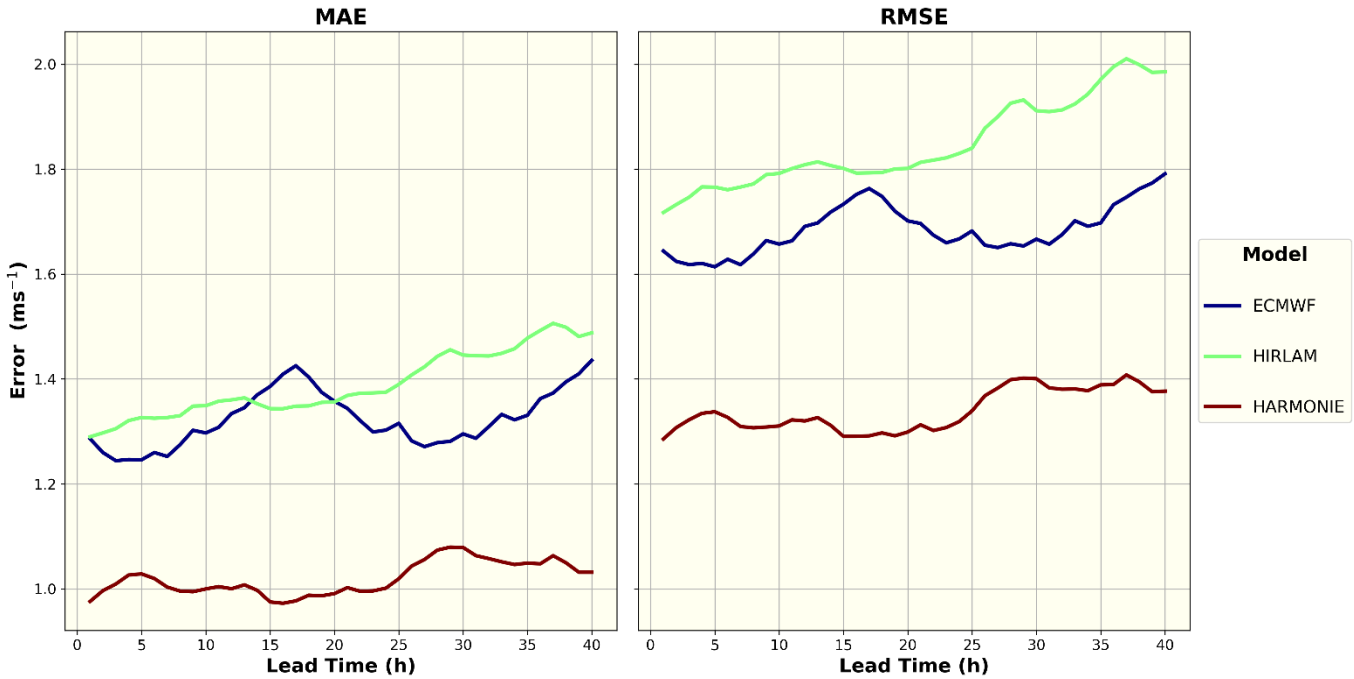

Fig. 8 Verification results for average wind speed for all data from 2018

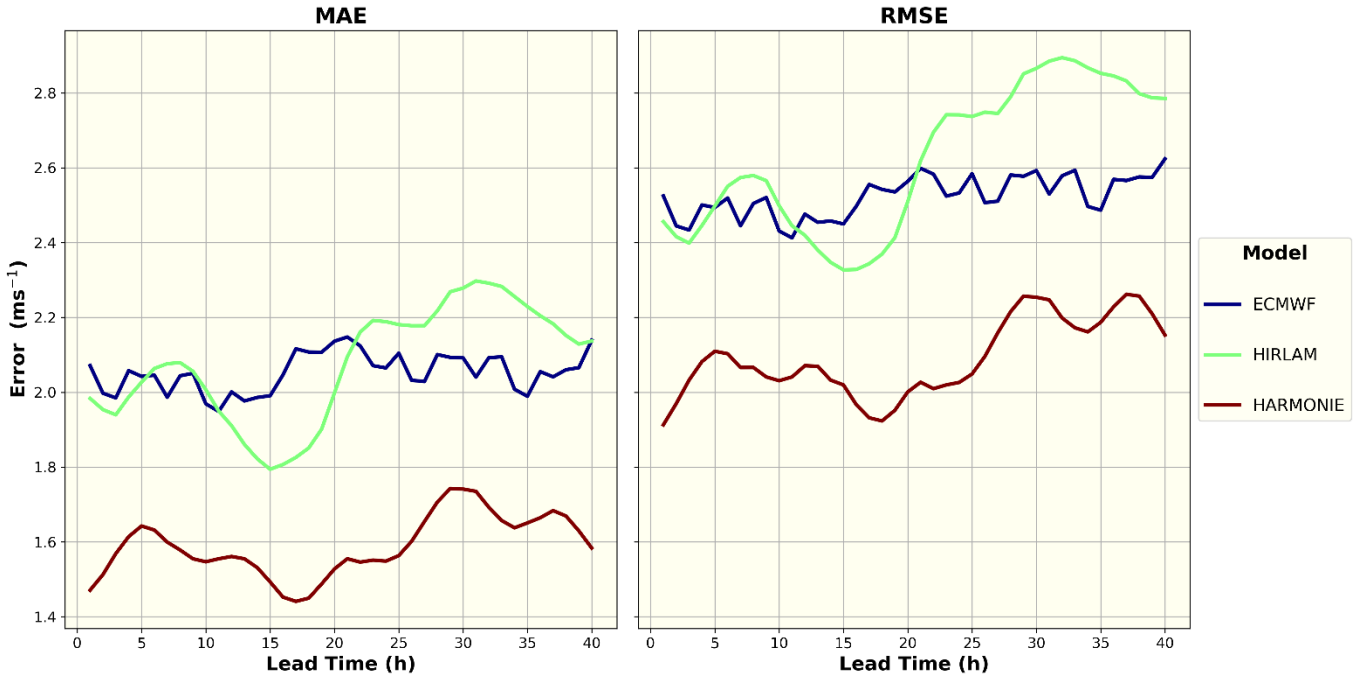

Fig. 9 Verification results for maximum wind gusts for all data from 2018

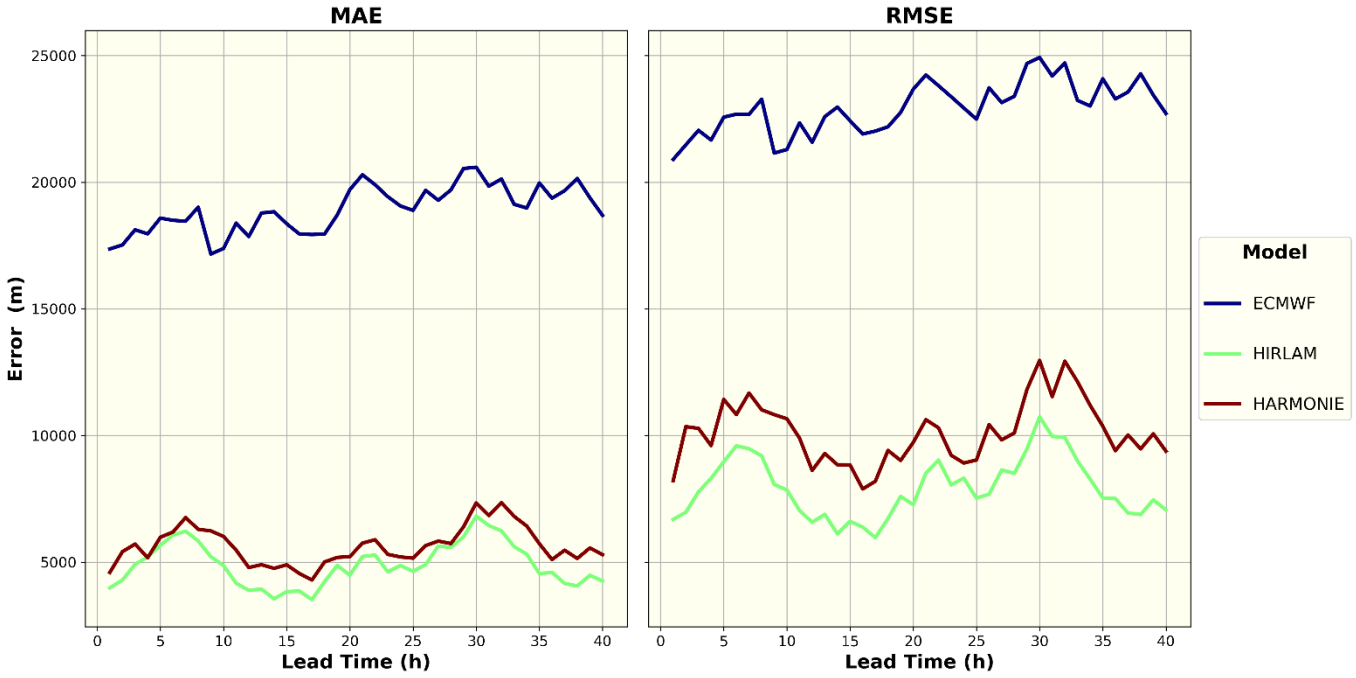

Fig. 10 Verification results for visibility with 0-2 km range for all data from 2018

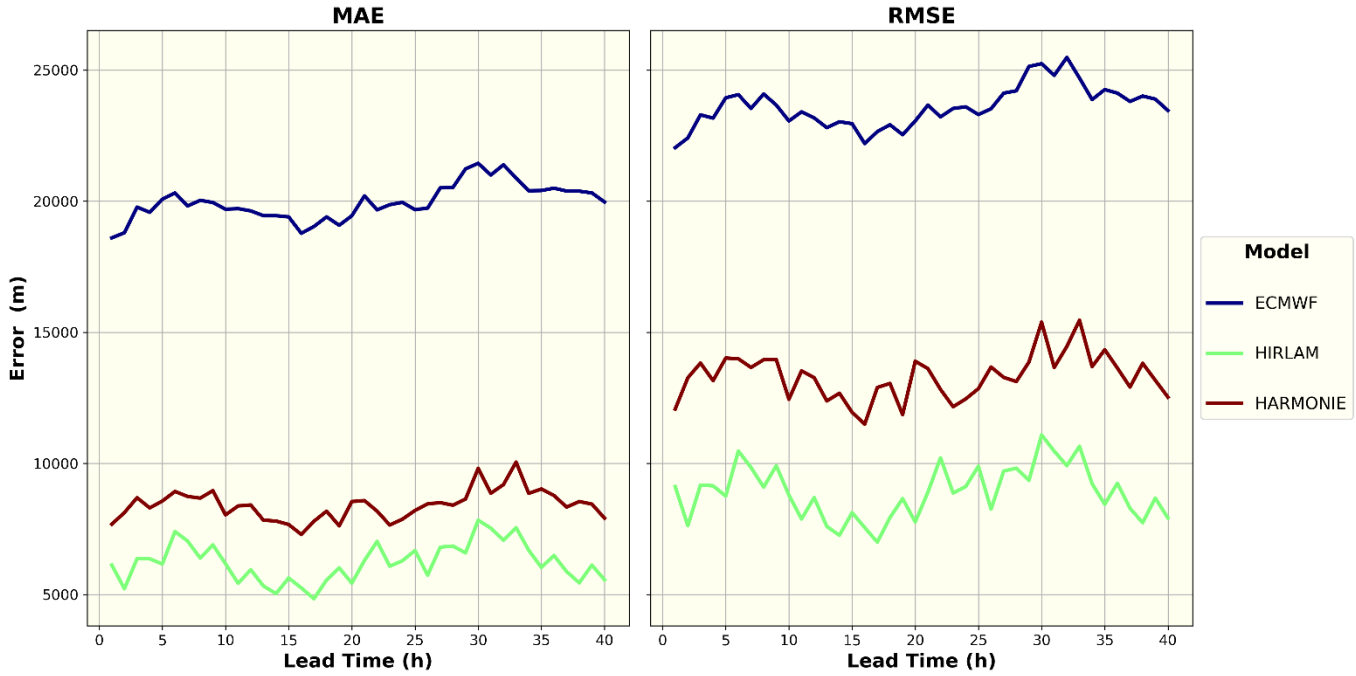

Fig. 11 Verification results for visibility with 0-2 km range for all data from 2018

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

3.2 Subjective verification

3.2.1 Subjective scores (including 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.

4. Requests for additional output

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

5. Feedback on ECMWF "forecast user" initiatives

We invite comments on how useful you find the information provided on ECMWF's "Forecast User Portal", see: (https://software.ecmwf.int/wiki/display/FCST/Forecast+User+Home), and on any changes you would like to see. The web-based "Forecast User Guide" was introduced in May 2018 (https://confluence.ecmwf.int/display/FUG/Forecast+User+Guide) and we would particularly welcome feedback on that.

6. 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

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(7. Structure of these Reports)

ECMWF is reviewing the way in which contributions such as these are gathered and collated. We have made some simple changes to the structure this year, as can be seen above. Please provide any comments you have on the whole process (e.g. schedule for collecting input, report content, report layout, TAC summary). Comments entered in this section will be examined and used by ECMWF, but will be removed prior to publishing your reports on the ECMWF website.