Application and verification of ECMWF products 2018

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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 and visibility have been added. Additionally, direct comparison between ECMWF and HIRLAM/HARMONIE verification results has been provided.

2. Use and application of products

Include medium-range deterministic (HRES) and ensemble (ENS) forecasts, monthly forecast, seasonal forecast.

2.1 Post-processing of ECMWF model output

2.1.1 Statistical adaptation

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.

2.1.2 Physical adaptation

ECMWF HRES and EPS 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 beginning of 2018 a 12 months hydrological simulations are prepared based on ECMWF seasonal forecasts (SEAS5).

2.1.3 Derived fields

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.

2.2 Use of ECMWF products

2.2.1 Use of Products

The ECMWF products are the basis for LEGMC medium-range forecasts for up to 14 days, and the only data source used for long range forecasts (up to 12 months ahead).

For operational purposes, ECMWF model data outputs from HRES, EPS and HRES-WAM are routinely provided to forecaster 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.

For 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.

3. Verification of products

Include medium-range HRES and ENS, monthly, seasonal forecasts. 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 weather parameters by national Services is particularly valuable.

3.1 Objective verification

3.1.1 Direct ECMWF model output (both HRES and ENS)

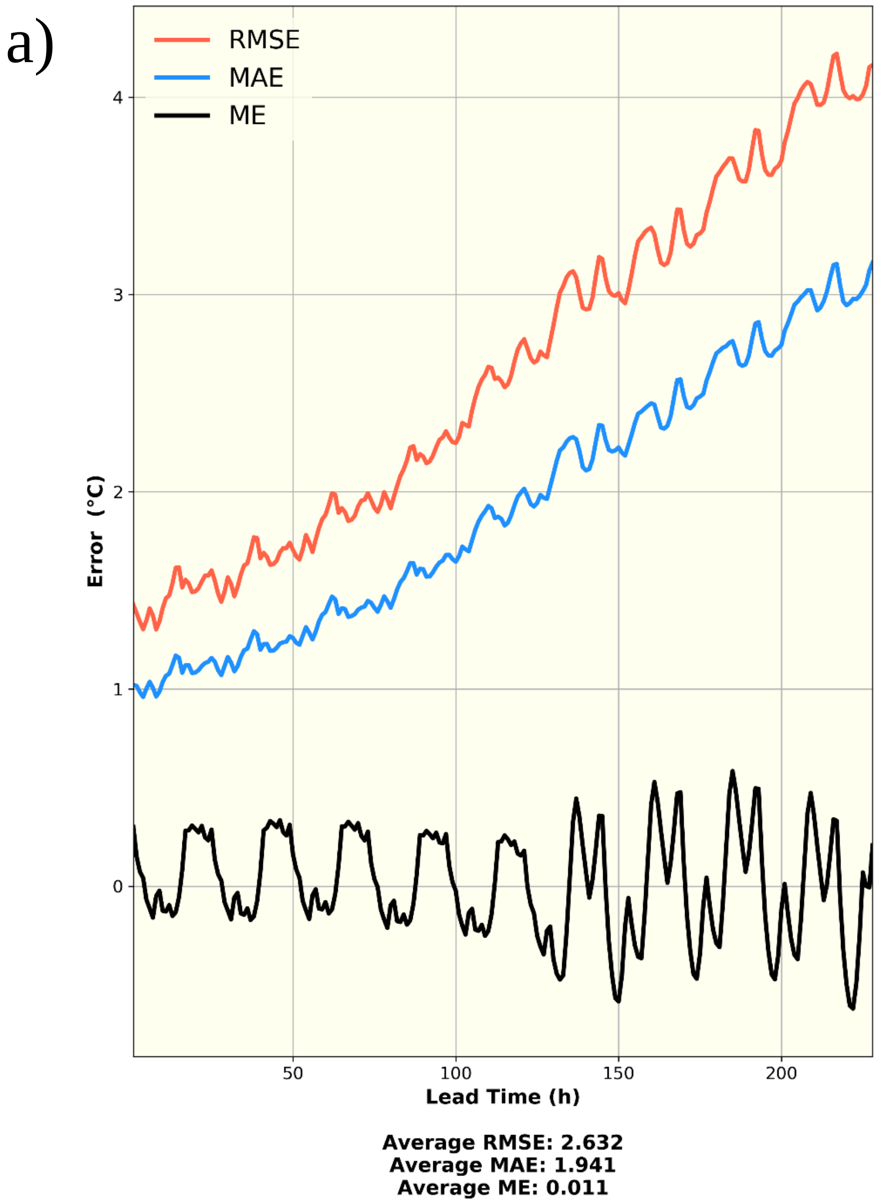
Verification of ECMWF HRES model runs at 00 and 12 UTC is performed yearly and quarterly (January-March, April-June, July-September, October-December) for a time period of maximum 228 h (lead time). Verification methodology used for the continuous forecasts of average air temperature, average wind speed 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).

3.1.2 ECMWF model output compared to other NWP models

A direct comparison of the ME, MAE and RMSE for ECMWF and HIRLAM/HARMONIE models is done regularly for the period up to 44 hours. Unfortunately the results are not available for the year 2017 due to the upgrade of the verification system.



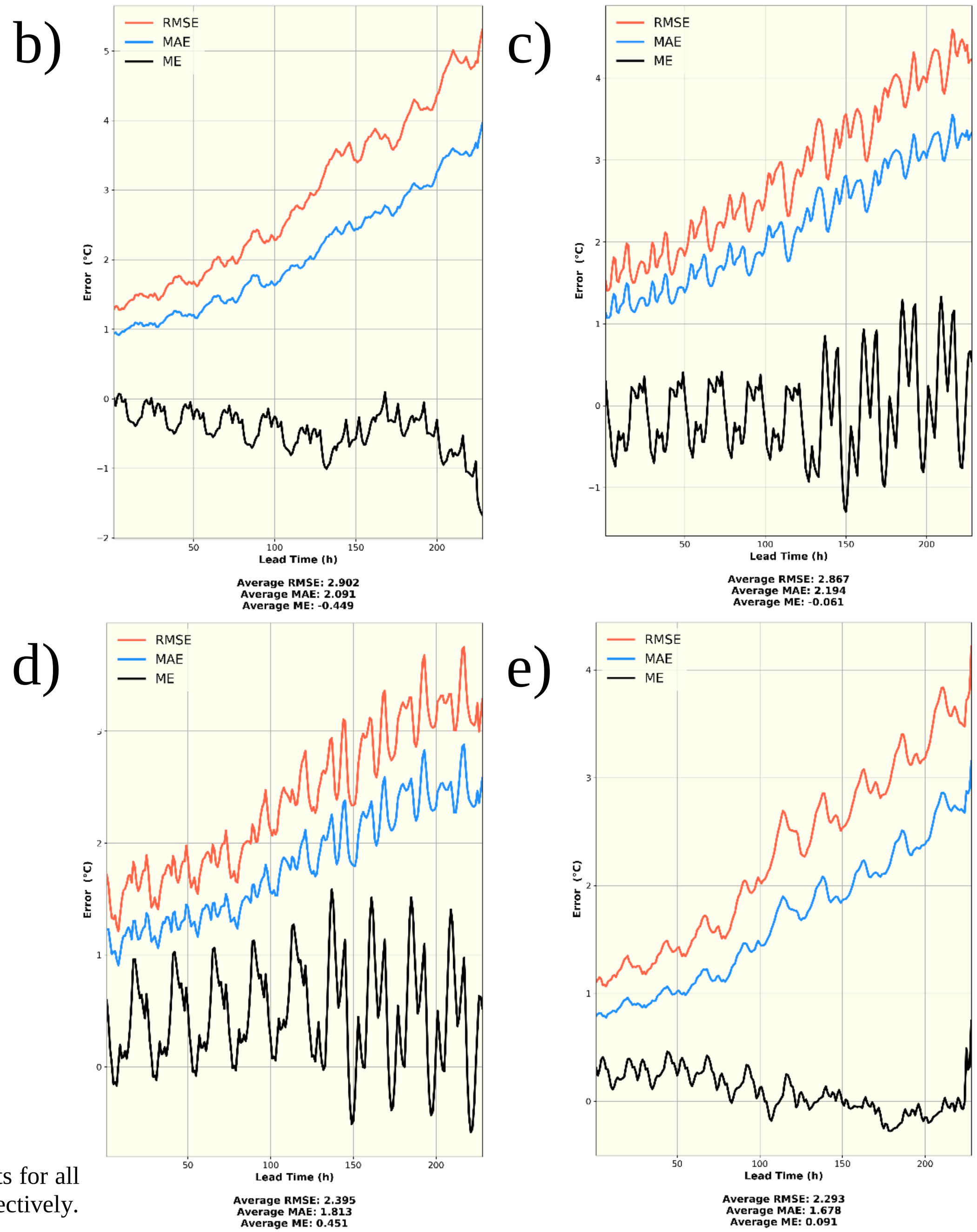
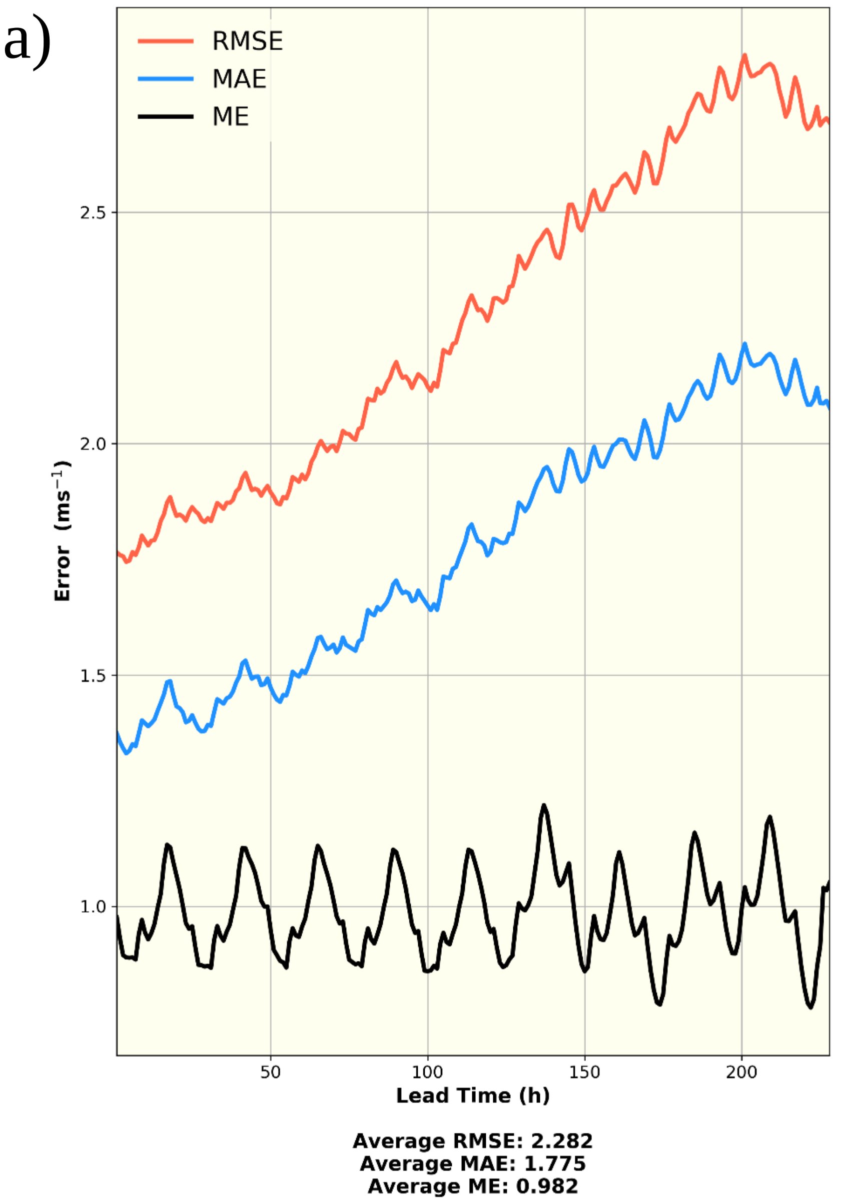


Fig. 1 Verification results for average air temperature. Plot a) shows verification results for all data from 2017, while plots b), c), d), e) correspond to quarters 1, 2, 3, and 4 respectively.



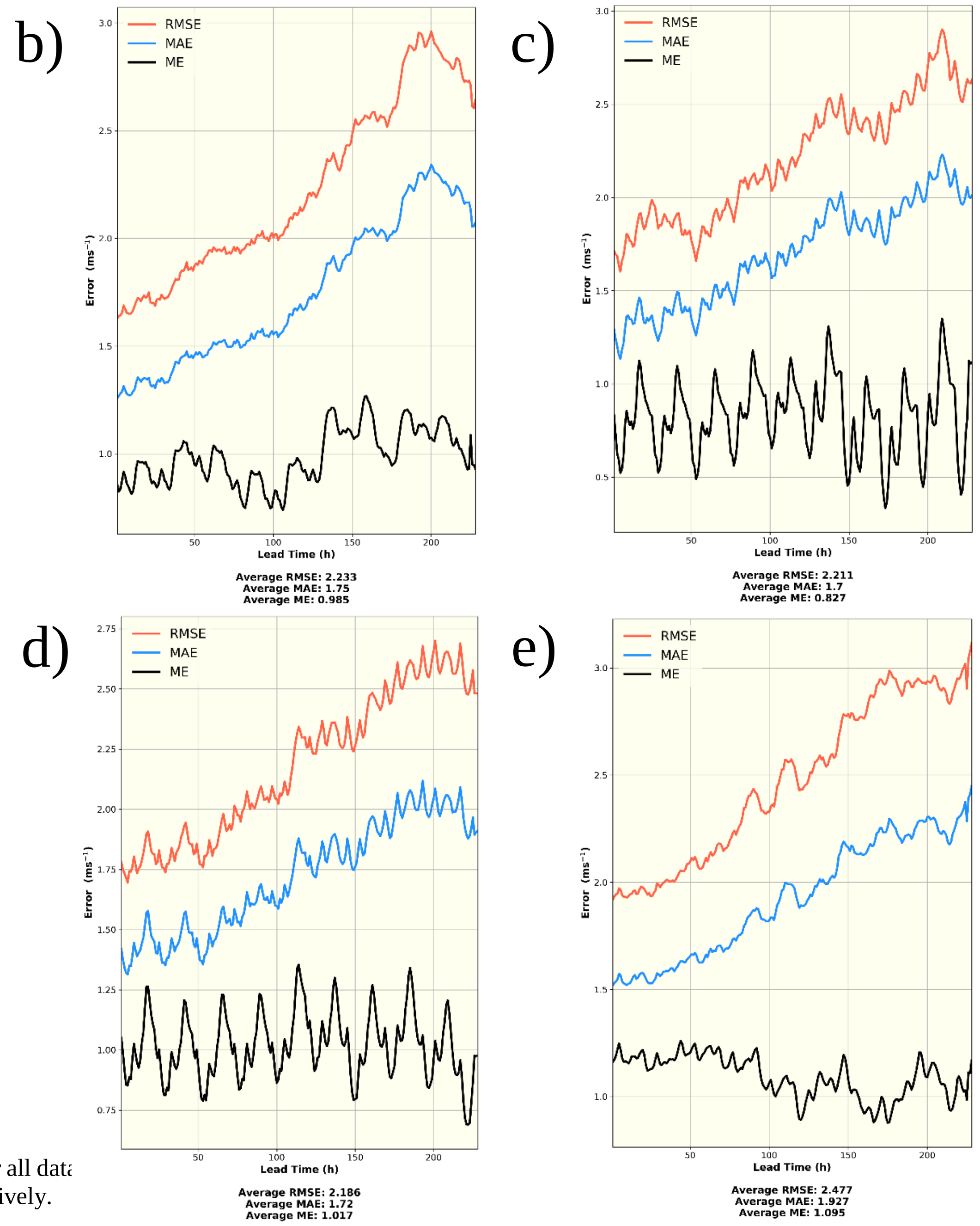


Fig. 2 Verification results for average wind speed. Plot a) shows verification results for all data from 2017, while plots b), c), d), e) correspond to quarters 1, 2, 3, and 4 respectively.

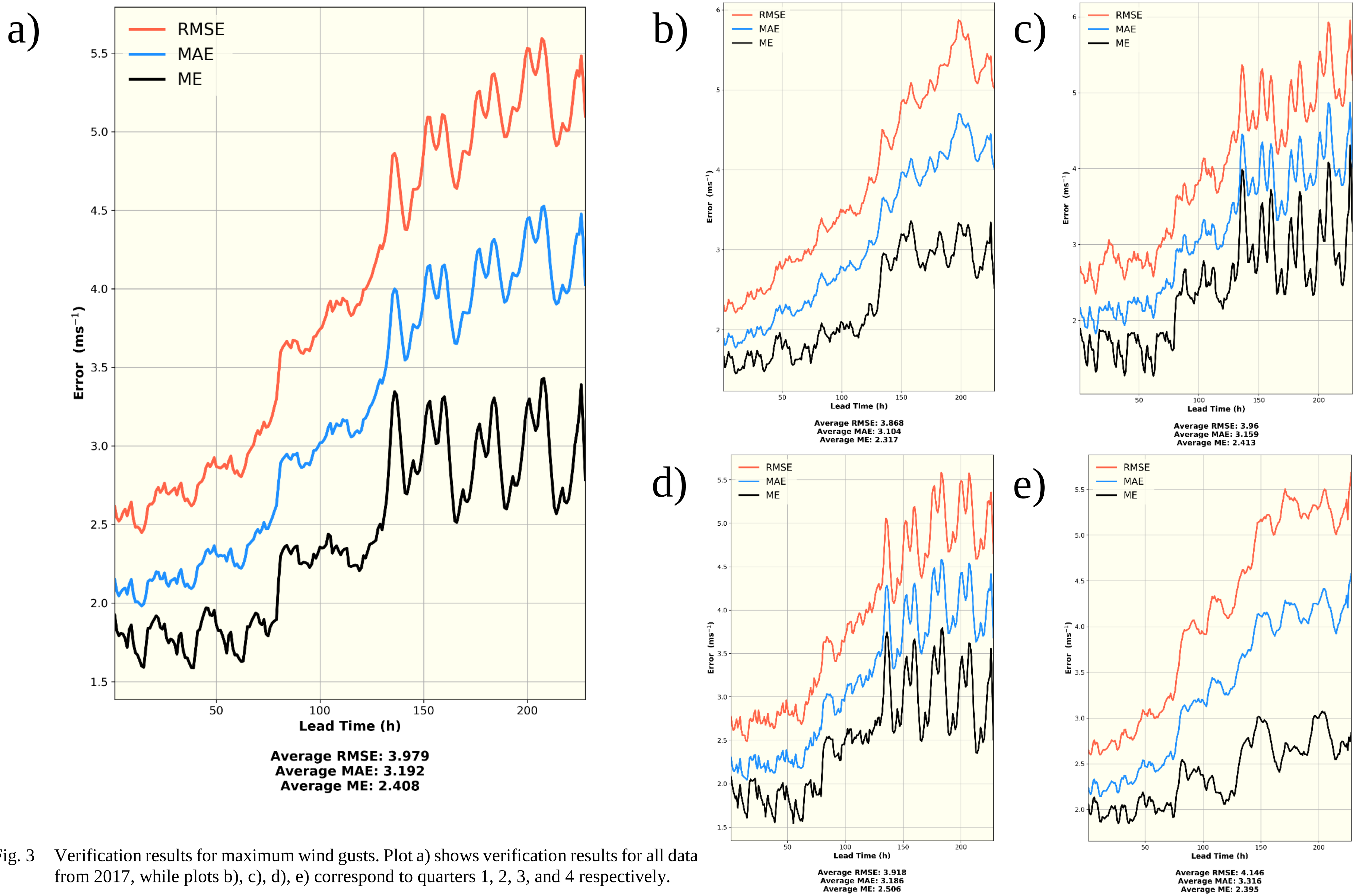


Fig. 3 Verification results for maximum wind gusts. Plot a) shows verification results for all data from 2017, while plots b), c), d), e) correspond to quarters 1, 2, 3, and 4 respectively.

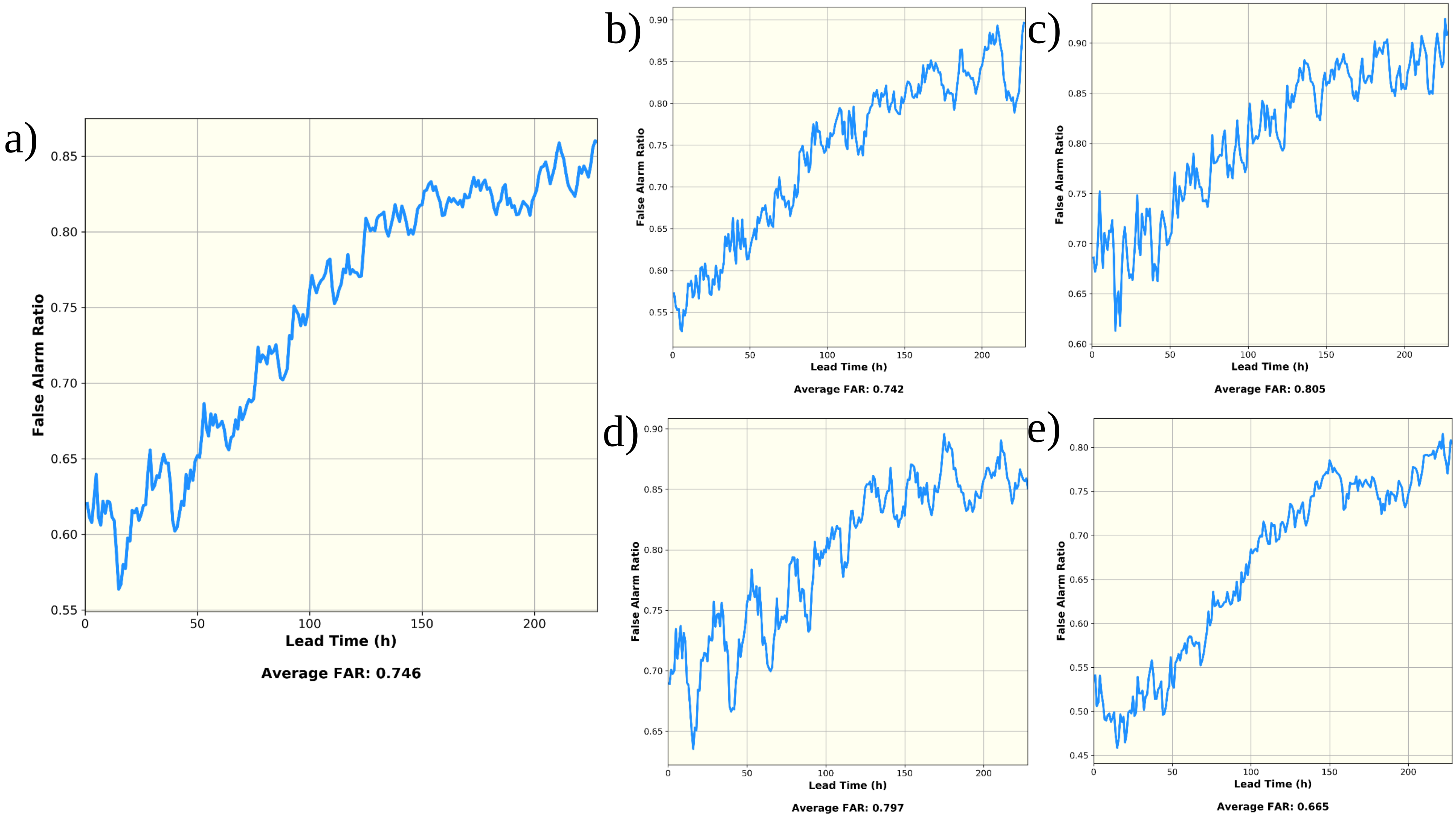


Fig. 4 Verification results for precipitation (FAR). Plot a) shows verification results for all data from 2017, while plots b), c), d), e) correspond to quarters 1, 2, 3, and 4 respectively.

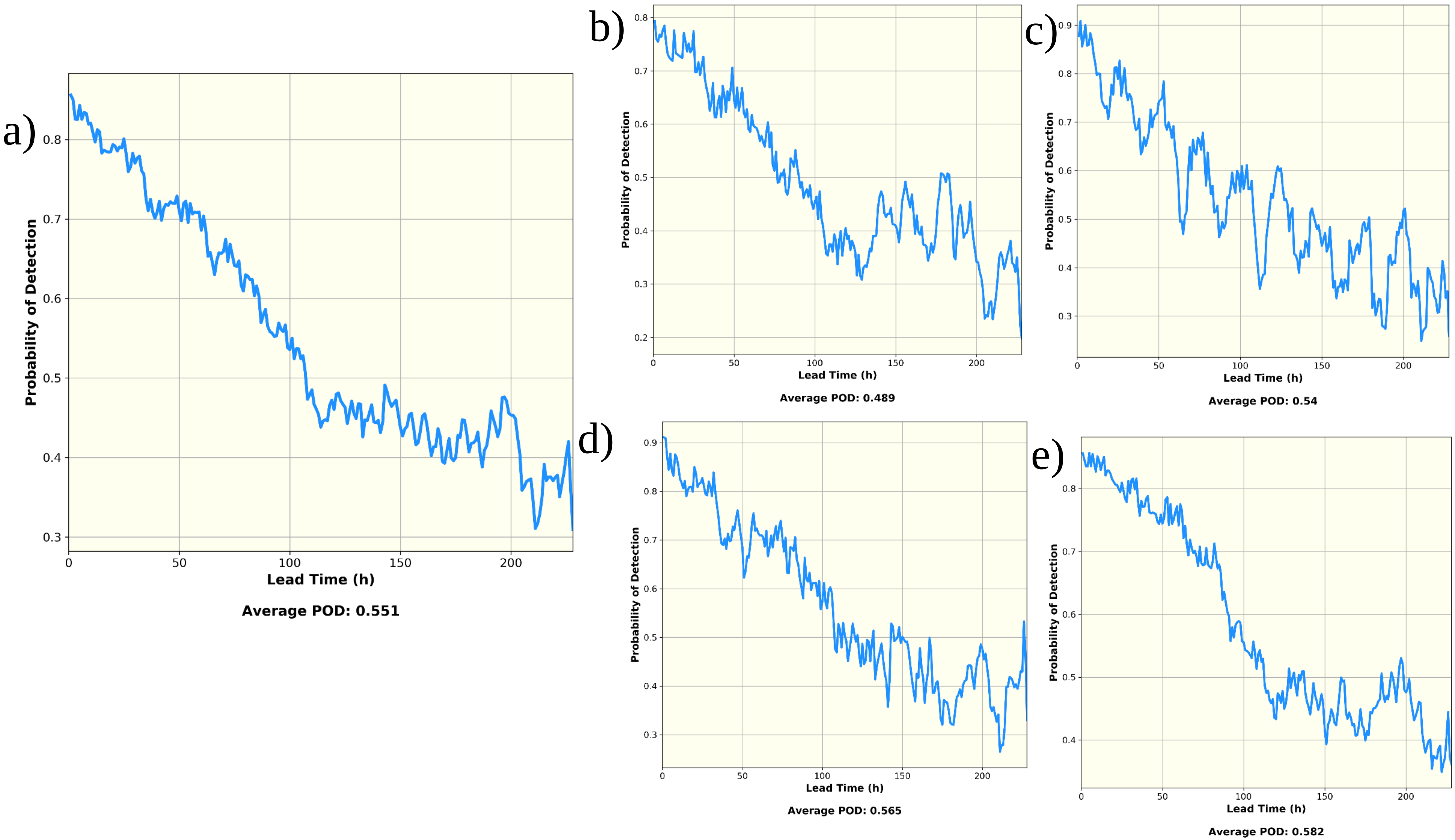


Fig. 5 Verification results for precipitation (POD). Plot a) shows verification results for all data from 2017, while plots b), c), d), e) correspond to quarters 1, 2, 3, and 4 respectively.

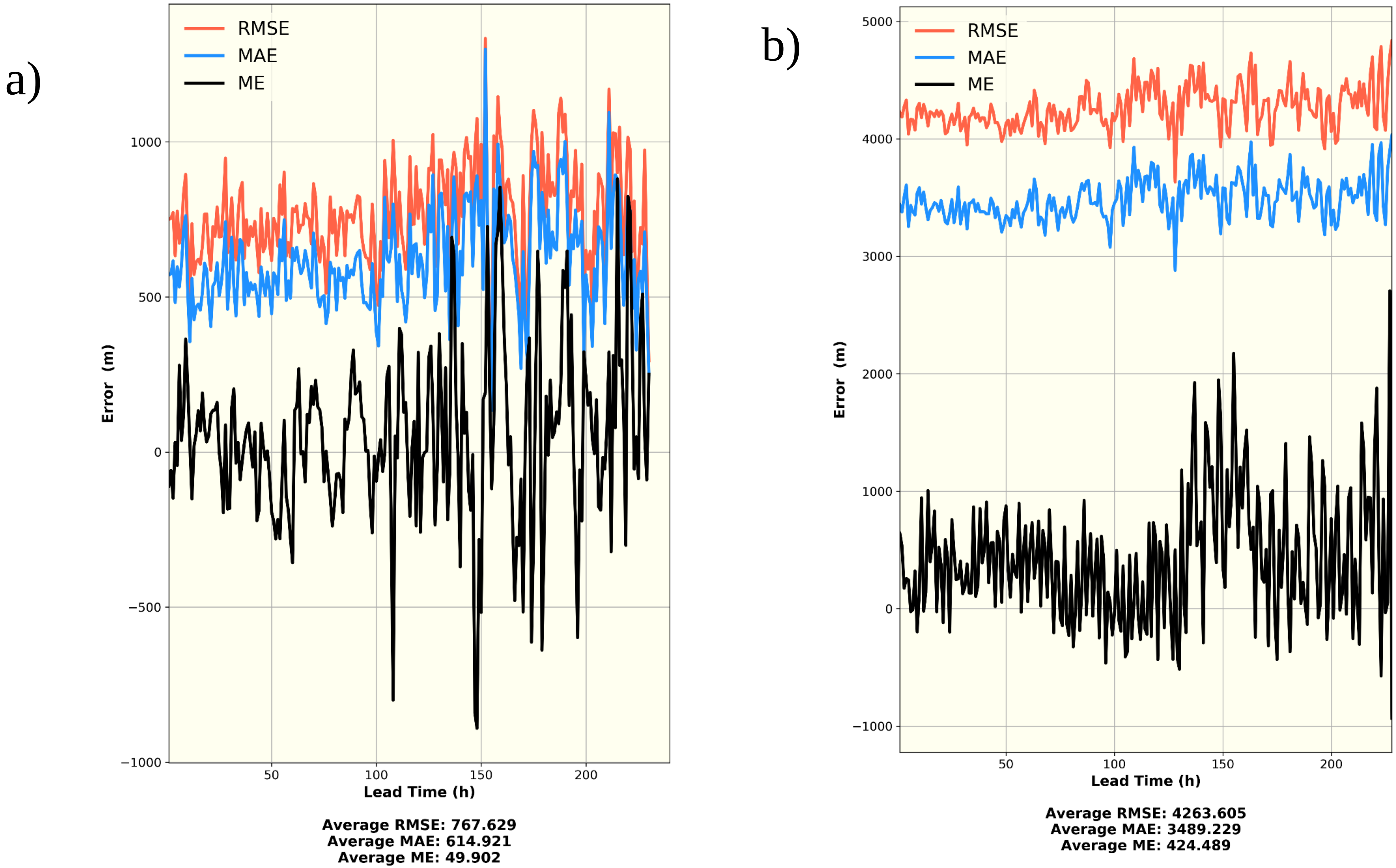


Fig. 6 Verification results for visibility for all data from 2017. Plot a) shows verification results for visibility data limited to 0-2 km range, while plot b) correspond visibility limited to 0-10 km range respectively.