HARMO 19
19TH INTERNATIONAL CONFERENCE ON HARMONISATION WITHIN ATMOSPHERIC DISPERSION MODELLING FOR REGULATORY PURPOSES

QUALITY OF WEATHER FORECAST FOR MODELLING AIR POLLUTION DISPERSION FOR NUCLEAR EMERGENCY

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KEYWORDS: validation, weather forecast, air pollution dispersion, nuclear emergency, field data set

Modelling the dispersion of pollution in the atmosphere immediately after a nuclear accident is key to taking the proper measures to protect the population.

The IAEA MODARIA programme is researching the quality of dispersion modelling if weather forecasts in fine resolution are used instead of meteorological measurements when measurement networks are damaged or deficient.

METHOD

Using a weather forecast we can implement measures to protect the population beforehand, when developments at a nuclear power plant indicate that a nuclear accident will happen. The quality of a weather forecast is expected to be slightly lower than that of weather measurements.

This poster shows how much lower and how that may affect the modelling of pollutant dispersion in the atmosphere.

Since the meteorologically measured data at the time of the Chernobyl and Fukushima accidents are deficient, IAEA MODARIA is using the Šoštanj 1991 data set to validate the modelling.

Šoštanj 1991 was a well-measured industrial pollution experiment using a non-radioactive tracer; it was presented at Harmo16. The Šoštanj 1991 data set comprises a roughly three-week list of meteorological and dispersion events for a 15 km x 15 km area over highly complex terrain.

We demonstrate the validation of a weather forecast using Šoštanj 1991 data set.

Weather forecasts were prepared with the WRF ARW model using historical border and initial conditions from the Climate Forecast System Reanalysis and ERA. How well the predicted wind fields matched the actual wind is evaluated graphically and statistically for 5 ground-level meteorological stations and for SODAR measurements at altitudes up to 1000 m above the basin floor. How well the temperature fields matched the actual temperatures is evaluated for 5 locations of ground-level meteorological stations, situated on the basin floor and on the peaks of nearby hills, comprising rural and urban locations. In the end we validate the precipitation and global solar radiation at a single ground-level meteorological station.

The established deficiencies in weather forecasts for these meteorological variables are a main cause of errors in dispersion modelling. It is crucial that we are aware of them and able to quantitatively define them.

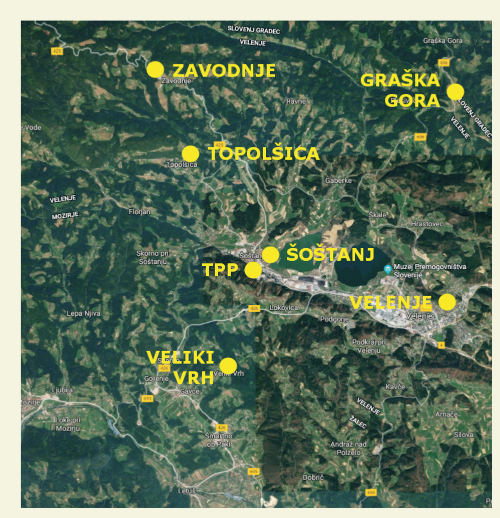
RESULTS

Forecasts of variables for which a fine-scale spatial and temporal analysis was carried out match relatively high with the measurements. Improvements will be necessary with regard to the wind speed, where the forecasts are too high as it pertains to the layers closer to the ground. In addition, there is room for improving directional matching. Statistical charts presented show that the wind speed is usually overepredicted and the air temperatures are mostly only slightly underpredicted. Air temperature is pretty well estimated (FB < 0.5 and NMSE < 1 except for Šoštanj station) even if model tends to underpredict the temperature. Same is with wind speed where models tends to overestimate the speed except for Zavodnje (-1 < FB > 1 and NMSE < 1 except for Zavodnje and Graška Gora).

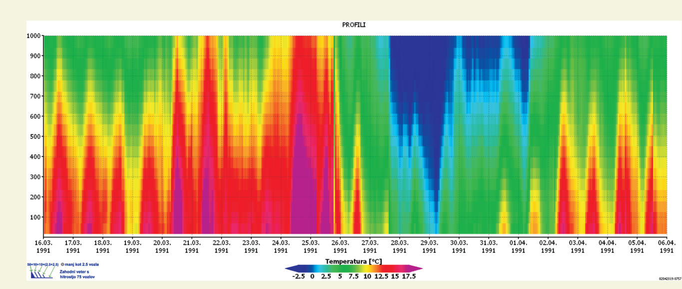
CONCLUSIONS

Many countries use meteorological data forecasts in order to predict atmosphere dispersion and emergency rescue actions in the event of nuclear accidents. It is therefore important to analyse the quality of weather forecasts in terms of those variables that significantly influence atmospheric dispersion modelling. The poster presents the validation over a smaller area around Šoštanj, Slovenia, over complex terrain which makes the modelling of basic meteorology and atmospheric pollution dispersion extremely challenging.
The poster presents a detailed graphical and numerical analysis of results and indicates which variables require improvements.

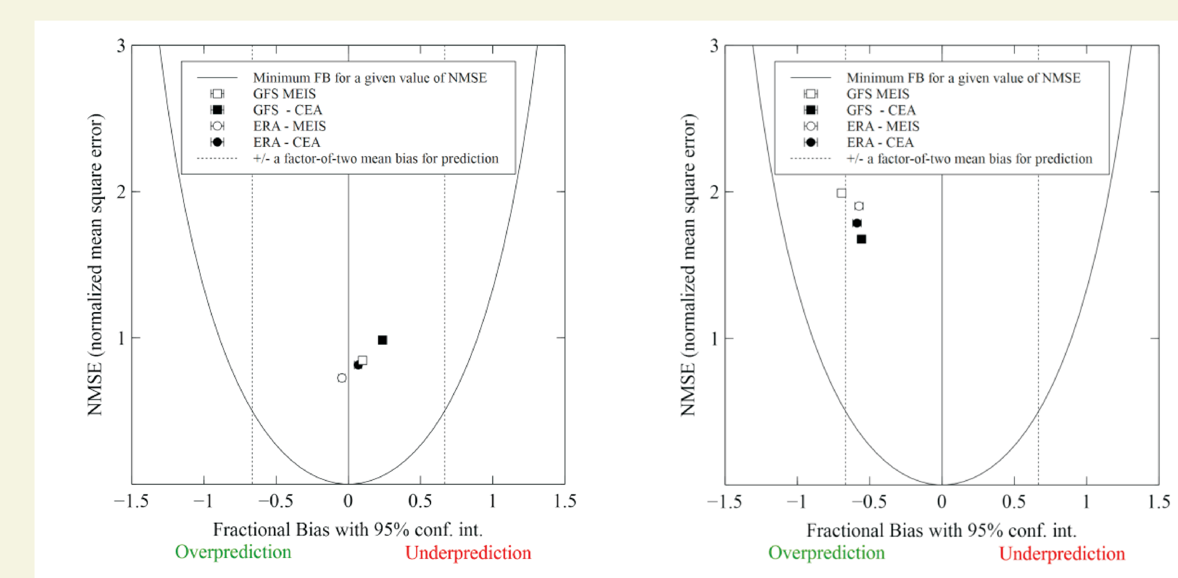
Group /exercise no.	Weather model	Inputs and boundary conditions *Saha et al., 2010 **Dee et al., 2011	Resolution	Domain 1 spatial and temporal resolution, grid	Domain 2 spatial and temporal resolution, grid	Domain 3 spatial and temporal resolution, grid
MEIS-1	WRF ARW 3.9.1	NCEP climate forecast system reanalysis (CFSR)*	0.5° 6 h	25 km 3 h 80 x 80	5 km 0.5 h 86 x 86	1 km 0.5 h 101 x 101
MEIS-2	WRF ARW 3.9.1	ERA Interim (ECMWF)**	0.7° 6 h	25 km 3 h 80 x 80	5 km 0.5 h 86 x 86	1 km 0.5 h 101 x 101
CEA-1	WRF ARW 4.0	NCEP climate forecast system reanalysis (CFSR)*	0.5° 6 h	25 km 3 h 80 x 80	5 km 1 h 86 x 86	1 km 0.5 h 101 x 101
CEA-2	WRF ARW 4.0	ERA Interim (ECMWF)**	0.7° 6 h	25 km 3 h 80 x 80	5 km 1 h 86 x 86	1 km 0.5 h 101 x 101



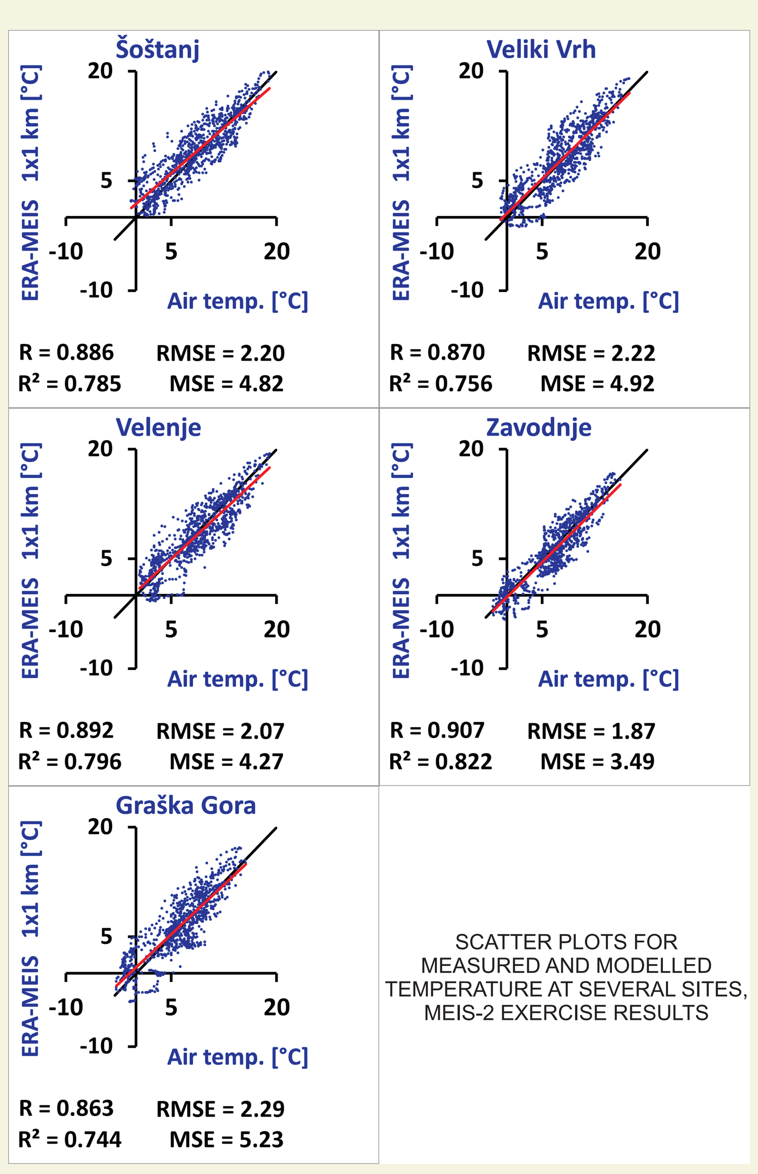
TARGET MODELLING AREA AND DISTRIBUTION OF METEOROLOGICAL STATIONS (GOOGLE MAPS, 25.3.2019), ŠOŠTANJ TPP - N 46.373945°, E 15.052642°



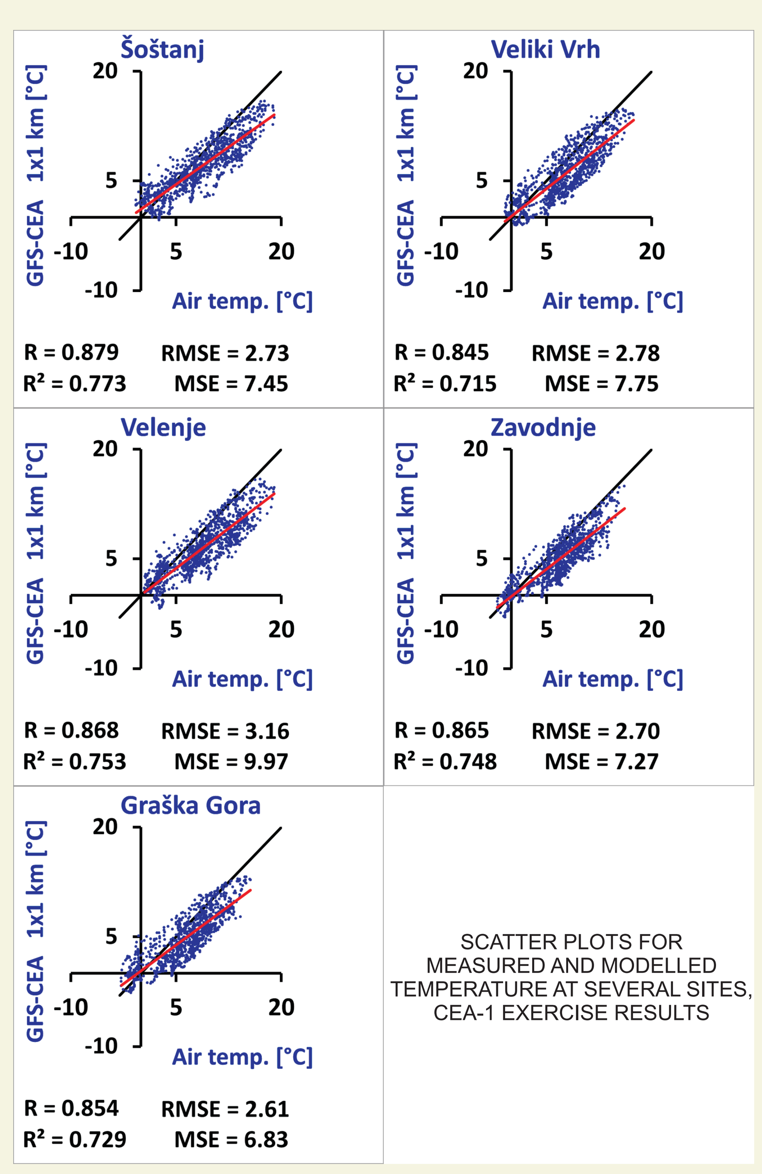
VERTICAL AIR TEMPERATURE PROFILE, MEIS-2 EXERCISE RESULT



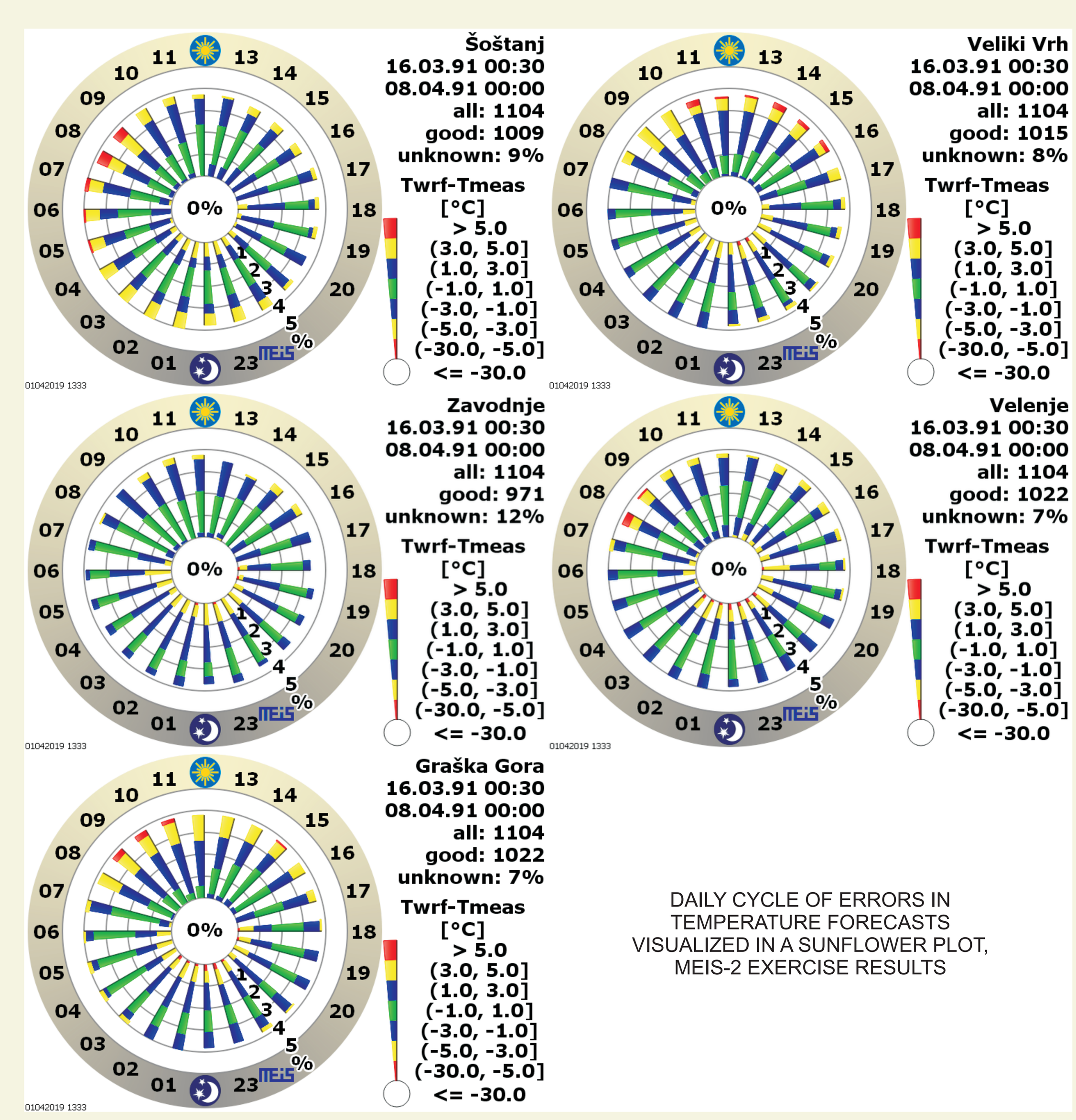
ON THE RIGHT: STATISTICAL ANALYSIS OF ALL DATA AIR TEMPERATURE (LEFT) AND WIND SPEED (RIGHT) FROM MARCH 15TH, 1991 (07:00) TO APRIL 5TH, 1991(12:00)



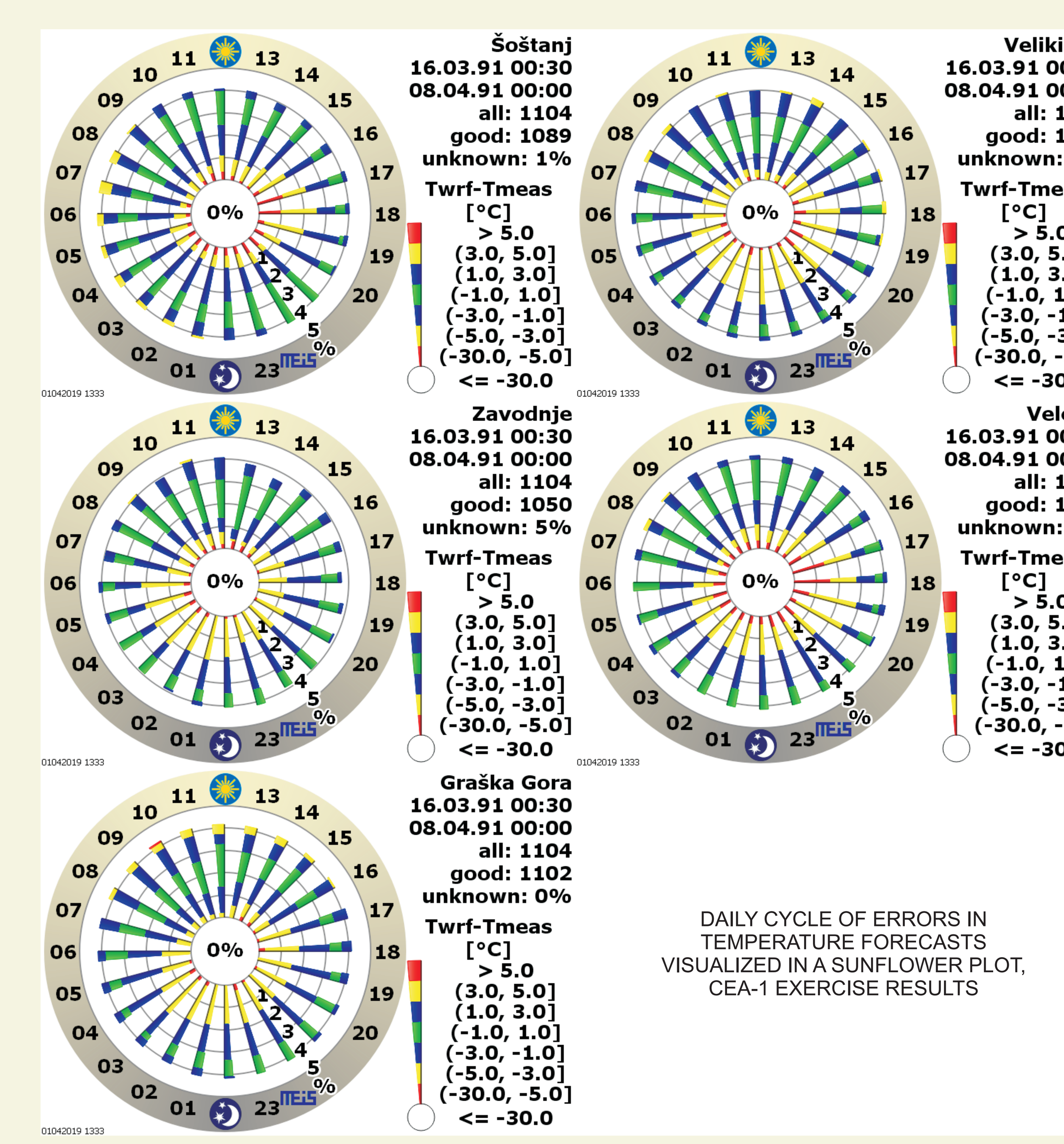
SCATTER PLOTS FOR MEASURED AND MODELLED TEMPERATURE AT SEVERAL SITES, MEIS-2 EXERCISE RESULTS



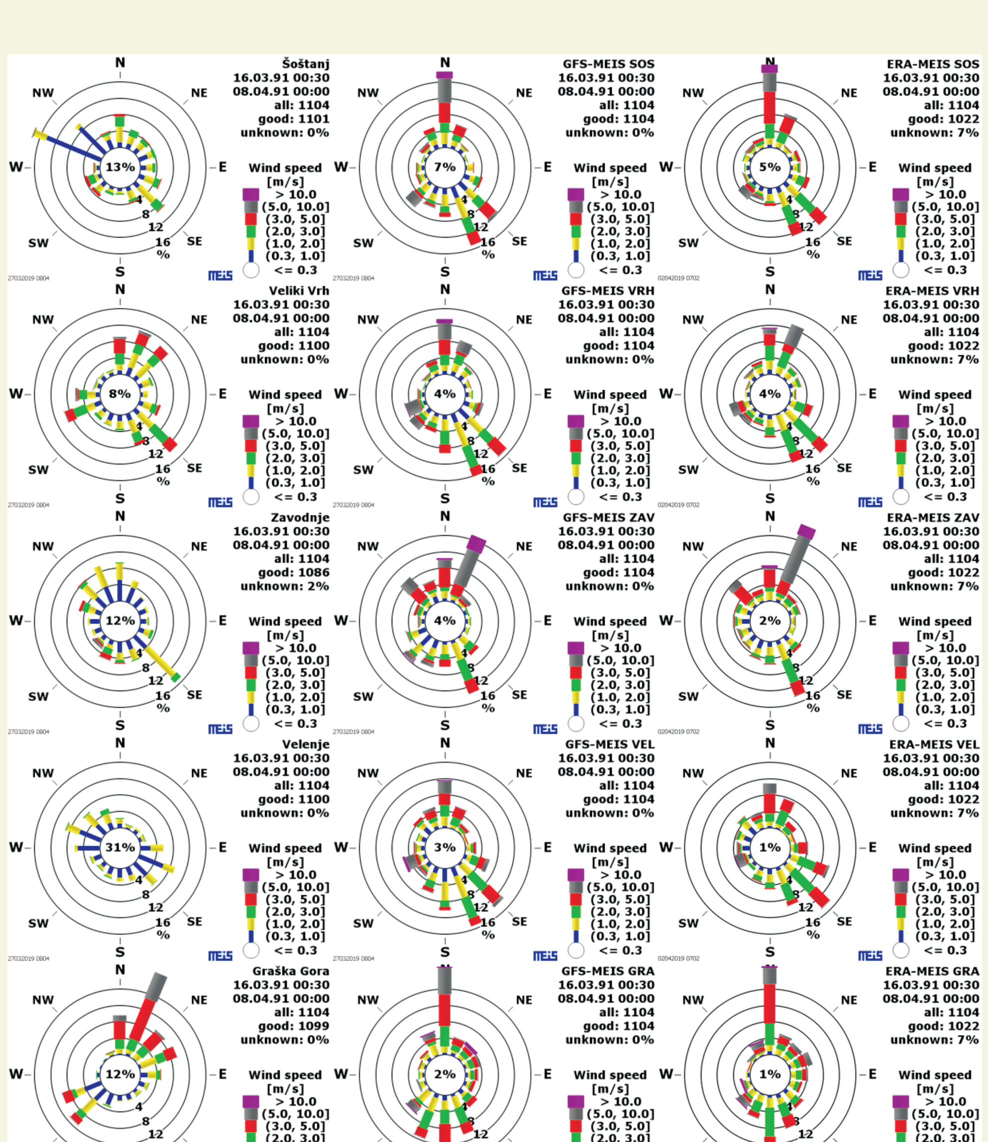
SCATTER PLOTS FOR MEASURED AND MODELLED TEMPERATURE AT SEVERAL SITES, CEA-1 EXERCISE RESULTS



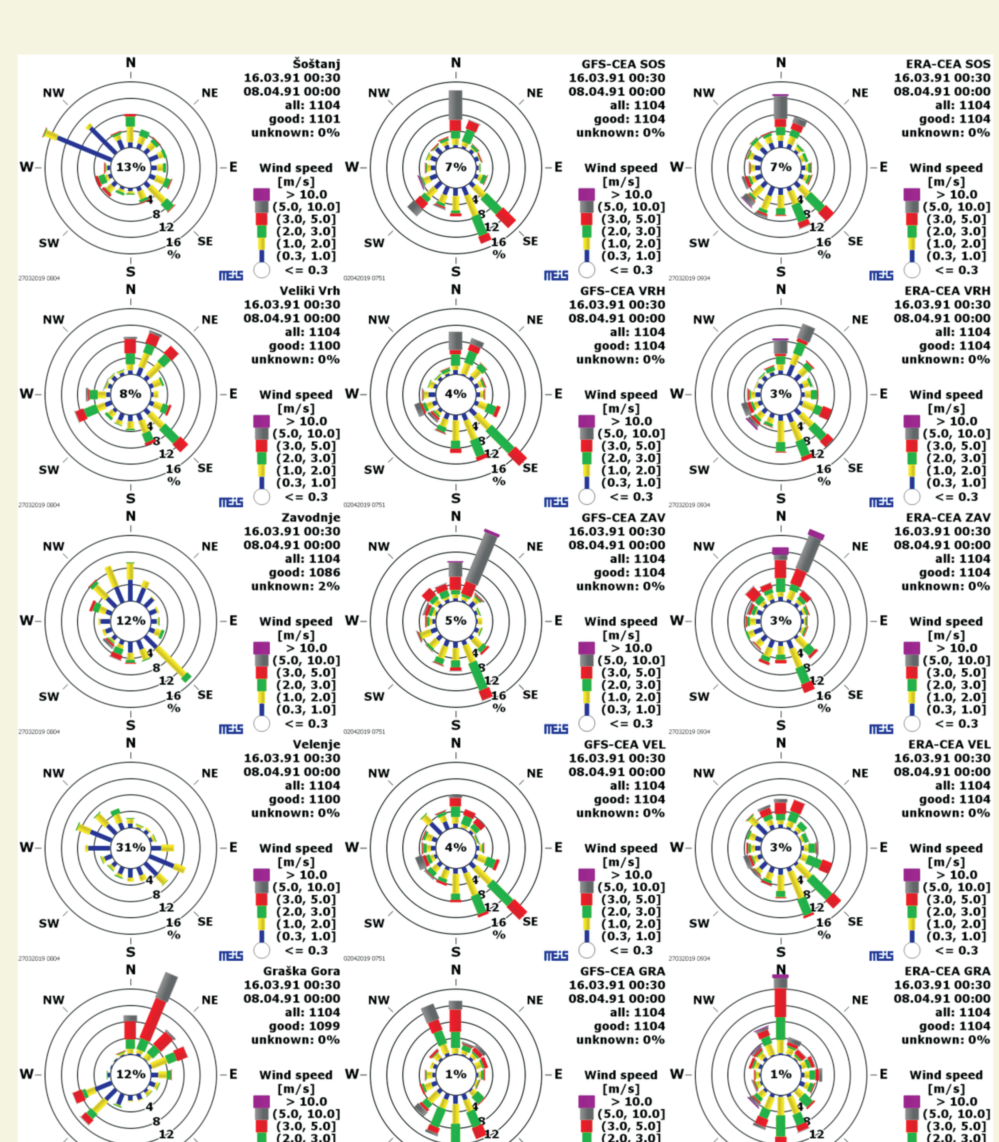
DAILY CYCLE OF ERRORS IN TEMPERATURE FORECASTS VISUALIZED IN A SUNFLOWER PLOT, MEIS-2 EXERCISE RESULTS



DAILY CYCLE OF ERRORS IN TEMPERATURE FORECASTS VISUALIZED IN A SUNFLOWER PLOT, CEA-1 EXERCISE RESULTS



WIND COMPARISON AT LOCATIONS ŠOŠTANJ, VELIKI VRH, ZAVODNJE, VELENJE AND GRAŠKA GORA. WIND ROSES OF MEASUREMENTS FOR GROUND LEVEL STATIONS AND WRF FORECASTS, MEIS-1 AND MEIS-2 EXERCISE RESULTS



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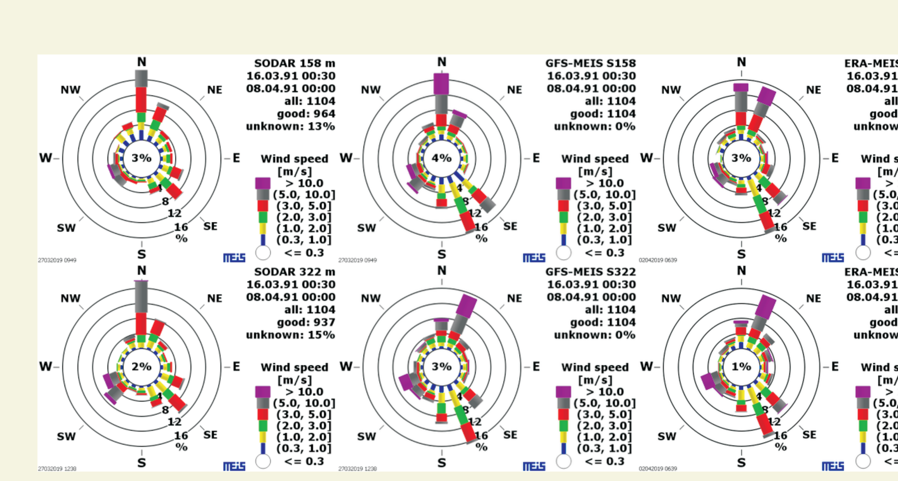
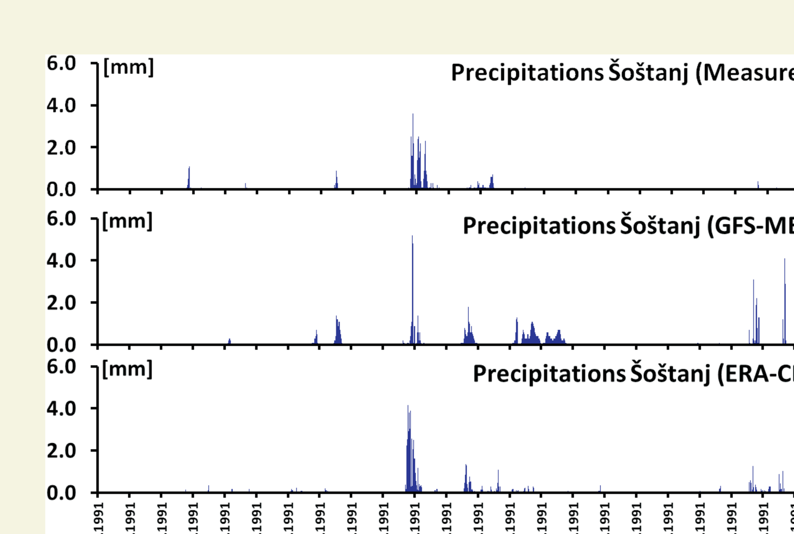
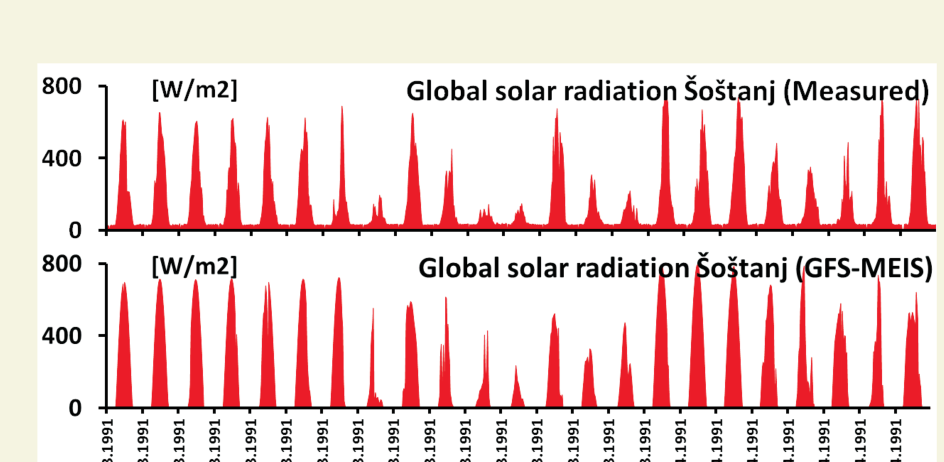


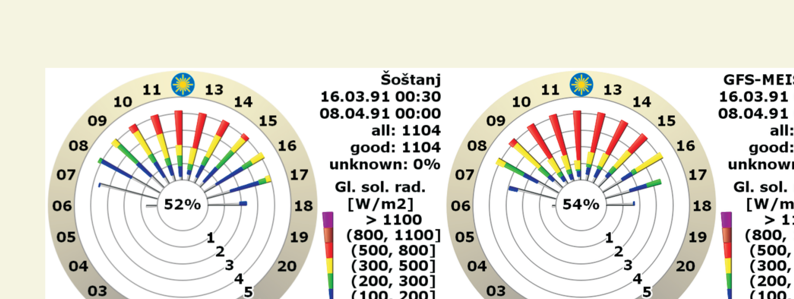
WIND COMPARISON AT SODAR LOCATION FOR TWO LEVELS AT 158 M AND 322 M HEIGHT ABOVE THE GROUND. WIND ROSES OF MEASUREMENTS AND WRF FORECASTS, MEIS-1 AND MEIS-2 EXERCISE RESULTS



PRECIPITATIONS: MEASUREMENTS, MEIS-1 EXERCISE RESULTS AND CEA-2 EXERCISE RESULTS



TIMELINE OF THE GLOBAL SOLAR IRRADIATION MEASUREMENTS AND MEIS-1 EXERCISE RESULTS



ANALYSIS OF THE DAILY CYCLE OF THE GLOBAL SOLAR IRRADIATION MEASUREMENTS AND MEIS-1 EXERCISE RESULTS

ACKNOWLEDGEMENT

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