Verification of 24 hours wind field forecast generated by WRF-ARW for January and July of 2009

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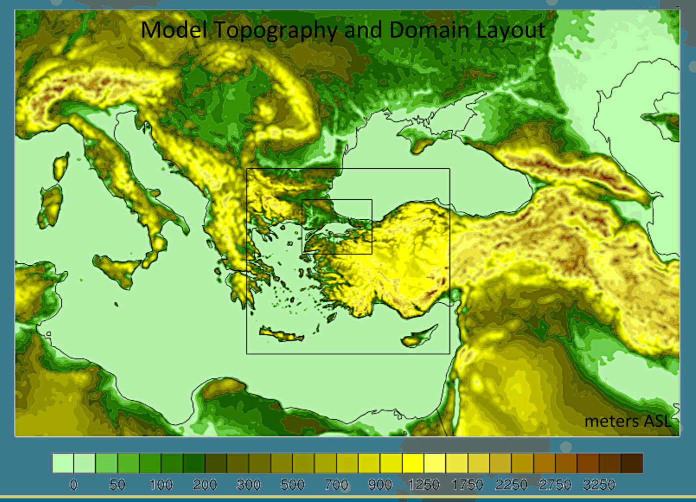
DATA & METHOD

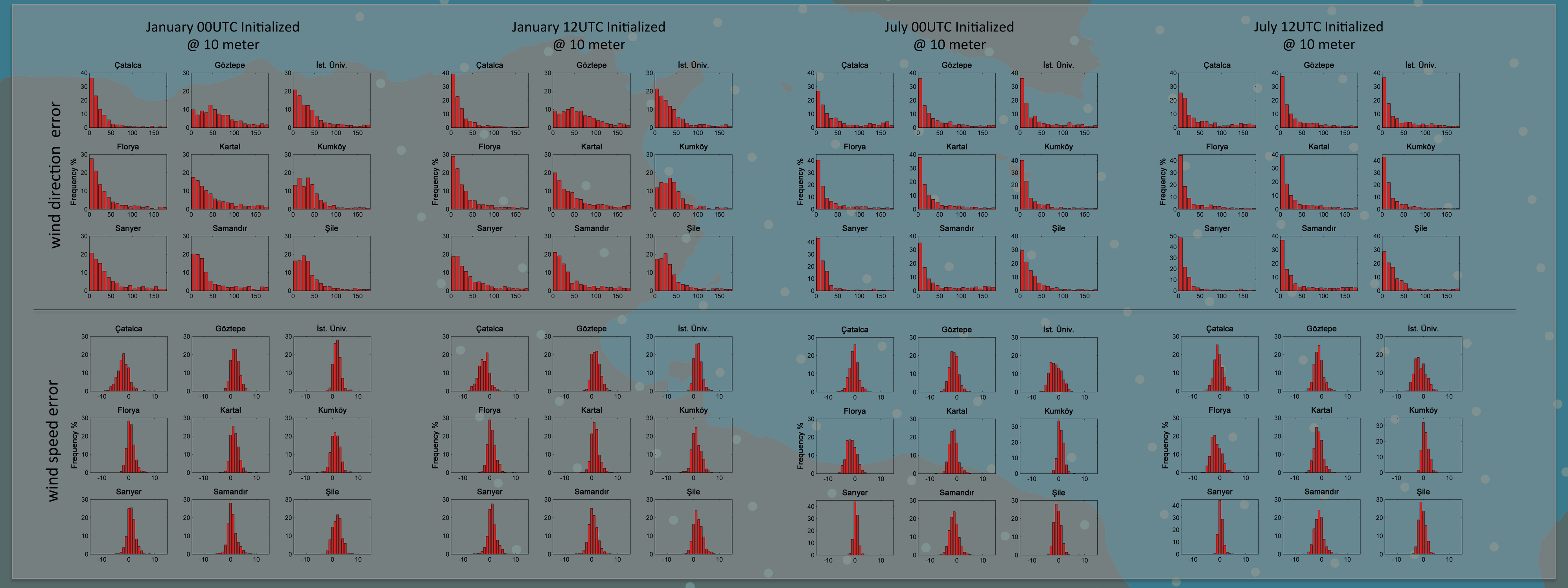
- 0000 & 1200 UTC cycles of ECMWF operational forecasts are used for model initialization and boundary conditions, wind fields are also used for comparisons between WRF model and observations.
- ERA Interim Re-analysis data are used as a reference for comparisons of spatial distribution of RMSE's between ECMWF Forecasts, and WRF wind fields, and also verified against radiosonde observations, again using RMSE method.
- Atmospheric soundings of Athens, Ankara, Isparta, Istanbul, and Izmir radiosonde observations provided the wind speed data at main isobaric levels to calculate RMSE of T+12, and T+24 hour forecasts at those levels. Closest grid point values are used at horizontal placement against radiosonde observations, whereas WRF eta levels are interpolated to main isobaric levels.
- 10m wind data at 9 ground stations within the finest domain of WRF are used for error analyses of wind speed and wind direction.
- ARW core of WRF v.3.3.1 model is chosen to produce atmospheric fields. Choice of domains, and configuration options can be seen below.



Configuration Choices of WRF-ARW	
Microphysics	WSM6
Planetary Boundary Layer	Monin-Obukhov
Boundary Layer	Yonsei University
Land Surface Model	Unified Noah
Cumulus Parametrization	* Grell Devenyi
Shortwave Radiation	Dudhia
Longwave Radiation	RRTM
Projection	Lambert Conformal
Vertical Cordinates	Terrain Following Sigma
Horizontal Grid Spacing	9km > 3km > 1km
Number of Grid Points South to North	270, 352, 310
Number of Grid Points West to East	420, 385, 400
Number of Vertical Levels	45
Initial Conditions	ECMWF Operational Forecasts
Boundary Conditions	ECMWF Operational Forecasts

* Only used at coarsest domain

VERIFICATION AGAINST GROUND STATIONS



- There are orographic differences up to 200m between observation points and the closest model grid. This might be the one of the reasons of the model wind speed deviations from the observations.
- Simulations initialized at 12 UTC perform better than the ones at 00 UTC, this is inherited from ECMWF forecasts.
- 60% of the wind speed errors varies between -1 m/s and 1 m/s. Stations located at rural areas of Istanbul (northern parts), have relatively small wind speed and wind direction errors, whereas errors increase with the urbanization level of the sites.

INTRODUCTION

This study is a part of greater project which aims to determine pollutant transport in case of a significant contaminant released from Istanbul, which is extremely populated and one of the most industrialized cities of Turkey. In this study, simulated wind fields are verified to investigate how model performs against ECMWF operational forecasts, under guidance of references: ERA Interim, ground stations, and radiosonde observations. Related two other poster presentations of this project are on display at **27 Apr 2012, 08:00-17:00.**

1. Cluster Analysis of the Trajectories for Forecasted Transport of Air Pollutants using WRF and HYSPLIT Models over Istanbul for January and July, 2009 @ XY15 by M. Acar et. al.

2. The Figure of Merit in Space (FMS) and Probability Analyses of the Concentrations for Forecasted Transport of Particles using the WRF and HYSPLIT Models over Istanbul for January and July, 2009 @ XY25 by C.Balli et. al.

Istanbul

CONCLUSIONS

- It is known that due to the scarcity of the observations at the high altitudes, ERA Interim data do not sufficiently represent those regions. Therefore, the differences between WRF and ERA Interim should not be considered as the errors of the WRF model.
- This configuration of WRF performs much better in July, as ECMWF forecasts also do.
- 12 UTC cycles of ECMWF operational forecasts are more reliable, therefore, simulations initialized with these data are also in good agreement with both radisonde and surface observations.
- WRF produces wind fields which are stronger than the observations near the surface.
- Jet levels are another weakness of WRF where model has high scores of RMSE, and it consistently over predicts wind speeds.
- The less error prone results are located in Istanbul, where the finest resolution domain lies on, the WRF improves the operational wind forecasts of ECMWF near the surface. The comparison of the WRF wind speeds and directions with the surface observations reveals that WRF simulations are better than both ECMWF operational forecast and Interim near surface.

ACKNOWLEGMENTS

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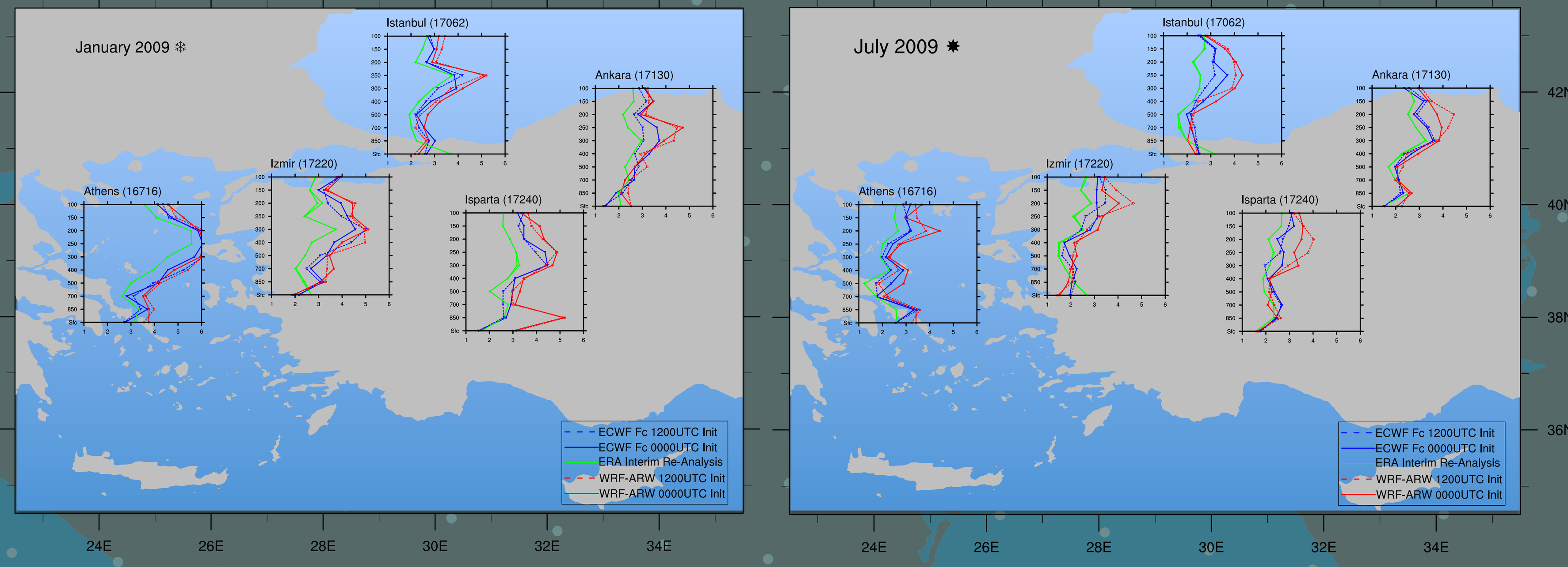
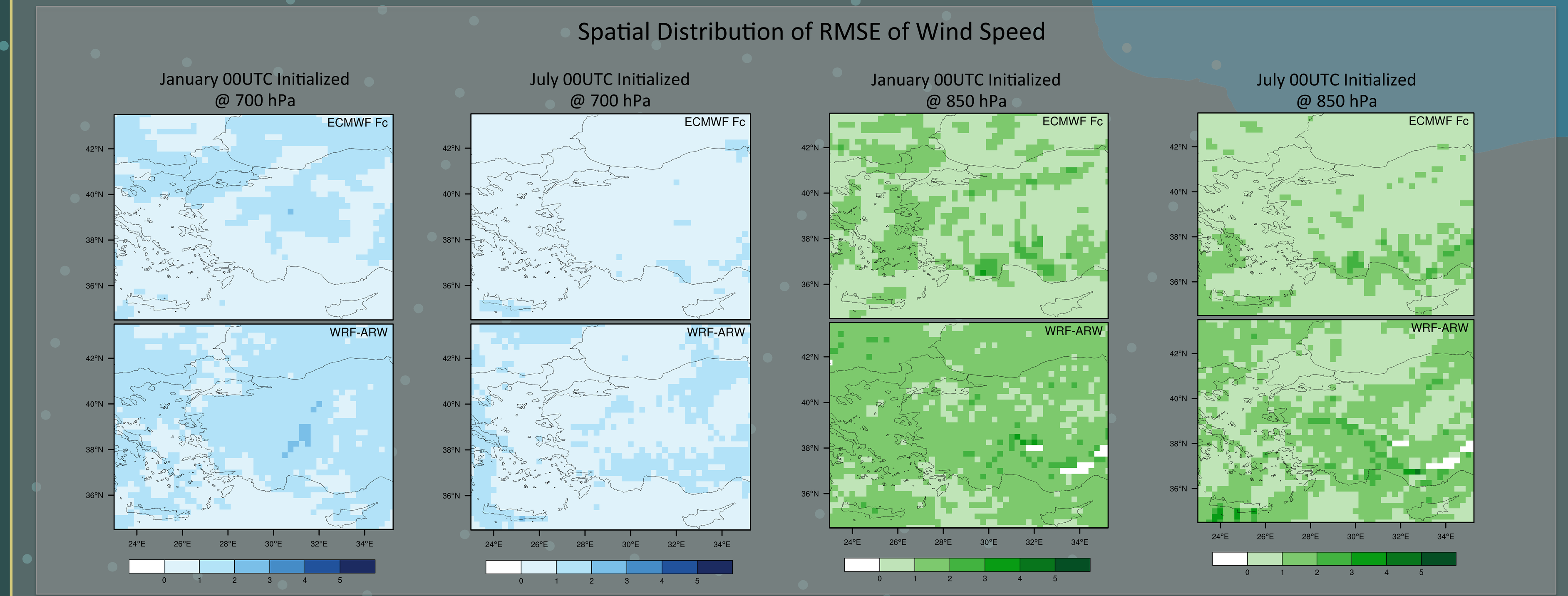
VERIFICATION AGAINST RADIOSONDE OBS.



- ERA Interim verifies the best against radiosonde observations but due to its coarse resolution, which causes representative errors, RMSE values are relatively higher near the surface.
- WRF performs better below 500 hPa level, and has consistently high RMSE scores at jet levels. In Istanbul, lies within the finest resolution domain, WRF has better scores near the ground probably profiting high resolution. July scores of WRF are apparently lower than January ones.
- Wind speed forecasts initialized at 12 UTC are in a good agreement with the observations than forecasts of 00 UTC . It is clear that WRF is sensitive to the driving field of ECMWF forecast data.

VERIFICATION AGAINST ERA INTERIM



- Spatial distribution of RMSE follows the topographical structure of the domain with large values around mountainous areas. Since ERA Interim has much smoother topography due to its coarse resolution, models with higher resolutions tend to produce higher variability due to fine representation of topography, even though they are interpolated to coarser resolutions. This effect weakens at higher atmospheric levels.
- Similar to radiosonde based verifications, month of July is better simulated than January and has lower scores of RMSE. WRF inherits errors of its driving field which also performs better in July but it is obvious that this configuration of WRF produce wind speed fields, which are closer to the wind fields of ERA-Interim between 700 hPa and 850 hPa levels in July.