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

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1. Introduction

The main focus of this study is to determine particulates and gases released from the hypothetical point source in Istanbul and transported by atmospheric flows. The aim is to compare the dispersion properties of 24 hourly WRF & HYSPLIT simulations to the one of ECWMF Era Interim and HYSPLIT by using FMS technique. The probabilities of the spread of the modeled concentrations for both January and July 2009 are presented.

Related poster presentations of this project are on display at 27 Apr 2012, 08:00--17:00

- *Verification of 24 hours wind field forecast generated by WRF-ARW for January and July of 2009 @ XY2 by F. Caglar et. al.*
- *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. Data

a. WRF & HYSPLIT Model

For the initial and boundary conditions 0.25 degree grid size ECMWF operational model data set is used to generate 24 hourly forecasts of atmospheric fields by the WRF model for both 00 UTC and 12 UTC, January and July of 2009. The interested model area has 3 nested domains with 9km, 3km, and 1km resolutions. The concentration analyses are performed in 3 nested-domains which are in the order of WRFD1, WRFD12, and WRFD123. Istanbul has been chosen as the central point of the nested domains, which have 420x270, 385x352, and 400x310 grid points, respectively (Figure 1).

HYSPLIT 24 hourly forward trajectory analyses are applied by using WRF results. 30,000 particulates with the initial delivery of 5,000 particles to the atmosphere are released at 10m over Istanbul.

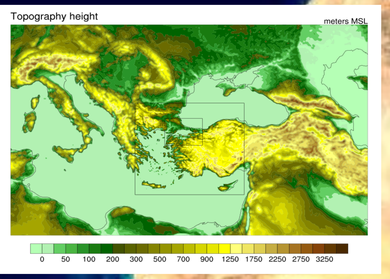

Figure 1. Model Domain – Topography Height

3. Methods

a. The Figure of Merit in Space (FMS) Analysis

FMS method is applied to the HYSPLIT concentrations, which are simulated by using the WRF model outputs. The space analyses are performed to compare HYSPLIT results to the concentrations calculated by using ECMWF Interim data. FMS can be counted as the statistical coefficient of this space analysis, so one can expect that high FMS values can show high agreement between observations and model results. Since FMS is a ratio between the intersections of the areas, it is a good indicator for the spread of the concentration in space.

b. Probability Analysis

The probabilities of the concentration spread are calculated for both January and July of 2009. Different probability distributions over the region are detected between 12 UTC and 00 UTC initializations.

4. Results

In this study, we have used percentage values of FMS for January and July of 2009 as fixed times and for a fixed concentration level. FMS analysis is applied to the 3-domain structures as defined above, WRFD1, WRFD12, and WRFD123. FMS values are calculated for the threshold value of 1 pgm^{-3}.

a. FMS Results

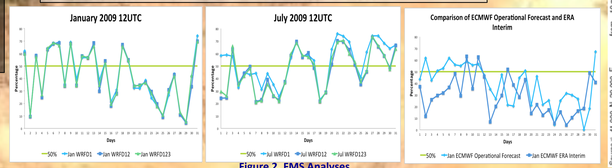

Figure 2. FMS Analyses

a. January 2009 12UTC b. July 2009 12UTC c. ECMWF ERA Interim - ECMWF Operational Forecast

The FMS results verify that WRF model wind velocity fields are in better agreement with ECMWF Forecast than ECMWF ERA Interim data for the level of 10m. Figure 2 shows that 15 days have a higher probability than 50% for July, whereas for January, 13 days pass over 50%. Consequently, this indicate that July model forecasts are more consistent with the ERA Interim concentrations than January forecasts.

b. HYSPLIT Concentrations

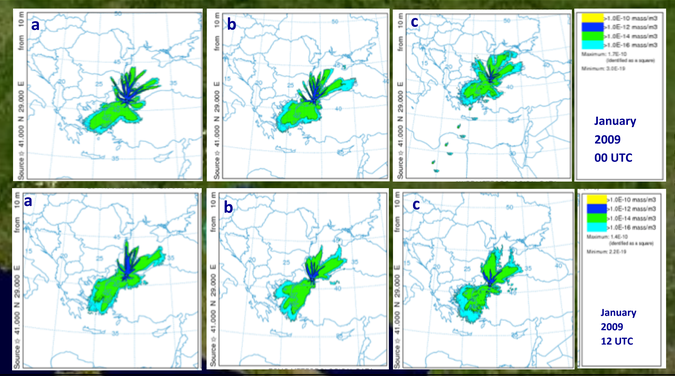

Figure 3. Sum of concentrations for 12 hours in January.
a. ECMWF ERA Interim
b. ECMWF Operational Forecast
c. WRFD123

Figure 3 The sum of concentrations for 12 hours, for January 00UTC and 12UTC. The concentration spreads to the Black Sea and the Northern neighbors of Turkey and extends to the Northern Aegean Sea and to the coast of Greece.

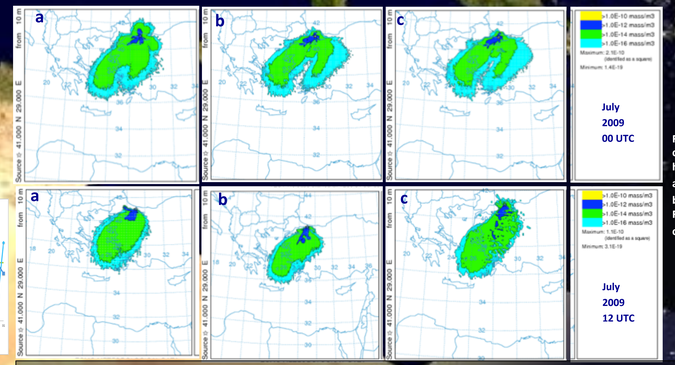

Figure 4. Sum of concentrations for 12 hours in July.
a. ECMWF ERA Interim
b. ECMWF Operational Forecast
c. WRFD123

Figure 4 shows the sum of concentrations for 12 hours, for July 00UTC and 12UTC. The concentration spreads to northwestern part of Turkey, where Marmara Seas, North Aegean, Central and Western Anatolia and the border of Greece.

c. Probability Results

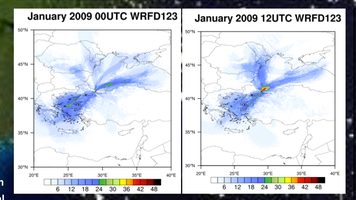

Figure 5. Probability Analyses of the Concentration for January WRFD123
a. January 2009 00UTC b. January 2009 12UTC

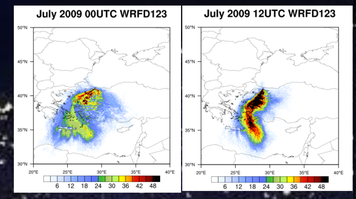

Figure 6. Probability Analyses of the Concentration for July WRFD123
a. July 2009 00UTC b. July 2009 12UTC

The higher probability concentrations, approximately 20%, can be seen over the Black Sea region extending to the northern neighbors of Turkey. We also observed secondary dominant particle dispersion in the northeast direction with the probability of 25% extending to the Northern Aegean Sea and to the coast of Greece.

The predominant wind direction in summer is northeasterly in the northwestern part of Turkey. North Aegean and Marmara Seas are affected by particles with 40% chance. Although, for further south, this probability is decreased to 25 to 30%, Central and Western Anatolia and the border of Greece are still at higher risk.

5. Conclusion

Istanbul is the hypothetical origin location of particle release. Therefore, the highest probability of concentrations is found in this location.

Dominant direction of particles' spread is southwesterly. As shown in the probability graphics, 12 UTC results show higher probabilities than 00 UTC.

As a result, our analyses indicate that if there is an explosion in Istanbul area, high-risk regions depend on the season.

If it occurs in winter, the transported hazardous particles might affect the northern part of Turkey and its neighbors, while in summer the southern and western part of Turkey is under the threat.

6. Acknowledgements

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