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RECENT VALIDATION OF THE OPERATIONAL MULTI-SCALE ENVIRONMENT MODEL WITH GRID ADAPTIVITY

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1. INTRODUCTION

In order to improve the fidelity of hazardous transport models, it is essential that the meteorological forecast itself be improved. This is because the modeling of atmospheric dispersion involves virtually all scales of atmospheric motion from microscale turbulence to planetary scale waves. The current operational atmospheric simulation systems are scale specific and cannot resolve the full spectrum required for the accurate forecast of local scale phenomena.

The Operational Multiscale Environment model with Grid Adaptivity (OMEGA) is a new atmospheric simulation that, with its embedded Atmospheric Dispersion Model (ADM), was conceived to advance the state-of-the-art in predicting the transport and diffusion of hazardous releases. The bulk of hazardous releases occur near the surface, are dispersed primarily in the PBL, and are strongly influenced by surface features. The grid structure, numerical basis, and physical models encapsulated by OMEGA have been discussed elsewhere (Bacon *et al.*, 1993, 1996), this paper is intended to briefly discuss recent validations of the model.

2. MODEL OVERVIEW

The development of the OMEGA/ADM model has been development guided by two basic design considerations in order to meet the goal of an operational tool: (1) the application of an unstructured mesh numerical technique to atmospheric simulation; and (2) the use of an embedded atmospheric dispersion algorithm. Table 1 provides an overview of the OMEGA system. In addition, the goal of creating an operational tool drove the design of XOMEGA (Figure 1), the OMEGA Graphical User Interface (GUI), and the creation of world-wide databases to support the model.

The OMEGA elevation database was built using a multi-variate krigging procedure from a wide variety of source data. The elevation data was built into two datasets: low-resolution (5 arc-minutes) and high-resolution (30 arc seconds). A land/water fraction dataset was derived at the same resolutions from the Digital Chart of the World and the World Vector Shoreline products of the US Defense Mapping Agency. These datasets were used to create the Bosnia-Herzegovina grid seen in Figure 2.

In addition to these databases, OMEGA uses data on sea surface temperature, soil type, soil temperature and moisture, land use, and vegetation.

Table 1. OMEGA Overview

Governing equations	Fully non-hydrostatic equation set
Dimensionality	3D
Grid structure	Unstructured and adaptive triangular prisms
Coordinate system	Rotating Cartesian coordinate framework
Numeric	Finite volume
Soil surface	Based on the force-restore rate method
PBL	Treated separately as viscous sublayer, surface layer, and transition layer
Turbulence closure	*1.5 order κ-ε closure*. Based on turbulent kinetic energy and its dissipation
Cumulus parameterization	Modified Kuo scheme
Microphysics	Extensive bulk-water microphysics
Radiation	Shortwave absorption by water vapor and longwave emissivities of water vapor and carbon dioxide
Initialization	Based on 4D data assimilation
Transport and diffusion	Embedded Eulerian and Lagrangian aerosol dispersion algorithms

3. RECENT VALIDATION

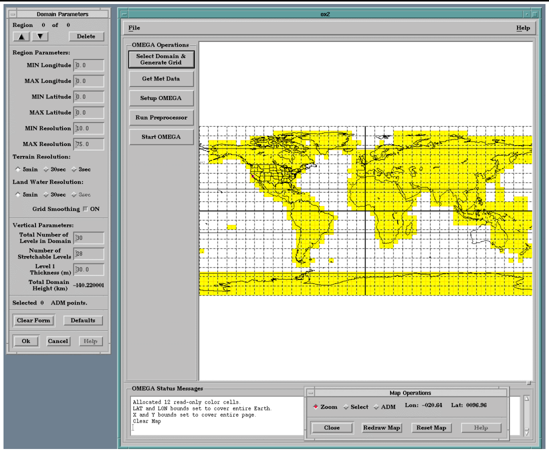

Figure 1. The OMEGA GUI Browse Map.

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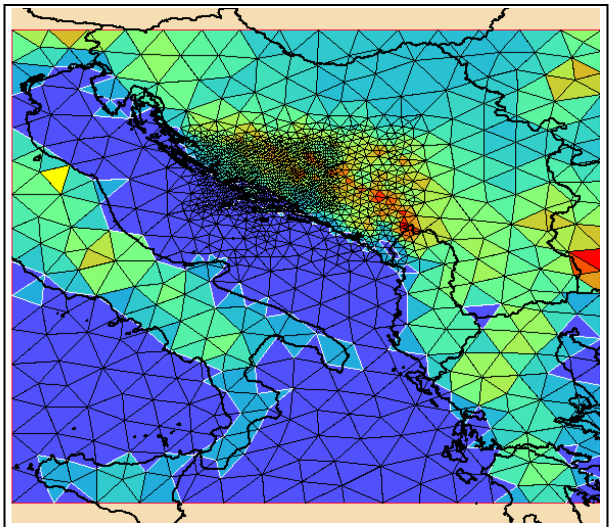

Figure 2. OMEGA grid for Bosnia - Herzegovina.

While we have checked the performance of the PBL, convective parameterization, and turbulence models, we will not discuss those here. Instead we jump to the validation of OMEGA against well-instrumented field experiments. OMEGA has supported a number of field exercises over the past year, including test releases over complex terrain at the White Sands Missile Range. Figure 3 (left) shows the terrain of the region with the test region marked. The prevailing wind at the time of release was northwesterly, causing the SF_6 cloud to head into the gap. Figure 3 (right) shows a comparison of the plume centroid forecast by OMEGA with those observed by lidar measurements. The agreement between this 24-hour **forecast** and the actual plume track is exceptionally good.

4. CONCLUSIONS

OMEGA represents a departure from traditional methods used for atmospheric simulation. For the first time in recent years, advanced numerical methods, developed by the computational fluid dynamics community, have been applied to the problems of atmospheric simulation and aerosol and gas dispersion. This has permitted the development of an extremely flexible and extremely high resolution simulation tool.

5. ACKNOWLEDGMENTS

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6. REFERENCES

Bacon, D., T. J. Dunn, Y-L. Ho, I. Lottati, M. D. McCorcle, S. E. Peckham, R. A. Sarma, S. Young, and J. Zack, 1993: Operational Multi-Scale Environment model with Grid Adaptivity (OMEGA). *Proc. 13th Conf. on Wea. Anal. and For.*, August 2-6, 1993. AMS., Boston, MA..

Bacon, D., Z. Boybeyi, P. Boris, T. J. Dunn, M. Hall, R. A. Sarma, S. Young, and J. Zack, 1996: An Overview of the Operational Multi-Scale Environment model with Grid Adaptivity . *Proc. 15th Conf. on Wea. Anal. and For.*, August 19-23, 1996. AMS., Boston, MA..

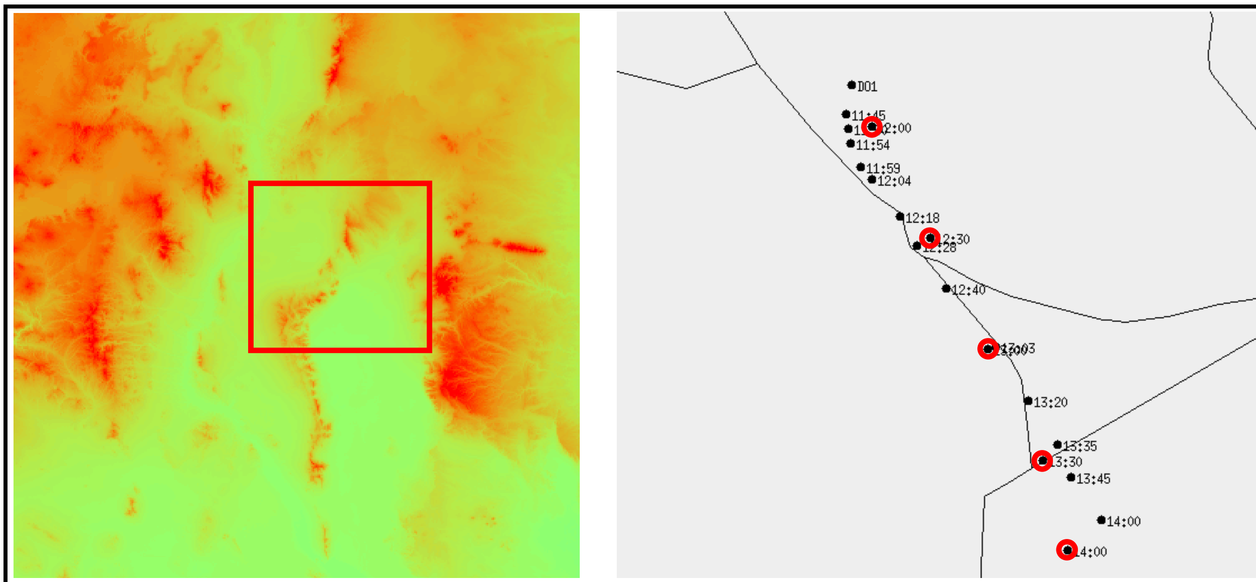

Figure 3. The terrain surrounding the test site at White Sands Missile Range (left) and a comparison of the OMEGA-forecasted plume centroid (circled dots) and the lidar-measured plume centroid.