Chapter 1: Introduction to the EMS

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1.1 The EMS: What is it?

The National Weather Service (NWS) Science and Training Resource Center's (STRC) Unified Environmental Modeling System (EMS) is a complete, full-physics, state-of-the-science numerical weather prediction (NWP) package that incorporates the NOAA (NEMS)* and WRF systems into a single user-friendly, end-to-end forecasting system. All the capability of the NCEP NEMS and NCAR WRF models are retained within the EMS; however, the installation, configuration, and execution of each has been greatly simplified to encourage its use within the operational, private, and university forecasting and research communities.

Nearly every element of an operational NWP system has been integrated into the EMS, including the acquisition and processing of initialization data, model execution, output data processing, and file migration and archiving. Even tools for the display of output are provided. Real-time forecasting operations are enhanced through the use of an automated process that incorporates various fail-over options as well as the synchronous post processing and distribution of forecast files. The EMS can run on either a stand-alone workstation or a cluster of Linux computers with minimal effort.

Additional information about the EMS, including much of the same stuff written in this guide can be found on the NWS Science Operations Officer (SOO) Science and Training Resource Center (STRC) web site:

http://strc.comet.ucar.edu

* Oops - NEMS NMM-B will be included in a future release but I'm too lazy to edit the document that was written before I could come to grips with my incompetence.

1.2 Why You Should Care

The EMS package was developed to promote the use of local numerical weather prediction models within the US National Weather Service (NWS) Weather Forecast Offices (WFOs) in order to achieve the following goals established by the SOO Science and Training Resource Coordinator (SOO STRC):

1. To improve the knowledge and use of NWP systems and issues at a local level.
2. To advance the forecasting process through an improved understanding of atmospheric processes and the use of non-traditional forecast tools.

3. To increase participation among the WFOs and other groups in developing and running NWP systems to examine local forecast problems.

Running the EMS locally will serve to provide \textit{(At least this is the plan)}:

1. NWP guidance to NWS WFOs and River Forecast Centers (RFCs) at temporal and spatial scales not available from operational data sources.
2. A powerful tool for studying local forecast problems and historically significant weather events.
3. An alternative to the configuration and physics of operational systems.
4. A means to develop and test new diagnostic forecast techniques.
5. A method of training forecasters on NWP-related issues.
6. More hair on your head and less on your back, \textit{and that’s a good thing!}

\textbf{1.3 A Summary Of The EMS Features}

- The EMS is a complete, full-physics, NWP package that incorporates dynamical cores from both the NCAR ARW and the NCEP NMM WRF models into a single end-to-end forecasting system.

- The system is easy to install and configure. Users should be able to run simulations within 30 minutes of installation. And with such wonderful documentation, why shouldn’t it be easy?

- Yes, the rumors are correct! No compilers are necessary for running the EMS. The system includes pre-compiled binaries optimized for 32- and 64-bit Linux systems running in distributed memory Linux environments. The MPICH executables are also included for running on local clusters across multiple workstations.

- The installation tool does just about everything the user could want, including the creation of a user account (if necessary), installation of the software, configuration of the system, and even determines which binaries are best for you.

- Auto-updating capability has been integrated into the EMS. When an update or patch becomes available, it is downloaded and installed automatically. And this time, it (almost) works!

- The EMS includes preconfigured WRF ARW and NMM core benchmark cases so that you can test the performance of your system.

- The EMS is designed to give users flexibility in configuring and running NWP simulations, whether it is for local research or real-time forecasting purposes.

- The EMS allows for the acquisition of multiple initialization data sets via NFS, FTP, and HTTP. And just like the developer, the system is semi-intelligent in that it can determine which data sets are available for ingestion at a given time.
• The system has the capability to reduce the likelihood of missed forecasts during real-time operations by incorporating multiple “fail-over” options that include alternate servers, data sets, or initialization forecast hour. Should there be a problem with a simulation, the EMS can also send e-mail to users.

• All configuration parameters have been organized and documented in easy to read files that contain default settings for each dynamical core.

• The system can be configured to automatically calculate an appropriate timestep for each dynamical core and horizontal grid spacing.

• The EMS supports the automated processing of forecast files concurrent with a model run, thus allowing users to view forecast fields while the model is still running.

• The post processor supports a wide variety of display software including AWIPS, BUFKIT, NCL, GrADS, GEMPAK, NAWIPS, and netCDF.

• The EMSUPP, a modified version of the NCAR Unified Post Processor (UPP), can processes forecast fields on 81 different pressure levels from 10 to 1025mb.

• Forecast files may be exported to remote systems via SFTP, FTP, cp, and/or SCP.

### 1.4 How Much Computer Power Is Necessary To Run The EMS?

The answer to this question depends upon whether you will be executing the EMS for research or real-time forecasting purposes. For real-time use, you need as much computer power as you can afford, with a premium placed on fast, multi-CPU Linux systems with at least 8GB of physical memory. The amount of memory should be commensurate with CPU performance. That's just the nature of NWP, as chances are that you will always want to run the model at higher resolutions over a larger computational domain with the most accurate (and expensive) physics and dynamics. For research purposes, you will still want all the best for your runs; however, you will not need to make as many compromises since the speed of the machine is not as critical as you are not up against any deadlines to get a forecast completed. Finally, if you plan on running nested simulations, consider increasing the amount of physical memory even further.

The binaries compiled for the EMS should run on any INTEL or AMD Linux (non-BSD) system running a minimum kernel version of 2.6 or later. Also, the processors must support SSE instructions so older AMD and INTEL processors may not be a viable option.

While the minimum amount of physical memory needed is ~8Gb, it is strongly suggested that machines have a minimum of 16Gb for real-time modeling to avoid paging and swapping issues. In general, if you have less than 4 Gb of memory, then consider increasing your system resources. Besides, memory is relatively inexpensive.

### 1.5 What Support Is Available For The EMS?

The STRC EMS modeling package is fully supported by the NWS Science and Training Resource Coordinator (SOO STRC). The US NWS and other NOAA agencies may request help from the SOO
STRC directly. Support is also available to other government agencies upon request. Non-governmental agencies, such as non-profit groups, academic institutions and the commercial sector are also welcome to use the EMS; however, support will be limited and up to the discretion of the SOO STRC. This means that you can ask for help, but it may take a while to get a response, so be persistent and patient -- it will eventually pay off.

**Please keep in mind that a single person conducts all EMS activities.** This includes testing, package design, development, support, research, computer maintenance, EMS real-time data server upkeep, web site development (or lack thereof), DVD burning, labeling, and mailing. So be kind and understanding as nothing gets done as quickly as it should, and many things not at all.

1.6 **What If I Have A Brilliant Idea That Must Be Incorporated Into The EMS?**

The EMS package is always under development, so please feel free to send the SOO STRC your suggestions for improvement; however, it is strongly suggested that you read the last paragraph in the previous section before doing so. It wouldn’t hurt to read the acknowledgements section either.