Air Force Weather Agency

Integrity - Service - Excellence

AFWA Plans For Frameworks and Standards

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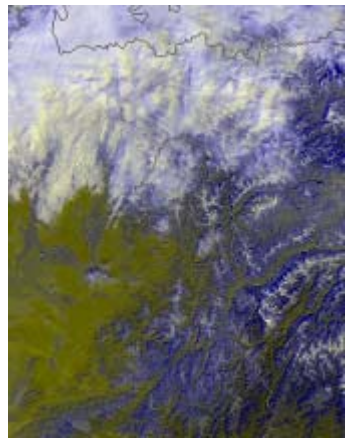
U.S. AIR FORCE

Air Force Weather Agency Mission:

Maximize our Nation's aerospace and ground combat effectiveness by providing:

- **Accurate, relevant and timely air and space weather information to DoD, coalition, and national users.**



Overview

- Earth System Modeling Framework (ESMF)
- Battlespace Environments Institute (BEI)
- BEI space weather initiatives

Motivation for ESMF

In climate research and NWP...

increased emphasis on detailed representation of individual physical processes; requires many teams of specialists to contribute components to an overall modeling system

In computing technology...

increase in hardware and software complexity in high-performance computing, as we shift toward the use of scalable computing architectures

In software …

development of frameworks, such as FMS, GEMS, CCA and WRF, that encourage software reuse and interoperability

The ESMF is a focused community effort to tame the complexity of models and the computing environment. It leverages, unifies and extends existing software frameworks, creating new opportunities for scientific contribution and collaboration.

Background

NASA's Earth Science Technology Office proposed the creation of an **Earth System Modeling Framework (ESMF)** in the September 2000 NASA Cooperative Agreement Notice (CAN):

> "Increasing Interoperability and Performance of Grand Challenge Applications in the Earth, Space, Life and Microgravity Sciences"

A large, interagency collaboration with roots in the **Common Modeling Infrastructure Working Group** proposed three interlinked projects to develop and deploy the ESMF, which were all funded:

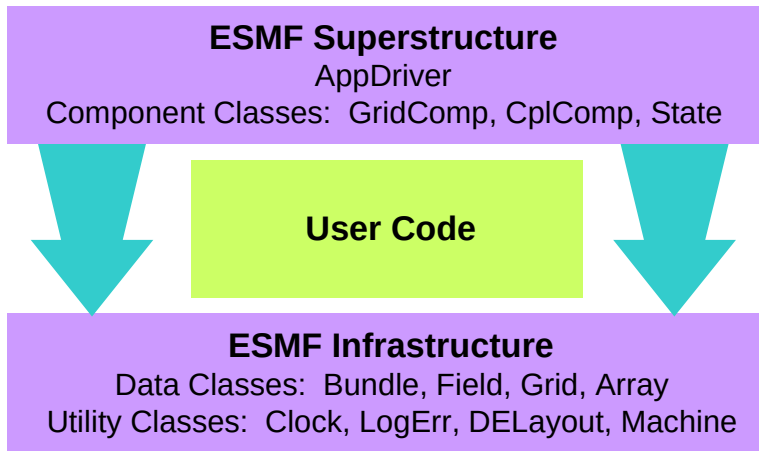
Part I: Core ESMF Development (PI: Killeen, NCAR)
Part II: Modeling Applications (PI: Marshall, MIT)
Part III: Data Assimilation Applications (PI: da Silva, NASA GMAO)

ESMF is a Community Effort

- **Collaborators and customers include:**
  - **NSF NCAR**
  - **NOAA GFDL, NOAA NCEP**
  - **DOE LANL, DOE ANL**
  - **NASA GMAO, NASA Land Information Systems, NASA GISS**
  - **DoD Navy, Air Force, and Army**
  - **Numerous Universities**
- **Users define development priorities**
- **Users actively test and evaluate the framework design and implementation**
- **~15% of ESMF source code is from user contributions**

What is ESMF?

1. ESMF provides tools for turning model codes into components with standard interfaces and standard drivers
2. ESMF provides data structures and common utilities that components use
   i. to organize codes
   ii. to improve performance portability
   iii. for common services such as data communications, regridding, time management and message logging



BEI Objectives

- To develop a *DoD-wide* whole-earth environment which interoperates with that from other agencies:
  - Migrate core DoD models to ESMF
    - Navy (e.g., NCOM, HYCOM, SWAN, COAMPS™)
    - Air Force (WRF, Kinematic Solar Wind and GAIM)
    - Army (e.g., ADCIRC, WASH123)
  - Development of tools and applications (e.g., extend ESMF to support unstructured grids and nesting)
  - Coupled applications: Air/ocean, air/ocean/ice, air/ocean/groundwater, air/space weather
  - Thorough testing, prototyping, documentation of all components

- Will result in cross-service/cross-agency collaborations and savings, and the rapid transfer of new models to support the DoD mission

BEI Technical Framework

- Technical Teams:
  - **Army (ERDC): Groundwater, riverine**
  - **Air Force (AFWA): Space weather, WRF**
  - **Navy (NRL-SSC): Ocean dynamics (waves, currents, ice), coupling**
  - **Navy (NRL-MRY) Atmospheric modeling, enhancements and coupling**
  - **NCAR: ESMF Core Team, unstructured grids, WRF, new capabilities for DoD**
- Management:
  - **NRL-SSC Provides Technical, Financial Oversight**

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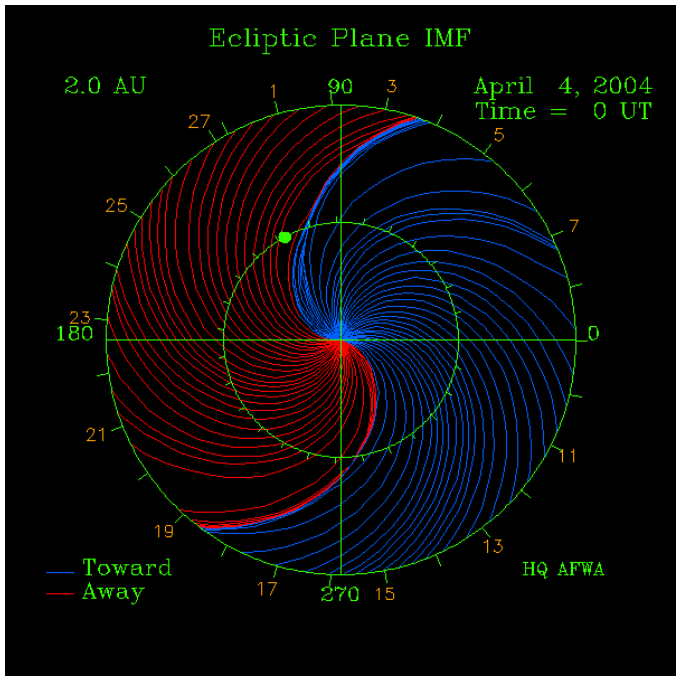
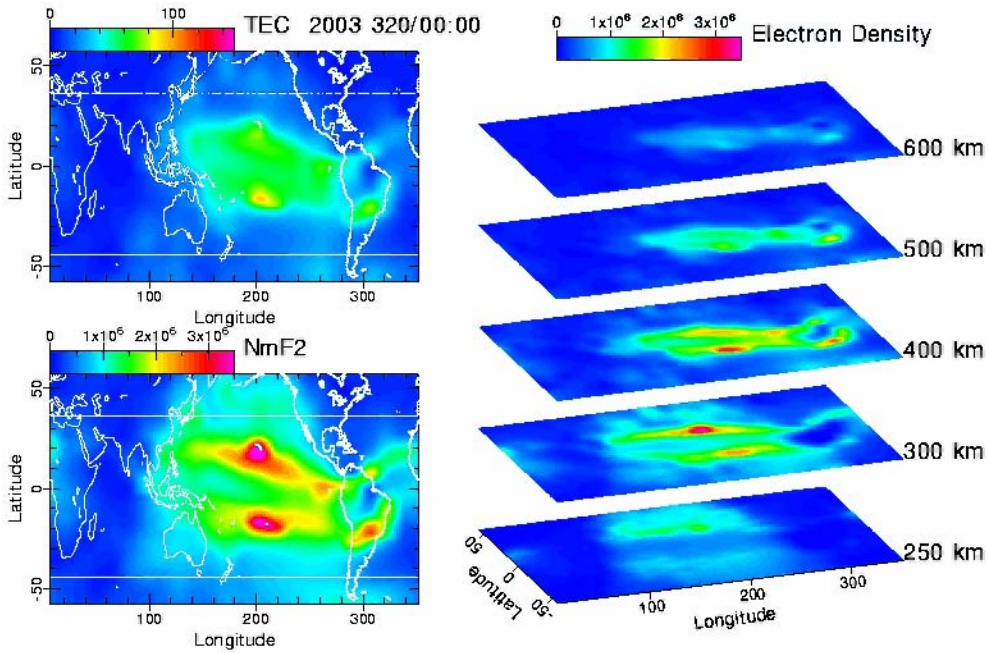
Space Weather Modeling Goals

Couple ESMF versions of Hakamada-Akasofu-Fry (HAF) Kinematic Solar Wind and Global Assimilation of Ionospheric Measurements (GAIM) models to provide DoD with the ability to forecast ionospheric conditions from hours to days.





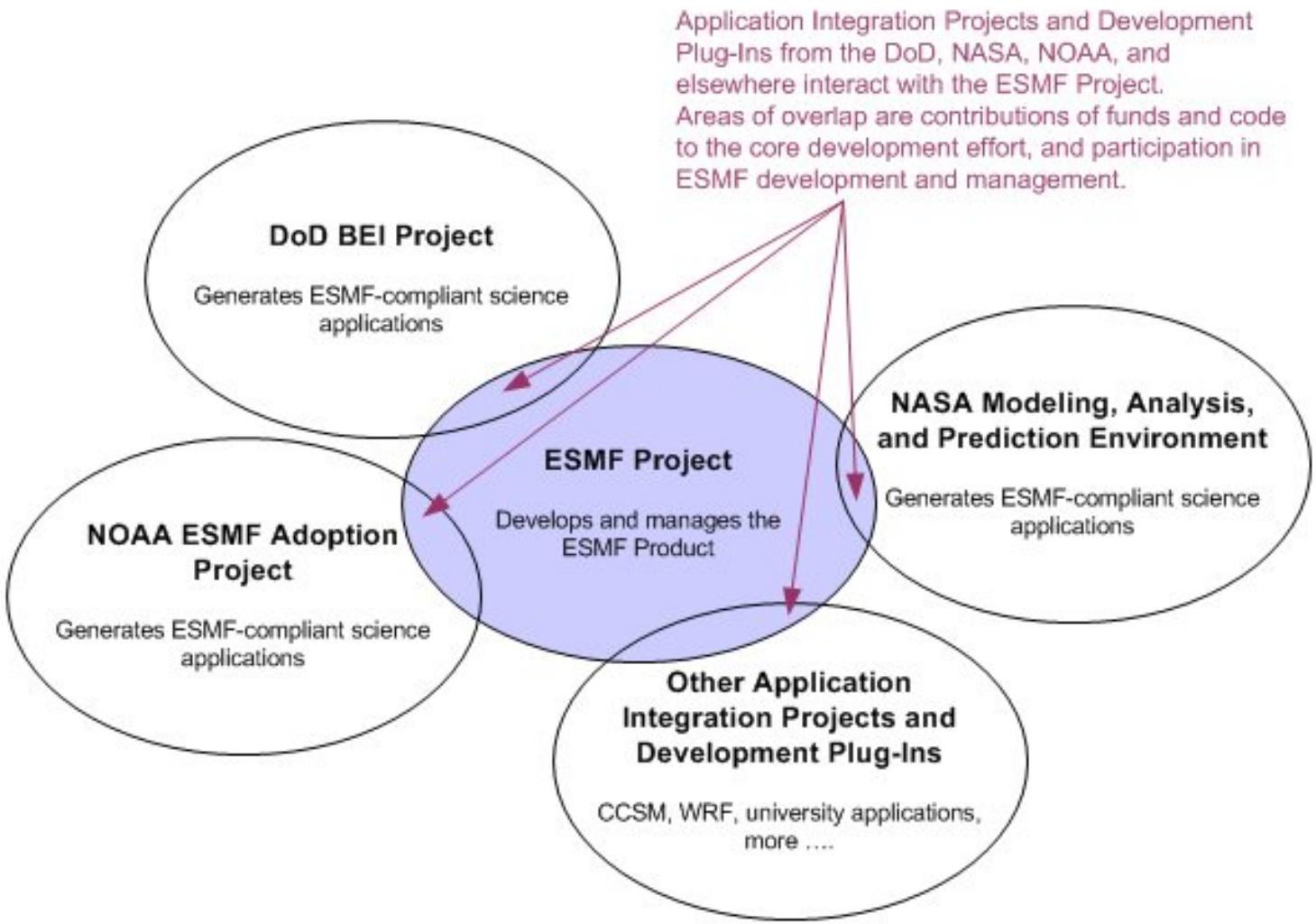
Extreme space weather conditions can adversely affect communications, radar, and satellite systems.

Summary

- BEI is the agency within the DoD charged with migrating all environmental models to a standardized modeling framework
- BEI intends to use the ESMF
- First space weather effort is directed at coupling HAF to GAIM within the ESMF construct

Backup Slides

BEI Interaction with ESMF and Related Efforts



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Terrestrial Modeling Goals

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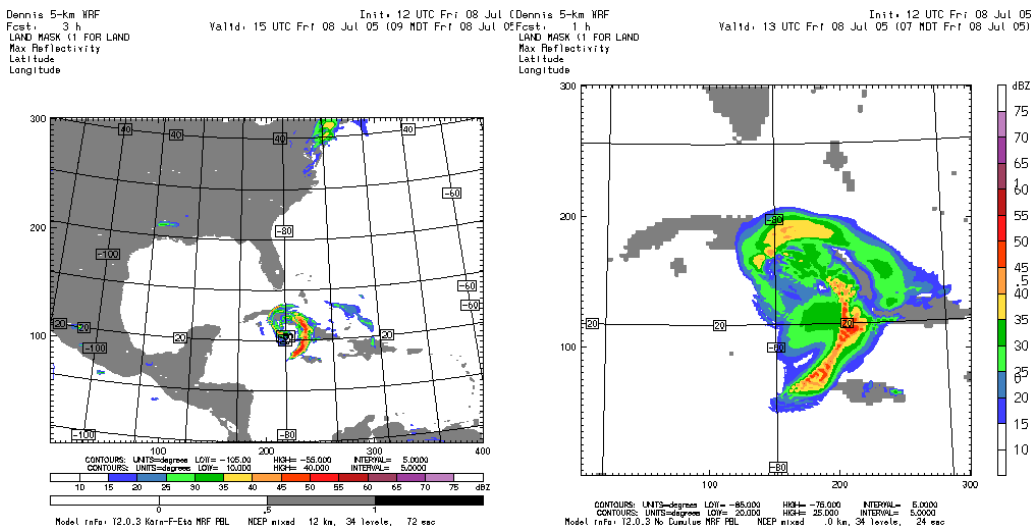
WRF-HYCOM Coupling

• Purpose: Develop and demonstrate on a DoD high performance computing (HPC) system a coupled atmosphere-ocean system based on the WRF model and Hybrid Coordinate Ocean Model (HYCOM) within the BEI-endorsed ESMF-based coupling software framework.

• Status: In work. Contractor in process of formalizing a WRF benchmark page, including a set of instructions, procedures, and definitions to ensure a fair process for accepting and posting vendor-contributed results



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Terrestrial Modeling Goals

WRF Optimization

• Status: In work. Contractor in process of formalizing a WRF benchmark page, including a set of instructions, procedures, and definitions to ensure a fair process for accepting and posting vendor-contributed results

• Target: AFWA-sized (or larger) domains and nests.