Results from the NCAR Space Weather Prediction Testbed Study

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Study of a Space Weather Developmental Testbed Center

A study of a possible developmental testbed center to support transition to operations of space weather models was requested by AFWA and NOAA.

The High Altitude Observatory and the Joint Numerical Testbed of the National Center for Atmospheric Research conducted this study.

SWDTC was too much of a mouthful, even for SWPC personnel

...so we came up with “SWEPT,” which was abbreviated to “SWPT.”

As part of that study, we have solicited input from the space weather research community, especially developers of numerical models, as to how such an operation should be organized, and how it might interact with researchers.

SWPT Study Report

Space Weather Prediction Testbed
Study Report

28 February, 2009

1. Executive Summary

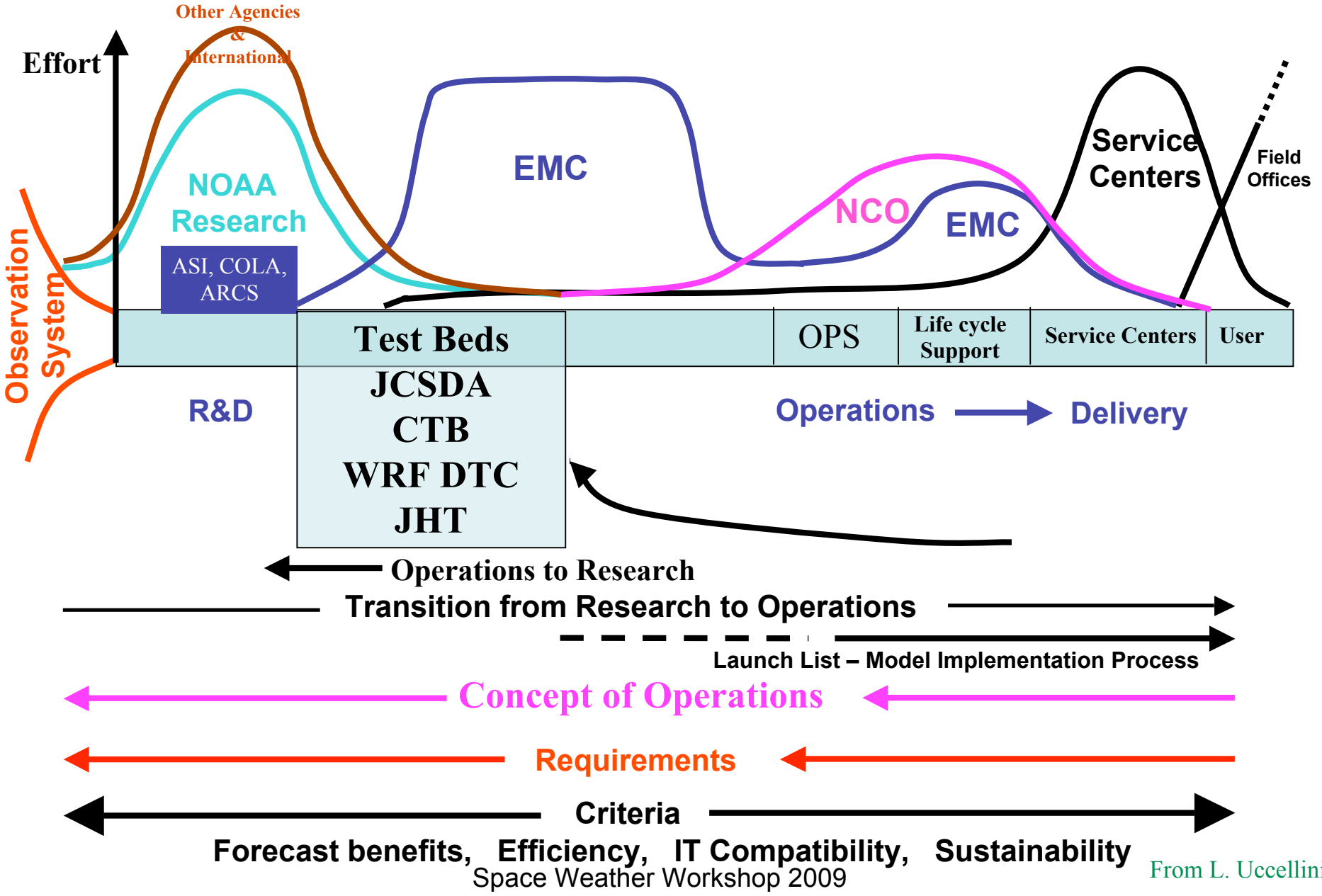
The NOAA Space Weather Prediction Center (SWPC) and the Air Force Weather Agency (AFWA) have requested a study of a Space Weather Prediction Testbed (SWPT). We have drafted a Concept of Operations for such a Testbed, formulated a conceptual model test plan, solicited input from the space physics research community, and evaluated implementation options.

Our principal recommendations are as follows:

- There is a clear need for some type of national facility for testing and evaluation of numerical models of the space weather environment, and transitioning them to operational agencies.
- These functions could be performed by an existing organization, such as SWPC or the CCMC, or performed by a new organization implemented in a scientifically cognizant university department, industrial organization, or federally-funded research and development center.
- The activity should be put out for competitive bids and competing proposals evaluated in a fair and objective manner.
- The research community should have an active collaborative role in the endeavor.

Schematics in the Model Transition Process

EMC and NCO have critical roles in the transition from NOAA R&D to operations

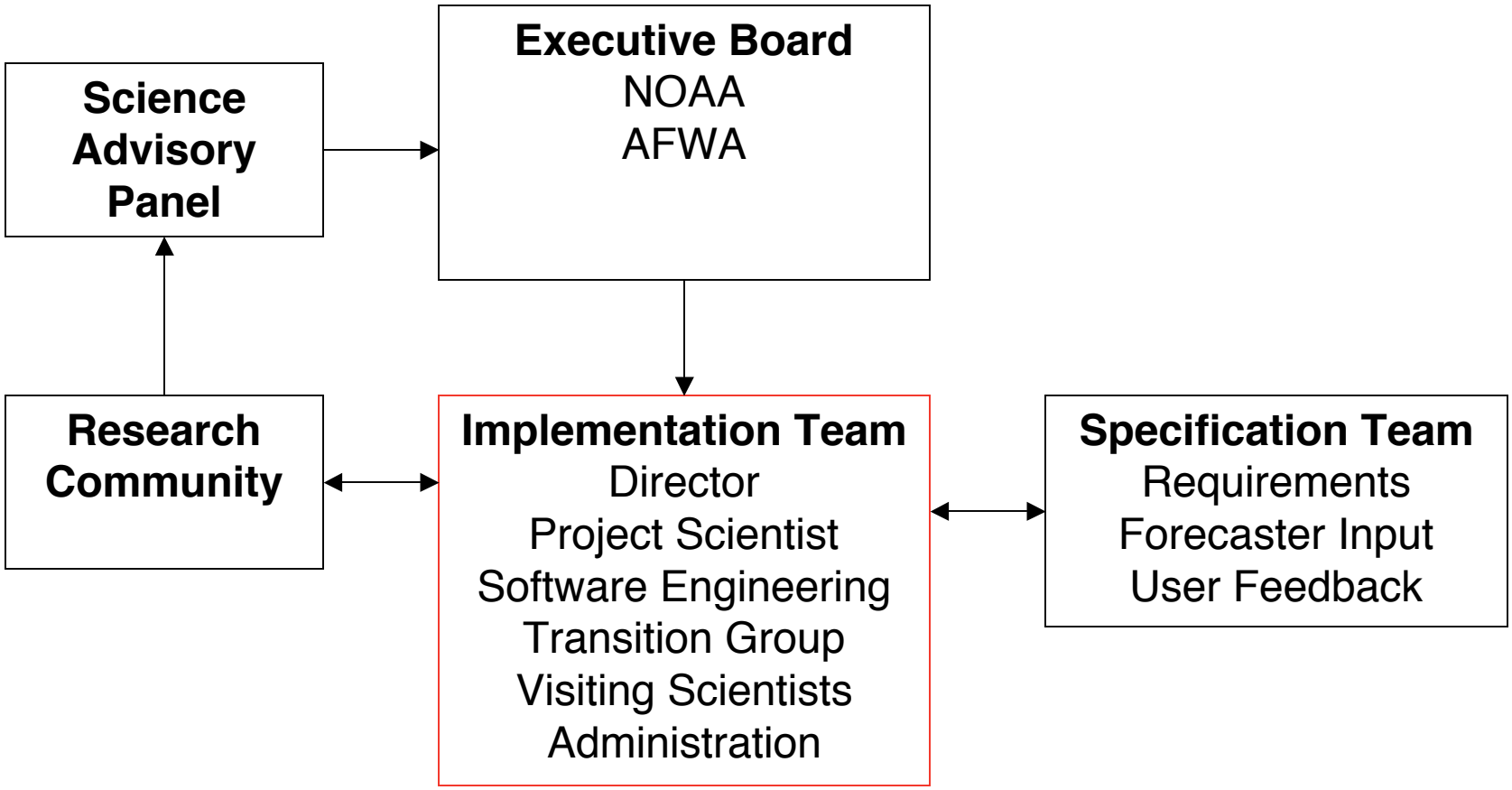


From L. Uccellini

Purpose and Goals of a SWPT

- Primary focus is on preparing models for operations
  - Improvements maybe required in reliability, stability, and efficiency for robust real-time operations
  - Standardization of input streams and identification of input source hierarchy
  - Outputs tailored to meet the needs of forecasters and commercial user interests
- Another goal is the establishment of a robust, routine, and on-going testing and evaluation process
  - Using metrics developed in conjunction with forecasters provide quantitative information about models capabilities
  - Quantitatively assess the effects of model improves
  - Being outside the SWPC security perimeter is important
- Provide a conduit for Operations-to-Research
  - Allow access to long-term database of model runs and skill reporting

Organizational Concept



Model Selection Process

- Decisions regarding which models are selected for transition to a SWPT are made by the Executive Board
  - This model process must be objective, fair, and transparent
- Models selection criteria include
  - Ability of the model to predict parameters directly relevant to the needs of forecast products
  - Track record of the model
  - Technical Readiness Level of the model source code
  - Availability of real-time input data needed by the model
  - Computational requirements needed for real-time performance

Transition Activities

- A SWPT will focus on the research engineering process designed to get models into operations
  - Software engineering is a key part of this process, but we do not believe it can be efficiently and effectively conducted without scientific expertise
  - This process includes efforts to
    - Automate and put in place redundancies for input data
    - Determine data output requirements for forecast products and model restarts
    - Develop the tailored forecast products and displays
  - We believe that that this process is enhanced by including the model authors in the product development loop
    - Dealing with the IP issues is a significant concern

Testing and Evaluation

- The T&E process conducted by a SWPT will focus on three aspects
  - Quantitatively determining the model robust
  - Assuring the robustness of the model
  - Assessing the effects of model resolution
- Metrics and skill scores will be tailored to accurately test the results in terms of the requirements of the forecast products
  - This includes examination of the distribution of errors and where possible determining uncertainty in verification measures

Comparative Overview of Concept of Operations Drafts

Solomon / Wiltberger Draft	***Gombosi et al. Draft***
Executive Board, consists of funding agency representatives	Executive Board, chaired by funding agency representatives
Initial Testing and Evaluation performed at CCMC	Initial Testing and Evaluation performed at CCMC
Executive Board has sole authority over model selection	Executive Board has sole authority over model selection
Further Testing and Evaluation performed at SWPT	Further Testing and Evaluation performed at SWPT
SWPT implementation is TBD	SWPT could be implemented by a government lab, non-profit, industry, or by the CCMC
SWPT partners closely with research model developers during transition	SWPT has “very limited direct association with model developers”

Areas of Broad Agreement

- There is a clear need do something to facilitate operational implementation of space weather models that should be supported by the research community
- Operational agencies should provide funding for work on transitioning to operations, including support for the model developer
- Interaction between operational users and model developers is needed to clarify the intersection of needs and capabilities
- The model selection process should be fair and transparent

Concerns about Intellectual Property

- Models have generally been developed by modest NASA and NSF grants and IP issues need to be addressed
  - This goes beyond monetary concerns and extends into areas of credit, prestige, and impact on future support
- It is unlikely that a single approach is going to meet all needs, but the acquisition process must respect the developers IP rights
  - These issues must be address by SWPC during the selection process
- Some developers have concerns about models being misused or that choices made during implementation process will reflect poorly on them

Concerns about researcher involvement

- Experience of several groups involved in transfer activities has found that the transition process is facilitated by having a collaboration of model developers and software engineers
- On the other hand, direct involvement of research scientists can lead to conflict of interest or model misuse
  - To some extent this can be mitigated by have the selection process outside of a SWPT

Concerns about competitive aspects

- A key concerned raised by some model development group leaders was that the model selection process could be unfairly biased if an organization involved in T&E had its own model development program
- A negative outcome of the establishment of the SWPT would be if selected models gain significant advantage over all research grade models in the funding process
  - Should be a concern for the operational agencies as well as the developers
  - This maybe mitigated to some extent by establishing a mechanism to compare the operational model with other models
- Considerable objection was raised to assigning the operation of the SWPT without a competitive bid

Recommendations

- Clear need exists for a national facility for testing and evaluating space weather models and transitioning them into operations
  - A demonstration project to test, evaluate, and transition a specific model is a good first step in beginning to address the community's concerns and establishing a track record of success
- These functions could be performed by existing organizations or by new organization implemented by a university, FFRDC, or small business
- This activity should be put out for competitive bids with a fair and objective evaluation process
- The research community should be an active collaborator in this endeavor