

Research To Operations: Continuous Improvement

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THEME: Atmosphere-Ionosphere-Magnetosphere Interactions

EXECUTIVE SUMMARY

The last few years have witnessed an explosion of new space weather operational capabilities, serving civilian and military users. Tremendous progress has been made implementing operational capability that can be traced back to requirements. All too often, however, the requirements exceed what is possible to achieve. Despite the fact that requirements are not being met in a strict sense, the deployed operational capabilities are clearly providing value to users. Operational effectiveness benefits from research targeted towards improving capability. Drawing an analogy to terrestrial weather, this white paper suggests a path forward that, over time, will lead to steadily improving operational capabilities in space weather.

1. Description

The existence of a requirement does not imply the requirement can be met. The space weather community (civilian and military) has made enormous strides in developing operational space weather capabilities of value to users. These capabilities have been developed based on a set of user requirements. However, the complex nature of space weather often implies that the implemented capability does not meet the stated requirements. Deploying an operational capability that does not meet requirements is still useful and of significant value, compared to there being no capability at all. In those cases where requirements are not yet met, there is a need to continuously improve the operational capability so that over time the gap will narrow between performance and stated requirements. A program of continuous improvement will succeed if there is a research community oriented towards producing research results that lead to operational improvements.

We advocate the development of a research community that is focused on operational effectiveness. Such a community has been developed in terrestrial weather. It is possible to do so for space weather as well.

Using the terrestrial weather community as a guide, we describe elements needed to create a robust community of researchers focused on continuously improving operational capability over time. Figure 1 shows a graph provided by the European Center For Medium Range Weather Forecast (ECMWF), the leading European weather prediction center. The figure shows the improvements to forecasting effectiveness that have occurred over the past thirty years. A standard forecasting metric (anomaly correlation of geopotential height at 500 hPa pressure level, global average) is plotted as a function of time, for different forecast periods (3-day to 10-day) and for Northern and Southern hemispheres. This figure demonstrates that the operational capability is continuously

being improved. Such improvement is needed when the delivered operational capability does not yet meet all the requirements.

The ability to produce such figures is of enormous programmatic value and provides a justification for continued funding to improve operational capability. Two key elements are needed to produce such a figure: 1) developing and maintaining at least one metric that is applied consistently over time; and 2) constant monitoring of forecast quality using that metric to assess operational capability.

We believe the following elements are important also: *open access to the metric value, and documentation of the methods used for forecasting*. Providing researchers with easy access to the forecast metric provides those researchers with the opportunity to propose new ideas that improve the forecasts. If the research community understands the methods and models underlying forecast effectiveness, that community can propose ideas to improve effectiveness. Conversely, if the methods and models underlying forecasting performance are not widely known or disseminated, a robust research community with a stake in performance improvement will not develop.

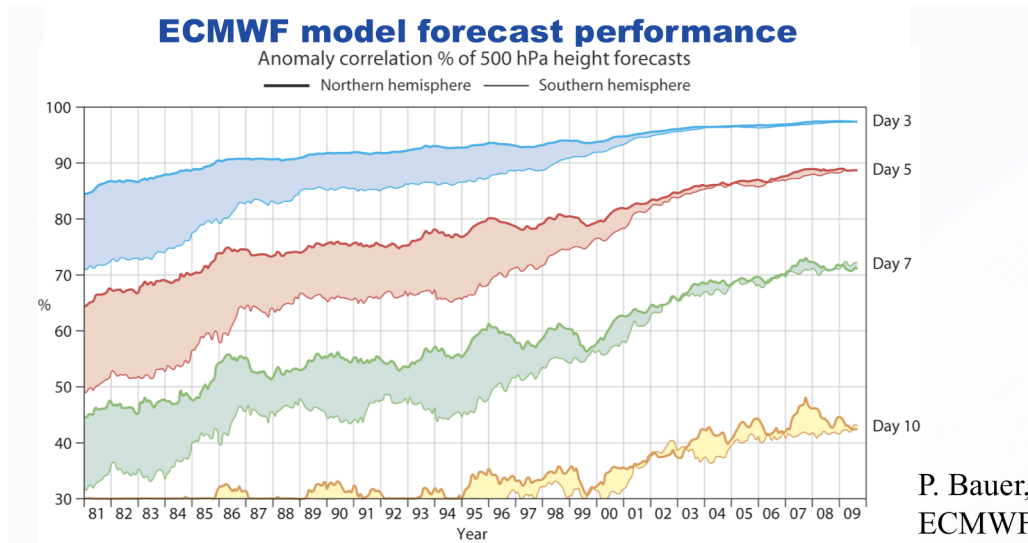


Figure 1. Improvements to weather forecasting effectiveness over time.

2. Concluding Remarks

The National Space Weather Program Assessment (National Space Weather Program, 2006) conducted by the Office of the Federal Coordinator for Meteorological Services and Supporting Research reached the following set of recommendations to “strengthen the science-to-user chain”:

- Maintain and strengthen both targeted and strategic space weather research
- Enhance emphasis and resources for transition of models to operational users
- Increase the private sector role in supplying products and services.

We believe that item 2 above, transitioning models to operations, is receiving sufficient attention. The recommendations suggested in this white paper are meant to strengthen

item 1: targeted space weather research. We have suggested two key elements needed to strengthen research targeted towards operational effectiveness. These two elements are: access to a forecasting metric applied consistently over time, and knowledge dissemination of the models and methods used for forecasting.

3. Acknowledgement

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4. References

National Space Weather Program (2006), “Report of the Assessment Committee for the National Space Weather Program”, FCM-R24-2006, June 2006.