

Report of the Working Meeting on: “Accomplishing Basic and Applied Space Weather Research
for the Benefit of Better Space Weather Predictions and Reliable Warnings”
Terry Onsager (NOAA) and Hermann Opgenoorth (IRFU)

The goal of this Working Meeting was to initiate an open discussion among the scientific and operational space weather communities on the appropriate balance between basic and applied research needed to advance space weather understanding and services. The increasing importance of space weather for our modern society has necessitated the urgent development of space weather services, similar to meteorology services. While it is undisputed that further basic research is essential to improve our fundamental understanding and to enable future improvements in predictive capabilities, dedicated scientific effort must also be devoted toward near-term, targeted goals, enabling space weather service providers to address the immediate need for space weather information expressed by the end-user communities. How can these two goals be achieved simultaneously, both efforts building largely from the same workforce and with constrained funding?

The discussion overwhelmingly supported an emphasis on continued and even enhanced basic research. Because there are such deep limitations in our ability to understand and to predict the complex dynamics of the Sun-Earth system, caution should be exercised in advertising prediction capability. There must not be a rush to create applications in areas where deficiencies in scientific understanding prohibit accurate and reliable results. Basic research must be and remain for quite a while the cornerstone of everything we do, advocate, and discuss.

It was also stressed that as we pursue basic research for the potential benefit of space weather understanding, good communication must be maintained with operational service providers and users of space weather information. Socio-economic studies on space weather impacts are also required. These efforts will refine our understanding of the information required and consequently help to prioritize dedicated research efforts, particularly for the development of applications in areas where scientific knowledge has become sufficiently mature.

The view was also expressed that progress in fundamental scientific understanding has more or less stagnated. The issues being worked on and debated today are seen by many scientists and user groups as only incrementally different from those discussed more than a decade ago. Consequently, what is most needed may be a more effective approach to solving the key problems that underpin our discipline. Again, this requires a dedicated effort to identify the key problems for enhanced topical research.

With this as background, the discussion briefly addressed the questions: *Is the space weather enterprise going well? Is it going as it should? Are there any changes that should be made?* No detailed, best-practice approaches to address the apparent stagnation of fundamental scientific knowledge were expressed by the forum. However, it was noted that various countries today are taking different approaches to the basic vs applied research balance. Some countries are favoring basic research with their funding opportunities, whereas others are explicitly favoring applied research. Even within the European space agency there are different approaches towards mission support for basic and applied research, as expressed by the Science Directorate and the Programme for Space Situation Awareness SSA, respectively. Better communication among the

European and national funding agencies and the involved scientists could perhaps strive to coordinate these complementary efforts. It was also recommended that future spacecraft missions in the Sun-Earth realm should, where possible, strive for dual value by providing observations needed for operational services together with the prime mission data, which often still is aimed at fundamental research alone.

This working meeting was well attended and demonstrated a strong interest in addressing issues related to the balance between basic and applied research, with the ultimate goal to strengthen space weather understanding, allowing for more reliable predictions for a growing user community. The growth in demand for space weather services is relatively recent compared with the history of solar-terrestrial physics and the space age, and evolution in the capabilities and priorities of the scientific workforce will occur slowly. A continuous, open dialogue will be required to maintain the most effective progress of the international space weather effort. This dialogue should not only take place between scientists and service providers on the one hand, and between service providers and end-users on the other hand. In order to base progress in dedicated space weather science on realistic requirements, and user expectations on realistic science understanding and progress expectations, the closure of the communication loop should also involve direct dialogue opportunities between scientists and potential space weather end-users. It was noted that the Space Weather Weeks in both Europe and the US serve already now - and hopefully even more so in the future - as an important catalyst to initiate and develop such communication channels.