



Hurricane and Ocean Testbed

Governing Charter

NOAA Hurricane and Ocean Testbed (HOT)

2022

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1. Mission Statement & Purpose

NOAA has formed the Hurricane and Ocean Testbed (HOT), which has a mission to accelerate the transfer of promising products and services, focused on tropical weather and marine phenomena, into operational forecast centers. Informed by social and behavioral sciences, this knowledge and technology transfer will occur in a holistic framework that strengthens the entire warning system, from data collection to forecast production to communication and dissemination to decision making. The demonstration of new products and services will occur in a physical facility that will provide the opportunity for effective, in-person interaction and follow-on collaborations between the operational and research and development communities.

HOT fits within the NOAA readiness level (RL) framework shown in Fig. 1 below. Once research output and products from research laboratories and developmental organizations are successfully evaluated for application in an operational environment, they are at RL 4. The HOT, like other NOAA testbeds and proving grounds, is focused on guiding research outputs at RL ~5 and navigating them through the transition process up to and including RL 8, marking a finalization of the transition activity/project that is ready to be deployed operationally.

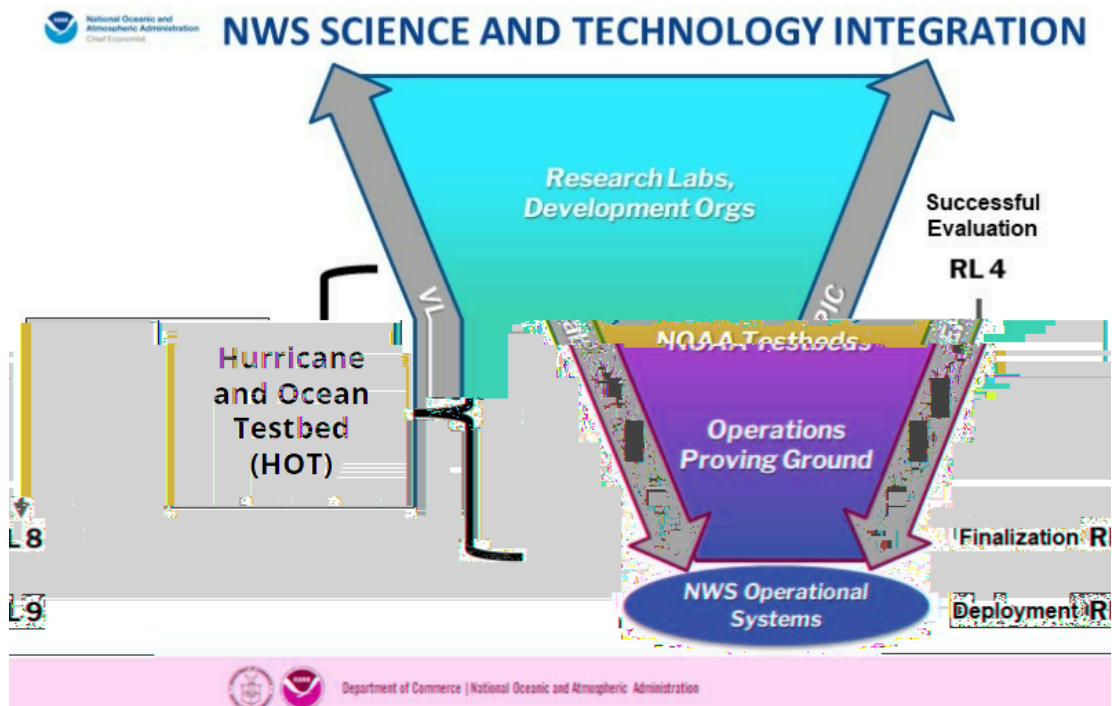


Figure 1. Schematic depicting integration of new science and technology into NOAA/NWS operations within the readiness level (RL) framework. HOT will occupy the same space in the RL spectrum as existing NOAA Testbeds and Proving Grounds.

2. Background and Scope

In 2001, NOAA and the U.S. Weather Research Program (USWRP) formed the Joint Hurricane Testbed (JHT) to advance the transfer of new research and technology into operational hurricane prediction. The mission of the JHT is *“to transfer more rapidly and smoothly new technology, research results, and observational advances of the USWRP, its sponsoring agencies, the academic community and other groups into improved tropical cyclone analysis and prediction at operational centers.”* For over 20 years, the JHT has successfully guided the transition of research to operations, with over 65% of almost 100 funded projects accepted for operational implementation.

While the JHT has successfully and almost exclusively focused on tropical cyclone-related projects, there is a need to broaden the scope of research to operations (R2O) and operations to research (O2R) activities to more holistically incorporate other aspects of the forecast and warning system. The expanded HOT scope is summarized below:

- **Incorporate Social, Behavioral, and Economic Sciences (SBES) and physical sciences**, e.g. both meteorology and oceanography
- **Emphasize an end-to-end value chain approach** (Fig. 2) to improving forecast products, consistent with:
 - Forecasting a Continuum of Environmental Threats (FACETS; <https://www.nssl.noaa.gov/projects/facets/>) in that it emphasizes threats, observations and guidance, forecaster decisions, useful output, and effective response, and verification, with social science informing all aspects of the forecast continuum.
 - NWS-implemented Impact-based Decision Support Services (IDSS; <https://www.weather.gov/about/idss>), which can be interpreted within this value chain framework as well -- IDSS works to strengthen communication between the forecast peaks (“Weather forecast”, “Impact forecast”) down to the “Decision” peak (Fig. 2)
- **Expand transition efforts to all operationally relevant projects**, including those funded by NOAA WPO (formerly JHT-funded projects), other NOAA programs, e.g. HFIP, and non-NOAA funded projects, as well as organic, unfunded collaborations with strong likelihood of operational impacts

- **Provide a devoted physical space** at NHC, the William Lapenta Laboratory, for researchers to test tropical and marine-related research and development in a quasi-operational environment
- **Provide an isolated cloud-based platform** that parallels the operational environment and eliminates as many IT barriers to collaboration and innovation as possible

The HOT will incorporate these elements, subsuming the JHT by expanding the scope of R2O and O2R activities in several ways that are expected to yield dividends for both research and operational stakeholders. This Charter serves to replace the existing JHT Charter.

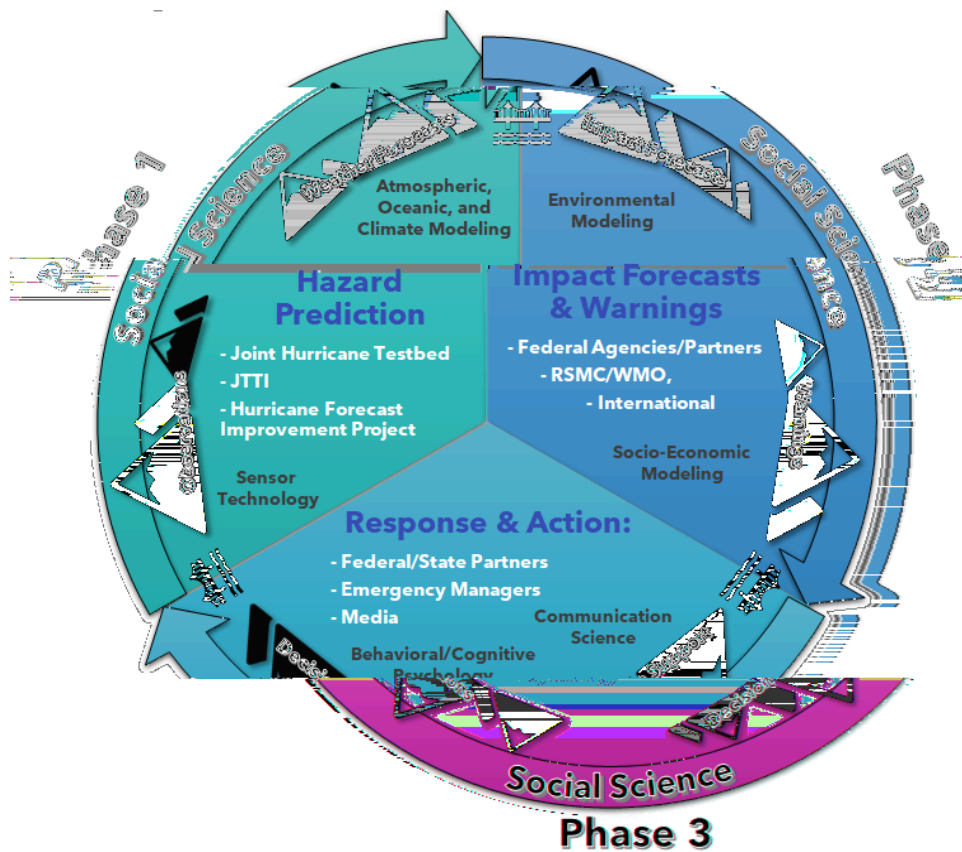


Figure 2: The peaks of expertise, “valleys of death”, and connecting bridges between them, in a conceptual value chain for a weather-related hazard warning. Adapted from Golding et al. (2019), “A Value Chain Approach to Optimising Early Warning Systems”, available at https://www.preventionweb.net/files/65828_f212qoldinaetalvaluechain.pdf. Social science research informs products and services across the value chain.

3. Concept of Operations

Similar to the former JHT and other NOAA Testbeds, NOAA will provide primary financial support for HOT projects through the USWRP, managed by the NOAA Oceanic and Atmospheric Research (OAR) Weather Program Office (WPO). WPO's Testbeds Program (<https://wpo.noaa.gov/Programs/Testbeds>) and Joint Technology Transfer Initiative (JTTI) Program (<https://wpo.noaa.gov/Programs/JTTI>) support advanced projects seeking to transition research to operations where testbed interactions and demonstrations in a quasi-operational environment are key. The NOAA Office of Science and Technology Integration (STI) also provides support for HOT projects. Ongoing and future NOAA Testbeds-, JTTI- and STI-funded projects that fall within the HOT scope are candidates for inclusion in the HOT. For example, SBES, EPIC, HFIP, and future NOAA programs relevant to the HOT mission, will be candidates for testing in the HOT. WPO and the HOT staff will continue to collaborate with principal investigators (PIs) on the transition process, e.g. development of Test Plans and R2O Transition Plans, via the process defined by WPO after projects are selected in the funding competition. The HOT itself will be jointly managed by both NWS and OAR co-Directors, as described in Section 6.

The HOT mission will be accomplished by the following:

- Assessing scientific breakthroughs and new techniques to identify advanced innovations with the potential for significantly improving the end-to-end forecast value chain;
- Completing tests of the observations, models, codes, and products in a quasi-operational technology environment subject to well-defined metrics for performance and usability within operational constraints;
- Facilitating the transfer of tested research outputs into the operational workflows of the forecast centers;
- Preparing documentation, training materials, and evaluations of performance characteristics of successful products to facilitate their use by operational center forecasters and support staff

HOT will strive to facilitate consistent and effective operational transitions of promising innovations (RL 5+), regardless of the funding source. HOT will solicit and accept projects through two pathways:

1. **NOAA WPO- and STI-Funded Projects** - As with the JHT, regular notices of funding opportunity (NOFOs) inviting projects will initiate the HOT proposal-driven transitions. WPO will prepare the NOFO with input from the HOT Leadership and the HOT Steering

Committee (SC; Appendix A). The NOFO will be open to the U. S. scientific community. Proposals will be reviewed under the purview of the SC. In addition to a HOT-specific NOFO, which has traditionally been biennial, other NOAA programs (e.g. JTTI, HFIP, Social Science/FACETs, Unified Forecast System Research to Operations [UFS-R2O]) will likely fund HOT-relevant projects. WPO- and STI-funded transition projects with a tropical or marine focus, in need of operational testing and evaluation, and aligned with operational objectives, will automatically become a HOT project.

2. **Other HOT Projects** - Resource- and staffing-permitting, to support the expanded scope of the HOT, as described above, HOT may separately maintain an open solicitation (e.g. a web-based form hosted on the HOT webpage) for interested PIs to submit proposals for projects to test. Some projects may be funded by other mechanisms (e.g. other NOAA line offices, or other agencies), while others may be unfunded, organic collaborations with organizations such as NOAA/OAR Labs and EMC. Any proposals received will be evaluated by HOT leadership and selected on the basis of RL, alignment with agency/program Annual Operating Plan (AOP) milestones and validated requirements, likelihood of success, and availability of resources to execute an evaluation and subsequent transition. HOT leadership will submit annually to the SC a list of “other” projects, if any, submitted for testing in the HOT. The SC will approve projects, resource permitting, that best align with the HOT mission.

The HOT activities are divided into infrastructure activities and transition projects. Infrastructure activities include administration and system support. Transition projects will involve the HOT facilitators serving as the interface between the researcher and the operational forecasters. The operational transition determination for transition projects will be made on the basis of:

1. Operational forecast/analysis benefit in the context of the forecast value chain,
2. Efficiency of use within operational users’ time and workflow constraints,
3. IT compatibility (programming languages, data flow, etc.) with operational systems, and
4. Long-term operations and maintenance (O&M) sustainability.

Final testing, validation, and acceptance of the new product will be the responsibility of, and at the discretion of, the operational forecast center. Long-term maintenance of the new product will then become the responsibility of the forecast center.

The scope of R2O that will be encouraged through HOT includes, but is not limited to, the following:

- New analyses of observations/new observing systems for real-time assessment of hazards (wind, rain, storm surge, severe weather, waves, dangerous ocean conditions)
- New model guidance for forecasts of hazards (wind, rain, storm surge, severe weather, waves, dangerous ocean conditions)
- Improvement of analysis products/forecast guidance from a SBES perspective
- Product enhancements to improve the collaboration and efficiency to produce forecasts and warnings, and/or messaging and communication of forecasts (IDSS) to end users

4. Execution of Testbed Activities

Decisions to support projects will involve determining how well proposed activities address a list of priorities provided by the operational center (NHC operational branches, and other national centers and WFOs in the future). In addition to regular interactions related to funded projects, at least one annual meeting, e.g. the HFIP meeting or a separate meeting as funding allows, will occur between the operational and research communities. The purpose of the annual meeting is to stimulate interactions and provide opportunities for organic collaboration and the linkage between operational needs and research and development activities.

The types of demonstrations executed in the HOT will depend on several factors and will be documented on the HOT webpage <https://www.nhc.noaa.gov/hot/>, which will be maintained by HOT staff. The Roles & Responsibilities of the HOT stakeholders are summarized below:

	Research PIs and Staff	HOT Staff	Operational Staff (e.g. NHC HSU/TAFB/TSB)
Project Phase: R&D	Mature research to RL suitable for experimentation Prepare transition and test plans	Provide technical requirements (file formats, code standards, AWIPS configurations, etc.) and documentation templates to PIs	Provide guidance to HOT Staff and PIs toward outcomes that will maximize operational impacts
Project Phase: Pre-Experiment	Provide to HOT Staff code and/or data samples adhering to operational	Determine mode of experimentation (AWIPS, web, etc) based on RL	Provide guidance to HOT Staff and PIs on technical operational requirements and

	<p>requirements</p> <p>Document all required components of project</p>	<p>Perform tests to ensure compatibility with HOT systems and operational needs (AWIPS, data flow, etc)</p> <p>Guide logistical preparations for experiment</p>	<p>constraints, to design an experiment or demonstration that will prove the hypothesis of operational impact</p>
Project Phase: Experiment	<p>Provide guidance to operational users during experimentation</p>	<p>Facilitate an experiment focused on factors that will enable a transition decision</p>	<p>Participate as volunteers in experimentation and provide real-time feedback to PIs</p>
Project Phase: Post-Experiment	<p>Execute any follow-on tasks necessary for advancing RL for operational transition</p>	<p>Collect feedback and document the experiment results with feedback from both operational and research stakeholders</p>	<p>Provide feedback on operational utility of projects to inform transition decision</p> <p>Prioritize and execute transitions for selected projects</p>

5. Facilities, Stakeholders and Organization

Facilities

The HOT is housed at the NHC in Miami, FL, within the William Lapenta Laboratory (the “HOT Lab”), and includes both the dedicated physical space and an isolated cloud-based virtual infrastructure for testing and evaluation. The HOT has an in-situ component and a distributed aspect. Whereas a small administrative staff and a core of facilitators are housed at the physical location, the researchers and their associated facilitators may be distributed both geographically and organizationally.

As allowed by the level of sustained O&M funding, the HOT Lab at NHC (Fig. 3) provides workstations, docking stations and desks for visiting scientists to work with operational staff in a series of off-season experiments and real-time demonstration projects. A specialized network

includes enhanced NHC WiFi, electrical enhancements, and IT security. A video teleconference and video wall capability is available for off-season experiments and real-time demonstrations. The ability to access AWIPS Cloud Computing is provided through the HOT. The HOT will likely utilize different modes of AWIPS to facilitate the diverse activities which will occur including transition, testing, evaluation, and parallel operational activities. The HOT will also serve as a facility to test, refine, augment, or activate the Continuity of Operations Plan (COOP) for the National Hurricane Center.

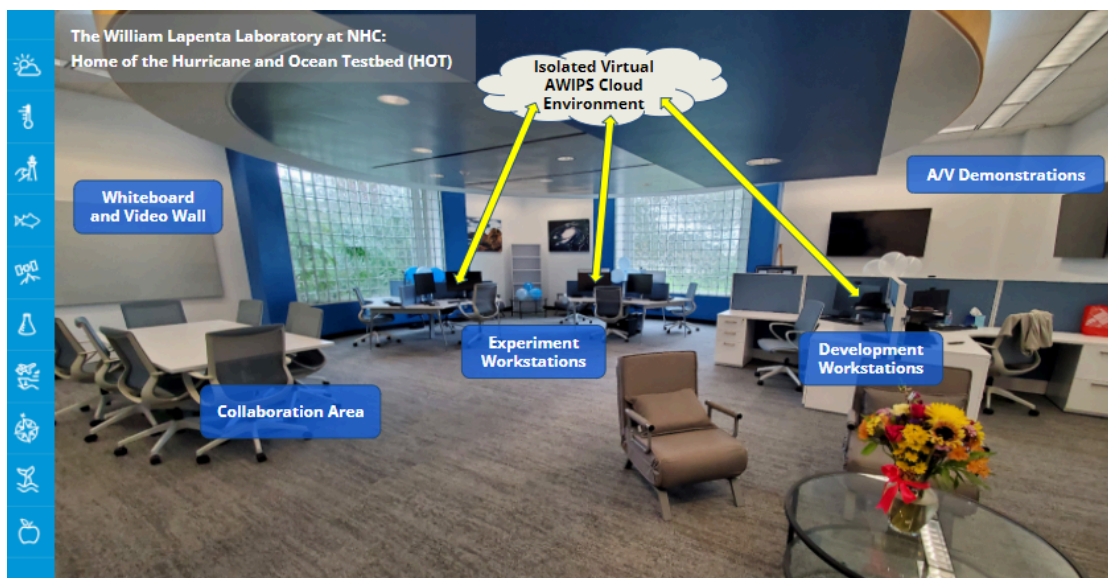


Figure 3: The William Lapenta Laboratory at NHC (January 2022)

Stakeholders

HOT will bring together the operational and research community to facilitate R2O and O2R. The primary operational entities that will be involved at the outset will come from NHC, including the Hurricane Specialist Unit (HSU), the Tropical Analysis and Forecast Branch (TAFB), and the Storm Surge Unit (SSU). Where missions overlap across NWS Centers, e.g. Ocean Prediction Center (OPC), and Weather Forecast Offices (WFOs), HOT welcomes their participation as well.

Key research participants include members of NOAA Research, in particular from the NOAA/OAR/Atlantic Oceanographic and Meteorological Laboratory (AOML). Other members of NOAA Research, including other NOAA research laboratories, cooperative institutes, and cooperative science centers will also have the opportunity to contribute products and services

to HOT. Researchers from other governmental agencies (e.g., NASA) will also be able to contribute, as will researchers from academia and participants from the private sector.

Research and development to be considered for transition at HOT may occur by projects formally funded through existing testbeds, programs, projects, and proving grounds, or through informal interactions between the research and operational community. One key aim of HOT is to provide a venue for organic interactions to occur between operations and research, from which more formal projects and transitions may occur.

Organization

Pending funding availability, the ideal initial staffing* profile for HOT will include:

- Two HOT Co-Directors (0.5 FTE each): one federal NOAA employee from each of NWS/NHC and OAR/AOML, appointed by the NHC Director and the AOML Director, respectively.
- Scientific Prototyper (1 FTE) to infuse both physical and SBES inputs into the design, testing, and evaluation of new products and product changes
- HOT IT Facilitator (1 FTE) to enable the initial standup of technical lab infrastructure, including cloud-based computing, data sharing, collaboration systems, etc. and technical collaborations with research PIs (data flow, visualizations, etc.)
- HOT R2O Facilitator (1 FTE) to support the execution and program management of existing R2O efforts, and provide organizational support for the HOT.

**Staffing estimates are based on the optimal HOT configuration, pending future funding availability. Technical and administrative staffing and associated O&M costs will scale as the volume of testing and evaluation increases, as funding allows.*

Principal investigators (PIs) and research staff of selected projects will collaborate with HOT staff throughout the course of projects. Furthermore, operational Points of Contact (POCs), including operational technical and forecast volunteers, will be selected to guide researchers and HOT staff on project progress.

6. Management Oversight

Oversight of the HOT is provided by an executive oversight committee (EOC) consisting of the NHC Director, the AOML Director, the OPC Director, the WPO Director, a SBES member, and executive representatives from the National Ocean Service (NOS) and the NWS. Annual objectives and resource allocations are approved by the EOC.

The HOT Steering Committee (Appendix A) is composed of internally and externally associated researchers, forecasters, and administrators in the physical science and SBES community. It advises the HOT Co-Directors on all activities, including prioritizing potential scientific and technological topics of investigation and selecting specific topics for intensive evaluation.

HOT Co-Directors will serve as co-Chairs of the Steering Committee, as well as provide operational oversight of HOT planning and execution.

7. Updates to Charter

It is anticipated that updates to this charter will be required periodically. Amendments will be made with approval of the Executive Oversight Committee.

Appendix A: Charter of the HOT Steering Committee

Purpose

The purpose of the HOT Steering Committee (SC) is to advise the HOT Co-Directors in all testbed activities including the proposal and review process, outreach, scientific assessment, and information technology. In addition, the SC remains aware of activities in tropical cyclone and marine research and brings this knowledge base to the HOT process. Initial composition of the SC will reflect the expanded scope of HOT (e.g. oceanography, SBES).

Specific Functions

The specific functions of the SC¹ include but are not limited to:

- Serving as a knowledgeable resource on HOT issues and other activities in physical and SBES components of tropical and marine research;
- Reviewing and seeking out reviewers for testbed proposals or extensions;
- Contributing to Announcements of Opportunity (AO), plans, reports, and budgets;

Membership

The HOT SC membership is derived from internally and externally associated researchers, forecasters, and administrators. Members will be individuals from throughout the spectrum of organizations familiar with advancing the analysis and prediction of tropical and ocean phenomena, including all components of the value chain outlined in the HOT Charter. Members will serve an initial three-year term, with the possibility of a three-year extension after the initial appointment. Members will broadly represent the research and operational community. New prospective members can be nominated by the HOT Co-Directors and sitting SC. New members will be approved by the co-chairs of the SC, who will inform funding organizations and other stakeholders of the new selectees.

SC Chairmanship

The HOT Co-Directors, one representative each from the operational and research community, will serve as the Co-chairs and will direct the activities of the SC, convene meetings, and provide meeting summaries.

Meetings

¹ To satisfy the Federal Advisory Committee Act (FACA) requirements, any members of the SC who are not federal employees will serve only in the capacity of reviewing proposals.

Meetings will be held as needed for proper conducting of HOT business. It is anticipated that virtual meetings will fill most needs. Meetings may focus on review of projects or development of the NOFO. Agenda items for meetings may be submitted to either co-chair by the USWRP/WPO, a member of the EOC, or any SC member. Any recommendations from meetings will be forwarded to the HOT Co-Directors.

The SC Role in the HOT Proposal Process

The SC role described below applies to the USWRP/WPO-funded proposal process. For other organic and/or unfunded projects, HOT Co-Directors will submit annually a list of proposed projects to the SC for approval.

New Proposals

The SC will identify new emerging research and make known these opportunities to the HOT and USWRP/WPO. The NHC, and other operational organizations as needed, will develop a statement of need. From the statement of needs and opportunities, USWRP/WPO will draft a NOFO and coordinate it with the HOT Co-Directors and SC. The USWRP/WPO will distribute the NOFO and will collect proposals from interested researchers. The SC will recommend review criteria and guidelines, for approval by the Executive Oversight Committee, and review submitted proposals. Proposals solicited by a NOAA NOFO will be reviewed in accordance with all NOAA policies associated with panel reviews for grants and cooperative agreements. In some cases (e.g. large number of proposals, conflicts of interests, or very specialized themes) outside reviewers may be called upon. Reviewers will be selected for their knowledge of the science, technology and/or meteorological operations. The SC and WPO will monitor the review process and ensure that there are no conflicts of interest. The SC will send their final panel recommendations to the HOT Co-Directors and the Executive Oversight Committee for a secondary review. The Executive Oversight Committee will recommend which proposals should be funded to the appropriate decision-making official in the office that is managing the NOFO and providing the funding.

Renewals

At the end of the first year of each project, the HOT Co-Directors and the SC will provide an accelerated review of the second-year milestones, timelines, and budgets as updated by the researchers. Given the SC endorsement for second-year funding, and continued endorsement of the project goals by the HOT and Executive Oversight Committee, the HOT Co-Directors will submit recommendation for the second year of funding to the appropriate program manager for final approval.

Amending this Charter

As the HOT and SC evolve it may become necessary to change the operation of the SC to optimize mission completion. Items may be added or deleted to this document with a two-thirds vote of the SC and approval of the HOT Co-Directors.