

Joint NOAA, Navy, NASA Hurricane Test Bed

Terms of Reference

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I. Overview

The U.S. Weather Research Program (USWRP) has formed the Joint Hurricane Test Bed (JHT) to advance the transfer of new research and technology into operational hurricane prediction. The JHT will routinely serve as a conduit between the operational, academic, and research communities. This facility will be located at the National Hurricane Center (NHC) in Miami, FL. Whereas the operational center and associated personnel could be the NHC, the Joint Typhoon Warning Center (JTWC, Navy), or the Central Pacific Hurricane Center (CPHC), and NHC will be specified in this document, both for brevity and to acknowledge the current focus of the JHT on that organization. Use of other facilities is possible depending on requirements, workload, and opportunity.

II. Mission Statement

The mission of the Joint (NOAA, Navy, and NASA) Hurricane Test Bed 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.

III. Concept of Operations

The JHT is the initial test bed activity funded by the USWRP and is established to accelerate the technology infusion focused on hurricane analysis and prediction. Until all test beds are organized under a national test bed activity, the USWRP Interagency Program Office (IPO) provides coordination and oversight. The USWRP/IPO will facilitate outreach, the proposal process, and interaction with the oversight board, funding, and other tasks common to the test beds. The JHT will work with the USWRP/IPO to accomplish those tasks appropriate for administration of the hurricane test bed.

The JHT mission will be accomplished by the following:

- assessing scientific breakthroughs and new techniques to identify advanced, real-time, data-analysis techniques, forecast models, and observational systems that have potential for significantly improving the forecast guidance provided to hurricane forecasters;
- completing tests of the codes, products, and observations in a quasi-operational information technology (IT) environment subject to metrics that mandate good scientific performance while meeting ease-of use criteria and time constraints;

- utilizing advanced statistical and numerical model output and stimulating model improvement in tropical weather analysis and forecasting applications;
- facilitating the transfer of tested research codes into the computer, communication, and display systems of the forecast center while incorporating adjustments necessary to generate forecast guidance products that are forecaster-friendly and time-efficient;
- preparing documentation, training materials, and evaluations of performance characteristics of successful products to facilitate their use by operational center forecasters and support staff.

A biennial Announcement of Opportunity (AO) inviting projects will be the initiation for JHT proposal-driven transitions. The JHT Director will prepare the AO with help from the JHT Steering Committee (SC; see section IV.B.5 and Appendix A-2). The AO will be open to the U. S. scientific community, including the NOAA Line Offices, Navy, NASA, NCAR, universities, and the private sector. Proposals will be reviewed under the purview of the SC. Salaries and expenses to support researcher participation in the transition can then be negotiated. Funded projects become a JHT activity.

The JHT activities are divided into infrastructure actions and transition projects. Infrastructure activities include administration and system support. Transition projects will involve the JHT facilitators serving as the interface between the researcher and the operational forecasters. The successful transition will be: 1) a converted research code that, running with an operational data stream on forecast center computers and display systems, is effectively utilized by the operational forecasters to improve products and services; 2) a new observational system that has provided documented evidence of positive diagnostic or forecast impact; or 3) a weather prediction product leading to better tropical cyclone forecasts. 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.

IV. Location and Organization

A. Facility

The JHT will be located the NHC in Miami, FL. The JHT will have a dedicated physical space and dedicated computer facilities. The JHT will have an *in-situ* component and a distributed aspect. Whereas a small administrative staff and a core of facilitators will be housed at the forecast center, the researchers and their associated facilitators may be distributed both geographically and organizationally.

B. Organization

Administration for the JHT will include a Director and part-time Administrative Support Assistants. Other than salaries, additional operating expenses include supplies, short-term visitor travel, publications, and possibly office space rental for the permanent staff. A Steering Committee (SC) will serve to aid the JHT Director in making decisions.

1. JHT Director

The Director shall be a civil servant selected by the NHC Director and approved by the USWRP. The responsibilities of the JHT Director are to:

- Provide scientific leadership and develop programs that facilitate the transition of observational systems and research results into improved guidance products for operational hurricane forecasting;
- Work with the SC to prepare an annual AO and provide to the USWRP/IPO for distribution.
- With the SC conduct a review process on submitted proposals;
- Work with the operational center Directors, the SC, and the USWRP/IPO as necessary, to determine final disposition of favorably reviewed proposals and submit to USWRP for funding approval;
- Negotiate the needs, milestones, and timelines with the funded principal investigators (PI);
- Supervise the administrative assistant(s) and internal facilitators, and coordinate external facilitator activities to achieve transition schedules;
- Manage and administer the JHT staff in a manner consistent with agency policies and guidelines;
- Identify, in conjunction with the SC and the operational forecast centers, tropical cyclone-related data, forecast applications, and numerical/statistical modeling needs and coordinate with the USWRP/IPO and other test bed Directors to accomplish appropriate transitions to operational guidance products;
- Prepare the Annual Operating Plan (AOP) for transition activities, infrastructure, deliverables, schedule, and budget for the USWRP/IPO; and
- Prepare the annual report summarizing yearly activities and present to the USWRP/IPO.

2. Administrative Support

This role includes part-time Administrative Support Assistants whose role is aimed at supporting the JHT Director.

- Provide input and feedback for JHT administration issues and documents (i. e. Announcement for Federal Funding Opportunity, AOP, JHT quarterly reports, etc.).
- Participate in JHT administration meetings, conference calls and

- individual project coordination meetings.
- Assemble and distribute relevant materials for each project to review panels or all parties concerned with each project for discussion or their information.
- Create and maintain consolidated time lines for each project, monitor their progress via quarterly reports and communicate with project PIs regarding reports and proposals.
- Work closely with USWRP/IPO on JHT administration, individual proposal's budget, progress reports and Grants-online issues.
- Participate in JHT Steering Committee meetings, as necessary.
- When needed, present JHT overview and status update at conferences
- Coordinate JHT presentation session with conference organizers and PIs for the Interdepartmental Hurricane Conference

3. Facilitation Team

A team of on-site or internal facilitators, who may be permanent staff or long-term contractors, will work directly with the operational center support staff and forecasters and with JHT-funded researchers and their staff. The team may also include off-site facilitators from universities, laboratories, or other test beds who are temporarily assigned to the JHT to work directly with the researcher and/or remotely access JHT systems. This group may also include long-term post-doctoral fellows associated with various projects interested in the technology transfer process. Given the nature of JHT tasks, the successful facilitator must have a suitable combination of scientific background, computer coding and display creation skills, knowledge/experience in operations, and an ability to collaborate.

The IT Facilitator(s) is responsible for working with the JHT-funded PI to assist in the transition and implementation of the project. The IT Facilitator is also knowledgeable on the operational center's computer environment.

A Point of Contact (POC) is a person(s) assigned to a JHT-funded project and they oversee the progress of the project. The POC's role is to provide guidance and feedback to the PI and the JHT staff on the project progress. The POCs are typically forecasters or modelers for the operational centers.

4. Researchers and their Staffs

These include the principal investigators with funded proposals and their support staff. Some responsibilities are the following:

- Coordinate with JHT staff;
- Complete applied research and transition activities on time, while alerting JHT Director and staff of any problems;
- Provide regular (at least semi-annual) reports;
- Aid in setting up system and testing procedure;
- Monitor scientific integrity of test; and
- Provide documentation and training materials for forecast and

maintenance efforts.

5. Steering Committee

The SC is made up of internally and externally associated researchers, forecasters, and administrators. It advises the JHT Director on all activities. The role of the SC is specified in the Charter in Appendix A-2.

V. Process and Operations

A. Technology Transfer

Under the direction of the JHT Director, the internal facilitators (employees of the JHT) serve as links between the researcher and the operational forecast center (see Appendix A-1 as an example). The researcher may have a team of external facilitators who are part of the research staff who work closely with the JHT. External facilitators may also be associated with other external locations (e.g., other test beds) that are providing assistance in some specific JHT task. We are aware of NOAA's administrative order (NAO) Policy on transition of research to application (NAO 216-105).

The test bed activity can run the gamut from new coded applications and new observations, to new model guidance. The facilitator may be called upon to create links to new and existing data, to configure new products from analyses, statistical methods, and numerical forecasts, and to convert research code to testable quasi-operational applications. With many possible need-options for data sets, computer systems, real-time communications, and display systems, the IT facilitator faces multiple challenges seeking to maintain the integrity of the research results while simultaneously ensuring timeliness and practical constraints imposed by the forecast cycle.

The researcher's role in preparation for the implementation is to provide case studies and documentation to the facilitators at NHC for training of the forecasters and maintenance personnel. Some continued involvement and funding of the research staff should be anticipated through the end of the first season of pre-implementation operational testing where tuning and adjustment may be required.

Given IT security issues and the unavailability of the operational center computing, communication, and display systems for outside use during the hurricane season, the JHT must have a separate dedicated system for transition work that closely matches the characteristics of the operational center system. Consequently, some JHT support staff are required for maintenance of the JHT system. All codes must be kept current and the JHT staff must have a working knowledge of these codes for answering questions from the researchers and off-site facilitators. Copies of these codes may be made available to prospective applicants as needed, but without guaranteed support. Every transition should attempt to move its code and displays to the existing (or projected) IT infrastructure (e.g., NHC/NCO/NWS). In cases where the advances require cutting-edge hardware or software not yet in place at the operational center, support for such

enhancement from the JHT will be considered.

B. Proposal Process

The transitions will be initiated by a proposal and review process. The JHT proposal process will be fair and unbiased and open to all interested researchers in the scientific community. The proposal cycle will begin with an informal review by the NHC and JHT staff to determine needs and shortfalls evident in the just-ended cyclone season. The SC and NHC will identify new emerging research and coordinate these opportunities with the JHT and USWRP/IPO. From the resulting statement of need and opportunities, the JHT Director and SC will draft an AO and coordinate it with NHC. When all groups are satisfied, the AO will then be issued to the community with a specified submission deadline. Instructions for drafting project proposals will be given in the AO. The proposal candidate must provide evidence that research results have sufficient maturity and potential for a positive forecast impact under operational conditions within an agreed upon period (typically one to two years). The SC may choose to distribute some proposals to external reviewers familiar with research and operational needs. Once the reviews have been returned, the SC will provide comments on the proposals and rankings to the JHT and NHC Directors for their comments and endorsements. Any differences in rankings will be negotiated between Directors and the SC before being provided via the USWRP/IPO for final approval.

A special review procedure is used for consideration of the second-year proposals prior to opening the new competition via the AO process. Given satisfactory progress on the first year milestones as reflected in the progress reports and the JHT Director's assessment, the SC will provide an accelerated review of the second-year milestones, timelines, and budgets as updated by the researchers. Given the SC endorsement that the second-year proposals should be funded, and continued endorsement of the project goals by the JHT and NHC Directors, the JHT Director will submit the funding requests via the USWRP/IPO for final approval. Having then established the remaining funding for that fiscal year, a new AO is prepared via the process described above. The combined funding needs for the continuing and new projects will be defined in the JHT operating plan and passed to the USWRP/IPO.

C. JHT Projects

Biennially the JHT will undertake a number of well-defined hurricane-related transition projects to support the goal of improved forecasts. A summary is given in Appendix A-1 of the various steps in the transition process as it would be applied at the NHC. Each project will have a well-defined metric for success and a timeline for the transition, which will be coordinated with the JHT Director prior to project initiation.

Upon acceptance and scheduling of the transition project, JHT facilitators (on-site or off-site) will be assigned the task and one or more point(s) of contact from the

operational center will be appointed by the center Director. In the NHC example in Appendix A-1, a point of contact is a person assigned to the NHC/Technology and Science Branch (TSB) or is a Hurricane Specialist, and the tasks of this person at each stage are as indicated. For the remote transition projects, the JHT will supply to the project scientists the required computing, system software, and communication capability to complete the transition on a system that closely matches the operational forecast center characteristics. The researcher will be expected to submit regular written progress reports. When the operationally capable code is demonstrated to provide improved forecast guidance according to the agreed-upon metric and meets the operational constraints, the operational forecast center Director will make the decision for full operational implementation.

In the case of the NHC, the JHT must interact closely with the TSB, which has the primary task of maintaining NHC computer, communication, and display systems. For hurricane NWP issues, NCEP/EMC and NCO will serve similar functions. Throughout the year, the TSB must ensure the continuous operation of these systems in support of the NHC 24-hour-by-seven-day operational forecast/warning function. Each equipment change or upgrade impacts the operational system. During the hurricane season, the TSB takes on additional duties. For example, some of the staff are qualified as Hurricane Specialists and may stand shift work, and all may be called on during a hurricane landfall to assist in forecaster support, media requests, etc. Validation of forecast performance is also an important function of both the TSB and hurricane forecasters. The TSB is also tasked with performing applied research and techniques development. However, the over-riding responsibilities to maintain the operational systems and to assist in the hurricane season warning process must always take precedence over applied research. By contrast, the full-time function of the JHT facilitators is to make transitions from research to operational forecast guidance products. Thus, the JHT is a complement to the TSB, without the distractions of supporting real-time operational forecasting. However, the close association could cause JHT delays during periods when TSB personnel are filling emergency duties.

Codes resulting from JHT work accepted for operational implementation will be the property of the U. S. government and will be in the public domain.

D. Relationship to other Test Beds

Within the USWRP/IPO a number of test beds with themes relevant to the JHT will have ongoing parallel activity. It is important that the JHT Director work closely with the other test bed Directors and advocate projects that may have a direct bearing on the hurricane forecast problem.

For example, it is expected that all data assimilation of existing and future satellite-based observation systems that will improve hurricane guidance products will be done at the Joint Center for Satellite Data Assimilation (JCSDA). Indeed, an important task of the JHT Director and operational forecast center Director (with the assistance of

the SC) is to advocate JCSDA projects that would have the maximum impact on hurricane forecast guidance. Since the JCSDA will not address non-data assimilation applications of satellite data or other observation systems (e.g., ground-based or aircraft-based radar), addressing the transition of these observational advances either as a direct display or via a data assimilation system will be in the purview of the JHT.

Significant improvements achieved during the last decade in the accuracy of hurricane track forecasts have been achieved primarily as a result of better guidance from dynamical models, e.g., from the Geophysical Fluid Dynamics Laboratory hurricane prediction model. Thus, the JHT Director should stay linked to activities at NCEP/Environmental Modeling Center (EMC) and NWP test beds where the next-generation regional numerical model for operational hurricane forecast guidance may emerge. A good example is the Weather Research and Forecasting (WRF) hurricane model being developed by a consortium of EMC, labs, and academia. Just as discussed above for the JCSDA, the JHT Director and NHC Director are encouraged to advocate those modeling advances that have the greatest potential for improving hurricane forecast guidance.

Global model advances also lead to improved hurricane forecast track guidance. These global model improvements are another example in which infrastructure enhancements are considered to be essential contributions to the USWRP Hurricane Landfall program. Where appropriate, modeling projects outside of the JCSDA and NWP test bed programs may be considered as a transition under the JHT purview, particularly where personnel at the tropical prediction centers may play a model evaluation role.

Until there is a viable observational test bed activity, JHT should play a lead role in advocacy for *in-situ* and remote observational strategies that will lead to improved specification of hurricane structure and the surrounding environment. The JHT Director should stay aware of strategies that could be applied to the standard aircraft, ocean, and shoreline observing methods currently used in the hurricane-prone regions.

The JHT is expected to coordinate its activities with those of other centers such as the NOAA Labs and Cooperative Institutes, the Naval Research Labs, and NCAR. Experiences gained and advances at other hurricane forecast centers should be shared to the mutual benefit of improving hurricane forecasts and warnings.

Appendix A-1 Tasks for Research, JHT, and NHC Personnel

Proposed tasks of the Joint Hurricane Test Bed (JHT) personnel (JHT Director and staff, middle column) working with the researcher (tasks in left column) and with the Technology and Science Branch (TSB) and Hurricane Specialists (HS) at the National Hurricane Center (NHC) in a three-phase process. Key decisions in the four-phase transition process are indicated in boxes.

Phase	Tasks of Researcher(s)	Tasks for JHT personnel	Tasks for TSB and HS
I A	Mature research or observational system result achieved	Monitoring of research or observational system for operational relevance	Monitoring of research or observational system for operational relevance
I B	Prepares proposal for JHT Steering Committee	Collaboration with researcher on estimating resources/timing for transition	Consult with JHT personnel and researcher as to forecast requirements



DECISION FOR TRANSITION



II A	Provides research or observation data/code	Adapts code for operational data stream and NHC hardware/software	Provides guidance as to operational requirements and constraints
II B	Assists in test/evaluation phase design and assessment	Performs Functional Tests : evaluates prototype operational product	Participates in test/evaluation for operational relevance/timing



DECISION FOR PRE-IMPLEMENTATION OPERATIONAL TEST



III A	Monitors test for veracity with research	Provides operationally capable code with full connectivity to NHC data streams and systems	TSB assists in parallel test of proposed operational product and HS provides feedback. TSB provides evaluation of proposed product
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DECISION FOR OPERATIONAL IMPLEMENTATION



III B	Provides materials for documentation and training for operational forecast and support staff	Provides case studies and documentation for training; transfer program to TSB if accepted	Conducts training in proper utilization
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Appendix A-2

Charter of the Joint Hurricane Test Bed (JHT) Steering Committee.

Purpose

The purpose of the JHT Steering Committee (SC) is to advise the JHT Director in all test bed activities including the proposal and review process, outreach, scientific assessment, and information technology. In addition, the SC remains aware of activities in tropical cyclone research and brings this knowledge base to the JHT process.

Specific Functions

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

- serving as a knowledgeable resource on JHT issues and other activities in tropical cyclone research;
- reviewing and seeking out reviewers for test bed proposals or extensions;
- contributing to Announcements of Opportunity (AO), plans, reports, and budgets;

Membership

The JHT 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 prediction and warnings of tropical cyclones. Members will serve a term having a typical minimum period of three years. Members will broadly represent the tropical storm community and will be drawn from the university research community, NOAA and DOD operations, and NOAA and DOD research. New prospective members can be nominated by the JHT Director and sitting SC. New members will be approved by the co-chairs of the SC, who will inform the USWRP/IPO of the new selectees.

SC Chairmanship

Co-chairs of the SC will be one representative each from the operational and research communities. Co-chairs will direct the activities of the SC, convene meetings, and provide meeting summaries.

Meetings

Meetings will be held as needed for proper conducting of JHT business. It is anticipated that telephone conference calls will fill most needs. At a minimum at least one meeting biennially shall be directed at the proposal and review process. Additional meetings may focus on review of projects or development of the AO. Agenda items for meetings may be submitted to either co-chair by the JHT Director, the USWRP/IPO, the NHC, or any SC member. Any recommendations from meetings will be forwarded to the JHT Director.

The SC Role in the JHT Proposal Process

New Proposals

The SC will identify new emerging research and make known these opportunities to the JHT and USWRP/IPO. The NHC, EMC and JTWC will develop a statement of need. From the statement of need and opportunities, the JHT Director and SC will draft an AO and coordinate it with the USWRP/IPO. The USWRP/IPO will distribute the AO and will collect proposals from interested researchers. The SC will establish review criteria and guidelines and review submitted proposals. 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 will monitor the review process and ensure that there are no conflicts of interest. The SC will send final selections to the JHT Director and NHC Director for endorsement. Any differences in proposal rankings will be negotiated between Directors and the SC before being sent to the USWRP for final processing and disbursement of funds.

Renewals

A special review procedure will be used for consideration of the second-year proposals. Given satisfactory progress on the first year milestones as reflected in the progress reports and input from the JHT Director, 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 JHT and NHC Directors, the JHT Director will submit the funding requests via the USWRP/IPO for final approval.

Amending this Charter

As the JHT and SC evolve it may become necessary to change 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 JHT Director.