

Performance of NWP-based ice loss predictions for resource assessment

A roadmap for improved validation as a crucial element in the model development process

Winterwind 2016 Åre, Sweden

Gemma Daron and Daran Rife

10 February 2016

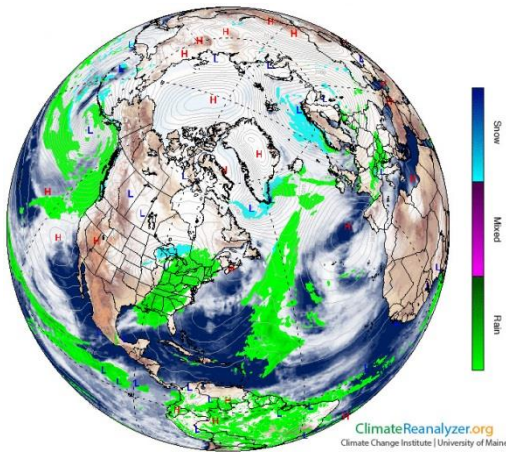
- **Advancing development and validation of turbine ice modeling methods for resource assessment**

Icing loss modeling: Current state-of-the-art

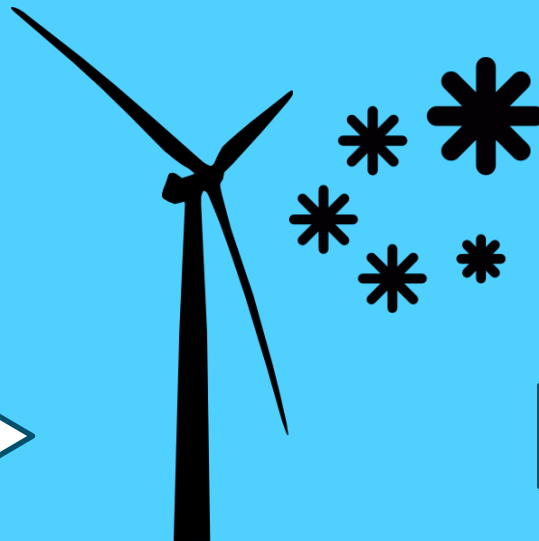
- Empirical (purely data driven)
- Statistical / machine learning
- **Mesocale NWP models**
- Combinations of the above

The icing loss modeling chain

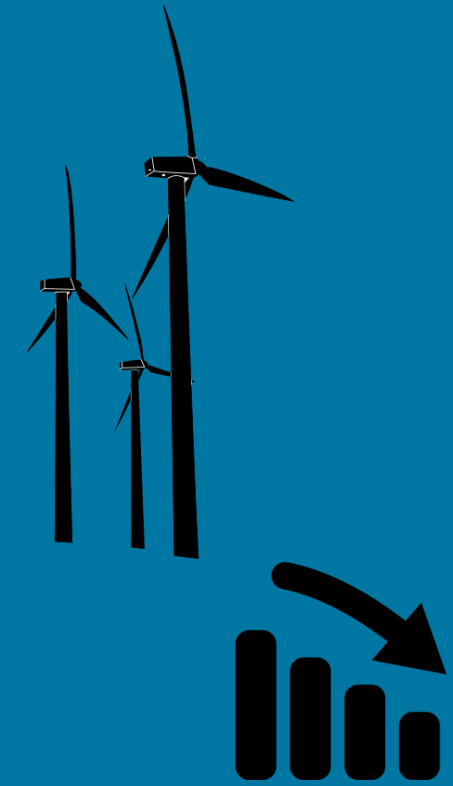
NWP model



Ice load model



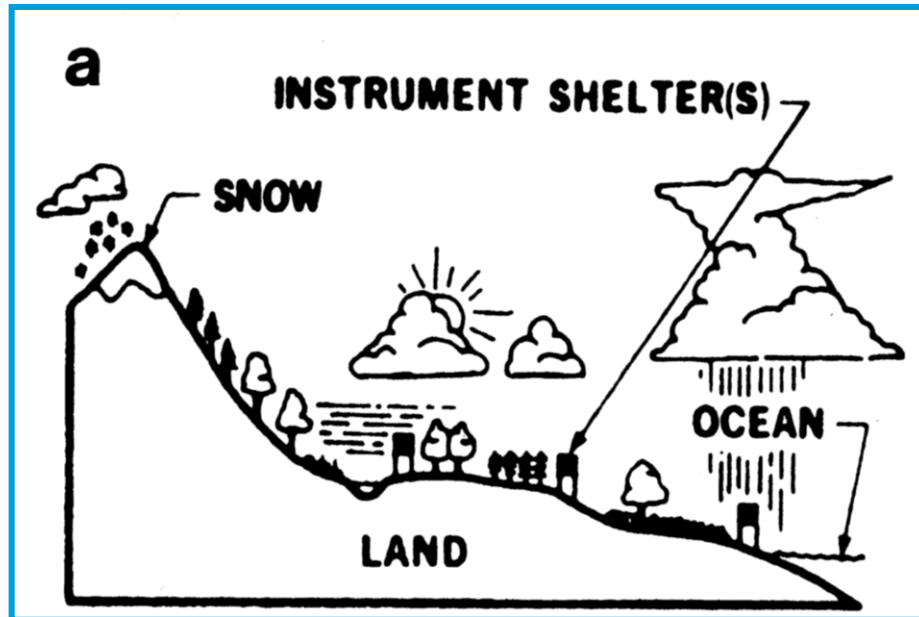
Production loss model



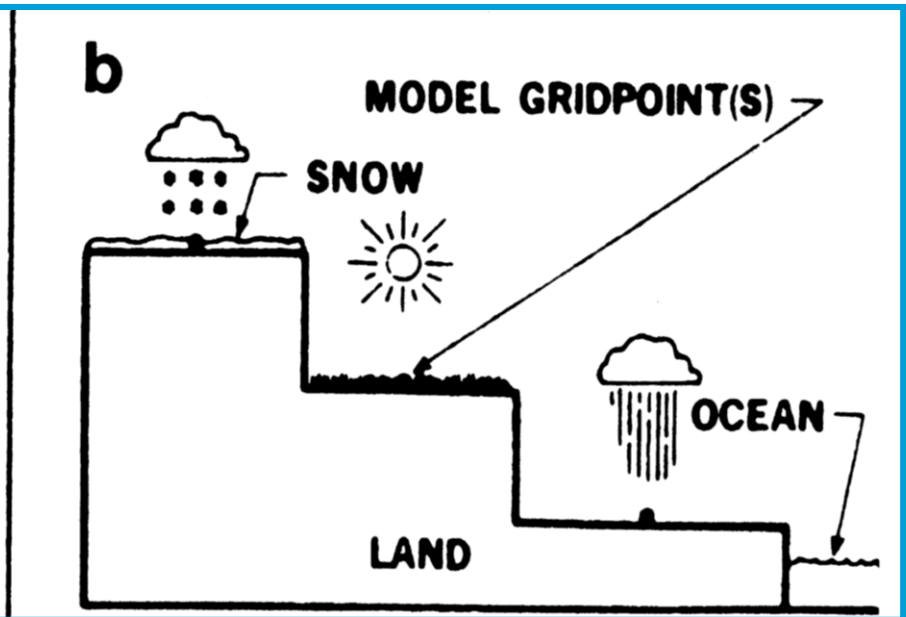
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Limitations of NWP Models: The big picture

Real world



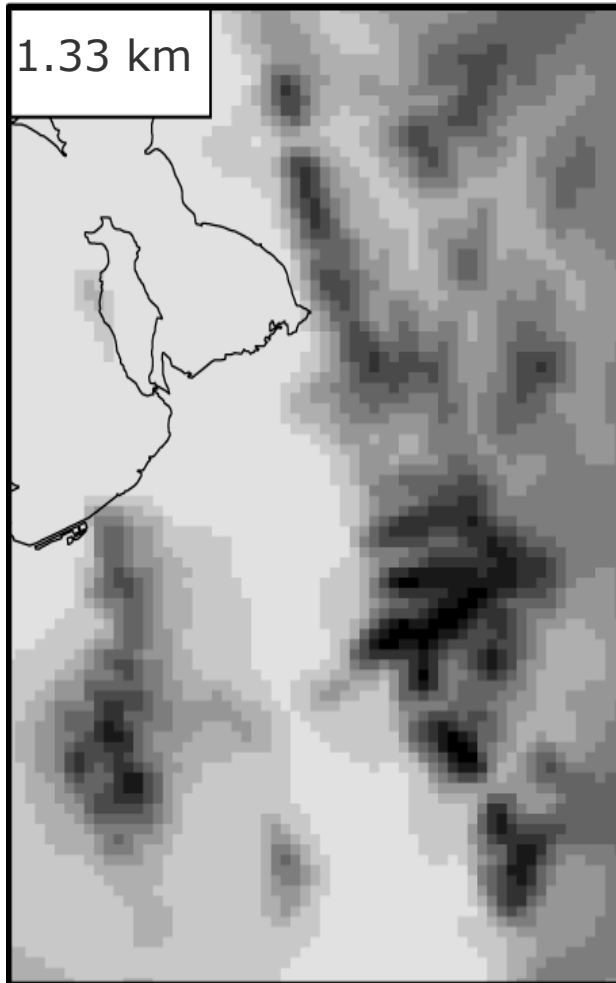
Model representation



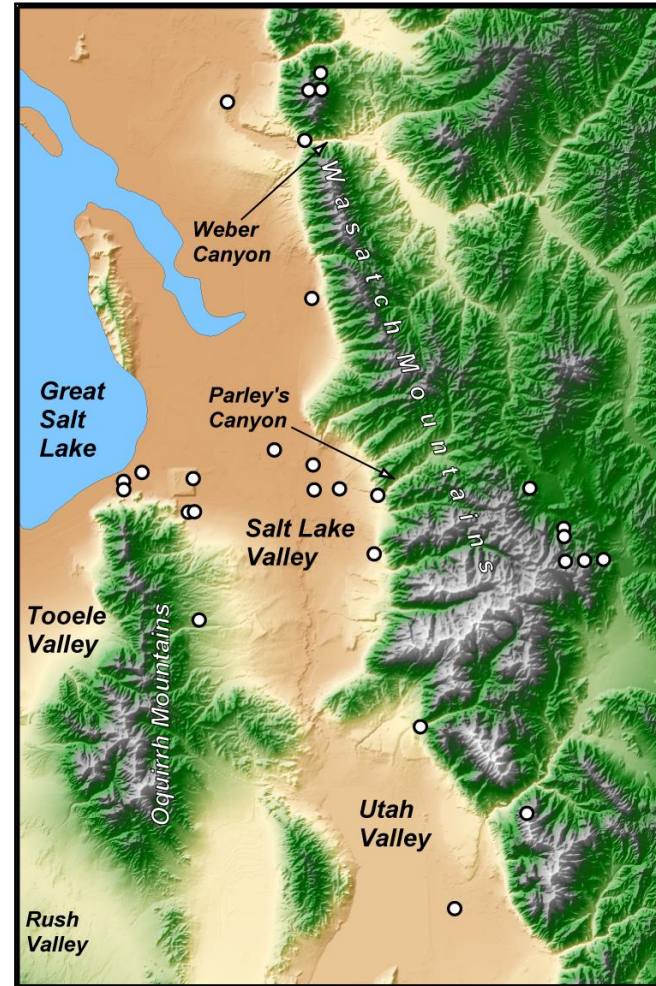
Imperfect representation of physical process, very small scale features poorly represented.

Limitations of NWP Models: Spatial discretization

Model topography



Actual topography



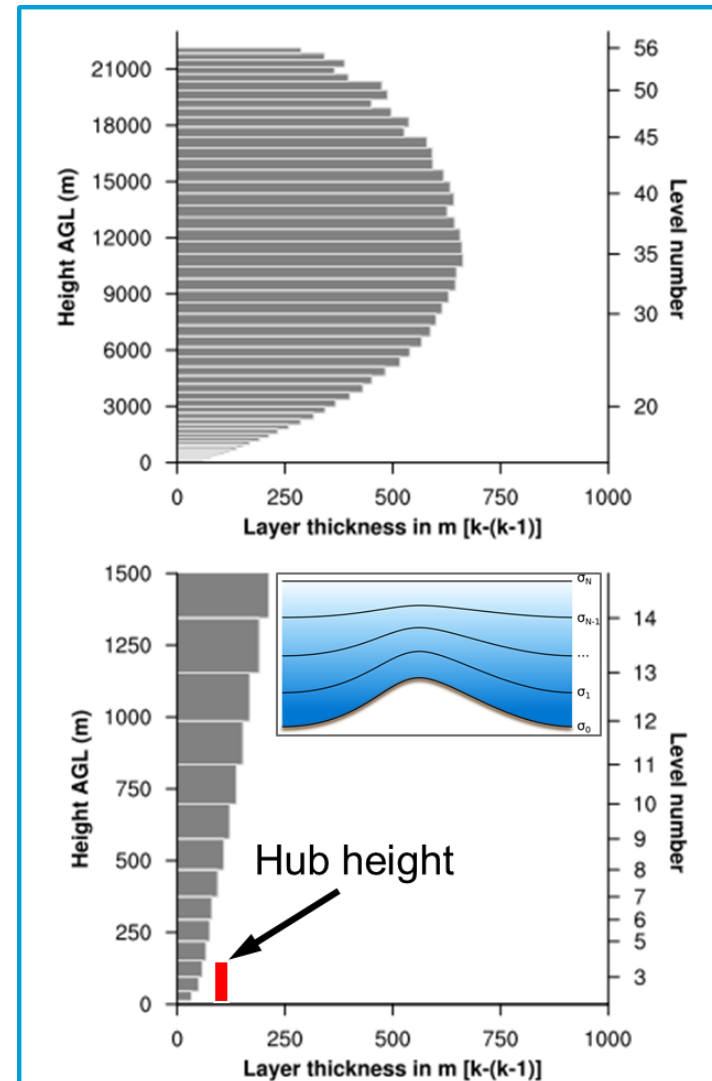
From Rife et al. (2004)

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Limitations of NWP Models: Atmospheric vertical structure

Typical discretization of atmospheric vertical structure in mesoscale models.

The real atmosphere is a fluid continuum!



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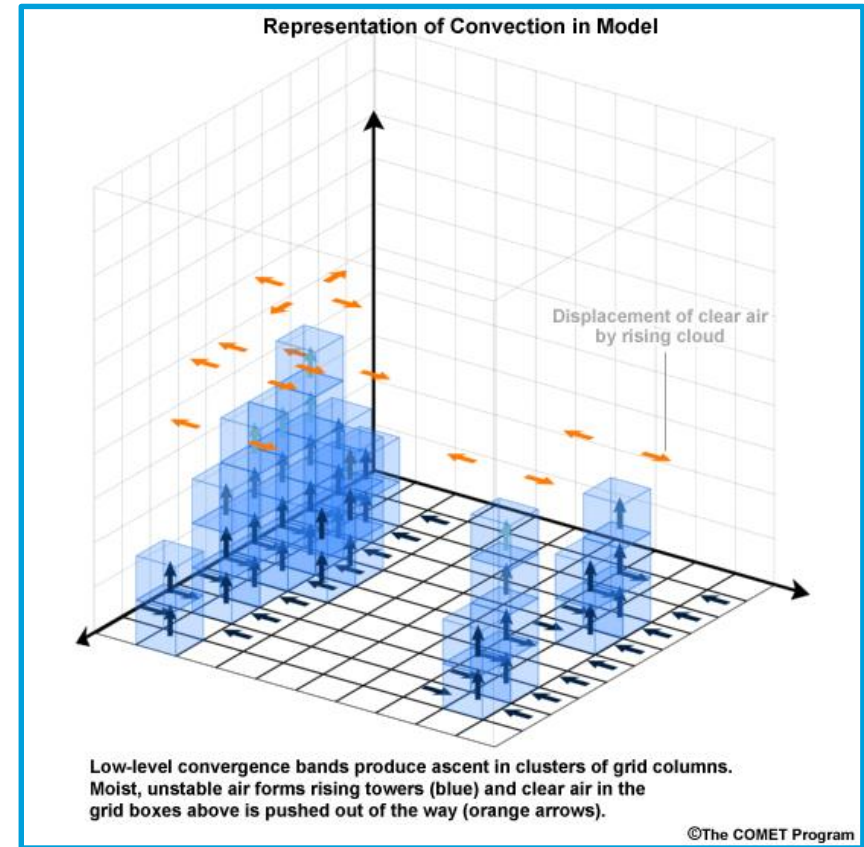
Limitations of NWP models: Representation of clouds

Nature



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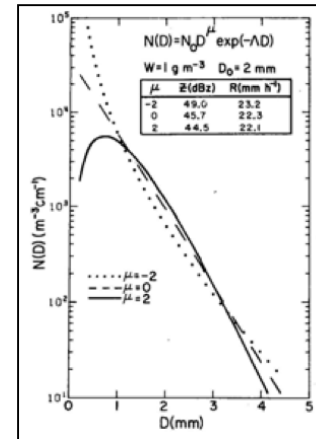
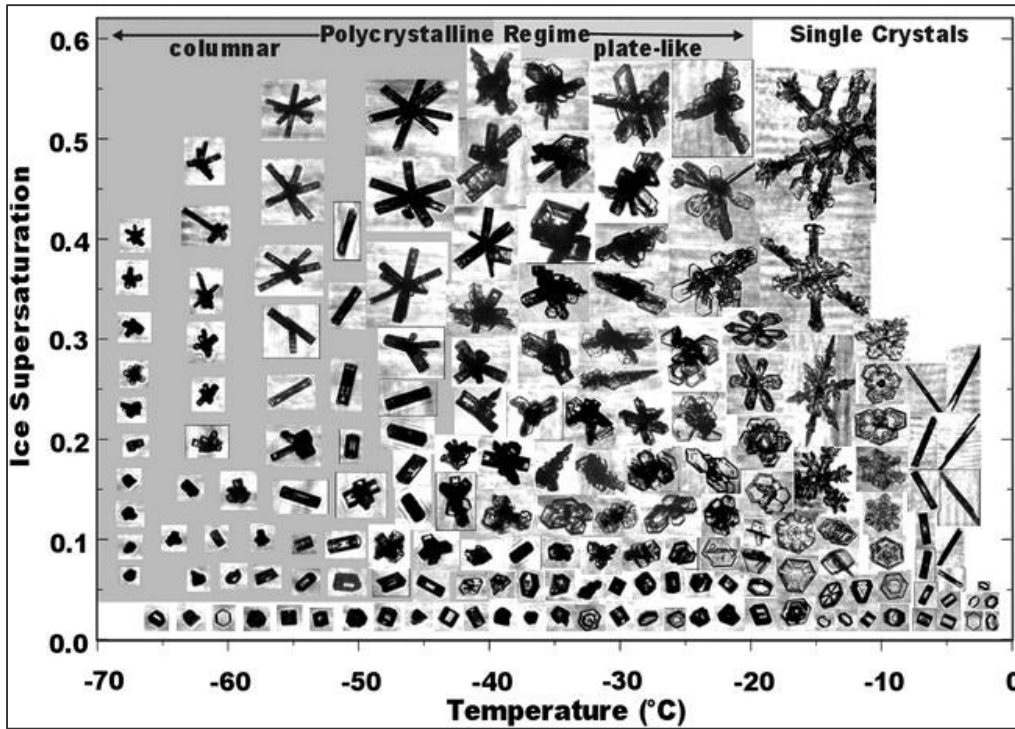
Model



Limitations of NWP models: Representation of cloud microphysics

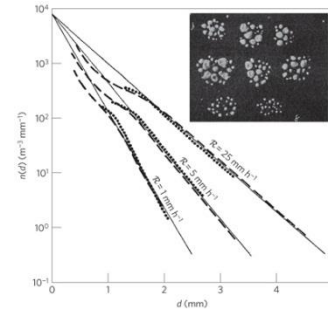
Representing all these processes in a cloud...

...with two parameters!



Gamma distribution

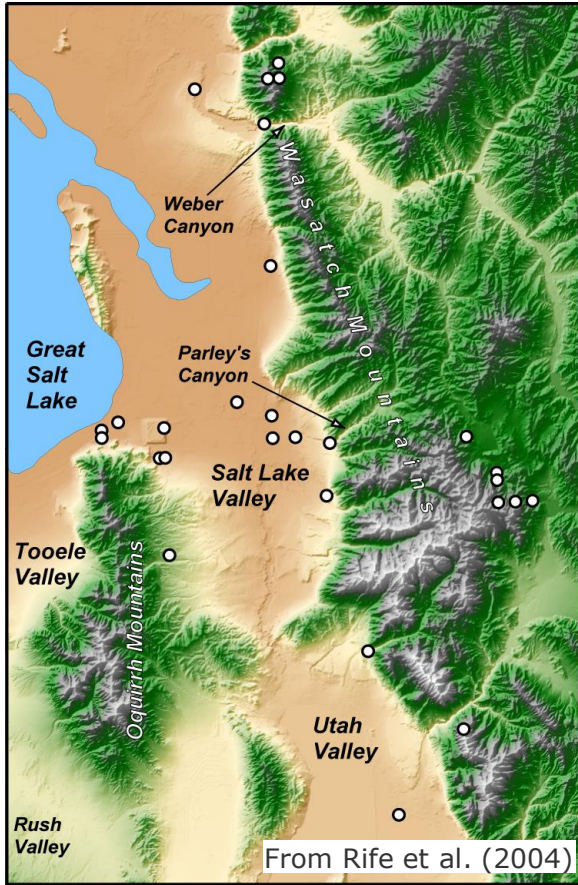
**This
OR
This**



Marshall-Palmer distribution

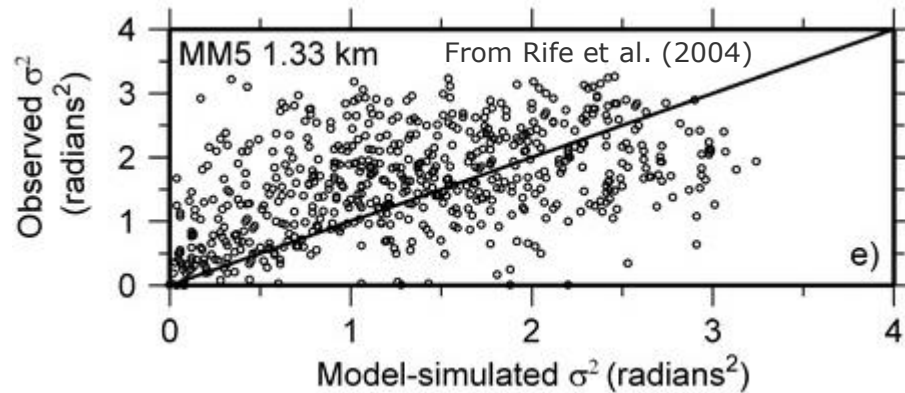
From Bailey and Hallet (2009, Journal of Atmospheric Sciences)

Limitations of NWP models: Spatial and temporal variability



White dots = obs stations

Spatial variance of winds from 1.33 km res model



Even high resolution models under represent true amount of atmospheric variability. CFD is not immune!

The need for comprehensive validation

- **Validation is a crucial element in model development**

- Provides method for objectively measuring improvement and/or choosing between model prediction systems
- Provides benchmark that serves as a minimum standard
- Aids understanding of uncertainties in model predictions
- Helps identify *sources* of systematic errors so they can be remedied or compensated for

Suggested reading: [Quality Assurance in Atmospheric Modeling \(Warner 2011\)](#)

Challenges of current development and validation efforts

- Limited and poorly coordinated
- No benchmark against which to measure benefits of new/improved systems
- Limited to small set of “case studies” for very specific regions, and each developer uses a different set of cases
- No unified set of metrics—Impossible to compare merits of competing systems
- Unclear end goals
- Lacks impartiality—All validation carried out by individual developers

Toward unified and coordinated development of turbine ice modeling systems

- **One idea:** “Turbine Ice Modeling Testbed”

Framework for conducting rigorous, replicable, and transparent testing of modeling systems

Examples of highly successful testbeds

Developmental Testbed Center

Developmental Testbed Center

ASSESSING ADVANCED NUMERICAL FORECAST TECHNIQUES FOR OPERATIONS AND RESEARCH

DTC Newsletter
NEW DTC Newsletter, 2016 Winter

Announcements

- MET Version 5.1 Release 10.26.2015
- Release of HWRFV3.7a system 08.31.2015
- GSI Version 3.4 Release 07.31.2015
- EnKF Version 1.0 Release 07.31.2015
- UPP Version 3.0 Release 05.05.2015

Fundamental Purpose of DTC

DTC

Research Community ↔ Operational Community

To serve as a bridge between research and operations to facilitate the activities of both halves of the NWP Community in pursuit of their own objectives:

Joint Hurricane Testbed

NATIONAL HURRICANE CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

USWRP Joint Hurricane Testbed

JHT Overview

Overview | [Current Projects](#) | [New Projects](#) | [Past Projects](#) | [Admin Presentations](#) | [Highlights](#) | [Staff](#) | [Committee](#) | [FAQ](#) | [Publications](#)

Mission Statement

The mission of the Joint Hurricane Testbed is to transfer more rapidly and smoothly new technology, research results, and observational advances of the United States Weather Research Program (USWRP), its sponsoring agencies, the academic community and other groups into improved tropical cyclone analysis and prediction at operational centers.

News

- 7 December 2015: New projects to be tested during the 2016 and 2017 hurricane seasons
- 6 October 2015: New JHT projects (Round 8; FY15-17) are announced

Main Activities

- Identify new techniques, models, observing systems, etc. with potential for improving forecast guidance, via an announcement of opportunity and a proposal, review, and funding process.
- Establish and maintain an infrastructure to facilitate the modification and transfer of research applications into the operational computing, communication, and display environment.
- Complete tests in a quasi-operational environment of tools, techniques, etc. provided by funded researchers, with metrics for scientific performance, ease-of-use, and time constraints.
- Prepare documentation, training, and performance evaluations of successfully transferred products to facilitate use and support in operations.

Please see the Joint Hurricane Testbed Terms of Reference (PDF) for more background information.

Collaborations between national forecasting centers and laboratories, academia, and private industry

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Roadmap to Turbine Ice Modeling Testbed

- **Establish a benchmark modeling system or reference**
 - Essential for understanding and quantifying value of new models/methods
- **Establish large set of historical cases spanning multiple geographic regions**
 - Permits extensive testing and evaluation of improvements and new methods
- **Establish “library” of high-quality QC’ed measurements**
- **Establish unified set of metrics applied consistently across all modeling systems**
- **Establish independent non-partisan body to perform validation**

Benefits of a testbed

- **Comprehensive validation will help guide development efforts**
 - Hone in on model deficiencies so they can be understood and remedied
- **By combining forces we can accomplish far more in far shorter time than any individual effort**
- **Elevates the credibility of all players**
- **Help establish global standards and increased consistency in methods**
- **Potential to dramatically increase confidence from investors**

Thank you! Questions?

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SAFER, SMARTER, GREENER

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