Annual Report 2024

Task 57

Photo: *Moon setting over King Plains Wind Farm operated by ENGIE North America, a partner in the American WAKE experimeNt (AWAKEN). (Photo credit: Bryan Bechtold / NREL.)*

Joint Assessment of Models (JAM)

Author: Regis Thedin, National Renewable Energy Laboratory (NREL), United States

The International Energy Agency (IEA) Wind Technology Collaboration Programme (TCP) Task 57, Joint Assessment of Models (JAM), aims to coordinate international efforts to assess wind energy models used across applications—from resource assessment to turbine control. The goal is to build confidence in model predictions through collaborative benchmarking, standardized validation protocols, uncertainty quantification, and stakeholder engagement.

In 2024, Task 57 launched two major benchmarks: one using the U.S. Department of Energy's (DOE) American Wake Experiment (AWAKEN) dataset, which offers utility-scale wind farm wake measurements. The AWAKEN benchmark focused on inter-farm wake effects. A second benchmark used measurements from the U.S. DOE Rotor Aerodynamic, Aeroelastic, and Wake (RAAW) field campaign, focused on rotor inflow and single turbine characterization.

These benchmarks followed a community-defined blueprint and incorporated expert input on model performance metrics. Data portals, documentation, and analysis frameworks have been established. The third benchmark will be released soon, and it is a complex terrain inflow data benchmark, based on the Wind Science & Engineering Test Site in Complex Terrain (WINSENT) campaign.

Stakeholder engagement through surveys and elicitation interviews has guided performance criteria and prioritization. The Task benefits from strong industry involvement through direct participation in benchmarking. Stakeholders include turbine manufacturers, wind farm developers, and consultants. In-kind contributions from national research labs, universities, and industry bolster efforts.

Introduction

Wind energy simulation tools are increasingly relied upon for design, control, and operation, yet their accuracy vary due to complexity and environmental uncertainty. As turbines grow in size and farms are deployed in diverse terrains, there is a need to standardize and improve model validation against high-fidelity field data.

Task 57 was created to address this challenge by coordinating international efforts to assess the performance of wind energy models. It leverages recent, high-quality datasets to build robust, universal benchmarks and foster collaboration among model developers, users, and data owners. It also builds on a prior, successful task focused on benchmarking.

The goal of Task 57 is to produce, carry out, and disseminate well-documented benchmarks combining inflow, turbine response, and wake effects, develop a universal validation blueprint, quantify modeling uncertainty, and generate actionable recommendations for model users. These outputs will inform model improvements and help standardize model use across application spaces.

A wide range of stakeholders including manufacturers, operators, consultants, and academic groups are supporting the Task. They contribute by leading benchmarks, supplying experimental data, and/or validating models. Table 1 lists participating institutions on the first two benchmarks.

Progress and Achievements

Since the start of the Task, JAM has launched two model validation benchmarks following the benchmark blueprint developed early in the Task. The AWAKEN benchmark, focused on farm-scale wake dynamics, uses field data from multiple wind plants in mildly complex terrain (Oklahoma, U.S.A.) (figure 1).

Some of the experimental data given to participants include lidar, meteorological towers, and turbine Supervisory Control and Data Acquisition (SCADA) data. The RAAW benchmark targets inflow characterization and near-rotor behavior, centered on a single 2.8 MW turbine with high-resolution inflow measurements.

Both benchmarks were publicly released with supporting documentation, data portals, and code templates to

COUNTRY/SPONSOR	INSTITUTIONS
USA	National Renewable Energy Laboratory (NREL), Massachusetts Institute of Technol ogy, University of California Berkeley, Johns Hopkins University, ArcVera Renewables, Lawrence Berkeley National Laboratory (LBNL), Sandia National Laboratories, Pacific Northwest National Laboratory (PNNL)
Canada	Veer Renewables, Dalhousie University
Denmark	Technical University of Denmark, Nordex
France	MeteoDyn, IFP Energies Nouvelles (IFPEN), TotalEnergies
Germany	Technical University of Munich, Hochschule Esslingen, Fraunhofer IWES, University of Oldenburg
Japan	New Energy and Industrial Technology Development Organization (NEDO)
Netherlands	Delft University of Technology, Whiffle, Netherlands Organization for Applied Scientific Research (TNO)
Sweden	Uppsala University, Vattenfall Europe Windkraft GmbH
Brazil (Limited Sponsor)	University of São Paulo

Table 1. *Countries Participating in Task 57*

Figure 1. *Task 57 kick-off meeting ahead of the TORQUE 2024 conference. Participation included a mix of industry, academia, and research institutions. (Image credit: Regis Thedin, NREL.)*

guide participants through simulation setup and submission. Both benchmarks currently have their own website with details [1,2], which will later in the task be combined into a single task-wide website for all benchmarks executed under JAM.

A third benchmark using the Wind Science & Engineering Test Site in Comple Terrain (WINSENT) dataset is in pre-launch stages. The WINSENT benchmark will explore wind inflow in complex terrain and is designed to engage both mesoscale and microscale modeling communities. This third benchmark addresses model performance under topographically complex conditions, including forest, extending JAM's benchmarking to a broader range of applications.

Task 57 launched a website, GitHub repositories for code sharing, Zenodo for data sharing, and LinkedIn for broader community reach—all these websites are listed under the official IEA Wind website for JAM [3]. Stakeholder surveys and expert interviews shaped the performance metrics and model evaluation criteria and will keep doing so.

Public workshops introduced the benchmarks and collected community feedback. Benchmark leads held regular working group meetings to assist participants and foster cross-institutional collaboration. A draft uncertainty quantification research plan was completed, focusing on upstream inflow conditions as the first step toward understanding uncertainty propagation through the wind plant modeling chain.

The Rotor inflow benchmark has begun incorporating this analysis, particularly through ensemble simulations and sensitivity studies of synthetic turbulence-generated inflow.

Deliverables and Publications:
- Benchmark Blueprint: Living document, constantly being updated; published on the website
- AWAKEN Benchmark
- RAAW Benchmark
- WINSENT Benchmark, planned for 2025
- Uncertainty Quantification Plan, delivered in 2025
- Peer-reviewed Publications: In preparation based on AWAKEN and RAAW benchmark outcomes, planned for 2025.

Communication Activities:
- Virtual kick-off March 12, 2024
- In-person kick-off ahead of the Torque 2024 conference: May 28, 2024 (figure 2)
- Next planned online meeting: June 17, 2025
- Joint mini-symposium at WESC 2025: Collaboration between Task 57 and Task 52

Highlights

- Early publication on the AWAKEN Benchmark [4]. A major publication is underway based on final results from the AWAKEN benchmarks. The benchmark publication will synthesize these insights and propose best practices for wake model validation.

- JAM is actively coordinating with other IEA Wind Tasks to broaden the reach and relevance of its benchmarks. With Task 52 (Lidar), JAM is jointly planning a workshop to align lidar measurement strategies with model validation needs. In parallel, early discussions with Task 47 (TURBINIA) have explored shared interests in benchmarking structural and aerodynamic model components. These connections support interoperability across tasks and reduce duplication of effort, amplifying the overall impact of IEA's modeling initiatives.

Outcomes and Significance

Task 57 has created a shared, international platform for rigorous wind model assessment, filling a long-standing gap in how models are validated and used across the industry. Through the AWAKEN and RAAW benchmarks, participants are now comparing model predictions against some of the most comprehensive experimental datasets available, enabling deep insights into model behavior under realistic conditions.

The same ideas are going to be pushed forward in the upcoming benchmarks. The standardized blueprint developed by JAM promotes proposal of new benchmarks, ensuring that validation efforts are consistent and comparable across model types and project contexts. Along with the detailed websites for each benchmark, these resources also allow new participants to onboard efficiently and contribute meaningfully.

As the energy transition accelerates, the ability to simulate and optimize wind energy systems with confidence is critical. JAM directly supports that by fostering collaboration, improving trust in models, and aligning international efforts. The Task is building a durable ecosystem of tools, data, and expertise that will outlast the Task's timeline and continue to benefit the global wind energy community.

Next Steps

In the next phase, JAM will finalize pre-planning phase and launch the WINSENT benchmark, focusing on inflow modeling in complex terrain. We will continue the execution and iteration phases for the AWAKEN and RAAW benchmarks, including workshops for deep-dive analysis and the preparation of peer-reviewed publications.

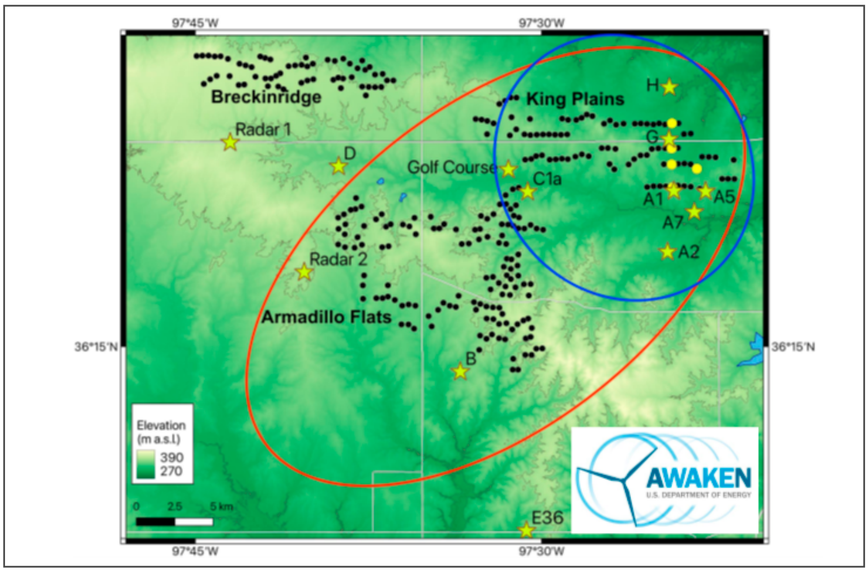

Figure 2. *The AWAKEN field campaign, subject of the first benchmark under JAM. Instrumented sites (yellow stars) and turbine locations (black circles). The red ellipse shows the region of interest for south-west wind, and the blue ellipse highlights the main area of interest for southern wind.* (Source: [4].)

The uncertainty quantification plan will be applied to these benchmarks to explore error propagation and refine performance metrics. We will also engage in cross-task collaboration activities and prepare actionable guidance for model users and developers. These efforts support the delivery of the Task's key outcomes by the end of the second project year. We have begun the identification of the fourth benchmark to be executed under the JAM umbrella.

References

[1] The AWAKEN Benchmarks (2025). Website; *awaken-benchmark.readthedocs.io*

[2] Rotor Inflow Benchmarks (2025). Website; *rotor-inflow-benchmark.readthedocs.io*

[3] IEA Wind TCP Task 57 JAM (2025). Website; *iea-wind.org/task57*

[4] N Bodini, A Abraham, P Doubrawa, S Letizia, R Thedin, et al. (2024) An international benchmark for wind plant wakes from the American WAKE ExperimeNt (AWAKEN). Download from; *iopscience.iop.org/article/10.1088/1742-6596/2767/9/092034*

Other links:

- Presentations, documents, and data; *zenodo.org/communities/jam/*
- AWAKEN Benchmark; *awaken-benchmark.readthedocs.io*
- RAAW Benchmark; *rotor-inflow-benchmark.readthedocs.io*
- Code; *github.com/IEA-Wind-Task57-JAM*

Task Contacts

Regis Thedin
Operating Agent
National Renewable Energy Laboratory (NREL)
regis.thedin@nrel.gov

Patrick Moriarty
Task Manager
National Renewable Energy Laboratory (NREL)
patrick.moriarty@nrel.gov

Lukas Vollmer
Task Manager
Fraunhofer IWES
lukas.vollmer@iwes.fraunhofer.de

Website:
iea-wind.org/task57/