Bridging Research and Operations: Extending uwtools with ecFlow Orchestration on an AI-Based Forecast System

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1. R2O2R Challenge & Objectives

Background: NOAA's modeling suite serves two audiences whose tooling has historically diverged. Research and development favors the Rocoto workflow manager for flexible, iterative experimentation; operations depends on ecFlow for reliable production delivery. The result is duplicated effort, two parallel infrastructures, and a discontinuous path from research to operations and back again (R2O2R).

Objective & Modernization: Add native ecFlow support to uwtools, so a single application can be orchestrated by either engine without forking or reimplementing the code. This modernizes model development and opens operational systems to the research community.

Closing the R2O2R Gap: By leveraging uwtools' capabilities (schema-checked configuration, reusable component drivers, and dual orchestration) workflow execution is standardized across the organization, turning UW-AIGFS from a one-off bridge into an adoptable tool available to any model.

Key Refactoring Goals:

- Unify configuration using schema-validated YAML
- Decouple *what* the workflow does from *where* and *how* it runs
- Make the full R2O2R loop reproducible and portable

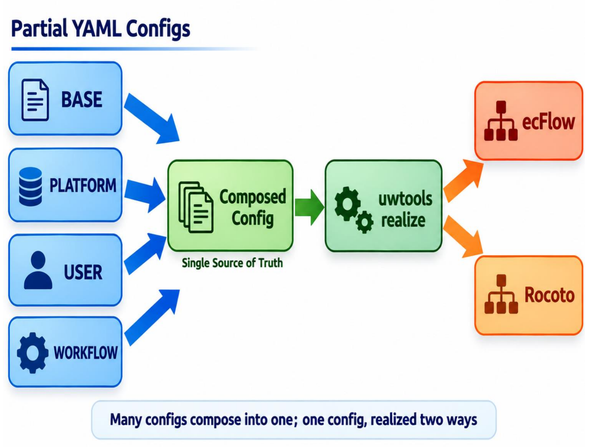
Check out uwtools on GitHub

Check out uw-aigfs on GitHub

2. Unified Architecture: uwtools & AIGFS

YAML Config Layer

Composes base, workflow, platform, and user configs into a single source of truth. Every config is schema-validated up front.



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uwtools Engine

Reusable drivers encapsulate each component as declarative, dependency-aware tasks:

- Initialization
- Model runs
- Post-processing

Drivers are platform-agnostic. The same driver code runs unchanged across HPC and cloud.

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Dual Orchestration

One application definition realizes to either engine:

- ecFlow (Ops/NCO) → suite.def + .ecf scripts
- Rocoto (R&D) → workflow XML

The same workflow serves operations and research from a shared codebase.

3. Operational Readiness: AIGFS Proving Ground

Why AIGFS? The first component of NWS's AI-based operational suite, AIGFS makes an ideal proving ground for uwtools. Its streamlined, data-driven, design is simple enough for clean, controlled testing. Refactoring AIGFS onto uwtools' dual orchestration opens an operational system to researchers while preserving its operational delivery path, demonstrating an early, real proving ground for a true R2O2R loop.

Engineering Rigor:

- **Dual-mode validated:** identical AIGFS config realized under both ecFlow and Rocoto
- **100% unit-test coverage:** every addition to the codebase is guarded by tests
- **Automated QA in CI:** enforced formatting, linting, and strict type checking on every change
- **Consistent local & CI testing:** developers run the exact same code-quality checks locally as in CI
- **Agile by design:** architecture built on uwtools means most science is done through configuration changes, not code rewrites

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Generative AI tools were used to assist with drafting and editing text and graphics; all content was reviewed and validated by the authors.

4. Portability & Next Steps

Cross-Platform Deployment

Demonstrating true platform independence across diverse environments:

- **Ursa (HPC):** Active real-time R&D execution
- **WCOSS2 (Operational HPC):** Running the uwtools-managed workflow on NOAA's operational platform is in progress
- **Google Cloud (GCP):** GSL proof-of-concept for cloud-native, real-time execution is in progress

The same drivers and YAML move across all three; machine-specific details live in separate, composable platform configs.

Closing the R2O2R Loop

Unifying workflow config under uwtools keeps operational models open to researchers and lowers the barrier for developers to adopt the same framework operations uses, all while preserving NCO's delivery path. The approach proven on AIGFS extends next to WCOSS2 and potential application to more NOAA models.