# DTC Update on Hurricane Supplemental Projects

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# Outline

- HAFS Infrastructure – Evan Kalina
- HWRF Physics in CCPP at NOAA/GSL – Man Zhang
- HWRF Physics in CCPP at NCAR – Mrinal Biswas/Mike Ek

**HSUP Resources**

$135 K (PoP: Jul 2019-Jun 2021)

# HAFS Infrastructure

## PI: Evan Kalina

**Deliverables:**

Establish an authoritative UFS workflows repository in GitHub with CROW code as the starting point (HU 12/2019)

Review the design and implementation of CROW with community partners (HU 06/2020)

Demonstrate that CROW or a CROW alternative can interact with the Common Infrastructure for Modeling the Earth (CIME) for building and running simple forecast model configurations (HU 06/2020)

Plan and document the design of the transition-to-operations workflow for the UFS hurricane application based on collected requirements and review with technical and scientific partners (HU 09/2020)

Demonstrate a workflow for a HAFS configuration that is suitable for simplified benchmarking that is part of a transition to operations, including the ability to do cycling without full DA (HU 06/2021)

# CROW review held on April 28

- Virtual meeting with Google Meet
- 60-70 participants(!) from GSL, NCAR, DTC, EMC, HRD, AER, GMU, SUNY Albany, and more
- Followed by UFS Workflows Workshop

# CROW review goals

- Understand direction of HAFS and UFS workflows development
- Discuss feedback that can inform the HAFS workflow design
- Gain familiarity with CROW
- Discuss whether CROW is an improvement over the existing HAFS configuration system
- Progress towards deciding whether to use CROW in HAFS

# CROW review discussion

- Advantages (not comprehensive)
  - CROW can generate Rocoto and ecFlow workflows
  - Opportunity to unify configuration managers across UFS
  - YAML offers more features for writing and organizing configuration files than .INI files
  - Underlying knowledge of CROW not necessary for HAFS users and most developers
  - Documentation exists (and is being expanded)
- Disadvantages (not comprehensive)
  - Need CROW knowledge to add new features
  - CROW would need to go to operations, and we do not yet know whether NCO would accept CROW

# Next steps

- Report summarizing CROW review feedback, to be provided to EMC partners
- Decision on whether to use CROW is needed, preferably within next ~3 months
- Will work with Mariana and Rocky to prototype a HAFS workflow that incorporates CIME
  - Current plan is to use the existing HAFS configuration system in this prototype

**HSUP Resources**

$62 K (PoP: Aug 2019-Jul 2021)

# HWRF Physics in CCPP (GSL)

## PI: Man Zhang

**Deliverables:**

- HWRF F-A, saSAS, and RRTMG parameterizations in CCPP (Jan 2020)
- HWRF Physics Suite Test Plan (Apr 2020)
- Successful HAFS v0.a runs using the HWRF suite (Apr 2020)
- **Inform preliminary results to EMC (Mid-May 2020)**
  - Assemble a prototype HWRF physics suite
  - Complete HAFS v0.a (GSL) and HAFS v0.b (NCAR) runs on Hera
  - Conduct full physics test on Orion; and conduct standard assessment for tropical cyclones, such as track error, intensity bias and error using MET-TC (Model Evaluation tools for Tropical Cyclones) tool
- Report on final test results (Jul 2020)

# The HWRF physics suite and the HAFS_p0.1 suite to be employed in HAFS v0.A/B

| Scheme/Suite | HWRF | HAFS_p0.1 |
|---|---|---|
| Microphysics | Ferrier-Aligo with separate hydrometeor species advection | GFDL |
| PBL | K-EDMF w/ HWRF namelist settings | K-EDMF w/ HWRF namelist settings |
| Deep/shallow cu | saSAS with HWRF settings on in all domains | saSAS with GFS settings on in all domains |
| Radiation | HWRF-RRTMG | GFS-RRTMG |
| Surface layer | GFDL | GFS w/ HWRF namelist settings |
| LSM | HWRF-Noah | GFS-Noah |
| Orographic gravity wave drag | on for 13km; off for 3 km | on for 13km; off for 3 km |
| Convective gravity wave drag | off | off |
| Ozone | NRL_2015 | NRL_2015 |
| H2O | NRL_2015 | NRL_2015 |

*Yellow highlights indicate aspects that differ between the suites.

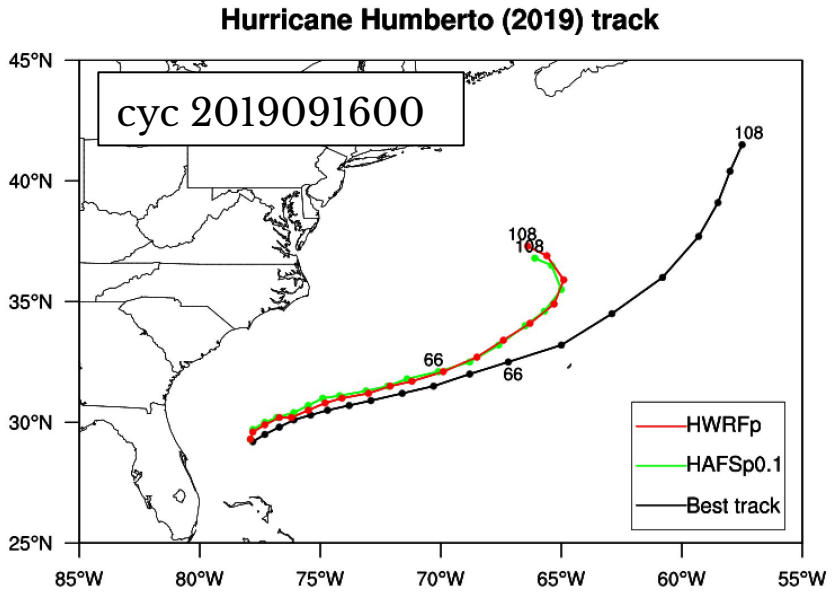
* GFDL surface layer scheme and HWRF Noah are not included in current HWRF physics repo

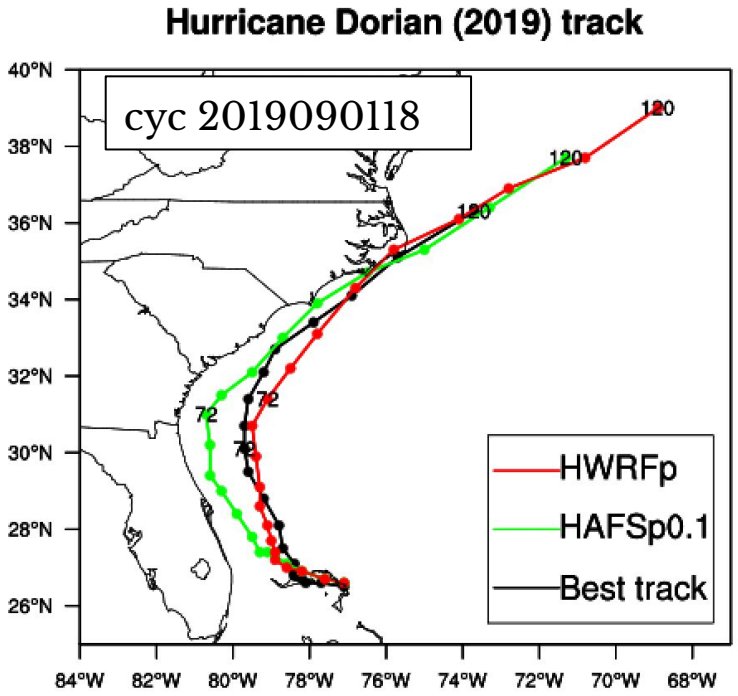
# HWRF Physics Schemes in CCPP

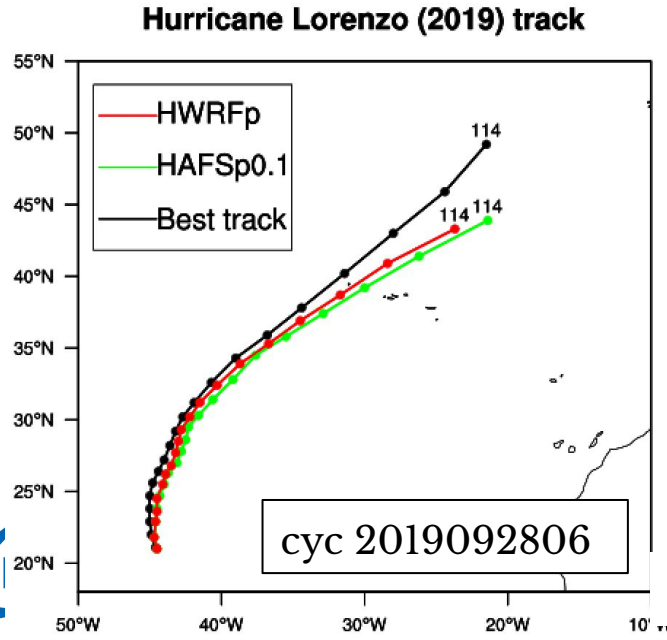
**dtc/hwrf-physics** branch on NCAR Github ccpp-physics repo includes:

- **Ferrier-Aligo MP** scheme with separate hydrometeor species advection
  - Lower RH threshold for the onset of condensation in outer domain: RHgrd=0.975 for outer domain; RHgrd=1.0 for 3-km domain
- **Generalized saSAS** with HWRF features:
  - hwrf_samfdeep = .T.
  - hwrf_samfshal=.T.
- **Generalized RRTMG** with HWRF features:
  - Thompson cloud fraction scheme (icloud=3)
  - Exponential cloud overlap method for LW/SW scheme (iovr_lw/iovr_sw=4 )
- **Generalized K-EDMF PBL** with HWRF features (NCAR task):
  - hurr_pbl =.T.
  - moninq_fac =-1.0

# Track Forecasts in HAFS v0.a

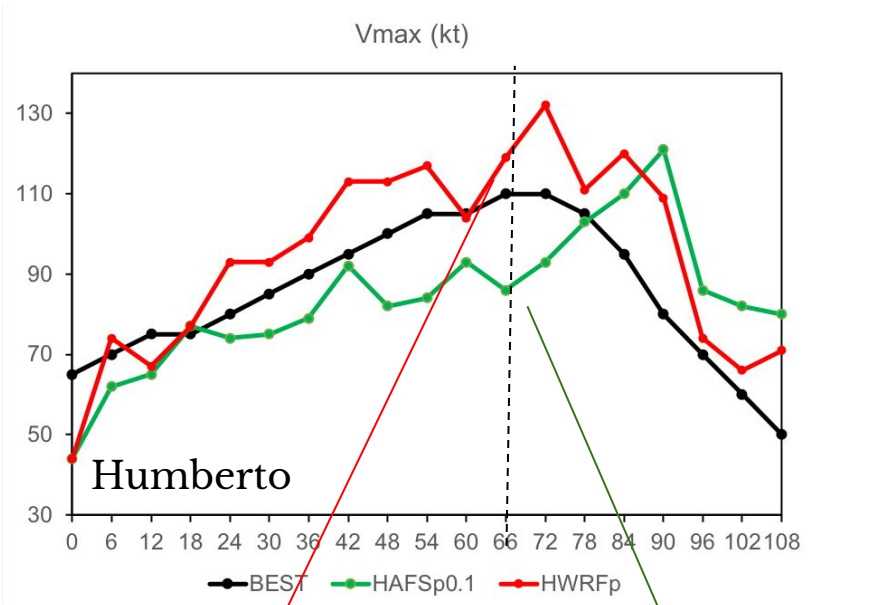


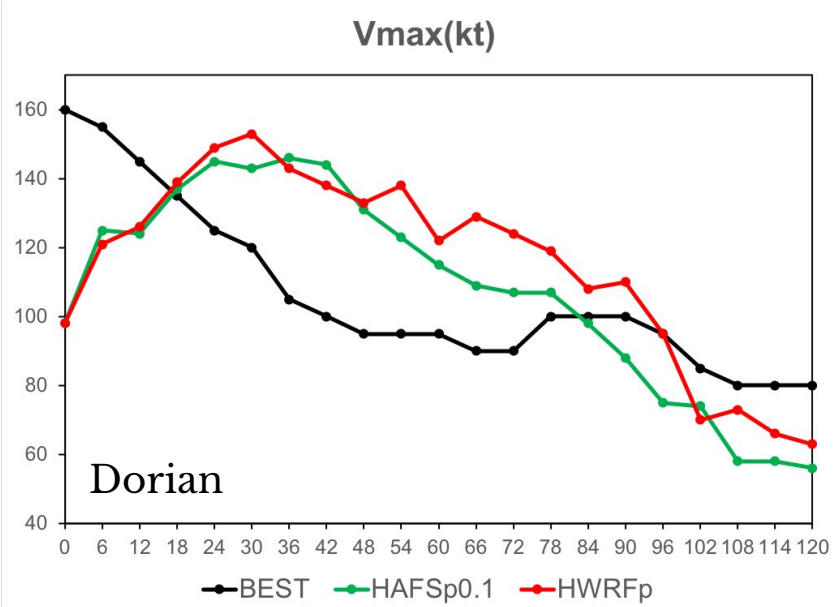




- HWRFp physics:
  - F-A, generalized RRTMG, saSAS, PBL with HWRF namelist settings
  - Using GFS surface layer scheme with HWRF namelist and Noah LSM

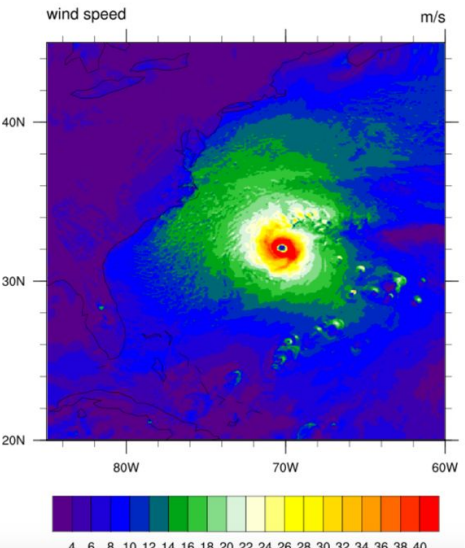
# Intensity Forecasts in HAFS v0.a



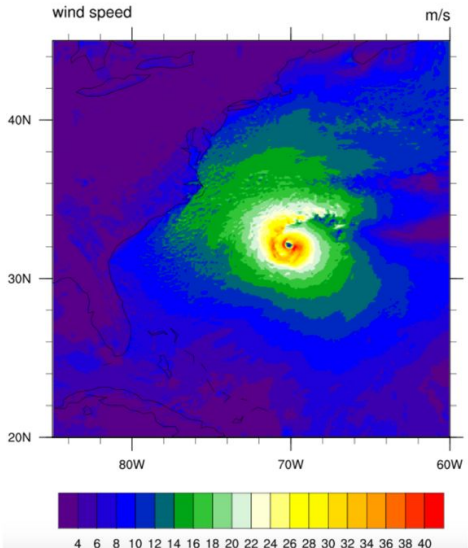



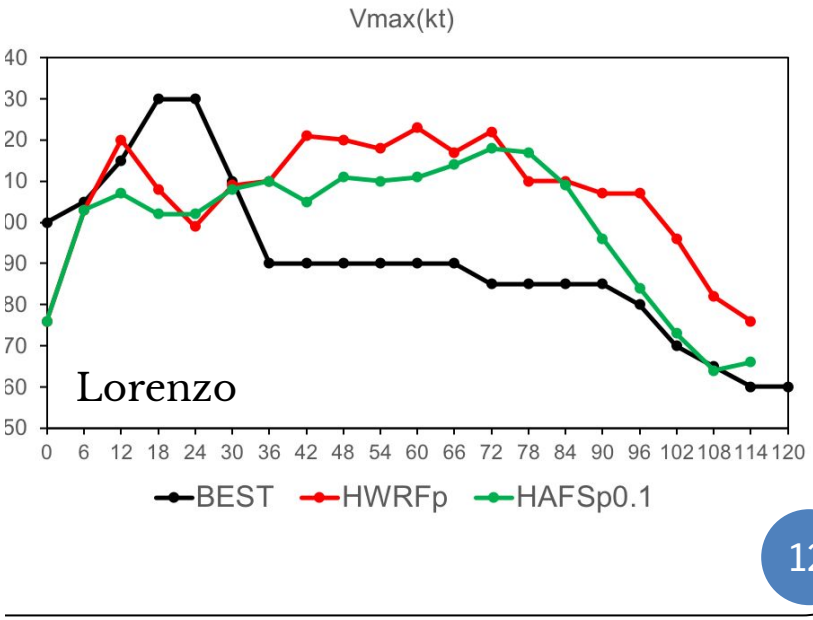

## f66 10m wind spd

HWRF_regional

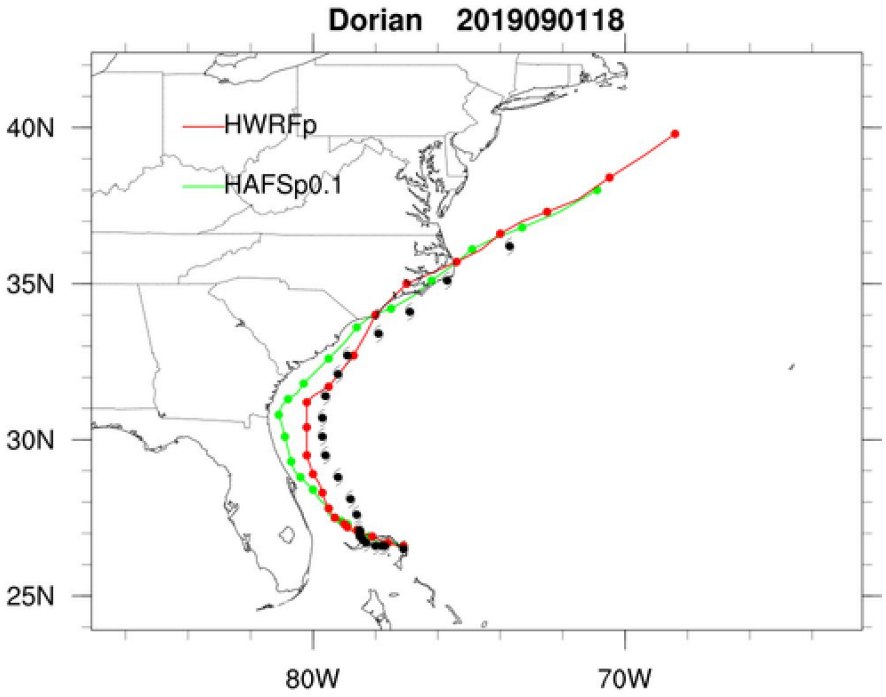


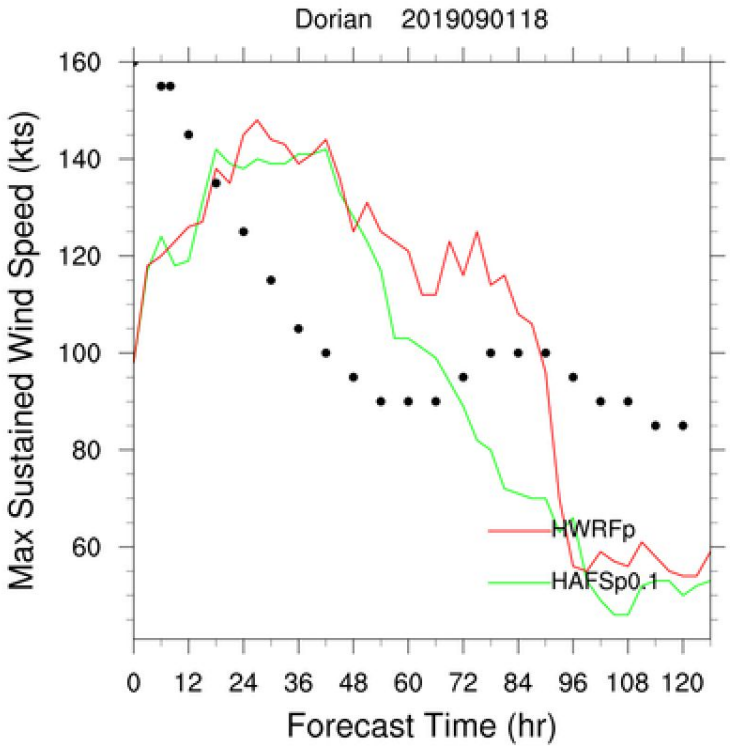

HAFS_regional



# Dorian in HAFS v0.b

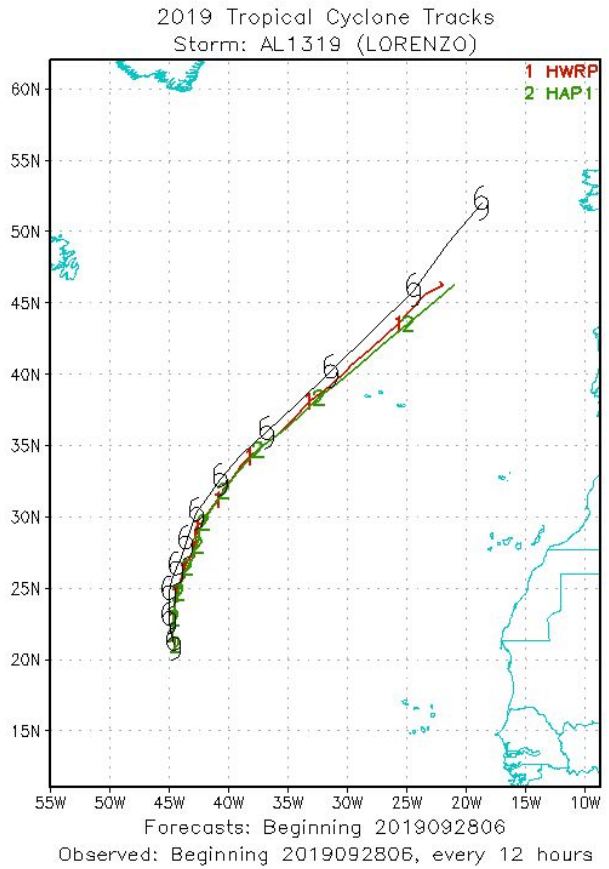


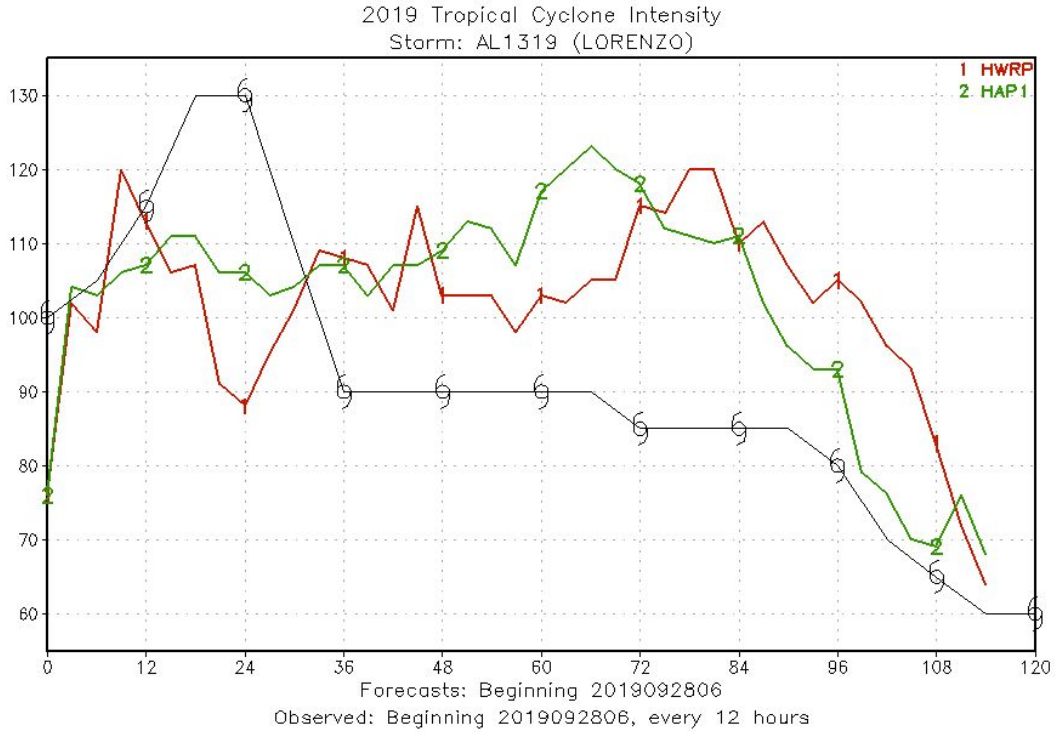




HWRFp in HAFS v0.b produces similar results as in HAFS v0.a

Courtesy of M. Biswas (NCAR/DTC)

# Lorenzo in HAFS v0.b




HWRFp (**HWRP**) in HAFS v0.b (**HAP1**) produces similar results as in HAFS v0.a

Courtesy of M. Biswas (NCAR/DTC)

# Wall Times on Hera

HAFS v0.a: npx, npy, npz = 2881, 1921, 64

| | HAFSp0.1 | HWRFp | difference |
|---|---|---|---|
| **Lorenzo** | 11499 | 14294 | +24.3% |
| **Dorian** | 11456 | 14325 | +25% |
| **Humberto** | 10997 | 13590 | +23.6% |

HWRFp requests slightly higher computational resource

**HSUP Resources**

$86K (PoP: Aug 2019-July 2021)

# HWRF Physics in CCPP (NCAR)

## PI: Mike Ek

**Deliverables:**

(1) Implement parameterizations from NOAA WRF model physics suite into the Common Community Physics Package (CCPP): EDMF PBL, GFDL surface-layer, and Noah land model schemes.

(2) Test this suite in a prototype configuration of the Hurricane Analysis and Prediction System (HAFS), for a number of test case hurricanes.

**Status:**

PBL code: in HWRF physics repo and being tested alongside rest of available HWRF schemes

Noah land code: runs as substitute for GFS Noah LSM in operational suite and combined with GFDL surface layer in FV3 for one C96 regression test

Surface layer: runs as substitute for GFS surface layer in operational suite and combined with HWRF Noah LSM r in FV3 for one C96 regression test

To Do: Submit new PRs to HWRF physics repo after cleaning up debugging statements/history, test with rest of HWRF suite

**HSUP Resources**

$86K (PoP: Aug 2019-July 2021)

# HWRF Physics in CCPP (NCAR)
## PI: Mike Ek

**Next Steps:**

- Combine with all HWRF physics
- Conduct full physics test on Orion
- Conduct standard assessment for tropical cyclone using MET-TC (Model Evaluation tools for Tropical-Cyclone) tool