HAFS Moving Nest and Physics Development, Tests & Evaluations at AOML

X. ZHANG[1], A. HAZELTON[1,2], W. RAMSTROM[1,2], G. ALAKA, JR. [1], H. CHEN[1,2], R. ST. FLEUR[1,2], M.-C. KO[1,2], L. GRAMMER[1,2]
S. GOPALAKRISHNAN[1], AND F. D. MARKS, JR. [1] ([1]AOML/HRD & [2]UM/CIMAS)

COLLABORATORS:

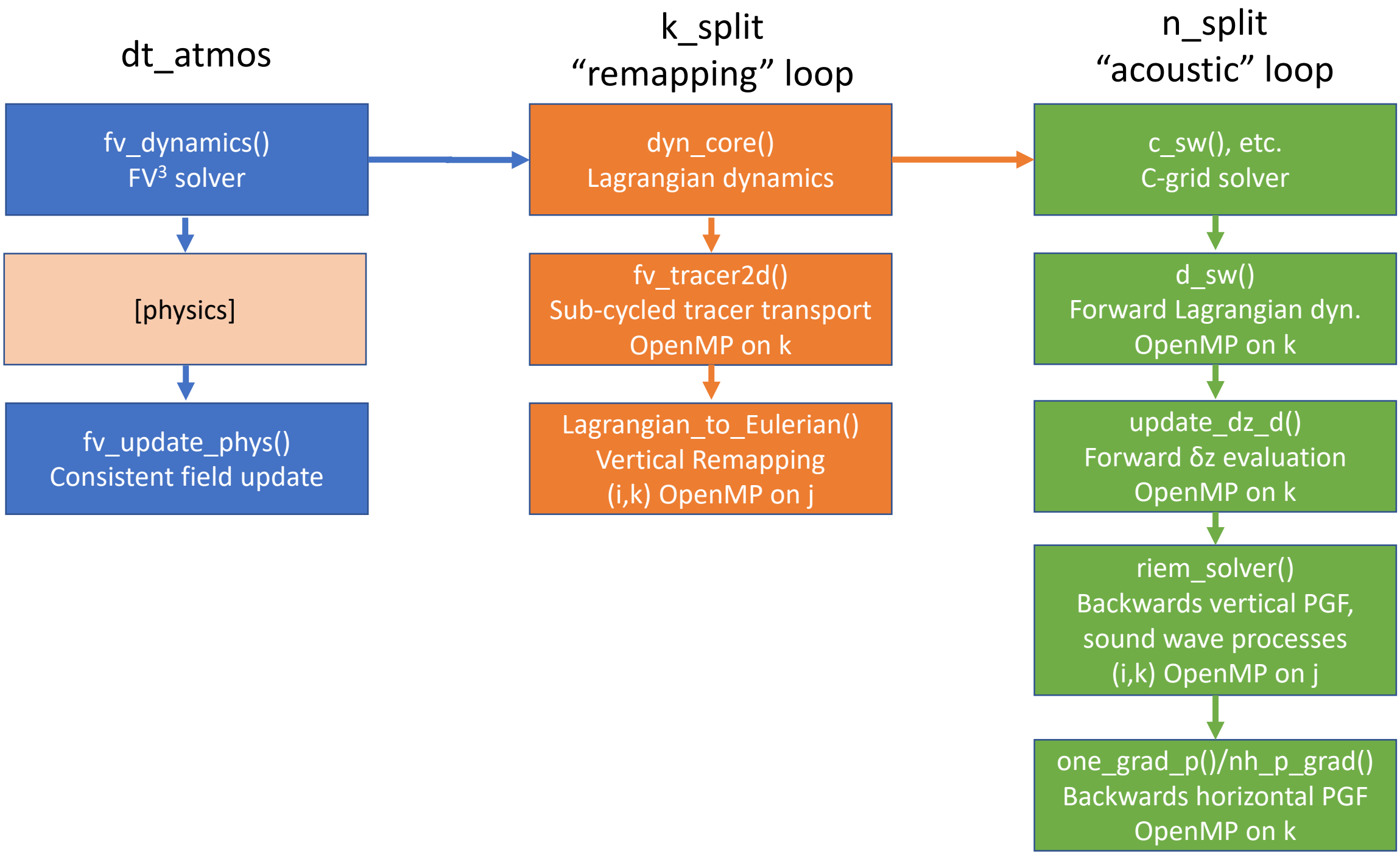
A. MEHRA AND HURRICANE PROJECT TEAM (NCEP/EMC)

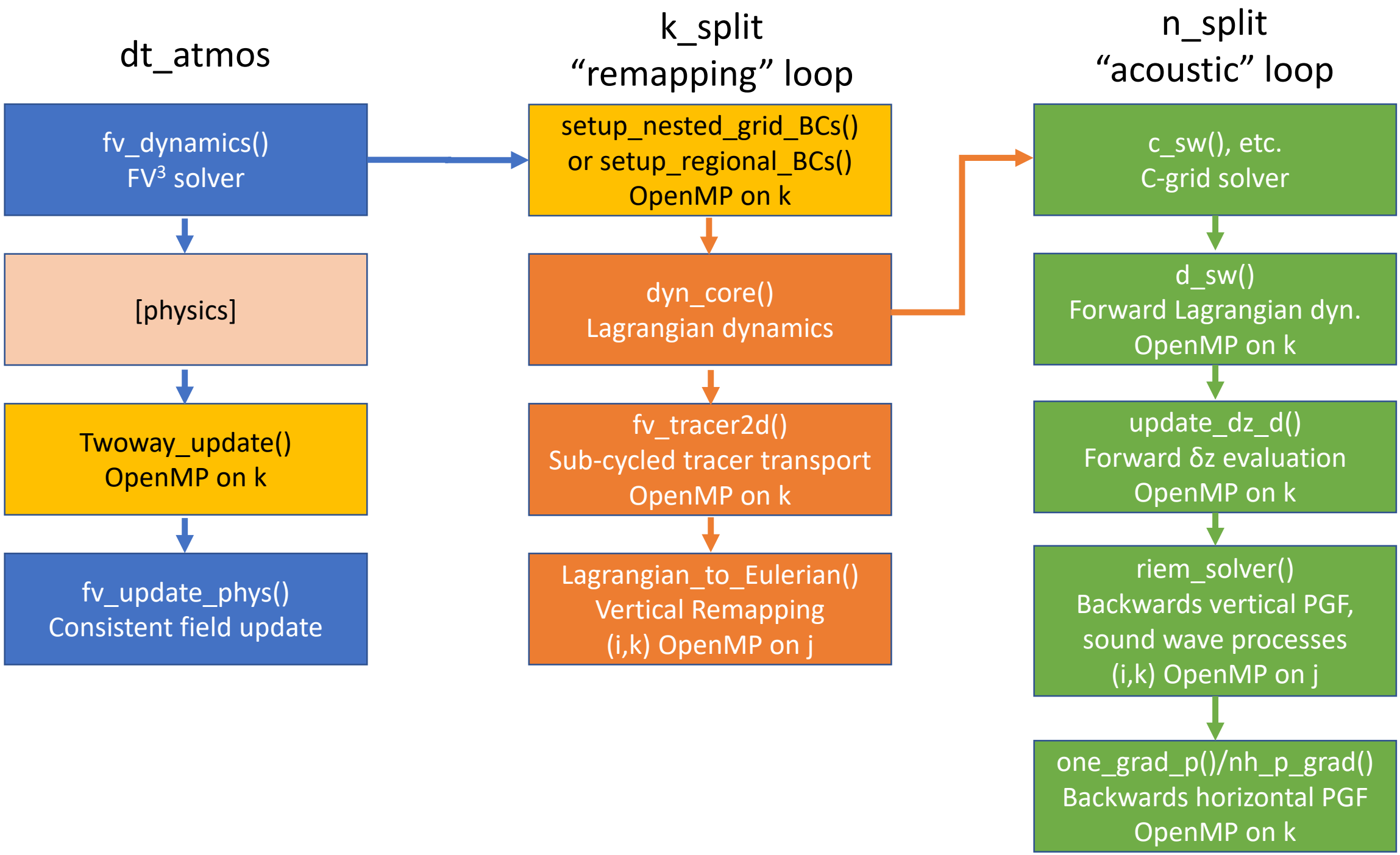
L. HARRIS AND WEATHER & CLIMATE DYNAMICS DIVISION (GFDL)

HAFS Activities at AOML

Completed
Ongoing

- Moving nest
  - Model infrastructure changes
  - Moving nest testing with the infrastructure
  - Moving nest in dynamic core
  - Configuration without physics for moving nest
  - Moving nest implementation with physics
  - Workflow for moving nest
- HAFS physics development and evaluation
  - Transitioned developments from the IPD version to CCPP
  - Added several diagnostic output variables related to PBL evaluation including K_m, TKE, and mixing length
  - Performing evaluations of EDMF-TKE through comparison with observations
  - Continuing development of research and forecast products
- HPC resource issues
  - UFS release code transitioned and tested on Orion
  - Data availability issue on Orion
- Publications and presentations related to HAFS
  - Publications (HAFS 0.B submitted to WAF)


dt_atmos
fv_dynamics()
FV3 solver
[physics]
fv_update_phys()
Consistent field update
k_split
“remapping” loop
dyn_core()
Lagrangian dynamics
fv_tracer2d()
Sub-cycled tracer transport
OpenMP on k
Lagrangian_to_Eulerian()
Vertical Remapping
(i,k) OpenMP on j
n_split
“acoustic” loop
c_sw(), etc.
C-grid solver
d_sw()
Forward Lagrangian dyn.
OpenMP on k
update_dz_d()
Forward δz evaluation
OpenMP on k
riem_solver()
Backwards vertical PGF,
sound wave processes
(i,k) OpenMP on j
one_grad_p()/nh_p_grad()
Backwards horizontal PGF
OpenMP on k


dt_atmos
fv_dynamics()
FV3 solver
[physics]
Twoway_update()
OpenMP on k
fv_update_phys()
Consistent field update
k_split
"remapping" loop
setup_nested_grid_BCs()
or setup_regional_BCs()
OpenMP on k
dyn_core()
Lagrangian dynamics
fv_tracer2d()
Sub-cycled tracer transport
OpenMP on k
Lagrangian_to_Eulerian()
Vertical Remapping
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C-grid solver
d_sw()
Forward Lagrangian dyn.
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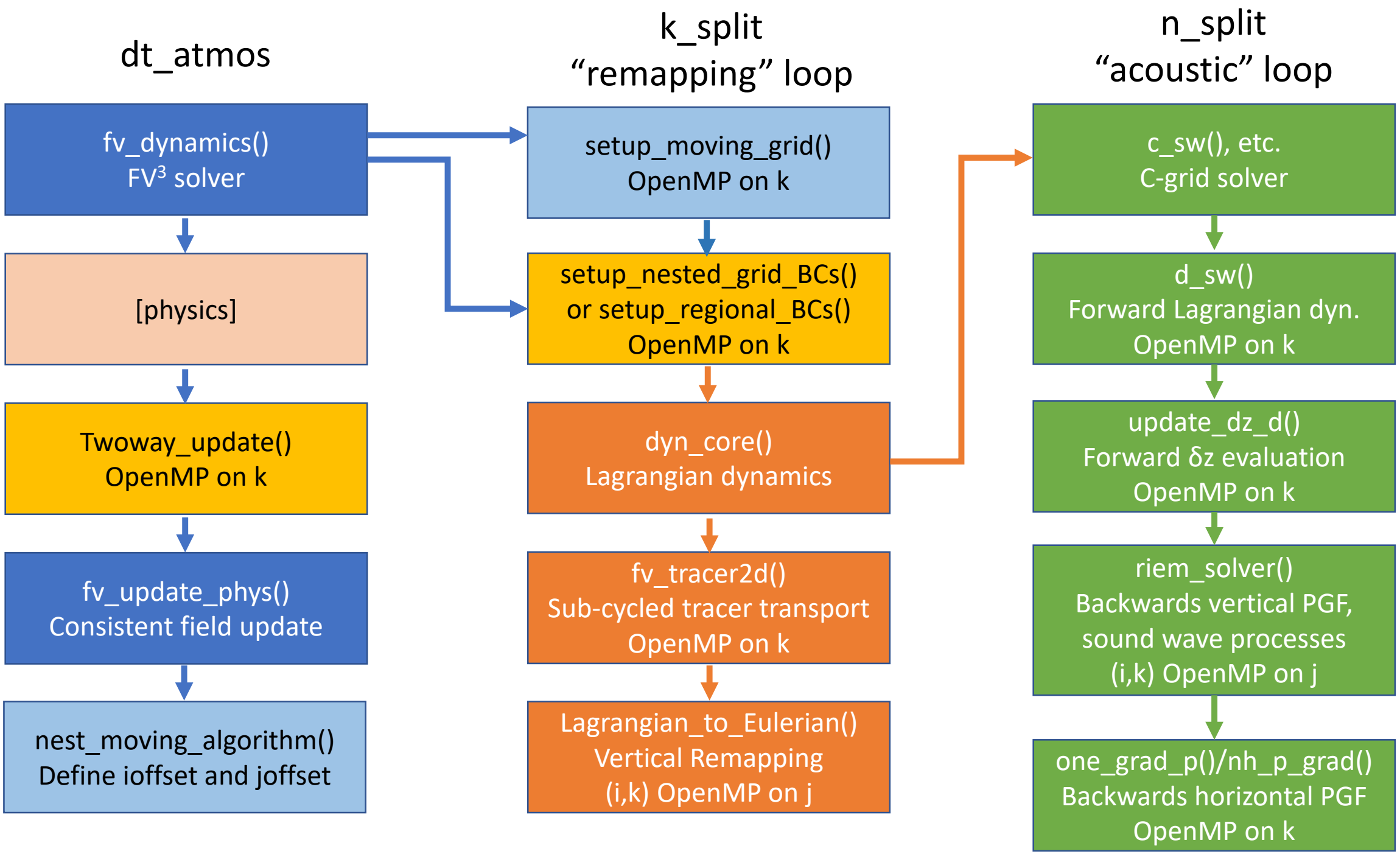
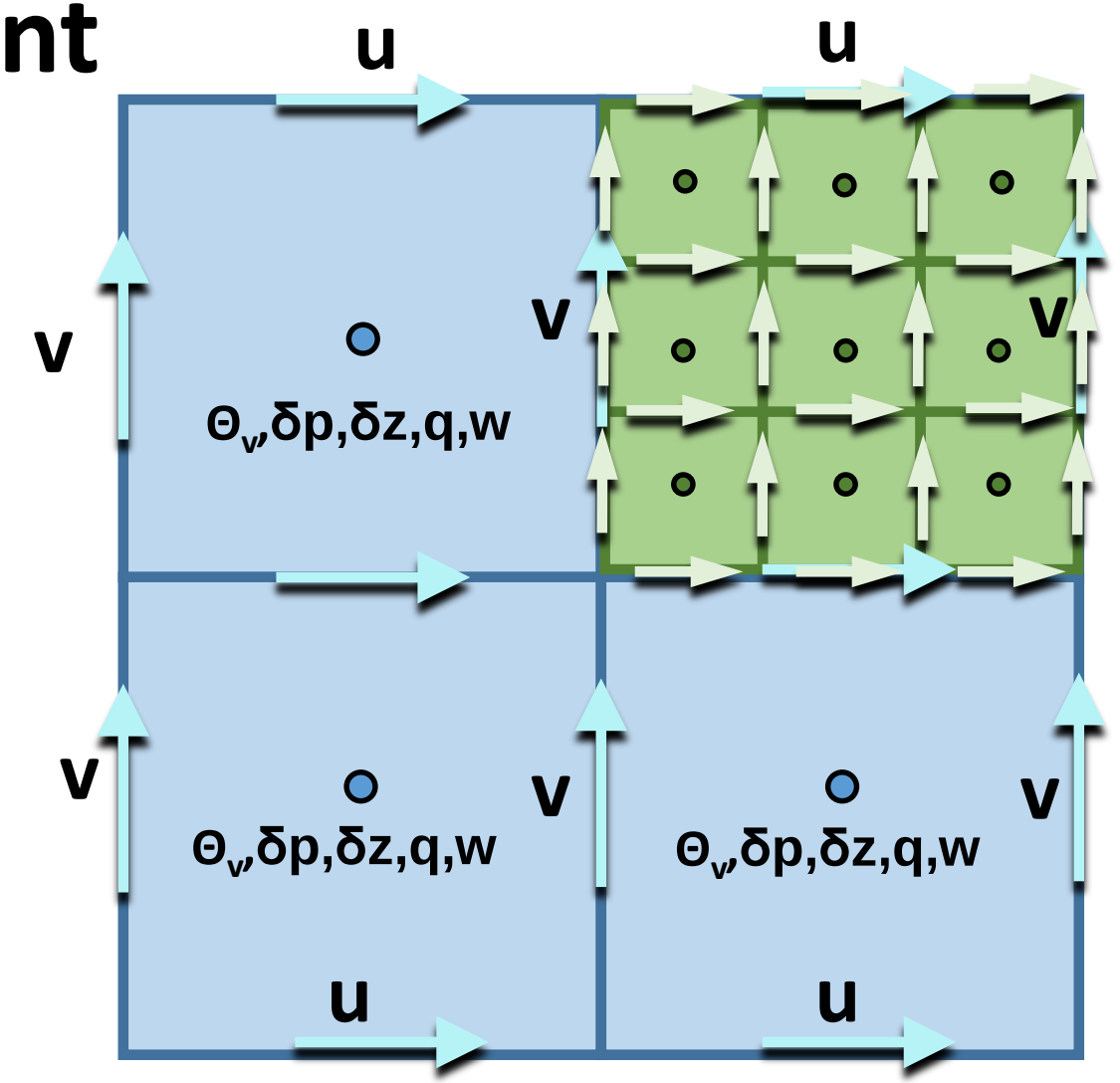

dt_atmos
k_split
"remapping" loop
n_split
"acoustic" loop
fv_dynamics()
FV3 solver
[physics]
Twoway_update()
OpenMP on k
fv_update_phys()
Consistent field update
nest_moving_algorithm()
Define ioffset and joffset
setup_moving_grid()
OpenMP on k
setup_nested_grid_BCs()
or setup_regional_BCs()
OpenMP on k
dyn_core()
Lagrangian dynamics
fv_tracer2d()
Sub-cycled tracer transport
OpenMP on k
Lagrangian_to_Eulerian()
Vertical Remapping
(i,k) OpenMP on j
c_sw(), etc.
C-grid solver
d_sw()
Forward Lagrangian dyn.
OpenMP on k
update_dz_d()
Forward δz evaluation
OpenMP on k
riem_solver()
Backwards vertical PGF,
sound wave processes
(i,k) OpenMP on j
one_grad_p()/nh_p_grad()
Backwards horizontal PGF
OpenMP on k

Moving Nest Development

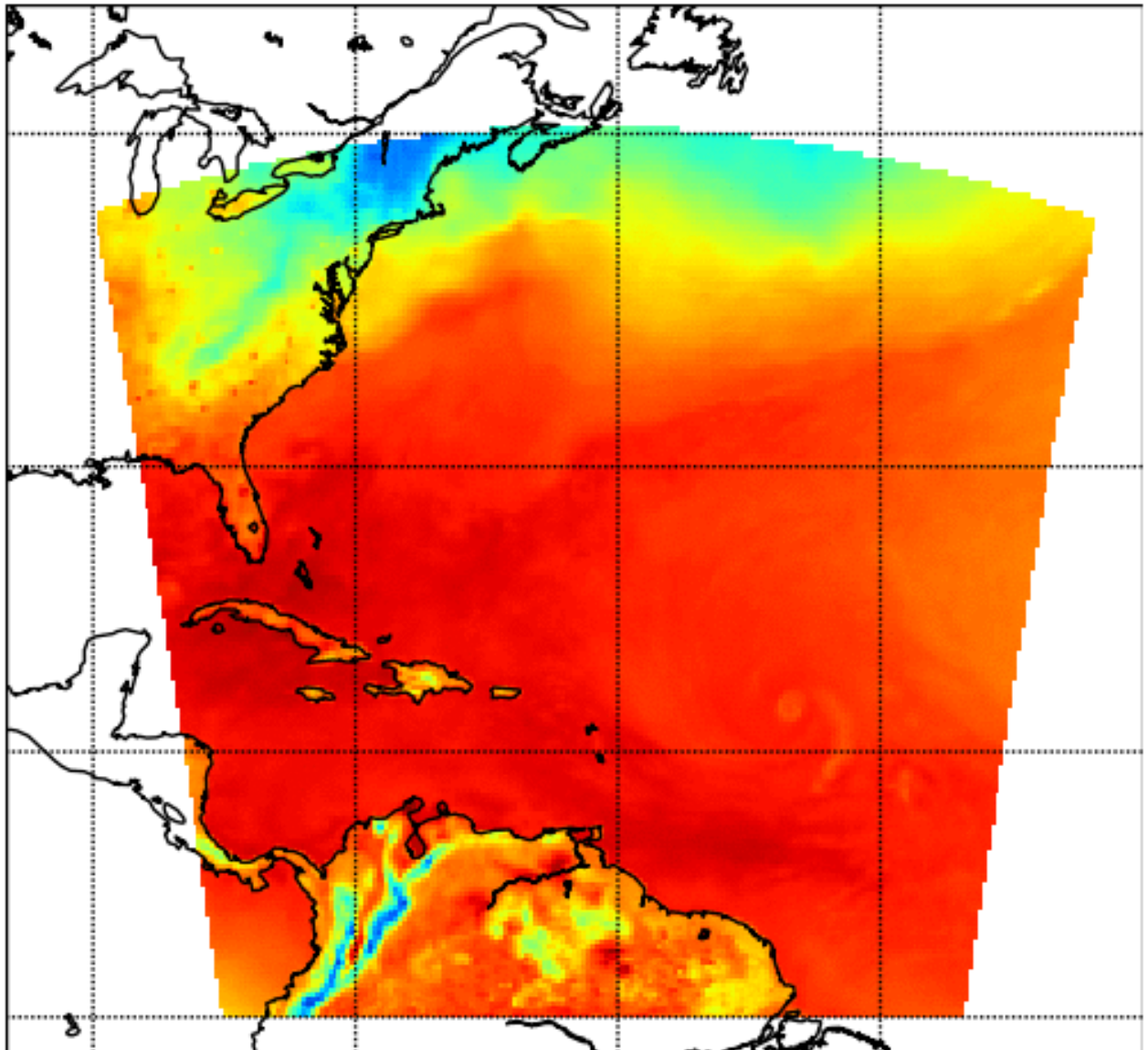
- Moving nest interpolation routines
  - Split code into fv_moving_nest.F90 and test driver modules
  - Stress test with more difficult values
- Identified dycore prognostic variables
- Subroutines in file fv_moving_nest.F90
- Handles Arakawa A and D grid staggers
- Work with Xuejin Zhang to insert moving nest code into dycore
- Attempt to turn off model physics for first tests



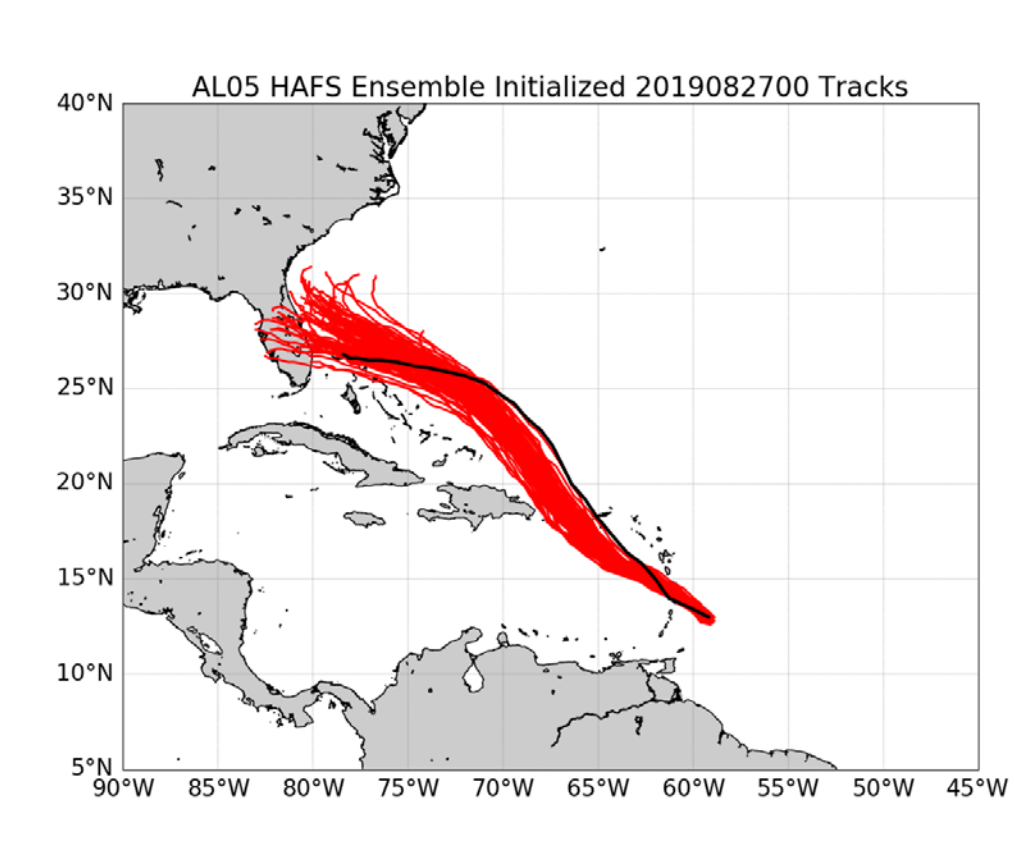
FV3 Prognostic Variable Staggering (Non-hydrostatic)

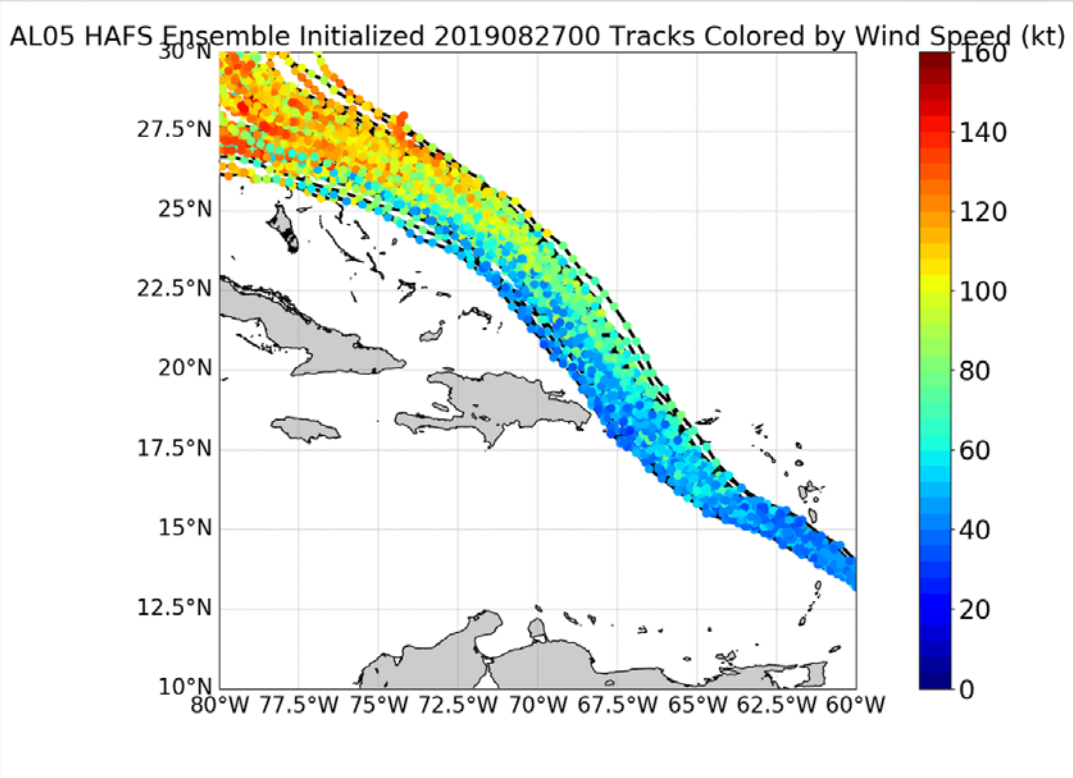
Integration with HAFS Workflow

- C96 for testing
  - 4x refinement nest
- Python script to generate/validate nest bounds, processor layouts
- Want to enable output of raw parent tiles and nest tile



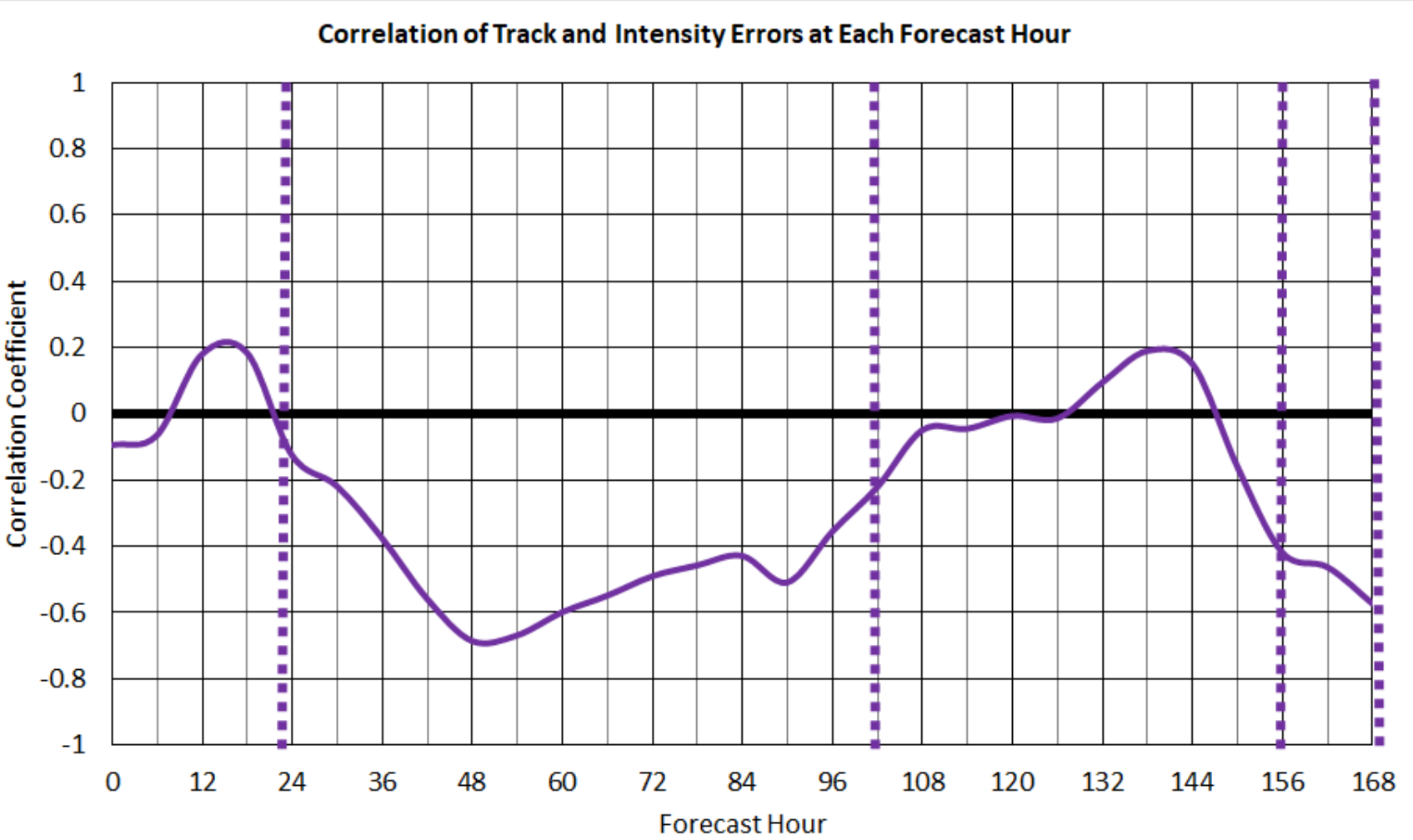
Dorian Ensemble Initialized 2019082700





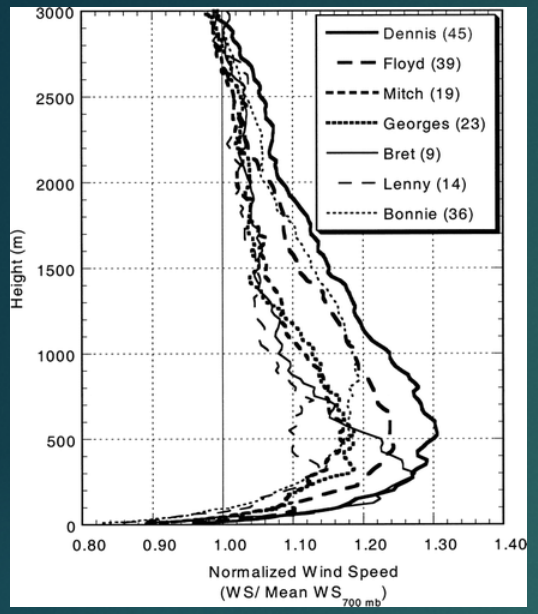
- Ensemble Set was fairly dispersive in track
- Observed track was still outside this set for a time
- Track and intensity related earl

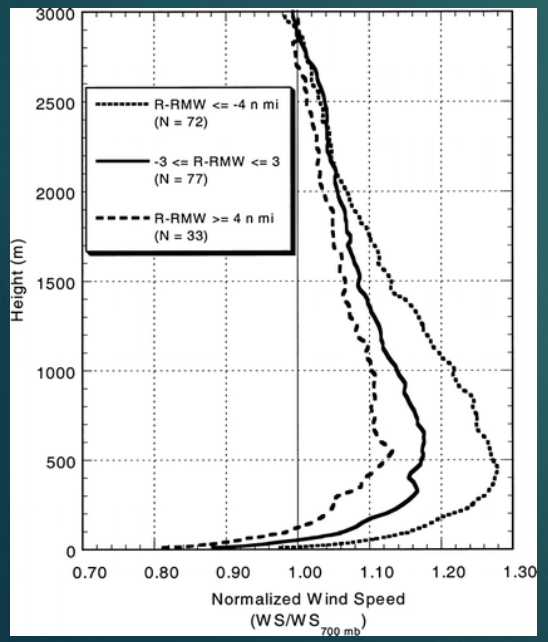
Correlation of Track and Intensity Error at

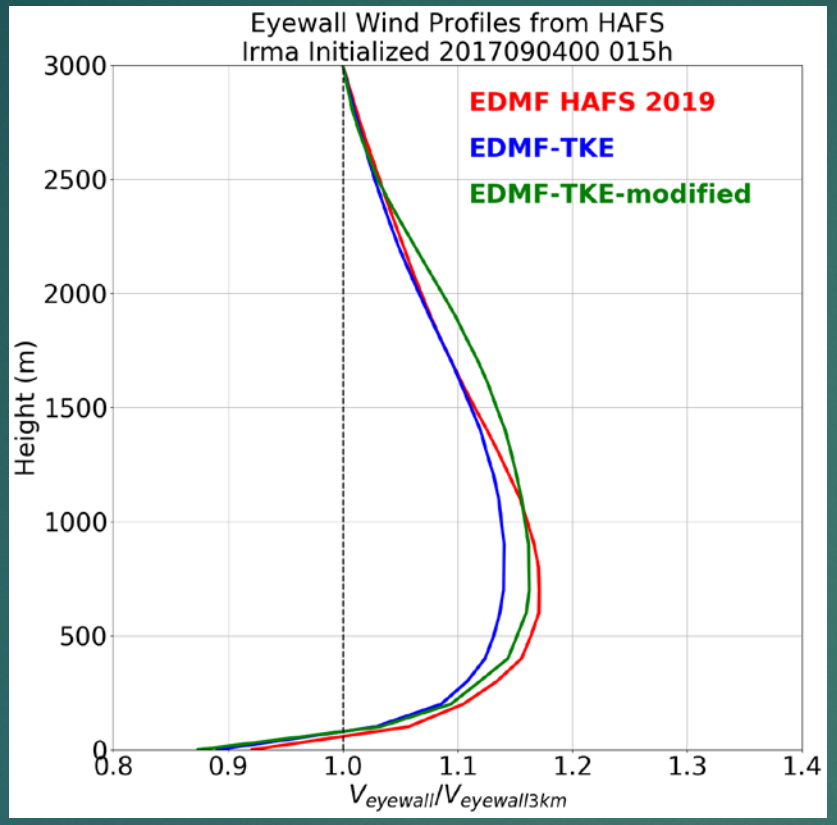


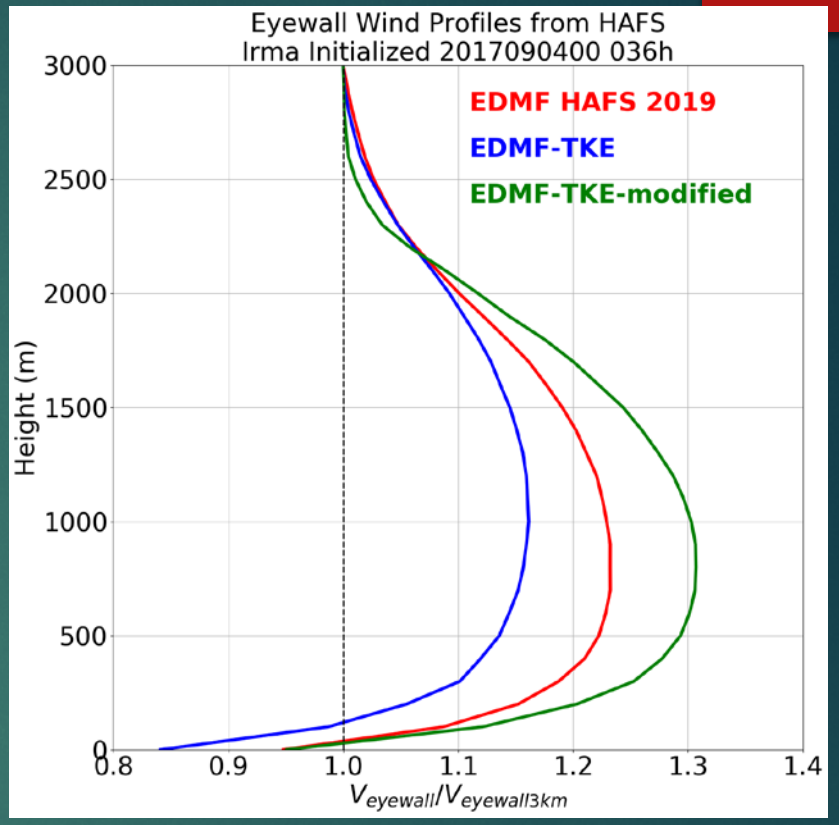
- Two periods where track and intensity are related:
  - Early period associated with center reformation, track near Antilles
  - Late period near possible landfall
- In the 102-156 hour range there is little relationship

PBL Wind Profile





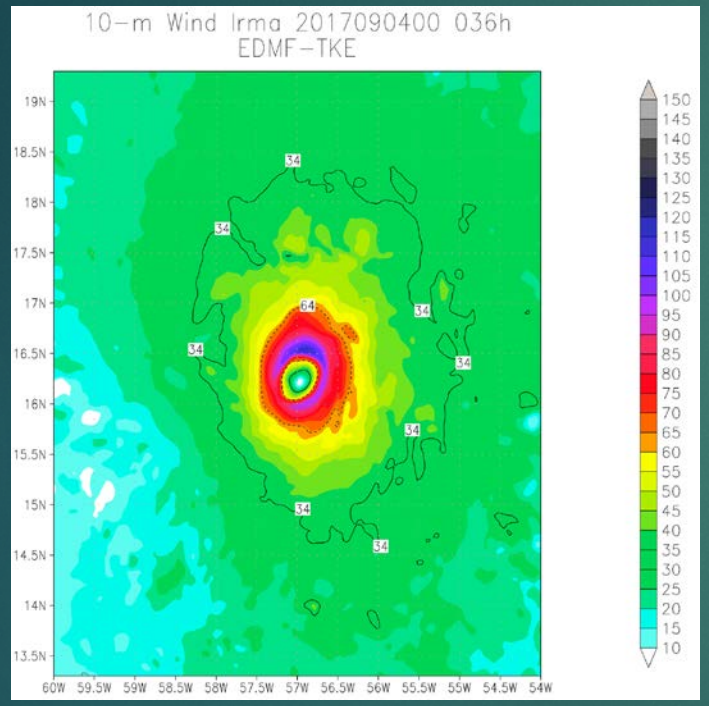




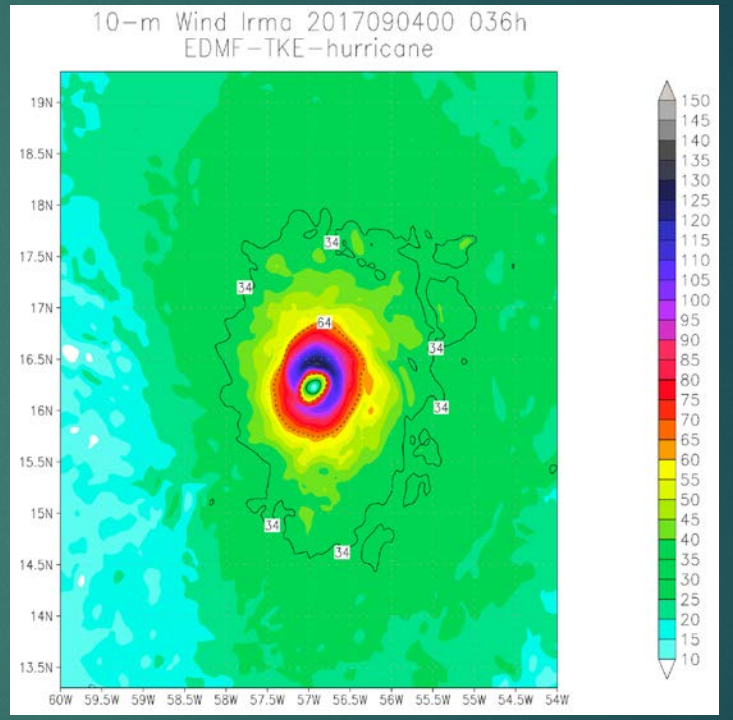
- Variability seen between forecast hours (similar to observational variability)
- EDMF-TKE seems to have too broad of a peak compared to obs and also compared to current HAFS EDMF scheme

Structure With Modifications to K/L

EDMF-TKE



EDMF-TKE



- Intensity difference is apparent
- Smaller RMW with PBL modifications
- Mean R34 was 118 n mi in modified, 134 n mi in original (Best Track: 115 n mi)

HPC Resources

- Resource allocated on Hera
- Model code transition to Orion underway (Global version worked)
- Porting of post-processing and graphics underway
- Data availability on Orion is an issue

Publications and Presentations

- **Publications**
  - ***Hazelton, A. T.***, Zhang, X., Ramstrom, W., Gopalakrishan, S., Marks, F. D., and J. A. Zhang, 2020: High-resolution ensemble HFV3 forecasts of Hurricane Michael (2018): rapid intensification in shear. *Mon. Wea. Rev., https://doi.org/10.1175/MWR-D-19-0275.1.*
  - ***Hazelton, A. T.,*** and coauthors, 2020: Atlantic Hurricane Forecasts From the Global-Nested Hurricane Analysis and Forecast System (HAFS): Composite statistics and key events. *Wea. Forecasting*, in preparation. (Submitted)