Python for HWRF Training

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DTC Developmental Testbed Center

NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce

Motivation & Goals

- HWRF Developers have expressed a need for more specific training using the Python scripts implemented in operations in 2015
- HWRF is a very complex system that keeps growing in complexity
- As research and development continues to be funded and required developers have a greater need to know the details of the complex scripting system

Agenda

9:00	HWRF System Overview	Christina
9:30	HWRF Internals Overview	Sam
9:50	Object-oriented Scripts	Christina
10:10	Produtil & Data Delivery	Sam
10:40	**~*~* Break *~*~**	
11:00	Logs Overview	Christina
11:20	Troubleshooting	Sam
11:50	Configuring	Sam
12:30	**~*~* Lunch *~*~**	
1:30	Rocoto for HWRF	Christina
2:00	Database	Sam
2:30	Debugging	Christina
3:00	**~*~* Break *~*~**	
3:30-5:00	Adding a Workflow Component	Christina & Sam

Resources for users and developers

Documentation

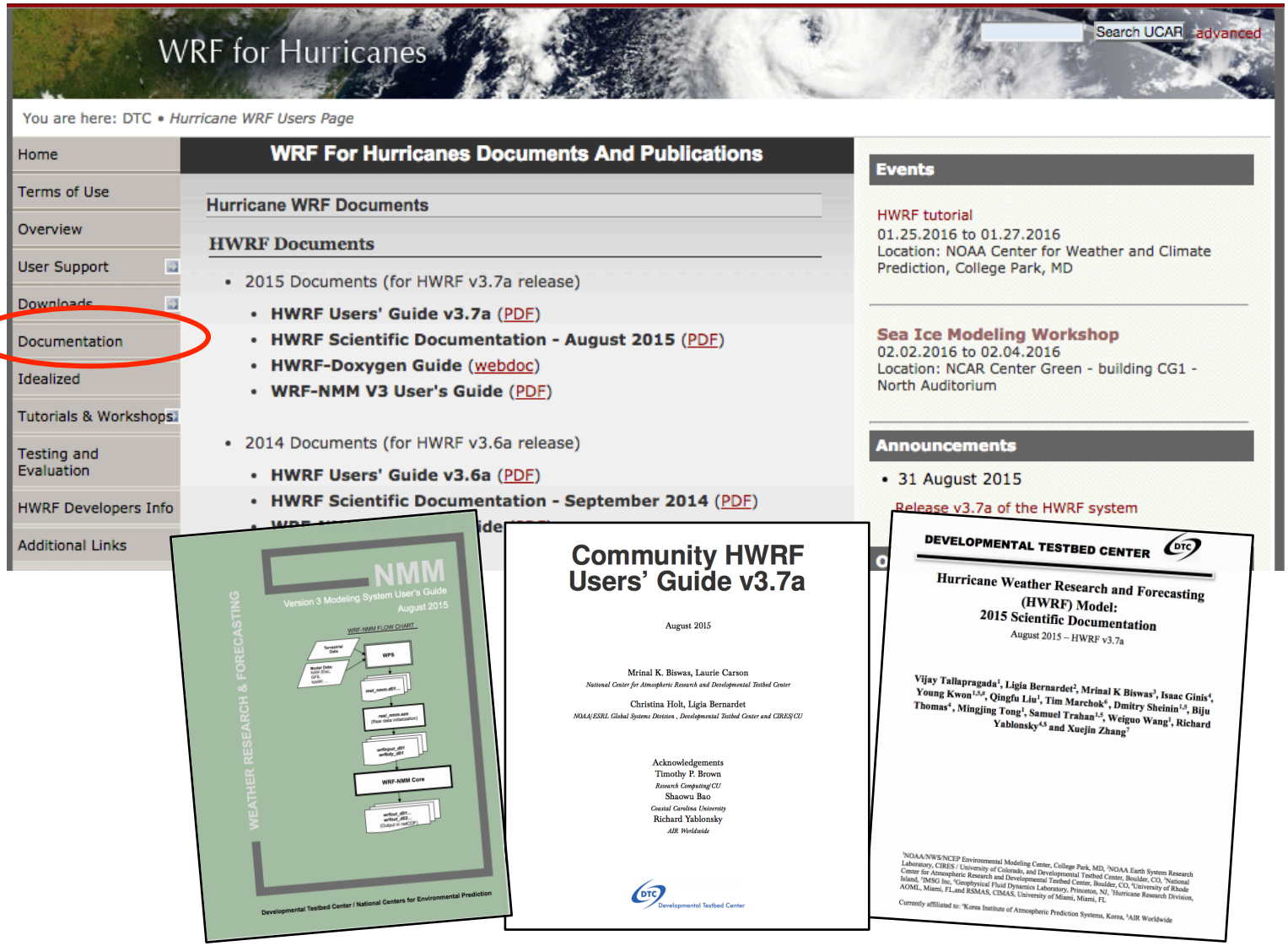
Developer webpage

Developer committee meetings and mailing list

Doxygen

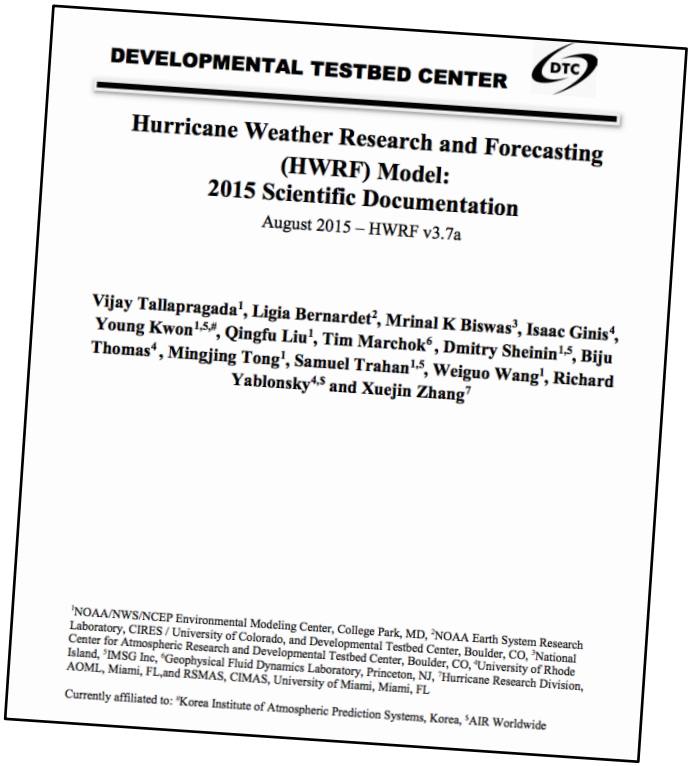
www.dtcenter.org/HurrWRF/users

User support webpage



Scientific Documentation

- Technical information covering each HWRF component
  - Authorship includes developers and experts
  - Chapters covering:
    - HWRF introduction
    - HWRF Initialization
    - MPI POM-TC
    - Physics Packages in HWRF
    - Design of moving nest
    - Use of GFDL Vortex Tracker
    - The idealized HWRF framework



DEVELOPMENTAL TESTBED CENTER

Hurricane Weather Research and Forecasting (HWRF) Model: 2015 Scientific Documentation

August 2015 – HWRF v3.7a

Vijay Tallapragada[1], Ligia Bernardet[2], Mrinal K Biswas[3], Isaac Ginis[4], Young Kwon[1,5,#], Qingfu Liu[1], Tim Marchok[6], Dmitry Sheinin[1,5], Biju Thomas[4], Mingjing Tong[1], Samuel Trahan[1,5], Weiguo Wang[1], Richard Yablonsky[4,5] and Xuejin Zhang[7]

[1]NOAA/NWS/NCEP Environmental Modeling Center, College Park, MD, [2]NOAA Earth System Research Laboratory, CIRES / University of Colorado, and Developmental Testbed Center, Boulder, CO, [3]National Center for Atmospheric Research and Developmental Testbed Center, Boulder, CO, [4]University of Rhode Island, [5]IMSG Inc, [6]Geophysical Fluid Dynamics Laboratory, Princeton, NJ, [7]Hurricane Research Division, AOML, Miami, FL,and RSMAS, CIMAS, University of Miami, Miami, FL

Currently affiliated to: [#]Korea Institute of Atmospheric Prediction Systems, Korea, [5]AIR Worldwide

http://www.dtcenter.org/HurrWRF/users/docs/scientific_documents/HWRF_v3.7a_SD.pdf

HWRF v3.7a User's Guide

- Includes detailed instructions on running each component
  - Geared towards public release, so some aspects will be missing
  - Running with wrappers, no Rocoto information
- Content:
  - Introduction & software installation
  - Running HWRF
  - HWRF preprocessing system
  - Vortex Relocation
  - DA
  - Merge
  - MPIPOM-TC
  - Forecast Model
  - Post processor
  - Forecast products
  - Idealized

http://www.dtcenter.org/HurrWRF/users/docs/users_guide/HWRF_v3.7a_UG.pdf

http://www.dtcenter.org/HurrWRF/developers

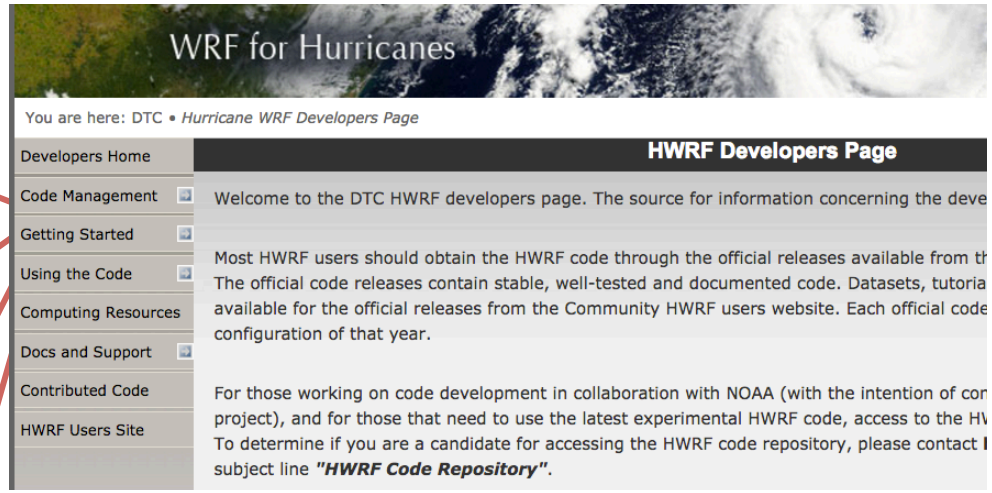
HWRF Developers Website

Code Management	Overview
Getting Started	Code Development Process
Using the Code	Roles and Responsibilities
Computing Resources	Testing

Getting Started	Obtaining Repository Access
Using the Code	Repository Structure
Computing Resources	Code Structure

Using the Code	Checking Out the Code
Computing Resources	Development Branches
Docs and Support	Build & Install
HWRF Users Site	Running HWRF

Docs and Support	Support for Developers
Contributed Code	FAQ
HWRF Users Site	Known Issues



Information hub for all developers

Trainings offered by DTC:

- HWRF automation with the Rocoto workflow management system
- HWRF code management

Communications

- **HWRF Developers Committee**
  - All developers welcome to attend biweekly meetings
  - Forum for discussion, plans, and updates for development, including testing, evaluation, and technical aspects
- **Mailing list for exchanging information about development**
  - hwrf_developers@rap.ucar.edu
  - All those with HWRF repository access are members

dev_meeting_20151109

Created and last modified by Christina Holt on Nov 12, 2015

Next meeting will be 11/23 at noon ET.

Participants

- DTC: Christina Holt, Ligia Bernardet, Jim Frimel, Kathryn Newman
- EMC: Sam Trahan, Zhan Zhang
- U Wisc: Allen Lenzen
- HRD: Xuejin Zhang

Minutes

Announcement of HWRF Tutorial in College Park

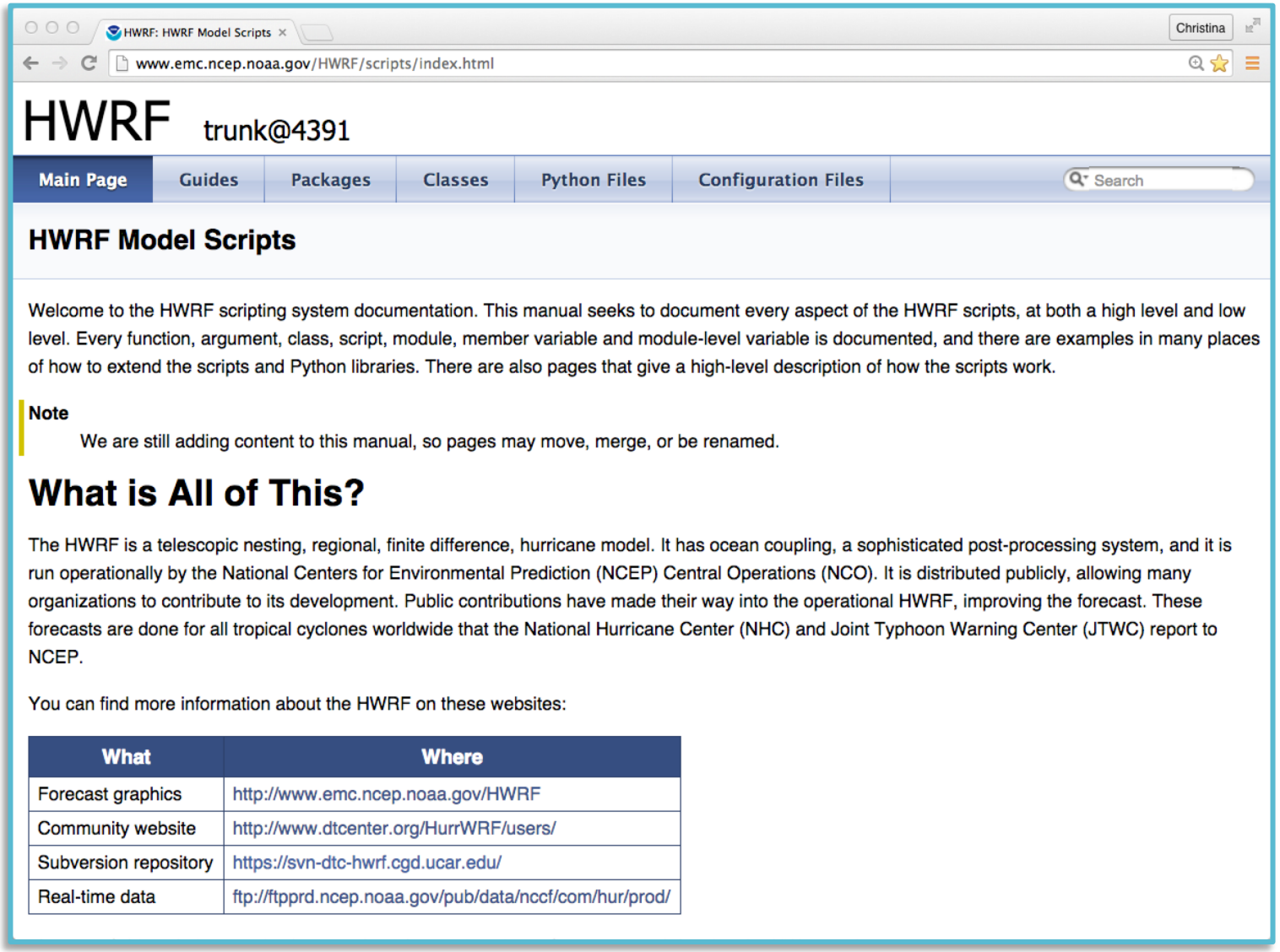
DTC and EMC are hosting an HWRF Tutorial 25-27 January, 2016 at the NOAA

Plan for bug fix and advection tests

All of the fixes have been committed to trunk.

- Bug for icloud=3 (WRF r8757)
- Non-hydrostatic state is retained after nest moves. (WRF r8758)

Doxygen Website



General Python help

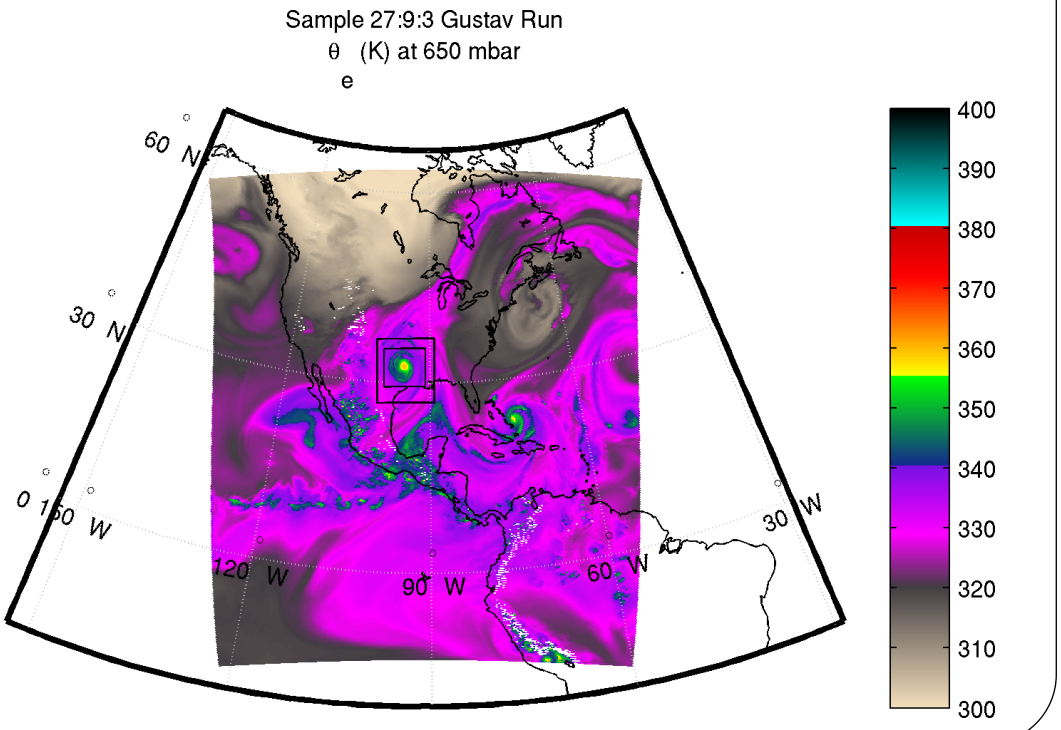
- Online (https://docs.python.org/release/2.6.6/)
- Open python in a terminal and use help() function for particular function. An example to get information with a Python list:

```
$ python
$ help(list)
```

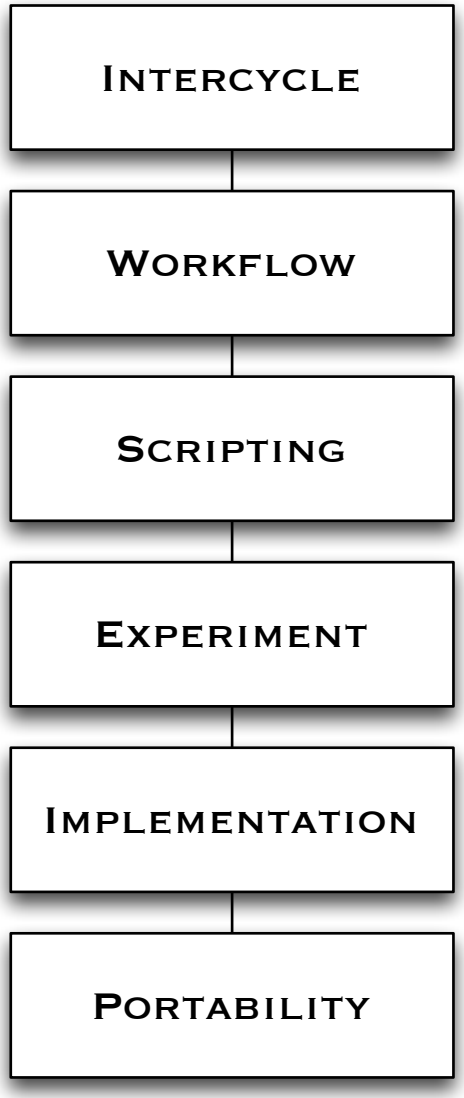
- Must use Python v2.6.6.
  - Only version available on NOAA machines
  - 2.7 may be used in future because it's the long-term support release
  - Version 3 is basically a different language

HWRF System Overview

- Overview of the system design
- Jobs of each task
- Common configurations and available capabilities

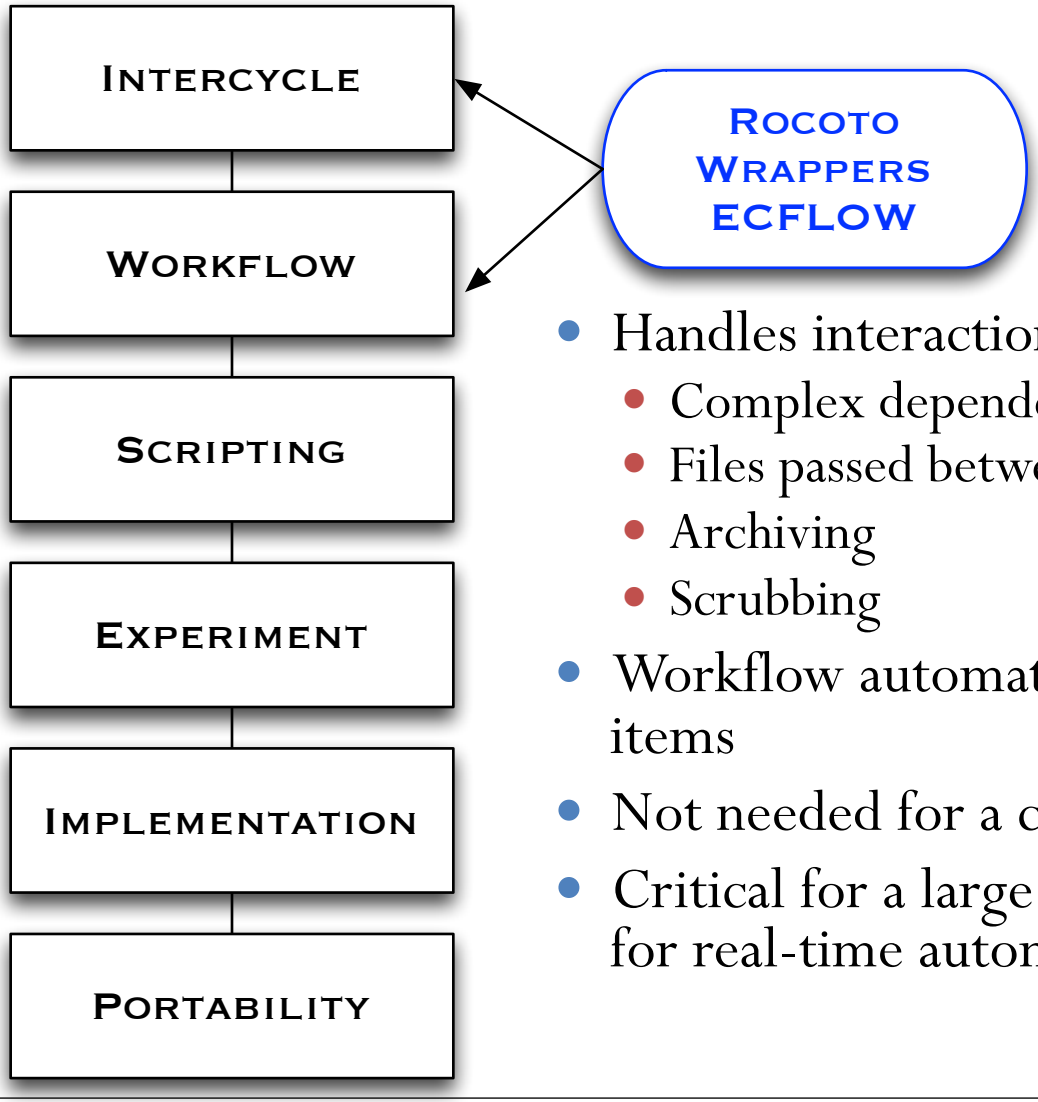


HWRF System: Overview



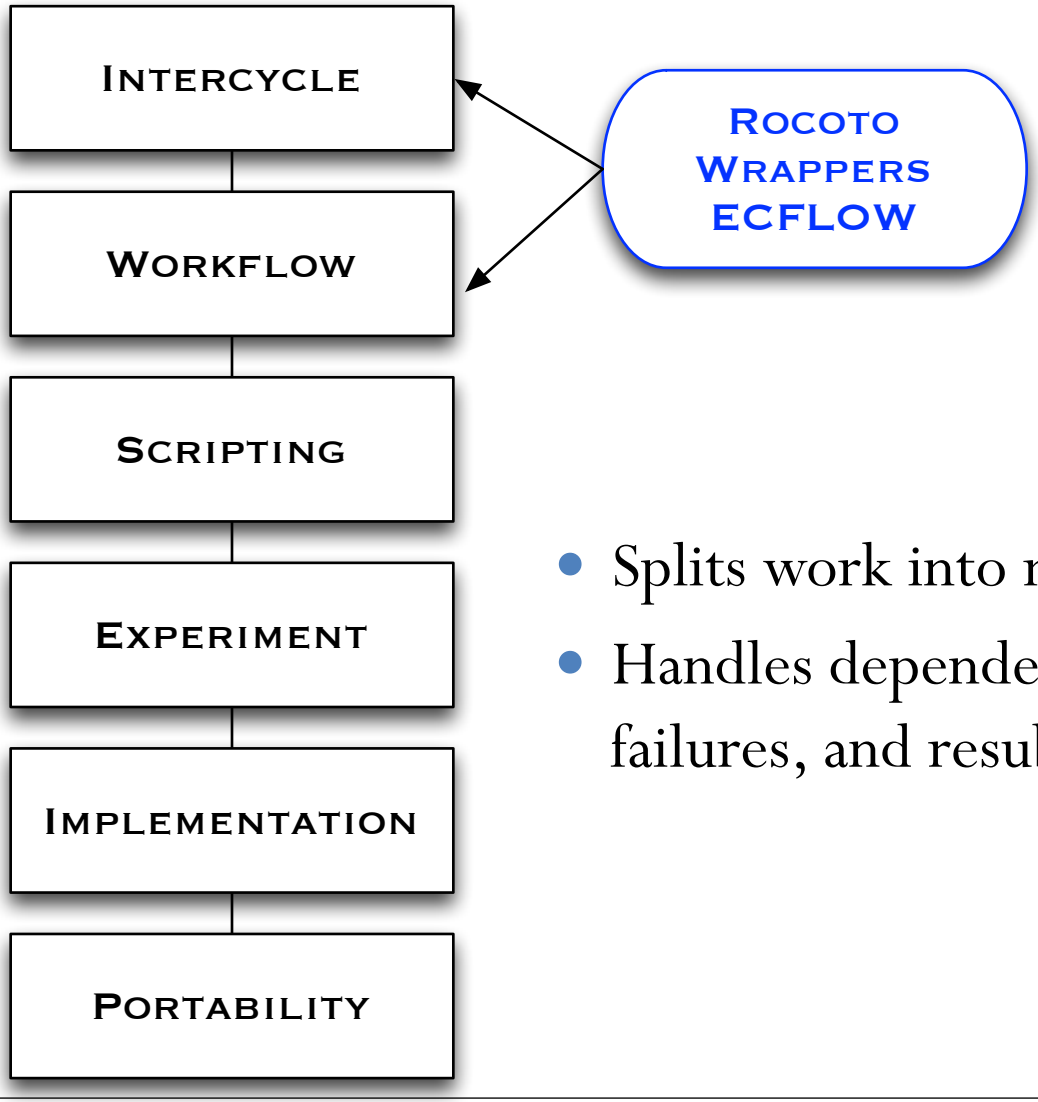
- 6 layers of scripts that are responsible for preparing for and running the 118 (for now) HWRF executables of the end-to-end system
- Most of these layers are written using an object-oriented (O-O) Python design
- O-O design makes the system highly configurable and reduces the footprint of the system drastically

HWRF System: Intercycle Layer



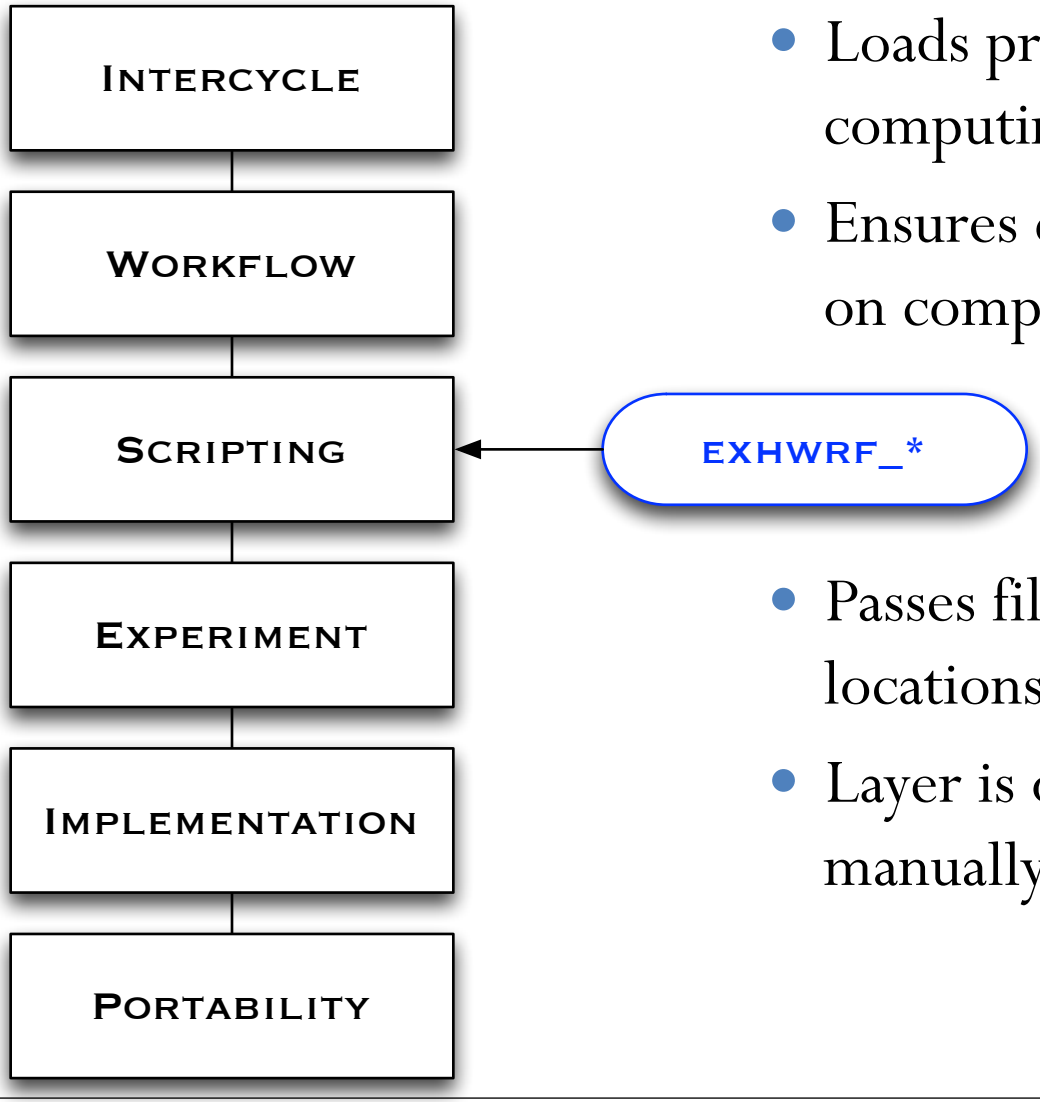
- Handles interactions between several cycles
  - Complex dependencies
  - Files passed between them
  - Archiving
  - Scrubbing
- Workflow automation takes care of these items
- Not needed for a case study
- Critical for a large retrospective study, and for real-time automation

HWRF System: Workflow Layer



- Splits work into multiple batch jobs
- Handles dependencies, submission, failures, and resubmission of jobs

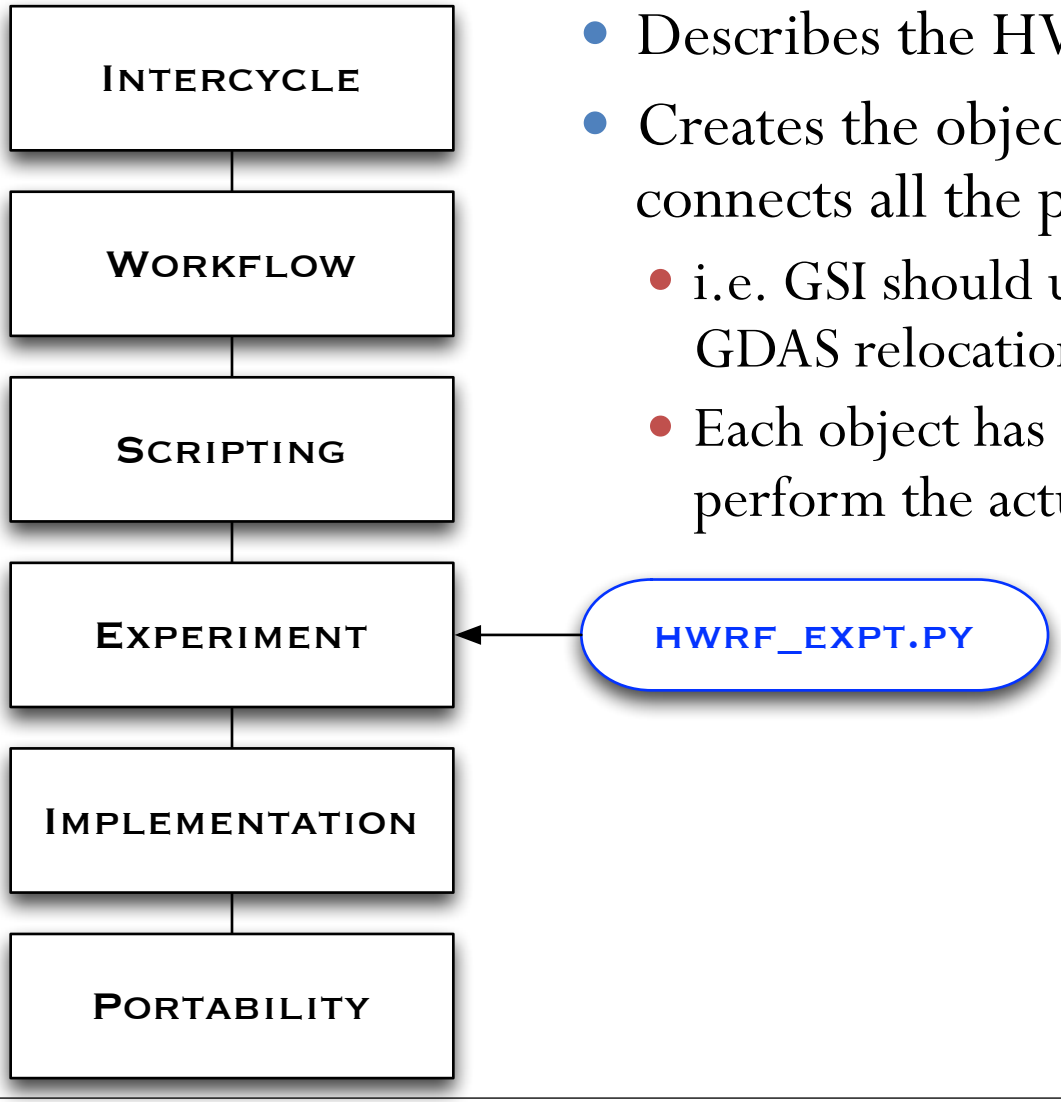
HWRF System: Scripting Layer



- Loads programs and libraries into computing environment
- Ensures connection to file system on compute node

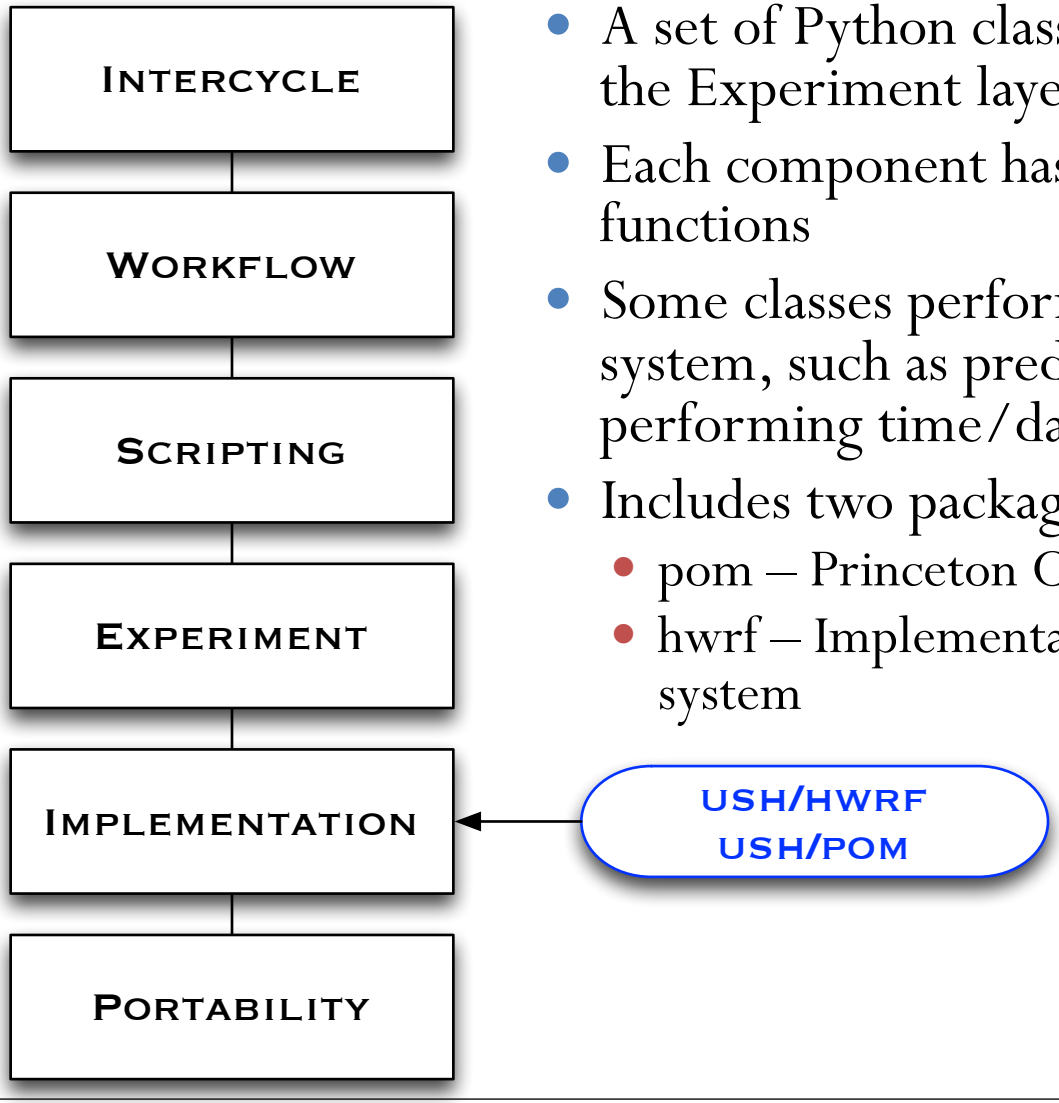
- Passes file and executable locations to the next lower layer
- Layer is optional – can be done manually by user

HWRF System: Experiment Layer



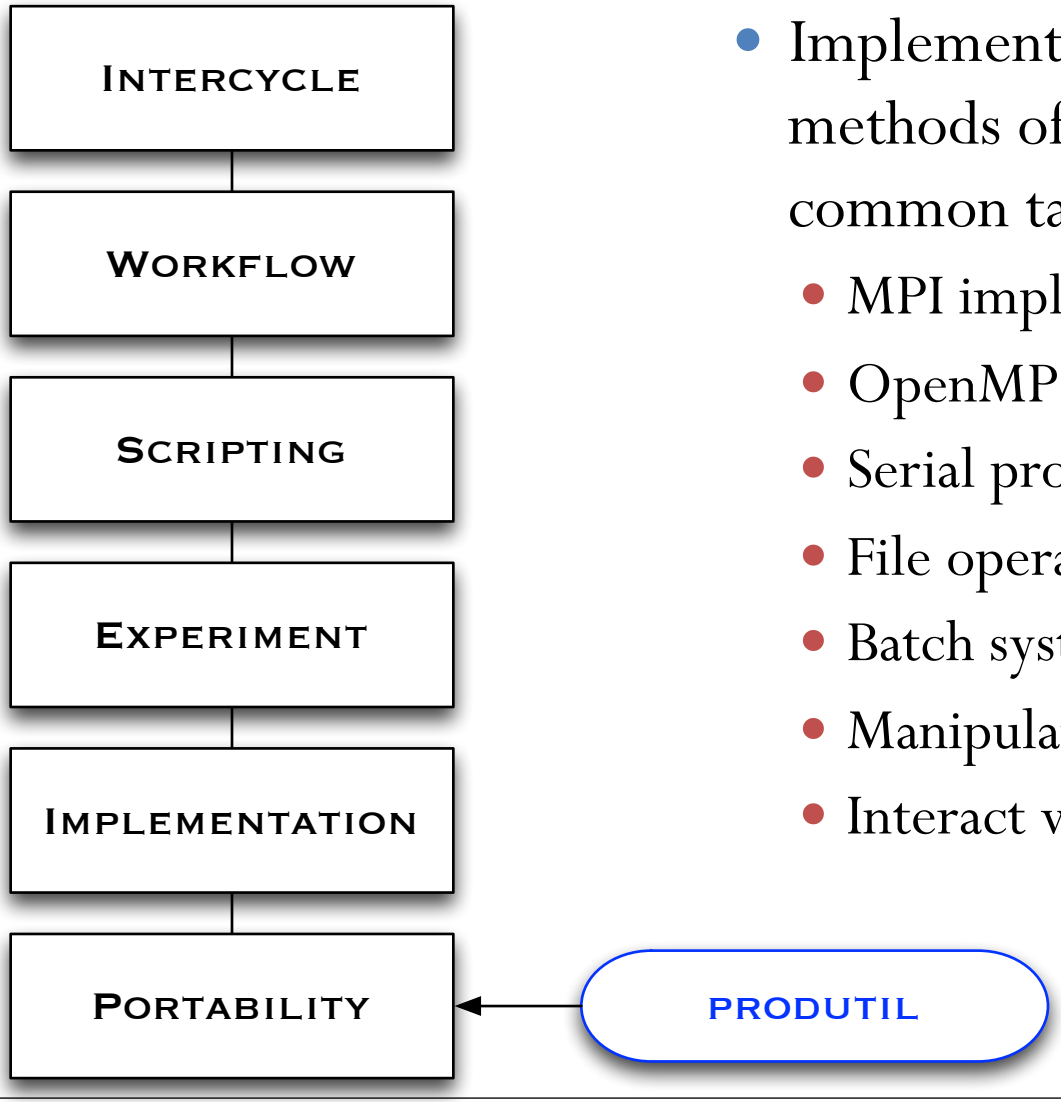
- Describes the HWRF workflow
- Creates the object structure that connects all the pieces
  - i.e. GSI should use input from the GDAS relocation output
  - Each object has a run() function to perform the actual task

HWRF System: Implementation Layer



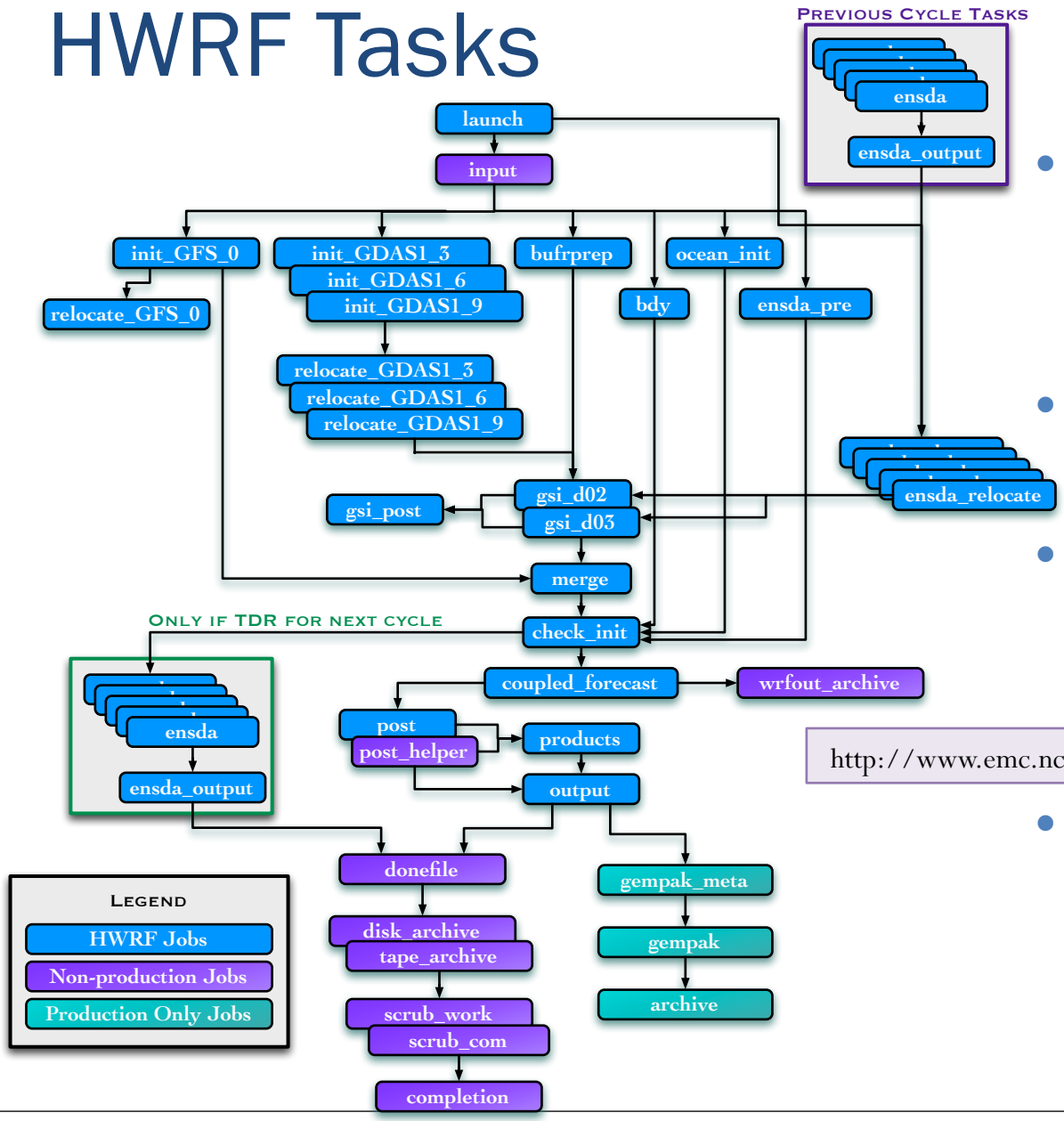
- A set of Python classes and functions used by the Experiment layer to run HWRF
- Each component has its own class and set of functions
- Some classes perform utilities to support the system, such as predicting filenames and performing time/date arithmetic
- Includes two packages
  - pom – Princeton Ocean Model initialization
  - hwrf – Implementation of most of the HWRF system

HWRF System: Portability Layer



- Implements cross-platform methods of performing common tasks
  - MPI implementation
  - OpenMP
  - Serial programs
  - File operations
  - Batch system interaction
  - Manipulate resource limitations
  - Interact with database file

HWRF Tasks



- Ensemble forecast was started from the GFS ensemble of the previous cycle when TDR is available
- GFS ensemble is used for hybrid DA when TDR is not available
- Descriptions of each task are available from the Doxygen documentation

http://www.emc.ncep.noaa.gov/HWRF/scripts/index.html

- Each box has its own set of jobs (Rocoto, ecFlow, wrappers to some extent), scripts, and Python classes

HWRF Default Configurations

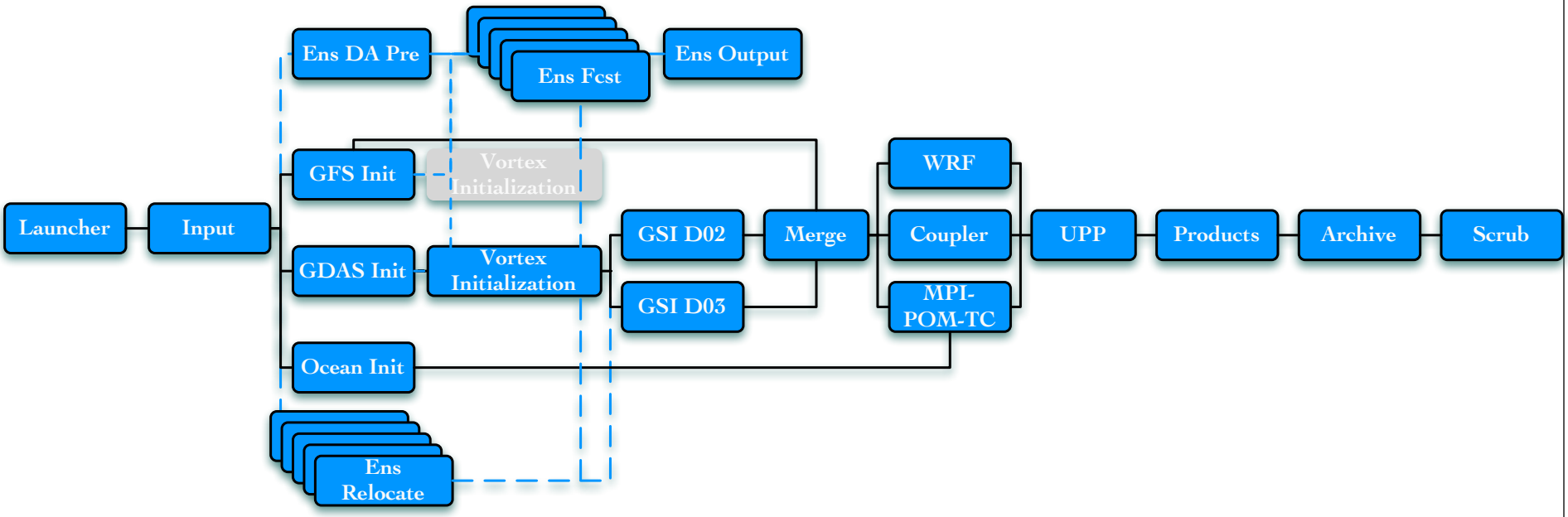
2016 Defaults

Basin	Ocean	Data Assim	Ensemble	Vertical	Model Top	Extra .conf File
N.Atl	3D POM	Always	TDR Only	61 level	2 mbar	hwrf_AL.conf (empty)
NE.Pac	3D POM	TDR Only	TDR Only	61 level	2 mbar	hwrf_EP.conf
NC.Pac	3D POM	TDR Only	TDR Only	61 level	2 mbar	hwrf_CP.conf
NW.Pac	3D POM	Never	Never	43 level	50 mbar	hwrf_other_basins.conf
N.Ind	3D POM	Never	Never	43 level	50 mbar	hwrf_other_basins.conf
S.Pac	3D POM	Never	Never	43 level	50 mbar	hwrf_other_basins.conf
S.Ind	3D POM	Never	Never	43 level	50 mbar	hwrf_other_basins.conf
S.Atl	None	Never	Never	43 level	50 mbar	hwrf_other_basins.conf

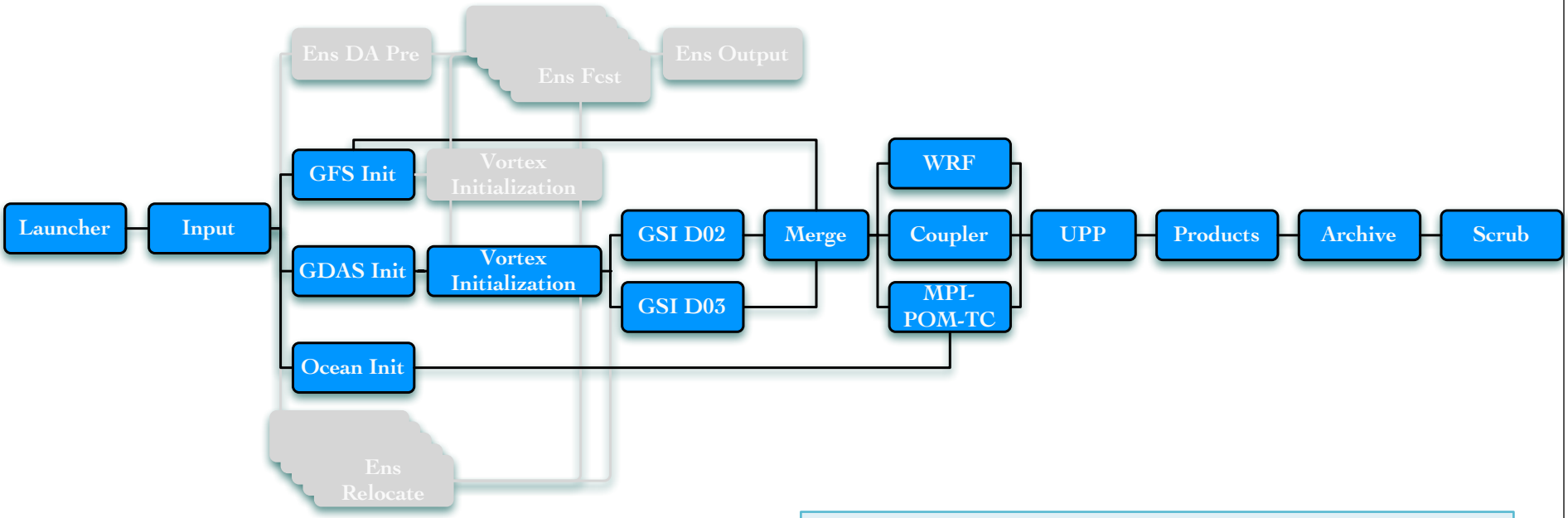
2015 Defaults

Basin	Ocean	Data Assim	Ensemble	Vertical	Model Top	Extra .conf File
N.Atl	3D POM	Always	TDR Only	61 level	2 mbar	hwrf_AL.conf (empty)
NE.Pac	3D POM	TDR Only	TDR Only	61 level	2 mbar	hwrf_2015_EP.conf
NC.Pac	None	Never	Never	61 level	2 mbar	hwrf_2015_CP.conf
NW.Pac	None	Never	Never	43 level	50 mbar	hwrf_2015_other_basins.conf
N.Ind	None	Never	Never	43 level	50 mbar	hwrf_2015_other_basins.conf
S.Pac	None	Never	Never	43 level	50 mbar	hwrf_2015_other_basins.conf
S.Ind	None	Never	Never	43 level	50 mbar	hwrf_2015_other_basins.conf
S.Atl	None	Never	Never	43 level	50 mbar	hwrf_2015_other_basins.conf

HWRF Workflow: AL or EP w/TDR

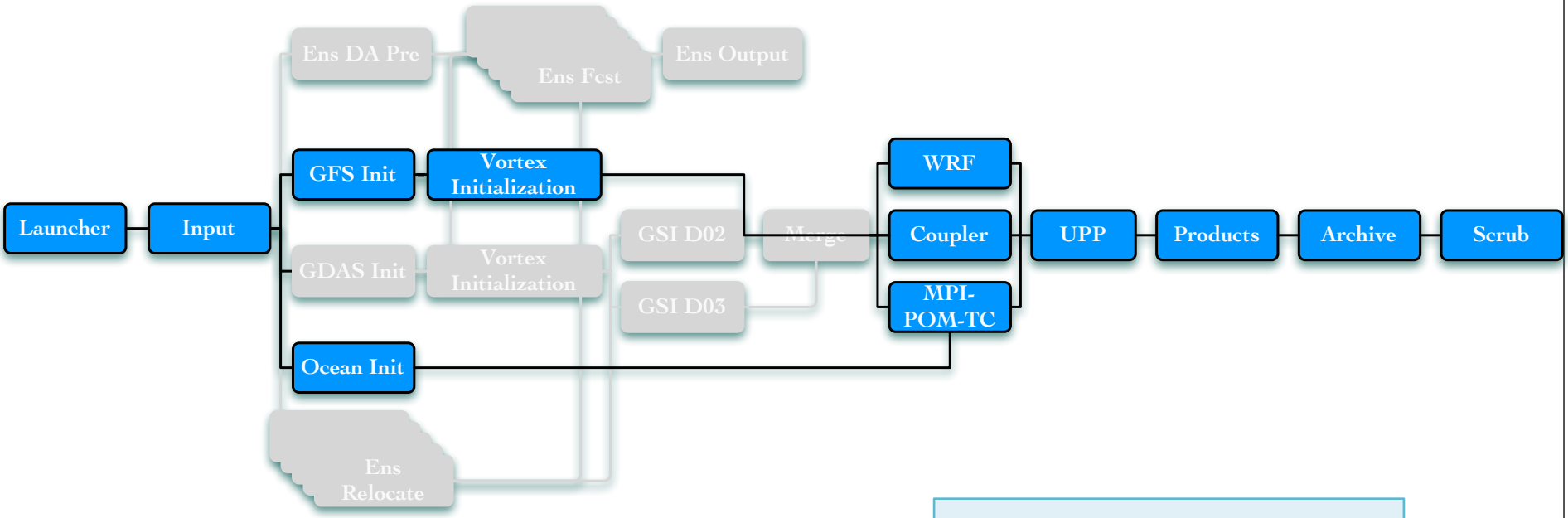


HWRF Workflow: Atlantic w/o TDR



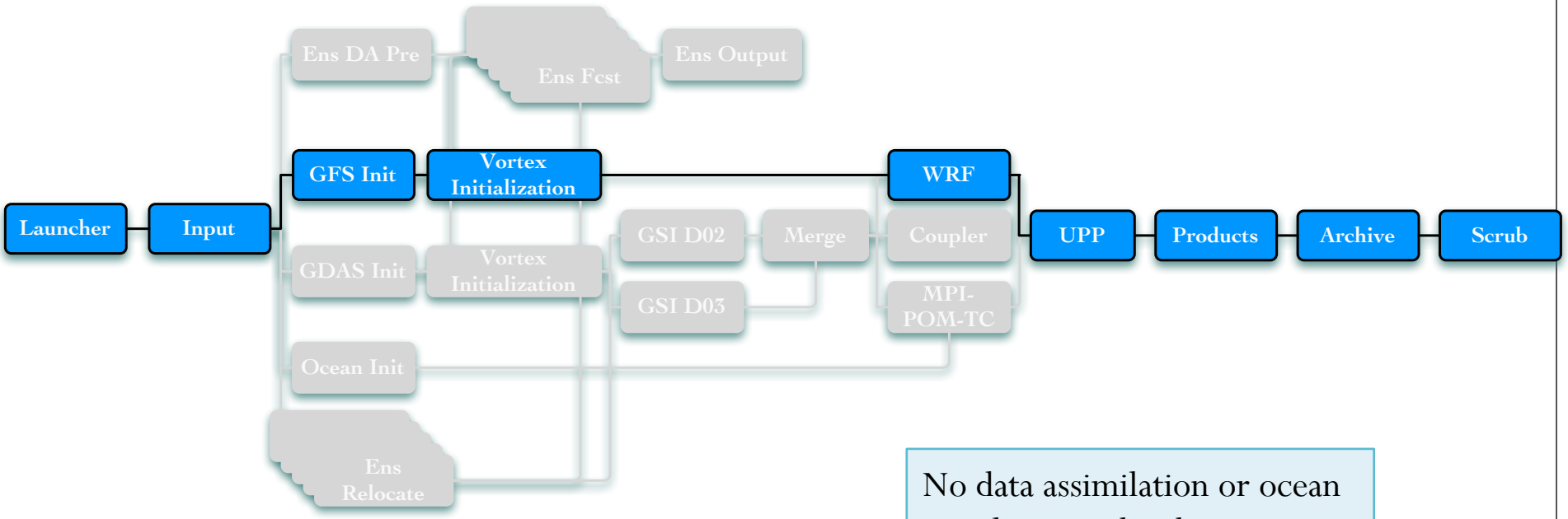
Data assimilation is performed with ensemble covariances provided by the global ensemble

HWRF Workflow: EP w/o TDR



No data assimilation is performed when TDR is unavailable

HWRF Workflow: All other basins



No data assimilation or ocean coupling in other basins. Lower vertical resolution is also used for forecast

Other Available Configurations

- Full system in all basins
- 27:9:3 resolution
- Lower vertical structure (Lower model top & 43 vertical levels)
- GEFS-based HWRF ensemble
- Different forecast length (6 hrly from 12 – 126 hours)
- Physics schemes
  - Scale-aware SAS, GFS PBL with EDMF, SAS, Thompson microphysics
- Disable select components
  - GSI, DA Ensemble, Ocean Coupling, Initialization
- Run without spectral files
- Multistorm capability

For information on running these additional configurations, visit:
http://www.emc.ncep.noaa.gov/HWRF/scripts/available_configurations.html

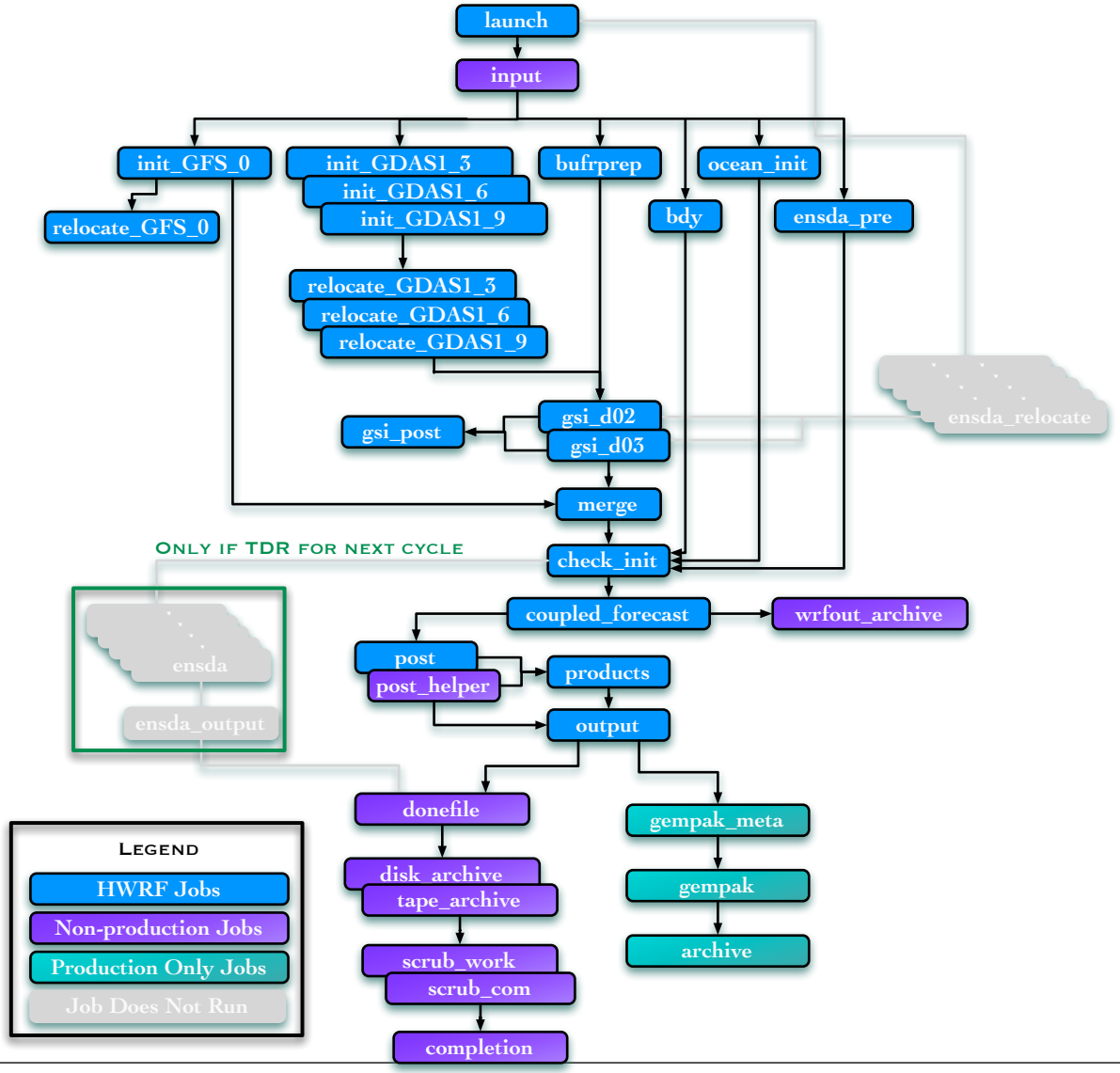
Questions?

Next up….

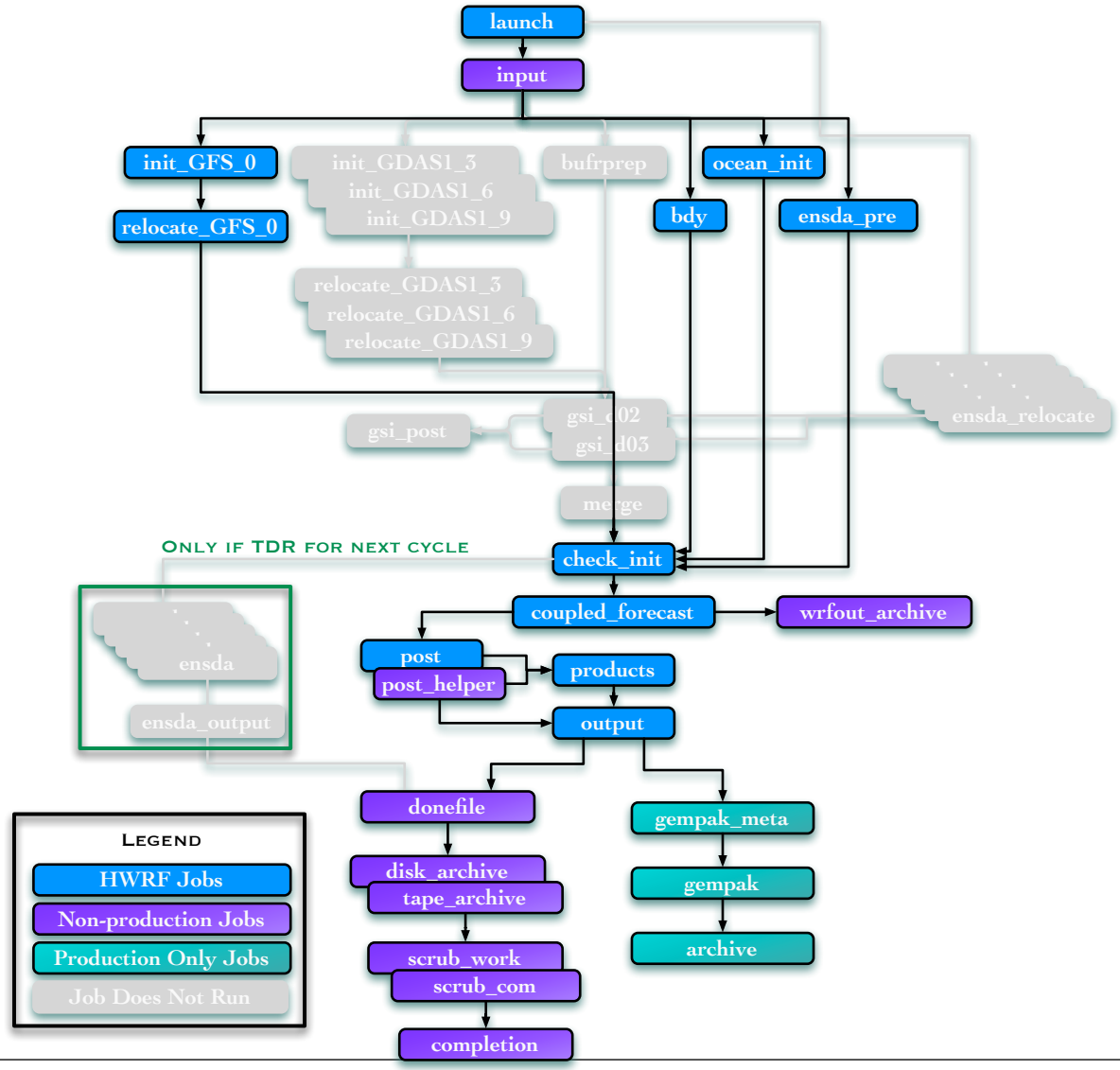
HWRF Internals Overview

Extras

HWRF Tasks: AL Default w/o TDR



HWRF Tasks: EP Default w/o TDR



HWRF Tasks: Other basins