2011 COAMPS-TC Ensemble HFIP-TJET Proposal

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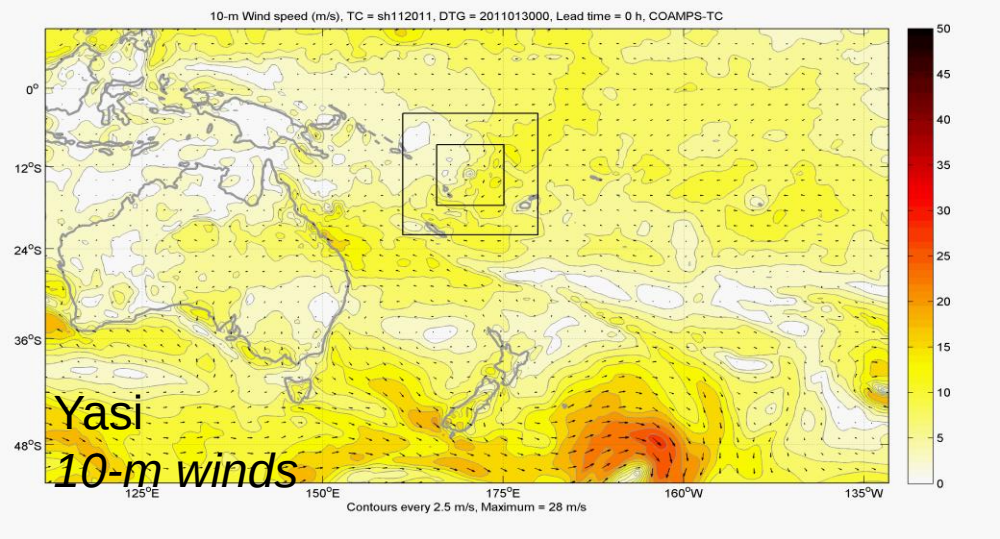
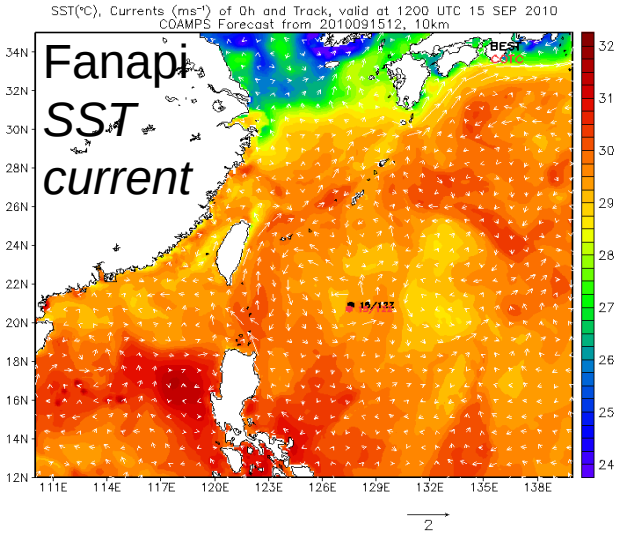
COAMPS-TC System Overview
Navy's Next Generation TC Model

- **Goal:** Significantly improve forecasts of TC intensity with sufficient fidelity to capture *rapid intensity changes*, *structure*, and *ocean response*, along with *probabilistic predictions*.
- **Analysis:** Vortex relocation, 3D-Var (NAVDAS), synthetic observations Ensemble Kalman Filter (using DART) (*focus of this talk*)
- **Atmosphere:** Nonhydrostatic, moving nests, CBLAST fluxes, dissipative heating, shallow convection, spray parameterization option
- **Ocean:** 3D-Var (NCODA), NCOM, SWAN, Wave Watch III options
- **Ensemble:** Members drawn from EnKF analysis *(focus of this talk)*
- **Configuration:** 45-15-5 km, GFS or NOGAPS BCs, uncoupled or coupled





COAMPS-TC
Overview of Tests and Improvements

➢ HFIP Retrospective and Real-Time Tests

- **Retrospective tests:** 400+ cases WATL, EPAC 2008-2009
- **Retrospective tests (underway):** 900+ cases WATL, EPAC 2008-2010
- **Real time:** 2008, 2009 (WATL, WPAC), 2010 (WATL, EPAC, WPAC)
- **ITOP:** a) coupled 45/15/5 km, b) 10-km invest, c) adjoint air-ocean targeting

➢ Improvements to COAMPS-TC for 2011:

- **Analysis:** Additional obs. (radiances, TPW), new synthetics, balance step
- **Physics:** New Fu-Liou radiation, new NRL microphysics, improved PBL
- **Air-Sea Coupling:** More robust system, 3D-Var (NCODA), interface develop.
- **New Capabilities:** EnKF (w/ DART), nested adjoint

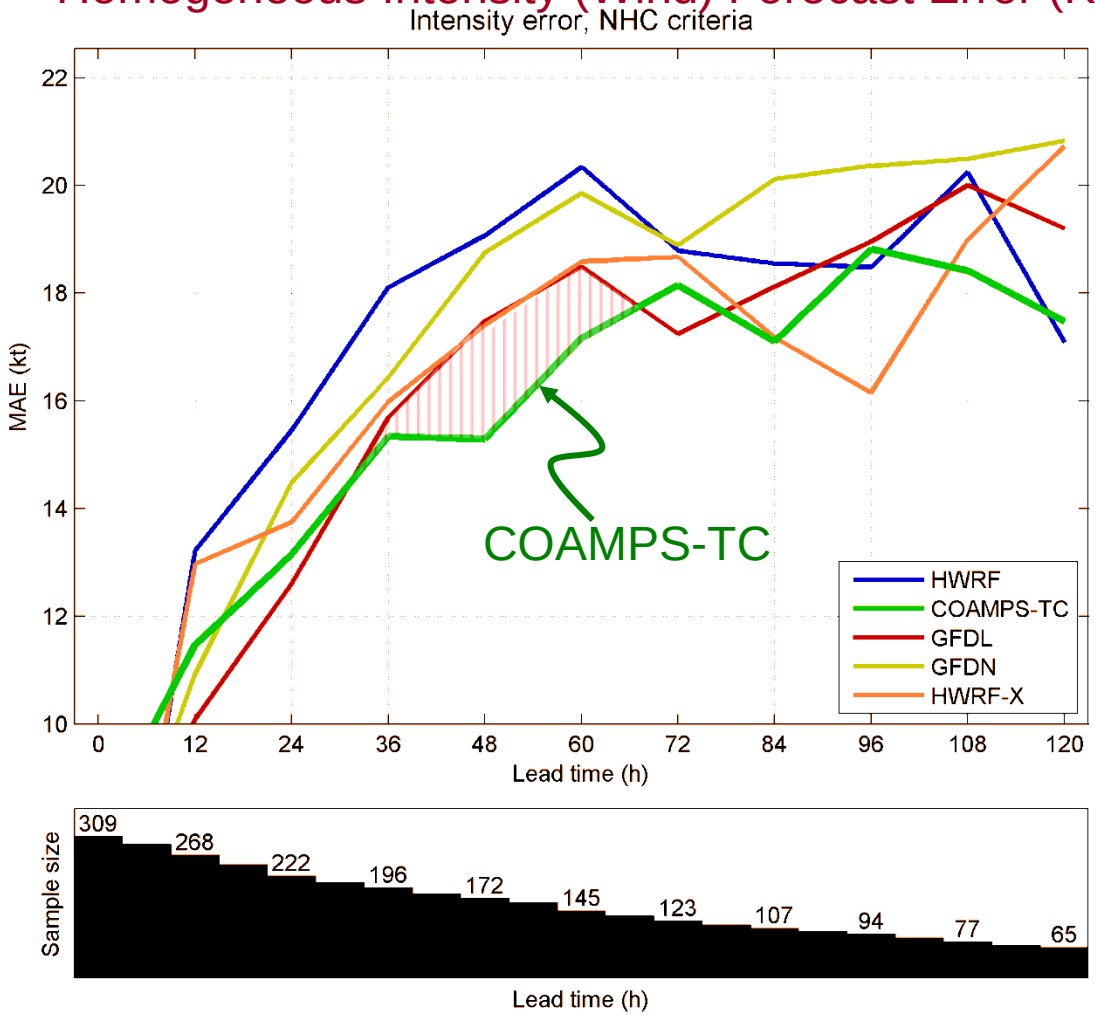
➢ Real-time Stream 1.5/2 Demonstration for 2011

- **Deterministic real-time:** HFIP (WATL, EPAC), HFIP/JTWC (WPAC, SH, IO)
  - Run on Cray XT5 at DoD HPC Navy DSRC
- **Ensemble:** HFIP (WATL, EPAC) (Proposed to run at NOAA on T-Jet)

COAMPS-TC

2010 Real-Time W. Atlantic Forecasts

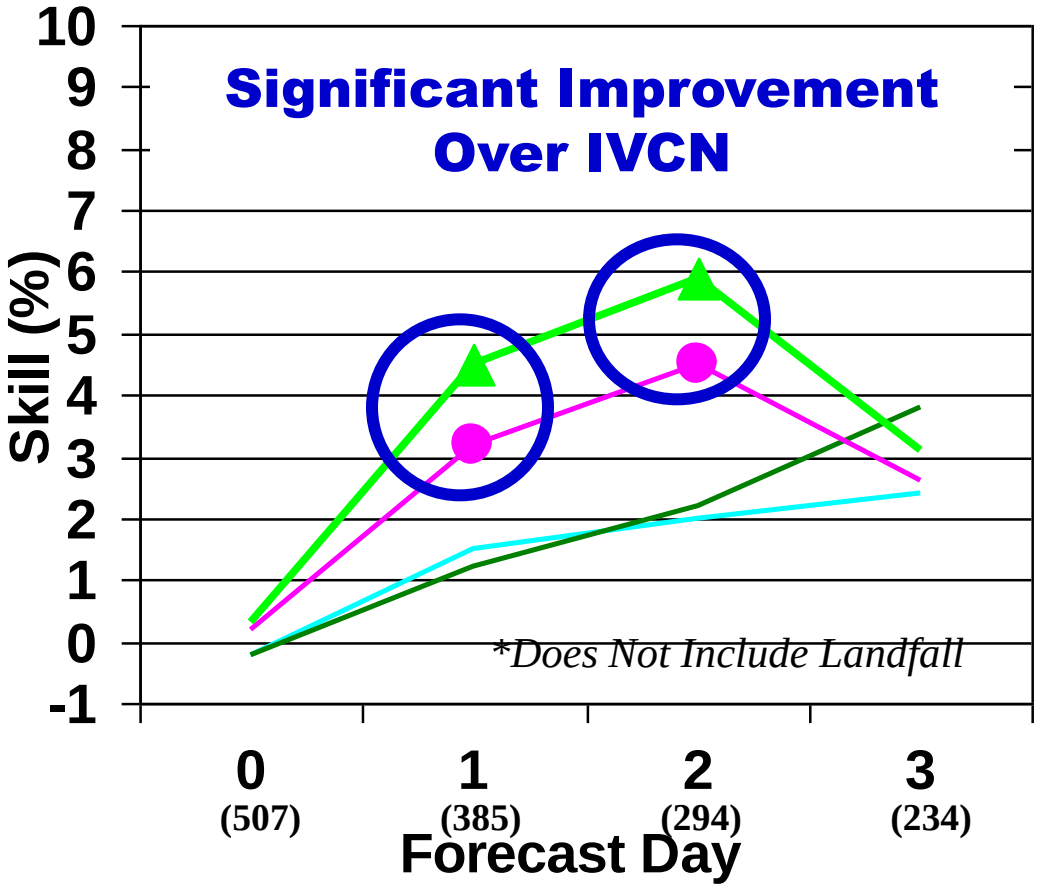
Homogeneous Intensity (Wind) Forecast Error (Kts)



- **COAMPS-TC Top Dynamical Model for Intensity in WATL (30-66h).**
- **36-48 h Skill Comparable to Statistical Models (LGEM).**

Atlantic Intensity Consensus

Intensity Skill Relative to 2006 NHC Consensus



ICON
(DSHP + LGEM + GHMI + HWFI)

IVCN
(DSHP + LGEM + GHMI + HWFI + GFNI)

IVCN+COAMPS

DSHP:+GHMI+GFNI+LGEM+COAMPS

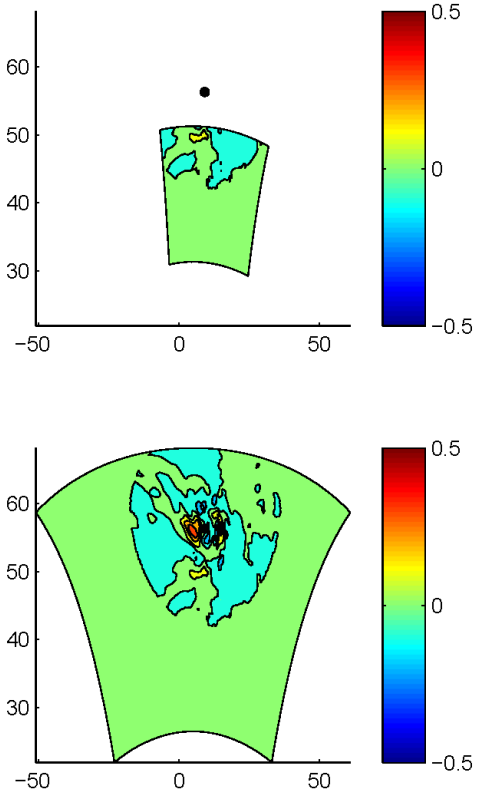
Courtesy of Buck Sampson

Addition of COAMPS-TC Improves the Intensity Consensus for 2009 and 2010 Atlantic Forecasts

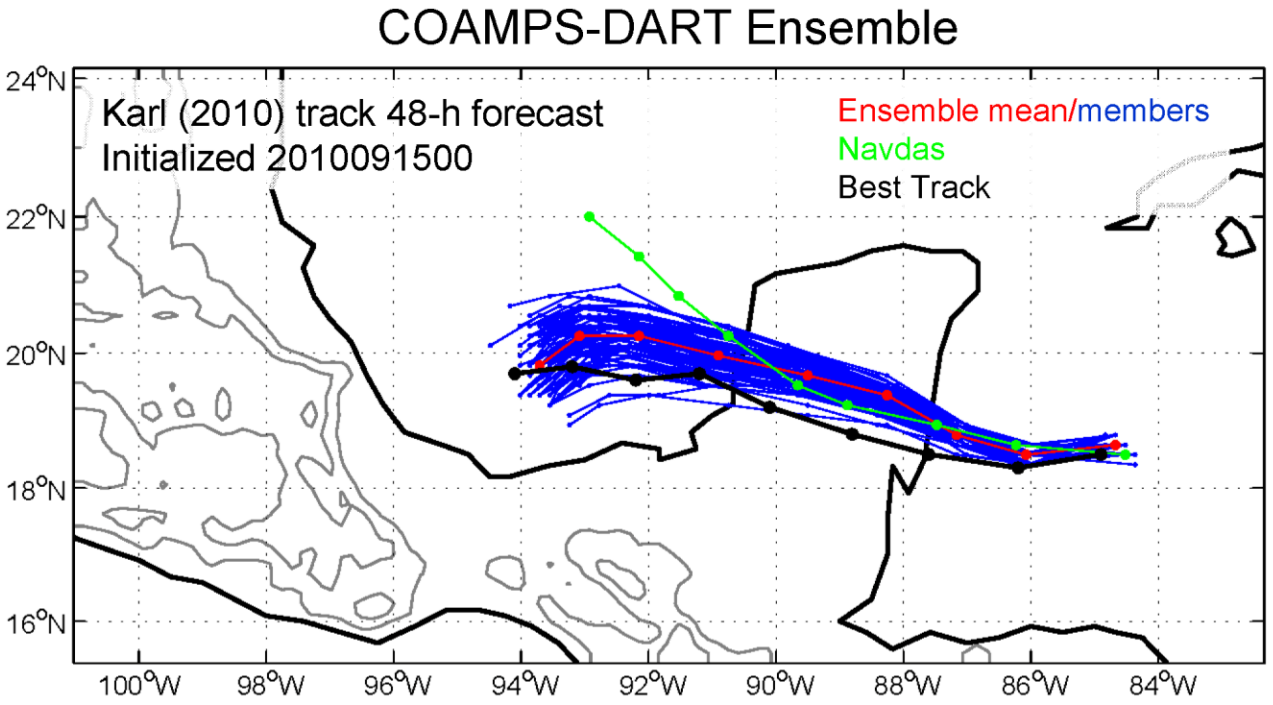
Proposed T-Jet System

Data Assimilation System

- **Serial Ensemble Kalman Filter**
  - Data Assimilation Research Testbed (DART)
  - 6-h assimilation cycle
- **2-way nested data assimilation**
  - Each nest updated with same innovation
  - Highest resolution nest defines innovation
- **Boundary conditions from global ensemble**
  - GFS EnKF preferred
  - NOGAPS-ET possible

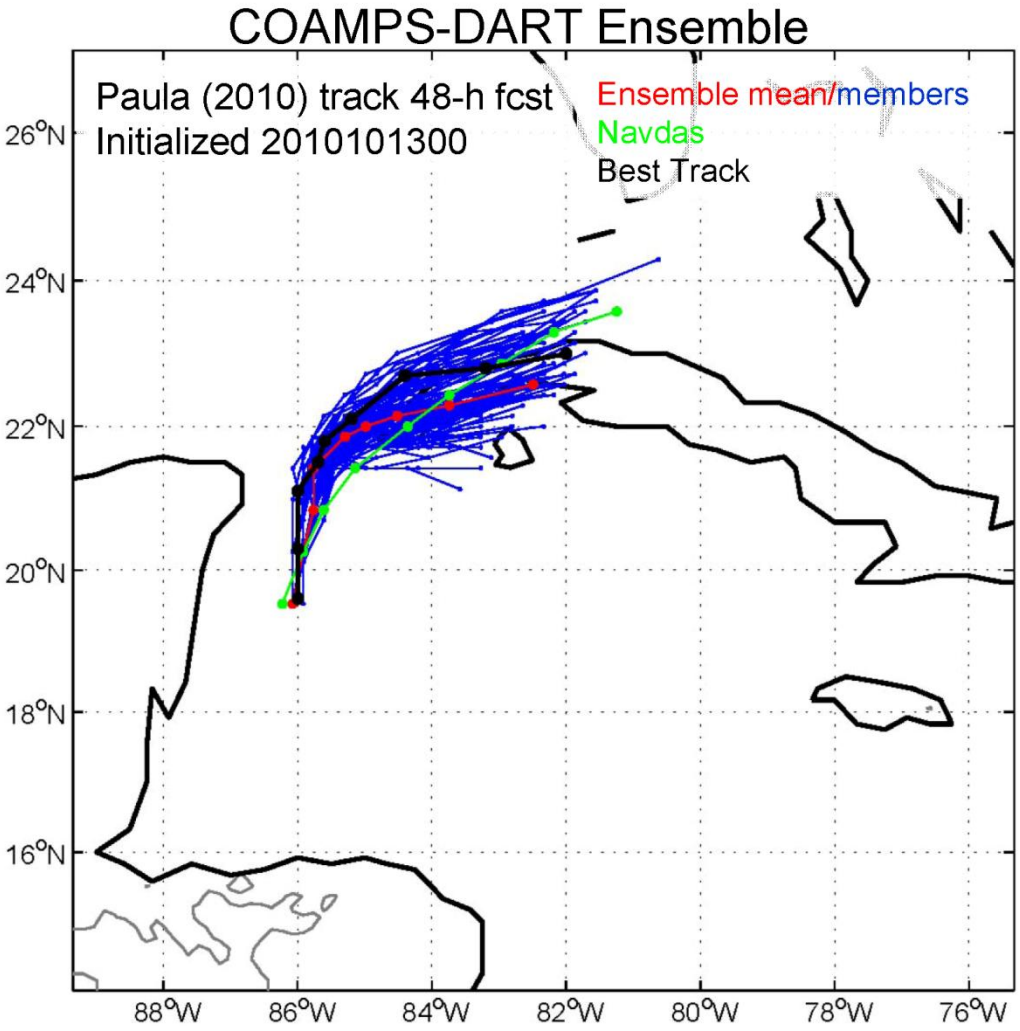


2010 Atlantic Test Cases
Karl



- Initial test of DA and forecasting systems promising.
- More samples needed for statistical meaningful sample

2010 Atlantic Test Cases
Paula



Data Assimilation Strategy

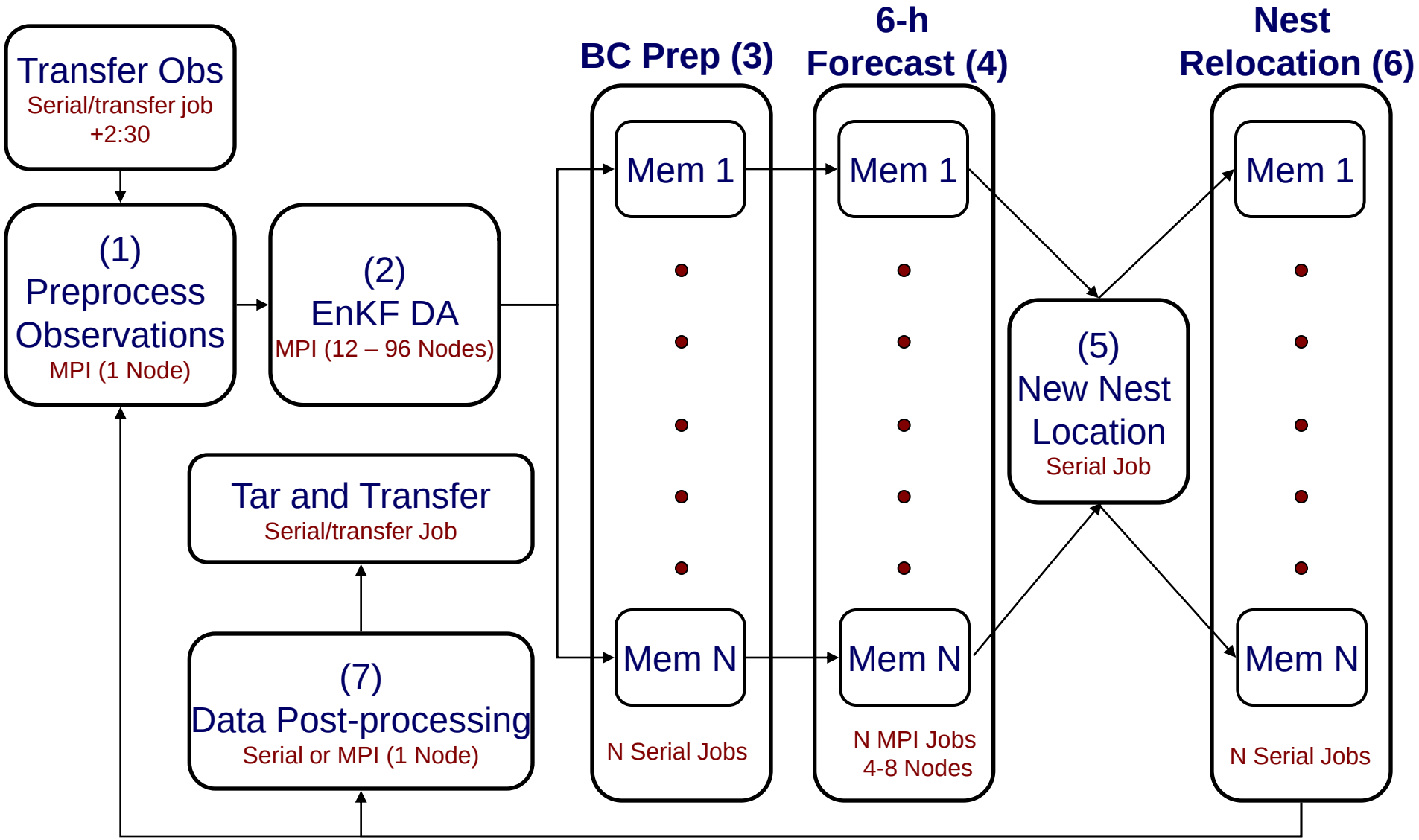
- **Hypothesis: Better initial synoptic–scale environment will improve track forecast**
  - Focus on satellite observations (e.g. radiances, gps-ro)
  - Primary source of thermodynamic data over the ocean
- **Greater coverage than radar observations**
  - Radar observations do not cover most tropical cyclones
  - Data sets available for every ocean basin at all times
- **Predictability issues:**
  - Hypothesis: Satellite's observe structures with greater predictability than inner-core observations (e.g. radar).
  - More bang for your buck.

Observations

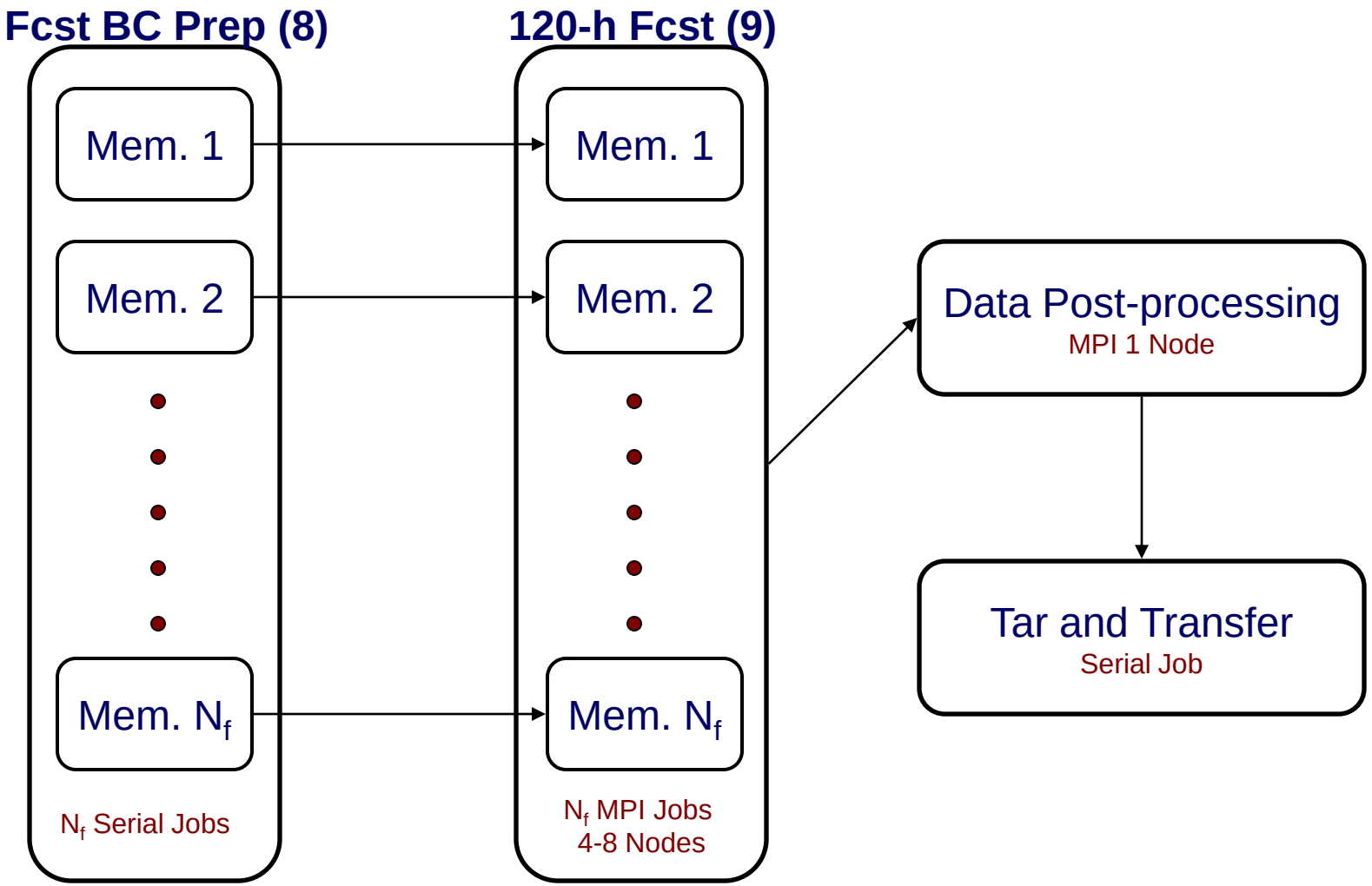
- **Satellite Based Observations:**
  - AMSU-A up to channel 8 (CRTM)
  - GPS-RO Bending Angle (ROPP)
  - WindSat and SSMI/S precipitable water
  - AScat and NRL WindSat
  - Geostationary Winds
- **Conventional Observations:**
  - ACARS/MDCARS
  - Vortex position
  - RAOB
  - SFC/SHIP data

T-JET Setup
&
Requirements

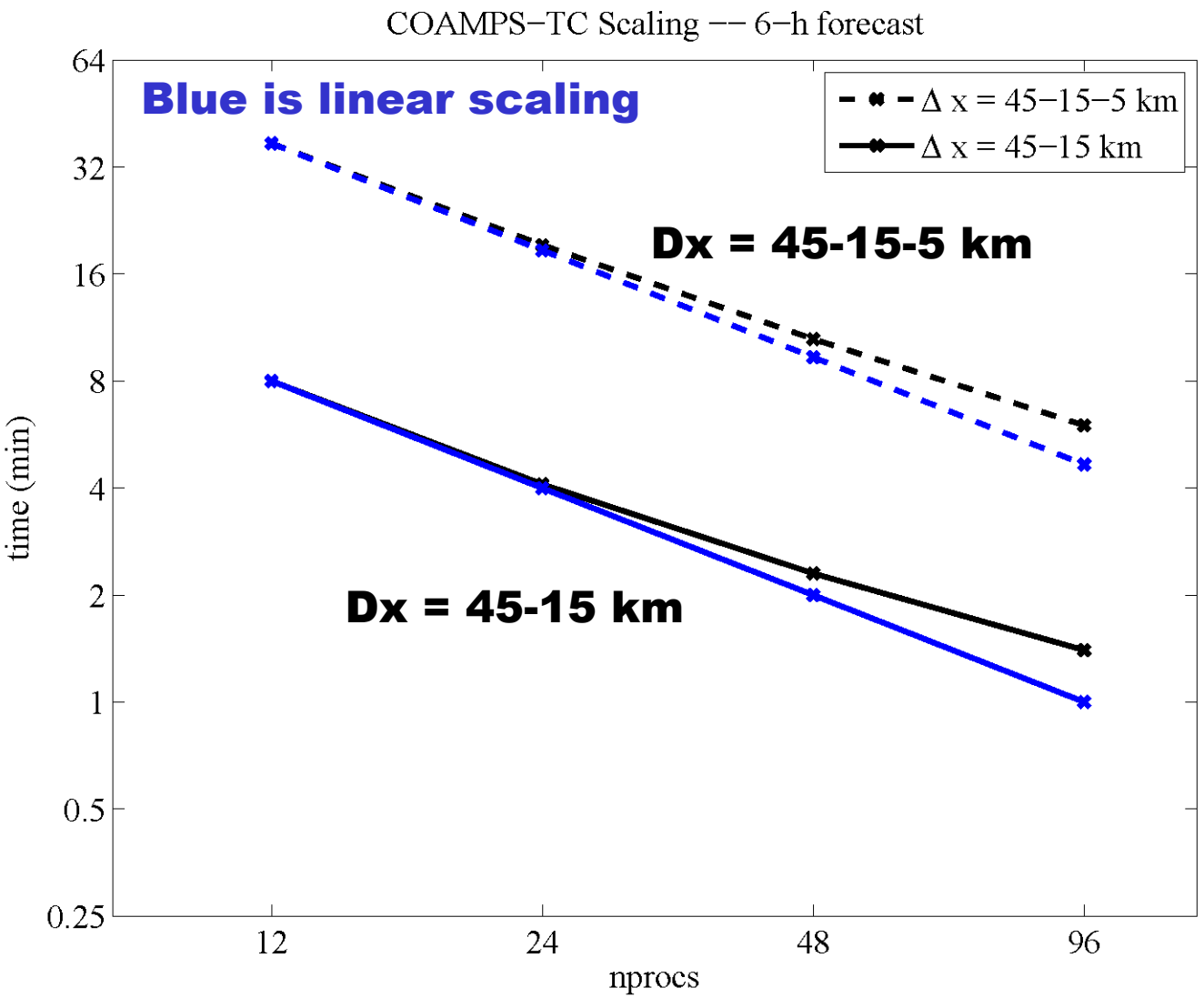
Data Assimilation Cycle



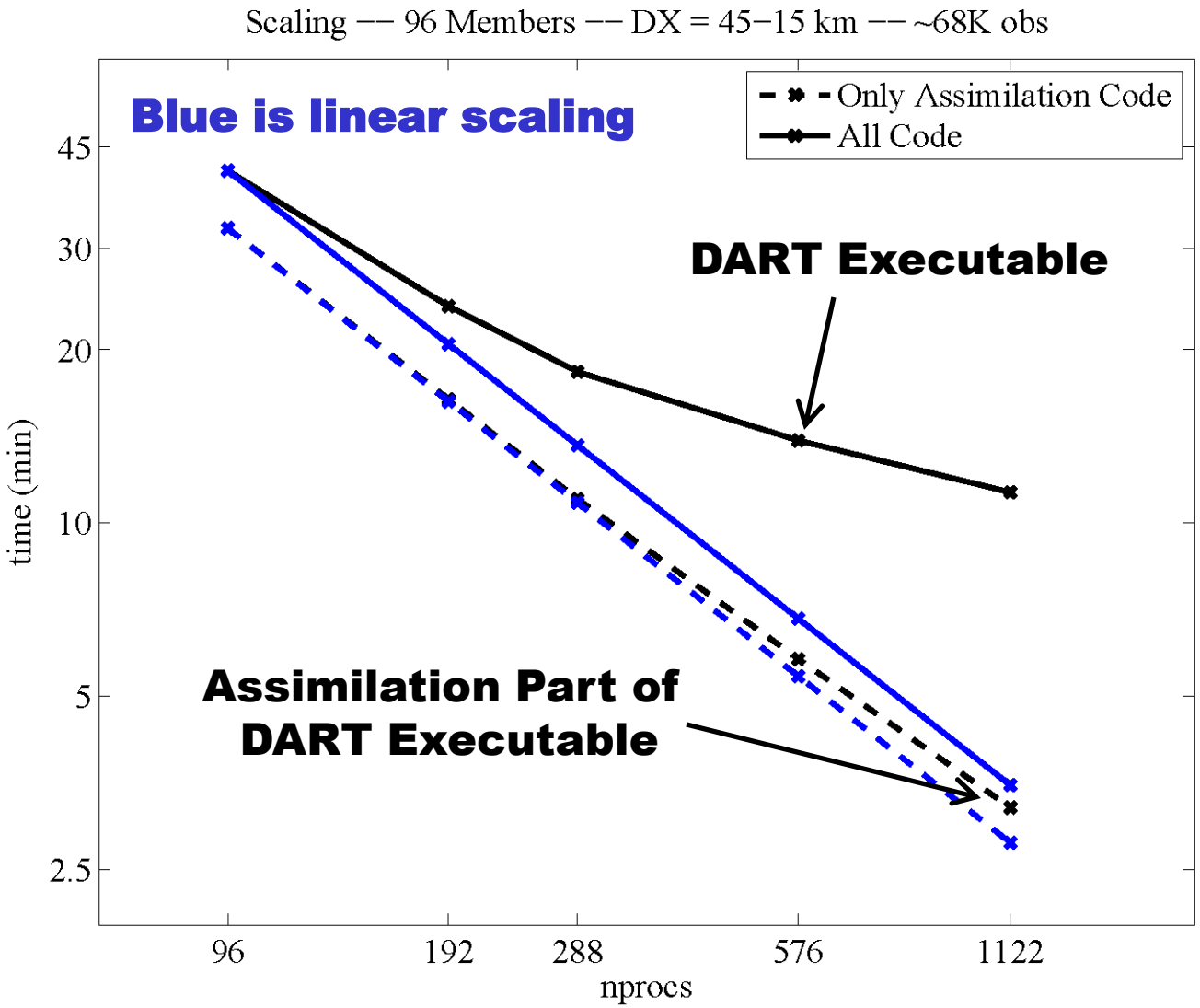
Forecast Ensemble



COAMPS Scaling



DART Scaling



Possible Configurations

Configuration 1

- 45-15-5 km horizontal resolution
- 96-member DA ensemble
- 6-h data assimilation cycle
- 120-h forecast for 10 members one time a day

Configuration 2

- 45-15 km horizontal resolution
- 96-member DA ensemble
- 6-h data assimilation cycle
- 120-h forecast for 20 members two times a day.

Configuration 3

- 45-15-5 km horizontal resolution
- 80-member DA ensemble
- 6-h data assimilation cycle
- 120-h forecast for 10 members one time a day

Configuration 4

- 45-15 km horizontal resolution
- 80-member DA ensemble
- 6-h data assimilation window
- 120-h forecast for 20 members two times a day

Configuration 1

Step	Nodes/Procs	Time
(1) Preproc obs	1 Node	5-7 minutes
(2) Data Assimilation	48 Nodes	21-25 minutes
(3) BC Prep	96 Serial Jobs	< 3 minutes each (large i/o, can be variable)
(4) 6-hr forecast	96 MPI Jobs 2 Node Jobs or 4 Node Jobs	24 minutes each 14 minutes each
(5/6) Find/Relocate New Nest	1/96 Serial Job	< 3 minutes each
(7) 120-hr forecast BC prep	10 Serial Jobs	6-13 minutes (large i/o, can be variable)
(8) 120-hr forecast	10 MPI Jobs 4 Node Jobs or 8 Node Jobs	220 minutes each 130 minutes each

Configuration 2

Step	Nodes/Procs	Time
(1) Preproc obs	1 Node	5-7 minutes
(2) Data Assimilation	24 Nodes	19-23 minutes
(3) BC Prep	96 Serial Jobs	< 3 minutes each (large i/o, can be variable)
(4) 6-hr forecast	96 MPI Jobs 2 Node Jobs or 4 Node Jobs	10 minutes each 7 minutes each
(5/6) Find/Relocate New Nest	1/96 Serial Job	< 3 minutes each
(7) 120-hr forecast BC prep	20 Serial Jobs	6-13 minutes (large i/o, can be variable)
(8) 120-hr forecast	20 MPI Jobs 4 Node Jobs or 8 Node Jobs	50 minutes each 33 minutes each

Questions and Issues

- **Will observation sets be available on T-Jet?**
  - **Will there be an predetermined cutoff time for observations?**
  - **What is the format of the data?**
- **Will the GFS global ensemble be available?**
  - **We would like data to at least 0.4 hPa for boundaries.**
  - **How many members will be available for the DA cycle?**
  - **How many members for forecasts?**
  - **What is the format of the data?**
- **Will there be time to re-run members if they don't run properly?**

Questions?

Configuration 3

Step	Nodes/Procs	Time
Preproc obs	1 Node	5-7 minutes
Data Assimilation	40 Nodes	21-25 minutes
BC Prep	80 Serial Jobs	< 3 minutes each (large i/o, can be variable)
6-hr forecast	80 MPI Jobs 2 Node Jobs or 4 Node Jobs	24 minutes each 14 minutes each
120-hr forecast BC prep	10 Serial Jobs	6-13 minutes (large i/o, can be variable)
120-hr forecast	10 MPI Jobs 4 Node Jobs or 8 Node Jobs	220 minutes each 130 minutes each

Configuration 4

Step	Nodes/Procs	Time
Preproc obs	1 Node	5-7 minutes
Data Assimilation	20 Nodes	19-23 minutes
BC Prep	80 Serial Jobs	< 3 minutes each (large i/o, can be variable)
6-hr forecast	80 MPI Jobs 2 Node Jobs or 4 Node Jobs	10 minutes each 7 minutes each
120-hr forecast BC prep	20 Serial Jobs	6-13 minutes (large i/o, can be variable)
120-hr forecast	20 MPI Jobs 4 Node Jobs or 8 Node Jobs	50 minutes each 33 minutes each