

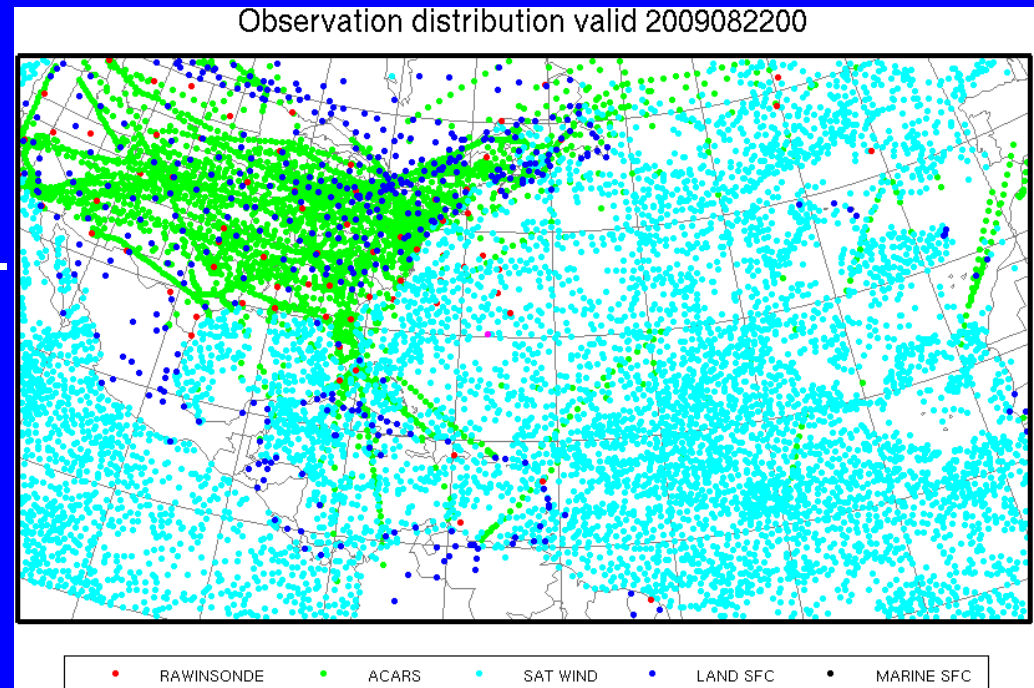
2011 MMM/SUNY AHW Computing Proposal

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2010 AHW Assimilation System

- WRF ARW (v3.1), 36 km horizontal resolution, 96 member continuously-cycling EnKF system
- Observations assimilated each six hours from surface and marine stations (P_{sfc}), rawinsondes, dropsondes (at least 100 km from storms), ACARS, sat. winds, TC position and minimum SLP, and GPS refractivity
- Initialized 12 km nest domain based on NHC INVEST declaration. Cycle with observations.
- Initialize at the beginning of season, cycle with observations and GFS boundary conditions



2010 AHW Forecasts

- High-resolution forecast generated on 12/4/1.33 km triple-nested domain
 - 12 km domain varies depending on storm
- Thompson Microphysics
- Kain-Fritsch cumulus parameterization on 12 km domain, explicit convection on other two
- Updated C_k/C_d formulation in Davis et al. 2008
- Pollard 1D Column ocean model
- SSTs from NCEP 1/12 degree analysis
- HYCOM Mixed-layer depths

Motivation

- Several issues emerged with AHW during and after last season related to Stream 1.5 selection
- Model timing too long
 - Model finished at t+10 hours
 - Difficult to speed up (doubling number of processors does not halve time)
- Too human intensive
 - Someone had to manually define domain and start forecasts (analysis system self-sufficient)

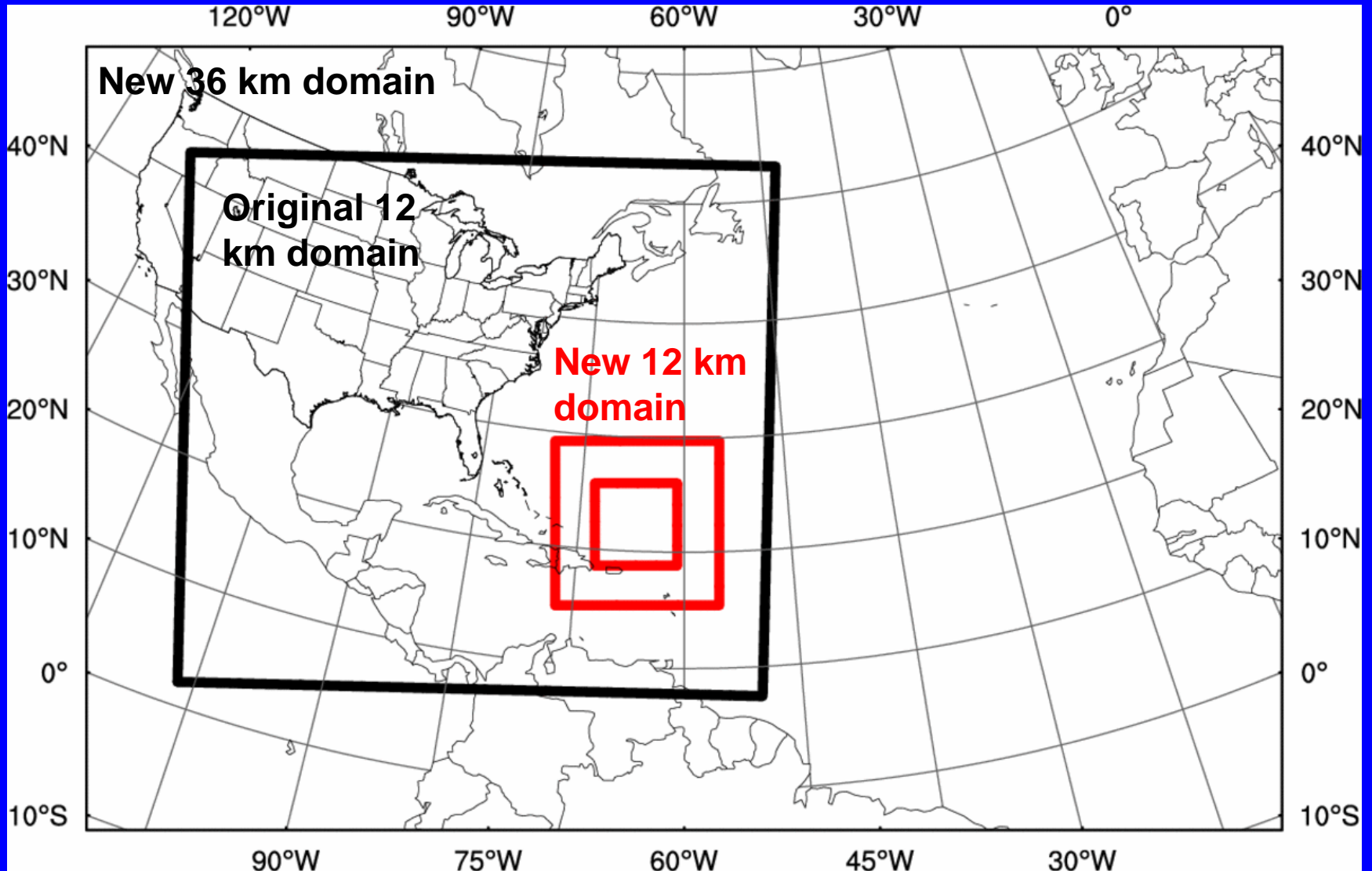
Motivation

- Limited number of cases
 - Computer allocation allowed for only one storm at a time (problematic during last season when up to 4 TCs existed at one time)
 - Single storm chosen by consensus
- Limited Computing allocation
- Multiple problematic track forecasts during 2010, including spurious storms

Changes for 2011

- Merger of the assimilation and high-resolution forecasting system
 - High resolution forecast integrated over entire 36 km domain used in assimilation system
 - Removes need for large, human-specified 12 km domain
 - 12 km domain now follows the TC center

Domain Changes



Changes for 2011

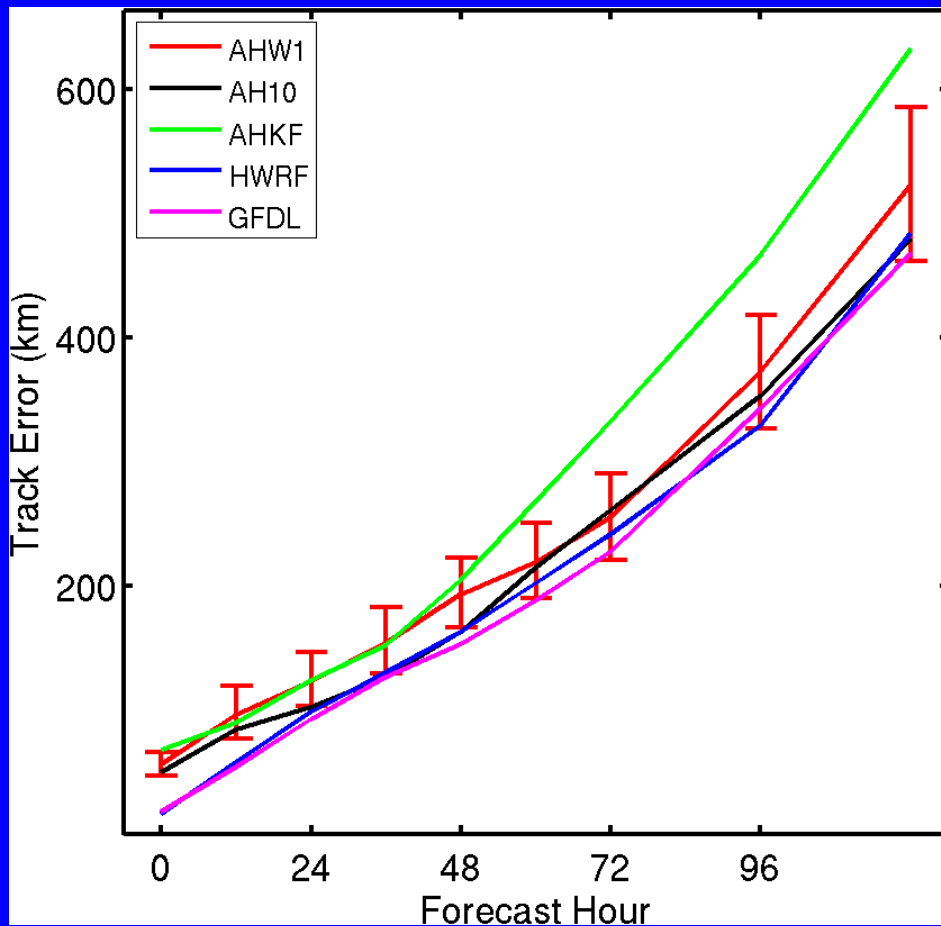
- Removal of 1.33 km domain
 - No clear benefit from using this domain in most storms
 - Substantial computational savings by removing it since it is the limiting step in the forecast

Changes for 2011

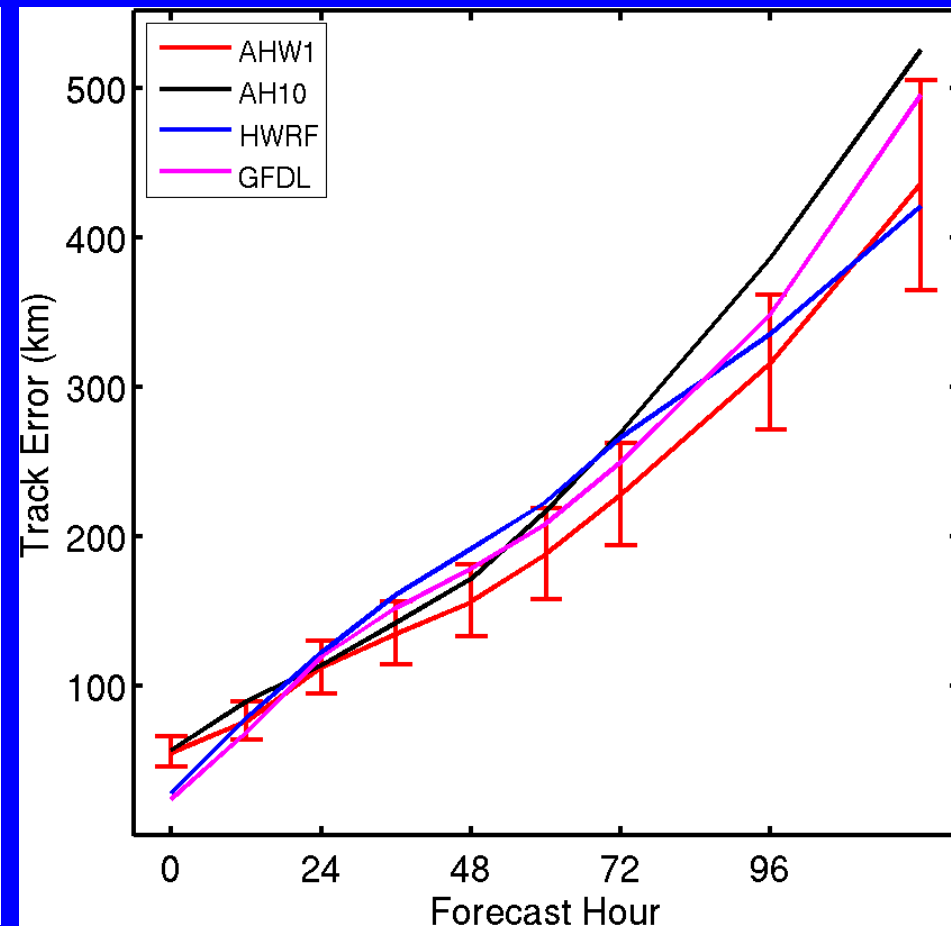
- 36 and 12 km domains now use Tiedtke cumulus parameterization
 - Includes robust shallow convection in the western Atlantic
 - Significant impact on track biases in this region through thermal wind balance

Forecast Errors

2008 Track Errors



2010 Track Errors

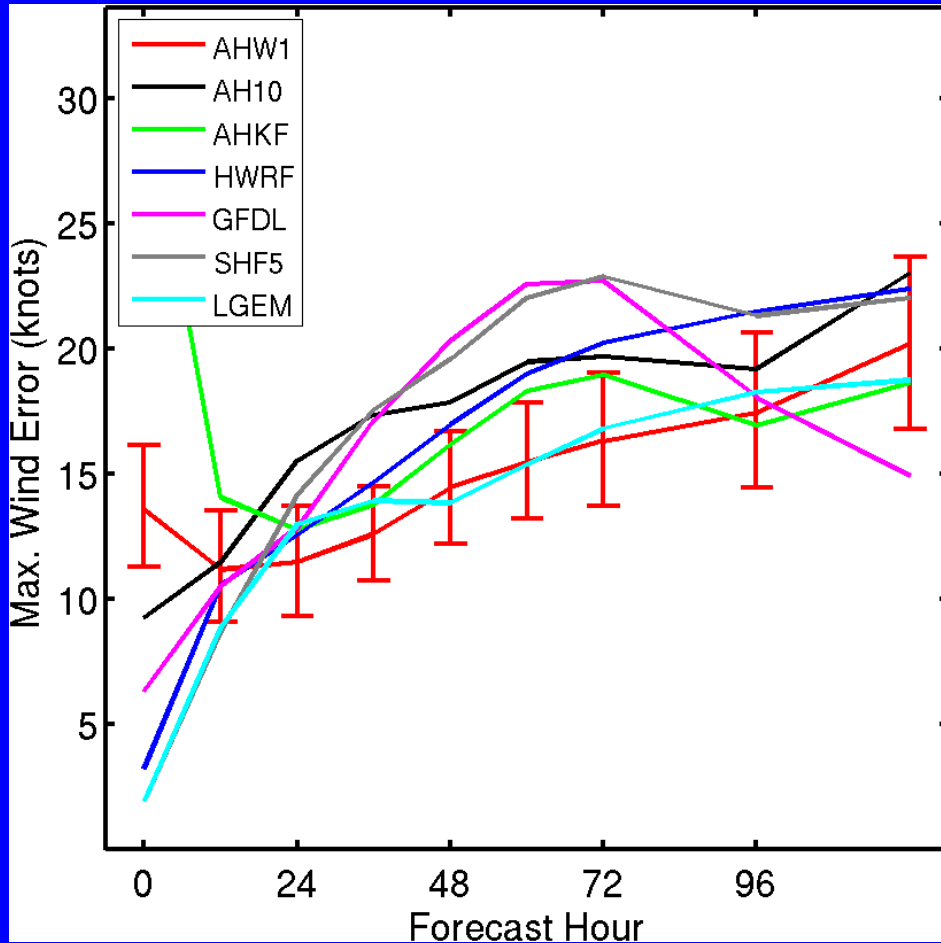


AI06-AL09 (68 forecasts,
homogeneous)

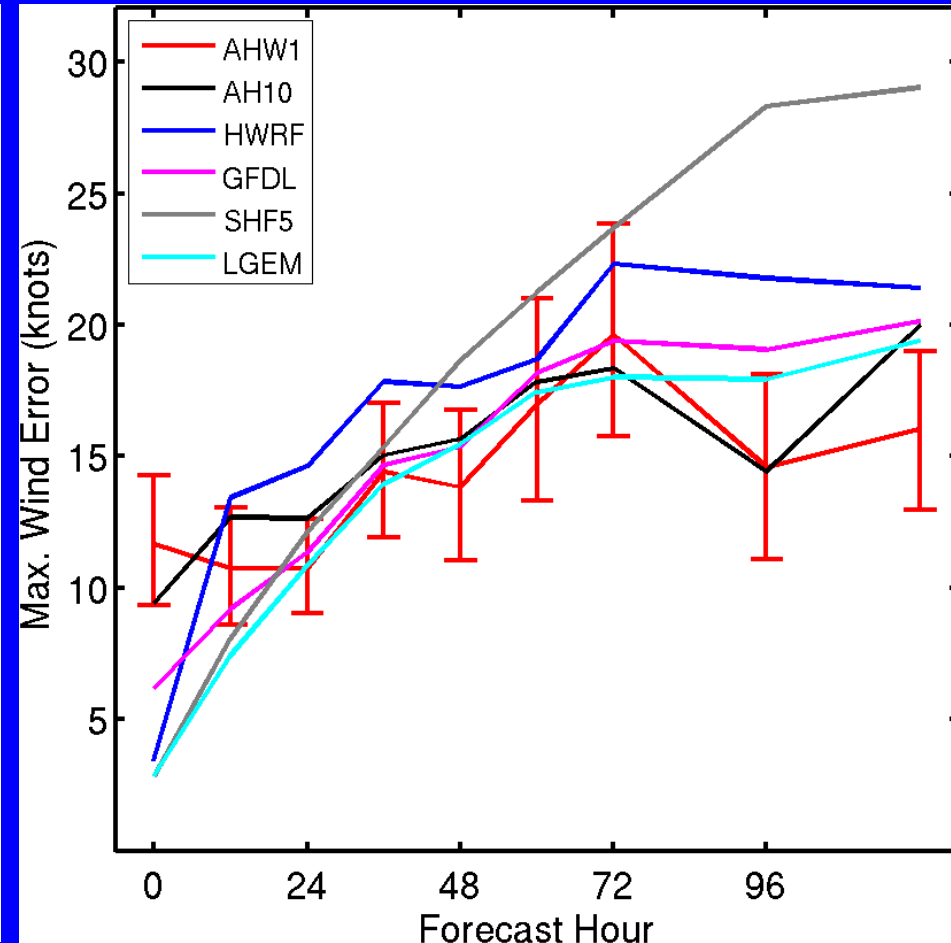
AI06-AL14 (42 forecasts,
homogeneous)

Forecast Errors

2008 Intensity Errors



2010 Intensity Errors



AI06-AL09 (68 forecasts,
homogeneous)

AI06-AL14 (42 forecasts,
homogeneous)

2011 AHW Jet Proposal

- Propose to generate forecasts each 6 h for any TC in the Atlantic basin
- Used the following assumptions
 - Have roughly 1000 cores to use
 - Need to satisfy Stream 1.5 timing
 - Reserve some nodes for multiple TCs at the same initialization time

2011 Jet Proposal

- Run EnKF assimilation system each 6 hours for Atlantic basin
 - Will start at t+3.5 hours after analysis time (limited by when the GFS prepbufr file becomes available)
 - 300 Jet cores
 - Duration: Depends on number of nests, 14 minutes with no nests, each nest 1.5 minutes longer
 - Not much benefit to adding more cores, I/O bound at some points in the code

2011 Jet Proposal

- Advance 96 data assimilation ensemble members to next assimilation time
 - Starts after analyses are ready
 - Use 12 jet cores per ensemble member (96 members)
 - Timing: 6 minutes for 36 km domain + 3 minutes per additional 12 km nest
 - Can finish at any point before next analysis time (i.e., after higher-resolution forecast)

2011 Jet Proposal

- Separate 36/12/4 km forecast from single member analysis for each system at least of TD strength (Stream 1.5 contribution)
 - Would like to do all storms simultaneously
 - Slower timing due to code structure
- Analysis member chosen by applying cost function to each TC
- Use 120 jet cores per storm
- Timing: 1.6 hours per storm for a 126 h forecast
- Delivery to NHC by t+6 h (0000 UTC forecast by 0600 UTC)

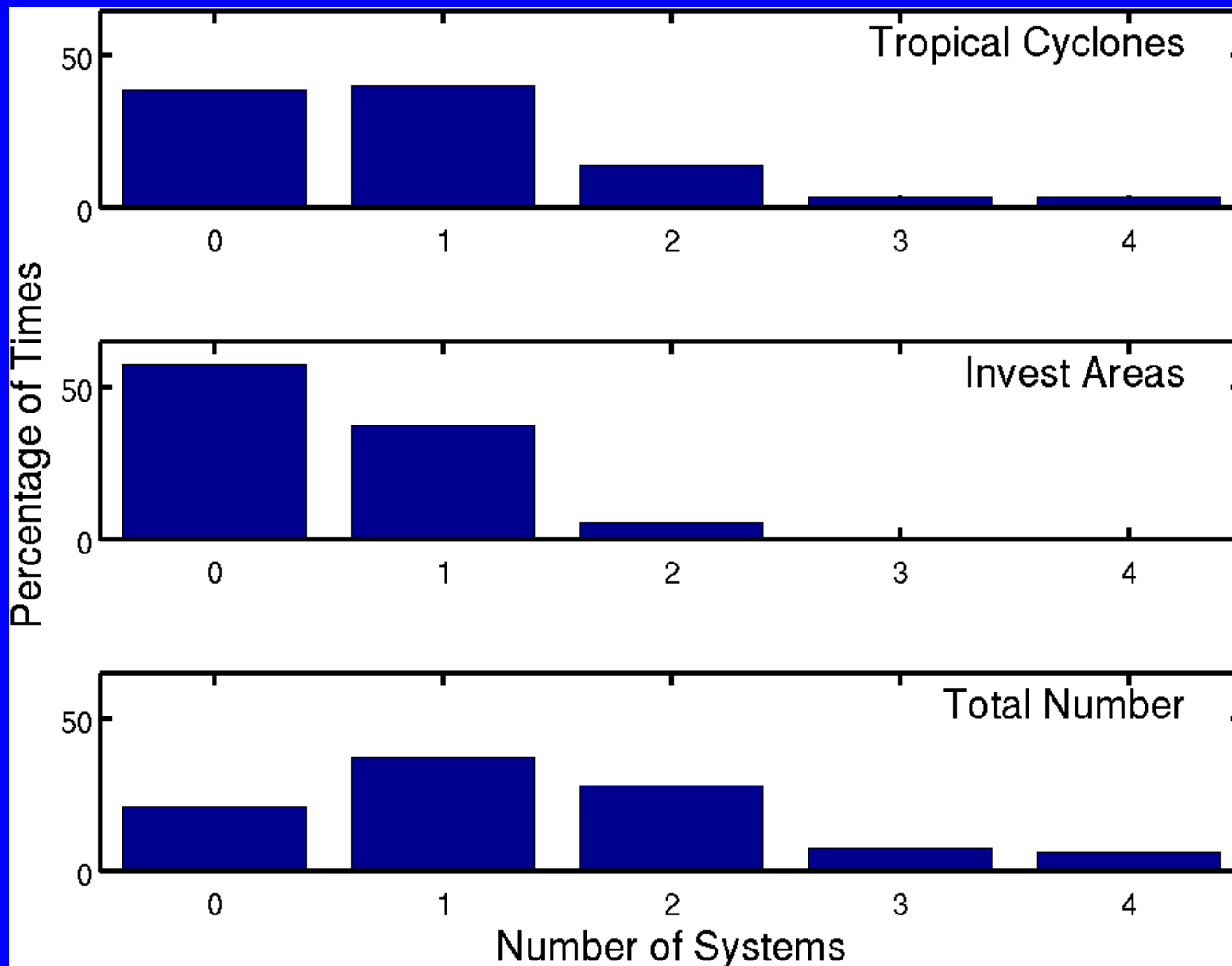
2011 Jet Proposal

- Run duplicate 36/12/4 km forecast with additional 1.33 km nest centered on TC center (similar to last season, Stream 2)
- Demonstrates whether additional resolution in TC core provides any benefit to forecast
- Use 180 cores
- Timing: 5 hours for 126 h forecast

2011 Jet Proposal

- Generate 20 member 36/12/4 km AHW ensemble forecasts (Stream 2)
- Provides estimate of uncertainty of AHW forecast, can be compared to variance in multi-model ensemble
- Choose members based on cost function used to determining control to get diversity
- Use 48 cores per member, 10 members at a time
- Timing: 2.9 hours for 120 hour forecast

Multiple Storms



Survey of Atlantic basin best track data from 1 August to 20 October 2006-2009

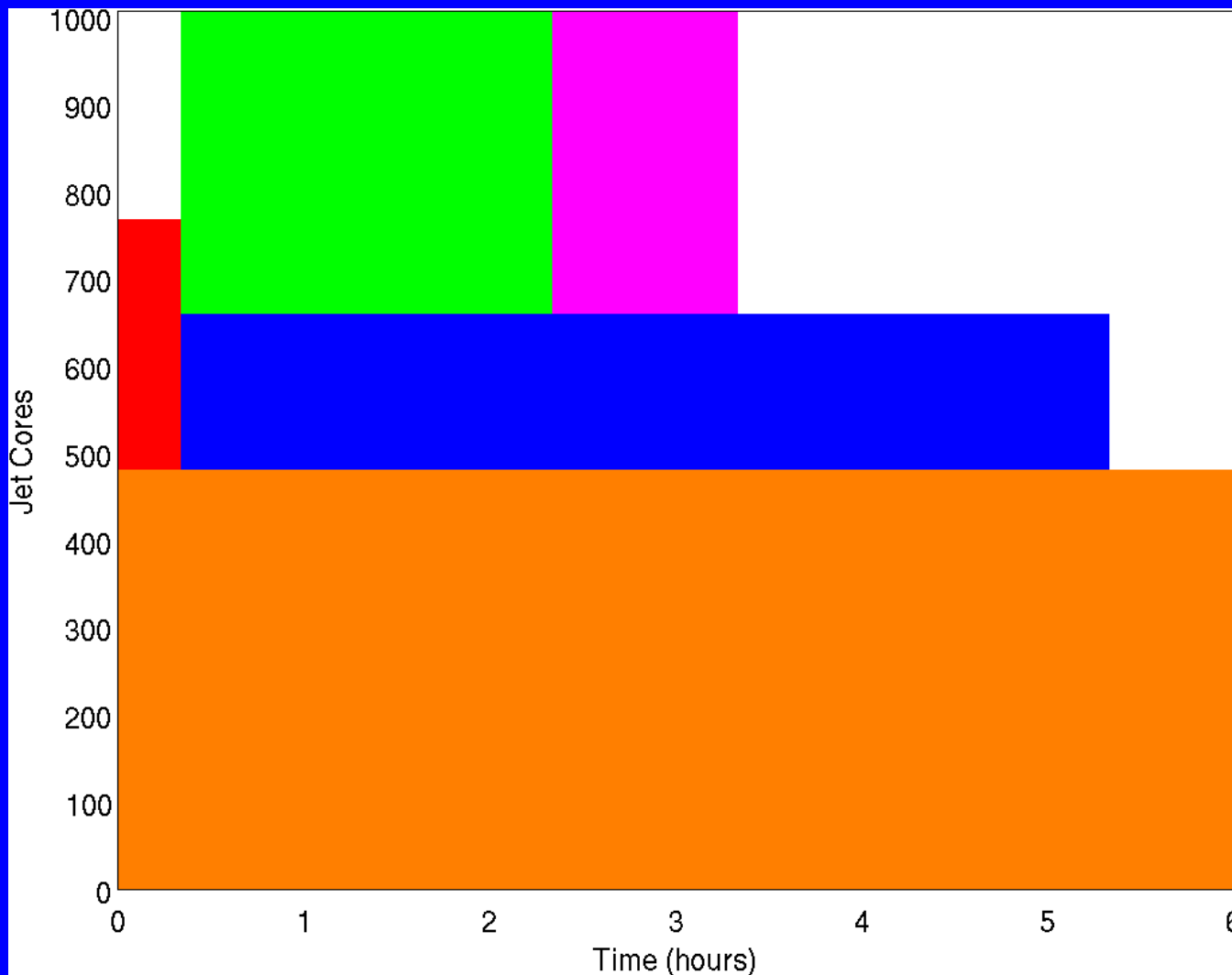
Multiple TCs

- Given current computing allocation, can run 36/12/4 km forecasts for all TCs
- For most “relevant” TC, 1.33 km and 4 km ensemble forecasts
 - Determined by finding all TC within 3000 km of Miami
 - If multiple TCs satisfy this criteria, choose strongest TC at 0 h

Post-Processing

- Tier-1 and Tier-2 files generated following the completion of forecast (15 min each)
- Graphics for website
- Time-radius cross sections of various fields and vertical levels (generated with Tier-1 data)
- Synthetic Satellite data
- Assimilation system verification
- All could be done with dedicated serial node

Straw 6 h Forecast Cycle



Data Assimilation

36/12/4 km Control Forecasts for all TCs

36/12/4/1.33 km Forecast for Single TC

Assimilation System Advance

36/12/4 km Ensemble Forecasts for Single TC

Additional Resource Priorities

- Additional 1.33 km forecast (180 processors per storm)
- Additional storm ensemble (480 processors per storm)
- Eastern Pacific AHW analyses and a 36/12/4 km control forecast for each TC (Stream 2). Might be able to fit into puzzle, but would need extensive testing prior to season