WAVEWATCHIII & NOPP

A case study for a R2O development paradigm

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Development History of WAVEWATCH III

- Structural development by Hendrik Tolman
  - V 2.22
    - Public release 2002
    - Single grid model
    - Modular, Fortran 90, MPI formulation
    - Included packages developed by external collaborators (e.g. Exact-NL, WAM 3 physics)
  - V 3.14
    - Public release 2008
    - Physics packages mostly unchanged (minor additions like linear growth term)
    - Main development was a multi-grid two way nested formulation
  - V 4.18
    - Public release 2013
    - Significant change in development paradigm
      - Model now in a community development paradigm with code ownership now distributed over multiple groups in different countries.
      - Version control to manage different contributions
    - Significant advancement in model features
      - Multiple physics packages
      - Numerical development

NOPP Wave Research Program

- In 2010 NWS, USACE, ONR and BOEM joined hands under the auspices of the National Ocean Partnership Program (NOPP) to support research by Academia, Industry and Government with an aim to
  - Bring advances in wind wave modeling research to operational models
  - Focus on deep and shallow water dynamics
  - Unify (as much as possible) on common platforms
- 7 different projects were selected
- Two open source models were identified – WAVEWATCH III (for deep water waves) and SWAN (for shallow water waves)
- NWS offered WAVEWATCH III as a development platform for the research
- NCEP took on the role for creating and supporting the community development platform
- The community development platform has continued today (almost 3 years past the end of the original NOPP Program)

Rules of Engagement

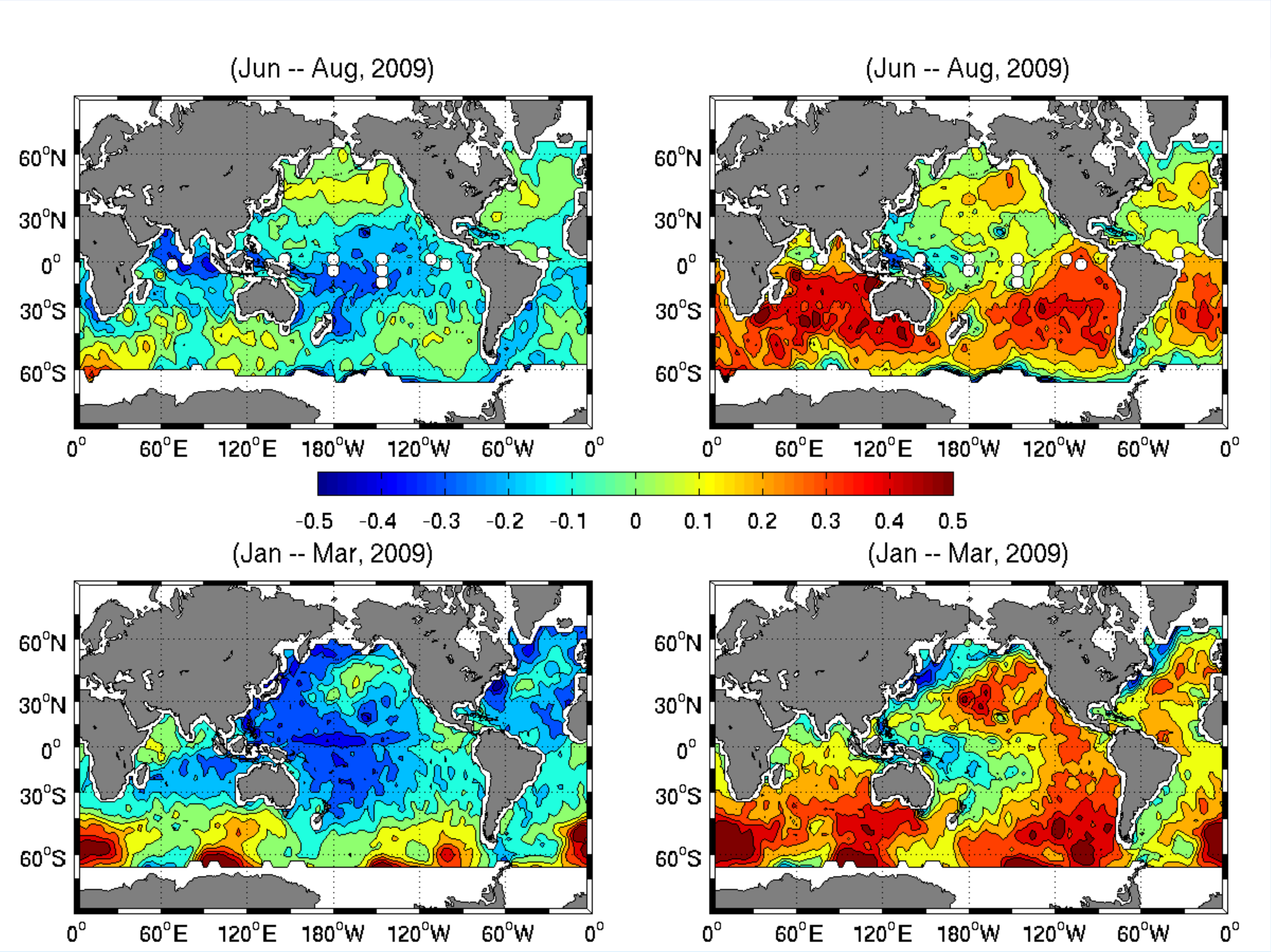
- Setting up a single code repository for the wave model
  - We used EMC subversion server
  - Common code base for research and operations
  - Operational code a sub set of the main development code
  - All development in the main code base
- Setting up the rules for development
  - Main code was in the Trunk
  - Development teams set up branches
  - Branches were set up as a function of “development” not “institute”
  - Regular communication was seen as key (monthly telecons + semi – annual meetings)
  - A “coding principles” guide was developed
- A regression test suite
  - Critical for code development, specially when multiple teams involved
  - Has to be as automated as possible to be tested at both branch and trunk level
  - WW3 currently has over 600 regression tests (considering all options)
  - Any new feature that is developed needs to come with a regression test case (provided by developer)

Transitioning codes to operations

- A common code repository for both research and operational code is essential
- Need to work with development center (e.g. EMC) to
  - Identify testing conditions that are as close to operations as possible
  - Meet operational computational requirements
  - Follow agreed coding standards
  - Address “critical gaps” in operational capability
- Communication is absolutely essential for any successful transition from research to operations. Requires listening to both sides

Example 1 – New Physics package

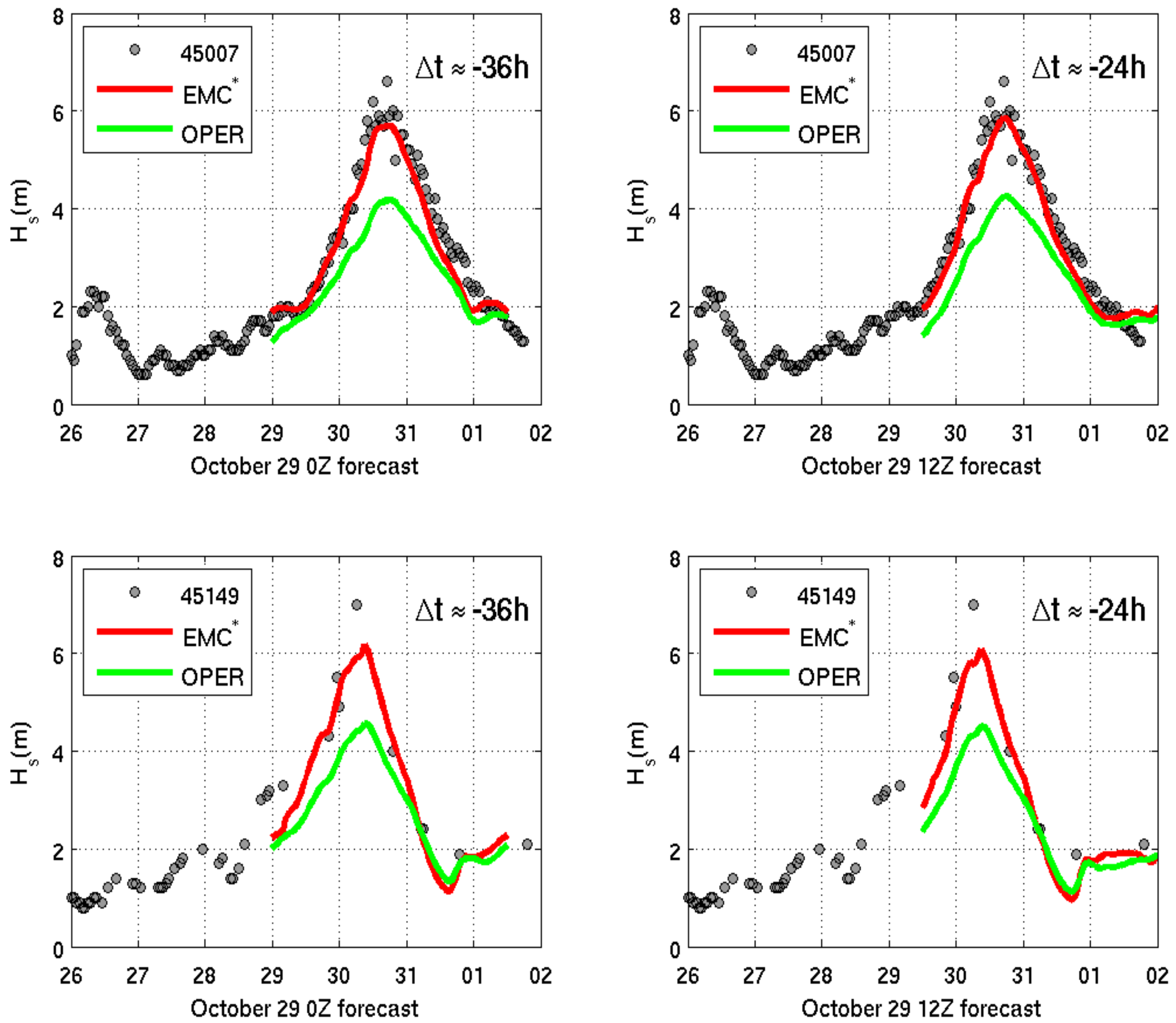
- Old Physics
  - Physics package developed in 1996
  - Codes in final configuration in operations in 2001
  - All development at EMC
- New physics
  - Developed under the auspices of NOPP
  - Coding done in common repository
  - Physics development led by IFREMER in France
  - Physics packages tested in global conditions for multi – year scenarios
  - Common code base led to seamless transition to EMC parallels
  - Constant communication allowed research team to address key issues during parallels
  - Transition from research code to operations was achieved in 9 months



New Physics

Old Physics

NCEP Great Lakes Wave Models, Forecasts during Post-Tropical Storm Sandy, Oct 2012

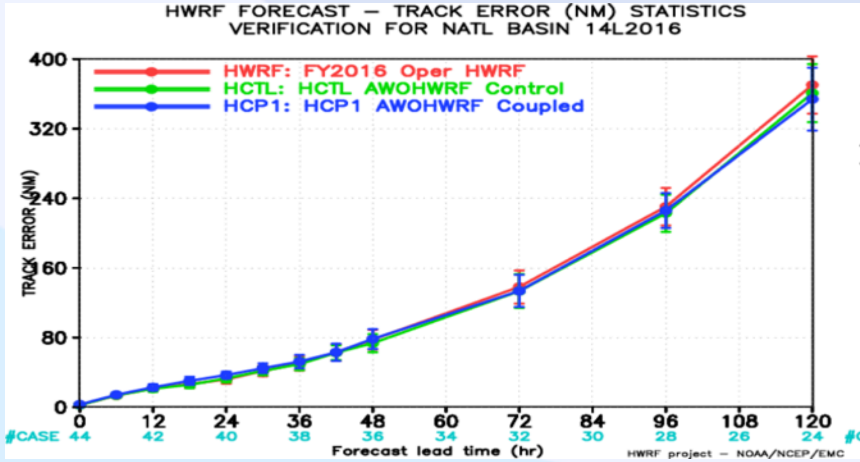


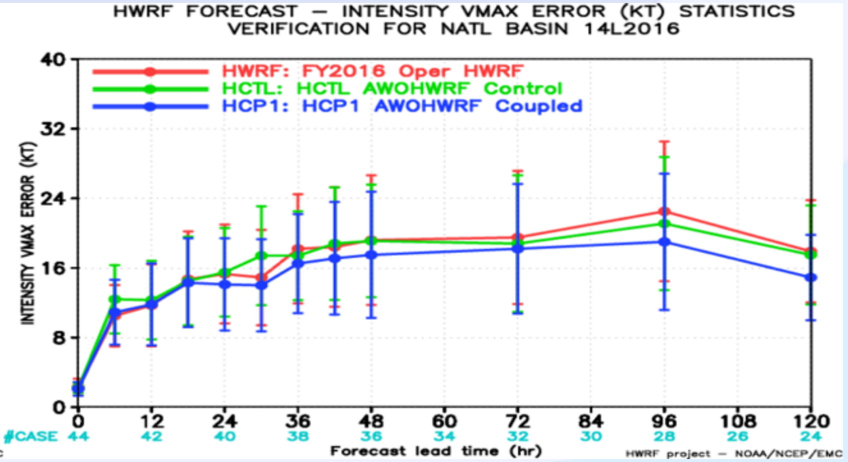
* EMC Parallel better, awaiting implementation

Example 2 – Wave – Hurricane coupling

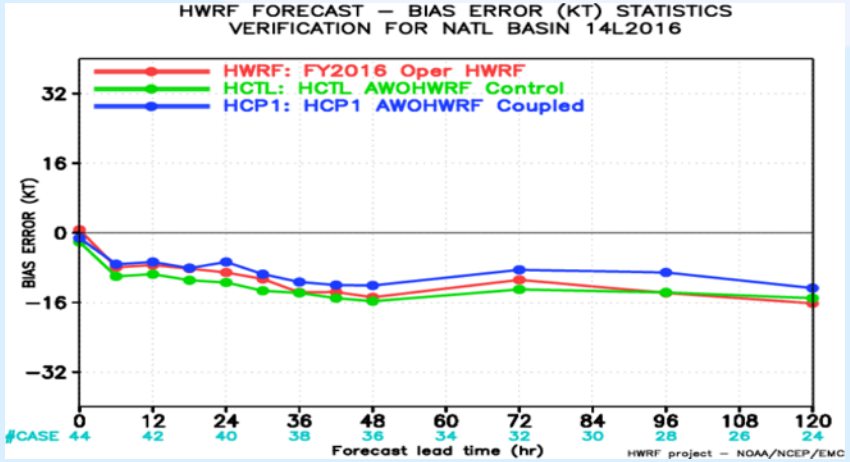
- Initial development was PhD thesis at University of Rhode Island
- Development work was done using a public release version (v 2.22) of the code not in repository
- Development team worked with NCEP code managers to bring their changes into WAVEWATCH III repository
- Coupled wave – hurricane tests running at EMC within 6 months
- In operations now we have one way coupled wave – hurricane models
  - Allowed us to retire stand alone hurricane winds driven wave models
- Next year development plans include two – way coupled wave – hurricane models

AWO coupling for Matthew





Operational HWRF
Control
Coupled



New Features in WAVEWATCH III since NOPP

- I/O
  - Expanded list of output parameters
  - Netcdf option
- Numerical
  - Multiple grid types (curvilinear, unstructured, SMC, tripolar etc.)
  - Second order advection scheme
  - Implicit propagation
- Physics packages
  - New growth / dissipation packages
  - Wave – mud and wave – ice dissipation
  - Moveable bed friction
  - New non linear interactions term (multiple DIA, TSA)
  - Tracking wave partitions
- Coupling capability
  - Multiple coupling infrastructure (NEMS/NUOPC, OASIS)
  - Wave – atmosphere coupling physics
  - Wave – ocean coupling physics

WAVEWATCH III development partners today

- IFREMER
- UKMO
- ENVIRONMENT CANADA
- NRL
- ECMWF
- USACE
- Swinburne University
- University of Rhode Island
- University of Melbourne
- FNMOC
- GFDL
- USGS
- NOS
- BIO

Final Remarks

- Our experiences in working with NOPP and setting up the community development platform for WAVEWATCH III has shown us that for successful transition from R2O we need
  - A common code base for development with strict rules that are enforced
  - Clear two – way communication between EMC and the researchers
  - Development to be tested in conditions pertaining to operational needs (as far as possible)
- A smoothly functioning R2O pathway is extremely beneficial to EMC (in significantly reducing the time it takes to bring research ideas into operations) as well as the developers (to see their work being implemented in operations)
- Of the 7 research proposals funded under NOPP, 2 worked directly with the WAVEWATCH III code base. These are now used in operations at BOM, INCOIS, UKMO, METEO-FRANCE, ENVIRONMENT CANADA, ECMWF and more