2016 Upgraded NWS GFDL Hurricane Forecast System Morris Bender, Timothy Marchok and Matthew Morin NOAA/GFDL Isaac Ginis and Biju Thomas University of Rhode Island

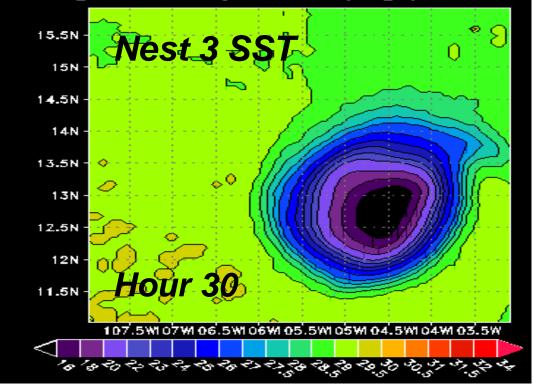
HWRF v. 10.0 / GFDL v. 14.0 Joint CCB Wednesday, May 18th , 2016, 11:30 am EMC Room 2155

2016 GFDL Scope of Changes

Changes from the 2015 GFDL model:

- Several bug fixes in SAS (Simplified Arakawa-Schubert) convection Scheme.
- Reduction in detrainment of cloud water and ice from SAS to Ferrier microphysics scheme.
- 5 minute relaxation time in tendencies of temperature and moisture in SAS Convective scheme.
- Improved representation of the initial wind profile.
- New functionality to use GFS GRIB data in lateral boundary file generation. (Reduces model run time 12-15 minutes).
- Increased Newtonian smoothing at lateral boundary (Addresses issue of sporadic model failures at lateral boundary).
- RTOFS (Real-Time Ocean Forecast System) in Eastern Pacific.
- Evaluated latest GFS PBL scheme. Improved tracks, but increased negative bias for intense storms. Withdrawn for consideration.
- The GFDL Ocean Initialization will run independently of the HWRF ocean initialization.

Hurricane Blanca (Initial time: June 3rd, 12z)

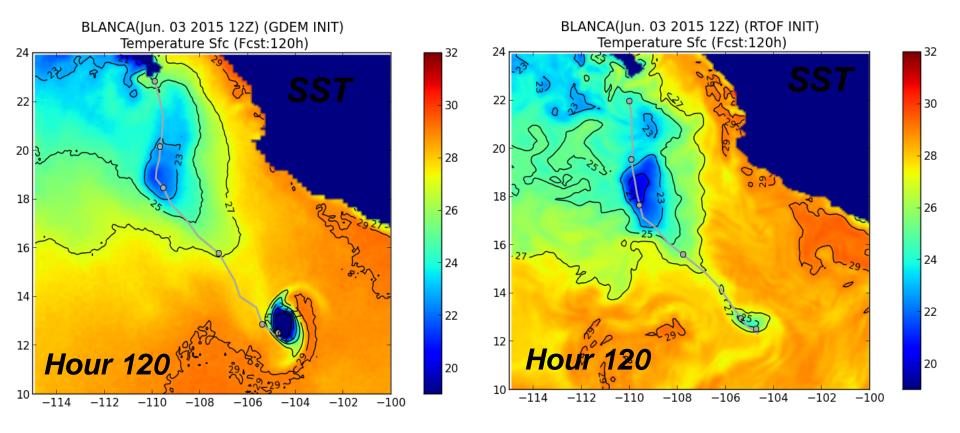


Unrealistic Cooling in Eastern Pacific Intense Hurricanes using GDEM Climatology in the GFDL/HWRF models had huge negative impacts on their respective intensity forecasts. Proposed Solution : Replace the GDEM climatology in the Eastern Pacific, with the HYCOM based global <u>Real Time Ocean Forecast</u> System (*RTOFS*).

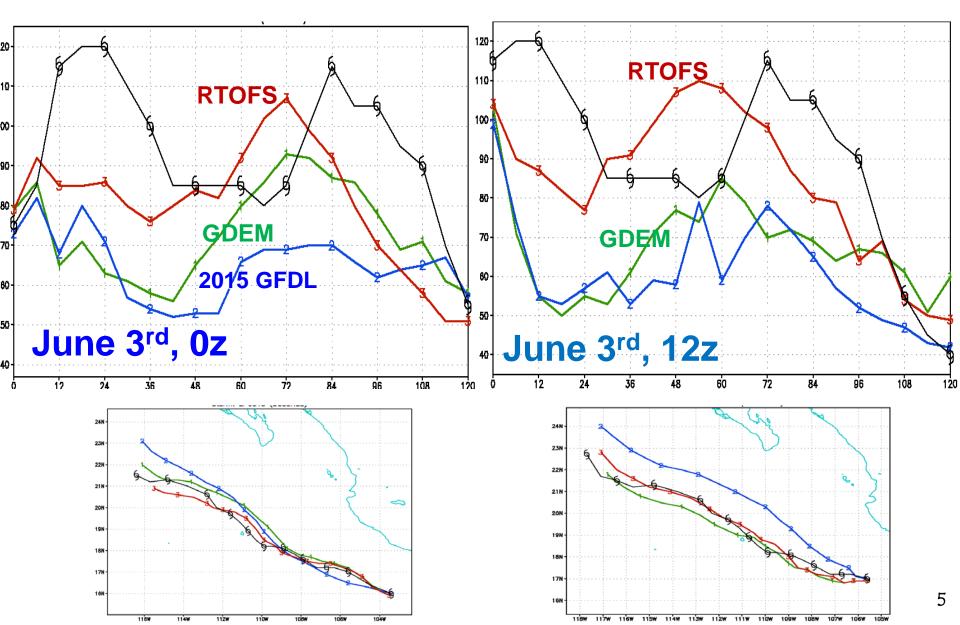
Hurricane Blanca (Initial time: June 3rd, 12z)

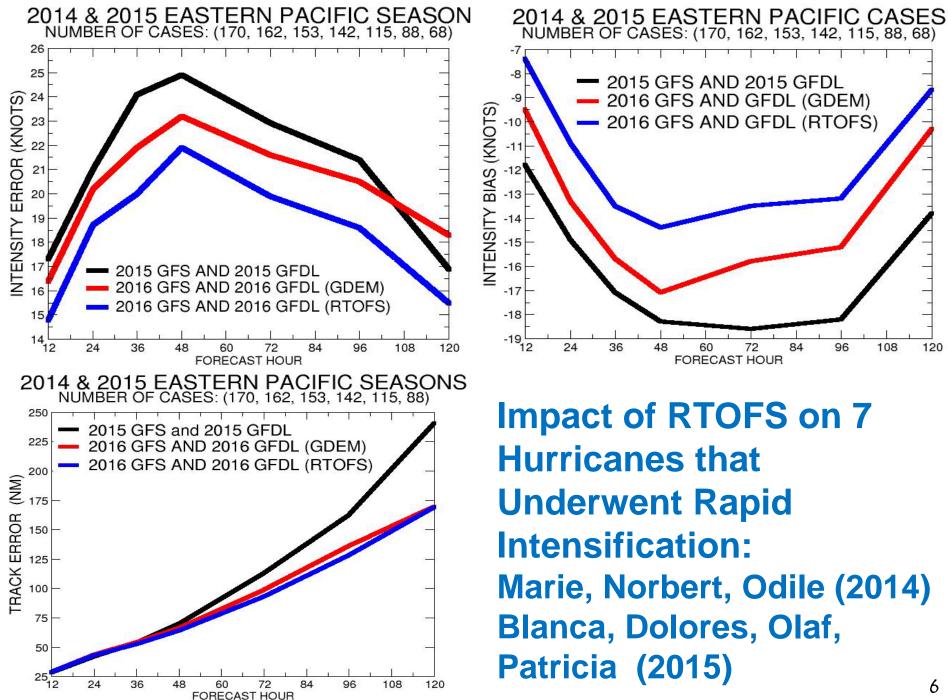
GDEM OCEAN CLIMATOLOGY

RTOFS REALTIME OCEAN ANALYSIS

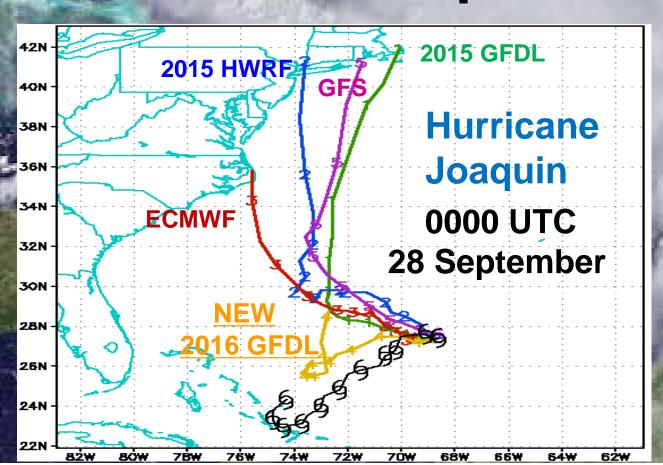


Hurricane Blanca (2015)





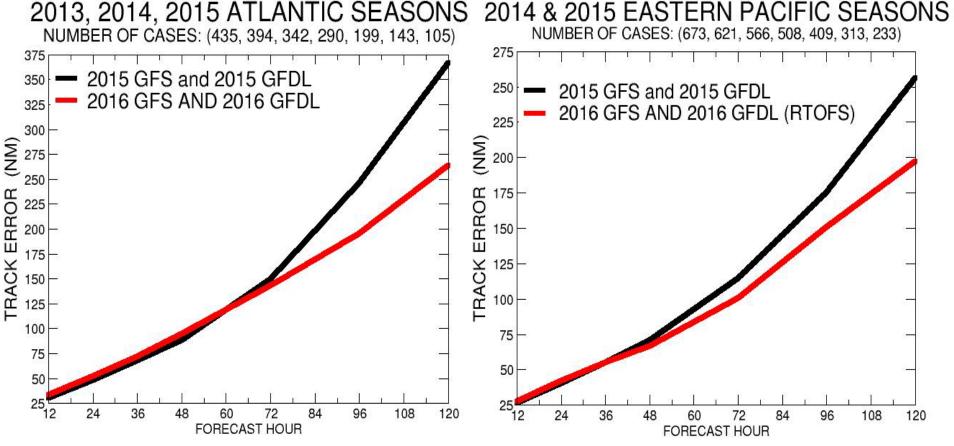
OVERALL Track and Intensity Impact



Significantly Reduced Track Error in 3-5 day forecast lead times over multiple seasons

Atlantic

Eastern Pacific



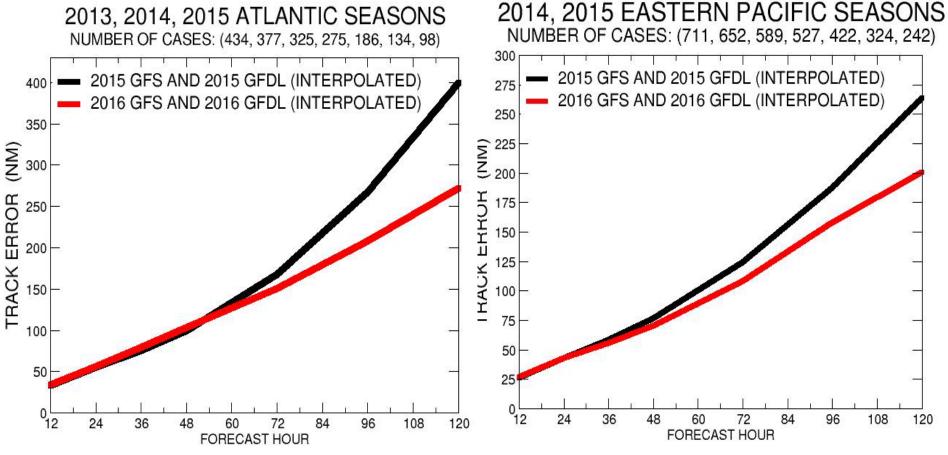
25% Reduced track Errors days 4-5

17% Reduced track Errors days 3-5

Similar Improvements for Interpolated Version

Atlantic

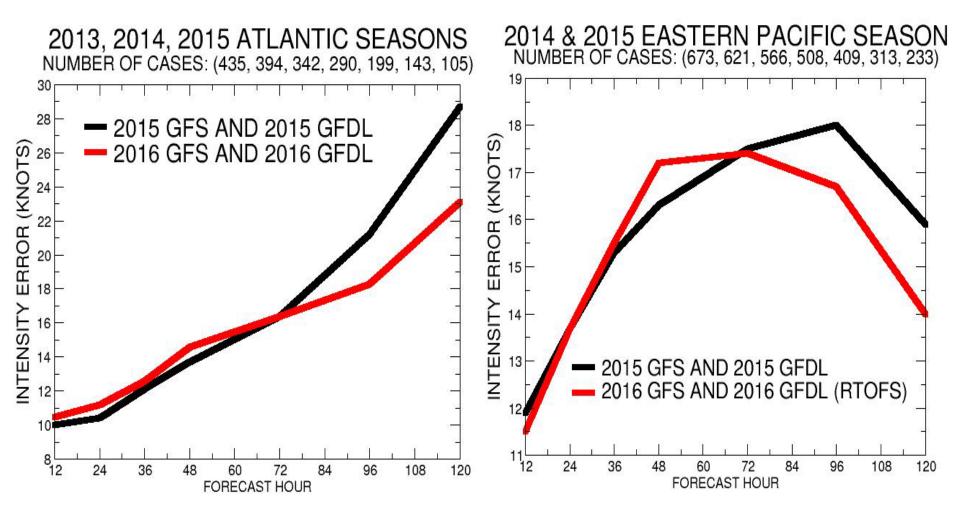
Eastern Pacific



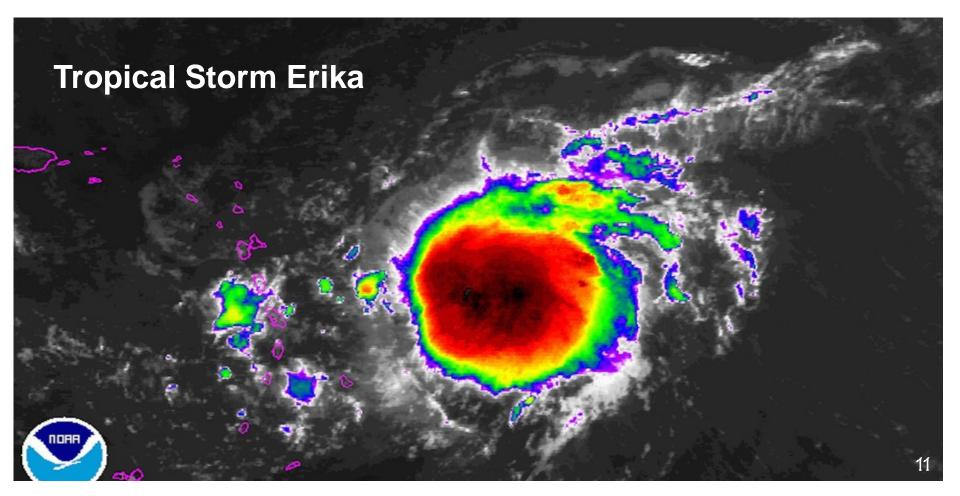
25% Reduced track Errors days 4-5

17% Reduced track Errors days 3-5

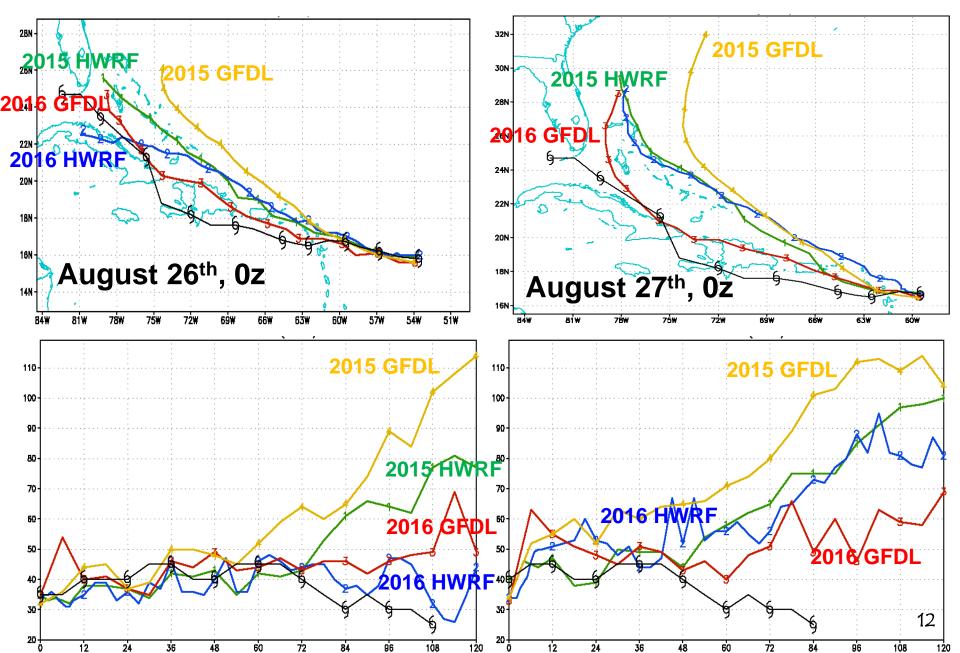
Reduced Intensity Error 3-5 day forecast lead times



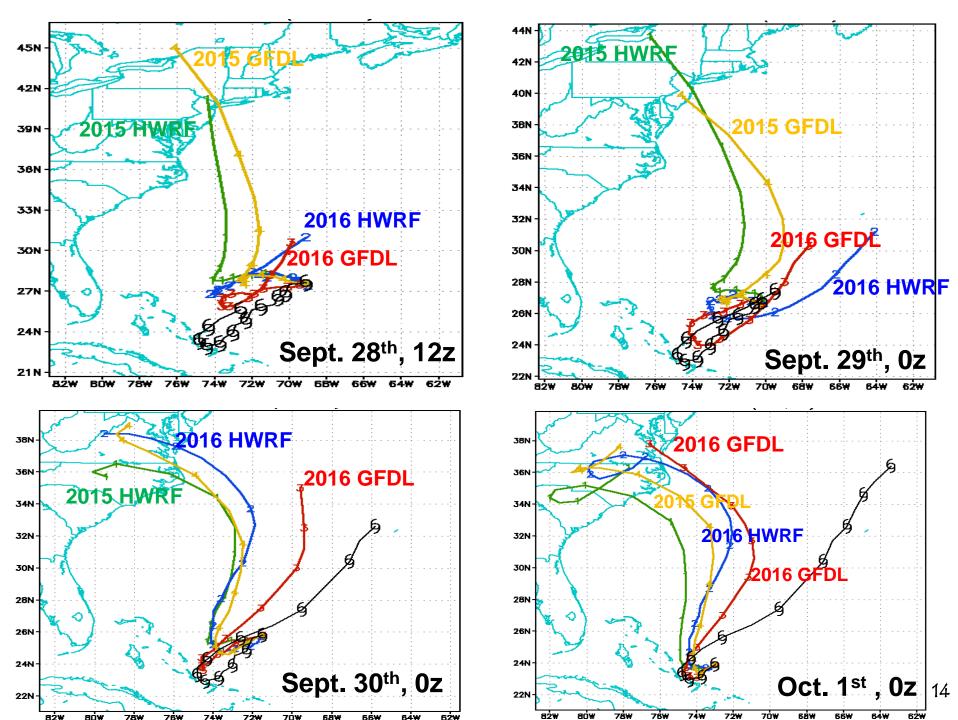
COMPARISON OF THE 2015 and 2016 GFDL AND HWRF MODELS IN THE ATLANTIC



Tropical Storm Erika (05I)

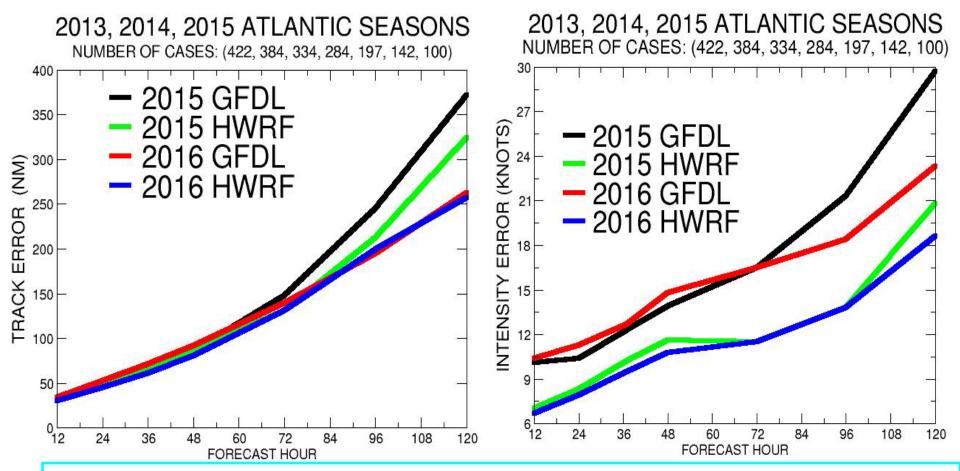


Hurricane Joaquin (11L) Impact on Track



TRACK

INTENSITY



Upgraded GFDL and HWRF models have very comparable track errors in the Atlantic Upgraded HWRF had more skillful intensity prediction

Resource and Timing Changes GFDL Forecast System

- Resource Neutral Implementation
 62 minutes for 126 forecast on CRAY
 6x6 Decomposition (45 total processors)
- 12-15 minute reduction in model run time using GRIB 2 data for lateral boundary formulation
- Will require 1 node addition resource per storm during ocean initialization since GFDL and HWRF will run independent initializations of the ocean

Recommendation of James Franklin, Acting NHC Director

NHC strongly supports this GFDL implementation.

I also understand there is some potential flexibility in the implementation date. NHC <u>strongly</u> favors the earliest possible implementation date.

As always, we greatly appreciate all of the effort and hard work that GFDL has put into improving one of our most important guidance models.

NHC RECOMMENDATION For Upgraded GFDL and HWRF

The National Hurricane Center strongly endorses the implementation of new versions of the GFDL Hurricane Model and the HWRF model for 2016. Retrospective runs of these models for the 2013, 2014, and 2015 hurricane seasons mostly show improvements to track and intensity forecasts. These improvements were as large as 15 percent in 3-5 day track forecast skill for the GFDL model in the Atlantic and eastern North Pacific basins. For the HWRF, the improvements were as large as 7 percent for 1-5 day track forecasts in the Atlantic basin.

We look forward to receiving this improved guidance for our operations, and we would like to <u>see these models</u> <u>implemented as early in this year's hurricane season as possible.</u>

Dr. Richard J Pasch Senior Hurricane Specialist National Hurricane Center



GFDL Hurricane Model V14.0.0

Project Status as of 5/10/2016

G

Project Information and Highlights

Lead: Morris Bender, GFDL and Steven Earle, NCO

Scope:

- 1. Import GFDL system on to new CRAY production machines.
- 2. Correct bug fixes in SAS (Simplified Arakawa-Schubert) convection
- 3. Modified detrainment of micro-physics in SAS convection scheme
- 4. Modified convective time scale in calling of SAS convection scheme
- 5 Increased Newtonian smoothing at lateral boundary to fix sporadic model failures over past 5 years
- 6 Improved representation of initial wind profile
- 7 Add new functionality to ingest GFS GRIB data to create lateral boundary condition. Needed to perform comprehensive testing of upgraded GFS.
- 8 RTOFS added to Eastern Pacific basin.
- 9 Evaluate performance of the GFDL model over multiple seasons with upgraded GFS

Expected Benefits: Significantly improved track & intensity forecast skill.

Issues/Risks

P Remove source of model failures during 2015 at the lateral boundary when strong tropical systems enter the integration domain.

Issues: Additional testing for 2013, 2014 and 2015 Atlantic and Eastern Pacific hurricane seasons with FY16 GFS upgrades.

Resource requirements:

- 1. Will require 1 node addition resource per storm for ocean initialization since GFDL and HWRF will run independent initializations of the ocean
- 2. Using GRIB data for lateral boundary generation, GFDL run time will be reduced 12-15 minutes with fewer nodes required in preprocessing step

<u>Risks</u>: None







Milestone (NCEP)	Date	Status
EMC testing complete	5/17/2016	
Initial Code Delivery to NCO	5/20/2016	
Technical Information Notice Issued	6/01/2016	
Initial Test Complete	6/01/2016	
CCB approval	5/18/2016	
Test with specific cases (Code Frozen)	6/20/2016	
Testing Ends	6/23/2016	
IT testing begins	6/06/2016	
IT testing ends	6/10/2016	
Management Briefing	6/30/2016	
Implementation	7/06/2016	

Scheduling



Finances

Associated Costs:

Funding Sources: GFDL Base: (2 FTE full time for 3 months); NCO Base: 1 man-month annually for maintenance

