

Tropical cyclone wind radii estimation using an empirical inland decay model

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Background

An empirical decay model (Kaplan and DeMaria 1995, 2001) has been used to predict the decrease in wind speed of landfalling tropical cyclones. The model assumes that a cyclone's maximum winds decrease exponentially with time after landfall to a non-zero background wind speed using:

$$V_t = V_b + (RV_0 - V_b)e^{-\alpha t}$$

where V_t = the maximum wind at some time t after landfall, V_0 is the landfall wind speed, V_b is the background wind speed and α is the decay constant.

DeMaria et al. (2006) recently developed a revised version of the original Kaplan and DeMaria decay model that improves the prediction for storms that cross islands and peninsulas. The new version decreases the rate of decay of landfalling storms according to the fractional area of the storm that is over land (F_m) during any given time and is given by:

$$V^{t+1} = V_b + (V^t - V_b)e^{-F_m \alpha t}$$

Real-time decay model methodology (2006)

- A wind field on a cylindrical grid with 5 km radial and 15 deg. azimuthal spacing was generated every hour along the NHC forecast track.
- The shape of the wind field was determined every hour by fitting the official NHC intensity, speed, and structure forecasts using a modified Rankine vortex.
- These wind fields were then decayed for time periods when storms were over land using the revised version of the Kaplan/DeMaria decay model (DeMaria et al. 2006).
- Estimates of the maximum wind and 64, 50 and 34 kt wind radii were then obtained every 6 h by sampling the model wind fields.

Decay model verification methodology

- Since real-time testing of the decay model did not commence until the end of September of 2006, the decay model was verified for the 11 hurricanes that made landfall in the Atlantic and E. Pacific basin since 2004.

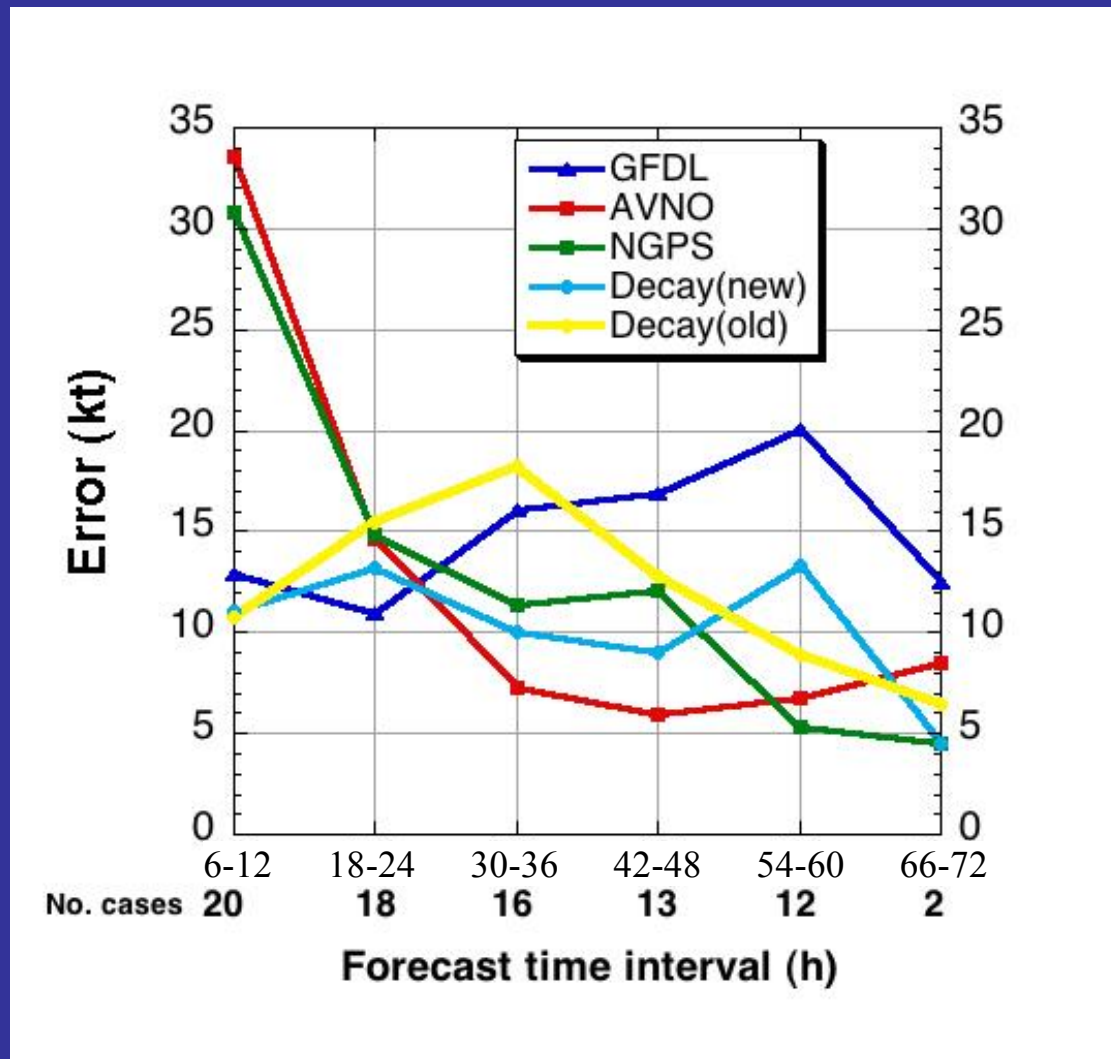
2004 - Charlie, Frances, Ivan, Jeanne

2005 - Cindy, Dennis, Katrina, Rita, Wilma

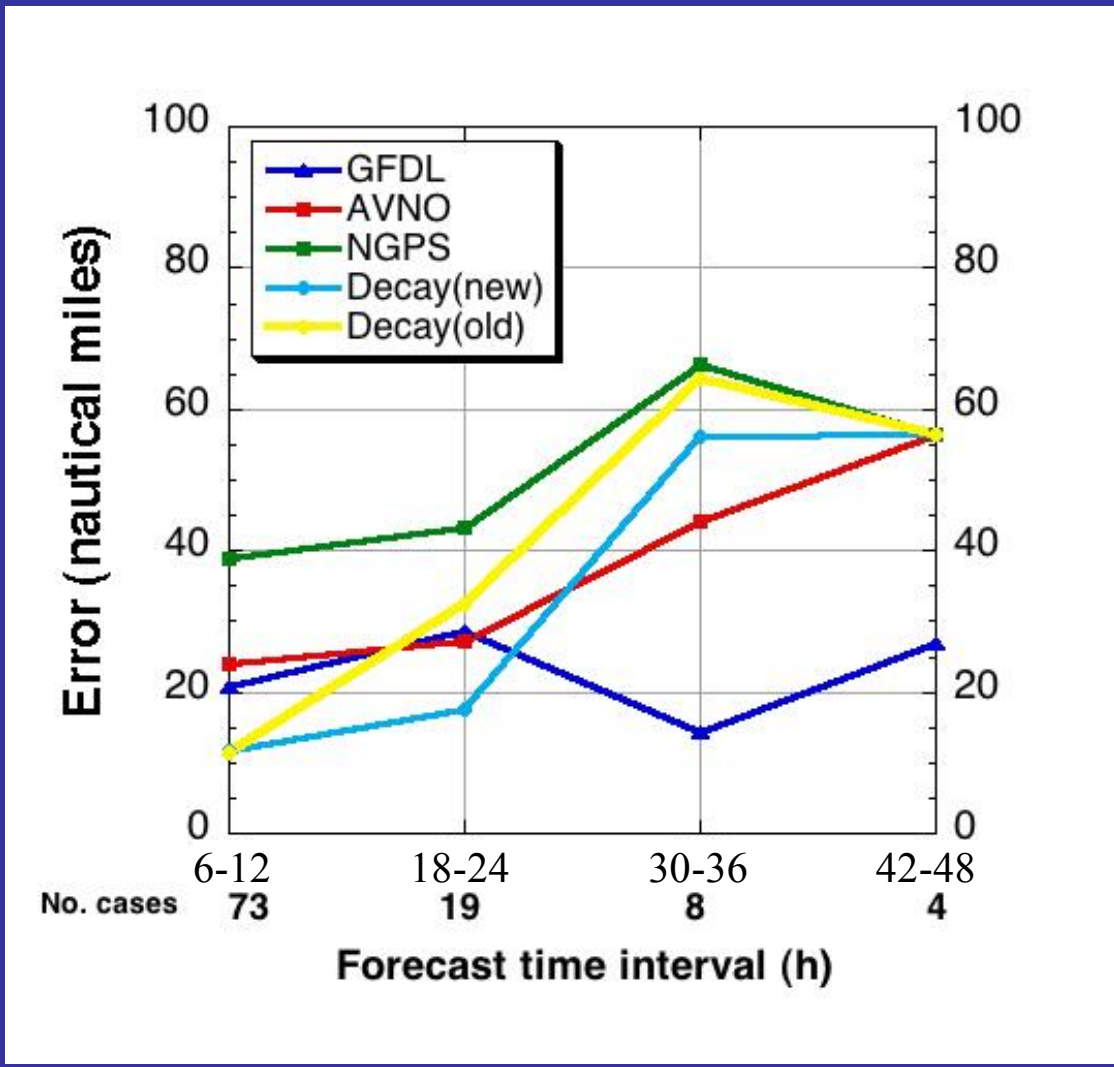
2006 - John, Lane

- Estimates of the maximum wind and 34, 50 and 64 kt winds were obtained by running the new and old version of the decay model using the NHC official forecast for forecast times that were within 12 h of landfall.
- The estimates were compared to those from the GFDL, AVN and NGPS models as well as the official forecast for time periods when the system remained tropical

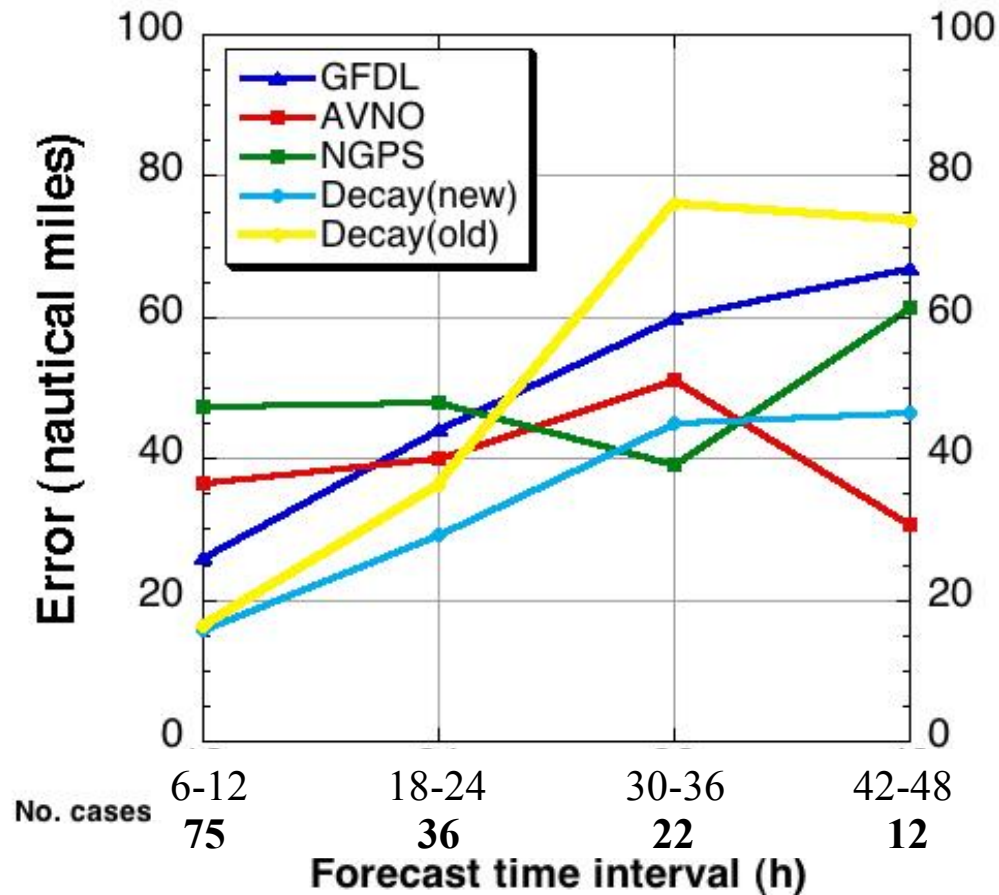
Absolute error in the model forecasted maximum wind



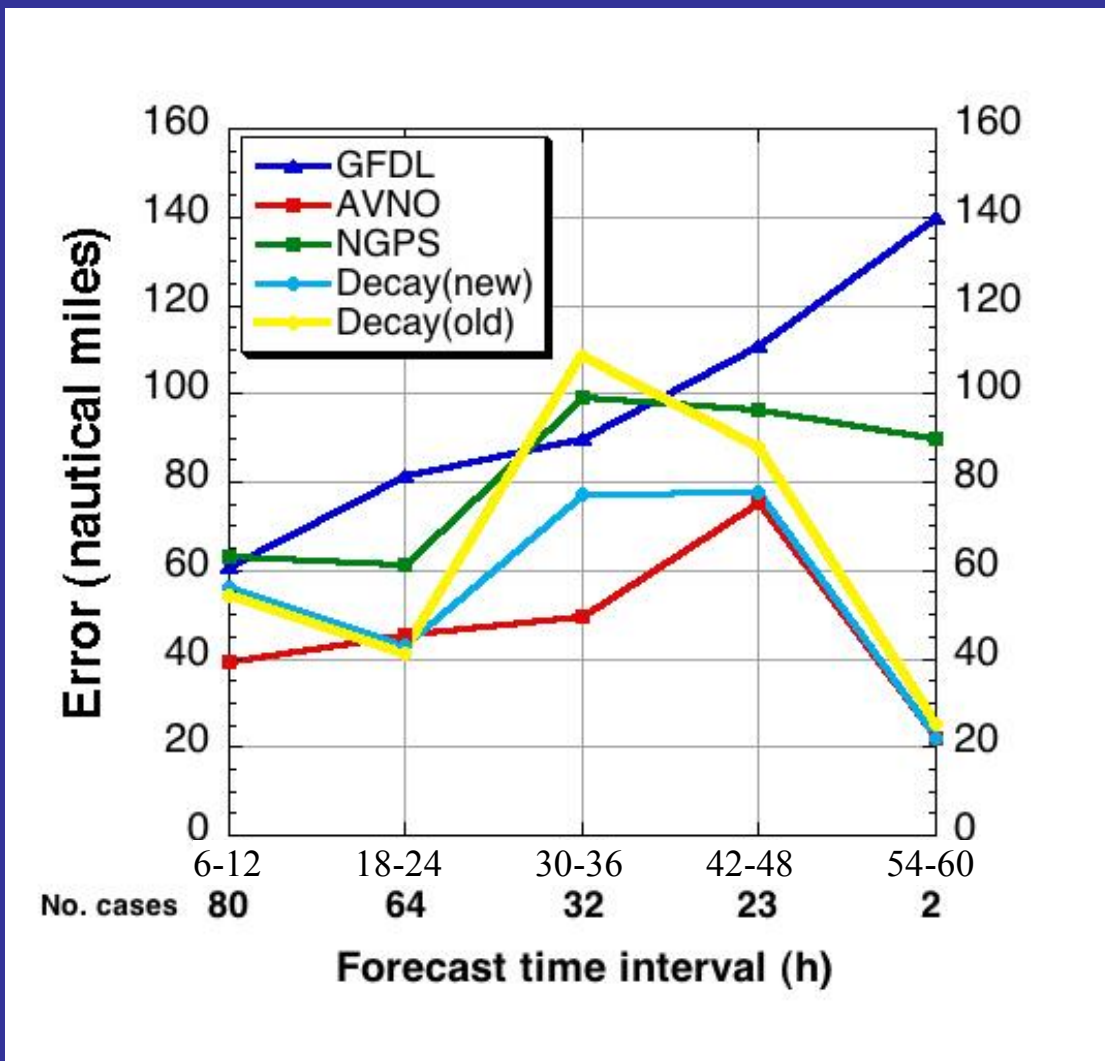
Absolute error in the model forecasted 64 kt wind radii



Absolute error in the model forecasted 50 kt wind radii



Absolute error in the model forecasted 34 kt wind radii

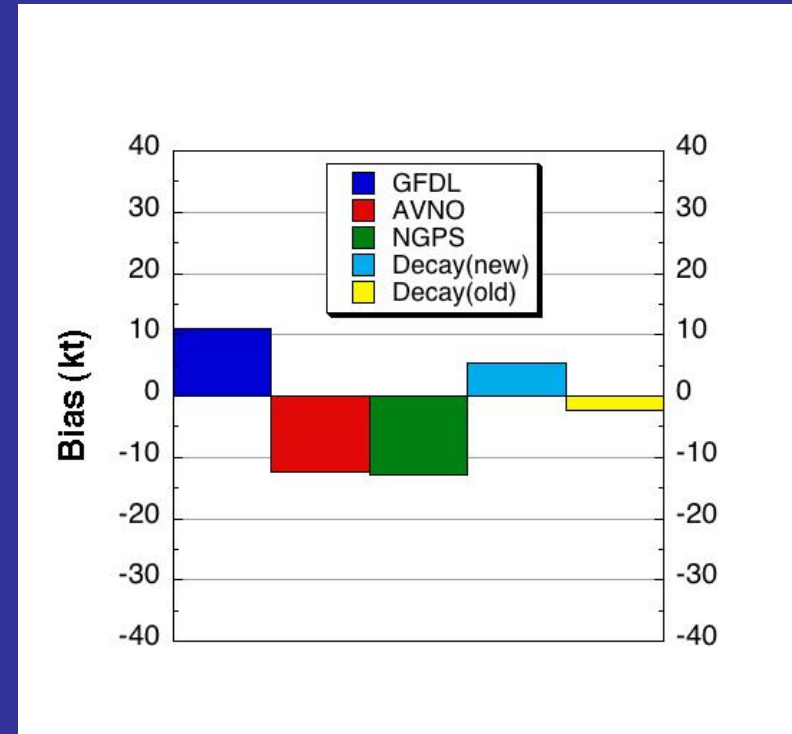
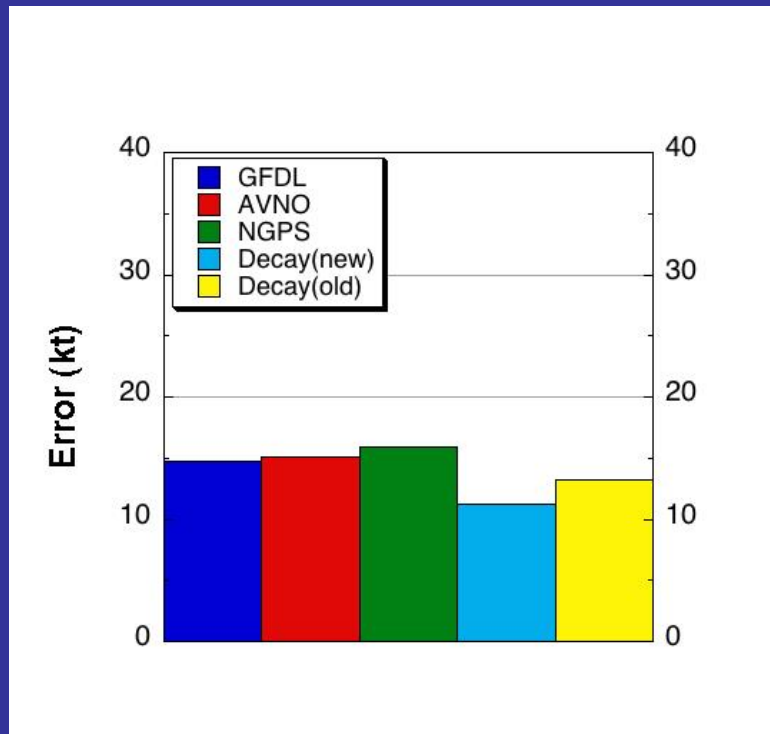


Sample mean absolute error and mean bias of the model maximum wind forecasts for all time intervals (0-72 h)

Mean Error

N=81

Mean Bias

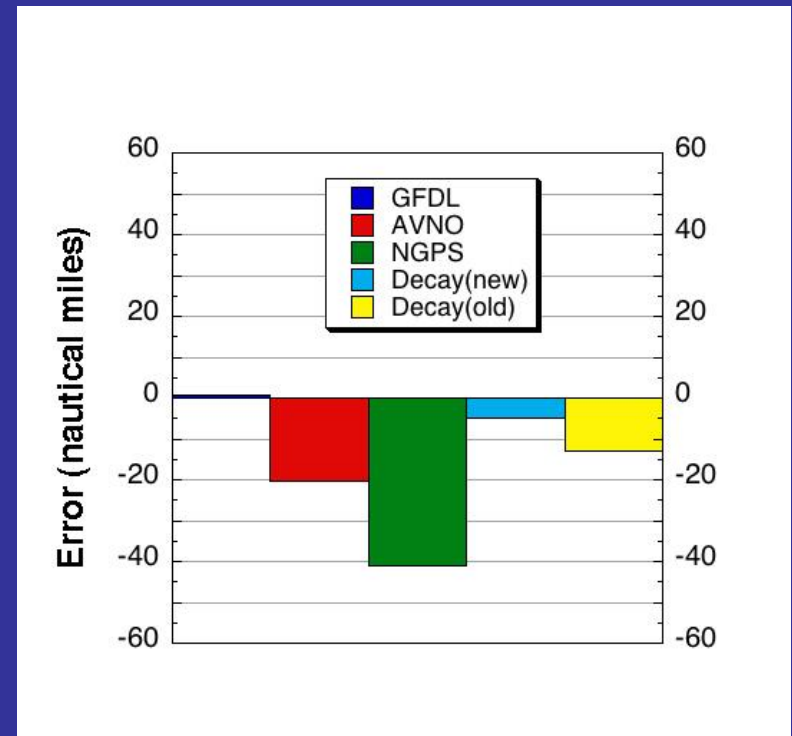
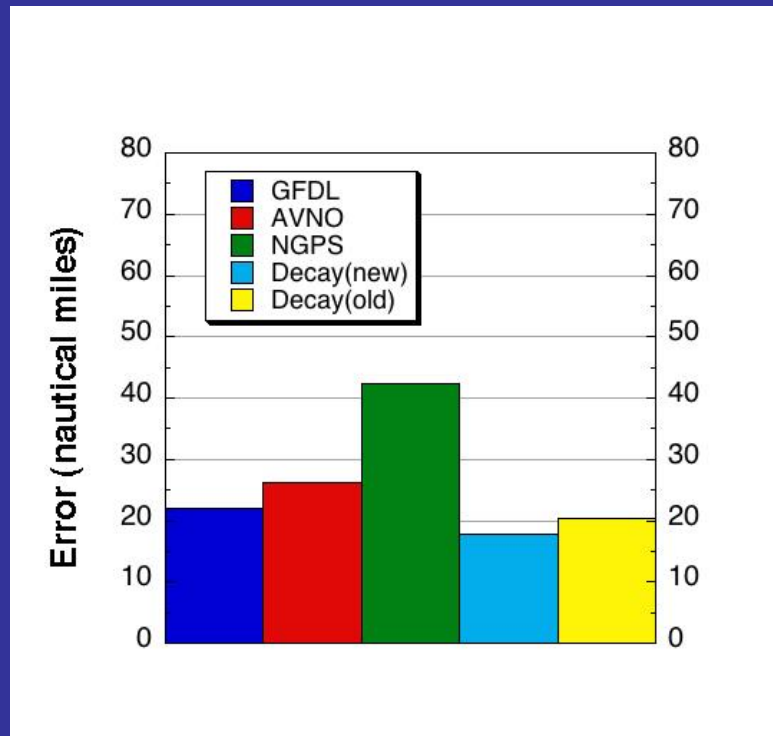


Sample mean absolute error and mean bias of the model 64 kt wind radii forecasts for all time intervals (0-72 h)

Mean error

N=104

Mean Bias

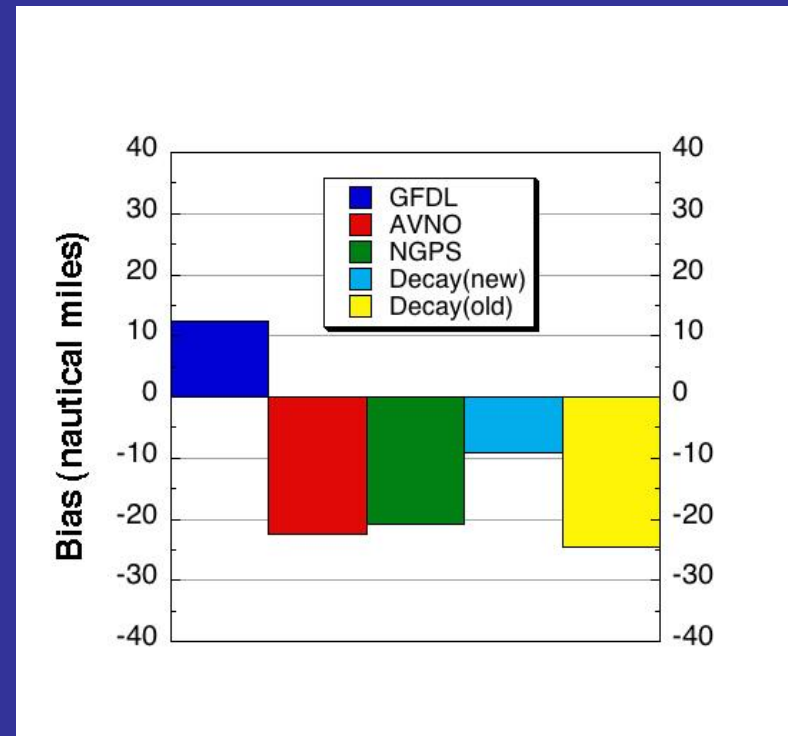
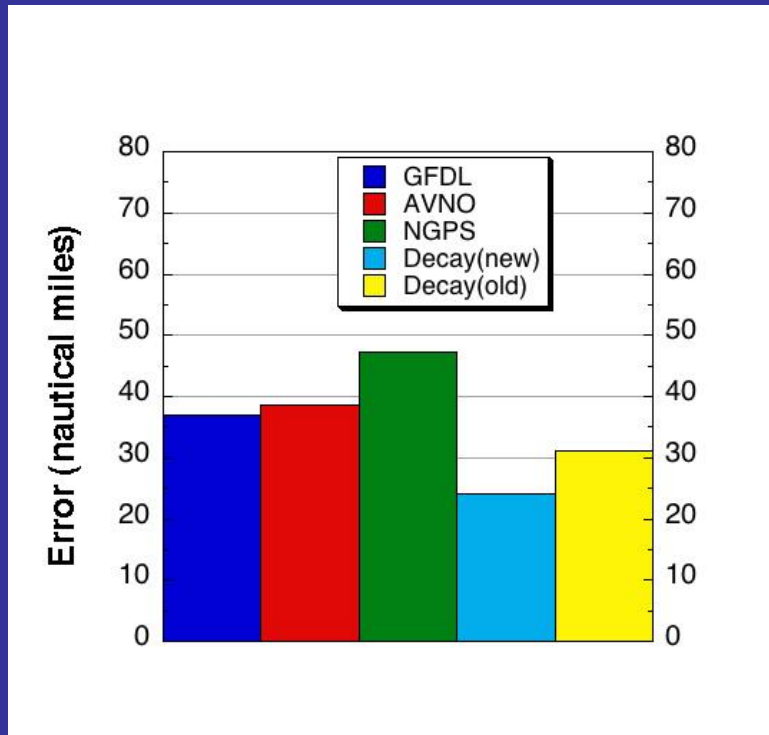


Sample mean absolute error and mean bias of the model 50 kt wind radii forecasts for all time intervals (0-72 h)

Mean error

N=145

Mean bias

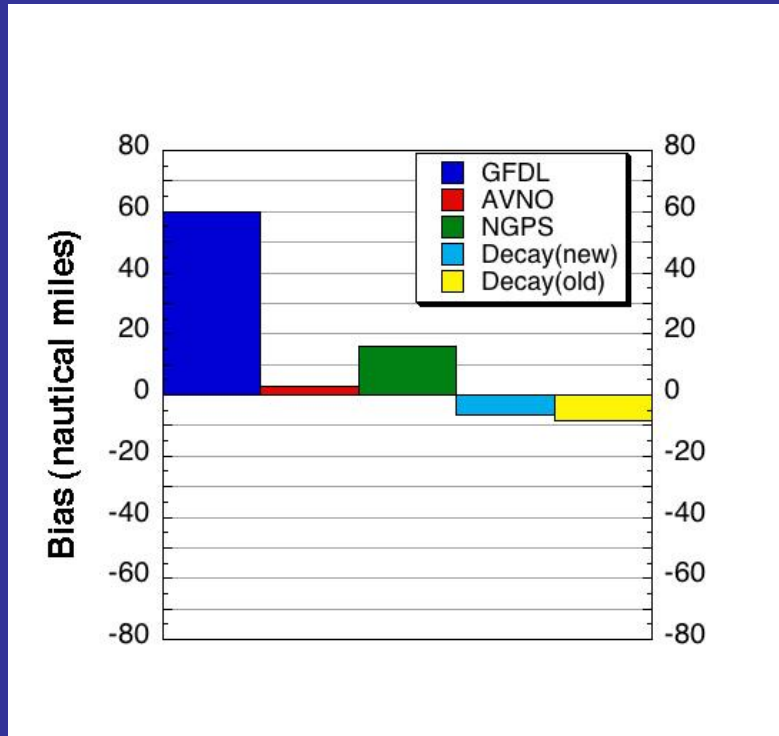
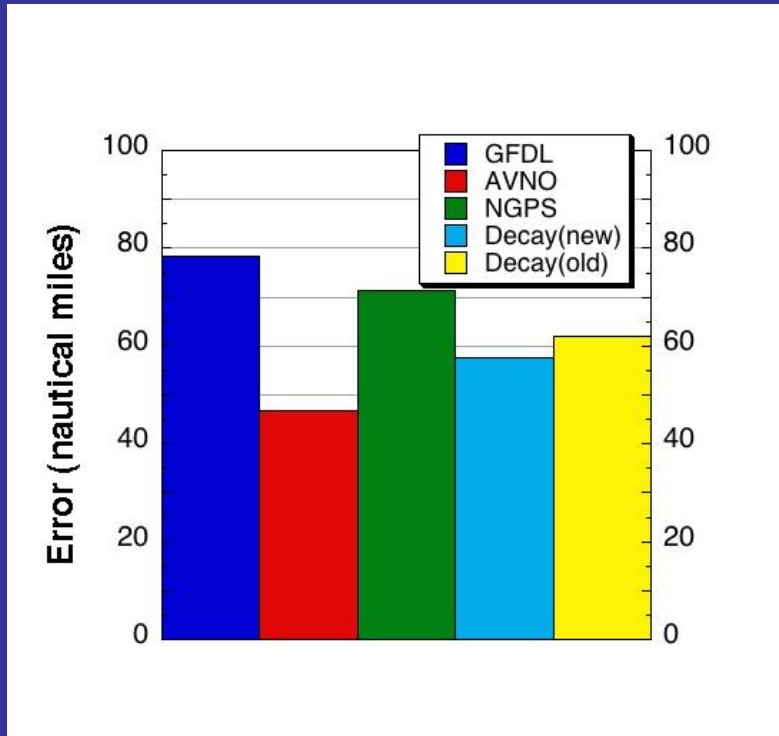


Sample mean absolute error and mean bias of the model 34 kt wind radii forecasts for all time intervals (0-72 h)

Mean Error

N=201

Mean Bias

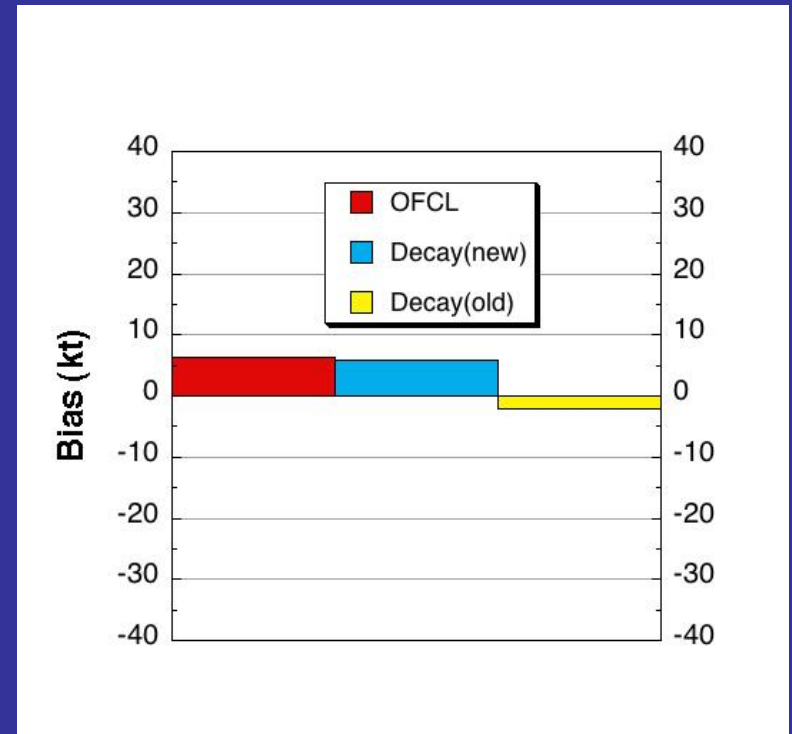
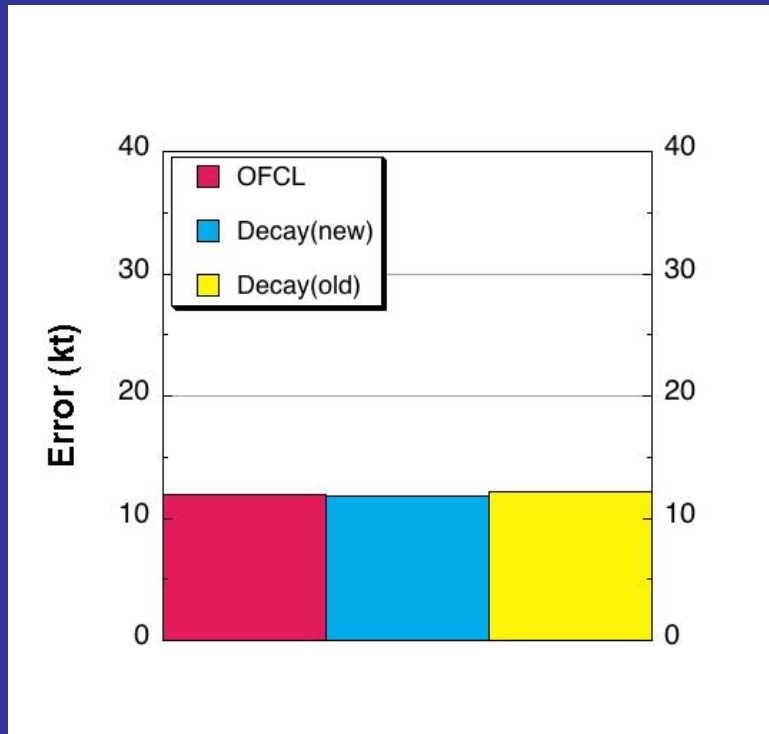


Sample mean absolute error and mean bias of the maximum wind forecasts for all time intervals (0-72 h)

Mean Error

N=36

Mean Bias

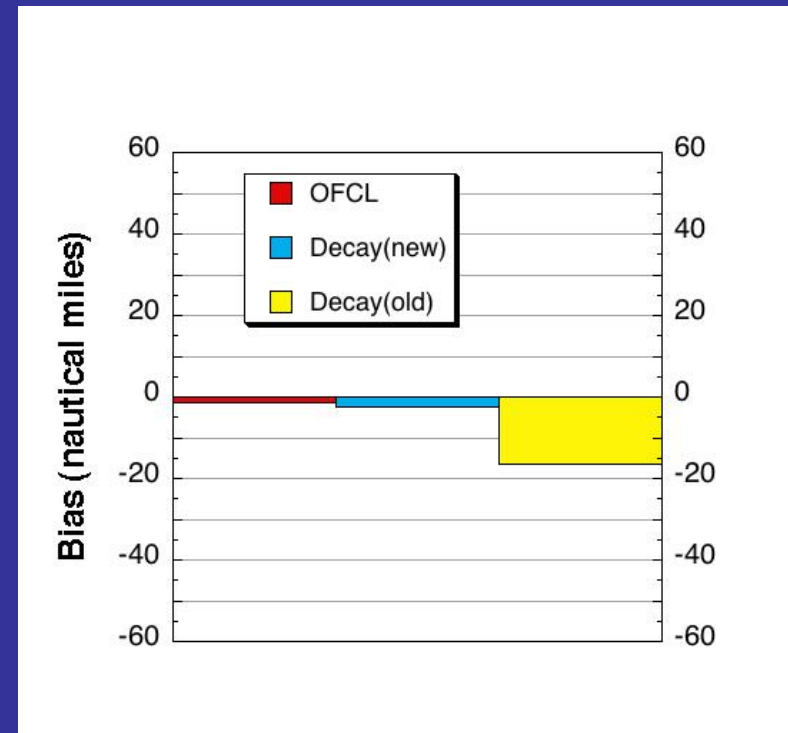
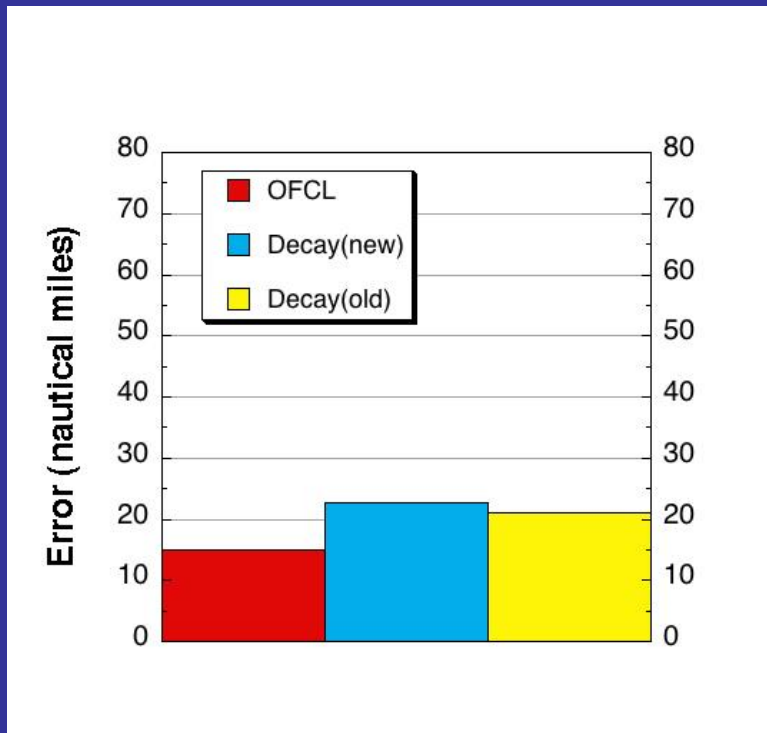


Sample mean absolute error and mean bias of the 64 kt wind radii forecasts for all time intervals (0-72 h)

Mean Error

N=39

Mean Bias

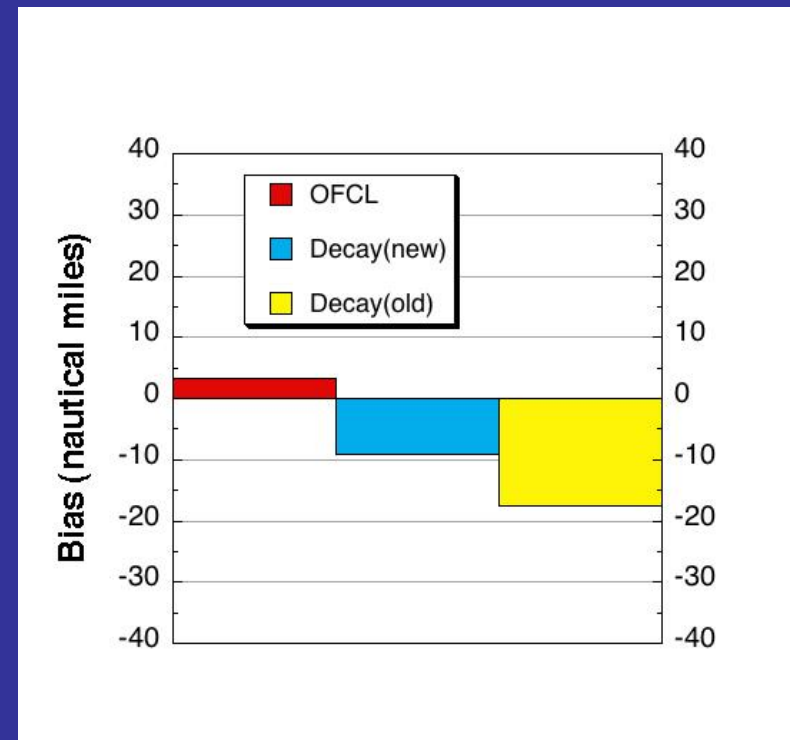
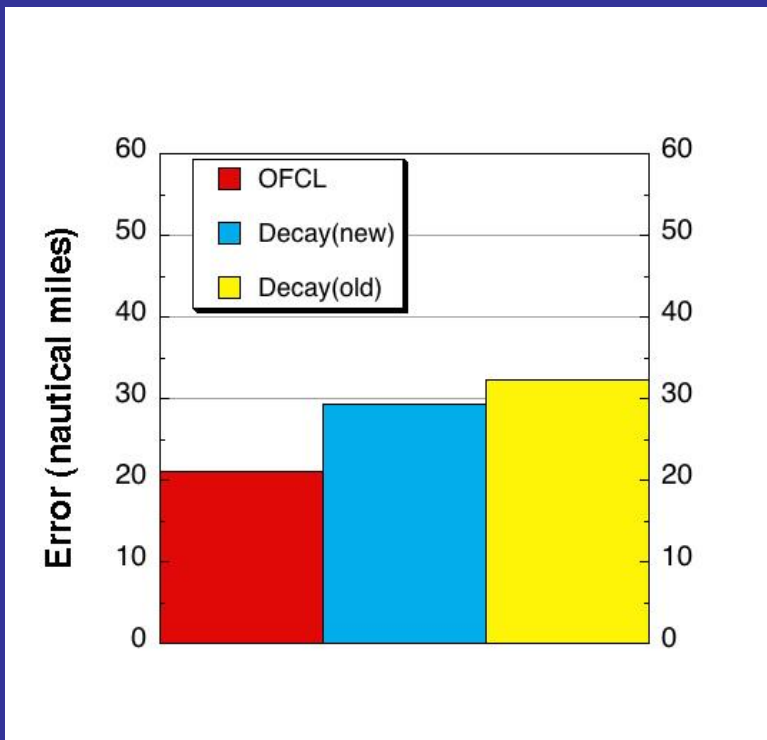


Sample mean absolute error and mean bias of the 50 kt wind radii forecasts for all time intervals (0-72 h)

Mean Error

N=66

Mean Bias

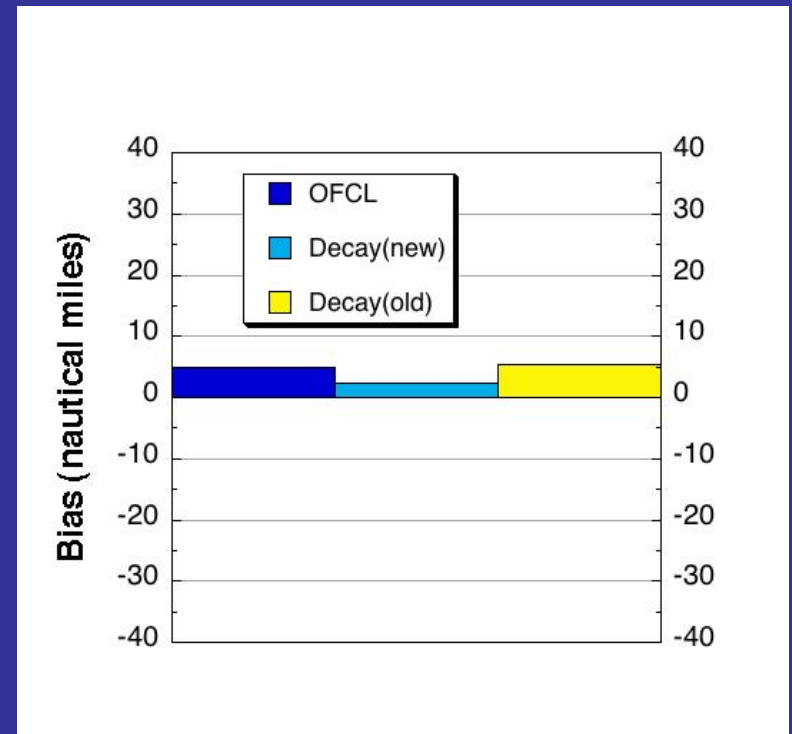
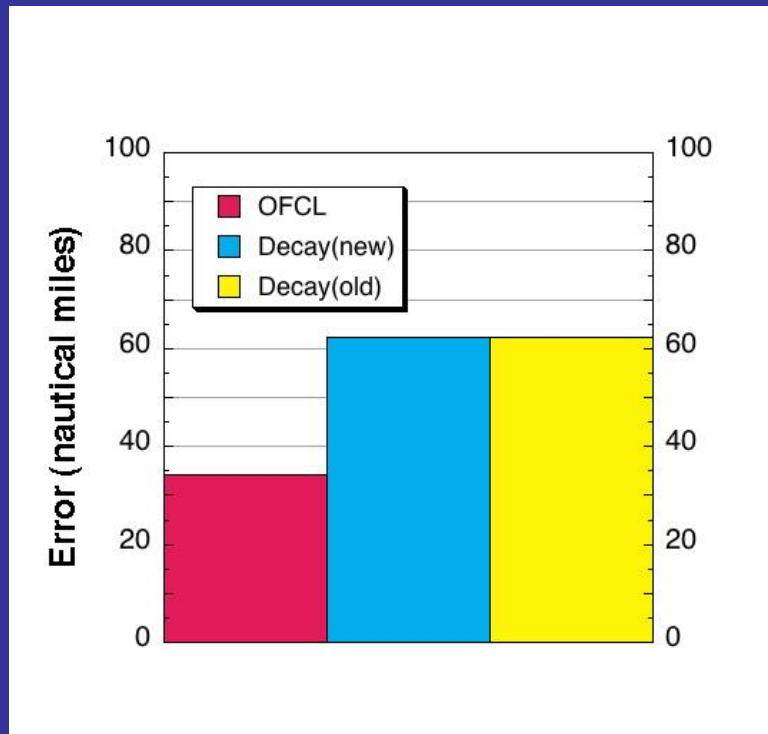


Sample mean absolute error and mean bias of the 34 kt wind radii forecasts for all time intervals (0-72 h)

Mean Error

N=91

Mean Bias



Summary

- The maximum wind, 64, 50 and 34 kt wind radii estimates were in reasonably good agreement with the best track estimates with a sample mean error of 11 kt in the maximum wind and 18 and 24 nautical miles for the 64 and 50 and wind radii, respectively. However, the 34 kt wind radii estimates were not quite as good with a mean error of 58 nautical miles.
- The decay model errors were generally lower than those of the other operational model guidance except for the 34 kt wind radii where the AVN model was superior. However, the OFCL wind radii forecasts were superior to those from the decay model while the OFCL and decay model maximum wind forecasts were similar.
- The revised version of the decay model was found to be superior to the older version
- The revised version of the decay model will be available for real-time use in the Atlantic and E. Pacific basins during the 2007 hurricane season.