

The impact of model resolution on hurricane forecasts

Glenn Greed (Met Office, UK)

Contact: glenn.greed@metoffice.gov.uk

The resolution of operational global NWP forecast models continues to increase alongside the availability of computer resources. In this report we consider the impact of further enhanced model resolution on forecasting extreme weather events such as hurricanes.

Prior to the start of the 2005 Atlantic hurricane season, a North American limited area model (NAM) was built to investigate whether a 17km, 38 level version of the Unified Model could provide improved forecast tracks and depths of hurricanes. By comparison the UK Met Office global model at the time was of resolution $0.83^{\circ} \times 0.55^{\circ}$ ¹; approximately 90km in the tropics and 60km in mid-latitudes with 38 levels. The NAM includes data assimilation (3DVAR) of all appropriate observations: Satellite, Sonde, Surface and Aireps, while the operational global model uses a superior 4DVAR scheme. Bogus observations applied to the UK Met Office global model are also applied to the NAM.

The NAM was run in real-time for the periods 24th-30th Aug 2005 and 21st-25th September 2005 during Hurricanes Katrina and Rita. Two 36-hour forecasts per day were produced, at 00z and 12z. *Resource availability prohibited NAM from running for the entire hurricane season.*

Table 1 presents the mean forecast track error from a sample of 17 forecast runs². Overall, an enhanced resolution of 17km does not improve the forecast track.

Table 1: Average forecast track error from observed track.

	T+0	T+12	T+24	T+36
Global	25km	51km	85km	117km
NAM	26km	45km	90km	121km

The track errors are similar; however there are some noticeable differences in the forecast tracks depicted in **figure 1**. For example, the global model tended to recurve Katrina too soon. Tracks from the NAM were generally to the left of those from the global model. Once Katrina became established in the Gulf of Mexico both models provided good guidance.

Unsurprisingly where enhanced resolution has a clear positive impact is in its ability to resolve deeper central pressures and stronger sustained wind speeds. For example, at 12z 29th Aug Katrina's observed pressure, near landfall, was 923mb with 110kt winds. The previous NAM forecasts valid at this time were fairly consistent: T+36 (959mb, 60kts), T+24 (962mb, 60kts) and T+12 (958mb, 62kts) **figure 2**. The corresponding global forecasts gave: T+36 (986mb, 40kts), T+24 (986mb, 39kts) and T+12 (979mb, 46kts). Observations of Rita, near landfall, at 00z 24th Sep, gave 931mb with 105kt winds. At this time the validating NAM forecasts were: T+36 (967mb, 61kts), T+24 (958mb, 68kts) and T+12 (974mb, 51kts), while the global model yielded: T+36 (990mb, 41kts), T+24 (988mb, 41kts) and T+12 (985mb, 41kts).

Enhanced resolution also yields higher precipitation totals and begins to resolve rain bands within the hurricanes matching better qualitatively with satellite and radar imagery. When Katrina made landfall, the NAM, 12z 29th Aug T+0 to T+3, forecast further intensified rainfall accumulations (**figure 3**) exceeding 128mm for the 3 hour period 12z-15z, highlighting a major rainfall event. Available station observations do not support such extreme totals in a 3hr period. For example, Newton MS, further inland, saw rain rates >25mm/hr for 3 consecutive hours later in the day, but these totalled less than 100mm. *Aside: The New Orleans Radar at 13z was registering reflectivity's between 45-50DBZ. This corresponds to rain rates of between 50 and 150mm/hr, with the Rosenfeld Tropical Z-R relationship.*

¹ The UK Met Office global model resolution was recently increased to $0.56^{\circ} \times 0.37^{\circ} \times 50$ levels, on 13th Dec 2005.

² Forecast sample includes 00z 25th-12z 29th Aug and 00z 21st-00z 24th Sep 2005 inclusive.

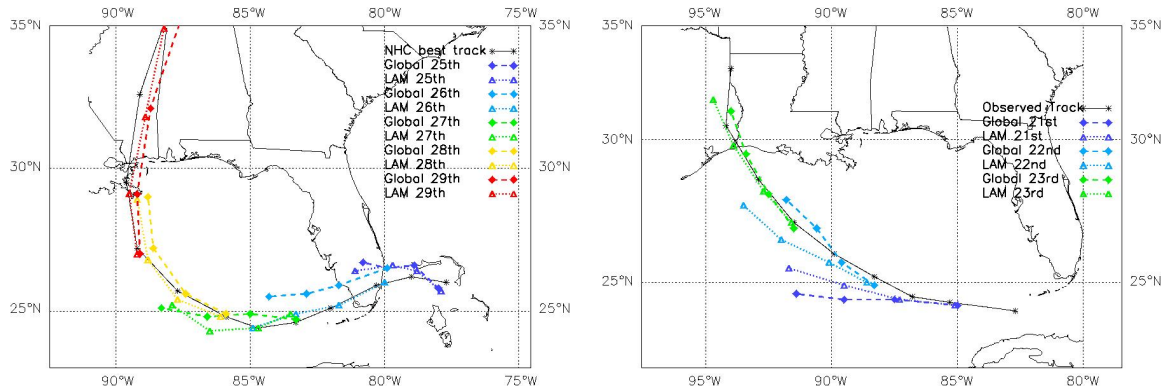


Figure 1: Daily short range T+0→T+36 forecast tracks of Katrina, 00z forecasts (left) and Rita 12z forecasts (right), comparing the global model (dashed lines) and NAM (dotted lines) with the NHC best track (solid line).

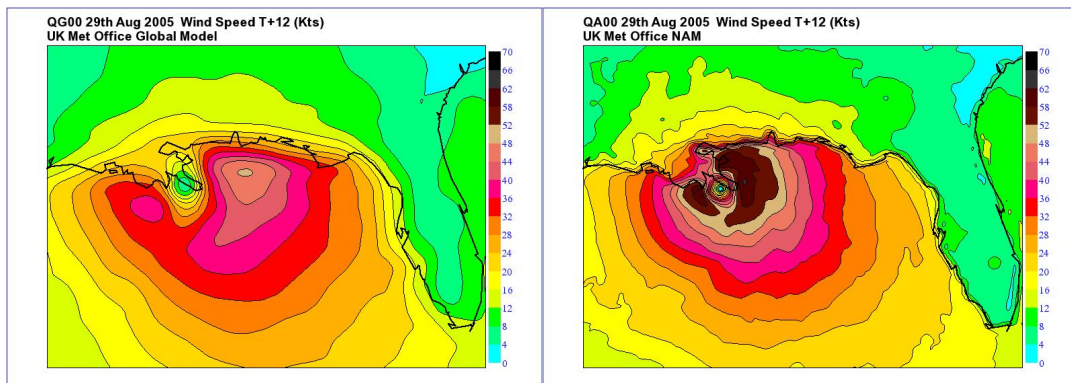


Figure 2: 00z 29th Aug 2005 T+12 forecast wind speed, global (left) and NAM (right). Observed max was 150kts.

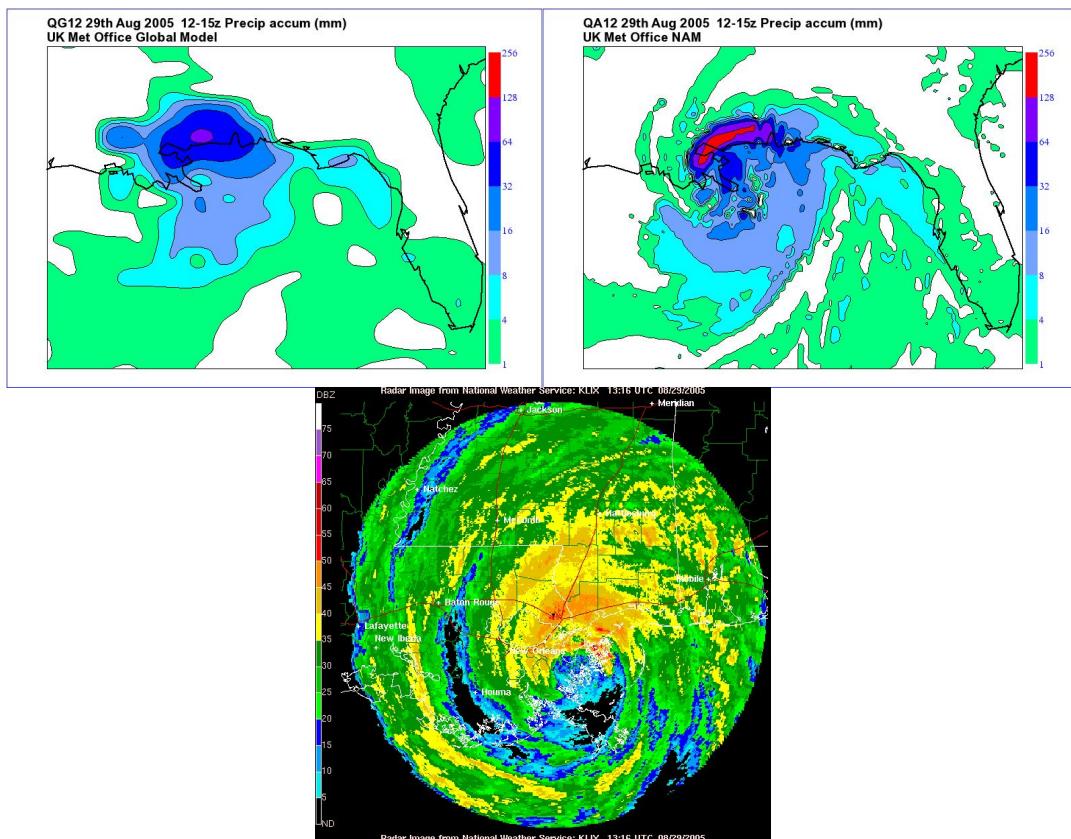


Figure 3: 3hr Precipitation accumulations 12z-15z 29Aug 2005, global (top left) max 67mm, NAM (top right) max 187mm and the New Orleans radar (c/o NOAA NWS, bottom) at 13z.