6B.3
NEW OPERATIONAL FORECASTS OF TROPICAL STORM ACTIVITY USING THE MET OFFICE DYNAMICAL SEASONAL PREDICTION MODEL

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1. A EUROPEAN FORECAST SYSTEM

Motivation for starting the new Met Office operational seasonal forecast of Atlantic tropical storms comes from recent research with European partners (ECMWF and Météo-France) and the development of a collaborative seasonal forecast system known as EUROSIP. This system shows that, for tropical storm frequency, prediction skill with dynamical systems is now challenging or even overtaking that of some well-known statistical-empirical methods (Vitart, 2006; Vitart et al. 2007).

Current dynamical seasonal forecasting systems do not have sufficient resolution to simulate the intensity and detailed structure of tropical storms. However, the larger-scale features are sufficiently realistic to allow counting of predicted storms using a parametric approach (Vitart, 2006). For example, model representations of tropical storms exhibit a warm temperature anomaly above the centre of the vortex – a characteristic of observed storms. A calibration procedure is applied, which adjusts the number of detected storms according to past model performance.

A large proportion of the inter-annual variability of North Atlantic tropical storms is associated with sea-surface temperature (SST) variability in the tropical Pacific Ocean (associated with the El Niño Southern Oscillation (ENSO) cycle) and the tropical North Atlantic. The success of the dynamical model forecasts is rooted in good prediction skill for SST in these regions and also in an ability to correctly translate predicted SST variability into variability of tropical storm frequency - through representation of ENSO impacts on Atlantic vertical wind shear and through local SST impacts (Vitart et al., 2007). Figure 1 shows the skill of EUROSIP forecasts produced in June to predict SST in August to October in the NINO3 region of the Pacific (5°N-5°S, 90°W-150°W) and the main development region of the North Atlantic (10°N-20°N, 20°W-60°W). Figure 2 shows the corresponding predictions of Atlantic tropical storm numbers.

Advantages for the dynamical models are seen both in skill scores calculated over multi-year re-forecasts, and also in recent real-time forecasts (2005 onwards). For example, the dynamical models correctly distinguished between the exceptionally active North Atlantic season of 2005 and the near-normal activity of the 2006 season unlike most statistical-empirical methods, which predicted higher values in 2006 than 2005. Table 1 shows the predicted number of storms from EUROSIP, the three constituent models of EUROSIP (ECMWF, the Met Office and Météo-France) and various statistical forecasts. It should be noted that the dynamical forecasts are for the period July to November unlike statistical forecasts which are for the whole season. Hence different observed totals are listed.

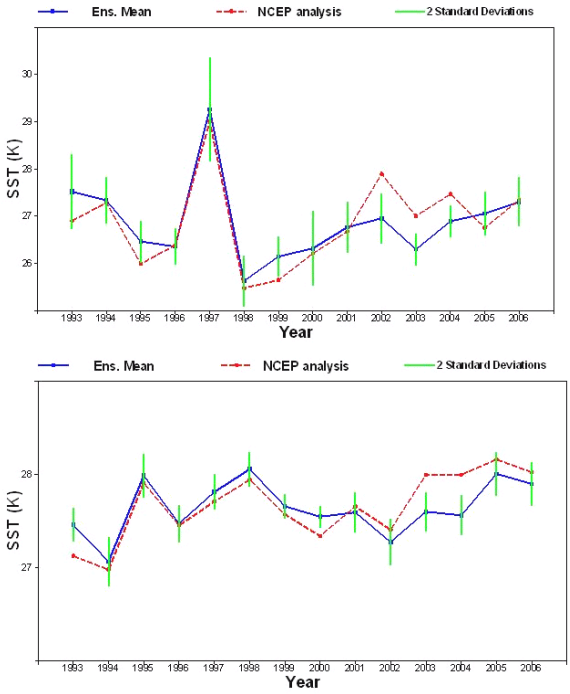

Figure 1. EUROSIP forecast of August to October SSTs from 1st June start time. NINO3 region of the Pacific (top) and main development region of the North Atlantic (bottom)

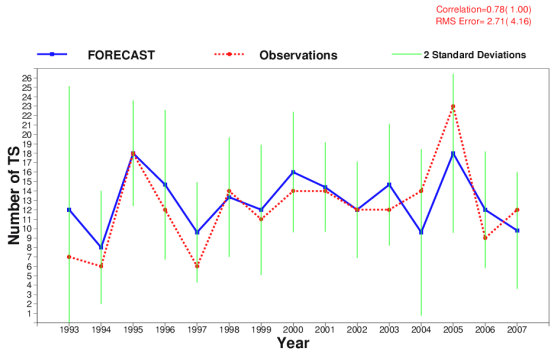

Figure 2. EUROSIP forecasts of July to November Atlantic tropical storm numbers from 1st June start time

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		2005	2006	2007
July to November	ECMWF	14.3	10.5	12.6
	Met O	15.0	10.7	9.8
	M-F	19.4	15.3	10.0
	EUROSIP	16.2	12.1	9.8*
	Observed	24	9	12
Whole Season	NOAA	12-15	13-16	13-17
	TSR	13.8	13.9	15.7
	CSU	15	17	17
	Observed	27	10	15

Table 1. Forecasts of Atlantic Storm numbers from EUROSIP and its constituent models and various statistical forecasts.
* 2007 value calculated using ensemble median rather than mean (see Vitart et al., 2007)

2. THE MET OFFICE SEASONAL FORECAST MODEL

For tropical storm prediction, the Met Office seasonal forecast model (known as GloSea) has similar skill to the EUROSIP multi-model, and potential for operational forecast products has been investigated at the Met Office using output from GloSea alone, using storm counts based on the post-processing developed by Vitart (2006). GloSea is a dynamical coupled ocean-atmosphere model run with a forecast ensemble of 41 members, each initialised with slightly varying ocean analyses to represent uncertainty in the initial state. It currently has a horizontal resolution of 2.5° x 3.75°. The ensemble of forecasts allows generation of a probability distribution for the predicted number of storms that reflects uncertainty in the forecast process.

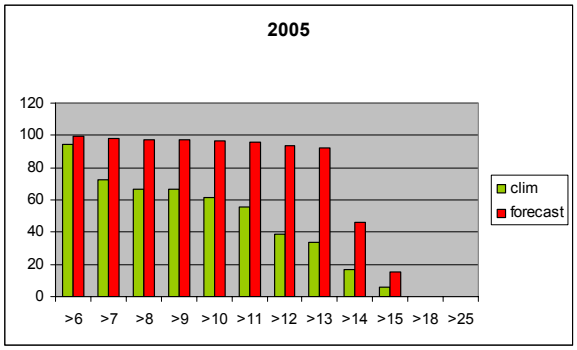

Figure 3. Cumulative probability forecast of the number of Atlantic sector named storms for July to November 2005. Bars in green represent climatological frequencies derived from 1987-2004. Bars in red are probabilities from the GloSea 41-member ensemble forecast.

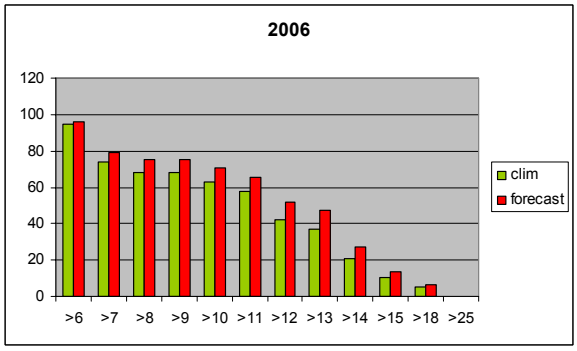

Figure 4. Cumulative probability forecast of the number of Atlantic sector named storms for July to November 2006. Bars in green represent climatological frequencies derived from 1987-2005. Bars in red are probabilities from the GloSea 41-member ensemble forecast.

Figures 3 and 4 show a probabilistic interpretation of the Met Office forecast ensembles for the 2005 and 2006 Atlantic seasons' tropical storm numbers. The deterministic predictions of storm numbers (ensemble mean) for these seasons were 15.0 and 10.7 as shown in Table 1. The model was able to distinguish between the active 2005 and near normal 2006 seasons, although of course the number of storms predicted for 2005 was still well below that observed.

In June 2007 the Met Office publicly issued, for the first time, a seasonal prediction of July to November North Atlantic tropical storm activity, using processed output from the GloSea model. Use of a dynamical prediction model distinguished this forecast from most other published or operational forecasts for the Atlantic sector, which are based on statistical-empirical methods. The forecast predicted between 7 and 13 tropical storms for the Atlantic sector in the period July to November with a headline figure of 10 tropical storms. The observed number of storms for this period was 12. A probabilistic interpretation of the forecast is shown in Figure 5.

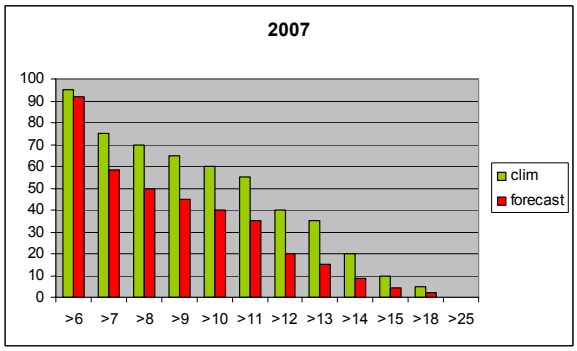

Figure 5. Cumulative probability forecast of the number of Atlantic sector named storms for July to November 2007. Bars in green represent climatological frequencies derived from 1987-2006. Bars in red are probabilities from the GloSea 41-member ensemble forecast.

Statistical forecasts were able to claim some success in predicting the number of storms in 2007 (e.g. TSR predicted 15.7 and 15 were observed in the whole season). However, the statistical forecasts grossly over-predicted other measures of tropical cyclone

activity such as storm days, hurricane days, net tropical cyclone activity and accumulated cyclone energy (ACE) index (e.g. TSR predicted an ACE index of 156, whilst a value of 70 was observed). Both TSR (Saunders & Lea, 2007) and CSU (Klotzbach & Gray, 2007) in their post-season reports cited cooler than expected SSTs in the North Atlantic for their poor predictions of net tropical storm activity in 2007. Figure 6 shows the GloSea June forecast of SST anomalies in the main development region of the North Atlantic for the period August to October. The negative SST anomalies were implicit in the GloSea prediction of storm numbers and were highlighted in the pre-season report issued in June 2007.

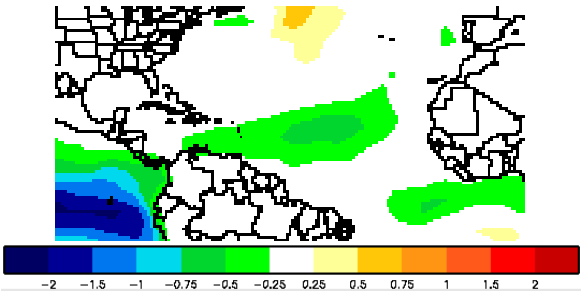

Figure 6. GloSea ensemble mean prediction of SST anomalies (°C) for the period August to October 2007 from 1st June start time

3. FUTURE DEVELOPMENTS

The unusual nature of the 2007 season (relatively high storm numbers compared to low net activity) throws up a challenge for dynamical seasonal forecast models to find ways of skilfully predicting measures of tropical cyclone activity other than just total storm numbers, as has been the case so far. Ongoing research indicates that forecasts of the ACE index may show some skill and may be issued in future forecasts from EUROSIP and the Met Office GloSea model.

At present, the GloSea forecast lead time is constrained by the fact that the model only runs out to six months. However, production of a longer lead time skilful forecast is a goal for future research.

A major upgrade to the GloSea system is planned in 2009. The new system will be based on the HadGEM3 climate model with an increase in resolution to 1.25° x 1.875°. This will increase the potential for more detailed products such as the prediction of hurricane numbers.

The Met Office plans to release another seasonal forecast of Atlantic tropical storm numbers for the 2008 season in mid-June.

4. REFERENCES

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