Using the MJO for Predictions of Weekly TC Probabilities: An Improved Statistical Model and Comparisons with ECMWF

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1. Introduction

This poster reports on recent improvements that have been made to a statistical prediction model of weekly TC activity for the Southern Hemisphere (original version described by Leroy and Wheeler 2008), and its comparison with hindcasts from the monthly ECMWF system (Vitart et al. 2010). The MJO provides an important component of TC predictability on this time scale (Fig.1), allowing for skilful probabilistic forecasts out to ~week 3. However, the relationship of TC activity with the seasonal cycle and other modes of intraseasonal to interannual variability is also important.

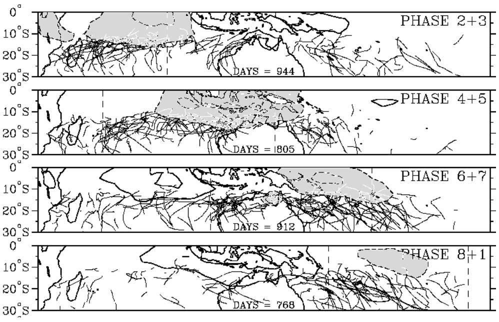

Fig.1. Relationship of TC tracks with MJO phase, as defined with the RMM index of Wheeler and Hendon (2004). Shading shows MJO OLR anomalies.

2. Improvement #1 – a new grid

The original statistical model was developed for just four large regions across the Southern Hemisphere. The new model uses a grid of multiple smaller overlapping regions (Fig.2), which allows for the predictions to be displayed as contour maps.

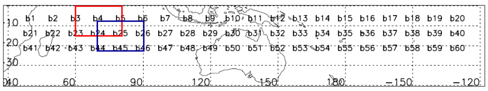

Fig.2. Definition of grid, composed of 60 overlapping regions that are each sized 20° longitude x 15°latitude.

As in Leroy and Wheeler (2008), logistic regression is used to relate the weekly variability of TCs in each overlapping region with the defined predictors.

3. Improvement #2 – new predictors

Previously we used five predictors: one representing the climatological seasonal cycle of TC activity in each region; two to represent the MJO, notably RMM1 and RMM2 (Wheeler and Hendon 2004); and two representing interannual variations in SST in the Indo-Pacific derived from EOFs. A different logistic regression equation was derived for each region and for each forecast lead: week1, week2, week3, etc..

Owing to a substantial trend in the original SST predictors which is not reflected by an observable trend in TC activity, the two SST predictors were replaced by (a) Nino 3.4 index, (b) Trans-Nino index (TNI), and (c) Indian Ocean Dipole mode index (DMI). A new climatological seasonal cycle of TC activity was also derived (Fig.3). The relative importance of each predictor in week 1 is in Fig.4.

4. Seasonal cycle and predictor selection order

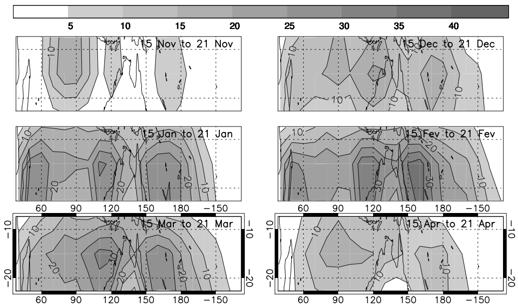

Fig.3. Climatological seasonal cycle of TC activity as derived for the new grid, expressed as the % probability of TC occurrence in each grid box.

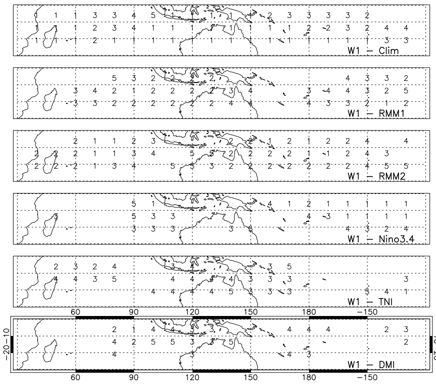

Fig.4. Order of step-wise predictor selection for each region in week 1.

5. Example forecast and web page

Forecasts are generated every day during November-April and displayed on the web at http://www.meteo.nc/espro/previcycl/cyclA.php. Maps of the Total Probability and Anomaly Probability (with respect to the seasonal cycle) are displayed (e.g. Fig.5). The web page also provide forecasts as a time series for each grid box.

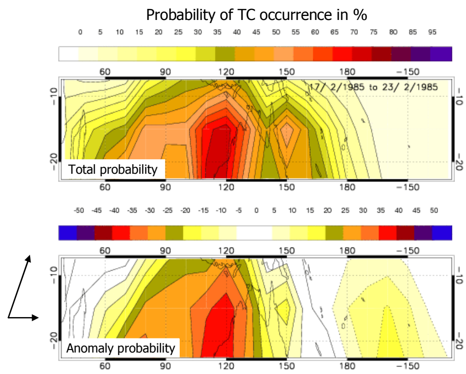

Fig.5. Hindcast generated using input data from 15th February 1985, showing the "week 1" forecast for the period 17th -23rd February. The MJO was in Phase 4 at the initial time.

6. Comparison with forecasts from ECMWF dynamical monthly forecast system

The ECMWF monthly system has been shown to realistically represent the impact of the MJO on TCs (Vitart 2009), hence it is of interest to make a comparison. Hindcasts were compared for the common 20-year period 1989-2008. The dynamical model hindcasts consist of an ensemble of 15 members integrated from the 15th of each month. Version Cy32r3 of the ECMWF system was used (T399/T255 resolution). TC-like vortices are tracked in the model and the ensemble is used to generate the probabilistic TC forecasts. (The ECMWF TC forecasts are not yet available in real time.)

Raw ECMWF output produces about 30% too many TCs, so a simple calibration was applied to reduce its forecast probabilities. The Calibrated ECMWF forecasts were found to display higher Brier skill scores than the statistical model during the first 3 weeks (Table 1), although the statistical model is more reliable (Fig.6).

Best skill and reliability was achieved from a simple multi-model combination of the statistical and dynamical forecasts (not shown). Thus the statistical model serves as a useful benchmark and as a component of multi-model combinations.

	CLIM	Var. CLIM	STAT	ECMWF	CECMWF
Week 1	0.	0.032	0.096	0.20	0.26
		+/- 0.05	*+/- 0.042*	*+/- 0.04*	*+/- 0.038*
Week 2	0.	0.067	0.096	0.025	0.13
		+/- 0.03	*+/- 0.038*	*+/- 0.038*	*+/-0.038*
Week 3	0.	0.046	0.04	0.038	0.085
		+/- 0.038	*+/- 0.04*	*+/- 0.035*	*+/-0.038*

Table 1. Brier skill scores as a function of forecast week for: the mean climatology (CLIM); the seasonal cycle climatology (Var. CLIM); the statistical model (STAT); the raw ECMWF output; and calibrated ECMWF (CECMWF). All grid boxes from Fig.1 were used. The numbers in italic represent the 95% interval of confidence.

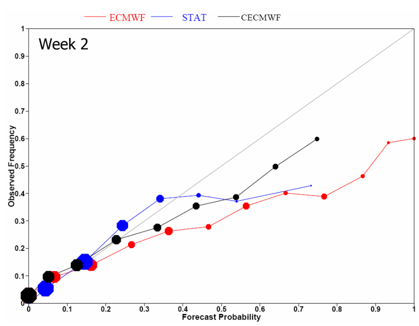

Figure 6. Reliability diagrams for the week 2 forecasts generated at all grid locations. Blue line for statistical model, red for uncalibrated ECMWF, and black for calibrated ECMWF. The area of each octagon is proportional to the number of cases populating that bin.

References

Leroy, A., and M.C. Wheeler, 2008: Statistical prediction of weekly tropical cyclone activity in the Southern Hemisphere. *Mon Wea. Rev.*, **136**, 3637-3654.

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