2A.2 SEASONAL PREDICTION OF NW PACIFIC TYPHOONS

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1. INTRODUCTION

The NW Pacific hosts an average of 17 typhoons per annum of which approximately 8 reach at least category 3 strength (referred to as "intense" hereafter). However, in any given year typhoon numbers can vary by a factor of 2.5 and intense numbers can vary by a factor of 5. Considering that windstorms are the most damaging and deadly natural peril, this variability gives rise to considerable uncertainty and risk. This paper describes the successful prediction scheme developed by Tropical Storm Risk.com (TSR) to reduce this uncertainty, together with its forecasts for the 2002 season.

2. PREDICTANDS AND PREDICTORS

Pacific typhoon track data was provided by Neumann [pers. comm.] and updated with information from the Joint Typhoon Warning Center website. Each storm was assigned with its highest 1-minute sustained wind speed achieved west of the dateline and converted into standard typhoon categories. The predictands comprised the annual totals of typhoons and intense typhoons.

The predictor field consisted of global sea surface temperature (SST) data obtained from the NCEP/NCAR 40-year reanalysis project (Kalnay et al., 1996). Other environmental variables were also considered but SSTs showed the strongest and most stable links to the predictands. In particular, inter-annual variability of intense typhoon numbers in the NW Pacific show a strong positive correlation with SSTs in the Central Pacific, particularly those in the Niño 4 region (5°S - 5°N, 160°E - 150°W). This relationship is strongest in August and September, corresponding to the onset of the main typhoon season. Furthermore, figure 1 shows this relationship is relatively stable over subsections of the data.

3. METHODOLOGY

The TSR forecast methodology centres around forecasting SST anomalies in the Niño 4 region ahead of time. This is done using a modified version of the CLIPER model developed by Knaff and Landsea (1997) for Niño 3.4. Knaff and Landsea restricted their predictors to be 1, 3 and 5 month initial conditions and trends of the predictand and 3 month initial conditions

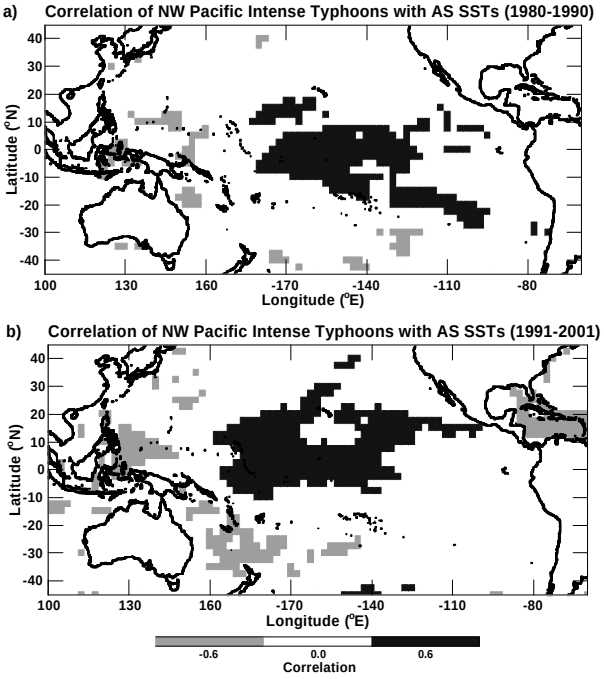

Figure 1. Correlation plot of NW Pacific intense typhoon numbers with SSTs for the periods a) 1980 – 1990 and b) 1991-2001. Areas shaded are significant at least to the 5% level, with grey indicating a negative association with SSTs and black, a positive one.

and trends of the predictors (SOI and Niño 1+2, 3 and 4), whereas the TSR version takes the average of 5 runs, where each run *j* uses the 1, 3 and 5 month initial conditions and trends of the predictand and the j^{th} month initial conditions and trends of the predictors. A simple linear regression forecast model converts these Niño 4 forecasts into NW Pacific typhoon and intense typhoon forecasts.

4. SKILL SCORE AND UNCERTAINTY

Forecast skill is rigorously assessed from the model's "real time" performance over the period 1987-2001. This is achieved by building the models on data up to 1986 to make a forecast for 1987, on data up to 1987 to make a forecast for 1988 and so on. Skill is then assessed on the 15 independent hindcasts.

The skill measure chosen is the percentage improvement in root mean square error over a climatological forecast, denoted as 'Skill Score Clim (%)' below. This is a robust skill measure, immune to the bias problems associated with other measures. For

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climatology we employ the running 10-year period prior to each forecast year. Positive (negative) skill indicates the model does better (worse) than the climatology forecast.

Confidence intervals are computed around the mean forecast skill levels using the bootstrap method (Efron and Gong, 1983). This tests the hypothesis that the model forecasts are more skilful than those from climatology to some level of significance. The skill plots below include the 95% two-tailed uncertainty in our forecast skill over a 15-year period.

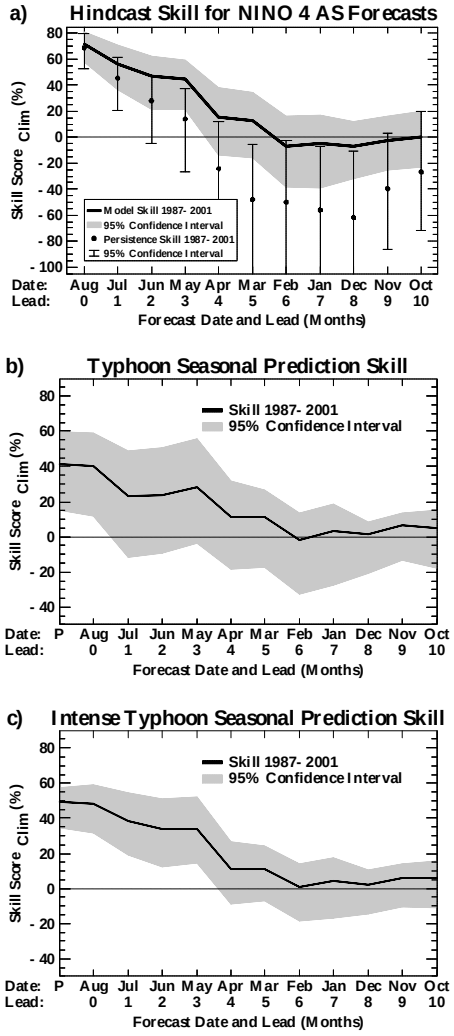

Figure 2. TSR simulated real-time forecast skill 1987-2001 as a function of forecast date and lead month out to the prior October.

5. TSR SIMULATED REAL-TIME FORECAST SKILL 1987-2001

Figure 2 displays the TSR simulated real-time skill 1987-2001 for (a) August-September Niño 4 SSTs, (b) Typhoon numbers, and (c) Intense Typhoon numbers. Skill is expressed relative to a rolling 10-year prior climatology. The 'P' on the skill figures' abscissa denotes the skill with perfect predictors, that is, with climate information through to the end of September. The 'Forecast Date' indicates that the forecast is issued on about the 7th of the month in question, thus permitting climate information from the previous month to be assimilated into the model.

For Niño 4 and intense typhoon numbers, positive skill to 95% confidence exists from May. Mean forecast skill climbs steadily for all three from early March through to the start of the peak typhoon season at the beginning of August, though confidence in our typhoon forecast skill is a little less than the others.

6. 2002 Forecast

Using data up to the end of February 2002, the CLIPER model anticipates weakly positive SST anomalies in the Niño 4 region. This translates into a forecast of 17 typhoons and 9 intense typhoons - approximately 10% more than the 10 year prior average. This forecast will be updated monthly as more information becomes available.

7. SUMMARY AND FURTHER INFORMATION

TSR has developed an innovative statistical forecast methodology for NW Pacific seasonal typhoon activity. These forecasts offer significant skill out to leads of several months. TSR is continuing to expand its services and to further improve the scientific and technical bases of its forecasts. For the 2002 season TSR has introduced monthly updated forecasts for NW Pacific typhoon and Atlantic seasonal hurricane activity. These forecasts together with further information on forecast methodology, simulated real-time forecast skill 1987-2001 as a function of lead time, and on TSR in general, may be obtained from www.tropicalstormrisk.com.

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