Seasonal Prediction of Northwest Australian Tropical Cyclones

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TC Frequency

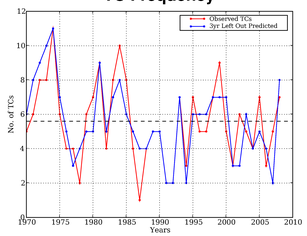


Fig. 2. Observed vs. seasonal prediction of TC frequency.

Years	Independent Prediction TC Count	Observed TC Count	Difference
2005	5	7	-2
2006	4	3	1
2007	2	5	-3
2008	8	8	0
2009	5	4	1
2010	5	Not Available	

Introduction

- Northwest Australian (NWAUS; 105-135°E; Fig. 1) region
  - Sub-basin of the Southeast Indian Ocean basin
  - Avg. TCs per year ~ 5.6
  - Avg. TC Days per year ~ 42.4
  - Avg. ACE per year ~ 7.65 * 10^4 m^2 s^{-2}
  - Avg. PDI per year ~ 8.67 * 10^9 m^3 s^{-3}
- Most active portion of the Australian TC basin

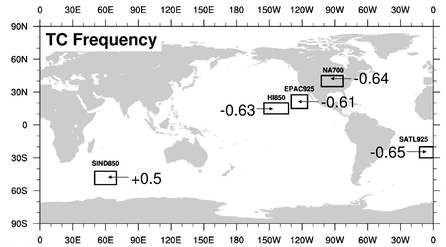


Fig. 4. Map of NCEP-NCAR Reanalysis predictors for TC frequency with correlation values.

$$\text{TC_Freq} = 5.5714 + -0.8826*\textbf{NA700} + -0.5763*\textbf{HI850} + 0.5861*\textbf{SIND850} \; -0.4613*\textbf{EPAC925} + -0.804*\textbf{SATL925}$$

NWAUS Region

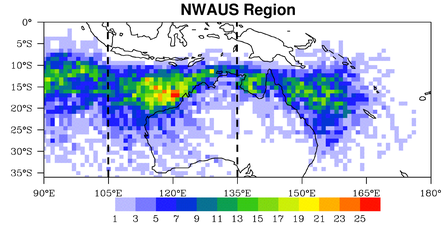


Fig. 1. TC frequency in 1x1 degree latitude/longitude boxes across the entire Australian region.

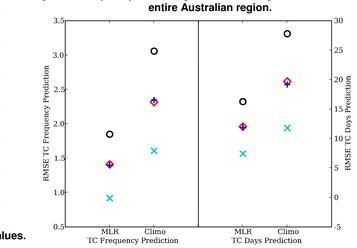


Fig. 6. Bootstrapped RMSE from prediction scheme and climatological prediction.

Data

- Woodside Energy Ltd. (WEL) dataset, initially defined by Harper et. al (2008)
- 13 TC metrics calculated
  - TC Frequency
  - TC Days
  - Intense TC Frequency
  - Intense TC Days
  - Accumulated Cyclone Energy (ACE)
  - Power Dissipation Index (PDI)
  - Landfalling TCs
  - Landfalling Intense TCs
  - Mean Storm Duration
  - Mean Intense Storm Duration
  - Season Length
  - Season Start Date
  - Season End Date

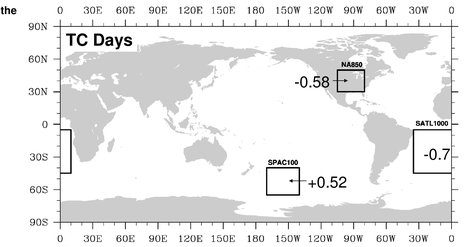


Fig. 5. Map of NCEP-NCAR Reanalysis predictors for TC Days with correlation values.

$$\text{TC_Days} = 43.641 + -11.075*\textbf{SATL1000} + -7.851*\textbf{NA850} + 6.997*\textbf{SPAC100}$$

TC Days

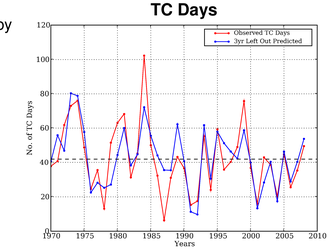


Fig. 3. Observed vs. seasonal prediction of TC days.

Years	Independent Prediction TC Days Count	Observed TC Days Count	Difference
2005	47	44.75	2.25
2006	29.5	22.75	6.75
2007	42	33	9
2008	71	51.75	19.25
2009	40.25	30.5	9.75
2010	34.5	Not Available	

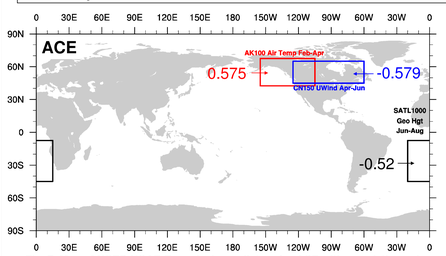
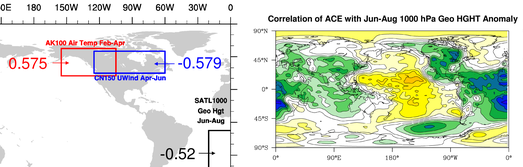
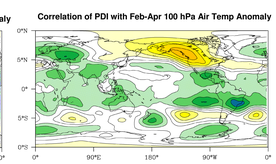


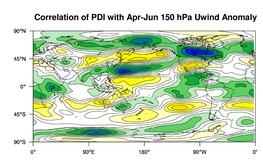
Fig. 7. Map of NCEP-NCAR Reanalysis predictors for ACE with correlation values.

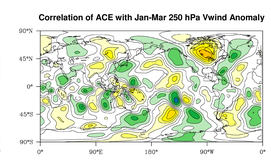
$$\text{ACE} = 73275 + -11581*\textbf{SATL1000} + 14279*\textbf{AK100} + 16348*\textbf{CN150}$$

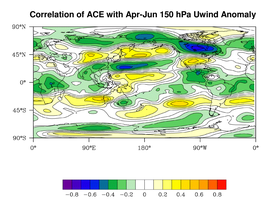
ACE			
	Obs. Below Avg.	Obs. Avg.	Obs. Above Avg.
Fcst. Below Avg.	2	5	0
Fcst. Avg.	7	15	4
Fcst. Above Avg.	0	1	5











ACE	2.50%	50%	97.50%
PC	0.308	0.564	0.795
POD1	0.000	0.200	0.572
POD2	0.417	0.722	0.938
POD3	0.154	0.556	0.917
Bias1	0.250	0.778	2.000
Bias2	0.893	1.231	1.929
Bias3	0.266	0.667	1.167
PSS	-0.170	0.214	0.583
HSS	-0.178	0.226	0.612

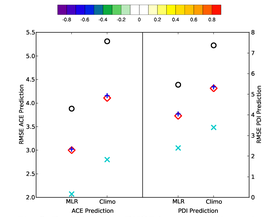


Fig. 9. Bootstrapped RMSE from prediction scheme and climatological prediction.

PDI	2.50%	50%	97.50%
PC	0.359	0.590	0.821
POD1	0.000	0.333	0.750
POD2	0.474	0.769	0.955
POD3	0.091	0.444	0.857
Bias1	0.273	0.667	1.430
Bias2	0.909	1.227	1.824
Bias3	0.308	0.786	1.600
PSS	-0.088	0.255	0.632
HSS	-0.093	0.266	0.643

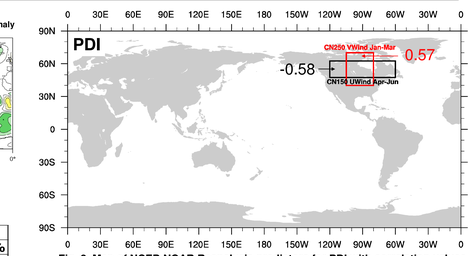


Fig. 8. Map of NCEP-NCAR Reanalysis predictors for PDI with correlation values.

$$\text{PDI}*10^{-9} = 8.313 + -2.84*\textbf{CN150} + 2.359*\textbf{CN250}$$

PDI			
	Obs. Below Avg.	Obs. Avg.	Obs. Above Avg.
Fcst. Below Avg.	3	2	1
Fcst. Avg.	6	16	4
Fcst. Above Avg.	0	3	4

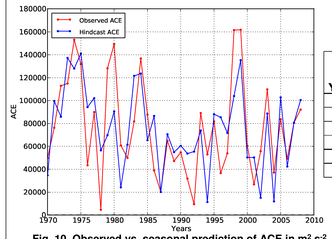


Fig. 10. Observed vs. seasonal prediction of ACE in m^2 s^{-2}.

Years	Independent Prediction ACE	Observed ACE	Ratio Predicted to Observed
2005	94732	83614	1.13
2006	46397	49130	0.94
2007	77586	80487	0.96
2008	96817	92098	1.05
2009	5838	53835	0.11
2010	95595	Not Available	

Note: ACE predictions are computed in m^2 s^{-2}.

Seasonal Prediction

- Seasonal prediction of TC frequency, TC days, ACE, and PDI are now conducted.
- Both ACE and PDI predictions are poorer than TC frequency and TC days predictions
- Fewer candidate predictors for ACE and PDI – many possible predictors cross correlate highly.
- Predictors primarily related to ENSO and NAO/AO climate indices.
- Non-linear techniques will be investigated, especially for ACE and PDI, to determine if improvements to seasonal forecasts can be obtained.

Years	Independent Prediction PDI	Observed PDI	Ratio Predicted to Observed
2005	9.46E+09	1.02E+10	0.93
2006	9.74E+09	5.98E+09	1.63
2007	8.83E+09	8.98E+09	0.98
2008	1.08E+11	1.03E+10	10.48
2009	7.34E+09	7.07E+09	1.04
2010	1.06E+10	Not Available	

Note: PDI predictions are computed in m^3 s^{-3}.

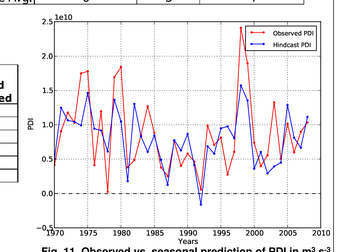


Fig. 11. Observed vs. seasonal prediction of PDI in m^3 s^{-3}.

Conclusion

A successful seasonal prediction is performed for both TC frequency and TC days for the NWAUS basin. Predictions of ACE and PDI have commenced, but are not as successful. Future research into alternate prediction techniques and development of a seasonal intensity index will take place.

References

Harper, B.A., S.A. Stroud, M. McCormack, and S. West, 2008: A review of historical tropical cyclones intensity in North-western Australia and implications for climate trend analysis. *Aus. Meteor. Mag.*, **57**, 121-141.

Further Information

Goebbert, Kevin H. and L. M. Leslie, 2010: Interannual Variability of Northwest Australian Tropical Cyclones. *J. Climate*, **23**, 4538-4555.