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Intensity Prediction of small tropical cyclones: the great forecast challenge

Why is it the hardest problem? Little data; little research; poor guidance. Analysis and intensity fluctuations





Joe Courtney, BoM AOGS 2013

Small TCs: R34 <= 60nm





Small TCs: How many?

Australian cases : 22% of TCs are small in Australian region, 30% in the northwest region (1992/93 – 2012/13)

- <u>Heidi</u> 2012; <u>Errol</u> 2011, Vince; <u>Magda</u> 2010; <u>Laurence</u>, Dominic, Freddy, Charlotte, Ellie 2009; Rosie, Ophelia 2008; <u>Kara</u> 2007; Monica, <u>Floyd</u>* 2006; Bertie 2005
 - Others: Tracy 1974;
 - Atlantic: Humberto, Marco; Pacific: Roke + others;
 - More in the Bay of Bengal?

Possibly under represented in databases because estimated R34 higher in the absence of good information historically not included as considered too weak ?



Small TCs: Where?

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Predominance off the northwest coast

Small does not mean weak - 8 of 12 are severe (cat 3 or more)

All 6 of the severe 'true' small systems were in the northwest





Small TCs: How good?

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Small TCs intensity errors are 20-30% higher on average



6/17 Challenge: poor intensity analysis

- Before we can determine the forecast we need to know the analysed intensity and intensity trend.
- Sampling the maximum wind is hard because RMW is small eg Heidi 2012 - Port Hedland, Tracy 1974 - Darwin intensity?







Dvorak limitations

Dvorak underestimates – any size criterion will fail –CDO/eye; resolving pinhole eyes;



Marco (Gulf of Mexico)

55 kn intensity from Recon 53 kn (SFMR 61 kn flight level) Vs Dvorak T2.0 (30kn 1min); SMALL: RMW=4kn; R34=30nm





Development happening underneath the "blob"



Magda 2010 T3.0@12Z 45 knots >> 12h later T4.5 65 knots

Microwave signatures of small TCs^{9/17}



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AMSU resolution

 AMSU measures the central thermal anomaly to derive the intensity but suffers from poor resolution esp on edge;



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AMSU can under-resolve

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Magda 06UTC 21/1/2010: 60kn BT intensity

Compare AMSRE with AMSU; CIMSS AMSU 51kn Vs 72kn ADT (1min)



Scat resolution

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 Ascat resolution – 25km; (Oceansat/Quickscat lower res) eg Errol Ascat 40kn likely max wind >55kn



Challenge 2: Intensity Fluctuations^{13/17}

Magda forecast 00UTC 20 Jan 2010



 Rapid intensification, temporary weakening; diurnal influences on the small system.

Challenge: Laurence 2009 14/17 Laurence forecast 06UTC 14 Dec **Actual Track** ? -1 06:00 14/12 06:00 15/12 00:00 16/12 06:00 16/12 Cat 1 to 4 in 24h 5 L 06:00 17/12

 The 'environment' affecting the intensity of the small TC is smaller than for larger storms.

Challenge: Monica

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Monica forecast for over land 24 April 2006



 Once environment becomes unfavourable small TC will weaken rapidly.

Some ways to improve

- Expertise in combining different analysis methodologies based on situation
 - COMET module coming <12months
- ADT (CIMSS) incorporating microwave from ARCHER
 - Cf CIMSS ADT to NESDIS ADT for TC ...
- Break Dvorak FT constraints if needed
- Caution interpreting observations
- Microwave patterns subjective analysis based on patterns
 37 and 85-91GHz channels
- RII & SEFI extended to SH ? (IWTC recomm.)
- NWP improvements inc. ensembles and display of shear
- EC integrated into STIPS ? No current plans ⊘

Summary: Small TCs

- Gale radius < 60nm
- Analysis: Dvorak underestimates (vis)?; AMSU resolution limitation; use microwave pattern (not objective!)
- Fluctuate intensity faster > more likely to undergo RI
- More common in Aust basis than elsewhere? Low-latitude/high SST
- 'vulnerable' to subtle environmental changes
- RI starts earlier (30 knots) than for larger TCs (50 knots)