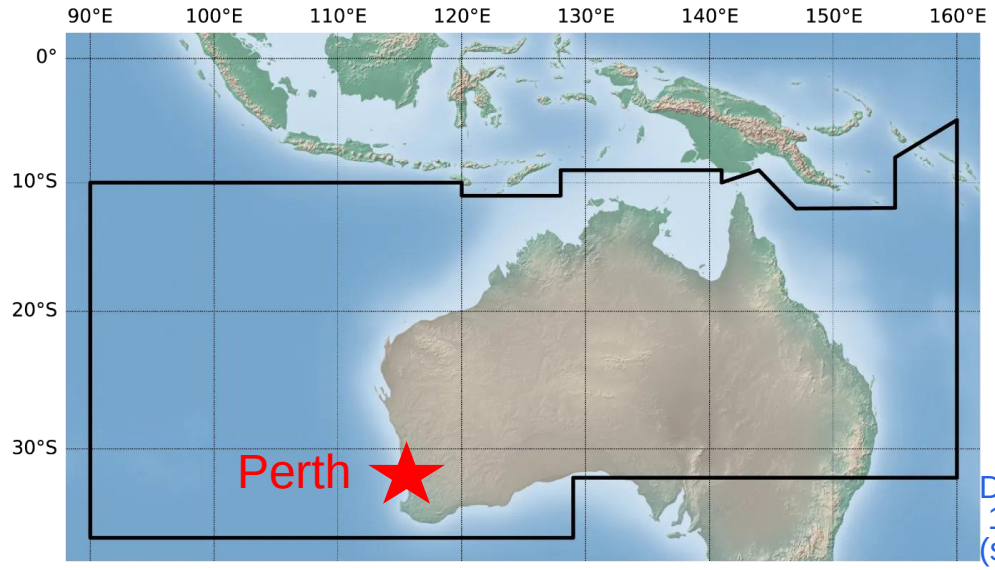
Characteristics of Rapid Intensification of Tropical Cyclones in the Australian Region

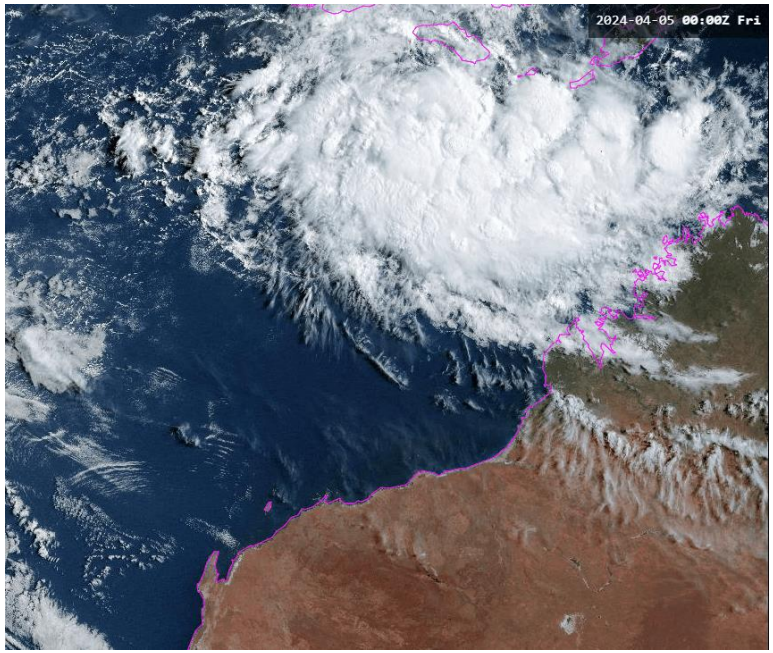
Joe Courtney, Craig Earl-Spurr, Matt Boterhoven and Linda Paterson
Tropical Cyclone Environmental Prediction Services, Bureau of Meteorology, Australia.

AMS Hurricane Conference, May 2024

Frequency
RI differences in the Australian region
RI and size and onset intensity
Forecasting applications



loop during RI of TC Olga



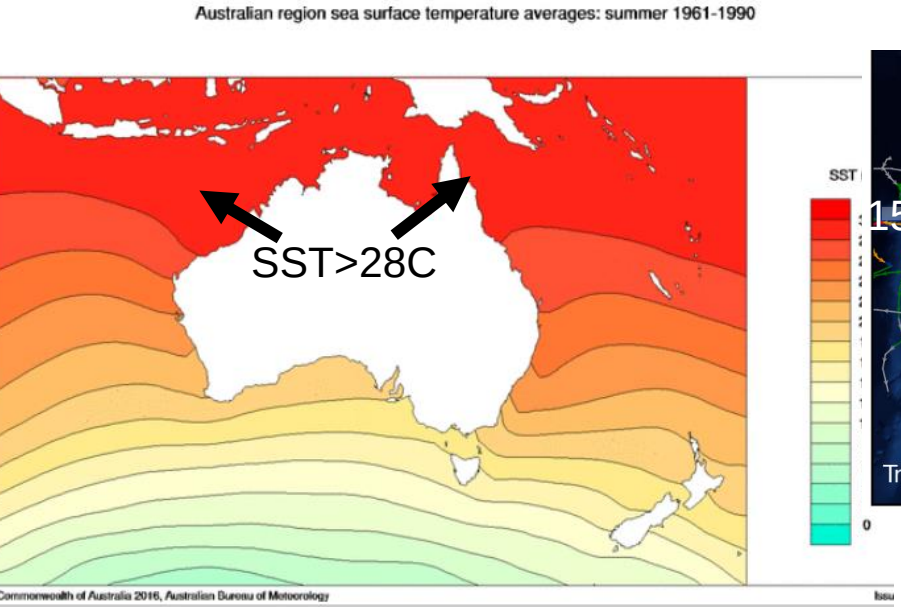
Data: BoM dataset http://www.bom.gov.au/clim_data/IDCKMSTM0
1981/82-2023/24 with subset from 2002/03-2023/24 for structure (same as IBTRaCS)

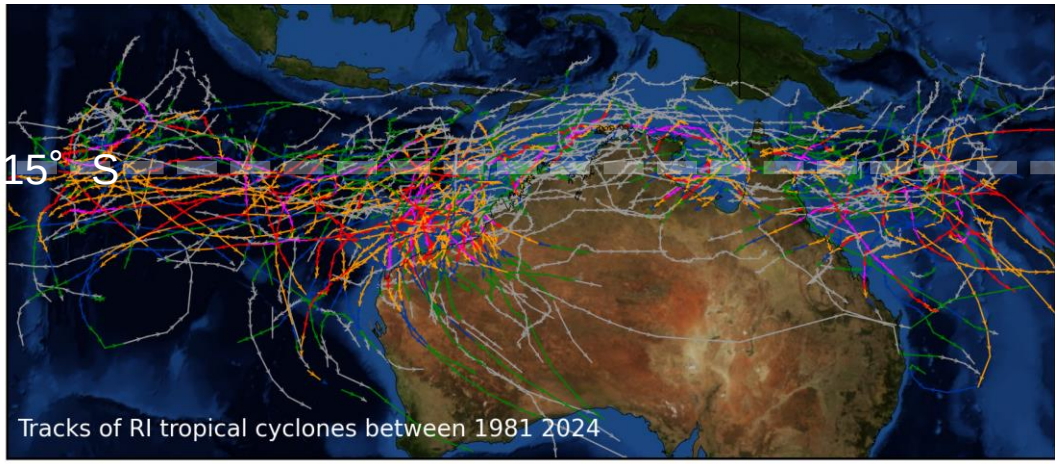
I acknowledge the Whadjuk Noongar people, the traditional owners of the land on which I present from today. I acknowledge their ongoing connection to country and commit to listening and working for healing of lands and peoples. I pay respect to their elders from the past to present day.

TCs in the Australian Region

Formation 5-15S in high SST (28+C) most with enhanced monsoon flow (MJO/ER/Kelvin waves);
Average of 10 TCs between Dec-April.
Formation often close to land, low population but oil and gas industry- 7-day forecast requirements

Note: TC = tropical storm (34+kn) and Severe TC (STC) = hurricane (64+kn)



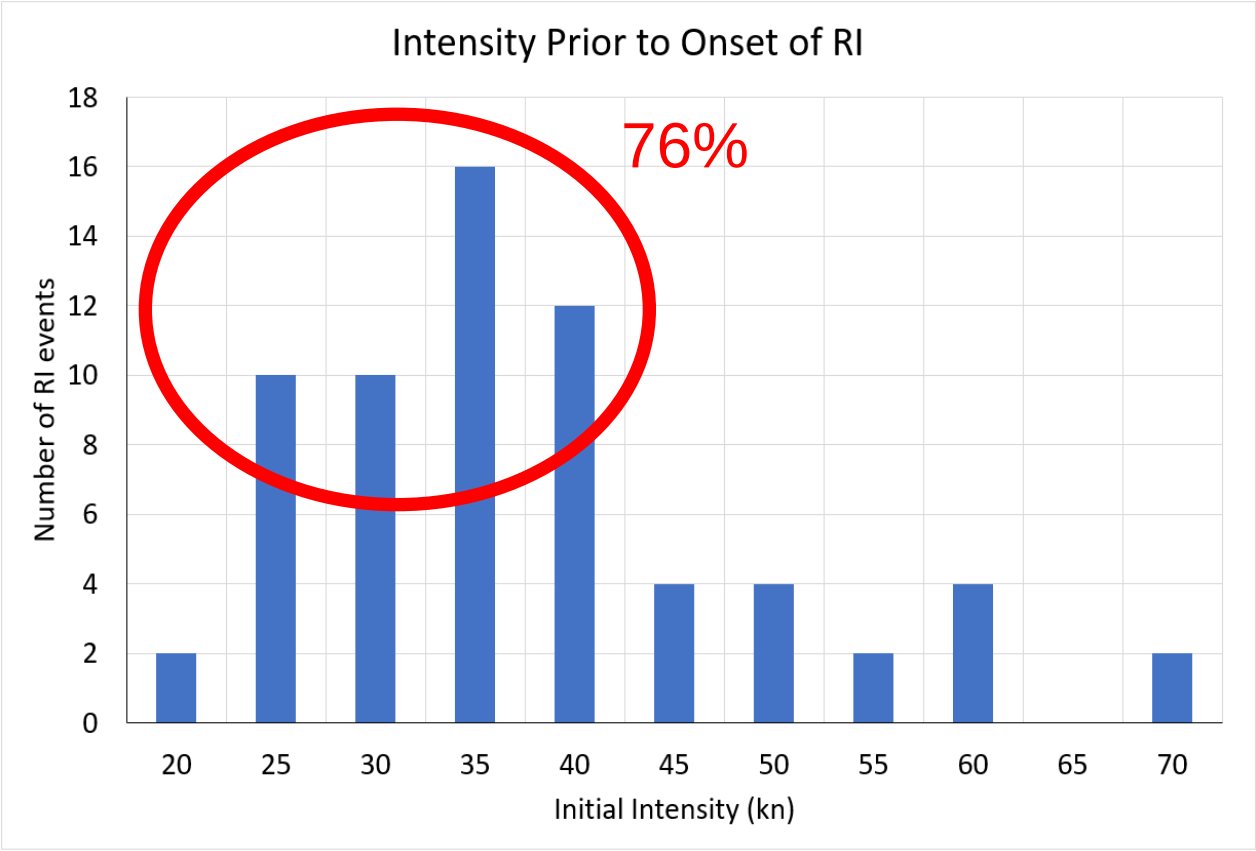


http://www.bom.gov.au/cgi-bin/climate/change/averagemaps.cgi?map=sst&season=1202

RI (30kn/24h) in the Australian Region

70% of STCs undergo RI (2002-24) cf 60% NA, 70% SW IO
95% for 24h change is 35kn cf. 30kn NA and SW IO
76% start of RI occurs 20-40kn; average 38kn

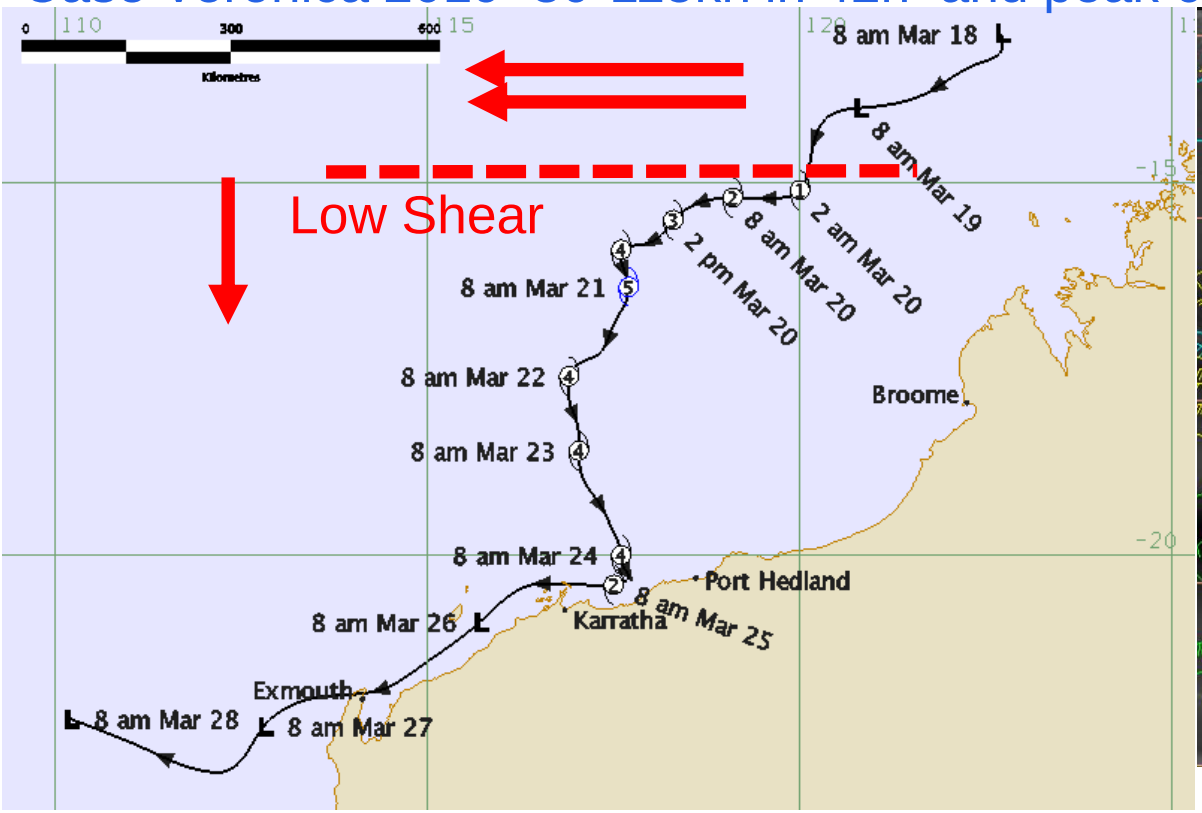
Period	%RI TCs (34+kn)	%RI STCs (64+kn)
1981-24	34	62
2002-24	34	**70**

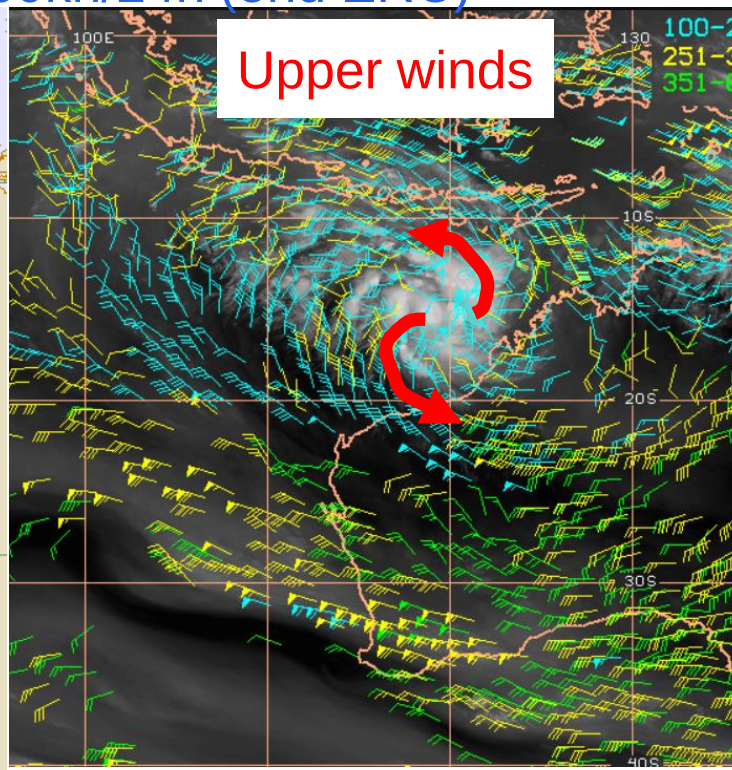


Synoptic situations: 'standard'

Formation on trough in a deep moist environment over high SSTs moving WSW from higher easterly shear to low shear with strong upper outflow poleward
Intensification from 30/40 to 65+ kn - duration shear and land dependent

Case Veronica 2019 30-115kn in 42h and peak 60kn/24h (end ERC)

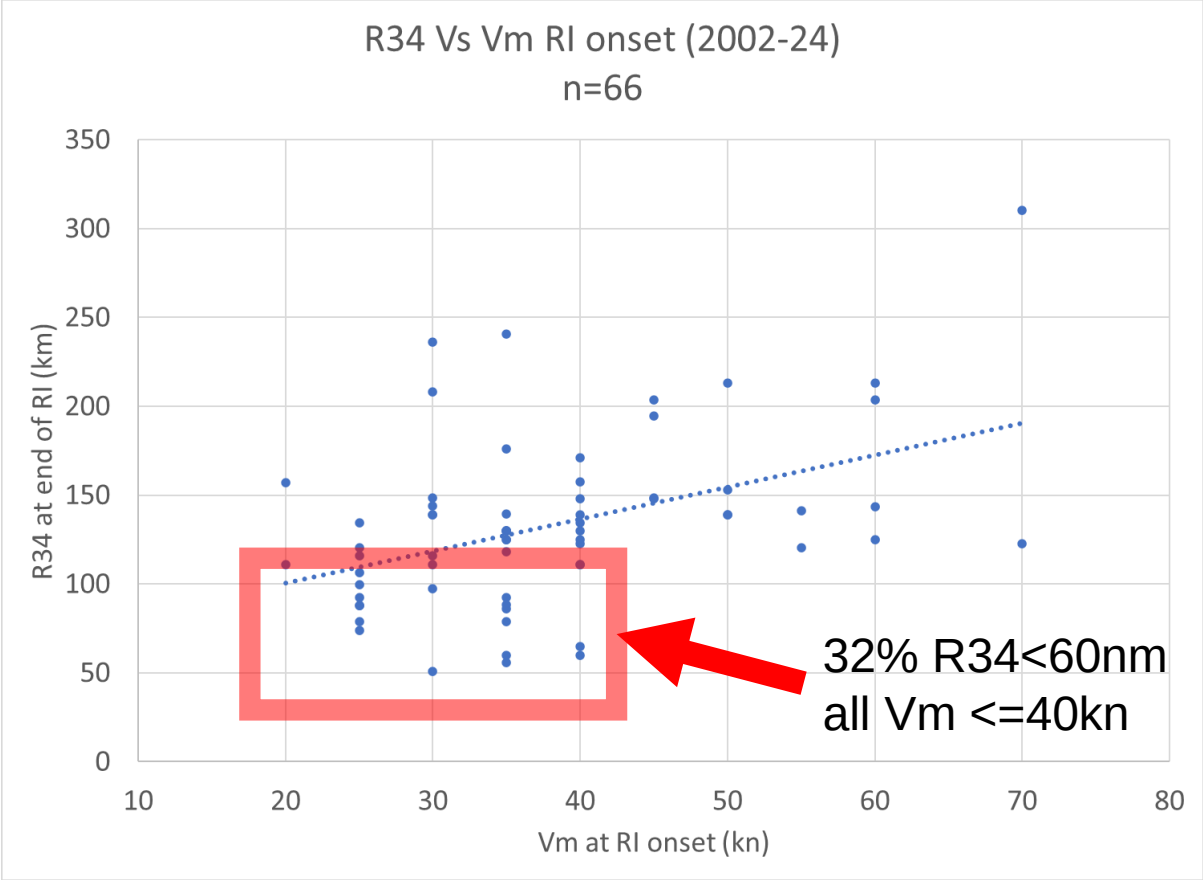




https://tropic.ssec.wisc.edu/archive/data/Australia/2019dsLargeWest/20190320.00.Australia.MidUpperWindsL

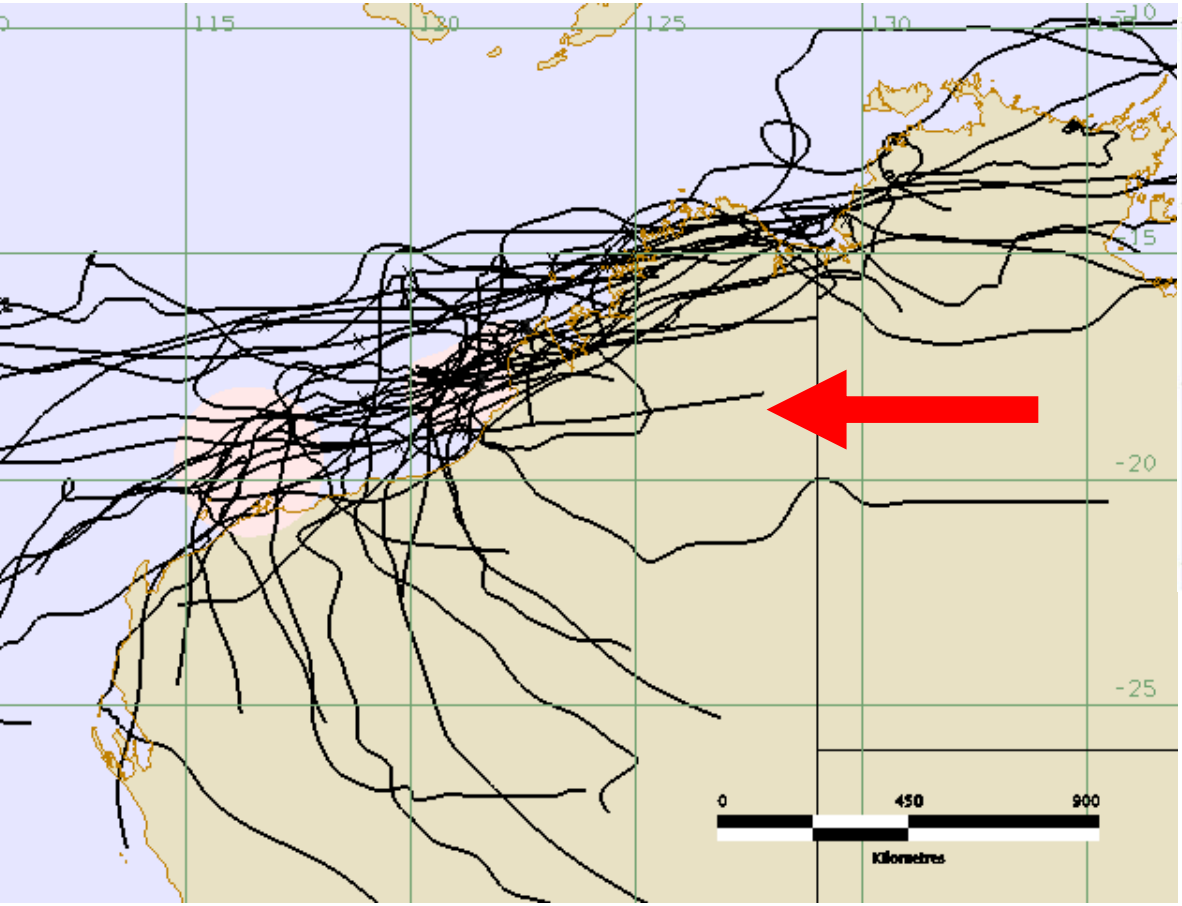
RI and size

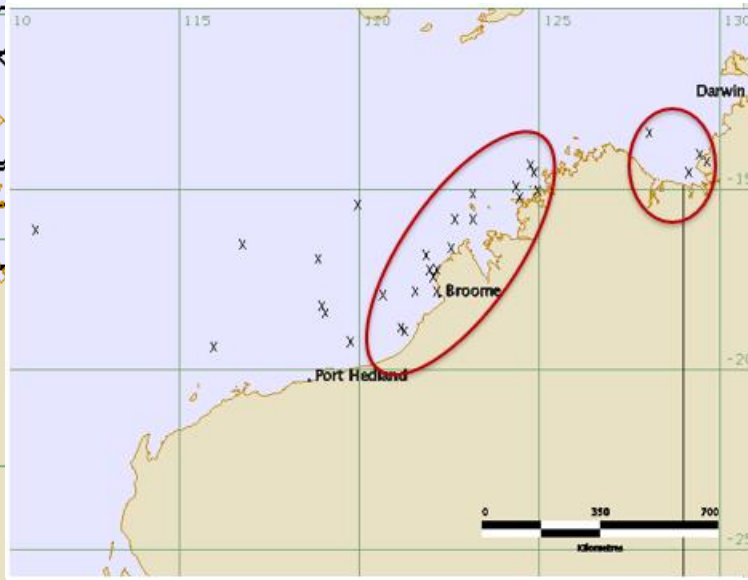
The smaller the circulation the more likely RI – experience matches other studies
Australian TCs are smaller than most other basins – more like NE Pacific
Smaller circulations have earlier RI onset: 32% less than 60nm all <40kn
Smaller form in absence of strong monsoon/MJO in drier environments



Synoptic situations: Offshore developers Unique to Australia?

36 cases in 45 years (1980-2024); 52% undergo RI; accounts for 10% of all RI cases
Intensification function of initial strength and wind shear/moisture environment
Typically small: ave R34=65nm

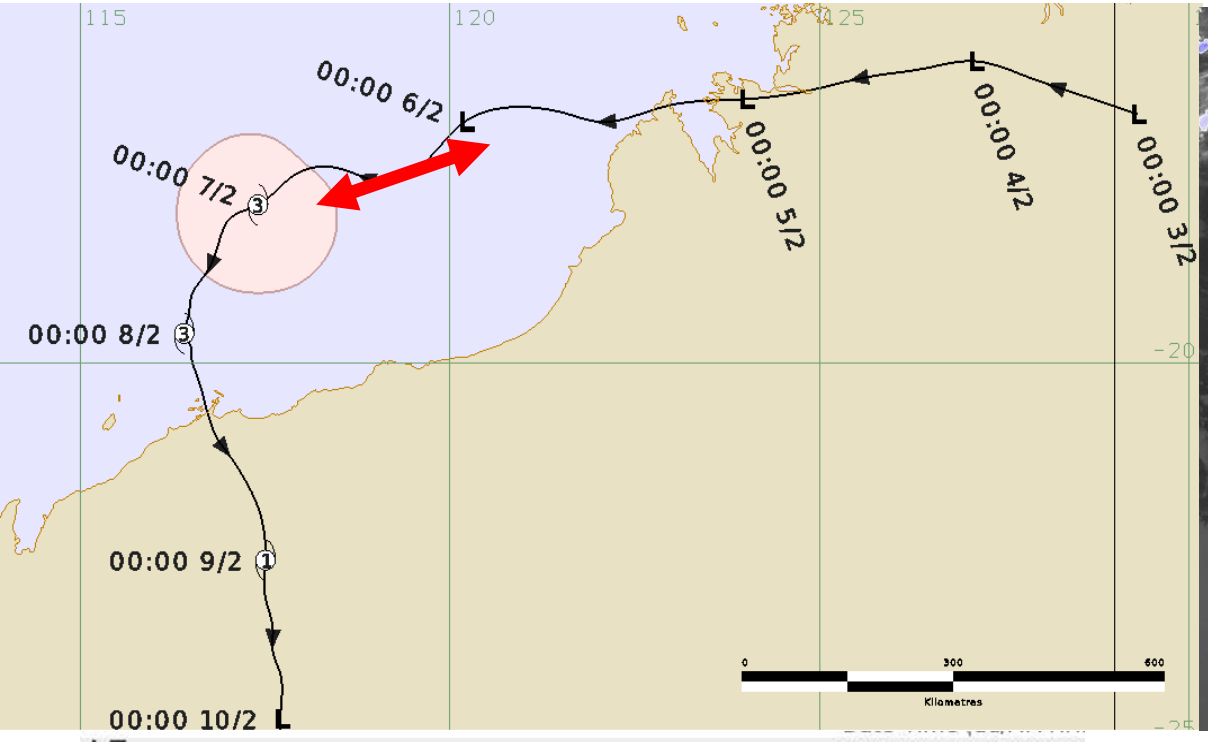


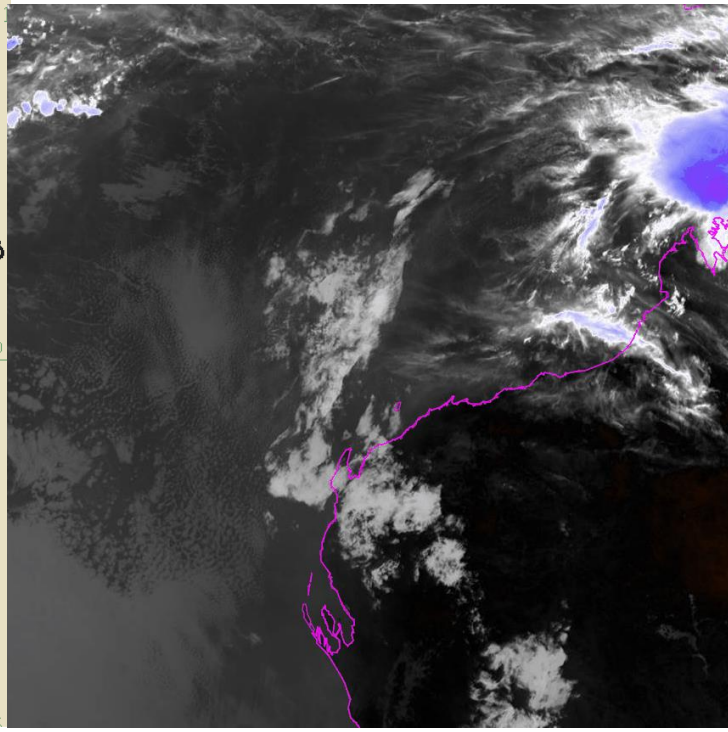


X marks location at TC intensity (34kn)

Synoptic situations: Offshore developers
Case: Damien 2020

30-65kn in 24h prior to crossing coast (00UTC 6 Feb to 00UTC 7 Feb)
R34 116 km (63 nm)
Environment: low wind shear and high SST; Forecast success

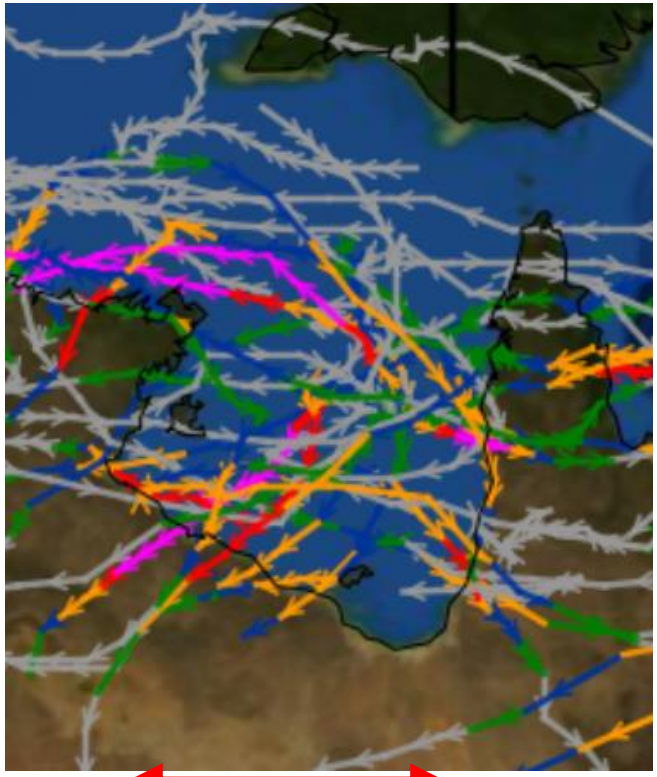




http://www.bom.gov.au/cyclone/history/damien-2020.shtml

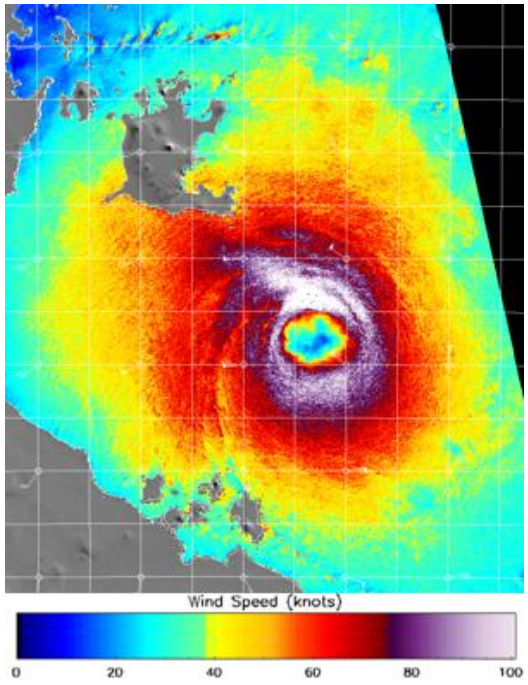
Gulf of Carpentaria: the perfect RI breeding ground

Difficult region from both track (often slow and erratic) and intensity
High SSTs, small size, typically a period of low wind shear, 90% of STCs undergo RI
Often short lifetime as landfall typically prevents MPI from being achieved



TC Megan March 2024
R34=141km (strong monsoon)
Vm 55 to 85kn

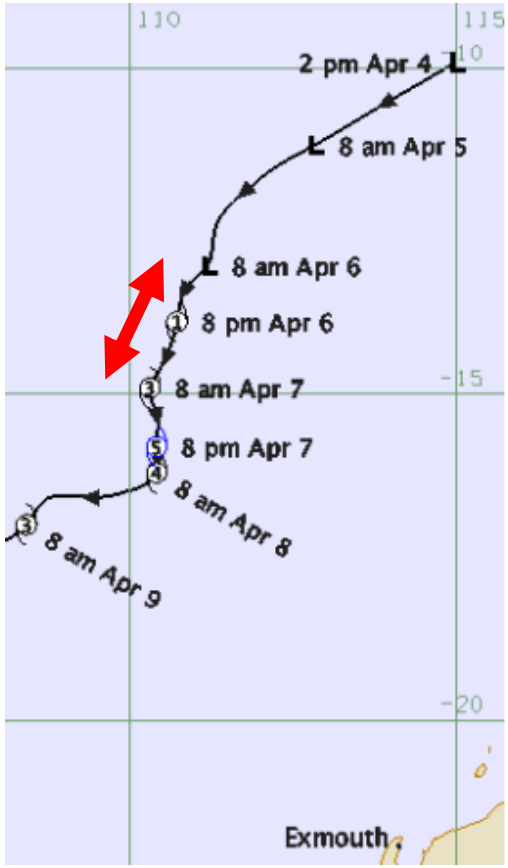
3 x SAR passes
SAR >> Dvorak/SATCON



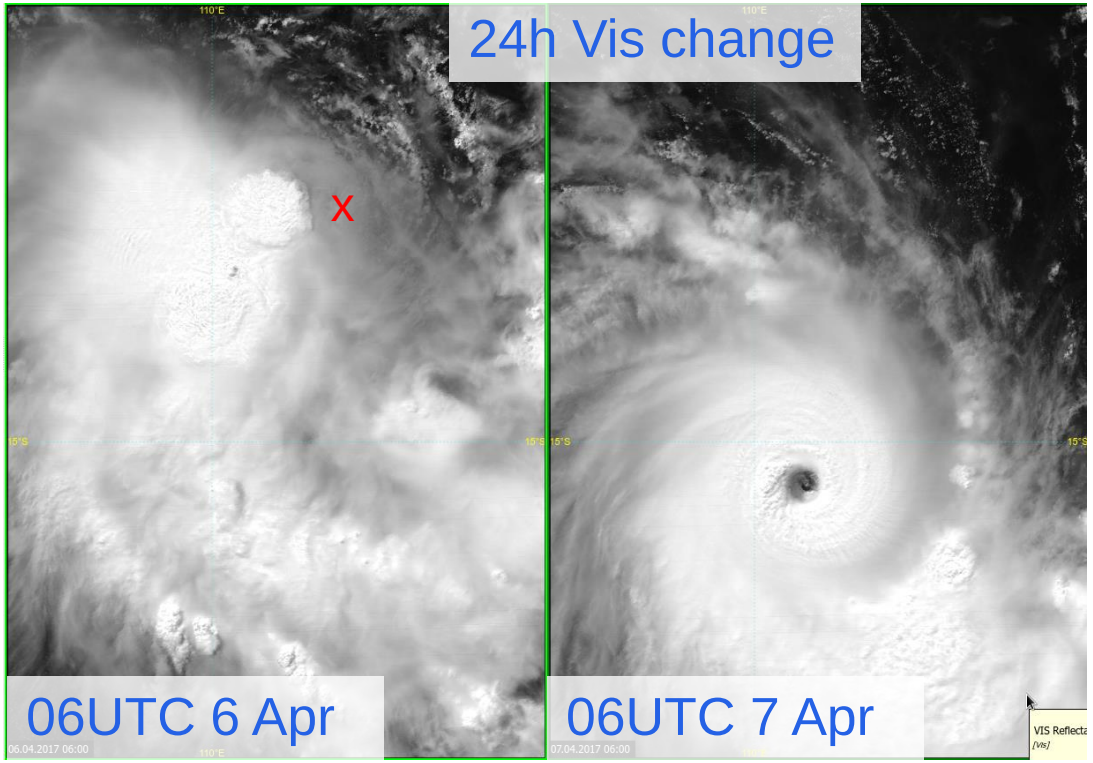
AMS Hurricane Conference, May 2024

Synoptic situations: RI in mod E'ly shear

Circulation overcoming E'ly shear (Ryglicki 2022)
Very difficult forecasting scenario



Case: Ernie 2017 onset in moderate ENE shear
45-120kn in 24h
R34=60km

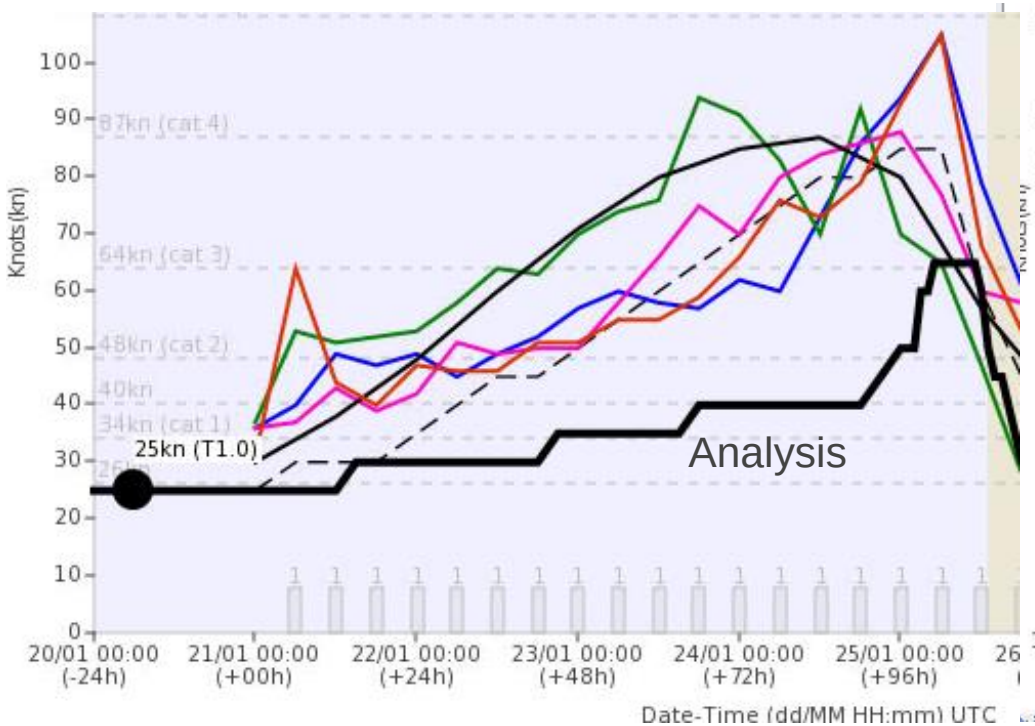


AMS Hurricane Conference, May 2024
http://www.bom.gov.au/cyclone/history/pdf/Ernie_report.pdf

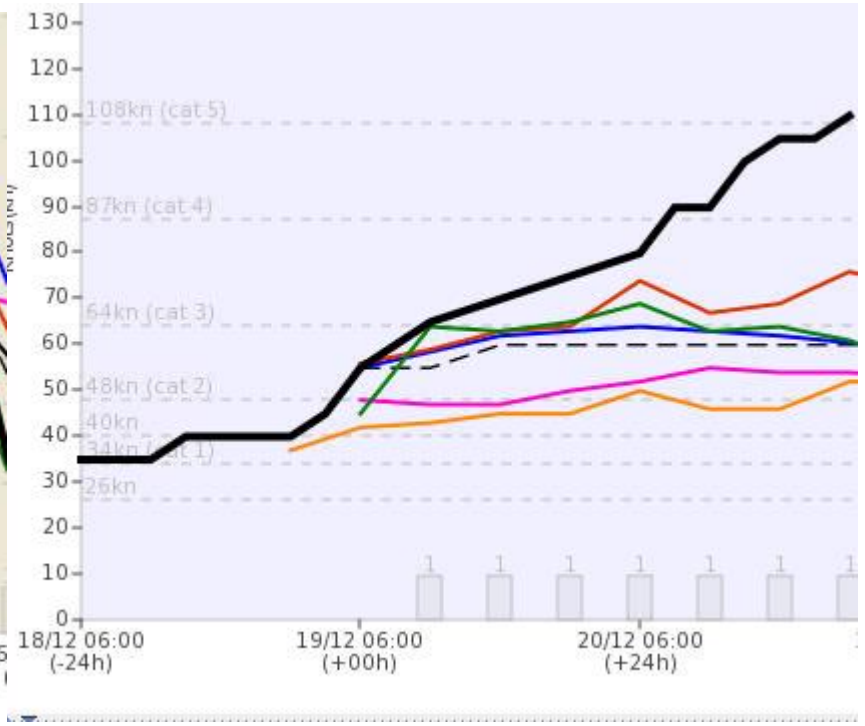
Forecasting applications

Timing RI onset – *'we think it will happen but not sure exactly when*'
Early stages: false Alarms esp. HWRF/HFSA/COAMPS; diagnostics (eg RIPA) N/A
Failure to pick RI still occurs
Forecasting 95% Vm challenge

Overforecast: early stages of Kirrily (2024)



Underforecast: Darian (2022) +48h 50kn error



Australian RI Summary

RI assisted by high SST and smaller size
RI onset majority occurs 20-40 kn
Offshore developing and Gulf of Carpentaria
Ongoing operational challenges
    RI in moderate wind shear
    Timing of RI onset

Next steps

Document for publishing
Further relationships to shear, MJO, and RI onset
Study non-RI cases
Further comparisons with other regions, ongoing studies

Questions?