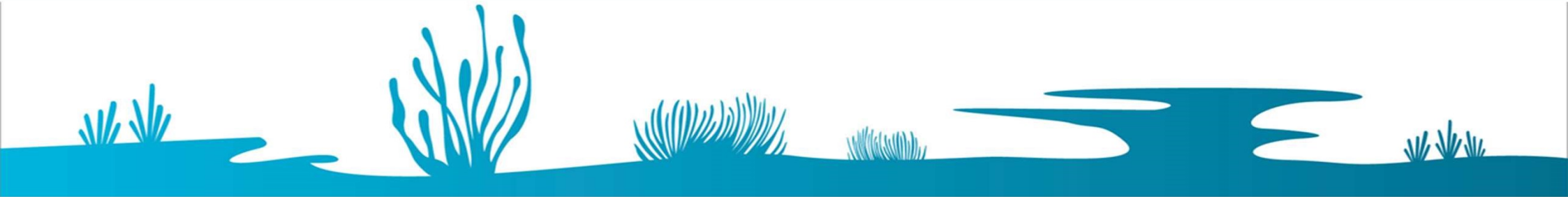
Climate and Oceans Support
Program in the Pacific

ACCESS-S Workshop

MODULE: Tropical Cyclone Climatology



Climate and Oceans Support Program in the Pacific

Outline

Part 1 - TC Climatology

- TCs in the Southern Hemisphere
- TC Impacts
- Consolidated TC Database for the SH
- TC Climatology
- Conclusion

Part 2 - TC Seasonal Prediction

- TC Seasonal Prediction
- TC Early Warning Communication
- Conclusion

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TCs in the Southern Hemisphere

- Tropical cyclones (TCs) affect countries in the Southern Hemisphere (SH) tropics every year causing significant loss of life, property and income from destructive winds, torrential rain, high ocean waves and storm surge.
- Typically, TC impacts on small island developing states (SIDS) and least developed countries (LDCs) are particularly devastating due to their high vulnerability, fragile economy and low resilience.

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TC Winston

- One of the recent examples of severe TC impact on Pacific Island Countries is TC Winston, which devastated Fiji in February 2016.

- the most intense tropical cyclone on record in the SH, and the strongest to make landfall in the SH.

- the costliest TC on record in the South Pacific Ocean. In Fiji, 44 fatalities were related to impacts of TC Winston, while damage and economic losses totaled about $1.4 Billion (2016 USD).

Winston at record peak intensity before landfall in Fiji on 20 Feb 2016

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TCs EWS

- To reduce the impact of TCs on society, early warning systems (EWS) are used to communicate the threat to the public.
- Strengthening EWS is vital for improving preparedness and this goal is aligned with the seventh global target of the Sendai Framework for Disaster Risk Reduction.
- This framework calls for a substantial increase in multi-hazard EWS. The Sendai Framework further refers to EWS as a critical element for disaster risk reduction.
- The Framework for Resilient Development in the Pacific (2016) identifies "strengthened disaster preparedness, response and recovery" as one of its key goals.
- Addressing the needs of Pacific Island Countries with improving EWS for TCs is a high priority; focus is on:
  - ✓ improving historical TC datasets,
  - ✓ tools for analysis of TC activity, and
  - ✓ communicating TC early warnings which are better understood by the general public.

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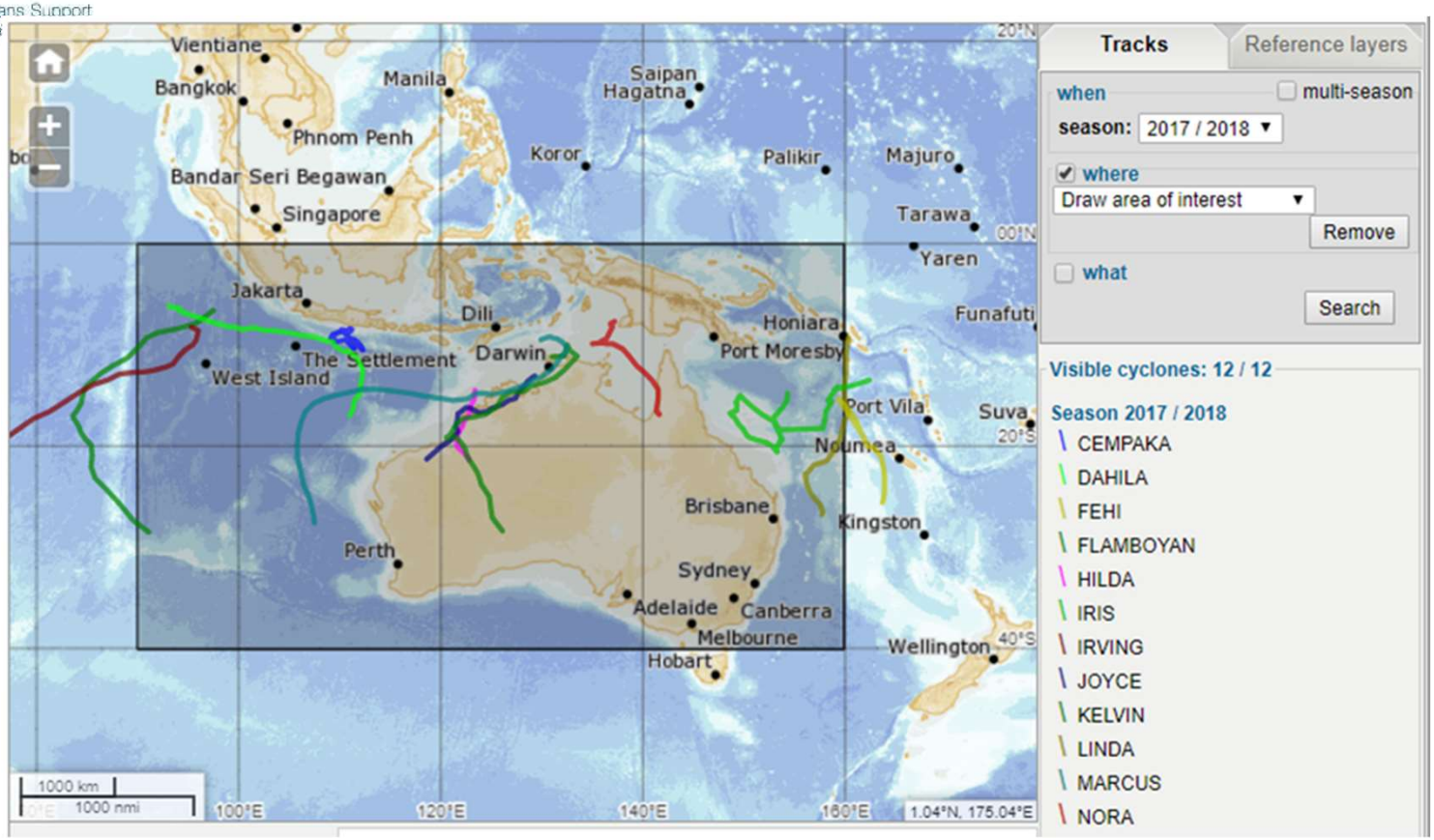
Consolidated TC Database for the SH

- The first version of the SH TC historical data archive was prepared at the National Climate Centre of the Australian Bureau of Meteorology (BoM), in collaboration with NMHSs of Fiji, France and New Zealand.
- Since its first release in 2003, the SH TC historical data archive has been revised and updated. It currently consists of TC best track data for the 1969/70 – 2017/18 seasons, starting with the time when geostationary and polar-orbiting satellite images ("satellite era") were first utilised operationally in NMHSs of WMO Regions I (Africa) and V (South-West Pacific).
- To display and analyse historical TC data, a specialised web-based information tool – the SH TC data portal – has been developed.
- The portal's functionality allows users to perform spatial and temporal selection of TC data and display selected cyclone tracks over a specified geographical area and time period including displaying changes in TC intensity over the lifetime of a cyclone.

SH TC Data Portal



select cyclone tracks over a specified geographical area and time period

Tracks of 12 TCs which passed through the Australian Region in the 2017/2018 TC season displayed in the SH TC data portal

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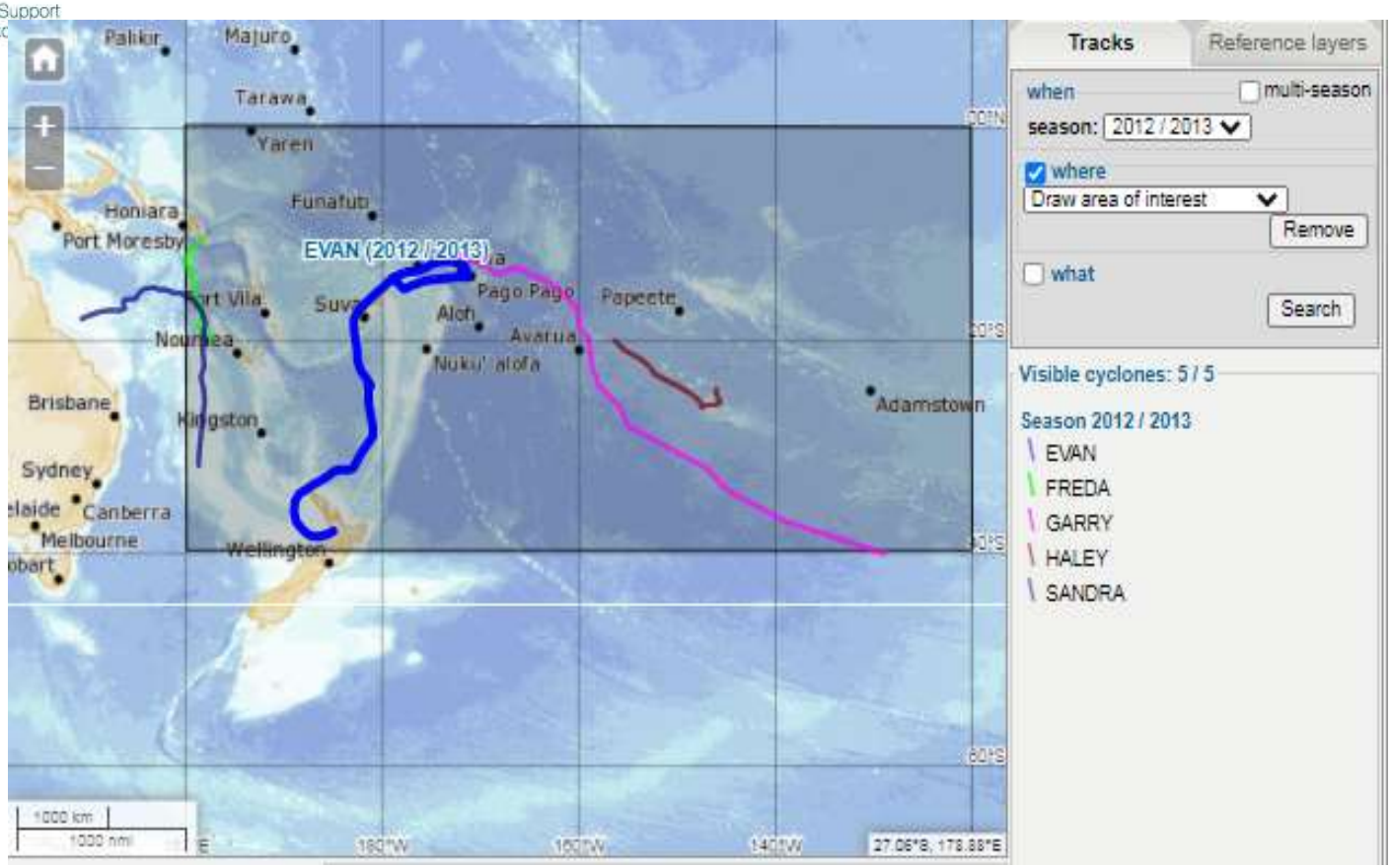
SH TC Data Portal



select cyclone tracks over a specified geographical area and time period

Tracks of 5 TCs which passed through the South Pacific Region in the 2012/2013 TC season displayed in the SH TC data portal. Track of TC *Evan* highlighted.

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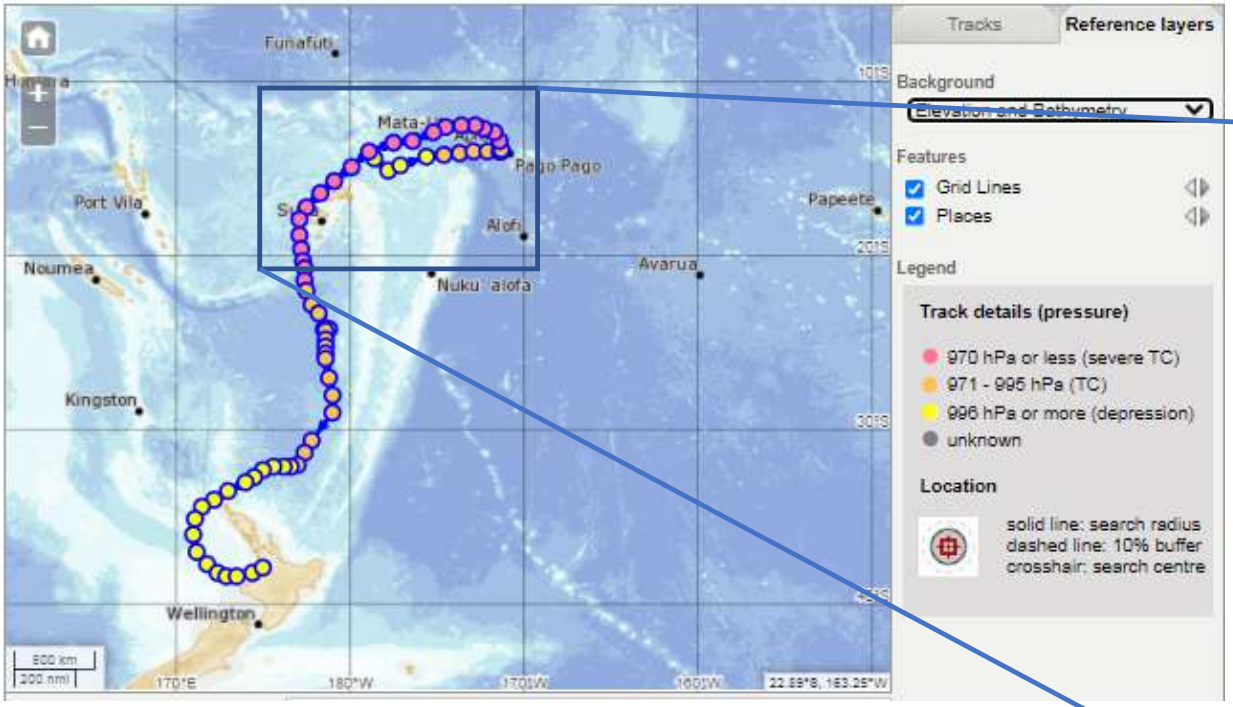
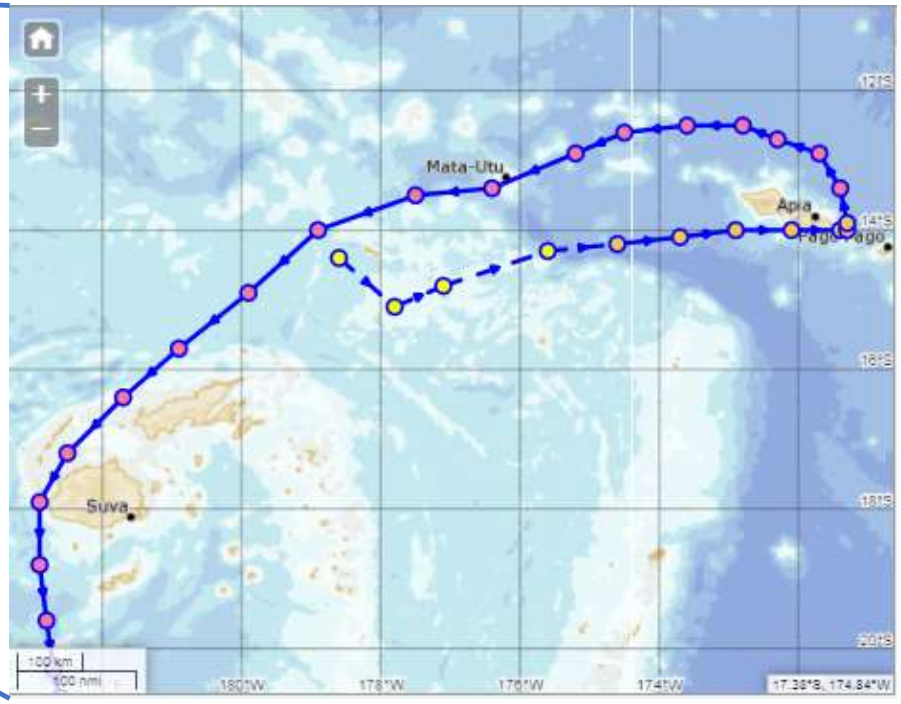
SH TC Data Portal





Track of TC *Evan* (displaying changes in TC intensity over the lifetime of a cyclone; zooming in)

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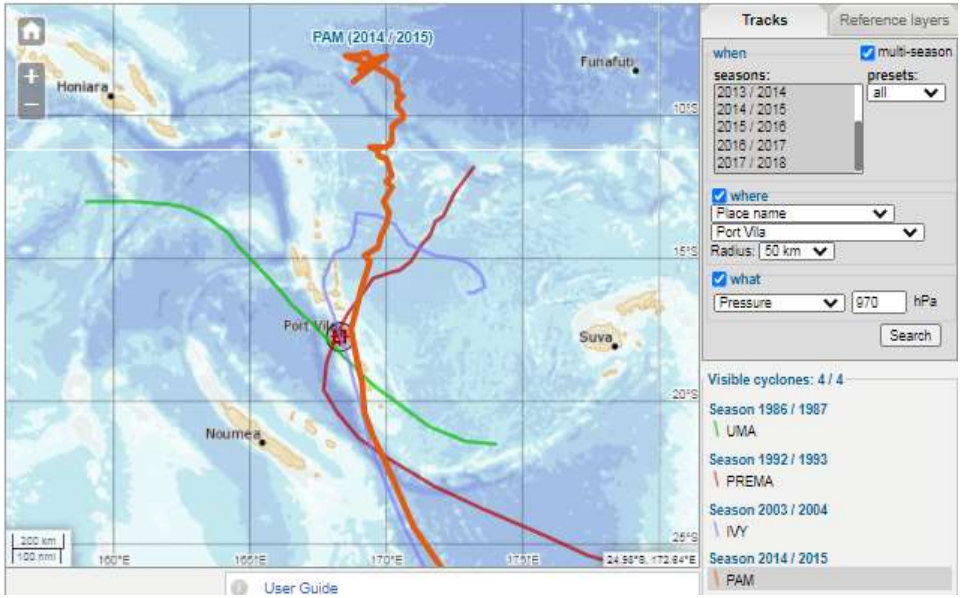
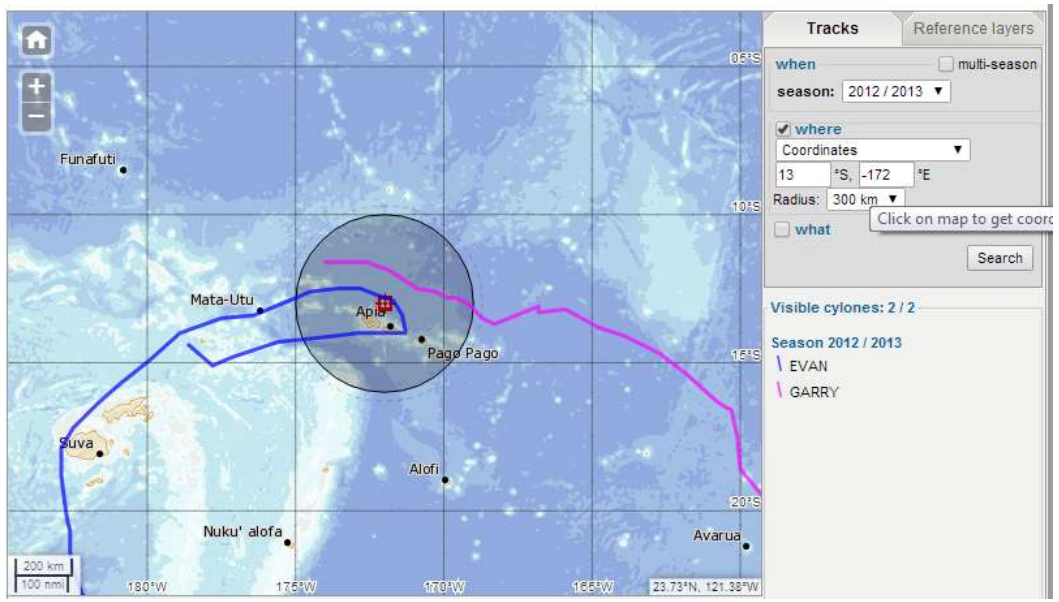
SH TC Data Portal





Place name : Port Vila
all years
50 km radius
970 hPa or lower
Returns: tracks of 4 TCs; track of TC Pam highlighted

Coordinates: 13°S -172°E
2012/2013
300 km radius
No pressure specified
Returns: tracks of 2 TCs, Evan and Garry

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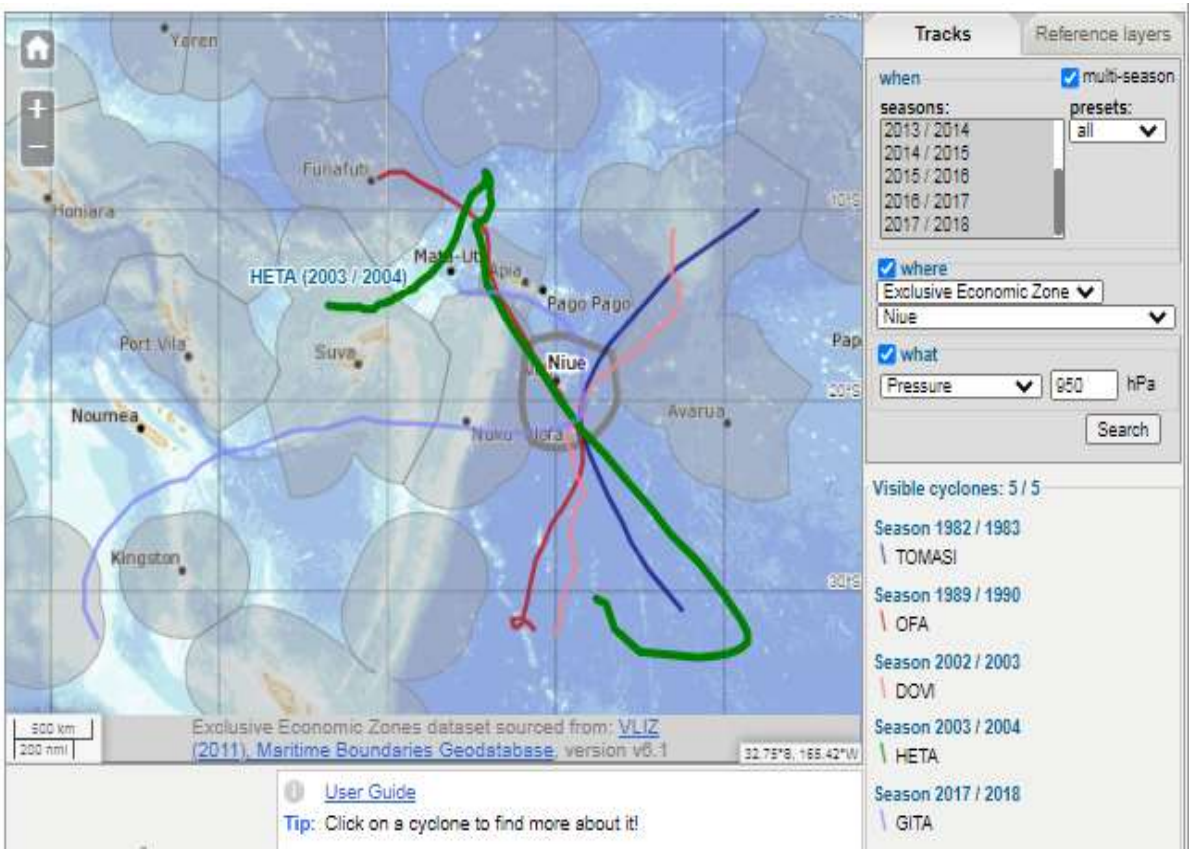
SH TC Data Portal



Tracks of 5 TCs (950 hPa or lower) in the EEZ of Niue; track of TC *Heta* is highlighted

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SH TC Climatology

- Accurate long-term historical records are essential for deriving historical risk profiles for TC activity and variability.
- An analysis of TC best track data available from the SH TC archive demonstrates significant spatial and temporal variability in TC activity in the South Pacific and South Indian Oceans.
- Hence, it is essential to understand the influence of the main global climate forcings on TC variability.
- The El Niño-Southern Oscillation (ENSO) is one of the key global climate drivers which significantly influence inter-annual variability of TC activity in the SH.
- Using best track data from the SH TC archive, we examined ENSO impact on TC spatial and temporal variability in the SH and its regions.

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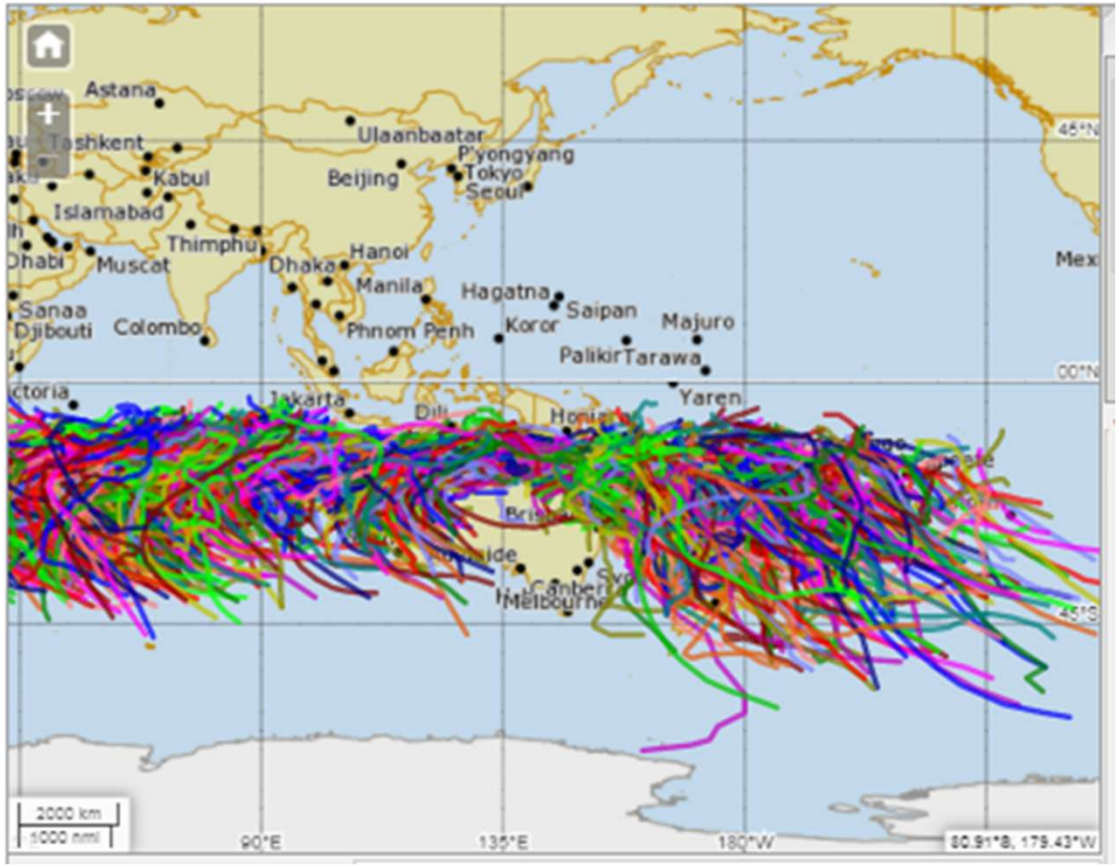
SH TC Climatology



TC tracks in the SH for all years (the 1969/70 – 2017/18 seasons; 1,275)

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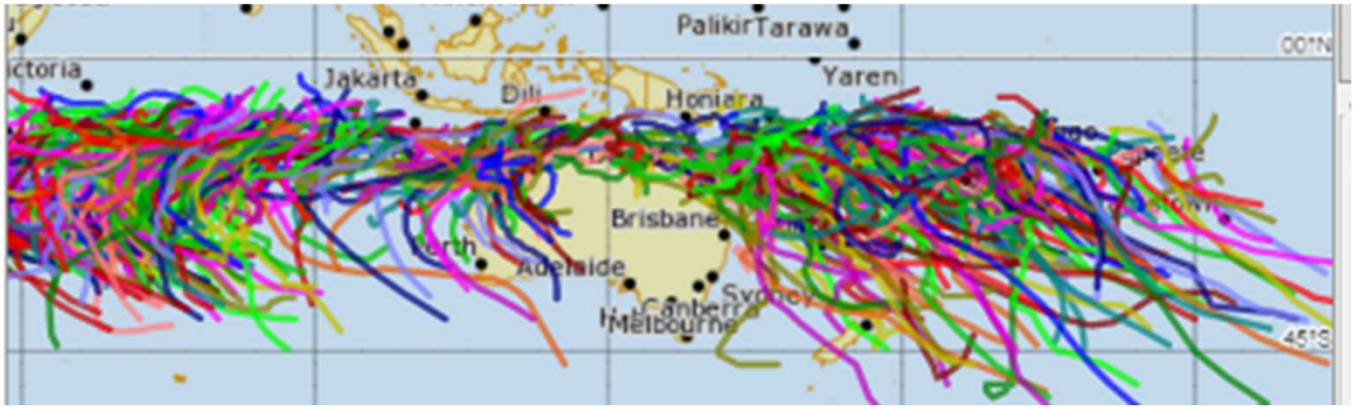
SH TC Climatology



TC tracks in the SH in El Niño years (476)

TC tracks in the SH in La Niña years (306)

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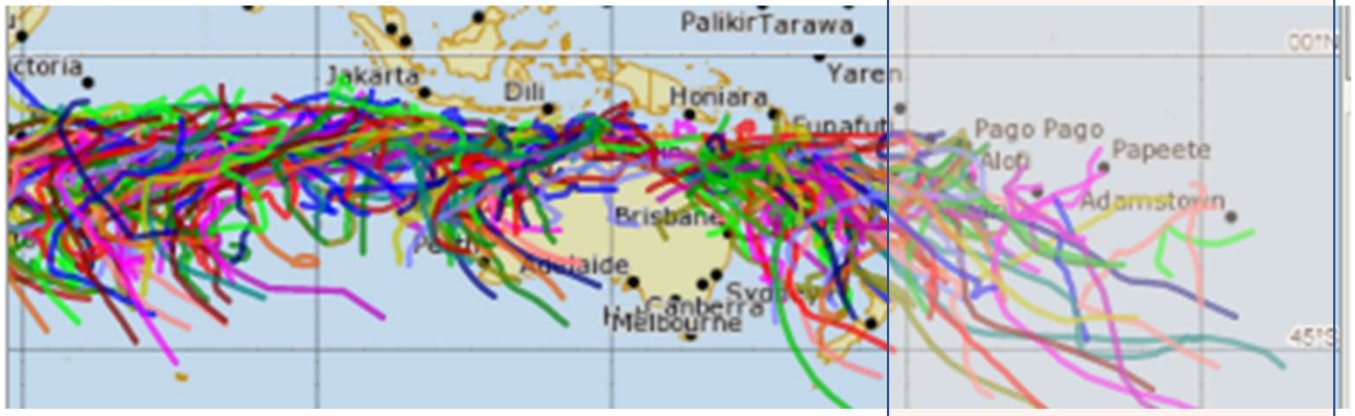
SH TC Climatology

TC tracks in the SH in El Niño years (476)



TC tracks in the SH in La Niña years (306)

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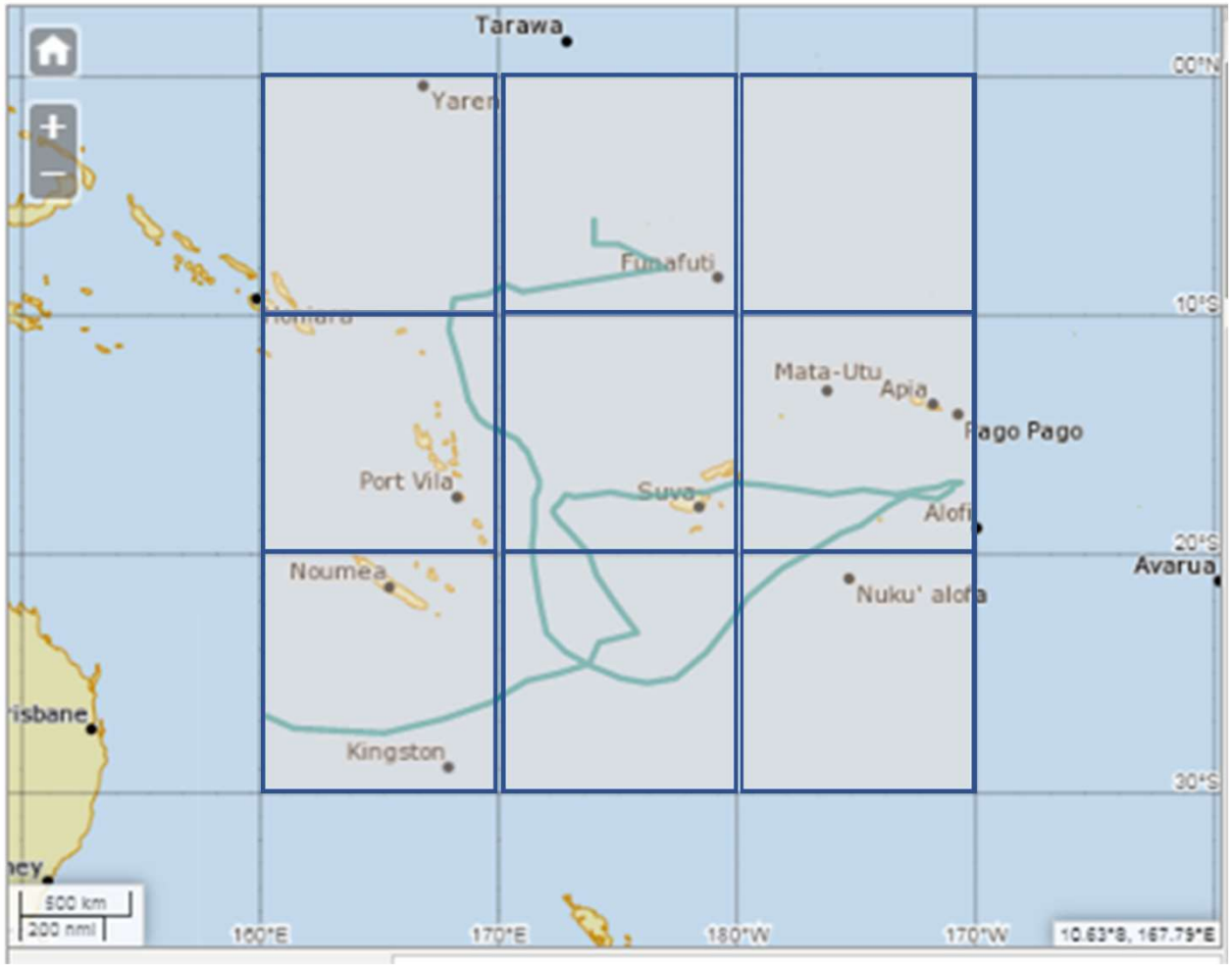
SH TC Climatology



1	1	0
1	2	1
1	2	1

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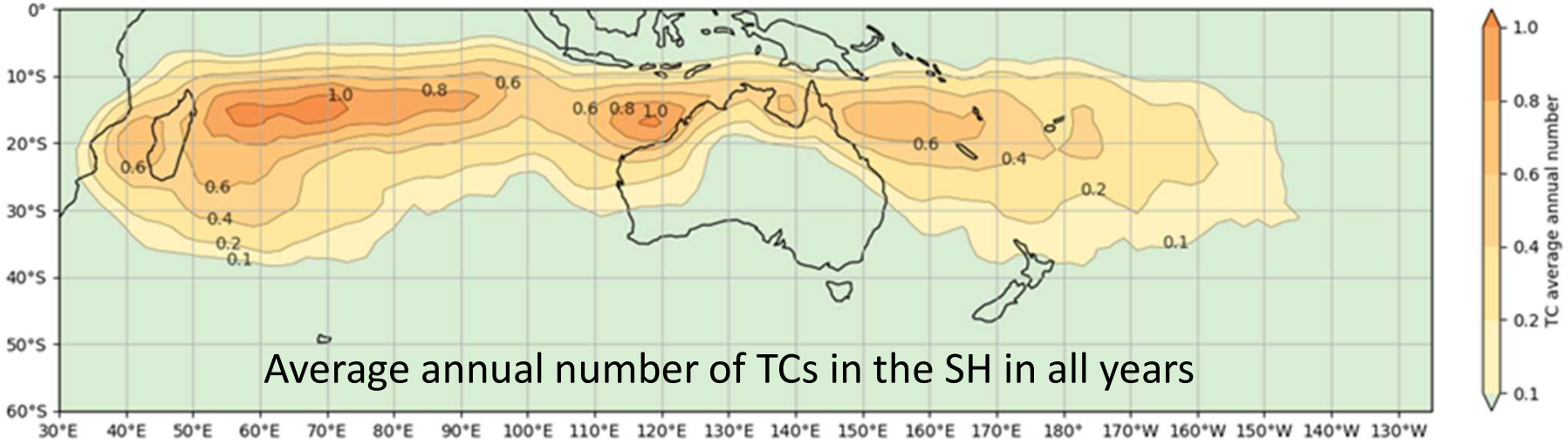
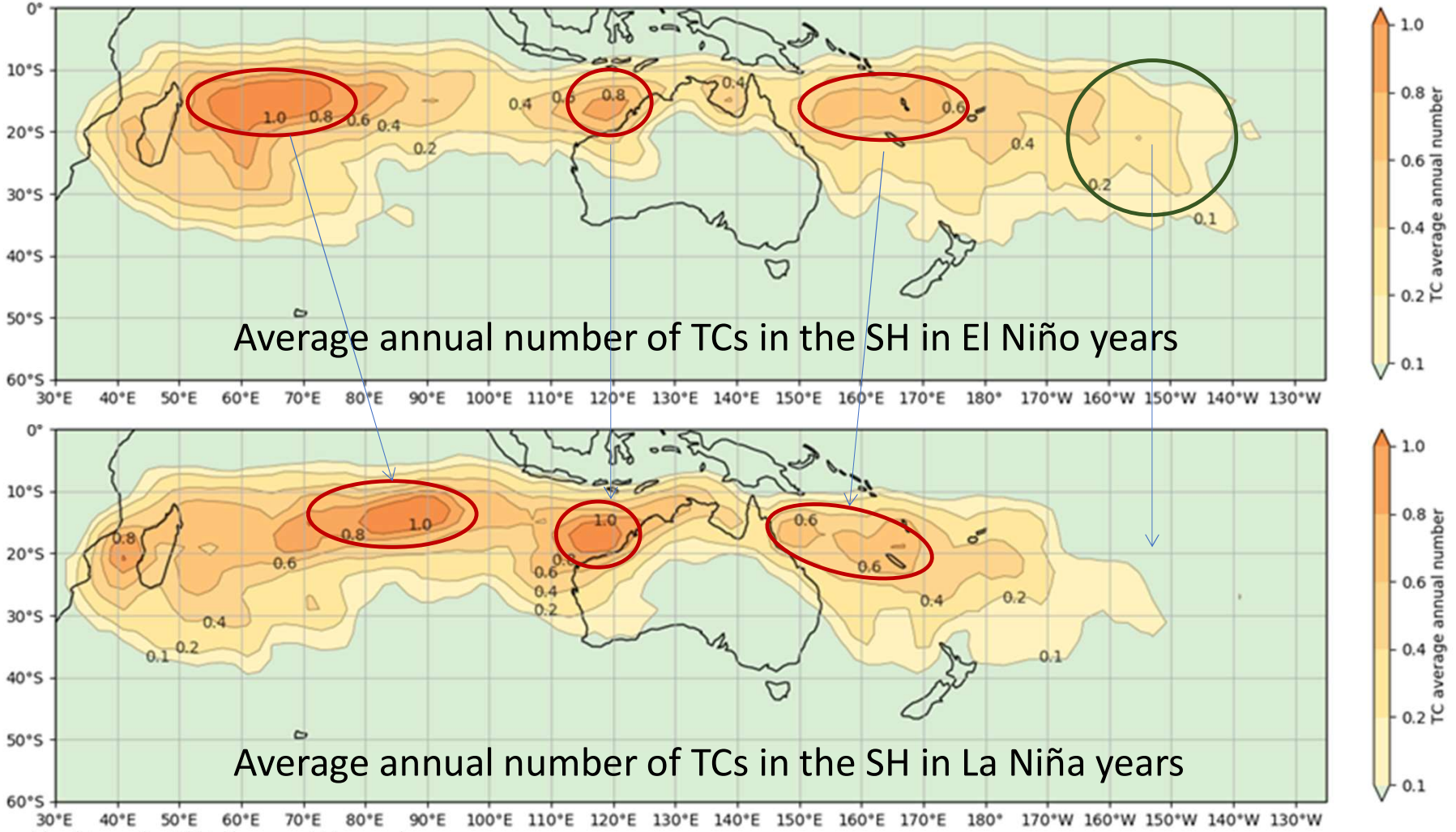
SH TC Climatology

- BoM produced a set of TC climatology maps which describe TC occurrence in the SH in terms of an average annual number using data for the 1969/70 – 2017/18 seasons.
- The maps were produced for all years, El Niño years, La Niña years and Neutral years.



Average annual number of TCs in the SH in all years

SH TC Climatology – ENSO Impact



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SH TC Climatology – ENSO Impact

The EEZ of Australia, Cook Islands, Fiji, Niue, PNG, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu displayed in the SH TC data portal

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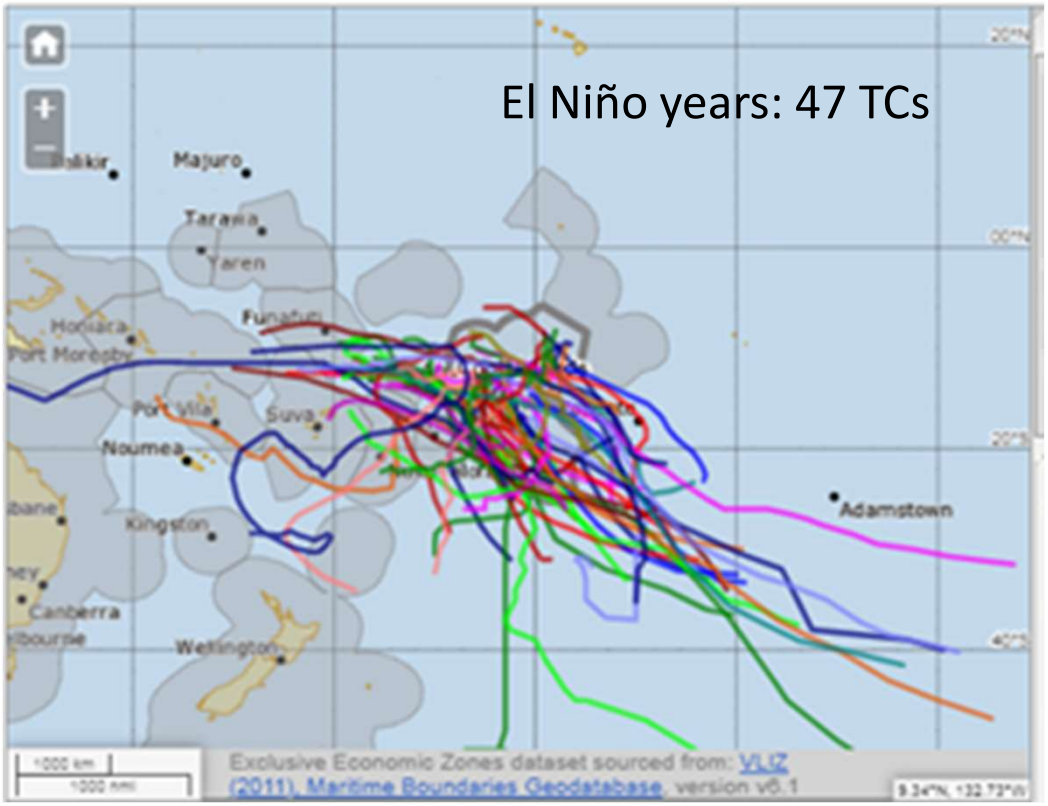
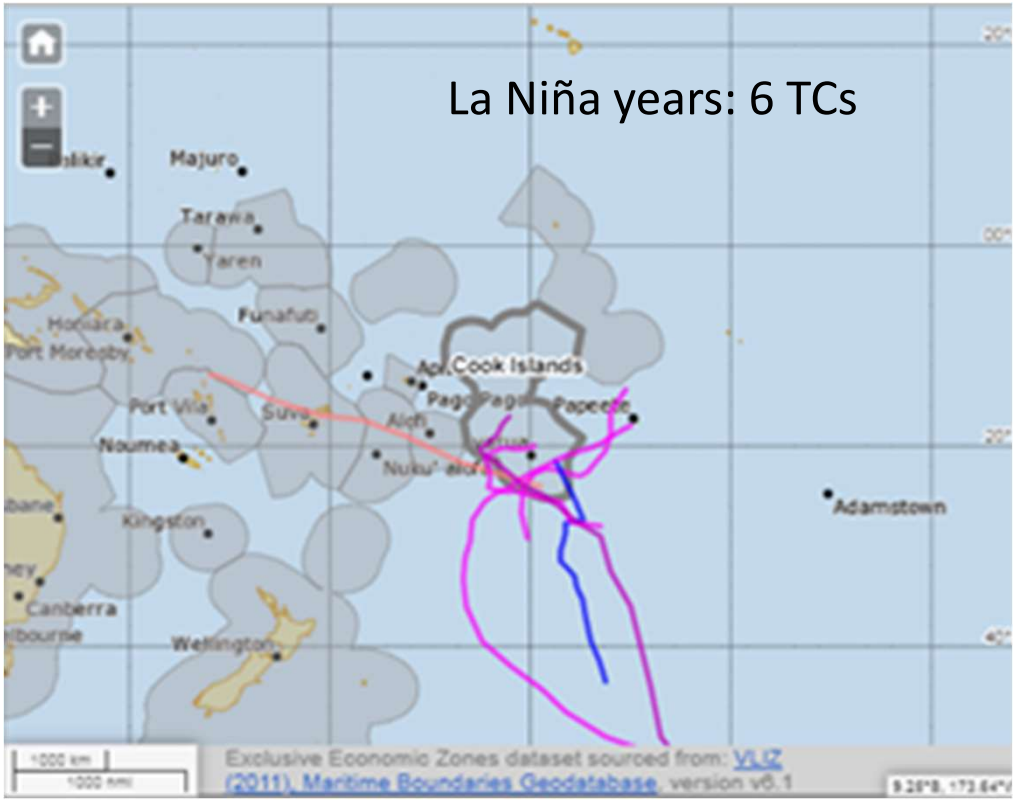
SH TC Climatology – ENSO Impact





The EEZ of Cook Islands displayed in the SH TC data portal

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SH TC Climatology – ENSO Impact

TC occurrences in the EEZ of ten Pacific Island Countries in El Niño, Neutral, La Niña and all years presented as an annual average number (TC, avg) and percentage (TC, %)

Country	El Niño years		Neutral years		La Niña years		All years	
	TC, avg	TC, %	TC, avg	TC, %	TC, avg	TC, %	TC, avg	TC, %
Australia	6.6	30.0	8.8	42.7	8.9	27.2	8.0	100
Cook Isl.	2.7	**62.0**	1.3	30.4	0.5	**7.6**	1.6	100
Fiji	3.1	41.2	2.6	36.0	2.6	22.8	2.8	100
Niue	1.6	**54.9**	0.8	31.4	0.6	**13.7**	1.0	100
PNG	1.3	30.0	2.2	52.5	1.2	17.5	1.6	100
Samoa	1.1	**52.6**	0.6	31.6	0.5	**15.8**	0.8	100
Solomon Isl.	3.9	**50.4**	2.4	33.1	1.9	**16.5**	2.8	100
Tonga	2.3	41.6	2.1	38.6	1.7	19.8	2.1	100
Tuvalu	1.5	**62.8**	0.6	27.9	0.3	**9.3**	0.9	100
Vanuatu	2.7	40.8	1.9	30.0	2.9	29.2	2.4	100
		El Niño				La Niña		

El Niño years:

> 50% of TC occurrences

La Niña years:

the proportion of TCs is small (7.6% to 16.5%)

SH TC Climatology – ENSO Impact

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Niue	1.6	54.9	0.8	31.4	0.6	13.7	1.0	100
PNG	1.3	30.0	2.2	52.5	1.2	17.5	1.6	100
Samoa	1.1	52.6	0.6	31.6	0.5	15.8	0.8	100
Solomon Isl.	3.9	50.4	2.4	33.1	1.9	16.5	2.8	100
Tonga	2.3	**41.6**	2.1	38.6	1.7	**19.8**	2.1	100
Tuvalu	1.5	62.8	0.6	27.9	0.3	9.3	0.9	100
Vanuatu	2.7	**40.8**	1.9	30.0	2.9	**29.2**	2.4	100
		El Niño				La Niña		

El Niño years:

~ 40% of TC occurrences

La Niña years:

the proportion of TCs is moderate (22.8%, 19.8% and 29.2%)

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SH TC Climatology – ENSO Impact

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Tonga	2.3	41.6	2.1	38.6	1.7	19.8	2.1	100
Tuvalu	1.5	62.8	0.6	27.9	0.3	9.3	0.9	100
Vanuatu	2.7	40.8	1.9	30.0	2.9	29.2	2.4	100

El Niño

La Niña

El Niño years:

30% of TC occurrences

La Niña years:

the proportion of TCs is less than in El Nino years (27.2% and 17.5%)

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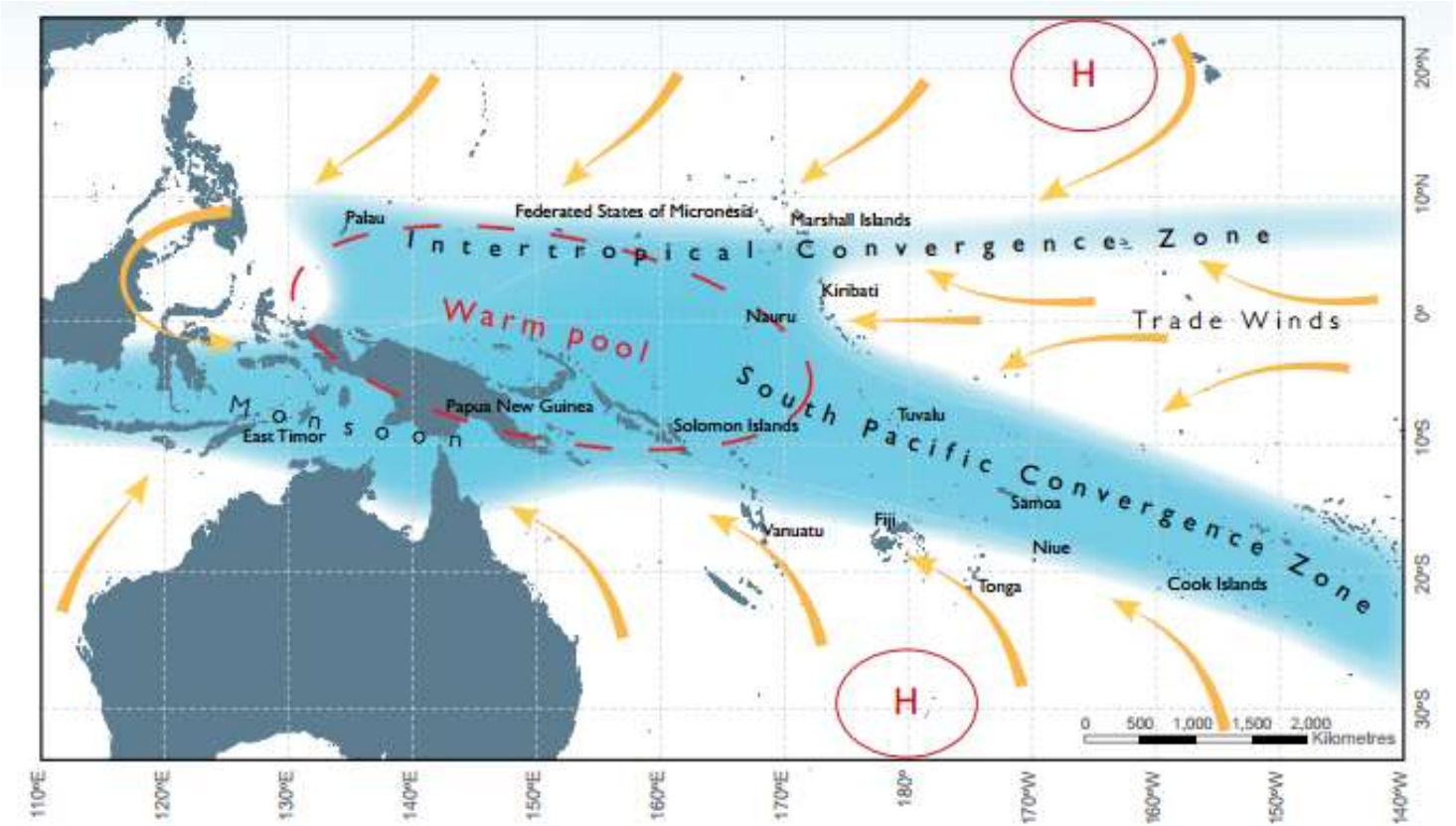
Climate of the Tropical Western Pacific



- Trade winds
- Western Pacific Warm Pool (WPWP)
- Intertropical Convergence Zone (ITCZ)
- **South Pacific Convergence Zone**
- Monsoon

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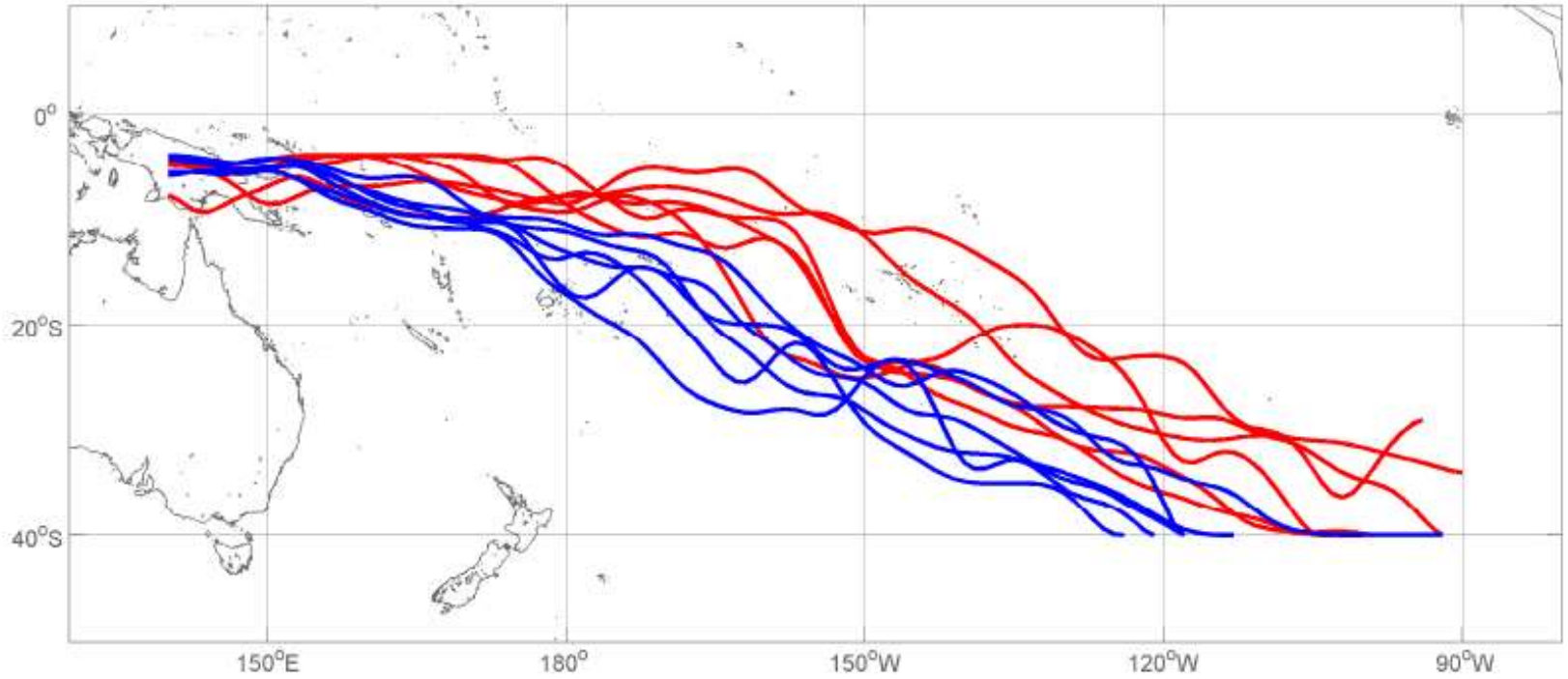
ENSO and the South Pacific Convergence Zone (SPCZ)
(from James Renwick & Brett Mullan, NIWA, N.Z.)



El Niño

La Niña

Shift in SPCZ position = large rainfall variability in affected countries

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SH TC Climatology

- The different impacts of the ENSO on TC inter-annual variability in these three clusters is explained by the countries' position in relation to the South Pacific Convergence Zone (SPCZ).
- The SPCZ is a large scale band of low-level convergence, cloudiness and precipitation which extends from the Western Pacific Warm Pool at the maritime continent south-eastwards towards French Polynesia.
- Its climatological (average over 30 years) position is presented as a line with coordinates 5°S 150°E – 30°S 120°W.
- Examining TC genesis in the area between the equator and the SPCZ in El Niño, Neutral and La Niña years shows significant differences in cyclogenesis.
- In the 1969/1970 to 2012/2013 TC seasons, 80 TCs were formed during the ENSO warm phase and 20 – during the ENSO cold phase.

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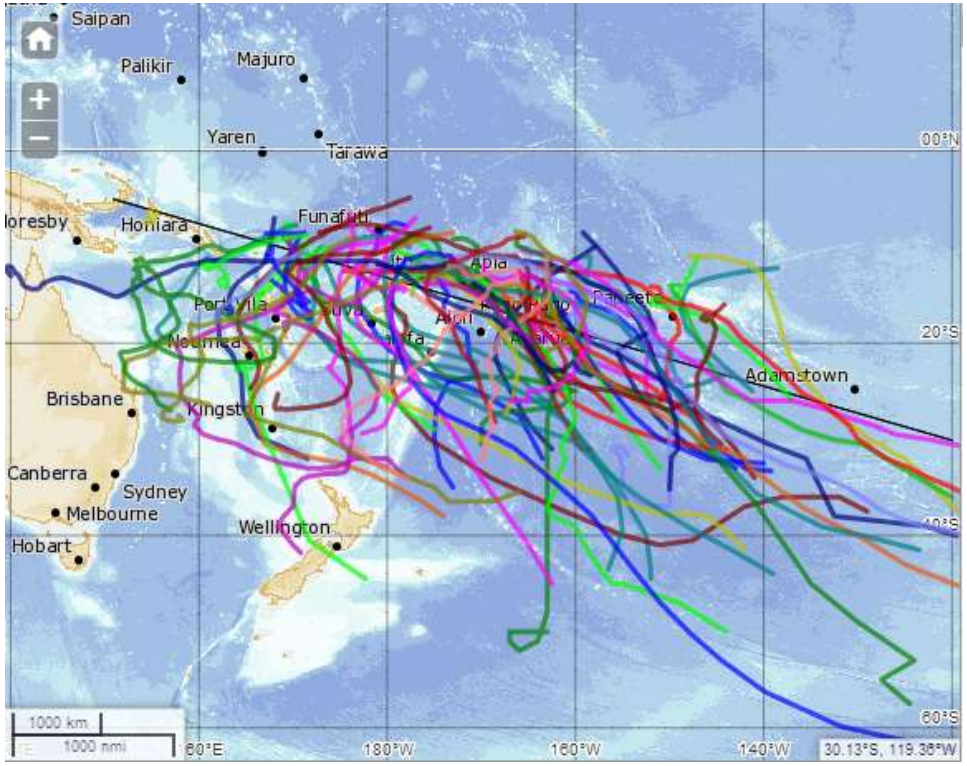
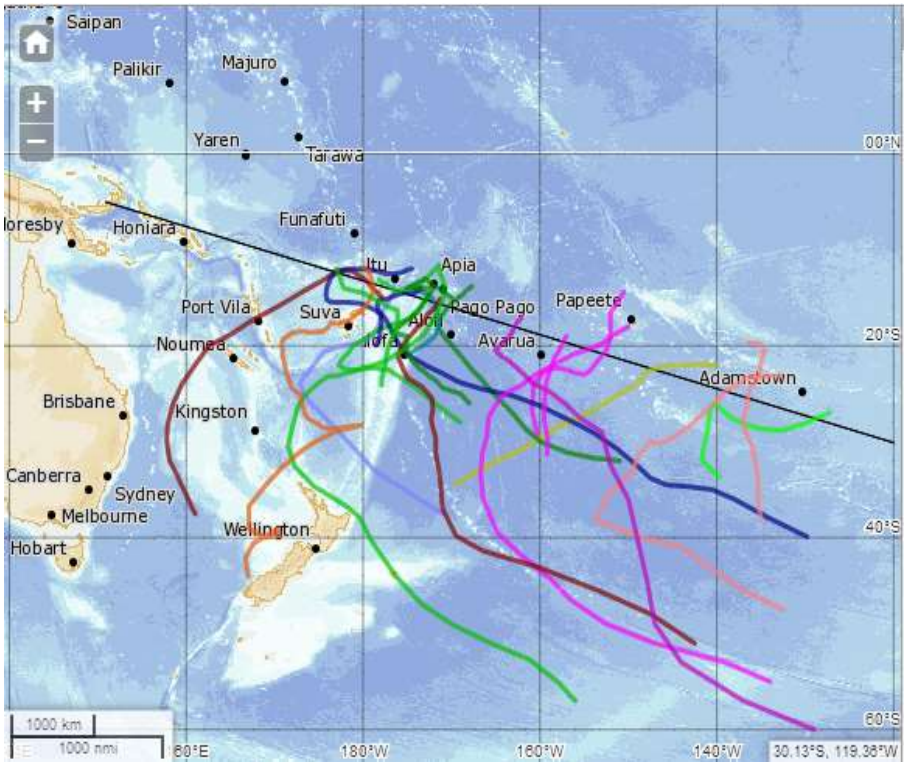
SH TC Climatology



Tracks of 80 TCs which formed in an area between the equator and the SPCZ in El Niño years recorded during 1969/1970 to 2012/2013 TC seasons



Tracks of 20 TCs which formed in an area between the equator and the SPCZ in La Niña years recorded during 1969/1970 to 2012/2013 TC seasons

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CONCLUSION

- Creating and maintaining the SH TC historical data archive for the satellite era that consists of consolidated TC best track data from RSMCs and TCWCs in WMO Regions I and V is an important contribution to strengthening TC EWS.

- This long (almost 50 years), accurate and carefully curated climatology for the SH allows analysis of TC spatial and inter-annual variability.

- ENSO is one of the key global climate drivers that modulates TC inter-annual variability; however, other factors are also important.