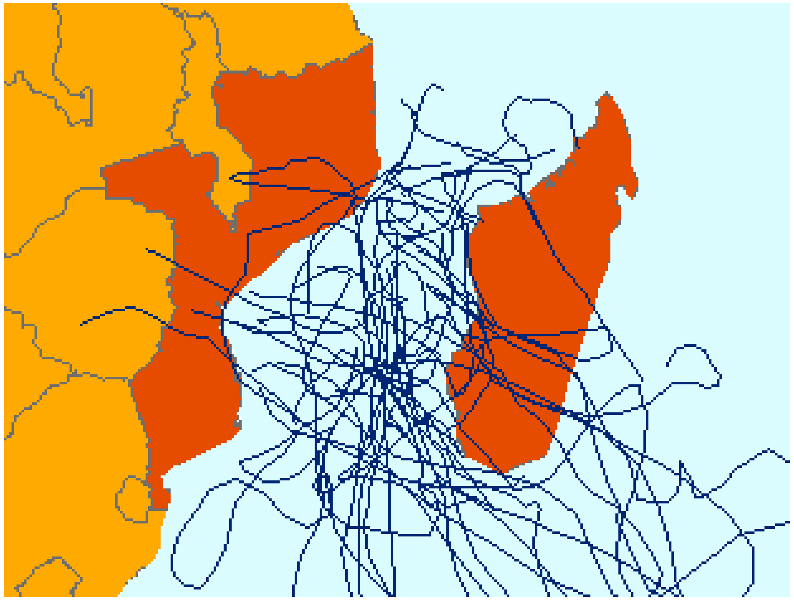
Tropical cyclones in the Mozambique Channel: Relationships with atmospheric teleconnections



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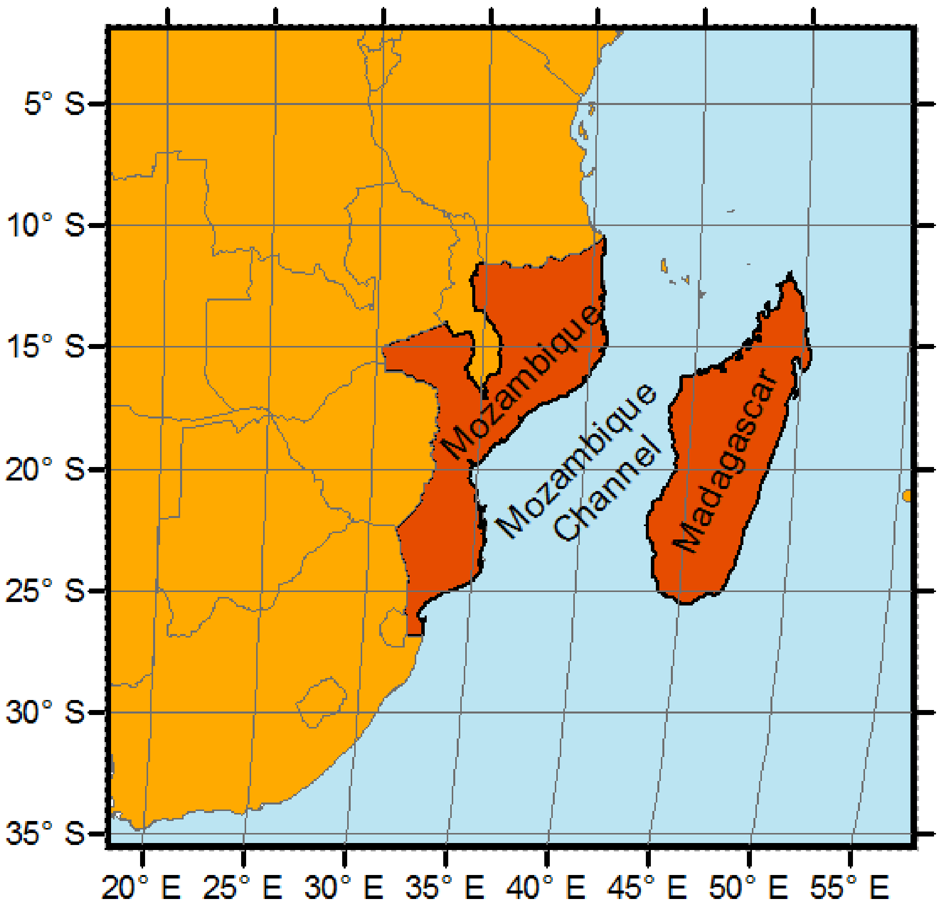
Funding: NSF CAREER Award BCS1053864

Study Goals

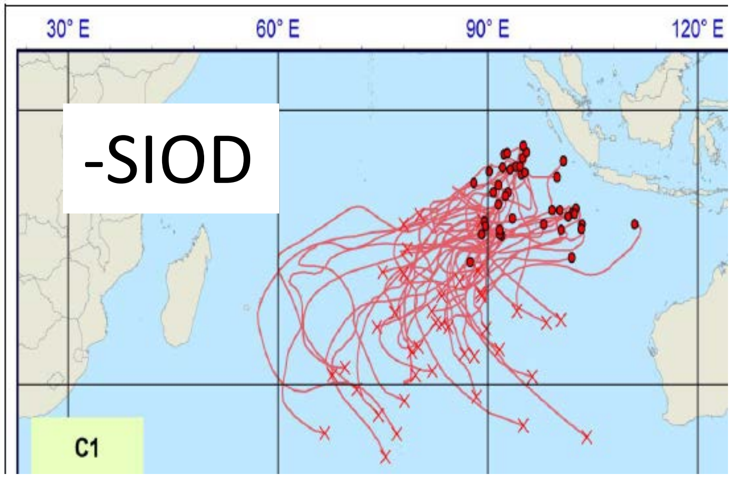
- Characterize tropical cyclone (TC) formation and movement in the MC
- Determine if atmospheric teleconnections known to influence TCs within the larger Indian Ocean have similar associations with TCs in the MC



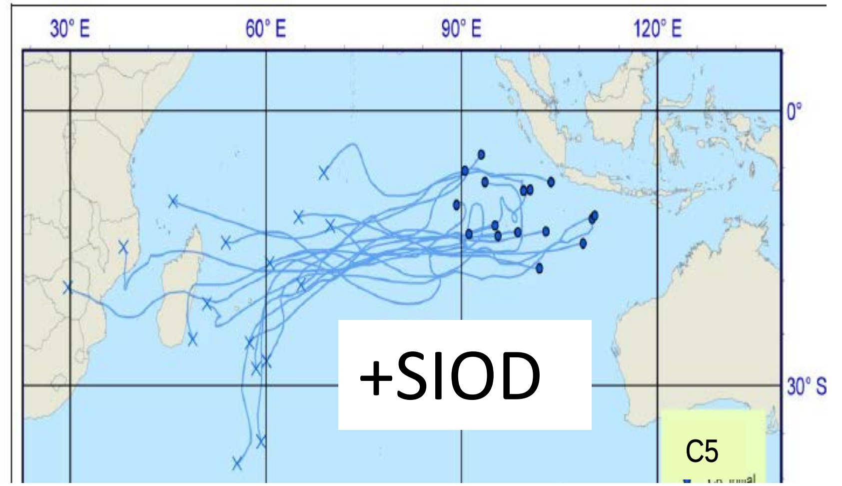
Mozambique Channel (MC)
Study Region

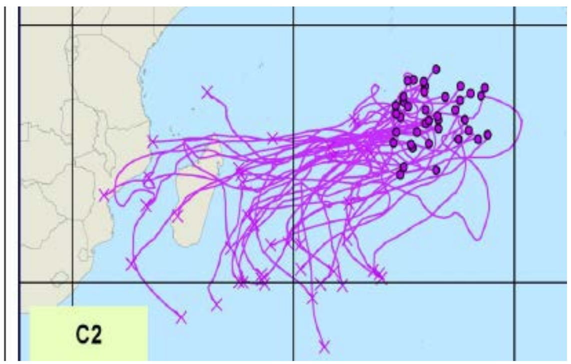
Motivation

- Ash and Matyas (2012, *IJOC*) looked at formation and motion in SWIO, ENSO and SIOD, but omitted MC
- Other studies leave out MC too (Jury 1993; Jury *et al.* 1999; Chang-Seng and Jury 2010)
- Some include the MC in their greater sample (Ramsay *et al.* 2012, Mavume *et al.* 2010, Ho *et al.* 2006)
- Matyas and Silva (2013, *Nat. Haz*.); Silva and Matyas (2014, *WCaS*): impacts from 2 MC TCs on subsistence farmers in rural Mozambique

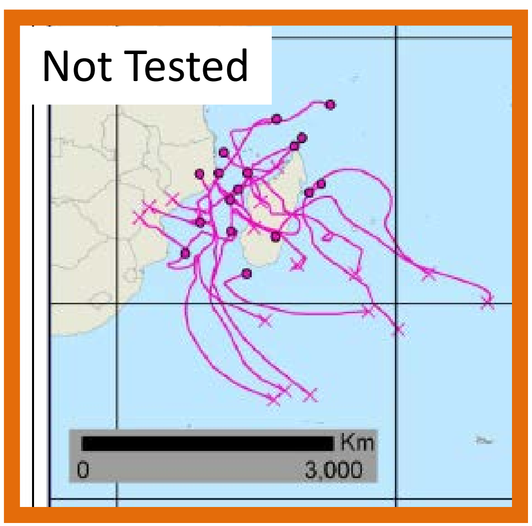


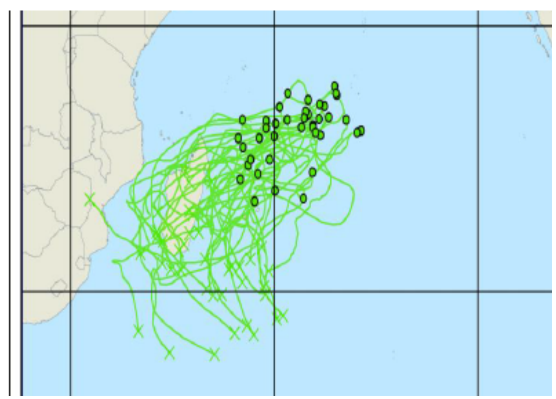
Ash and Matyas
Intl. J Climatology
Published online
Nov. 2010
DOI:
10.1002/joc.2249



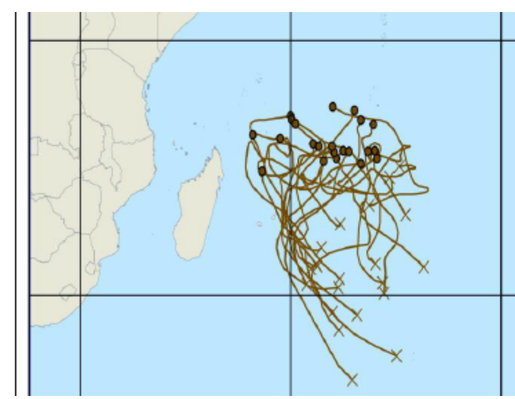


No SIOD
or ENSO
Association





+SIOD La Niña



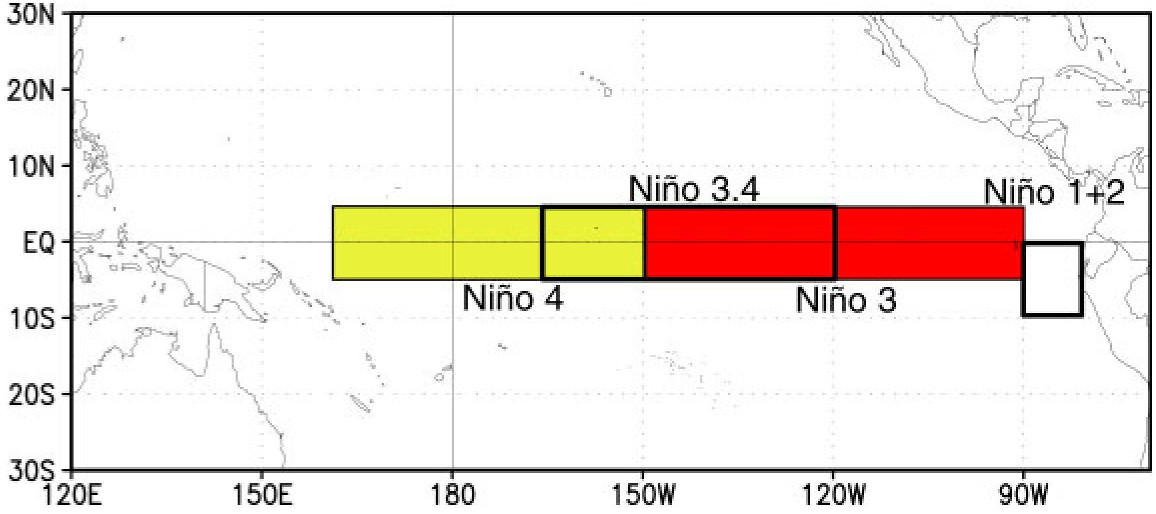
-SIOD El Niño

Data and Methods

- 1980-2010; formation within the MC
- TC positions: IBTrACS v03r04 (Knapp *et al.* 2010)
- Track attributes calculated in GIS: sinuousity, heading from start to end point, turn ratio (/)
- NCEP-NCAR reanalysis data: SST, geopotential heights/anomalies 500 hPa, 200-850 hPa u/v shear, precipitable water, velocity potential 200 hPa
- Data taken from grid cell where TC formation occurred
- Teleconnection values
- Nonparametric statistical tests

El Niño Southern Oscillation

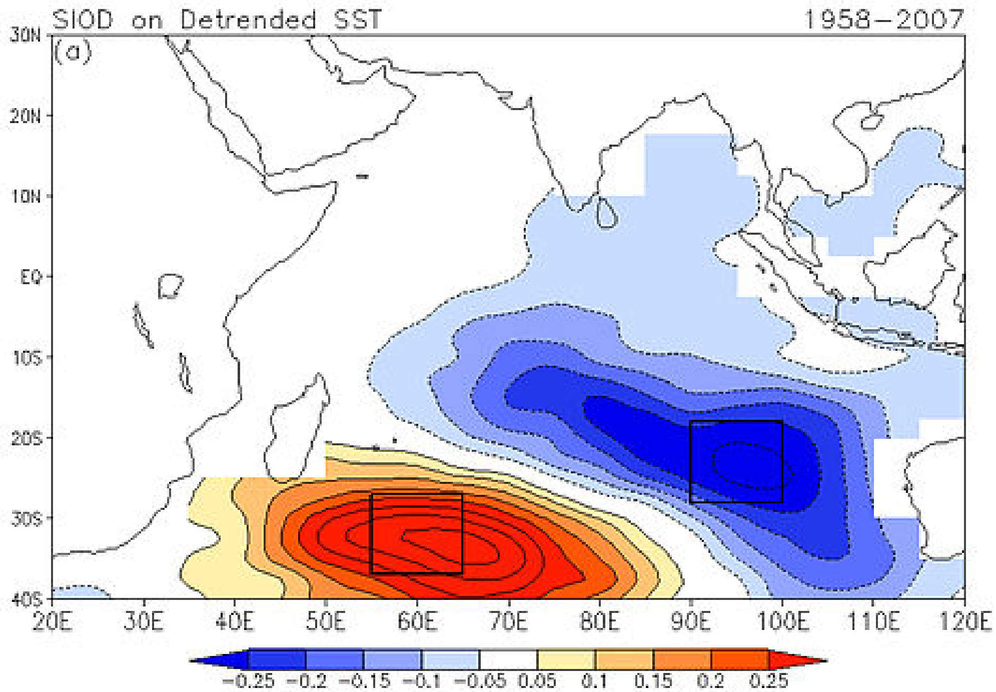
- Oceanic Niño Index (ONI)
- Monthly, 1950 - present

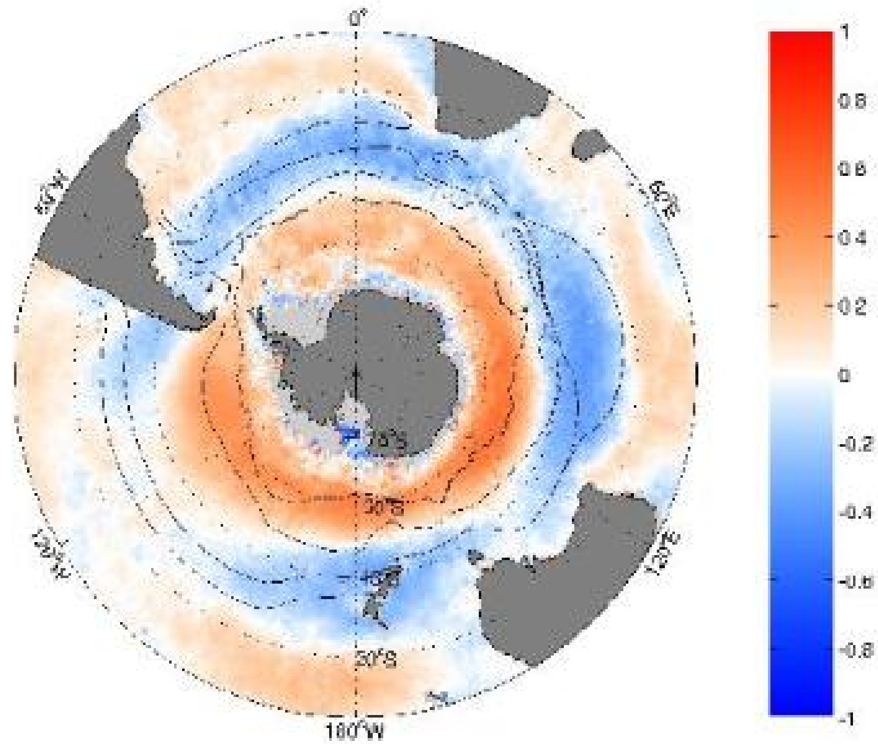


- 3-month running mean of ERSST.v3b SST anomalies (1981-2010) in the region 5°N-5°S, 120°-170°W

IOSD + and SAM +

Image from
Lovenduski (2006)



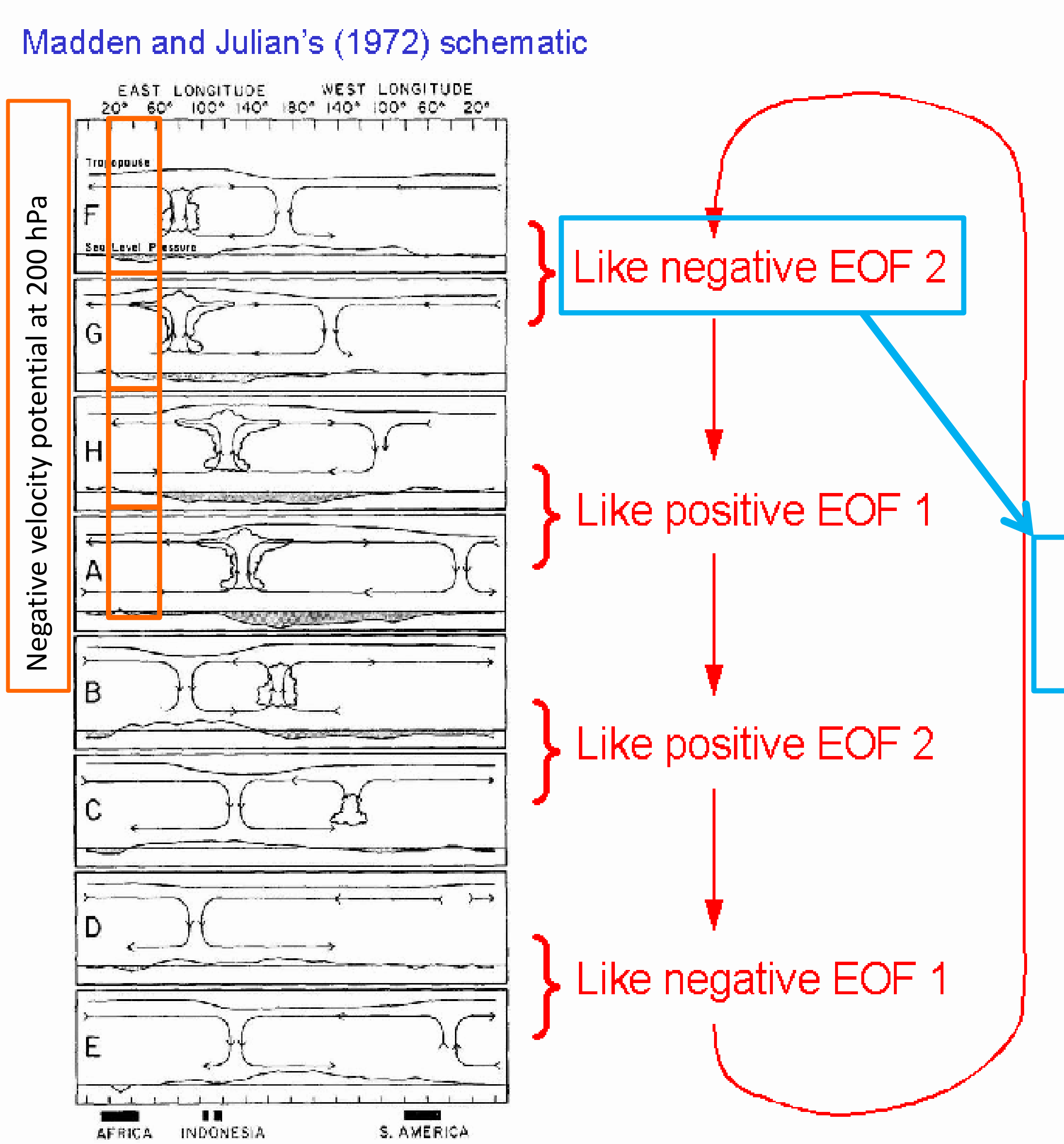


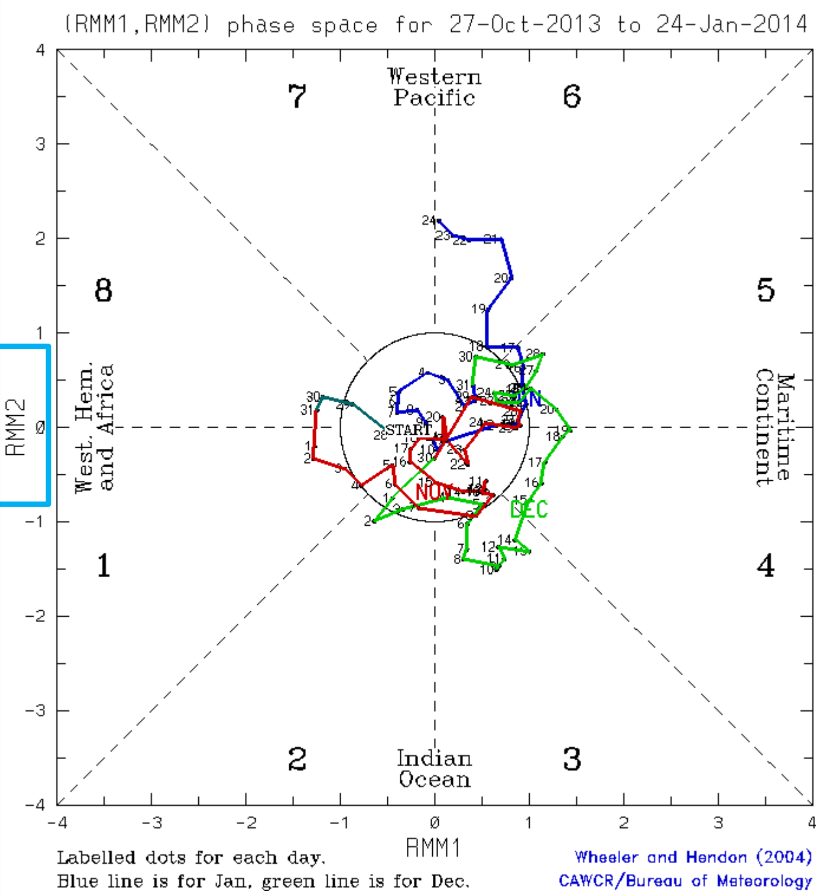
- Behera and Yamagata (2001)
- SST anomalies 29°–10°S, 85°–105°E and 42°–30°S, 50°–80°E
- Monthly, 1958 - 2007

- Nan and Li (2003)
- Diff. in normalized zonal - mean SLP 40 - 70° S
- Monthly, 1948 - present

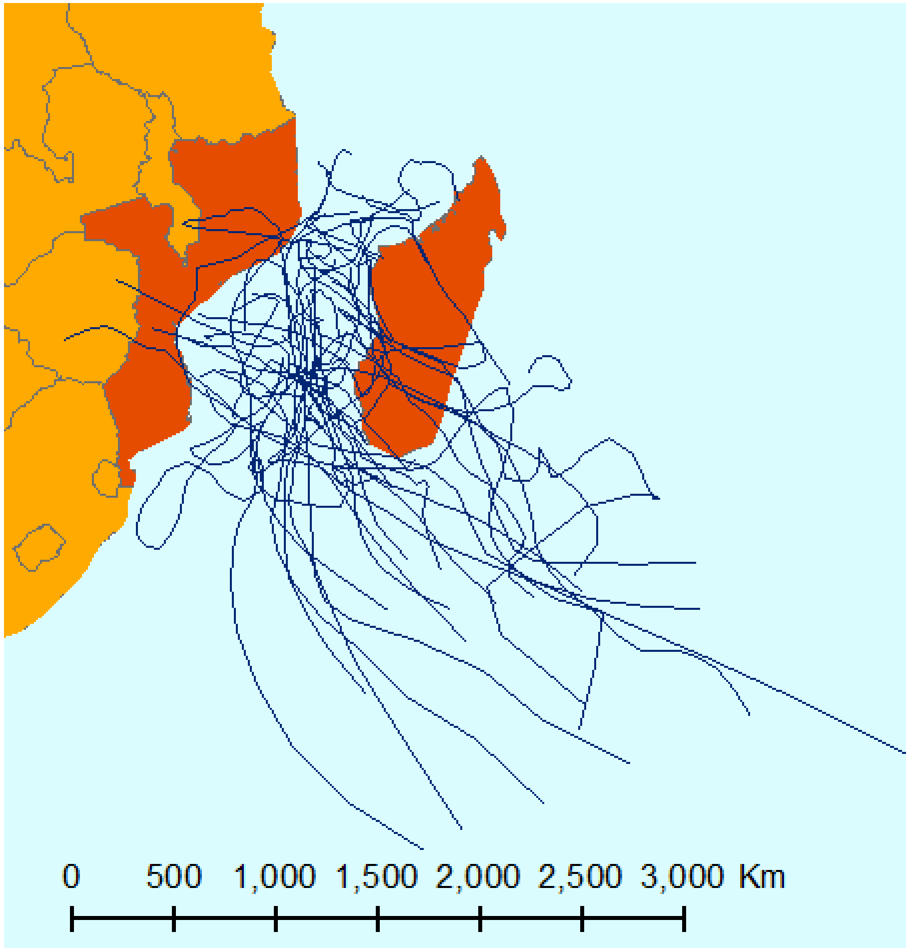
MJO representation

Source: http://cawcr.gov.au/staff/mwheeler/maproom/RMM/





1980-2010: 40 TCs and 21 landfalls

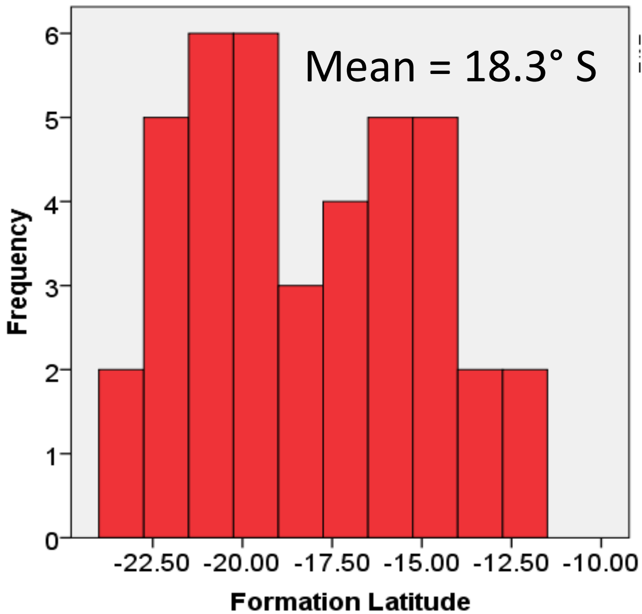


Formation Frequency: X^2 Test

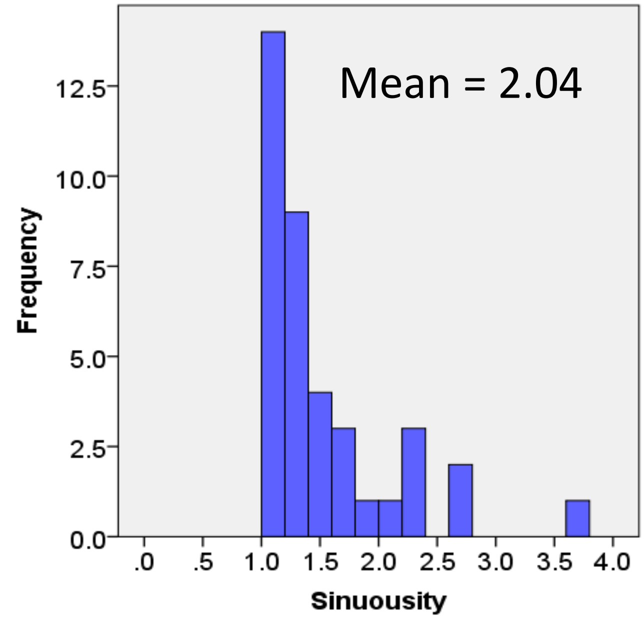
Phase Count	Phase Count	Phase Count	X^2	*p*-value
El Niño 10	Neutral 17	La Niña 13	1.850	0.397
IOSD + 20	IOSD - 16		0.444	0.505
SAM + 26	SAM- 14		3.600	0.058
Vel. Pot. - 32	Vel. Pot + 8		14.400	**0.000**
RMM2 - 20	RMM2 + 20		0.000	1.000

Track Attributes

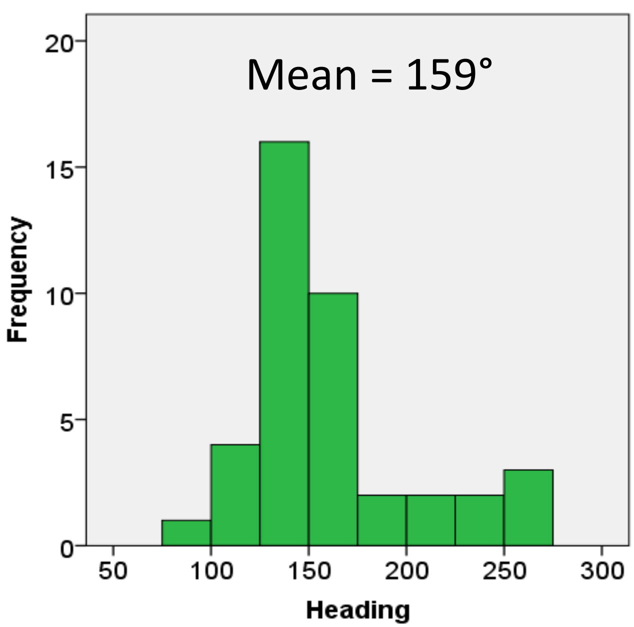
Formation Latitude



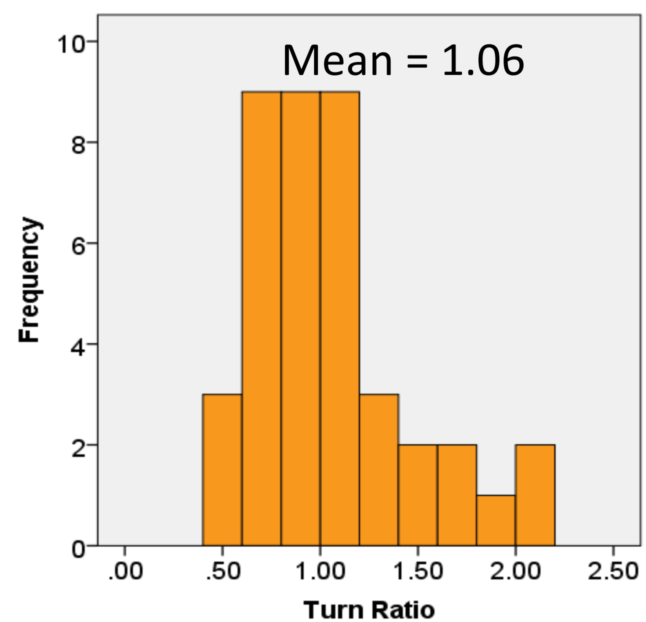
Actual / Straight line



Start point to end point



Start to Mid / Mid to End



Spearman’s Rank Correlation Coefficients

Significant at *α*
0.01
0.05
0.10

Variables	Formation Latitude
Midpoint Latitude	**0.632**
SST	**0.435**
TC Forward Speed	**-0.427**
Zonal Shear	*-0.340*
SAM	*-0.326*
Sinuousity	*0.316*
IOSD	-0.295

Spearman's Rank Correlation Coefficients

Variable	Sinuousity	Heading	Turn Ratio
Heading	**0.447**		
Start Latitude	*0.316*		
Start Longitude	*0.396*	0.287	0.264
Midpoint Longitude		**-0.565**	
Midpoint Latitude	*0.319*		
End Longitude	*-0.391*	**-0.638**	0.283
End Latitude	*0.369*		
Duration	**0.459**		
Speed	*-0.352*		
Precip. Water	*0.350*		
Zonal Shear 200 – 850 hPa		**-0.416**	0.287
IOSD*	*-0.419*		
200 hPa Velocity Potential	-0.302		

*n=36 rather than 40 for the IOSD result.

Spearman's Rank Correlation Coefficients

Variables	IOSD*	ONI	SAM	Vel. pot.
Starting longitude	*-0.387*			
Midpoint latitude	-0.300			
Ending latitude	-0.292			
Sinuousity	*-0.419*			-0.302
Precipitable water				*-0.360*
Geopot. Height 500 hPa		*0.343*		
Height anomaly 500 hPa		**0.445**		
Zonal shear		*-0.337*	*0.376*	
SST				*-0.371*
RMM2				**0.659**

*n=36 rather than 40 for the IOSD result.

Conclusions

- +IOSD: formation S/W, less curved
- +SAM: formation S, strong westerly shear
- El Nino: higher GPH/anom, weak/easterly shear
- MJO (- RMM2): highly correlated with 200 hPa velocity potential as expected
- - 200 hPa velocity potential: more frequent formation, higher PW, more curved, higher SSTs

Thank you!

- Revised manuscript under review as of 1/17/2014

Matyas, C. J. Tropical cyclone formation and motion in the Mozambique Channel, ***Intl. J of Climatology*** (examines 1948-2010)

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- Matyas, C.J. and Silva, J.A. 2013. Extreme weather and economic well-being in rural Mozambique. ***Natural Hazards***, 66, 31-49, DOI: 10.1007/s11069-011-0064-6.
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