Rapid Increase of High Ocean Heat Content Regions in the Western North Pacific Ocean for Super Typhoons

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Bo Qiu, Eric D'Asaro, Peter Black (USA)

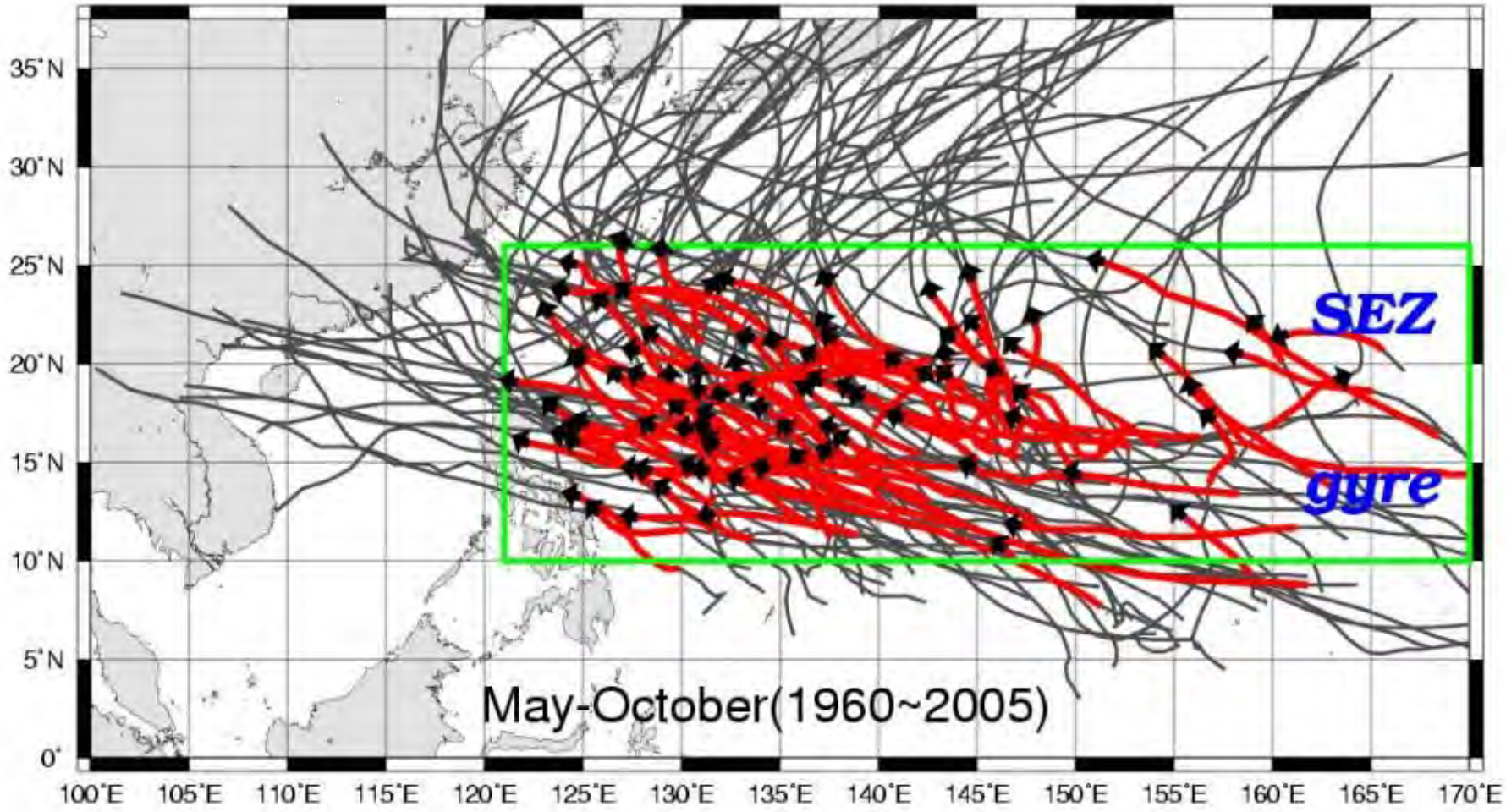
Saffir Simpson Tropical Cyclone Scale

Category	Winds (knots)
TD	< 34
TS	34-63
1 (Issac)	64-82
2	83-95
3	96-113
4	114-135
5 (Sanba, 150kts)	>135

> 130 kts

super typhoon

Hurricane Katrina (2005) ,supertyphoon Maemi (2003)……



Cat 5: WNP: 51%; Atlantic: 9% ;

Lin et al. MWR 2005; 2008; 2009

What is the long-term variability of SST and subsurface condition in this MDR (Main Development Region)?

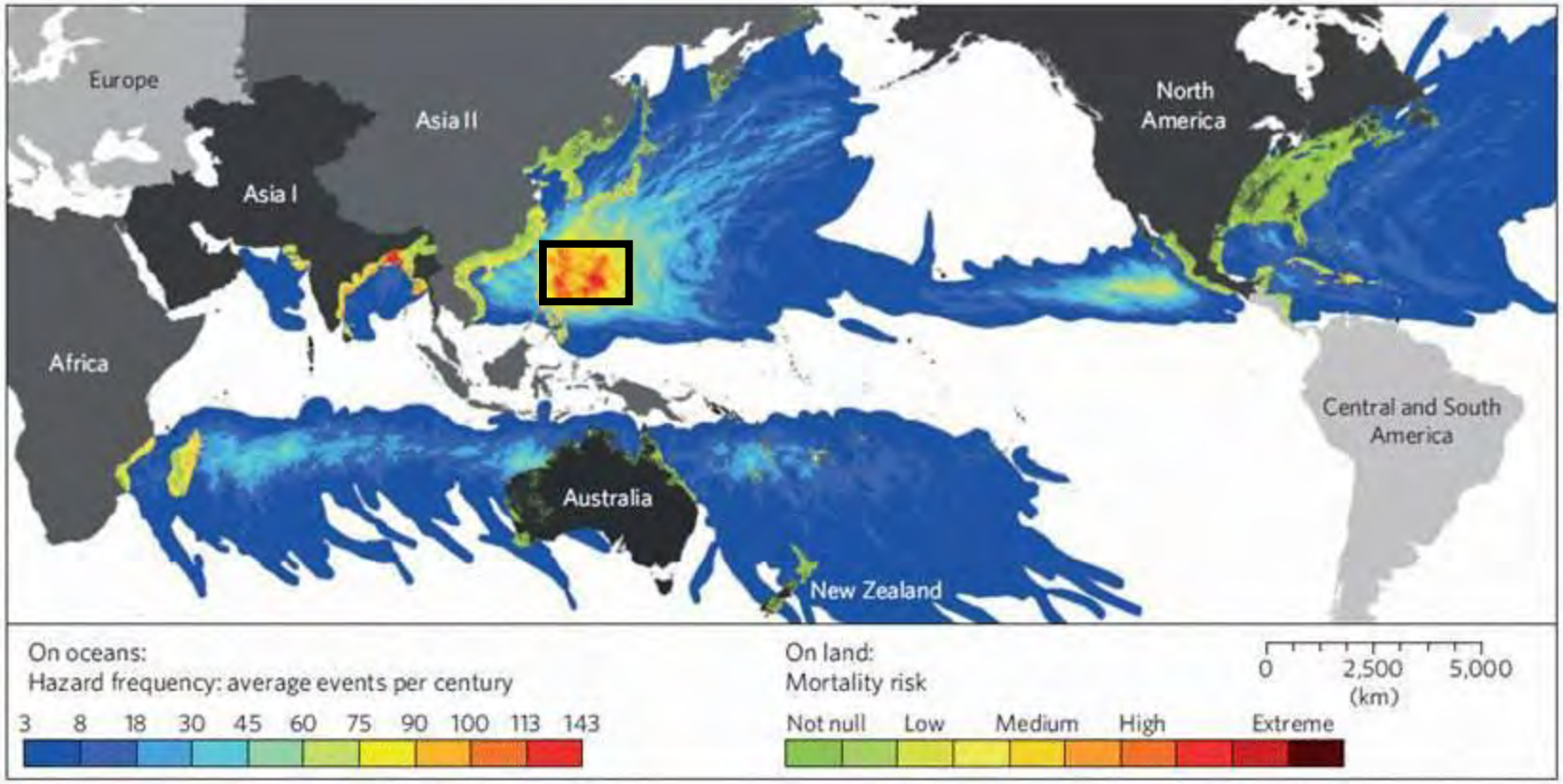
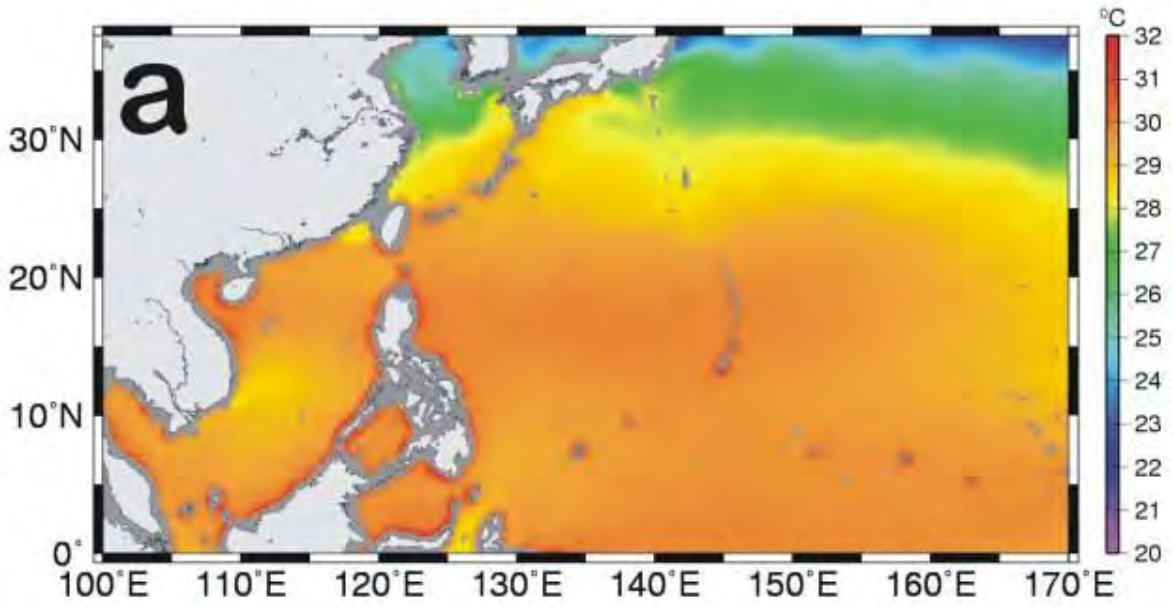
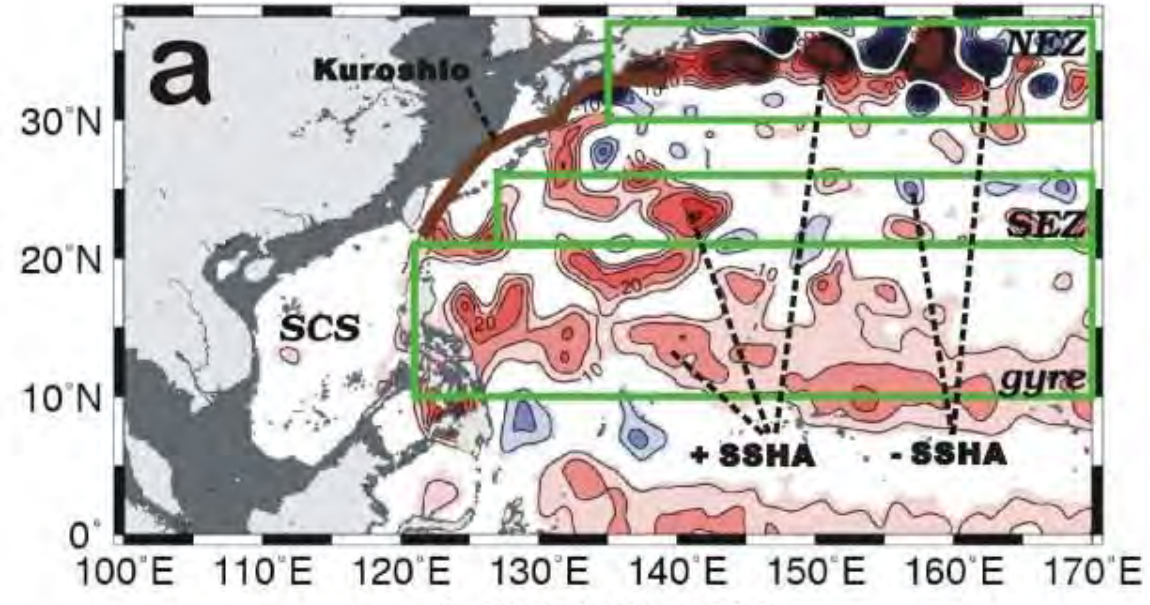


Figure 1 | Map showing distribution of hazard frequency and mortality risk from TCs for the year 2010. Estimates are applied to all pixels on a geographic grid. Mortality risk is categorized from low to extreme.

Peduzzi et al. *Nat. C.C.* 2012


a
°C
32
31
30
29
28
27
26
25
24
23
22
21
20
30°N
20°N
10°N
0°
100°E
110°E
120°E
130°E
140°E
150°E
160°E
170°E


a
Kuroshio
NEZ
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SCS
gyre
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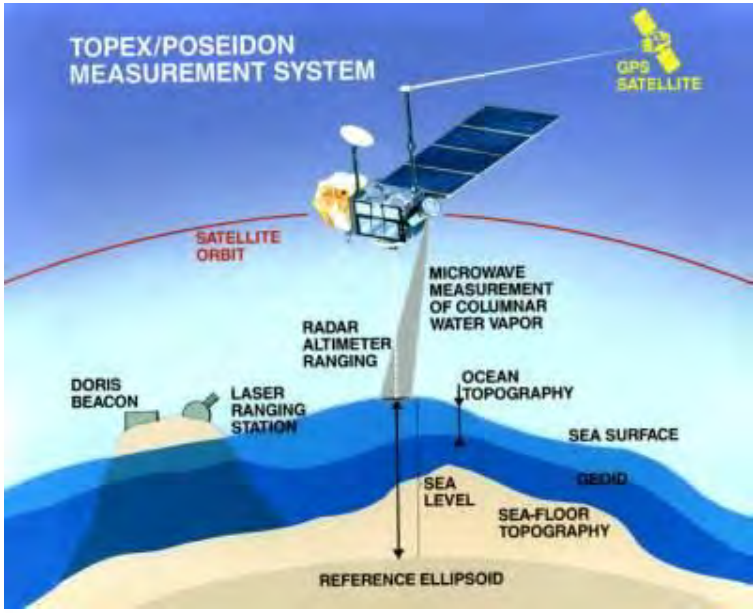
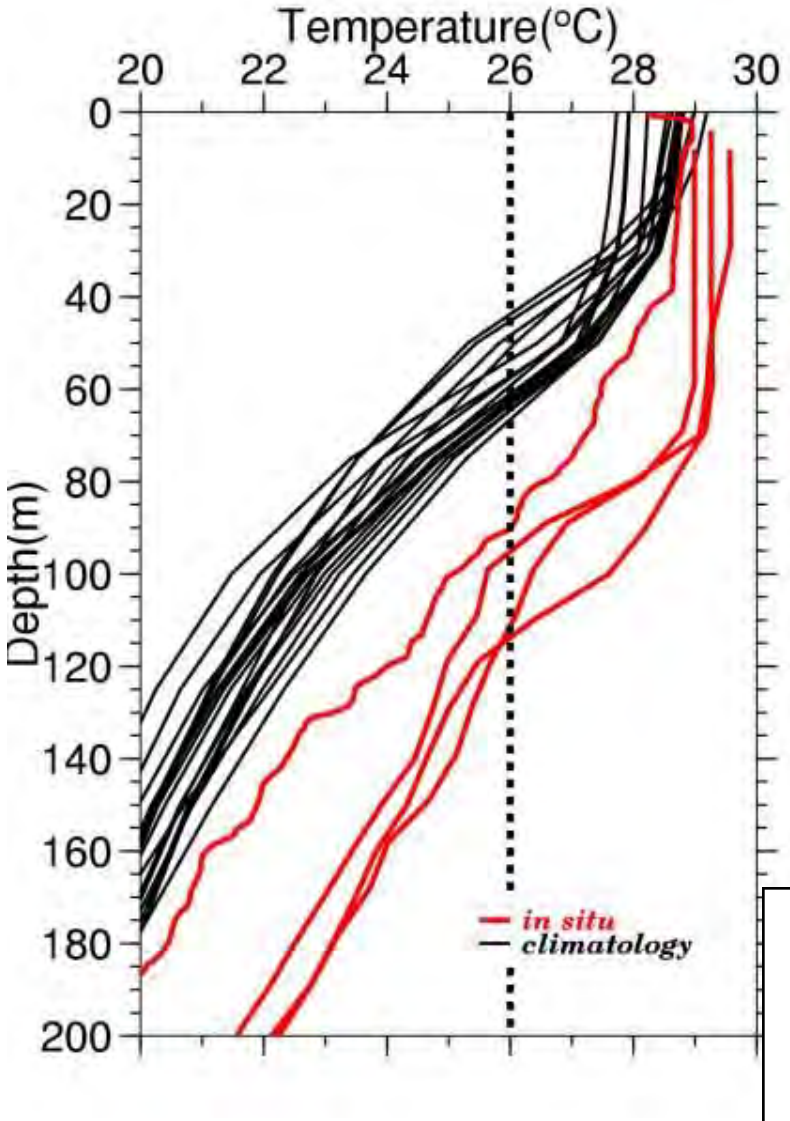
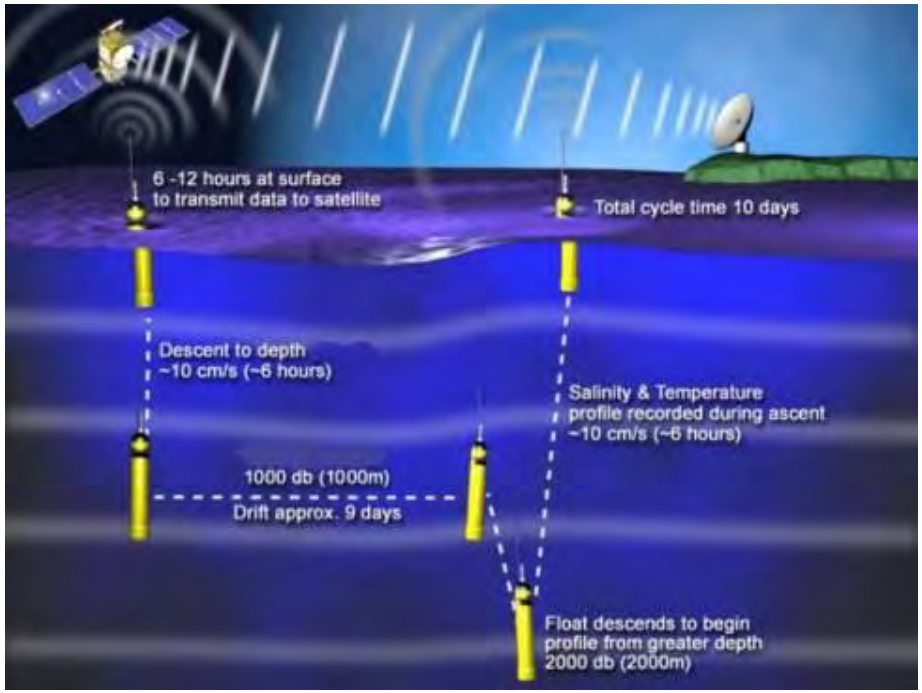

TOPEX/POSEIDON
MEASUREMENT SYSTEM
GPS
SATELLITE
SATELLITE
ORBIT
MICROWAVE
MEASUREMENT
OF COLUMNAR
WATER VAPOR
RADAR
ALTIMETER
RANGING
DORIS
BEACON
LASER
RANGING
STATION
OCEAN
TOPOGRAPHY
SEA SURFACE
GEOID
SEA
LEVEL
SEA-FLOOR
TOPOGRAPHY
REFERENCE ELLIPSOID

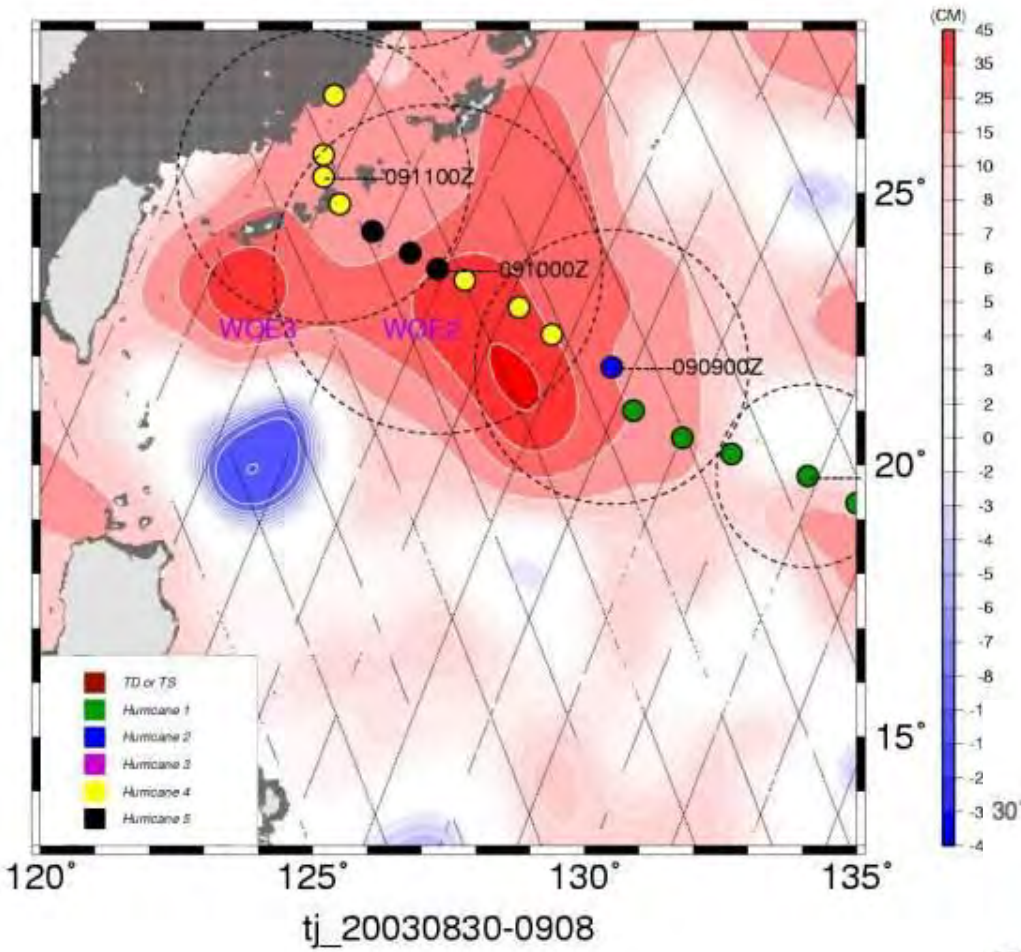


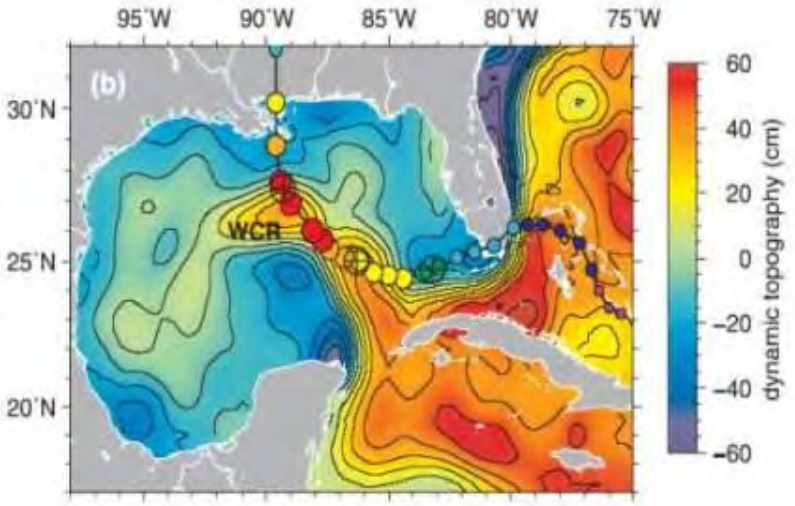
Lin et al. MWR 2008



In situ profiles	*In situ* D26 (m)	D26 (m) Climatology	Deepening / shoaling of D26 (m)	% of deepening/ shoaling w.r.t. climatology
Saomai (2000)	88	58	+30	+52%
Maemi_1	129	63	+66	+105%
Maemi_2	96	63	+33	+52%
Maon	109	63	+46	+73%
Average	106	62	+44	+69%

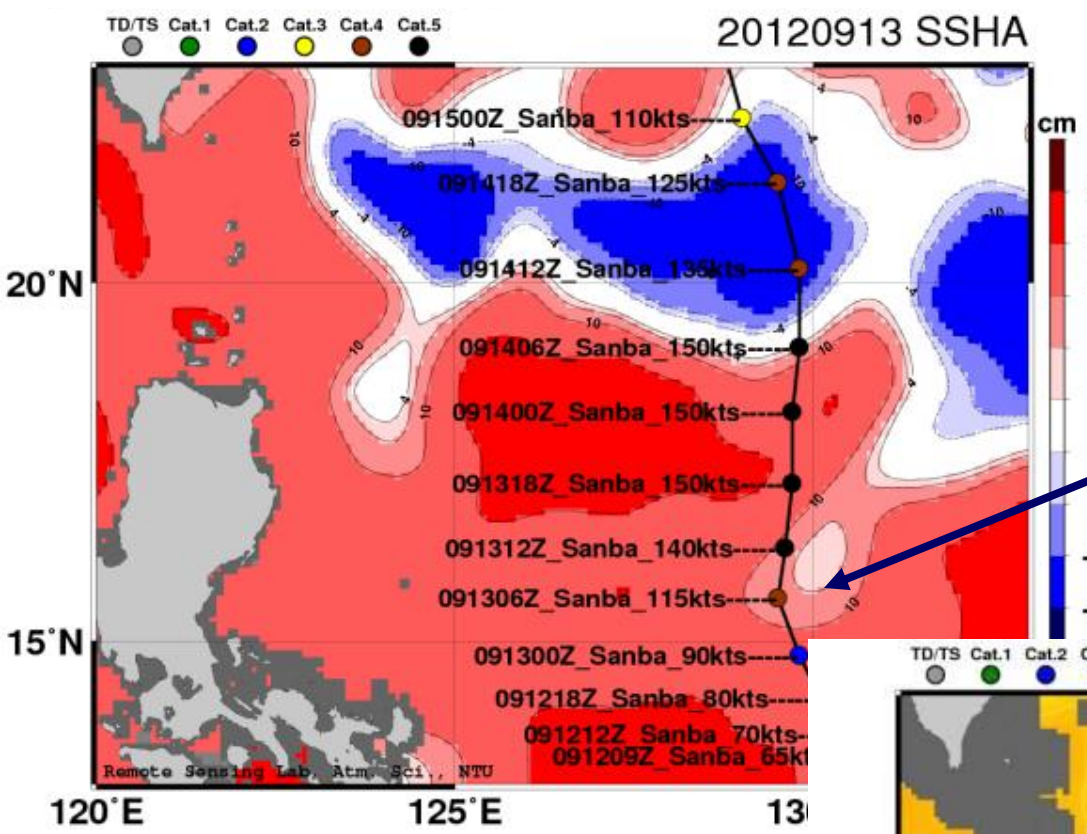
Lin et al. MWR 2005; 2008



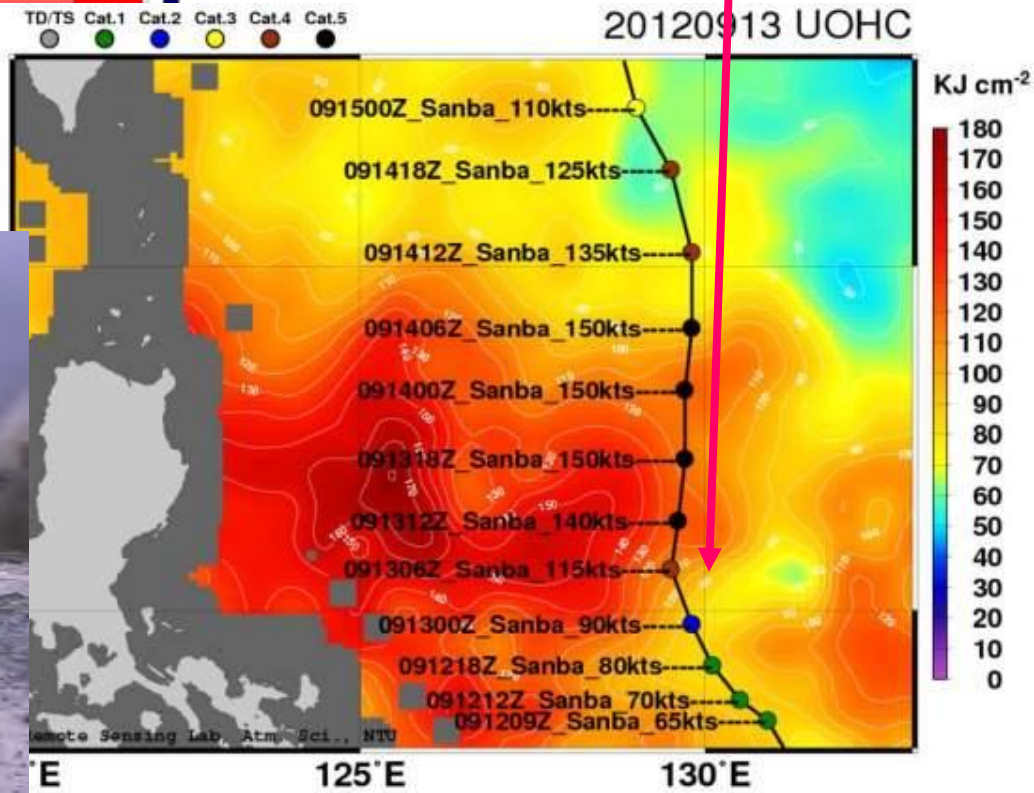


Maemi : most intense TC on earth in 2003 & one of the costliest typhoon to S. Korea

Scharoo et al. EOS 2006

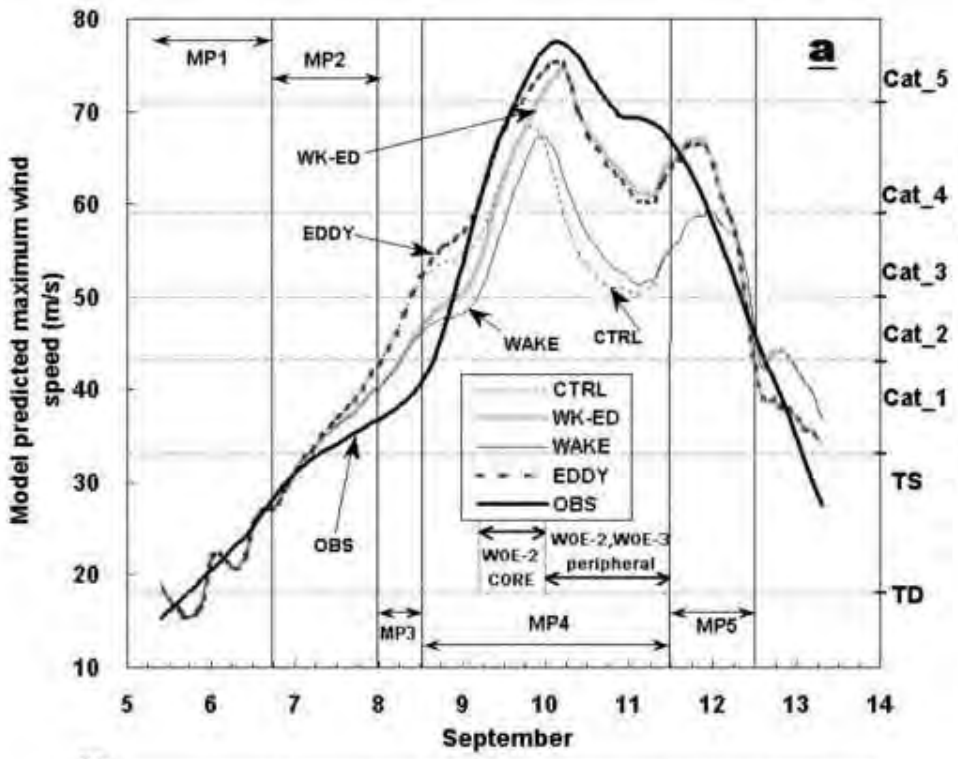


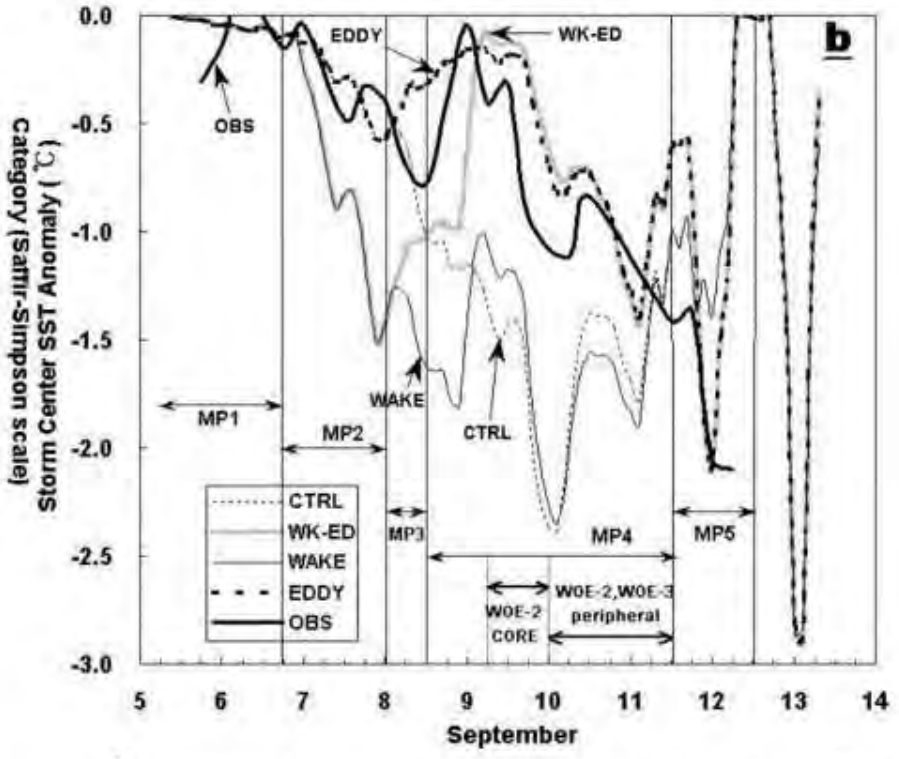
Rapidly-intensified in 12 h from cat 2 to 5



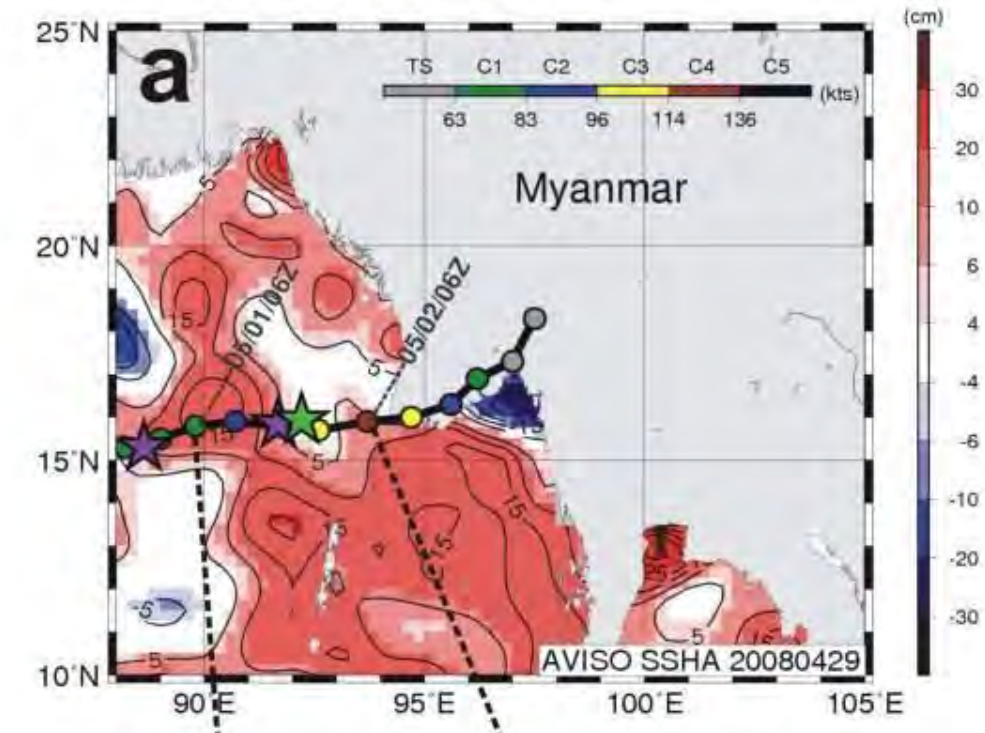
MIT's CHIPS (Coupled Hurricane-Ocean Model)

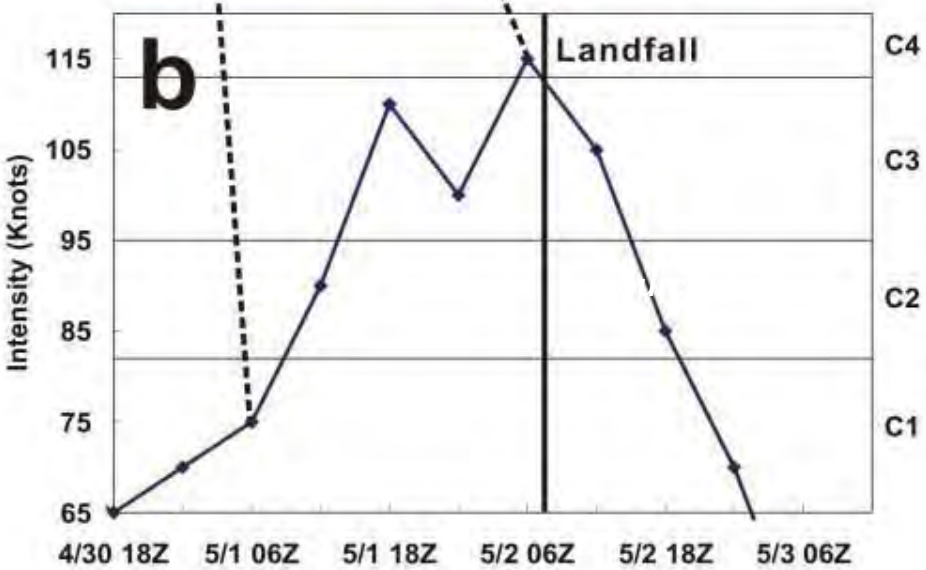
Lin, Wu, Emanuel et al., 2005, MWR





Killer cyclone Nargis (2008)





Catastrophic event (> 130,000 death):

RI took place just prior to landfall

Lin et al.

GRL 2009

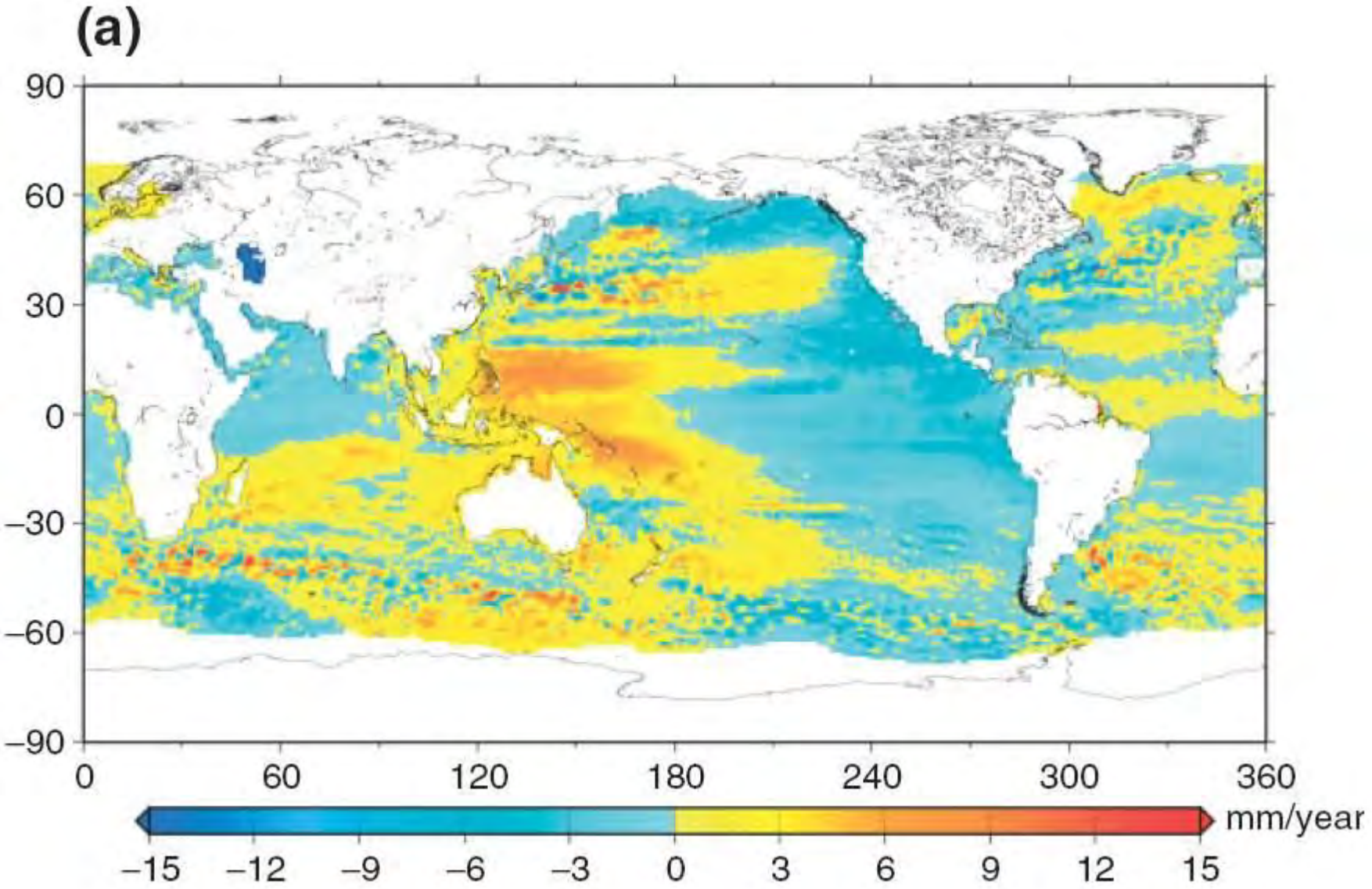
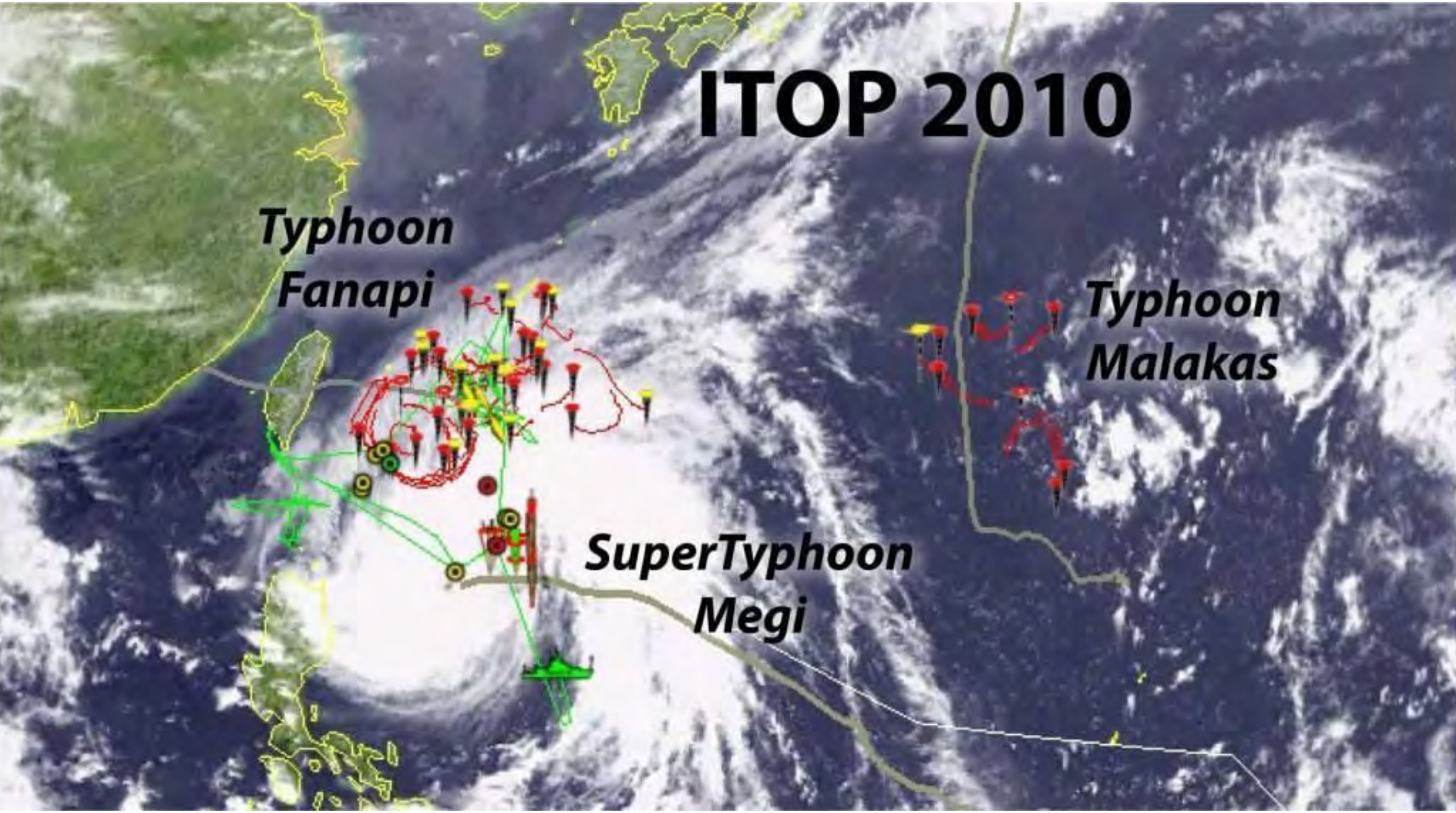


FIGURE 9 | (a) Spatial trend patterns in altimetry-based sea level over 1993–2009 with respect to the global mean rise (a uniform mean trend of 3.3 mm/year has been removed).

After Cazenave and Remy 2011 ; Qiu and Chen JPO 2012

Case 1: Supertyphoon Megi: Cat 5



Case 2: Typhoon Malakas: Cat2: Case 3: Typhoon Fanapi: Cat 3

Conclusions

- ***Rapid increase (~ 40 %) of warm ocean feature area in the West Pacific MDR is observed in the past decade.***

- ***Extreme deep/warm subsurface (D26 > 135m) region increased from 3 to 12%. From ocean's perspective, there is an increase chance to support cat 5 or cat 6 super typhoons.***

- ***It is not clear whether this is a long-term trend and how long will this increase continue.***

- ***It will be interesting to see whether atmospheric conditions have also been improved for category-5 super typhoons in the past 2 decades.***

- ***Propose revision of Emanuel's MPI theory over the West Pac through inclusion of ocean's subsurface information.***