Year of the Maritime Continent – Archipelagic seas around the Philippines

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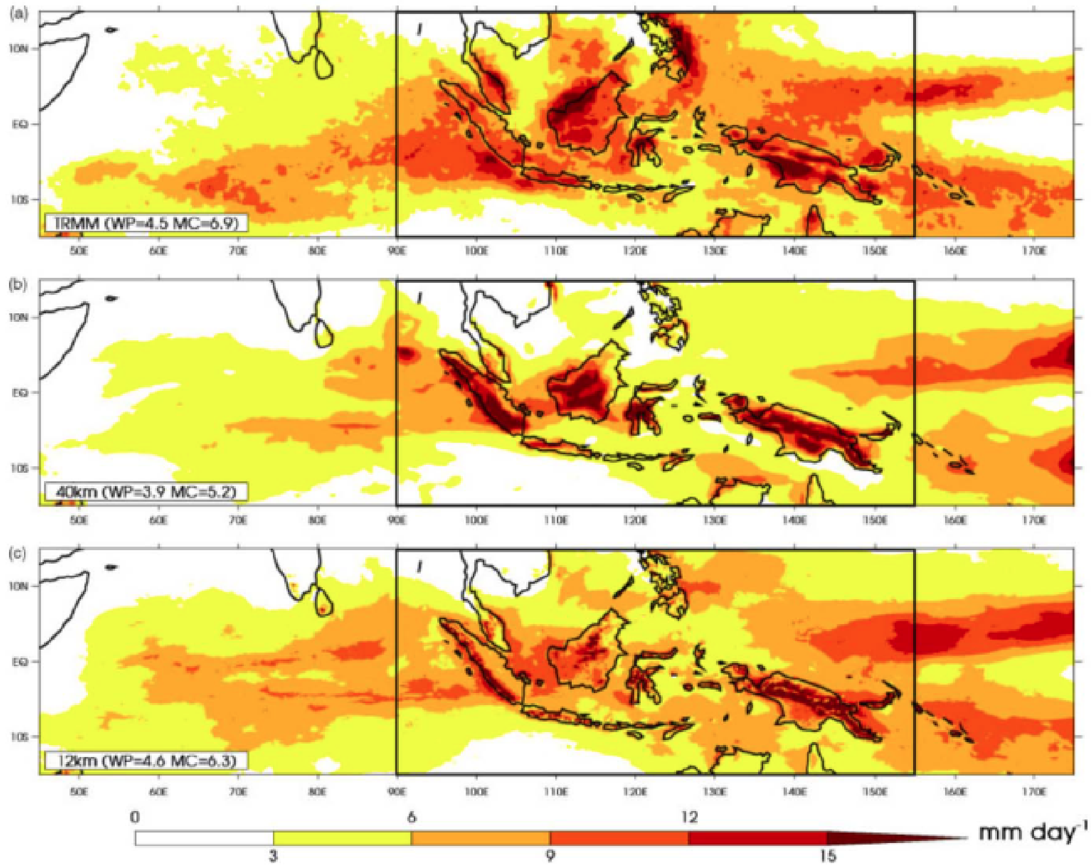
Research Questions in the MC

Overestimate/Underestimate for Land/Ocean region

TRMM
(2008/09)

UKMet UM
40km

UKMet UM
12km

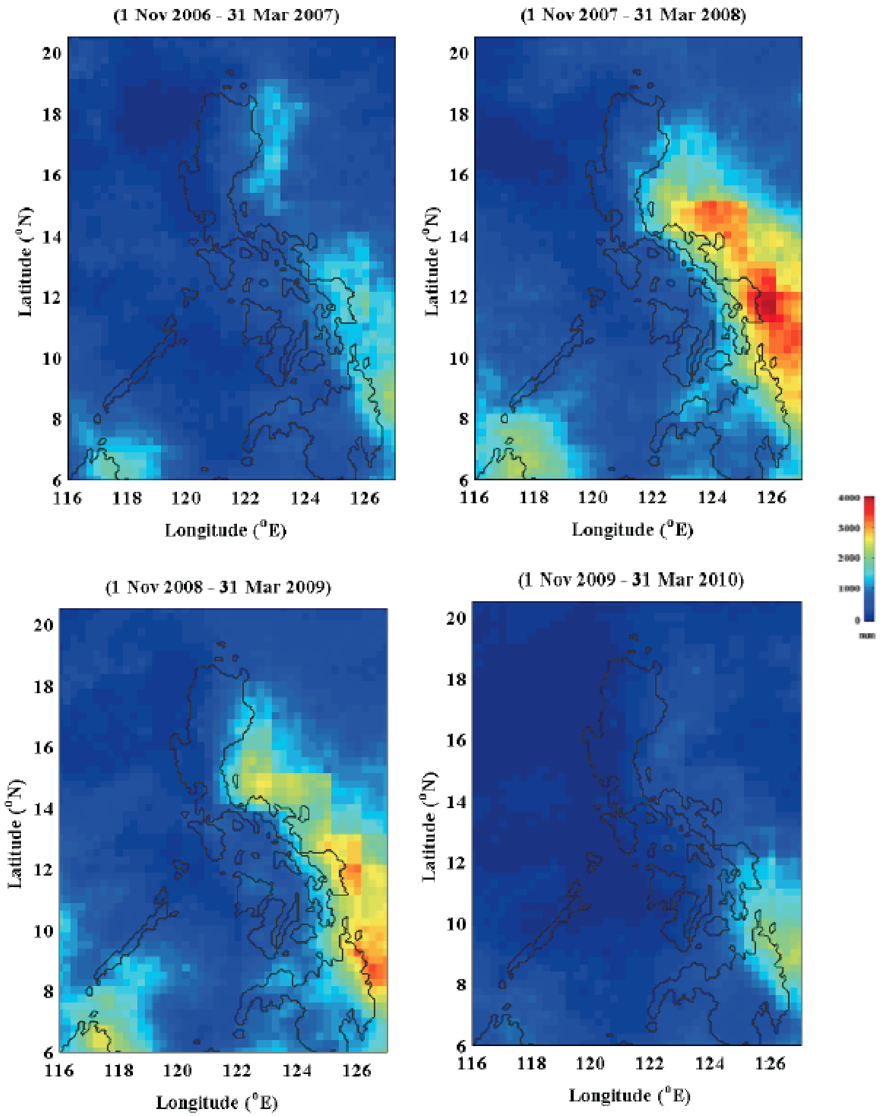


From Love et al. (2011)

Significance of ‘underestimation’ of precipitation in models

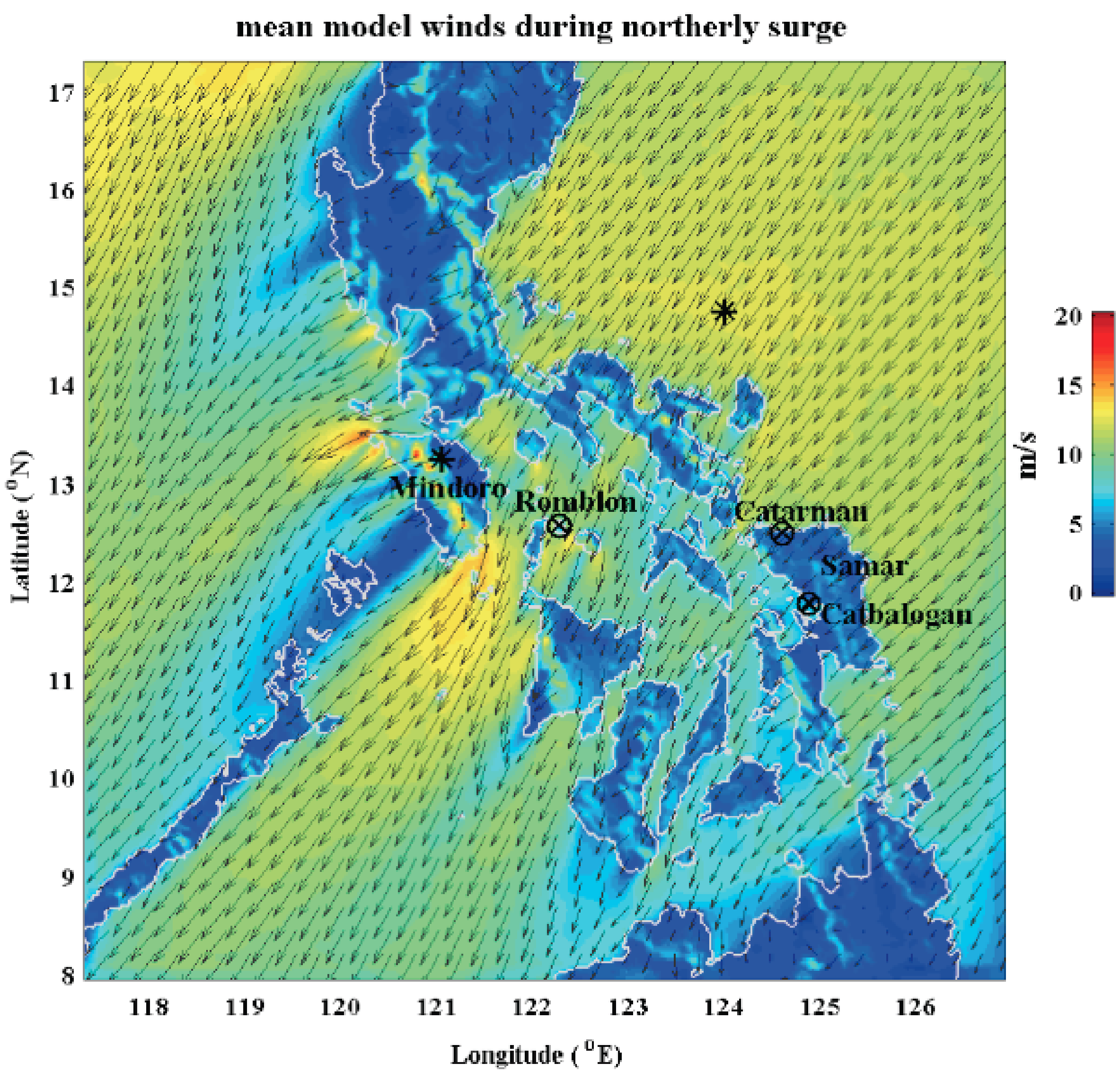
- Flooding disasters
- Barrier layer formation, higher SST
- Reduced productivity, food security

What influences rainfall patterns in the Philippines? From Pullen et al (paper submitted to JGR: "**Multi-scale influences on extreme winter rainfall in the Philippines**")



- Eastern Philippines receives a lot of rain
- Combination of factors
  - NE Monsoon
  - Monsoon surges
  - La Nina
  - High MJO Activity
  - Orographic effects
  - High SST

2008 monsoon surge using COAMPS



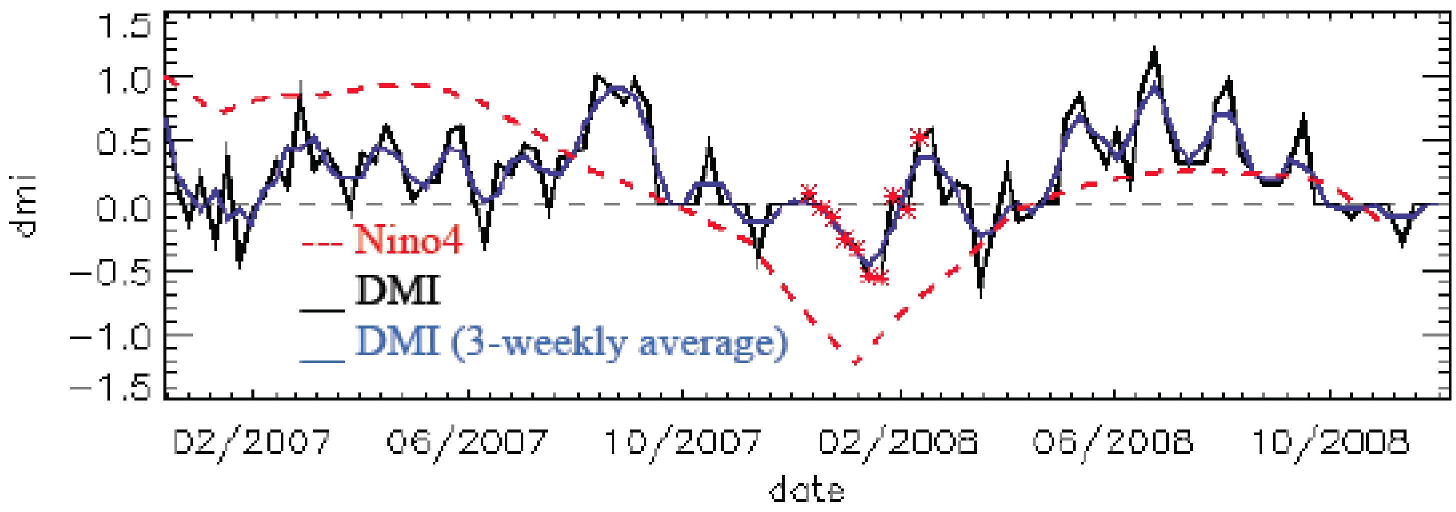
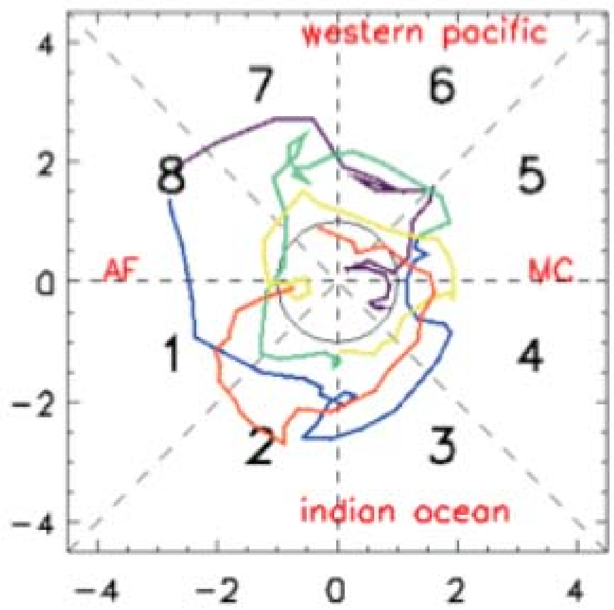


Figure 4: Weekly Dipole Mode Index (DMI) (black line) and 3-weekly averaged (blue line). The period with anomalous rainfall, and when the DMI is negative to neutral, is indicated with red stars. The red dashed line is the Nino4 index, based on monthly data (with 28 subtracted off to scale to the DMI range). Negative Nino4 values represent La Nina conditions.



MJO Index

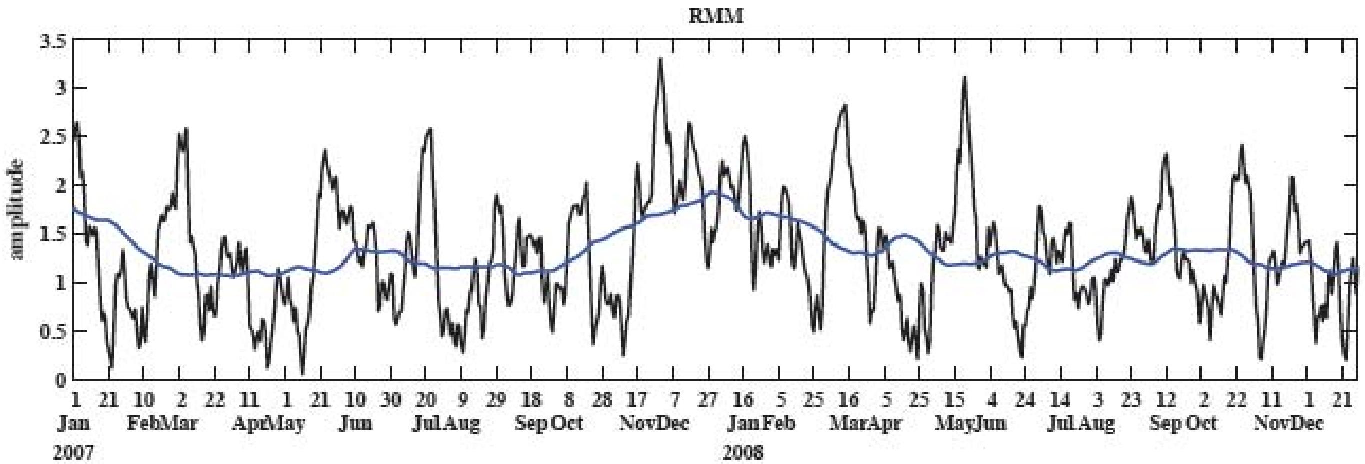


Figure 5: (Top)Wheeler-Hendon diagram for 11 November 2007 to 31 March 2008 showing the amplitude and phasing of MJO for Nov 2007 (purple), Dec 2007 (blue), Jan 2008 (green), Feb 2008 (yellow), and Mar 2008 (orange). MC is Maritime Continent. AF is Western Hemisphere and Africa. (Bottom) RMM amplitude in black, with the 90-day running mean in blue.

Discrepancies between satellite, model and rain gauge rainfall data

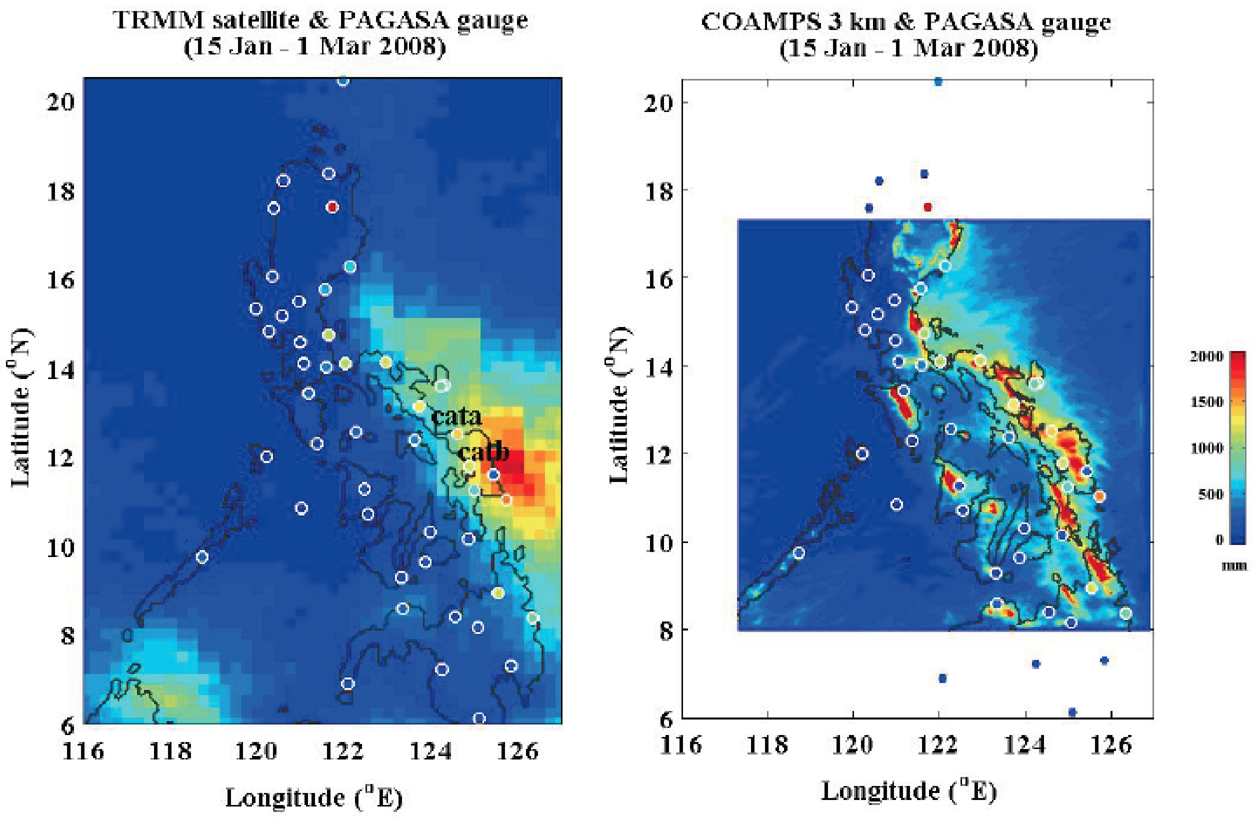


Figure 6: TRMM satellite and PAGASA gauge rainfall totals (circles) for 15 January – 1 March 2008 (left panel). COAMPS and PAGASA gauge rainfall totals (circles) for the same time period (right panel).

Project NOAH Weather Stations, rain and river gauges

MJO signals from eastward propagating rain bands through the Philippines.

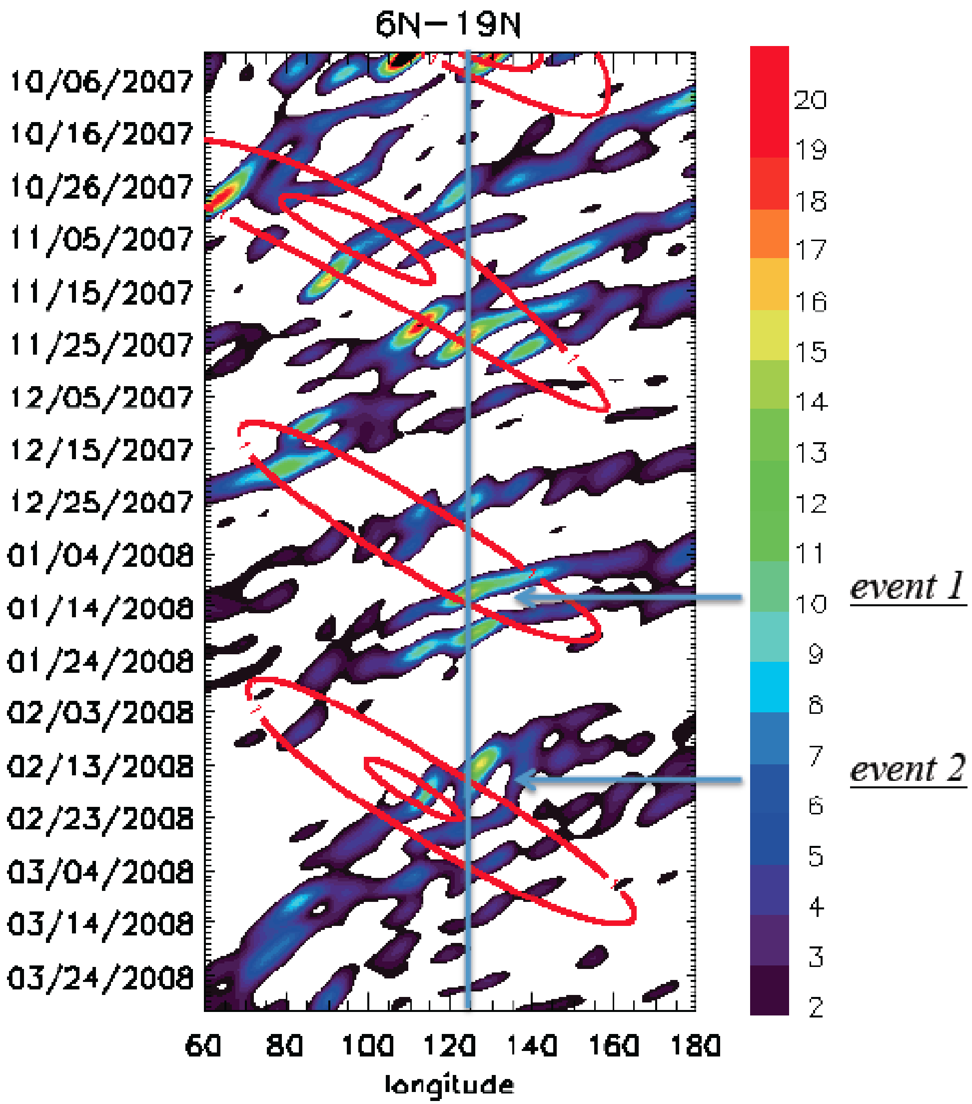
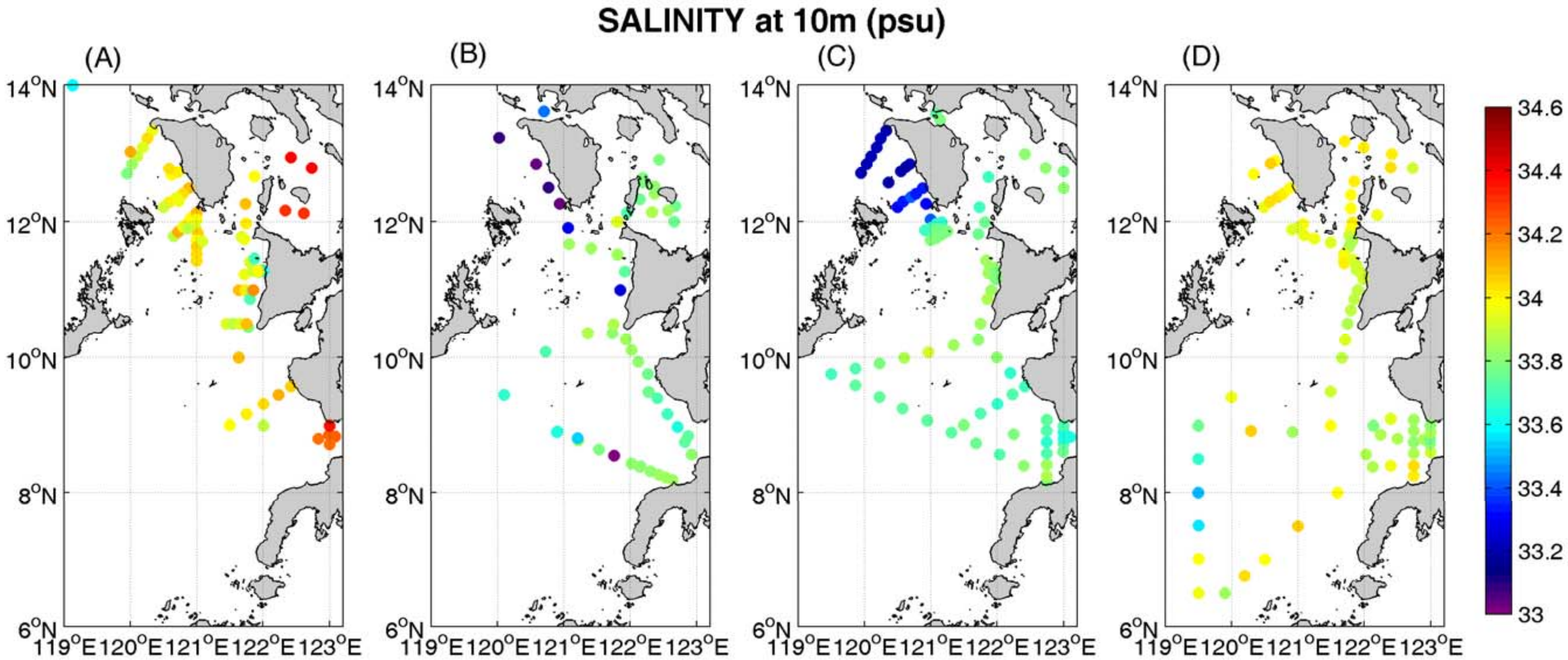


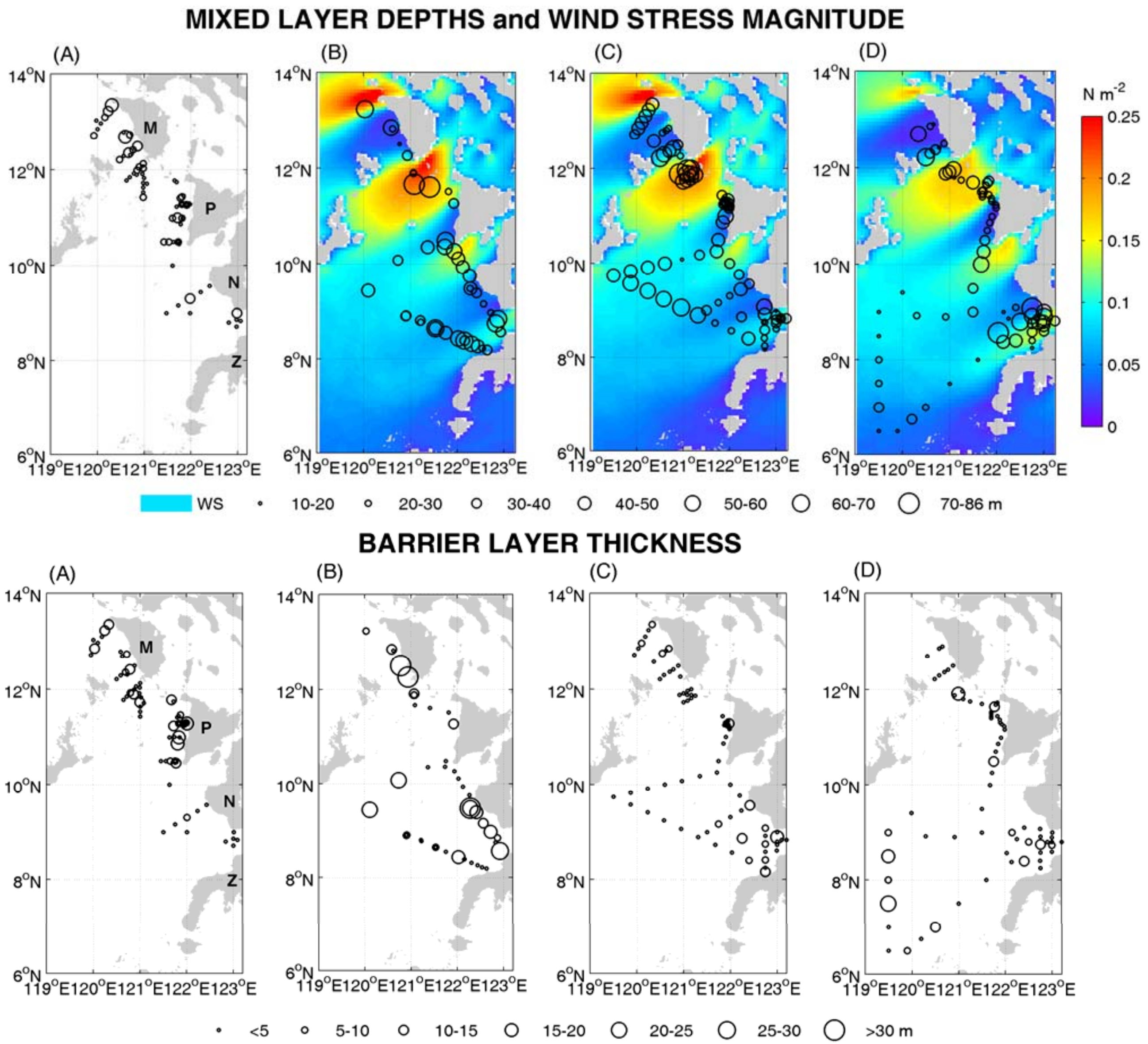
Figure 9: Time-longitude plot of the TRMM precipitation in mm/day averaged between 6-19N. The shading indicates westward propagating component of precipitation with periods between 3 and 40 days and zonal wavenumbers 1-40. The red contours indicate the low-frequency (intraseasonal) component, with a period of 40-80 days and zonal wavenumbers 1 through 6. The longitude of the Philippines is ~118 to 126, approximated by the blue vertical line at 125. MJO events 1 and 2 are shown with blue arrows and labeled.

Low surface salinity during extreme rainfall event in late 2007 to early 2008



(A) June 2007, (B) Dec 2007, (C) Jan 2008, (D) Mar 2009

Barrier layer formation and erosion (Cabrera et al., in prep)



Barrier layer in waters around MC

tropical Pacific (Sprintall & Tomczak, 1992)

South China Sea (Wu et al., 2001; Pan et al., 2006; Zeng et al., 2009)

Bay of Bengal (Vinayachandran et al., 2002)

Sulu and Celebes or Sulawesi Sea (Chu et al., 2002)

Southeastern tropical Indian Ocean off Sumatra & Java (Qu & Meyers, 2005)

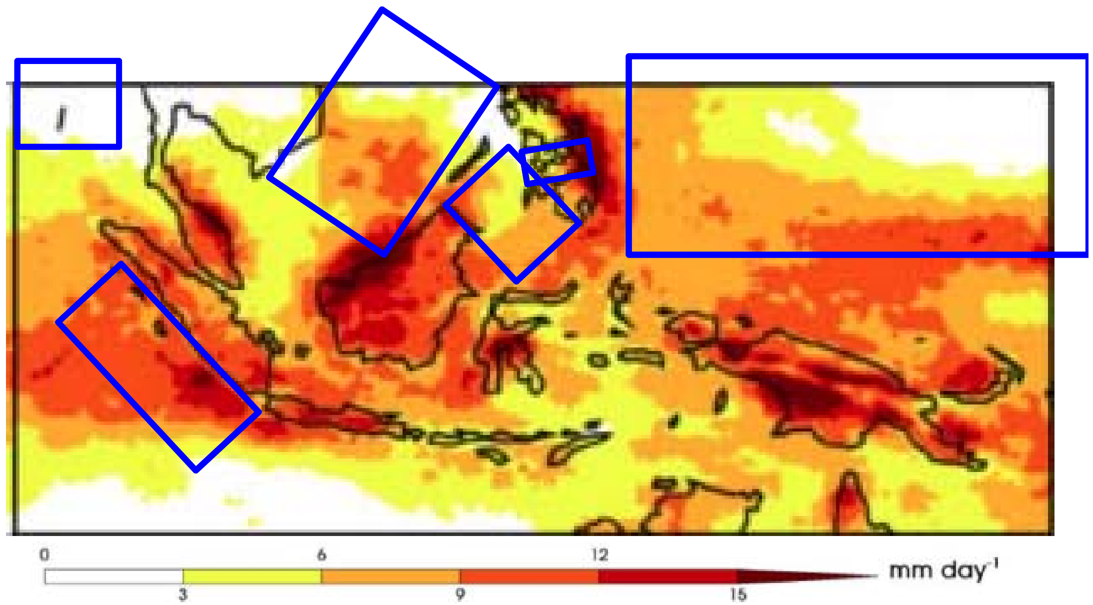


Image: TRMM 2008/09 from Love et al, 2011

Impact of Barrier layer

- Suppressed upwelling (Qu et al., 2005; Rixen et al., 2006; Cabrera et al., 2011)

ENSO-driven carbon see saw in the Indo-Pacific

Tim Rixen,[1] Venugopalan Ittekkot,[1] Bambang Herunadi,[2] Patrick Wetzel,[3] E. Maier-Reimer,[3] and Birgit Gaye-Haake[4]

Received 24 October 2005; revised 10 February 2006; accepted 16 February 2006; published 11 April

[1] The sediment trap experiments have been carried out during the 2001/2002 El Niño/La Niña transition in the monsoon-driven and freshwater influenced upwelling system off South Java. The results indicate that enhanced precipitation rates and associated river discharges increase the CO_2-uptake of the biological pump by increasing the organic carbon export and reducing the carbonate precipitation. The freshwater, furthermore, forms a buoyant low salinity surface layer that caps off the nutrient and CO_2-rich subsurface waters which shortens the upwelling season during wet La Niña conditions. A reduced capping-effect during dryer El Niño conditions strengthens the upwelling and as shown by our model results increase CO_2 emission into the atmosphere along the freshwater influenced continental margins in SE Asia. By contrast El Niño weakens upwelling and reduces the CO_2 emission in the equatorial Pacific Ocean. **Citation:** Rixen, T., V. Ittekkot, B. Herunadi, P. Wetzel, E. Maier-Reimer, and B. Gaye-Haake (2006), ENSO-driven carbon see saw in the Indo-Pacific, *Geophys. Res. Lett.*, *33*, L07606, doi:10.1029/2005GL024965.

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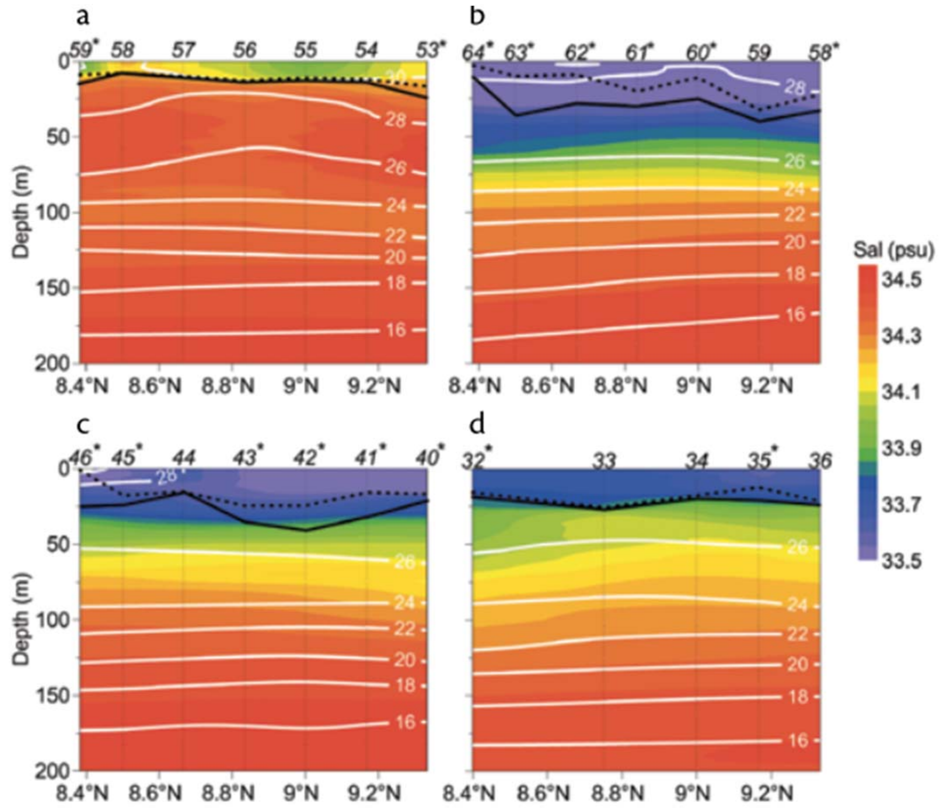

Figure 5. Temperature and salinity sections across 124°E in the Bohol Sea during the four PhilEx cruises. (a) The exploratory cruise of June 2007, (b) the Joint US/Philippines Cruise of November–December 2007, (c) the regional Intensive Observational Period of January 2008 (IOP-08), and (d) the regional Intensive Observational Period of January 2009 (IOP-09). White isolines plot temperature and colored contours indicate salinity. The black dashed lines mark mixed-layer depths (MLDs) and the black solid lines isothermal depths (IDs). Station numbers are shown along the tops of the sections. Asterisks denote stations with a barrier layer (ID-MLD) thicker than 3 m.

Impact of Barrier layer

- Suppressed upwelling (Qu et al., 2005; Rixen et al., 2006; Cabrera et al., 2011)
- Less productivity, low fishery during La Niña (Villanoy et al., 2011)

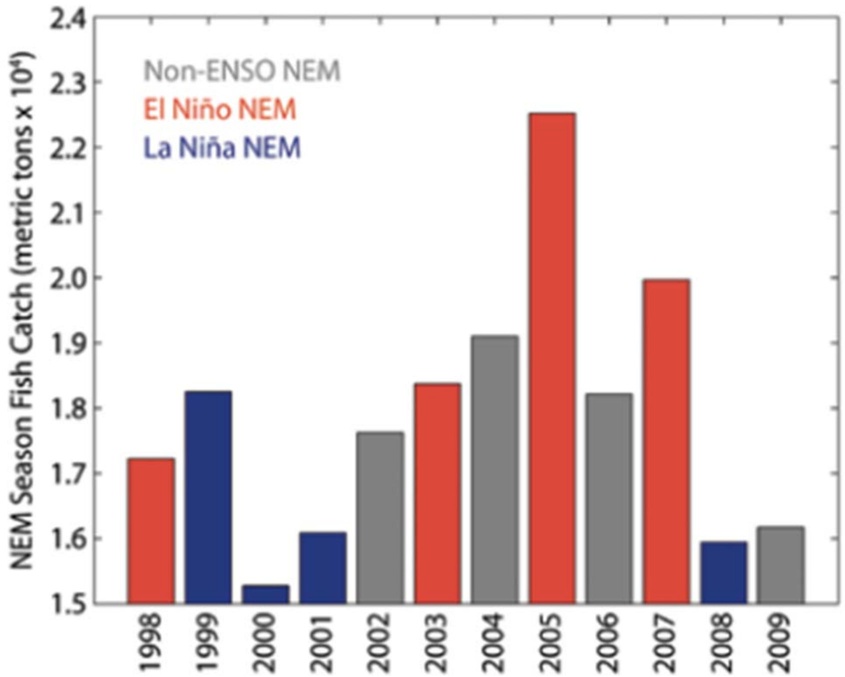

Figure 9. Historical data on the marine municipal fisheries production for Zamboanga del Norte province ports during the northeast monsoon (NEM). Data are from the Philippine Bureau of Agricultural Statistics (http://www.bas.gov.ph, fishery production database accessed in August 2010). The assumption that sardines comprise the majority of fish catch during NEM is based on fish catch monitoring data along the northern coast of Zamboanga Peninsula. Bar colors represent ENSO phases during the NEM season.

Impact of Barrier layer

- Suppressed upwelling (Qu et al., 2005; Rixen et al., 2006; Cabrera et al., 2011)
- Less productivity, low fishery (Villanoy et al., 2011)
- Suppressed typhoon-induced cooling (Wang et al., 2011)

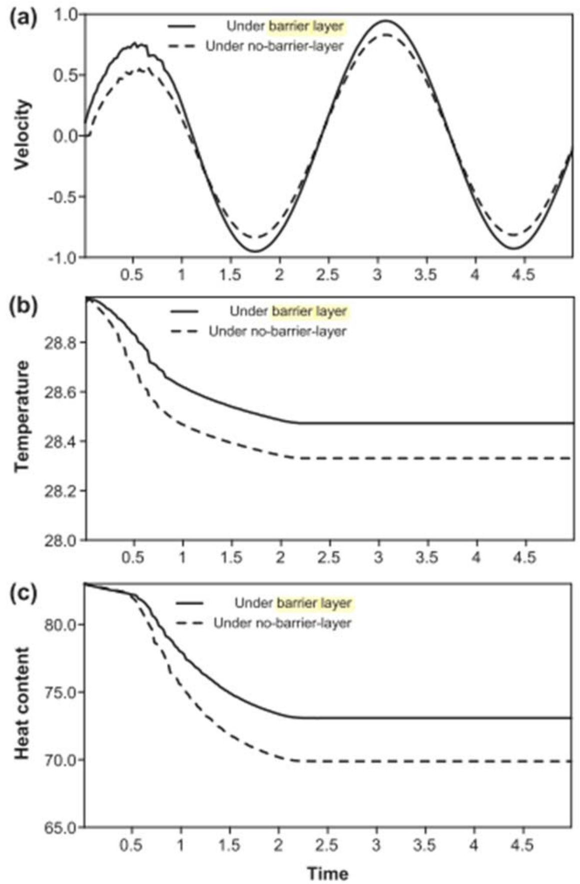

Fig. 12. The evolution of (a) zonal velocity (m/s), (b) temperature (°C), and (c) typhoon heat content (kJ/cm^2). The solid and dashed lines represent the barrier layer and no-barrier-layer condition, respectively.

Future studies

- Importance of spatial resolution (especially for resolving narrow mountains and island gaps)
- Analysis of rainfall and river gauge data (H_0: short watershed retention times for MC?)
- Monitoring of surface salinity or upper ocean T-S properties
- Feedback of fresh ocean in atmospheric models