Maritime Continent as an Important Hot Spot in Climate Change - YMC Initiative Malaysia-China.

Azizan Abu Samah et al. azizans@um.edu.my

Countries Claiming Ownership
- China
- Vietnam
- Malaysia
- Taiwan
- Philippines

IOES NARC Dept of Geography
Distribution of available in situ observations (T, S, V) from 1929-2009
Some drivers of Weather and Climate in the Maritime Continent.

The constant drivers:
1. The daily diurnal forcing.
2. The orographic pattern.

The variable drivers:
1. Monsoons: Summer and Winter Monsoon
2. Enso-La Nina
3. Pacific Decadal Oscillations
4. High latitude and mid-latitude interactions: Siberian High, Arctic Oscillation.
5. Polar Warming. Sea level rise. Primary productivity.
Diurnal Cycle of Cloud Cluster over the MC
1. Case study: 2\textsuperscript{nd} May 2012 afternoon
2. Caused flash flood and landslide over the central west coast due to intense rainfall.

Source: MetMalaysia

Possible Mechanisms

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Role of Orography. Courtesy of Fadhil M. Nor.
Sensitivity experiments (flatten Sumatra and Removed Sumatra)

Control
Mean precip. 2\textsuperscript{nd} May over Klang Valley:
CTR : 9.61

Flat Sumatra
Mean precip. 2\textsuperscript{nd} May over Klang Valley:
flat SI: 7.83

No Sumatra
Mean precip. 2\textsuperscript{nd} May over Klang Valley:
No SI : 27.79

Weaker rainfall even less intense rainfall

No severe convection over the sea
moisture source from the Indian Ocean
The Monsoons of in the Maritime Continent

FIG. 3. Mean QuikSCAT wind for Jan (black) and Jul (red), and topography (m).
Fig. 7. Differences of TRMM PR rainfall and QuikSCAT winds between boreal winter and boreal summer (DJF minus JJA). Warm colors are the boreal summer monsoon regime and cool colors are the boreal winter monsoon regime. See text for details.
The role of midlatitude forcing in winter, cold surges and Siberian High.
Another feature of the Cold Surge is the Borneo Vortex which in meteorology is known as a transient
Borneo Vortex Publications

Article: Properties of strong off-shore Borneo vortices: A composite analysis of flow pattern and composition as captured by ERA-Interim
Peter Braesicke · Ooi See Hai · Azizan Abu Samah
[Show abstract]
Article · Apr 2012 · Atmospheric Science Letters

Article: A case study of the Borneo Vortex genesis and its interactions with the global circulation
See Hai Ooi · Azizan Abu Braesicke
[Show abstract]
Article · Nov 2011 · Journal of Research Atmospheres
## Rainfall in mm

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**Borneo Vortex Study.**

Nanyang, 13 January 2009

Star dated 18 January 2010
Some research findings from our research group

1. The initiation of cold surge from the Siberian High is due to the “push factor” i.e. increase of pressure gradient and southward troughing of the Siberian High which is influence by the subtropical jet.
2. The cold surge is channelled by the topography of land and sea towards the South China Sea (SCS)
3. The surge increase the wind velocity over the SCS and the dry subsiding air start to become very moist due to evaporation from the warm sea surface.
4. The “pull factor” constitute the monsoon trough or ITZC that is now near Borneo island.
5. The alignment of the Borneo island and Sumatra/Peninsular and its position across the equator contributed to the formation of a cyclonic vortex known as the Borneo Vortex.
6. This cyclonic vortex ordered the process of deep convection and feed the moist air into the system to sustain rainfall for more than 48 hours.
7. There is also a diurnal influence of the spatial location of convection as observed earlier by Houze et al.
8. The deep convection of the Borneo vortex was observed to strengthen the ascending branch of the Hadley Circulation in both Hemisphere and also the East-West Walker circulation.
9. Via the Hadley Circulation the Borneo Vortex will then feedback into the subtropical jetstream hence completing the cycle.
The Hadley Circulation.
Figure 2a: Hadley Circulation (m/s) and relative humidity (%) averaged between 110°E and 117.5°E) for the periods (top) 6 – 10 January 2010; (center) 11 – 15 January 2010; and (bottom) 16 – 20 January 2010.
An important aspect of the Maritime Continent is that this is the hot spot region of deep organized convection. So on one hand it is a major cause of flooding but on a global scale it contributes to the transport of heat, momentum and also greenhouse and ODS to the mid and high latitude.

Article: The SHIVA Western Pacific campaign in fall 2011
Pfeilsticker K. · M. Dorf · B. Sturges · Nor Aieni Binti Haji Mokhtar
[Show abstract]
Full-text available · Article · Jan 2013 · Malaysian Journal of Science
Deep convection in the tropics associated with the monsoon transport not only CFC but locally generated short lived halocarbon to the stratosphere and the Polar regions.

This may change with global warming.
Case study of Ashfold et al. (2015)

- Observations of $\text{C}_2\text{Cl}_4$ in **Malaysian Borneo** ($\sim 4^\circ \text{N}$) Instrument of Gostlow et al. (2010)

- Winter 2008/09
- One rainforest site; one coastal site
- Strong, coherent intra-seasonal variability

Ashfold, M. J. et al., *Atmos. Chem. Phys.*, 2015, 15, 3565-3573
Case study of Ashfold et al. (2015)

- **NAME** model suggests influence of East Asian pollution

Low C2Cl4, winds from Pacific

O3, CO, ~4 days

High C2Cl4, ‘cold surges’ from East Asia

Ashfold, M. J. et al., *Atmos. Chem. Phys.*, 2015, 15, 3565-3573
Case study of Ashfold *et al.* (2015)

- **NAME** shows possibility of tropical pollutant
- Initialise forward trajectories in mid-latitudes
- Transport from East Asia to the tropics (~4 days)
- And uplift towards the stratosphere (total <10 days)

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The different scale of climate variability can also influence the ocean circulation of the South China Sea itself via wind stress and precipitation.
The South China Sea is one of the most productive tropical sea and is very much influence in the summer by the SW monsoon and in the winter by the NE Monsoon. In the longer time scale it is also influence by the ENSO cycle.
Fig.3  Current patterns located in the upper layer are in units of m/s for SODA (a to b) and for the model (c to d). (Daryabor et al. 2014, Ocean Dynamics).
Climatology of SST development of cold tongue during the NE monsoon.
All this processes influence the spatial variation of primary productivity.

Climatological chlorophyll-a concentration (mg/m³)
The ENSO-LA NINA influence both the Global Circulation such as the Subtropical Jetstream and via the monsoon wind variation the primary productivity of the South China Sea.
Composite of wind speed anomaly speed during El Nino years

Stronger jet

Sea surface temperature anomaly during El Nino year 1983

Warmer SST
EL NIÑO SOUTHERN OSCILLATION AND STRENGTH OF STJ

Composite of wind speed anomaly speed during La Nina years

Weaker jet

Sea surface temperature anomaly during La Nina year 1989

Cooler SST
Anomalies during La Nina years of chlorophyll-a concentration
Anomalies during El Nino years of chlorophyll-a concentration
The Global Drivers: The role of the Polar region: Arctic and Antarctic.
Arctic Oscillation and Siberian High

Arctic Oscillation

• Non-seasonal SLP variations north of 20°N, characterized by SLP anomalies of one sign in the Arctic and anomalies of opposite sign in mid latitude, centered about 37-45°N (Thompson and Wallace (1998).

Fig. 3. Arctic Oscillation phases and its influence over northern hemisphere (photo courtesy: [http://www.appinsys.com/GlobalWarming/AO_NAO.htm](http://www.appinsys.com/GlobalWarming/AO_NAO.htm) and J Wallace, Univ. of Washington).
Result:

Arctic Oscillation and Siberian Air Temperature

Arctic Oscillation and Air Temperature anomalies (averaged NDJFM)

Fig. 4: Arctic Oscillation and air temperature anomalies (80°–120°E, 40-60°N) averaged over NDJFM.

Correlation coefficient: 0.65
Fig. 5 : (left) Air temperatures at Siberian high area are above the average temperature during AO positive phase. (right) Air temperatures over Siberian area are lower [colder] than average during AO negative phase.
China Malaysia Cooperation on Marine Research.

- Covers research that include atmospheric, oceanic and biological process.
- The Chinese-Malaysian Joint Committee has approved 18 research projects that will be jointly funded between MOSTI (Malaysia) and SOA (China).
BACHOK MARINE RESEARCH STATION

• Regional GAW Station.
• Land Base Window to the South China Sea.
• Run by University of Malaya.
• Already setup a Joint Centre FIO-UM.
• UM-NCAS cooperation on transboundary air pollution especially during the cold surges.
Bachok Marine Research Station, Kelantan
---- an ideal place for observing the ocean and atmosphere
AWS was installed in August 2015
Buoy Deployment Malaysia-China.

- Main objectives:
- To study air sea interactions and ocean currents variability and the monsoon.
- Integrate with the ongoing observations at the Bachok Marine Research Stations.
Observation Plan:

- Land-based meteorological station
- Mooring system
- Physical-ecological model
- Processes, mechanisms
- Response to climate change
Surface buoy

Diameter: 1.5m
Total Displacement: 1300kg
Buoy Weight: 530kg
Mooring System Weight: <750kg
Depth: <300m

CTD 40m Plastic Coated Steel Cable, Real-time Transmission

100kg Anchor

Depth+20m Anchor Chain 100kg Grab Anchor
TRBM
(trawl-resistant bottom mount)
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<tr>
<th>Bil.</th>
<th>Tajuk</th>
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| 1    | **Flagship 2:** *Cold Surge and Madden Julian Oscillation Interaction Over Maritime Continent*  
*2.1: Multiscale Climate Variabilities Over Southeast Asia and Their Association to the Extreme Climate*  
**Title of Malaysian Project:**  
Multiscale climate variabilities over maritime continent and their association to the extreme weather | **China:**  
First Institute of Oceanography (FIO)  
Dr. Liu Lin  
**Malaysia:**  
IOES, Universiti Malaya  
Profesor Dato’ Dr Azizan Abu Samah |
| 2    | **2.3: Impacts of Monsoon on Marine Environment and Ecosystem in the Southern South China Sea (IMMEESS)**  
**Title of Malaysian Project:**  
Seasonal and interannual variabilities of the monsoons and its impacts on the marine environment and ecosystem in the southern south china sea, potential influence of future climate change on the | **China:**  
First Institute of Oceanography (FIO)  
Professor Dr. Yue Fang  
**Malaysia:**  
IOES, Universiti Malaya  
Profesor Dato’ Dr Azizan Abu Samah |
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• Terima kasih.
• Thank You.
• Azizan Abu Samah.
• azizans@um.edu.my.