Why The Deeper Understanding Is Important to Disaster Mitigation?

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Disaster Mitigation, APAN44

Rationale

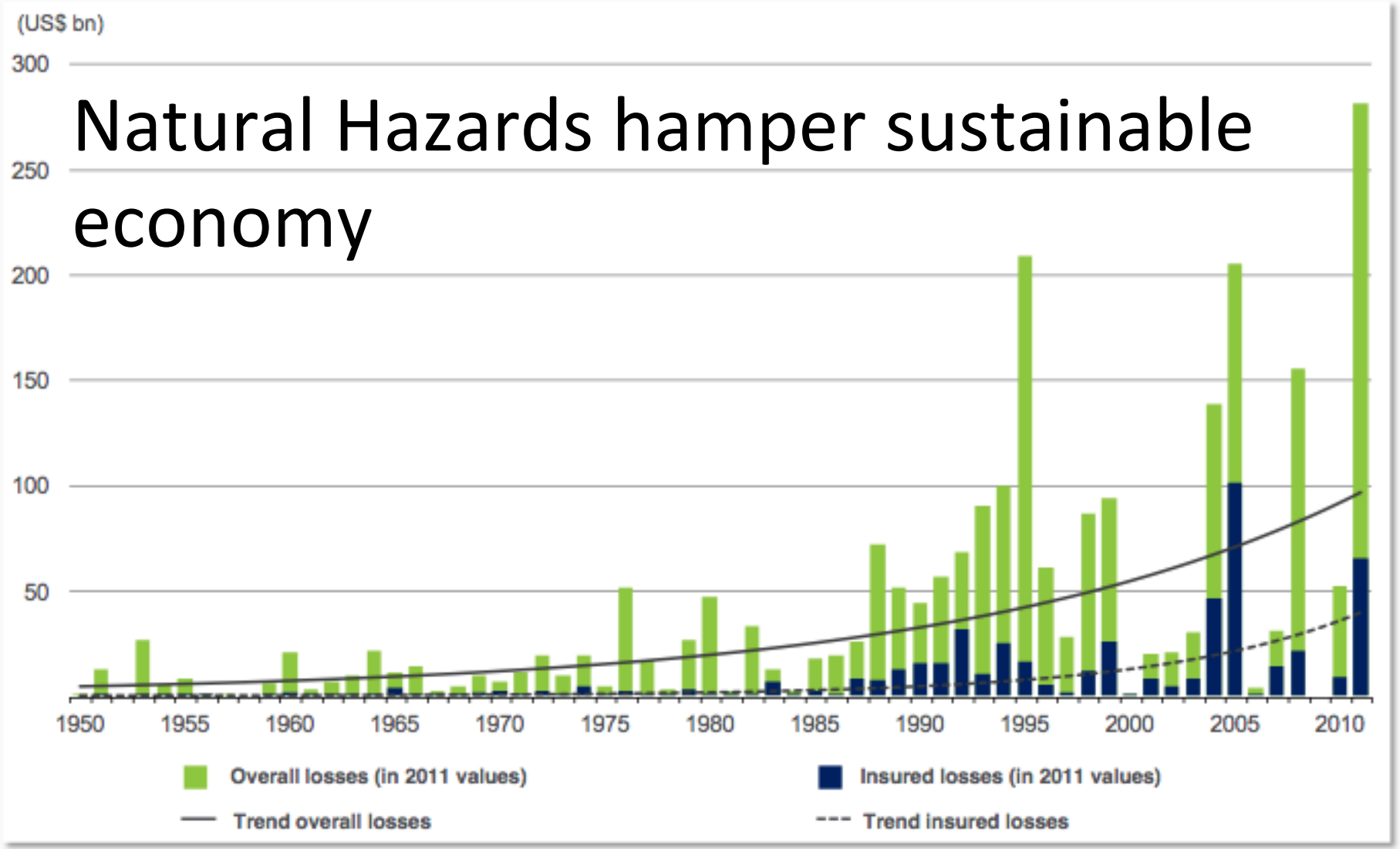
- Disaster Mitigation often focuses on the worst case scenarios of natural disasters in order to protect the general public in case the worst might happen!
- Obviously, this is NOT the most optimized way to mobilize the mitigation resources and protect the loss of lives and property
- Had we predicted the disasters much more accurately, then the society as a whole could be better protected!
- However, the non-linearlity and inter-couplings of different forms of natural disasters deter us from improving accuracy easily!
- Therefore, some sort of deeper qualitative understandings such as possible weather and disaster patterns are crucial!

NatCatSERVICE

Great natural catastrophes worldwide 1950 – 2011

Overall and insured losses with trend

Munich RE



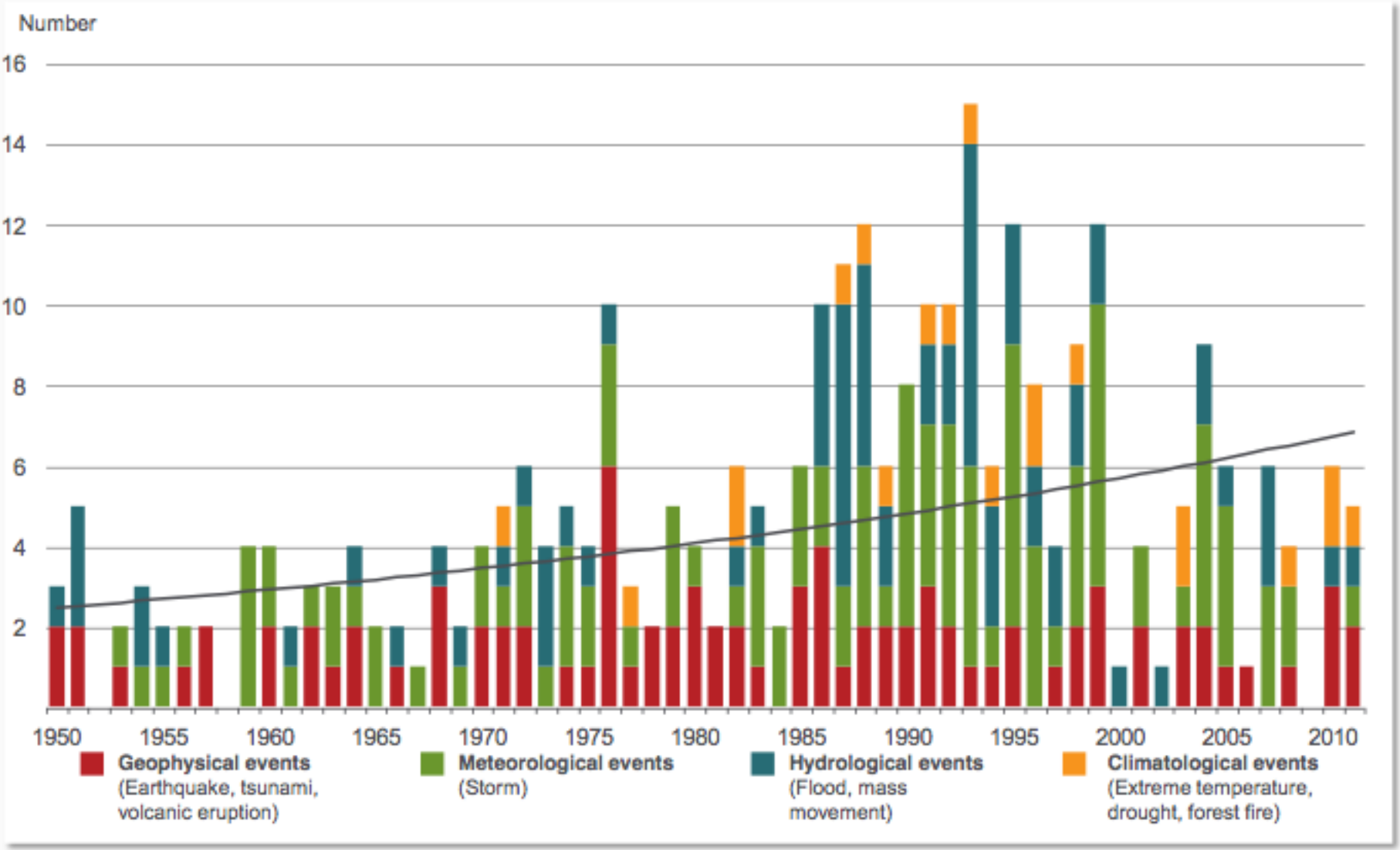
Natural Hazards hamper sustainable economy

NatCatSERVICE

Great natural catastrophes worldwide 1950 – 2011

Number of events with trend

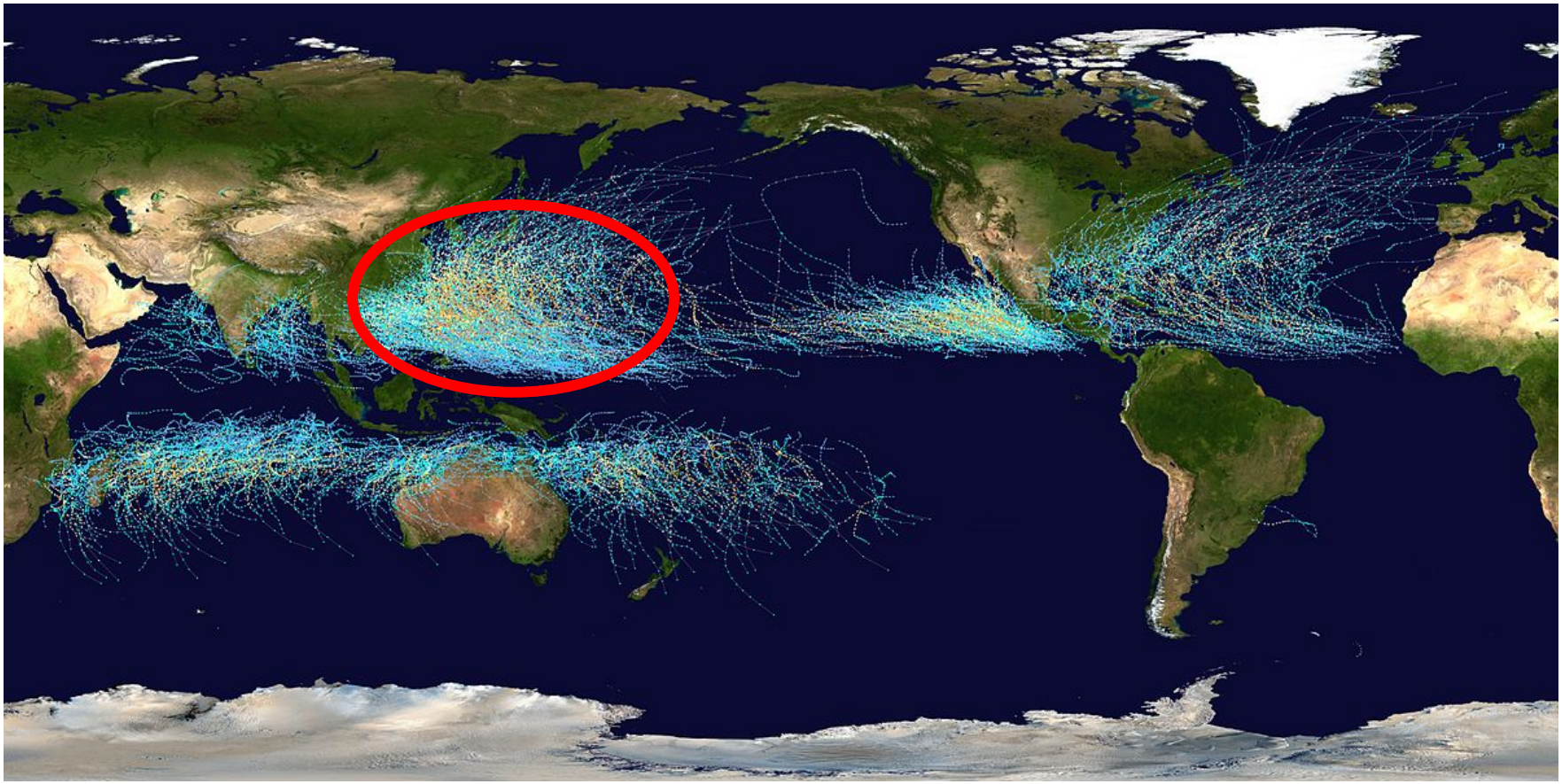
Munich RE



Examples if Time Allows

- **Flooding case in Taiwan (Soudelor 2015)**
- **Flooding case in Sri Lanka (2016)**
- **Storm surge in Philippines (Haiyan, 2013)**
- **Flooding in Malaysia (2014-2015)**
- **Environmental Research Topics**

The Great Global Trend of Typhoon



Tracks of all tropical cyclones which formed worldwide between 1985 and 2005.

(from Joint Typhoon Warning Center)

Average Counts Increase

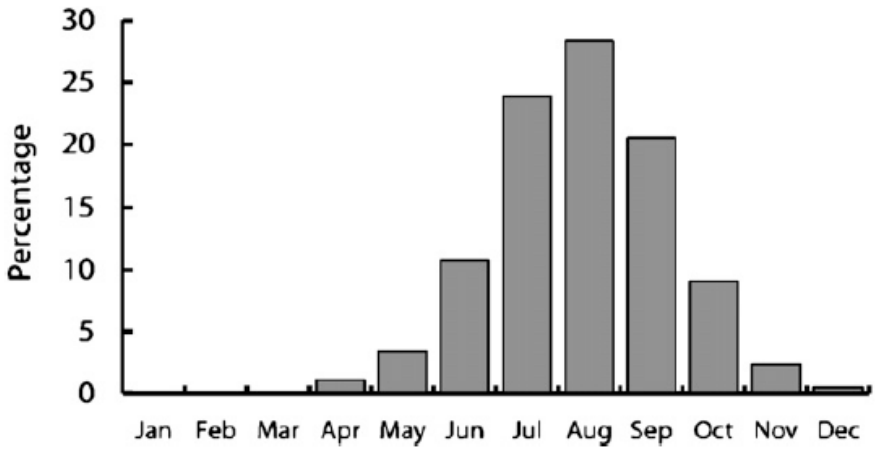
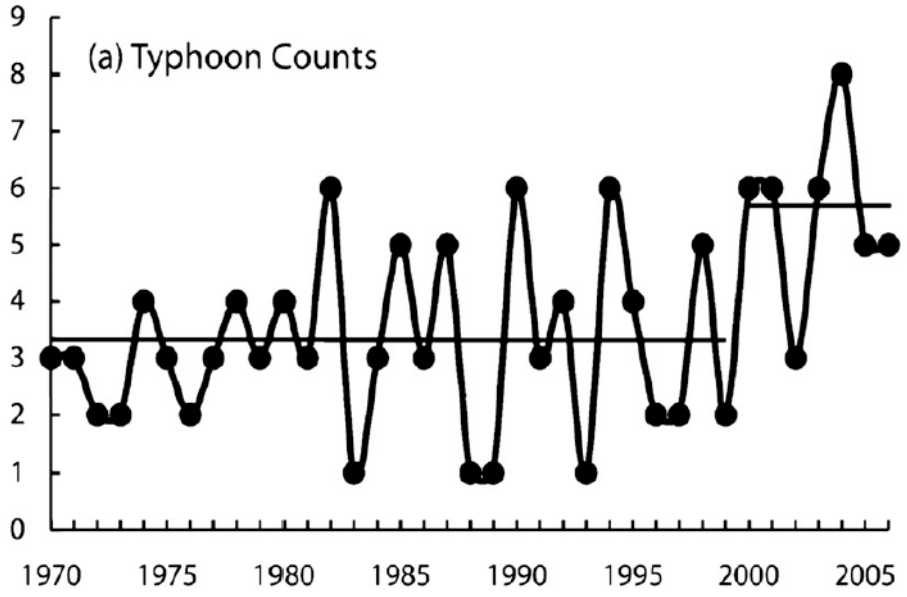


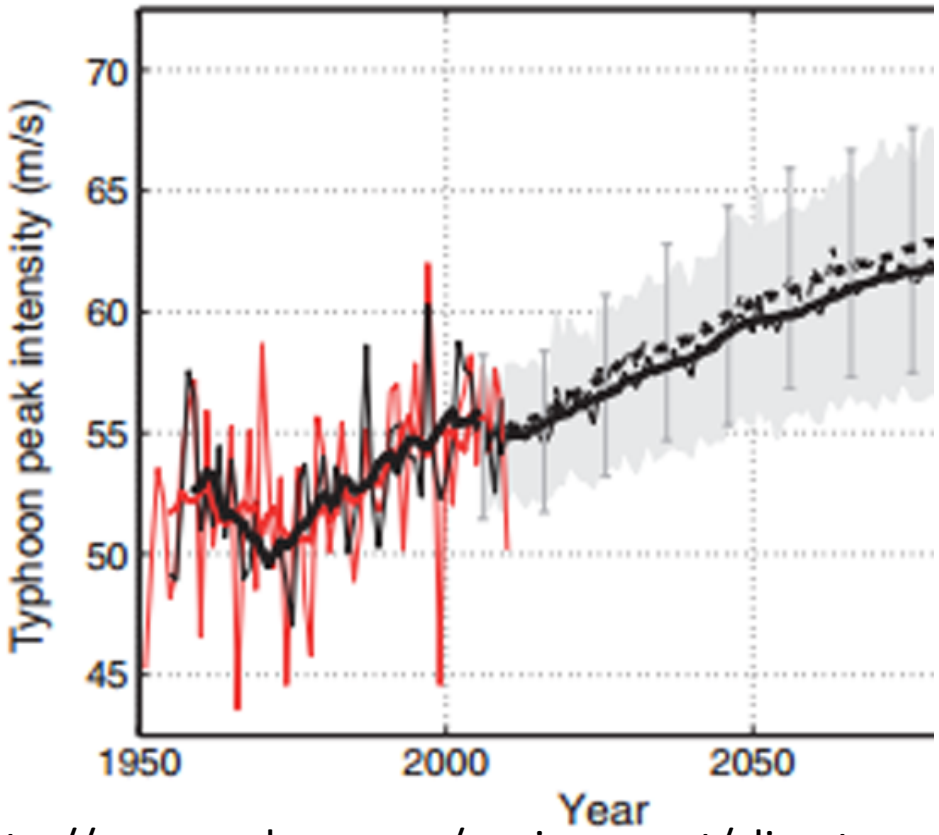
FIG. 2. Monthly percentage of typhoons impacting Taiwan averaged over the period of 1970–2006.

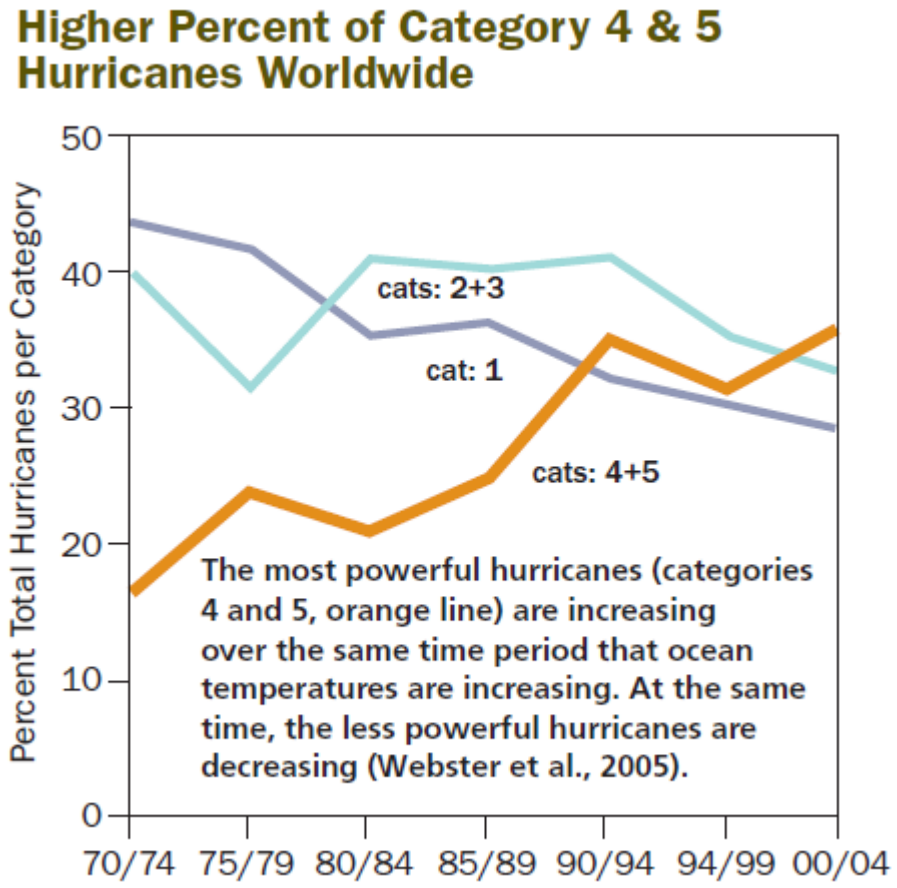


Time series of seasonal (JJASO) **typhoon numbers passing the vicinity of Taiwan from 1970 to 2006** as complied by the Central Weather Bureau. The vicinity was defined as21–26N, 119–125E.

(Tu et al. 2009)

Future Warming and Typhoon

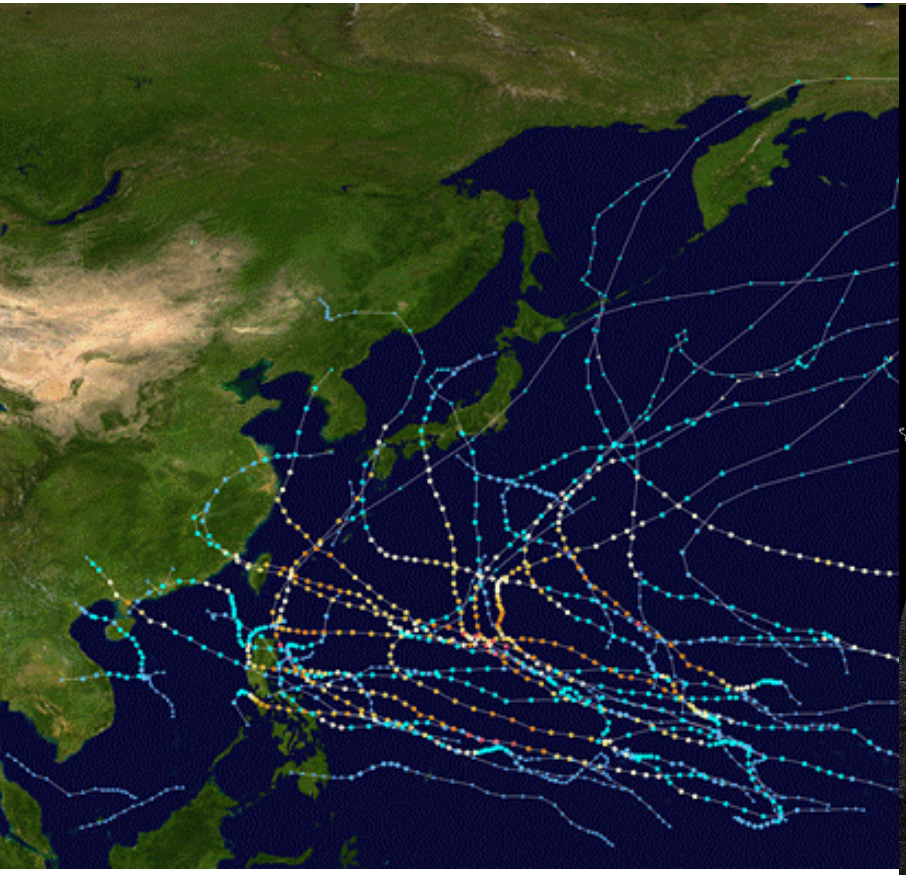


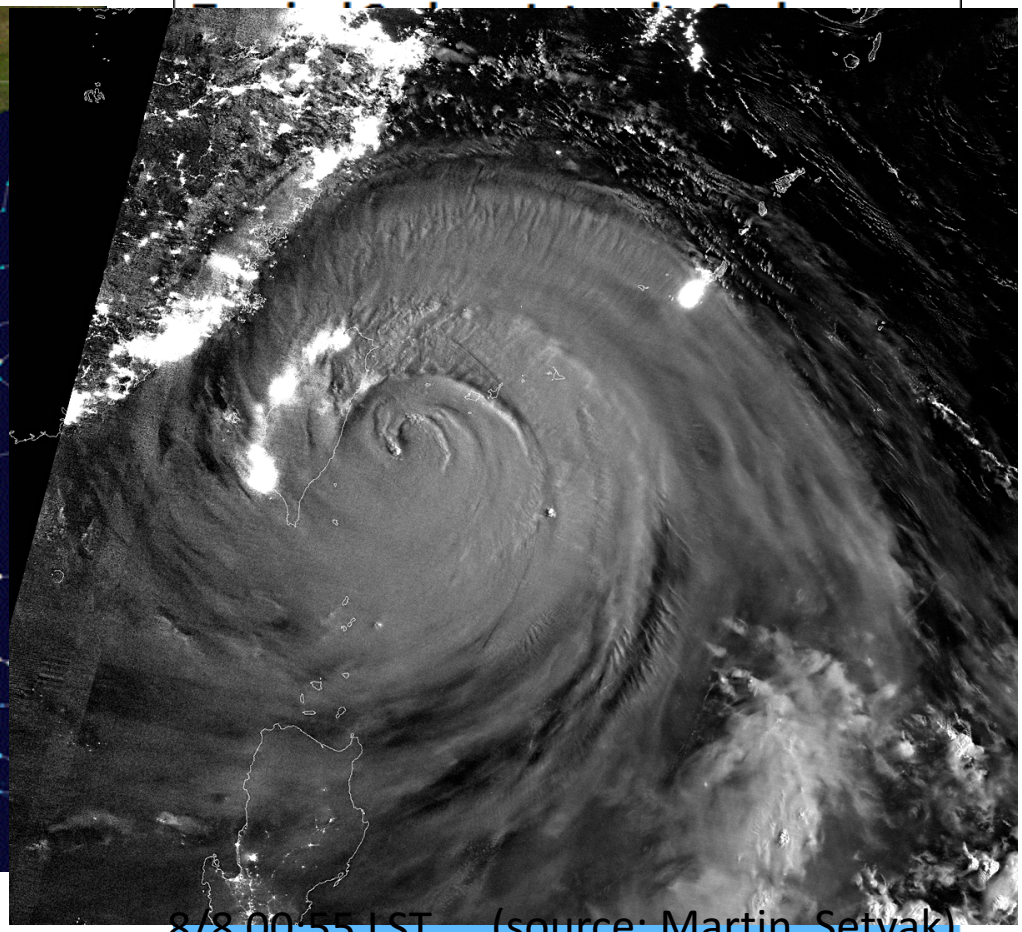


http://www.smh.com.au/environment/climate-change/super-typhoons-to-increase-in-strength-with-climate-change-researchers-find-20150529-ghcbfs.html

Flooding in Taiwan (Soudelor, 2015)

Storm tracks in 2015

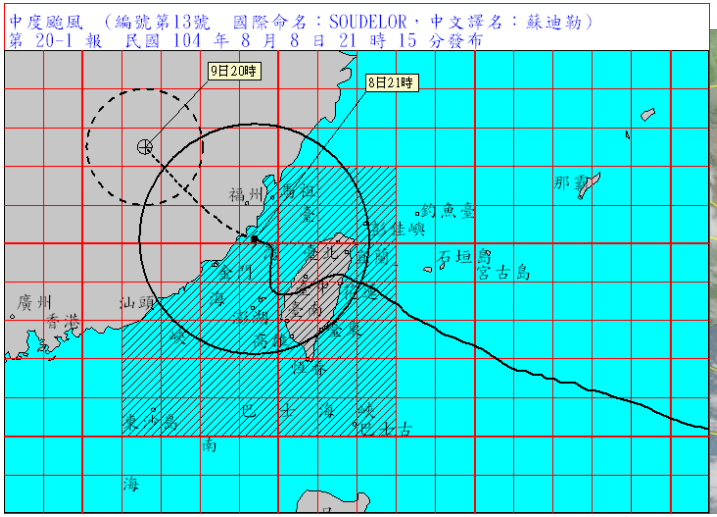




8/8 00:55 LST (source: Martin Setvak)

with peak winds at 180 mph (290 kph), according to the Joint Typhoon Warning Center.


中時電子報
chinatimes.com


中度颱風 （編號第13號 國際命名：SOUDELOR，中文譯名：蘇迪勒）
第 20-1 報 民國 104 年 8 月 8 日 21 時 15 分發布
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8日21時
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那霸
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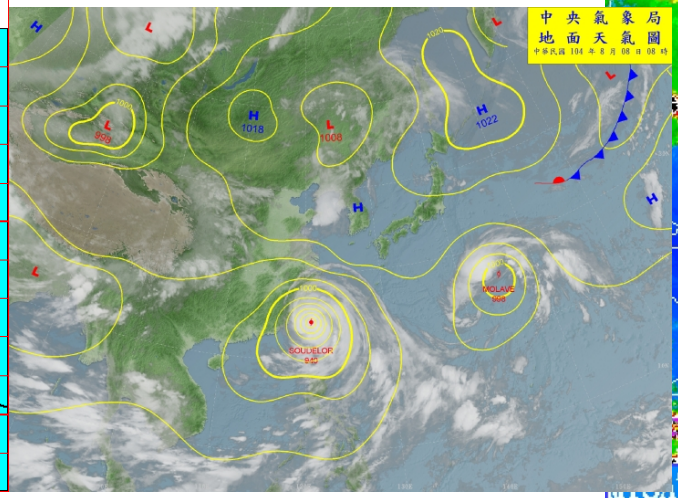
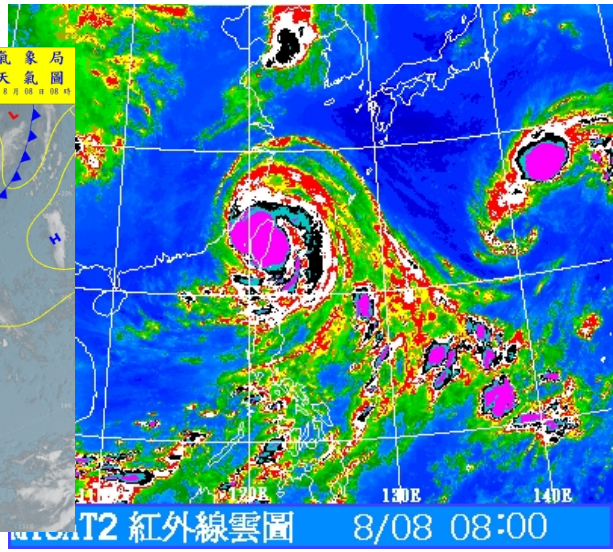
宮古島
廣州
香港
山頭
東沙島
南海


中央氣象局
地面天氣圖
SOULELOR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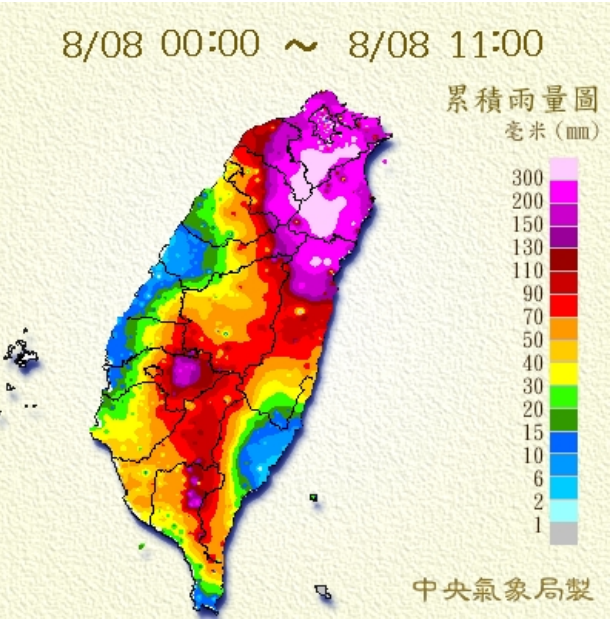
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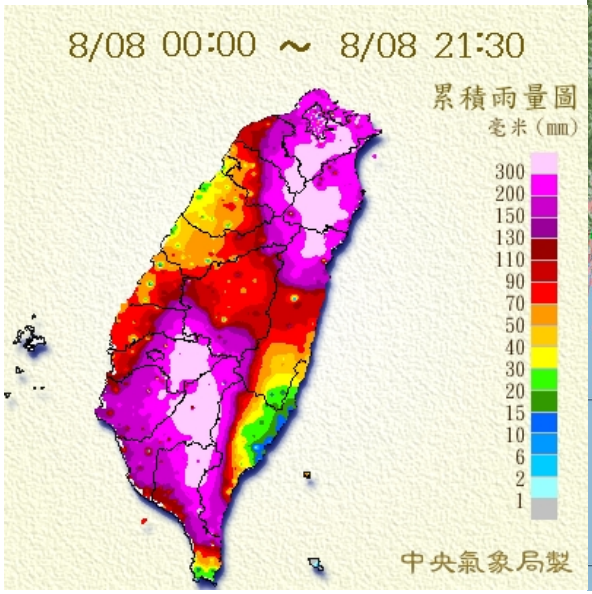
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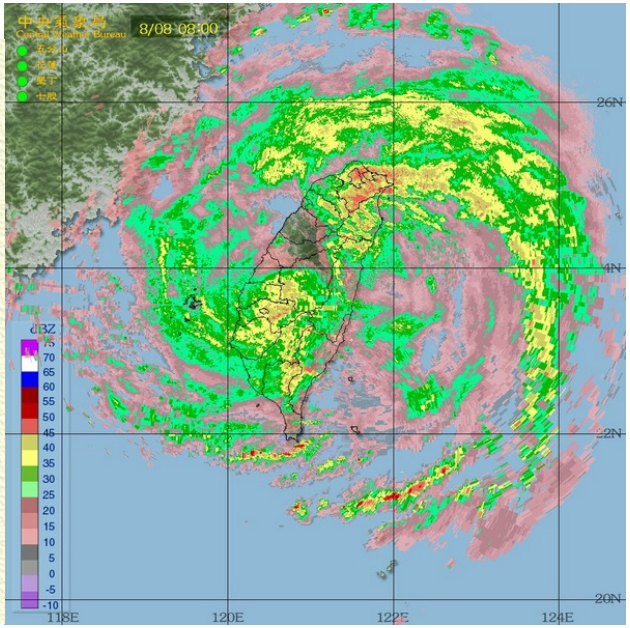
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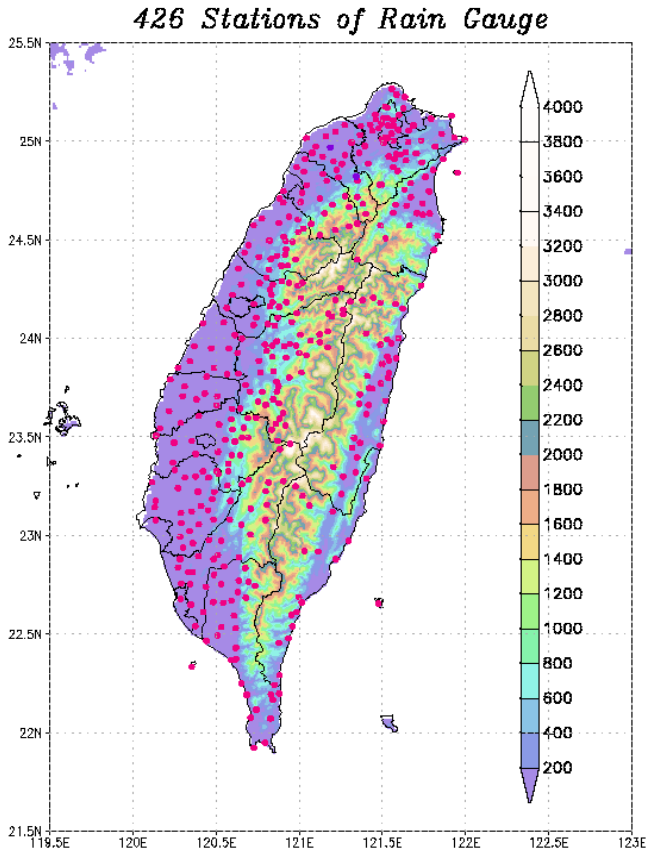
124E

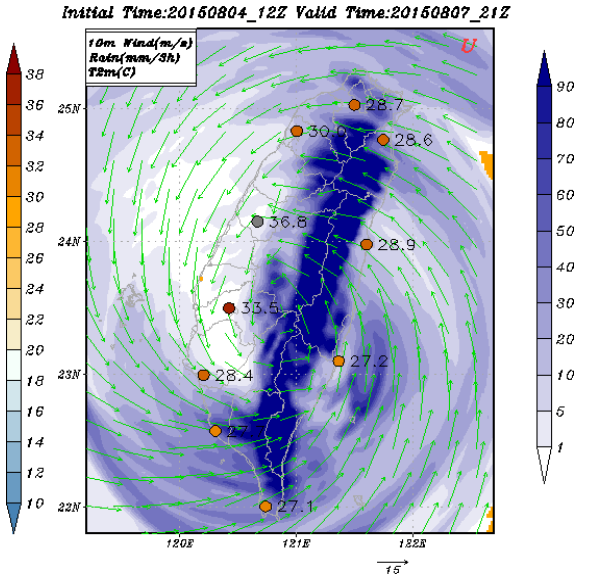
How good can we simulate (predict) typhoon ?

- I.C., B.C. and resolution: the forecasting of track, intensity
- dynamic of Typhoon circulation and their interaction with the Taiwan terrain
- mesoscale wind and precipitation distribution



Initial condition impacts on landfall simulation

08/04-12Z



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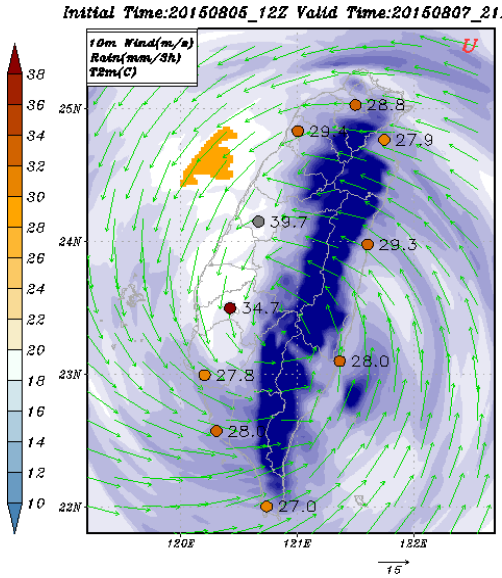

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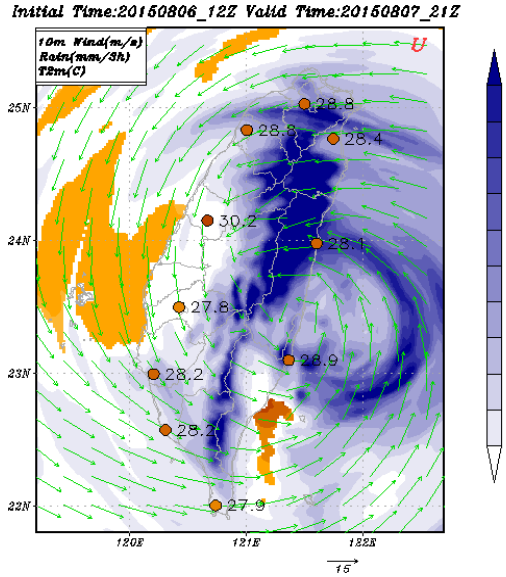

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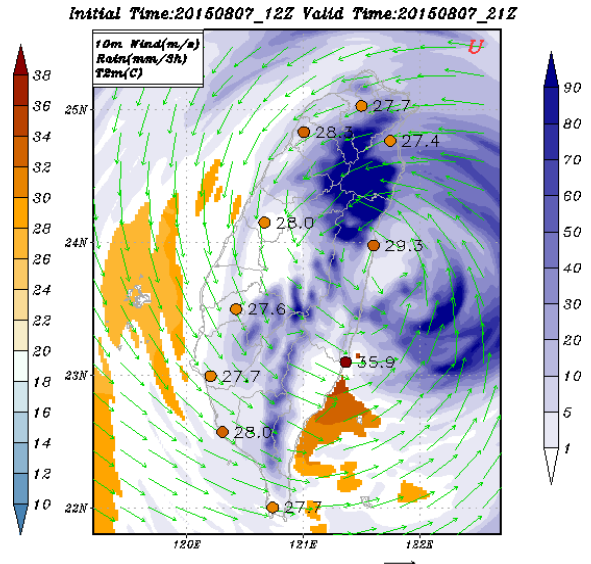

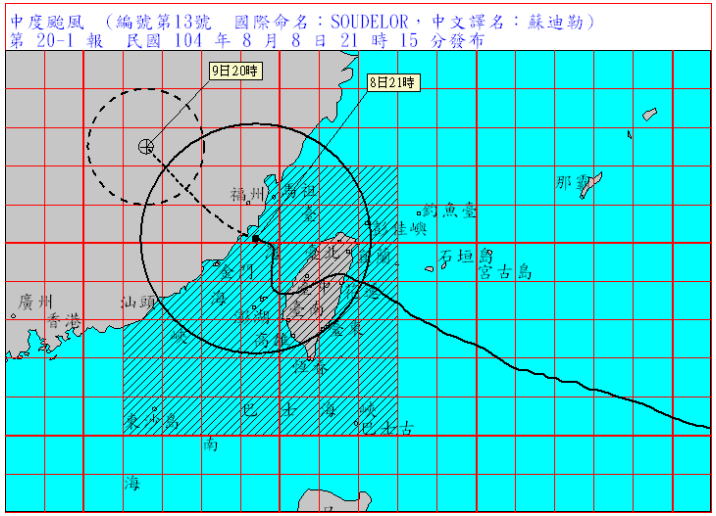

Flooding in Sri Lanka (2016)

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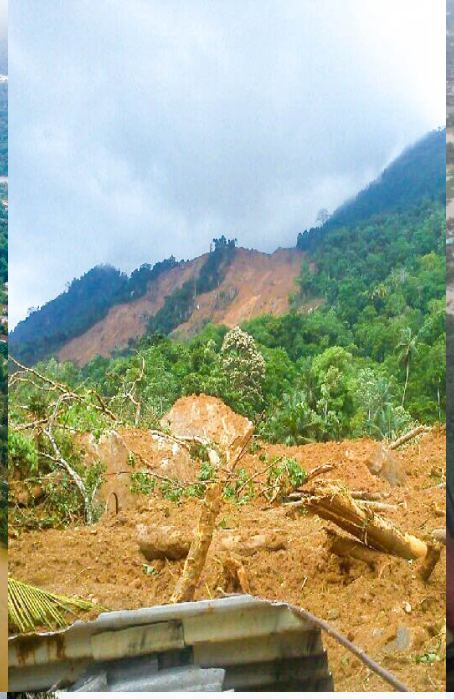
[1] Taiwan International Graduate Programme,

[2]Research Center for Environmental Changes, Academia Sinica, Nangang, Taipei, Taiwan.

[3] Institute of Atmospheric Physics,College of Earth Science, National Central University, Jhongli, Taoyuan, Taiwan


WWW.NEWS.CN

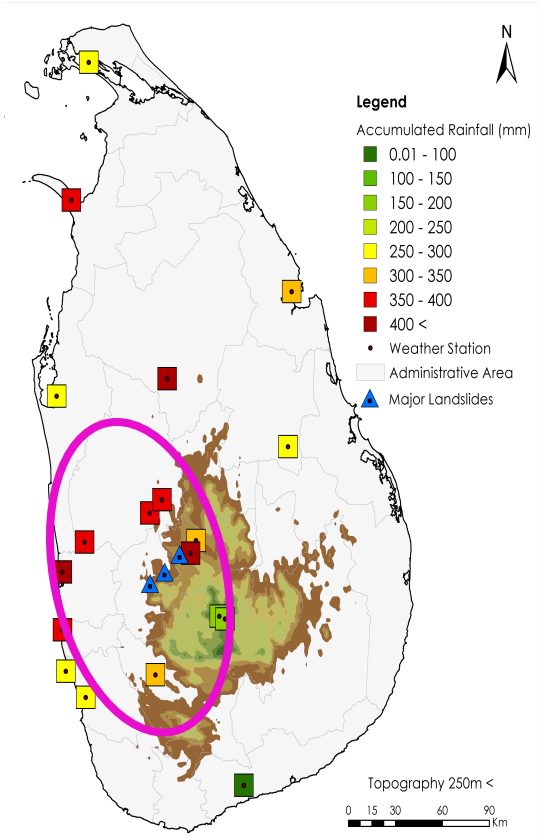
The flooding event

- A depression in the Bay of Bengal in the Indian Ocean to the South East of Sri Lanka caused heavy rainfall across Sri Lanka since 14 May 2016
- Causing wide spread heavy rains, flooding and land slide in as many as 22 districts,.
- **According to the Meteorology Department the last four days had seen one of the highest rainfalls in Sri Lanka**
- Total number of people affected 427,918, 101 deaths, 100 missing (landslide)
- Worst affected district - Colombo (Capital) – 185,835 affected
- Kelani Ganga is one of the main river basin in Sri Lanka which experienced **large scale flooding and subsequent damage to property and livelihoods**.

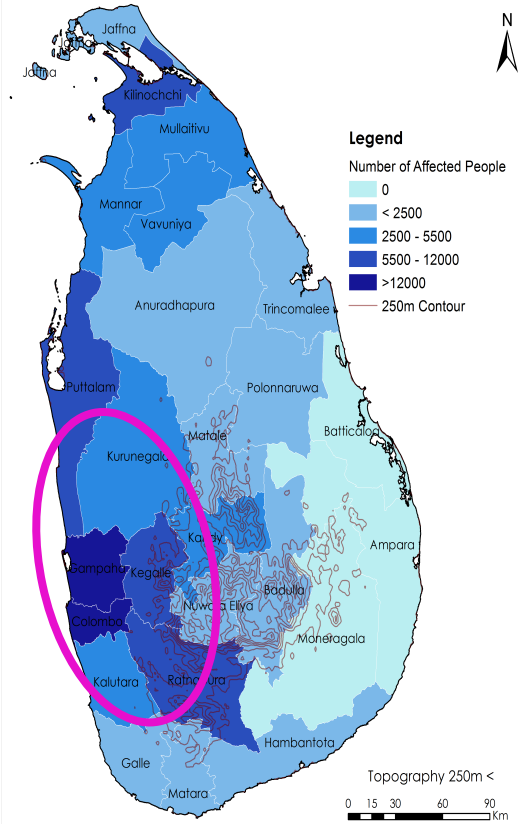
Research Questions & Assumptions of the study

- What was the main cause for the heavy rainfall and flooding in western part of Sri Lanka?
  - — Main cause for the heavy rainfall was the low pressure system.
- Why May 15 & 16 received the maximum rainfall over western part of Sri Lanka?
  - — May 15 & 16 was the period low pressure system approaching and passing along Sri Lanka
- Why only western part of Sri Lanka received relatively maximum rainfall and why not the eastern part of Sri Lanka?
  - — Location of the heavy rainfall was following the low pressure system
  - — Westerlies and the low pressure system winds were interacting with mountain only over western part of Sri Lanka

What was the main cause for the heavy rainfall and flooding in western part of Sri Lanka?

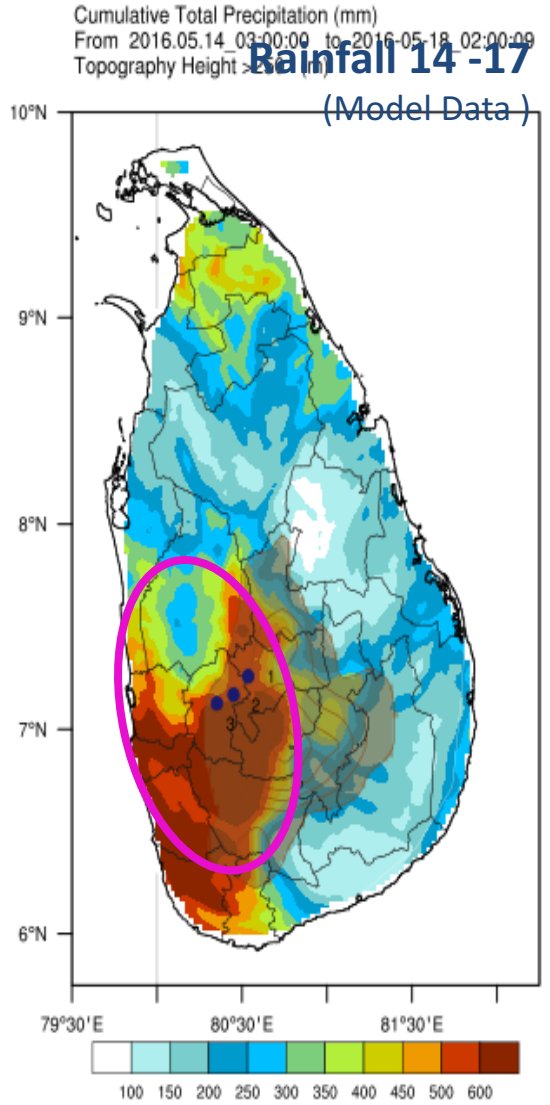


Source: Department of Meteorology



Source: Disaster Management Center (DMC)

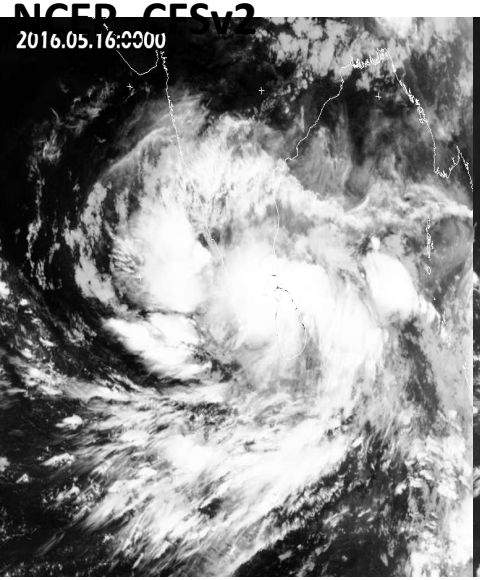
Rainfall 14 -17 (Weather Station Data)

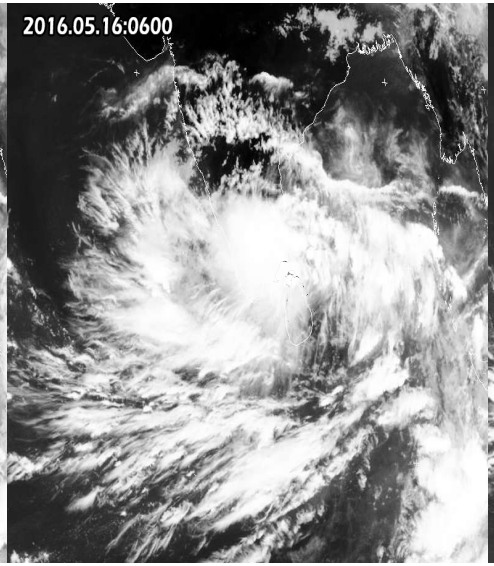


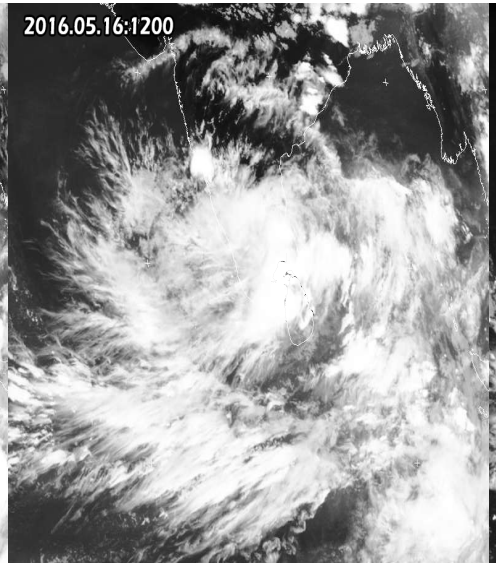
Rainfall 14 -17 (Model Data)

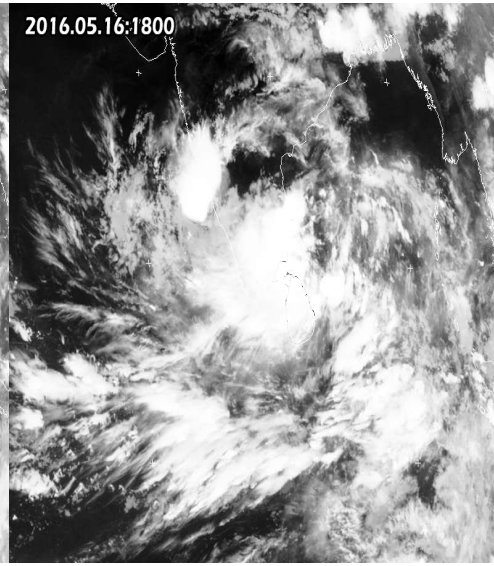
No. of Affected People as of 2016.05.22

Met_em Data / NCEP_CFSv2

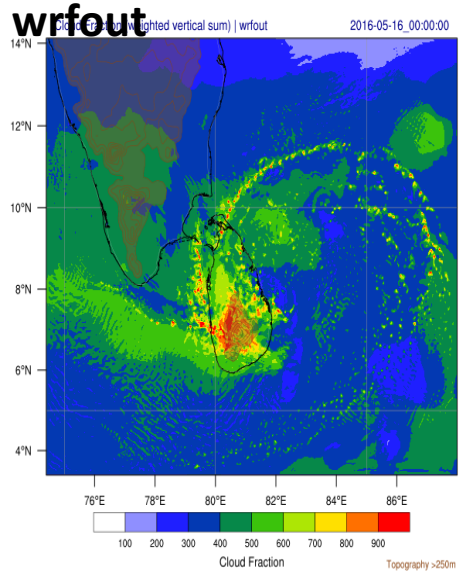


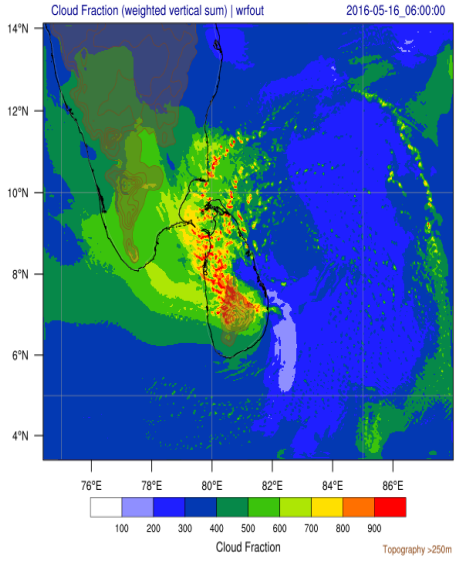


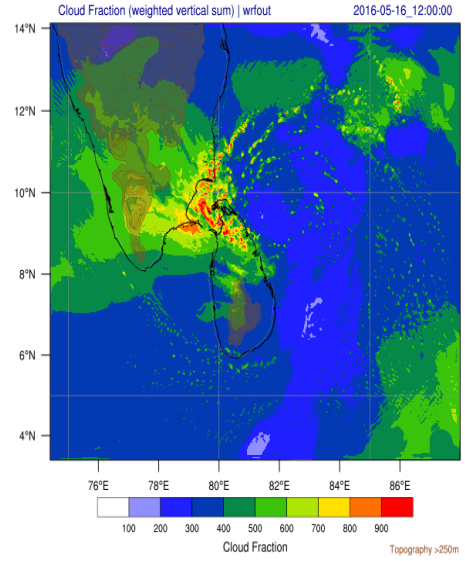


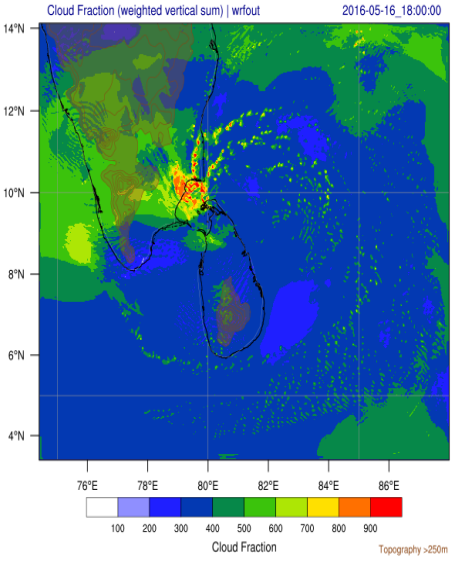


Model Results / wrfout



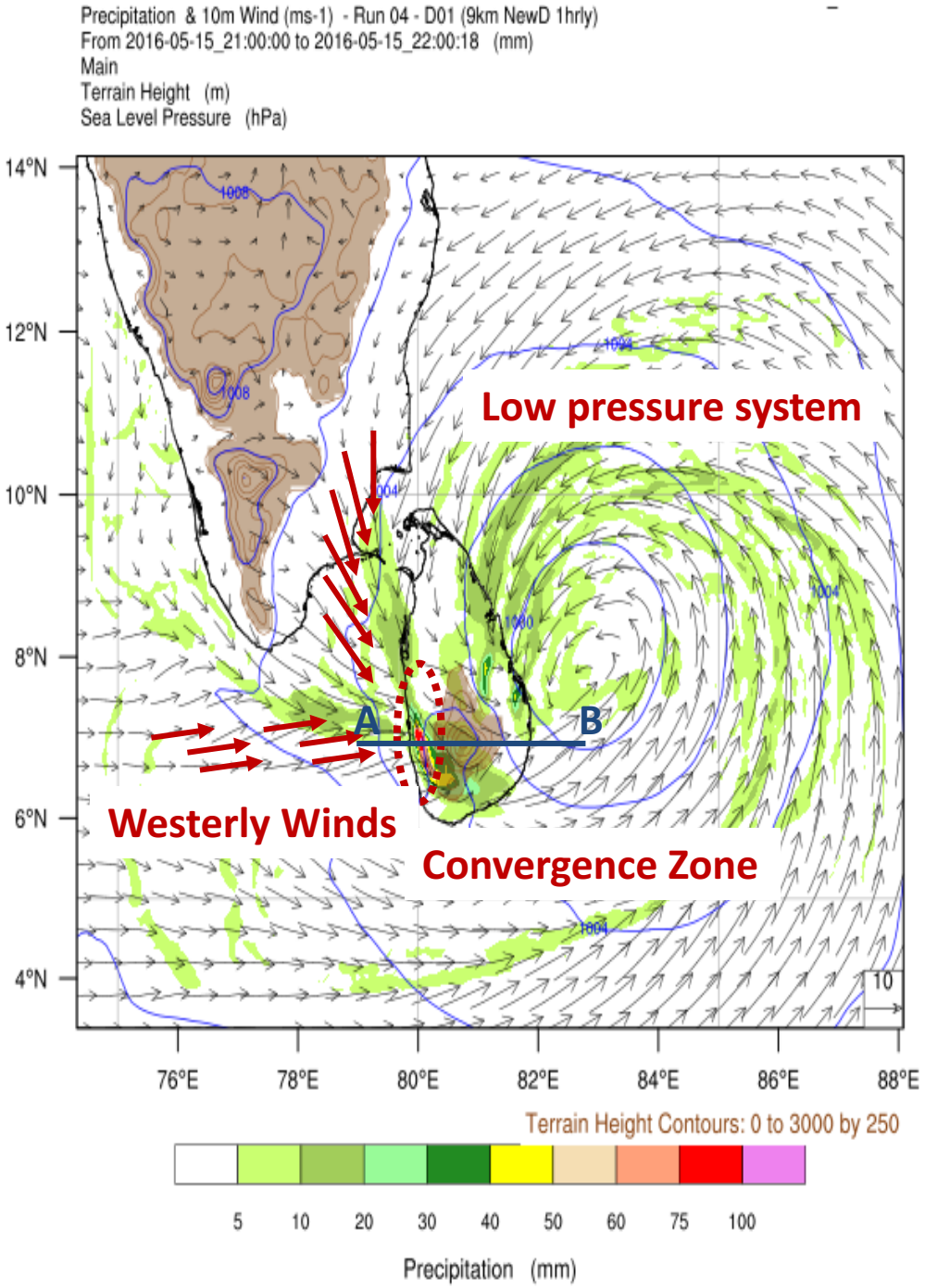


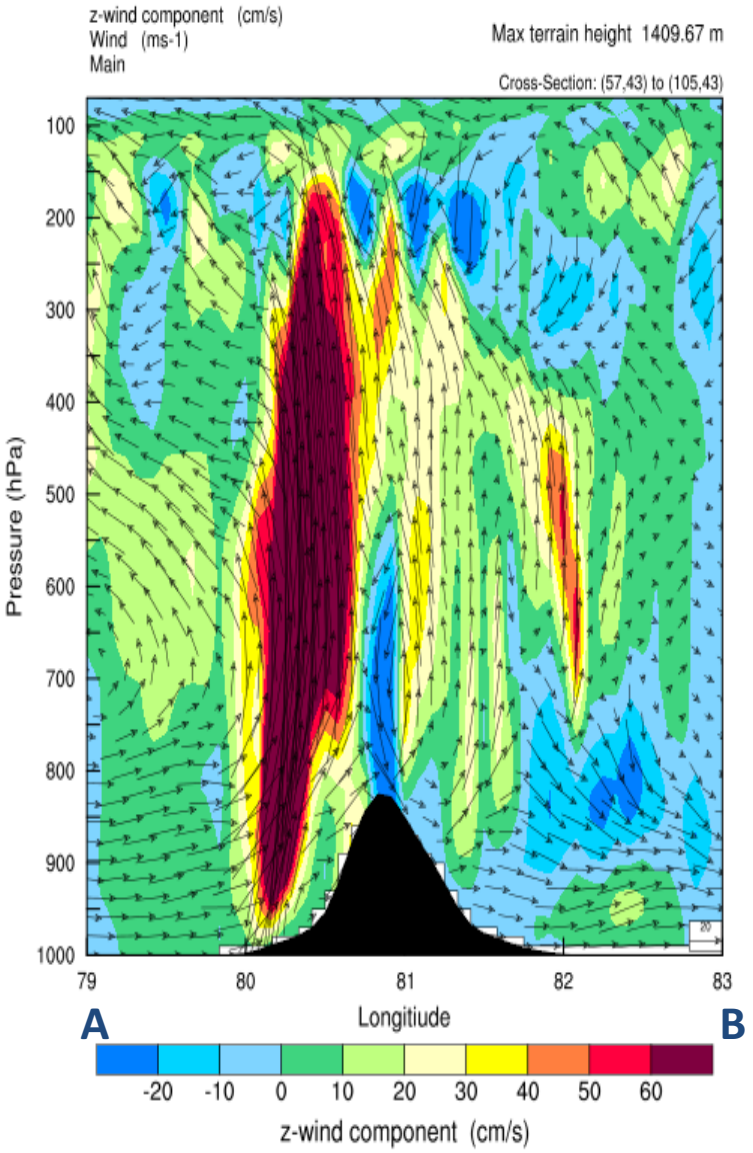




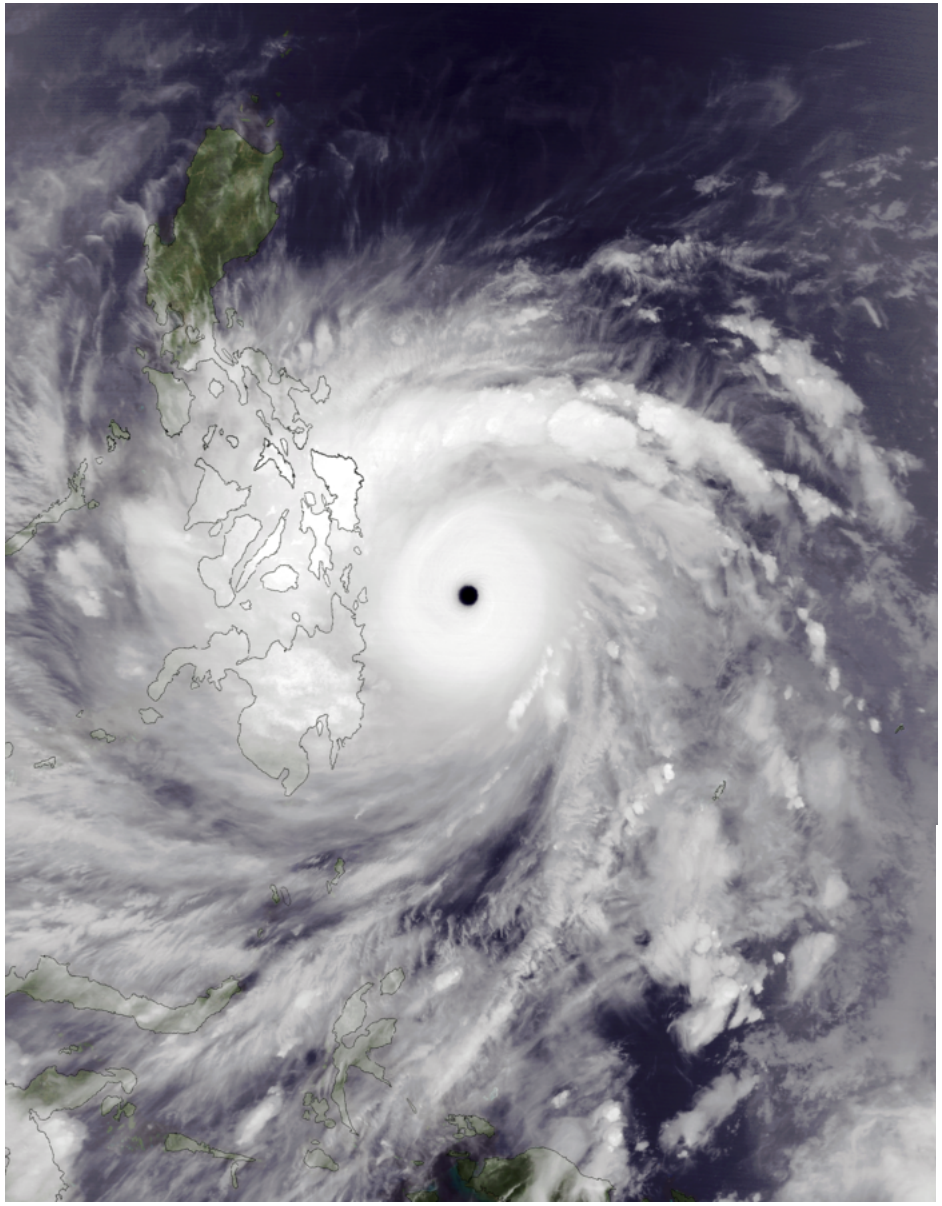
Cloud Image (Satellite) and Cloud Fractions (weighted vertical column sum) (WRF)–

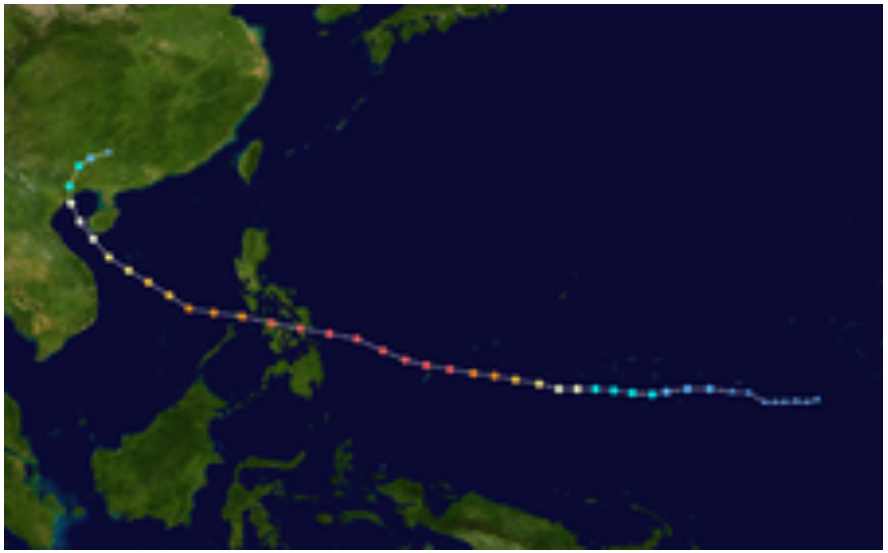
Mechanisms of the rainfall event





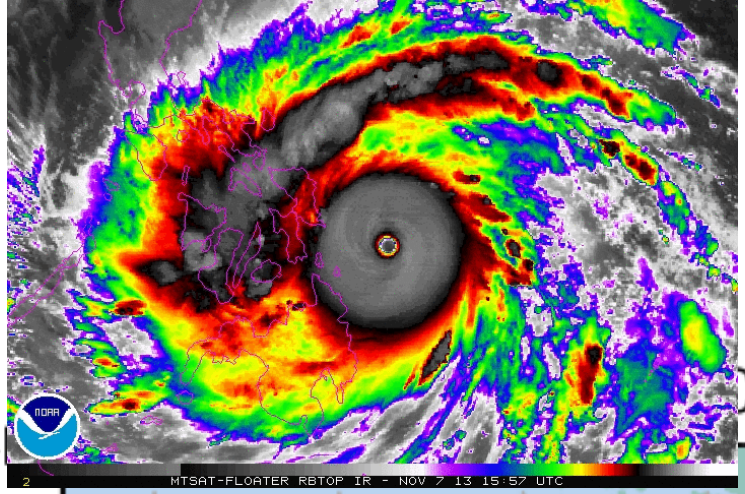
Storm Surge in Philippines (Haiyan, 2013)

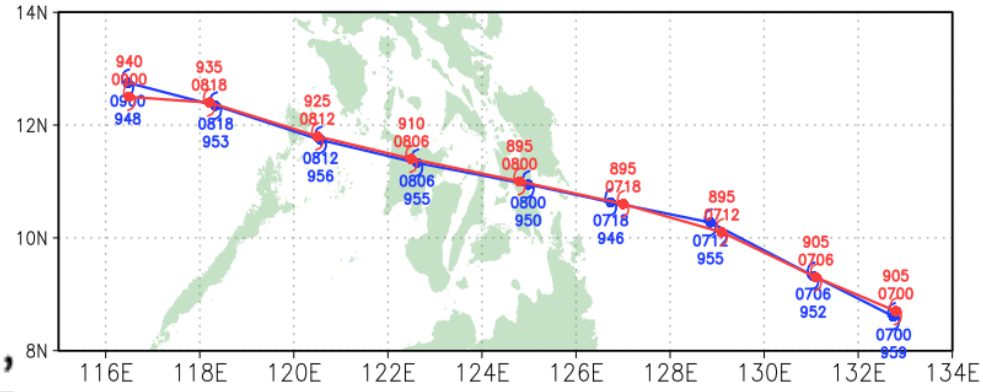




Duration : Nov.3-11
Peak: 230 km/h (145 mph) (10min)
Intensity: 895 hpa

四級 4	最高持續風速	59–70 m/s	131–156 mph	114–135 kt	210–250 km/h
	風暴潮	13–18 ft		4.0–5.5 m	
	中心最低氣壓	27.17–27.88 inHg		920–944 mbar	
	潛在傷害	小建築的屋頂被徹底地完全摧毀。靠海附近地區大部分淹沒，內陸大範圍發洪水。			
	典型熱帶氣旋	颱風哈格比 –颱風尹布都 –熱帶氣旋翠西 – 颱風賀璞 – 颱風杜鵑 – 特強氣旋風暴納爾吉斯 – 颱風珍珠 - 強颱風韋森特 - 颱風馬鞍 - 颱風尤特			
五級 5	最高持續風速	≥70 m/s	≥157 mph	≥137 kt	≥252 km/h
	風暴潮	≥19 ft		≥5.5 m	
	中心最低氣壓	<27.17 inHg		<920 mbar	
	潛在傷害	大部分建築物和獨立房屋屋頂被完全摧毀，一些房子完全被吹走。洪水導致大範圍地區受災，海岸附近所有建築物進水，定居者可能需要撤離。			
	典型熱帶氣旋	颱風狄普 – 颱風卡崔娜 – 颶風約翰 – 颶風琳達 – 熱帶氣旋莫妮卡 – 颶風威爾瑪 – 強烈颱風電母 – 颱風寶發 – 颱風梅姬 – 超強颱風三巴 – 超強颱風烏莎吉 – 特強氣旋風暴費林 - 颱風范斯高 - 颱風利奇馬–超強颱風海燕			


MTSAT-FLOATER RBTOP IR - NOV 7 13 15:57 UTC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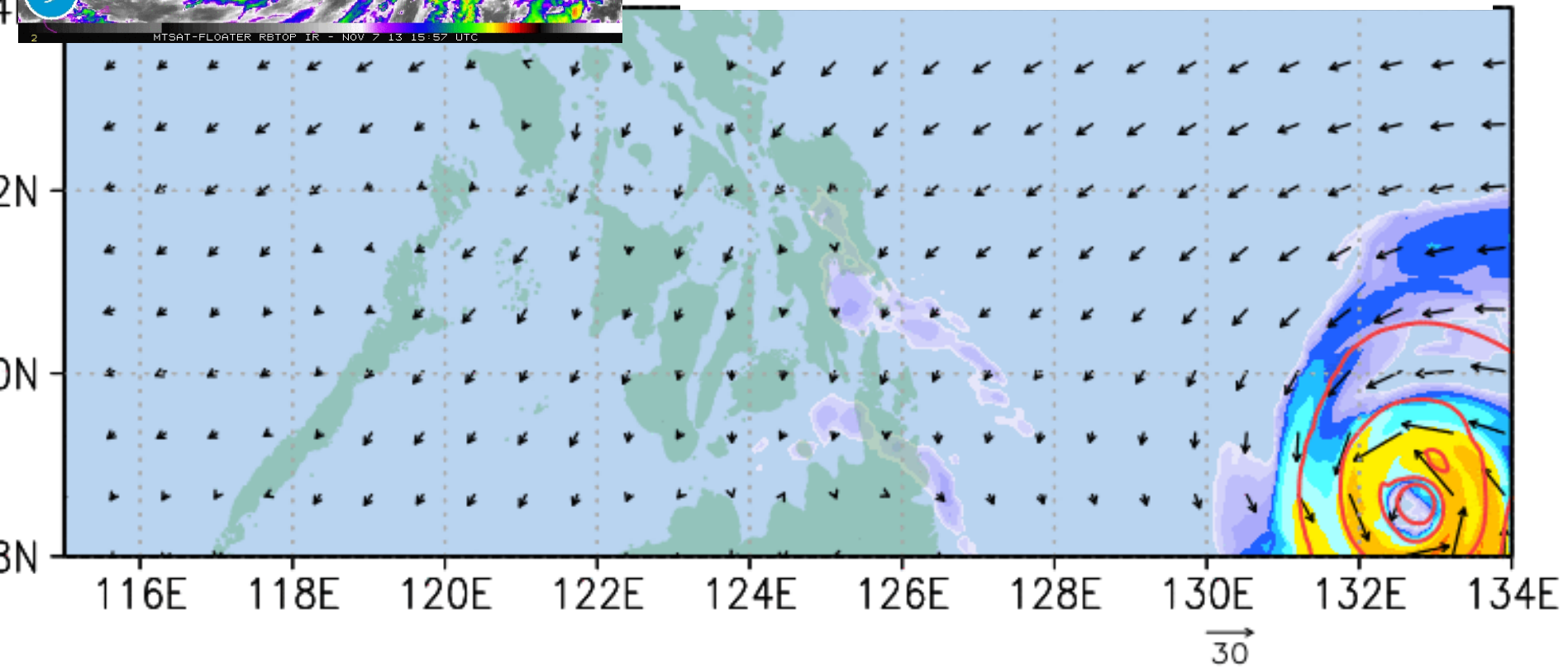
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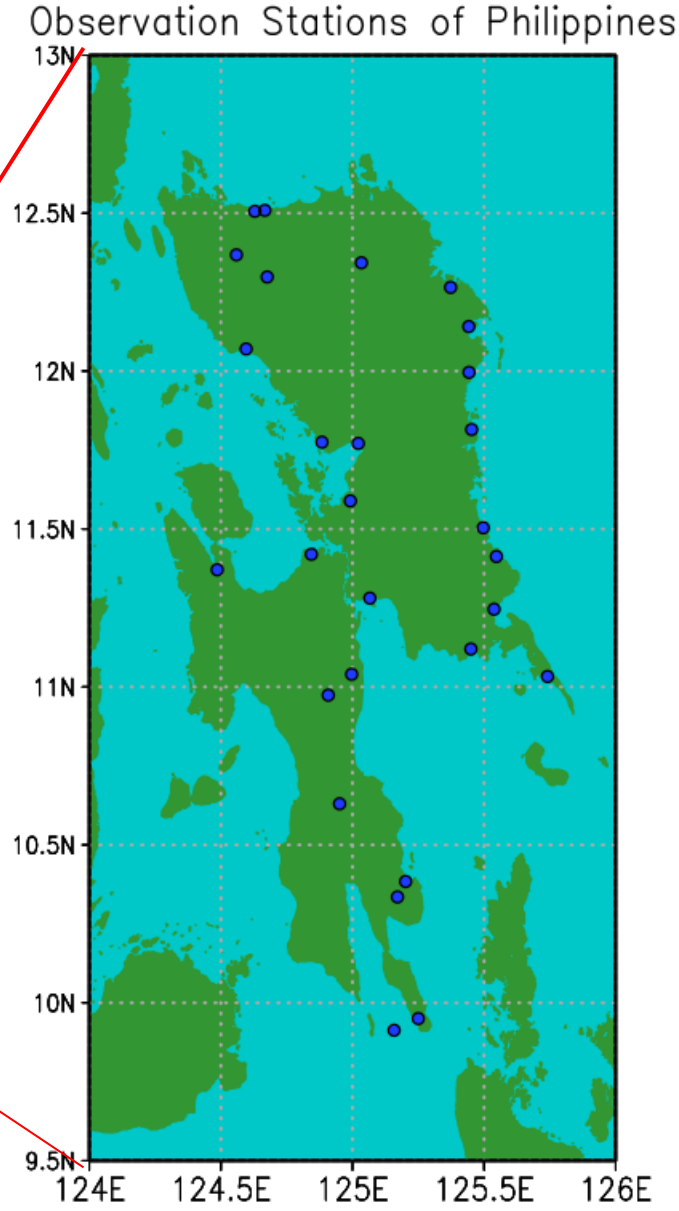
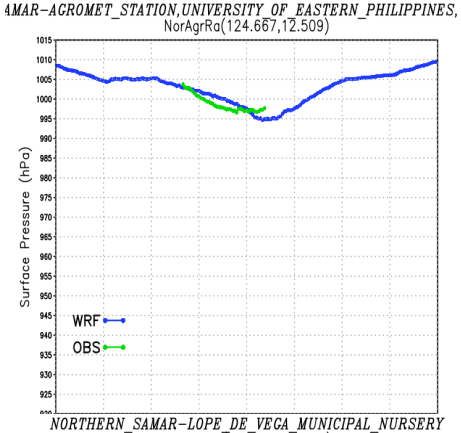
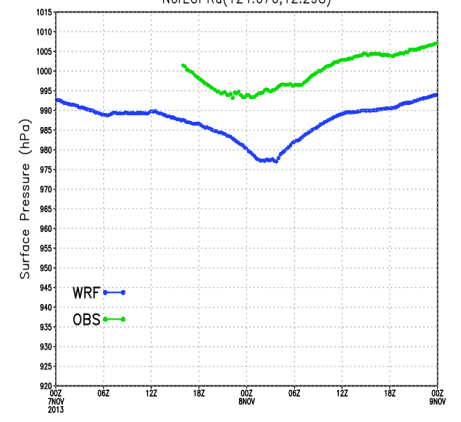
Samar & Leyte

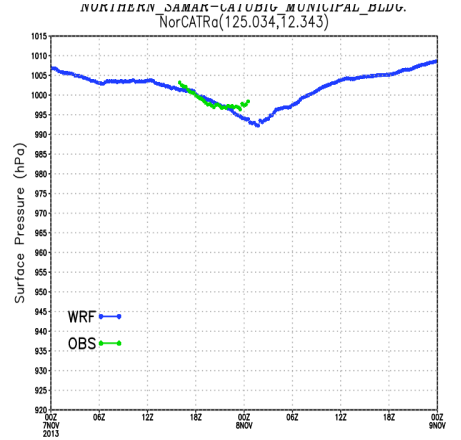

Philippine Sea
South China Sea
LUZON
EASTERN VISAYAS
NORTHERN SAMAR
VISAYAS
Sulu Sea
MINDANAO
MALAYSIA

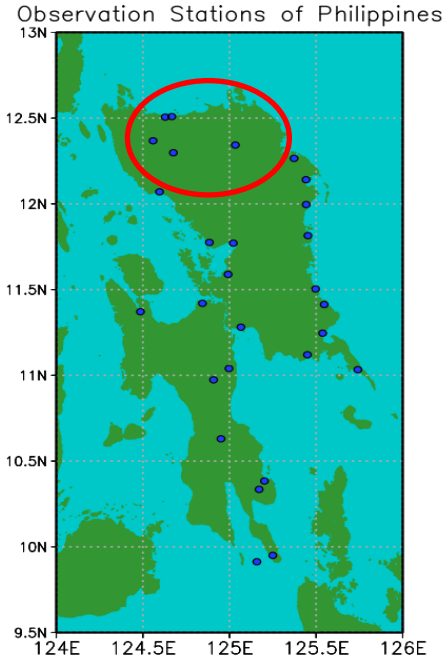

Observation Stations of Philippines
13N
12.5N
12N
11.5N
11N
10.5N
10N
9.5N
124E
124.5E
125E
125.5E
126E

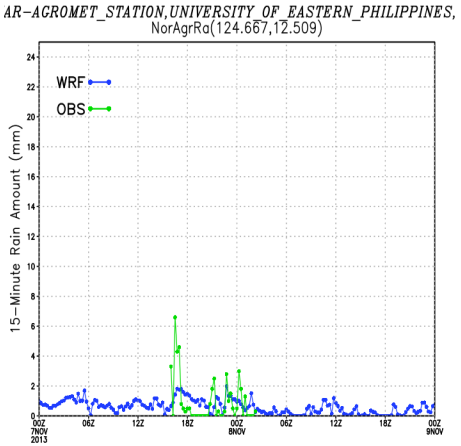
Northern Samar

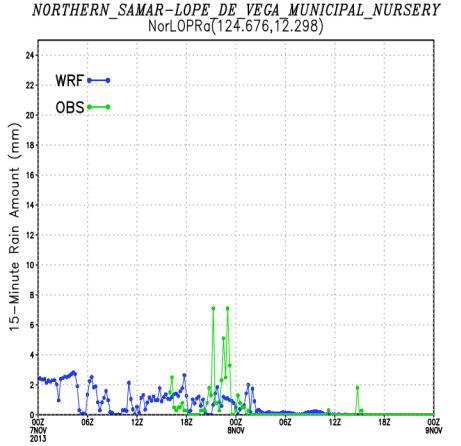


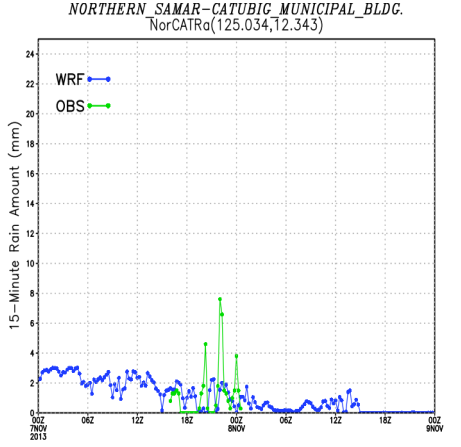


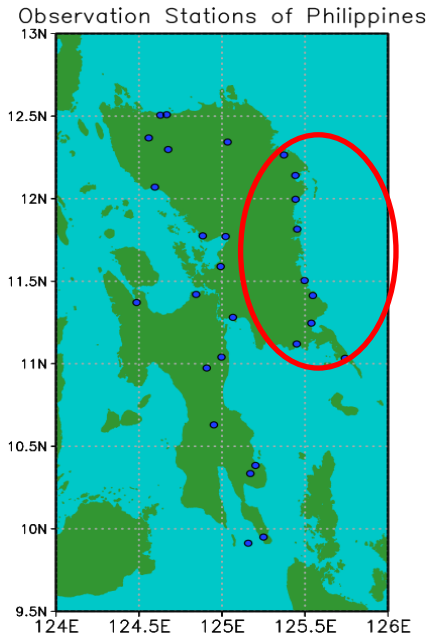


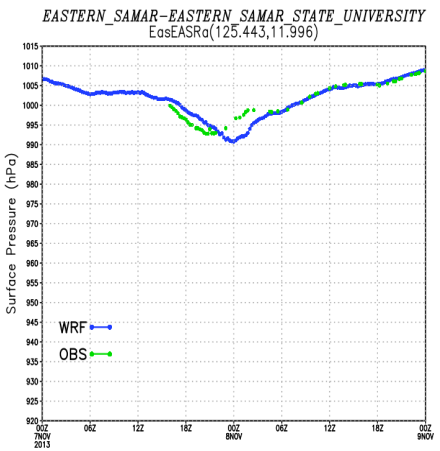


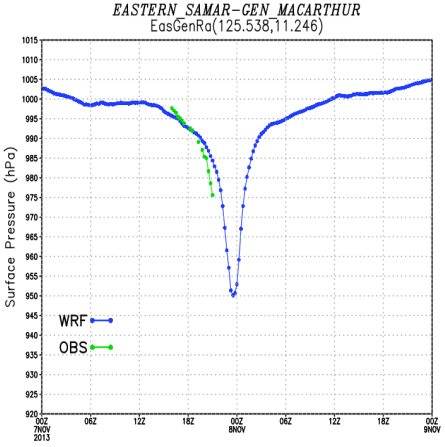


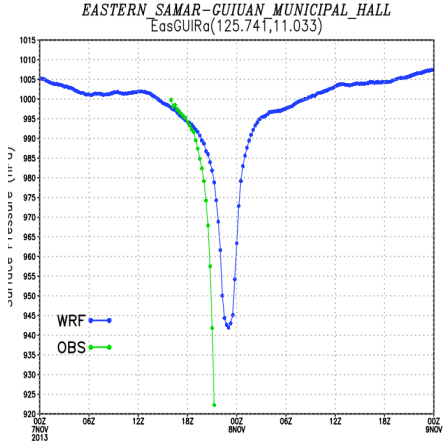


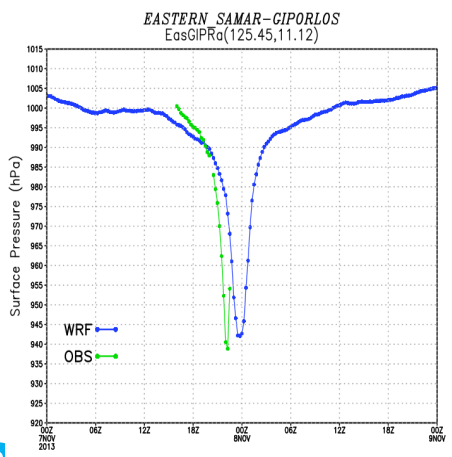


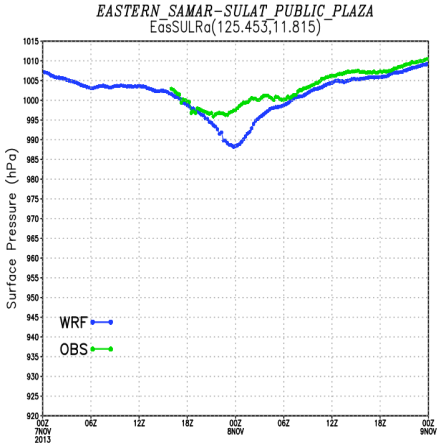


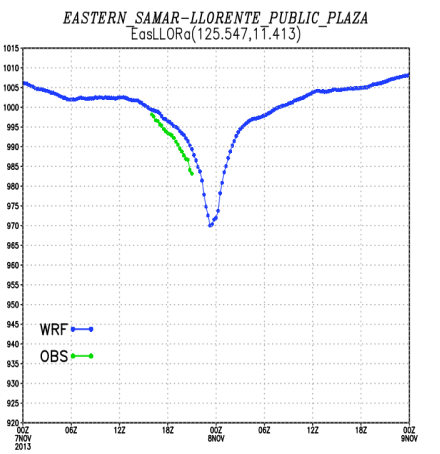






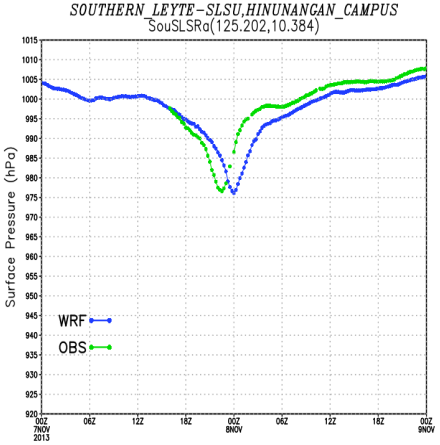


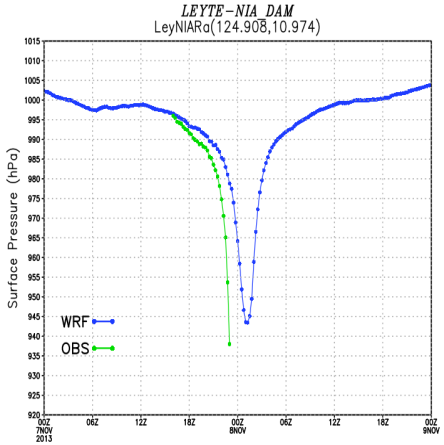


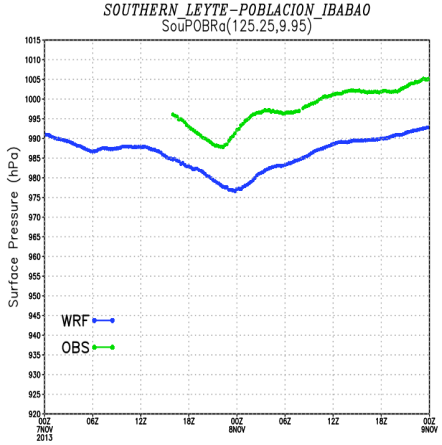


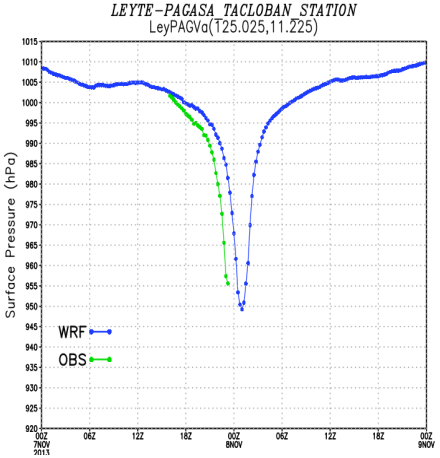
Eastern Samar

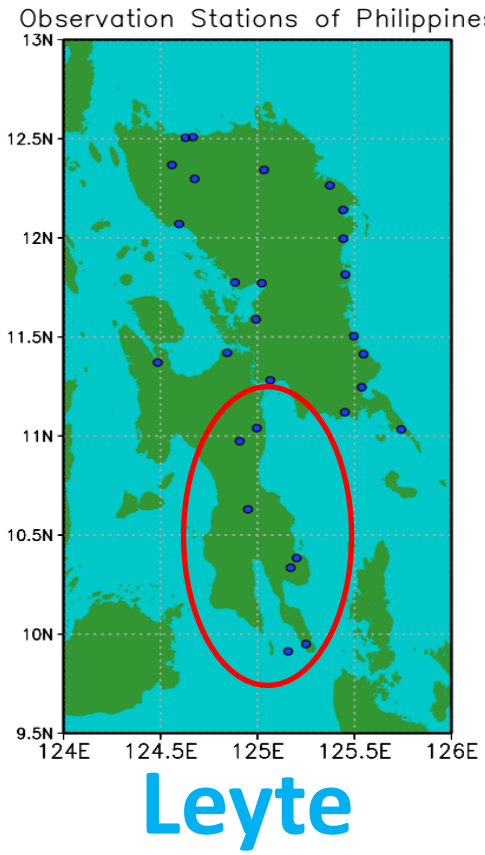
(pressure)


SOUTHERN_LEYTE-SLSU,HINUNANGAN_CAMPUS
SouSLSRa(125.202,10.384)
Surface Pressure (hPa)
WRF
OBS


LEYTE-NIA_DAM
LeyNIARa(124.908,10.974)
Surface Pressure (hPa)
WRF
OBS


SOUTHERN_LEYTE-POBLACION_IBABAO
SouPOBRa(125.25,9.95)
Surface Pressure (hPa)
WRF
OBS


LEYTE-PAGASA_TACLOBAN_STATION
LeyPAGVa(125.025,11.225)
Surface Pressure (hPa)
WRF
OBS


Observation Stations of Philippines
13N
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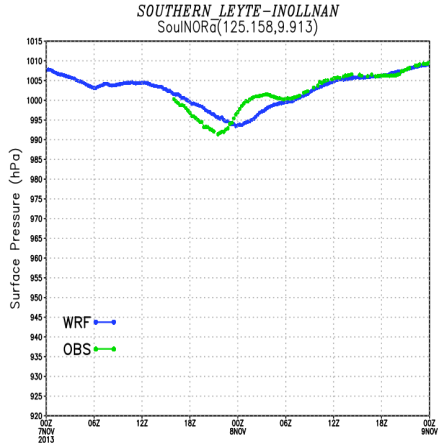
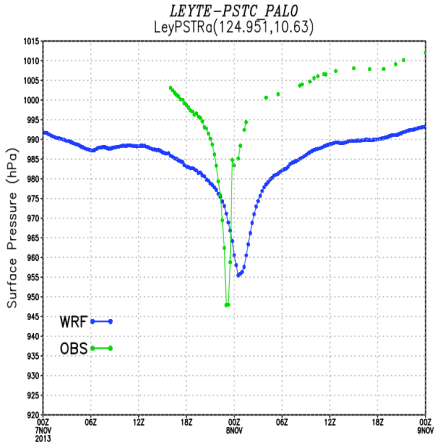
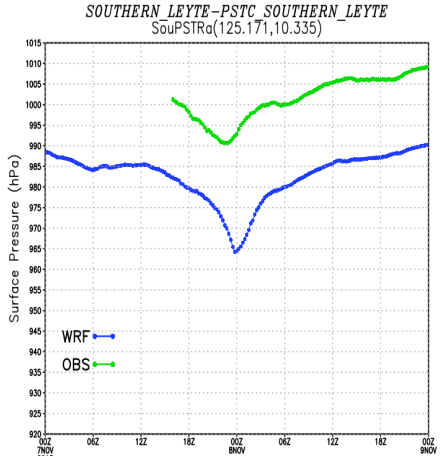
11.5N
11N
10.5N
10N
9.5N
124E
124.5E
125E
125.5E
126E
Leyte

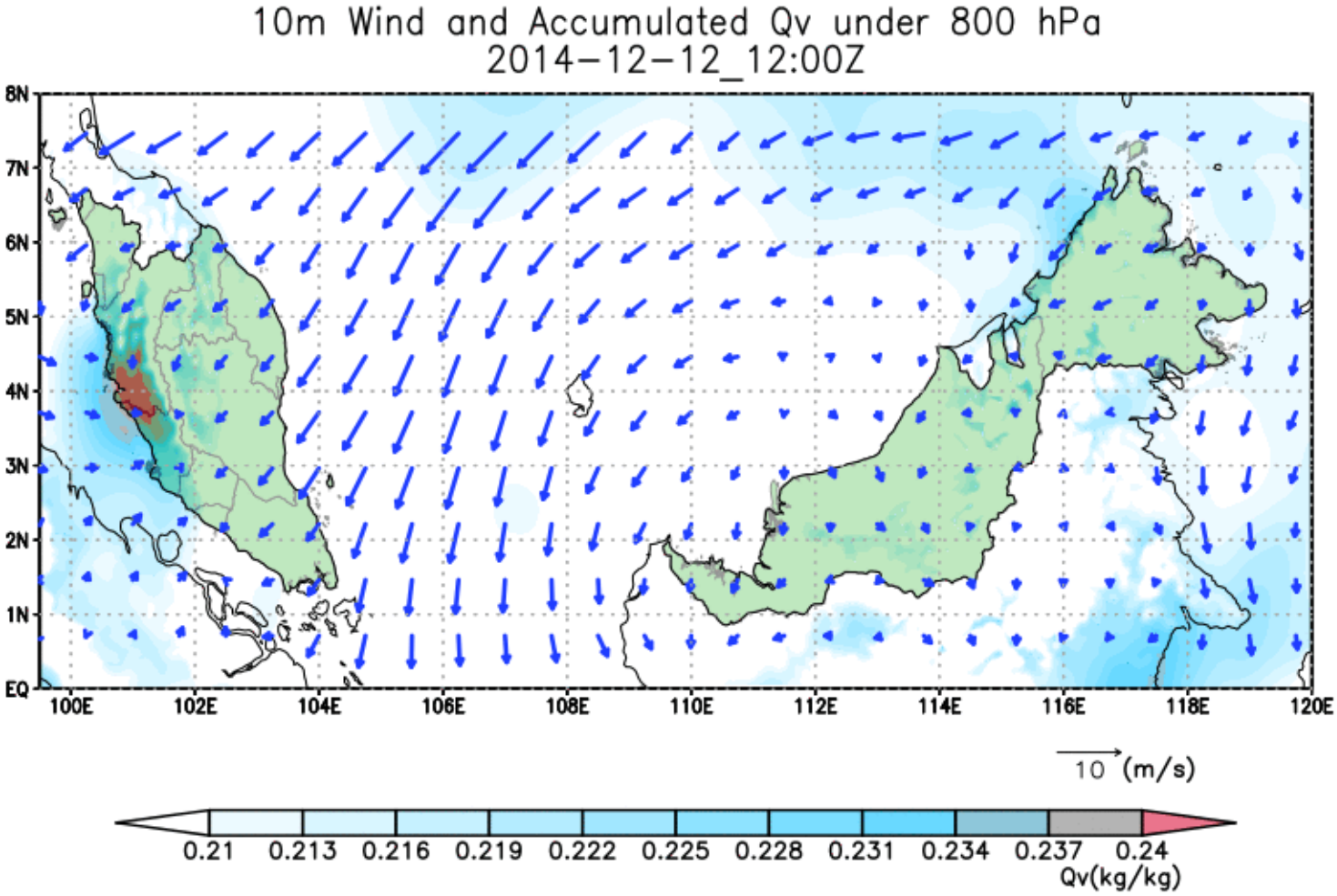

SOUTHERN_LEYTE-INOLLNAN
SouINORa(125.158,9.913)
Surface Pressure (hPa)
WRF
OBS


LEYTE-PSTC_PALO
LeyPSTRa(124.951,10.63)
Surface Pressure (hPa)
WRF
OBS


SOUTHERN_LEYTE-PSTC_SOUTHERN_LEYTE
SouPSTRa(125.171,10.335)
Surface Pressure (hPa)
WRF
OBS

Flooding in Malaysia (2014-2015)

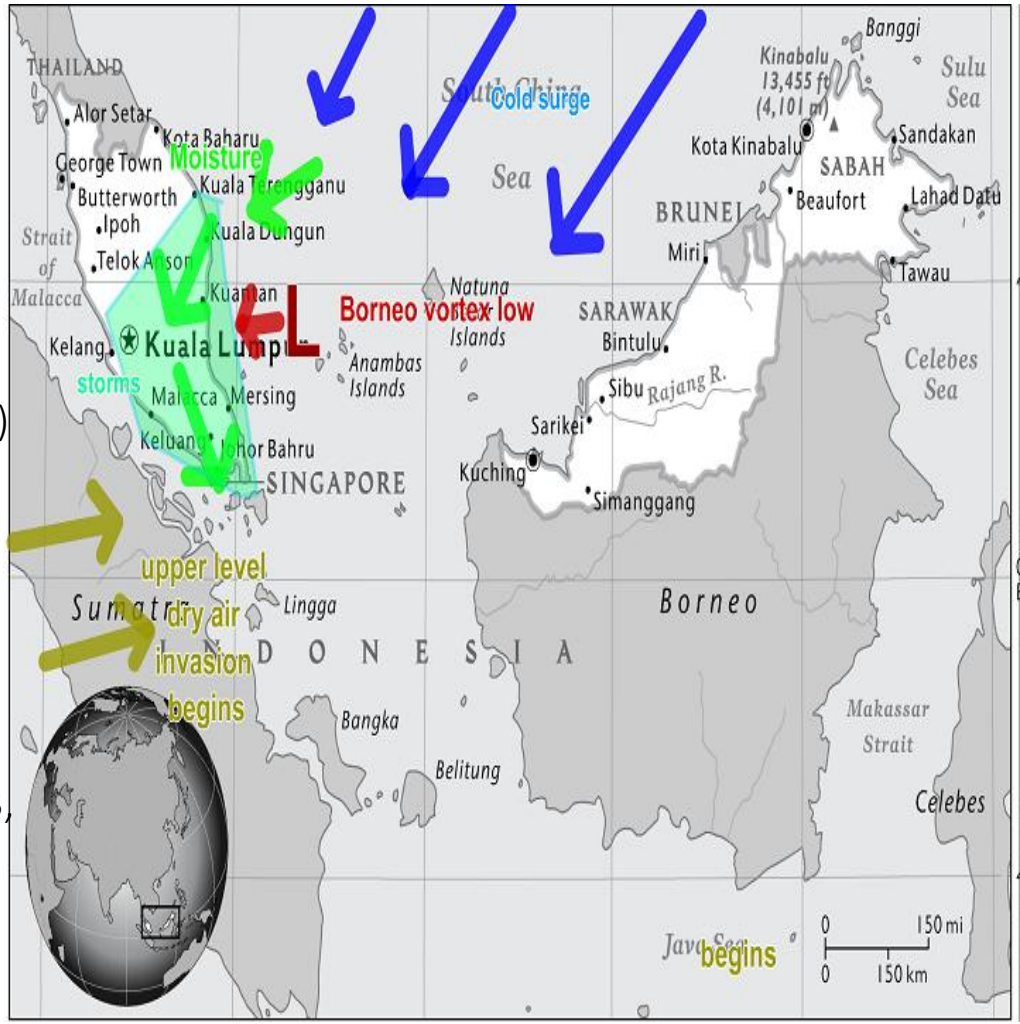
As part of the northeast monsoon,[4] heavy rains since 17 December forced 3,390 people in Kelantan and 4,209 people in Terengganu to flee their homes.[5] Several Keretapi Tanah Melayu(KTM) intercity train services along the East Coast route were disrupted on 18 December following the floods.[6] On 20 December, the area of Kajang, Selangor, was also hit by serious floods.[7]By 23 December, most rivers in Kelantan, Pahang, Perak and



The **2014–15 Malaysia floods** hit Malaysia from 15 December 2014 – 3 January 2015. More than 200,000 people affected while 21 killed on the floods.[1] This flood have been described as the worst floods in decades

- This area is subjected to significant largescale and mesoscale interactions
  - **Topographic feature :** distribution of deep convection (Chang et al, 2005)
  - **northeasterly cold surges** dominate the low-level circulation patterns (Zhang et al. 1997)
  - Quasi–stationary **Borneo vortex** (Johnson and Houze, 1987; Chang et al. 2003, Chang et al. 2005, Juneng et al. 2007)
  - Madden-Julian Oscillations **(MJO):** (Madden and Julian, 1972)

on intra-seasonal time scales peak amplitude during boreal winter over the Maritime Continent



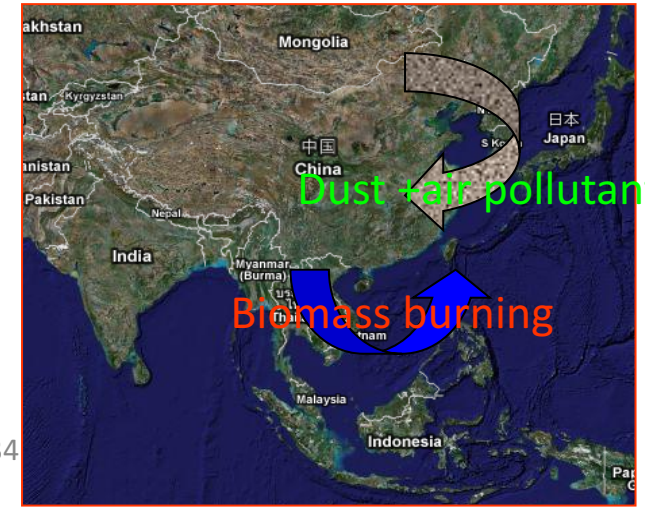
Environmental Research Topics

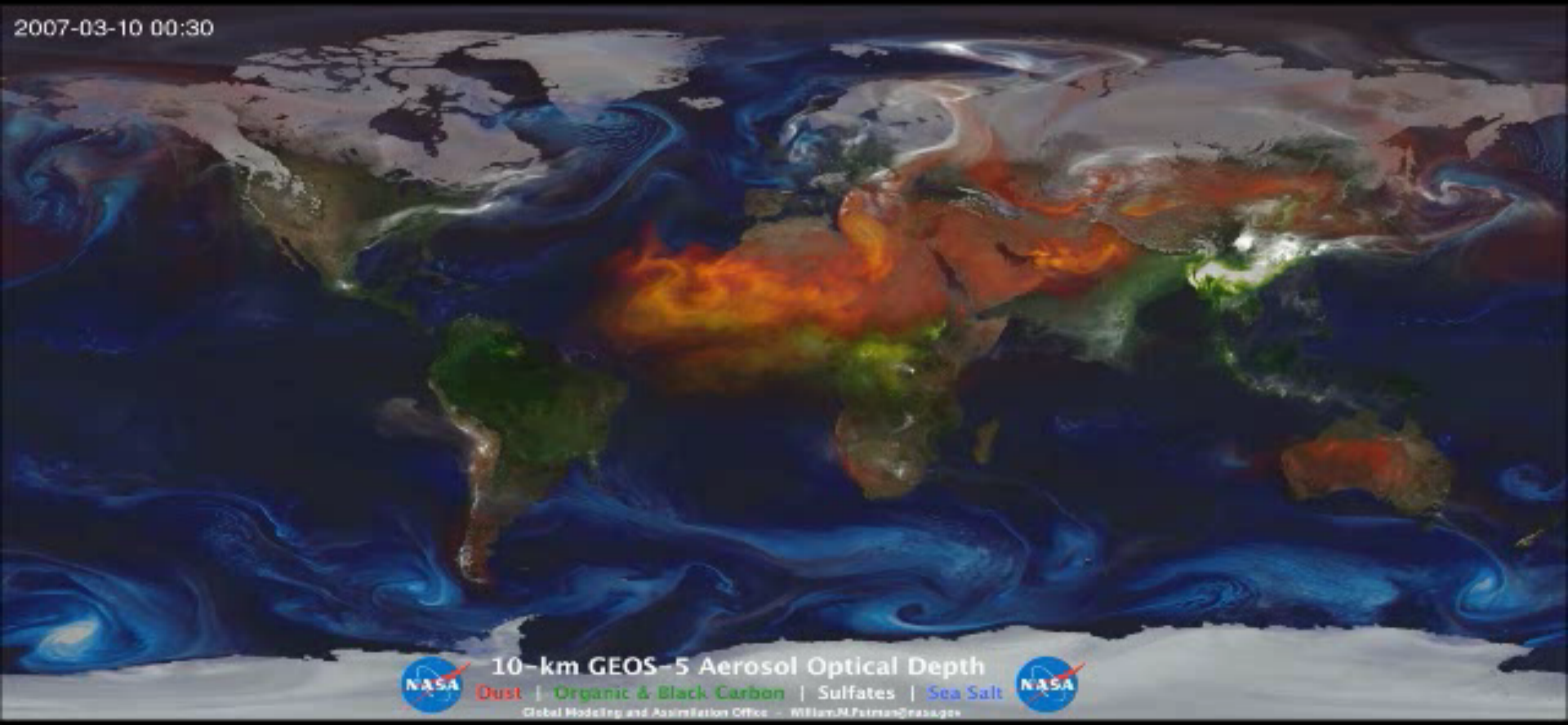
Environmental Research Topics

- **Long-range transport of air pollutants to Taiwan**

  Asian dust and air pollutants from China

  Impact of Biomass burning pollutants from Indochina



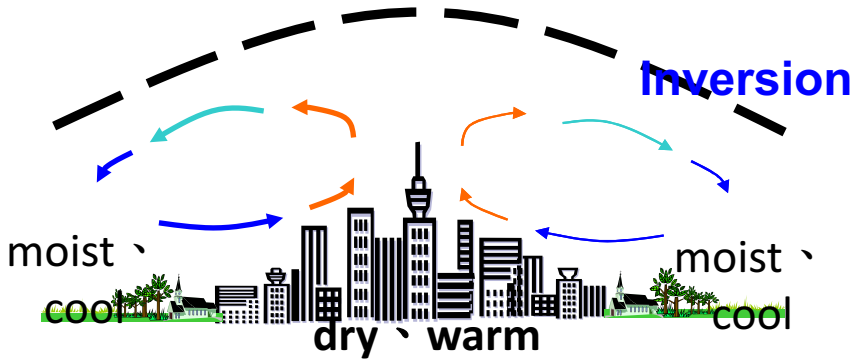

2007-03-10 00:30
10-km GEOS-5 Aerosol Optical Depth
Dust | Organic & Black Carbon | Sulfates | Sea Salt
Global Modeling and Assimilation Office - William.M.Putman@nasa.gov

Research Topics

- **Long-range transport of air pollutants to Taiwan**

  Asian dust and air pollutants from China

  Impact of Biomass burning pollutants from Indochina



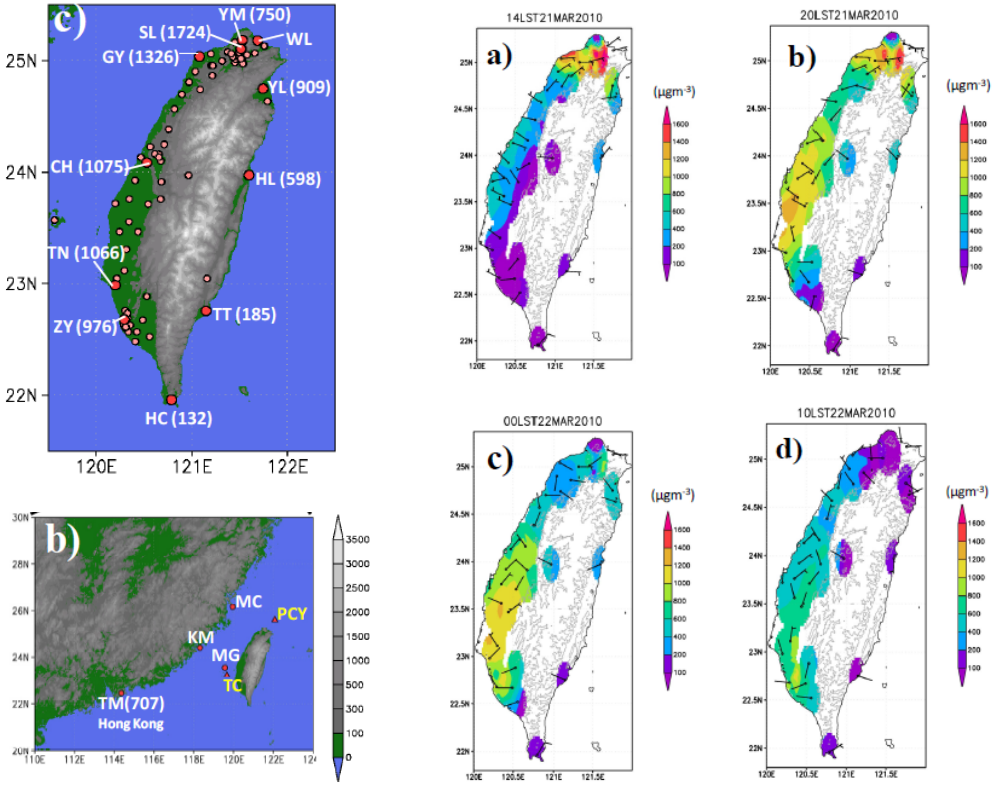
UHI effect

Atmos. Chem. Phys., 12, 271–285, 2012
www.atmos-chem-phys.net/12/271/2012/
doi:10.5194/acp-12-271-2012

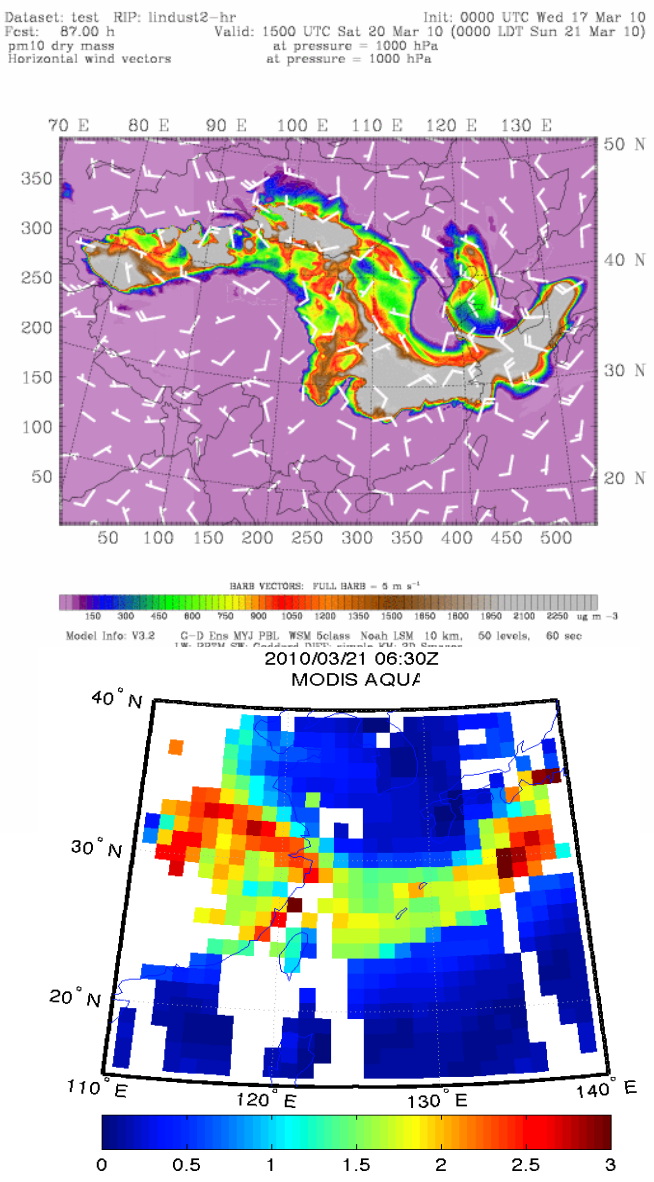
Atmospheric Chemistry

The impact of channel effect on Asian dust transpo a case in southeastern Asia

C.-Y. Lin[1], Y.-F. Sheng[1], W.-N. Chen[1], Z. Wang[2], C.-H. Kuo[3], W.-C. Chen[1], and T. Yan



Model: WRF/Chem, 10 km resolution

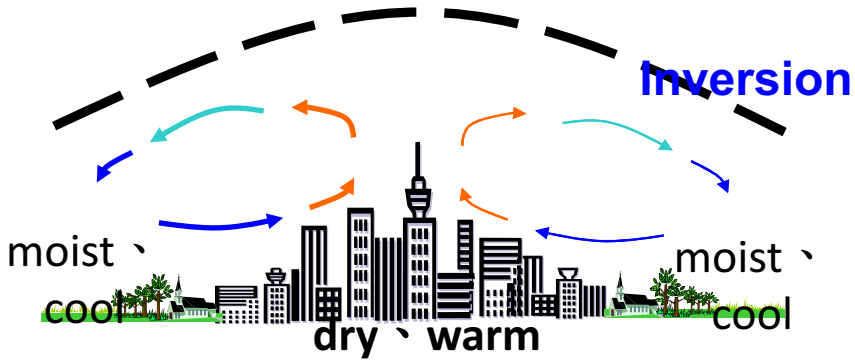


Research Topics

- **Long-range transport of air pollutants to Taiwan**

  Asian dust and air pollutants from China

  Impact of Biomass burning pollutants from Indochina

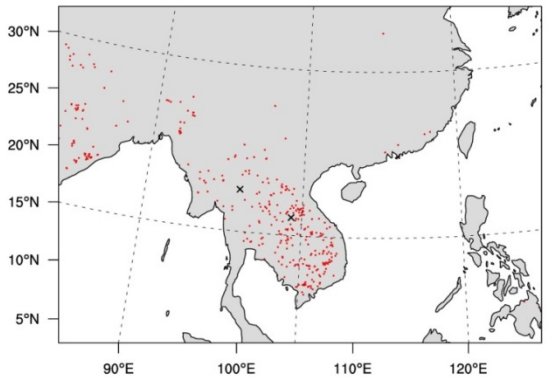


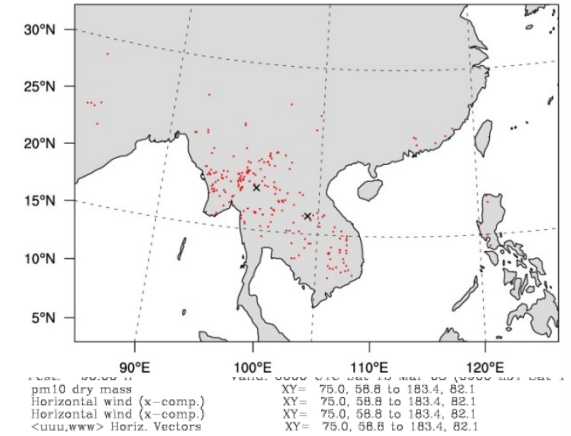
UHI effect

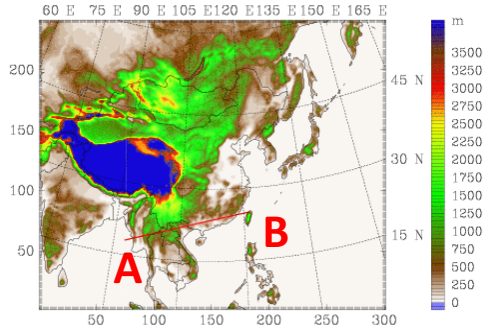
Tellus SERIES B CHEMICAL AND PHYSICAL METEOROLOGY

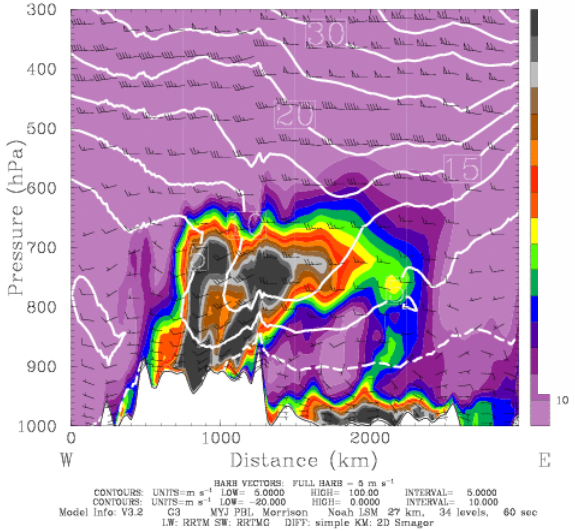
Modelling of long-range transport of Southeast Asia biomass-burning aerosols to Taiwan and their radiative forcings over East Asia

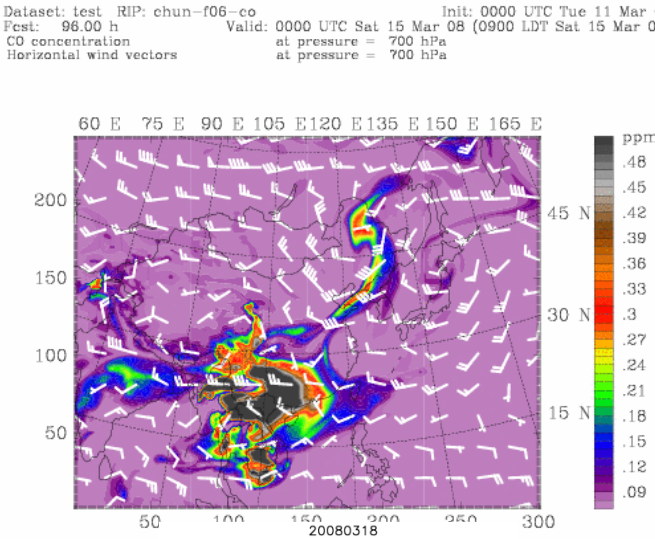
By CHUAN-YAO LIN[1]*, CHUN ZHAO[2], XIAOHONG LIU[2,3], N
WEI-NEI CHEN[1], [1]*Research Center for Environmental Changes, Acaden*

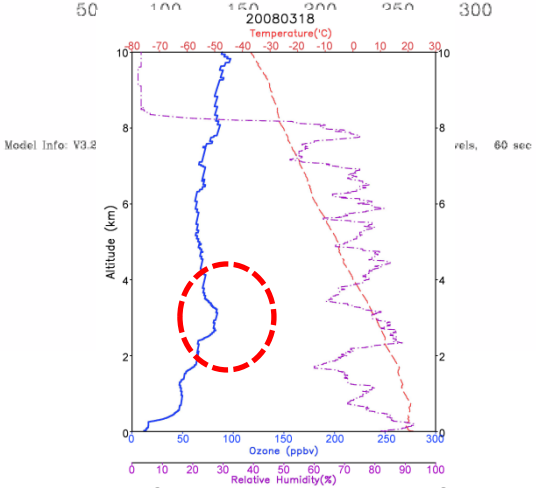










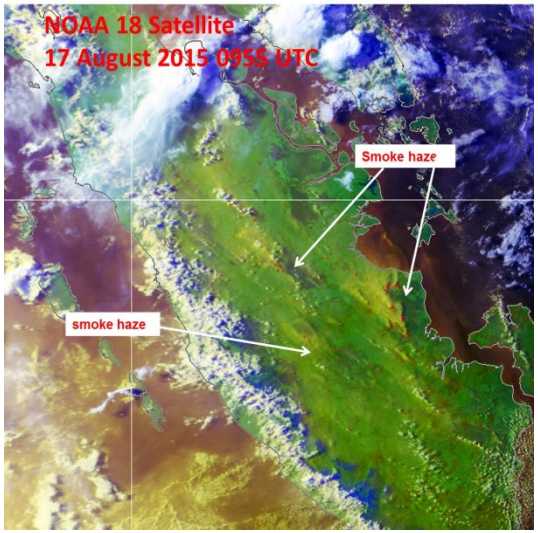


Model: WRF/Chem,
15 km resolution

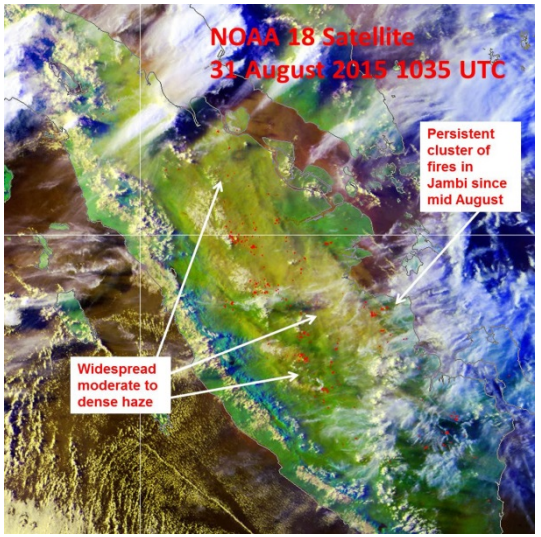
South East Asia haze 2015

The haze affected Indonesian from at least late June, to the end of October, turning into an international problem for other countries in September.

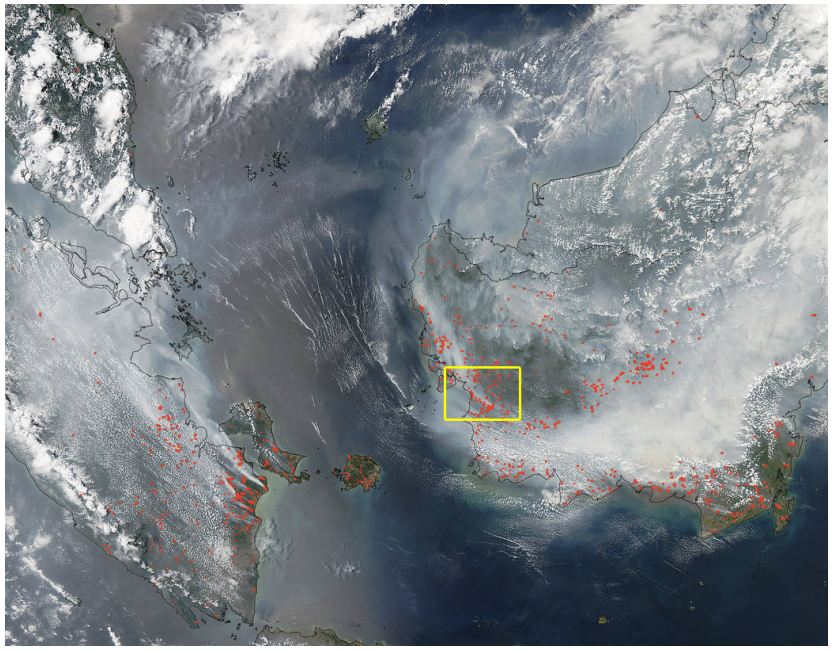
https://zh.wikipedia.org/wiki/



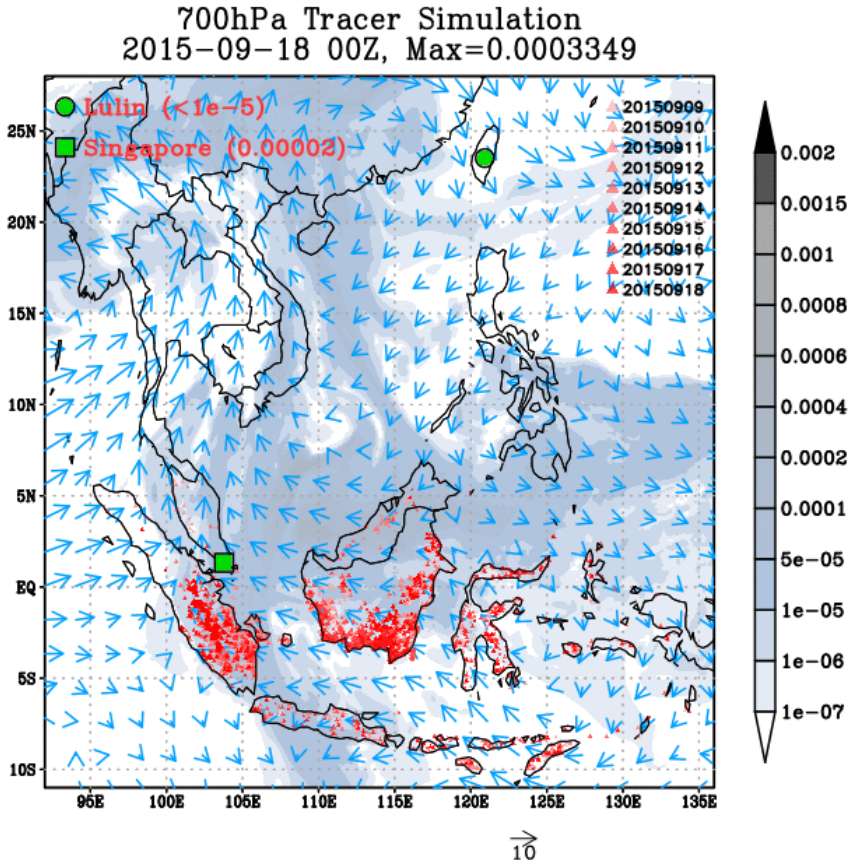
NOAA-18 satellite picture on 29 August 2015 shows deterioration of smoke haze situation in Kalimantan

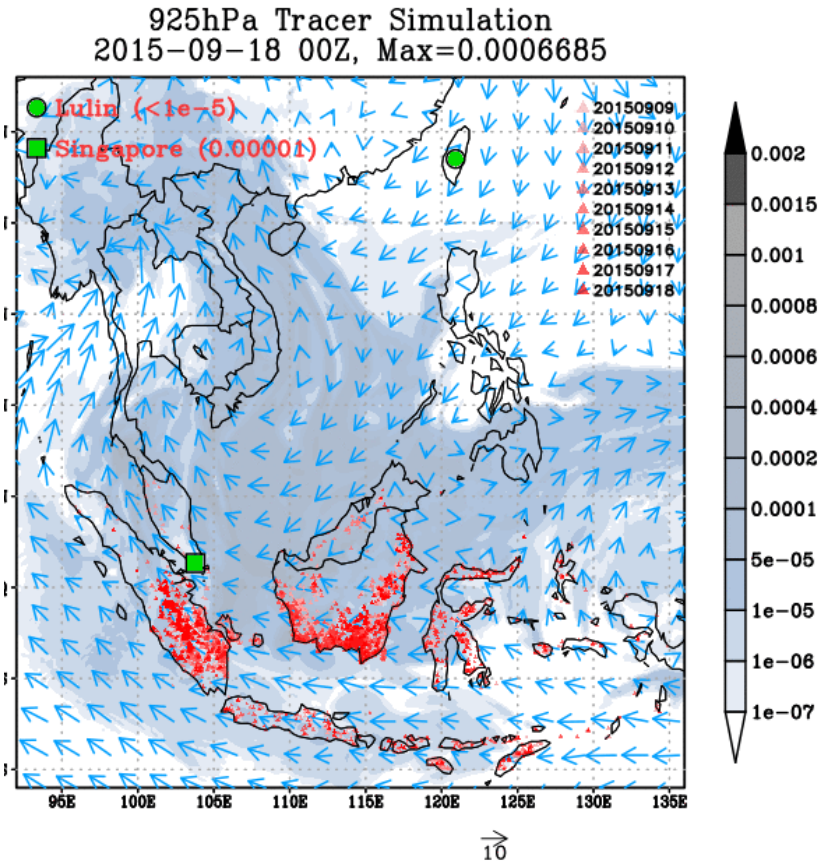


NOAA-18 satellite picture on 31 Augusts 2015 shows widespread smoke haze from Sumatra spreading into the Strait of Malacca.



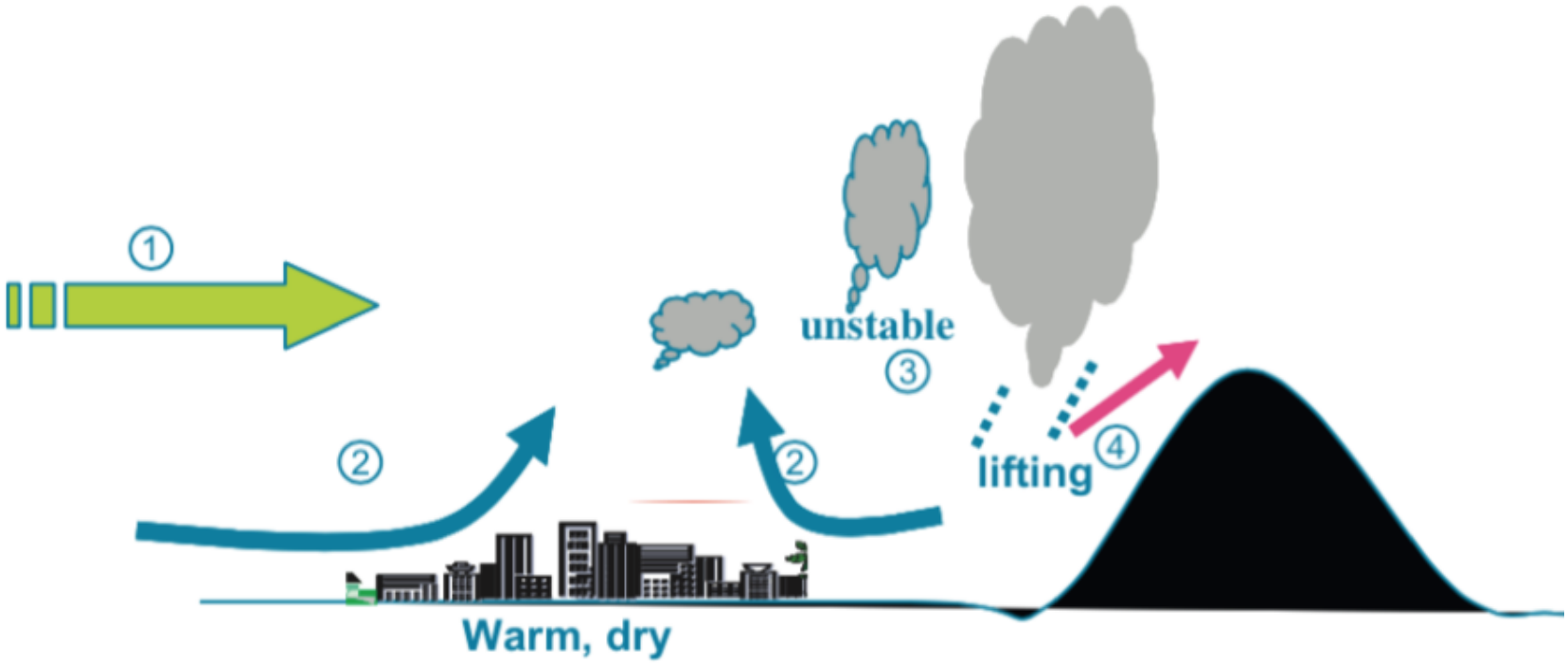
NASA's Aqua satellite collected this natural-color image with the Moderate Resolution Imaging Spectroradiometer, MODIS, instrument on September 22, 2015.

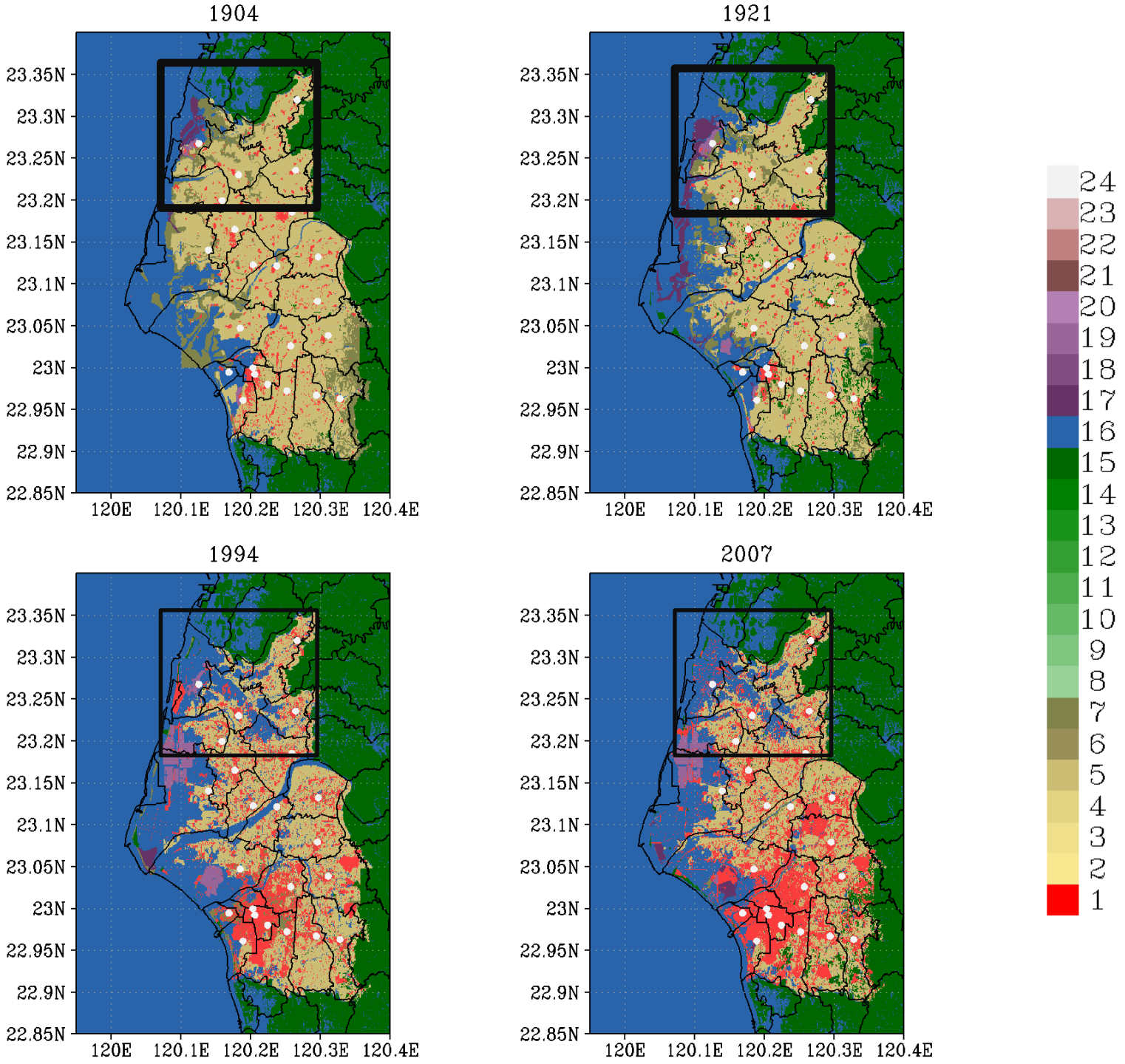




Resolution: 10 km

Impacts of Urbanization to Taiwan West Land on Precipitation




1904
1921
1994
2007
23.35N
23.3N
23.25N
23.2N
23.15N
23.1N
23.05N
23N
22.95N
22.9N
22.85N
120E
120.1E
120.2E
120.3E
120.4E
24
23
22
21
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19
18
17
16
15
14
13
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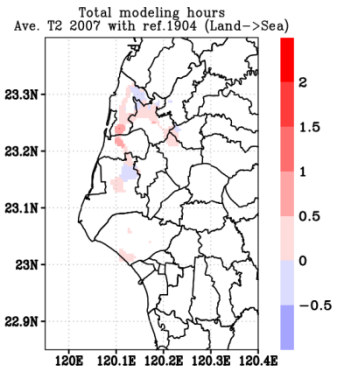
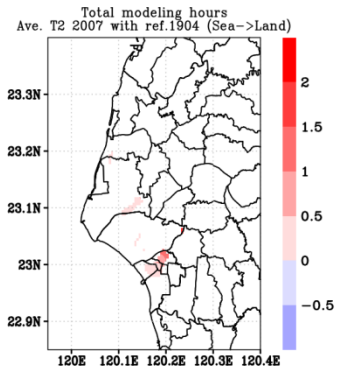
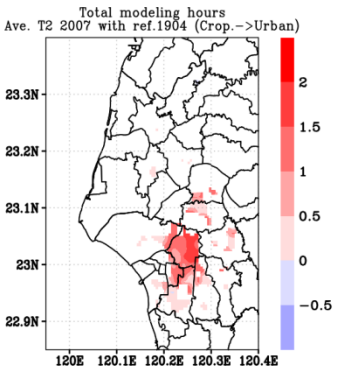
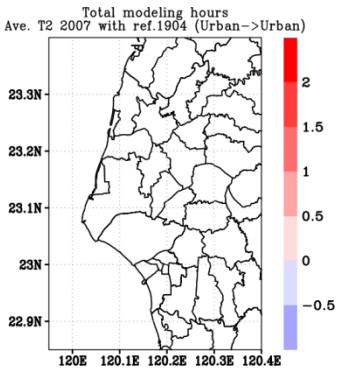
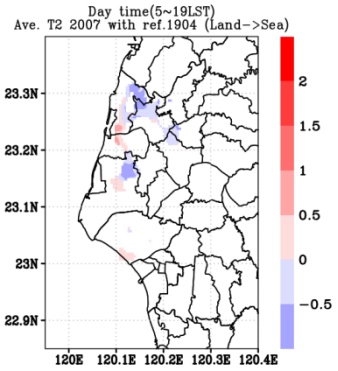
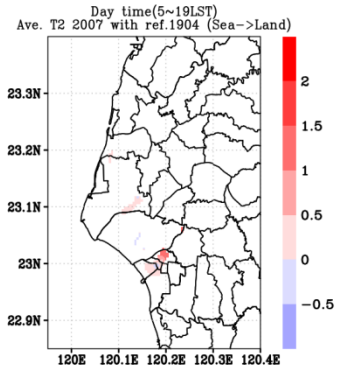
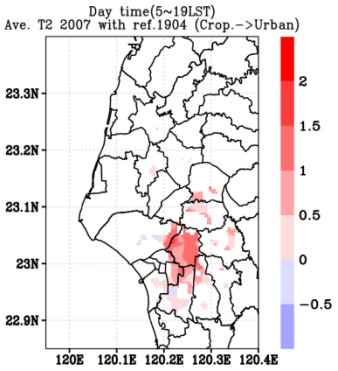
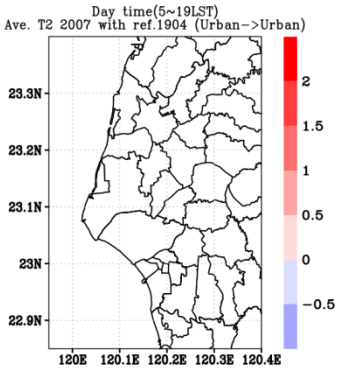
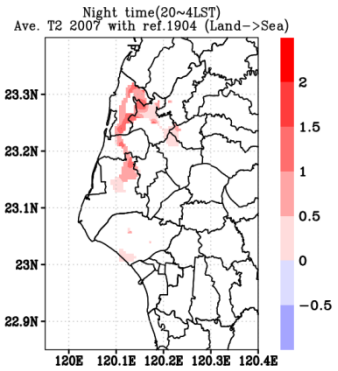
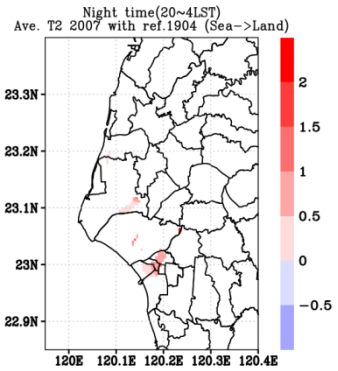
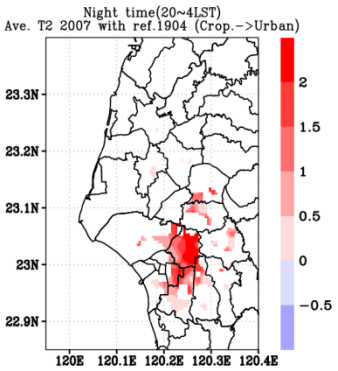
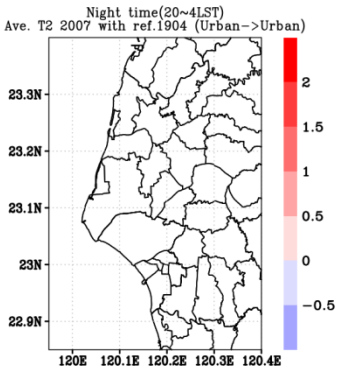
1

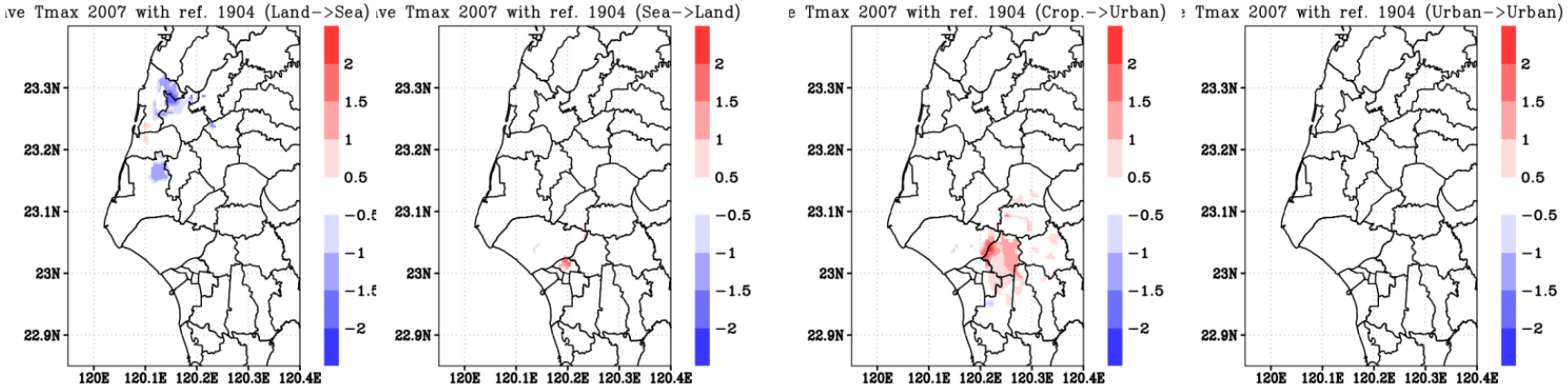
Differences of Diurnal Average Temperature 1904 and 2007

	Land -> Water	Water -> Land	Farm -> City	City -> City
All Time				
Day Time				
Night				

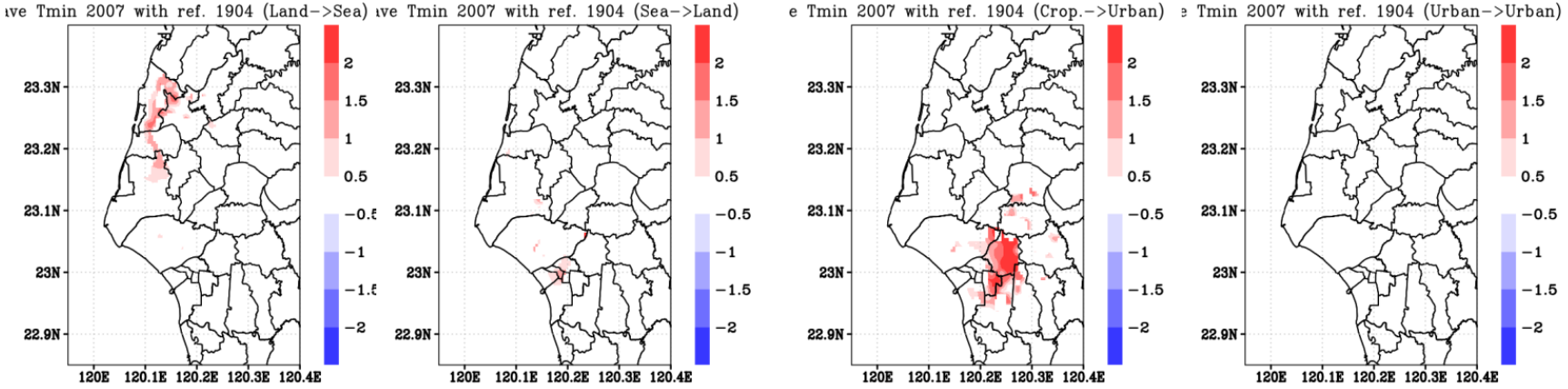
Average on Differences of Highest and Lowest Temperature in a Day

Land -> Water | Water -> Land | Farm -> City | City -> City

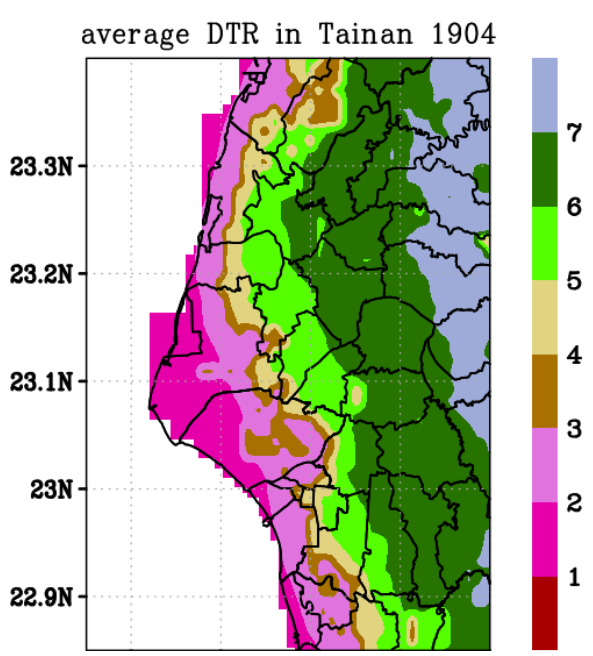
Tmax

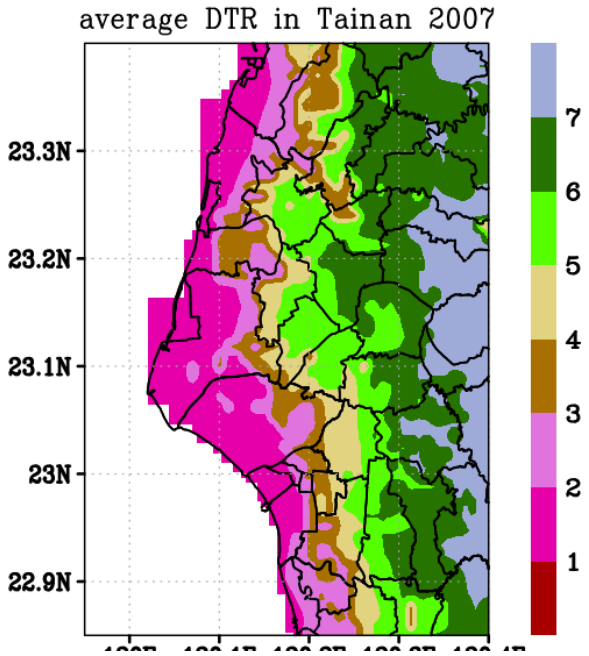


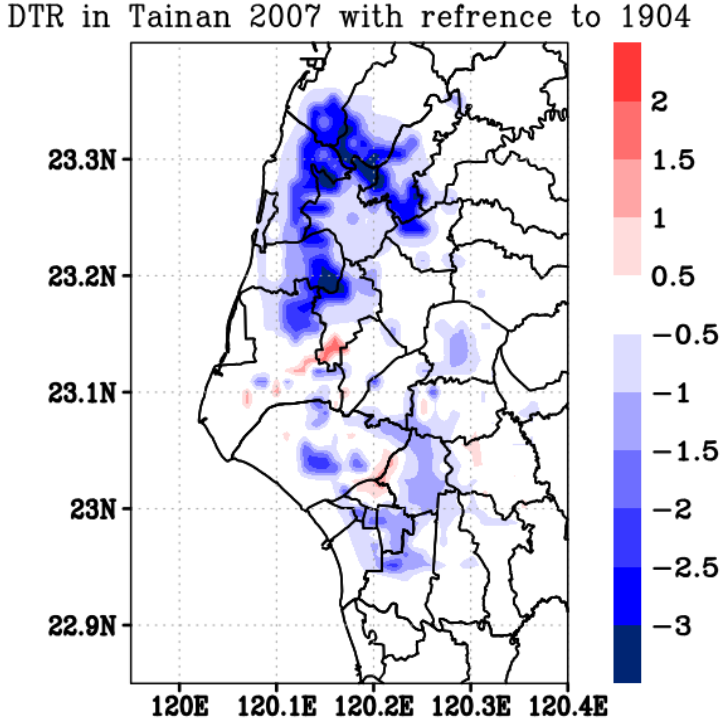
Tmin

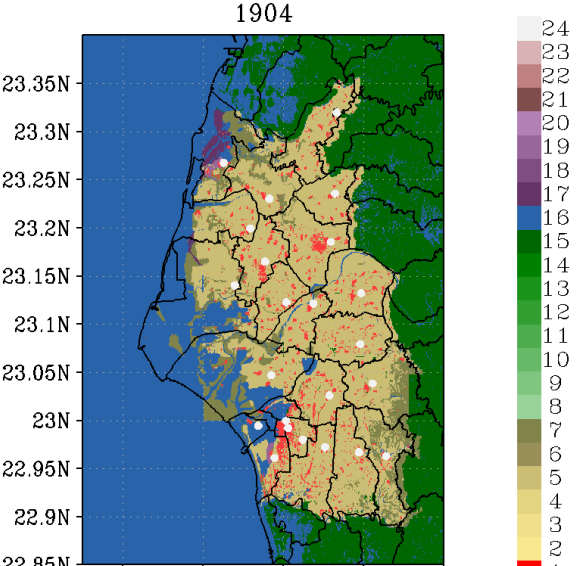


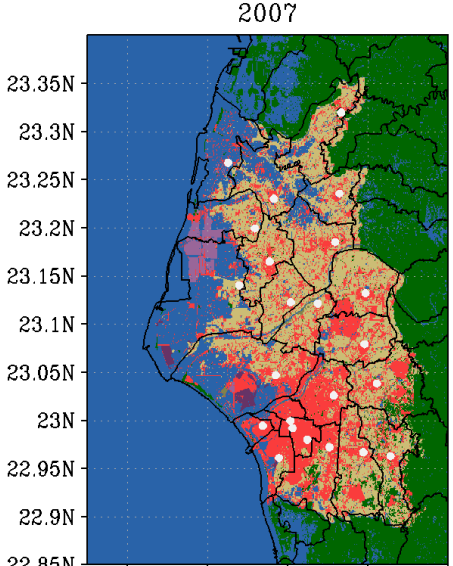
Average Diurnal Temperature Range



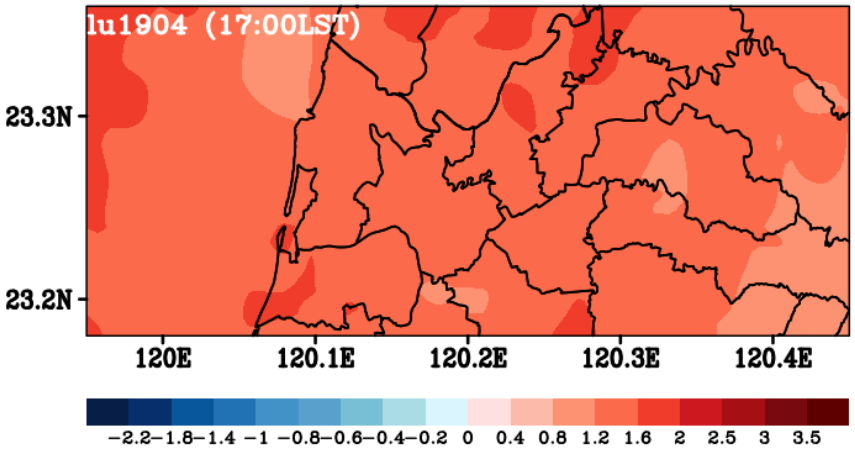


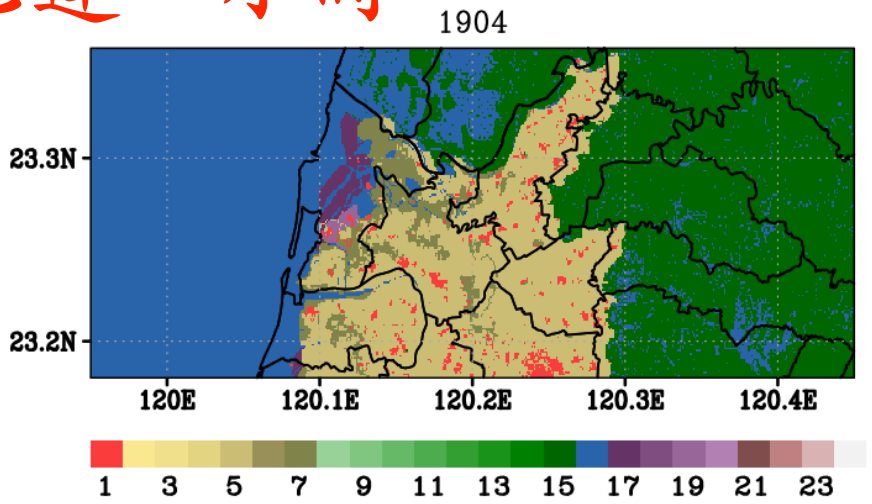


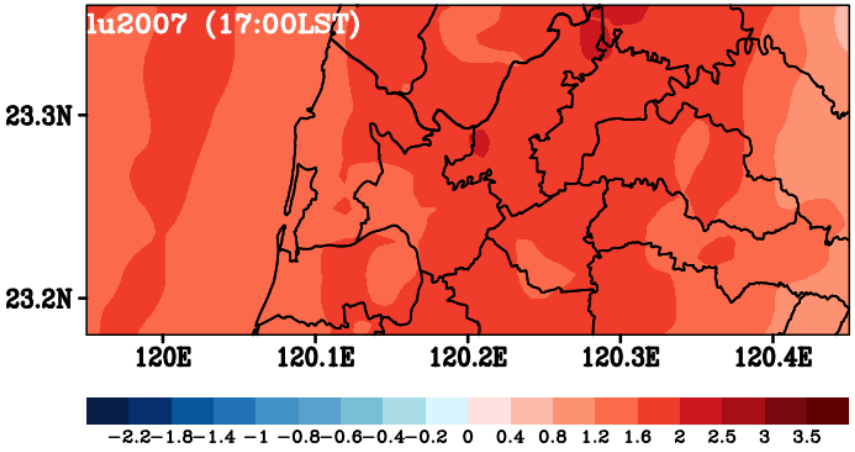


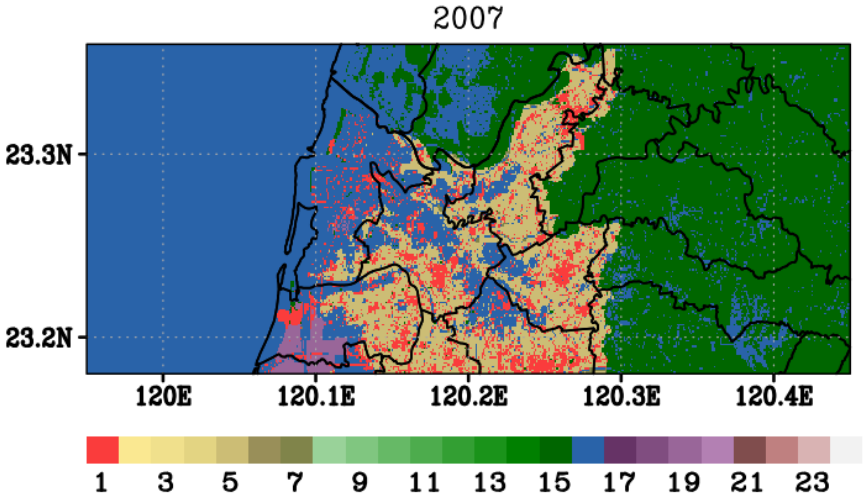


北區過去(陸地多)夜間陸風出現較早，夜間降溫較現在快。2007 時，陸風延後時間最多已達一小時

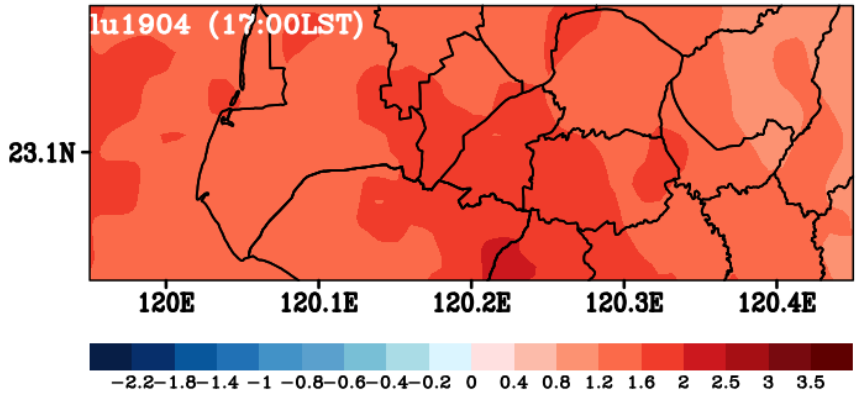


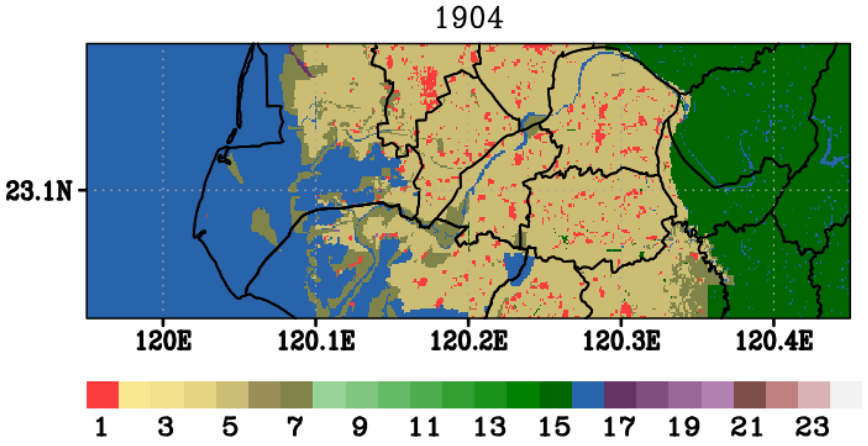


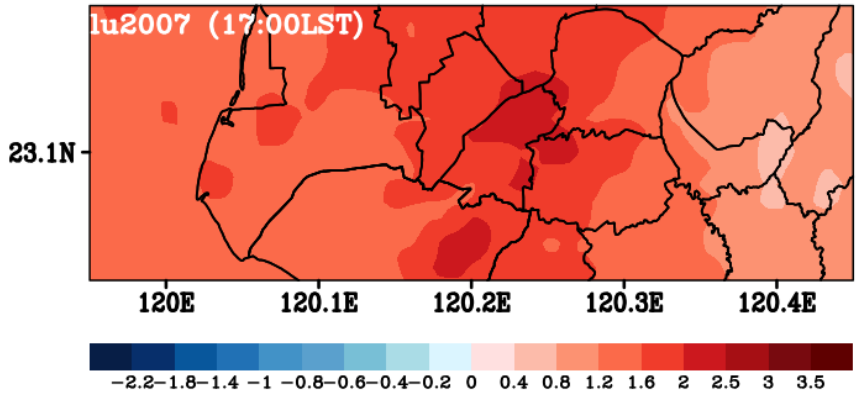


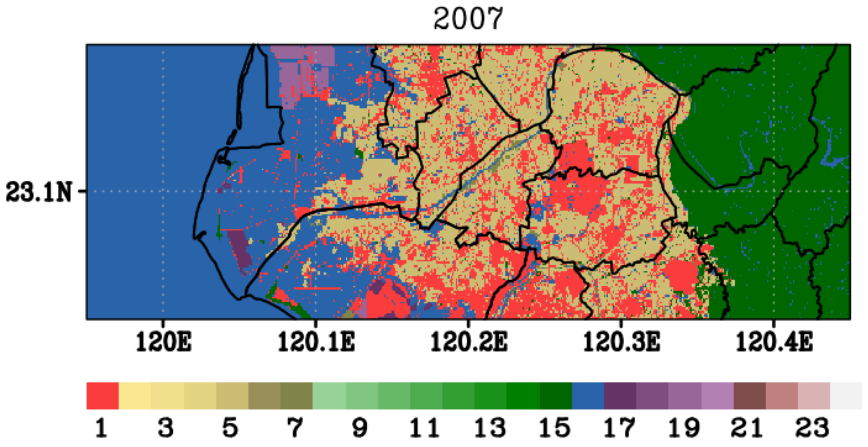


中區在過去夜間陸風出現時間較現在早：(農地轉都市)過去夜間降溫快，所以較早出現陸風

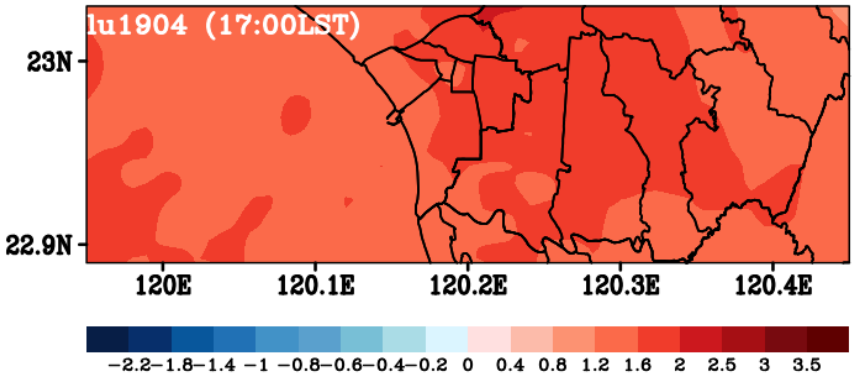


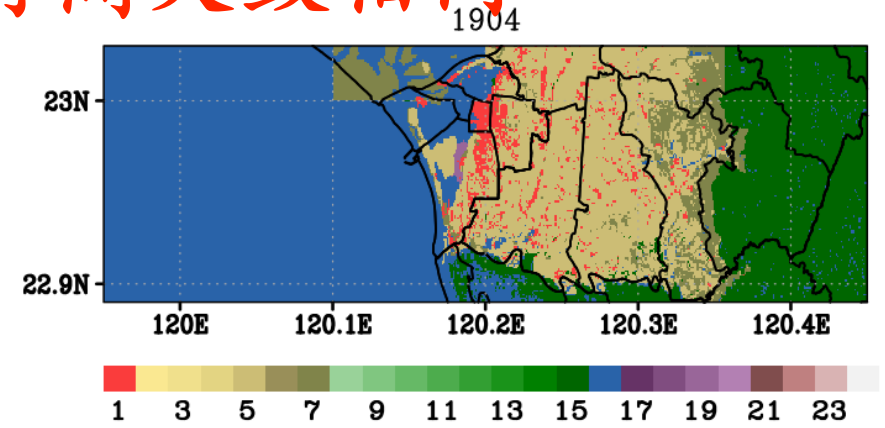


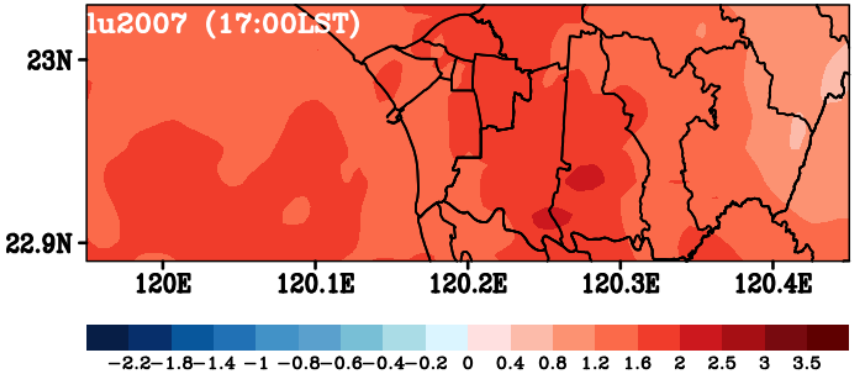


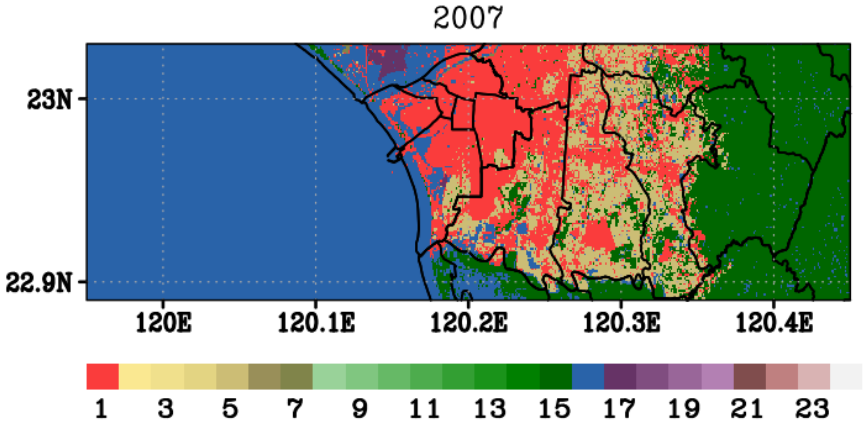


南區由於都市化區域靠海，受海洋調節大，所以雖然現在都市變多，但夜間陸風現在跟過去出現的時間大致相同







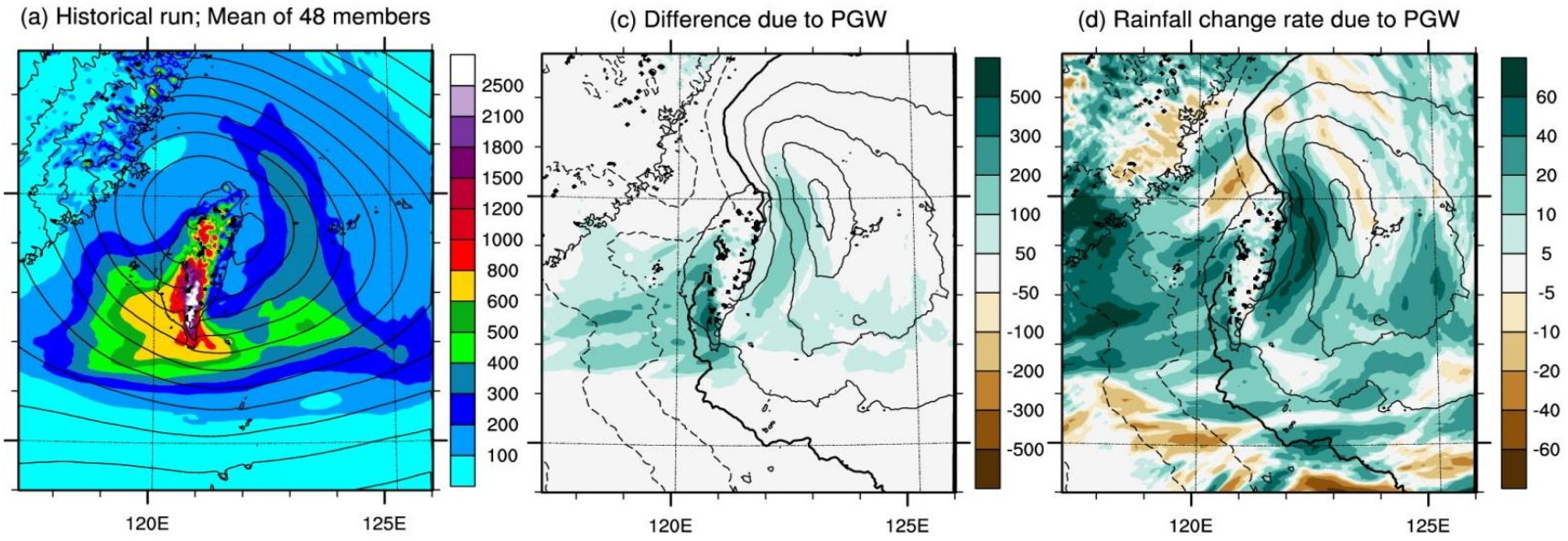


Pseudo Global Warming Experiment for Historical Typhoons - Typhoon Morakot (2009) in the end of 21st Century

Superposition circulations of future change and historical events

$$C_{PGW} = C_{history} + (\overline{C}_{future} - \overline{C}_{present})$$

$\overline{C}$: Climatology of 30 day mean; $C = T \cdot RH \cdot U \cdot V \cdot \Phi \cdot SST$



- Consider circulation change of MRI-AGCM3.2S in 2075-2099 under A1B scenario and 2009 typhoon Morakot (top rainfall record : 3000 mm in 5 days)
- 48 ensemble runs.
- Precipitation increase rate over southern plain can reach 40% (from 3000 mm to 4200 mm)

Summary

- Three fundamental issues for deeper understanding: I.C., B.C. and Observation Data
- Resolution and Computing Power are getting to be more important!
- Interaction with Terrain structure often being ignored
- Interaction of different Air systems are not easily predicted, look for potential pattern
- Long-range Dust transport and Biomass burning are recently realized. Importance of Mesoscale!
- Data, Data, Data! Observation stations are often destroyed after the onset of major disaster events!

Thank you !!!