



1st Joint Project Team Meeting for Sentinel Asia STEP3 (JPTM2013) at Grand Millennium Hotel, Thailand

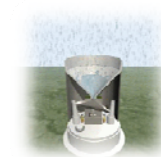


Satellite Thai Meteorological Department (TMD)



Kamol Promasakha na Sakolnakhon

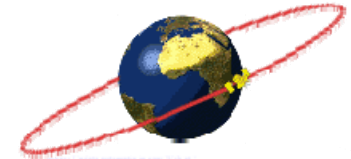
Director of Meteorological Radar & Satellite Data Analysis Sub-Bureau,
Meteorological Radar & Satellite Analysis Sub-Bureau, Weather Forecast Bureau,
promasakha123@hotmail.com or promasakha23@hotmail.com
Mobile phone: 091-8193266 or 080-6057537



Outline

- TMD Satellite,
- Visualization,
- Satellite Mapping
- Soil Water Assessment Tool(SWAT)
- Hydrology Engineer Center-River Analysis System (HEC-RAS)
- Results
- Conclusions

TMD web site



Outlook - promasakha123...
กรมอุตุนิยมวิทยา
Thai Meteorological Department

Search by Google
1182
TMD Call Center th

Home | Weather | Climate | Archive | About Us

Weather

- Northern
- Northeastern
- Central
- Eastern
- Southern(East Coast)
- Southern(West Coast)

Weather XML

"LEHAR" [Tropical Storm]
Max Wind Speed 90 km/hr near the Center

Aviations
Shipping Forecast
Ocean Waves

Daily forecast
7-day forecast
Daily Summary
Weekly Summary Nov 15, 2013 - Nov 21, 2013

Three Monthly Forecast [Nov 1, 2013 - Jan 1, 2014]
Winter 2013 Forecast [October till February]
Rainfall and severe flooding over Thailand in 2011
Natural Disasters 2011

Update !

- Weather Radars
- Satellite Images
- Weather Maps
- NWP Model
- GIS

News !

- Warning News
- Storm Tracking
- Earthquake Report

Weather Symbols

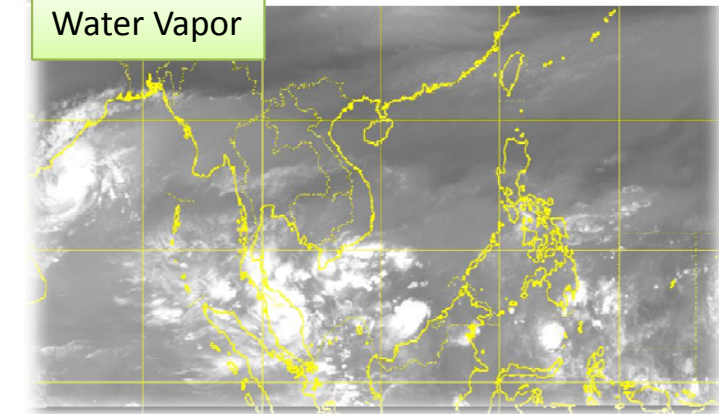
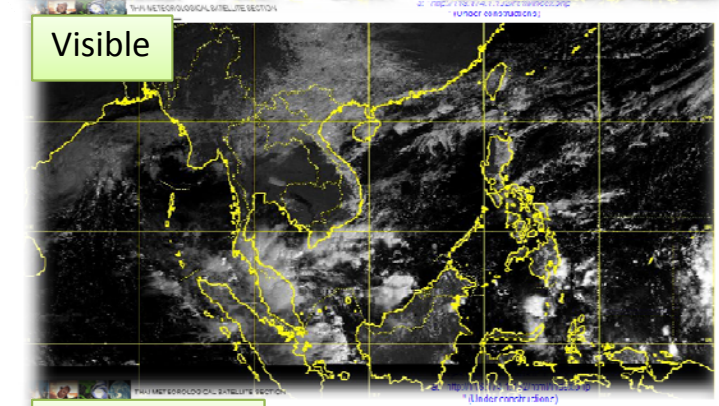
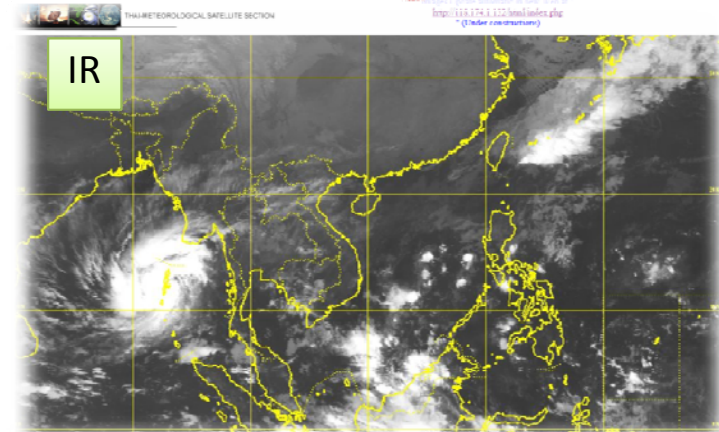
Forecast Service for your website
Thai Meteorological Department

Daily Forecast Nov 25, 2013

Chiang Mai	21 32
Bangkok	24 33
Phuket	24 33
Krabi	23 32

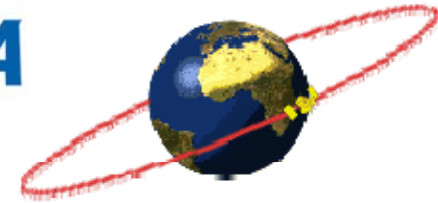
Thai Meteorological Dept.

Contact web master at webmaster@tmd.go.th
Thai Meteorological Department www.tmd.go.th/en



<http://www.tmd.go.th>

TMD Satellite



ภาพดาวเทียม เปรียบเทียบดาวเทียม ภาพ 3 มิติ ฐานข้อมูล เว็บบอร์ด

ดาวเทียม: MTSAT ภูมิภาค: SouthEast Asia ดาวเทียม: IR1 เวลา: 2013 11 25 00 ยกเลิก ดู

ภาพเคลื่อนไหว: 3 ชั่วโมงล่าสุด อัตราภาพ: 1 ชั่วโมง ความเร็วภาพ: ช้ากว่า เร็วกว่า 1 หน้าที่/ภาพ เล่น หยุด

MTSAT-2 CH4 25-11-2013 00:04

MTSAT-2 CH4 25-11-2013 00:04

ภาพดาวเทียม เปรียบเทียบดาวเทียม ภาพ 3 มิติ ฐานข้อมูล เว็บบอร์ด

ดาวเทียม: MTSAT ภูมิภาค: Full Disk ดาวเทียม: IR1 เวลา: 2013 11 25 00 ยกเลิก ดู

ภาพเคลื่อนไหว: 3 ชั่วโมงล่าสุด อัตราภาพ: 1 ชั่วโมง ความเร็วภาพ: ช้ากว่า เร็วกว่า 1 หน้าที่/ภาพ เล่น หยุด

ภาพดาวเทียม เปรียบเทียบดาวเทียม ภาพ 3 มิติ ฐานข้อมูล เว็บบอร์ด

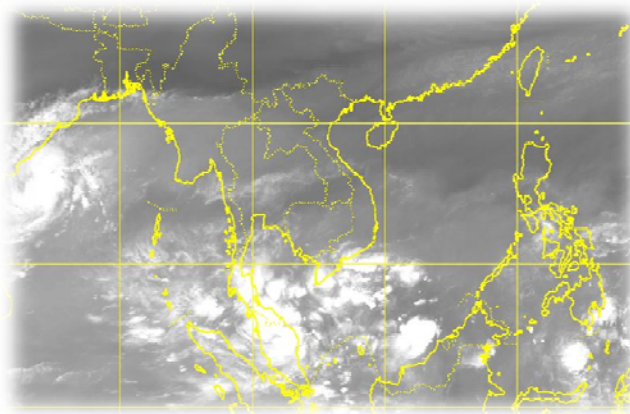
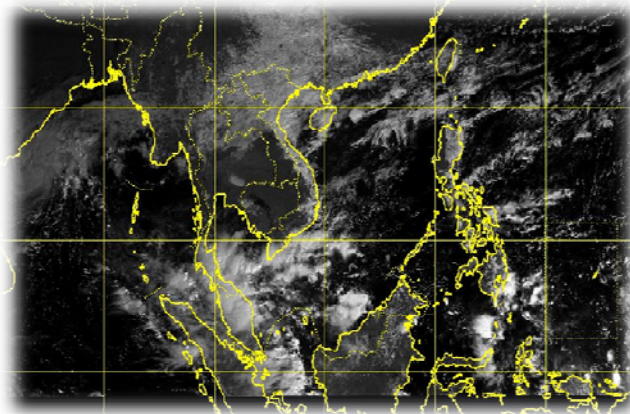
ดาวเทียม: MTSAT ภูมิภาค: SouthEast Asia ดาวเทียม: IR1, IR2, IR4, Visible, Water Vapor เวลา: 2013 11 25 00 ยกเลิก ดู

ภาพเคลื่อนไหว: 3 ชั่วโมงล่าสุด อัตราภาพ: 1 ชั่วโมง ความเร็วภาพ: ช้ากว่า เร็วกว่า 1 หน้าที่/ภาพ เล่น หยุด

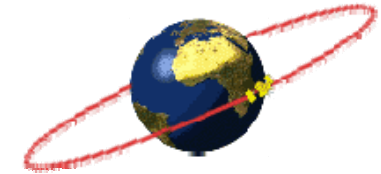
MTSAT-2 CH4 25-11-2013 00:04

2013-11-25 00:04 UTC

Zoom In Zoom Out



Satellite Data Analysis

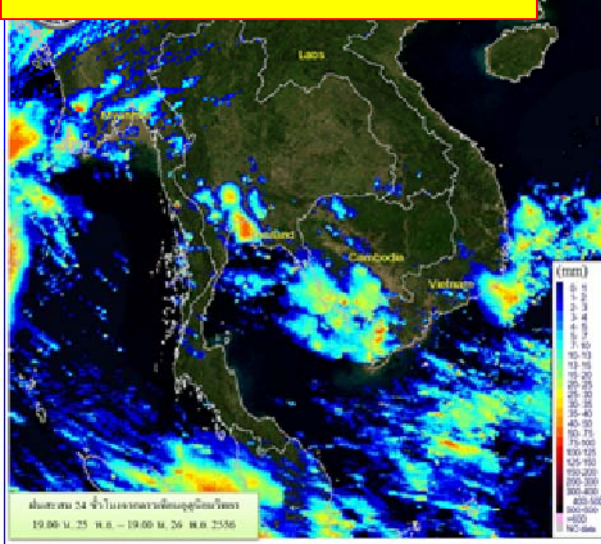


วิเคราะห์ภาพถ่ายดาวเทียม



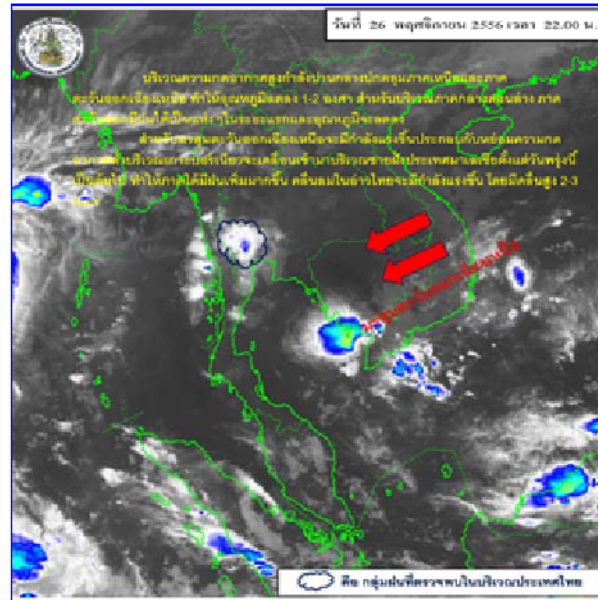
เปรียบเทียบฝน 24 ชั่วโมง จากดาวเทียมอุตุนิยมวิทยา กับฝนจากสถานีตรวจอากาศ

Estimated Rainfall from Satellite



วันที่ 26/11/2013
00UTC 12UTC

วิเคราะห์ภาพถ่ายดาวเทียม วันที่ 26/11/2013



เขตกึ่งเขตร้อน เขตกึ่งเขตร้อน เขตกึ่งเขตร้อน เขตกึ่งเขตร้อน
เขตกึ่งเขตร้อน เขตกึ่งเขตร้อน เขตกึ่งเขตร้อน เขตกึ่งเขตร้อน

ภาพประมวลผลระบบ 3 ชั่วโมง จากดาวเทียมอุตุนิยมวิทยา ในวันที่ (26/11/2013)

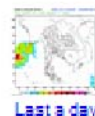


00UTC 03UTC 06UTC 09UTC 12UTC
ใช้คลิกดู

ภาพประมวลผลระบบ 3 ชั่วโมง จากดาวเทียมอุตุนิยมวิทยา เมื่อวันที่ (25/11/2013)



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ใช้คลิกดู

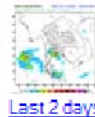


Last a day

การประมวลผลภาพถ่ายดาวเทียม เมื่อวันที่

00UTC	01UTC	02UTC	03UTC	04UTC	05UTC
06UTC	07UTC	08UTC	09UTC	10UTC	11UTC
12UTC	13UTC	14UTC	15UTC	16UTC	17UTC
18UTC	19UTC	20UTC	21UTC	22UTC	23UTC

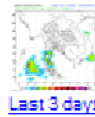
ใช้คลิกดู ฟังก์ชันประมวลผล



Last 2 days

การประมวลผลภาพถ่ายดาวเทียมในรูปแบบ Excel

01NOV	02NOV	03NOV	04NOV	05NOV	06NOV
07NOV	08NOV	09NOV	10NOV	11NOV	12NOV
13NOV	14NOV	15NOV	16NOV	17NOV	18NOV
19NOV	20NOV	21NOV	22NOV	23NOV	24NOV
25NOV	26NOV	27NOV	28NOV	29NOV	30NOV



Last 3 days



USSMภาพถ่าย

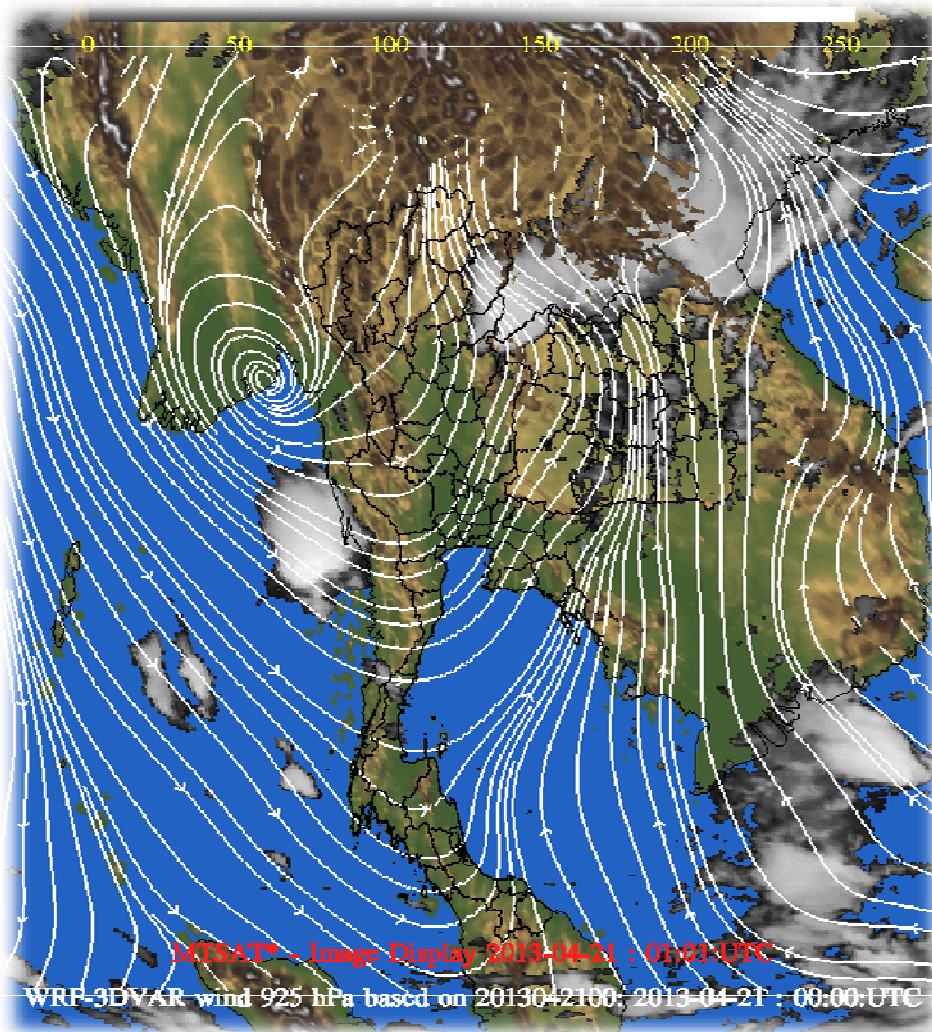
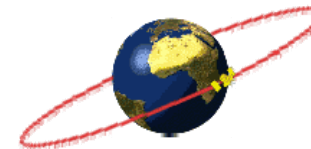
- ภาพถ่ายล่าสุด
- 26 พฤศจิกายน 2556 เวลา 22:00 น
 - 26 พฤศจิกายน 2556 เวลา 19:00 น
 - 26 พฤศจิกายน 2556 เวลา 18:00 น
 - 26 พฤศจิกายน 2556 เวลา 17:00 น
 - 26 พฤศจิกายน 2556 เวลา 16:00 น
 - 26 พฤศจิกายน 2556 เวลา 15:00 น
 - 26 พฤศจิกายน 2556 เวลา 14:00 น
 - 26 พฤศจิกายน 2556 เวลา 13:00 น
 - 26 พฤศจิกายน 2556 เวลา 12:00 น
 - 26 พฤศจิกายน 2556 เวลา 11:00 น
 - 26 พฤศจิกายน 2556 เวลา 10:00 น
 - 26 พฤศจิกายน 2556 เวลา 09:00 น
 - 26 พฤศจิกายน 2556 เวลา 08:00 น
 - 26 พฤศจิกายน 2556 เวลา 07:00 น
 - 26 พฤศจิกายน 2556 เวลา 04:00 น
 - 26 พฤศจิกายน 2556 เวลา 01:00 น
 - 25 พฤศจิกายน 2556 เวลา 22:00 น
 - 25 พฤศจิกายน 2556 เวลา 19:00 น
 - 25 พฤศจิกายน 2556 เวลา 18:00 น
 - 25 พฤศจิกายน 2556 เวลา 17:00 น
 - 25 พฤศจิกายน 2556 เวลา 16:00 น
 - 25 พฤศจิกายน 2556 เวลา 15:00 น
 - 25 พฤศจิกายน 2556 เวลา 14:00 น
 - 25 พฤศจิกายน 2556 เวลา 13:00 น
 - 25 พฤศจิกายน 2556 เวลา 12:00 น
 - 25 พฤศจิกายน 2556 เวลา 11:00 น
 - 25 พฤศจิกายน 2556 เวลา 10:00 น

เลือก เวลา 07:00 น.

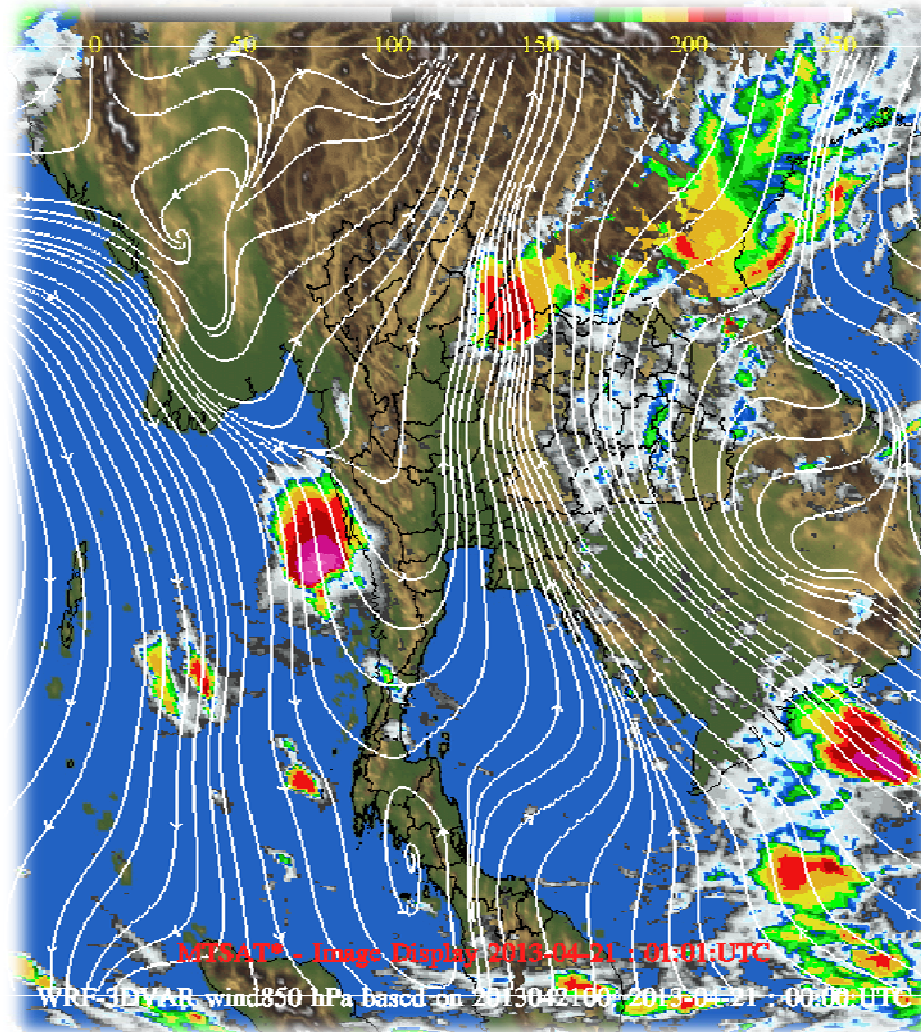
<http://www.satda.tmd.go.th/>

ฝนตก 10.0% จากดาวเทียม จากดาวเทียมอุตุนิยมวิทยา จากดาวเทียมอุตุนิยมวิทยา จากดาวเทียมอุตุนิยมวิทยา

Brightness temperature MTSAT



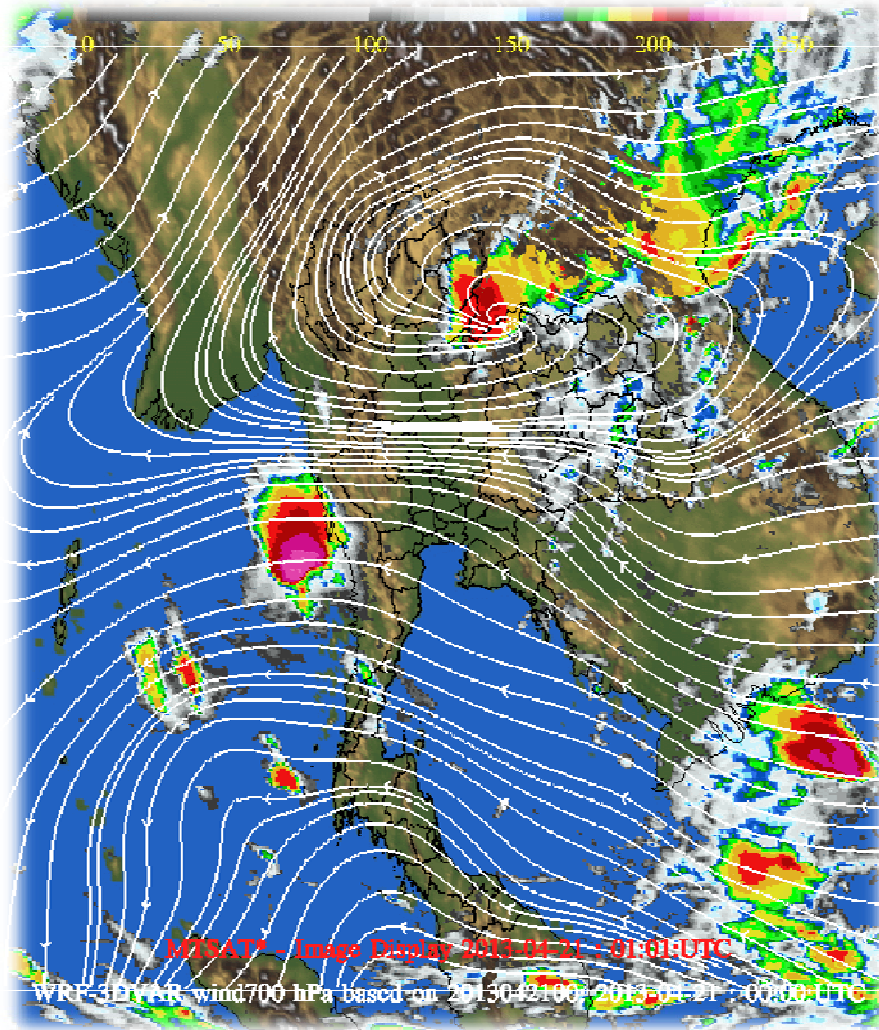
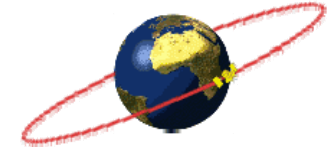
Wind 925hPa from WRF-3DVAR



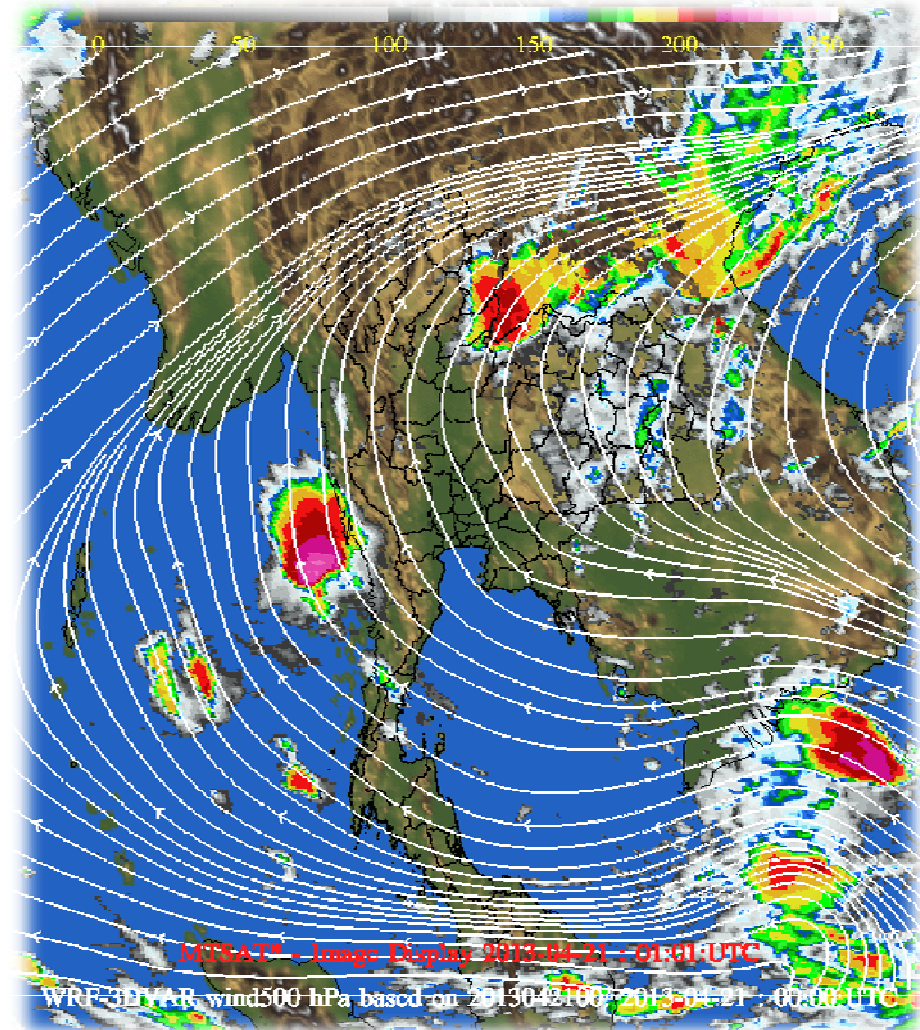
Wind 850hPa from WRF-3DVAR

21 April 2013

Brightness temperature MTSAT



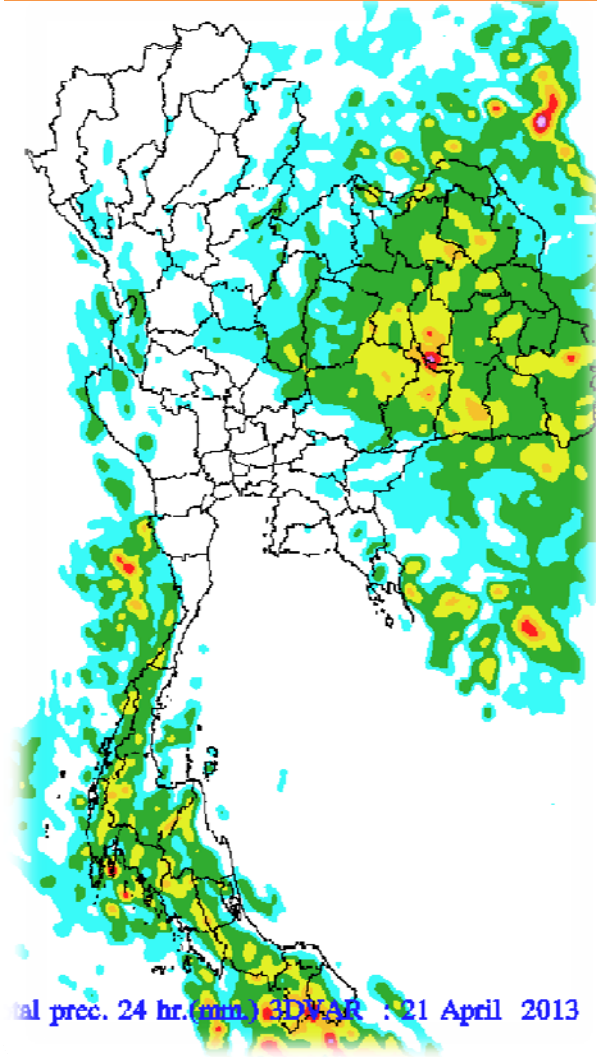
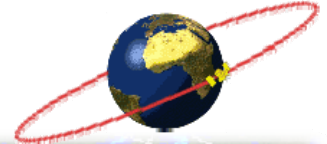
Wind 700hPa from WRF-3DVAR



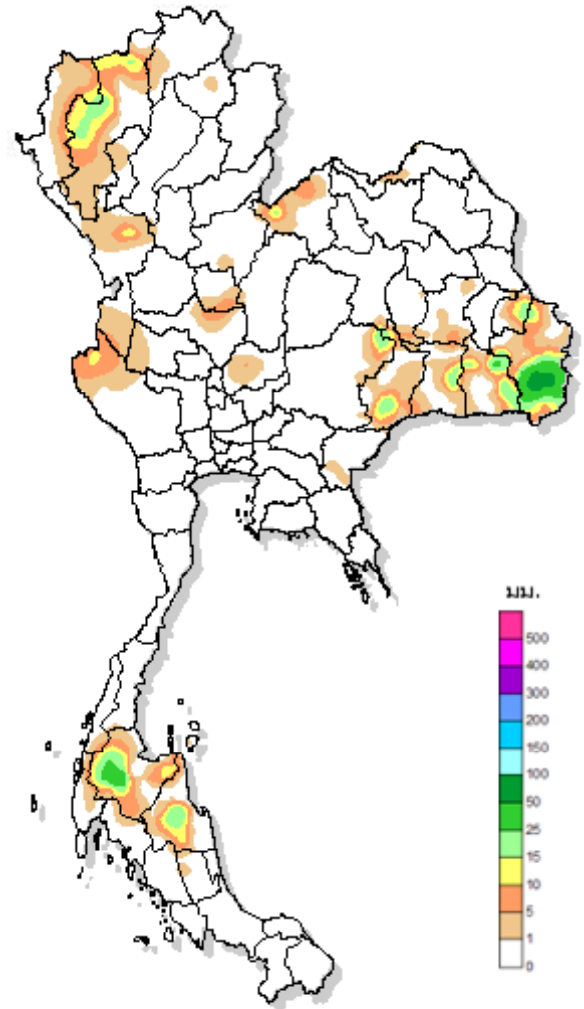
Wind 500hPa from WRF-3DVAR

21 April 2013

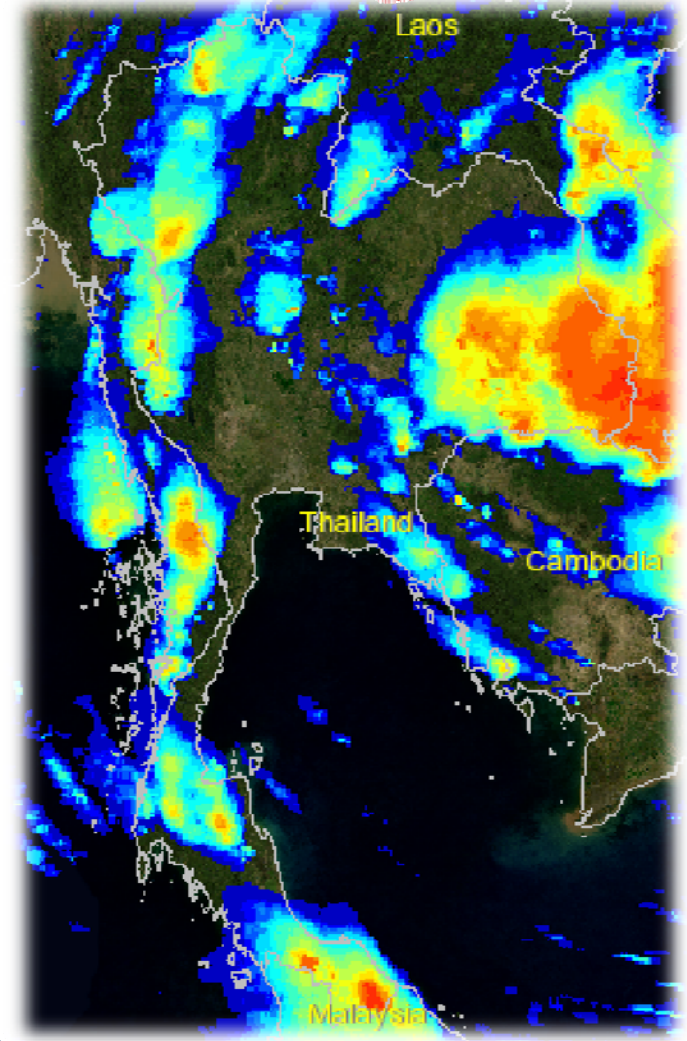
Comparison 21 Apr. 2013



WRF-3DVAR

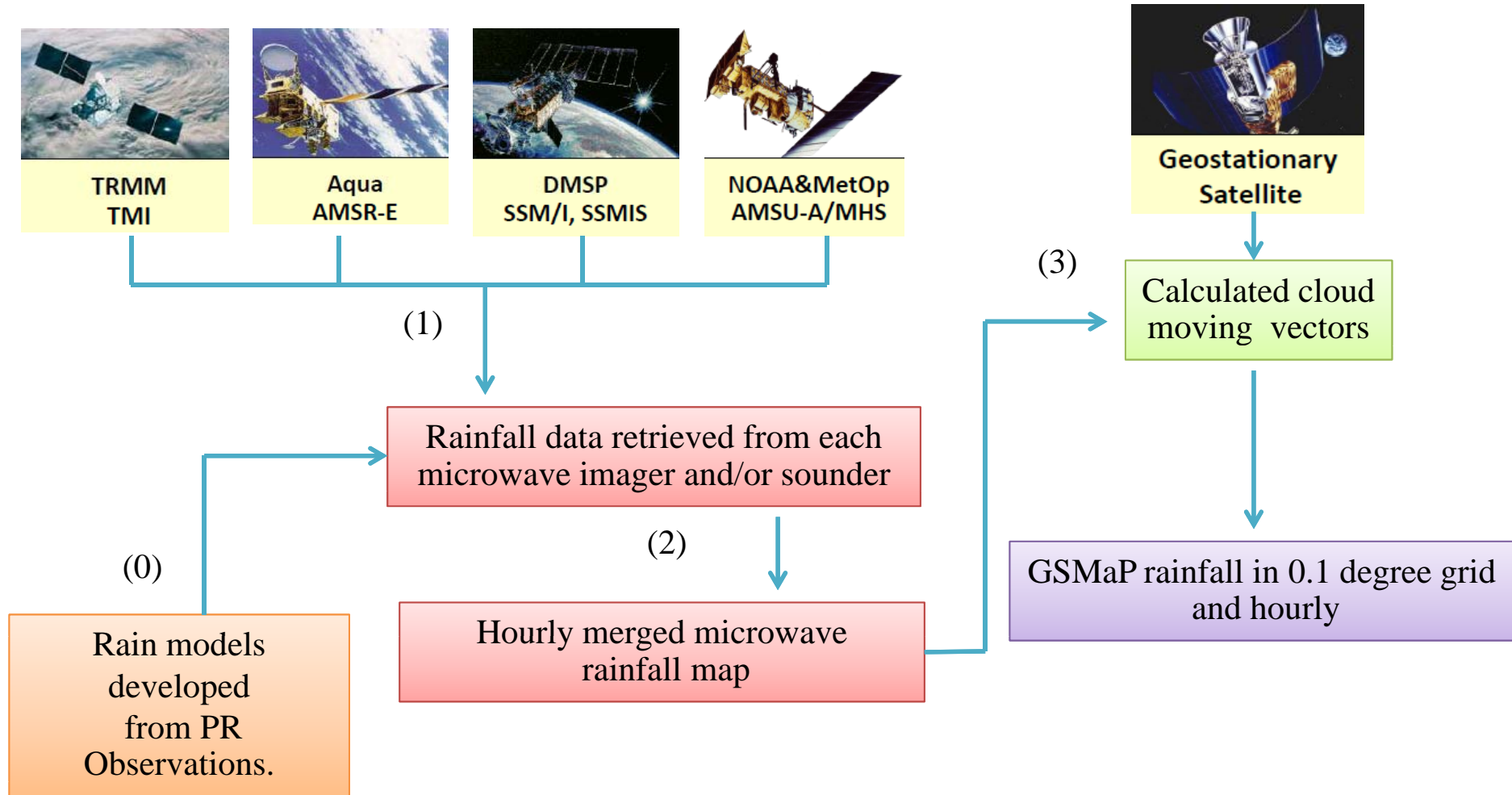
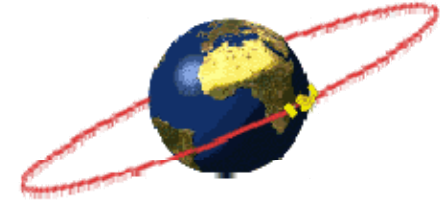


AWS (12h)

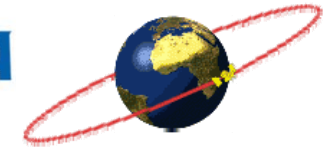


Estimated Rainfall from Satellite (12h)

Algorithm overview

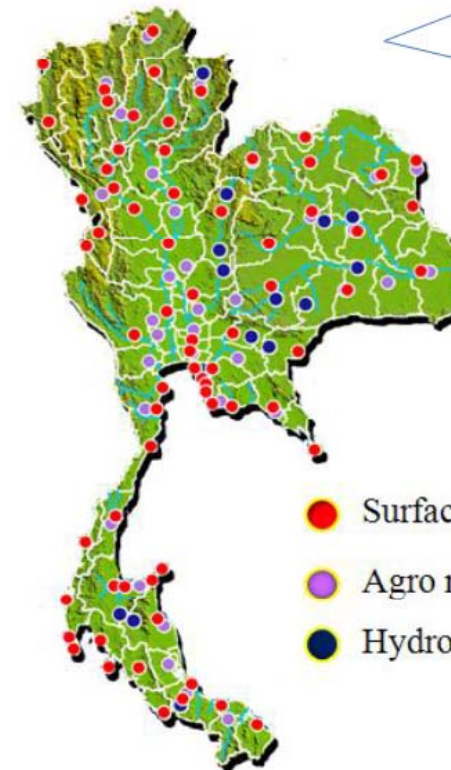
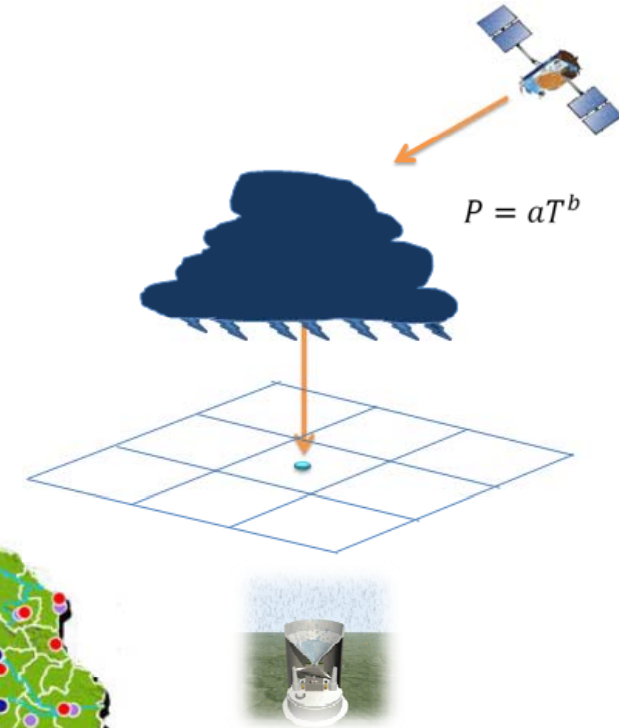
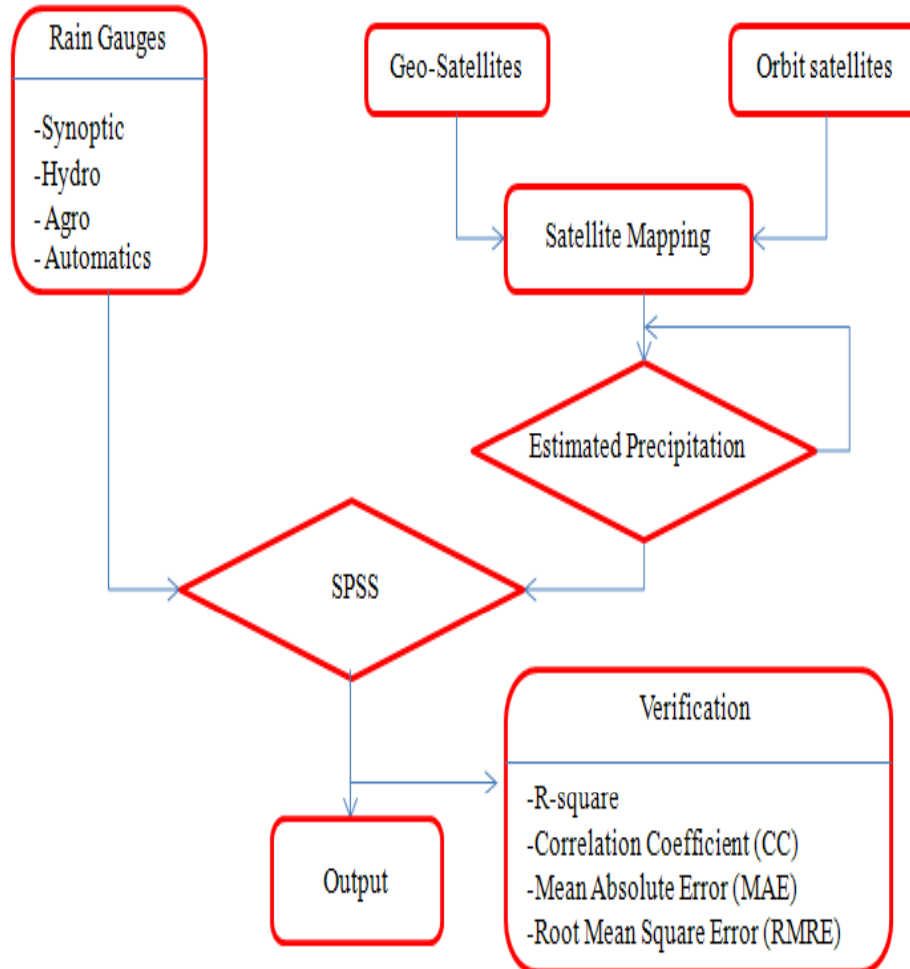


Conceptual of Frame Work



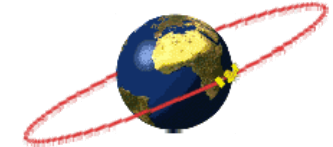
Meteorological Data

Satellite Data

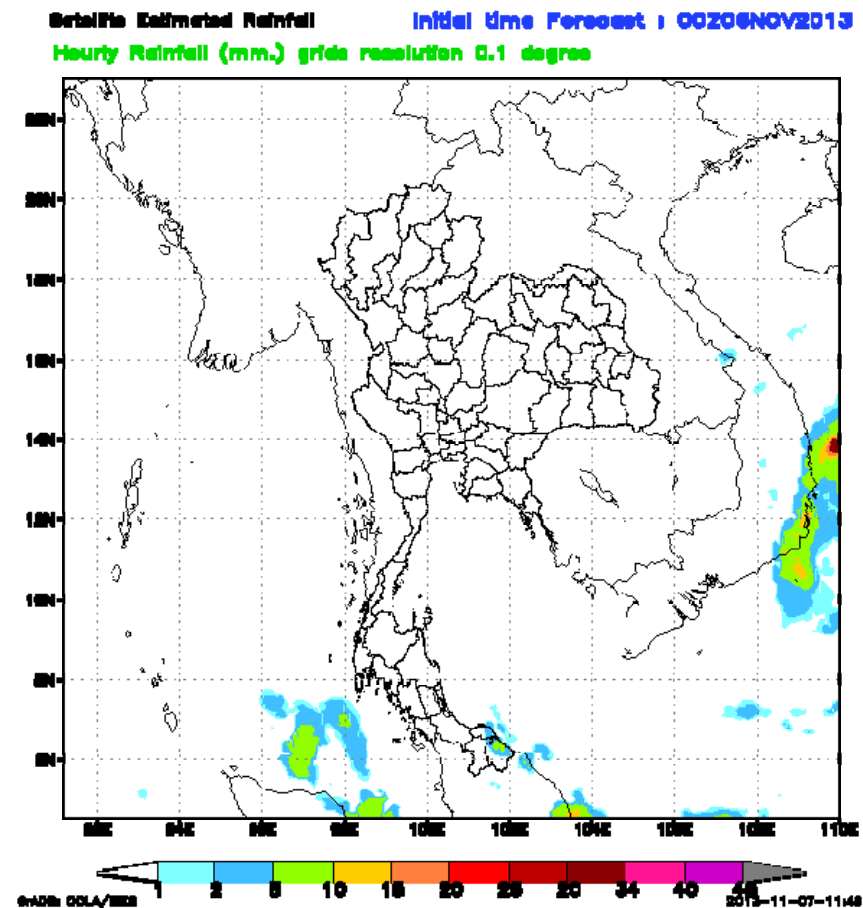
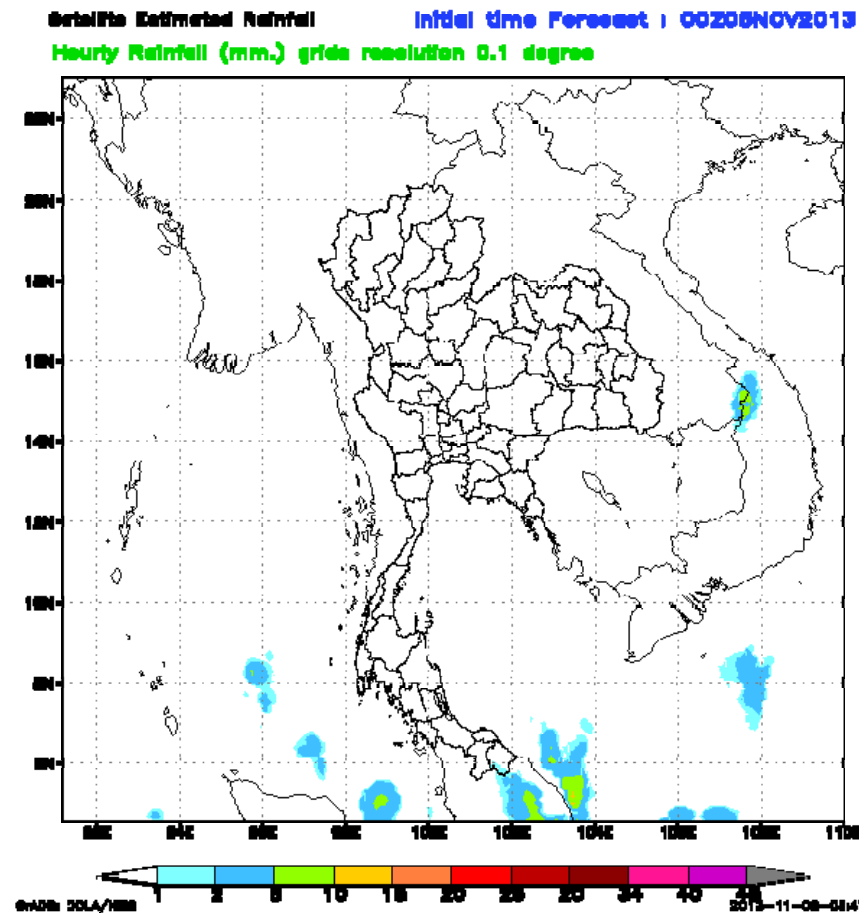


- Surface stations (71)
- Agro met. stations (33)
- Hydro met. stations (16)

Data sets



The data sets used passive microwave radiometer data sets used in the hourly GSMaP_MVK (TRMM/TMI, Aqua/AMSR-E, ADEOS-II/AMSR, DMSP/SSMI) have resolution grid about 0.1 degree with cover a region of Thailand between latitude $5.6^{\circ}N$ to $20.5^{\circ}N$, and longitude $97.3^{\circ}E$ to $105.5^{\circ}E$, an approximately area about $513,000km^2$ during 2000-2010 periods.



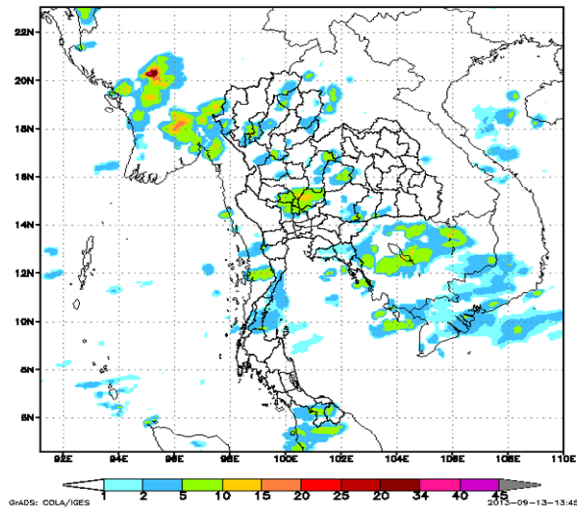
Training



Standard operating procedure (SOP)

Manual

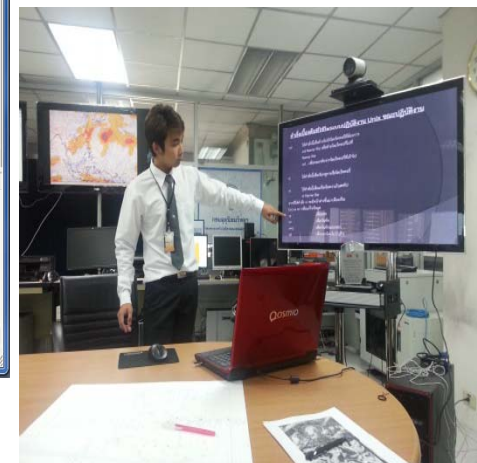
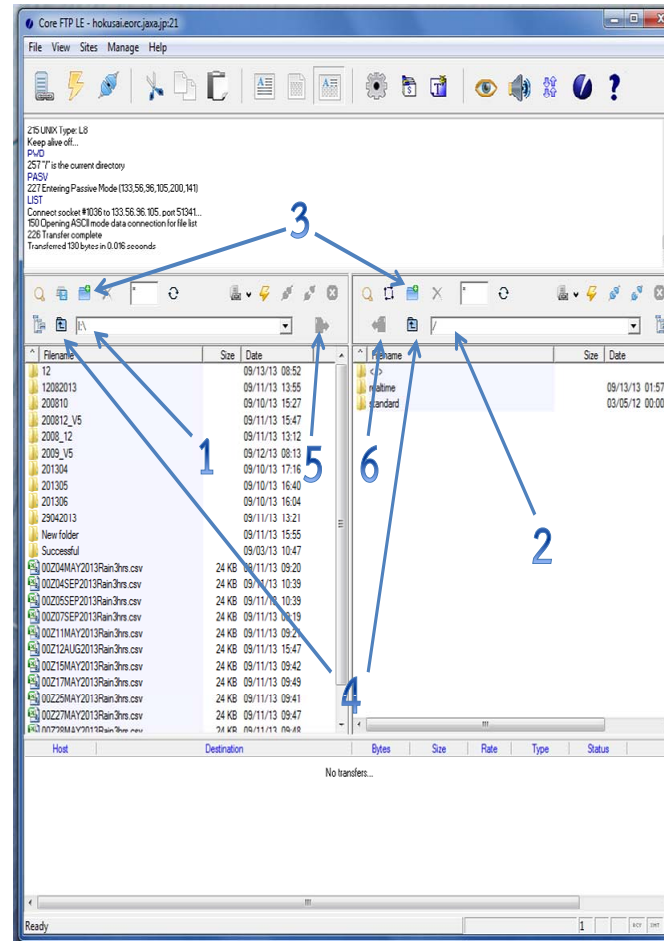
Hourly Rainfall (mm.) grids resolution 0.1 degree



Convert and Upload

Estimated Precipitation

Retrospect from Satellite



Over Thailand, 2000-2010

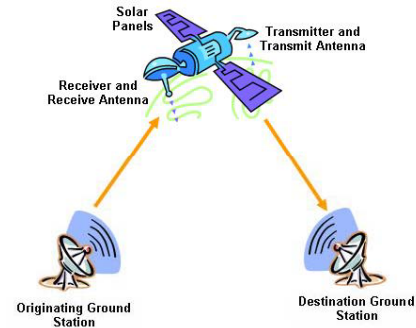
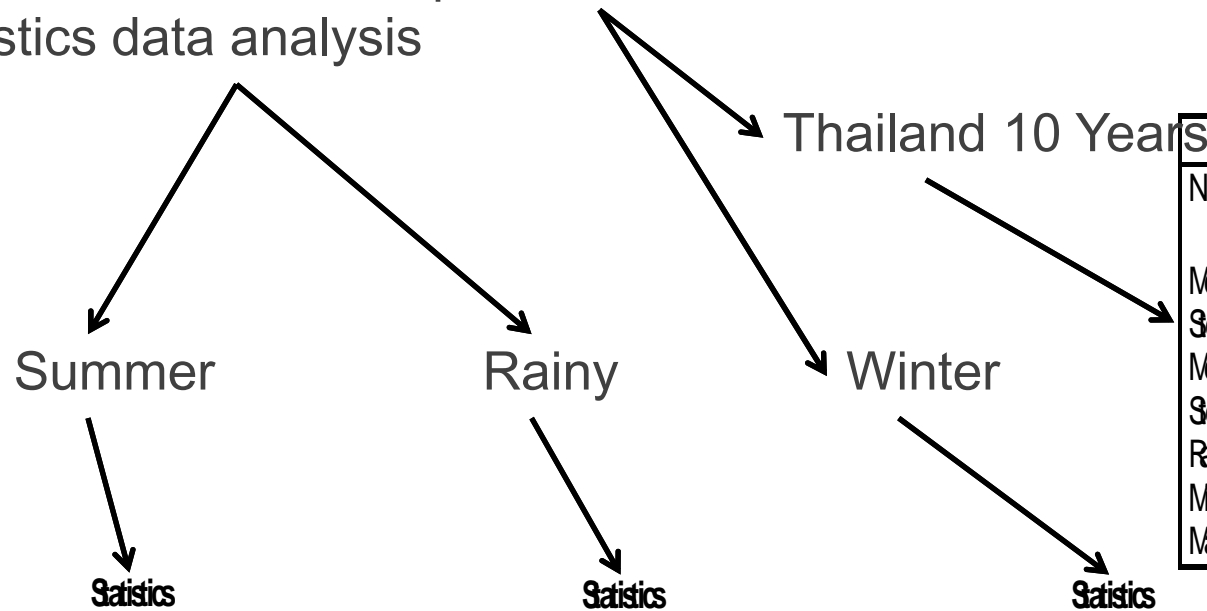


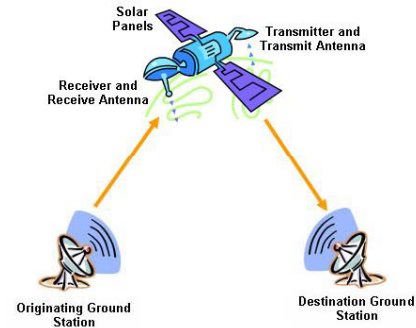
Table shows the descriptive statistics data analysis



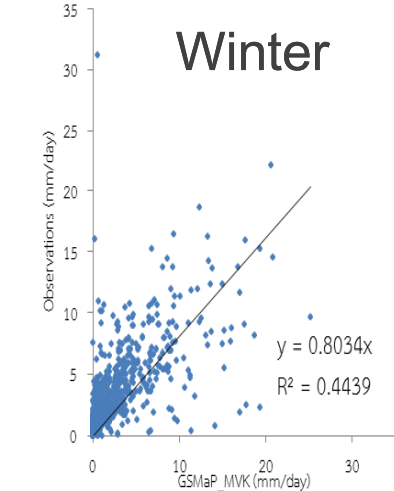
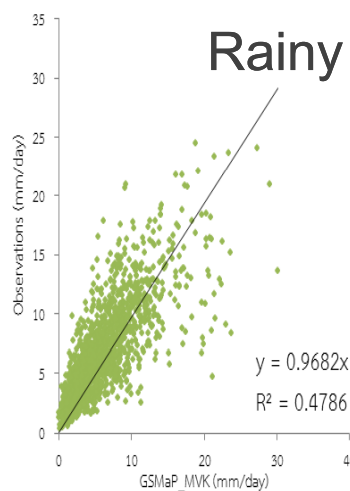
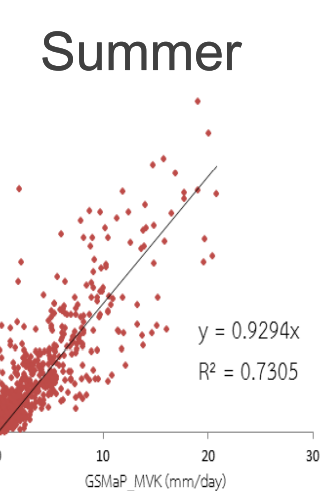
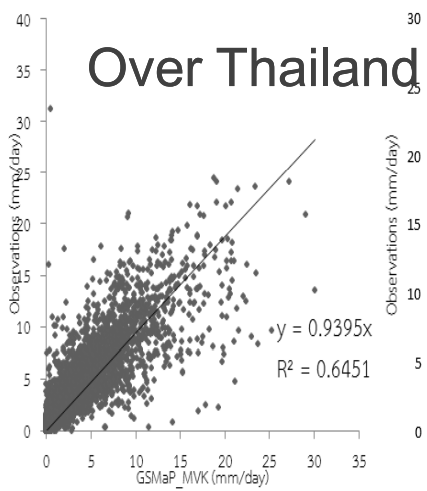
	Statistics	
	Observations	GMp_MK
N Valid	3652	3652
Missing	0	0
Mean	4.228328024352	3.766199290570
Std. Error of Mean	.0692279470110	.0718674290254
Median	3.075000050000	2.345098000000
Std. Deviation	4.1835680441611	4.3430766398311
Range	31.1921580000	30.0705900000
Minimum	.0000000000	.0000000000
Maximum	31.1921580000	30.0705900000

	Summer Observations	Summer GMp_MK		Rainy Observations	Rainy GMp_MK		Winter Observations	Winter GMp_MK
N Valid	892	892	N Valid	1530	1530	N Valid	1230	1230
Missing	0	0	Missing	0	0	Missing	0	0
Mean	2.950862793981	2.776754163059	Mean	6.6615180140	6.02551582370	Mean	2.128099001129	1.673378768662
Std. Error of Mean	.1243944812729	.1254816602629	Std. Error of Mean	.10199428308	.111923745845	Std. Error of Mean	.0865620615432	.0926512286891
Median	1.581372550000	1.266666650000	Median	5.7862745000	5.087255000000	Median	.895098030000	.171568630000
Std. Deviation	3.7152114849988	3.7476815739338	Std. Deviation	3.98952825343	4.377921318687	Std. Deviation	3.0358488620643	3.2494042097661
Range	24.0509800000	20.7568630000	Range	24.03137348	30.033335097	Range	31.1921580000	25.2901950000
Minimum	.0000000000	.0000000000	Minimum	.40882352	.087254903	Minimum	.0000000000	.0000000000
Maximum	24.0509800000	20.7568630000	Maximum	24.44019700	30.0705900000	Maximum	31.1921580000	25.2901950000

Over Thailand, 2000-2010



	Correlation
Year	0.832
Summer	0.864
Rainy	0.777
Winter	0.727



Pearson's Correlation

Descriptive statistical analysis

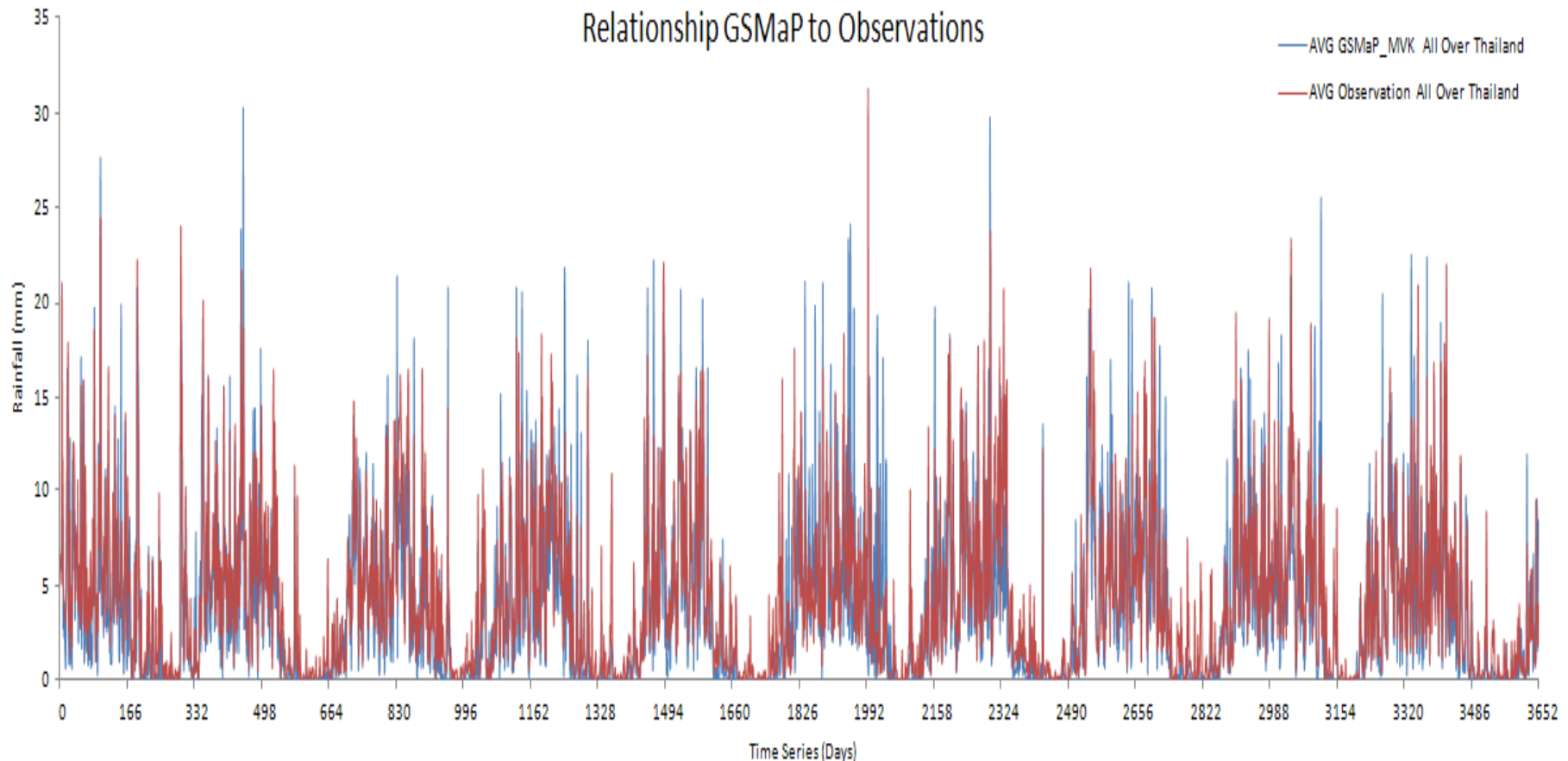
	Observations	GSMaP_MVK	Bas	PE(%)	MAE	RMSE
Year	15441.855	13749.524	1692.331	10.959	1.546	2516
Summer	2632.170	2474.750	157.420	5.981	1.137	1.956
Rainy	10192.123	9217.241	974.882	9.565	2.062	2.890
Winter	2617.562	2057.533	560.029	21.395	1.203	2.374

Estimated rainfall in time series

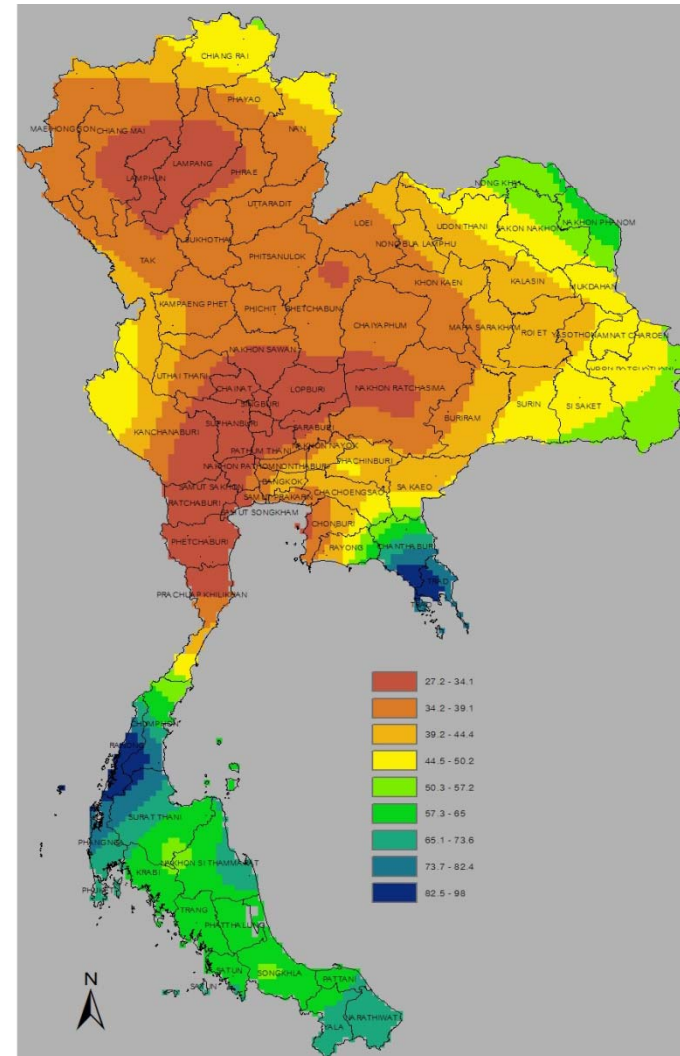
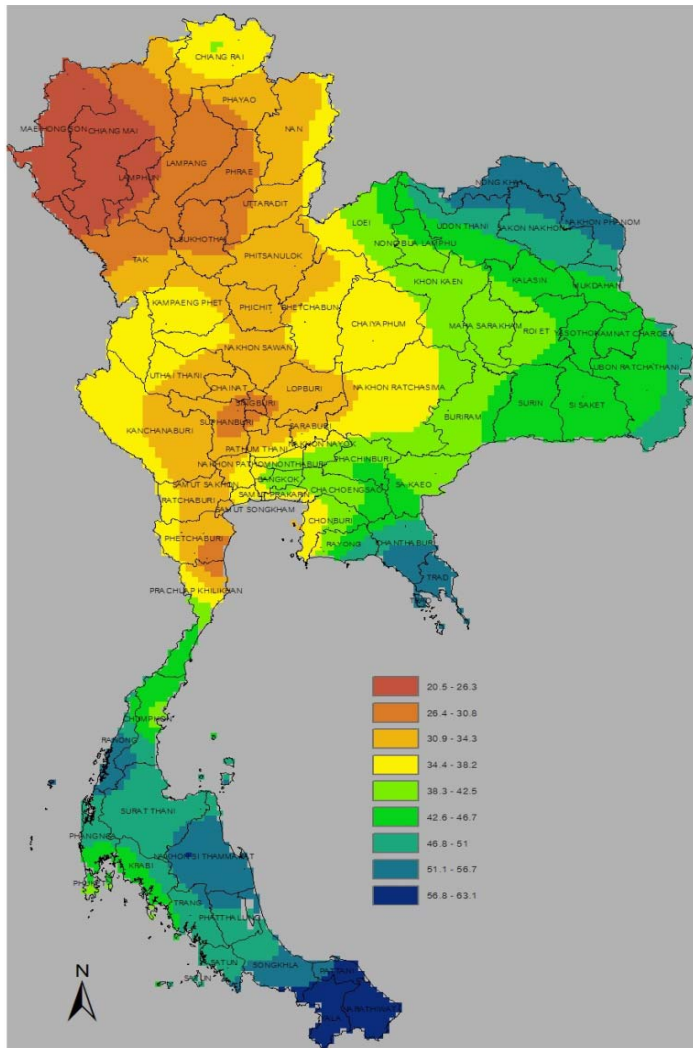


Estimated rainfall over whole Thailand (16 May 2000 -15 May 2010: 10 years)

The first experiment is comparison GSMaP_MVK to rain gauge station over whole Thailand was conducted by comparison GSMaP_MVK estimated rainfall to rain gauge observations during 2000 - 2010 periods. The results showed a good relationship both data.



Comparison Sat. rainfall to Obs. over Thailand

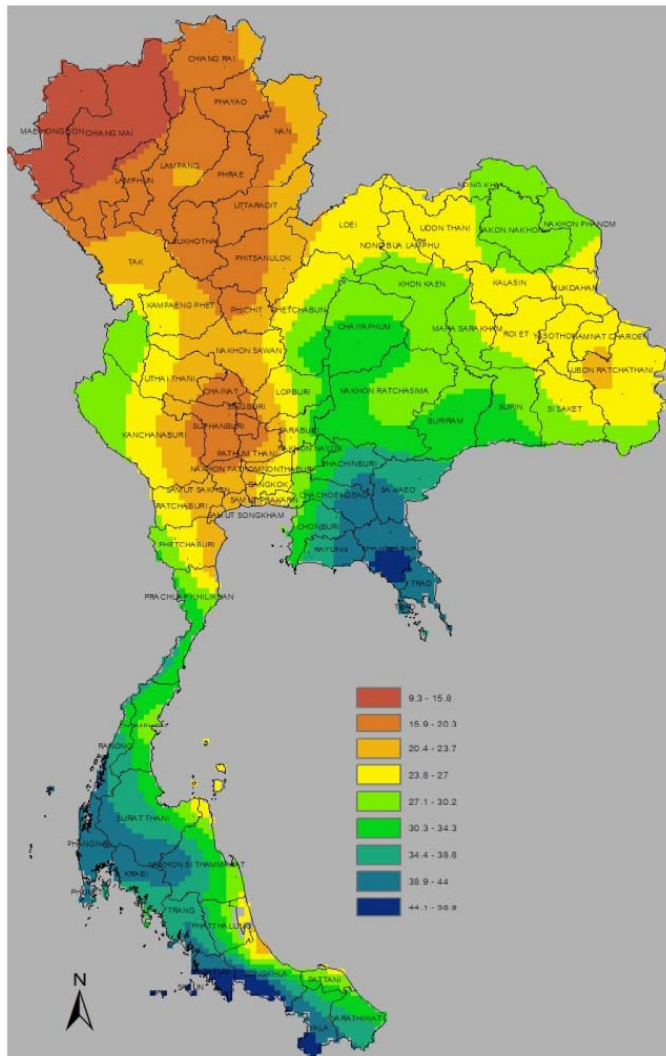


Rainfall from Satellite Rainfall from Observations

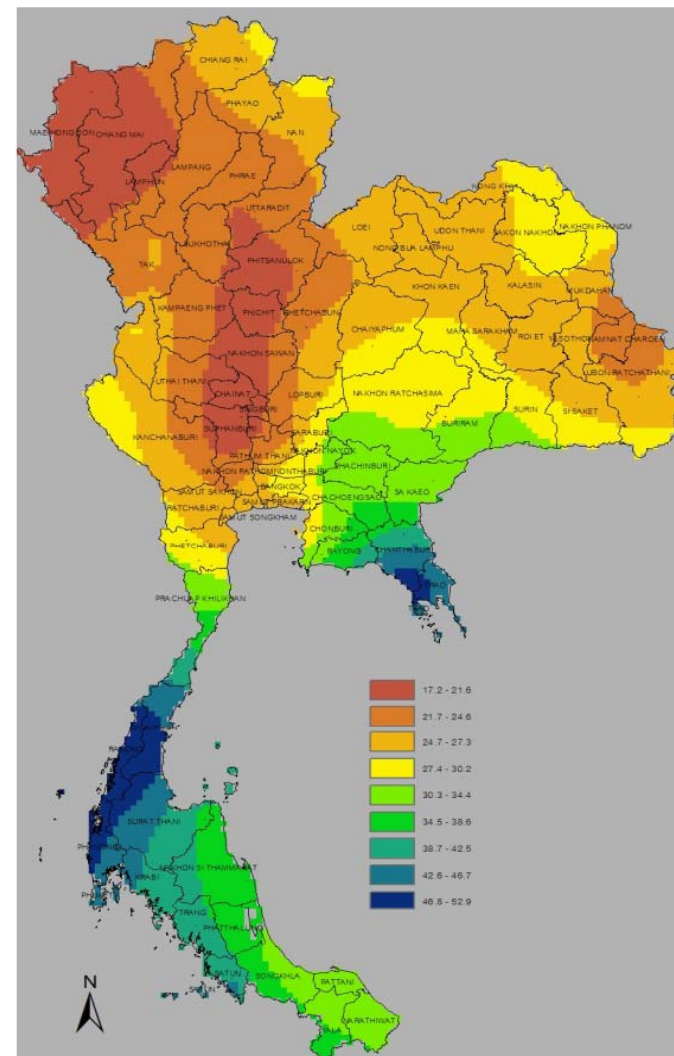
Over Thailand

Picture By Nipon Sukunthamet

Comparison Sat. rainfall to Obs. over Thailand



Rainfall from Satellite

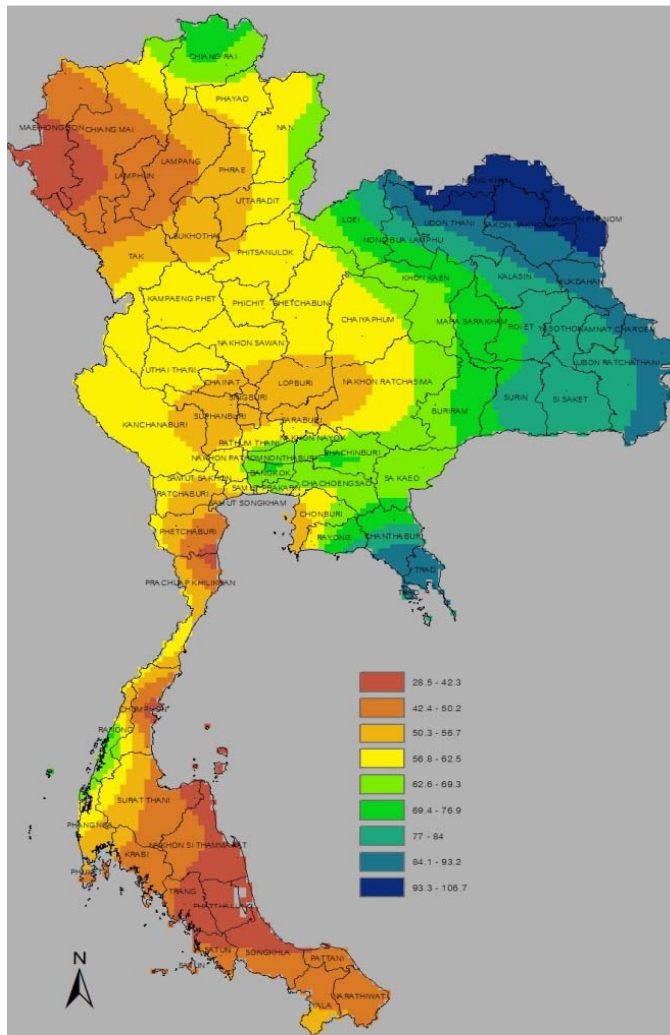


Rainfall from Observations

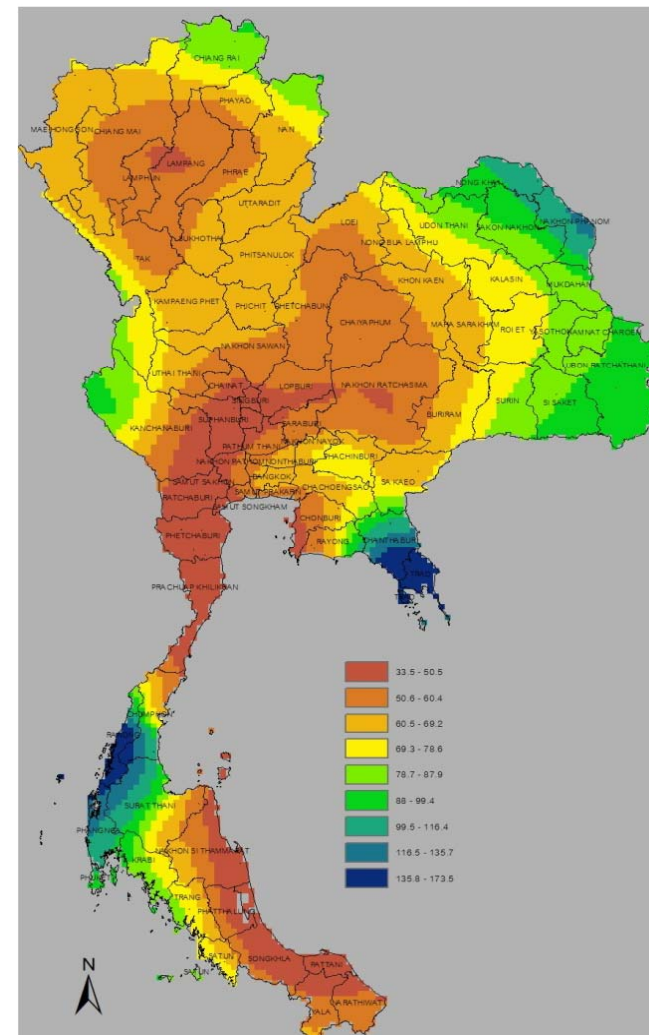
Picture By Nipon Sukunthamet

Summer

Comparison Sat. rainfall to Obs. over Thailand



Rainfall from Satellite

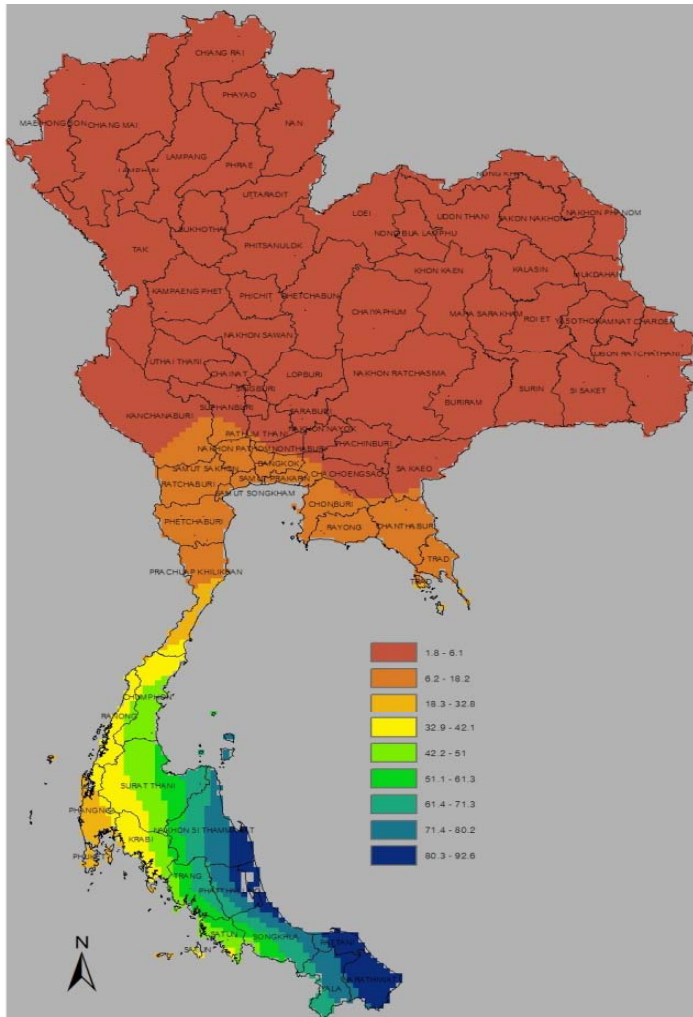


Rainfall from Observations

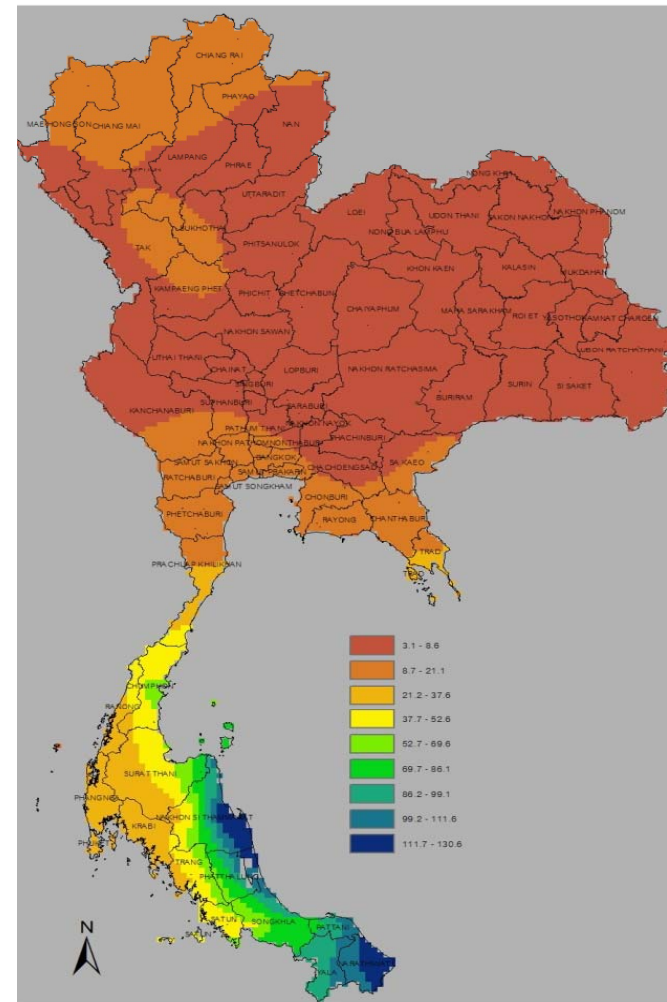
Picture By Nipon Sukunthamet

Rainy

Comparison Sat. rainfall to Obs. over Thailand



Rainfall from Satellite



Rainfall from Observations

Winter

Picture By Nipon Sukunthamet

Results and Discussions

Study the relationship of the estimated rainfall from meteorological satellite data to the measures rainfall from rain gauge observations over whole country by amount of average daily rainfall. The results showed that the relationship of linear regression the both data, R^2 is 0.6451, CC is 0.80, MAE is 1.55, $RMSE$ is 2.51 and STD is 4.27. The relationship of the both data in summer season as R^2 is 0.7305, CC is 0.85, MAE is 1.14, $RMSE$ is 1.95 and the STD is 3.73. In rainy season has the R^2 is 0.4788, CC is 0.69, MAE is 2.06, $RMSE$ is 2.89 and the STD is. 4.19, and in winter season has the R^2 is 0.4436, CC is 0.67, MAE is 1.20, $RMSE$ is 2.37 and STD is 3.15 are following table 1.1.

Table 1.1:

Region	Season	a	R^2	CC	MAE	$RMSE$	STD	No. Observations
Over Area	All	0.9394	0.6451	0.80	1.55	2.51	4.27	102
	Summer	0.9294	0.7305	0.85	1.14	1.95	3.73	102
	Rainy	0.9681	0.4788	0.69	2.06	2.89	4.19	102
	Winter	0.8030	0.4436	0.67	1.20	2.37	3.15	102

Therefore, the relationship between the both data showed that the linear regression of R^2 is low 0.4436 and a maximum of 0.7305 is low 0.4436, and the coefficient of correlation as the CC has a minimum value of 0.67 in winter and a maximum of 0.85 on the season

Table and Graph summarize estimation rainfall from meteorological satellite and correlation with observation in August 2013

	Sum of Satellite	Sum of Observations	Bas of Sum	FE of Bas	AVG of FE/Day	Mean Absolute Error	Root Mean Square Error	Correlation
Thailand	22348.7	23576.4	1227.7	521	11.42	207.75	261.36	0.85
Northern	5623.7	7665.3	2041.6	2663	15.12	98.81	130.04	0.82
North-Eastern	5591.4	4921.8	-669.6	-136	-75.38	92.02	143.36	0.57
Central	4142	2666.5	-1485.5	-55.92	-78.83	72.33	121.36	0.77
Eastern	2856.1	3002.1	146	4.86	-17.57	52.41	83.58	0.54
Southern	4135.5	5330.7	1195.2	2242	28.24	52.39	73.35	0.91

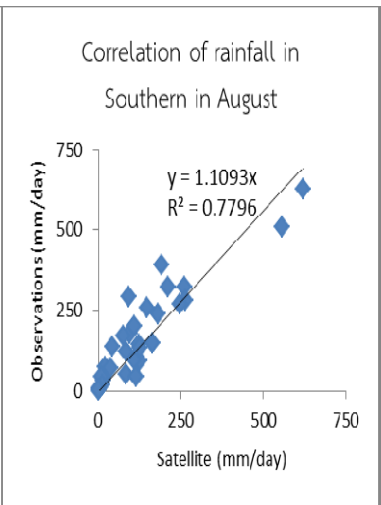
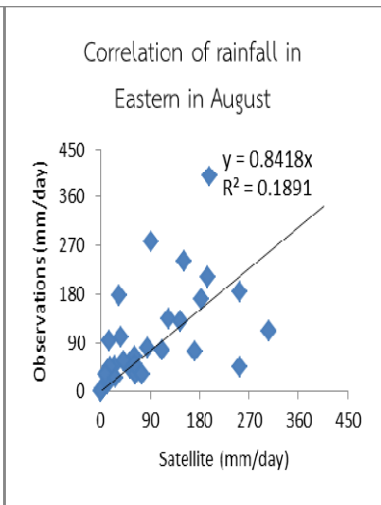
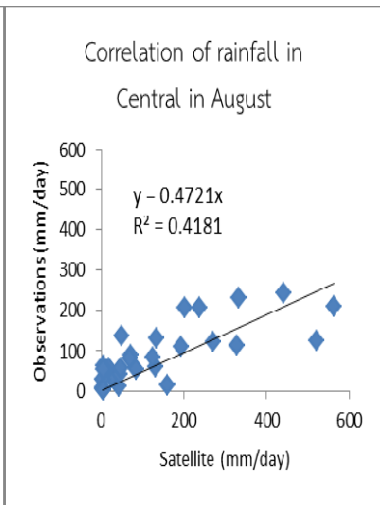
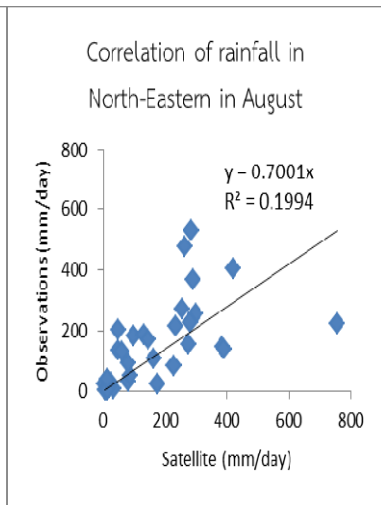
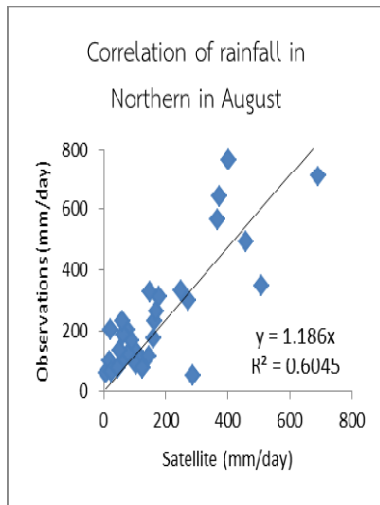
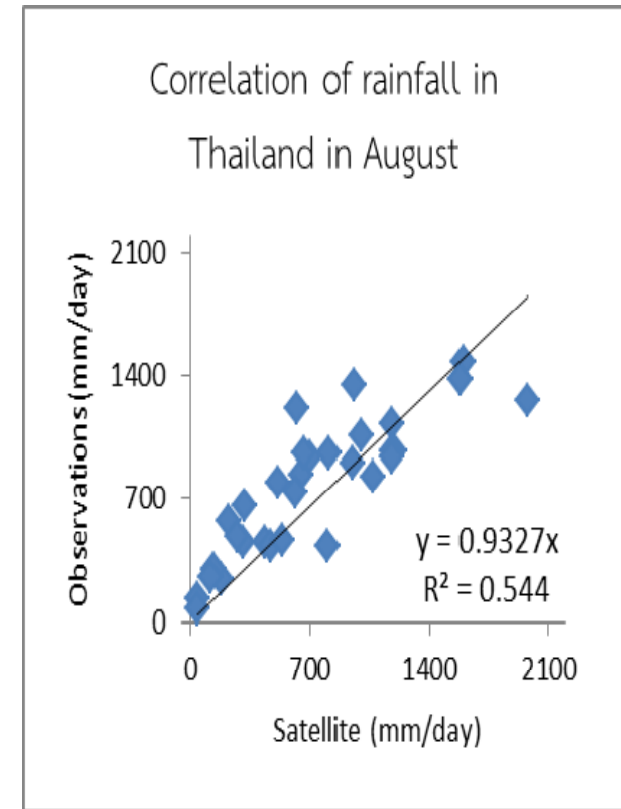


Table and Graph summarize estimation rainfall from meteorological satellite and correlation with observation in September 2013

	Sum of Satellite	Sum of Observations	Bias of Sum	PF of Bias (%)	AVG of PE/Day (%)	Mean Absolute Error	Root Mean Square Error	Correlation
Thailand	26981.5	31119.8	7135.3	21.6	30.13	327.7	453.11	0.85
Northern	5375.7	8585.9	3210.2	37.39	48.74	122.57	147.75	0.85
North-Eastern	6742.5	9007	2264.5	25.14	47.01	122.75	190.28	0.79
Central	5150.6	5662.8	512.2	9.04	79.45*	89.84	137.96	0.75
Eastern	4833.9	5082.4	248.5	4.89	79.23	92.12	145.57	0.76
Southern	4881.8	6081.7	1199.9	19.73	68.09	97.9	143.71	0.64

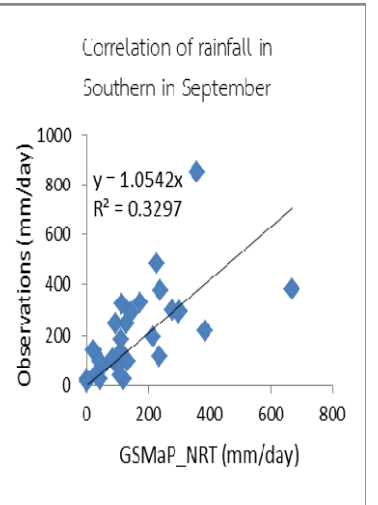
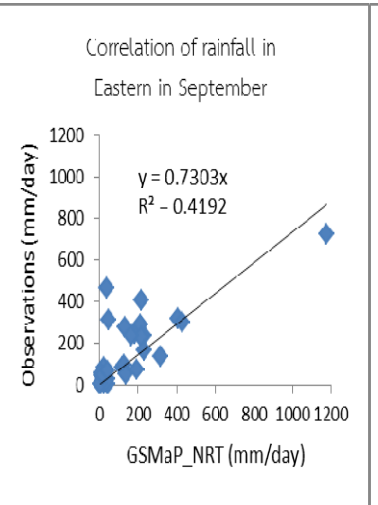
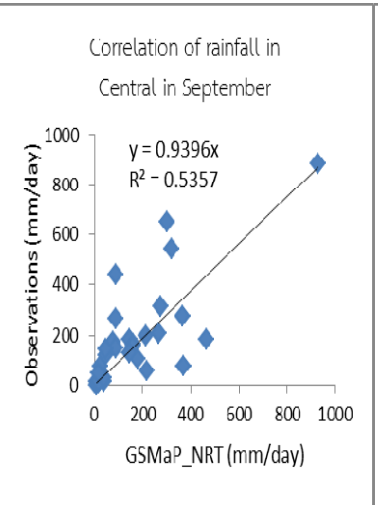
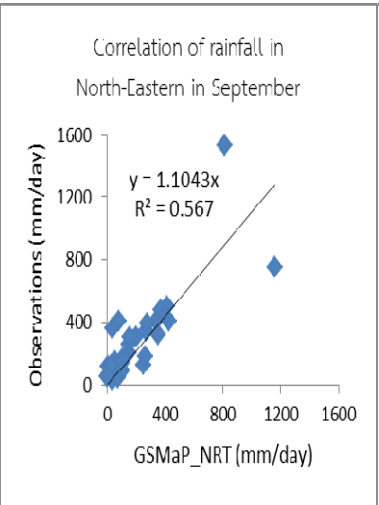
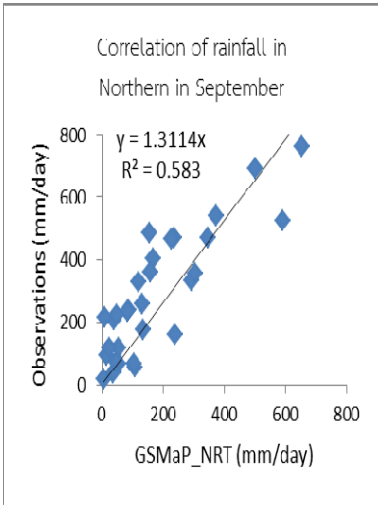
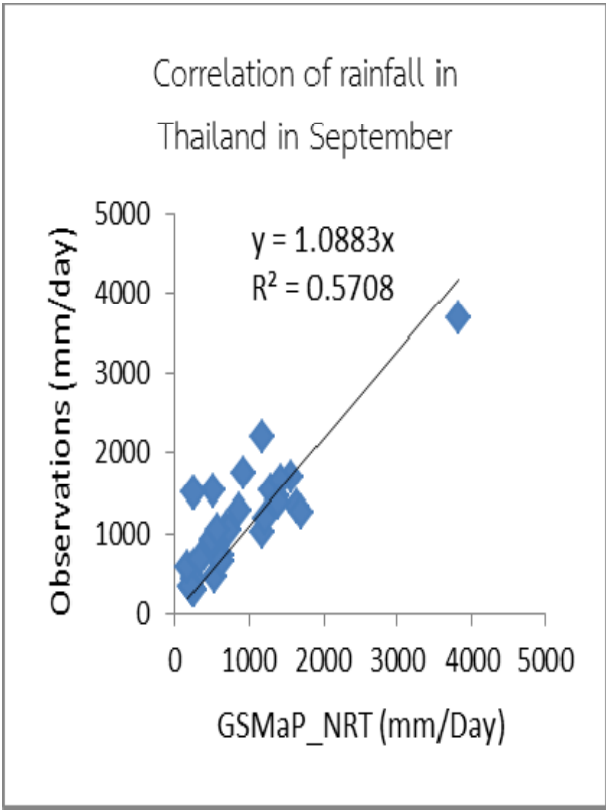
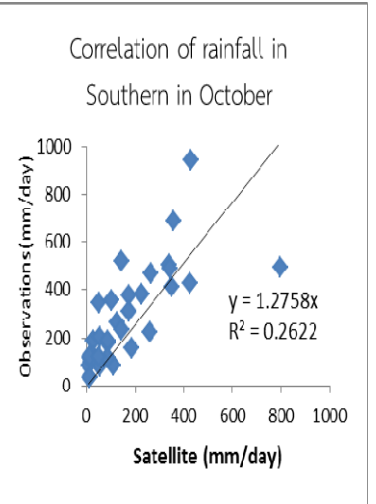
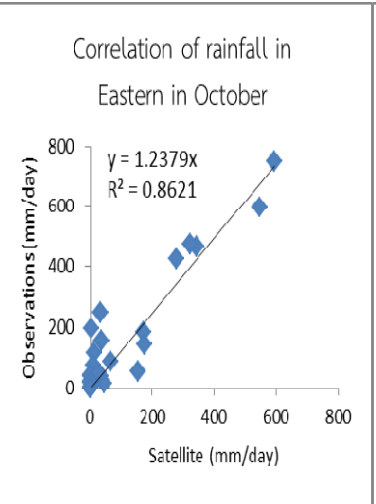
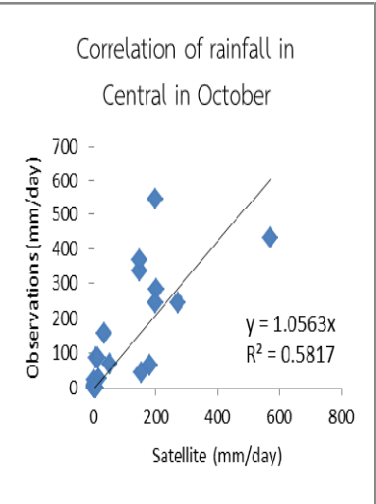
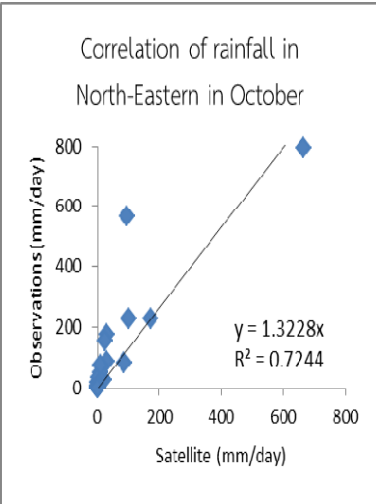
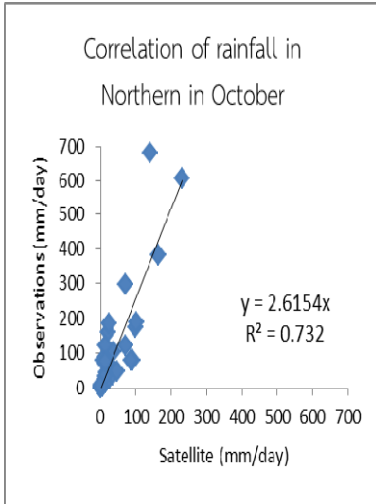
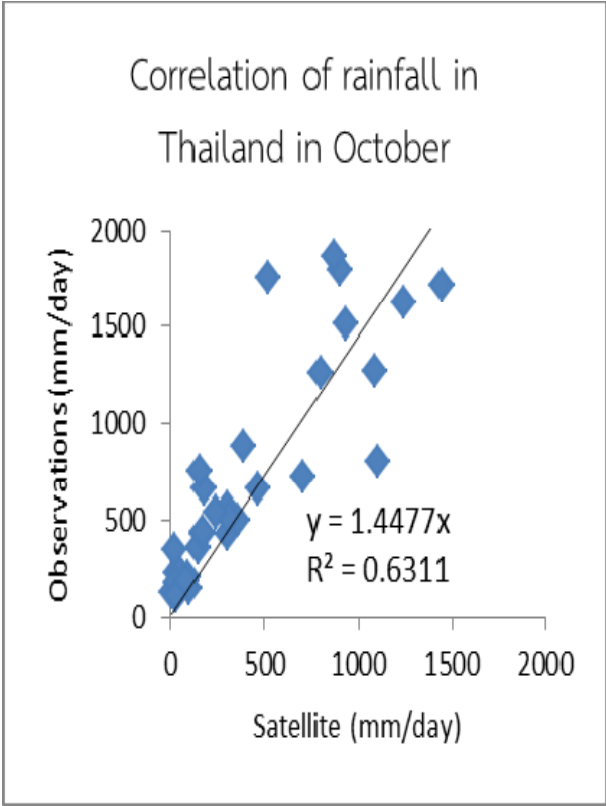
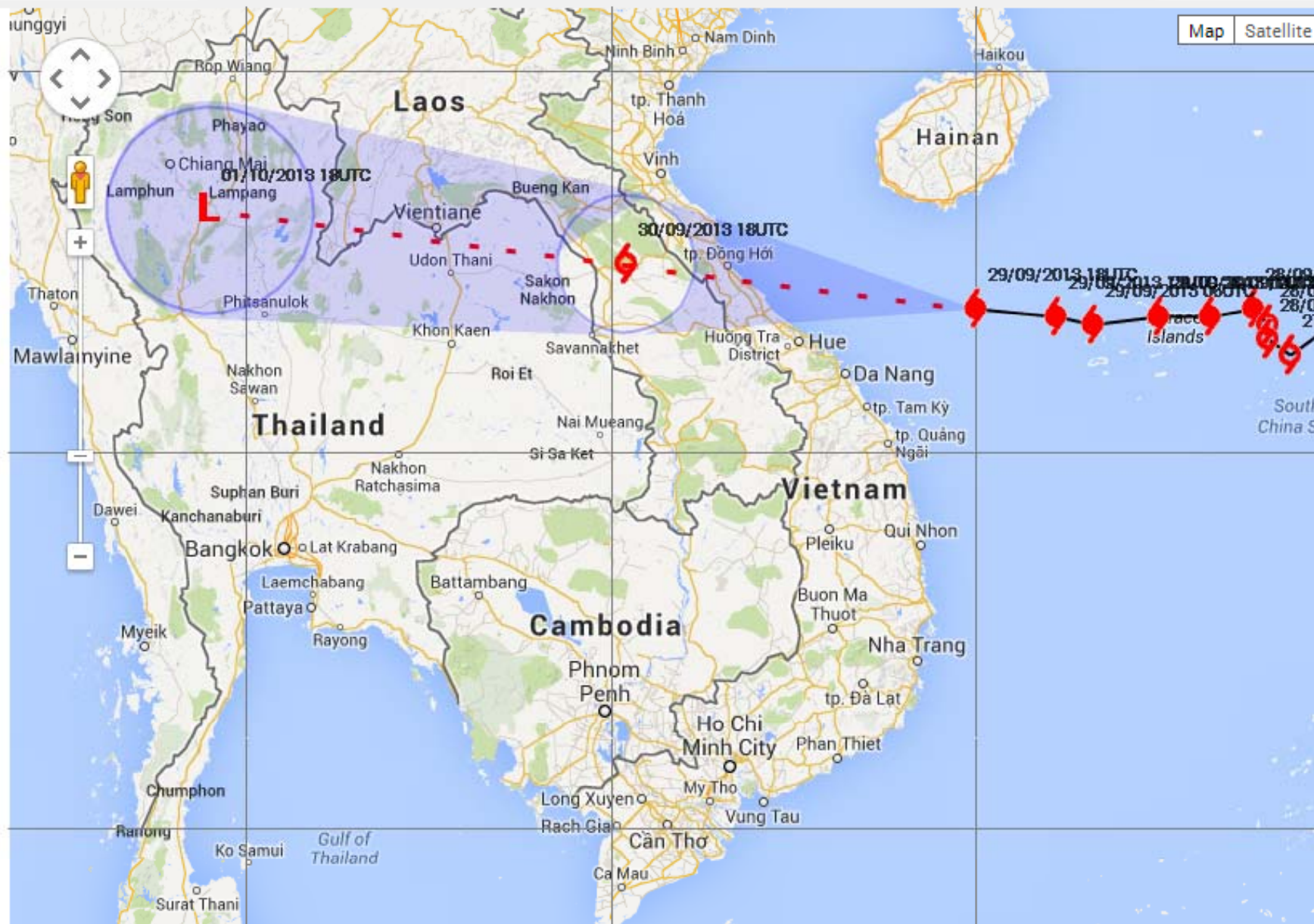


Table and Graph summarize estimation rainfall from meteorological satellite and correlation with observation in October 2013

	Sum of Satellite	Sum of Observations	Bias of Sum	PE of Bias	Mean Absolute Error	Root Mean Square Error	Correlation
Thailand	13242.00	22790.60	9548.60	41.90	327.74	430.47	0.85
Northern	1322.80	3600.30	2277.50	63.26	75.22	142.01	0.86
North-Eastern	1273.80	2576.70	1302.90	50.56	42.40	99.43	0.87
Central	2219.60	3050.50	830.90	27.24	53.44	96.49	0.78
Eastern	2896.20	4352.40	1456.20	33.46	57.37	83.86	0.94
Southern	5529.60	9210.70	3681.10	39.97	143.93	185.01	0.72



TY "WUTIP" 20130930

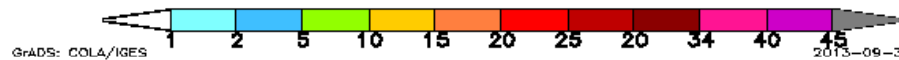
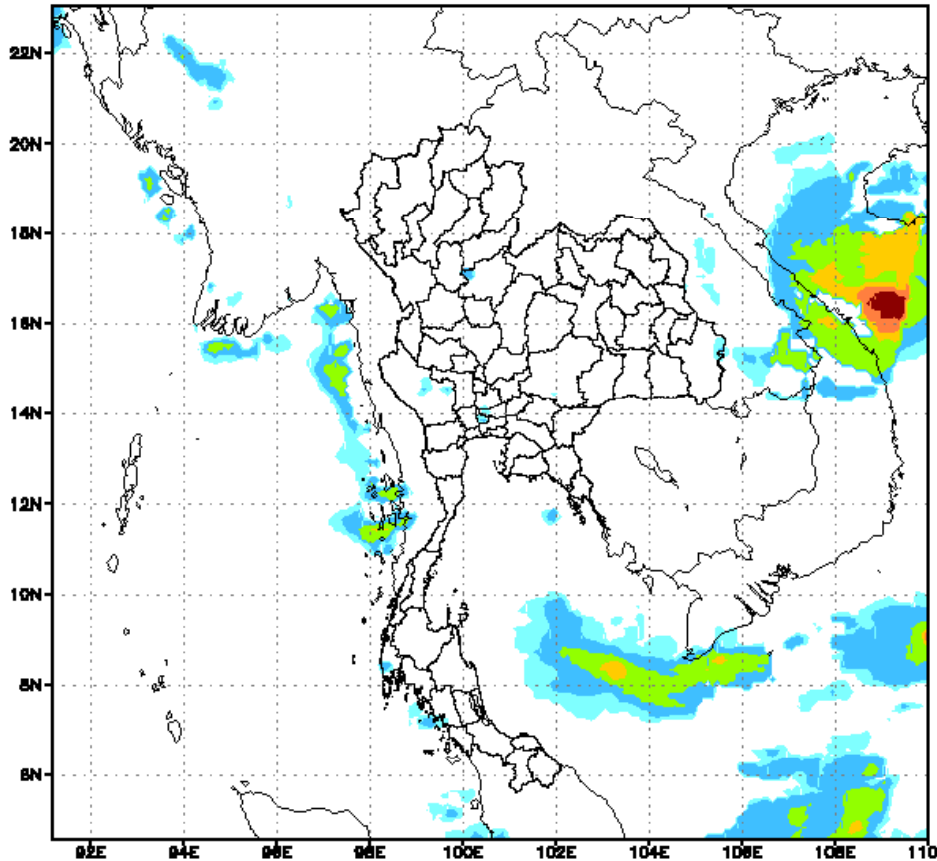


<http://www.metalarm.tmd.go.th/monitor/typhoon>

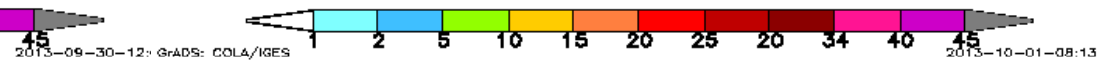
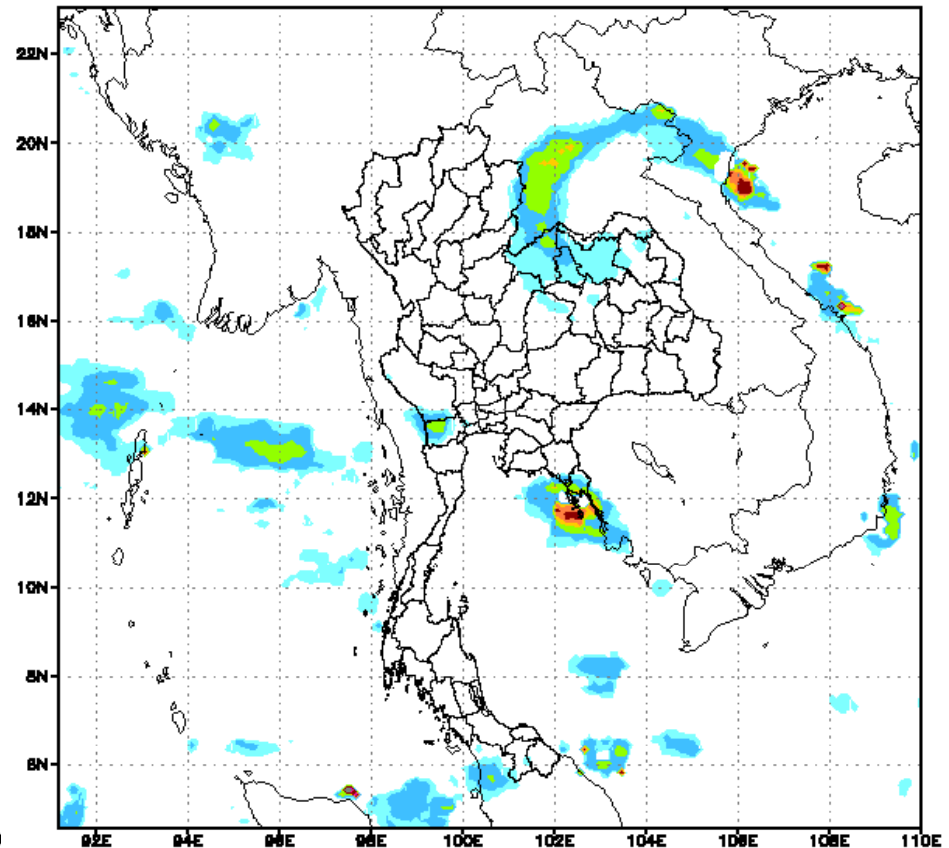
TC "WUTIP" attack 30 September 2013



Satellite Estimated Rainfall Initial time Forecast : 23Z29SEP2013
Hourly Rainfall (mm.) grida resolution 0.1 degree



Satellite Estimated Rainfall Initial time Forecast : 19Z30SEP2013
Hourly Rainfall (mm.) grida resolution 0.1 degree



29 September 2013

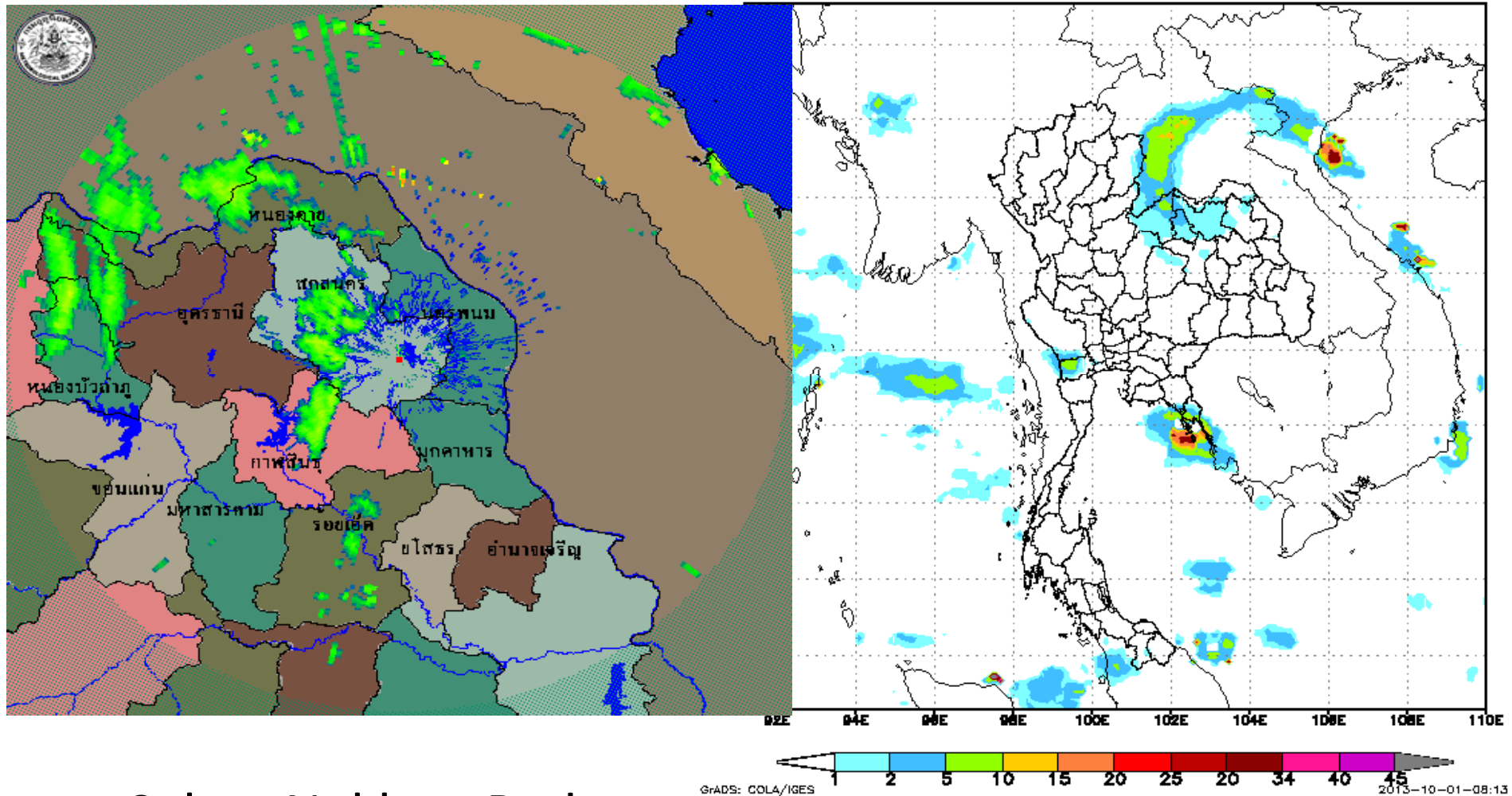
30 September 2013

Comparison Radar to Satellite, 30 SEP 2013

Satellite Estimated Rainfall

Initial time Forecast : 19Z30SEP2013

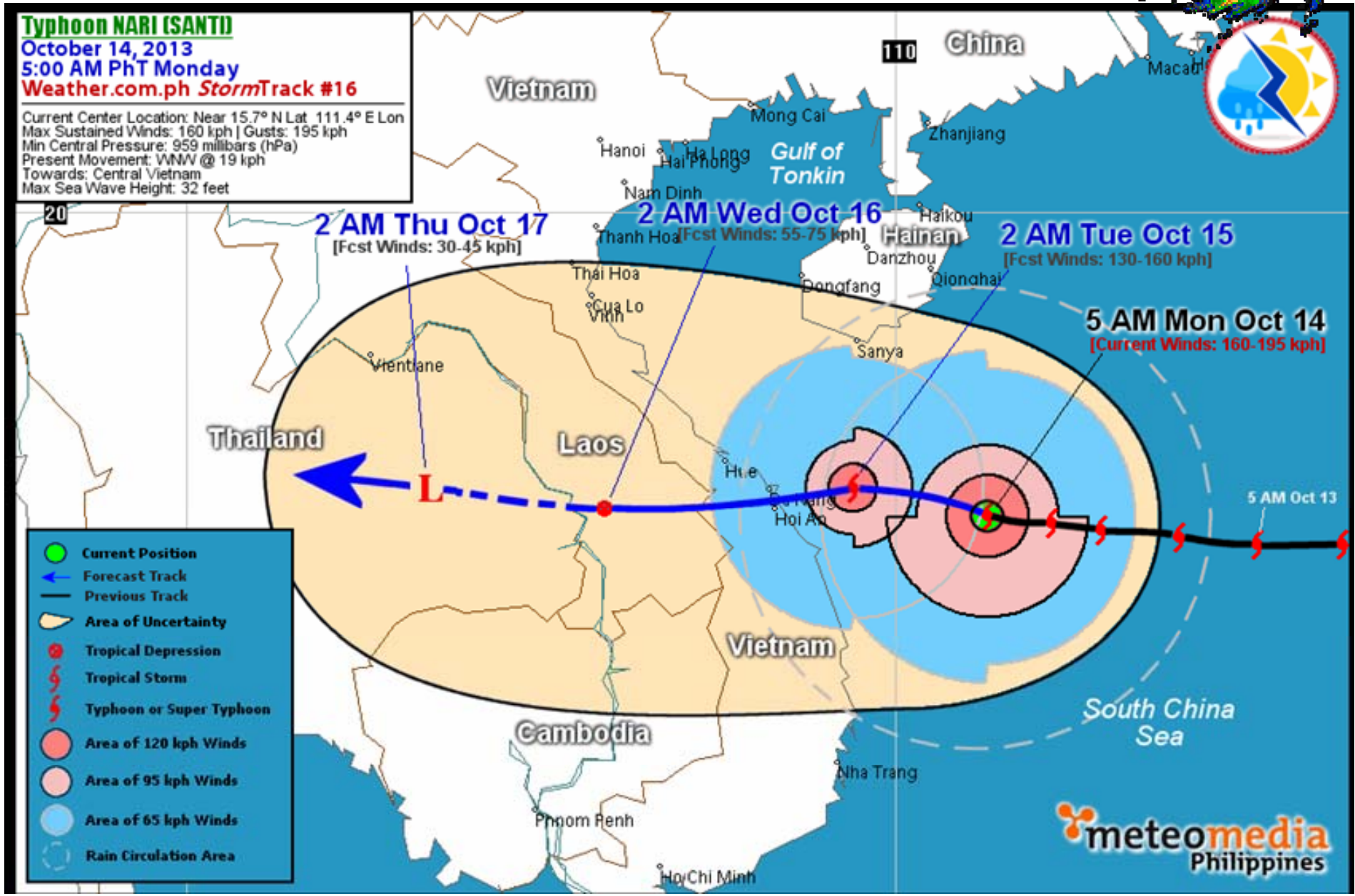
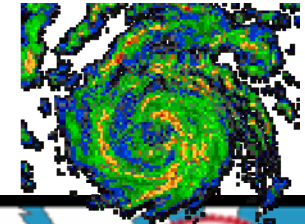
Hourly Rainfall (mm.) grida resolution 0.1 degree



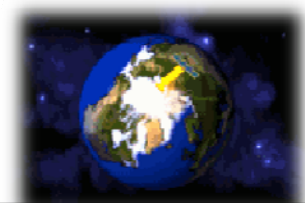
Sakon Nakhon Radar
30 Sep 2013

Estimated Rainfall from Satellite
30 Sep 2013

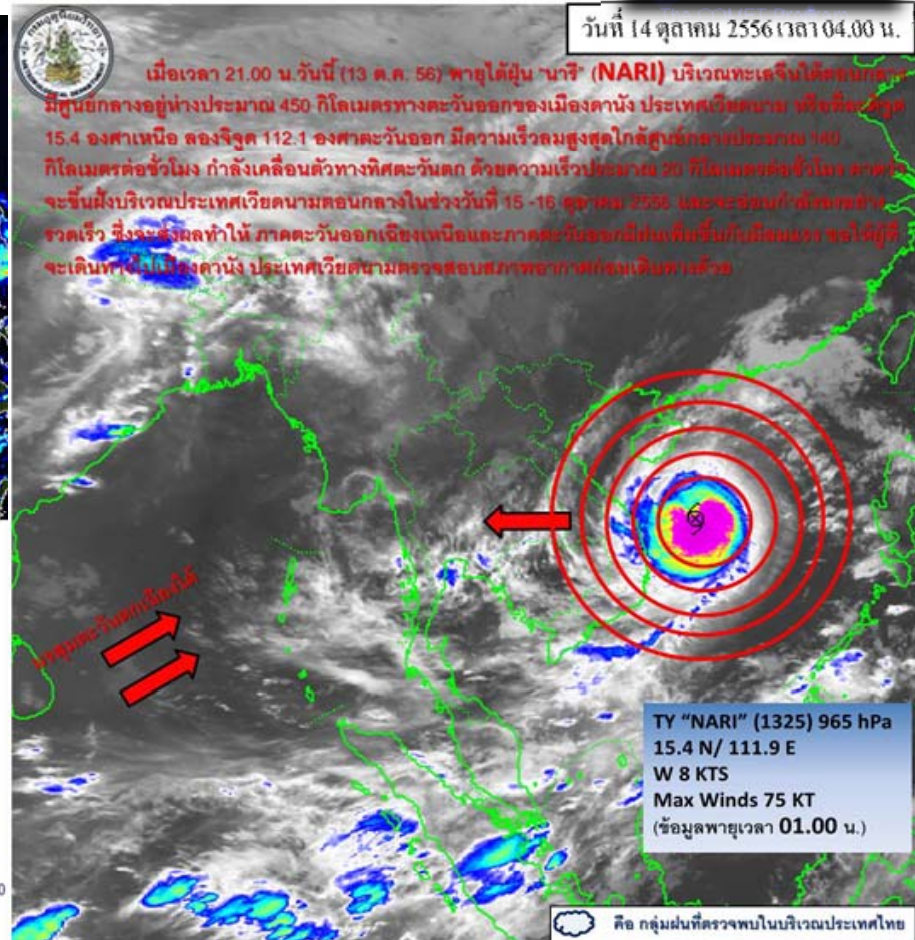
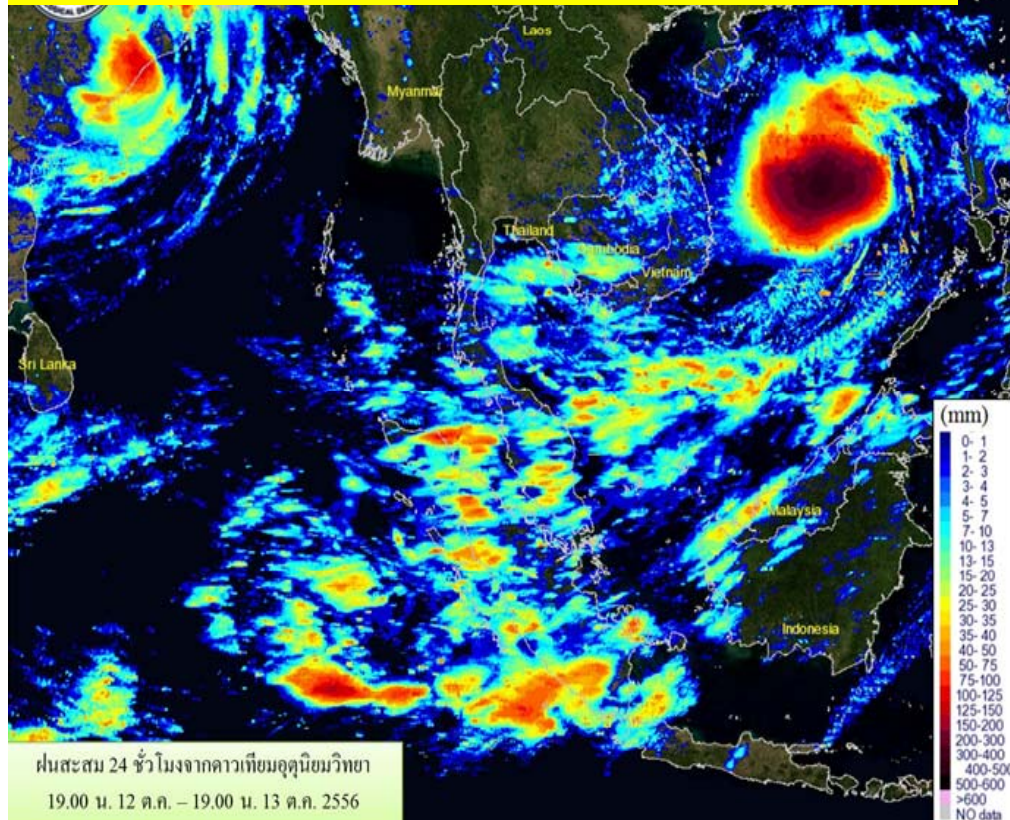
TY "NARI" 2013101400



Satellite Analysis Data



Rainfall Satellite Analysis Data



Estimated rainfall

Clouds cover area

<http://www.satda.tmd.go.th/sat/2013101304.jpg>

Estimated rainfall from satellite



Satellite Estimated Rainfall

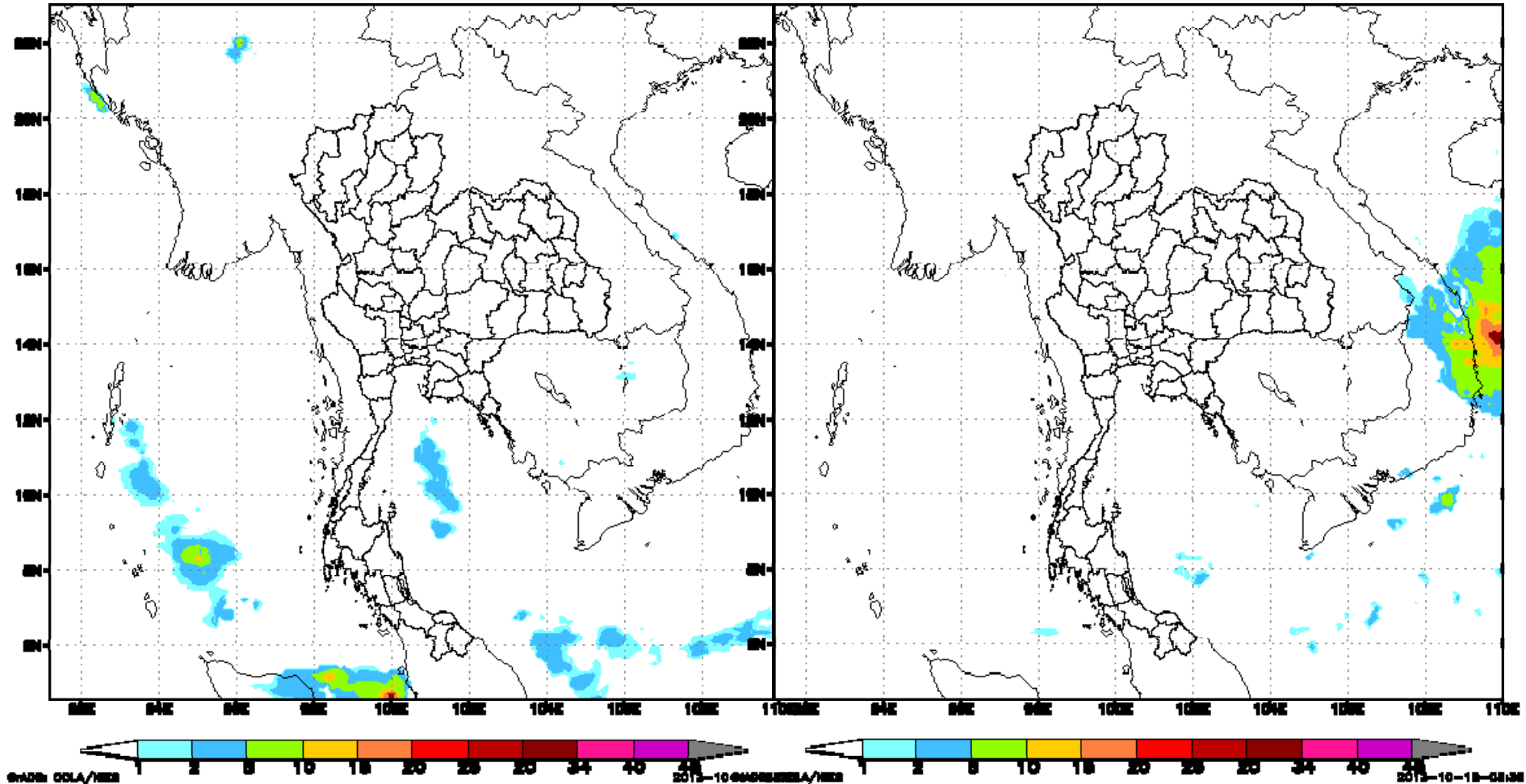
Initial time Forecast : 00Z13OCT2013

Hourly Rainfall (mm.) grids resolution 0.1 degree

Satellite Estimated Rainfall

Initial time Forecast : 00Z14OCT2013

Hourly Rainfall (mm.) grids resolution 0.1 degree



Before, TC "NARI" attack 13-14 October 2013

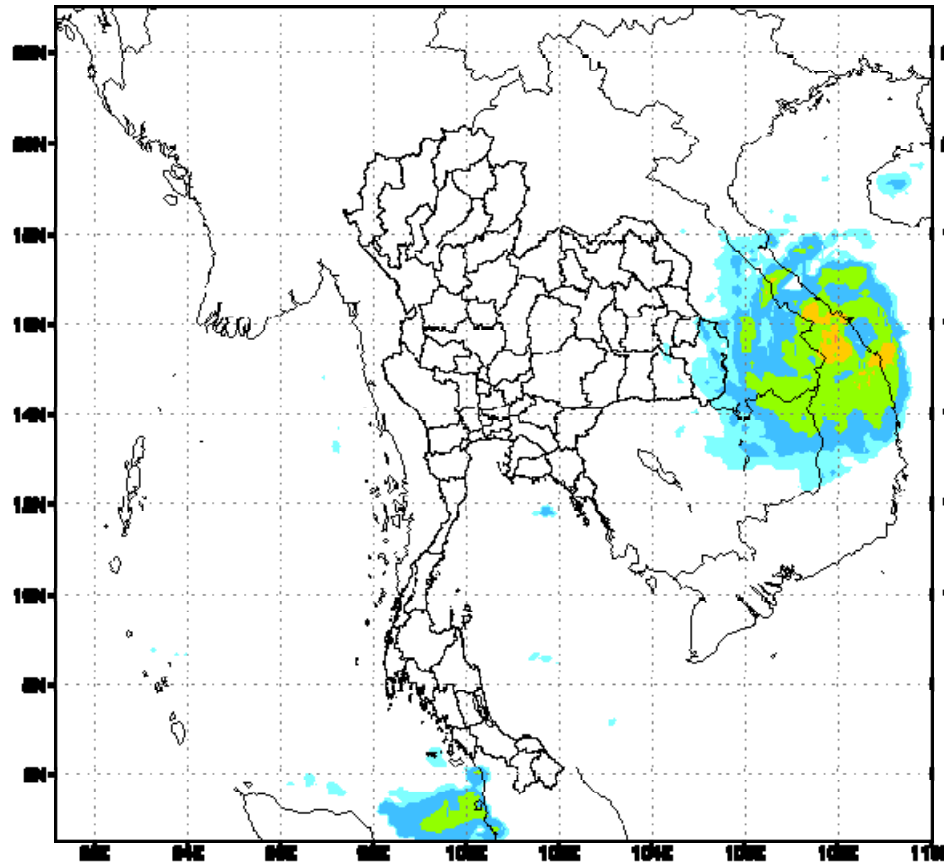
Estimated rainfall from satellite



Satellite Estimated Rainfall

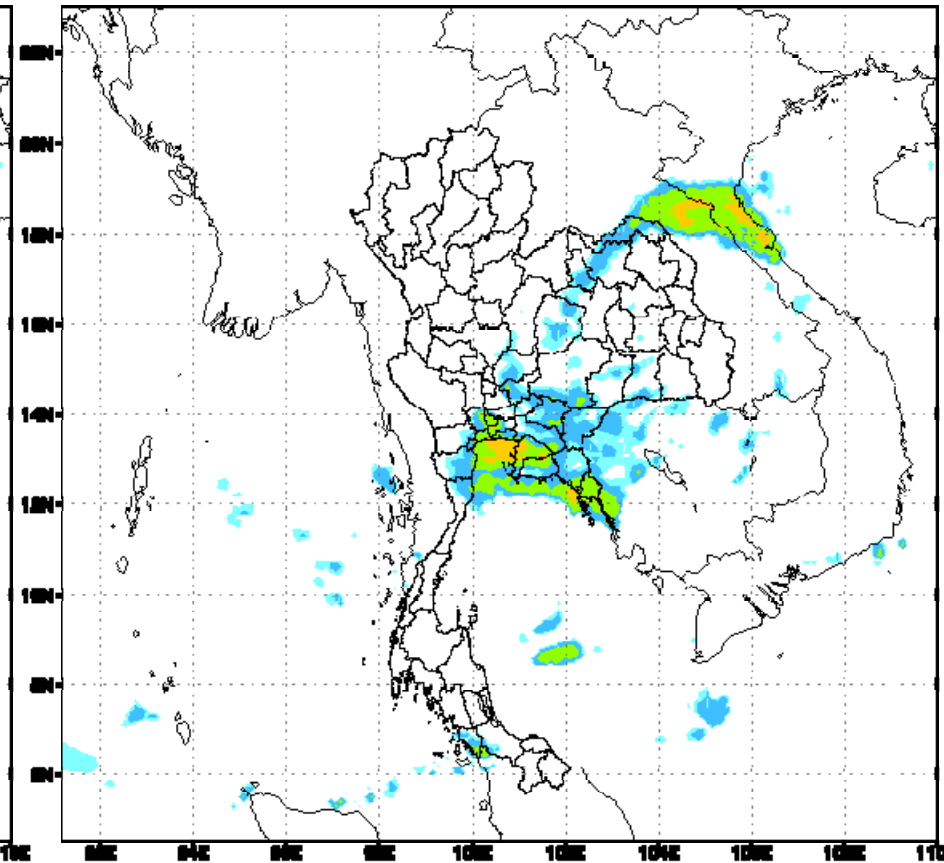
Initial time Forecast : 00Z15OCT2013

Hourly Rainfall (mm.) grids resolution 0.1 degree



Initial time Forecast : 00Z16OCT2013

Hourly Rainfall (mm.) grids resolution 0.1 degree



During, TC "NARI" attack 15-16 October 2013

Estimated rainfall from satellite



Satellite Estimated Rainfall

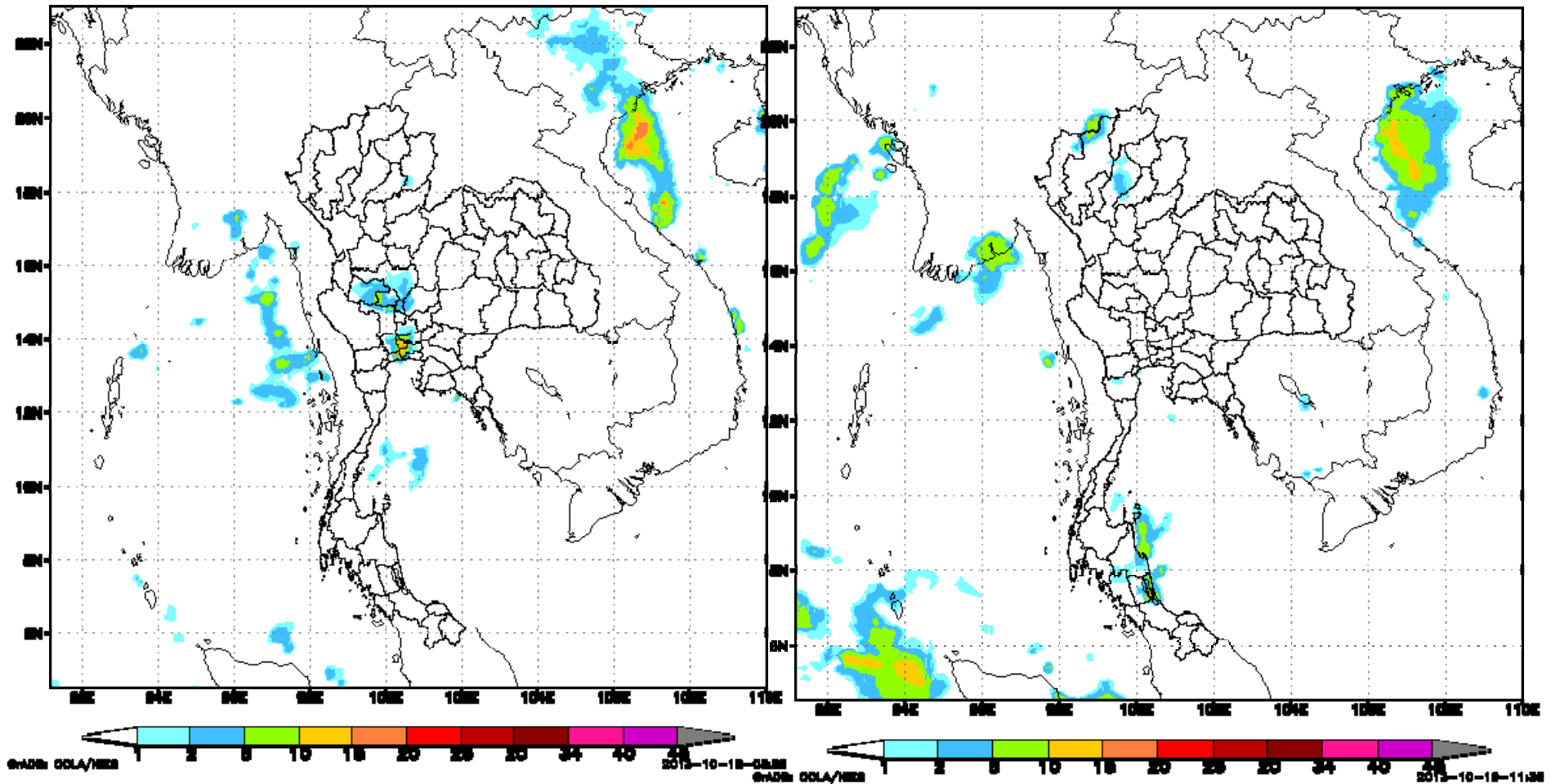
Initial time Forecast : 00Z17OCT2013

Satellite Estimated Rainfall

Initial time Forecast : 00Z18OCT2013

Hourly Rainfall (mm.) grids resolution 0.1 degree

Hourly Rainfall (mm.) grids resolution 0.1 degree

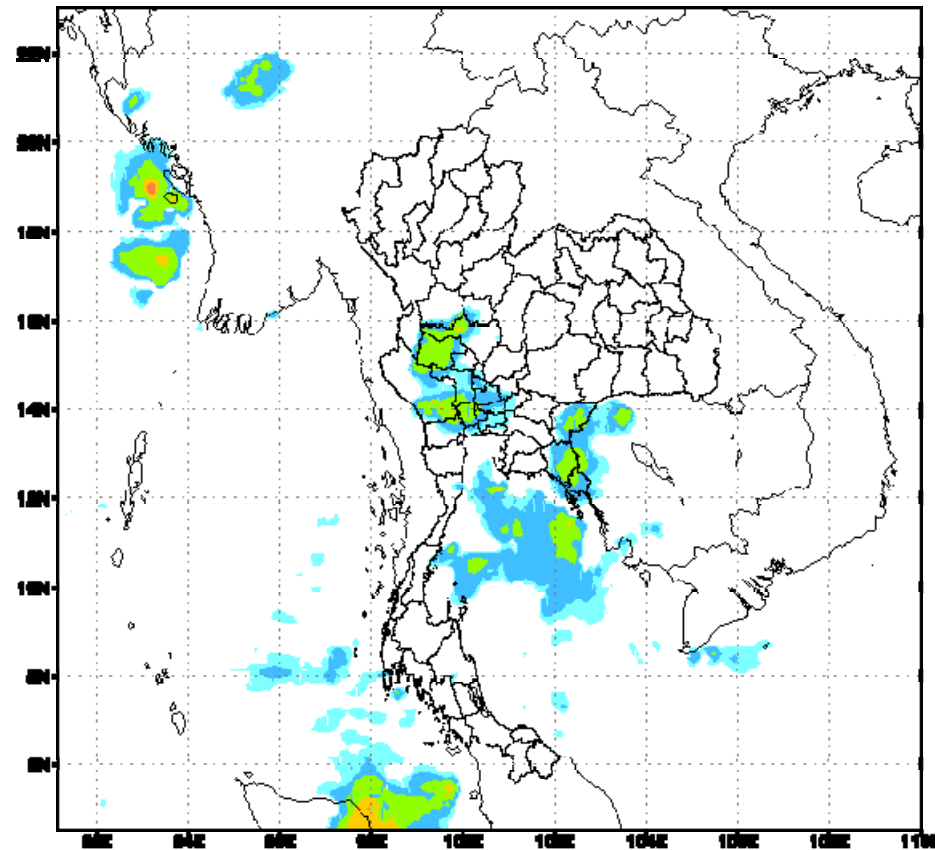


After, TC "NARI" attack 15-16 October 2013

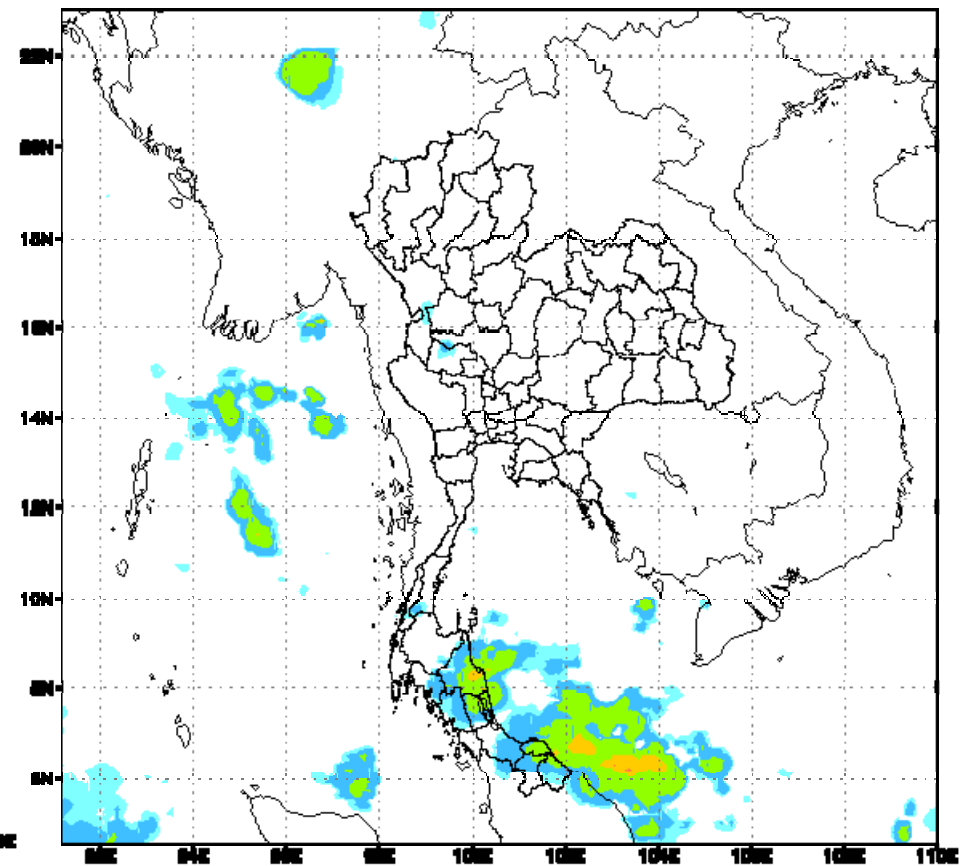
Estimated rainfall from satellite



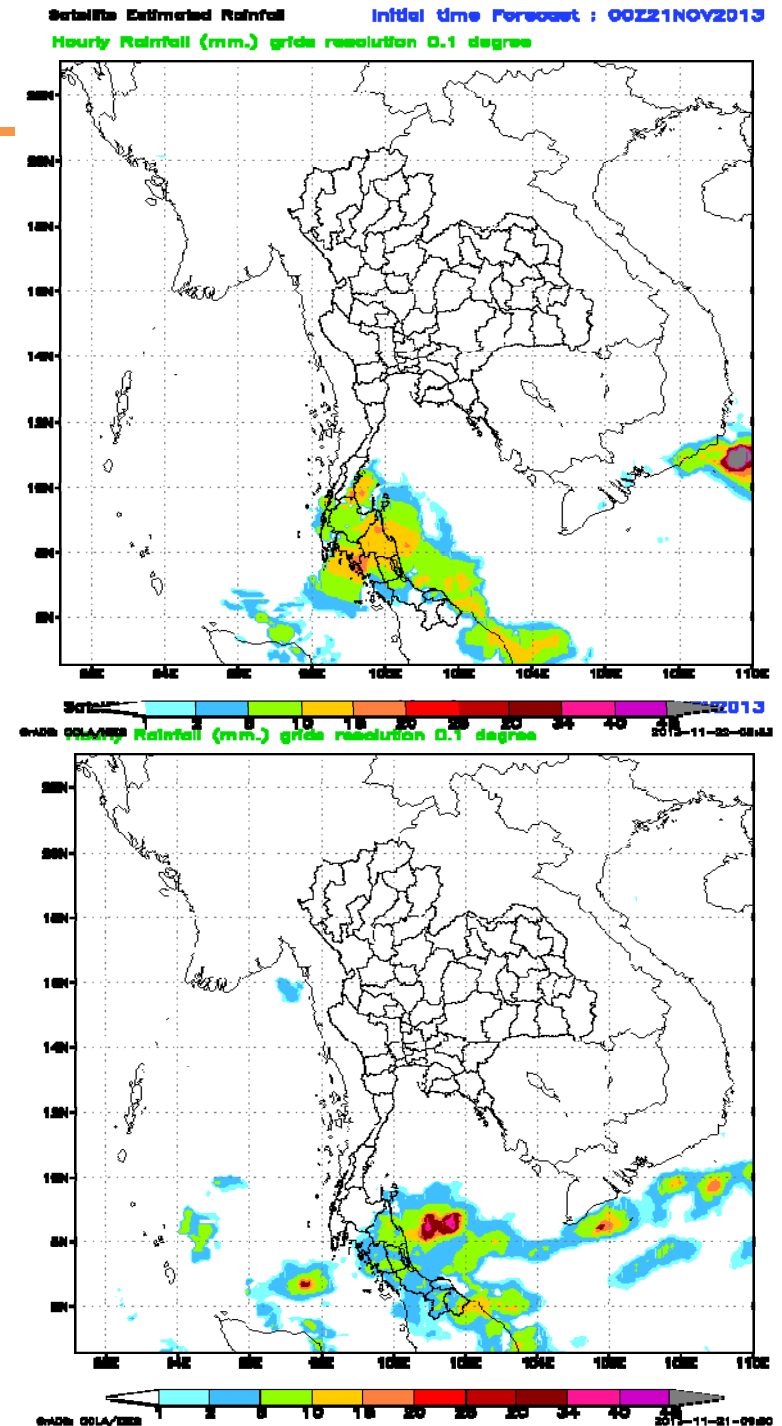
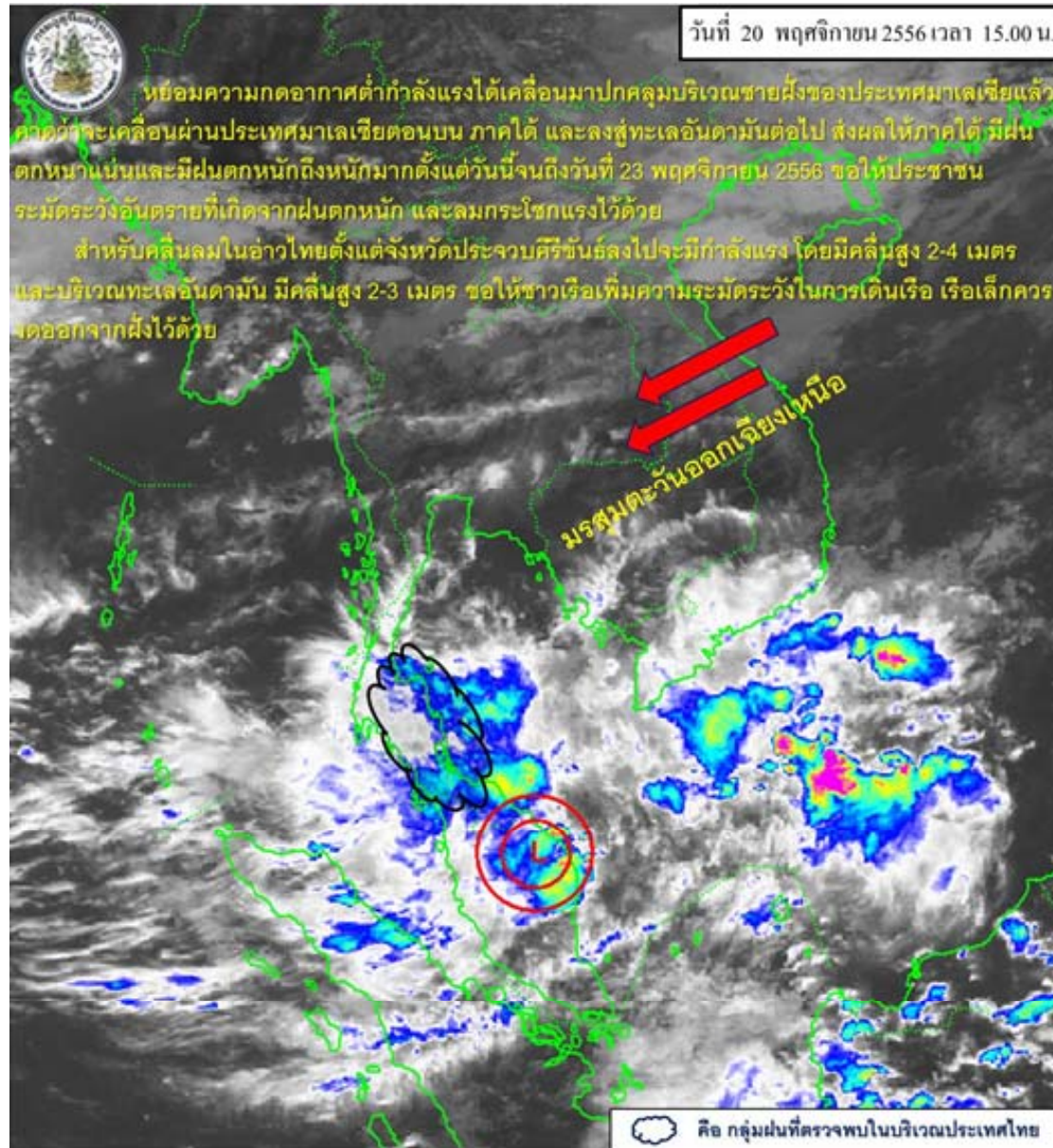
Satellite Estimated Rainfall Initial time Forecast : 00Z19OCT2013
Hourly Rainfall (mm.) grid resolution 0.1 degree



Satellite Estimated Rainfall Initial time Forecast : 00Z20OCT2013
Hourly Rainfall (mm.) grid resolution 0.1 degree



Satellite images, 20 November 2013

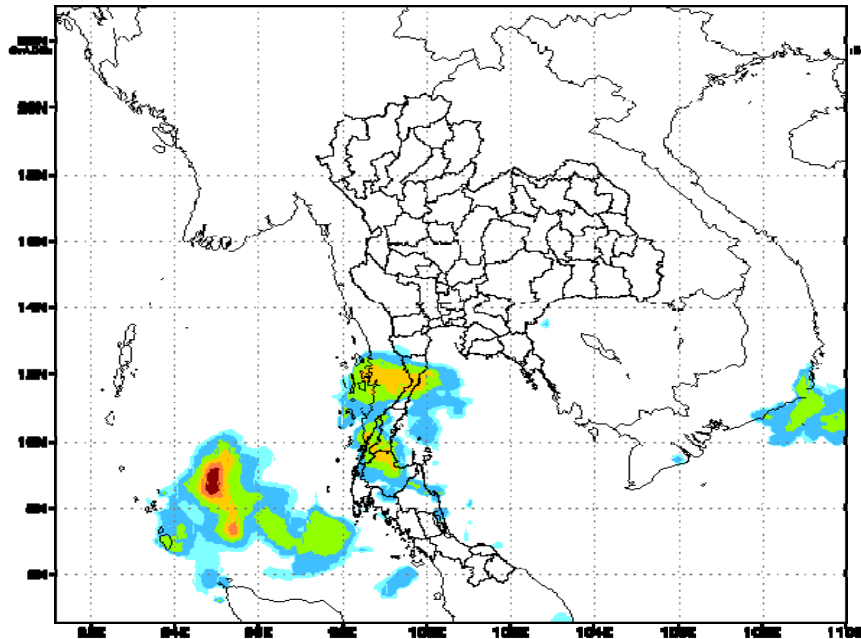
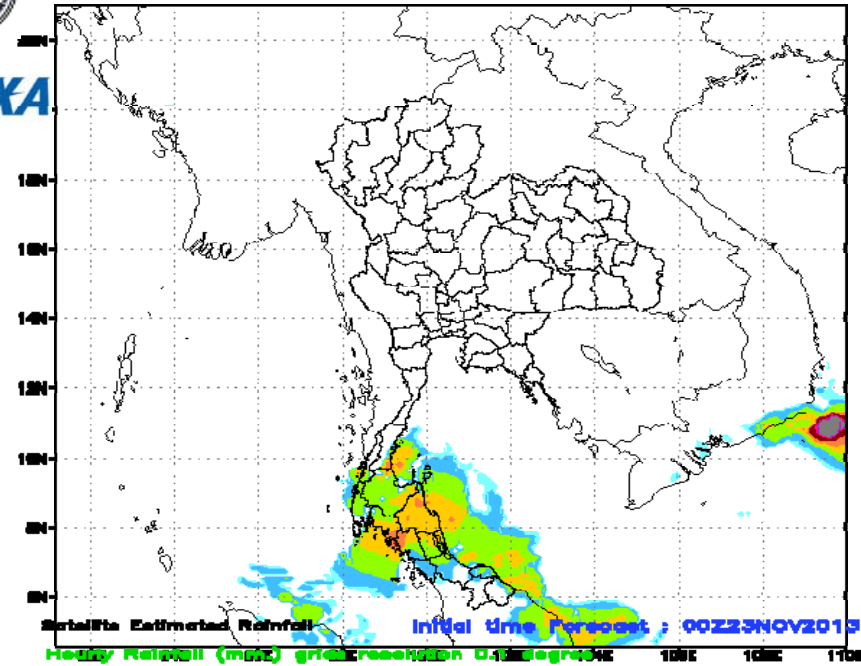




Satellite Estimated Rainfall

Initial time Forecast : 00Z21NOV2013

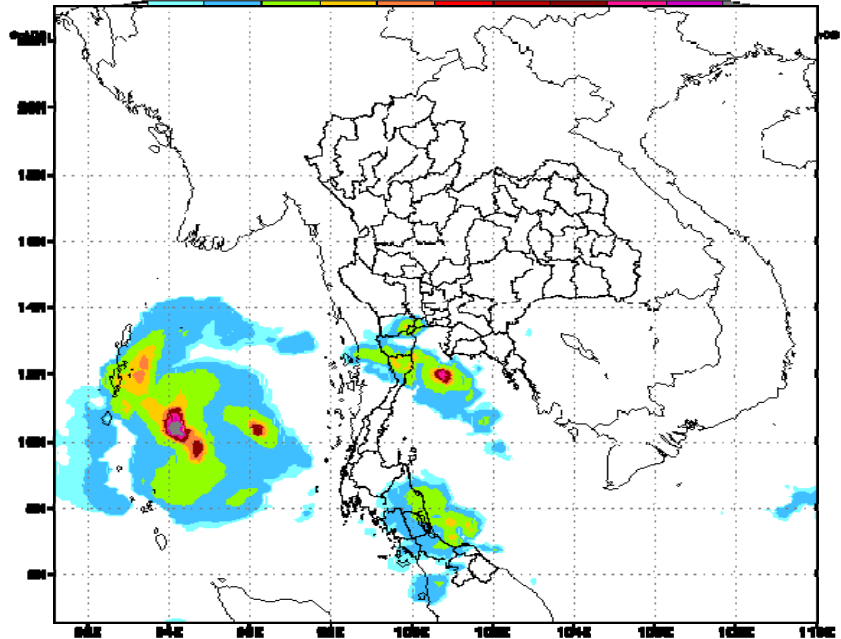
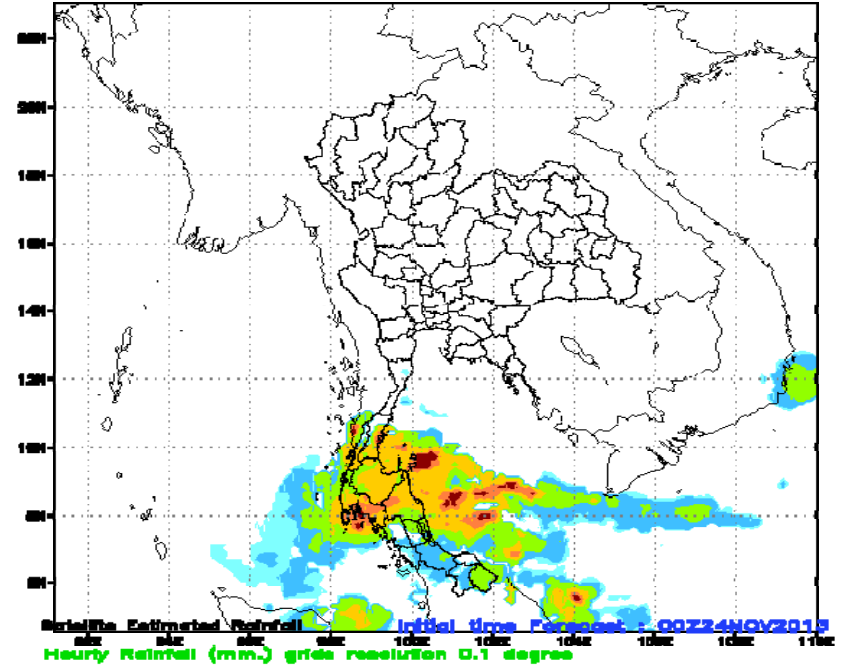
Hourly Rainfall (mm.) grid resolution 0.1 degree



Satellite Estimated Rainfall

Initial time Forecast : 00Z22NOV2013

Hourly Rainfall (mm.) grid resolution 0.1 degree



Conclusions



Performance of the meteorological satellite rainfall over the country and vary according to the season of rain. The conditions of terrain characteristics of each part cover Thailand has contributed significantly to the estimation of precipitation that can separate detailed study of each sector further.

However, the amount of average daily rainfall throughout the year, the estimated rainfall from satellite is consistent with the amount of average daily rainfall measurements at rain gauge stations, and also the relationship of good information desirable.

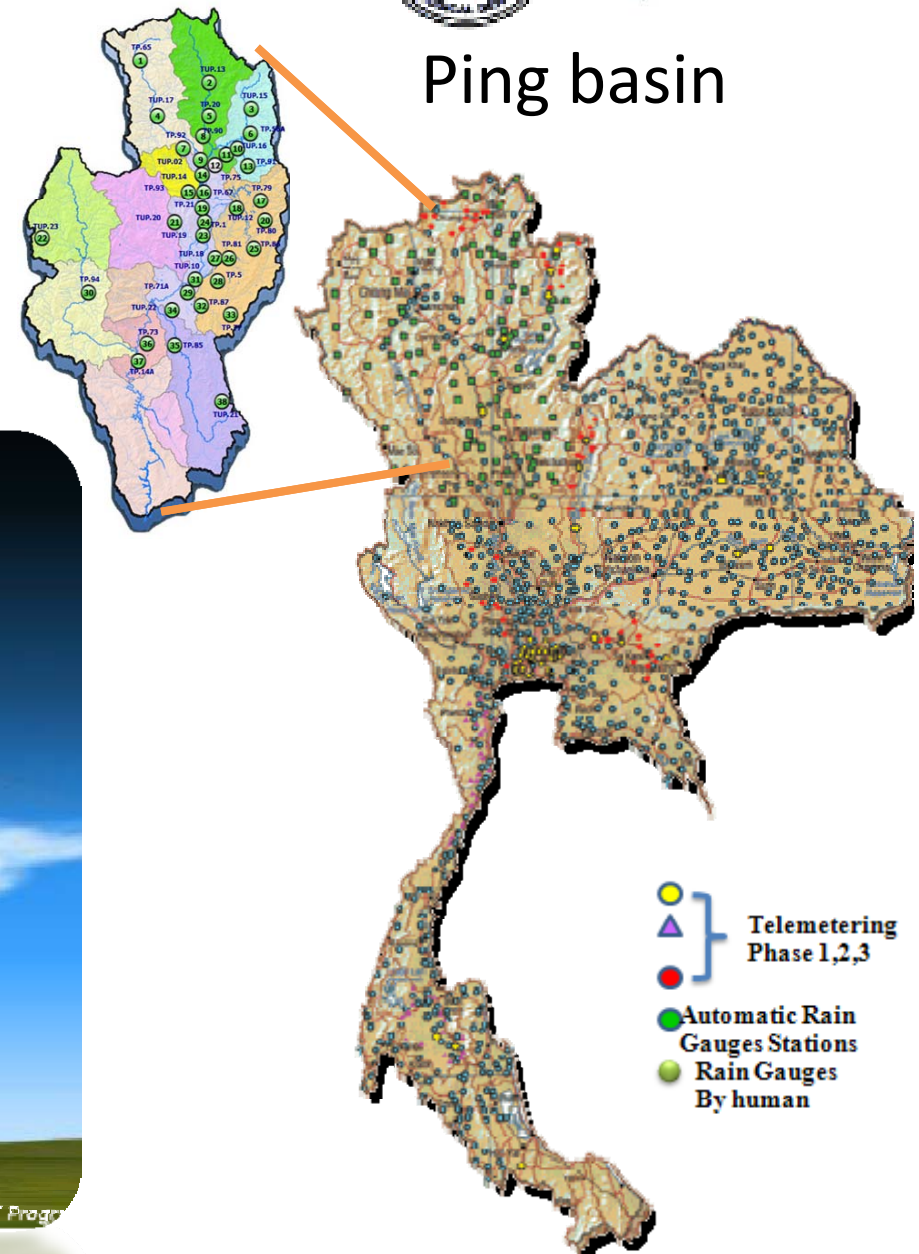
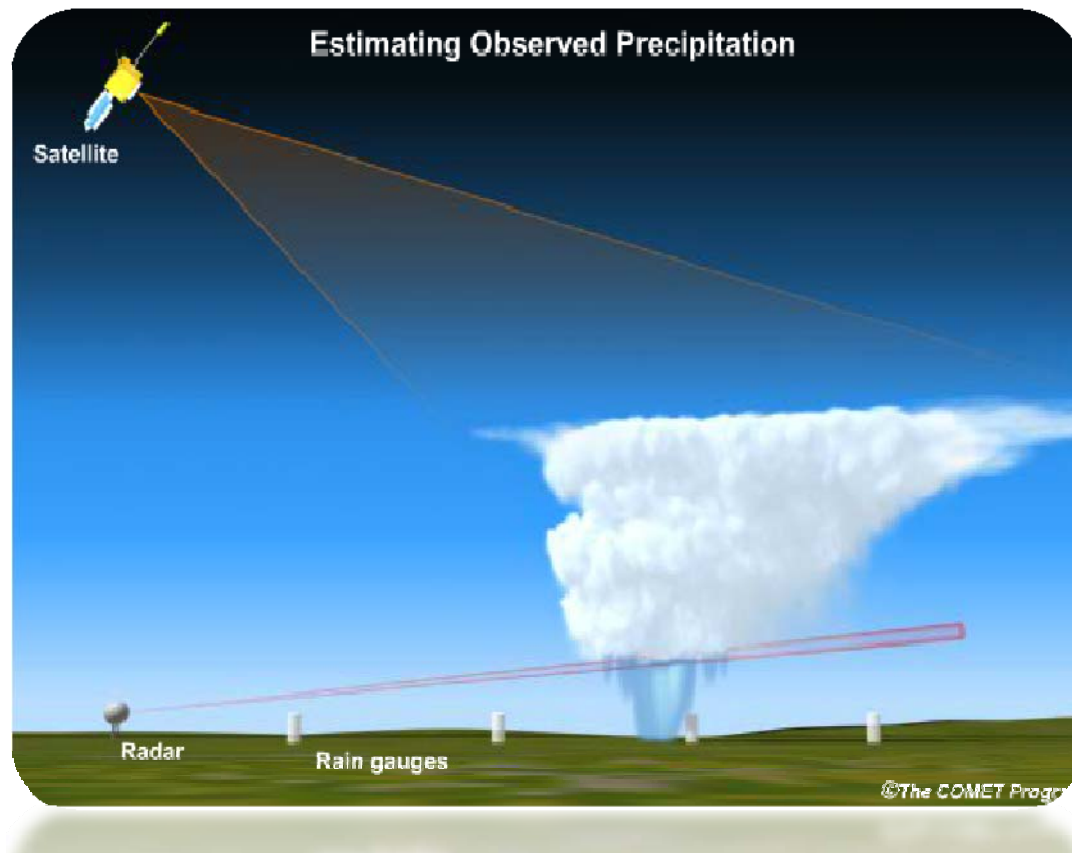
Therefore, the estimated rainfall from satellite is enough to use the potential of the estimated rainfall in the whole area of Thailand.

Future work

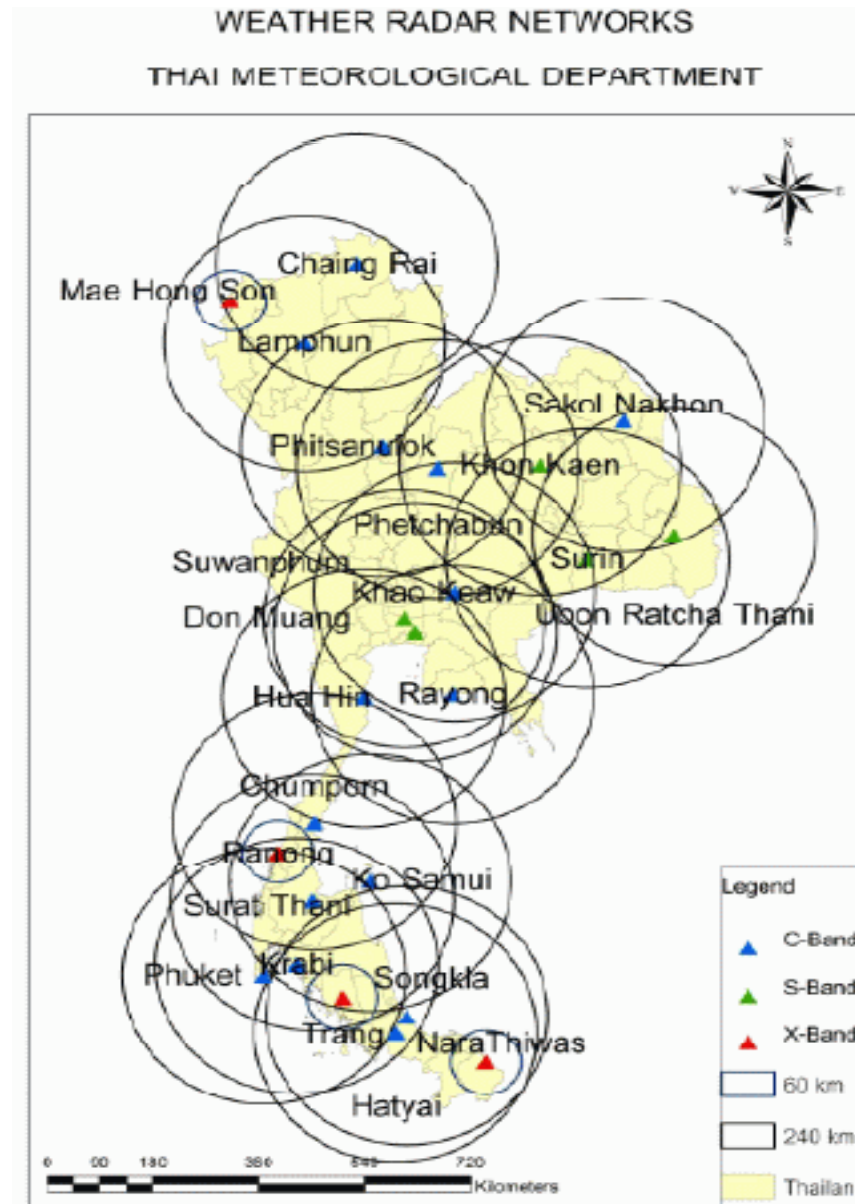
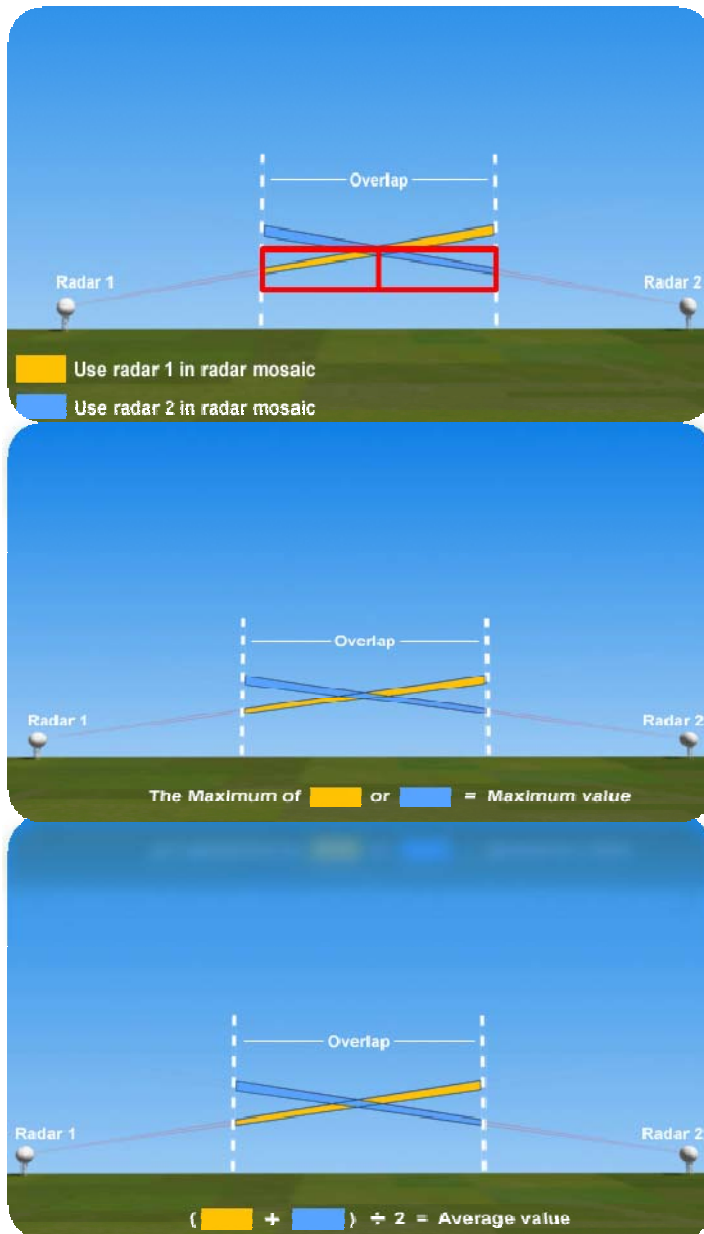


Remote sensing

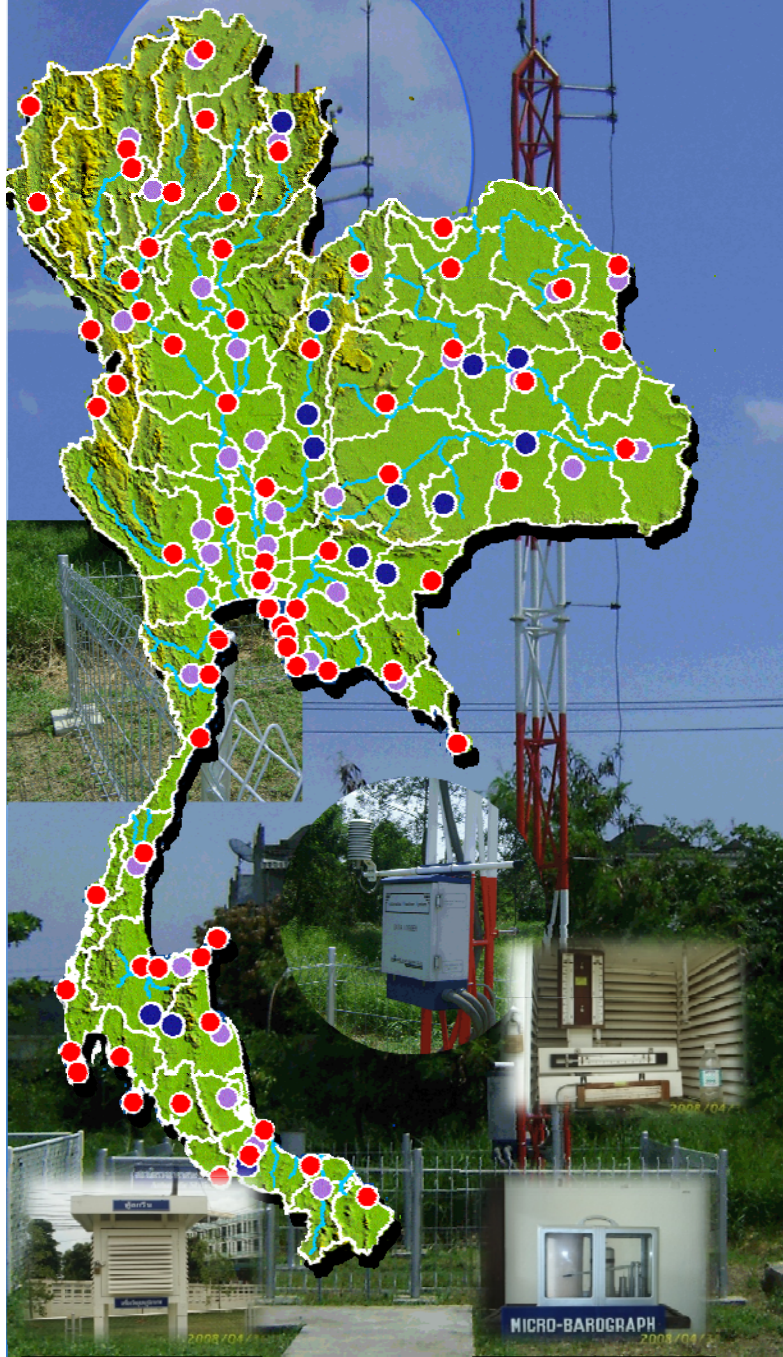
1. Satellite mapping
2. Radar composite



Met. Radar Mapping

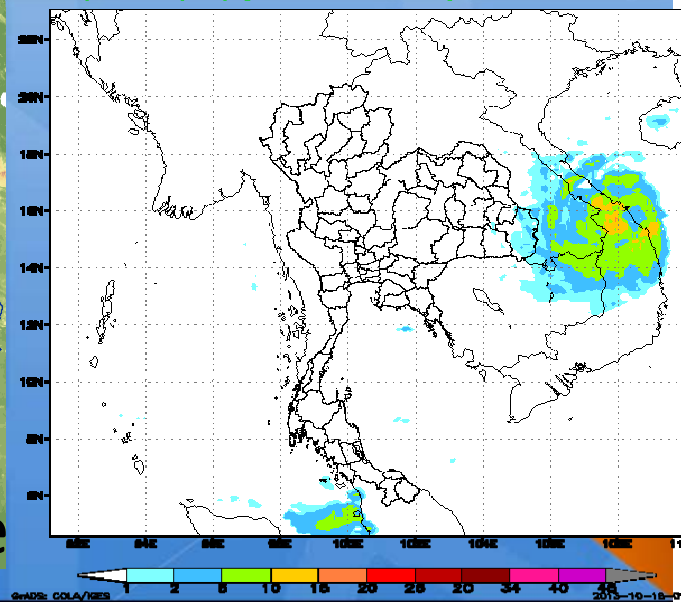
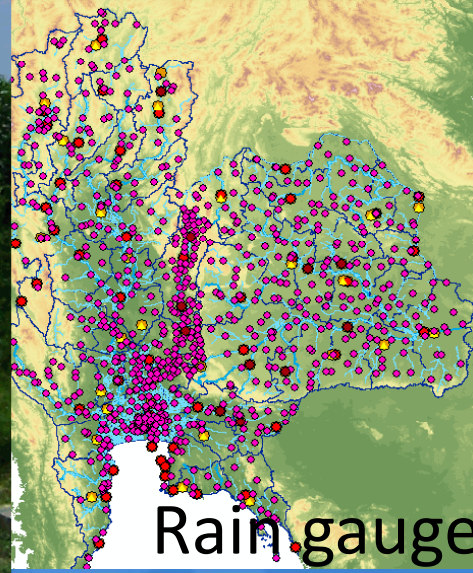
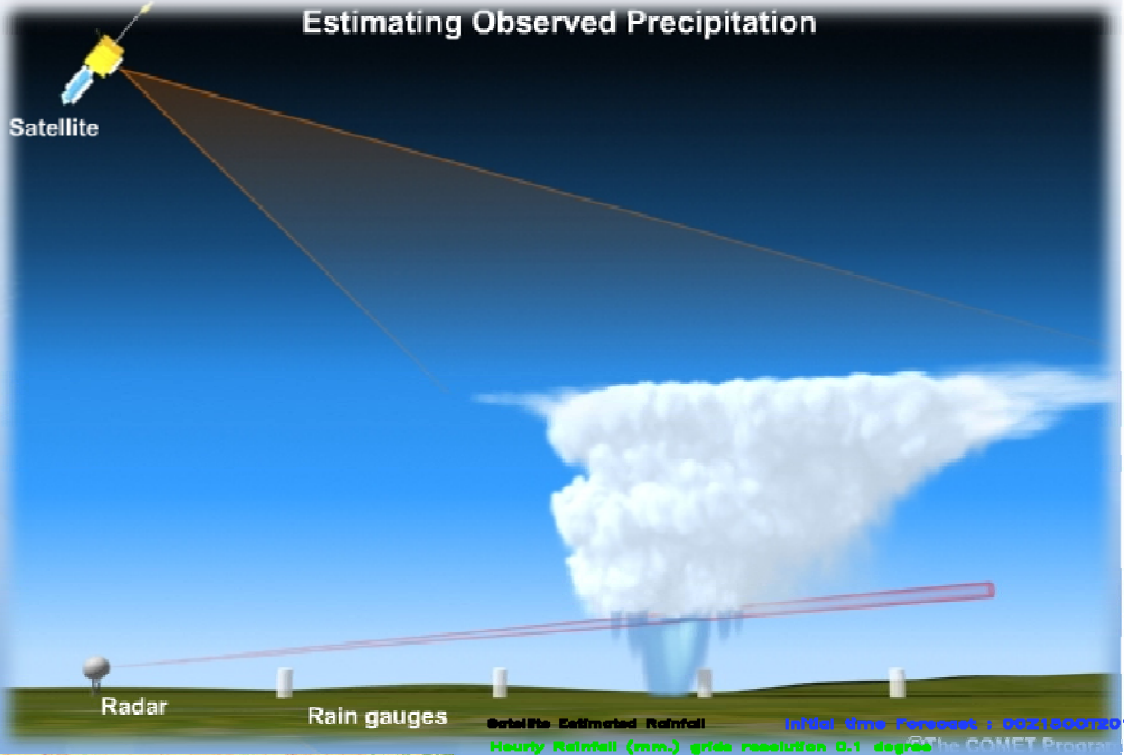


Observation : TMD

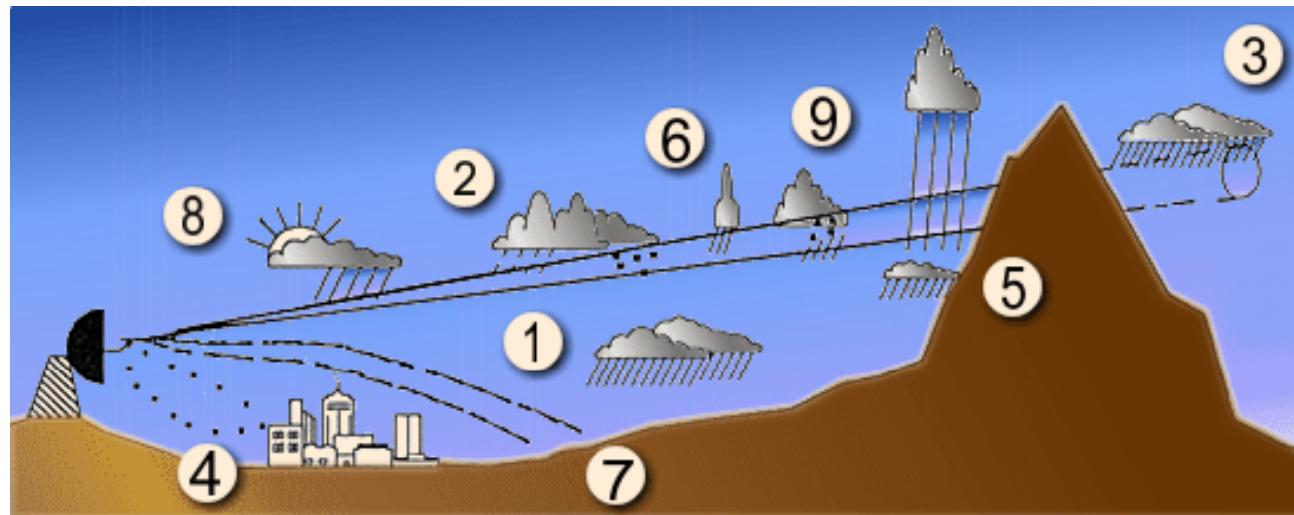
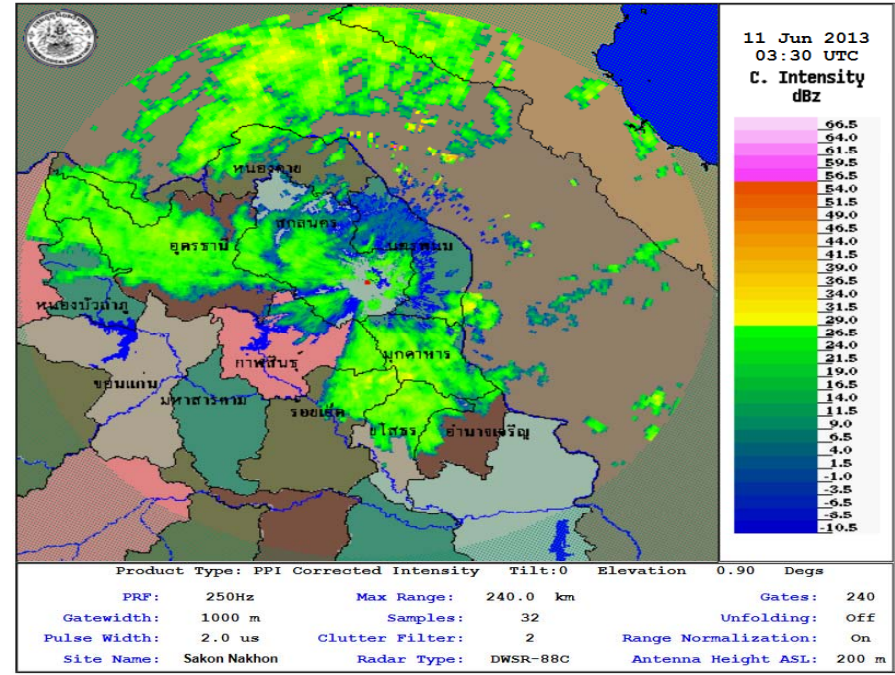
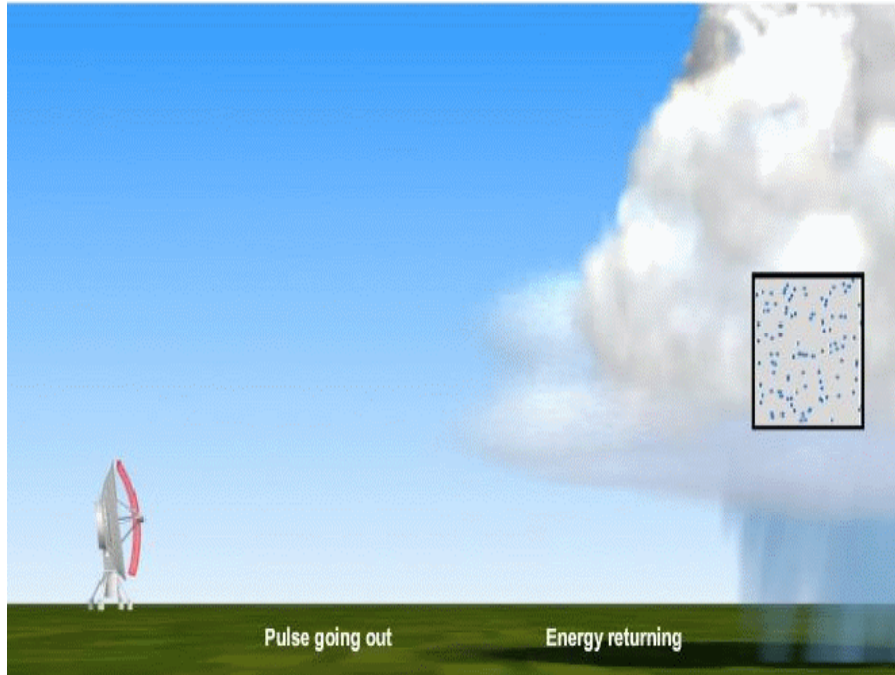


Estimate precipitation from satellite

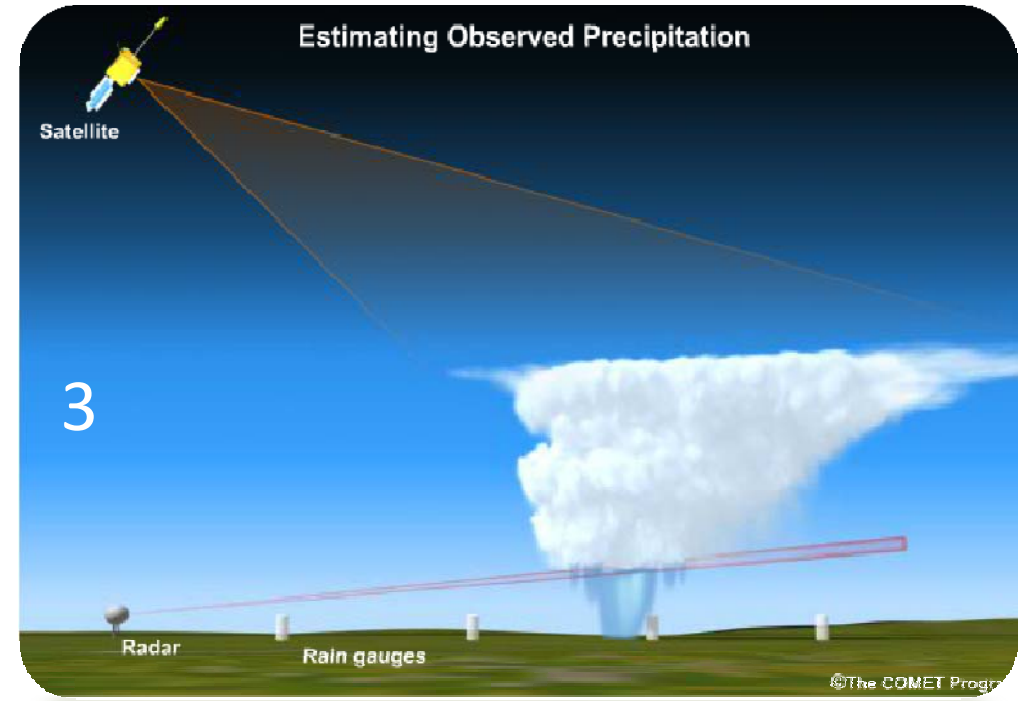
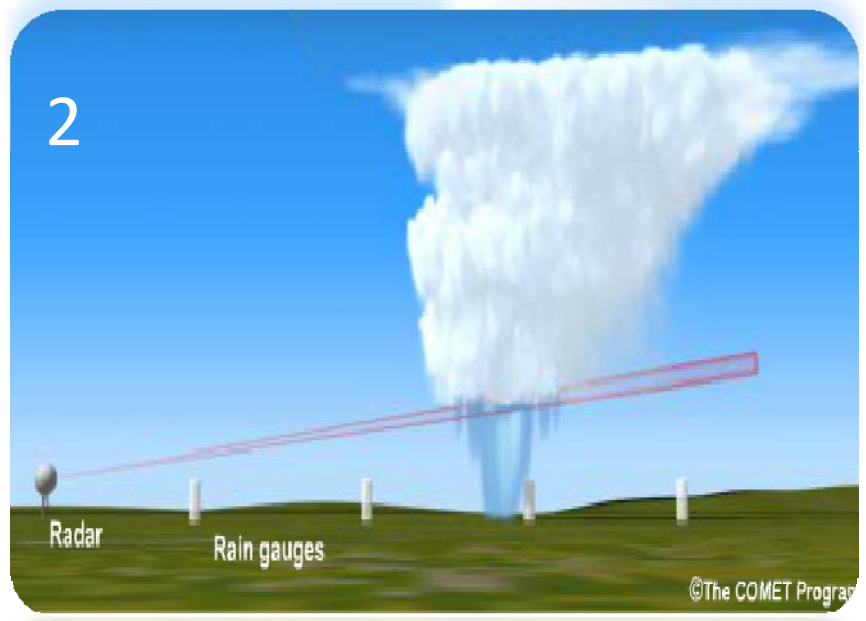
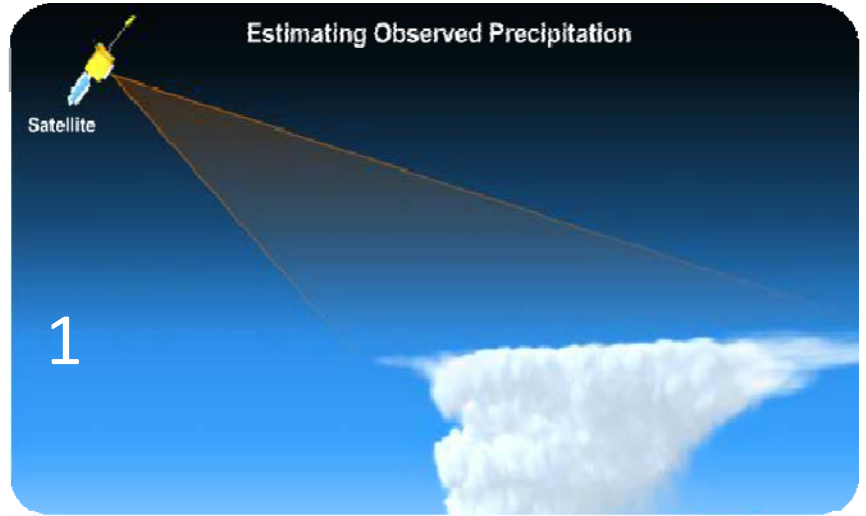
Estimating Observed Precipitation



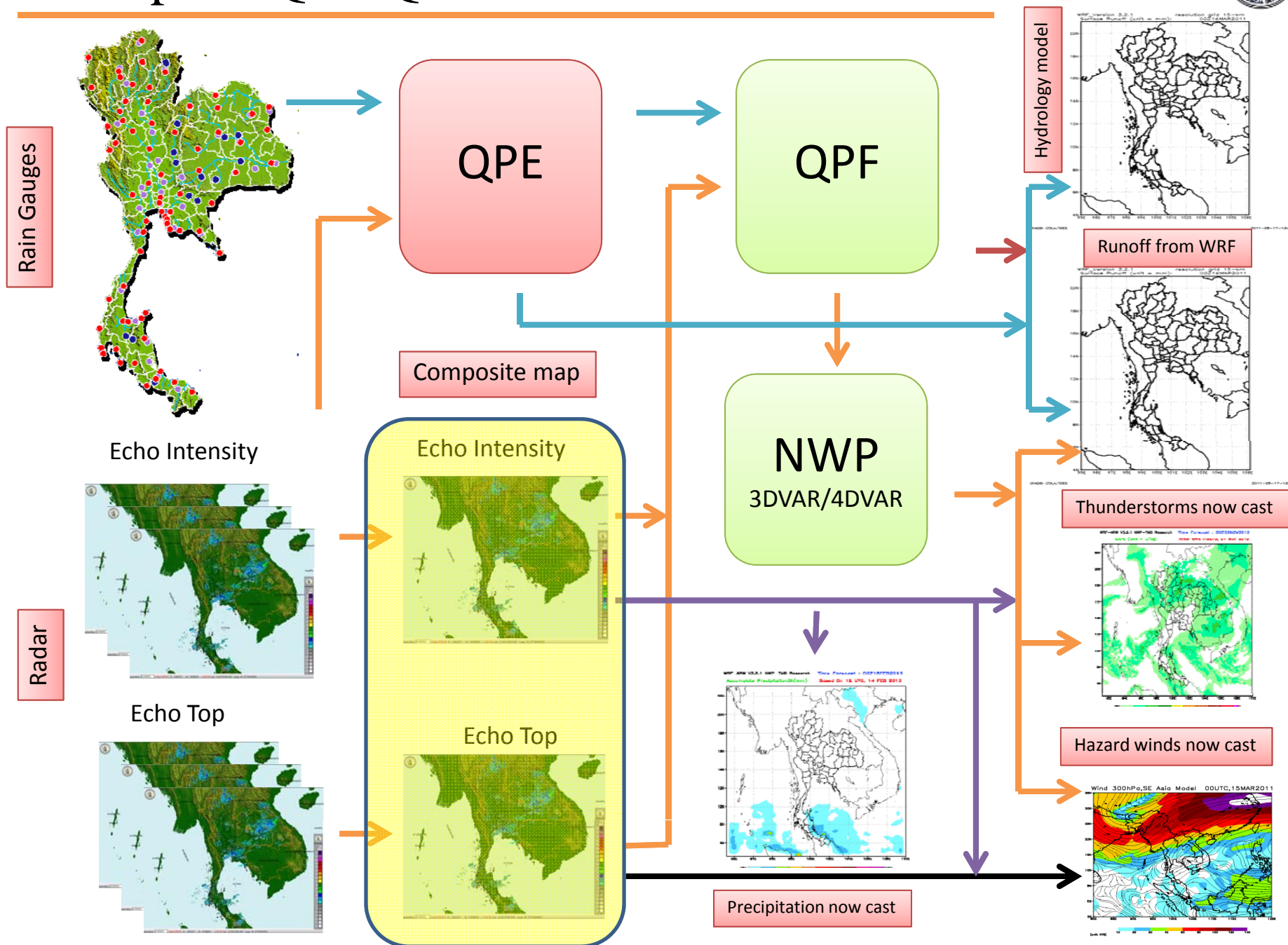
Radar Meteorology



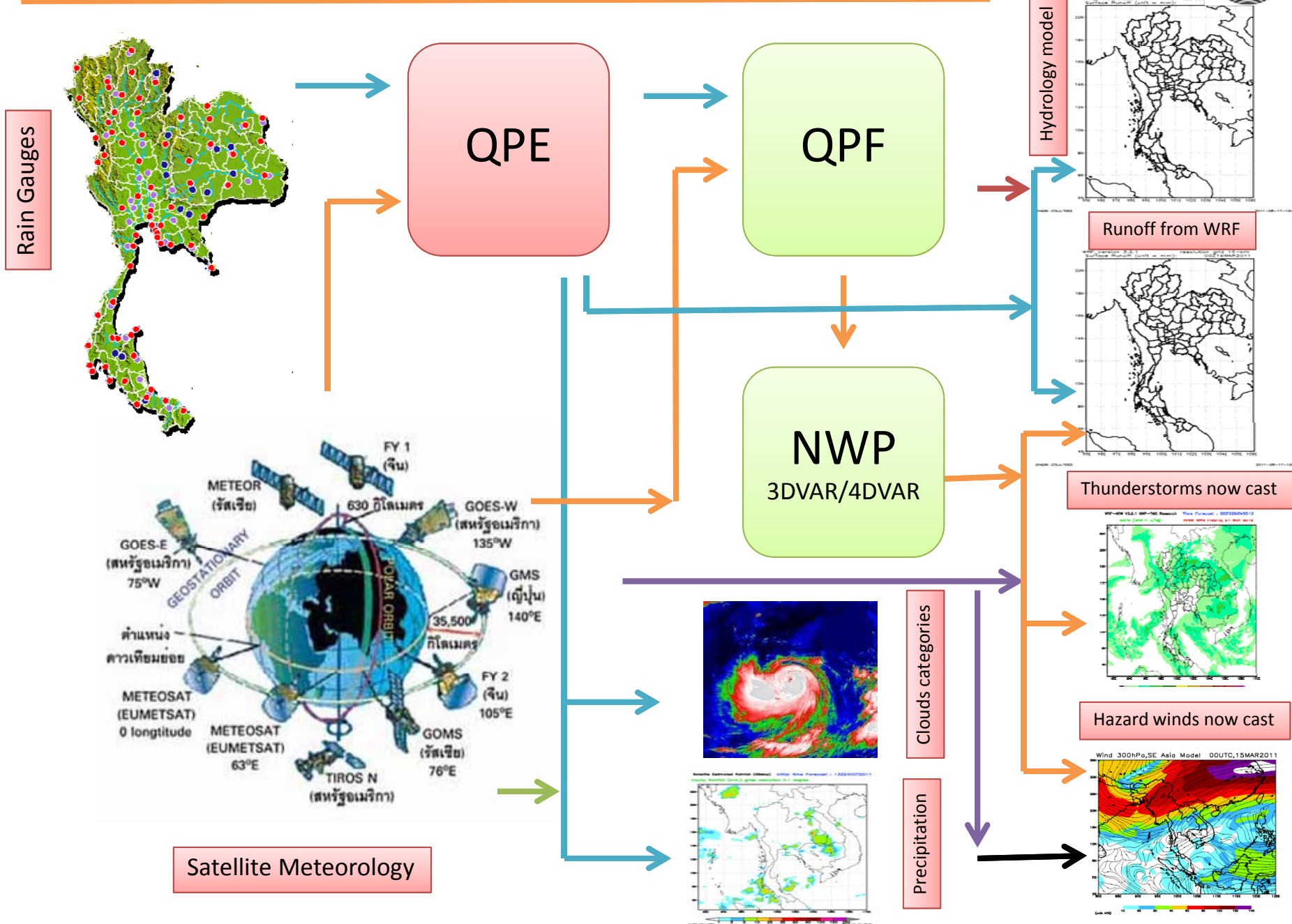
Future work



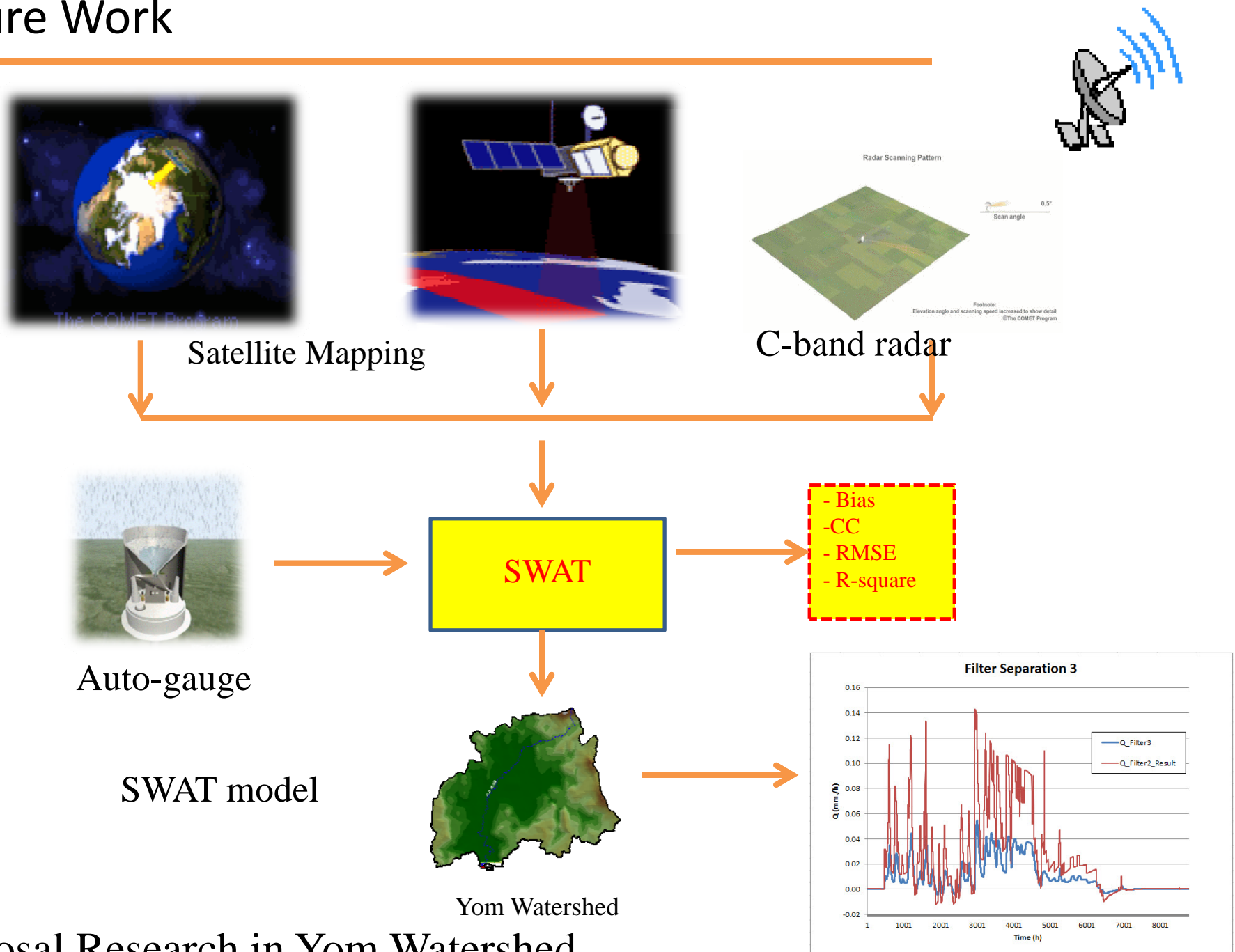
Conceptual QPE/QPF of Radar



Conceptual QPE/QPF of Satellite



Future Work



Proposal Research in Yom Watershed

Acknowledgement

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