The analysis of typhoon parameters by using AMSU/AMSRE data

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Outline

- The mission of MSC/CWB
- Satellite Data
- The analysis of typhoon parameters by using AMSU data
- Utilization of AMSR-E for precipitation
- Future plan

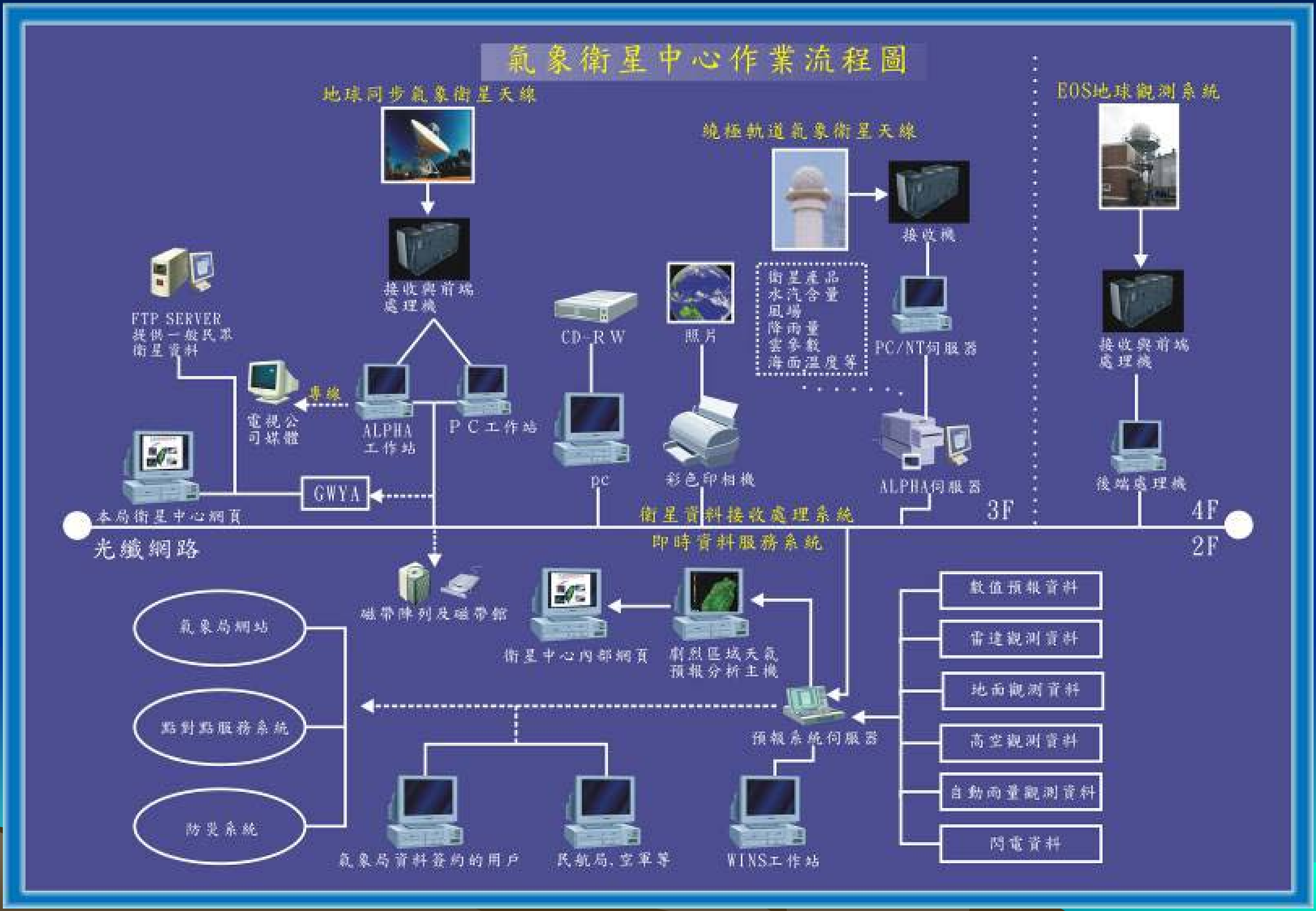
The mission of MSC/CWB

- 1. Receiving Geostationary and Orbital Meteorological Satellite data
- 2. Supporting satellite info. and images for weather analysis
- 3.Support fishing, agriculture, flooding announcement system parameters, air pollution etc.
- 4.Studying satellite initial data for NWP

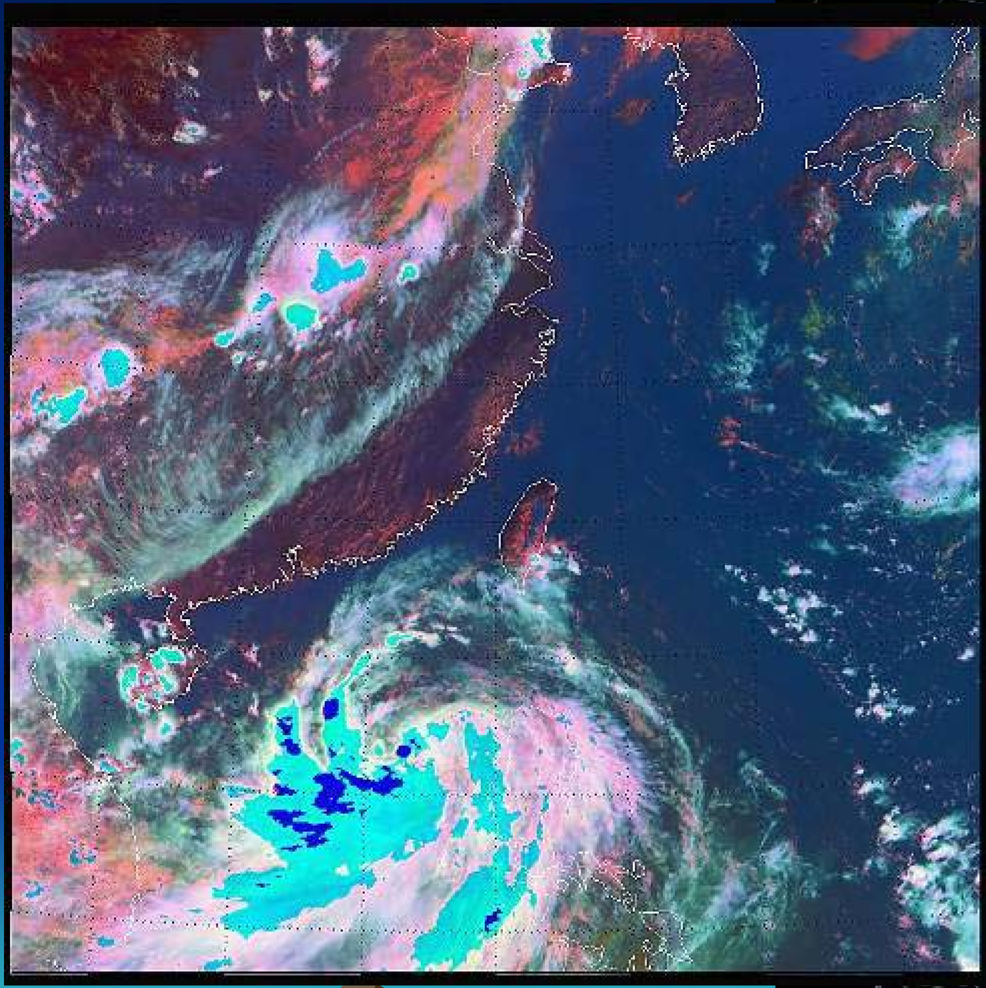
Organization of MSC

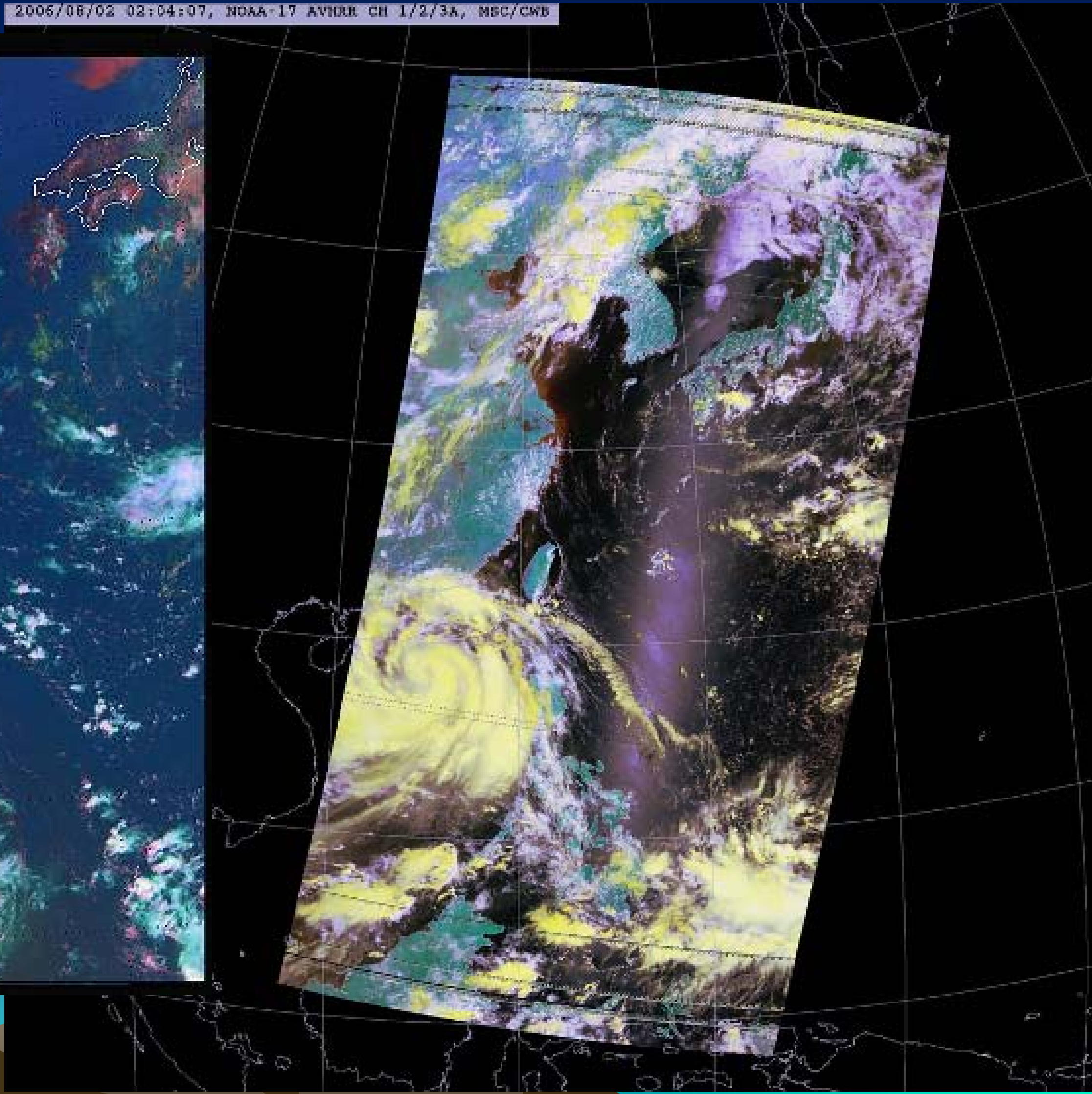
- DIRECTOR
  1 Director, 2 deputy directors,
    - 3 Technical Specialists
- 7 sections   52 staff
  - Receiving & Processing section
  - System Engineering
  - Systems Control
  - Analysis & Interpretation
  - Forecast Systems
  - Technical Development
  - Data Supply

Satellites Data Flowchart

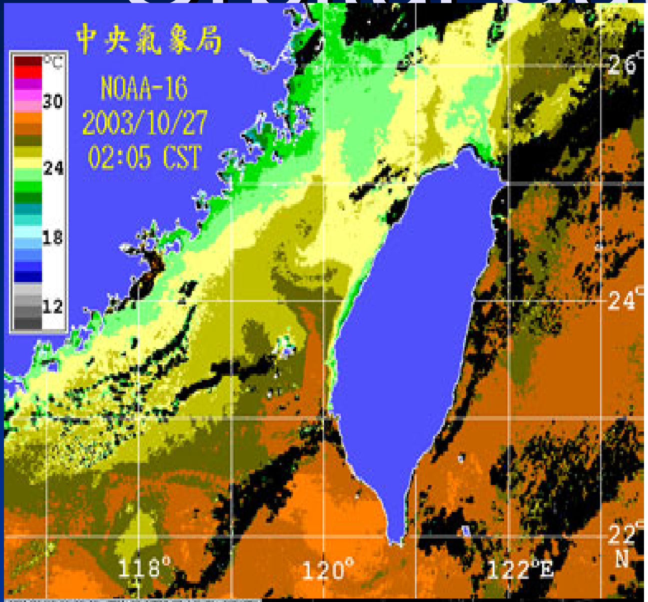


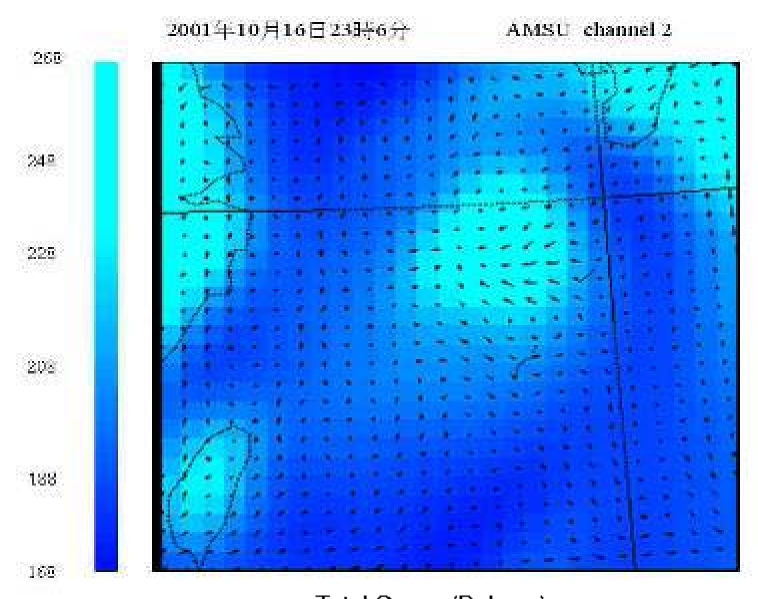
Satellite Data

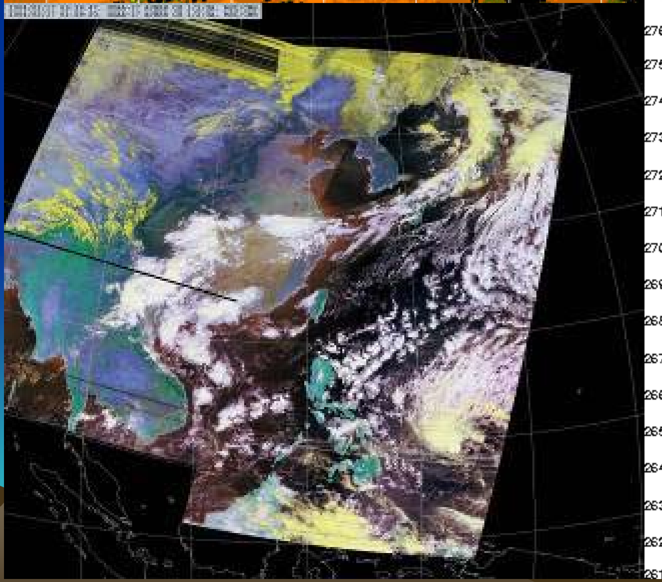


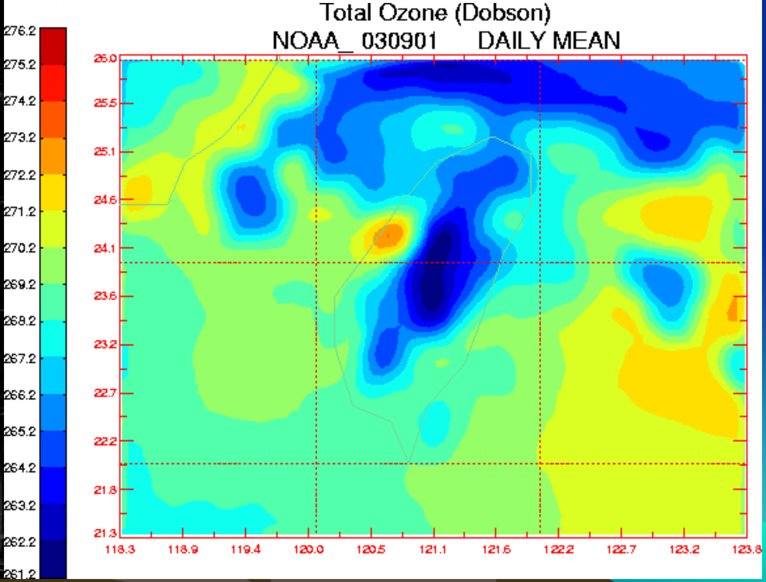


Orbital Satellite Products

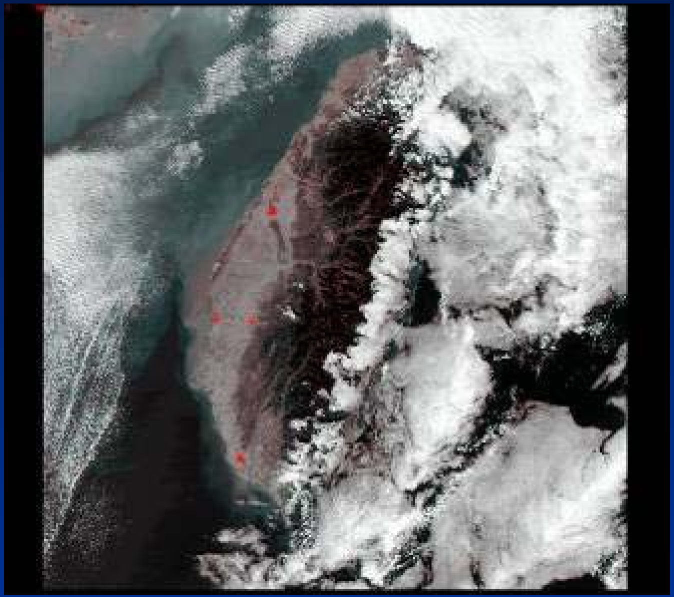


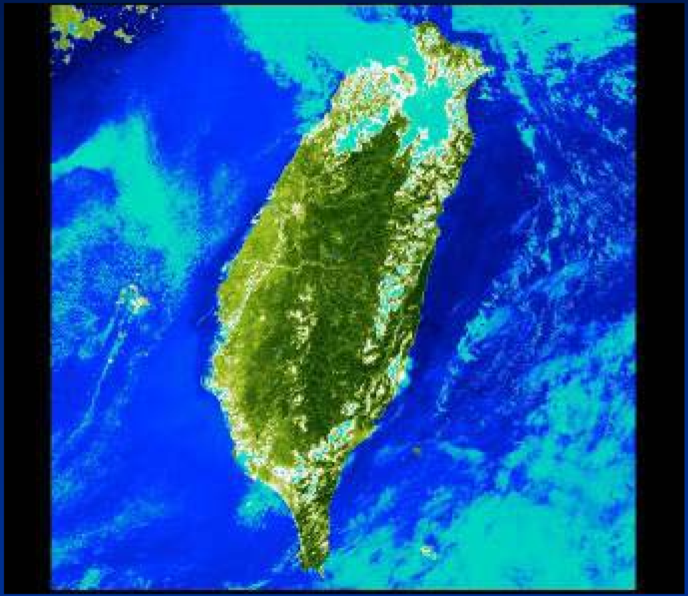


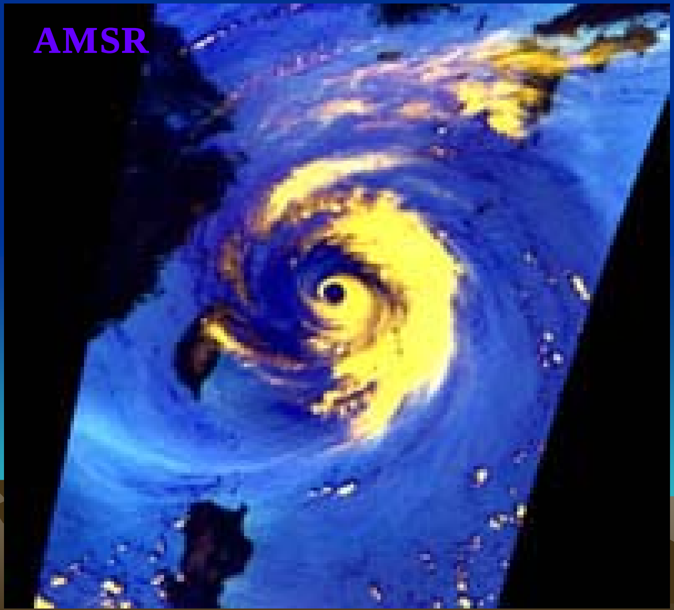




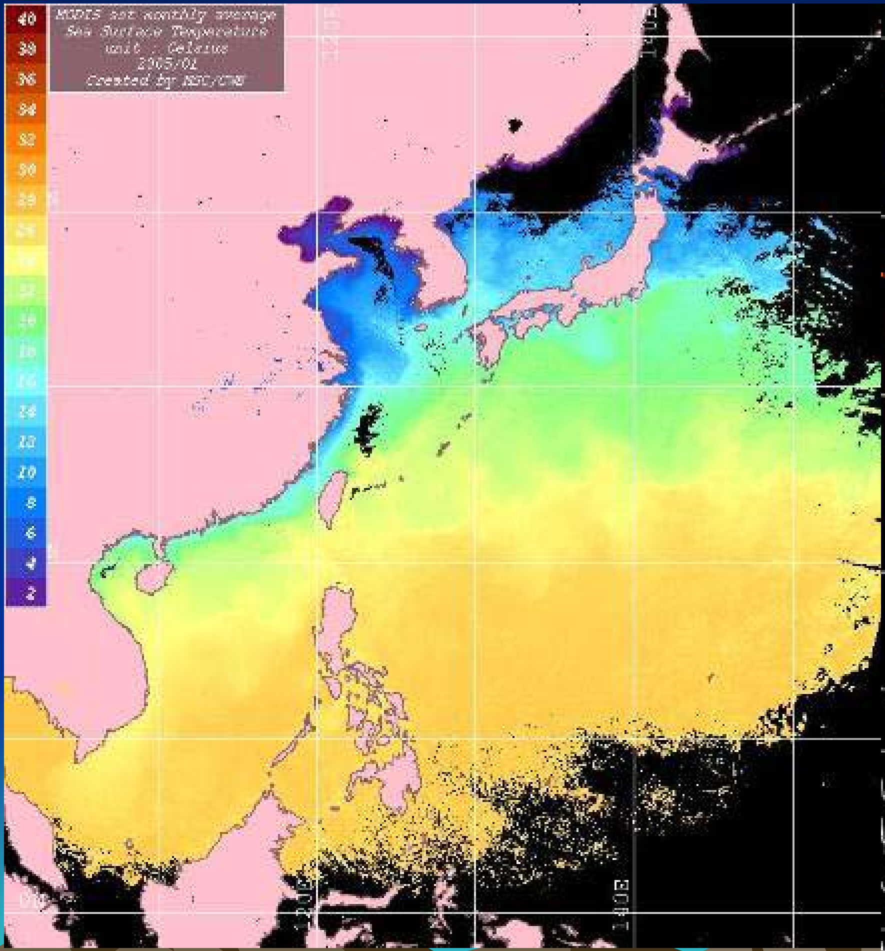
Products of EOS

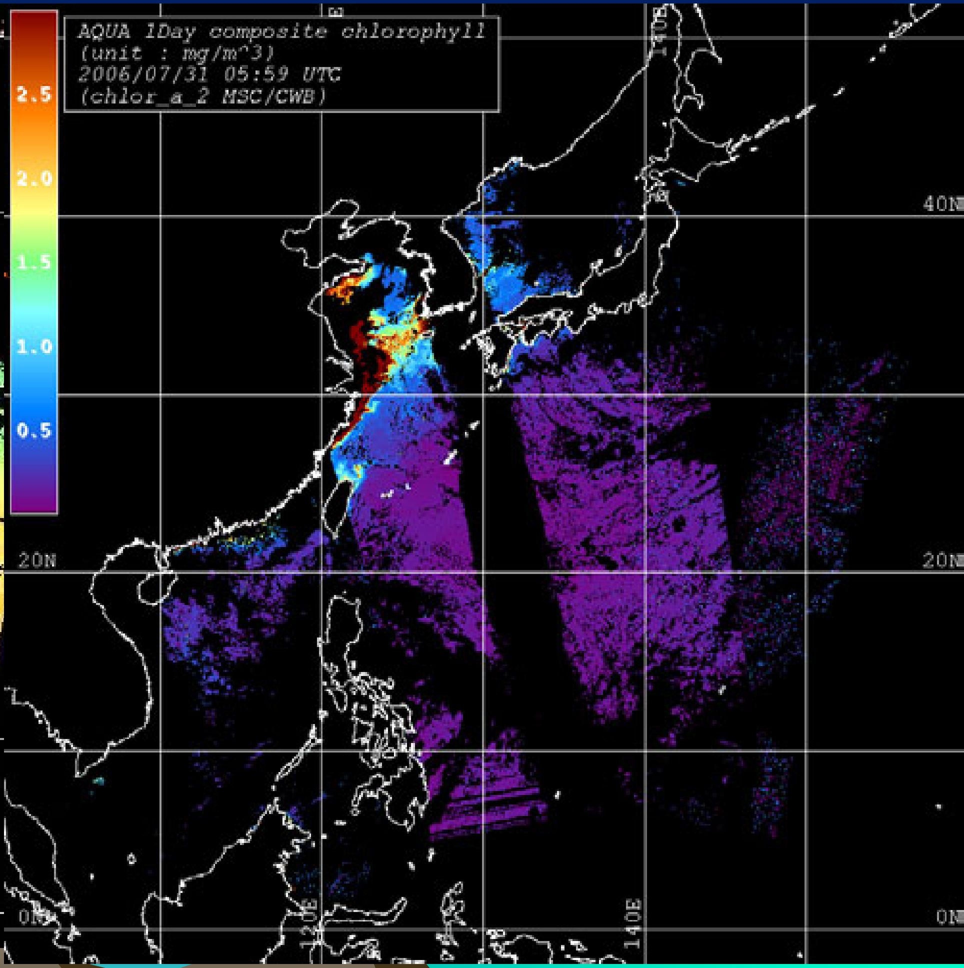




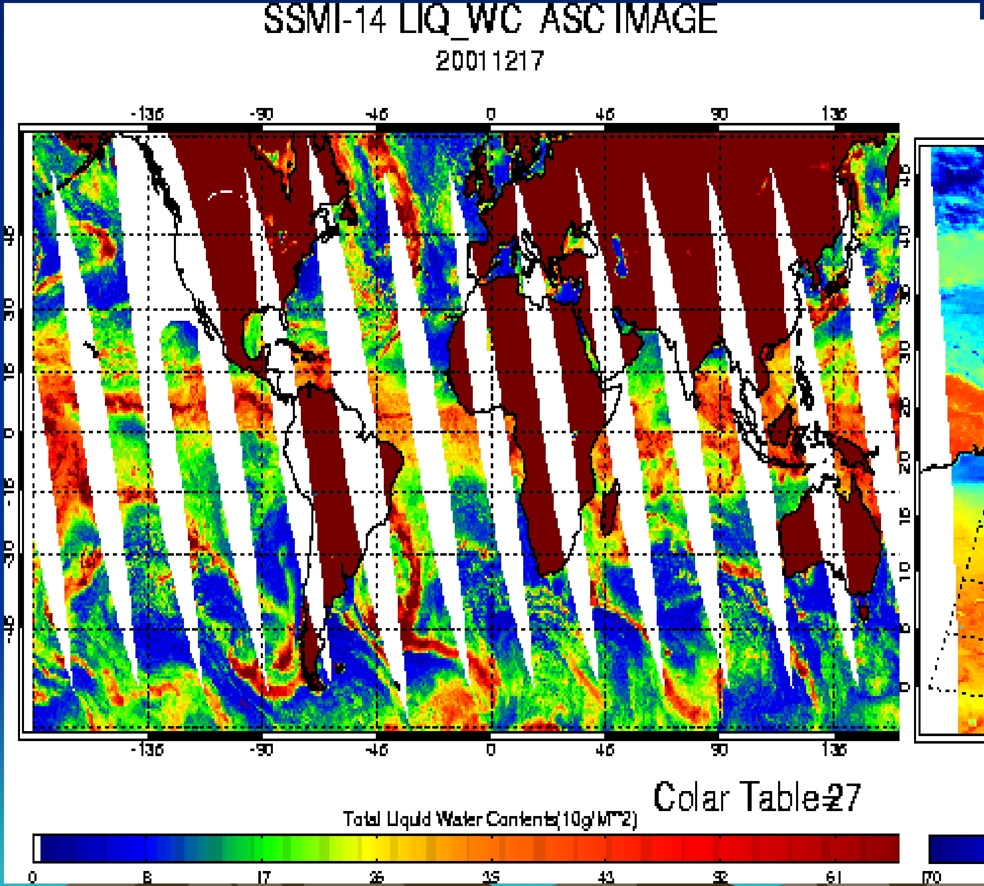


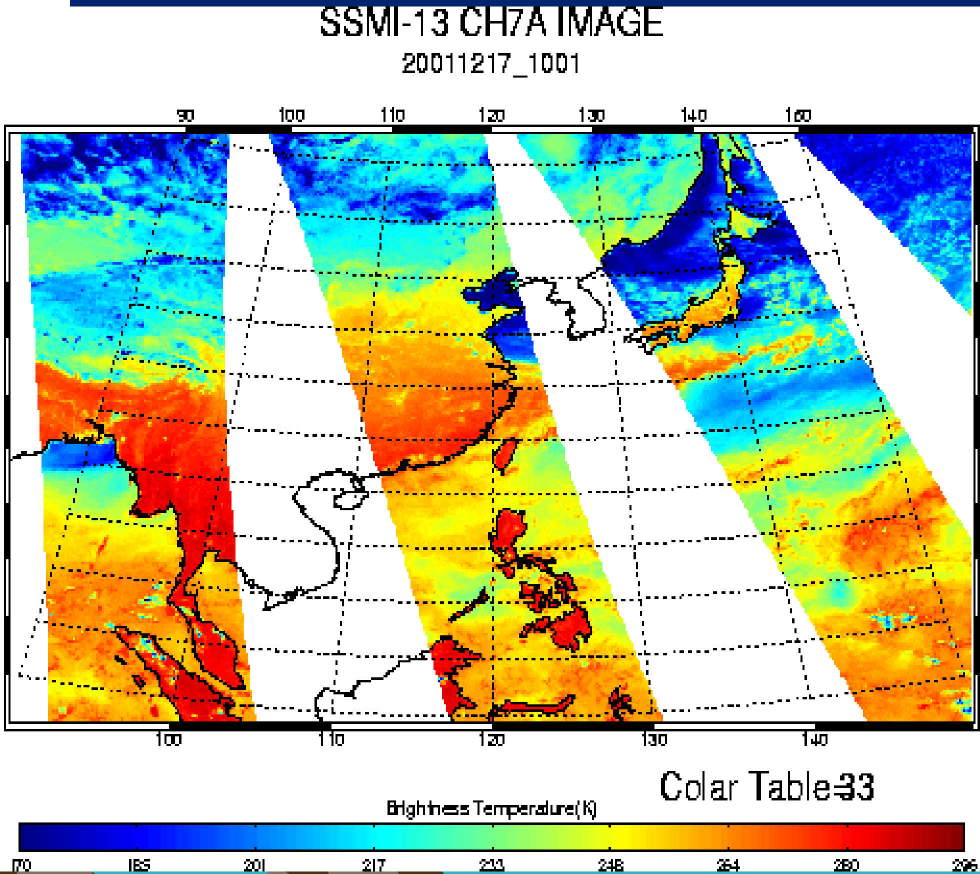
SST & Ocean Color from MODIS



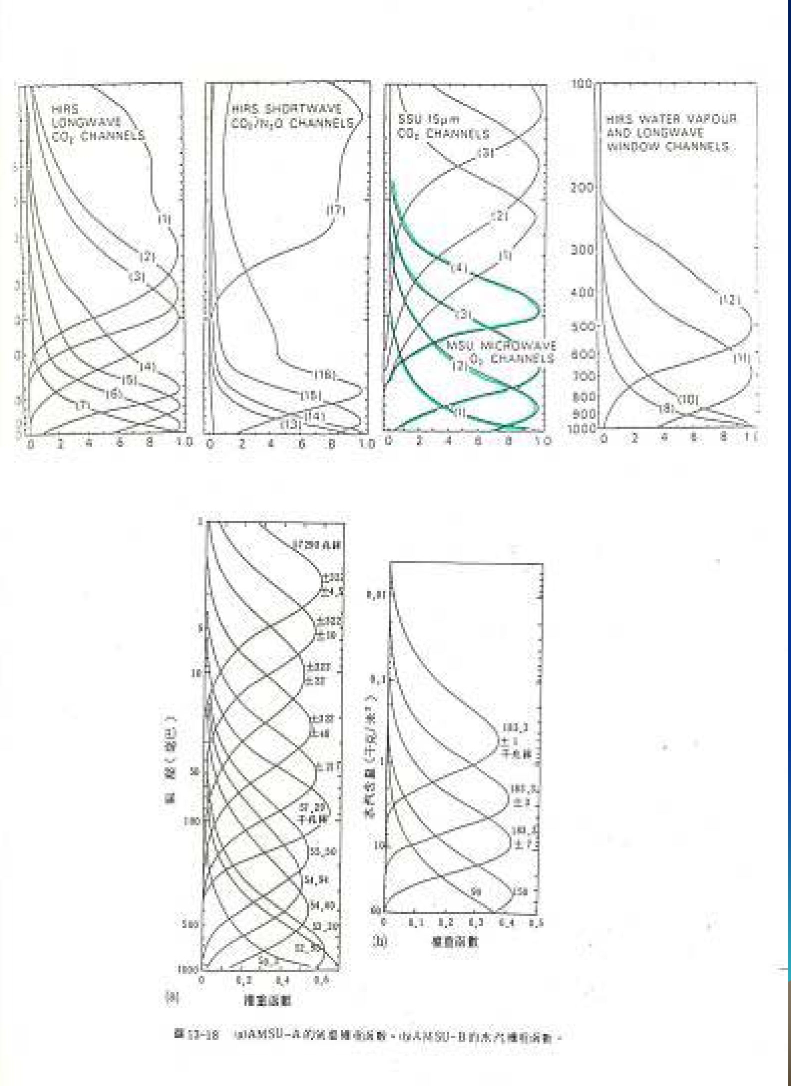


SSM/I


SSMI-14 LIQ_WC ASC IMAGE
20011217
Colar Table=27
Total Liquid Water Contents(10g/M**2)


SSMI-13 CH7A IMAGE
20011217_1001
Colar Table=33
Brightness Temperature(K)

The analysis of typhoon arameters by using AMSU data



1D-VAR

- Merit: May use original observed data
- Initial data: 12 Hrs forecasted from regional model of CWB
- Error covariance: collected more than 30,000 data sets from analysis field and forecast field. 3~4 day before target data
- Area: 2N~47N/ 94E~150E

Temperature Retrieval

$$T(p) = C_o(p,\theta_s) + \sum_{i=1}^{n} C_i(p,\theta_s) T_b(\nu_i,\theta_s)$$

1)No-Limb correction
2)Using channel 6-11, channel 3-5 are excluded. Avoid scattering by heavy rain and ice
3)data: June-July 2005
4)Statistical established the coefficients for each angle

Derivation of the height field

- Assumption:
  - Hydrostatic balance.
  - Geopotential height at 50hPa is uniform (Kidder et al. 2000)
- Make 2-Dimention temperature grid data as function of radium of typhoon and pressure
- 50 hPa height is evaluated from environmental data (outside typhoon)
- Integrate the retrieved temperature from 50 hPa downward to obtain geopotential height.

Rotational component of velocity

- Nonlinear balance equation

$$f\nabla^2\psi + 2(\psi_{xx}\psi_{yy} - \psi^2{}_{xy}) + \psi_x f_x + \psi_y f_y = \nabla^2\varphi$$

  - To obtain stream function (Zhu, 2002)
  - Reset the value of stream function as average of its neighboring point when ellipticity condition is violated
- By omega and continuity equation derived divergent wind. (Tarbell et al.1981)

Cloud Liquid Water

- Latent heat is related to precipitation

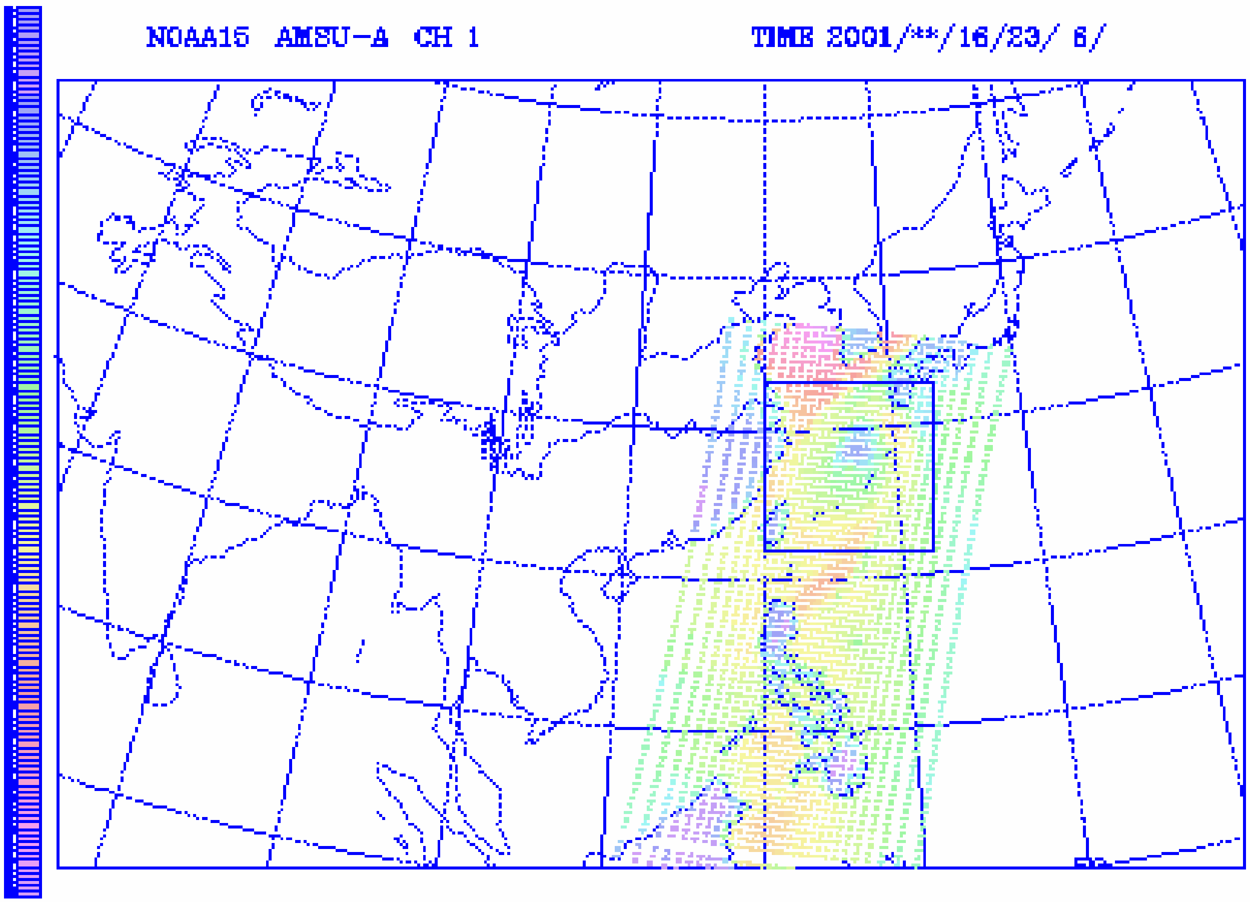
$$CLW = \cos\theta\{D_0 + D_1 \ln[T_s - T_B(\nu_1)] + D_2 \ln[T_s - T_B(\nu_2)]\}$$

$$R = 0.002(100CLW)^{1.7}$$

Assimilation & forecast system

- 3DVAR NWP model: nonhydrostatic MM5
- Input retrieved parameters into typhoon field
  - Not objectively determine the absolute sea level pressure, use the default setting for the observation error
  - Primary determined by 2 parameters, leads to underestimate of typhoon intensity
  - Leave the solution to this dilemma to future work

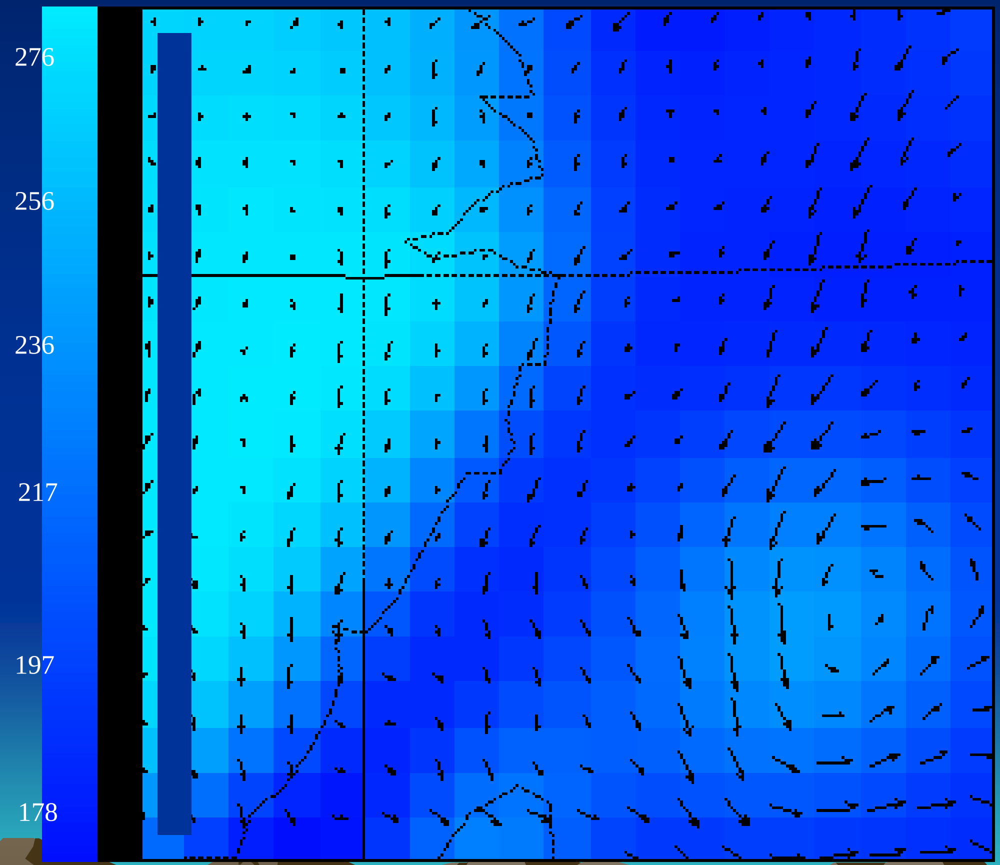
NOAA 15 AMSU-A CH1



500hPa wind for Lina 200116

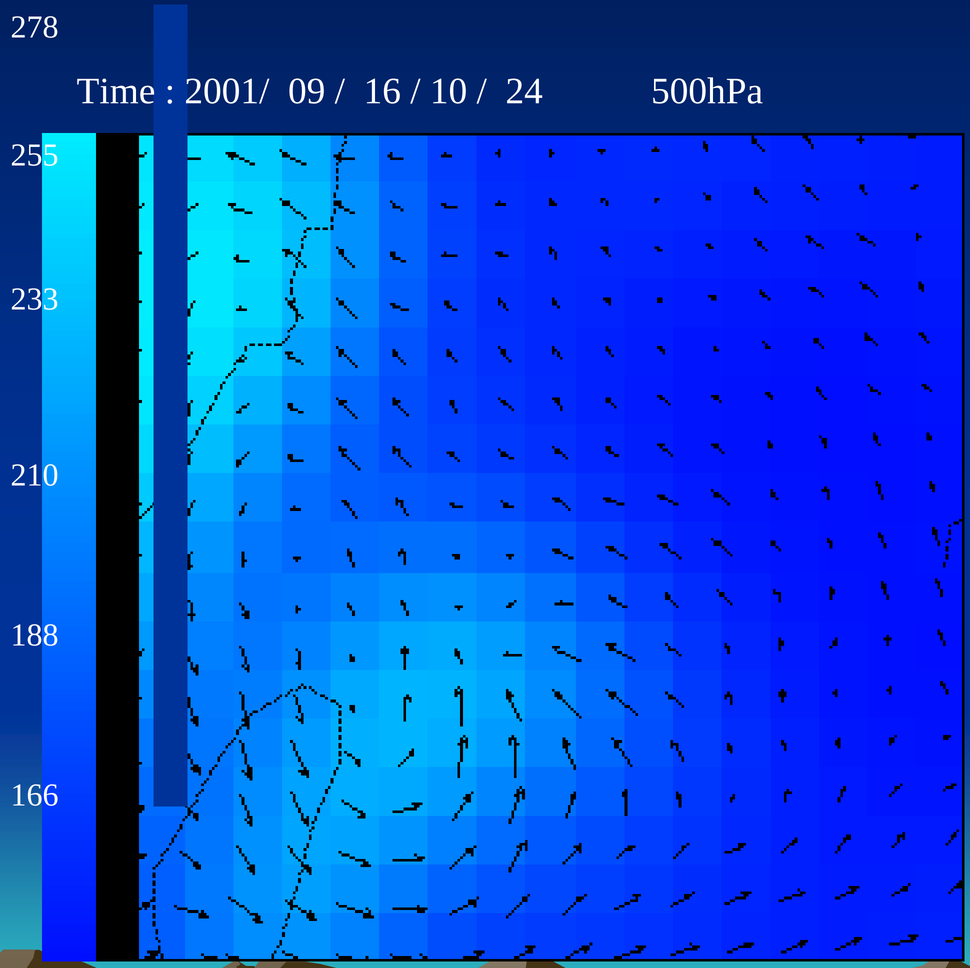
Time 2001 / 09 / 14 / 23 / 34 AMSU channel 2

5.8K Temperature Anomaly

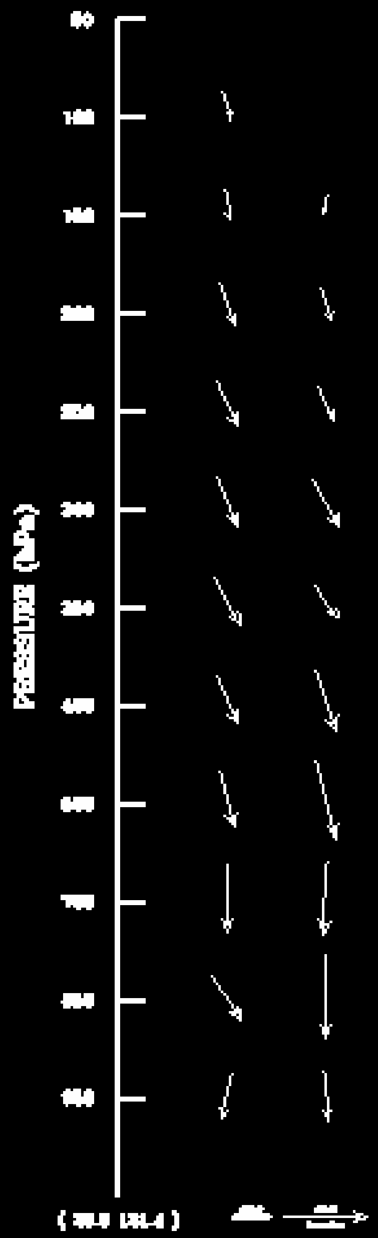


Max wind 27.3m/s
MSLP 987.8hPa

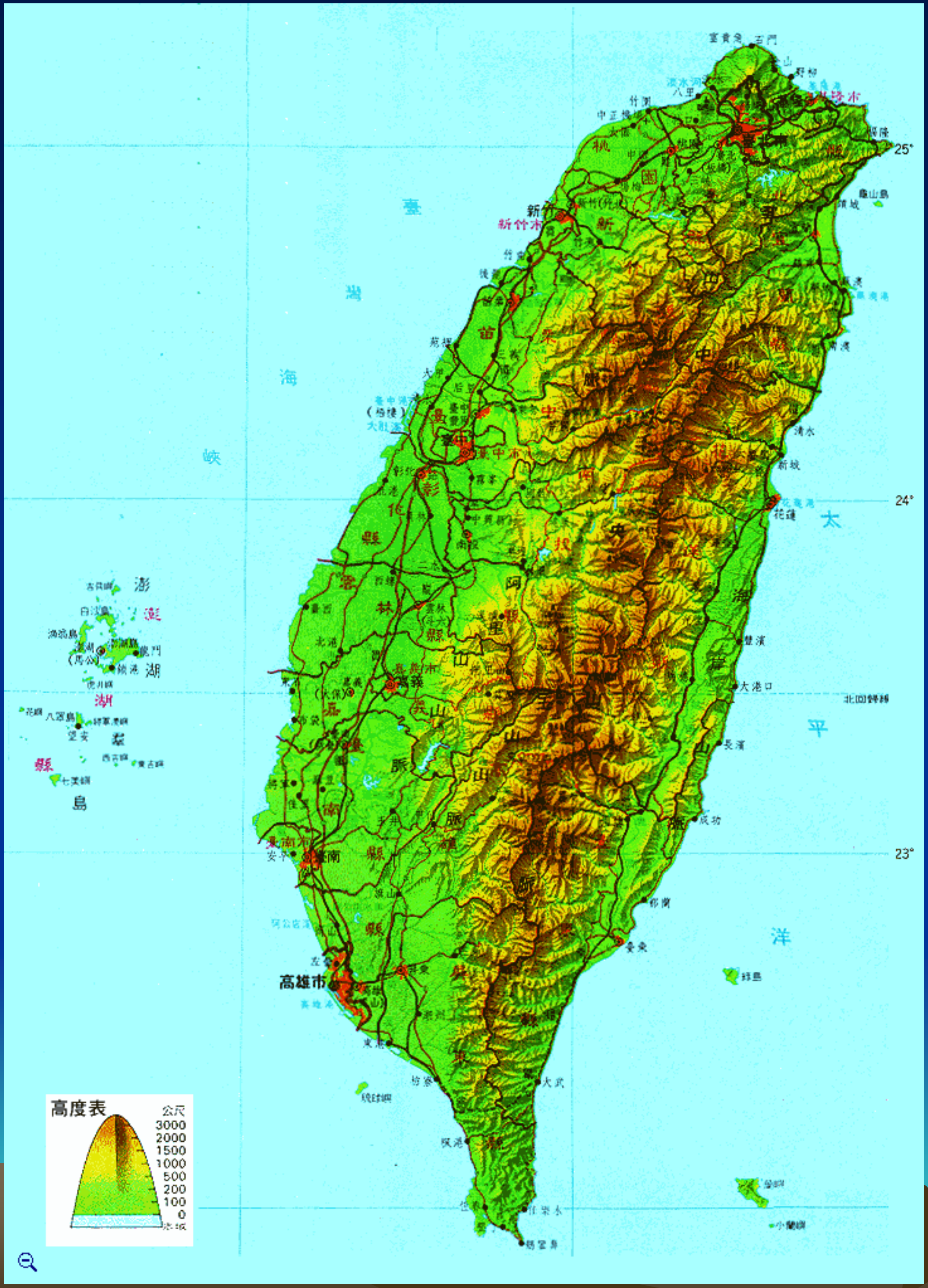
500hPa wind for Lina 200116



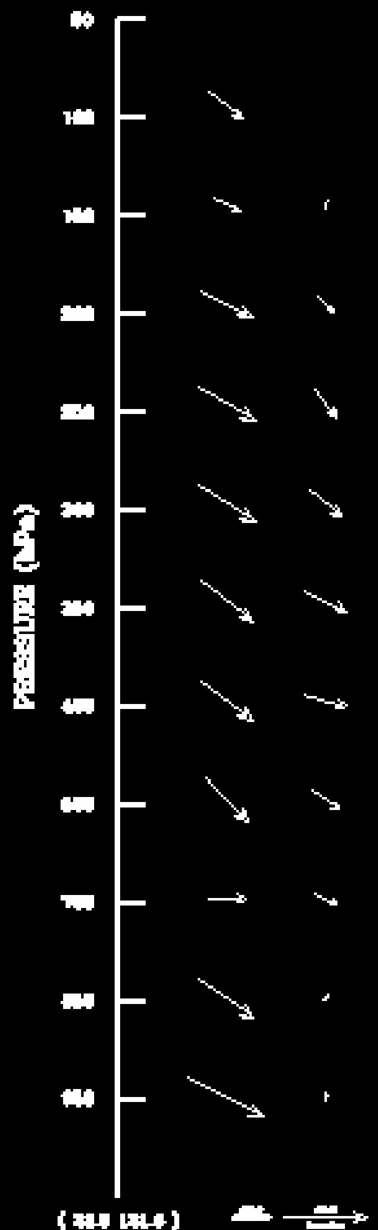
Estimated/observed



In Taipei

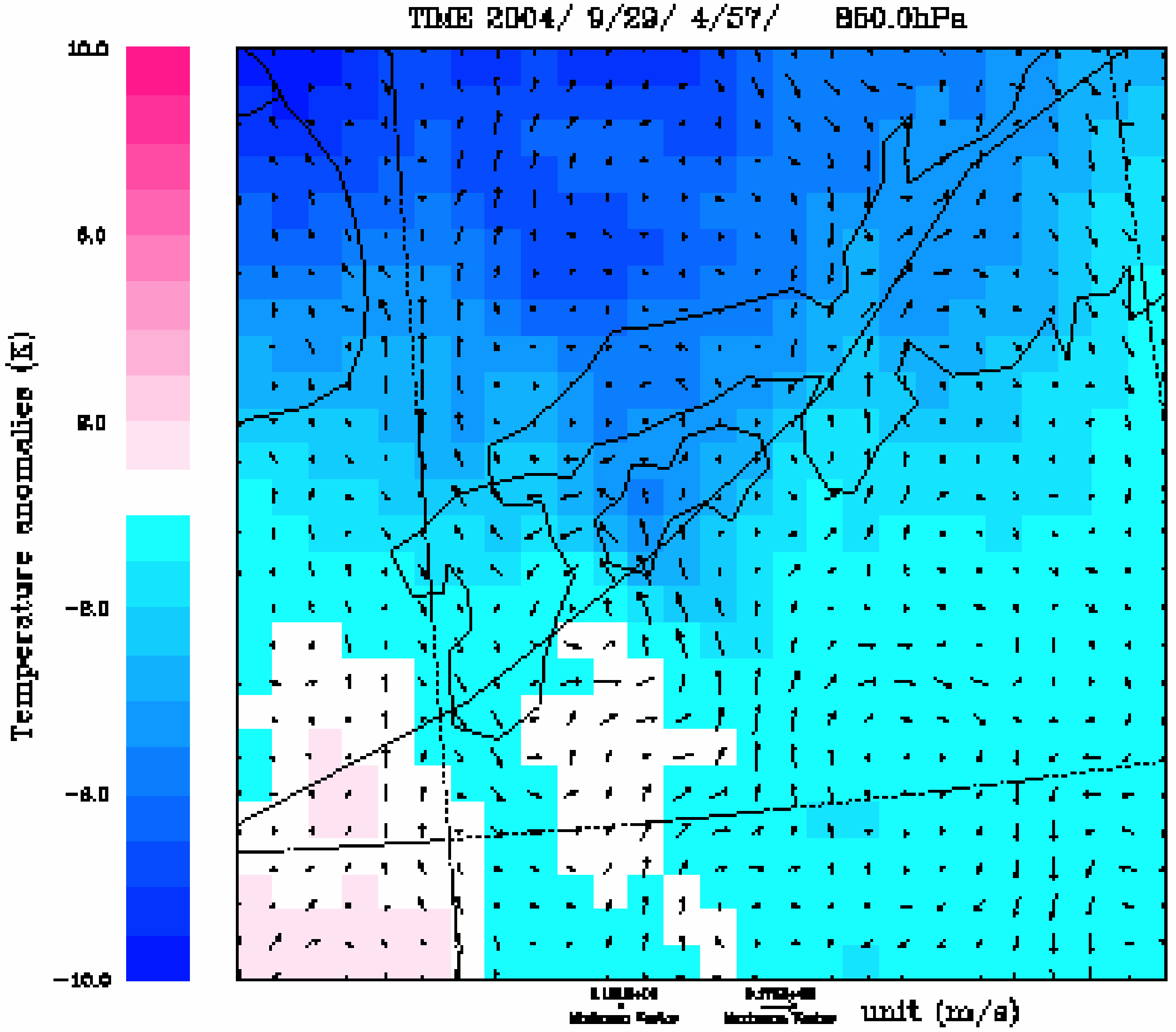

臺
灣
海
峽
太
平
洋
澎
湖
島
高雄市
25°
24°
23°
高度表
公尺
3000
2000
1500
1000
500
200
100
0

Estimated/observed

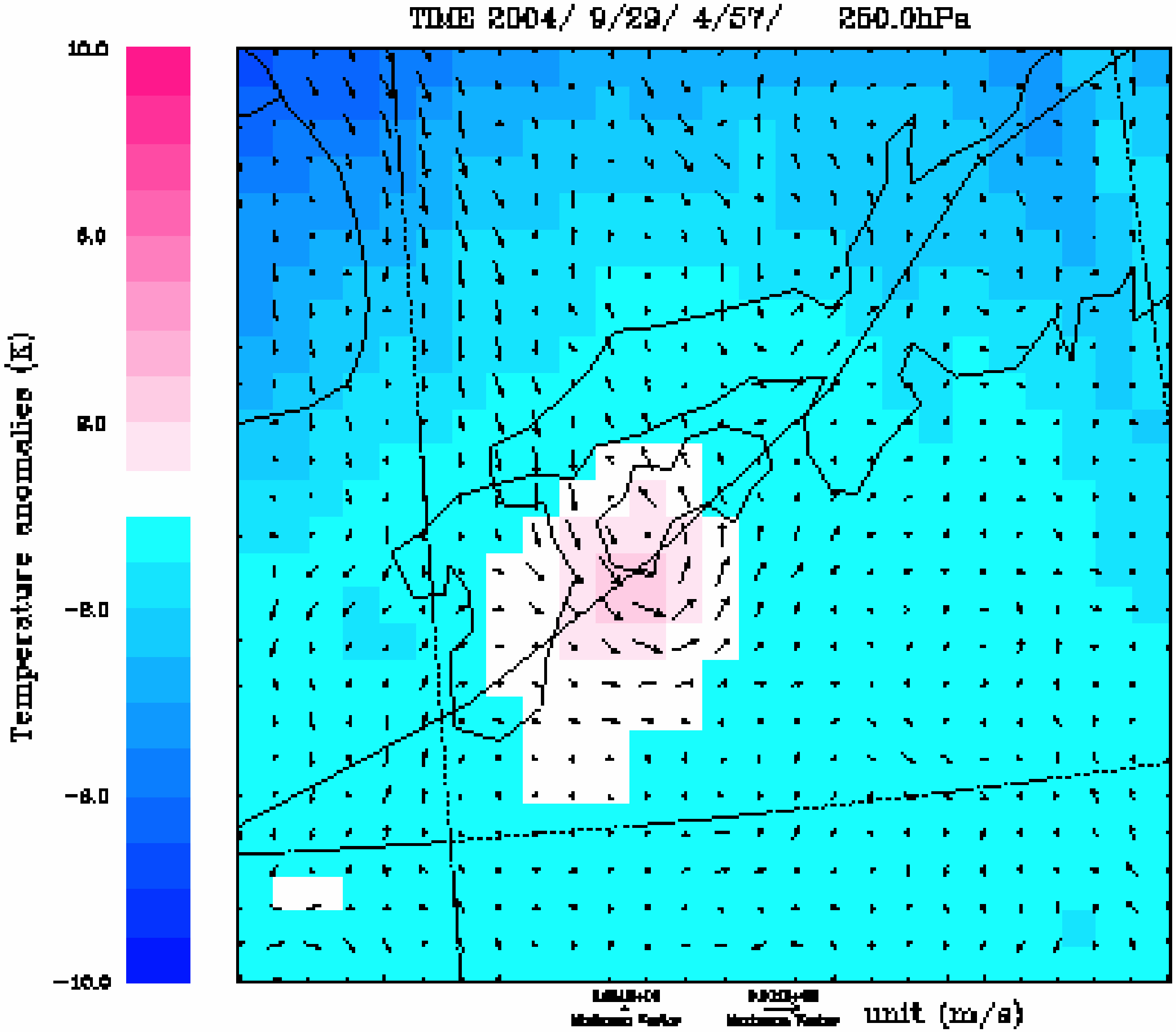


In HuaLain

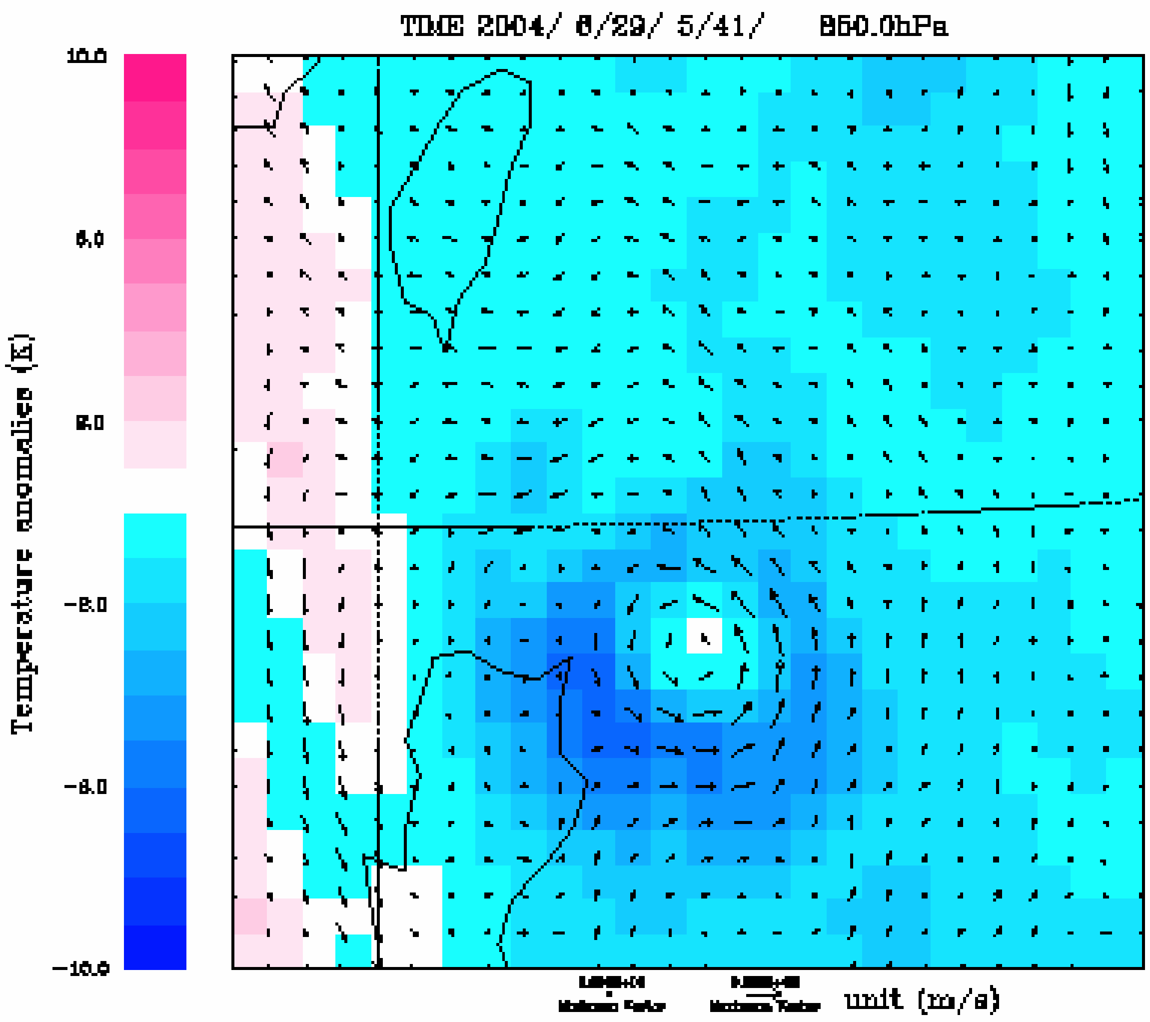
MEARI 200421 850hPa



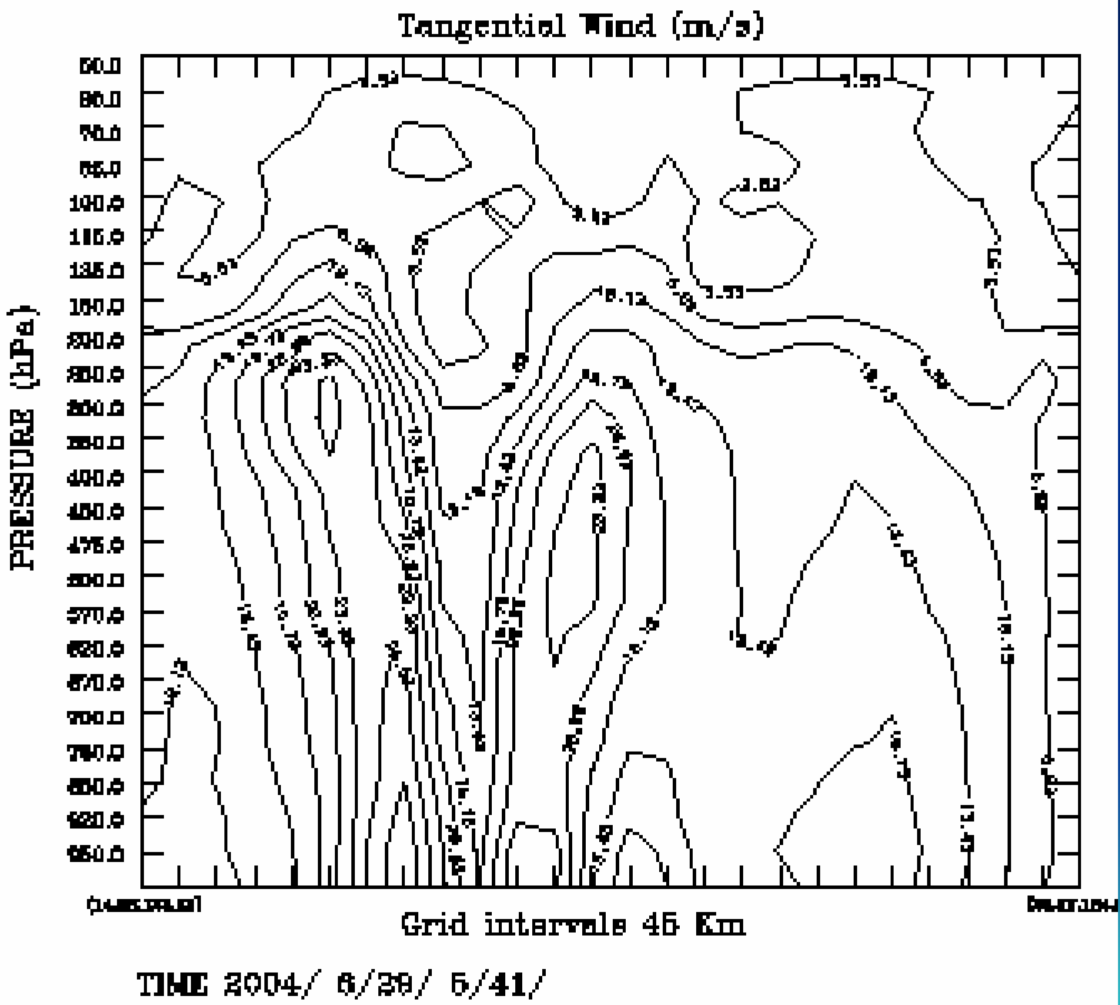
MEARI 200421 850hPa



MINDULLE 200407 850hPa



Vertical structure of Tangential wind

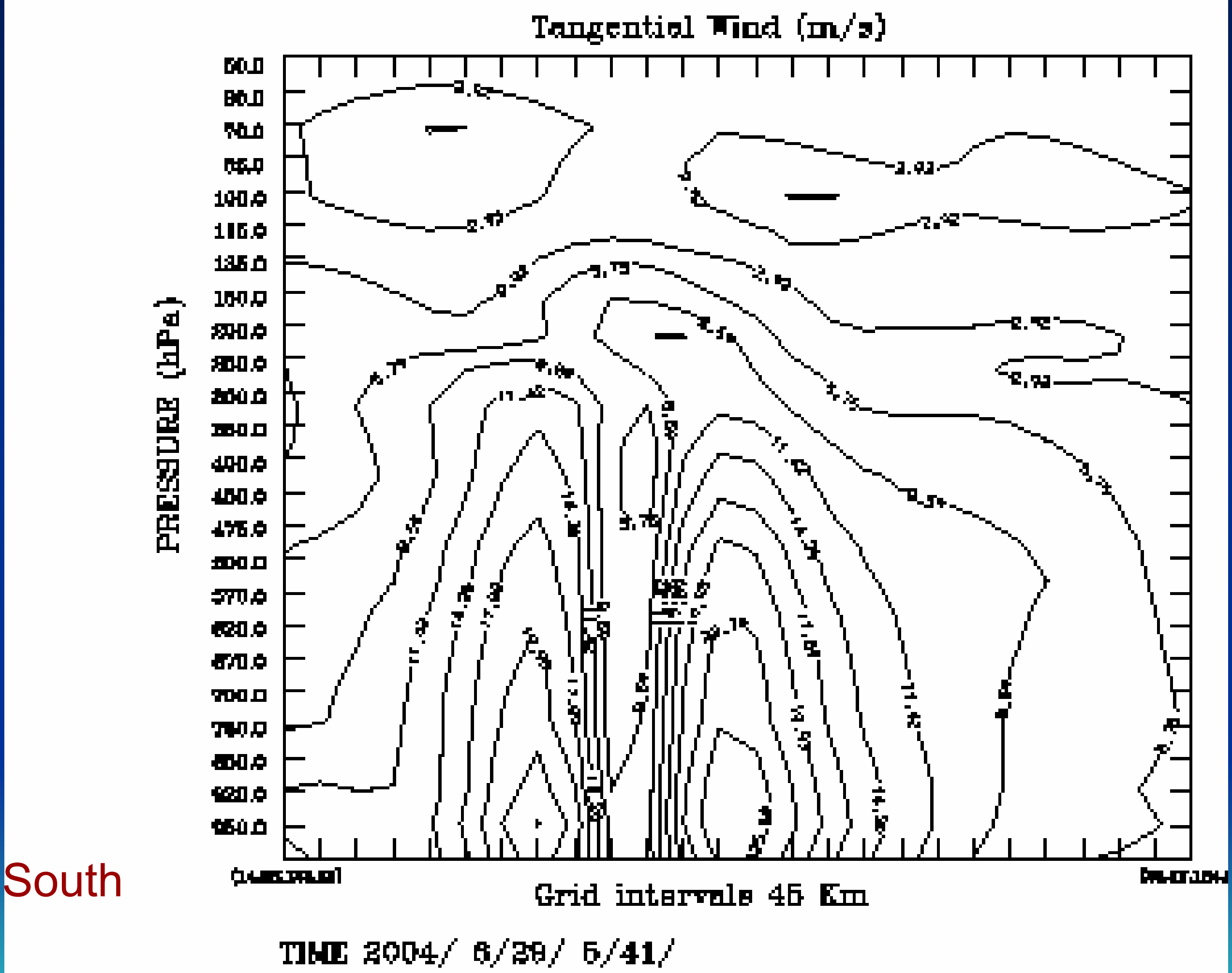


MINDULLE

South

North

Vertical wind structure from analysis field

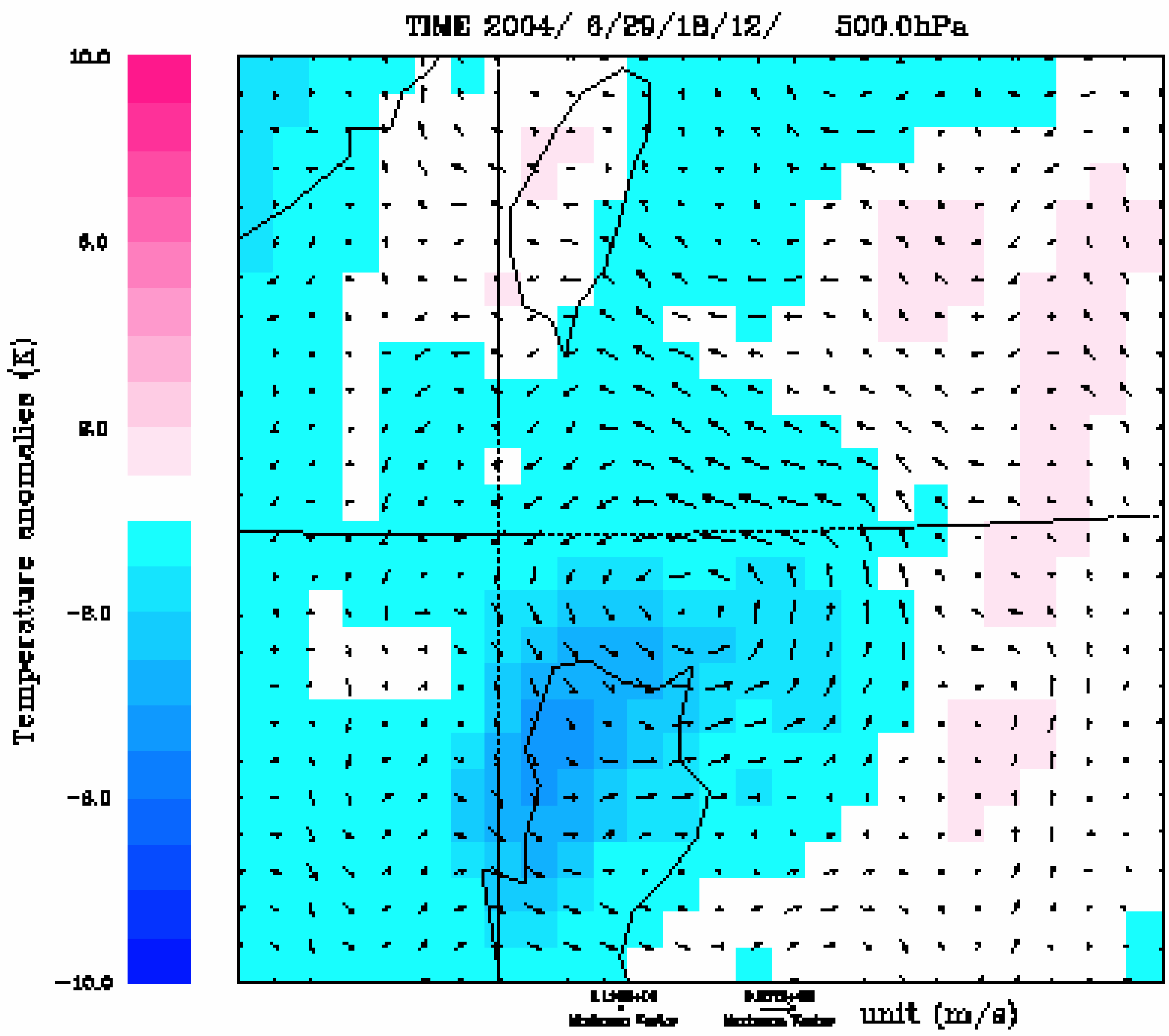


MINDULLE

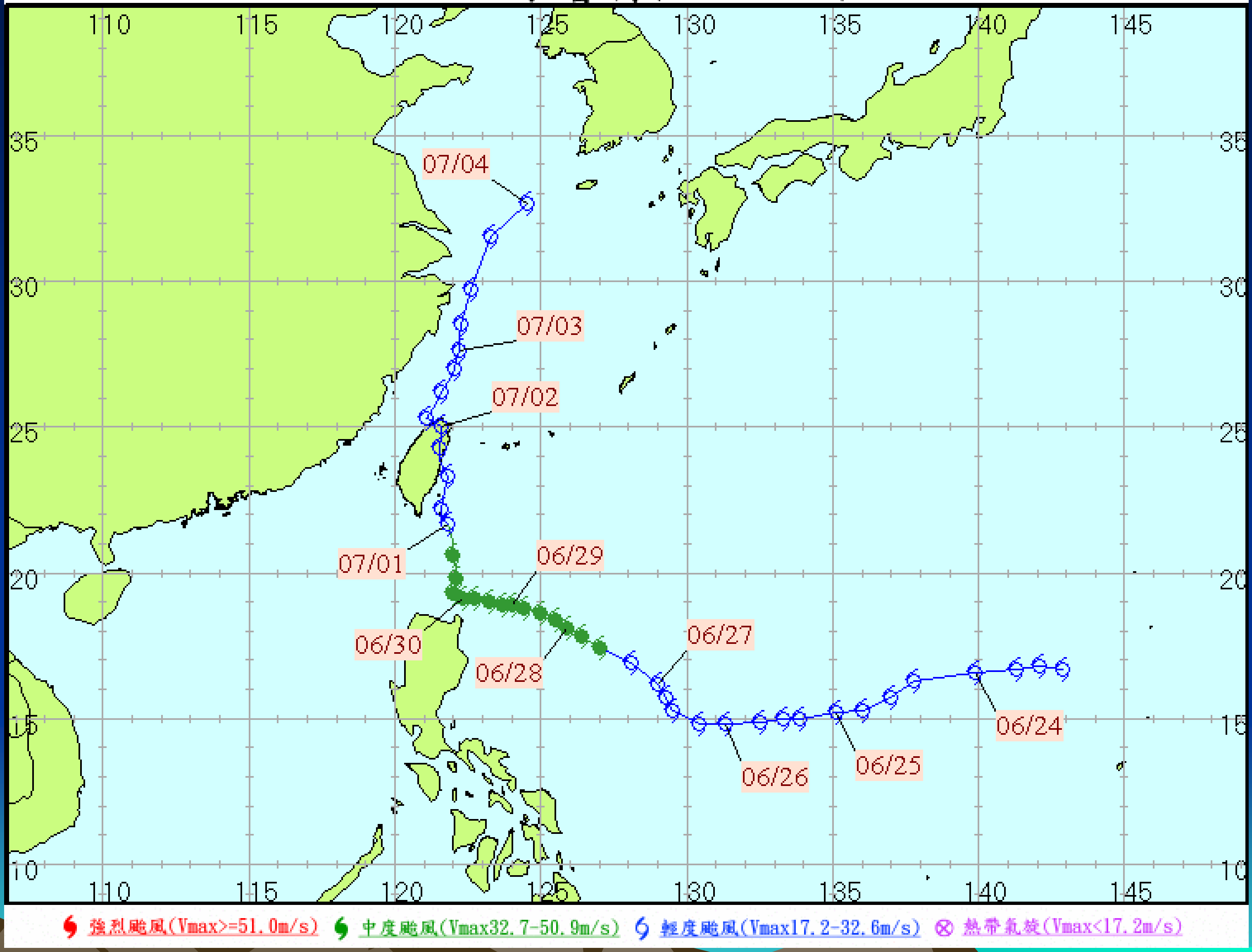
South

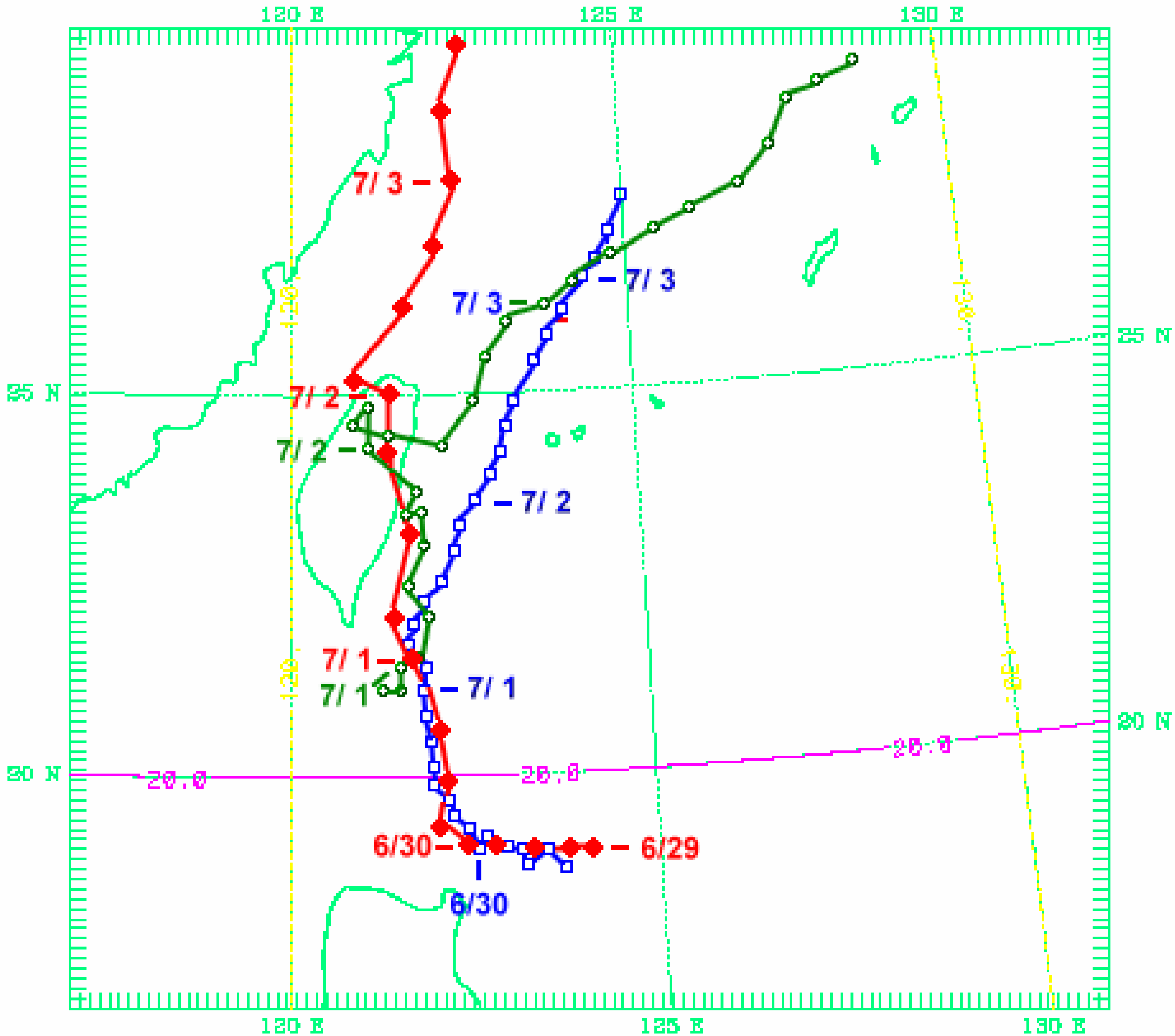
North

MINDULLE 200407 500hPa
12 Hours later

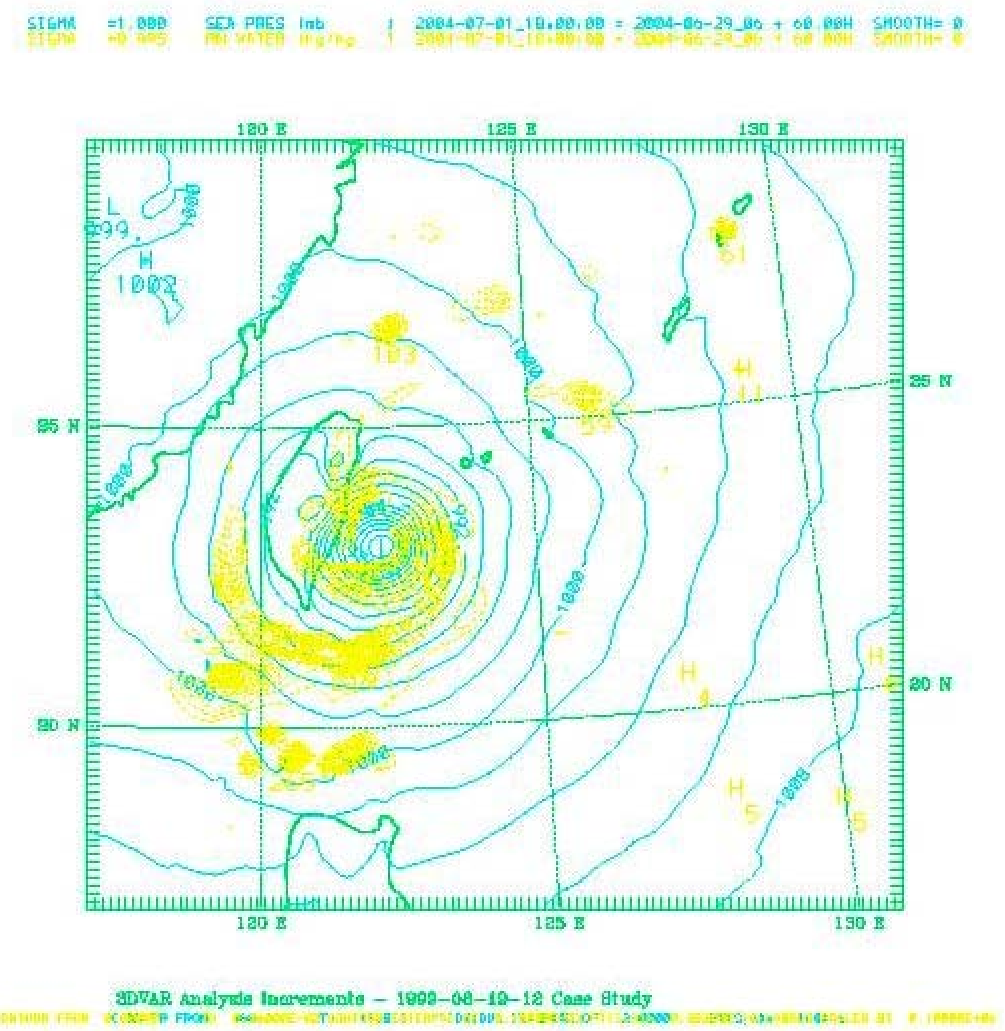


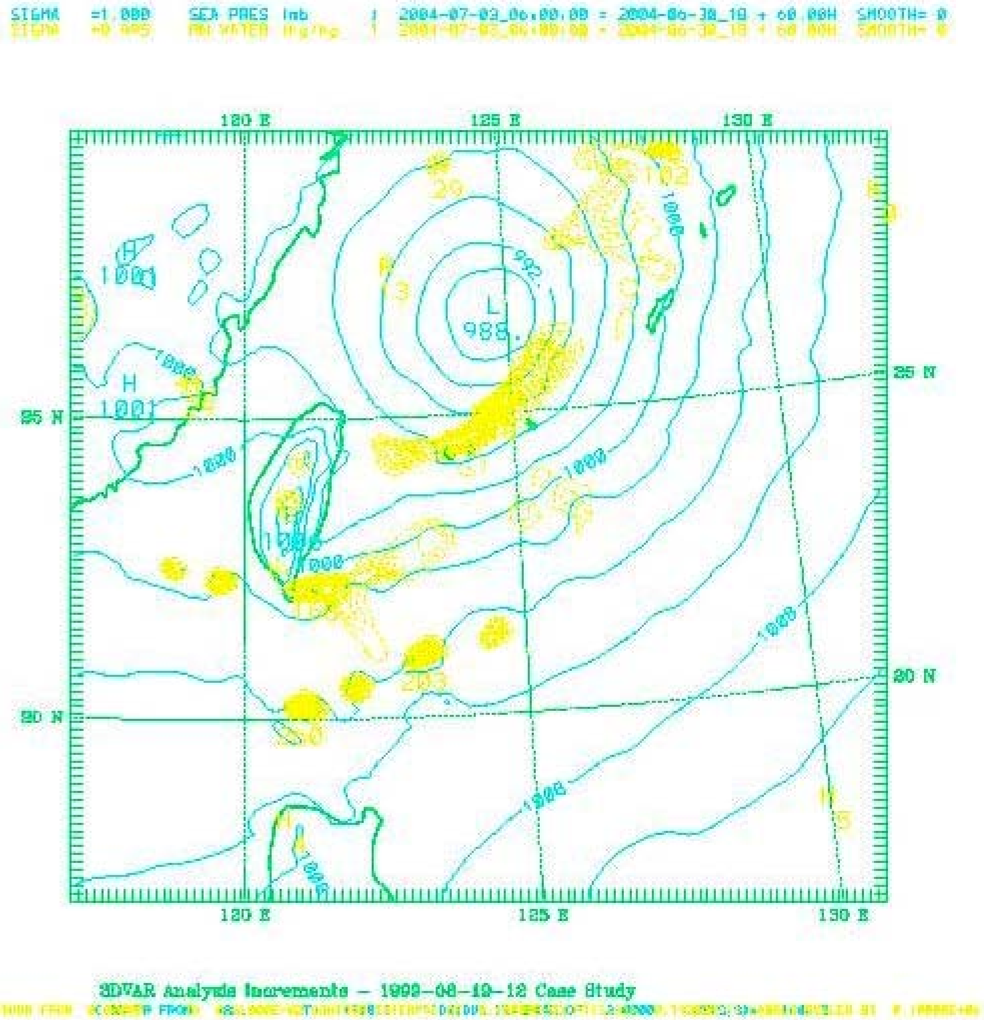
2004 敏督利(MINDULLE)





120 E
125 E
130 E
25 N
20 N
7/ 3
7/ 3
7/ 3
7/ 2
7/ 2
7/ 2
7/ 1
7/ 1
7/ 1
6/30
6/29
6/30
20.0


SIGMA =1.000 SEA PRES (mb) | 2004-07-01_18:00:00 = 2004-06-29_06 + 60.00H SMOOTH= 0
120 E
125 E
130 E
25 N
20 N
3DVAR Analysis Increments — 1999-08-19-12 Case Study


SIGMA =1.000 SEA PRES mb | 2004-07-03_06:00:00 = 2004-06-30_18 + 60.00H SMOOTH= 0
120 E
125 E
130 E
25 N
20 N
H
1001
L
988.
992
1000
3DVAR Analysis Increments – 1999-08-19-12 Case Study

Conclusion and future work

- Three dimensional Typhoon temperature and wind fields can be estimated by AMSU data. And typhoon various structure at different environments could be depicted.
- The typhoon fields driven from AMSU could provide an initial condition for NWP forecast. In estimating process assumed 50 hPa height is constant and integrated from top to lower levels to calculate height at each levels seem reasonable.
- Improving the forecast of typhoon track
- *Do not recover the full intensity of typhoon*
- *More accurate temperature estimate (data or technique), such as combine AMSU with AIRS, dropwindsounde*

Acknowledgements

- Professor Da-Lin Zhang of University of Maryland for help and instruction
- Dr. Tong Zhu and Dr. Fuzhong Weng for discussion
- Dr. N. grody for precipitation rate
- Dr. Tsan Mo of NOAA NESDIS for useful information and advices

Status of using NASA/DAAC version for precipitation of Typhoon monitored by AMSRE

- Introduction
- AMSR-E instrument
- Algorithms of rainfall retrieval
- Analysis for typhoon
- Conclusion

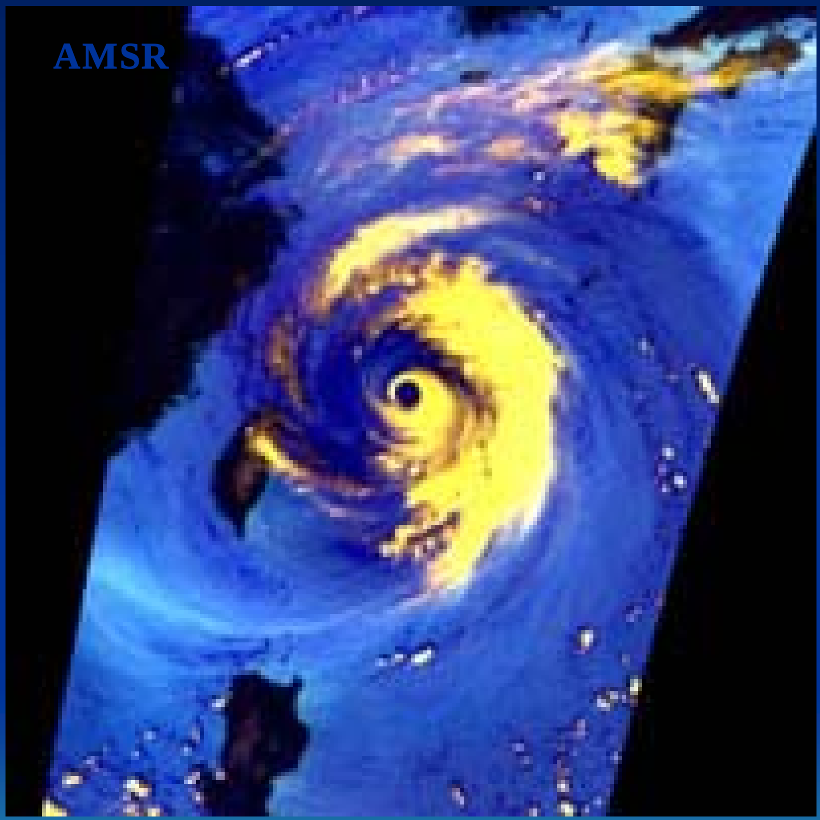
introduction

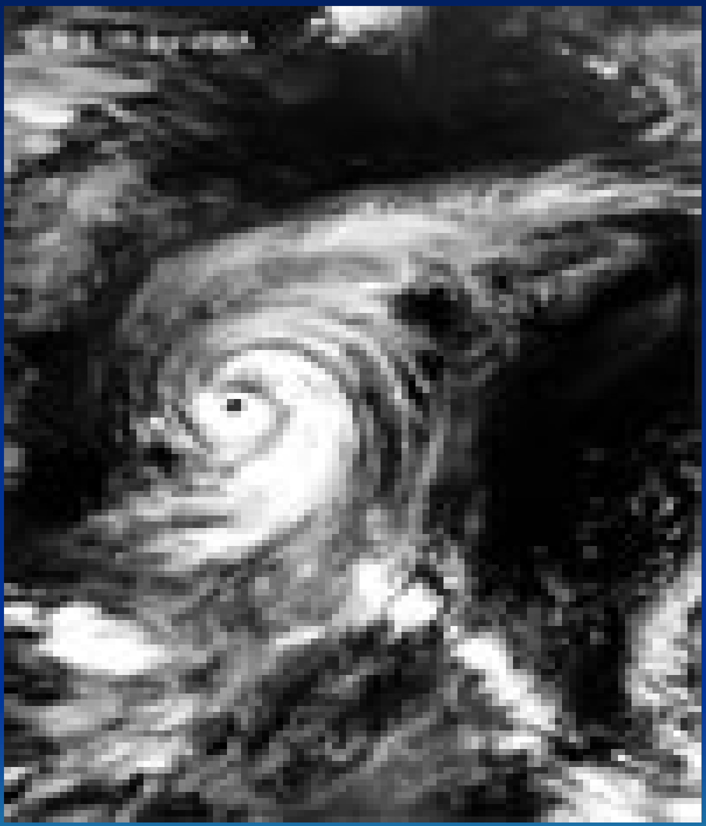
- The merit and disadvantage
- Instruments for rainfall retrieval
  - MV , IR/VIS
- Major rainfall retrieval satellite data
  - SSM/I,AMSU,TMI,AMSR,AMSRE
  - MTSAT,GOES,MSR
- Available DB MV satellite data
  - AMSU,AMSR-E,
  - MTSAT/IR/VIS

Characters of AMSR-E

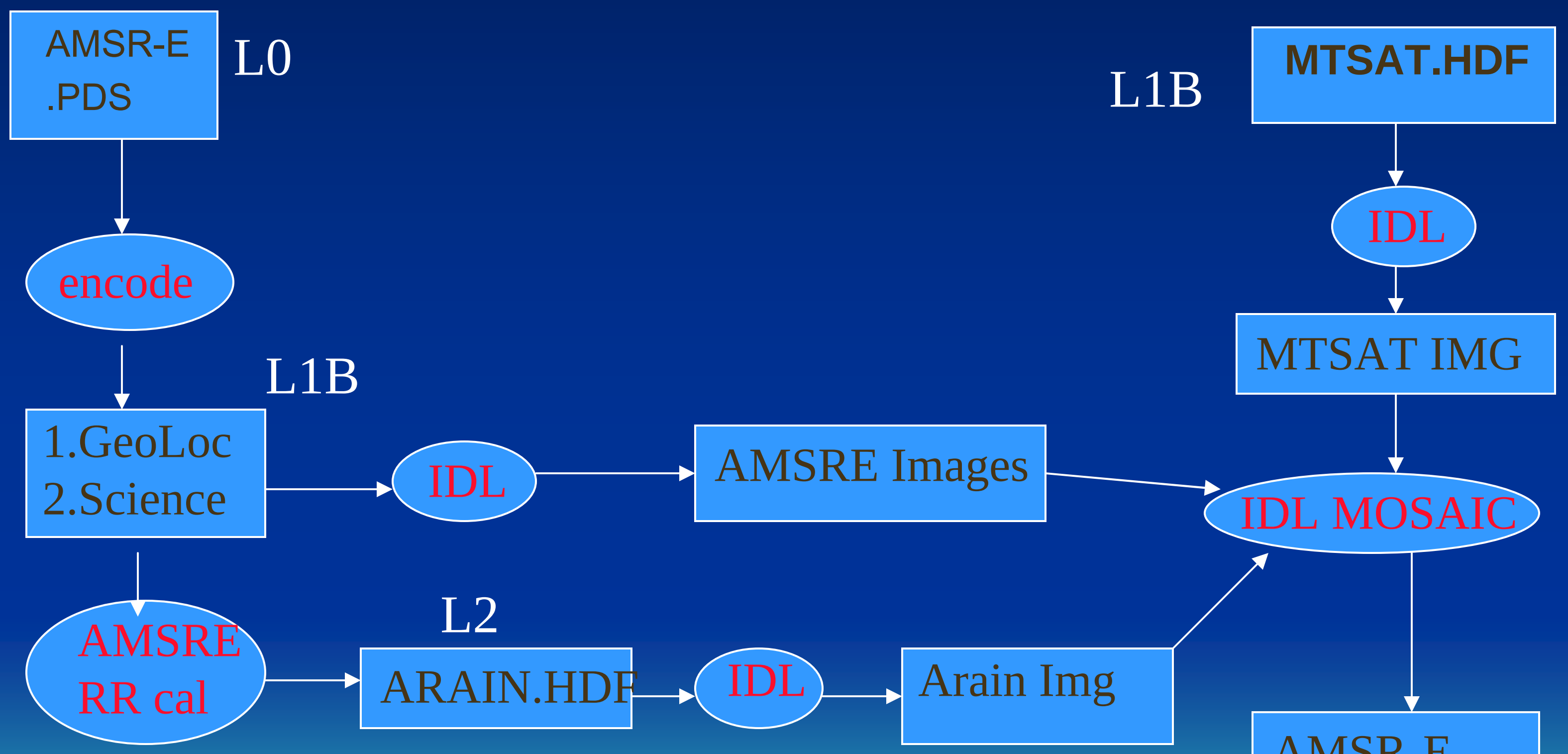
Freq (GHz)	Band Width (MHz)	Precision (K)	resolution (km)	IFOV (km x km)	SAMPLING RATE (km x km)	INTEGRATION TIME (MSEC)	MAIN BEAM EFFICIENCY (%)	BEAM WIDTH (degrees)
6.925	350	0.3	56	74 x 43	10 x 10	2.6	95.3	2.2
10.65	100	0.6	38	51 x 30	10 x 10	2.6	95.0	1.4
18.7	200	0.6	21	27 x 16	10 x 10	2.6	96.3	0.8
23.8	400	0.6	24	31 x 18	10 x 10	2.6	96.4	0.9
36.5	1000	0.6	12	14 x 8	10 x 10	2.6	95.3	0.4
89.0	3000	1.1	5.4	6x4	5x5	1.3	96.0	0.18

Motivation in Sep. 2002





Flowchart of data processing



Theory Basic of precipitation retrieval

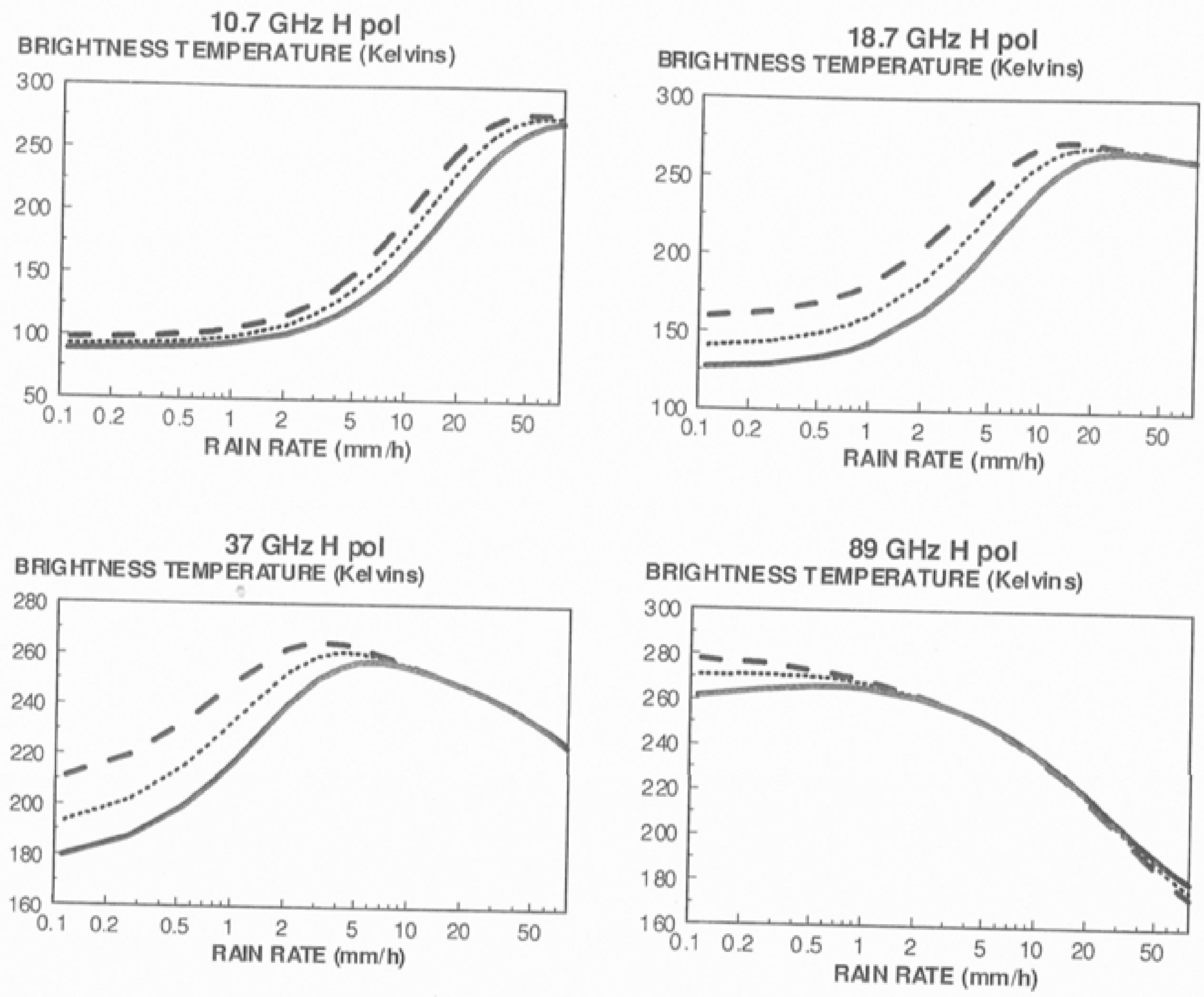
- AMSR-E and TRMM (Tropical Rainfall Measuring Mission) TMI (Microwave Imager) have similar frequencies, wider coverage
- physical based approach is available over ocean
- High land surface emissivity makes MV retrieval more complicated
- Physically structure about ice and rain are still

ambiguous

Based on NASA DAAC version

- Products of precipitation is used for global climate. Mean time frequency and spatial domain data is not suit to weather service.
- Based on experience of rainfall retrieval from TMI, SSM/I, Algorithm for AMSRE was developed.

Nonlinear relationship between Rainfall and BT



rature as a function of rain rate over the

Level-2 Ocean Algorithm

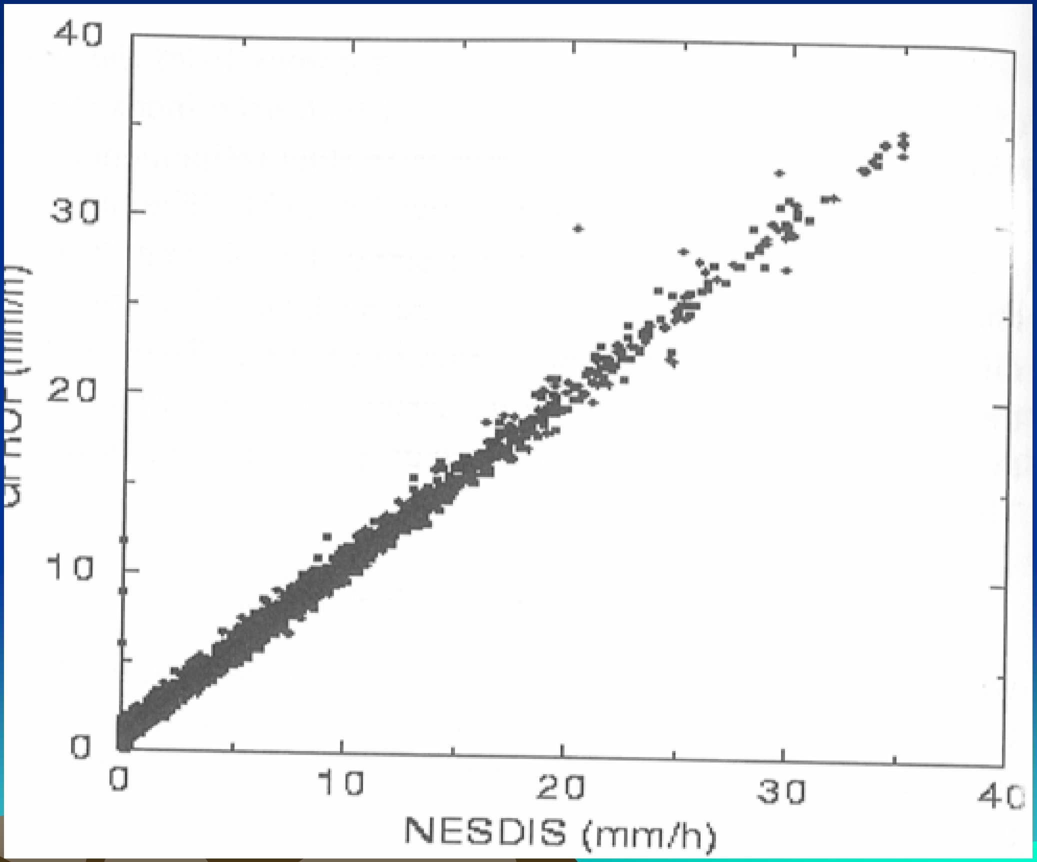
- Using forward model may estimate BT on board, when retrieving from observed BT on board, it is sensitive to the profile of atmospheric
- Precipitation retrieval means whole vertical distribution of rainfall
- Cloud Model is relative to retrieval precision

- Convective cloud and stratus cloud needs to be classified first.
- Cloud profile data base is using by Bayesian approach,
- Base on TB and C/S cloud to choose profile.

Level-2 Land Algorithm

- BT of could top is indirect information, caused by scattering of ice or rain drops
- Transfer scattering signal to rainfall by statistic method, lack of consistent background
- screening problem : rain or no rain
- SI method developed by Grody, improved by Ferraro
- Radar data could be used for calibration

- AMSRE team developed useful algorithm for precipitation retrieval



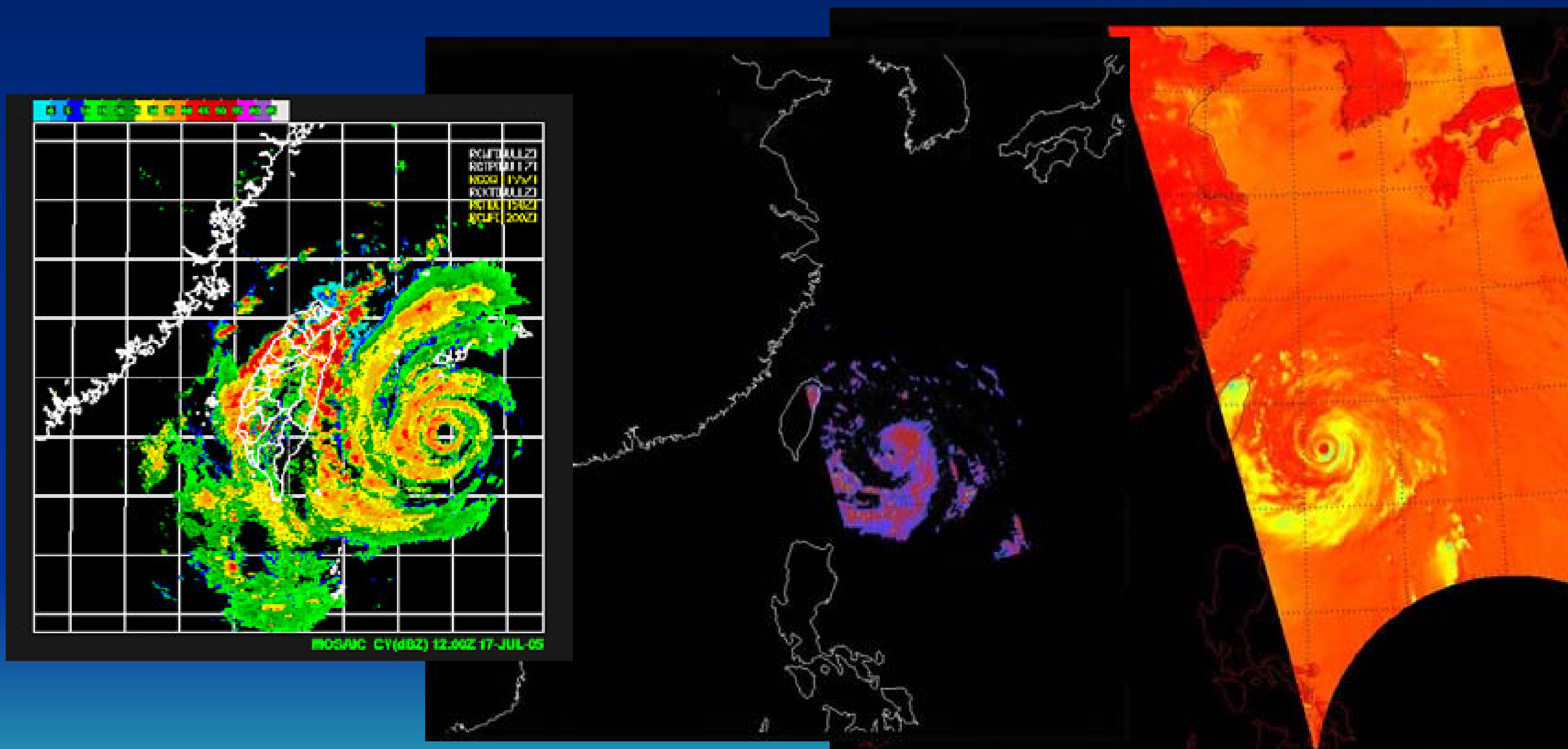
Other errors

- Homogeneous distribution with a FOV
- Above frozen level may have super cold liquid water drops

Results

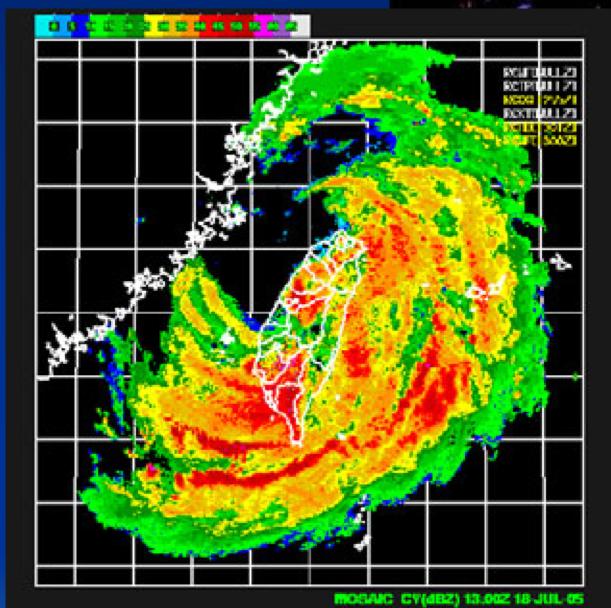
- Cases
- 2005/6/13-2005/10/1
- 0505Haitang
- 0509Matsa
- 0510SanVu Talim(0513)
- 0515Khanun
- 0518Damrey
- 0519Lonhwang

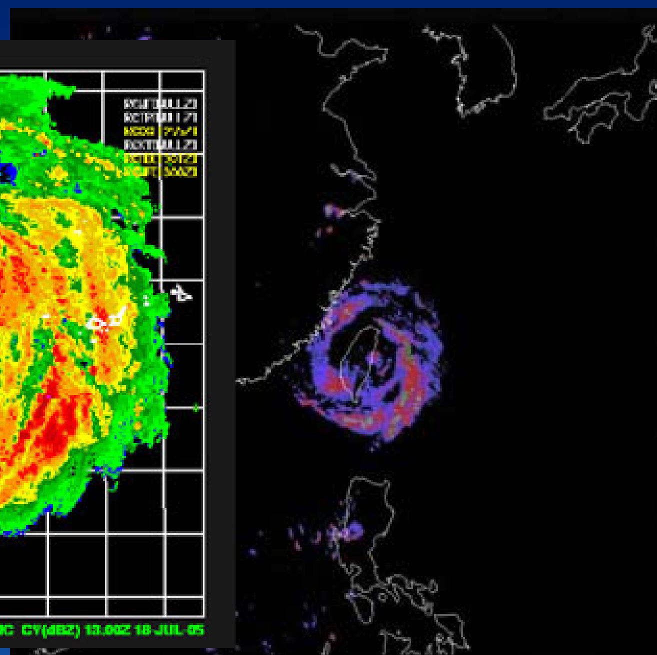
Haitang0717_0437

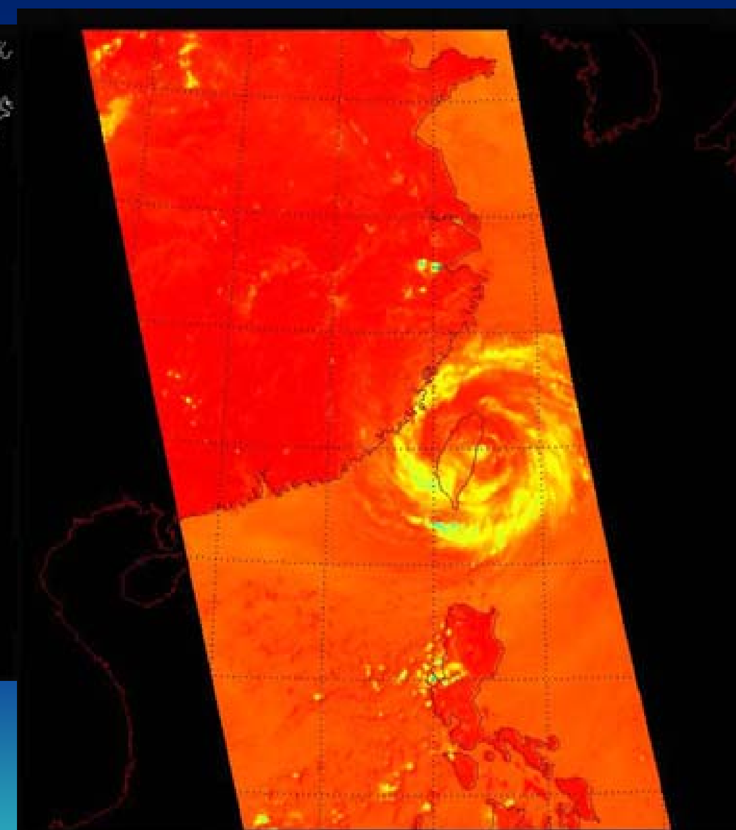


E:50mm/hr O:18Z 台北35mm/hr

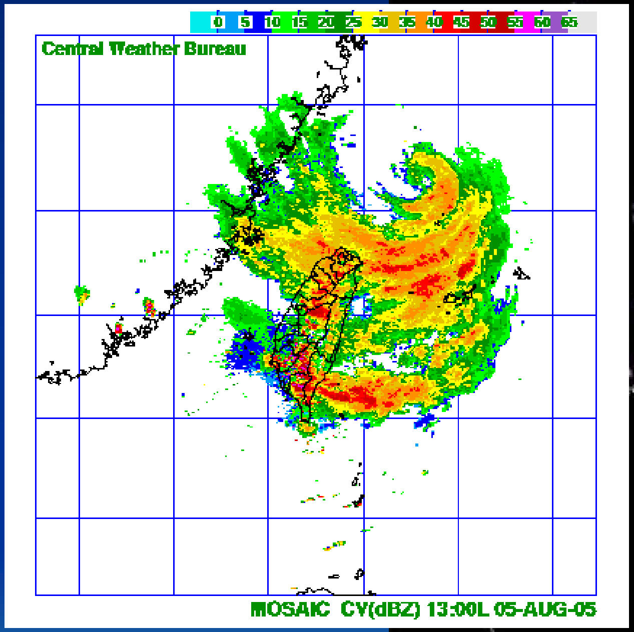
Haitang 0718_0519

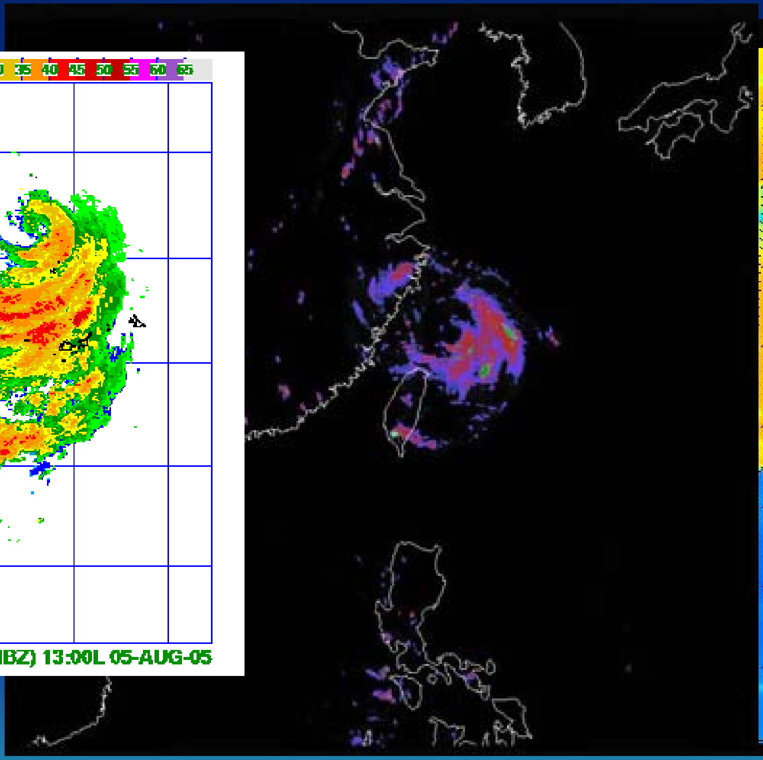


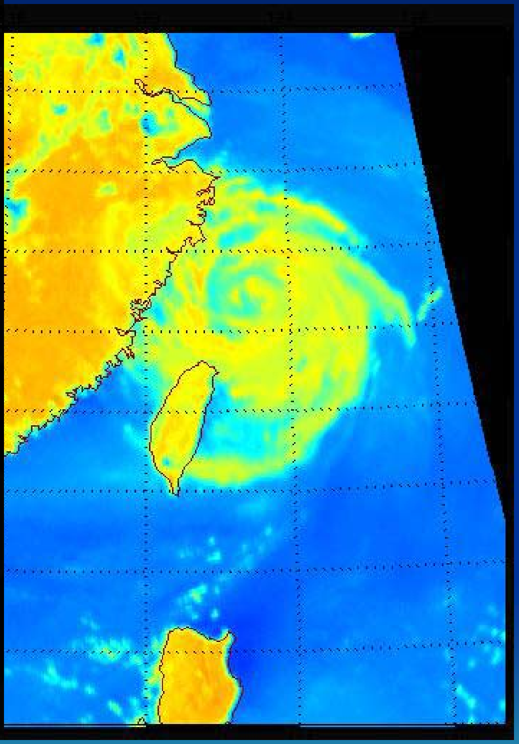




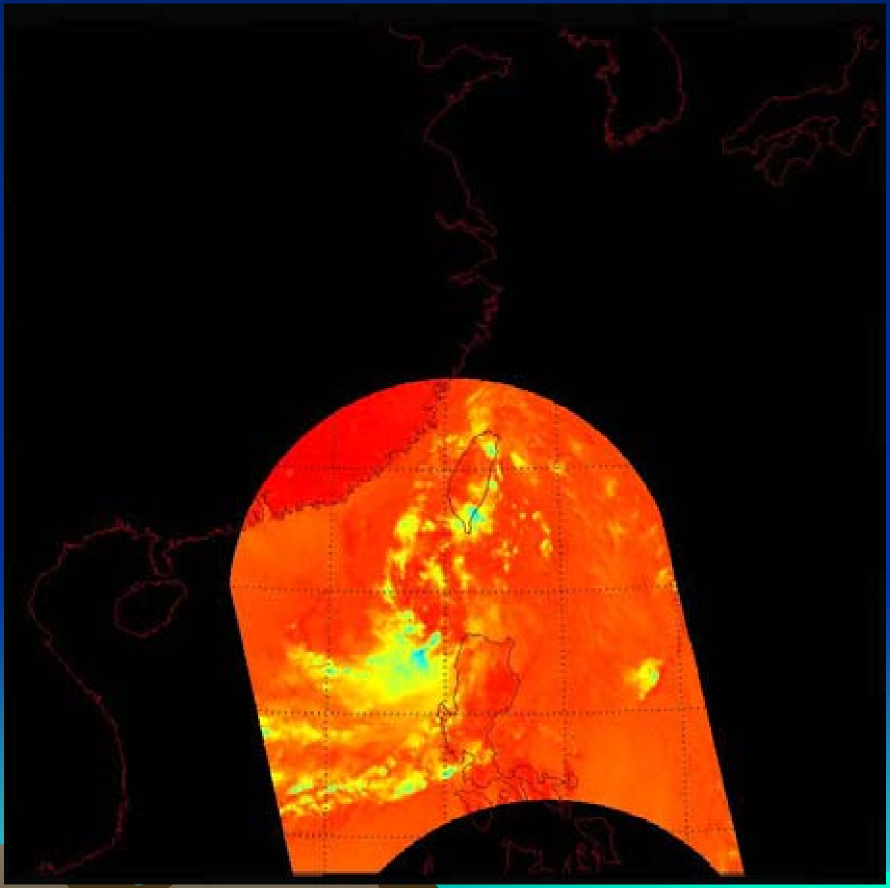
Matsa 0805_0507



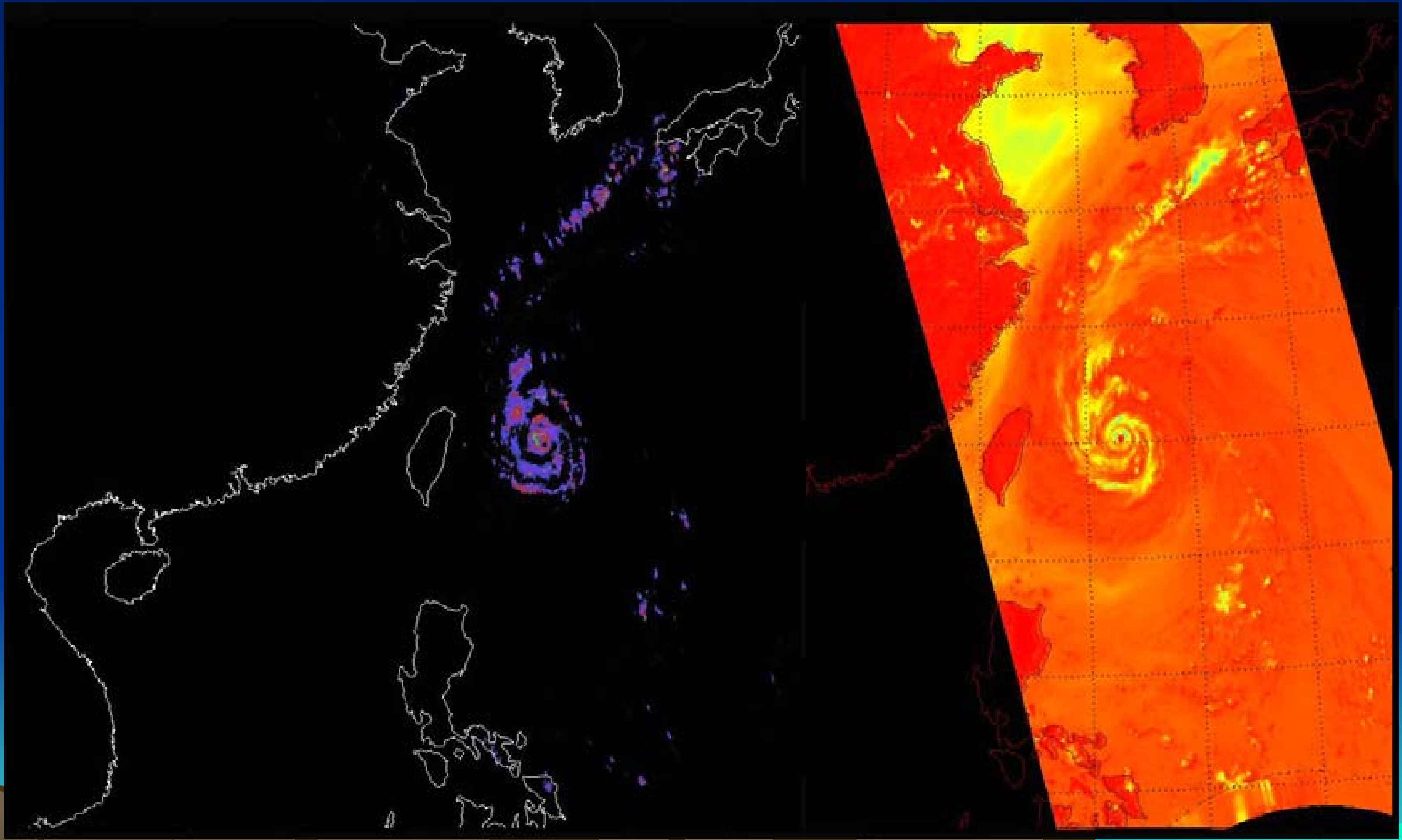




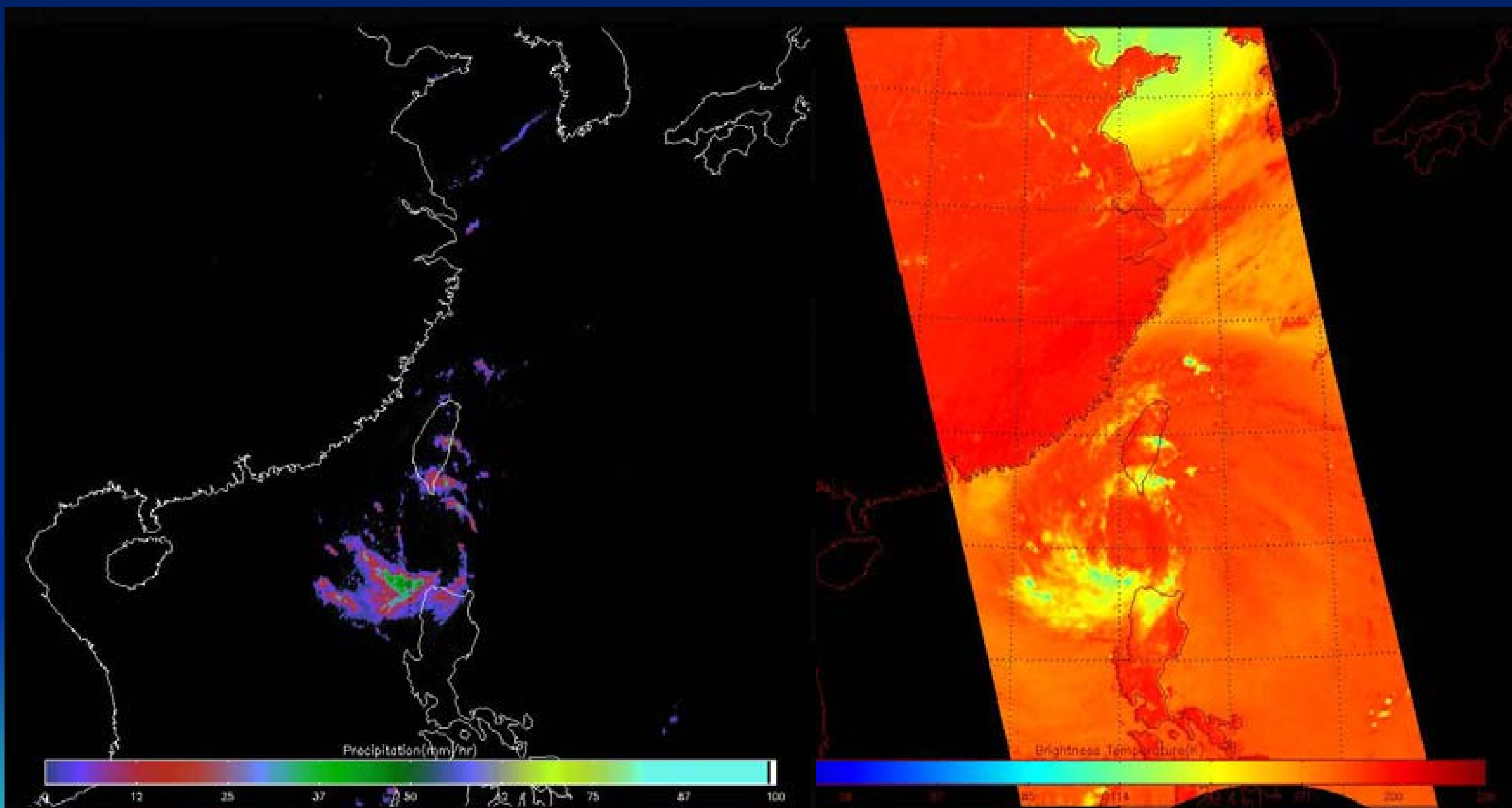
SanVu 0812_0513



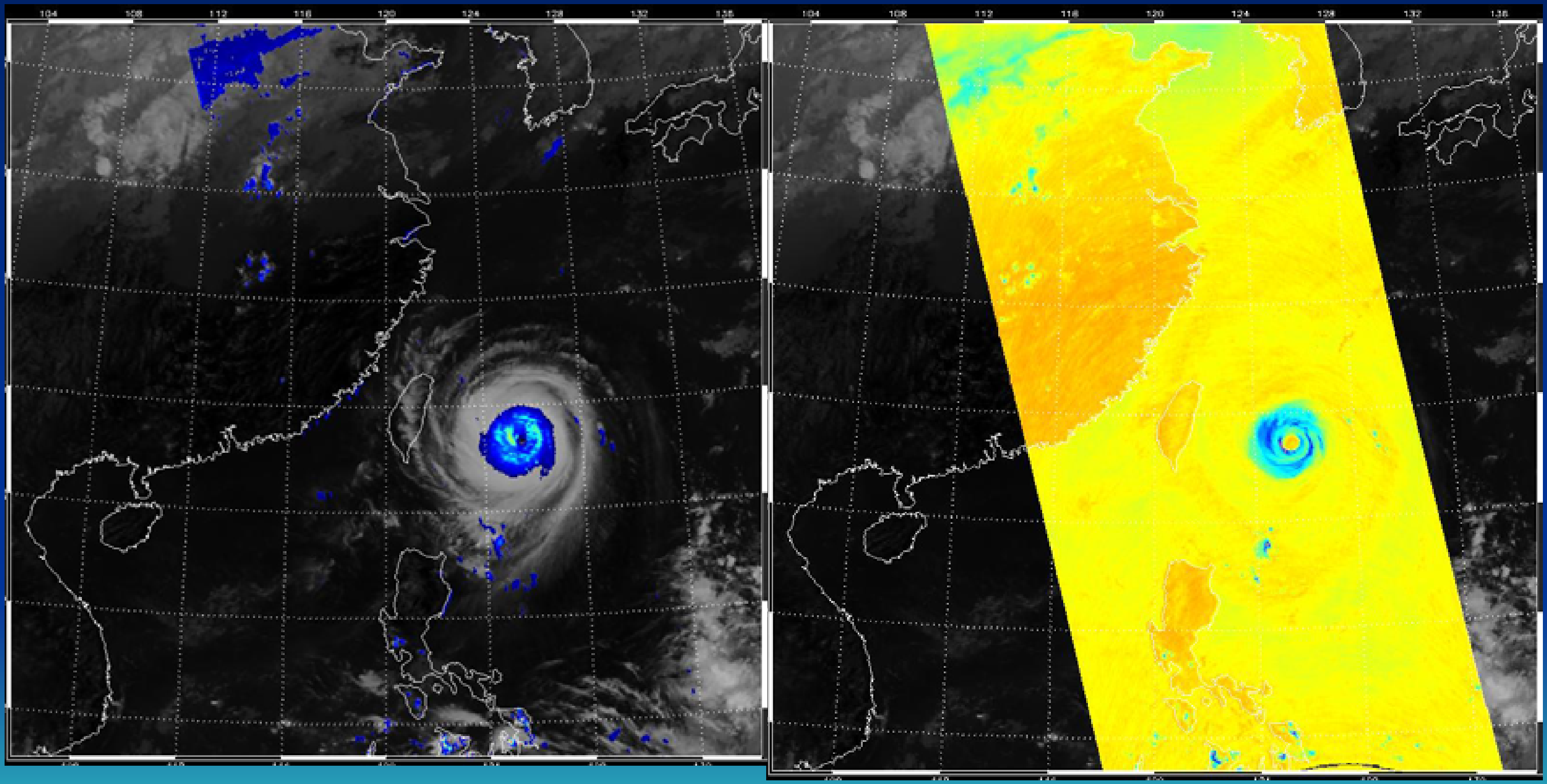
Khanun 0910_0441



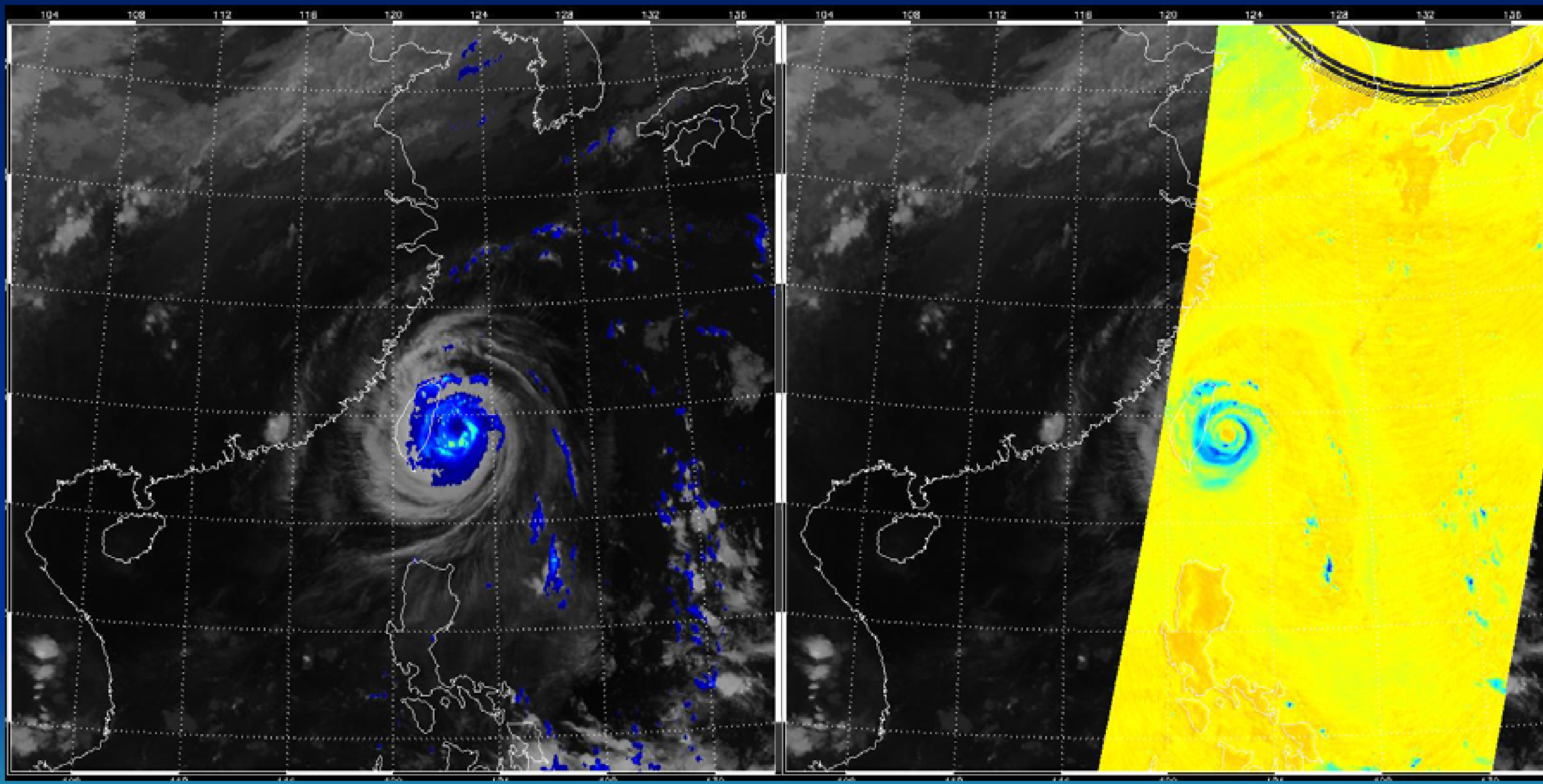
Damrey 0922_0505



Longwang 1001_0459

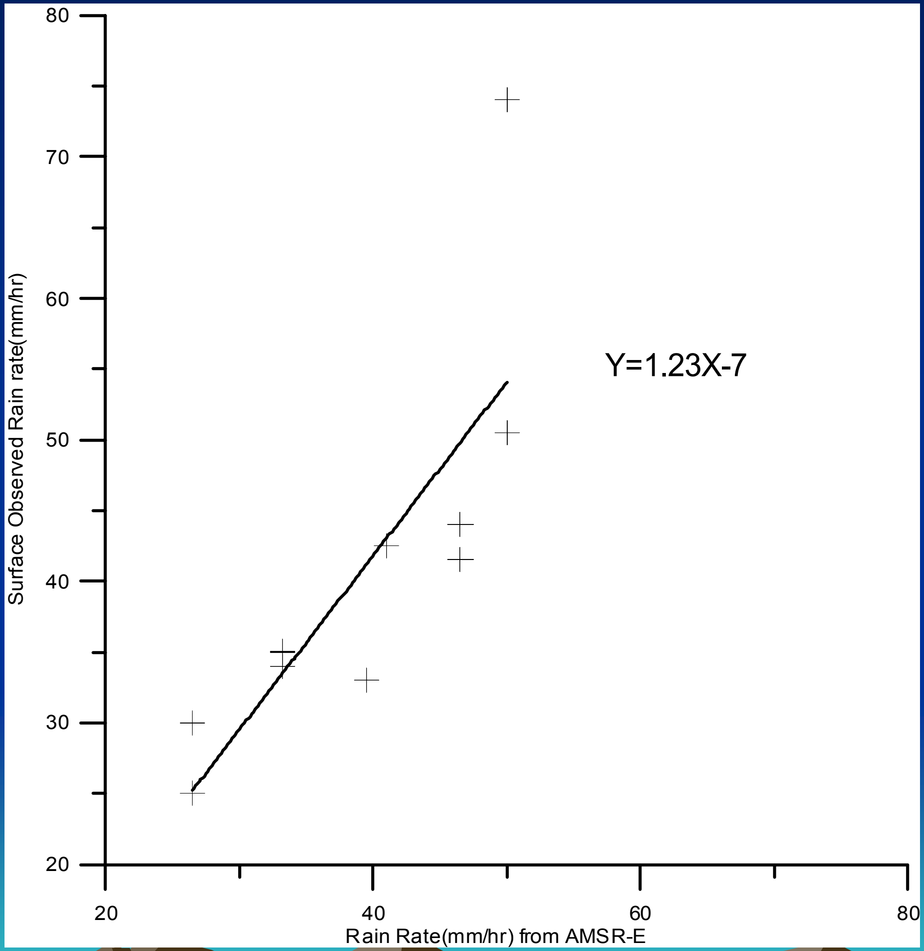


Longwang 1001_1707



E:39.5mm/hr O:龜山33mm/hr24LST

Comparison of maximum rain rate 12 hours before landing



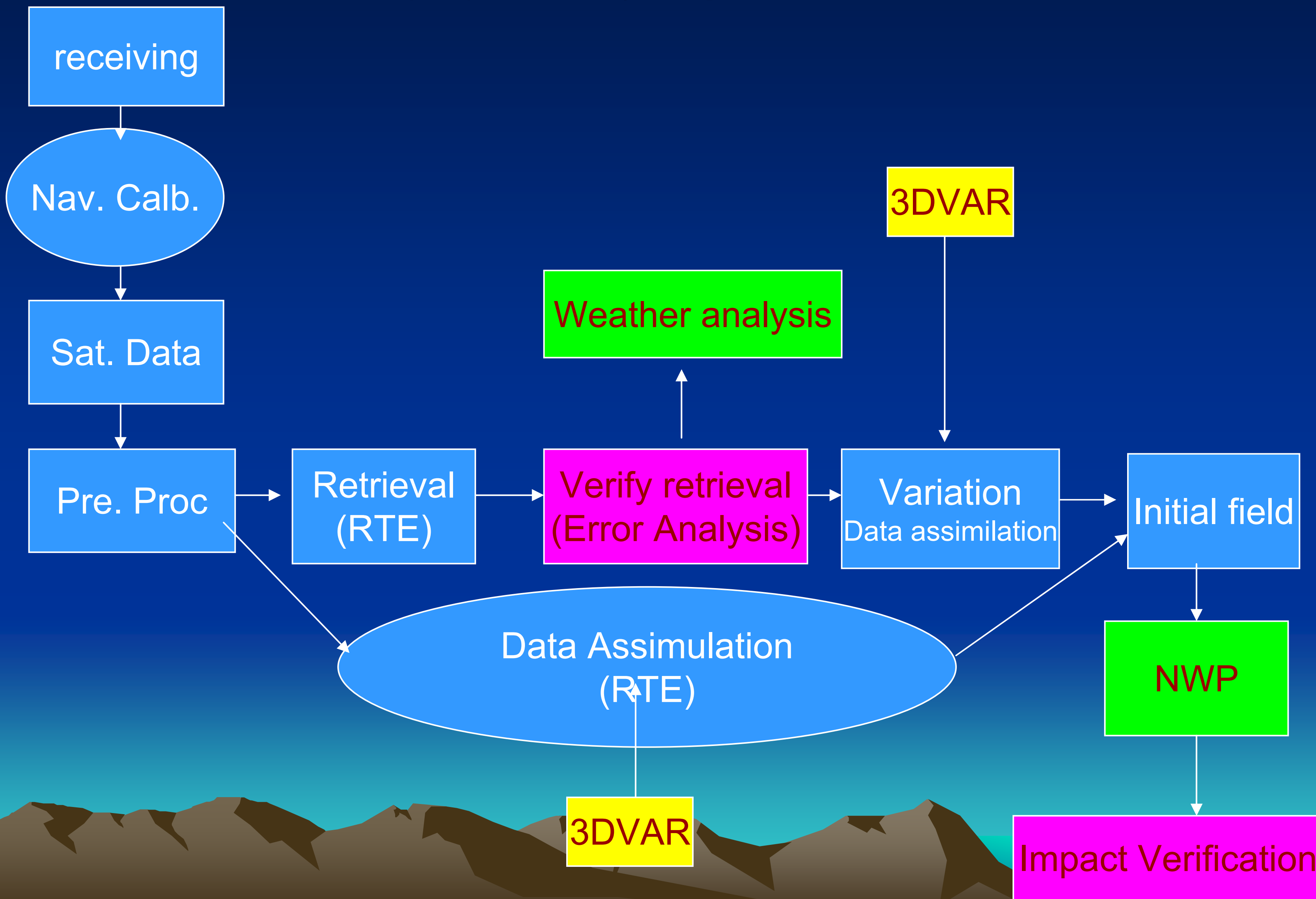
conclusion

- AMSRE data is useful for heavy rainfall retrieval and it is possible be a index of flooding warning
- Comparison is difficult over land for beam filling problem
- Geographic effects need to be implement for precipitation retrieval model

Future plan

- Try to find out how to add LWC & rain in WRF Model
- Improve and create more better satellite retrieved products
- Improve info. of Typhoon track and rainfall estimation before landing (hitting)
- 6 Year's meteorological project will be issued from government since 2010

Role of MSC in 3D/4D NWP Model



Thank you for your patient

The End