

# A Modeling Study of the Precipitation Features of the Rainfall Event on 1-3 June 2008 (IOP 4) during the SoWMEX/TiMREX

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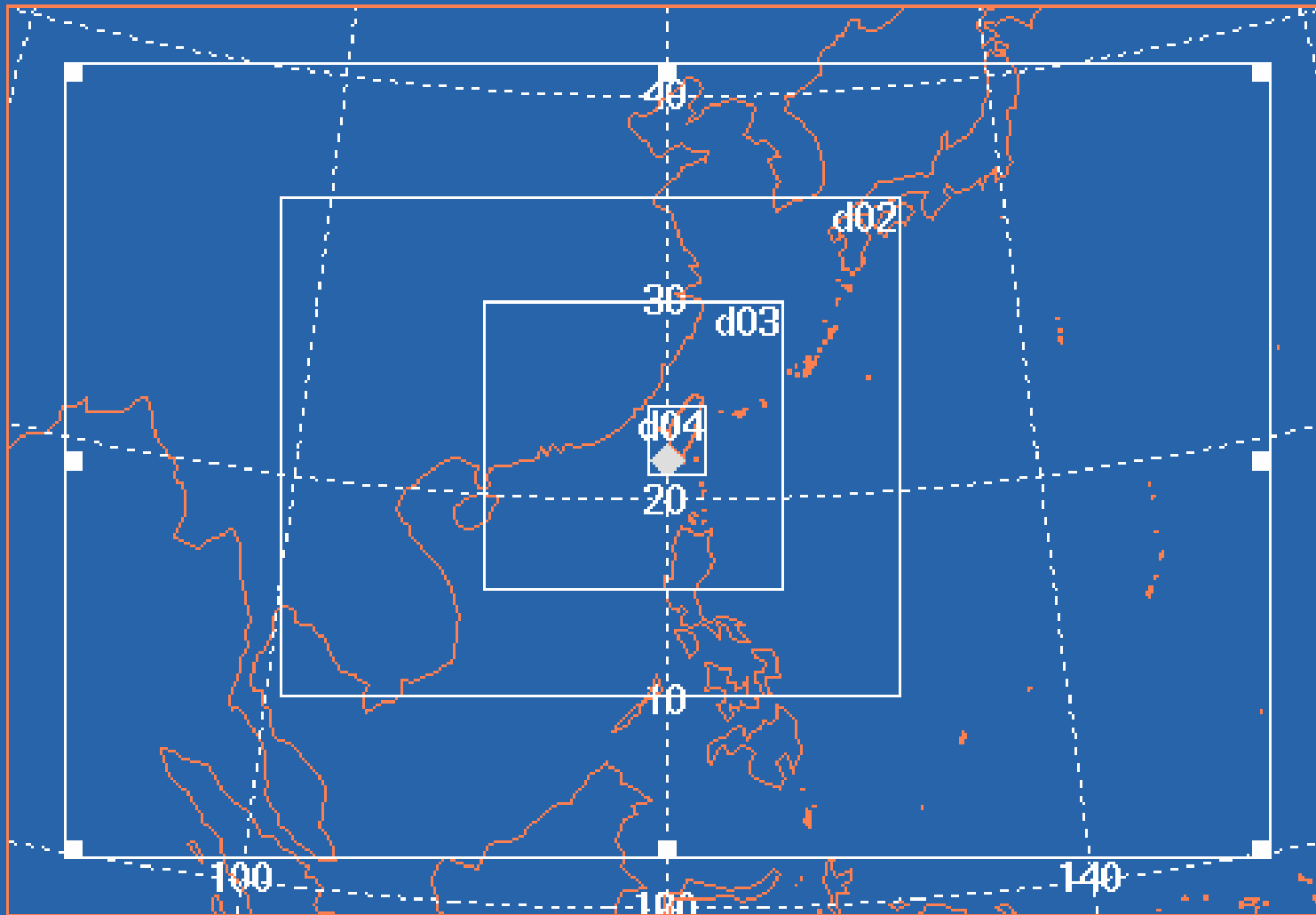


# Objectives

- To investigate the capability of WRF model to simulate the synoptic, kinematic and precipitation features associated with the Mei-Yu frontal system on 1-3 June 2008 (IOP 4).
- To understand the evolution from frontal precipitation to orographic precipitation for this case.



# WRF Configuration



Two-way  
interactive

D1: 45 km

D2: 15 km

D3: 5 km

D4: 1.67 km

32 levels

In vertical

# WRF model setup

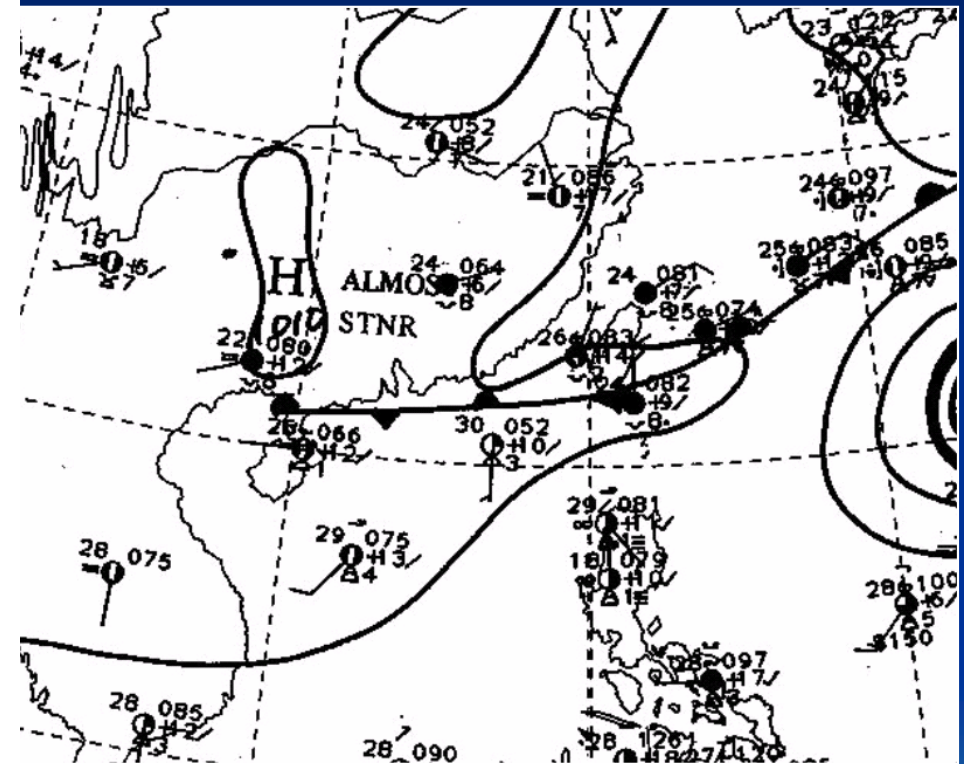
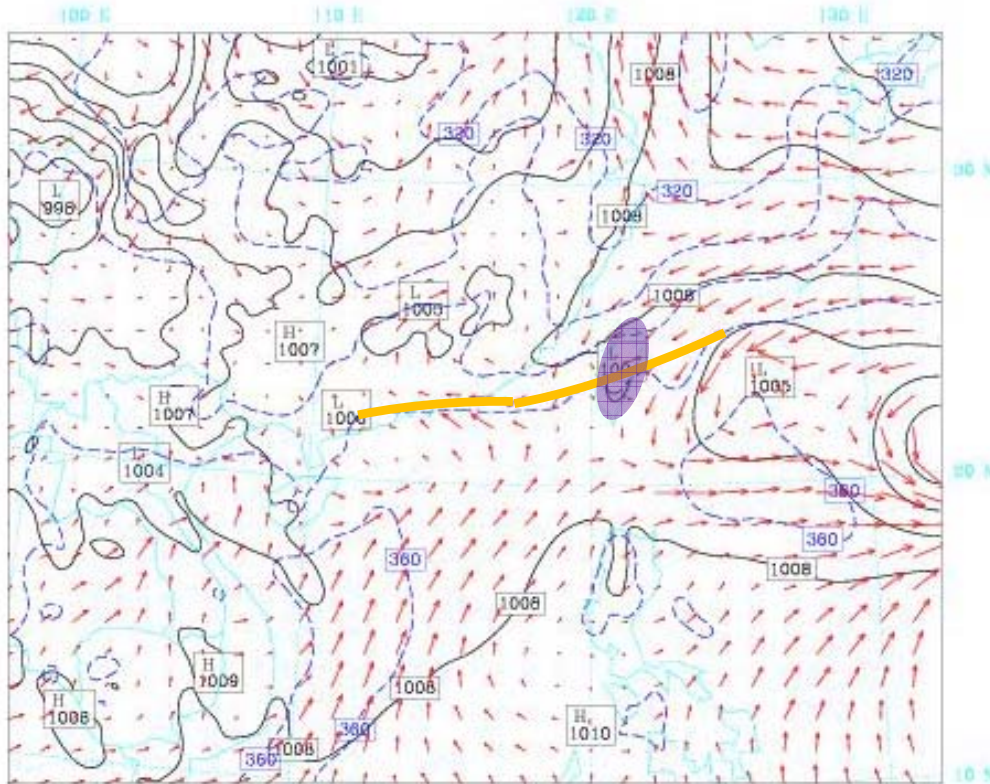
Version	V 3.1.1
Fcst Period	72 h
Cumulus	Grell-Devenyi (2002)
Microphysics	WSM6/WDM6
PBL	YSU
Radiation	RRTM for shortwave Dudhia (1989) for longwave
I.C.	NCEP/FNL analysis (2008/06/01 0000 UTC)
B.C.	NCEP/FNL analysis



# Frontal Position on Domain 2

Dataset: d2 RIP: pre Init: 0000 UTC Sun 01 Jun 08  
Fest: 0.00 h Valid: 0000 UTC Sun 01 Jun 08 (0800 LST Sun 01 Jun 08)  
Sea-level pressure at k-index = 31 sm=10  
Equivalent potential temperature at k-index = 31 sm=10  
Horizontal wind vectors at k-index = 31

t = 0 h  
(00 UTC 1 June 2008)

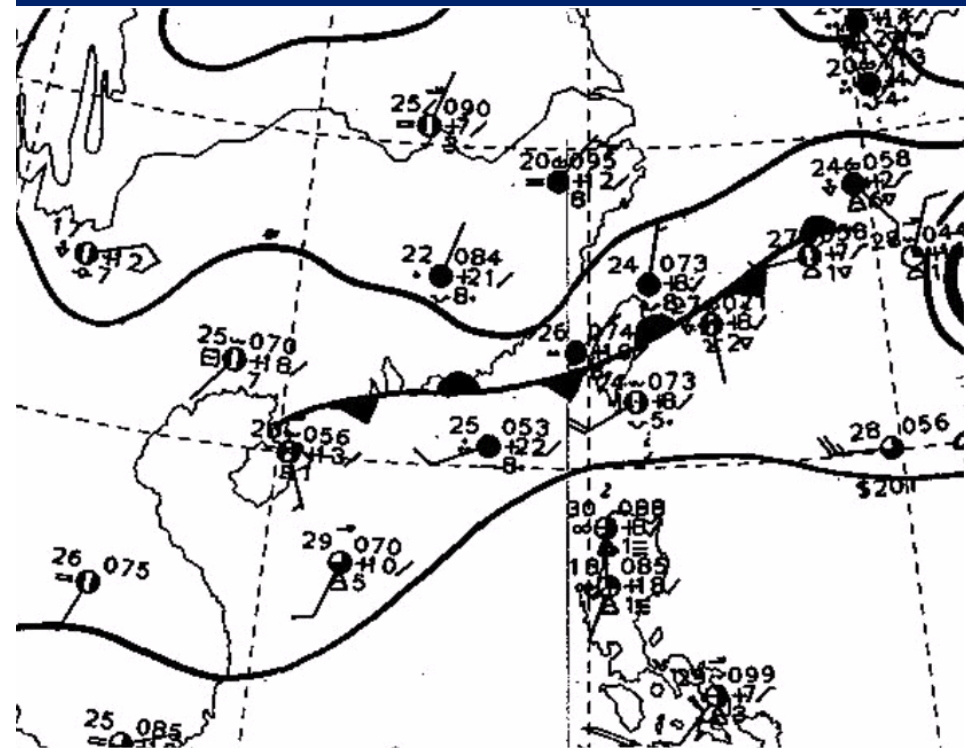
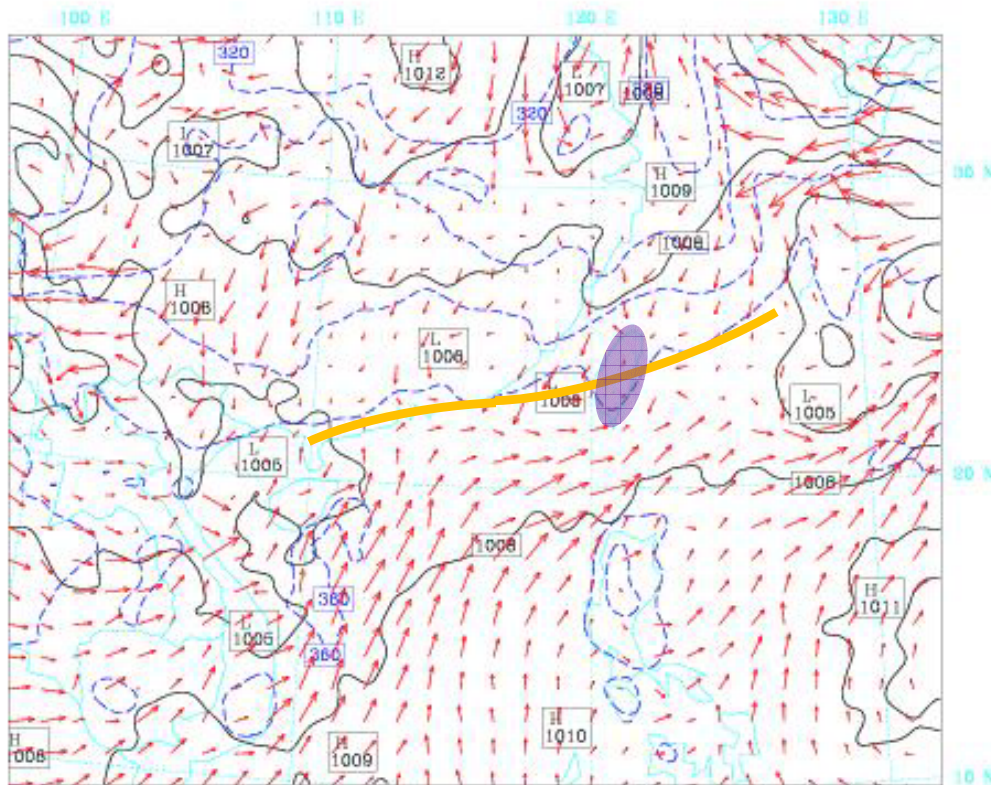


Model Info: V3.1 M C-D Ens YSU PBL Ther-Diff 15 km, 31 levels, 60 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

# Frontal Position on Domain 2

Dataset: d2 RIP; pre  
Fest: 24.00 h  
Sea-level pressure  
Equivalent potential temperature  
Horizontal wind vectors  
Init: 0000 UTC Sun 01 Jun 08  
Valid: 0000 UTC Mon 02 Jun 08 (0800 LST Mon 02 Jun 08)  
sm=10  
at k-index = 31  
sm=10  
at k-index = 31

t = 24 h  
(00 UTC 2 June 2008)

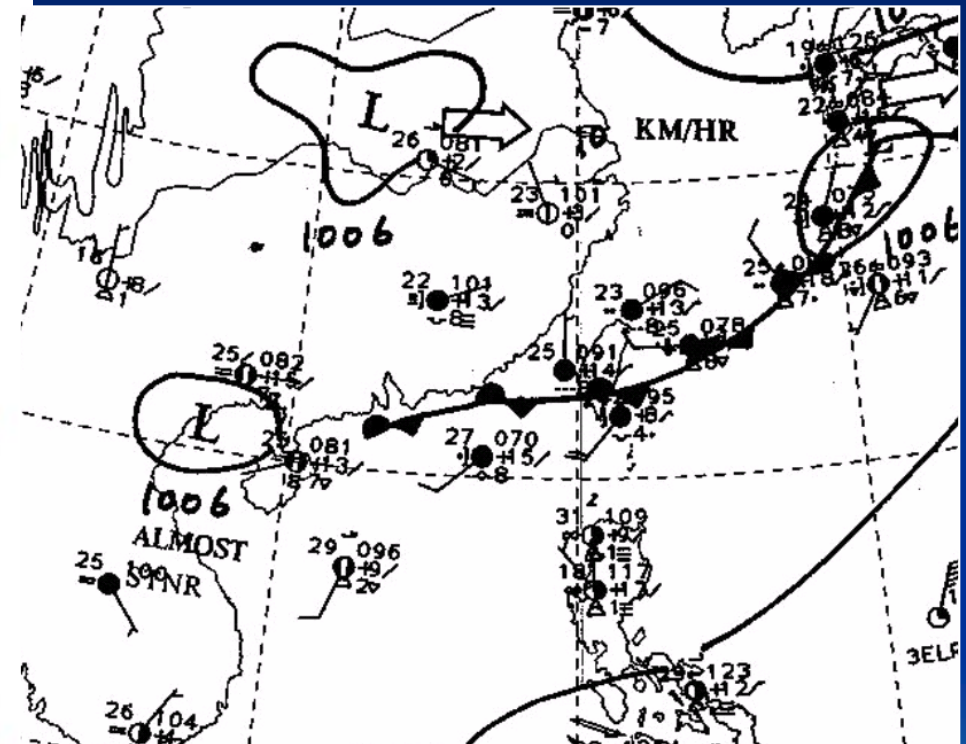
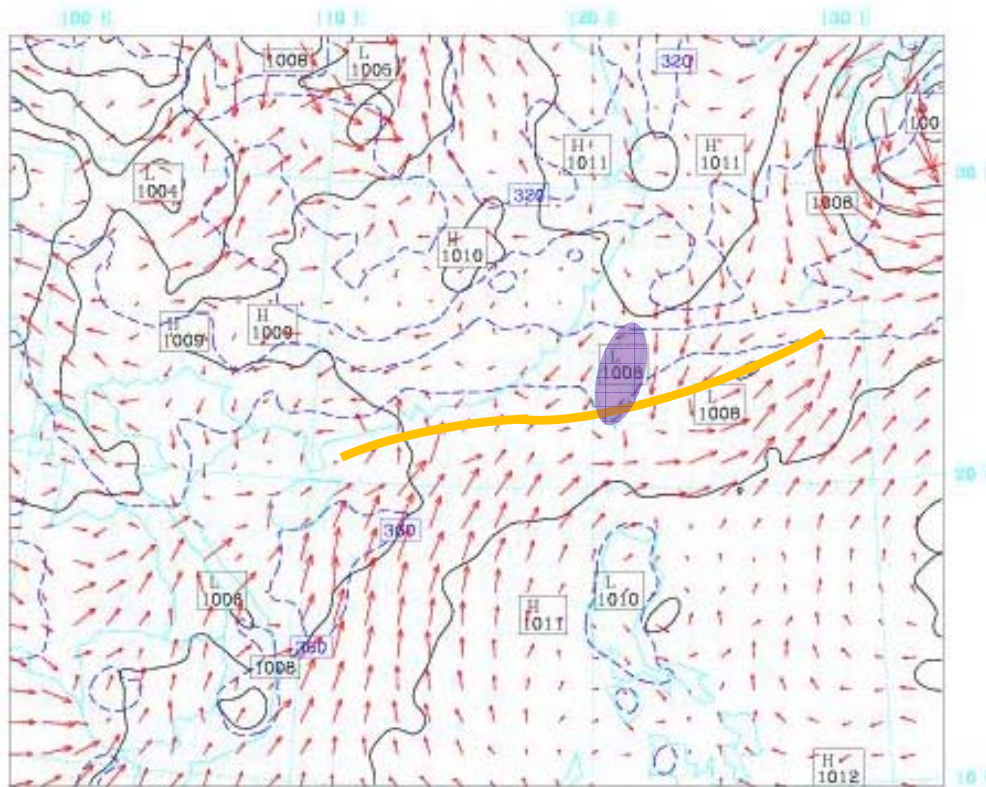


Model Info: V3.1 M C-D Ens YSU PBL Ther-Diff 15 km, 31 levels, 60 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor  
MAXIMUM VECTOR: 19.2 m s<sup>-1</sup>

# Frontal Position on Domain 2

**t = 48 h**  
**(00 UTC 3 June 2008)**

Dataset: d2 RIP: pre Init: 0000 UTC Sun 01 Jun 08  
Fest: 48.00 h Valid: 0000 UTC Tue 03 Jun 08 (0800 LST Tue 03 Jun 08)  
Sea-level pressure sm=10  
Equivalent potential temperature at k-index = 31 sm=10  
Horizontal wind vectors at k-index = 31

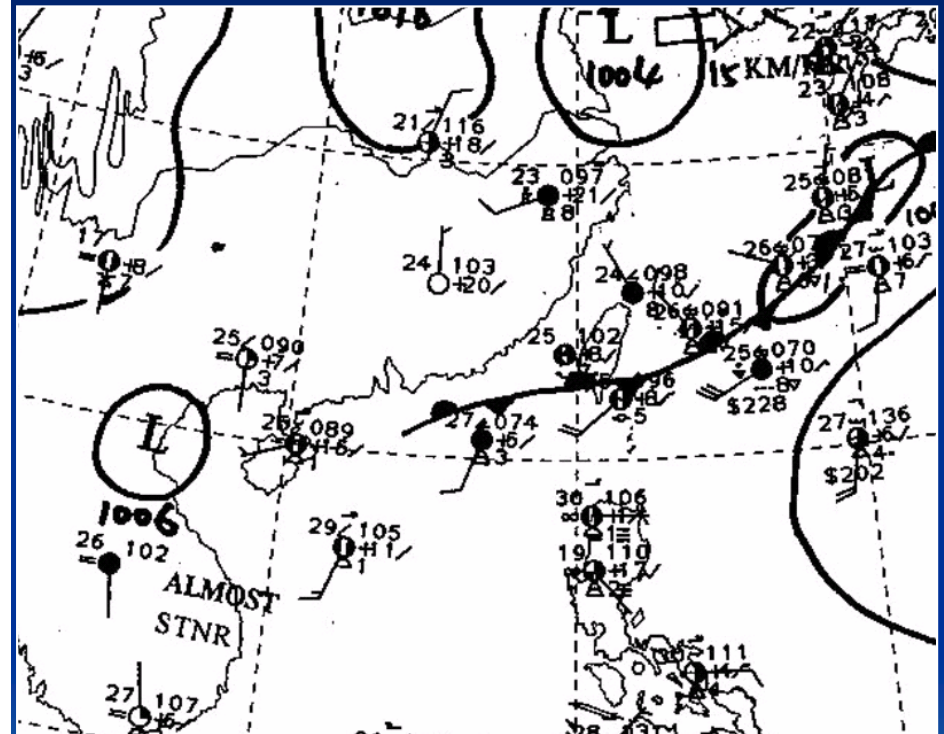
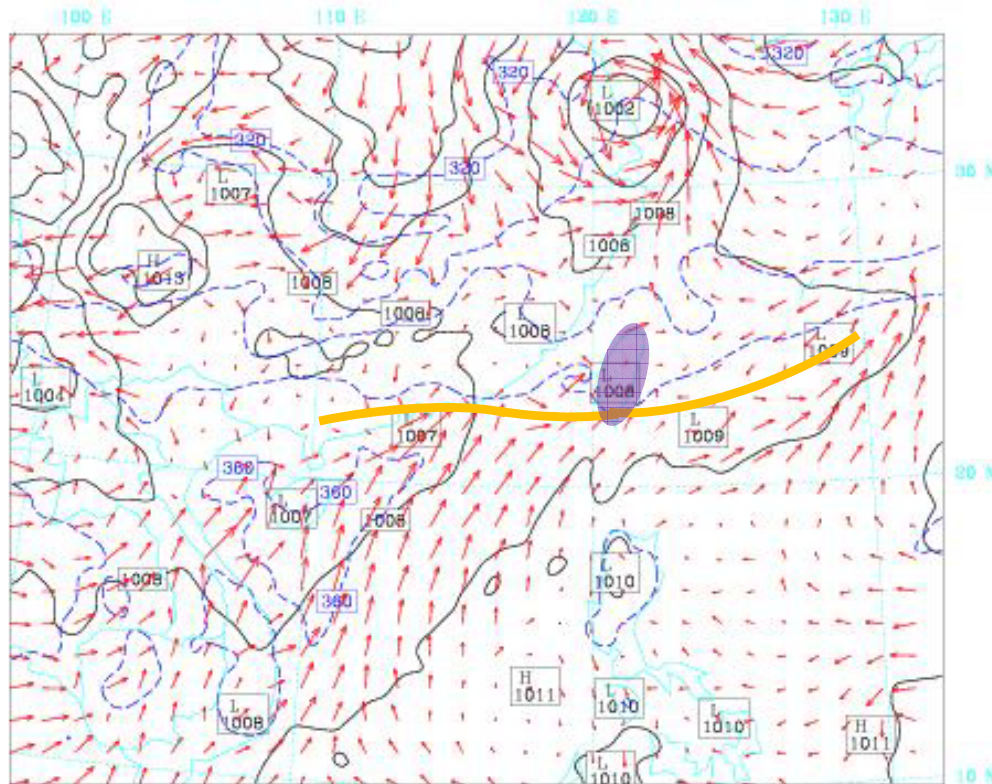


Model Info: V3.1 M C-D Ens YSU PBL Ther-Diff 15 km, 31 levels, 60 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

# Frontal Position on Domain 2

Dataset: d2 RIP: pre Init: 0000 UTC Sun 01 Jun 08  
Fest: 72.00 h Valid: 0000 UTC Wed 04 Jun 08 (0800 LST Wed 04 Jun 08)  
Sea-level pressure sm=10  
Equivalent potential temperature at k-index = 31 sm=10  
Horizontal wind vectors at k-index = 31

t = 72 h  
(00 UTC 4 June 2008)



Model Info: V3.1 M G-D Ens YSU PBL Ther-Diff 15 km, 31 levels, 60 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

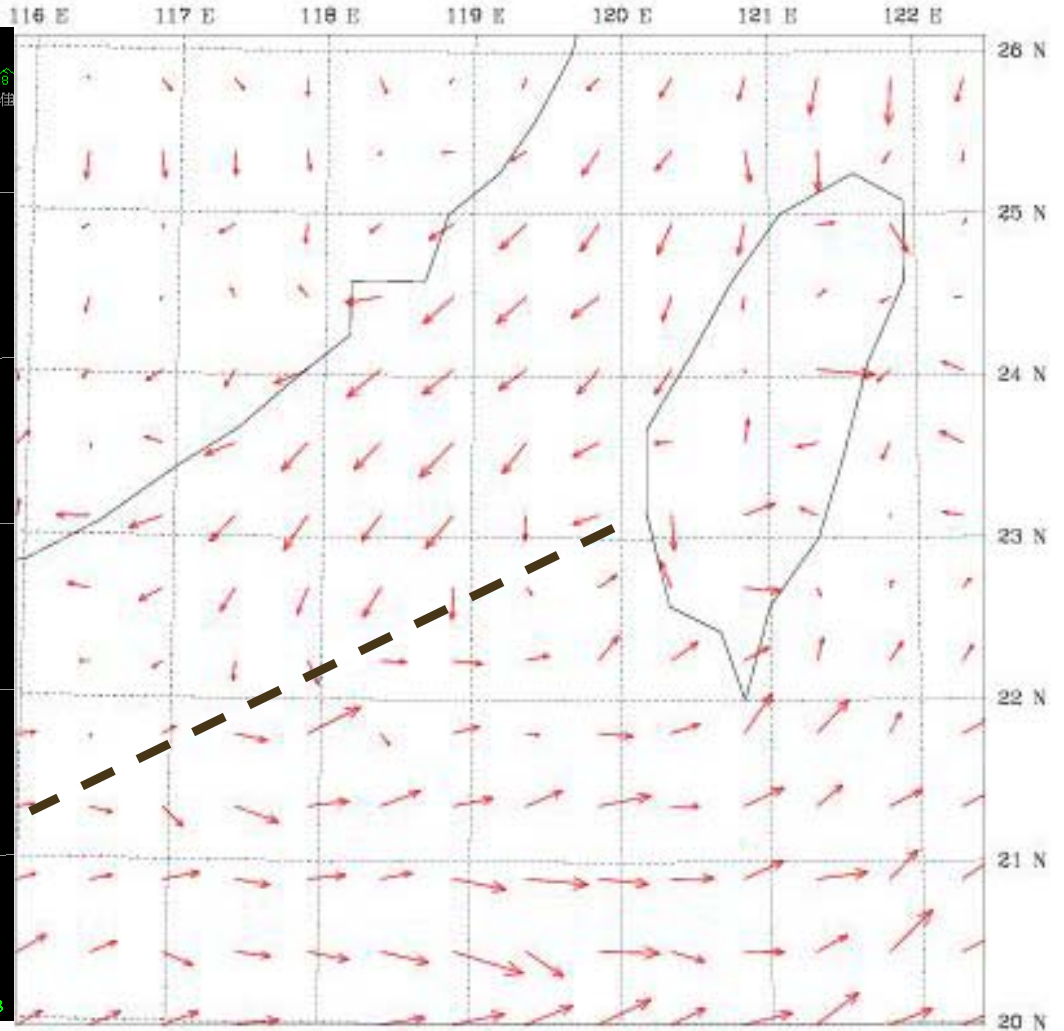
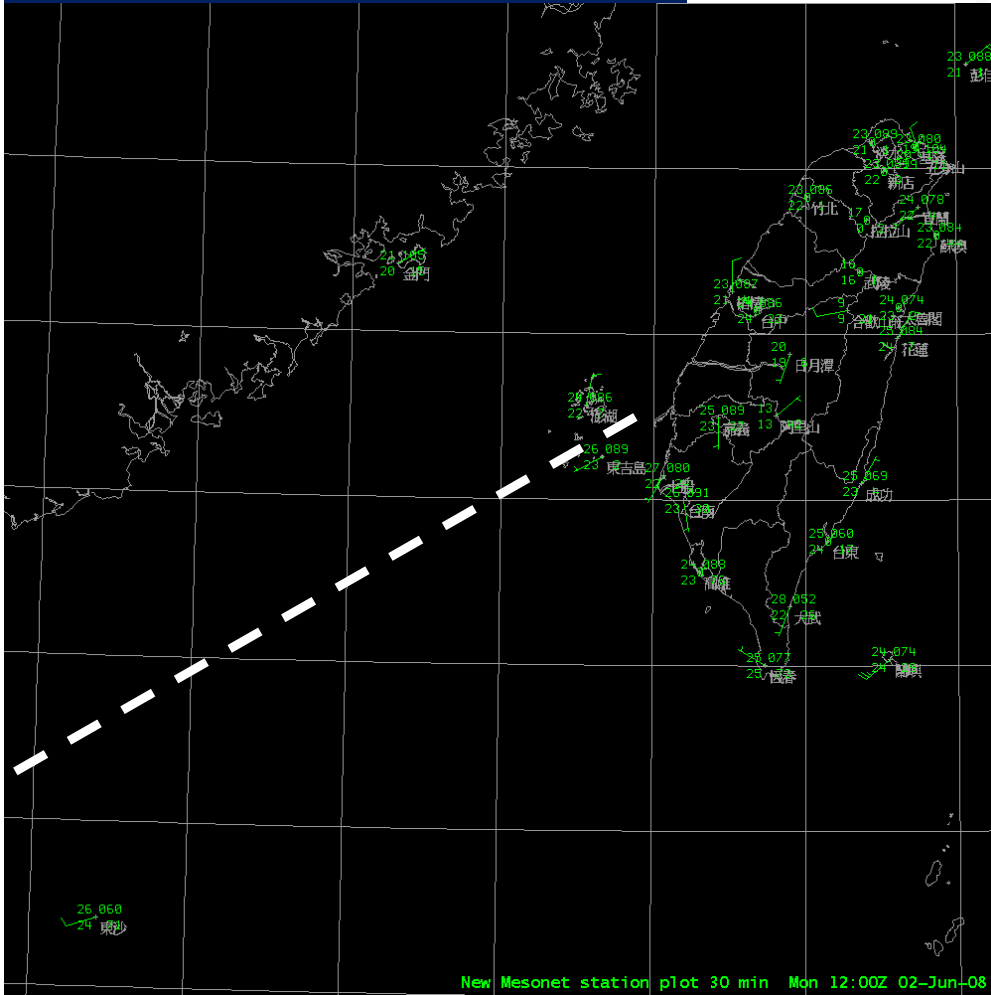
MAXIMUM VECTOR: 17.5 m s<sup>-1</sup>

# Simulated Surface Wind on Domain 3

## Observed Surface Wind

Dataset: d3 RIP: 0602 d3 wd  
Fest: 28.00 h  
Horizontal wind vectors

Init: 0000 UTC Sun 01 Jun 08  
Valid: 0400 UTC Mon 02 Jun 08 (1200 LST Mon 02 Jun 08)  
at k-index = 31

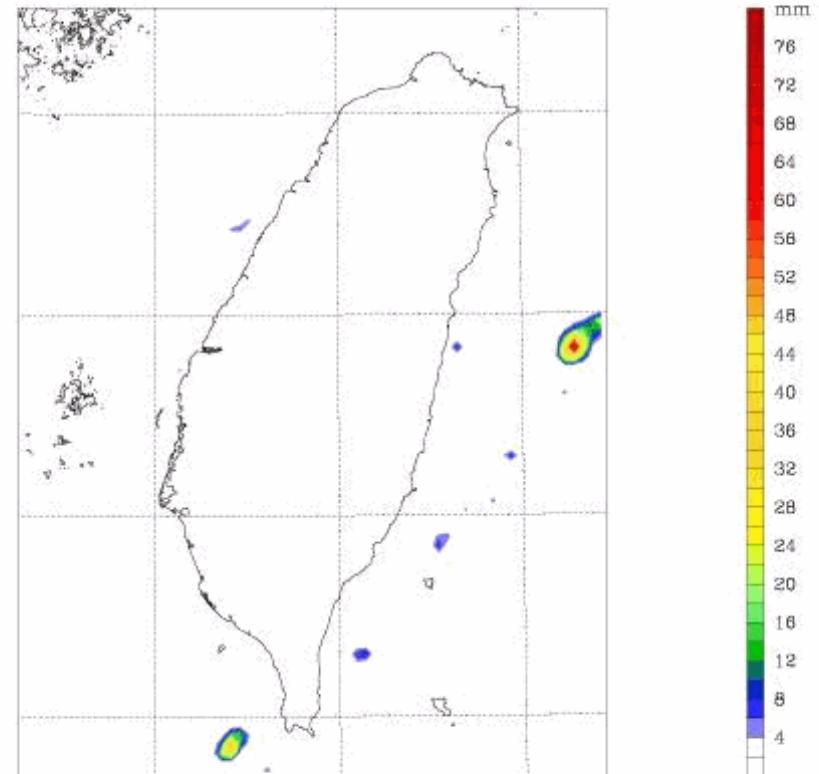
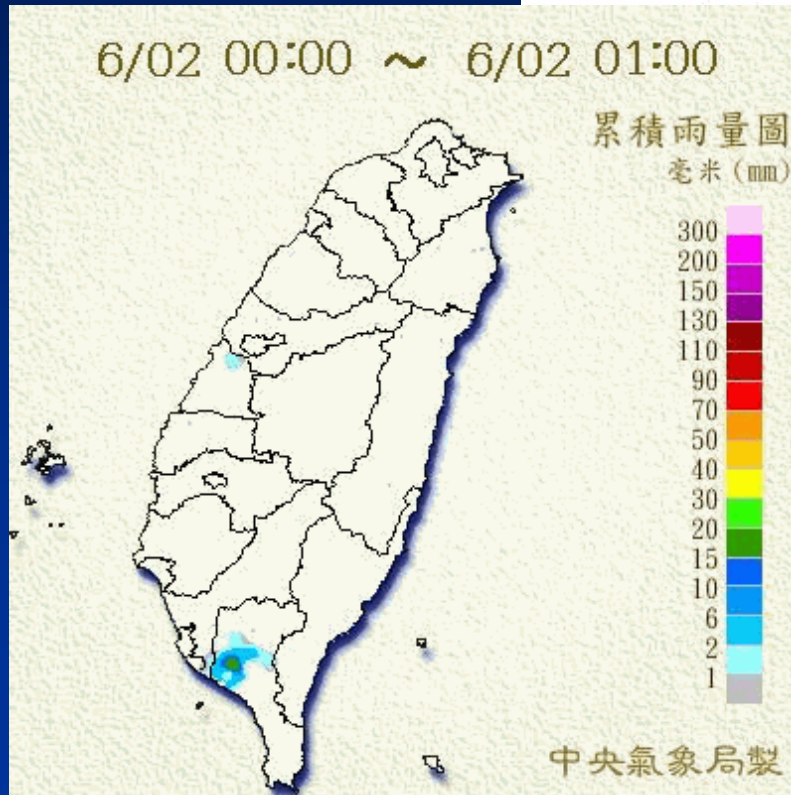


Model Info: V3.1 M No Cu YSU PBL Ther-Diff 5.0 km. 31 levels. 20 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

MAXIMUM VECTOR: 15.0 m s<sup>-1</sup> →

# Observed vs. WRF Accumulated Rainfall on 2 June

Dataset: d3 RIP: 0602 d3 rain Init: 0000 UTC Sun 01 Jun 08  
Fest: 17.00 h Valid: 1700 UTC Sun 01 Jun 08 (0100 LST Mon 02 Jun 08)  
Total precip. in past 1 h

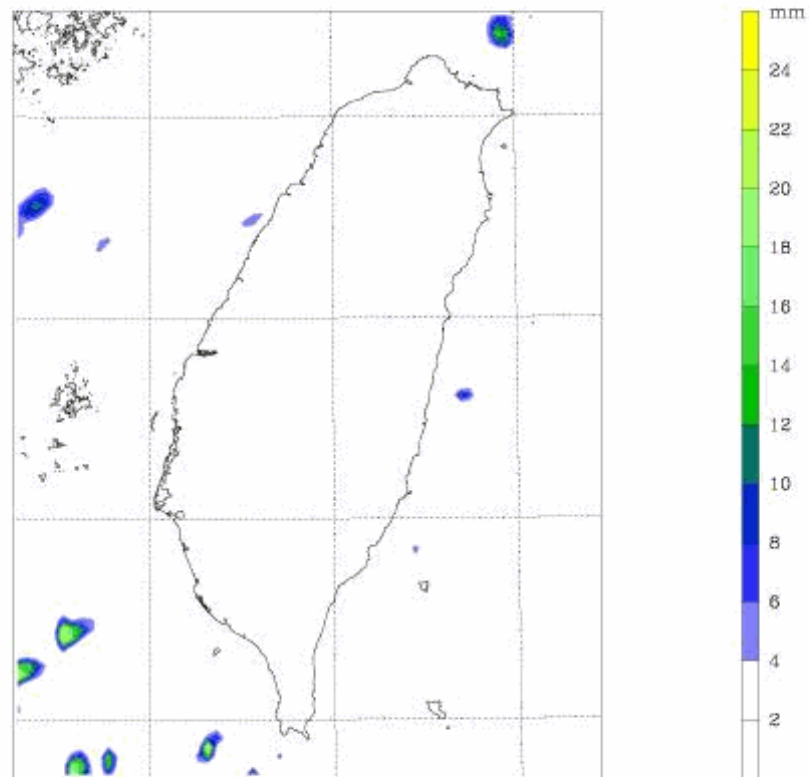
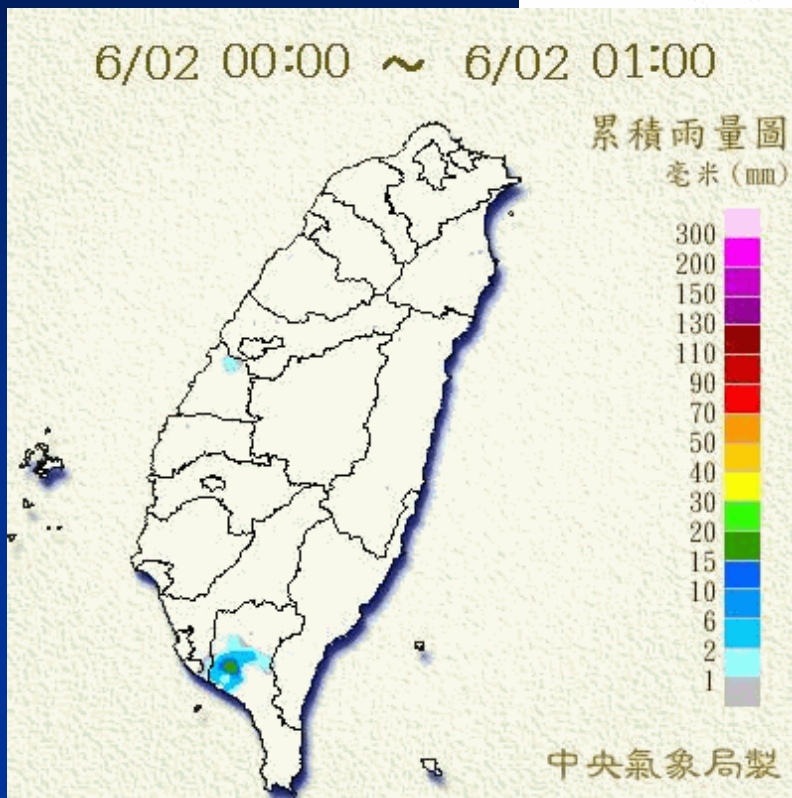


Model Info: V3.1 M No Cu YSU PBL WSM 5class Ther-Diff 5.0 km, 31 levels, 20 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

# Observed vs. WRF Accumulated Rainfall on 2 June

## WSM6

Dataset: d3 RIP: 0602 d3 rain Init: 0000 UTC Sun 01 Jun 08  
Fest: 17.00 h Valid: 1700 UTC Sun 01 Jun 08 (0100 LST Mon 02 Jun 08)  
Total precip. in past 1 h

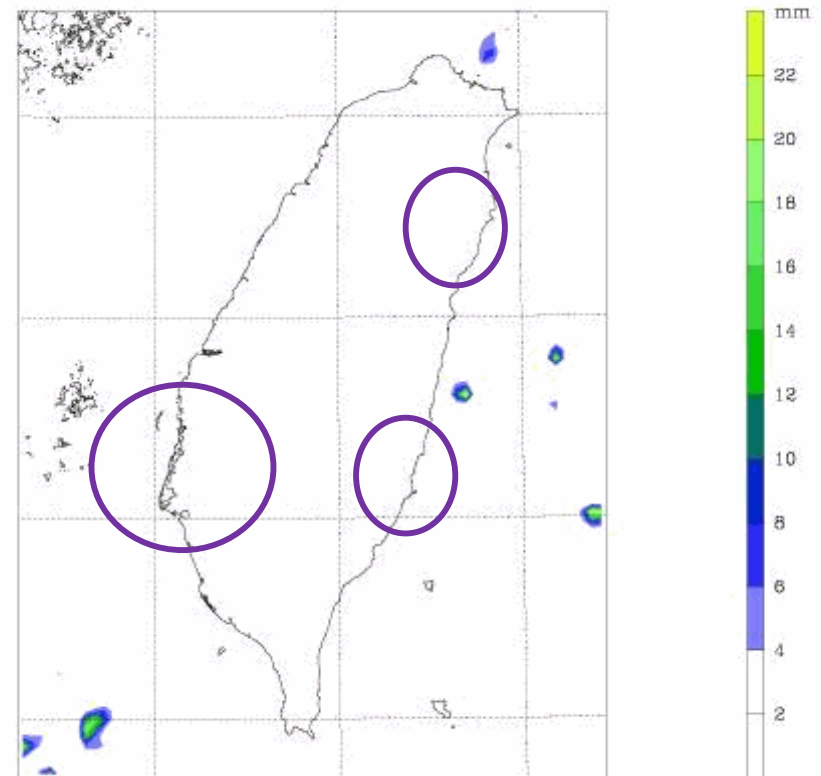
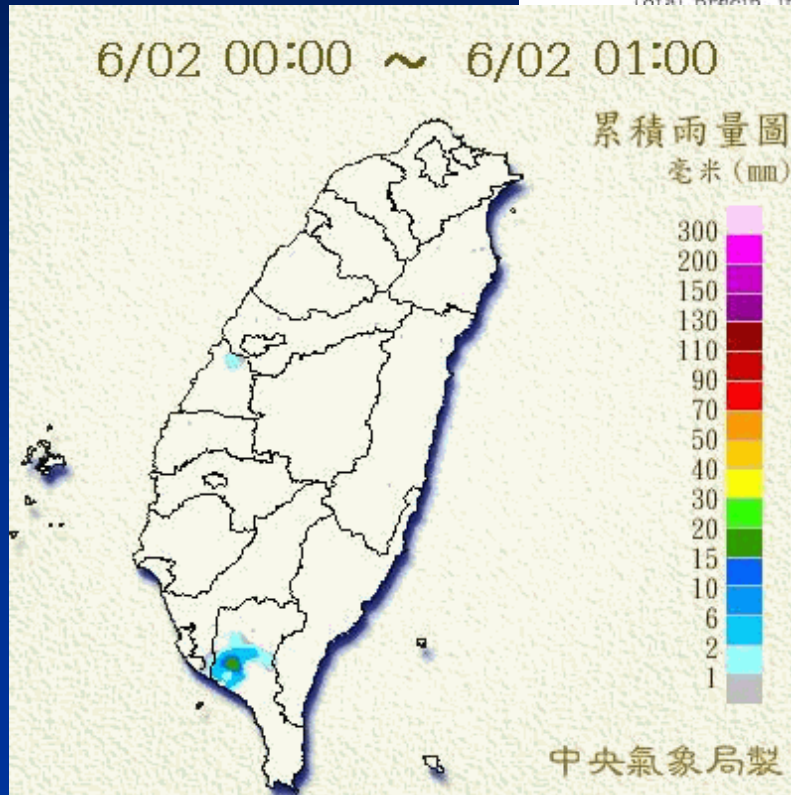


Model Info: V3.1 M No Cu YSU PBL WSM 6class Ther-Diff 5.0 km, 31 levels, 20 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

# WRF Accumulated Rainfall on 2 June

## WDM6

Dataset: d3 RIP: 0602 d3 rain Init: 0000 UTC Sun 01 Jun 08  
Fest: 17.00 h Valid: 1700 UTC Sun 01 Jun 08 (0100 LST Mon 02 Jun 08)  
Total precip. in past 1 h



Model Info: V3.1 M No Cu YSU PBL Ther-Diff 5.0 km, 31 levels, 20 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

**WDM6 in better agreement with observed rainfall !**

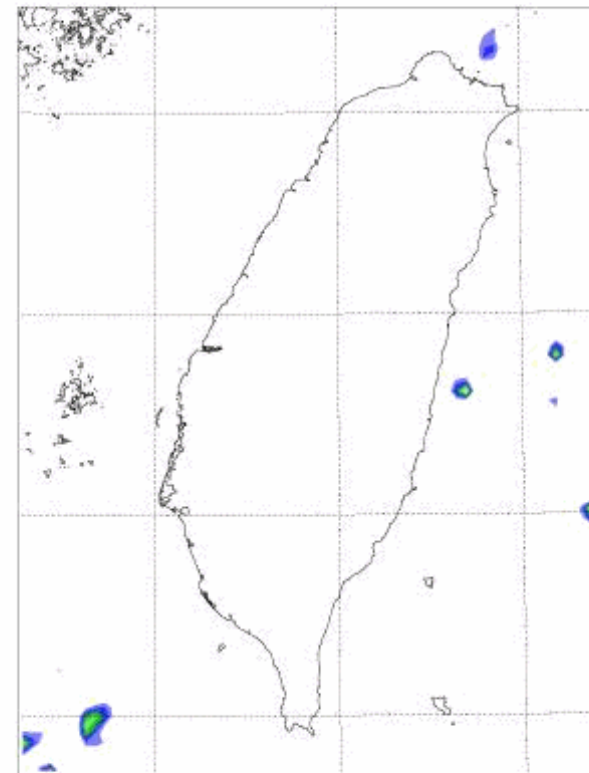
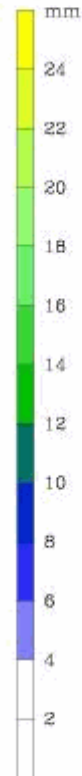
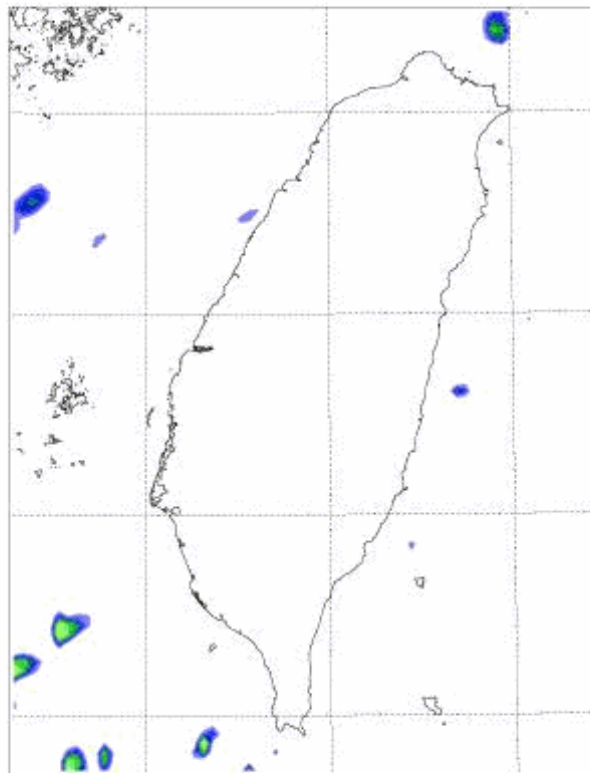
# WRF Accumulated Rainfall on 2 June

## WSM6

## WDM6

Dataset: d3 RIP: 0602 d3 rain Init: 0000 UTC Sun 01 Jun 08  
Fcst: 17.00 h Valid: 1700 UTC Sun 01 Jun 08 (0100 LST Mon 02 Jun 08)  
Total precip. in past 1 h

IP: 0602 d3 rain Init: 0000 UTC Sun 01 Jun 08  
1 Valid: 1700 UTC Sun 01 Jun 08 (0100 LST Mon 02 Jun 08)  
1 past 1 h



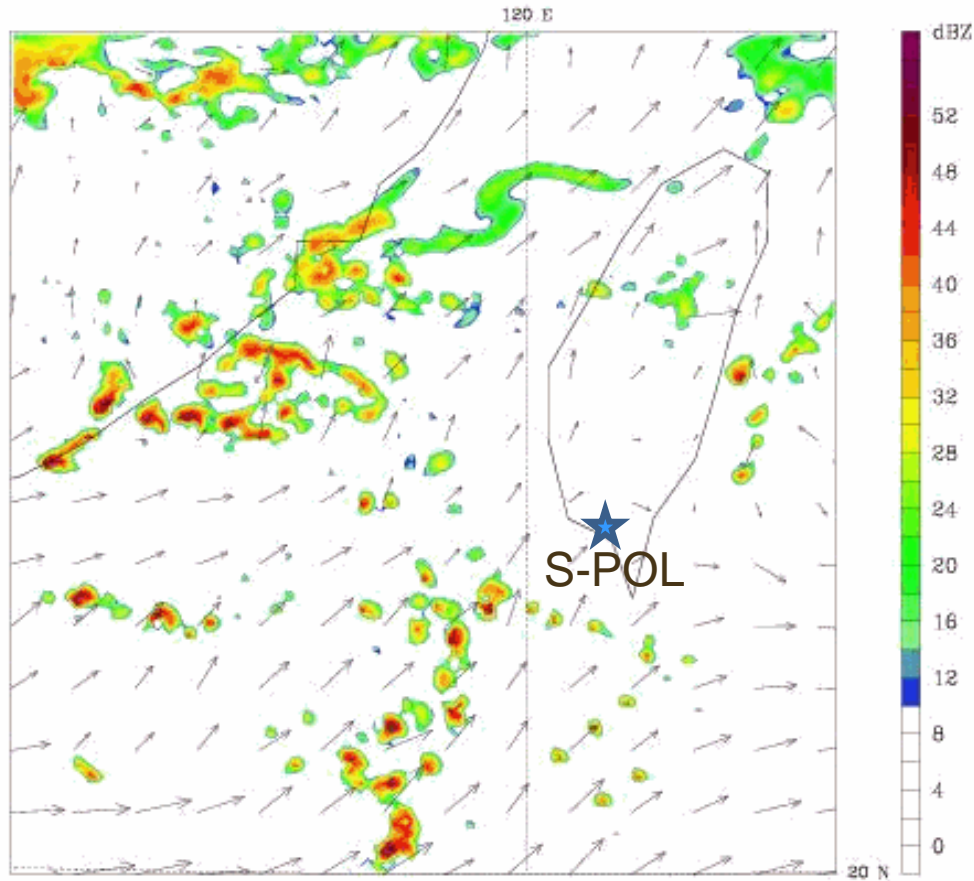
Model Info: V3.1 M No Cu YSU PBL WSM 6class Ther-Diff 5.0 km, 31 levels, 20 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

ifo: V3.1 M No Cu YSU PBL Ther-Diff 5.0 km, 31 levels, 20 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

# Hourly Radar Reflectivity at 850 hPa

Dataset: d3 RIP: dbz  
 Time: 17:00 h  
 Reflectivity ( )  
 Horizontal wind vectors

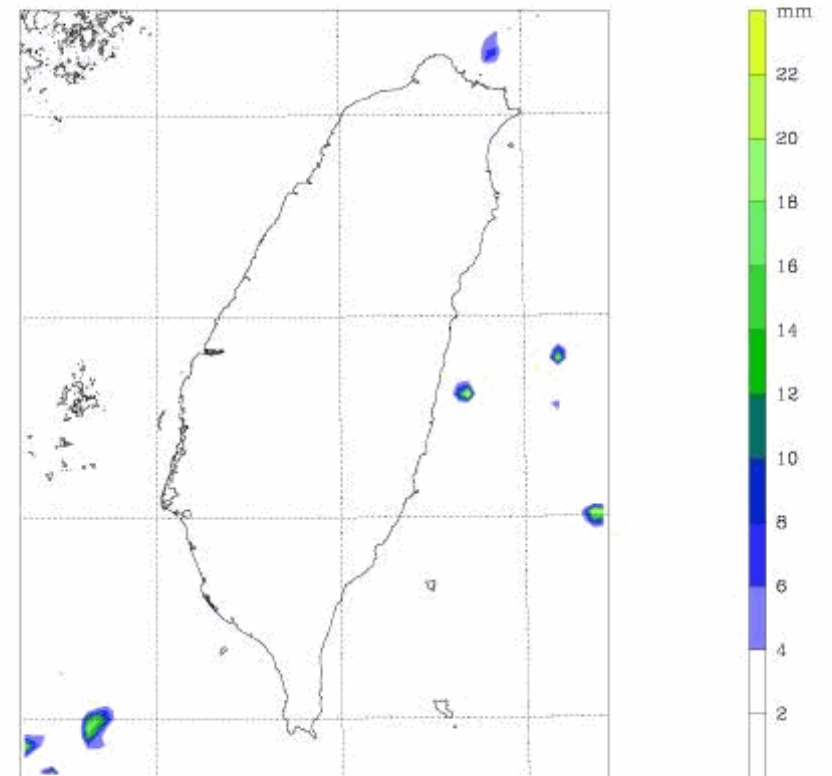
Init: 0000 UTC Sun 01 Jun 08  
 Valid: 1700 UTC Sun 01 Jun 08 (0200 LDT Mon 02 Jun 08)  
 at pressure = 850 hPa  
 at pressure = 850 hPa



Model Info: V3.1 M No Cu YSU PBL Ther-Diff 5.0 km, 31 levels, 20 sec  
 LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor  
 MAXIMUM VECTOR: 9.8 m s<sup>-1</sup>

# Accumulated Rainfall on 2 June

Dataset: 0602 d3 rain  
 Init: 0000 UTC Sun 01 Jun 08  
 Valid: 1700 UTC Sun 01 Jun 08 (0100 LST Mon 02 Jun 08)  
 Duration: 1 h



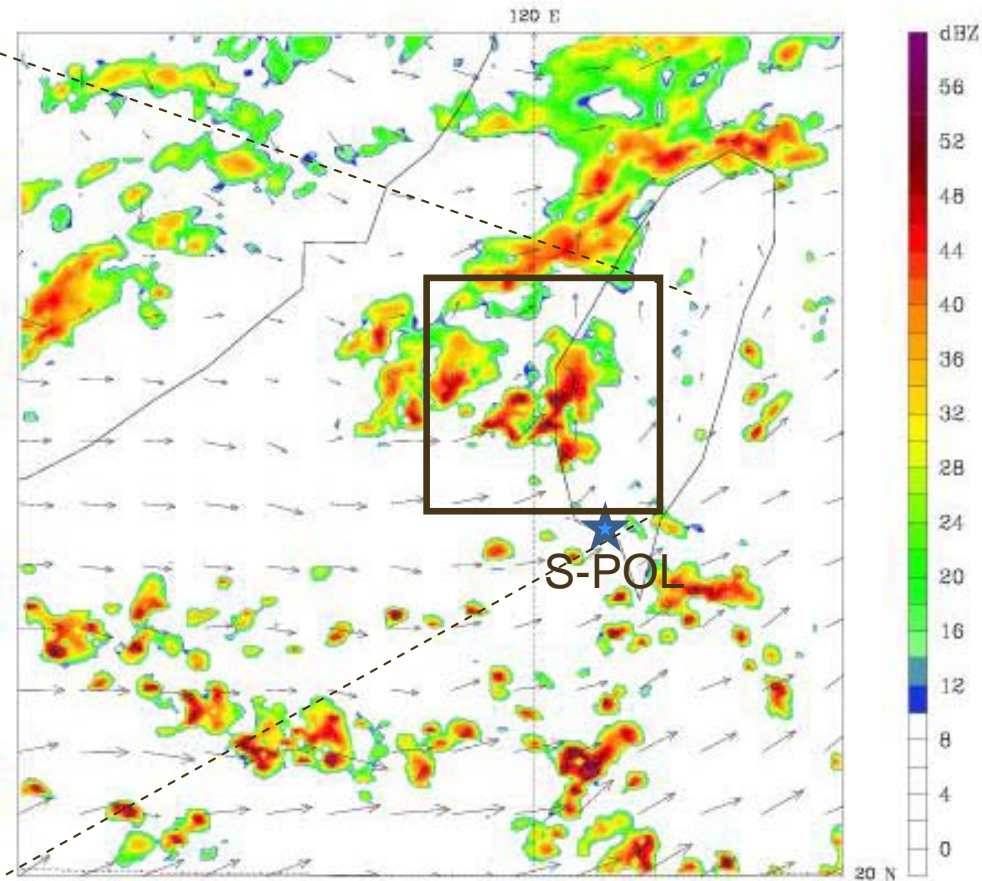
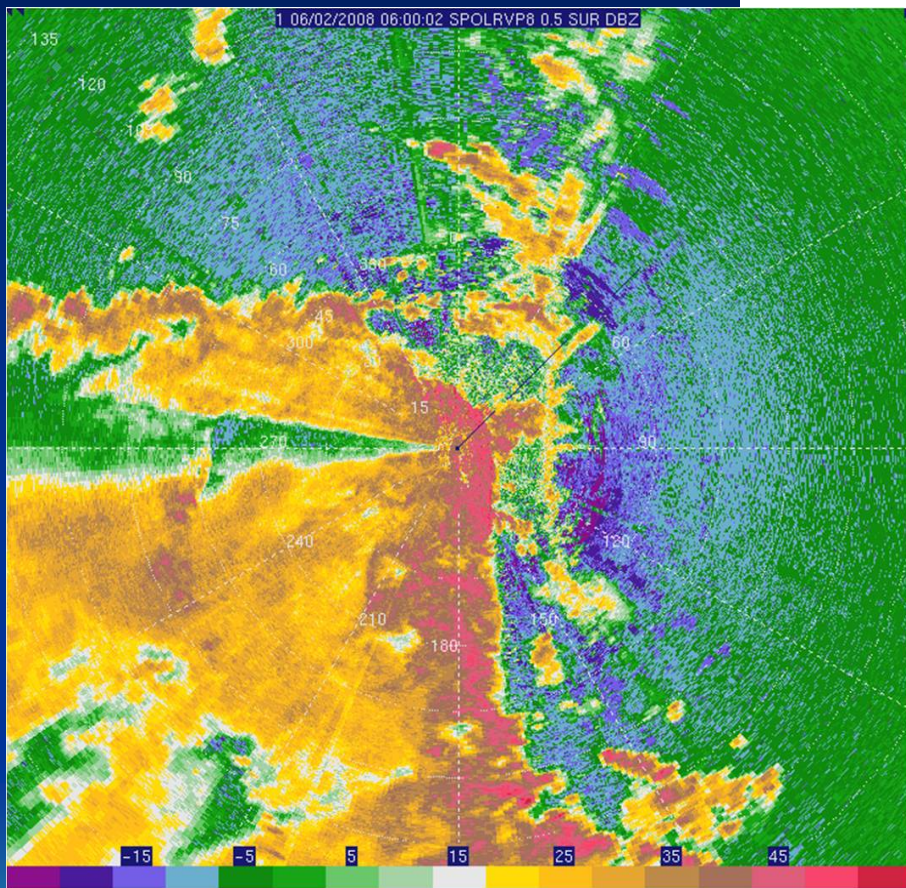
Model Info: V3.1 M No Cu YSU PBL Ther-Diff 5.0 km, 31 levels, 20 sec  
 LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

# Simulated Radar Reflectivity

## S-POL Radar Reflectivity

Dataset: d3 RIP: dbz  
Fest: 25.00 h  
Reflectivity ( )  
Horizontal wind vectors

Init: 0000 UTC Sun 01 Jun 08  
Valid: 0100 UTC Mon 02 Jun 08 (1000 LDT Mon 02 Jun 08)  
at pressure = 850 hPa  
at pressure = 850 hPa



Model Info: V3.1 M No Cu YSU PBL Ther-Diff 5.0 km, 31 levels, 20 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

MAXIMUM VECTOR: 13.9 m s<sup>-1</sup>

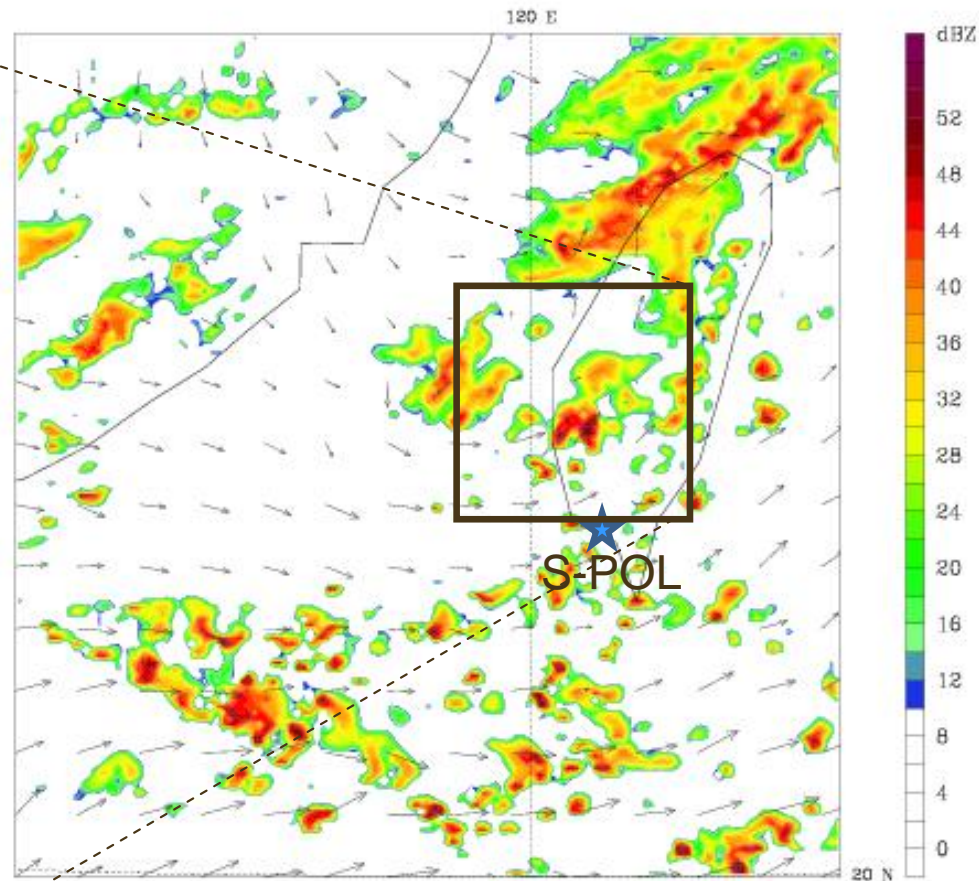
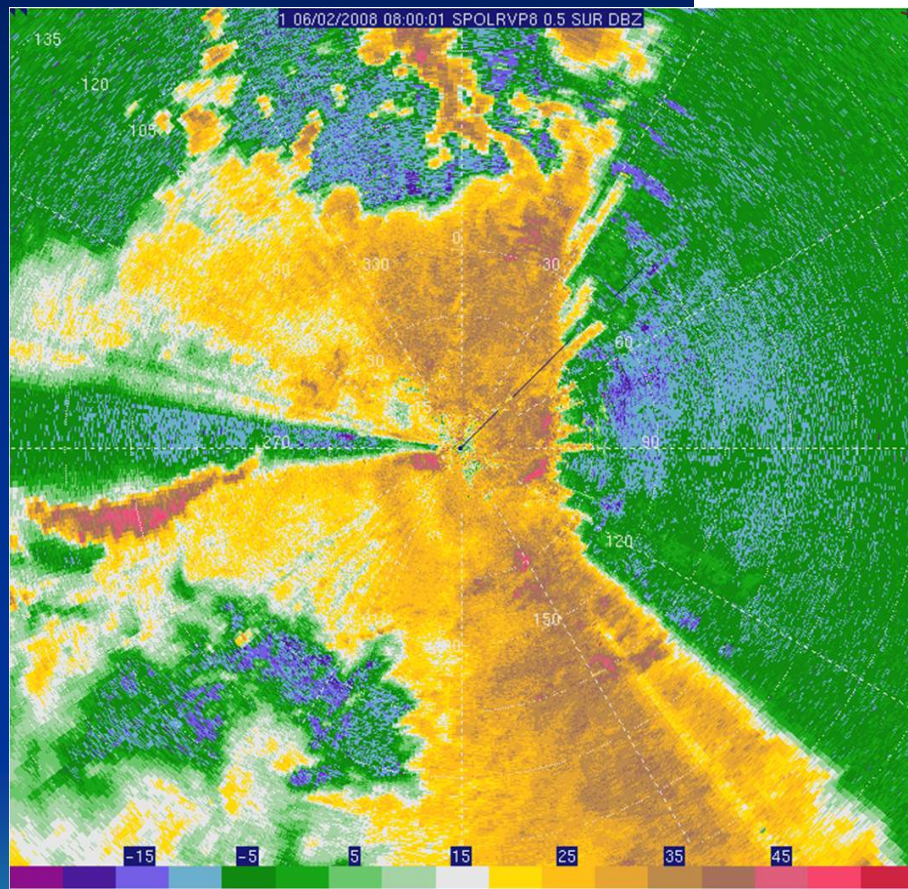


# Simulated Radar Reflectivity

## S-POL Radar Reflectivity

Dataset: d3 RIP: dbz  
Fest: 27.00 h  
Reflectivity ( )  
Horizontal wind vectors

Init: 0000 UTC Sun 01 Jun 08  
Valid: 0300 UTC Mon 02 Jun 08 (1200 LDT Mon 02 Jun 08)  
at pressure = 850 hPa  
at pressure = 850 hPa



Model Info: V3.1 M No Cu YSU PBL Ther-Diff 5.0 km, 31 levels, 20 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

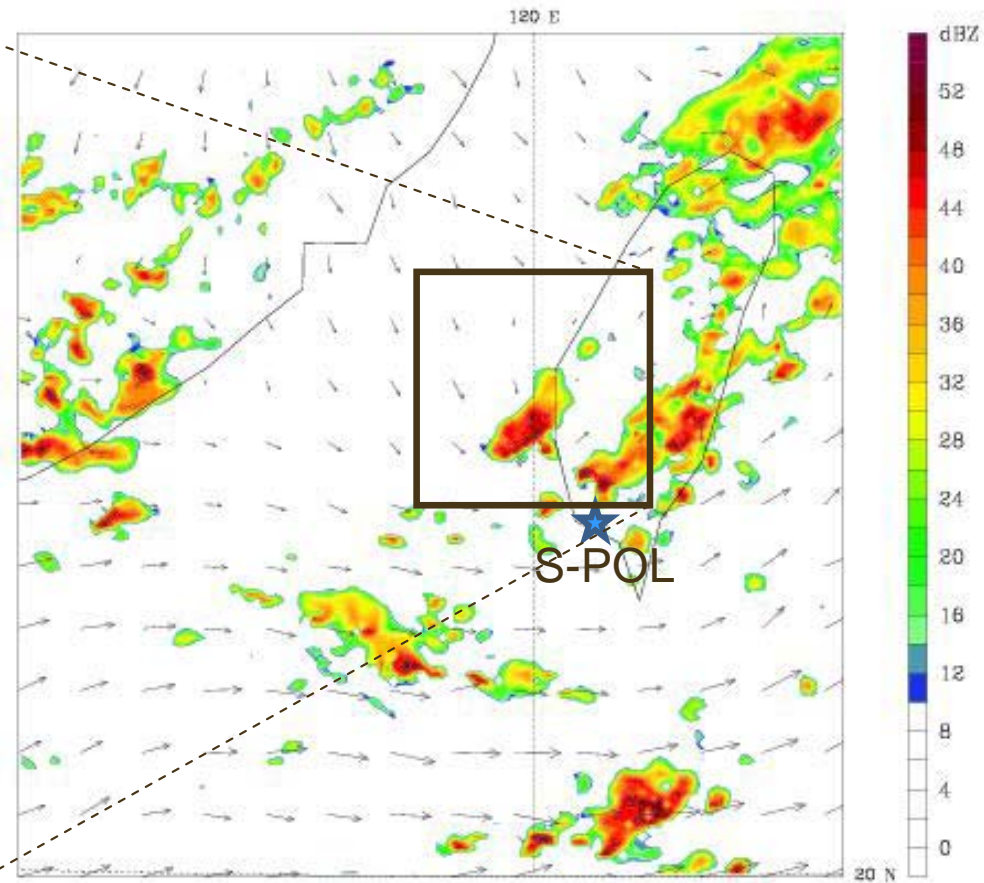
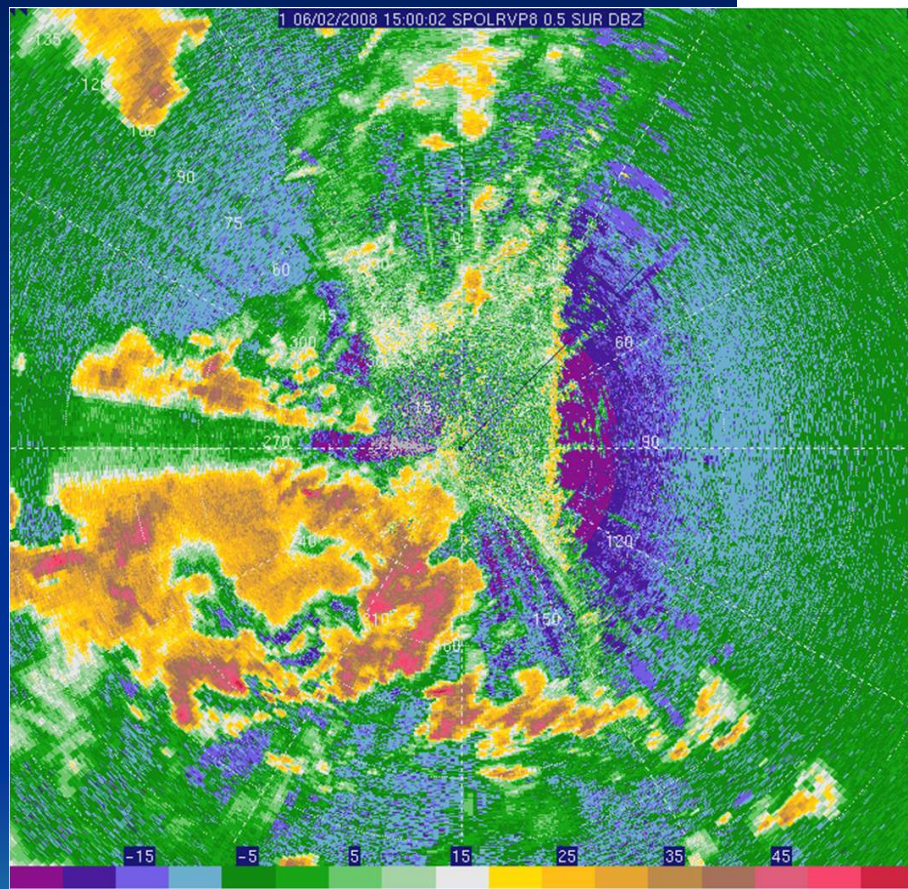
MAXIMUM VECTOR: 15.0 m s<sup>-1</sup>

# Simulated Radar Reflectivity

## S-POL Radar Reflectivity

Dataset: d3 RIP: dbz  
Fest: 30.00 h  
Reflectivity ( )  
Horizontal wind vectors

Init: 0000 UTC Sun 01 Jun 08  
Valid: 0600 UTC Mon 02 Jun 08 (1500 LDT Mon 02 Jun 08)  
at pressure = 850 hPa  
at pressure = 850 hPa



Model Info: V3.1 M No Cu YSU PBL Ther-Diff 5.0 km, 31 levels, 20 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

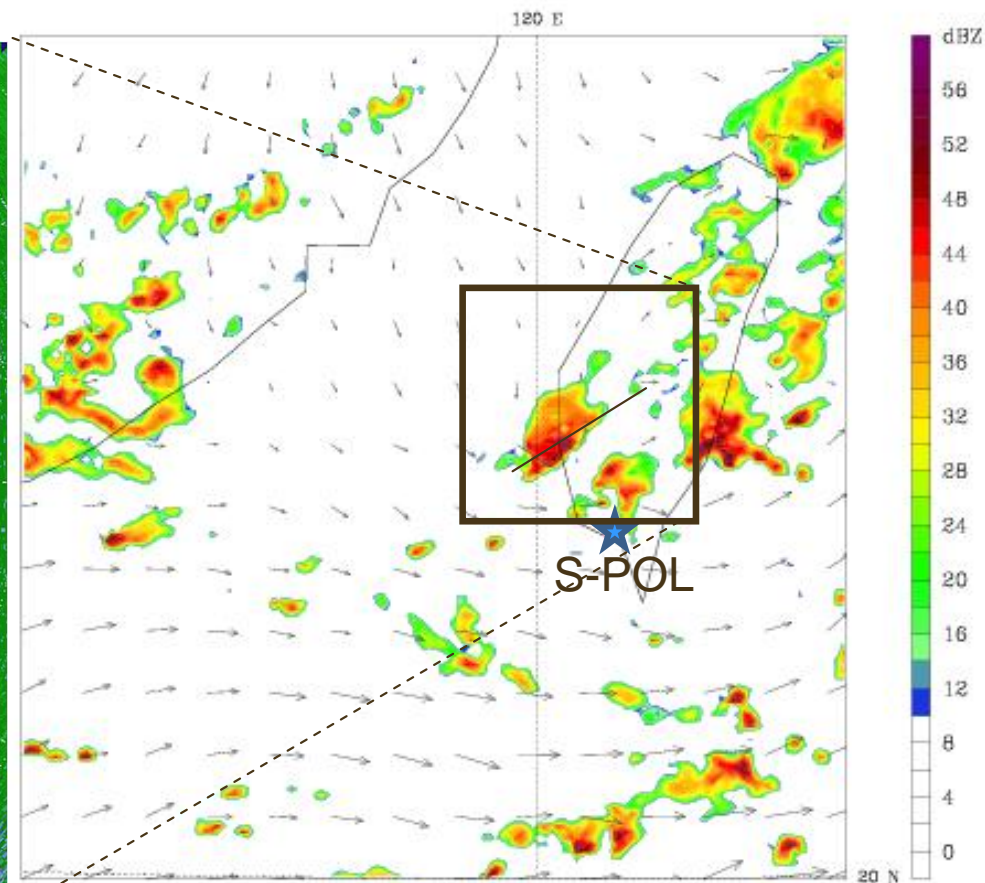
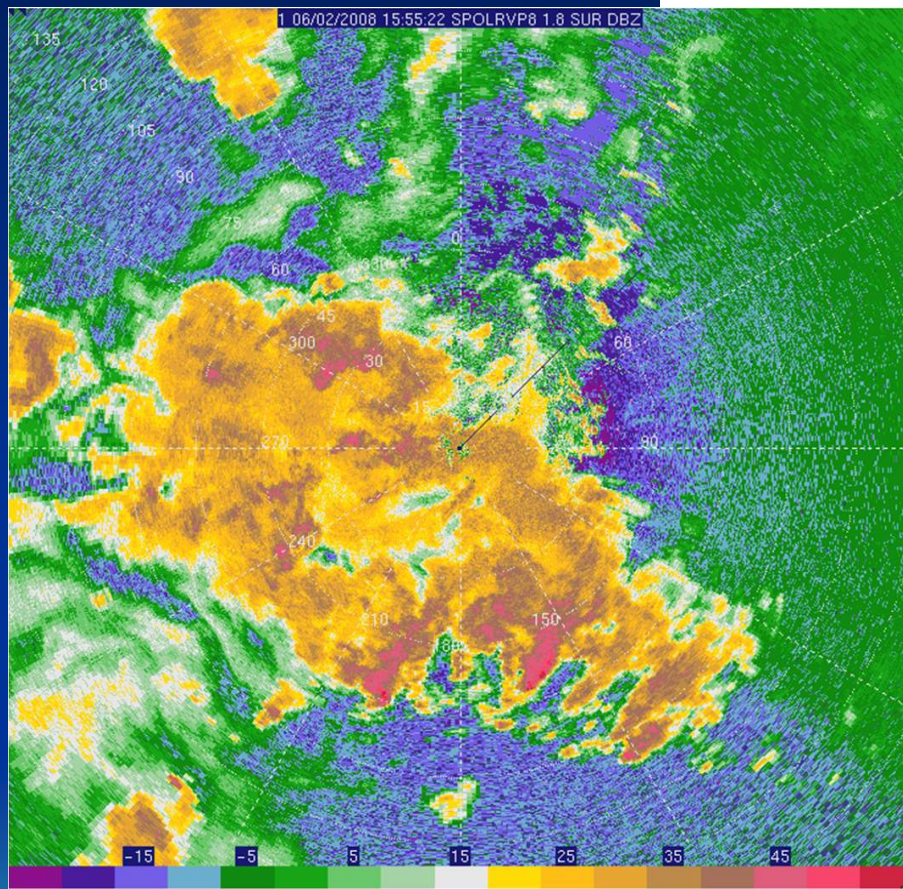
MAXIMUM VECTOR: 17.4 m s<sup>-1</sup>

# Simulated Radar Reflectivity

## S-POL Radar Reflectivity

Dataset: d3 RIP: dbz  
Fest: 31.00 h  
Reflectivity ( )  
Horizontal wind vectors

Init: 0000 UTC Sun 01 Jun 08  
Valid: 0700 UTC Mon 02 Jun 08 (1600 LDT Mon 02 Jun 08)  
at pressure = 850 hPa  
at pressure = 850 hPa



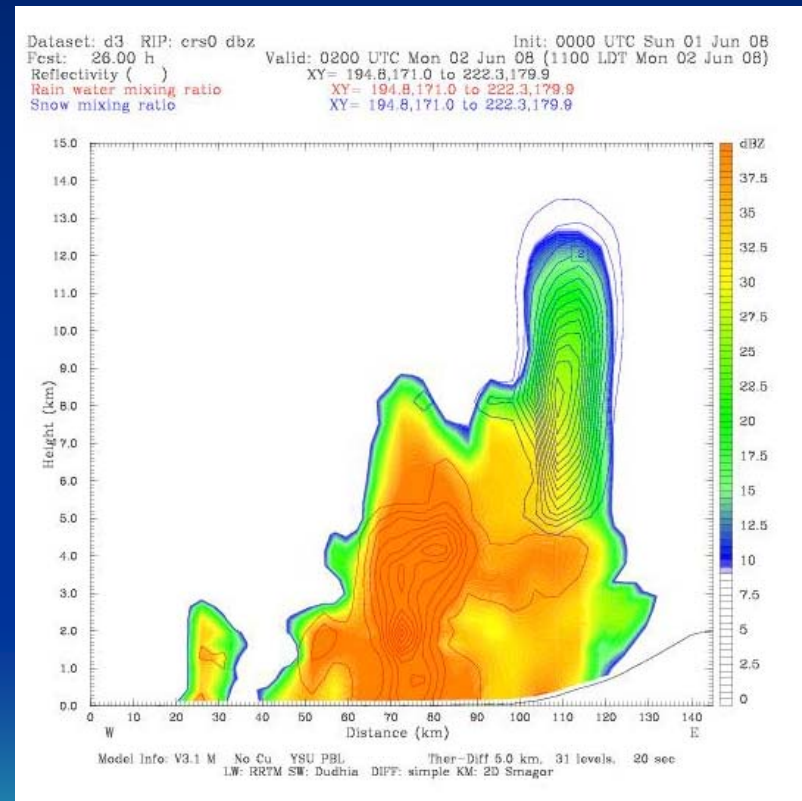
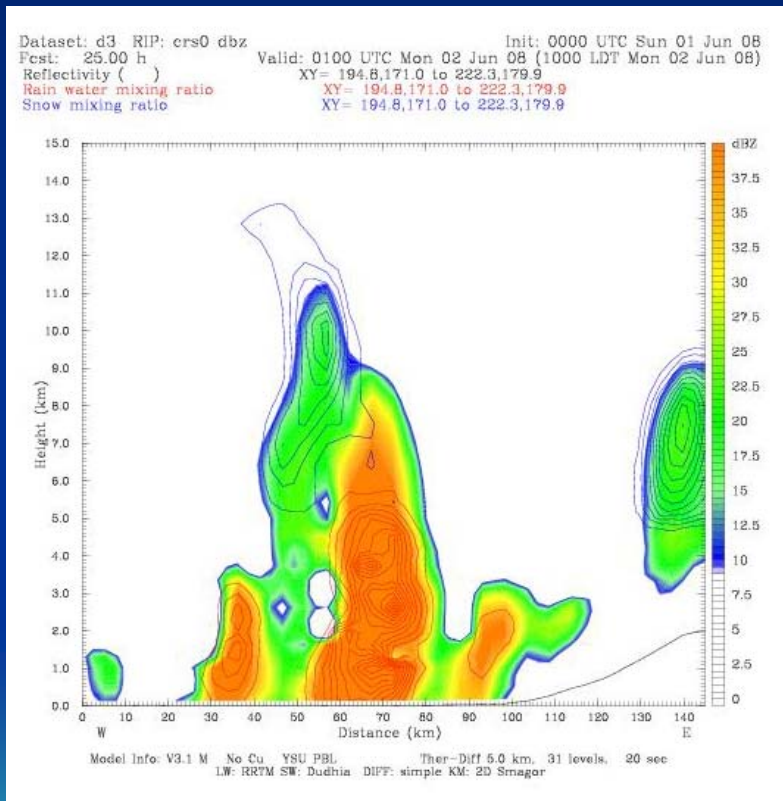
Model Info: V3.1 M No Cu YSU PBL Ther-Diff 5.0 km, 31 levels, 20 sec  
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

MAXIMUM VECTOR: 19.8 m s<sup>-1</sup>

# Vertical Cross Sections of Z, Qr, and Qs

t = 25 h

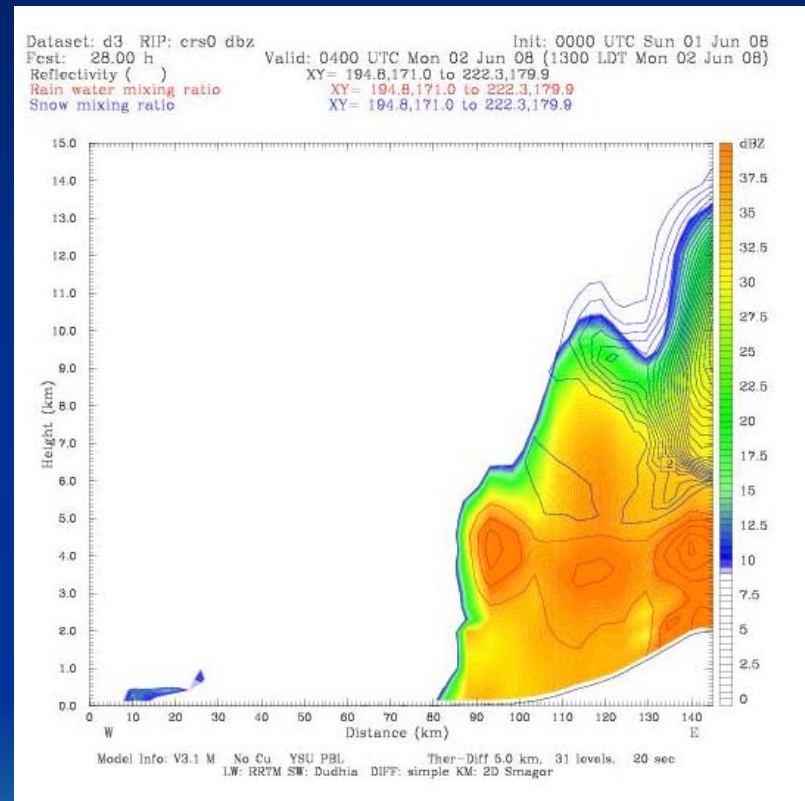
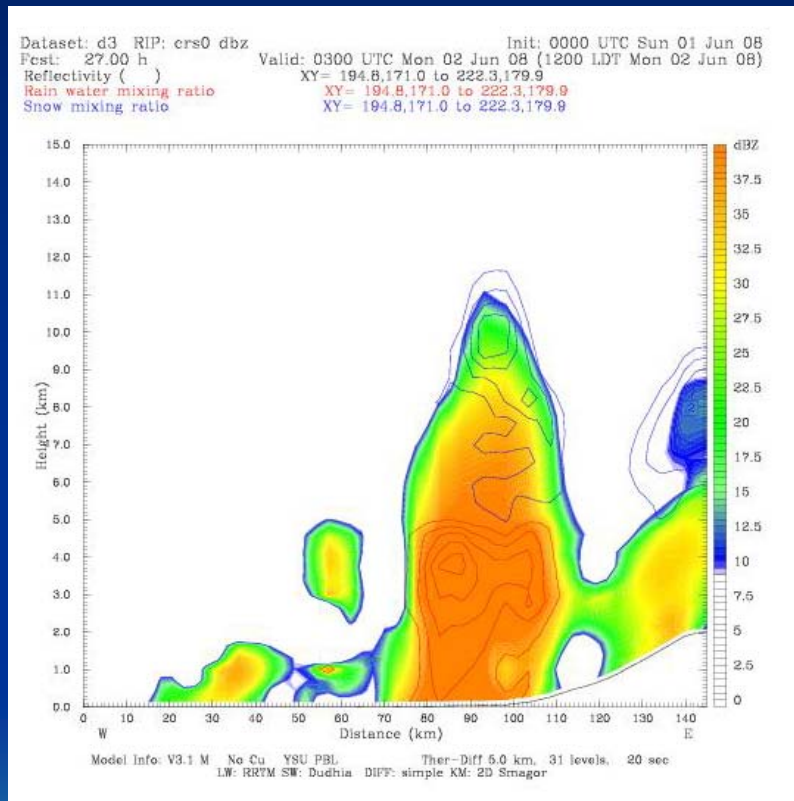
t = 26 h



# Vertical Cross Sections of Z, Qr, and Qs

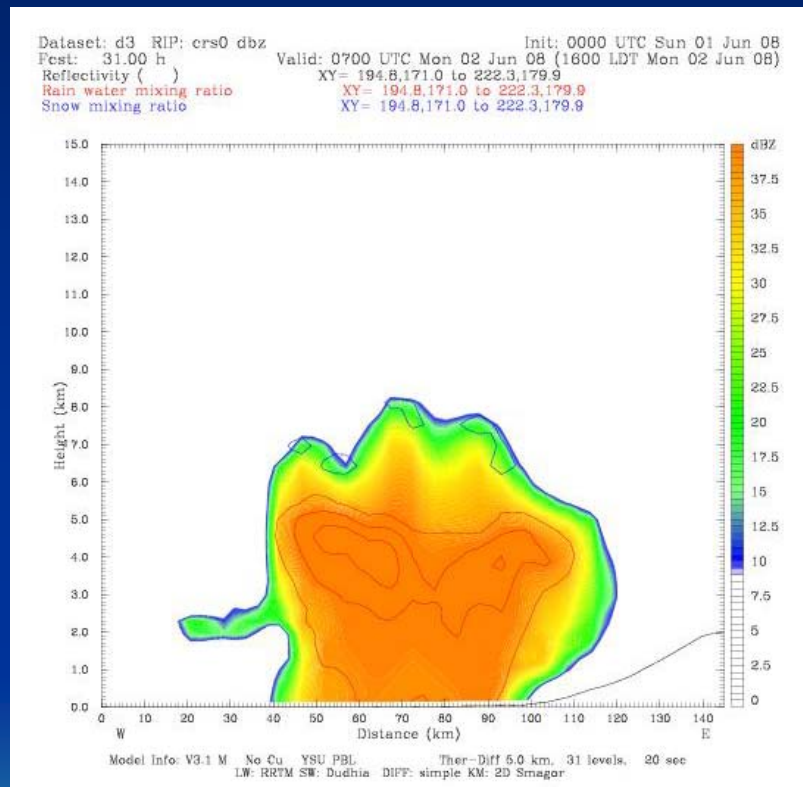
t = 27 h

t = 28 h

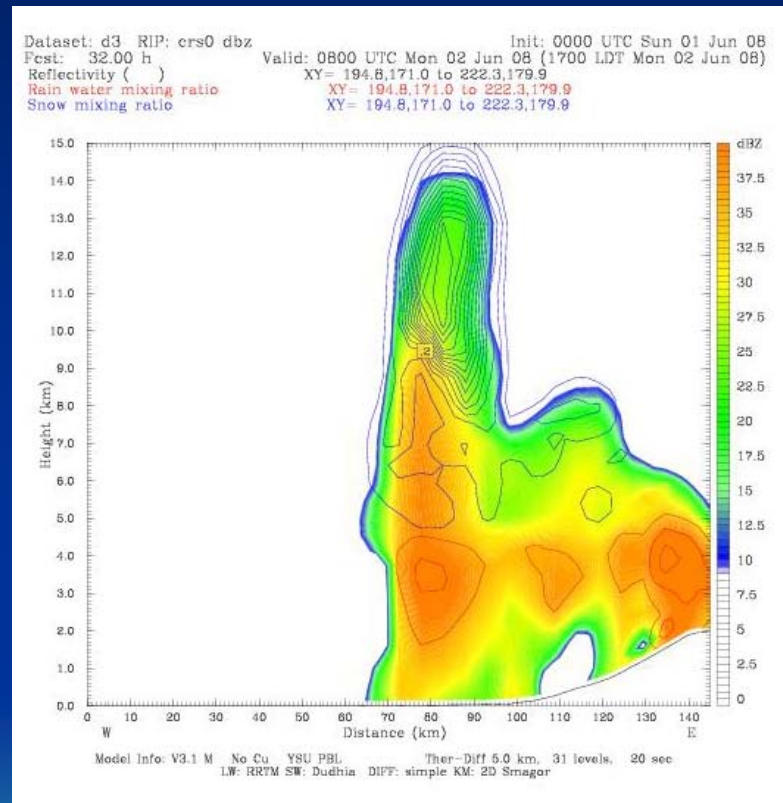


# Vertical Cross Sections of Z, Qr, and Qs

t = 31 h



t = 32 h



# Summary

- Several MCSs were embedded with the quasi-stationary Mei-Yu front on 1-3 June 2008, resulting in heavy rainfall and local flooding.
- A quadruply nested-grid WRF model with the finest grid size of 1.67 km is used to simulate the synoptic environment, kinematic and precipitation structures in this frontal convective systems.
- Preliminary comparisons with the S-POL observation show that the WRF model reproduces reasonably well the movement of Mei-Yu frontal system, wind shift, and the embedded precipitation structures, although the simulated frontal position is slightly to the north of the observed.

# Summary

- Evident differences in precipitation structures are found in simulations using the 6-category single-moment (WSM6) and double-moment (WDM6) microphysics schemes.
- More work will be conducted to further investigate the hydrometeor calibration with S-POL PID products and microphysical evolution of the MCSs embedded in this quasi-stationary Mei-Yu front.

