Impacts of cyclogenesis and moisture transport by the marine boundary layer jet on heavy rainfall over southern Taiwan during the 2018 Mei-Yu season

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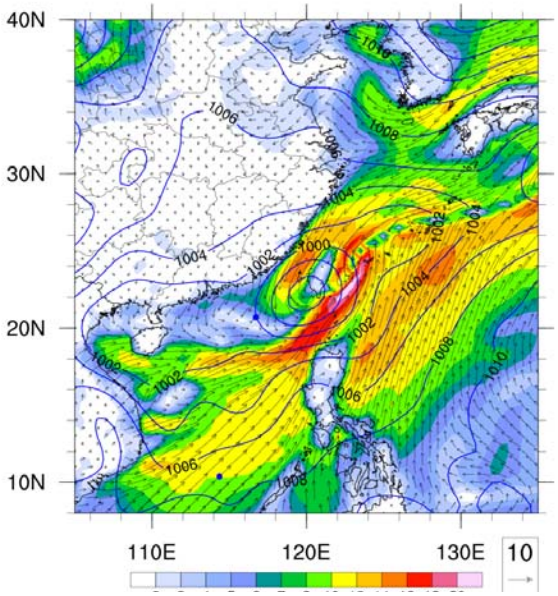
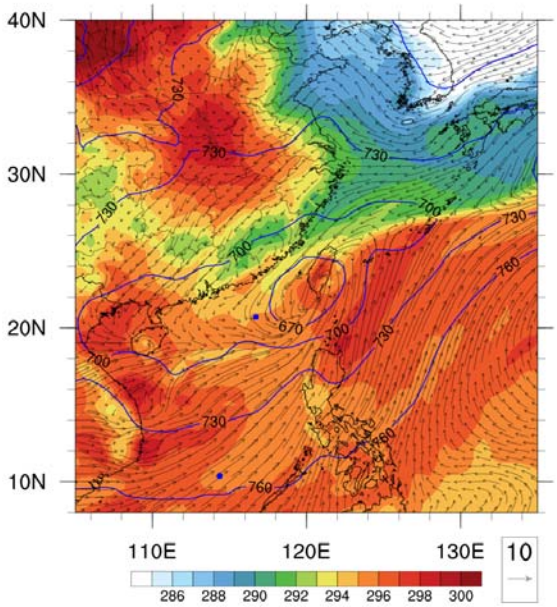
Outlines

1. Introduction
2. Cyclogenesis over the northern China Sea along the Mei-Yu Front (June 15 with heavy rainfall over southern Taiwan)
3. Cyclogenesis over the northern China Sea along the Mei-Yu Front (June 16-18)
4. Marine Boundary Layer Jet (MBLJ) and moisture transport (June 17-20)
5. Heavy Rainfall over Southern Taiwan (June 19-20)
6. Summary
7. Future Work

SLP+10m Winds



925hPa HGT+theta+Winds



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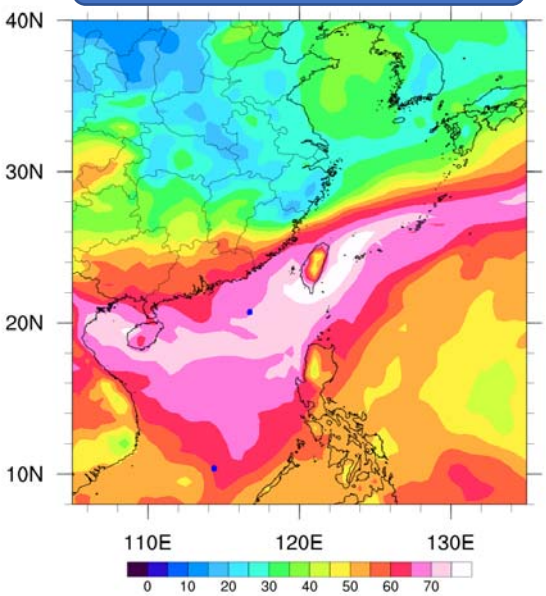
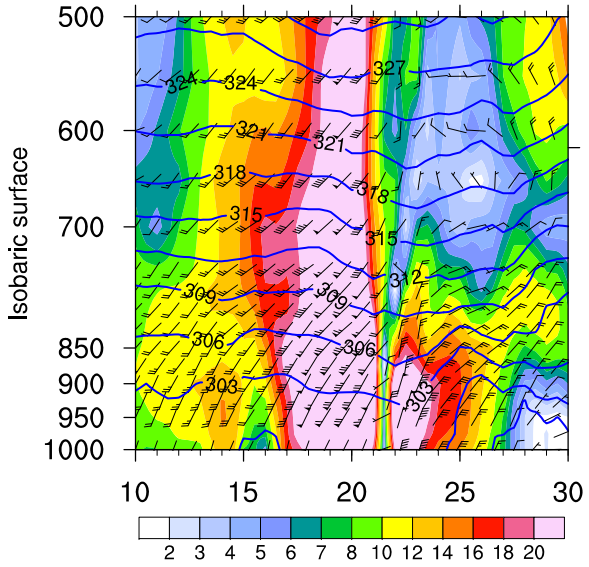


6/15 00UTC (熱帶風暴格美 Gaemi/日本氣象廳命名颱風凱米)

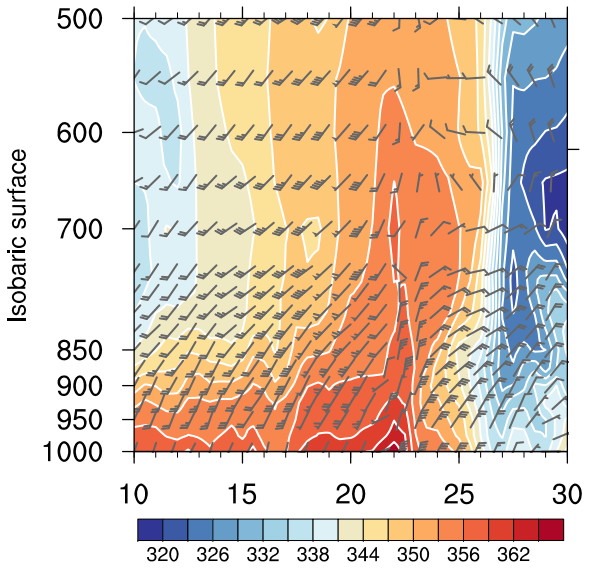
1 barb=5m/s

Vertical cross section at 120E (熱帶風暴格美Gaemi/ 日本氣象廳命名颱風凱米) 6/15 00UTC

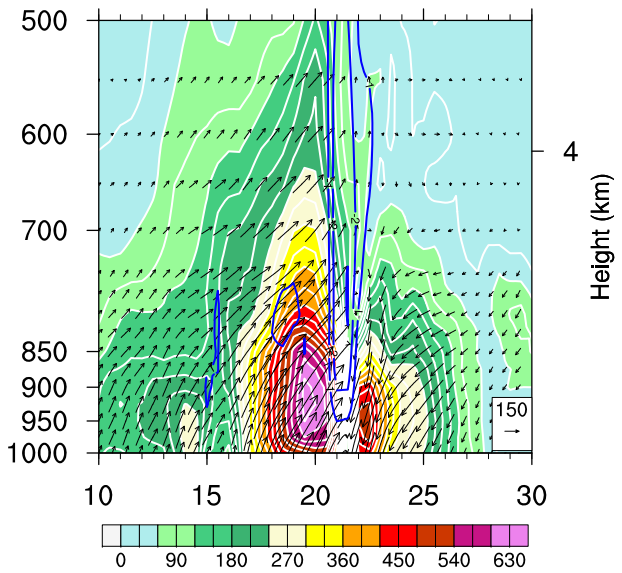
Wind Speed+theta+barb



thetae+barb



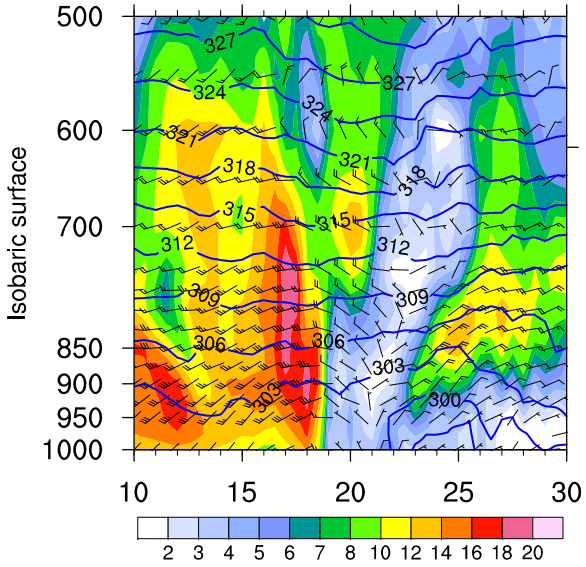
Moisture flux (g kg-1 m s-1) +w(Pa/s, upward)



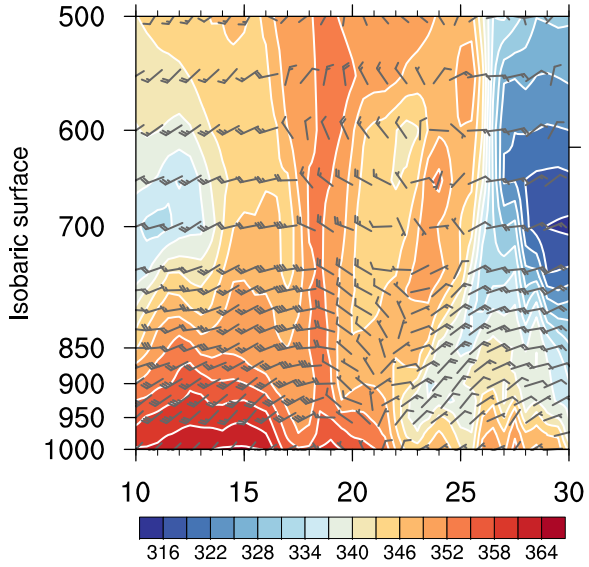
1 barb=5m/s

Vertical cross section at 114E (Mei-Yu frontal cyclogenesis: pre-cyclogenesis stage) 6/15 00UTC

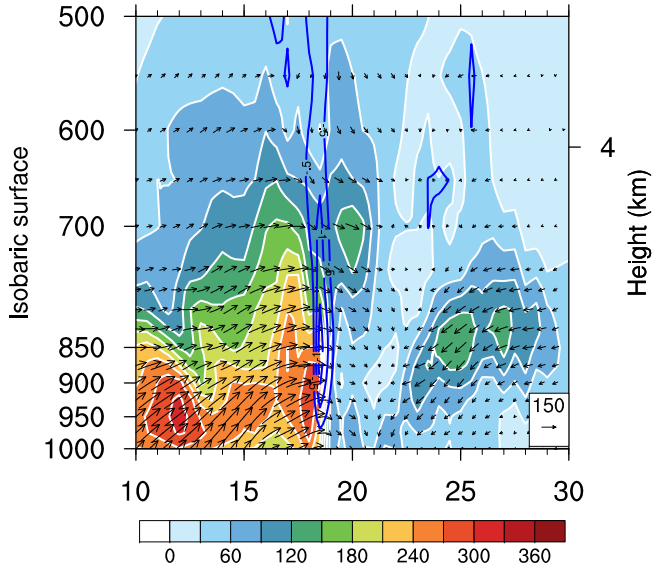
Wind Speed+theta+barb



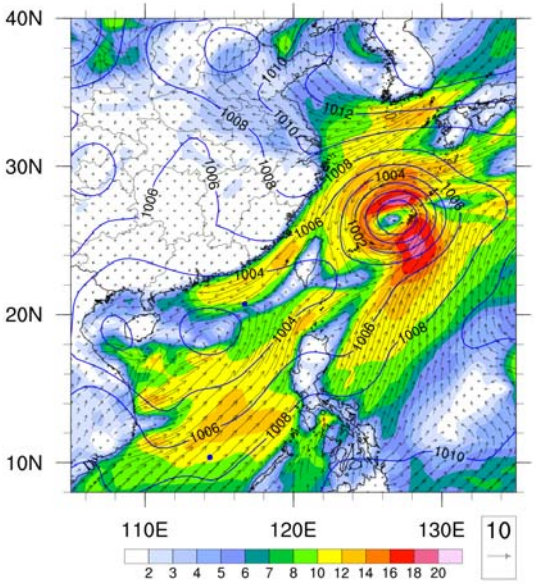
thetae+barb



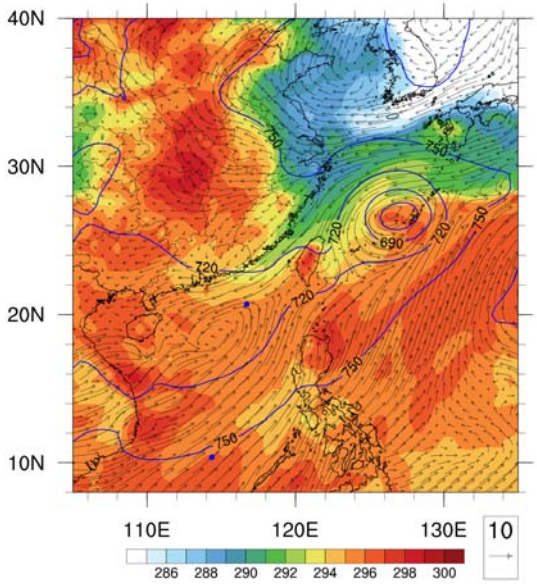
Moisture flux (g kg-1 m s-1) +w(Pa/s, upward)



SLP+10m Winds



925hPa HGT+theta+Winds



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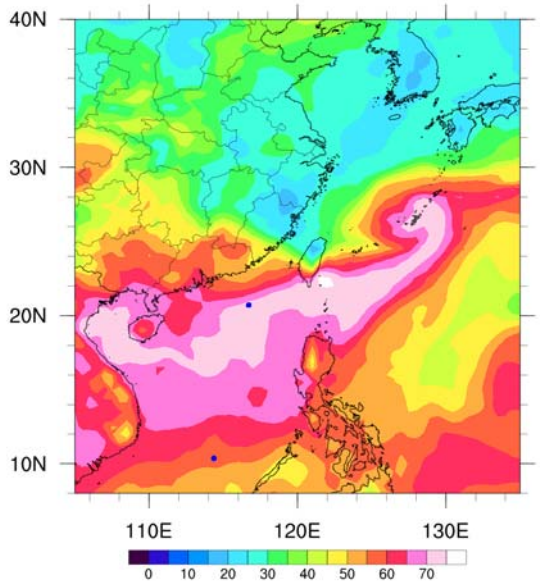
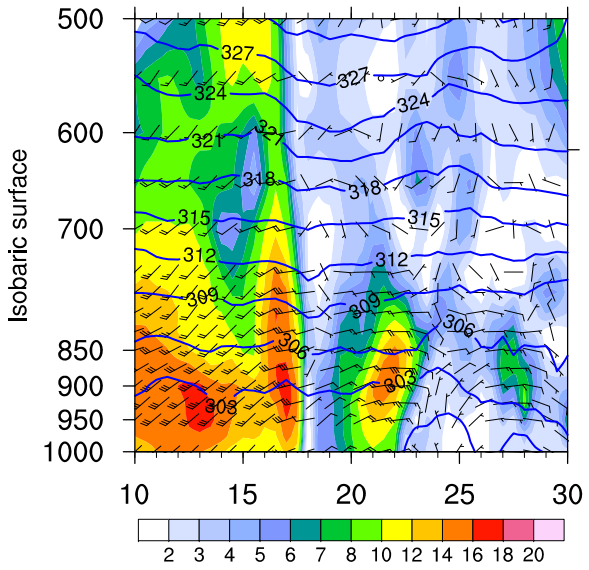


6/16 00UTC (Mei-Yu frontal cyclogen-esis: developi-ng stage)

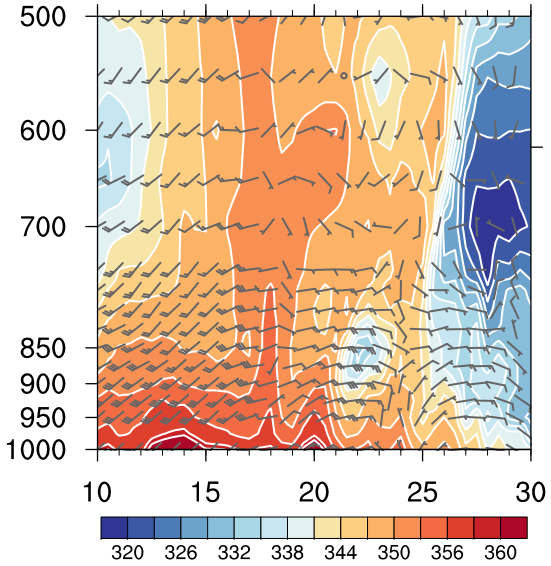
Vertical cross section at 114E (Mei-Yu frontal cyclogenesis: developing stage) 6/16 00UTC

1 barb=5m/s

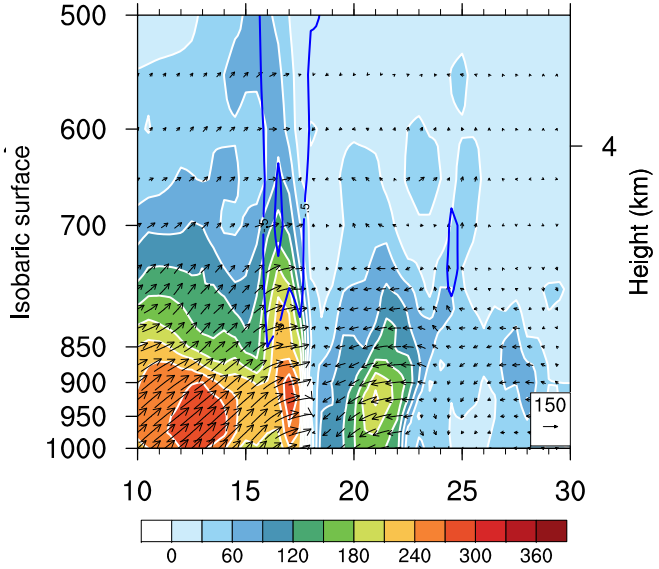
Wind Speed+theta+barb



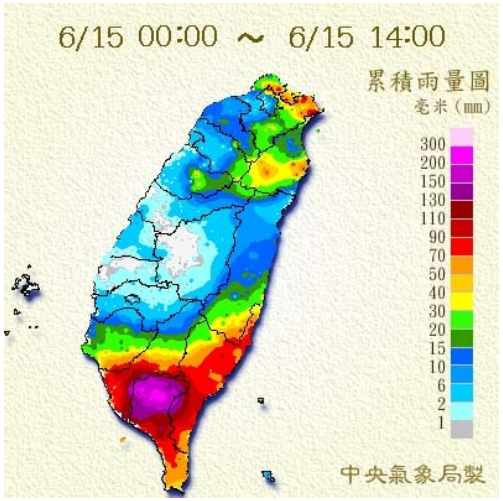
thetae+barb



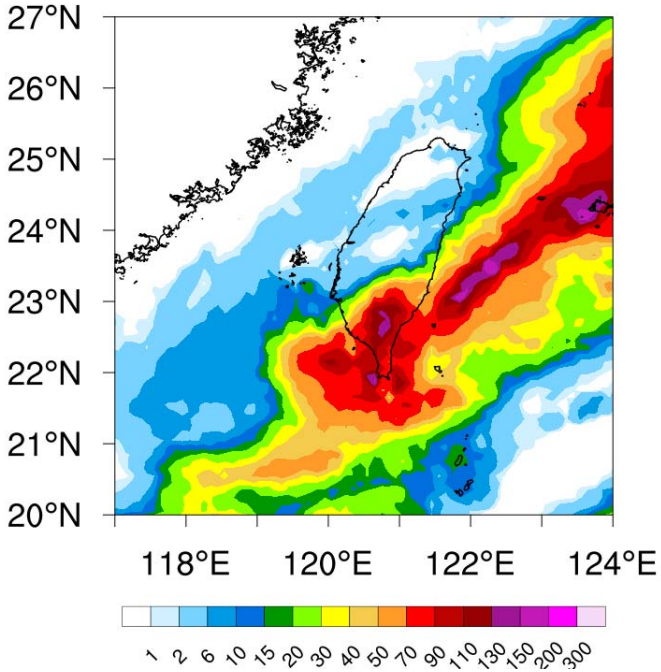
Moisture flux (g kg-1 m s-1) +w(Pa/s, upward)

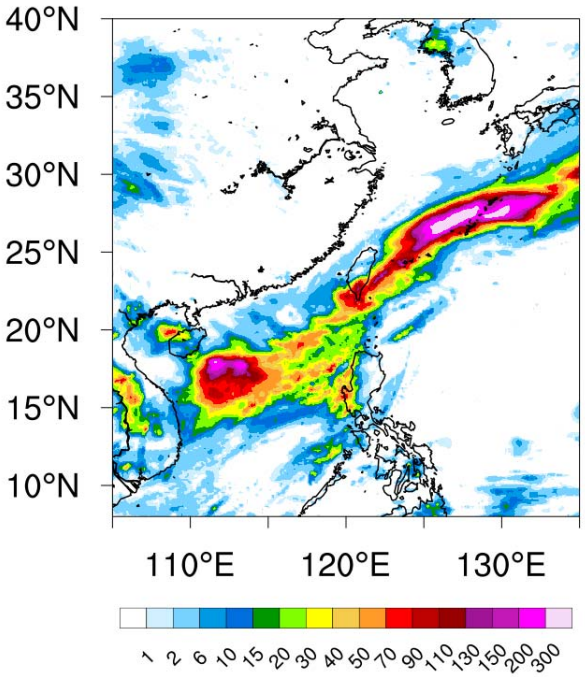


Rain gauge daily rainfall (mm)

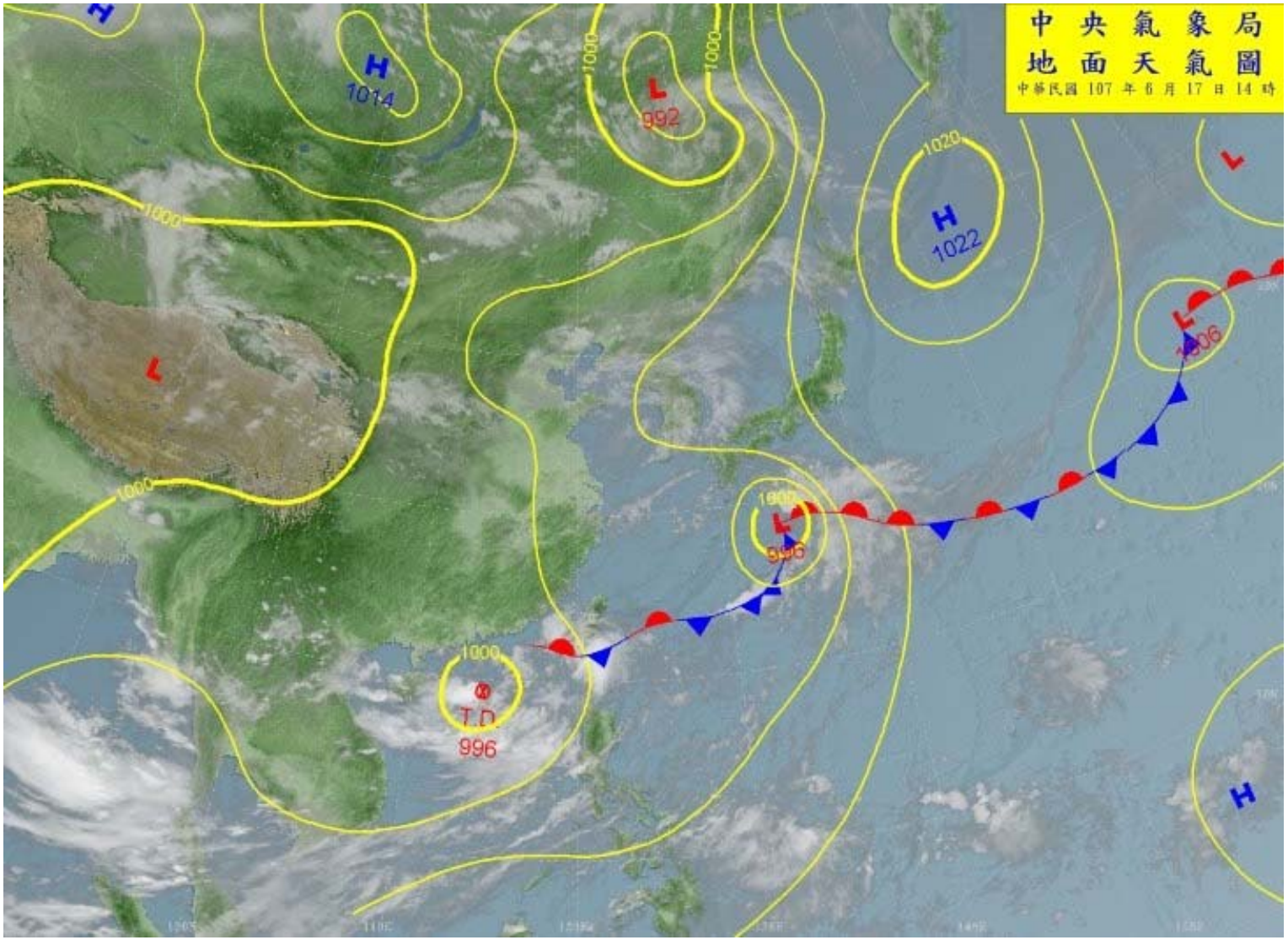


GPM daily rainfall (mm)

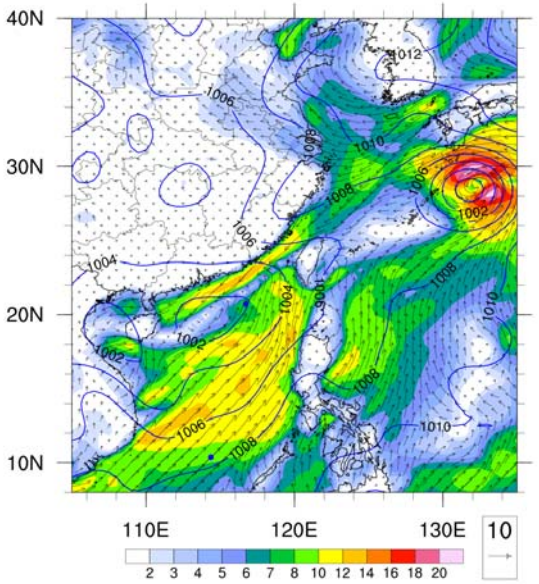




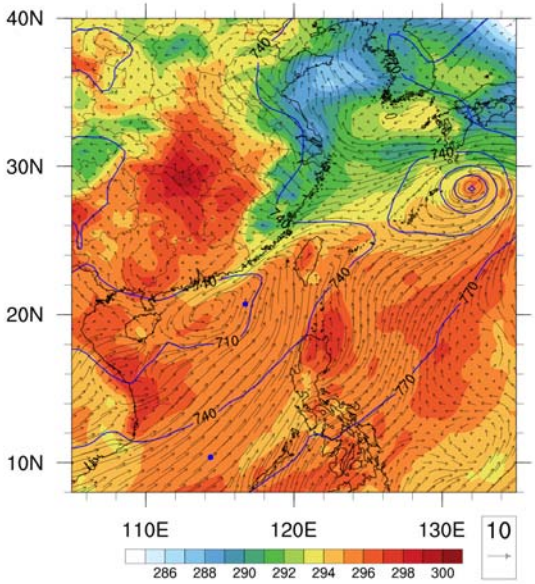
6/17 06UTC (Mei-Yu frontal cyclogenesis: mature stage)



SLP+10m Winds



925hPa HGT+theta+Winds



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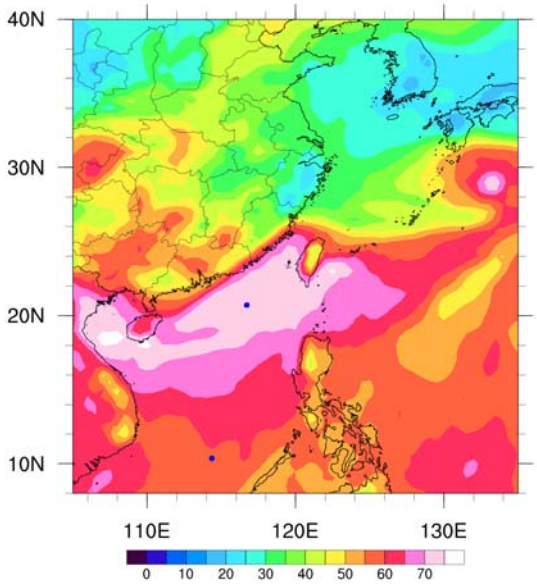
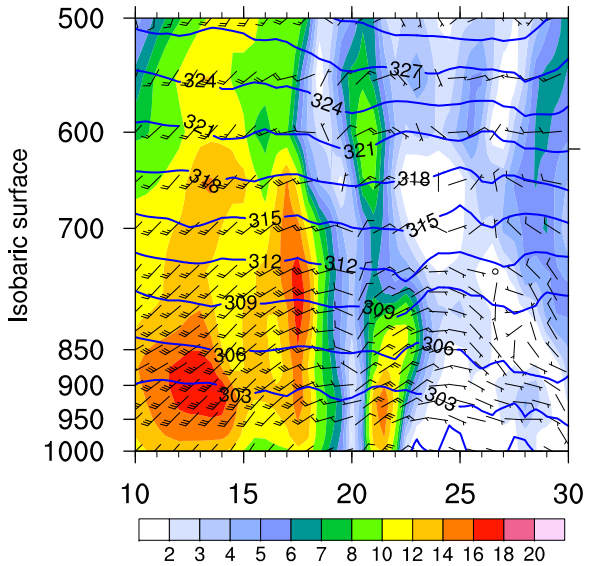


6/17 00UTC (Mei-Yu frontal cyclogen-esis: mature stage)

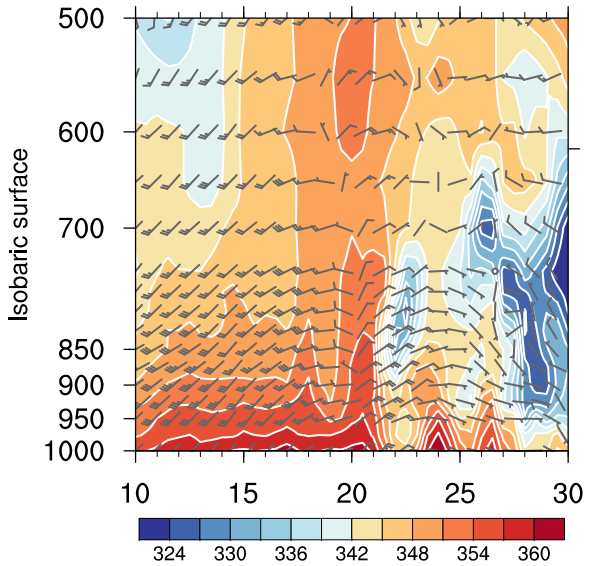
Vertical cross section at 114E (Mei-Yu frontal cyclogenesis: mature stage) 6/17 00UTC

1 barb=5m/s

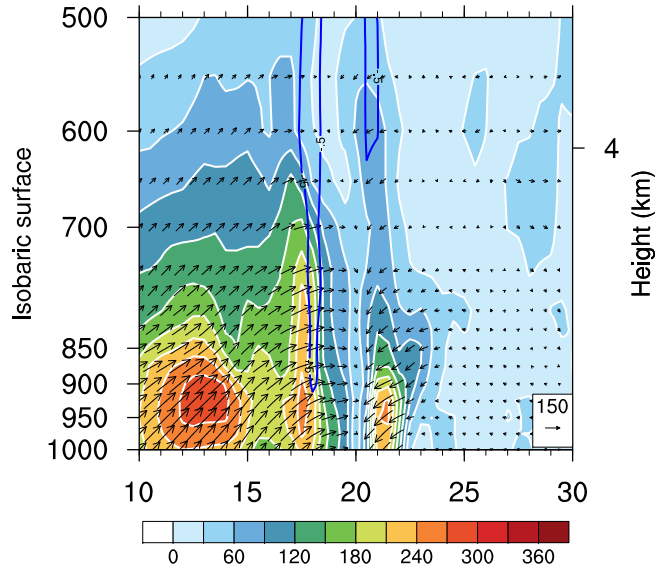
Wind Speed+theta+barb



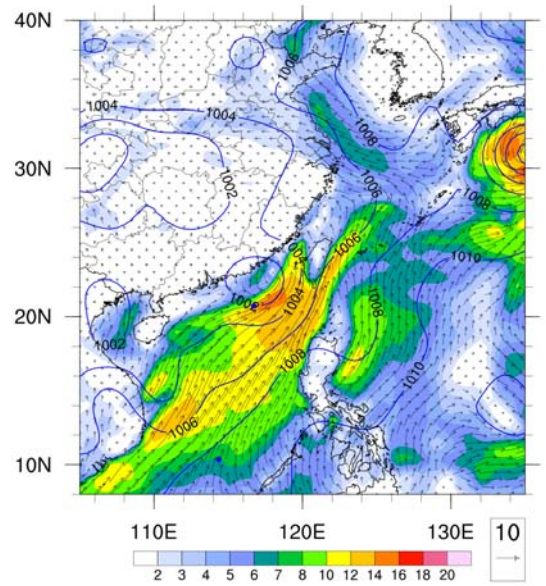
thetae+barb



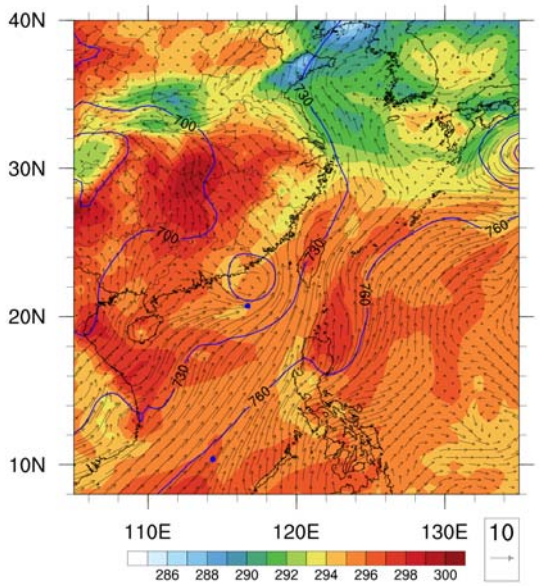
Moisture flux (g kg-1 m s-1) +w(Pa/s, upward)



SLP+10m Winds

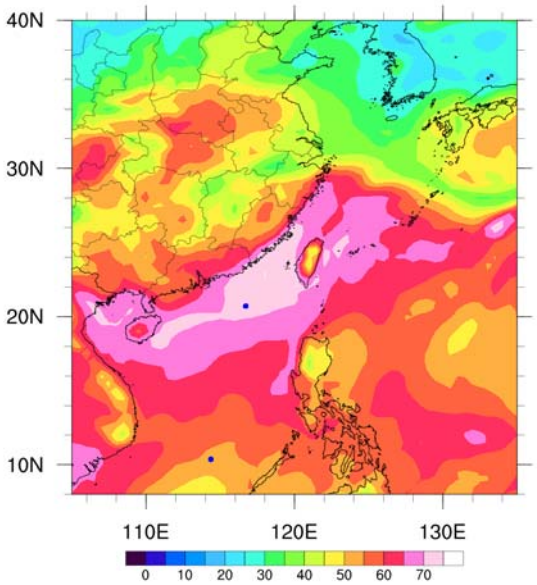


925hPa HGT+theta+Winds



6/18
00UTC

TPW



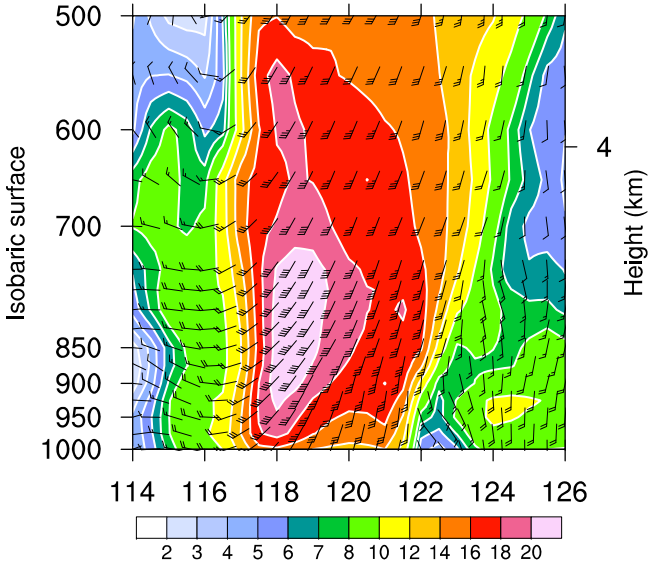
1 barb=5m/s

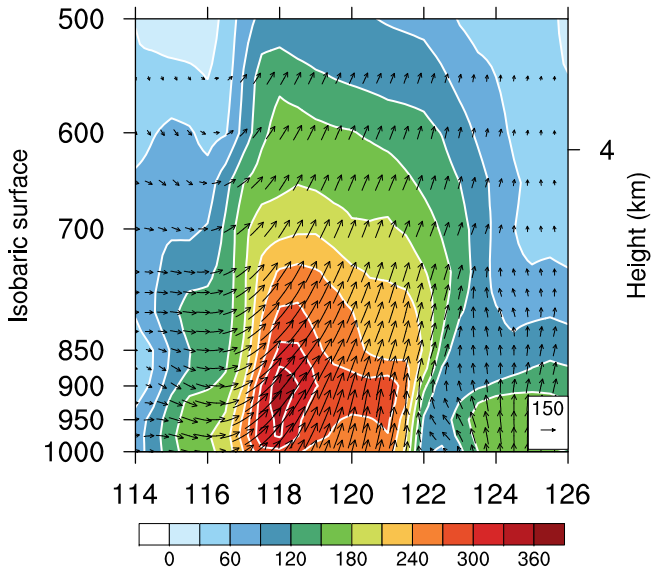
Vertical cross section at 21N and 118E (Mei-Yu frontal cyclone & MBLJ) 6/18 00UTC

Wind speed + barb

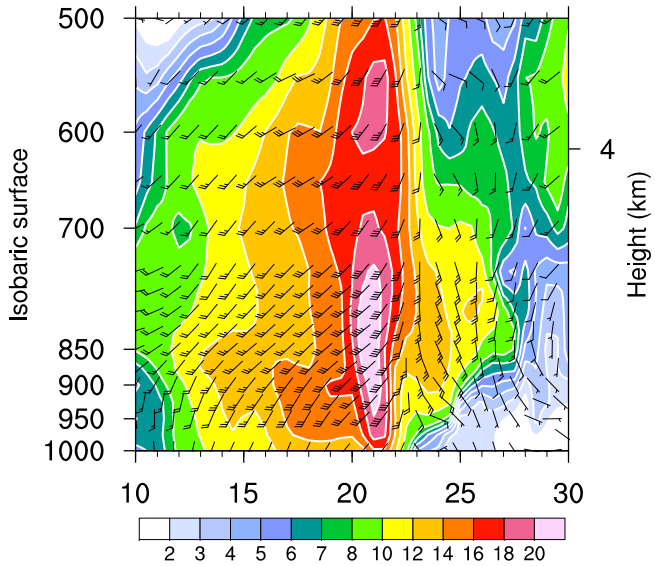
Moisture flux (g kg-1 m s-1)

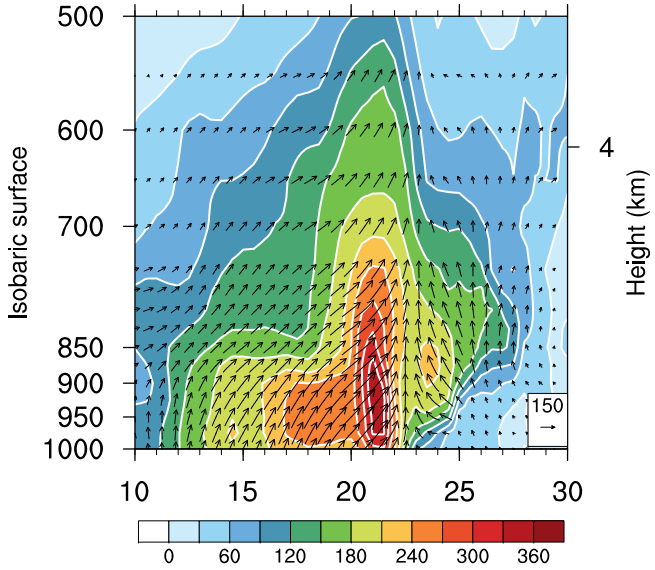
21N



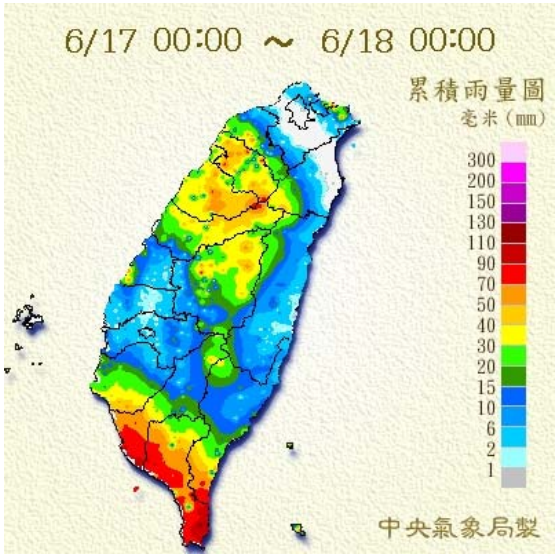


118E

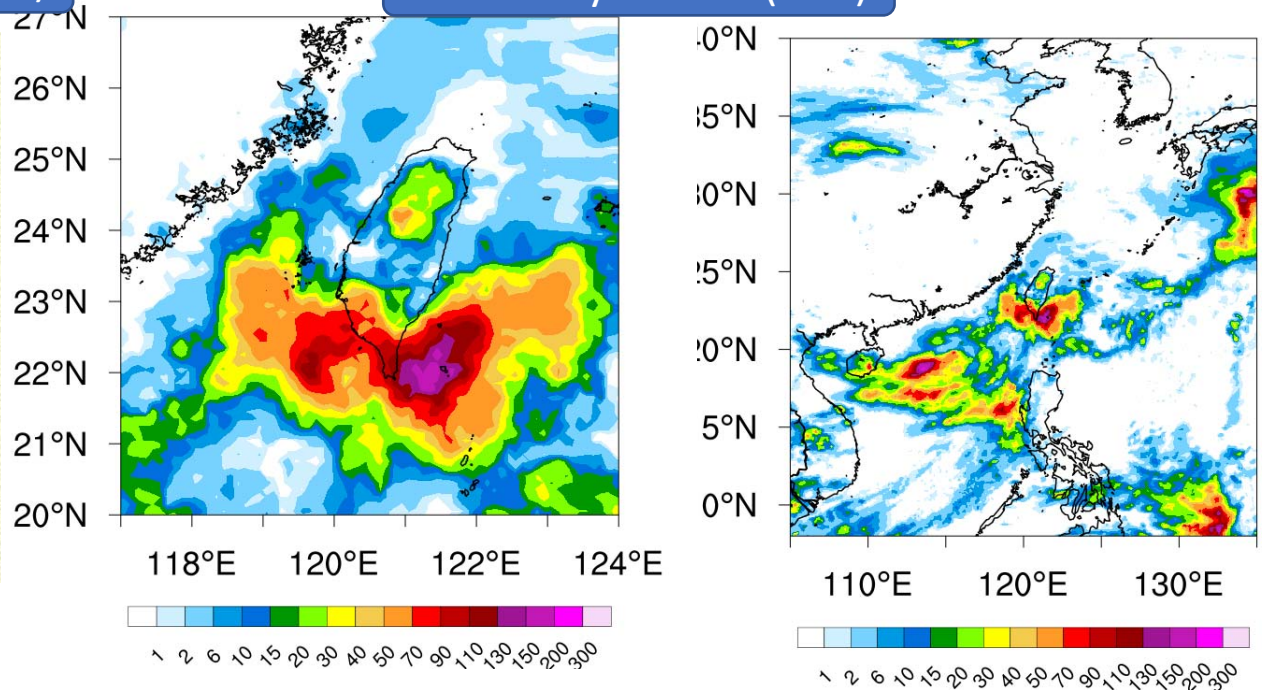


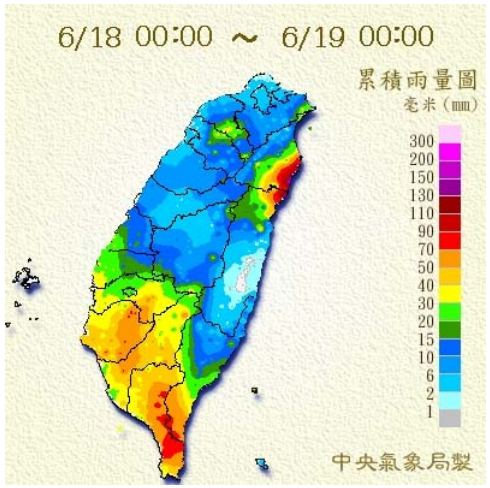


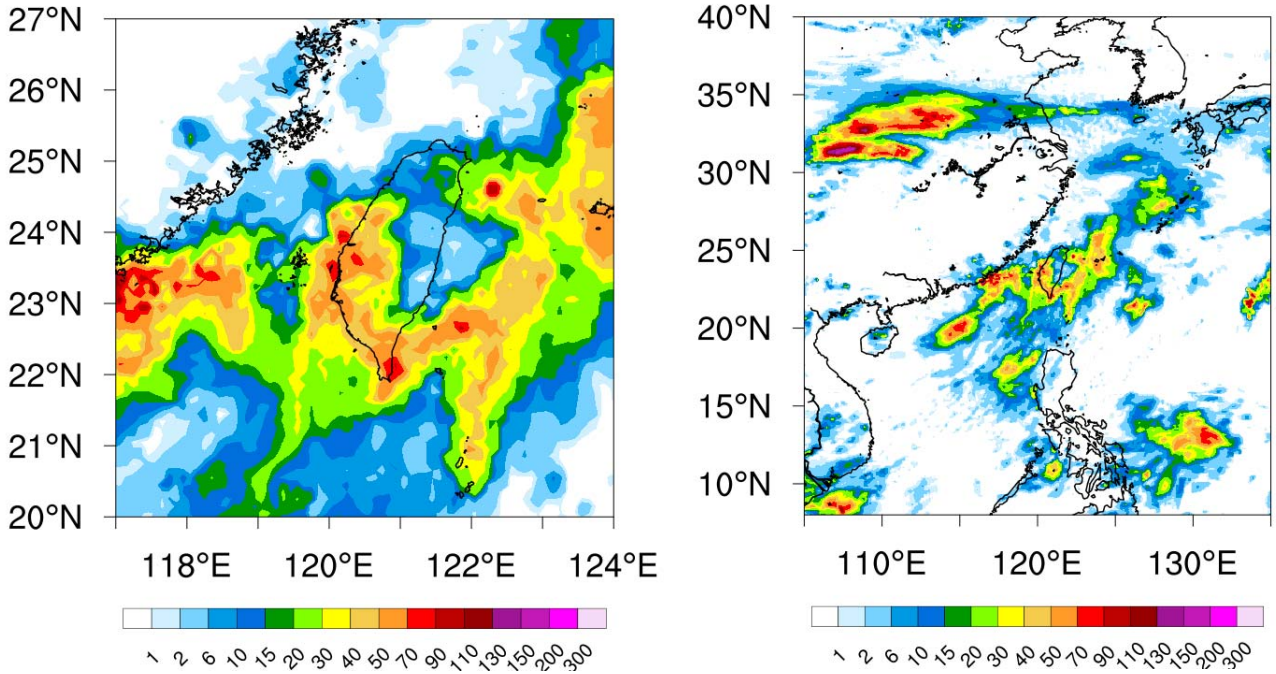
Rain gauge daily rainfall (mm)



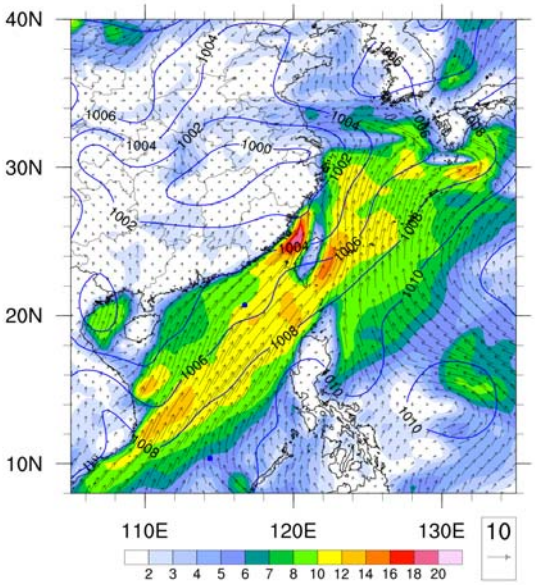
GPM daily rainfall (mm)



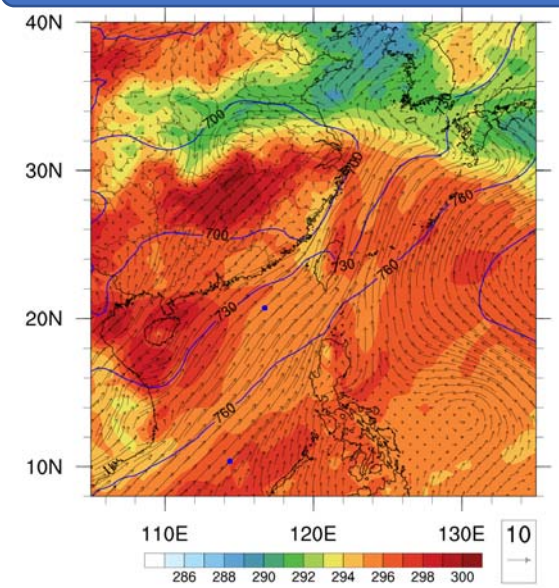




SLP+10m Winds

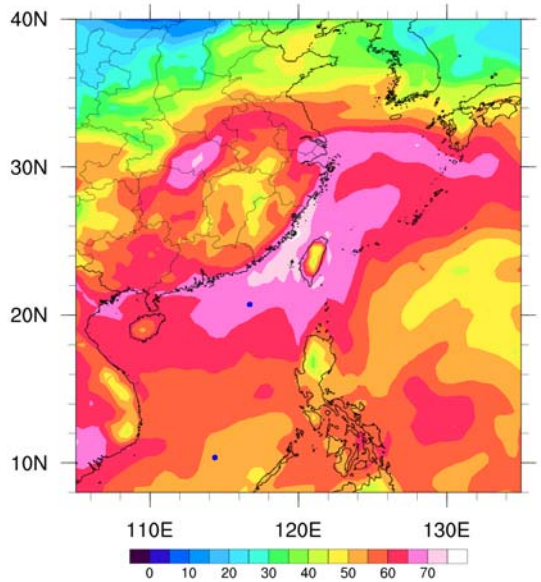


925hPa HGT+theta+Winds

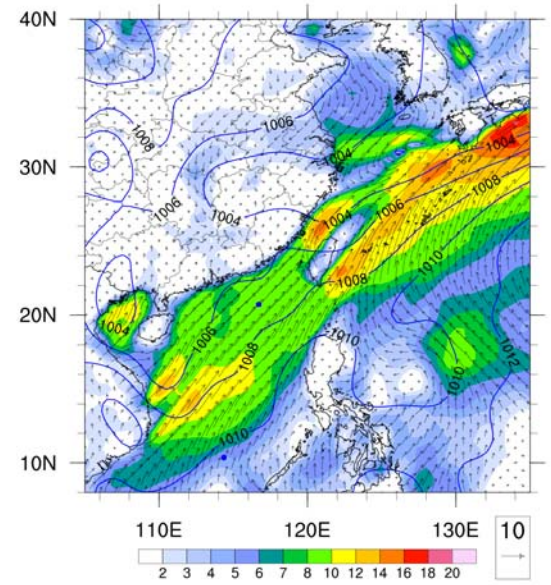


6/19
00UTC

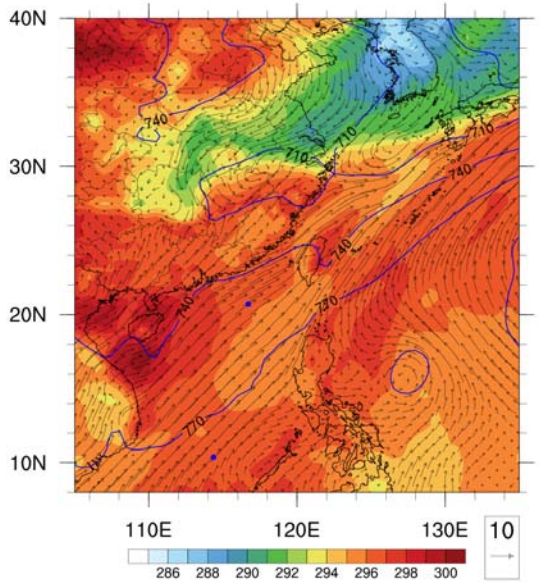
TPW



SLP+10m Winds



925hPa HGT+theta+Winds



6/20
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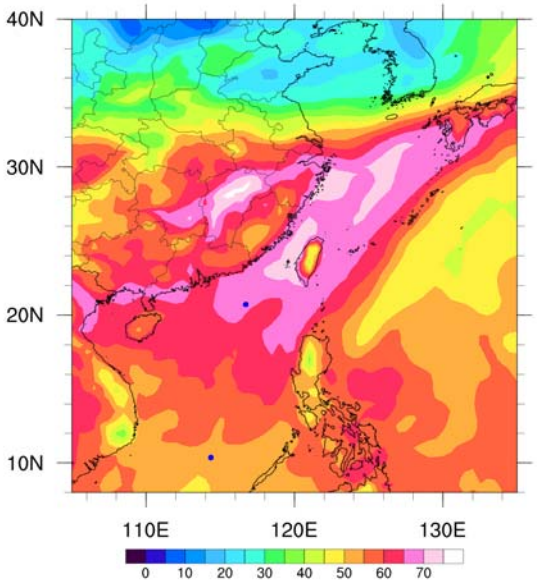


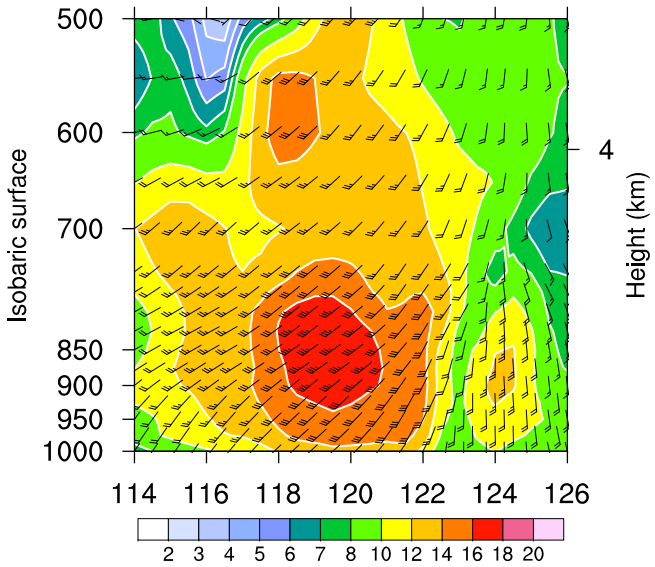
1 barb=5m/s

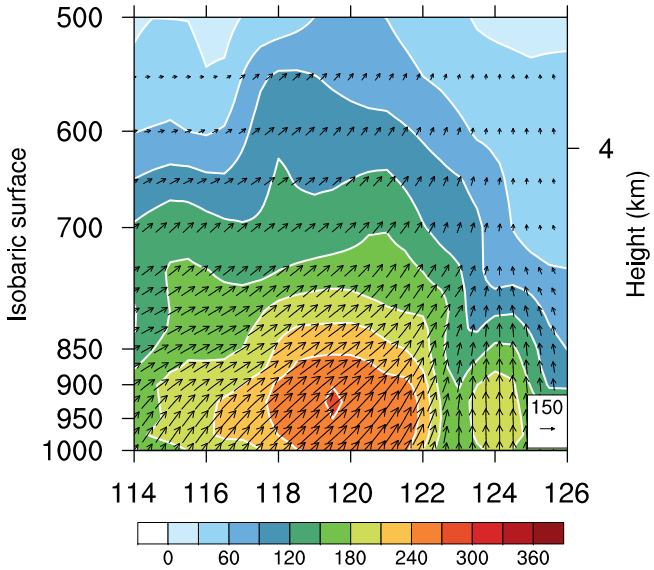
Vertical cross section at 21N and 118E (Marine boundary layer jet) 6/19 00UTC

Wind speed + barb

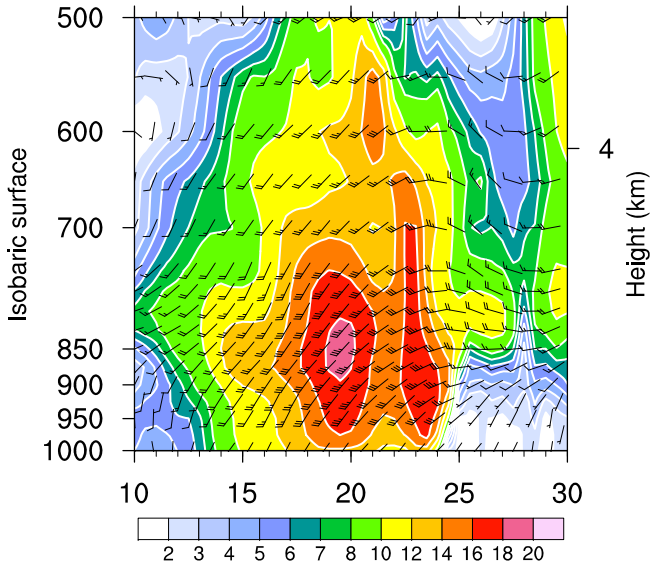
Moisture flux (g kg-1 m s-1)

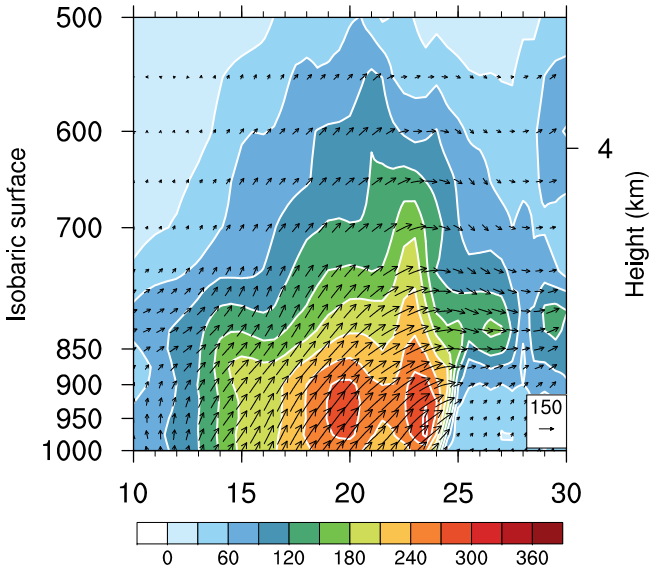
21N





118E





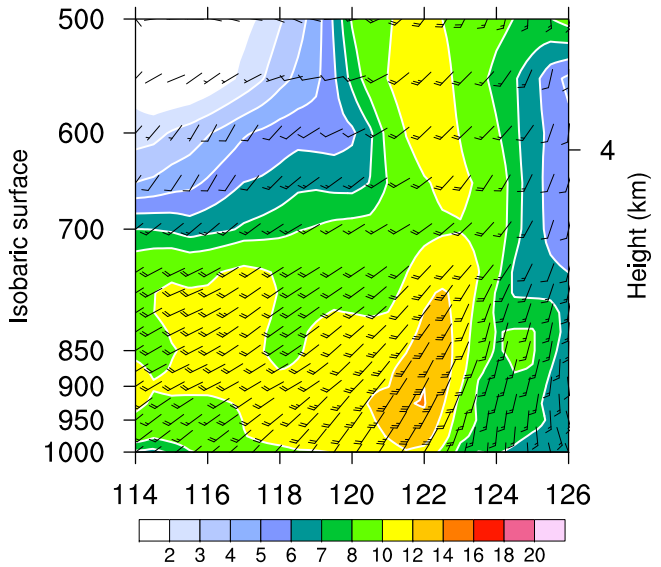
1 barb=5m/s

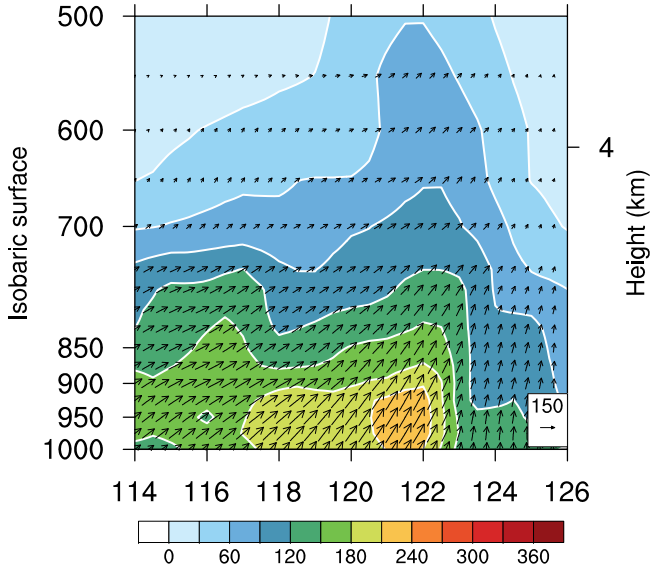
Vertical cross section at 21N and 118E (Marine boundary layer jet) 6/20 00UTC

Wind speed + barb

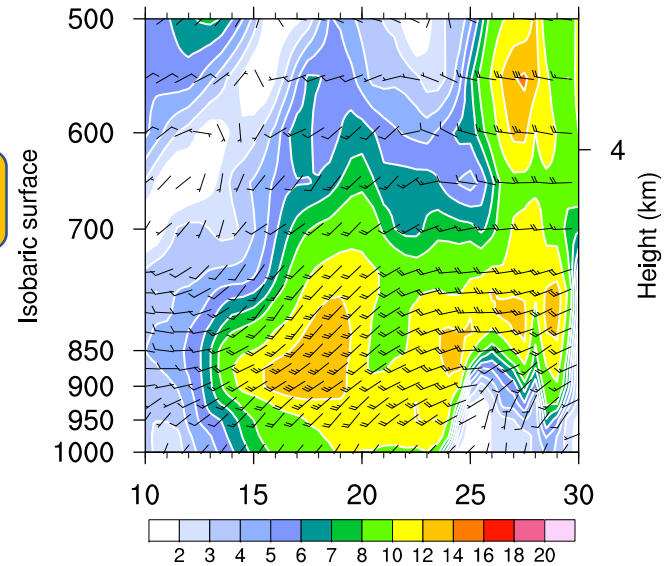
Moisture flux (g kg-1 m s-1)

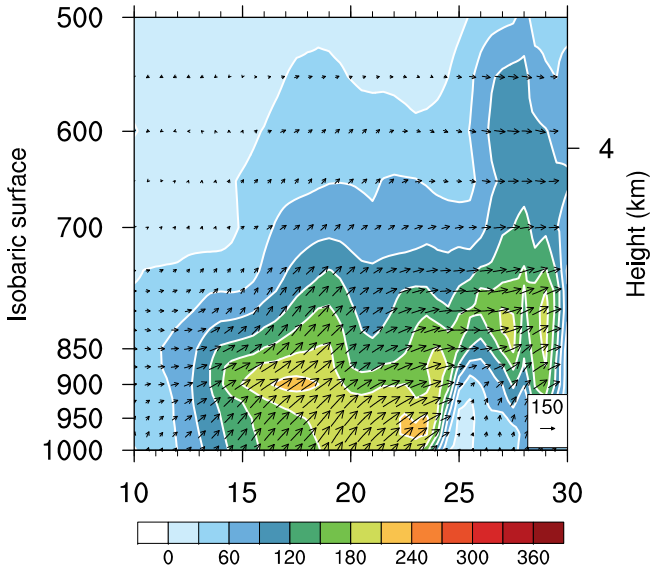
21N





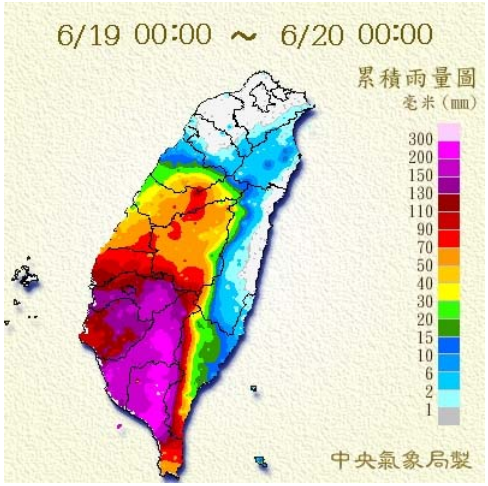
118E

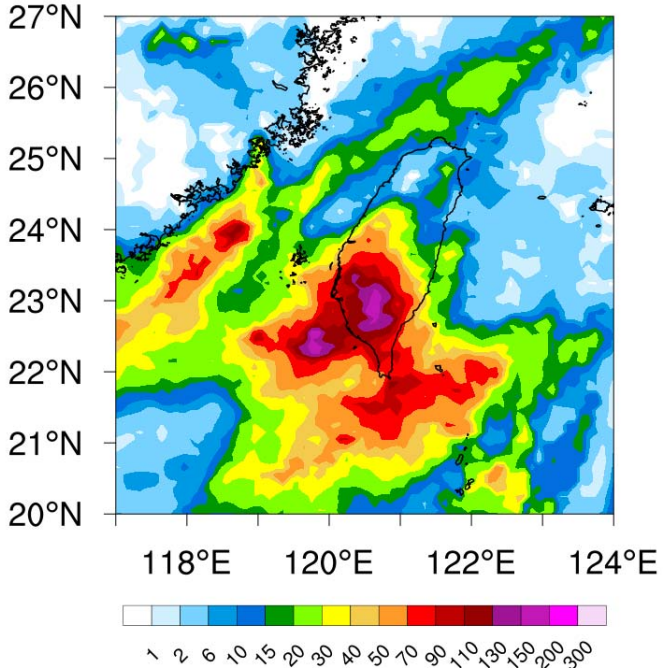


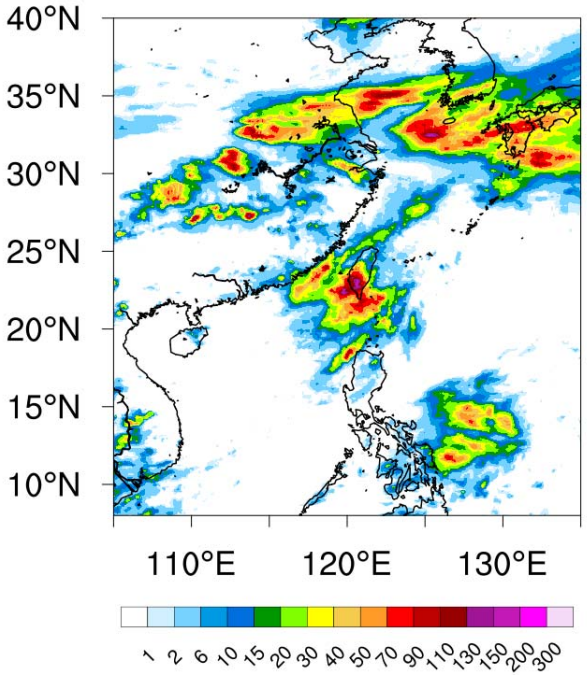


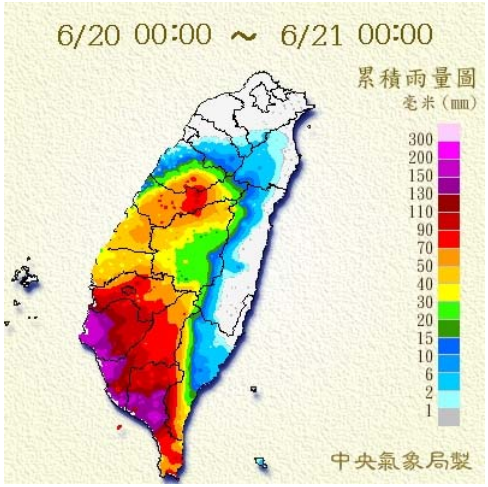
Rain gauge daily rainfall (mm)

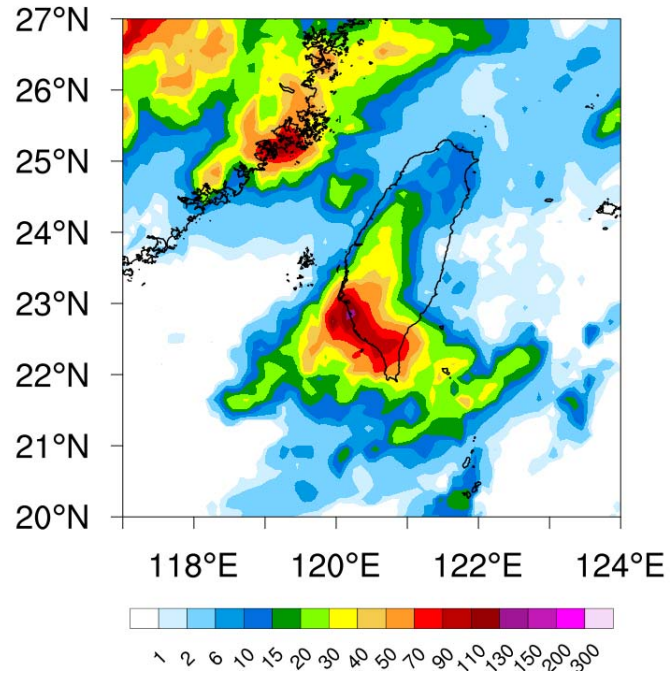
GPM daily rainfall (mm)

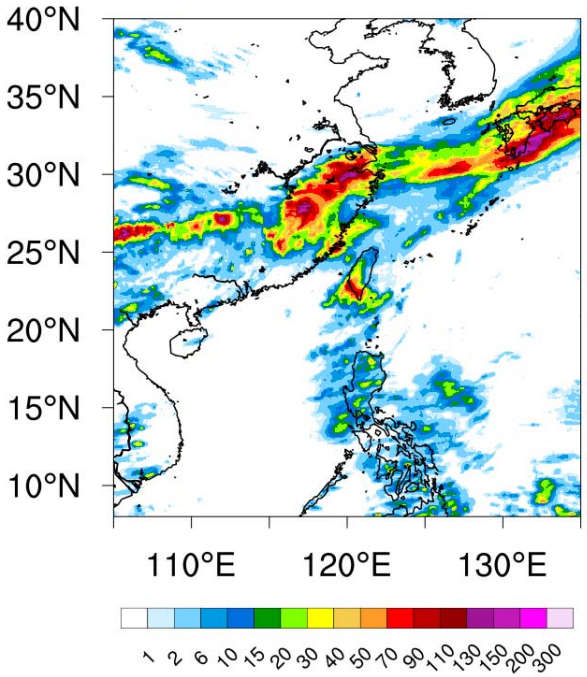


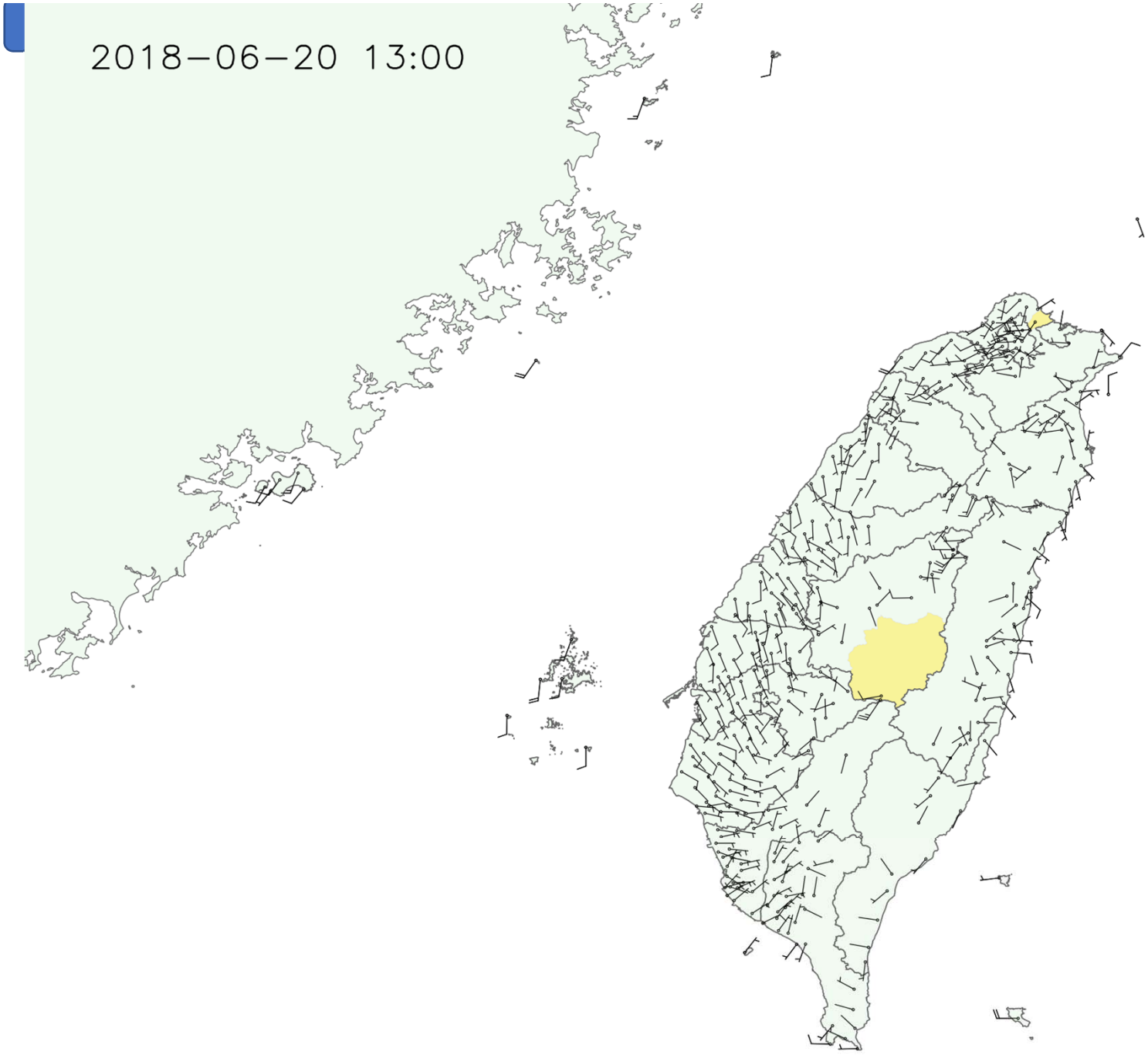




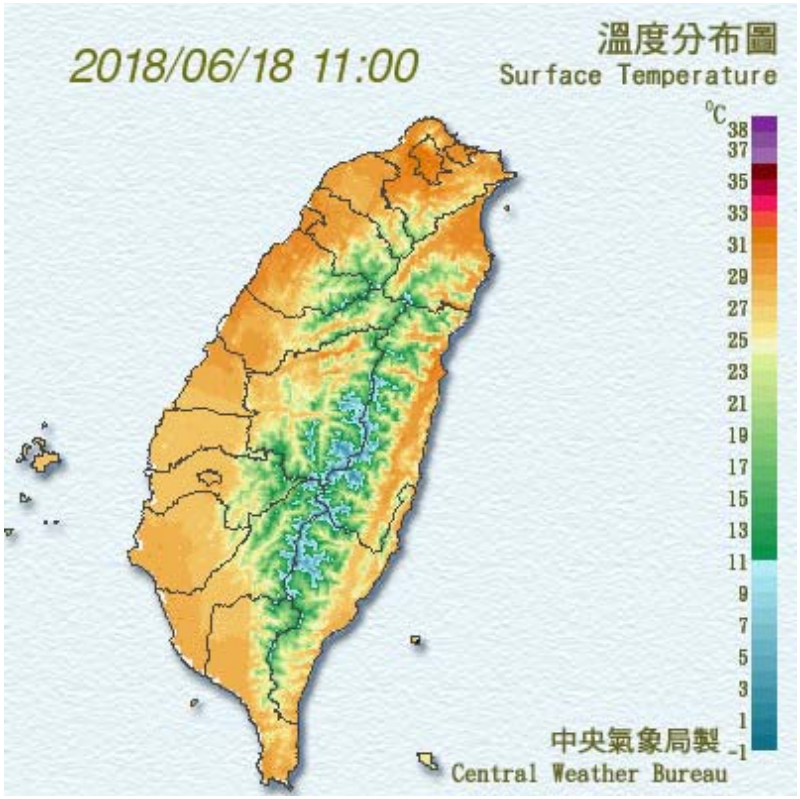


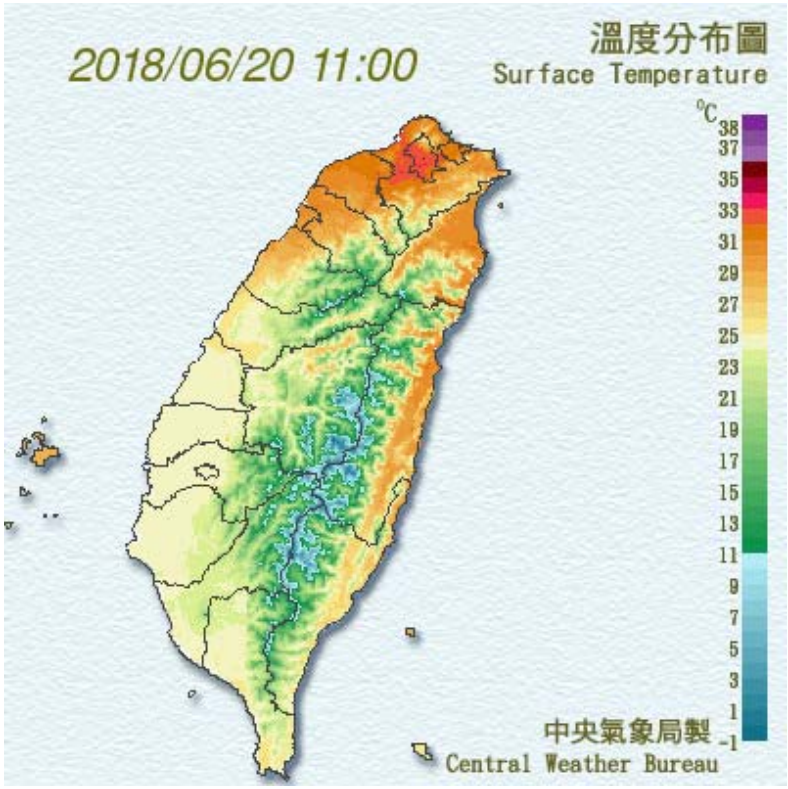


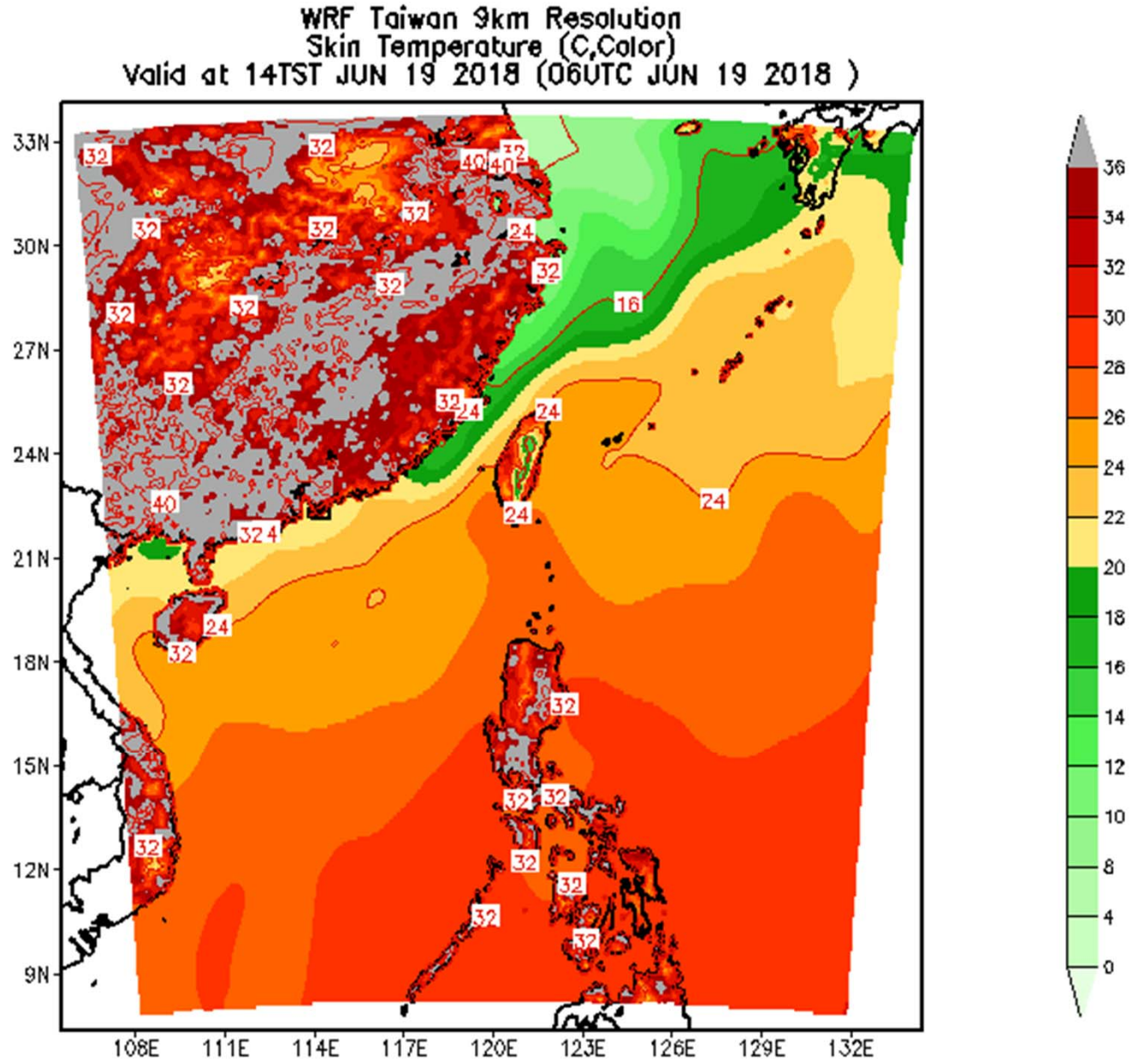



2018-06-20 13:00

Surface air temperature at 11 am June 18 vs. June 20






WRF Taiwan 9km Resolution
Skin Temperature (C,Color)
Valid at 14TST JUN 19 2018 (06UTC JUN 19 2018)
33N
30N
27N
24N
21N
18N
15N
12N
9N
108E
111E
114E
117E
120E
123E
126E
129E
132E
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
4
0

Summary

1. During the 19–20 June 2018 South China Sea Two-Island Monsoon Experiment (SCSTIMX), heavy precipitation (> 600 mm) occurred over southwestern Taiwan. Prior to this heavy rainfall event, a series of mesoscale cyclones formed along the NE-SW orientated Mei-Yu front south of Taiwan between the strong (> 15 m s^{-1}) cold northeasterlies coming from the Taiwan Strait and the warm, moist prefrontal southwesterly flow. These mesoscale cyclones developed in the open ocean in the subtropics under baroclinic settings.

2. On 15 June, heavy rainfall (> 300 mm) occurred over southern Taiwan with maximum rainfall in the Pintung County due to the passage of a mesocyclone in a warm moist environment.

3. The dissipation of the Mei-Yu front south of Taiwan occurred after the last mesocyclone made landfall over the southern China coast around 0600 UTC 18 June, bringing SSW monsoon flow over the Taiwan area. During 18 June, the SSW monsoon flow strengthened and extended northeastward.

4. During 19–20 June, the horizontal moisture fluxes associated with the strong (> 20 m s^{-1}) SSW monsoon flow occurred primarily within the marine boundary layer (MBL) with maximum TPW > 65 mm.

5. The heavy rainfall over southwestern Taiwan during 19-20 June is mainly caused by the warm, moist marine boundary jet (MBLJ) impinging on southwestern Taiwan under favorable large scale settings including warm advection within the SSW monsoon flow and the passage of a 500-hPa trough to the north.

6. On 19 June, the maximum rainfall axis (> 300 mm) occurred on the windward slopes of the Central Mountain Range due to orographic blocking and lifting.

7. On 20 June, with the development of cold pool (~ 25°C) over southwestern Taiwan, due to rain evaporative cooling, the rainfall maximum (> 300 mm) occurred along the southwestern coast.

8. This heavy rainfall event over southern Taiwan ended in the late afternoon of 20 June after the weakening of the MBLJ due to the westward extension of the West Pacific Subtropical High.

Thank you

Remove PPT

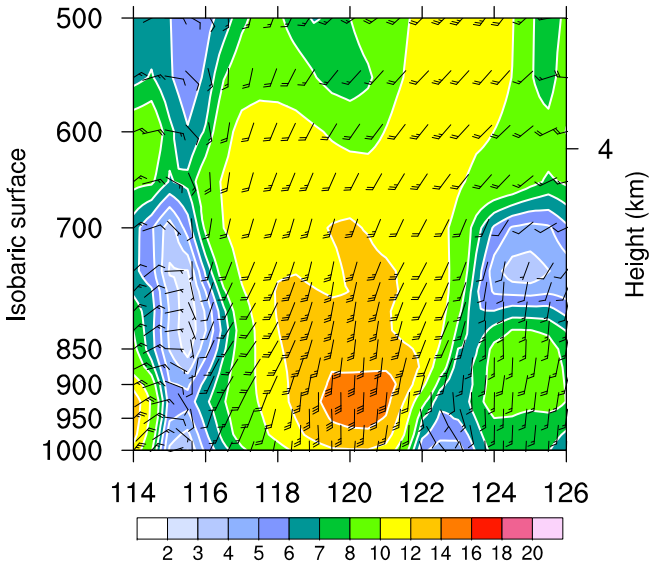
1 barb=5m/s

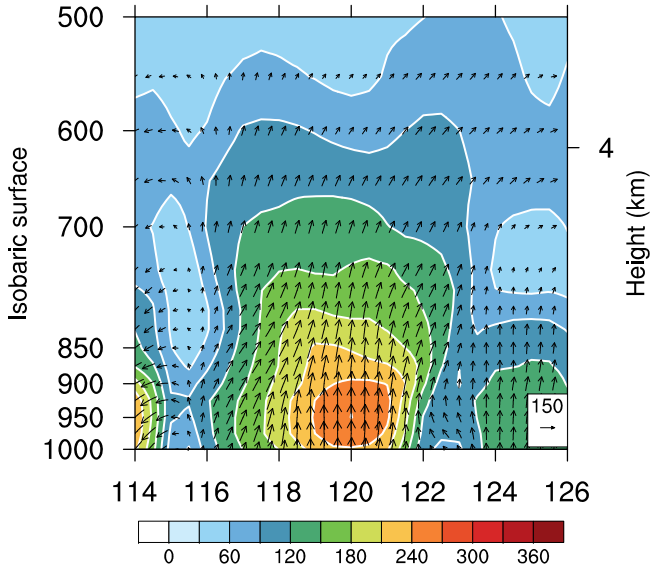
Vertical cross section at 21N and 118E
(Marine boundary layer jet associated with Mei-Yu frontal cyclone) 6/17 00UTC

Wind speed + barb

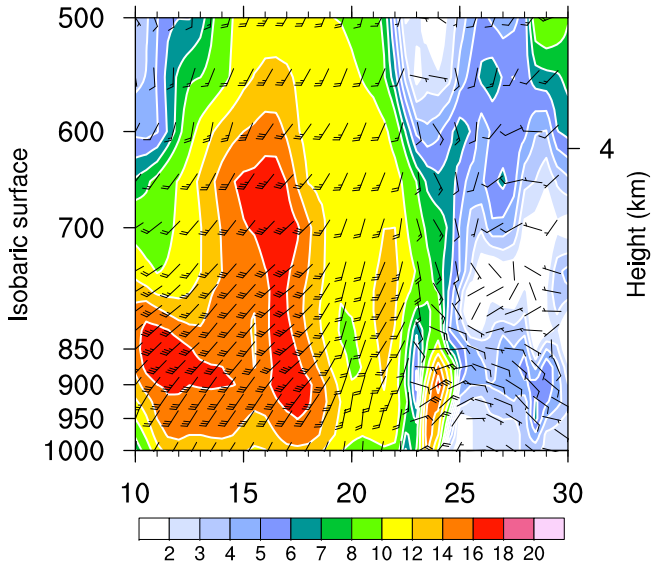
Moisture flux (g kg-1 m s-1)

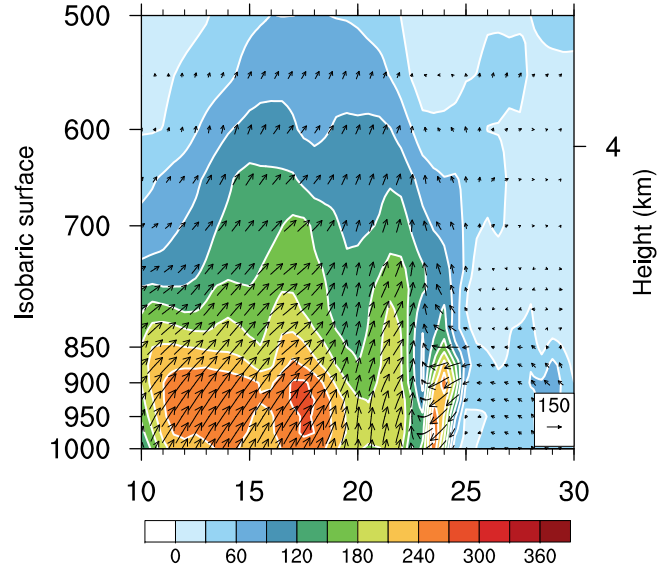
21N



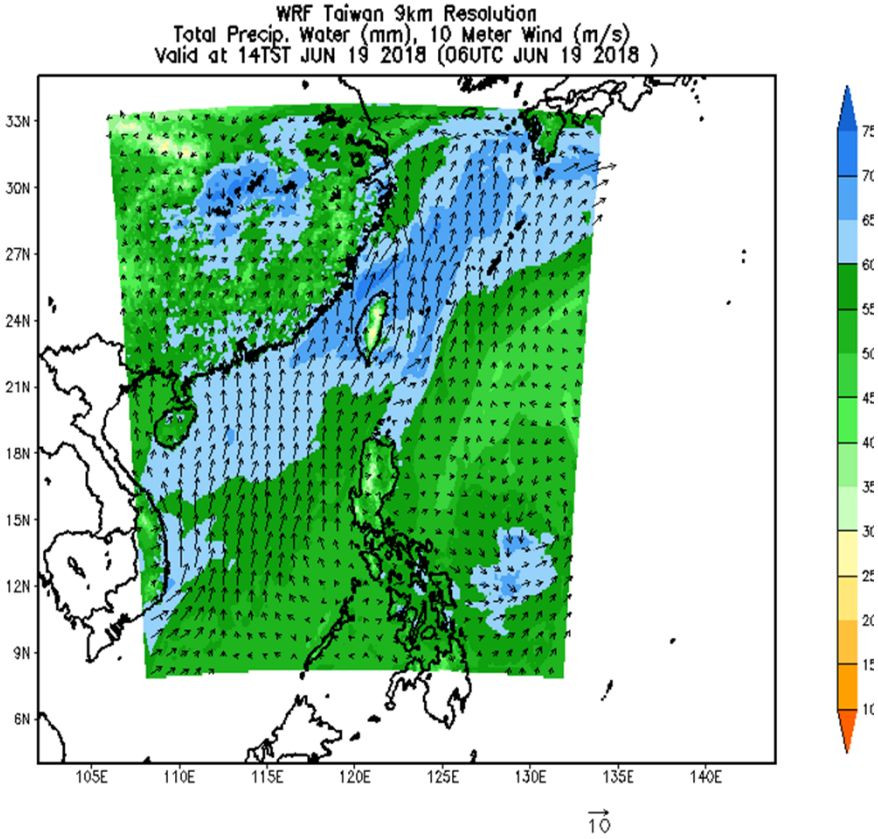


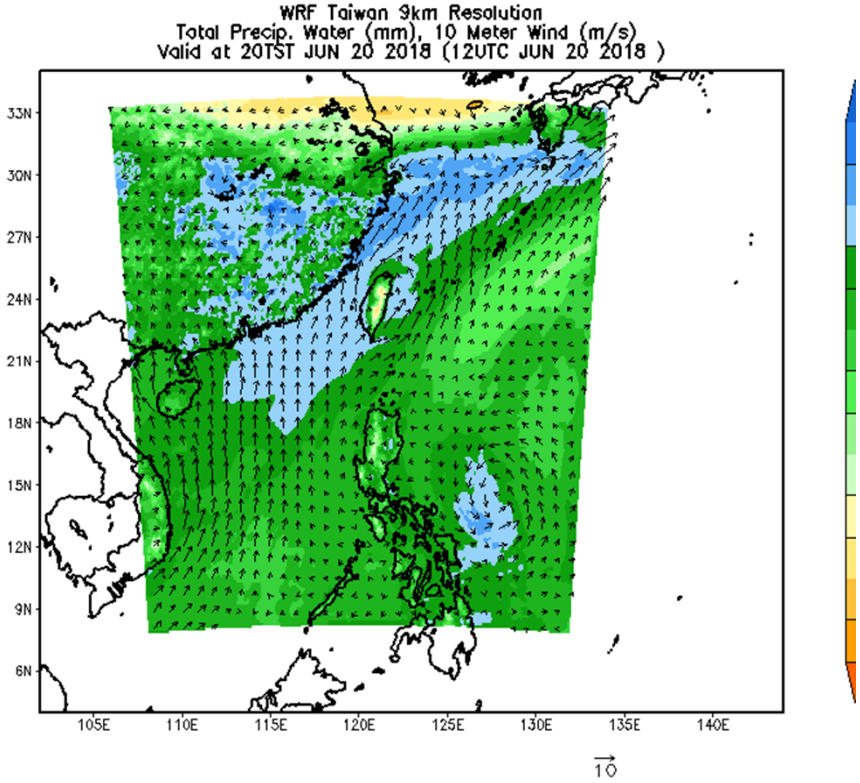
118E



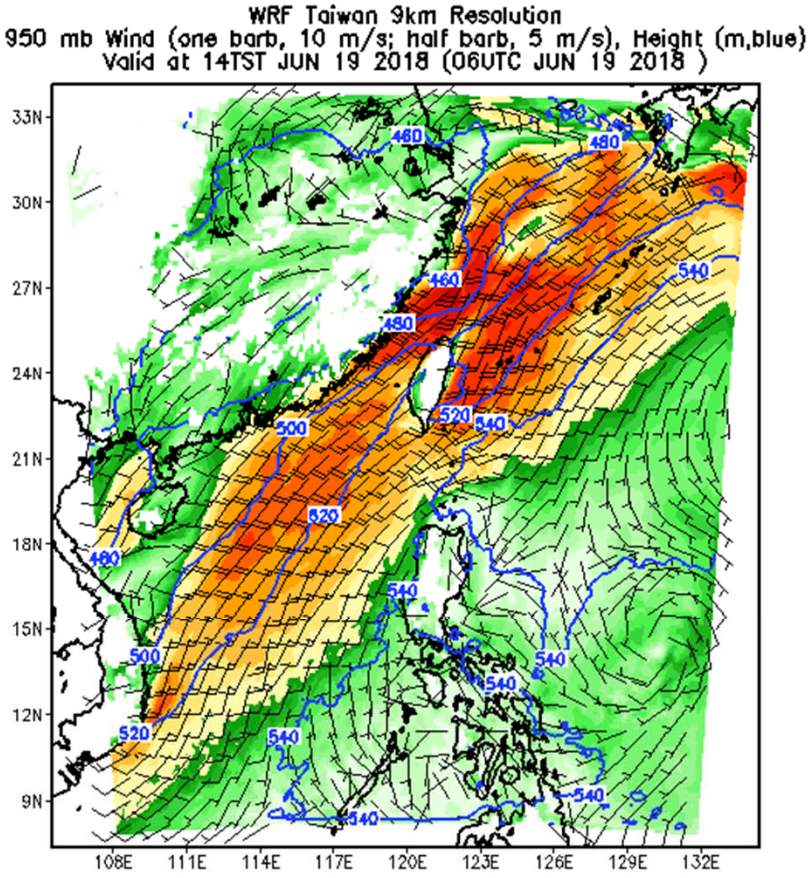


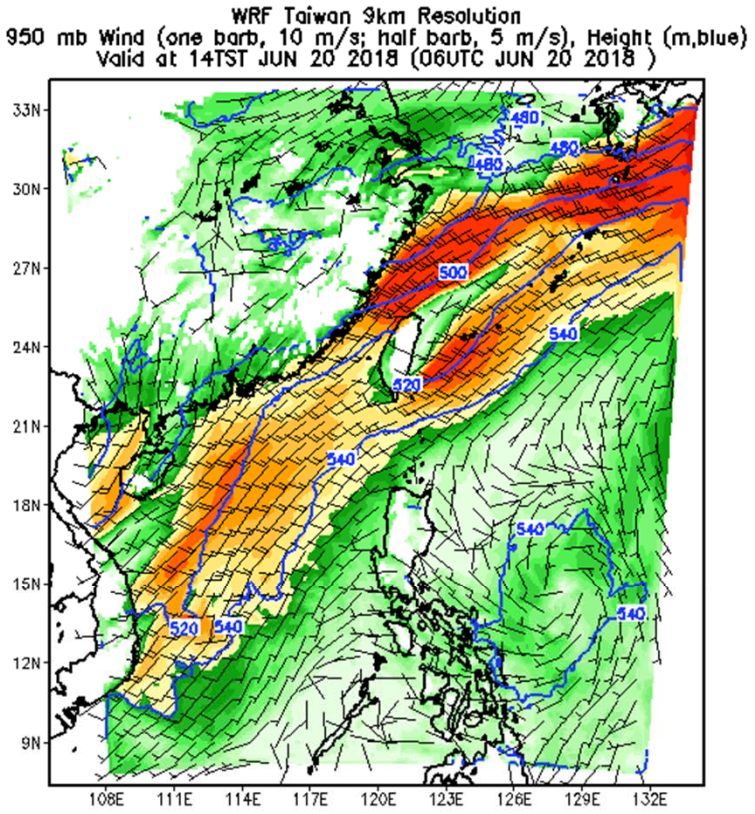
Model forecast (TPW and 10-m winds) initialized at 12 UTC 18 June



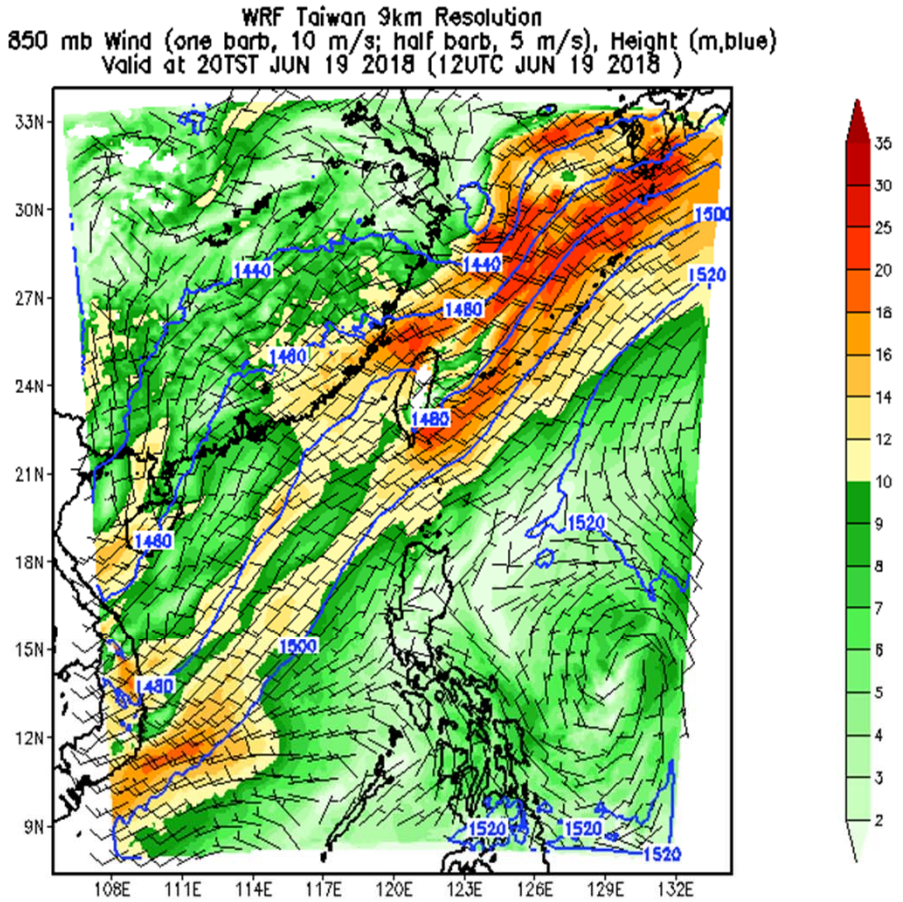


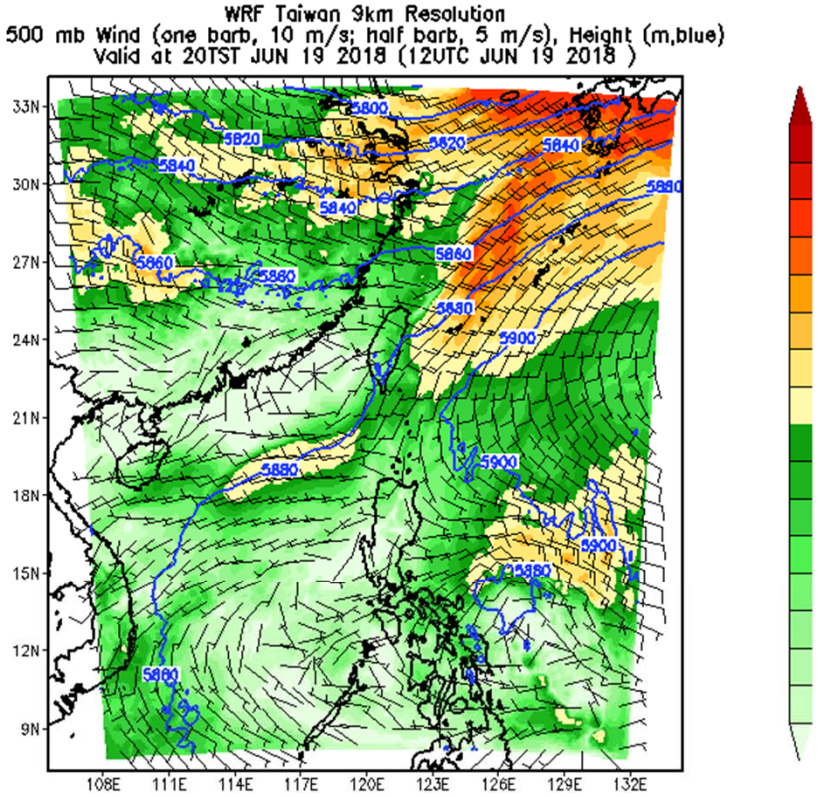
Model forecast initialized at 12UTC 18 June (9 km grid) 950 hPa

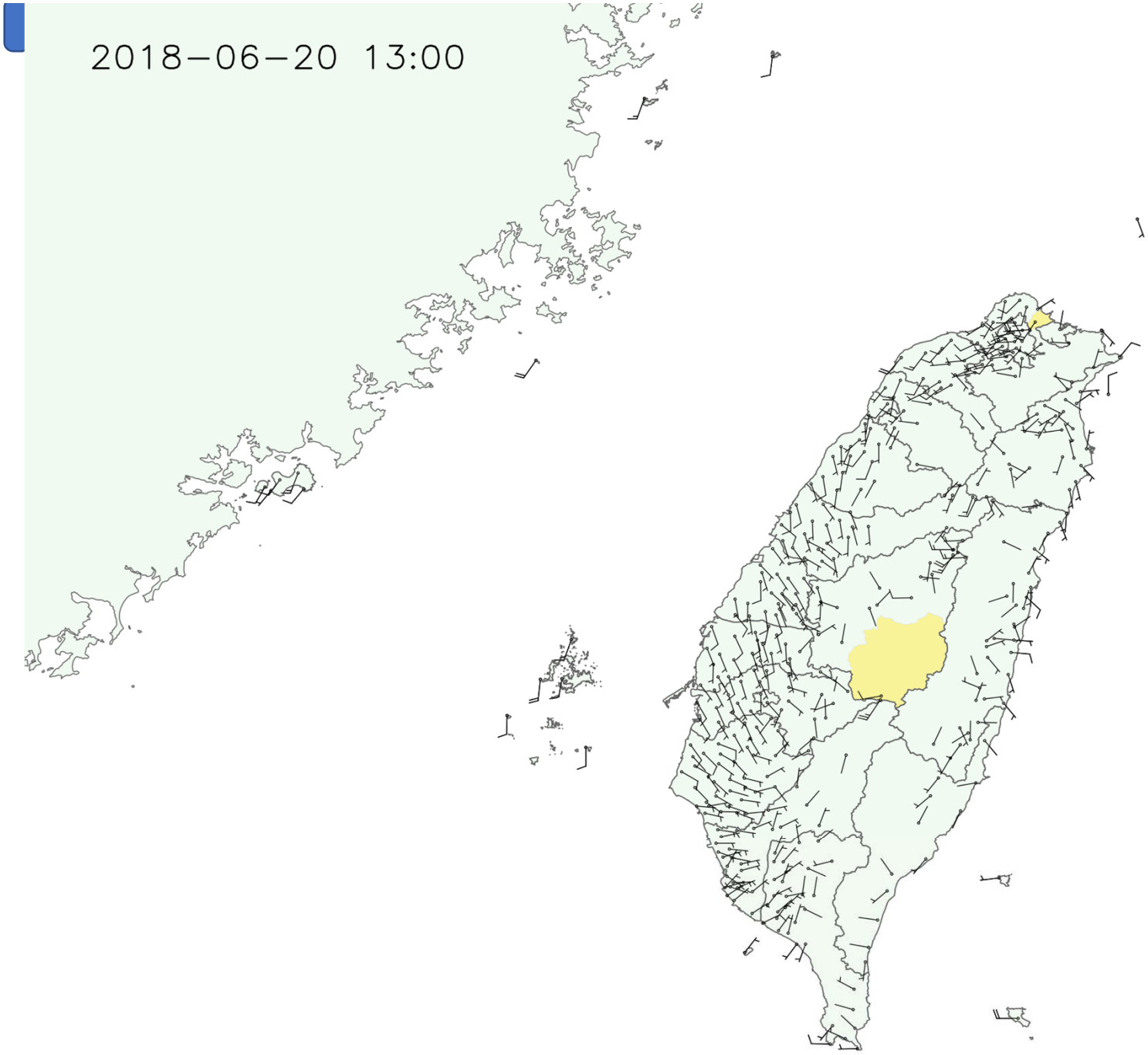




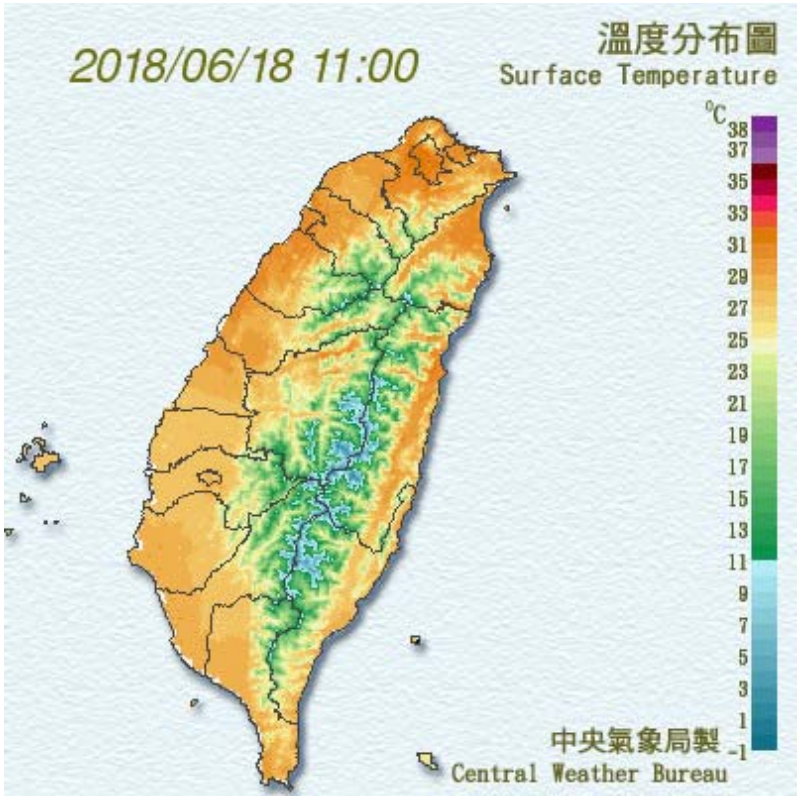
24-h forecast (850-hPa and 500-hPa) initialized at 12 Z 18 June

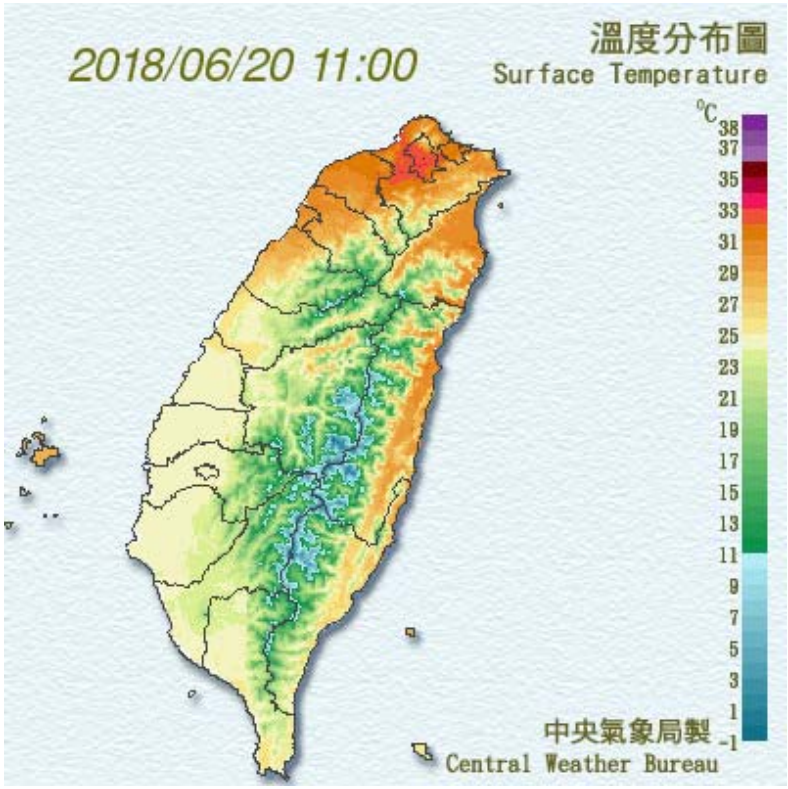


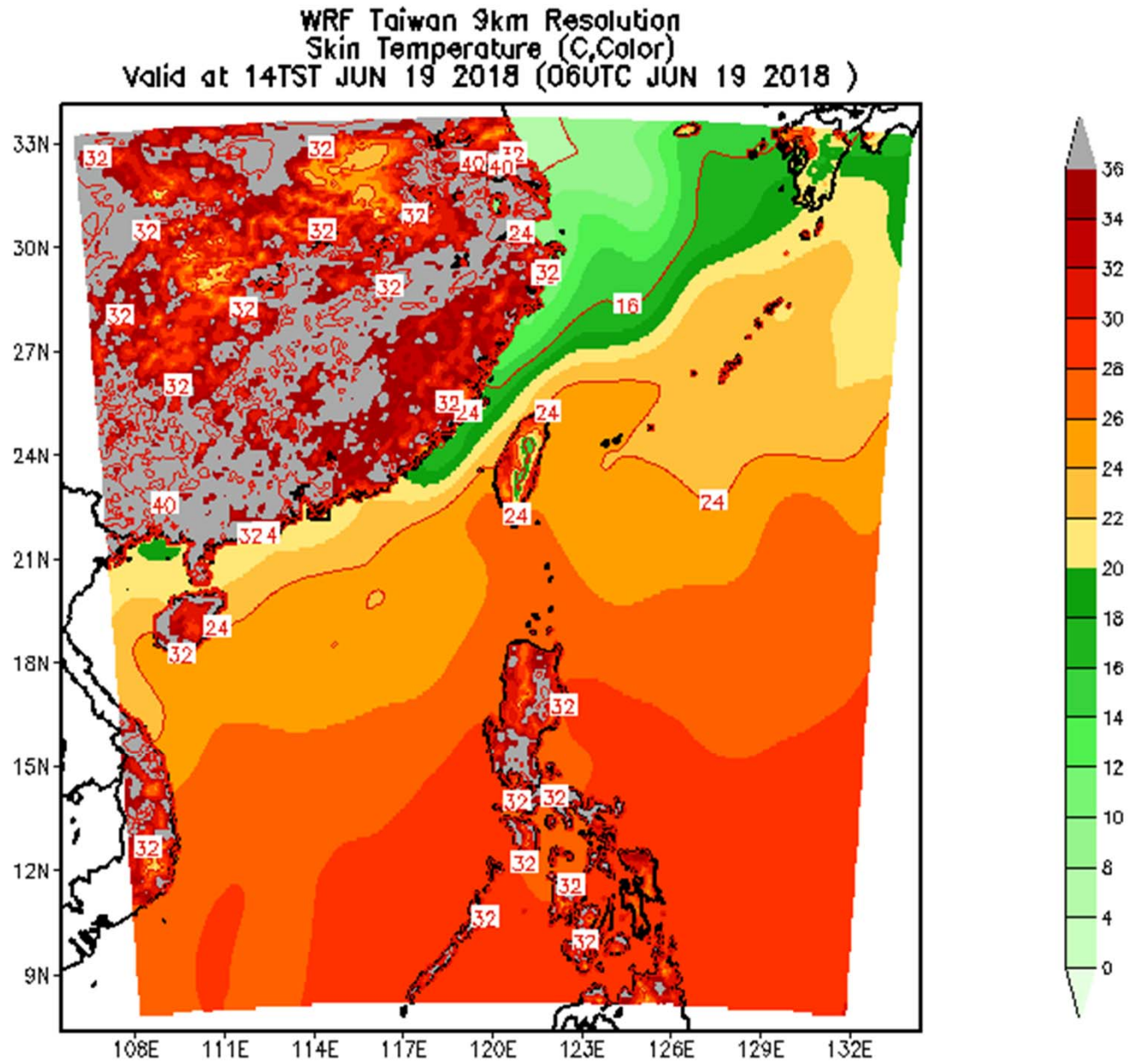



2018-06-20 13:00

Surface air temperature at 11 am June 18 vs. June 20






WRF Taiwan 9km Resolution
Skin Temperature (C,Color)
Valid at 14TST JUN 19 2018 (06UTC JUN 19 2018)
33N
30N
27N
24N
21N
18N
15N
12N
9N
108E
111E
114E
117E
120E
123E
126E
129E
132E
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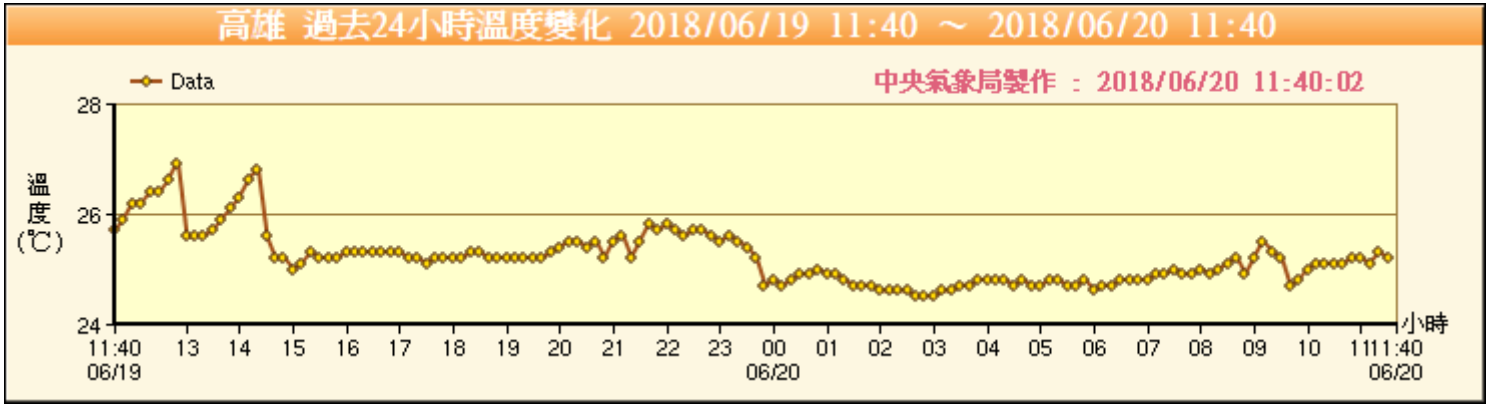
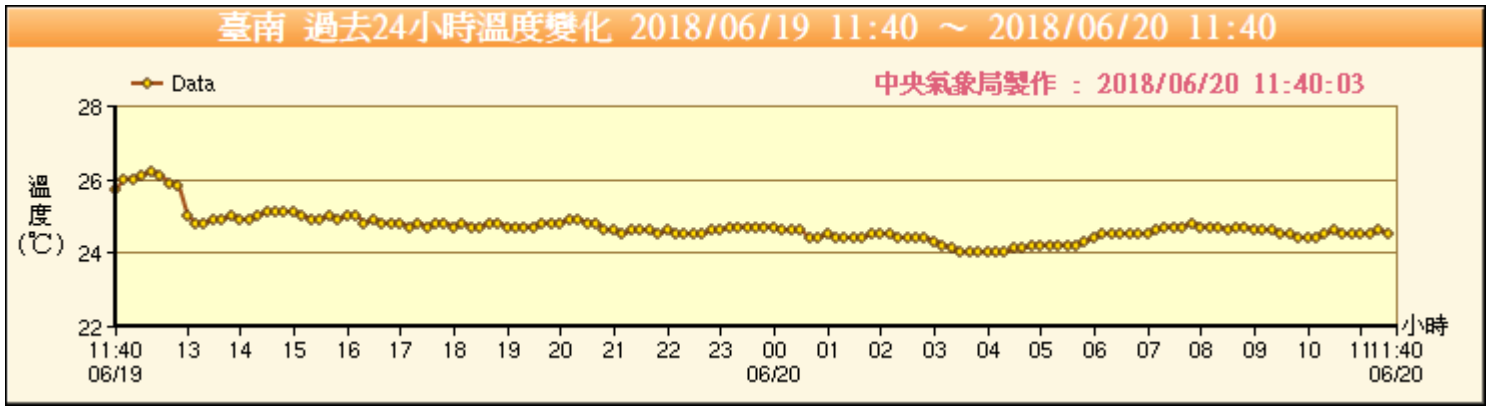

高雄 過去24小時溫度變化 2018/06/19 11:40 ～ 2018/06/20 11:40
Data
中央氣象局製作 : 2018/06/20 11:40:02
溫度(℃)
28
26
24
小時
11:40 06/19
13 14 15 16 17 18 19 20 21 22 23 00 06/20 01 02 03 04 05 06 07 08 09 10 11
11:40 06/20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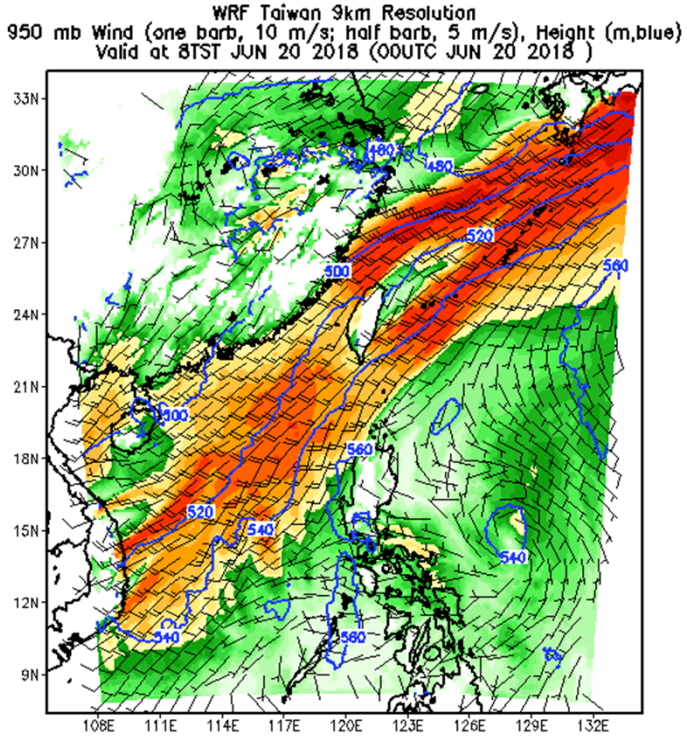
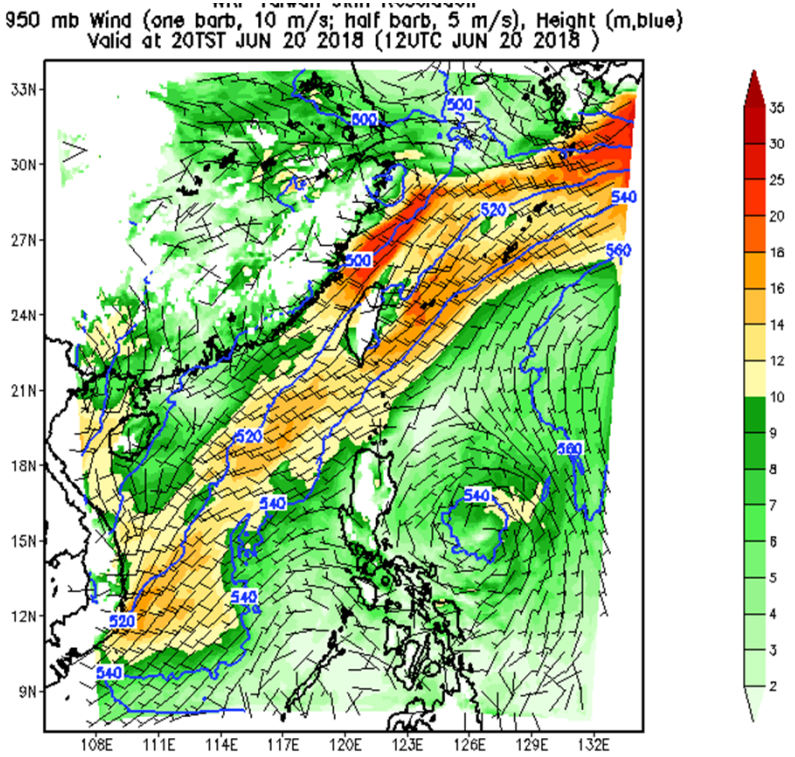
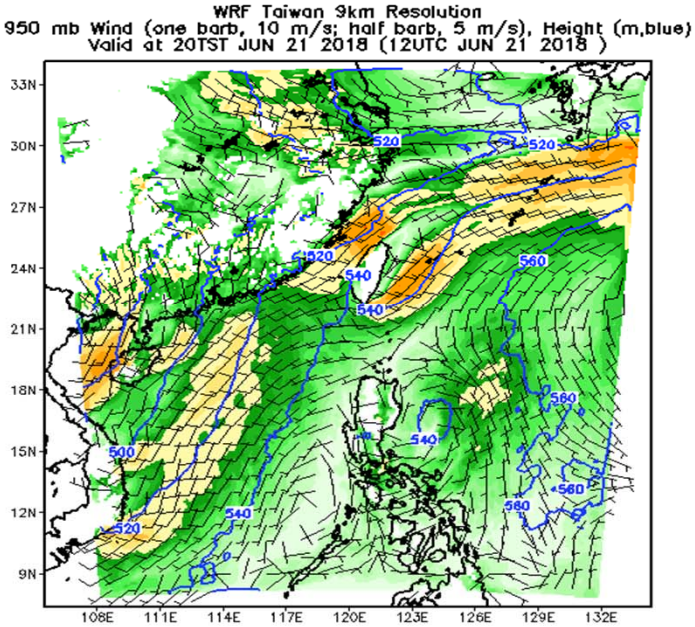
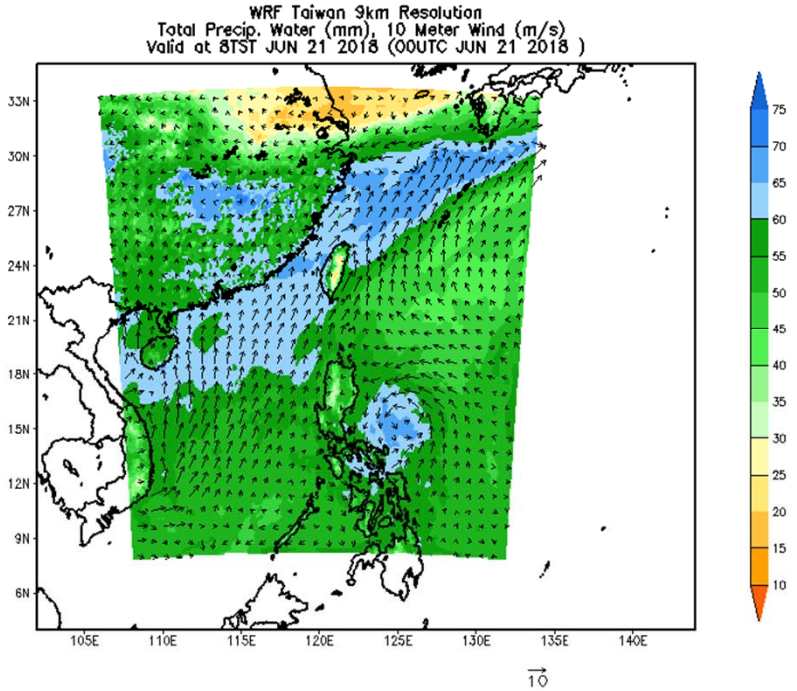
Data
中央氣象局製作 : 2018/06/20 11:40:03
溫度(℃)
28
26
24
22
小時
11:40 06/19
13 14 15 16 17 18 19 20 21 22 23 00 06/20 01 02 03 04 05 06 07 08 09 10 11
11:40 06/20


WRF Taiwan 9km Resolution
950 mb Wind (one barb, 10 m/s; half barb, 5 m/s), Height (m,blue)
Valid at 8TST JUN 20 2018 (00UTC JUN 20 2018)


950 mb Wind (one barb, 10 m/s; half barb, 5 m/s), Height (m,blue)
Valid at 20TST JUN 20 2018 (12UTC JUN 20 2018)


WRF Taiwan 9km Resolution
950 mb Wind (one barb, 10 m/s; half barb, 5 m/s), Height (m,blue)
Valid at 20TST JUN 21 2018 (12UTC JUN 21 2018)


WRF Taiwan 9km Resolution
Total Precip. Water (mm), 10 Meter Wind (m/s)
Valid at 8TST JUN 21 2018 (00UTC JUN 21 2018)

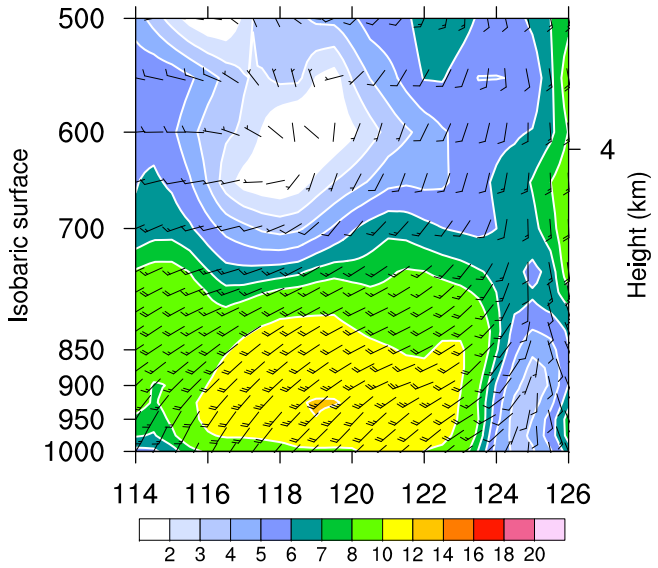
1 barb=5m/s

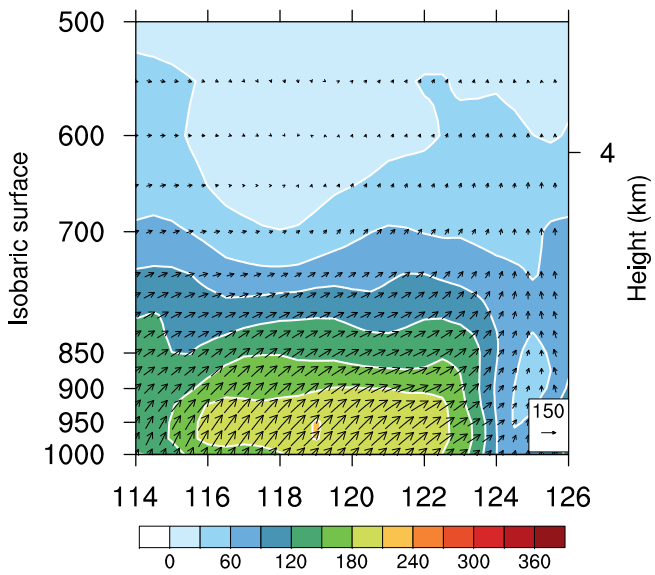
Vertical cross section at 21N and 118E (Marine boundary layer jet) 6/21 00UTC

Wind speed + barb

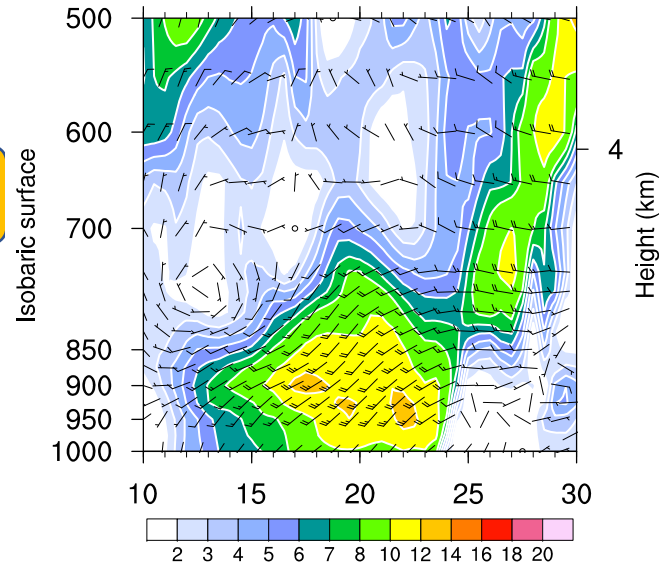
Moisture flux (g kg-1 m s-1)

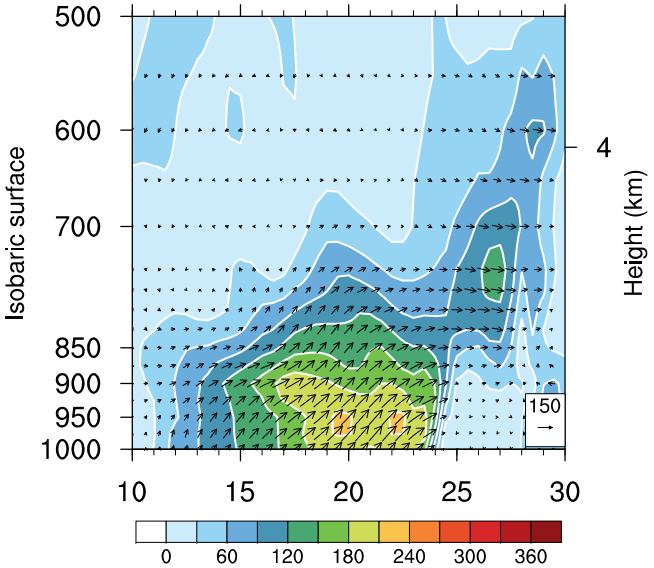
21N





118E

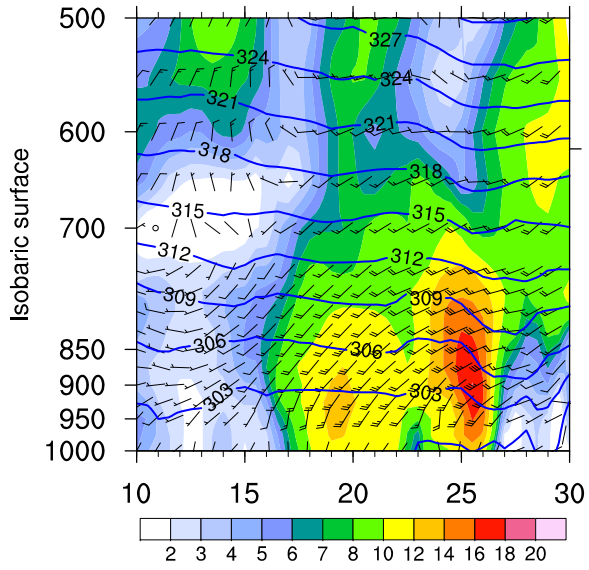




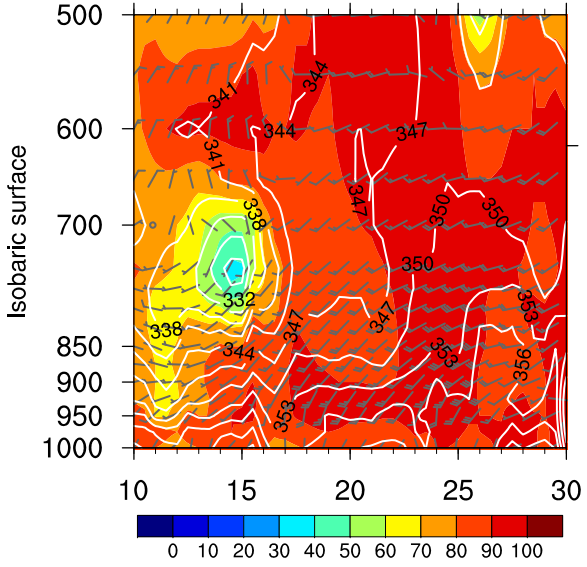
OLD PPT

Vertical cross section at 120E (Marine boundary layer jet) 6/20 00UTC

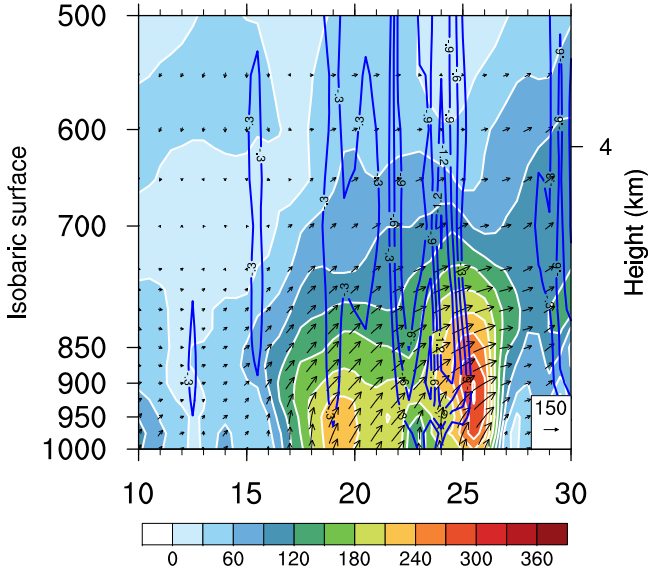
Wind Speed+theta+barb



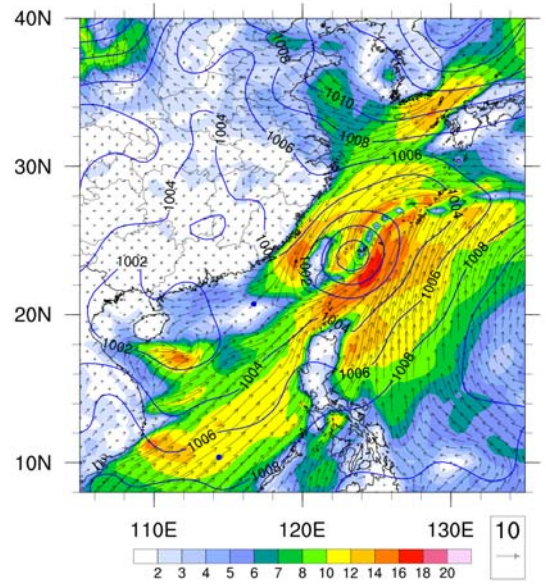
RH+thetae+barb



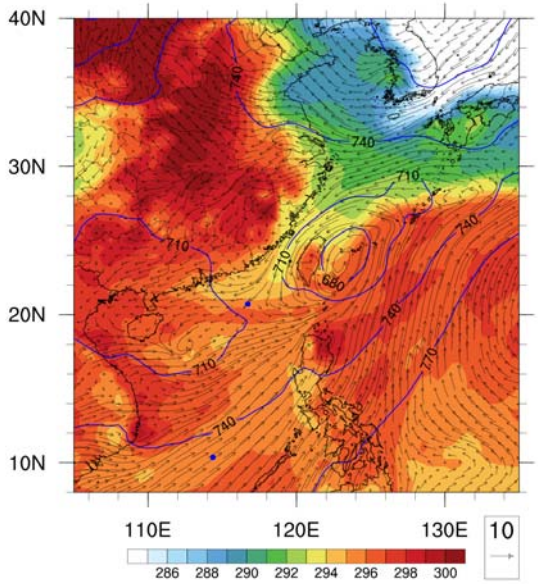
Moisture flux +w(Pa/s, upward)



SLP+10m Winds

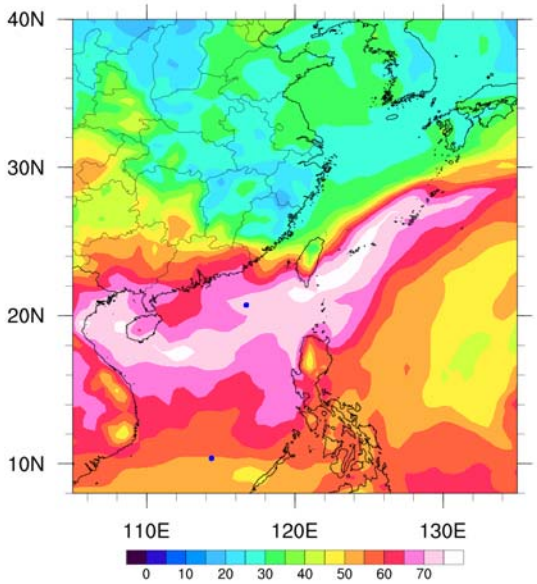


925hPa HGT+theta+Winds

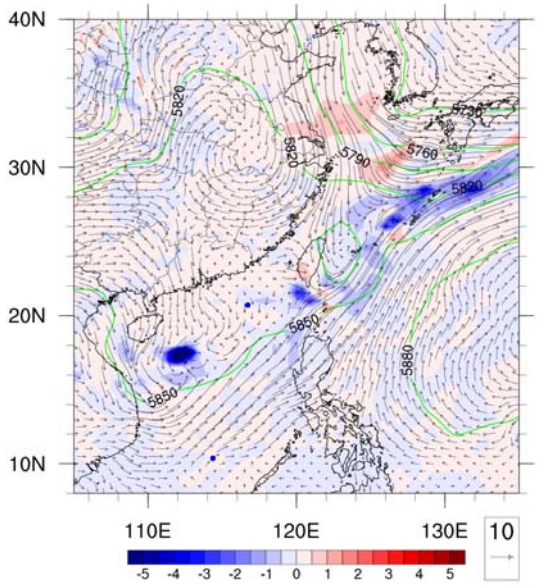


6/15
12UTC

TPW

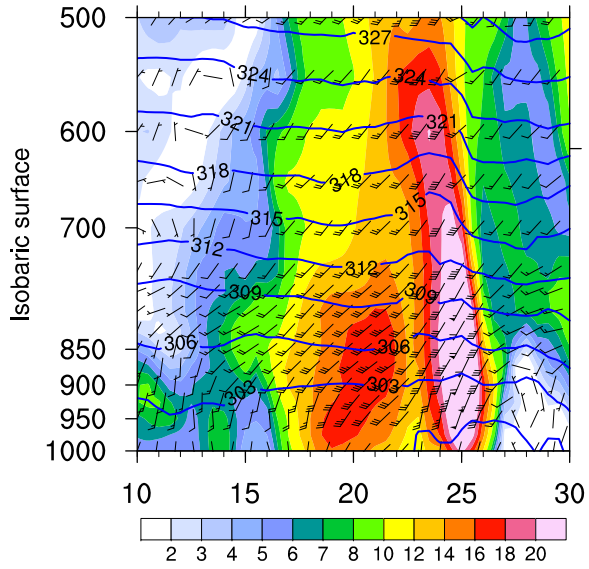


500hPa HGT+w(Pa/s)+Winds

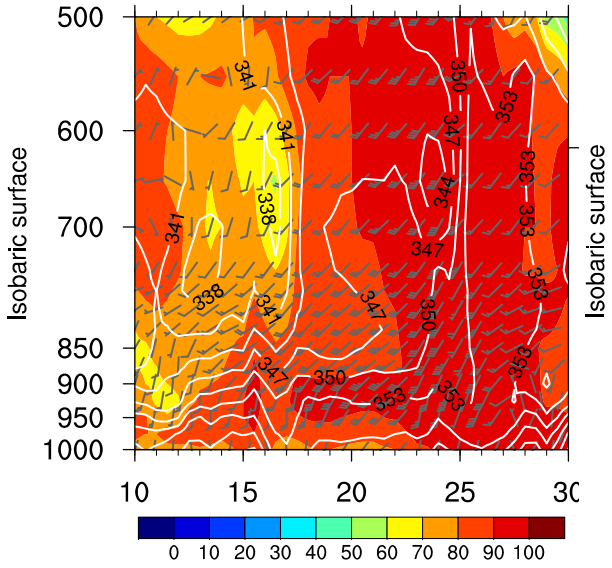


Vertical cross section at 120E (Marine boundary layer jet) 6/19 00UTC

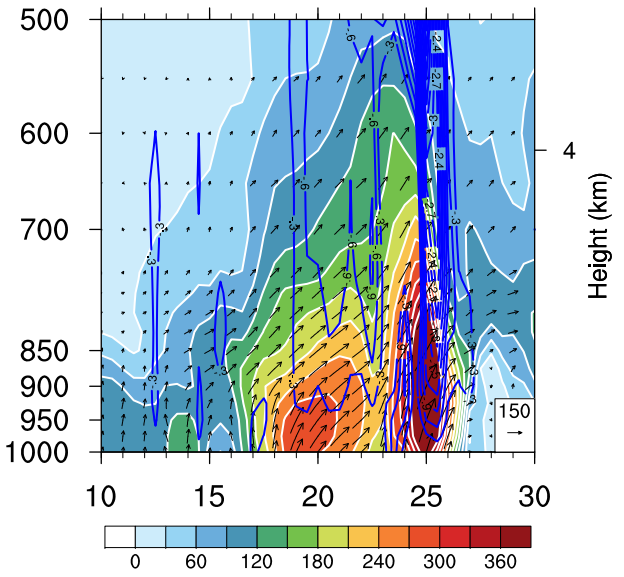
Wind Speed+theta+barb



RH+thetae+barb



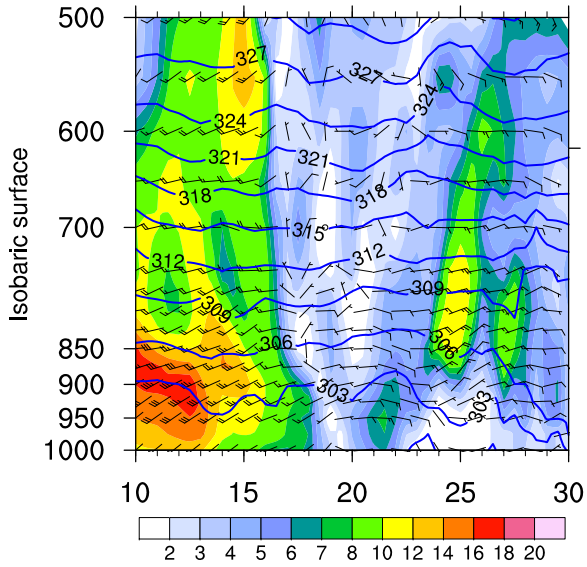
Moisture flux +w(Pa/s, upward)



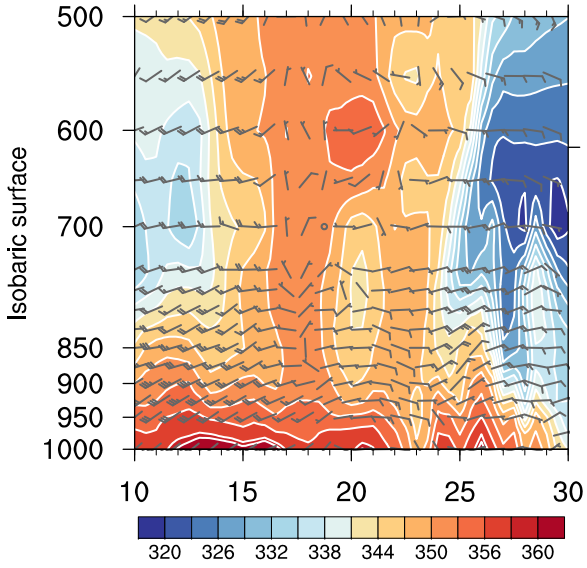
Vertical cross section at 114E (Mei-Yu frontal cyclogenesis: initial stage) 6/15 12UTC

1 barb=5m/s

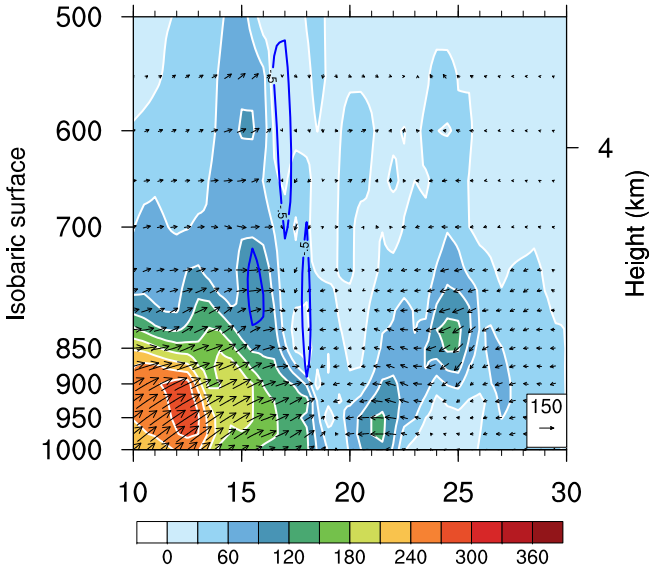
Wind Speed+theta+barb



thetae+barb

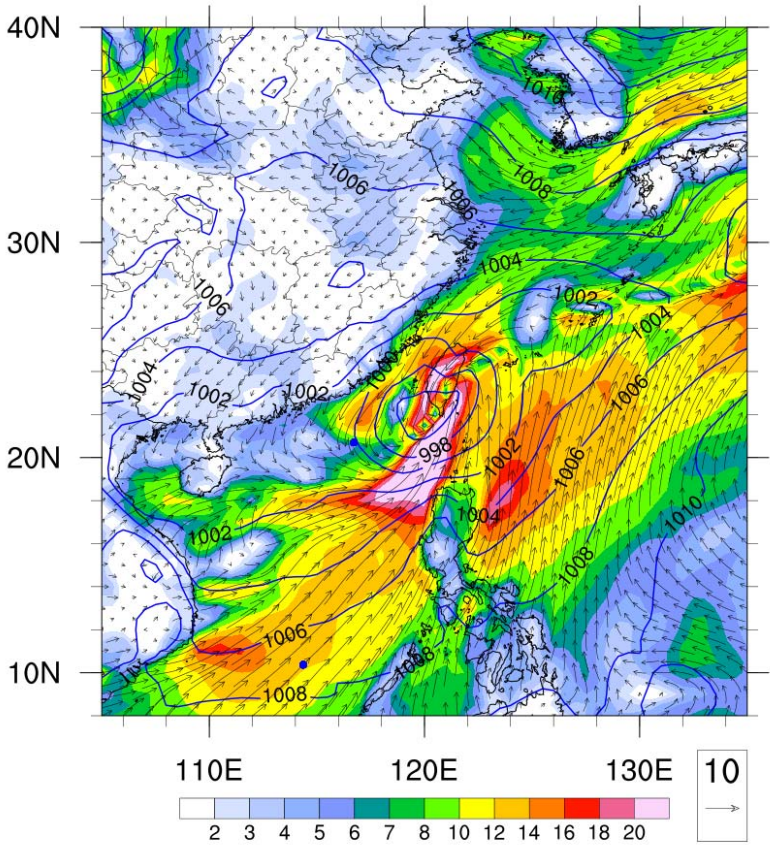


Moisture flux (g kg-1 m s-1) +w(Pa/s, upward)

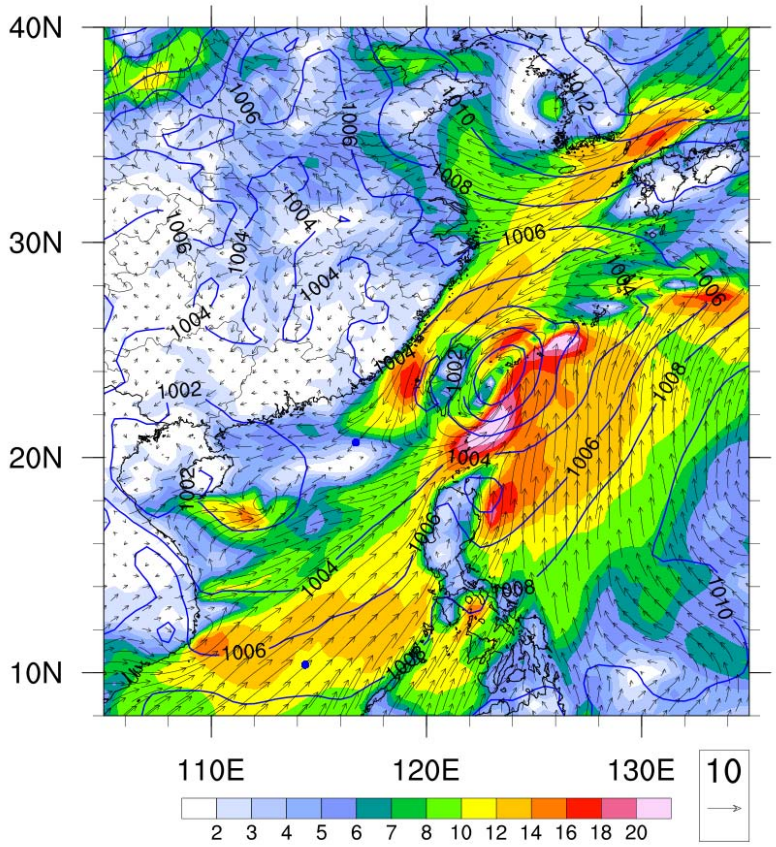


SLP (hPa) & 1000hPa winds (m/s)

6/15 00UTC

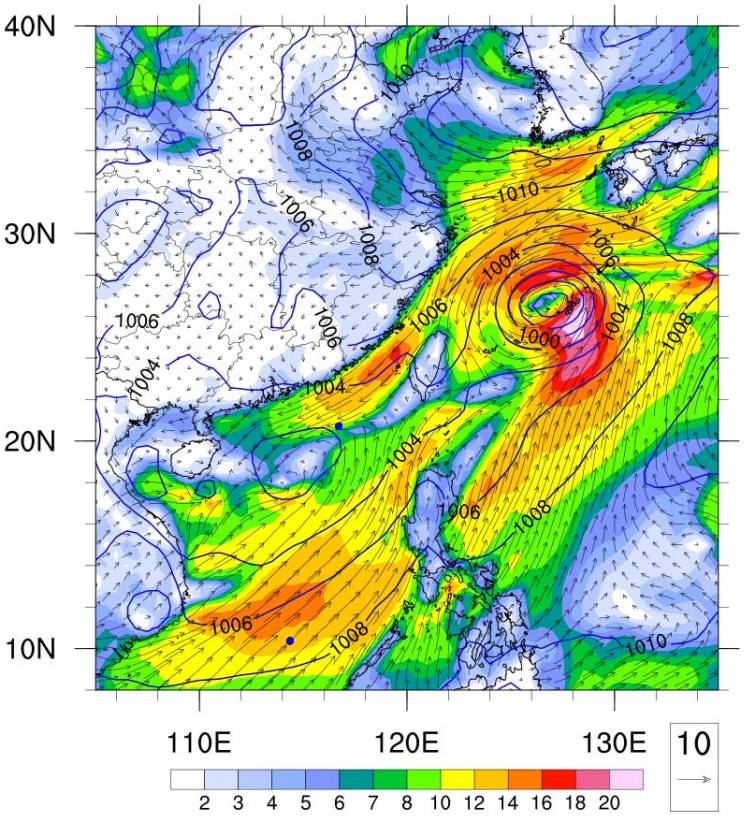


6/15 12UTC

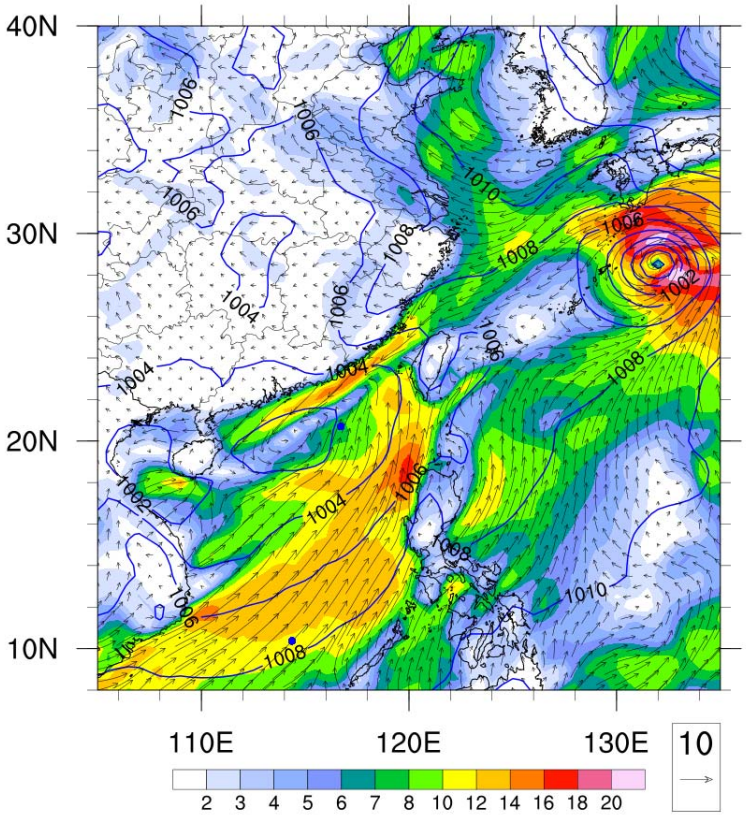


SLP (hPa) & 1000hPa winds (m/s)

6/16 00UTC

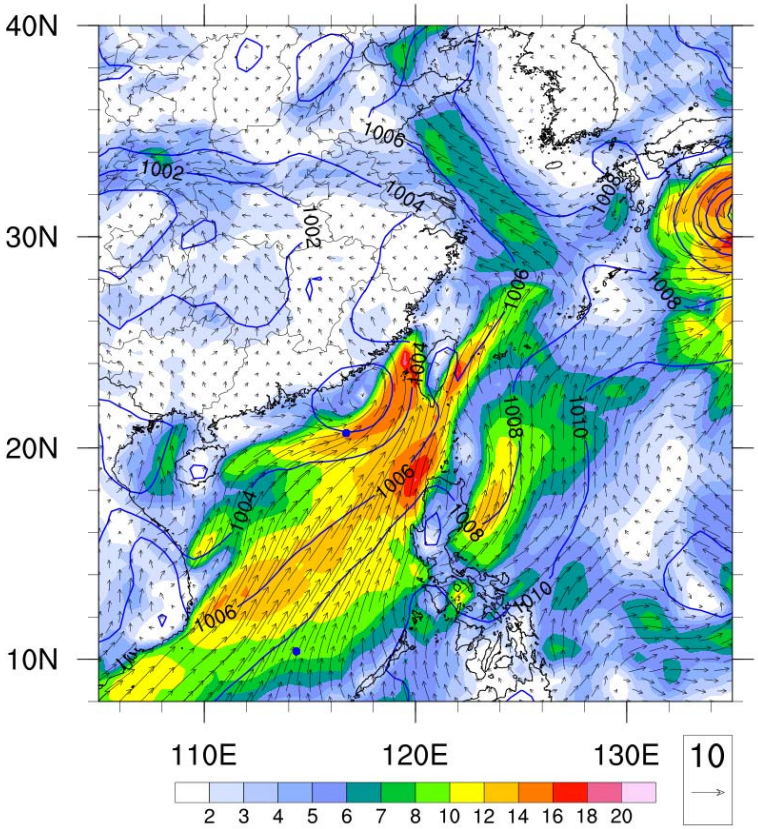


6/17 00UTC

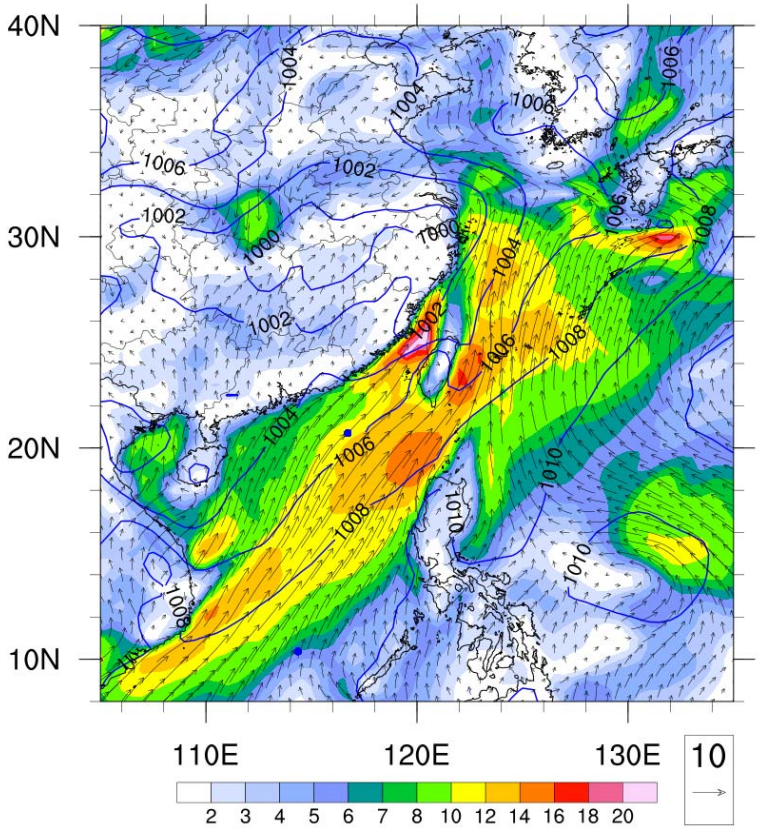


SLP (hPa) & 1000hPa winds (m/s)

6/18 00UTC



6/19 00UTC



SLP (hPa) & 1000hPa winds (m/s)

6/20 00UTC

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