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The mechanisms of the evolution of a Mei-Yu frontal rain band revealed from multiple Doppler/Polarimetric radar observation in the torrential rain event on June 11, 2012

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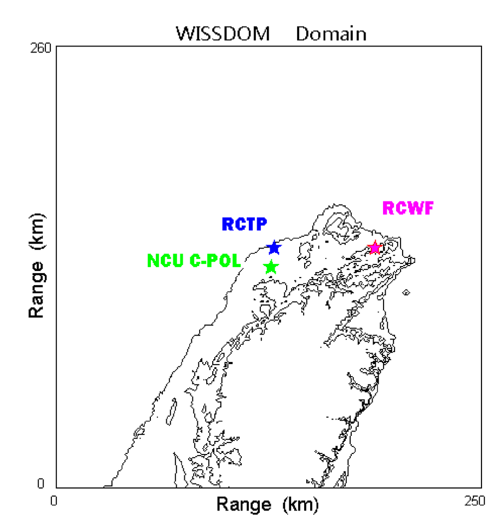
1. Introduction

- A Mei-Yu frontal rain band brought about 500mm rainfall to northern Taiwan within 10 hours.
- The numerical weather predictions were not able to forecast the movement of the rain band and the extreme rainfall.
- On June 11, 2012 the strong southwesterly had encountered the Central Mountain Ridge and brought torrential rainfall to the mountain area.
- Meanwhile the strong low level southwest wind which was called barrier LLJ was detected to the west coast of the island. (Chen et al. 1998)
- The leading edge was moving southeastward in a fast speed of 14.5km/hr. Within 6 hours this rain band evolved into a bow shape before it cast the landfall at 2200LST.
- Once it reached the north coast, the movement of system was almost stationary and brought the most intense rainfall between 2200LST to 2400LST in northern Taiwan.
- The purpose of this article is to utilize the Doppler radar network data near northern Taiwan to study the dynamical reasons for the evolution and movement of this torrential rain event.

2. Method and Data

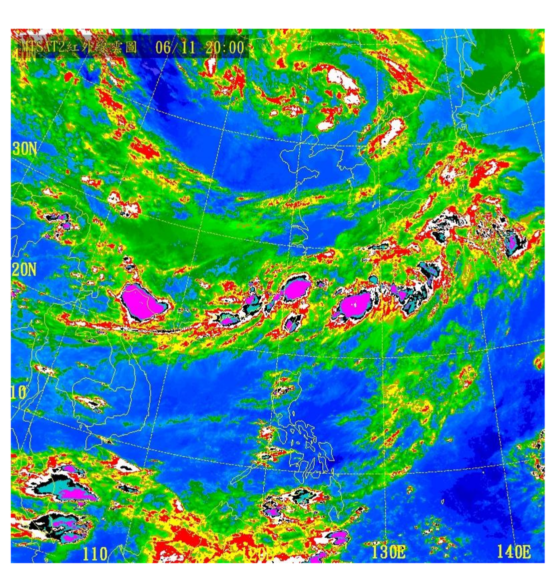
- WISSDOM
  The algorithm was proposed by Liou et al. 2012, and is called Wind Synthesis System used to Doppler Measurements (WISSDOM). The three dimensional winds at different time stages are retrieved. The wind fields were further applied to the calculation of the perturbation pressure and temperature fields.

- Radar data
  We used three radar observation at northern of Taiwan that are S-band RCWF, C-band RCTP and NCU C-POL from 2000 LST to 2400 LST on 11th June 2012. The RAKIT system, which developed by NCU radar lab, is used for radar data quality control in the study.

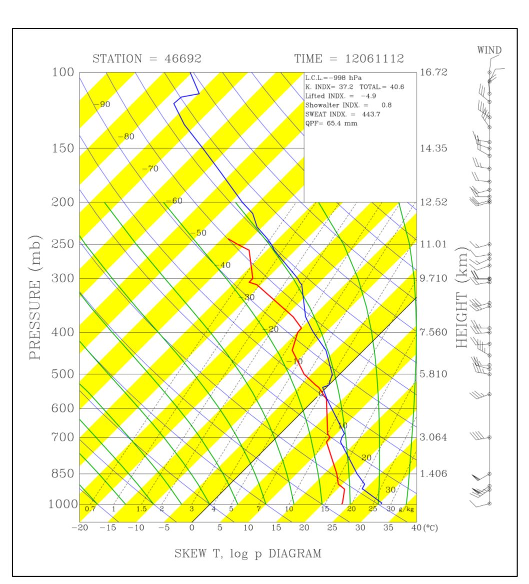


▲ The domain of WISSDOM and three radars in northern of Taiwan.

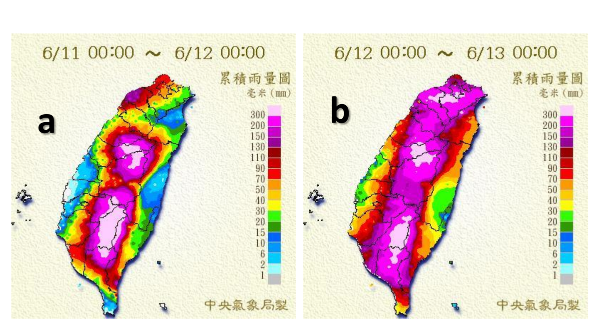
3. Observation and analyses



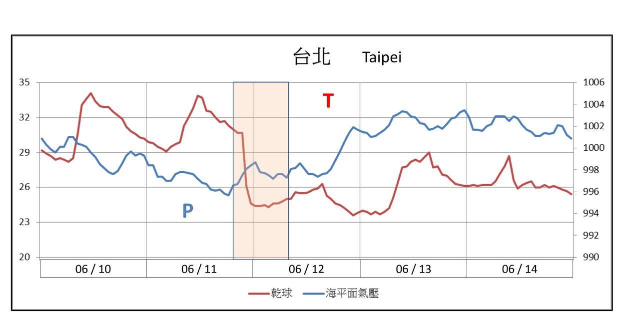
▲ The Satellite images of east Asia area at 2000 LST(1200 UTC), June 11.



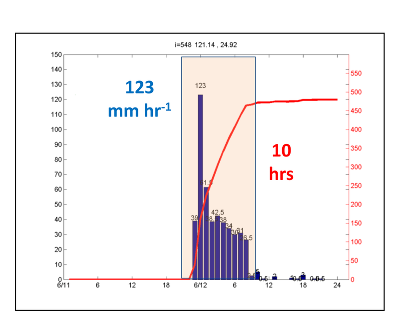
▲ The Banciao sounding before heavy precipitation at 1200 UTC, June 11.



▲ (a) The total rainfall accumulation on June 11. (b) on June 12.



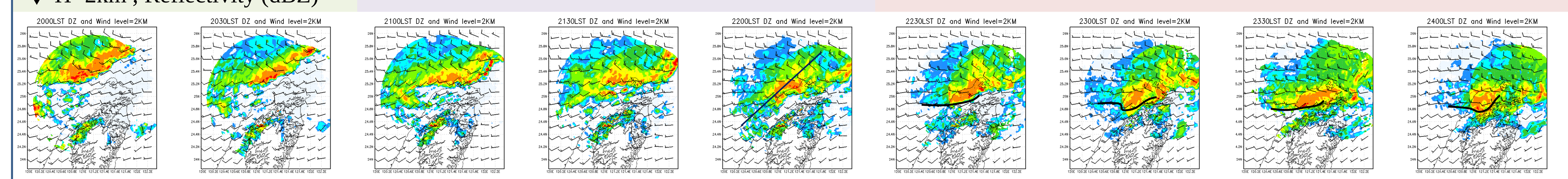
▲ The surface observation of the Taipei station from June10 to June14.



▲ The rainfall hour accumulation of YangMei station from June11 to June 12.

Fast motion		Landfall and merging			Stationary movement			
2000	2030	2100	2130	2200	2230	2300	2330	2400

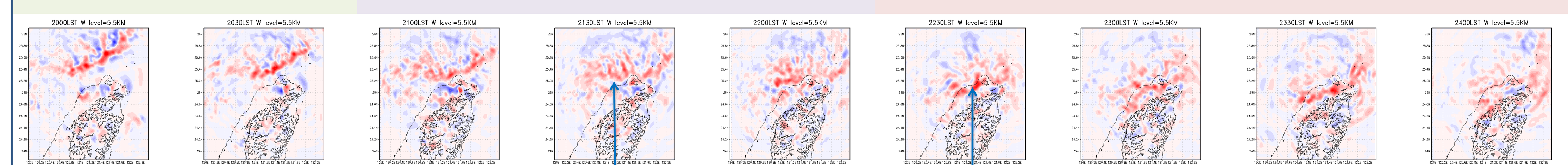
▼ H=2km , Reflectivity (dBZ)



◎ Strong southwesterly encountered the Mei-Yu front. The convergence between the southwest wind and the northwest wind at the leading edge.

◎ The southward propagation speed of the newly formed convection was balanced by the northward component of the southwesterly.

▼ H=5.5km, vertical velocity (m/s)

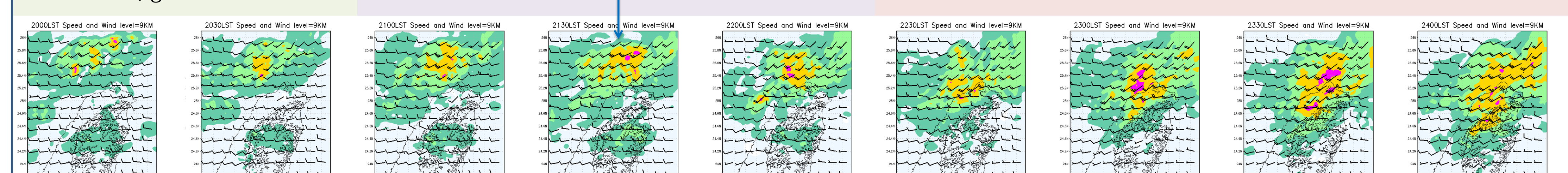


◎ The central part of leading edge was moving southeast in a speed of 14.5km/hr

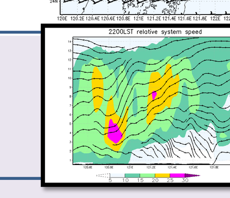
◎ The wavy vertical motion field at 2130LST (from 4km up to 12km)

◎ The strongest vertical motion appeared at the encounter point between the LLJ, the Mei-Yu front and the terrain of northern Taiwan.

▼ H=9km, ground-relative wind

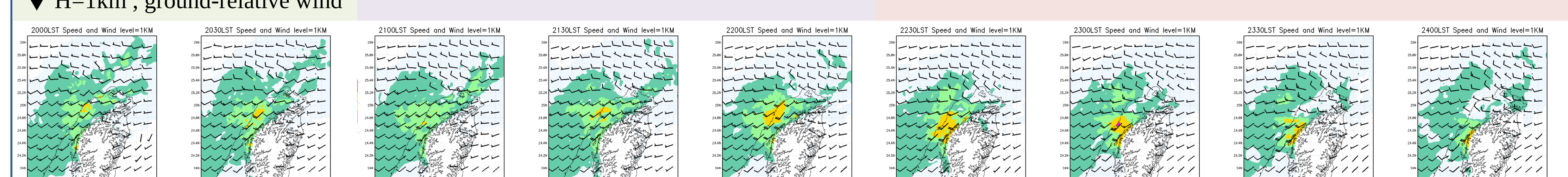


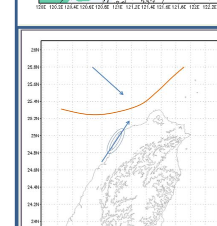
◎ The upper level wind of stratiform region was strengthen before landfall.



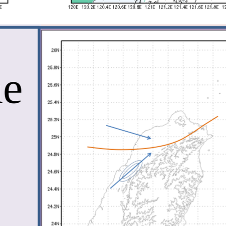
◎ The upper level wind of stratiform region to the NE was reaching maximum after landfall.

▼ H=1km , ground-relative wind





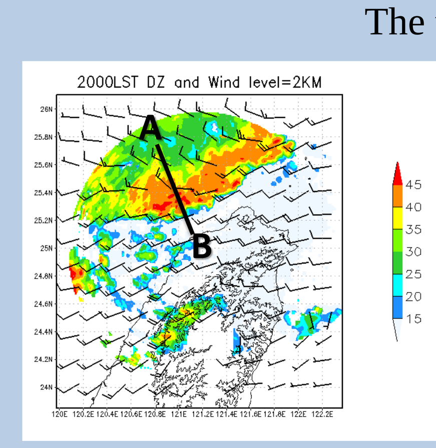
◎ The Low Level barrier jet was enhancing while the front was approaching the land (from 2000LST to 2200LST).



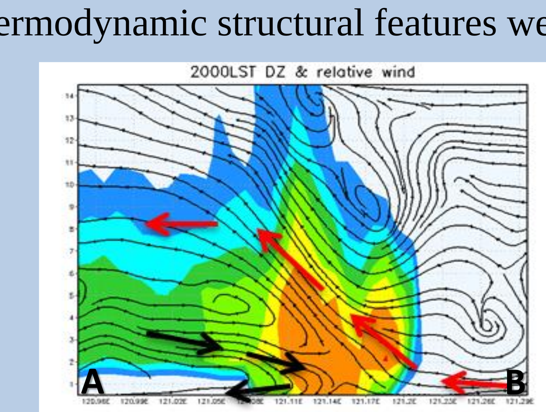
◎ As the system became stationary, the jet axis was shifting from the coast toward the foothill of mountain.

5. Thermodynamic features

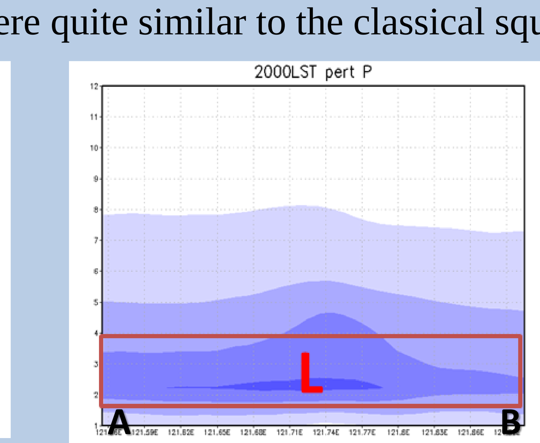
The thermodynamic structural features were quite similar to the classical squall line. (Houze, 1989)



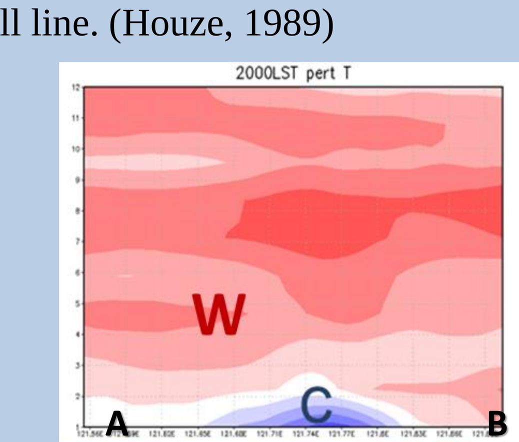
▲ H=3km, Reflectivity Red line is cross section.



▲ Reflectivity(dBZ, shaded); wind field (black stream line) along cross section A to B



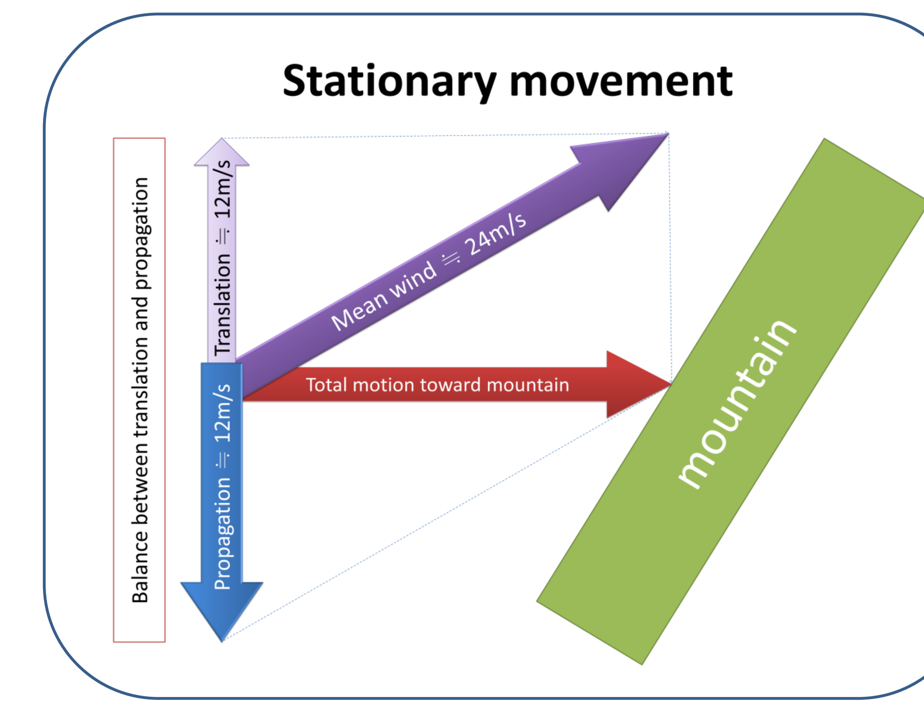
▲ Pressure perturbation (hPa, shaded)



▲ Temperature perturbation (shaded)

6. Conclusion

- The changes of the vertical motion and the new cell propagation were studied in detail. The interactions between the low level jet, the Mei-Yu front and the high terrain was also discussed.
- The fast motion of leading edge: the cold pool dynamics of the Mei-Yu front and the stronger convergence from the southwest Low level barrier Jet promoted the convection of the central part of the leading edge.
- The stationary movement of system on land: The propagation speed toward south was balanced by the southwest barrier jet. Hence the newly formed convection was pushed back to northeast and joined the old system.
- The interaction between the front, the terrain and the jet was clearly shown by the radar analyses. It can explain the movement and evolution of different stages of this system.
- There are many interesting meso-scale phenomena need to be further studied, including the kinetic energy transport, the weak evolution of the stationary system, microphysical characteristics etc.
- While the operation forecast model was not able to catch the timing, the movement and the strength of this system, the proper radar data assimilation in the future may have chance to improve the short range forecast.



7. Reference

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