

Characteristics of Severe Rainfall Events at the Duplicate Display of Satellite Images and Winds

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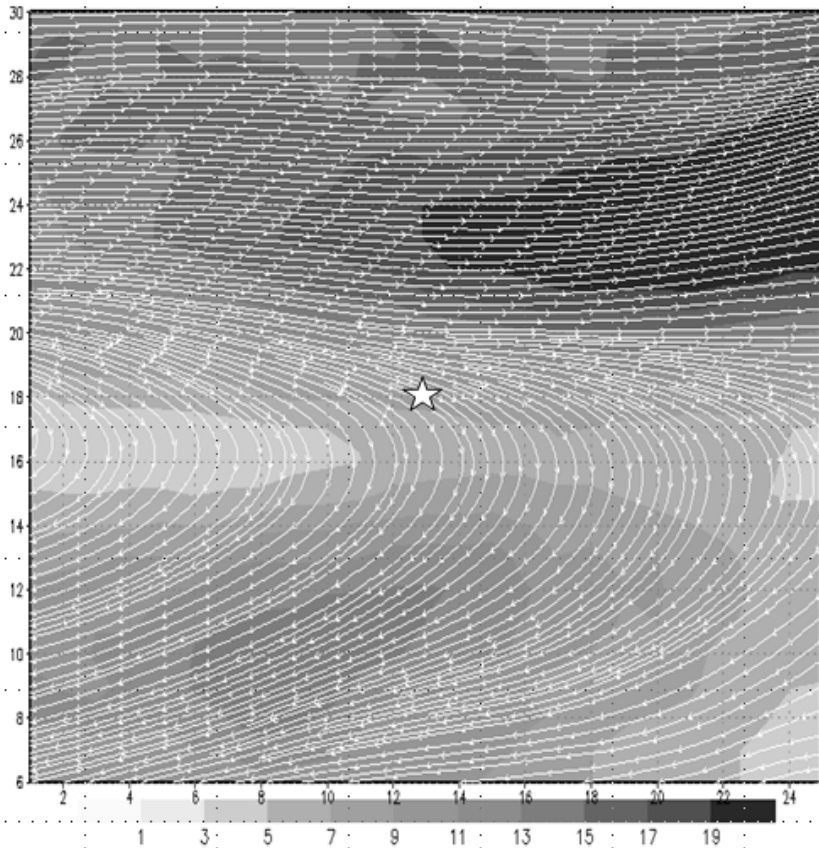
National Satellite Meteorological Center

20 Feb. 2012

Characteristics of Severe Rainfall Events at the Duplicate Display of Satellite Images and Winds

- An active Meiyu frontal system with sustain and severe rainfall is often coupled with an anti-cyclonic ridge in higher troposphere-----a divergent flow above the rain belt.
- Close to and to the north of the anti-cyclonic ridge, there is a jet stream along with a distinct boundary of zonal orientation. The space between the jet and the ridge is about 6-8 latitude.
- Dark and bright areas with subsidence and ascending motions are at the either sides of the northern boundary of the rain cluster.
- While the northern boundary of the cloud cluster is distinct, feathered cirrus out flow can be detected along the southern boundary.

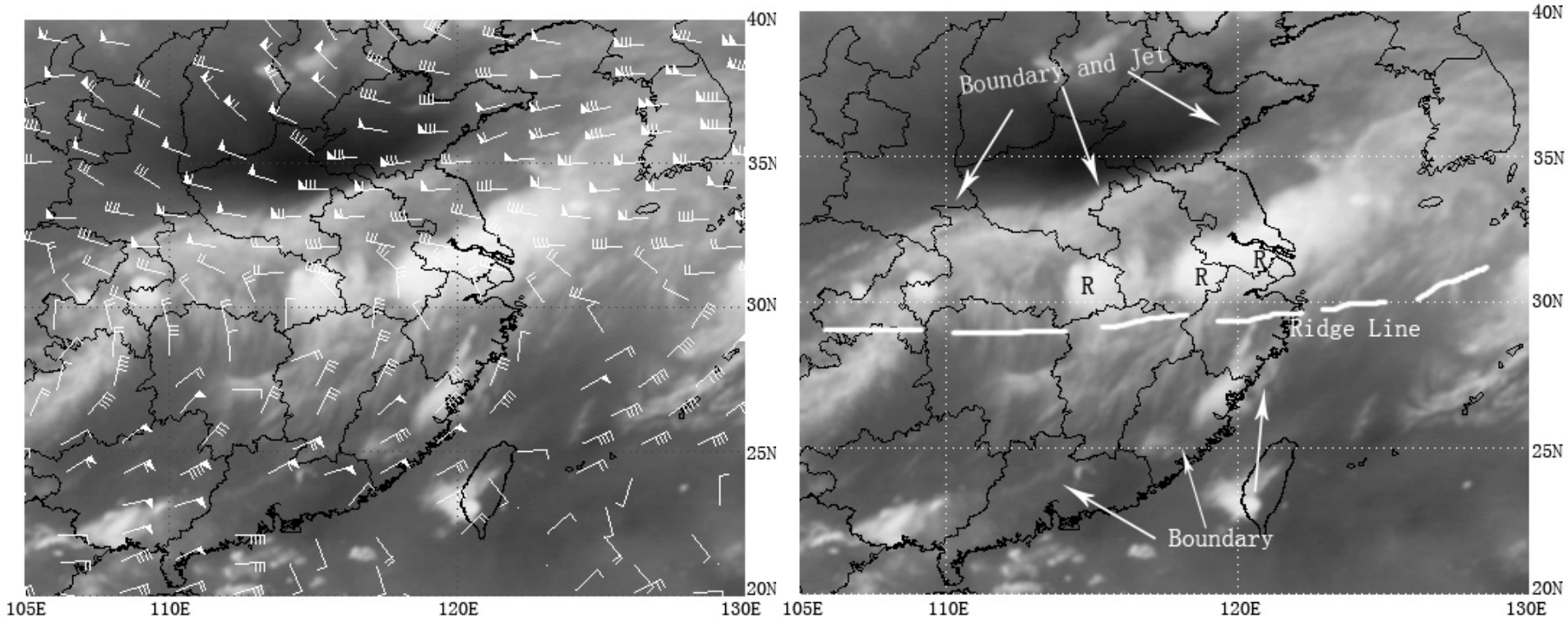
The composition of high level AMVs for the 35 examples from 1998 to 2005 belonging to the Meiyu frontal systems



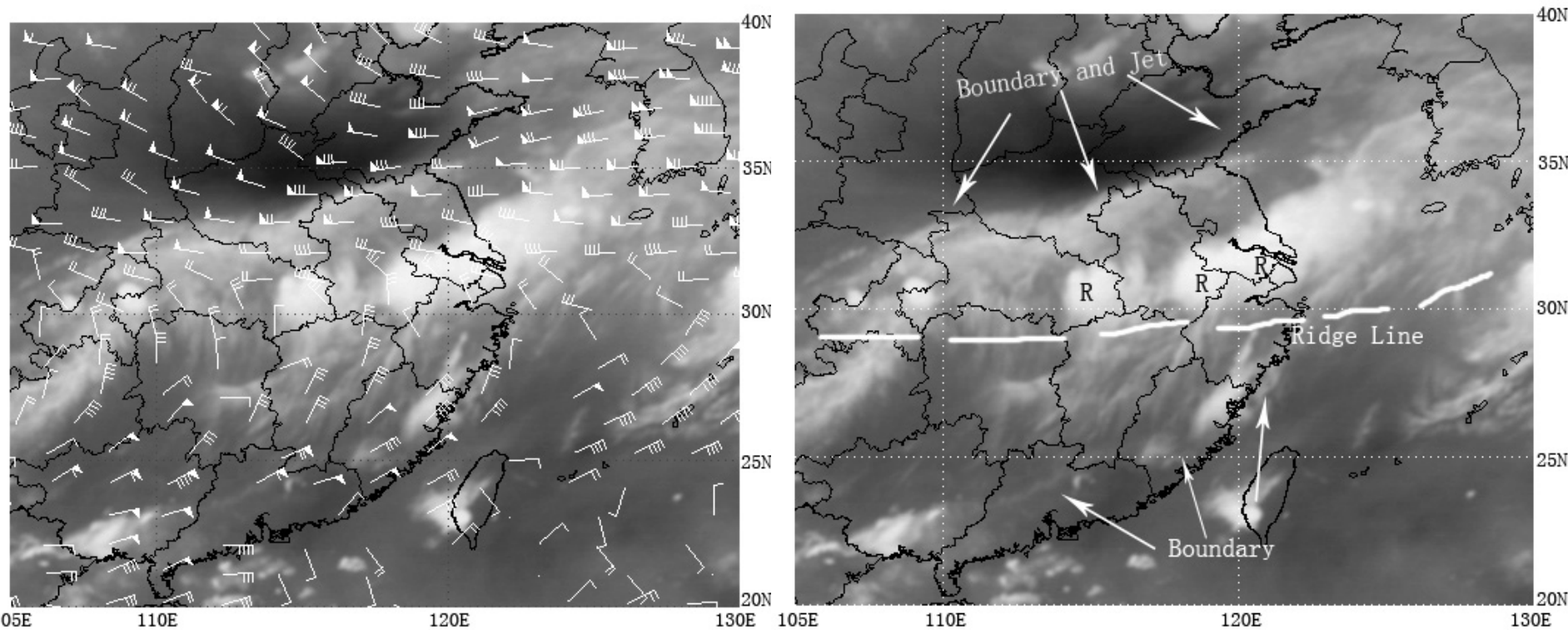
A star symbol represents the location of the rainfall center; stream lines are accompanied with grey scales expressing speed. A jet stream is to the northeast side of the rainfall center. To the south of the rainfall center, there is an anti-cyclonic ridge. The space between the jet and the ridge is about 8 degree in latitudinal distance. The rainfall center is between the jet and the ridge at the right side of the jet's entrance region. Diffluent flow is above the rainfall center.

**The image characteristics of a typical
severe rainfall event**

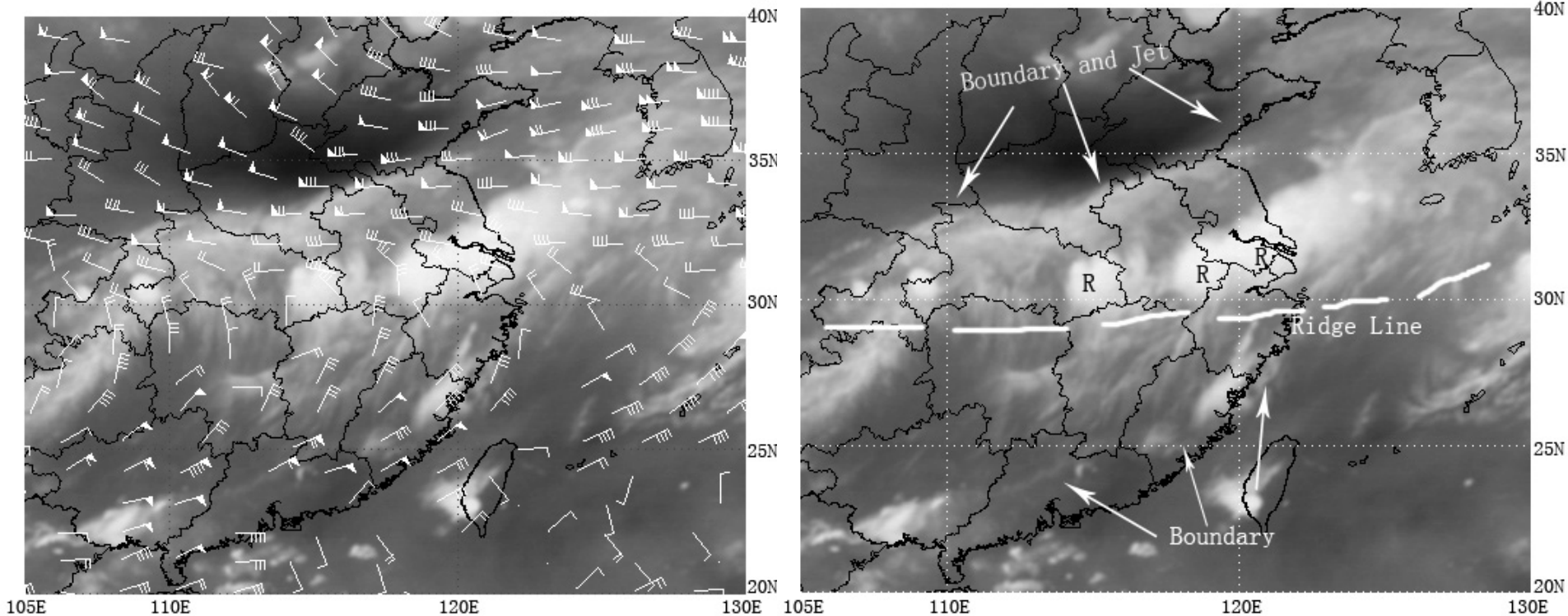
The bright rain cluster has a distinct northern boundary along the line of the westerly jet. Dark and bright features are to the north and south sides of the boundary and the jet, which indicate subsidence and ascending motions to the either side respectively.



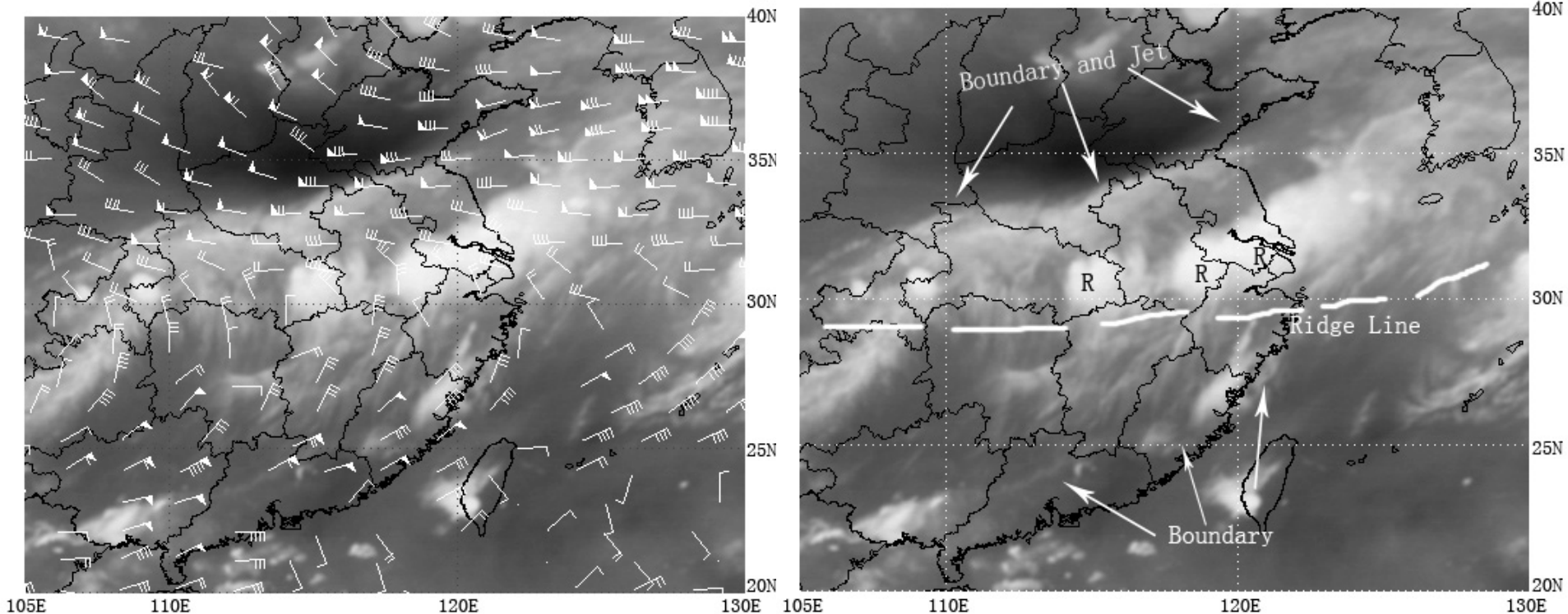
As compared with the sharp northern boundary, the transition of image tone between the two sides of the southern boundary takes a long distance. The cirrus out flow from the rain cluster is seen to the south of Yangtze River in China.



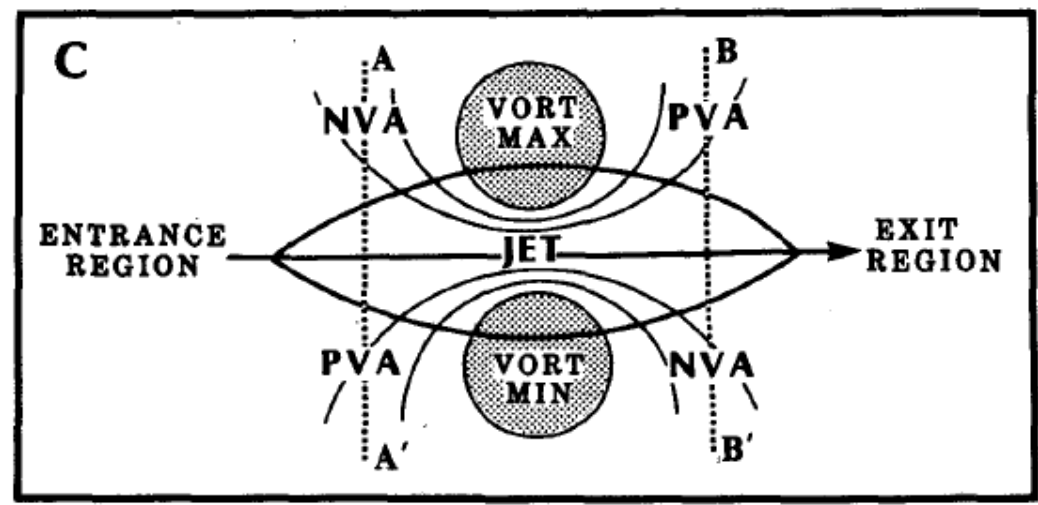
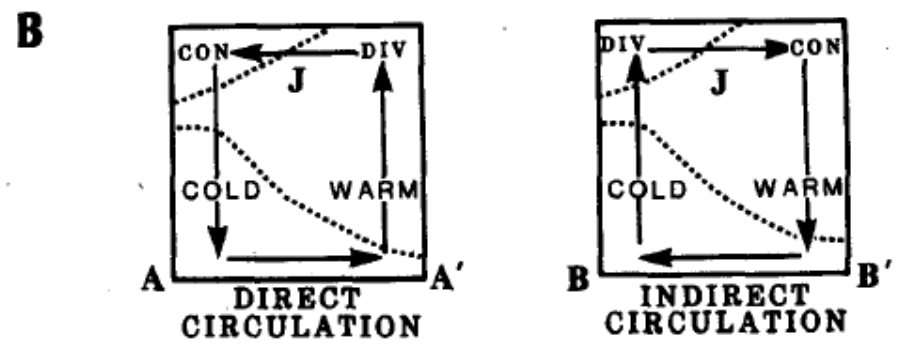
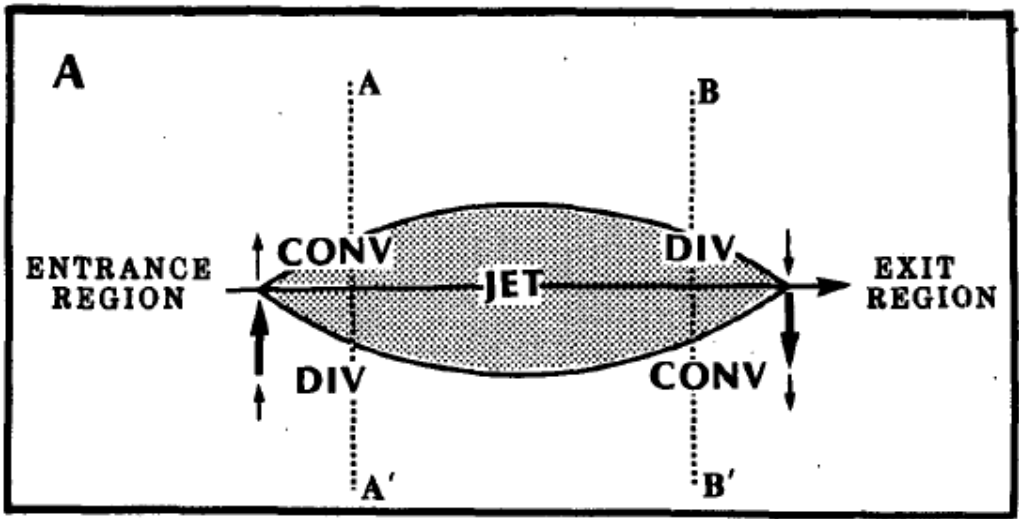
A sharp northern boundary associated with a ragged southern boundary implies divergence above the rain belt. The AMV pattern is coincident with the image feature.



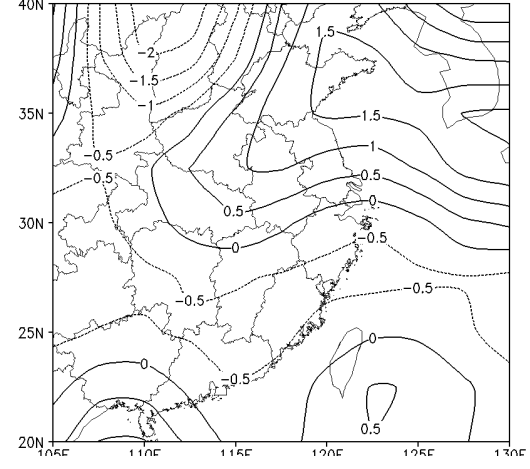
A diffluent pattern is observed above the rain belt. Since the speed maxima along the jet streak increases toward downstream, the rain belt is just under the right side of the jet's entrance region. Based on this, it is qualitatively judged that divergence and positive vorticity advection may exist above the rain cluster.



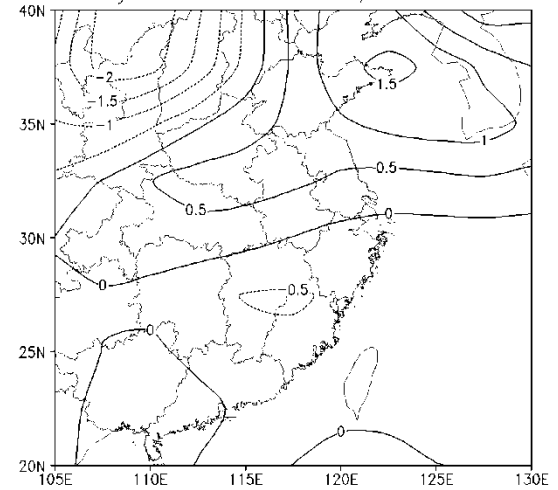
The rain belt is just under the right side of the jet's entrance region



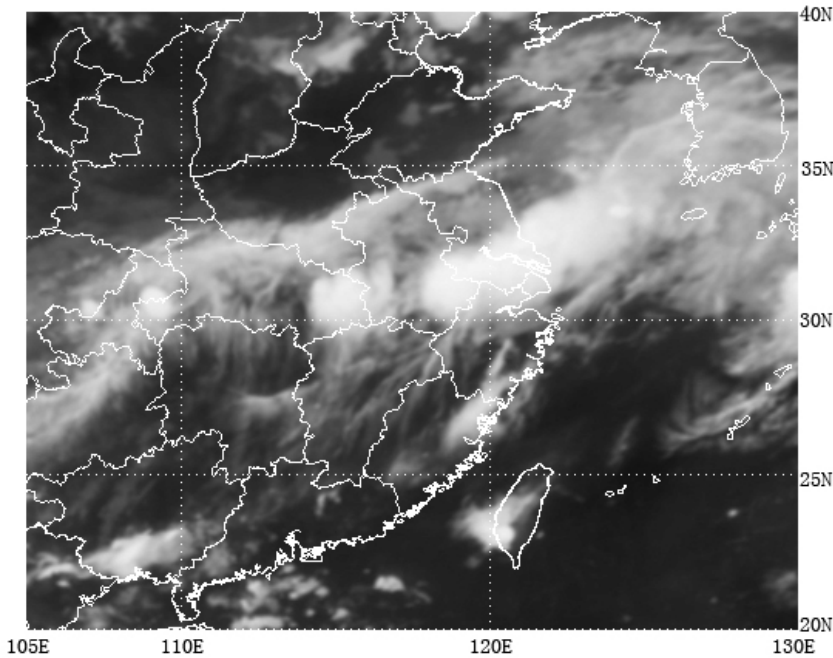
divergence at 200hPa, 20070703 1200 (ncep)



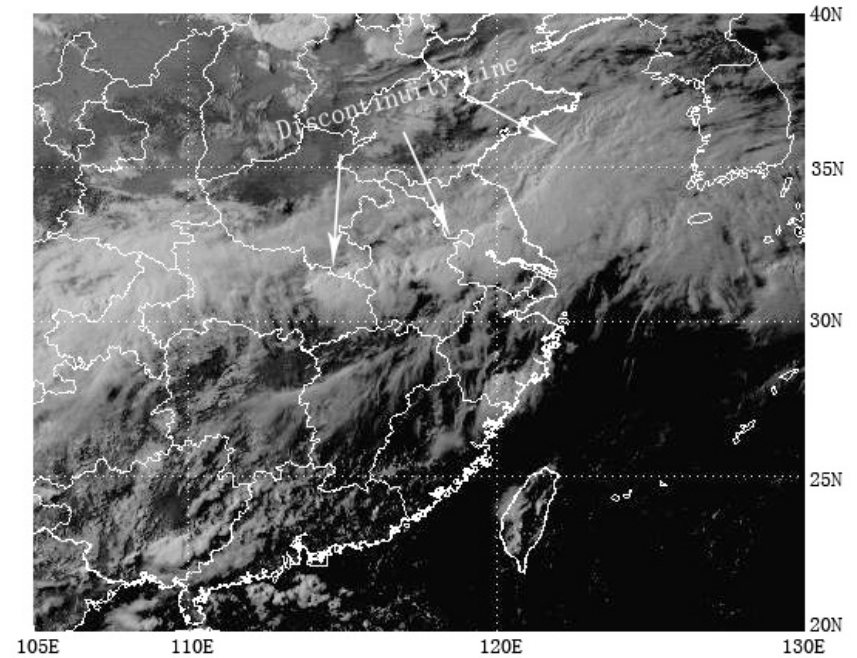
relative vorticity advection at 200hPa, 20070703 1200 (ncep)



Infrared image of FY2C at 1130 GMT on 3th July 2007

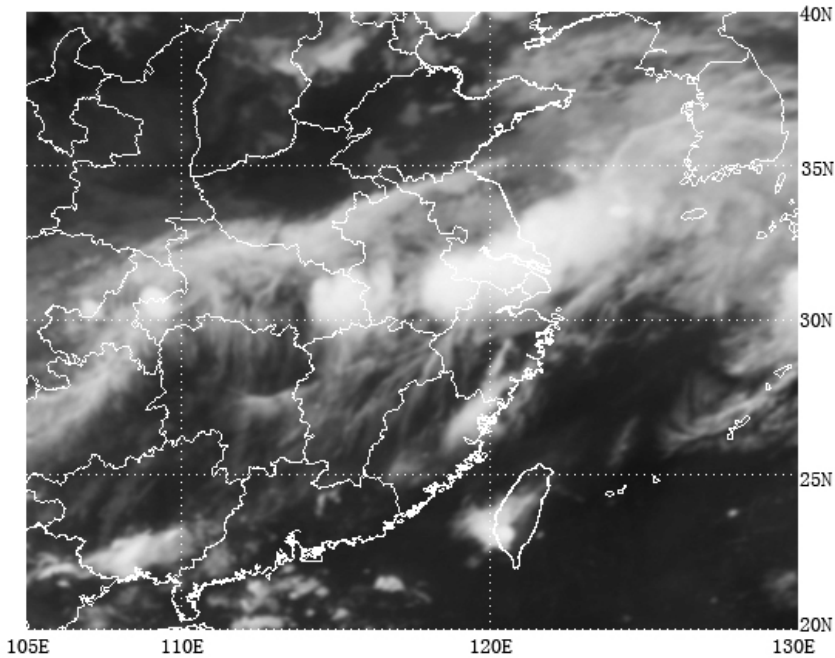


Visible (VIS) image of FY2C at 0930 GMT on 3th July 2007

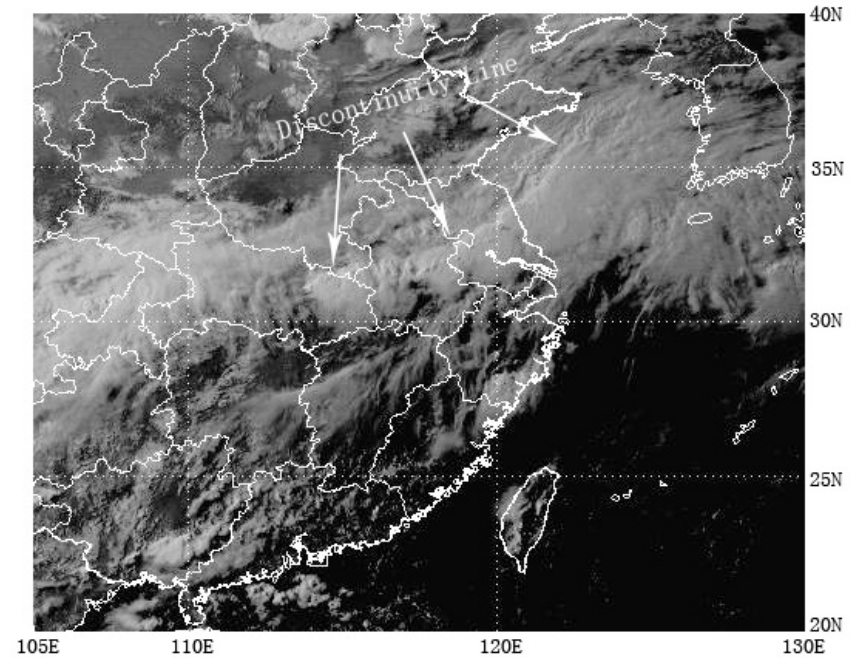


When there is a dark region at the rear of the front in WV images, convective rain often develops in the warm sector of the frontal system. In VIS image, an arc line of discontinuity separates the deep convective clouds from the stratus clouds on the frontal belt.

Infrared image of FY2C at 1130 GMT on 3th July 2007



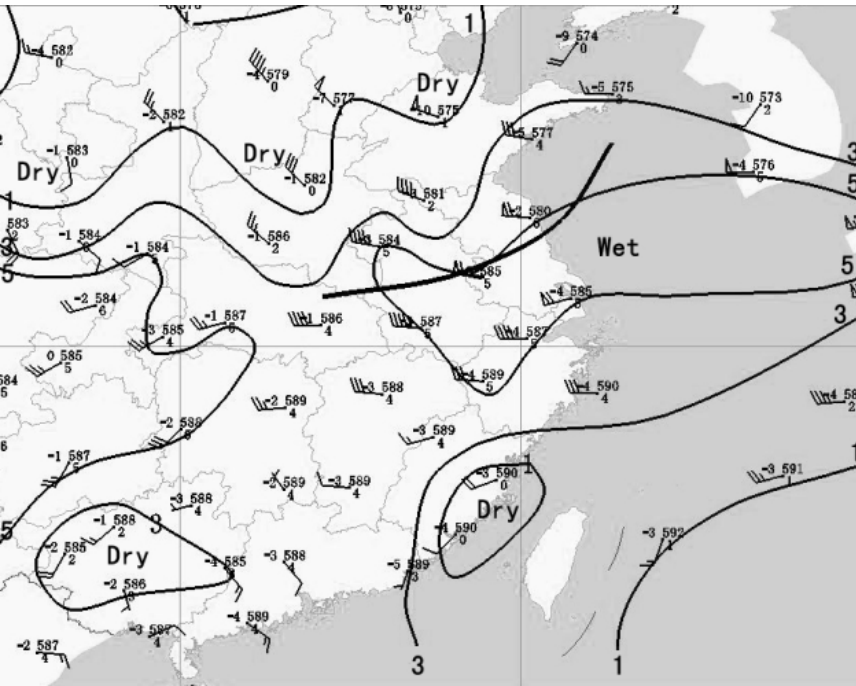
Visible (VIS) image of FY2C at 0930 GMT on 3th July 2007



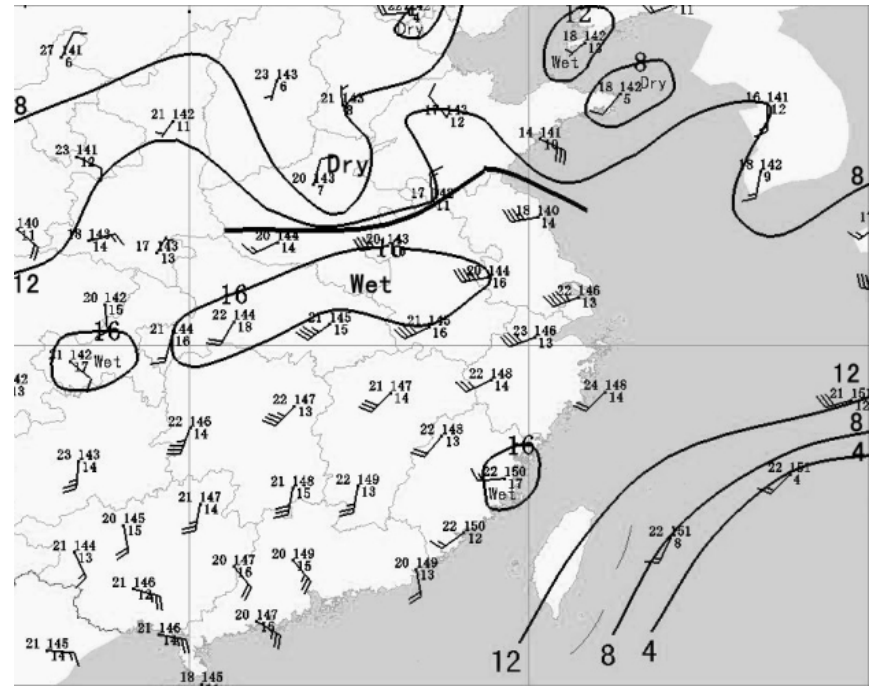
This discontinuity line is in fact the frontier edge of the dark region with center around 114°E 34°N in WV image. The severe rainfall is mainly caused by the convections along and to the southeast of the discontinuity line where cool and dry air aloft are moving and invading above the lower warm and moist air.

This phenomenon is also noticed in the weather maps.

500 hPa weather map at 1200 GMT on 3th July 2007



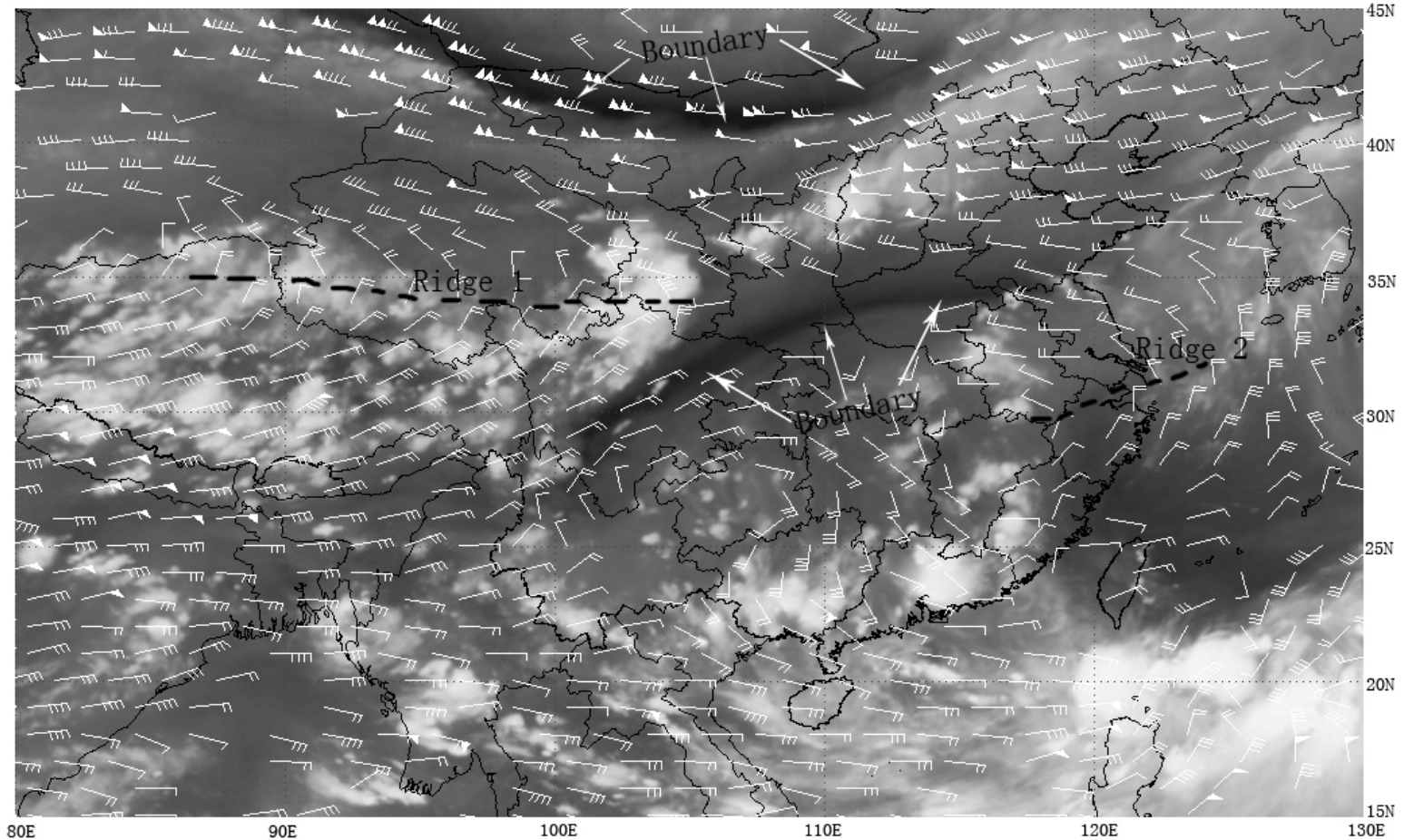
850 hPa weather map at 1200 GMT on 3th July 2007



Although the black area in WV image is behind the front, the frontier edge of the dry intrusion may have already moved ahead of the surface front which may not be seen clearly on the WV image. As a result, severe convective rainfall happens in the warm sector along the frontier edge of the mid-troposphere dry intrusion.

the severe rainfall events located to the north of Nanling Mountain (north of 25°N) is frequently associated an active boundary with a jet in adjacent in higher troposphere

An active boundary accompanied with a jet



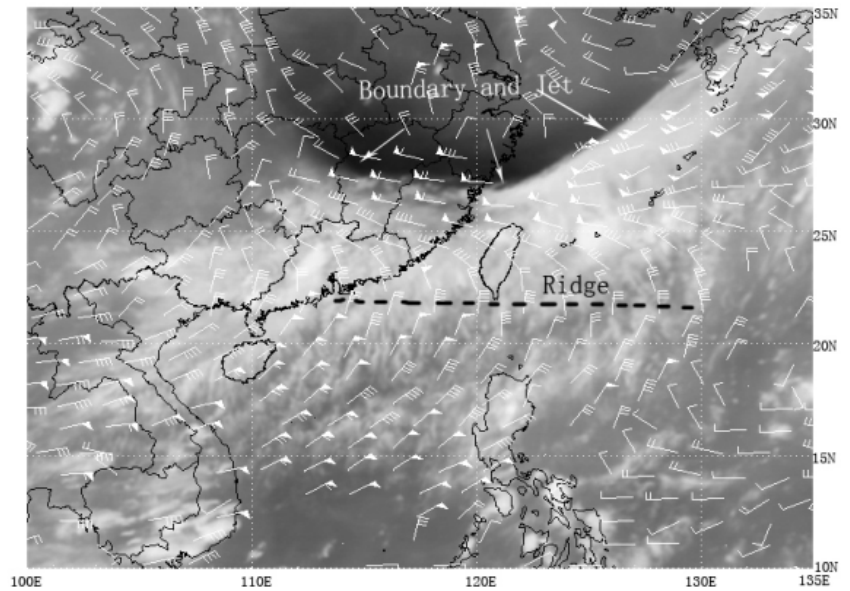
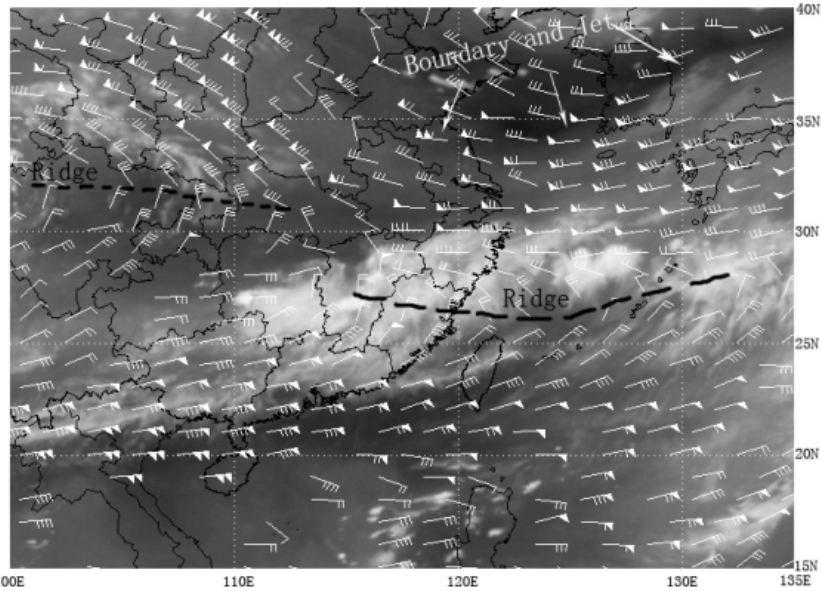
Ridge 1 is accompanied with a jet. Diffluent aloft outflow is above the rain cluster. Ridge 2 is associated with a deformation field rather than a jet. Only scatter rain can be detected.

Normally, the space widths of 6-8 degrees in latitudinal distance are favourable for the severe rainfall to happen to the north of Nanling Mountain in China.

A narrow space between the jet and the ridge

Wuyi Mountain severe rainfall

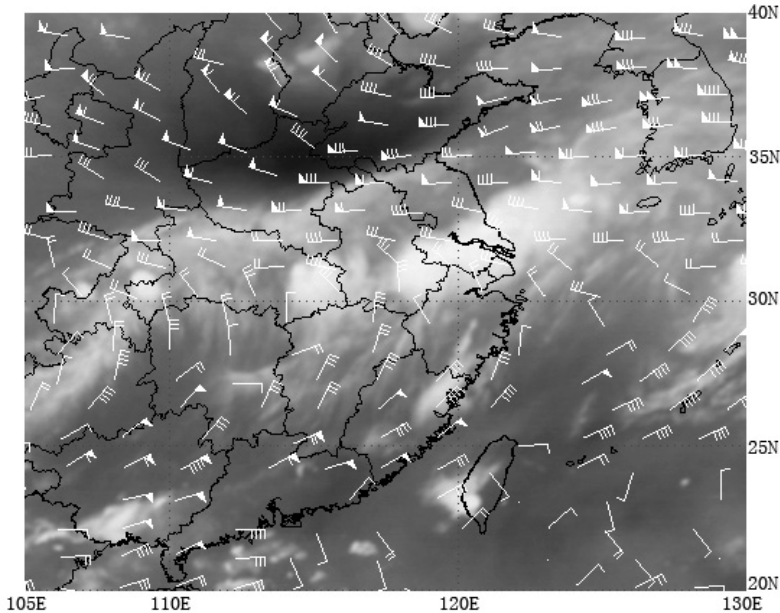
Guangxi severe rainfall



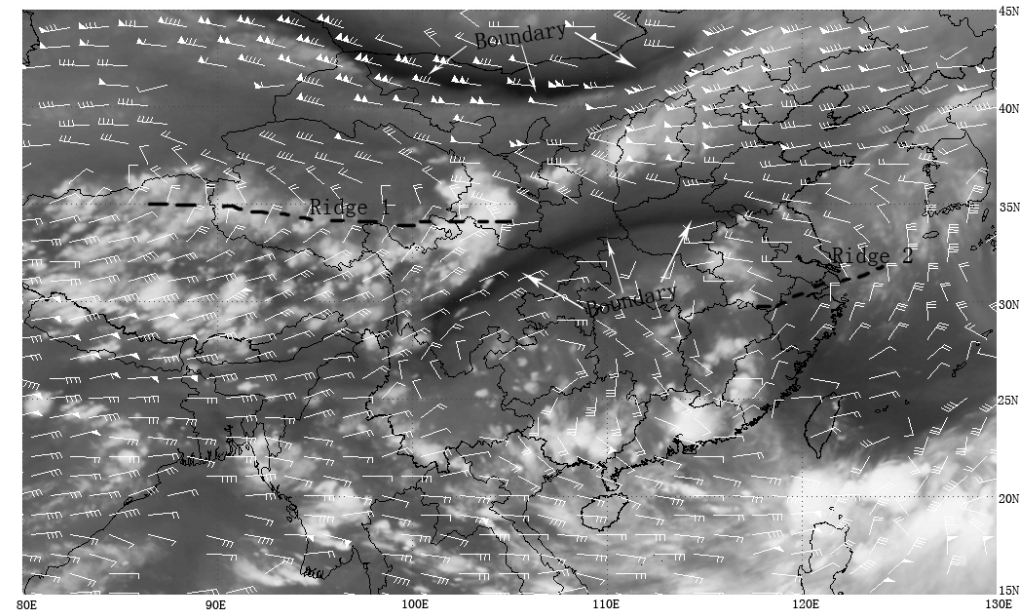
For the two cases in Wuyi Mountain and Guangxi, the space widths from the jet to the ridge are 8 and 6 degrees in latitudinal distance respectively.

A narrow space between the jet and the ridge

Huaihe severe rainfall

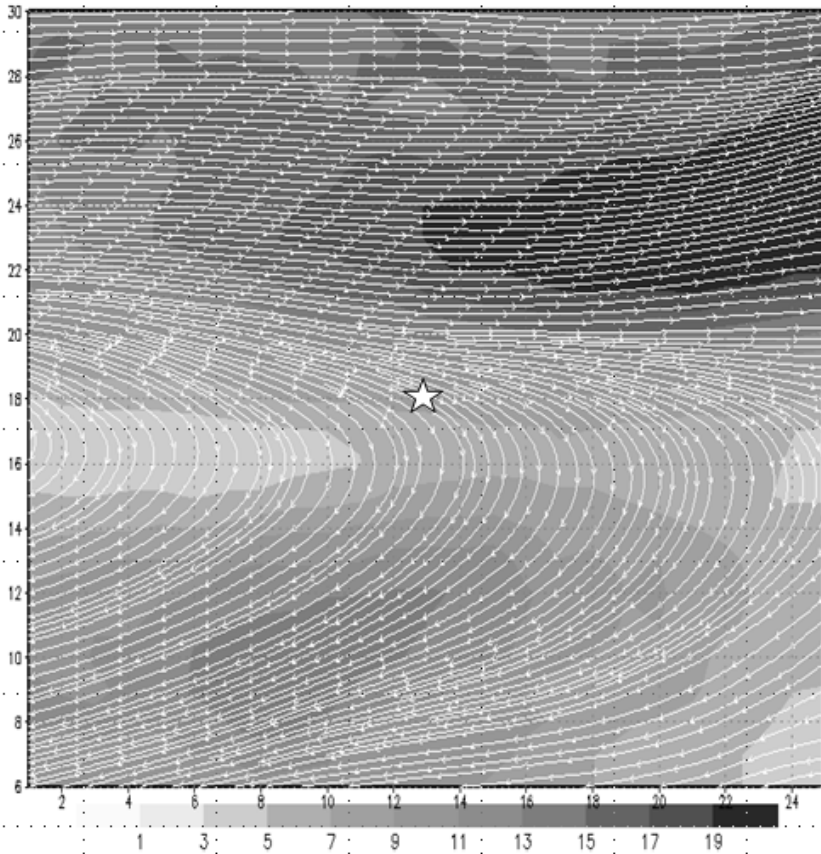


Zhouqu severe rainfall



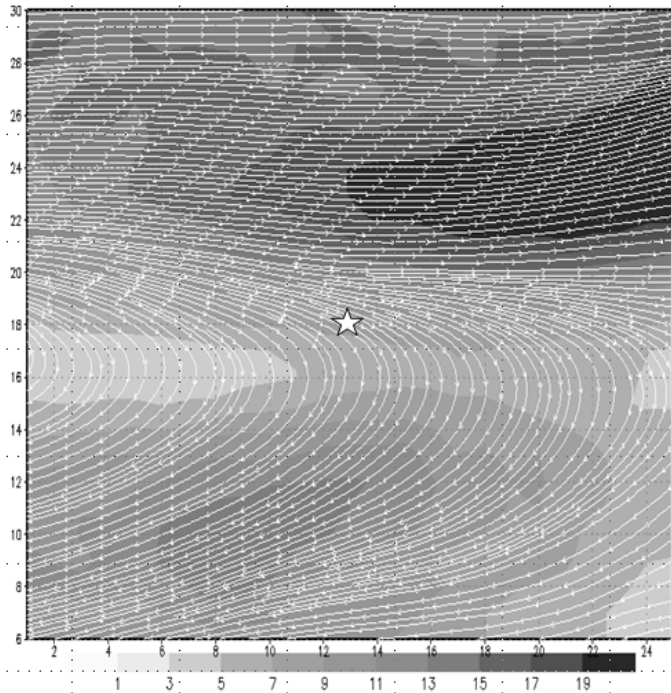
For the Huaihe and Zhouqu cases, along the same longitudes of the jets (119°E , 35°N and 106°E , 41°N), the ridges are at (119°E , 28°N) and (106°E , 34°N); the space widths from the jet to the ridge are both 7 degrees in latitudinal distance.

Action of narrow space between jet and ridge (1)



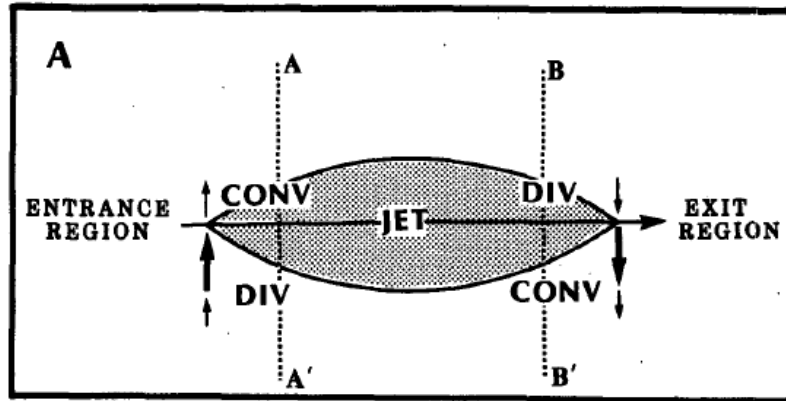
- The latitudinal gradient of the zonal wind and the related anti-cyclonic vorticity to the south of the jet is enhanced. When the upper level anti-cyclonic circulation is coupled with the low level cyclonic one, the CISK mechanism is initiated.

Action of narrow space between jet and ridge (2)

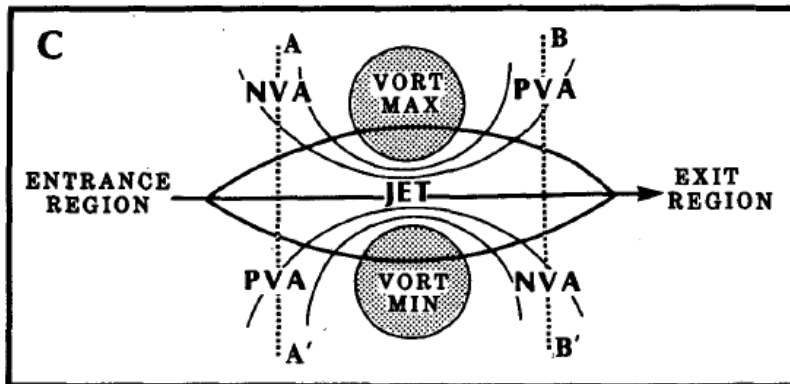
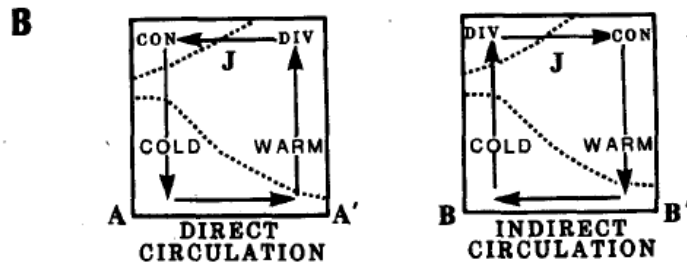


- If the upper level anti-cyclonic vorticity ($-\Delta U/\Delta Y$) is strengthened to a magnitude comparable to the coriolis parameter (f), the absolute vorticity ($f-\Delta U/\Delta Y$) reduces. A small absolute vorticity means a condition closer to **the inertial instability** in the upper troposphere. This is favourable to the out flow in the upper troposphere.

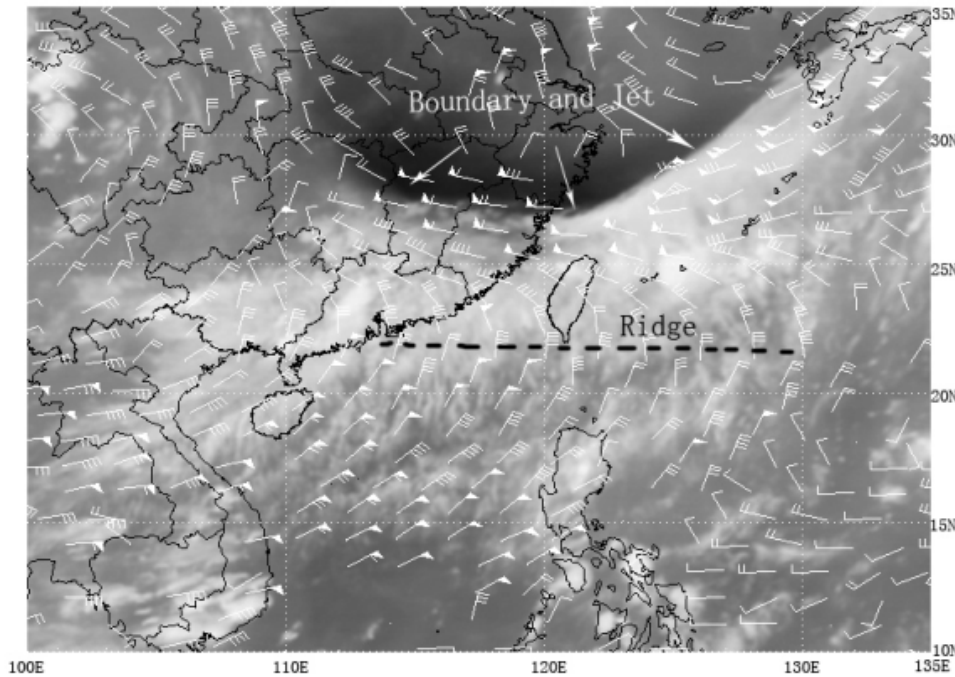
Action of narrow space between jet and ridge (3)



- Since the observed jet steak has its speed maxima to the downstream side of the rain cluster, the rain cluster is at the right side of the jet's entrance region. This is favourable to the divergence in high level and the ascending motion in the troposphere.

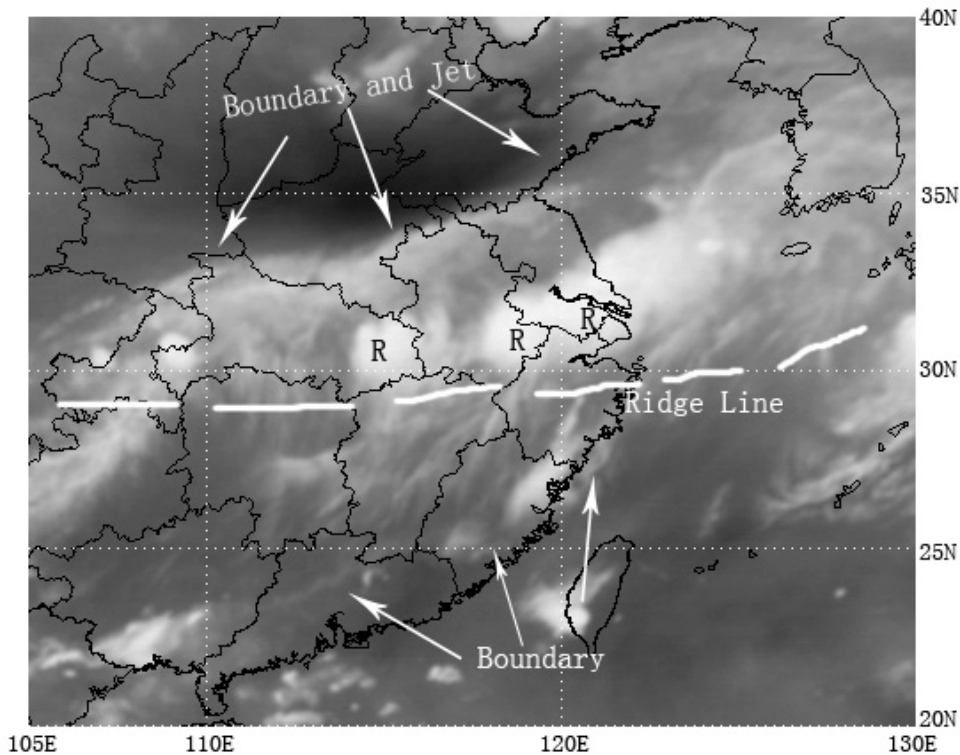


Action of narrow space between jet and ridge (4)



- In case the jet and the ridge are closed with each other, the upper level diffluent flow pattern and the related divergence are observed.

Action of narrow space between jet and ridge (5)



- The dark tone to the north of the boundary and jet supplies subsidence motion which compensates the ascending in the cloud cluster.

End