Typhoon Relocation in CWB WRF

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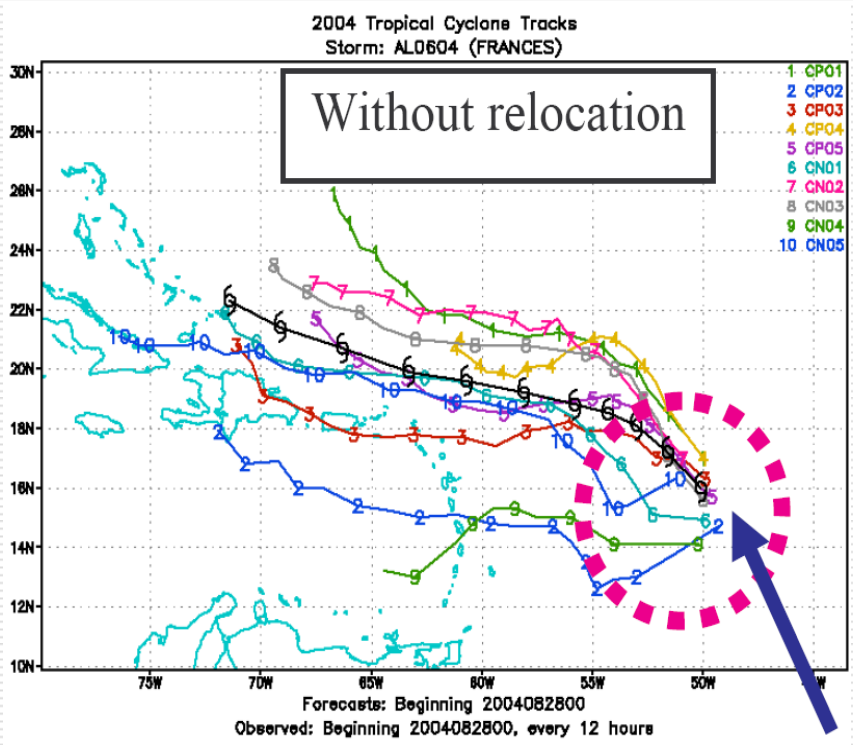
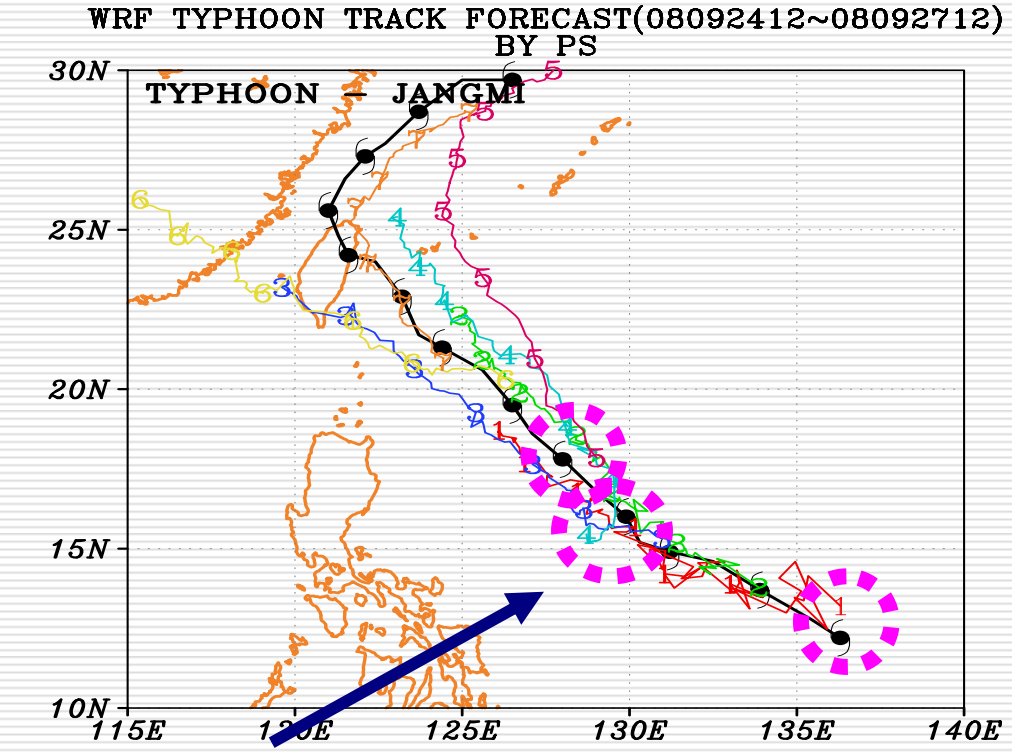
Motive





Liu et. al (2006) Hurricane Relocation in Global Ensemble Forecast System. 27th Conference on Hurricanes and Tropical Meteorology.

Large initial spread

Relocation Scheme

(on eta-surface, maximum to 4 tropical cyclones):

(1) **Apply filter** scheme **to get basic flows** (filter out L< 1200km)

(2) **Compute perturbation fields** as the residual of the basic flow from total fields

(3) Interpolate eta=.85 perturbation wind to typhoon centered polar coordinates and **compute azimuthally averaged tangential wind profile** at 24 directions

(4) **Determine the typhoon edge** locations,

From the starting location, search outward at 24 directions to find the first place that

a. $v < 6$ m/s and $dv/dr < 4 \times 10^{-6}$, or b. $v < 3$ m/s until 800km end

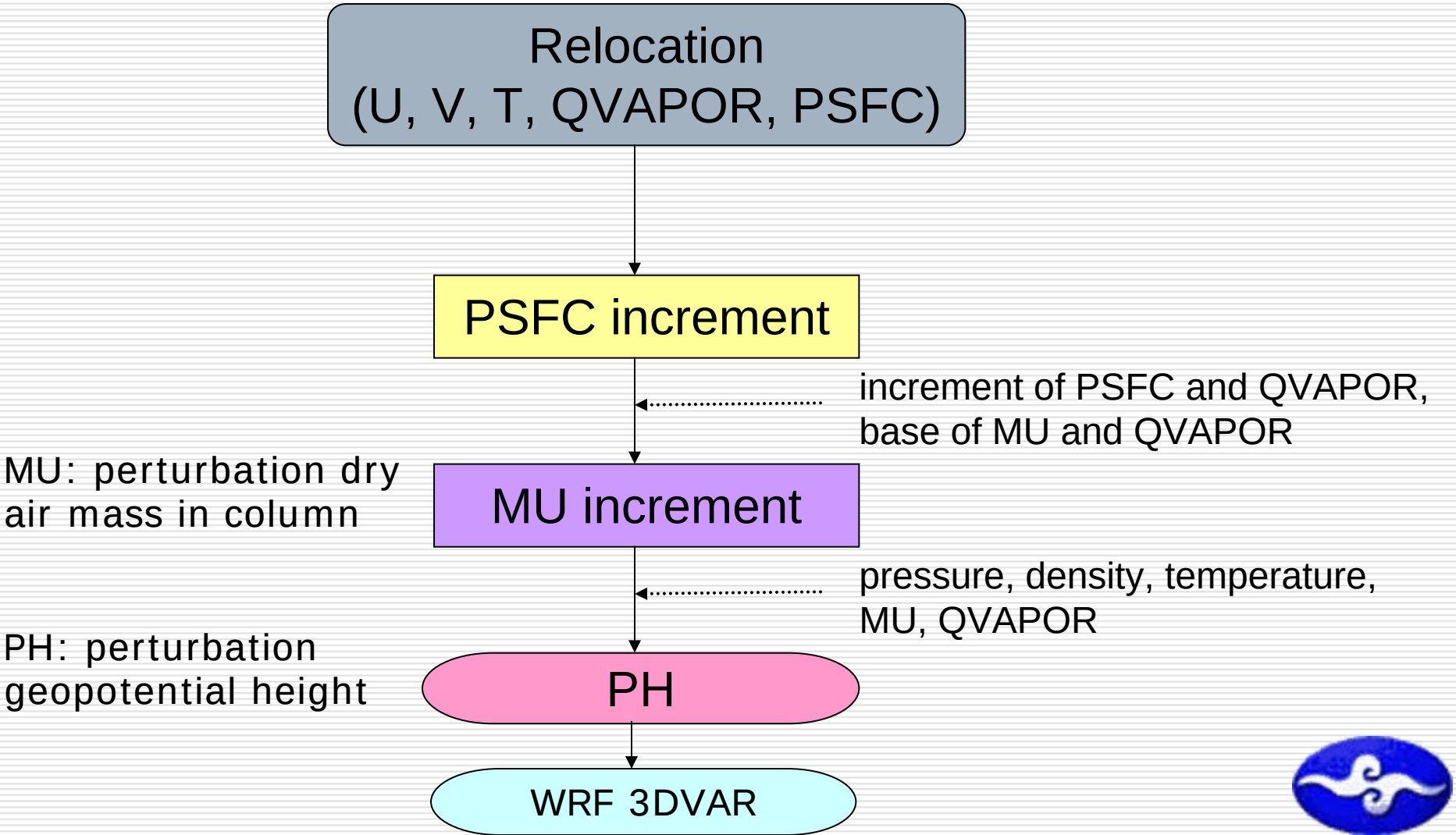
(5) **Compute non-typhoon perturbation fields** by the 2-pass Barnes analysis

(6) **Compute typhoon circulation** as the residual of non-typhoon circulation from the total perturbation fields

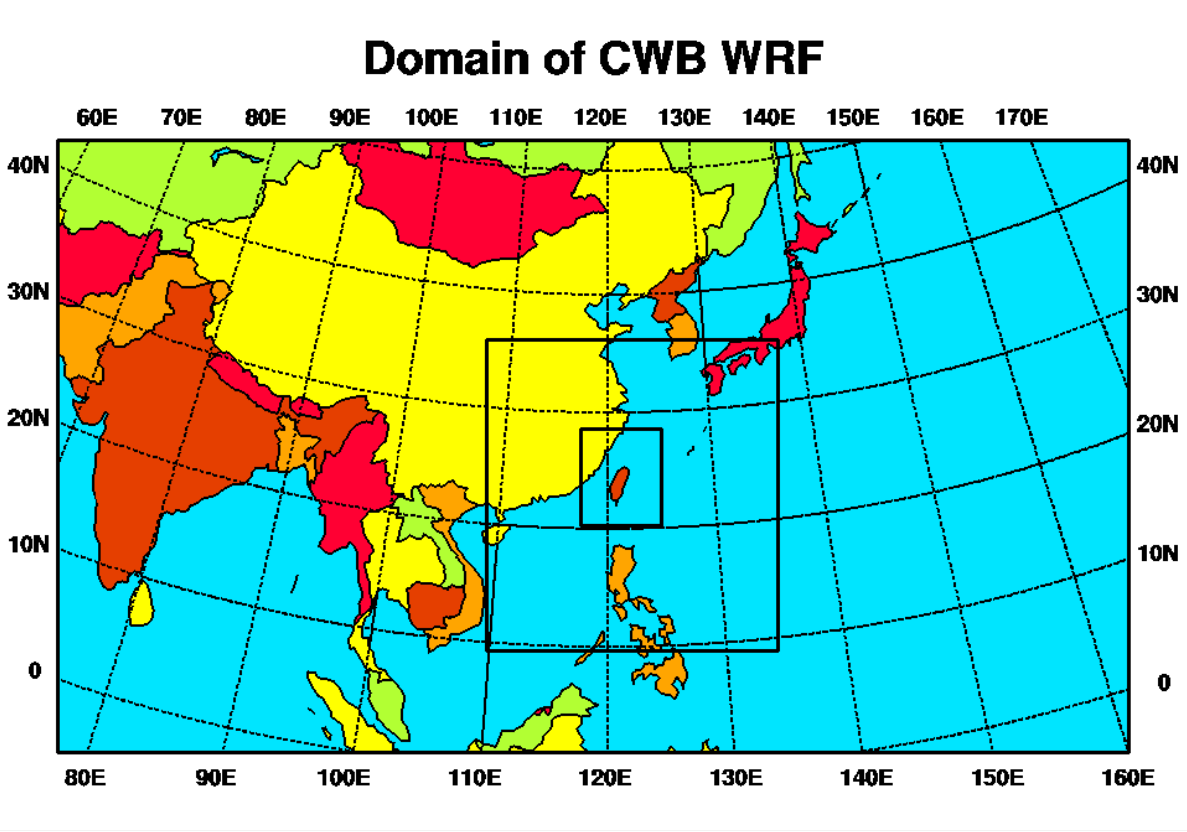
Skip the relocation scheme when:

1. The distance between 颱(obs – firstguess) < 1 grid
2. The Max. wind of 颱 < 15m/s
3. The 颱 center is too close to domain LB < 300km
4. The 颱 center is too close to land (>10m) < 200km (for eta-coord.)

Flow chart of typhoon relocation in CWB WRF

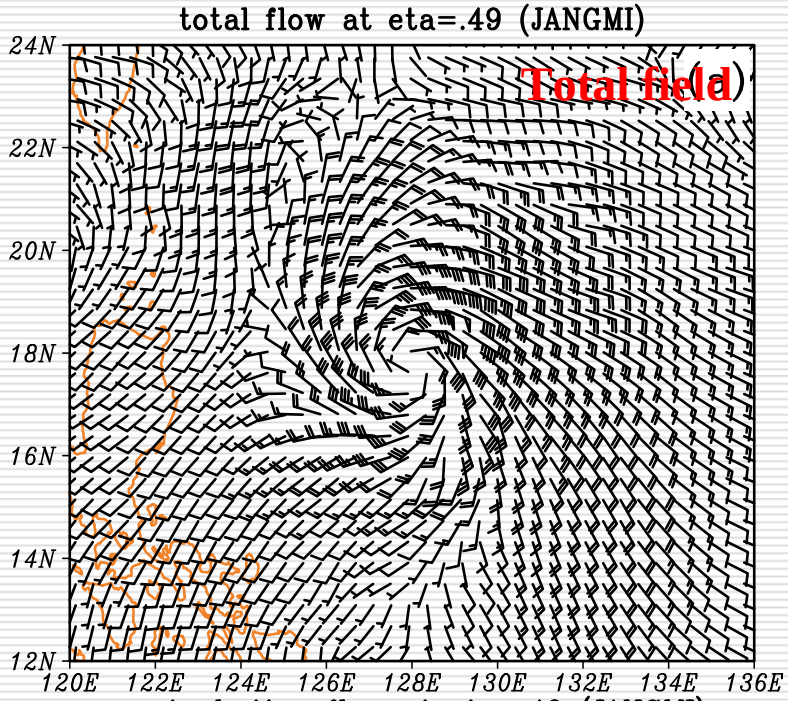


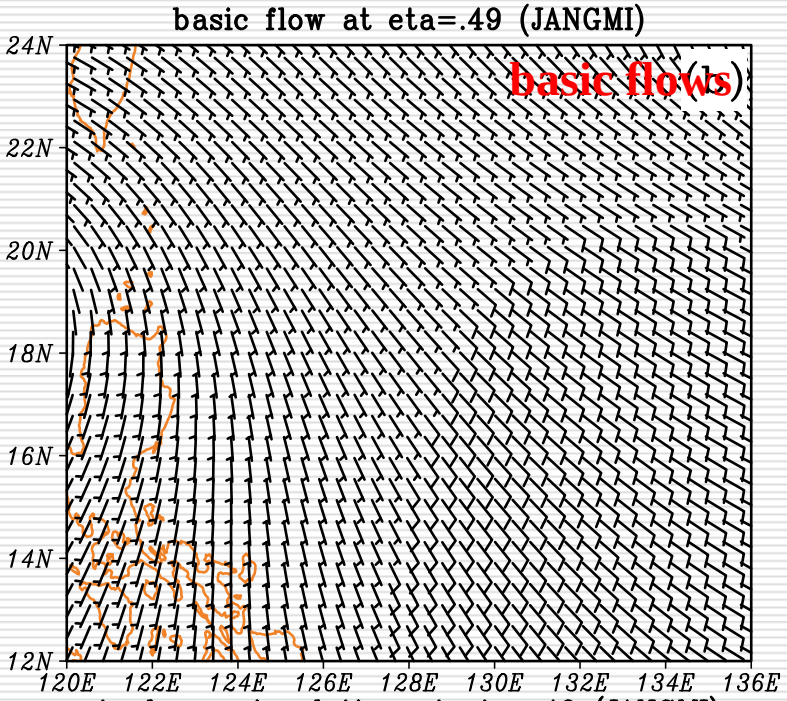
CWB WRF

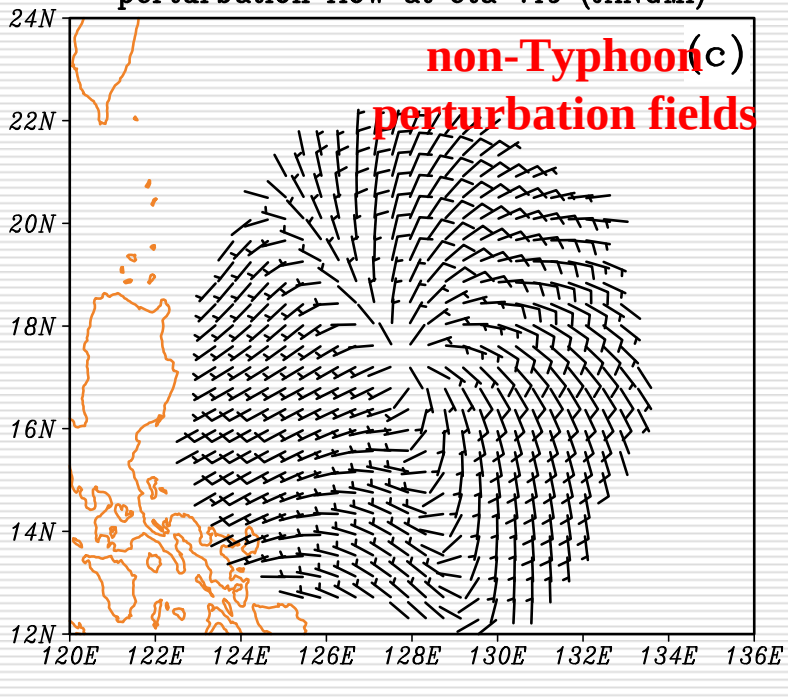


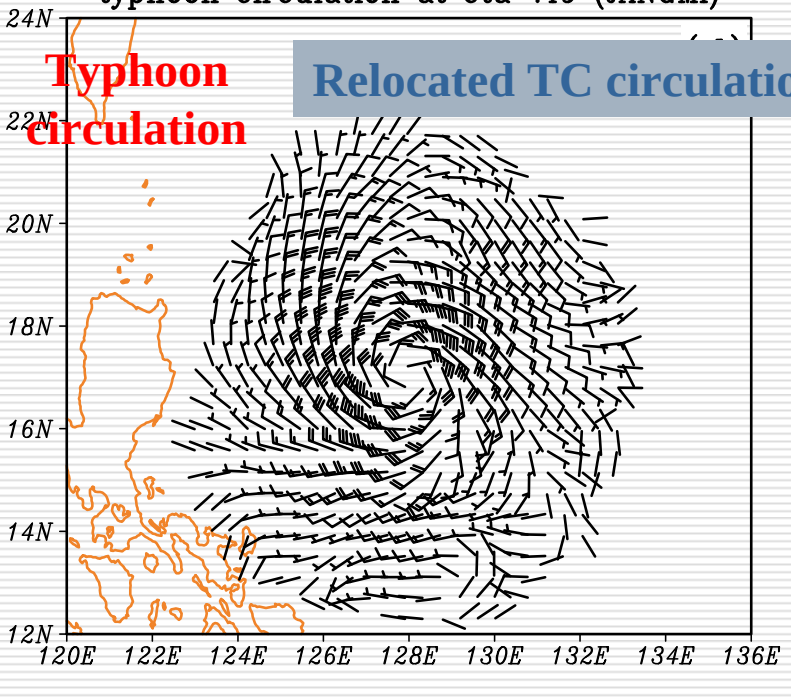
WRF-ARW Version 3.0.1

- D1: 45-km resolution
  222X128
- D2: 15-km resolution
  184X196
- D3: 5-km resolution
  151X181
- Goddard microphysics scheme
- Grell-Devenyi cumulus scheme
- YSU PBL scheme
- WRF-3DVAR observation: GTS conventional observations, bogus


total flow at eta=.49 (JANGMI)
Total field
(a)
24N
22N
20N
18N
16N
14N
12N
120E 122E 124E 126E 128E 130E 132E 134E 136E

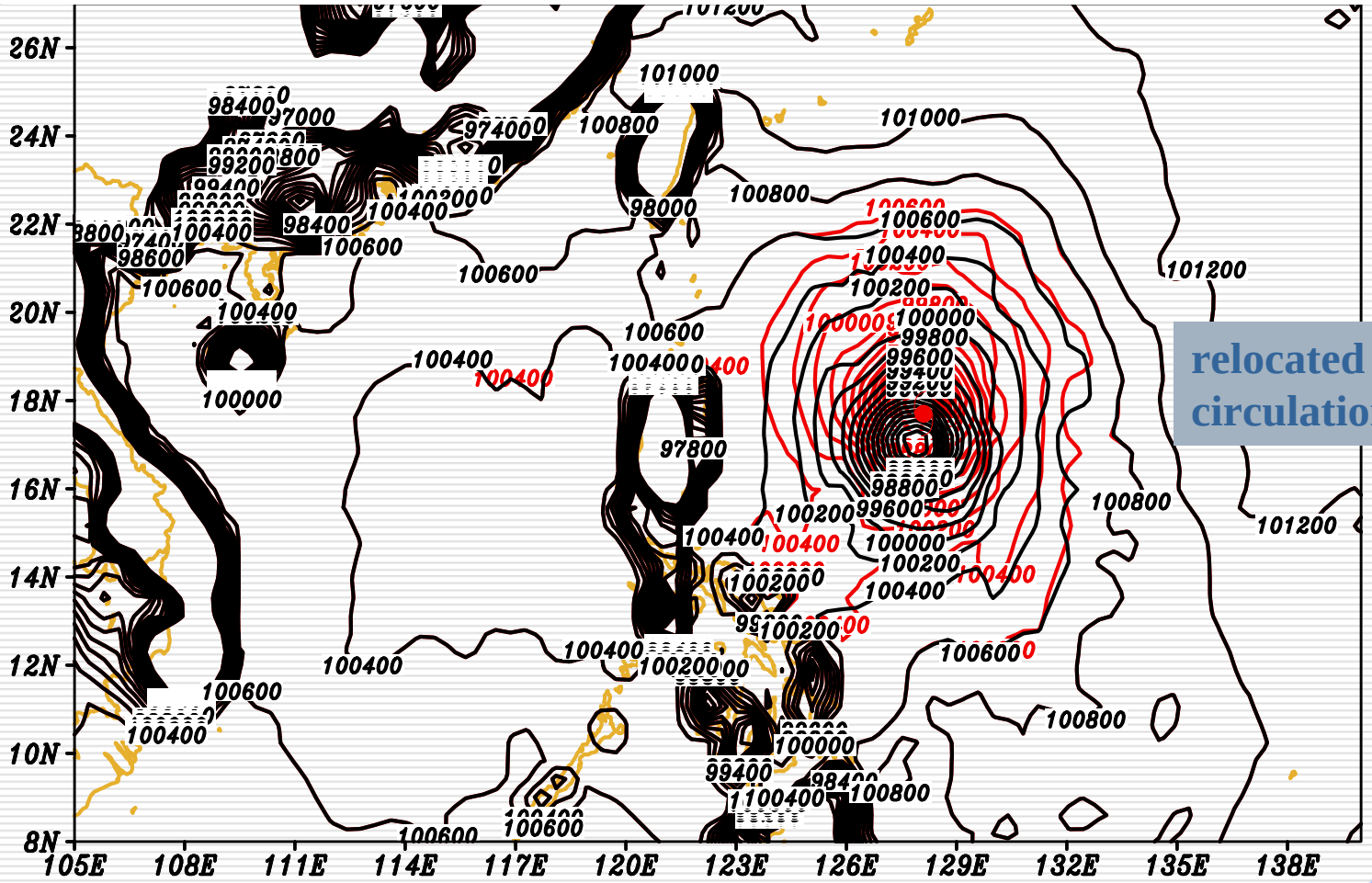

basic flow at eta=.49 (JANGMI)
basic flows
(b)
24N
22N
20N
18N
16N
14N
12N
120E 122E 124E 126E 128E 130E 132E 134E 136E


perturbation flow at eta=.49 (JANGMI)
non-Typhoon
perturbation fields
(c)
24N
22N
20N
18N
16N
14N
12N
120E 122E 124E 126E 128E 130E 132E 134E 136E


typhoon circulation at eta=.49 (JANGMI)
Typhoon
circulation
Relocated TC circulation
24N
22N
20N
18N
16N
14N
12N
120E 122E 124E 126E 128E 130E 132E 134E 136E

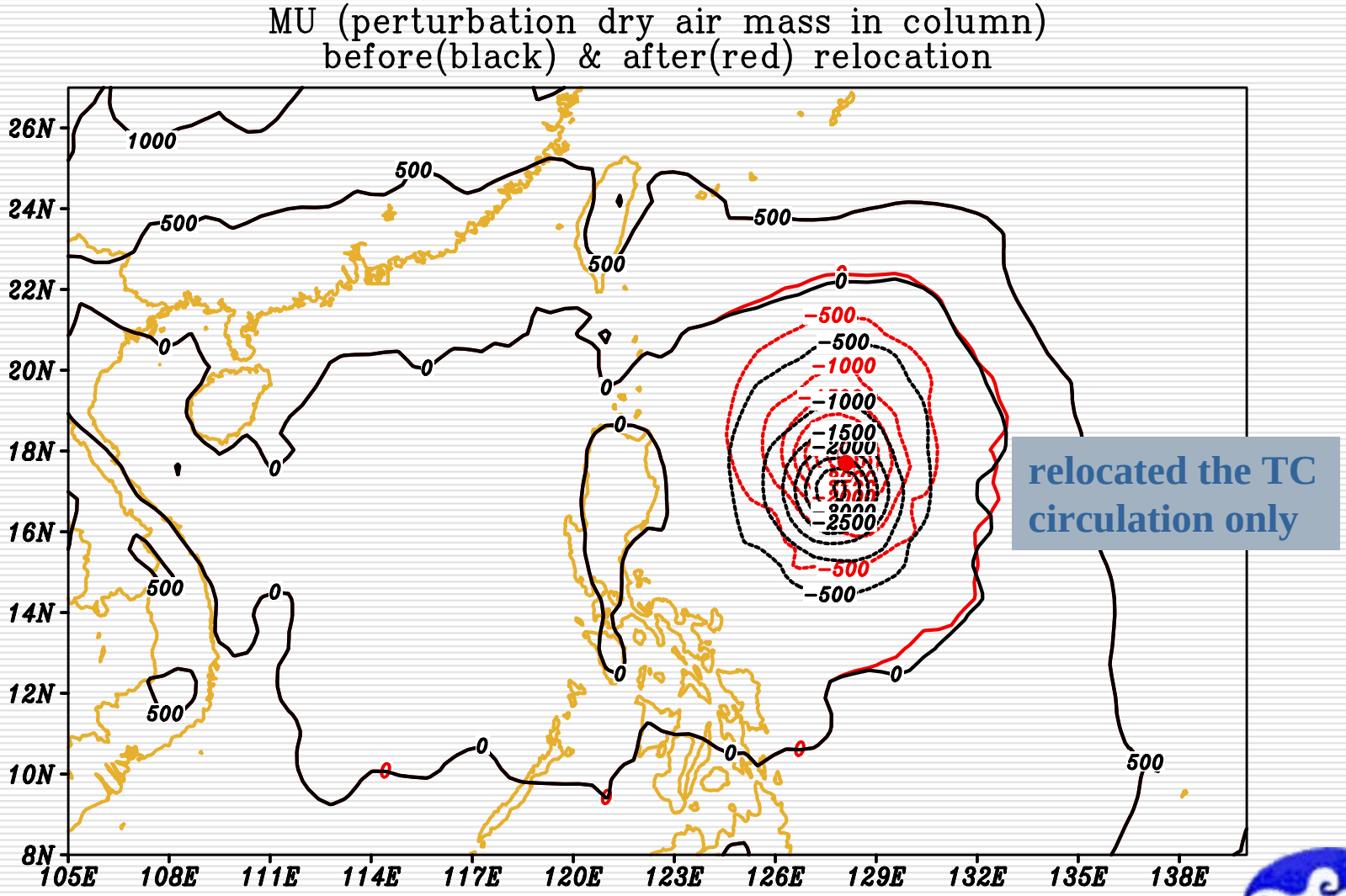
TYPHOON JANGMI (PSFC)

Surface Pressure
Before (Black) VS After (Red) Relocation

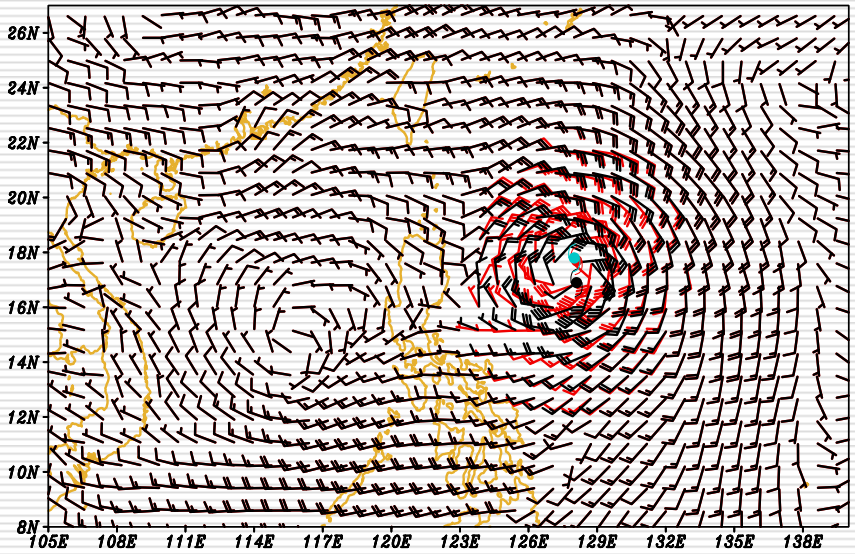


12Z26SEP2008

TYPHOON JANGMI (MU)



wind before(black) & after(red) relocation at eta=.85



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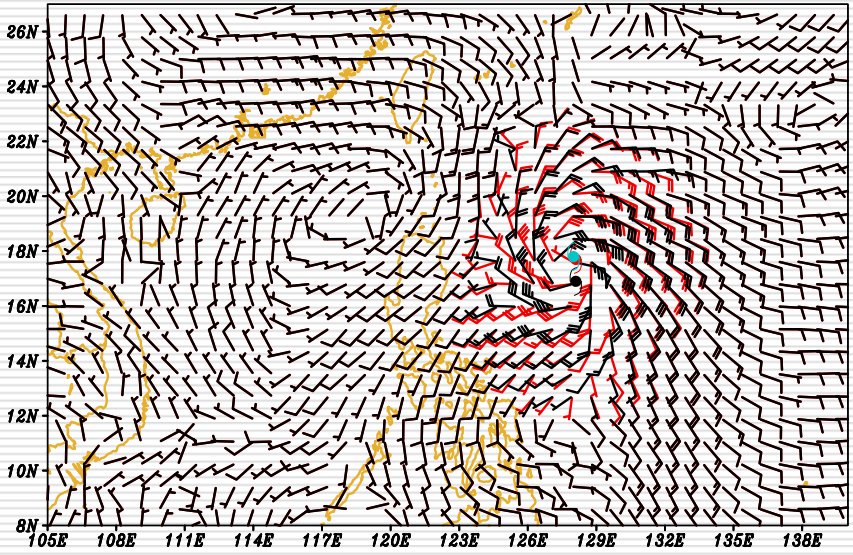
Before relocation

after relocation

obs

relocated the TC circulation only

wind before(black) & after(red) relocation at eta=.49



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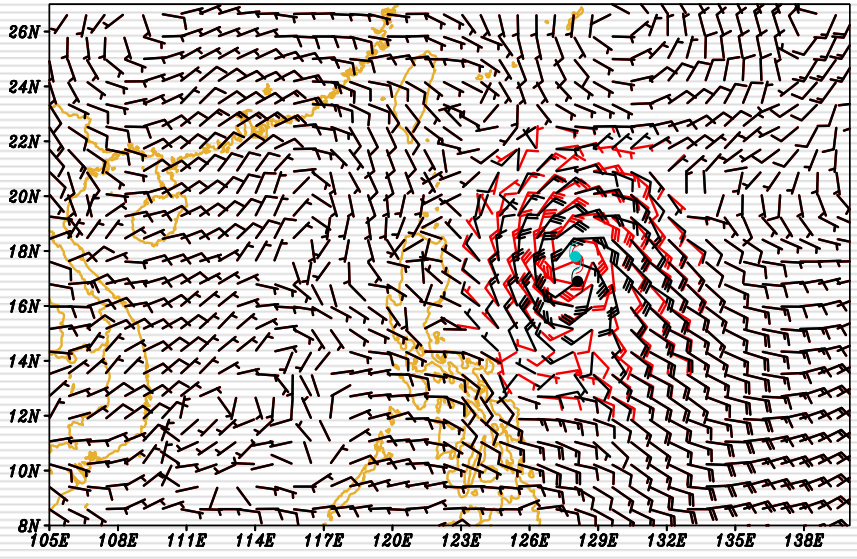
wind before(black) & after(red) relocation at eta=.31



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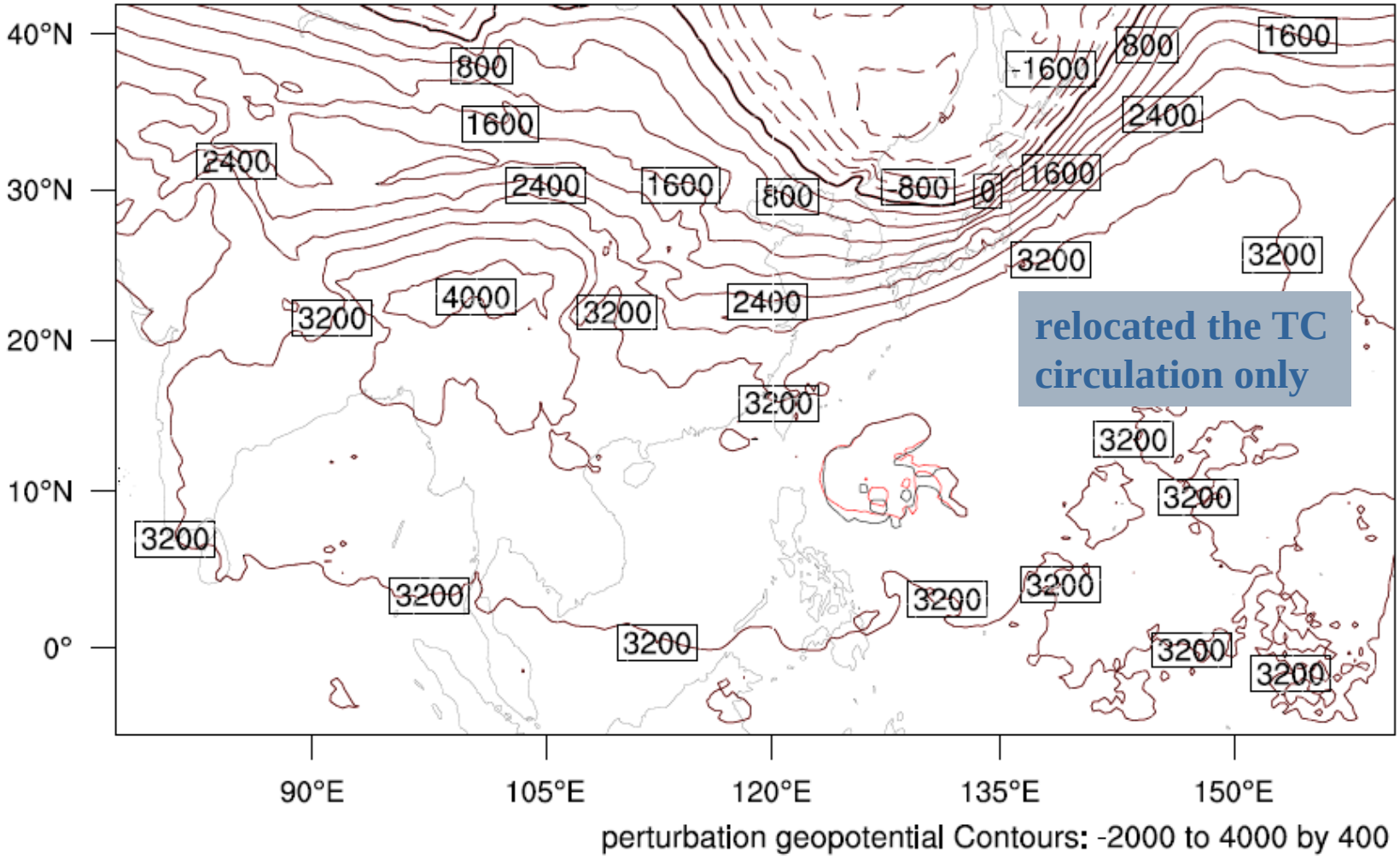
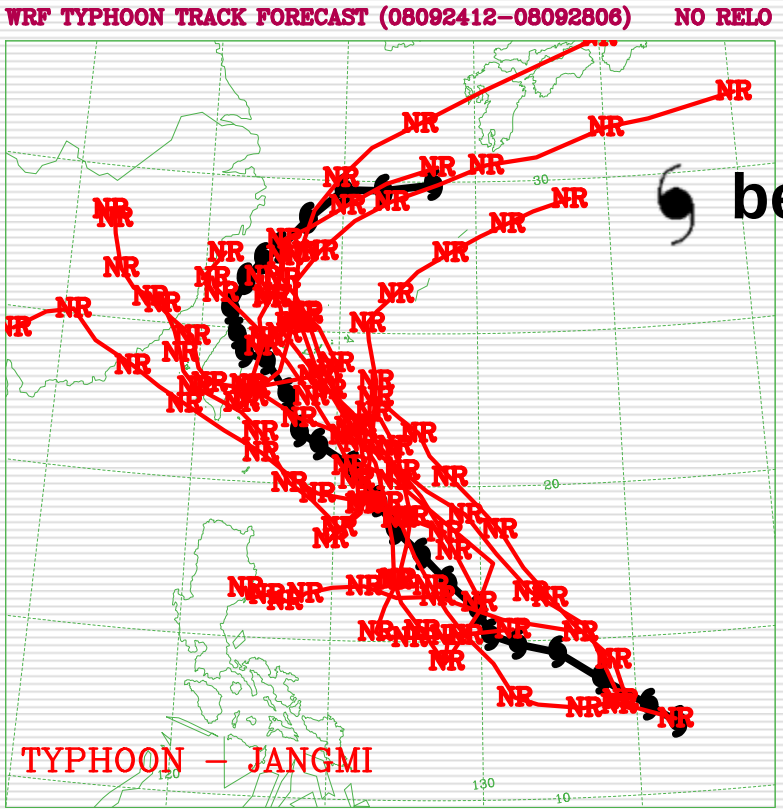
TYPHOON JANGMI (PH)

PH (perturbation geopotential) at eta=.49
Before (Black) VS After (Red) Relocation

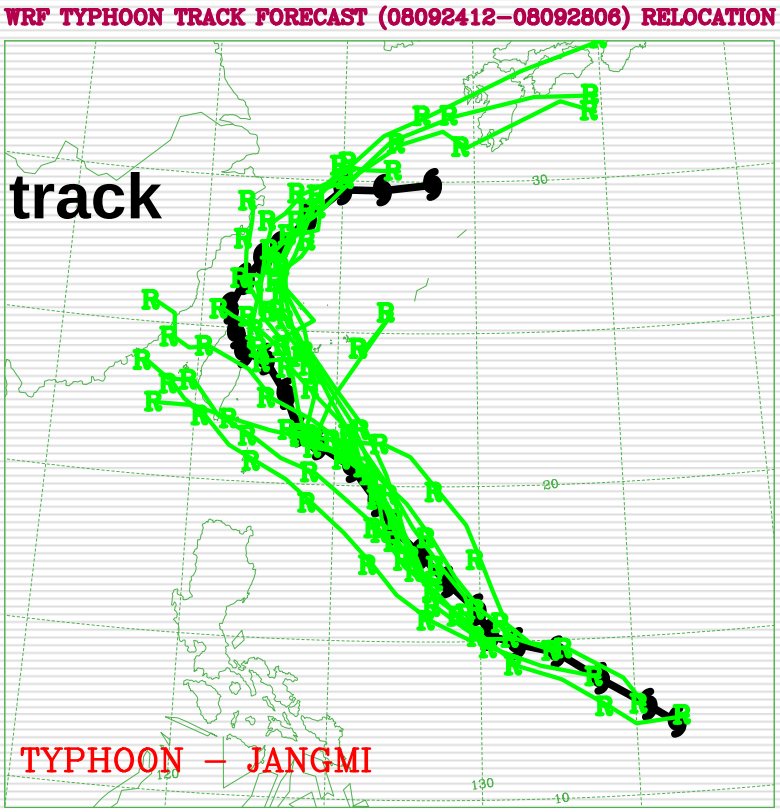


The best tracks(CWB) and forecast tracks(without & with relocation) of Typhoon Jangmi

(16 cases)



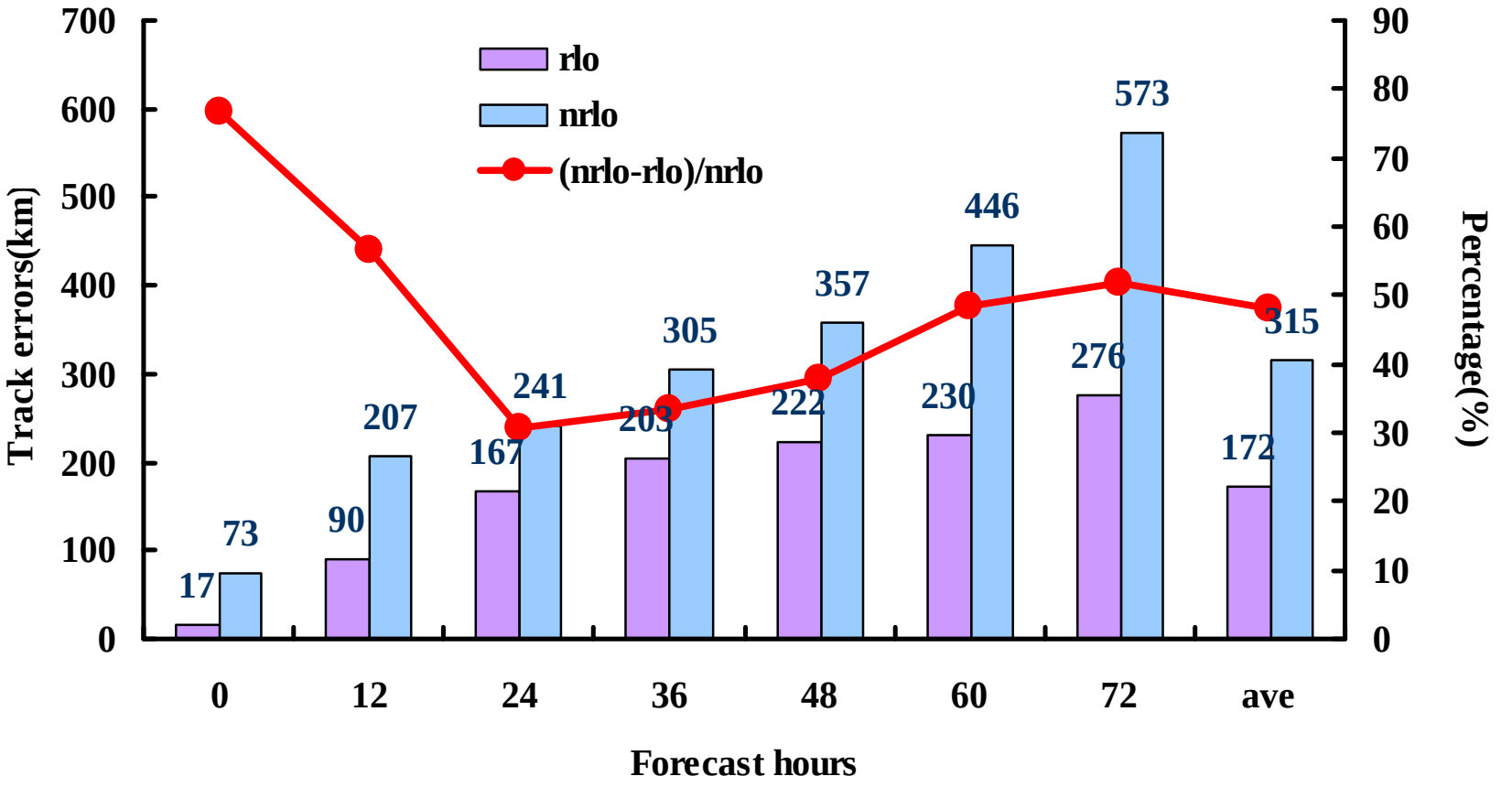
best track



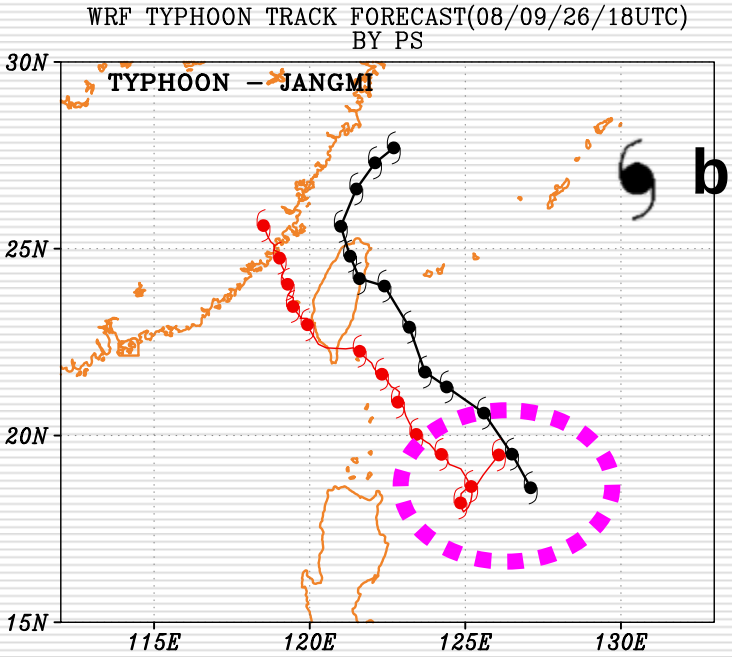
without relocation

with relocation

The simulated typhoon track errors and the percentage differences of the track errors

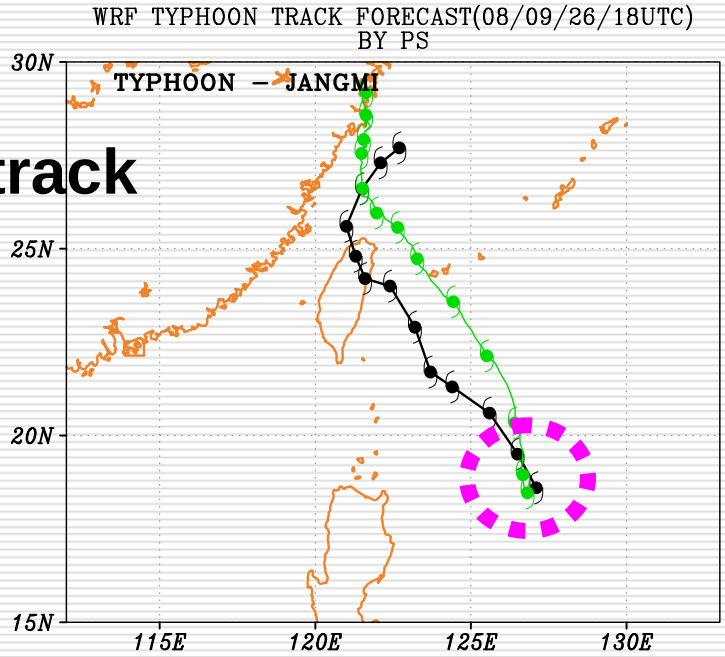


Comparison of the simulated tracks between typhoon relocation experiments



without relocation

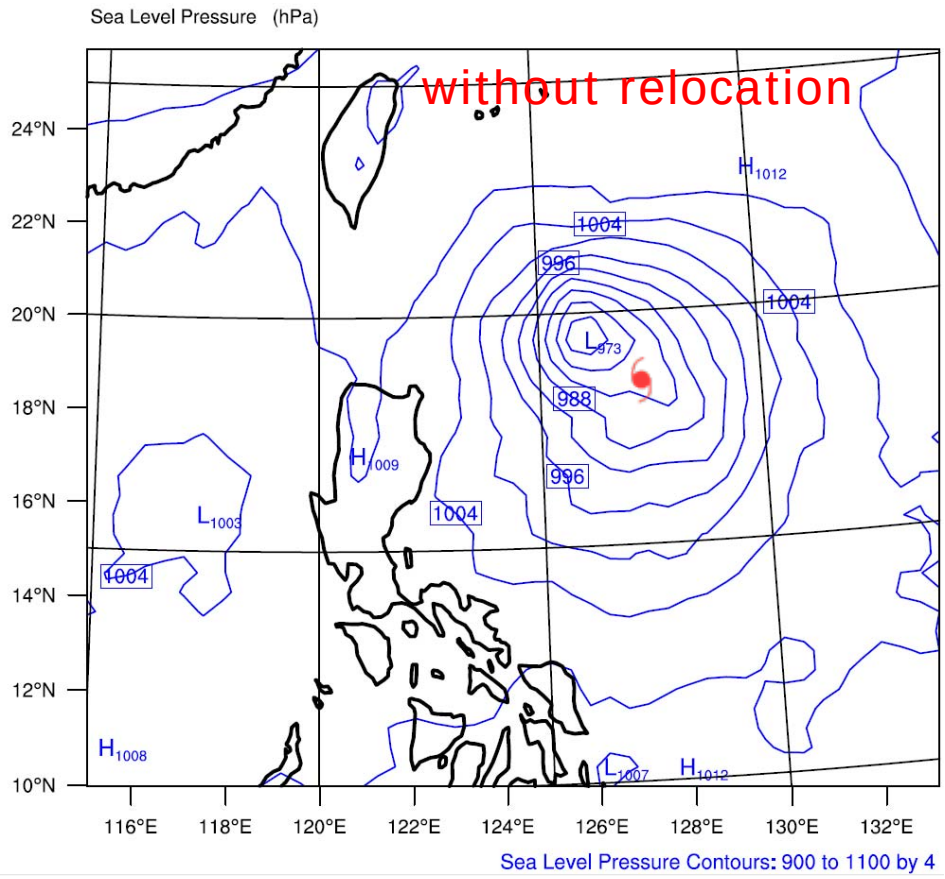
best track

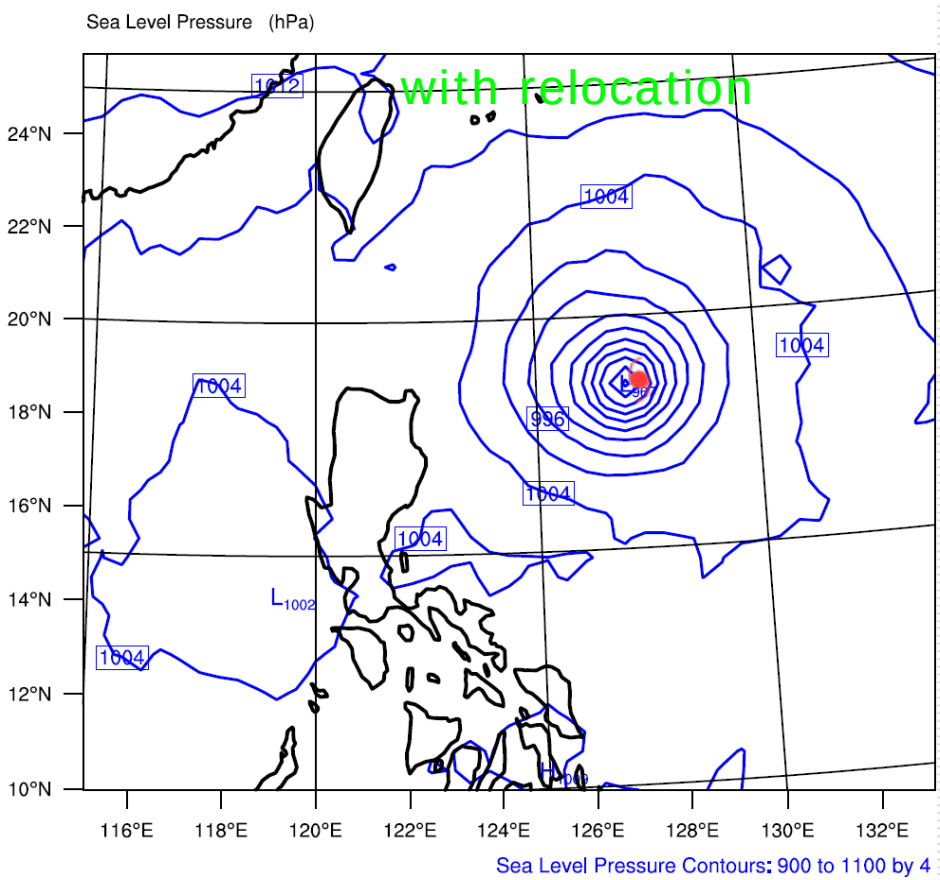


with relocation

	00	12	24	36	48	60	72	hours
With	**18**	**89**	**222**	**176**	**203**	**147**	**195**	**km**
Without	78	222	188	262	247	359	475	km

Analysis of Sea Level Pressure

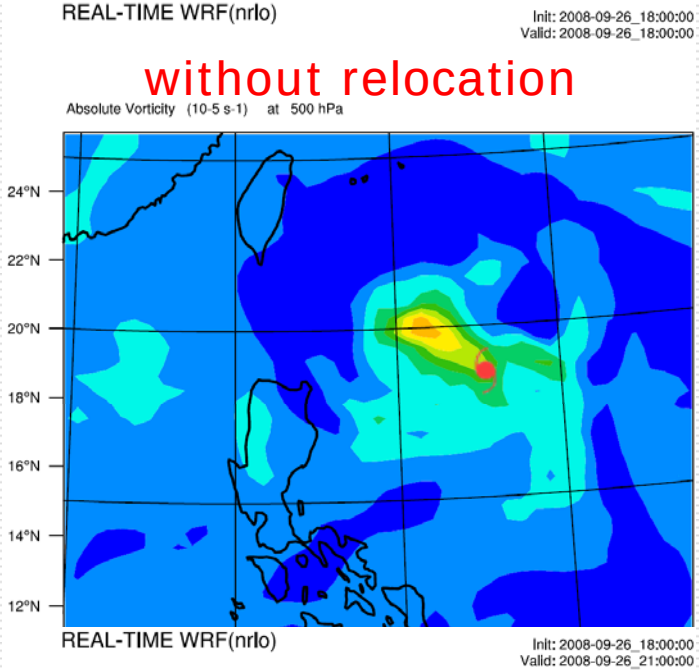


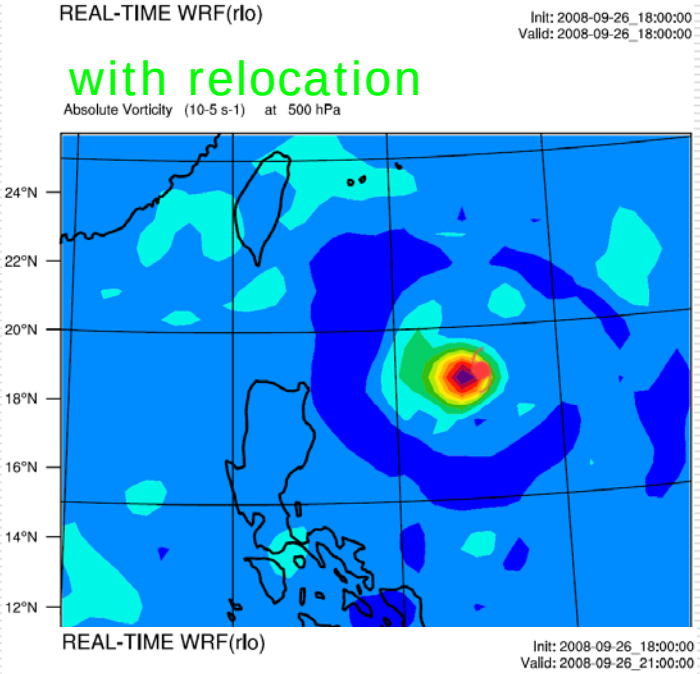


500hPa Vorticity

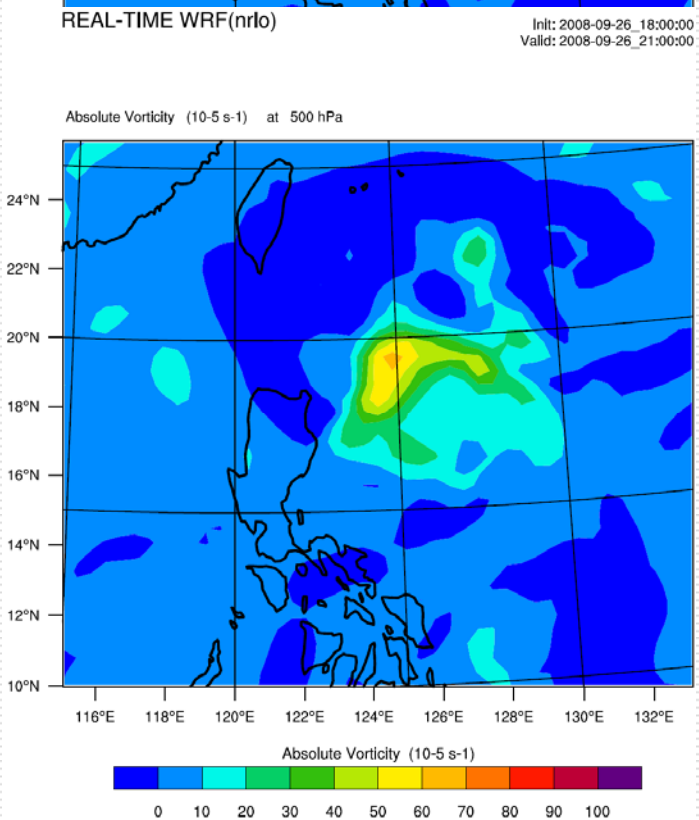
without relocation

with relocation

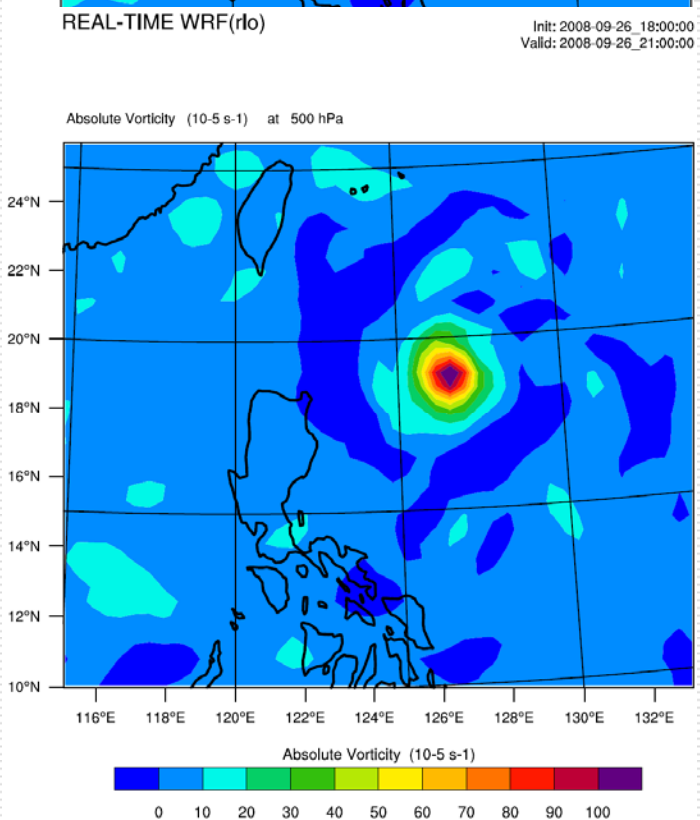




analysis



+3 hr forecast



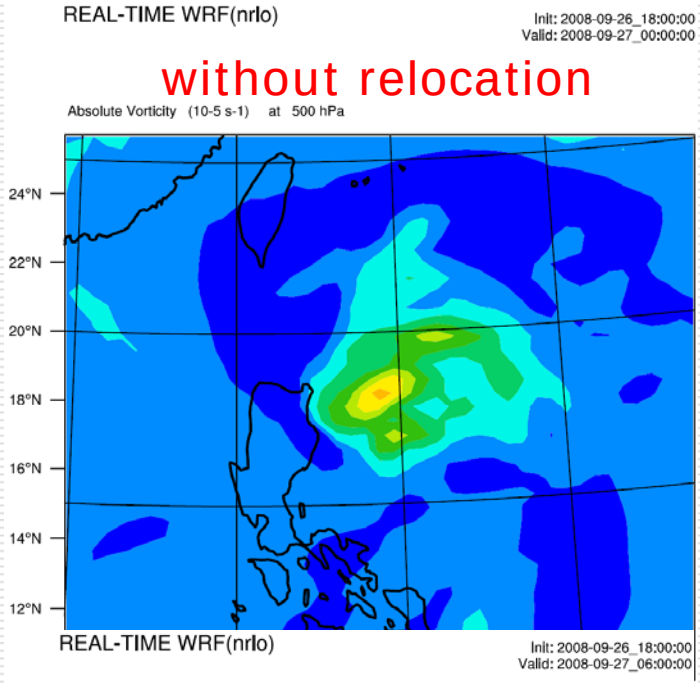
500hPa Vorticity

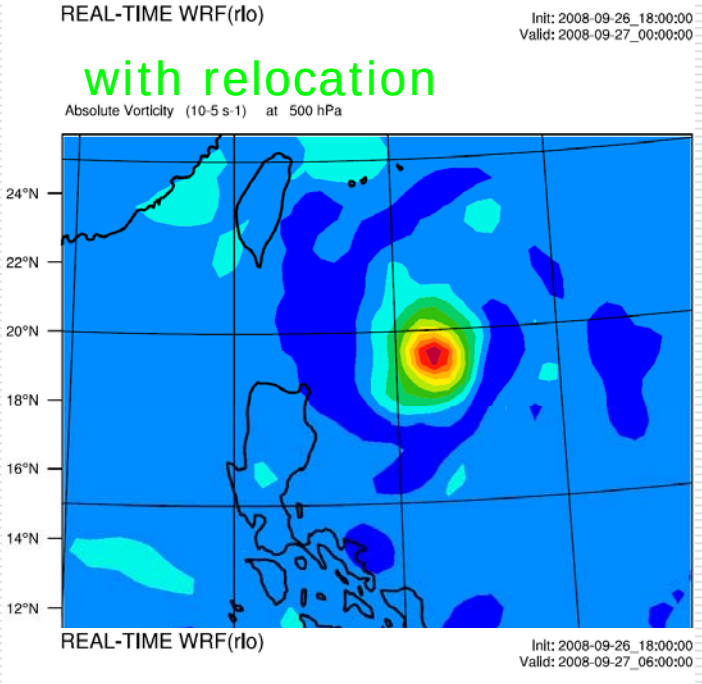
without relocation

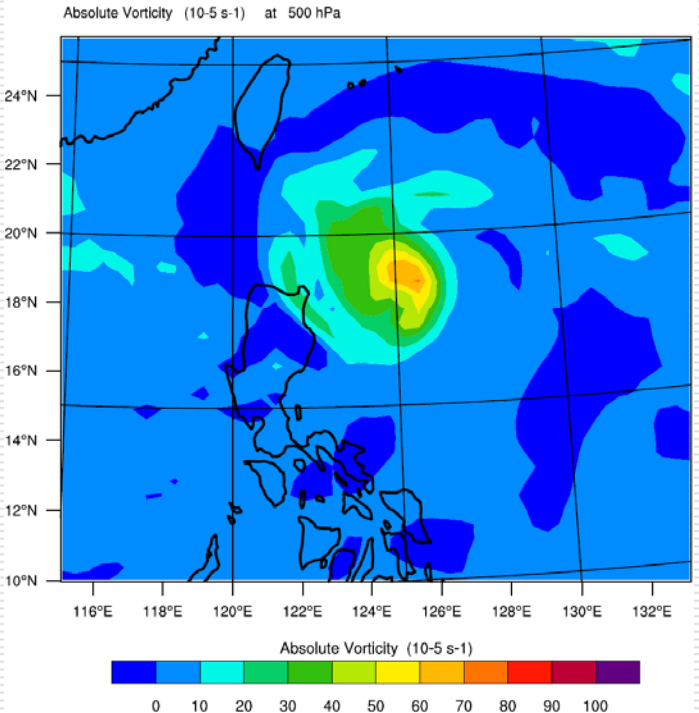
with relocation

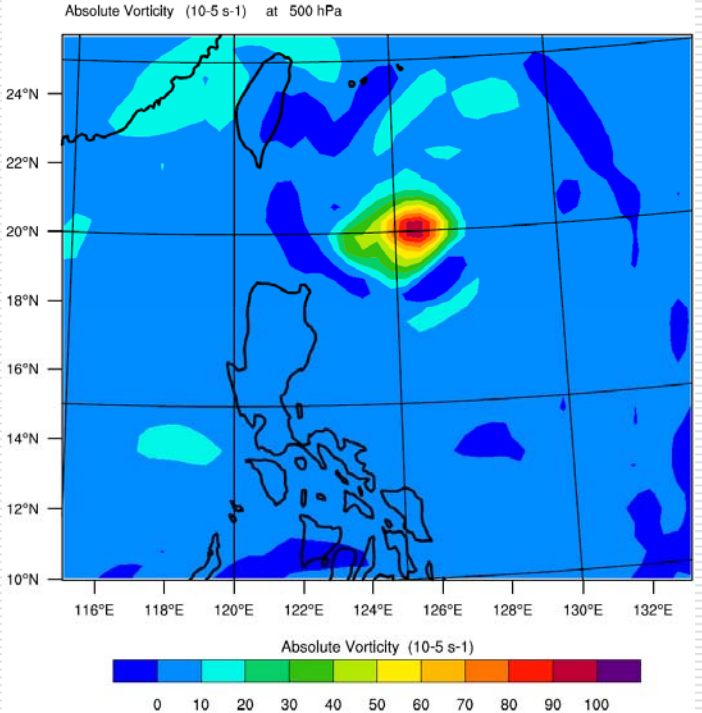
+6 hr forecast

+12 hr forecast

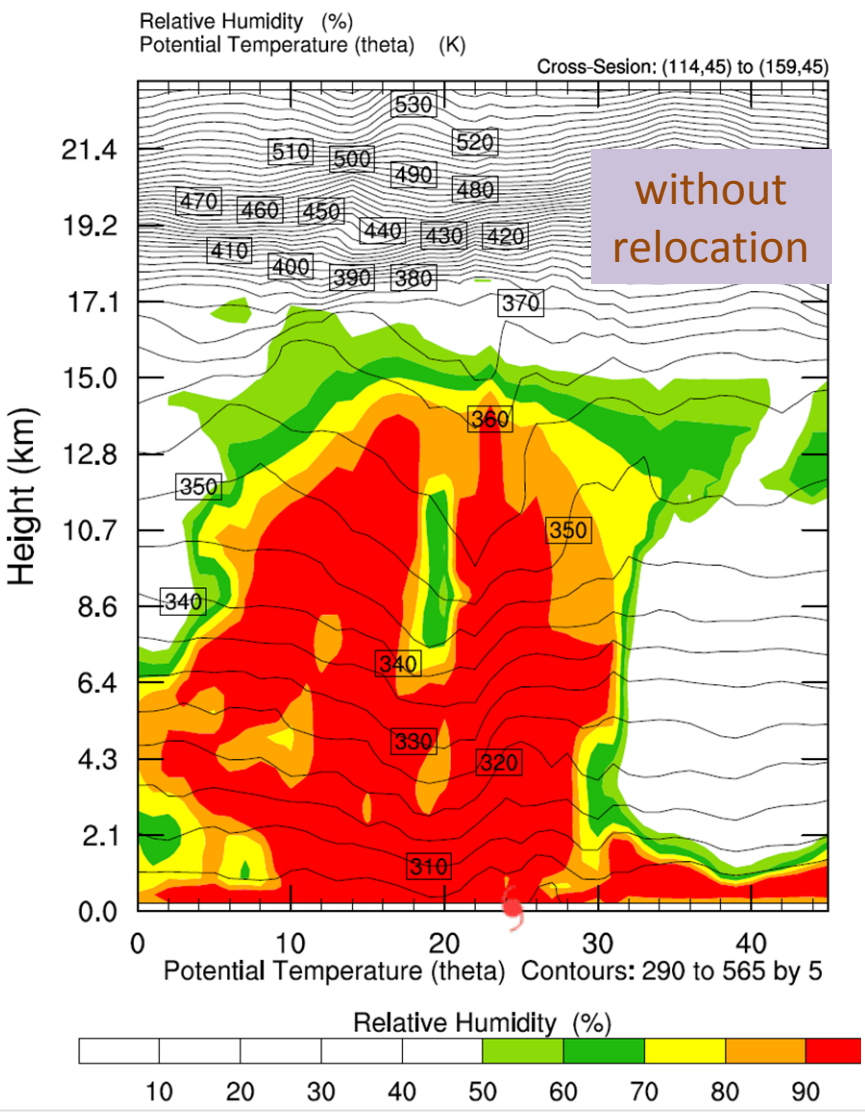


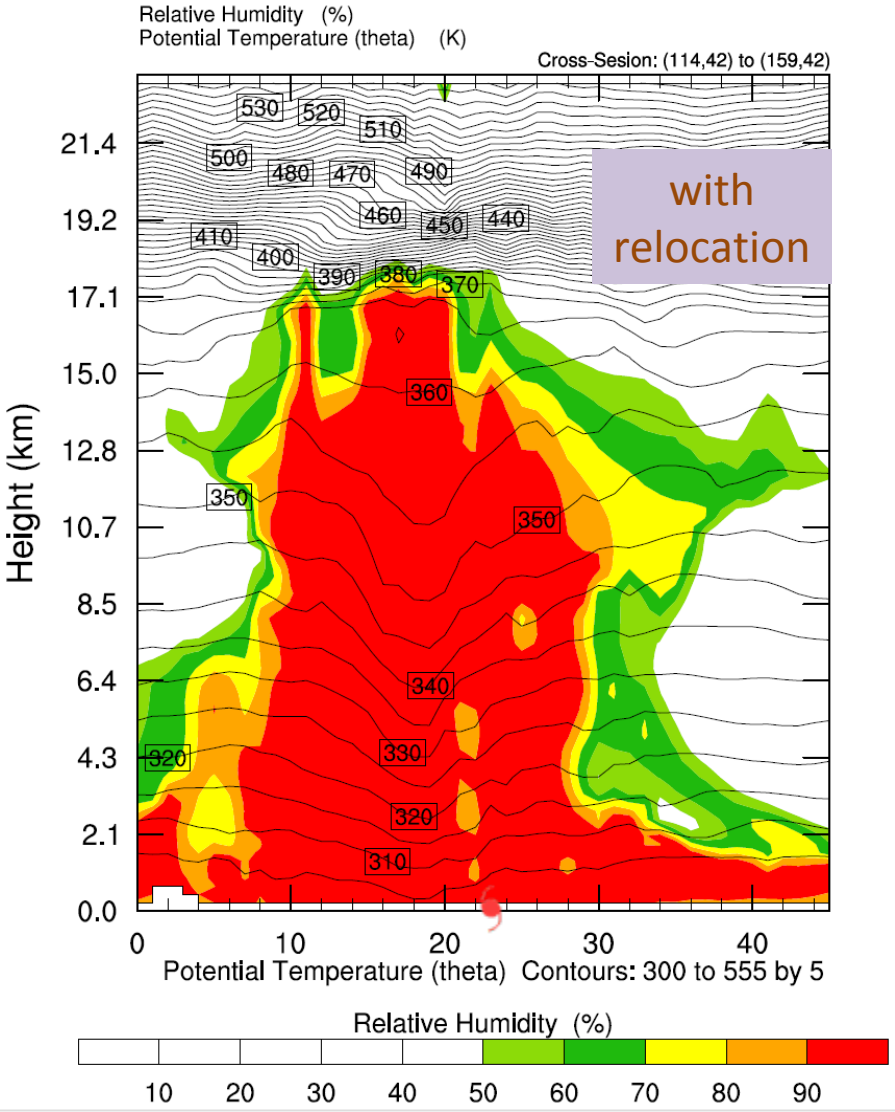






Zonal cross section of potential temperature (contour) and relative humidity (shaded) cutting through typhoon center





summary

- For the typhoon relocation method, the atmosphere flow of the first guess is decomposed into basic flow, non-typhoon perturbations, and typhoon circulation. The typhoon circulation then can be either removed from the first guess or relocated to its observed position.
- In the comparison of the difference from the WRF 3DVAR input with and without typhoon relocation procedure, the variables were relocated only around the region of the typhoon circulation and the typhoon center was close to the observed position.

summary

- The simulated typhoon tracks are considerably improve in all of the forecast hours. In particular, it reduces the adjustment for the inconsistence with the model dynamics and physics in the earlier integration periods.
- With the typhoon relocation, large errors in the first guess fields due to the position error are eliminated and the analyzed typhoon circulation is much reasonable without twisted centers.