THE STRUCTURE ANALYSIS OF TYPICAL WESTERN PACIFIC OCEAN EDDIES FORCED BY STRONG TYPHOONS

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- 2 The typhoon “Mawar” and the sea eddy created by “Mawar”
- 3 The super typhoon “Nuri” and the sea eddy created by “Nuri”
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1 The impact of global warming on typhoon

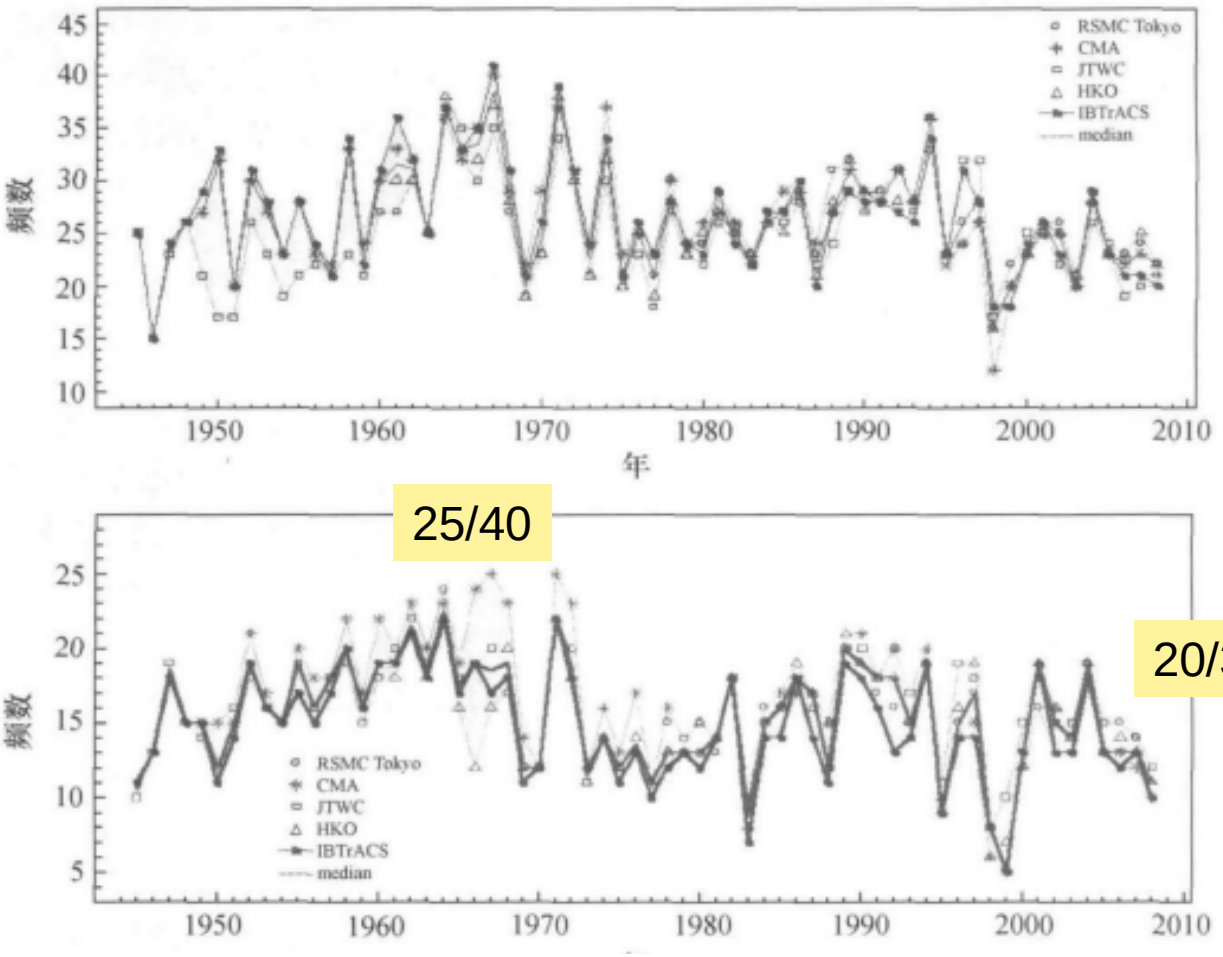
(1) Typhoon statistic Facts

There are different points of view :

1) Since 1970, the hurricanes at North Atlantic ocean are getting more active and have close correlation with SST according to observation.

2) The trend line of the proportion of strong typhoon is going up.

3) There is no clear trend for annual variance of number of tropic cyclone



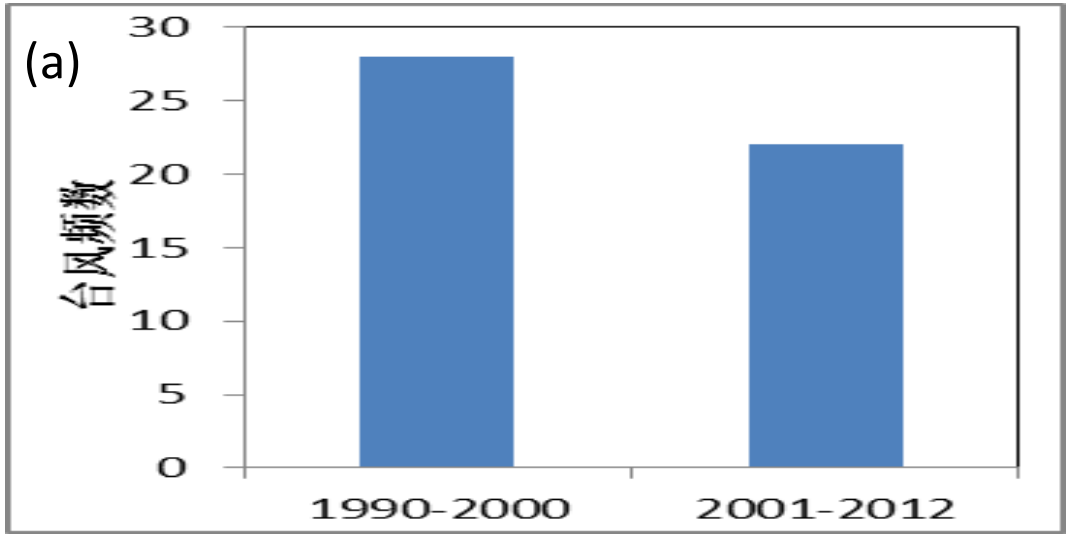
The time series of tropic cyclone number in North-west Pacific ocean

(a) Tropic storm (b) typhoon

(2) Globe Warming and Typhoon

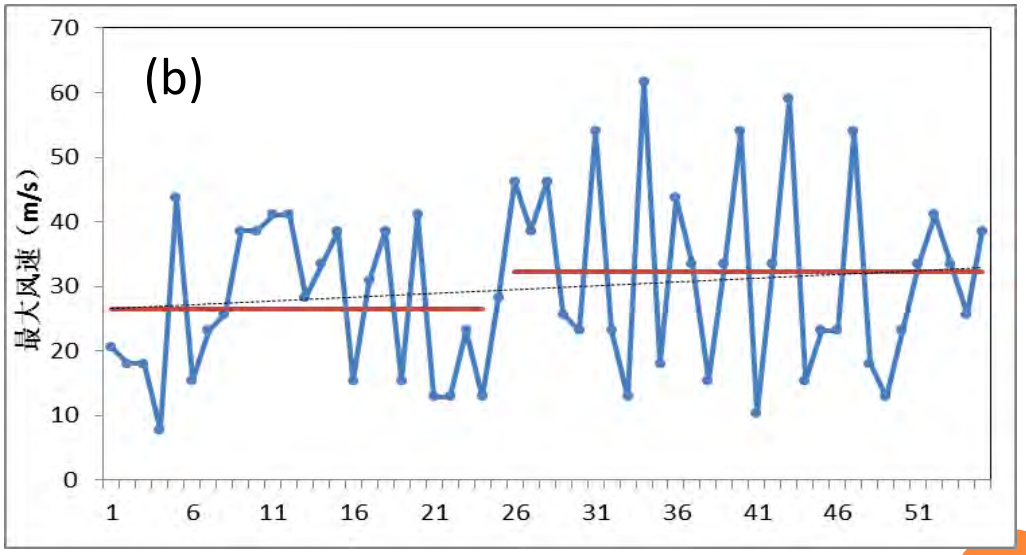
1) Numerical simulation shows that the strong typhoons will be more stronger including maximum velocity and precipitation and their number under the conditions of globe warming and SST rising .

2) No clear evidence shows that there are more typhoons having created under the conditions of globe warming and SST rising . Because the improved ways of observation may increase the number of typhoon.

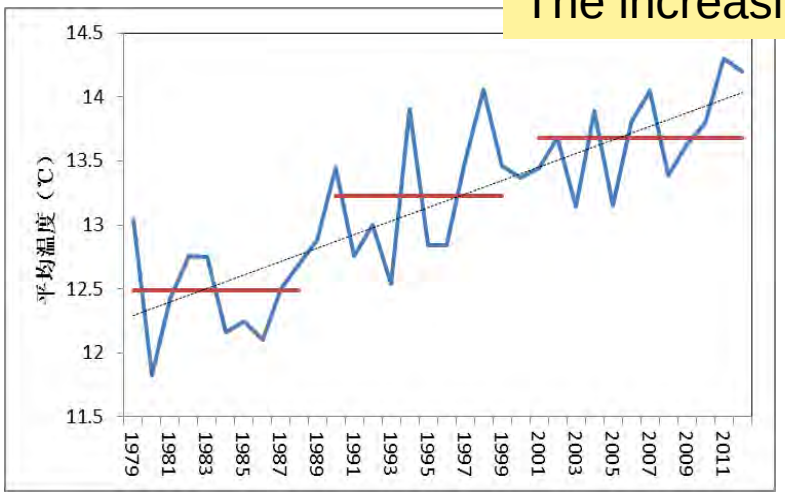


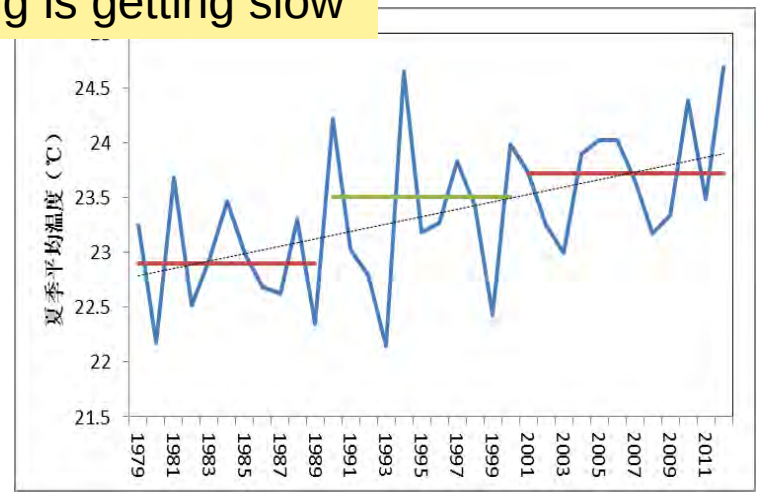
The number of typhoons that impact Jiangsu Province during 1990-2012

The maximum velocity of the typhoons that impact Jiangsu Province during 1990-2012

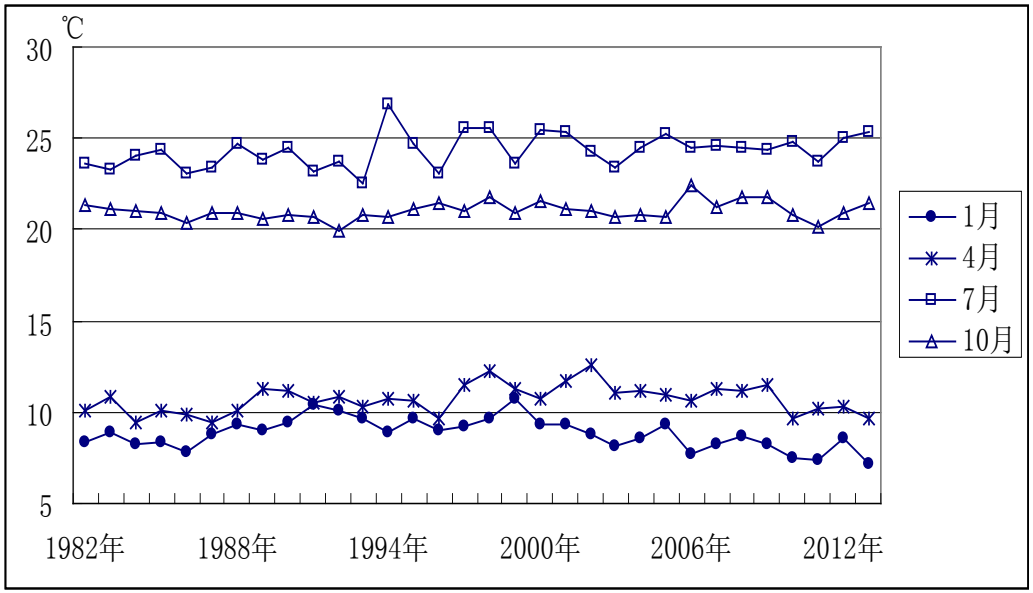


The increasing is getting slow





Average air temperature at 2m over sea , a) annual, b) summer



Average SST of four seaons over yellow and east seas

There are different points of view in China :

1) The number of typhoon decrease in some sense over West pacific ocean during 50 years.

2) The number of the landing tropic cyclone in China decrease in some sense during 50 years. But the intensity of the landing typhoon increase.

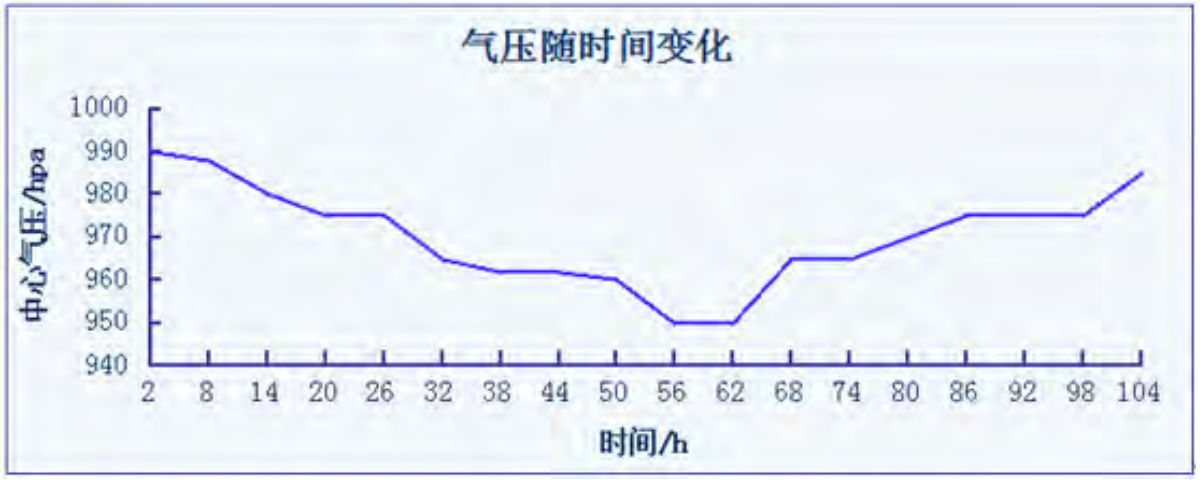
3) There is no clear evidence on that the typhoon climate change is caused by globe warming influence

4) The disasters of typhoon will cause the coastal vulnerability increasing by economic development.

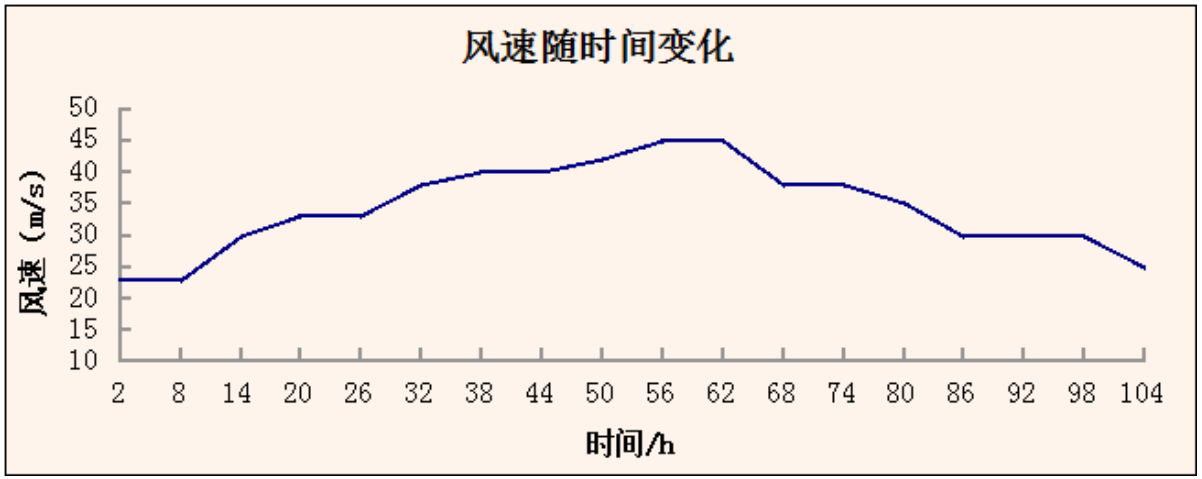
2 The Typhoon “Mawar”(2012) and the Sea Eddy Created by “Mawar”

(1) The Typhoon “Mawar”(2012)

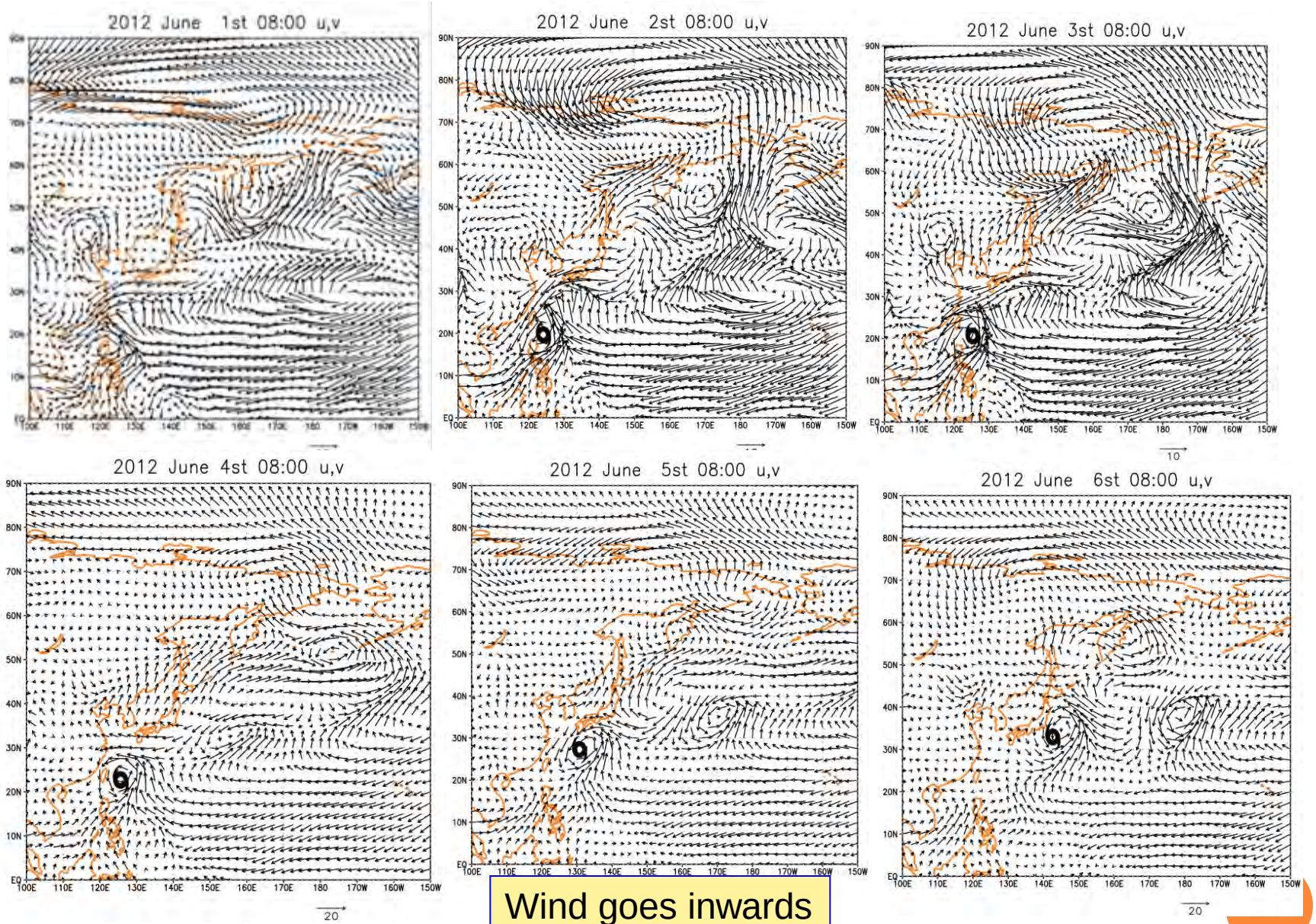
Trajectory



Decresing:
0.7hPa/h



Pressure and wind speed time series of “Mawar” center



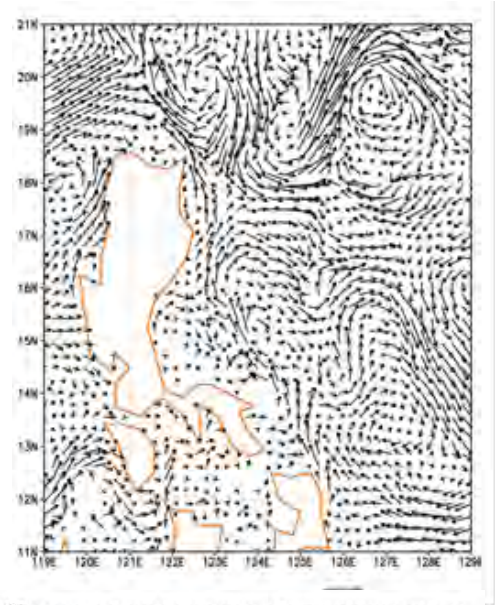
The wind vector field over sea surface of "Mawar"

The typhoon “Mawar” features during its lifetime

Date	Time	Central pressure（hPa）	Lon	Lat	Wind Scale	Wind velocity（m/s）	Radius（km）	Moving speed（km/h）	Movement direction	Intensity
20120602	8	988	124.3	16.6	9	23	180	10	WN	Tropical Storm
20120603	8	965	125	18.8	13	38	250	13	NNE	Typhoon
20120604	8	950	126.1	21.6	14	45	320	15	NNE	Strong typhoon
20120605	8	970	130.3	25.9	12	35	350	35	EN	Typhoon
20120606	8	985	141	31.3	10	25	350	50	EN	Strong tropical storm

(2) The Sea Eddy Created by Typhoon “Mawar”

a



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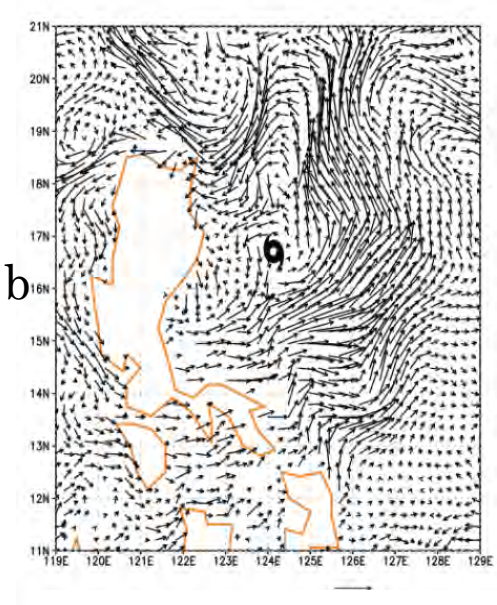

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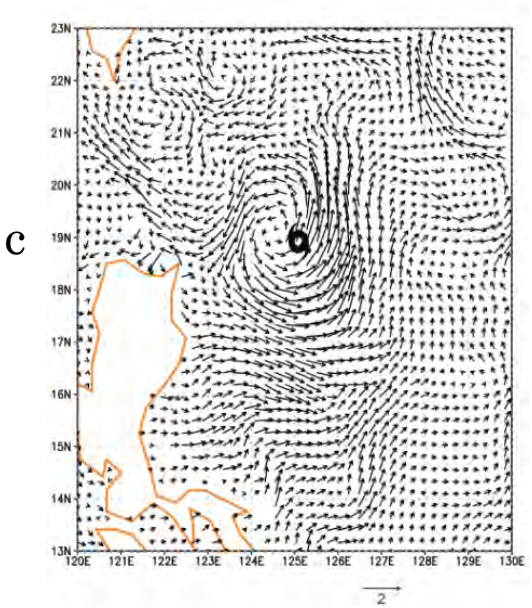

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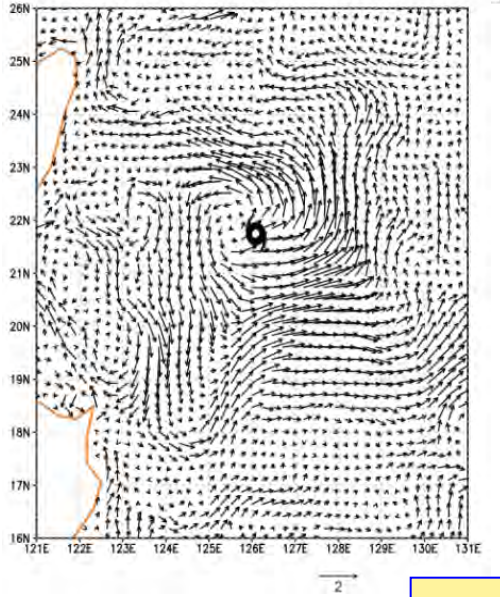

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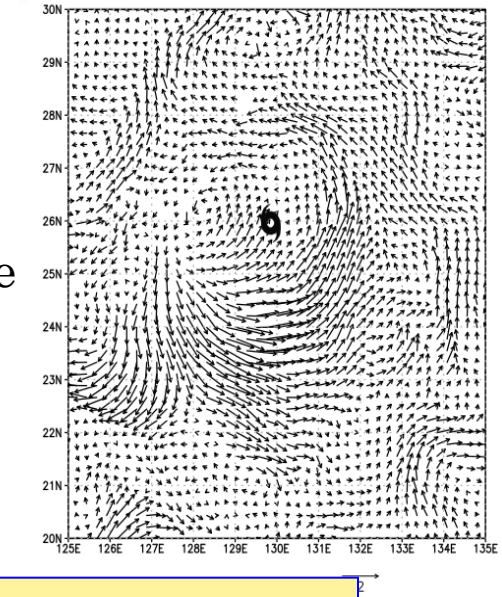
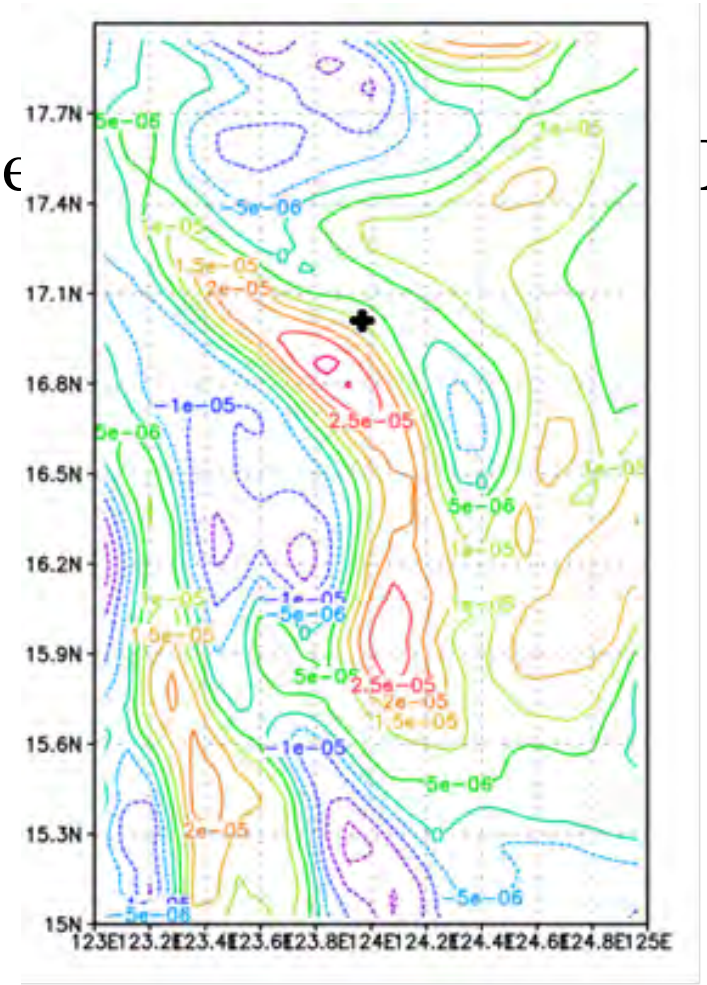


a, Flow field at 8:00 Jun 1st
b, Flow field at 8:00 Jun 2nd
c, Flow field at 8:00 Jun 3rd
d, Flow field at 8:00 Jun 4th
e, Flow field at 8:00 Jun 5th

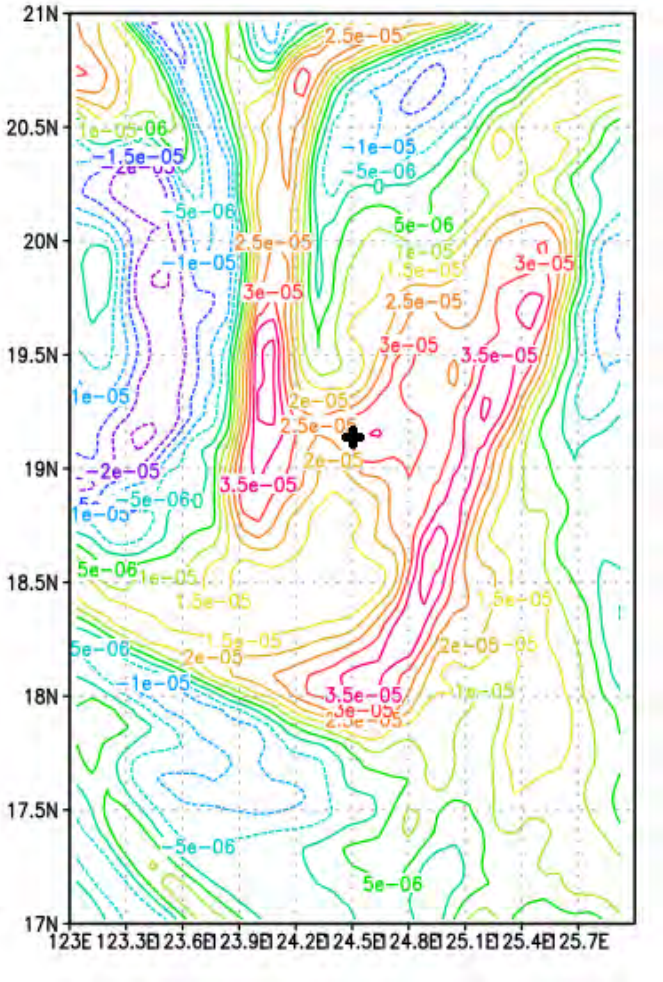
Black circle indicates the typhoon’s location.

Wind goes outwards

Oce M

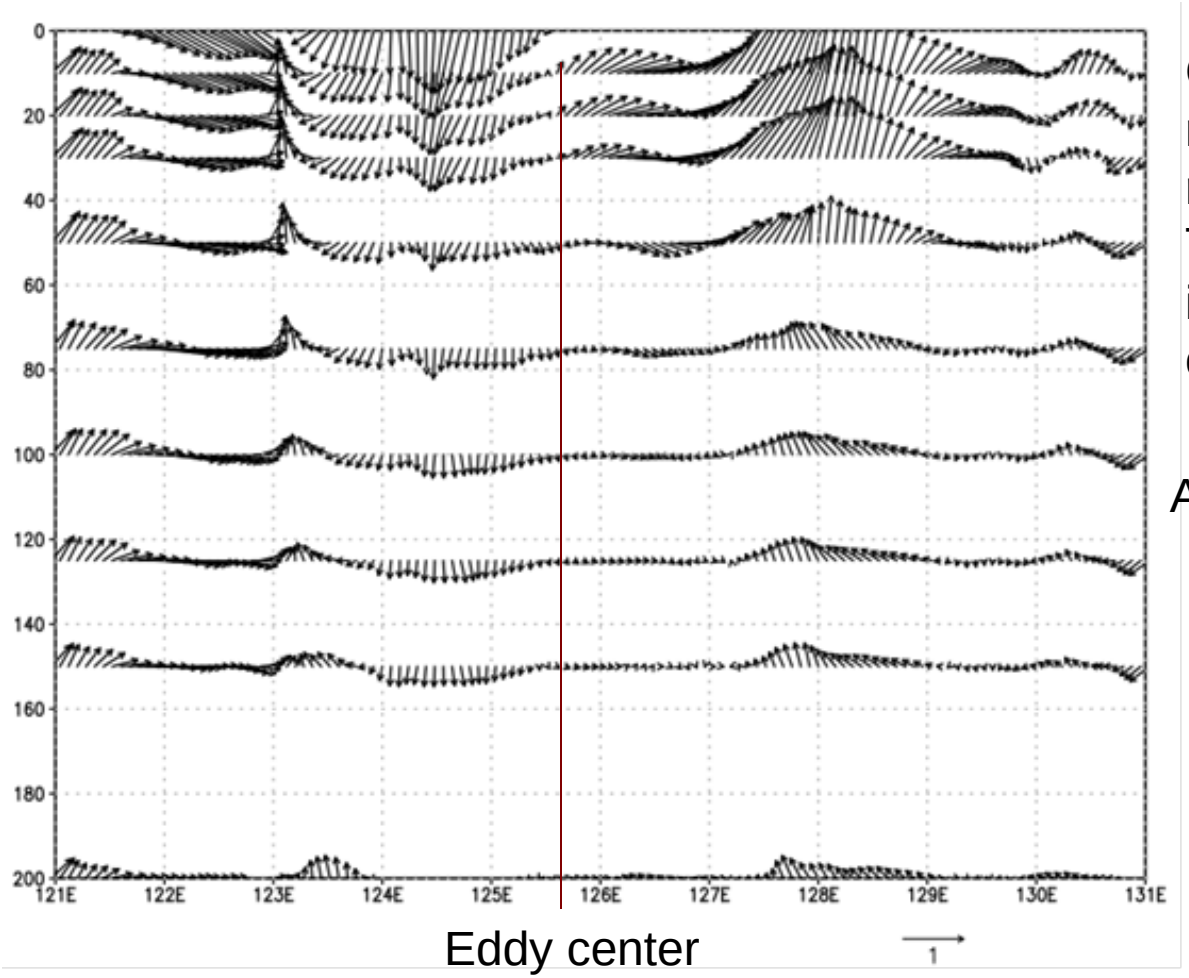


Vorticity at 8:00 on Jun 2



Vorticity at 8:00 on Jun 3

Vorticity increasing with time , positive area extending with time
black cross indicates sea eddy center



Cyclone eddy, more strong at right side ,
Two circuses, inside weak and outside strong

About 100m depth

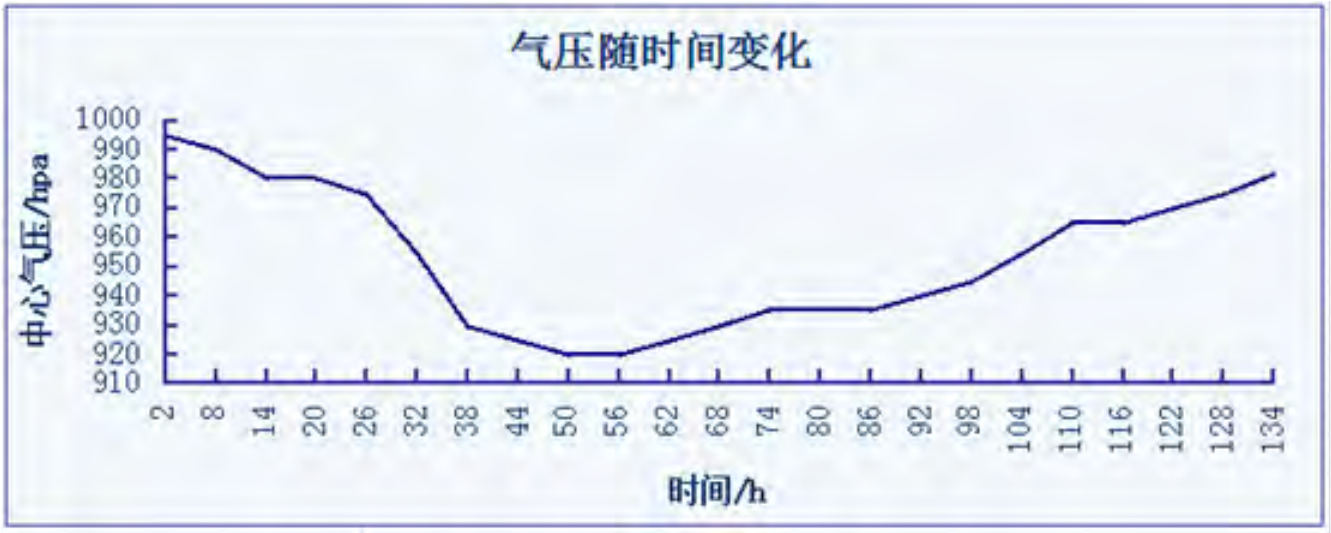
300km radius, Smaller than typhoon radius

Typhoon "Mawar" 4th June sea eddy flow vector at the vertical cross section (21.8° N), passing through the eddy center

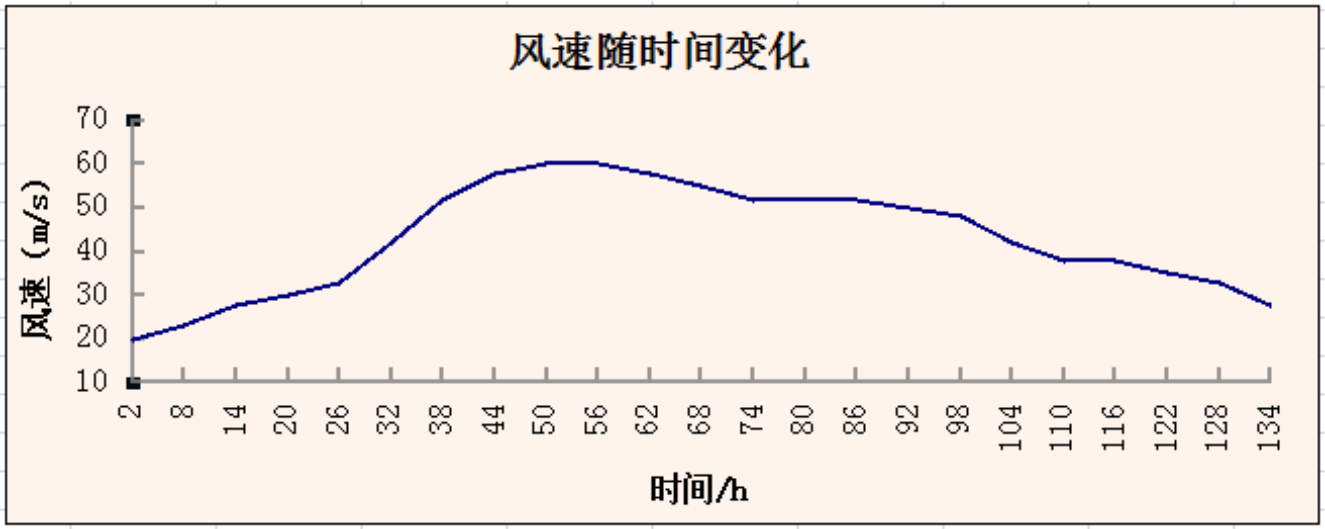
3 The Typhoon “Nuri”(2014) and the Sea Eddy Created by “Nuri”

(1) The Typhoon “Nuri”(2014)

Trajectory



Decresing: 2.1hPa/h

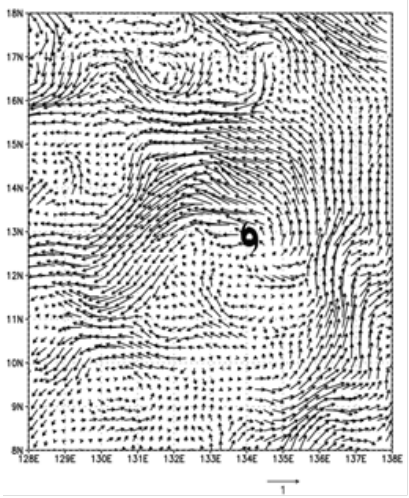


Pressure and wind speed time series of “Nuri” center

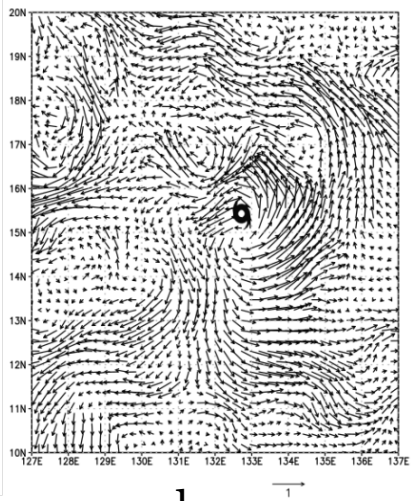
The typhoon “Nuri” features during its lifetime

Date	Time	Central pressure（hPa）	Lon	Lat	Wind Scale	Wind velocity（m/s）	Radius（km）	Moving speed（km/h）	Movement direction	Intensity
20141101	8	990	133.9	13.3	9	23	200	12	WN	Tropical Storm
20141102	8	955	132.7	15.5	14	42	270	15	NWN	Strong typhoon
20141103	8	920	132.5	18.4	17	60	270	17	EN	Super typhoon
20141104	8	935	134.9	21.3	16	52	270	17	NEN	Super typhoon
20141105	8	955	137.2	24.7	14	42	240	22	NEN	Strong typhoon
20141106	8	975	140.2	28.1	12	33	220	58	EN	Typhoon

(2) The Sea Eddy Created by Typhoon “Nuri”



aa



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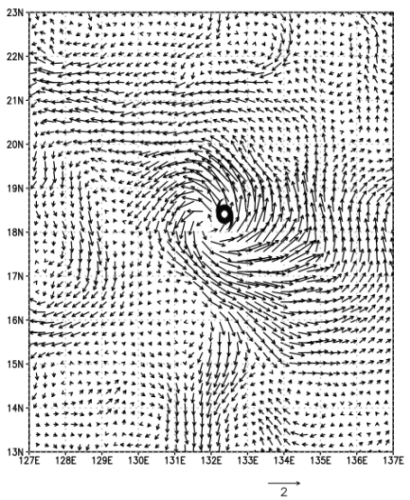

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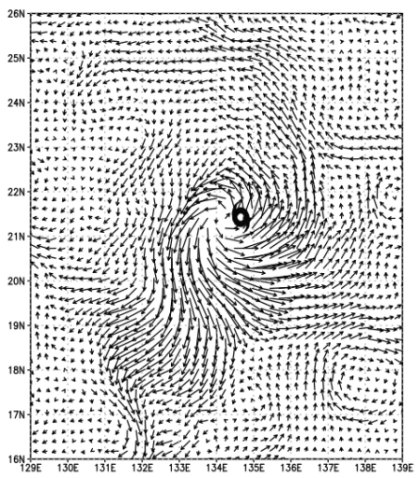

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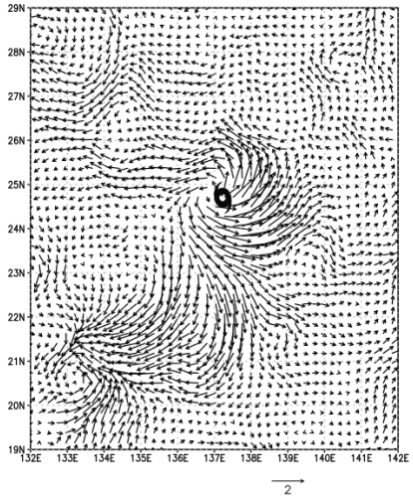

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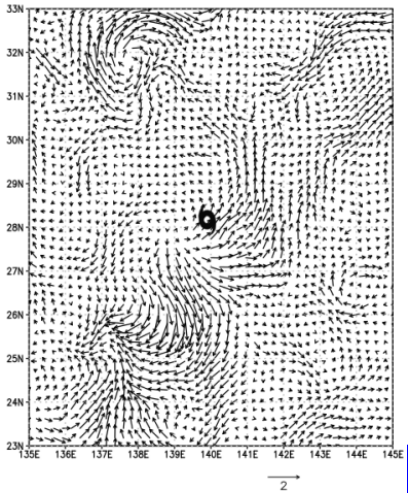
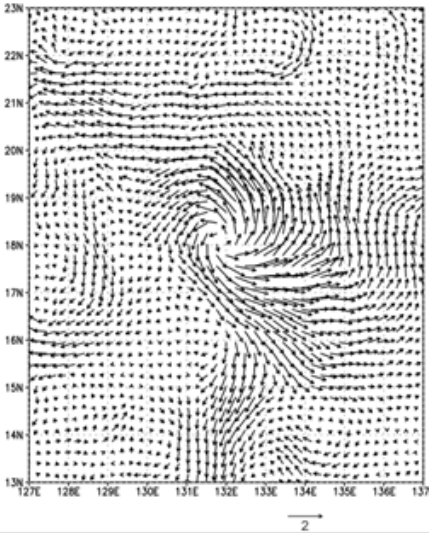


f

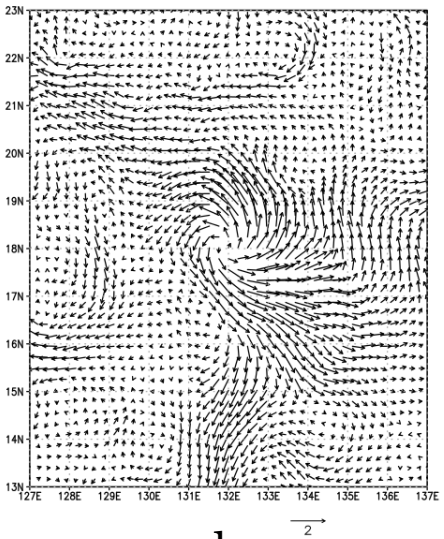
a, flow field at 8:00 Nov 1st
b, flow field at 8:00 Nov 2nd
c, flow field at 8:00 Nov 3rd
d, flow field at 8:00 Nov 4th
e, flow field at 8:00 Nov 5th
f, flow field at 8:00 Nov 6th

Flow goes outwards

The flow field at sea surface of “Nuri” lifetime



a



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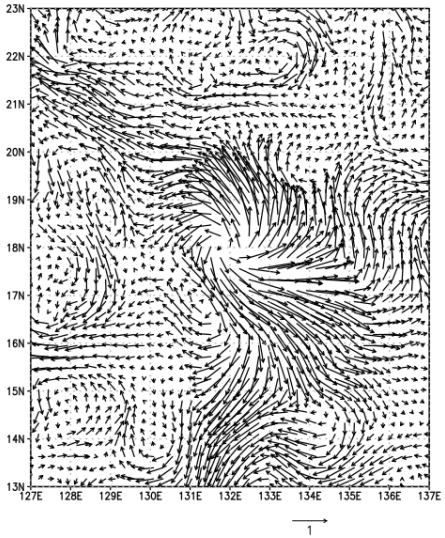

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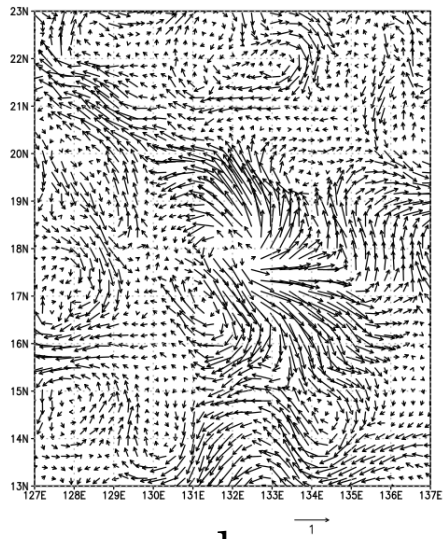

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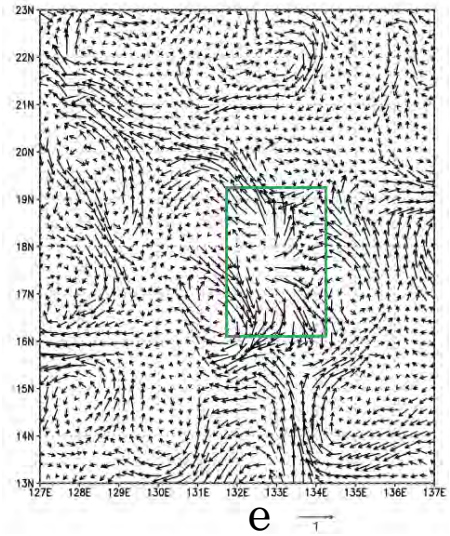

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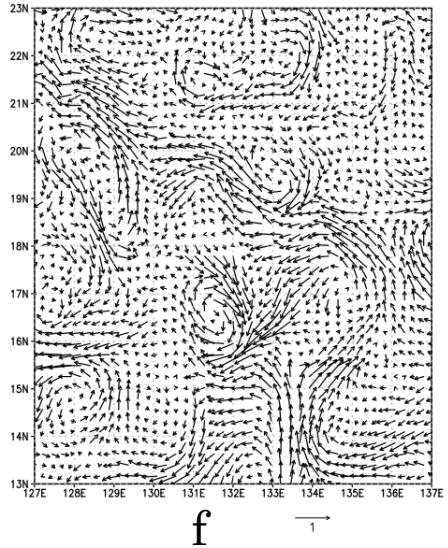
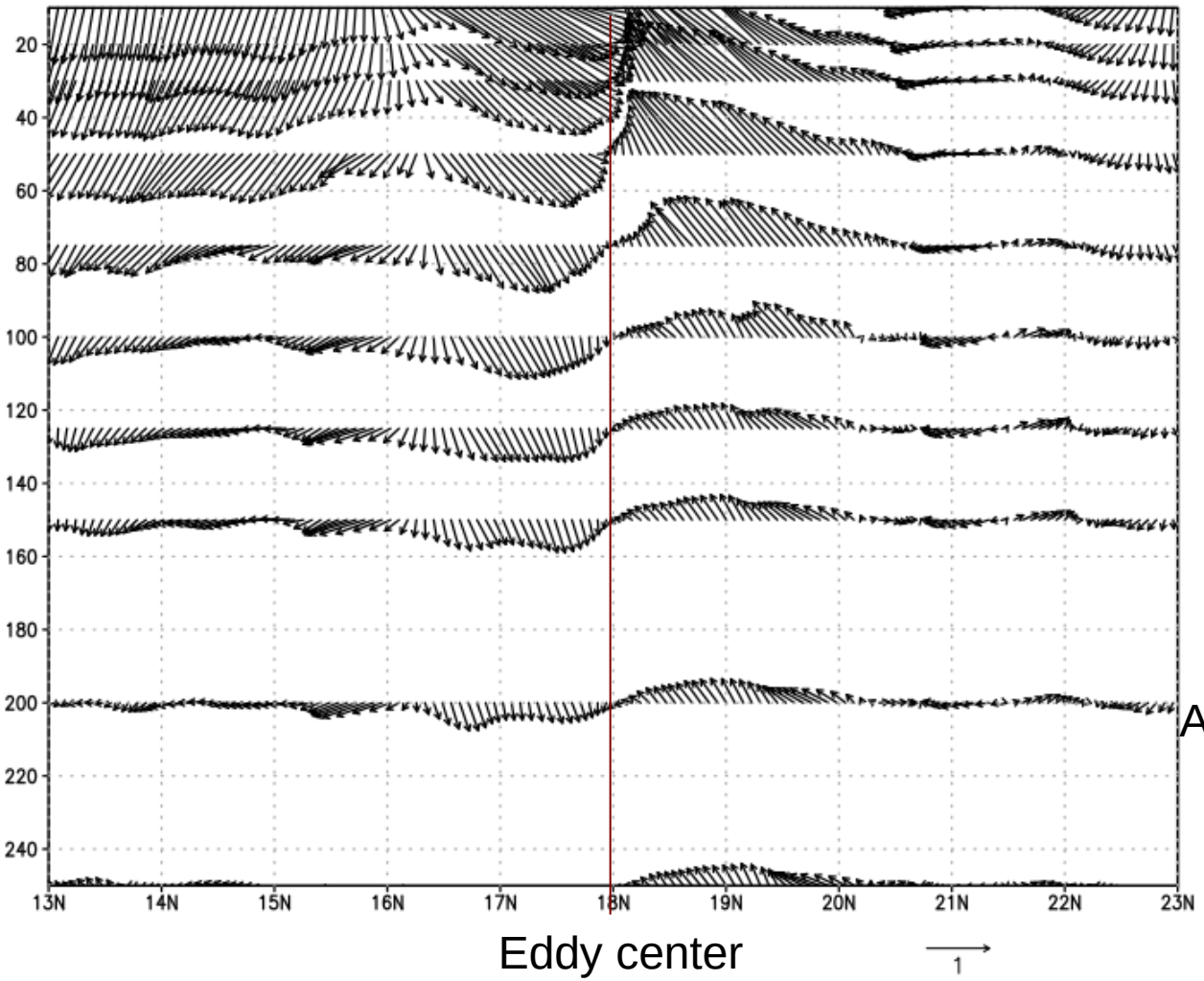


f

a, Flow field at 10m at 8:00 Nov 3rd
b, Flow field at 20m at 8:00 Nov 3rd
c, Flow field at 40m at 8:00 Nov 3rd
d, Flow field at 50m at 8:00 Nov 3rd
e, Flow field at 75m at 8:00 Nov 3rd
f, Flow field at 100m at 8:00 Nov 3rd

Flow goes outwards

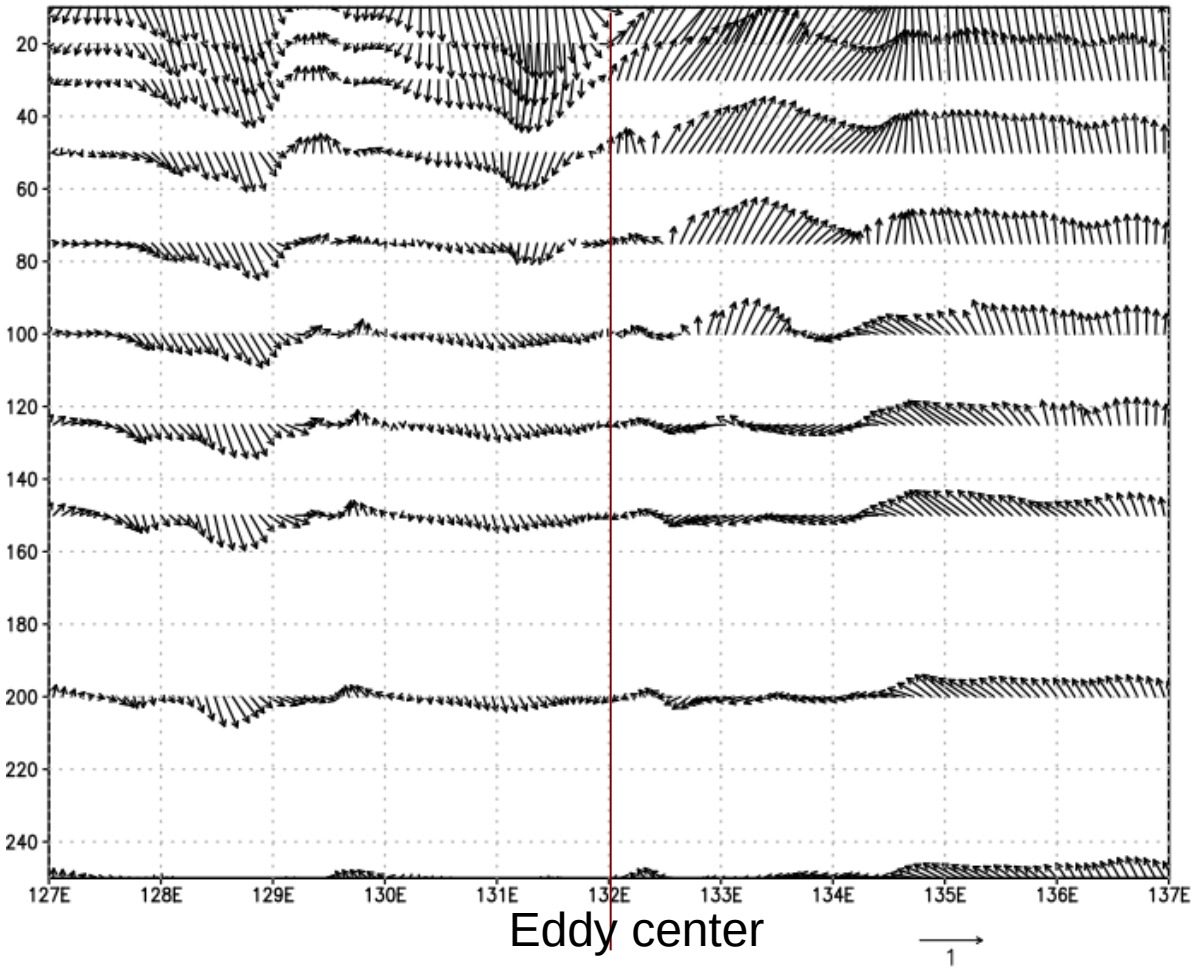
The flow field at different level of "Nuri" lifetime



250km radius
Smaller than
typhoon radius

About 200m depth

Typhoon “Nuri" 3rd Nov. sea eddy flow vector at the vertical cross section (132° E), passing through the eddy center



Cyclone eddy, more strong at right side ,

About 200m depth

Typhoon “Nuri" 3rd Nov. sea eddy flow vector at the vertical cross section (18.5° N), passing through the eddy center

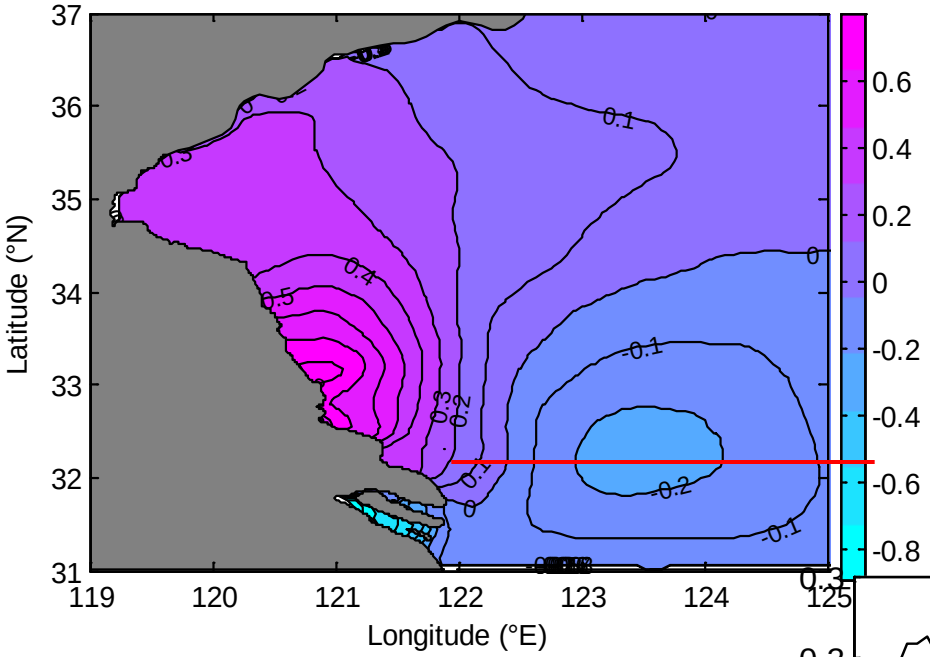
4 The Possible Impacting Mechanism

(1) Wind Dynamics

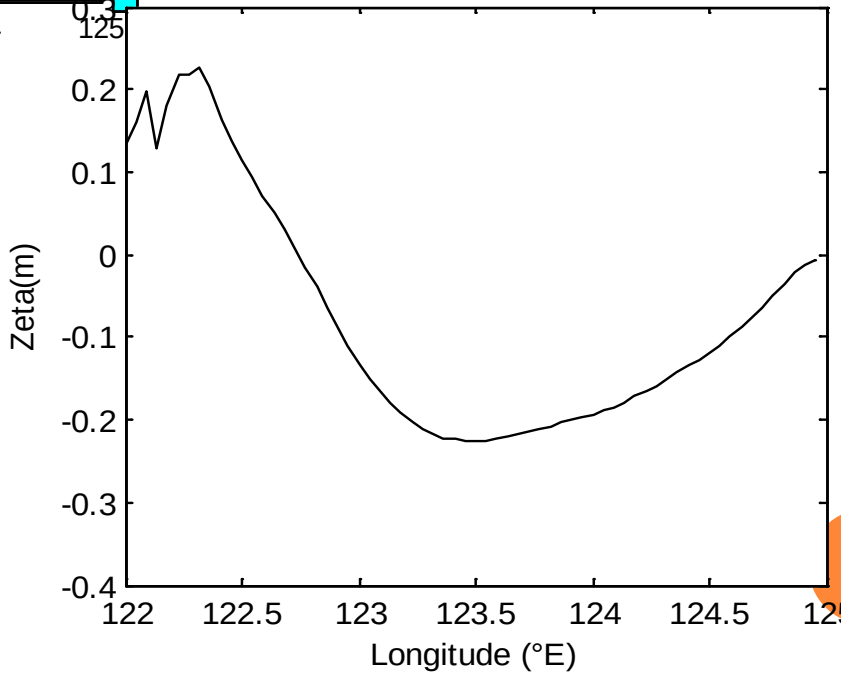
1) Typhoon sea surface wind: wind drifting forces sea water Ekman drift , and creates the upwilling inside the sea eddy.

2) Wind stress distribution: It is un-uniform, forces the sea surface flow divergence and convergence. The water momentum transports complex.

3) The stronger typhoon is with a stronger drifting force, and creates the stronger sea eddy .



The sea eddy forced by Typhoon is with low surface center, and large velocity side has a large gradient and a steep slope.



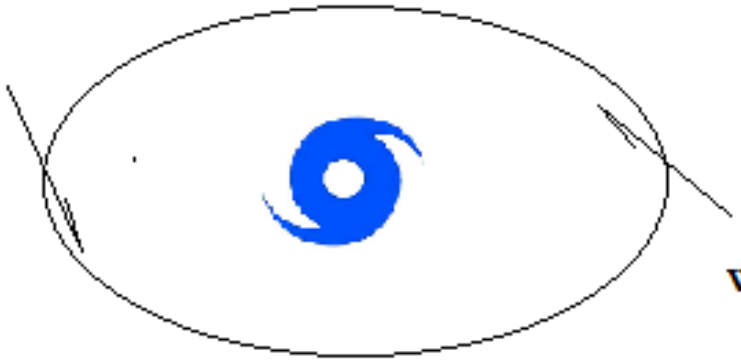
(2) SST and sea temperature

The upwilling, in the sea eddy forced by typhoon wind drifting, brings the deep cold water to surface layer. So typhoon sea eddy is a kind of cold center eddy.

The southeast part of typhoon sea eddy, the flow comes from lower latitudesm, SST and sea temperature is warmer; the northwest part of typhoon sea eddy, the flow comes from higher latitudes, SST and sea temperature is colder;

The moving sea eddy mixes the water within the area of the typhoon trajectory.

The typhoon sea eddy forces sea water elements redistribution.

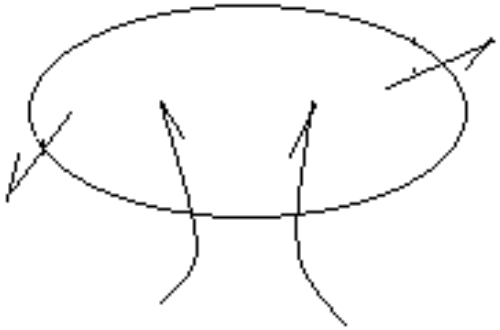


typhoon

large radius

wind convergence

warm center



typhoon sea eddy

size less

flow divergence

with upwilling inside

cold water

cold center

5 Summary and Discussion

(1) There is no clear evidence on that the increasing trend of typhoon number in west pacific ocean under the climate warming

(2) The typhoon during moving over sea creates typhoon sea eddy

(3) The typhoon sea eddy is with a less radius than typhoon itself, it responses to typhoon strong wind and is with asymmetry flow intensity and its depth proportional to typhoon intensity.

(4) The typhoon wind convergence and drifting creates sea eddy with surface flow divergence , further the upwilling inside sea eddy.

(5) The typhoon sea eddy is a kind of cold center eddy. The moving sea eddy mixes the water within the area of the typhoon trajectory. The typhoon sea eddy forces sea water elements redistribution.

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THANKS FOR YOUR ATTENTION !

PICES 2015, Qingdao, China, Oct.14-25