# Numerical study for the explosively deepening extratropical cyclones in the northwestern Pacific Region

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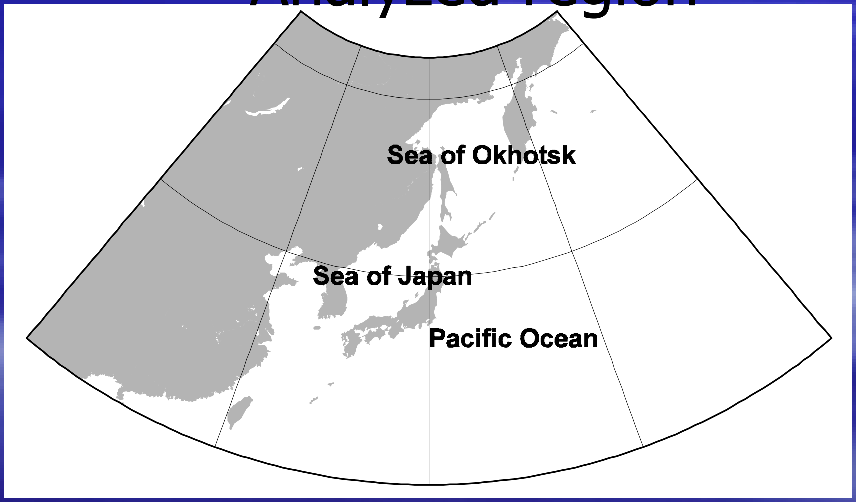
# Introduction

- Yoshida and Asuma (2004) analyzed statistical characteristic for explosively developing extratropical cyclones in the northwestern Pacific region.

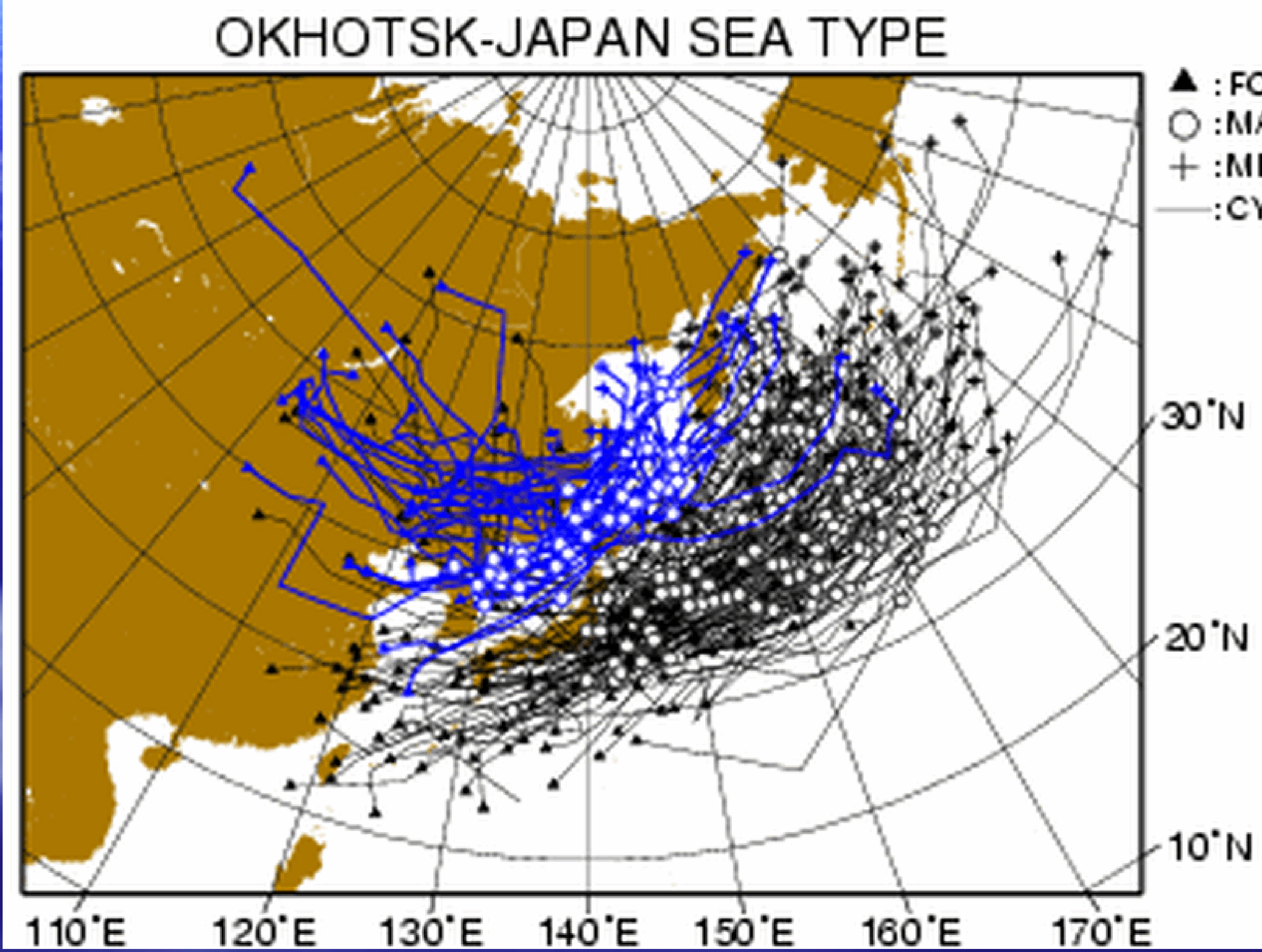
•Analyzed term :
Oct 1994 – Mar 1999
(5 winter seasons)

•Data :
JMA GANAL

Analyzed region

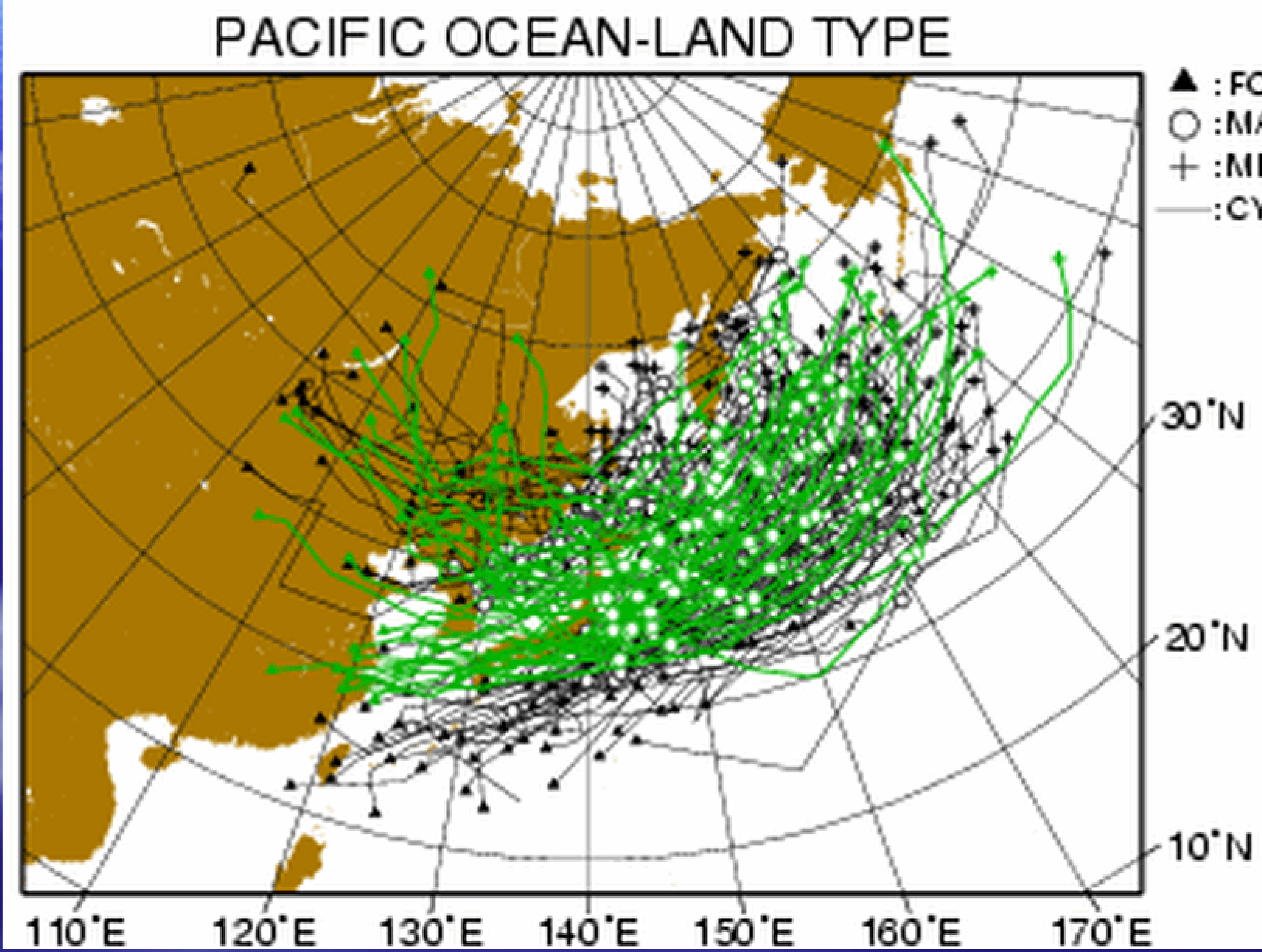


# OJ type



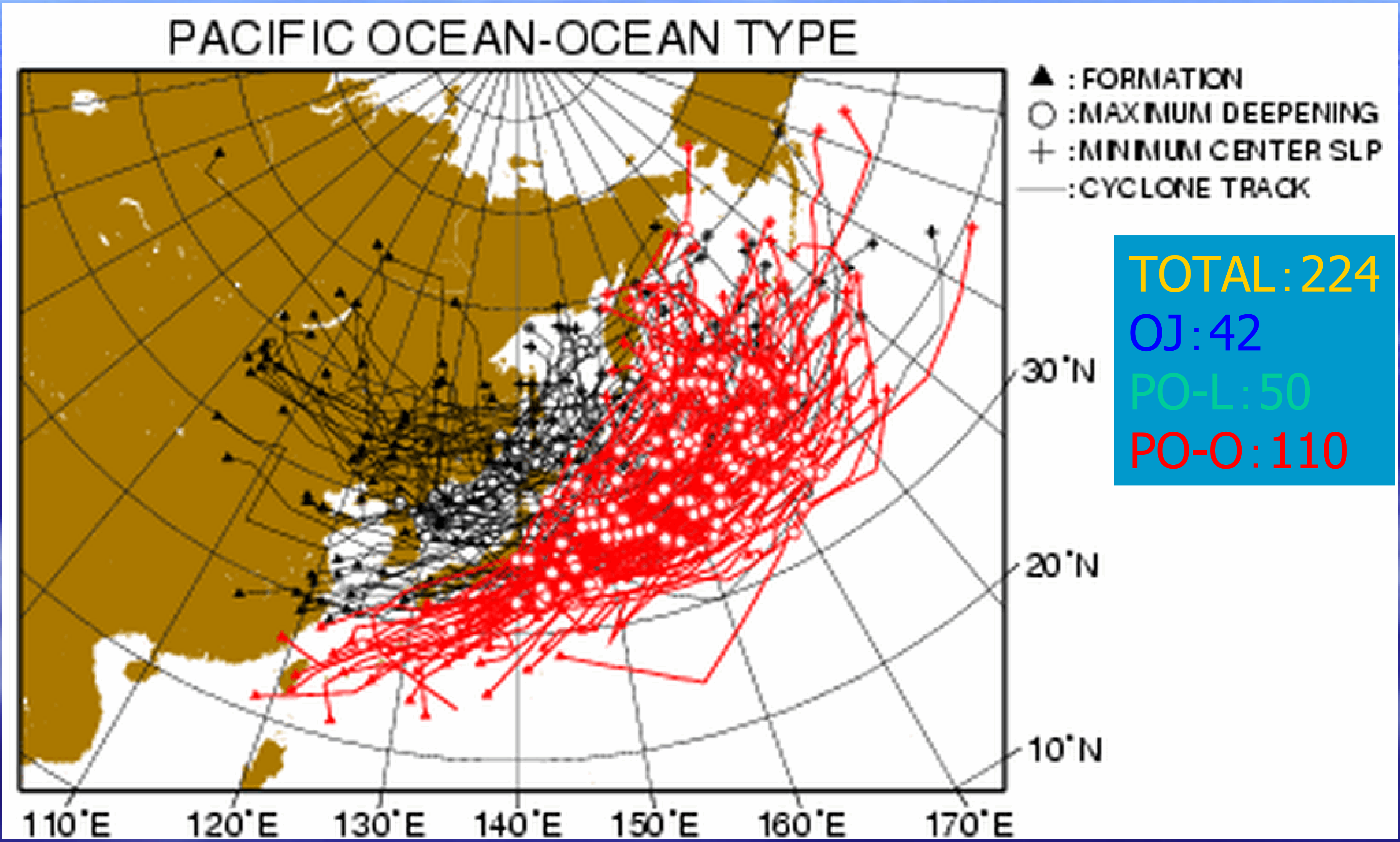

TOTAL : 224
OJ : 42

# PO-L type




TOTAL：224
OJ：42
PO-L：50

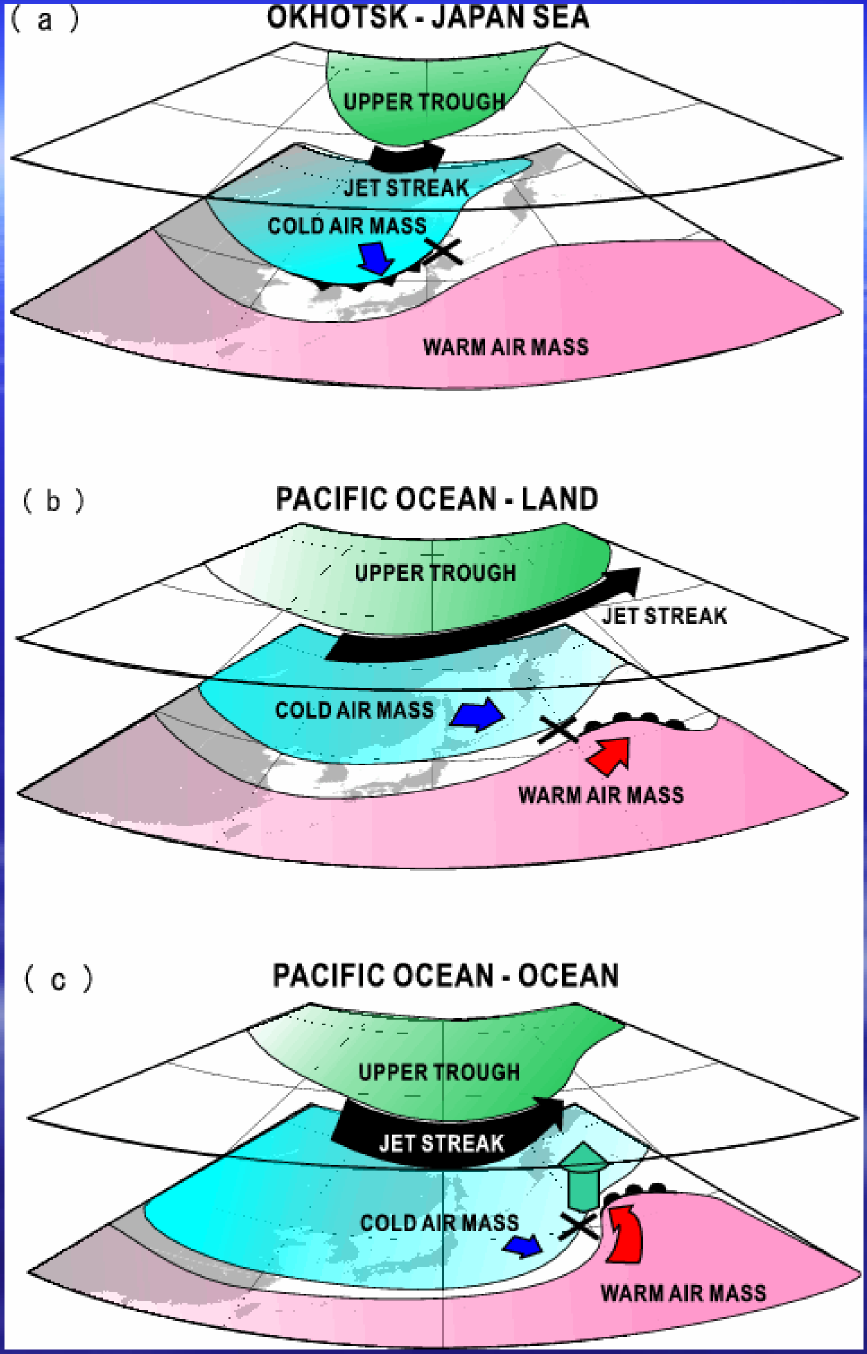
# PO-O type




TOTAL : 224
OJ : 42
PO-L : 50
PO-O : 110

Seasonal variation of cyclone track reflects seasonal change of atmospheric environment.

cyclone's meso-scale structure and physical processes (latent heat release), which is influenced by larger-scale atmospheric environment, causes difference of maximum deepening rate between three types.

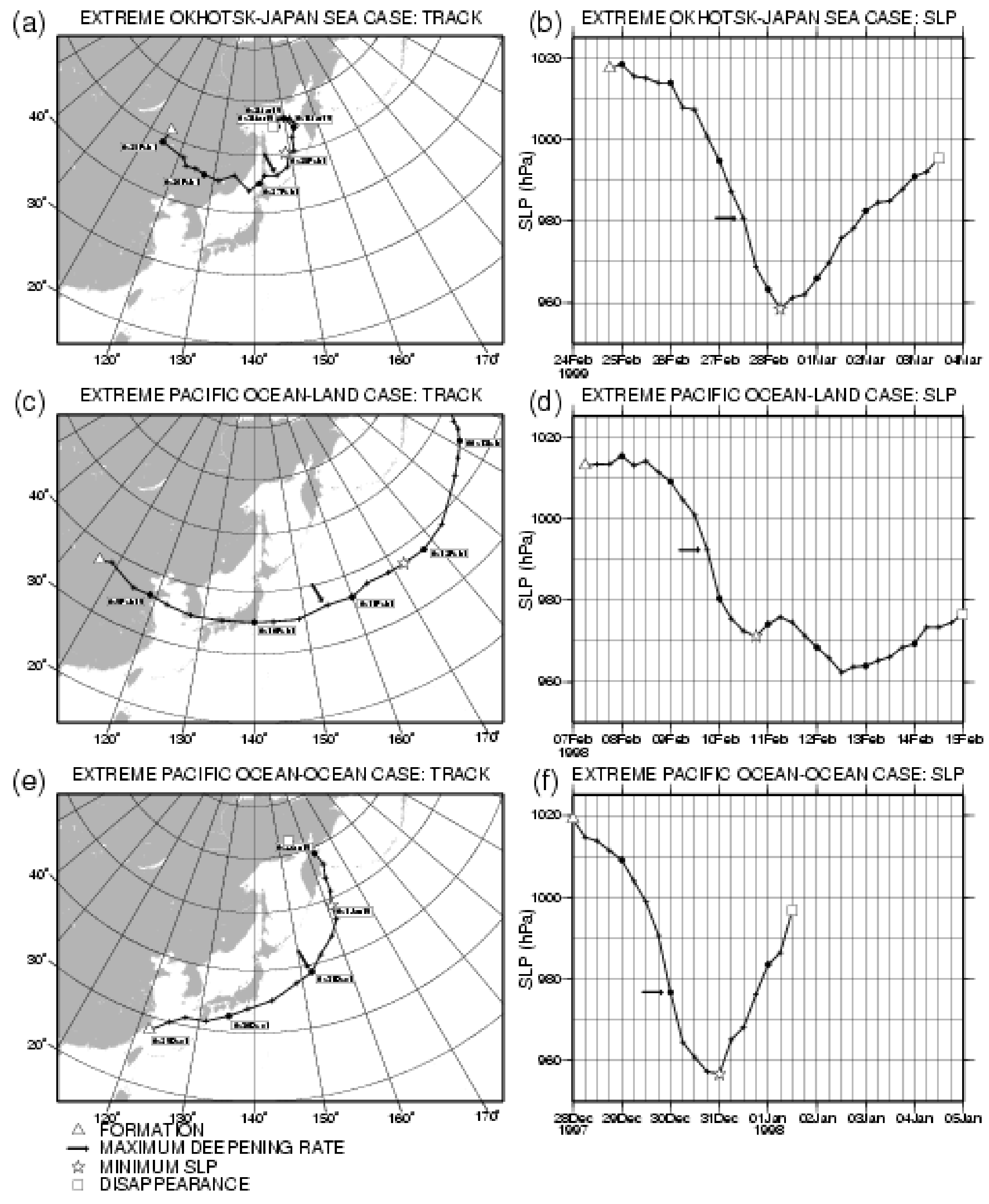


# Objectives

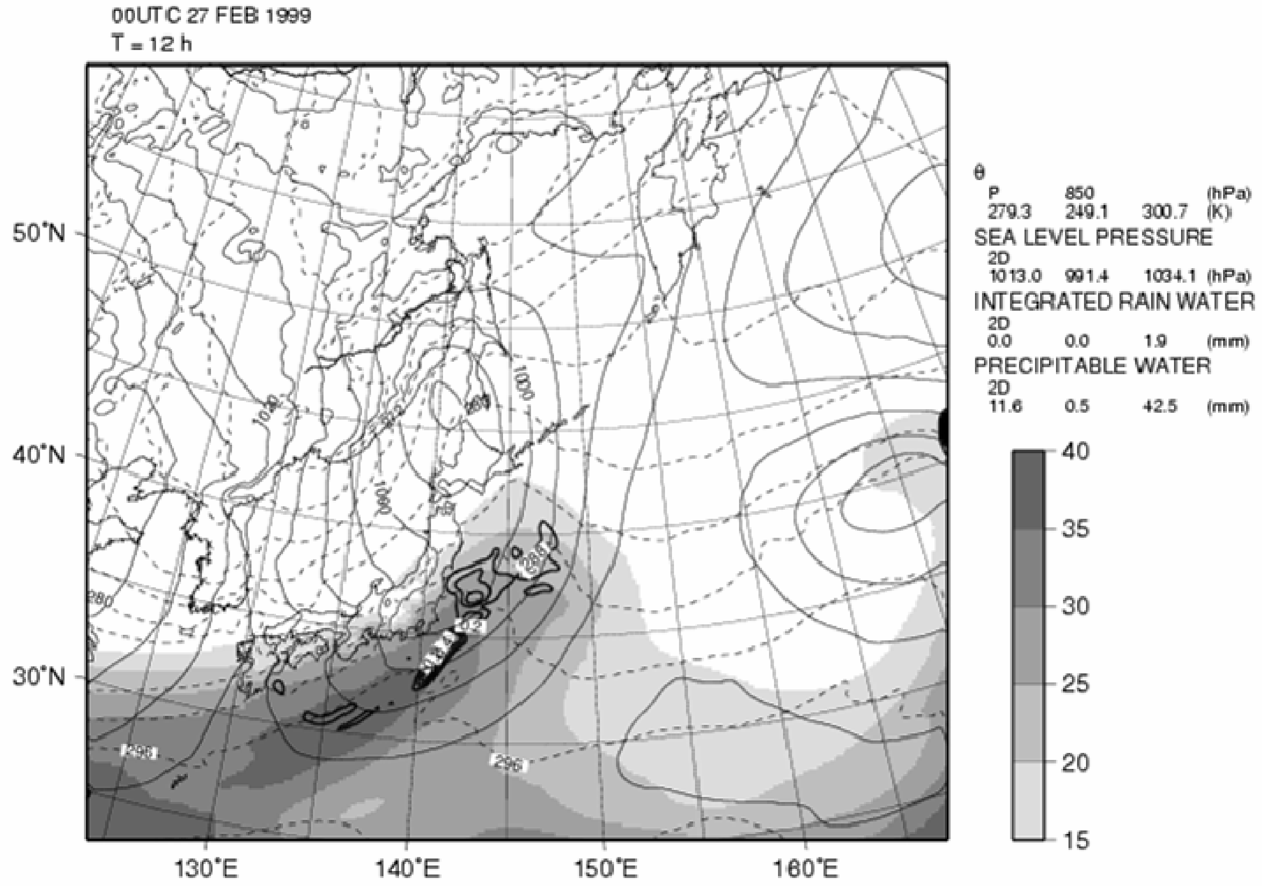
- To analyze time evolution extreme cases, which were most rapidly developing cyclones for each type.
- To clarify relation between latent heat release and explosive cyclogenesis using numerical simulations.

# Model description

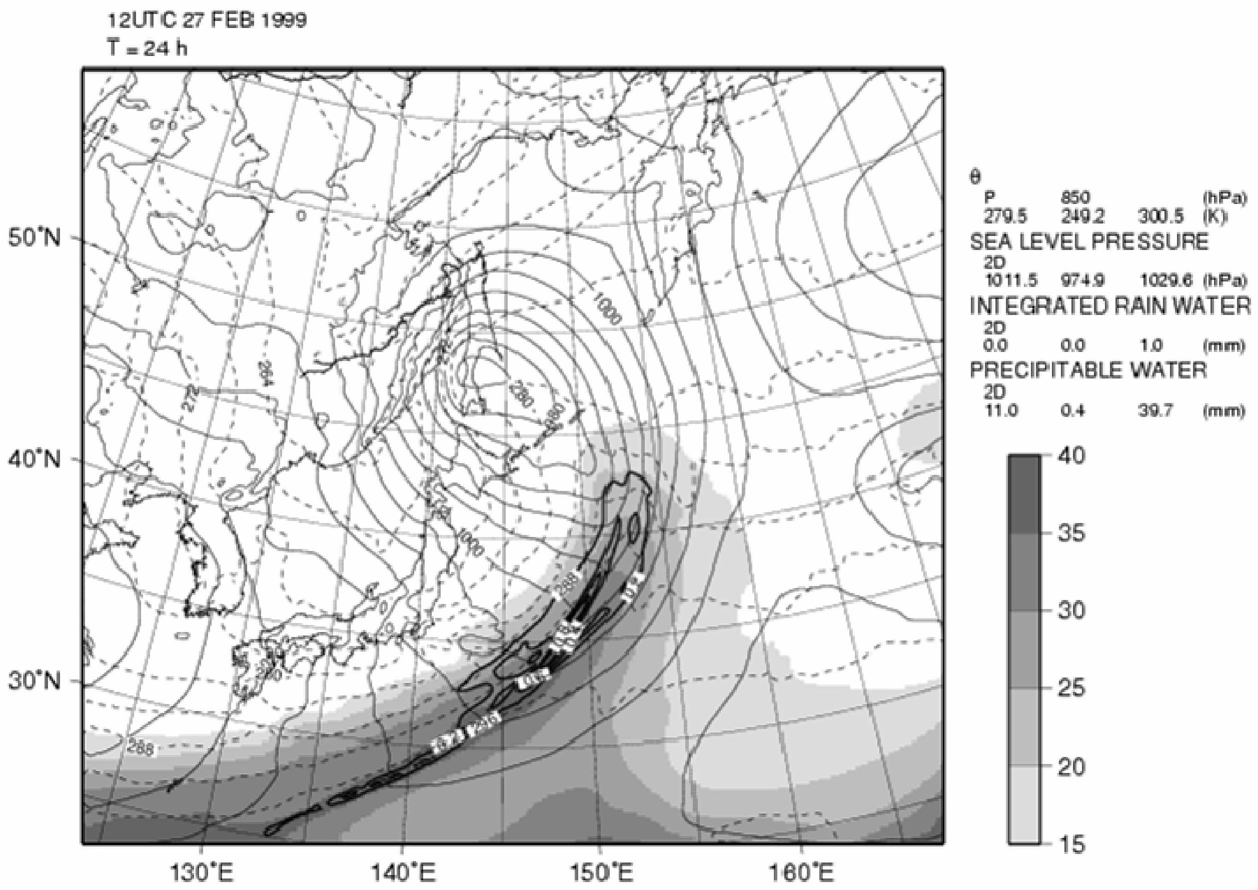
- PSU-NCAR MM5 ver. 3. 6. 1
  - Horizontal resolution:
    - Domain 1 : 45 km (200 x 160)
    - Domain 2 : 15 km (301 x 271)
  - Vertical resolution
    - 23 sigma level from surface to 100 hPa
  - Initial and boundary condition
    - GANAL, Reynolds SST
  - Integration
    - 48 hours (starting 24 hours before maximum deepening rate)
  - Sensitivity experiment
    - Control and no latent heat release by condensation runs


(a)
EXTREME OKHOTSK-JAPAN SEA CASE: TRACK
(b)
EXTREME OKHOTSK-JAPAN SEA CASE: SLP
SLP (hPa)
1020
1000
980
960
24Feb 1999
25Feb
26Feb
27Feb
28Feb
01Mar
02Mar
03Mar
04Mar
(c)
EXTREME PACIFIC OCEAN-LAND CASE: TRACK
(d)
EXTREME PACIFIC OCEAN-LAND CASE: SLP
07Feb 1998
08Feb
09Feb
10Feb
11Feb
12Feb
13Feb
14Feb
15Feb
(e)
EXTREME PACIFIC OCEAN-OCEAN CASE: TRACK
(f)
EXTREME PACIFIC OCEAN-OCEAN CASE: SLP
28Dec 1997
29Dec
30Dec
31Dec
01Jan 1998
02Jan
03Jan
04Jan
05Jan
40°
30°
20°
120°
130°
140°
150°
160°
170°
FORMATION
MAXIMUM DEEPENING RATE
MINIMUM SLP
DISAPPEARANCE

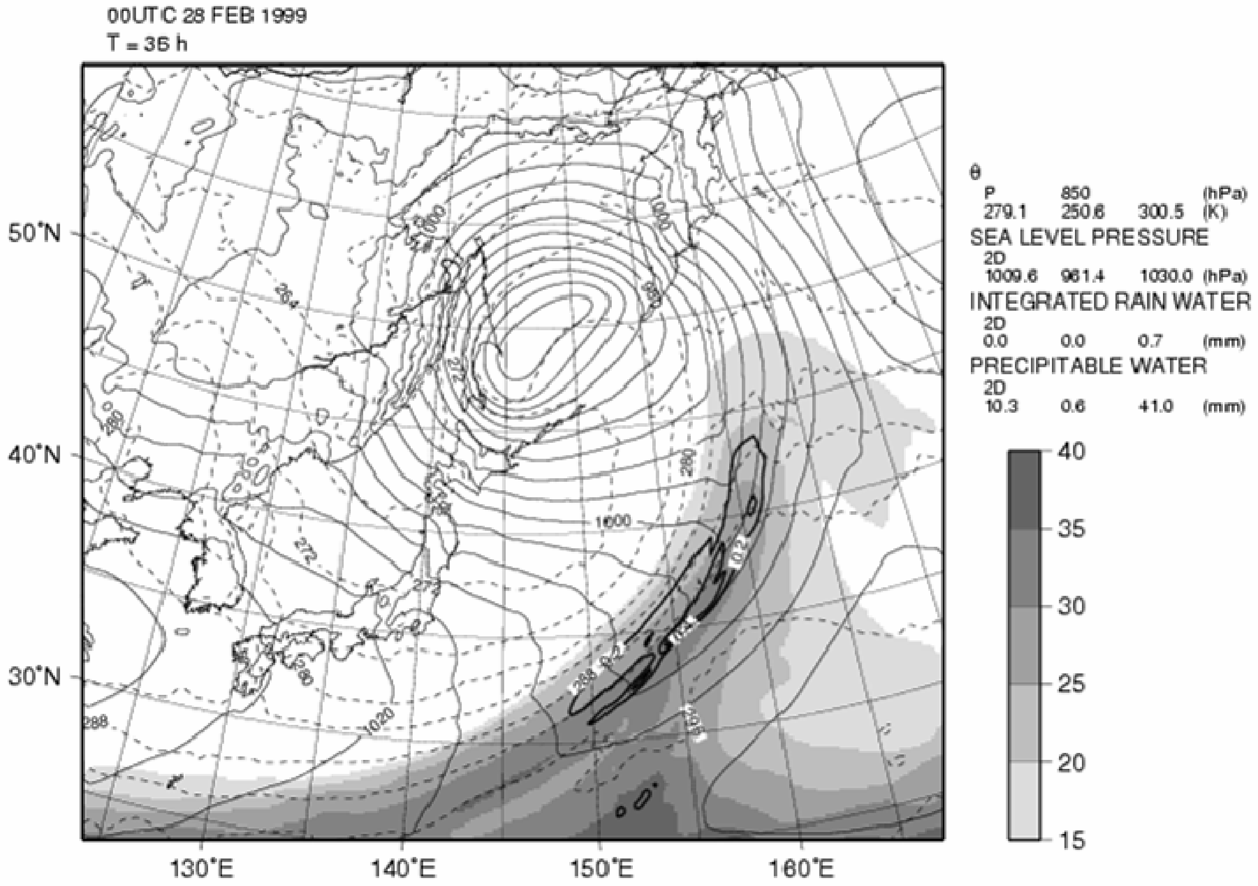
# OJ case: 12 h before max



# OJ case: Maximum deepening rate

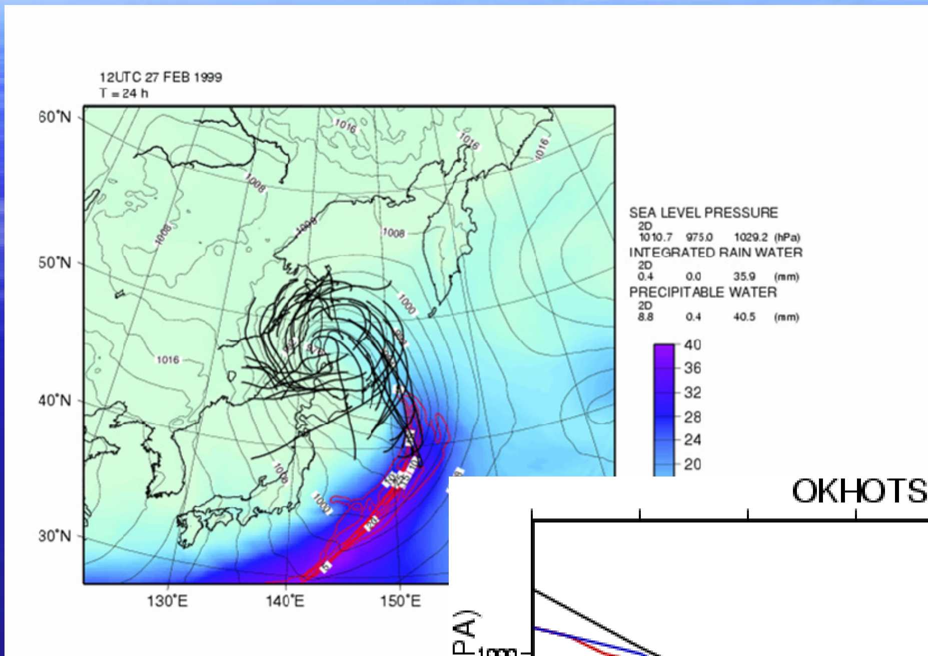


# OJ case: 12 h after max

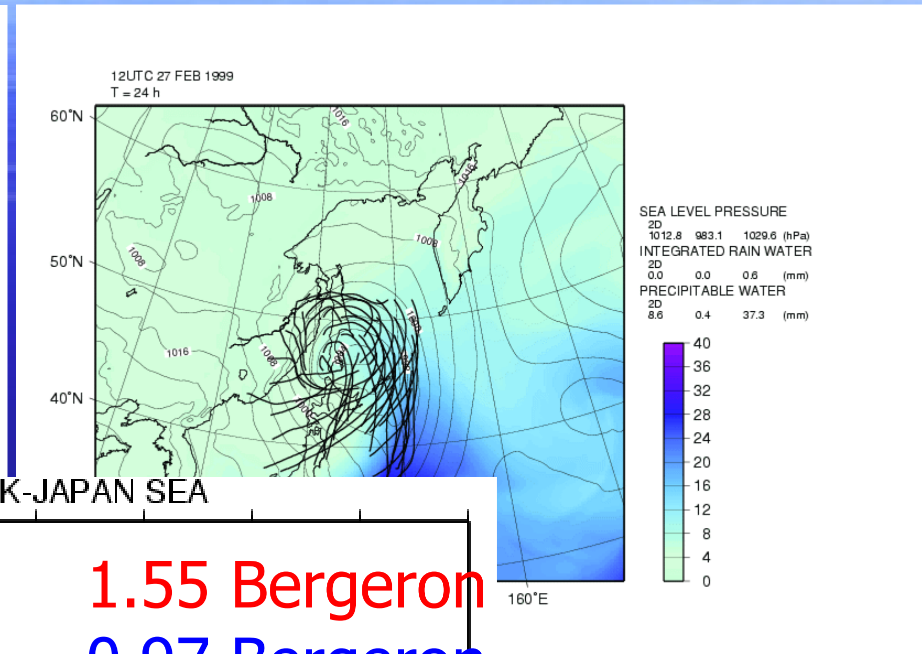


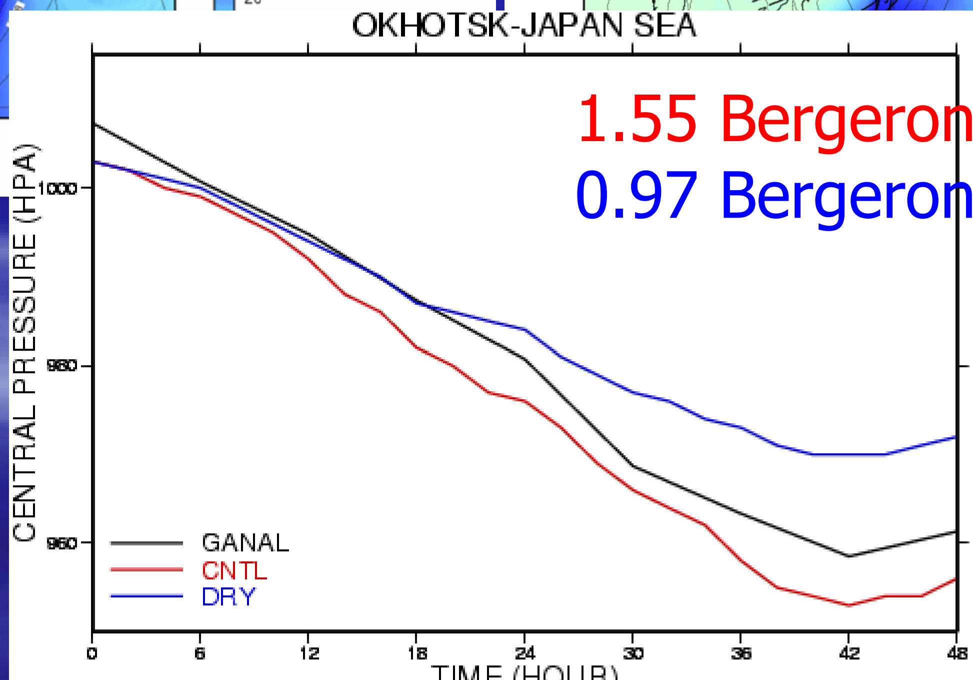
# OJ case: Backward trajectory from 850 hPa near cyclone center

CNTL

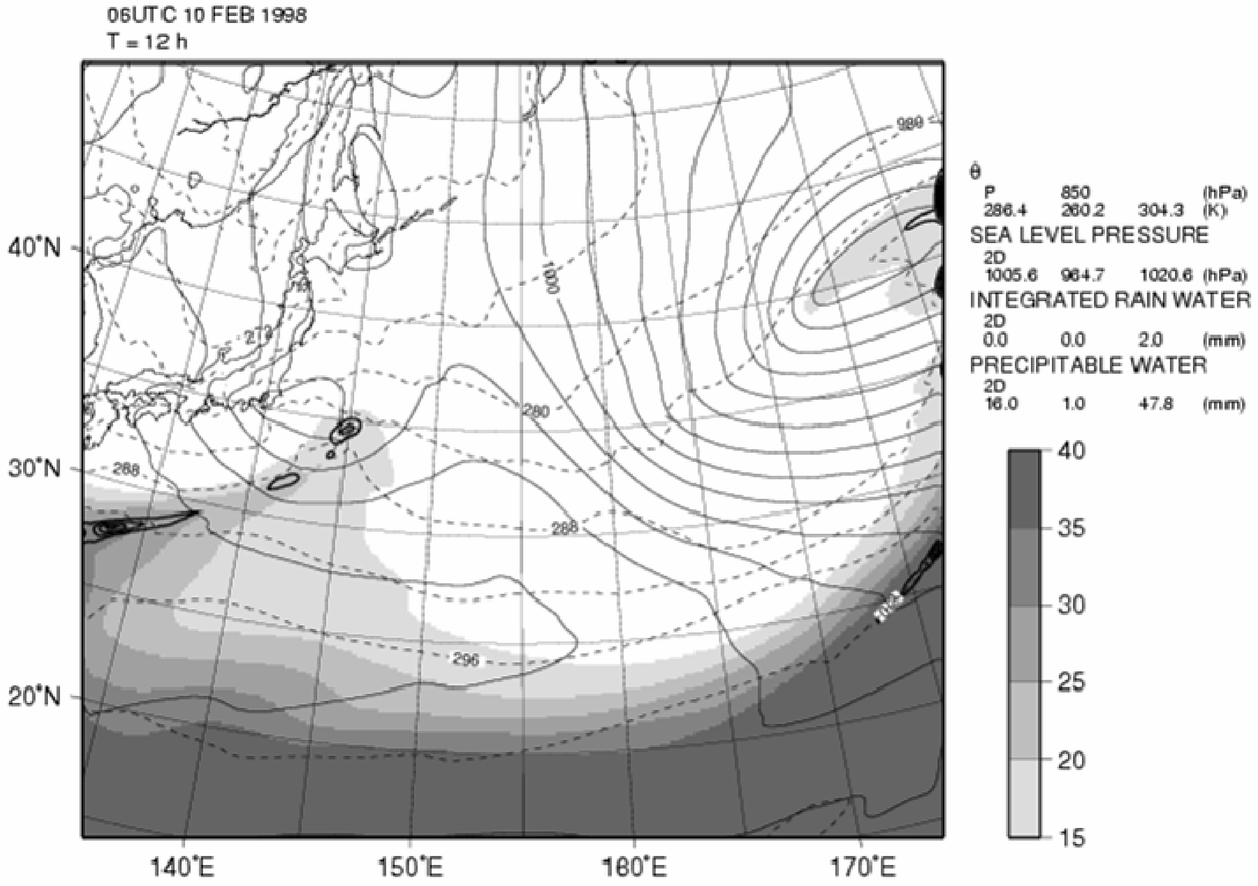



DRY

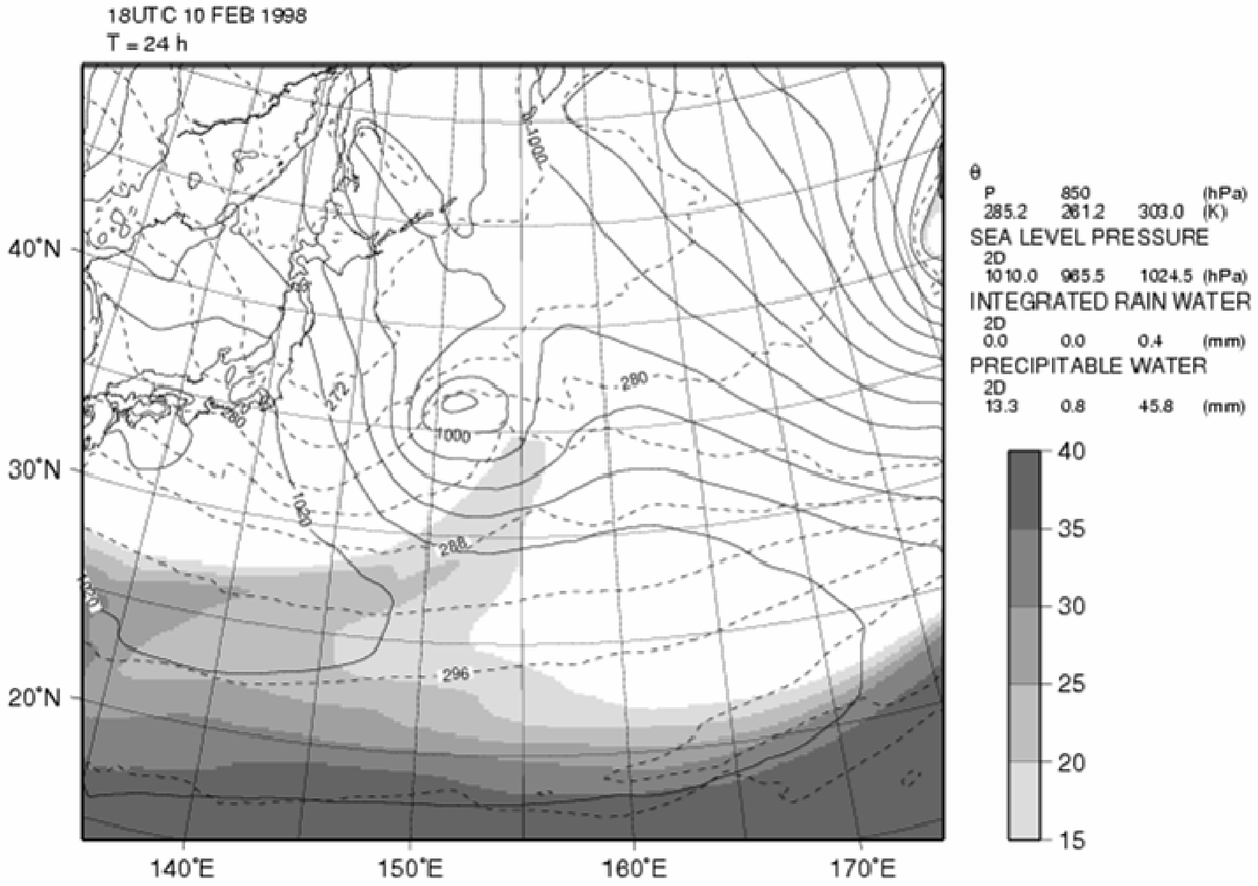


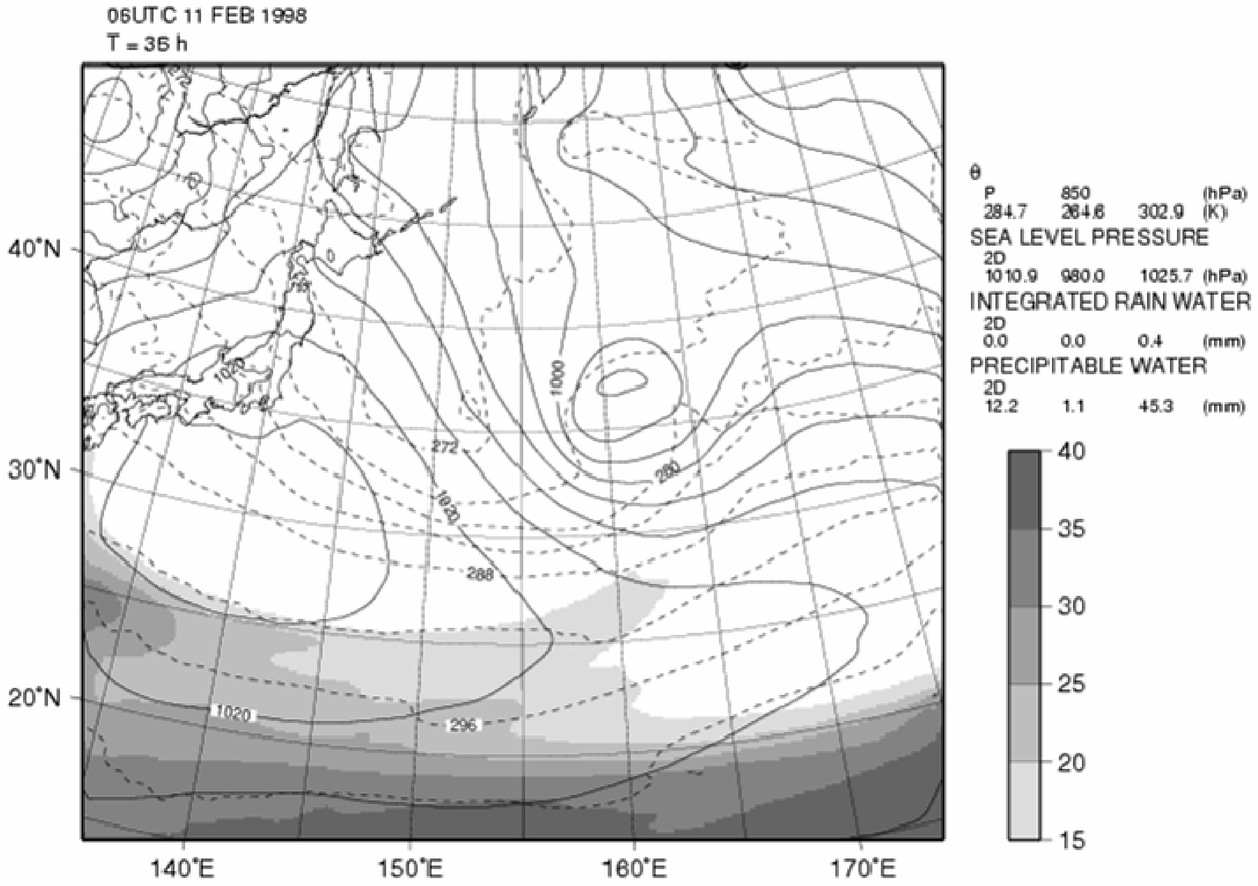
# PO-L case: 12 h before max



# PO-L case:
# Maximum deepening rate



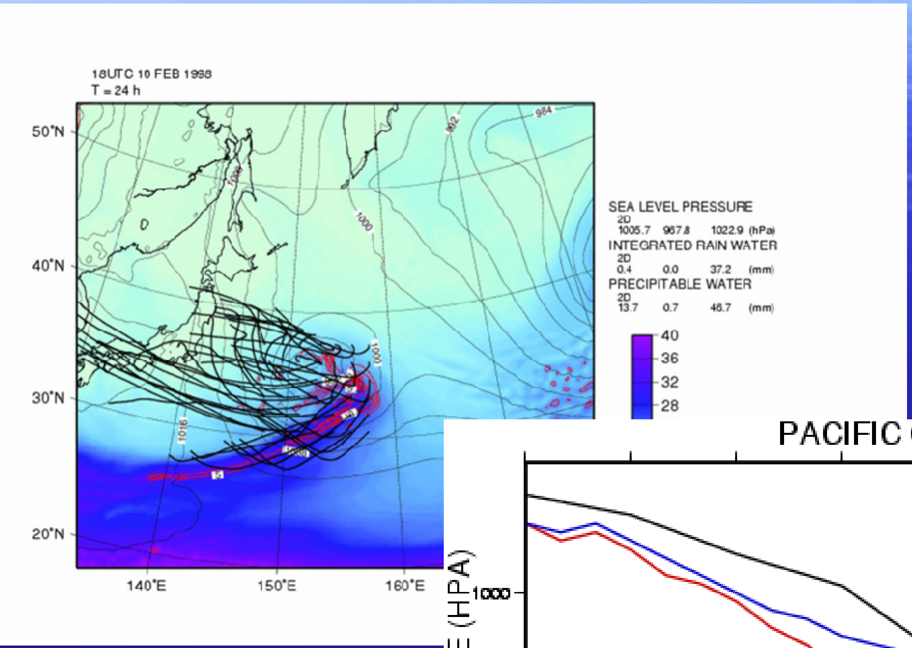
# PO-L case: 12 h after max

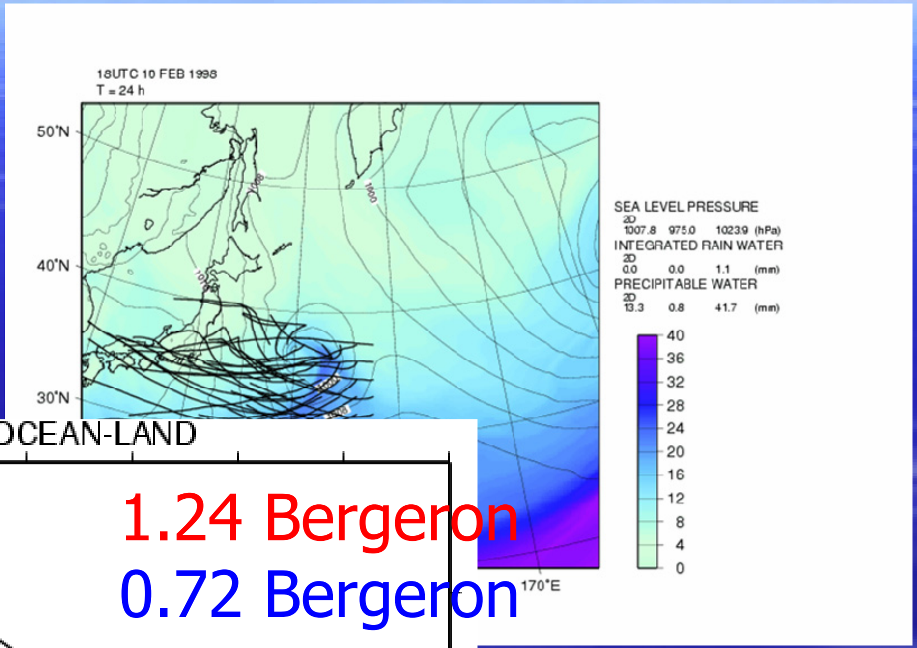


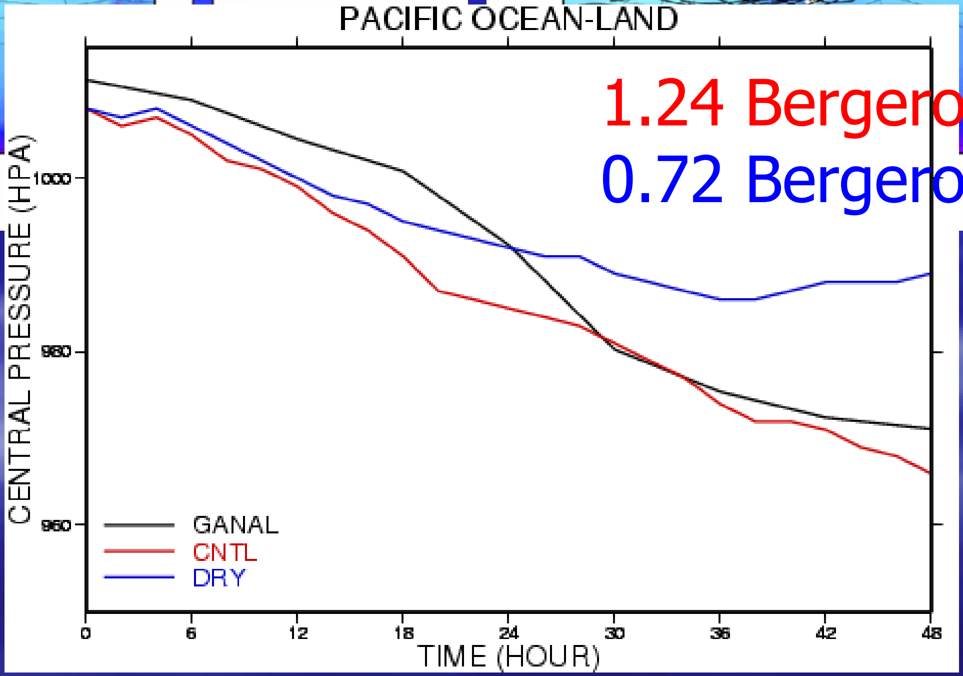
# PO-L case backward trajectory

CNTL

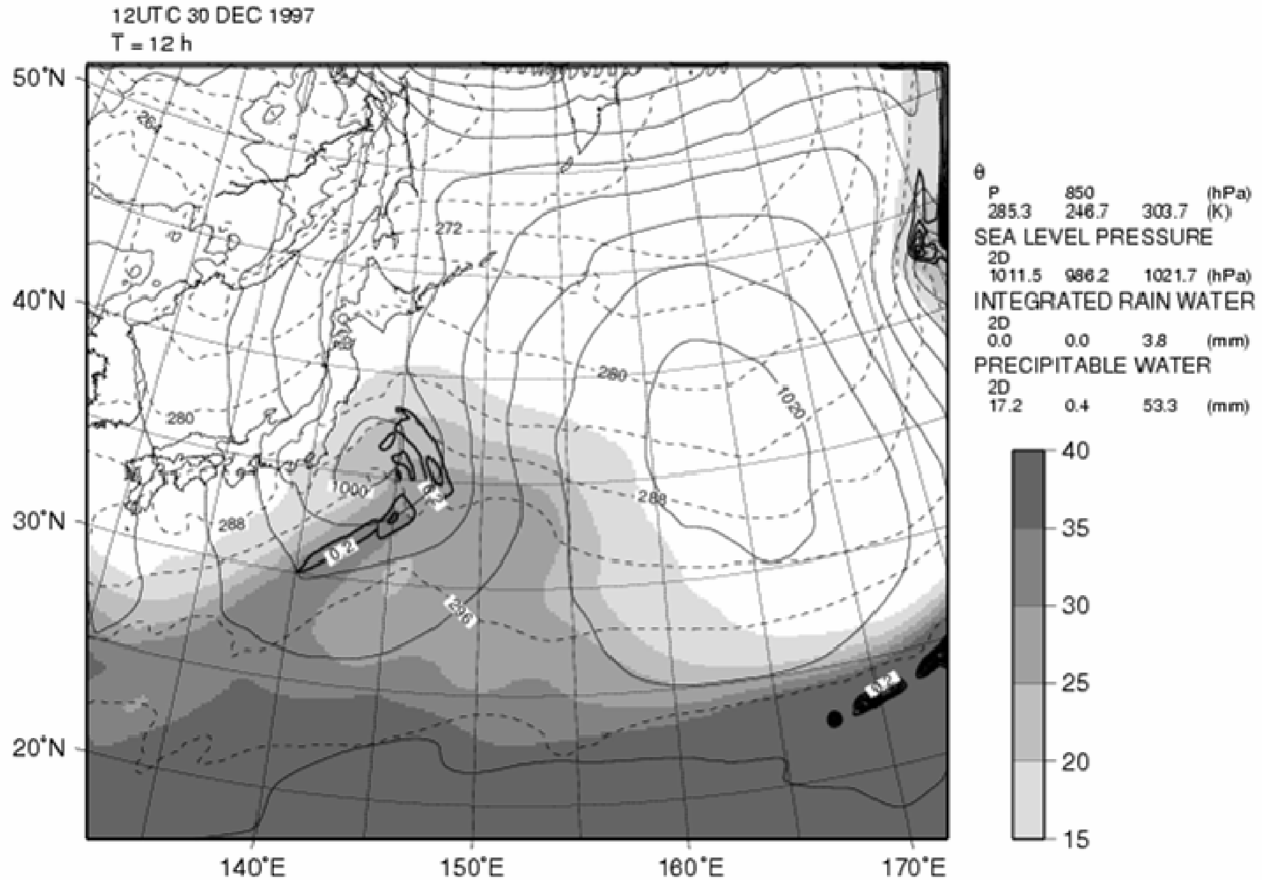
DRY



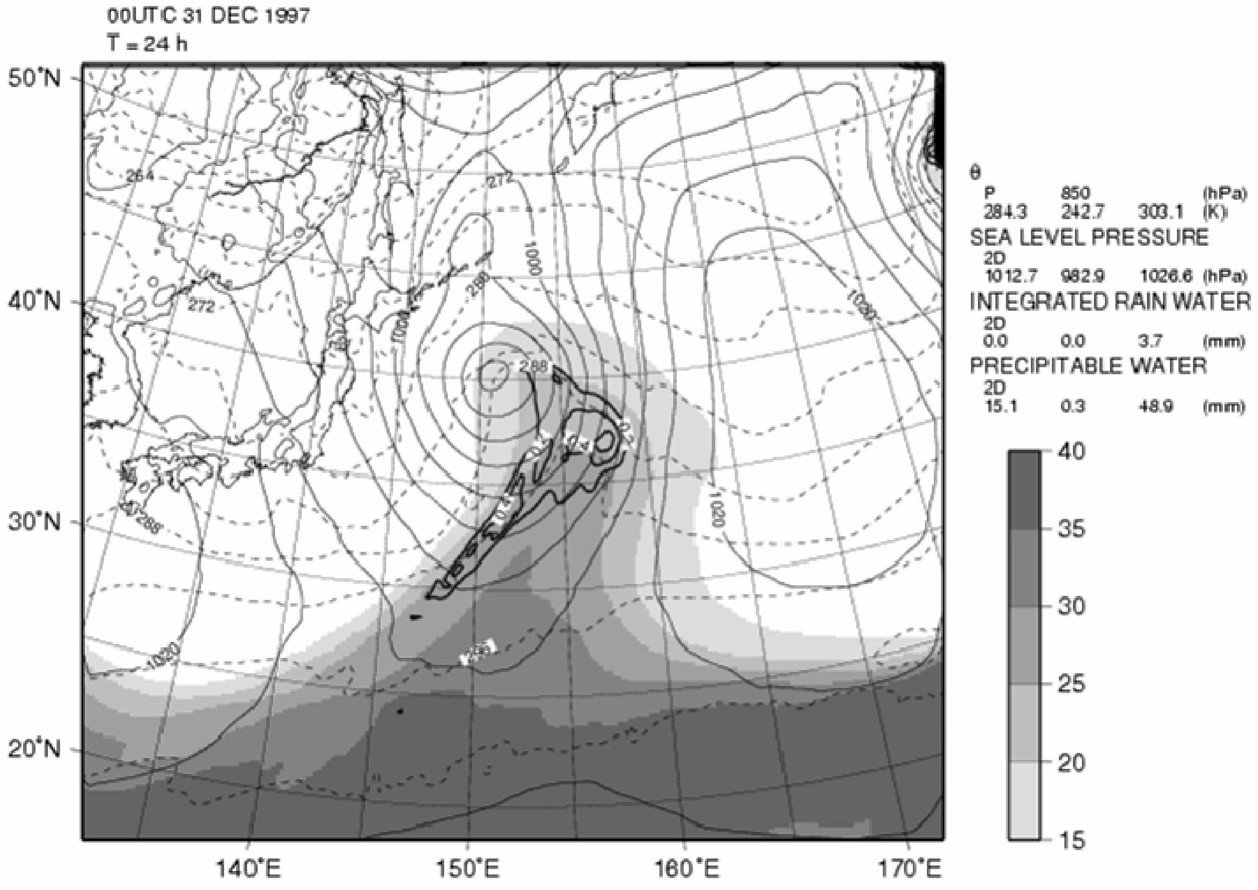



# PO-O case: 12 h before max

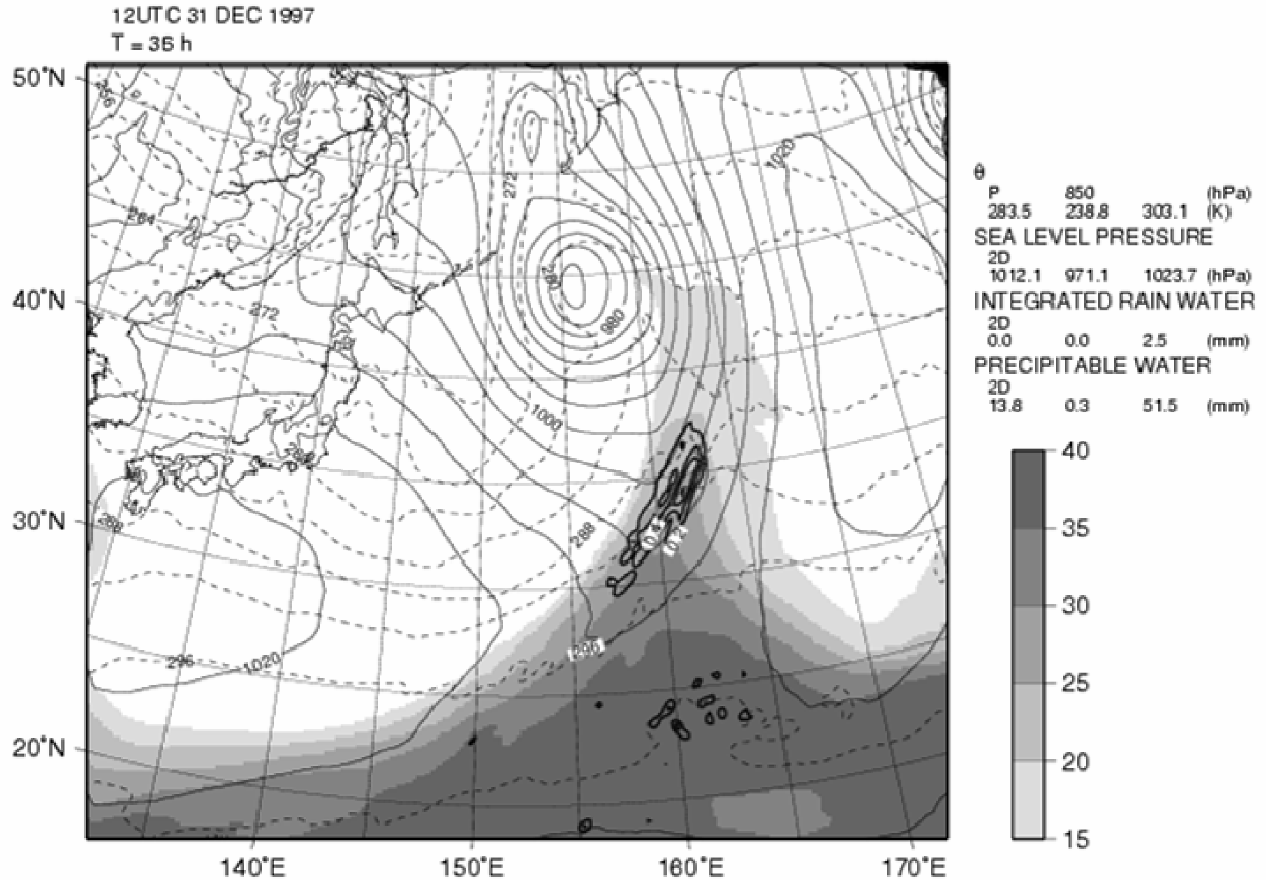


# PO-O case: Max



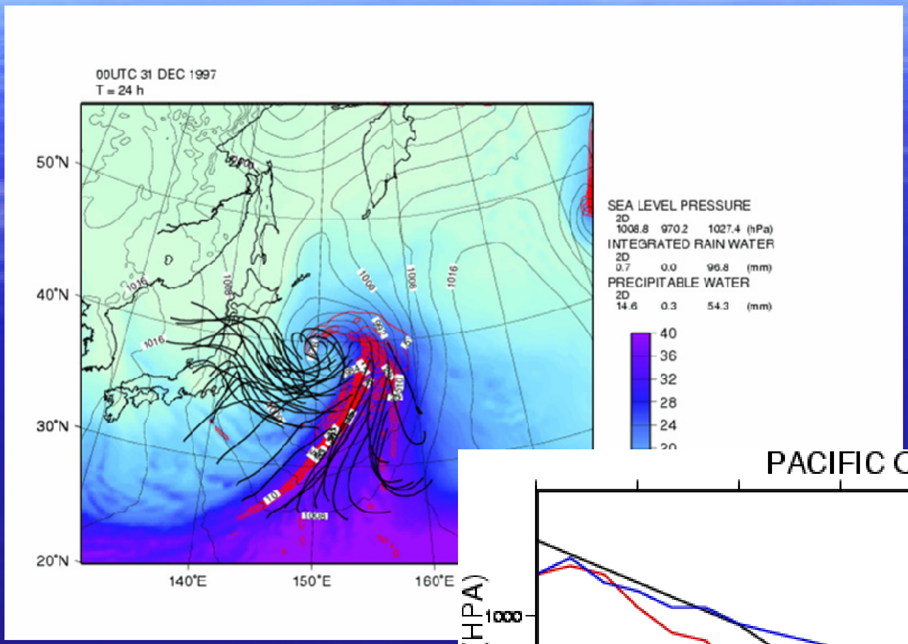
00UTC 31 DEC 1997
T = 24 h
50°N
40°N
30°N
20°N
140°E
150°E
160°E
170°E
θ
P 850 (hPa)
284.3 242.7 303.1 (K)
SEA LEVEL PRESSURE
2D
1012.7 982.9 1026.6 (hPa)
INTEGRATED RAIN WATER
2D
0.0 0.0 3.7 (mm)
PRECIPITABLE WATER
2D
15.1 0.3 48.9 (mm)
40
35
30
25
20
15

# PO-O case: 12 h after max

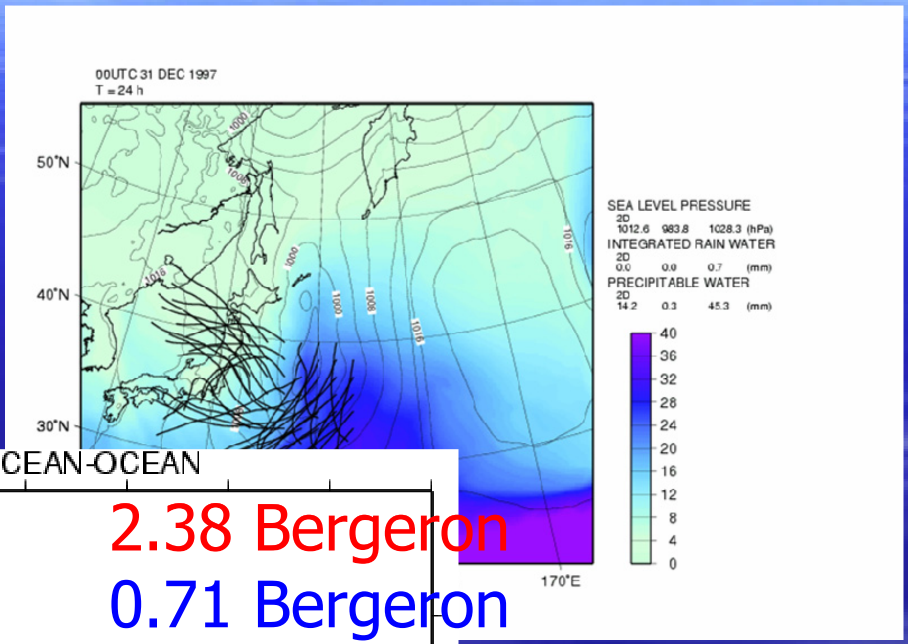


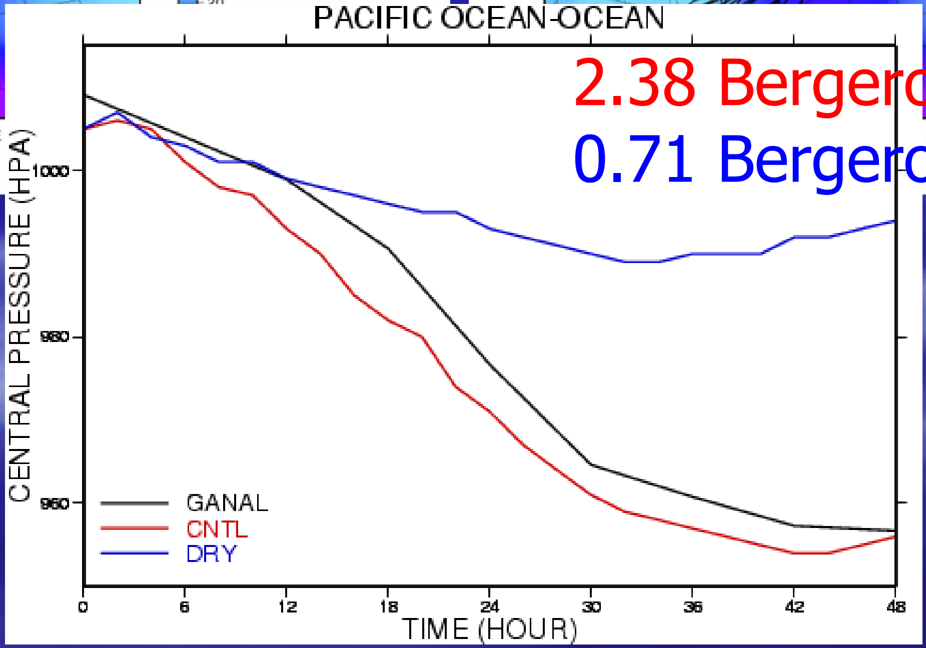
# PO-O case backward trajectory

CNTL




DRY



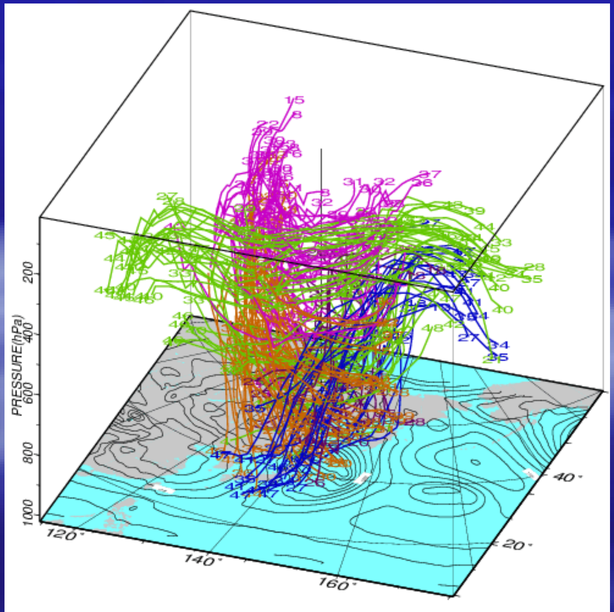




2.38 Bergeron

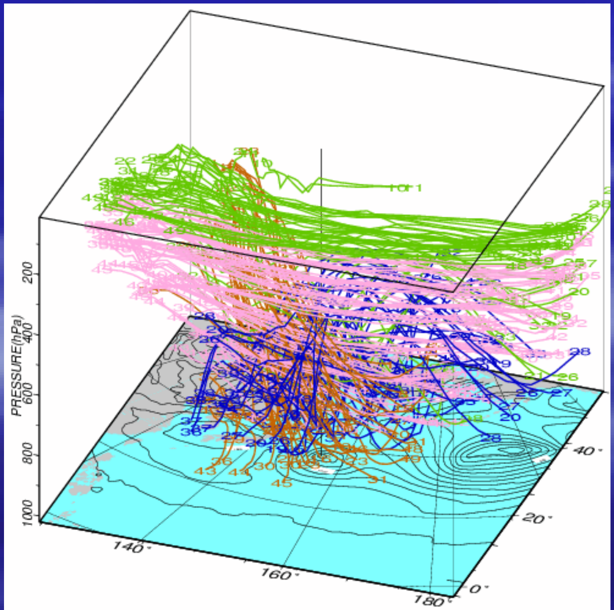
0.71 Bergeron

# Conclusions

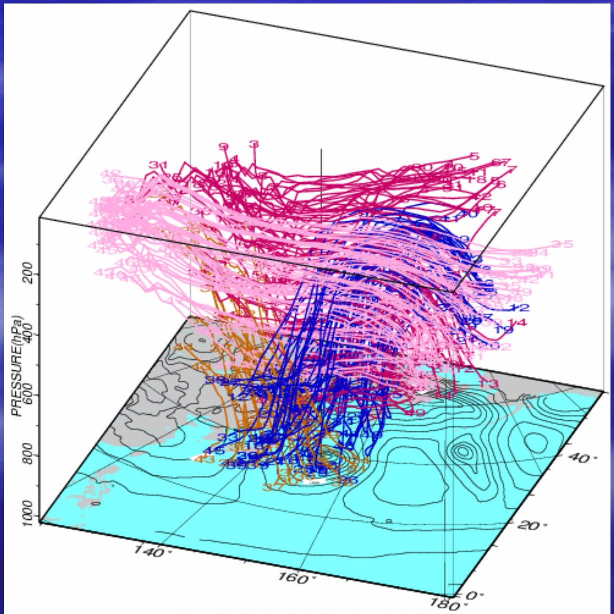
- For OJ and PO-L cases, latent heat release was not effective on development, while PO-O case was very sensitive to latent heat release.
- Water vapor distribution and upper jet characterized different cyclone structures and evolutions between three types.



OKHOTSK-JAPAN SEA



PACIFIC OCEAN-LAND



PACIFIC OCEAN-OCEAN