

Interaction between Extratropical Cyclone Activity and Sea Ice Distribution over the Sea of Okhotsk in Coupled Atmospheric-Ocean Simulations

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1. Introduction

- The Sea of Okhotsk is one of the southernmost seasonal sea-ice ocean in the Northern Hemisphere.
- In the northwestern Pacific region, synoptic-scale extratropical cyclones are active in winter, as called “storm track”.

1. Introduction

- Possible interaction between sea-ice and cyclone
 - Sea ice makes baroclinicity at lower level.
 - Cyclones develop over the baroclinic zone.
 - Sea ice is moved by wind associated with cyclones.
 - Sea ice blocks off sea surface heat flux which affects cyclogenesis.

2. Objective

- To clarify relation between sea ice over the Sea of Okhotsk and extratropical cyclone activity in the northwestern Pacific region.

3. CFES (Coupled Atmospheric-Ocean-Sea Ice model for the Earth Simulator)

- AGCM

- AFES (AGCM for the ES) based on CCSR/NIES AGCM 5.4.02

- OGCM

- OIFES (OGCM + Sea Ice model for the ES) based on MOM3 + IARC sea-ice model

Model configuration

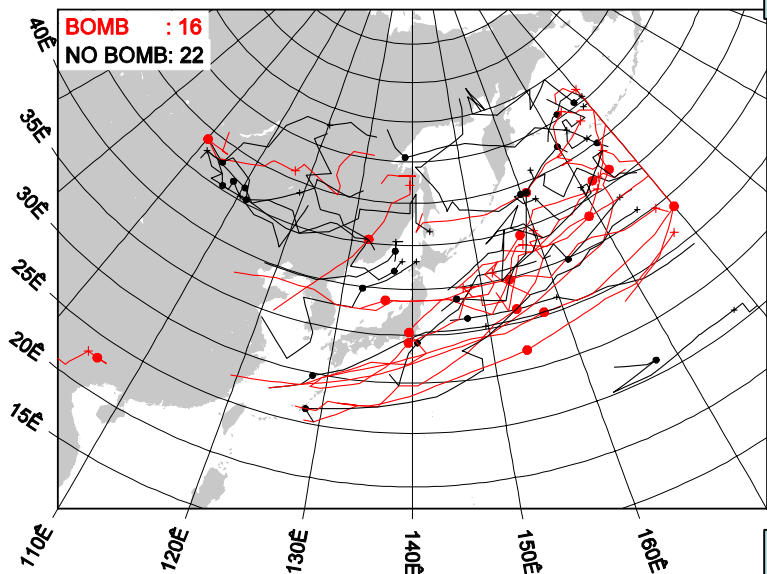
	AFES	OIFES
Horizontal resolution	T106 (about 1.125 degree) T239 (about 0.5 degree)	0.25 degree
Vertical resolution	48 levels	54 levels
Initial condition	Integrated data for 2 months from 00 UTC 1 Nov 1981 using ERA40	Temp. salinity : January climate data from World Ocean Atlas 98 Motion : no motion
Integrated term	5 and a half years (4 seasons from Jan–Mar 0002 to Jan-Mar 0005 are used)	

Analysis methods

- Cyclone activity
 - Cyclone tracking using the nearest neighbor method
 - Cyclone definition
 - a SLP minimum with 500 km radius
 - continued for 2 days and more
- Sea-ice activity
 - Sea-ice area
 - Change rate of sea-ice area (%/day)

Results: T106

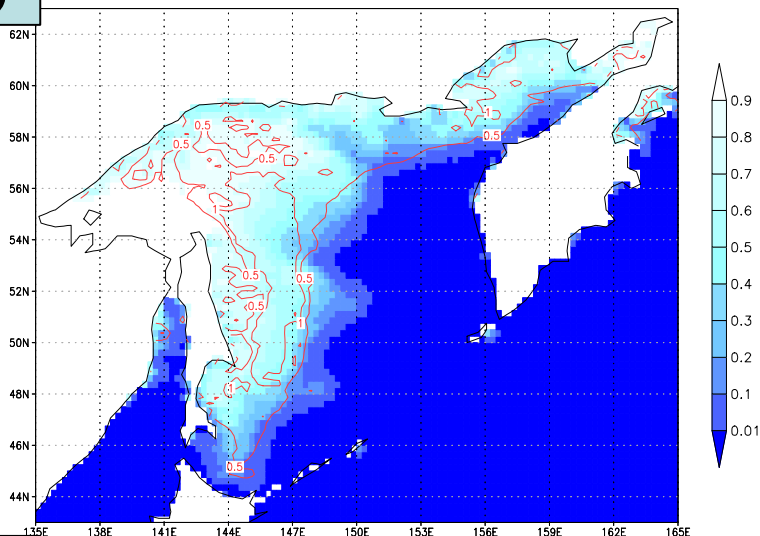
T106: 0002.01-03 : CYCLONE TRACK



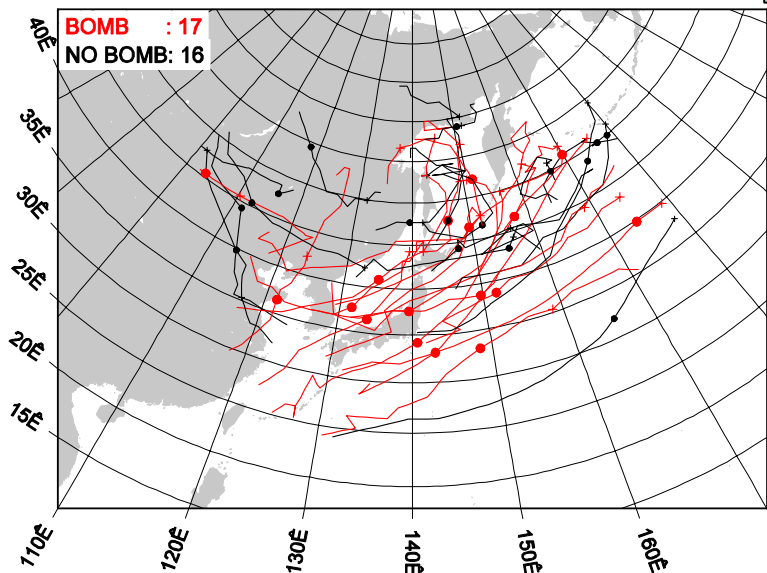
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2

SEA ICE FRACTION (COLOR), CHANGE RATE (%/DAY)
T106: 0z1JAN0002 - 18z31MAR0002



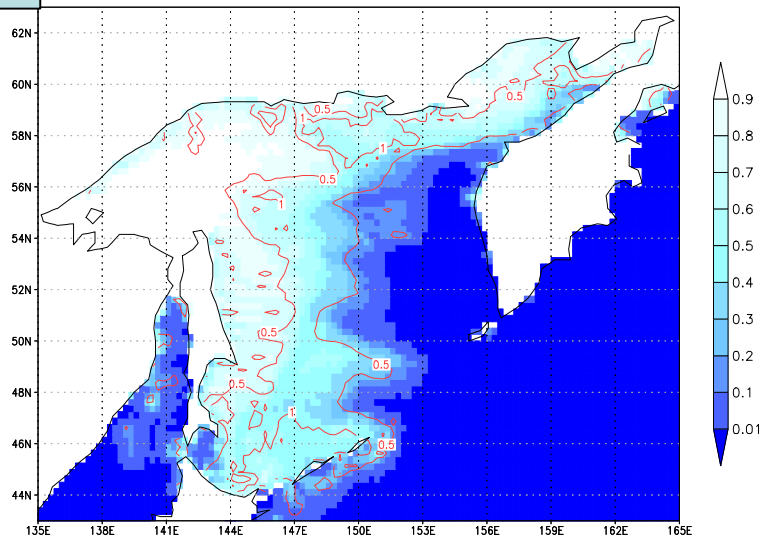
T106: 0004.01-03 : CYCLONE TRACK



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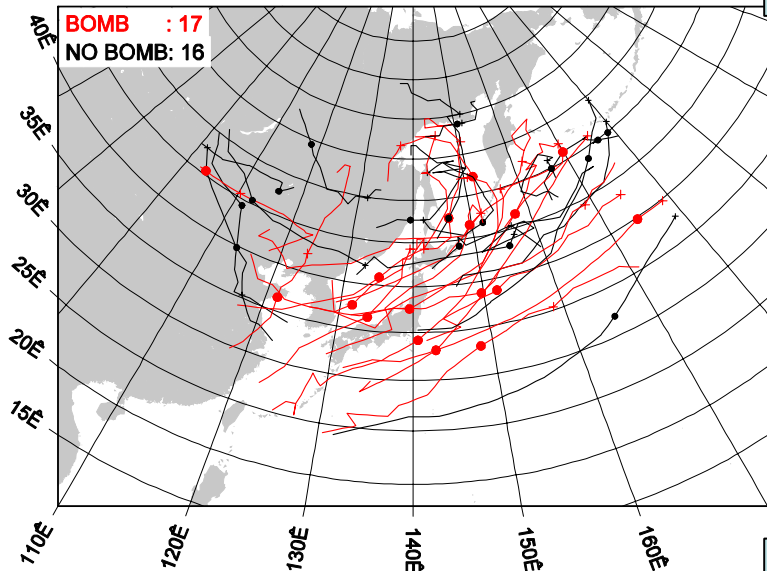
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SEA ICE FRACTION (COLOR), CHANGE RATE (%/DAY)
T106: 0z1JAN0003 - 18z31MAR0003



Results : T106

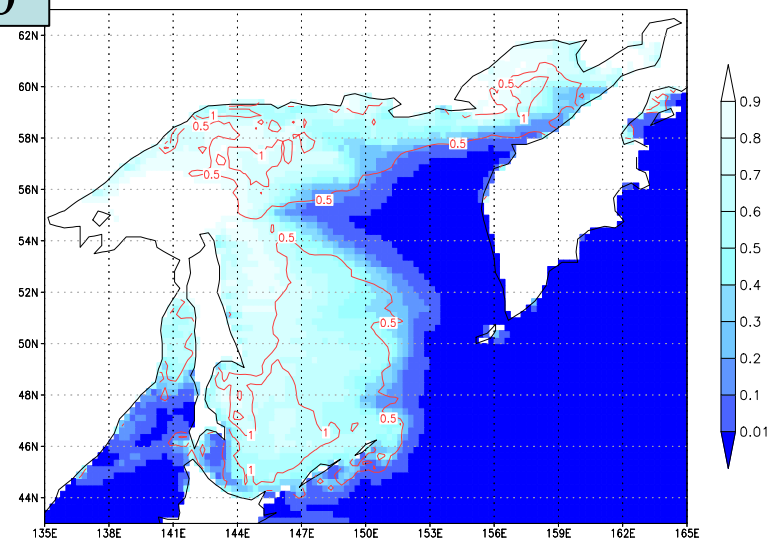
T106: 0004.01-03 : CYCLONE TRACK



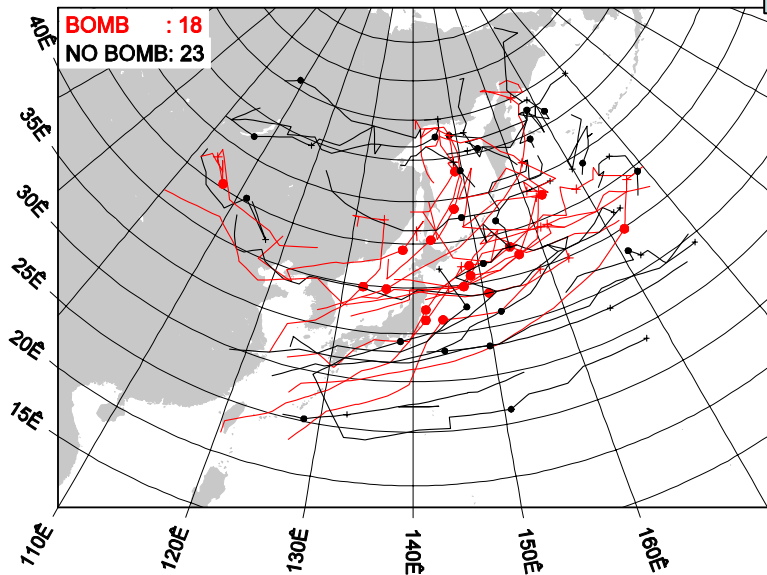
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4

SEA ICE FRACTION (COLOR), CHANGE RATE (%/DAY)
T106: 0z1JAN0004 - 18z31MAR0004



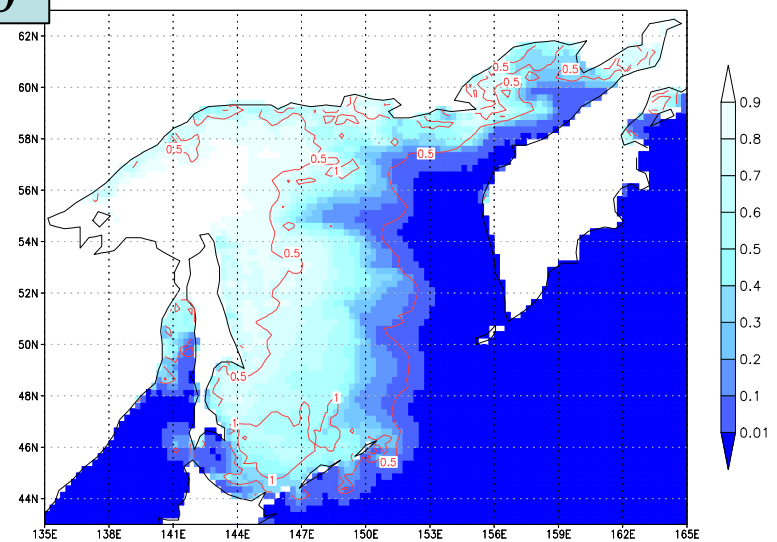
T106: 0005.01-03 : CYCLONE TRACK



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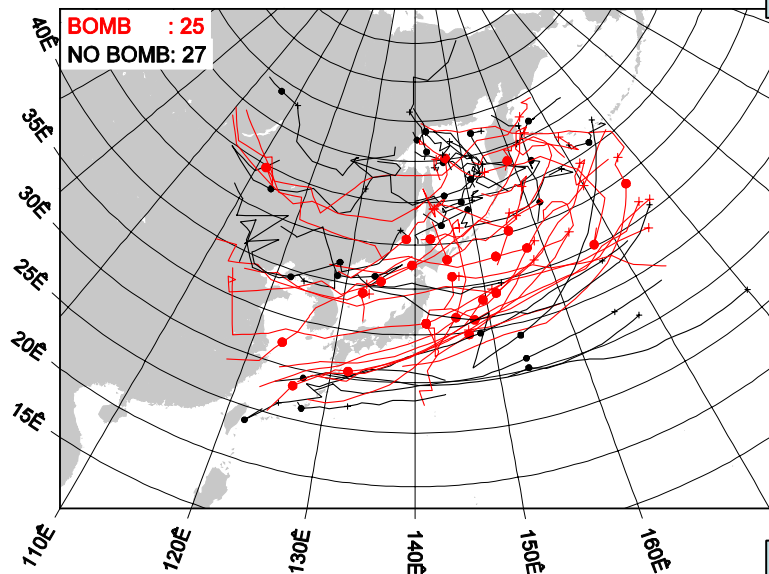
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SEA ICE FRACTION (COLOR), CHANGE RATE (%/DAY)
T106: 0z1JAN0005 - 18z31MAR0005



Results : T239

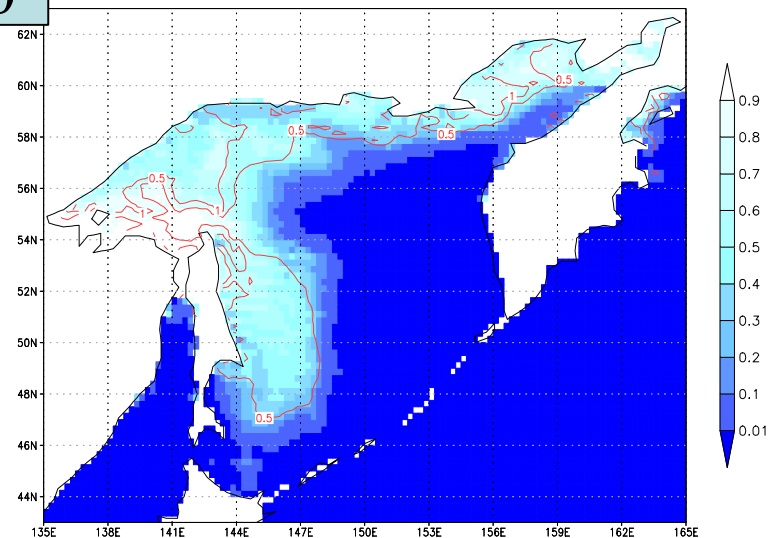
T239: 0002.01-03 : CYCLONE TRACK



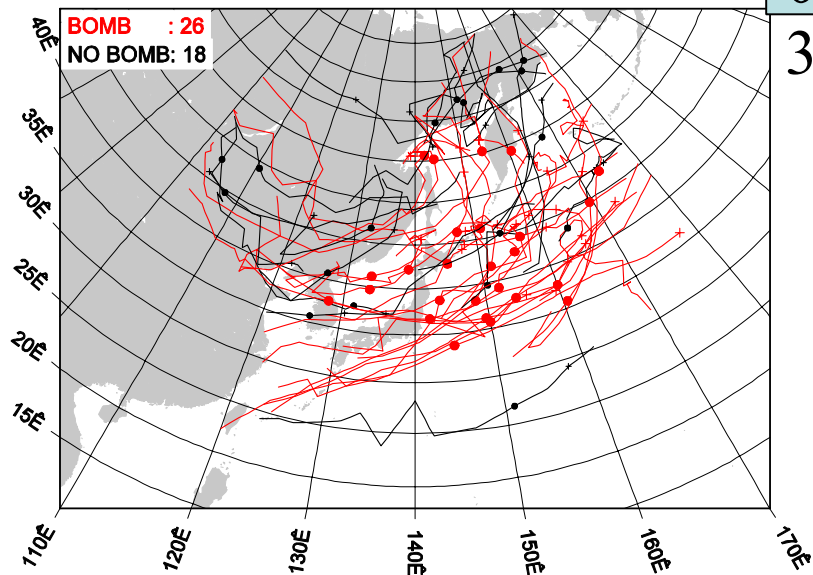
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2

SEA ICE FRACTION (COLOR), CHANGE RATE (%/DAY)
T239: 0z1JAN0002 - 18z31MAR0002



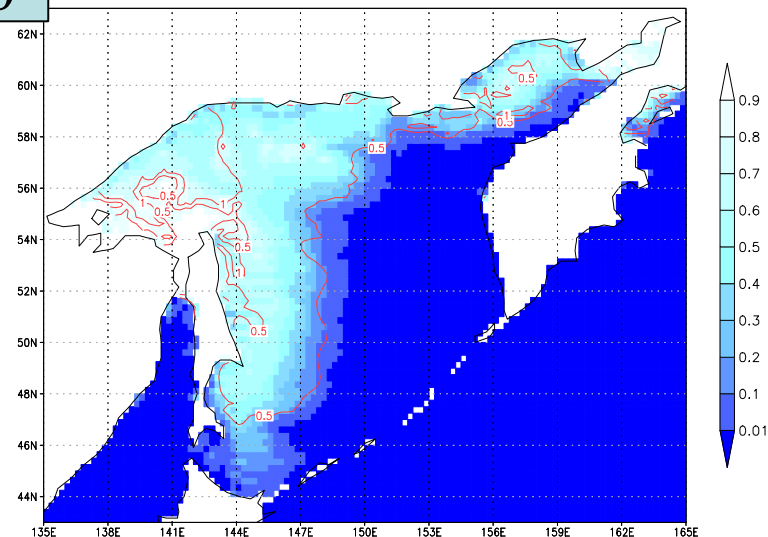
T239: 0003.01-03 : CYCLONE TRACK



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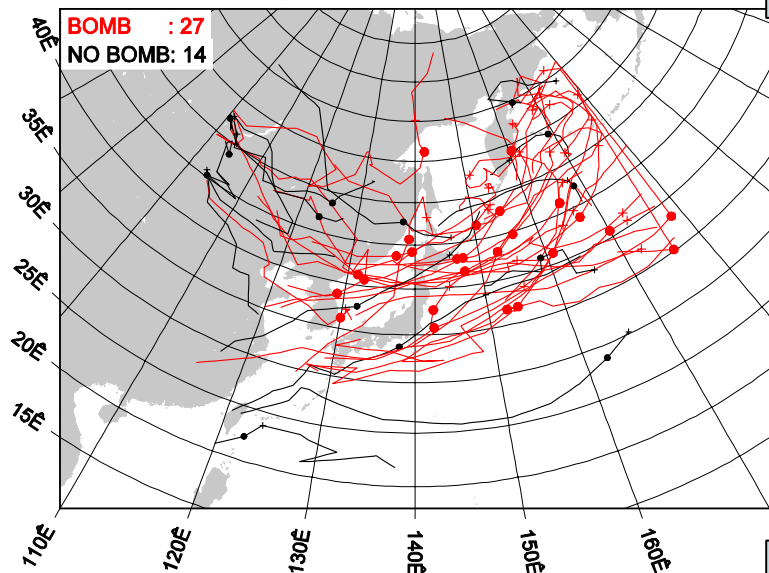
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SEA ICE FRACTION (COLOR), CHANGE RATE (%/DAY)
T239: 0z1JAN0003 - 18z31MAR0003



Results : T239

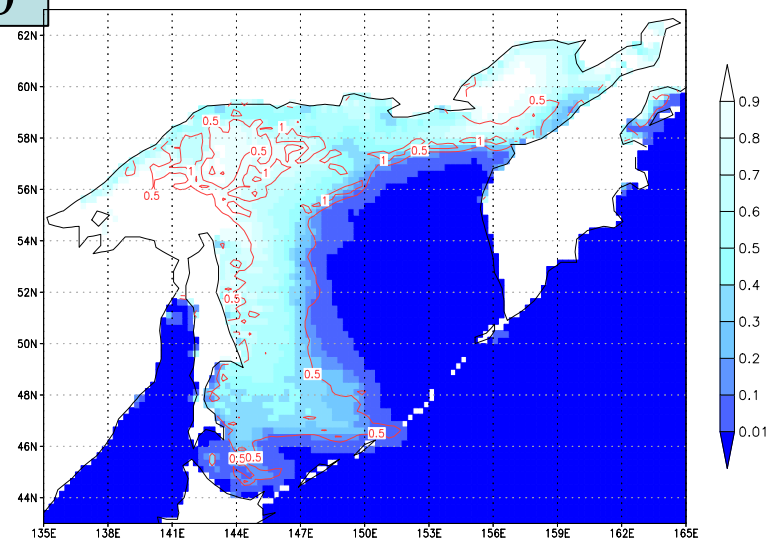
T239: 0004.01-03 : CYCLONE TRACK



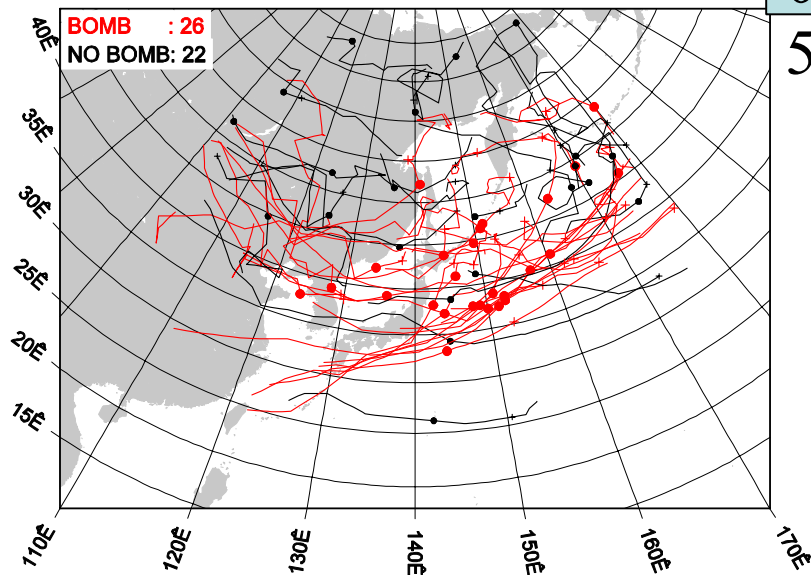
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4

SEA ICE FRACTION (COLOR), CHANGE RATE (%/DAY)
T239: 0z1JAN0004 - 18z31MAR0004



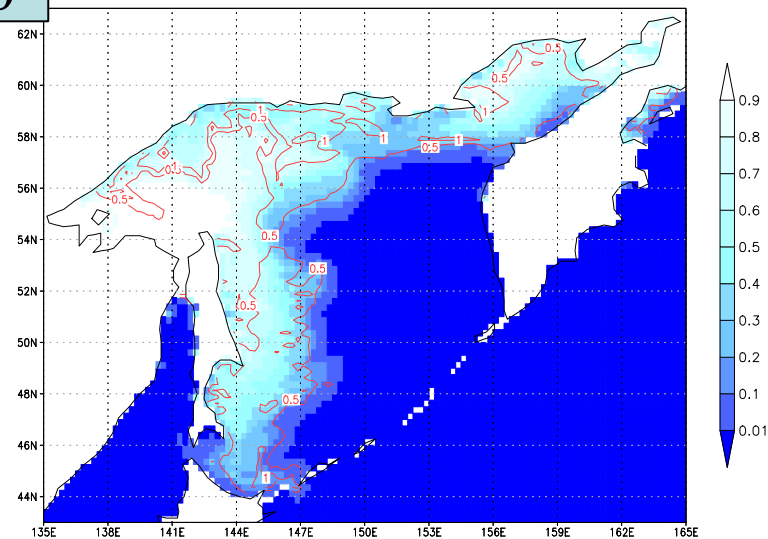
T239: 0005.01-03 : CYCLONE TRACK



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5

SEA ICE FRACTION (COLOR), CHANGE RATE (%/DAY)
T239: 0z1JAN0005 - 18z31MAR0005



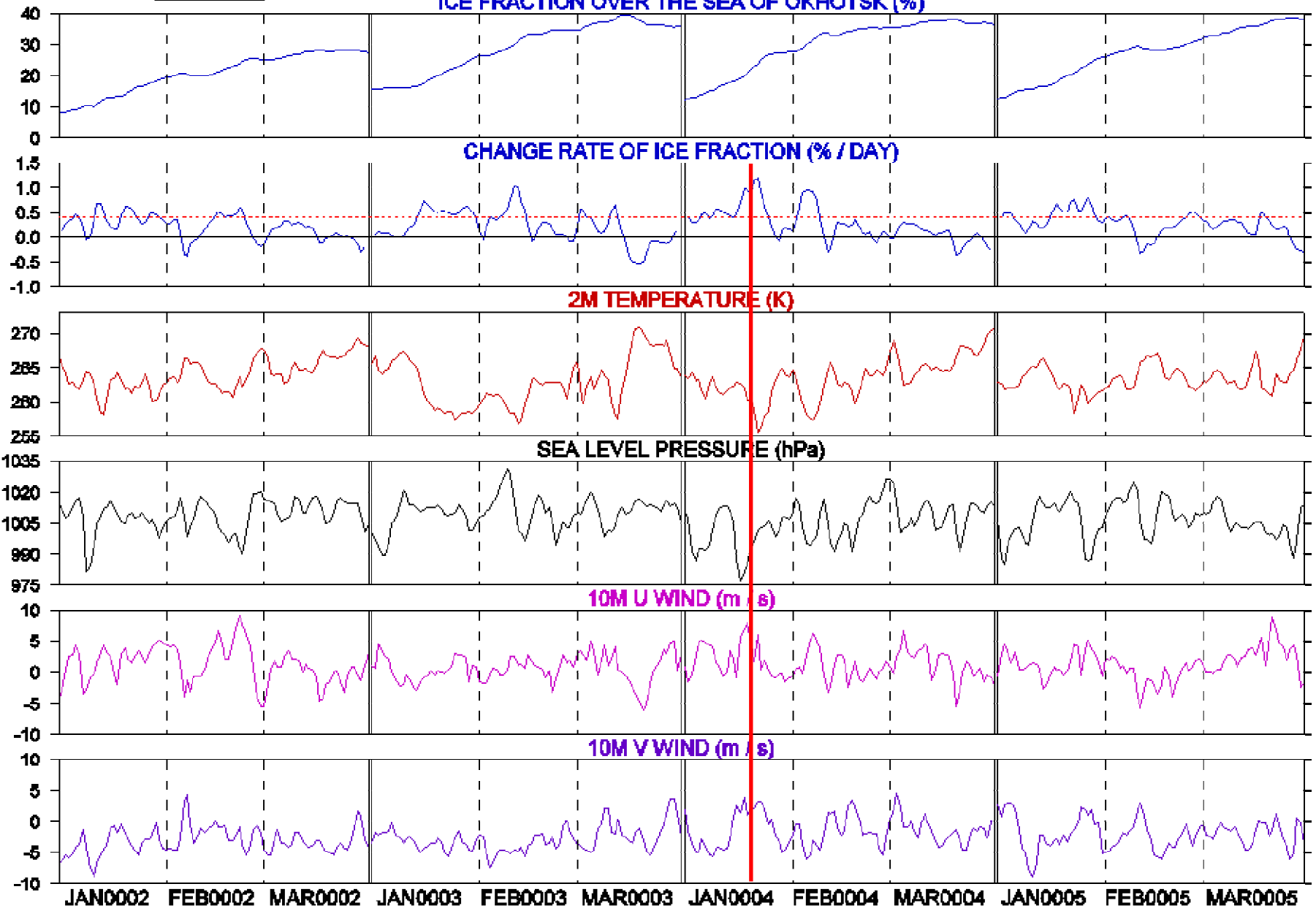
Summary (1)

- In T239 result, Rapidly developing cyclones over the northwestern Pacific Ocean appeared more frequently than T106.
- Sea-ice area for T239 were smaller than T106.
- Cyclone tracks may affect sea-ice extension.

Atmospheric environment

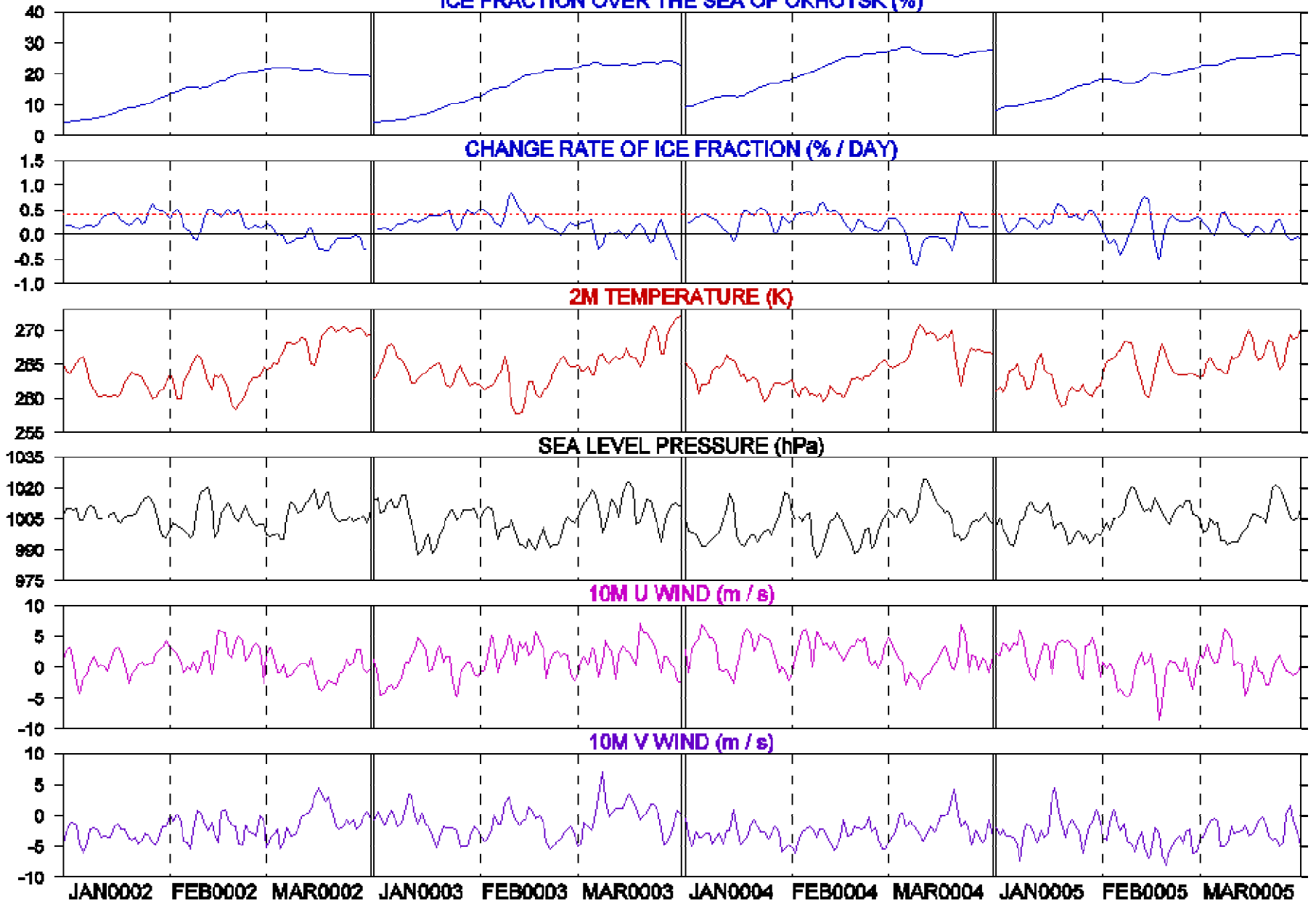
T106

TIME SERIES OF DAILY VARIABLES AVERAGED OVER THE SEA OF OKHOTSK
ICE FRACTION OVER THE SEA OF OKHOTSK (%)



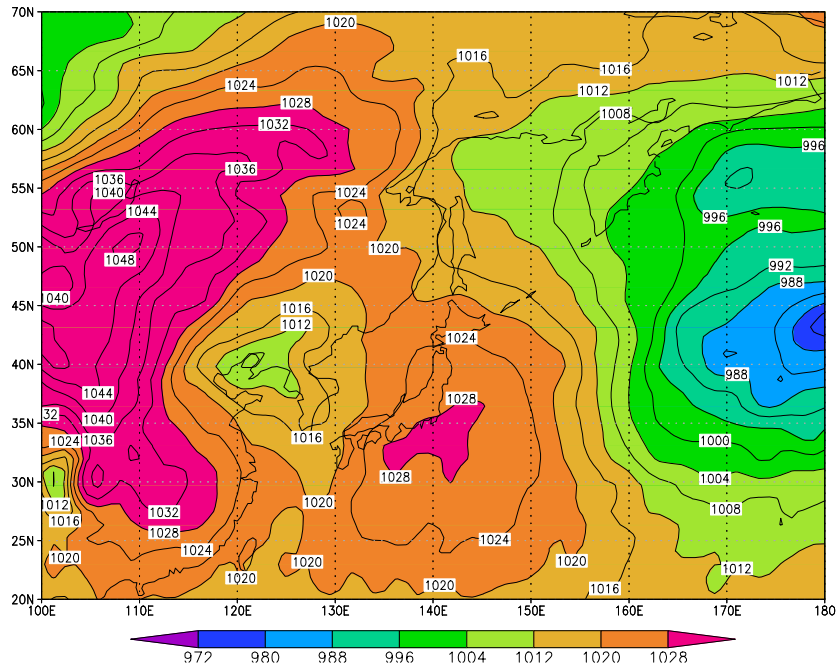
T239

TIME SERIES OF DAILY VARIABLES AVERAGED OVER THE SEA OF OKHOTSK
ICE FRACTION OVER THE SEA OF OKHOTSK (%)

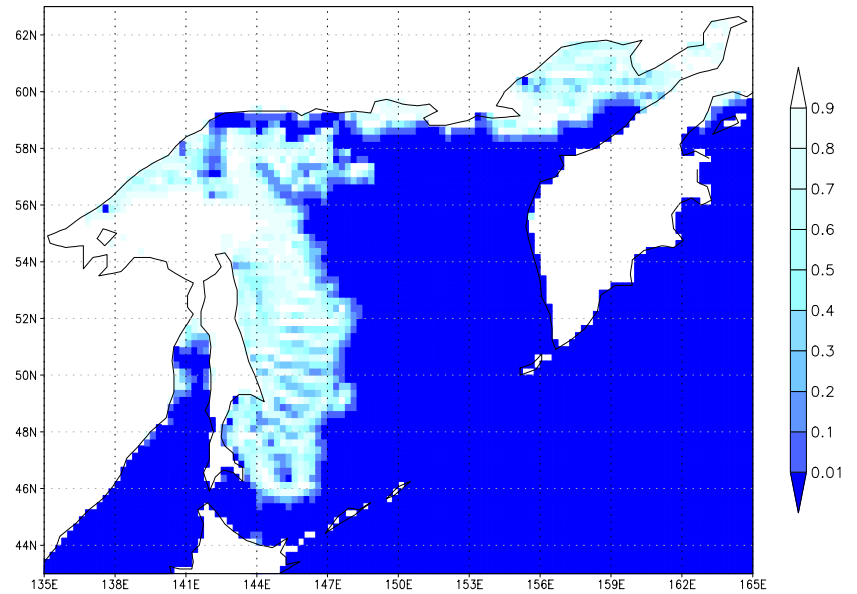


BOMB case: 0z14JAN0004

SLP T106 : 0Z14JAN0004

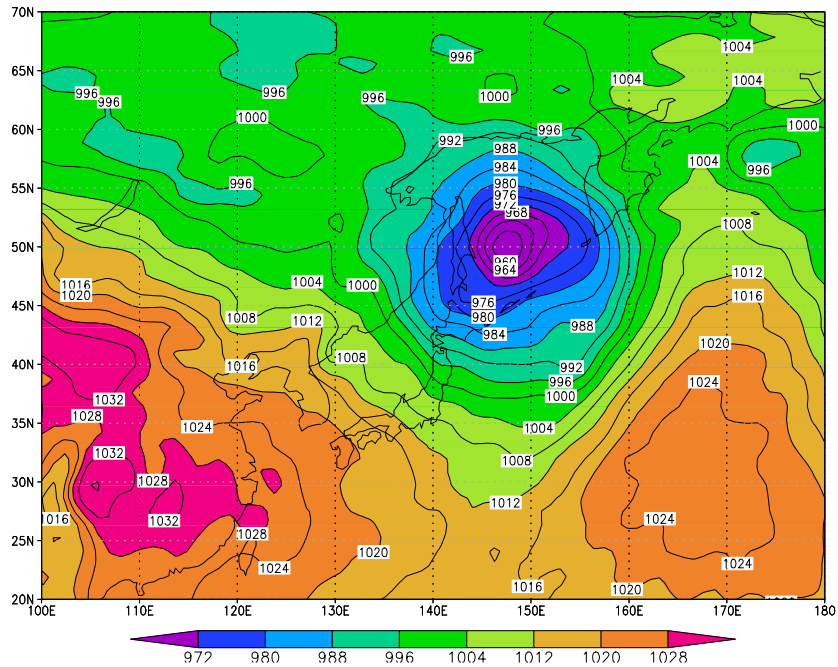


SEA ICE AREA T106 : 0z14JAN0004

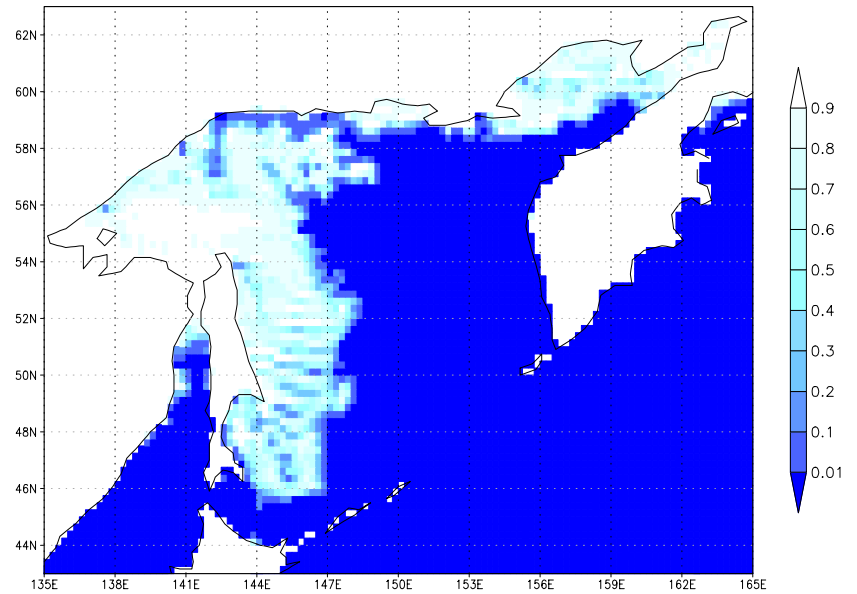


BOMB case: 0z16JAN0004

SLP T106 : 0Z16JAN0004

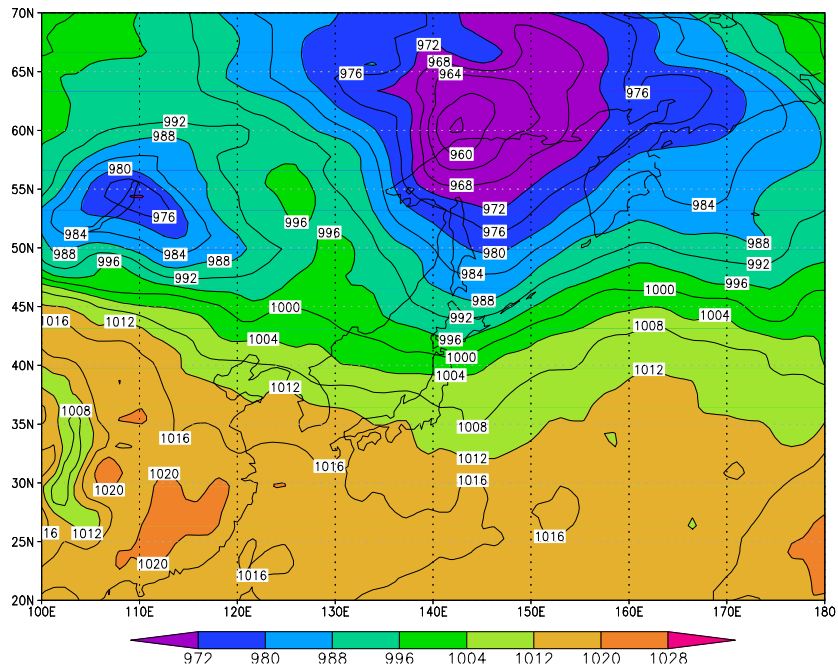


SEA ICE AREA T106 : 0z16JAN0004

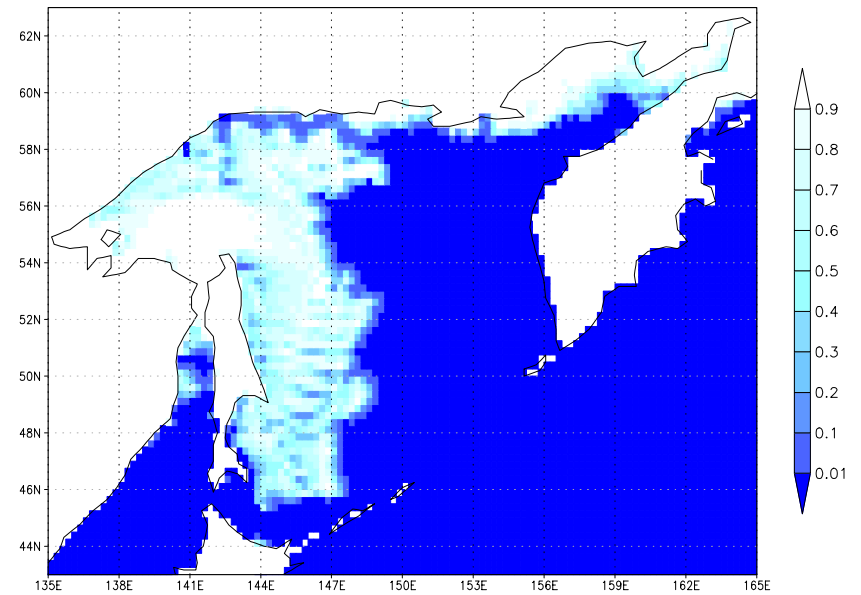


BOMB case: 0z18JAN0004

SLP T106 : 0Z18JAN0004

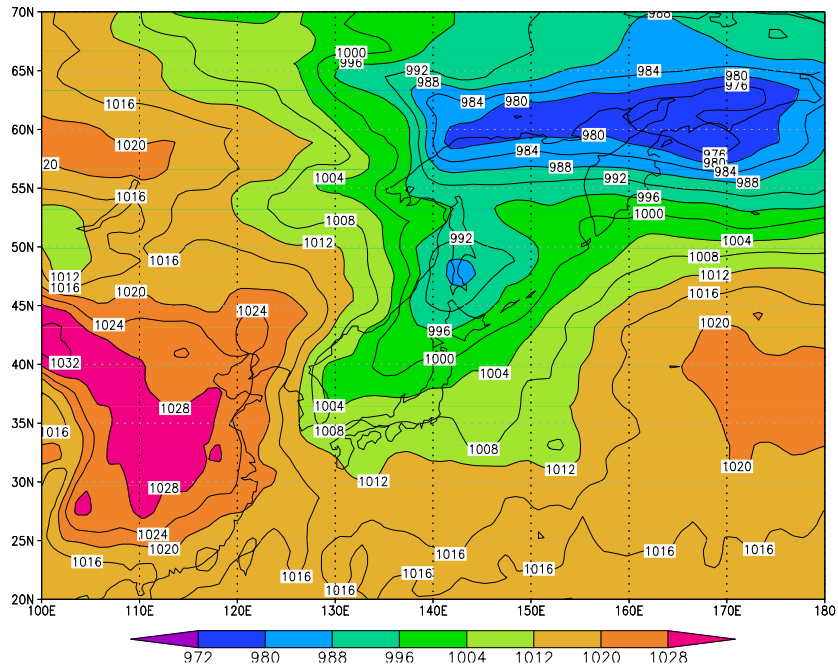


SEA ICE AREA T106 : 0z18JAN0004

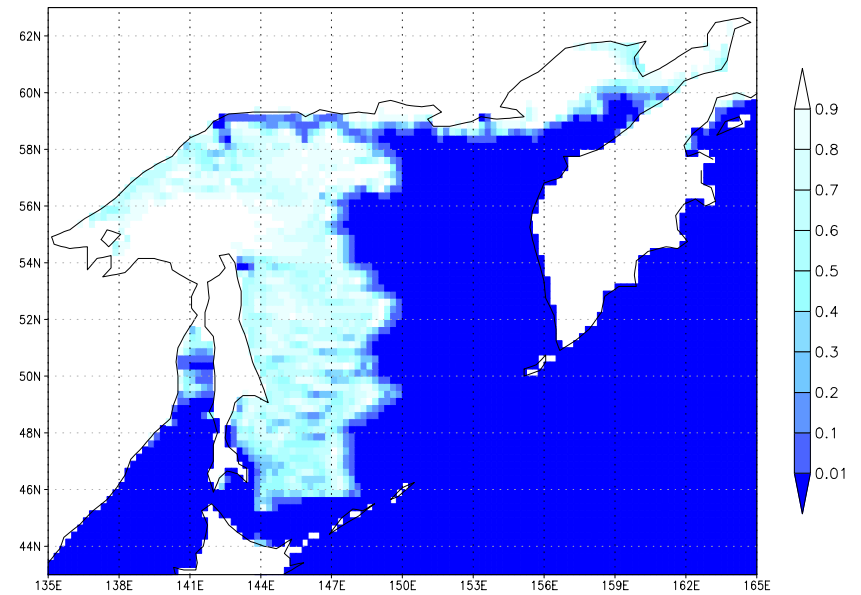


BOMB case: 0z20JAN0004

SLP T106 : 0Z20JAN0004



SEA ICE AREA T106 : 0z20JAN0004



Composite analysis

- Rapid extension of sea-ice is defined as follows;

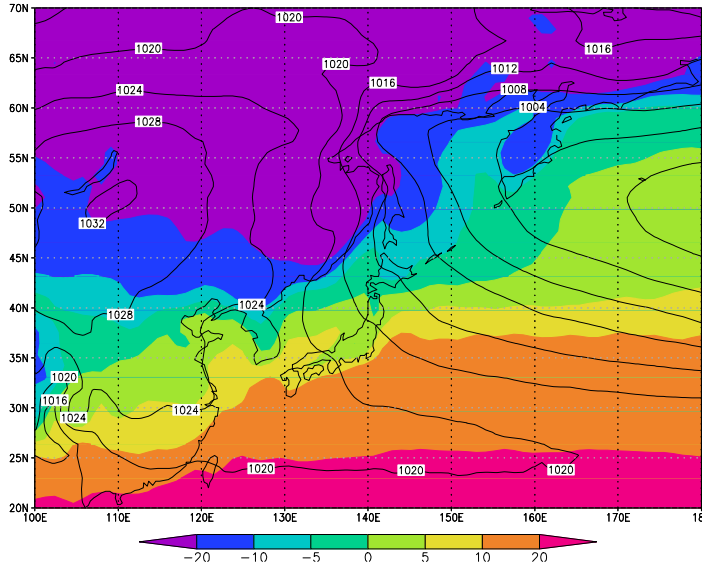
Change rate of sea-ice area > 0.4 %/day

- Composite for rapid extension and Anomaly from 4 winter seasons (Jan, Feb, Mar) are analyzed.

2 m temperature, SLP

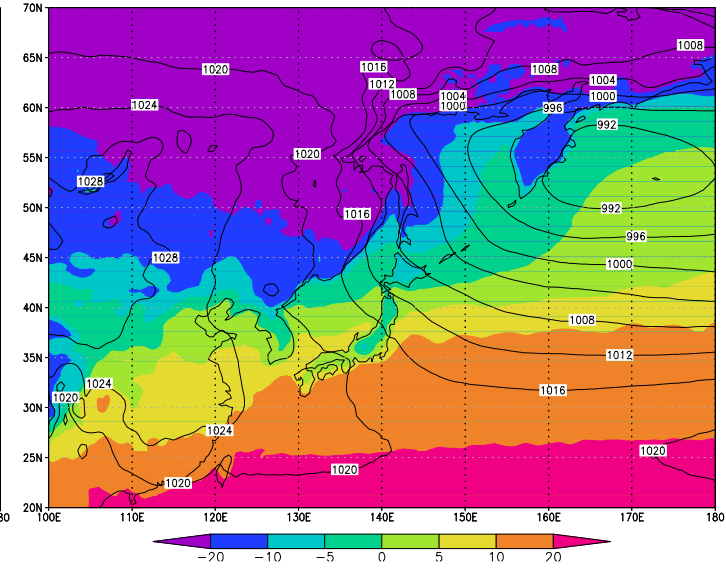
T106

T106: T2, SLP COMPOSITE

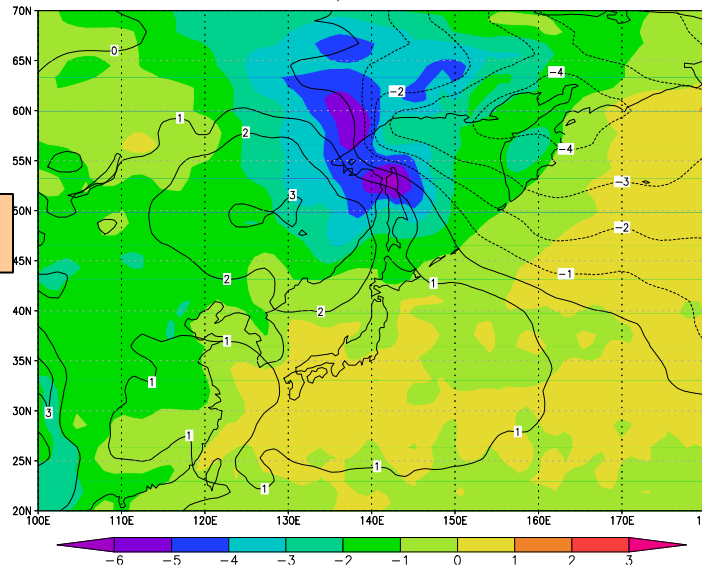


T239

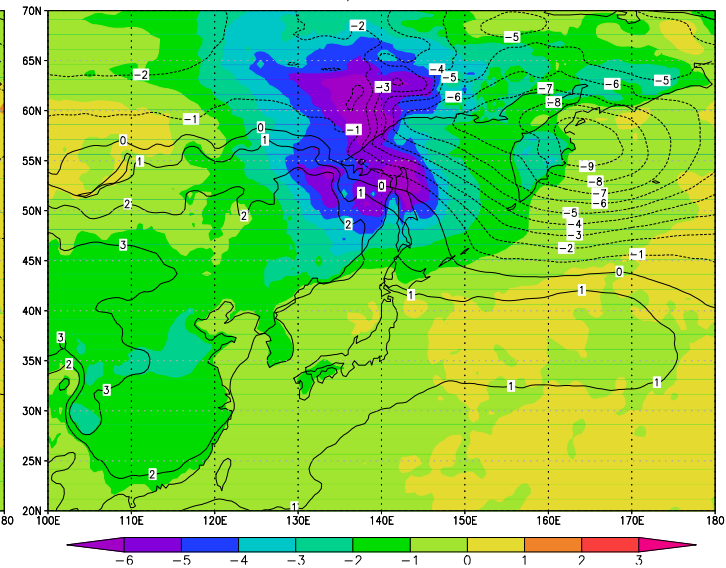
T239: T2, SLP COMPOSITE



T106: T2, SLP ANOMALY



T239: T2, SLP ANOMALY



COMP

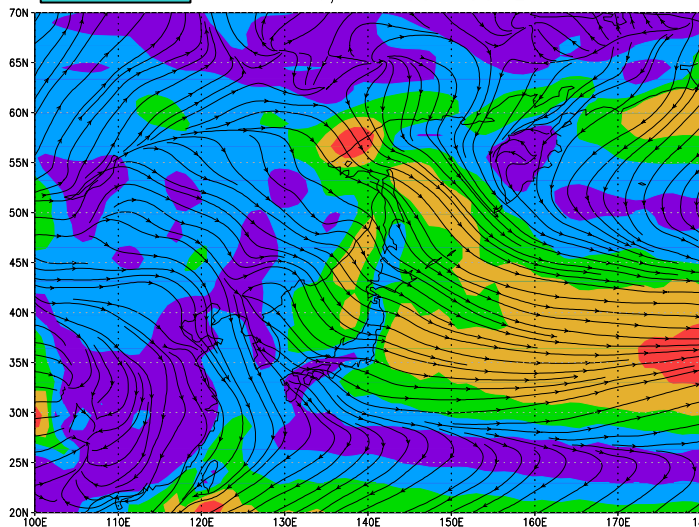
ANOMALY

10 m wind (stream line, speed)

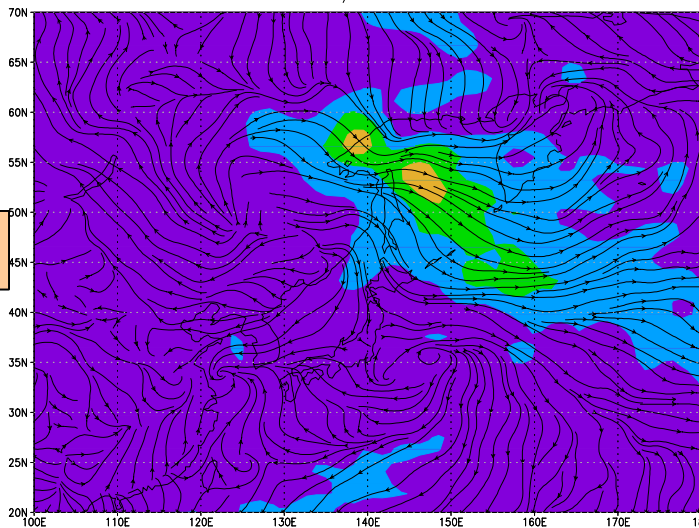
COMP

T106

T106: U10, V10 COMPOSITE

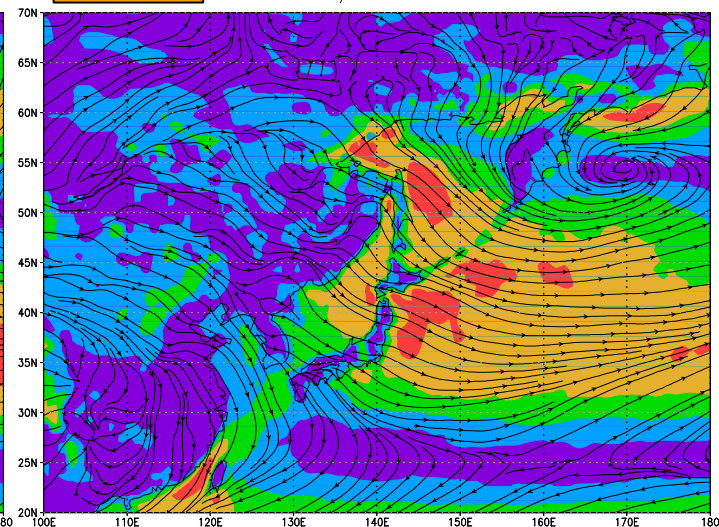


T106: U10, V10 ANOMALY

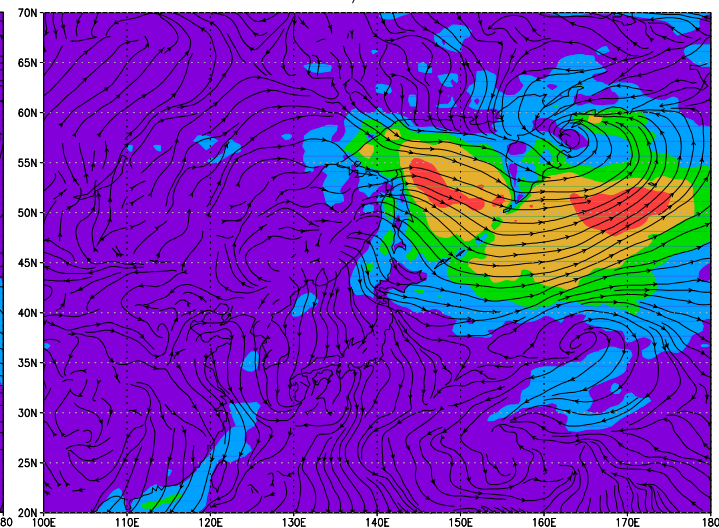


T239

T239: U10, V10 COMPOSITE



T239: U10, V10 ANOMALY



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Summary

- The Aleutian low in T239 deepened when sea ice rapidly extended.
- After a “BOMB” cyclone passed over the Sea of Okhotsk, sea-ice rapidly extended.
- Rapidly developing cyclone over the northwestern Pacific Ocean may affect depth of the Aleutian low.

Future works

- Comparison with observation
- Does sea ice affect cyclone activity?
- Why were cyclone tracks different between T106 and T239?