7th Jul. 2004

Diurnal cycle of cloud system migration over Sumatera Island

Namiko SAKURAI[1], Fumie MURATA[4], Manabu D. YAMANAKA[1,3], Hiroyuki HASHIGUCHI[2], Shuichi MORI[3], HAMADA Jun-Ichi[3], Yudi I. Tauhid[5], Tien Sribimawati[5], Budi Suhardi[6]

1: Graduate School of Science and Technology, Kobe University,
2: Research Institute for Sustainable Humanosphere, Kyoto University,
3: Frontier Observation Research System for Global Change,
4: Research Institute for Assessment and Application of Technology,
5: Agency for the Assessment and Application of Technology,
6: Indonesia Meteorological and Geophysical Agency

sakurai@ahs.scitec.kobe-u.ac.jp

At Jambi

Introduction

・The convective activity in the tropical area plays an important role on the global transport of water vapor and energy, hence on the climate.

・Diurnal cycle is dominant over the land in the tropics, especially Indonesian maritime continent.

・Diurnal cycle of convective activity has several patterns.

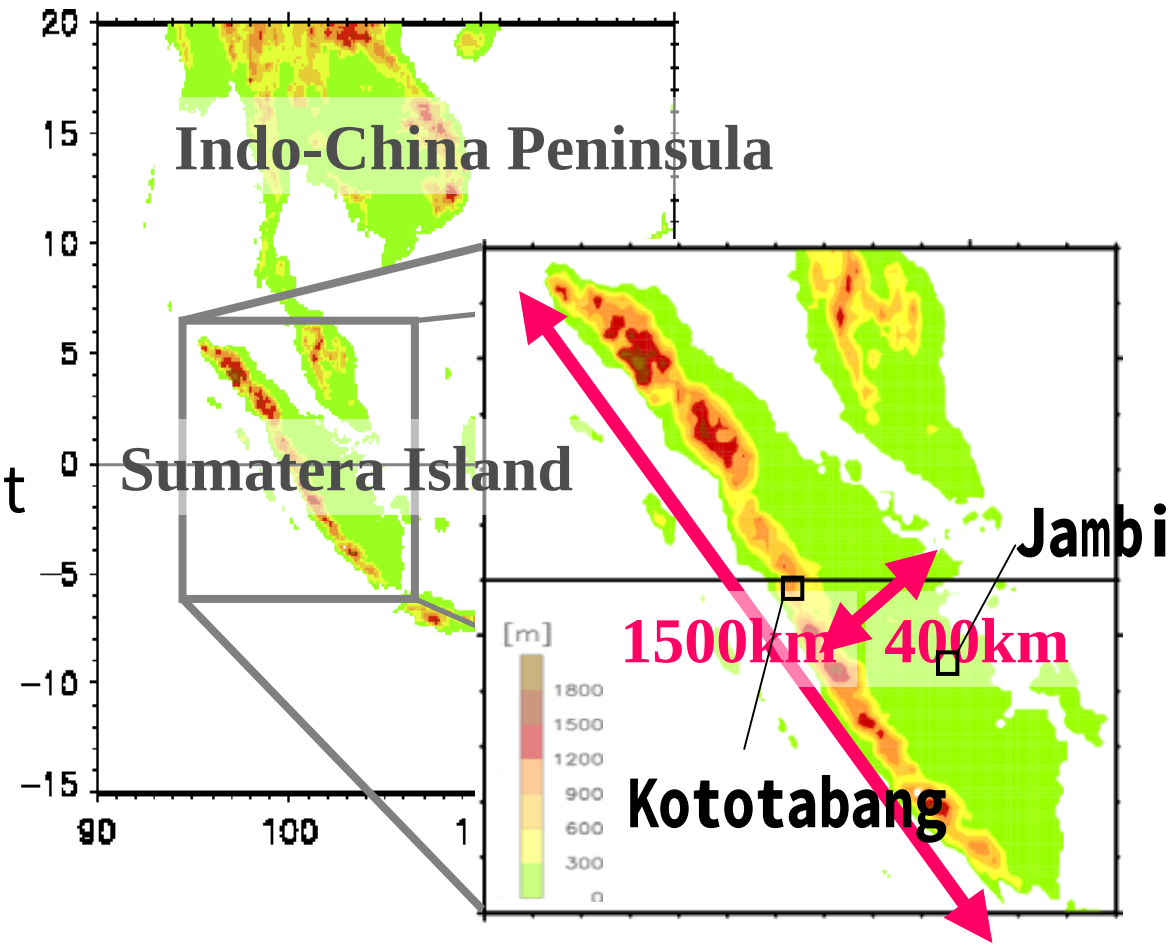


Fig.1 Geographical map Sumatera Island

Object

We focus on one diurnal cycle that convection gets active in the mountainous area, migrating westward and/or eastward during night over Sumatera Island, and show the features;

seasonal variation

and

the relationships with larger scale phenomena.

Data

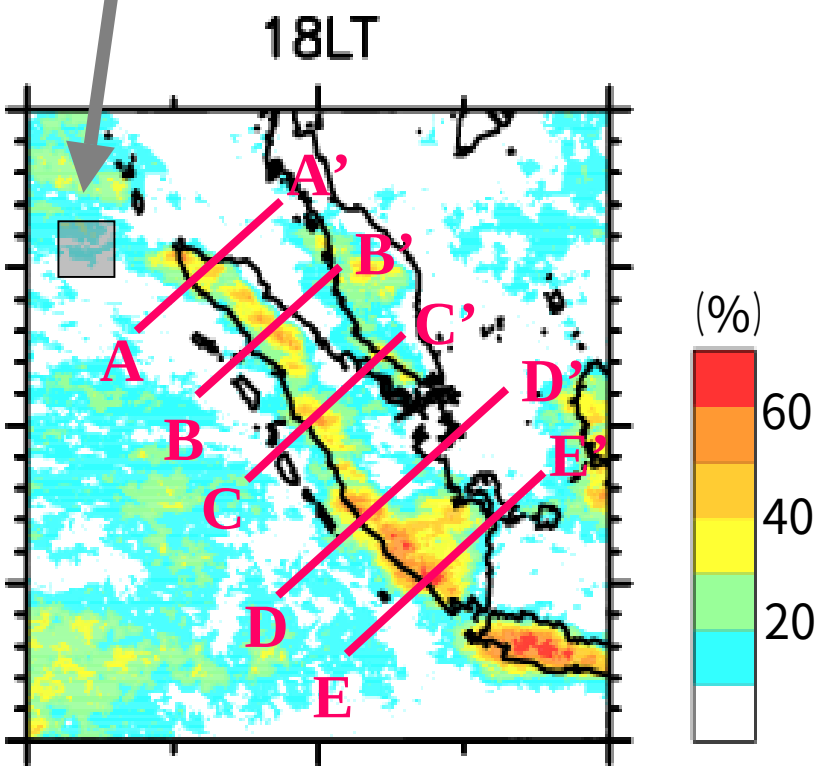
analysis period

	GMS IR1	NCEP/NCAR	rawinsonde
2001May			
Jun			
Jul			
Aug			
Sep			
Oct			
Nov			
Dec			
2002Jan			
Feb			
Mar			
Apr			
time resolution(hr)	1	6	6
spatisl resolution(°)	0.05 °	2.5 °	
station			Kototabang/Jambi

Analysis methods

$$\alpha = \frac{(\text{The number of } T_{BB} \ (<230\text{K}))}{(\text{Total number of data for analysis period})} \times 100$$

Correspondence to the temperature at about 11km.

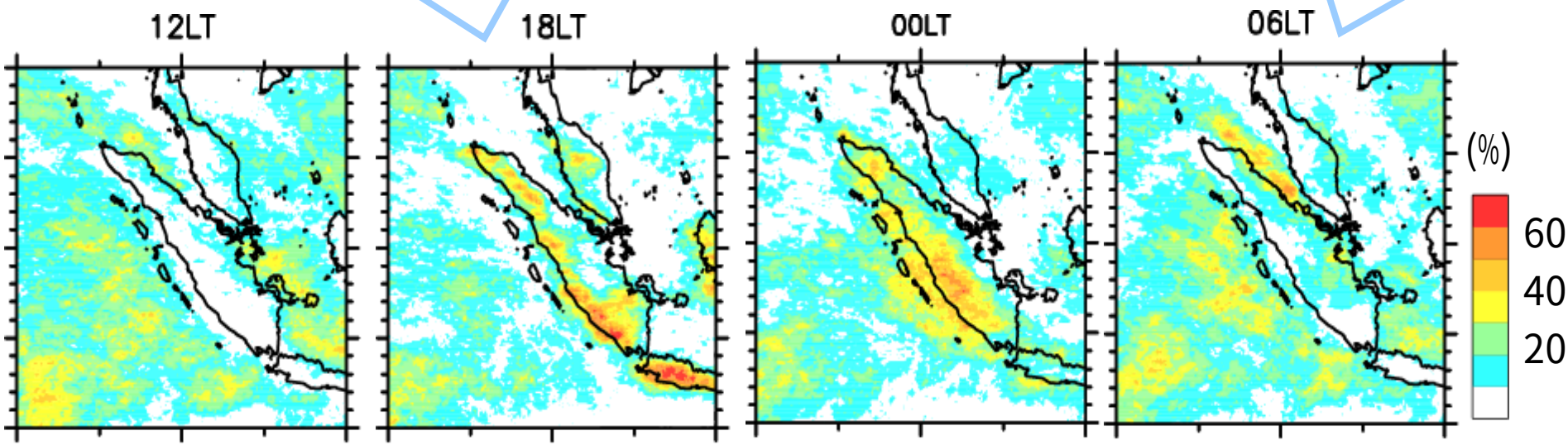


- Define the threshold value as 230 K
- Define α, and calculate it from May 2001 to April 2002.
- Make time series of α in 5 areas (A-A' ～E-E') to investigate regional characteristics.
- Separate results of time series of α into 3 types
  (W: South-Westward,
  WE: Both south-Westward and north-Eastward,
  E: North-Eastward)

Result1: Diurnal cycle of cloud system migration observed in November 2001

Tall cloud systems are concentrated in the western part of Sumatera Island.

Cloud systems are over the seas off the both coastlines.



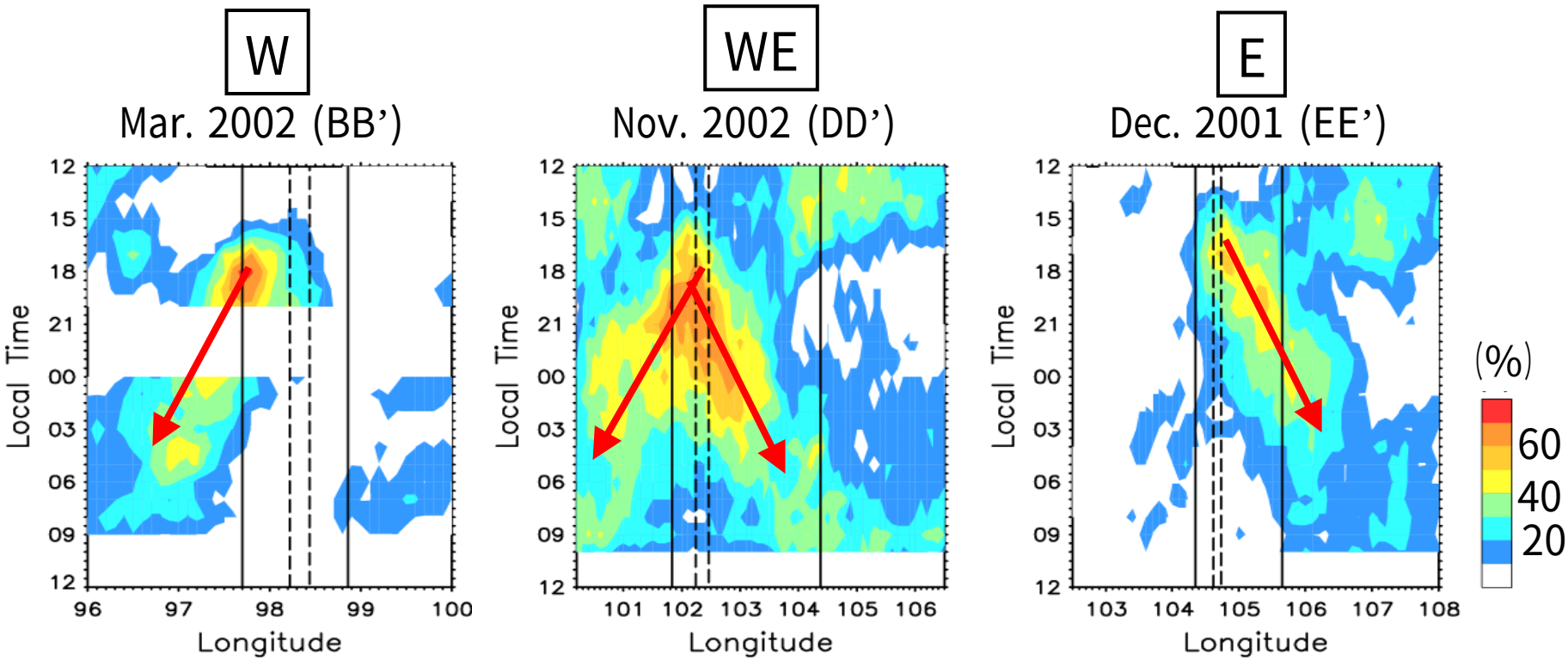
Cloud systems separate and migrate both westward and eastward.

Migratory velocity: 3-10 m/s.
Migratory distance: 140-400 km.

Fig.1 Horizontal distribution of occurrence frequency α in November 2001

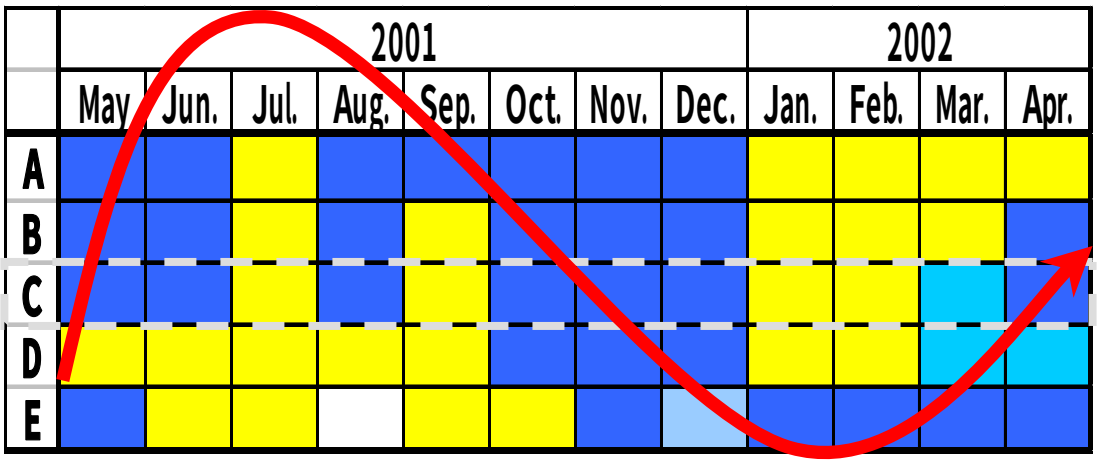
Result2: Seasonal variation

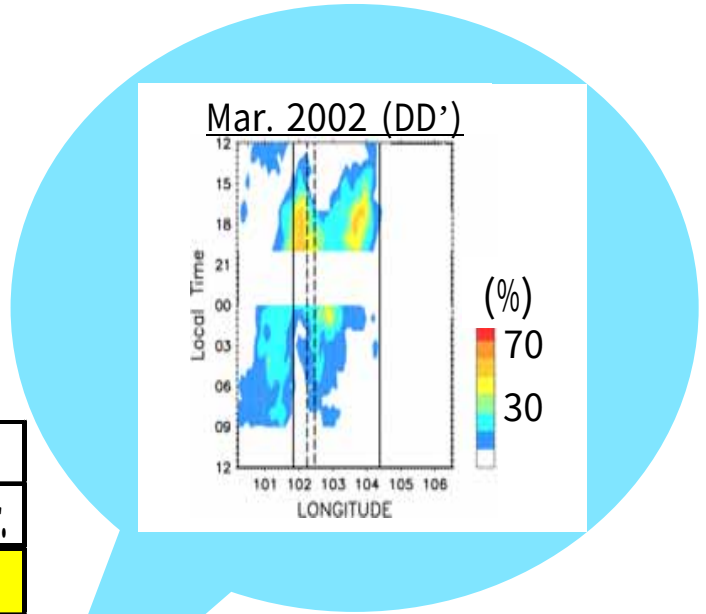
Typical patterns of migratory direction of cloud systems (α)



Diurnal cycle of cloud system migration has 3 patterns, southwestward(W), both southwestward and northeastward(WE), northeastward(E).

Seasonal variation of migratory direction of cloud systems





●: south-Westward, ●: north-Eastward, ●: both,
●: both but north-eastward migration does not reach the eastern coast.

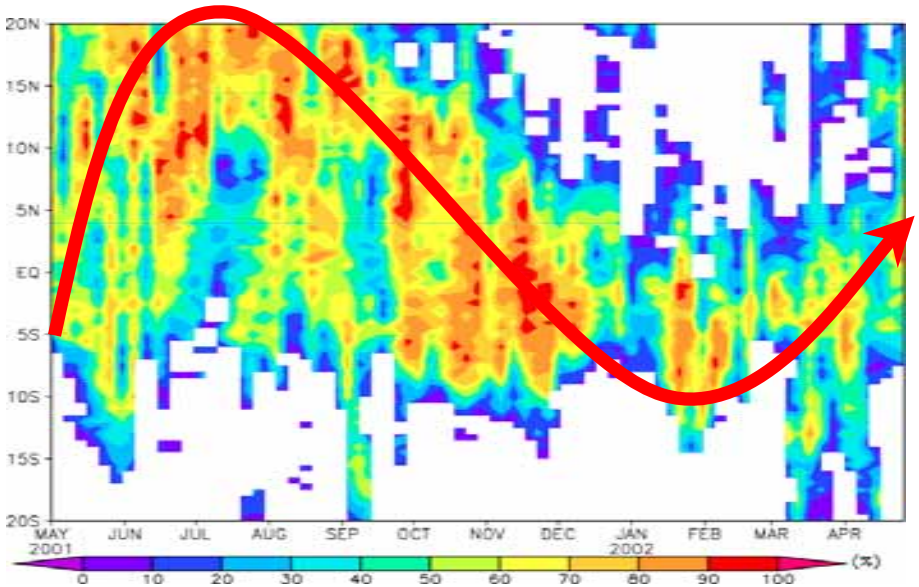
W: No seasonal change(●, ●)
E: Oscillation northward and southward with an annual cycle.(●, ●, ●)

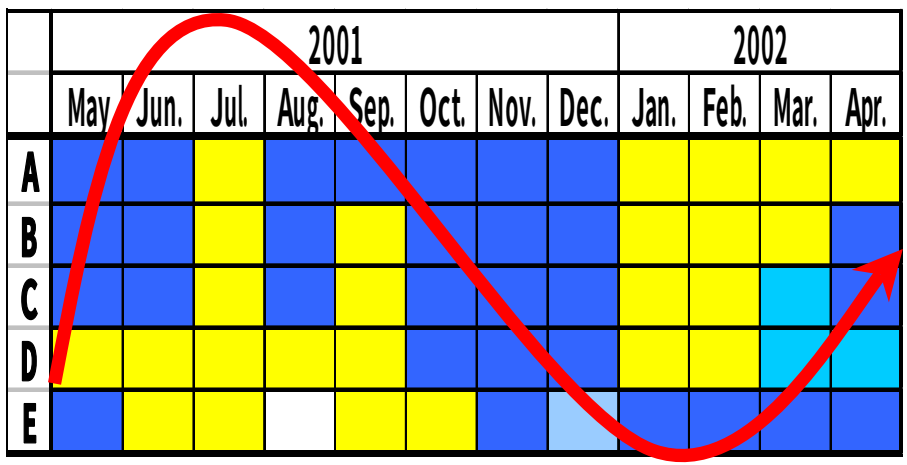
Result3: Comparison with large scale phenomena

ITCZ

Fig.5 ITCZ at 100 ° E.
Occurrence frequency of T_{BB} which less than 270K for every 5 days.

Northeastward migrations appear in/near ITCZ.



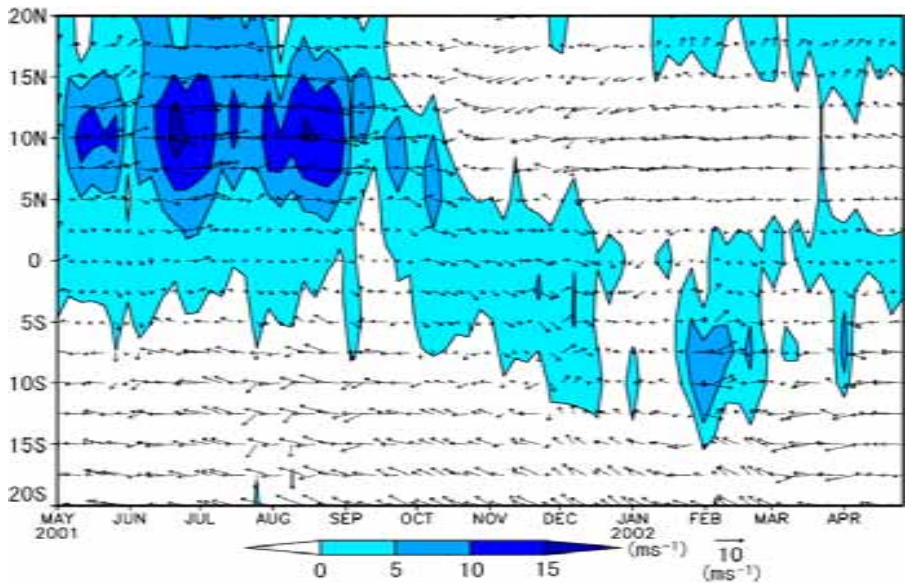


Background wind
- 1 -

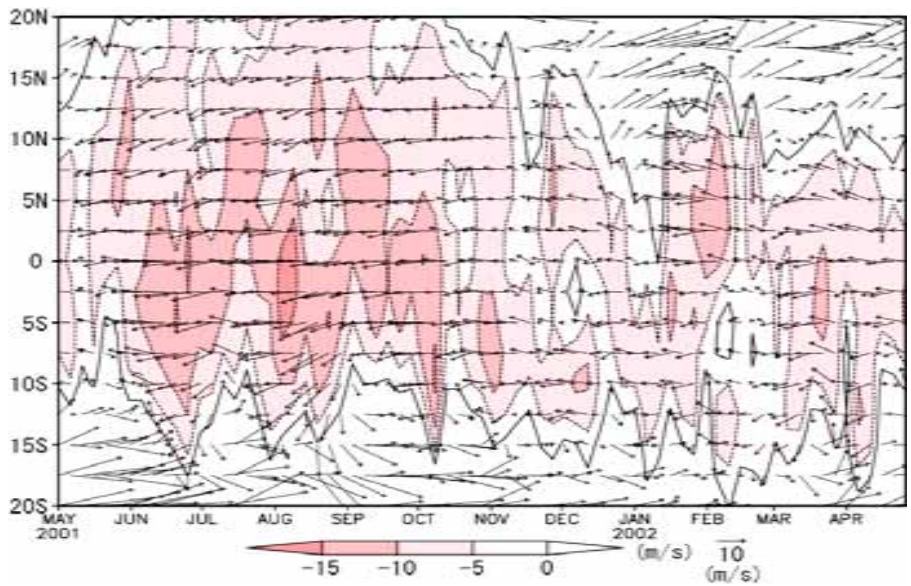
Fig.6 Seasonal variation of horizontal wind at 100 ° E.

	in ITCZ	out ITCZ
lower troposphere	westerly	easterly/weak westerly
upper troposphere	easterly	

850hPa

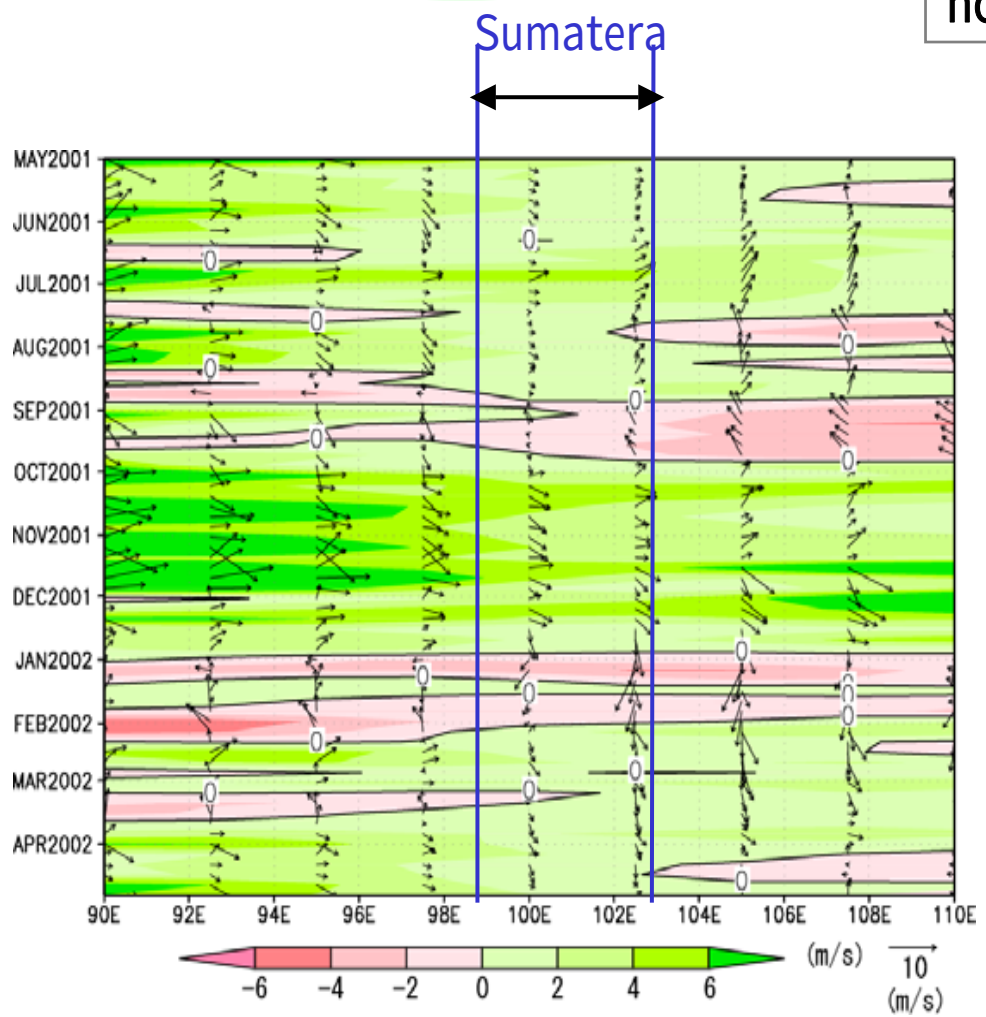


300hPa



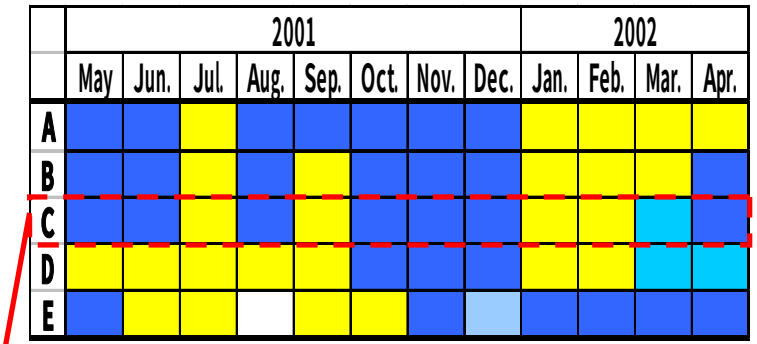
Back ground wind -2-

Relationship between zonal wind direction in the lower troposphere and northeastward migratory direction



(W:south-Westward, E：north-Eastward)

WE
WE
W
WE
W
WE
WE
WE
W
W
W (E)
WE



South-Westward migration (Sep. and Jan.)
→ Easterly wind

North-Eastward migration appears frequently (Oct.-Dec.)
→ Strong westerly wind

Fig.7 Time-longitude cross-section of seasonal variation of horizontal wind at 850 hPa on the equator.

Back ground wind -3-

Relationship between zonal wind speed in the lower troposphere and occurrence of northeastward migration

・E appears when easterly wind more than 1 m/s blows.
・The stronger westerly wind blows, the farther cloud systems migrate eastward.
・Diurnal cycle of cloud system migration is not dominant when strong zonal wind blows (> -3, < 8(m/s))(figure not shown).

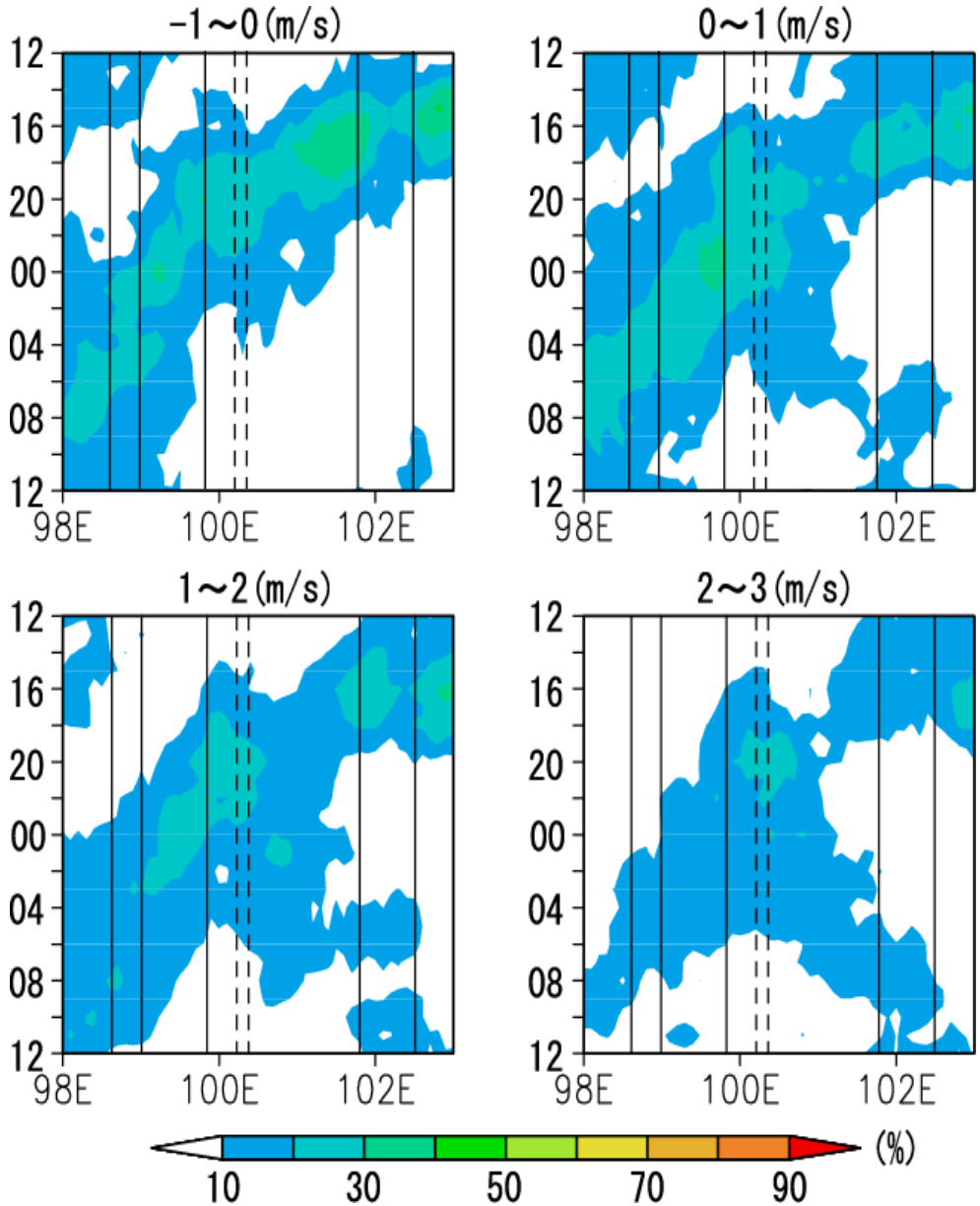
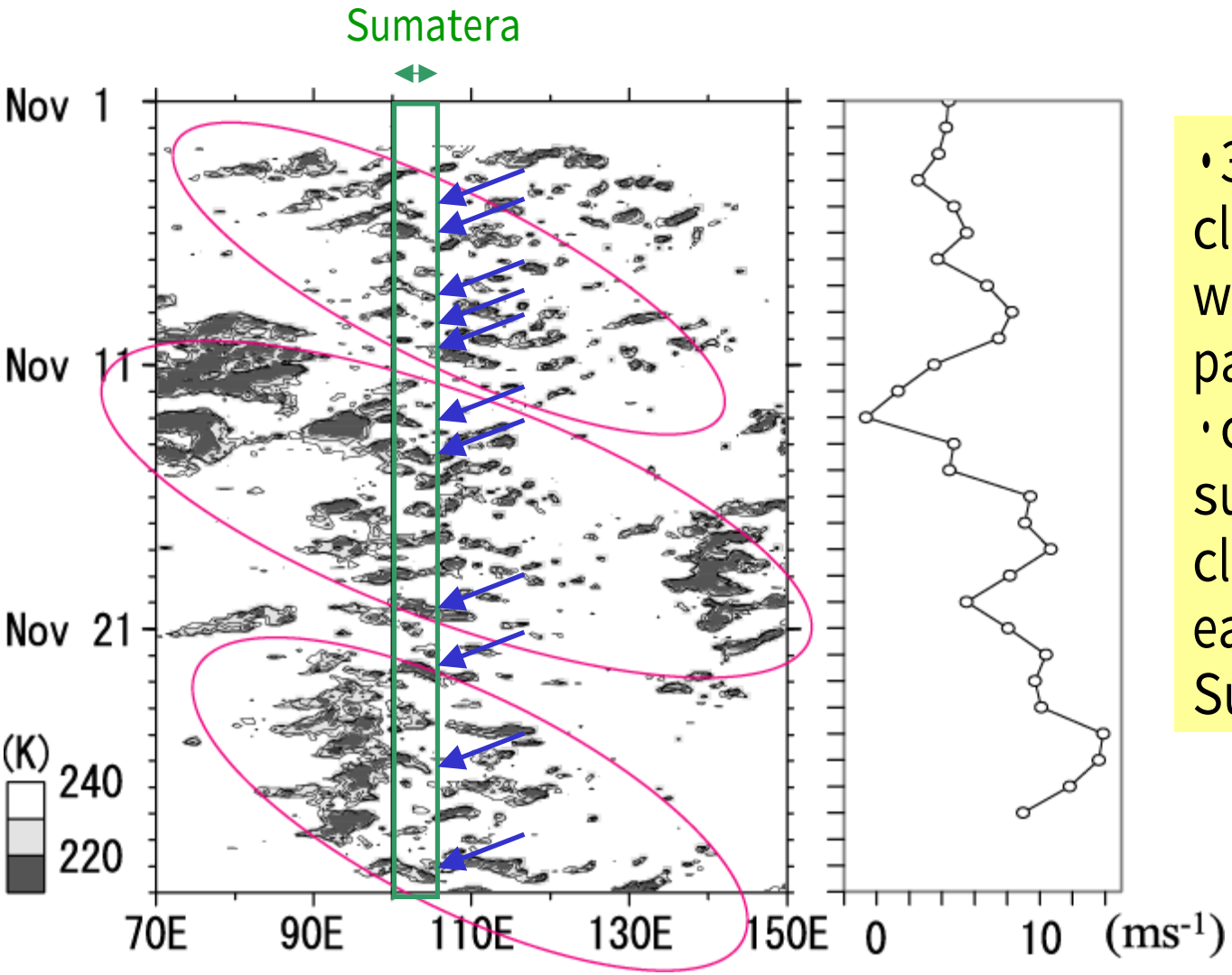


Fig.9 Time series of α along CC' line each daily zonal wind speed at 850hPa

Super cloud cluster



・3 super cloud clusters which have wind variations pass.
・cloud clusters in super cloud clusters migrate eastward over Sumatera Island.

Fig.4 Time-longitude cross-section of T_{BB} and profile of zonal wind with rawinsonde in 2-4 km at Kototabang in November 2001

Summary

About diurnal cycle of cloud system migration over Sumatera Island(Figure1)…

① Occurrence tendency of cloud systems migration is different between southwestward and northeastward.
→Migratory mechanism is different each migratory direction.

About northeastward migrati
② It occurs when super clou cluster passes in ITCZ.
③ It occurs when westerly wind blows in the lower troposphere.
④ Migratory distance depends on westerly wind speed.