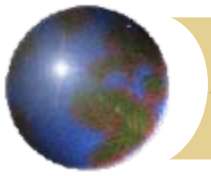


# HARIMAレーダーでみたMJO抑制期における スマトラ島沿岸部の対流活動日変化について

海洋研究開発機構 (JAMSTEC)

地球環境観測研究センター (IORGC) 森 修一

HyARC 共同利用研究第2回日変化ワークショップ@強羅静雲荘 2007年03月09日

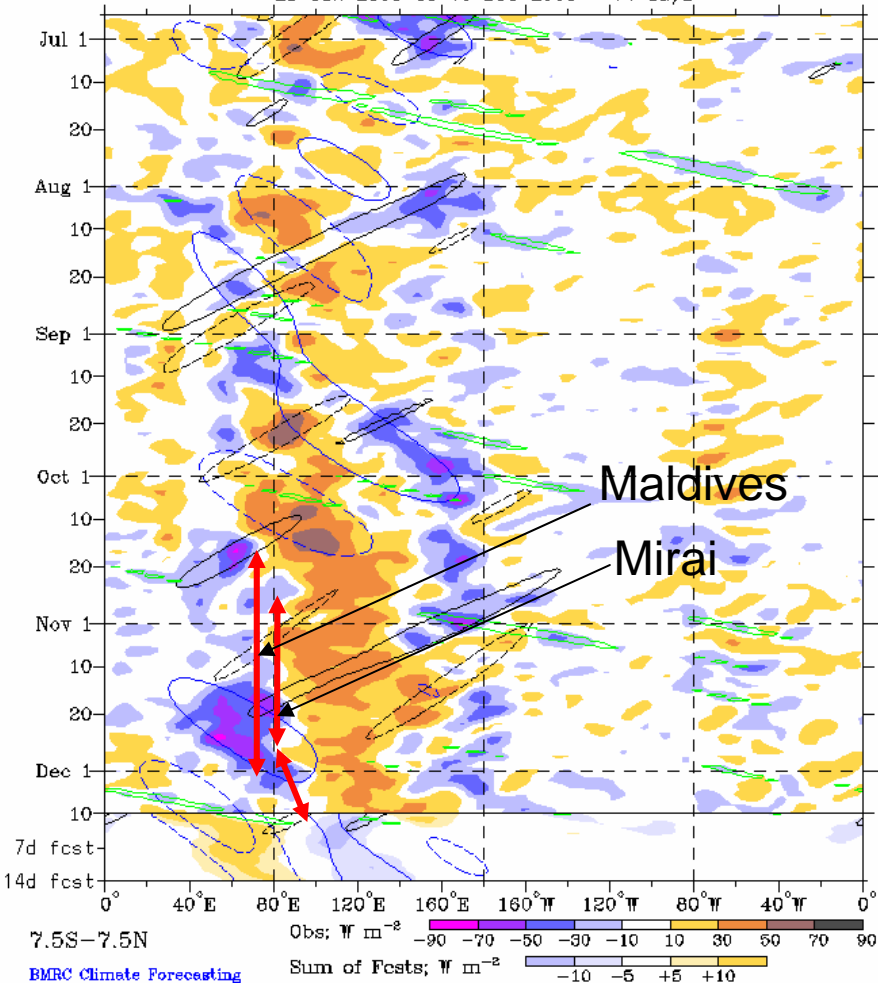


# Introduction

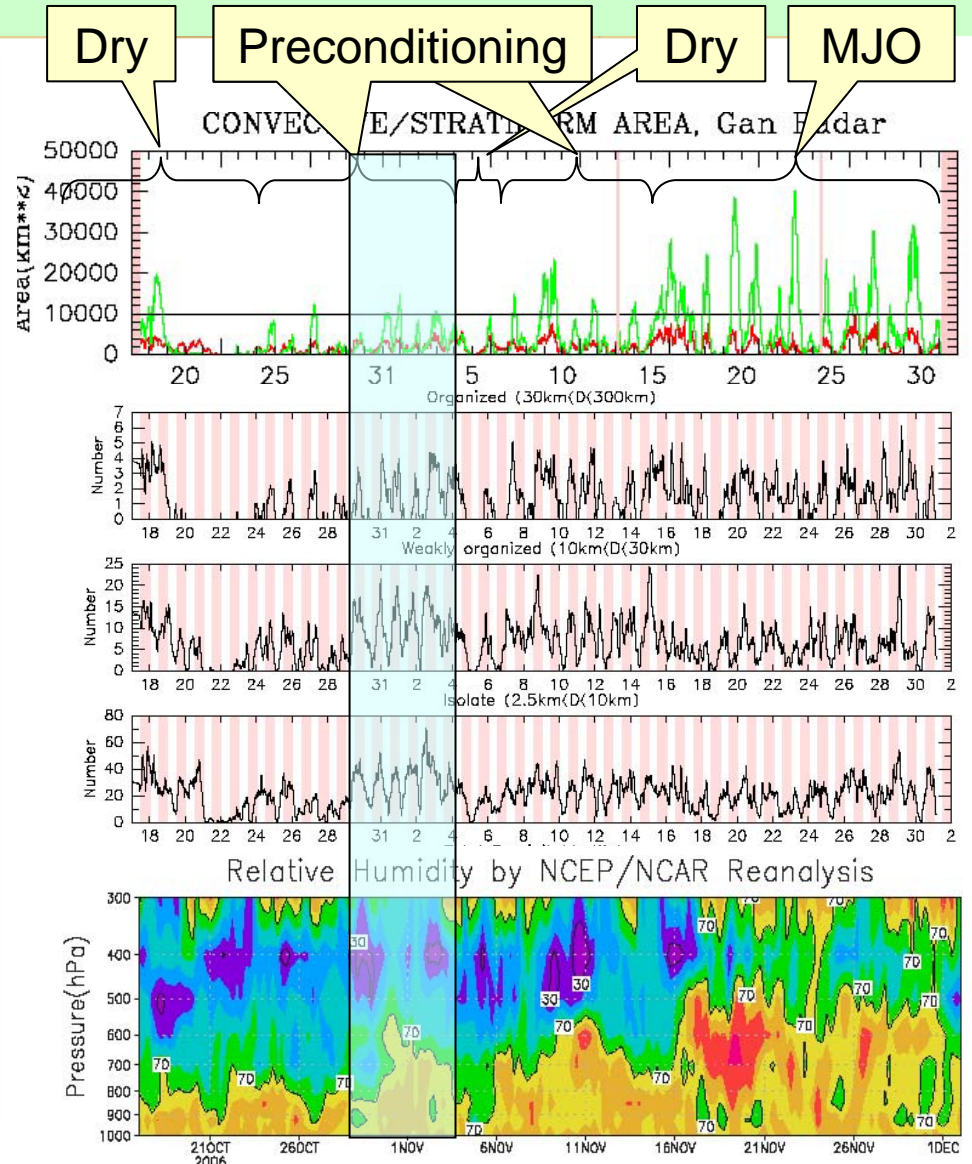
- **海大陸域 (MC) における降水変動の2モード:**
- **季節内変動 (ISV)**
  - ・OLRやNCEPなど公開データによる力学的、解析的研究の歴史は長いですが、MC付近におけるMJOの変調など解決されていない問題点も多く、進行盛衰など予測が困難.
- **日周期変動 (DV)**
  - ・地味な現象だが年間降水量の大半を稼いでおり、(熱)力学的な環境場の改変に大きく貢献している可能性あり.
  - ・MCでは日変化を解析できる地上観測がなく、GMS等による雲活動の変動しか理解されていなかった.
- **ISVとDVを結ぶ架け橋 (Missing Link)**
  - ・高時間分解能のレーダーとゾンデの観測により、階層間相互作用 (Up/Down Scaling) の一端を明らかにしたい.

# Hovmeller, Radar, RH profile, etc. around Gan (城岡・勝俣)

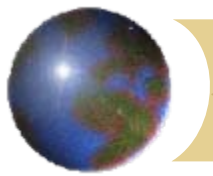
Real-time filtering superimposed upon 1-2-1 filt, R21, OLR Anoms  
 MJO blue CINT=10; n1ER black CINT=10; Kelvin green CINT=15  
 Negative contours solid, positive dashed (excluding Kelvin)  
 26-Jun-2006 to 10-Dec-2006 + 14 days



寒色系が対流活発



日変化が顕著



# Summary and Future Work

- \* HARIMAUによりXDRやWPRの設置と集中ゾンデ観測
- \* 集中観測データは引き続き解析中, XDRは連続運用中

## ➤ 季節内変動 (ISV)

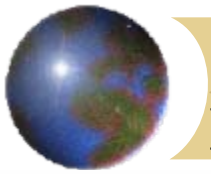
- ・今回はISV (MJO) 不活発期であり, 対流抑制期に対応.

## ➤ 日周期変動 (DV)

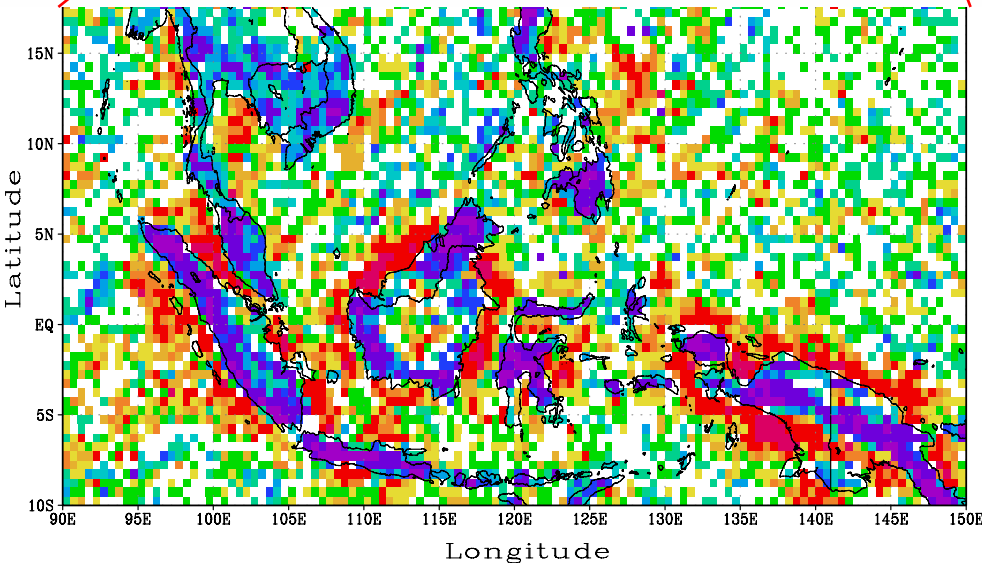
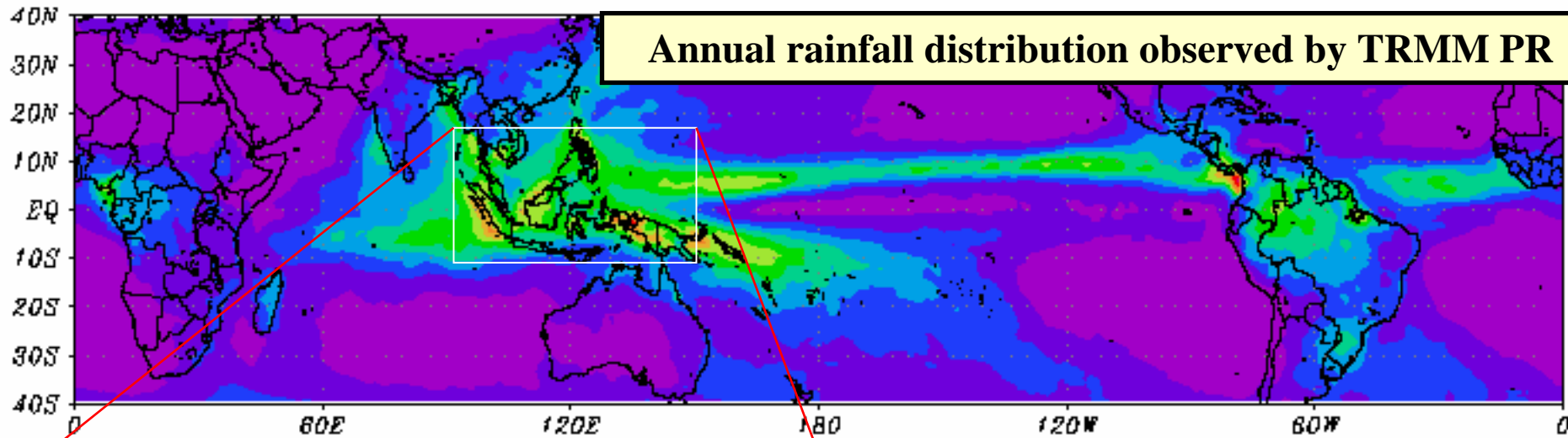
- ・海陸風の交代が著であり, 午後に内陸 (山岳) 部で発生した対流系が発達しながら夜間に海上へ移動する.
- ・海上へ移動後に衰弱する対流系が多いが, 夜間の海上で新たに発生する (線状) 対流系も頻繁に観測された.

## ➤ ISVとDVを結ぶ架け橋 (Missing Link)

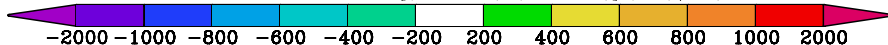
- ・ゾンデ観測データも援用し, DV対流系による水蒸気の鉛直輸送や対流不安定の解消, 鉛直加熱 (冷却) 過程等について解析, 検討を進めて行きたい.



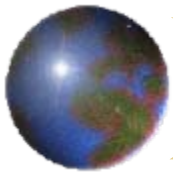
# Background: Missing Link between Diurnal and Intraseasonal Variations



Rainfall difference [(00-11LST)-(12-24LST)] (mm/year)



*Clear contrast* between  
**Morning rain (00-11LST)**  
over the Coastal sea region  
and  
**Evening rain (12-23 LST)**  
over the Land region



# Background:

## Missing Link between Diurnal and Intraseasonal Variations

### MJOの変質⇔海洋大陸の役割

Hierarchy structure of intraseasonal oscillations over the Tropical Pacific Ocean

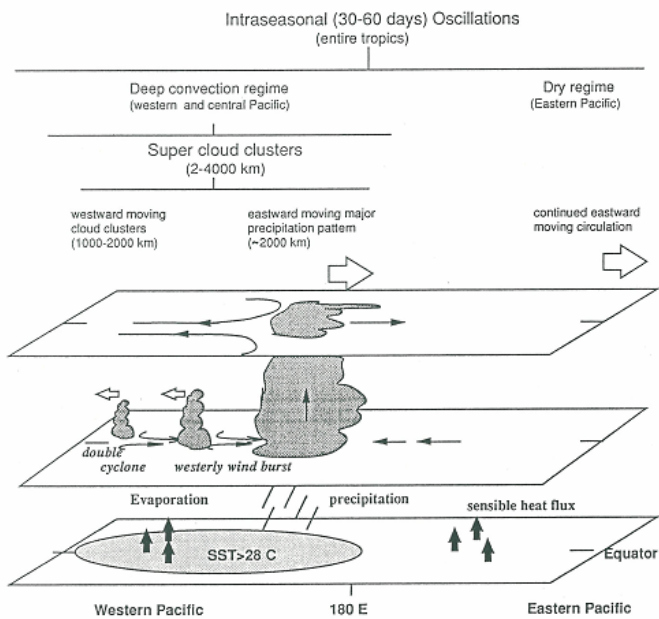


Fig. 13. Schematic showing the hierarchy structure of intraseasonal oscillations over the tropical Pacific as inferred from the model simulation. Horizontal scales shown are only approximate. Large overlap may occur within the super cloud cluster substructures.

(Lau et al. 1989)

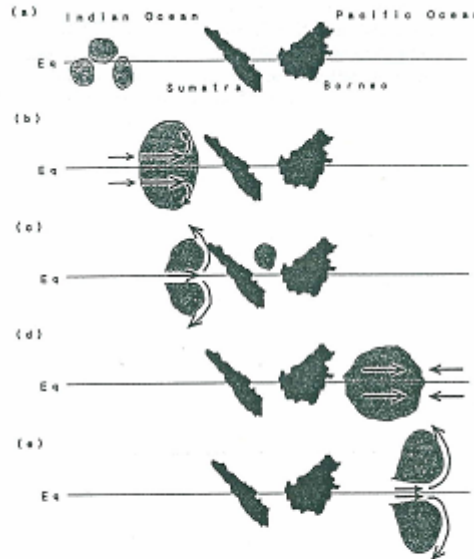
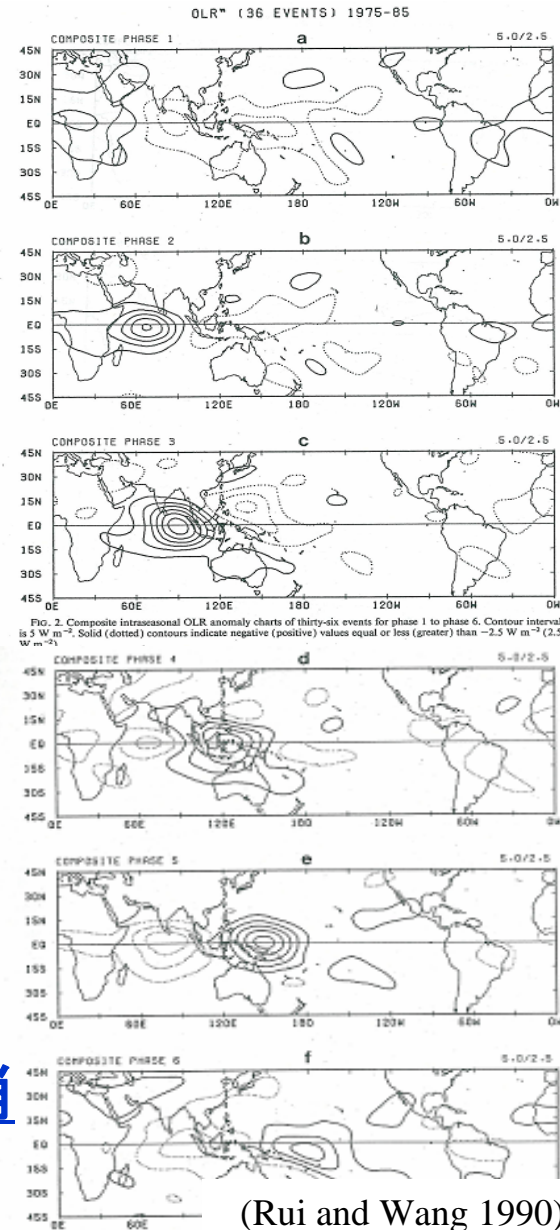


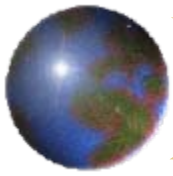
Fig. 19. Schematic picture when convective systems propagate along the equator from the Indian Ocean to the western Pacific. Light shaded regions denote convective regions and arrows indicate low-level winds.

(Nitta et al. 1992)



(Rui and Wang 1990)

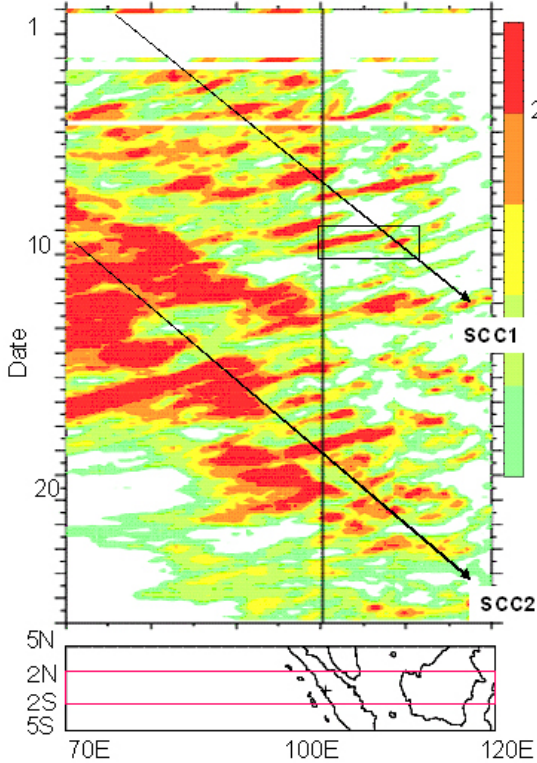
- ・大規模山岳地系による力学的バリア
- ・日変化対流活動による対流不安定の解消
- ・海面からの潜熱顕熱フラックス供給途絶



# Background:

## Missing Link between Diurnal and Intraseasonal Variations

2002年11月

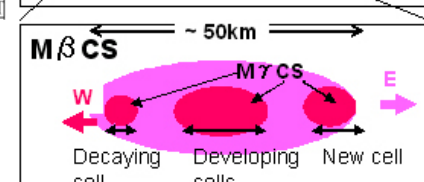
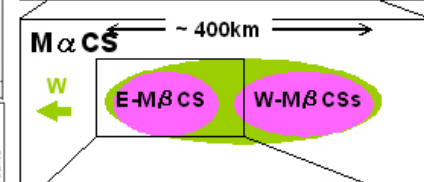
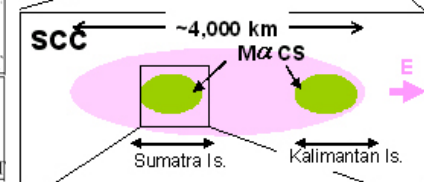
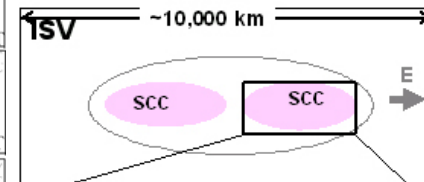
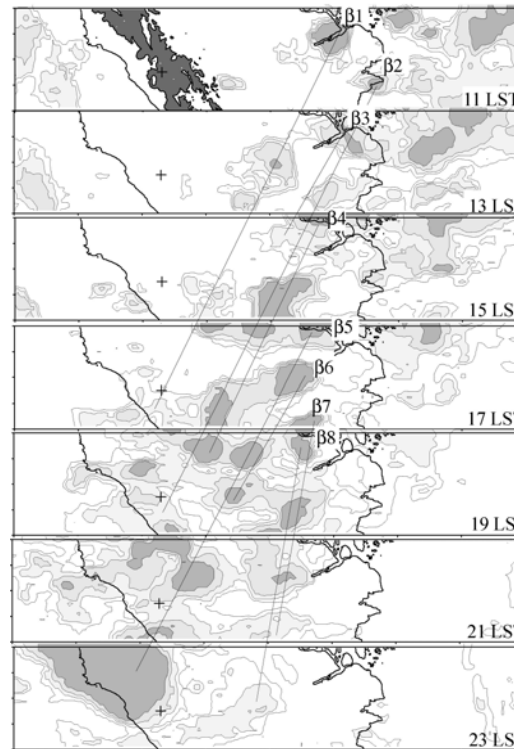
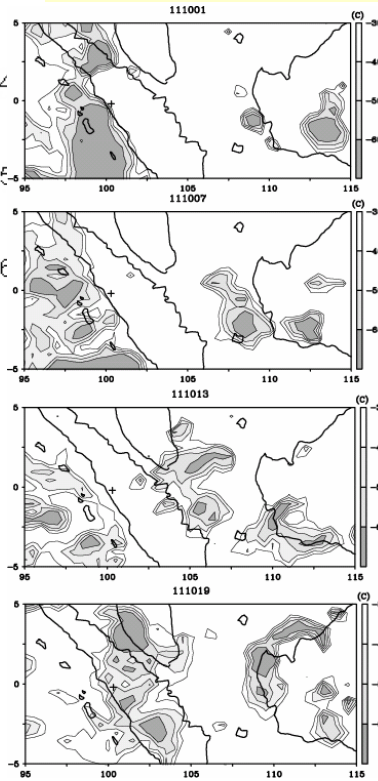


超雲団 (SCC)

~4,000km

日周期雲団 (CC)

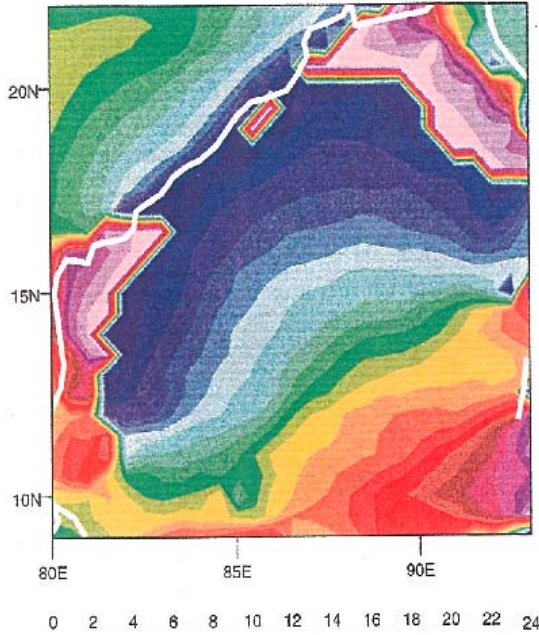
~400km



季節内変動 (ISV)

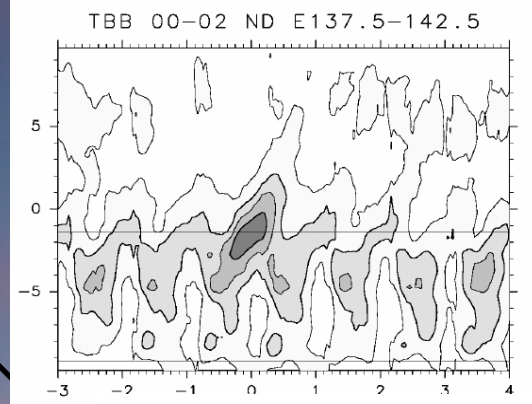
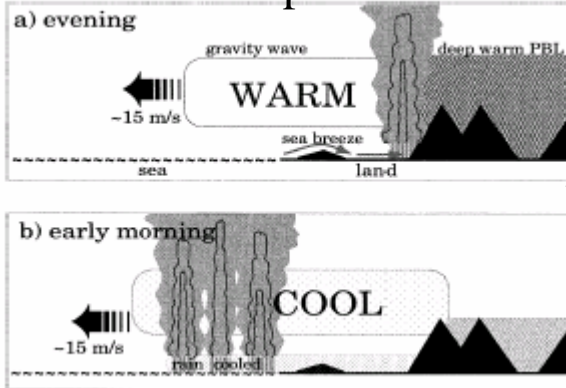
~10,000km

# Phase Delay of Rainfall Diurnal Cycle Commonly Seen in tropical region



Yang and Slingo, 2001;  
Zuidema 2003

Mapes et al. 2003



Kubota et al. 2006

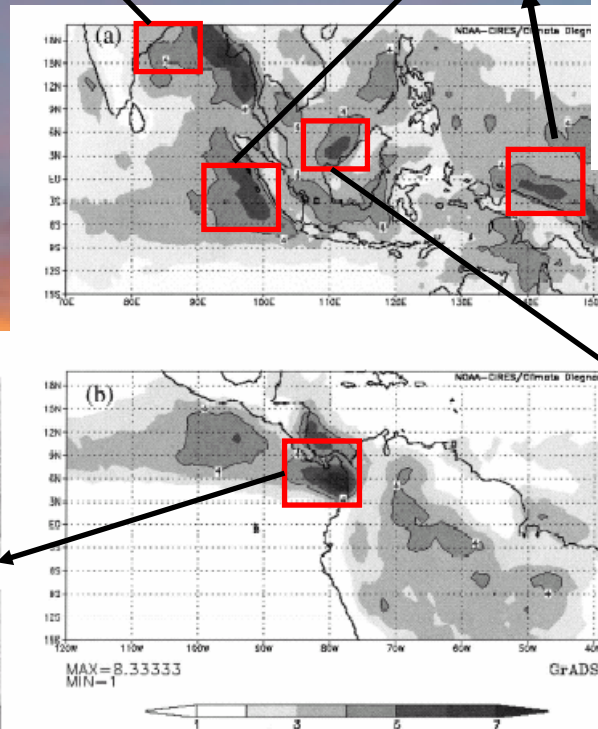
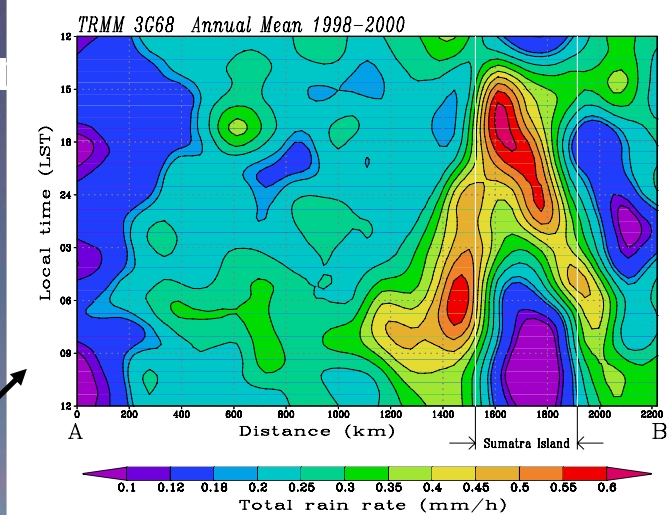
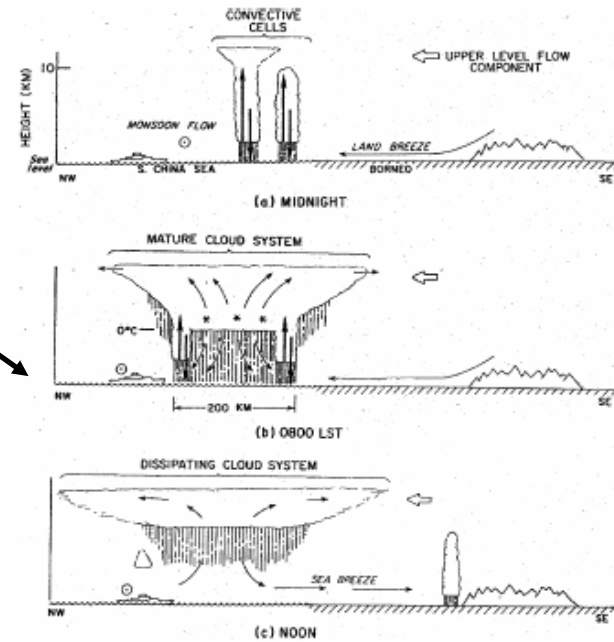


FIG. 2. Long-term annual-mean climatology of the HRC dataset in (a) Asian and (b) American long

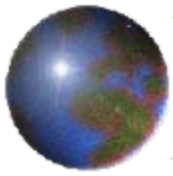


Mori et al. 2004



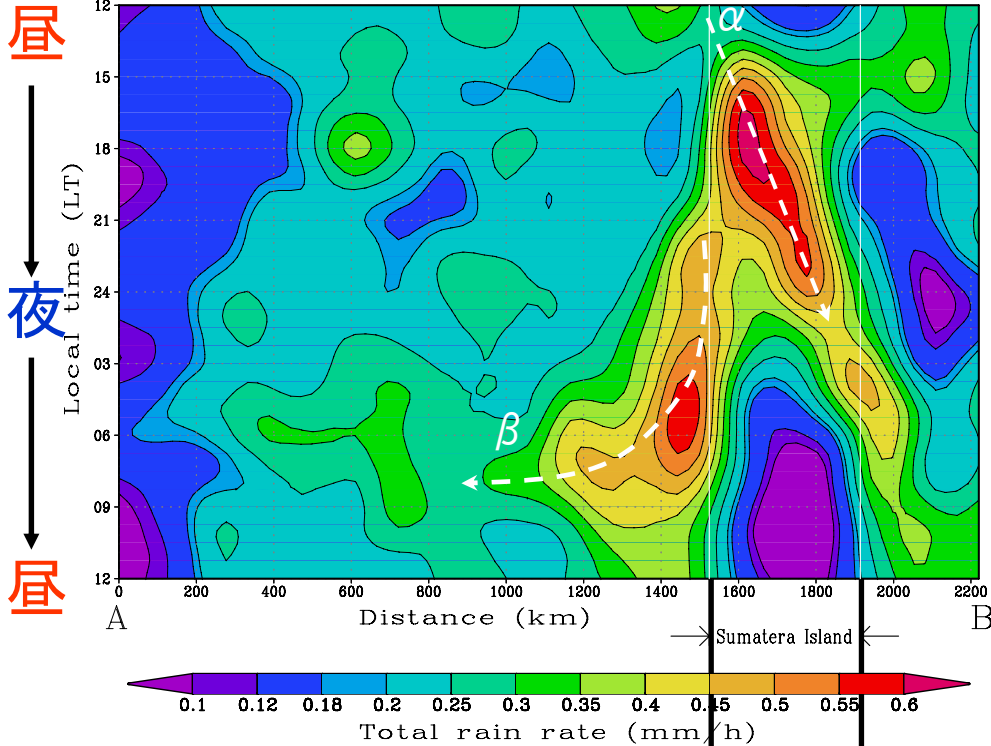
Houze et al. 1981





# Diurnal Rainfall Peak Migrations over Sumatera Island

TRMM 3G68 Annual Mean 1998-2000

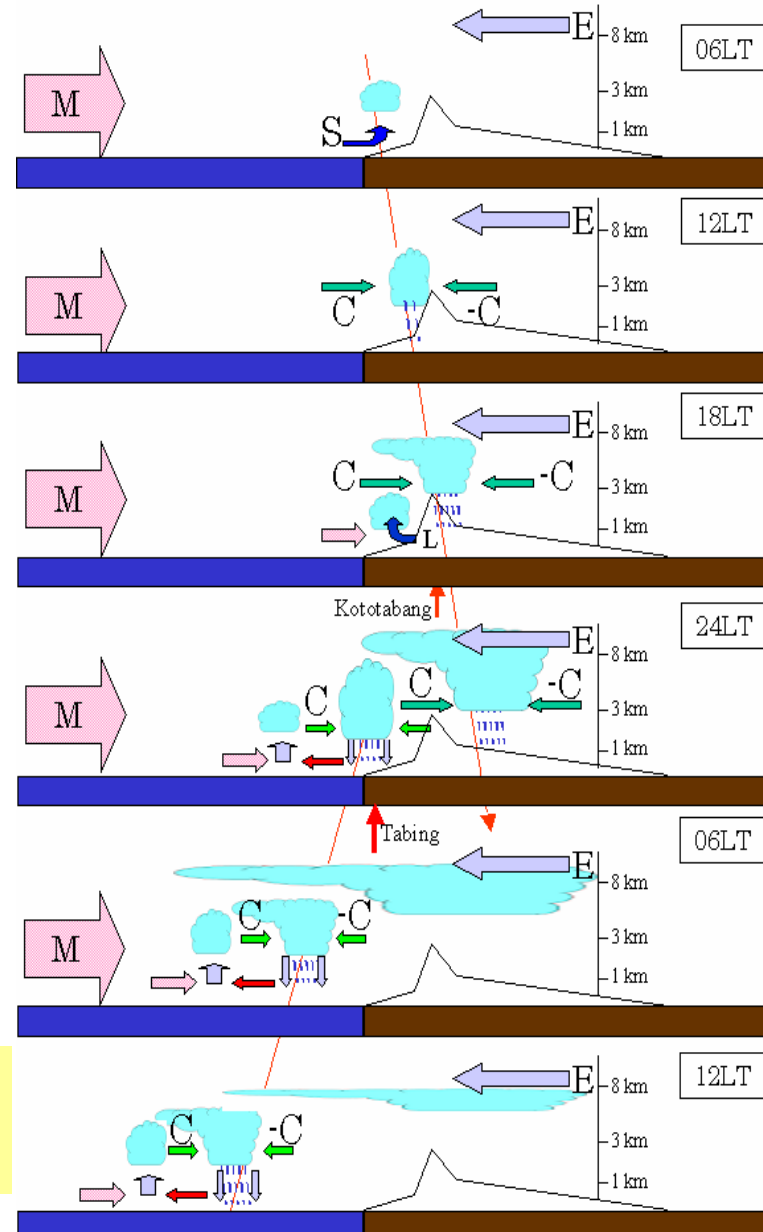


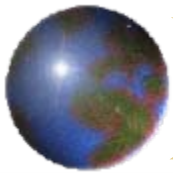
インド洋

スマトラ島

Mori et al. MWR 2004

スマトラ島の海岸線を基準にして描いた  
雨が降る場所と時間の変化(日変化)





# Diurnal Rainfall Peak Migrations over Sumatera Island

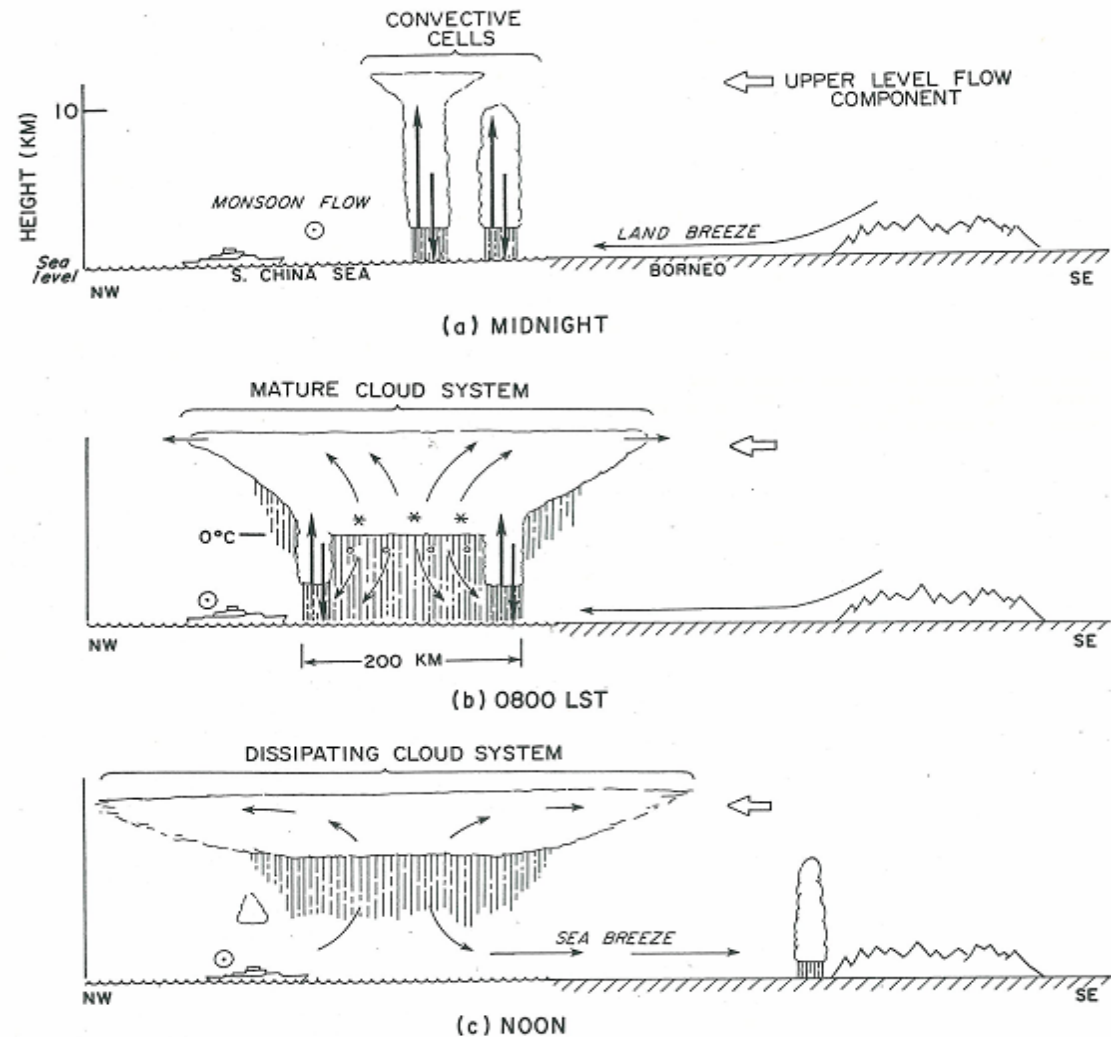
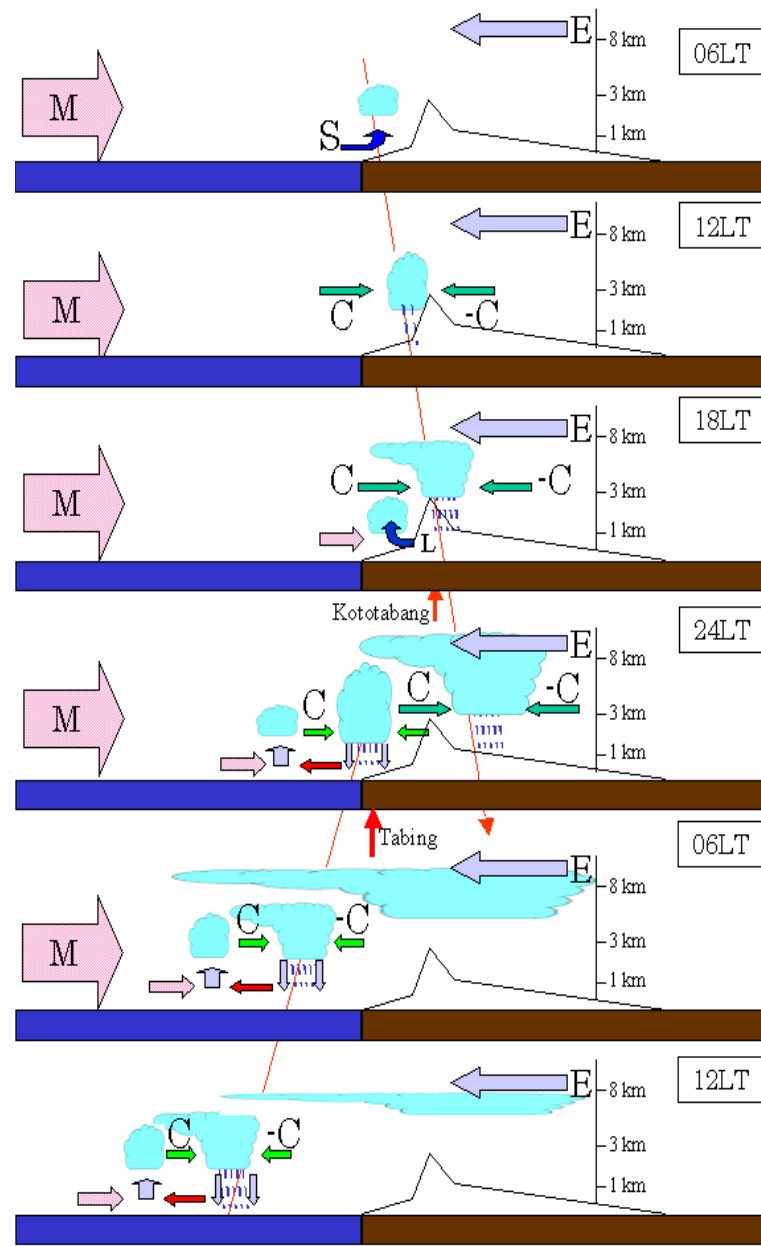


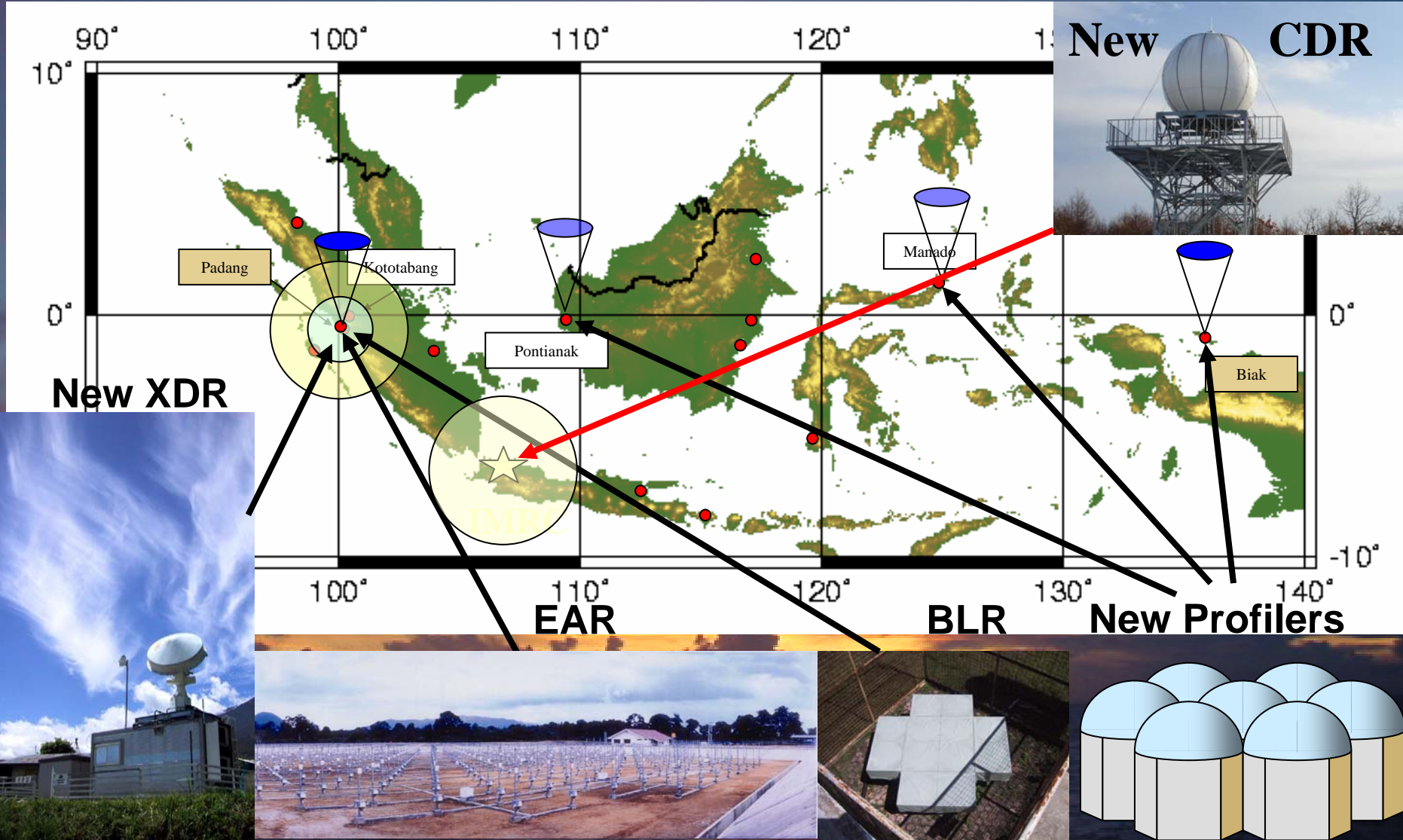
FIG. 16. Schematic of the development of diurnally generated mesoscale precipitation feature off the coast of Borneo. Various arrows indicate airflow. Circumscribed dot indicates northeasterly monsoon flow out of page. Wide open arrow indicates the component of the typical east-southeasterly upper level flow in the plane of the cross section. Heavy vertical arrows in (a) and (b) indicate cumulus-scale updrafts and downdrafts. Thin arrows in (b) and (c) show a mesoscale updraft developing in a mid-to-upper level stratiform cloud with a mesoscale downdraft in the rain below the middle-level base of the stratiform cloud. Asterisks and small circles indicate ice above the 0°C level melting to form raindrops just below this level.

Houze et al. 1981



# HARIMAU funded by JEPP (FY2004-2009)

Installing Doppler radars and wind profilers over Indonesia  
Operating and data collecting through the satellite networking





# What's HARIMAU?

**WWF**

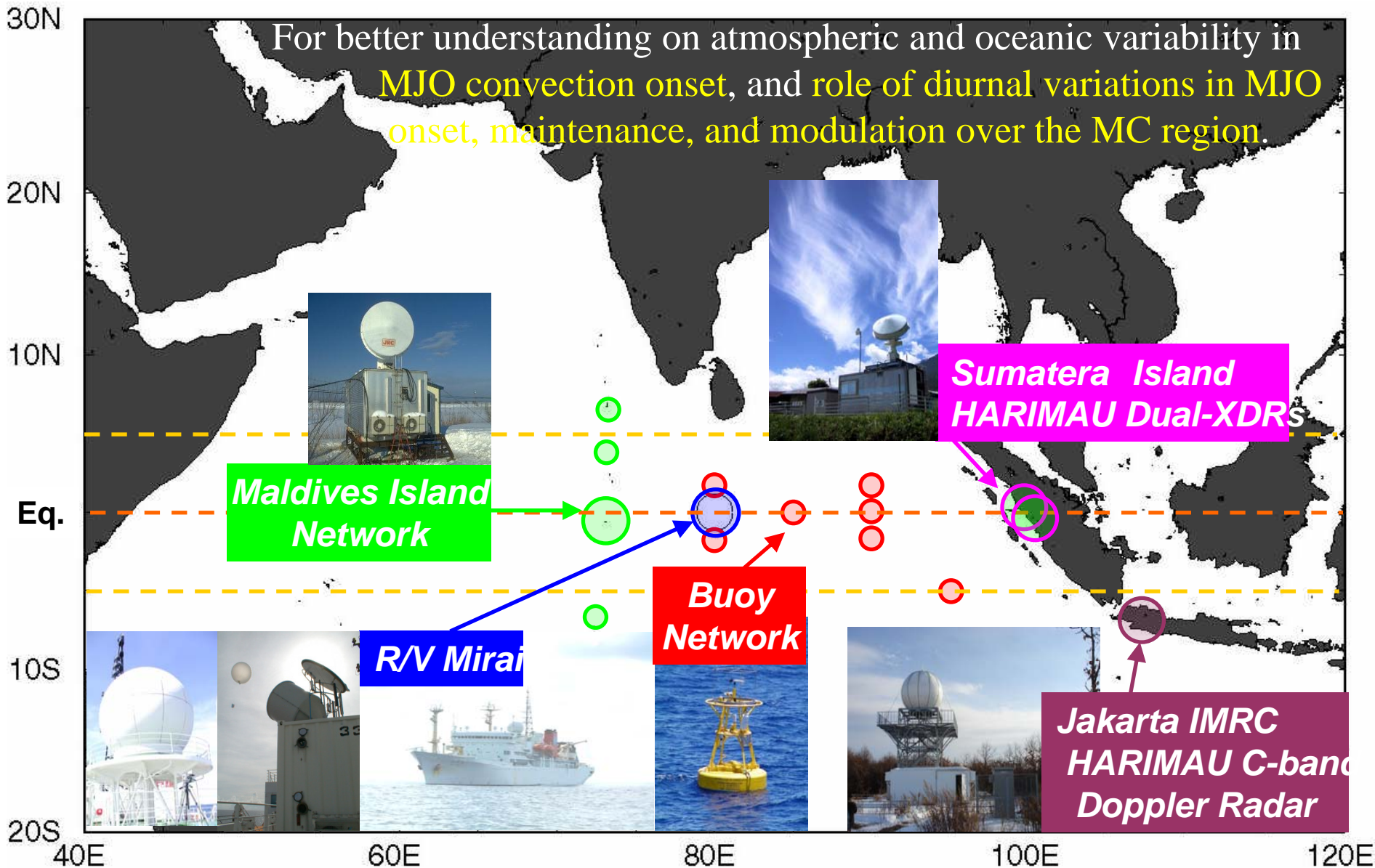
**3 Euro**  
**stoppen die Säge**  
Retten Sie seine Heimat  
**wwf.de**

Harimau: Tiger in Indonesian and Malay. Harimau Sumatera (Sumatra Tiger) is one of the most popular animal in Indonesia, but is assigned as species in the red data book.

Mit Ihrem 3 Euro im Monat hat der Lebensraum der letzten 500 Sumatra-Tiger noch eine Chance.

**ORGC**  
Institute of  
Observational Research  
for Global Change

**HARIMAU2006** with **MISMO** during October 23 – November 21  
(**MIRAI** Indian Ocean cruise for the **Study on MJO-convections Onset**)

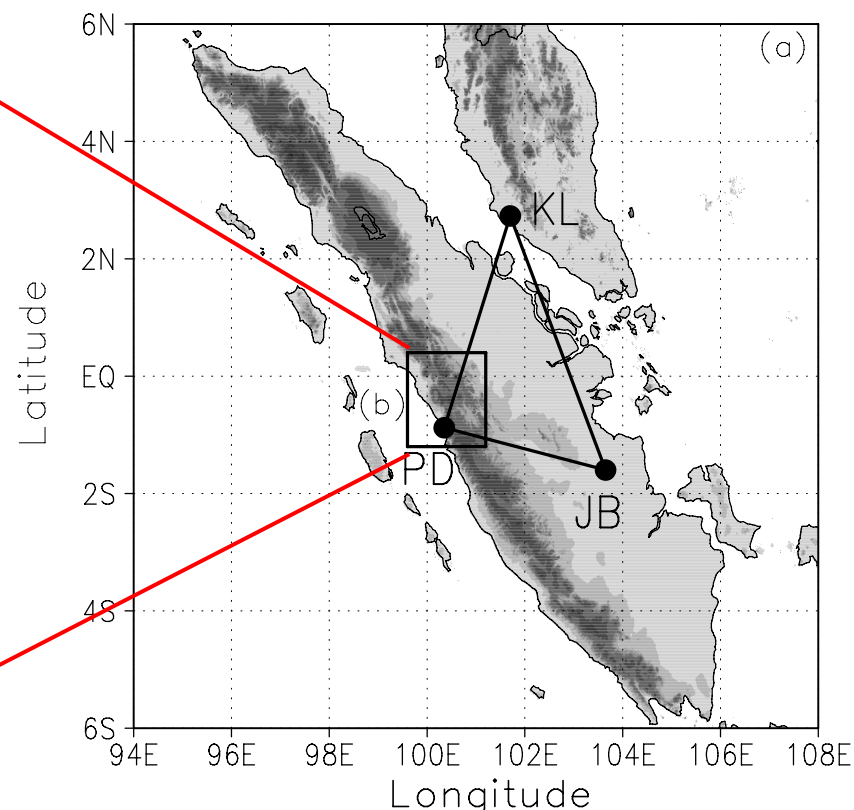
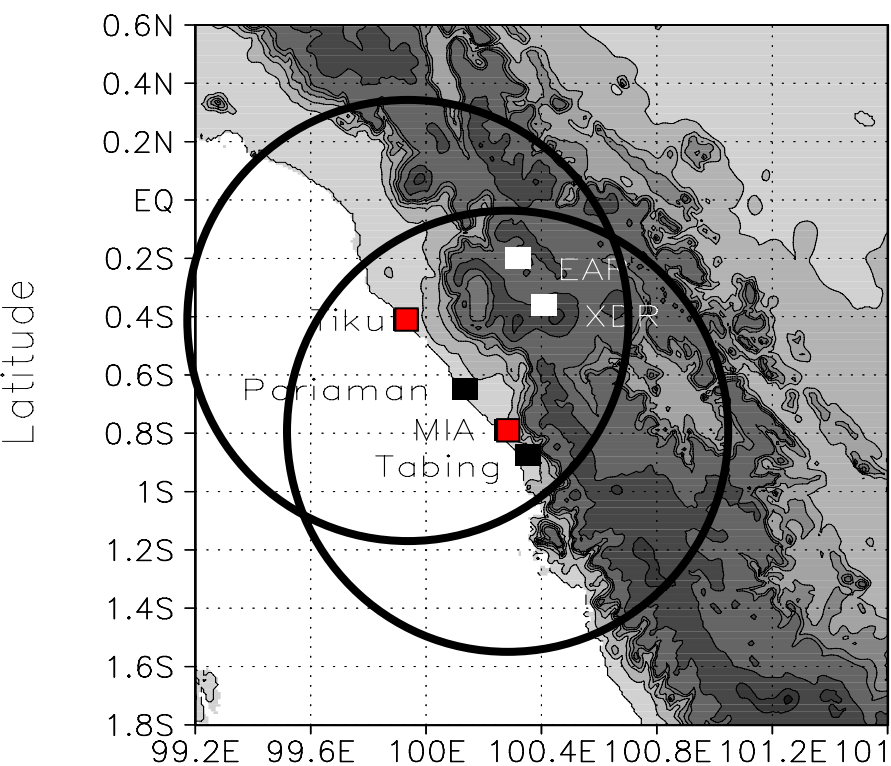


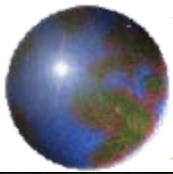


# HARIMAU2006観測におけるレーダー配置図

## Hydrometeorological **AR**ray for **ISV-M**onsoon **AU**tomonitoring

1. MIA-XDRと北大Tiku-XDRによるデュアルドップラーレーダー観測
2. スマトラ本島とシベル島における高層レーウィンゾンデ観測
3. HARIMAU-MISMO連携同期観測
4. MIA-XDRデータ公開Webサイト開設, 観測情報共有ブログ開設

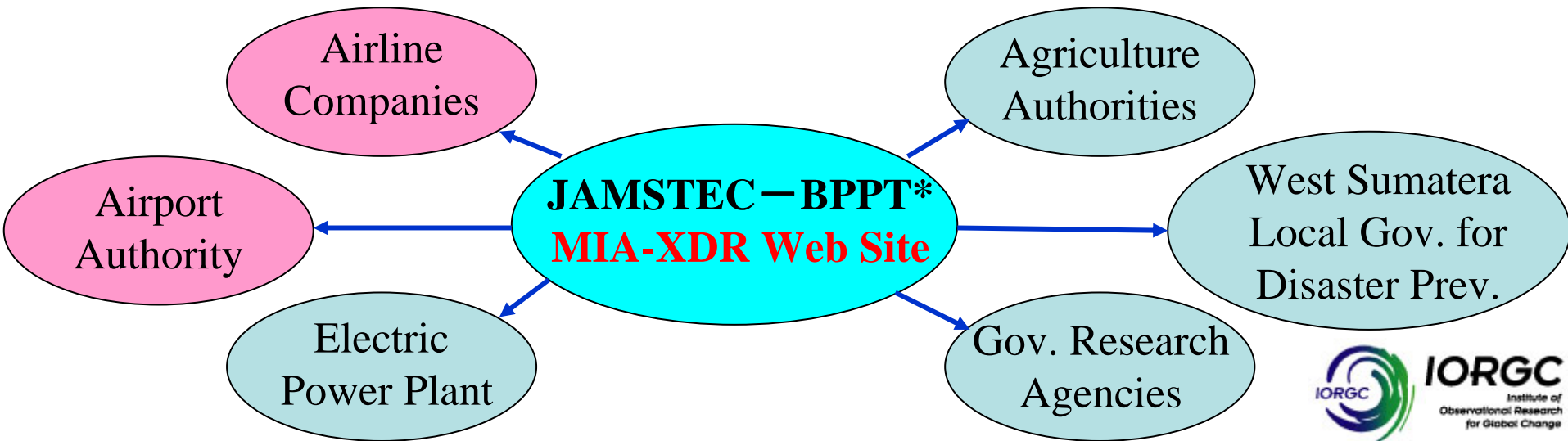




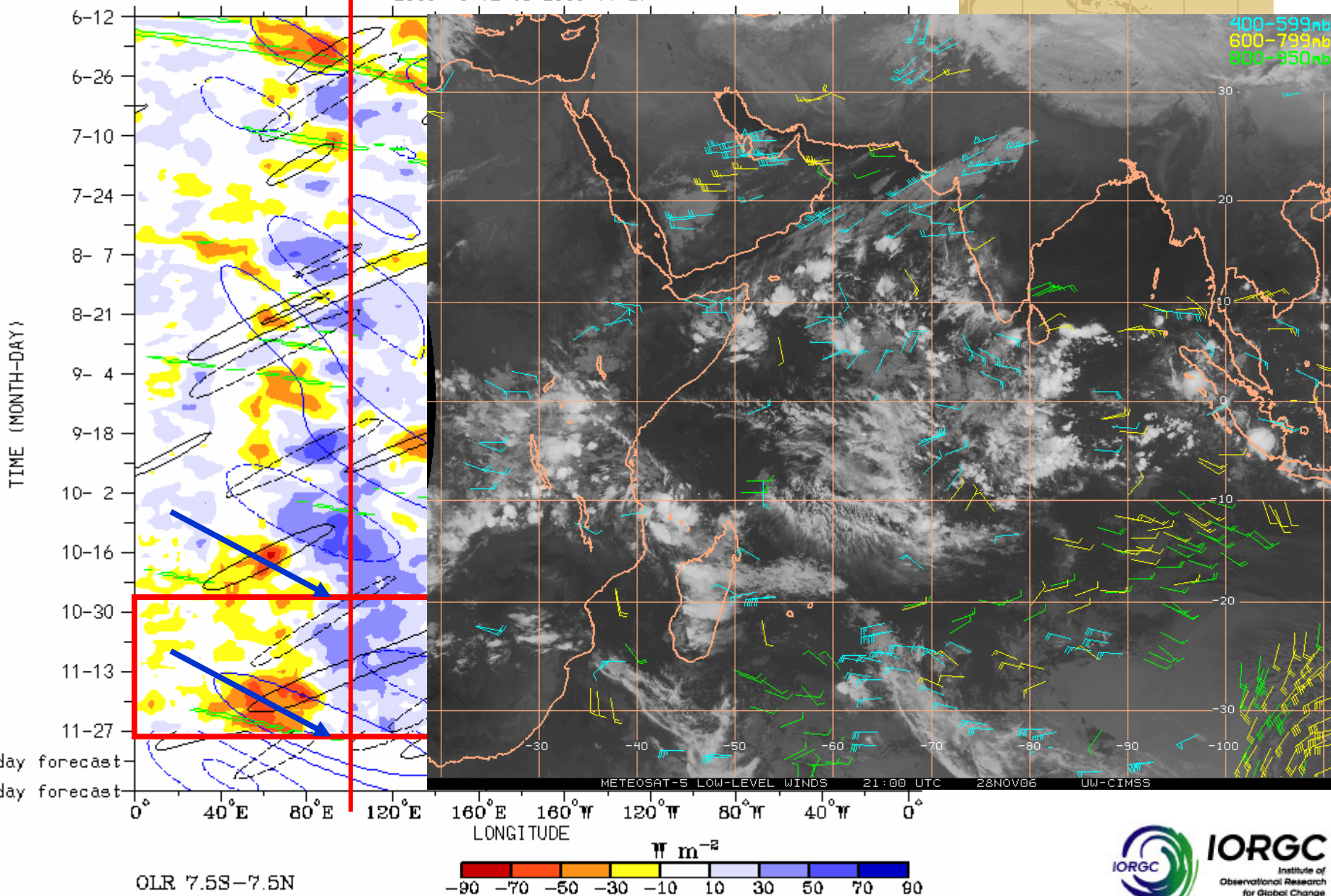
# Minangkabau International Airport (MIA, WIPT) and Schematic of Real-Time Radar Data Distribution



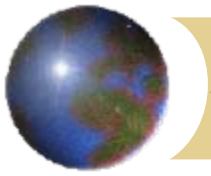
- ・スマトラ島第2の都市(人口60万人)
- ・乗り入れ航空会社: 12社
- ・乗り入れ路線: 国内 3, 国際2路線 (Jakarta線は約10往復/日)



Real-time filtering superimposed upon 3drm OLR Anomalies  
 MJO blue CINT 10, ER1 black CINT 10, Kelvin green CINT 15  
 Negative contours solid, positive dashed (exl Kelvin)  
 2006- 6-12 to 2006-11-27

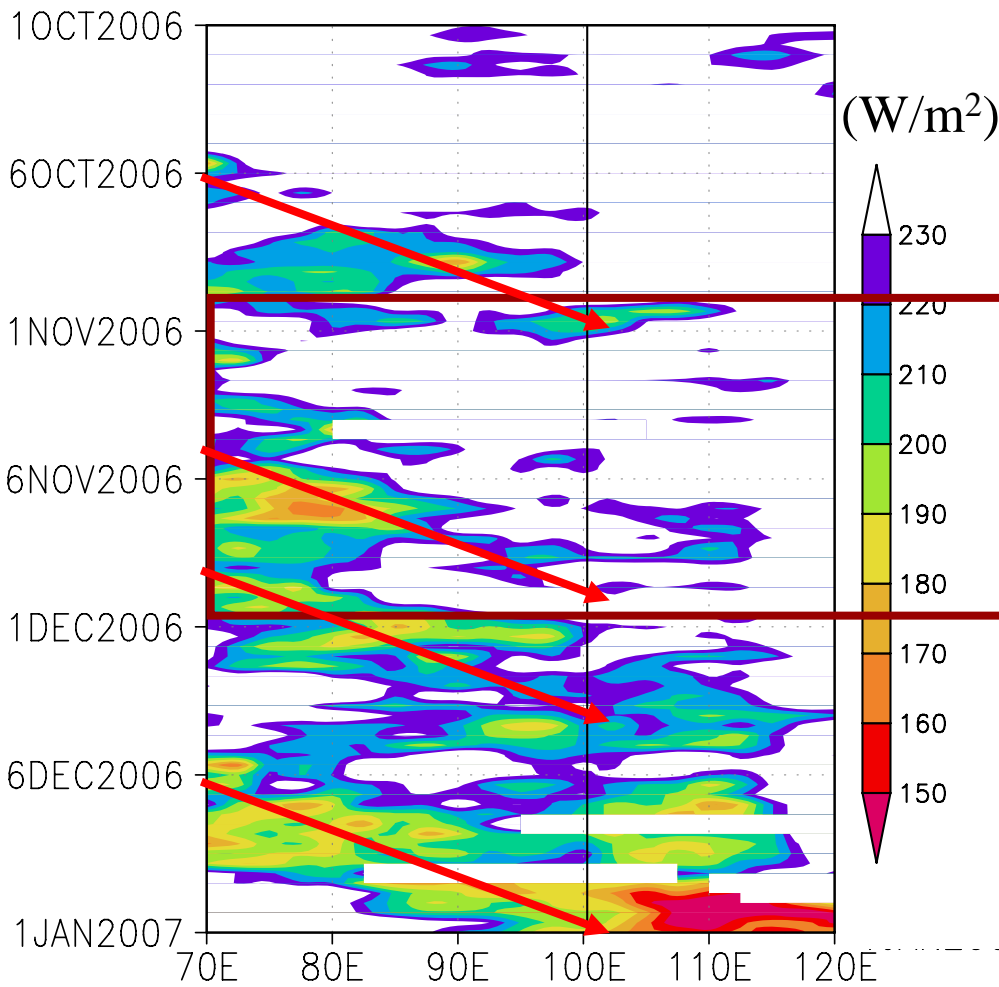




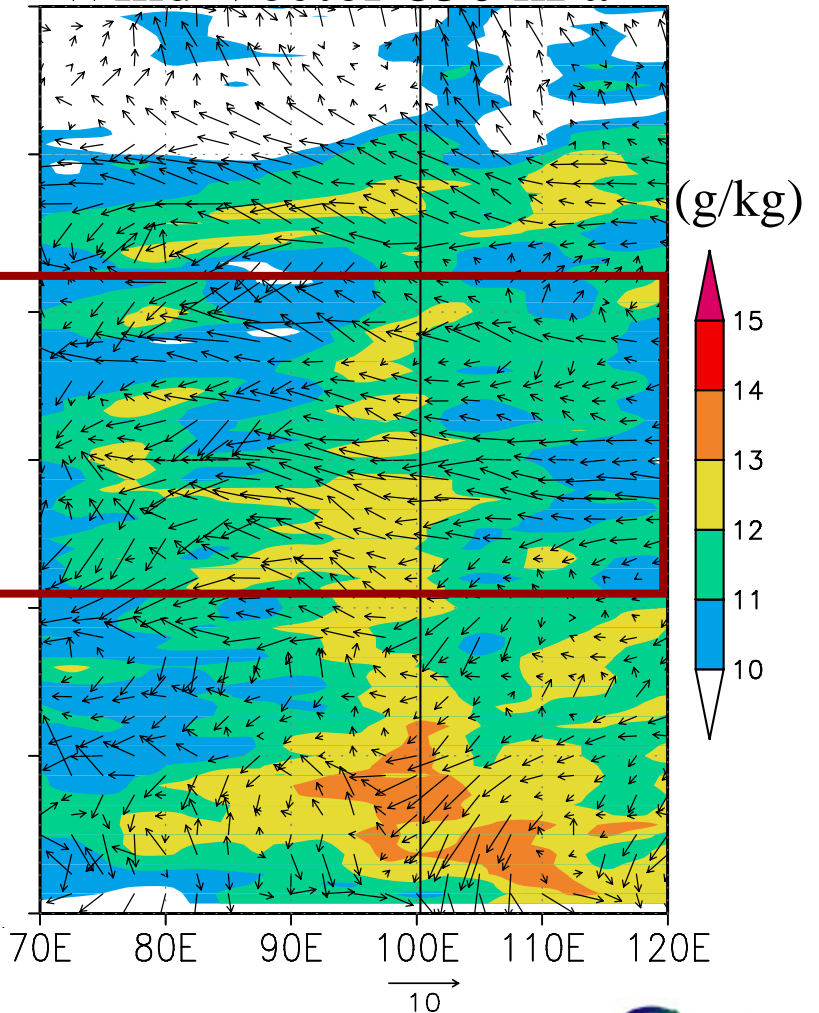


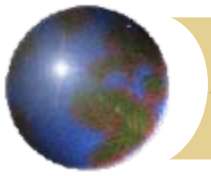
# 観測期間中のOLR, 下層風, 水蒸気量の変化

## OLR

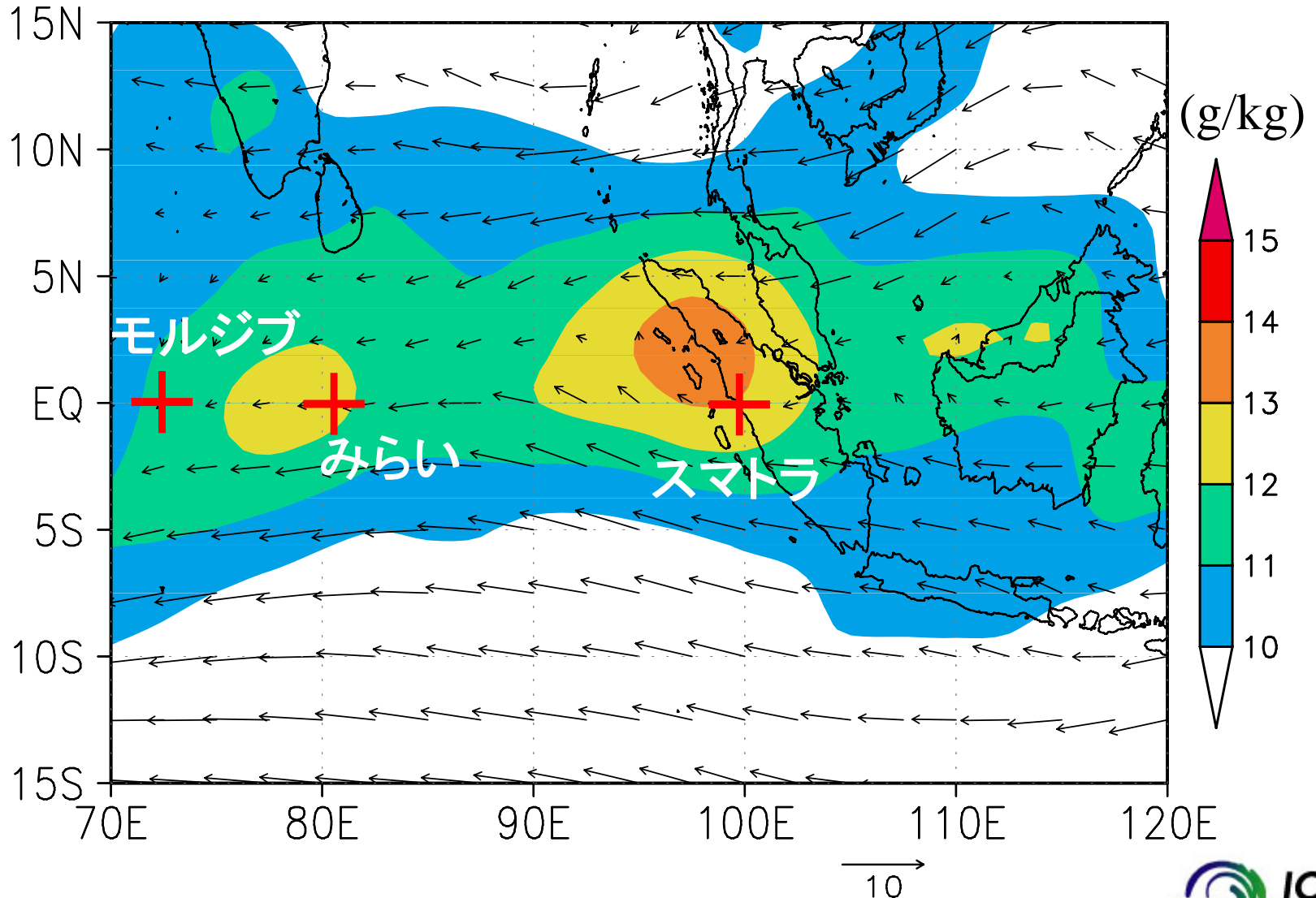


## Specific Humidity and Wind Vector 850 hPa

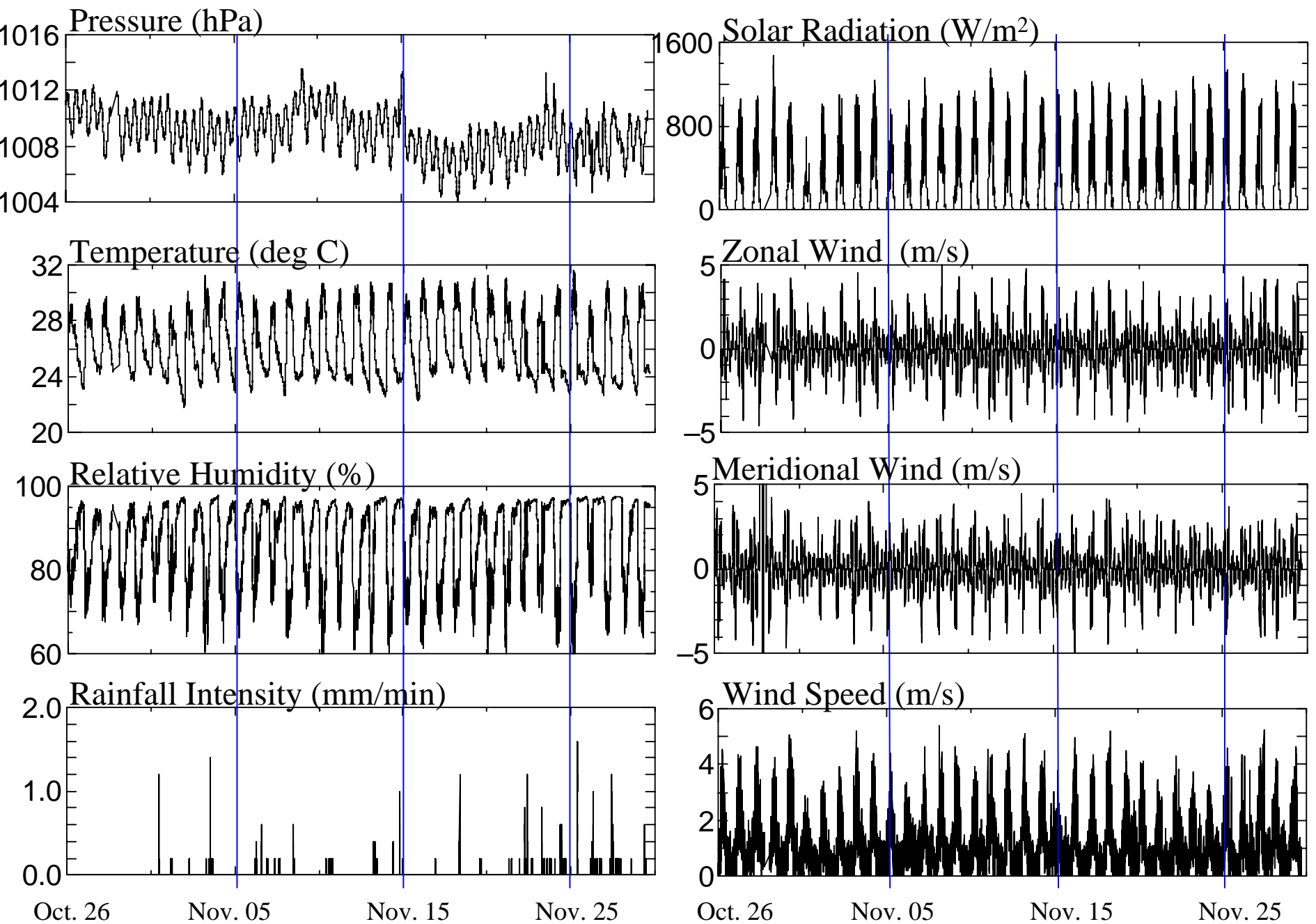




# 観測期間中の下層風と比湿(850hPa)



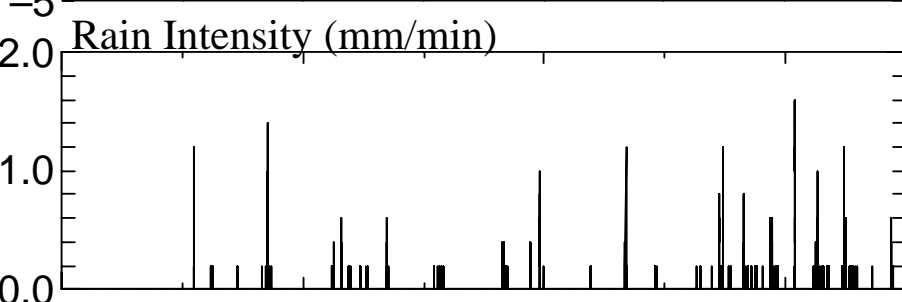
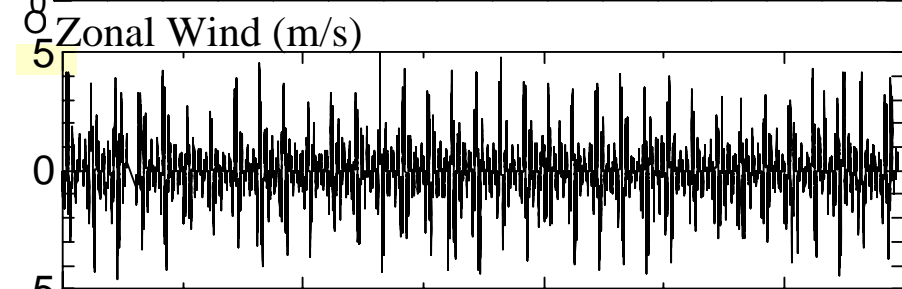
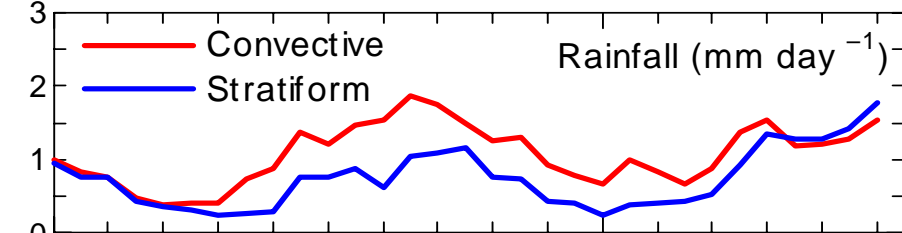
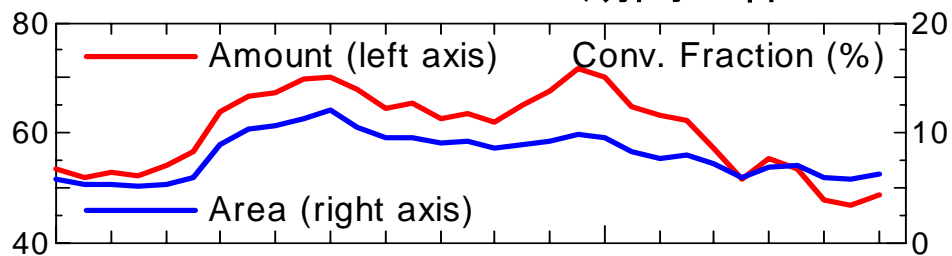
Temporal average during Oct. 28 – Nov. 27, 2006



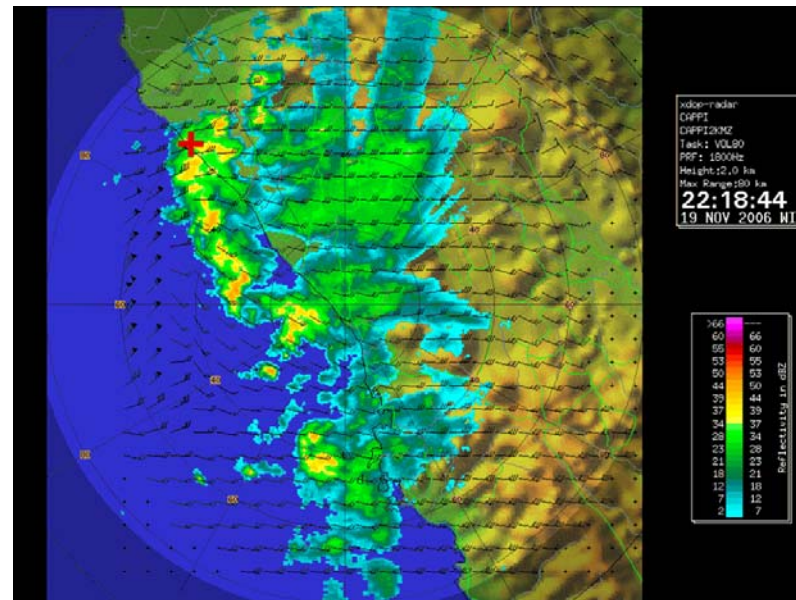


# MIA-XDR観測データ初期解析結果

## HARIMAU2006期間全体



Oct. 26 Nov. 05 Nov. 15 Nov. 25



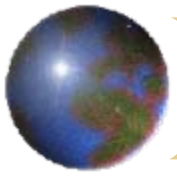
## 降水量計算

Convective Rain:  $Z=148 \cdot R^{1.55}$

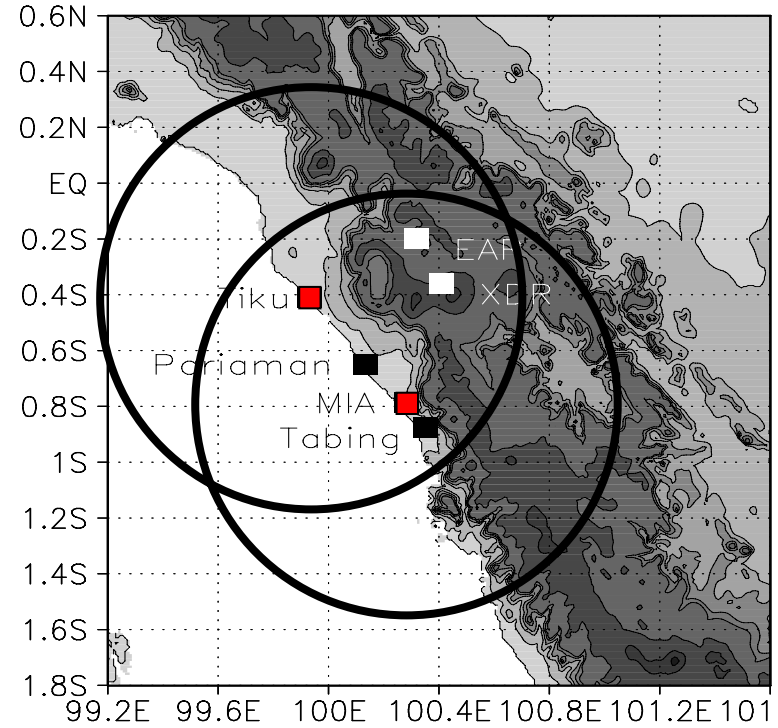
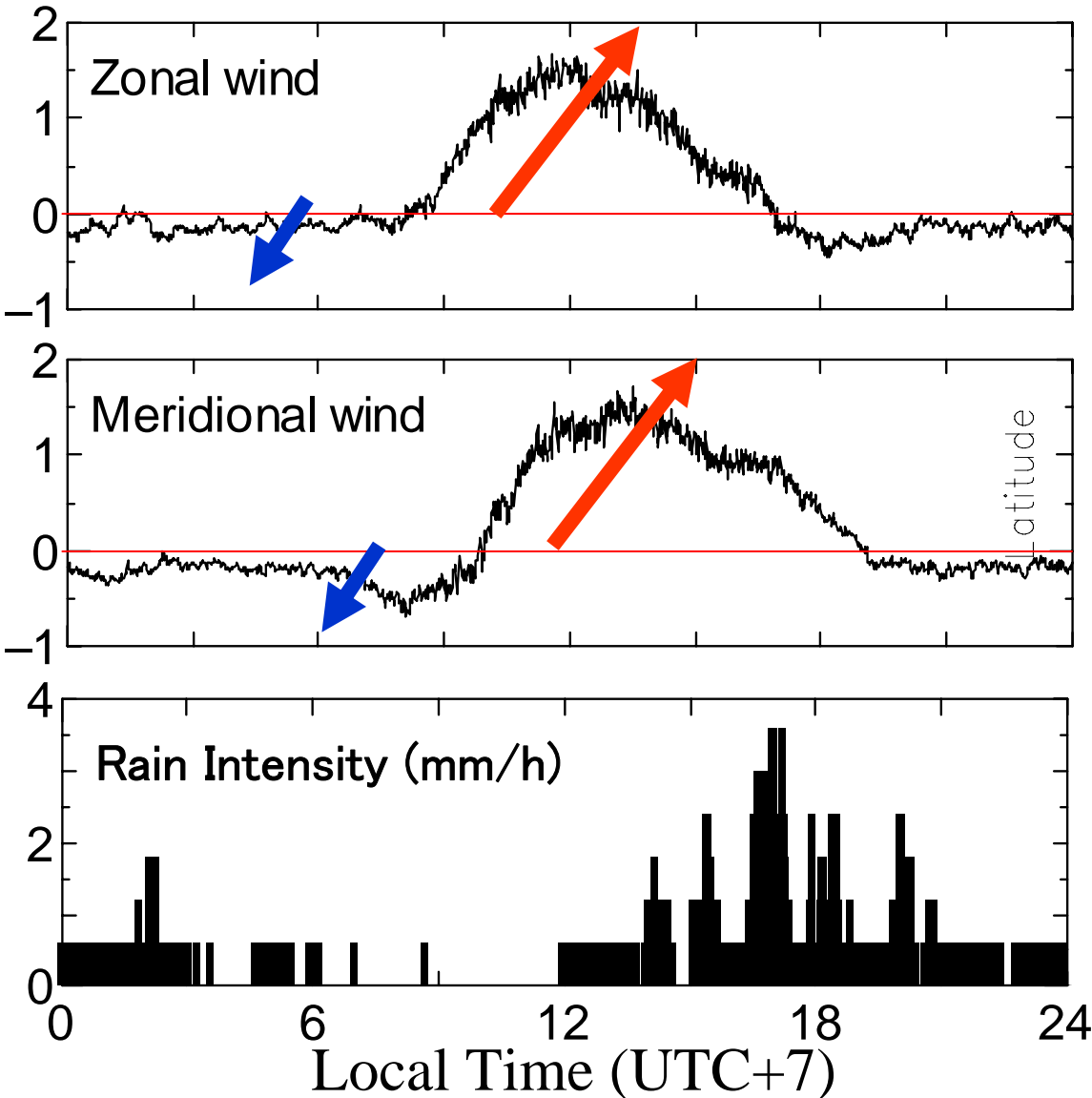
Stratiform Rain:  $Z=276 \cdot R^{1.49}$

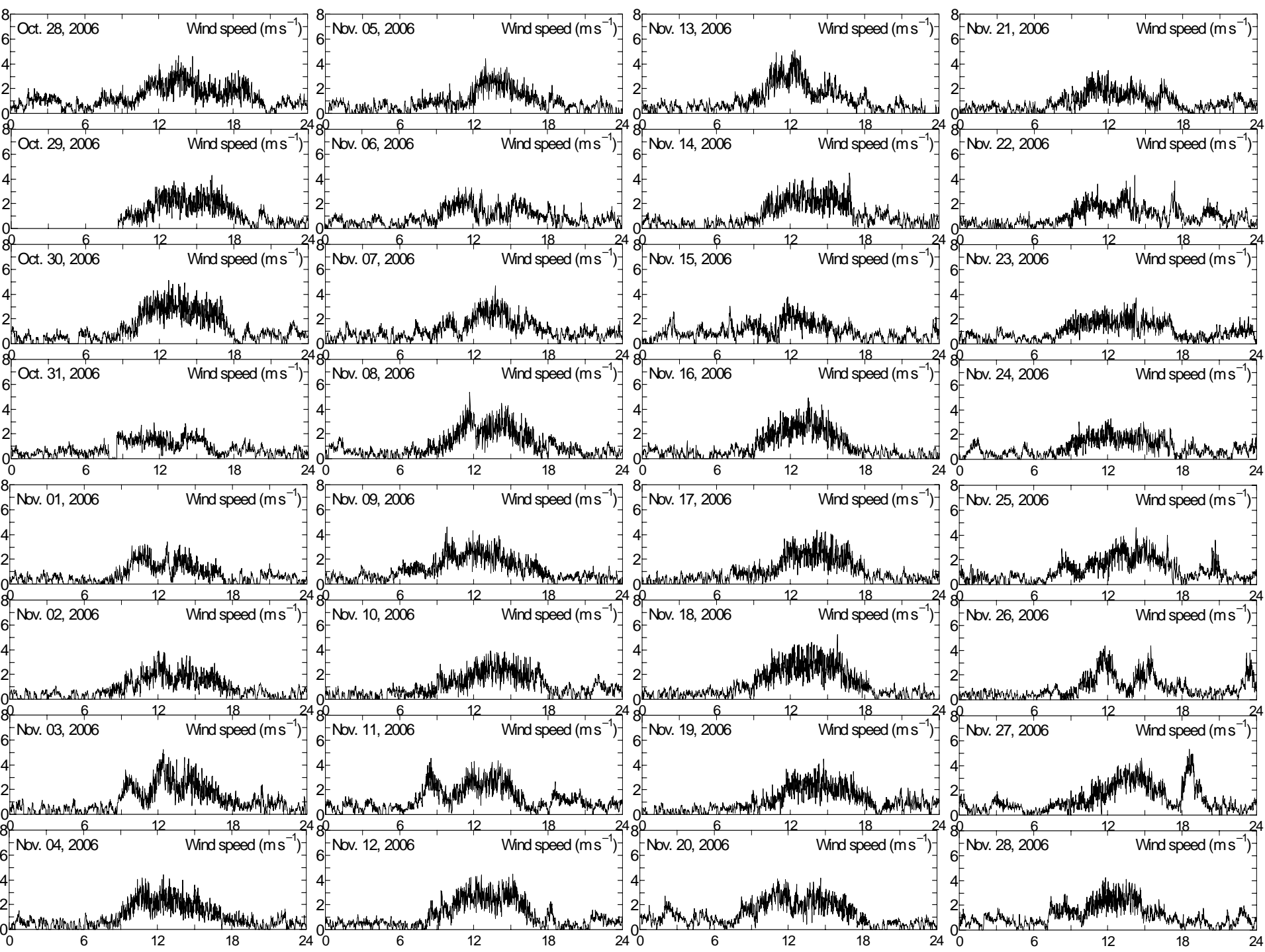
(Schumacher and Houze 2003)

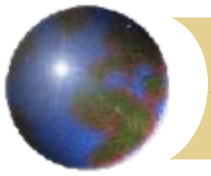
TRMM2A25 (ver.5) の推定初期値



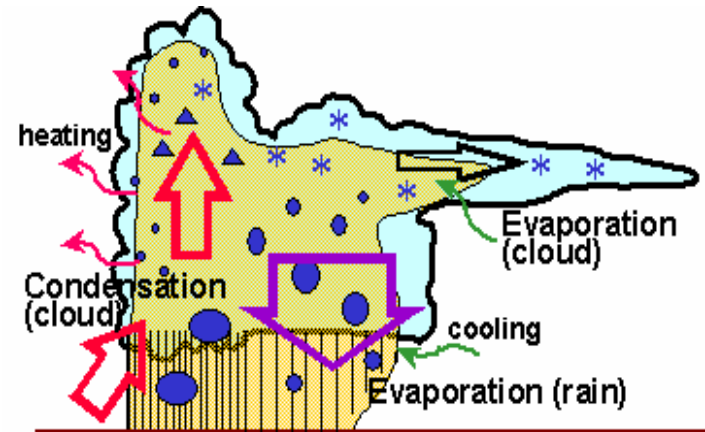
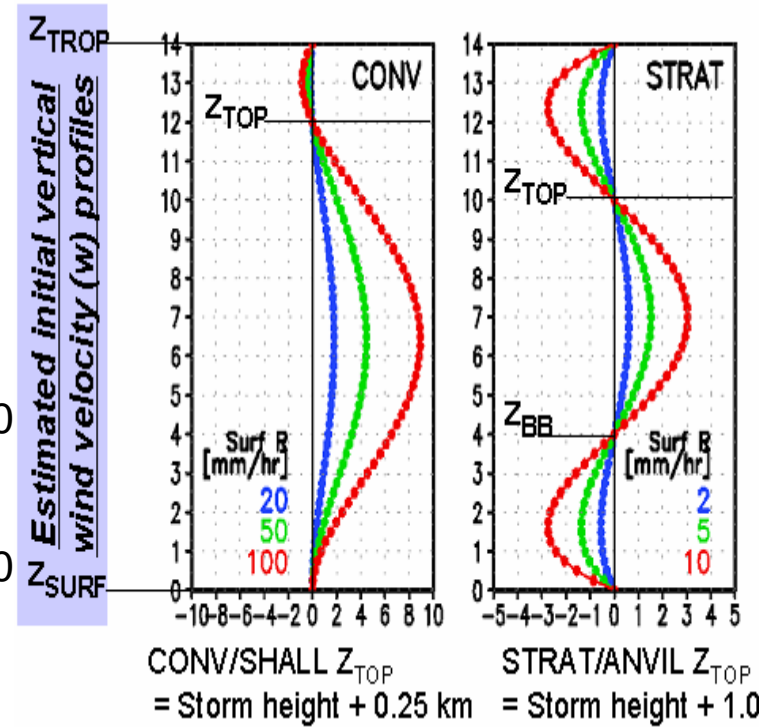
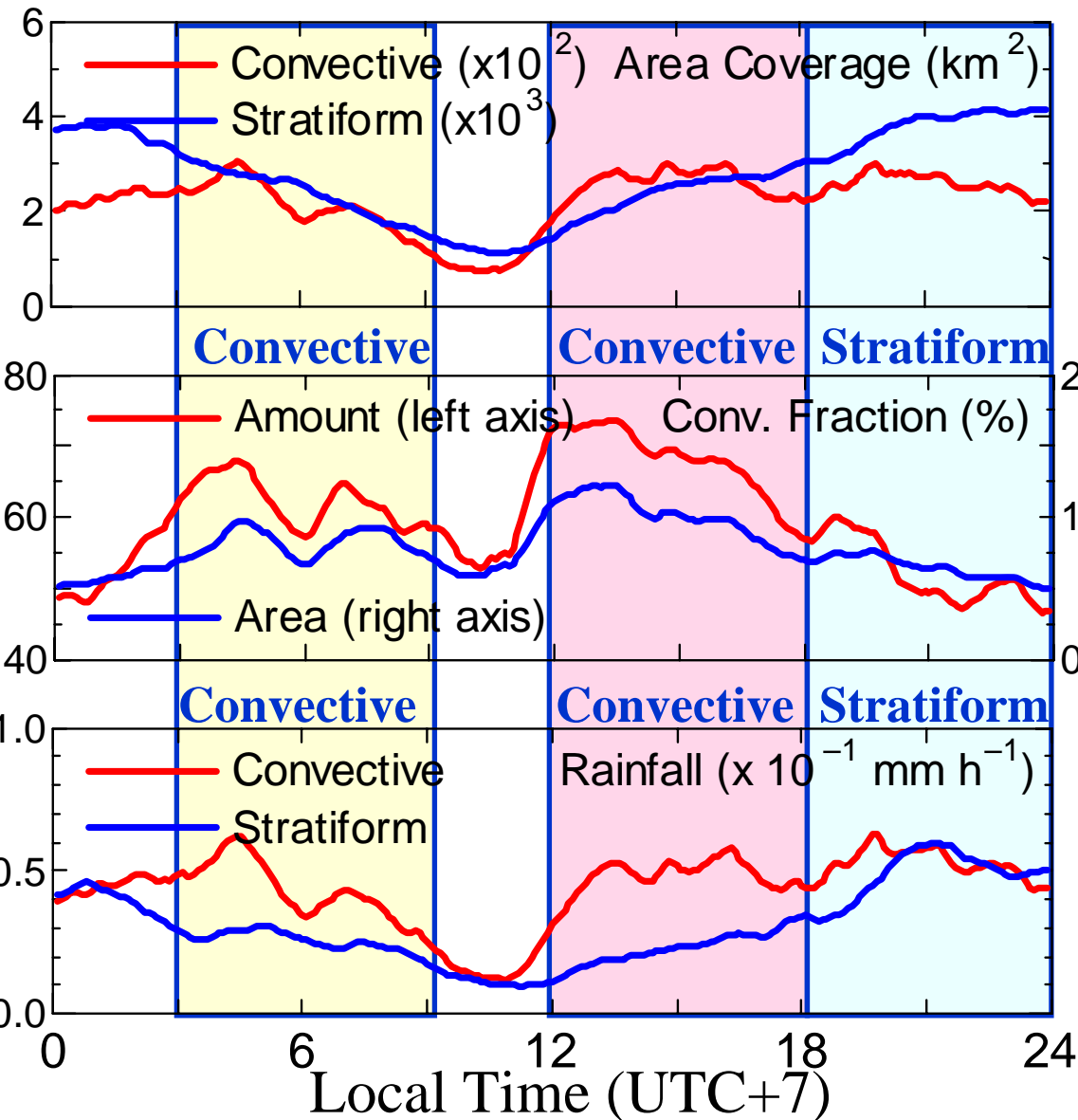
# Diurnal Variations: MAWS Data at MIA-XDR Site

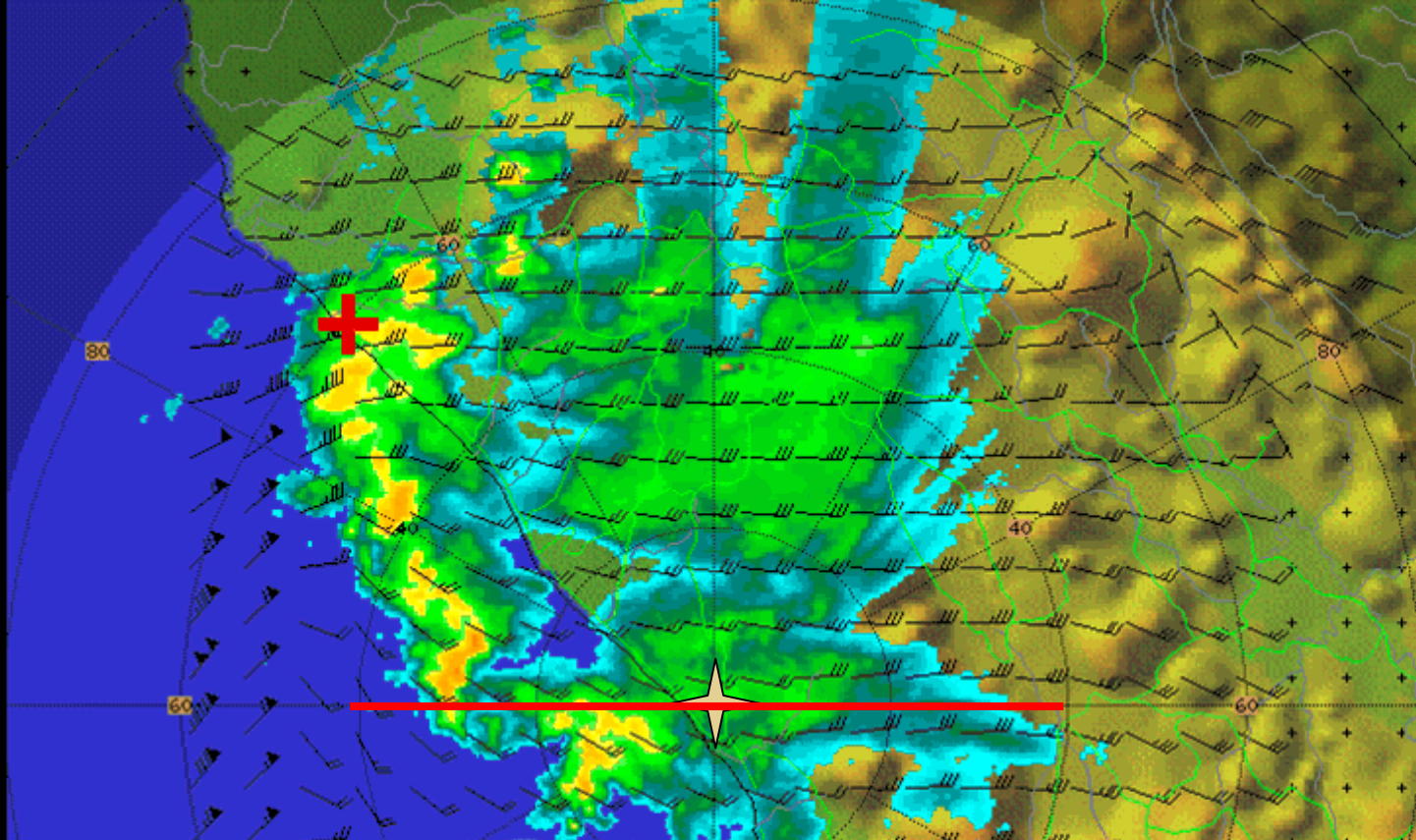




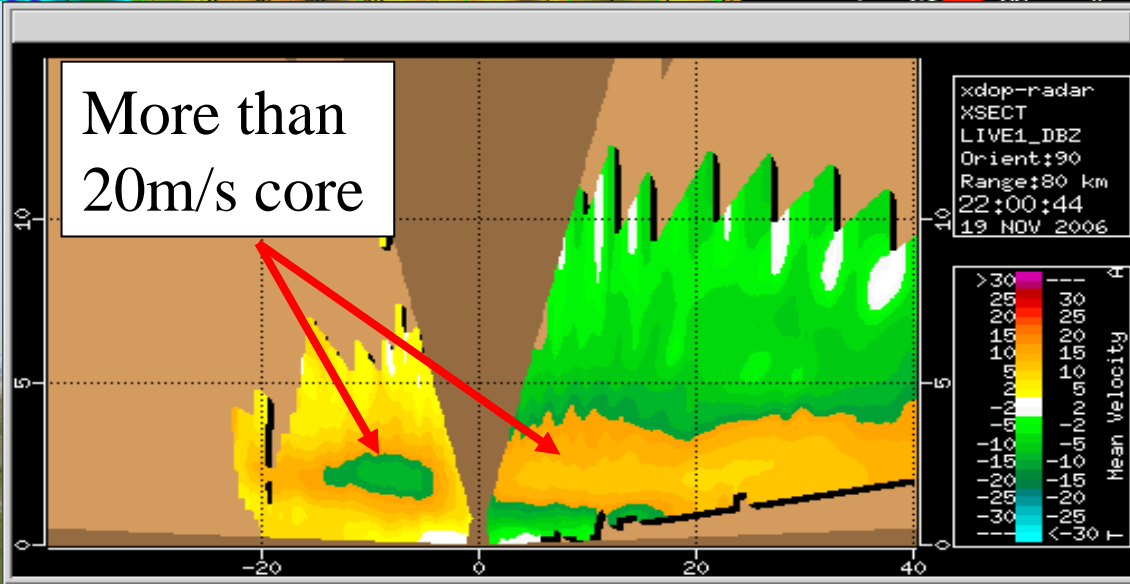
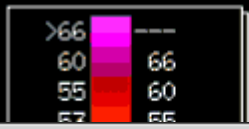


# Echo Area, Convective Fraction, and Rainfall

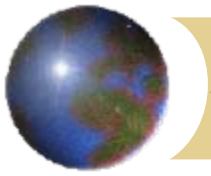




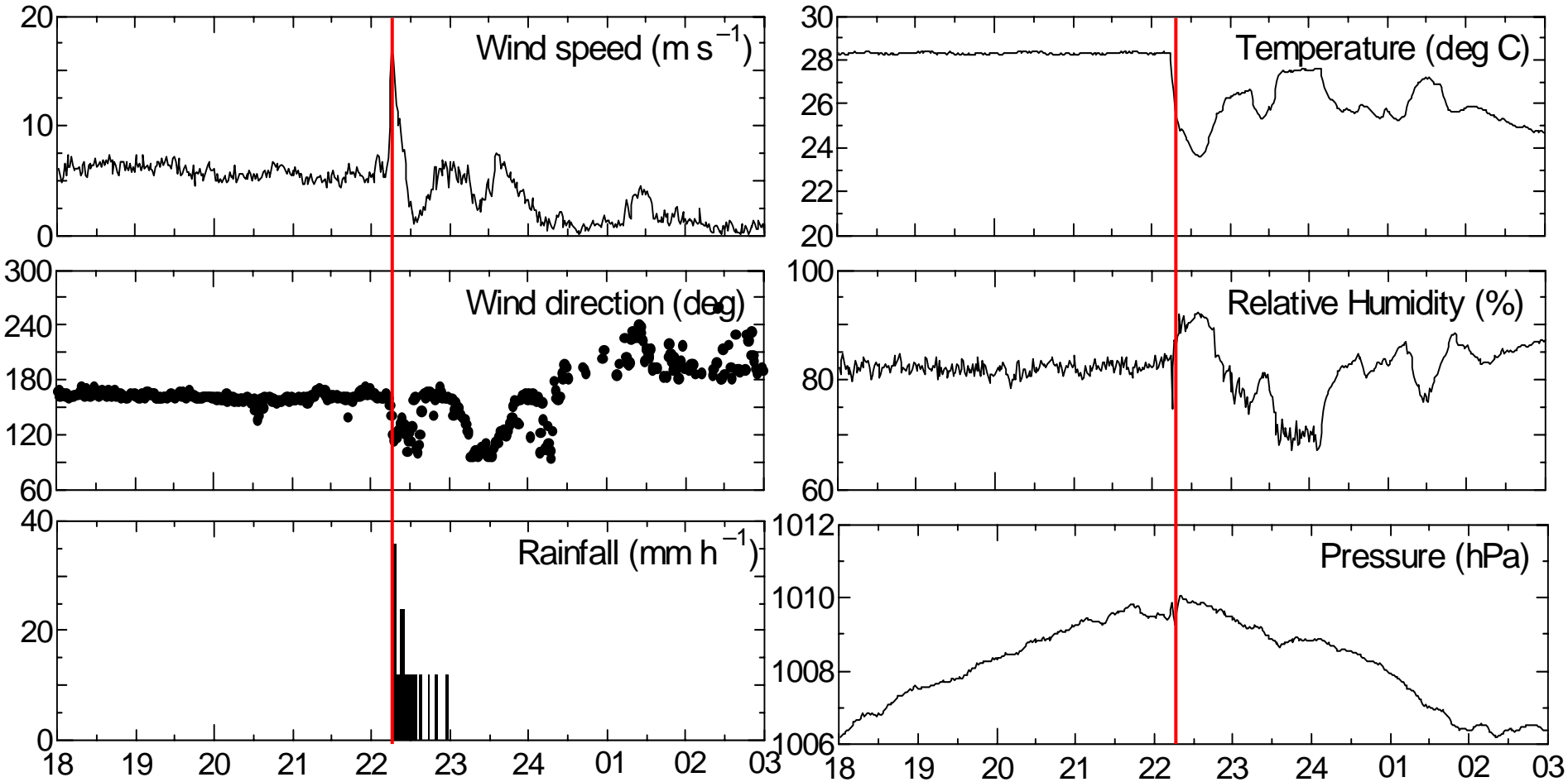
xdop-radar  
CAPPI  
CAPPI2KMZ  
Task: VOL80  
PRF: 1800Hz  
Height: 2.0 km  
Max Range: 80 km  
**22:18:44**  
19 NOV 2006 WIT



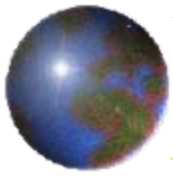




# Severe Gust Event at Tiku-XDR site



1. Striking gust wind of 17m/s observed at 22:15LT with heavy shower.
2. Temperature dropped 4 deg C which is uncommon event in the tropics.
3. Surface pressure and humidity showed unique characteristics, too.
4. **Need further analysis of XDR data to capture the mechanism.**



# Damaged House near the Tiku-XDR Site





# Summary and Future Work

- \* HARIMAUによりXDRやWPRの設置と集中ゾンデ観測
- \* 集中観測データは引き続き解析中, XDRは連続運用中

## ➤ 季節内変動 (ISV)

- ・今回はISV (MJO) 不活発期であり, 対流抑制期に対応.

## ➤ 日周期変動 (DV)

- ・海陸風の交代が著であり, 午後に内陸 (山岳) 部で発生した対流系が発達しながら夜間に海上へ移動する.
- ・海上へ移動後に衰弱する対流系が多いが, 夜間の海上で新たに発生する (線状) 対流系も頻繁に観測された.

## ➤ ISVとDVを結ぶ架け橋 (Missing Link)

- ・ゾンデ観測データも援用し, DV対流系による水蒸気の鉛直輸送や対流不安定の解消, 鉛直加熱 (冷却) 過程等について解析, 検討を進めて行きたい.