The DYNAMO Field Campaign

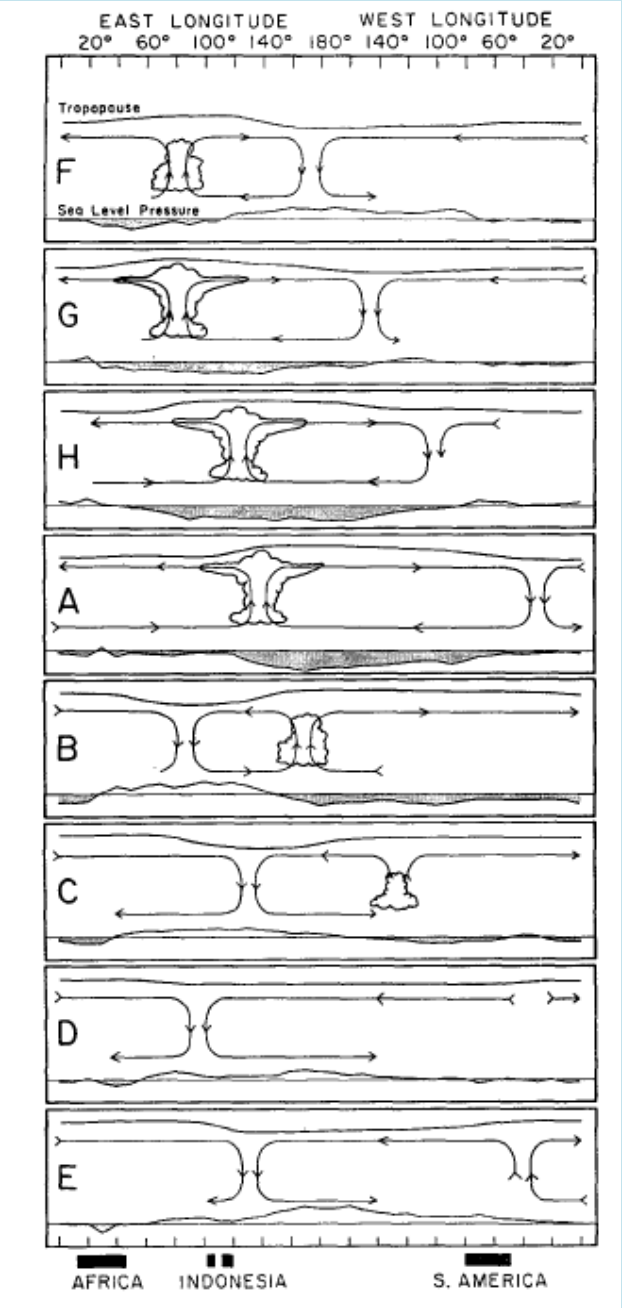
Debriefing for the US CLIVAR PSMIP

July 18, 2012

Chidong Zhang

RSMAS, University of Miami

DYNAMO: Dynamics of the Madden-Julian Oscillation (MJO)



Madden and Julian 1972

DYNAMO: Dynamics of the Madden-Julian Oscillation (MJO)

Importance of the MJO: bridging weather and climate; providing a major source for subseasonal predictability

Main Problems: prediction skill of the MJO, especially its initiation, remains low; most climate models fail to reproduce the MJO.

Goal: To expedite the progress of advancing our understanding of MJO initiation processes and improving simulation and prediction of the MJO

DYNAMO Hypotheses

I. Deep convection can be organized into an MJO convective envelope only when the moist layer has become sufficiently deep over a region of the MJO scale; the pace at which this moistening occurs determines the duration of the pre-onset state.

II: Specific convective populations at different stages are essential to MJO initiation.

III: The barrier layer, wind- and shear-driven mixing, shallow thermocline, and mixing-layer entrainment all play essential roles in MJO initiation in the Indian Ocean by controlling the upper-ocean heat content and SST, and thereby surface flux feedback.

DYNAMO Field Experiment (October 2011 – March 2012)


Falcon

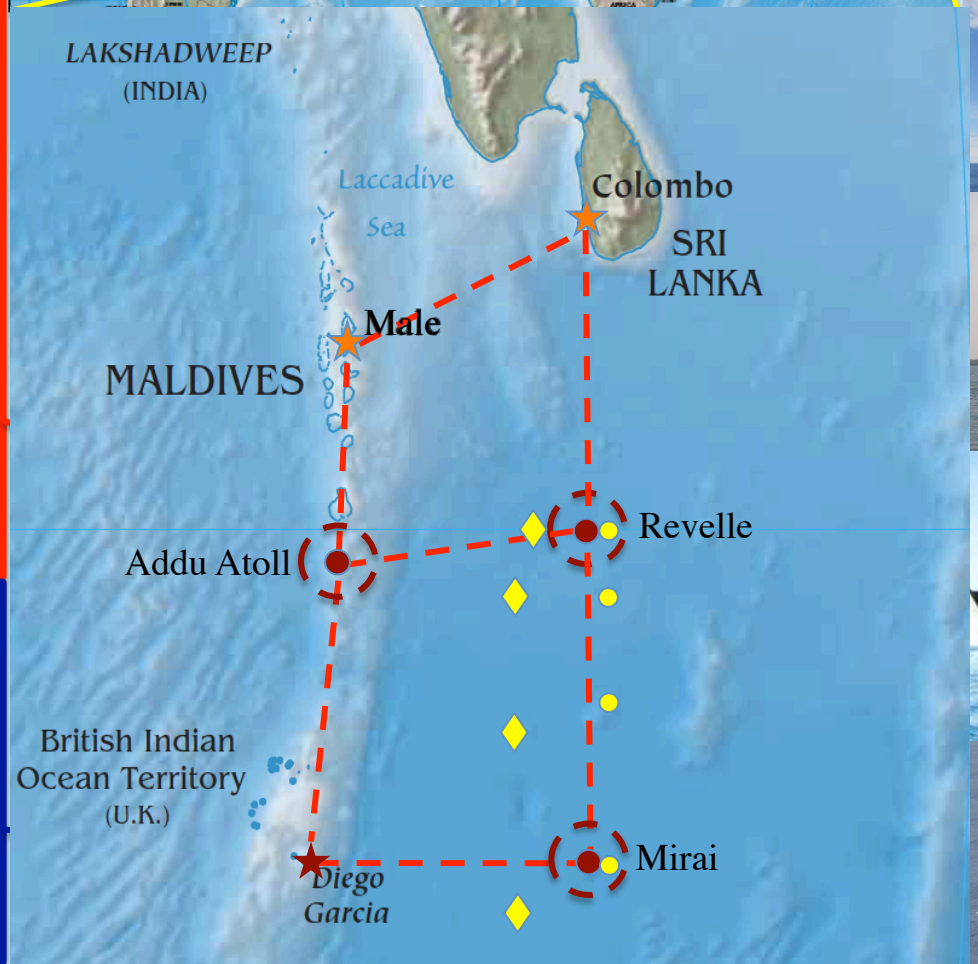

S-PolKa


SMART-R


AMF2


ISS


P-3



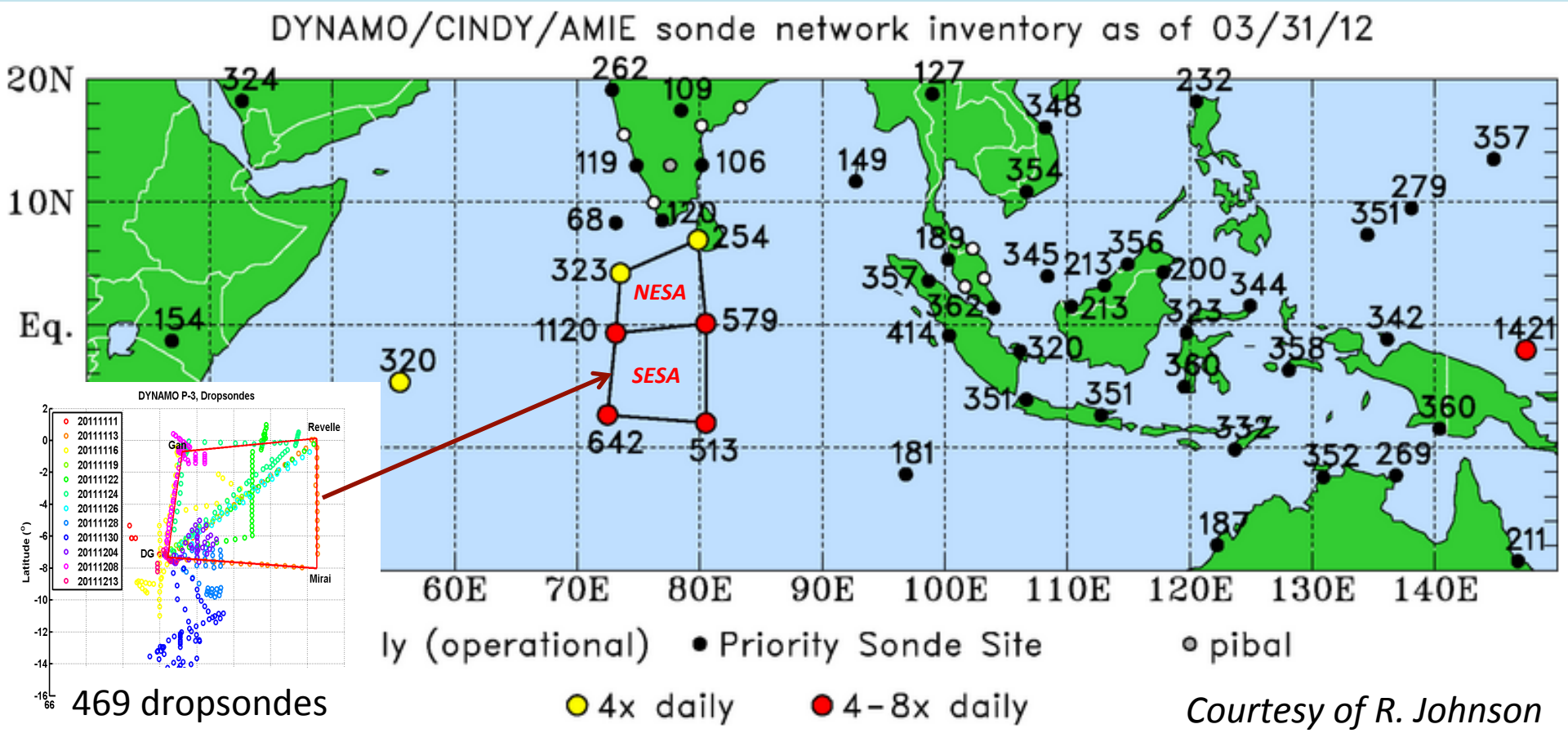

R/V B. Jaya-III


R/V R. Revelle


R/V S. Kanya


R/V Mirai

DYNAMO/CINDY Atmospheric Sounding Network



469 dropsondes

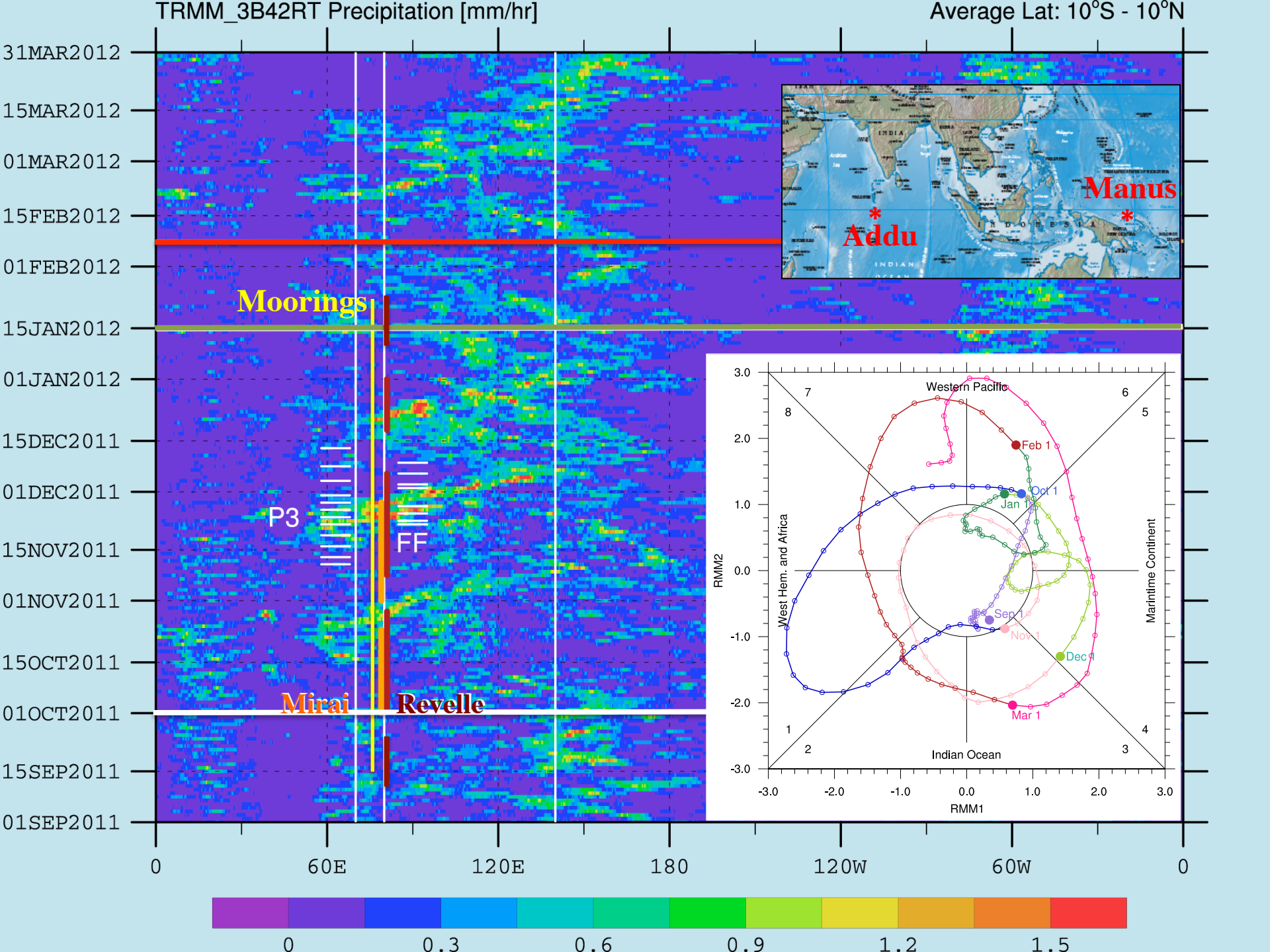
Courtesy of R. Johnson

Total number of soundings: 18,992* + 4,401** = 23,393

* Priority Sounding Site (PSS) sondes: 17,544
Non-PSS sondes: 1448

**Pibals

Total high-resolution soundings: 11,918 (incl. 469 dropsondes)


TRMM_3B42RT Precipitation [mm/hr]
Average Lat: 10°S - 10°N
31MAR2012
15MAR2012
01MAR2012
15FEB2012
01FEB2012
15JAN2012
01JAN2012
15DEC2011
01DEC2011
15NOV2011
01NOV2011
15OCT2011
01OCT2011
15SEP2011
01SEP2011
0
60E
120E
180
120W
60W
0
Moorings
P3
FF
Mirai
Revelle
Addu
Manus
INDIA
INDONESIA
INDIAN OCEAN
Western Pacific
West Hem. and Africa
Maritime Continent
Indian Ocean
RMM1
RMM2
Feb 1
Oct 1
Jan 1
Sep 1
Nov 1
Dec 1
Mar 1
0
0.3
0.6
0.9
1.2
1.5

International Participation:
37 universities (~100 students)
20 centers, laboratories, and organizations

from **fourteen countries:** Australia, France, Korea, India, Indonesia, Japan, Kenya, Maldives, Poland, Seychelles, Sri Lanka, Taiwan, UK, US

US Funding Agencies: NSF, ONR, DOE, NOAA, NASA
(*Thanks to the US Clivar Office!*)

Trilogy of International Field Experiments on tropical Weather and Climate:

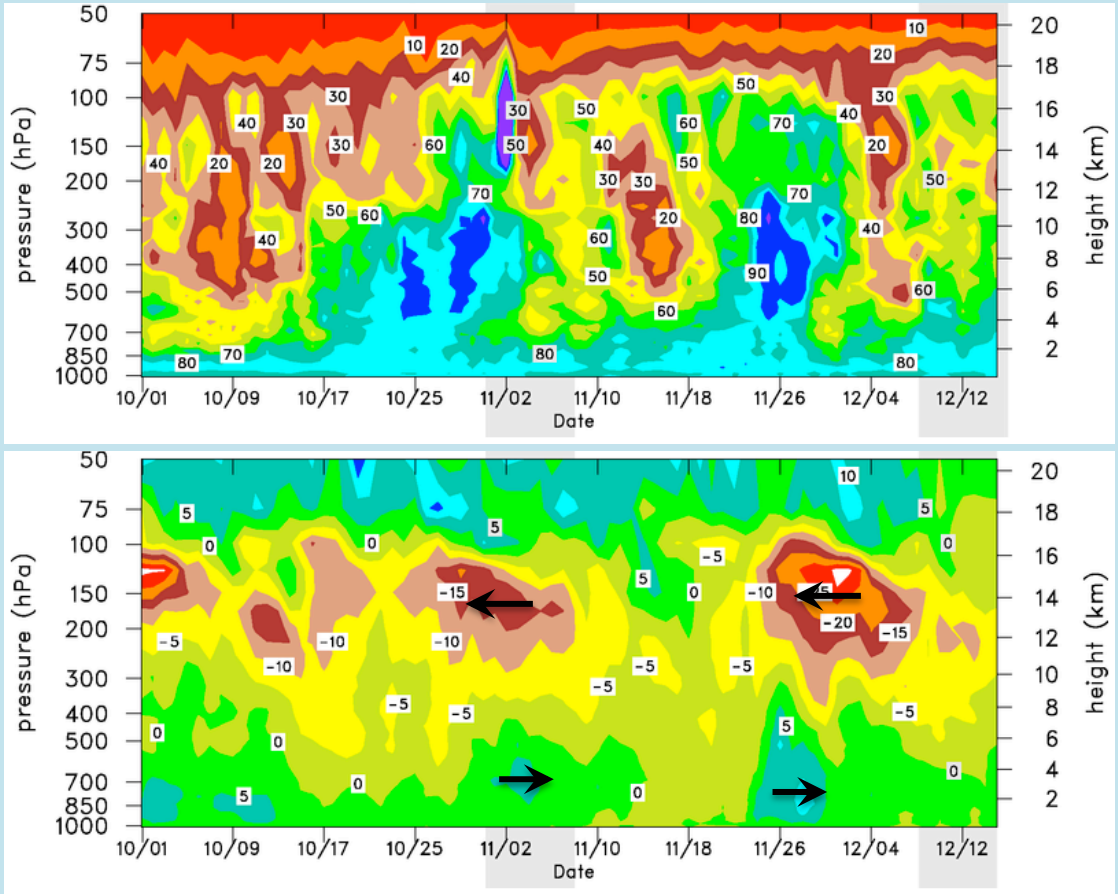
GATE (Atlantic Ocean): 1974

TOGA COARE (western Pacific Ocean): 1992-1993

DYNAMO (central Indian Ocean): 2011-2012

DYNAMO Hypotheses

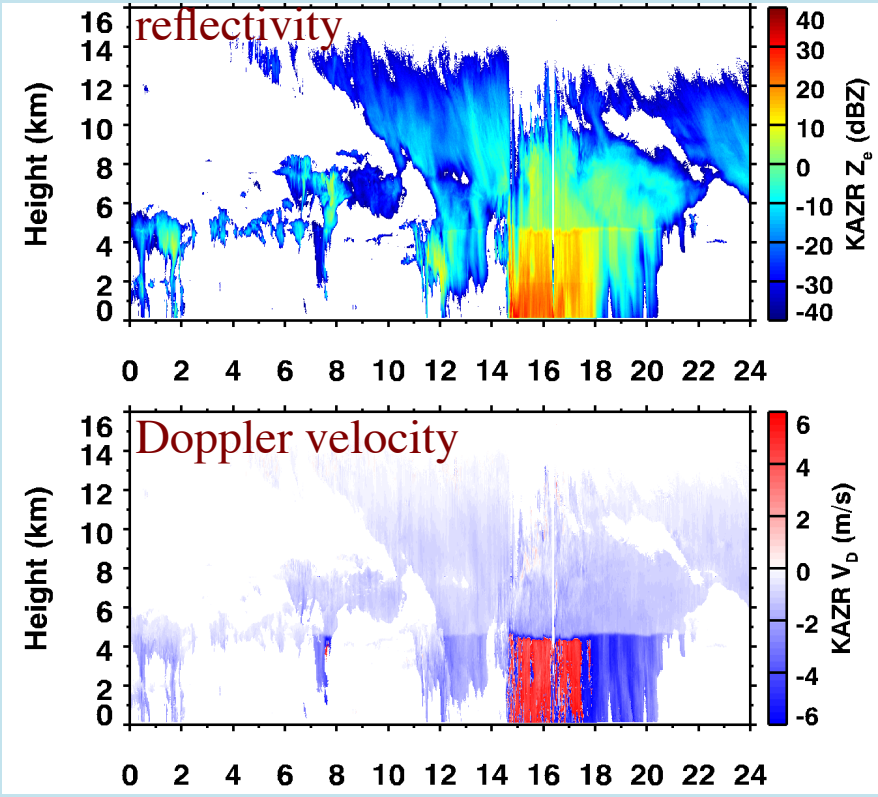
I. Deep convection can be organized into an MJO convective envelope only when the moist layer has become sufficiently deep over a region of the MJO scale; the pace at which this moistening occurs determines the duration of the pre-onset state.



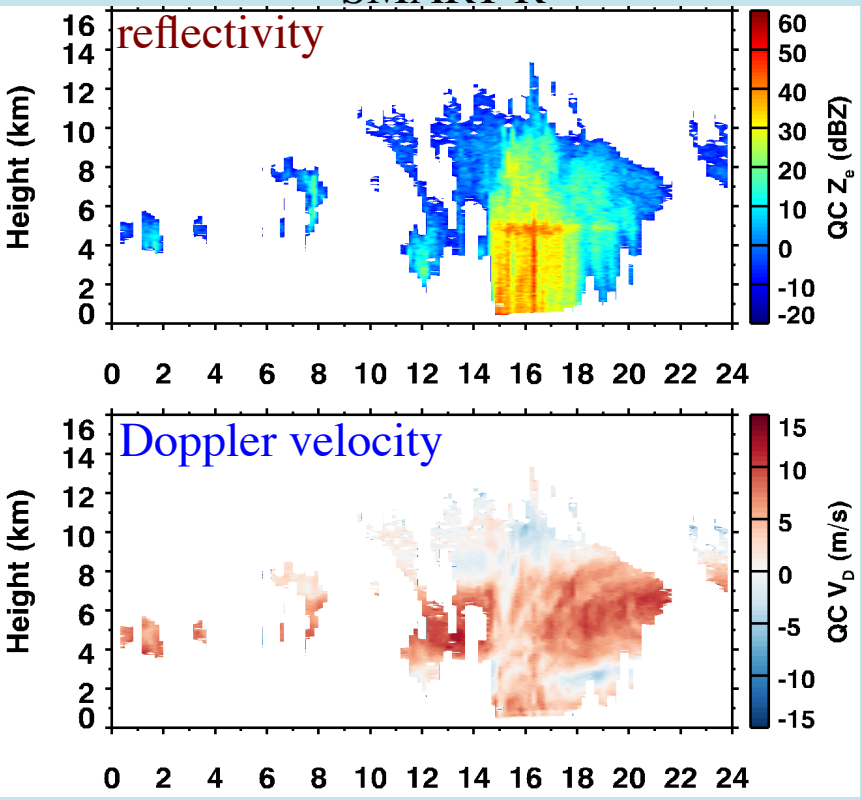
DYNAMO Hypotheses

II: Specific convective populations at different stages are essential to MJO initiation.

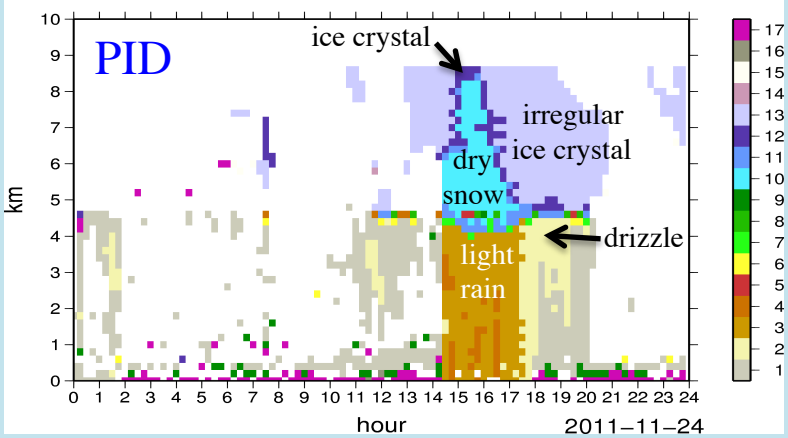
KAZR



SMART-R

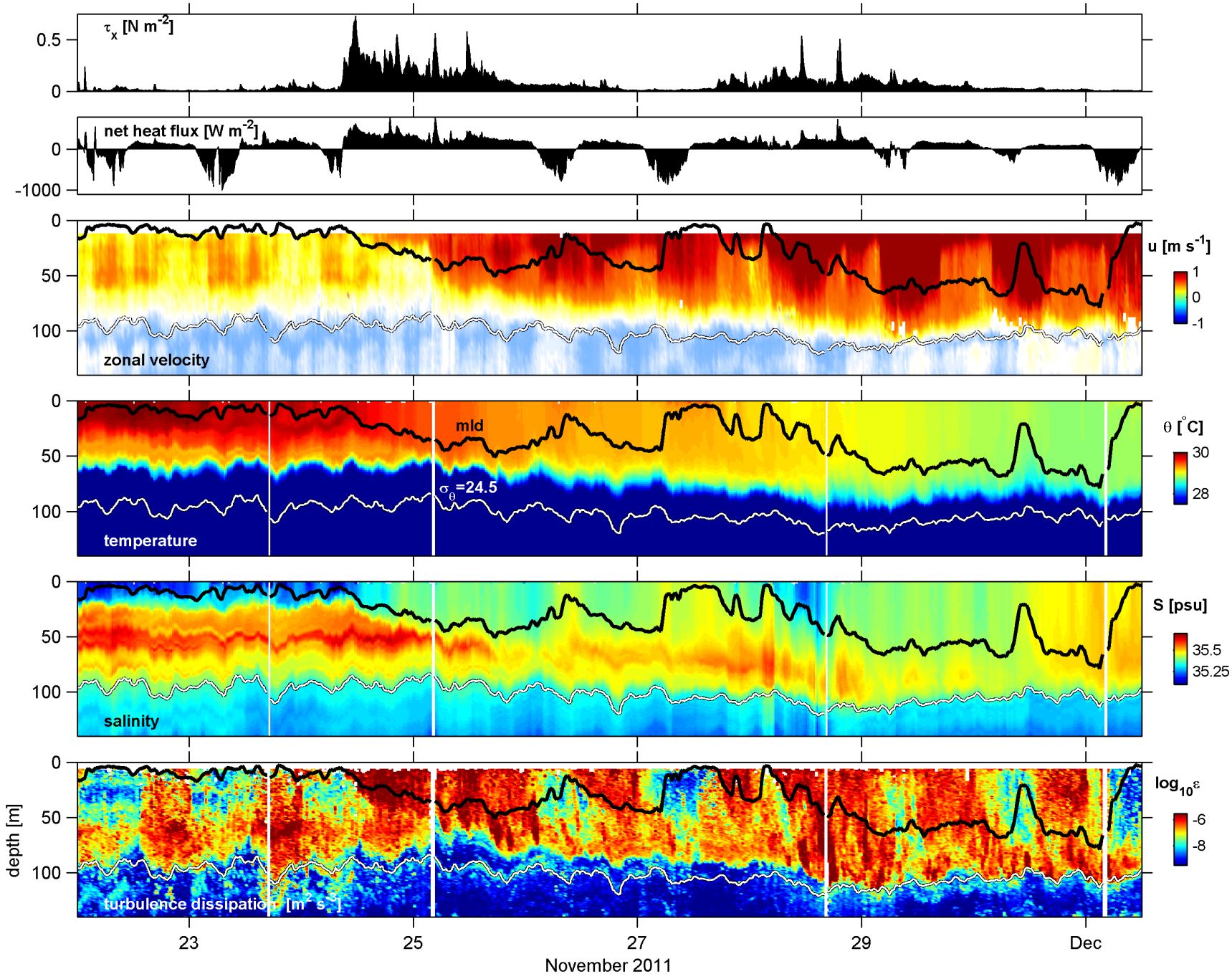


S-PolKa



DYNAMO Hypotheses

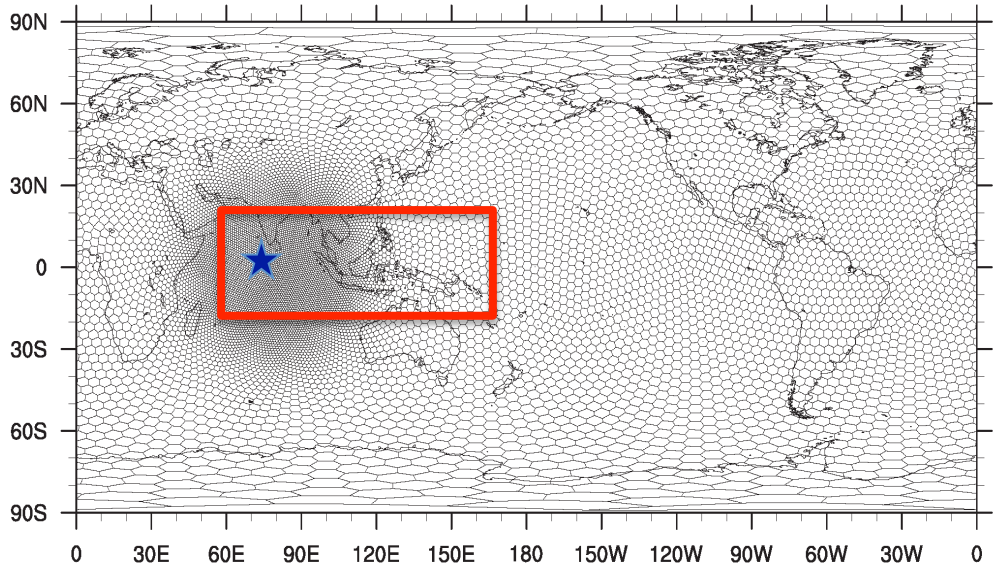
III: The barrier layer, wind- and shear-driven mixing, shallow thermocline, and mixing-layer entrainment all play essential roles in MJO initiation in the Indian Ocean by controlling the upper-ocean heat content and SST, and thereby surface flux feedback.

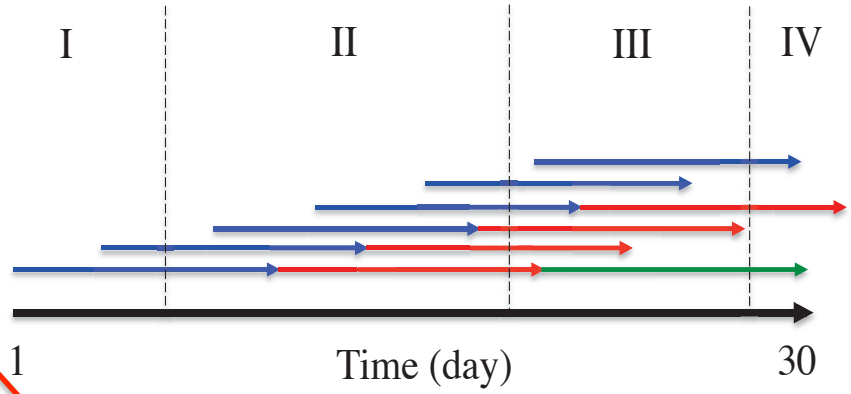

τx [N m-2]
0.5
0
net heat flux [W m-2]
0
-1000
0
50
100
zonal velocity
u [m s-1]
1
0
-1
mld
σθ=24.5
temperature
θ [°C]
30
28
salinity
S [psu]
35.5
35.25
depth [m]
turbulence dissipation [m2 s-3]
log10ε
-6
-8
23
25
27
29
Dec
November 2011

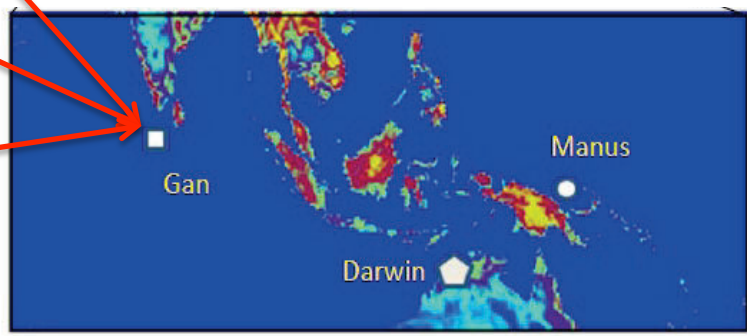
Coordinated DYNAMO activities:

- Denial experiments (ECMWF; NCEP?)
- Assessment of NWP real-time forecast skill (NCEP, NRL, ECMWF, UKMO, JMA, CPTEC, EC, CWA, JAMSTEC) and research model hindcast skill assessment (CSU, GISS, IPRC)
- Unified sounding QC (workshop in February 2012)
- Radar data integration (workshop in August 2012)
- November 24 MJO front case study
- November MJO case study
- Cold pool focused study
- Three MJO comparisons
- DOE project on applications of field observations to cloud resolving modeling

NCAR MPAS
NASA GOES5
PNNL WRF
Harvard SAM
NASA GCE








Thank you!

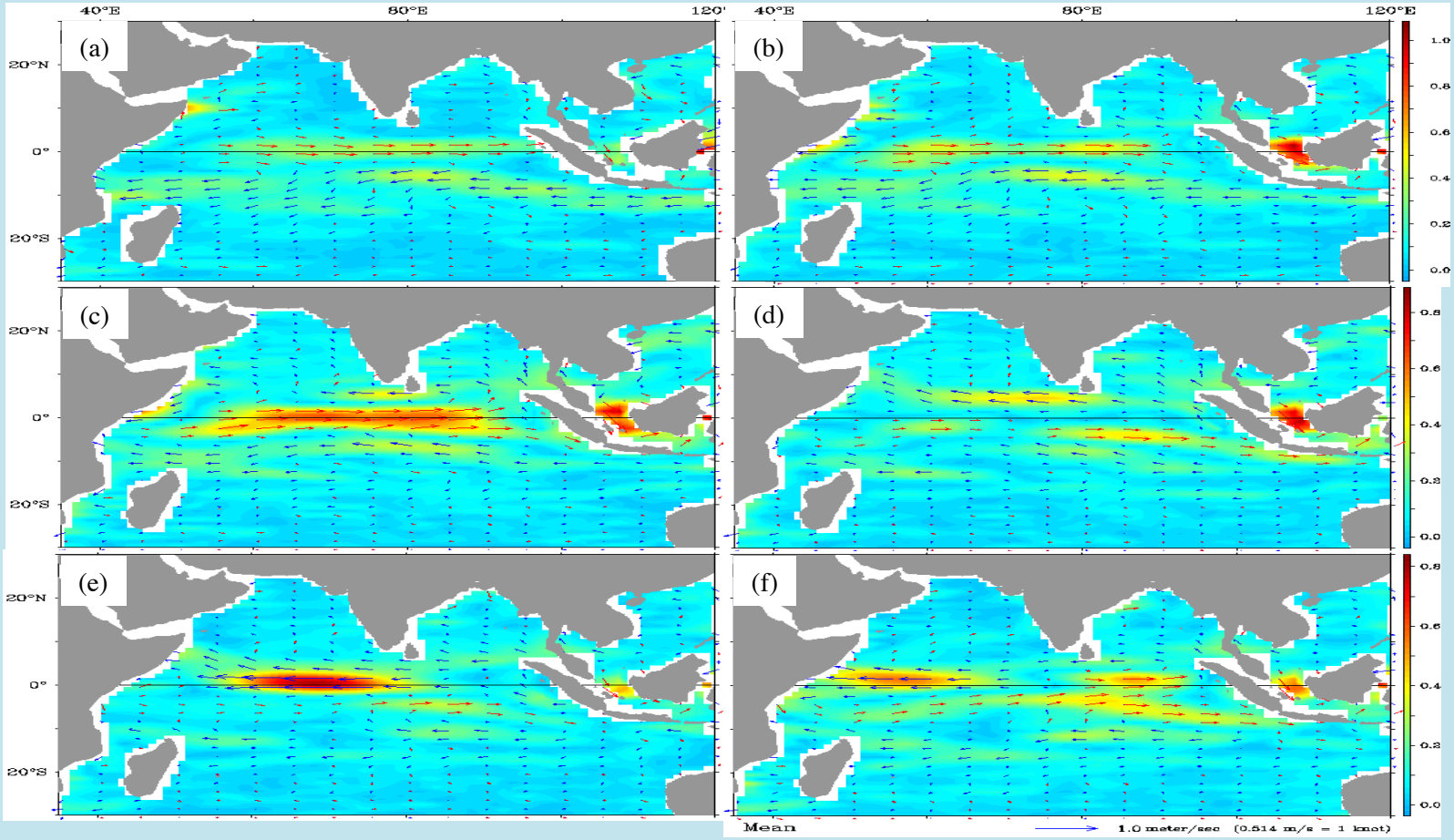
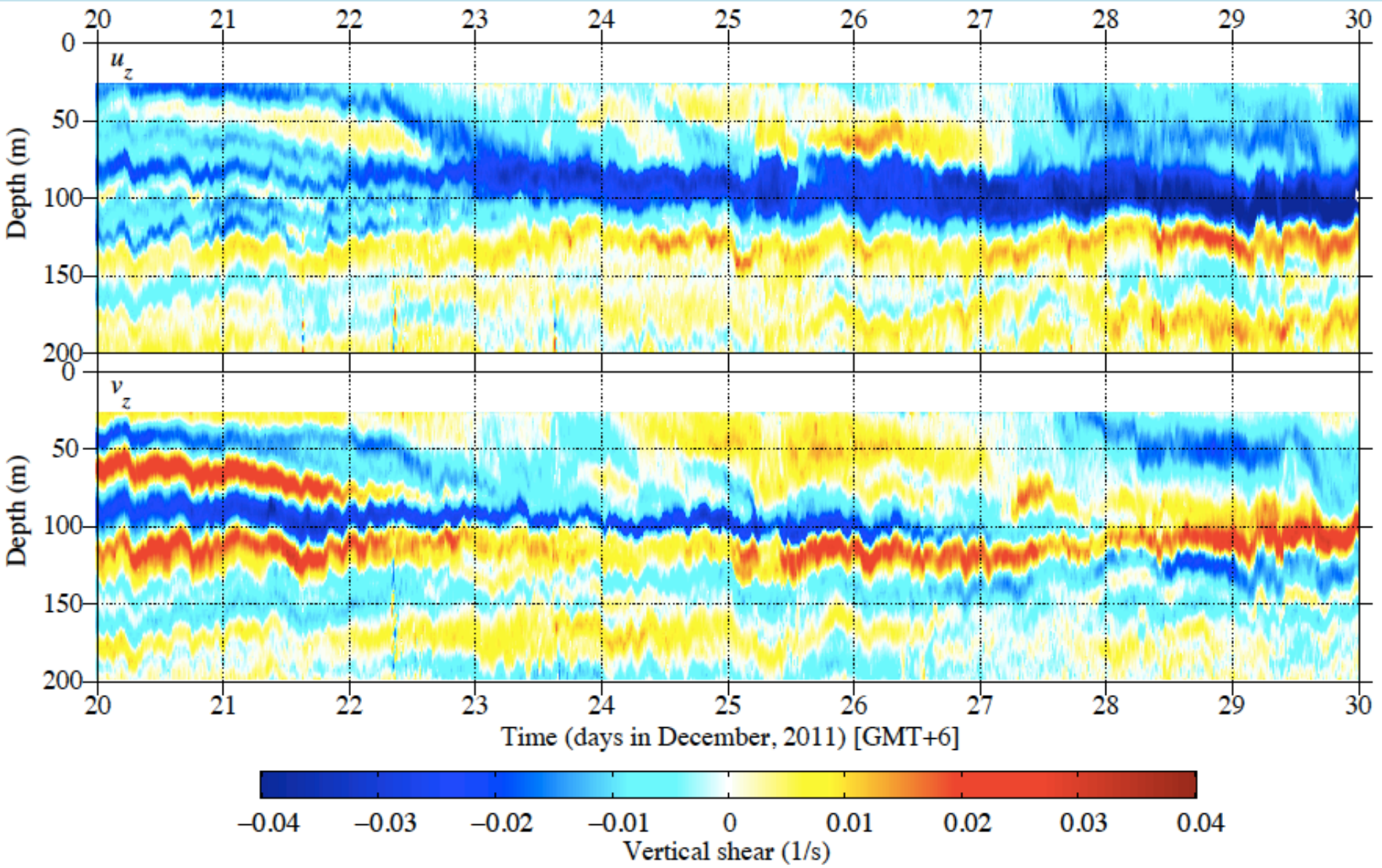
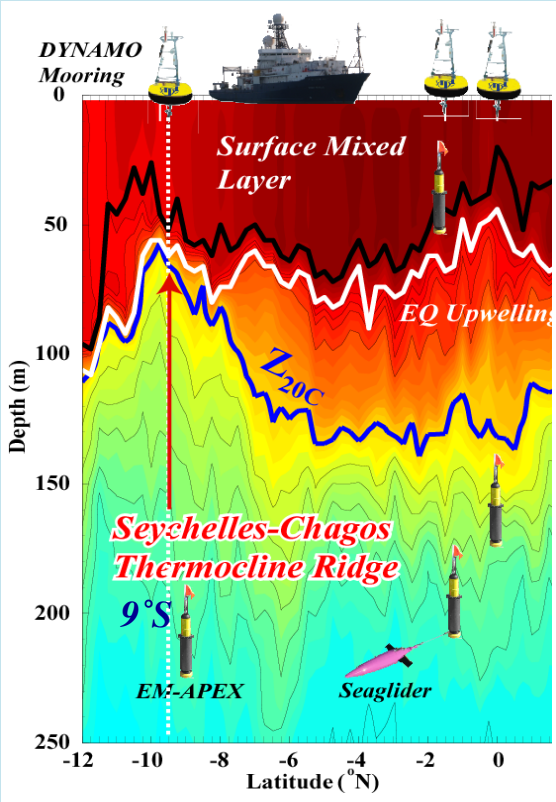
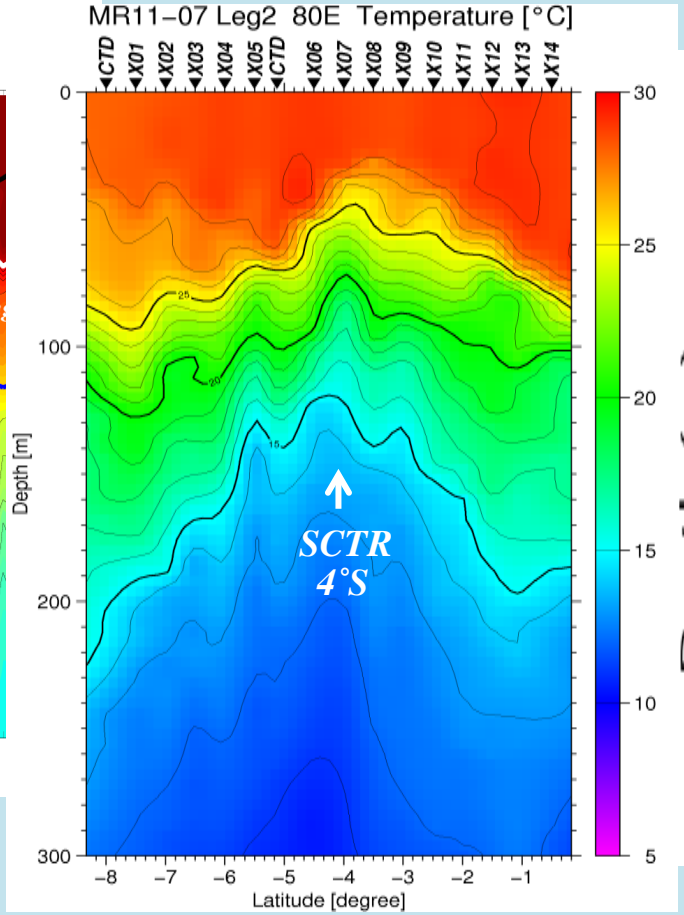


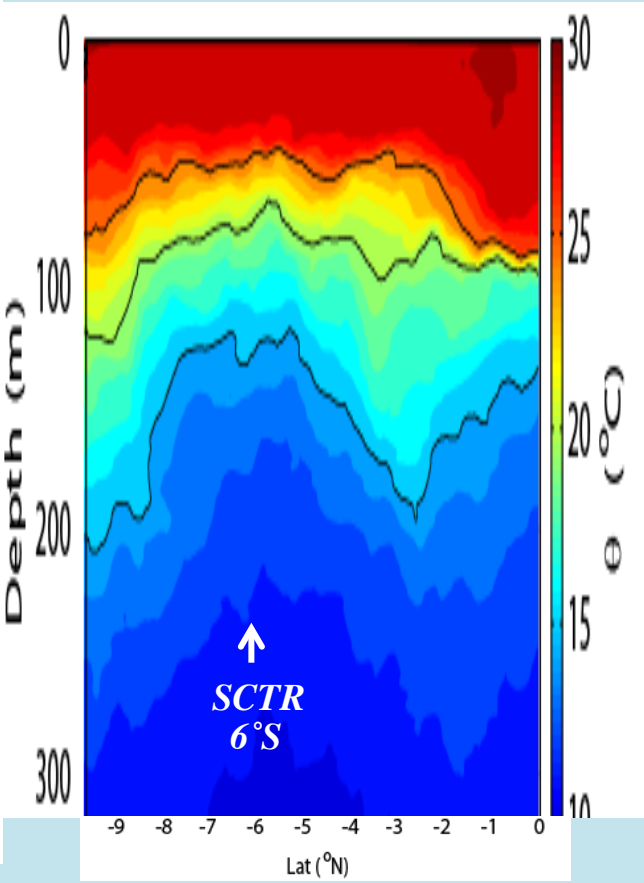
Figure 8 Monthly mean near surface current for (a) October, (b) November, (c) December of 2011, and (d) January, (e) February and (f) March of 2012 from NOAA Ocean Surface Current Analysis - Real time.


20
21
22
23
24
25
26
27
28
29
30
0
50
100
150
200
u_z
v_z
Depth (m)
Time (days in December, 2011) [GMT+6]
–0.04
–0.03
–0.02
–0.01
0
0.01
0.02
0.03
0.04
Vertical shear (1/s)

A migrating Seychelles-Chagos Thermocline Ridge (SCTR)?



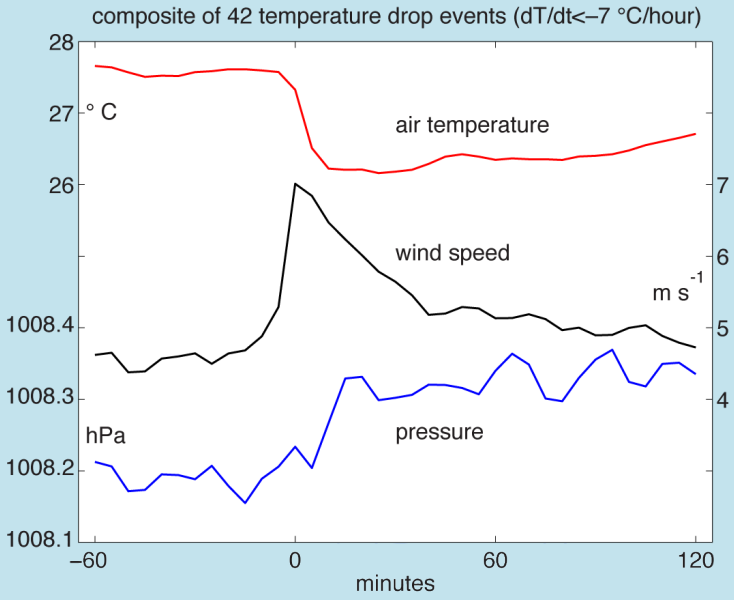


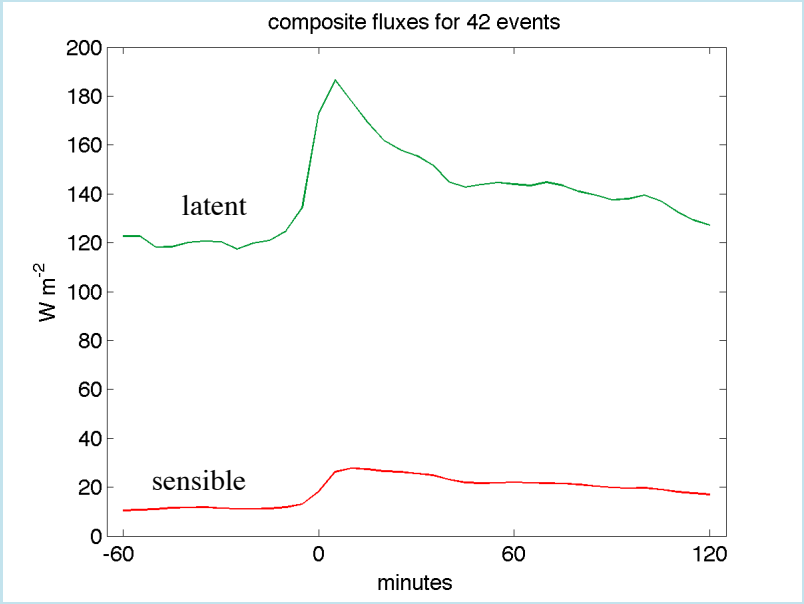


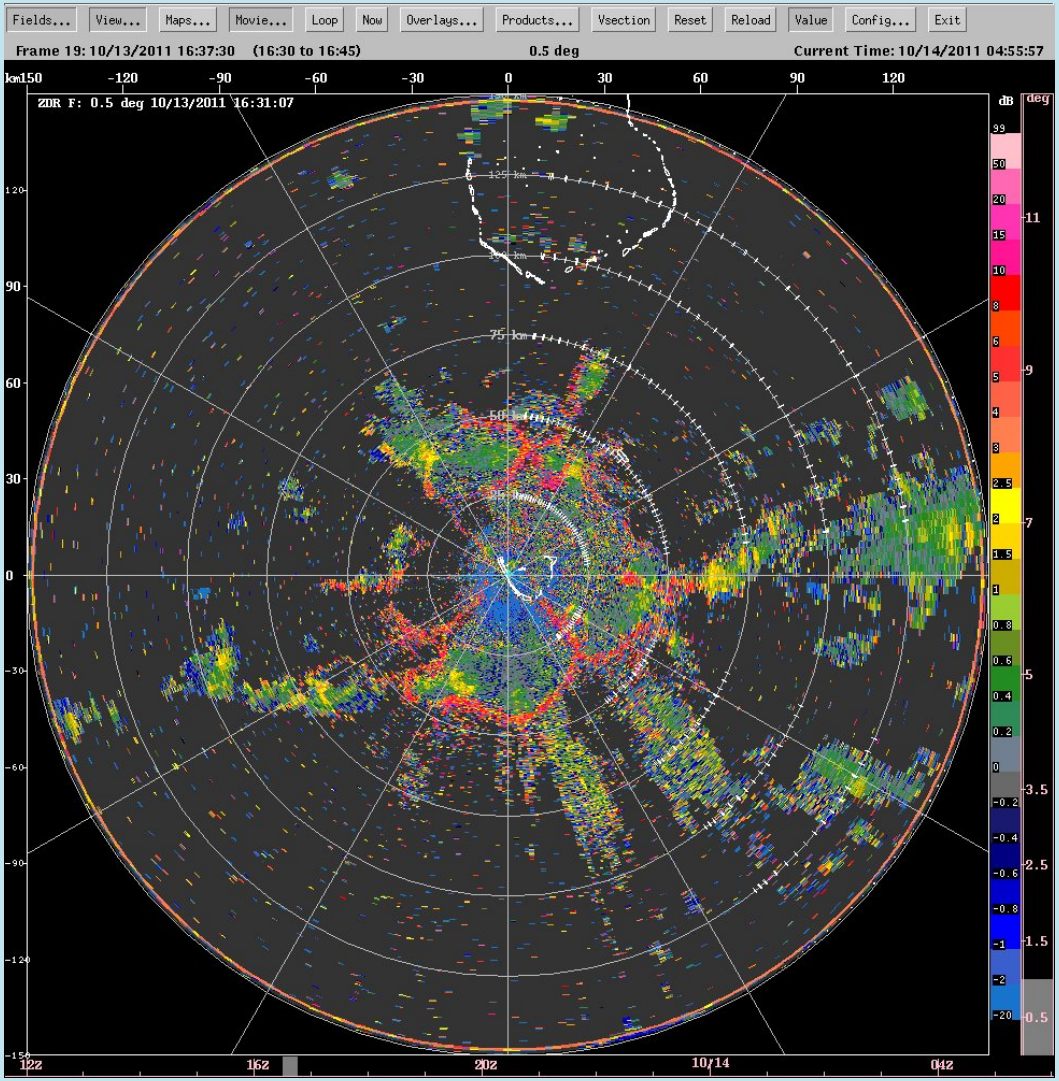
Sep. 9-10, 78.5°E Revelle XBT (RC Lien, UW)

Nov. 28-29, 80.5-78.1°E, Mirai XCTD (M. Katsumata, JAMSTEC)

Jan 2012, SeaSoar (K. Heywood, UEA)


composite of 42 temperature drop events (dT/dt<–7 °C/hour)
28
27
26
° C
air temperature
7
6
wind speed
m s -1
1008.4
1008.3
1008.2
1008.1
hPa
pressure
5
4
–60
0
60
120
minutes


composite fluxes for 42 events
200
180
160
140
120
100
80
60
40
20
0
latent
W m-2
sensible
-60
0
60
120
minutes


Fields...
View...
Maps...
Movie...
Loop
Now
Overlays...
Products...
Vsection
Reset
Reload
Value
Config...
Exit
Frame 19: 10/13/2011 16:37:30 (16:30 to 16:45)
0.5 deg
Current Time: 10/14/2011 04:55:57
ZDR F: 0.5 deg 10/13/2011 16:31:07
km
dB
deg
12z
16z
20z
10/14
04z