

# CINDY2011 / DYNAMO

Cooperative **Indian Ocean** experiment on intraseasonal variability in the Year 2011 / Dynamics of the Madden-Julian Oscillation

1 October 2011- 31 March 2012

## Goal :

collect in-situ observations to advance our understanding of **MJO initiation** process and to improve **MJO prediction and simulation**.

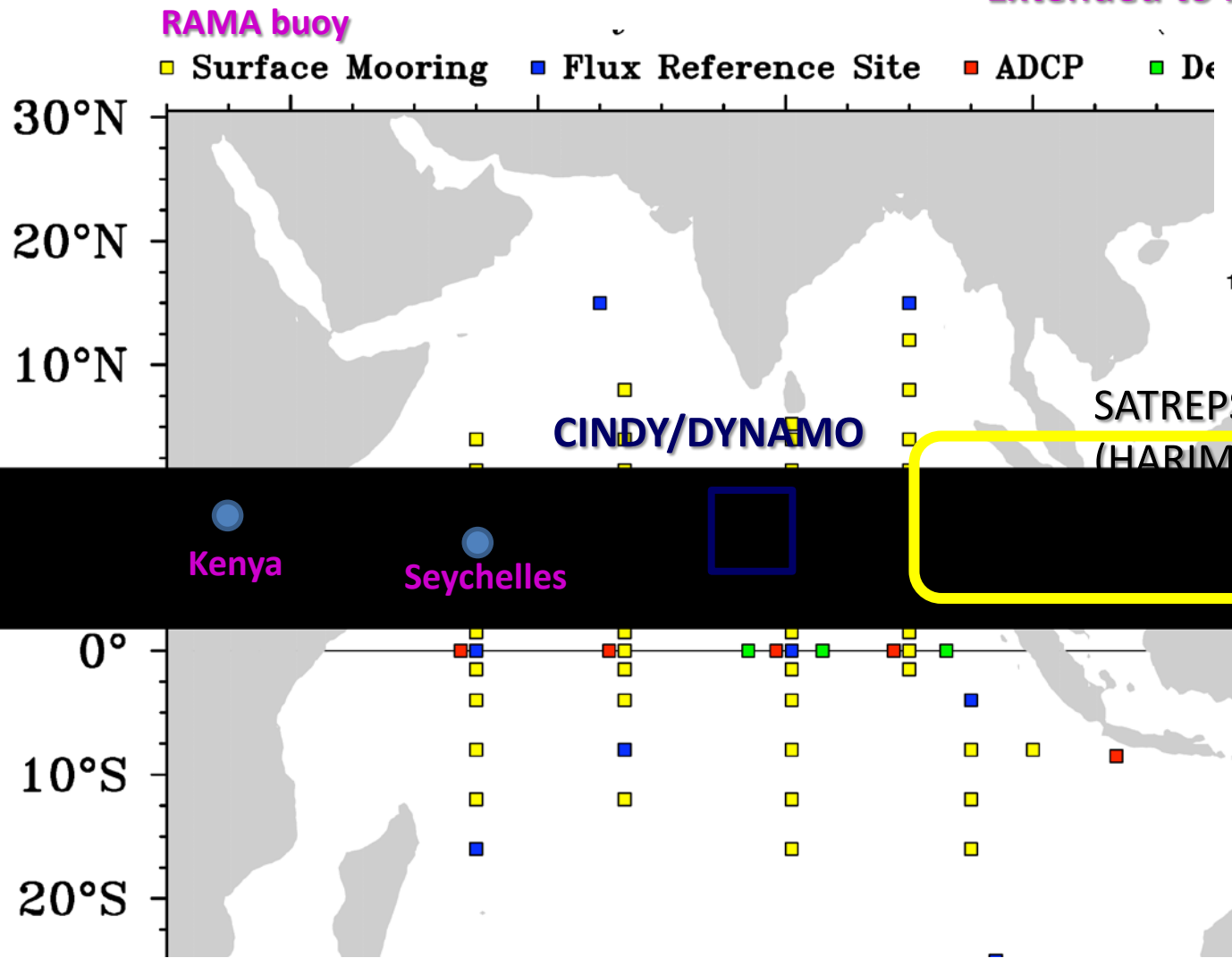
**Key objectives:** to document and understand **broad network**

- 1) the evolution of **heating** and **moisture profiles** associated with the MJO,
- 2) convective, meso-scale, and synoptic evolution through the life cycle of the MJO, **sounding & radar array, aircraft (Falcon, P-3)**
- 3) air-sea interaction associated with the MJO **Ship, RAMA buoy**

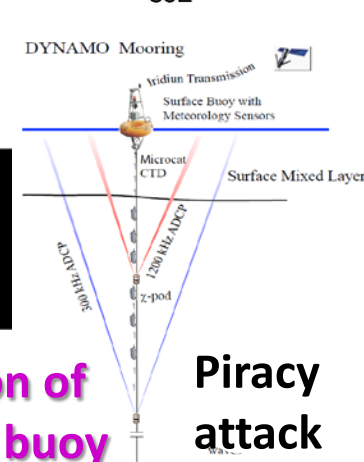
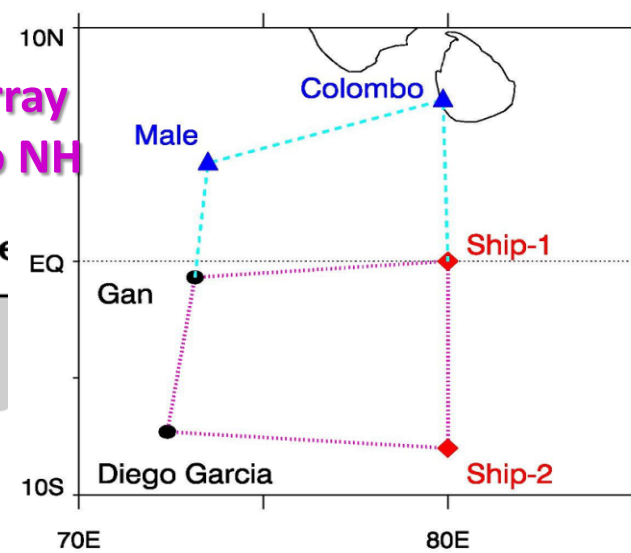
## Special remarks :

- 1) multi-national participation (Japan, USA, India, Indonesia, France, Maldives, Seychelles, Kenya, Sri Lanka, Australia)
- 2) **observation-modeling** synergy (**real-time forecast**, hindcasts, reanalysis)
- 3) endorsement from **CLIVAR-SSG**. **NCEP/CPC, NRL, JAMSTEC (NICAM)**

# Updates of observation plan

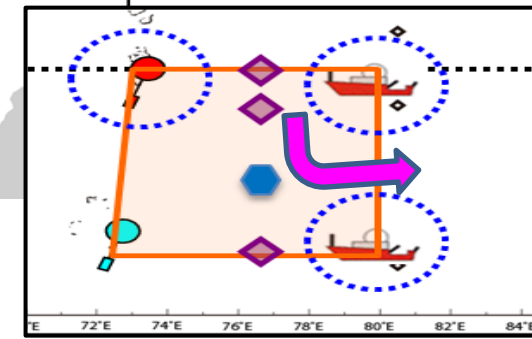


Sounding array  
Extended to NH



Re-location of  
DYNAMO buoy

Piracy  
attack



CINDY Workshop, @Yokomaha, 8-11 Nov, 2010

4<sup>th</sup> DYNAMO Workshop, @Miami, 28 Feb-2 Mar, 2011

# Observation Network of CINDY2011 / DYNAMO + Collaborative Projects

Ship-1 & 2 sites will be occupied by 4 ships

Radar, sounding, aircraft



Gan ; Super site

Japan / Mirai



US / Roger Revelle



India / Sagar Kanya



Indonesia/Baruna Jaya



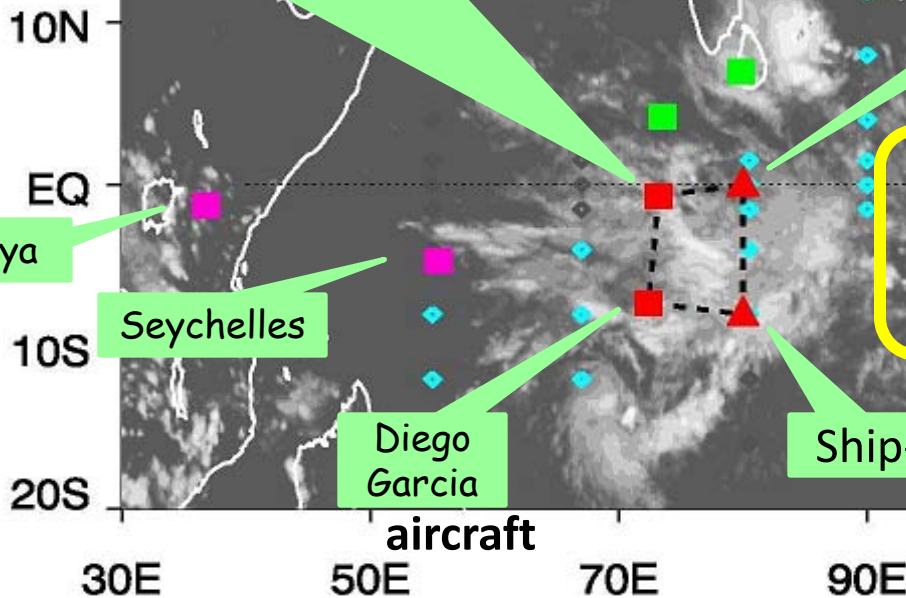
Ship-1

Kenya

Seychelles

Diego Garcia

Ship-2



aircraft



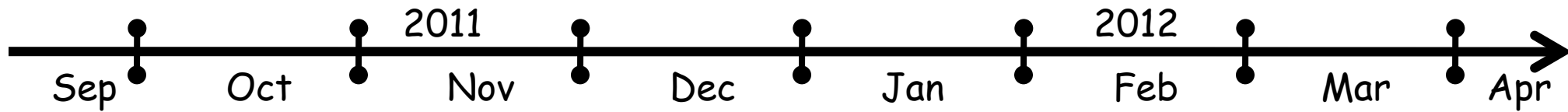
SATREPS  
Indonesia/Japan



ARM MJO Investigation  
Exp. by US DOE

Observation network will be formed over the central equatorial Indian Ocean with Islands, ships, and moorings. By combining relevant projects, it is possible to monitor the entire life cycle of MJO convection from IO to Pacific

# Observation Period



(2 months)

## Special Obs Period

Enhanced Sounding &  
Radar Observations

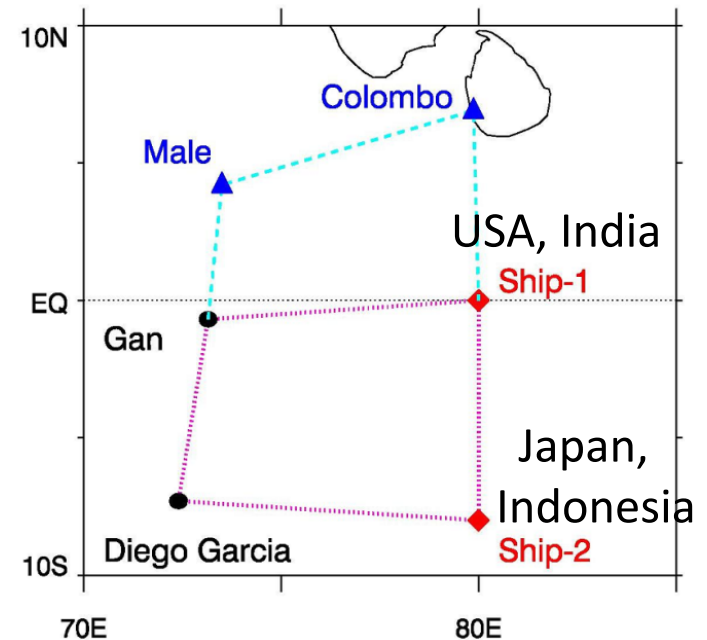
\* 8 times/day Sonde  
+ Northern Array

## Intensive Obs Period (3.5 months)

Sounding & Radar array  
Ship, Land-based, Buoys, Floats, etc.

## Extended Obs Period (6 months)

Land-based sites (SMART-R, AMF2, etc.)



# CINDY/DYNAMO modeling activities

## Real Time Forecasts:

Assist field operations (i.e., aircraft), give general view of past and on-going large-scale weather conditions, and for post-field data analysis

**'dry run' is operated by NCEP, NRL → EOL field data catalog (web)**

NCEP CPC (GFS, GEFS, CFS, diagnostics), NRL (COAMPS, triply nested)

JAMSTEC (stretched NICAM), Meteo-France (Aladin-Reunion, operational)

POAMA ??

## Hindcasts, process oriented post-campaign studies:

**15 Global Models, 3 Regional Models, 5 Small-domain Models**

Model intercomparisons

Collaboration with other projects

## Reanalysis: (need more inputs & collaboration)

Observational data transfer to operational centers through GTS

Special reanalysis for CINDY/DYNAMO: NCEP, JAMSTEC(ALERA), ECMWF(??)

# CINDY/DYNAMO modeling activities

## Real Time Forecasts:

**'dry run' is operated by NCEP, NRL → EOL field data catalog (web)**

to get the PIs familiar with the data products to be employed during DYNAMO, receive feedback from the PIs, and to finalize data products in advance of the start of the field stage.

NCEP CPC (Global Forecast System, Global Ensemble FS, Climate FS, operational, weekly updated forecast & diagnostics released)

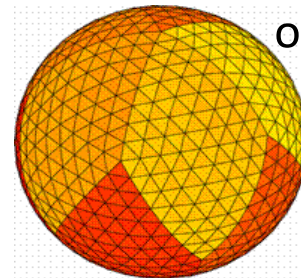
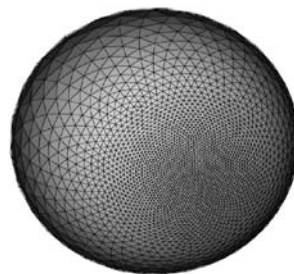
NRL (COAMPS, triply nested regional coupled model)

- *Resolution:* 27 and 9 km (452x252,226x181), 40 vertical levels One ocean (NCOM) grid, 1/8 degree (811x433), 60 vertical levels, 23 sigma layers, One wave (SWAN) grid (406x207), 33 freq (1-24s), 36 directions. The model domain covers the entire IO and Maritime Continent.
- *Length of forecasts:* Goal is 5-day forecasts
- *Data assimilation Frequency:* Twelve hour update cycle
- *Coupling:* fully 6-ways with 6 minute coupling interval

# NICAM simulation plan

Nonhydrostatic ICosahedral Atmospheric Model

stretched grid



original grid

## 1. real-time forecasts

Model: regionally stretched NICAM

Resolution: 14~28km mesh 90deg x 90 deg domain (center: 80E, 8S)

Length of forecasts: 7-days (5-days prediction)

Period: Oct. – Nov. 2011 → Mirai (e-mail)

(+ Sep., Dec. 2011, Jan.-Feb. 2012)

Frequency: 3 (or 6) times / week

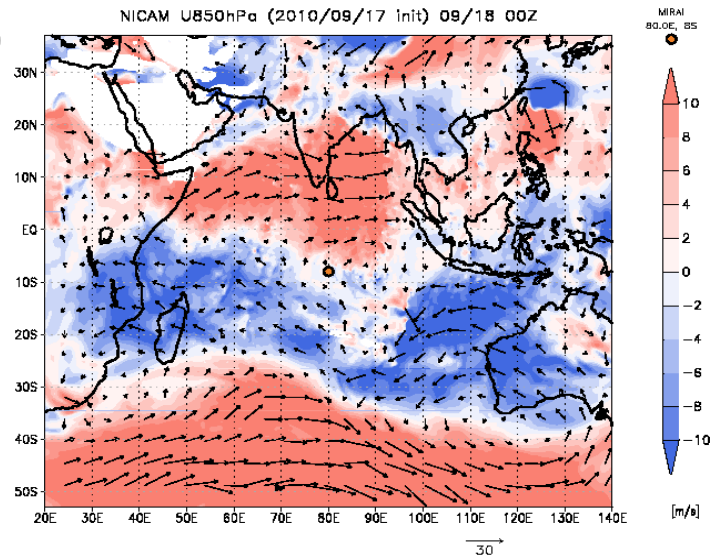
## 2. Hindcast with original NICAM (after IOP)

1-2 month run with 14 km mesh

(Oct. – Nov. 2011 and/or prominent event)

1-2 month run with 7 km mesh

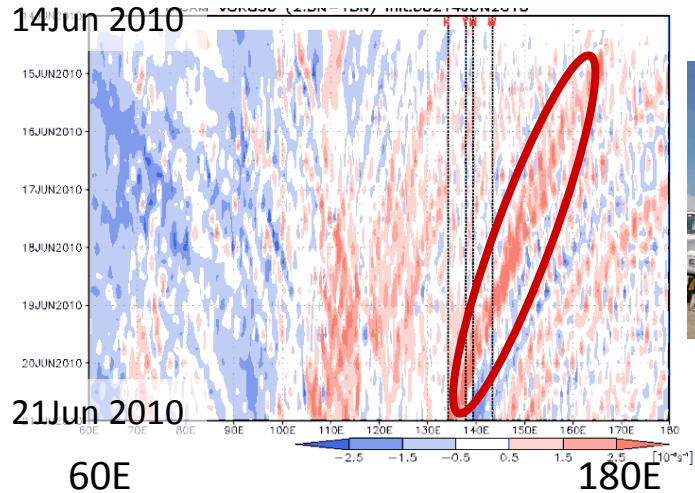
option: ensemble run with 14-km mesh



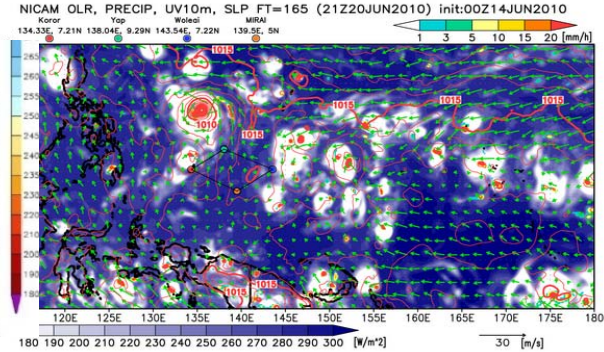
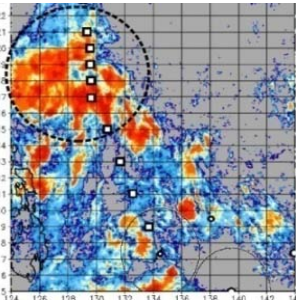
# Realtime forecast PALAU2010 field experiment (stretch grid)

May-June 2010

Vorticity (850 hPa) 5N-5S



Aircraft observation (Moteki et al.)

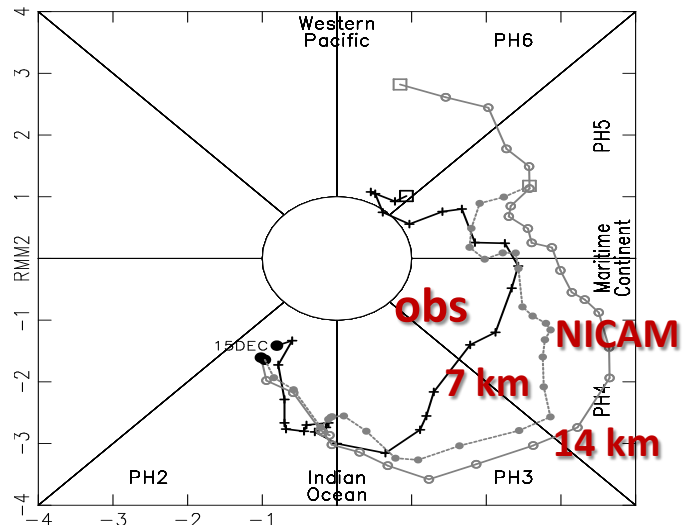
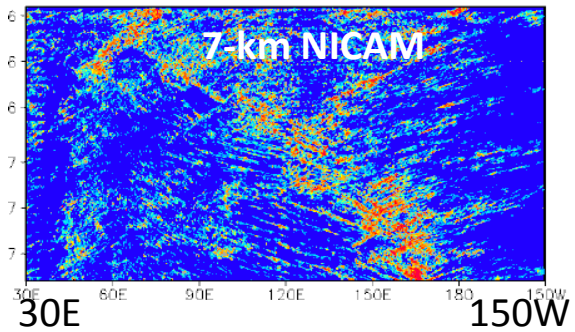
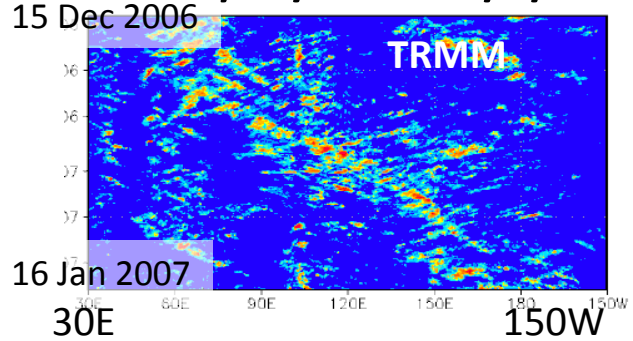


NICAM forecast

# Hindcasts of a MJO event (global 7/14-km grid)

2006/12/15-2007/1/16

Miura et al.(2007)



Liu et al. (2009)



# CINDY/DYNAMO modeling activities

## Model intercomparison:

### Goal:

**Develop a framework to conduct process-oriented comparison of different models as they simulate MJO initiation.**

### Guide parameterization improvements

-Common variables/diagnostic quantities (likely different among hierarchy of models)

*SST, ocean temperature, salinity, currents, mixed layer depth, surface fluxes, radiative fluxes, OLR, boundary layer processes, Q1, Q2, convective momentum transport, microphysics, vertical profiles of  $u$ ,  $v$ ,  $q$ ,  $T$ ,  $PS$*

-Common initialization if hindcast experiments

-Will need to later choose interesting cases.

-Interface with WCRP/YOTC MJO Task Force

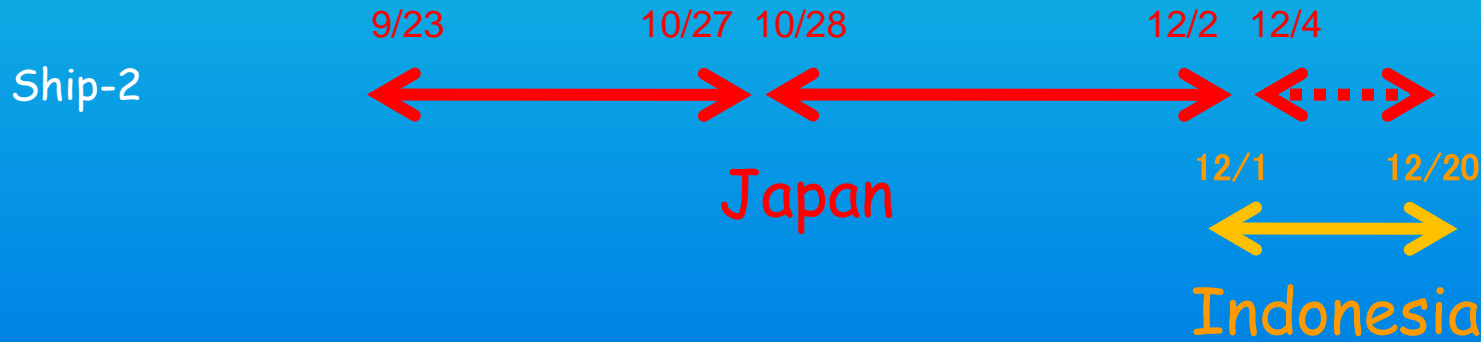
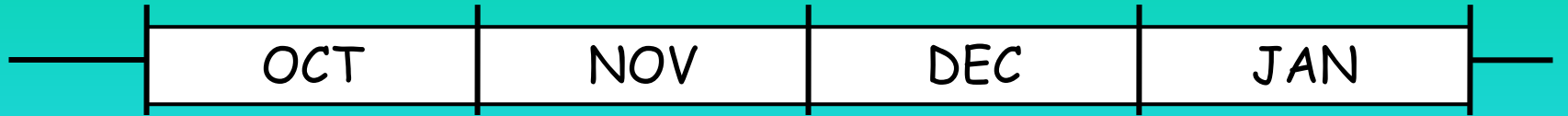
# AAMP10 action items

## **CINDY2011/DYNAMO**

- Action: AAMP to support the CINDY-DYNAMO request for provision of high res forecasts and analyses from available forecast centres. Hendon will correspond with Zhang and Kuno.
- AAMP/YOTC to promote coordinated numerical experimentation for Cindy-Dynamo, perhaps drawing upon pre-existing YOTC protocol and/or ISV hindcast protocol, and making use of the full range of modelling abilities (AGCMs, OGCMs, CGCMs, tropical channel, coupled regional mesoscale, regional, cloud resolving, SCM, ocean mixed layer models). Hendon to coordinate discussion between YOTC/CINDY-Dynamo.

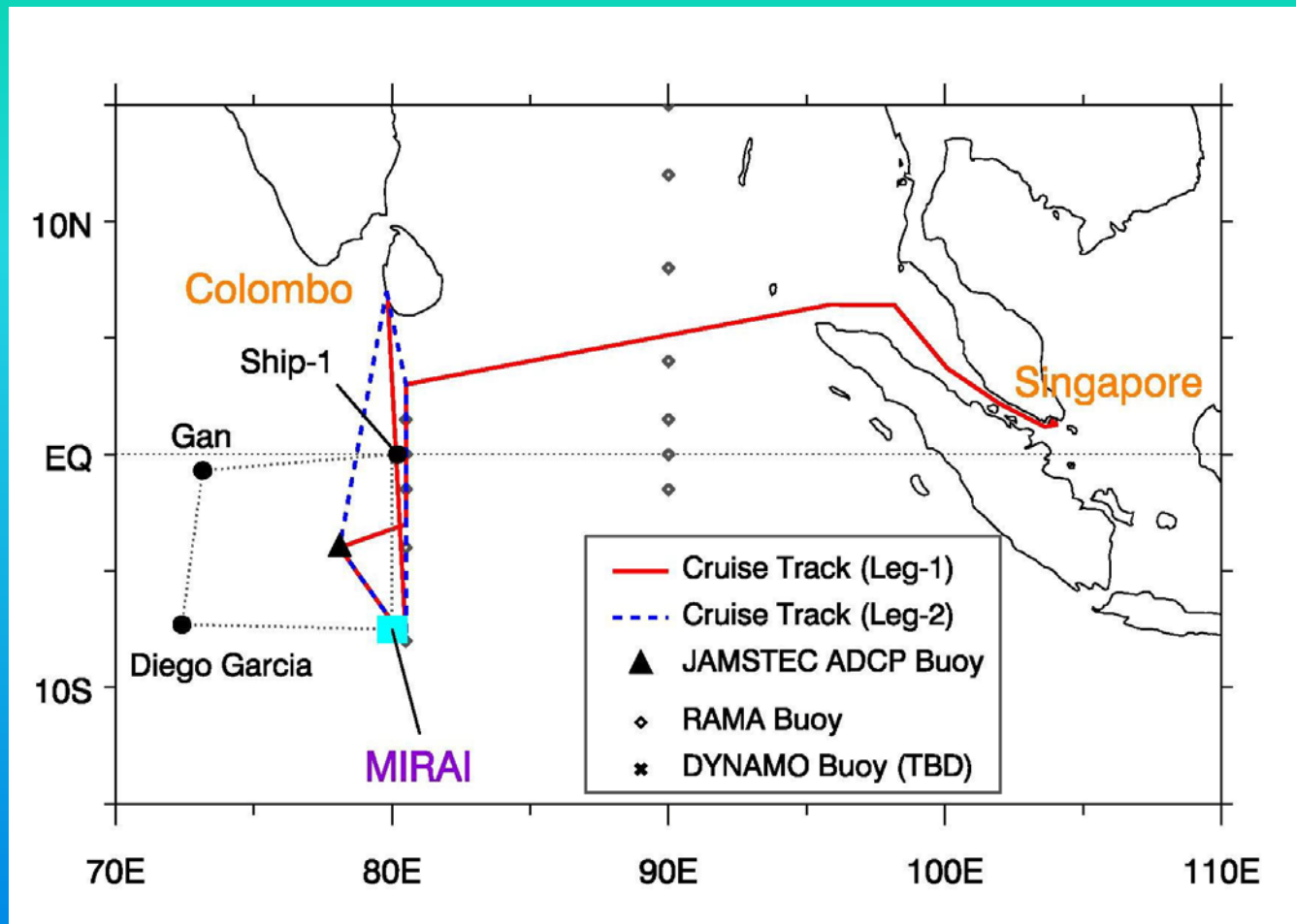
Extra Slides

# Ship Rotation Plan



- Stationary observation cruise
- ⋯ Non-stationary, but within Array area

# R/V Mirai Planned Cruise Track



Sep. 23	Lv Singapore	Start of Mirai CINDY Cruise
Sep. 27	Ar (0, 80E)	Start to deploy Sea-gliders
Sep. 29	Ar (4S, 78E)	Deploy ADCP/PAL buoy
Oct. 1	Ar (8S, 80E)	Start Stationary Observation

Call at Colombo (6 days break in October)

Nov. 28	Lv (8S, 80E)	End of Stationary Observation
Nov. 29	Ar (4S, 78E)	Recover ADCP/PAL buoy
Dec. 2	Ar Colombo	End of Mirai CINDY Cruise

Ship time  
71 days in total  
On station;  
53 days in Leg – 1 & 2

# Observations on-board the MIRAI

## Atmospheric Measurements :

C-band Scanning Doppler Radar (Vol. scan = every 10 min)  
Radiosonde (Vaisala RS92-SGP, every 3 hours)  
Surface Meteorology including Turbulent Flux & Solar Radiation  
Skin-SST (Infrared Radiometer, Sea-snake floating thermistor)  
GPS-derived Precipitable Water Vapor measurement  
Ceilometer

Sky radiometer (by Toyama Univ.)  
LIDAR (by National Institute of Environmental Studies, Japan)  
95-GHz FMCW Vertical Pointing Cloud Radar (by Chiba Univ.)  
Video-sonde (by Yamaguchi Univ., 10-20 times)  
Water Vapor-sonde (by Hokkaido Univ., 10-20 times)

## Oceanic Measurements :

CTD (every 3 / 6 hours down to 500 m depth)  
+ water sample for biogeochemical analyses (Nutrients, Chl-a)

+ LADCP (by IPRC)

Micro-structure Profiler

Shipboard ADCP

Sea Surface Monitor (T, S, DO, Chl-a)

Argo (Ascent once per day from 500 m parking depth) x 1

Sub-surface ADCP mooring with PAL (passive aquatic listener)

Sea-glider (EQ, 80E)



# DYNAMO - Ship & Mooring

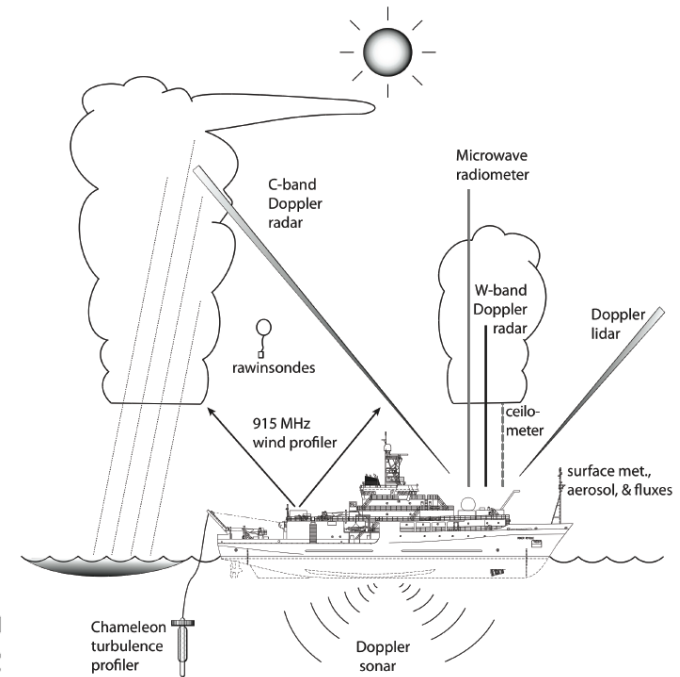
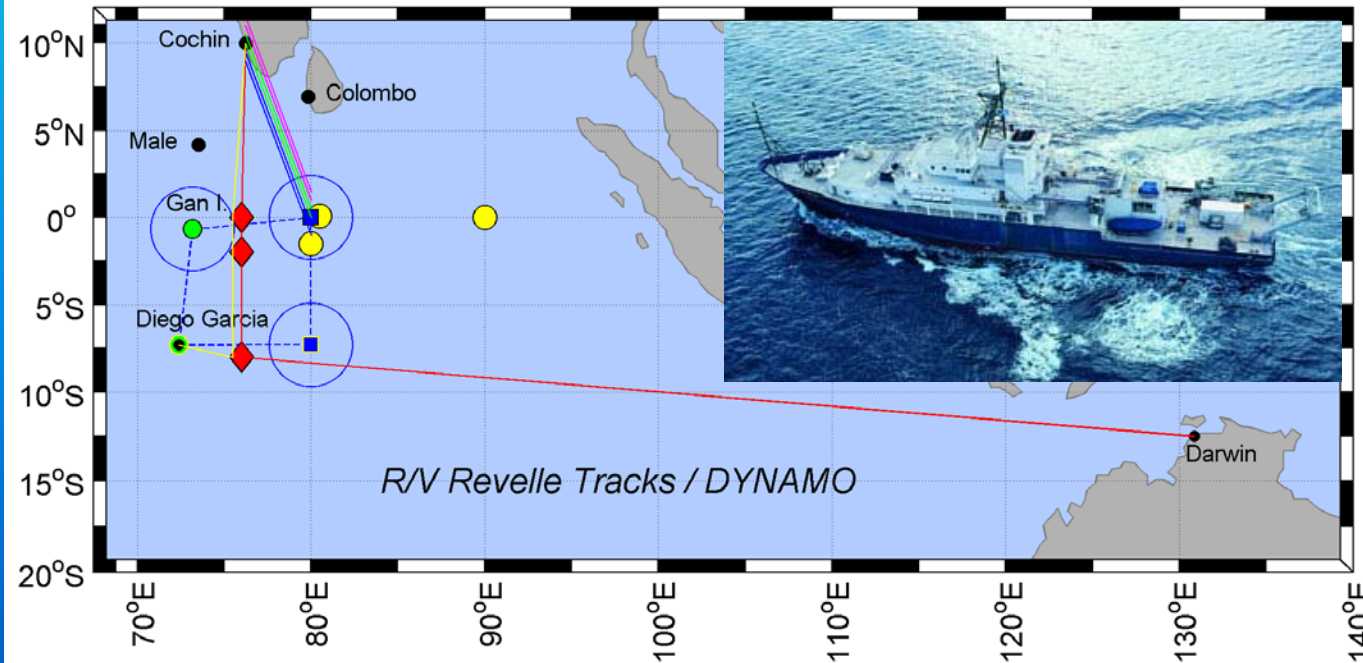
USA - DYNAMO (PI: Prof. C. Zhang / U Miami)

## Atmospheric Obs.

- C-band scanning Doppler radar
- W-band vertical pointing radar
- Radiosonde ( 8/day - SOP, 4/day - others)
- Wind Profiler
- Lidar
- Turbulent Flux Measurement
- Surface Meteorology

## Oceanic Obs.

- Turbulence Profiler ( 8-10 times / hour )
- CTD + water sample ( 1 time / day at noon )  
for biogeochemical analysis
- Sea-soar
- ADCP
- Skin-SST
- Sea Surface Monitoring



# DYNAMO - Land-based Observations

## NCAR S-PolKa Radar



## Texas A&M SMART Radar



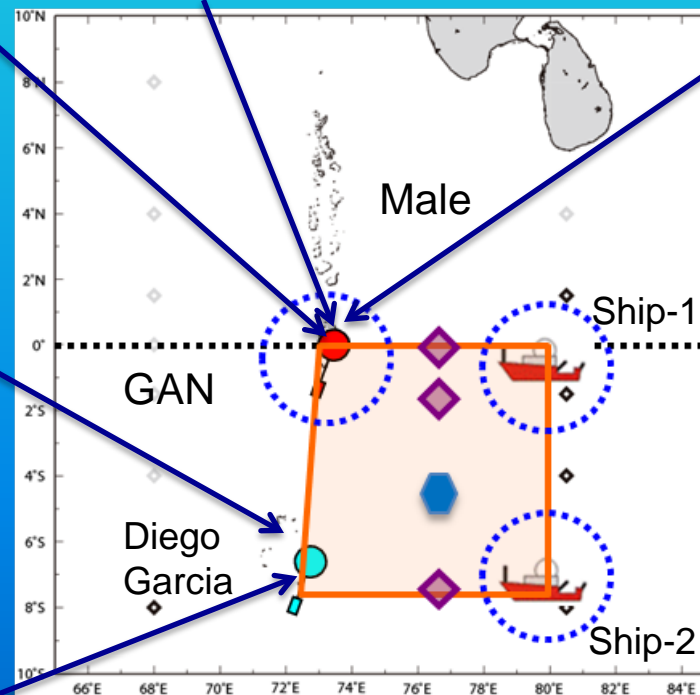
## ARM AMF2



## NOAA P-3



## NCAR ISS



## Gan Island - Super Site -

- Scanning Radars (S/C/X/Ka/W bands)
- Radiosonde (8/day)
- 915MHz Wind Profiler
- Micropulse Lidar
- Microwave Radiometer
- Total Sky Imager
- Ceilometer
- Surface Meteorology



# Aircraft Observations

## French ( Falcon-20 )

Period : Nov 1 - Dec 15 ( 4 weeks )  
40 flight hours  
Obs range : Within 1000km, 3-9 km in height  
Base : Gan (0.7S, 73.2E)  
Main target : MCS  
Measurements : Radars

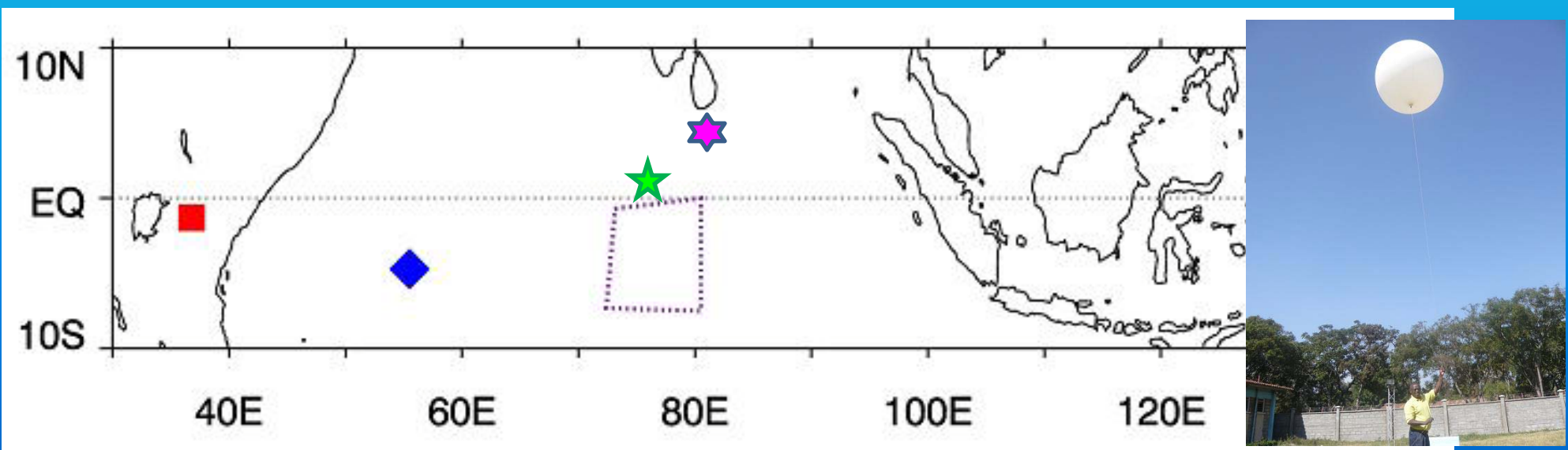


## US DYNAMO ( NOAA WP-3D )

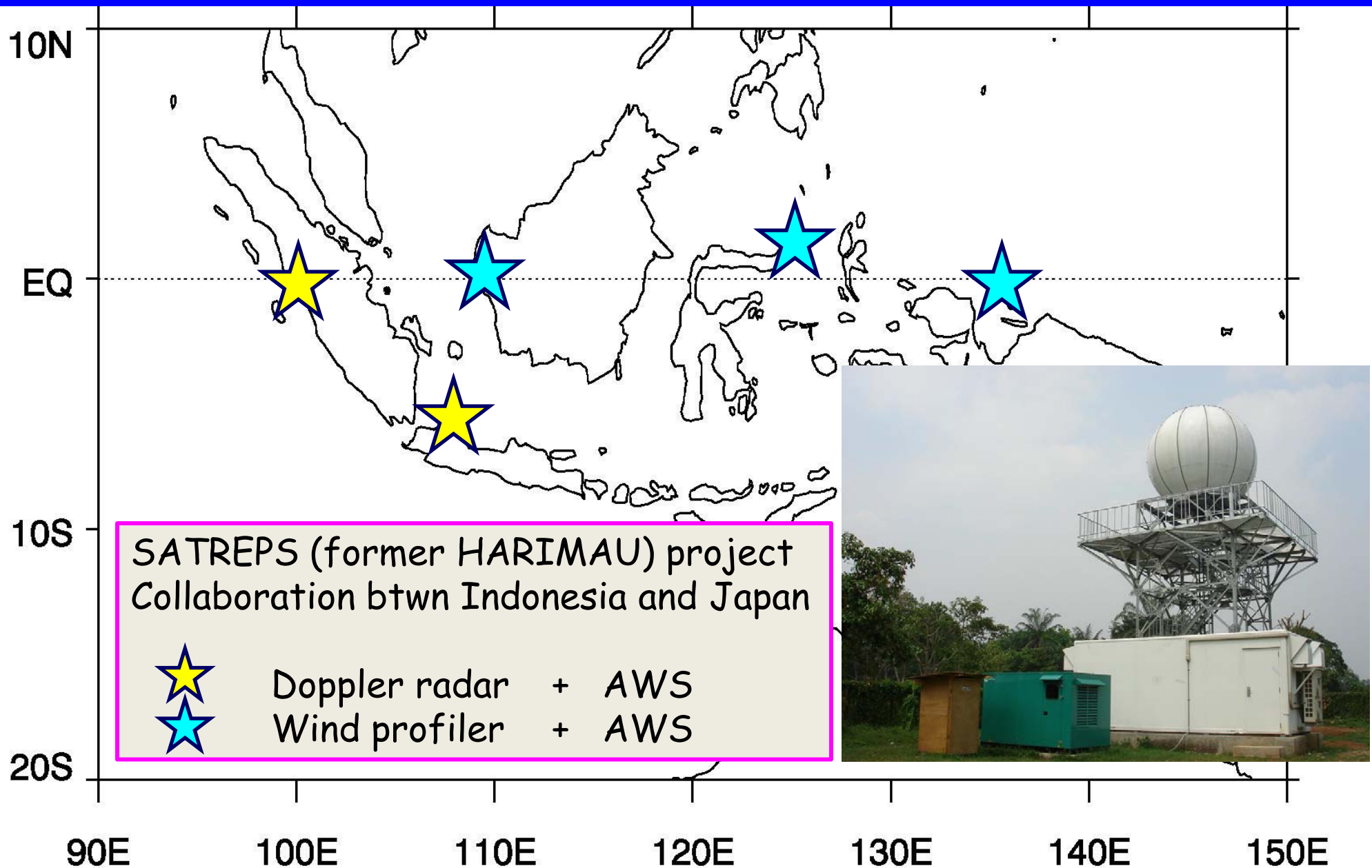
Operation Period : 45 days  
105 science mission + 70 ferry hours  
Base : Diego Garcia (7.3S, 72.5E)  
Main target : Air-sea boundary layer process  
Measurements : Dropsonde, AXBT, C/X radars, etc.

# Enhanced Radiosonde Soundings at Western & Northern Sites

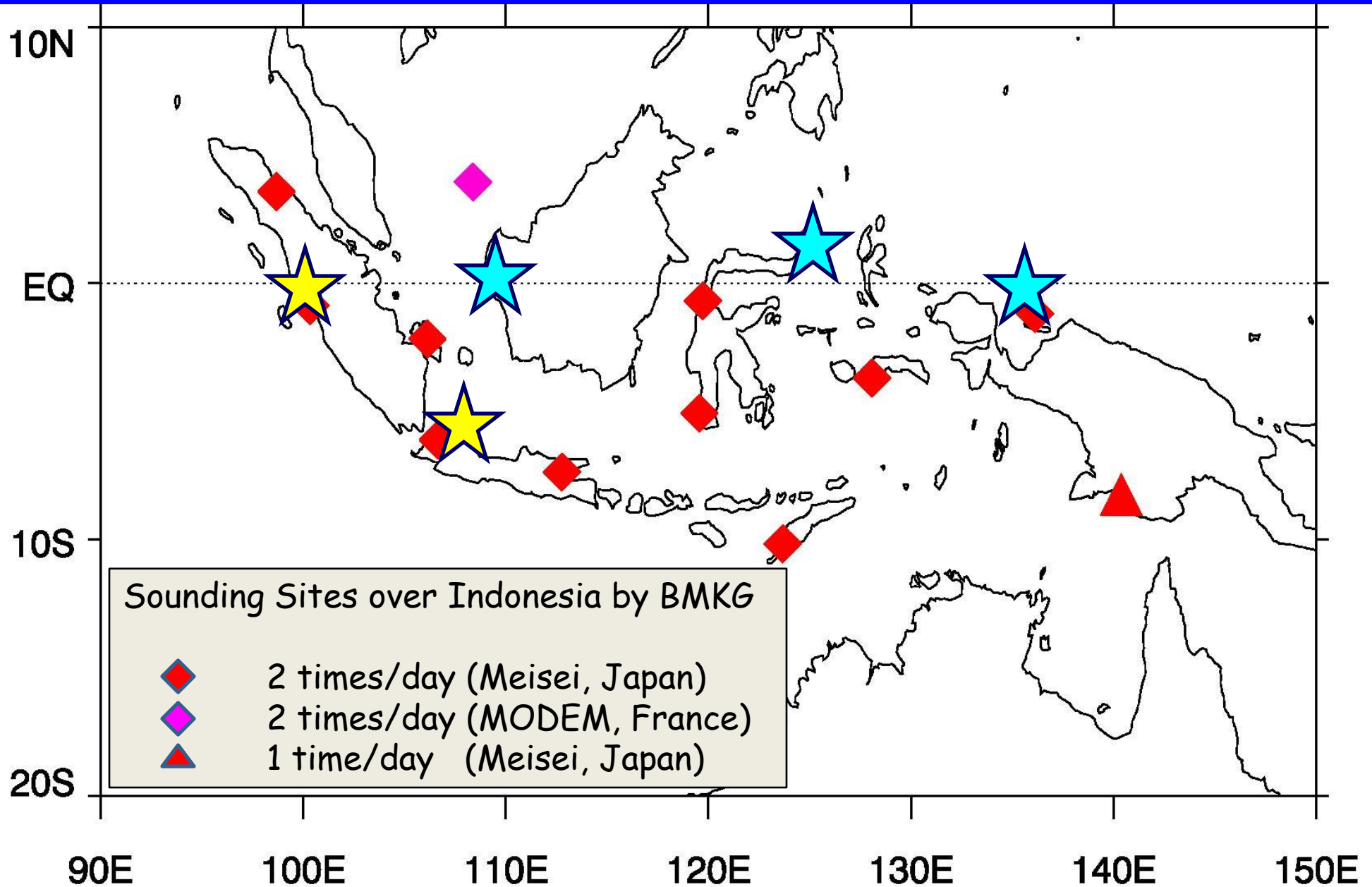
Kenya	2 times/day	(Oct - Jan)
Seychelles	4 times/day	(5 weeks in Oct - Nov)
	2 times/day	(Others in Oct - Jan)
Male	4 times/day	(Oct 1 - Dec 15)
Colombo	2 times/day	(Oct 1 - Nov 28)



# Indonesia - Radar Observations by BPPT



# Indonesia - Radiosonde Soundings by BMKG



# Relevant Projects in U.S.

## AMIE (ACRF MJO Investigation Experiment) by ARM Program

PI : Dr. Charles Long (PNNL)

Period : Oct 2011 - Mar 2012

Methods :

Intensive Observations at Manus, PNG

- 1) ACRF (Lidar, cloud radar, flux, microwave radiometer, etc. )
- 2) Enhanced radiosonde ( 8 times/day )
- 3) SMART-R C-POL Radar

