

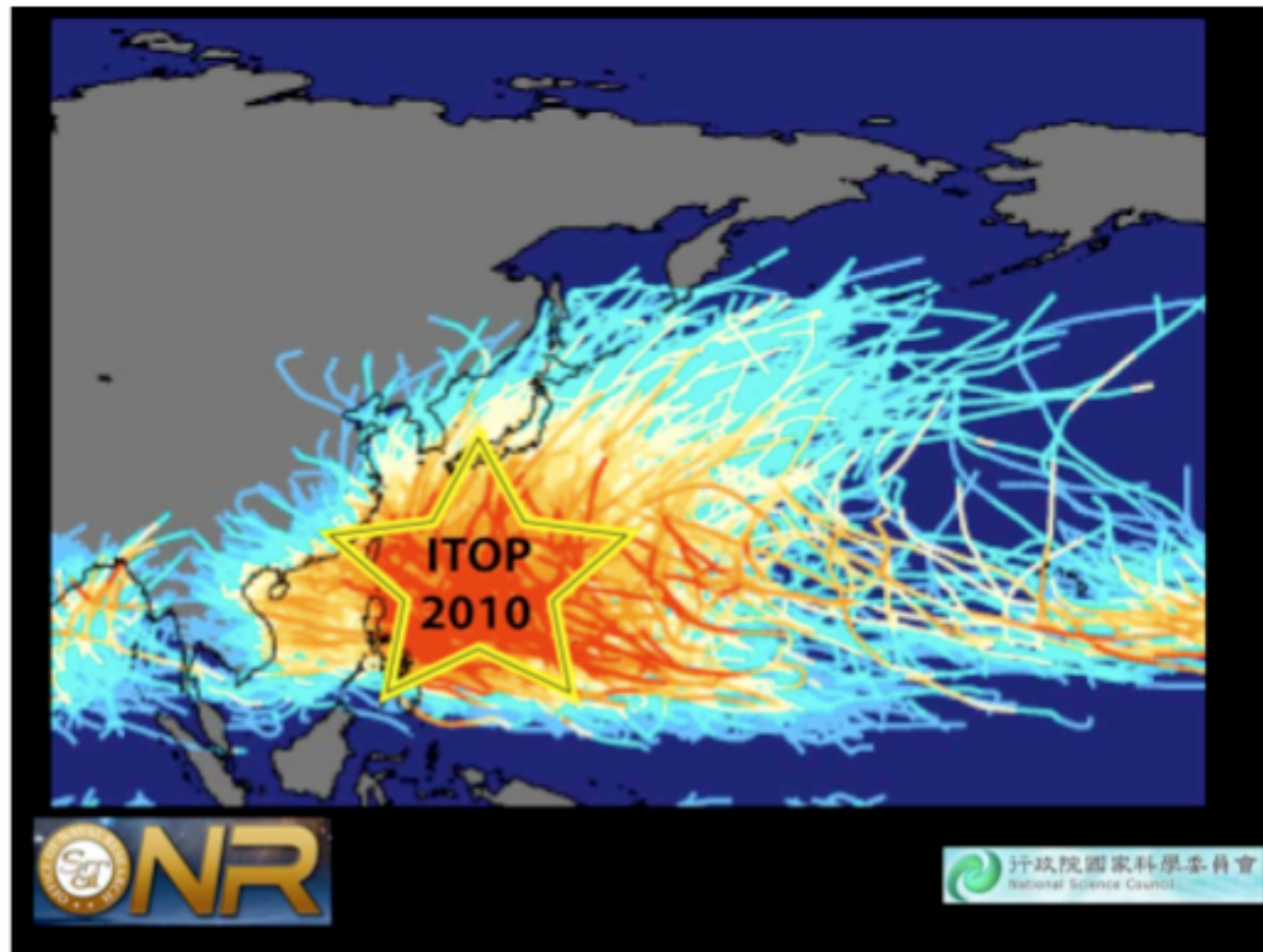
# TCS-10 / ITOP

## Impact of Typhoons on the Ocean in the Pacific

James Moore, EOL, NCAR

Eric D-Asaro, University of Washington

SoWMEX/TiMREXWorkshop 2010



# ITOP Science Questions

What are the *air-sea fluxes* for winds greater than 30 m /s ?

What is the *surface wave field* under typhoons ?

What is the *three-dimensional response* of the ocean ?

How do *ocean eddies* affect this response ?

How does the ocean affect *typhoon intensity* ?

How does the *cold wake* of a typhoon disappear ?

# ITOP Operations

- \* Scientists from >6 nations involved
- \* Operations Centers in Monterey and Guam, Data Catalogs from EOL and MBARI
- \* Operational/research model products from 16 high-res systems
- \* 300 flight hours, >60 ship days from US and Taiwan Vessels
- \* 700 dropsondes + DOTSTAR, 600 AXBTs deployed

# ITOP Facilities



C-130



DOTSTAR

Lagrangian-Float

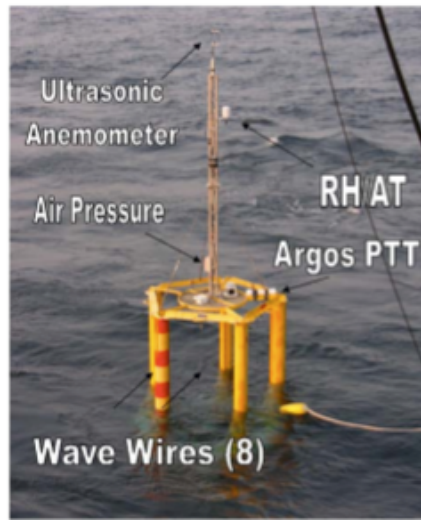
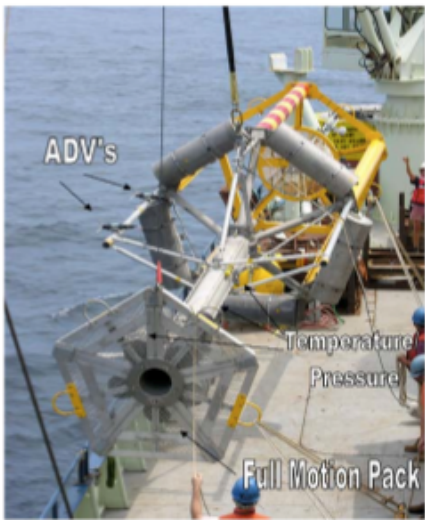


ITOP Mooring



EASI-ASIS Buoys in tandem mooring

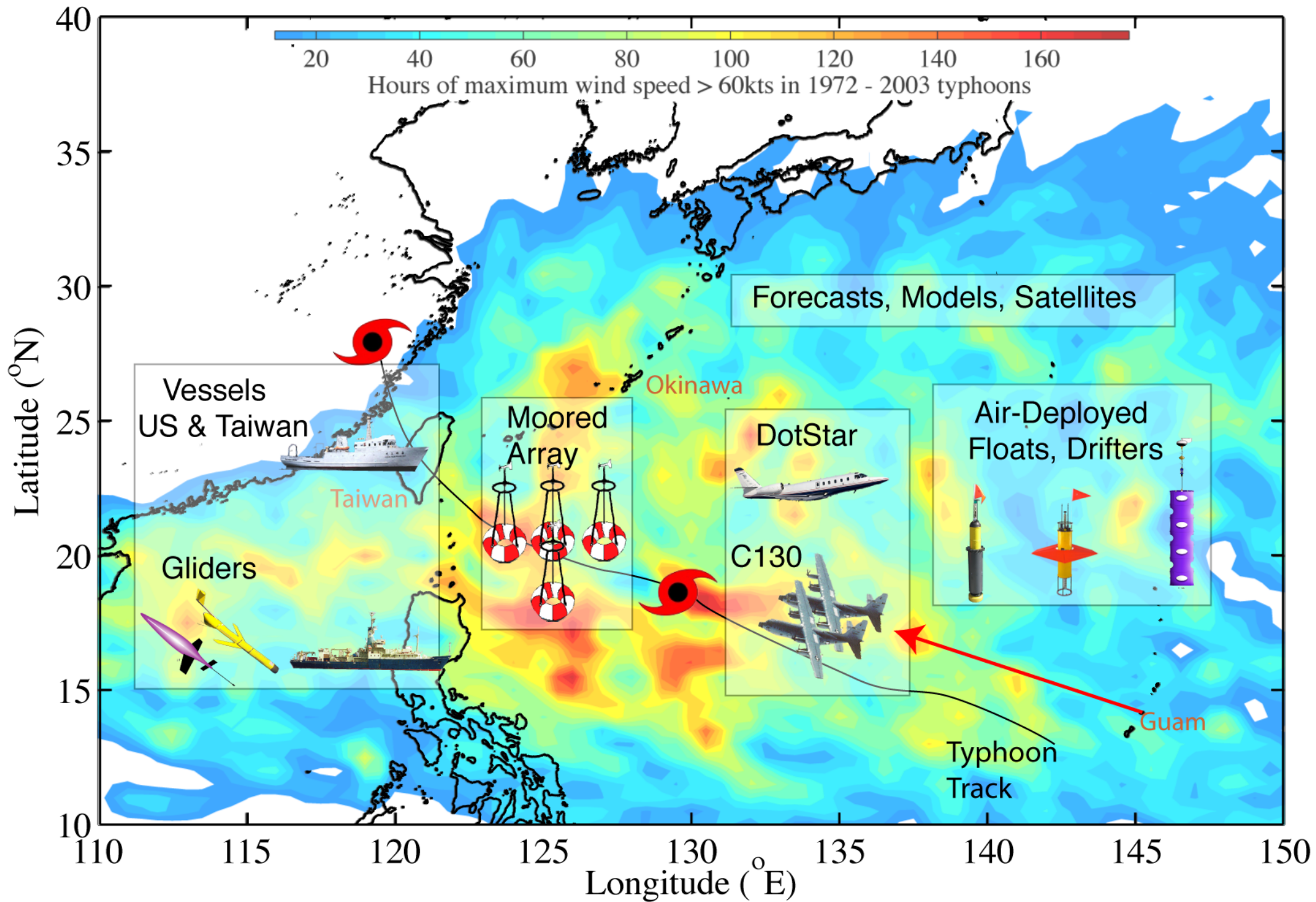
Air-Sea Interaction Spar (ASIS) Buoy



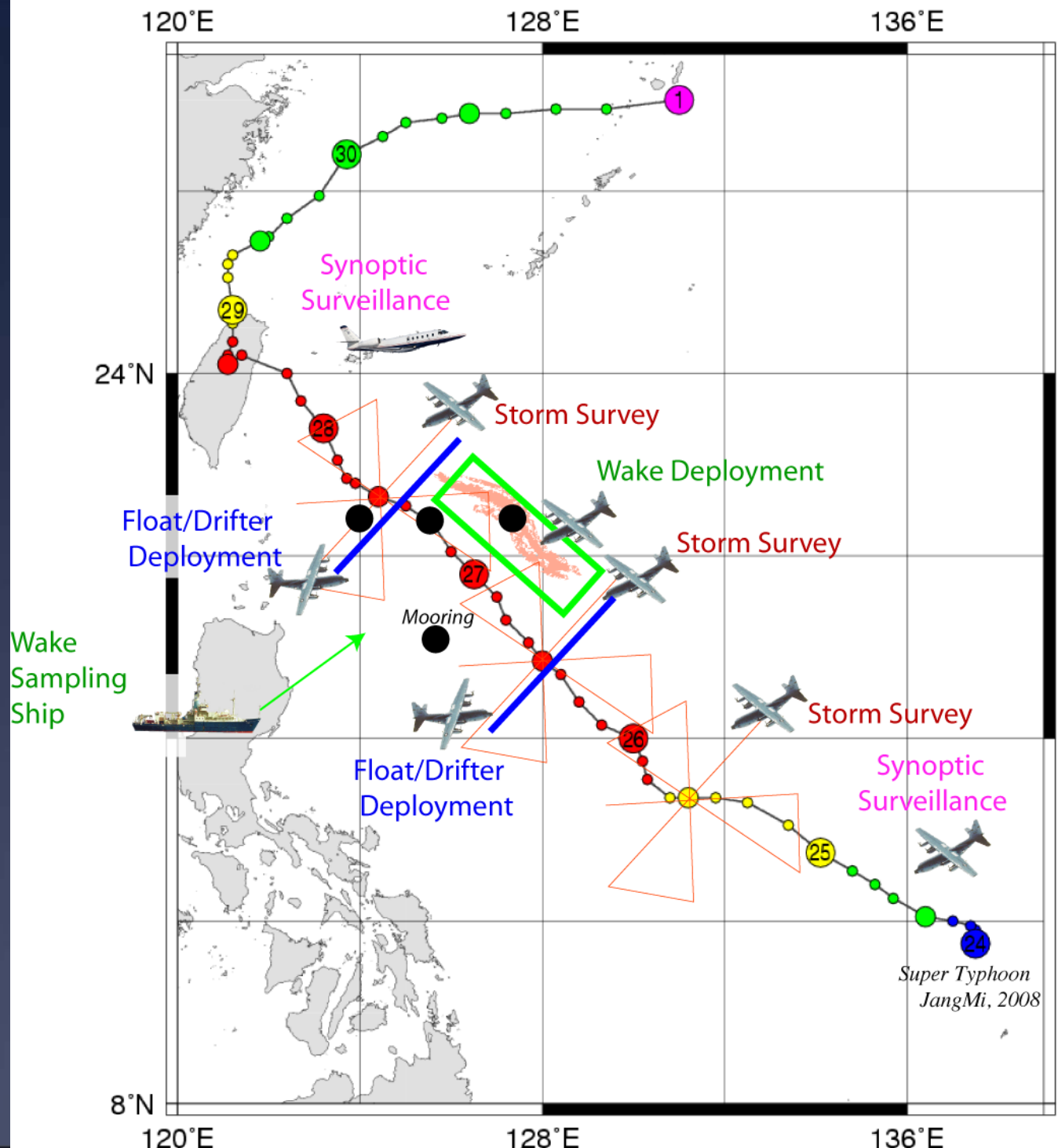
EM-APEX



# ITOP 2010 - Resources



# ITOP 2010 Storm Operations

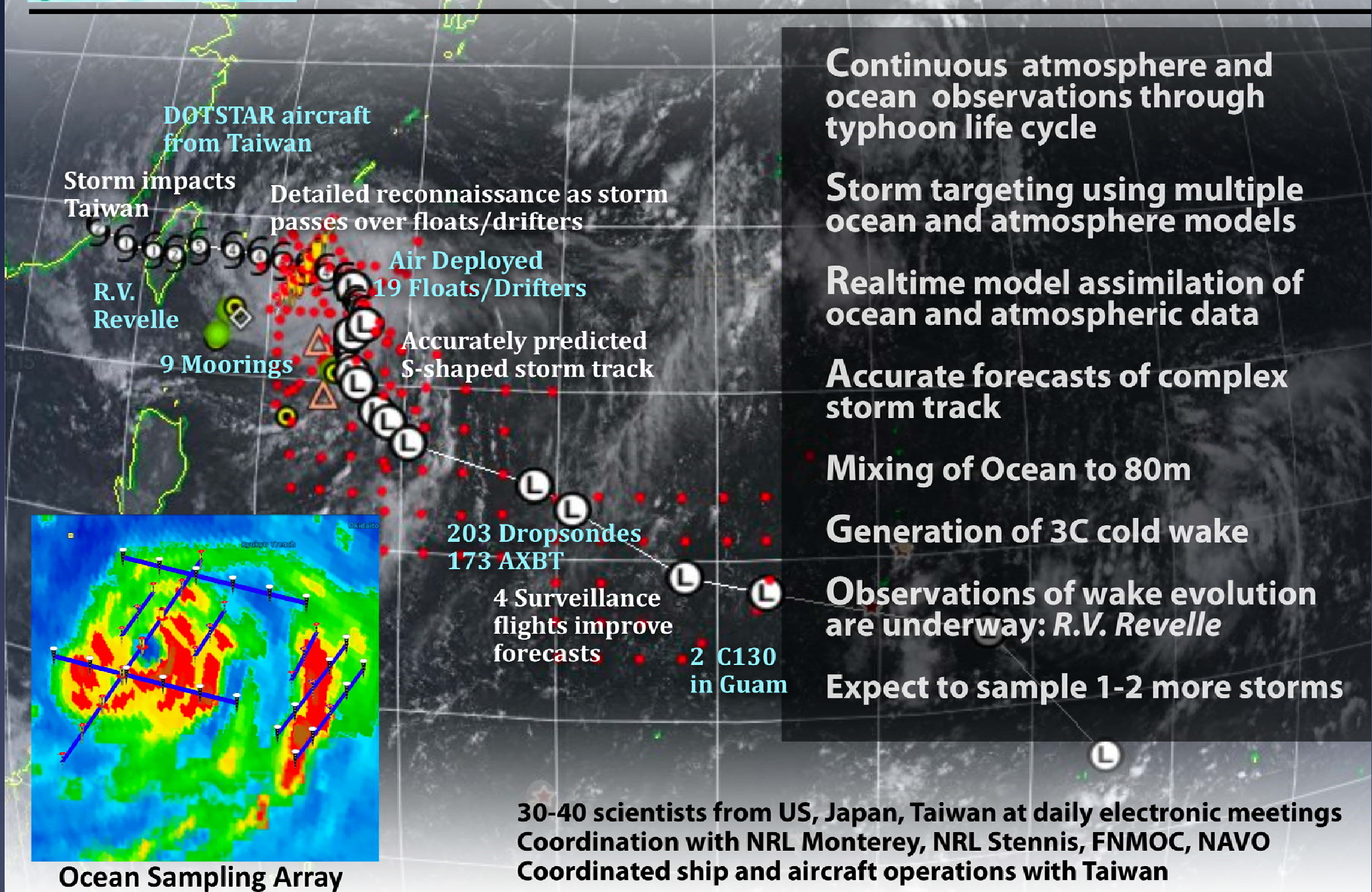


# *R/V Revelle* Cruise Accomplishments

- \* Cold Wake Cruise from 17 September -11 October
- \* Detailed measurements on Typhoon Fanapi (Cat 3, 14-22 Sept)
- \* 2917 underway CTDs
- \* 10 gliders deployed, all operational
- \* 172 VMP profiles
- \* 21 CTD profiles (water samples 12/cast)
- \* 3 sediment traps (2 recovered)
- \* 3 superdrifters, 1 ADOS recovered
- \* Coordinated operations with C-130 (AXBT intercomparison)

# ITOP studies Typhoon Fanapi

*Detailed atmosphere-ocean measurements in a typhoon*



**Continuous atmosphere and ocean observations through typhoon life cycle**

**Storm targeting using multiple ocean and atmosphere models**

**Realtime model assimilation of ocean and atmospheric data**

**Accurate forecasts of complex storm track**

**Mixing of Ocean to 80m**

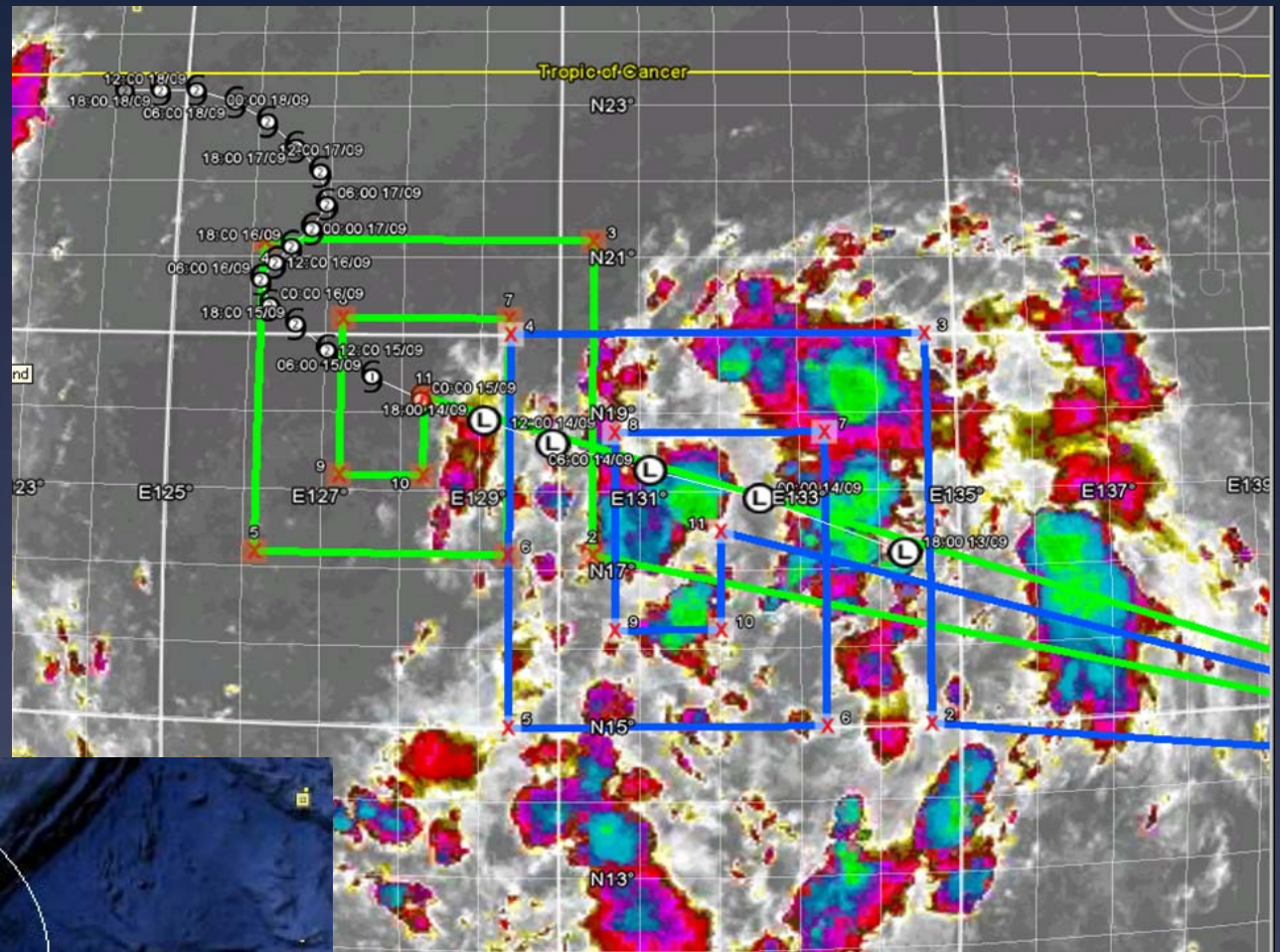
**Generation of 3C cold wake**

**Observations of wake evolution are underway: R.V. Revelle**

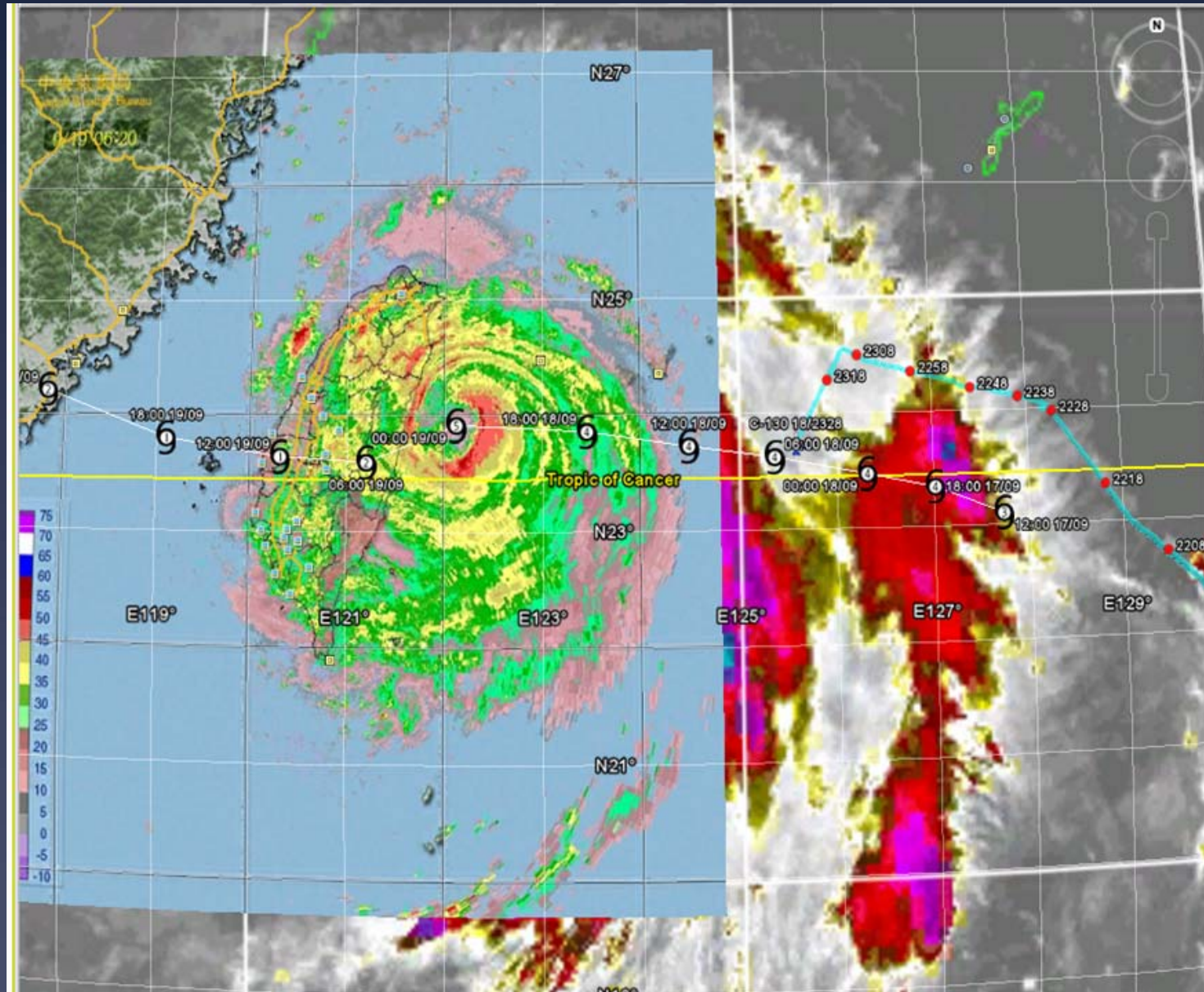
**Expect to sample 1-2 more storms**

**30-40 scientists from US, Japan, Taiwan at daily electronic meetings**  
**Coordination with NRL Monterey, NRL Stennis, FNMOC, NAVO**  
**Coordinated ship and aircraft operations with Taiwan**

# Developing Fanapi (IR-sat) C-130 tracks, storm forecast position

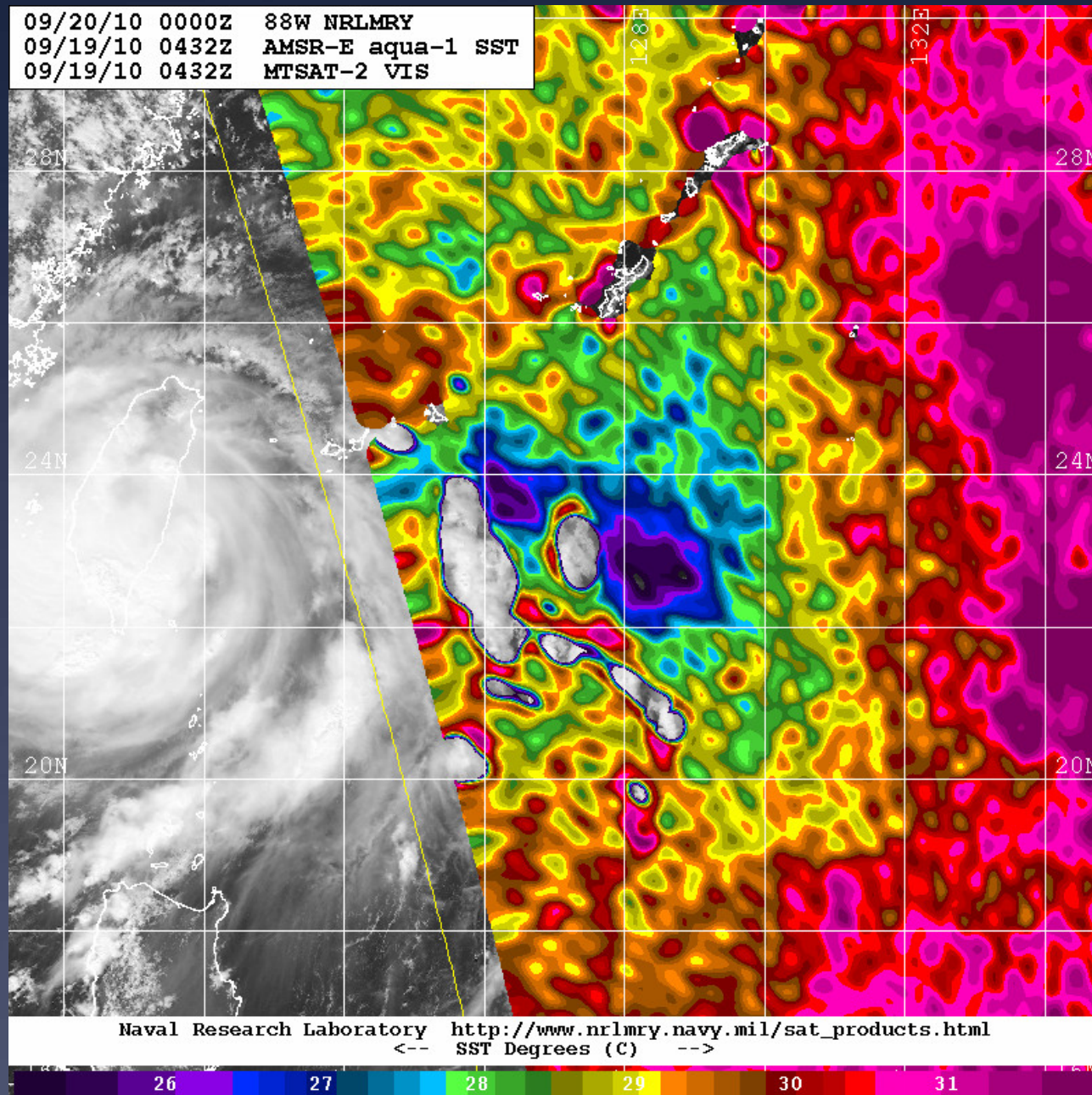


# Typhoon Fanapi (track and fcst) (GE, IR-sat, Taiwan radars, C-130 track, dropsonde times)



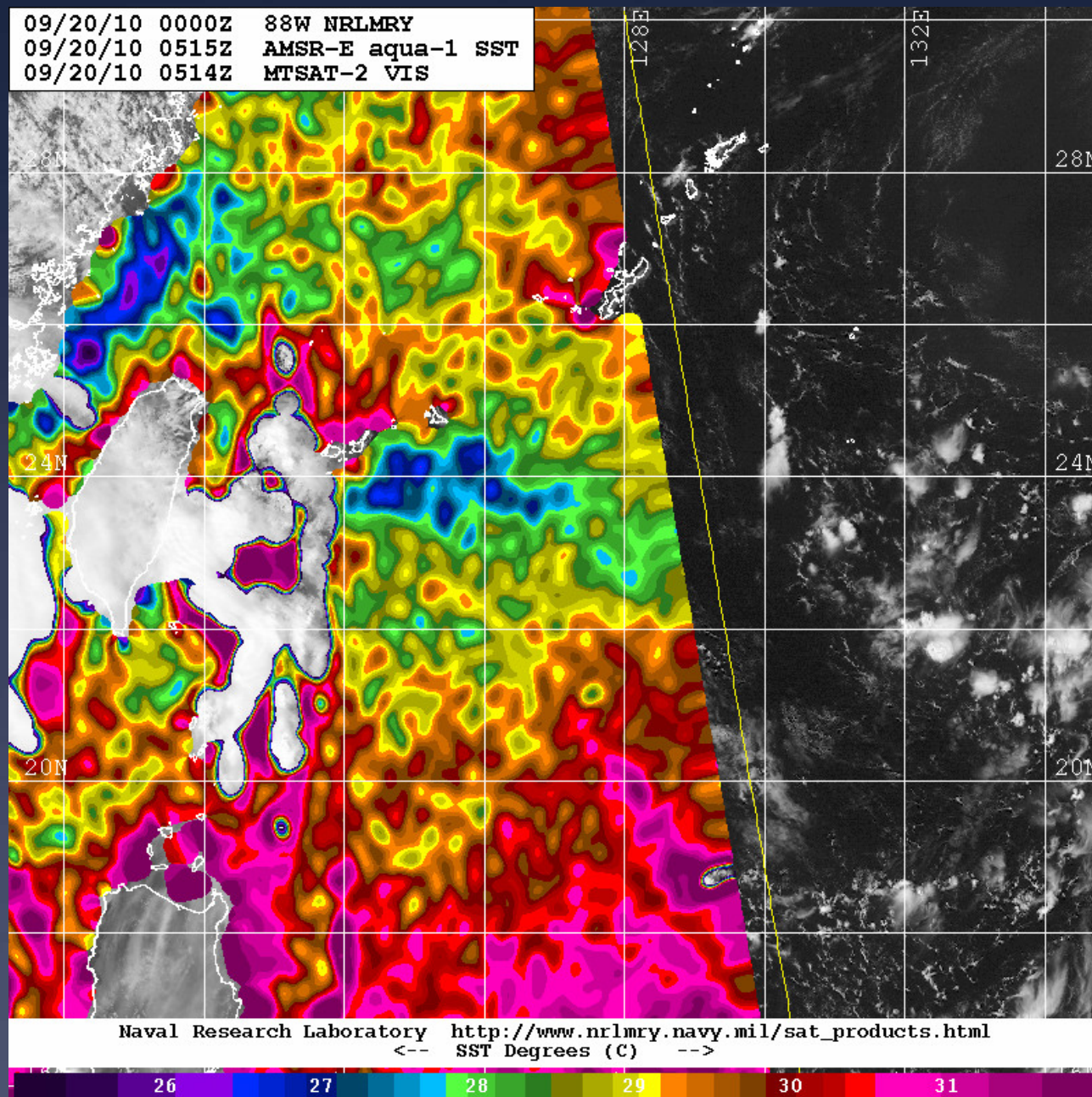
# Typhoon Fanapi Cold Wake Evolution

AMSR-SST  
MTSAT Vis



# Typhoon Fanapi Cold Wake Evolution

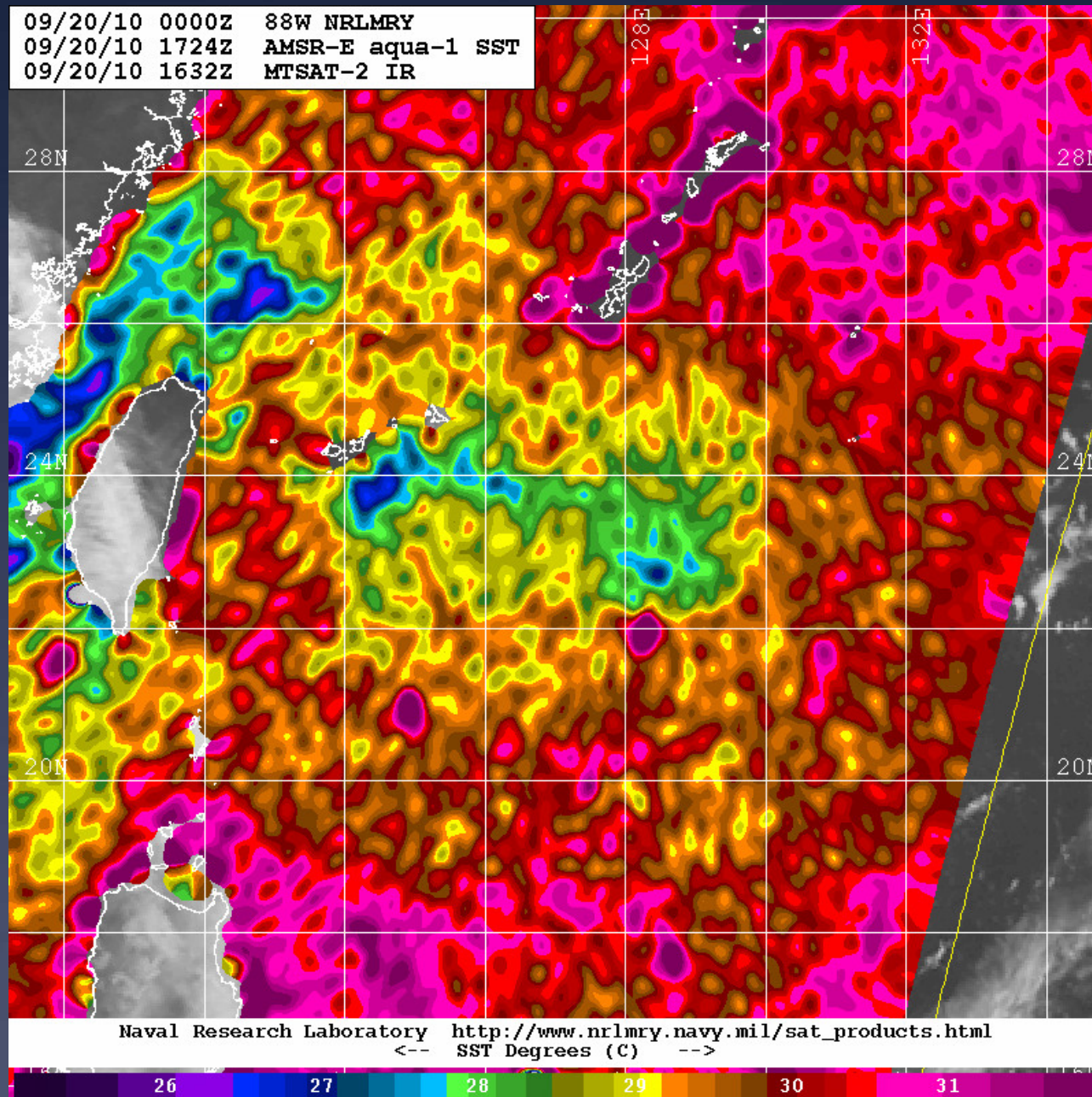
→  
AMSR-E SST  
MTSAT IR/Vis



# Typhoon Fanapi Cold Wake Evolution

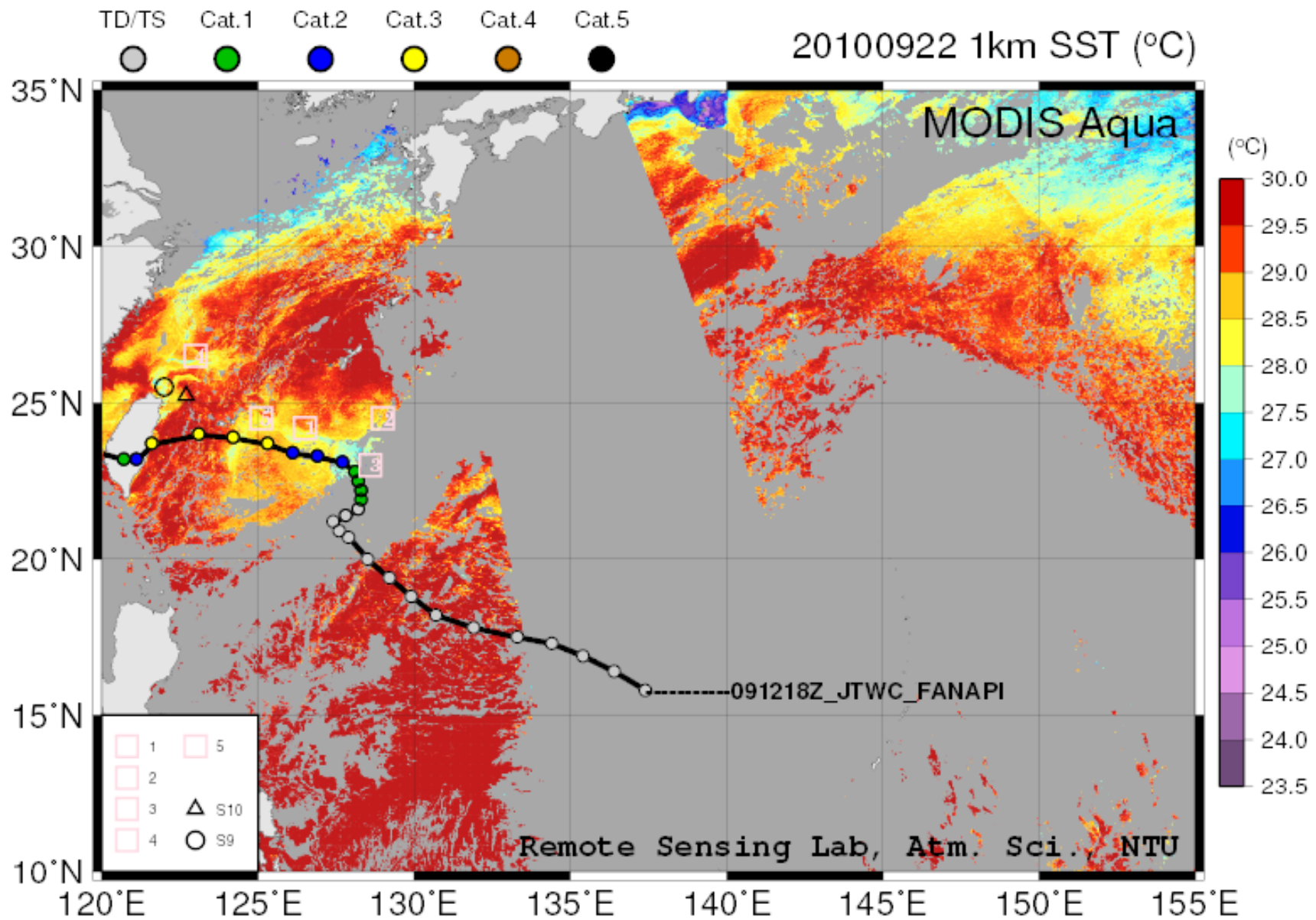
AMSR-E SST

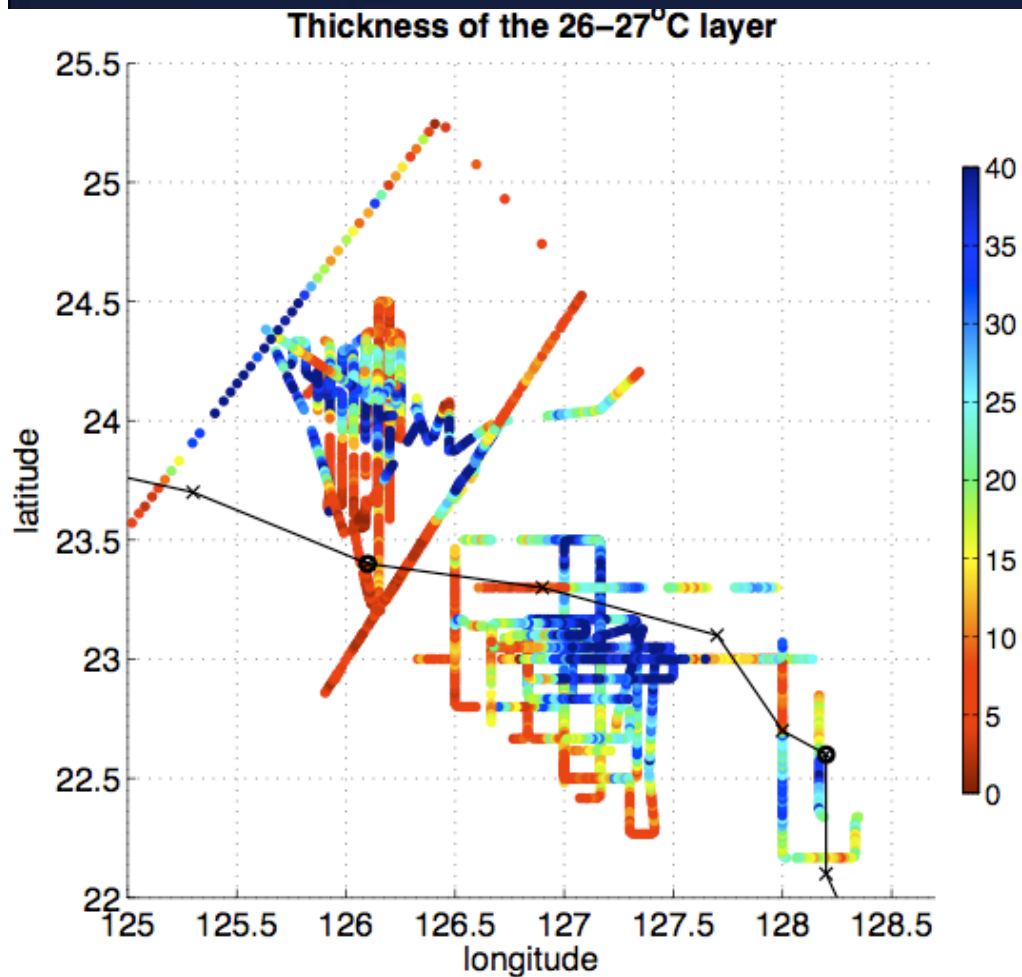
MTSAT IR



# Summary of Ty Fanapi with MODIS derived

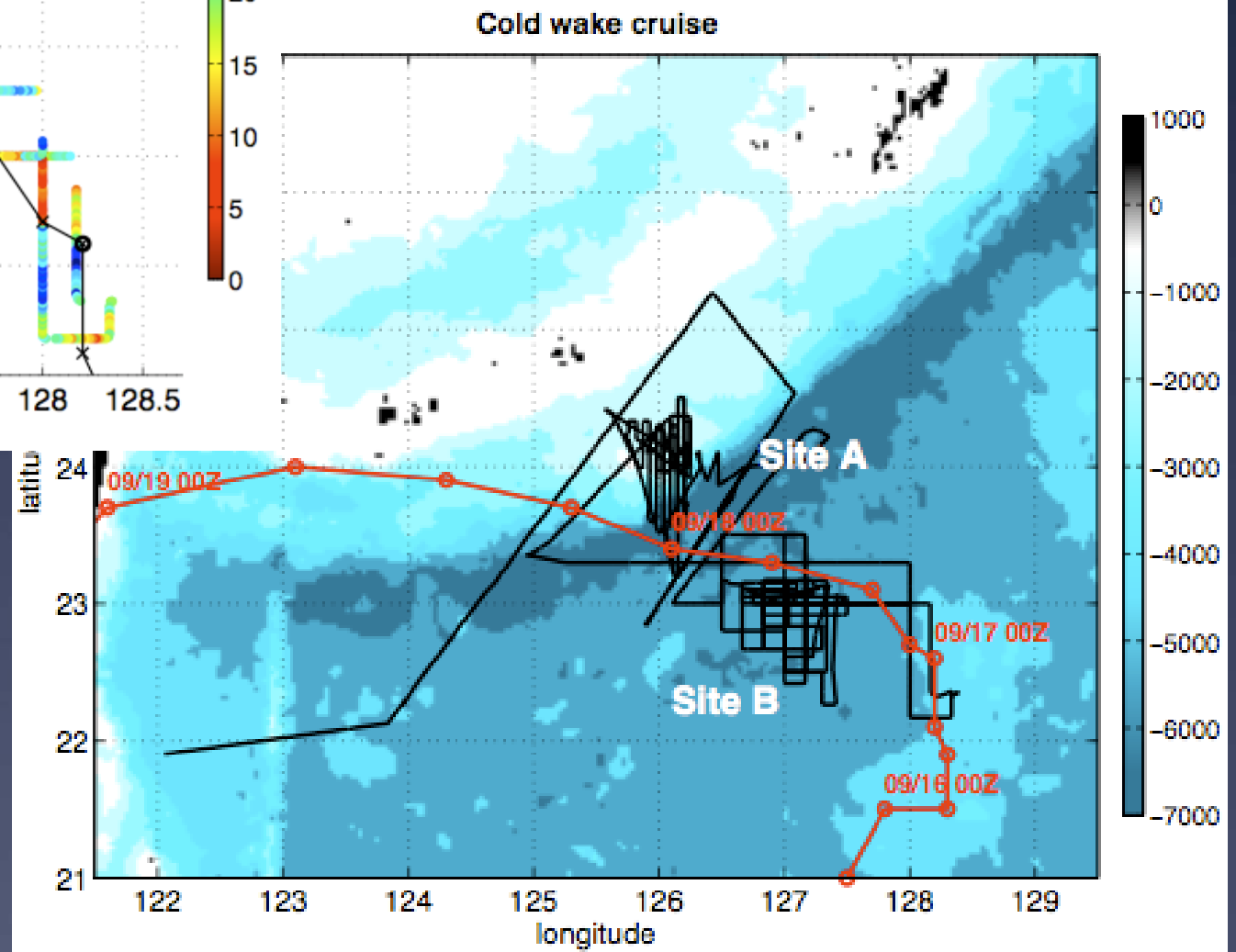
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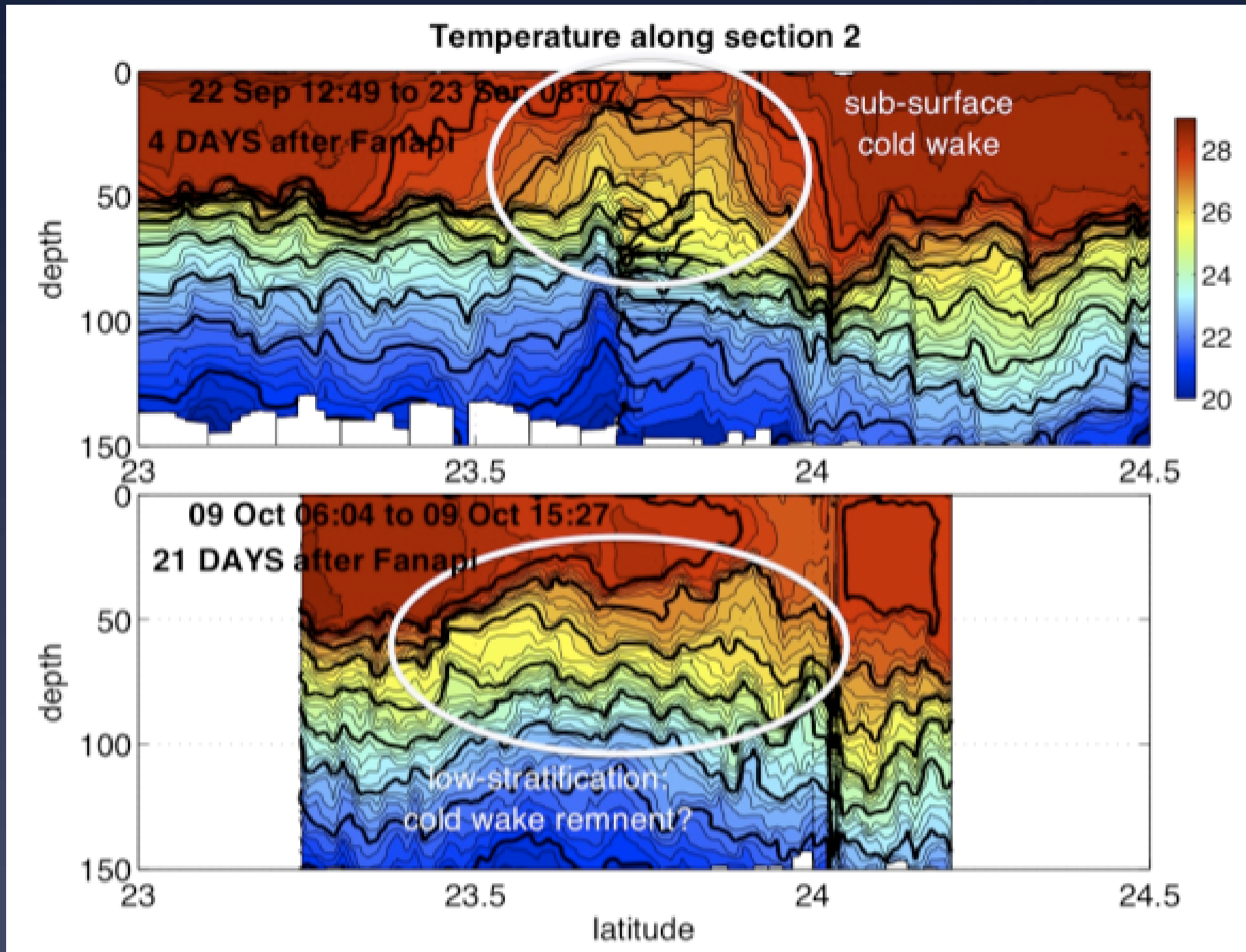


*R/V Revelle* Cold Wake Cruise  
Track (black/color) in Sept-Oct  
2010 and Fanapi storm track

Below-- with bottom topography  
Left— with 26-27°C layer thickness



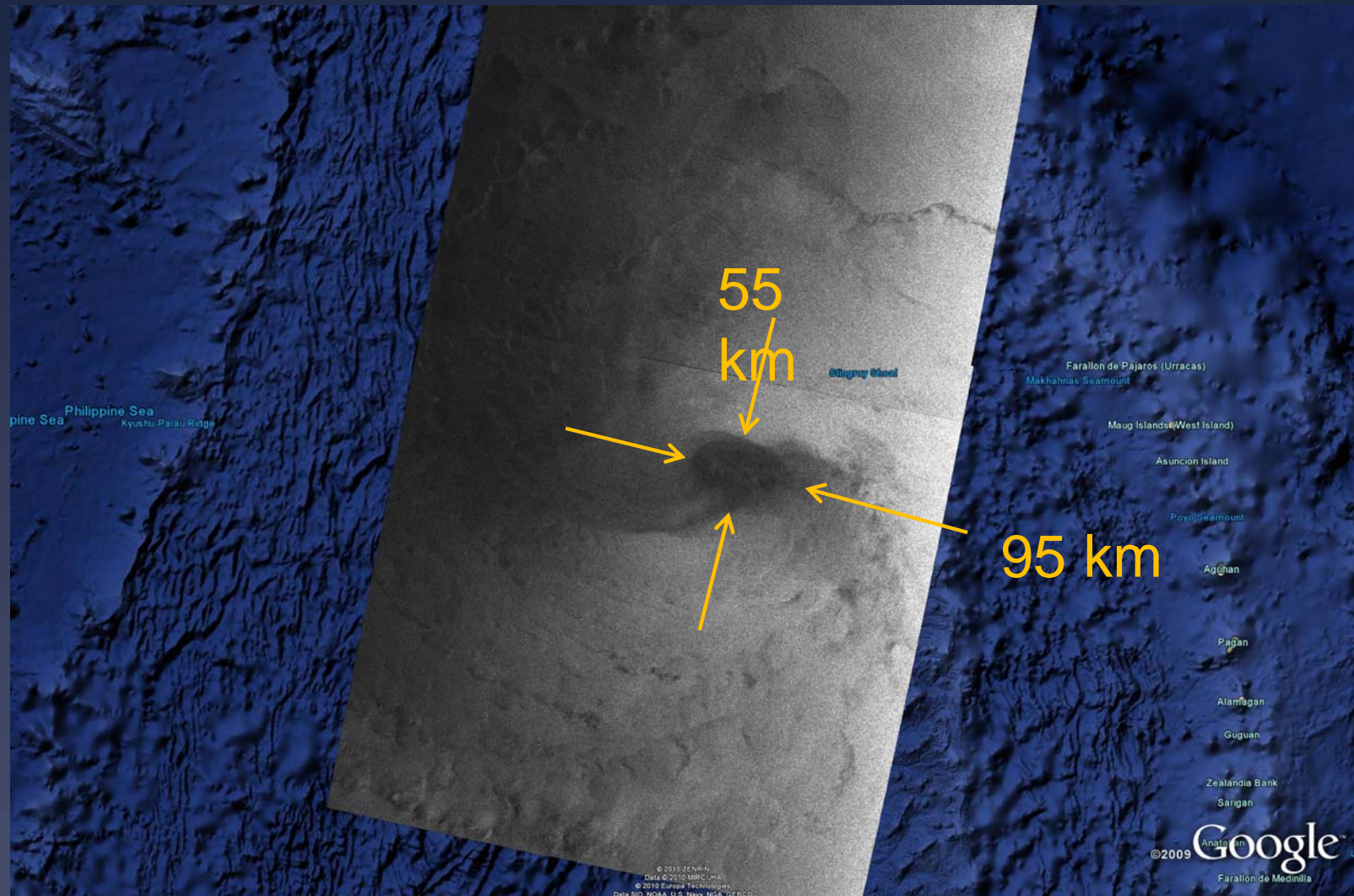
# R/V Revelle water column temperatures across Fanapi Cold Wake



# Typhoon Malakas Eye Sep 22, 2010 22:03 GMT

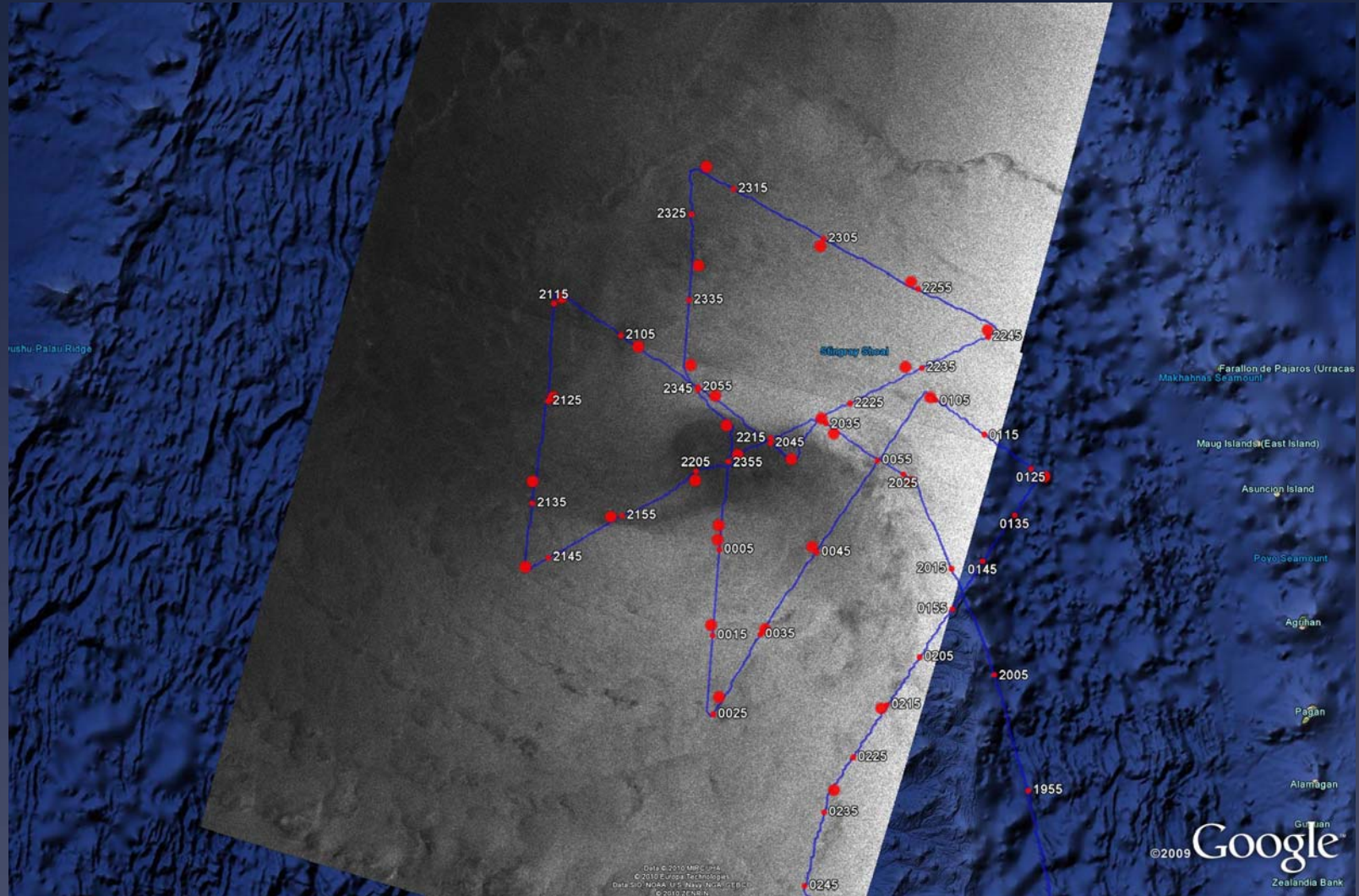
Northern edge of eyewall clearly defined while the southern and eastern edges are not.

Center at:  
19 42' N  
141 13' E

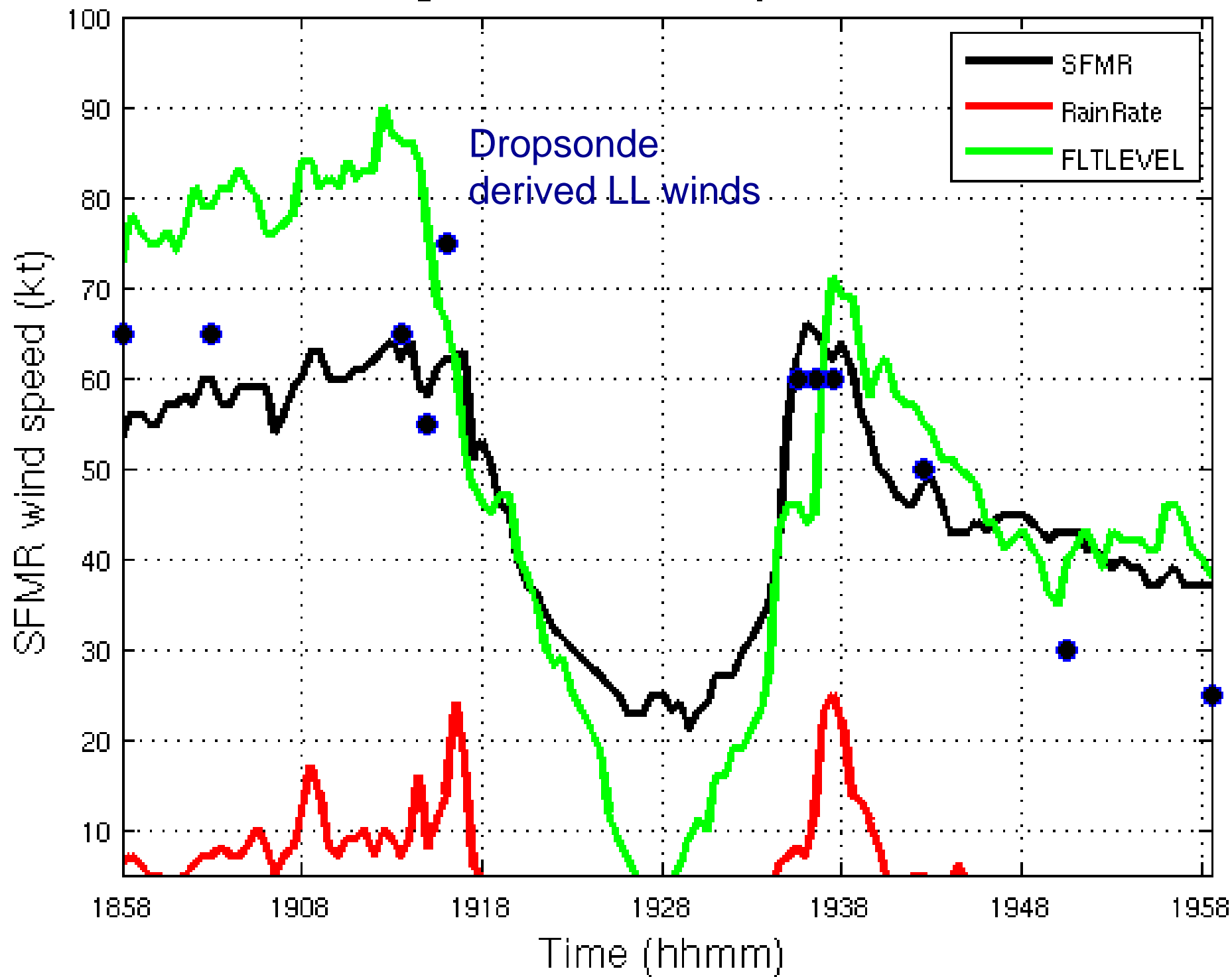


# Typhoon Malakas Eye Sep 22, 2010 22:03 GMT

C130 Flight tracks (blue), dropsondes and AXBTs (big red dots), HDobs (small red dots)



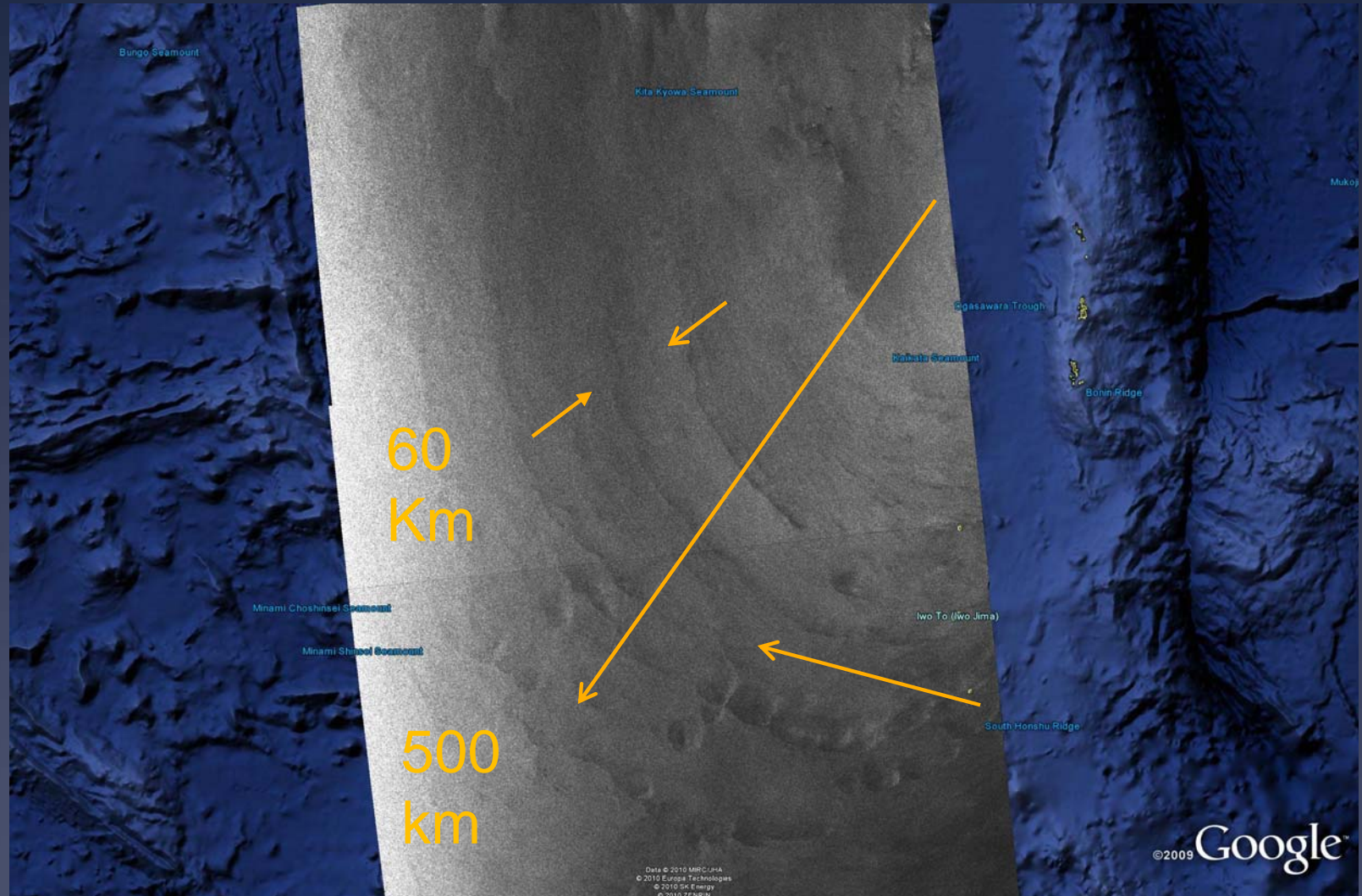
# TS Malakas: Flight:1200 UTC 23 September East-West Pass



# Typhoon Malakas Sep 24, 2010

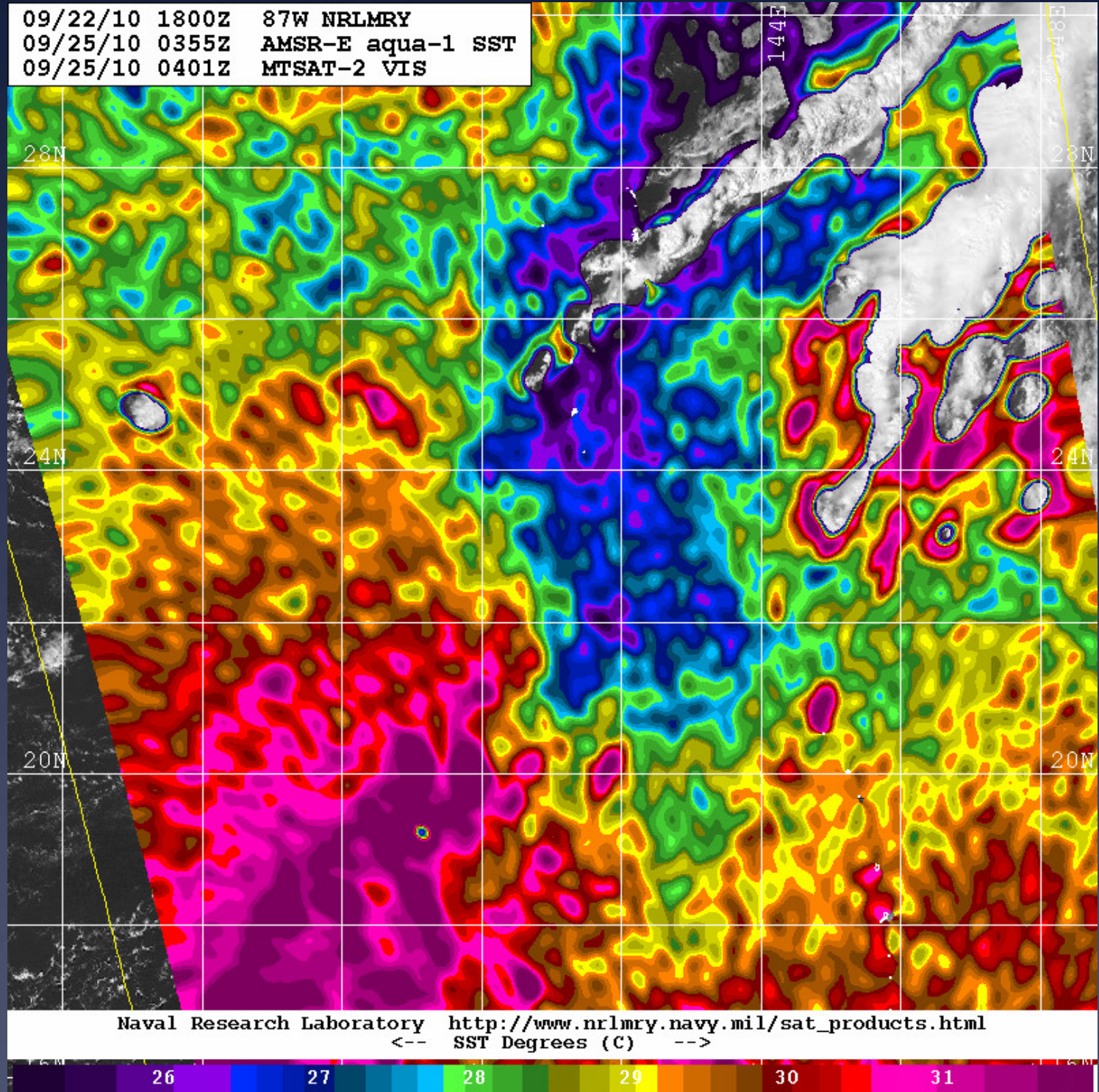
## 08:49 GMT

Edge of typhoon  
Malakas showing  
scales of outer  
bands.

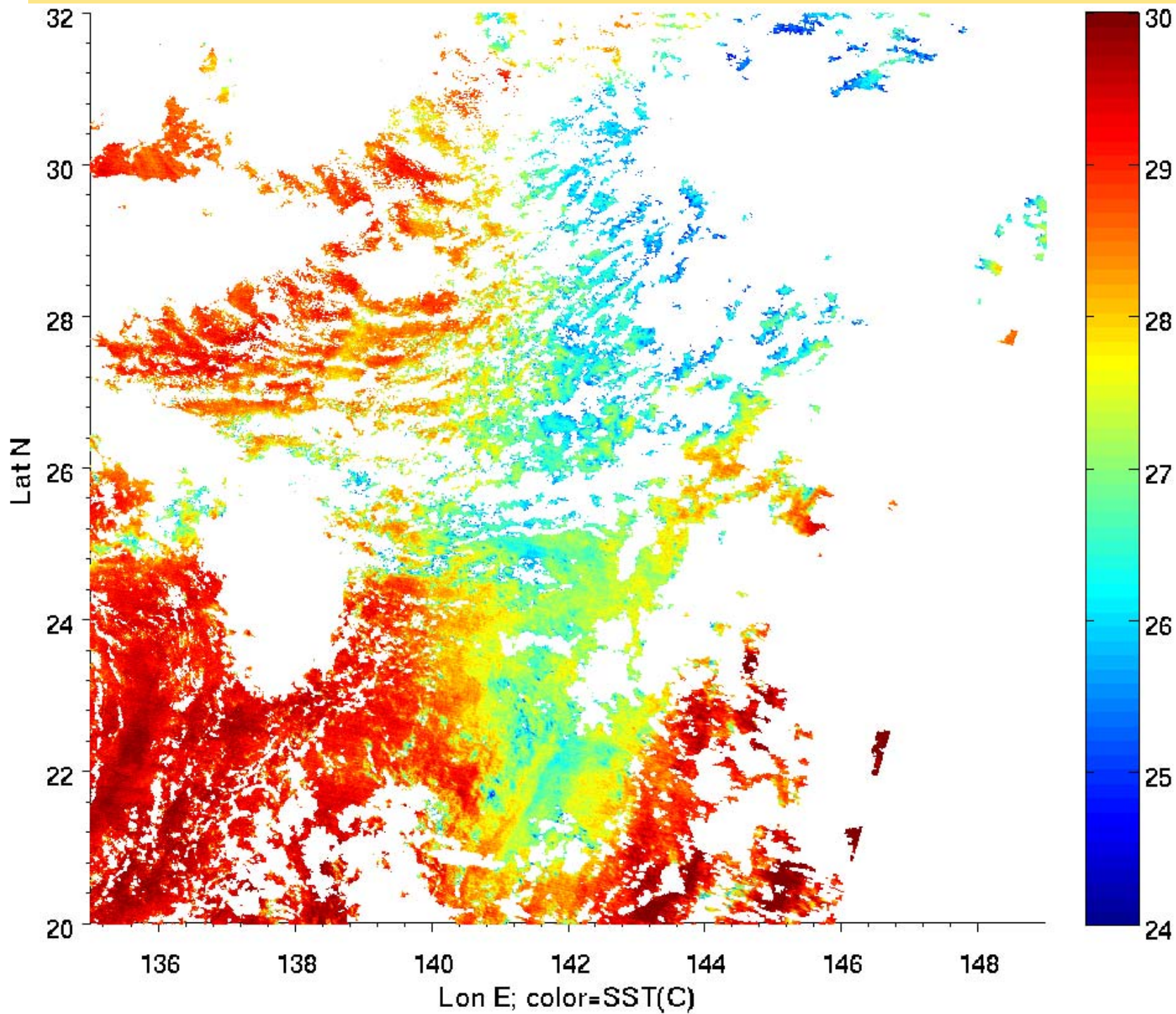


# AMSR-E SST MTSAT IR

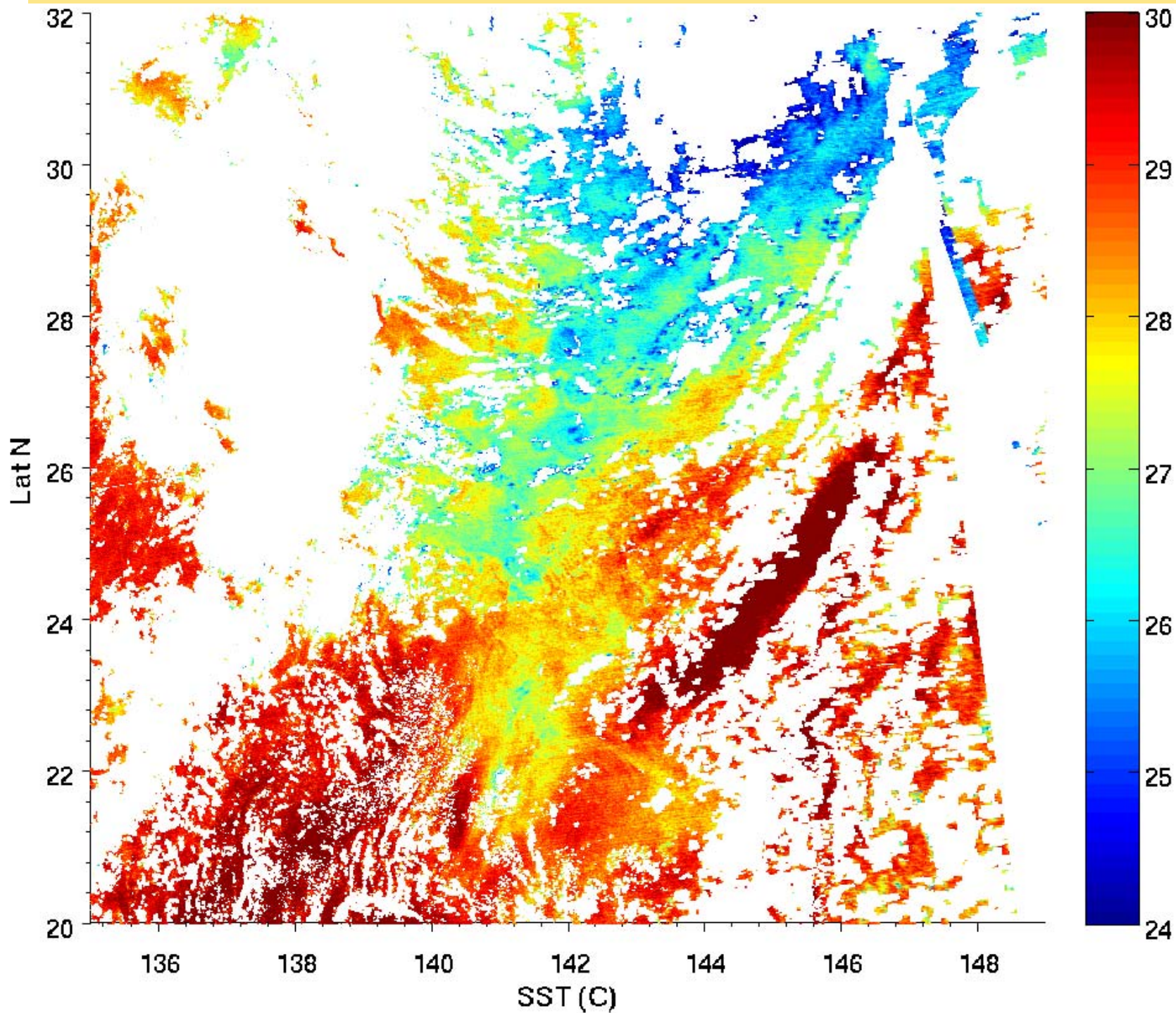
09/22/10 1800Z 87W NRLMRY  
09/25/10 0355Z AMSR-E aqua-1 SST  
09/25/10 0401Z MTSAT-2 VIS



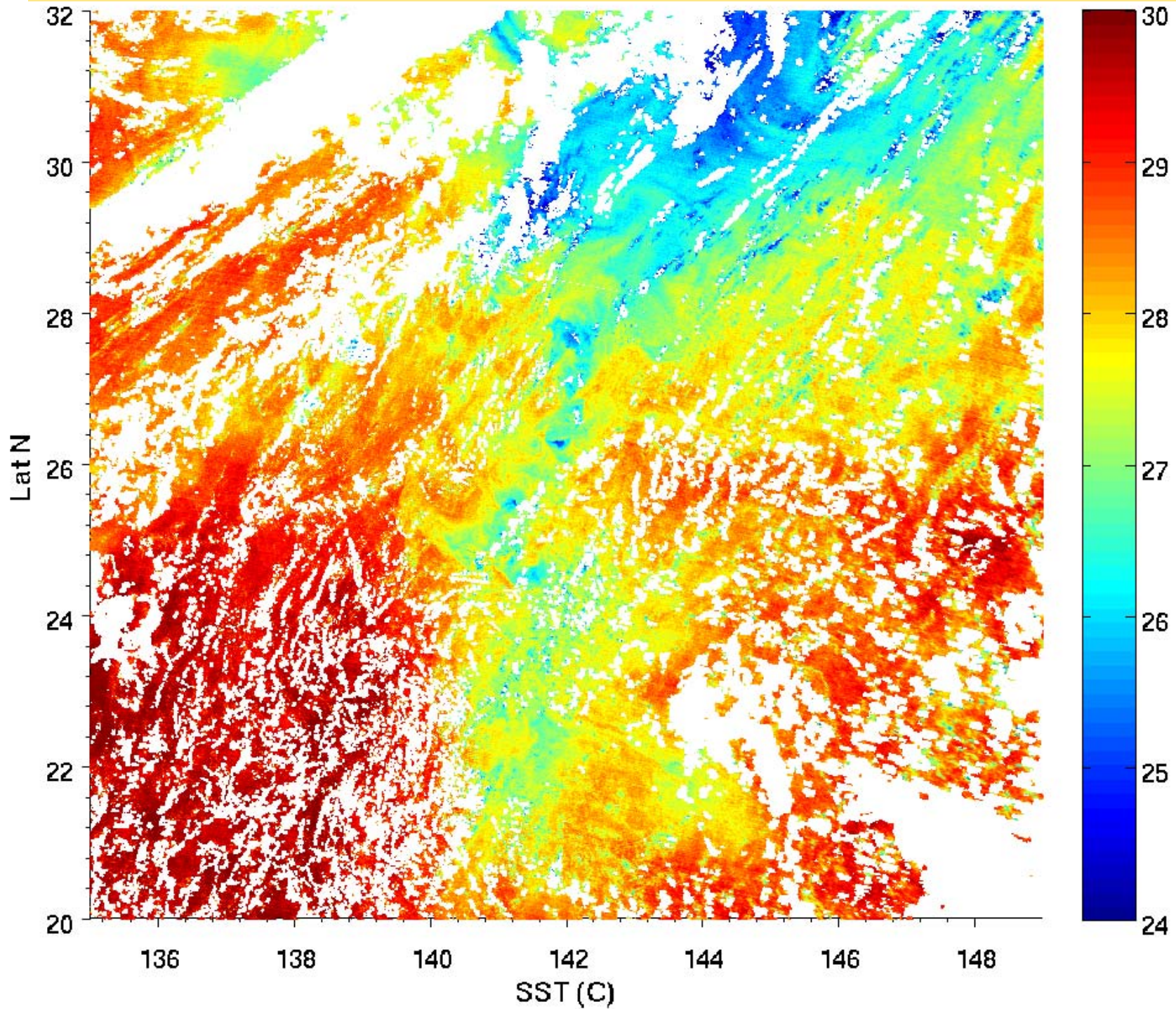
# Ty Malakas Cold wake, multi-source SST plot 9/26



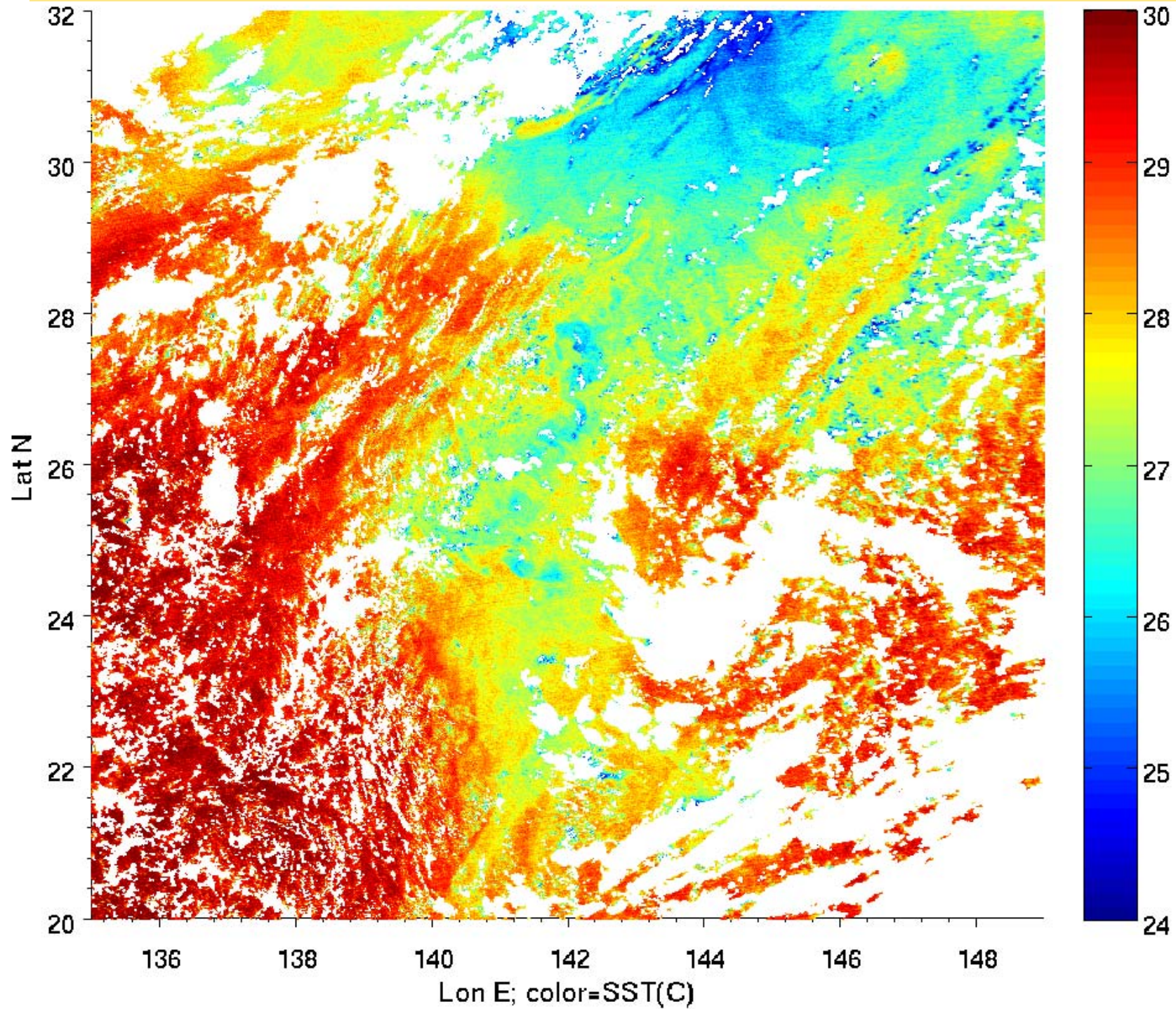
# Ty Malakas Cold wake, multi-source SST plot 9/27



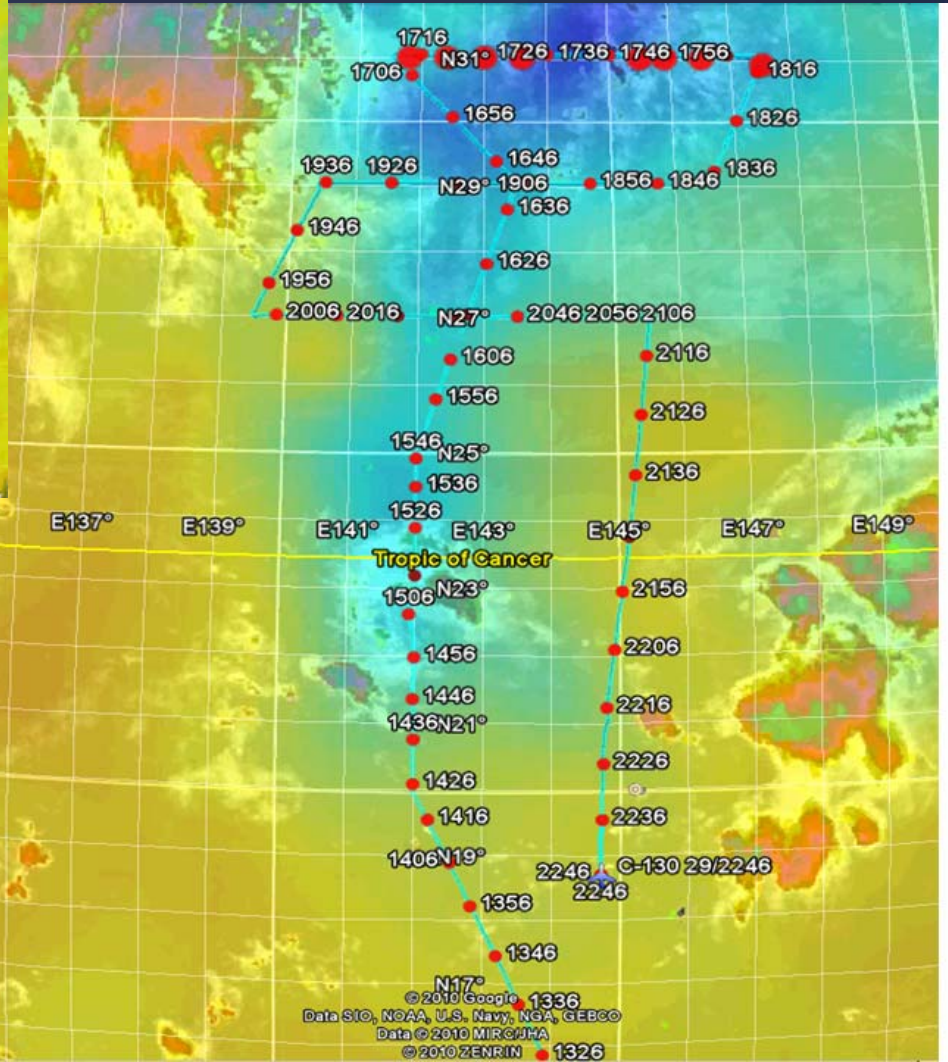
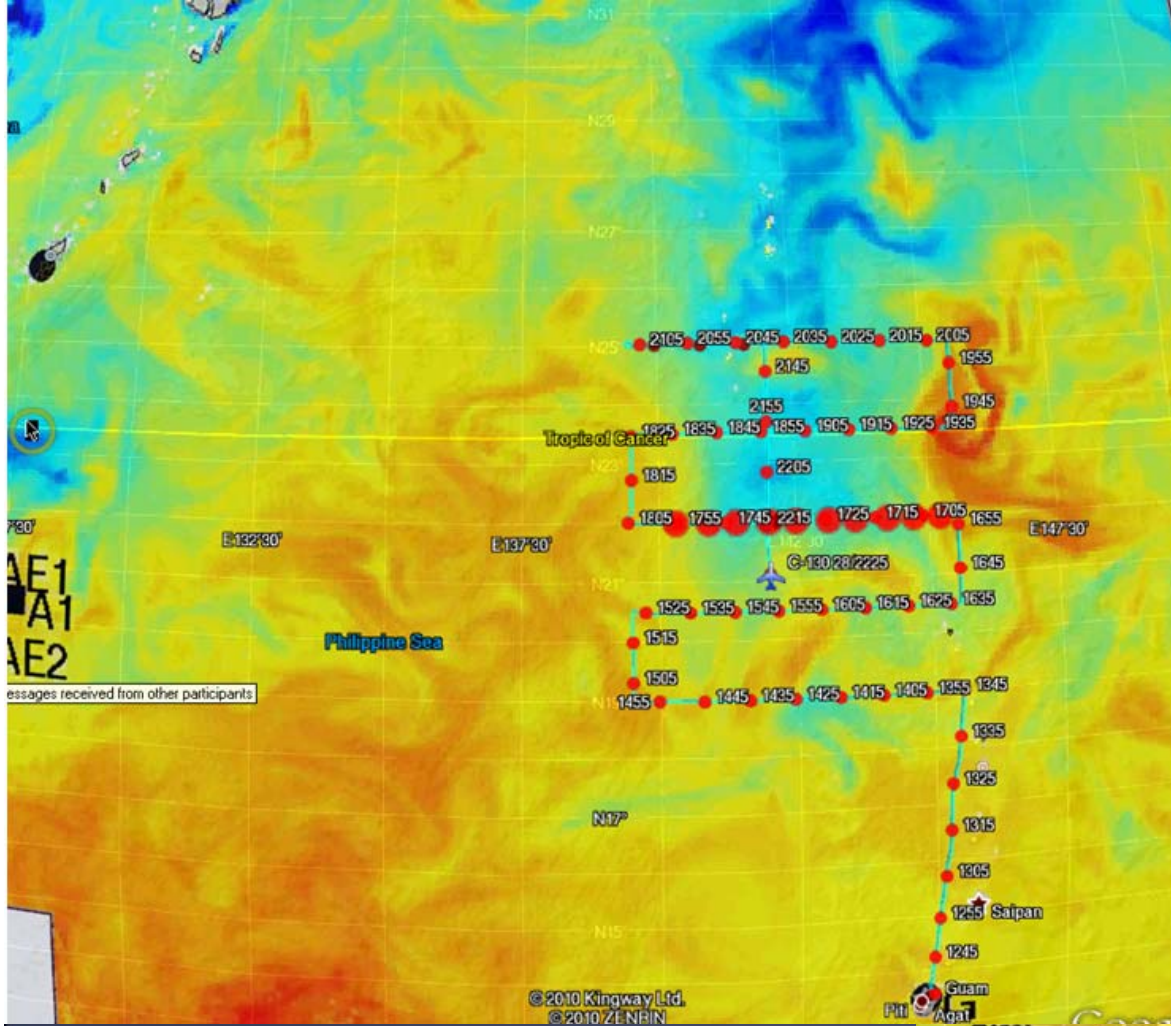
# Ty Malakas Cold wake, multi-source SST plot 9/28



# Ty Malakas Cold wake, multi-source SST plot 9/29

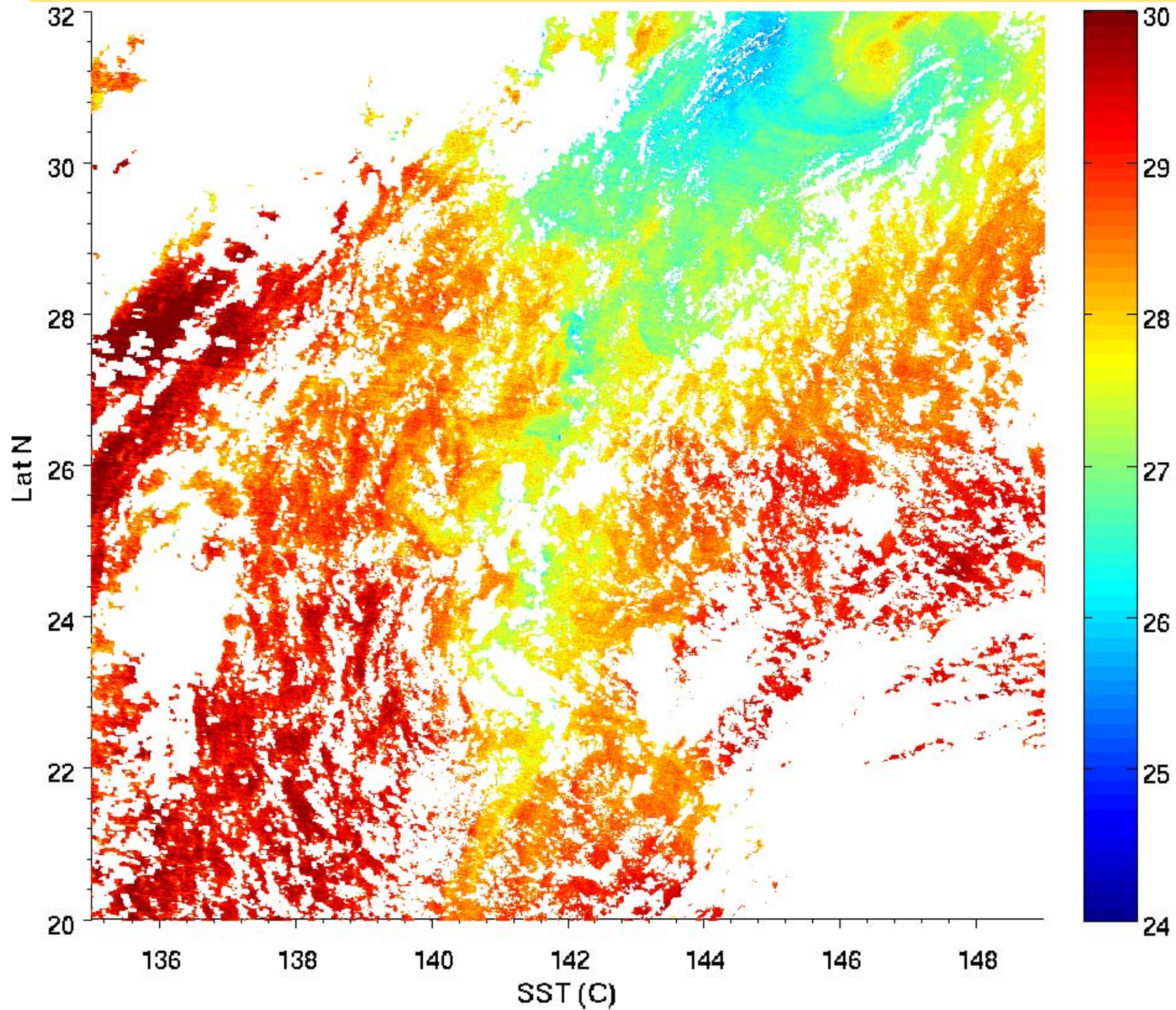


TY Malakas Cold wake flight  
 28 Sept 1230-2330 UTC  
 C-130 track (blue),  
 dropsondes/AXBTs (large red  
 dots), HDobs (small red dots),  
 model derived SST, MTSat IR  
 image overlays

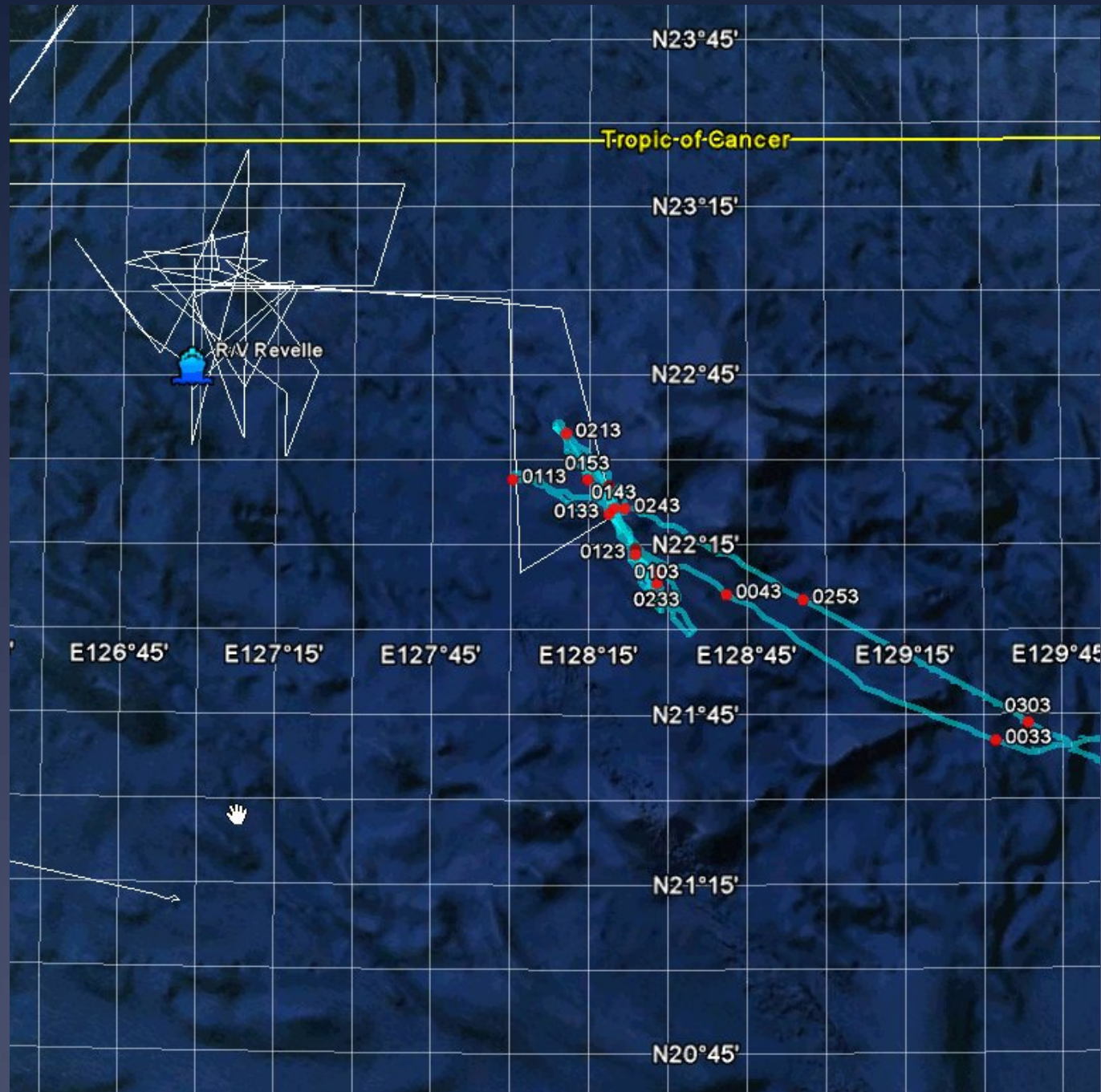


Ty Malakas Cold wake C-  
 130 flight 1300-2300  
 29 Sept (blue track)  
 Dropsondes/AXBT (large  
 red dots)  
 HDobs (small red dots)

# Ty Malakas Cold wake, multi-source SST plot 9/30



# ITOP Ship Aircraft Intercomparison



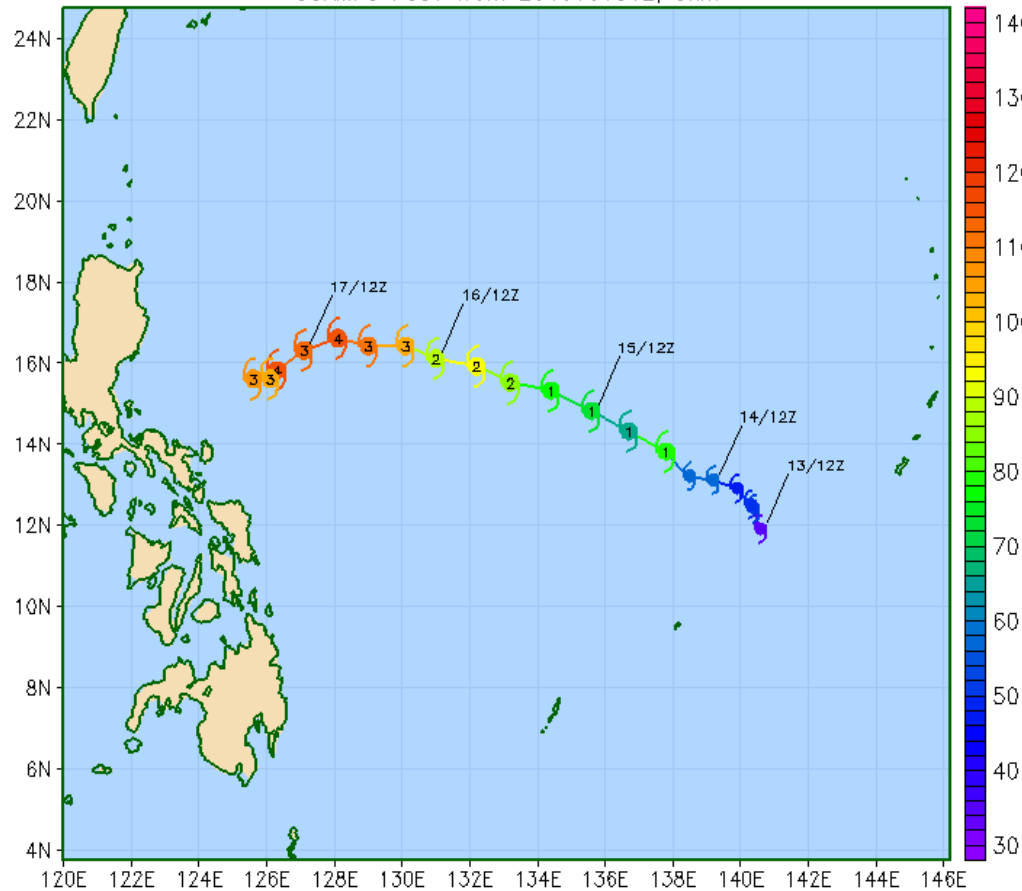


# Coupled COAMPS-TC Forecast for Typhoon

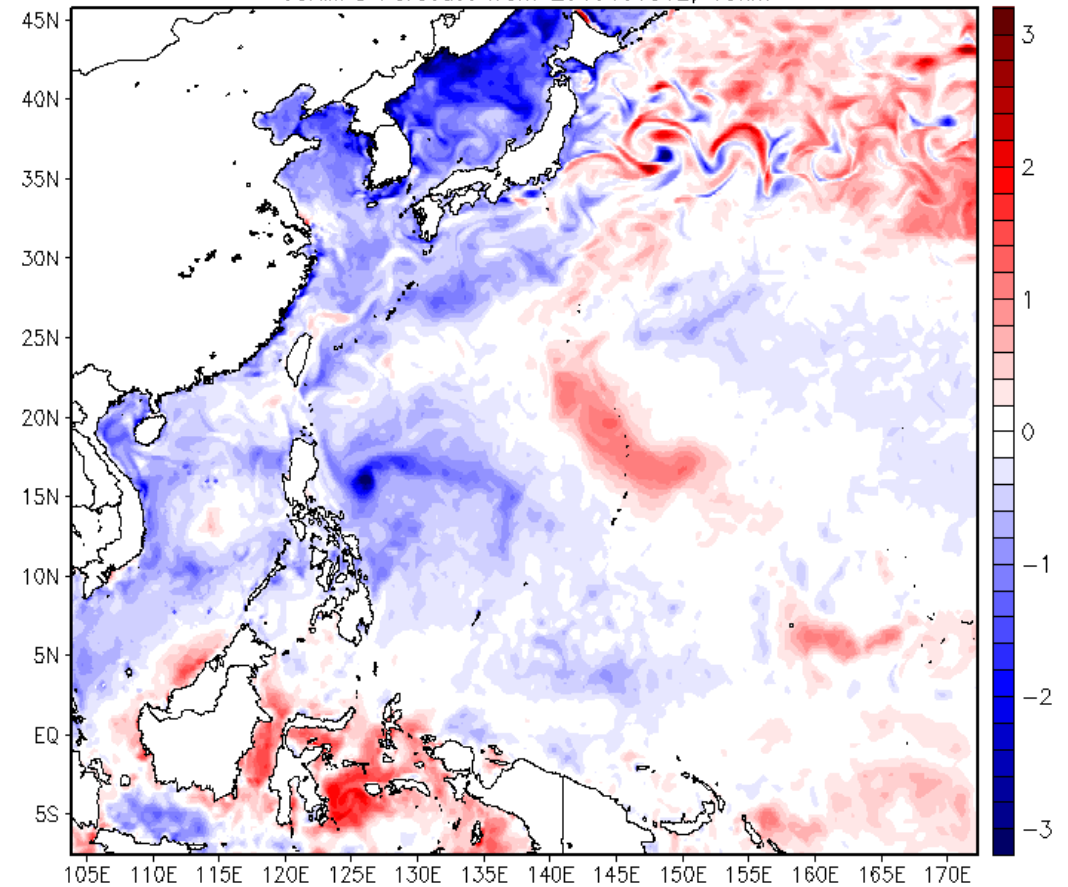
## Track and Intensity

## SST Change

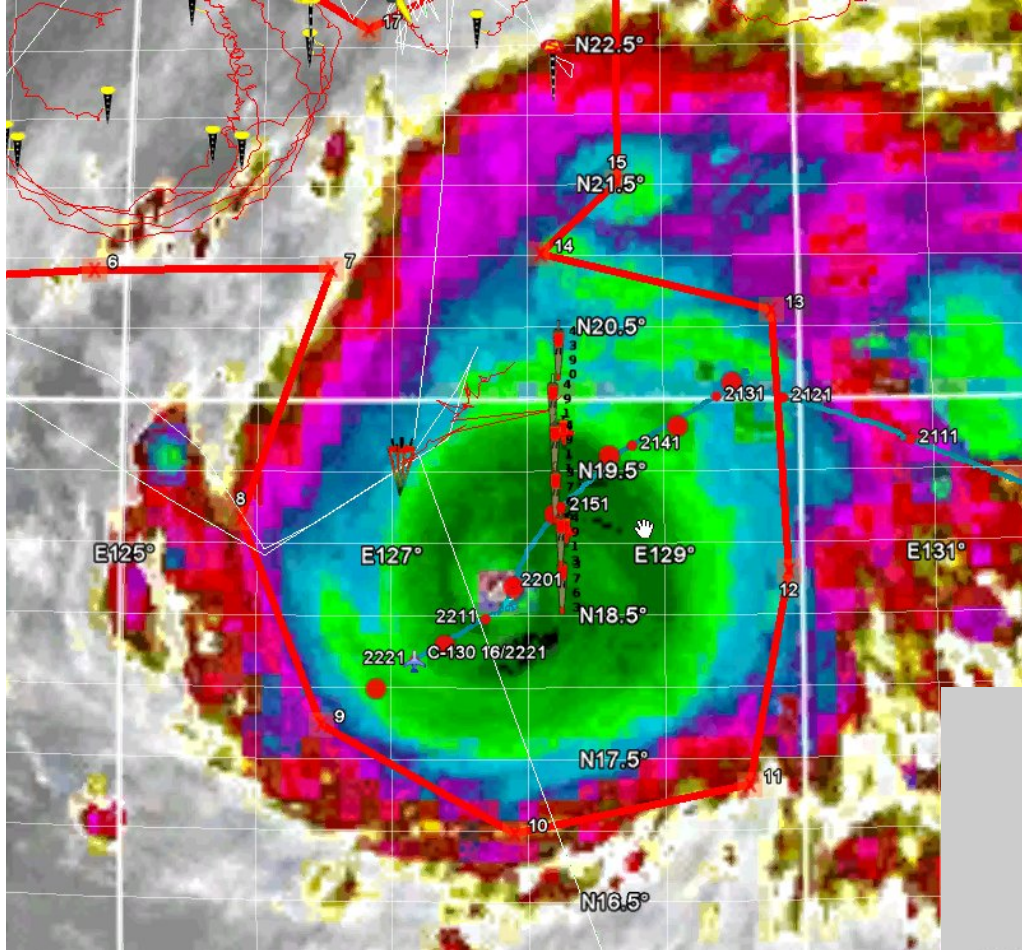
Track and Maximum Wind Speed (kt) Forecast  
COAMPS FCST from 2010101312, 5km



Sea Surface Temperature Change (°C) of 120h, valid at 1200 UTC 18 OCT 2010  
COAMPS Forecast from 2010101312, 10km



For more information, go to  
<http://www.nrlmry.navy.mil/coamps-web/web/cpltc>



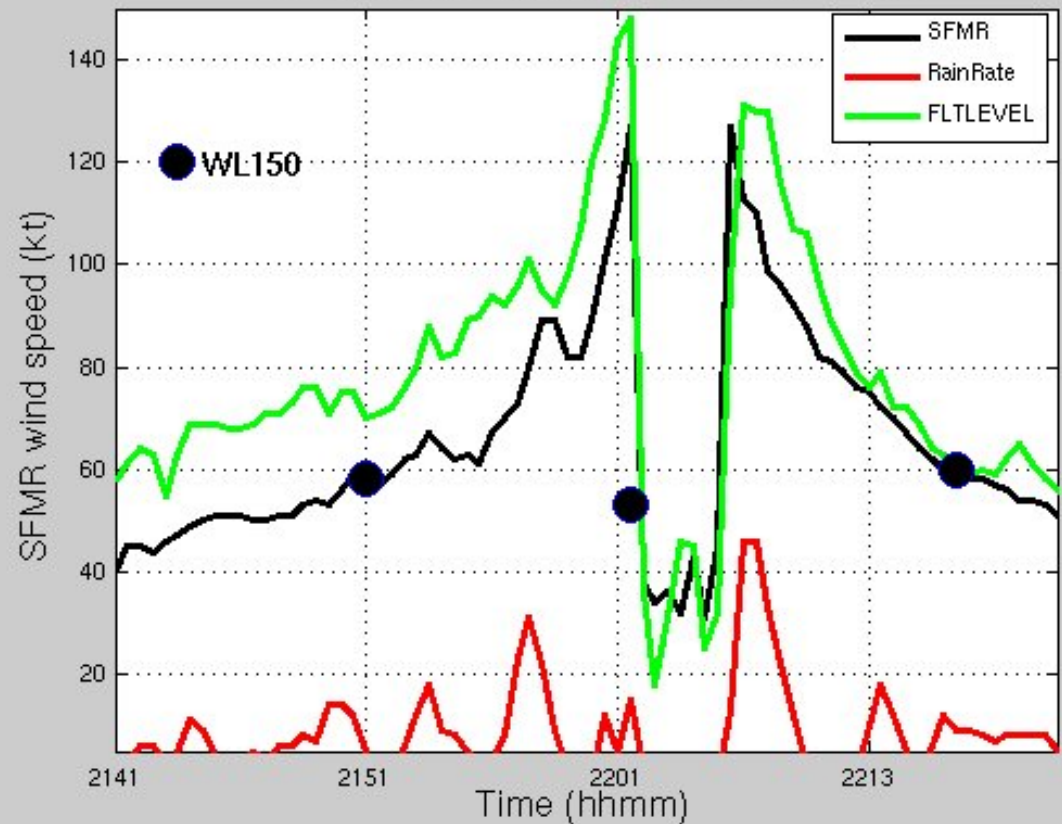
# STyMegi 16 Oct

(C-130 (blue) and DOTSTAR tracks (red), float line (N-S near 128E) Dropsonde and AXBT (big red dots), HDobs (small red dots))

## C-130 cross-section 16 Oct (2141-2221 UTC)

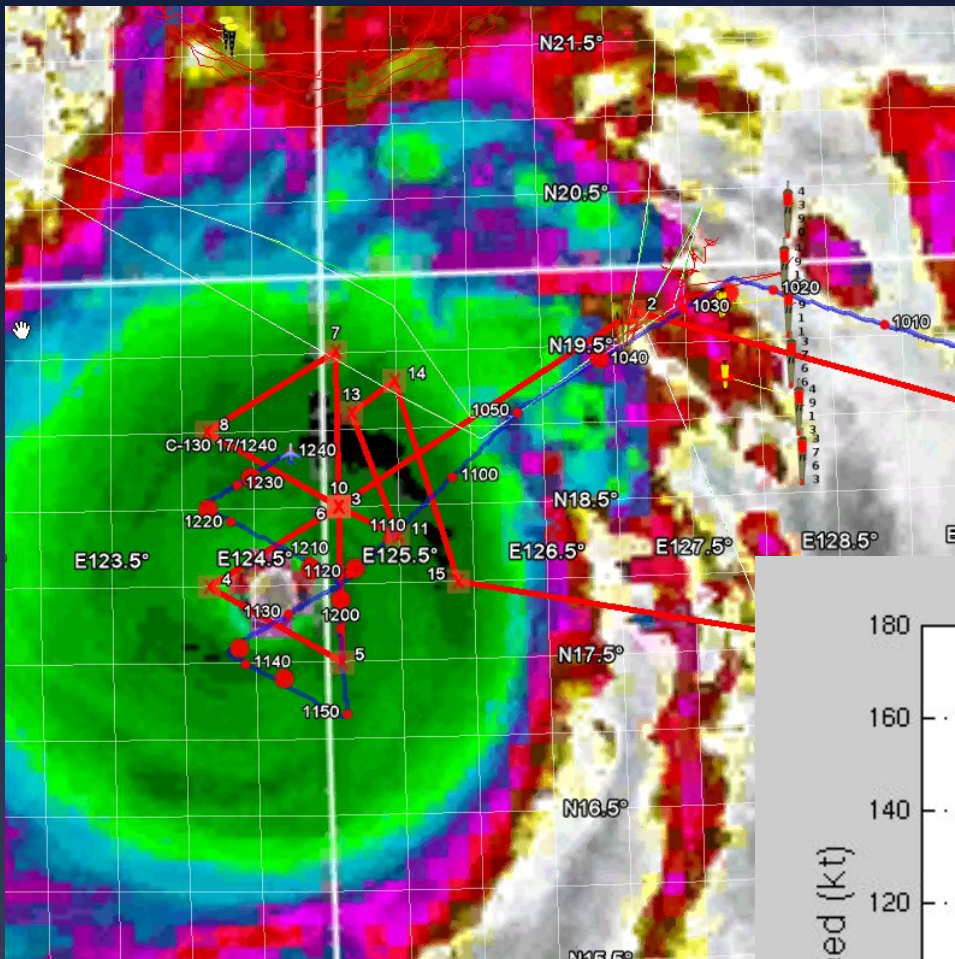
Flight level winds (green), SFMR derived surface winds (black), surface rain rate (red) and dropsonde derived lowest 150m wind speed (black dot)

TY MEGI: 16 October 2141-2221 NE-SW Pass



# STyMegi 17 Oct

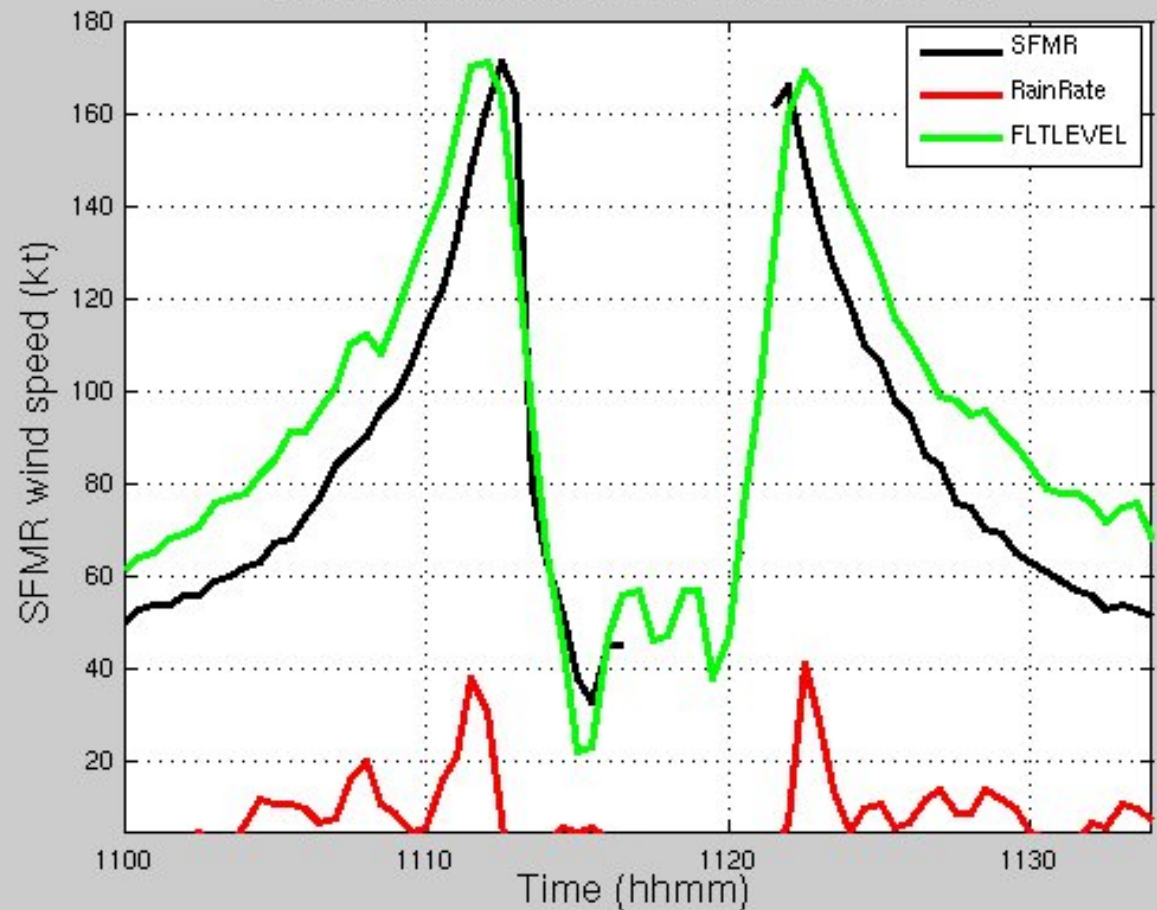
(C-130 (blue-real and red-planned tracks), float line (N-S near 128E) Dropsonde and AXBT (big red dots), HDobs (small red dots))



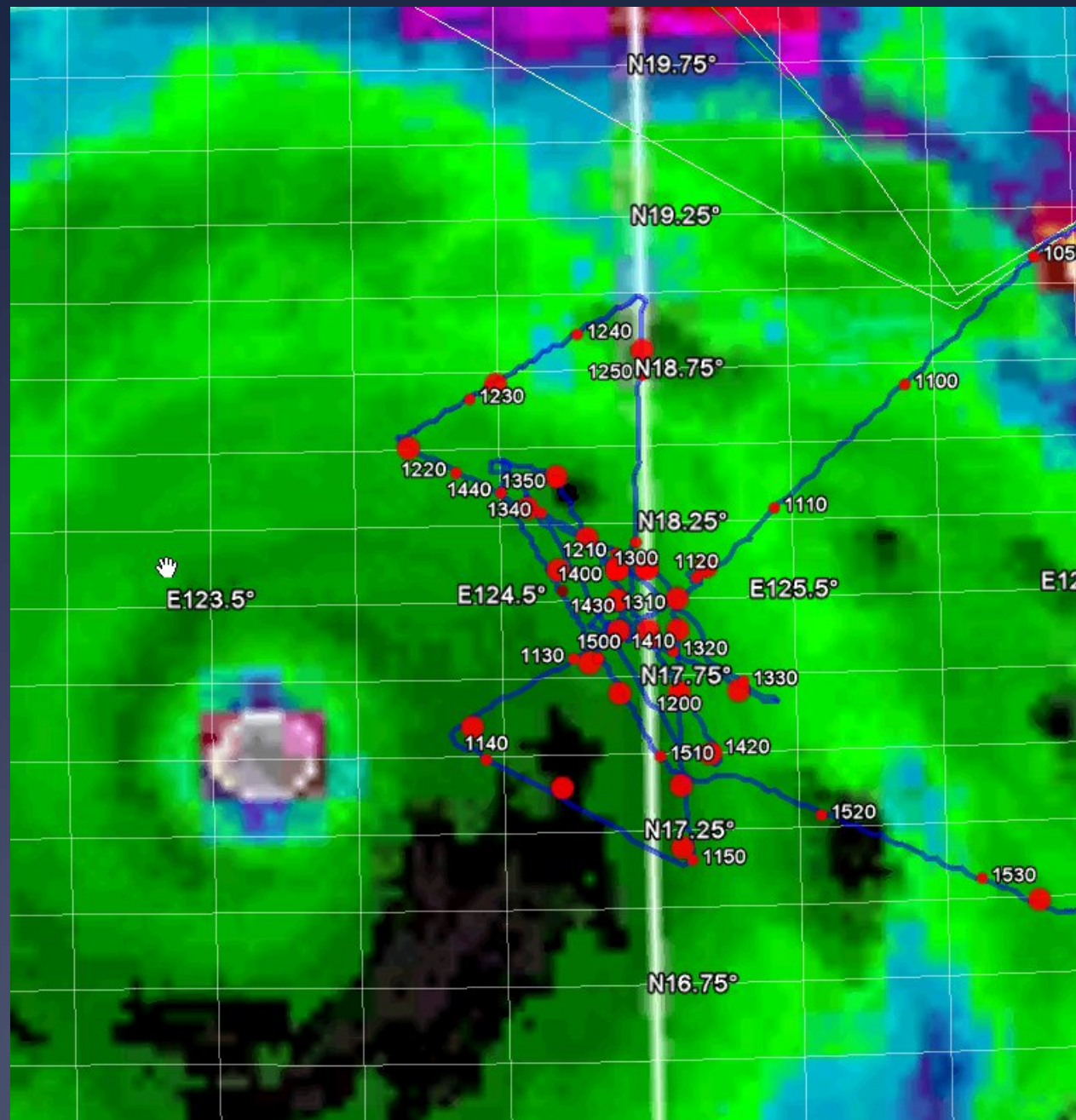
C-130 cross-section 17 Oct  
(1100-1134 UTC)

Flight level winds (green), SFMR  
derived surface winds (black),  
surface rain rate (red)

TY MEGI: 17 October 1100-1134 NE-SW Pass

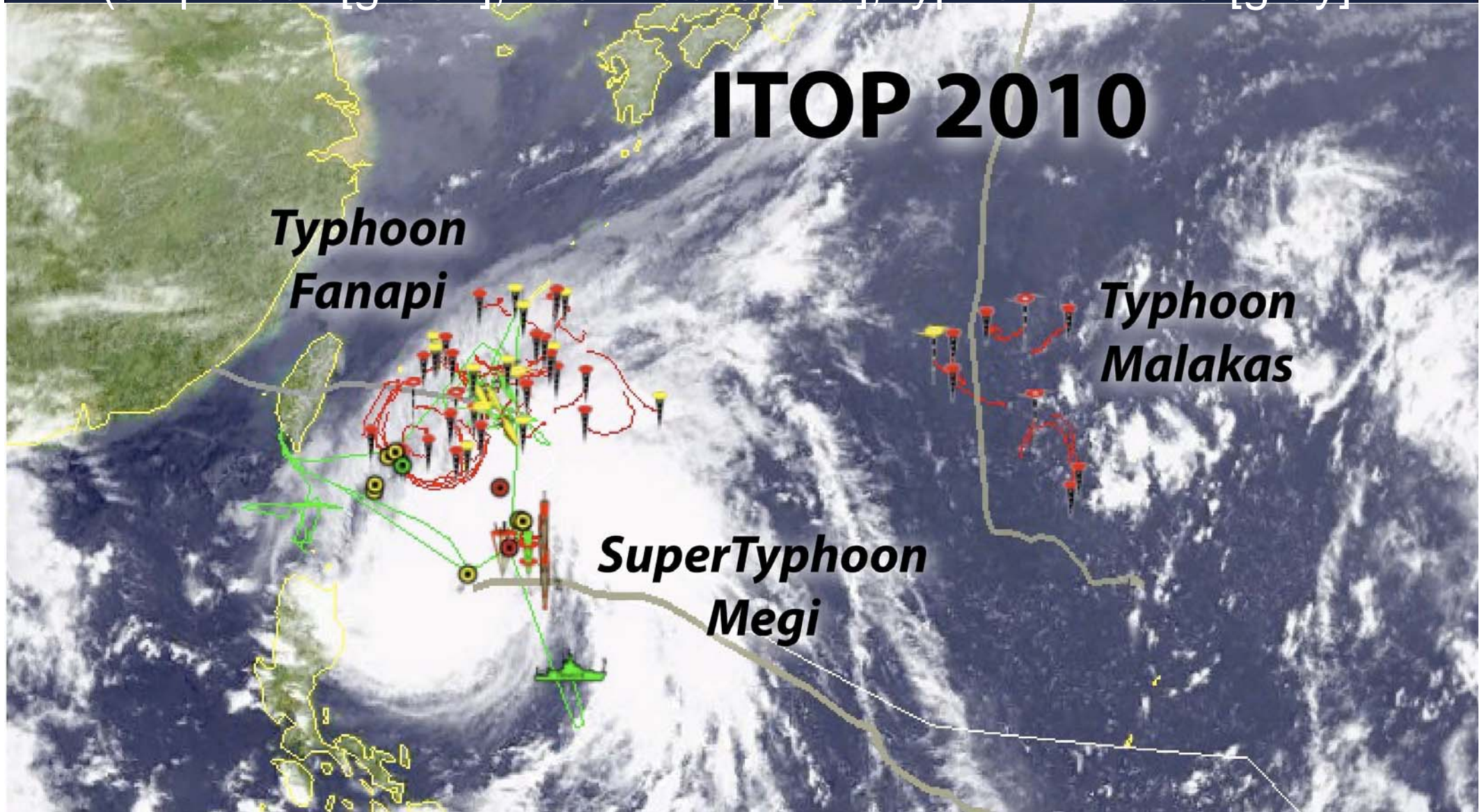


# STyMegi (IR sat), C-130 track (blue), dropsondes and HDobs (red dots)



# Summary of Events

(ship track [green], float tracks [red], typhoon tracks [gray])



Satellite image (MTSAT Visible) from 17 October 2010

# ITOP Firsts

- \* Airborne deployment of buoys and floats immediately ahead/ behind 2 typhoons and 1 super-typhoon in WestPac
- \* High resolution measurements of 3 typhoon cold wakes
- \* USAF C-130 recon in radius of max-wind in Sty Megi
- \* Rapid deployment of dropsondes and AXBTs in super typhoon high-winds
- \* *R/V Revelle* deployment/high resolution obs in cold wake of typhoon
- \* Air drop AXBT/*R/V Revelle* intercomparison