TCS-10 / ITOP
Impact of Typhoons on the Ocean in the Pacific

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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

R/V Revelle

DOTSTAR

Lagrangian Float

Air-Sea Interaction Spar (ASIS) Buoy

ITOP Mooring

EASI-ASIS Buoys in tandem mooring

EM-APEX
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

DOTSTAR aircraft from Taiwan

Storm impacts Taiwan

Detailed reconnaissance as storm passes over floats/drifters

Air Deployed
19 Floats/Drifters

Accurately predicted S-shaped storm track

203 Dropsondes
173 AXBT

4 Surveillance flights improve forecasts

2 C130 in Guam

Ocean Sampling Array
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
Summary of Ty Fanapi with MODIS derived
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

Temperature along section 2

22 Sep 12:49 to 23 Sep 03:07
4 DAYS after Fanapi

sub-surface
cold wake

09 Oct 06:04 to 09 Oct 15:27
21 DAYS after Fanapi

low-stratification;
cold wake remnant?
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

Dropsonde derived LL winds
Typhoon Malakas Sep 24, 2010 08:49 GMT

Edge of typhoon Malakas showing scales of outer bands.
AMSR-E SST
MTSAT IR
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

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

Flight level winds (green), SFMR derived surface winds (black), surface rain rate (red)
STyMegi (IR sat), C-130 track (blue), drops sondes and HDobs (red dots)
Summary of Events
(ship track [green], float tracks [red], typhoon tracks [gray])

ITOP 2010

Typhoon Fanapi
SuperTyphoon Megi

Typhoon Malakas

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