Integrating Atmospheric Observations of ITOP in a High-Resolution Mesoscale Model Based on EnKF Data Assimilation

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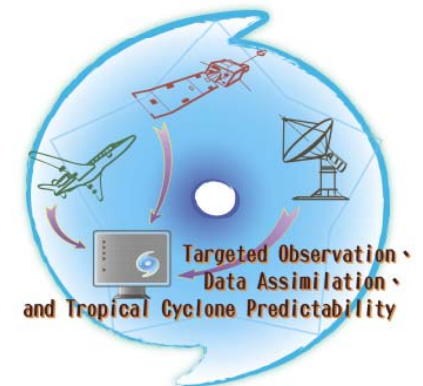
National Taiwan University, Taipei, Taiwan

ITOP Workshop (May 18, 2011)

Sorry for not being to attend the workshop…

Outline

- Data from DOTSTAR, C130 in ITOP
- EnKF data assimilation and analyses
- Results in Typhoon Fanapi (2010)
- Ongoing works and challenging issues

Internal wave and Typhoon-Ocean interaction Project in the Western North Pacific and Neighboring Seas (ITOP, 2010)

C130

DOTSTAR

International collaboration:

Taiwan
US
Japan

ITOP planning meeting, Taipei, 2008

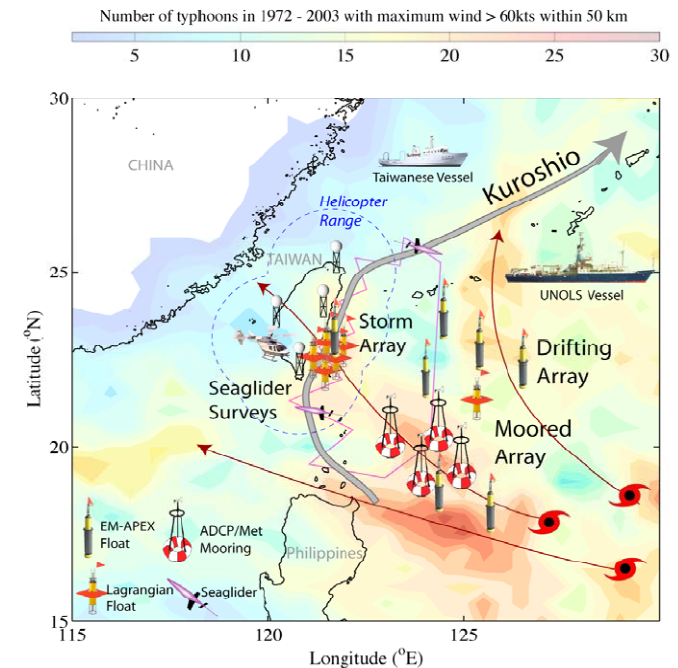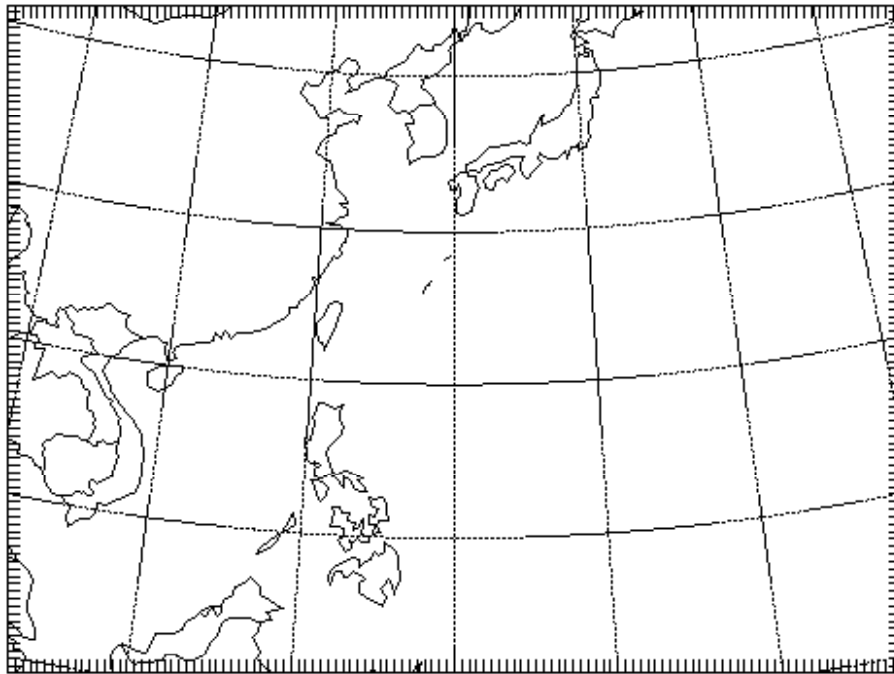**ITOP operation, Guam, 2010**

- **DOTSTAR, TCS-10, and ITOP coordination**
- Investigation of the roles of upper ocean thermal structures (eddies and/or wakes) on typhoon-ocean interaction.
- Understanding the feedback of the typhoon-ocean interaction to typhoon intensity and structure evolution.
- Numerical simulation experiments (coupled model) with the T-PARC (and TCS-10) and ITOP data.

Number of typhoons in 1972 - 2003 with maximum wind > 60kts within 50 km

5   10   15   20   25   30

CHINA

Taiwanese Vessel

Kuroshio

Helicopter Range

TAIWAN

UNOLS Vessel

Storm Array

Drifting Array

Seaglider Surveys

Moored Array

EM-APEX Float

ADCP/Met Mooring

Philippines

Lagrangian Float

Seaglider

Latitude (°N)

Longitude (°E)

# ITOP ensemble reanalysis based on EnKF (*ITOP_EnKF*)

Model domain

- 18 Aug. ~ 25 Oct. 2010

- 45 ensemble members

- Single domain: 121*91 grids with (coarse) 54-km resolution

- Initial ensemble generated from NCEP FNL at 1800 UTC 17 Aug.

- Boundary conditions are also from NCEP FNL over the whole analysis.

- 6-hour cycling assimilation

- Observations assimilated: radiosonde, dropwindsonde data, surface station data, cloud motion vectors, and aircraft reports.
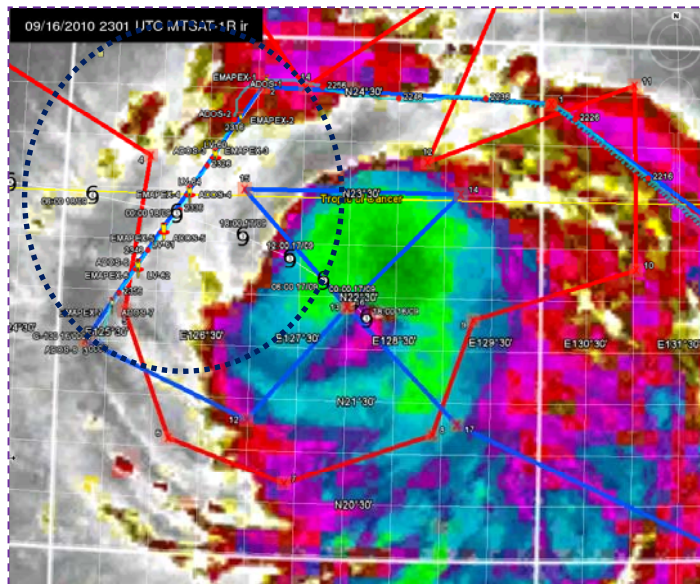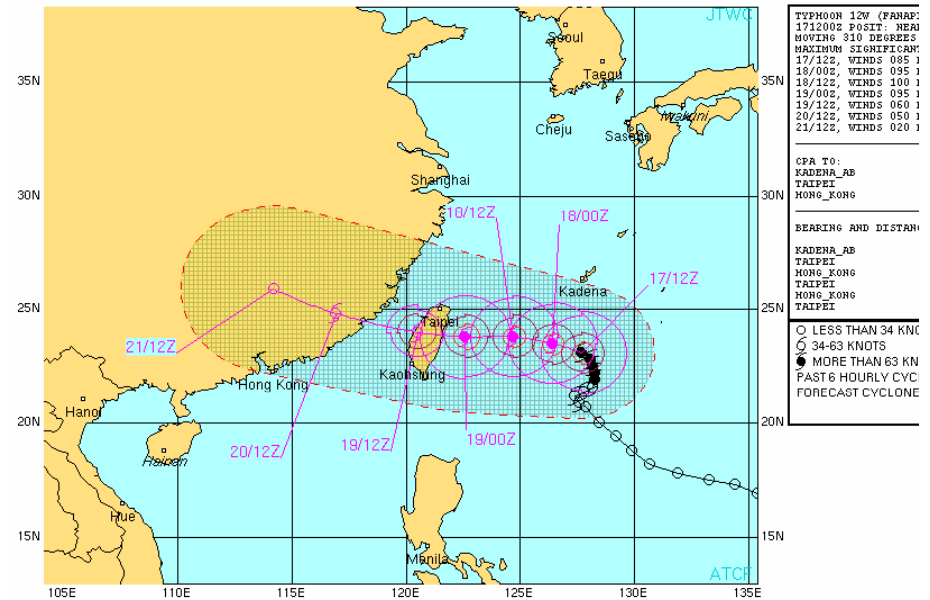
ITOP ensemble reanalysis based on EnKF (*ITOP_EnKF*)

TC Tracks During ITOP

Analysis Tracks —— (6-hr) Forecast Tracks —— Observation (JMA)
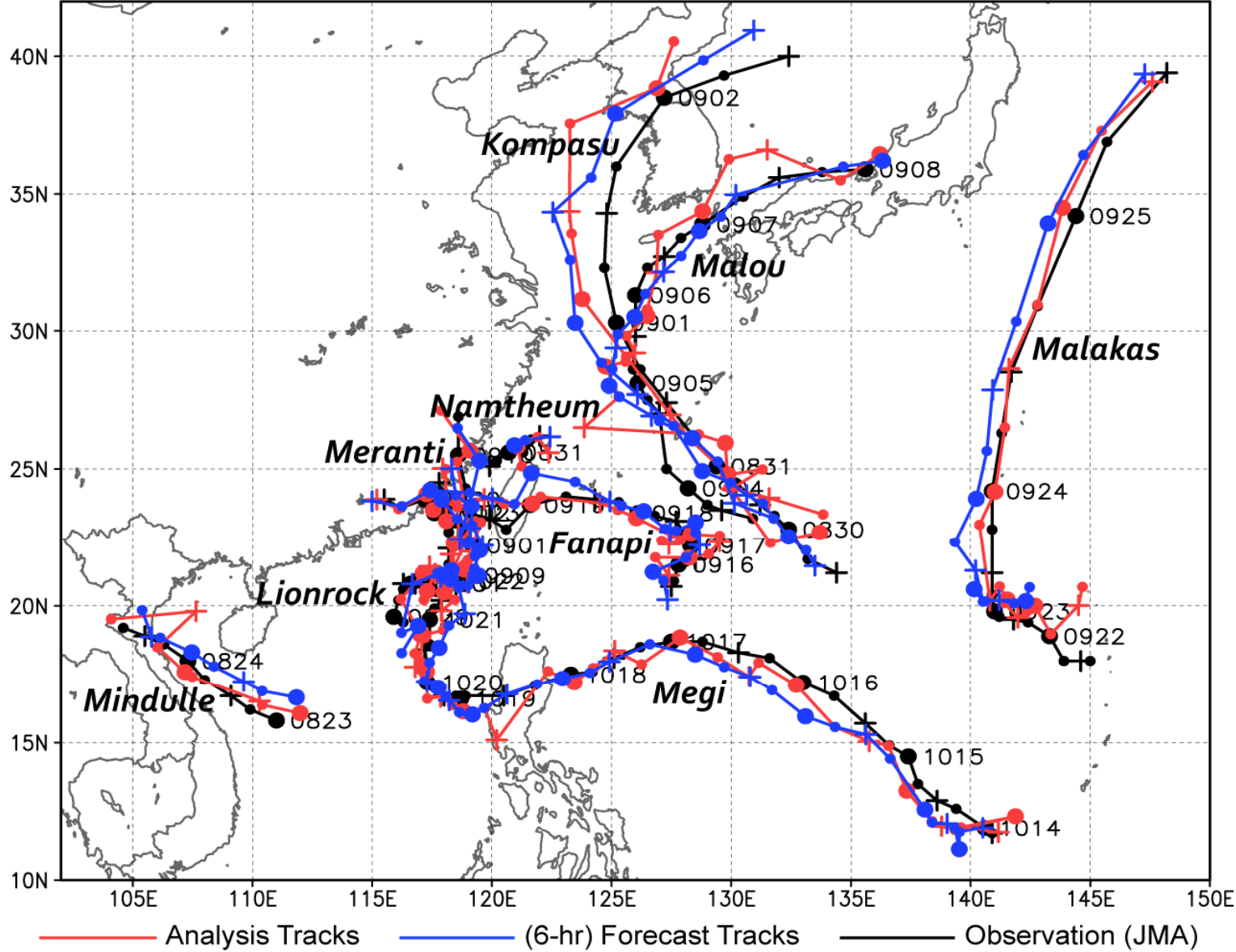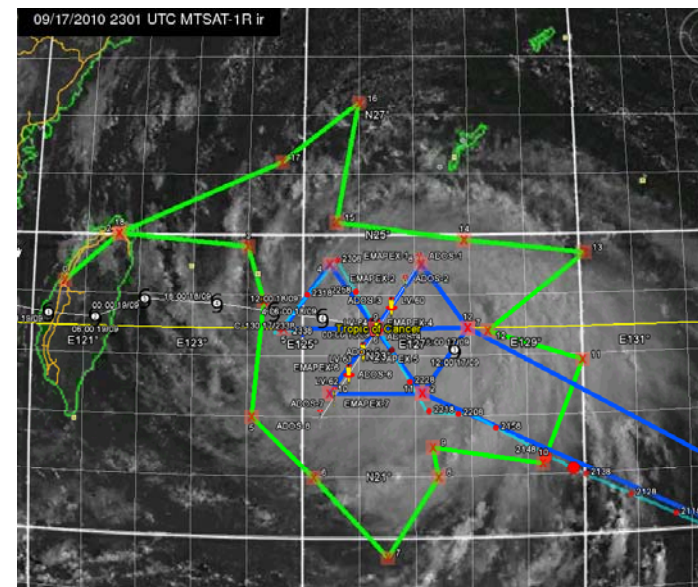
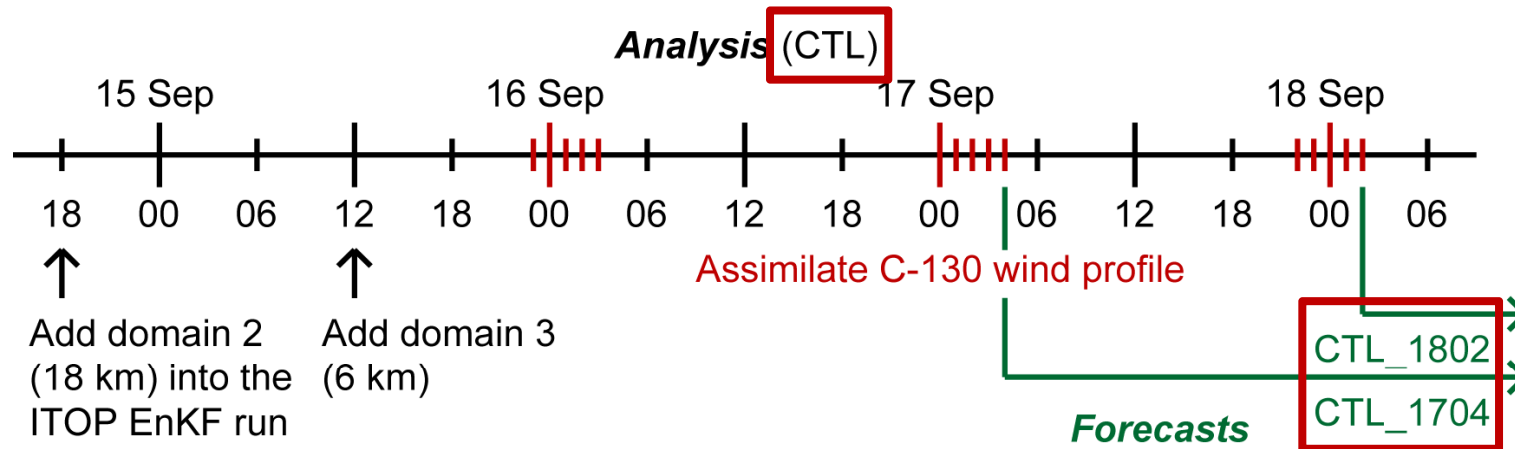# ITOP DOTSTAR/C130 joint observations: Fanapi (2010)
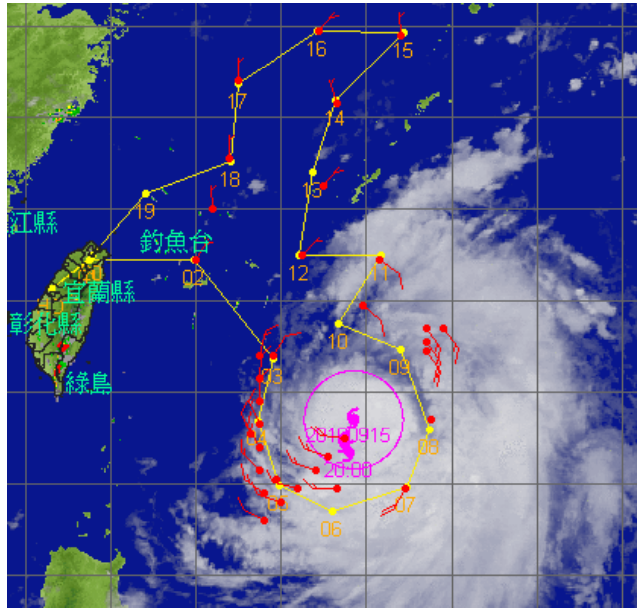
0000 UTC, Sept. 16th

0000 UTC, Sept. 17th

0000 UTC, Sept. 18th
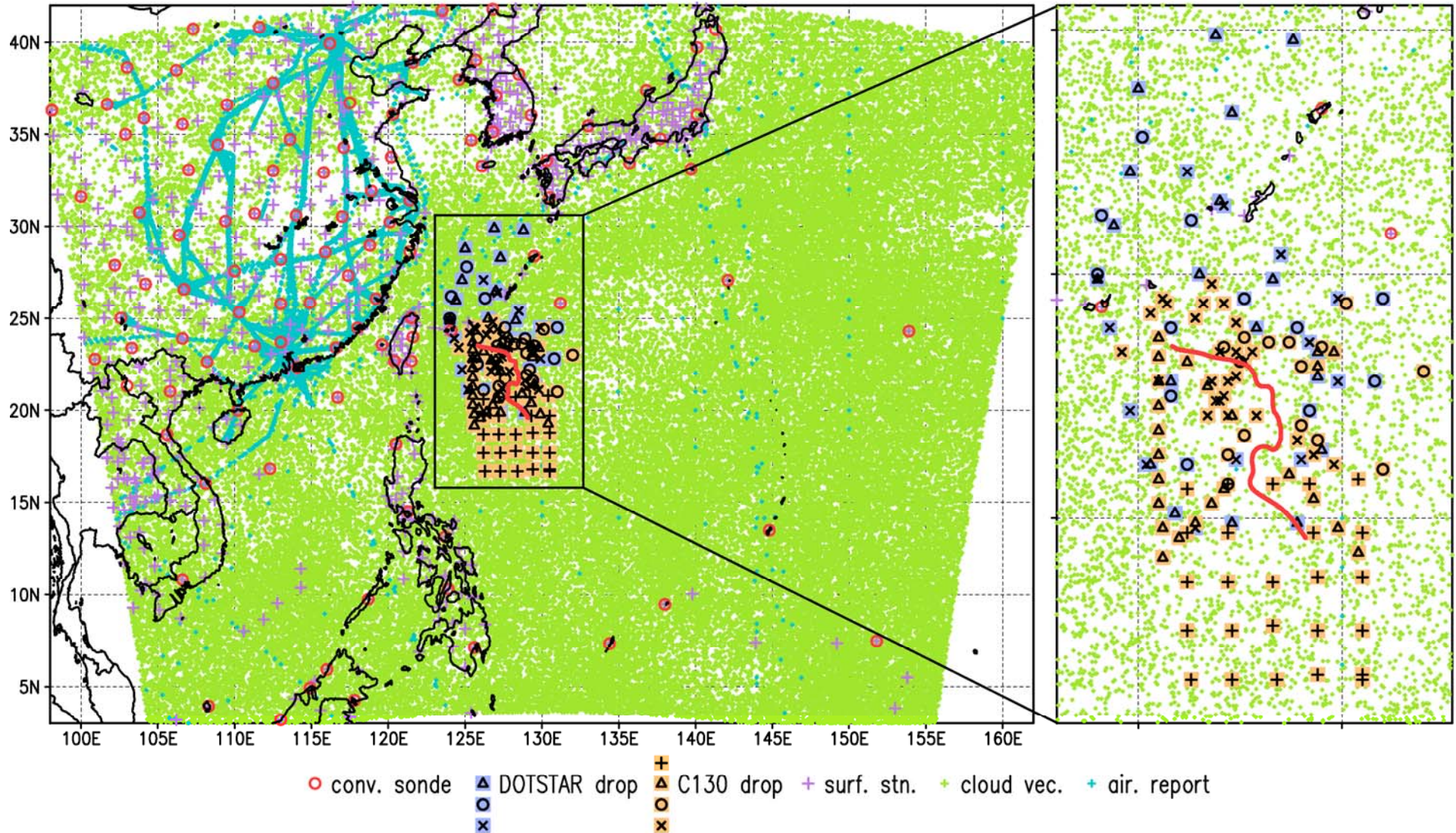
High-resolution analysis and forecast of Typhoon Fanapi

- 1- hour Cycling run from its genesis, initialized with low-resolution ITOP_EnKF run at 1800 UTC 14 Aug.
- Add two additional vortex-following domains (18- and 6-km resolutions).
- Use the same 45-member ensemble.
- Use the same data stream for assimilation, but also include few additional special parameters for TCs (methodology modified from Wu et al. 2010, 2011):
  - TC center position (every hour).
  - Minimum central SLP (every hour).
  - Azimuthal-mean 700-hPa tangential wind profile from 3 C130 missions (when available; using the same composite data for each one mission).

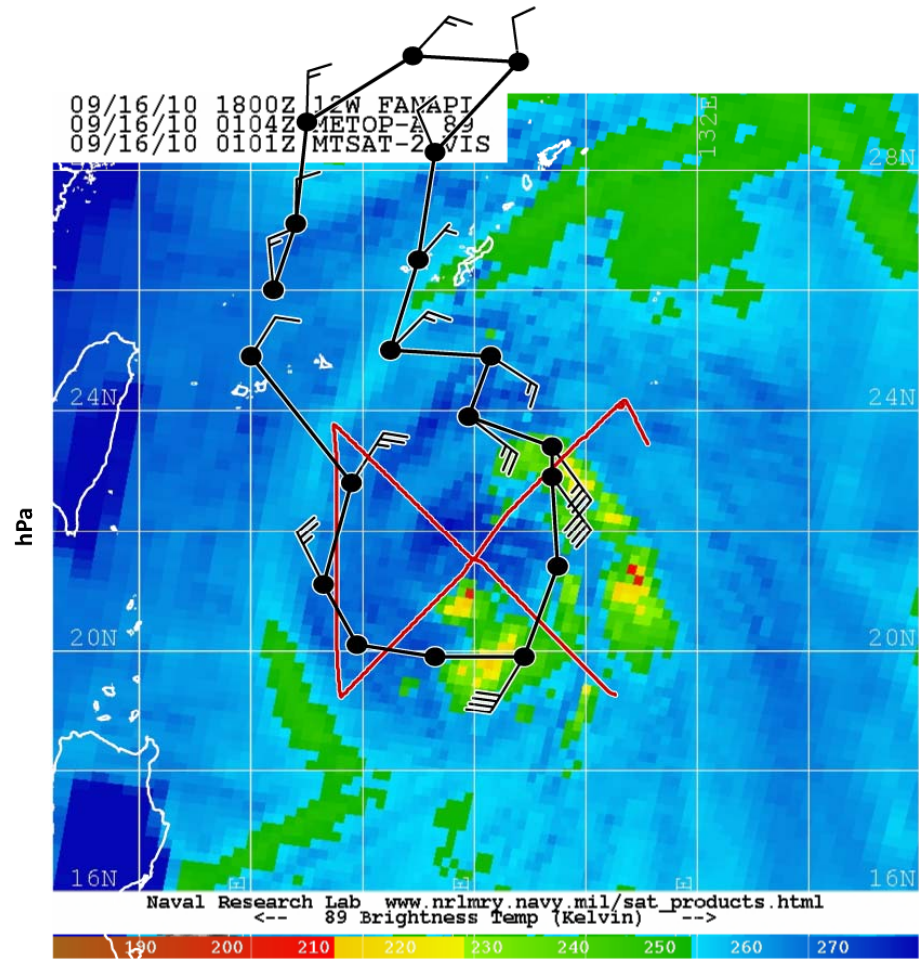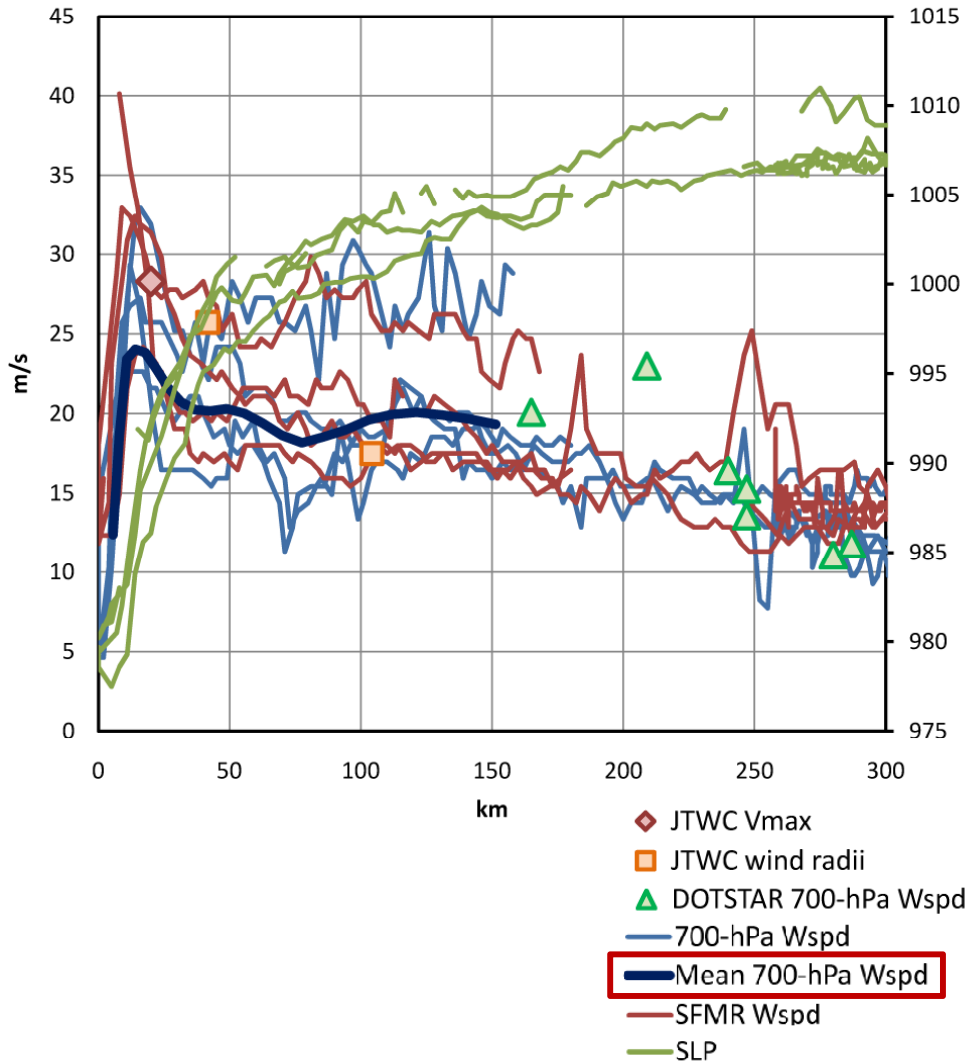# Data distribution in Fanapi

From 1730 UTC 14 August to 0230 UTC 18 August

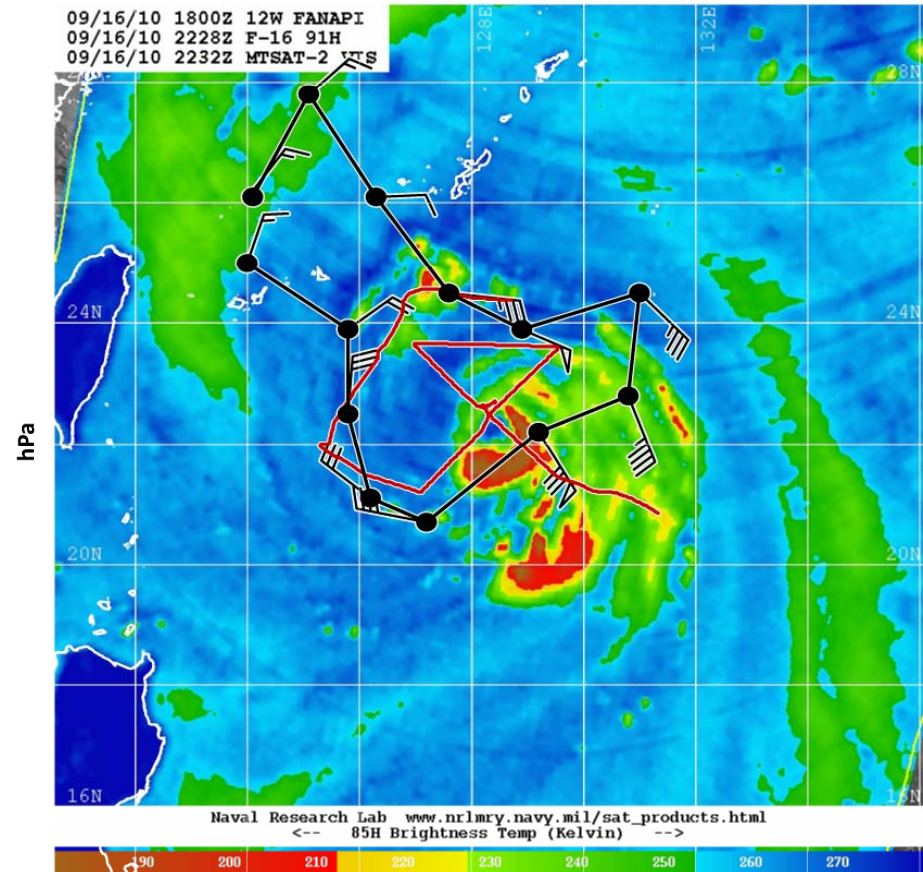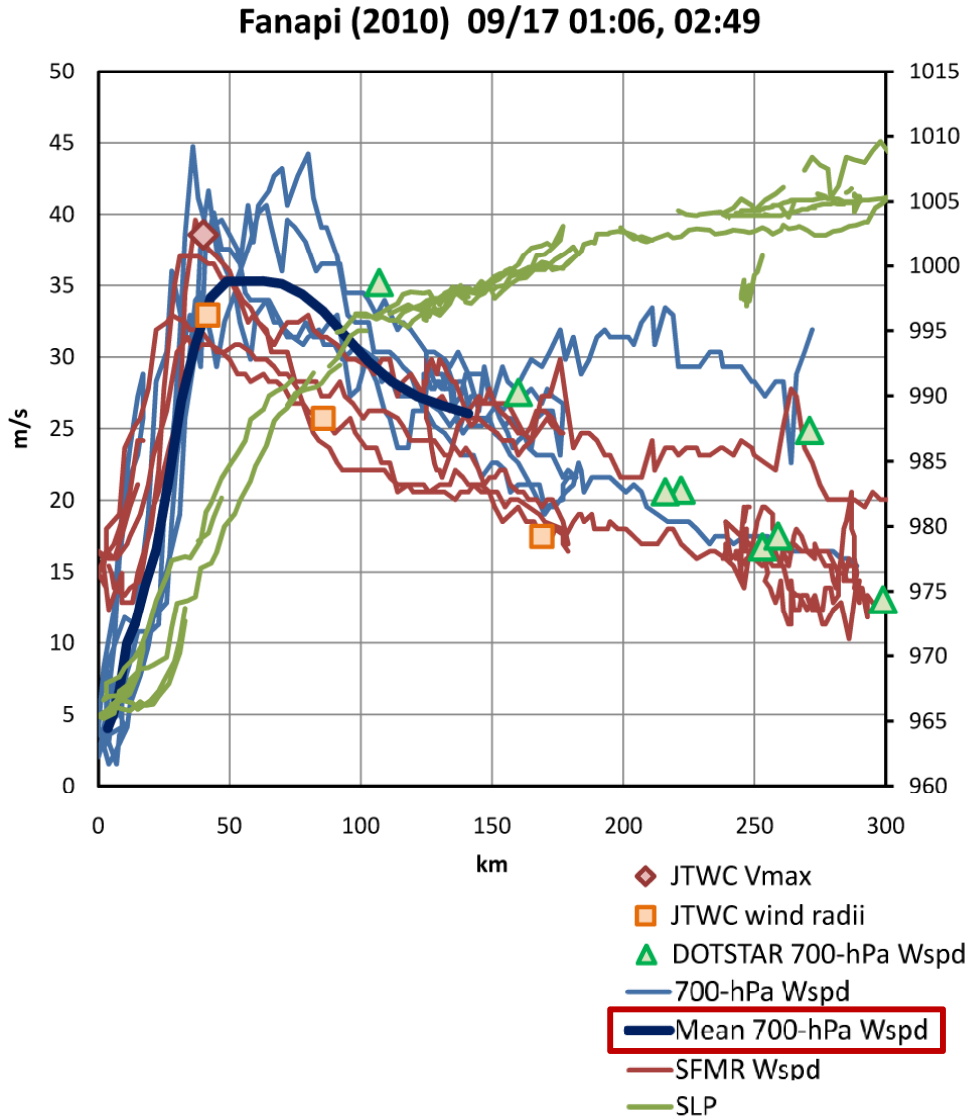

Spatial Distribution of Observations

3 consecutive C130-DOTSTAR joint fight missions (I)
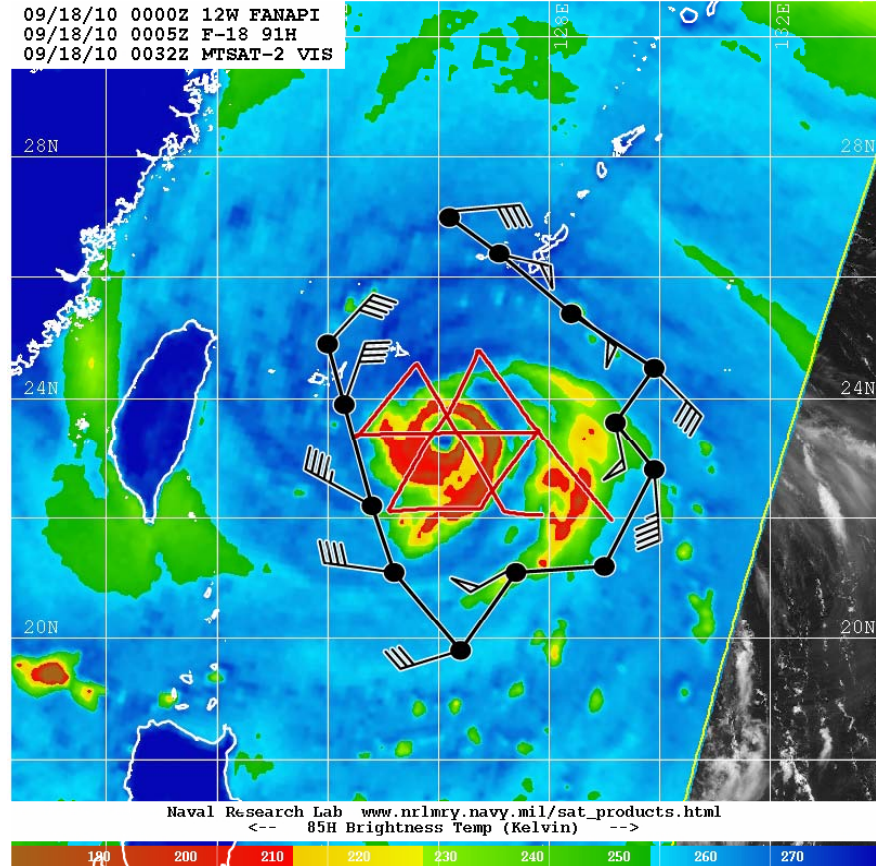

Fanapi (2010) 09/15 23:24, 09/16 02:54

Legend:
- ◆ JTWC Vmax
- ▣ JTWC wind radii
- △ DOTSTAR 700-hPa Wspd
- — 700-hPa Wspd
- — Mean 700-hPa Wspd
- — SFMR Wspd
- — SLP

3 consecutive C130-DOTSTAR joint fight missions (II)

Fanapi (2010) 09/17 01:06, 02:49

Legend:
- ◆ JTWC Vmax
- ▫ JTWC wind radii
- △ DOTSTAR 700-hPa Wspd
- — 700-hPa Wspd
- — Mean 700-hPa Wspd
- — SFMR Wspd
- — SLP

3 consecutive C130-DOTSTAR joint fight missions (III)

Fanapi (2010) 09/17 22:45, 23:57, 09/18 01:13

Legend:
- ◆ JTWC Vmax
- ■ JTWC wind radii
- △ DOTSTAR 700-hPa Wspd
- —— 700-hPa Wspd
- —— Mean 700-hPa Wspd
- —— SFMR Wspd
- —— SLP

09/18/10 0000Z 12W FANAPI
09/18/10 0005Z F-18 91H
09/18/10 0032Z MTSAT-2 VIS

Naval Research Lab www.nrlmry.navy.mil/sat_products.html
<-- 85H Brightness Temp (Kelvin) -->
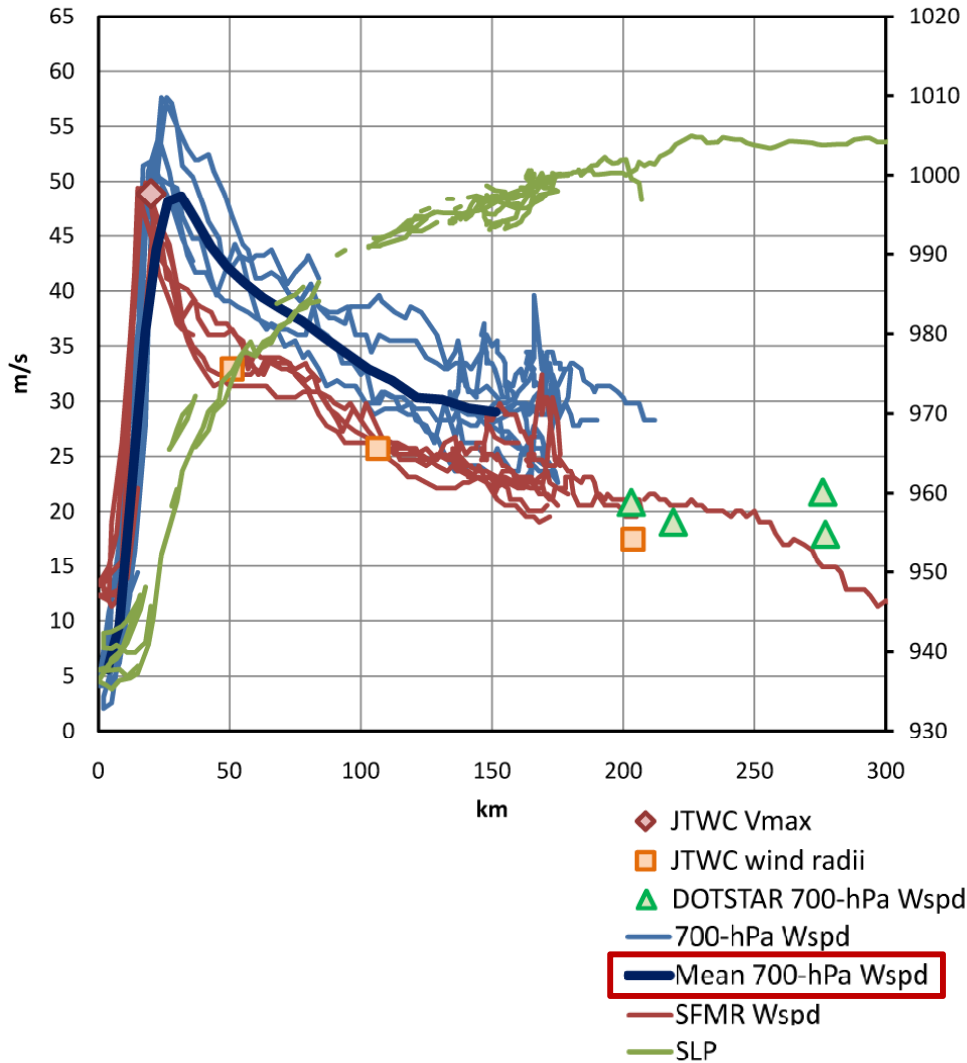
2-km resolution run initialized from ensemble mean (*CTL_1802_2km*)
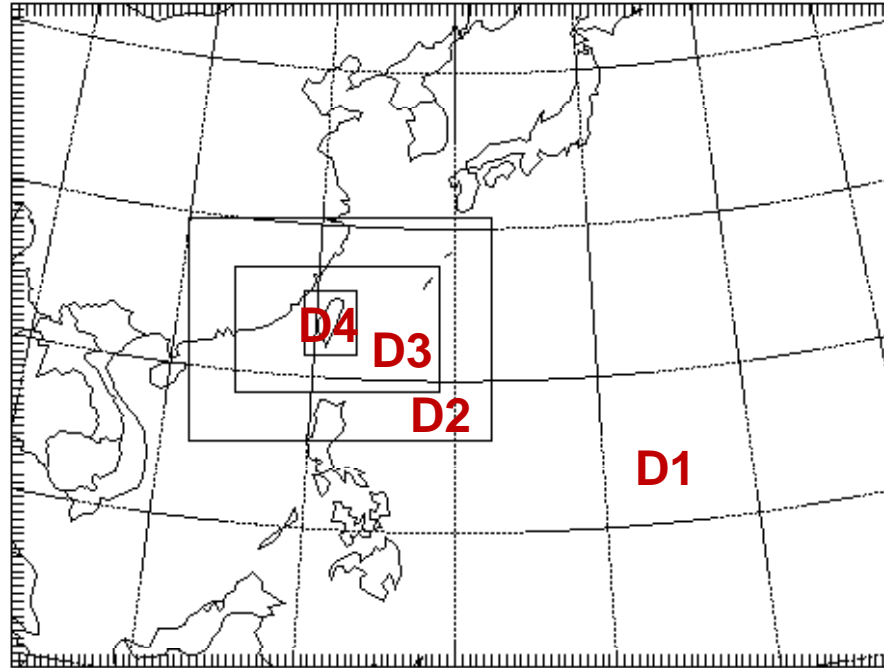
- Use larger fixed domains in this simulation (data interpolated from the original moving domains).
- Add additional domain 4 covered Taiwan island with 2-km resolution.
- The track of Fanapi is nearly the same as that in *CTL_1802* (6 km / moving domain).
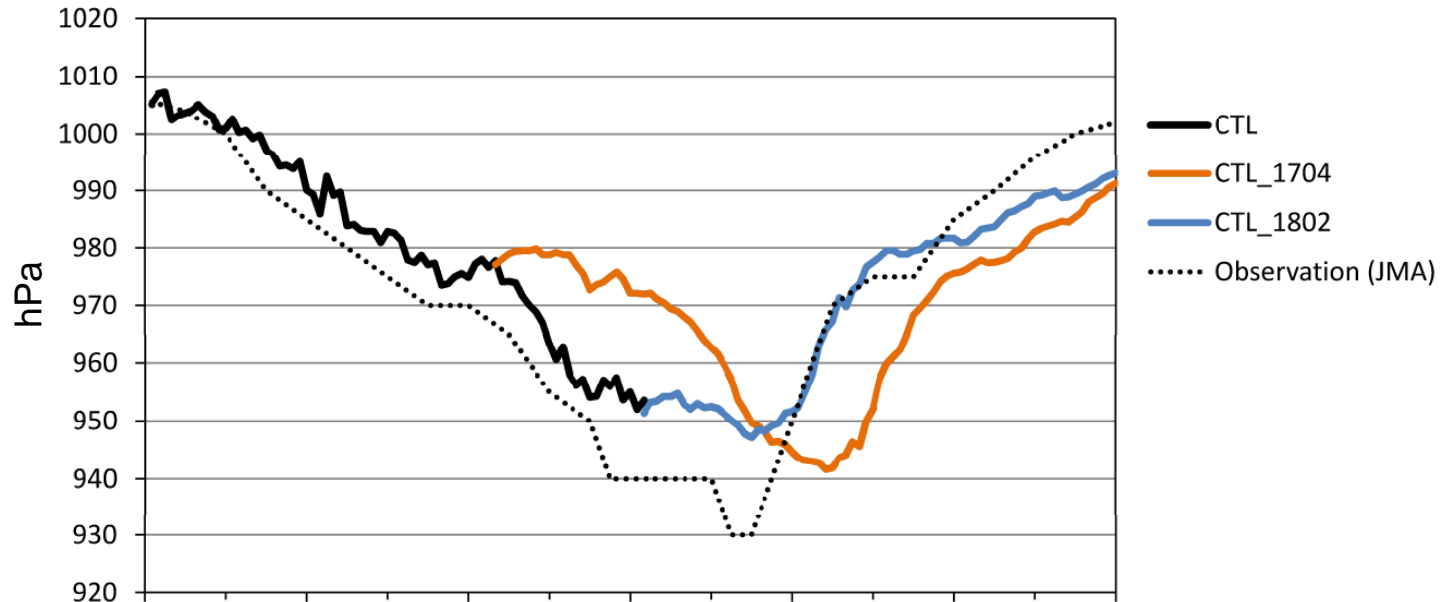
Forecasts : Ensemble tracks (*CTL_1704, CTL_1802*)
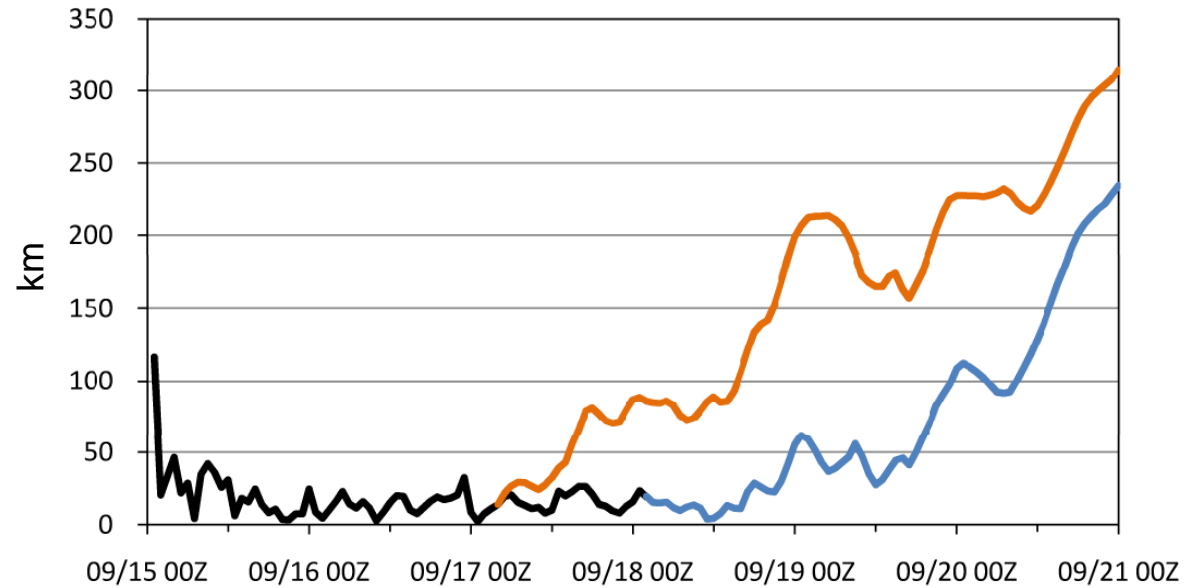

Ens Track Fcsts [04Z 17SEP, 02Z 18Sep]
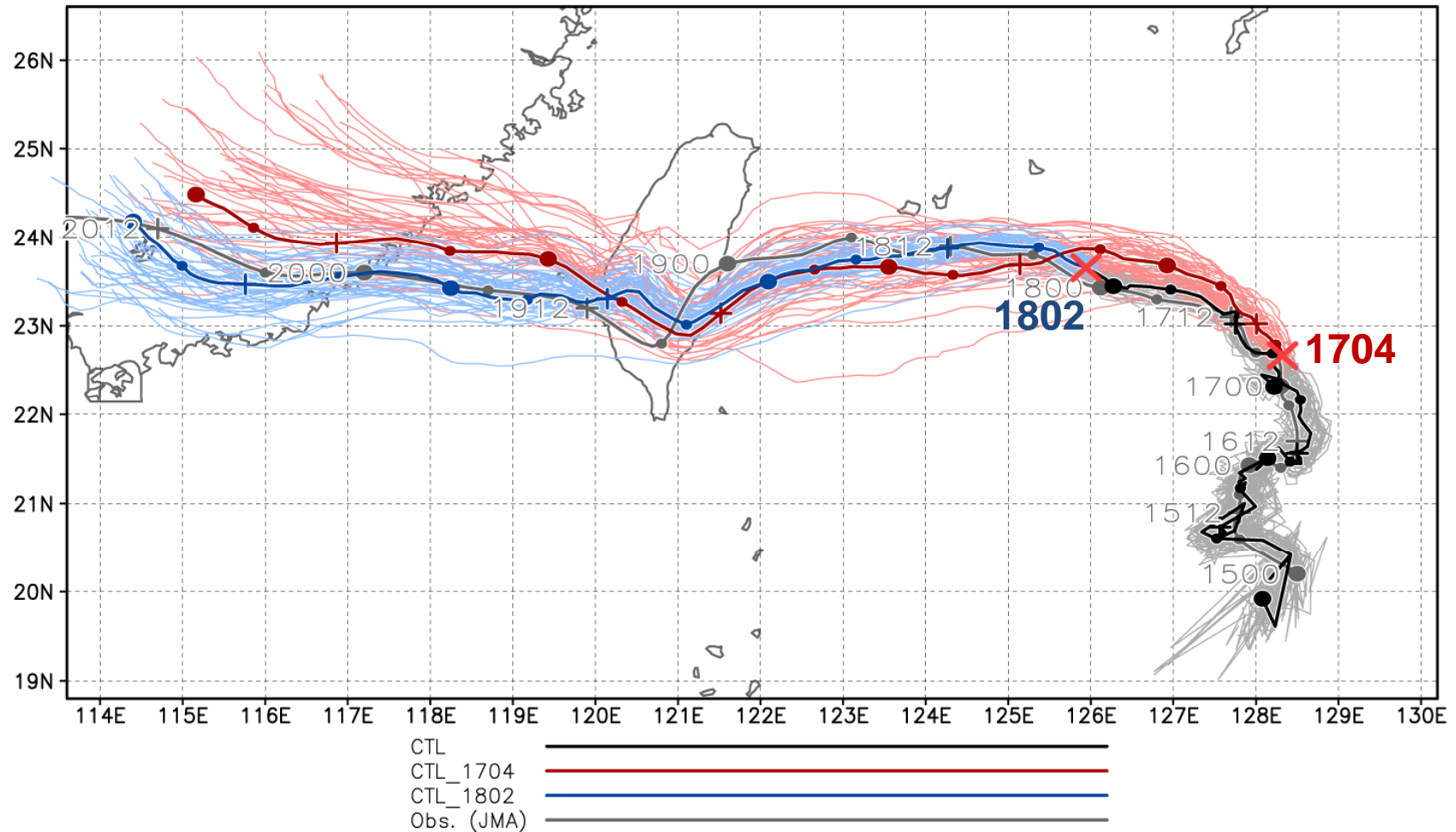
- The simulated Fanapi in *CTL_1704* moves slower than the observed track.
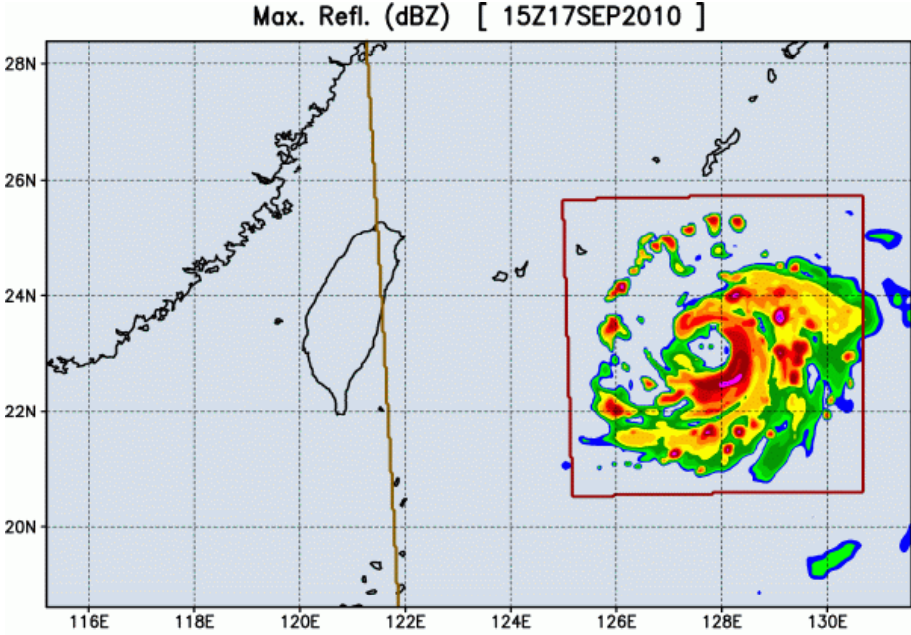
Forecasts : Track errors and intensities

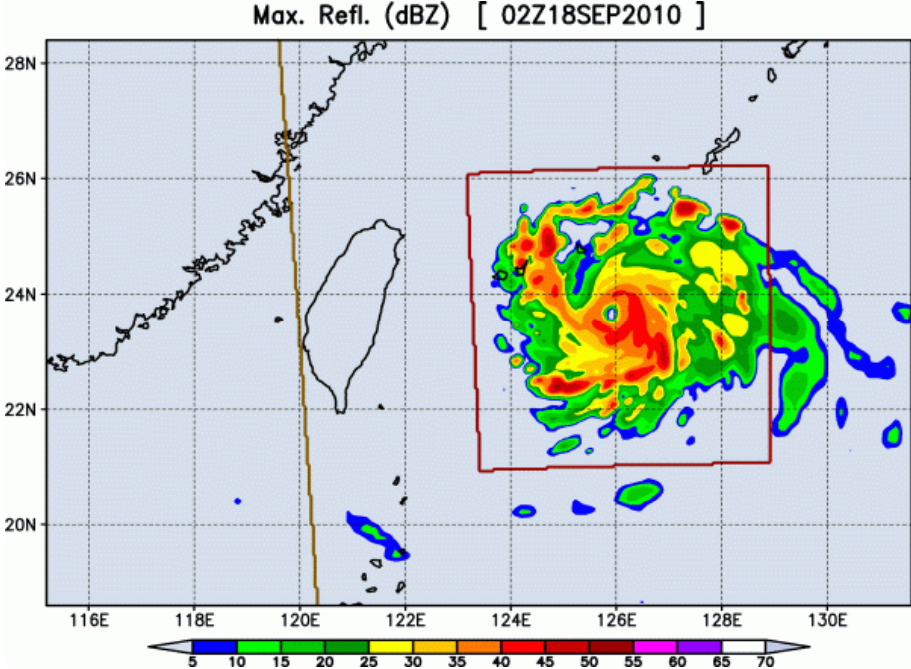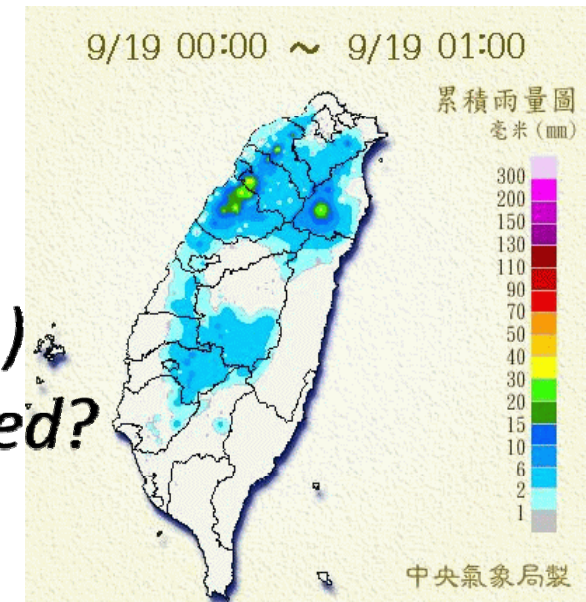# Forecasts : Radar reflectivity

Ongoing works

- **Typhoon-ocean interaction**
  - *Coupled model simulation*
  - *Cold wake (model vs. ITOP observation)*
    How it formsed, sustained and decayed?
  - *Feedback to intensity*

- **Interaction with Taiwan terrain**
  - *Track*

  - *Intensity and structure change*

  - *Rainfall and its predictability*