



Ensemble-based Variational Assimilation for a Cloud-Resolving Model

Kazumasa AONASHI

Meteorological Research Institute

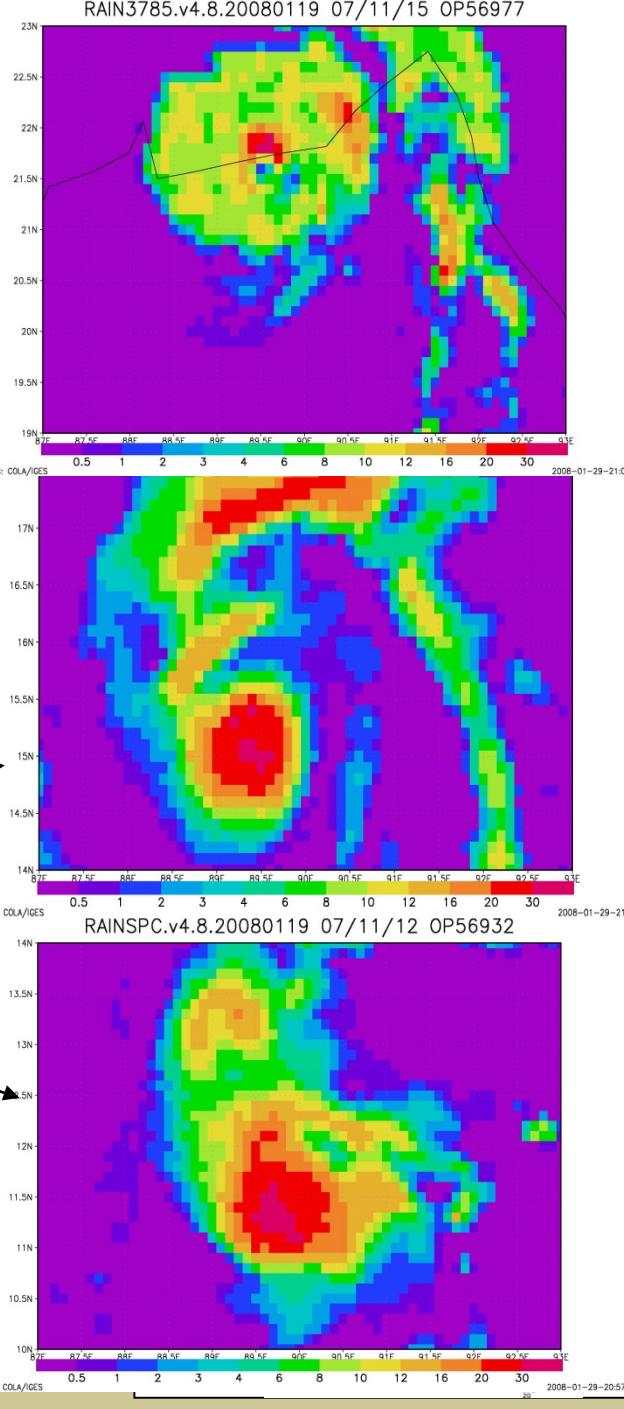
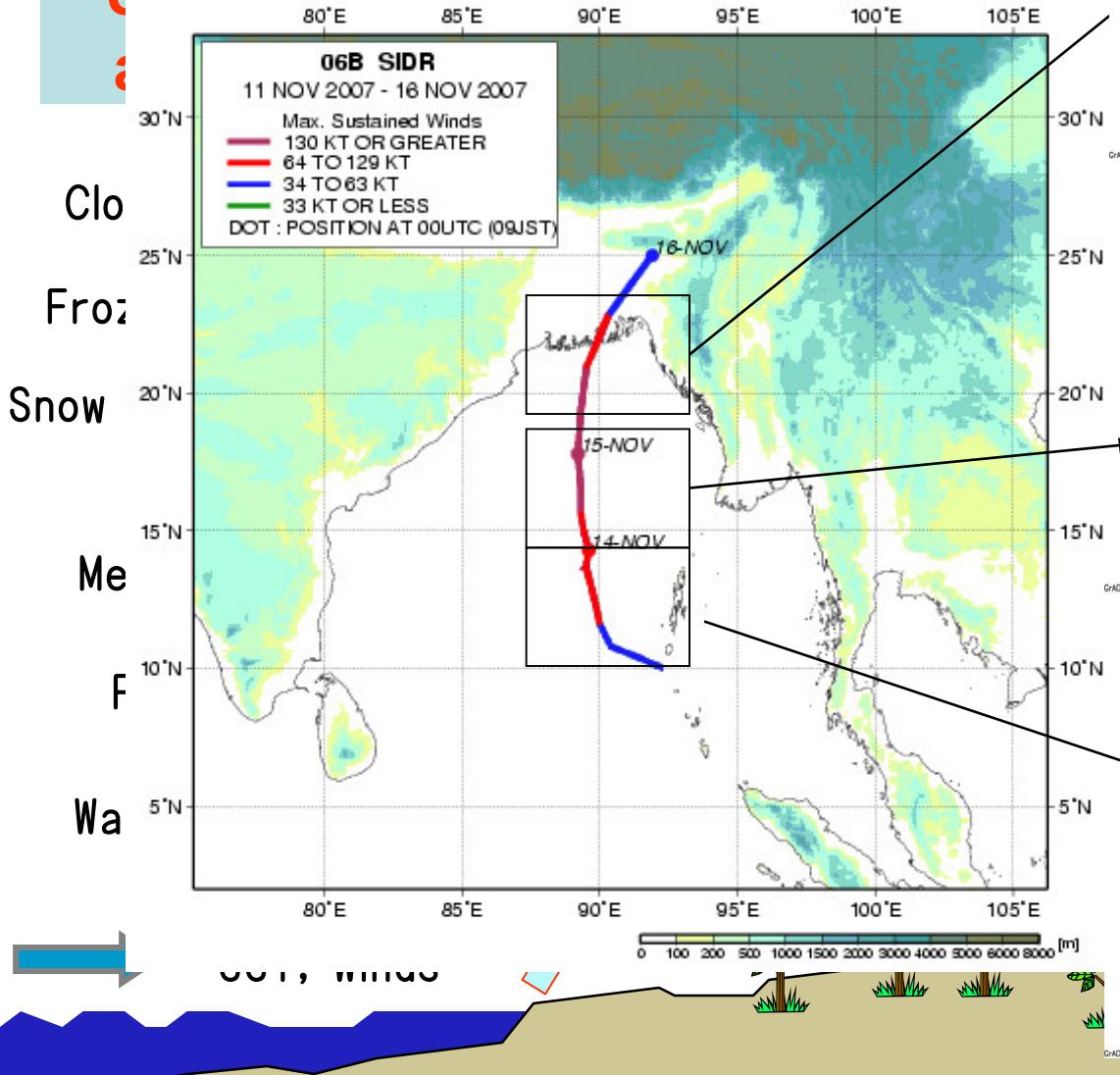
aonashi@mri-jma.go.jp

- Dual-scale neighboring ensemble method
- Experiment results using simulated data (TY0404)
- Experiments using real data (TY1411)

GOAL: Ensemble-based Variational System to incorporate MW

MWR TBs are functions

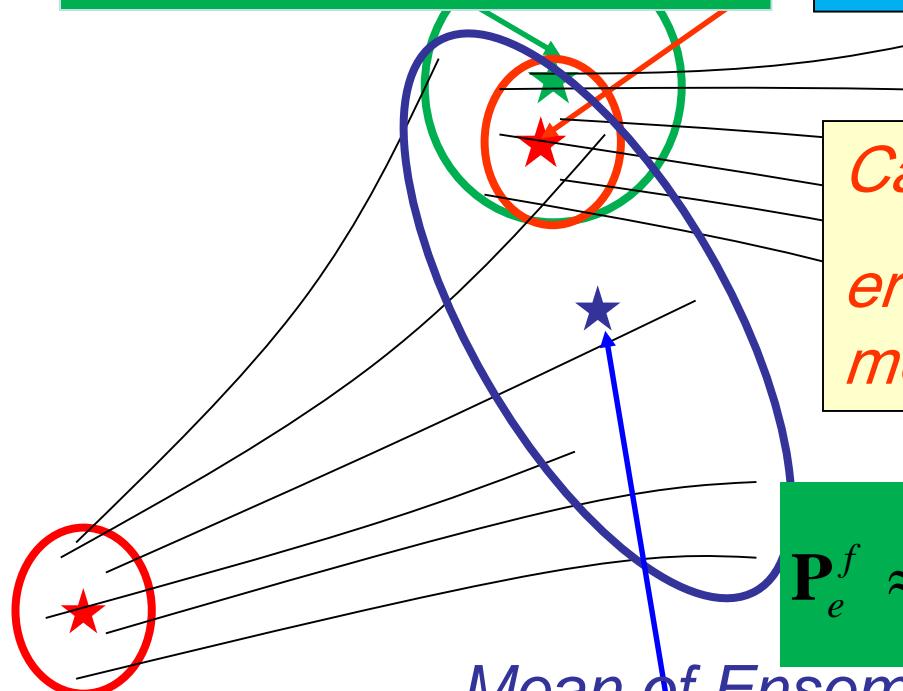
of various atmospheric bands



Ensemble-based Variational Assimilation

$$J_x = 1/2(\bar{X} - \bar{X}_f)P_f^{-1}(\bar{X} - \bar{X}_f) + 1/2(Y - H(\bar{X}))R^{-1}(Y - H(\bar{X}))$$

Calculation of analysis of Ensemble mean



Calculation of analysis of error cov. and Ensemble member.

$$\mathbf{P}_e^f \approx \frac{\delta \mathbf{X}_{t1}^f (\delta \mathbf{X}_{t1}^f)^T}{N-1}$$

Mean of Ensemble forecasts

Ensemble forecasts

$T=t0$

$T=t1$

$T=t2$

Dual-scale Neighboring Ensemble Method

(1) Dual Scale Separation

Separation of ensemble forecast error into large-scale modes (65 km ave.) and local modes (deviation).

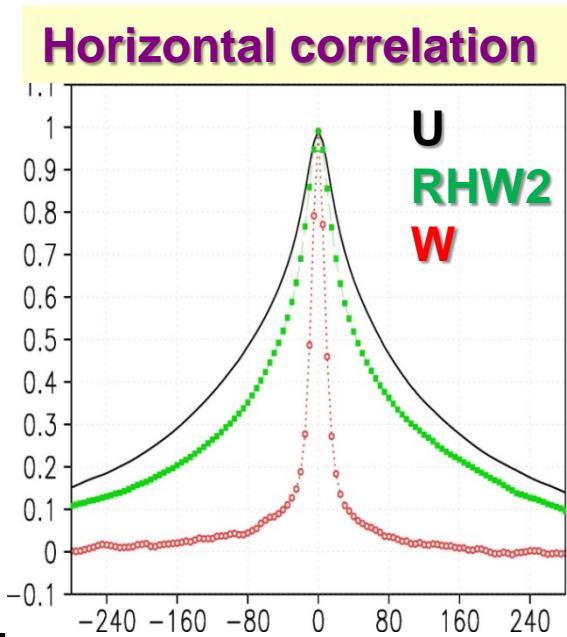
Assume that precip-related variables only have local modes.

(2) Neighboring Ensemble (NE) method

Spectrally localized forecast error correlation (Buehner 2010) :

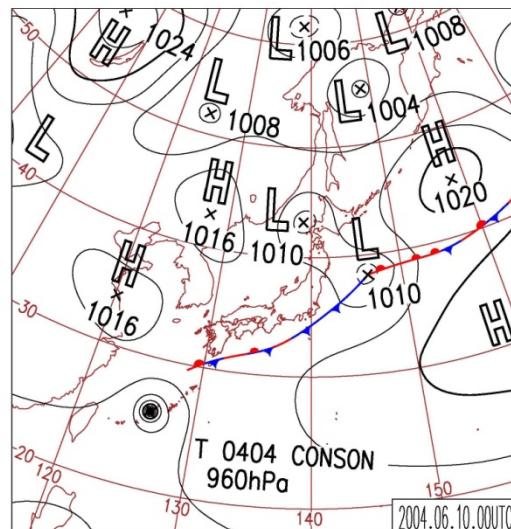
$$C_{sl}(x1, x2) = \int C(x1 + s, x2 + s) L_{sl}(s) ds$$

we approximated the forecast error correlation for deviation using neighboring members of the target points (5×5 grids).



EnVA(OSSE)

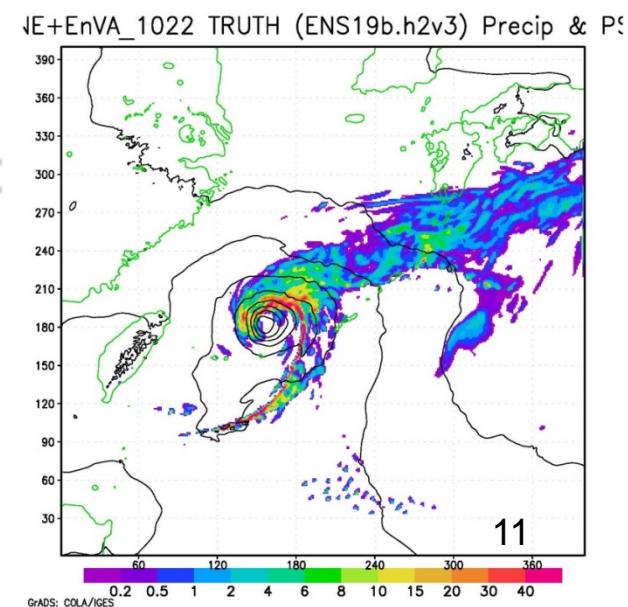
Typhoon Conson
(04/6/9/22 UTC)



JMANHM(Saito et al, 2005) 5 km res.

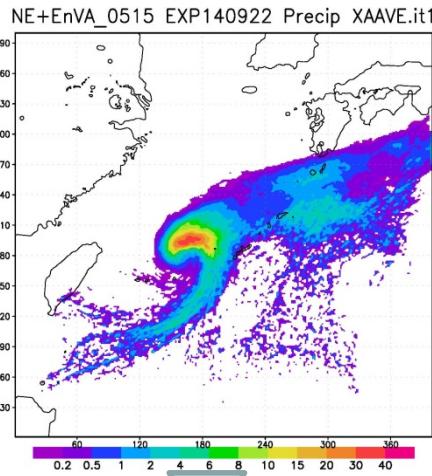
First guess: Ensemble forecast (04/6/9/15) :
100 members started with perturbed initial
data

Observation: Conventional + TMI TB
(10v,19v,21v,37v,85v)

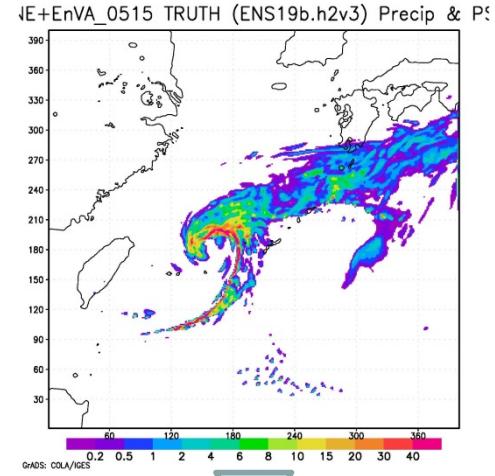


Surface Precipitation (mm/h) and TB19v (K) for 04/6/9/22 UTC

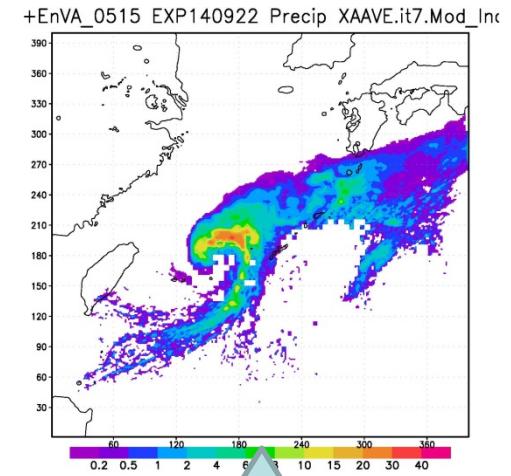
First guess
(Mean of Ens. FCST)



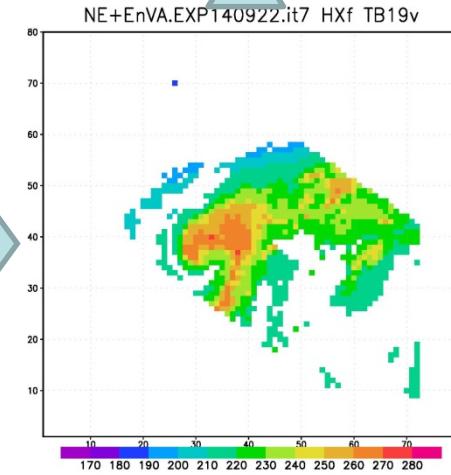
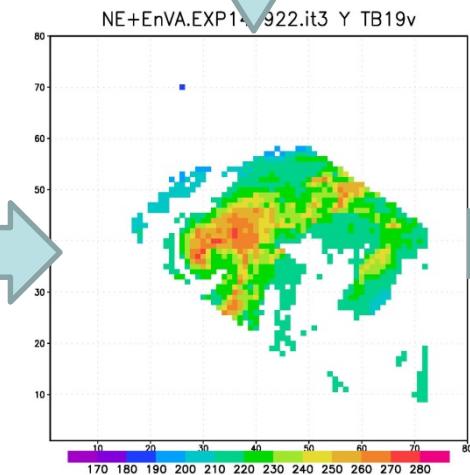
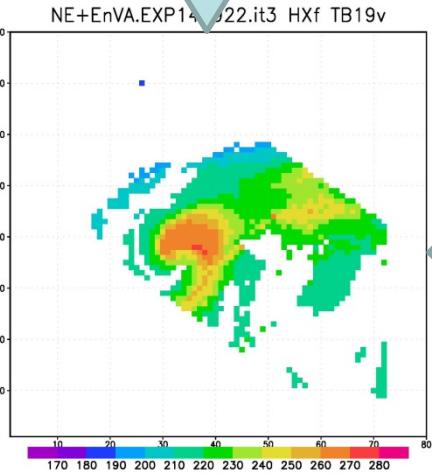
Truth
TBo



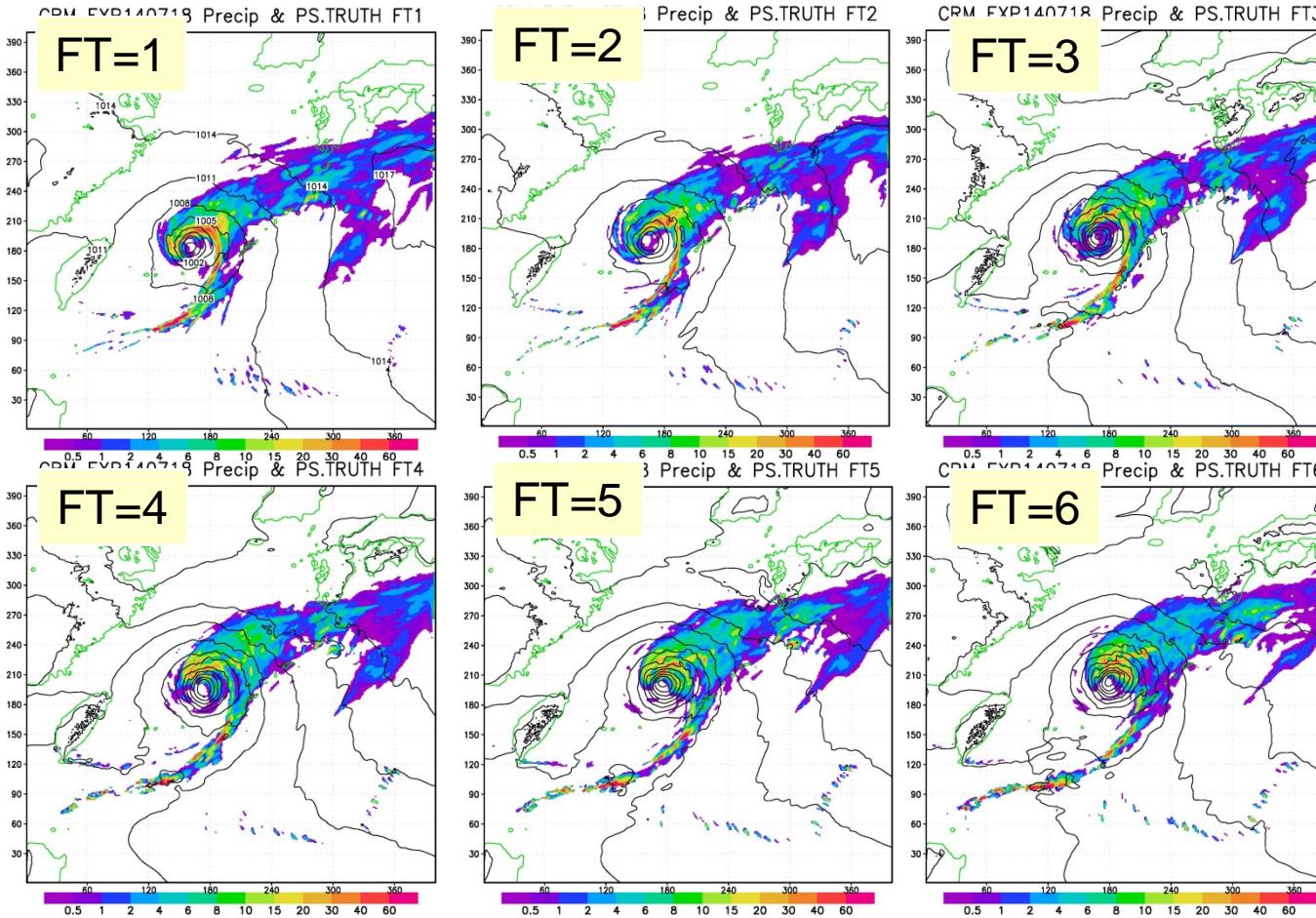
Analysis of
Ens. mean



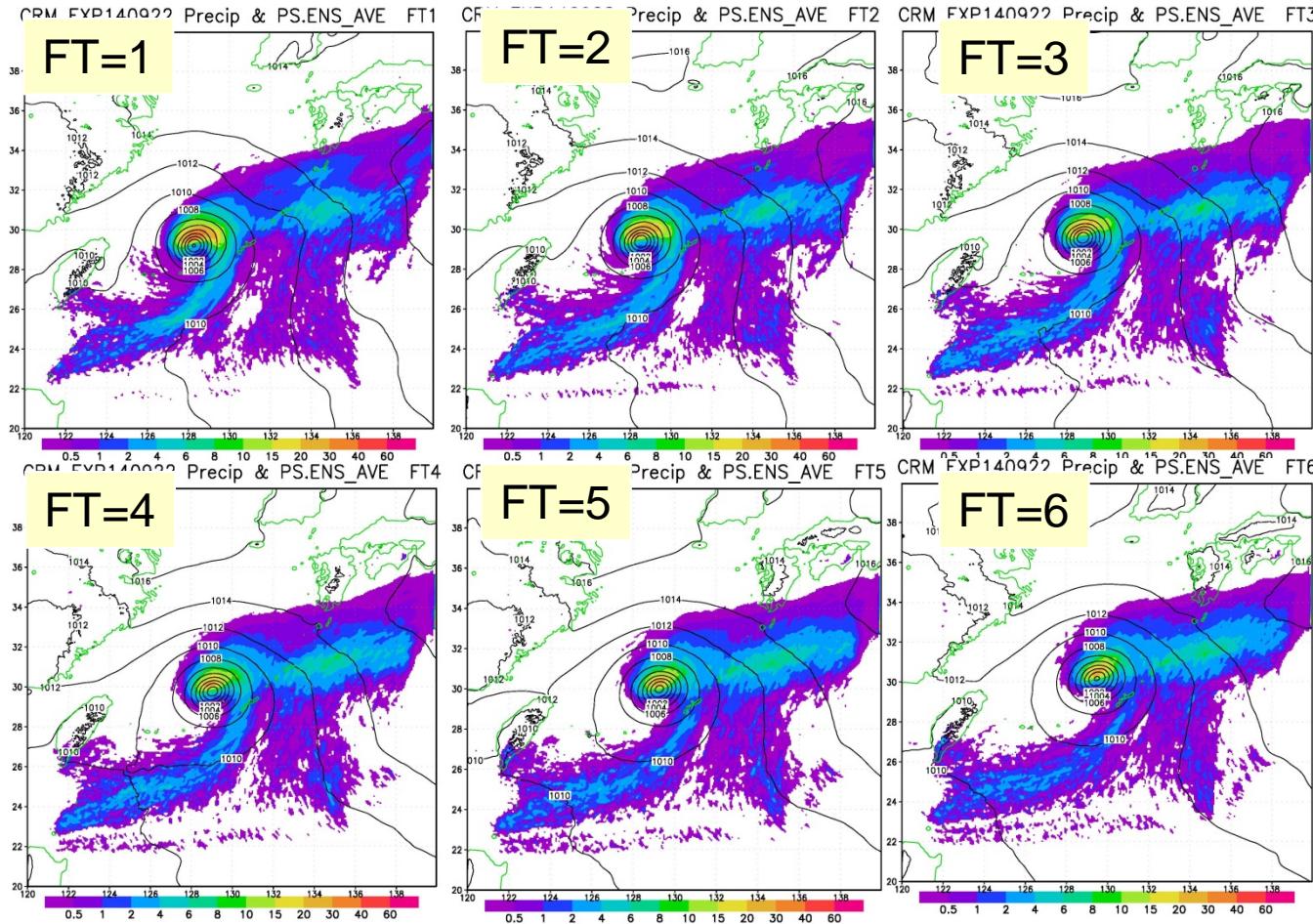
Surf
Precip
>0.1
mm/h



OSSE: Hourly Precipitation Truth(Init: 04/6/9/22 UTC) FT=1-6h



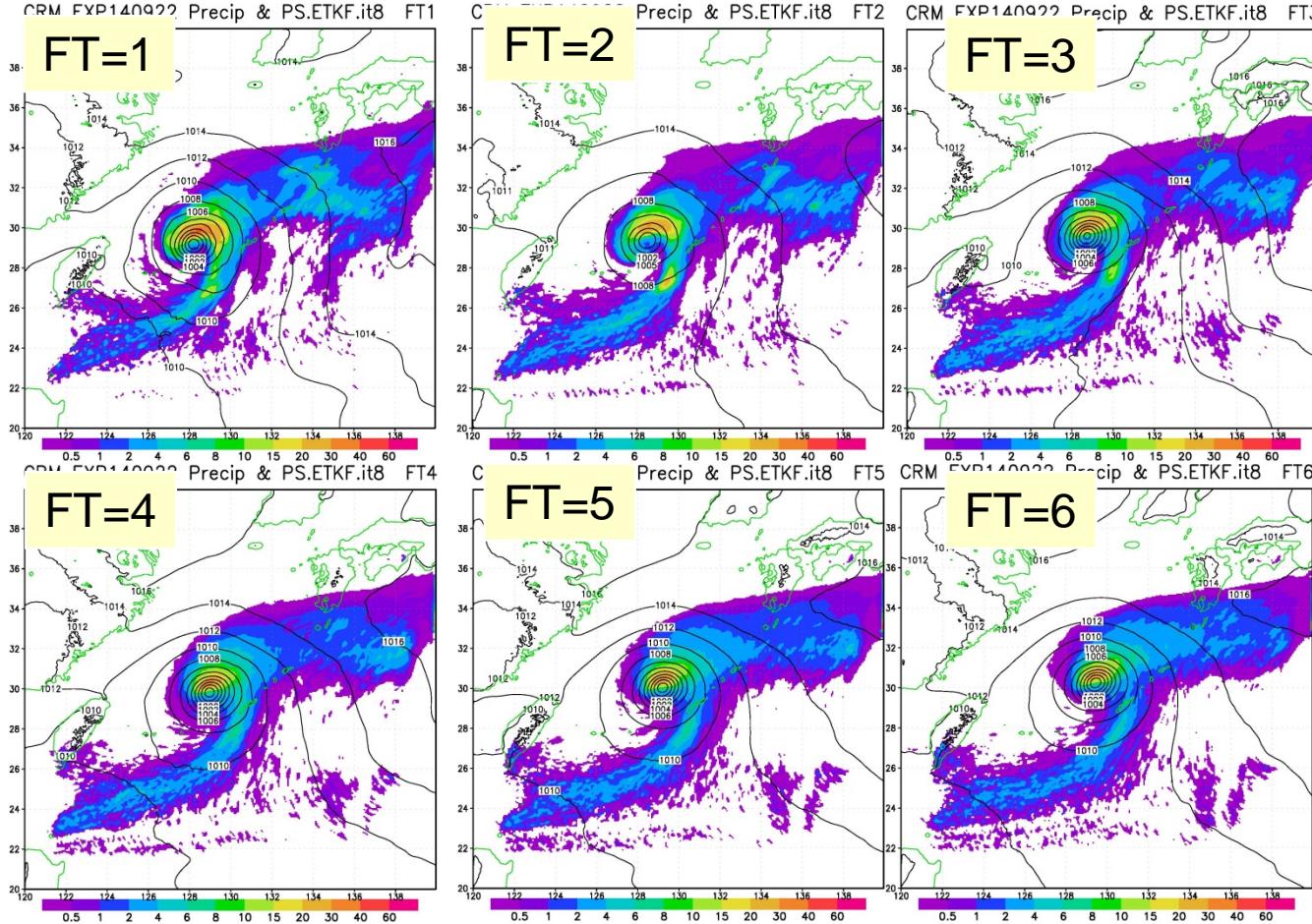
Ensemble Forecast for Hourly Precipitation NoDA (Init: 04/6/9/22 UTC, 100 member) started with the first guess



Ensemble Forecast for Hourly Precipitation

DA(Init: 04/6/9/22 UTC, 100 member)

started with the EnVA analyses

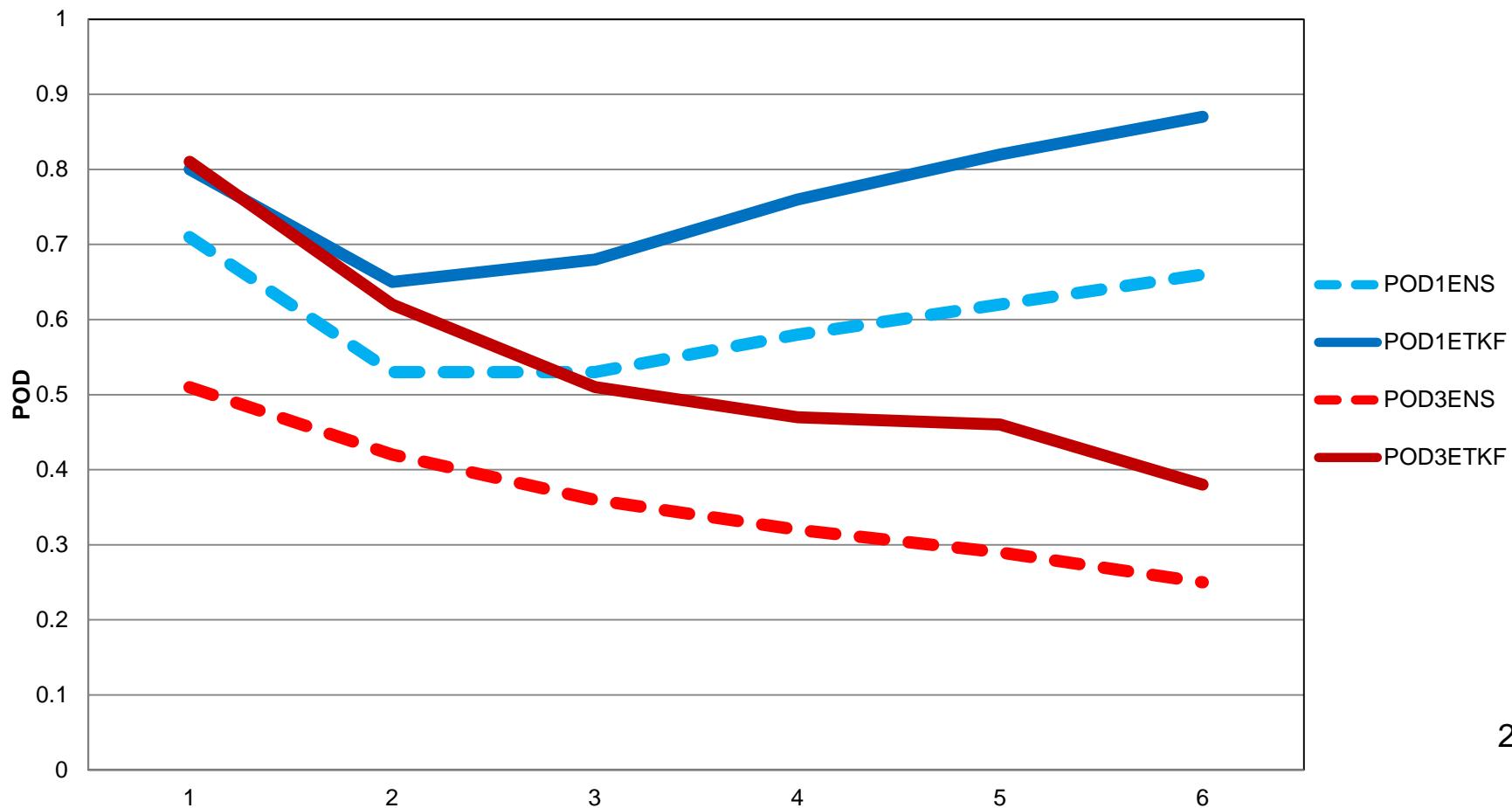


POD for NoDA(dash) and DA(solid)

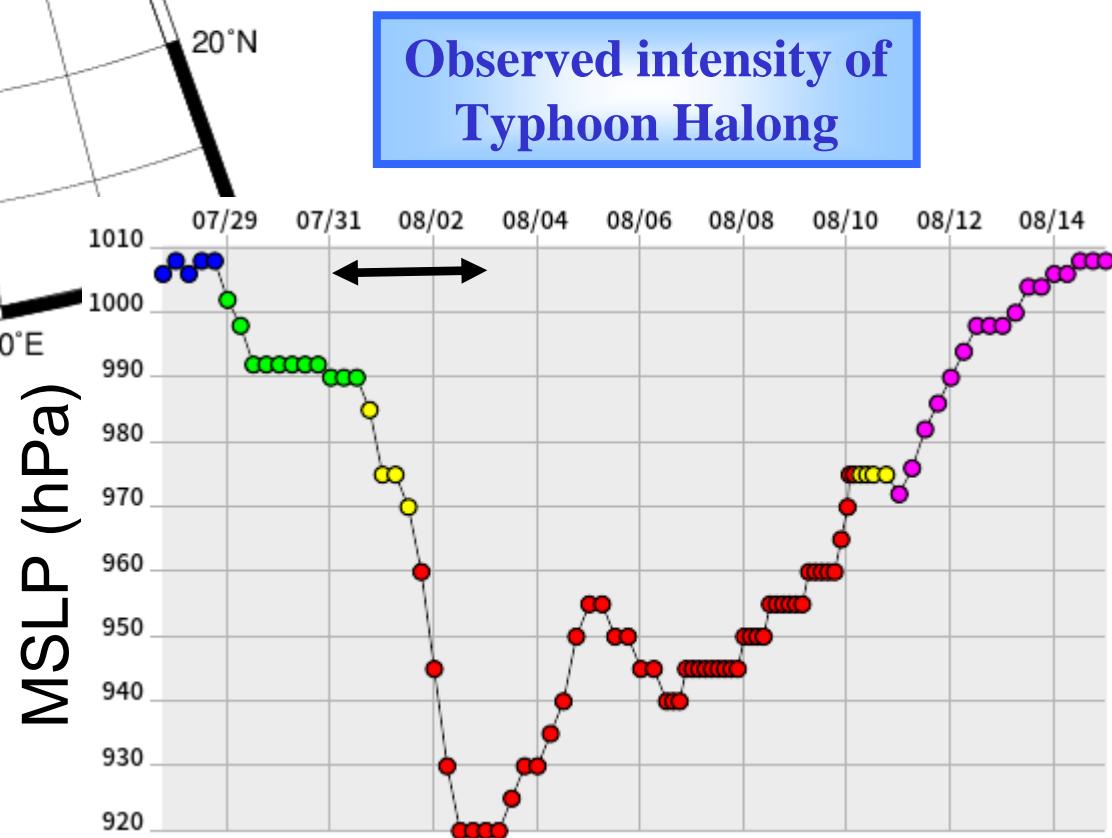
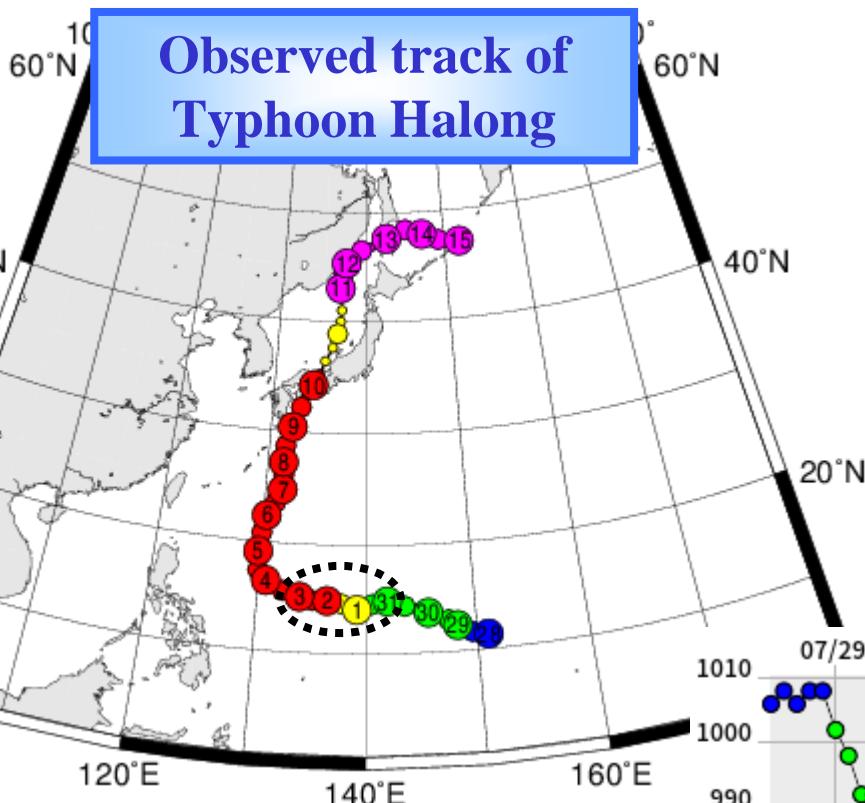
(Init: 04/6/9/22 UTC) FT=1-6h

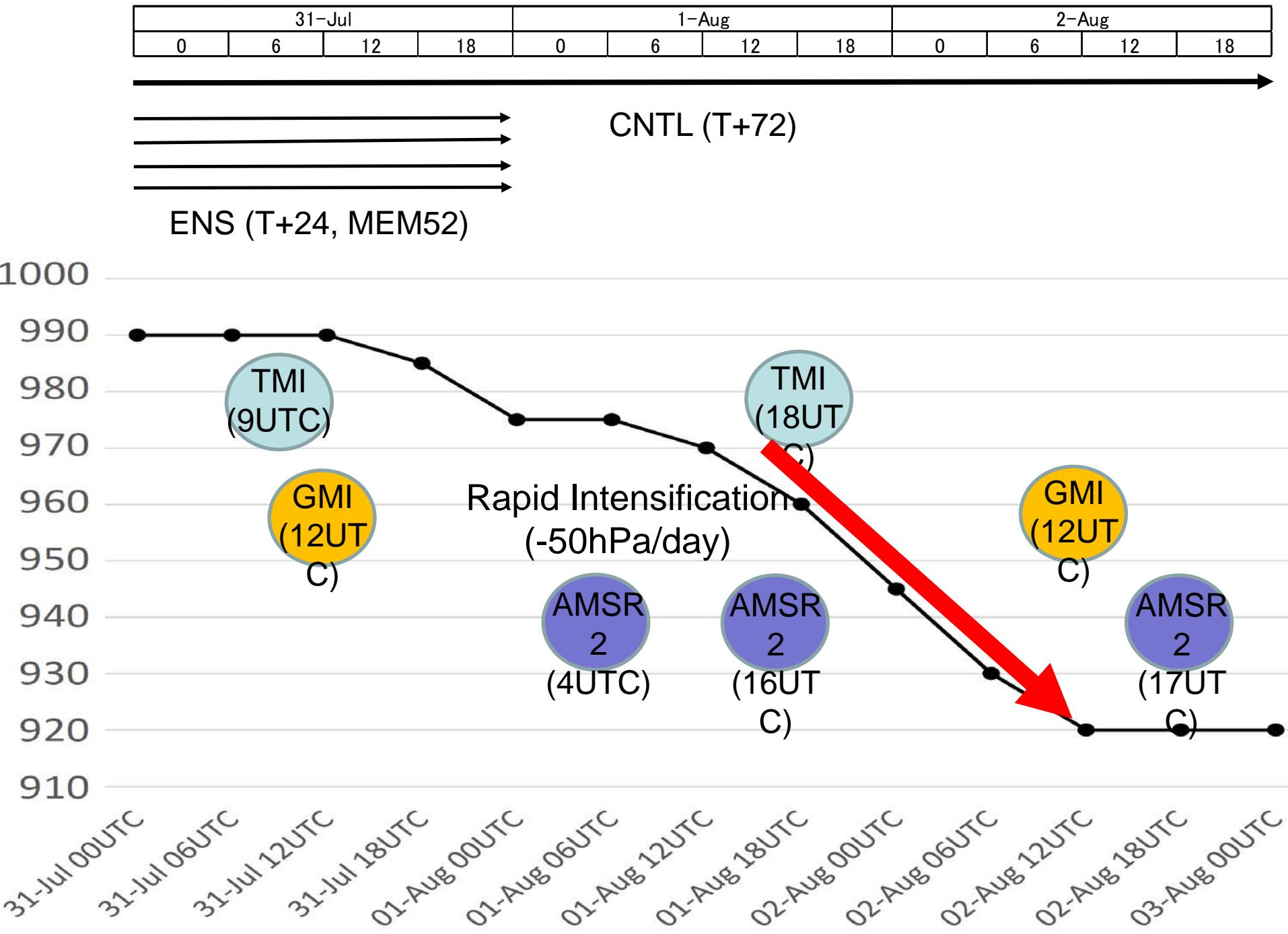
Blue: Th=1 mm/hr

Red: Th=3 mm hr



Typhoon Halong (2014)

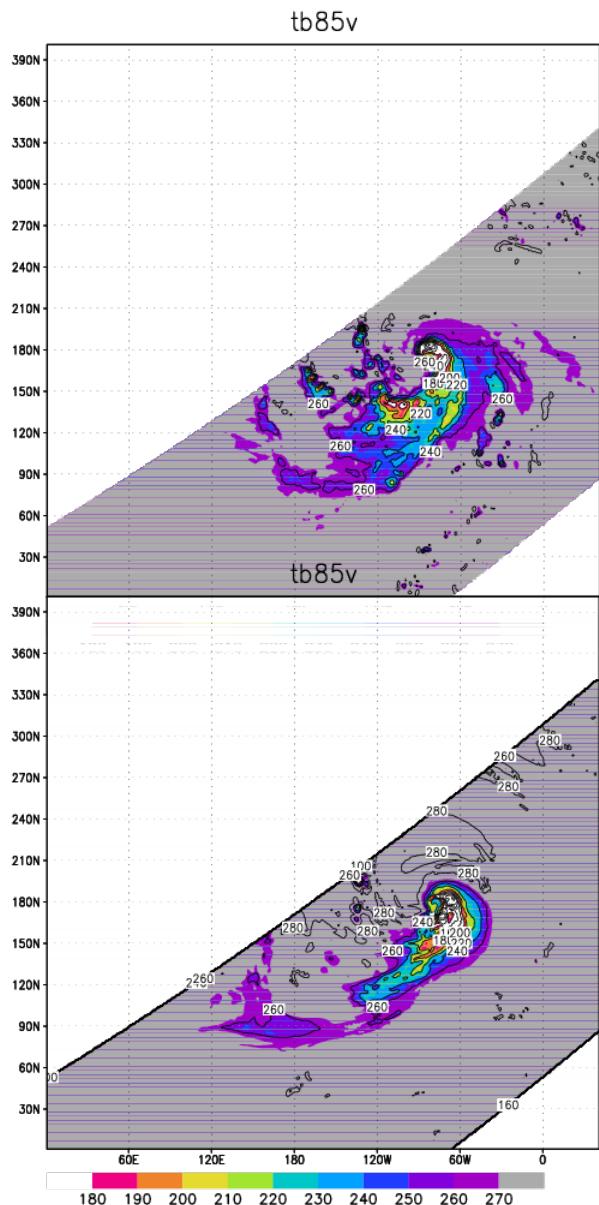




Verification before RI: TMI TB85v

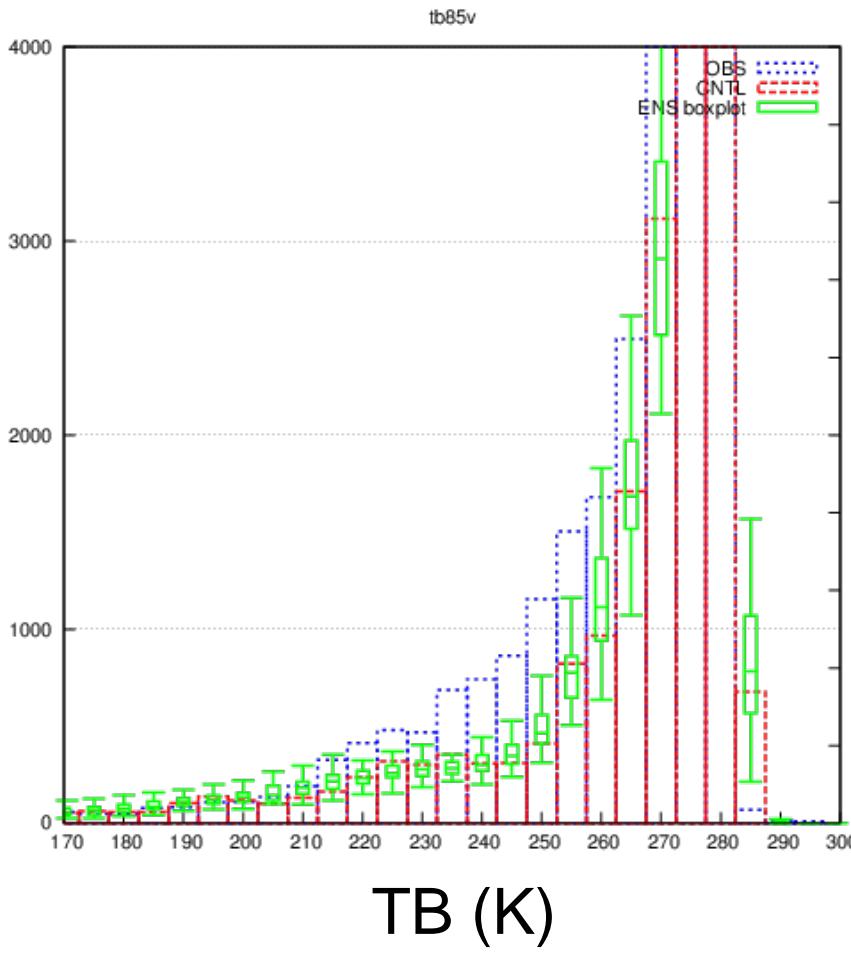
TB85v

OBS (TMI)



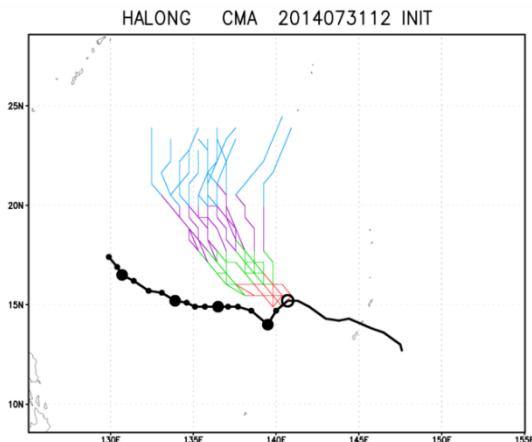
JMA/NHM

Blue: Observation
Red: JMA/NHM
Green: ENS

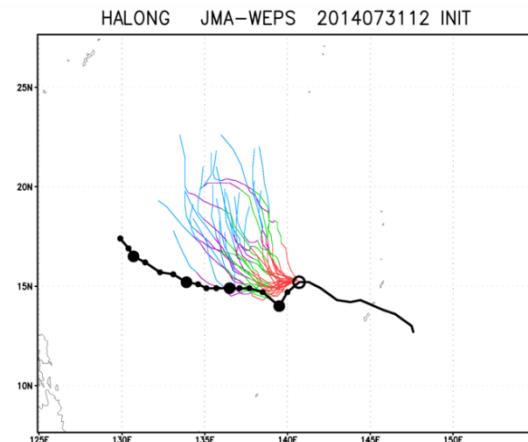


Track Prediction

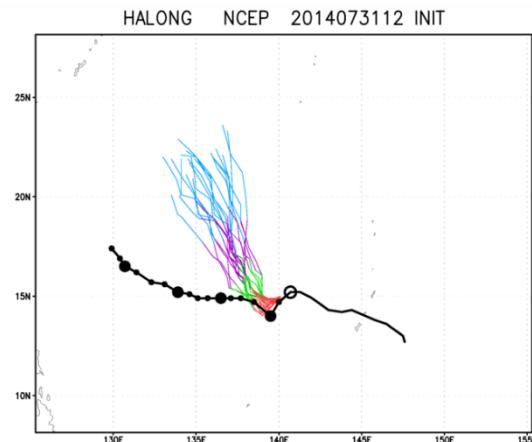
China



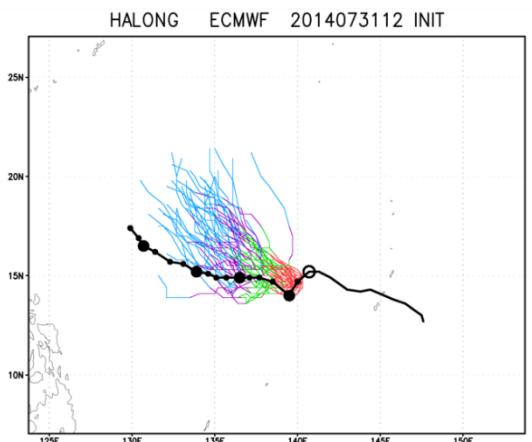
JMA



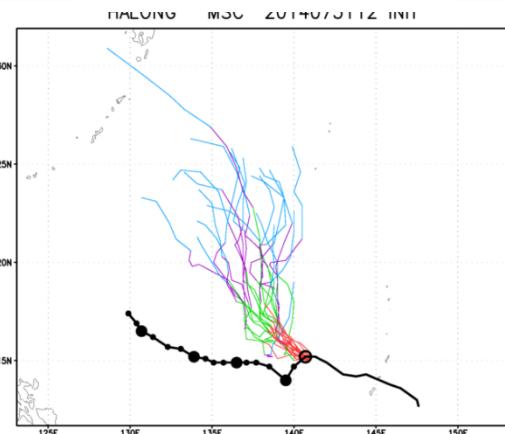
NCEP



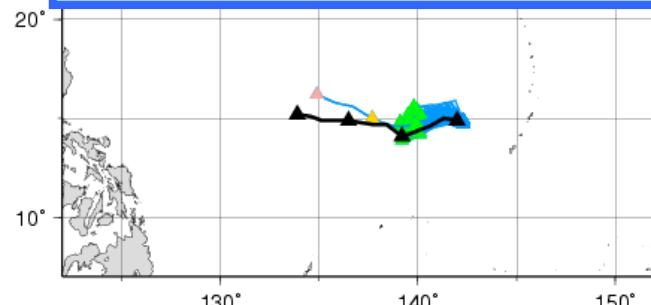
ECMWF



Canada



Simulation result
-CTL+ENS-



Summary

- Dual-scale neighboring ensemble method
- Experiment results using simulated data (TY0404)
- Experiments using real data (TY1411)