

Typhoon simulation with the 20 km mesh global spectral model on the Earth Simulator

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Kyousei 4 Research Project



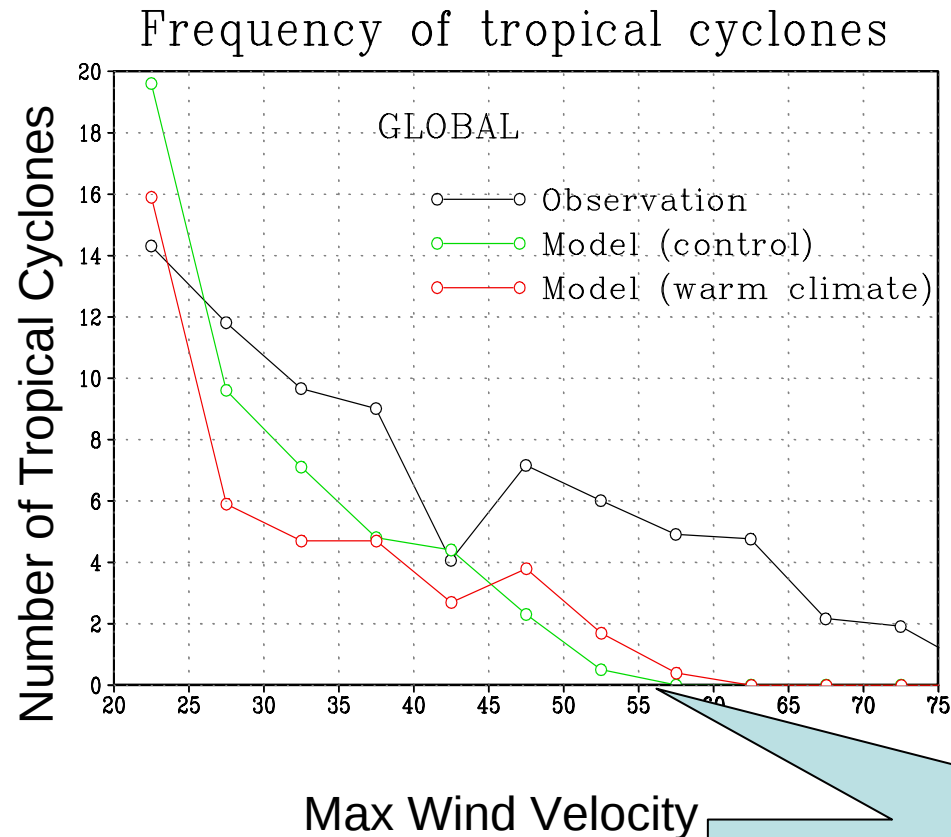
- Numerical experiments on the Earth Simulator

20 km global model

Effects of global
warming on typhoons
and hurricanes by time
slice experiments

Contribution to the IPCC-AR4, and
government policies on the global environment

Result of the Time Slice Experiment



Yoshimura-san will show this later

In the case of warmer climate
Total TC's number will be decreased.
Stronger TCs will be increased.

Purpose and Motivation



Is the time slice experiment reliable?

Are typhoons predictable with the high resolution AGCM?



Lets verify its typhoons predictability with short range forecasts.

Bottom Line



Our 20km mesh AGCM can simulate

Typhoon Position

Typhoon Strength

Heavy Rainfall

more **realistically** than JMA operational
60km mesh GSM.

A Problem in short range forecasts



- Initialization (NNMI) becomes impractical when horizontal resolution is increased.

	Vertical Mode(KByte)		Horizontal Mode(MByte)	
	Eigen Value	Eigen Vector	Eigen Value	Eigen Vector
T106L40	0.31	25.00	0.44	31.60
T213L40	0.31	25.00	1.76	251.00
TL319L40	0.31	25.00	3.92	837.27
TL511L60	0.47	56.25	10.02	3423.38
TL959L60	0.47	56.25	35.19	22535.25

22Gbyte!!

- Introduction of New Initialization Scheme

Vertical mode Initialization (Bourke and McGregor 1983)

Horizontal Mode Separation is not required → computational efficiency

Incremental NMI (Ballish et al. 1992)

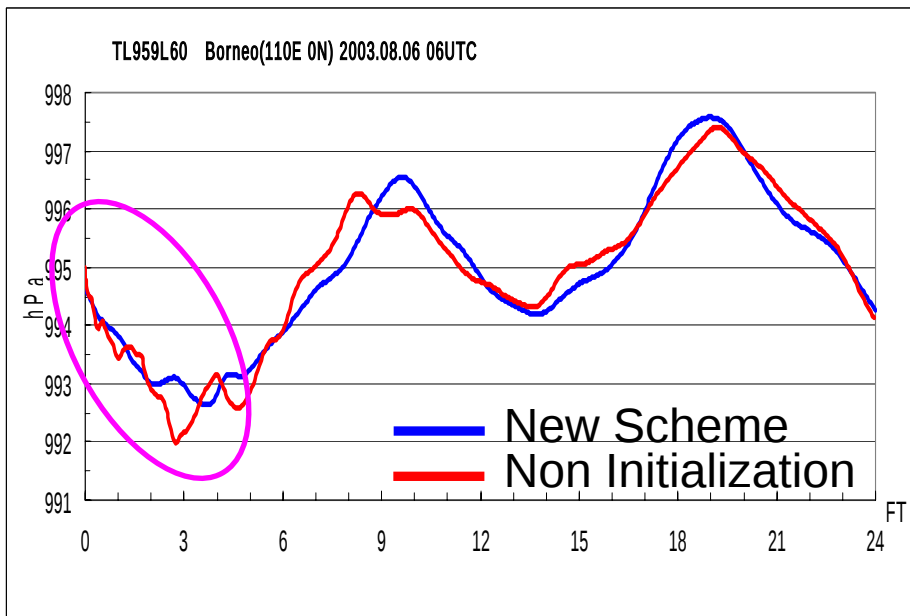
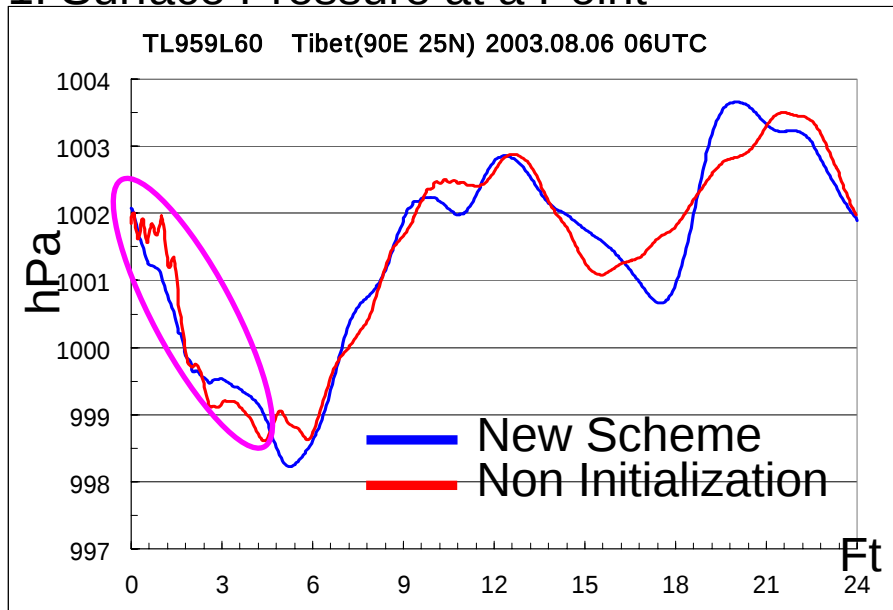
Support Vertical mode Initialization assumption

Refinement of tidal mode

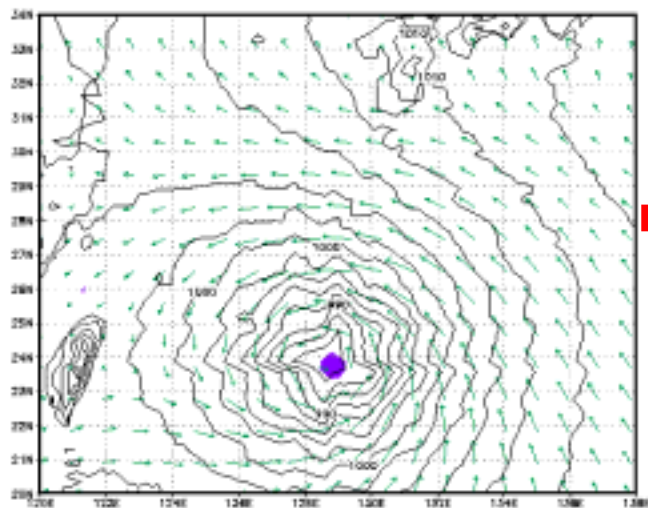
Results of the New Initialization



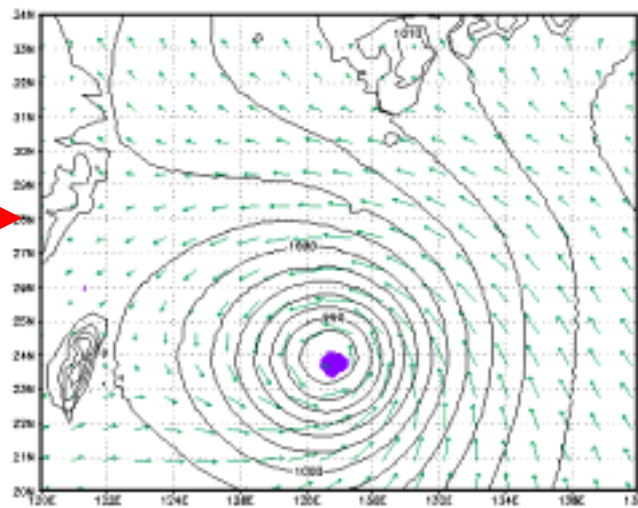
1. Surface Pressure at a Point



2. Two Dimensional Surface Pressure Distribution



Non Initialization



New Scheme

TL959L60
2003 08 06 06
UTC Initial
By the Earth
Simulator

Short Range Typhoon Forecasts



- Model

20 km mesh AGCM(TL959L60)



- Comparison

Model: JMA operational global spectral model (GSM; T213L40, 60km mesh)

Truth: Regional Specialized Meteorological Center (RSMC) Best Track Data

- Target typhoons to be predicted

Typhoon	Integration term
DIANMU(T0406)	2004061312-2004062112 8days
MAEMI(T0314)	2003090600-2003091318 8days
ETAU(T0310)	2003080306-2003080906 6days
HALONG(T0207)	2002070800-2002071612 9days

- Initial data

- JMA 60km mesh analysis is used by Interpolating into 20km mesh
- 20km mesh typhoon bogus is embedded in the interpolated analysis

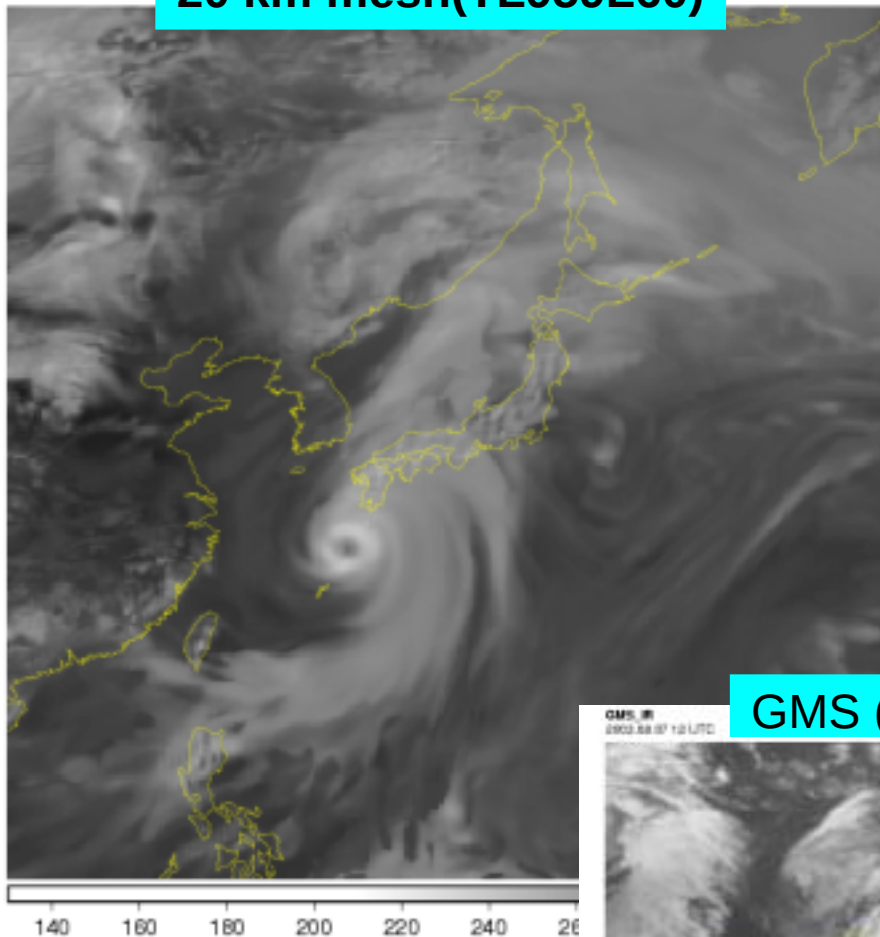


An Example of Typhoon Simulation



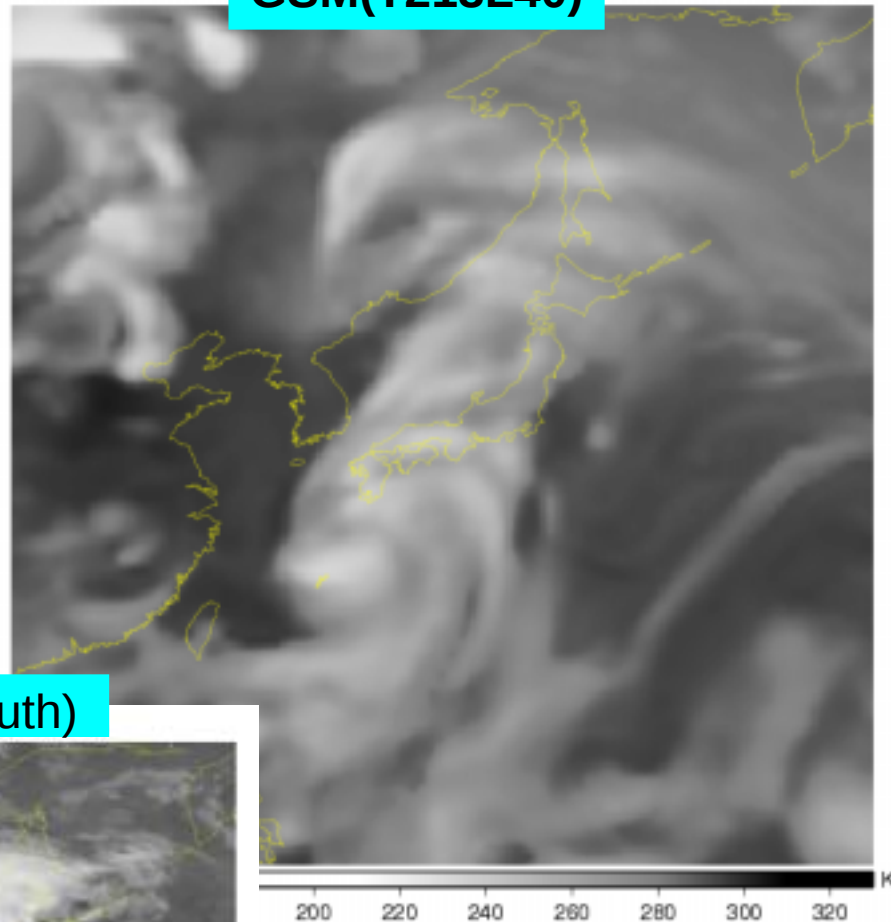
GSM_IR
2003.08.07 12 UT

20 km mesh(TL959L60)

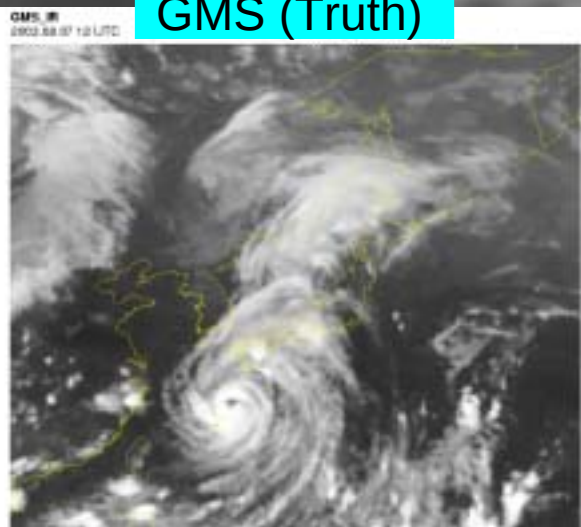


GSM_IR
2003.08.06 00 UTC

GSM(T213L40)



GMS (Truth)

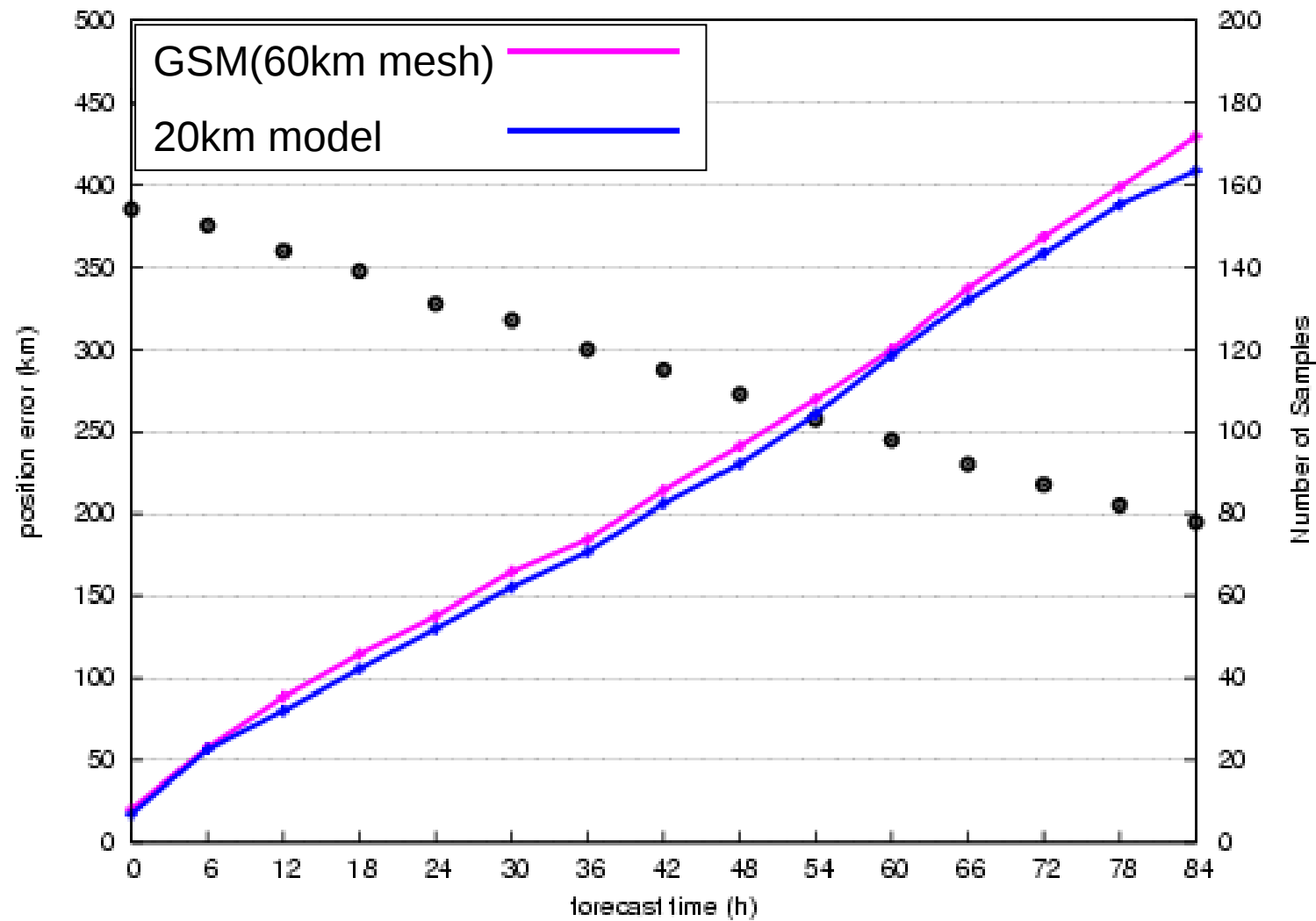


Infrared image

2003 08 07 12 Initial

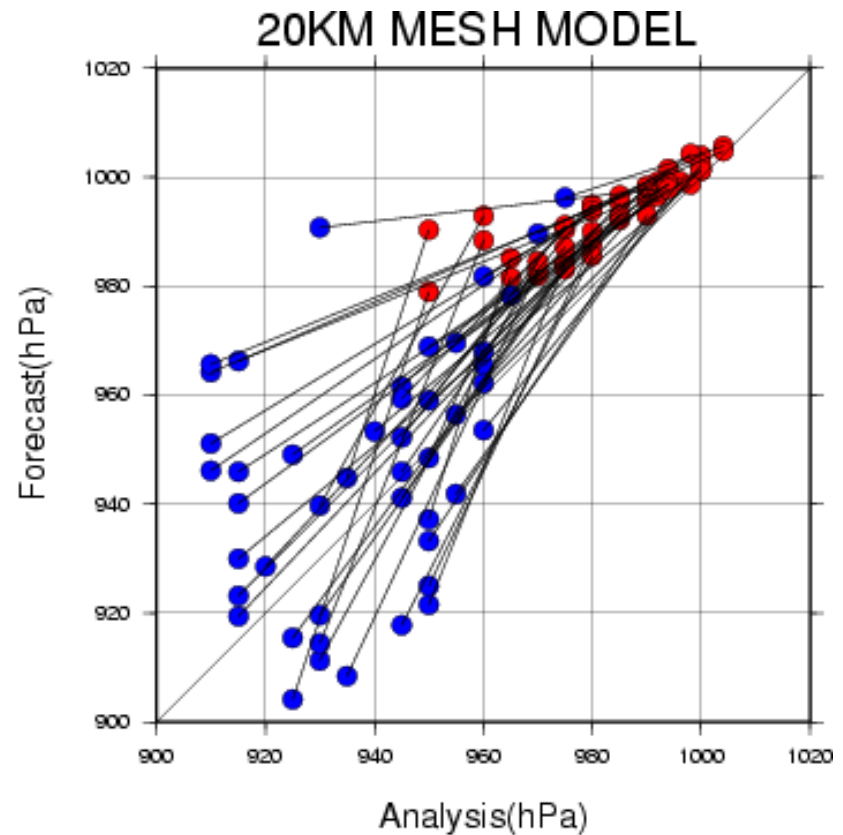
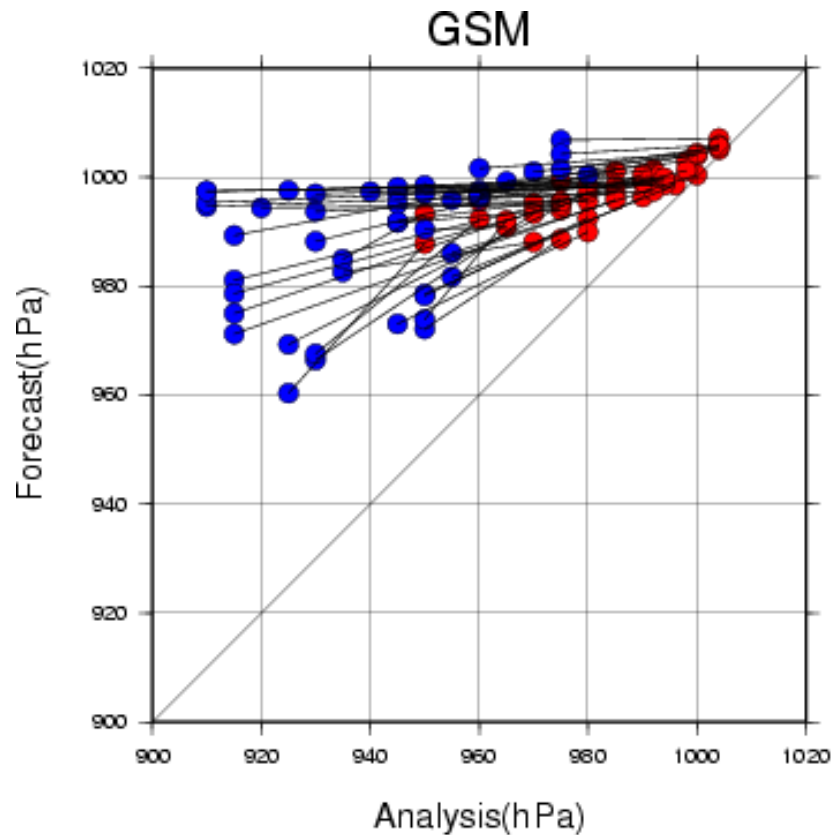
FT=36

Typhoon Position Error

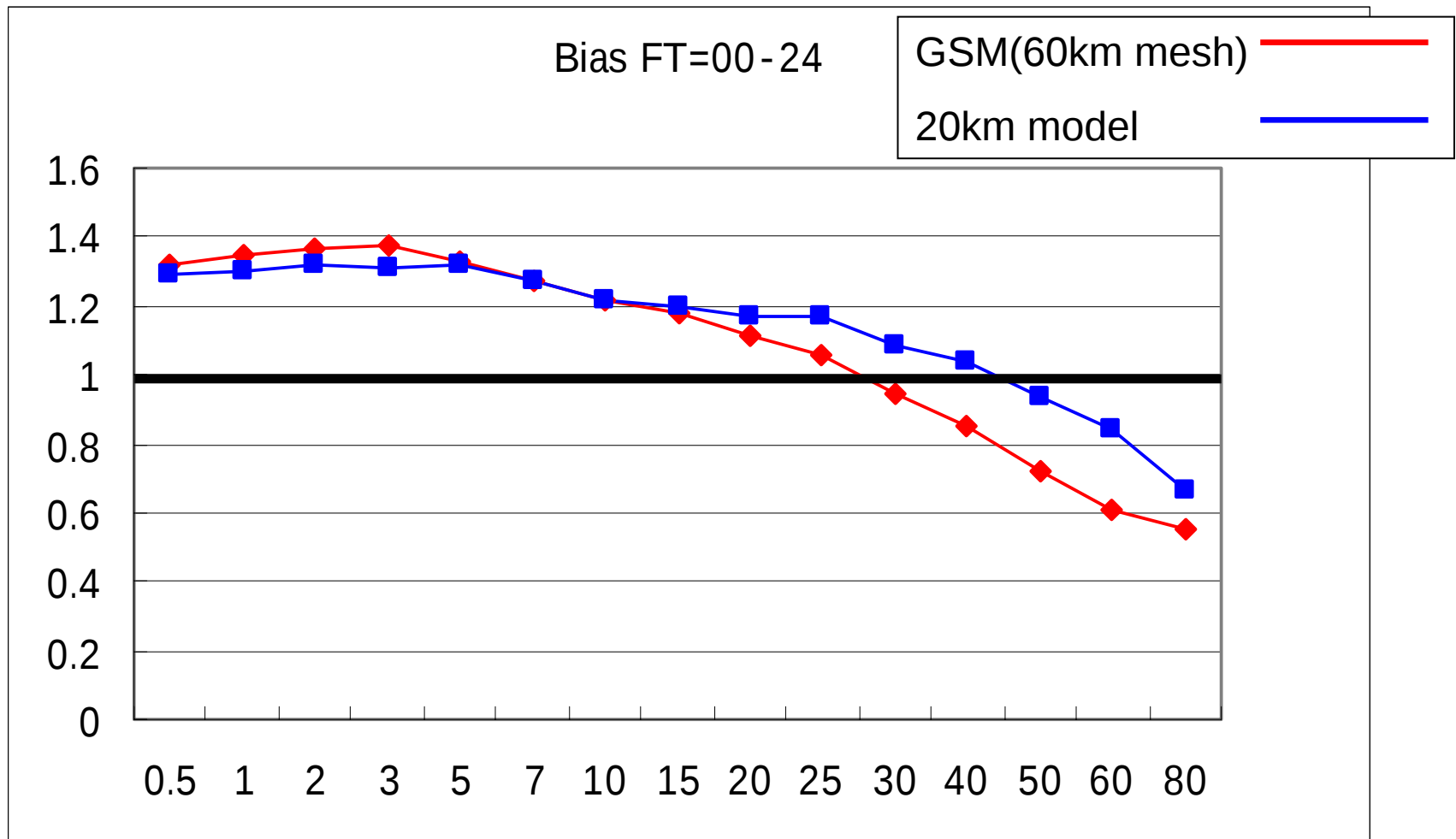


Intensifying Tendency

- FT=0
- FT=72



Precipitation Bias Score



Verification Period : 18 days (same as typhoon forecast period)

Area : Japan

Observation : AMeDAS (Automated Meteorological Data Acquisition System)

Typhoon simulations in a forecast mode

- Our 20km mesh AGCM can simulate position and intensity of typhoons more realistically than a lower resolution JMA GSM.

A new initialization scheme

- computationally effective for high resolution model
- succeeded in removing spurious gravity wave

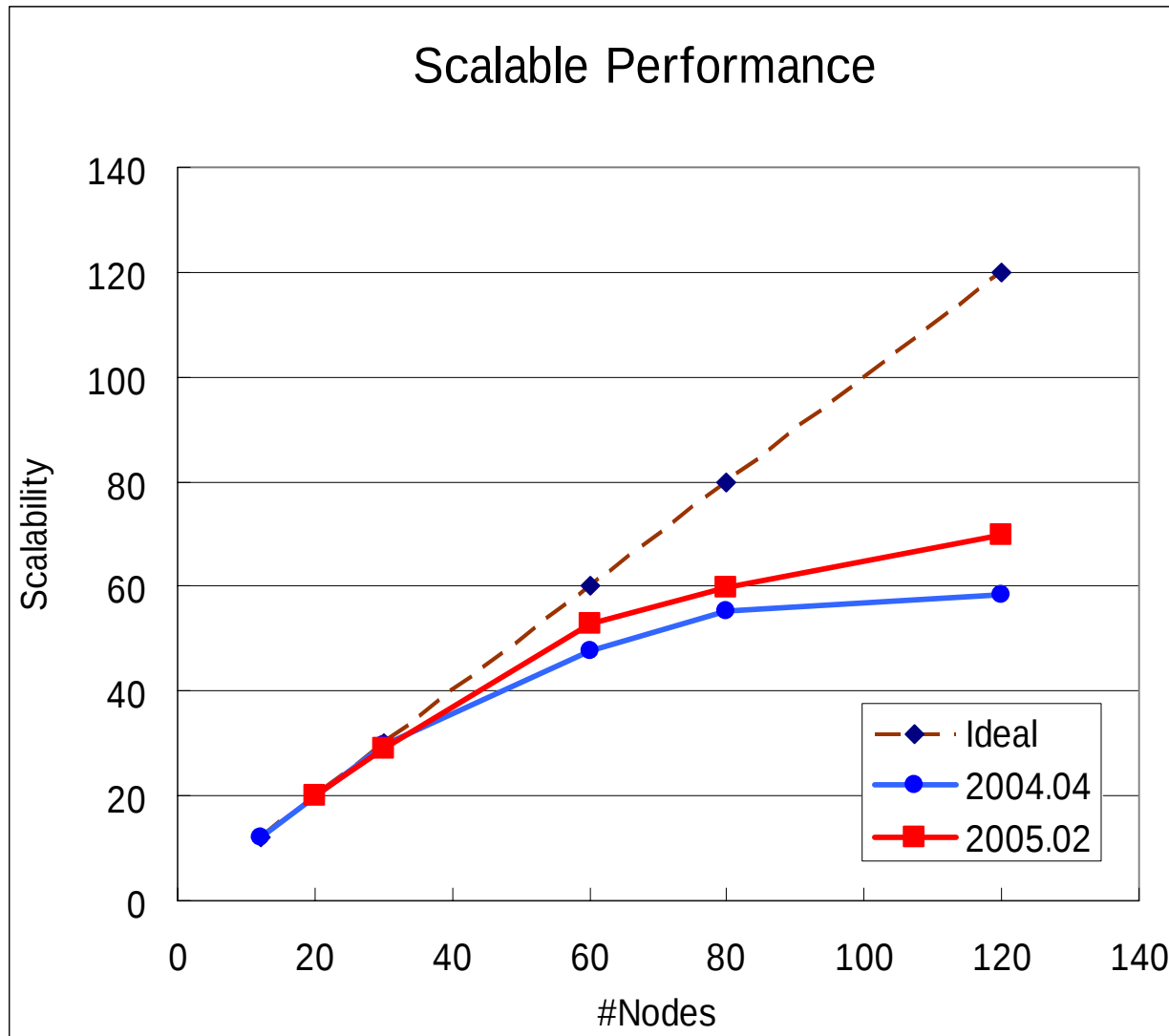
The 20 km mesh AGCM

	20 km mesh AGCM	JMA Global Spectral Model (GSM)
Horizontal Grids	1920x 960	640 x 320
Vertical Layers	60	40
Truncation Wave	TL959	T213
Grid Spacing	20km	60km
Top Layer Pressure	0.4hPa	
Dynamical frame	Semi-Lagrangian scheme	Eulerian scheme
Radiation Process	Shibata et al. (1999) Solar (every hour) Infrared (3 hourly)	
Precipitation Process	Prognostic Arakawa-schubert Large-scale condensation Prognostic cloud water content	
Gravity wave drag	Iwasaki et al (1989)	
Land surface	Simple Biosphere(SiB) model	
PBL and surface fluxes	Mellor-Yamada level 2 Moni-Obukhov similarity	

Computational Performance of the 20 km mesh AGCM on the ES



- Execution Time : 1 day forecast
 - TL959L60 : 6min (with 60-nodes)

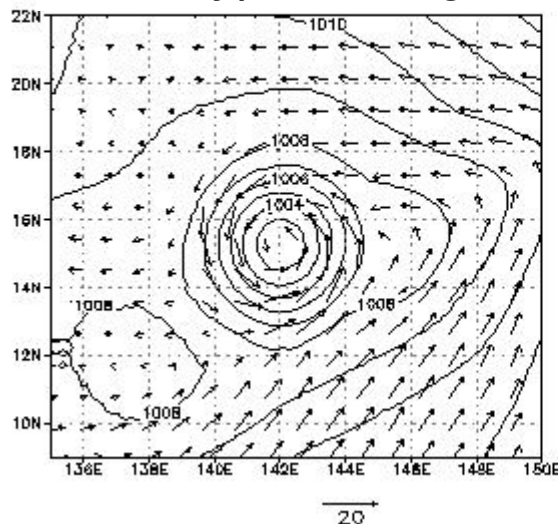


Typhoon Bogus

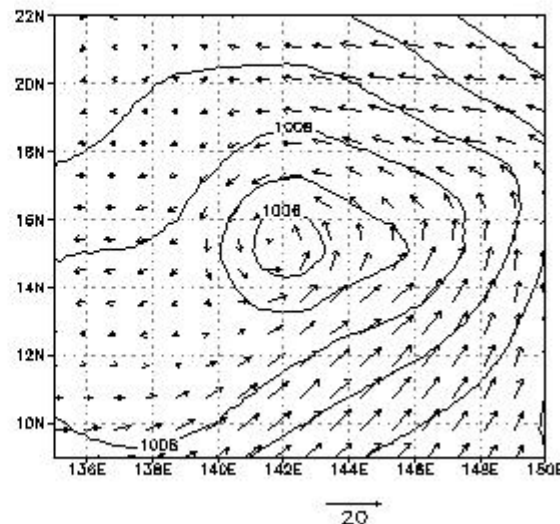


PSEA,WIND 2003090600UTC INIT FT=000

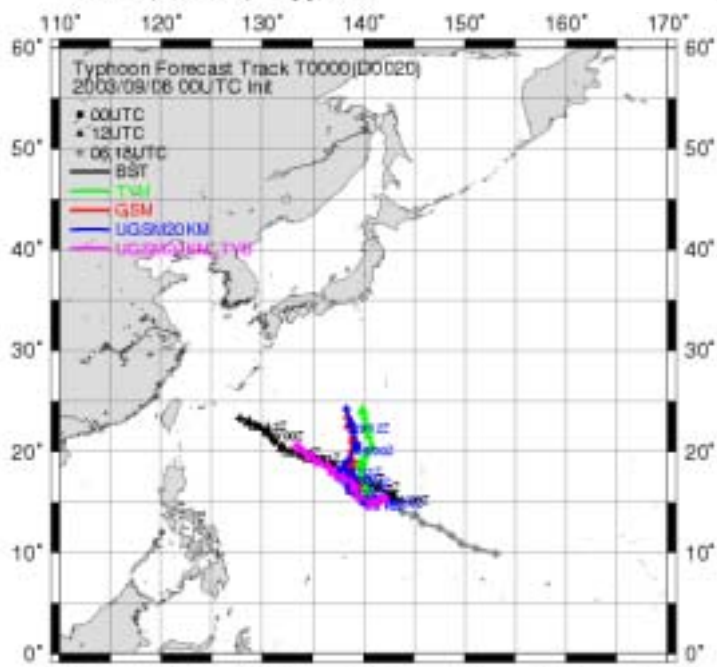
With Typhoon Bogus



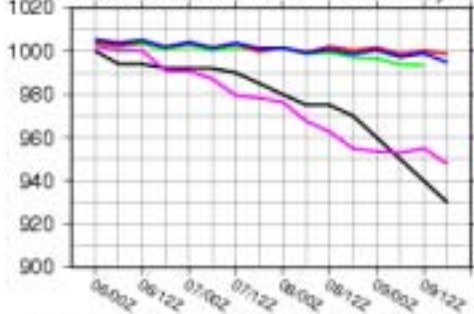
W/O Bogus



T0000(D0020) Typhoon



hPa T0000 Central Pressure Forecast-Analysis



GSM(60km mesh)

20km mesh (W/O Bogus)

20km mesh (With Bogus)

(m) T0000 Maximum Wind Forecast-Analysis

