Impact of Dam Water Release Based on a Numerical Model of the Kangjin Bay, South Sea, Korea

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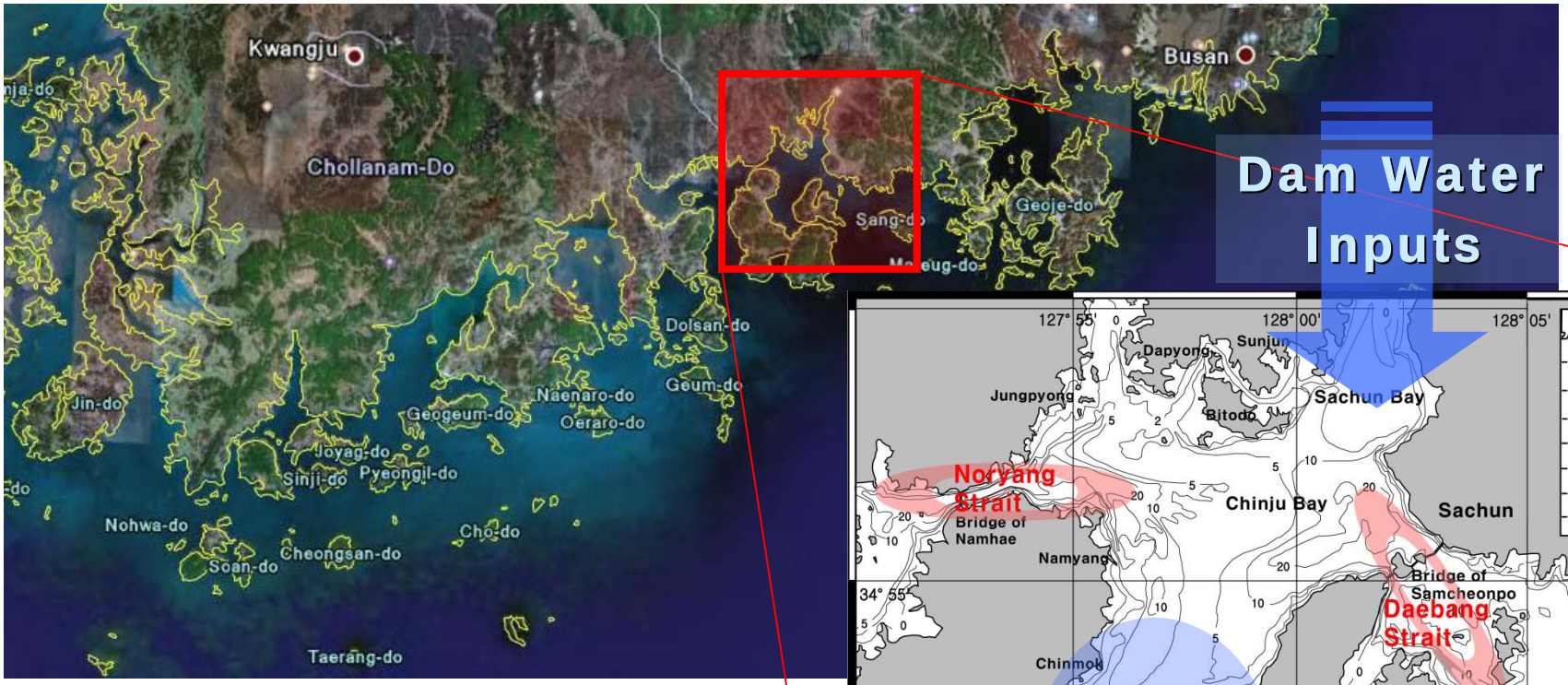
Physical Setting & Bottom Topography



- Location : 34°52’ N, 127°58’ E
- E-W : 10 km, N-S : 18 km
- Mean depth : 8.9 m, Max. depth : 20 m
- Area : 195.9 km^2
- 3 straits : Noryang, Daebang, Changseon

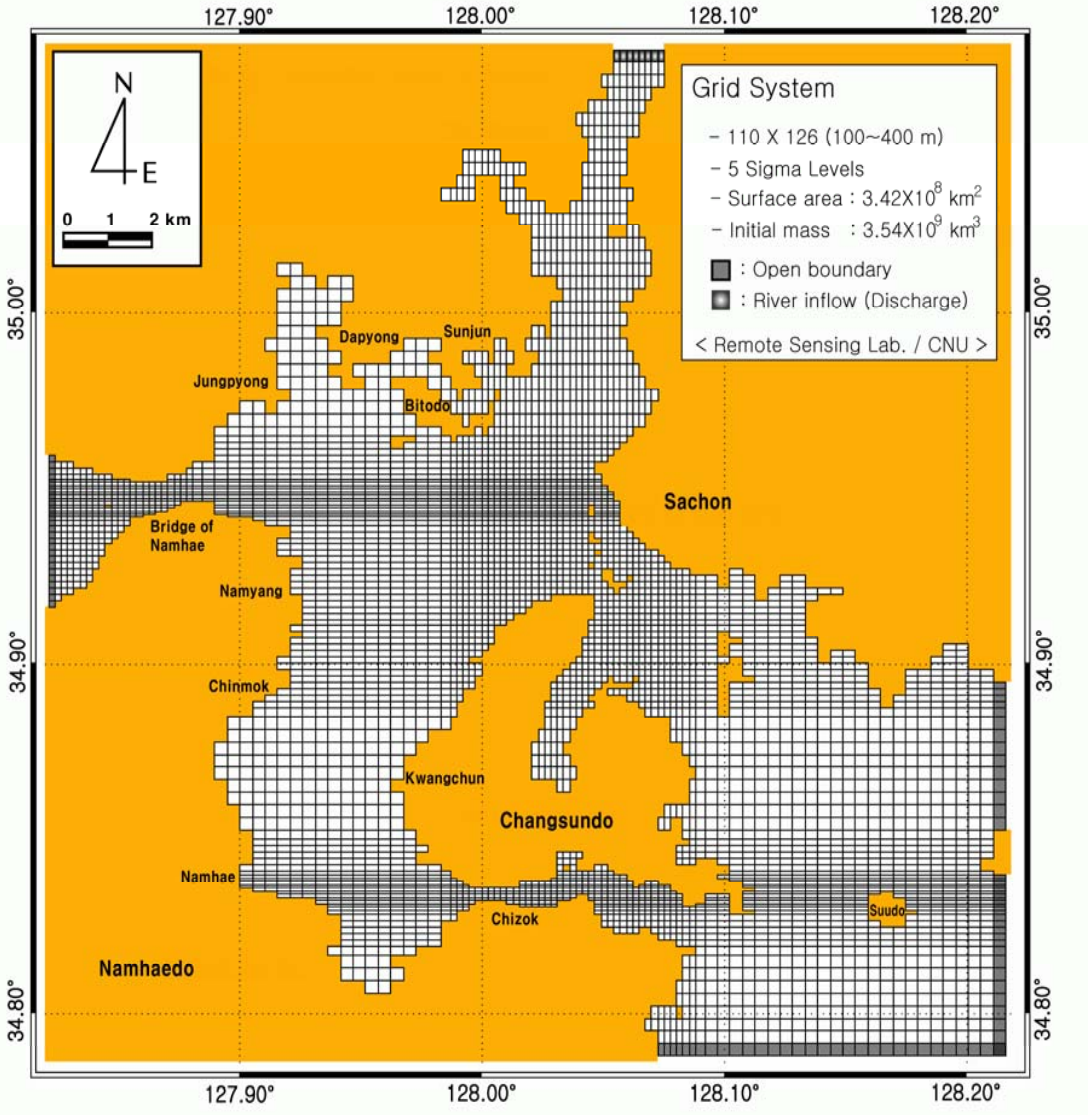
Introduction

- Previous study
  - Real-time monitoring of the environmental parameters in the Marine Large-Arc Shell Culture Bed (Ro, 2006)
  - Tidal & sub-tidal current characteristic (Ro, 2007)
  - Numerical modeling of tide & tidal current (Ro et al., 2007)

- This study investigates current system in the Kangjin Bay by using numerical model
  : Tidal & residual, Wind-driven and Density-driven current

- How much salinity is diluted by fresh water dam discharge?
- Flushing time?

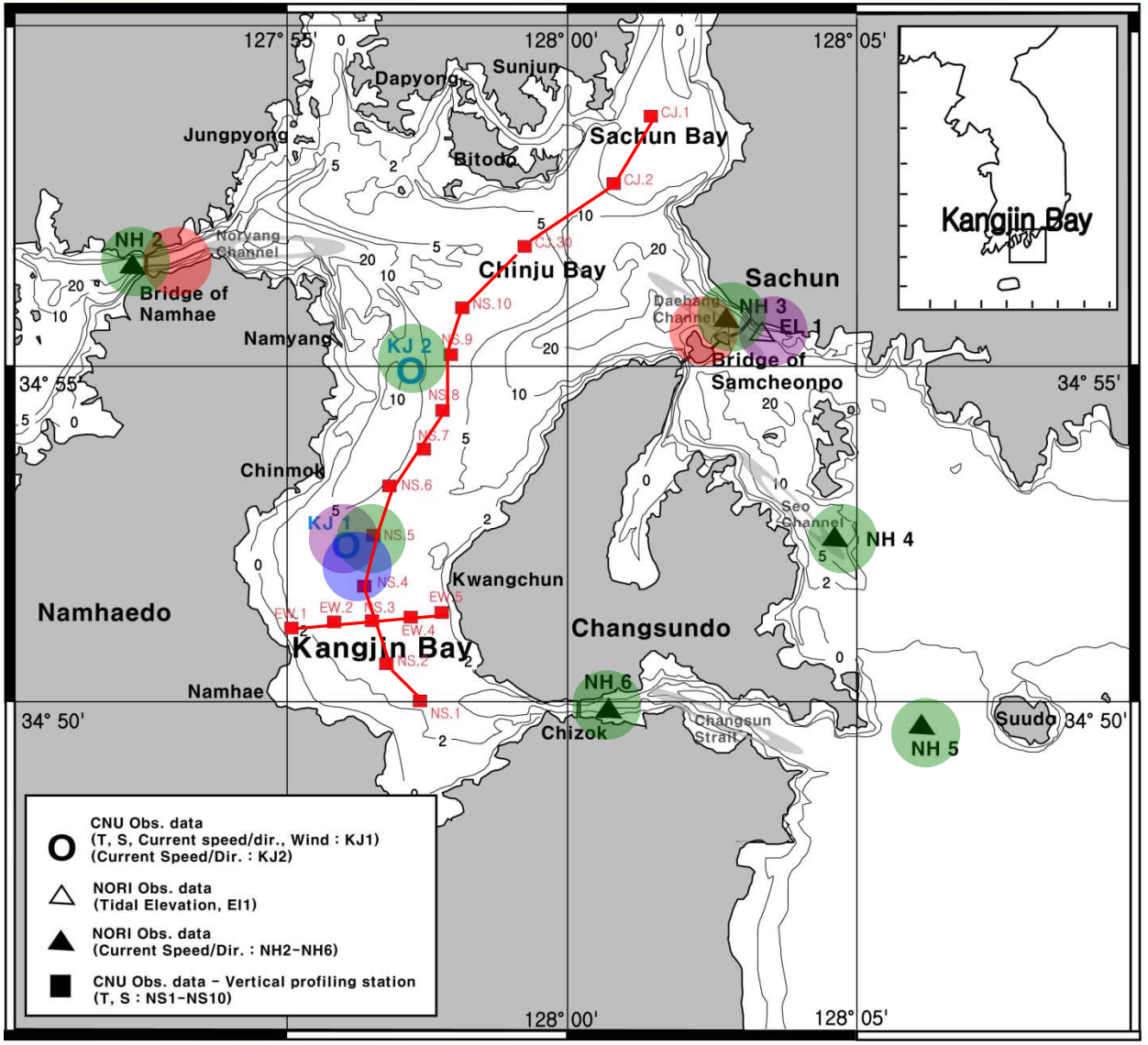
Model Specification



- **Model code**
  - ECOM3D (Hydroqual, 2002)
- **Grid system**
  - 110 X 126
  - 100-400 m
  - 5 sigma levels
- **Time step**
  - Internal : 20 sec
  - External : 2 sec
- **Open boundary condition**
  - 4 major tidal constituents
  - M2, S2, K1, O1
- **Dam discharge**
- **Obs. Temp. & Salt. data**
- **Obs. Wind data**

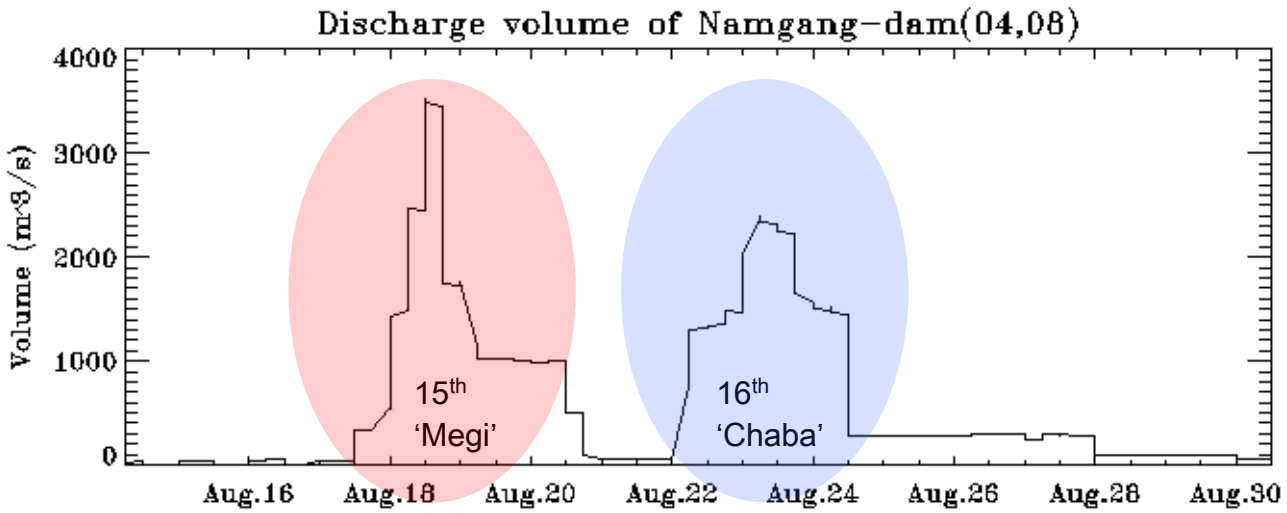
Field Measurements & Datasets

- **Surface elevation**
  - Tide gauge at 2 stations (KJ1, EL1)
- **Current & direction**
  - RCM9 at 7 stations (KJ1, KJ2, NH2-6)
  - ADCP at 2 stations (DB, NR)
- **Water quality parameters**
  - Temp., Salt. and D.O. etc.
  - Real-time monitoring sys. (KJ1)
- **Meteorological data**
  - AWS (KJ1)
- **Surveys**
  - E-W and N-S cross section



Field Measurements & Datasets

- Dam Discharge Data by KWRC



- Aug.15~30, 2004 (15 days)
- Total discharge volume : 8.41×10^8 m^3
- Total mass of KJ Bay = 1.96×10^9 m^3
- Total mass of model domain = 3.54×10^9 m^3
- 1st peak discharge : 3,500 m^3/sec
- 2nd peak discharge : 2,800 m^3/sec

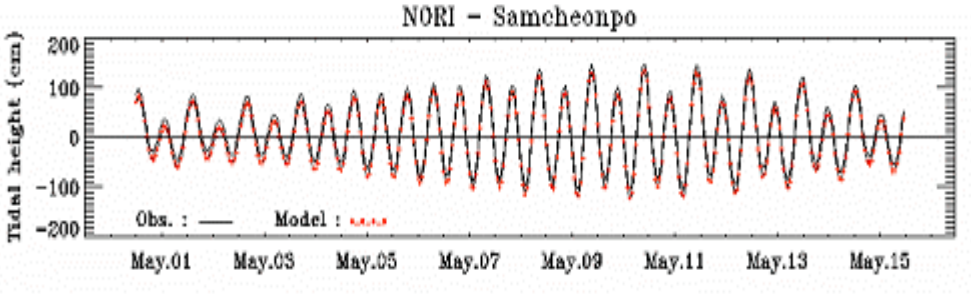
Model Calibration & Verification (Tide and Tidal Currents)

- Skill analysis = (1-R.error)
- Between obs. & res. of harmonic analysis
- most scores : over 0.9

(1-R.Error)
0.8 ≤ blue ≤ 1.0
0.6 ≤ black < 0.8
Red < 0.6

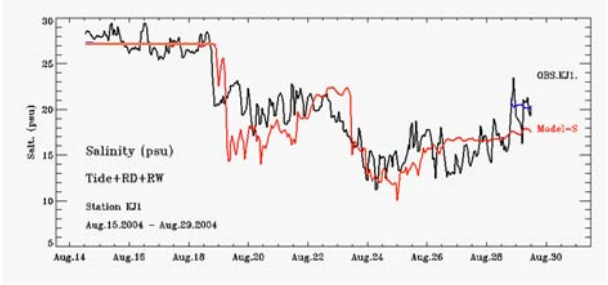
Tidal Current (1-R.Error)		CNU(Obs.) Vs Model Results						NORI(Obs.) Vs Model Results									
		KJ-1		KJ-2		NR		NH-2		NH-3		NH-4		NH-5		NH-6	
		Amp.	Phase	Amp.	Phase	Amp.	Phase	Amp.	Phase	Amp.	Phase	Amp.	Phase	Amp.	Phase	Amp.	Phase
U-comp.	M2	0.93	0.93	0.92	0.88	0.85	0.91	0.88	0.94	0.83	0.93	0.99	0.98	0.97	0.92	0.67	0.91
	S2	0.92	0.94	0.89	0.91	0.88	0.89	0.86	0.91	0.84	0.87	0.95	0.94	0.99	0.97	0.67	0.84
	K1	0.81	0.98	0.86	0.91	0.77	0.72	0.87	0.86	0.98	0.99	0.90	0.97	0.76	0.90	0.95	0.76
	O1	0.99	0.99	0.10	0.90	0.80	0.69	0.78	0.89	0.73	0.96	0.90	0.92	0.50	0.99	0.68	0.70
V-comp.	M2	0.94	0.94	0.97	0.96	0.89	0.95	0.94	0.90	0.87	0.93	0.95	0.98	0.90	0.98	0.63	0.93
	S2	0.97	0.95	0.92	0.94	0.92	0.87	0.97	0.90	0.63	0.87	0.88	0.94	0.86	0.97	0.64	0.87
	K1	0.36	0.98	0.84	0.99	0.49	0.54	0.92	0.82	0.99	0.98	0.91	0.98	0.63	0.91	0.31	0.71
	O1	0.35	0.99	0.15	0.84	0.59	0.58	0.80	0.78	0.97	0.99	0.89	0.99	0.84	0.90	0.67	0.69

Tidal Elev. (1-R.Error)	CNU(Obs.) Vs Model Results		NORI(Obs.) Vs Model Results	
	KJ-1		Samcheonpo	
	Amp.	Phase	Amp.	Phase
M2	0.94	0.95	0.97	0.96
S2	0.91	0.98	0.92	0.99
K1	0.89	0.96	0.91	0.96
O1	0.98	0.92	0.98	0.71

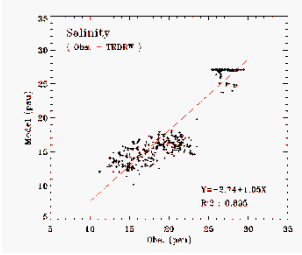


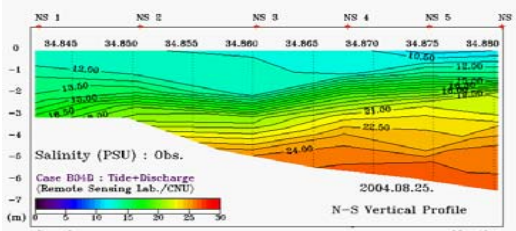
Model Calibration & Verification (Salinity and Sigma-t)

<N-S cross section> <E-W cross section>

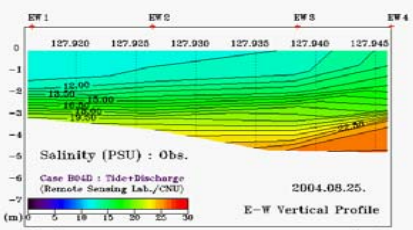


- **Salinity (0.895)**

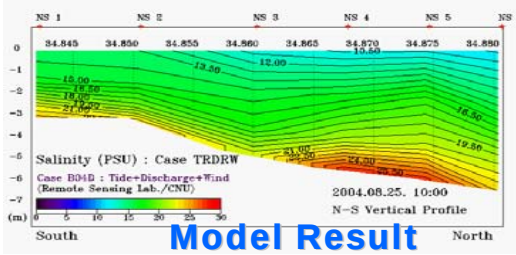




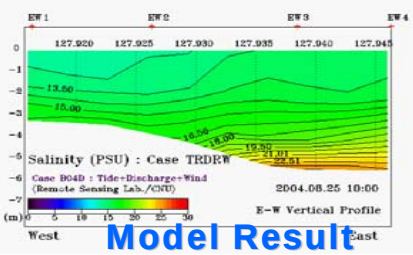
Observed



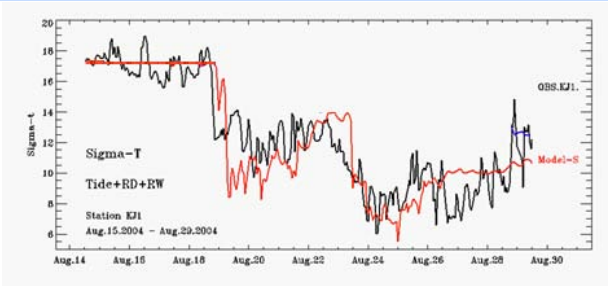
Observed



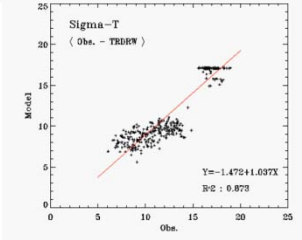
Model Result

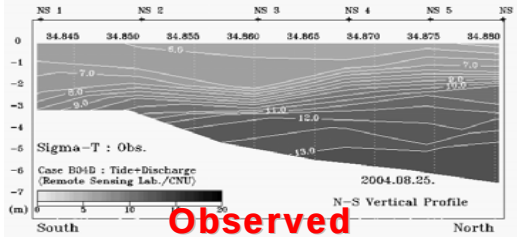


Model Result

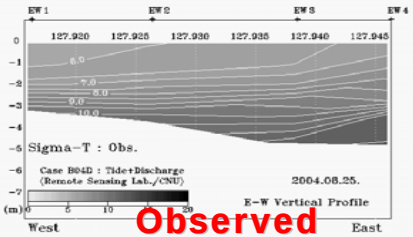


- **Sigma-t (0.873)**

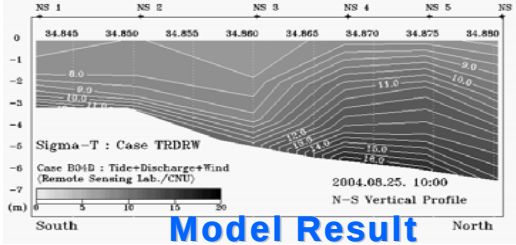




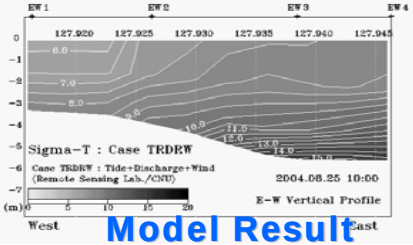
Observed



Observed



Model Result

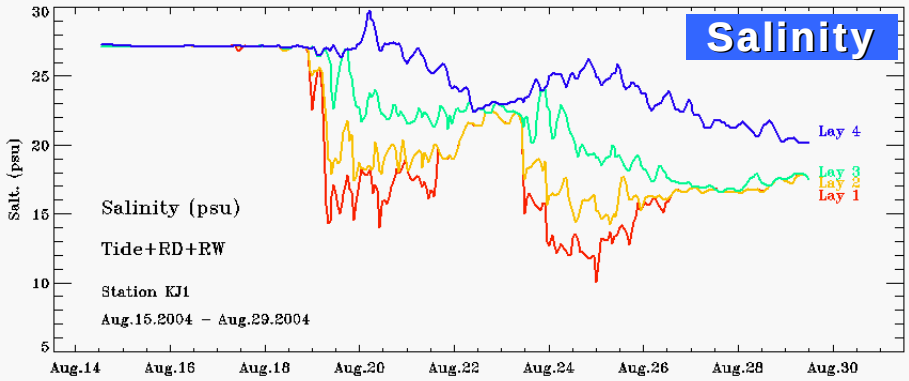


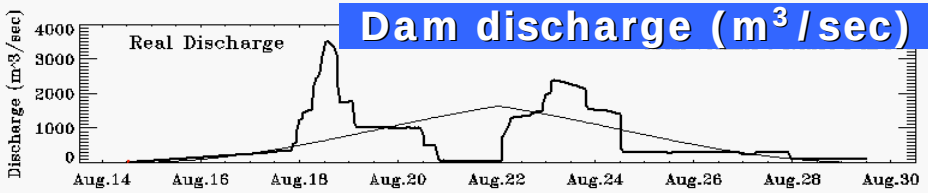
Model Result

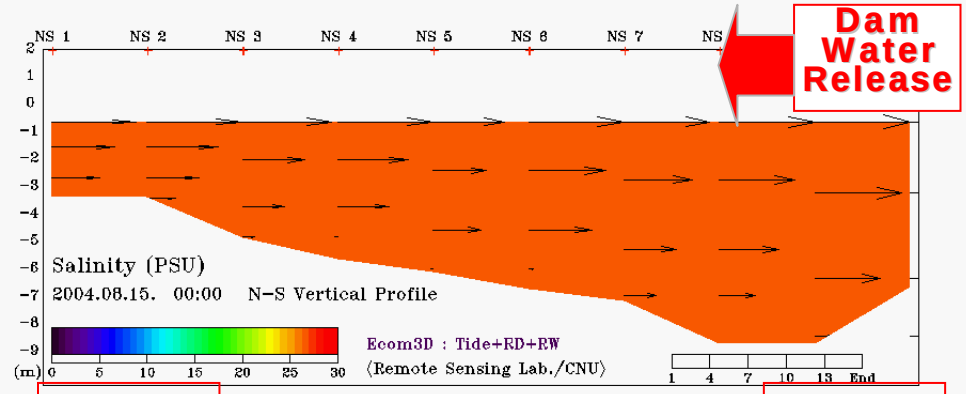
Model performance is highly satisfactory !!!

Model Results (Salinity)

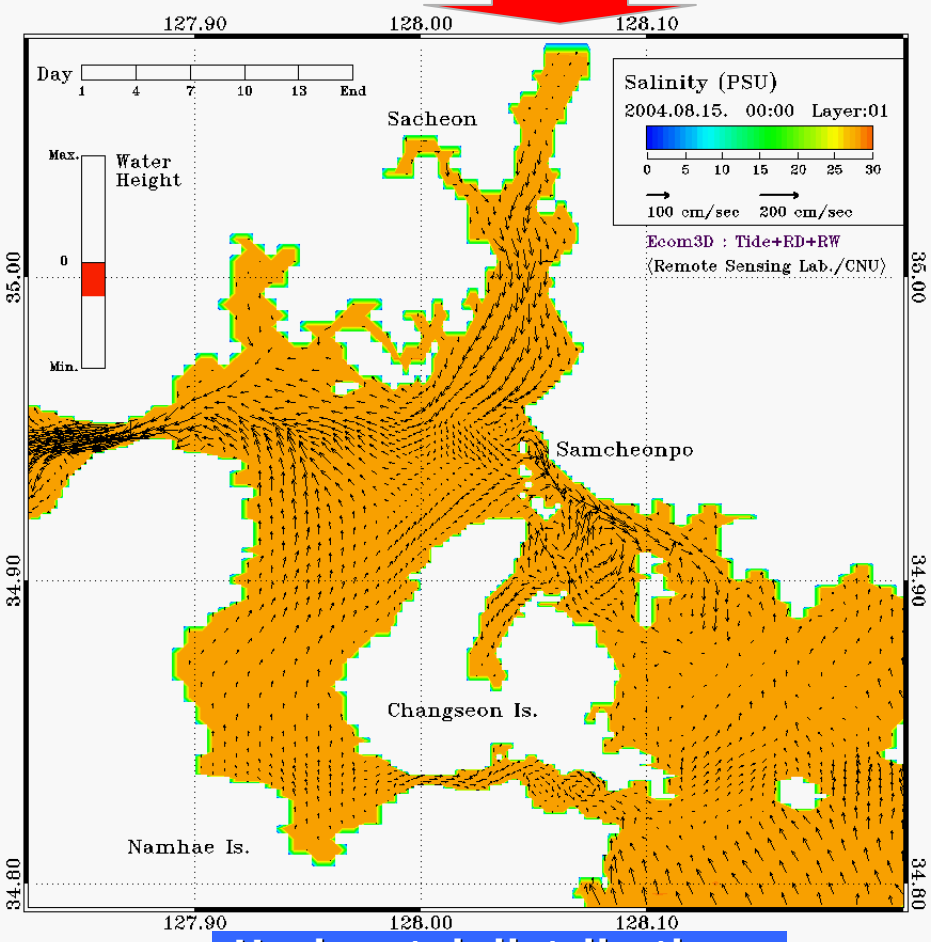
- Case-TDW (Tide+Discharge+Wind)







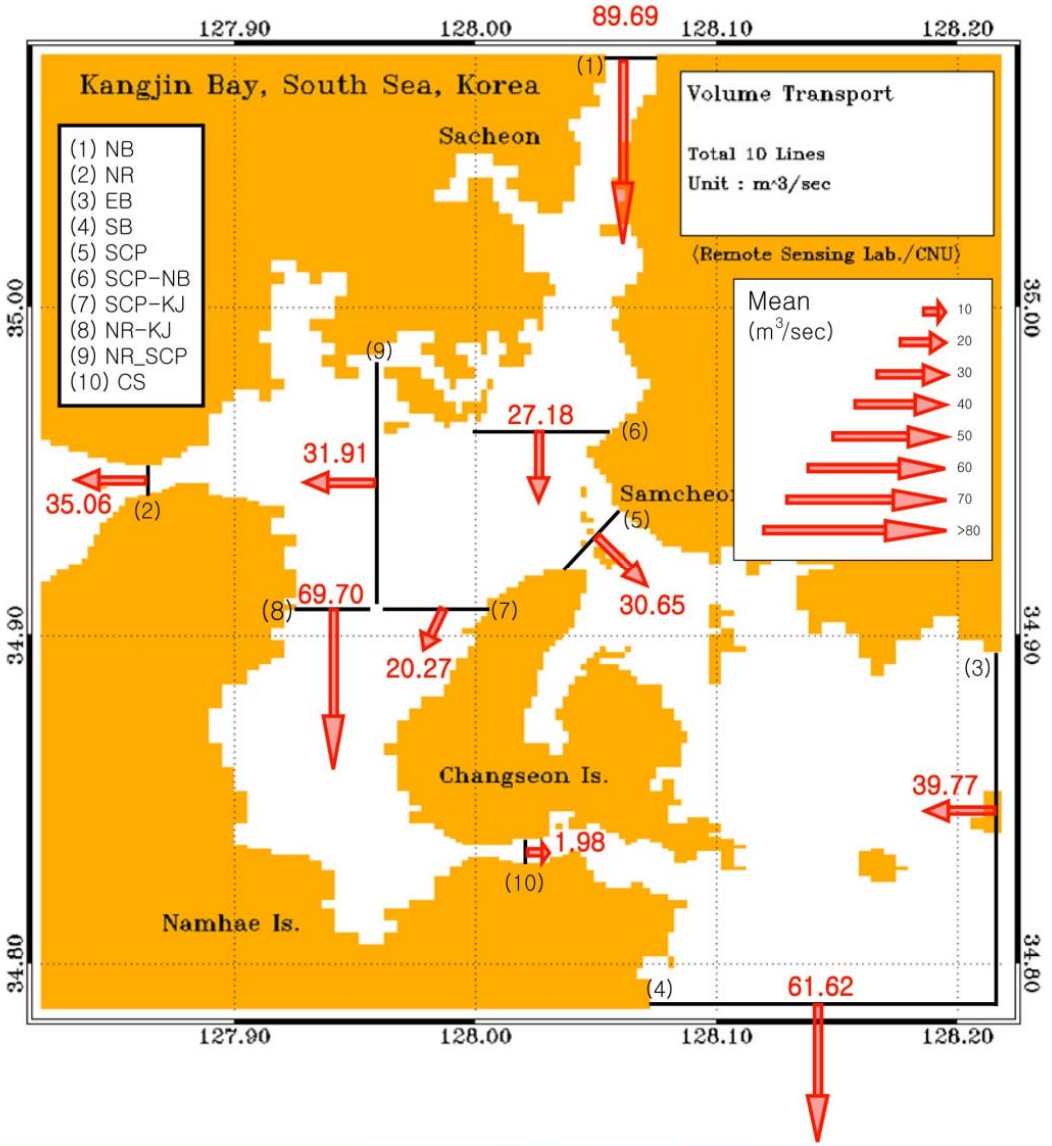
Dam Water Release



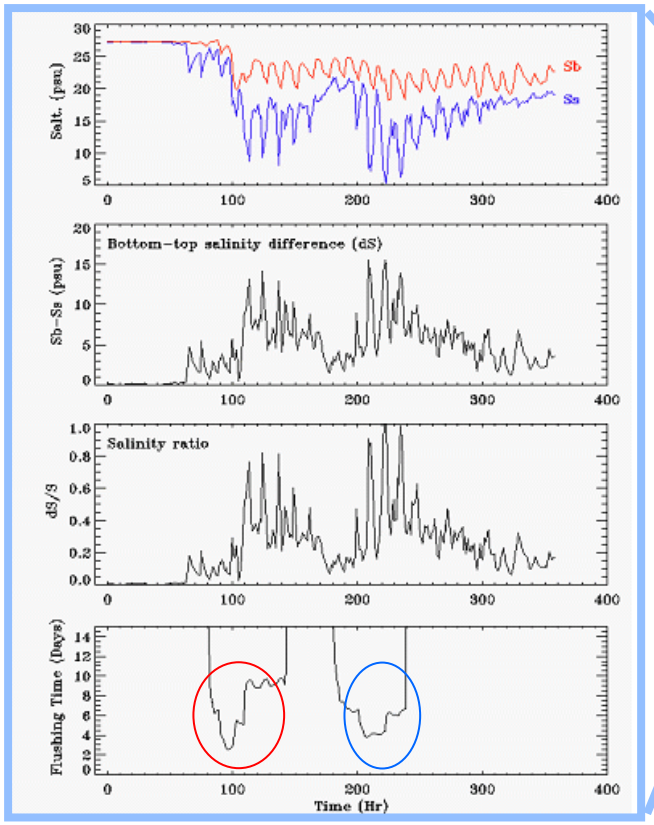
Horizontal distribution

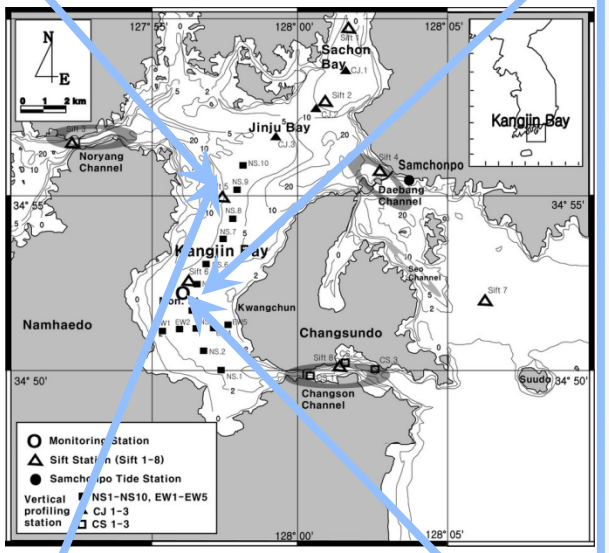
Net Volume Transports Variation

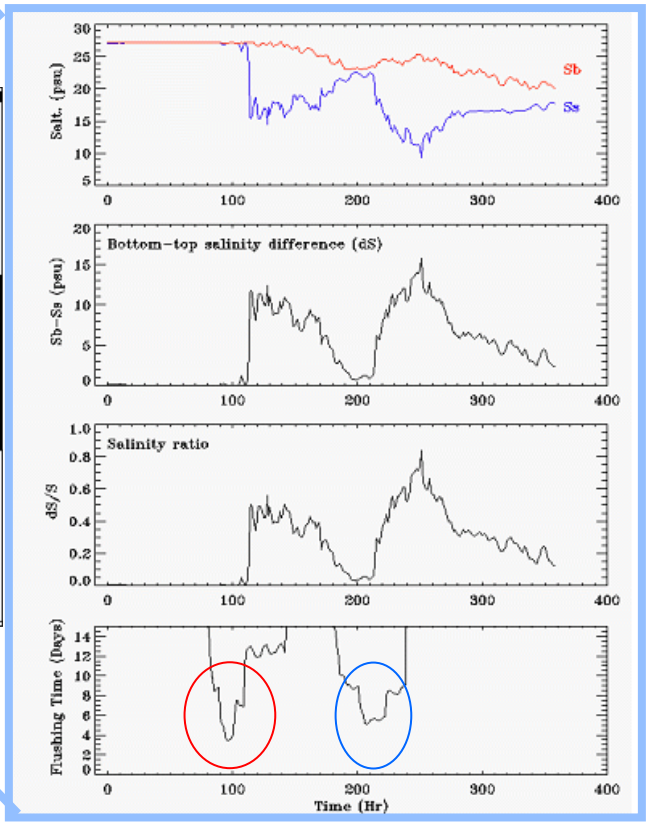
(after dam discharge)



Flushing Time







1st peak discharge (3,500 m^3/sec) : 4.2 days

2nd peak discharge (2,800 m^3/sec) : 5.7 days

Summary

- To understand the Circulation of Kangjin Bay by using numerical model

- Model results are found to compare well with the Obs. Data

- **Surface salinity**
  - 1st peak discharge → 15 (psu)
  - 2nd peak discharge → 10 (psu)

- **Flushing time**
  - 1st peak discharge (3,500 m^3/sec) : 4.2 days
  - 2nd peak discharge (2,800 m^3/sec) : 5.7 days

Summary

- **3 channels are very narrow : bottle-neck effect**

- **Large amount dam discharge in the summer season**

→ Increase of the volume of traffic into bay

→ Thick fresh water covers sea water surface for a long time

→ Stratification between surface & bottom by strong density current

→ **Ecosystem will be seriously affected by fresh water**

Thank you