Calibrating a Tidal Model of the South China Sea

Pavlo Zemskyy*, Ooi* S.K.,
Alamsyah Kurniawan*,
Herman Gerritsen+

* - SDWA, NUS, Singapore
+ - Deltares, The Netherlands

singapore-delft water alliance

SINGAPORE DELFT BY SIDE

of May, 2010

Context

- Introduction
  - South China Sea Domain
  - Model Set up
  - Motivations
- Preparations for OpenDA
- Calibration steps with OpenDA
  - Sensitive analysis
  - Iterative calibration
- Conclusions and further plans

South China Sea Domain

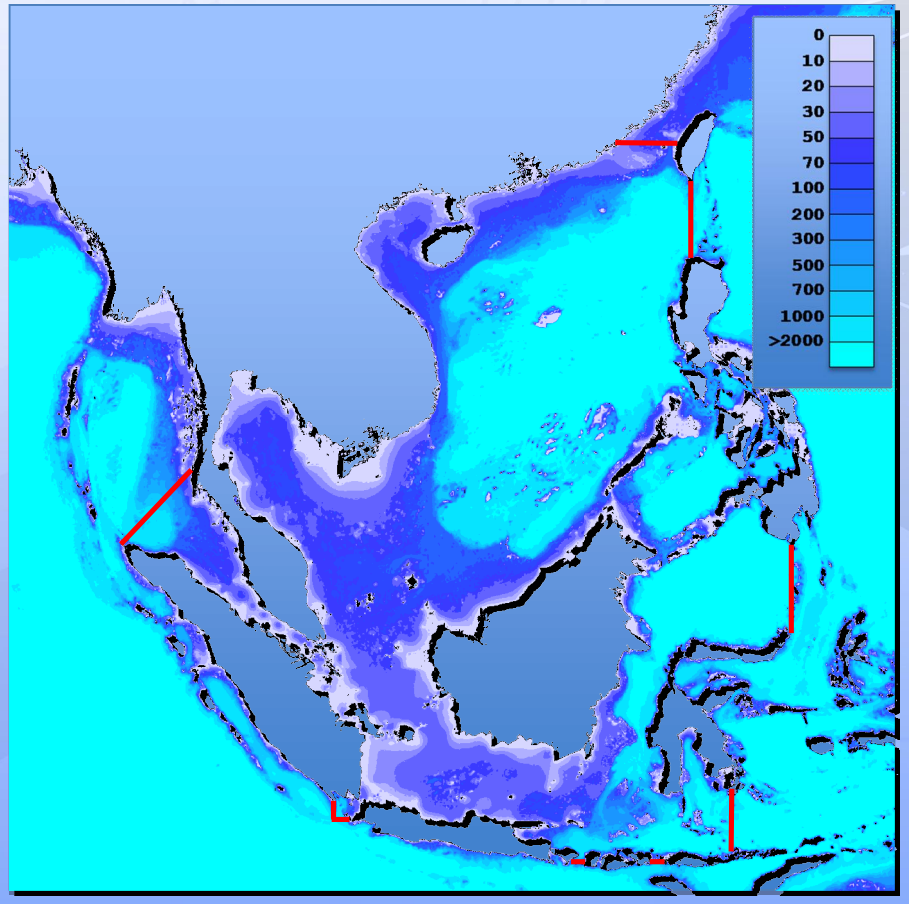
- Coverage:

  95° – 124 °E. L.

  8°S.L. – 26 °N. L.

- Tide interaction zone of Pacific Ocean and Indian Ocean

- High depth variance:
  - From 5000 m in central parts to 100 m on the Sunda Shelf
  - Deep basins of SCS, Sulu Sea and Celebes Sea are connected via shallow ridges

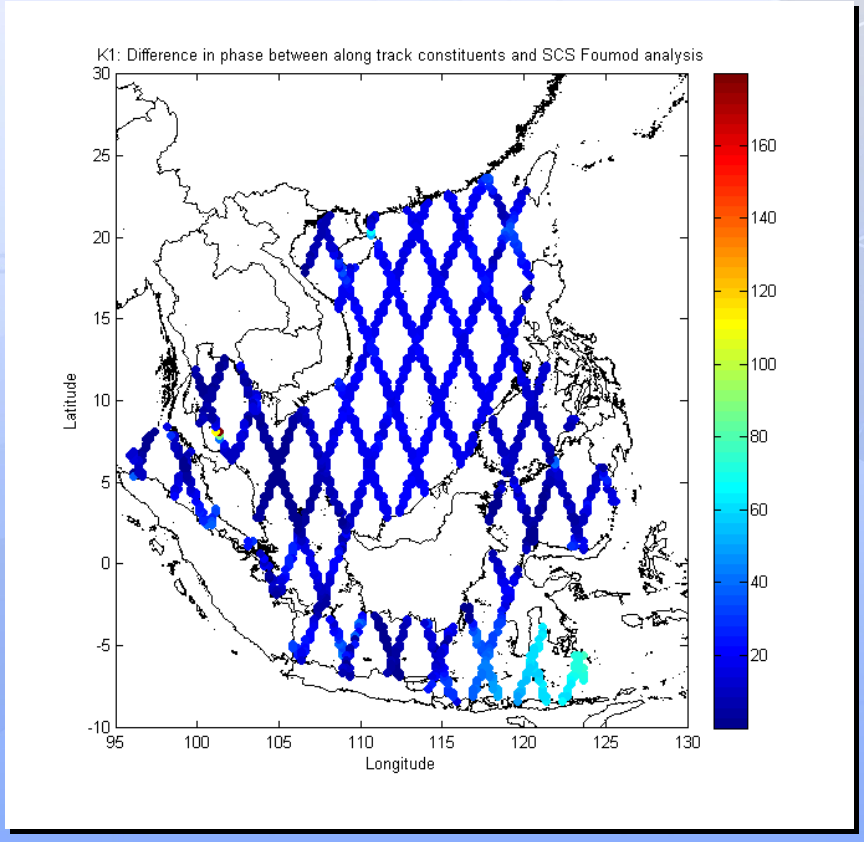


Model Setup

- Delft3DFlow
- 1/4 degree spatial resolution
- 124 x 133 regular rectangular on sphere grid (7497 active nodes)
- 11 open boundary segments
- Bathymetry schematization based on charts and GEBCO
- Boundary forcing: M2, S2, K1, O1, P1, K2, N2 and Q1
- Internally generated tidal forcing based on 11 constituents
- Details are published in SAT2SEA report

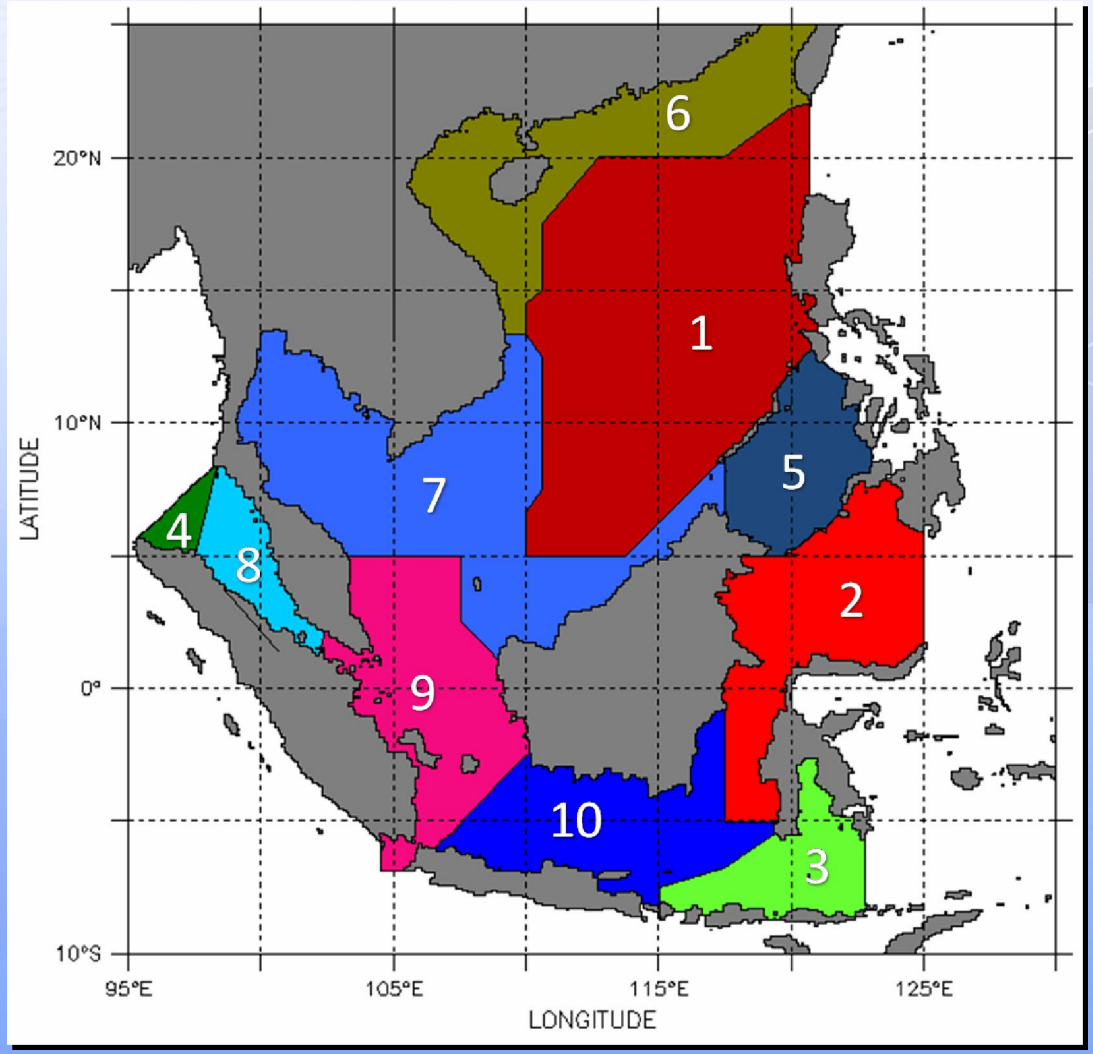
Motivations

- SAT2SEA model has been calibrated for a specific month
- Systematic usage of new remote altimetry data set
- Inconsistency with local measurements



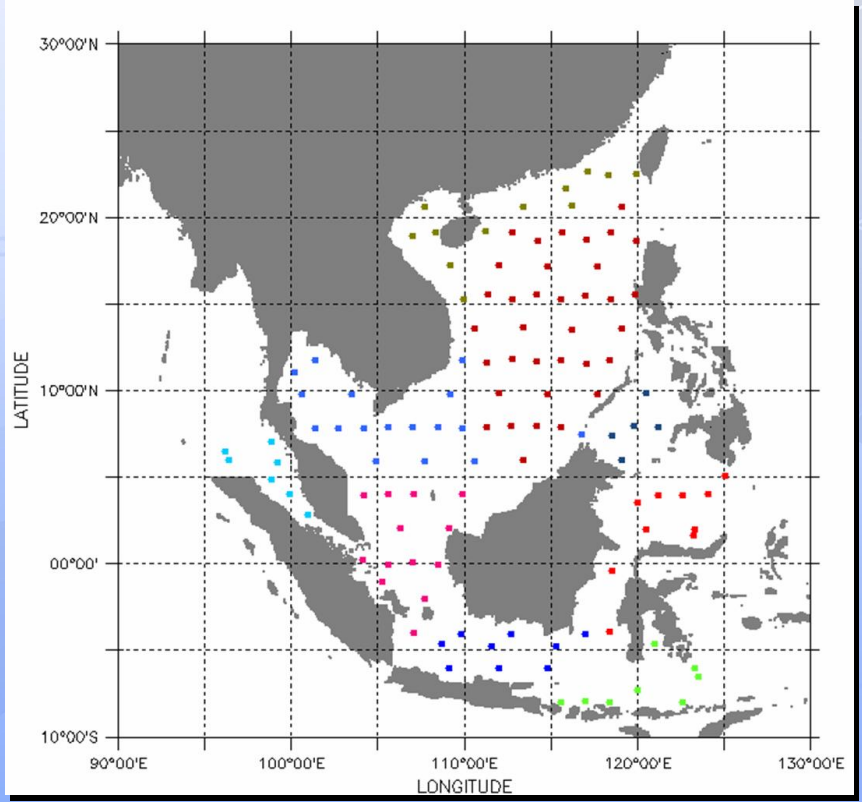
Observation Regions

#		Obs. points
R 1	Deep	36
R 2	Deep	10
R 3	Deep	8
R 4	Deep	2
R 5	Deep	5
R 6	Shallow	12
R 7	Shallow	17
R 8	Shallow	7
R 9	Shallow	13
R 10	Shallow	9



Set of Observations

- 119 along-track observation points
- Internally consistent
- Reference time series based on 8 tidal constituents: M2, S2, K1, O1, P1, K2, N2, Q1



Performance Criteria

Good of Fitness

$$GoF = \frac{1}{2}\sum_{r=1}^{r=R\max}\sum_{s=1}^{s=S\max}\sum_{n=1}^{n=N\max} w_{r,s}\left(H_{r,s,n}^{sim}(t) - H_{r,s,n}^{obs}(t)\right)^2 \Big/ \sigma_{Hobs}{}^2$$

Vector difference

$$VD_{k,r,s} = \sqrt{\left[\left(H_{c,k}\cos G_{c,k} - H_{o,k}\cos G_{o,k}\right)^2 + \left(H_{c,k}\sin G_{c,k} - H_{o,k}\sin G_{o,k}\right)^2\right]}$$

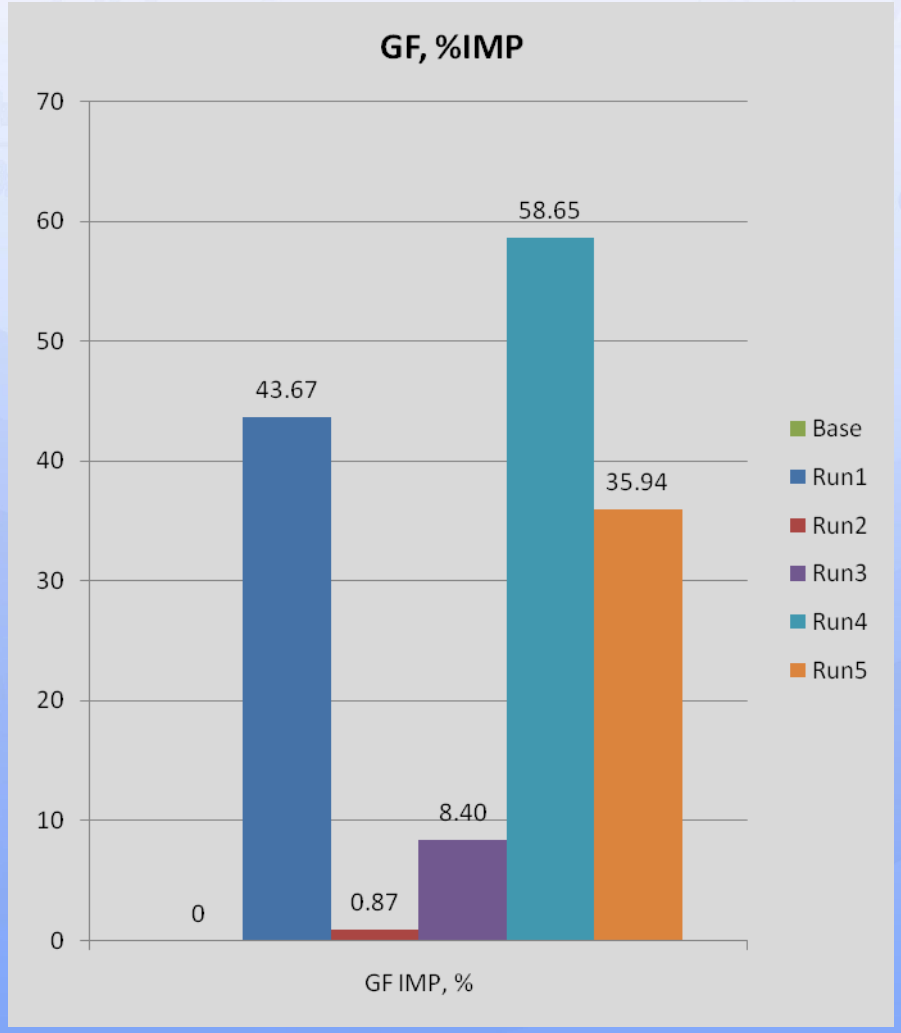
Sum vector difference

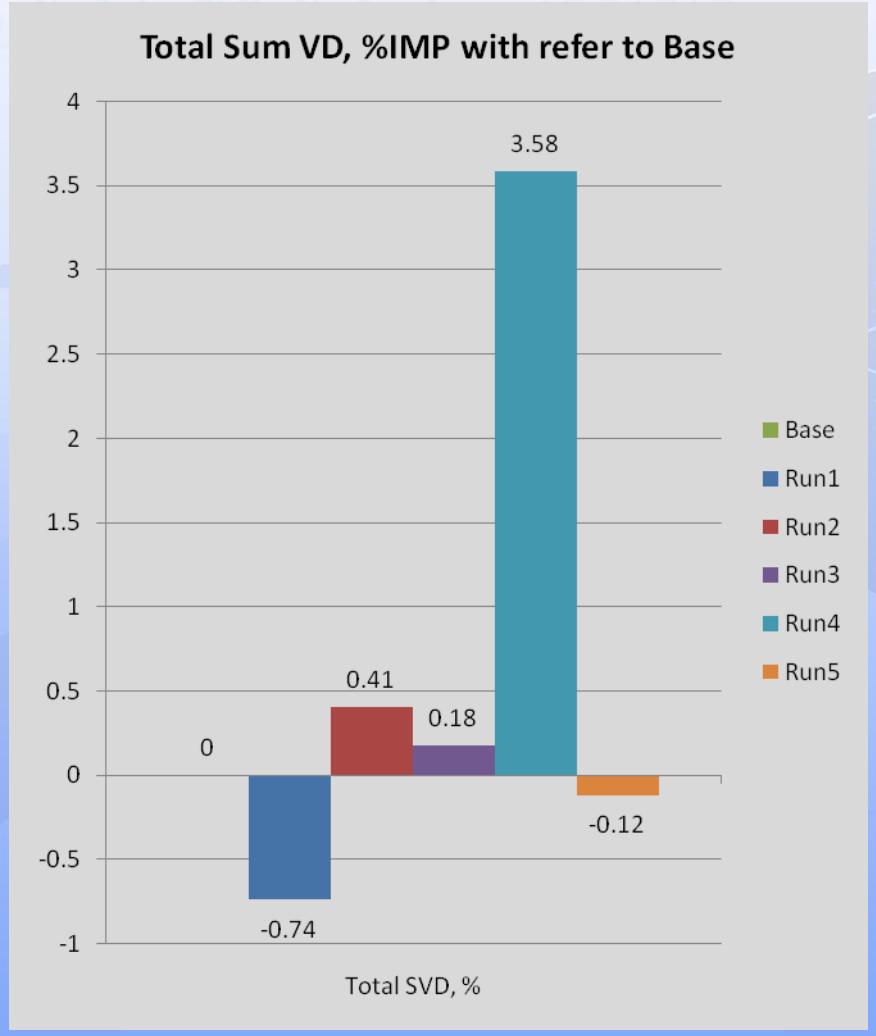
$$SVD_k = \sum_{r=1}^{r=R\max}\sum_{s=1}^{s=S\max} VD_{k,r,s}$$

Sensitivity analysis runs

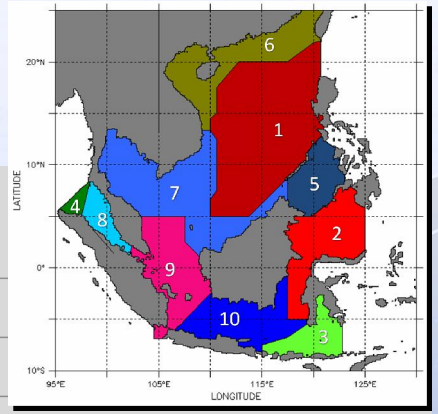
Run ID	Description	Observers
Run1	Changing phases of semi-diurnal constituents M2 and S2 at Celebes Sea boundaries	R 2
Run2	Changing phases of semi-diurnal constituents M2 and S2 at Flores Sea boundaries	R 3
Run3	Changing phases of semi-diurnal constituents M2 and S2 at Celebes and Flores Sea boundaries	R2 and R3
Run4	Changing phases of diurnal constituents K1 and O1 at Flores Sea boundaries	R3
Run5	Changing phases of semi-diurnal constituents K1 and O1 at Luzon and Taiwan Straits boundaries	R1

Comparison of Runs1-5

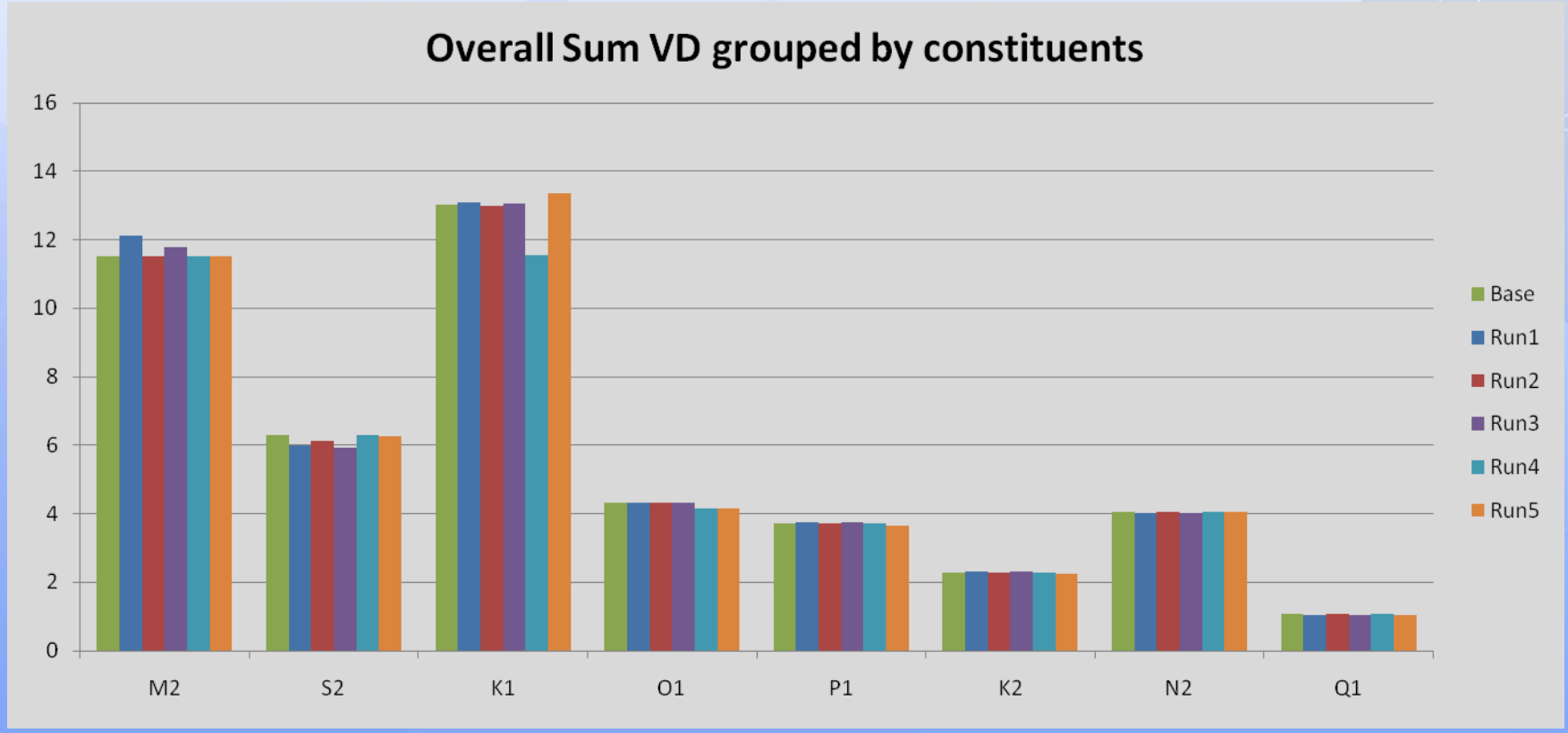




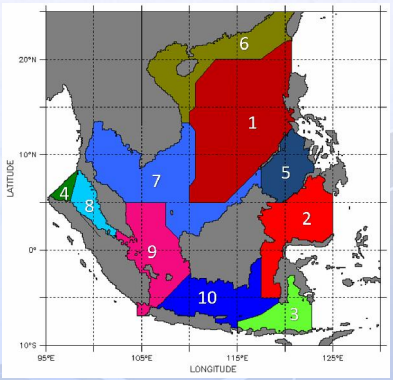
Comparison by regions

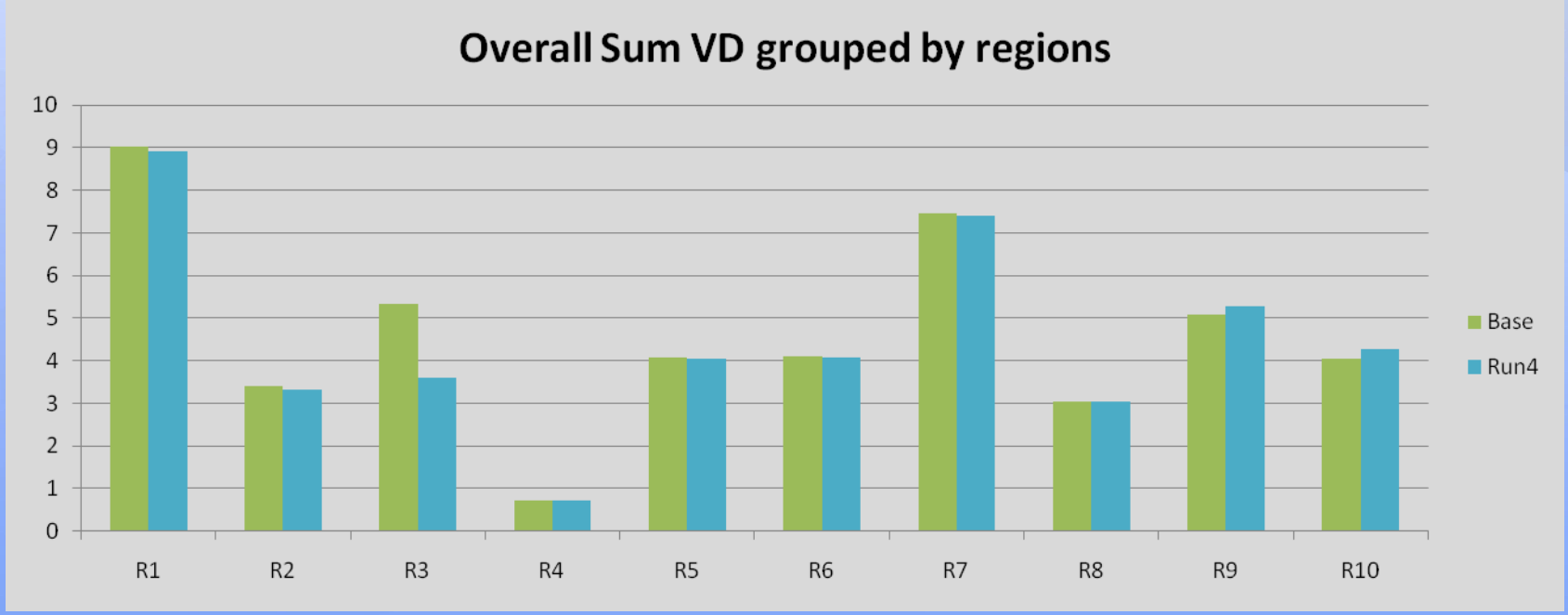


Comparison by constituents



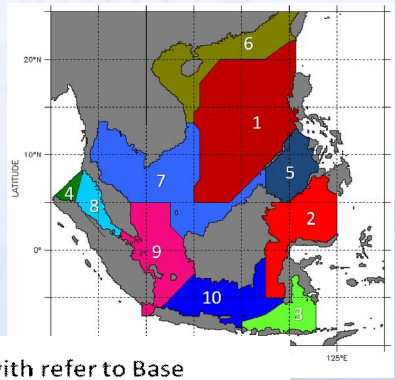
Detailed analysis of Run4

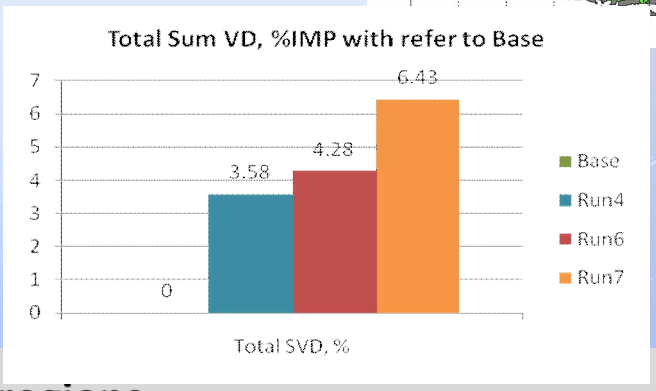


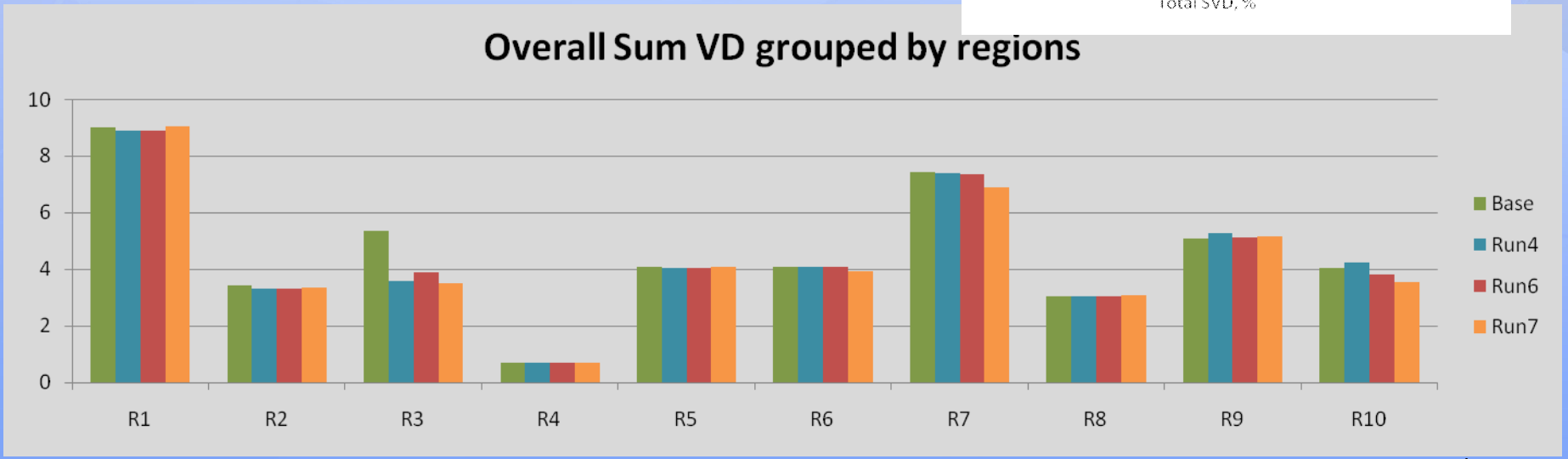


Second iteration – runs based on Run4

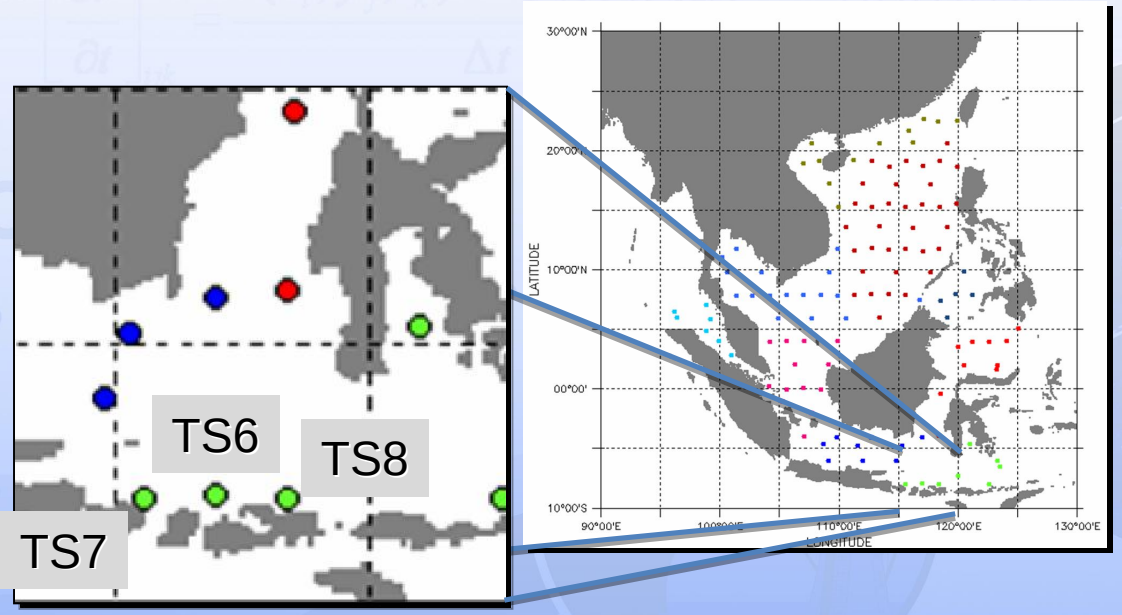
Run ID	Description	Observers
Run6	Changing phases of K1 and O1 at Sape Sea and Lombok Strait boundaries	R 3, R10
Run7	Changing bathymetry in R9 and R10	R 6 – R10







Inconsistency with local observations



Location	Phase			VD	
	Observed	Base Run	Run6	Base Run	Run6
Lombok BC		303.792	255.305		
TS6	303.339	290.554	251.923	0.080	0.232
TS7	305.359	284.623	247.876	0.107	0.181
TS8	301.384	293.616	267.089	0.073	0.244

Conclusions and further plans

- Calibration of SCS model is still in progress
- OpenDA not only automates calibration routines but also assists in sensitivity analysis
- Improvement of GoF criterion does not necessarily guarantee improvement of overall model performance
- OpenDA provides a mathematically correct solution, but it is the researcher's responsibility to keep it consistent with physical meaning