

新垂直網格系統於台灣海域 作業化海流模式之發展與應用

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Vertical grids in ocean models

❖ Geo-potential coordinates (ζ)

- PGE small
- Easiest to implement – no transformation
- Staircase

❖ Terrain-following coordinates

- Good for surface and bottom controlled processes
- PGE and diapycnal mixing issues

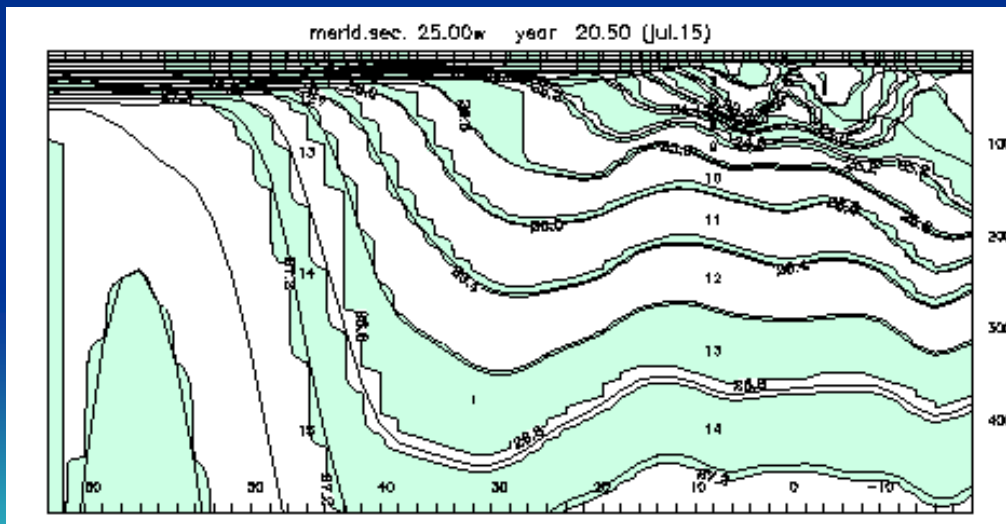
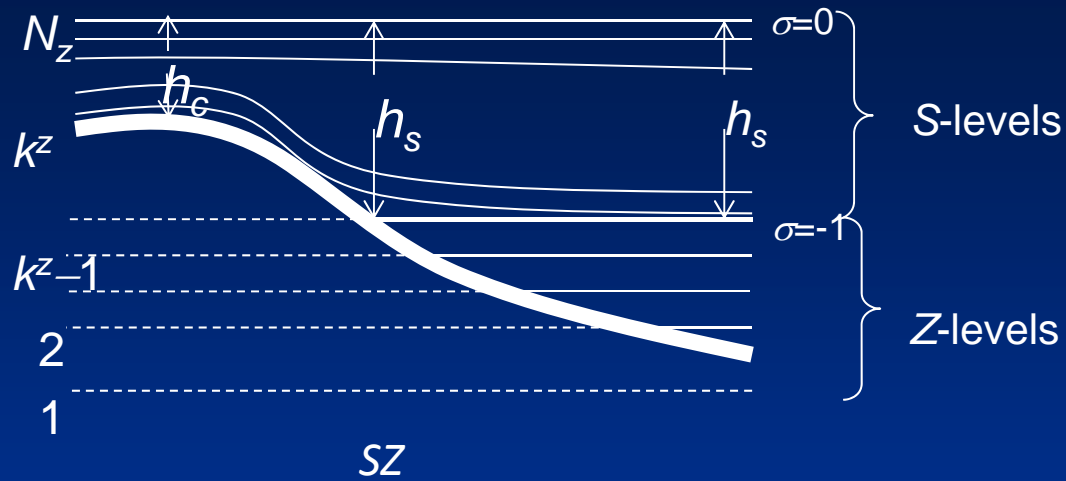
❖ Isopycnal coordinates

- PGE small
- Good for very long-term simulation
- Problematic for well-mixed zones

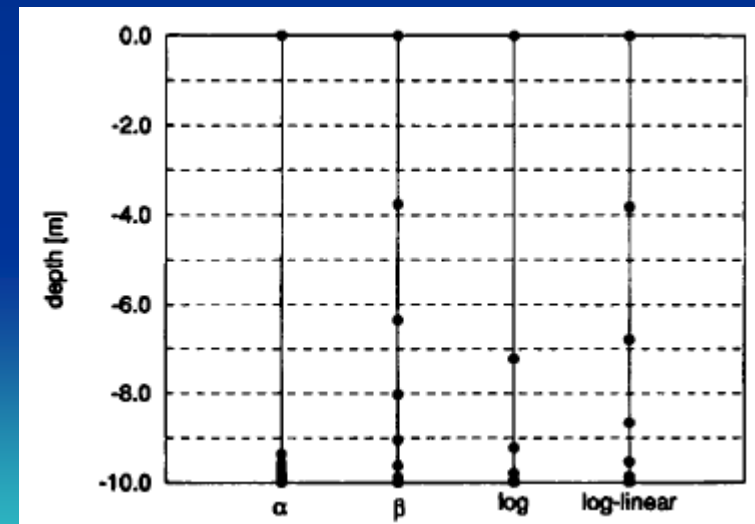
❖ Hybrid



Hybrid coordinates



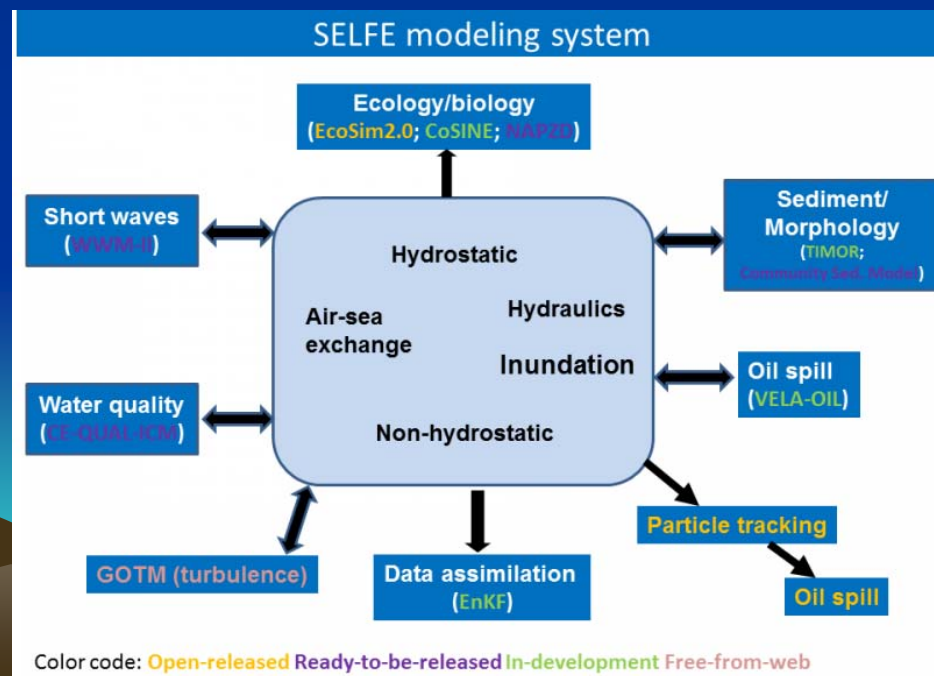
HYCOM



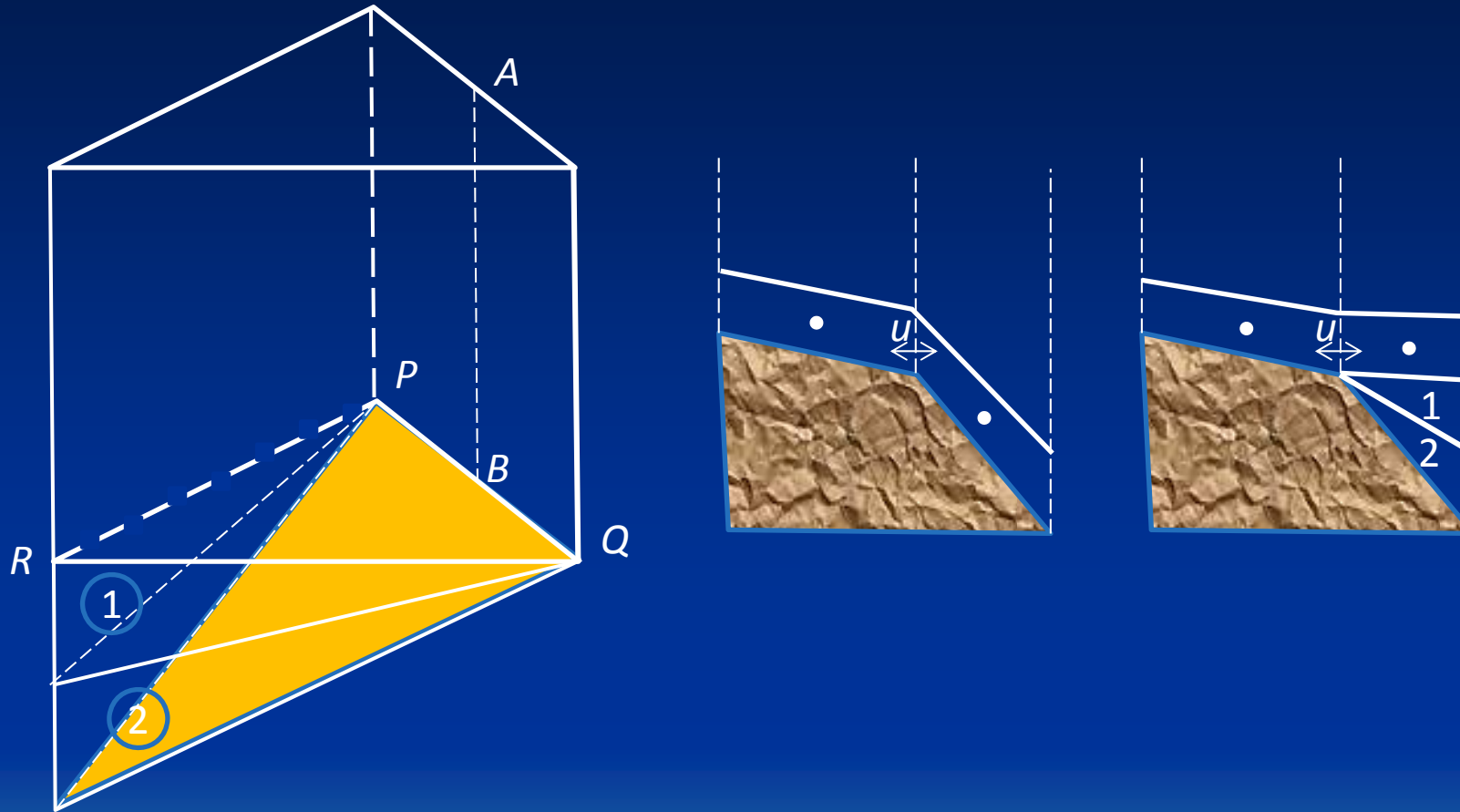
LSC (Fortunato and Baptista 1996)

SELFE

- ❖ Semi-implicit Galerkin Finite Element/Finite Volume with Eulerian-Lagrangian method for momentum advection
 - Can handle non-orthogonal unstructured grid (very skew elements)
- ❖ S or SZ for vertical grid – so far!
- ❖ Mass conservative transport
- ❖ Benchmarked inundation schemes (NTHMP 2011)
- ❖ Entire modeling system based on MPI parallelism
- ❖ Open source and driven by user community needs
 - http://ccrm.vims.edu/w/index.php/Main_Page
 - http://www.stccmop.org/knowledge_transfer/software/selfe



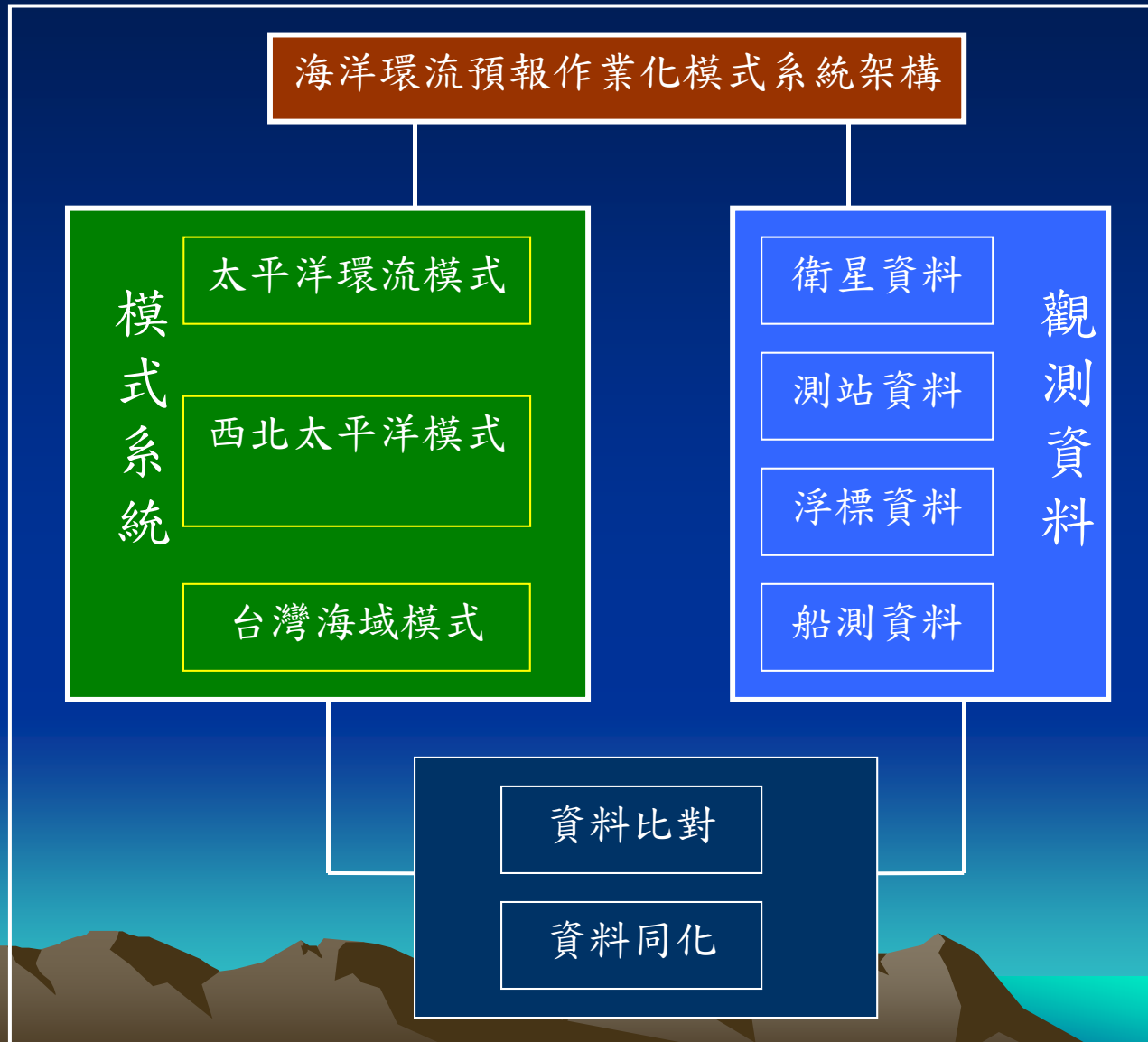
What to do with the staircases?



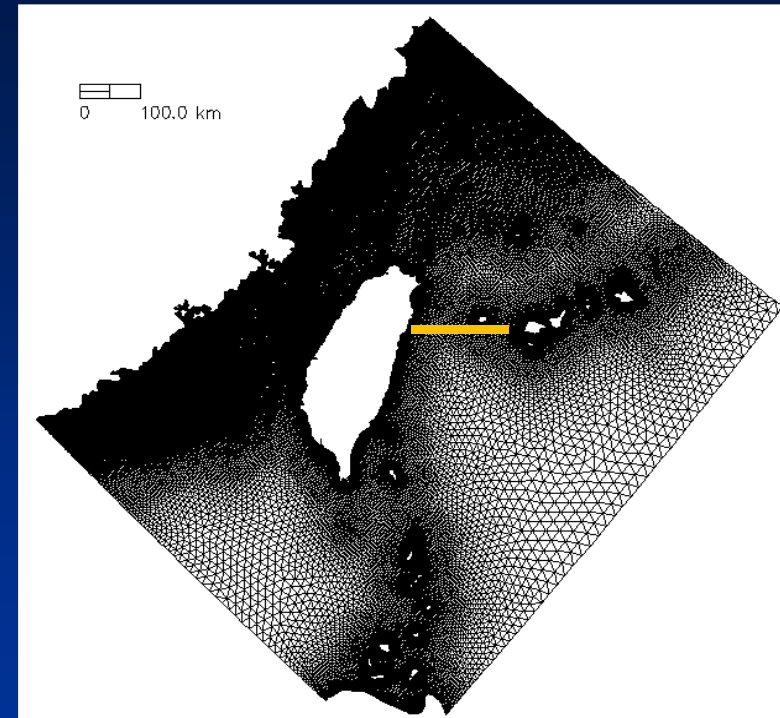
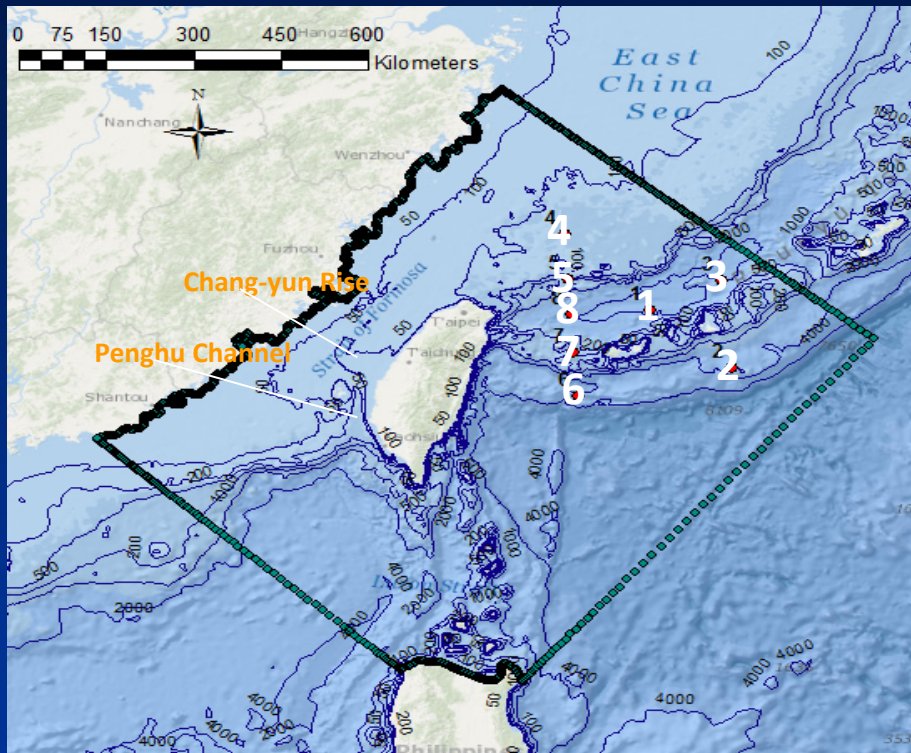
LSC²= Localized Sigma Coordinates with Shaved Cells

台灣海域海流模式系統架構

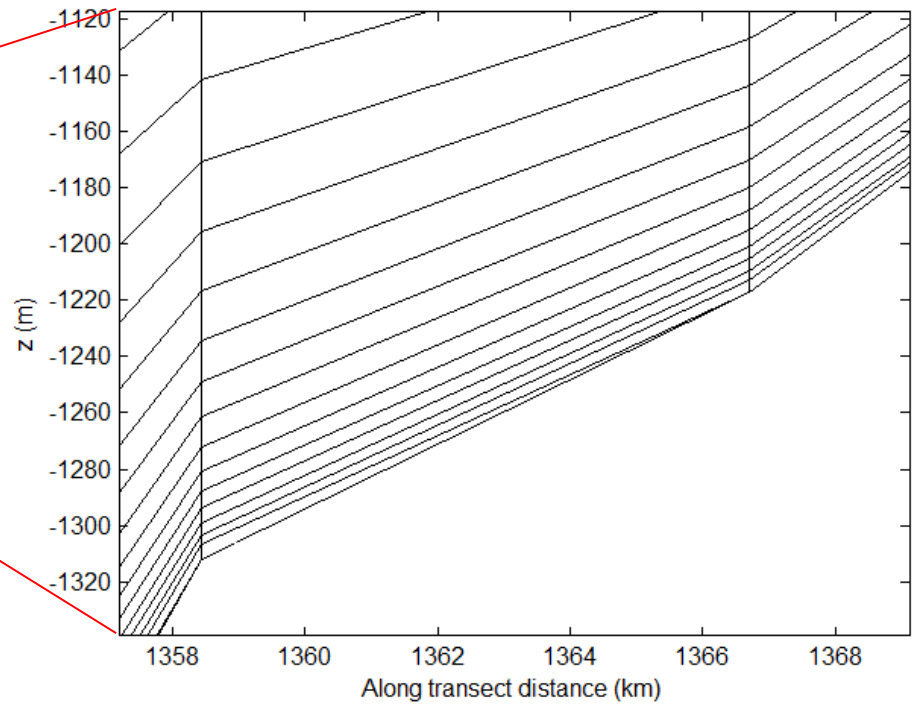
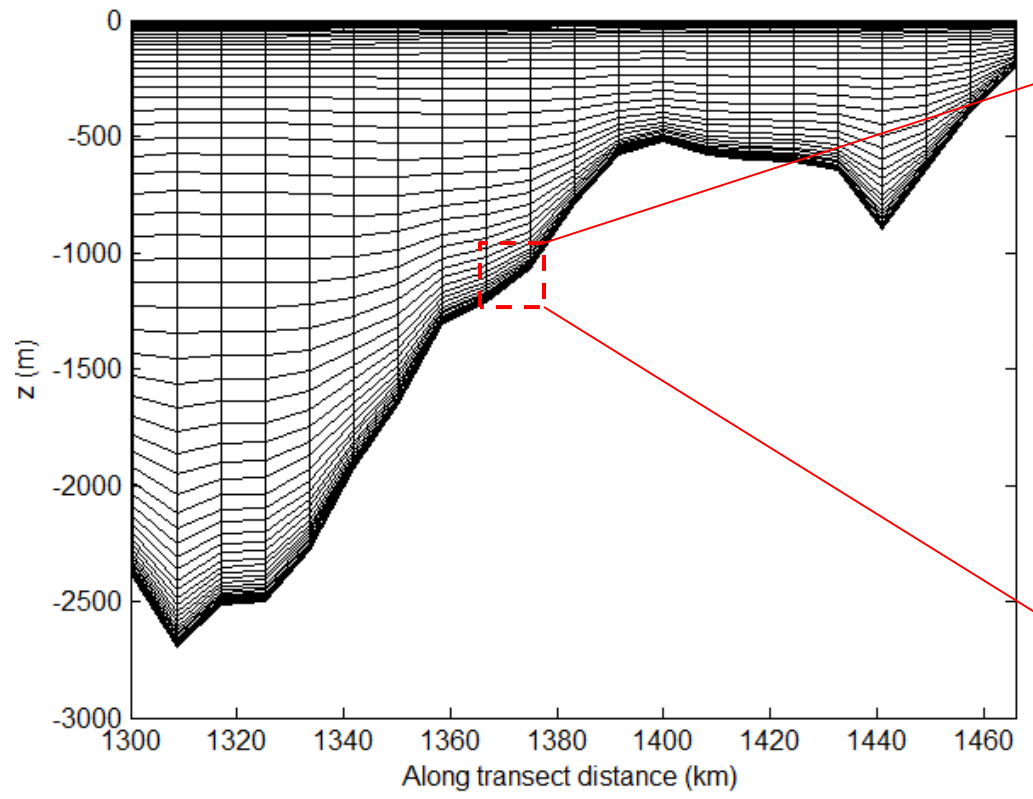
ROCFORS



OCM3 grid

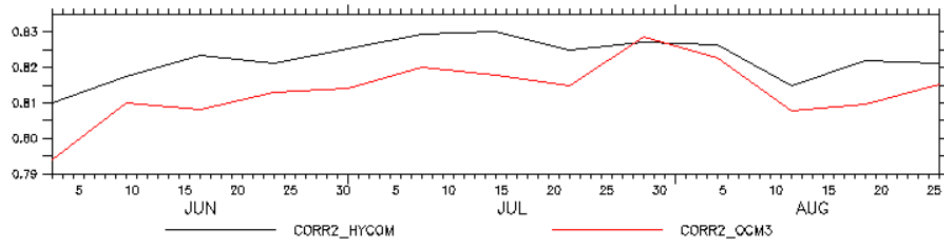
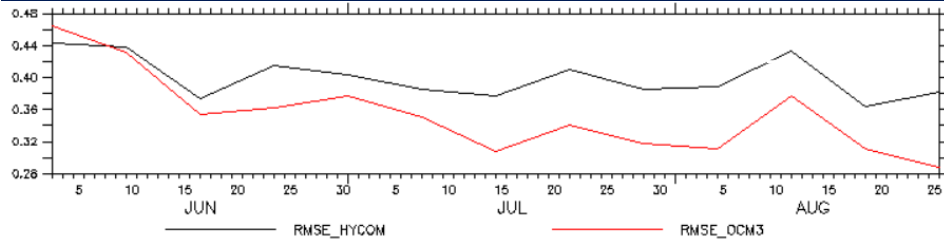


- 95K nodes, 185K elements with resolution from 22km to 60m (around the island)
- SZ grid: 26S + 8Z, $h_s=1\text{km}$
- LSC² grid: max=94 vertical levels; average=24 levels
- $\Delta t=150\text{s}$; k-kl; albedo=0.15; TVD transport
- No any DA technique
- i.c. & b.c. from HYCOM + CWB-WRF & CFSR
- With and without tides
- 216x faster than realtime on 104 CPUs (on VIMS-Clusters)
- 3 cases that cover spring, summer and winter (90 days each)

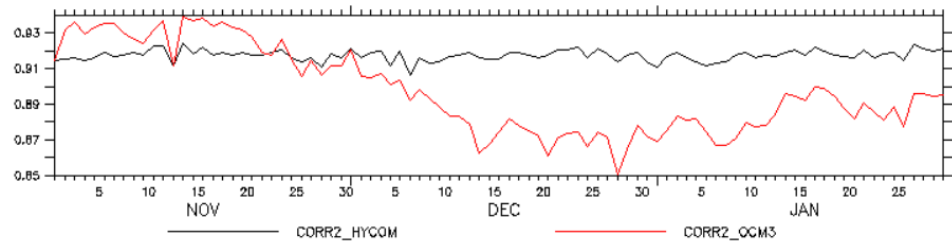
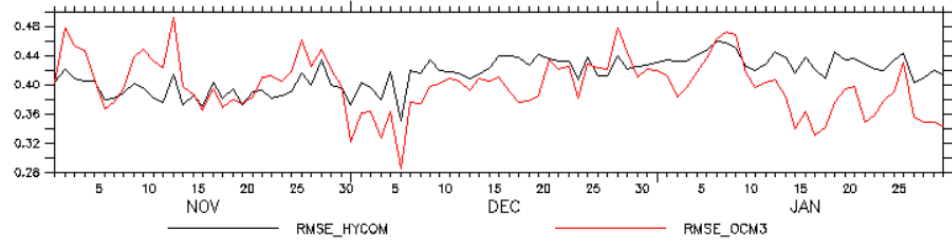


SSH skill (vs AVISO)

2009 (summer)

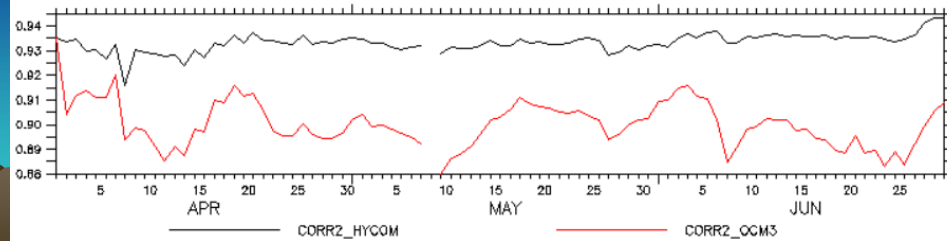
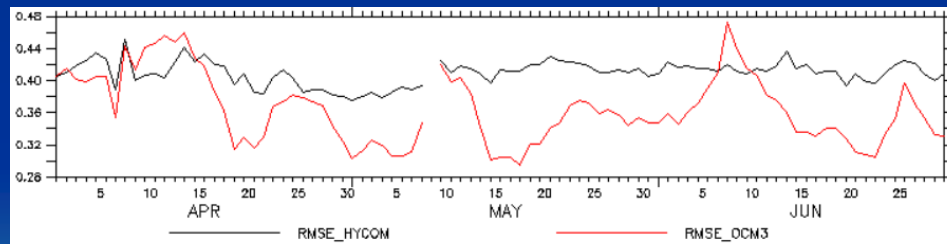


2012 (winter)

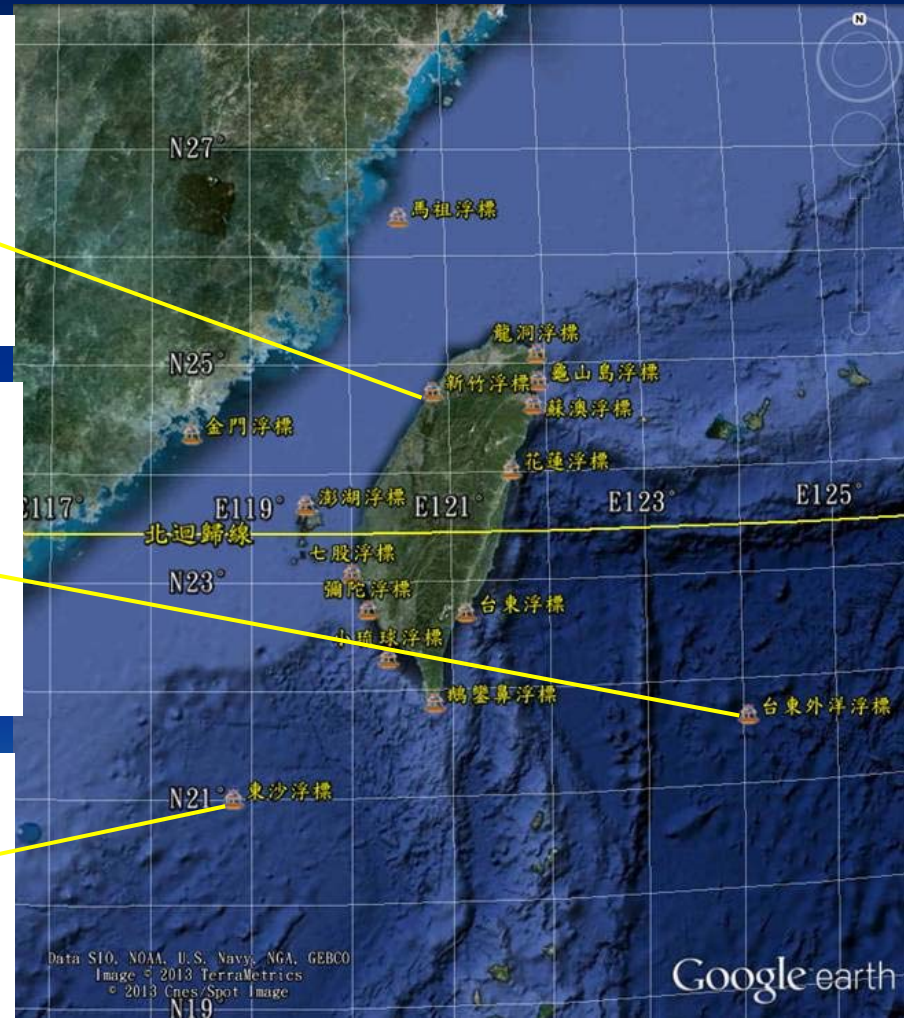
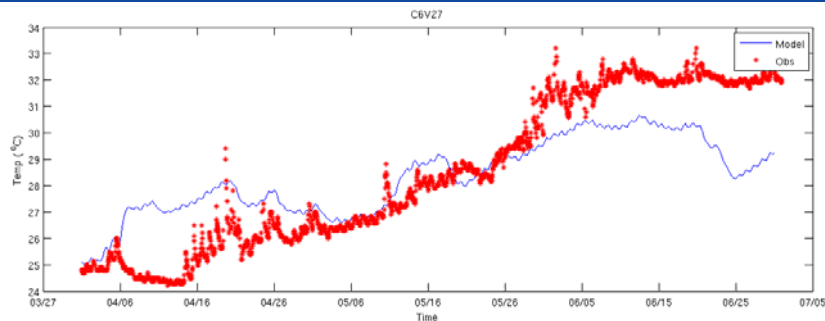
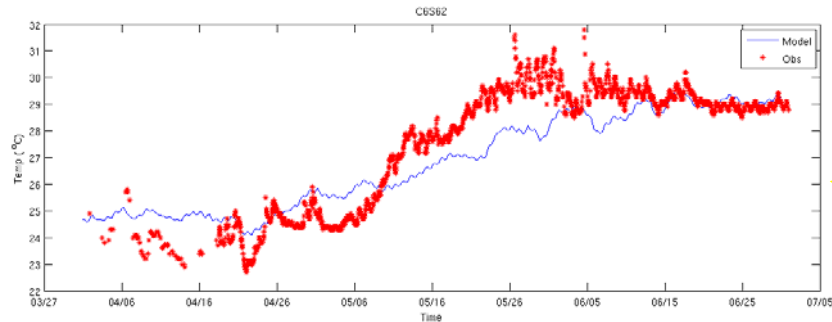
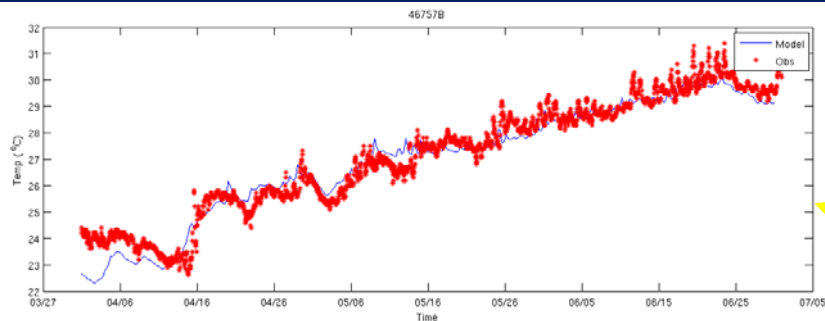


2013 (spring)

HYCOM
OCM3

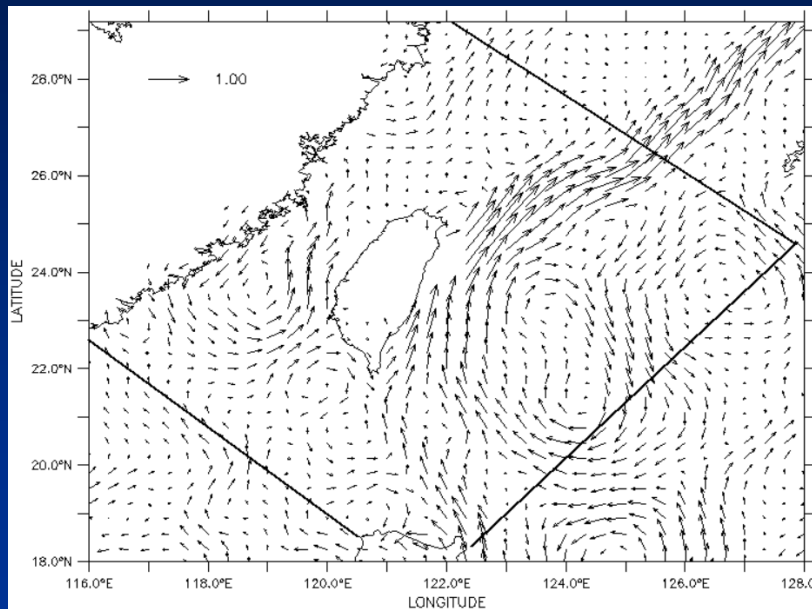


CWB Buoy (OCM3 vs data, 2013)

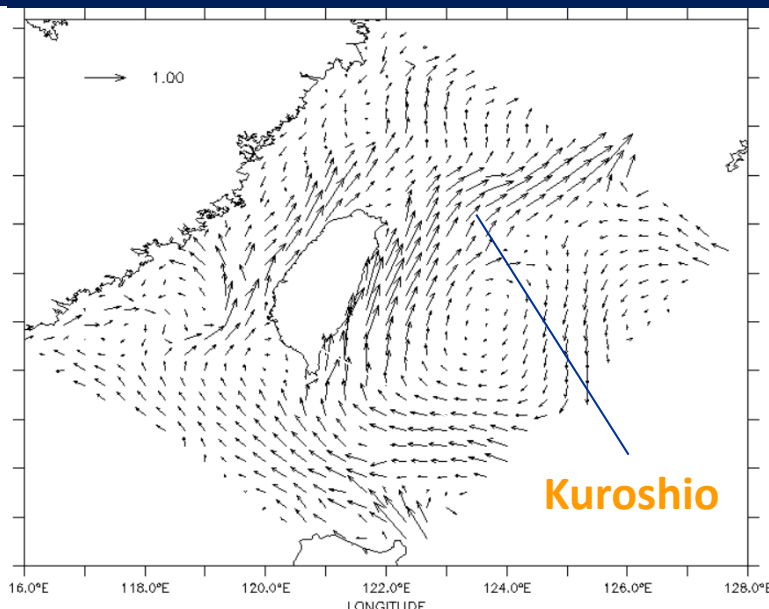


SSC, 00:00 GMT Aug. 26, 2009

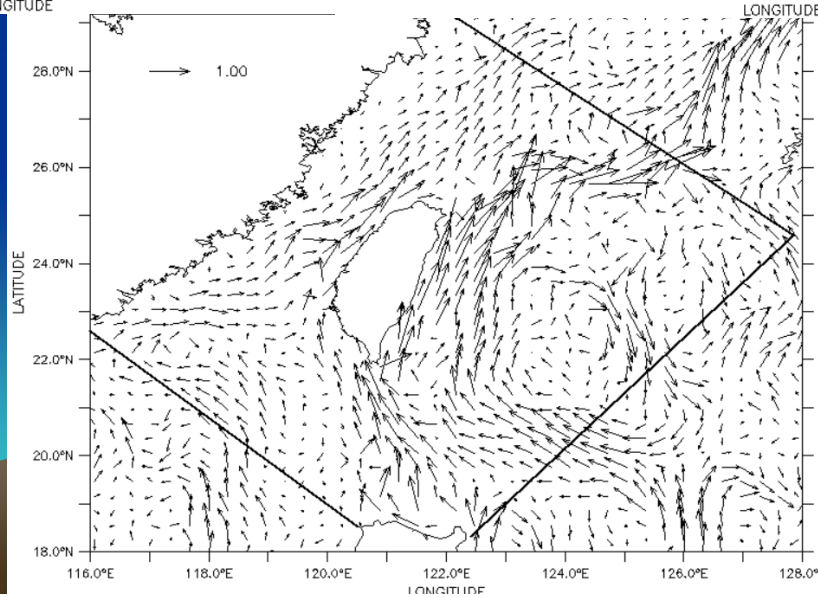
AVISO



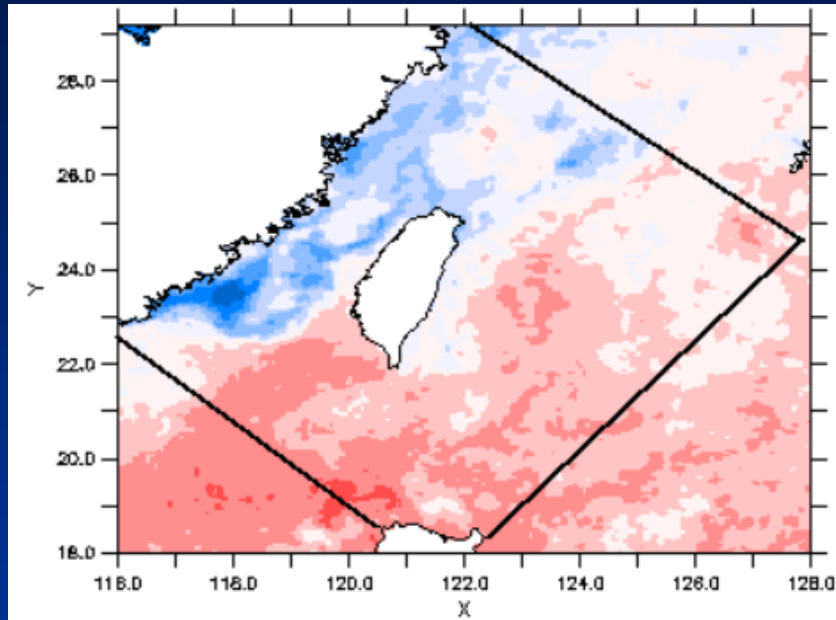
OCM3



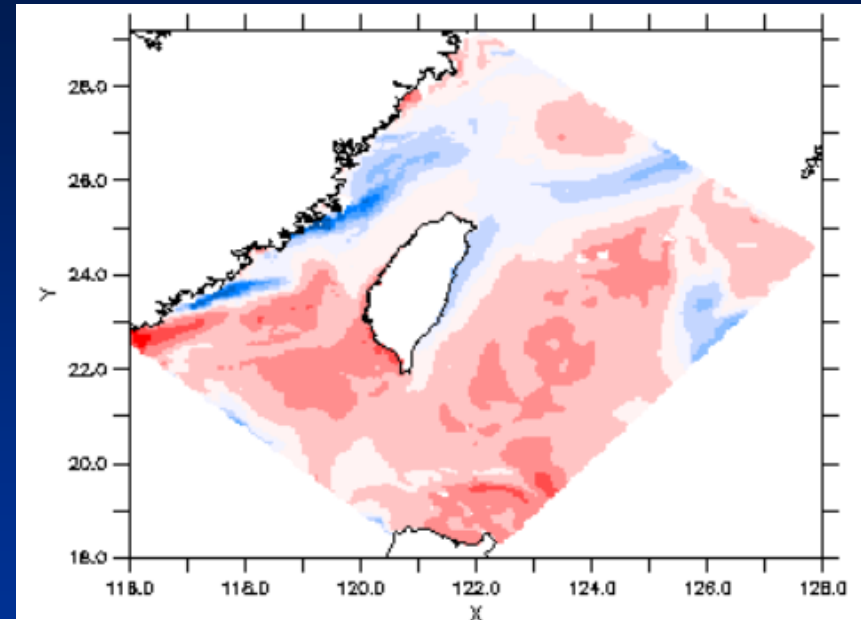
HYCOM



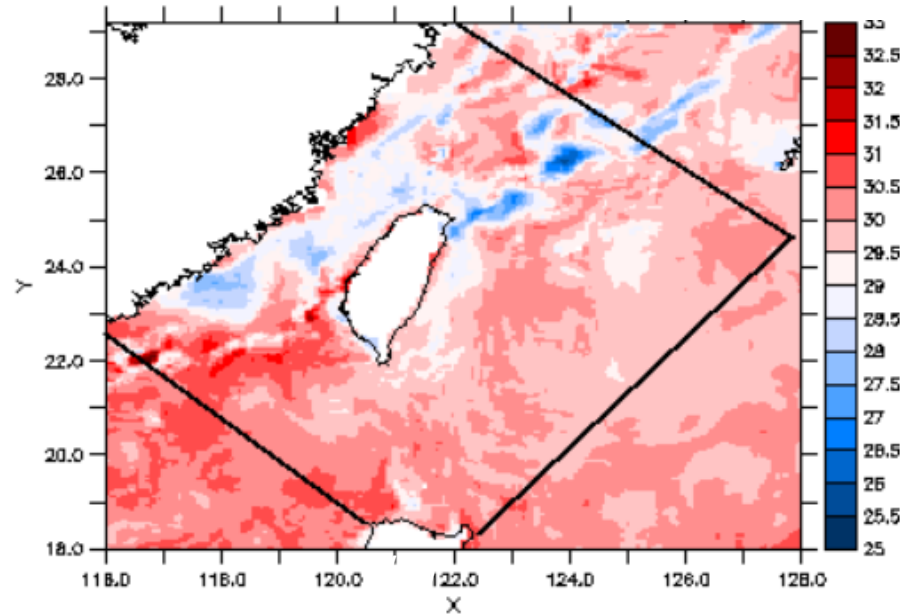
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GHRST

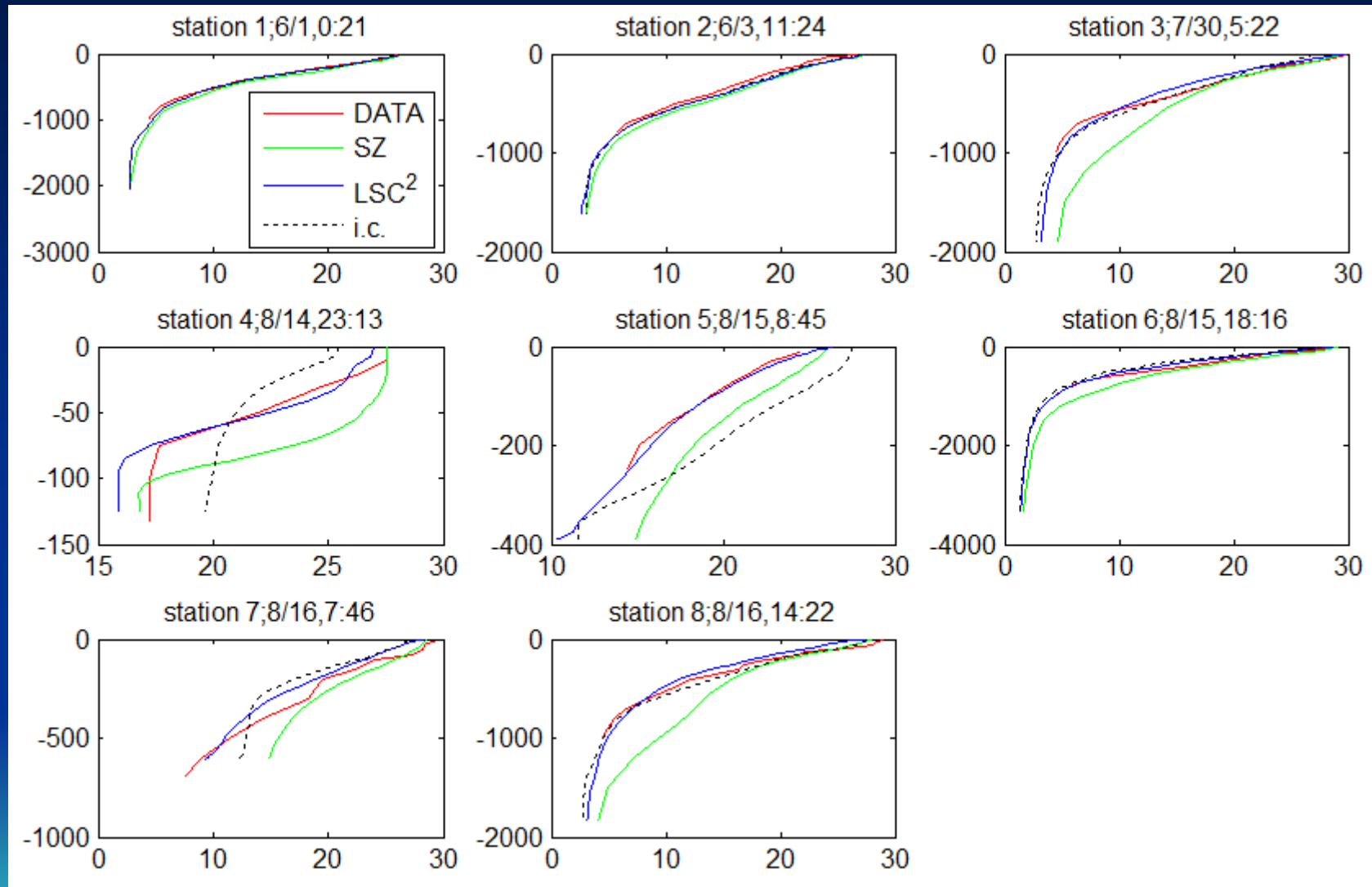


HYCOM



OCM3

CTD casts (From WOD)



z (m)

T (°C)

SZ: 1.49 °C

LSC²: 0.7 °C

Conclusions

- ❖ SELFE has been applied to marginal seas around Taiwan
 - ❖ Major features (currents and eddies) are reproduced
 - ❖ Qualitative match with satellite images
 - ❖ Higher resolution is possible in the future
- ❖ New LSC² grid
 - ❖ Reduce PGE
 - ❖ Same efficiency as SZ grid
 - ❖ Better resolve vertical structure of temperature
- ❖ Future works
 - ❖ Combine OCM2 & OCM3 to include all Kuroshio
 - ❖ Optimization of the 3D grid
 - ❖ Ensure smooth transition horizontally
 - ❖ Minimize computational cost
 - ❖ Deal with under-resolved regions



Thanks for your attention

