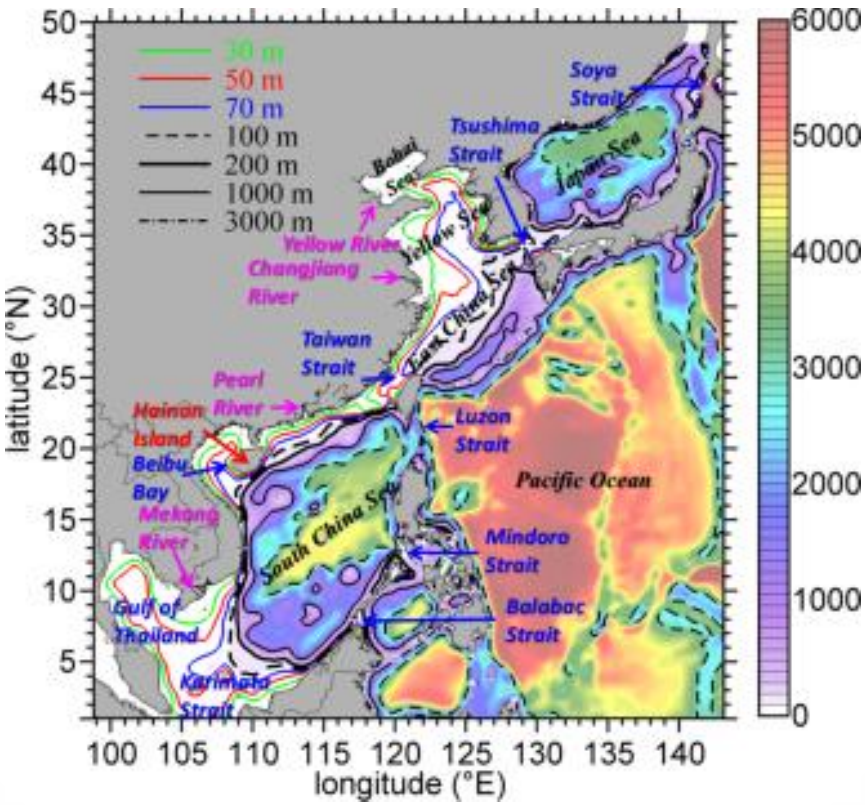
國立臺灣大學 海洋研究所
Institute of Oceanography, National Taiwan University

CODA Lab

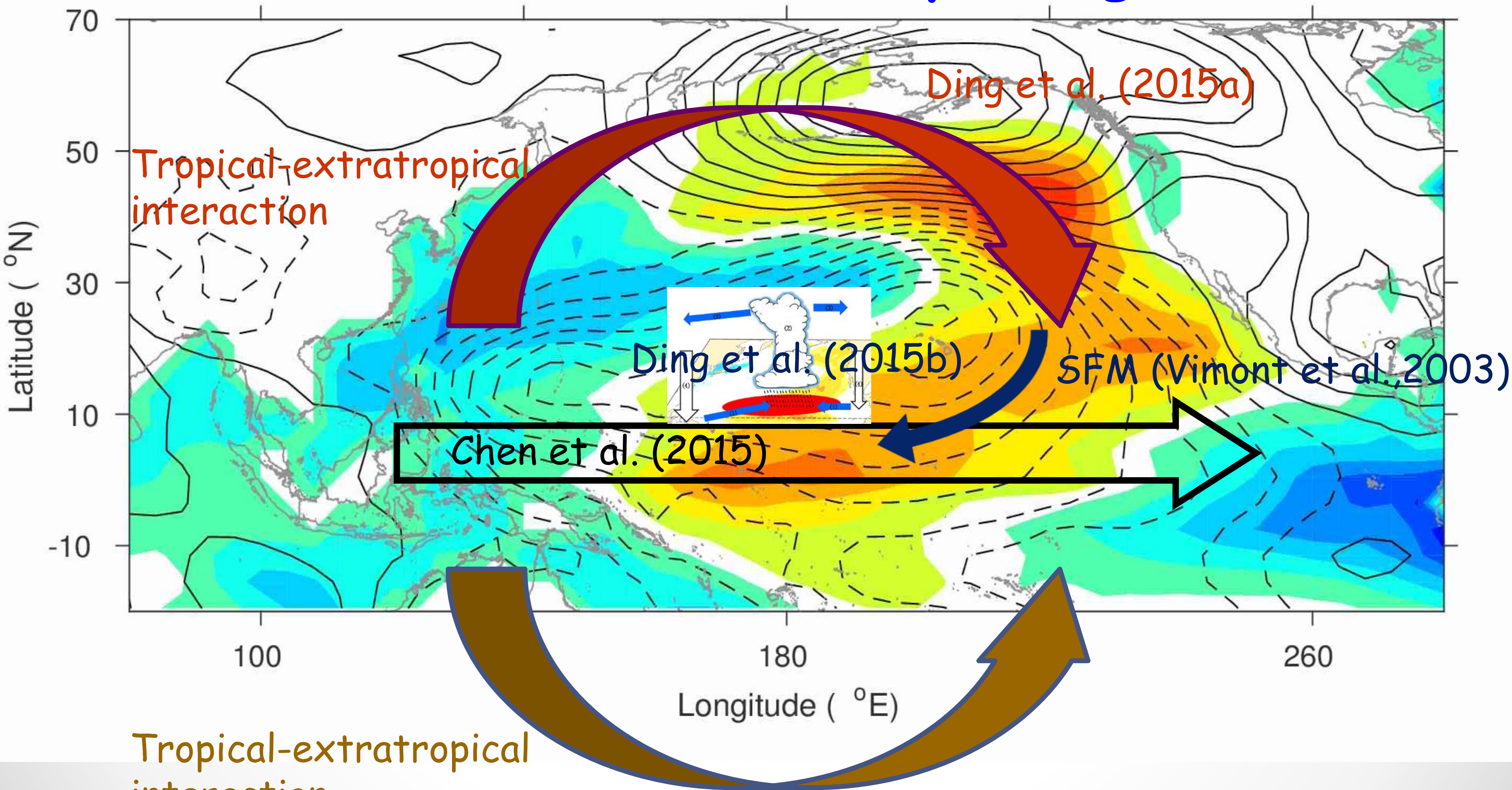
Ocean-atmospheric interaction in the South China Sea



Yu-heng Tseng and Yi-chun Kuo
Institute of Oceanography,
National Taiwan University

- Distinct ocean-atmospheric interaction between northern and southern SCS
- Impacts of river discharge parameterization in the global coupled model system
- Operational nowcast/forecast system in the Western Pacific

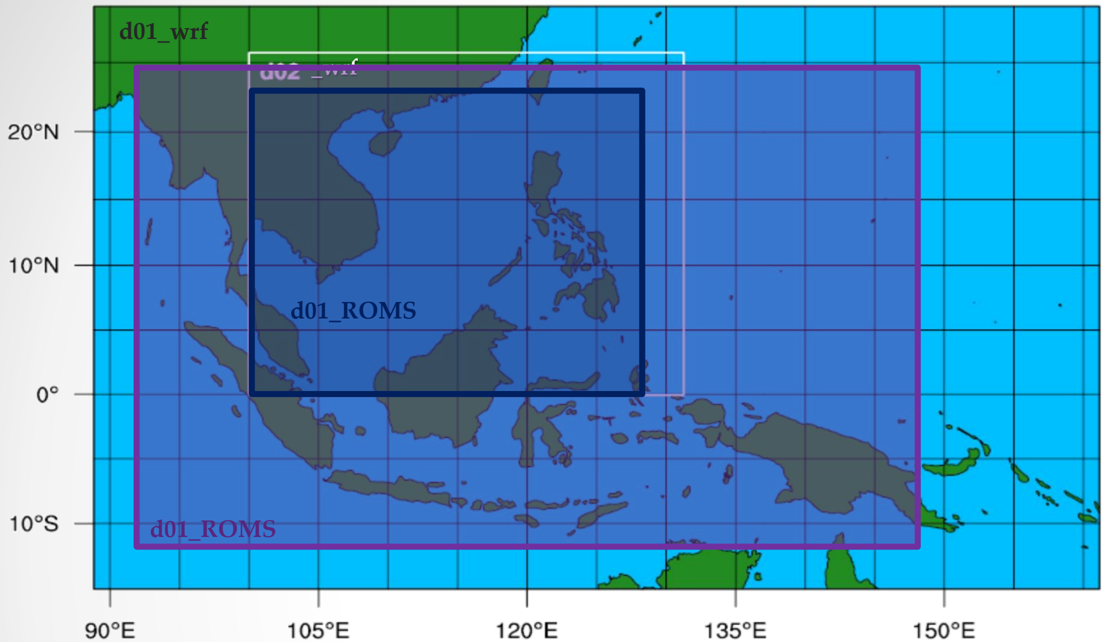
New North Pacific climate paradigm

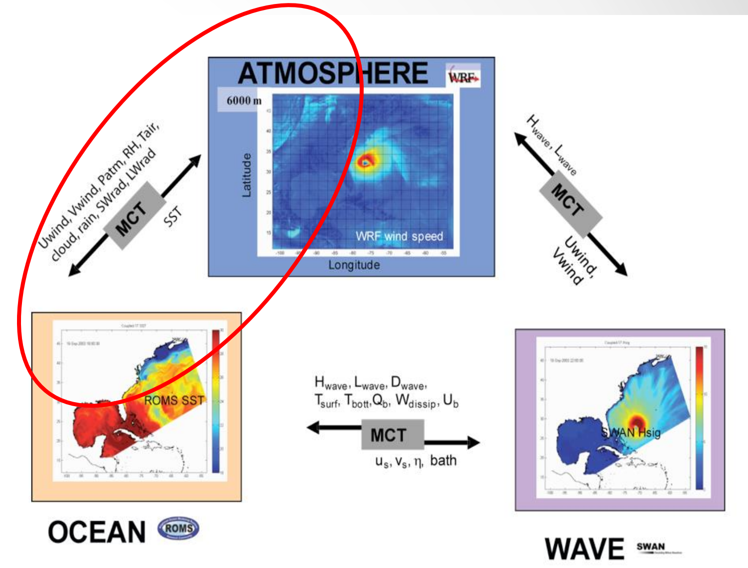


Tropical-extratropical interaction

Ding et al. (2015c); Ding et al. (2016), Zhang et al. (2014a,b)

Distinct ocean-atmospheric interaction between northern and southern SCS





Model ran for 1 year (2016)

Weather Research and Forecasting Model (WRF)
Horizontal Resolution: Domain 1 =36km, Domain 2 =12km
Vertical : 36 levels
Data:
1. Geography: http://www2.mmm.ucar.edu/wrf/src/wps_files/geog_complete.tar.bz2
2. Initial and boundary : NCEP FNL Operational Model Global Tropospheric Analyses, continuing from July 1999 (ds083.2)

Regional Ocean Modeling System (ROMS)
Horizontal Resolution:
Domain 1 : 26~27 km
Domain 2 : 8~9 km
Vertical : 36 levels
Data:
1. geography : ETOPO2
2. Initial and boundary : HYCOM

Atm. dominates SST variation

$\partial SST/\partial t$ = heat flux + other source(adv)

time lag

SST

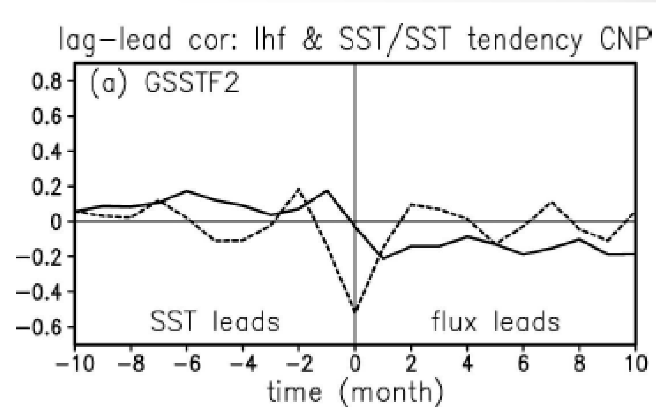
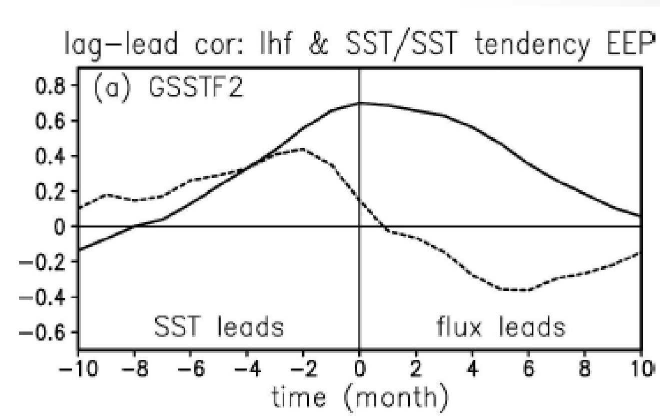


FIG. 9. Lag–lead correlation of latent heat flux–SST (solid curves) and latent heat flux–SST tendency (dashed curves) calculated based on area means in the central North Pacific region

SST dominates heat flux change

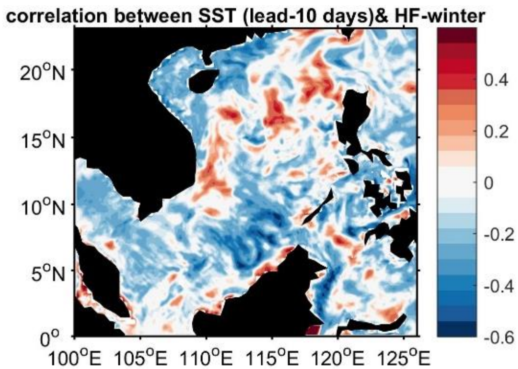
$\partial SST/\partial t$ = heat flux + other source(adv)

heat flux =f(SST)

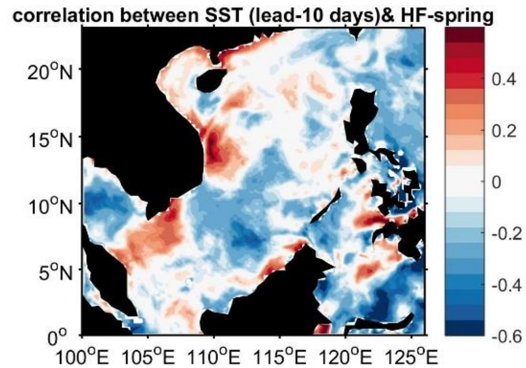


Correlation _ SST lead

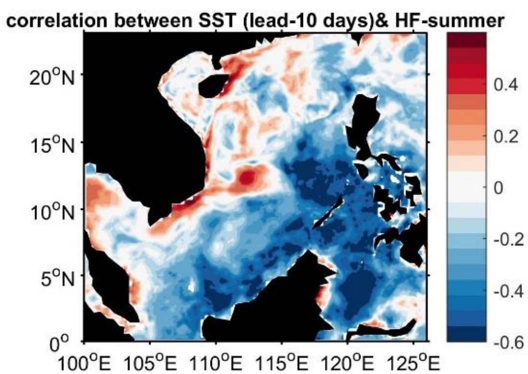
winter



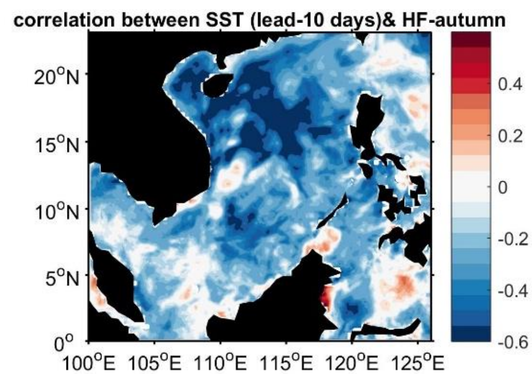
spring



summer

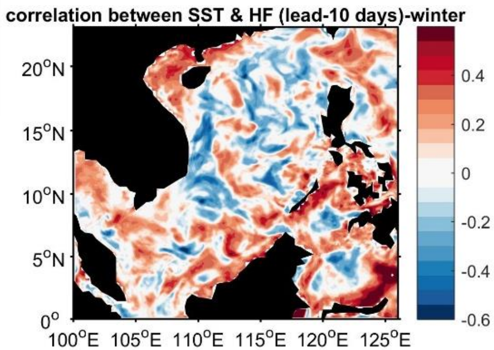


autumn

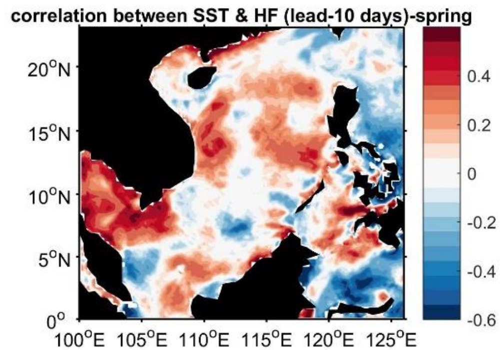


Correlation _total heat flux lead

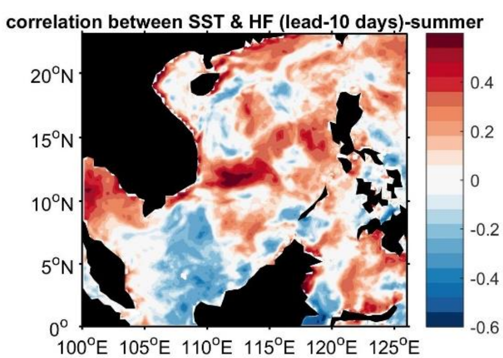
winter



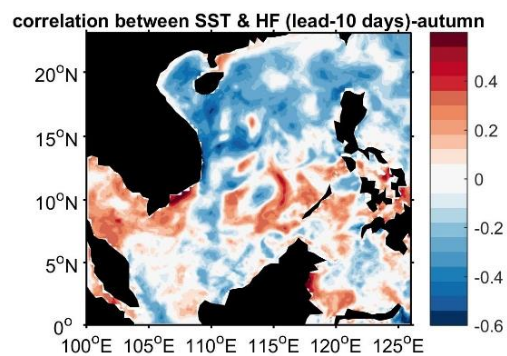
spring

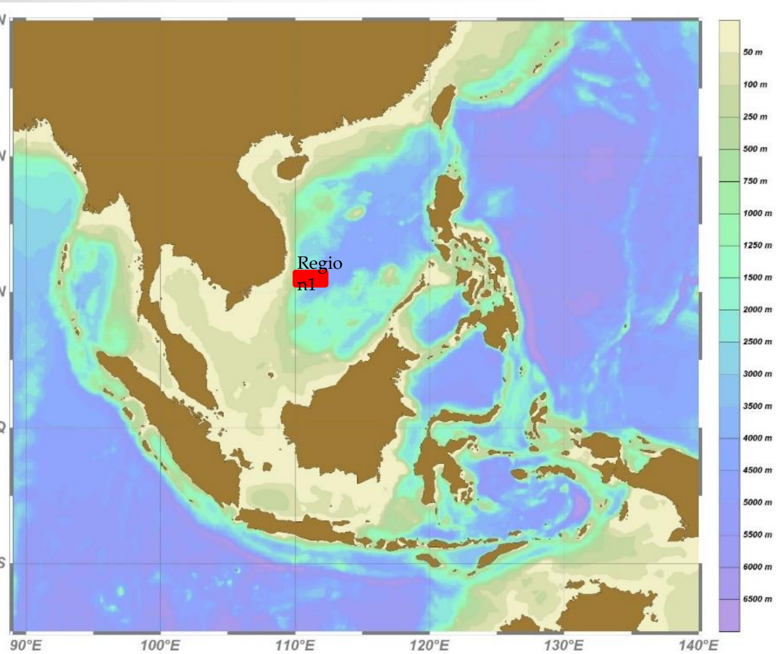


summer



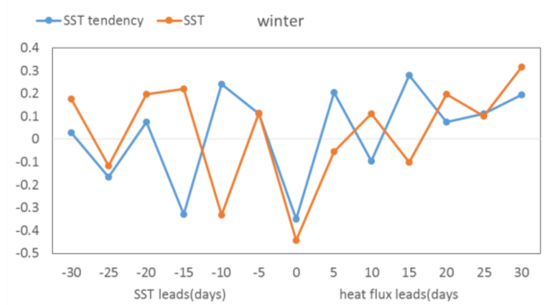
autumn



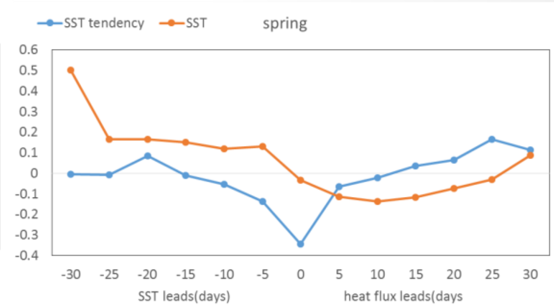


Region 1 (off southeast Vietnam)

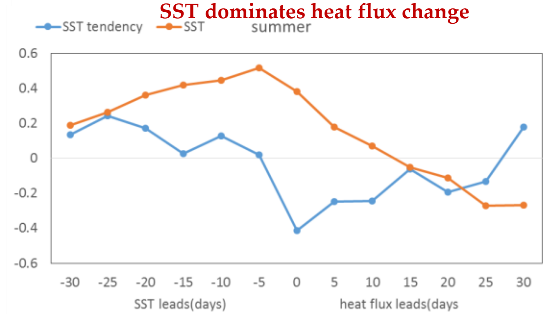
lat_r1s=10; lat_r1n=12; lon_r1w=110; lon_r1e=113;

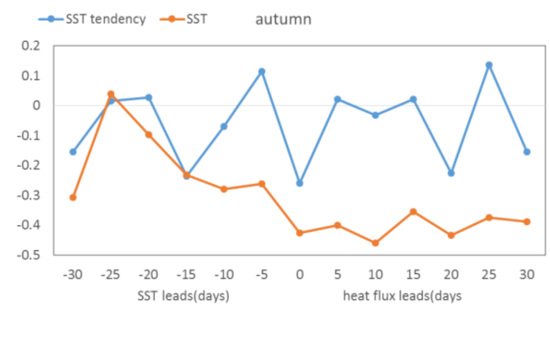


Atm. dominates SST variation



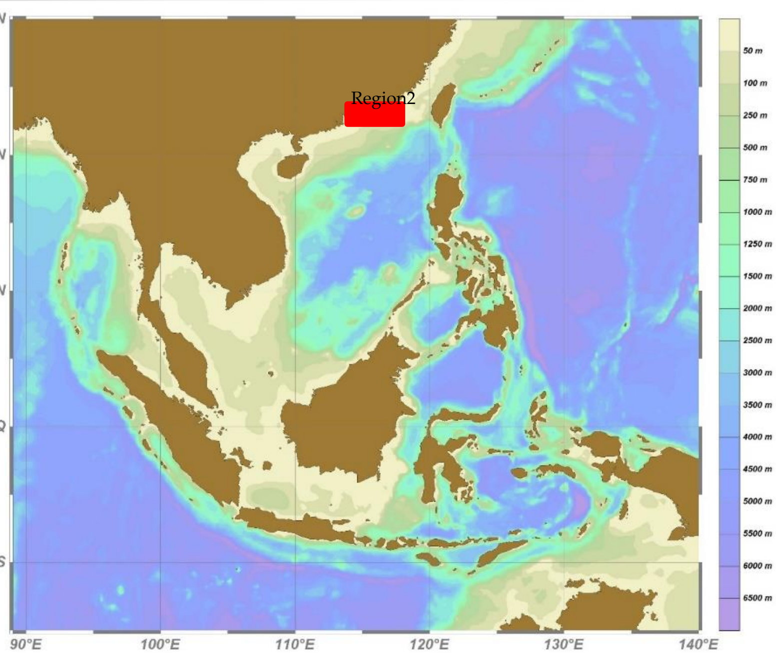
SST dominates heat flux change





Region 2 (off southeastern China coast)

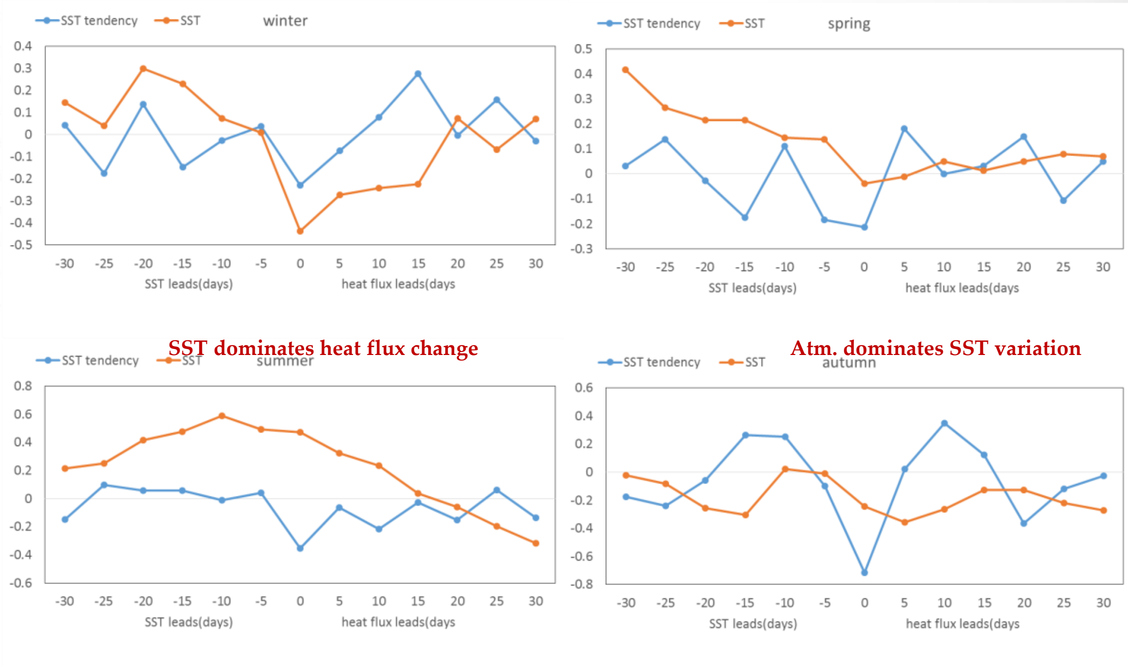
lat_r2s=22; lat_r2n=23; lon_r2w=113; lon_r2e=117;

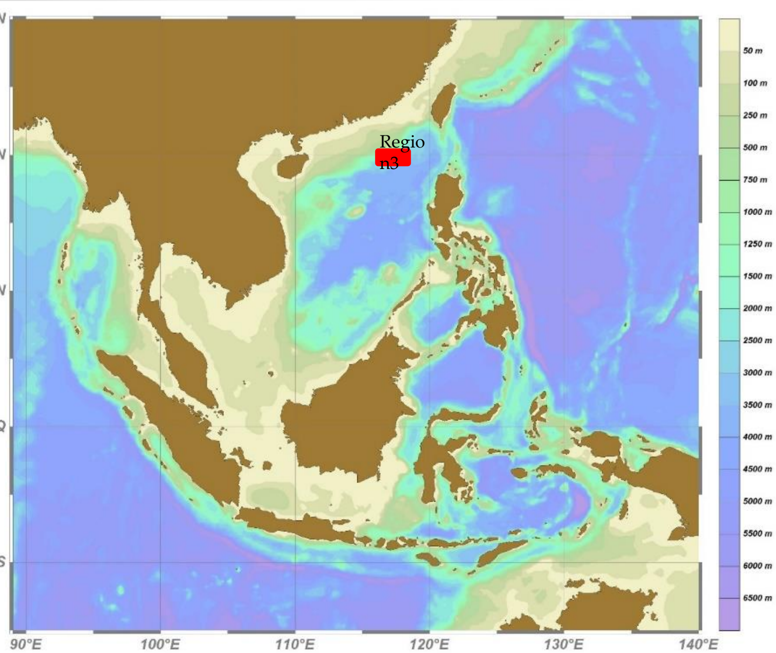


Atm. dominates SST variation (winter)

SST dominates heat flux change (summer)

Atm. dominates SST variation (autumn)

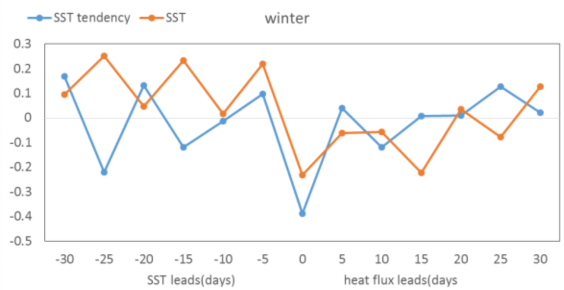


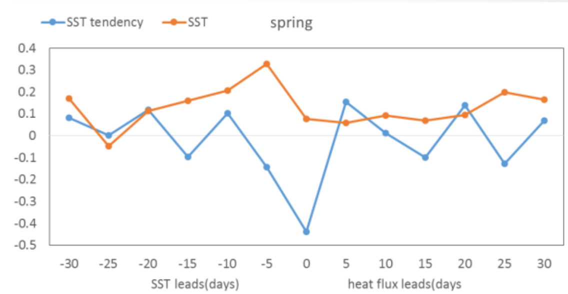


Region 3 (northern SCS)

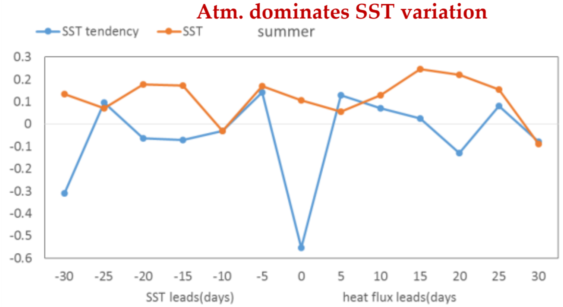
```
lat_r3s=18; lat_r1n=20; lon_r3w=115; lon_r3e=117;
```

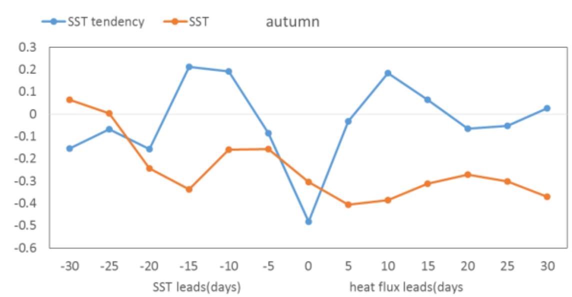
Atm. dominates SST variation





Atm. dominates SST variation





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Interactions of river discharge parameterizations with the Madden-Julian oscillation in the CESM

Charlotte A. DeMott[1]
Yu-heng Tseng[2]
Frank Bryan[2]

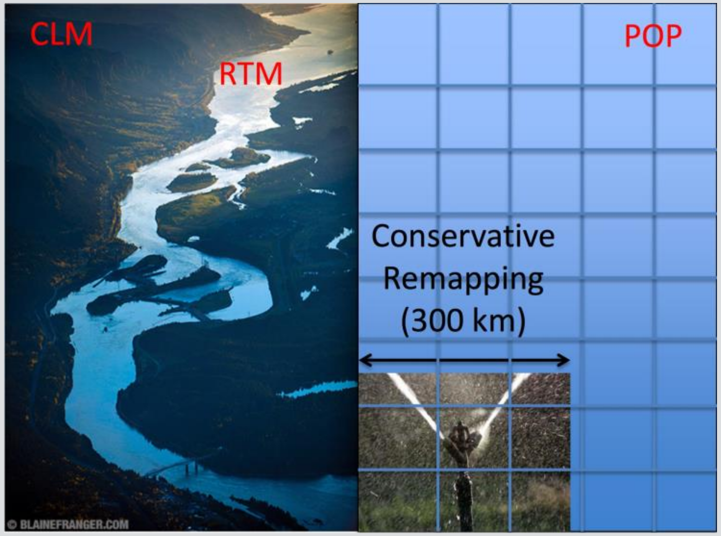
[1]Colorado State University, Fort Collins CO USA
[2]National Center for Atmospheric Research, Boulder CO USA

NSF

American Geophysical Union Fall Meeting, 2016 San Francisco CA

River discharge in CESM

<u>virtual salt flux</u>



- river discharge is spread uniformly over ocean surface (**300 km x 300 km** area adjacent to river delta).
- no vertical mixing.

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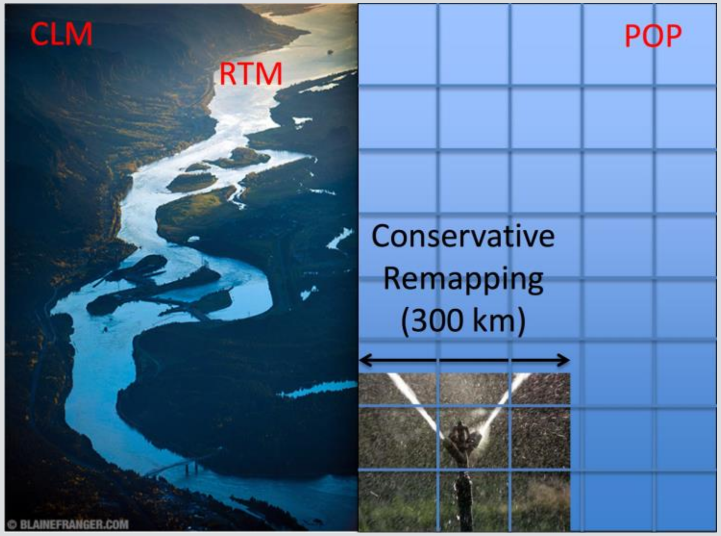
River discharge in CESM

virtual salt flux



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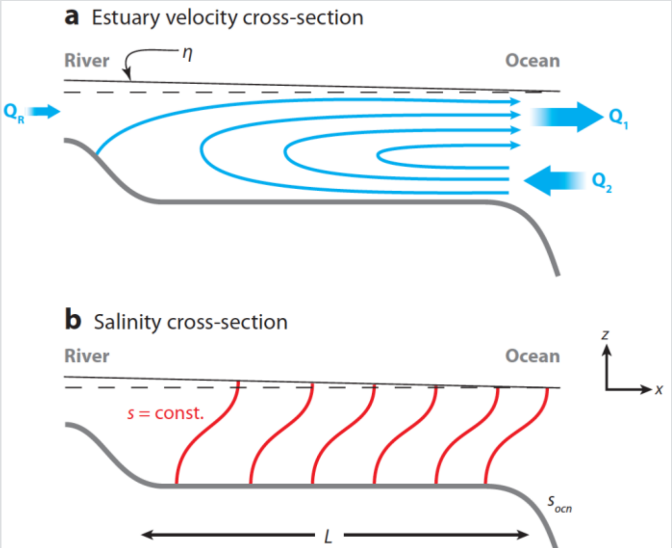
estuary box model

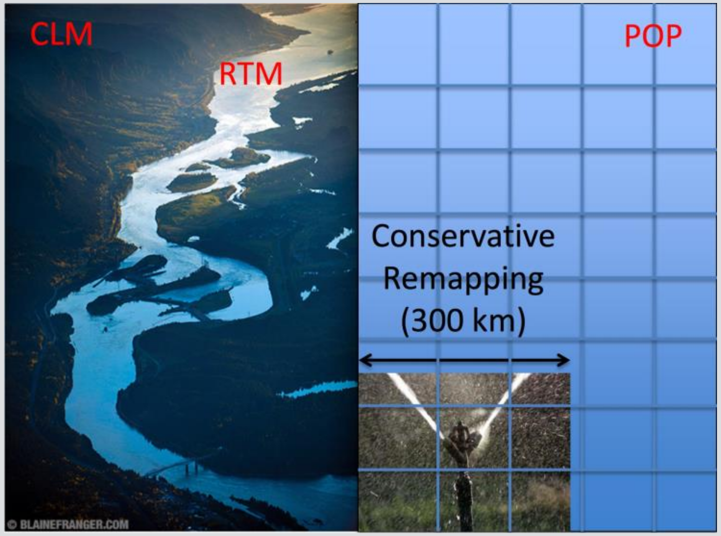


adapted from: MacCready and Guyer (2010)

- river discharge is mixed with adjacent ocean water at river delta grid point.
- delta-specific geometry for 20 largest deltas (~65% global drainage); generic geometry for other deltas.

River discharge in CESM

virtual salt flux



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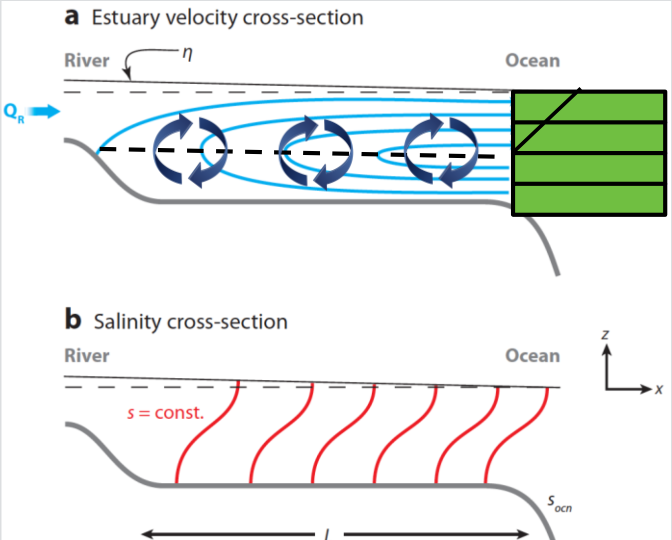

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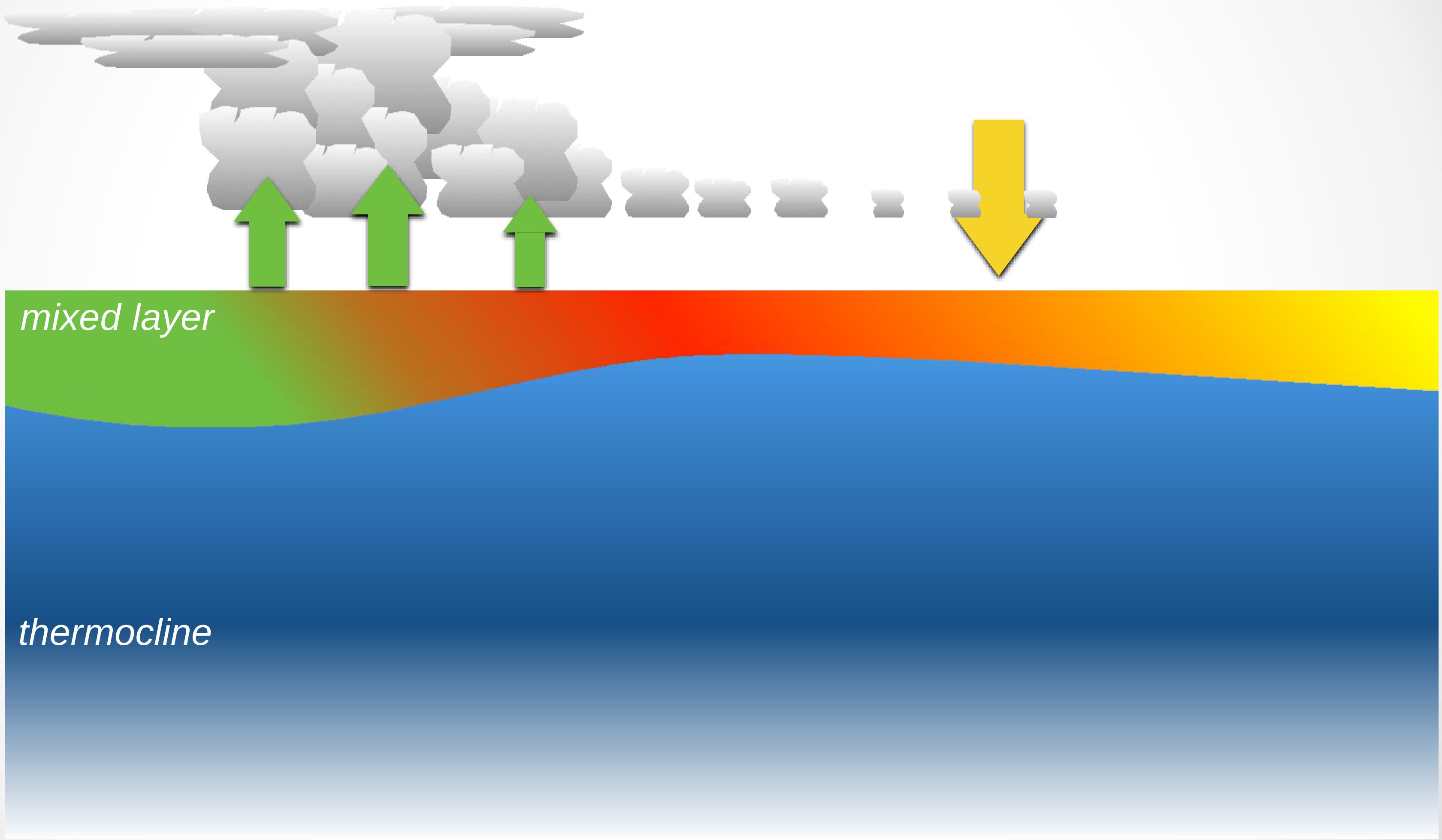
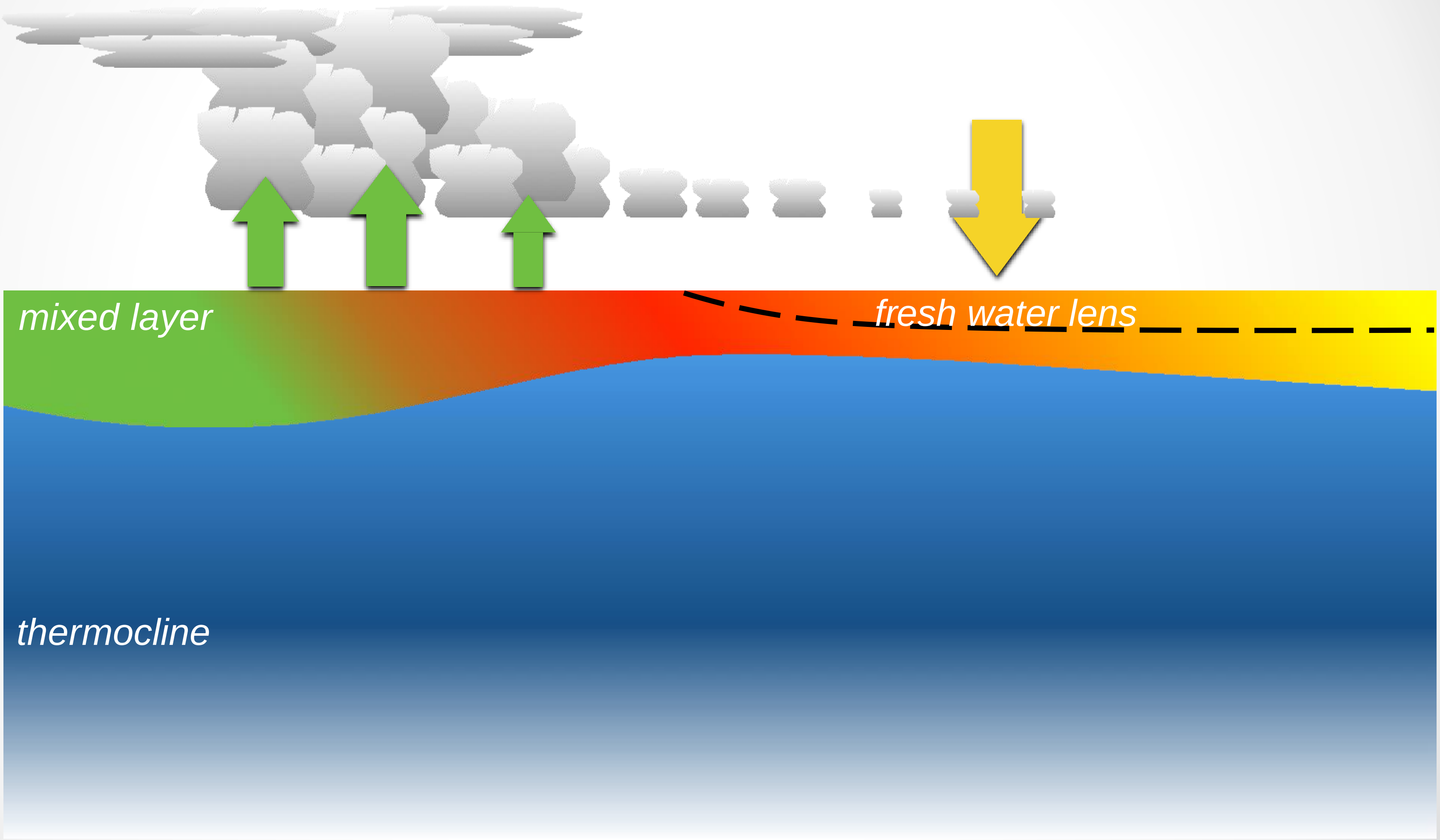
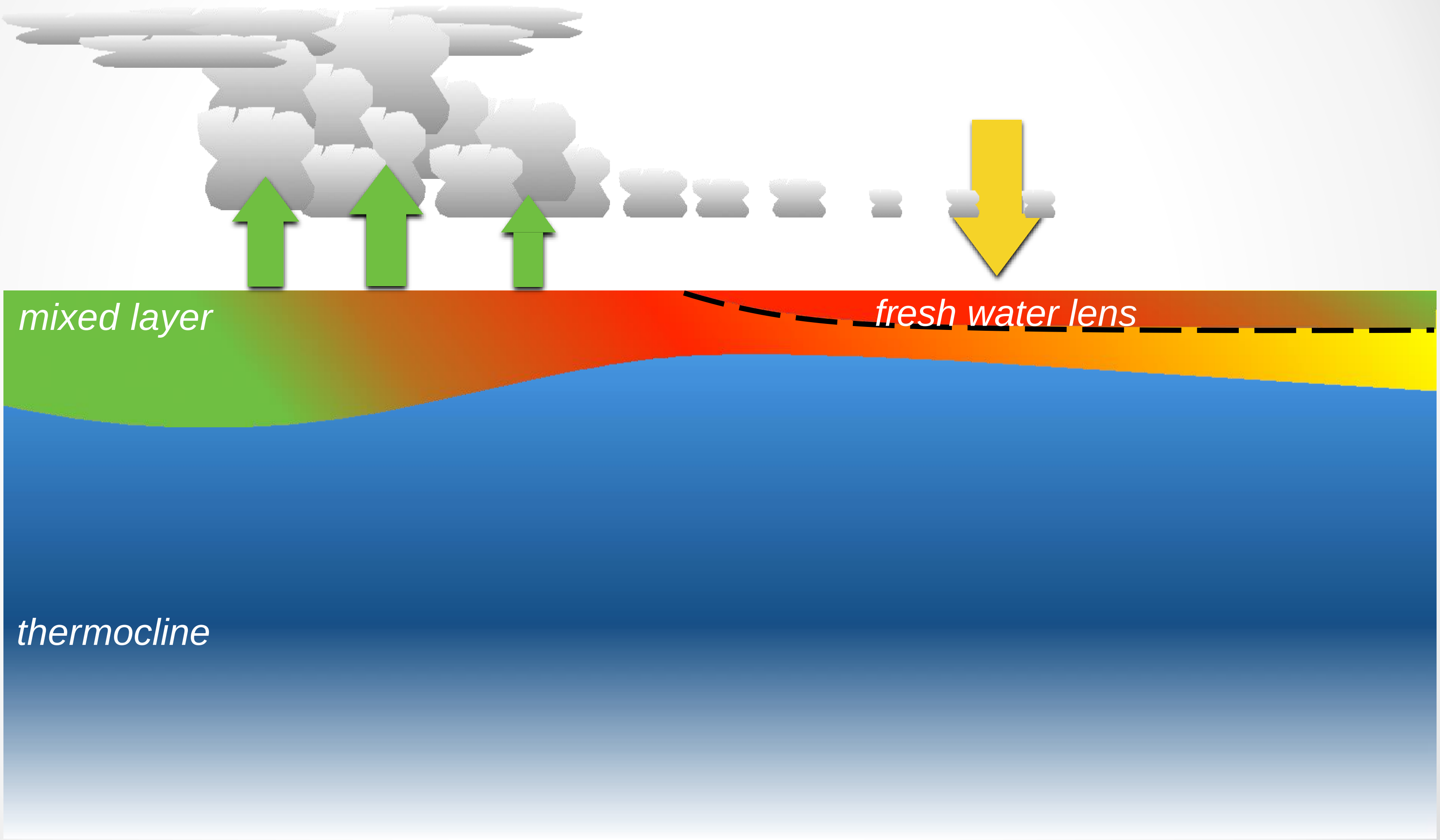
salinity-MJO interactions



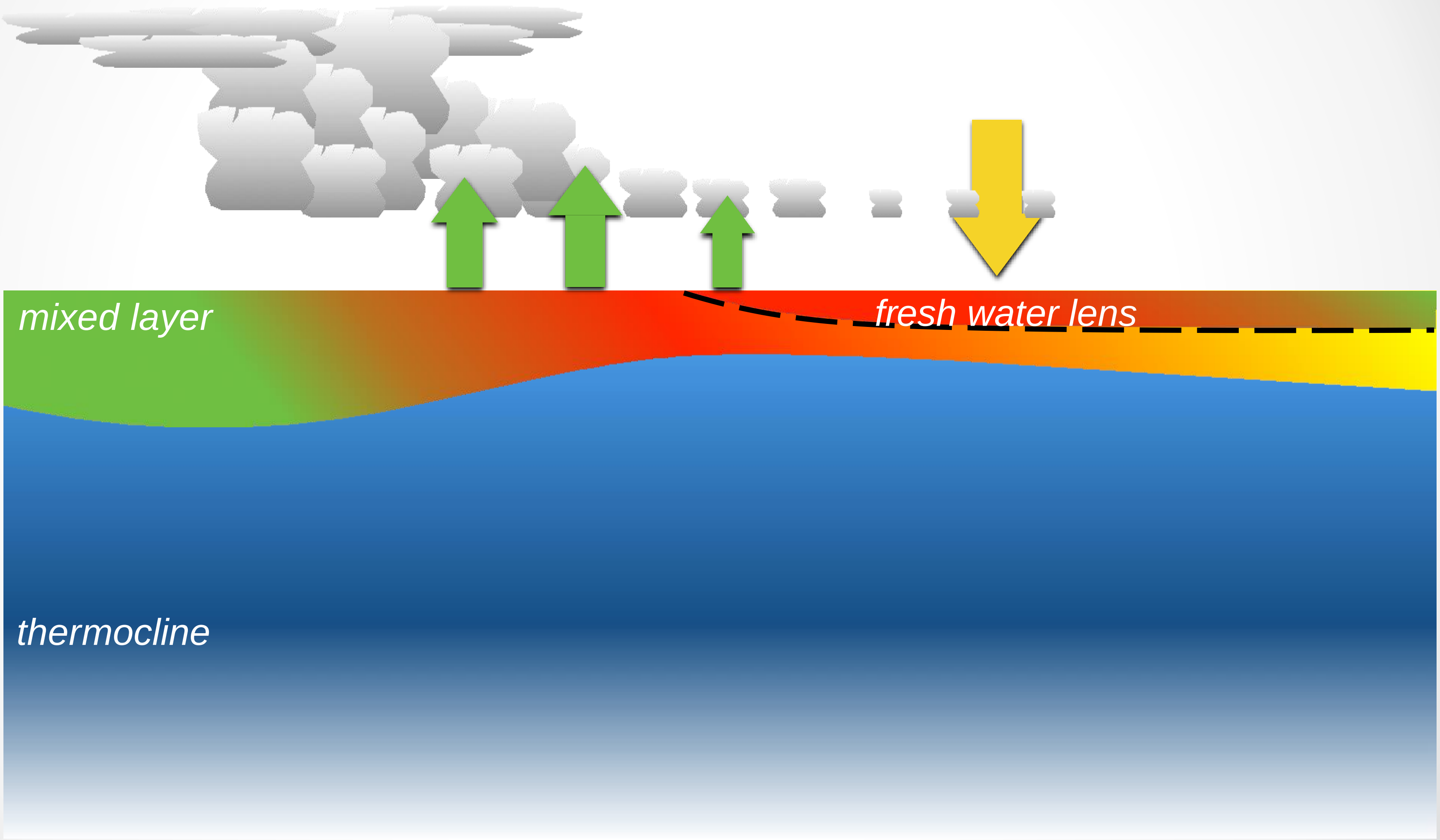
salinity-MJO interactions



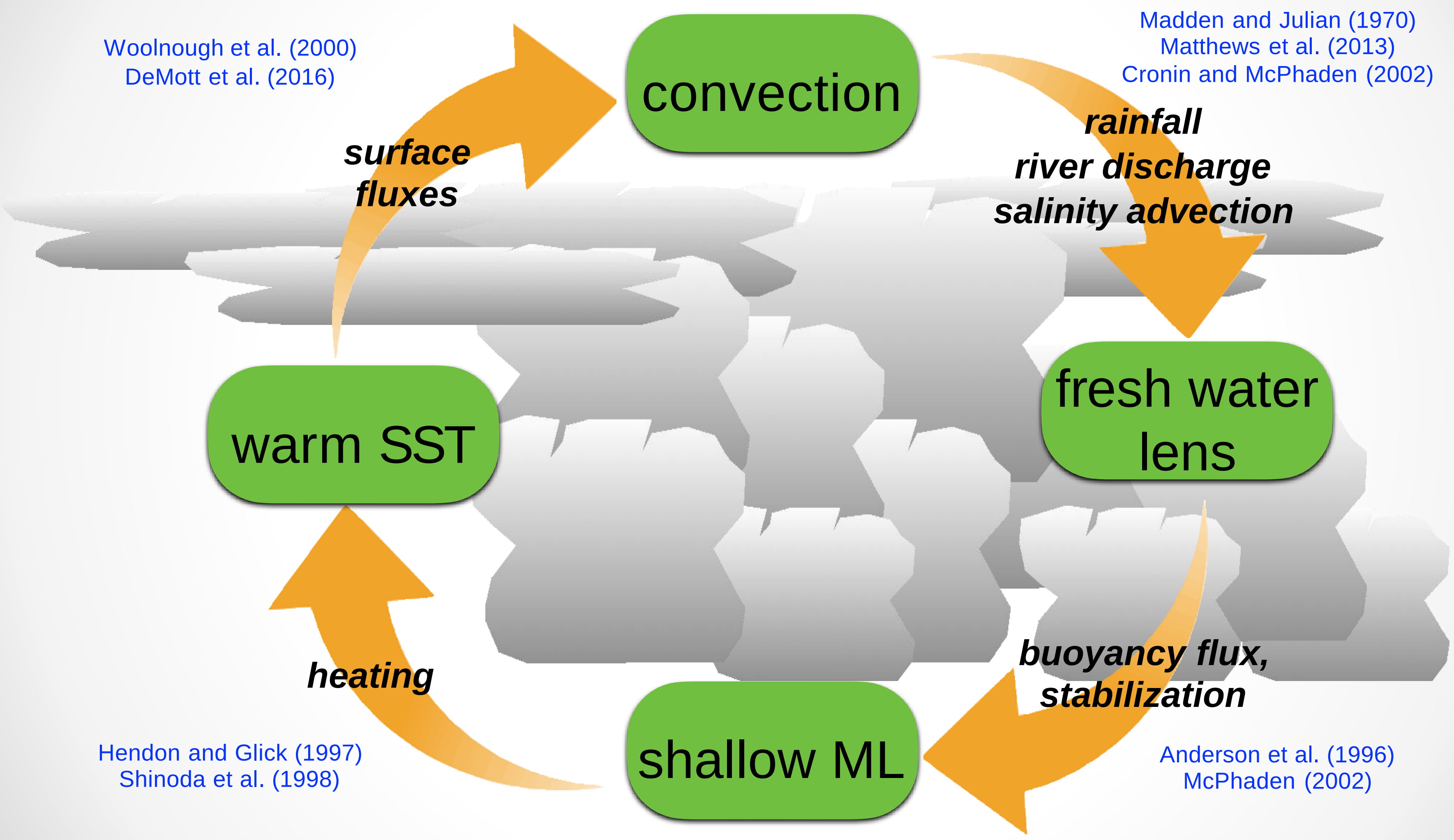
salinity-MJO interactions



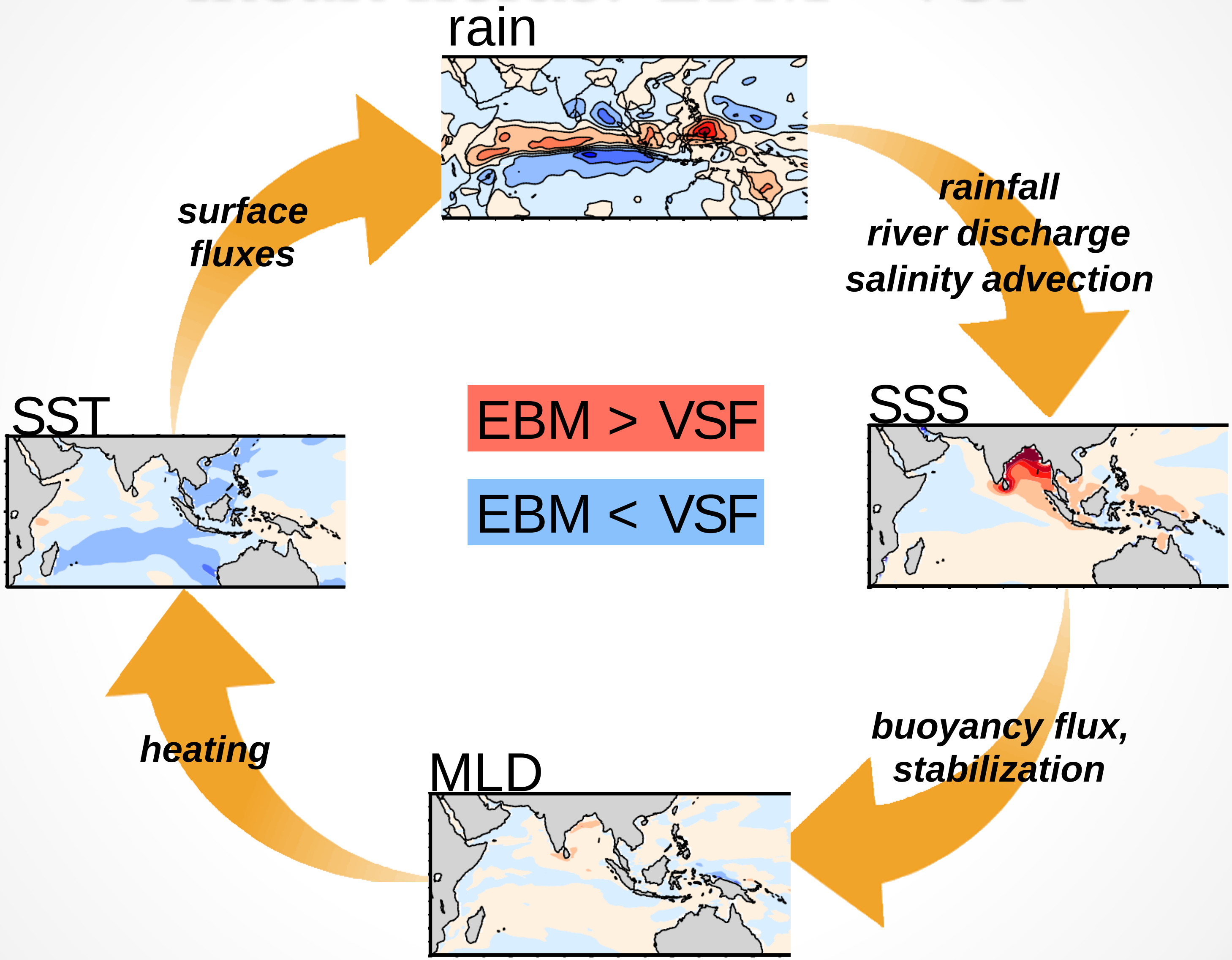
salinity-MJO interactions



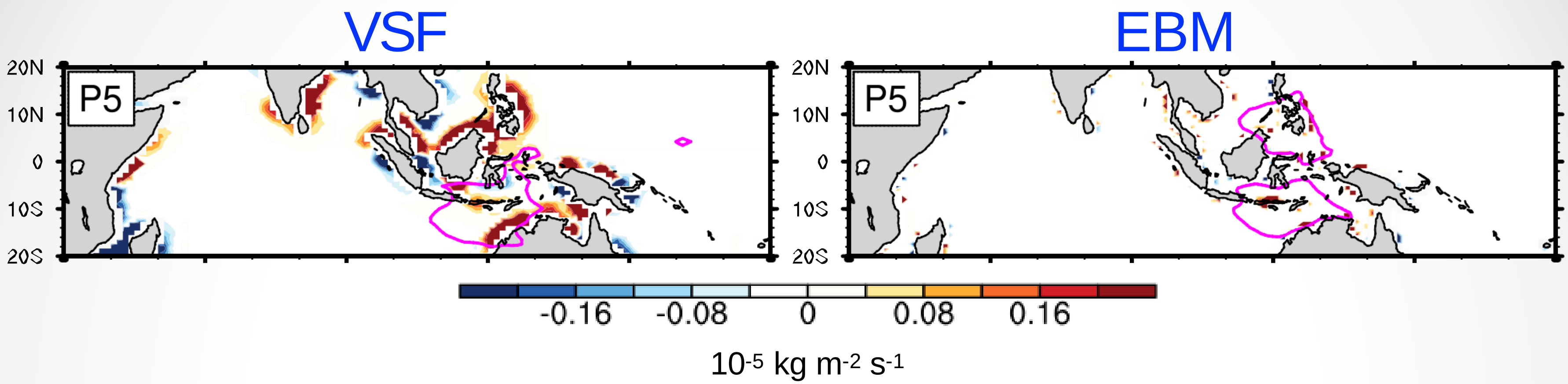
river discharge-convection interactions



mean fields: EBM - VSF

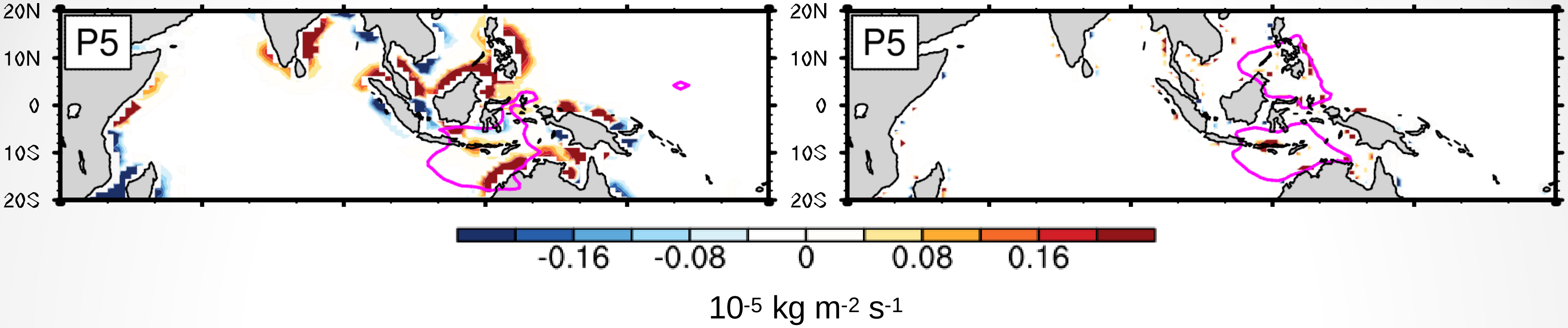


anomalous runoff in VSF vs EBM



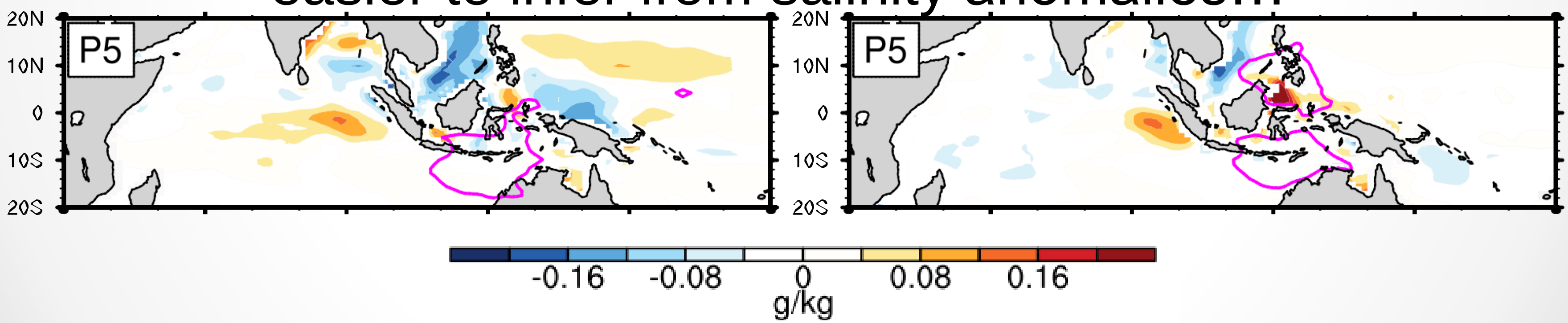
anomalous runoff in VSF vs EBM

VSF EBM



runoff in EBM is hard to see!

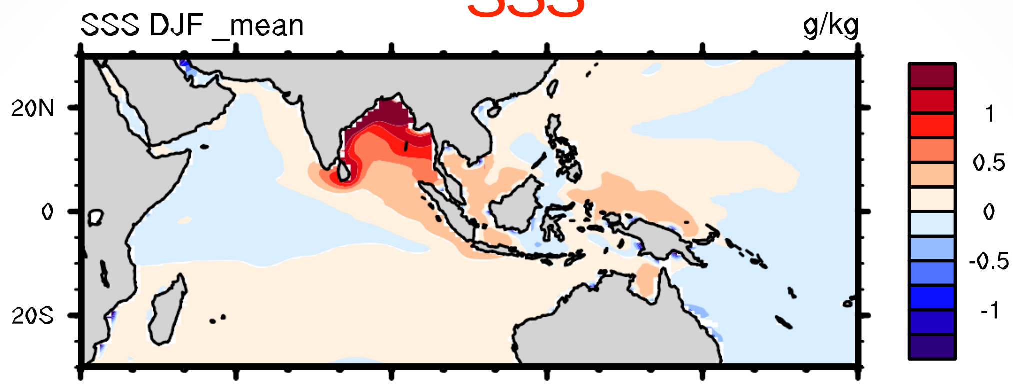
easier to infer from salinity anomalies…



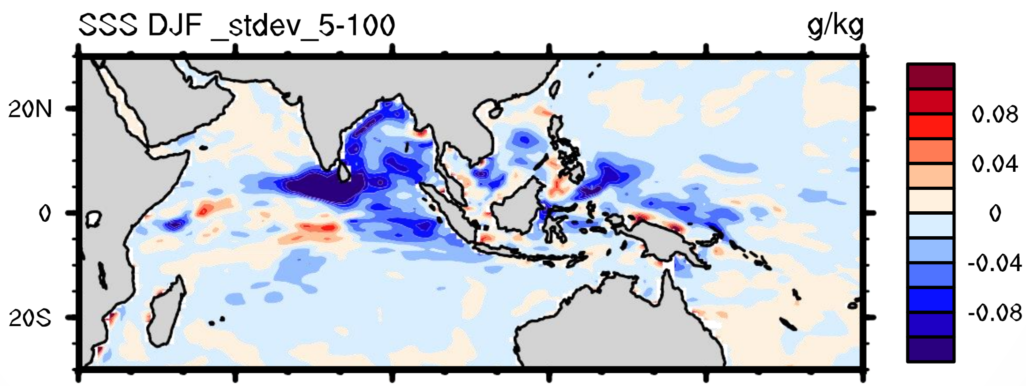
salinity impacts: EBM - VSF

SSS

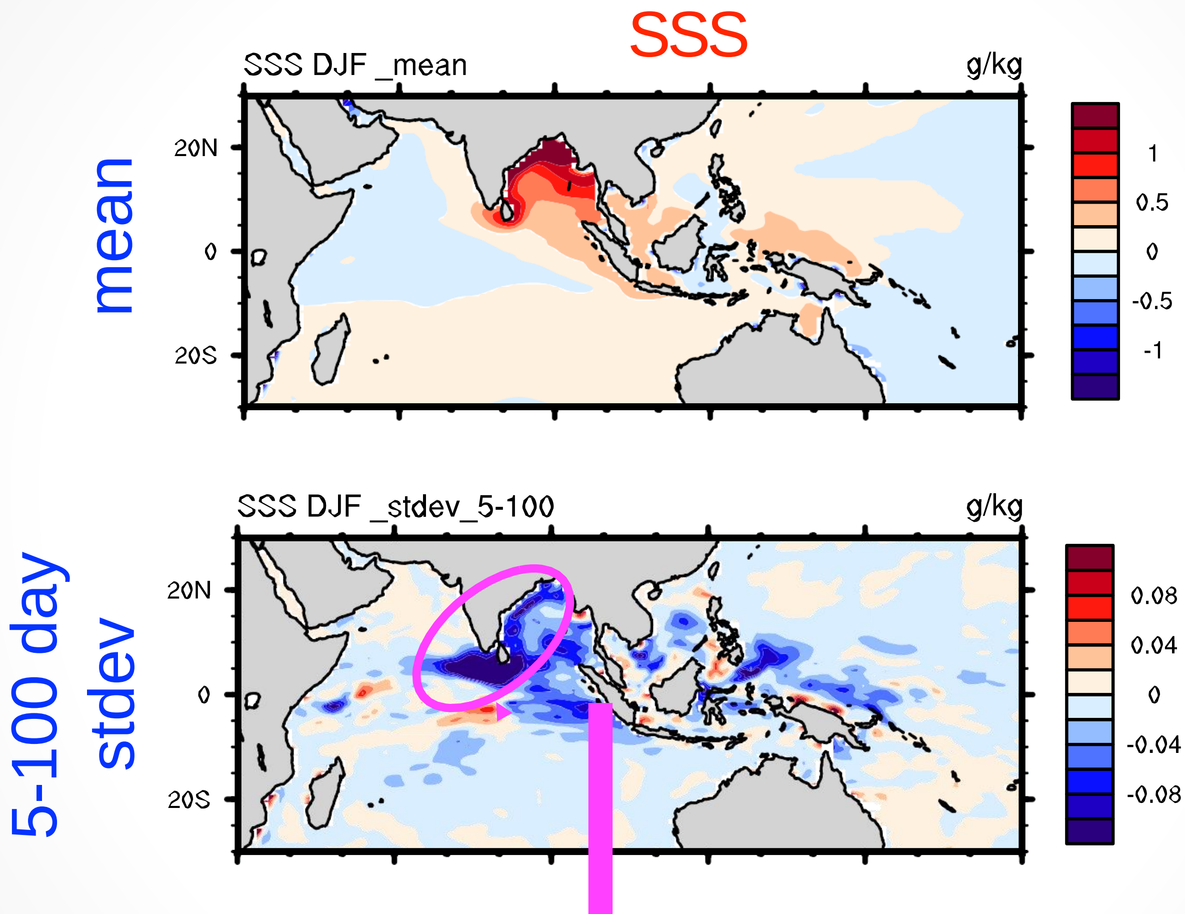
mean



5-100 day stdev



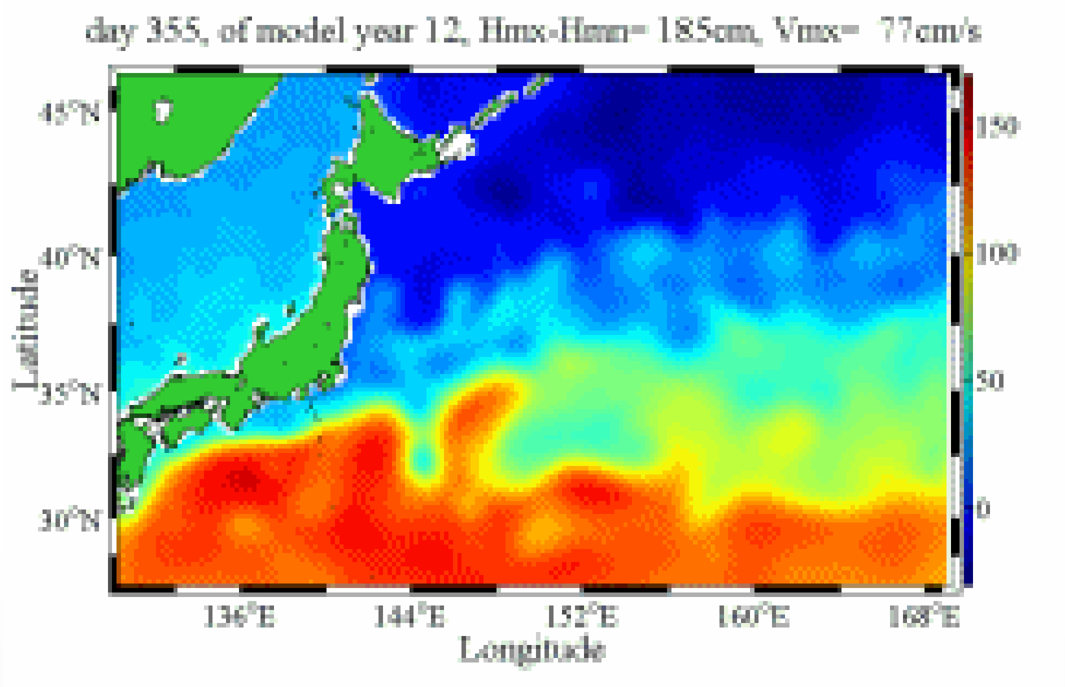
salinity impacts: EBM - VSF



VSF: salinity advection originating from Ganges River discharge

Real time ocean nowcast system

http://140.112.68.33/



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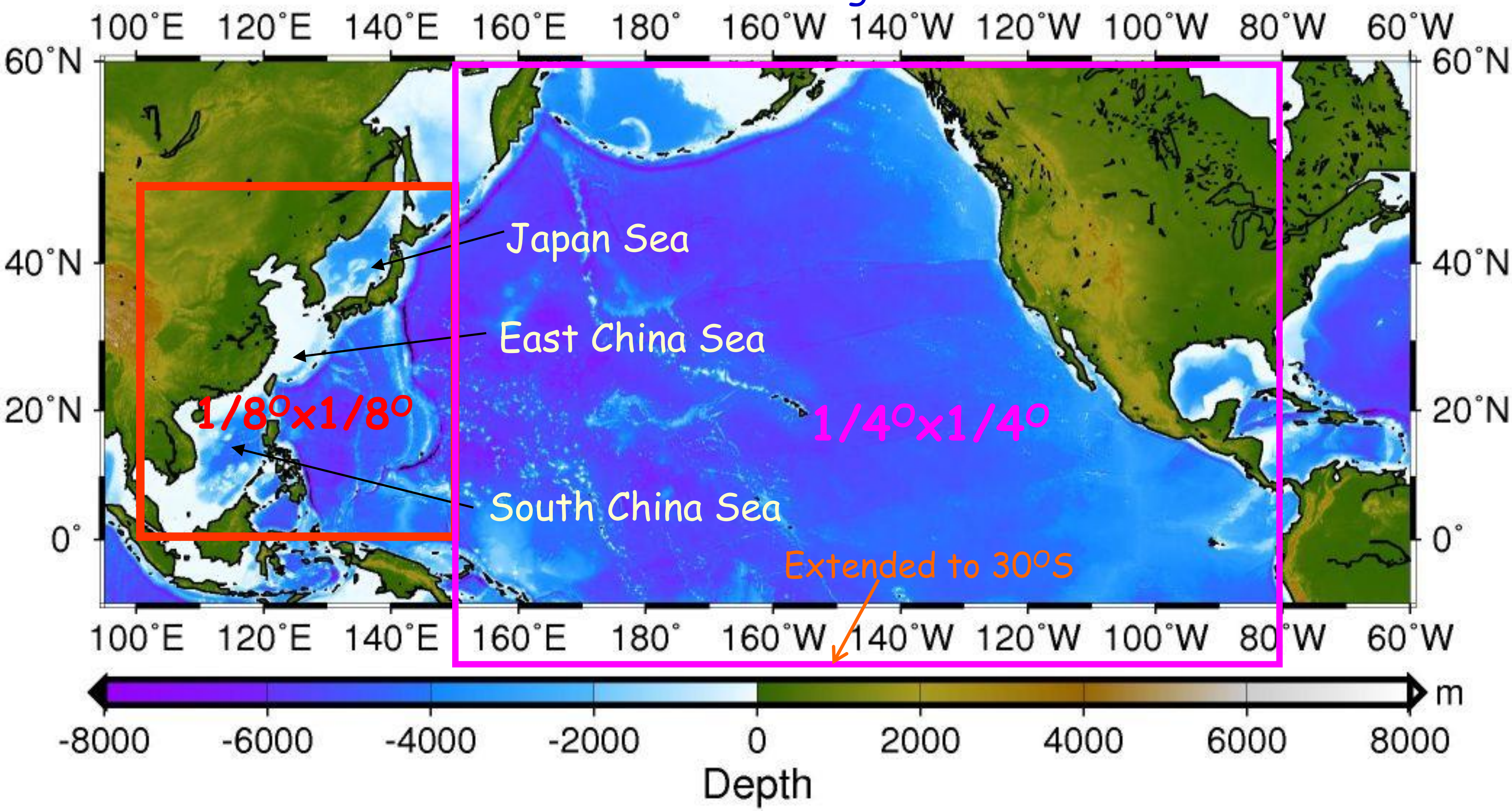
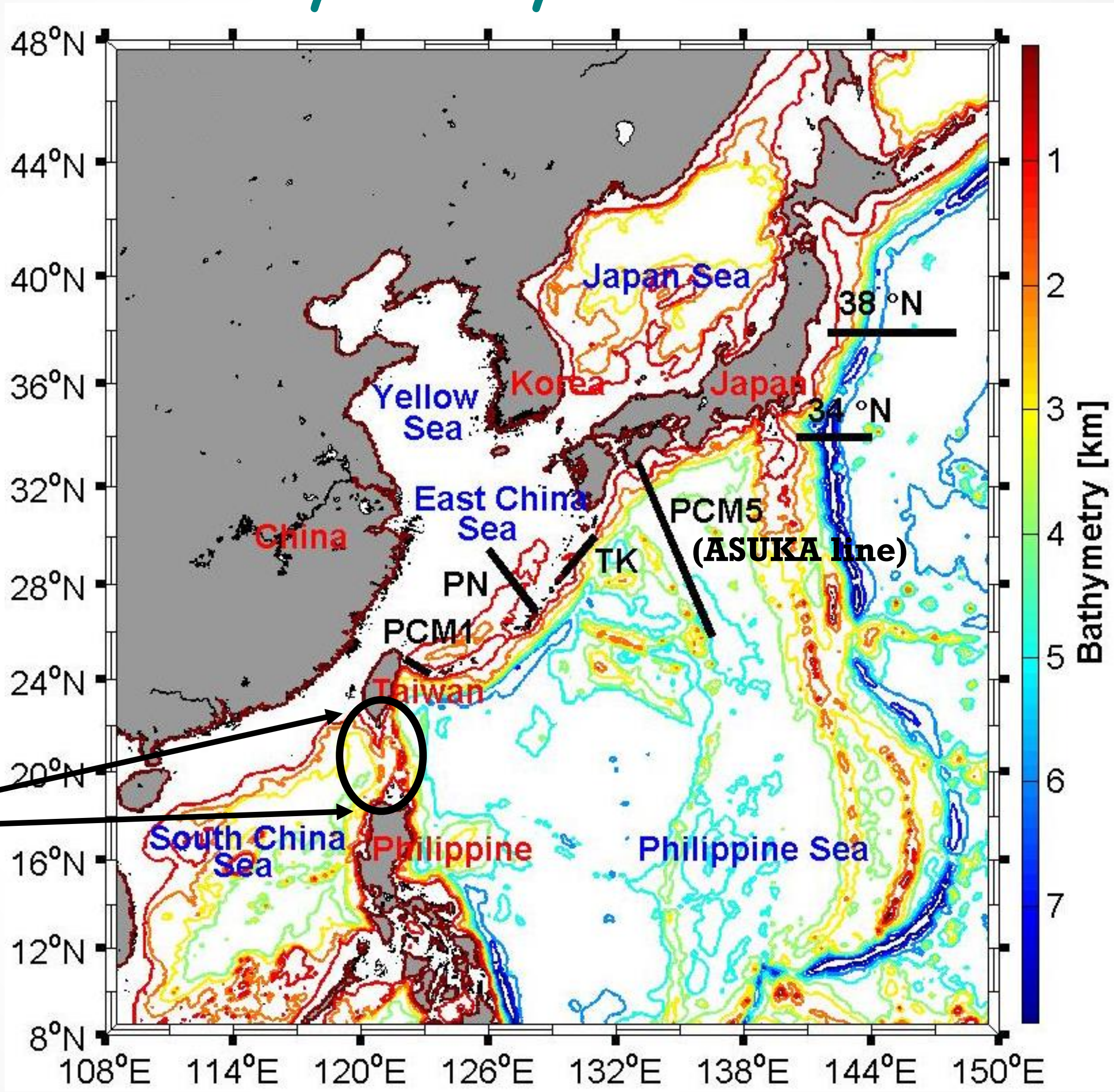
Taiwan Multi-scale Community Ocean Model (TIMCOM)

NPB (North Pacific Basin) Domain:
30°S to 60°N and 150°E to 80°W
grid resolution 1/4°
TAI Domain:
0° to 50°N and 100°E to 150°E
grid resolution 1/8°



- 4^{th} order accurate, Z-level, free surface
- Mixed Arakawa “a” and “c” grids
- The control volume equations include fluxes of the conservation of **momentum**, **heat** and **salt** across control volume faces.
- Bathymetry:
  - Interpolated from unfiltered ETOPO2 depth data
- The vertical resolution ~ linear-exponential stretched grid, 26 layers
- Varying latitude and uniform longitude grid (Mercator grid).
- Surface forcing:
  - NCEP GFS atmospheric state
  - Use 1/12° HYCOM global model for the initialization.
- The northern boundary is closed. Insulated bottom, with non-slip conditions parameterized by a nonlinear bottom drag.
- Sub-grid scale vertical mixing is parameterized by eddy diffusivity/viscosity using a modified Richardson number based approach based on Pacanowski and Philander (1982)

TAI domain bathymetry and observations

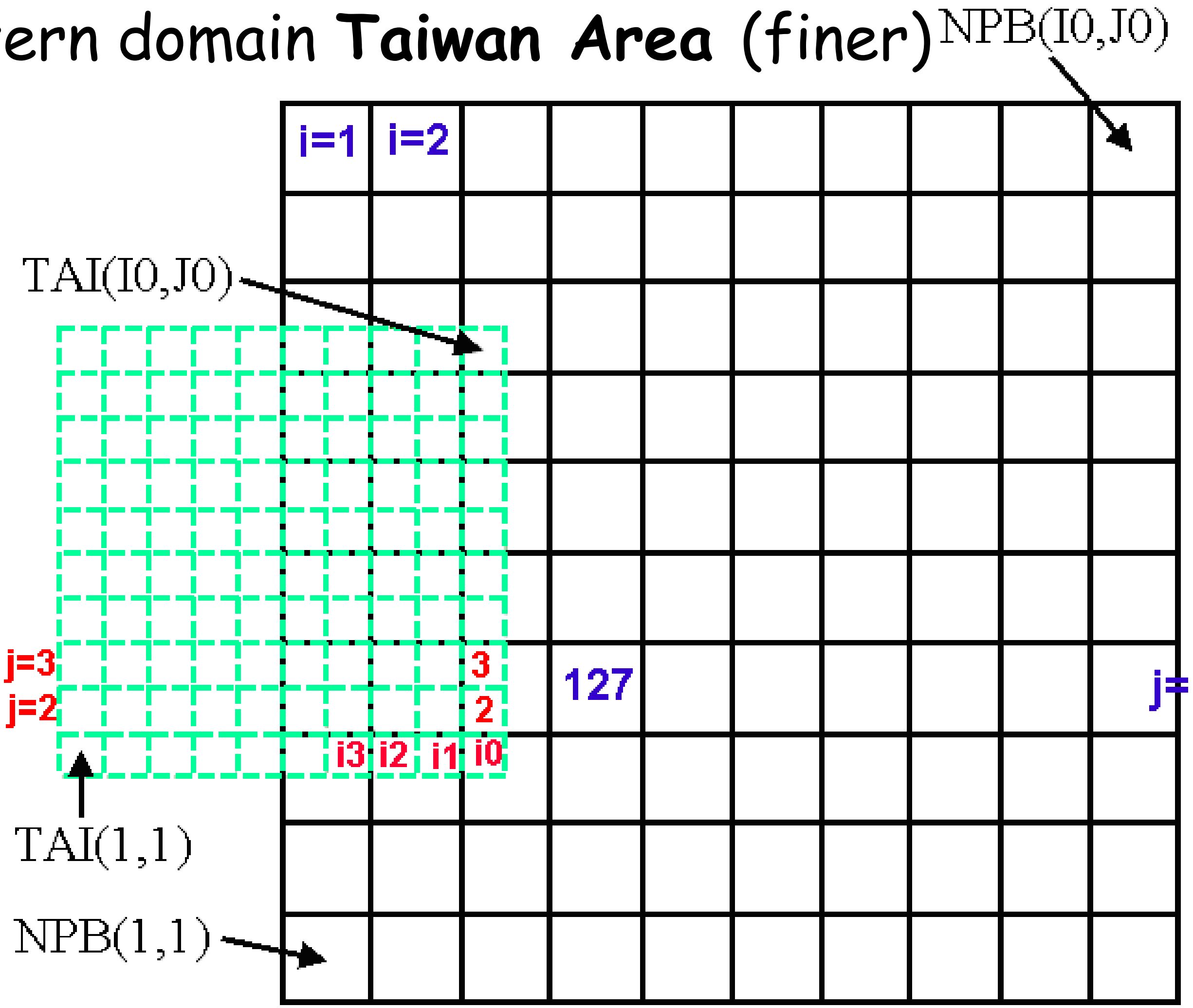


The Luzon and Taiwan Straits, the SCS

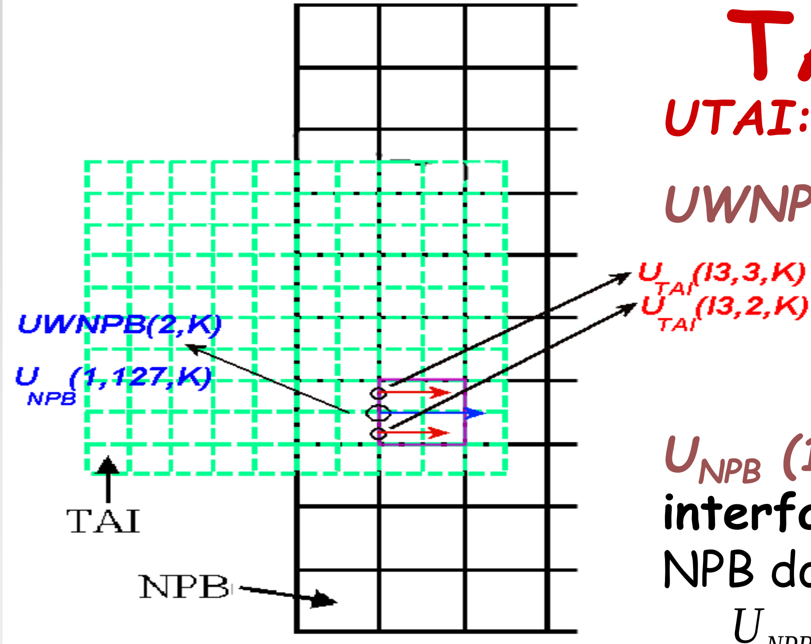
Multiple-domain Coupling

NPB： The eastern domain **North Pacific Basin** (coarser)

TAI： The western domain **Taiwan Area** (finer)



TAI to NPB



UTAI: the **cell face** velocity *U* of the TAI domain.

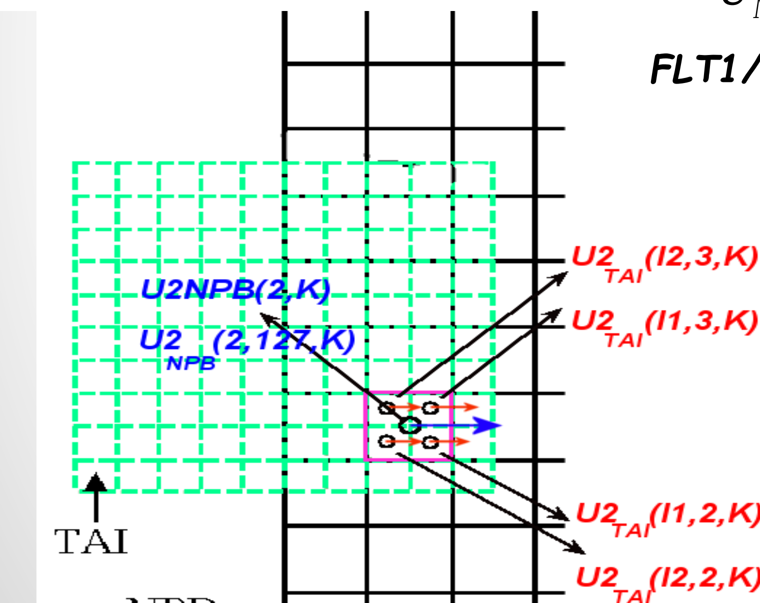
UWNPB: the **intermediate** cell face velocity *U* at **west interface** for the boundary cell (purple square) in the NPB domain

$$UWNPB(2,K) = 1/2 \times (U_{TAI}(I3,2,K) + U_{TAI}(I3,3,K))$$

U_{NPB} **(1,127,K):** the **final** cell face velocity *U* at **west interface** for the boundary cell (purple square) in the NPB domain

$$U_{NPB}(1,127,K) = [FLT1 \times UWNPB(2,K) + FLT2 \times (U_{NPB}(1,127,K)]$$

FLT1/FLT2 : time filter, where FLT1=FLT2-1



U2TAI: the **cell center** velocity *U* of the TAI domain.

U2WNPB: the **intermediate** cell **center** velocity *U* in the NPB domain

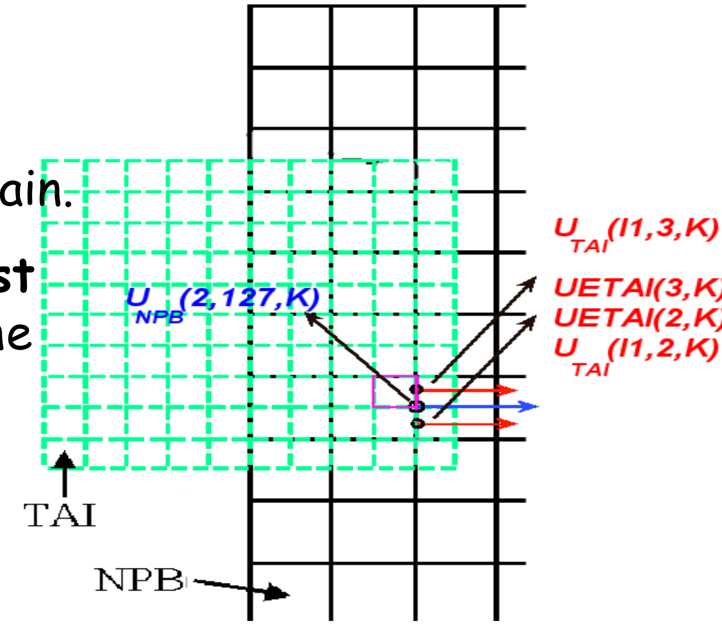
$$U2_{NPB}(2,127,K) = U2_{NPB}(2,127,K) + dU$$

where dU=U2NPB(2,K)-U1NPB(2,127,K)

$U2_{NPB}$ **(1,127,K):** the **final** cell **center** velocity *U* in the NPB domain

$$U2NPB(2,K) = 1/4 \times (U2_{TAI}(I2,2,K) + U2_{TAI}(I2,3,K) + U2_{TAI}(I1,2,K) + U2_{TAI}(I1,3,K)$$

NPB to TAI

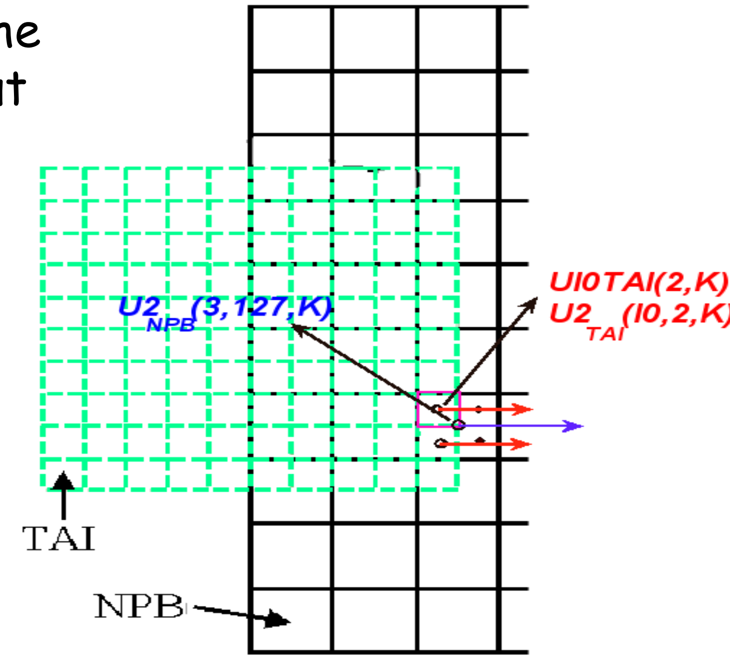


U_{NPB}: the **boundary face** velocity *U* of the NPB domain.

UETAI: the **intermediate** cell face velocity *U* at **east interface** for the boundary cell (purple square) in the TAI domain

$$UETAI(2,K) = U_{NPB}(2,127,K)$$
$$UETAI(3,K) = U_{NPB}(2,127,K)$$

U_{TAI} (I1 ,2,K): the **final** cell face velocity *U* at **east interface** for the boundary cell (purple square) in the TAI domain. It is essentially the same as *UETAI* but the land masks are imposed to ensure conservation.

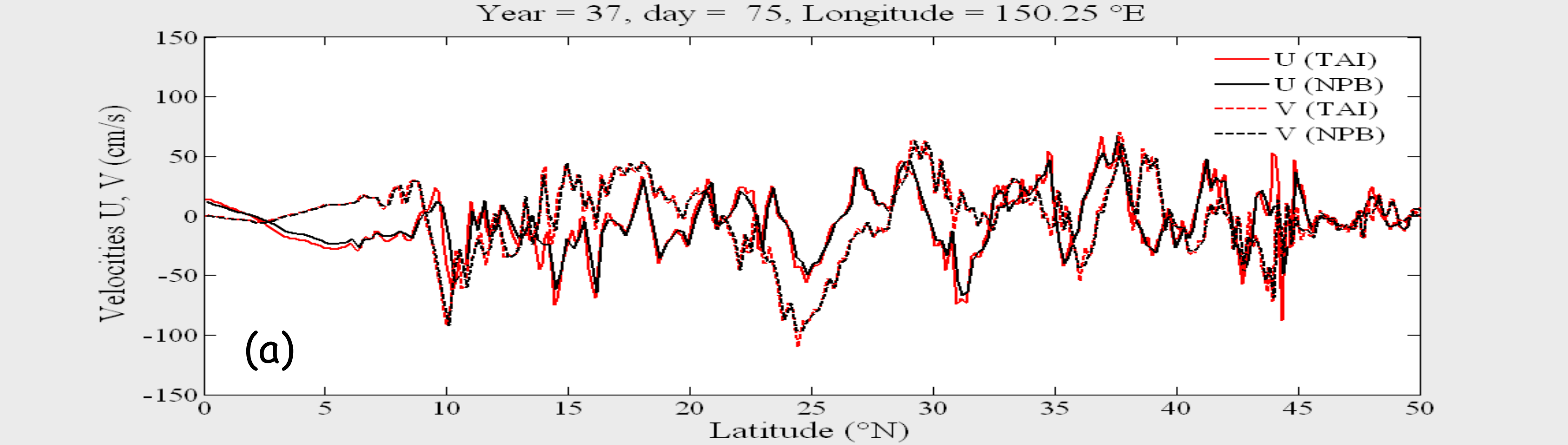


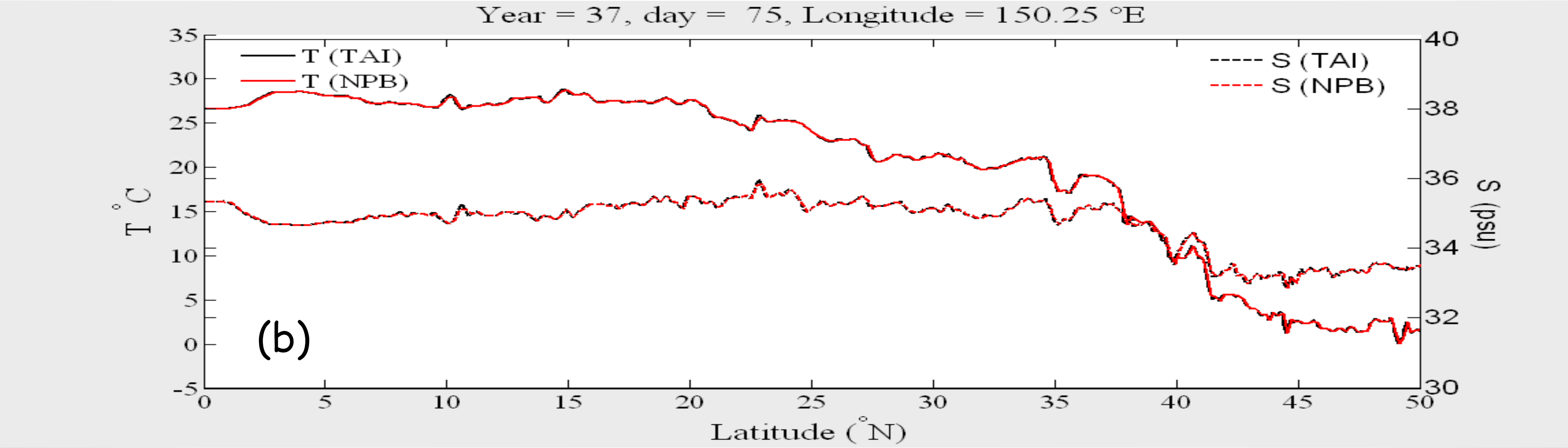
UIOTAI: the **intermediate** cell **center** velocity *U* in the TAI domain

$$UI0TAI(2,K) = U2_{NPB}(3,127,K)$$

U2TAI: the **final** cell **center** velocity *U* in the TAI domain $U2_{TAI}(I0,2,K) = UI0TAI(2,K)$

Comparison of the surface (a) velocities and (b) temperature/salinity at the interface of TAI and NPB





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