The fates of terrigenous organic carbon and absorbed atmospheric CO_2 in the East China Sea

K. K. Liu

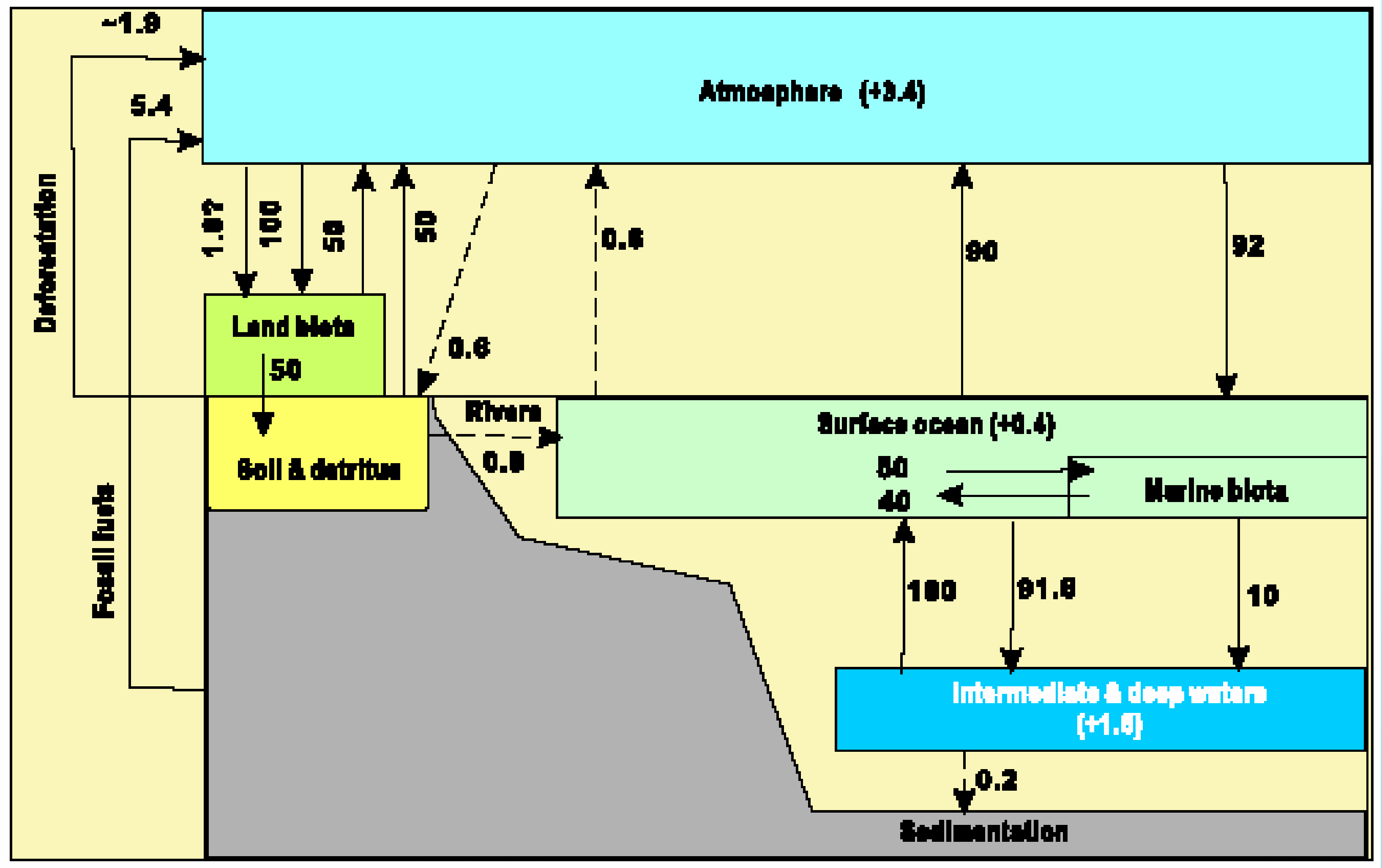
Institute of Hydrological Sciences,

National Central University, Taiwan

Collaborators

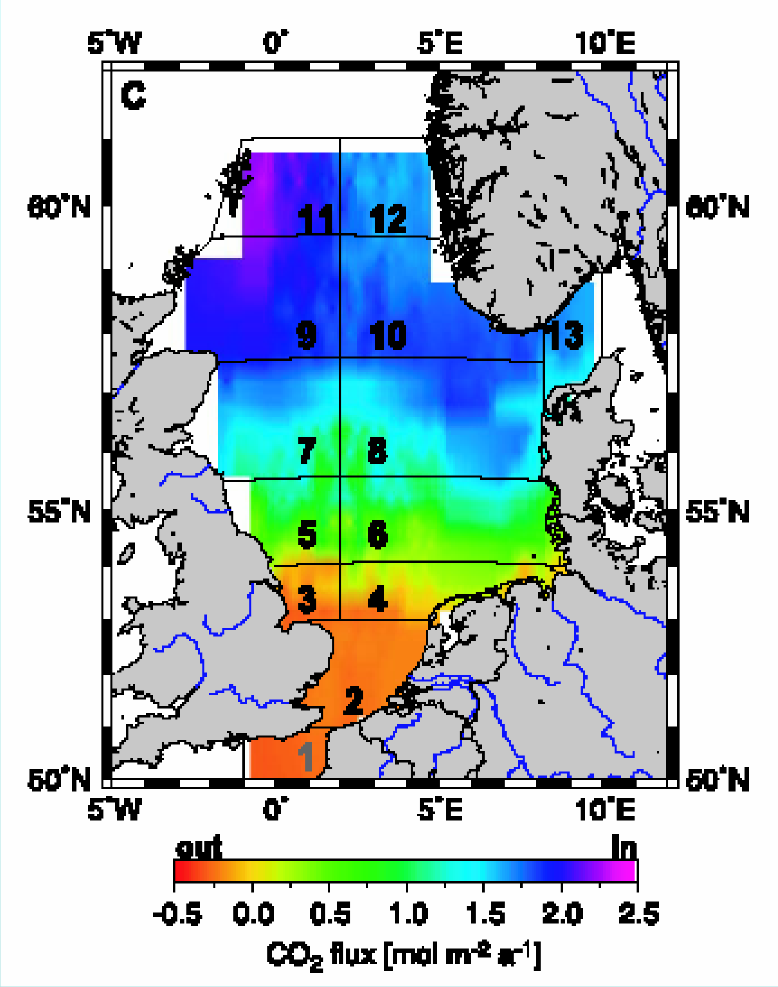
G.-C. Gong, C.-R. Wu, H.-J. Lee

Coastal ocean: source or sink of atm-CO_2?

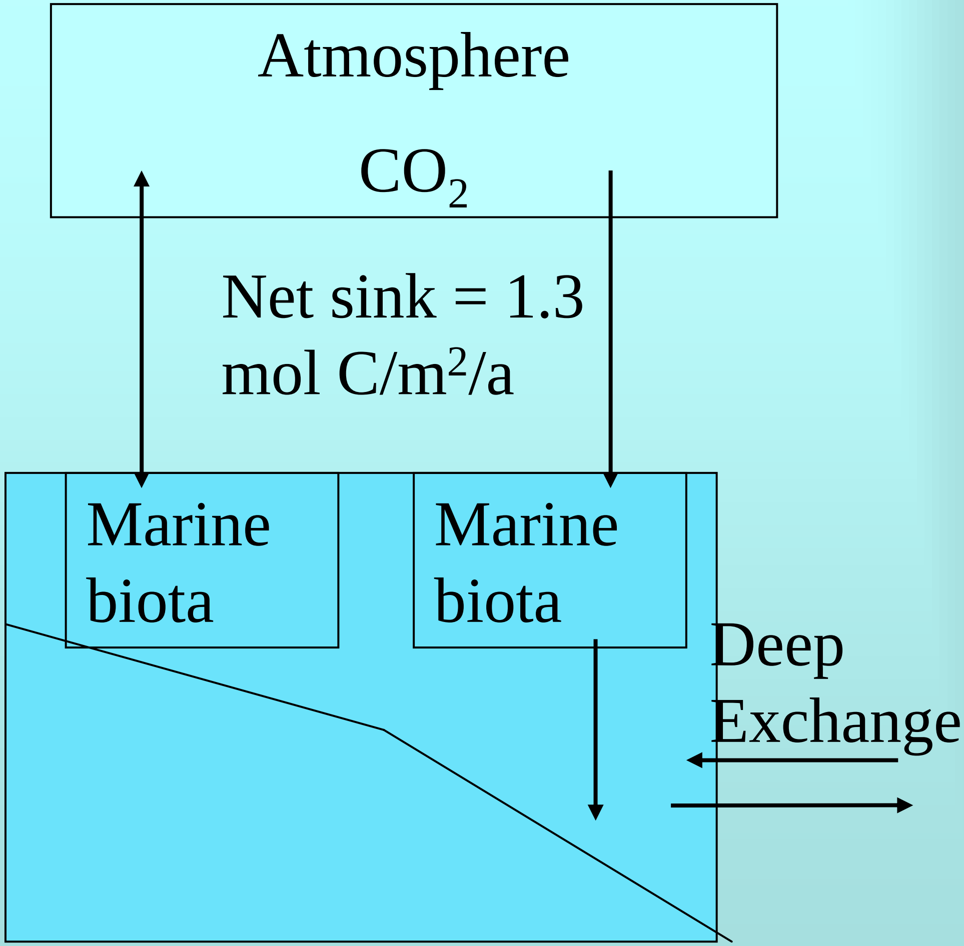


(Siegenthaler & Sarmiento)

North Sea: Continental Shelf pump

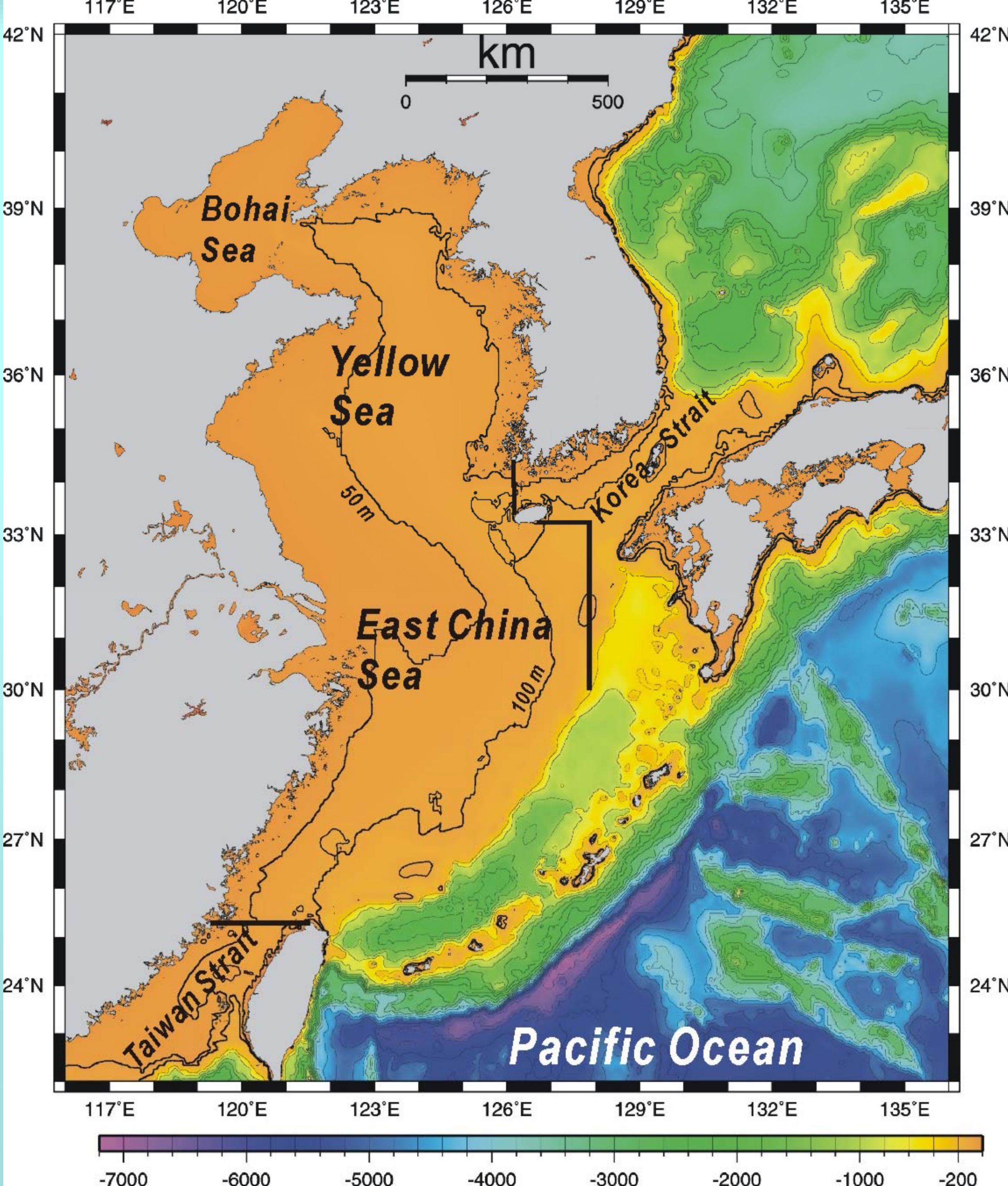


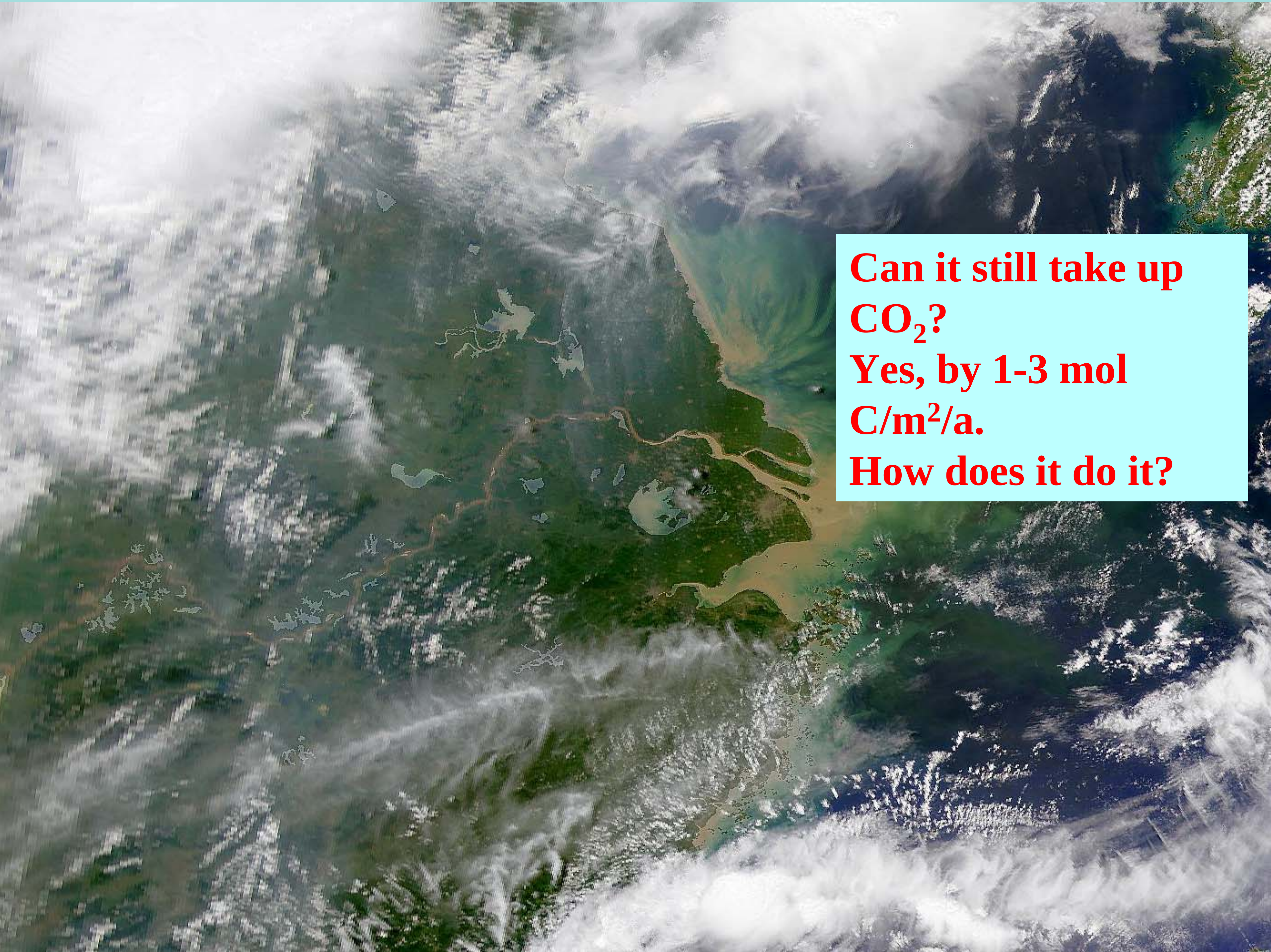
(Thomas et al., 2004)



The East China Sea-Yellow Sea-Bohai Sea Shelf:

- **Area: $1x10^6$ km^2**
- **Riverine discharge: ~900 Gmol C/a = 0.9 mol C/m^2/a**



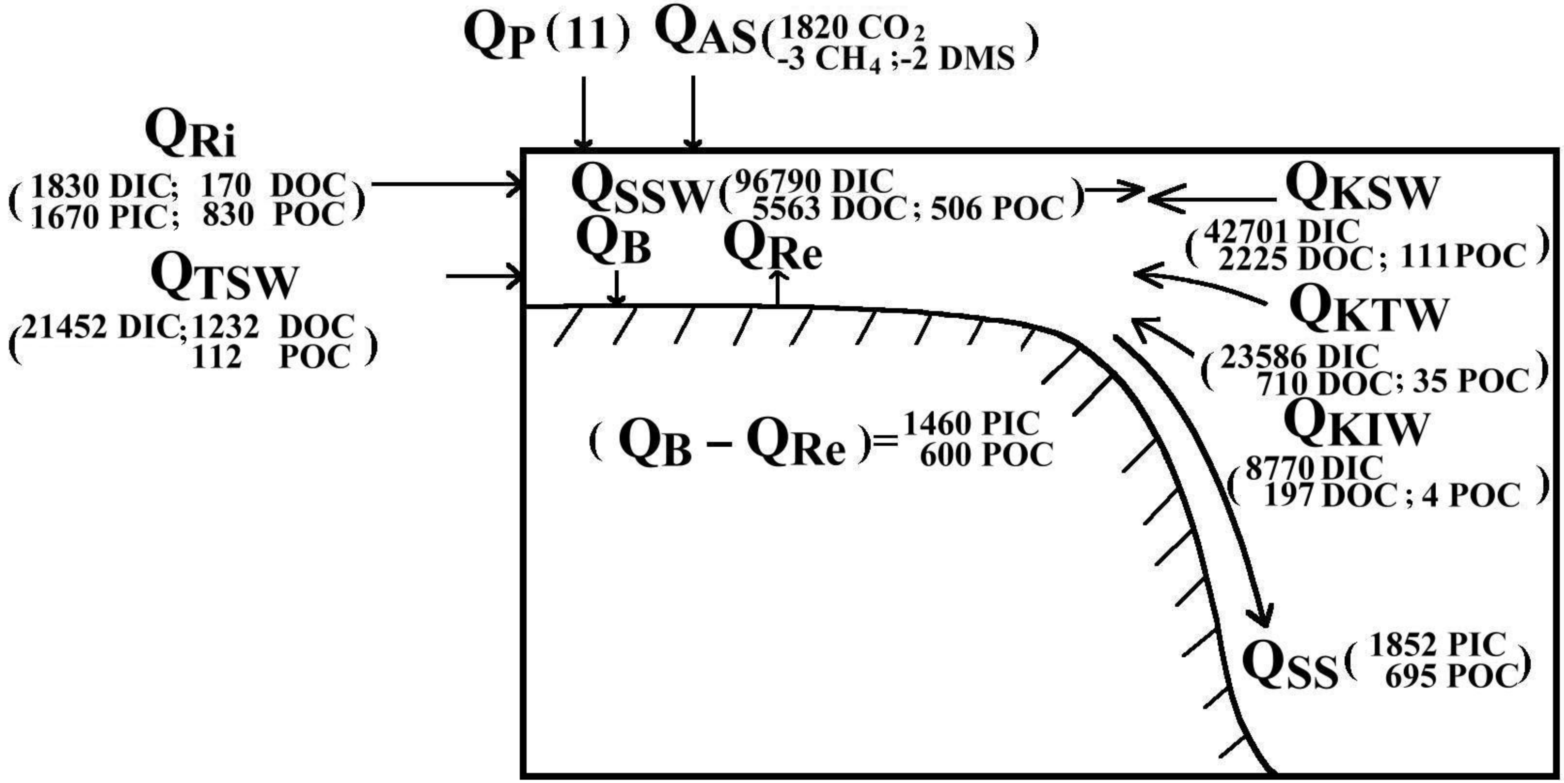


Can it still take up CO_2?

Yes, by 1-3 mol C/m^2/a.

How does it do it?

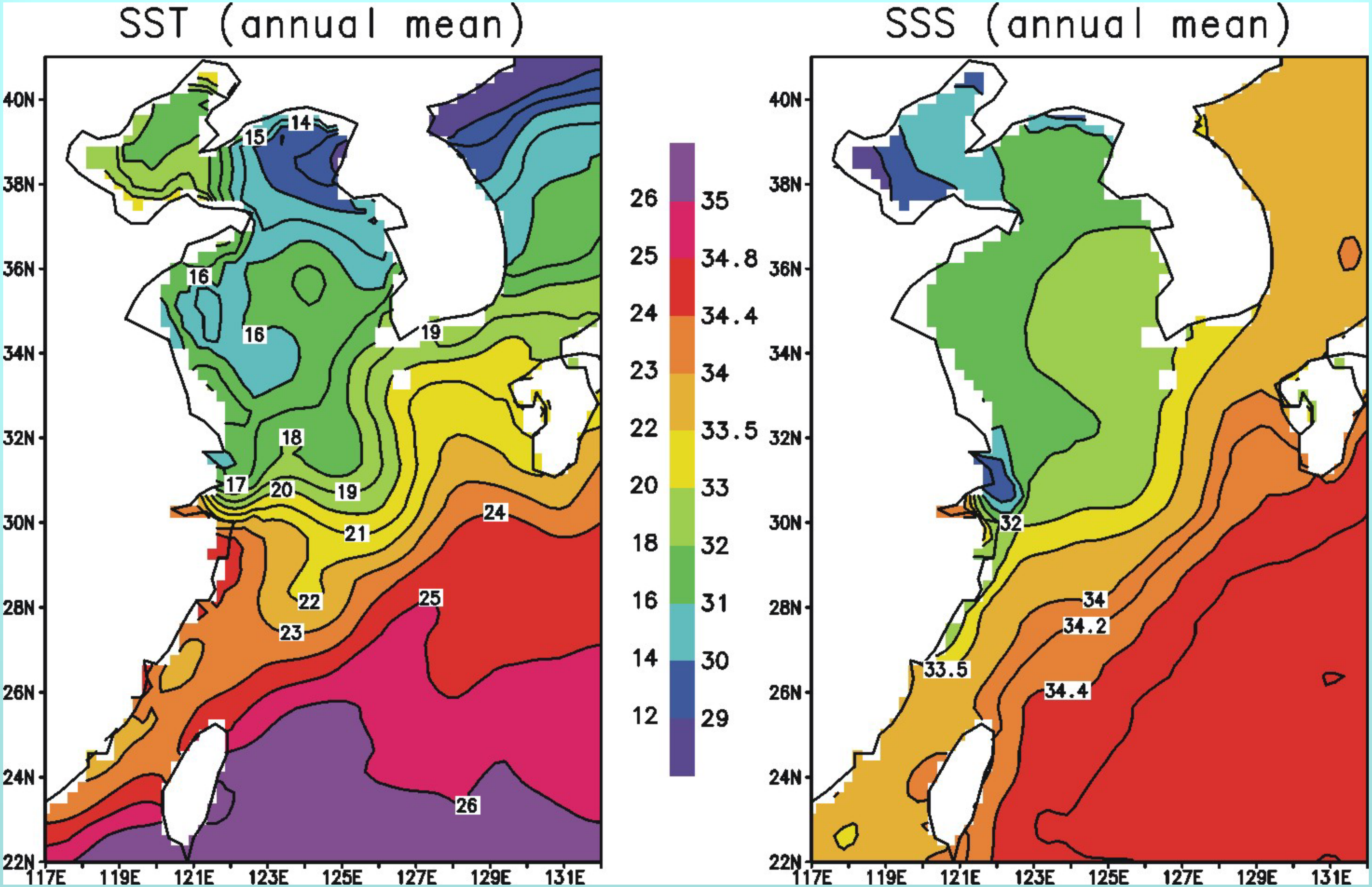
1-Box model (Chen & Wang, 1999)



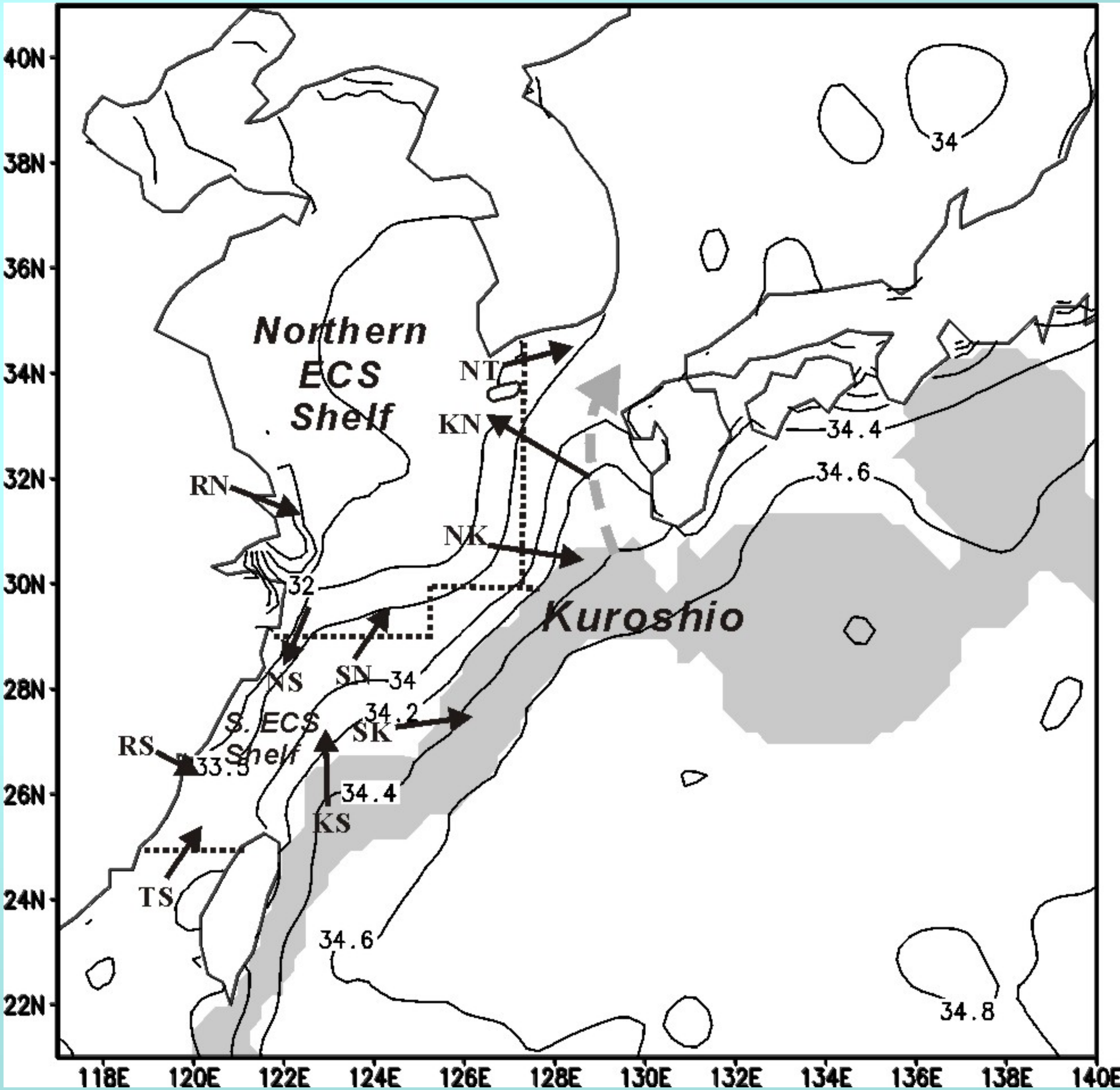
Comparison of estimated residence time (τ)

	Qr(km 3/y)	Skuro	Sshelf	Qk(Sv)	Qs(Sv)	V(km3)	Tau(yr)
Nozaki et al. 1989					0.60	45000	2.38
Li (1994)	885	34.50	33.00	0.71	0.74	25000	1.09
Chen et al., 1996	1110	34.50	32.00	0.51	0.55	45000	2.71
Chen & Wang, 1997	1217	34.56	33.45	1.29	1.34	45000	1.07
Chen, 1998	1217	34.56	33.45	1.15	1.55	45000	0.92

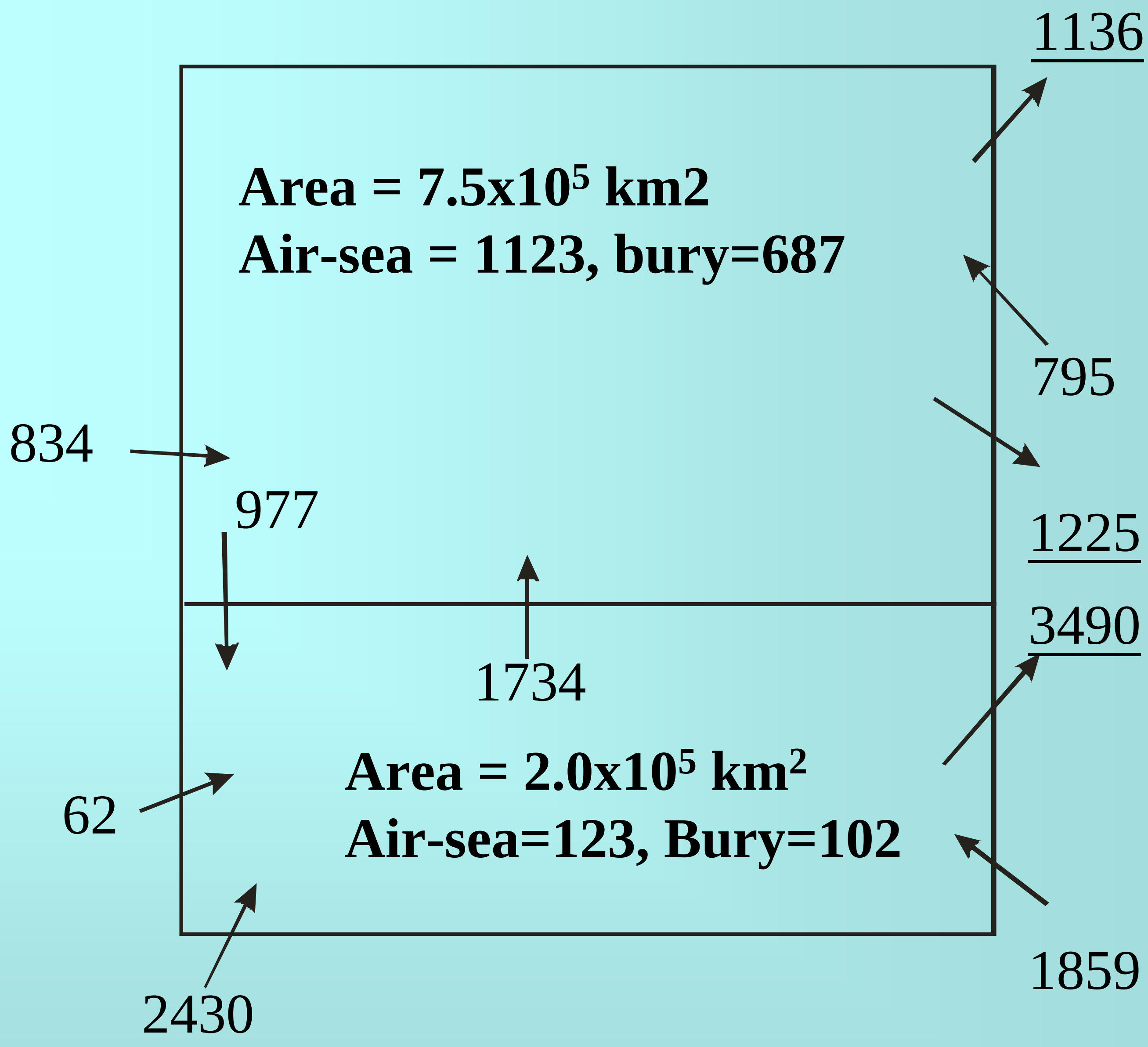
Annual mean SST & SSS



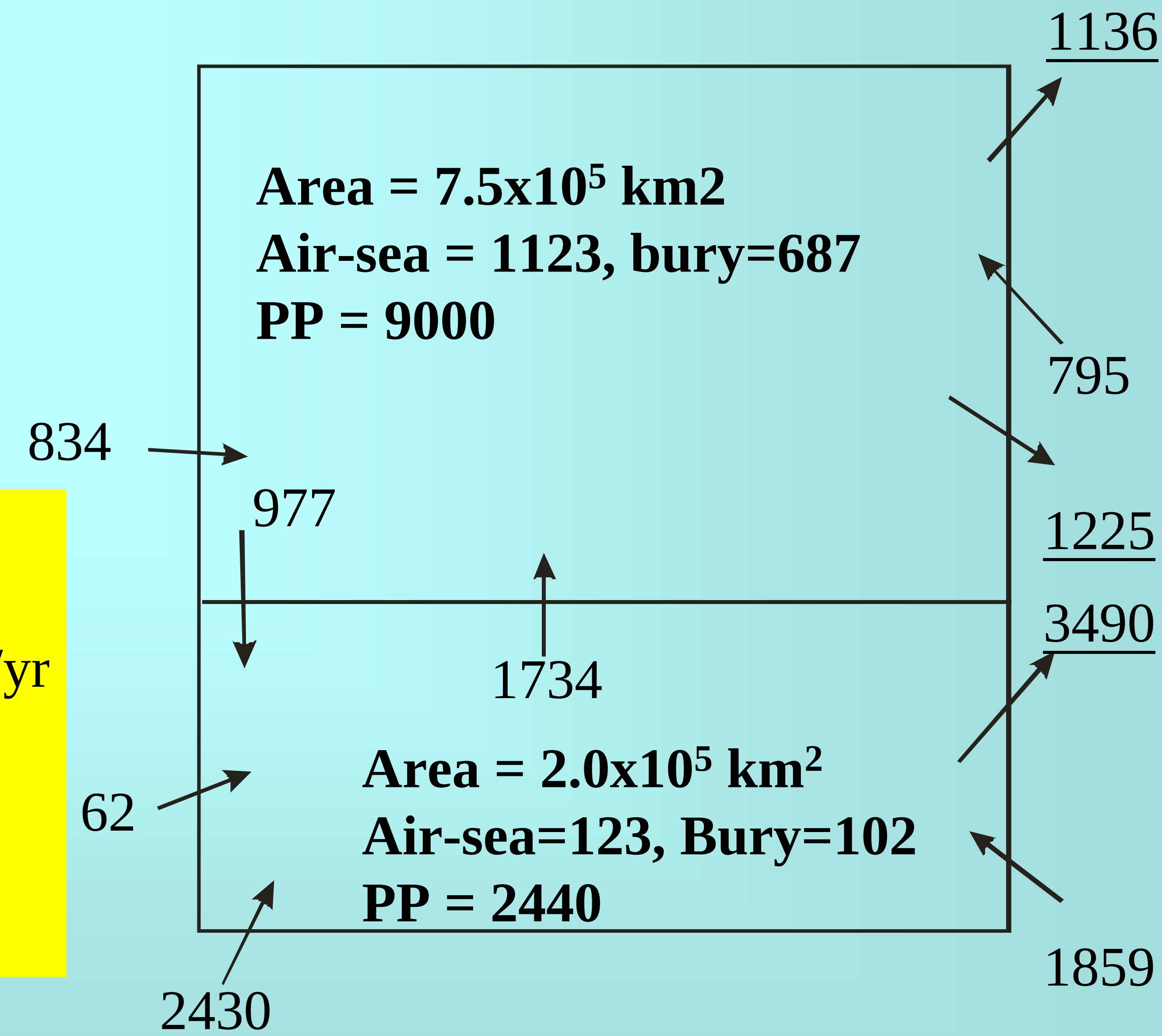
Two-box model with transports



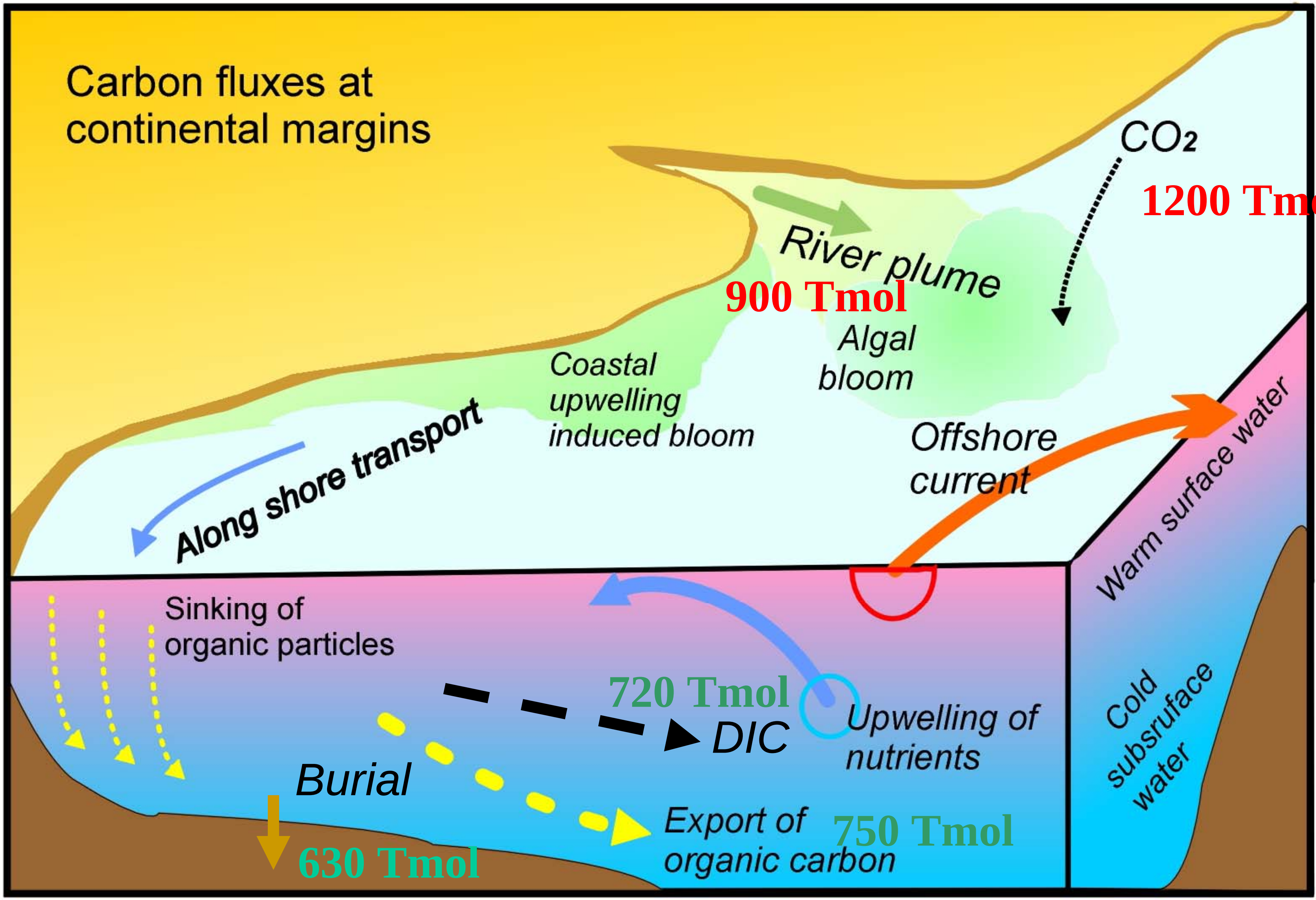
Organic carbon budget (Gmol/yr)



Organic carbon budget (Gmol/yr)



Carbon export:
OC=767 Gmol/yr
Burial=730 Gmol/yr
PP=11440
Export ratio = 7%
Burial ratio = 6%


Carbon fluxes at continental margins
CO2
1200 Tmol
River plume
900 Tmol
Algal bloom
Coastal upwelling induced bloom
Along shore transport
Offshore current
Warm surface water
Sinking of organic particles
720 Tmol
DIC
Upwelling of nutrients
Cold subsrufface water
Burial
630 Tmol
Export of organic carbon
750 Tmol

Summary-1

- **From salt balance, we found the Kuroshio intrusion to the Yellow Sea to be 0.4 Sv and the northward flow from the southern shelf to be 0.78 Sv.**
- **From the volume transports, we obtained the residence time of 1.1-3.0 yr for the northern shelf and a mere 3-6 months for the southern shelf.**

Summary-2

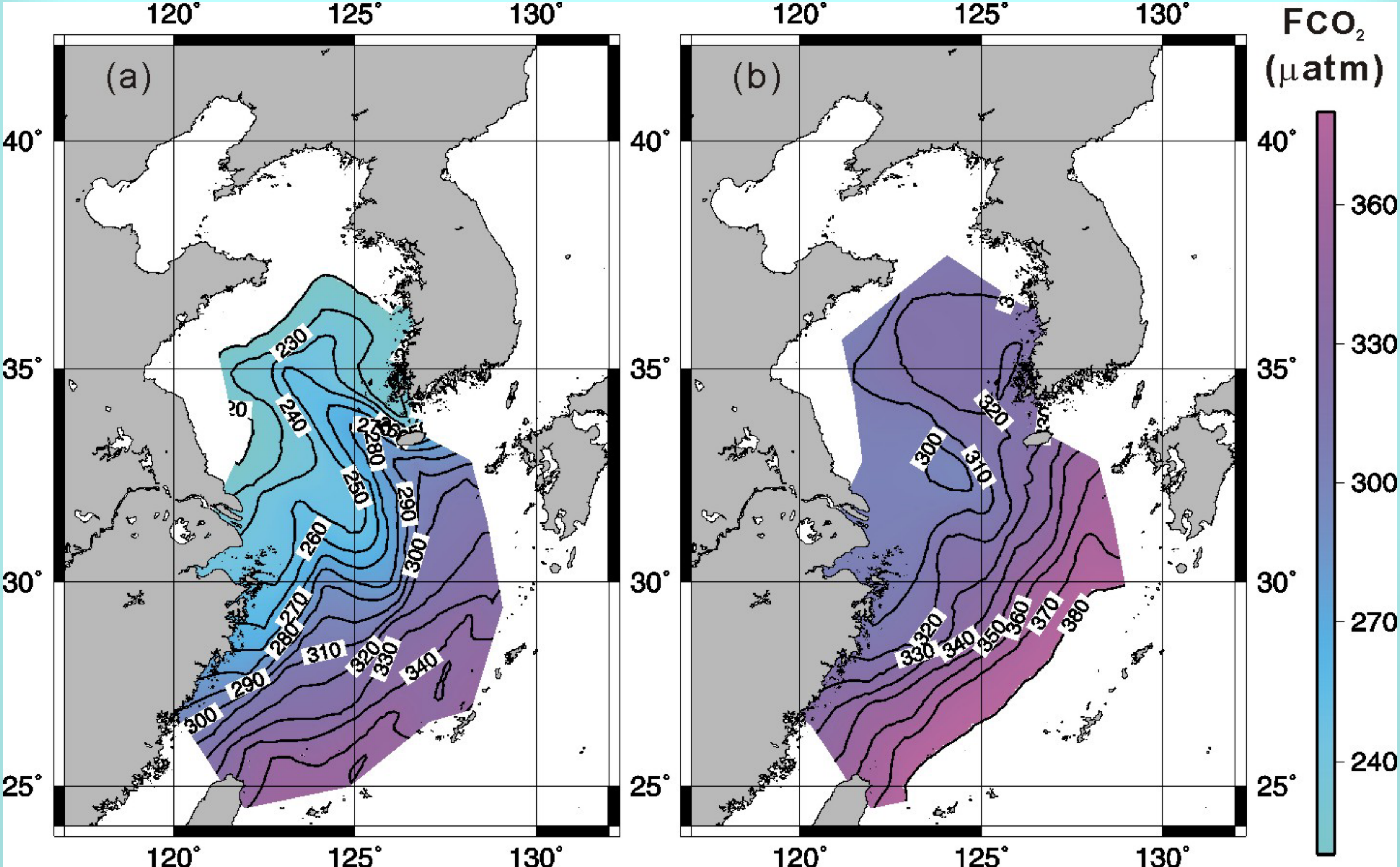
- The estimated input of atmospheric CO_2 reaches 1246 Gmol yr^{-1}, which is further amended with a huge riverine load of organic carbon (896 Gmol C yr^{-1}).
- The fates of the carbon input follow three pathways of roughly equal importance; 34% is buried in shelf sediments, 36% is exported as DOC and POC and the rest (30%) is exported as inorganic carbon.

Thank you!

Comparison with Chen & Wang (1999)

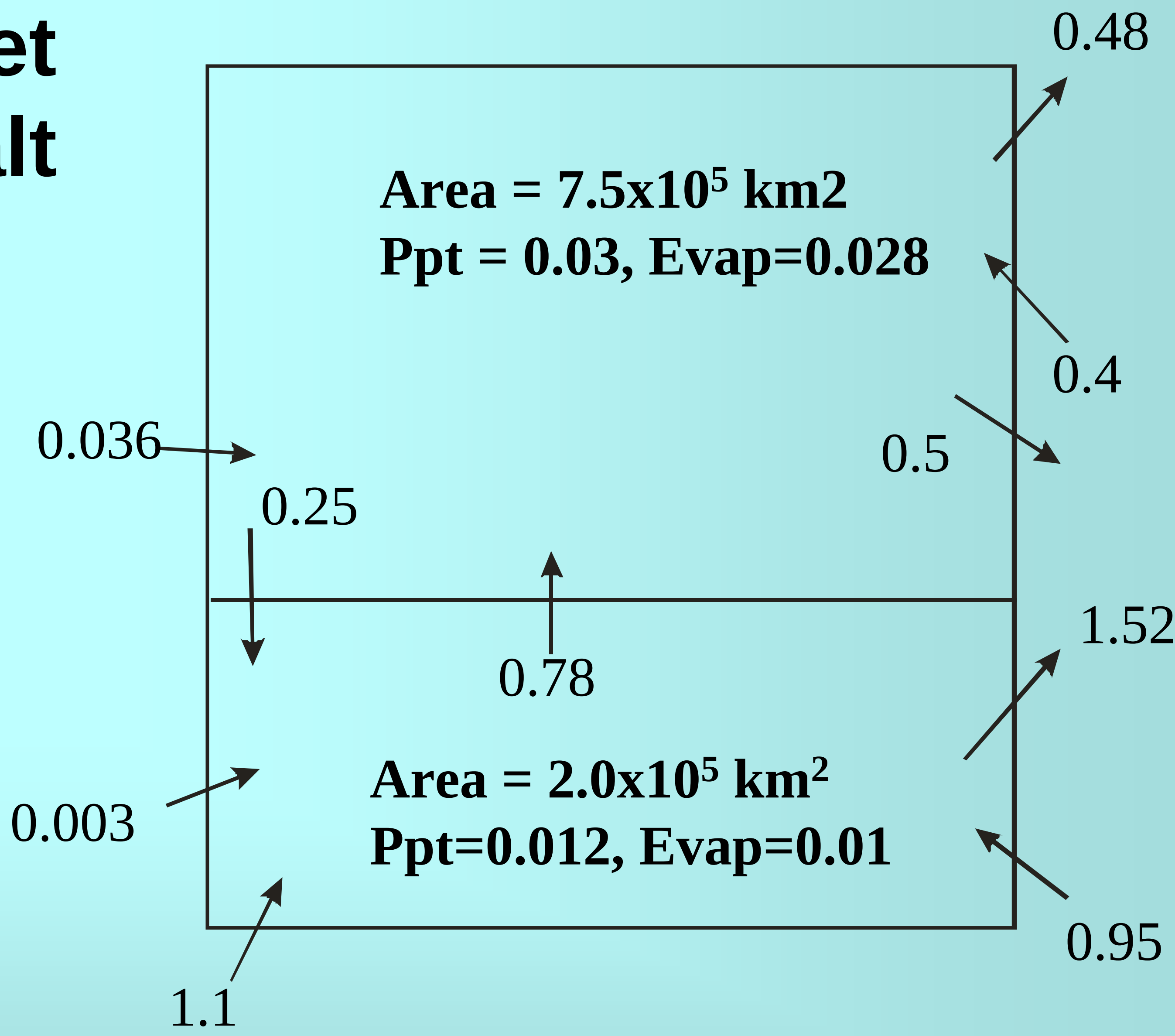
Study Processes	Chen & Wang (1999)	This study
Input		
Air-sea	1820	1246
Riverine OC	1000	896
Riverine IC	3500	
Output		
Export of DOC	1199	593
Export of POC	939	174
Export of DIC	281	645
Export of PIC	1852	
Burial of POC	600	730
Burial of PIC	1460	

P_{CO2} in the ECS
(Tsunogai et al., 1999)



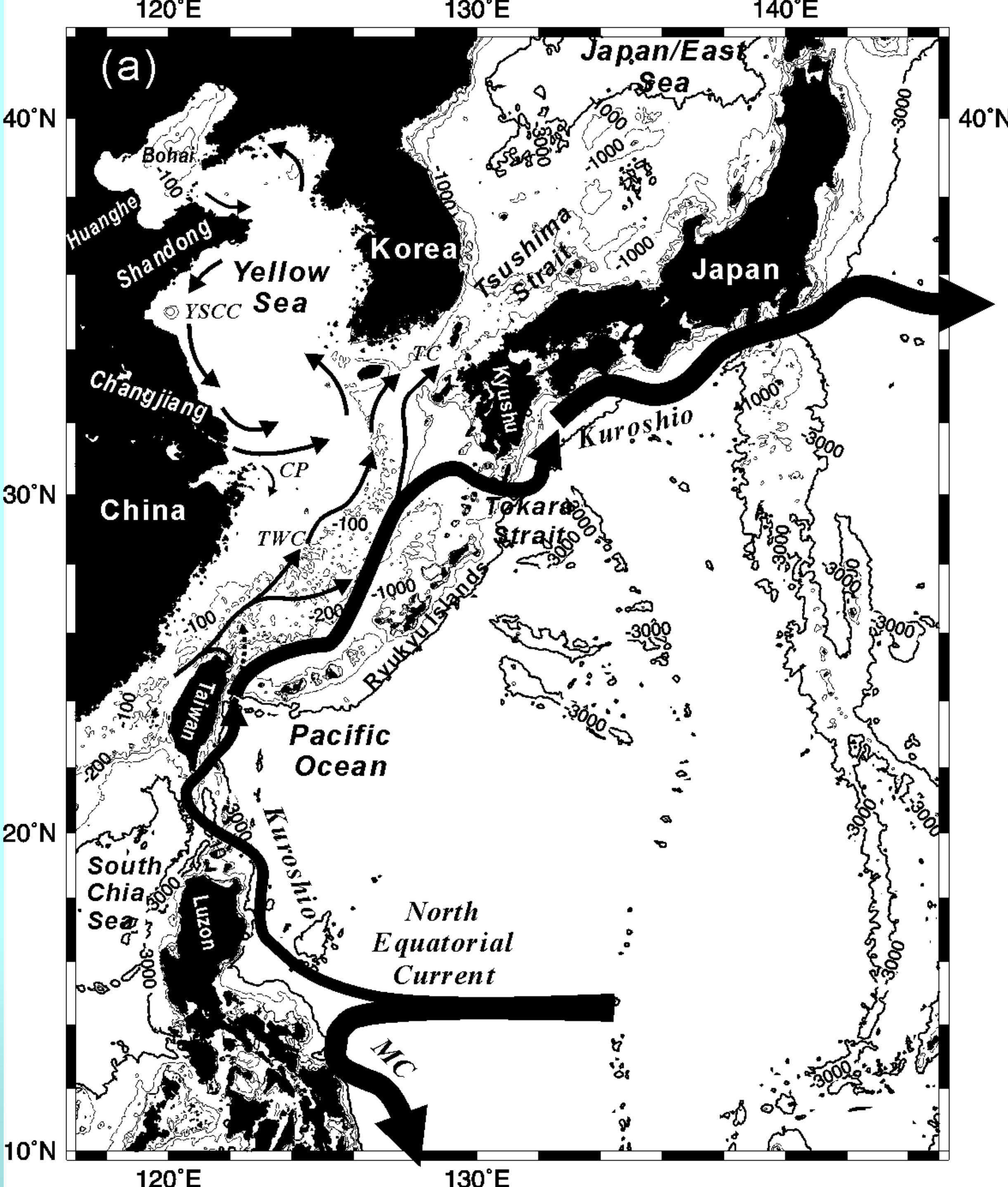
Water budget based on salt balance & observed-modeled transports (Sv)

Residence time:
Northern shelf =1.1-3 yr
Southern shelf: = 3-6 months

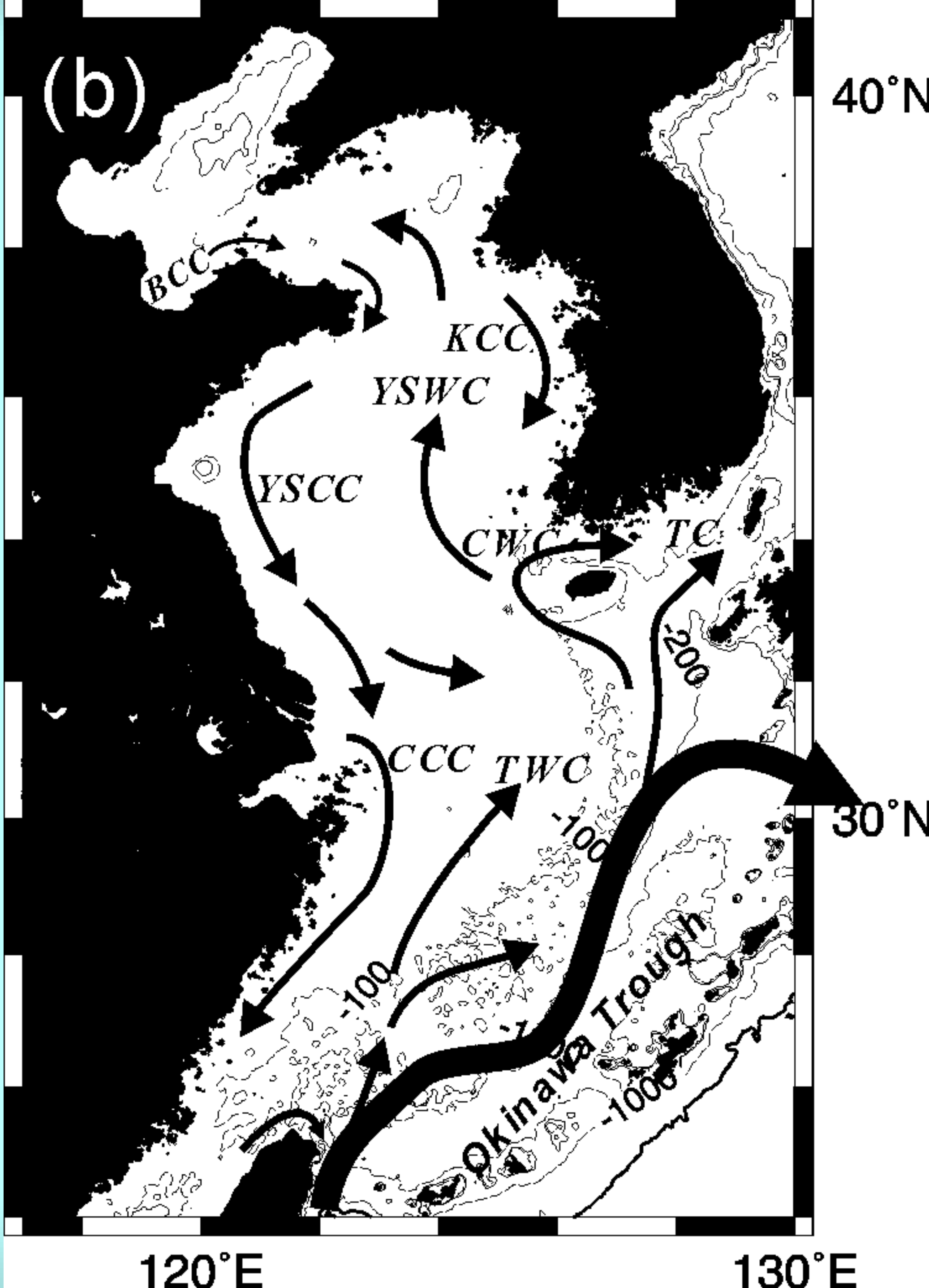


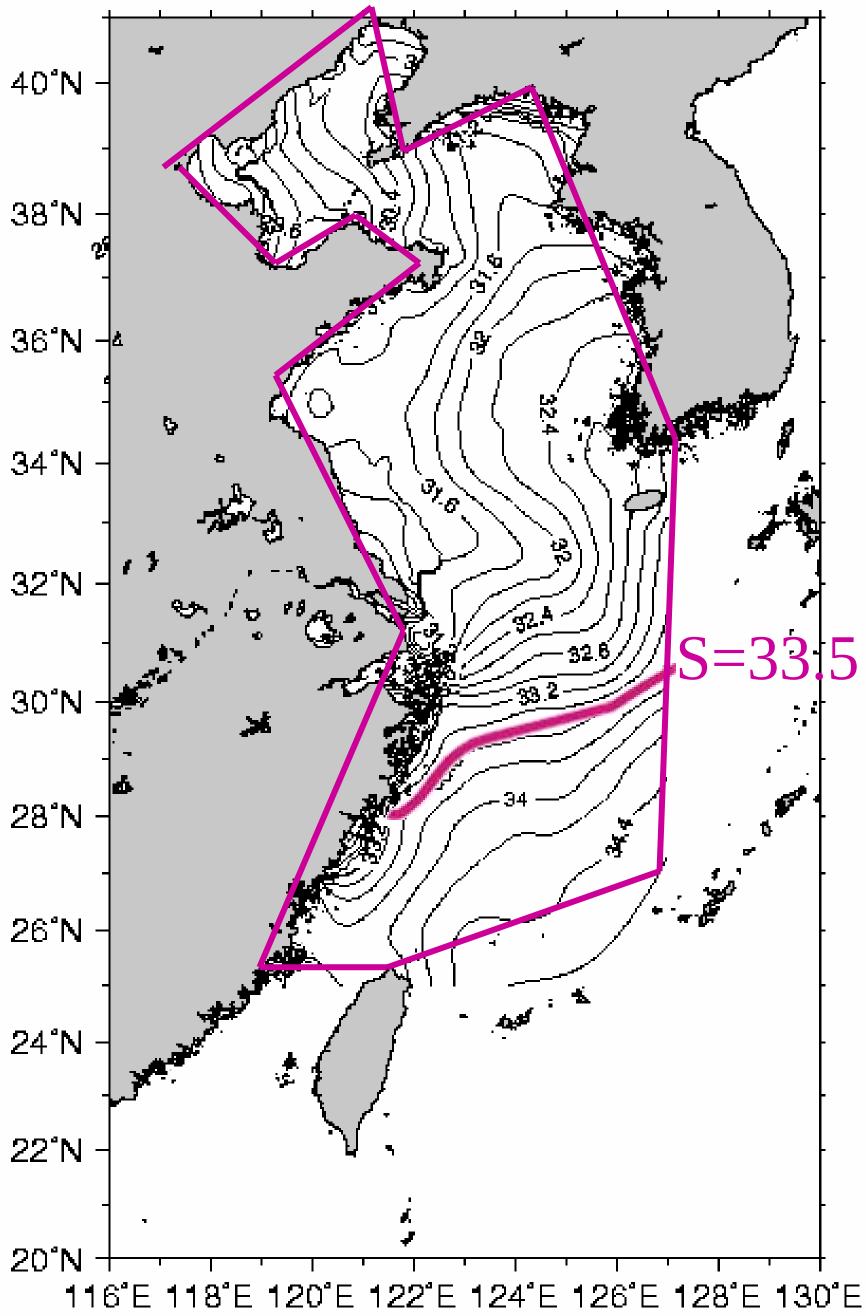
Circulation in ECS and vicinity in summer

(Lee & Chao, 2003, Wu, personal communicat., etc)

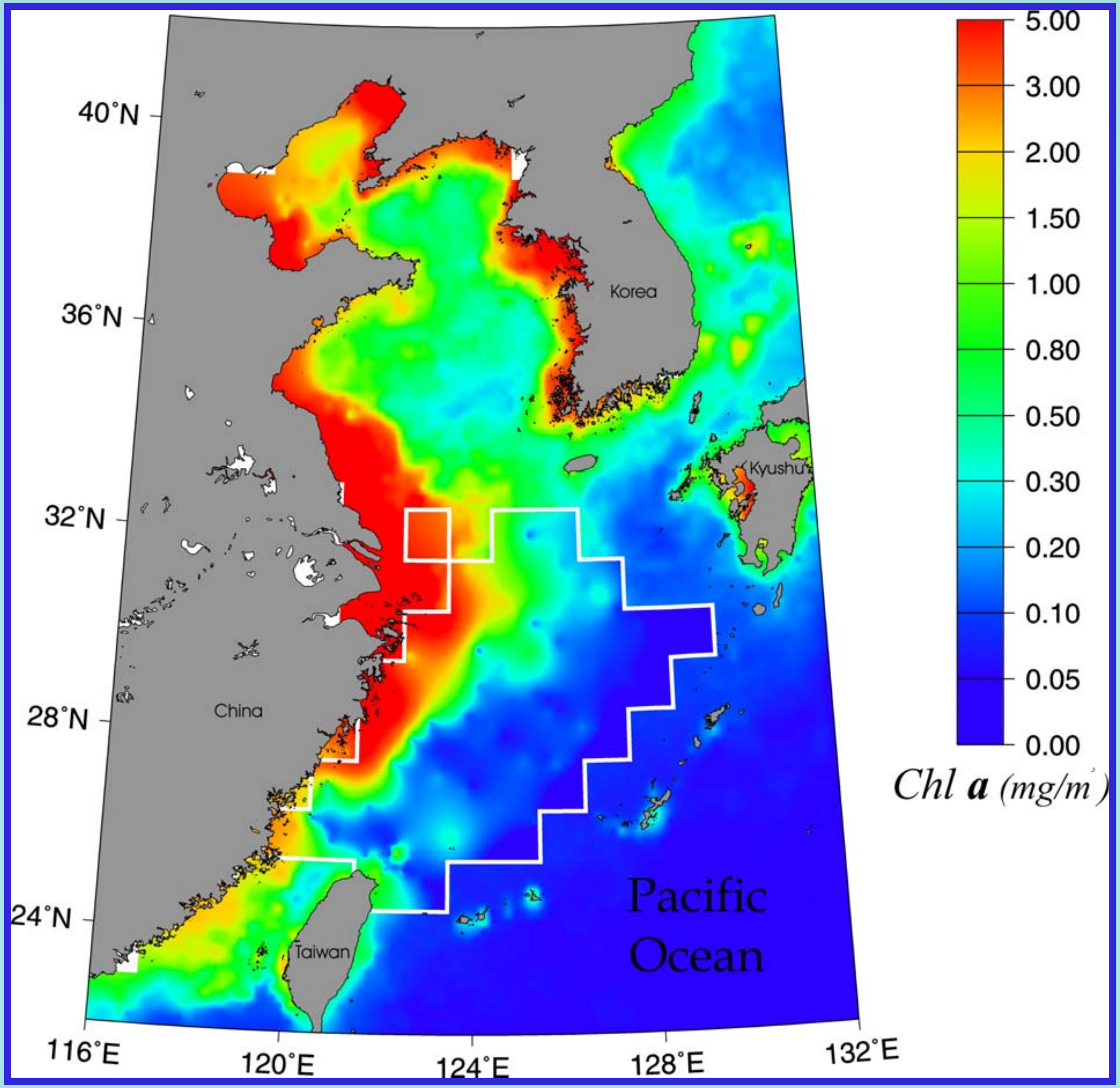


Circulation in ECS and vicinity in summer (Lee & Chao, 2003, Wu, personal communicat., etc)



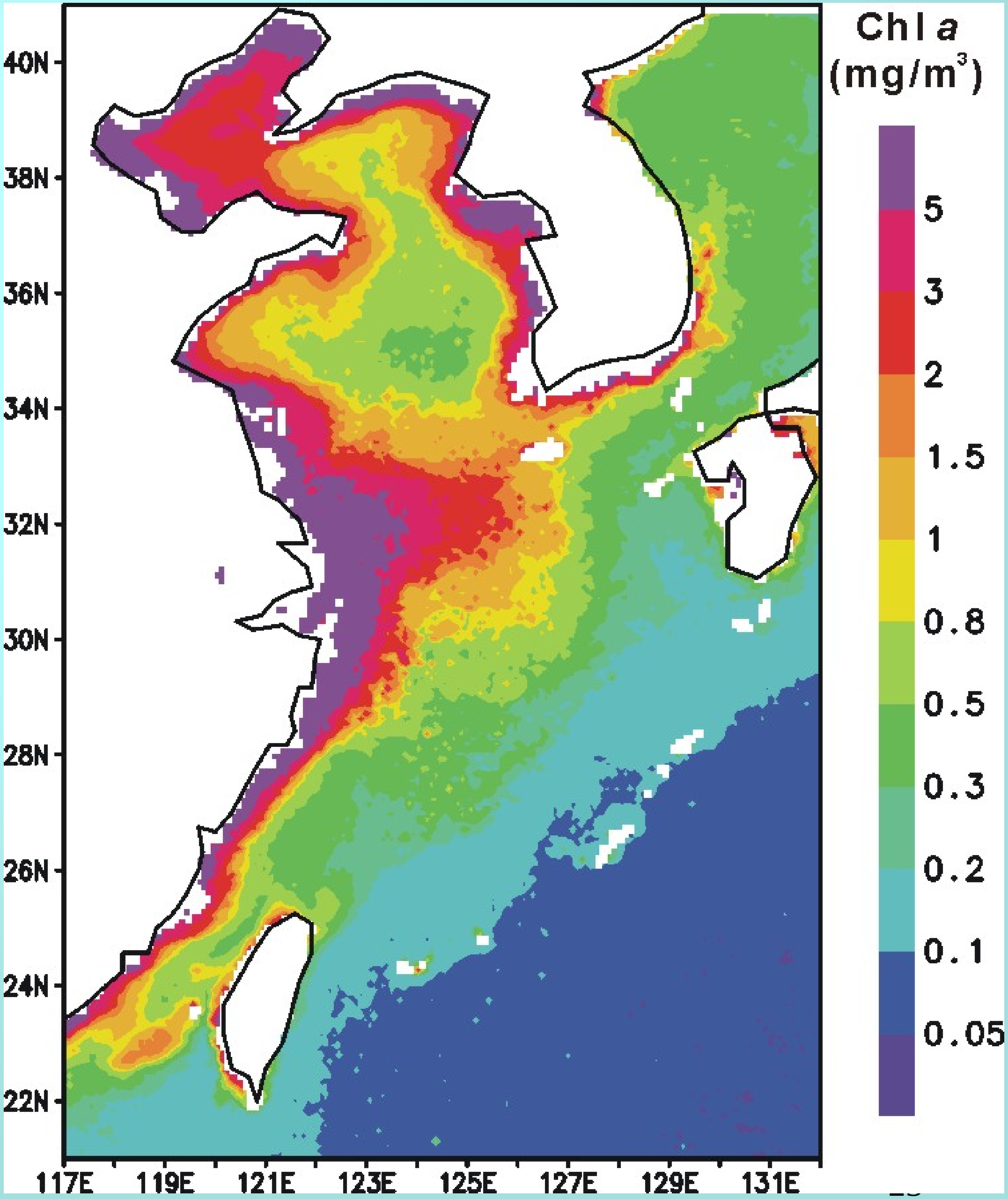


Two-box model



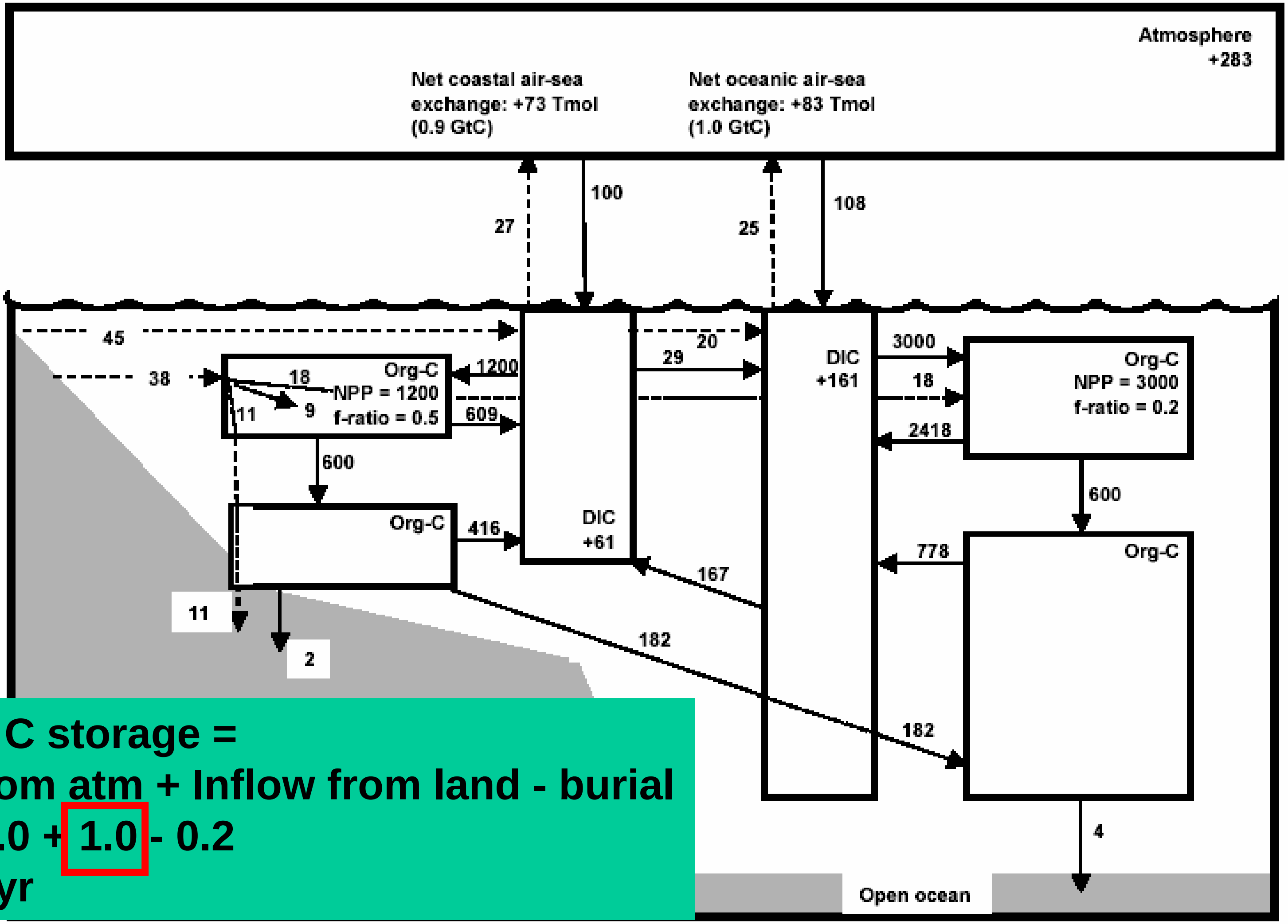
40°N
36°N
32°N
28°N
24°N
116°E
120°E
124°E
128°E
132°E
Korea
Kyushu
China
Taiwan
Pacific Ocean
5.00
3.00
2.00
1.50
1.00
0.80
0.50
0.30
0.20
0.10
0.05
0.00
Chl a (mg/m³)

SeaWiFS Chl in July

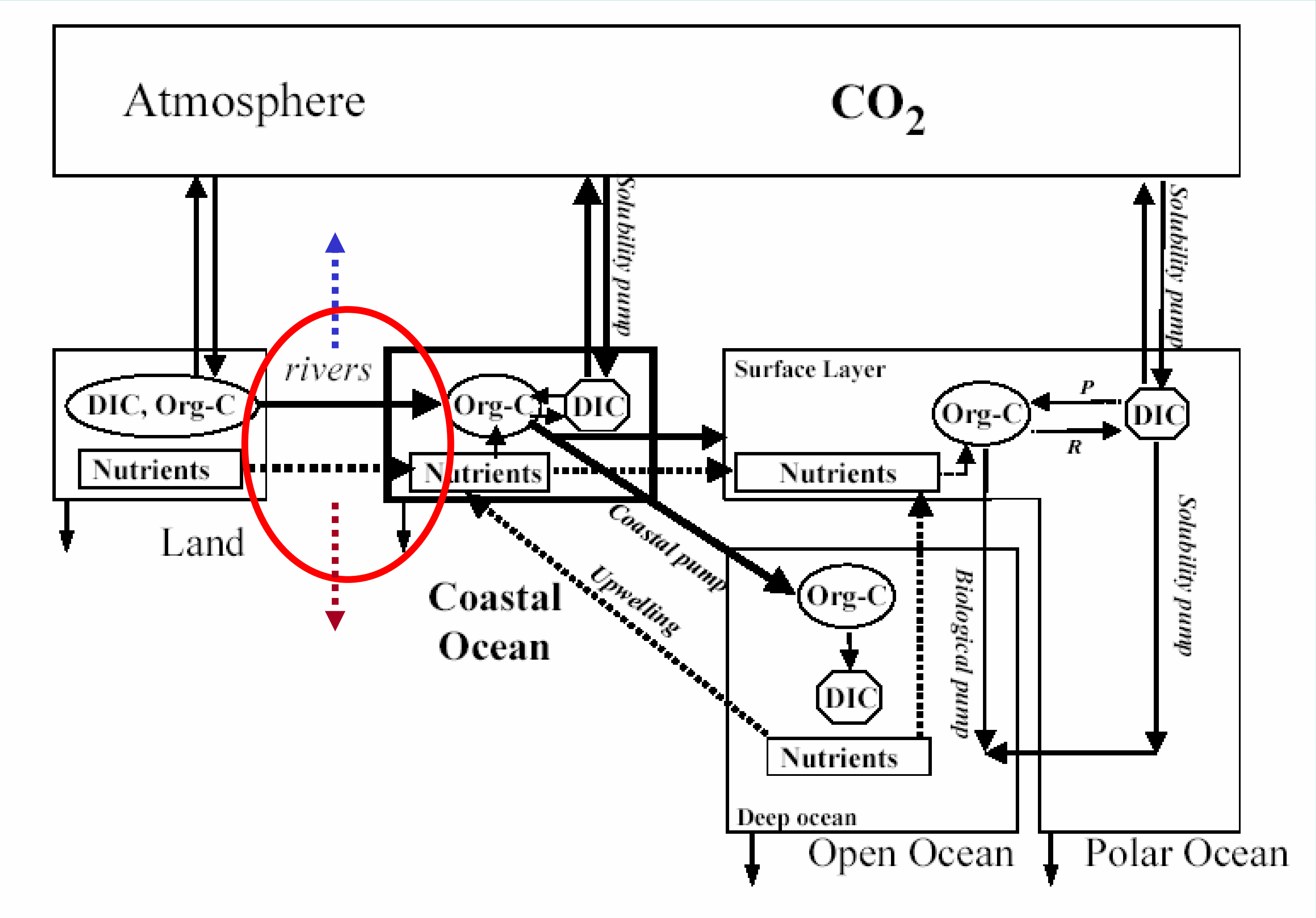


Ocean Carbon Budget (Tmol C/yr)

Ducklow & McCallister (2005) The Biogeochemistry of CO_2 in the Coastal Oceans, The Sea, V. 13, Ch 9.



Oceanic C storage =
Intake from atm + Inflow from land - burial
= 0.9 + 1.0 + 1.0 - 0.2
= 2.7 Gt/yr



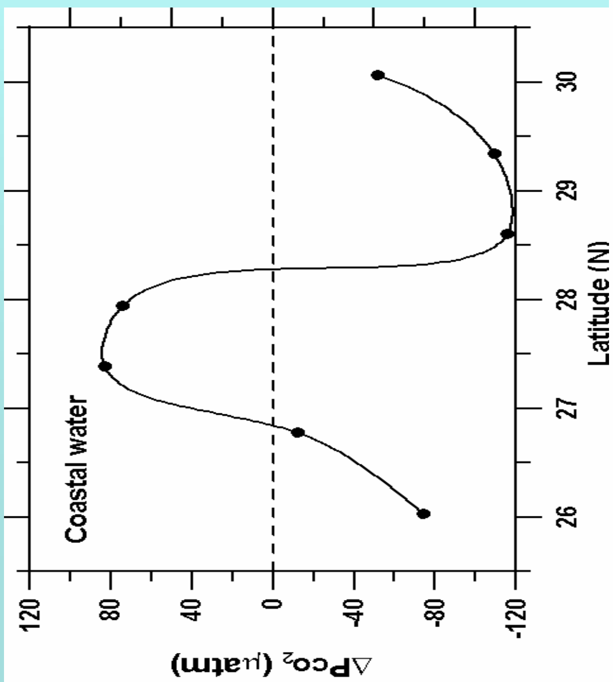
Land-ocean flux a one-way traffic?

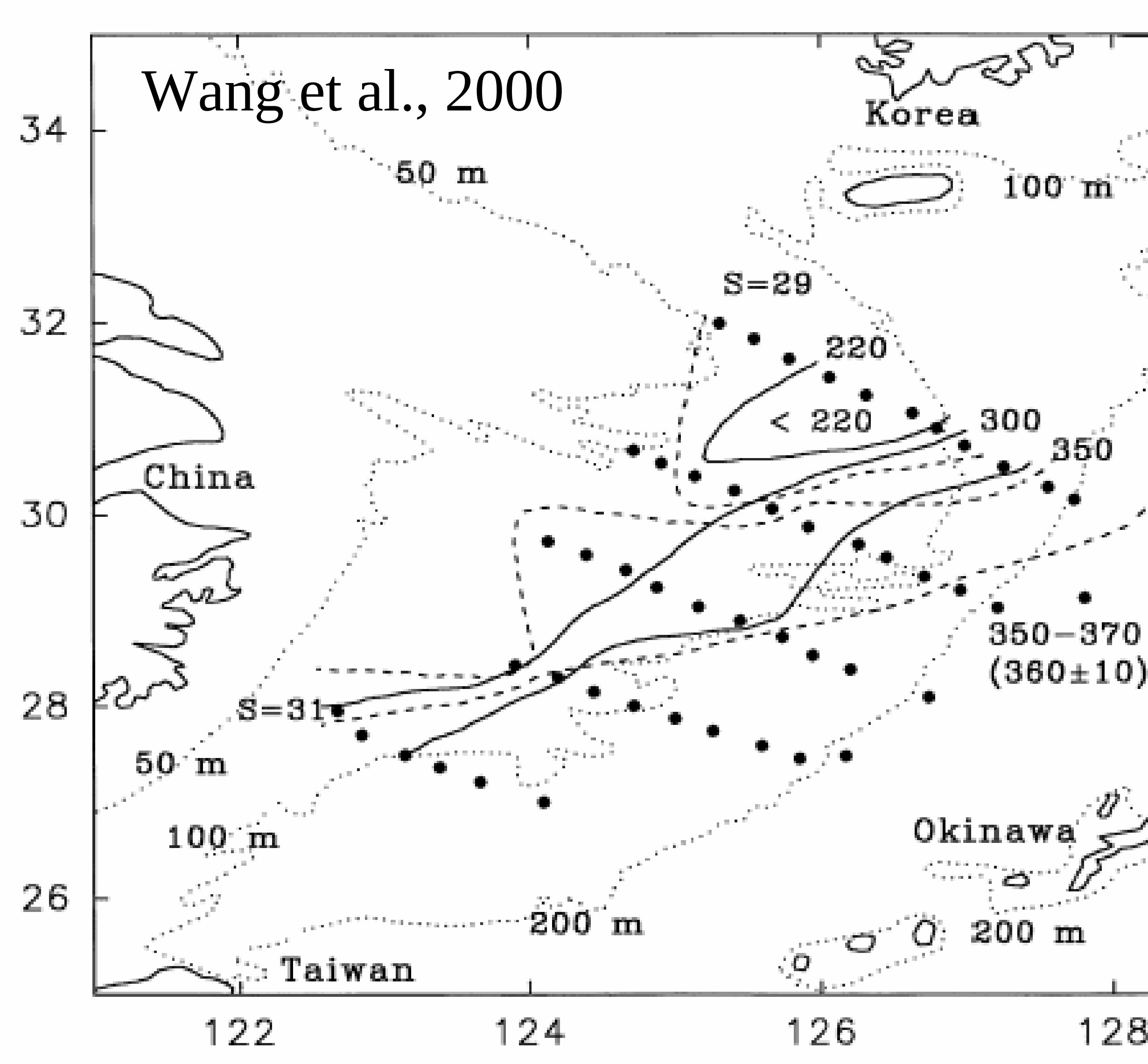
Fate of terrigenous org-C, Fe, ...?

More P_{CO2} in the ECS

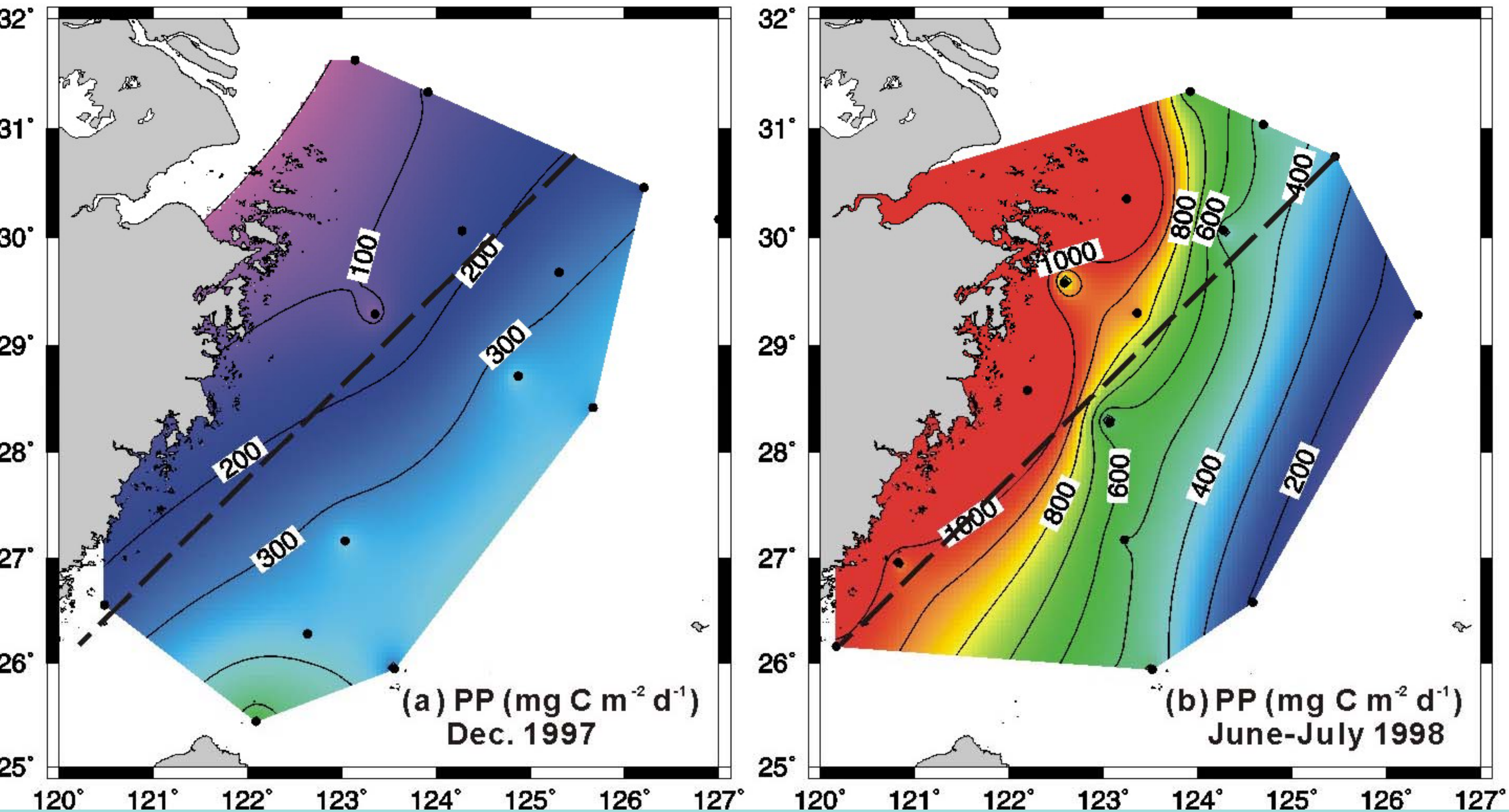
CO_2 uptake:
North:1.5 mol C m^{-2} y^{-1}
South:0.6 mol C m^{-2} y^{-1}

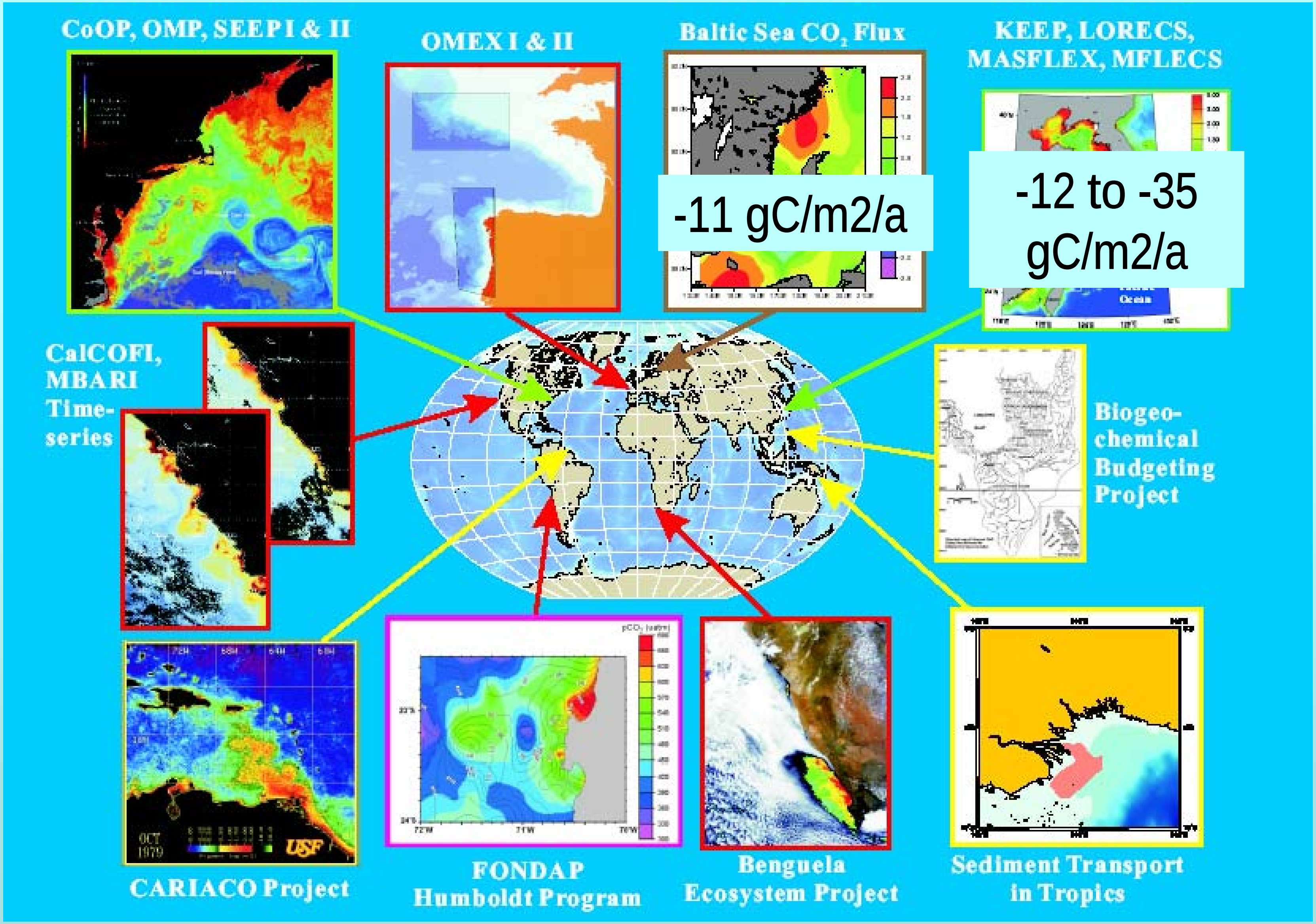
LORECS data along coast (summer)





PP in the ECS (Gong et al., 2003)




CoOP, OMP, SEEP I & II
OMEX I & II
Baltic Sea CO_2 Flux
KEEP, LORECS, MASFLEX, MFLECS
-11 gC/m2/a
-12 to -35 gC/m2/a
CalCOFI, MBARI Time-series
Biogeo-chemical Budgeting Project
CARIACO Project
FONDAP Humboldt Program
Benguela Ecosystem Project
Sediment Transport in Tropics