Carbon flux, distribution and budget with special reference to the fugacity of carbon dioxide (fCO_2) in the SERIES iron fertilization experiment

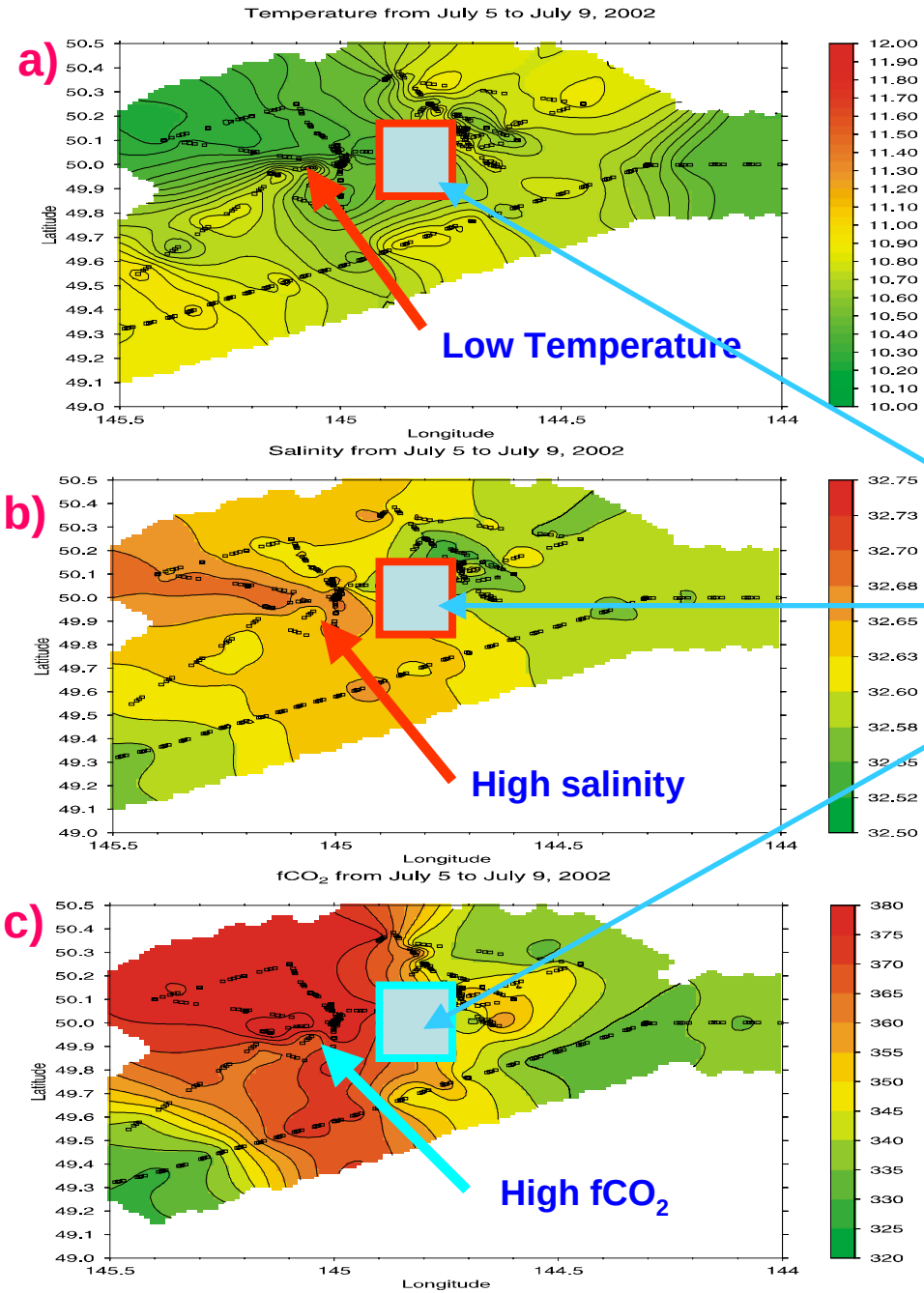
by

Chi Shing Wong*, David Timothy, Cliff Law, Yukihiro Nojiri, Liusen Xie, Shau-King Emmy Wong, John Page.

Climate Chemistry Laboratory/Centre for Ocean Climate Chemistry
DFO Institute of Ocean Sciences
Sidney, B.C. Canada

***Correspondence Author: WongCS@pac.dfo-mpo.gc.ca**

Presenter: Jim Christian, IOS/CCCMA



T, S and fCO_2 background before SERIES (July 5-9, 2002)

Square is the area of SERIES started

Fig. 1. (a), (b), (c). Background survey of temperature (°C), salinity (psu) and sea surface fCO_2 (μatm) before SERIES.

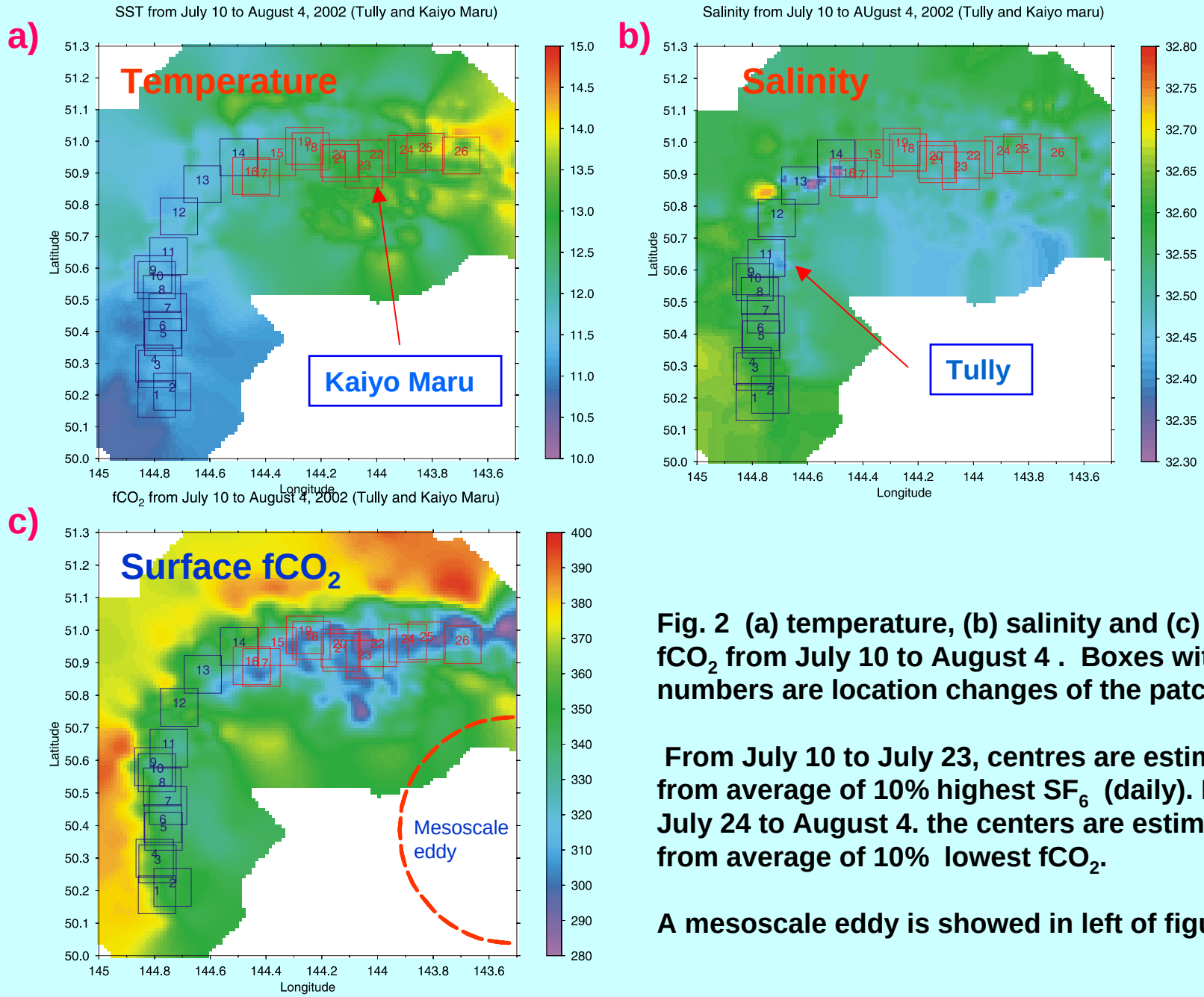


Fig. 2 (a) temperature, (b) salinity and (c) sea fCO_2 from July 10 to August 4 . Boxes with numbers are location changes of the patch center.

From July 10 to July 23, centres are estimated from average of 10% highest SF_6 (daily). From July 24 to August 4. the centers are estimated from average of 10% lowest fCO_2.

A mesoscale eddy is showed in left of figure (c) .

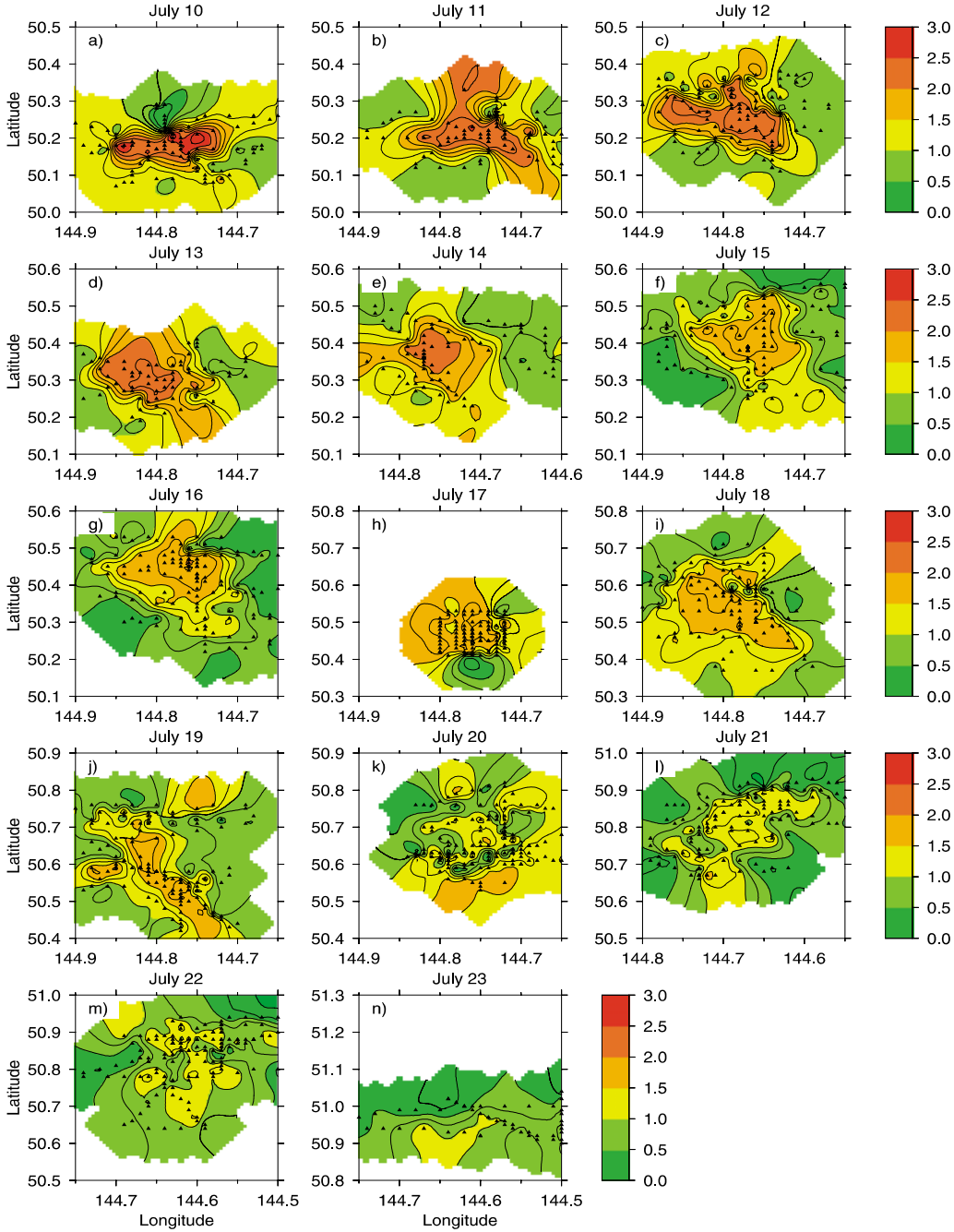


Fig. 3. Daily SF_6 distribution. SF_6 (fmol kg $^{-1}$) has been converted to log_{10} scale. The vertical and horizontal axis indicate latitude and longitude.
Filled triangles represent the ship track.
Because the iron enrichment patch was moving clockwise slowly, each graph is referenced to the patch center for the day.

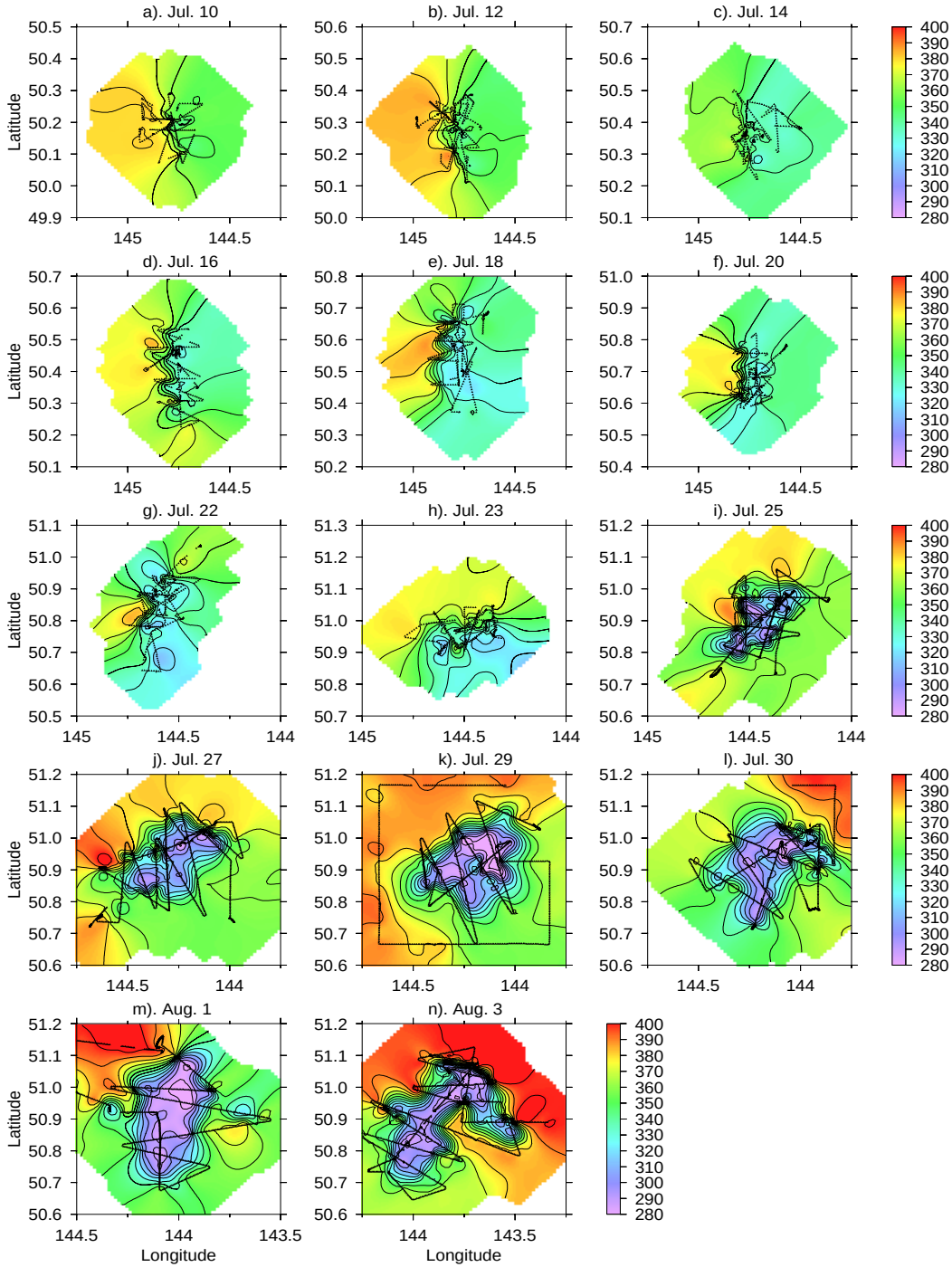


Fig. 4. Daily sea water fCO_2 (µatm) distribution from Tully and Kaiyo Maru. Filled triangles represent the ship track.

Because the iron enrichment patch was moving clockwise slowly, each map is referenced to the patch center for that day.

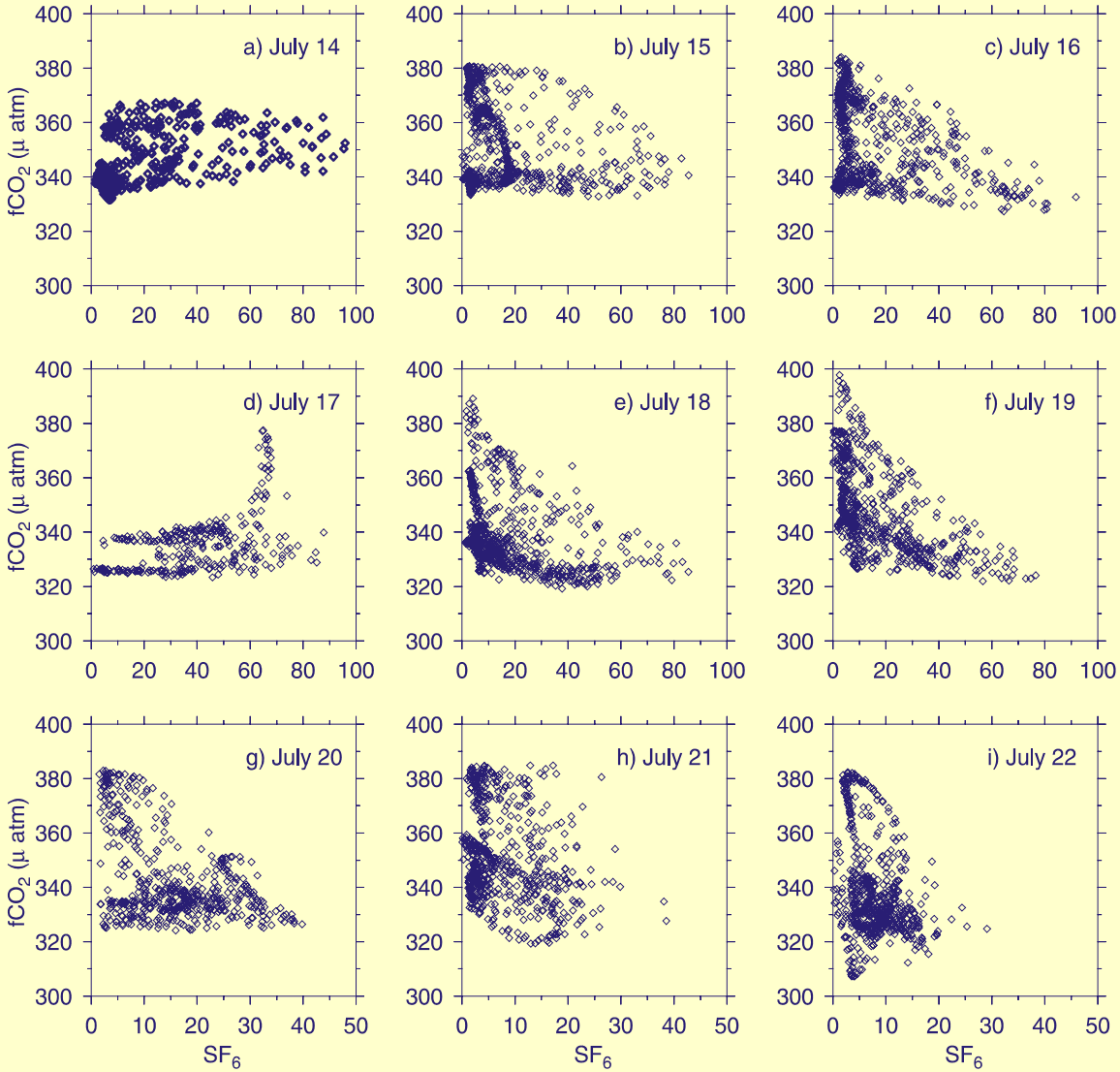


Fig. 5. fCO_2 as a function of the tracer SF_6 for day 5 (July 14) to day 13 (July 22).

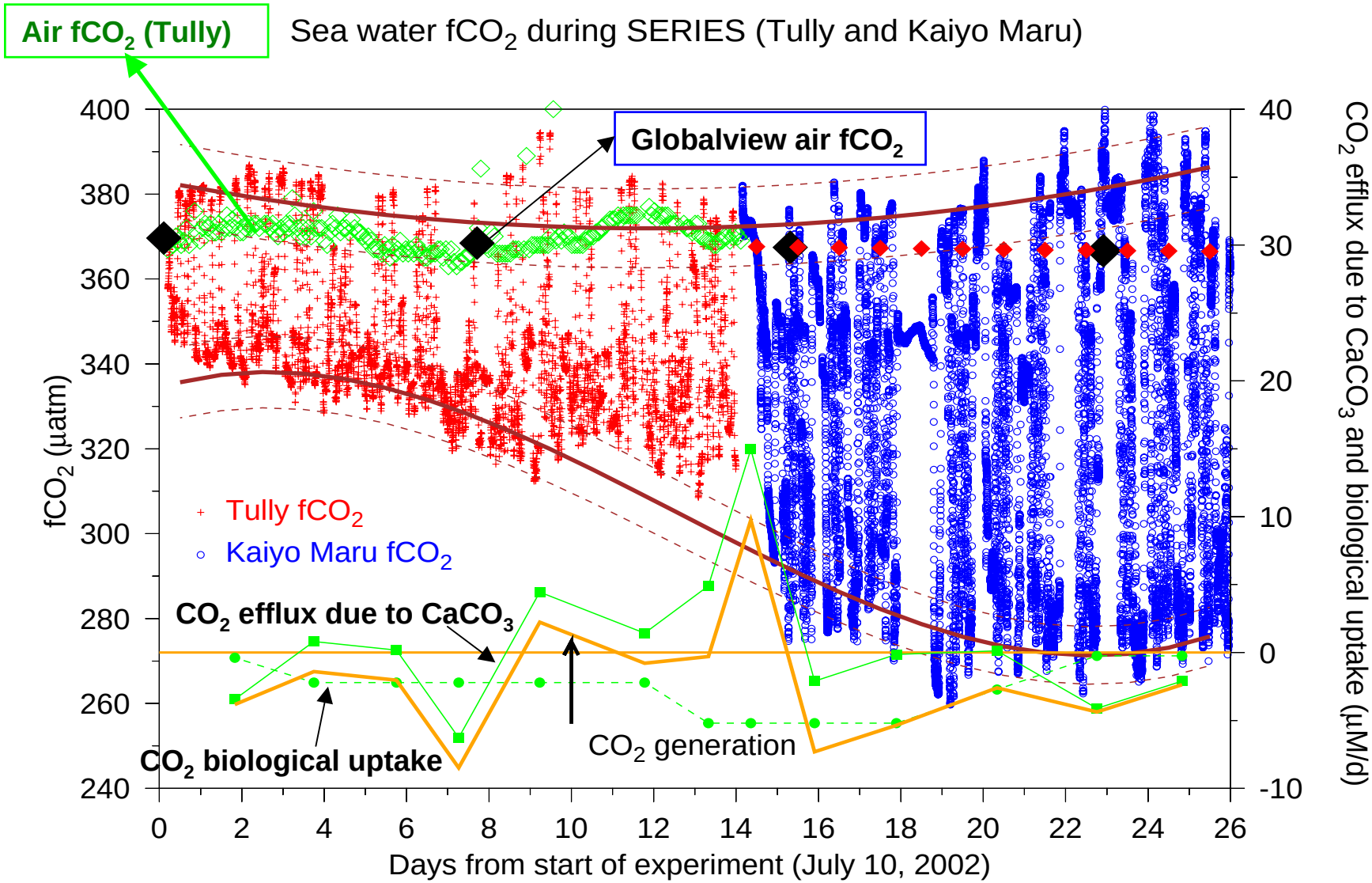


Fig. 6. Evolution of the air and sea surface fCO_2. The solid brown lines are the fitted lowest and highest fCO_2. Green diamonds are air fCO_2 from Tully, black diamonds from NOAA Globalview and red diamonds interpolated Globalview air fCO_2 for different latitude and month. Solid green line is CO_2 efflux due to $CaCO_3$ formation, solid orange line CO_2 change due to biological uptake, and broken green line total CO_2 change from efflux and uptake.

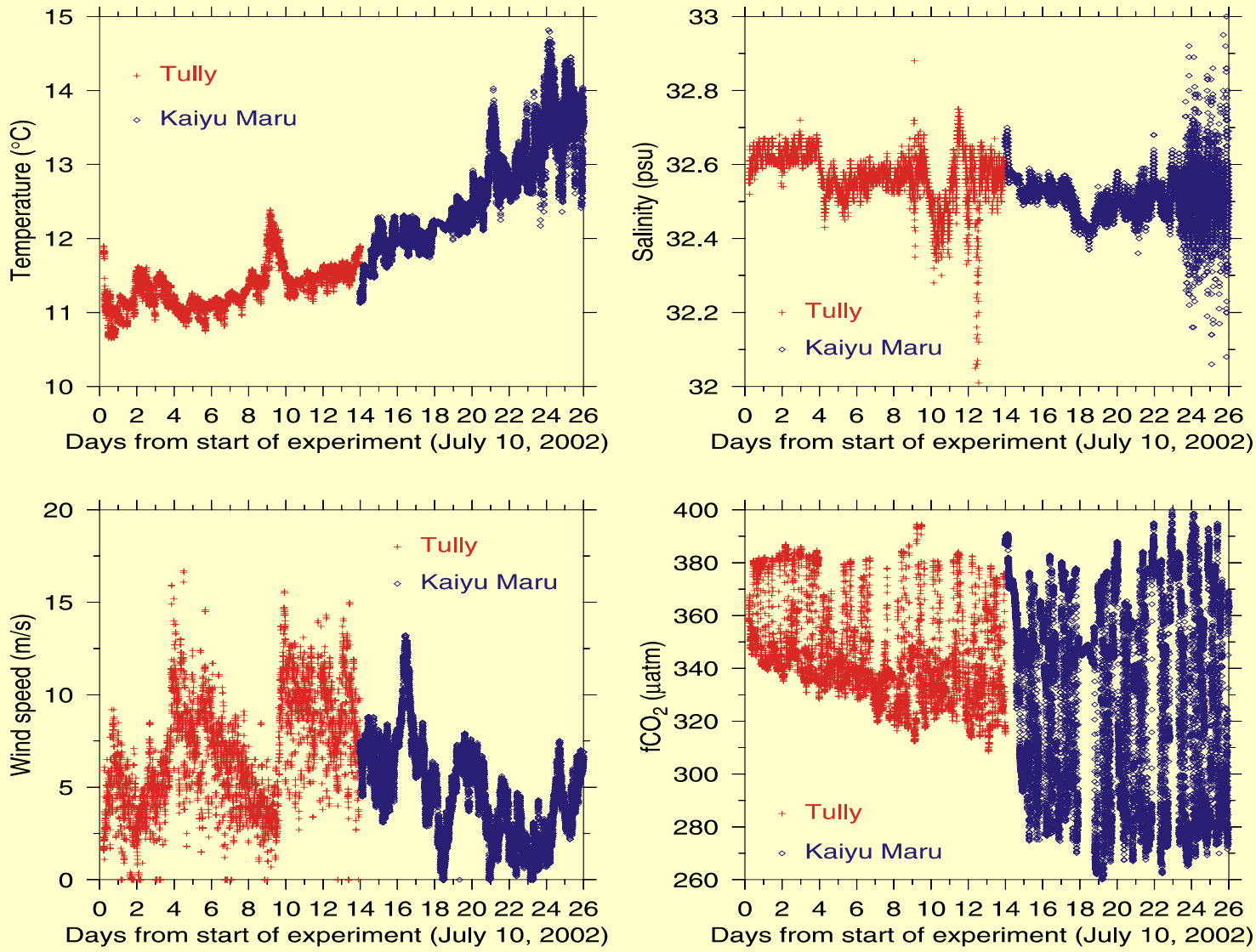


Fig. 7. Time-series of temperature, salinity and fCO_2. include data from Tully (red) and Kaiyo Maru (blue).

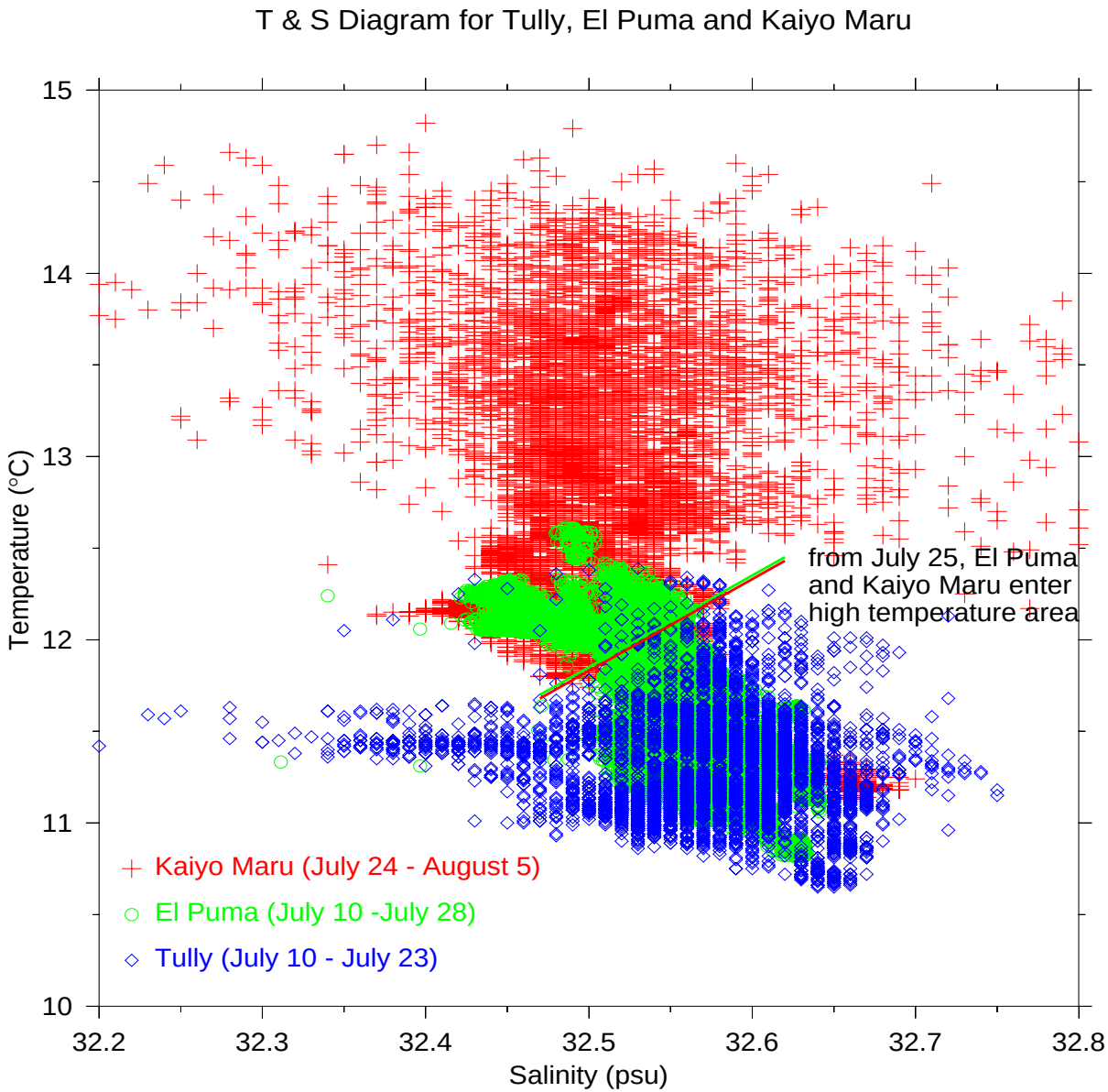


Fig. 8. T & S Diagram for Tully, El Puma and Kaiyo Maru.

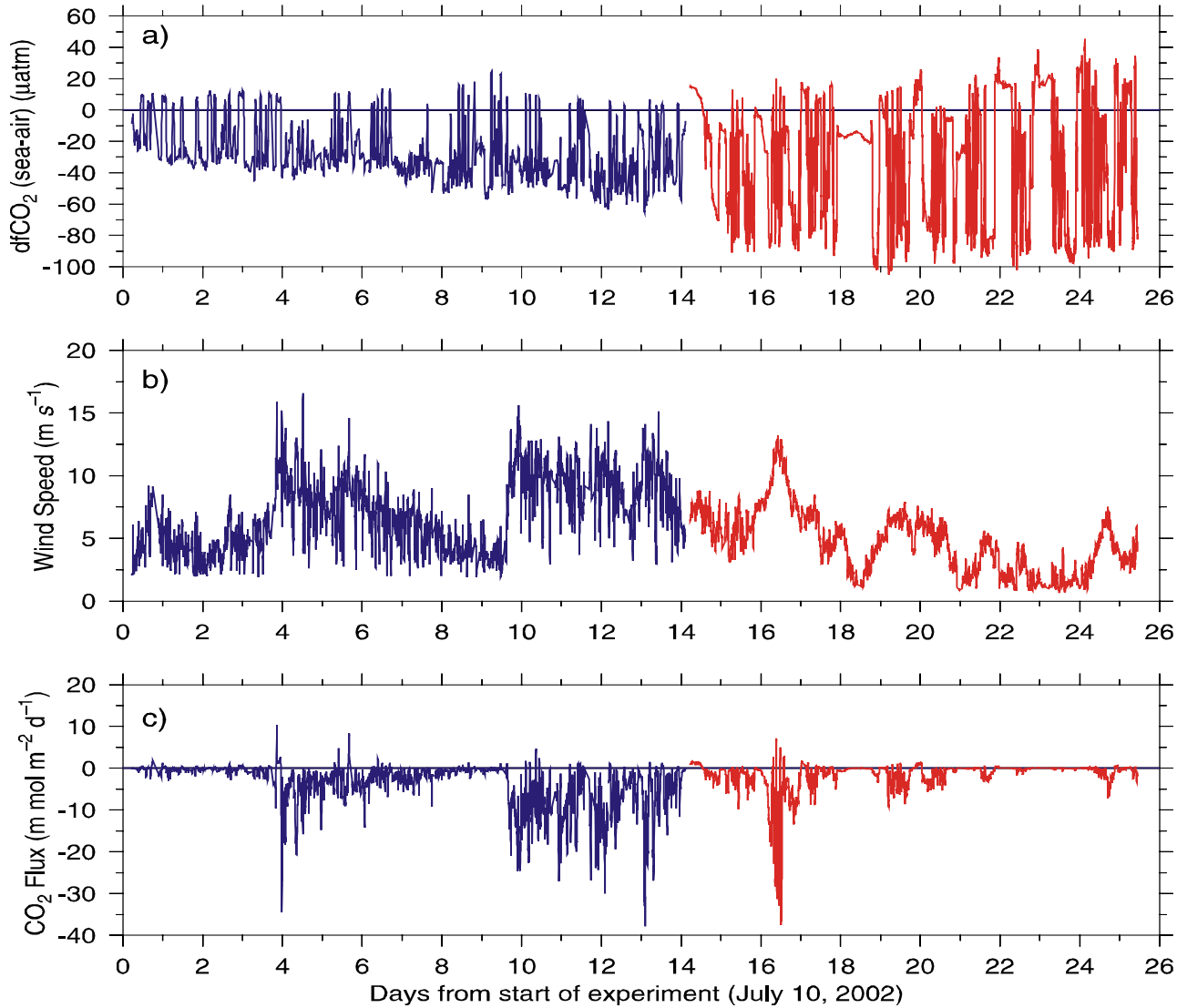
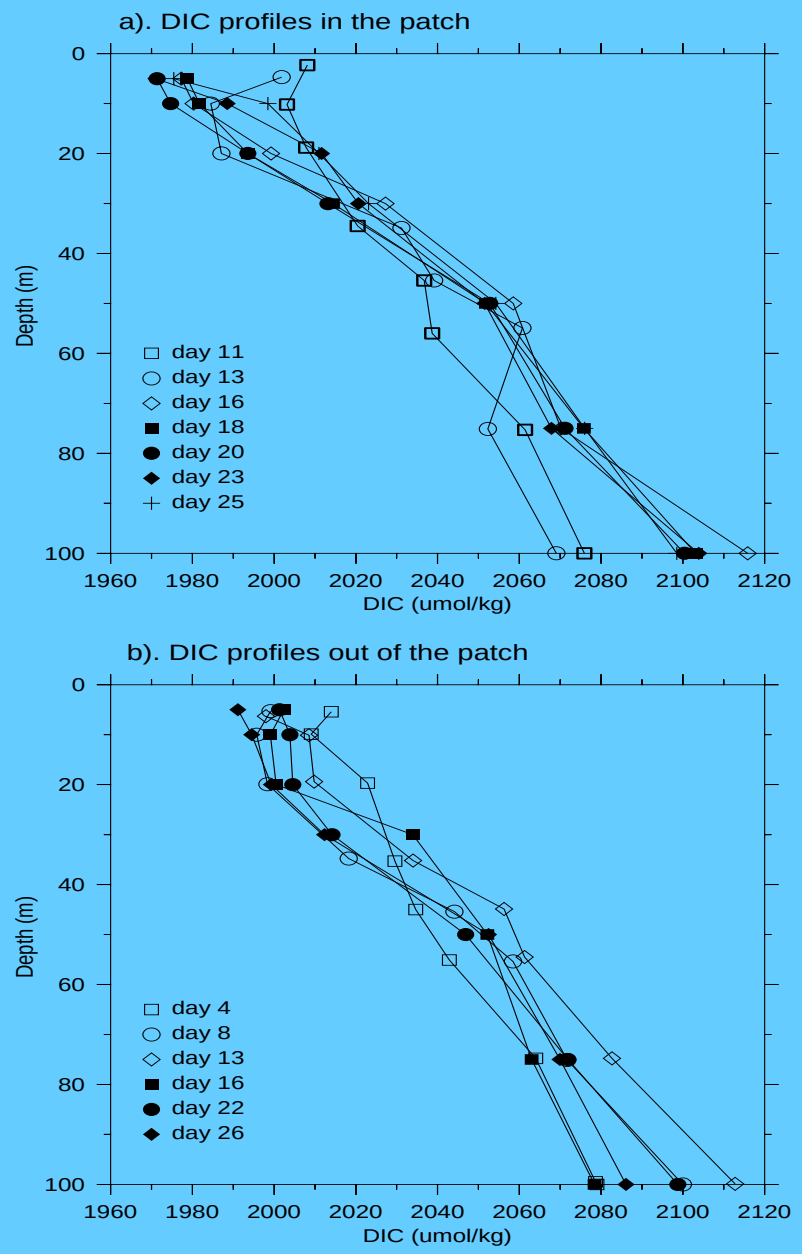


Fig. 9 **(a) fCO_2 difference between air and sea, (b) wind speed, (c) air-sea CO_2 flux which is estimated from Wanninhkof cubic wind speed relationship for Tully (blue) and Kaiyo Maru (red)**



DIC inside the iron patch

DIC Outside the iron patch

Fig. 10. DIC profile inside the iron patch (a) and outside the iron patch (b)

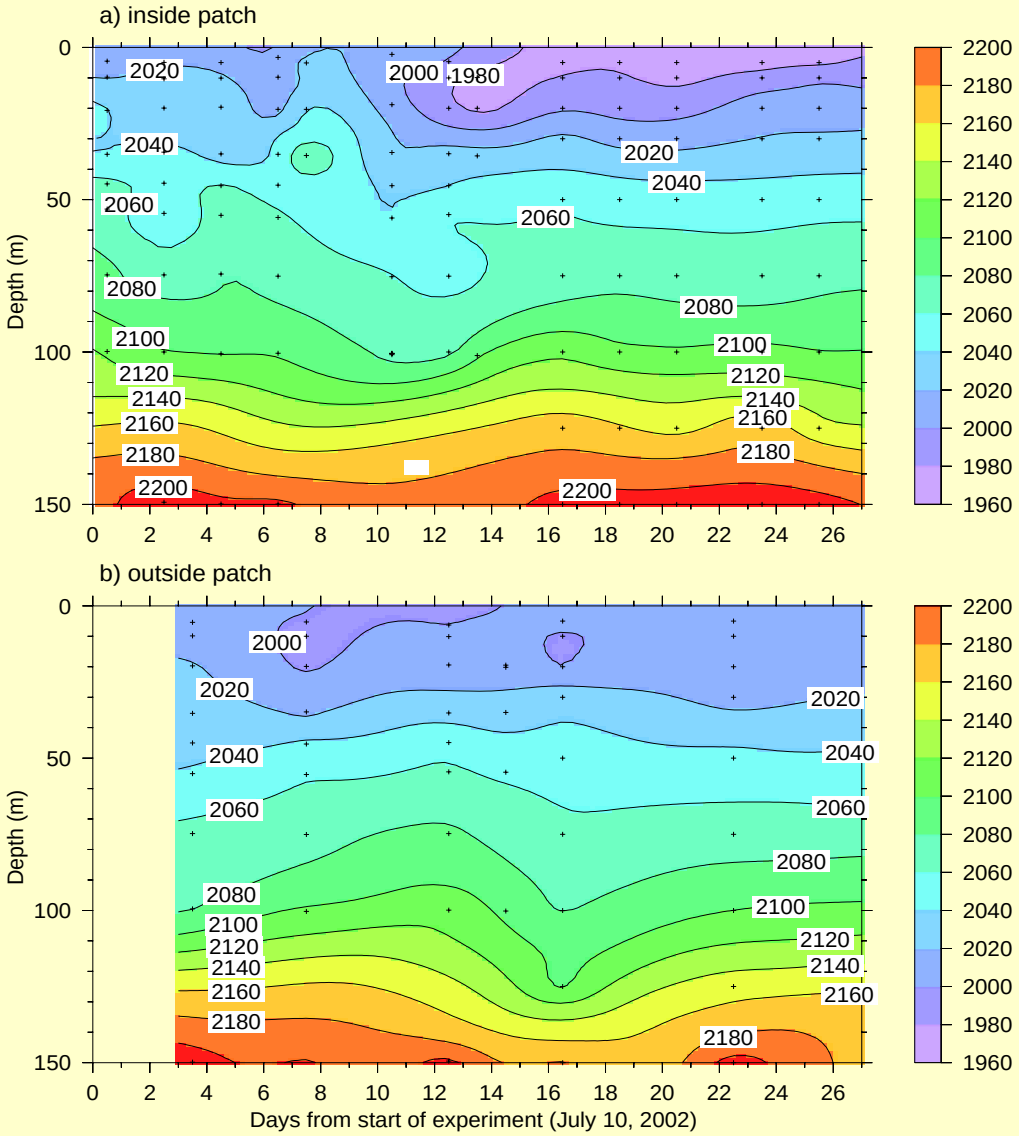
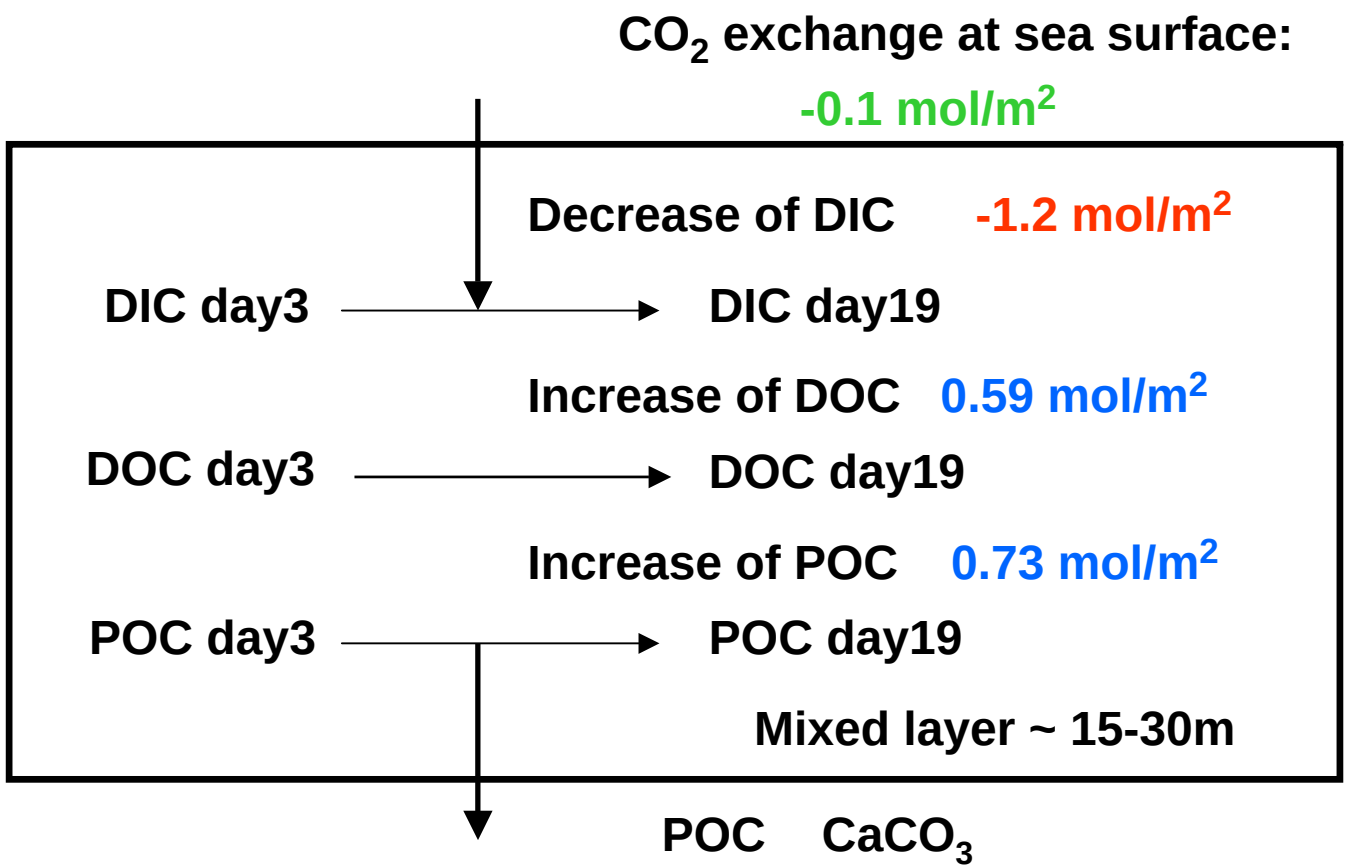


Fig. 11. The vertical evolution of dissolved inorganic carbon (DIC) (μmol kg $^{-1}$) inside and outside the iron patch for day 0 of iron injection to Day 26 when Kaiyo Maru left the site.

Fig. 12 Carbon budget and flux change in the patch during SERIES



Inorganic C budget = -1.20 + (-0.1) = -1.3 mol/m^2

Organic C budget = 0.73 + 0.59 + 0.28 + 0.16 = 1.76 mol/m^2

CONCLUSIONS:

The iron patch, marked by SF_6 expands due to mixing as it was moving clockwise along the arm of an eddy, first compressed in a north-south direction, then in an east-west direction.

The fCO_2 evolved with

(1) formation of $CaCO_3$ shells by *E. Huxleyi*

(2) export of POC (diatoms)

(3) storms, change in wind speed and

(4) loss of iron due to mixing and detritus flux out of the mixed layer

The decrease in DIC in the upper 30 m balanced the increase in DOC, with uncertainty of the carbon content in different plankton species and the state of health of the plankton community.