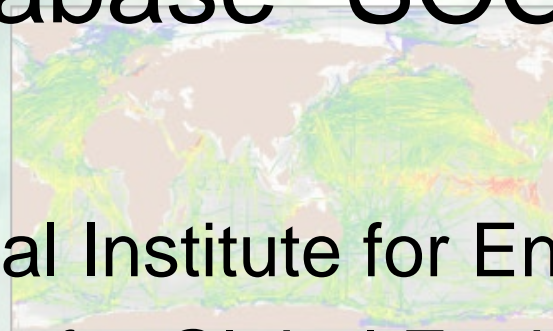


Welcome to SOCAT
A Collection of Surface Ocean CO₂
Observations Quality Controlled by the
Science Community

Evaluation of oceanic CO₂ uptake based on global pCO₂ observation database "SOCAT"



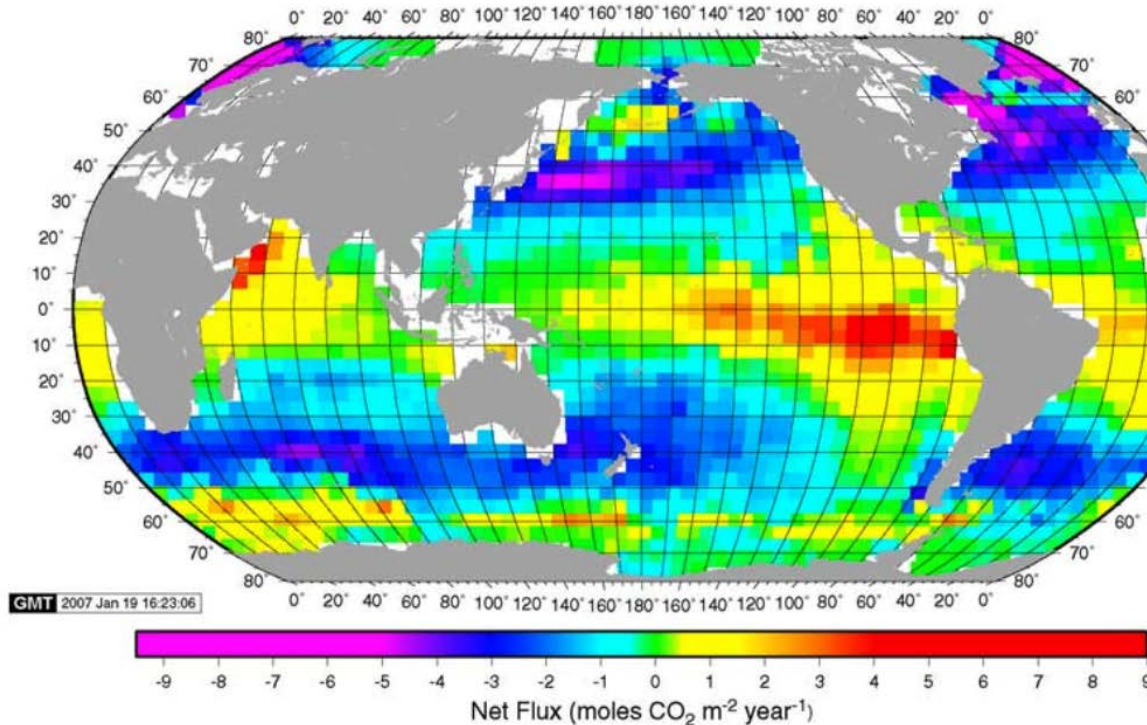
National Institute for Environmental Studies
Center for Global Environmental Research

Shin-ichiro Nakaoka

- Data Set Viewer
- Gridded Data Viewer
- Table of Data Sets
- Data Download
- Data Upload and
- Fair Data Use
- Products using SOCAT
- SOCAT Credits
- SOCAT Version 3

- About
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- SOCAT Help:
 - Videos
 - FAQ
 - Questions

Motivations for pCO₂ observation



Anthropogenic oceanic
CO₂ exchange:
 $-1.6 \pm 0.9 \text{ PgC yr}^{-1}$

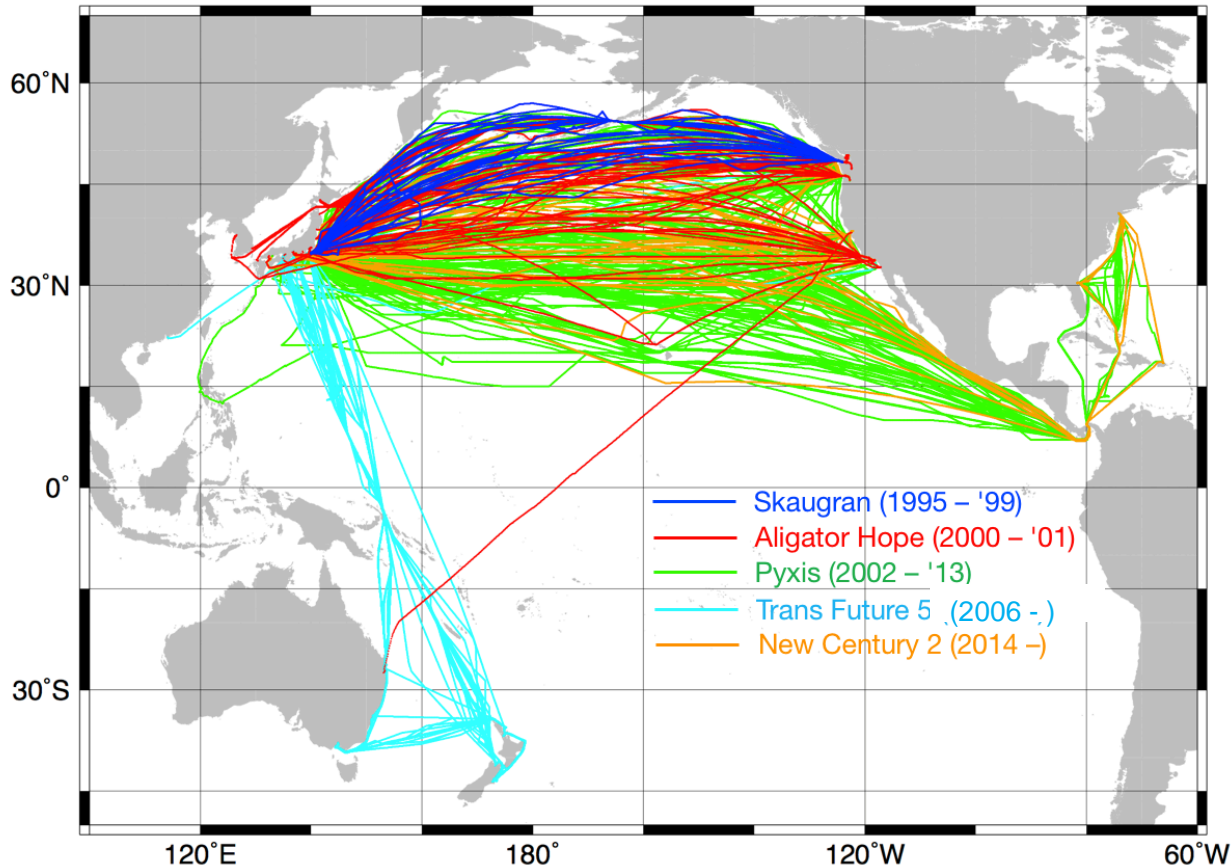
Fig. Climatological annual mean sea-air CO₂ flux distribution

Takahashi et al. (2009, DSR II)

- Long-term (~35yr) monthly mean pCO₂ and sea-air CO₂ flux

Knowledge of their Inter-annual variability are still insufficient

NIES VOS measurements for CO₂



Pros

- Frequent measurements
- (relatively) low cost

Cons

- Difficult to make obs. in hydrographic cast
- Obs. routes depends on country's trade circumstances

Combination of VOS and research vessel's observations is crucial.

NIES VOS measurements for pCO₂

New Century 2
(Kagoshima-senpaku Co.)



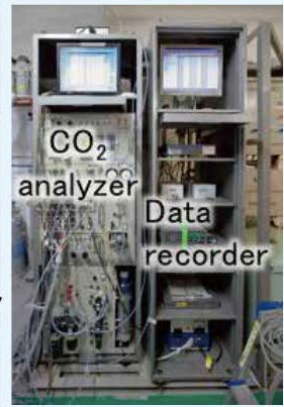
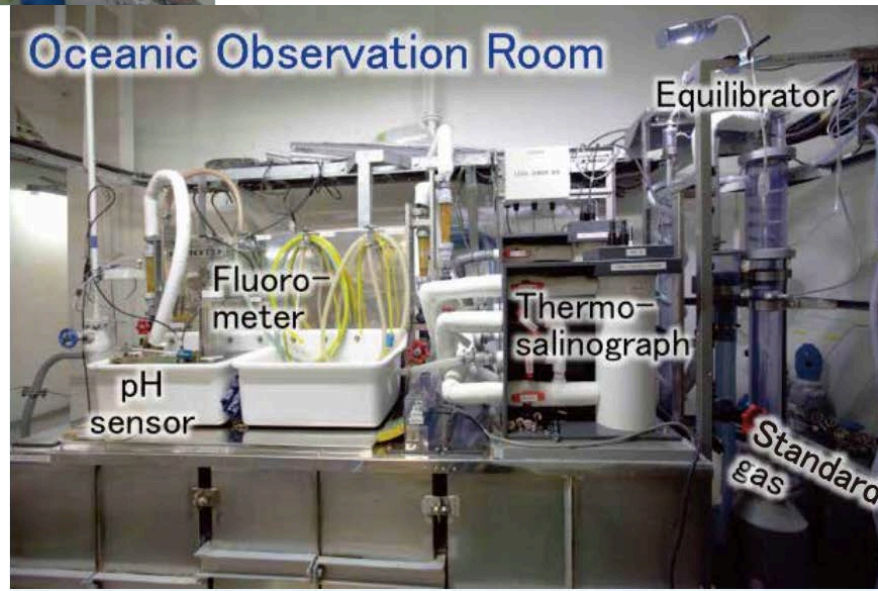
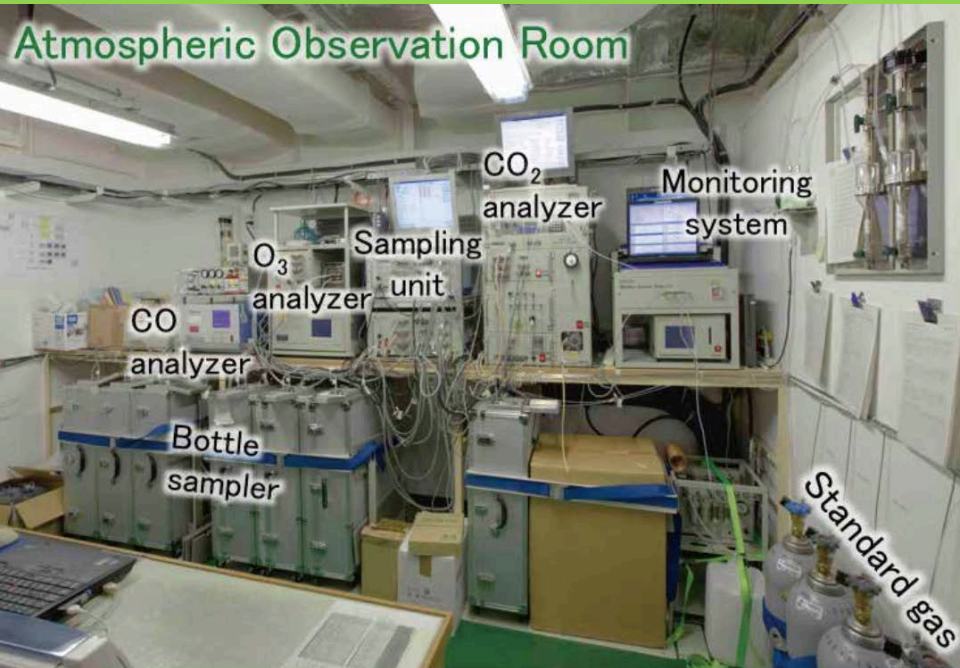
Trans Future 5 (Toyofuji Shipping Co.)



Course: Toyohashi ~ U.S west/east cst.
Term: 4 (west cst.) ~ 8 weeks (east cst.)
Start since: Apr. 2014 ~

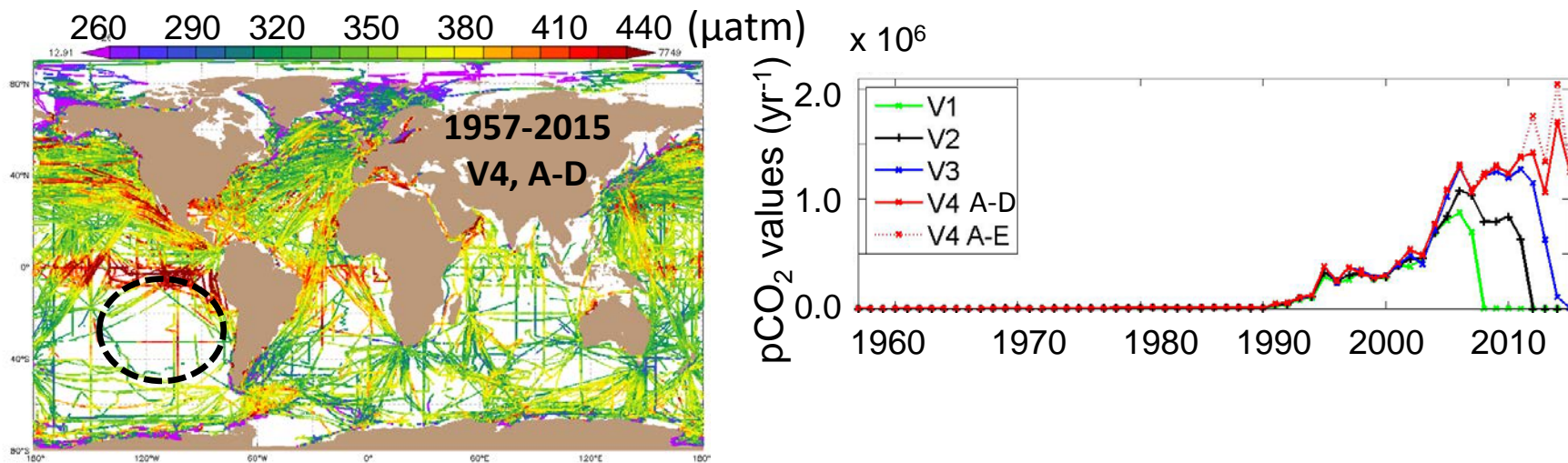
Course: Nagoya ~ Aus. ~ NZ
Term: 6 weeks
Start since: Feb. 2006 ~

NIES VOS measurements for pCO₂



International pCO₂ database “SOCAT”

Downloadable at <http://socat.info> in text, NetCDF, ODV, Matlab



Global synthesis and gridded products of surface ocean pCO₂ or fCO₂ (fugacity of CO₂) in uniform format with quality control;

Interactive online viewers;

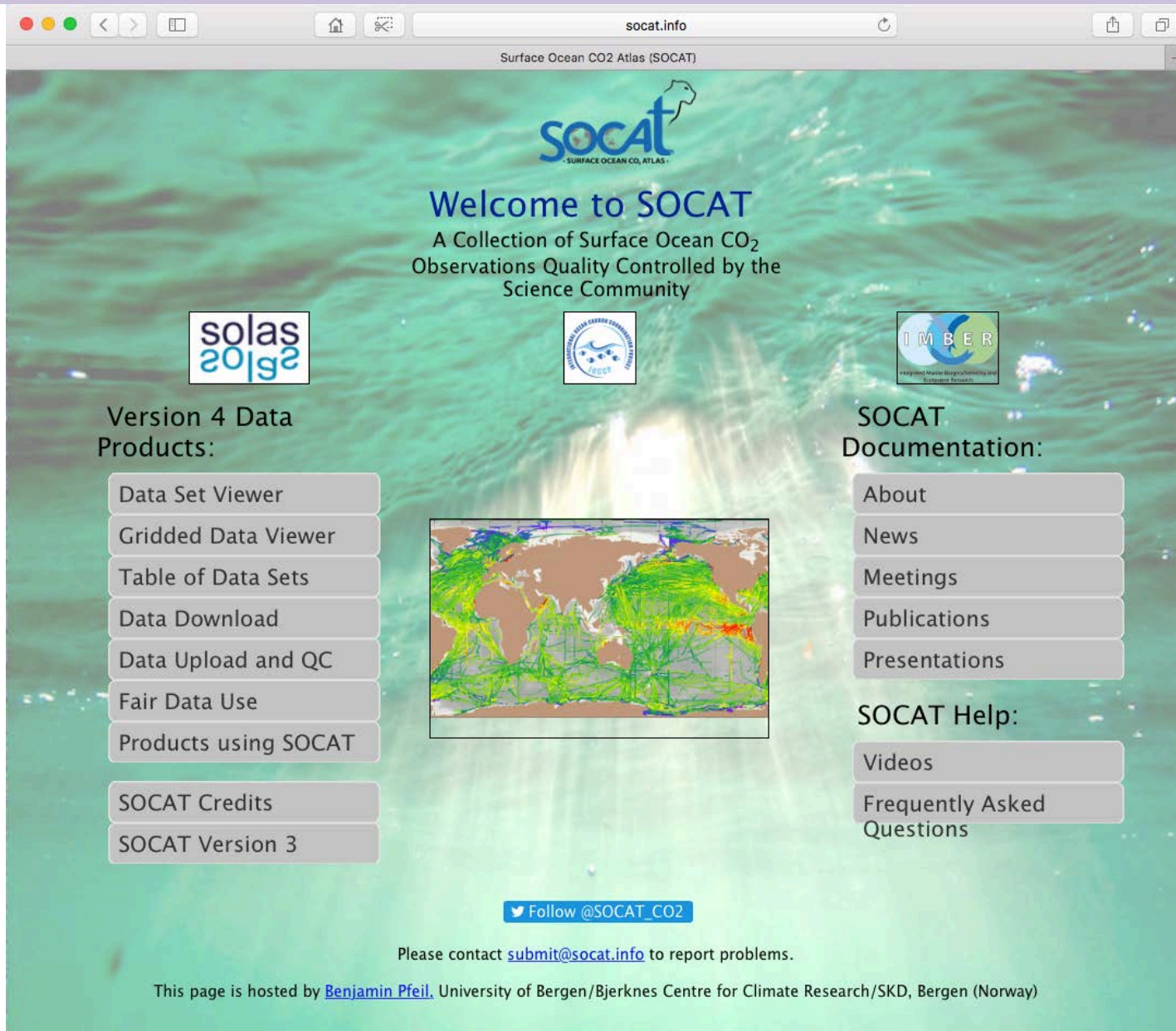
V4: 18.5 million fCO₂ values, accuracy < 5 μatm from 1957-2015 (flags of A-D);

Plus calibrated sensor data (< 10 μatm, flag of E);

Documented in ESSD articles;

Community activity with >100 contributors worldwide.

International pCO₂ database “SOCAT”



The screenshot shows the SOCAT website interface. At the top, the browser address bar displays "socat.info" and the page title is "Surface Ocean CO2 Atlas (SOCAT)". The main heading reads "Welcome to SOCAT" followed by "A Collection of Surface Ocean CO₂ Observations Quality Controlled by the Science Community". Logos for SOLAS 2013, IOC, and IMBER are visible. The page is organized into three main columns of navigation links. The left column lists "Version 4 Data Products" and "SOCAT Credits". The center column features a world map with green and yellow data points. The right column lists "SOCAT Documentation" and "SOCAT Help". At the bottom, there is a Twitter follow button and contact information.

Surface Ocean CO₂ Atlas (SOCAT)

socat
- SURFACE OCEAN CO₂ ATLAS -

Welcome to SOCAT

A Collection of Surface Ocean CO₂ Observations Quality Controlled by the Science Community

solas 2013

IOC

IMBER
Integrated Marine Biogeochemistry and Ecosystem Research

Version 4 Data Products:

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SOCAT Credits

- SOCAT Version 3

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- Presentations

SOCAT Help:

- Videos
- Frequently Asked Questions

[Follow @SOCAT_CO2](#)

Please contact submit@socat.info to report problems.

This page is hosted by [Benjamin Pfeil](#), University of Bergen/Bjerknes Centre for Climate Research/SKD, Bergen (Norway)

International pCO₂ database “SOCAT”

ferret.pmel.noaa.gov

LAS UI

Live Access Server

SOCAT Fair Data Use Statement

OPeNDAP (F-TDS) / THREDDS


Help

SOCAT Data Viewer

Data Set: Update Plot

One Plot Annotations

Plot Options



90 N
180 W 180 E
80 S

Start date/time: 1957 Jan 01
End date/time: 2016 Dec 31

Maps

Latitude-Longitude

My selections:

WOCE_CO2_water = 2
 fCO2_recommended != NaN

Select:

by Dataset

by Region

by Metadata

investigators
 organization
 QC flag
 SOCAT version
 vessel name

Keifu Maru II
Knorr
Kofu Maru
L Astrolabe
L Alalante

Print... Link... Animate Correlation Viewer Google Earth Show Values Export to Desktop Application Save As... Table of Datasets Thumbnails

DATA SET: SOCAT v4 Data Collection

VARIABLE: fCO₂ recommended (µatm)

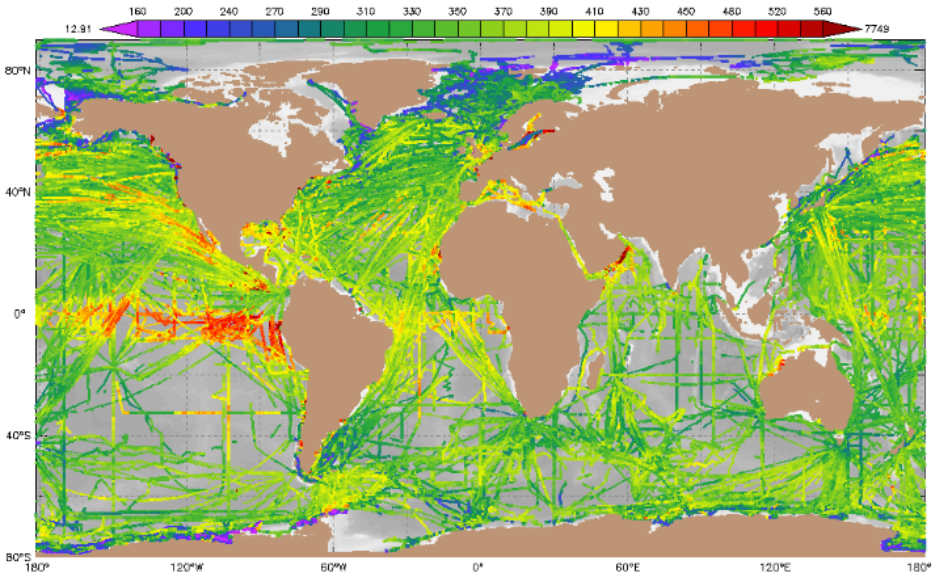
01-Jan-1957 00:00 to 31-Dec-2016 00:00

OPeNDAP URL: <http://ferret.pmel.noaa.gov/socat/erddap/tabledap>

- 4277 trajectories shown
- Data subsampled for efficiency ([explanation](#))
- Where fCO₂_recommended is valid
- Where WOCE CO2 water is 2

LAS 8./Ferret 7 NOAA/PMEL

Print + fCO₂ recommended

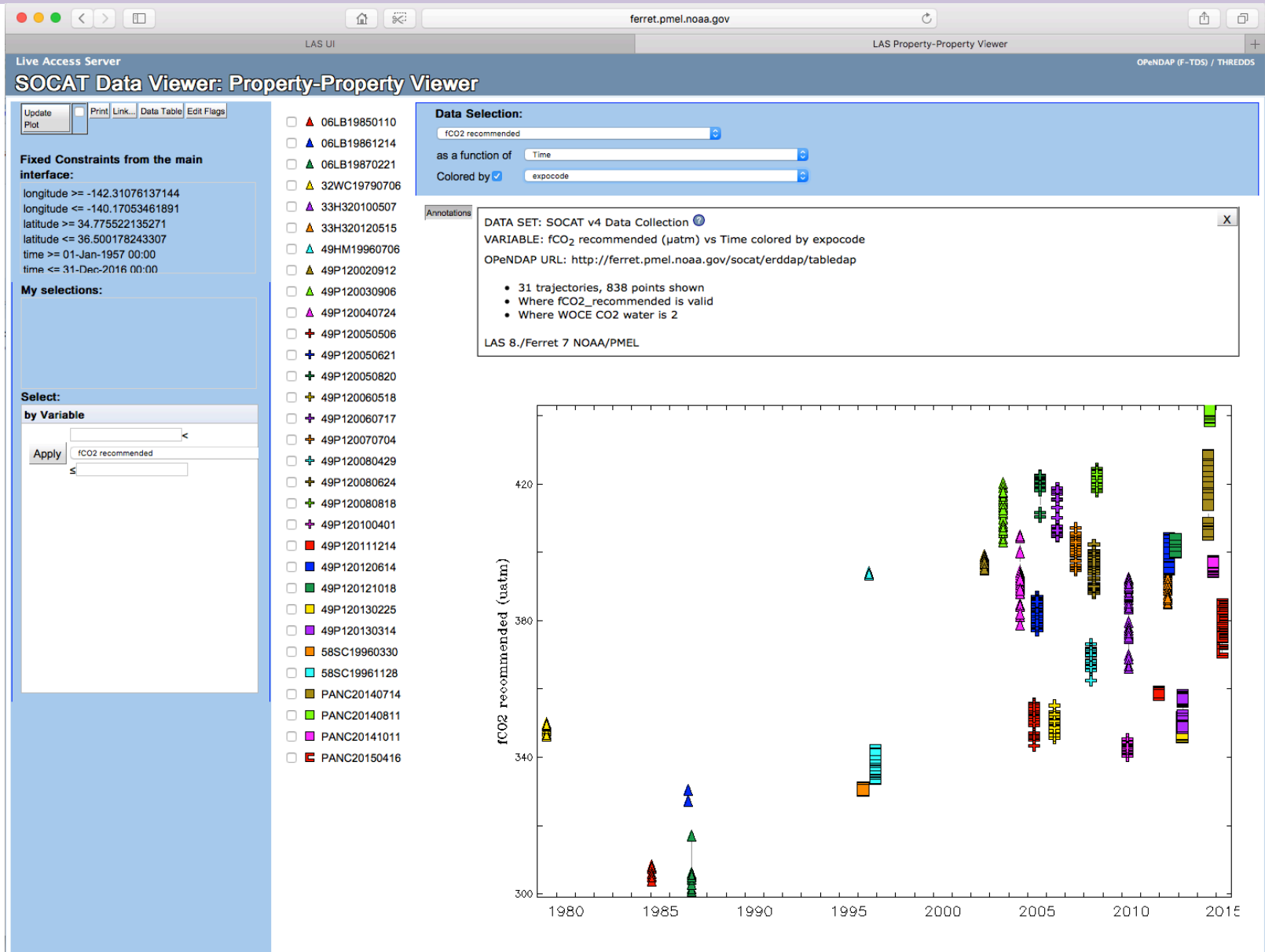


12.91 160 200 240 270 290 310 330 350 370 390 410 430 450 480 520 560 7749

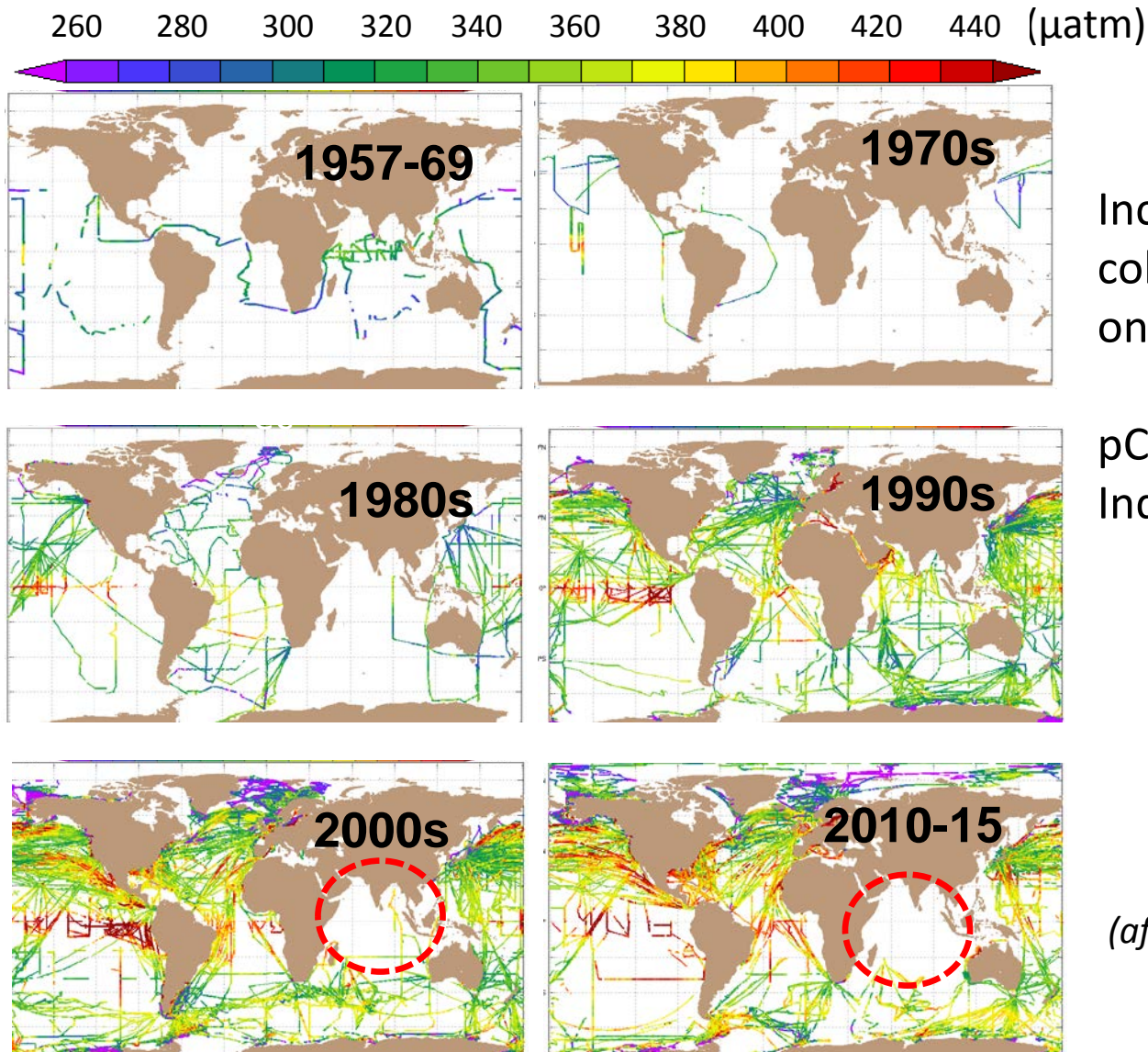
80°N
40°N
0°
40°S
80°S

180° 120°W 60°W 0° 60°E 120°E 180°

International pCO₂ database "SOCAT"



International pCO₂ database “SOCAT”

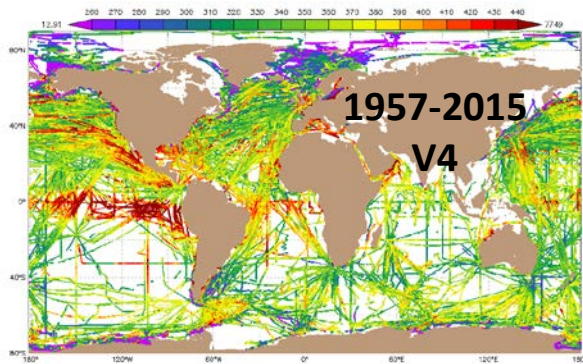


Increase in pCO₂ data collection from 1990s onwards.

pCO₂ are not sampled in the Indian Ocean after 2000.

(after Bakker et al., 2016 ESSD)

pCO₂ Mapping and evaluation of CO₂ flux

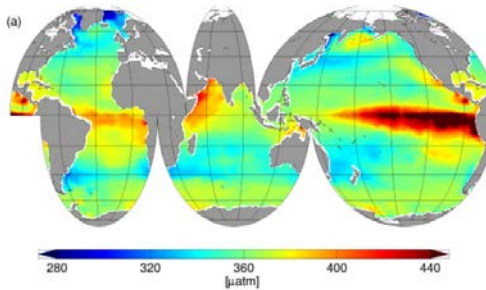


A synthesis data product



after Bakker et al., 2016 ESSD

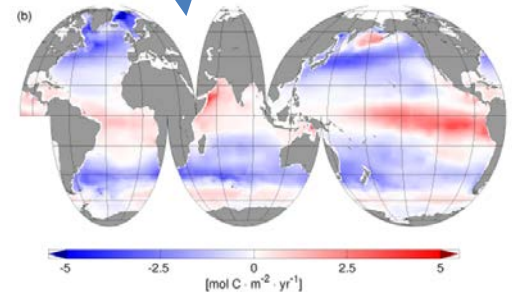
Mapping techniques



pCO₂ products



Flux = $k * \Delta pCO_2(w-a)$
Gas transfer parameterisation,
wind speed product



Air-sea CO₂ flux products

Pacific: Nakaoka et al., 2013, BG; Ishii et al., 2014, BG

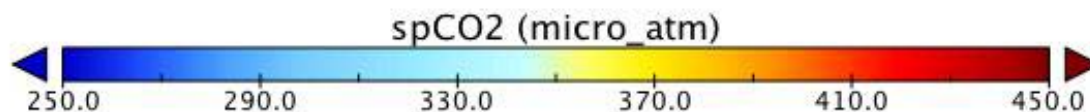
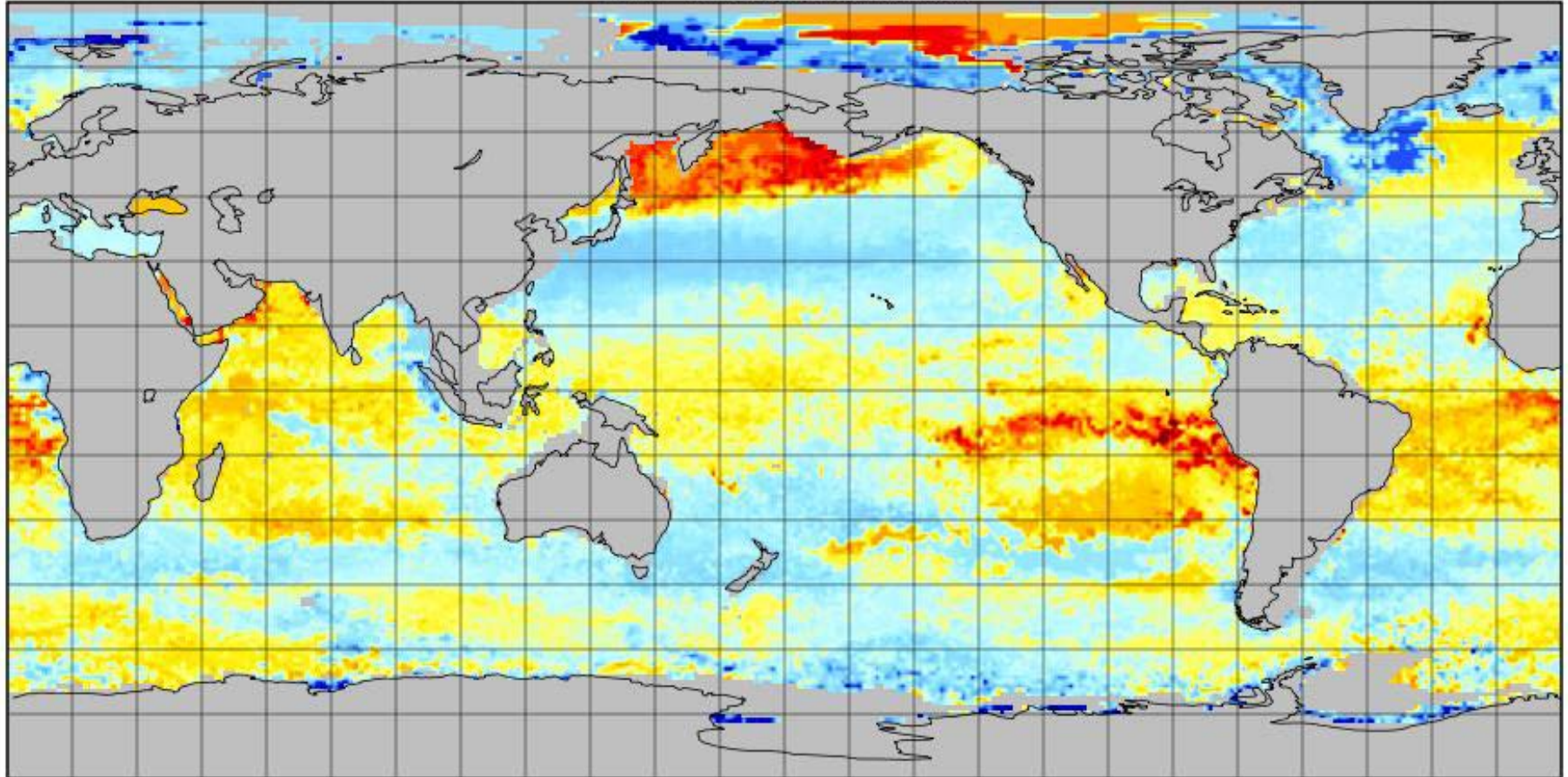
Global: Rödenbeck et al., 2015, BG

Landschützer et al., 2014, GBC, 2015, Science

pCO₂ Mapping and evaluation of CO₂ flux

$$p\text{CO}_2^{\text{sea}} = f_{\text{SOM}}(x, y, z, \text{SST}, \text{SSS}, \text{MLD}, \text{CHL}) + \alpha (t - t_{\text{ref}})$$

Time: 1998-01-15 00:00:00

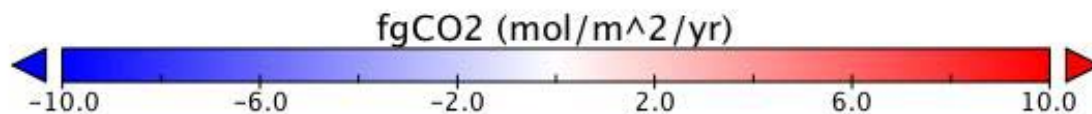
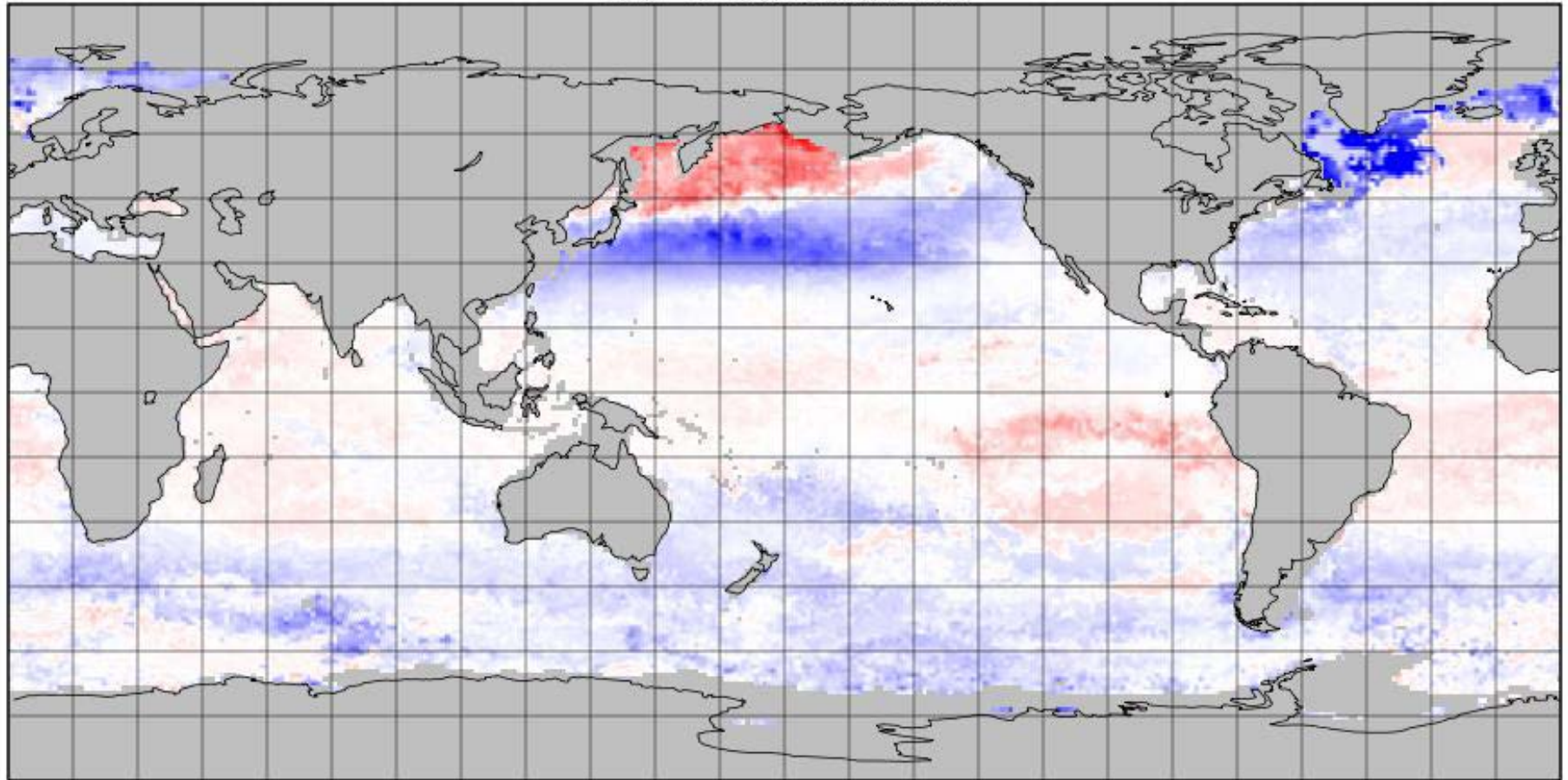


Data Min = 177.0, Max = 473.2, Mean = 348.9

pCO₂ Mapping and evaluation of CO₂ flux

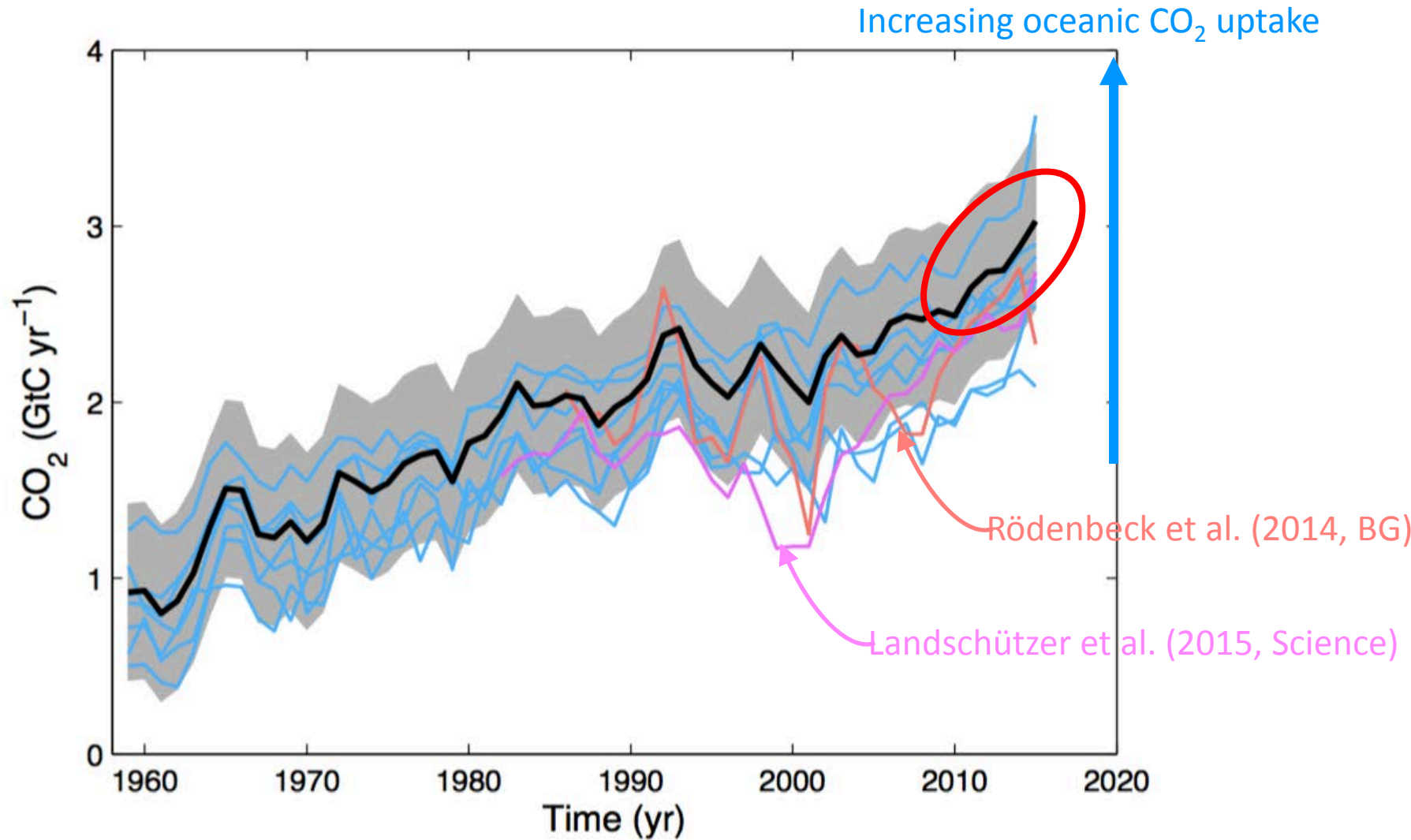
$$F = s \cdot k \cdot \Delta p\text{CO}_2 = s \cdot k \cdot (p\text{CO}_2^{\text{sea}} - p\text{CO}_2^{\text{air}})$$

Time: 1998-01-15 00:00:00



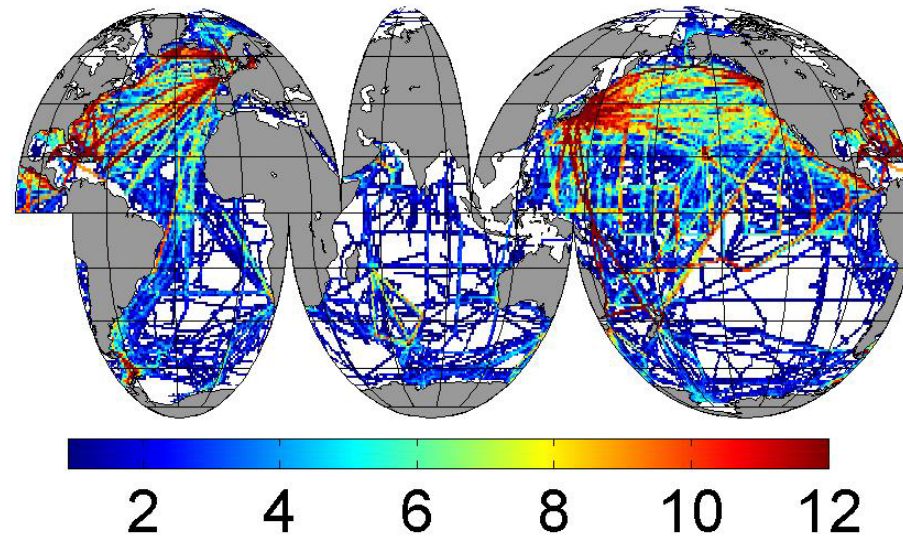
Data Min = -28.2, Max = 10.1, Mean = -0.4

pCO₂ Mapping and evaluation of CO₂ flux



Le Quere et al. (2016 ESSD)

Future SOCAT versions



Months of the year
with $f\text{CO}_2$ values
(1970-2014) (V3)

(Bakker et al., 2016 ESSD)

V5 Data submission ends 15 January 2017;

V5 Quality control ends 31 March 2017;

V5 Release in summer 2017;

V6: V5 dates + 1 year

Summary

- NIES has measured atmospheric and oceanic CO₂ since 1995 using VOS with cooperation of shipping companies.
- NIES plays a role in SOCAT as a data provider as well as a quality controller for the North Pacific.
- SOCAT is a helpful tool for understanding observed pCO₂ variation and it is available to the public.
- While a lot of pCO₂ measurements has been made, there is still less observation in the eastern equatorial Pacific and in the Indian Ocean after 2000.
- Products of pCO₂ distribution using SOCAT are proposed in SOCOM project.
- Oceanic CO₂ uptake increases rapidly after 2010.

Acknowledgements

SOCAT is an international effort, supported by the International Ocean Carbon Coordination Project (IOCCP), the Surface Ocean Lower Atmosphere Study (SOLAS), and the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) program.

The many researchers and funding agencies responsible for the collecting data and quality control are thankful for their contributions to SOCAT.

Thank you for your attention!

