

# Observation-based estimates of the regional and global ocean carbon sink

Peter Landschützer

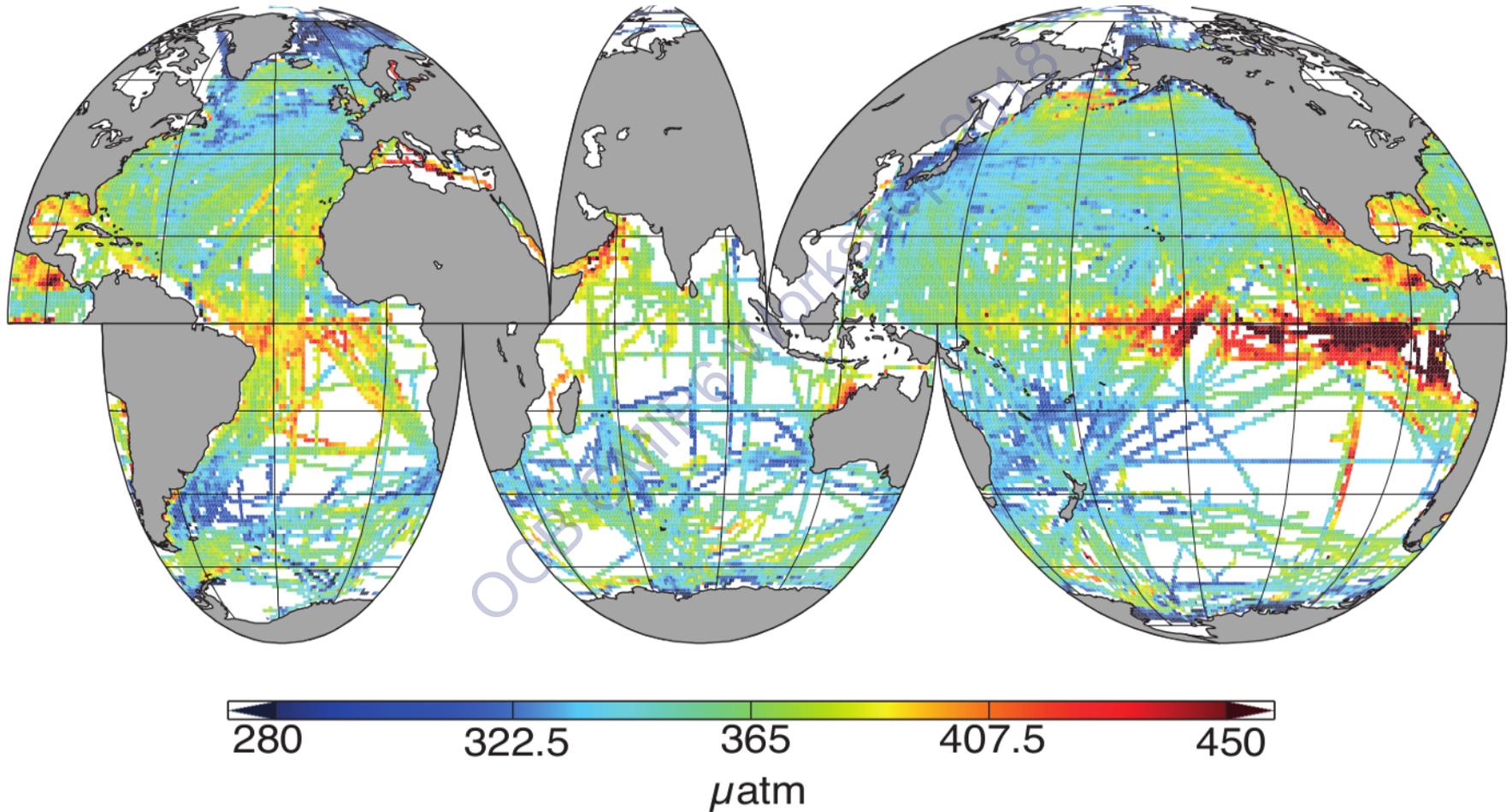
Max-Planck-Institut für Meteorologie, Hamburg, Germany



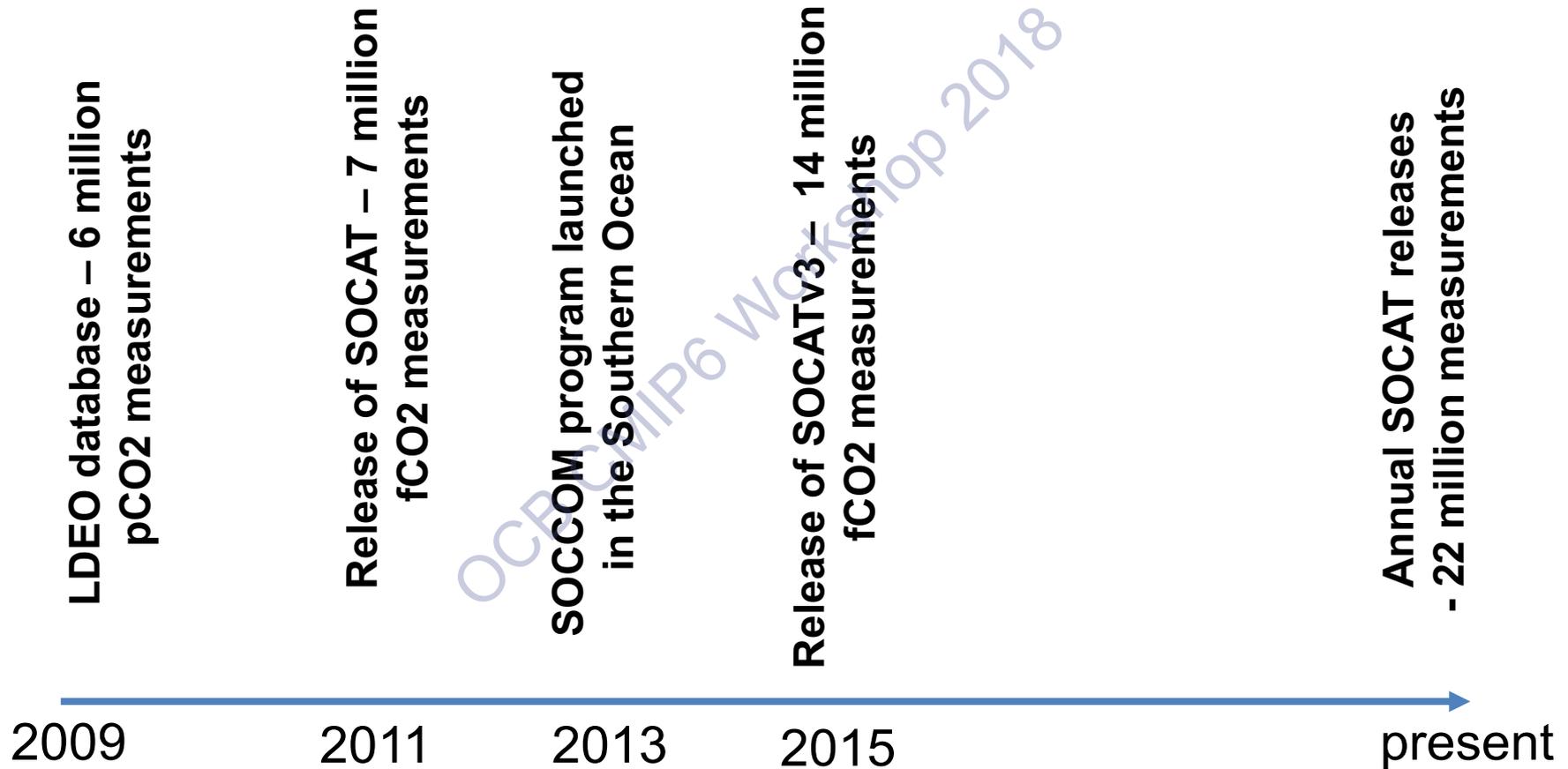
# “mobility” quiz:

- How many cars are registered in the USA?
- How many ships/vessels/sailboats, etc. are registered globally?

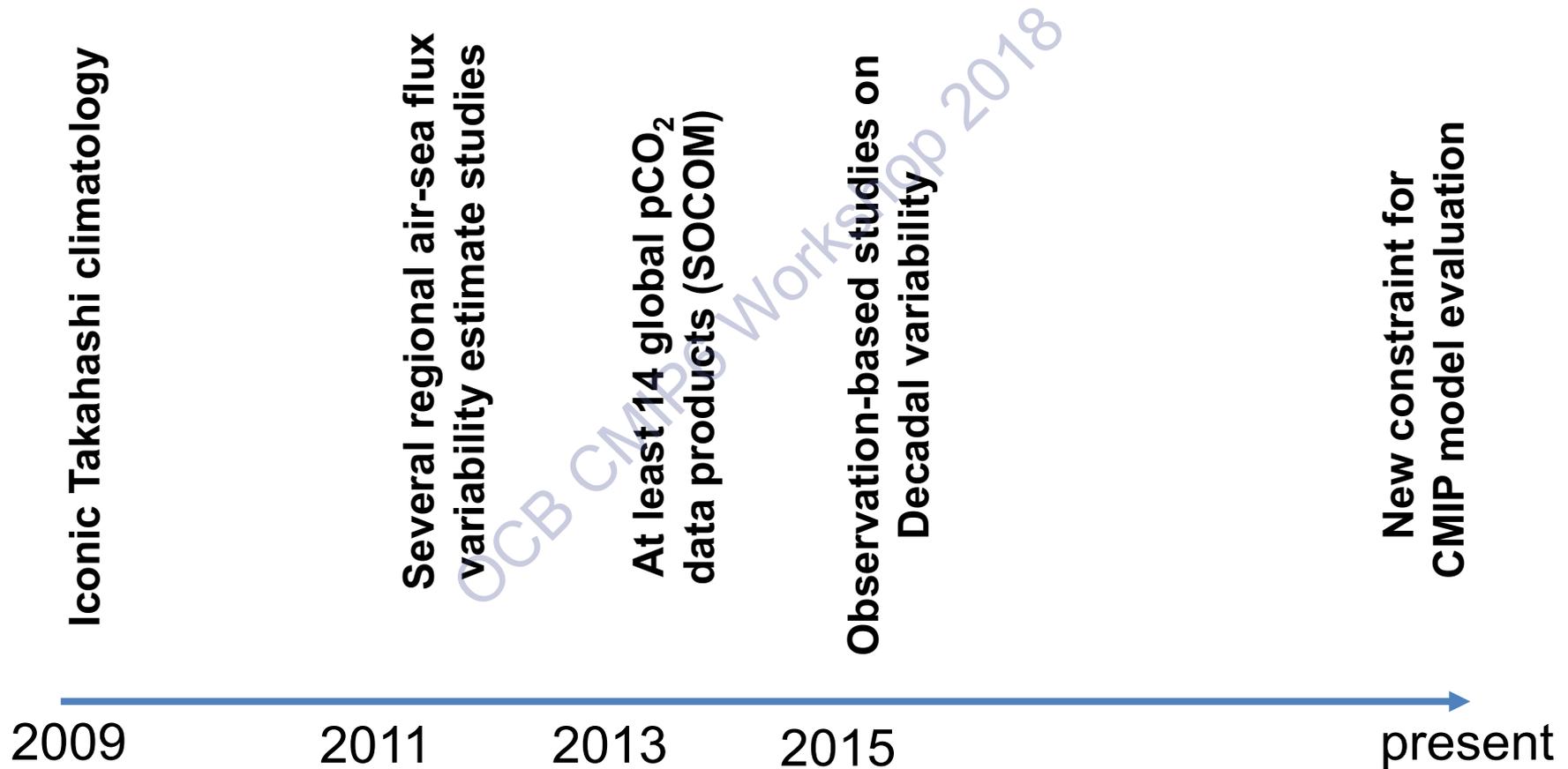
# The SOCAT database (1982-2014)



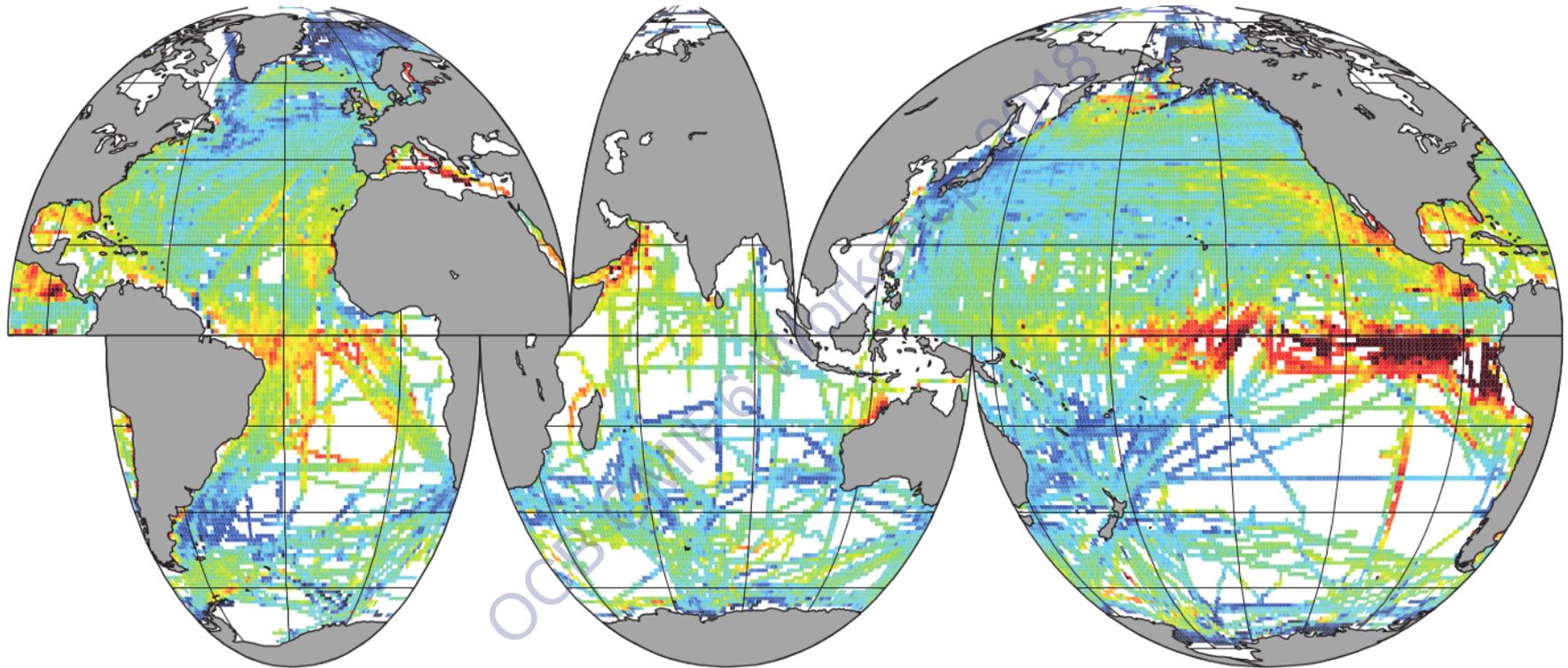
# A brief history of an extraordinary community effort ...



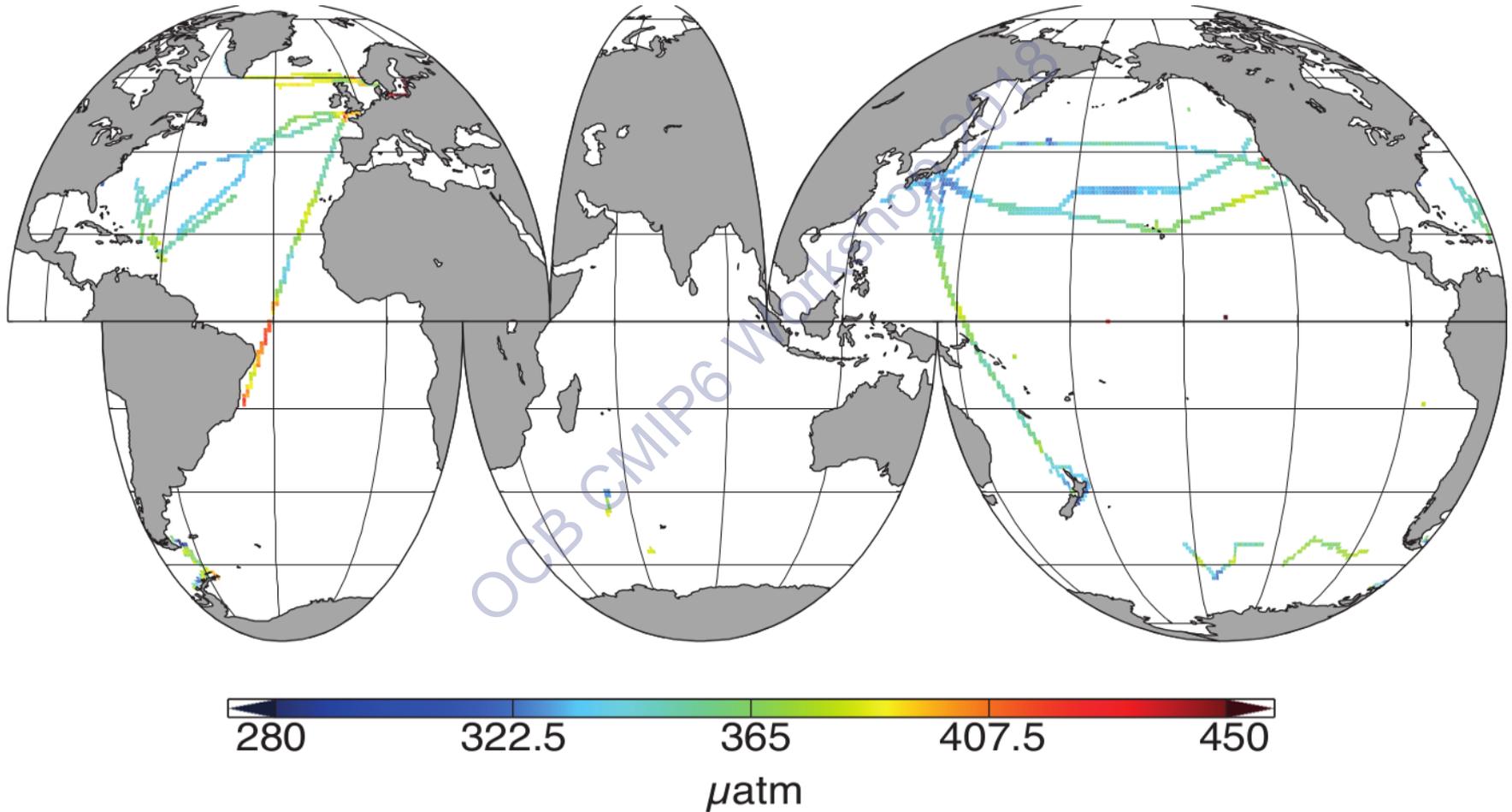
# A brief history of an extraordinary community effort ...



# The SOCAT database (1982-2014)



# The SOCAT database (Dec 2009)

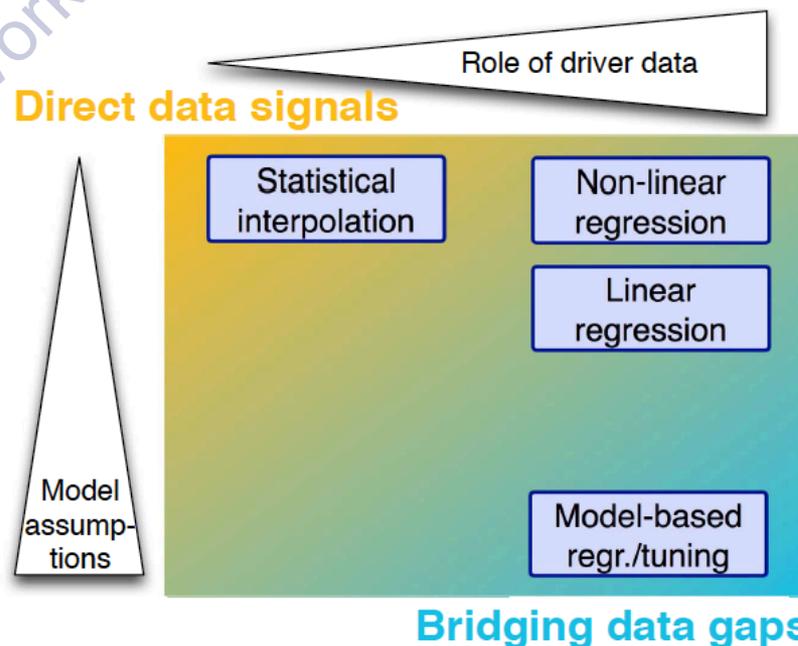




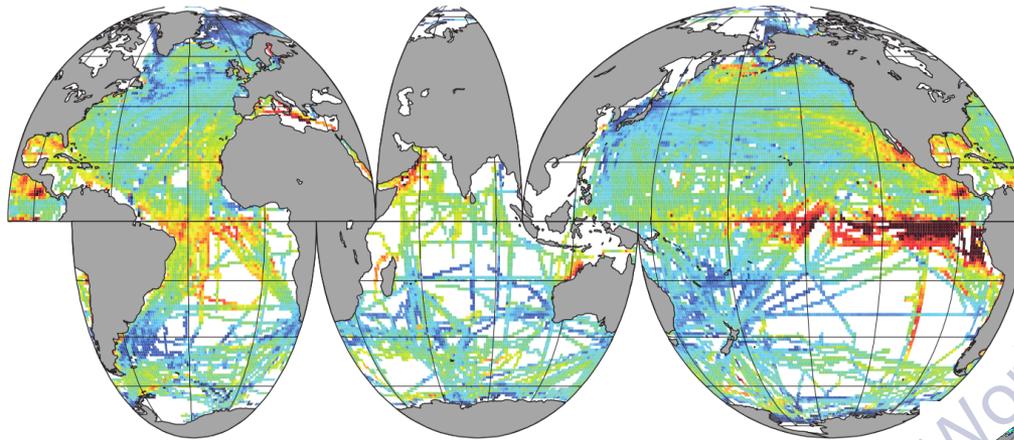
## Data-based estimates of the ocean carbon sink variability – first results of the Surface Ocean $p\text{CO}_2$ Mapping intercomparison (SOCOM)

C. Rödenbeck<sup>1</sup>, D. C. E. Bakker<sup>2</sup>, N. Gruber<sup>3</sup>, Y. Iida<sup>4</sup>, A. R. Jacobson<sup>5</sup>, S. Jones<sup>6</sup>, P. Landschützer<sup>3</sup>, N. Metzl<sup>7</sup>, S. Nakaoka<sup>8</sup>, A. Olsen<sup>9</sup>, G.-H. Park<sup>10</sup>, P. Peylin<sup>11</sup>, K. B. Rodgers<sup>12</sup>, T. P. Sasse<sup>13</sup>, U. Schuster<sup>6</sup>, J. D. Shutler<sup>6</sup>, V. Valsala<sup>14</sup>, R. Wanninkhof<sup>15</sup>, and J. Zeng<sup>8</sup>

OCB CMIP6 Workshop 2018



# Mapping approaches

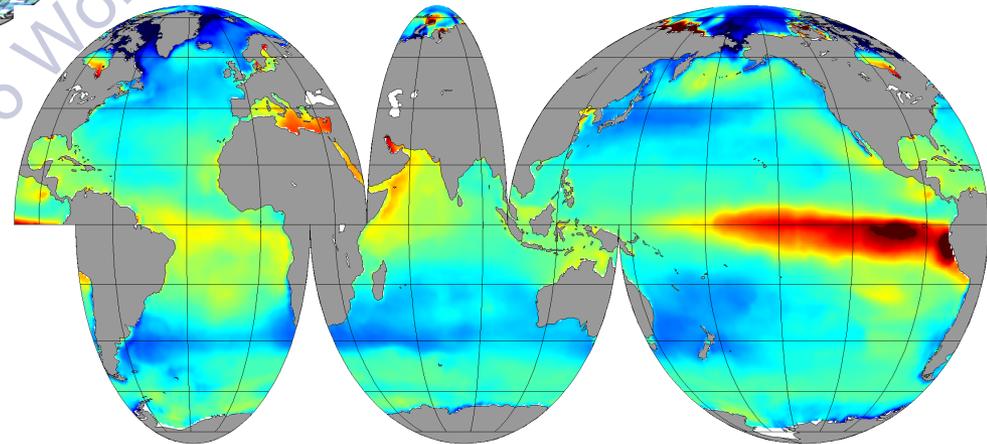


280 365 450  
[μatm]

(II)  $\text{CO}_2 \text{ flux} = k_x \times \text{solubility} \times (\text{pCO}_{2\text{air}} - \text{pCO}_{2\text{oc}})$

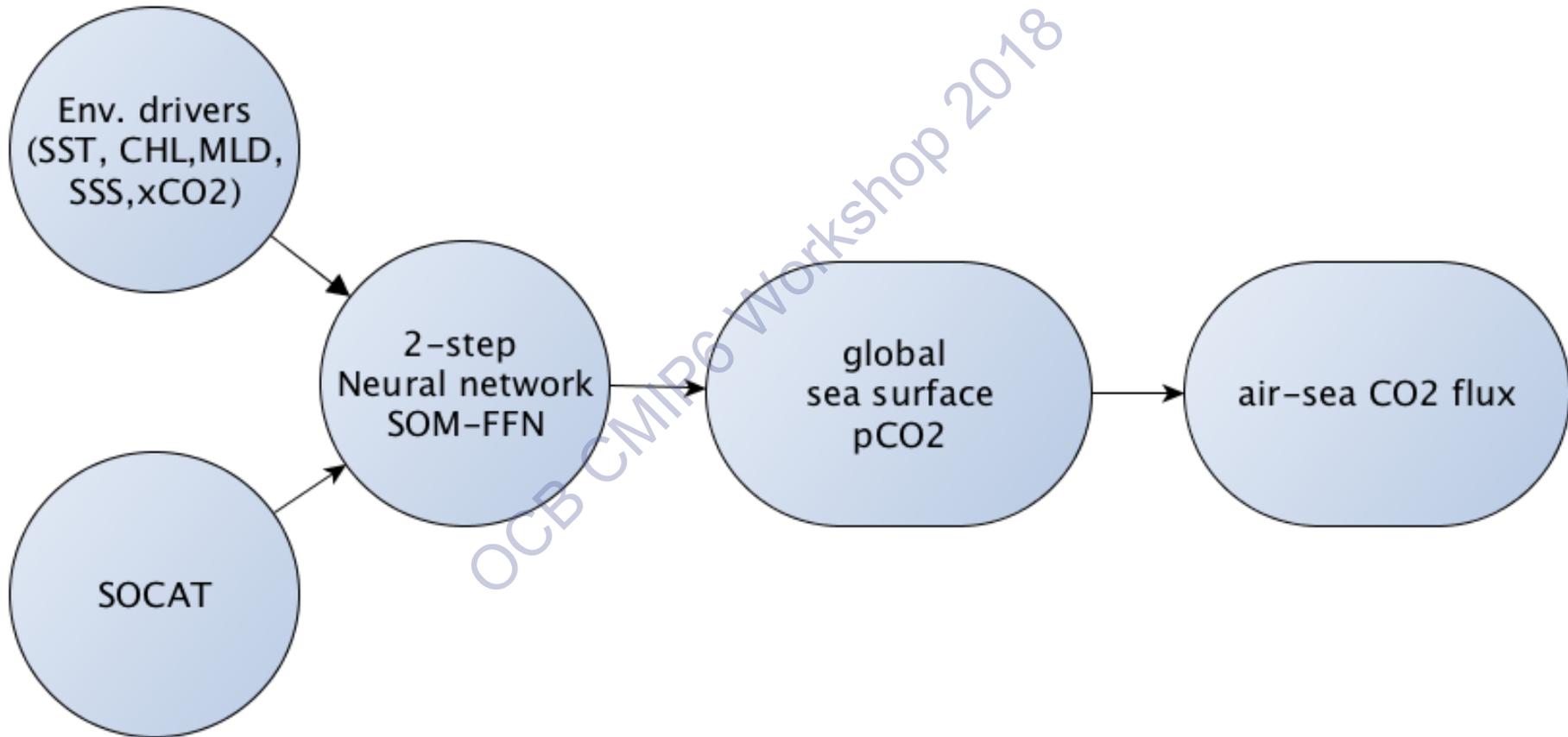


(I) machine learning,  
statistical interpolation  
based on autocorrelation  
structure,  
mixed layer scheme, ...



280 365 450  
[μatm]

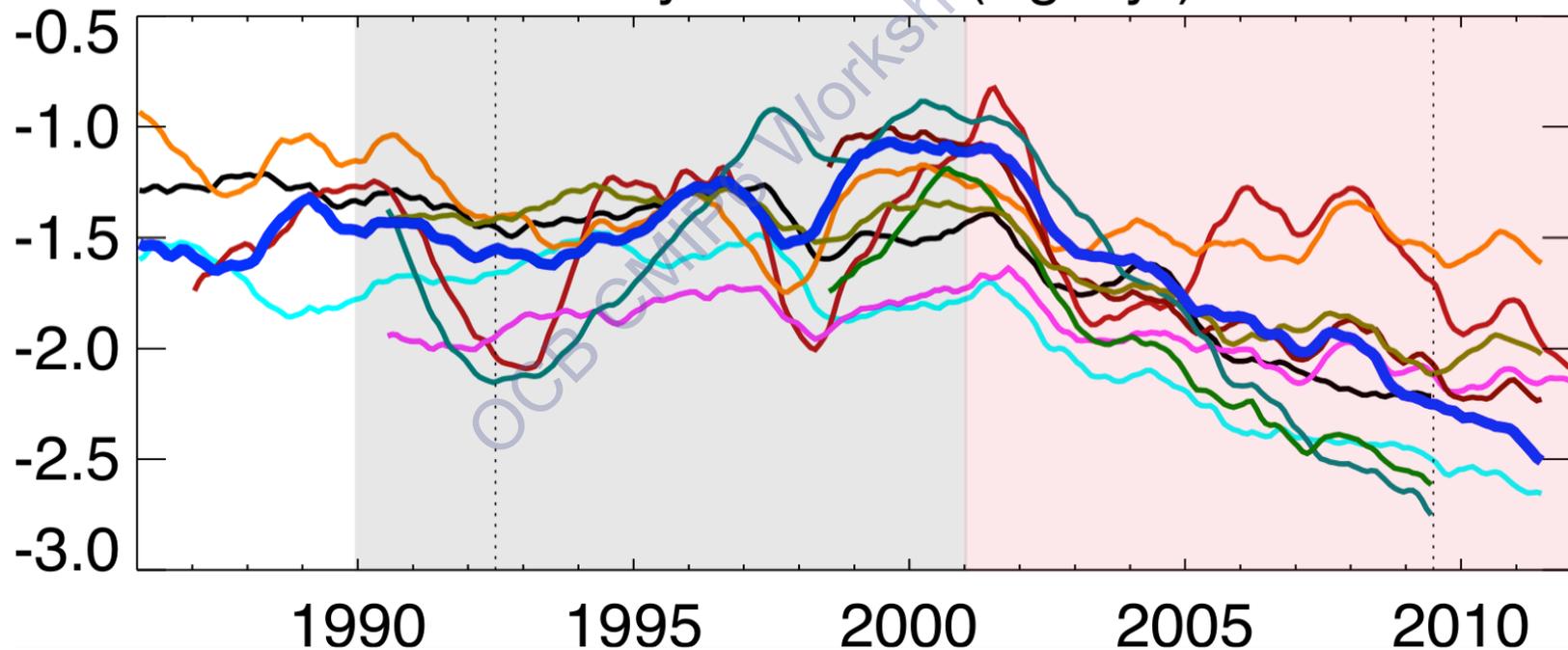
# 2 step data interpolation method (SOM-FFN)



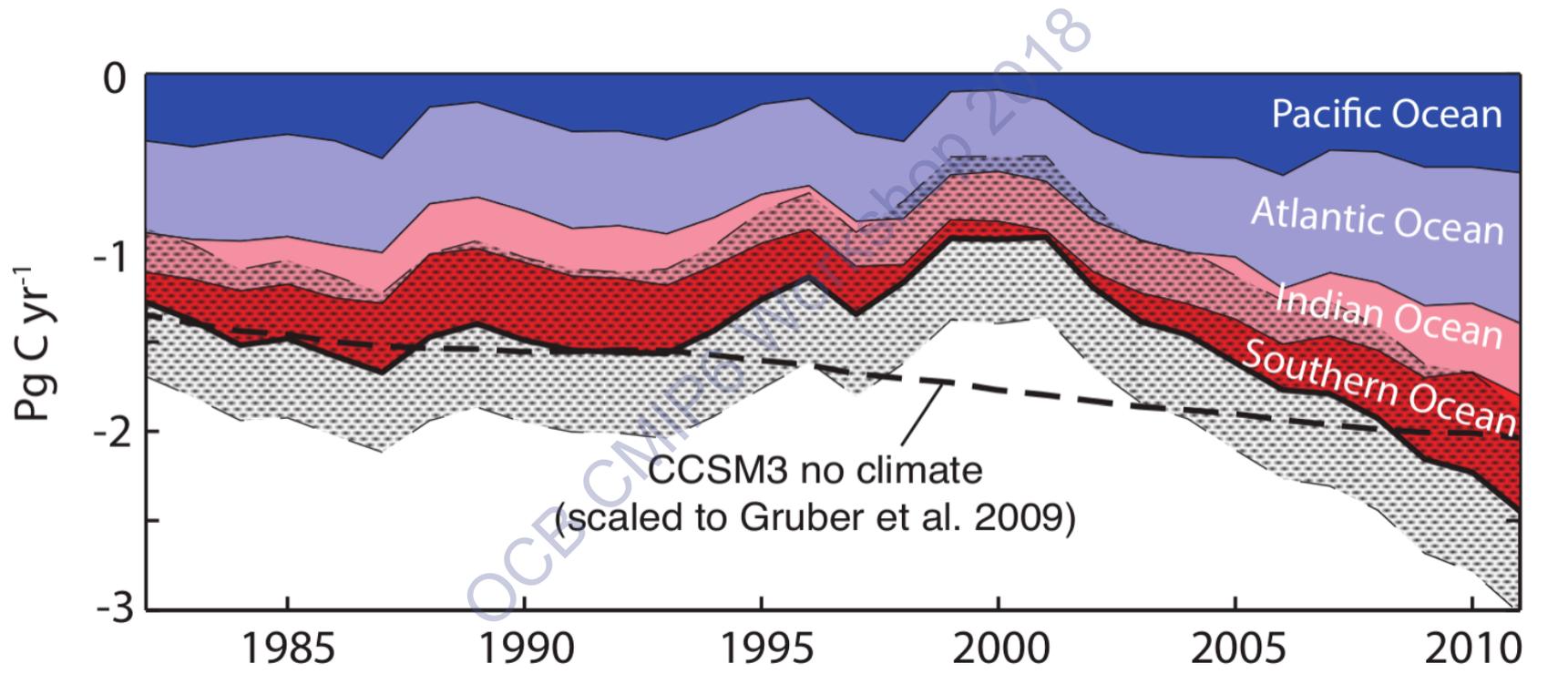
# CO<sub>2</sub> flux intercomparison



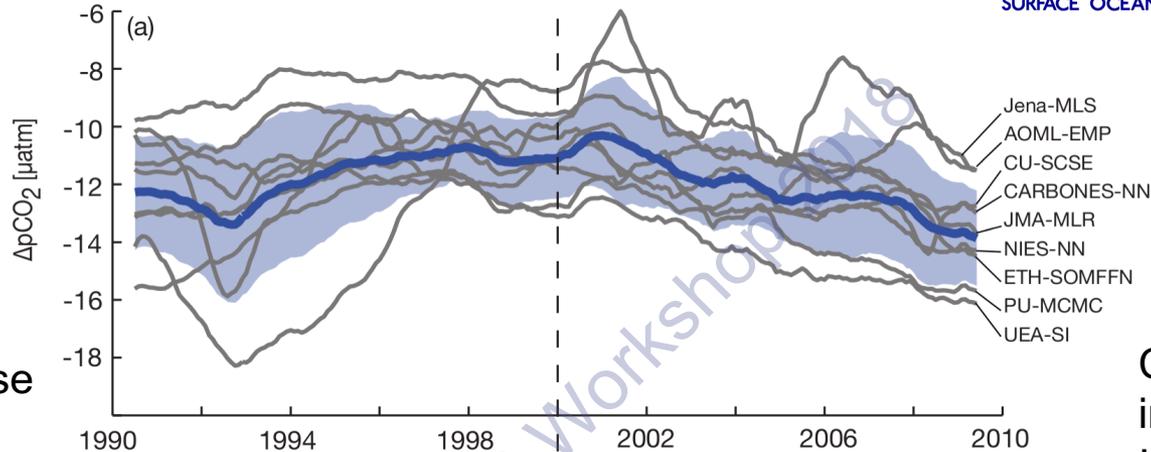
Yearly CO<sub>2</sub> flux (PgC/yr)



# Decadal air-sea CO<sub>2</sub> flux variations

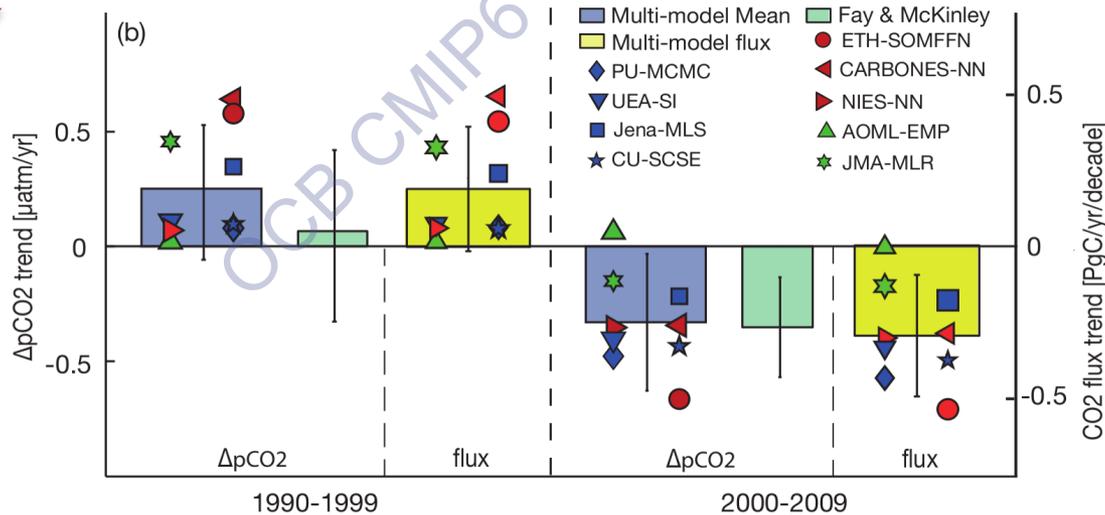


# Southern Ocean flux trends

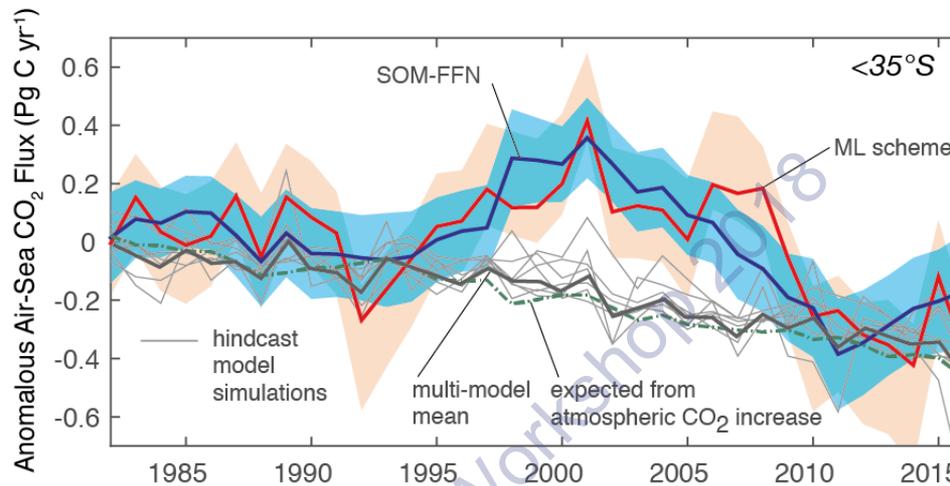


Consistent decrease  
in  $\Delta p\text{CO}_2/\text{CO}_2$  flux  
in 90s

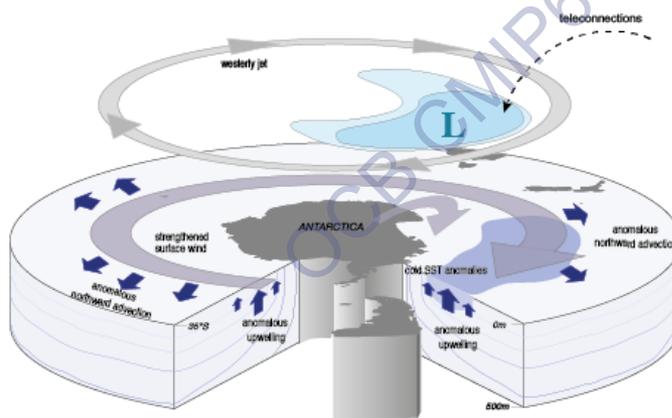
Consistent increase  
in  $\Delta p\text{CO}_2/\text{CO}_2$  flux  
In 2000s



# Southern Ocean flux trends



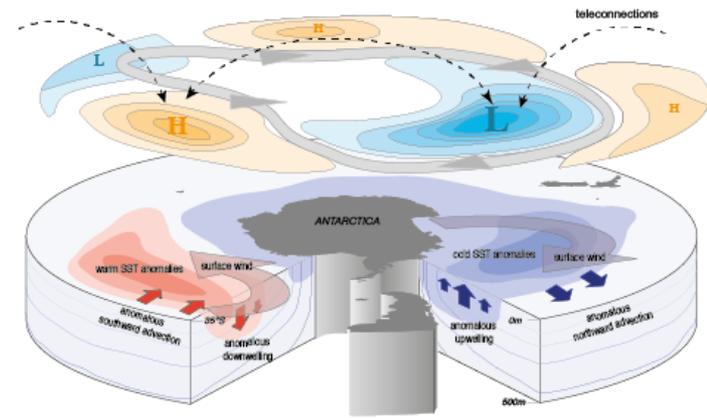
1990s



**ATLANTIC SECTOR**  
 Thermal trend ⊕  
 Non-thermal trend ⊕  
 Overall pCO<sub>2</sub>-trend ⊕

**PACIFIC SECTOR**  
 Thermal trend ⊖  
 Non-thermal trend ⊕  
 Overall pCO<sub>2</sub>-trend ⊕

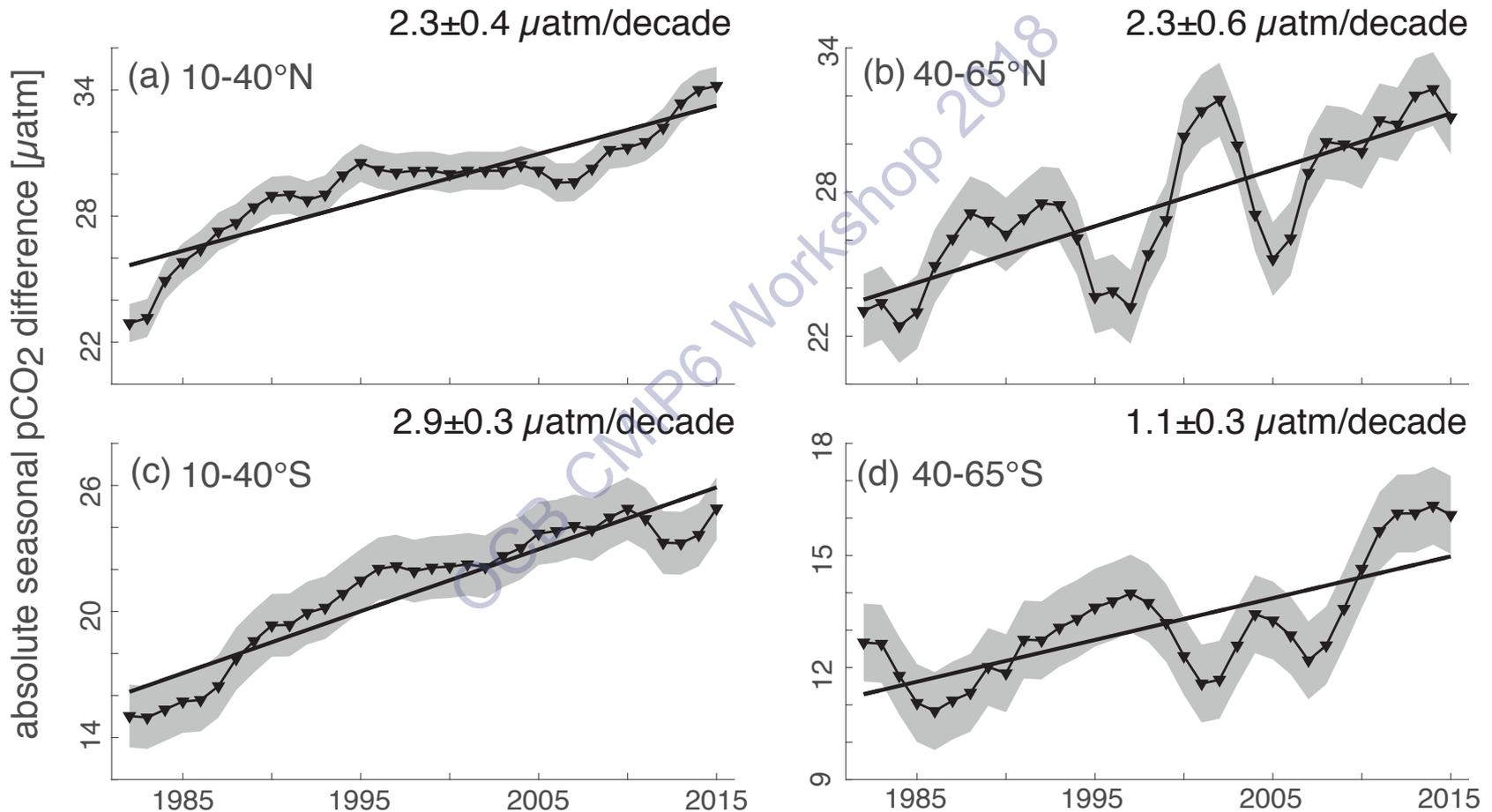
2000s



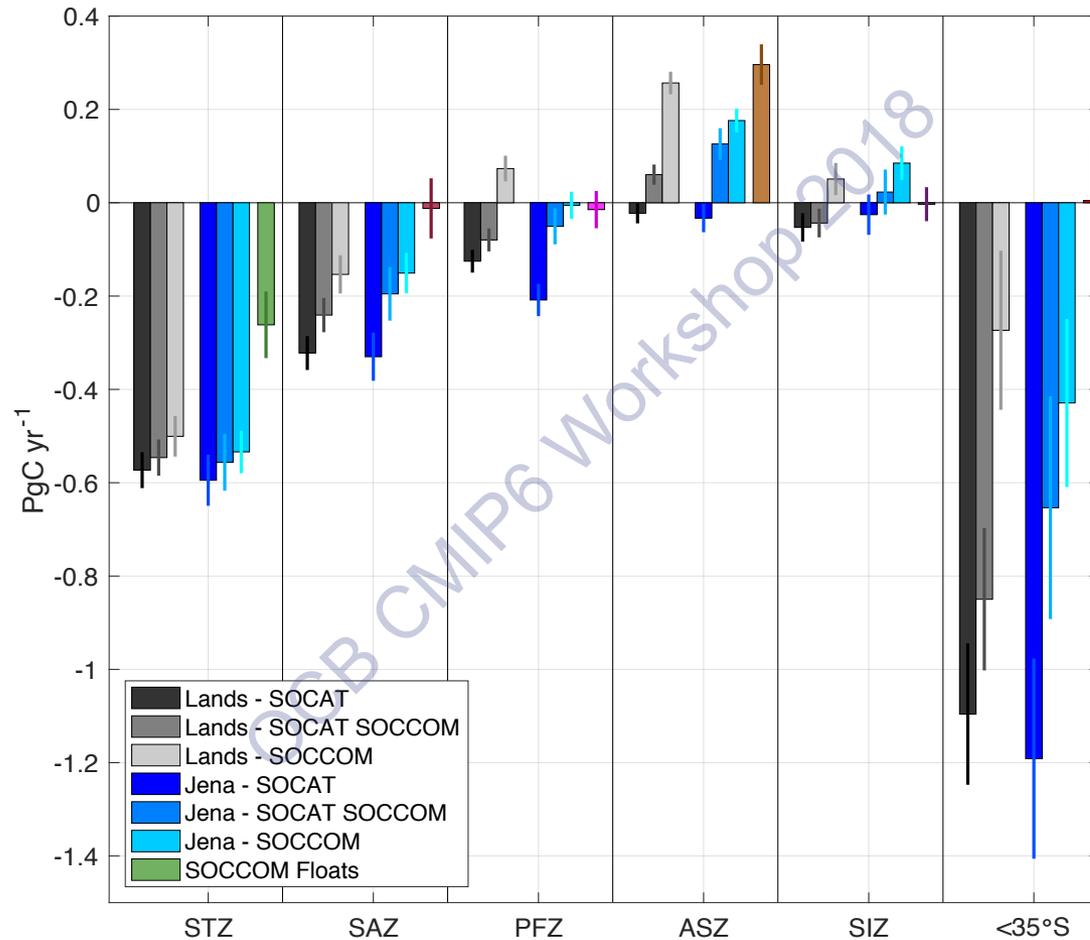
**ATLANTIC SECTOR**  
 Thermal trend ⊕  
 Non-thermal trend ⊖  
 Overall pCO<sub>2</sub>-trend ⊖

**PACIFIC SECTOR**  
 Thermal trend ⊖  
 Non-thermal trend ⊕  
 Overall pCO<sub>2</sub>-trend ⊖

# New frontiers for SOCAT-based estimates: changing seasonality



# New challenges ahead: Do we understand the SO carbon cycle?



# Summary

- Strong increase in surface ocean pCO<sub>2</sub> observations (direct and indirect) in last decade
- At least 14 complementary gap-filling methods
- New frontiers:
  - Decadal variability
  - Long term trends
  - Changing seasonality
- New data streams keep challenging our understanding of the ocean carbon cycle

