integrated carbon observation system

UNIVERSITY OF EXETER

The Oceans Component of ICOS: European component of a GHG observation network

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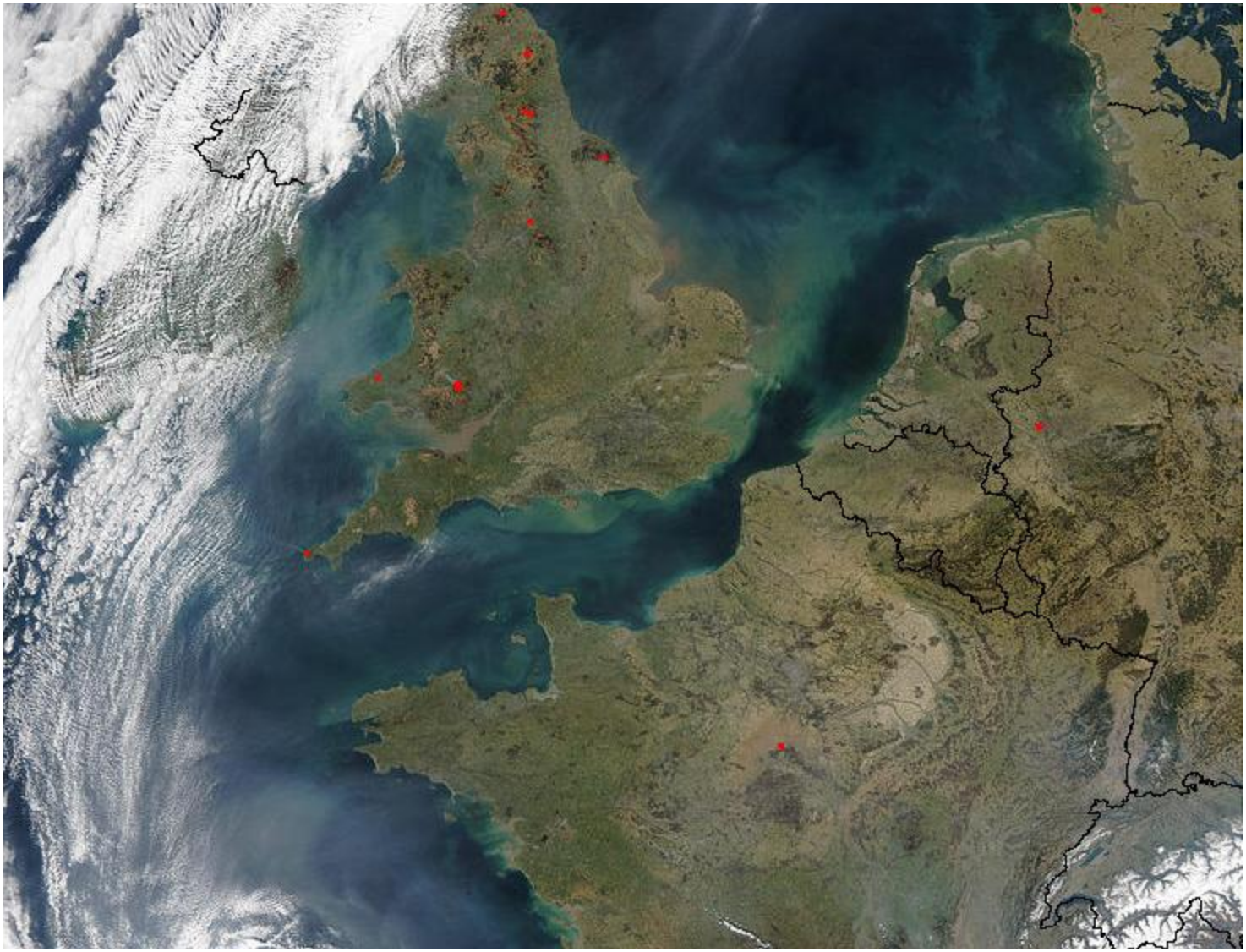
Why an oceans observing system?

- Ocean net CO_2 fluxes are large: (CH4 and N2O fluxes also significant).
  - Needed for full carbon budget
  - Need to understand the marine carbon cycle in order to better predict/project human influence on the planet.
- Marine fluxes of CO_2 vary widely from year to year
  - Sensitive to changing climate
- Marine uptake of CO_2 is responsible for ocean acidification.

Why an oceans observing system?

- Ocean fluxes can be computed with precision over the North Atlantic and North Pacific basins, using the currently existing network. By contrast, it is not presently possible to calculate continental fluxes by observation.
- Observation of marine fluxes therefore provides a strong constraint on continental fluxes.

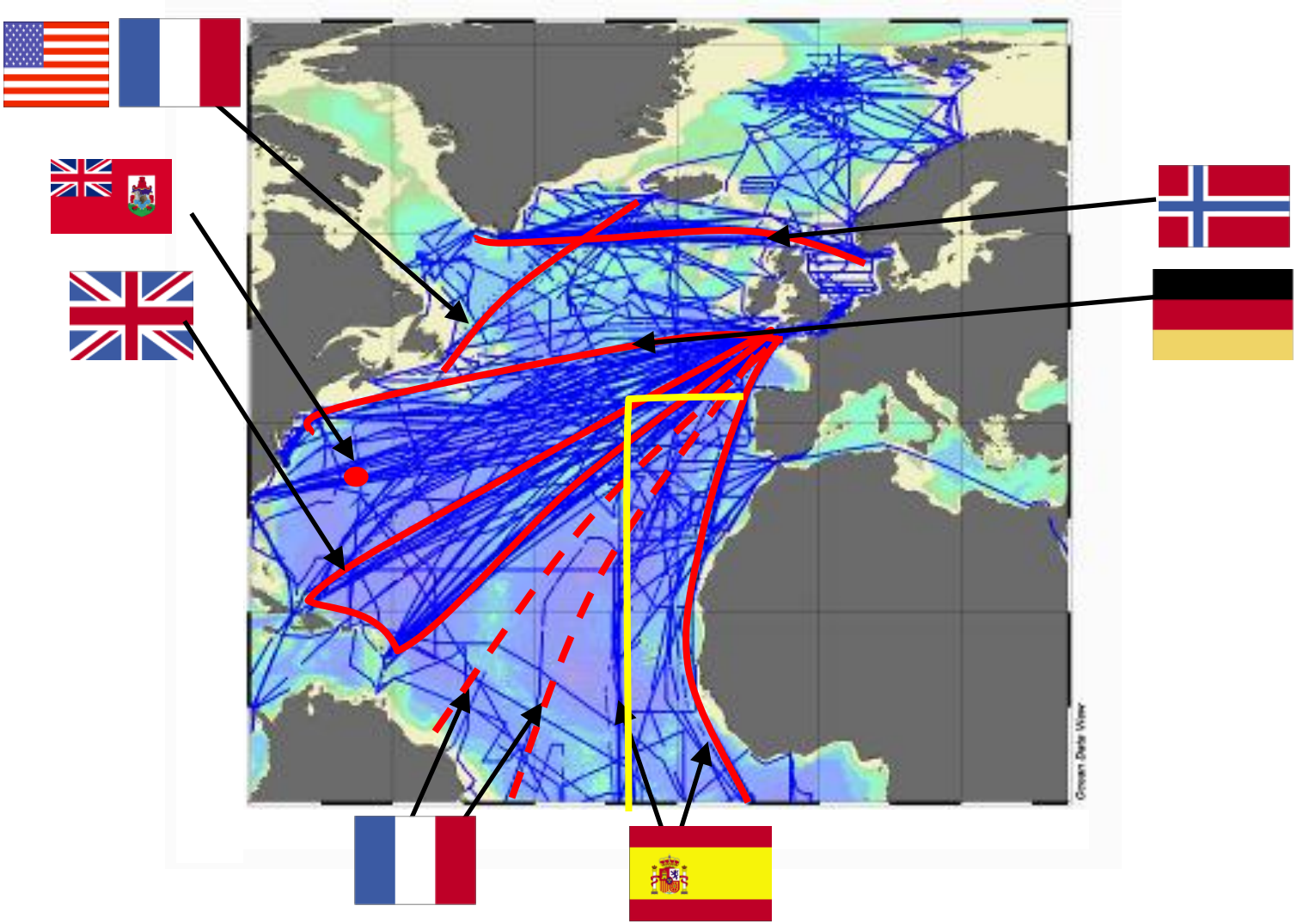


Spatial scales of variation are much larger at sea than on land

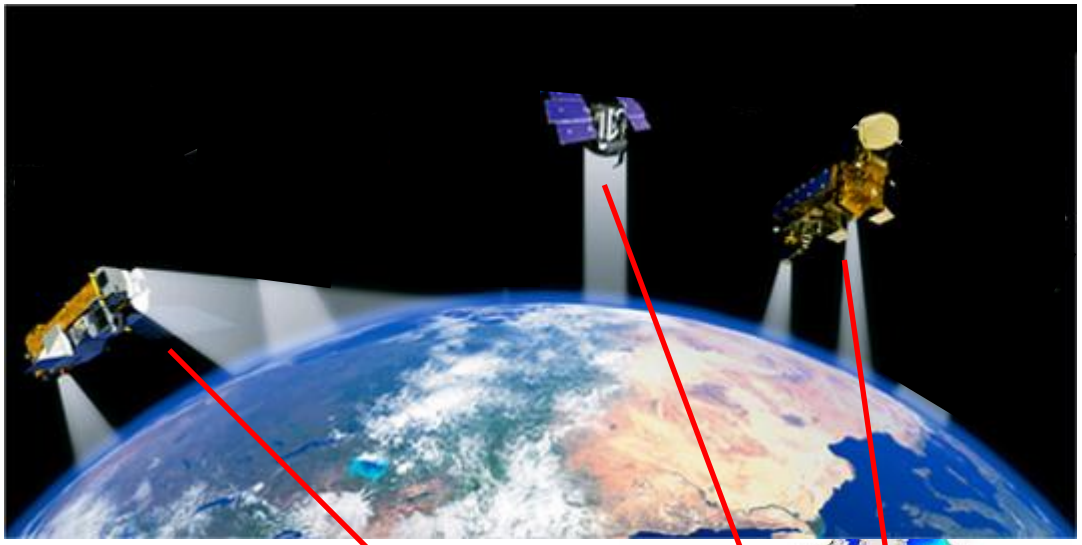
integrated carbon observation system

… making it easier to scale up point measurements of fluxes to large scales.

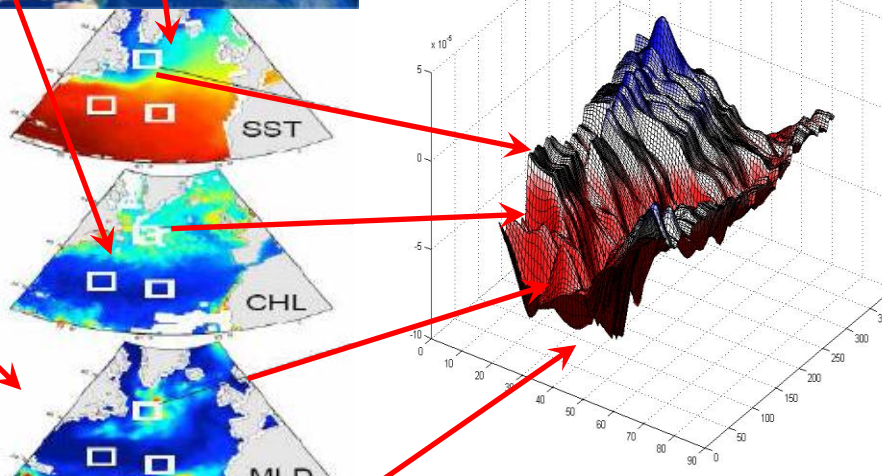
Sea surface measurements in the observing system



Satellite SST, chl, winds can be used to interpolate the network observations accurately, to create mappings

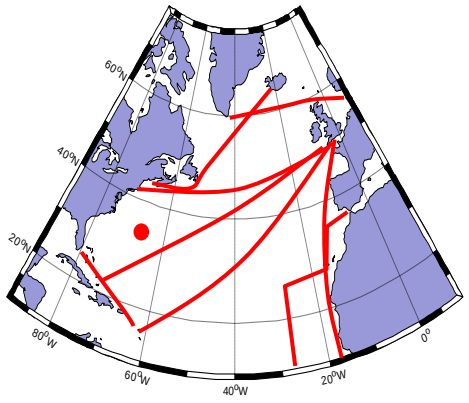


CO_2 mapping

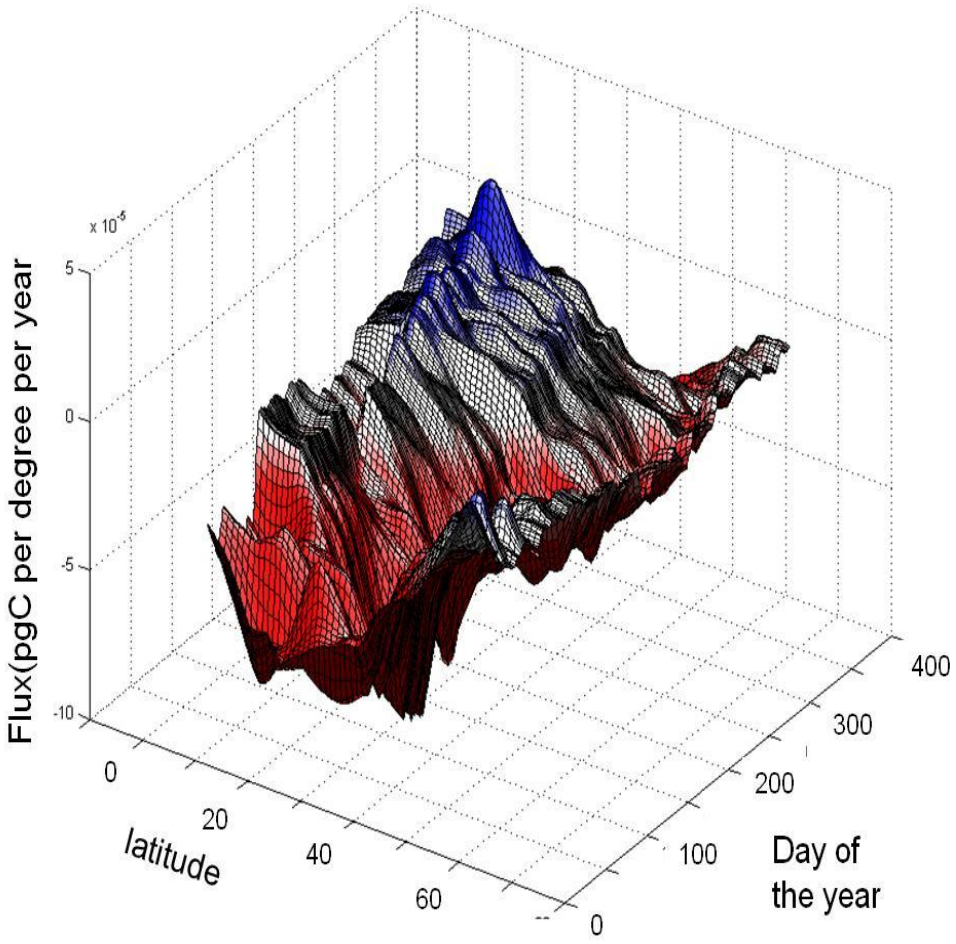


CO_2 measurement network

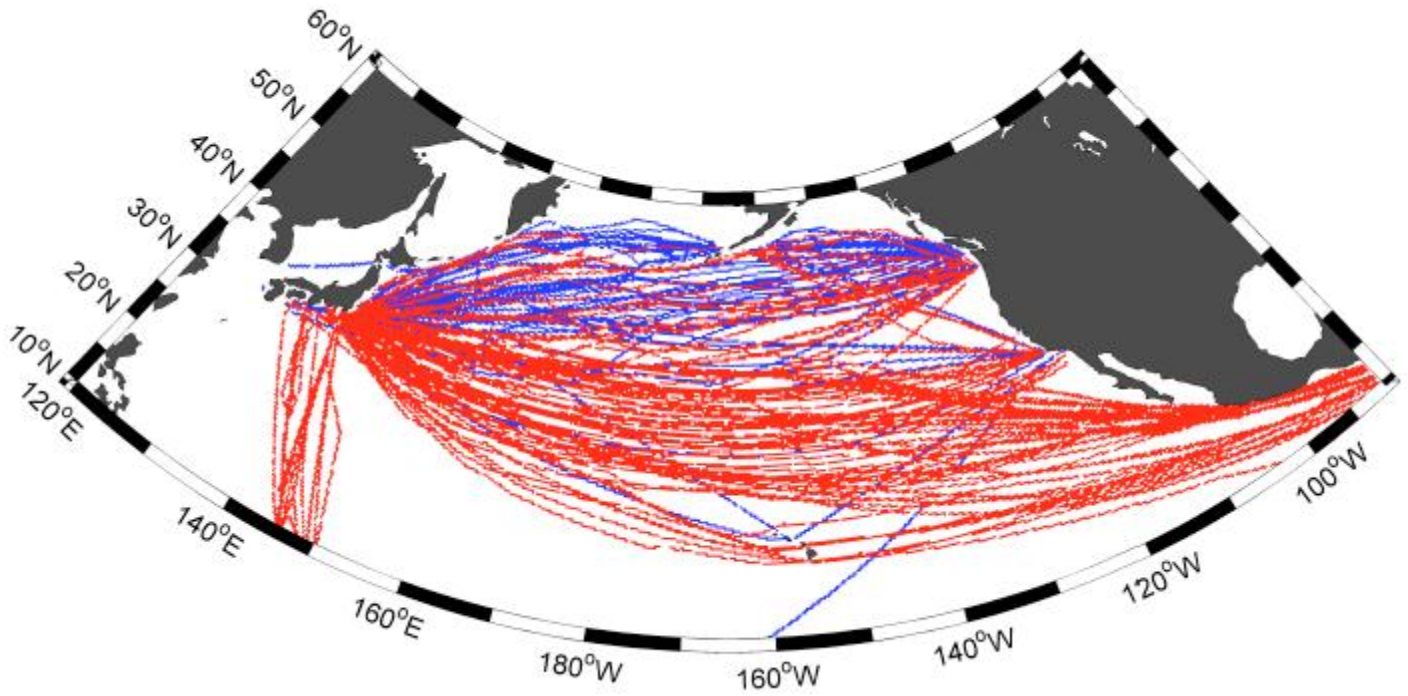
Spot CO_2 values



Carbo-Ocean and CarboChange projects have shown that such a network can define the seasonal and annual fluxes into the North Atlantic region to within 10%.



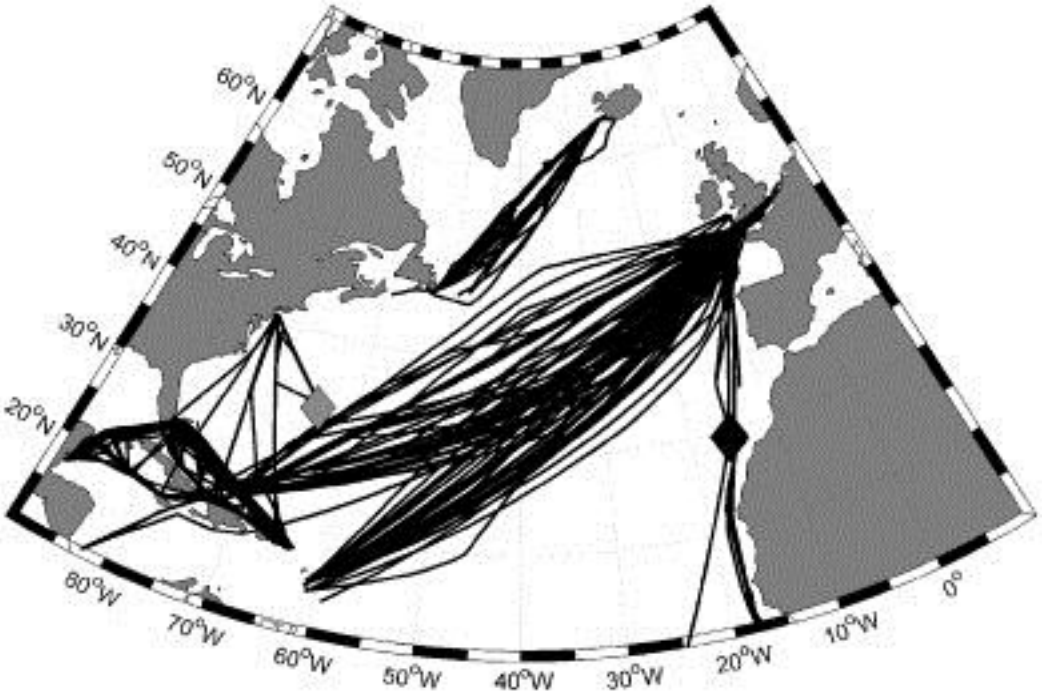
Pacific coverage



blue=1998-2001, red=2002-2008

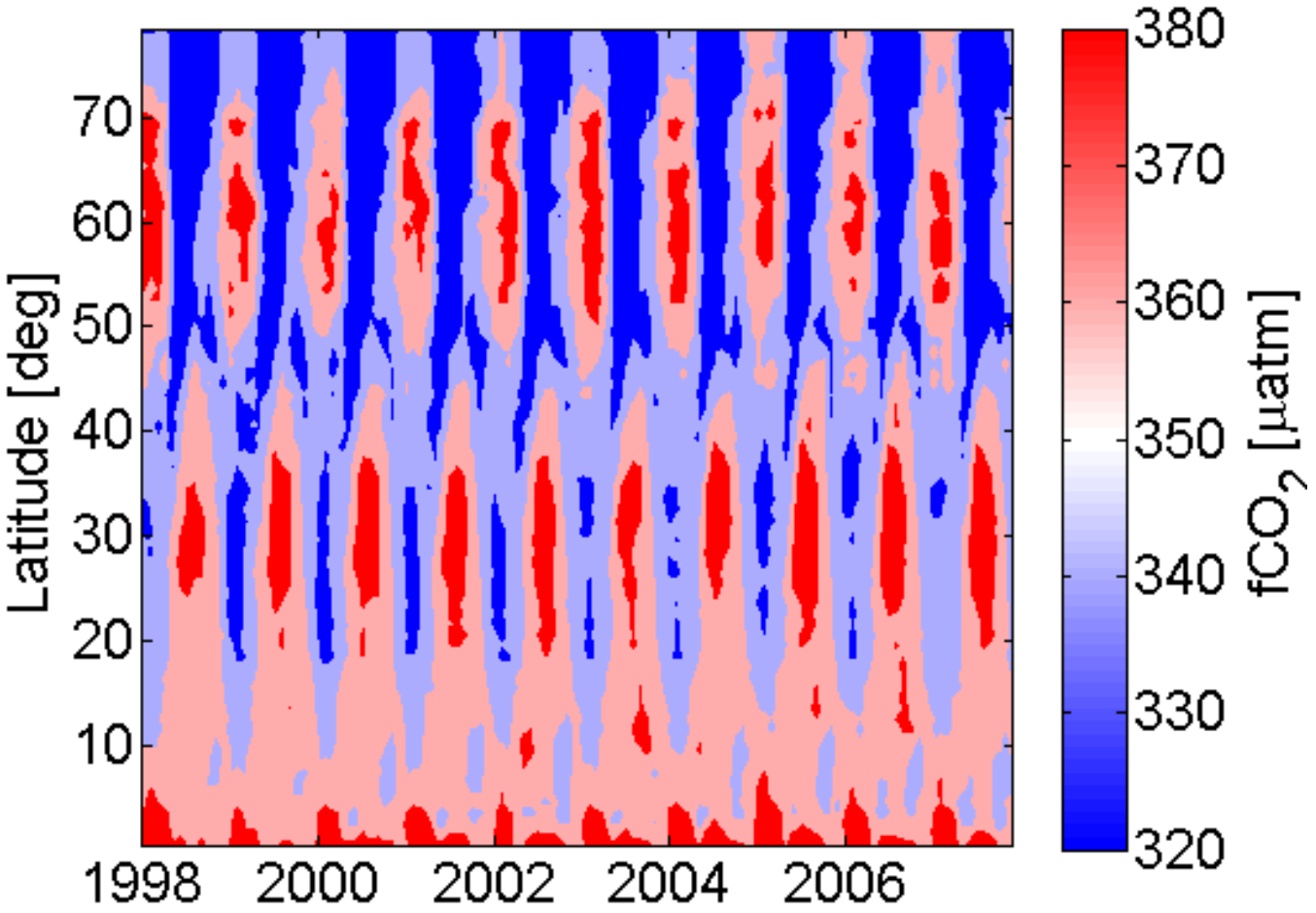
Nakaoka et al, Biogeosciences Discuss., 10, 4575–4610, 2013

Atlantic coverage

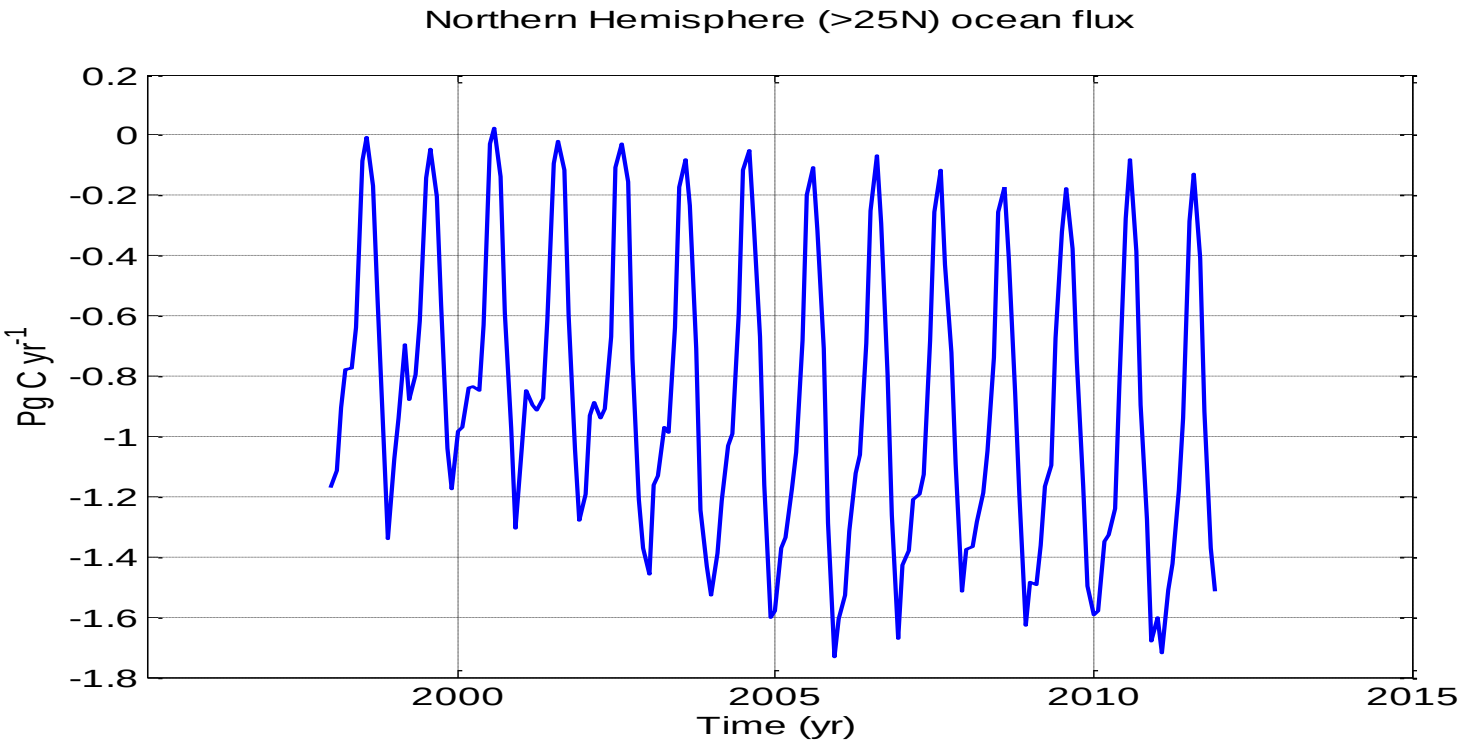


U. Schuster et al, Deep Sea Res II, 56, 620-629 (2009)...

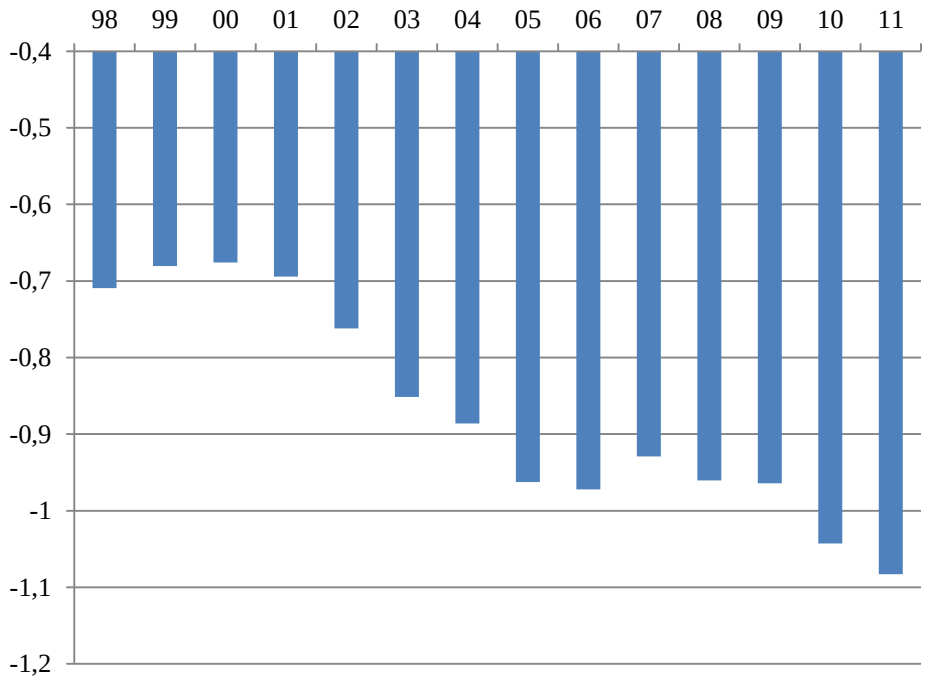
Long term seasonal cycle, N. Atlantic



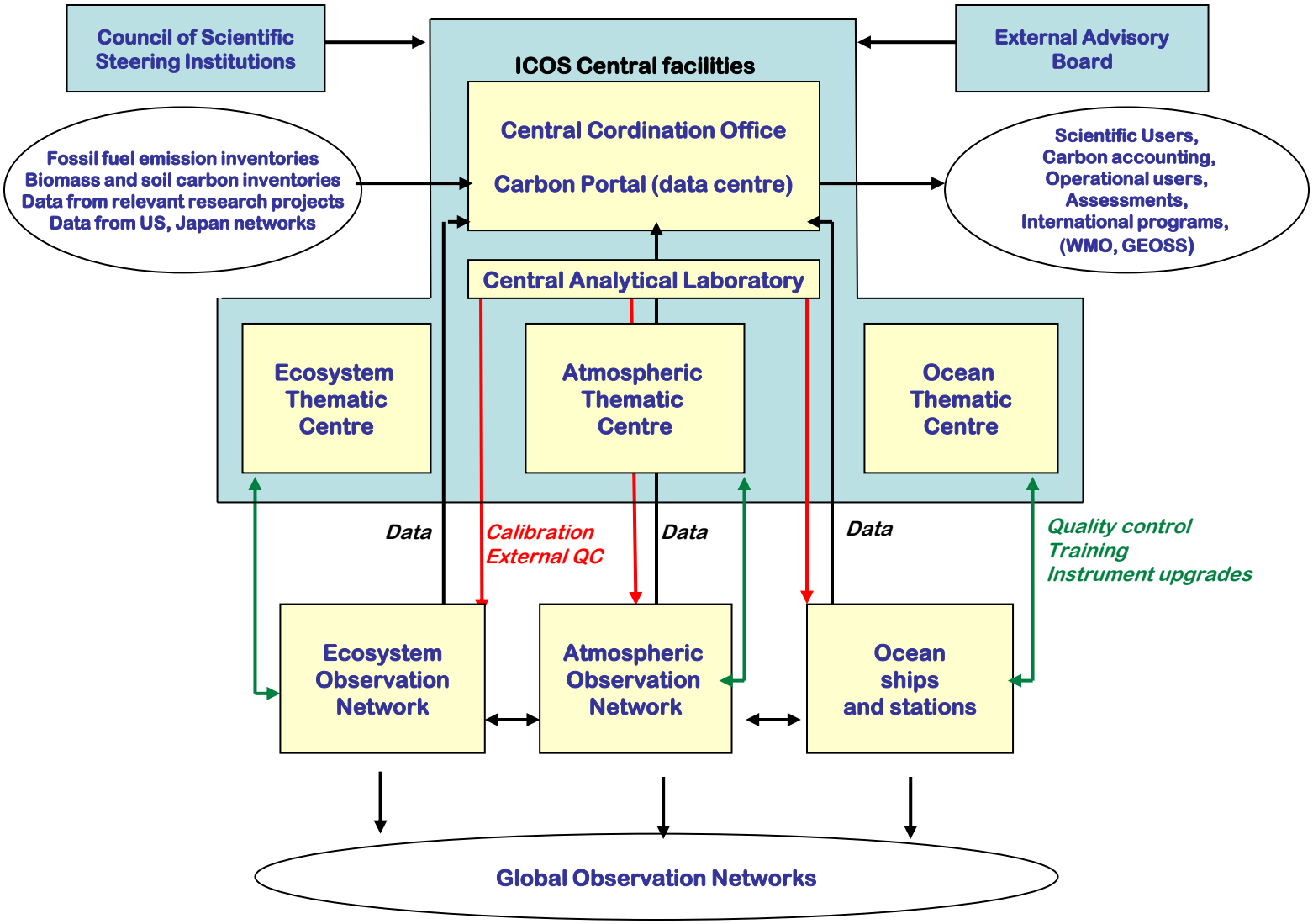
- Mean N. Hemisphere ocean flux for 14 year period N of 25N is -0.86 PgC yr^{-1}
- Uncertainty derives mostly from gas exchange; 20%?



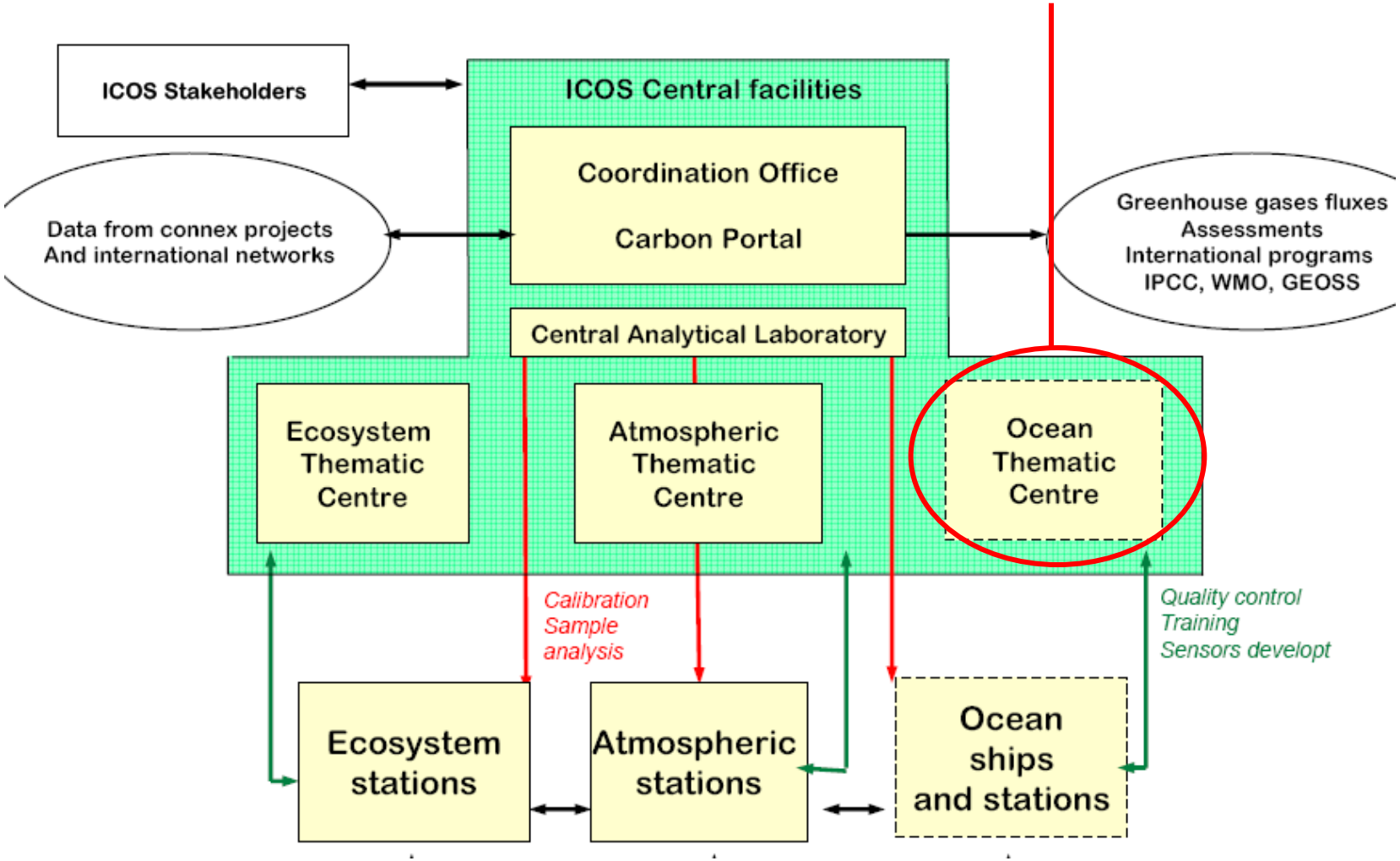
Annual average fluxes north of 25N.



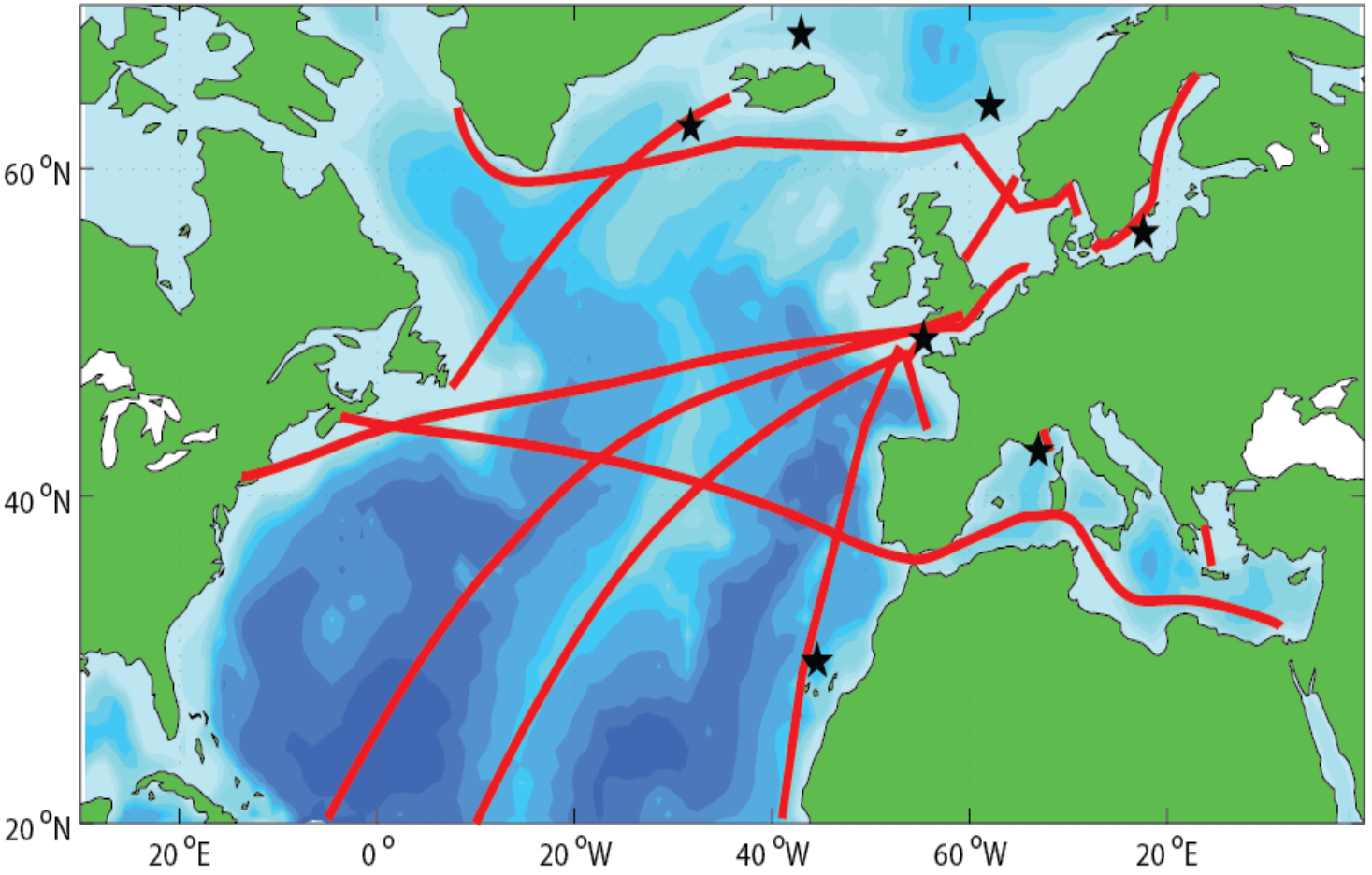
ICOS Elements



Ocean thematic data centre



Marine ICOS: currently proposed North Atlantic and marginal seas observing system



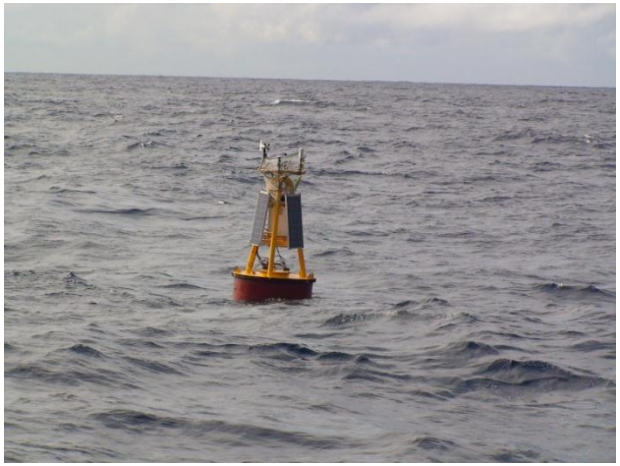
★ Time series station

Instrumented shipping route

integrated carbon observation system

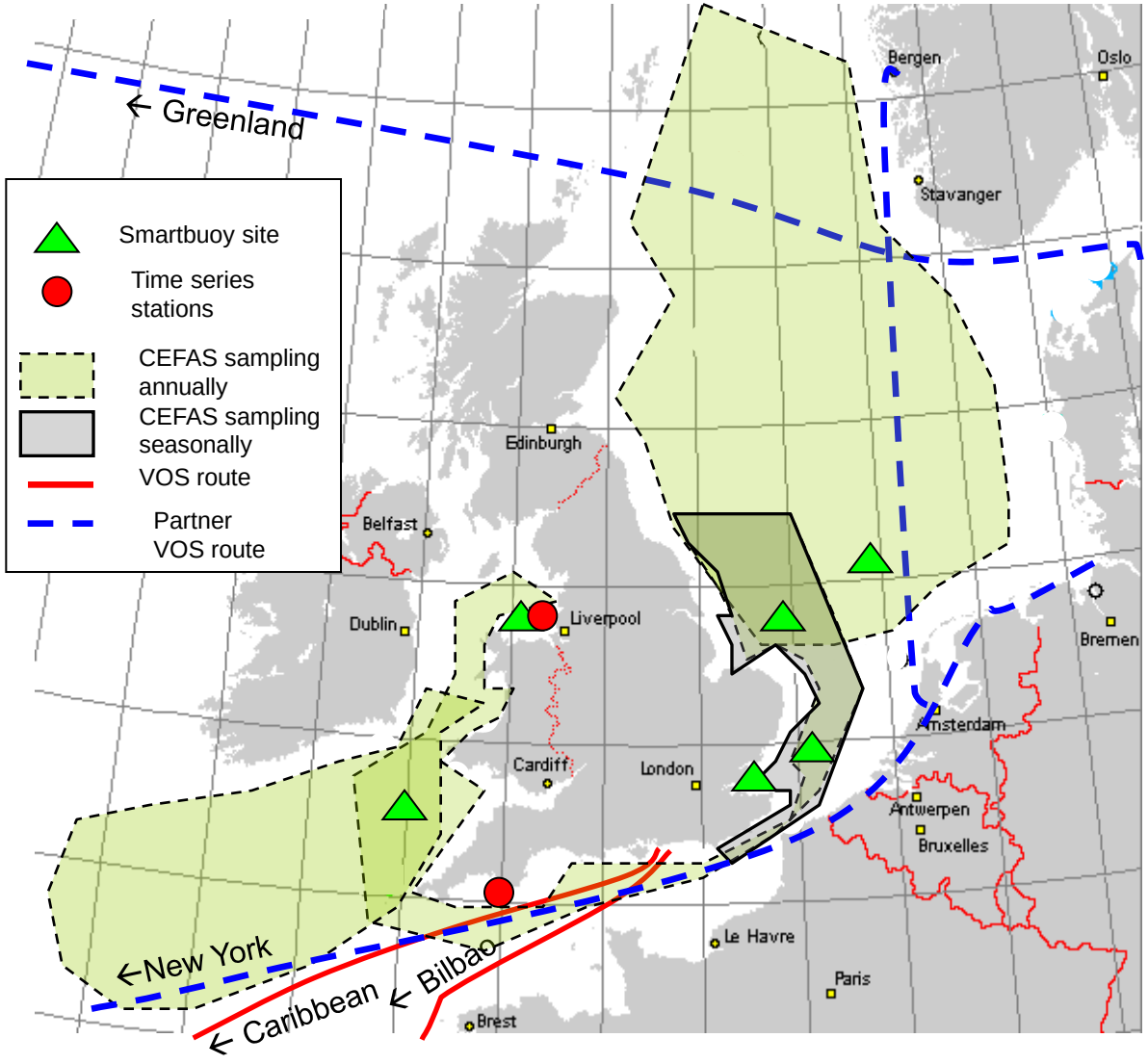
Marine platforms: voluntary observing container ships and ferries

… large fixed observing buoys



Photos: M. Gonzalez-Davila, J, M. Santana-Casiano,
U. Las Palmas Gran Canaria

And time series serviced by small research ships



UK ocean acidification program coverage

Liason with the shipping industry

- Shipping companies move vessels from regular routes at short notice – a major problem in maintaining a network
- Companies have little vested interest in supporting measurements and may withdraw co-operation if it impacts their normal operations.
- Need a single central facility with which they can deal
- Need to foster co-operation and information exchange between companies, and between stakeholders and companies.

Core observations in the marine network

- Ocean pCO_2, O_2, surface temperature, salinity
- Samples for carbonate parameters, nutrients
- CH_4 and N_2O at coastal stations
- Meteorological parameters
- Atmospheric CO_2

Current Partners

UK: University of East Anglia; National Oceanography Centre, Southampton; Plymouth Marine Laboratory

Norway: Bjerknes Centre for Climate Research and University of Bergen

France: IPSL – LOCEAN

Germany: IFM-GEOMAR, Leibniz institute, Kiel; Alfred Wegener institute, Bremerhaven

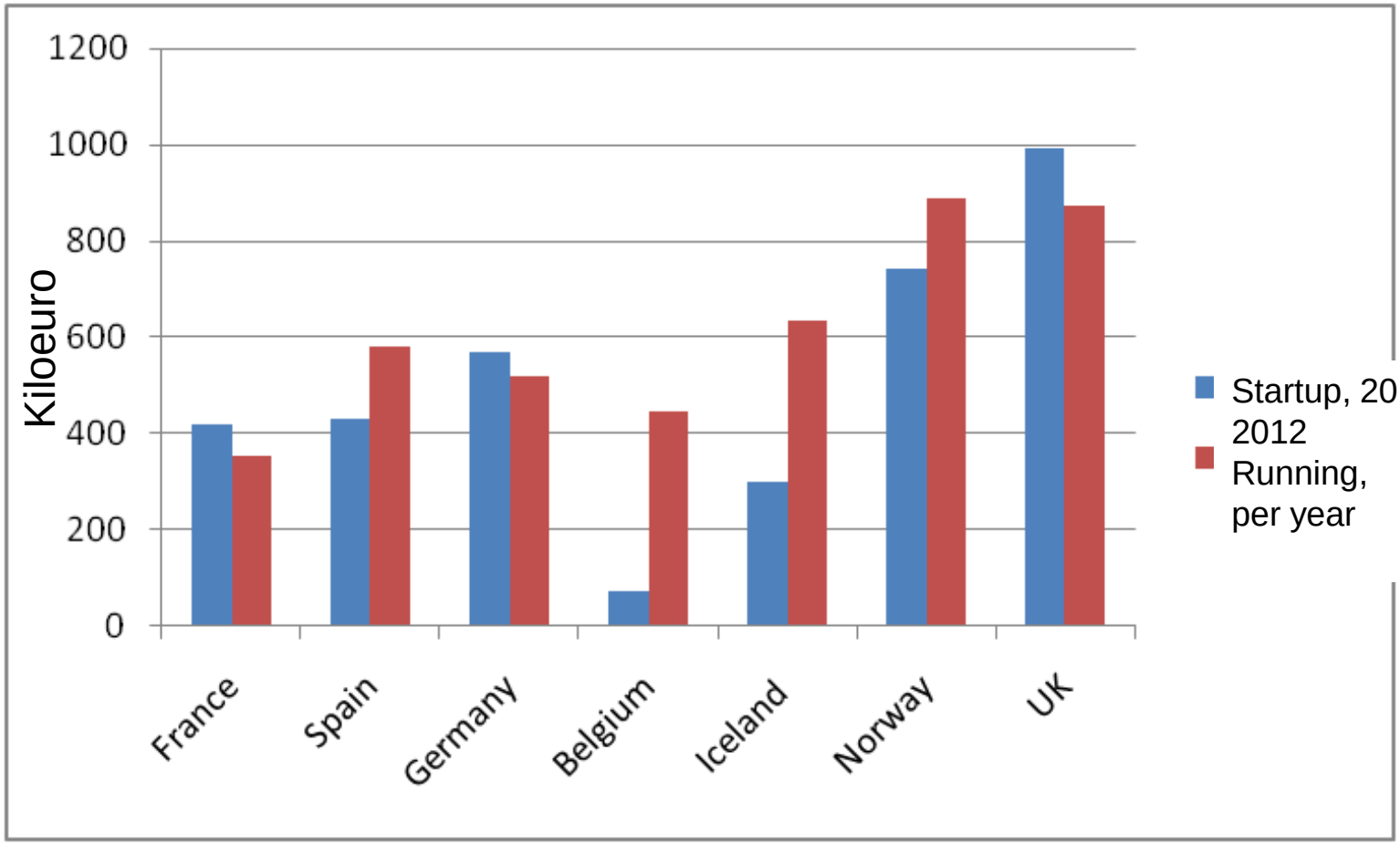
Spain: Instituto d Investaciones Marinas de Vigo; Universidad de Las Palmas de Gran Canaria

Iceland: Marine Research Institute, Reykjavik.

Belgium: Université de Liège;

The Netherlands: NIOZ, Texel

Indicative costs for the network



(Does not include costs of data centre etc.)

Maintaining the CO2 observation network

- Funding
- Transition to operational mode
- Platforms
  - Liason with shipping industry
  - New sensors for floats, gliders etc.