# Intra-annual variability of carbon signature and transport in the North Atlantic Ocean



**Raphaël Bajon***, Lidia Carracedo, Herlé Mercier, Fiz F. Pérez, Antón Velo, Rémy Asselot and Virginie Thierry

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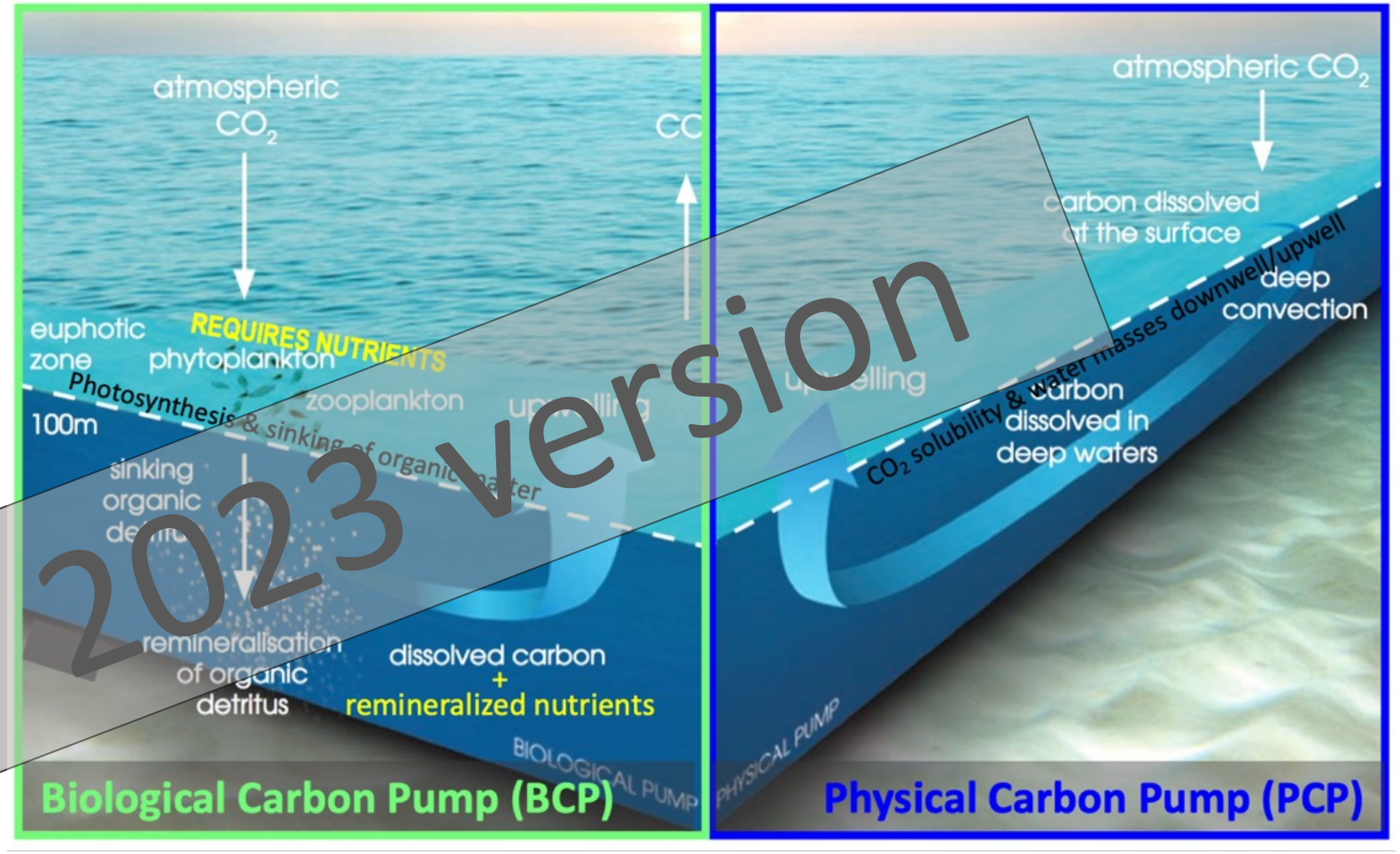
*contact: raphael.bajon@ifremer.fr

# Background

**DIC** (**D**issolved **I**norganic **C**arbon)
=
$C_{nat}$ + $C_{ant}$
(**nat**ural + **ant**hropogenic)




Adapted from
*Bopp et al., 2002*

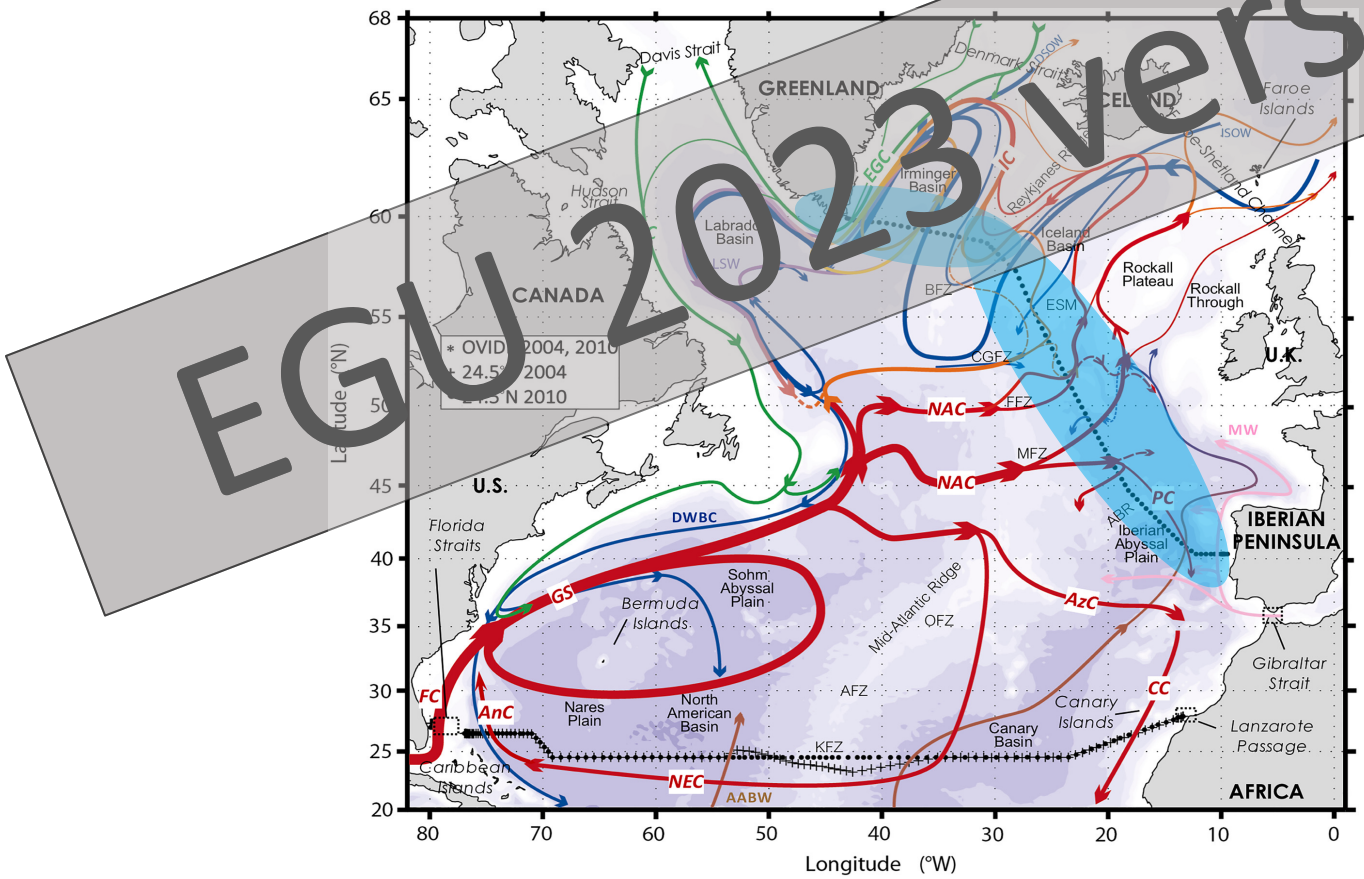


Processes involved in carbon uptake are strongly dependent on intra-annual timescales

# Deriving time series of volume, DIC and $C_{ant}$ transports in the subpolar North Atlantic to analyse seasonal variability

1. Methods
2. Time series
3. Seasonal cycle

EGU 2023 version

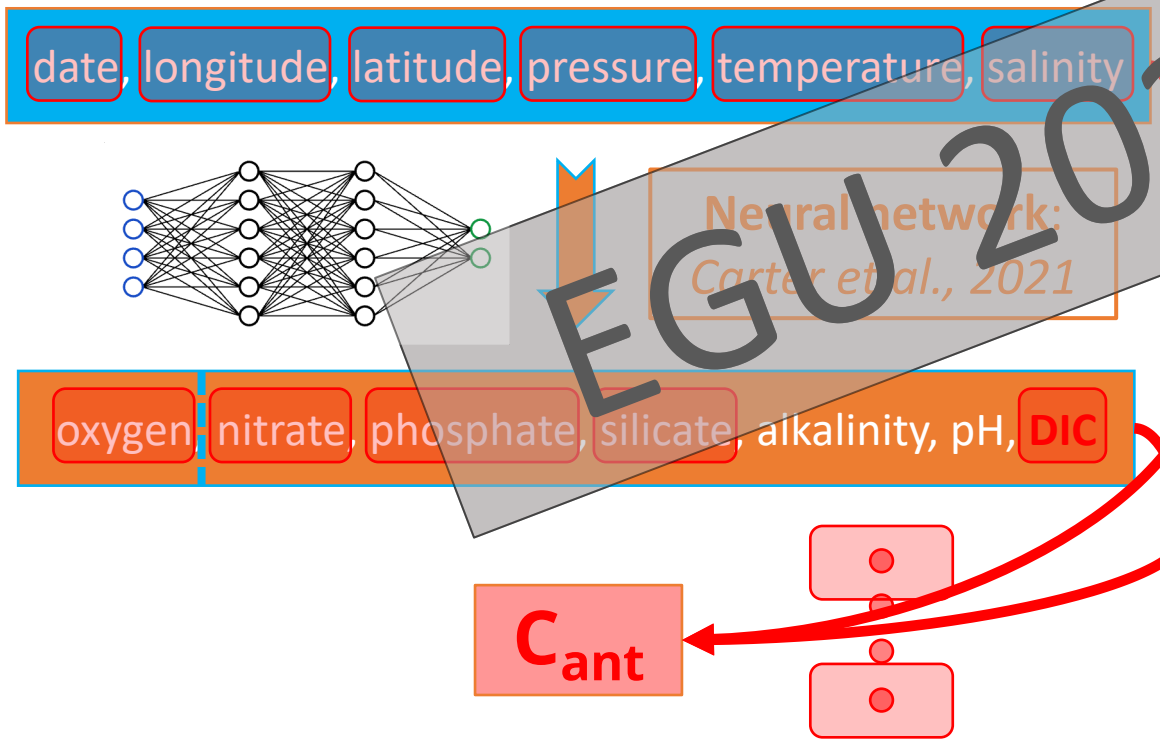



Adapted from
*Daniault et al., 2016*

# Data

- **CORA** (Coriolis Ocean database for ReAnalysis): monthly temperature and salinity, 0 - 2,000m
- **GOBAI-$O_2$:** monthly temperature, salinity and oxygen, 0 - 2,000m

➡ **Compute $C_{ant}$ and DIC**

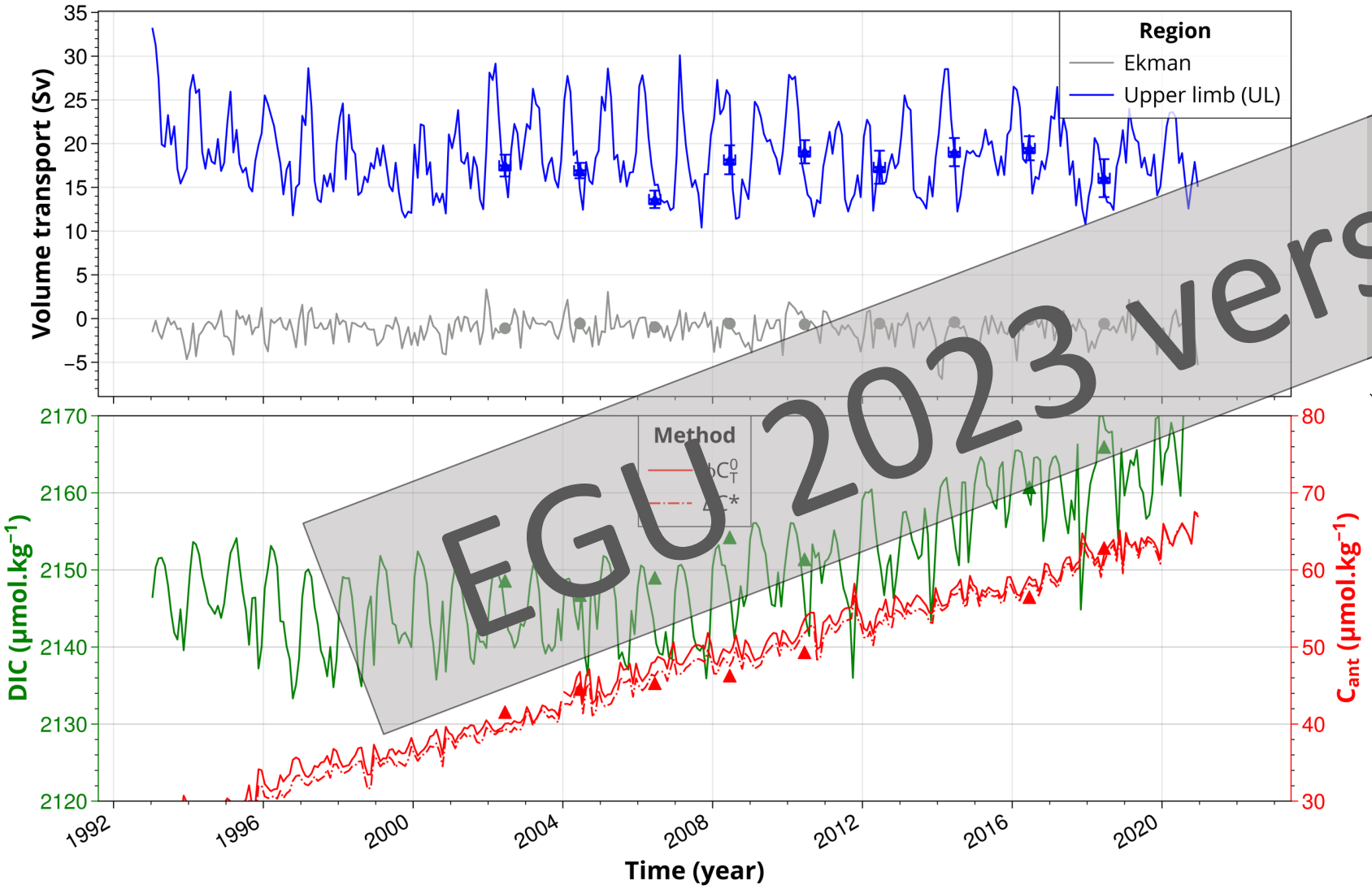



**Validation data**

- **GO-SHIP A25 OVIDE** cruises: bottle and CTD data, 2002 to 2018, every 2 years

**Two back calculation methods:**
**$\phi C_T^0$** (*Vazquez-Rodriguez et al., 2009*) **and $\Delta C^*$** (*Gruber et al., 1996*)

# Volume transport and mean DIC and $C_{ant}$ concentrations in the AMOC upper limb






High variability (seasonal to decadal)

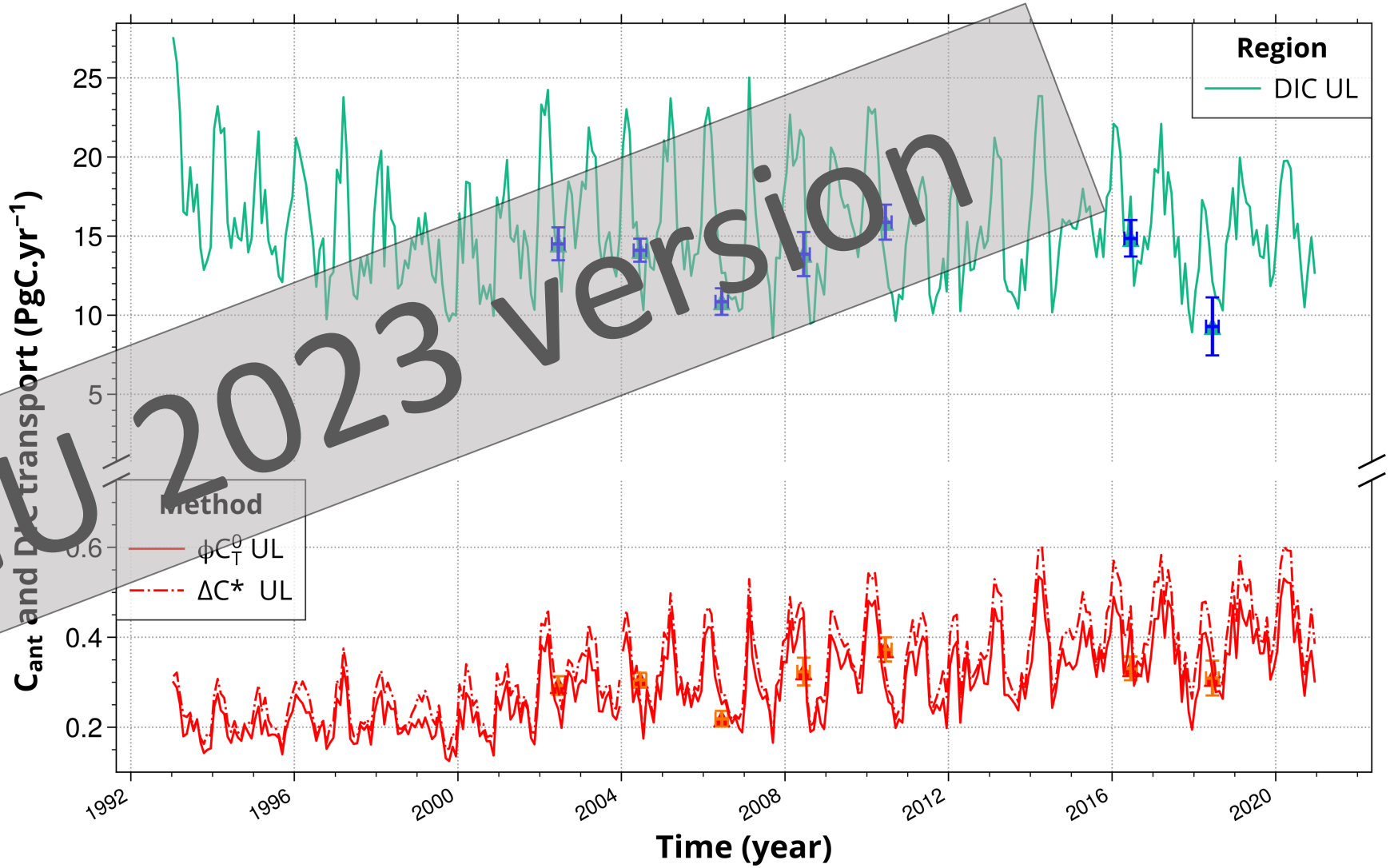
**[DIC]** ≃ Const. or ↘ between 1993-2004 before ↗ since

**[$C_{ant}$]** (2021) ≃ 2 x [$C_{ant}$] (1993)

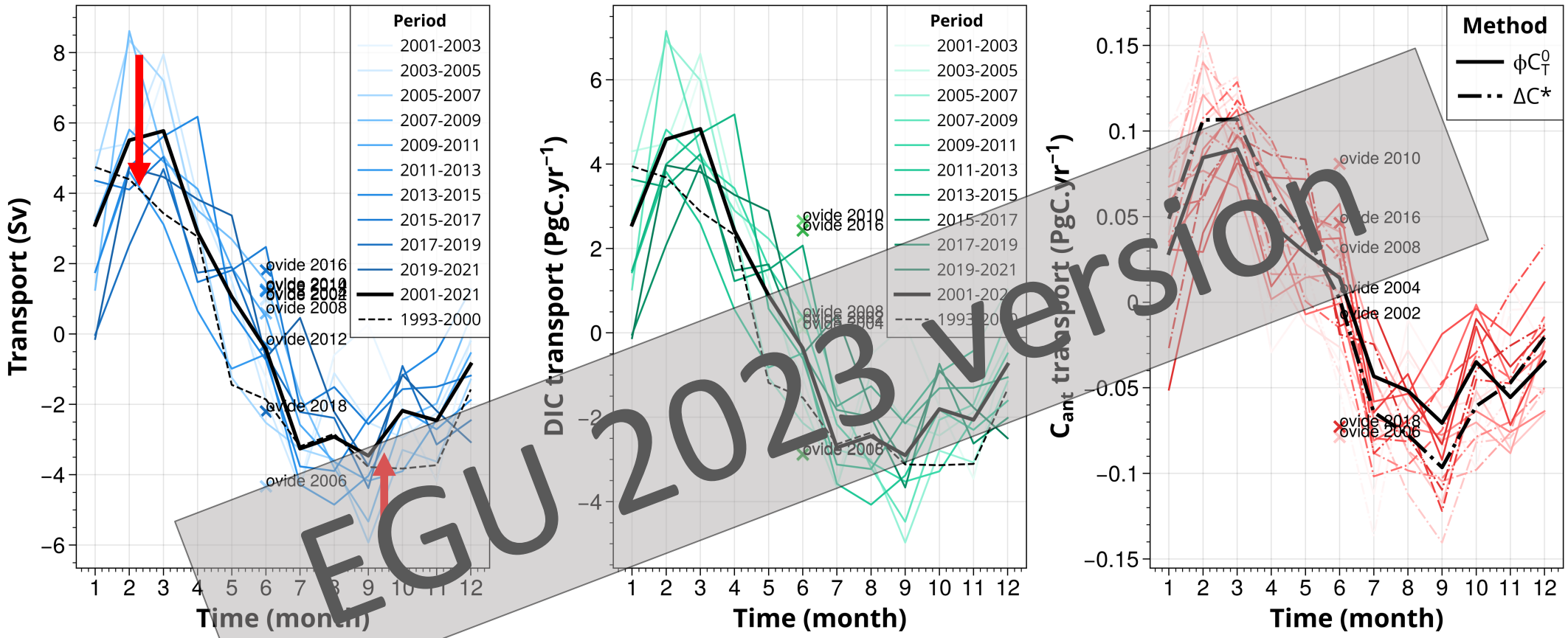
# DIC and $C_{ant}$ transports in the AMOC upper limb

Variability of volume transport well reflected in the **DIC** transport

**Doubling of $C_{ant}$ transport**: from 0.2 PgC.yr$^{-1}$ in 1993 to 0.4 PgC.yr$^{-1}$ in 2021



# Upper limb seasonal fluctuations



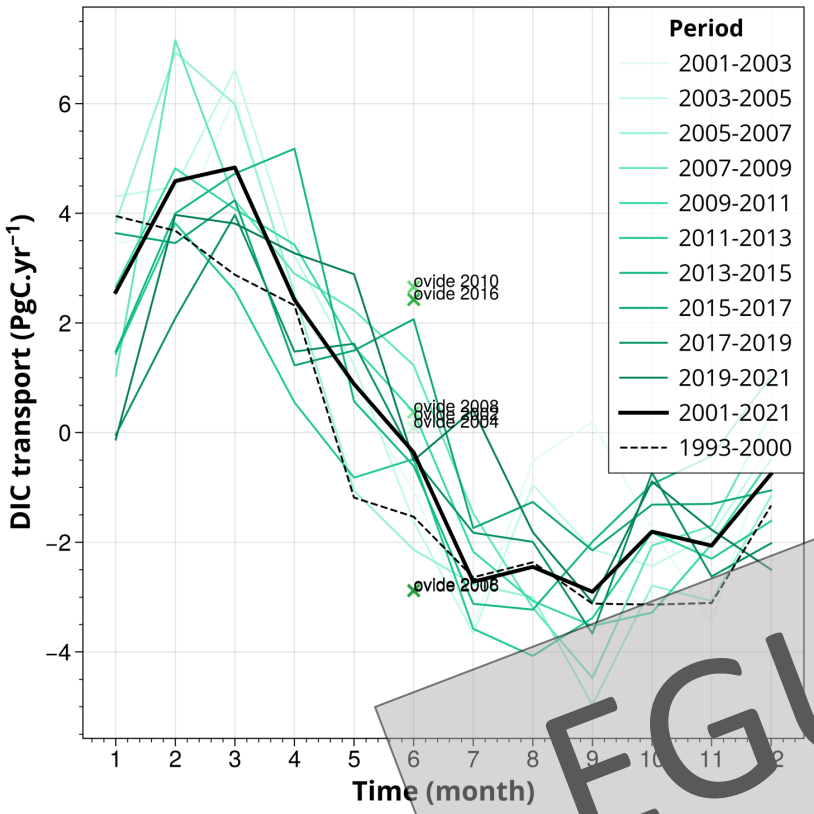


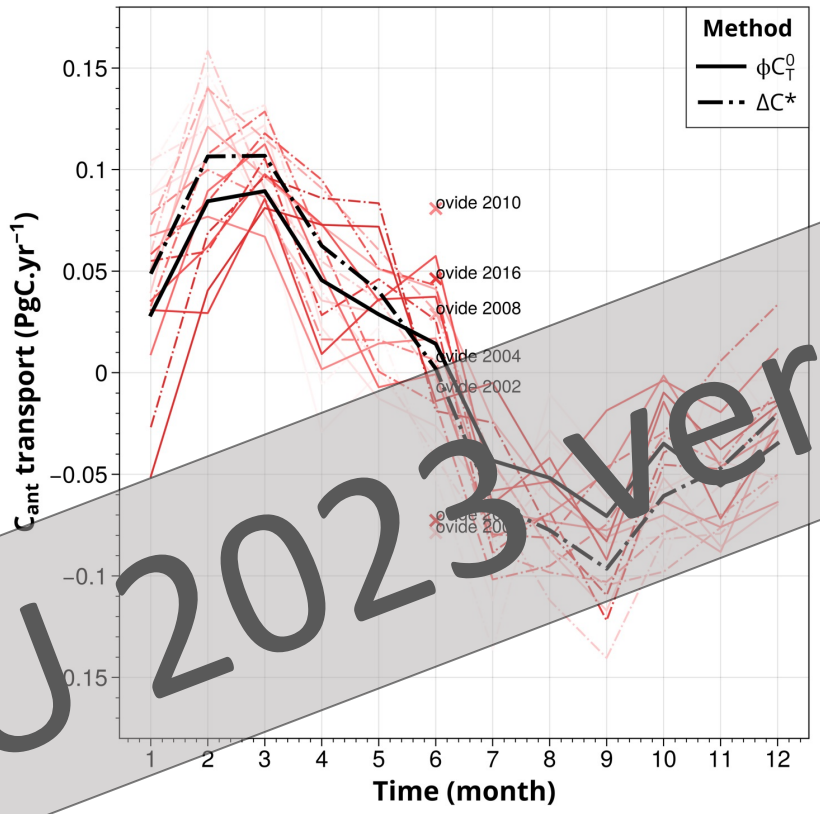

**Decrease** in min/max amplitude in the last two decades

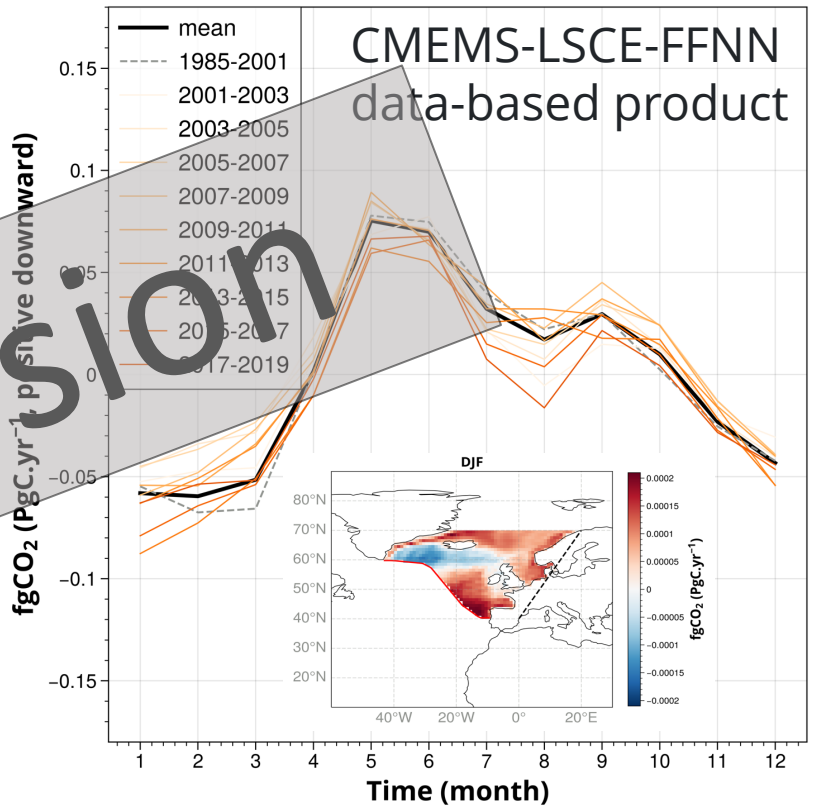
DIC and $C_{ant}$ transport seasonality is about **+/- 25%** of its annual mean

⇒ **Circulation driven DIC and $C_{ant}$ transport variability**

# Sea-air $CO_2$ fluxes north to GO-SHIP A25 OVIDE






2 peaks of $CO_2$ sea-air fluxes corresponding to **phytoplankton blooms**

⇒ **Different factors governing** the seasonal cycle

**Seasonality of DIC transport in the AMOC upper limb** is one order of magnitude higher than **seasonality of $CO_2$ sea-air fluxes**

# Take home messages

➡ Monthly DIC and $C_{ant}$ transports over three decades: good agreement with OVIDE. Summer OVIDE cruises representative of the annual mean transport.

➡ DIC and $C_{ant}$ transport seasonal variability mainly driven by volume transport. Seasonal fluctuations (volume transport, DIC and $C_{ant}$ transports) significant compared to the annual average, by about +/- 25 %. Changing amplitudes.

➡ $C_{ant}$ transport to the north doubling over the 2001-2021 period due to rapid $C_{ant}$ increase. Constant over 1993-2001.



**Contact**
raphael.bajon@ifremer.fr

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