

SSB Boundary fluxes and budgets

Synthesis component of WP5, cross programme effort...

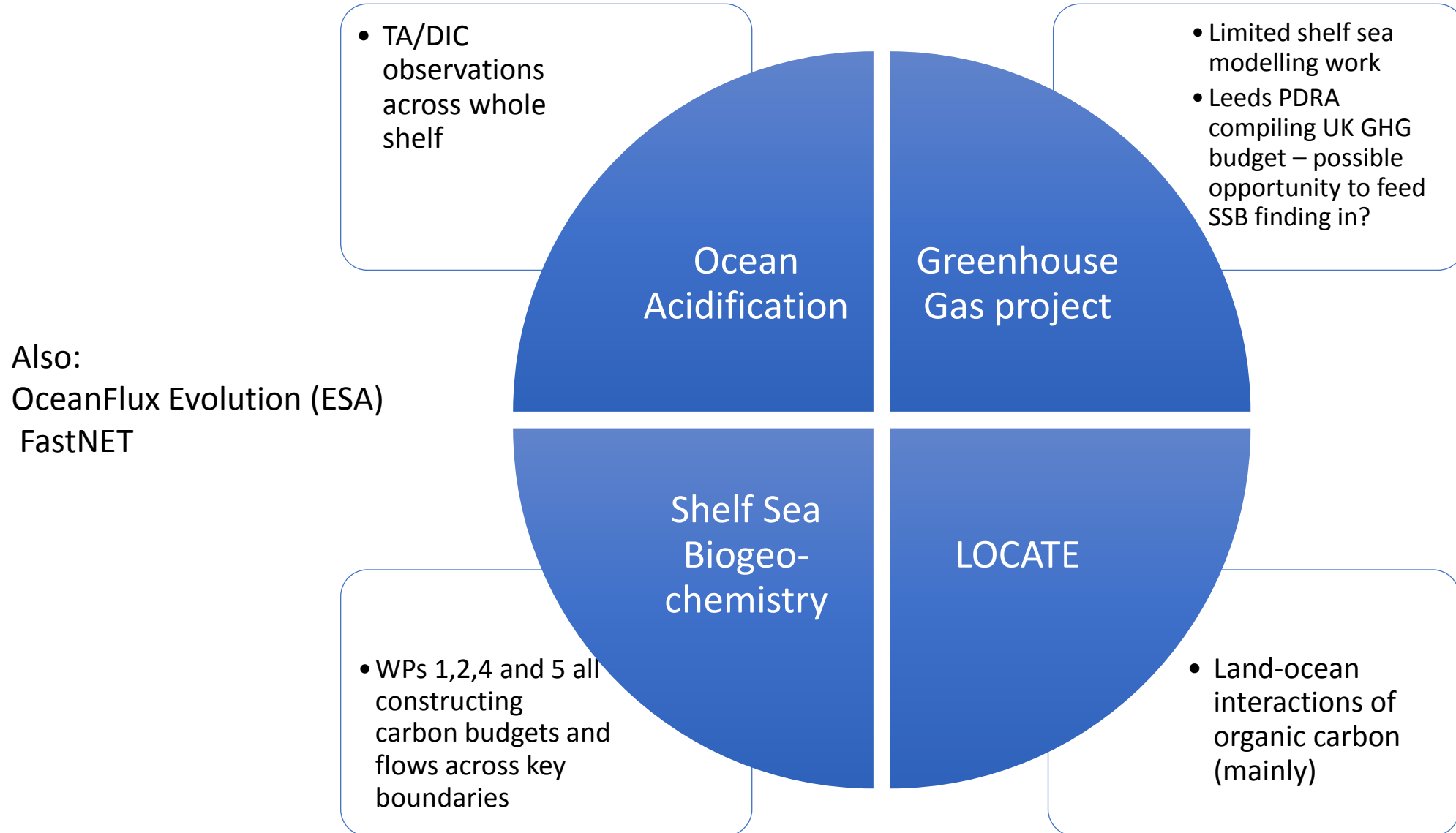
Summary of 2 skype discussions held in early May

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Liam Fernand (Cefas), Naomi Greenwood (Cefas), Tim Jickells (UEA),
Martin Johnson (UEA/Cefas), Silke Kroeger (Cefas), Dan Mayor (NOC),
Johan van der Molen (Cefas), Richard Sanders (NOC), Tiago Silva (Cefas),
Jamie Shutler (Exeter), Sarah Wakelin (NOC)

Motivation

- Make sure our various budgets and fluxes are directly comparable and understand how they compare to other studies (i.e. are differences methodological or real?)
- Ensure data from other related UK programmes are included / compatible / able to feed in
- Provide framework for future studies?

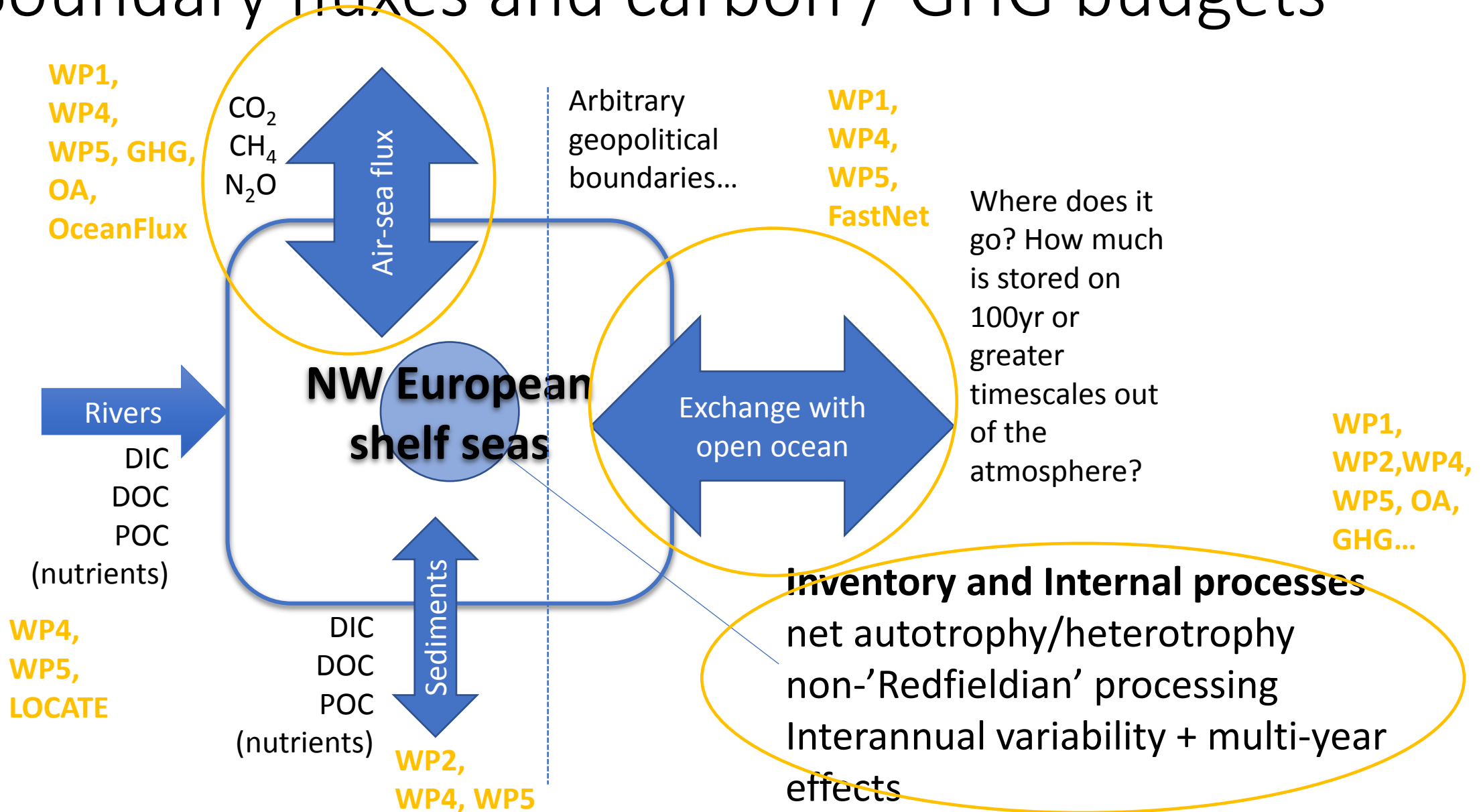
UK research programmes context



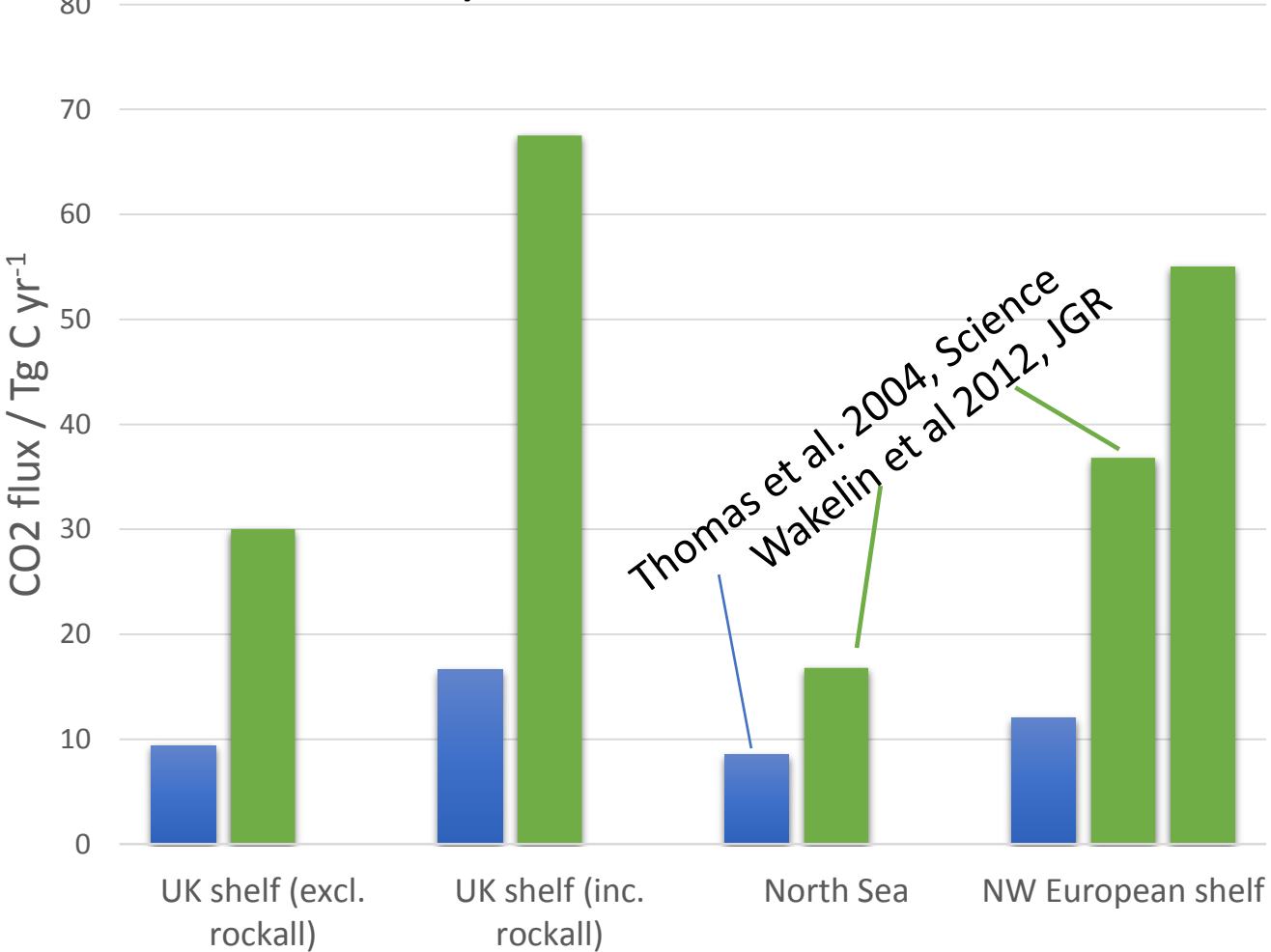
WP5 C budget deliverables

- UK Blue Carbon budget (carbon flows, storage and management options for UK territorial waters and wider shelf)
 - Air-sea greenhouse gas fluxes
 - Coastal and offshore sediment storage
 - Net export to open ocean
- All of the above done with previous estimates but now need feed-in from other SSB work packages to deliver best possible estimate to Defra
- Future scenarios
 - Trawling, warming, riverine nutrient fluxes
 - From NEMO-ERSEM, changes relative to baseline SSB run

Boundary fluxes and carbon / GHG budgets



Air-sea flux of CO₂ – data vs models (pre-SSB data)



Hot off the press!

CANDYFLOSS 2015 estimate:

27 to 35 Tg C

(uncertainty due to shelf definition – parameterisation and data uncertainties still being calculated).

Baseline NEMO-ERSEM high res 2015 estimate:

36 Tg C

Data: SOCAT v2 fCO₂ / Oceanflux (Bakker, Shutler, Land)
 Modelled: POLCOMS-ERSEM, Nightingale 2000 (Artioli, Blackford)

Air-sea GHG fluxes – issues and challenges

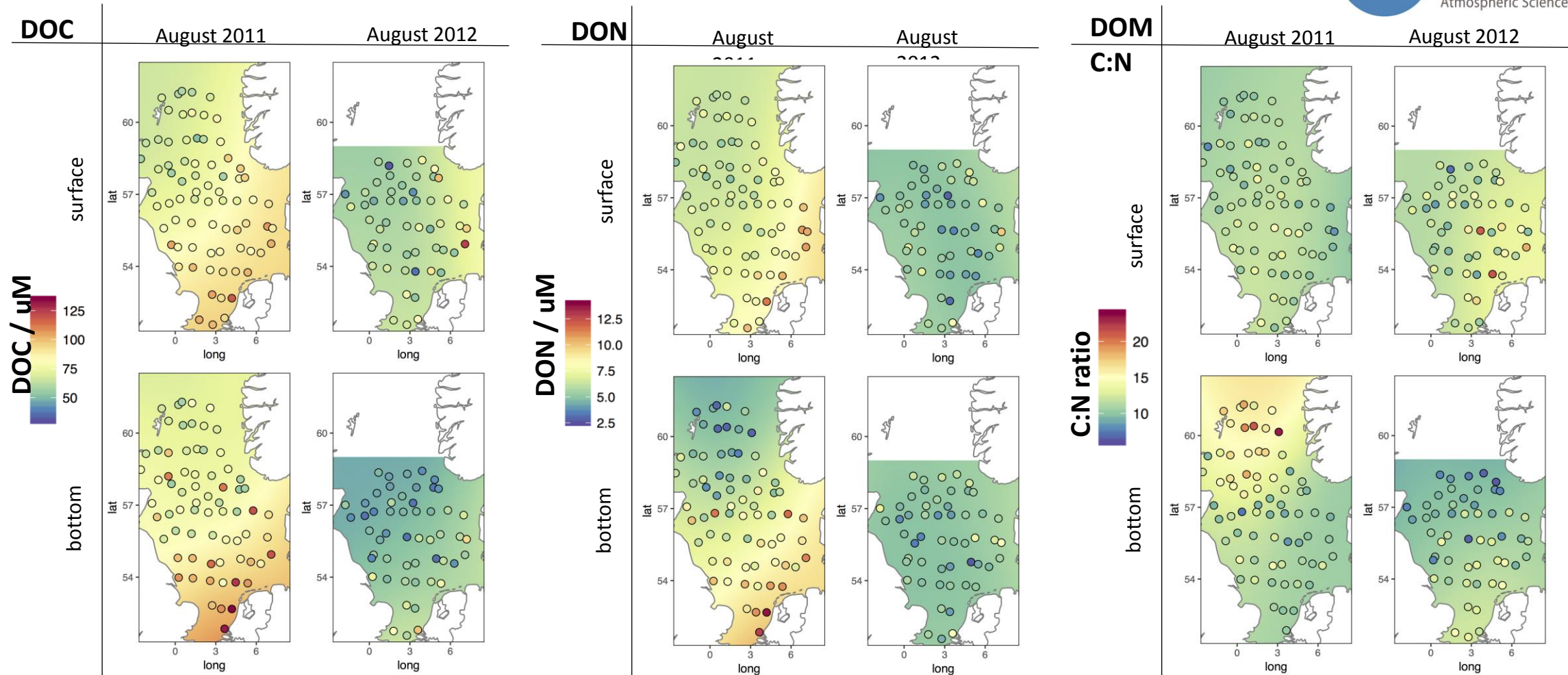
- Land mask at different resolutions of the model has potentially large effects on total air-sea flux estimates (and other aspects of budget presumably)
 - Also, definition of shelf area...
- Air-sea flux estimate methods differ between data based estimates (gasFlux) and model outputs
 - Treatment of variable pCO₂ in atmosphere (monthly average values, year-on-year increases)
 - Different gas exchange parameterisations (not something that can be varied easily in model)
 - Do we need a sensitivity experiment in data based estimate to compare results from model type parameterisation and treatment of gas exchange, with best practice approach in GasFlux?

Lateral exchange (across geopolitical boundaries or shelf-edge exchange)

- Tiago and Sarah developing scripts to calculate budgets and fluxes across any given boundary in SSB model outputs
- Define a standard set of lateral boundaries to meet cross programme objectives and allow intercomparison of different model runs from SSB and beyond?
 - e.g. ICES areas? 200m Contour for shelf-edge?
- In order to compare model values with observations at the shelf scale do we need a set of exchange fluxes from the physical model to use to estimate exchange fluxes from observations (or do we just compare concentration fields)?

Distribution, stoichiometry and interannual differences in the DOM inventory of the the North Sea 2011-2012

Saisiri Chaichana, Tim Jickells, Martin Johnson



Distribution, stoichiometry and interannual differences in the DOM inventory of the the North Sea 2011-2012

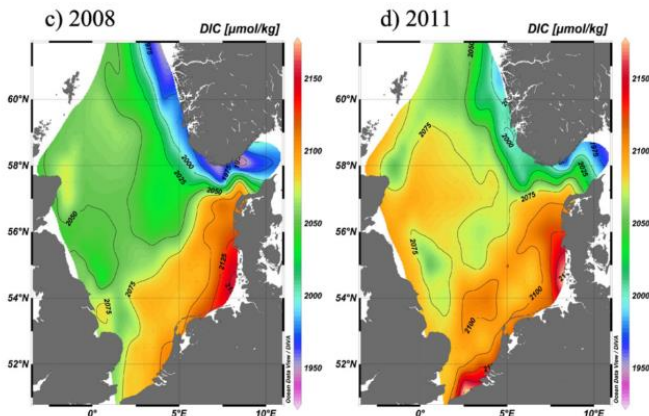
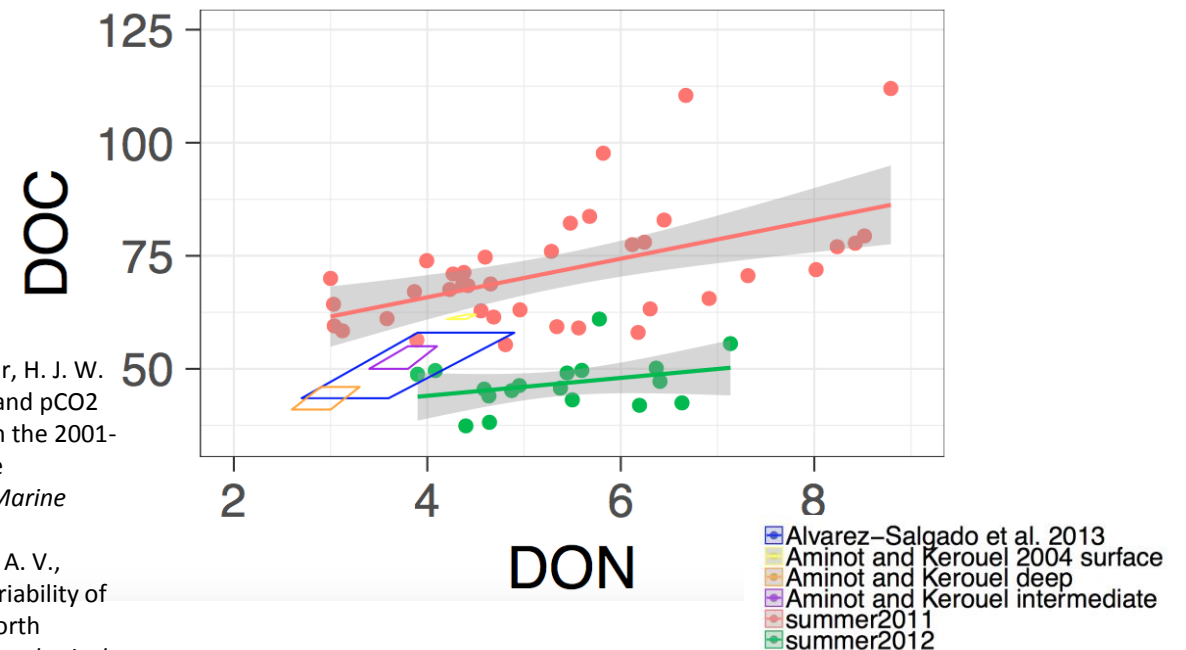
Saisiri Chaichana, Tim Jickells, Martin Johnson

Inventory Change in 1 year 2011 to 2012: decrease of 10 to 20 Tg Carbon

- Equivalent to magnitude of annual air-sea flux
- What is fate of this carbon?
- Clargo et al 2015 also see elevated DIC in 2011 (20 to 40 μM higher than 2008)
- Link to NAO e.g. Salt et al 2013?



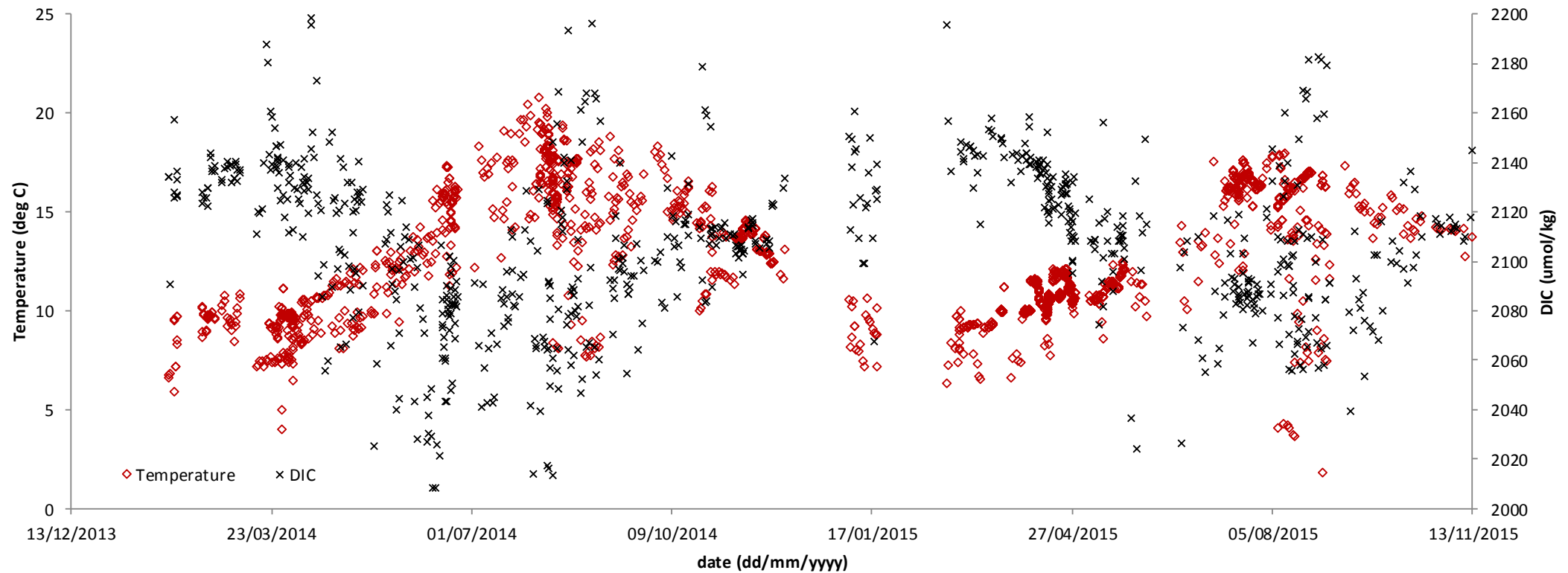
C:N of Northern Bottom waters in 2011 not consistent with N. Atlantic C:N 'endmember' (elevated DOC relative to DON)



Clargo, N. M., Salt, L. A., Thomas, H., & de Baar, H. J. W. (2015). Rapid increase of observed DIC and pCO_2 in the surface waters of the North Sea in the 2001-2011 decade ascribed to climate change superimposed by biological processes. *Marine Chemistry*, 177

Salt, L. A., Thomas, H., Prowe, A. E. F., Borges, A. V., Bozec, Y., & De Baar, H. J. W. (2013). Variability of North Sea pH and CO_2 in response to North Atlantic Oscillation forcing. *Journal of Geophysical Research: Biogeosciences*, 118(4), 1584–1592.

Hartman et al submitted SSB DIC (black crosses)



Planned publications?

- Hartman, S. et al, Seasonality and spatial heterogeneity of the surface water carbonate system on the NW European shelf (DIC synthesis paper)
- Vas Kitidis, Jamis Shutler et al, synthesis paper on air-sea CO₂ fluxes
- Chaichana et al Distribution, stoichiometry and interannual differences in the DOM inventory of the the North Sea 2011-2012
- Data-model comparison papers...
- Suggest a multi-year synthesis paper to put SSB years into context?

Cross-programme workshop?

- Resolve technical issues
- Agree definitions, boundaries, key analyses
- Compile international data across multiple years
- Conduct large-scale data synthesis (and model comparison)?
- Write a paper