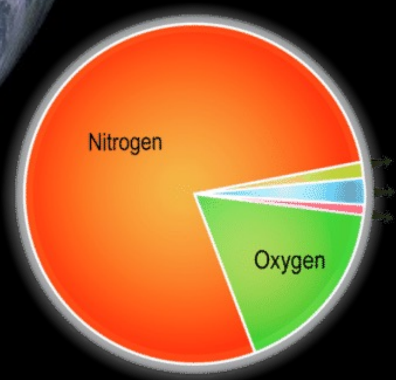
Ocean Carbon for climate (OC4C): project overview

Professor Jamie Shutler, University of Exeter, UK.

Eunice Foote
1856

Discovered the properties of green house gases

The importance of the oceans



Importance of the ocean

Global carbon budgets
Used to advise governments to guide and motivate action.

Food security and conservation
Identify regions and ecosystems at risk.

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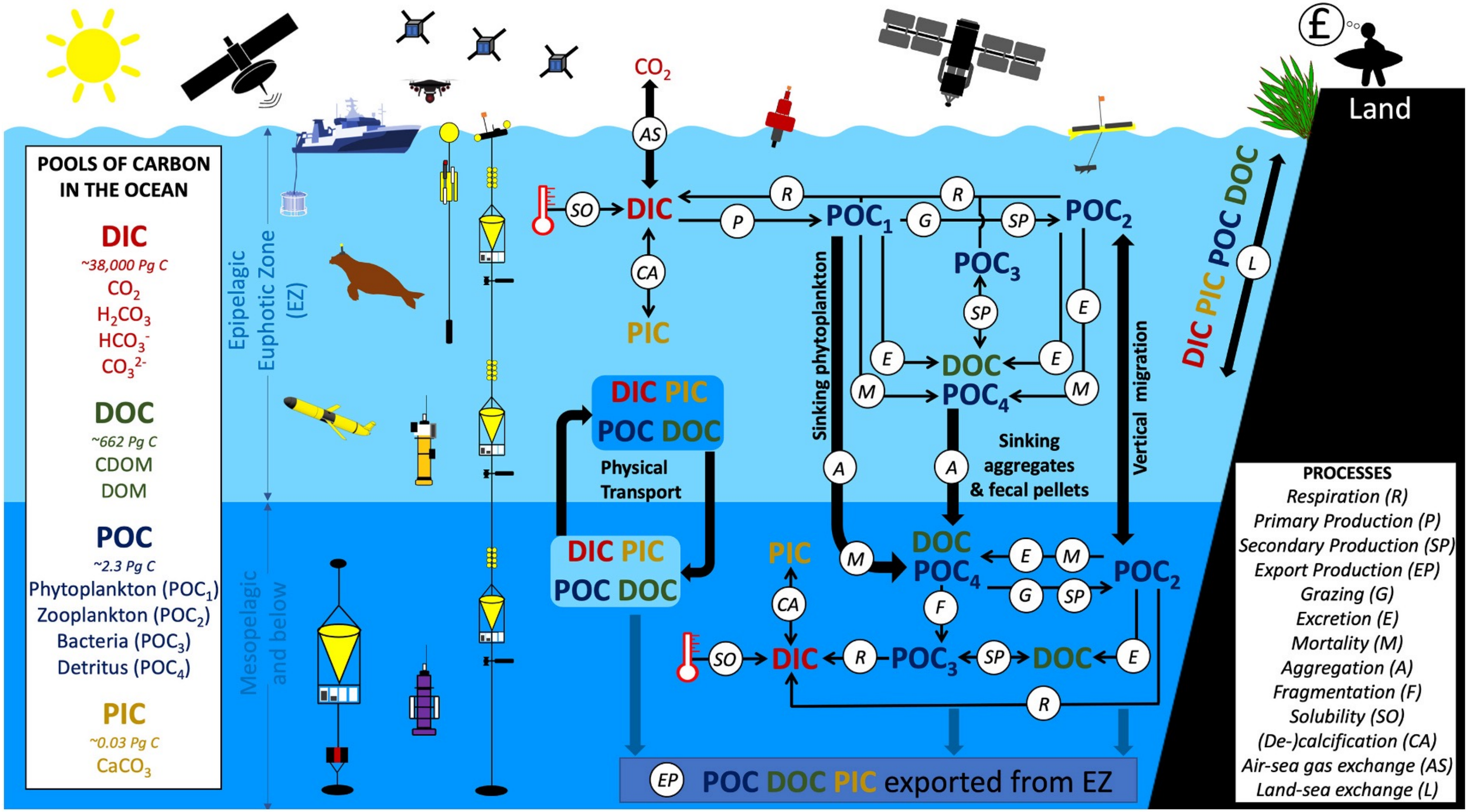
"The ocean data provides one of only two observational constraints on the global carbon assessments (the other being the atmosphere)", Shutler *et al.*, (2020).

Vision: a budget of ocean carbon fluxes and pools - an integrated satellite-based perspective

The increasing contribution and importance of ocean observations within ocean carbon assessments, which rely on the synergistic use of satellite remote sensing data and *in situ* data, warrants a more systematic approach and effort to accelerate their exploitation.

Jamie Shutler and Shubha Sathyendranath

This holistic picture of the carbon cycle from an ocean perspective is from Brewin et al. (2021).
But at the moment, the Global Carbon Budget assessments focus on just the Dissolved Inorganic Carbon (DIC) component, ignoring how everything can, and will be, changing DIC through time.



Vision resulted in some Objectives

Our objectives here are:

- To improve estimates of air-sea fluxes, and reduce uncertainties in uptake of anthropogenic carbon by
  - improving the representation of physical fields and processes relevant for air-sea carbon exchange
  - Incorporating biological contributions that modulate these fluxes

- To produce an integrated, satellite-based budget of pools and fluxes of carbon in the ocean
  - primarily using satellite data to drive the budget estimates
  - but also incorporating other sources of data where essential
  - And coupling with models to reduce uncertainties and fill gaps

- To generate global climate quality time series of ocean carbon pools and fluxes, to improve our understanding of the threats to the ocean resources from climate change, on a regional basis

- Explore implications for regional economy and vulnerability to climate change, on a regional basis

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And in two projects

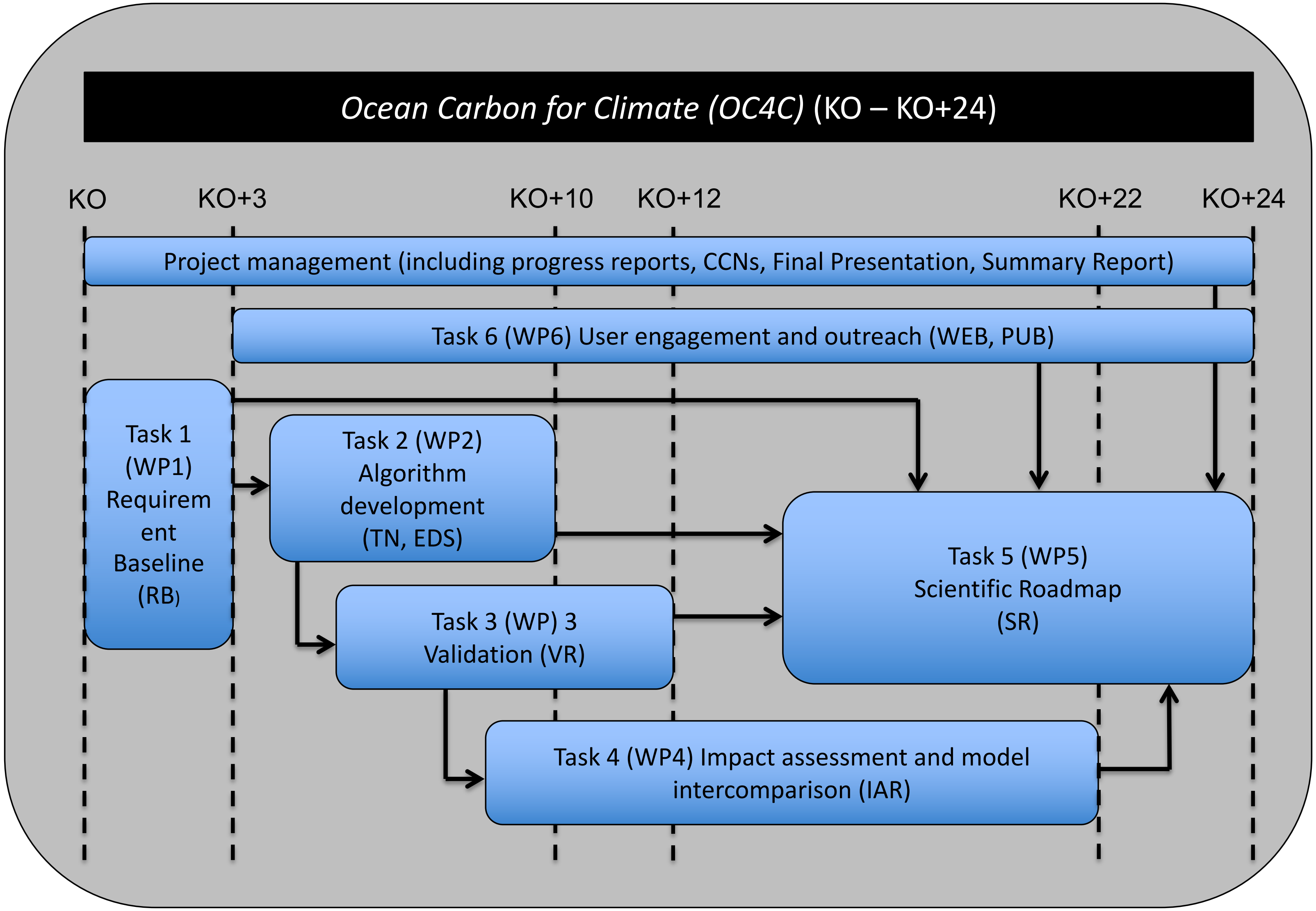
The ocean carbon for climate (OC4C)
initiated by the ESA Climate programme
2 years, started 03 June 2024.

University of Exeter PML AWI LSCE
VLIZ COLUMBIA CLIMATE SCHOOL LAMONT-DOHERTY EARTH OBSERVATORY Space ConneXions

in parallel with

Satellite-based observations of Carbon in the *Ocean*: Pools, fluxes and Exchanges (SCOPE)
initiated by the ESA Science and Society programme

The intention is that the two projects are the beginning of a longer-term commitment and effort.



Ocean Carbon for Climate (OC4C) (KO – KO+24)
KO
KO+3
KO+10
KO+12
KO+22
KO+24
Project management (including progress reports, CCNs, Final Presentation, Summary Report)
Task 6 (WP6) User engagement and outreach (WEB, PUB)
Task 1 (WP1) Requirem ent Baseline (RB)
Task 2 (WP2) Algorithm development (TN, EDS)
Task 3 (WP) 3 Validation (VR)
Task 5 (WP5) Scientific Roadmap (SR)
Task 4 (WP4) Impact assessment and model intercomparison (IAR)

WP2 (task 2) algorithm development (via experiments)

TR-4	○ Identify an adequate reference SST data source and perform reanalysis to a common depth.

TR-5	○ Assess the most adequate land/ocean/ice masks

TR-6	○ Assess multiple CO_2 interpolation schemes

TR-7	○ Incorporate biological modulation and control on pCO_2 and also consider incorporating observation-based alkalinity

TR-8	○ Update the gas transfer velocity coefficient (Ks) with the latest advancements on its geophysical dependencies (wind speed, whitecaps, etc.)

TR-9	○ Update and use dedicated EO tools (e.g. FluxEngine) for the routine provision of harmonised and consistent ocean carbon flux data

TR-10	○ Embed the generated high quality, global, multi-mission, consistent time-series of relevant ocean carbon datasets within an experimental data package for further exploitation and reference by the user community.

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WP4 (task 4) impact assessment and model intercomparison

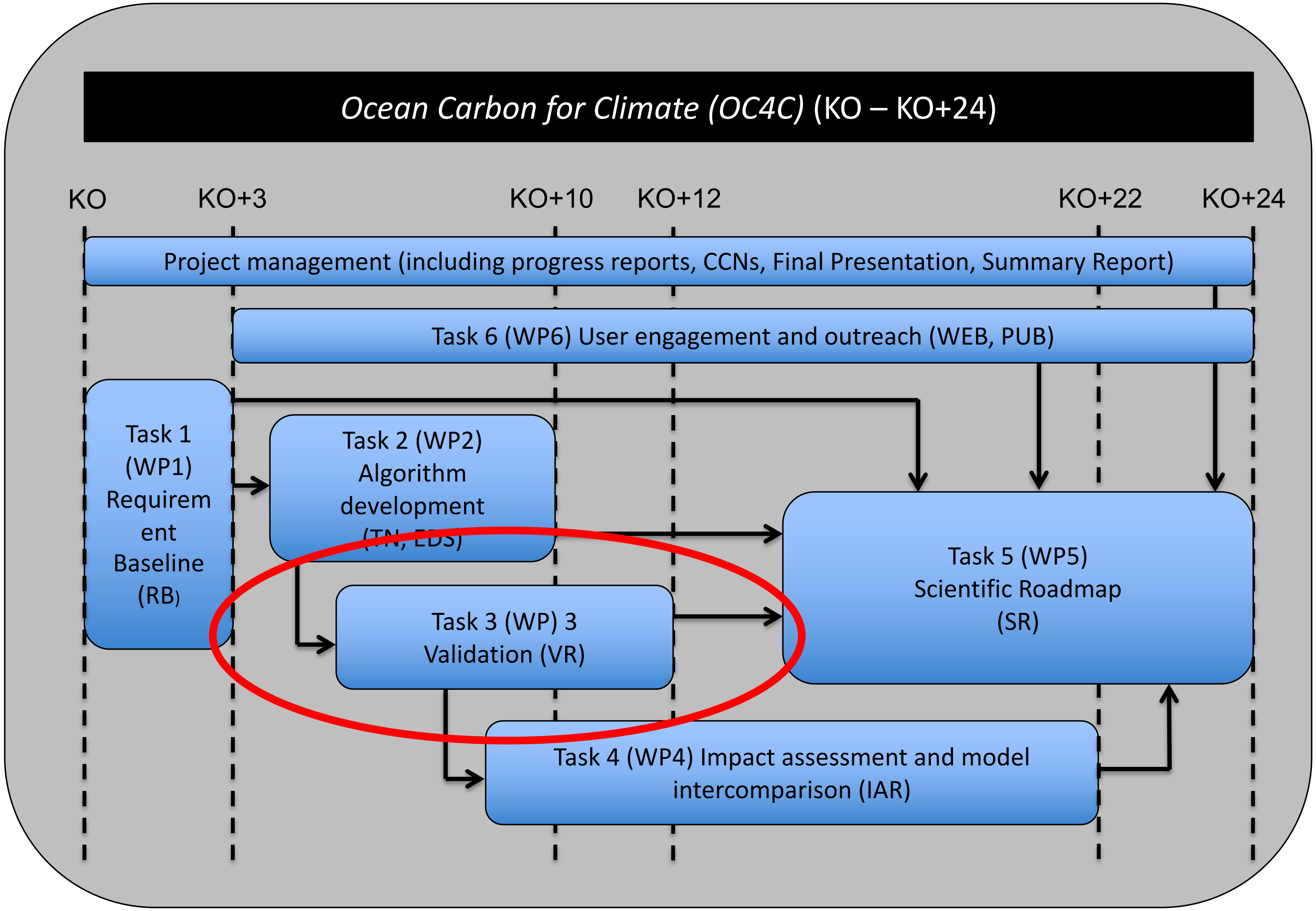
TR-13	○ Assess the differences existing between observation-based and model-based CO_2 fluxes estimates, once the upgraded estimates developed in Task-2 are considered.

TR-14	○ Evaluate to which extent the two estimates come any closer, when uncertainties/error bars upon the observation-based estimates are included.

TR-15	○ Assess if and to which extent the ocean carbon sinks are correlated to major climate indexes (such as ENSO), and identify any temporal lags.

TR-16	○ Sample the modelled pCO_2 data at the same locations in space and time as the in-situ data underpinning the EO-based approaches. Evaluate EO-model spatial and temporal consistencies or discrepancies, once devoid of the sampling effect.

TR-17	○ Upscale GOBMs models at EO spatial and temporal resolution and assess statistics evolution, once devoid of the representation error.



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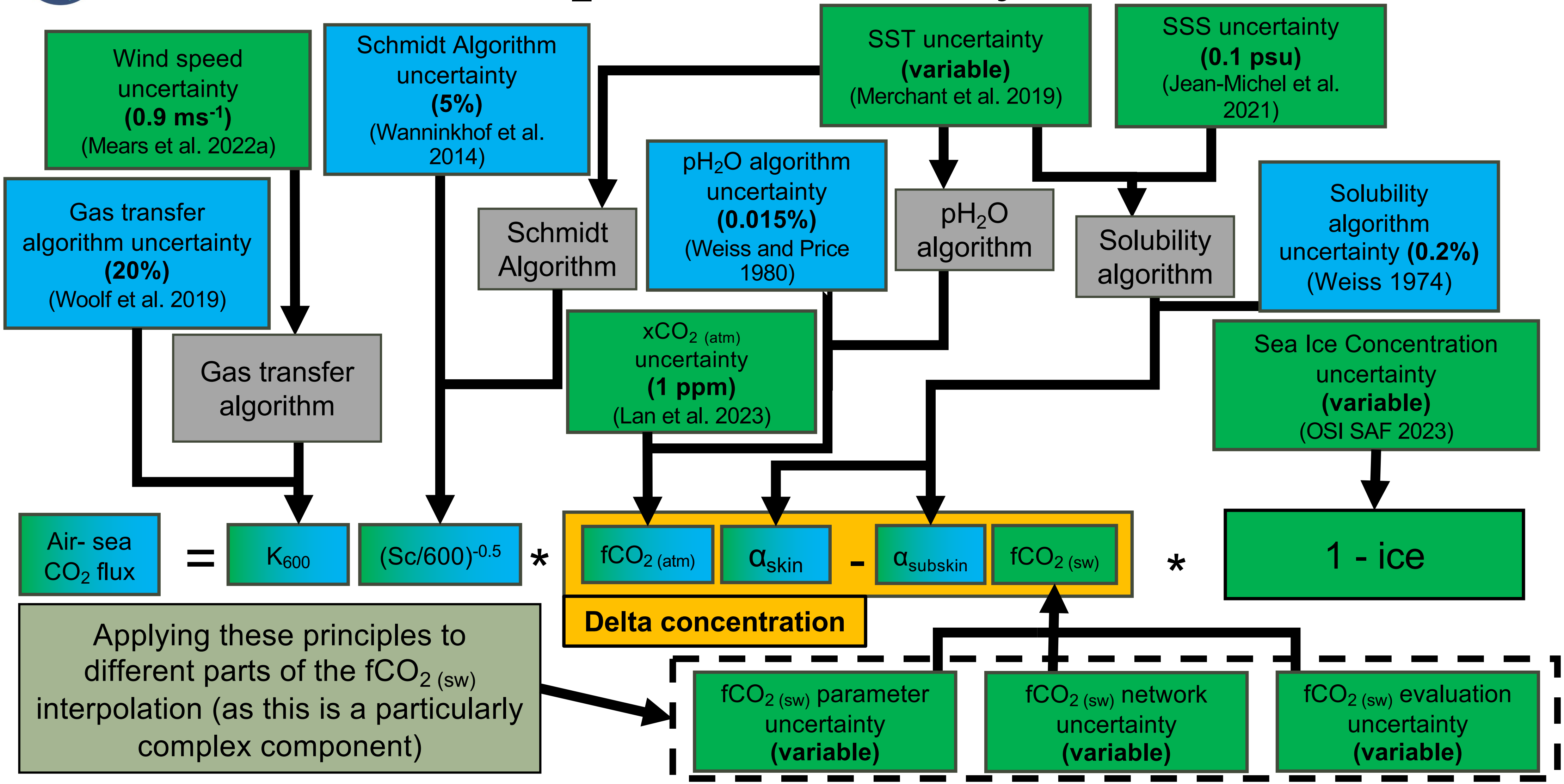
The air-sea CO_2 flux uncertainty framework



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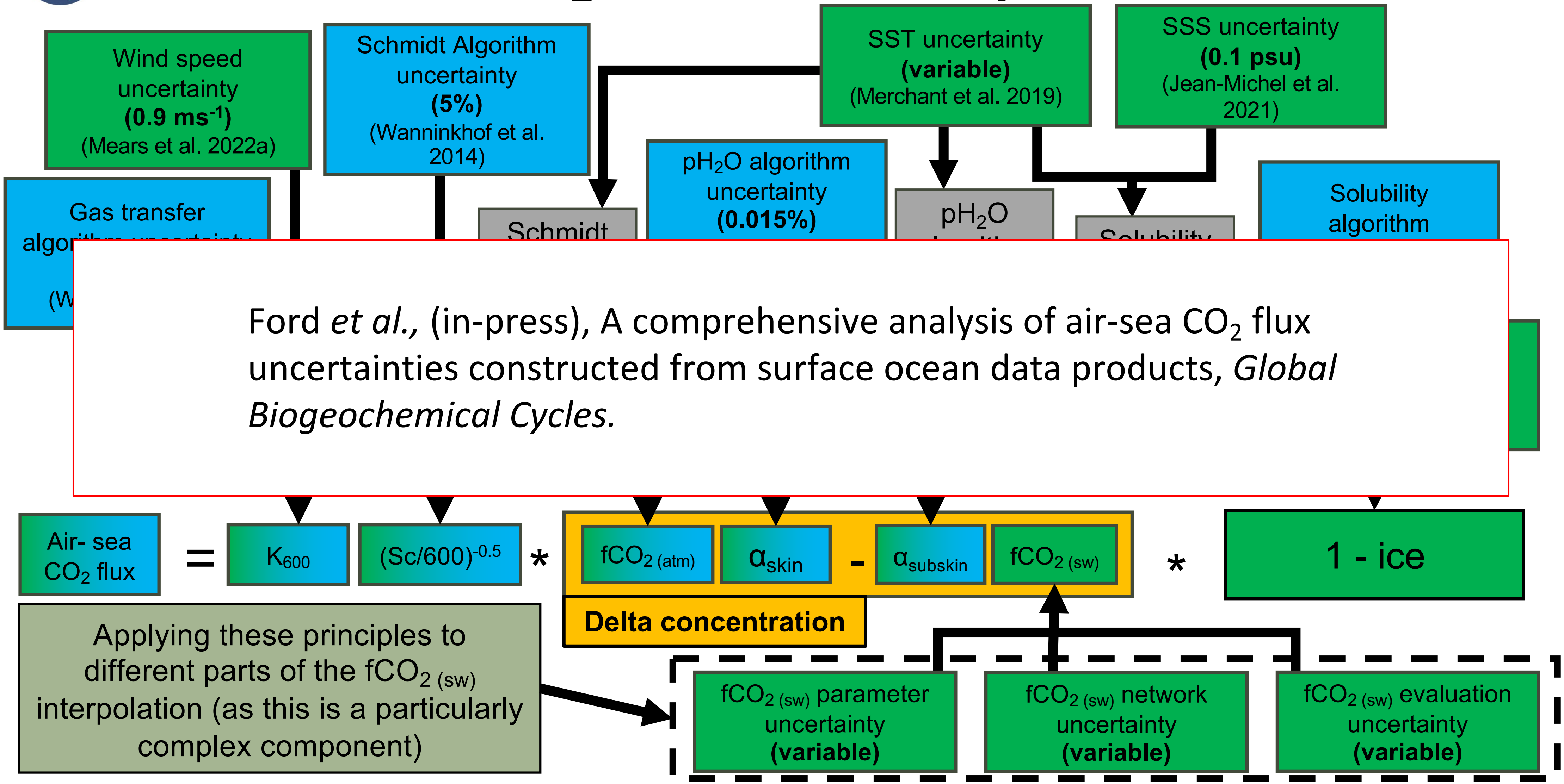

Ford *et al.,* (in-press), A comprehensive analysis of air-sea CO_2 flux uncertainties constructed from surface ocean data products, *Global Biogeochemical Cycles.*