LCA DISCUSSION FORUM

Regionalized Characterization Factors for Ocean Acidification

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3 September, 2024

This project is funded by the European Union's Horizon Europe research and innovation programme under grant agreement no. 101059379.

Project funded by

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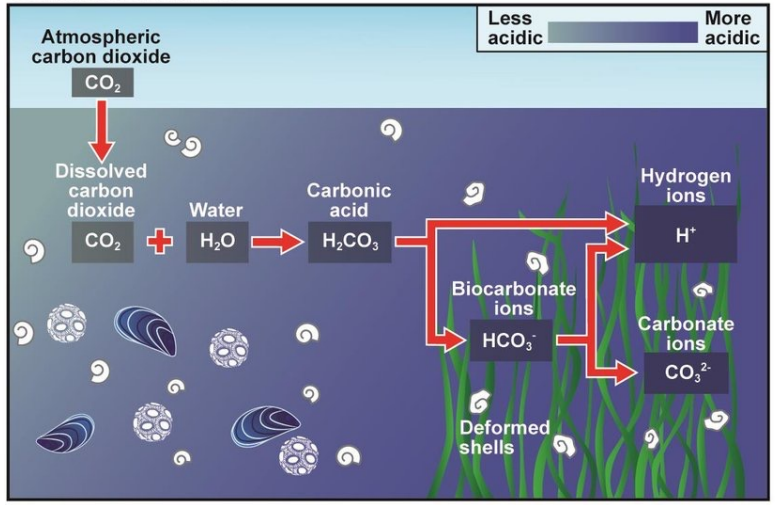
Why does it matter?



Deformed shells

Food web disruption

Coral reef collapse

Tissue acidosis

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Current State

Fate model

- Spatially generic
- Includes CO2, CO, and CH4

Effect model

- Spatially delineated for 3 regions
- SSDs for slightly and strongly calcifying species

Research Gap

Marine biogeochemical cycles affect pH and ocean acidification differently in different ecosystems

Regionalized mid and endpoint CFs are necessary to accurately model ocean acidification impacts

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Research Objective

Generate climate-region specific CFs for impacts from ocean acidification for CO2, CH4, and CO

Fate model

- Spatially delineate FF for 232 coastal marine ecoregions and 18 FAO major fishing zones for open ocean
- Include CO2, CO, and CH4

Effect model

- Expand SSD curves for more robust coverage of slightly or non-calcifying species
- Expand regional specificity if possible

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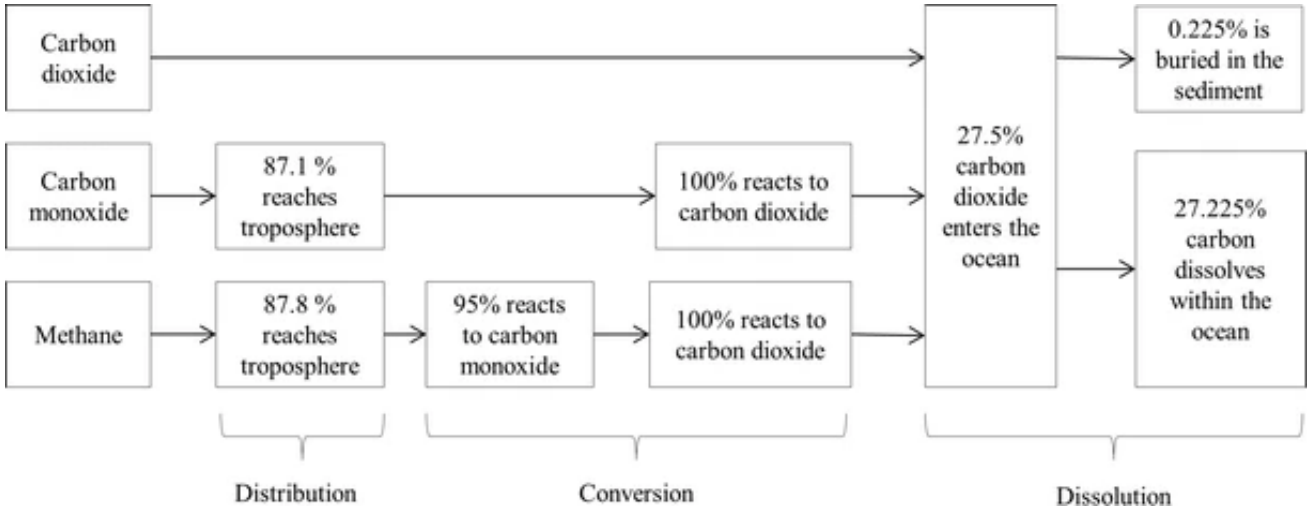
Creating a Spatially Explicit Fate Model

$$CF_i = \text{fate factor}_i \times \text{fate sensitivity factor}_i$$



Dissolution factor (DF) From Bach et al (2016), not spatially delineated

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Creating a Spatially Explicit Fate Model

CF_i = fate factor$_i$ x fate sensitivity factor$_i$

Equation 1

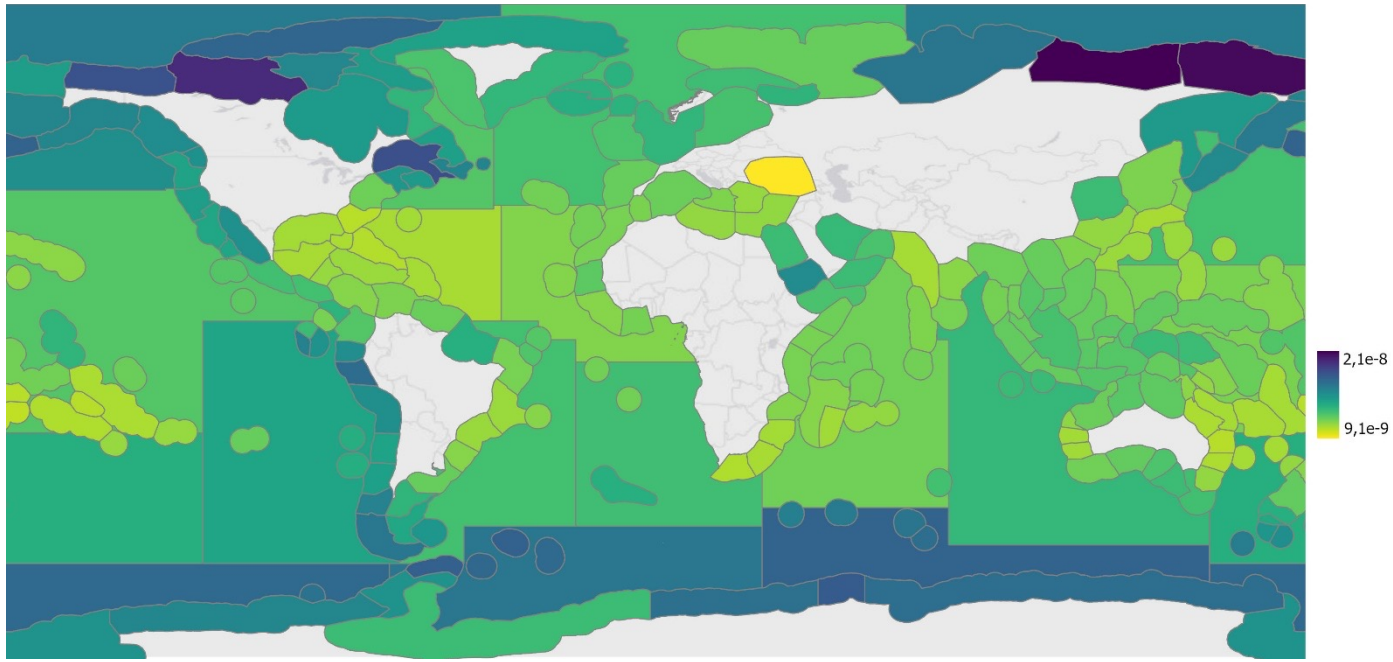
$$\frac{\Delta spCO2}{spCO2_{orig}} = Revelle\ Factor * \frac{\Delta DIC}{DIC_{orig}}$$

Equation 2

$$\Delta DIC = \frac{\left(\frac{(\Delta CO2 \cdot DF)}{M}\right)}{SO}$$

$spCO_2$ = *surface partial pressure of* CO_2 (Pa/m^3)
DIC = dissolved inorganic carbon (mol/m^3)
Δ *CO2= emitted CO2 (g)*
DF = dissolution factor
M = molar mass (g/mol)
SO = surface ocean area (km^2)

Average change in spCO2 (Pa/m^3) per kg CO2 emitted



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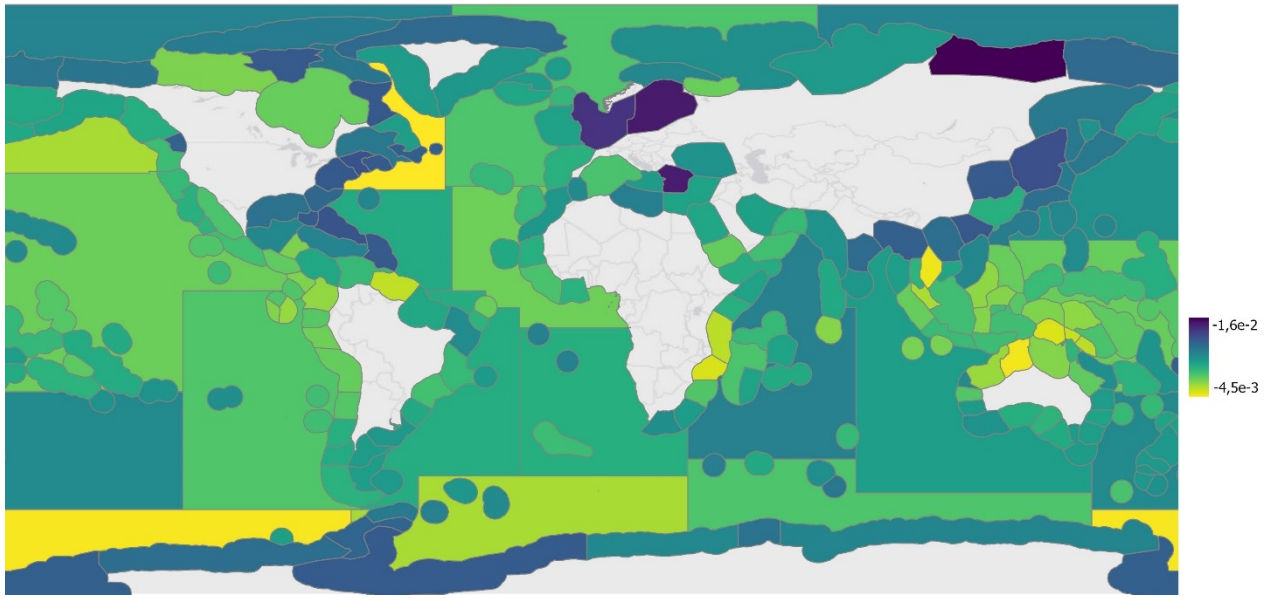
Creating a Spatially Explicit Fate Model

$$CF_i = \text{fate factor}_i \times \text{fate sensitivity factor}_i$$

- **Fate Sensitivity Factor** reflects the changes in the considered environmental compartment when the substance enters it
- Sourced data from complex biogeochemical marine model (PISCES) to account for spatial differences in biogeochemical cycles
- Calculated pH ~ spCO2 relationship using linear regression modelling to spatially delineate fate sensitivity factor

Average change in marine pH per unit increase of spCO2 (Pa/m^3)



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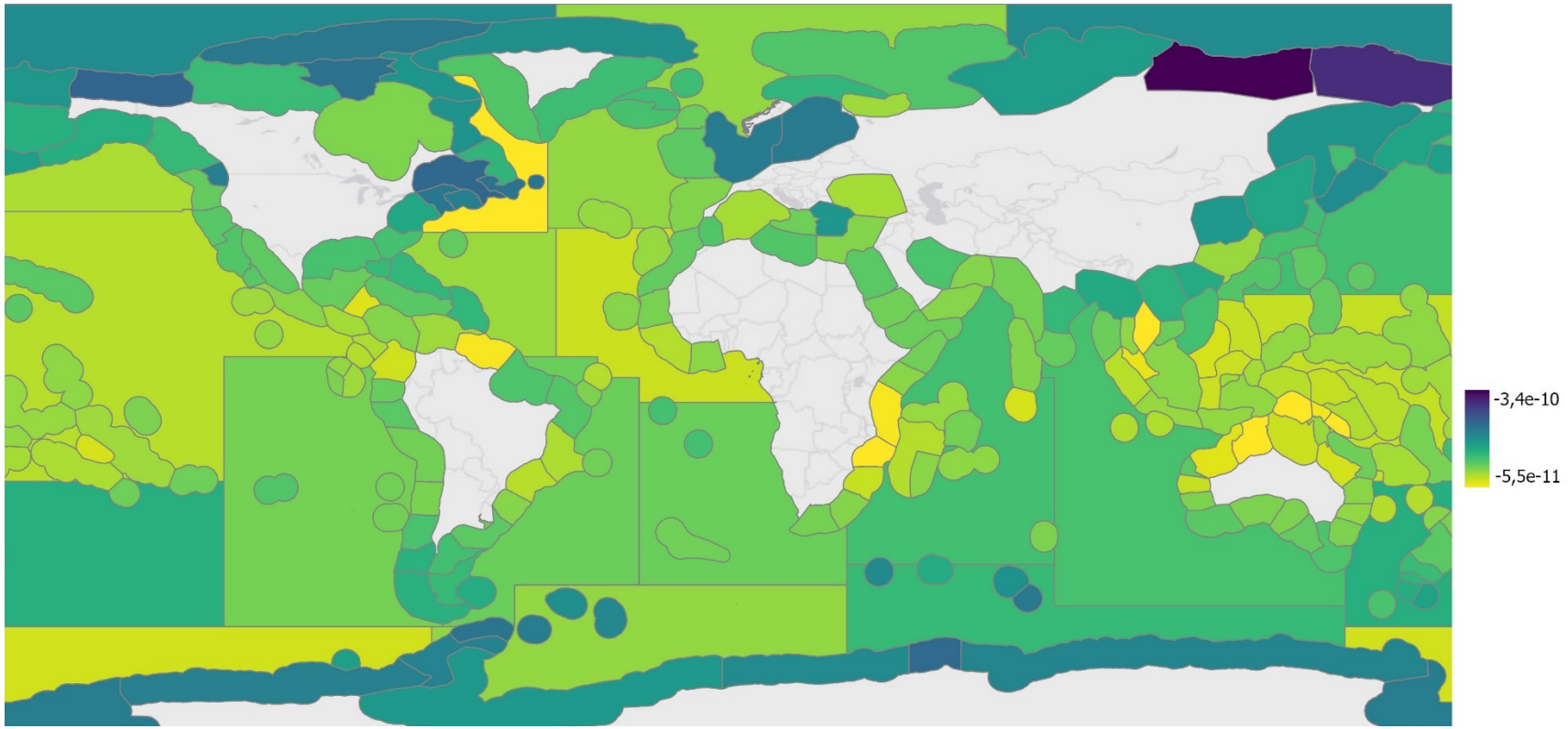
Creating a Spatially Explicit Fate Model

CF_i = fate $factor_i$ x fate sensitivity $factor_i$

Preliminary midpoint CF_{co2} (pH/kg_{emit})



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Expanding Current Effect Factor

The challenge

Marine acidification/pCO2 is not a standard ecotoxicology chemical experiment – little to no data in standard toxicology format

The approaches

1

Calcifying Species Sensitivity Distributions for Ocean Acidification

Ligia B. Azevedo,*[,†,‡] An M. De Schryver,[§,∥] A. Jan Hendriks,[‡] and Mark A. J. Huijbregts[‡]

- Calculates empirical relative responses for each experiment
- Uses ERR value and corresponding pH to fit a logistic regression curve and extrapolate EC50 and EC10 values

2

Characterization factors for ocean acidification impacts on marine biodiversity

Laura Scherer | İrem Gürdal | Peter M. van Bodegom

- Grouped experiments into pCO2 bins and categorized responses as negative, positive, or neutral
- Calculated PAF per pCO2 bin as fraction of species with a negative response relative to total
- Took mid-range pCO2 bin value and converted to pH to represent each bin

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Upcoming:

- Seabed damage
- Overexploitation

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Thanks for listening!

Comments? Questions? Feelings? Contact me!

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