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Marine Matters

Invasive species: an increasing threat to marine ecosystems under climate change?

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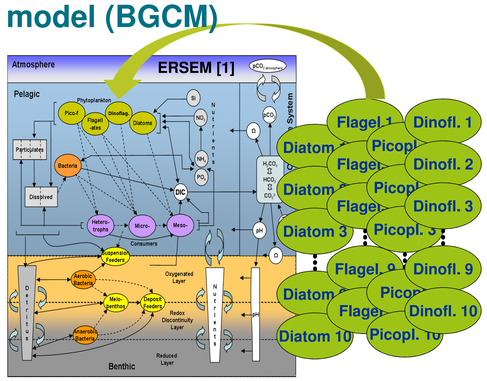
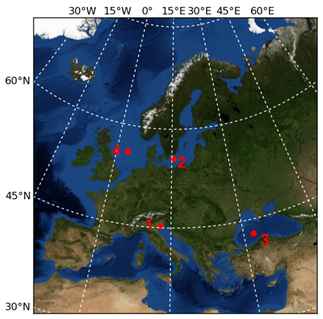
DivERSEM : including diversity in a biogeochemical model (BGCM)

- Each phytoplankton PFT has been split in 10 sub-type or "species"
- Parameterisation of mortality and temperature response has been updated to account for species-specific behaviour
- Species-specific parameters have been randomly generated from a uniform distribution (±30%) centred in the standard value with some constraint to simulate physiological trade-offs



Implementing the model in the European shelf seas

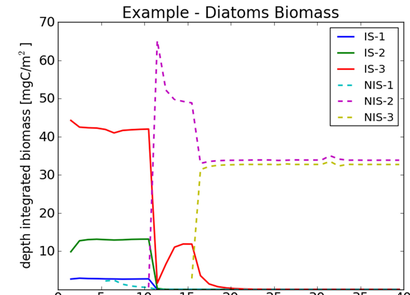
The model has been implemented on four European seas on a 1D set up coupled to the turbulence model GOTM [2] with two different set-ups: present day (PD) and future climate (~2100 A1B scenario). Forcings have been taken from 3D fully coupled BGCM, see www.meeceatlas.eu
In each scenario, the indigenous community is adapted to the local temperature range. For each regional sea an ensemble of 100 members has been set-up, each member running for 40 climatological years.



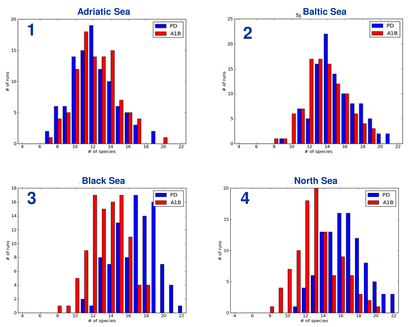
Simulating invasions from Non-Indigenous Species (NIS):

- A new randomly generated species is added into the system at regular intervals (5 years)
- The success of an invasion is determined by the presence of the NIS after 3 years of the invasion, and its impact on community structure is classified using the BioPollution Level index [1] looking at its mean biomass in the fourth year
- On the far right, one example of the output: the indigenous community is composed by 3 species (IS-1, IS-2, IS-3) and 3 successful invasions are simulated with impact C0, C3, C2

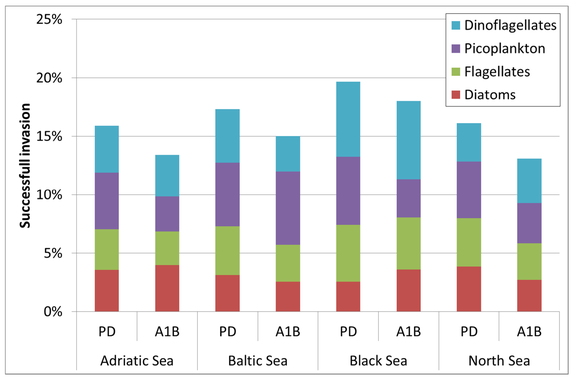
IMPACT (BPL)	Biomass
C0 – Nul	<5% PFT
C1 – Weak	5% ÷ 30% PFT
C2 – Moderate	30% ÷ 50% PFT
C3 – Strong	>50% PFT



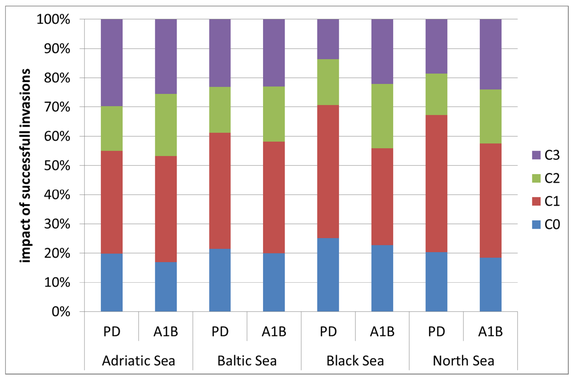
1. Changes on richness of indigenous community



2. Changes on susceptibility to invasion



3. Changes on impact of successful invasion



1. Distribution of species richness before any invasion occurs in all the 100 members of the ensemble for each domains and climate scenarios
2. Likelihood of success of an invasion and type of the colonizing NIS (mean over the entire ensemble)
3. Distribution of the impact of the successful invasions on the community structure. Note that only the impact of successful invasion is studied

Key outcomes from the model:

- Changes in nutrient concentration due to climate change can affect richness of indigenous community due to several co-occurring factors (e.g. reduced chemical energy, change in phenology and phytoplankton succession)
- Any policy aimed to change nutrient concentration (e.g. reducing eutrophication) could have similar impact on the plankton richness.
- Likelihood of successful invasion does not change significantly with climate change, but the type of more successful invaders will change.
- Impact of the NIS invasions on the community structure may increase under future climate as a consequence of the decrease in diversity of the indigenous community.

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Marine Ecosystem Evolution in a Changing Environment

References:
[1] Blackford et al., *J. Mar. Sys.*, 2004; [2] Olenin et al., *Mar. Poll. Bull.*, 2007; [3] Burchard et al., *Technical Report EUR 18745 EN*, 1999

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