Iron supply to the Southern Ocean mixed layer from below; The ocean model effect

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Leci n'est pas l'océan.

Olbers et al. (2012)
Two ocean models

MITgcm

FESOM
Two identical model runs

MITgcm - REcoM2

FESOM - REcoM2
The Southern Ocean; and HNLC area
Physical iron supply

1. Up-/downwelling
2. Vertical eddy diffusion
3. Horizontal advection
4. En-/detrainment

MLD min → N → MLD max
Total iron supply from below

- **FESOM**
  - Ent.: Entrainment
  - Diff.: Diffusion
  - Adv$_z$: Upwelling
  - Adv$_h$: Horizontal advection

- **MITgcm**
  - Ent.: Entrainment
  - Diff.: Diffusion
  - Adv$_z$: Upwelling
  - Adv$_h$: Horizontal advection

- 20 μmol Fe m$^{-2}$ yr$^{-1}$
- 84 μmol Fe m$^{-2}$ yr$^{-1}$
Surface iron concentrations
Net primary production

a) FESOM
Mean summer NPP

NPP : 3.1 Pg C yr⁻¹
EP : 1.1 Pg C yr⁻¹

b) MITgcm
Mean summer NPP

NPP : 2.1 Pg C yr⁻¹
EP : 1.2 Pg C yr⁻¹
Physical iron supply

1. Up-/downwelling
2. Vertical eddy diffusion
3. Horizontal advection
4. En-/detrainment
Seasonal iron supply; Entrainment

**FESOM**

![Graph of FESOM showing seasonal iron supply and entrainment. The graph plots [μ mol Fe/m²/month] against month, with peaks and troughs indicating variation throughout the year.]

**MITgcm**

![Graph of MITgcm showing seasonal iron supply and entrainment. The graph plots [μ mol Fe/m²/month] against month, with peaks and troughs indicating variation throughout the year.]

Month Month
Seasonal MLD and ferricline
Seasonal MLD and ferricline

(a) FESOM

(b) MITgcm

MLD (MITgcm)
Ferricline

Depth [m]

Month

DFe [mmol m$^{-3}$]

-200 -150 -100 -50 0

0 0.05 0.1 0.15 0.2 0.25 0.3 0.35

0 2 4 6 8 10 12

Helmholtz Association
Total iron supply from below

a) FESOM

- Ent.: Entrainment
- Diff.: Diffusion
- Adv$_z$: Upwelling
- Adv$_h$: Horizontal advection

b) MITgcm

- Ent.: Entrainment
- Diff.: Diffusion
- Adv$_z$: Upwelling
- Adv$_h$: Horizontal advection
Upwelling of iron
Total iron supply from below

a) FESOM

- Ent.: Entrainment
- Diff.: Diffusion
- $\text{Adv}_z$: Upwelling
- $\text{Adv}_h$: Horizontal advection

b) MITgcm

- Ent.
- Diff.
- $\text{Adv}_z$
- $\text{Adv}_h$
Turbulent diffusion
Seasonal NPP
Seasonal NPP

- Diatoms: 21%
- Nanophytoplankton: 79%

- Diatoms: 33%
- Nanophytoplankton: 67%

Graphs showing seasonal NPP for FESOM and MITgcm models.
Physical iron supply

Now

Future?

MLD
Physical iron supply

Now

Future

MLD
Conclusion

• The ocean model has a large impact on the biogeochemical results in the Southern Ocean

• It affects:
  • The vertical iron supply
  • The phytoplankton species composition
  • The timing of the spring bloom

• Future scenarios