Sensitivity of the spherical granular sea-ice model to the ice strength and the angle of friction

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Model description

UVic Model

Parameters of the granular sea-ice model

Parameter effect on ...

Sea-ice thickness

Sea-ice speed

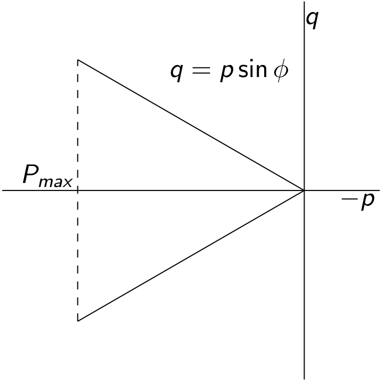
THC strength

Summary

Model

- UVic Earth System Climate Model version 2.6
- 3-D ocean model (MOM 2.2) (3.6° E-W and 1.8° N-S, 19 unequally spaced layers)
- energy-moisture balance model for the atmosphere with heat and moisture transport as diffusion
- moisture advection is also included
- simple zero layer thermodynamics with two categories (sea ice, open water)
- NOW: sea-ice model with elastic-viscous-plastic rheology or granular rheology

The different parameters of the granular sea-ice model



- $P_{max} = P^* h \exp[-C(1-A)]$
  with h the ice thickness, C a constant and A the ice concentration
- ϕ the angle of friction
- We can change two other variables:
  δ angle of dilatancy
  η_{max} maximum coefficient of friction

Parameters Settings

- UVic Model run with a CO_2 concentration of 365 ppm
- started from a restart with a sea-ice cover and existing THC
- mean monthly wind stress forcing
- $\delta = 0^\circ$
- $\eta_{max} = 1 \times 10^{15} \cos^2(\phi_{lat})$ g/s

		ϕ			
		30°	45°	60°	75°
P^* in [dynes/cm^2]	3×10^5	X	X	(X)	(X)
	3×10^6	X	X	(X)	(X)
	3×10^7	(X)	(X)	(X)	(X)

- Nomenclature during the presentation:

$P^* = 3 \times 10^5 \longrightarrow$ P5 $\quad \phi = 30^\circ \longrightarrow \phi30$

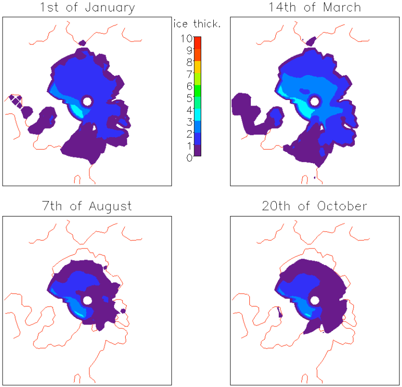
$P^* = 3 \times 10^6 \longrightarrow$ P6 $\quad \phi = 45^\circ \longrightarrow \phi45$

$P^* = 3 \times 10^7 \longrightarrow$ P7 $\quad \phi = 60^\circ \longrightarrow \phi60$

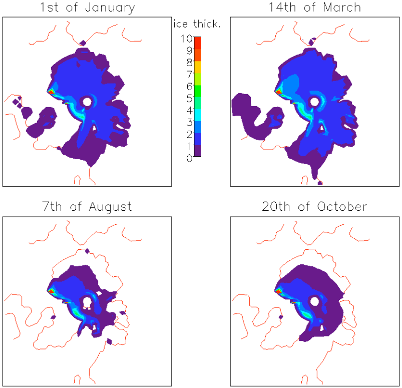
Sea-ice thickness

Seasonal ice thickness after 80 years of integration

EVP



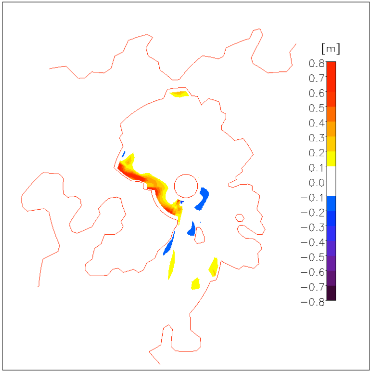
P5 and $\phi 30$



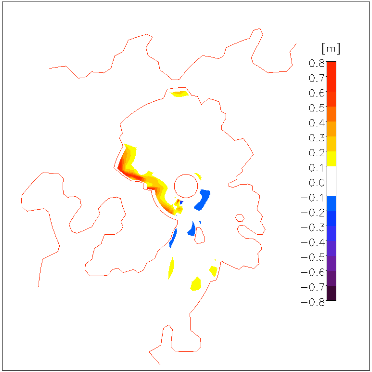
Sea-ice thickness differences as a function of P^*

Snapshot of the 14^{th} of March after 80 years of integration

P5-P6 at ϕ30



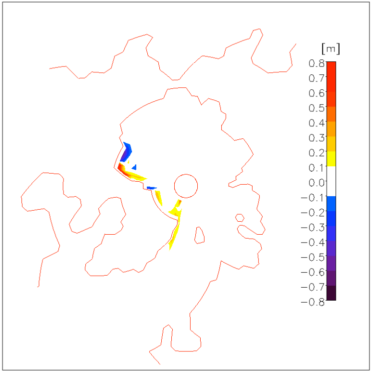
P5-P6 at ϕ45



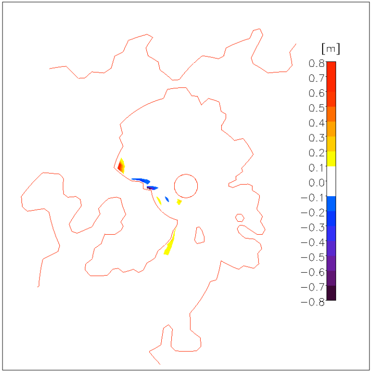
Sea-ice thickness differences as a function of ϕ

Snapshot of the 14th of March after 80 years of integration

$\phi 30 - \phi 45$ with P5



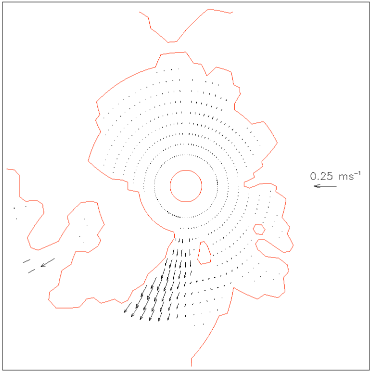
$\phi 30 - \phi 45$ with P6



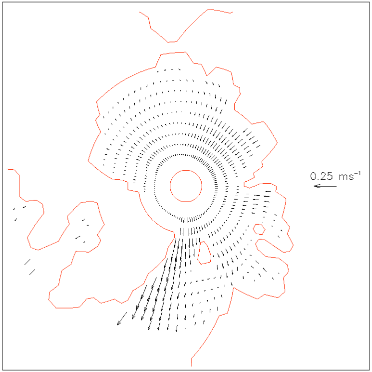
Sea-ice speed

Snapshot of the 14^{th} of March after 80 years of integration

EVP

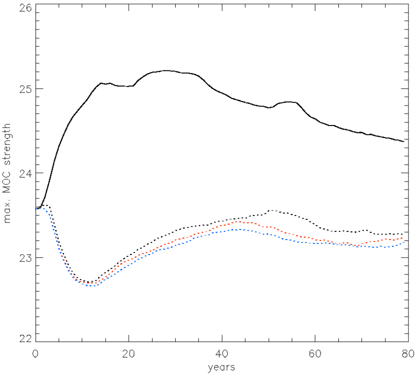


P5 and $\phi 30$



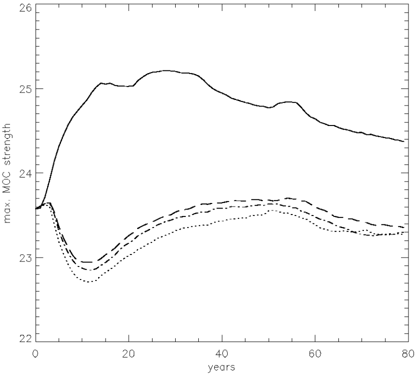
THC strength with changing parameters

Max. THC strength as a function of P^*



P5 P6 P7 $\phi = 30°$ EVP

Max. THC strength as a function of ϕ



$\phi 30$ $\phi 45$ $\phi 60$ $P^* = 3 \times 10^5$ dynes/cm^2 EVP

Summary

- Converted the granular sea-ice model to spherical coordinates
- Maximum sea-ice thickness of the granular model is larger than with the evp, but overall thickness is lower
- Changes in sea-ice thickness as a function of P^* larger than the ones in function of ϕ
- With increasing $P^* \rightarrow$ thicker ice north of Greenland, thinner ice at Fram Strait
- With increasing ϕ the thickness is not changing much
- The sea-ice speeds in the Arctic Basin are larger for the granular rheology than for the evp rheology
- With increasing P^*, the maximum overturning strength is decreasing
- With increasing ϕ, the maximum overturning strength is increasing