Integrating model and data over the Southern Ocean (SO) at the Last Glacial Maximum to better understand the sea-ice cover

F. Lhardy[1] (fanny.lhardy@lsce.ipsl.fr), N. Bouttes[1], D.M. Roche[1,2], X. Crosta[3]

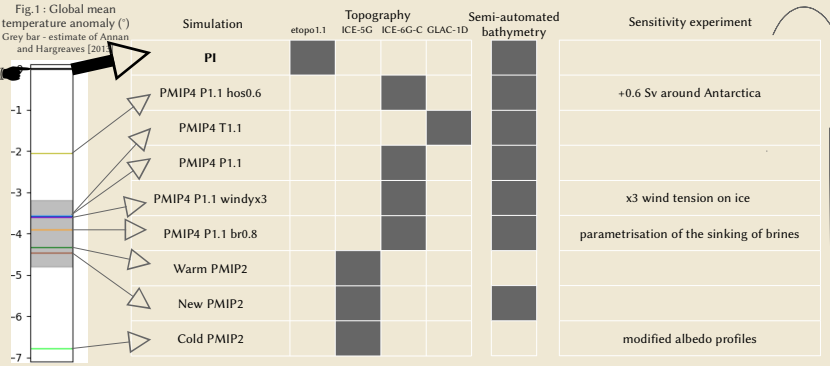

Fig.1 : Global mean temperature anomaly (°) Grey bar - estimate of Annan and Hargreaves [2013]

A set of simulations displaying contrasting climates (due to different boundary conditions and experimental setting)

Inverse methodology :

What surface conditions should be simulated in the SO to agree well with the proxy data?

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1. Model-data comparison : sea-surface temperatures and sea ice

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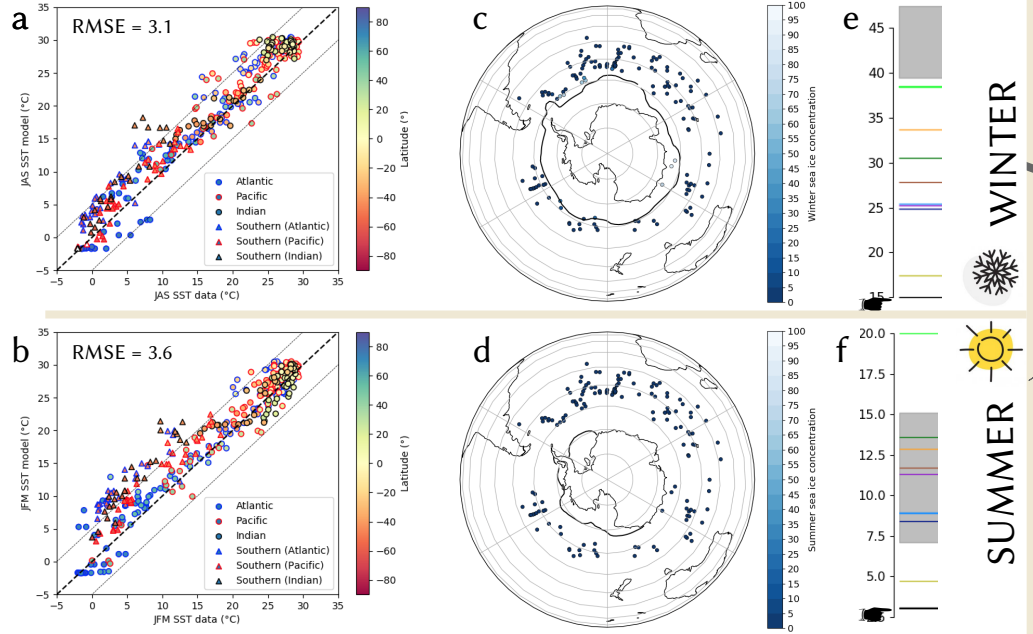

Fig. 2 : Austral winter (a) and summer (b) SSTs in a model vs data diagram. 1:1 line - perfect model-data agreement with WOA SST data. Marker color - latitude of the grid cell found nearest the core coordinates.

Fig. 3 : Winter (c) and summer (d) sea-ice edges. Data points – sea-ice concentration (%) from Schweitzer [1995]

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2. Deep ocean circulation : streamfunctions

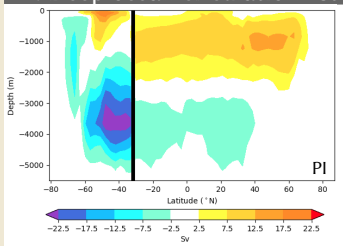

Fig. 5 : Streamfunctions in the Atlantic (North of 32°S) and Southern Ocean (South of 32°S)

Systematic (and consistent) biases in regional and seasonal patterns of the SO :

SST	SEA ICE
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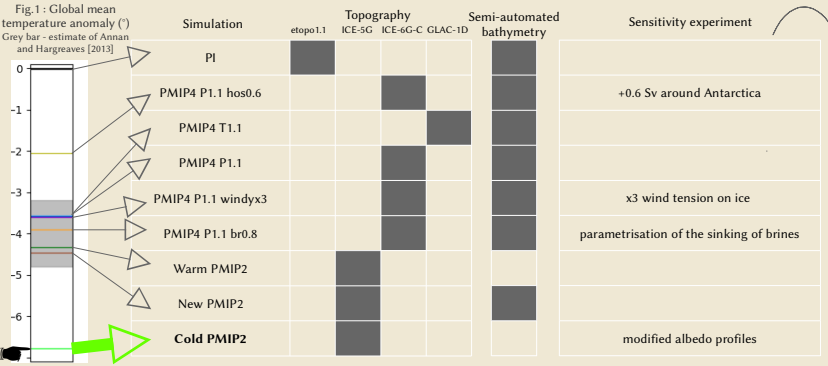

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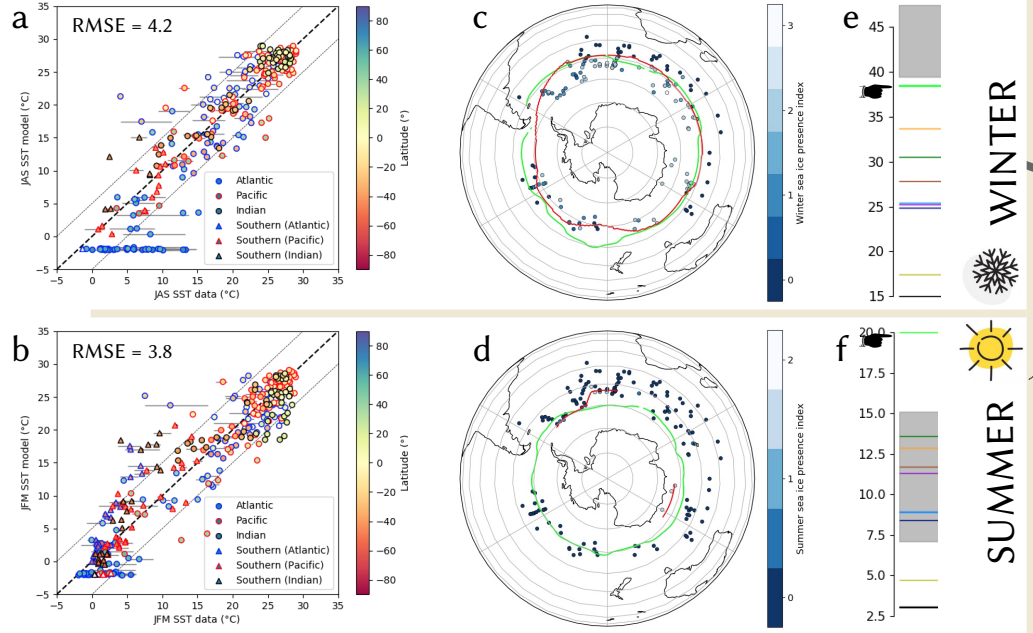

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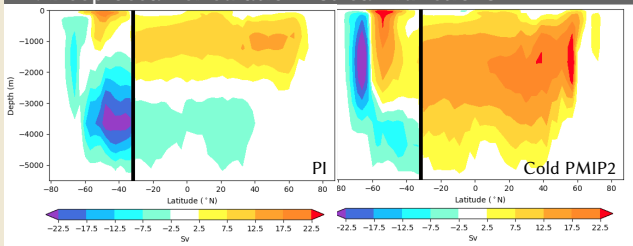

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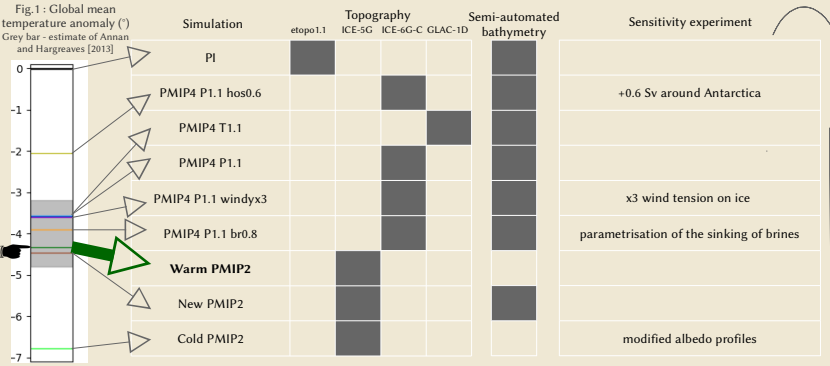

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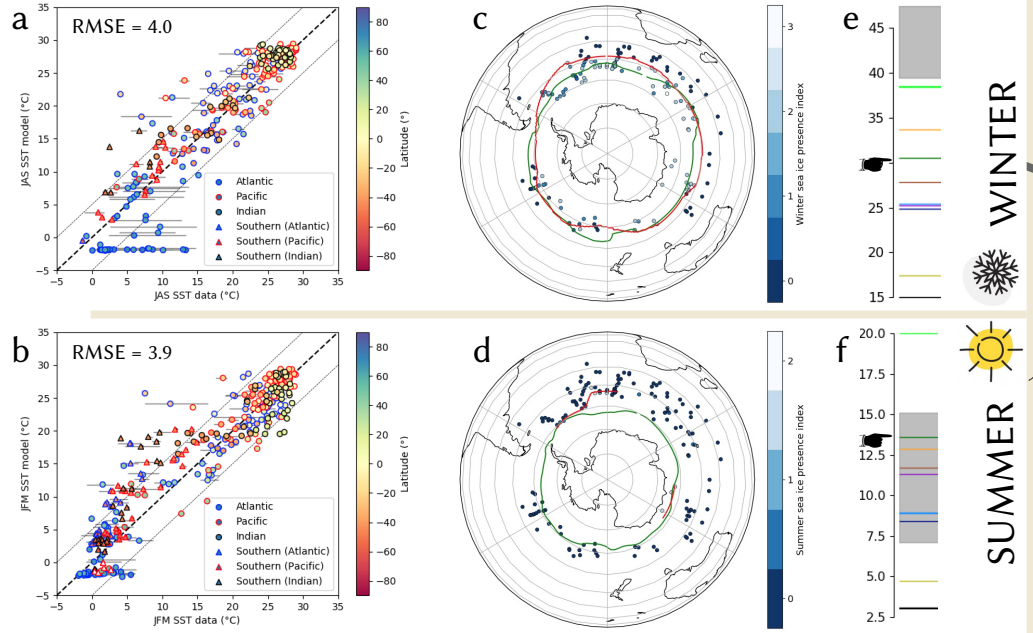

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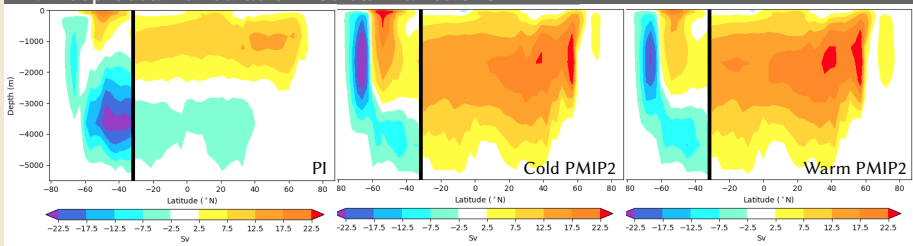

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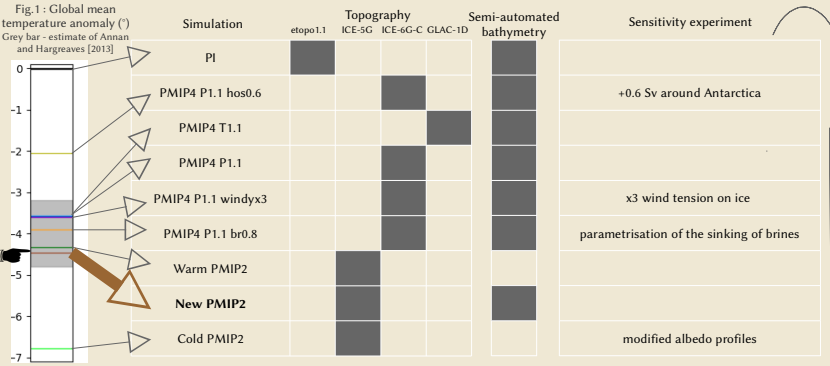

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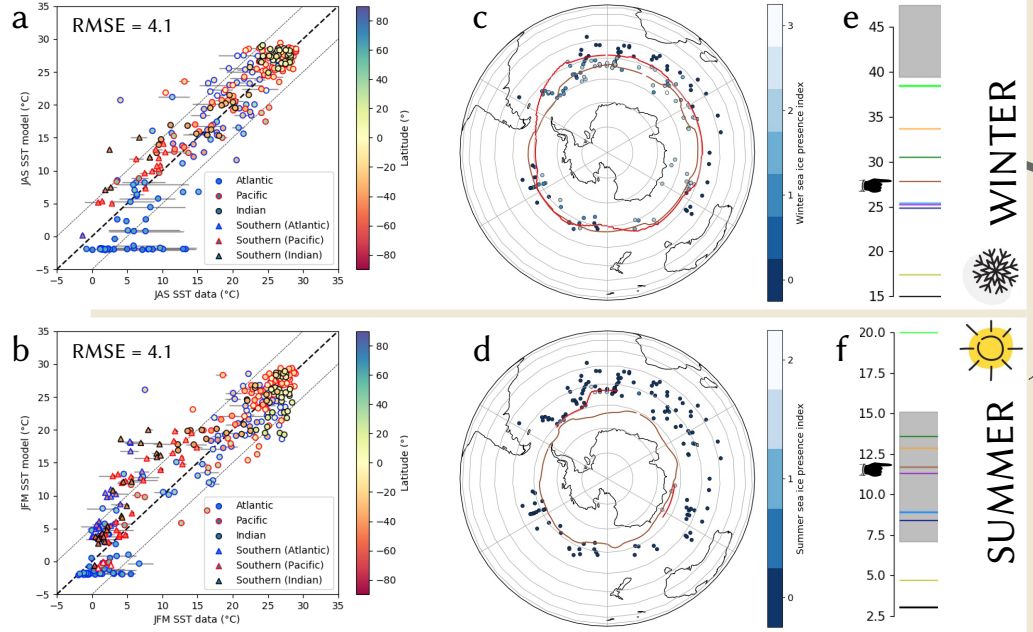

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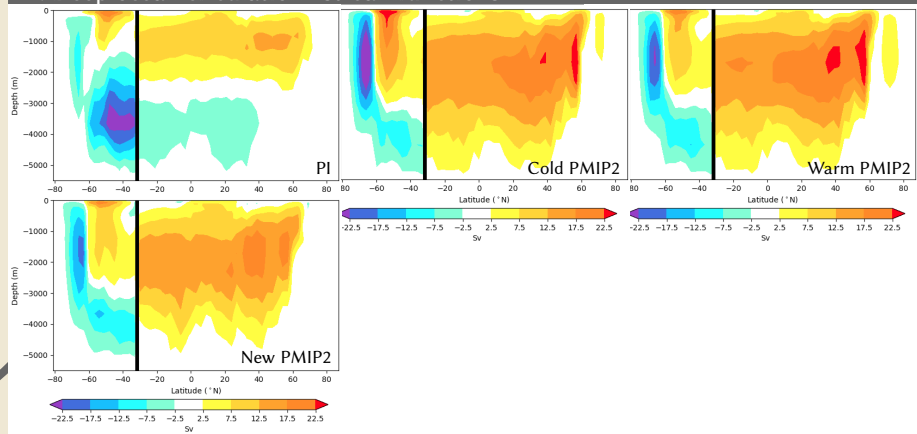

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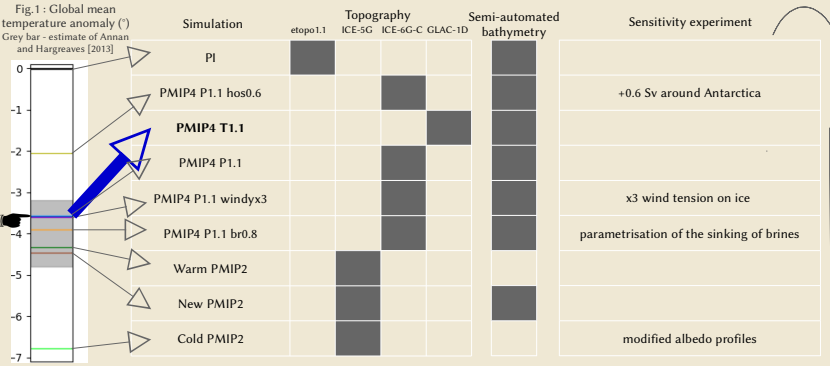

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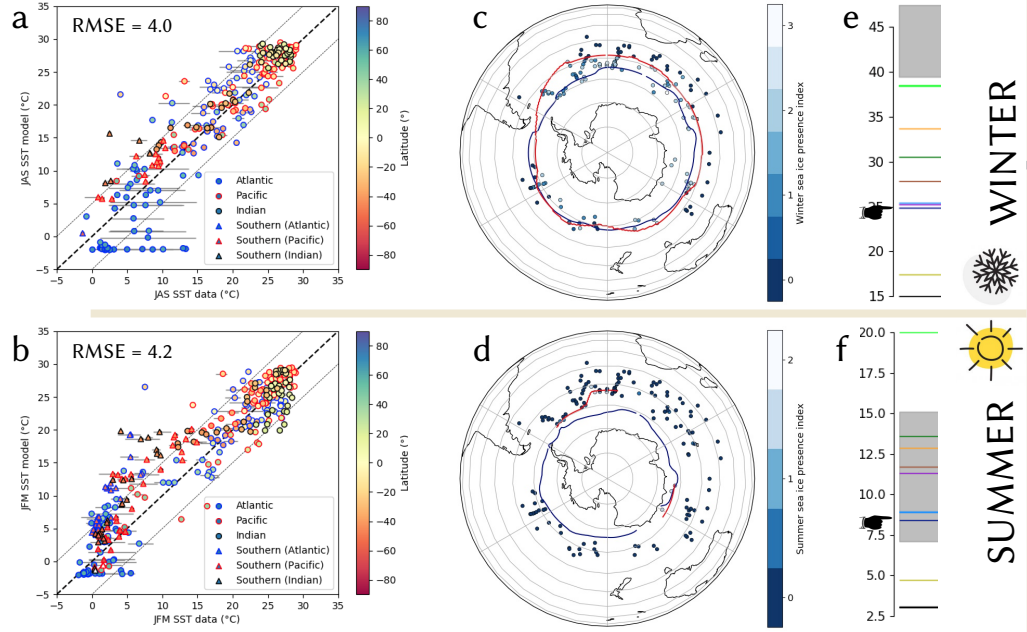

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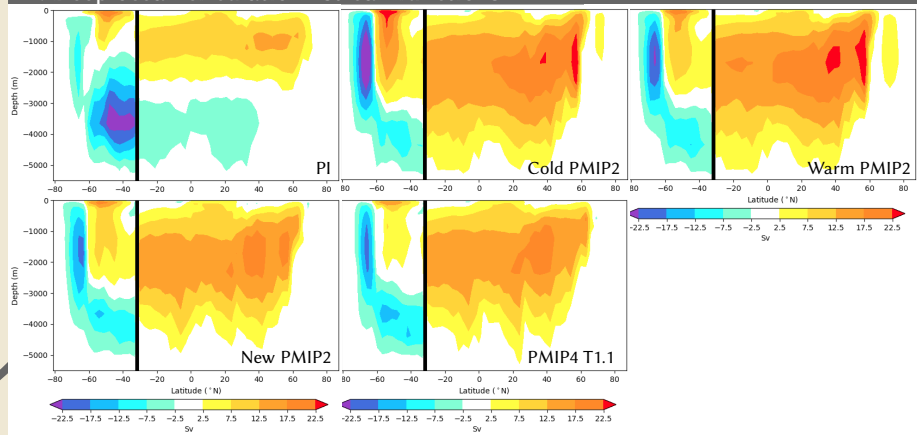

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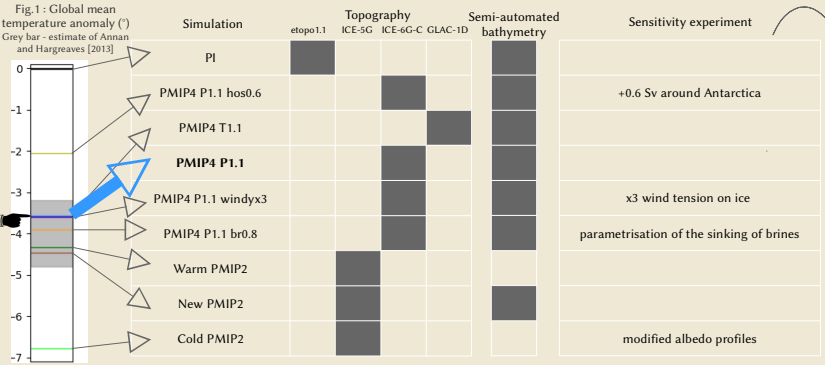

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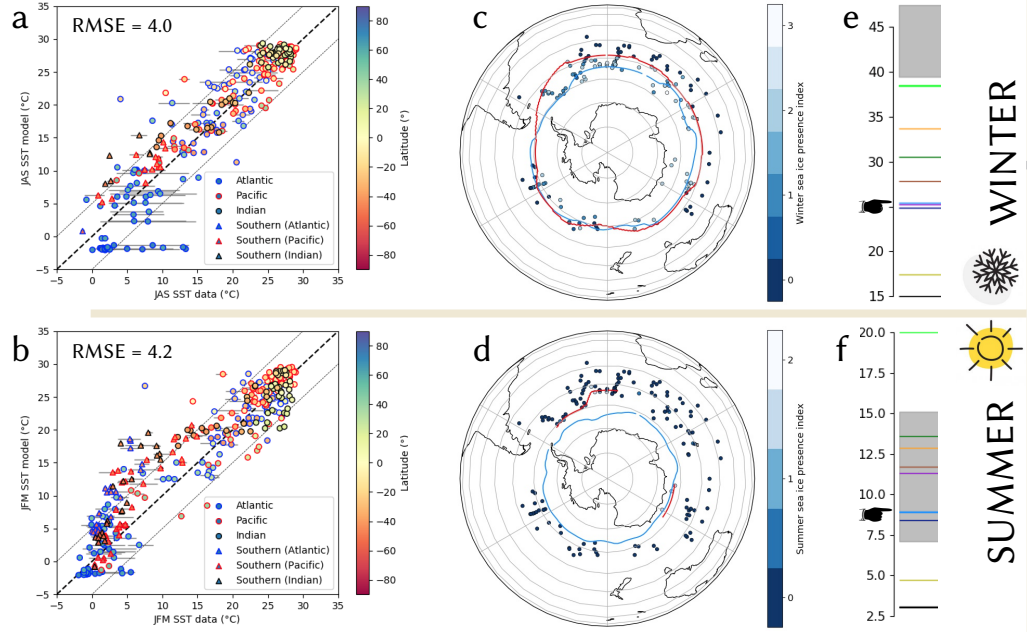

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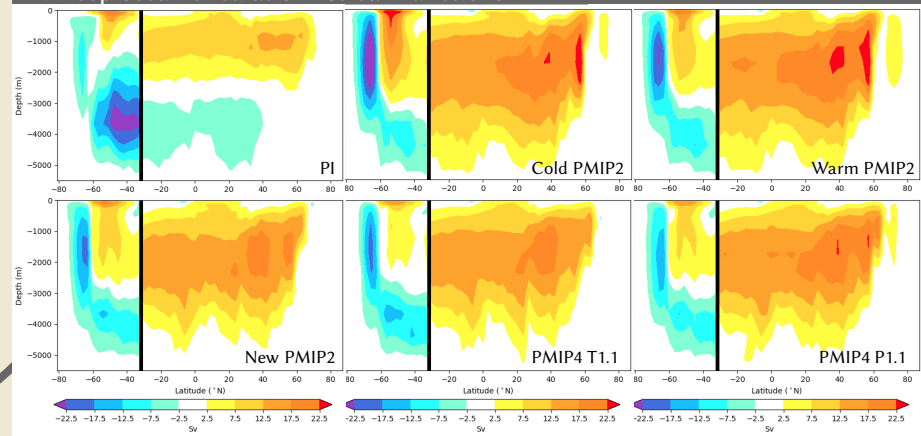

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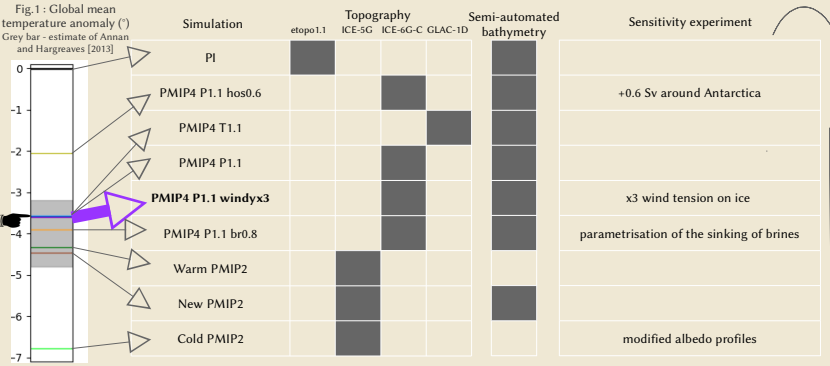

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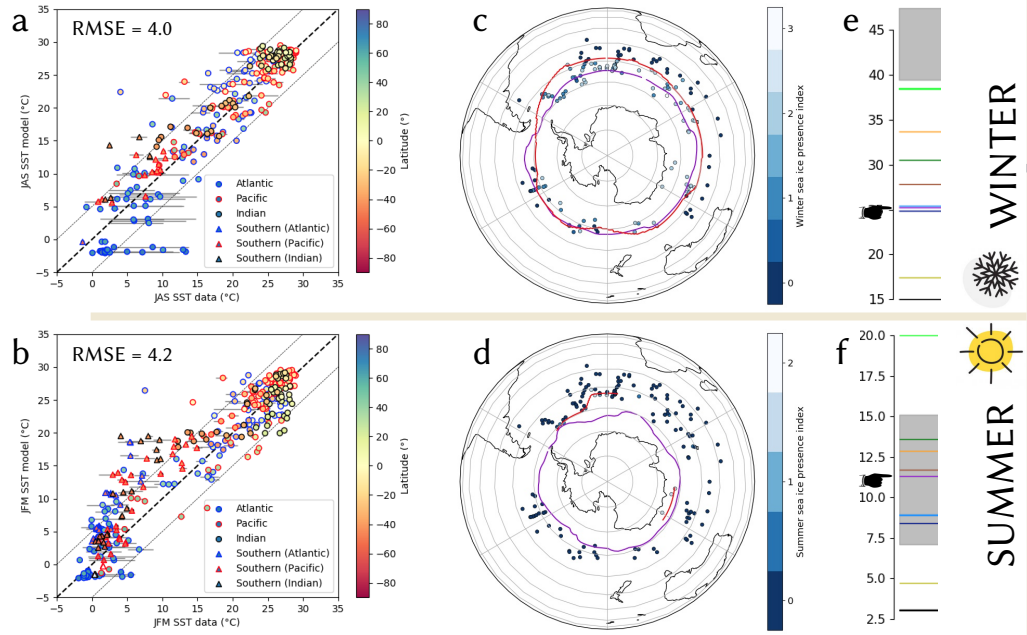

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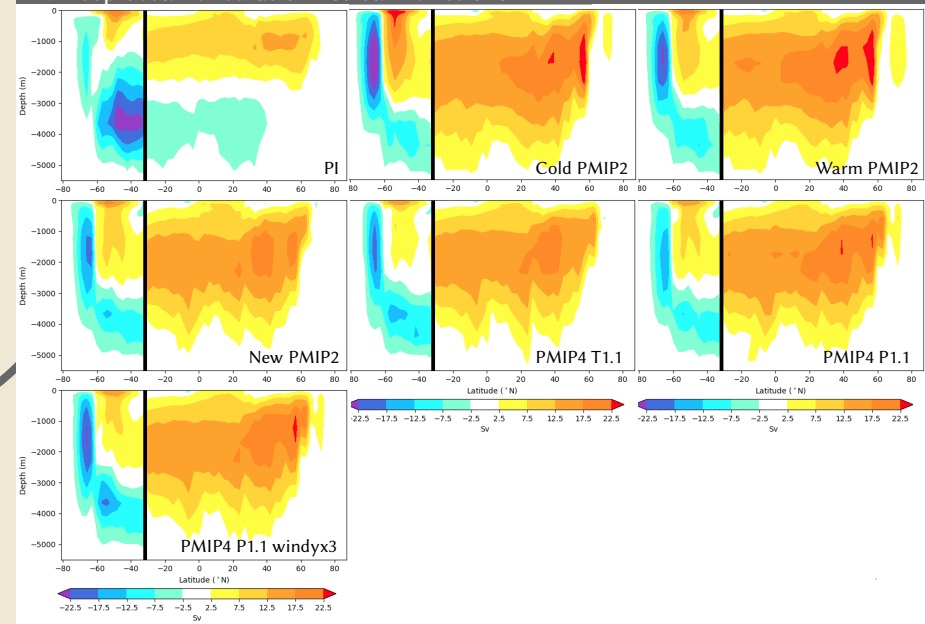

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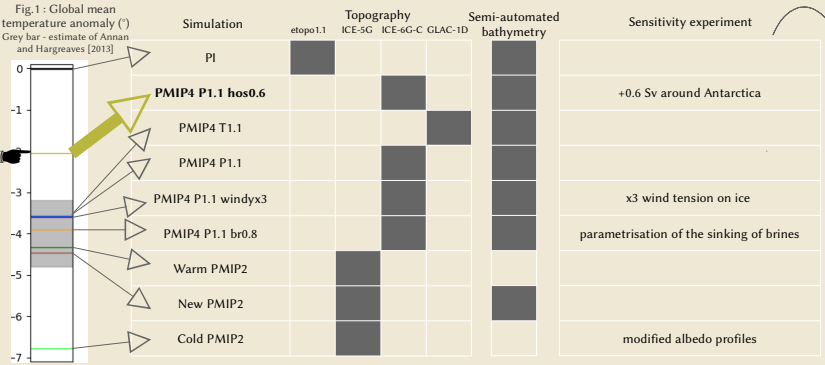

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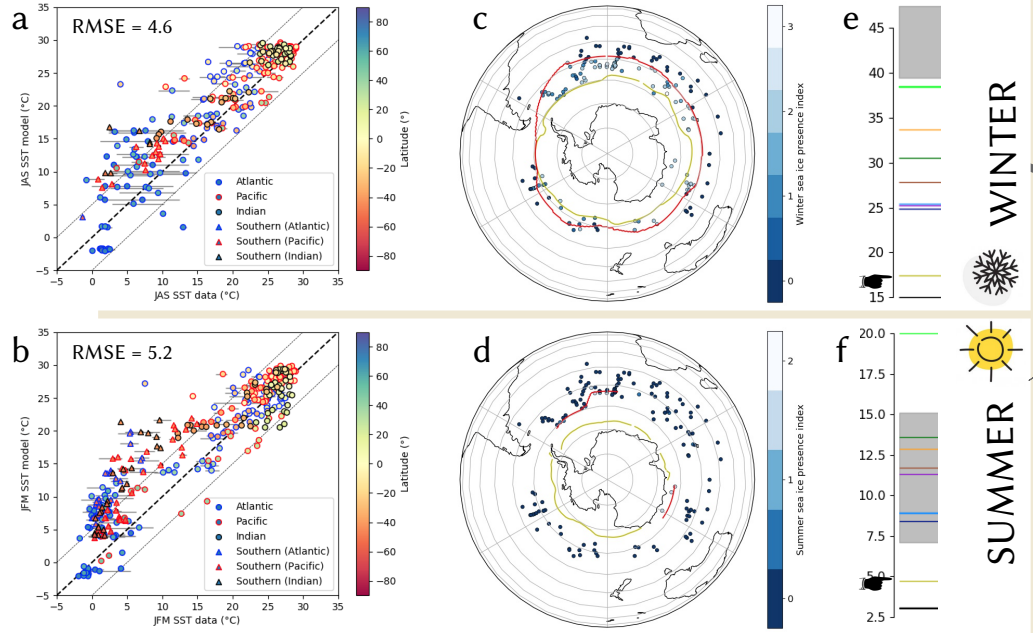

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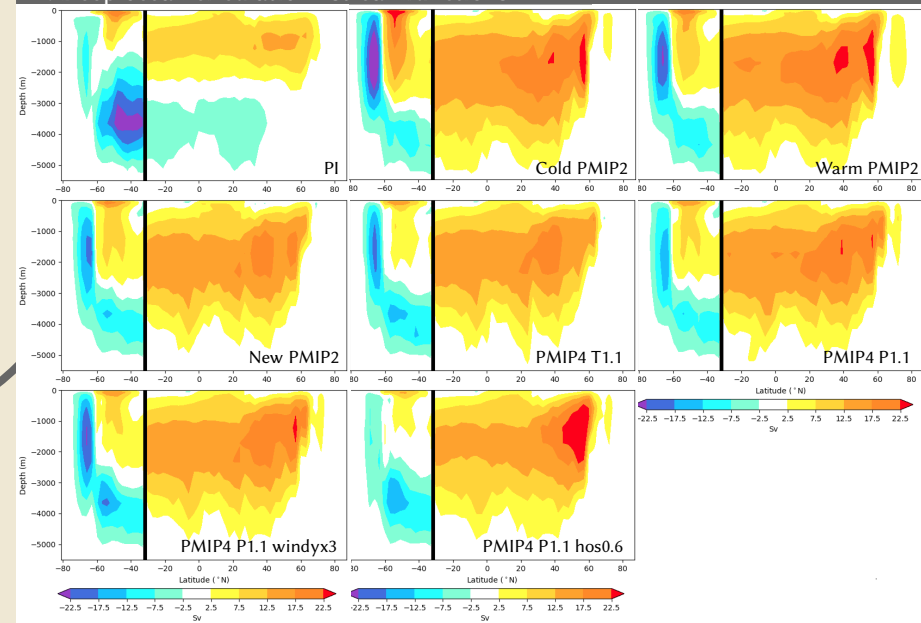

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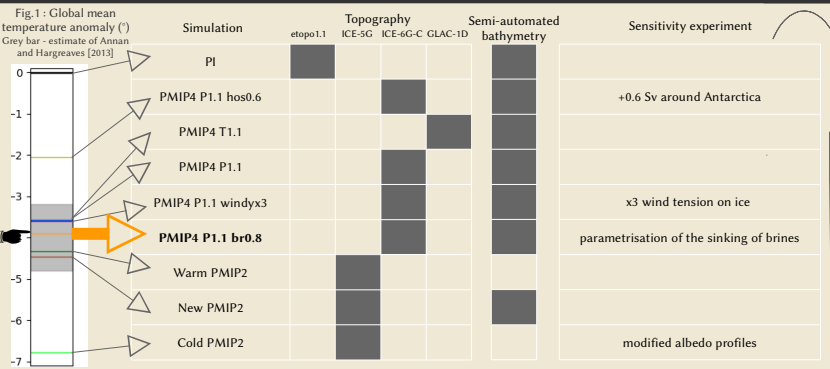

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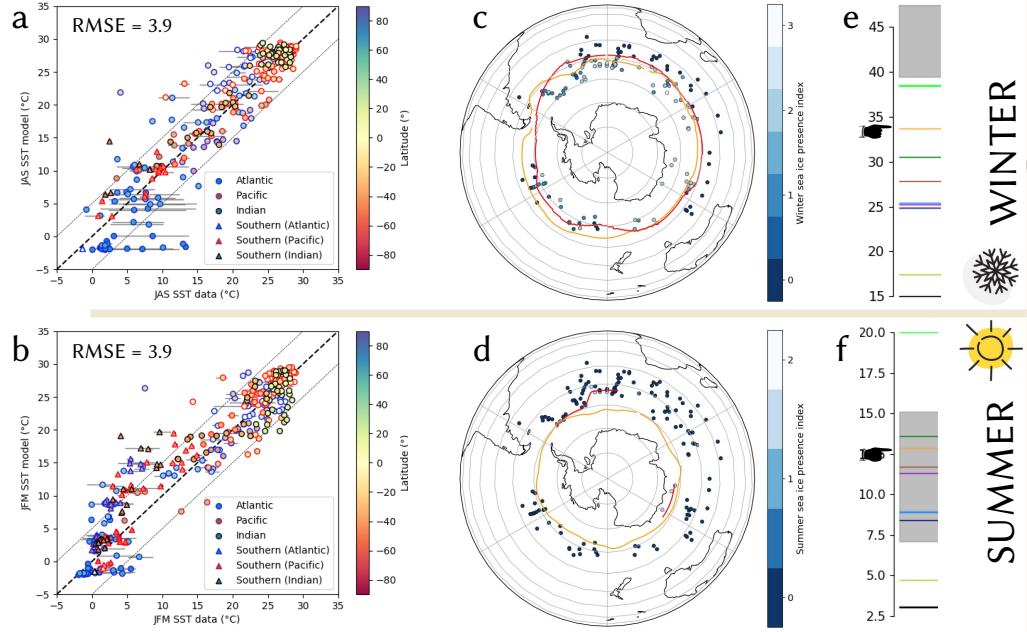

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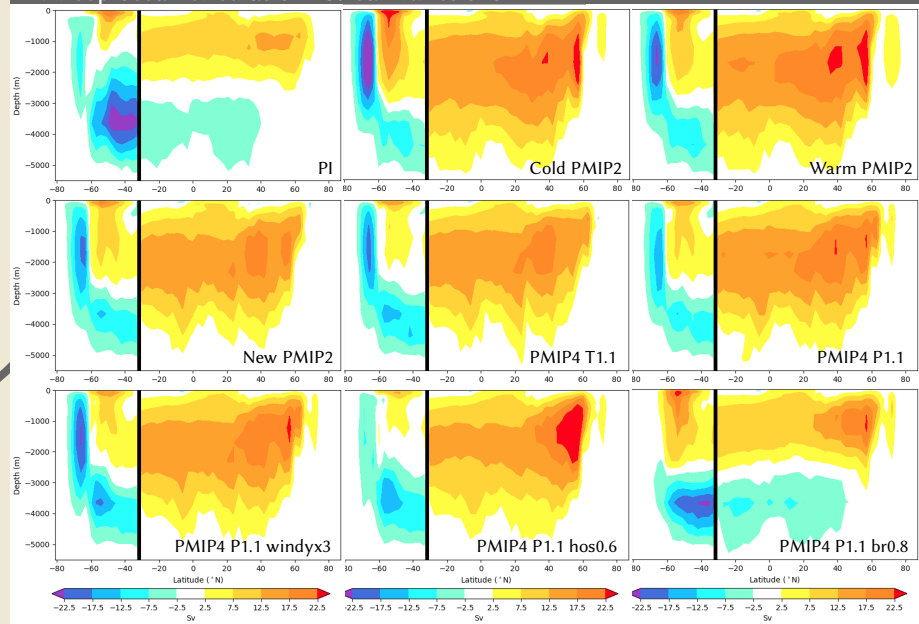

Fig. 5 : Streamfunctions in the Atlantic (North of 32°S) and Southern Ocean (South of 32°S)

Systematic (and consistent) biases in regional and seasonal patterns of the SO :

SST	SEA ICE
Warm bias in the Altantic & Indian sectors (~40-50°S), especially in summer	Round sea-ice edge (proxies suggest an oval-shaped distribution)
Some simulations are slightly too cold at ~60°S in the Pacific sector	Underestimated sea-ice seasonality

A colder SO is broadly associated with an enhanced convection in the SO and NADW cell.

However the experimental setting has here a larger impact than surface conditions, or boundary conditions.