SEA ICE DECLINE SIMULATIONS WITH AN ATMOSPHERIC MODEL OF INTERMEDIATE COMPLEXITY

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1.INTRODUCTION

In the present study, the SPEEDY global atmospheric model was used to simulate impacts on the climate, caused by sharp changes on Arctic sea ice extent. This model has a spherical geometry and is based on primitive equations on spectral dynamics. The parameterizations used are the same found in complex climate models, but they were simplified for resolution in just 8 vertical levels and thus, it is considered a model of intermediate complexity, useful for long integrations. It is noteworthy that, of the 8 levels considered, the highest level corresponds to the stratosphere, the lowest level to a level in PBL and the other six levels are in the intermediate layers of the so-called “free atmosphere”.

2.METODOLOGY

Two experiments with SPEEDY integrations for periods over a hundred years were implemented for impact determination. One, considered as control, used current ice sheet and in the other, the sea ice extent throughout the region north from 60^0N parallel was decreased by 50%. Differences between average fields of meteorological variables in each integration were implemented and the respective levels of statistical significance were established.

3.RESULTS

The global distribution of the difference between the experiment with Arctic polar ice decline and the control experiment shows that the 200 hPa velocity potential fields (χ) indicate Americas’ longitudinal strip as a mass source or divergence in January, while other longitudinal strip of mass sink (convergence) is positioned over Asia and the Indian Ocean. In July, those longitudinal strips move eastward with the χ > 0 sector positioning in the Pacific Ocean and the χ < 0 sector in the Indian Ocean (Figure 1).

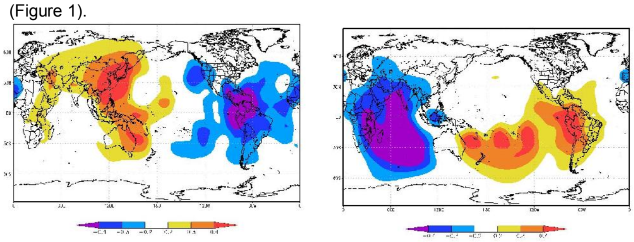

Figure 1 – Differences between averaged fields of potential velocity at 200 hPa, with and without sea ice reduction, on January (left) and July (right).

In contrast, the global distribution of the variable stream function (ψ) is given by latitudinal strips. In January, this field suggests, in SPEEDY simulations, that an Arctic warming results in cyclogenesis in 850 hPa in the middle latitudes of both hemispheres. On the other hand, in July, the results suggest increased anticyclonic vorticity also in the middle latitudes of both hemispheres (Figure 2).

In the analysis of vertical motion at 500 hPa, some sectors should be highlighted where the statistical tests indicate significant differences between the experiments with and without reduction of Arctic ice. On the southeastern coast of Brazil, the simulations indicate a latitudinal displacement of the South Atlantic Convergence Zone in January. In October, this analysis indicates an intensification of subsidence movements in the interior of Brazil, which is equivalent to a delay of the start of the rainy season (Figure 3).

The analysis of the sea ice reduction impact at the Artic Sea impact over the rain shows significat effects over the SACZ on January, over the ITCZ and east coast of Northeast Brazil on April and on the central region of Brazil in October (Figure 4).

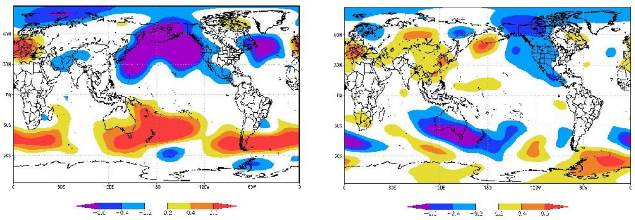

Figure 2 – Differences between the averaged fields of stream function at 850 hPa, with and without sea ice reduction, on January (left) and July (right).

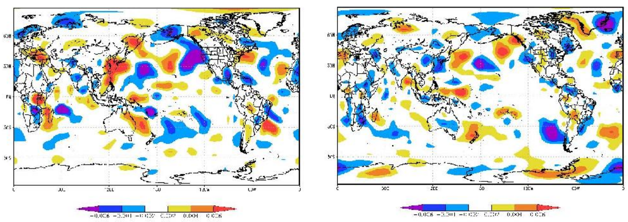

Figure 3 – Differences between the averaged fields of omega at 500 hPa, with and without sea ice reduction, on January (left) and July (right).

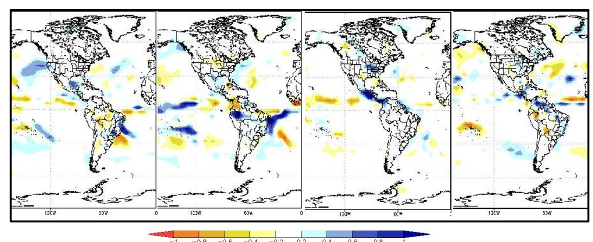

Figure 4 – Differences between the averaged fields of the precipitation, with and without sea ice reduction, on January (left) and July (right).

4.CONCLUSIONS

Results show a reasonable consistency among various simulated fields, indicating that Arctic thawing probably affects several regions in the World, including South America. The SPEEDY model shows adequation for the simulations we wished in this study.

5.REFERENCES

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