Current state of GEM climate simulation at RPN

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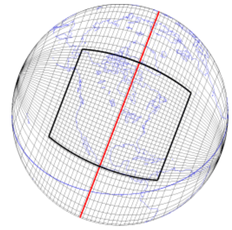

1. Introduction

The Canadian Meteorological Centre/Recherche en Prévision Numérique (CMC/RPN) operational Global Environmental Multiscale (GEM) model is generally used to perform the short and medium range forecasts required by the Meteorological Service of Canada (MSC) clients. The model is also being used for seasonal forecasts, following its Historical Forecast (HFP) validation, and for even longer term type integrations. These last simulations and their comparison with climate means are essentially seen as a mean to evaluate the meteorological performance of the operational model. Accordingly, the recently developed Limited Area Model (LAM) GEM mode is a particularly important addition given the increasing resolutions at which even global operational forecast models are now routinely run.

2. Model and data

We compare results from a uniform 22-year AMIP2 (Atmospheric Model Intercomparison Project v2) simulation, from a 13-year SGMIP (Stretched Grid Model Intercomparison Project) variable resolution simulation and from a preliminary 2-year LAM (Limited Area Model) climate simulation, all using the GEM forecast model. These will be referred to by their acronyms in the following text. The AMIP2 also provides boundary conditions to the LAM. The same physics parameterizations are used for all three runs. The only differences relate to the horizontal grid used in each and the length of the time step. This is set at 22.5 minutes for SGMIP and LAM and 45 minutes for AMIP2. The LAM and SGMIP also share their maximum resolution area, which covers all of North America (NA) with a 50 km mesh. The number of horizontal mesh points on the SGMIP grid is approximately that of a global 1° uniform grid. The minimum SGMIP horizontal resolution is 1.8°, slightly less than the AMIP2 1.5° resolution. The vertical discretization is chosen such to be appropriate for the higher resolution SGMIP and LAM versions and consists of 60 hybrid vertical layers, with a top level at 2 hPa. The maximum vertical resolution occurs in the near the surface and in the PBL, with a 500 m secondary maximum around the equatorial tropopause. Results are compared with the freely available ERA40 reanalysis means for the corresponding periods.

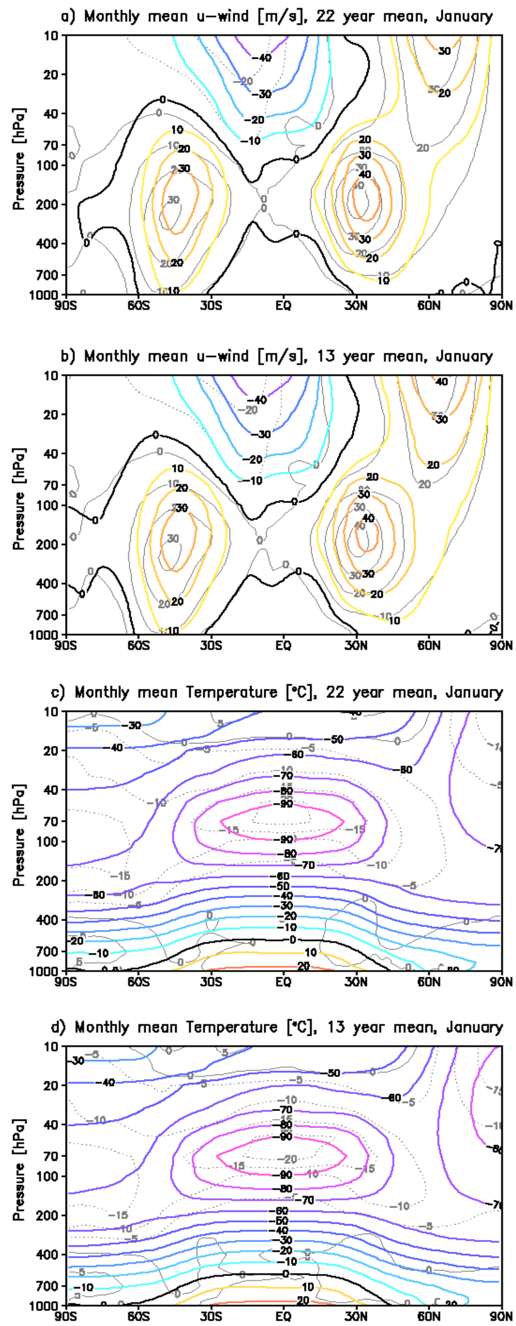

Fig. 1 January mean AMIP2 (a, c) and SGMIP (b,d)U and T. Pale lines indicate ERA40 U fields and T difference w.r.t. ERA40. Units are m/s and ℃.

3. Results

The AMIP2 and SGMIP global means and variances are very similar and the only significant differences between them can be explained by the increased resolution over NA. The simulations display the same strength and weaknesses, *i.e.* a too deep troposphere which can be seen by the vertical displacement of both the mid-latitude zonal wind jets and of the Tropical tropopause.

AMIP2 and SGMIP suffer from excess precipitation over the mid-latitudes while there is a deficit over the ITCZ. This has been traced to the Kuo-type convection scheme and a correction is forthcoming. The deep troposphere is thought to be related to faulty radiation and cloud interaction in the tropics: As a consequence a more recent radiation code is also being implemented. SGMIP does manage to be in better balance than AMIP2 in terms of global energy and moisture budgets. With respect to the transient evolution of these budget terms, SGMIP is generally closer to ERA40 than is AMIP2.

Finally turning to the high resolution domain results, Fig. 2 shows the January mean surface air temperatures over most of NA for AMIP2, SGMIP and LAM, respectively. All three images are very similar, except that, as expected, the LAM and SGMIP show much more detail, particularly over the Western part of the continent where the orography is important. At this point, we believe that most of the differences between the LAM and SGMIP results can be explained by the different averaging periods. Further tests where the LAM is driven by a SGMIP-configured model are currently under way to verify this.

4. Conclusions

The results from the AMIP2 and SGMIP simulations are very similar with respect to the large scales. The two generally share the same strengths and weaknesses. As expected, significant differences between the two can be seen over the SGMIP North-American high resolution domain.

The SGMIP and LAM results over North America are also rather similar. Some of the differences can probably be attributed to the small number of samples in this preliminary LAM simulation.

Acknowledgements

The authors gratefully acknowledge the help of Michel Desgagné and Lubos Spacek, both of RPN, with the GEM/LAM version. This research was partly supported by CFCAS through a grant to the Regional Climate Network and by the Office of Science (BER), U.S. Department of Energy, Grant No. DE-FG02-01ER63199.

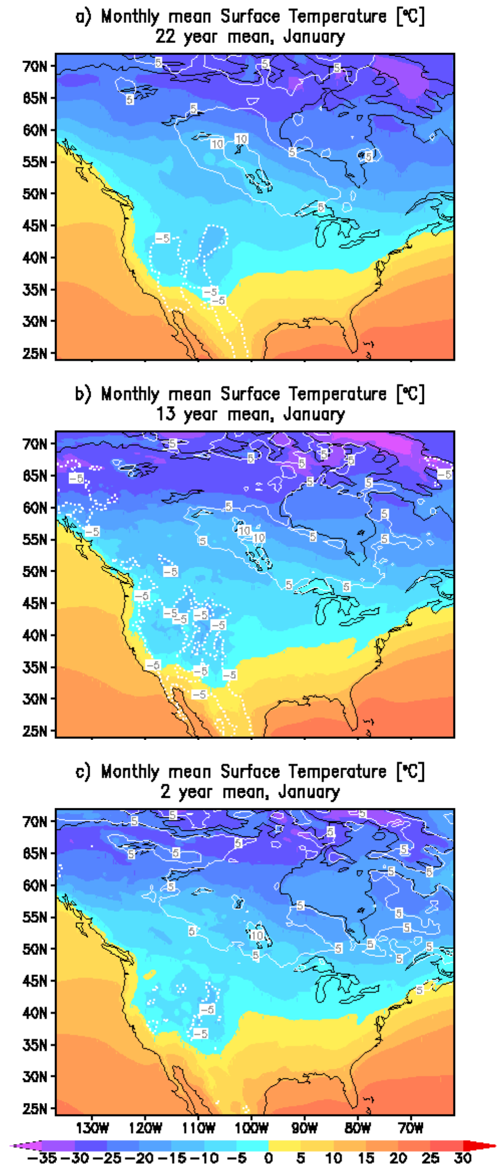

Fig. 2 January mean AMIP2 (a), SGMIP (b) and LAM (c) surface air temperatures. White lines indicate difference w.r.t. ERA40. Units are in °C.

References

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