Climate simulations by the IAP RAS model of intermediate complexity with an implemented ocean general circulation module

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The climate model of intermediate complexity developed at the A. M. Obukhov Institute of Atmospheric Physics RAS (IAP RAS CM) has been comprehensively described in (Petoukhov et al., 1998; Handorf et al., 1999; Mokhov et al., 2005). It includes modules for the redistribution of shortwave and longwave radiation, convection, cloud and precipitation formation. Large-scale atmospheric and oceanic dynamics (with scales larger than those corresponding to synoptic processes) are resolved explicitly. The synoptic-scale processes are treated as Gaussian ensembles. Sea ice in the IAP RAS CM is diagnosed based on surface air and sea surface temperatures. In the model version used here, surface hydrology is prescribed. The IAP RAS CM horizontal resolution is 4.5°×6° with 8 vertical layers in the atmosphere (up to 80 km). Here, the statistical-dynamical oceanic model previously used in the IAP RAS CM is replaced by oceanic general circulation model developed at the Institute of Numerical Mathematics RAS was used. The spatial resolution of the new oceanic module is 3°×5° with 25 vertical layers. Correction of heat and impulse fluxes between atmosphere and ocean in coupled model is not applied for the new version of the IAP RAS CM.

Numerical experiments with the initial and boundary conditions corresponding to the present climate and to the doubled concentration of carbon dioxide in the atmosphere have been carried out. All basic atmospheric and oceanic fields obtained in the first numerical simulations are in general agreement with the corresponding observed data. The simulated globally and annually averaged surface air temperature is 13.5°C, while the observational value is 14°C (Brohan et al., 2006). Geographical distribution of surface air temperature is also close to observations. Most marked deficiencies are found in Antarctic and North-Atlantic regions, on the coast of Barents Sea and over Africa.

In the previous model version, doubling of the CO_2 atmospheric content caused globally averaged surface air temperature rise about 2.2 K. In the present version, this increase amounts 2.8 K. Corresponding estimations with different state-of-the-art models are in the range 1.8 – 4.5 K.

References

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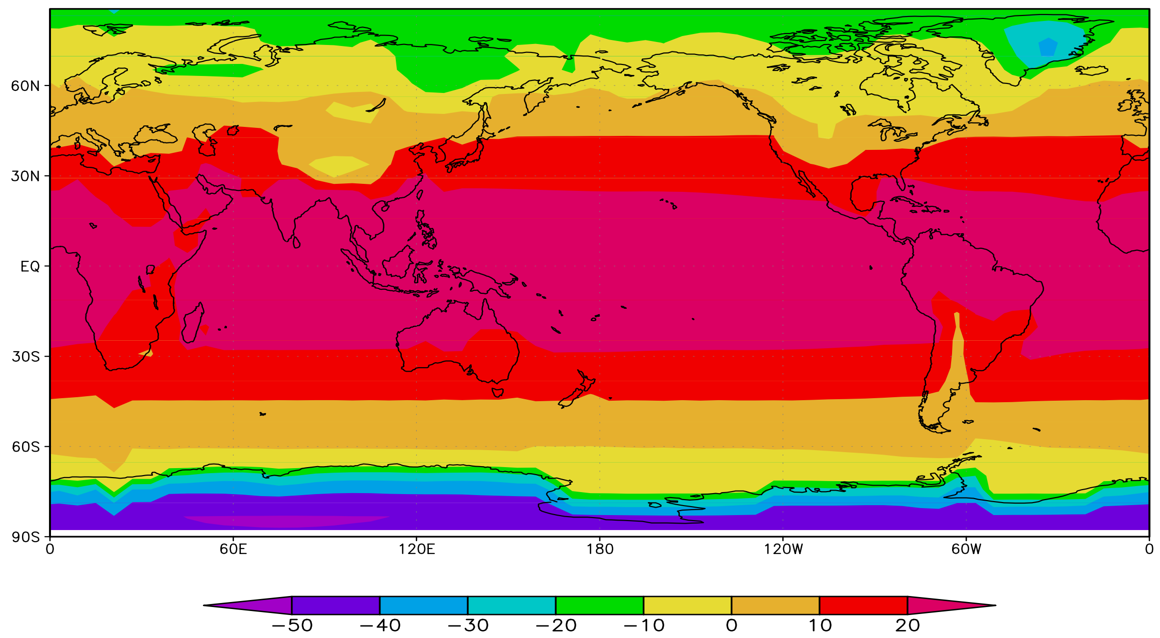
Annual mean surface air temperature from simulations [^{o}C]



Annual mean surface air temperature from observations [^{o}C]