Geophysical Research Abstracts
Vol. 17, EGU2015-10744, 2015
EGU General Assembly 2015

Identifying early signs of Global Warming in the Energy budget of the ERA-20CM experiment

Valerio Lembo (1,2) and Piero Lionello (1,2)

(1) Università del Salento, Di.S.Te.B.A., Lecce, Italy (valerio.lembo@unisalento.it), (2) CMCC, Euro Mediterranean Center on Climate Change, Lecce, Italy

This study investigates the relation between the energy budgets of the climate system and the evolution of surface temperatures for understanding the mechanisms involved in anthropogenic Global Warming. The analysis is based on ERA-20CM, an ensemble of 10 AMIP-like simulations covering the period 1900−2009 and carried out with the IFS-ECMWF model. Simulations are forced by prescribed atmospheric composition, solar irradiance, SST and Sea-ice concentrations (SIC). The 10 members sample the uncertainty in the Had-ISST2 observational dataset for SST and SIC. This dataset is meant to reproduce the real evolution of the atmospheric component of the climate system on decadal time scales.

The ensemble mean of the last decade of simulations (2000−2009) can be compared with observational datasets, based on satellite data and surface observations. At the Earth's surface simulations show a significant underestimate of the downward thermal radiation (-9W/m^2), upward thermal radiation (-4W/m^2) and latent heat flux (-2W/m^2), while the solar net flux is overestimated (+4W/m^2). As a result there is a net warming of the surface (+1.5W/m^2), which is larger than observational estimates. Further the energy balance shows a net cooling (-2.1W/m^2) of the atmosphere that added to the net warming of the surface determines a total net cooling (-0.6W/m^2). Compared to CERES-EBAF satellite observations, which instead show a net warming of about $1W/m^2$ a systematic bias in net radiation at Top of Atmosphere (TOA) is suggested (-1.6W/m^2). Actually, the energy deficit of the atmosphere has not changed during the simulated period (it is always about -2.1W/m^2) and it is likely to be a model systematic bias. In fact, the small heat capacity of the atmosphere would prevent it from absorbing such an amount of heat without changing dramatically its temperature. As a result, a systematic bias in surface budget can be defined as the difference between the total and atmospheric bias, i.e. amounting to about $0.4W/m^2$.

If the last decade bias is assumed to be constant over the entire integration period, some considerations can be proposed on the recent evolution of the climate system. Global mean average SST time series evidence two warming periods at the beginning (W1: 1905−1945) and end of the simulated period (W2: 1975−2005) separated by an intermediate period (IP) with almost no change in temperature. The ocean versus land temperature contrast is rapidly decreasing during W2, because of the larger temperature increase of the land with respect to ocean surface. The analysis is carried out in detail comparing four decades, which mark the limits of the three periods: 1906−1915, 1940−1949, 1970−1979, 2000−2009. Despite the two previous decades, the third decade shows a net positive balance at the surface (+0.9W/m^2) with a value only slightly lower than in the last decade (+1W/m^2). This is interpreted as a significant absorption of heat by the ocean, associated with a major warming phase of the ocean interior, which has begun at the end of the IP.