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Validadion of three Brazilian Global Atmospheric Model experiments (without, fixed and monthly climatological aerosol) against ERA5 and CERES-EBAF

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The Sun's radiation is the primary energy source for chemical, biological, and physical processes that happen in the climate system. Thus, the earth-atmosphere radiative balance system is one of the main aspects of climate change. Natural fluctuations in incident solar radiation caused by the sunspot cycle can influence the energy balance. In addition, human activities can also affect this balance. Changes in gases and aerosols emissions to the atmosphere can modify its composition because they are involved in complex chemical reactions, such as ozone concentrations. Gases and aerosols can absorb, scatter, and reflect incident solar radiation, thereby affecting the balance. This study assesses the direct impact of aerosol (through changing the optical depth of aerosol-AOD in the radiation subroutine) on the surface atmospheric temperature and radiation balance. Three simple experiments for 1998-2017 were carried out through numerical modeling using BAM-v1.2 (Brazilian Global Atmospheric Model), the operational weather and climate forecasting model at CPTEC/INPE (Center for Weather Forecasting and Climate Studies/National Institute for Space Research). These experiments were zero aerosols, fixed AOD over the land and ocean, and AOD climatology with a spatial and temporal variation (AOD-C). The surface atmospheric temperature was validated against the ERA5 reanalysis from December to February (DJF) and June to August (JJA). Also, the downward shortwave solar radiation on the clear-sky variable was validated against CERES-EBAF satellite data. We performed the bias, the difference between the model and the reanalysis data (ERA5) and EBAF-CERES, correlation and RMSE of the model results against ERA5 and EBAF-CERES for surface temperature and downward shortwave solar radiation on clear-sky respectively. Our results have shown a positive bias atmospheric surface temperature for the northern hemisphere continent and a negative bias for the southern hemisphere continent during JJA. We observed a decrease in this positive bias in the northern hemisphere in the experiments with fixed aerosols, but an important improvement (vies, correlation, and RMSE) was observed in the experiment with AOD-C. On the other hand, during the DJF period, the model has a positive bias only in some continental areas, such as southwestern South America and South Africa, North Africa, and the Australian continent. Similarly, to JJA, we observed improvements in these regions in the experiments that use fixed and AOD-C. The

downward shortwave solar radiation on clear-sky results for both DJF and JJA showed an inversion from the positive bias to a negative bias in the model version without aerosols to the model with fixed aerosols and AOD-C, due to the presence of the aerosol, which reduces short wave flow. An important improvement (vies, correlation, and RMSE) in the downward shortwave solar clear sky was observed in the version that uses AOD-C during JJA.