51-year Simulation of the Period from 1951 to 2001 by the JMA AGCM

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1. Introduction: We have evaluated the climate variations and changes over the 51-year period from 1951 to 2001 simulated by the Japan Meteorological Agency (JMA) Atmospheric General Circulation Model (AGCM). The numerical experiments were conducted under the framework of the Climate of the 20th Century International Project (C20C, http://grads.iges.org/c20c/). Model's ability to reproduce linear trend and year-to-year variability of land-surface air temperature and land-only precipitation were investigated for all four seasonal means and annual mean field.

2. Model: The model called MJ98 (Shibata et al. 1999) was originally used for operational numerical weather forecasting and were later modified for climate research usage. The model has a spectral resolution of triangular truncation at wave number 42 (T42), corresponding to about 270 km horizontal grid spacing. It has 30 vertical levels with top at 0.4 hPa. For cumulus convection, a prognostic Arakawa-Schubert scheme is used. For Land surface processes, a Simple Biosphere scheme (SiB) is used.

3. Experimental design: Six-member ensemble integrations were performed from 1951 to 2001, forcing with the observed Sea Surface Temperature (SST) and sea ice data "HadISST1" by Rayner et al. (2003). As for greenhouse gases, the observed concentration of carbon dioxide CO_2 adapted from Hansen et al. (2002), increasing from 311 ppmv in 1951 to 370 ppmv in 2001, was given homogeneously to the whole atmosphere without any seasonal cycle. The concentration of both CH_4 (1650 ppbv) and N_2O (306 ppbv) are kept constant in time and space.

4. Validation data: Land-surface air temperature is validated using the variance adjusted observational data "CRUTEM2v" by Jones et al. (2001) for the 51-year period from 1951 to 2001. Land-only precipitation is validated using the observational data by Hulme et al. (1998) for the 47-year period from 1951 to 1997. Both observational data are based on monthly mean at 5-degree longitude-latitude box.

5. Trend: Figure 1 shows the time series of summer land-surface air temperature anomaly averaged for the Northern Hemisphere. Model reproduces observed positive trend, although the magnitude of trend is underestimated. Figure 2 shows the time series of summer land-only precipitation ratio averaged for the Northern Hemisphere. Model well reproduces observed negative trend.

6. Year-to-year variability: Model's ability to simulate year-to-year variability of land-surface air temperature was investigated by calculating the temporal correlation coefficient between observed temperature and simulated temperature. Correlation coefficient between two time series in Fig. 1 is very high at 78.8, but it reduces to 69.0 if linear trends are excluded from these two time series. Similarly, correlation coefficient between two detrended time series in Fig. 2 reduces to 45.0.

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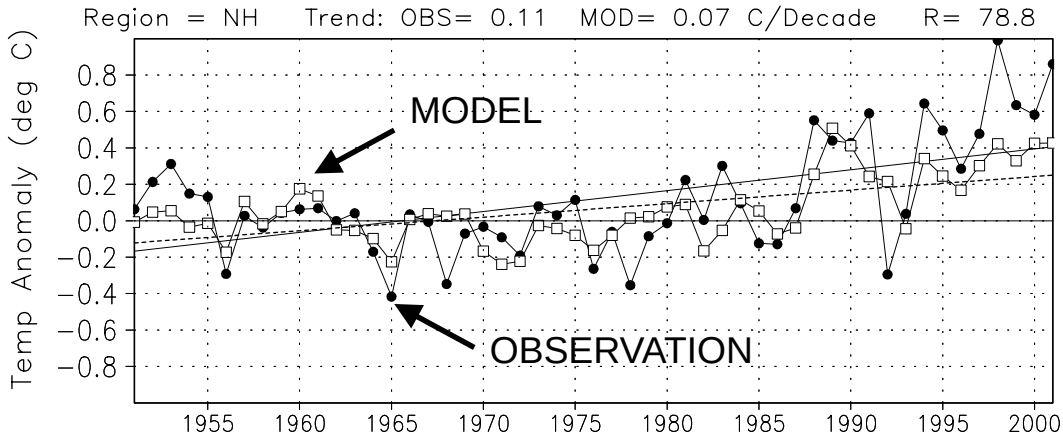

Fig. 1. Time series of summer mean (June - August) land-surface air temperature anomaly (°C) averaged for the Northern Hemisphere (2.5-87.5 °N) from 1951 to 2001. Anomalies are relative to 1961-1990 climatology. Black circle ● indicates observation by Jones et al. (2001). The slant solid line is the linear regressed line by least square fitting to observed time series. White square □ indicates ensemble average of model simulations. The dashed line is the linear regressed line for model. Values of observed trend (OBS) and model trend (MOD) are shown at the top outside the panel by the unit °C/decade. The value of R in the top-right corner outside the panel denotes the temporal correlation coefficient (%) between two time series. R reduces to 69.0, if linear trends are excluded from these two time series.

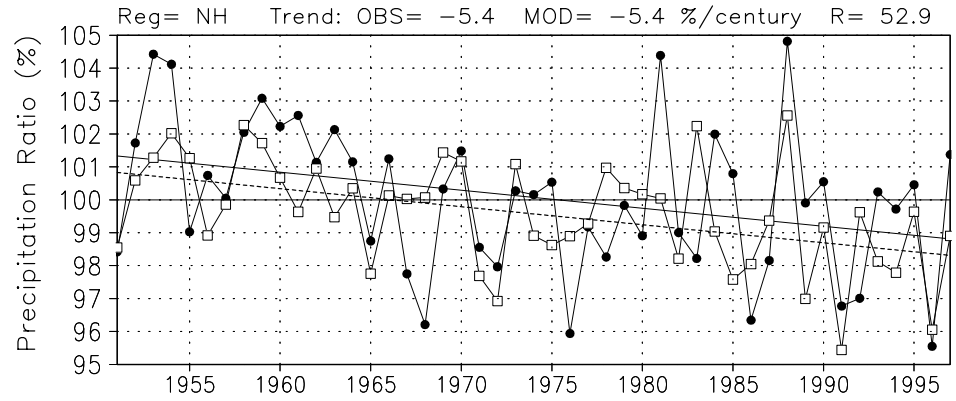

Fig. 2. Same as Fig. 1, but for land-only precipitation ratio (%) to the 1961-1990 climatology. Note that time series end in 1997 owing to the limitation of observational data adapted from Hume et al. (1998). Trend unit is %/century. The value of R reduces to 45.0, if linear trends are excluded from these two time series.