4 Discussion

4.1 Global Hydrologic Balances

The main points to emerge were:

(a) Of the 39 model runs examined, the globally averaged precipitation for 1970-1999 varied from 916.5 to 1187.2 mm per year and was close to the widely quoted (but as yet unmeasured) value of 1000 mm per year for global precipitation (Section 3.3).

(b) All 39 model runs showed steadily increasing global precipitation over the next 100 years for the A1B scenario. This is of course equal to the increase in evaporation. The increase in annual precipitation for the A1B scenario by the end of the 21st century simulated by the 39 model runs varied from 22.9 to 69.1 mm per year (Section 3.3). The differences between global averages of the model runs can be largely attributed to differences in surface temperature in the model runs (Held and Soden 2006) with increases in global precipitation of ~ 2% for every °C increase in temperature. Hence models with larger projected increases in precipitation also tend to have larger projected increases in surface temperature (and evaporation). We did not summarise the response to the A2 scenario because of the small number of model runs available. Given that the A2 scenario predicts warmer temperatures (IPCC 2007), then it follows that the increase in global precipitation over the 21st century would have been even larger than that for the A1B scenario.

(c) The mean increase in global precipitation at the end of the 21st century averaged across all model runs is 46.9 mm per yr (Section 3.3). On average, this increase was more or less equally shared between the ocean (46.4 mm per yr) and land (48.2 mm per yr) surfaces (Section 3.3). These "averages" hide differences between the models with some models predicting nearly all of the increase in precipitation to fall on the ocean (e.g., see the CSIRO model runs in Section 3.3) while others predicted nearly all of the increase over land (e.g., see the ECHO-G model runs in Section 3.3). The remaining 18 models produced results falling between these extremes. Those differences presumably relate to differences in model formulations.

4.2 Australian Hydrologic Balances

The main points to emerge were:

(a) Of the 39 model runs examined, the Australian average precipitation for 1970-1999 varied from 190.6 to 1059.1 mm per yr. The observed annual precipitation for Australia over the 20th century falls in range of ~ 400 to 500 mm per yr (Section 3.4). Hence there were large differences between model simulated precipitation and observations.

(b) When compared to observations, some models show little year-to-year variation in simulated Australian precipitation while other models showed markedly more year-to-year variation than present in the observations. Those differences presumably relate to differences in model formulations.

(c) Many models predicted the unphysical result that E exceeded P over Australia (Section 3.4). We believe that this is a result of the calculation procedure and not a problem with the models. When calculating E (and P) for land surfaces we used the land area fraction defined by each model and assumed that the fraction of E attributable to land was equal to the land area fraction of the pixel. However, along the coast of dry continental regions like Australia, most of the E from coastal pixels would in fact originate from the ocean. Thus we would have overestimated E from the land (and underestimated E from the ocean) when splitting the results into land and ocean fractions. Hence, the global totals would still be correct, but the partitioning between ocean and land would vary depending on how dry the adjacent land surface was. The maximum error would occur over very dry land masses, because there, most of the evaporation from a coastal pixel would in fact be attributable to the ocean. That is consistent with the results showing that E also exceeded P over the Middle East (Section 3.1). There is no way to correctly account for this using the available data. As a future remedy, climate models would need to archive the precipitation and evaporation fluxes from both the land and ocean regions for each pixel.

(d) Of the 39 model runs examined for the A1B scenario, 24 showed increases in Australian precipitation to the end of the 21st century while 15 showed decreases. The overall average across all model runs was for a small increase in Australian annual precipitation of 8 mm per yr by the end of the 21st century. Within that average, some models predict a drop in annual precipitation of as much as 100 mm per yr (notably the CSIRO and UKMO models) while other predict increases of the same order (notably the MIROC3.2 medium resolution models from Japan, see Section 3.4).

(e) It was found that if a model predicts more precipitation than observed, then each run from that model also tended to predict more precipitation. However, this was not a general finding, because some model runs from a given model predicted increases while other runs predicted decreases. The notable example was the German model (MPI-ECHAM5) that predicted the following changes in continental average precipitation from the four runs; -21.9, -128.1, -35.9, 30.4 mm per yr. These four results were all based on the same (A1B) scenario which indicates that the differences are due to internal dynamics (sometimes called chaos). We do not know why some models show pronounced internal dynamics while others do not, but again it must relate to differences in model formulation (McWilliams 2007).

(f) The overall pattern of some models predicting precipitation increases while other predict decreases was expected from the IPCC summaries that show a complex pattern of both wetting and drying in mid-latitude terrestrial regions.

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