GLOBAL

INDEX PRECIPITATION
YEAR 2080-2099 RELATIVE TO 1980-1999
SCENARIO A1B

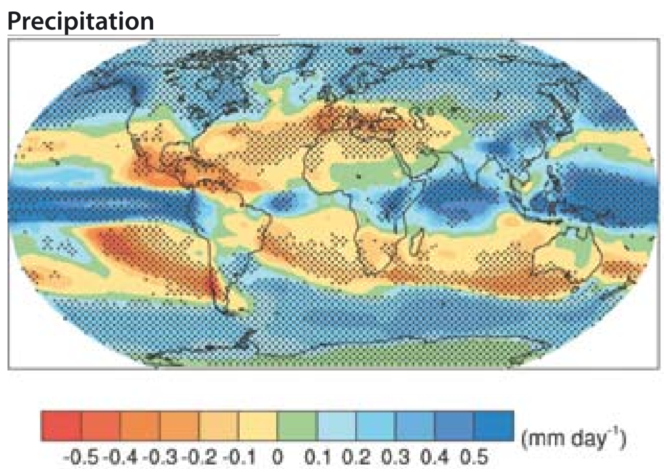
Reference: WG1 2007

1 The major global trends in precipitation

Because of its very nature (small scale, intermittence, spatial heterogeneity, etc.), precipitation is far less well represented by models than temperature. Precipitation is in fact a phenomenon that takes place on a smaller scale than the model resolution, and is not explicitly represented. Simplified physical models make it possible to represent it using large-scale variables, which constitute the sub-grid “parameterisations” of the models (below the model resolution).

FIGURE 1 shows the annual precipitation changes projected at the end of this century for the A1B scenario. For certain regions such as the high latitudes or the equator, the projections indicate that major regional contrasts will be enhanced, with an increase in precipitation in the intertropical convergence zone or in the mid-latitudes and a drying in the arid or semi-arid regions of the tropical belt. The models do not however agree on the transition zone (thus the lack of stippling on the map).

Many tropical regions are characterized by the monsoons. The Asian monsoon, for example, affects China, Southeast Asia and India. In these regions, winds change direction and reverse seasonally. The monsoons develop because of changes in atmospheric pressure caused by the varied rate of warming and cooling of the continental landmasses and the oceans. The strongest, best-known monsoons are those affecting India and Southeast Asia. The winter monsoon blows from the northeast, from the interior of the Asian continent to the equatorial low pressure belt, and is generally dry. On the other hand, during the summer months (summer monsoon), the large landmasses of Asia and the Indian sub-continent warm up, producing a seasonal continental low pressure area. The air flow reverses and the wind blows from the southwest across the Indian Ocean to south Asia. A considerable amount of moisture is accumulated in the air, and then, is deposited as heavy rain during the rainy season from May to September.



MODIFIED AND BASED ON WORKING GROUP I CONTRIBUTION TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. FIGURE 10.12. CAMBRIDGE UNIVERSITY PRESS.

FIGURE 1 Multi-model mean changes in precipitation (mm/day). Changes are anual means for the SRES A1B scenario for the period 2080 to 2099 relative to 1980 to 1999. The regions are stippled where a least 80% models aggree on the direction of the mean change.

2 Uncertainties

2.1 The mean state

FIGURE 2 indicates that the models agree on an increase in precipitation in northern Europe in winter, while in summer and on a projected decrease in precipitation in the Mediterranean basin and in certain northern countries (The United Kingdom), but perhaps an increase across nothern Eurasia. Furthermore, FIGURE 3 shows that the mean state of precipitation has consistent results over large horizontal scale and the global hemispheric one.
FIGURE 2 shows that less there is clearly agreement between the climate models on changes in winter and summer precipitation (i.e., lack of stippling) than on the annualized precipitation (FIGURE 1). For example, in central Europe, the models do not coincide, whether for the summer or winter periods. The local-scale representation of precipitation (FIGURE 3) is therefore relatively uncertain as this variable is highly sensitive to relief and, therefore, to the model resolution; due to their very low resolution the global climate models cannot property take this into account.

2.2 Variability

The change in variability is far more difficult to quantify than the mean state. Improvements have been made in model representation of phenomena such as El Niño (periodic anomaly in atmospheric circulation that is related to changes in temperature of surface waters in the Pacific Ocean), or the North Atlantic Oscillation (north-south oscillation in the air pressure distribution between the arctic and Icelandic regions and the subtropical belt near the Azores and the Iberian Peninsula), but few converge on the results of projections. The dispersion between models comes mainly from physical parameterisations used in each model.

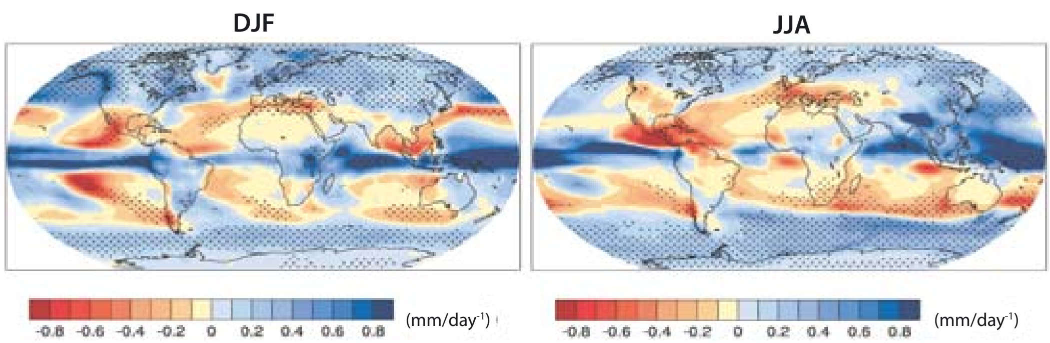


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FIGURE 2 Multi-model mean changes in precipitation (mm day-1) for boreal winter (DJF, left) and summer (JJA, right). Changes are given for the SRES A1B scenario, for the period 2080 to 2099 relative to 1980 to 1999. Stippling denotes areas where the magnitude of the multi-model ensemble mean exceeds the inter-model standard deviation.

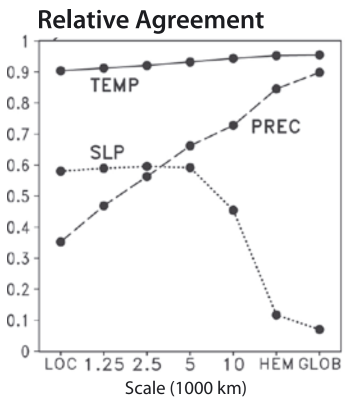

FIGURE 3 Statistics of annual mean responses to the SRES A1B scenario, for 2080 to 2099 relative to 1980 to 1999, calculated from the 21-member AR4 multi-model ensemble using the methodology of Räisänen (2001). Results are expressed as a function of horizontal scale on the x axis ('Loc': grid box scale; 'Hem': hemispheric scale; 'Glob': global mean) plotted against the y axis showing the relative agreement between ensemble members, a dimensionless quantity defined as the square of the ensemble-mean response (corrected to avoid sampling bias) divided by the mean squared response of individual ensemble members. Values are shown for surface air temperature, precipitation and sea level pressure. The low agreement of SLP changes at hemispheric and global scales reflects problems with the conservation of total atmospheric mass in some of the models, however, this has no practical significance because SLP changes at these scales are extremely small.

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2.3 Extremes

FIGURE 4 shows 1) the agreement on decreases and increases in projected precipitation (the same result as FIGURE 2) 2), the extreme events associated with their occurrence probability. Across the globe, some regions are affected by extreme rains and droughts. The estimation of changes to these extremes is accompanied by a reliability indicator for these results.

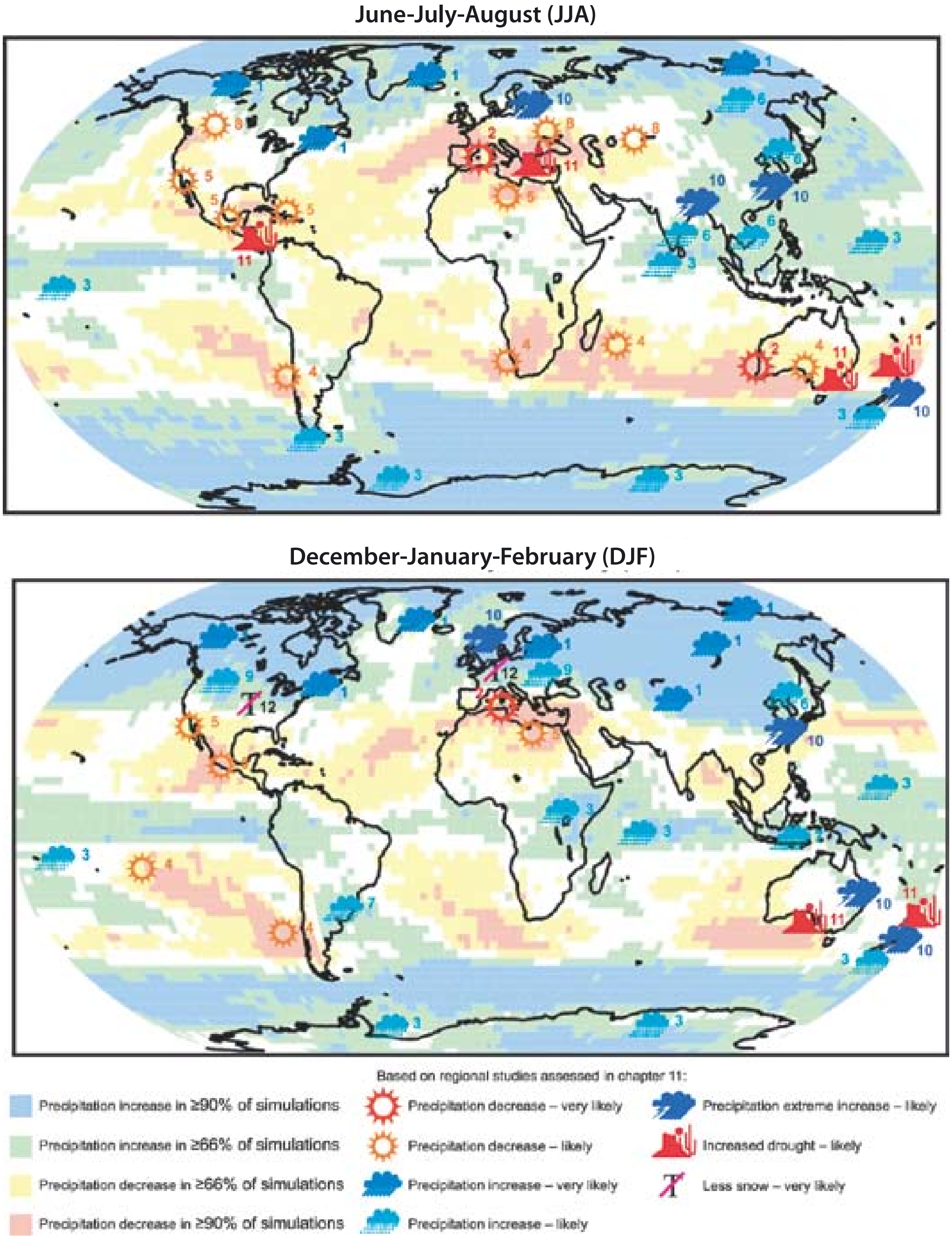

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FIGURE 4 Robust findings on regional climate change for mean and extreme precipitation, drought, and snow. This regional assessment is based upon AOGCM based studies, Regional Climate Models, statistical downscaling and process understanding. More detail on these findings may be found in the notes below, and their full description, including their sources, is given in the text. The background map indicates the degree of consistency between AR4 AOGCM simulations (21 simulations used) in the direction of simulated precipitation change.