EUROPE
CENTRAL EUROPE

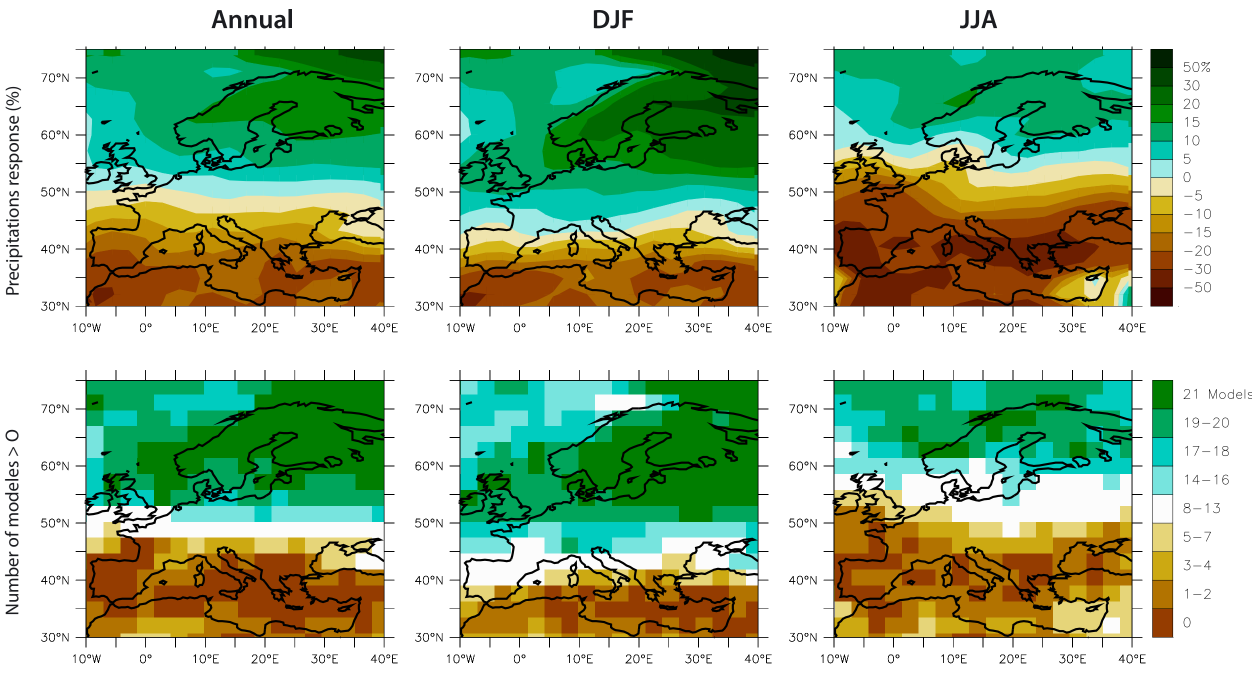
INDEX PRECIPITATION
YEAR 2080-2099 RELATIVE TO 1980-1999
AND 2080-2099 RELATIVE TO 1961-1990
SCENARIO A1B

Reference: WG1 2007, Tebaldi *et al.* (2006), Chauvin and Denvil (2007)

1 The major trends in precipitation

Changes in atmospheric circulation (winds) are partly responsible for precipitation changes over Europe. Throughout the 21st century, annual precipitation increases (with a 90-99% probability) in most of northern Europe and decreases in most of the Mediterranean region.[1] The projections in the annual mean precipitation in Europe are consistent between the different climate models, except in the 50°N band (see FIGURE 1 of the global precipitation fact sheet). The results for summer precipitation remain consistent between models around the Mediterranean basin and in the Scandinavian countries, north of 60°N (see FIGURE 2 of the global precipitation fact sheet). For winter precipitation projections, there is consistency between models over the Mediterranean Sea and regions located beyond 55°N (see FIGURES 1 AND 2). On the other hand, France, the Iberian Peninsula and the central European countries south of 55°N do not show agreement in the simulated winter precipitation changes. In summer, northern France and central Europe remain regions in which the projections by the different climate models do not agree.

1. See section 1 of the global precipitation fact sheet for the physical explanation of these phenomena.

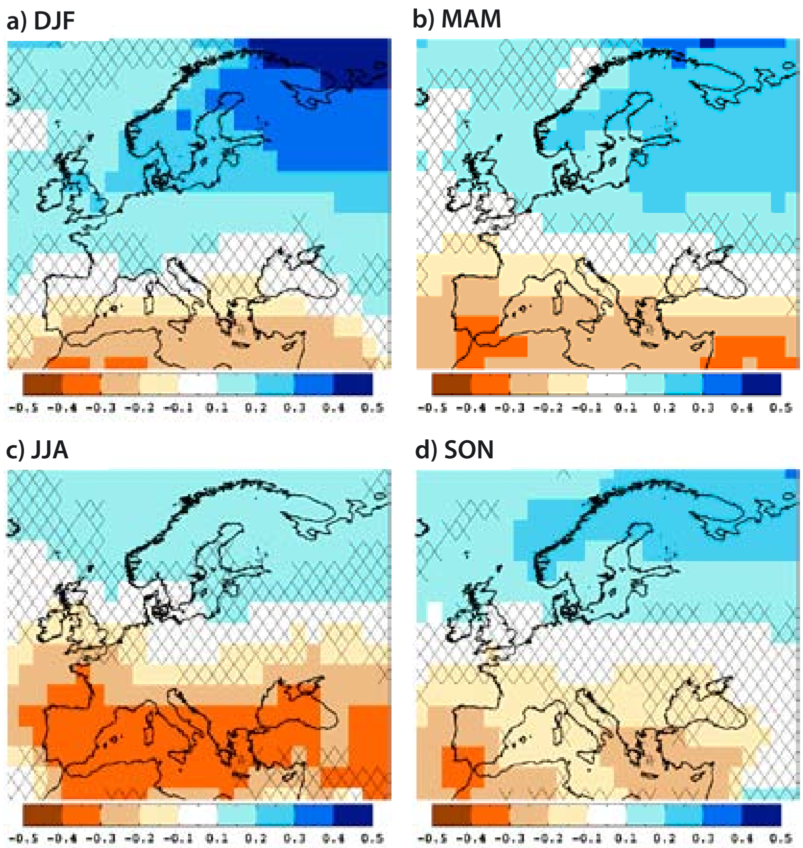


MODIFIED AND BASED ON WORKING GROUP I CONTRIBUTION TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. FIGURE 11.5. CAMBRIDGE UNIVERSITY PRESS.

FIGURE 1 Precipitation changes over Europe from the multi-model data set-A1B simulations. Top row: Annual mean, DJF and JJA precipitation change between 1980 to 1999 and 2080 to 2099, averaged over 21 models. Top: Fractional change in precipitation. Bottom: Number of models out of 21 that project increases in precipitation.

According to the A1B scenario, projections for precipitation in central Europe show two opposite trends, separated at 50°N, and the contrasts are less pronounced in the near future (2030-2049). As an annual mean, precipitation increases north of this limit and decreases south of it, at the latitude of the Mediterranean. This limit descends to 40-45°N in winter and moves up again to 50-60°N in summer (see FIGURES 1 AND 2). For example, precipitation increases by 20 to 50% in Scandinavian countries, whereas in summer in southern Italy and Greece, projections indicate a precipitation decreases of 30-50%. In central Europe, precipitation increases (66-90% probability) in winter but decreases in summer.

In northern Europe, winter precipitation is intensified by the increase in westerly winds, and in summer, the lower precipitation is principally due to anticyclonic flows, mainly from the east. Moreover, summer drying in continental and south-eastern Europe is linked to an increase in evaporation and an early snowmelt. The projections particularly indicate very rainy winters in most of central and northern Europe. Extreme daily rain events noticeably increase (90-99% probability) in northern Europe. The total number of rainfall days per year noticeably decreases (90-99% probability) in the whole of the Mediterranean basin. The risk of drought increases (66-99% probability) in central Europe and the Mediterranean region. The snow season length decreases (90-99% probability) and snow depth tends to decrease (66-90% probability) in most of Europe.



THÈSE DE JULIEN BOÉ, 2007 (CERFACS)

FIGURE 2 Relative change (no unit expressed) in precipitation according to the A1B simulations of 21 climate models over four seasons, between the periods 2080-2099 and 1961-1990. The crossed areas indicate zones where the models produce results having opposite signs.

2 Percentiles of precipitation distribution

TABLE 1 represents the different percentiles[2] of probability distribution for precipitation (% change) projected by the A1B scenario and between 2080-2099 and 1980-1999. Winter and summer are represented over both northern and southern Europe.

TABLE 1

		Percentiles				
Region	seasons	5	25	50	75	95
Northern Europe	DJF	6	13	17	21	27
	JJA	-12	-5	0	4	11
Southern Europe	DJF	-15	-11	-9	-6	-2
	JJA	-44	-32	-25	-17	-5

In the north of Europe, winter precipitation increases for the whole distribution and summer precipitation increases above the median value (see FIGURE 1). The median value for precipitation changes is 17% in winter whereas no difference is observed in summer. The difference between the 5th and 95th percentiles is slightly larger in summer (23%) than in winter (21%). The 5th and 95th percentiles tell us that in winter the high precipitation values increase more (27% for the 95th percentile) than the low values (6% for the 5th percentile). In summer, the low values (5th percentile) decrease by around 12%, while the high values (95th percentile) increase by 11%.

In southern Europe, the opposite applies as the percentiles indicate that precipitation decreases (see FIGURE 1). The median value of precipitation decrease is 9% in winter compared to 25% in summer. The difference between the 5th and 95th percentiles is larger in summer (39%) than in winter (13%). The lower values decrease much more than the higher values, in winter (15% for the 5th percentile and 2% for the 95th percentile) and also in summer (44% for the 5th percentile and 5% for the 95th percentile).

In this example, the precipitation extremes show that northern Europe in winter and southern Europe in summer will be the most affected by changes in the hydrological regime.

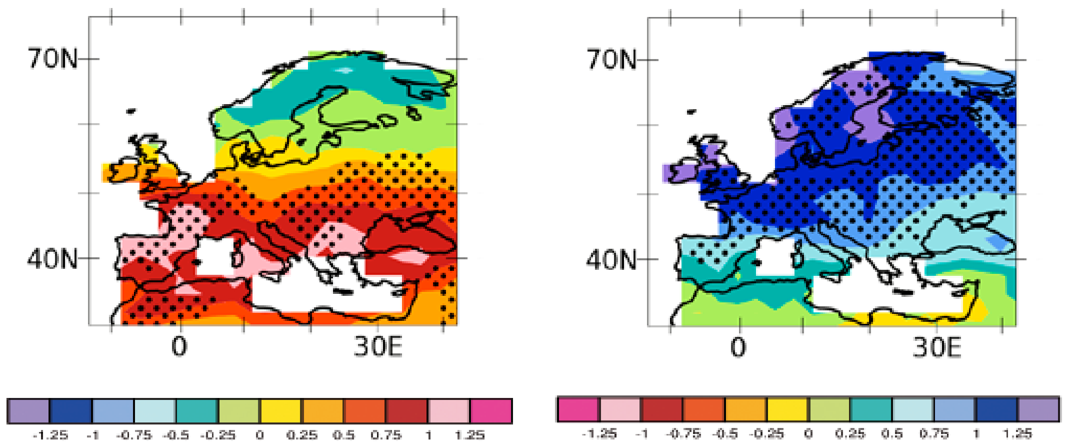
2. See paragraphs 1.1 and 1.2 of the technical fact sheet for further information.

3 Climate indices for precipitation

In Europe, the models consistently produce (see FIGURE 3):

- an increase in dry days with a dry gradient towards the south (except for northern Europe)
- an increase in extreme rainfall days, especially in northern Europe, which is noticeably affected by this phenomenon.

On the other hand, the results of the models do not allow a firm conclusion regarding a reduction in dry days in northern Europe, or an increase in very heavy rainfall in France and Spain.



a/ Dry days (std. Dev.)

b/ Extreme rainfall (std. Dev.)

FIGURE 3 Changes in spatial patterns of simulated (a) dry days and (b) the number of days when the precipitation goes over the 95th percentile between the periods 2080-2099 and 1980-1999. Stippling denotes areas where at least five of the nine models concur in determining that the change is statistically significant. Extreme indices are calculated only over land following Frich et al. (2002). Each model's time series was centred on its 1980 to 1999 average and normalised (rescaled) by its standard deviation computed (after de-trending) over the period 1960 to 2099. The models were then aggregated into an ensemble average, both at the global and at the grid-box level. Thus, changes are given in units of standard deviations (see paragraph 1.3 of the technical fact sheet for further information).