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SUPPLEMENTARY INFORMATION

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**CORRESPONDENCE: Drought-induced decline in Mediterranean truffle harvest *by U. Büntgen et al.***

All correlations used in this manuscript are Pearson's Product-moment correlation coefficients. Inter-series correlations, abbreviated with the term *Rbar*, refer to grand average correlations between each time-series that was available. Significance levels were corrected for first-order autocorrelation in each time-series (i.e. we adapted the degrees of freedom in autocorrelated data).

Information on annual truffle harvestfrom Spain and France was compiled by the national Truffle Grower Associations and published through the head organization Groupement European Tuber GET, whereas data from Italywere collected and published by the National Institute for Statistics ISTAT.

For Spain see: La Federacion Española de Asociaciones de Truficultores(FETT), Reyna, S., De Miguel, A., Palanzón, C., Hernández, A. 2005. Spanish trufficulture. In: Proceedings of the Fourth International Workshop on Edible Mycorrhizal Mushrooms. Murcia, Spain, 28 November–2 December 2005. Universidad de Murcia, Murcia. P. 109.

For France see: La Fédérationfrançaise des trufficulteurs (FFT), Courvoisier, M. (1995) La production et les cours de la truffed'hiver 1903–1995. Le TrufficulteurFrancais 10, 8–9 and Courvoisier, M. (1995) La production et les cours de la truffed'hiver 1903–1995. Le TrufficulteurFrancais 13, 10–11.

For Italy see: La FederazioneNazionaleAssociazioniTartufaiTartuficoltori (FNAT), Data collected by The National Institute for Statistics ISTAT (1961-2003) and compiled in the COST action E30 report: Pettenella, D., Klöhn, S., Brun, F., Carbone, F., Venzi, L., Cesaro, L., Ciccarese, L. 2004. Economic integration of urban consumers' demand and rural forestry production.Italy's Country Report, COST Action E30. Pp.29-38.

For details on *Quercus ilex* growth in a nearby site see: Montserrat-Marti, G. et al. (2009): Summer-drought constrains the phenology and growthof two coexisting Mediterranean oaks with contrastingleaf habit: implications for their persistence and reproduction. Trees 23: 787-799.

**Table S1 |**Regional truffle harvest data (tones/year)as shown in figure S1 and the main text (Fig. 1).

| Year | Spain | France | Italy | Spain & France | Spain & Italy | France & Italy | All | Spain z-scores | France z-scores | Italy z-scores | Spain & France z-scores | Spain & Italy z-scores | France & Italy z-scores | All z-scores |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1970 | 40 | 40 | 30 | 80 | 70 | 70 | 110 | 0.443 | 0.4111 | 0.814 | 0.4775 | 0.6803 | 0.7219 | 0.65303174 |
| 1971 | 60 | 100 | 5 | 160 | 65 | 105 | 165 | 1.4158 | 2.9116 | -1.031 | 2.4907 | 0.5114 | 1.9312 | 1.85025661 |
| 1972 | 60 | 100 | 35 | 160 | 95 | 135 | 195 | 1.4158 | 2.9116 | 1.183 | 2.4907 | 1.5251 | 2.9678 | 2.50328835 |
| 1973 | 70 | 40 | 30 | 110 | 100 | 70 | 140 | 1.9022 | 0.4111 | 0.814 | 1.2325 | 1.694 | 0.7219 | 1.30606349 |
| 1974 | 60 | 36 | 30 | 96 | 90 | 66 | 126 | 1.4158 | 0.2444 | 0.814 | 0.8801 | 1.3561 | 0.5837 | 1.00131534 |
| 1975 | 40 | 38 | 35 | 78 | 75 | 73 | 113 | 0.443 | 0.3278 | 1.183 | 0.4271 | 0.8493 | 0.8255 | 0.71833492 |
| 1976 | 50 | 25 | 50 | 75 | 100 | 75 | 125 | 0.9294 | -0.214 | 2.2903 | 0.3516 | 1.694 | 0.8946 | 0.97954762 |
| 1977 | 70 | 100 | 30 | 170 | 100 | 130 | 200 | 1.9022 | 2.9116 | 0.814 | 2.7424 | 1.694 | 2.795 | 2.61212697 |
| 1978 | 15 | 15 | 25 | 30 | 40 | 40 | 55 | -0.773 | -0.631 | 0.4449 | -0.781 | -0.333 | -0.315 | -0.5441931 |
| 1979 | 40 | 20 | 25 | 60 | 65 | 45 | 85 | 0.443 | -0.422 | 0.4449 | -0.026 | 0.5114 | -0.142 | 0.10883862 |
| 1980 | 30 | 45 | 10 | 75 | 40 | 55 | 85 | -0.043 | 0.6195 | -0.662 | 0.3516 | -0.333 | 0.2036 | 0.10883862 |
| 1981 | 40 | 20 | 50 | 60 | 90 | 70 | 110 | 0.443 | -0.422 | 2.2903 | -0.026 | 1.3561 | 0.7219 | 0.65303174 |
| 1982 | 40 | 33 | 15 | 73 | 55 | 48 | 88 | 0.443 | 0.1194 | -0.293 | 0.3013 | 0.1735 | -0.038 | 0.1741418 |
| 1983 | 30 | 13 | 30 | 43 | 60 | 43 | 73 | -0.043 | -0.714 | 0.814 | -0.454 | 0.3425 | -0.211 | -0.1523741 |
| 1984 | 12 | 11 | 20 | 23 | 32 | 31 | 43 | -0.919 | -0.797 | 0.0758 | -0.957 | -0.604 | -0.626 | -0.8054058 |
| 1985 | 5 | 26 | 15 | 31 | 20 | 41 | 46 | -1.259 | -0.172 | -0.293 | -0.756 | -1.009 | -0.28 | -0.7401026 |
| 1986 | 20 | 20 | 35 | 40 | 55 | 55 | 75 | -0.53 | -0.422 | 1.183 | -0.529 | 0.1735 | 0.2036 | -0.1088386 |
| 1987 | 30 | 60 | 15 | 90 | 45 | 75 | 105 | -0.043 | 1.2446 | -0.293 | 0.7291 | -0.164 | 0.8946 | 0.54419312 |
| 1988 | 8 | 30 | 6 | 38 | 14 | 36 | 44 | -1.113 | -0.006 | -0.958 | -0.579 | -1.212 | -0.453 | -0.7836381 |
| 1989 | 45 | 14 | 30 | 59 | 75 | 44 | 89 | 0.6862 | -0.672 | 0.814 | -0.051 | 0.8493 | -0.176 | 0.19590952 |
| 1990 | 30 | 17 | 1 | 47 | 31 | 18 | 48 | -0.043 | -0.547 | -1.327 | -0.353 | -0.637 | -1.075 | -0.6965672 |
| 1991 | 10 | 20 | 1 | 30 | 11 | 21 | 31 | -1.016 | -0.422 | -1.327 | -0.781 | -1.313 | -0.971 | -1.0666185 |
| 1992 | 30 | 31 | 1 | 61 | 31 | 32 | 62 | -0.043 | 0.036 | -1.327 | -7E-04 | -0.637 | -0.591 | -0.391819 |
| 1993 | 8 | 22 | 2 | 30 | 10 | 24 | 32 | -1.113 | -0.339 | -1.253 | -0.781 | -1.347 | -0.868 | -1.0448508 |
| 1994 | 4 | 9 | 30 | 13 | 34 | 39 | 43 | -1.308 | -0.881 | 0.814 | -1.209 | -0.536 | -0.349 | -0.8054058 |
| 1995 | 20 | 11 | 25 | 31 | 45 | 36 | 56 | -0.53 | -0.797 | 0.4449 | -0.756 | -0.164 | -0.453 | -0.5224254 |
| 1996 | 25 | 24 | 20 | 49 | 45 | 44 | 69 | -0.287 | -0.256 | 0.0758 | -0.303 | -0.164 | -0.176 | -0.239445 |
| 1997 | 80 | 20 | 24 | 100 | 104 | 44 | 124 | 2.3885 | -0.422 | 0.3711 | 0.9808 | 1.8292 | -0.176 | 0.95777989 |
| 1998 | 7 | 10 | 4 | 17 | 11 | 14 | 21 | -1.162 | -0.839 | -1.105 | -1.108 | -1.313 | -1.213 | -1.2842958 |
| 1999 | 35 | 21 | 10 | 56 | 45 | 31 | 66 | 0.1998 | -0.381 | -0.662 | -0.127 | -0.164 | -0.626 | -0.3047481 |
| 2000 | 6 | 17 | 4 | 23 | 10 | 21 | 27 | -1.211 | -0.547 | -1.105 | -0.957 | -1.347 | -0.971 | -1.1536894 |
| 2001 | 20 | 9 | 5 | 29 | 25 | 14 | 34 | -0.53 | -0.881 | -1.031 | -0.806 | -0.84 | -1.213 | -1.0013153 |
| 2002 | 40 | 39 | 20 | 79 | 60 | 59 | 99 | 0.443 | 0.3694 | 0.0758 | 0.4523 | 0.3425 | 0.3418 | 0.41358677 |
| 2003 | 7 | 9 | 6 | 16 | 13 | 15 | 22 | -1.162 | -0.881 | -0.958 | -1.133 | -1.246 | -1.179 | -1.262528 |
| 2004 | 22 | 27 | 10 | 49 | 32 | 37 | 59 | -0.432 | -0.131 | -0.662 | -0.303 | -0.604 | -0.418 | -0.4571222 |
| 2005 | 14 | 15 | 8 | 29 | 22 | 23 | 37 | -0.822 | -0.631 | -0.81 | -0.806 | -0.942 | -0.902 | -0.9360122 |
| 2006 | 20 | 28 | 10 | 48 | 30 | 38 | 58 | -0.53 | -0.089 | -0.662 | -0.328 | -0.671 | -0.384 | -0.4788899 |

**Table S2 |**Regional tree growth data as utilized in figure S4 and figure S5.The term *Year* refers to the absolutely dated calendar year A.D. The term *Series* refers to the number of samples that are available during this year. The abbreviation *TRW* refers to the raw tree-ring width values (mm/yr).

| Year | Series | TRW | Year | Series | TRW | Year | Series | TRW | Year | Series | TRW |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1970 | 10 | 1.131 | 1980 | 20 | 0.754 | 1990 | 20 | 0.953 | 2000 | 19 | 0.61 |
| 1971 | 10 | 2.763 | 1981 | 20 | 0.433 | 1991 | 20 | 0.714 | 2001 | 19 | 0.753 |
| 1972 | 10 | 2.544 | 1982 | 20 | 0.67 | 1992 | 20 | 0.456 | 2002 | 18 | 0.487 |
| 1973 | 10 | 2.505 | 1983 | 20 | 0.589 | 1993 | 20 | 0.582 | 2003 | 17 | 0.517 |
| 1974 | 11 | 1.179 | 1984 | 20 | 1.494 | 1994 | 20 | 0.516 | 2004 | 15 | 0.831 |
| 1975 | 11 | 0.647 | 1985 | 20 | 0.742 | 1995 | 20 | 0.436 | 2005 | 15 | 0.472 |
| 1976 | 16 | 0.644 | 1986 | 20 | 0.439 | 1996 | 20 | 1.001 | 2006 | 14 | 0.52 |
| 1977 | 19 | 1.193 | 1987 | 20 | 0.48 | 1997 | 20 | 3.218 | 2007 | 4 | 0.42 |
| 1978 | 20 | 0.886 | 1988 | 20 | 1.841 | 1998 | 19 | 0.687 | | | |
| 1979 | 20 | 1.086 | 1989 | 20 | 0.591 | 1999 | 19 | 0.975 | | | |

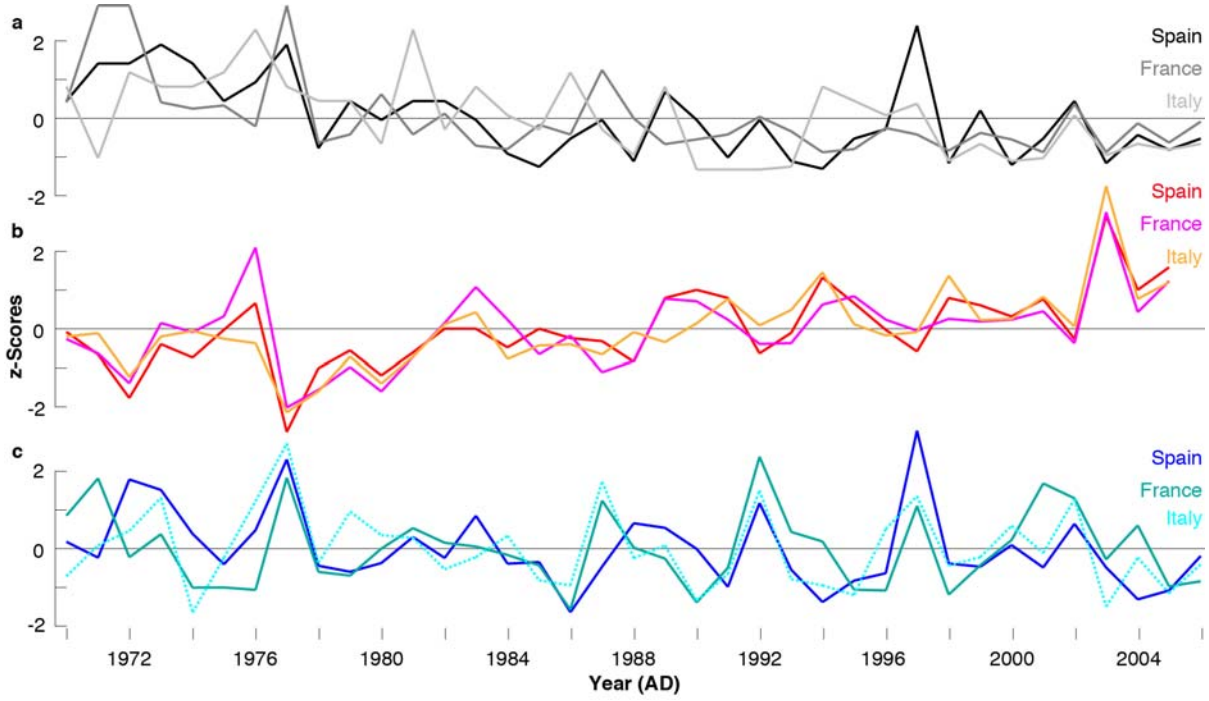


**Figure S1 |**Truffle harvest and climate change.**a**, Regional-scale truffle production with an inter-series correlation (*Rbar;* each series is correlated against each series) of 0.40 compared to variation in summer (June-August),**b**, temperature maxima (*Rbar* of 0.84), and **c**, precipitation totals (*Rbar* of 0.40). The individual time-series (tons/year) were normalized (mean of 0.0 and standard deviation of 1.0) over the common period 1970-2006.

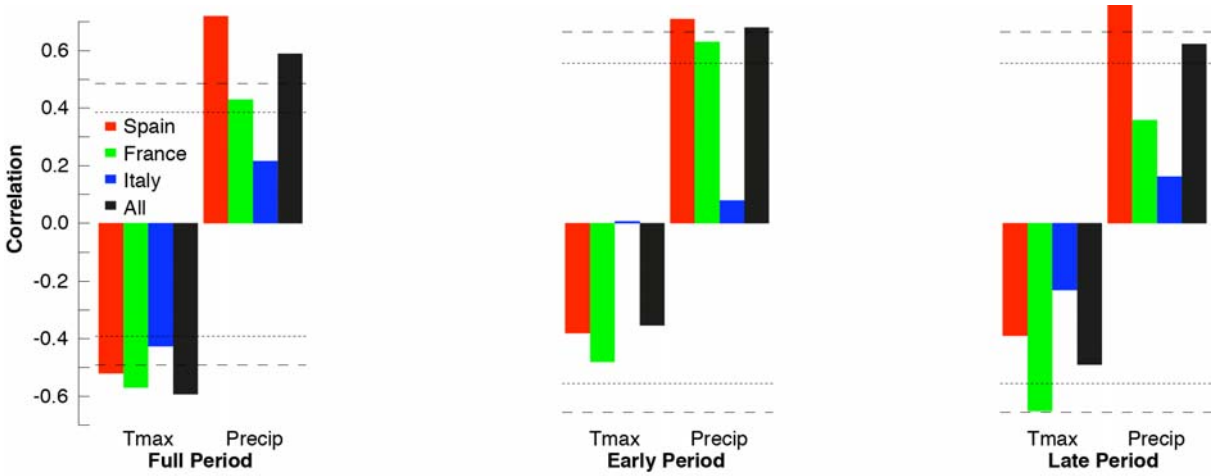


**Figure S2 |**Truffle harvest and climate forcing.Relationship between regional (Spanish, French and Italian) and averaged (Mediterranean) rates of truffle production and variations in summer (June-August) climate (temperature maxima and precipitation totals) computed over the full (1970-2006), early (1970-1987) and late (1988-2006) periods.Dotted and dashed lines refer to 99.0% and 99.9% significance levels, respectively.

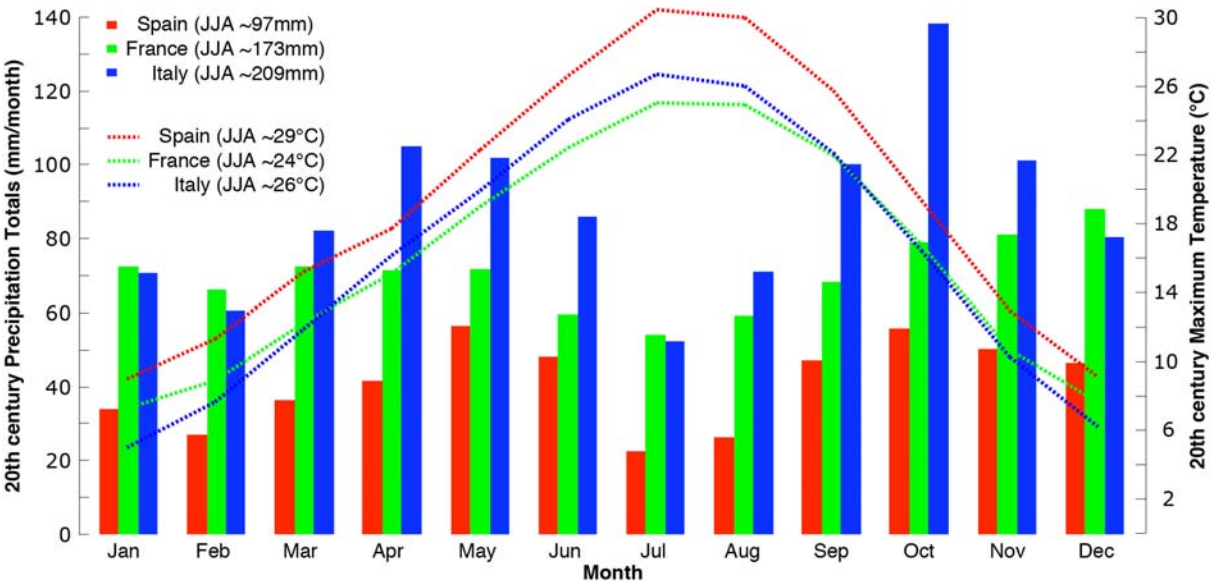


**Figure S3 |**Climaticbackground.Annual cycle of precipitation totals and temperature maxima computed for each month and the three regions in Spain (1.0-0.5°W and 41.0-41.5°N), France (0.5-1.0°E and 45.5-46.0°N) and Italy (8.0-8.5°E and 44.5-45.0°N) over the 1901-2000 period. Precipitation totals (mm) and temperature means (°C) are indicated for the June-August (JJA) summer season. Data were extracted from the griddedCRUTS3.1compilation via the KNMI climate explorer (http://climexp.knmi.nl).

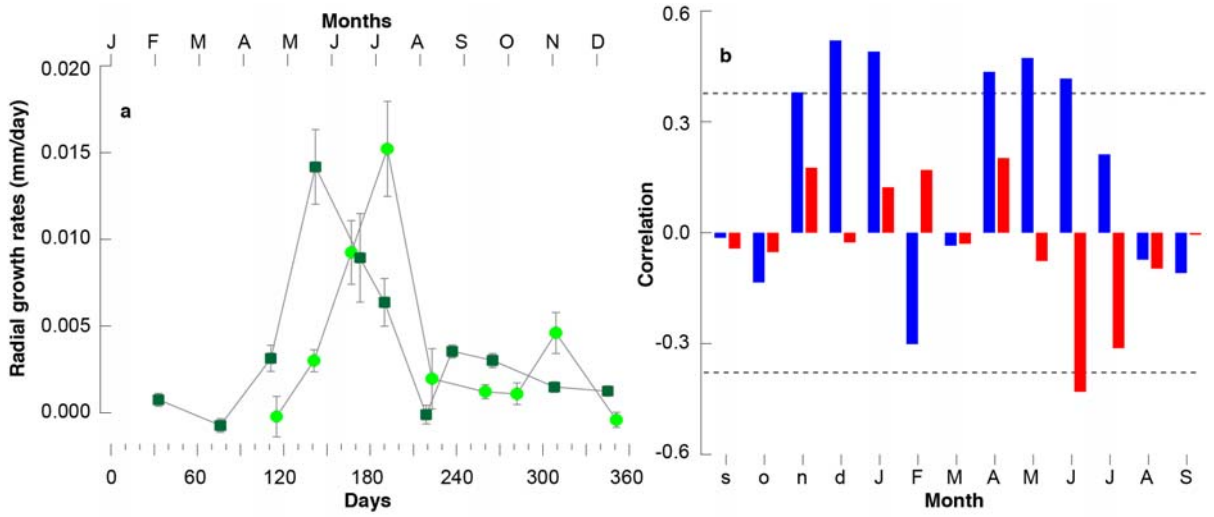


**Figure S4 |**Tree growth and climate.**a**, Intra-annual growth variations of radial stem increment (± SE, *n* =10 trees) obtained from manual dendrometer bands (Agriculture Electronics Corporation, Tucson, USA) in a site in northeast Spain (Huesca, Alcubierre, 42°18'N, 0°47'W). Radial growth rates (mm/day) were calculated by subtracting consecutive readings of cumulative growth rates and dividing them by the number of days elapsed between successive readings. **b**, Correlation analysis between ring width indices and monthly mean temperatures (red) and precipitation totals (blue) computed over the 1970-2007 period and using the interval from previous to current year September.

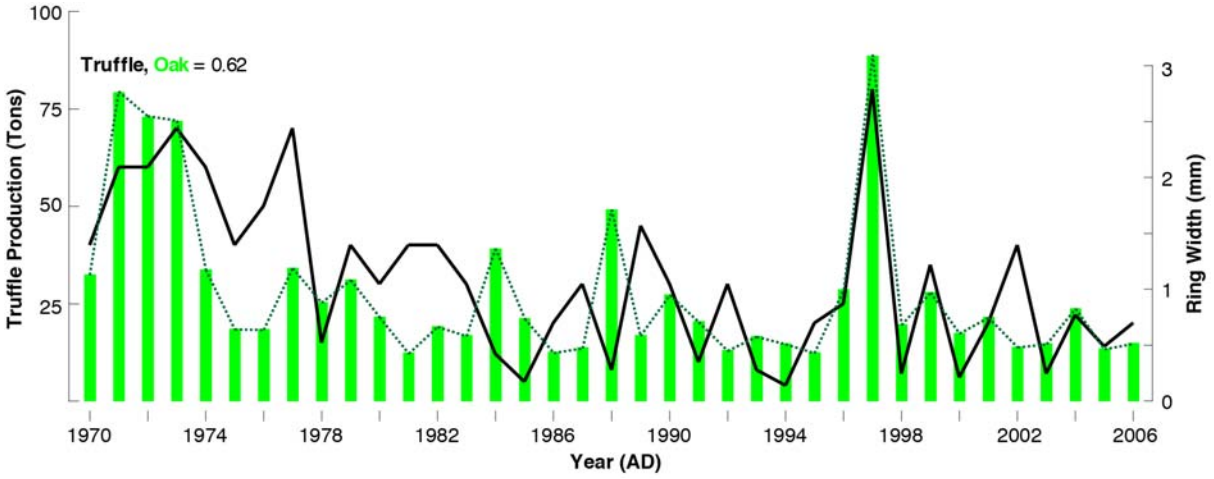


**Figure S5 |**Truffle harvest and tree growth.Comparison between Spanish truffle production and variation on ring width of 20 samples from eleven oak (*Quercus ilex*) trees from a site in northeast Spain (Huesca, Alcubierre, 42°18'N, 0°47'W). The annually cross-dated and well-replicated chronology covers the 1970-2006 period. Inter-series (*Rbar*) correlation in 0.82, and mean ring width is 0.95 mm.

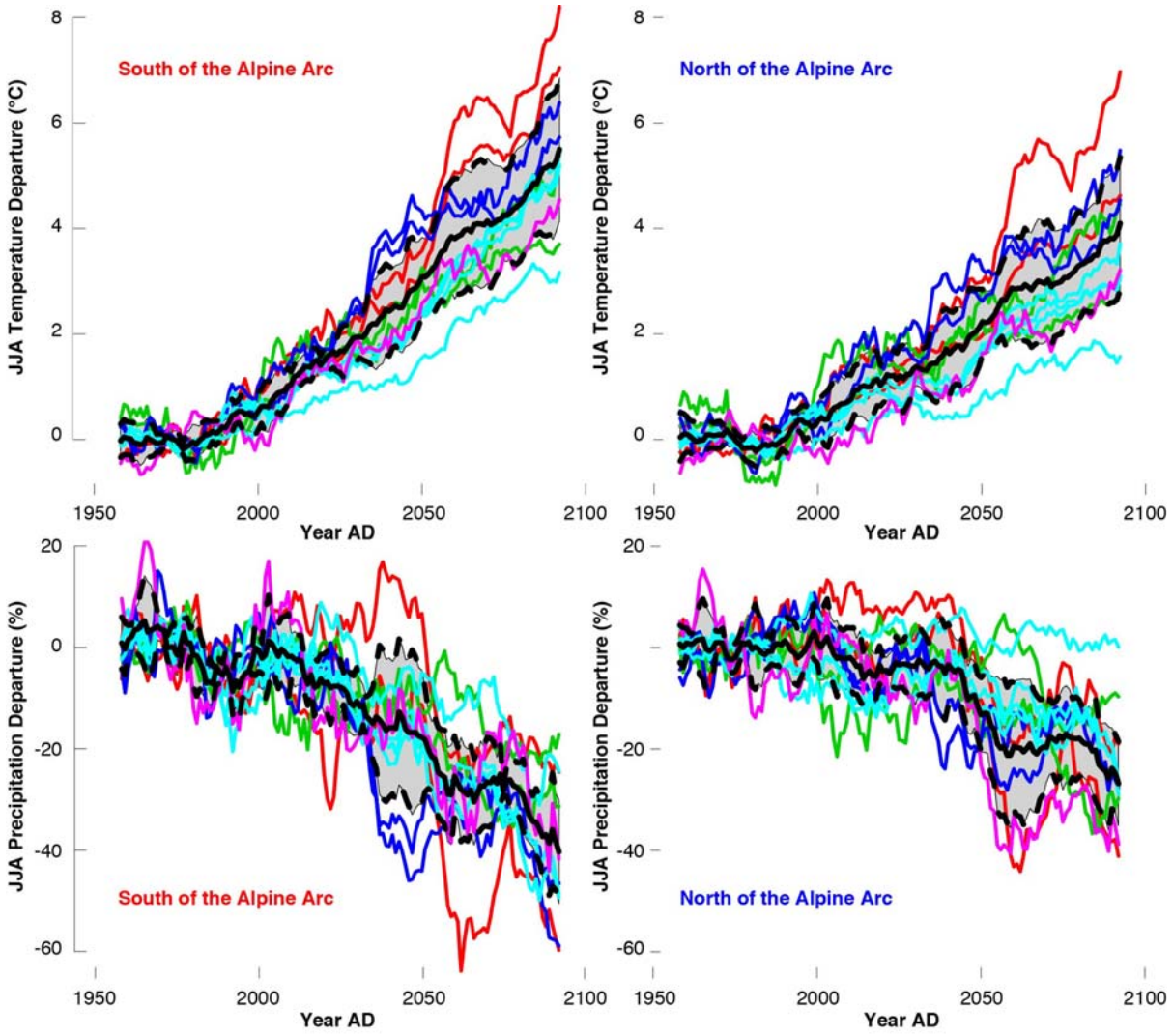


**Figure S6 |**Climate variations.Simulated (color lines) mean June-August (JJA) summer temperature (upper panels) and precipitation (lower panels) change (in °C and %) separated between Europe south (left) and north (right) of the Alpine arc between 1950and 2099 AD, and expressed as 15-year moving averages with respect to 1960-1989. The simulations were performed with 12 RCMs driven with 6 GCMs forced with the SRES A1B emission scenario within the European multi-model experiment ENSEMBLES (Linden&Mitchell 2009: ENSEMBLES: Climate Change and its Impacts: Summary of research and results from the ENSEMBLES project). The solid black line indicates the multi-model mean and the grey band a range of +/- 1.0 standard deviation.

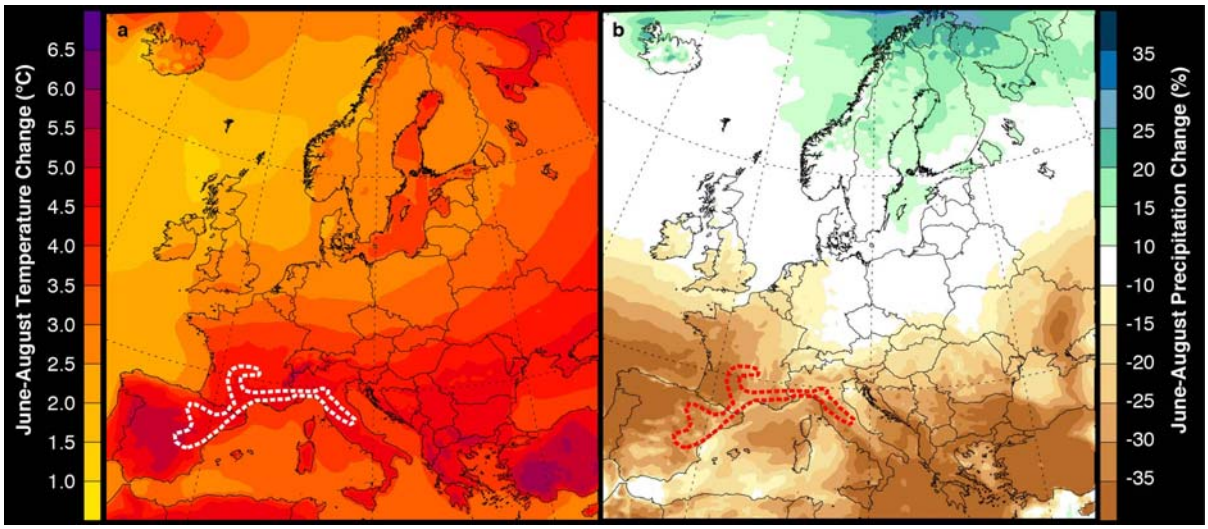


**Figure S7 |**Climate patterns.Projected mean **a**,June-August summer (JJA) temperature (°C) and **b**, precipitation (%) change over Europe in 2070-2099 AD with respect to the reference period 1960-1989. Shown is the ENSEMBLES multi-model mean across 12 RCMs (RCMs driven by the same GCM are averaged first to give each driving GCM equal weight) for the A1B emission scenario.