Table 4.7 Selected climate change scenarios for the alpine region

Type of study	No.	Applied Technique	Major historical, or assumed future forcing	Climate model(s)	ΔTemperature					ΔPrecipitation (in %)				
					REG	Win	Spr	Sum	Aut	REG	Win	Spr	Sum	Aut
Empirical	(1)	Paleoclimatic analog based on pollen and lake level data (Guiot, Harrisson, and Prentice 1993)	Orbital parameters of Holocene warm phase (6’000 yr B.P.)	—Δ	**N, W** **SE**		≥ +3 °C < -1–2 °C			**E, SW** **other**		≤ -30% (–)		
	(2)	Instrumental analog: change of means 1981-90 relative to 1901-10 (see section 4..5.1.2)	Historical GHG increase (CO_2 from 295 to *354* ppmv)	—	**N** **S**	+1.7 +1.6	+0.9 +0.5	+1.1 +0.5	+1.7 +1.3	**N** **S**	+15 +11	+10 +24	-11 -22	+8 -15
	(3)	Extrapolation of frequencies of Alpine weather types: 1975-91 vs. 1945-74 (section 4.5.1.3)	Historical GHG increase (CO_2 from 310 to *356* ppmv)	—	**N** **S**	(+) (+)	(+) (–)	(o) (o)	(o) (+)	**N** **S**	(–) (–)	(o) (+)	(o) (o)	(+) (o)
Semi-empirical	(4)	Linear statistical downscaling using anomalies of large-scale atmospheric	2 x CO_2 (from 330 to *660* ppmv)	CCC/ GCMII	**N** **S**	+3.1 +2.2	+2.6 +2.0	+2.6 +2.2	+2.2 +1.9	**N** **S**	+30 +36	+4 +14	-4 +1	+4 +13
	(5)	fields (Gyalistras et al. 1994; Gyalistras 1994)	2 x CO_2 (from 344 to *720* ppmv)	ECHAM1-T21/LSG	**N** **S**	+1.1 +0.9	+1.6 +1.3	+1.5 +1.3	+1.4 +1.2	**N** **S**	-8 +2	-14 +2	-2 +11	-2 +35
	(6)		IPCC BaU, years 2075-84 (from 344 to *1100* ppmv CO_2 equivalent)	ECHAM1-T21/LSG	**N** **S**	+2.0 +1.2	• •	+2.7 +2.4	• •	**N** **S**	+4 +43	• •	+6 +27	• •

Model based	(7)	Nesting of RegCM in GCM (Giorgi, Marinucci, and Visconti 1992)	2 x CO_2 (from 330 to *660* ppmv)	CCM1, MM4-RegCM		+3.7	+3.2	+2.4	+4.7		+1	+6	+16	-12
	(8)	High-resolution GCM driven by coarse-resolution GCM (Beniston et al. 1995)	IPCC BaU, years 2045-49 (from 344 to *750* ppmv CO_2 equivalent)	ECHAM1 T21/LSG, ECHAM3-T106 high res. GCM		+1.8	•	+5.5	•		+30	•	-40	•
	(9)	As(8), but in addition RegCM nested in the high-resolution GCM (after Beniston et al. 1995, Marinucci et al. 1995)	"	As above, but in addition RegCM2-RegCM	**N** **S**	+0.8 +1.2	• •	+3.5 +2.5	• •	**N** **S**	+5 +15	• •	-30 -5	• •
	(10)	As (9), but RegCM-simulations stratified by large-scale weather classes (after Frey-Buness 1993, Frey-Buness, Heimann, and Sausen 1995)	IPCC BaU, years 2075-84 (from 344 to *1100* ppmv CO_2 equivalent)	ECHAM1-T21/LSG & ECHAM3-T42, REWIH3D-RegCM	**N** **S**	+2.0 +2.3	• •	+2.4 +2.1	• •	**N** **S**	≥ +50 ≥ +45	• •	≥ 0 ≥ +30	• •

Note: REG refers to alpine sub-regions such that (W/SW/SE) denotes the western/southwestern/southeastern Alps and N and S the northern and southern alpine slopes. The symbols (+/o/–) refer respectively to a positive trend/no trend/negative trend; BaU = Business as Usual. Bullets denote missing values. For Scenario 1, the data are annual averages; for Scenario 2, the N-slope averages are for the Basel, Bern, Neuchatel, Saentis, and Zuerich, and the S-slope data are for Lugano only; for Scenario 3, the temperature trends apply in winter for mountain regions, in spring to valleys; for Scenarios 4 and 5 the data are averages for thirty-two locations on the north and eight locations on the south slopes of the Swiss Alps; for Scenario 6, the temperatures signify averages for the locations Bern, Davos, and Saentis (N-slope) and Bever and Lugano (S-slope), and likewise for the precipitation (with Saentis excluded); for Scenarios 7–10, the data are temporal and spatial averages and apply to the entire alpine region. The data are derived for scenario 7 from five simulations of the months of January, April, August, and November; for scenario 8 from a five-year simulation; for scenario 9 from five simulated Januarys and Julys for the western/central Alpine region northward of 44°N and westward of 13°E; and for scenario 10 from ten simulated Januarys and Julys. Changes for the N- and S-slope of the Alps in the scenarios 9 and 10 were obtained from our own analyses of the results provided by Beniston et al. (1995) and Frey-Buness (1993).