What would be the fate of snow in the western Himalaya: A climate change perspective?

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ICIMOD

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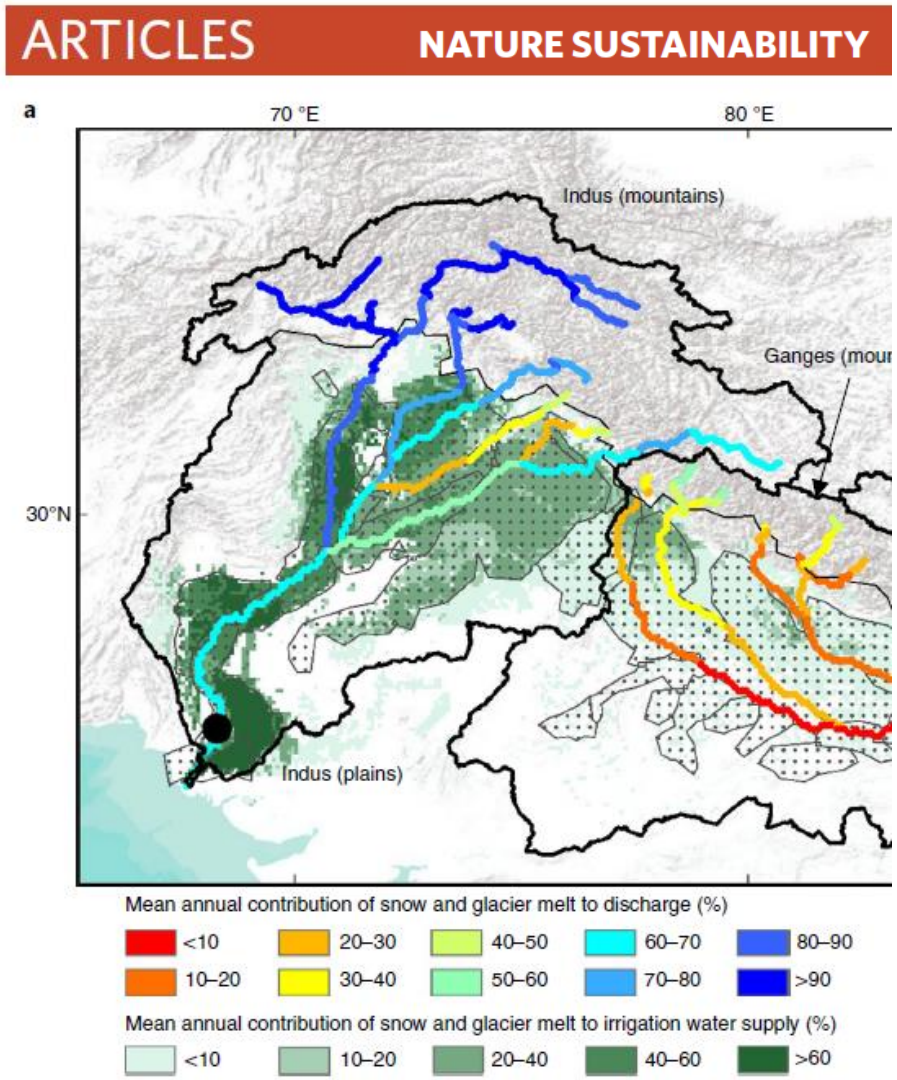
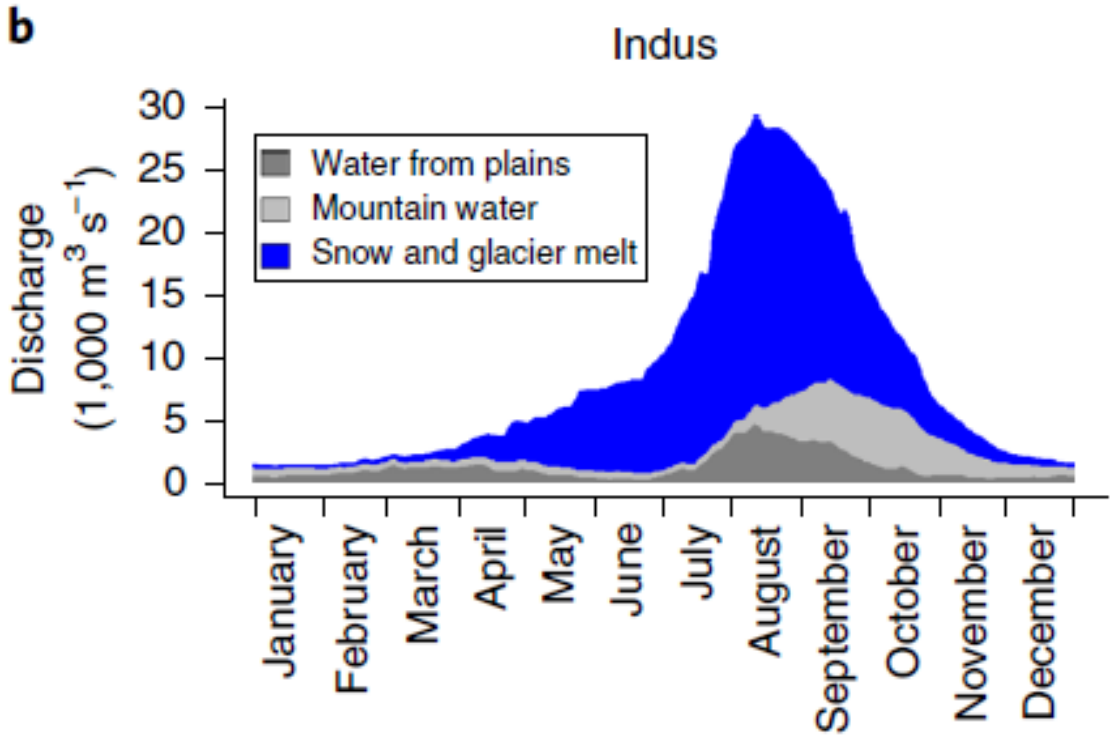
Importance of snowmelt



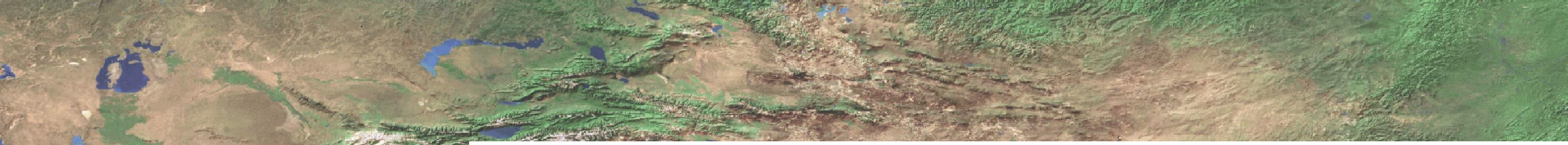
Biemans et al. 2019

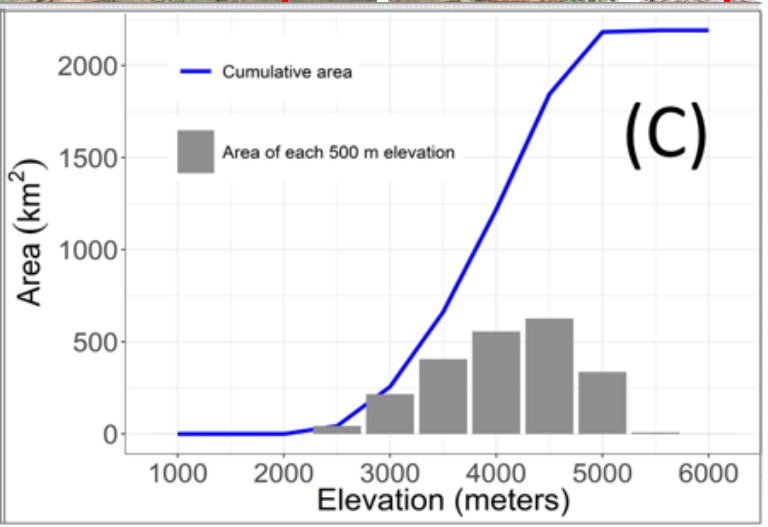


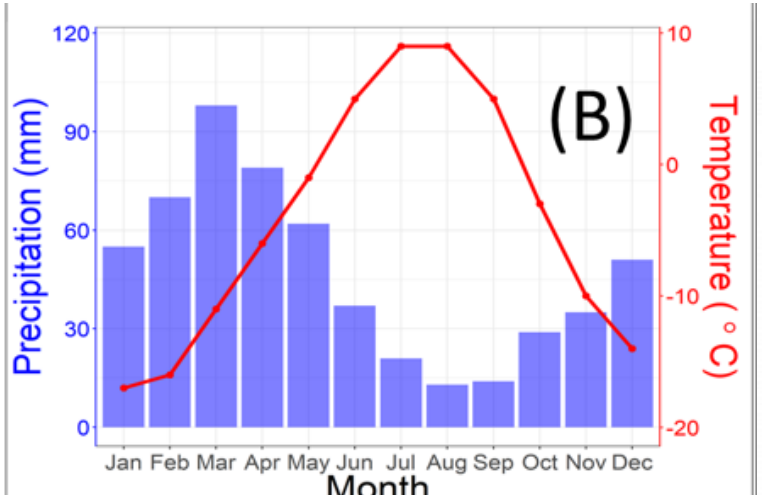
Strong dependency of meltwater

In Inuds basin, up to 60% of the total irrigation withdrawals originate from mountain snow and glacier melt in the Spring season

What would be the impact of climate change on snow dynamics?




Cumulative area
Area of each 500 m elevation
(C)
Area (km²)
2000
1500
1000
500
0
1000
2000
3000
4000
5000
6000
Elevation (meters)

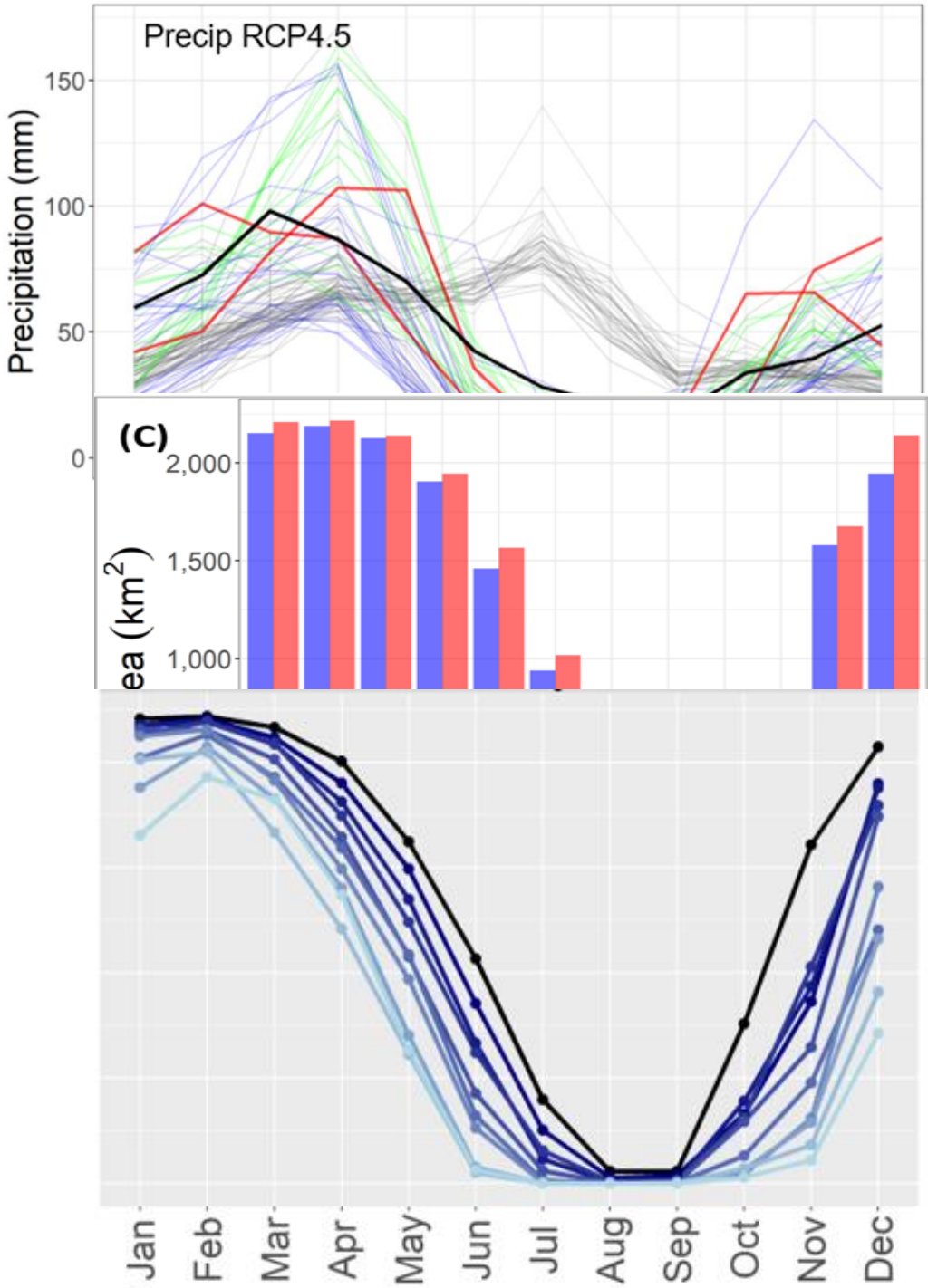

(B)
Precipitation (mm)
Temperature (°C)
120
90
60
30
0
10
0
-10
-20
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month


Afghanistan
Pakistan
HIMALAYA
Nepal

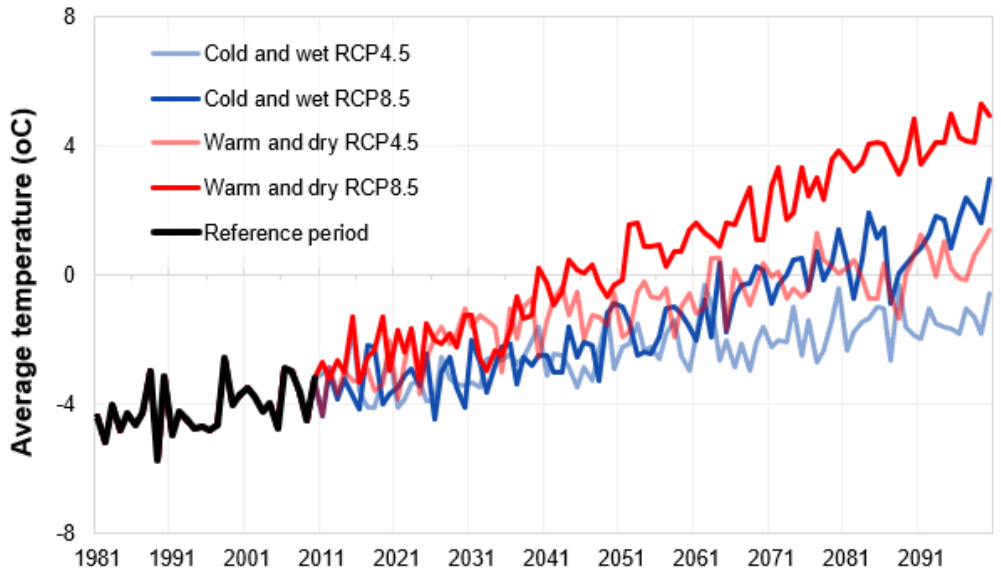
N
(A)
Area: 2210 km²
Legend
watersheds
Elevation (m asl)
High : 5718
Low : 2038
0 4 8 16 24 32
Kilometers

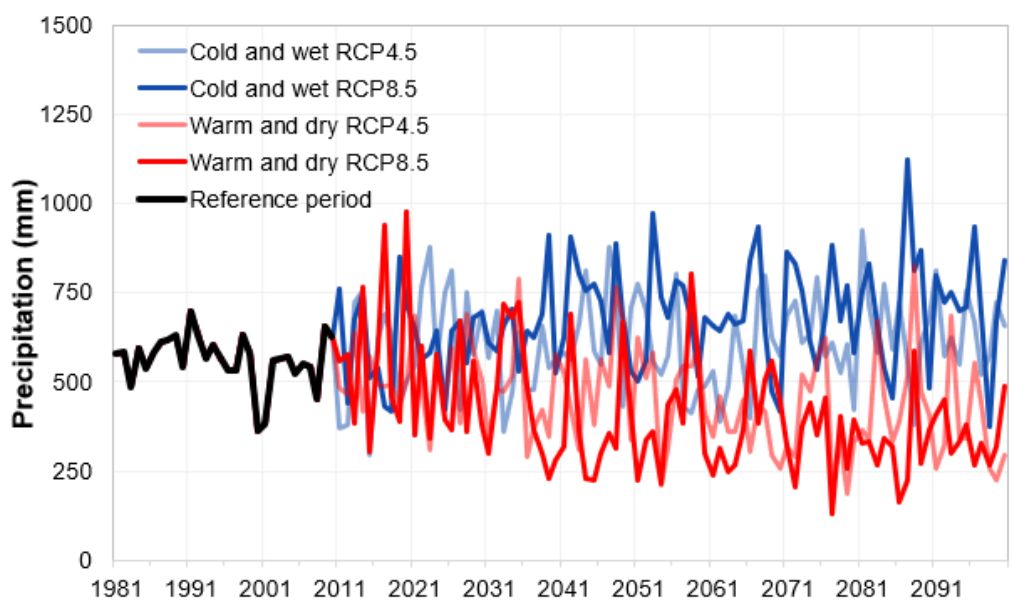
Methodological approach

1. **Global model selection and downscaling**
   a) Model selected based on historical performance
   b) RCP4.5 and RCP8.5
   c) Cold-wet models (2) and **warm-dry** models (2)
   d) Statistical empirical downscaling (9 x 9 km)
2. **Cryospheric-hydrological J2000 model**
   a) ERA5 reference data (1981-2010)
   b) Validation with MODIS snow cover data
   c) 8-days and monthly comparison
   d) Snow storage and snowmelt
3. **Future snow dynamics**
   a) Decadal snow cover change
   b) Annual snow cover change
   c) Changes in snow storage and snowmelt



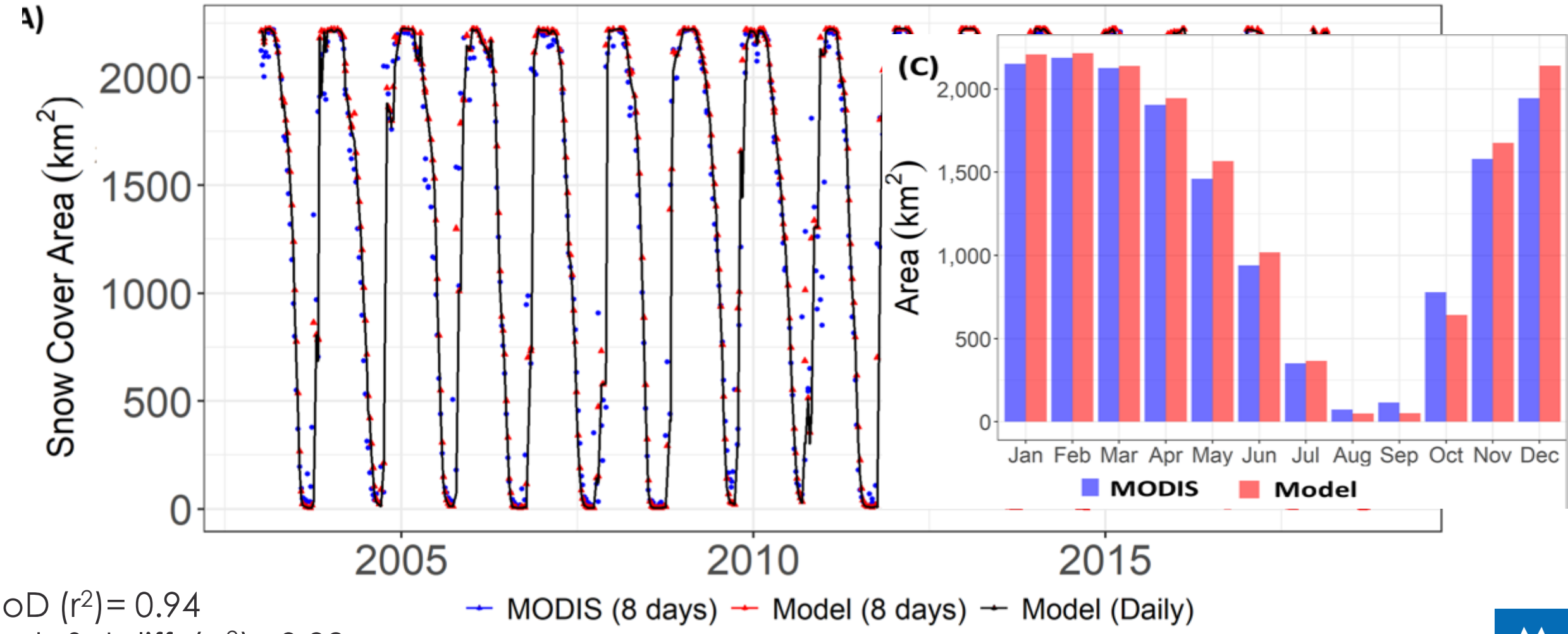
Future climate change in Panjshir





RCPs	Model characteristics	Model runs	Mid Century		End Century	
			Precip (%)	Temp (oC)	Precip (%)	Temp (oC)
RCP45	Cold and Wet	MRI-CGCM3_r1i1p1	4%	1.86	13%	2.5
	Warm and dry	IPSL-CM5A-LR_r2i1p1	-17%	3.1	-26%	4.3
RCP85	Cold and Wet	MRI-CGCM3_r1i1p1	23.3%	2.2	27.6%	4.9
	Warm and dry	IPSL-CM5A-LR_r4i1p1	-34%	4.4	-40%	7.8

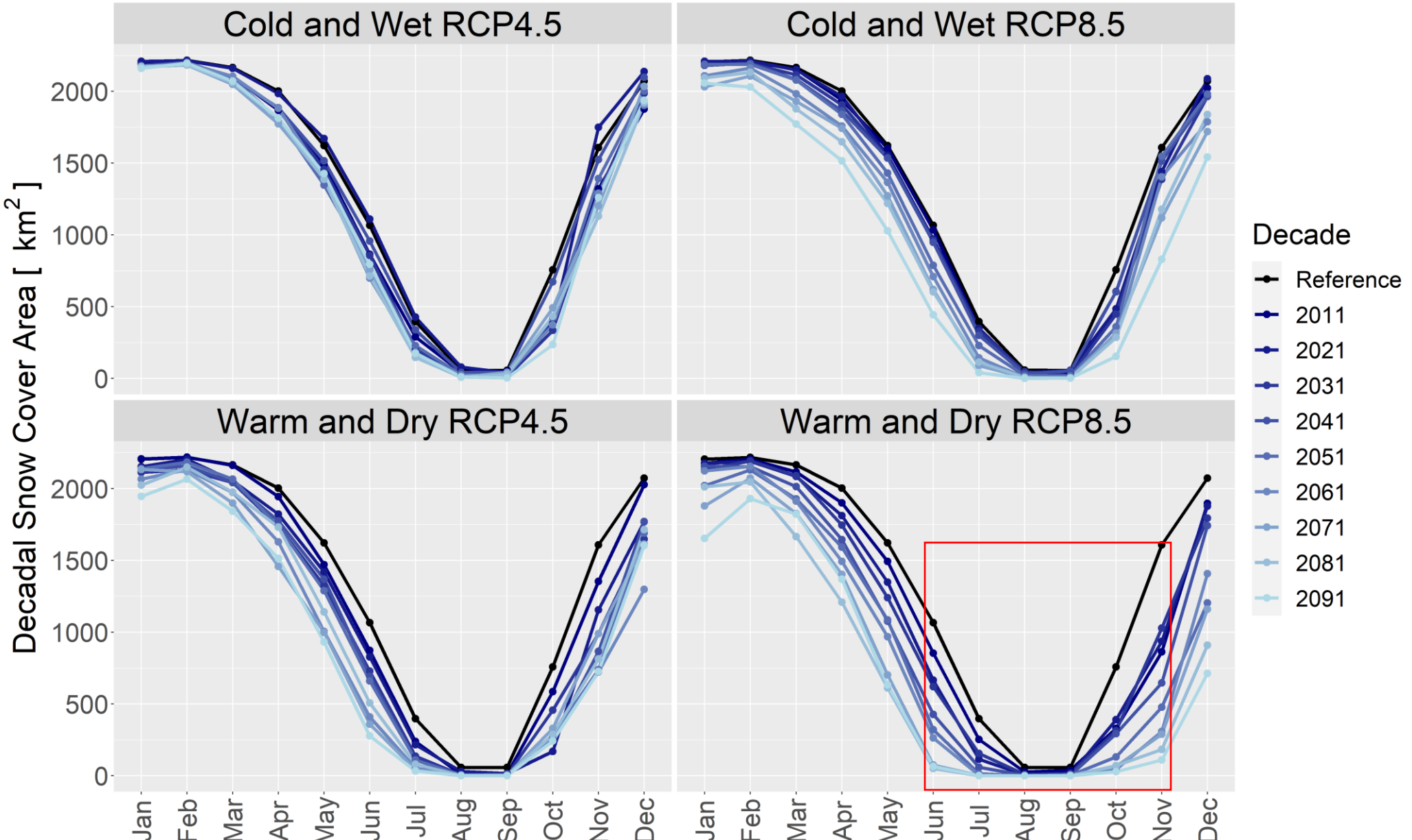
Modelling snow cover using the J2000 model (2003-2018)



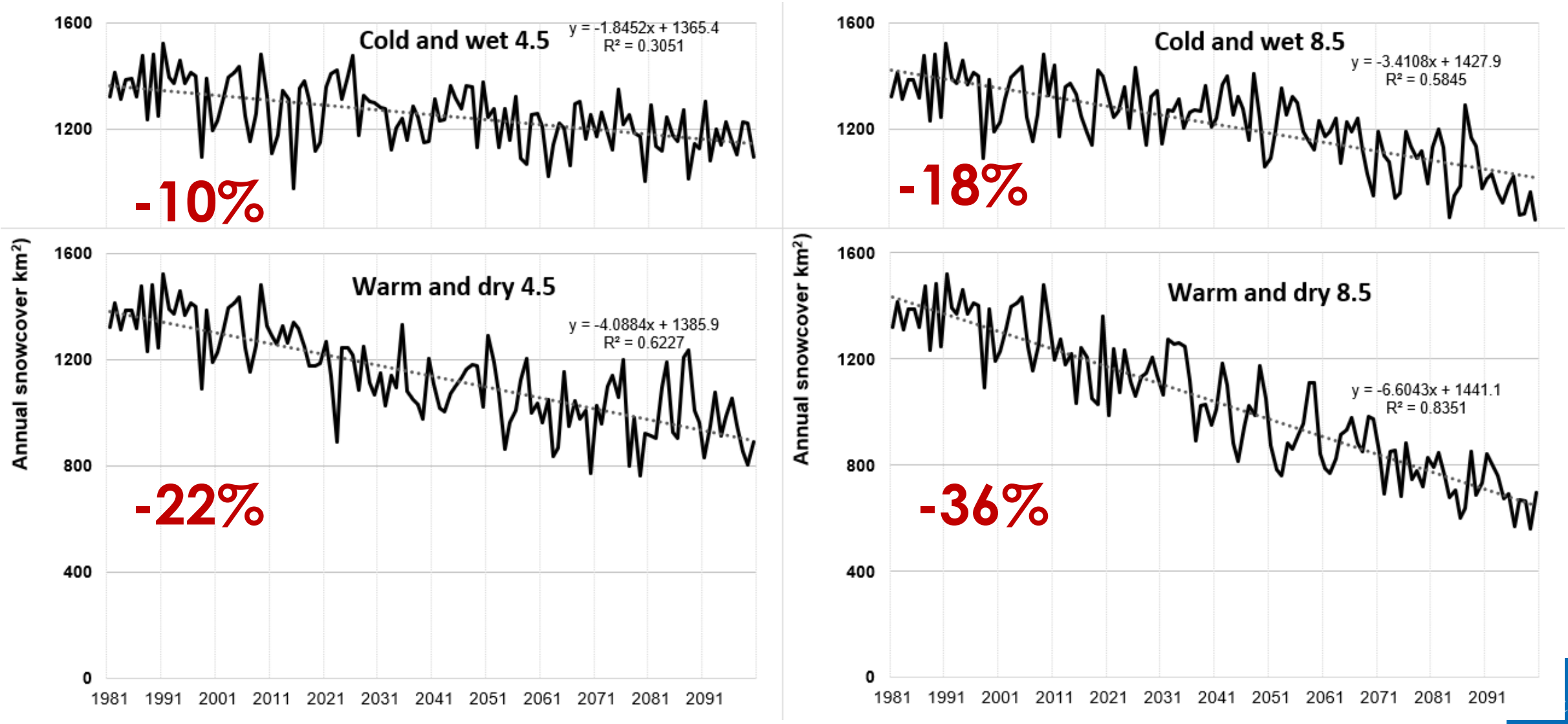
CoD (r^2)= 0.94

Nash-Sutcliff (e^2)= 0.92

Changes in decadal snow cover



Change in annual snow cover



Changes in snow storage and snowmelt

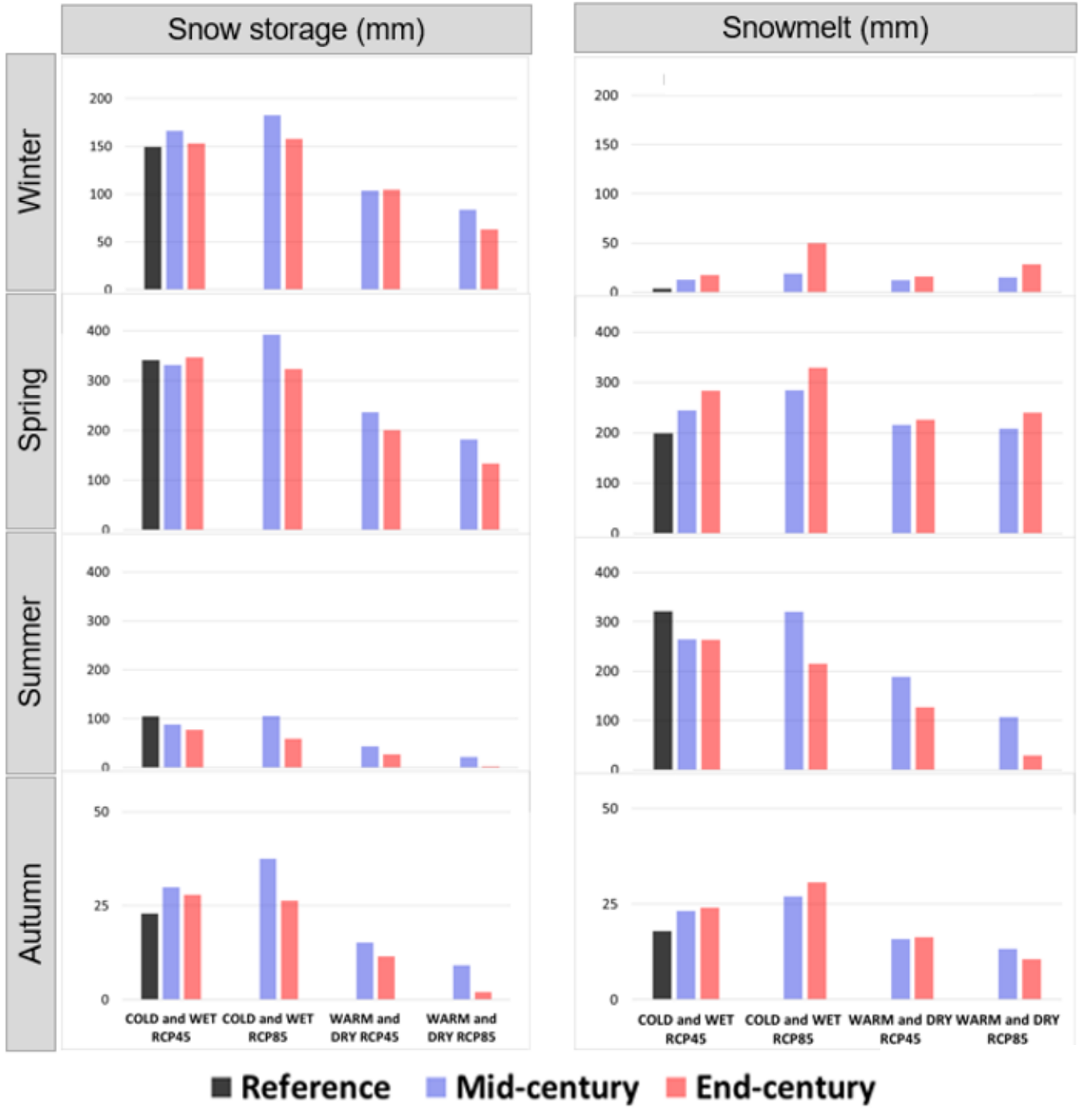
Decreasing snow storage in summer

- Increase in cold-wet RCP4.5 scenarios (except summer)

Increasing snowmelt in winter and spring and decrease in summer

- Higher decrease in RCP8.5 than 4.5

Reference: 1981-2010
Mid century: 2036-2065
End century: 2071-2100



Summary

Panjshir basins' snow storage capacity will be reduced in the future

Even during the optimistic scenario (cold-wet), the snow cover is likely to decrease

Increasing snowmelt in winter and spring could be an opportunity for downstream agriculture

Adaptation strategy is required to better cope with decreasing snowmelt scenarios in summer


The pulse of
the planet.