Impact of a climate change on the alpine French catchments

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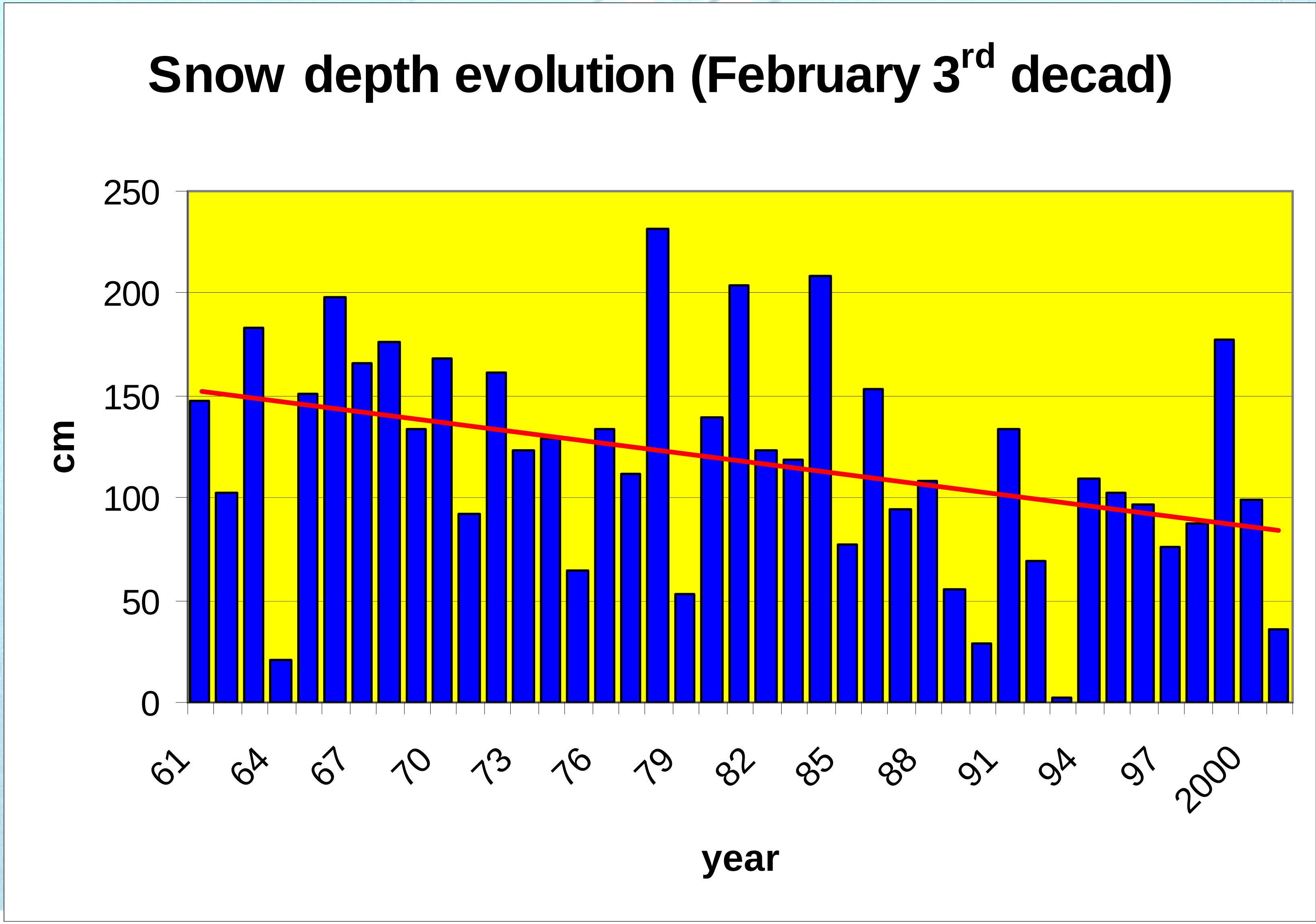
Plan

- General framework
- Methodology
- Results

The snowpack evolution at Col de Porte (1340 m)



The strakes of a climate change

The hydrological impacts and the snow particular case

General	*Snow role in mountainous watersheds*
Water resources	**Water storage in winter**
Vegetation evolution	**Extension partly controlled by snow cover characteristics**
Eco-systems	**Strong interactions with the snowpack**
Human activities	**Determinated by snow in winter**

Main uncertainties

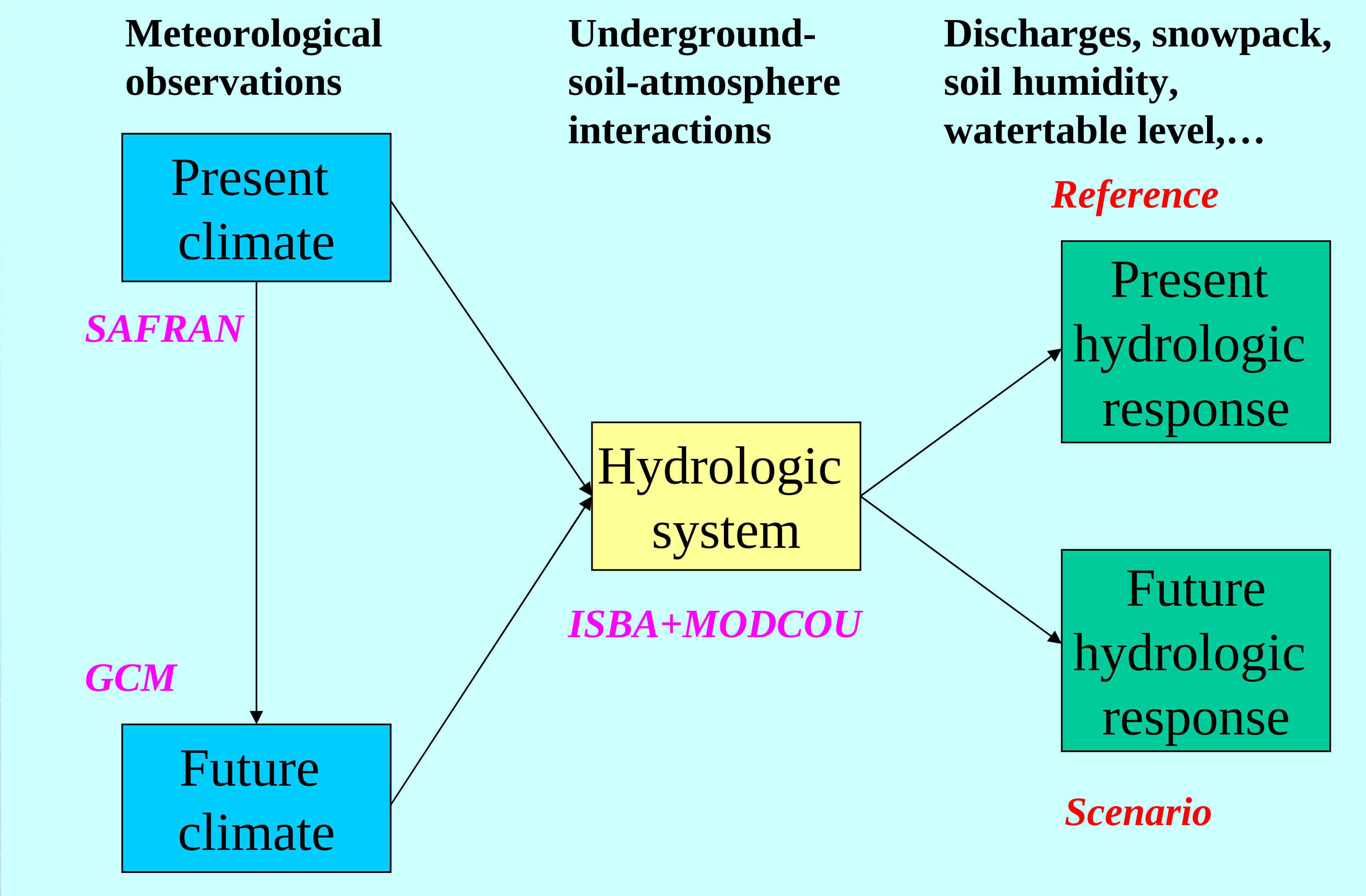
Source	Treatment
Hydrological modelling hypothesis	-model as physical as possible -identification of the dominant processes
Uncertainties on the future climate	- trends > absolute values - use of multiple scenarios (probabilistic analysis)
Human activity	- « pseudo-natural » simulation - use of management scenarios

The GICC-Rhône project

- **Goal** : to evaluate the impact of a climate change on the water resources of the Rhône basin

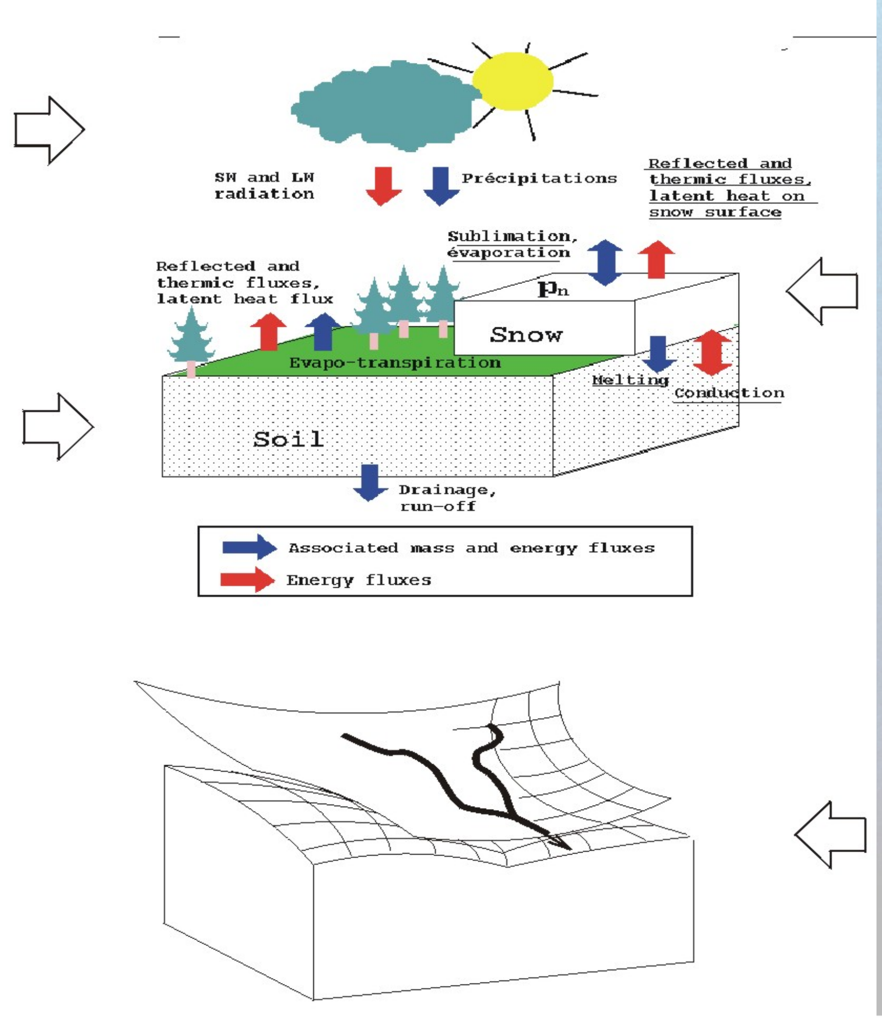
- **Principle** : to use deterministic tools validated for the present climate (GEWEX/Rhône)

Modelling principle



The hydrological modelling

- Distribued modelling (over the French part of the Rhône basin)
- 3 combined models (SAFRAN, ISBA, MODCOU)
- Time steps from 5 min to 1 day
- Spatial resolution: 64 km²



Hydrological modelling validation

- Simulation of the Rhône basin from 1981 to 1995
- Validation of snow pack with 24 daily snow depth observations (Alps)
- Validation of discharges by comparison with daily observations (to be completed for pseudo-natural discharges)

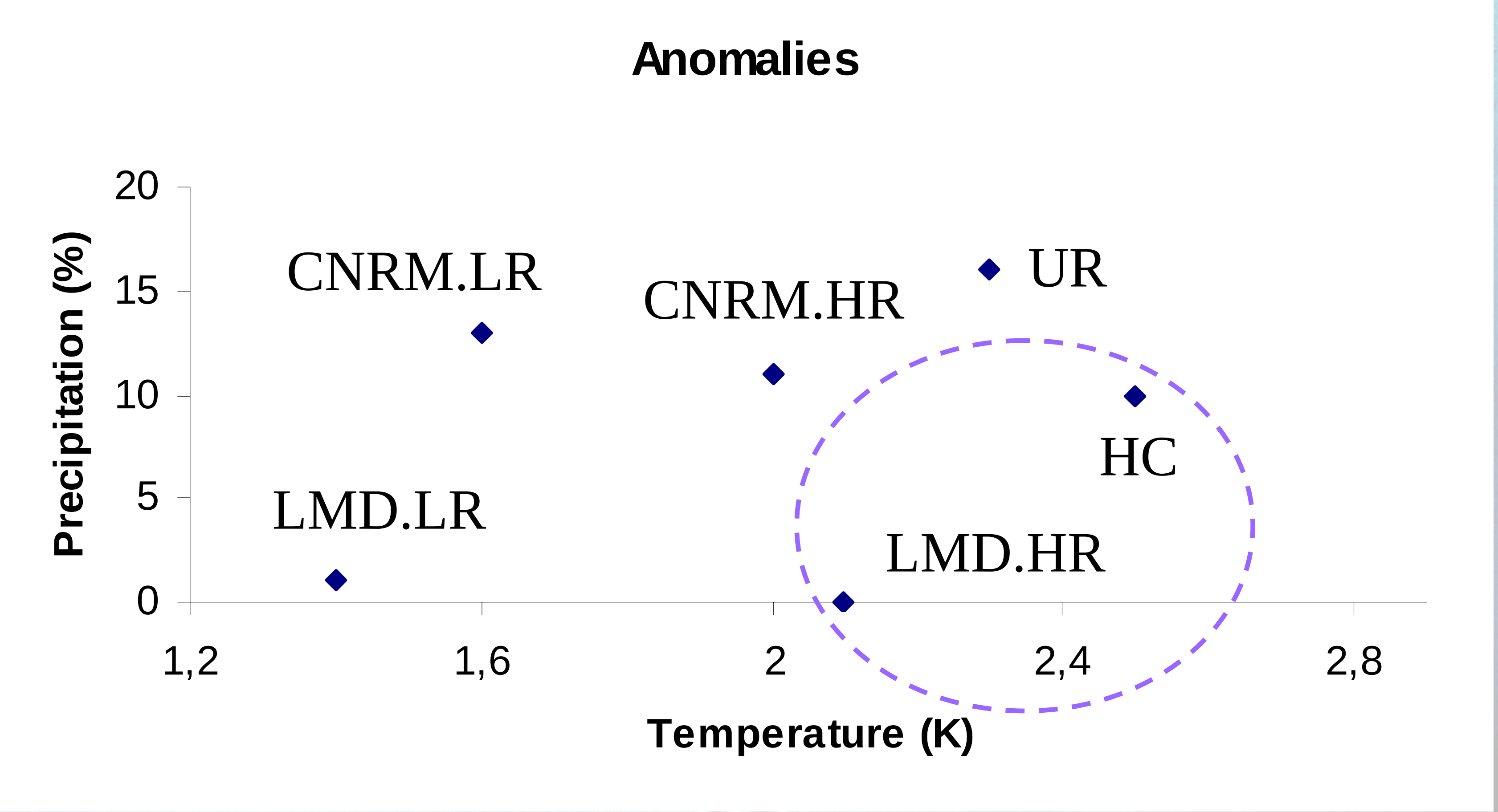
The climate scenarios

- Hypothesis: $2xCO_2$ for years 2050-2060
- Calculation of a trend :

  air temperature : absolute variation

  precipitation : relative increase
- 4 GCM results : CNRM, LMD, HC, UR
- 2 resolutions : low (100 km) and high (50 km)
- 2 precisions : (P+T) or (P+T+Rad+V+Hu)

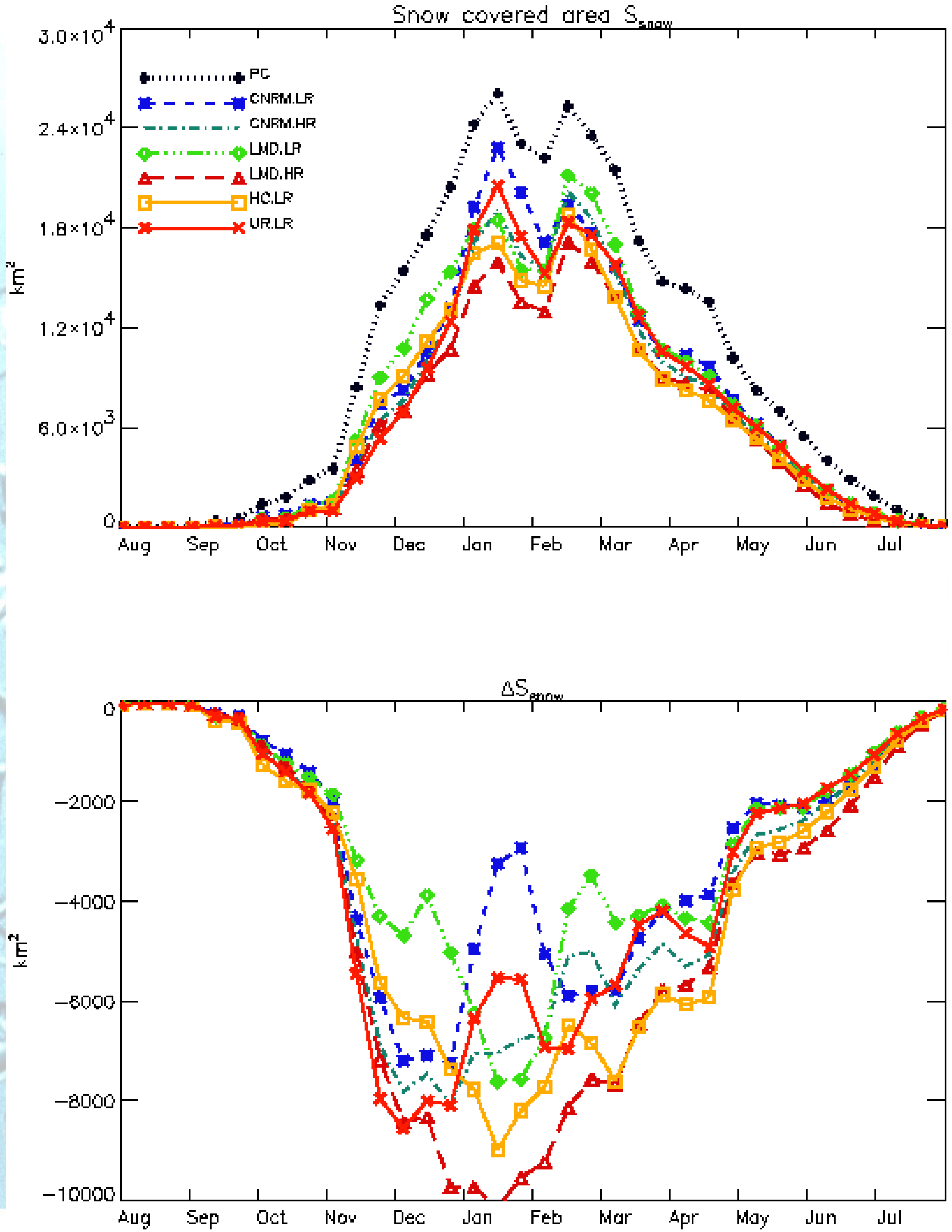
The climate scenarios: Winter P and T anomalies (oct-april)



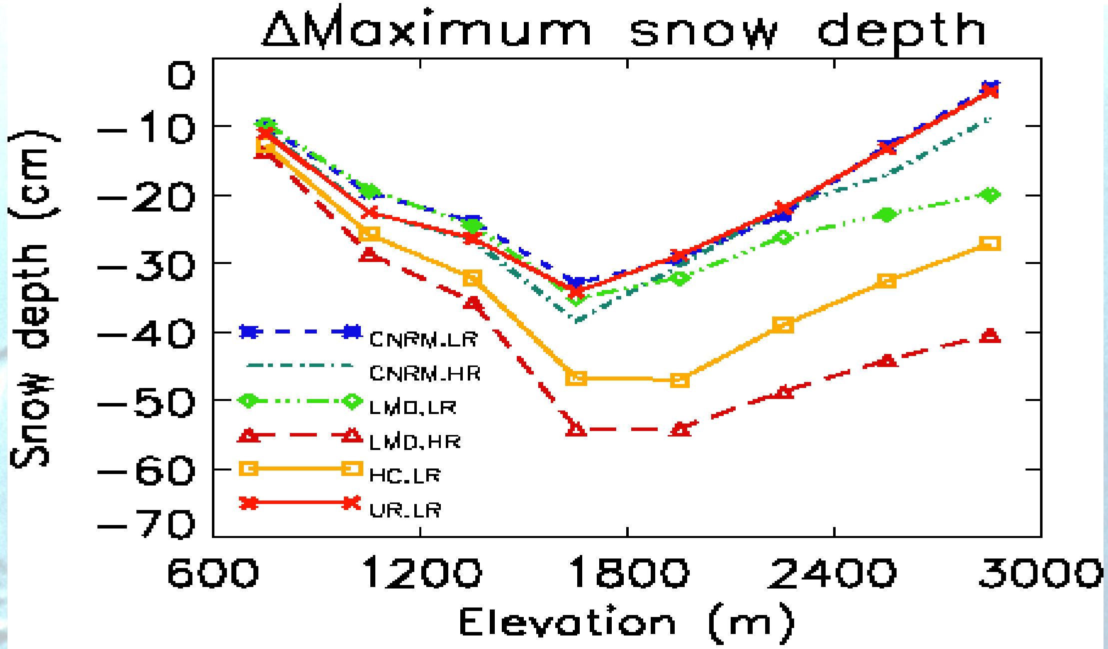
The climate scenarios: annual precipitation anomalies (%)

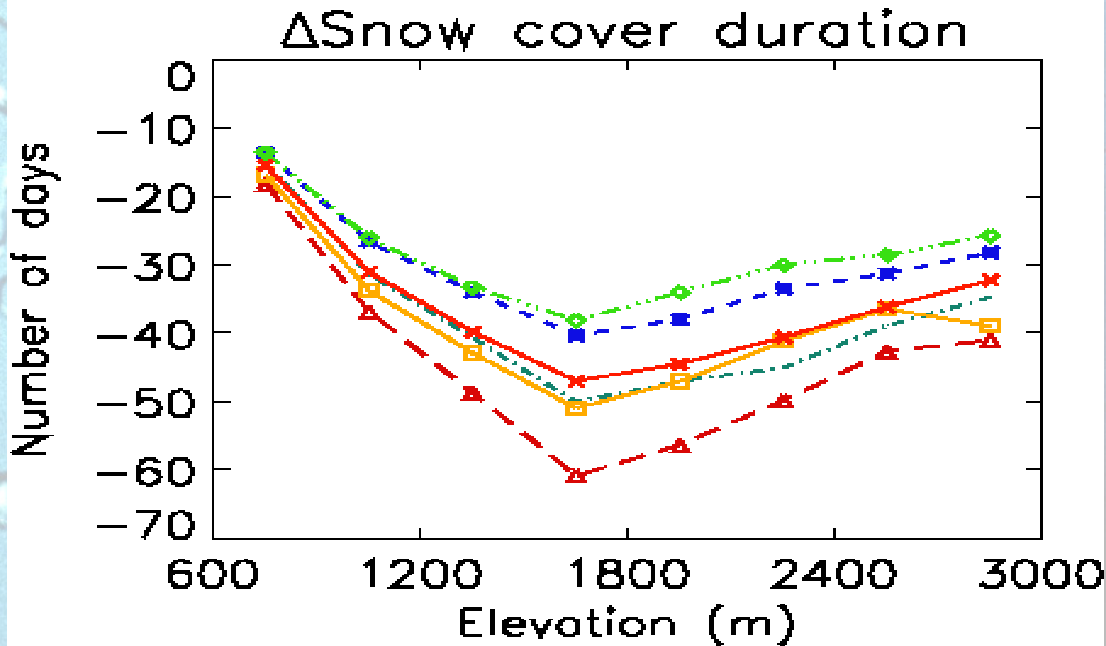
Scenario / Catchment		CNRM LR	LMD LR	HC LR	UR LR	CNRM HR	LMD HR
Isère	PT	14	2	9	24	28	-5
	PS	*-18*	*-22*	*-29*	*-17*	*-17*	*-39*
High Durance	PT	14	2	9	24	24	-2
	PS	*-11*	*-13*	*-20*	*-7*	*-4*	*-28*

Results : snow covered area

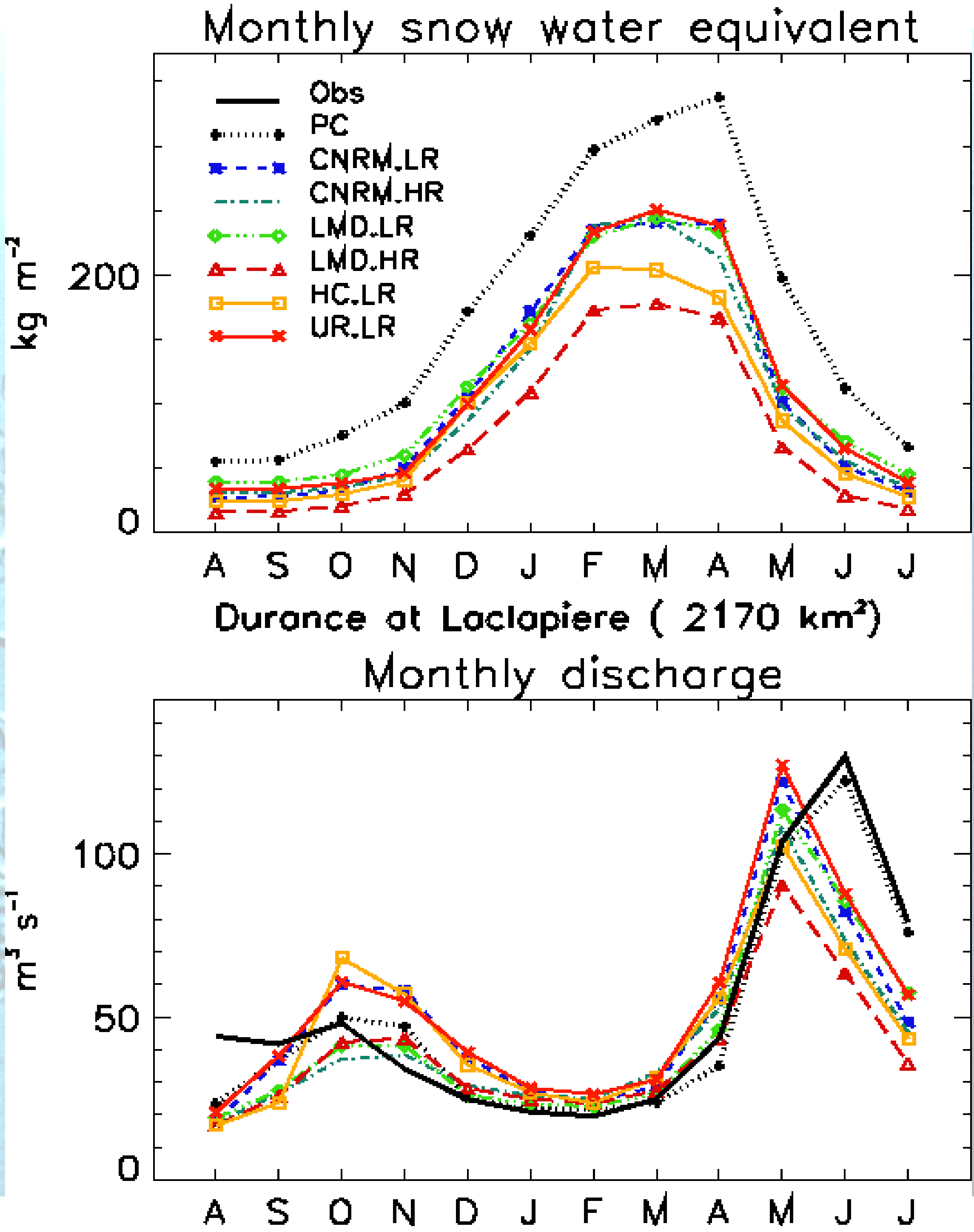


Results : elevation effect

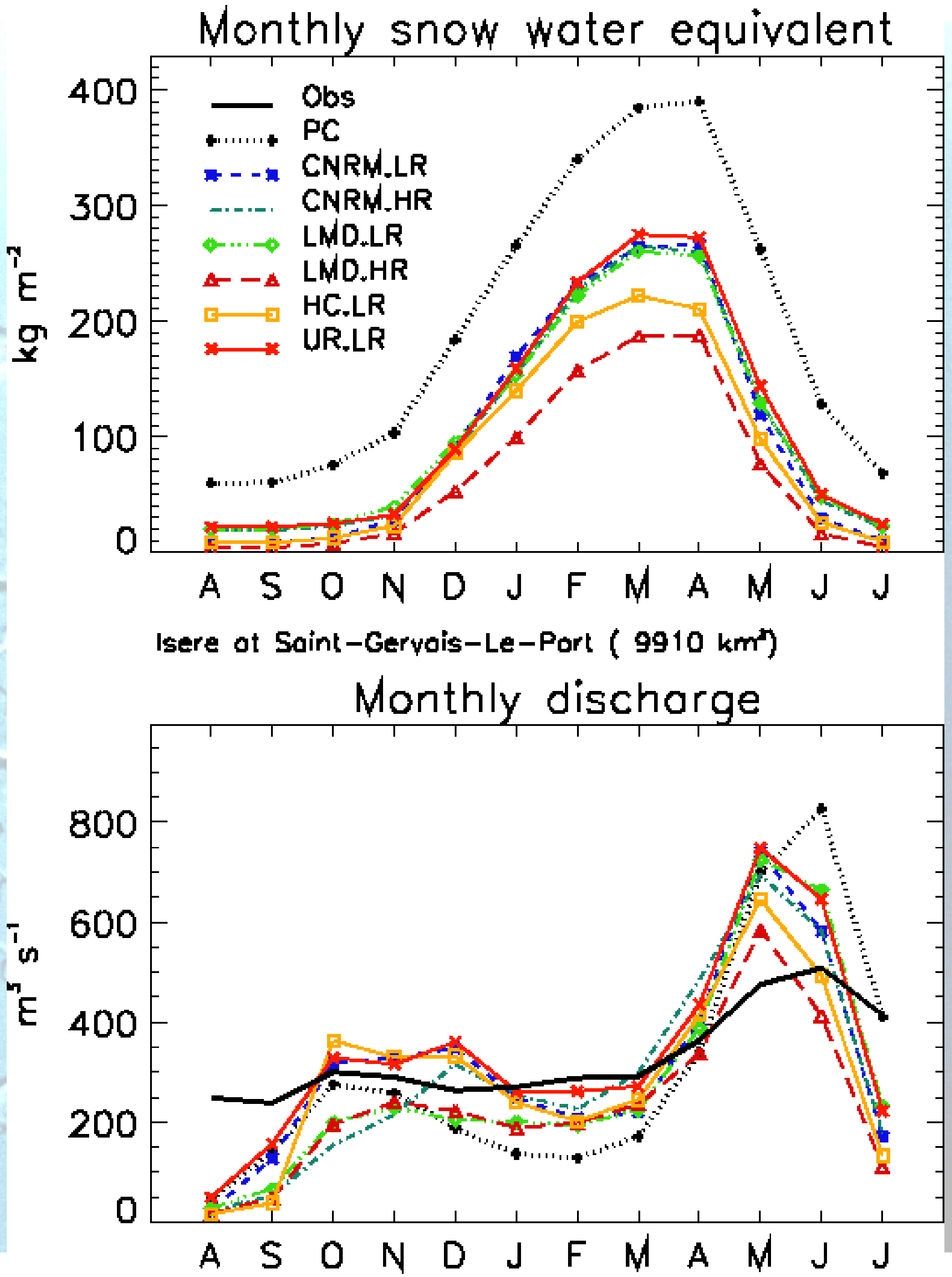




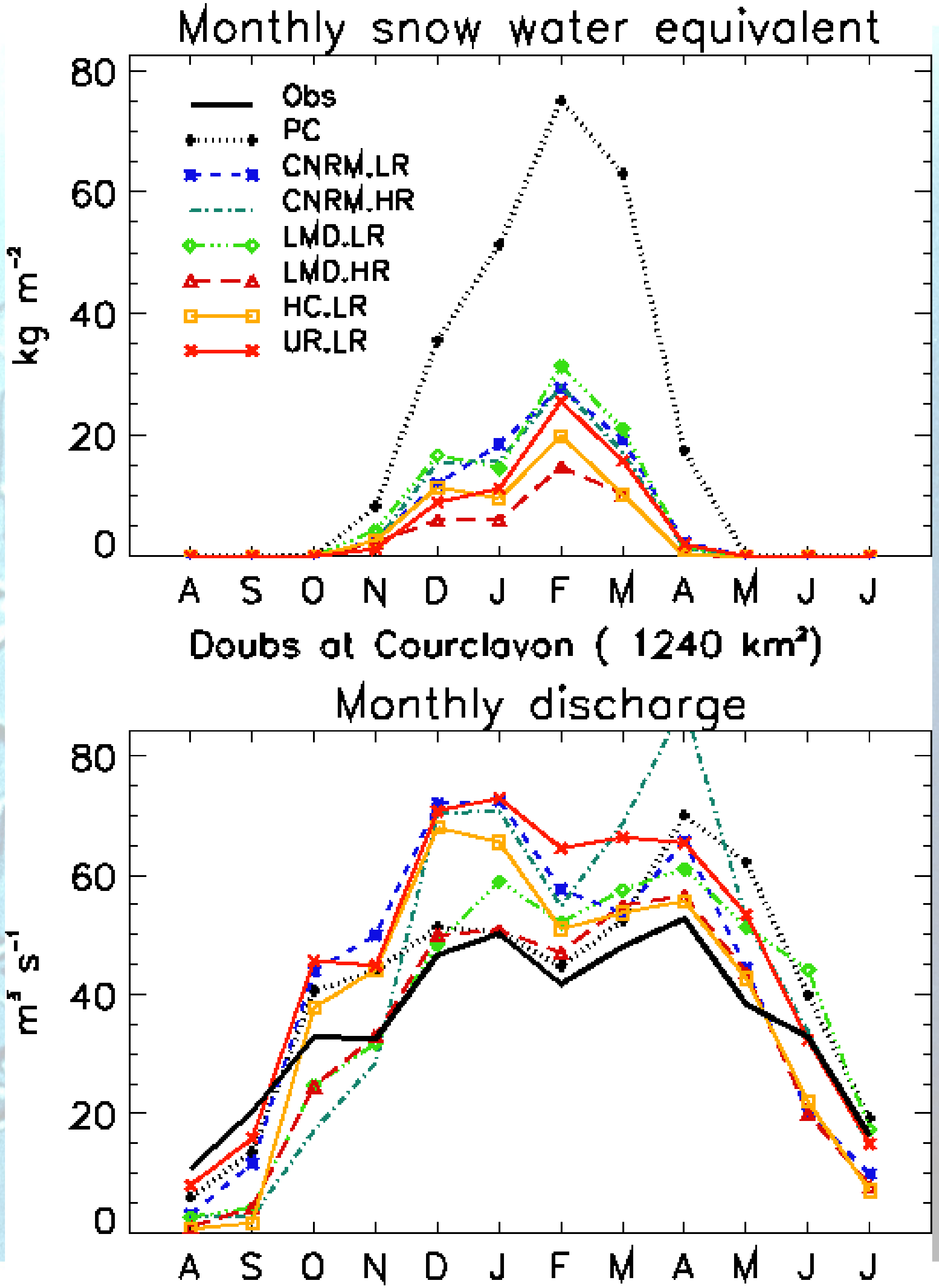
Results : Durance catchment



Results : Isère catchment



Results : Doubs catchment



2 scenarios families

Effect	*« Moderate» family*	*« Extrem» family*
Snow cover duration (elevation<1800m)	**-30 to –40 days**	**-50 to –60 days**
Snow cover accumulation (elevation<1800m)	**-20 to –30 cm**	**-40 to –50 cm**
Annual discharge	**+5 to –10%**	**-10 to –20%**
Max monthly discharge	**0 to –20 % (1 month earlier)**	**-20 to –30 % (1 month earlier)**

Conclusion and outlook

- **General trends**
  - Snowpack reduction (accumulation, duration)
  - Lower impact for high altitude
  - Melting period discharge 1 month earlier
- **Outlooks in the GICC project**
  - Applications to other study fields (vegetation,…)
  - Uncertainties estimation