

Statistical downscaling models of meteorological variables for climate change impact studies.

Temporal transferability ;
uncertainties in future hydrological projections.

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Abdelkader Mezghani¹, Joël Gailhard⁴

¹LTHE



²CERFACS



³Météo-France CNRM

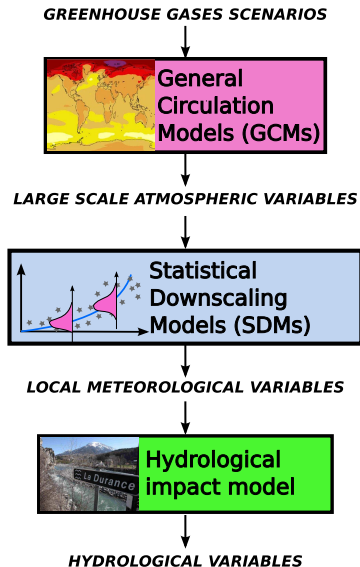


⁴EDF-DTG



AMS conference
26th january 2011

Typical methodology for impact studies



Model	Method	Predictors
ANALOG	Analog resampling	Z_{700}, Z_{1000}
DSCLIM-10	Weather types + regional indices	P_{SL}
DSCLIM-11		P_{SL}, T_a
DSCLIM-21		Z_{850}, Z_{500}
D2GEN-10	Regressions + stochastic generator	P_{SL}, u_{700}, v_{700}
D2GEN-22		$P_{SL}, u_{700}, v_{700}, HU_{700}, q_{700}$
D2GEN-32		$P_{SL}, u_{700}, v_{700}, HU_{700}, F_{q_{700}}$

ANALOG [EDF/LTHE, Obled et al., 2002, Gailhard, 2009]

DSCLIM [CERFACS, Boé et al., 2006, Pagé et al., 2011]

D2GEN [LTHE, Mezghani and Hingray, 2009]

1 SDMs evaluations

- Climatological evaluation
- Chronological evaluation

2 Future projections

- Dispersion of meteorological changes
- Significance of meteorological changes
- Hydrological impacts

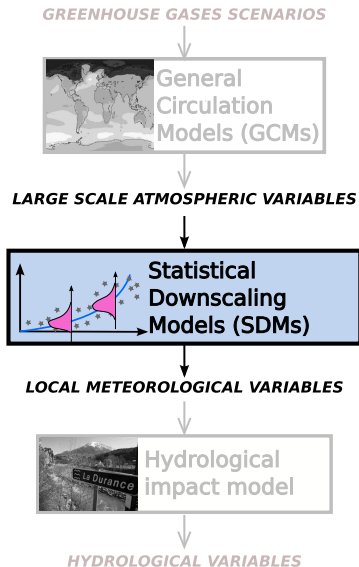
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SDMs evaluation



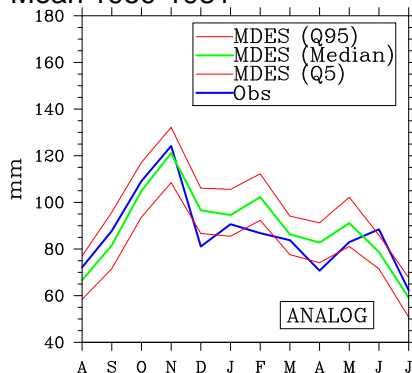
**OBSERVATIONS
(NCEP REANALYSIS)**

Evaluation

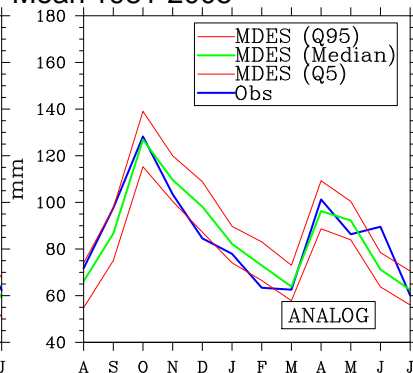
100 SCENARIOS

Seasonal cycle of Durance basin precipitation.
(southern French Alps, 3580 km², Elevation : 700-4100m.)

Mean 1959-1981

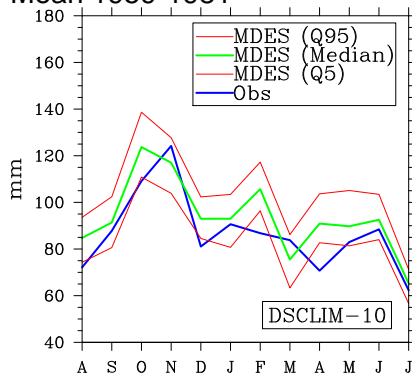


Mean 1981-2005

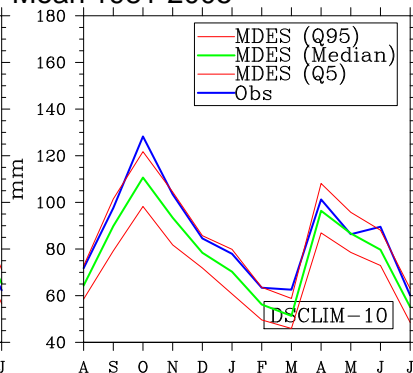


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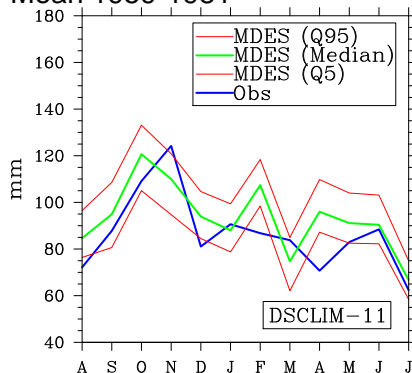


Mean 1981-2005

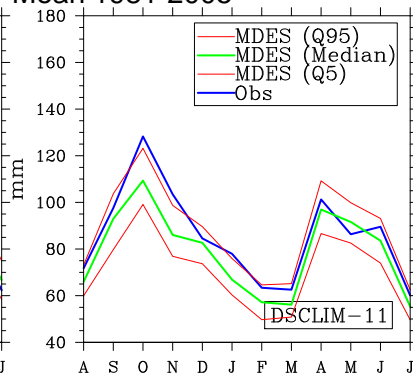


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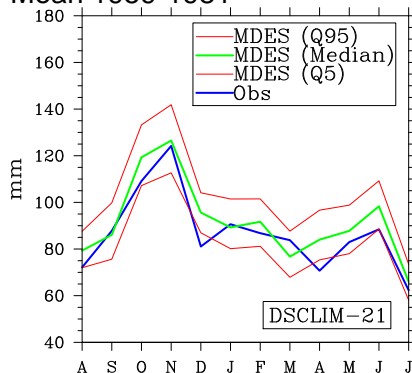


Mean 1981-2005

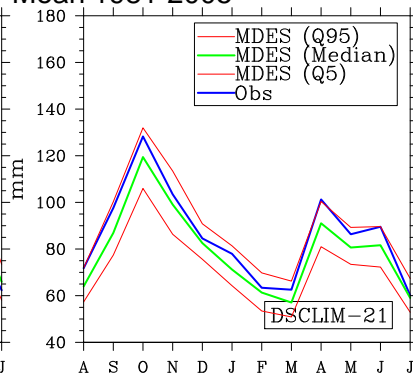


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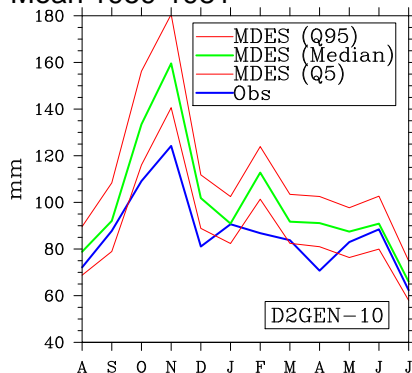


Mean 1981-2005

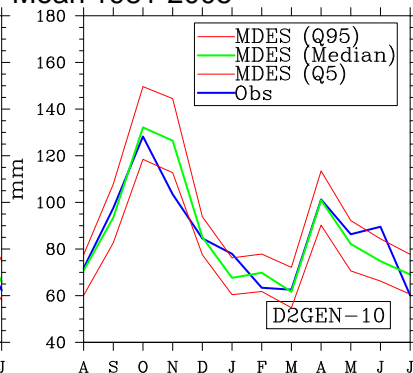


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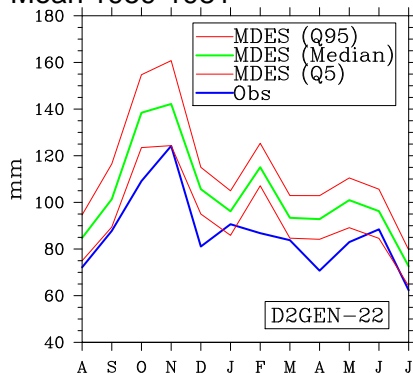


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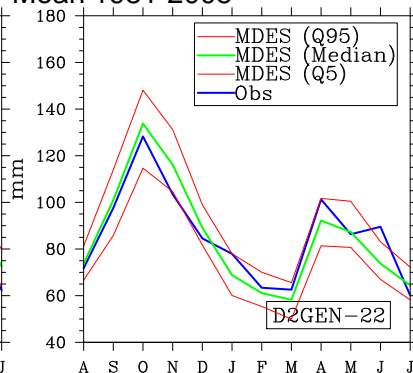


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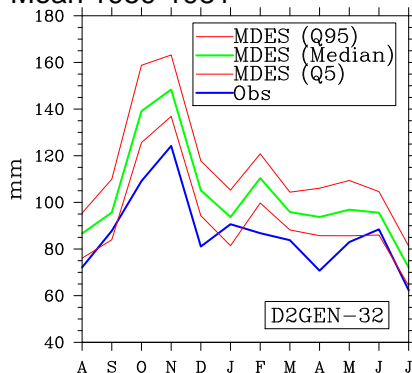


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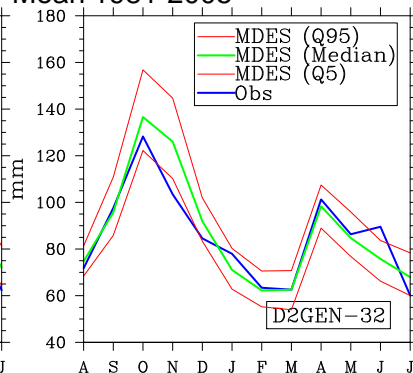


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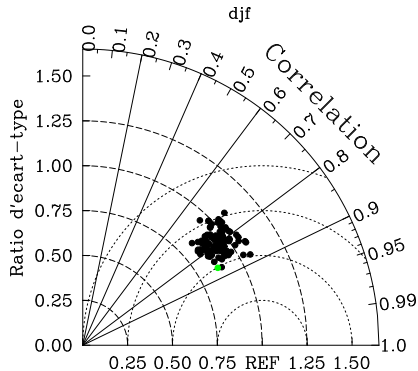
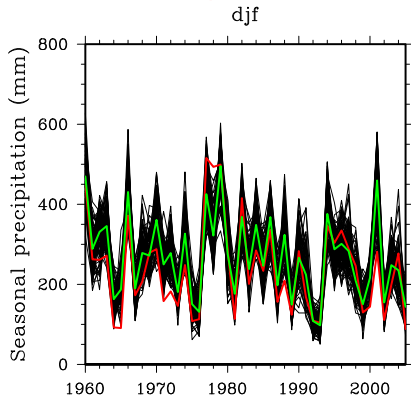
Mean 1981-2005



SDMs chronological evaluation

Winter (DJF) basin precipitation

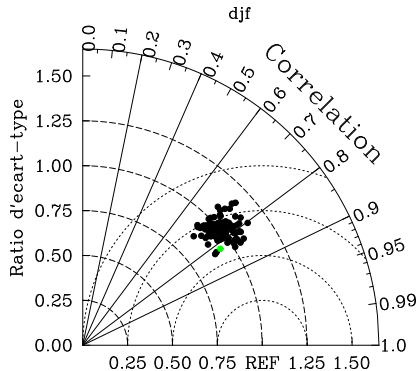
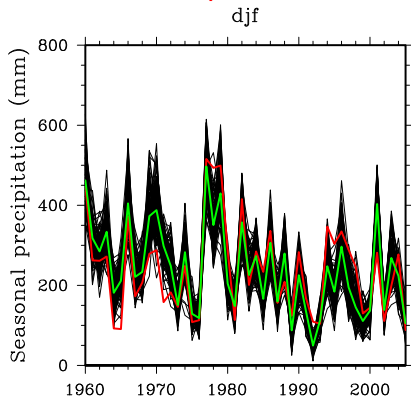
Observed sequence; 100 scenarios **ANALOG** + median



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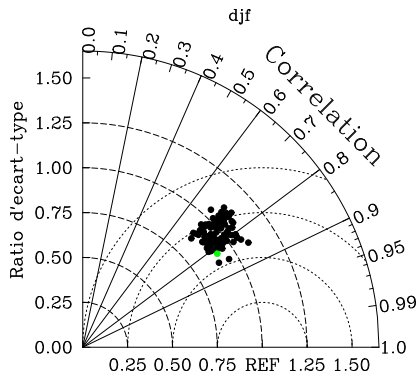
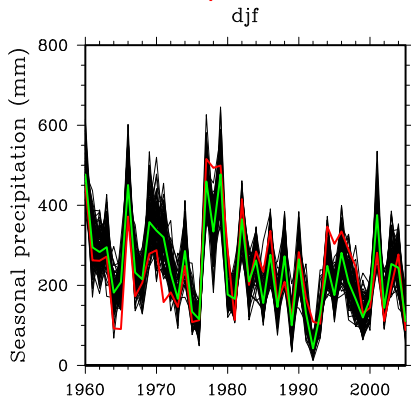
Observed sequence; 100 scenarios **DSCLIM-10** + median



SDMs chronological evaluation

Winter (DJF) basin precipitation

Observed sequence; 100 scenarios **DSCLIM-11** + median



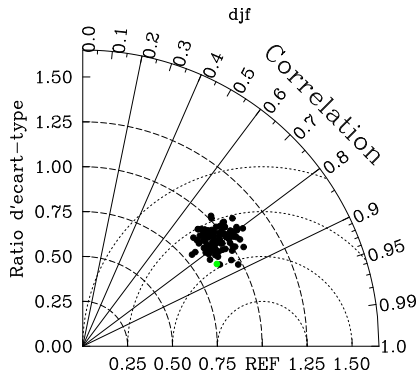
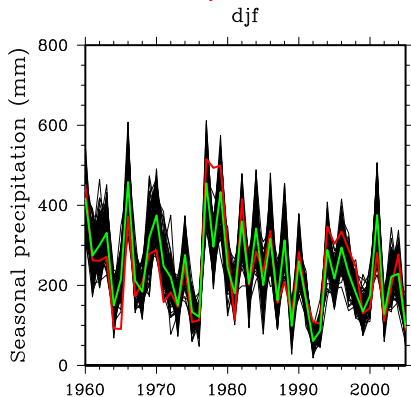
SDMs chronological evaluation

Winter (DJF) basin precipitation

Observed sequence; 100 scenarios

DSCLIM-21

+ median

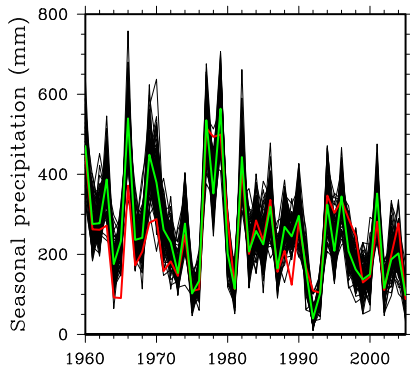


SDMs chronological evaluation

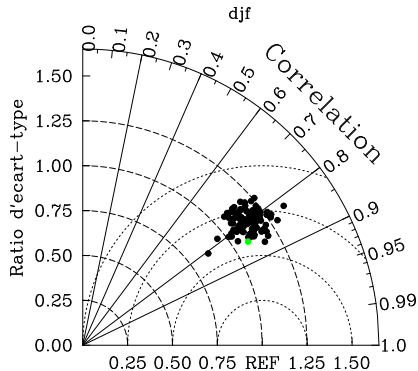
Winter (DJF) basin precipitation

Observed sequence; 100 scenarios

djf



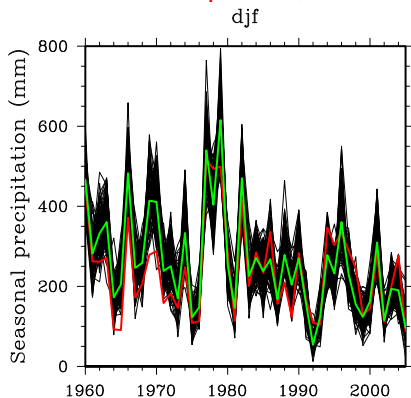
D2GEN-10 + median



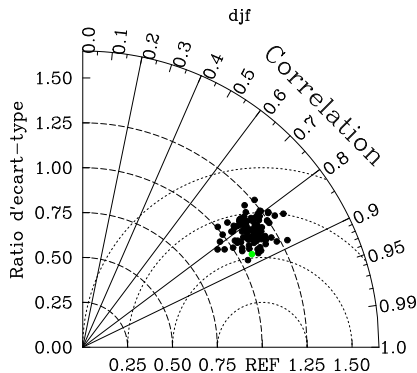
SDMs chronological evaluation

Winter (DJF) basin precipitation

Observed sequence; 100 scenarios



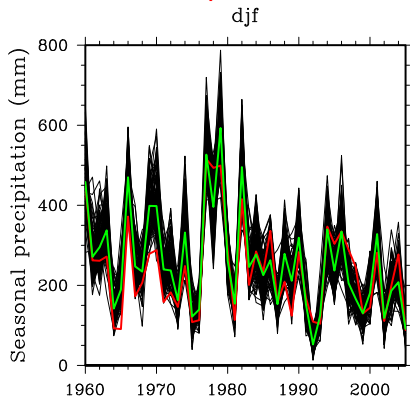
D2GEN-22 + median



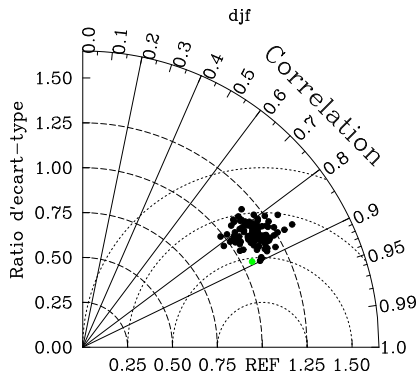
SDMs chronological evaluation

Winter (DJF) basin precipitation

Observed sequence; 100 scenarios



D2GEN-32 + median



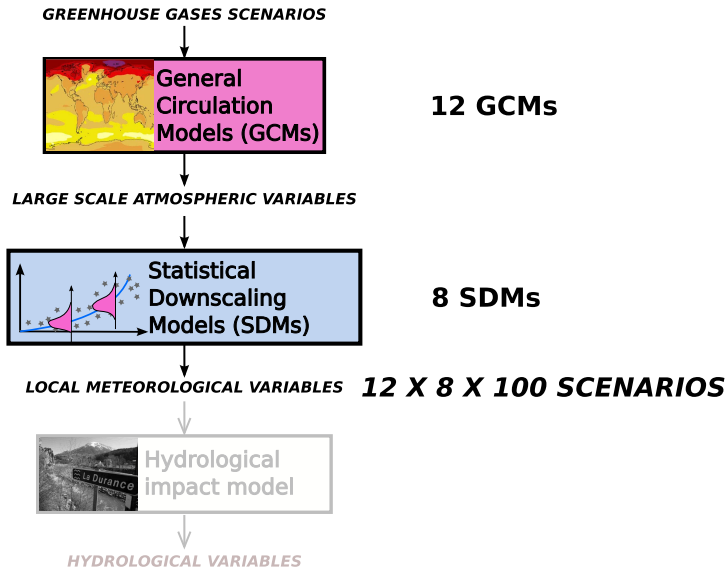
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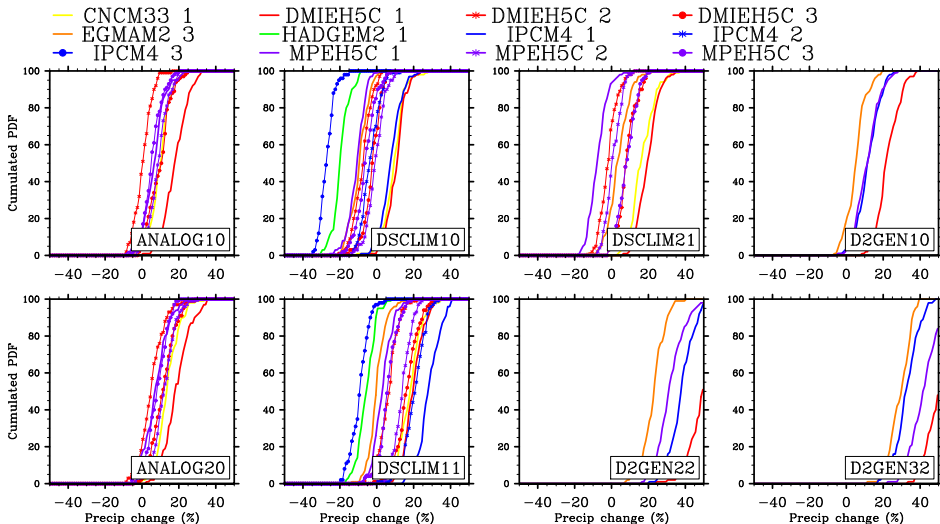
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Future projections (Durance basin)



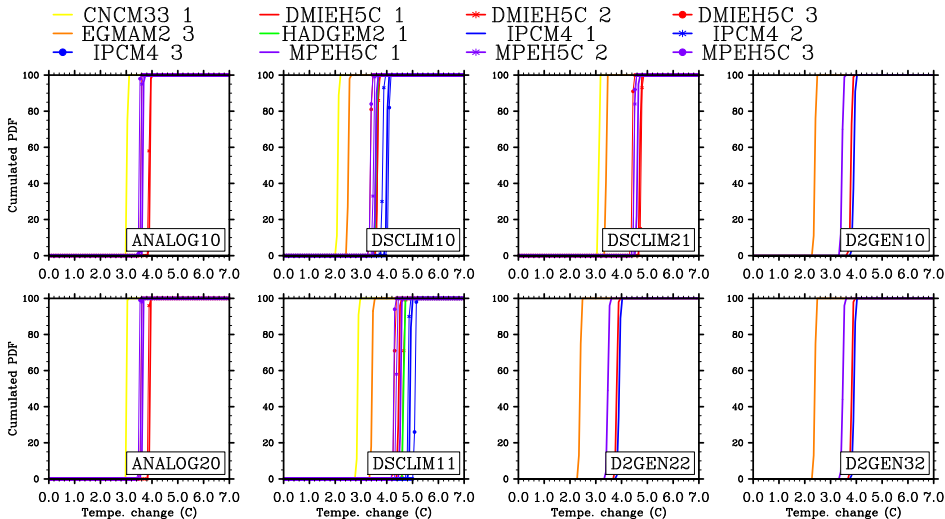
Winter precipitation changes (Durance basin)



1 line = Distribution of changes among 100 scenarios for 1 GCM and 1 SDM Changes

between **2080-2099** and **1980-1999**

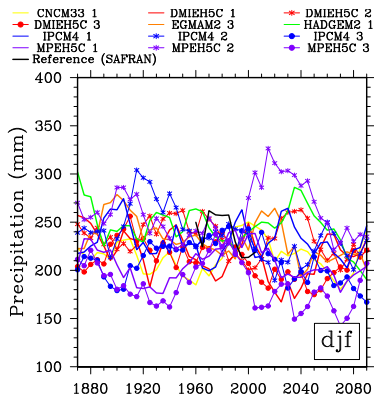
Annual temperature changes (Durance basin)



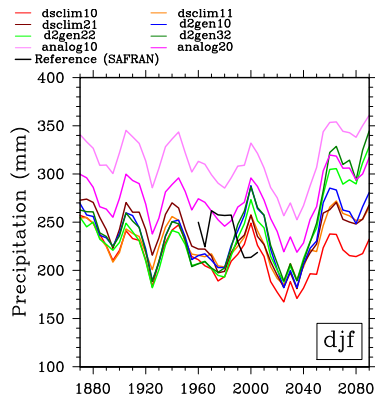
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Winter precipitation evolution (Durance basin)

12 GCM
+ 1 SDM (DSCLIM-10)

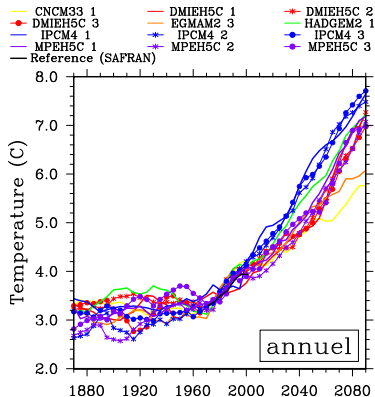


1 GCM (DMIEH5C-1)
+ 8 SDM

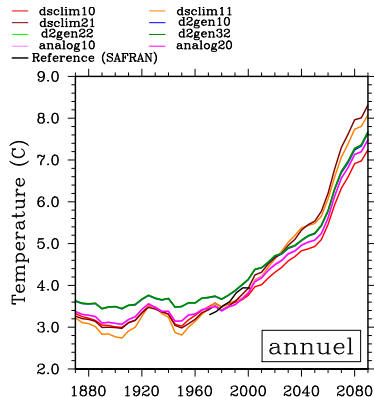


Annual temperature evolution (Durance basin)

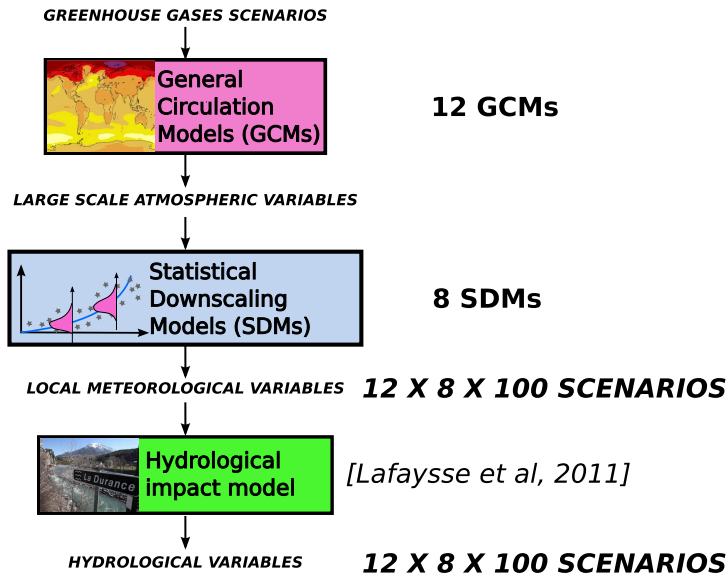
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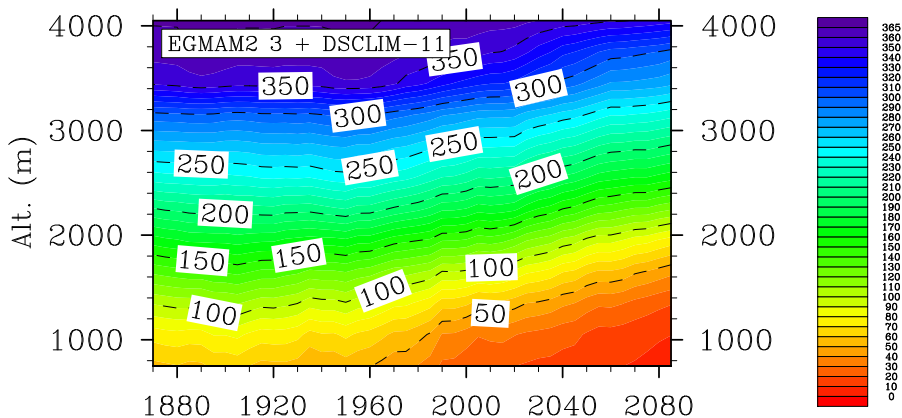
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Future projections (Durance basin)

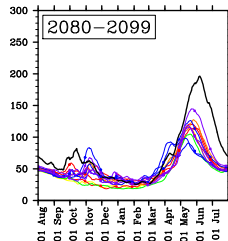
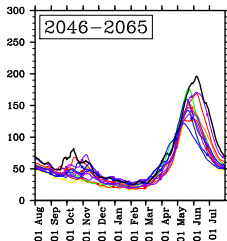
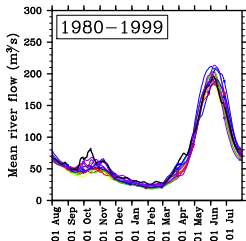


Snow cover duration (days/year, Durance basin)



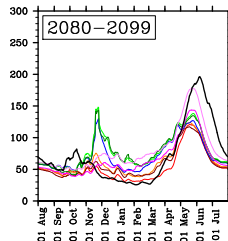
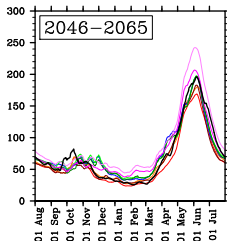
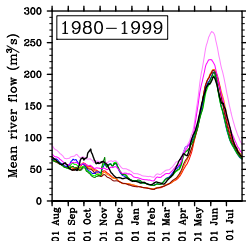
Seasonal cycle of river discharges (Durance basin)

— CNCM33 1 — DMIEH5C 1 — DMIEH5C 2 — DMIEH5C 3 — EGMAM2 3
 — HADGEM2 1 — IPCM4 1 — IPCM4 2 — IPCM4 3 — MPEH5C 1
 — MPEH5C 2 — MPEH5C 3 — Reference (SAFRAN)



12 GCM
 + 1 SDM
 (DSCLIM-10)

— dsclim10 — dsclim11
 — d2gen10 — d2gen22
 — analog10 — analog20



1 GCM
 (DMIEH5C-1)
 + 8 SDM

Evaluations

- ▶ Transferability : data heterogeneities problem
- ▶ Chronological evaluation : similar results between SDMs

Projections

- ▶ Simulated changes are strongly model-dependant (GCMs + SDMs) and predictors-dependant
- ▶ High dispersion of results
- ▶ Robust hydrological signal due to snow cover decrease

Recommandation

- ▶ Do account for downscaling-related uncertainty ! As important as GCMs uncertainty !

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Thanks for attention



Photo : Eric Jabot

- J. Boé, L. Terray, F. Habets, and E. Martin. A simple statistical downscaling scheme based on weather types and conditional resampling. *J. Geophys. Res.*, 111, 2006.
- J. Gailhard. Communication personnelle, EDF/DTG, 2009.
- M. Lafaysse, B. Hingray, P. Etchevers, E. Martin, and C. Obled. Influence of spatial discretization, underground water storage and glacier melt on a physically-based hydrological model of the Upper Durance River basin. *J. Hydrol.*, 403(1-2) : 116–129, JUN 6 2011. ISSN 0022-1694. doi : {10.1016/j.jhydrol.2011.03.046}.
- A. Mezghani and B. Hingray. A combined downscaling-disaggregation weather generator for stochastic generation of multisite hourly weather variables over complex terrain : Development and multi-scale validation for the Upper Rhone River basin. *J. Hydrol.*, 377(3-4) :245–260, OCT 30 2009. ISSN 0022-1694. doi : {10.1016/j.jhydrol.2009.08.033}.
- C. Obled, G. Bontron, and R. Garcon. Quantitative precipitation forecasts : a statistical adaptation of model outputs through an analogues sorting approach. *Atmos. Res.*, 63(3-4) :303–324, AUG 2002. ISSN 0169-8095.
- C. Pagé, E. Sanchez-Gomez, and L. Terray. DSCLIM : A software to provide climate projections using a weather typing based statistical downscaling methodology. *submitted to Environmental Modelling & Software*, 2011.