Tailings2024
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Methodology to Incorporate Climate Change and Snow Line Variations for Dam Design Flows Estimation

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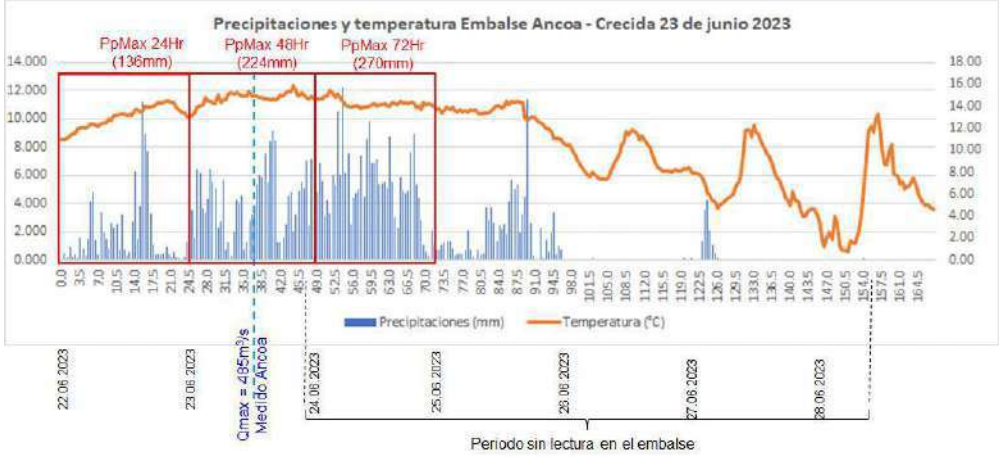
Context

- Extreme event between June 23th and 26th, 2023
- Synergistic effect of rain on snow
- Flood evacuation and energy dissipation system in construction
- Max flow over the actual design



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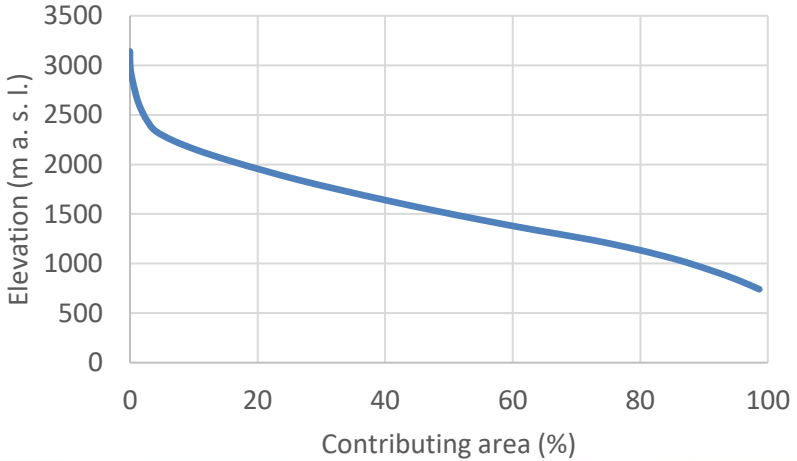
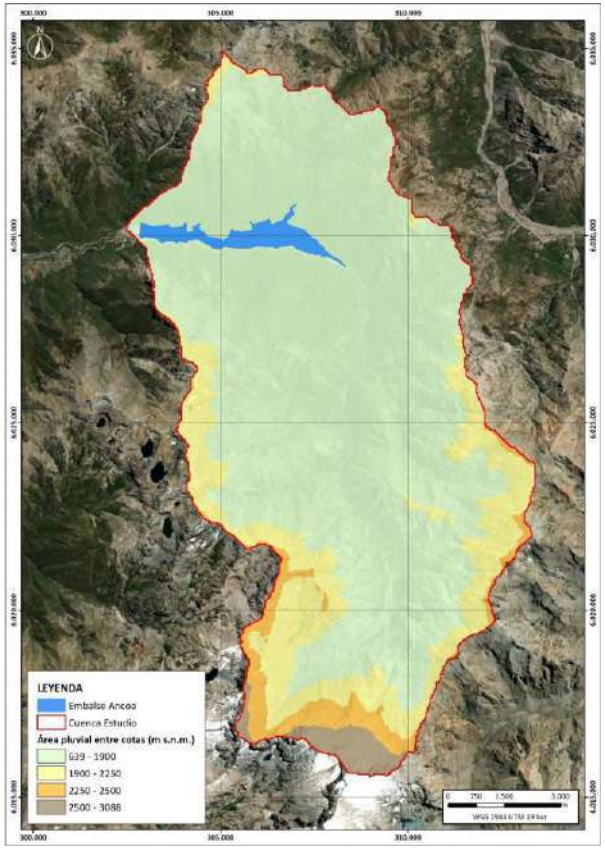
Objective

- Update the design flows of works through the analysis of extreme events
- Consider the effects of climate change and variations in the snow line
- Aligns with current technologies and tools
- Providing a proactive framework

Study Zone

- Reservoir in Maule region
- Contributing area of 123 km^2
- Elevation ranging from 639 to 3,088 m a. s. l.
- 1,800 mm/year
- -5°C to 30°C





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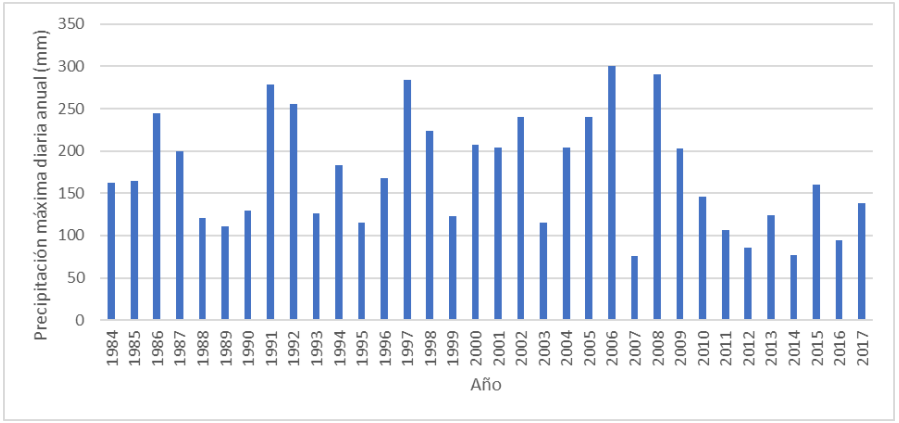
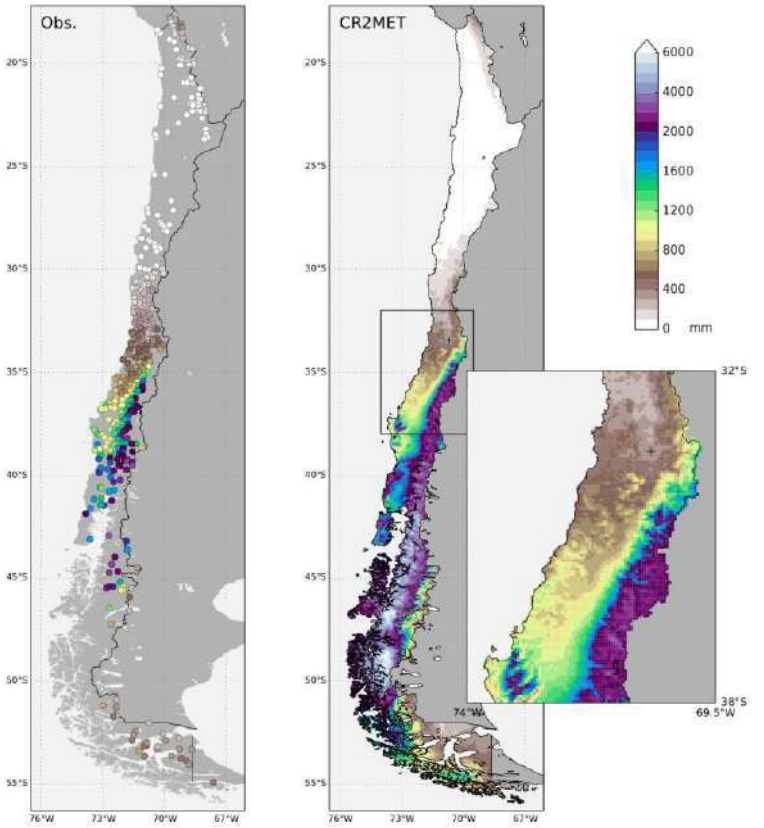
Hydrometeorological characterization

- Use of daily observed data in the study area
- Gridded product based on observed data and elevation gradient



Maximum anual daily precipitation observed

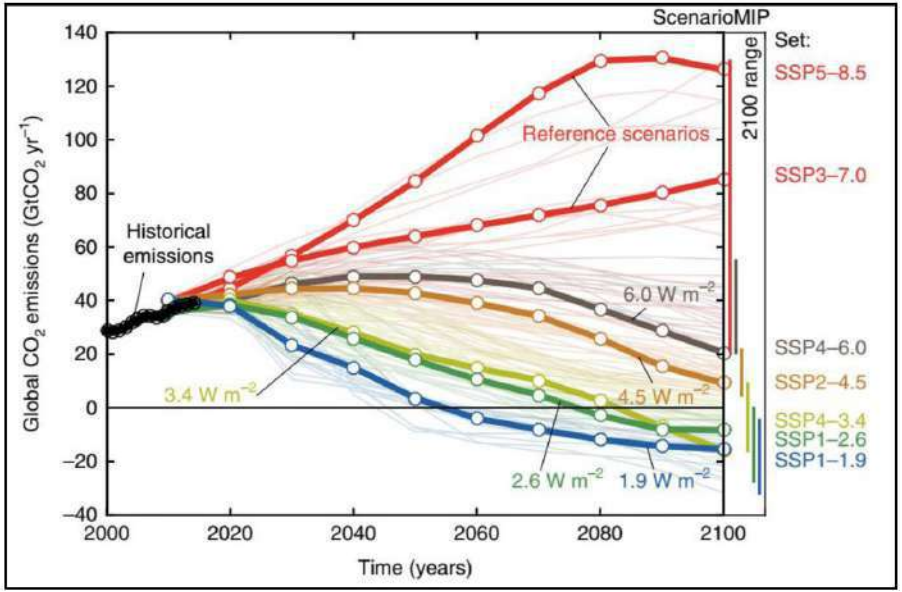


Comparison between observational data and the CR2MET product of average annual accumulated precipitation (Boisier, 2023)

Future assessment

- General Circulation Models (GCM) from CMIP6
- 20 models for SSP2-4.5 and SSP5-8.5

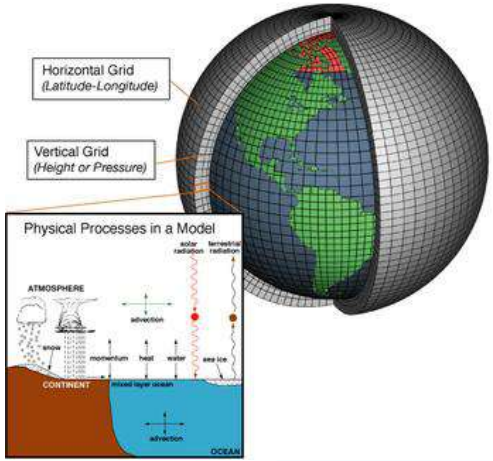
CMIP6 international collaborators

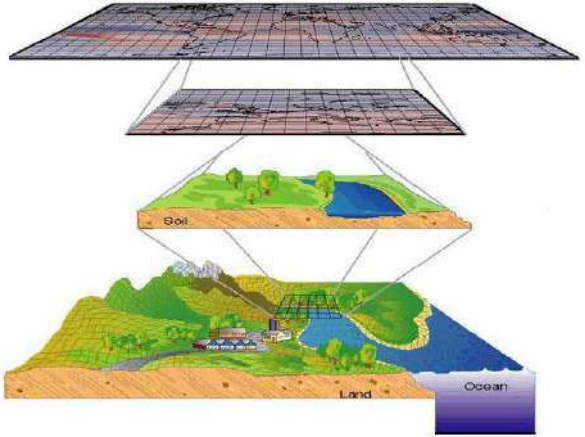


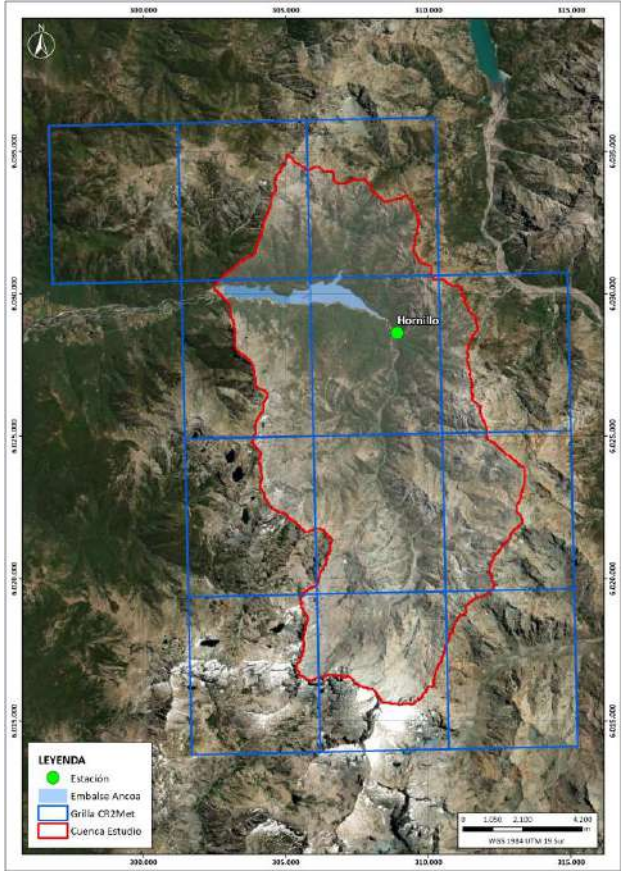
CMIP6 scenarios (Rogelj et al., 2018)

Use of GCM

- Downscaling and bias correction
- Historical period 1984-2014
- Future period 2030-2060



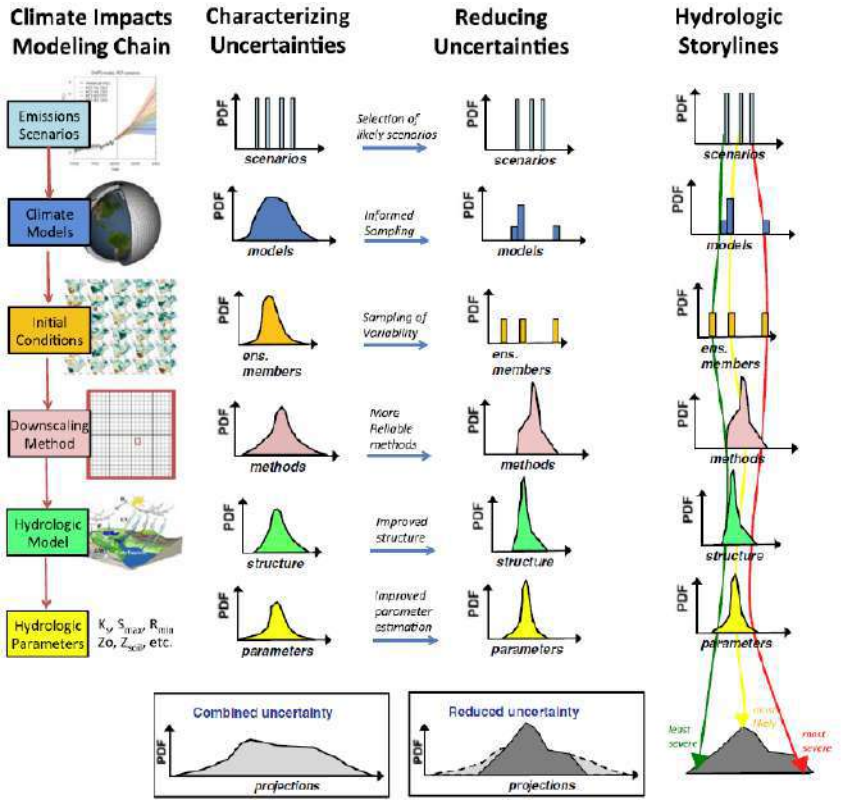




Study area and grid

Uncertainty

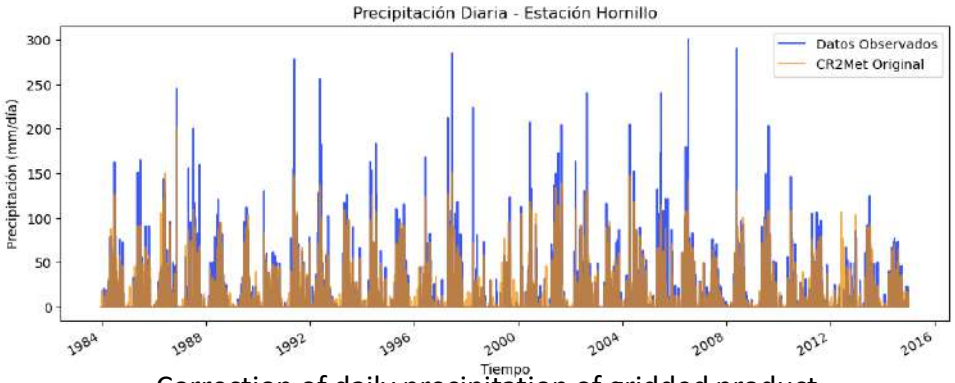
- Each step has an uncertainty
- Addressing this is relevant to making decisions
- It allows to justifying and limit the range of results generated



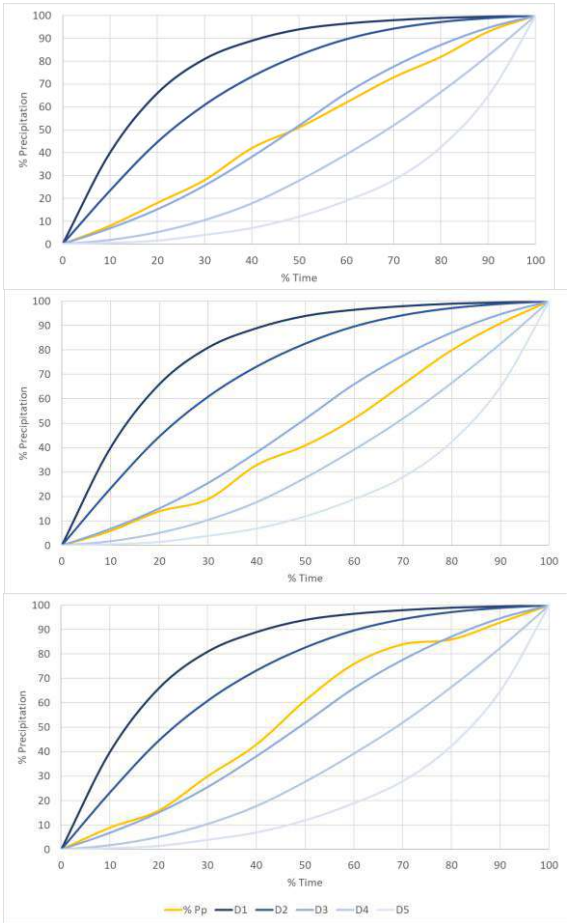
Cascade of uncertainty in climate change study on the hydrology of a study área (Clark et al., 2015)

Reduce uncertainties

- Selection and use of information and assumptions that reflect the characteristics observed in the study area
- Correction or adjustment if necessary



Correction of daily precipitation of gridded product

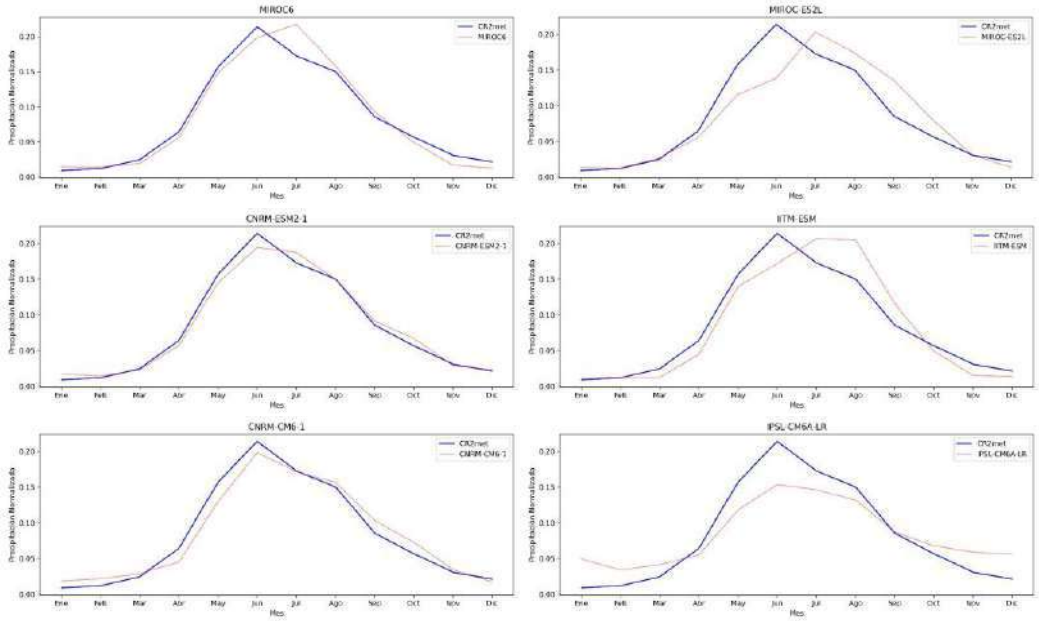


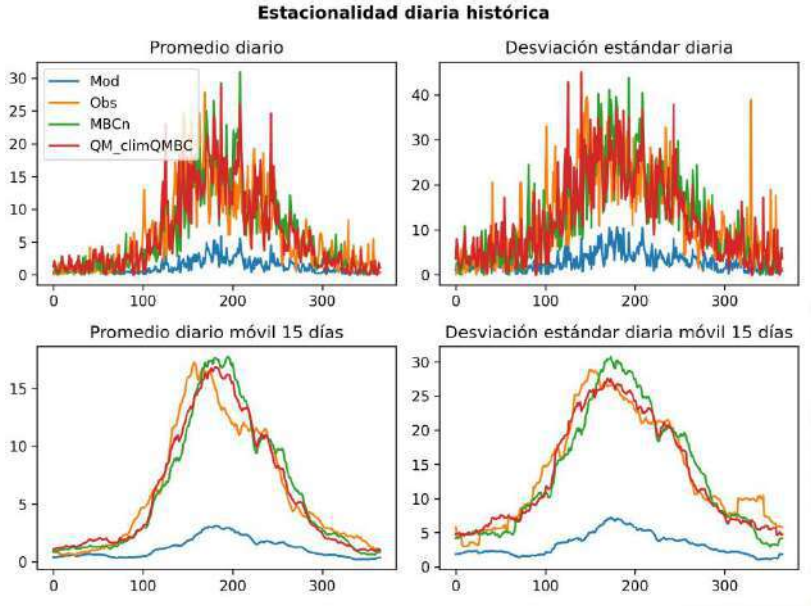
Reduce uncertainties

- Historical performance
- Statistical metrics

Good performance

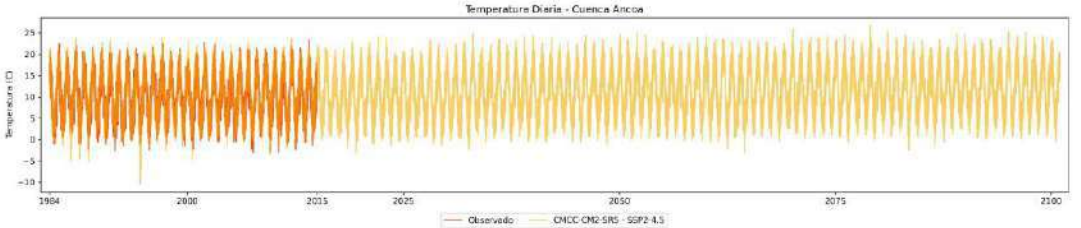
Bad performance

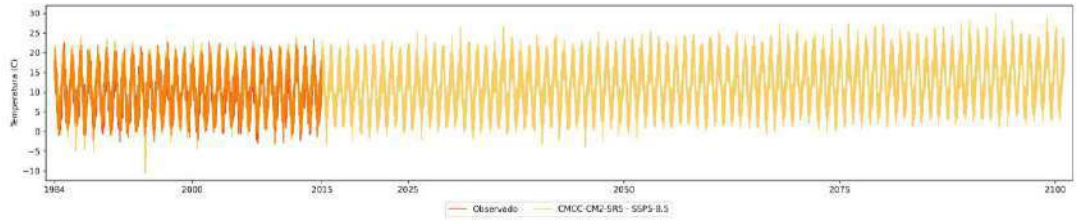


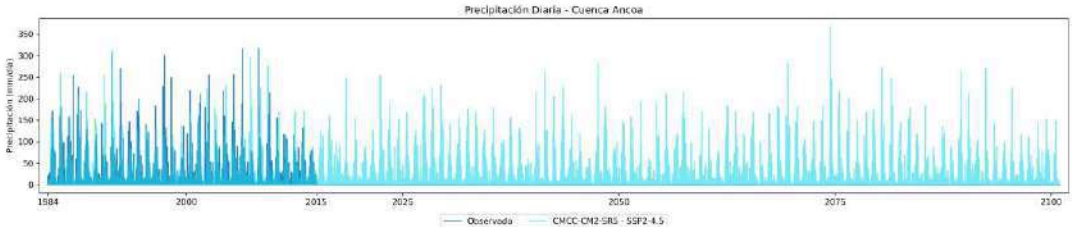


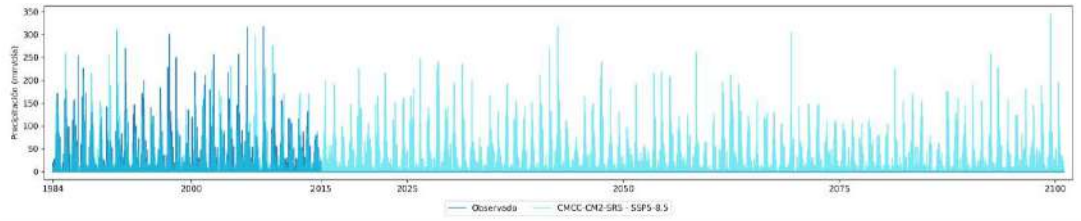
Data adjustment

- Precipitation and temperature series up to 2100
- Frequency analysis of precipitation series
- PMP with Stowhas method (Stowhas, 1985)
- Max pp for 24, 48 and 72 hrs









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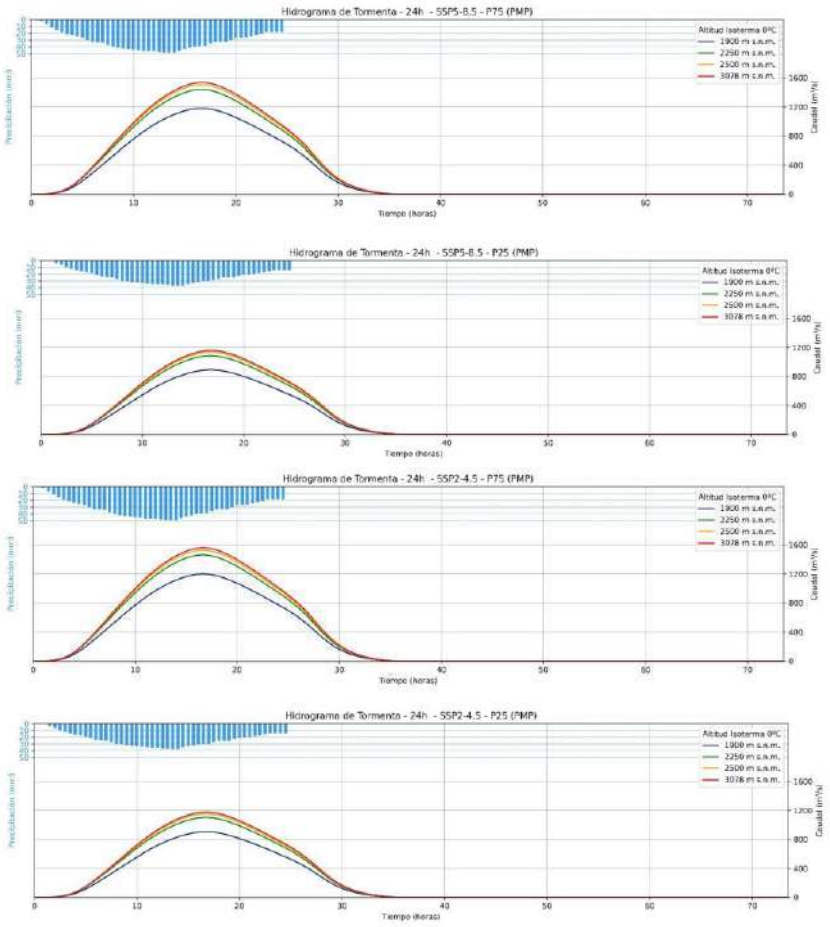
Projected floods

- Use of Linsley-type synhetic unit hydrograph
- Morphological characteristics for the different positions of snow line
- Use of curve numer (CN=78) to determine effective precipitation
- Storm distribution according to Benitez and Verni (1985) type 3
- Precipitations from GCM projections



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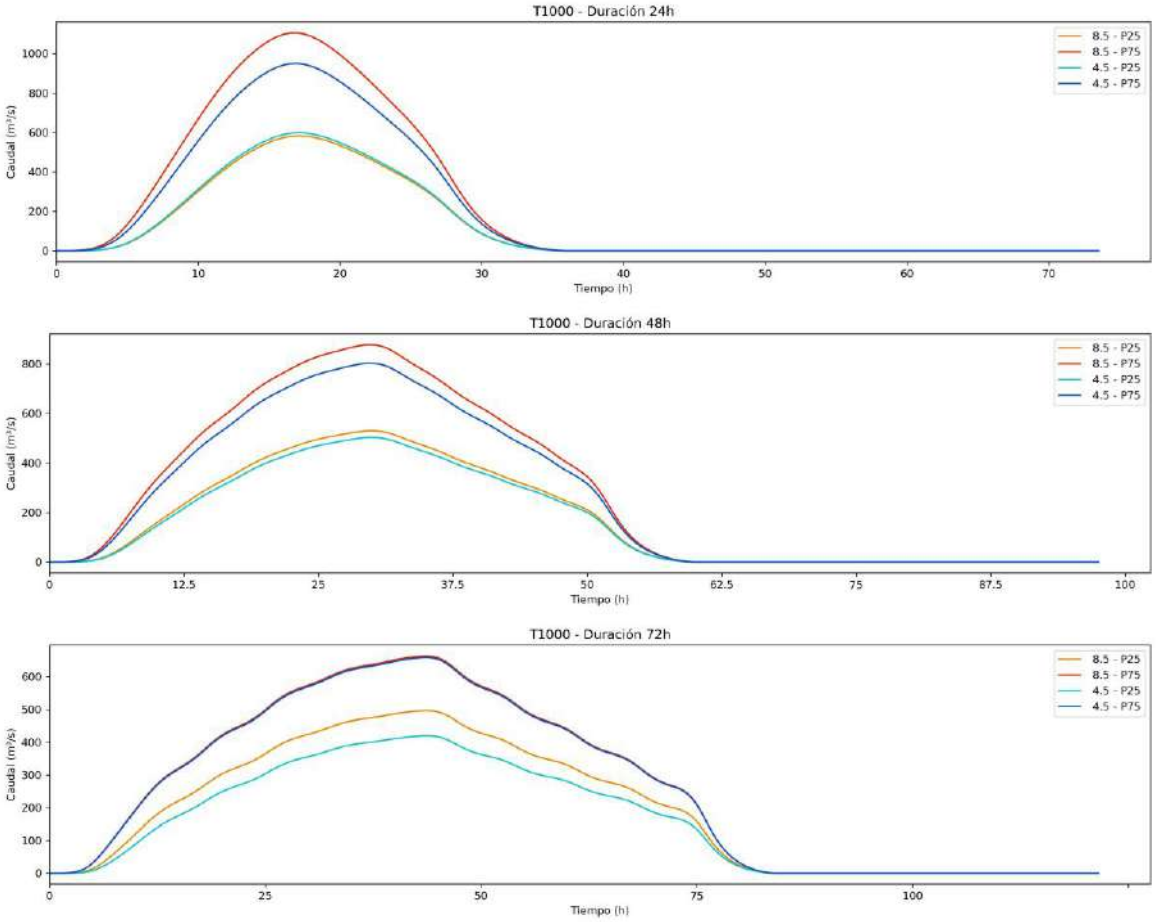
Results

- 24 hrs duration generates maximum flows
- There are no major differences between scenarios
- GCM selection is crucial (up to 400 m^3/s of difference)



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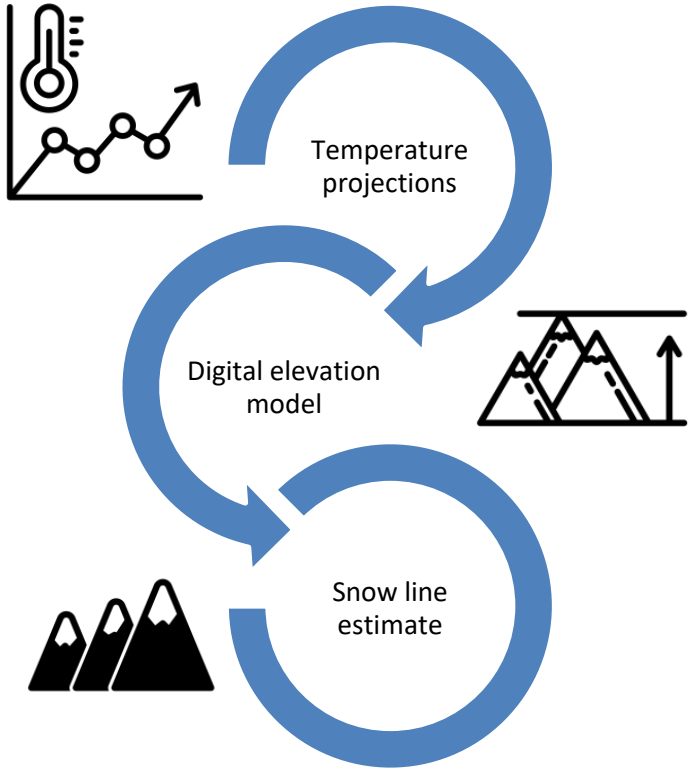
Conclusions

- Adopted design flow was 884 m^3/s
- GCM selection must be correctly justified
- Assessing future windows
- Snow line analysis may be crucial in other types of basins
- Rain on snow effect



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