# Modeling
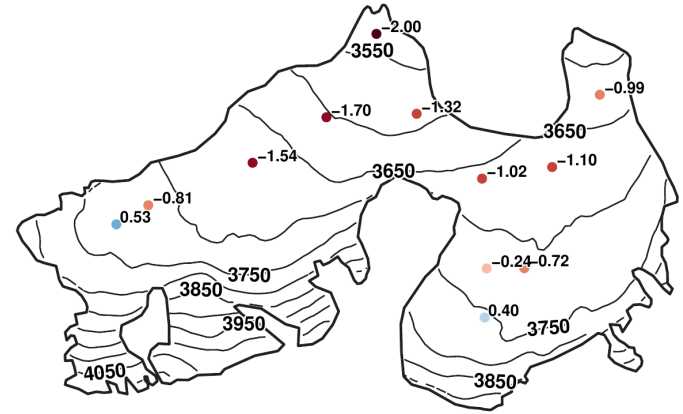# glacier mass balance
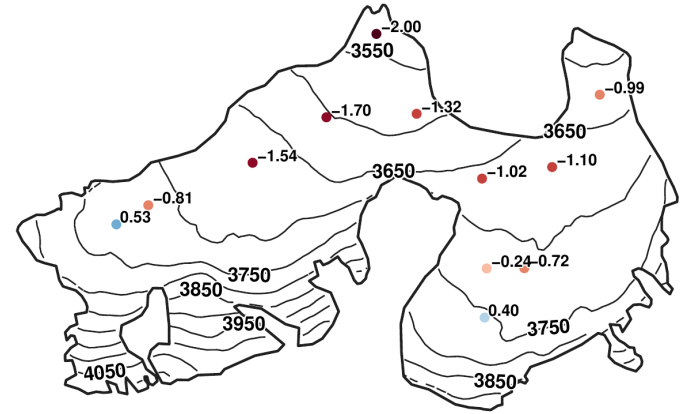# from point measurements

*Enrico Mattea*

# Introduction

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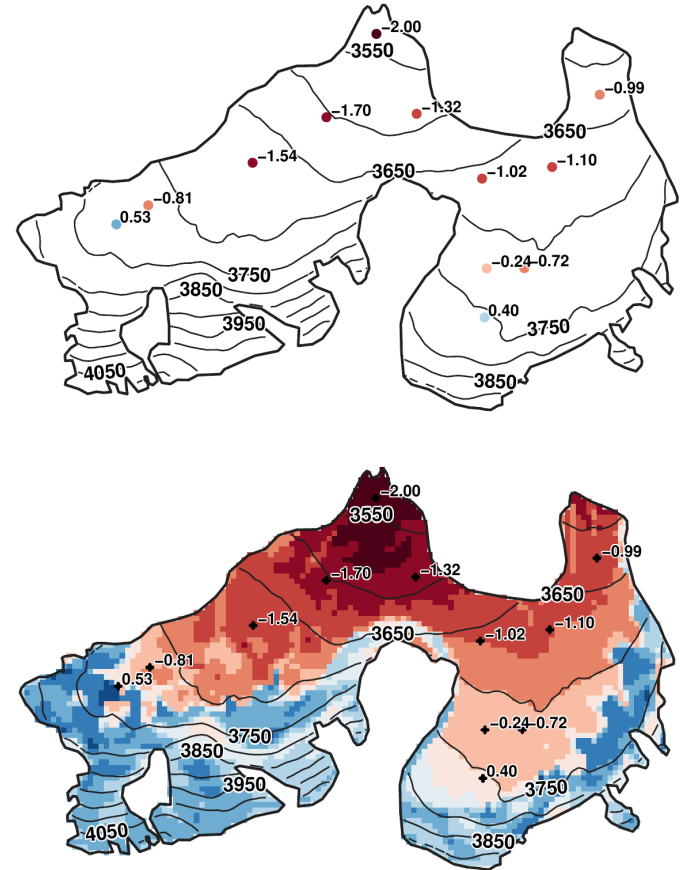
# Introduction

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- How do we go from these to the **total mass balance** of a glacier?

→ **Mass balance model**

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- **Avalanches** → Snow redistribution (also outside the glacier)

# Mass balance model

- The model simulates **snowfall, melt and avalanches**
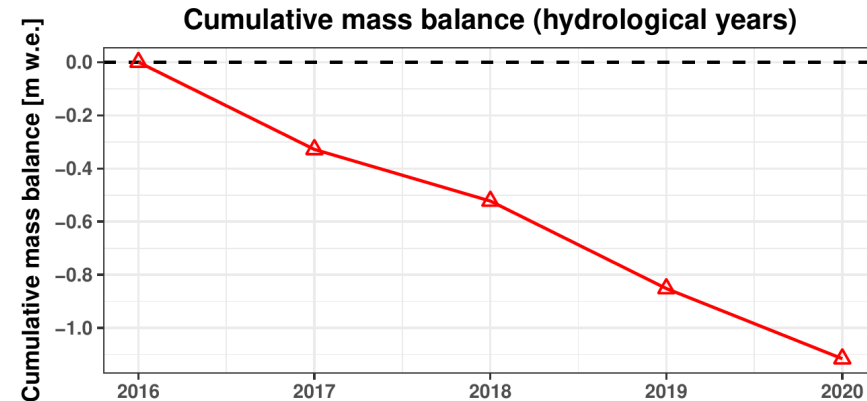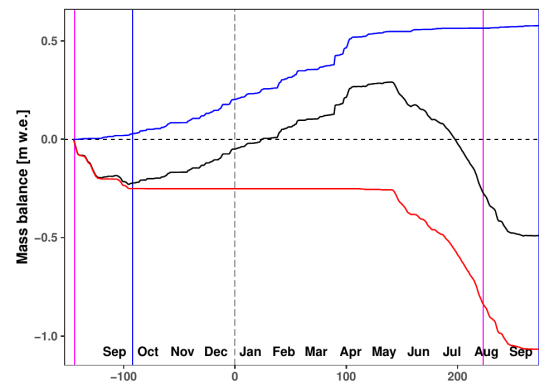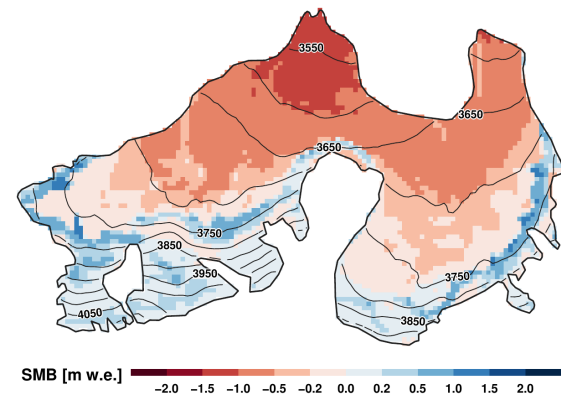
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- At **daily resolution**

- **Output:** mass balance maps, time series, comparison with the measured points

# Mass balance model

The simulation is automatically repeated to **optimize the melt parameters**, until there is no bias compared to the measured points
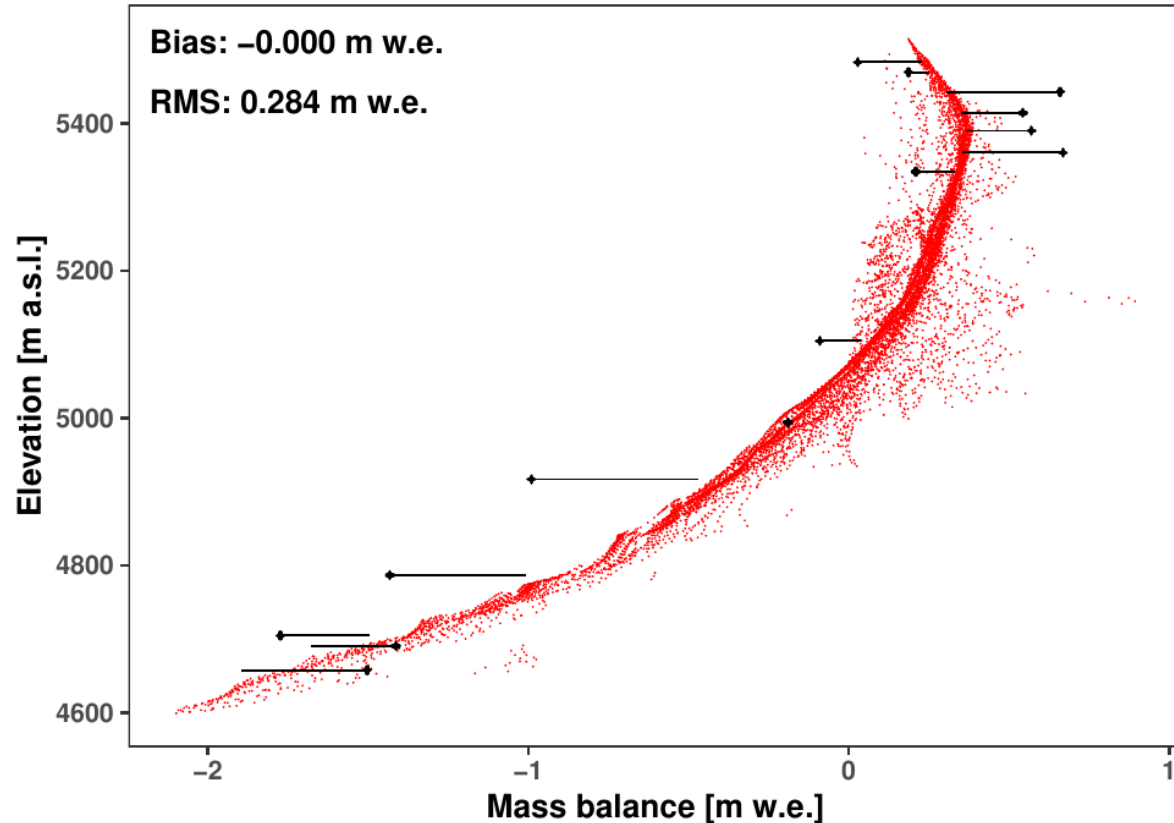
# How to use the model

- The model uses the  script language: free, open-source
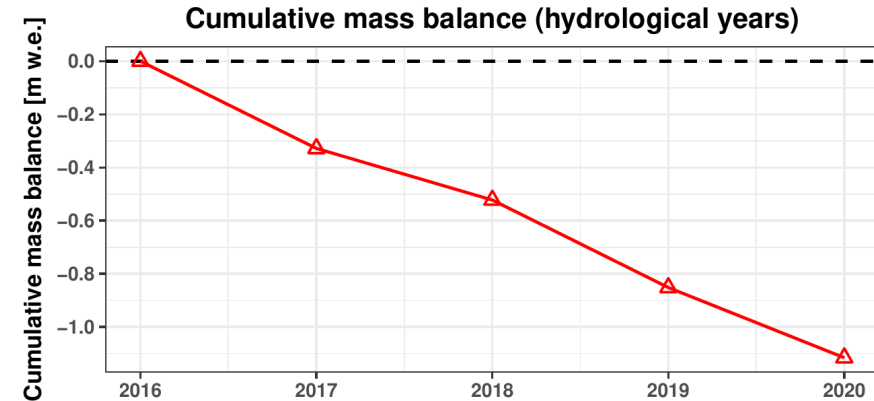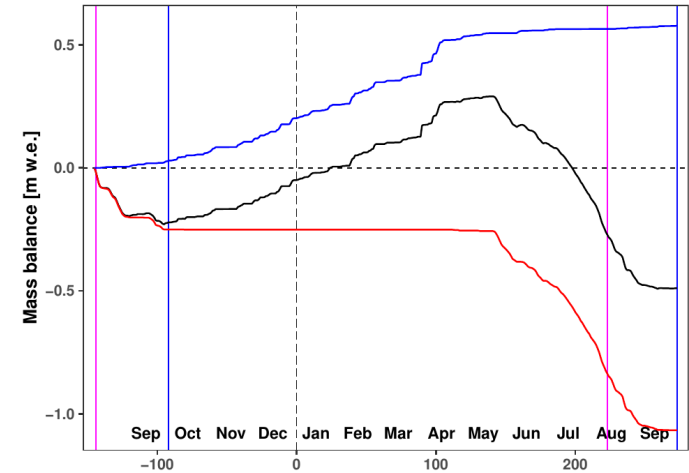
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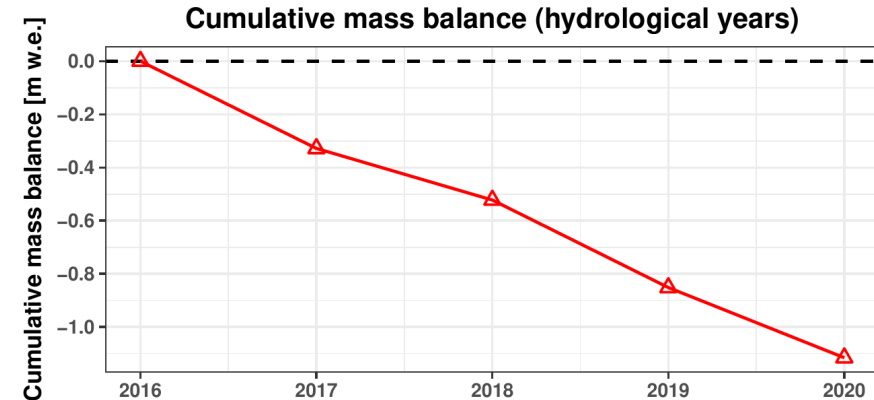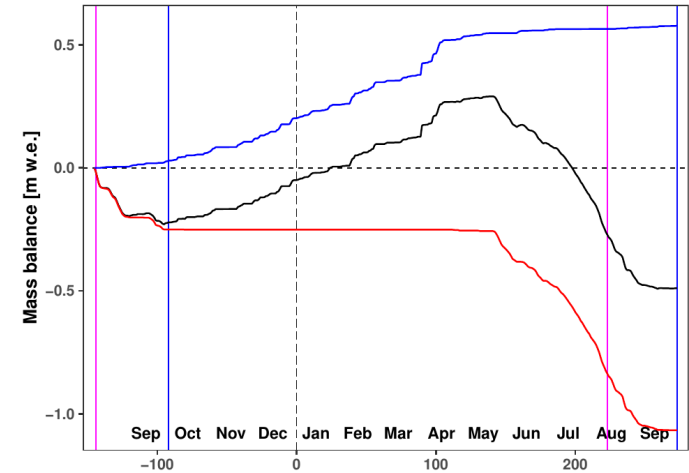- Installation is described in the **model tutorial 1**

# How to use the model

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- For several years, the model also shows the **cumulative mass balance**





Cumulative mass balance (hydrological years)

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- Prepare the **input files**

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- Prepare the **input files**
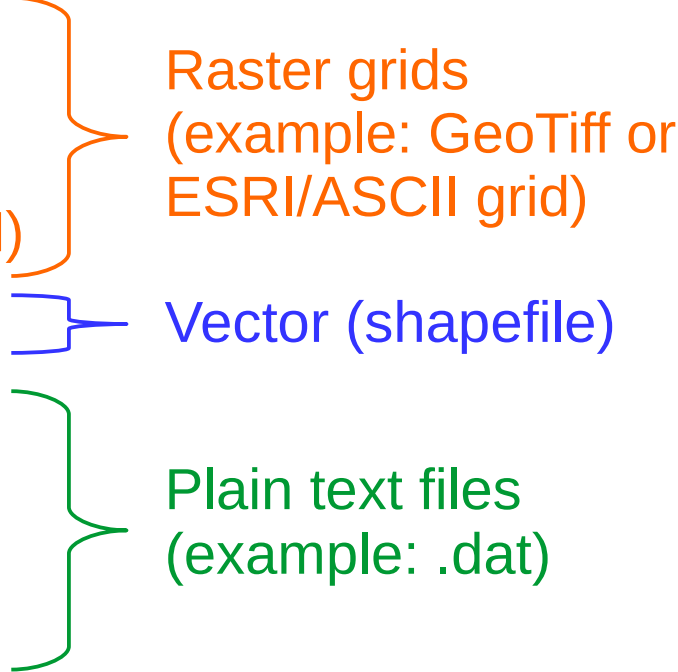
- Setup the model **parameters**

- **Run** the model!

# Input files

- Digital elevation model (DEM)

- Surface type (ice, firn, debris)

- Daily solar radiation (computed from the DEM)

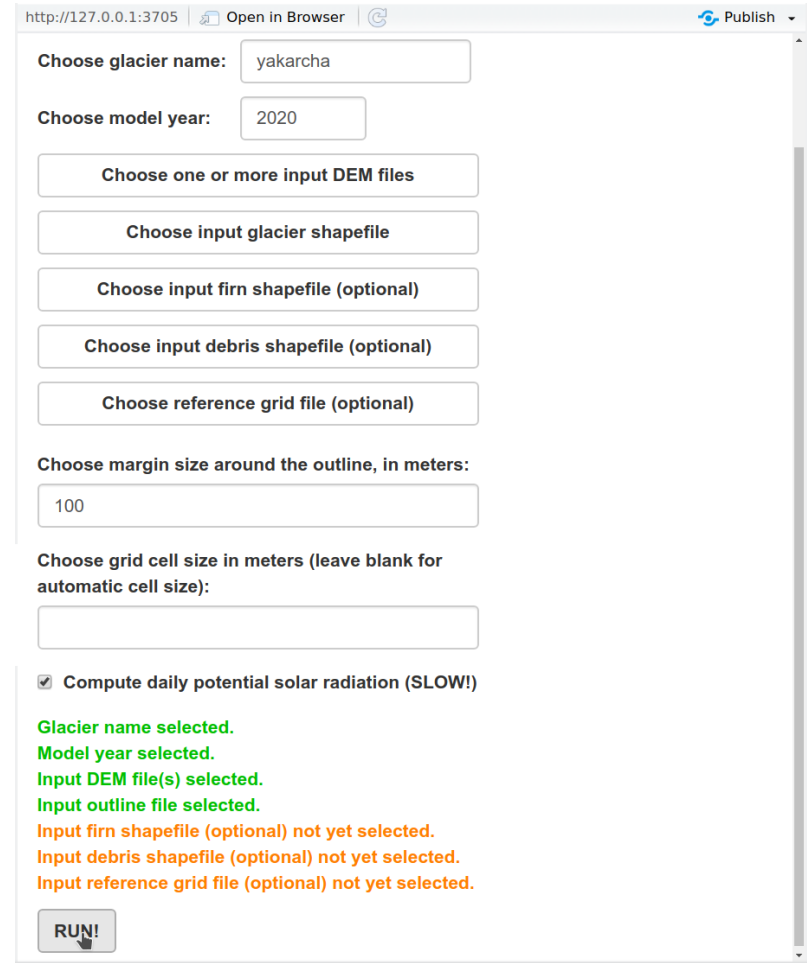Raster grids
(example: GeoTiff or
ESRI/ASCII grid)

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- Digital elevation model (DEM)

- Surface type (ice, firn, debris)

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- Glacier outline

Raster grids
(example: GeoTiff or
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Vector (shapefile)

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Raster grids (example: GeoTiff or ESRI/ASCII grid)

- Glacier outline

Vector (shapefile)

- Meteorological series (daily temperature and precipitation)

- Mass balance measurements (stakes, snow pits, snow probes)

Plain text files (example: .dat)

# Input files

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- If you simulate **several years**, you can use several **DEMs**

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- **Fixed parameters:** glacier name, model years, AWS altitude, physical parameters (snowfall distribution, avalanches, …)

- **Annual parameters (optional):** to use a special value of a parameter in a specific year. One file per year (example: *param_2020.dat).* Precipitation correction, melt factors, altitude bands for contour-line correction.

# Running the model

- When input data and parameters are ready:
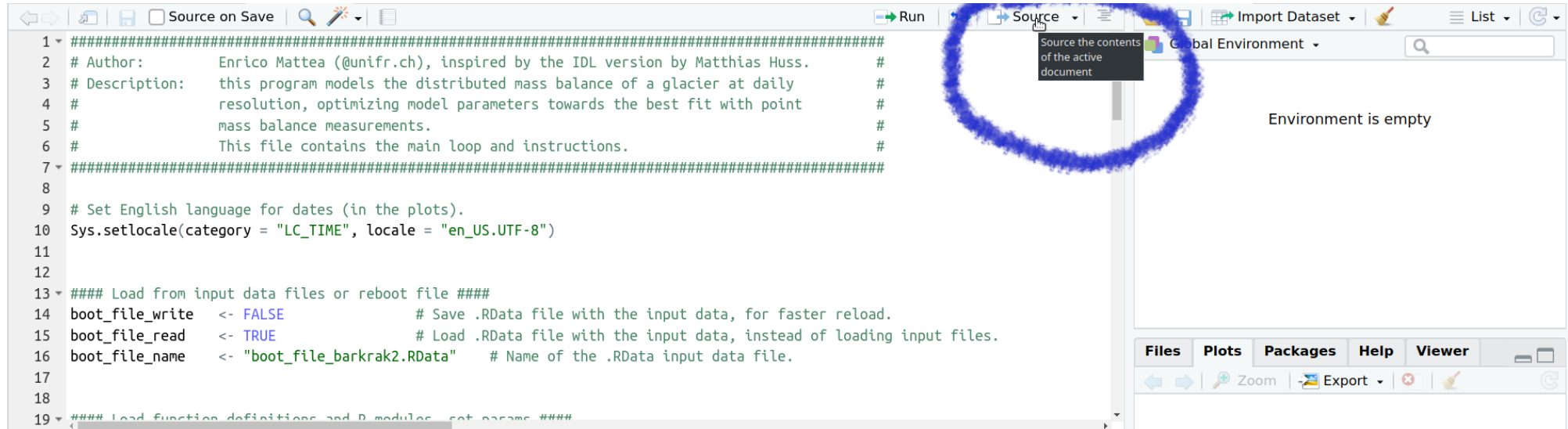
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- Model output:
  - **PDF** files → plots
  - **CSV** files → data of the plots
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  - **PDF** files            → plots
  - **CSV** files            → data of the plots
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- Output files:
  - *overview.pdf*        → main results
  - *overview_areaplot.pdf*   → mass balance 1 Oct to 30 Sep
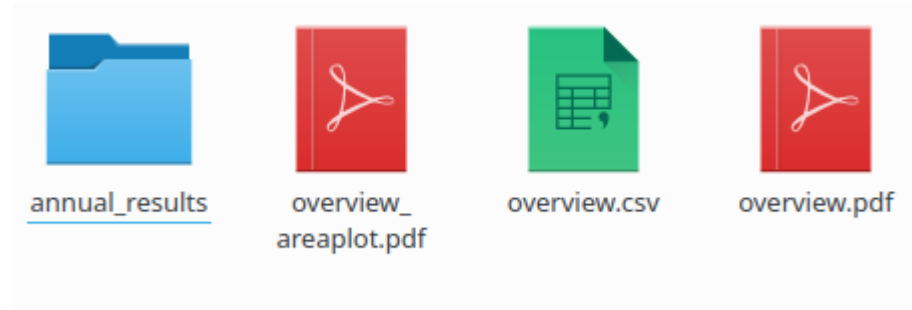  - *annual_results/*       → detailed annual results
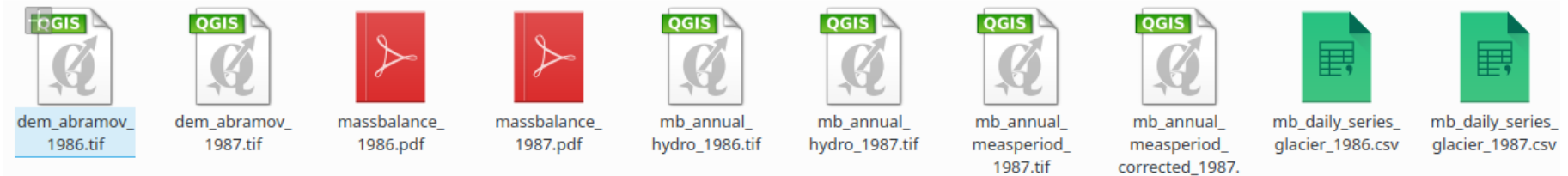
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annual_results     overview_areaplot.pdf     overview.csv     overview.pdf

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| annual_results | overview_areaplot.pdf | overview.csv | overview.pdf |

- Under *annual_results/*:



| mb_daily_series_stakes_1987.csv | mb_ele_bands_1986.csv | mb_ele_bands_1987.csv | mb_winter_fixedperiod_1986.tif | mb_winter_fixedperiod_1987.tif |

| dem_abramov_1986.tif | dem_abramov_1987.tif | massbalance_1986.pdf | massbalance_1987.pdf | mb_annual_hydro_1986.tif | mb_annual_hydro_1987.tif | mb_annual_measperiod_1987.tif | mb_annual_measperiod_corrected_1987. | mb_daily_series_glacier_1986.csv | mb_daily_series_glacier_1987.csv |

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mb_daily_series_stakes_1987.csv    mb_ele_bands_1986.csv    mb_ele_bands_1987.csv    mb_winter_fixedperiod_1986.tif    mb_winter_fixedperiod_1987.tif

dem_abramov_1986.tif    dem_abramov_1987.tif    mb_..._ance_1986.pdf    mb_..._ance_1987.pdf    mb_annual_hydro_1986.tif    mb_annual_hydro_1987.tif    mb_annual_measperiod_1987.tif    mb_annual_measperiod_corrected_1987.    mb_daily_series_glacier_1986.csv    mb_daily_series_glacier_1987.csv

# Thank you for your attention!

*enrico.mattea@unifr.ch*