

The role of the cryosphere for runoff in a highly glacierized alpine catchment, an approach with a coupled model and in-situ data

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Table S1. Data Gaps of the 5-min records of meteorological parameters and for missing daily snow heights (SH) at the individual monitoring sites. The observation parameters for each station are shown in Table 1.

Stations	2019	2020	2021	2022
AWS-A met. sensors	08.04. - 01.05. 22.05. - 16.06. 14.07. - 08.08.	no	No	no
AWS-A SH	02.05. - 22.05.	14.03. - 16.03. 02.05. - 03.05. 05.05. - 06.05.	31.01. - 01.02 10.02. - 11.02.	no
HVP met. sensors	06.11. - 04.12.	23.04. - 06.05.	No	no
HVP SH	01.01. - 06.02. 22.05. - 23.05. 27.05. - 04.06.		07.02. - 08.02. 06.12. - 15.12.	01.02. - 02.02. 15.12. - 18.12.
ABL	No	no	No	no
PS	No	no	No	no

S2. Initialisation file for the parameters of the Alpine3D Model

```
[ALPINE3D]
GLACIER_KATABATIC_FLOW = FALSE
LATERAL_FLOW = FALSE
[EBALANCE]
TERRAIN_RADIATION = TRUE
TERRAIN_RADIATION_METHOD = SIMPLE
[FILTERS]
DW::ARG1::MAX = 360.000000
DW::ARG1::MIN = 0
DW::ARG1::SOFT = TRUE
DW::FILTER1 = MIN_MAX
ILWR::ARG1::MAX = 600.000000
ILWR::ARG1::MIN = 100.000000
ILWR::ARG1::SOFT = TRUE
ILWR::FILTER1 = MIN_MAX
LANDUSE = ARC
LANDUSEFILE = ../input/surface-grids/lc_20m.asc
METEO = SMET
METEOPATH = ../input/meteo
POI = SMET
POIFILE = ../input/surface-grids/awsa_hvp.poi
SNOW = SMET
SNOWPATH = ../input/snofiles
STATION1 = AWSA
STATION2 = HVP
STATION3 = PS
TIME_ZONE = 1
[INTERPOLATIONS1D]
ENABLE_RESAMPLING = TRUE
PSUM::ACCUMULATE::PERIOD = 3600
```

ISWR::ARG1::MAX = 1500.000000
ISWR::ARG1::MIN = 0
ISWR::ARG1::SOFT = TRUE
ISWR::FILTER1 = MIN_MAX
PSUM::ARG1::MAX = 100.000000
PSUM::ARG1::MIN = 0
PSUM::ARG1::SOFT = TRUE
PSUM::FILTER1 = MIN_MAX
RH::ARG1::MAX = 1
RH::ARG1::MIN = 0.050000
RH::ARG1::SOFT = TRUE
RH::FILTER1 = MIN_MAX
TA::ARG1::MAX = 320.000000
TA::ARG1::MIN = 240.000000
TA::FILTER1 = MIN_MAX
VW::ARG1::MAX = 50.000000
VW::ARG1::MIN = 0.200000
VW::ARG1::SOFT = TRUE
VW::FILTER1 = MIN_MAX
[GENERAL]
BUFFER_SIZE = 370
BUFF_BEFORE = 1.5
[INPUT]
CATCHMENT = drainagebasin-20m.asc
CATCHMENT_NUMBERING = ALPINE3D_OLD
COORDPARAM = 32T
COORDSYS = UTM
DEM = ARC
DEMFILE = ../input/surface-grids/dem-20m.asc
GRID2D = ARC
GRIDS_START = 0.0
GRIDS_WRITE = TRUE
HARDNESS_IN_NEWTON = FALSE
MASK_GLACIERS = FALSE
METEO = SMET
METEOPATH = ../output
OUT_CANOPY = FALSE
OUT_HAZ = FALSE
OUT_HEAT = TRUE
OUT_LW = TRUE
OUT_MASS = TRUE
OUT_METEO = TRUE
OUT_SOILEB = FALSE
OUT_STAB = FALSE
OUT_SW = TRUE
OUT_T = TRUE
PRECIP_RATES = TRUE

PSUM::RESAMPLE = ACCUMULATE
[INTERPOLATIONS2D]
DW::ALGORITHMS = AVG
DW::LISTON_WIND::SOFT = FALSE
ILWR::ALGORITHMS = AVG_LAPSE
ILWR::AVG_LAPSE::RATE = -0.03125
ISWR::ALGORITHMS = IDW AVG
PSUM::ALGORITHMS = IDW AVG
RH::ALGORITHMS = LISTON_RH IDW_LAPSE AVG
RH::IDW_LAPSE::SOFT = FALSE
RH::LISTON_RH::SOFT = FALSE
TA::ALGORITHMS = IDW_LAPSE AVG_LAPSE
TA::AVG_LAPSE::RATE = -0.006
TA::IDW_LAPSE::RATE = -0.006
VW::ALGORITHMS = IDW AVG
VW::LISTON_WIND::SOFT = FALSE
VW_MAX::ALGORITHMS = IDW_LAPSE AVG
VW_MAX::IDW_LAPSE::SOFT = FALSE
[OUTPUT]
AVGSUM_TIME_SERIES = TRUE
CLASSIFY_PROFILE = FALSE
COORDPARAM = 32T
COORDSYS = UTM
CUMSUM_MASS = FALSE
EXPERIMENT = Vernagt
GRID2D = NETCDF
GRID2DFILE = grids.nc
GRID2DPATH = ../output/grids
GRIDS_DAYS_BETWEEN = 0.04166
GRIDS_PARAMETERS = HS SWE ISWR TA PSUM
MS_WATER MS_SNOWPACK_RUNOFF SURF_ALB
ALBEDO_AGING = TRUE
ALBEDO_AVERAGE_SCHMUCKI = ALL_DATA
ALBEDO_FIXEDVALUE = 999.
ALBEDO_PARAMETERIZATION = LEHNING_2
ALLOW_ADAPTIVE_TIMESTEPPING = TRUE
CANOPY_HEAT_MASS = TRUE
CANOPY_TRANSMISSION = TRUE
COMBINE_ELEMENTS = TRUE
DETECT_GRASS = FALSE
ENABLE_VAPOUR_TRANSPORT = FALSE
FORCE_RH_WATER = TRUE
FORESTFLOOR_ALB = TRUE
HARDNESS_PARAMETERIZATION = MONTI
HEIGHT_NEW_ELEM = 0.02
HOAR_DENSITY_BURIED = 125
HOAR_DENSITY_SURF = 100
HOAR_MIN_SIZE_BURIED = 2.0

PROF_DAYS_BETWEEN = 1
PROF_FORMAT = PRO
PROF_START = 0.0
PROF_WRITE = TRUE
SNOWPATH = ../output
SNOW_WRITE = FALSE
TIME_ZONE = 1
TS_DAYS_BETWEEN = 0.04166
TS_FORMAT = SMET
TS_START = 0.0
TS_WRITE = TRUE
WRITE_PROCESSED_METEO = TRUE
[SNOWPACK]
ATMOSPHERIC_STABILITY = MO_MICHLMAYR
CALCULATION_STEP_LENGTH = 15
CANOPY = FALSE
CHANGE_BC = FALSE
ENFORCE_MEASURED_SNOW_HEIGHTS = FALSE
GEO_HEAT = 0.06
HEIGHT_OF_METEO_VALUES = 4.5
HEIGHT_OF_WIND_VALUE = 4.5
MEAS_TSS = FALSE
ROUGHNESS_LENGTH = 0.001
SNP_SOIL = TRUE
SOIL_FLUX = TRUE
SW_MODE = INCOMING
[SNOWPACKADVANCED]
ADJUST_HEIGHT_OF_METEO_VALUES = TRUE
ADJUST_HEIGHT_OF_WIND_VALUE = TRUE
ADVECTIVE_HEAT = FALSE
[TECHSNOW]
SNOW_GROOMING = FALSE
SNOW_PRODUCTION = FALSE
HOAR_THRESH_RH = 0.97
HOAR_THRESH_TA = 1.2
HOAR_THRESH_VW = 3.5
JAM = FALSE
METAMORPHISM_MODEL = DEFAULT
MINIMUM_L_ELEMENT = 0.0025
MIN_DEPTH_SUBSURF = 0.07
NEW_SNOW_GRAIN_SIZE = 0.3
NUMBER_SLOPES = 1
PERP_TO_SLOPE = FALSE
PLASTIC = FALSE
RESEARCH = TRUE
SALTATION_MODEL = SORENSEN
SNOW_ALBEDO = PARAMETERIZED
SOIL_EVAP_MODEL = EVAP_RESISTANCE
SOIL_THERMAL_CONDUCTIVITY = FITTED
STRENGTH_MODEL = DEFAULT
SW_ABSORPTION_SCHEME = MULTI_BAND
THRESH_DTEMP_AIR_SNOW = 3.0
THRESH_RAIN = 1.8
THRESH_RH = 0.5
TWO_LAYER_CANOPY = TRUE
T_CRAZY_MAX = 340
T_CRAZY_MIN = 210
VARIANT = DEFAULT
VISCOSITY_MODEL = DEFAULT
WATERTRANSPORTMODEL_SNOW = BUCKET
WATERTRANSPORTMODEL_SOIL = BUCKET
WATER_LAYER = FALSE
WIND_SCALING_FACTOR = 1.0

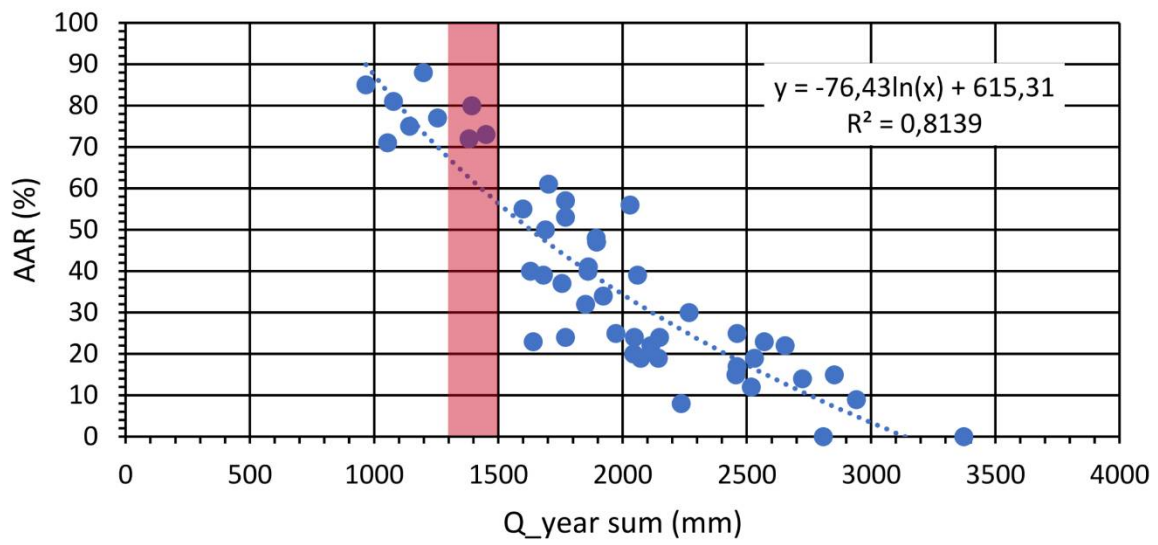


Fig. S3. Relationship between accumulation area ratio (AAR) and the total discharge of the Vernagtferner basin based on mass balance and gauge measurements since 1973. The red bar indicates the long term mean basin precipitation. In the case of balanced conditions (basin precipitation equals discharge), the AAR is found to be 58-68 %.