Mauro Valt@arpa.veneto.it

.. snow

On site measurement

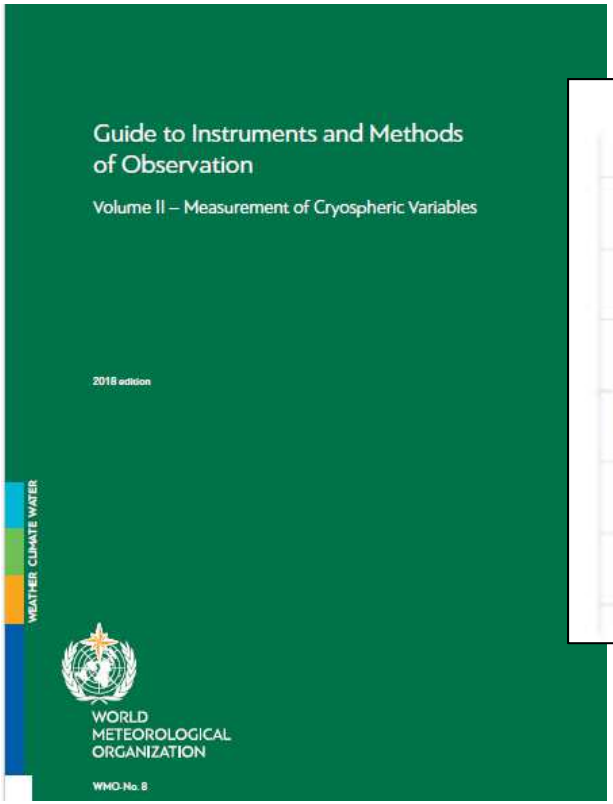
- Snow depth HS
- New snow HN
- Density
- Snow Water Equil
- Surface Snow Area SSA
- SCA
- …..

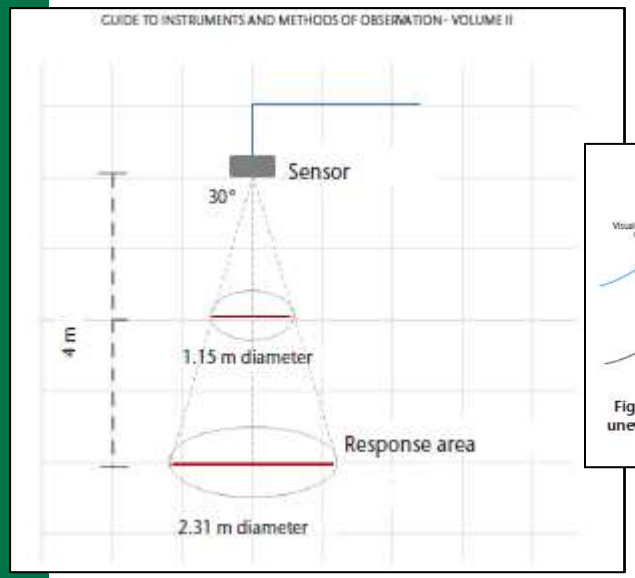
snow measurement

- manual measurements
- Automatic W. Stations
- Satellite images
- snow-specific sensors

WMO Guide to Instruments and Methods of Observations – Measurement of Glaciers

Posted on 2024-02-21 by Charles Fierz





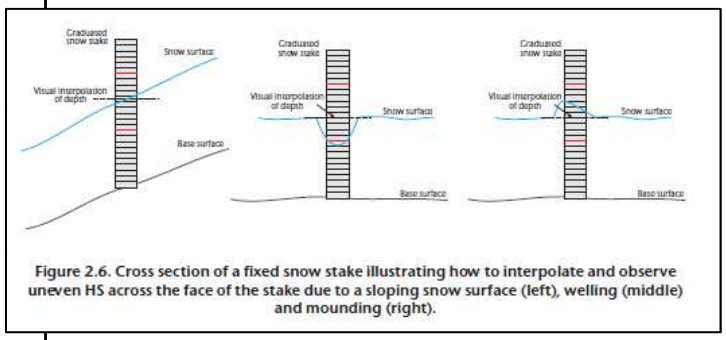
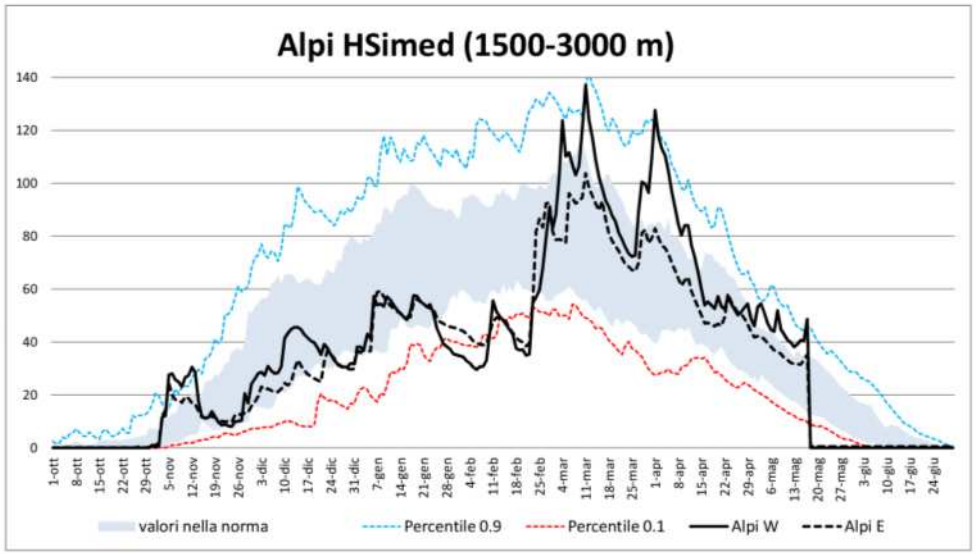


Figure 2.6. Cross section of a fixed snow stake illustrating how to interpolate and observe uneven HS across the face of the stake due to a sloping snow surface (left), welling (middle) and mounding (right).

- https://cryosphericsciences.org/wmo_8_ii_3/

Winter 2023-2024



After the early winter snowfall, winter seemed to be headed for a new spring drought.The atmospheric circulation changed dramatically in the 3rd decade of February, and a long period of heavy snowfall was established, especially in the Western Alps (W) with much snow at high altitudes and in some valley bottoms. The graph shows the trends of the 2 major sectors of the Alps (W and E) compared with the 1991-2020 average

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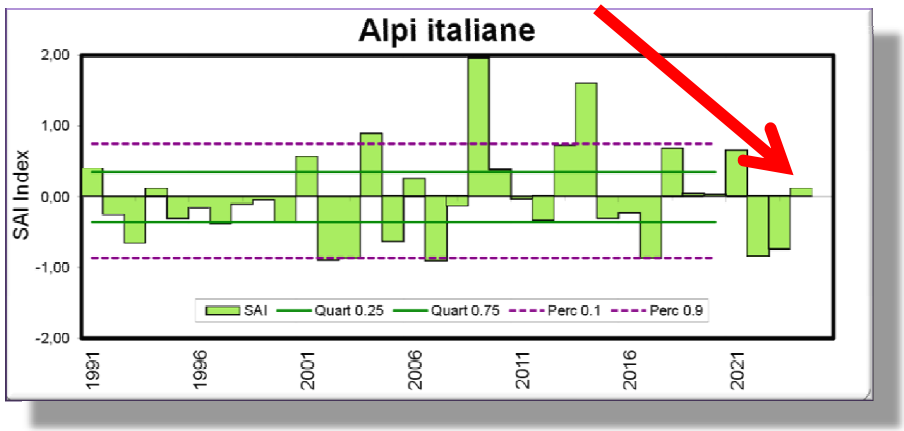
New Snow



The new snow in late February-March and April, determined the seasonal cumulus in balance with higher values in the W alps and negative values in the E alps

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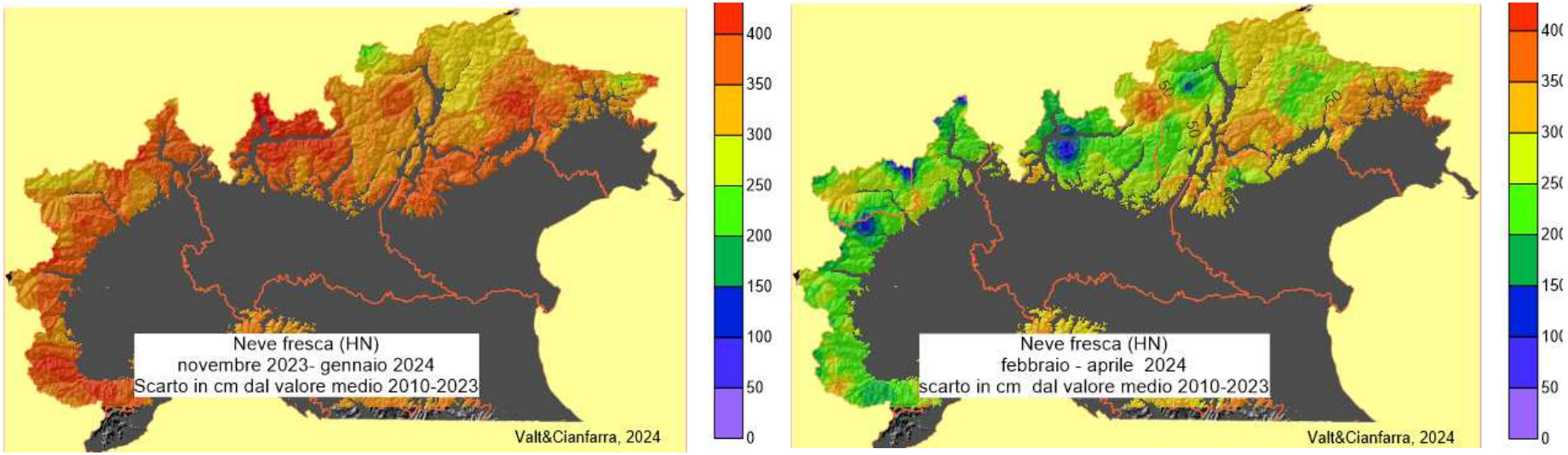
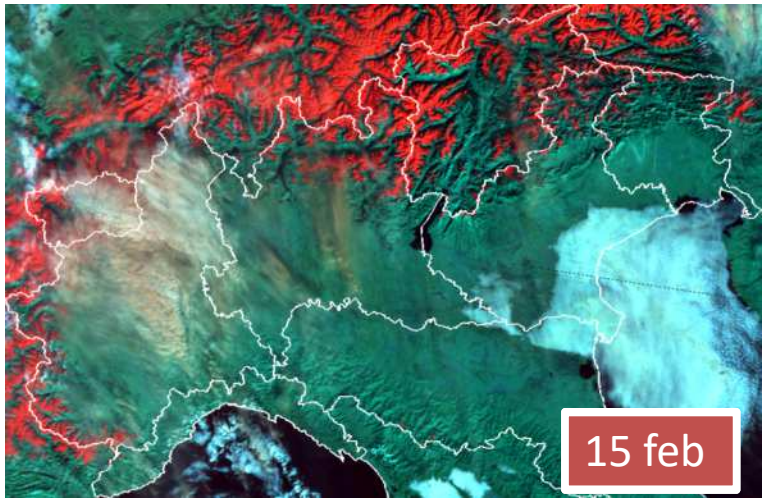
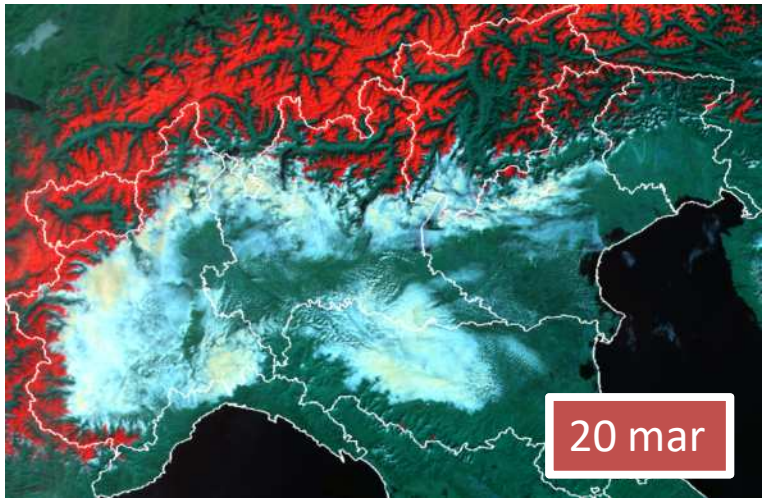
deviation from the mean NDJ and FMA



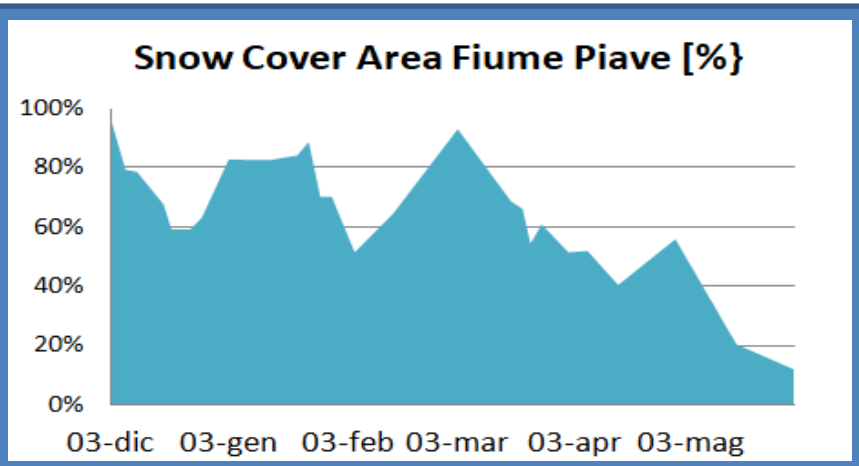
In the 2 maps la the deviations in cm of seasonal fresh snow accumulation from the 2010-2023 average for the November to January period (NDJ) characterized by low precipitation and the February to April period (FMA) decisively with more snow

Snow Cover Area





In the 2 MODIS images, the situation in February after the long warm period and the situation in March after snowfall and short period of mild temperatures. The images are elaborations of spectral combinations of bands 3,6,7 (red-colored snow) from the MODIS sensor of the Terra satellite. Processing by CVA Arabba..



The extent of snow cover (SCA) was greatly affected by temperature trends that resulted in snowpack melting at low altitudes and along sunny slopes

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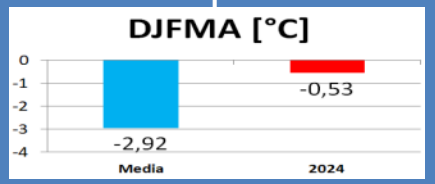
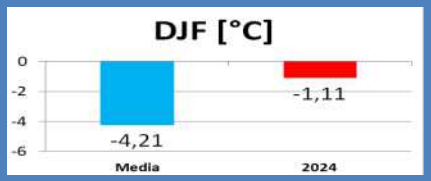
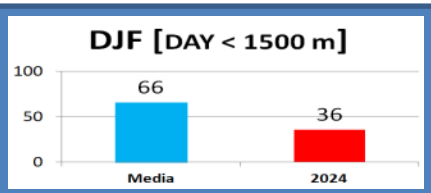


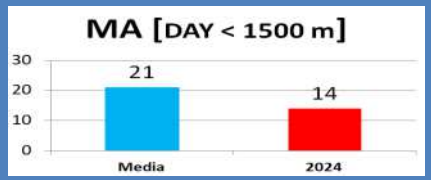
WINTER WARM>90°perc.



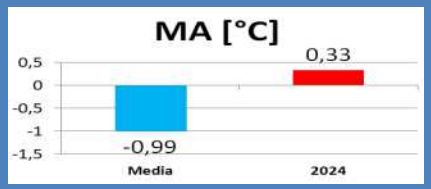
DJF WARM > 90° perc.



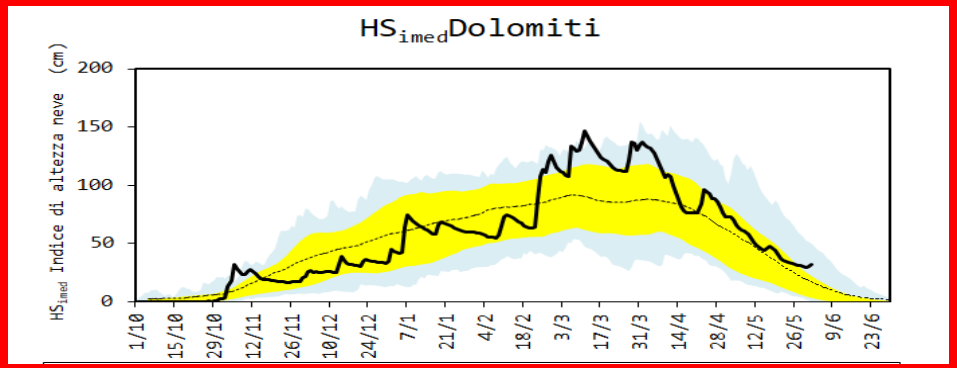
days with snow on the ground (-30 gg)



days with snow on the ground(-7 gg)



MA MITE above normal



The average HSimed snowpack thickness was always in the normal range (yellow band) until the 2nd decade of February and then increased sharply with a lot of snow, especially at higher altitudes. .

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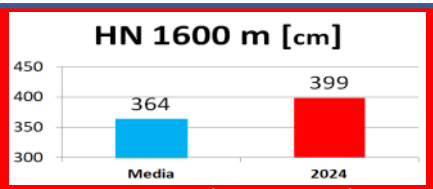
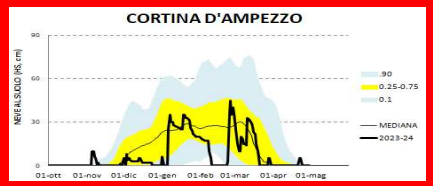
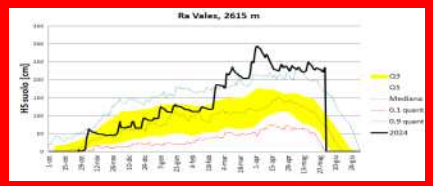
Lago di Cavia (NDJFMA).



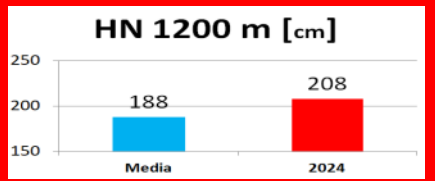
Arabba (NDJFMA)



HS Cortina d'A. Snowfall and melting

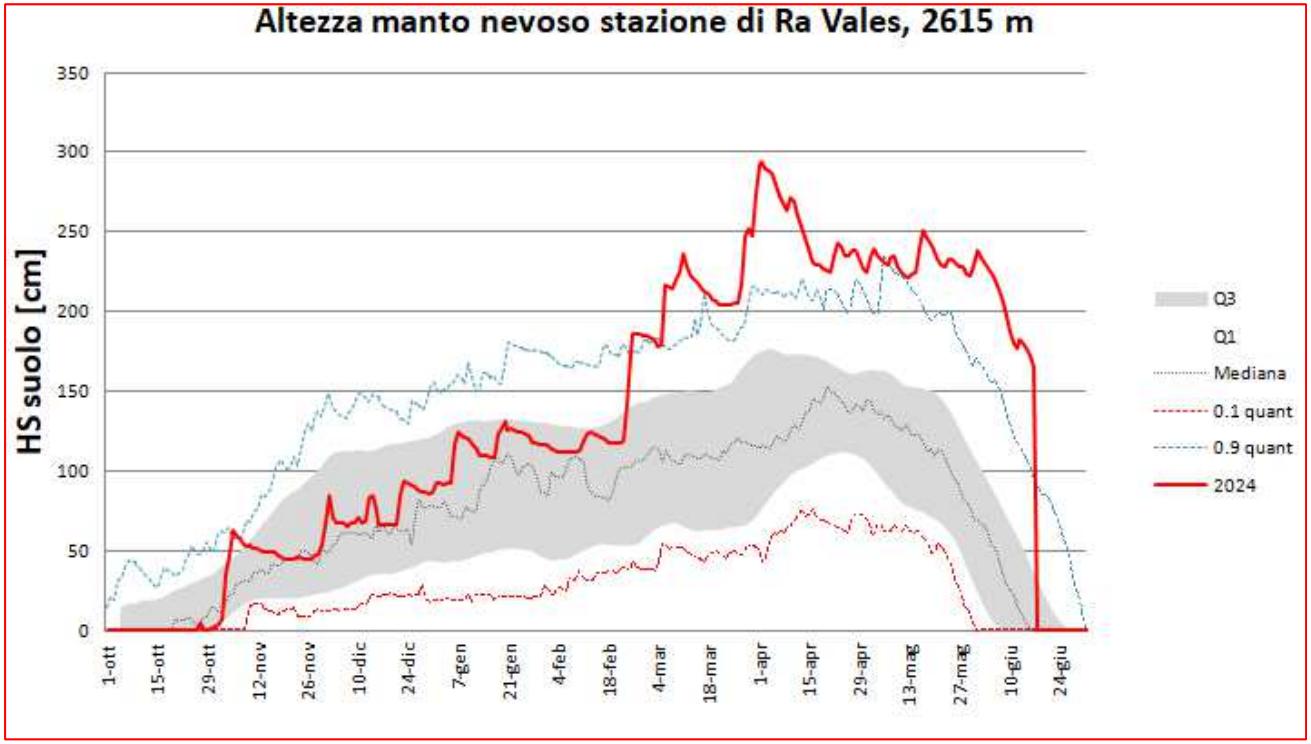


HS Ra Vales, continuous accumulation

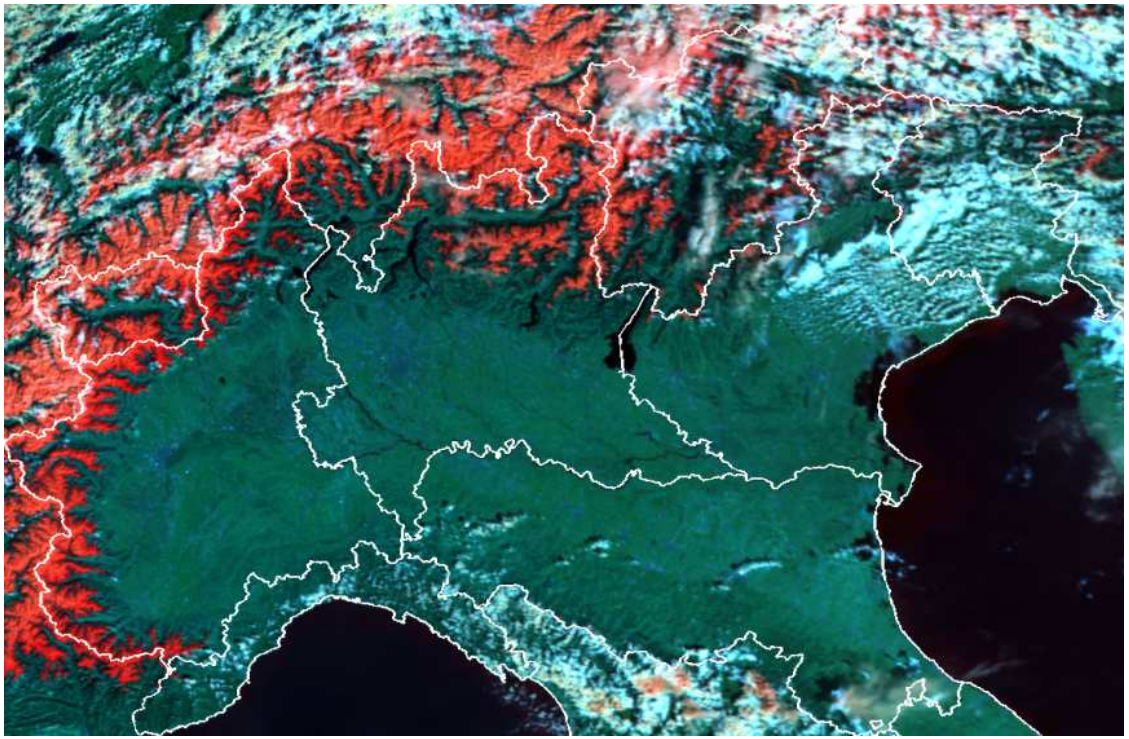


Cortina d'A. (NDJFMA)

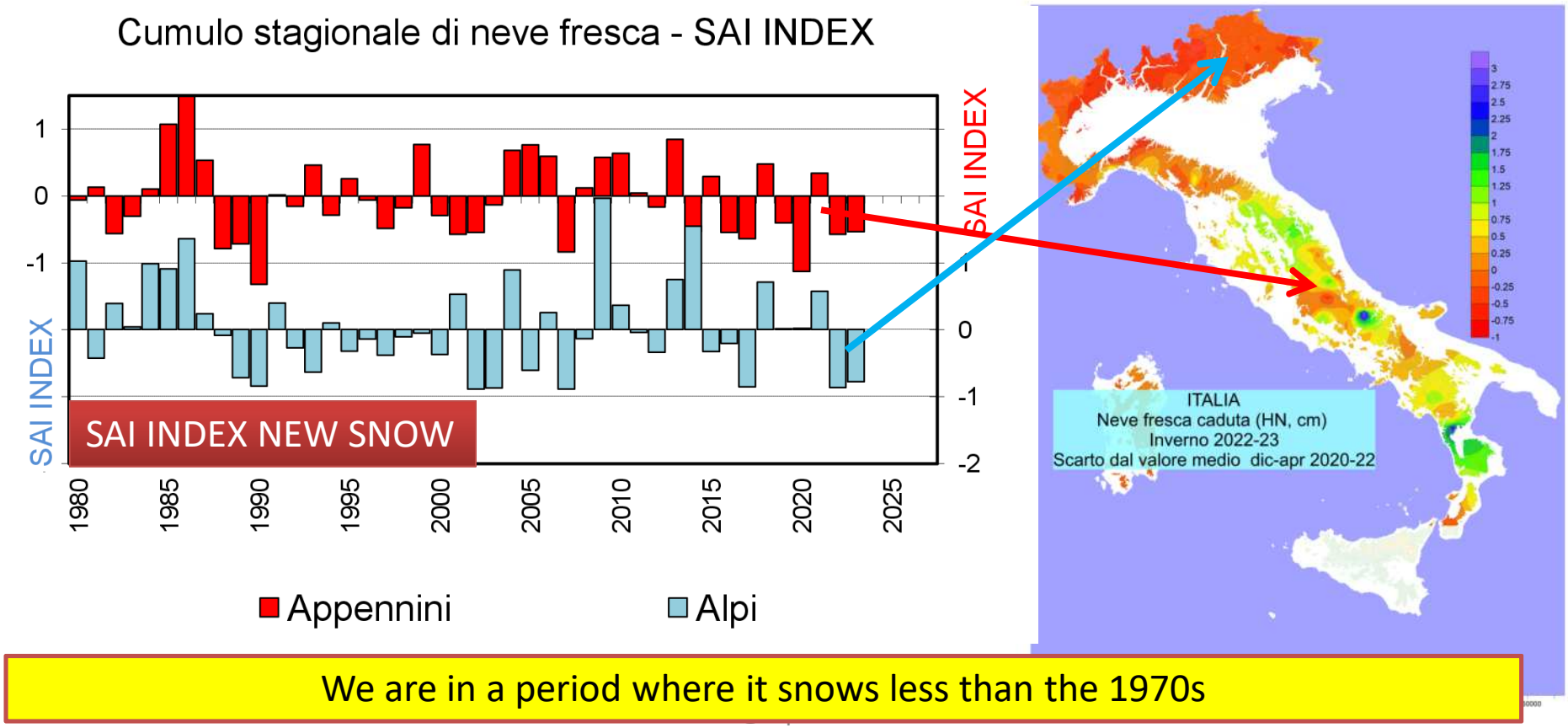
Lots of snow at high altitude, MAM snow.



what trends?

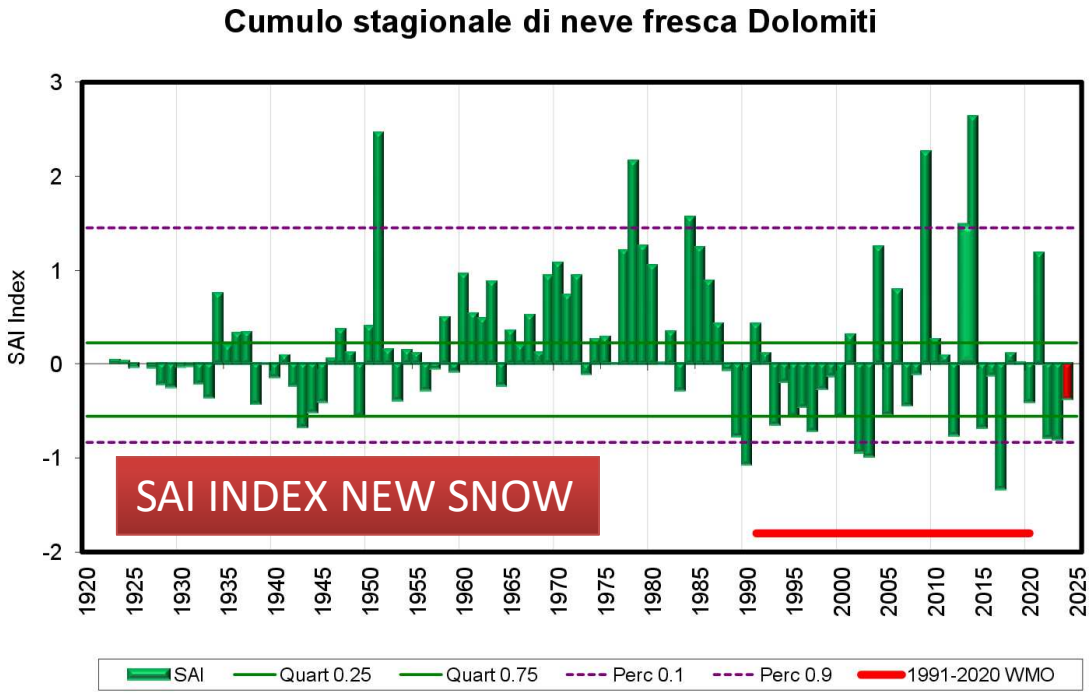


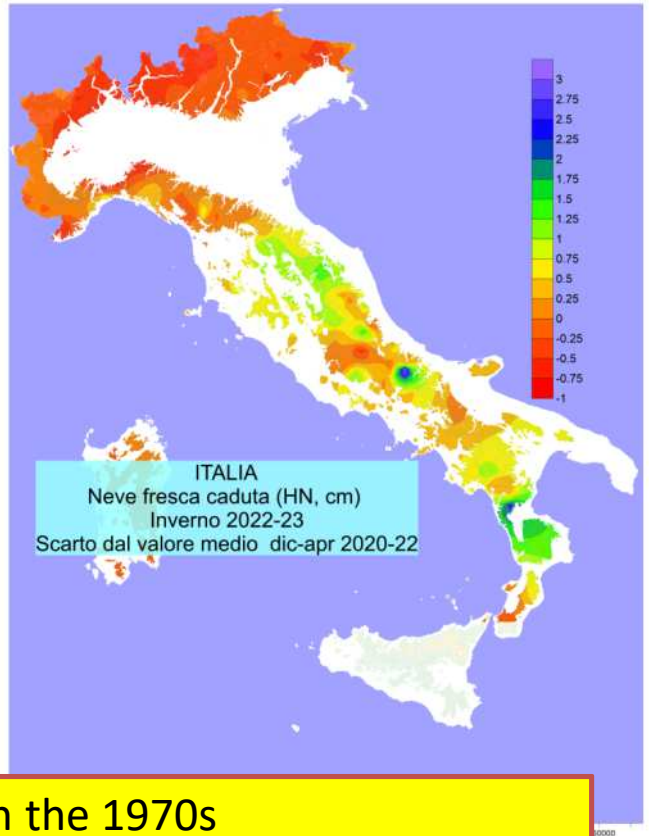
LESS SEASONAL SNOW



We are in a period where it snows less than the 1970s

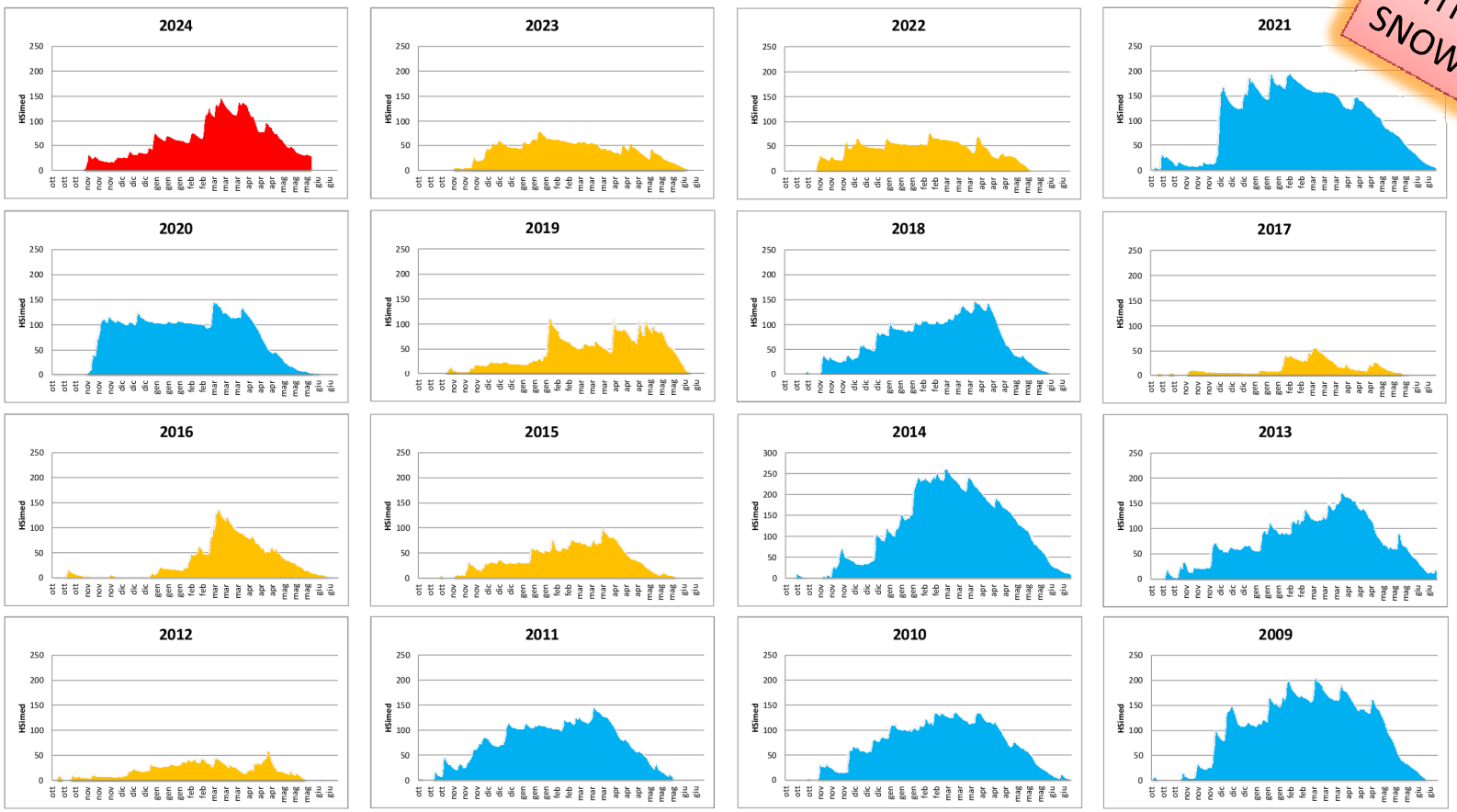
LESS SEASONAL SNOW





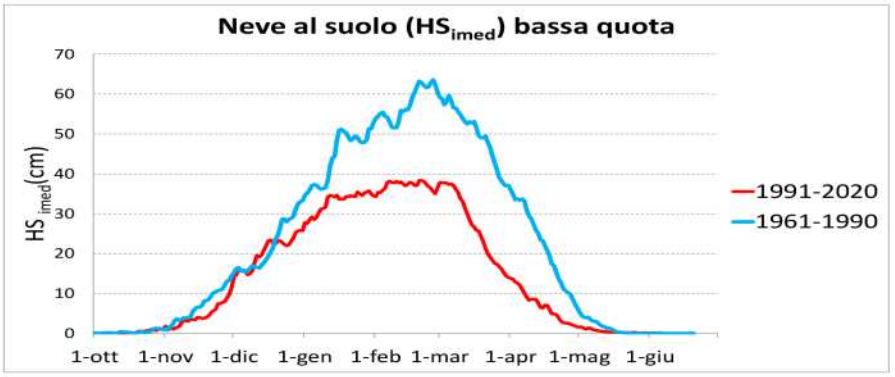
We are in a period where it snows less than the 1970s

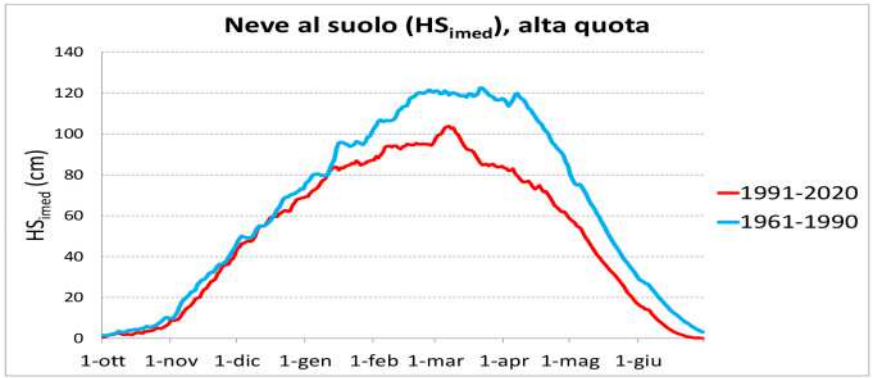
HS_{imed} DOLOMITI



MANY WINTERS WITH LITTLE SNOW

The snow regime from 1961 to the present



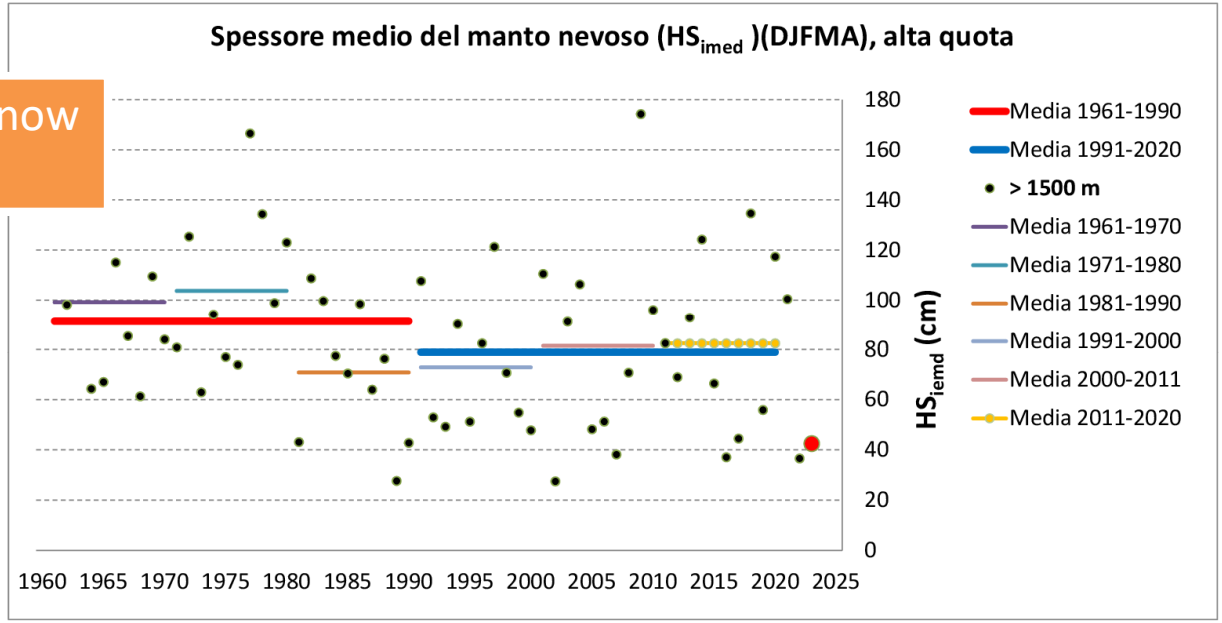


https://aineva.it/wp-content/uploads/Pubblicazioni/Rivista96/NV96_07.pdf

Looking at the 30-year climate trend, the regime change especially from mid-January onward is evident

The snow regime from 1961 to the present

Average snow depth



https://aineva.it/wp-content/uploads/Pubblicazioni/Rivista96/NV96_07.pdf

It is snowing less, and this is a trend that has been going on since the 1980s that is also affecting the average thickness of snow on the ground).

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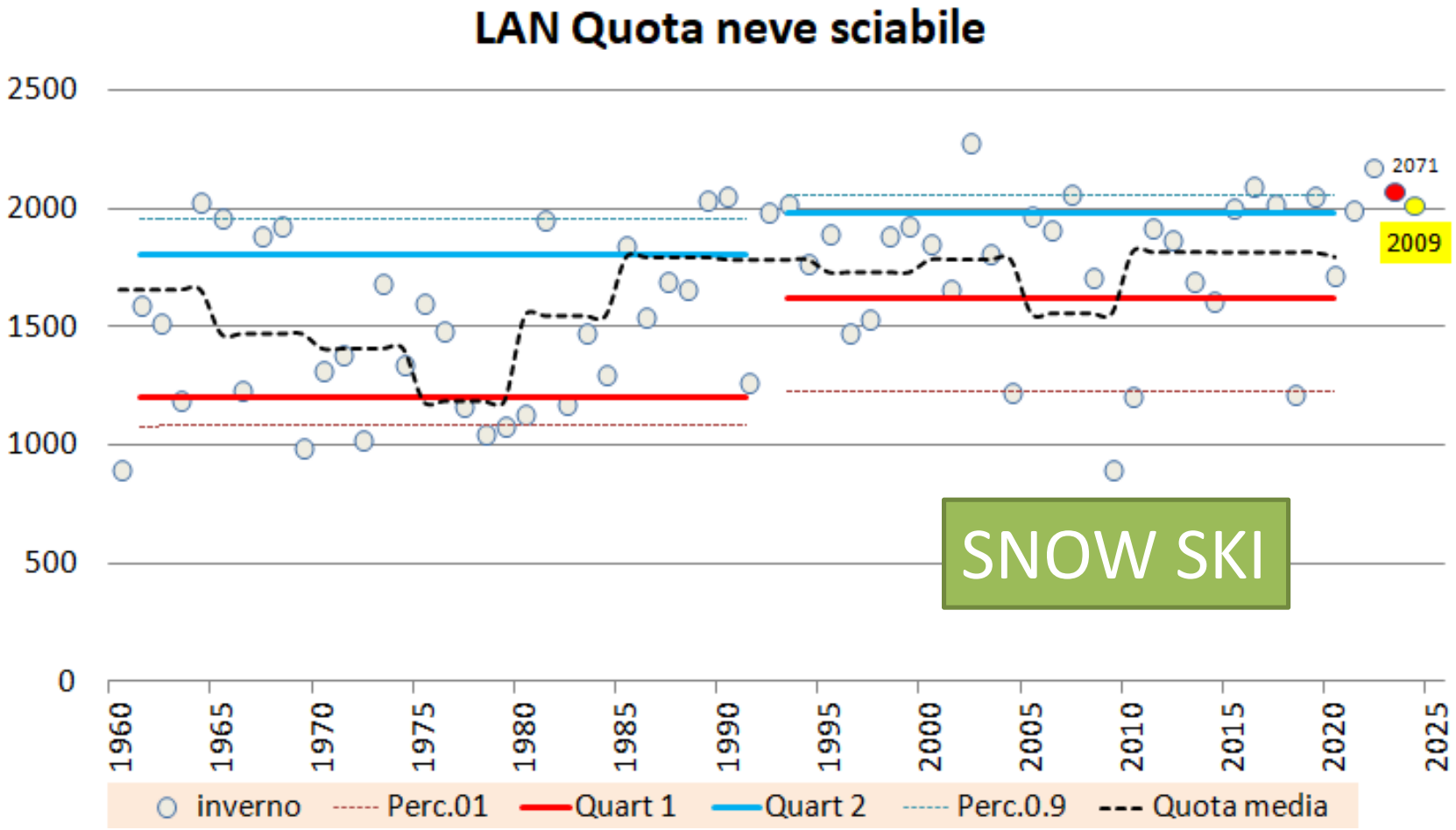

LAN Quota neve sciabile
2500
2000
1500
1000
500
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2071
2009
SNOW SKI
inverno
Perc.01
Quart 1
Quart 2
Perc.0.9
Quota media

Repercussions on skiing

Low-altitude ski areas are at risk

Data for the Italian Alps, show an increase in snow elevation of 233 m for every 1°C increase in temperature.

Caviola, 1100 m, anni ‘70

CROCE D'AUNE IN ASCESA

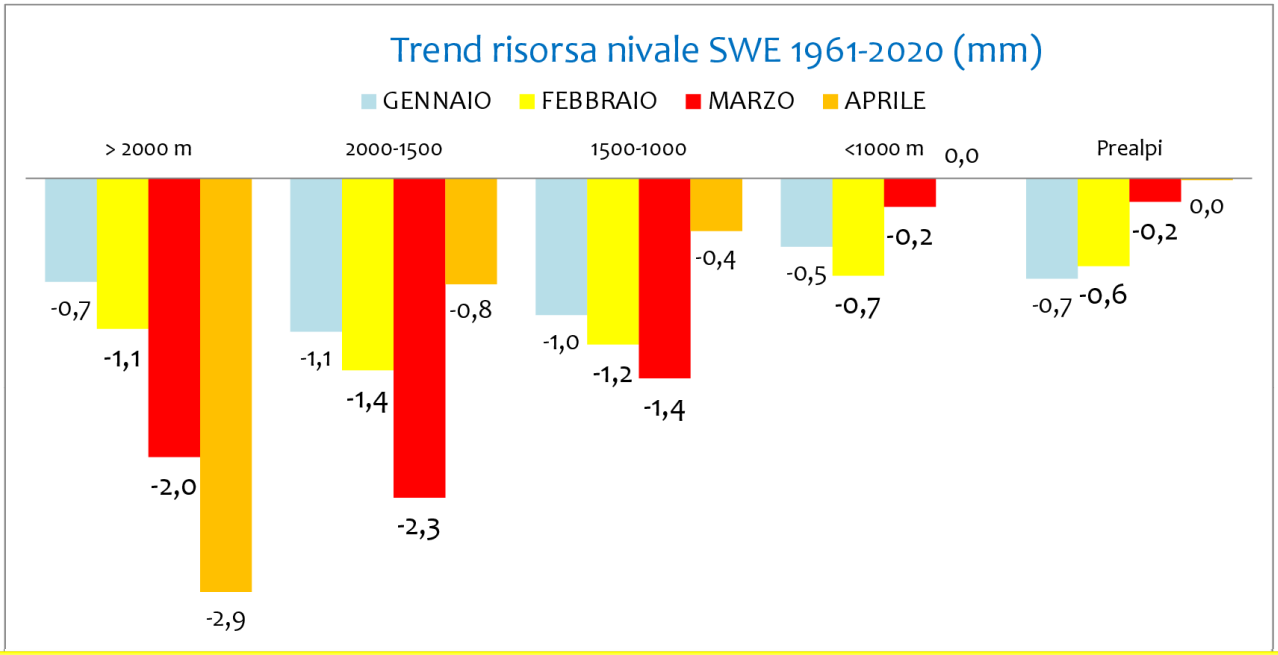
Una stazione turistica civettuola; questo si può dire di Croce d'Aune dove, ad onor del vero, ad un afflusso di appassionati degli sport bianchi davvero invidiabile non corrisponde certo una ricettività adeguata. Comunque la gente si accontenta di quel pochissimo che c'è. Una sciovia, due alberghi e tanti meravigliosi campi di sci. Vi si giunge partendo da Pedavena ed imboccando la 50 bis in circa venti minuti, comodamente. Il passo, a metri 1011, presenta una pendenza media dell'otto per cento ed un dislivello di 700 metri. La località si trova in ottima posizione panoramica a cavallo tra la Valle Feltrina e la Valle del Cismon ed è, come si è detto, meta frequentata da numerosissimi villeggianti desiderosi di aria balsamica e di quiete. E' punto di partenza per numerose passeggiate ed escursioni sul monte Avena e sulle famose Vette Feltrine. L'innevamento è ottimo da dicembre a marzo e numerosissime sono le piste di discesa: dal Monte Avena a Croce d'Aune, dal Passo alla località Salzen (slalom gigante: difficile), dal Passo verso Pedavena, la pista dei Roccoli.

Agordo, 650 m, anni ‘60

SNOW WATER EQUIVALENT

Snowpack constitutes a valuable water resource, the release of which is slow and independent of the availability of precipitation. The extent of this resource, however, is difficult to quantify except through a combination of different survey methods.

Snow resource



The most basic elevation bands have a greater decrease decrease right in March

From the point of view of the availability of the snow water resource in the Piave-Cordevole basin (reference area of 2110 km2 above 800 m altitude), the loss of Million cubic meters of water equivalent in March is 48% compared to the 1961-1990 period equal to 240 Mm3.

Prime ripercussioni: risorsa nivale

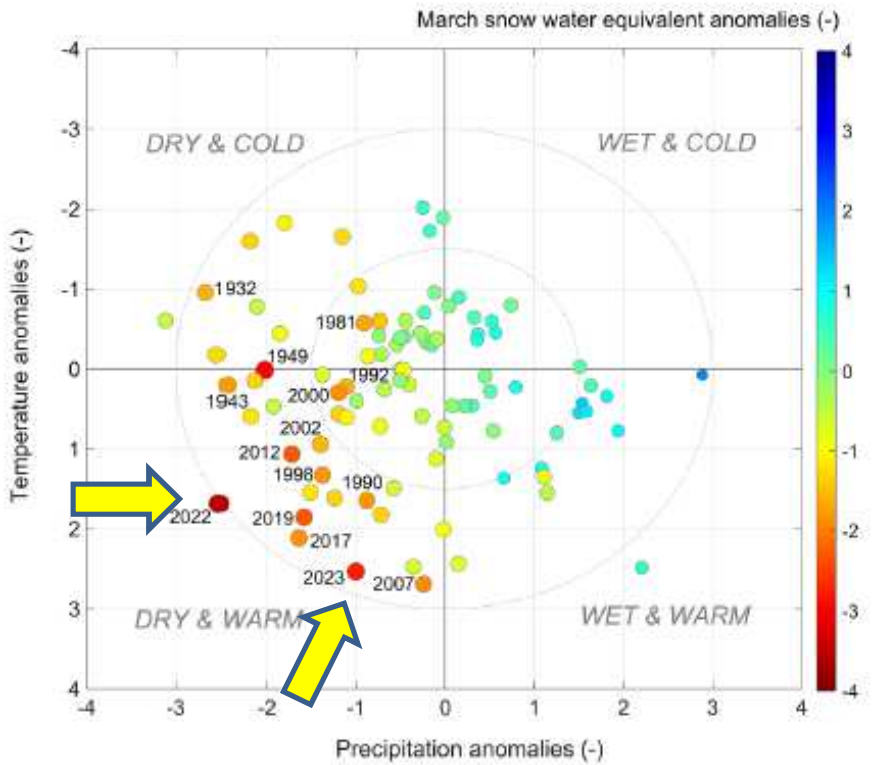
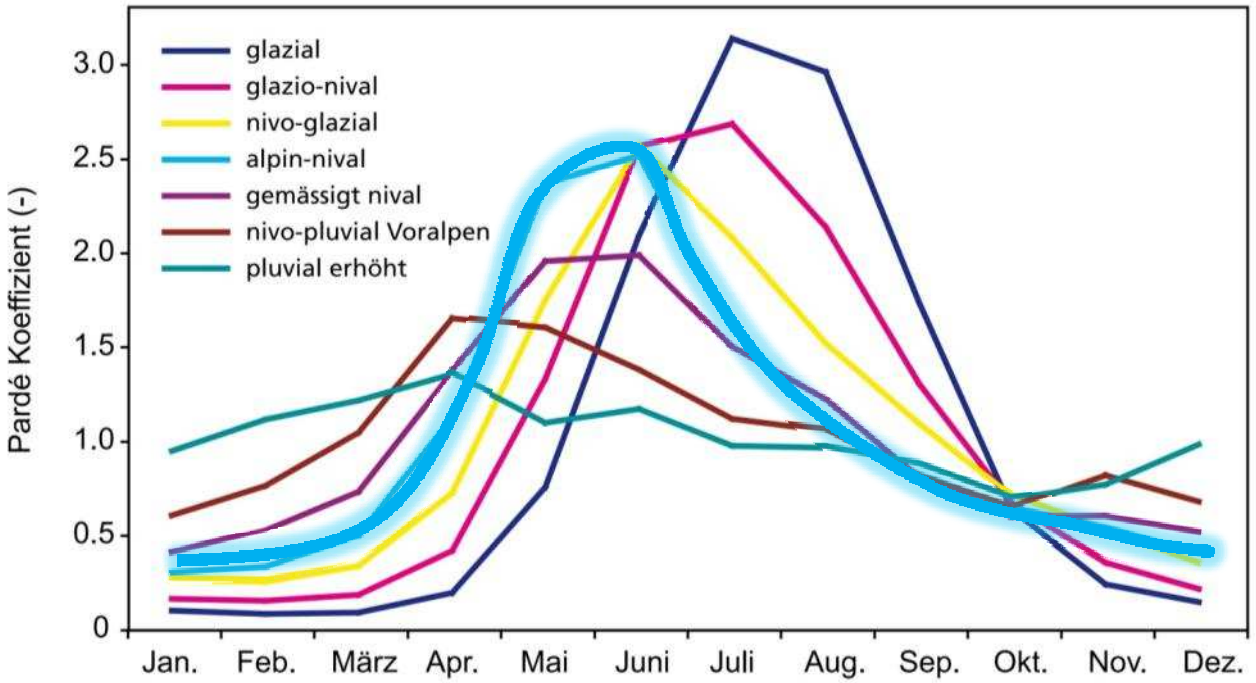


Figure 3. Scatterplot between winter precipitation anomalies (March SPI4) and temperature anomalies (March AT4*). March SWE anomalies (March SSWEI) are shown using dimension/colour scale, from small/blue (positive, +4) to large/red (negative, −4). Inside and outside circles show 1.5 and 3 isoradial coordinates, respectively. Only the years with SSWEI < -1.5 are labelled.

Status of March 2022 and March 2023.They have been among the driest and warmest in the past 100 years.What will this year be like?

https://iopscience.iop.org/article/10.1088/1748-9326/acdb88/meta

Relative dynamics of runoff over the year in catchments located at different altitudes (e.g., CH)

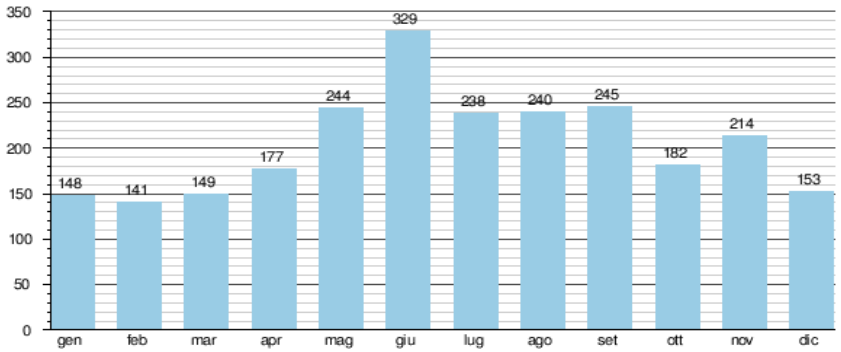


https://www.slf.ch/it/neve/la-neve-come-risorsa-idrica/

The Venetian plain lives off the water of the PO, Adige, Brenta-Bacchiglione, and Piave rivers.The 3 main basins of the northeast have different dynamics

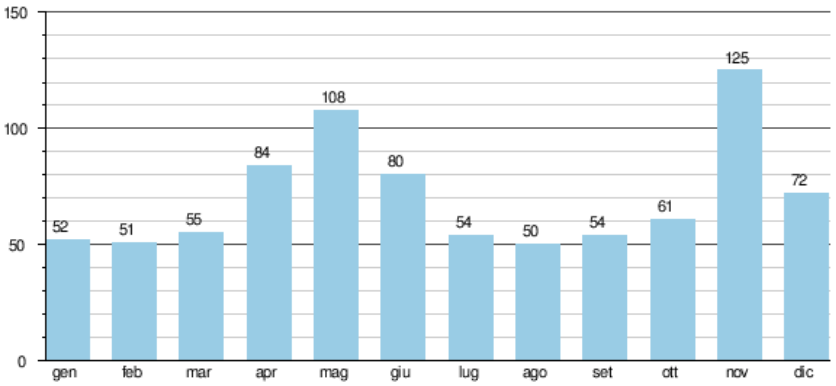
Adige river

- The ADIGE is a river in northeastern Italy, in length-about 410 km- the second largest Italian river after the Po, the third largest in basin width after the Po and Tiber, and the fourth largest in water volume after the Po, Ticino, and Tiber, with 235 m³/s average annual flow at the mouth.Many glaciers in both South Tyrol and Trentino (Orteles-Cevedale, Pala Bianca, Simulaun, Venoste Orientali, Western Breonie, Gran Pilastro , Alti Tauri, Tre Signori, Vedrette di Ries, Adamello; Brenta...



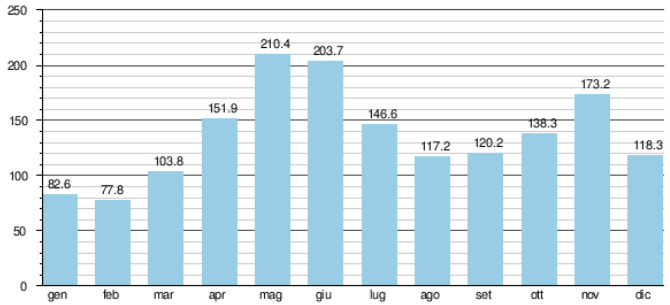
Brenta River

- The Brenta is a river in northern Italy, a tributary of the Adriatic Sea. It originates from the lakes of Caldonazzo and Levico in Trentino-Alto Adige and reaches the sea after a course of 174 km,[1] making it the 13th longest waterway in the country. Near Chioggia, the waters of the Brenta intersect with those of the Bacchiglione, then flow into the Adriatic Sea after 6 km.



Piave River

- The Piave River presents a hydrological regime strongly influenced by the withdrawals (both for agricultural and energy purposes) that are made at the Soverzene, Busche, Fener, and Nervesa weirs. The "natural" regime has a spring maximum, where the rainfall contribution is supplemented by that from melting snow, and an autumn secondary...



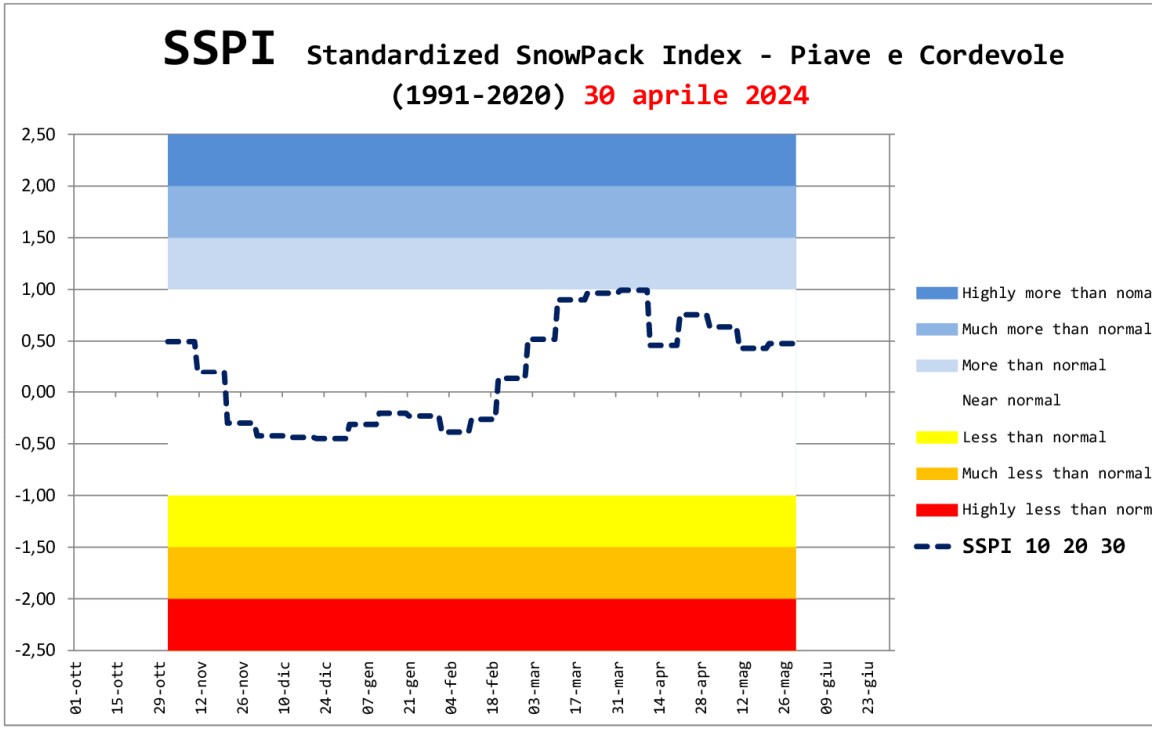
Acqua idropotabile

- There is a lot of water on earth, but not all people have the same amount of waterIstat's latest census on water for civilian use was from the year 2012. In this year, the daily consumption of water delivered to users was 241 liters per inhabitant.

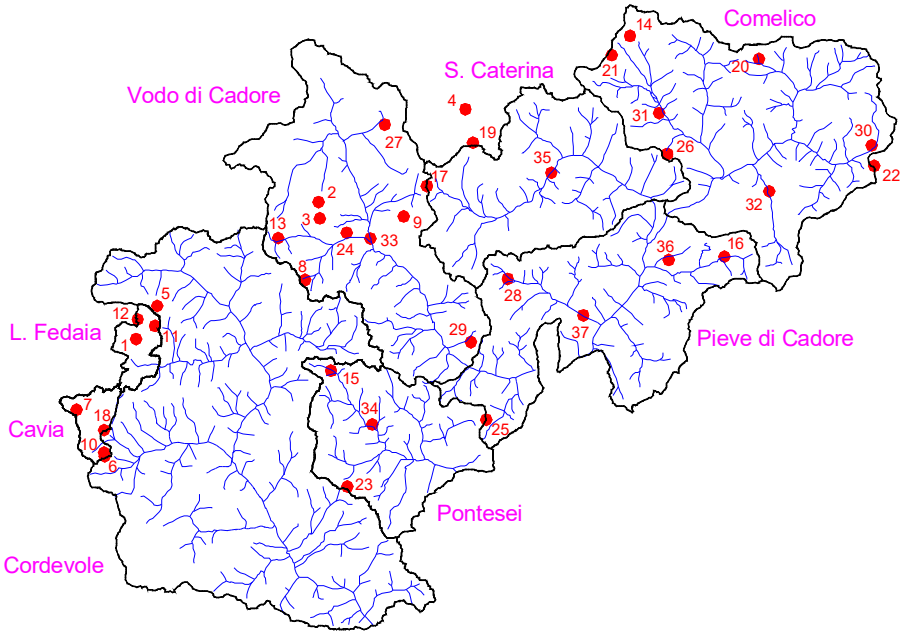
78 litri per il bagno/doccia (39%)
40 litri per i sanitari (20%)
24 litri per il bucato (12%)
20 litri per lavaggio stoviglie (10%)
12 litri per il giardino lavaggi vari (6%)
12 litri per la cucina (6%)
2 litri per bere (1%)
12 litri per altri usi (6%)

- **Some peoples have less than 50 liters per week!!!**

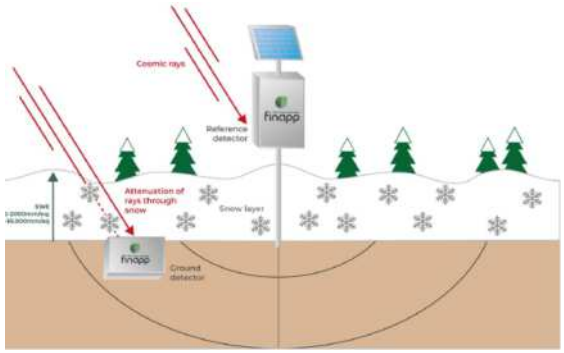
SWE in winter 2023-24

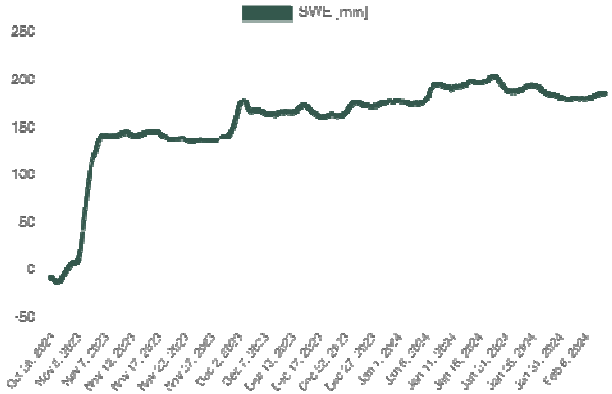


Monitoraggio dello SWE-misure dirette



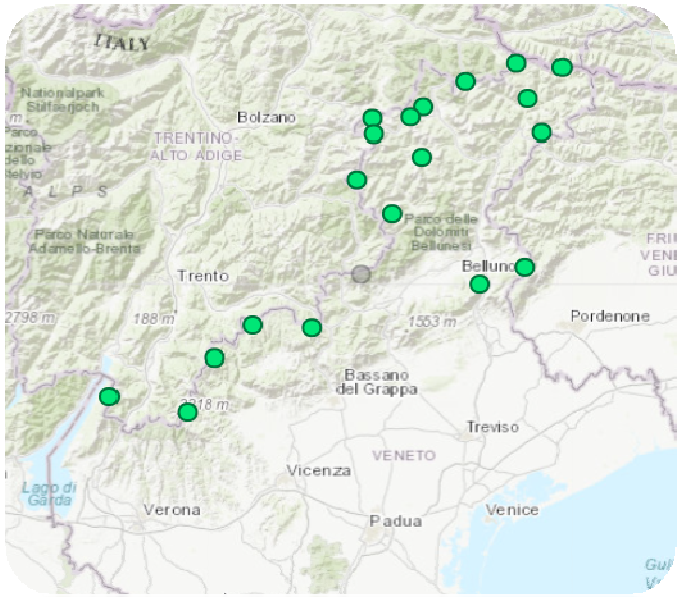
Monitoring of the snow resource





New network of the Veneto Region (ARPA Avalanche Center) with innovative sensors. Finapp's CRNS (Cosmic Ray Neutron Sensing) probe is an integrated sensor for measuring ambient neutrons that enables estimation of SWE

23 stazioni



https://aineva.it/wp-content/uploads/Pubblicazioni/Rivista95/NV95_2.pdf

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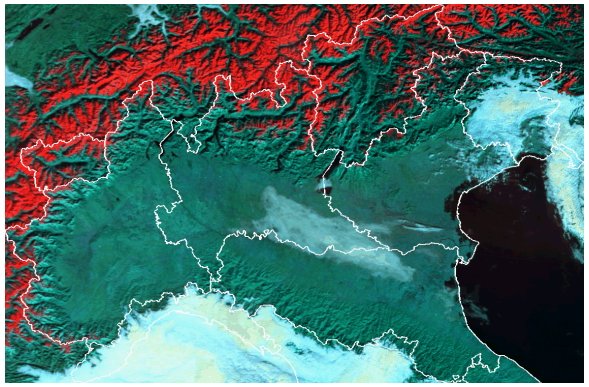
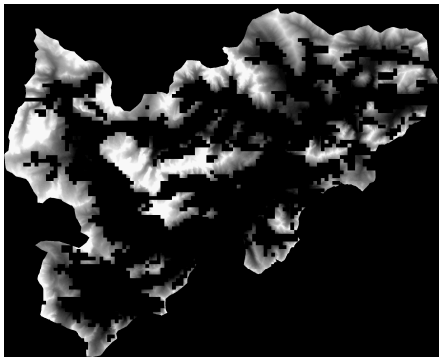
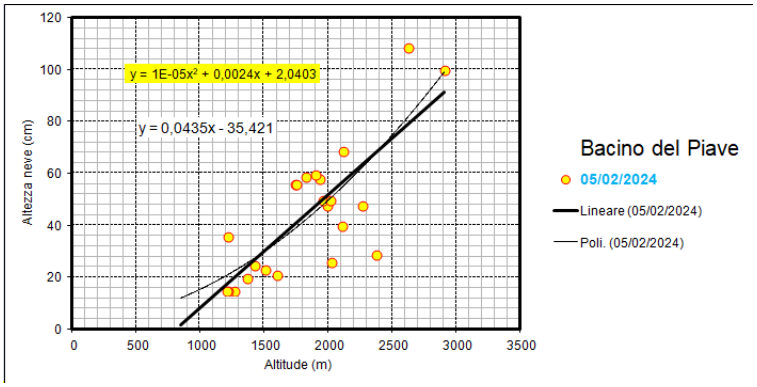
Monitoring of the snow resource



From satellite images. (MODIS; red snow in this image ...



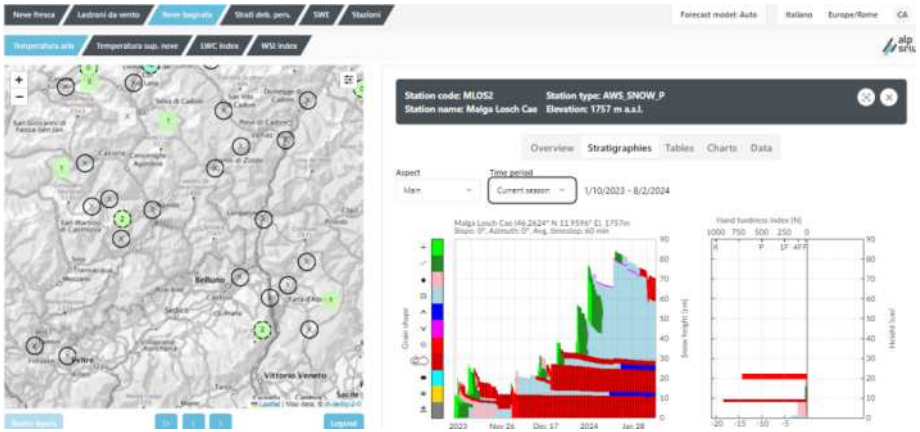
... Determining where there is snow and at what altitude ...

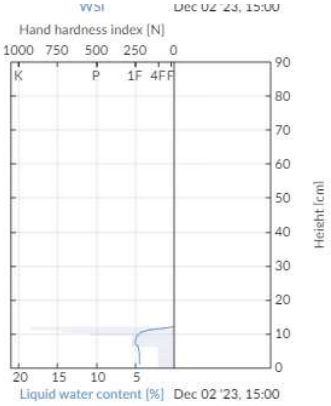


... knowing how much snow there is at different elevations and knowing the average density ...

It can be estimated how many Million cubic meters of water equivalent there are per basin (110 Million on this image of February 5, 2024

Monitoring of the snow resource





Snowpack: snowpack simulation model that, in addition to stratigraphy, simulates us the presence of liquid water in the snow (snow with a temperature of 0°C and its potential availability for percolation into the ground).
Network of 24 stations managed by the Arabba Avalanche Center (ARPAV).