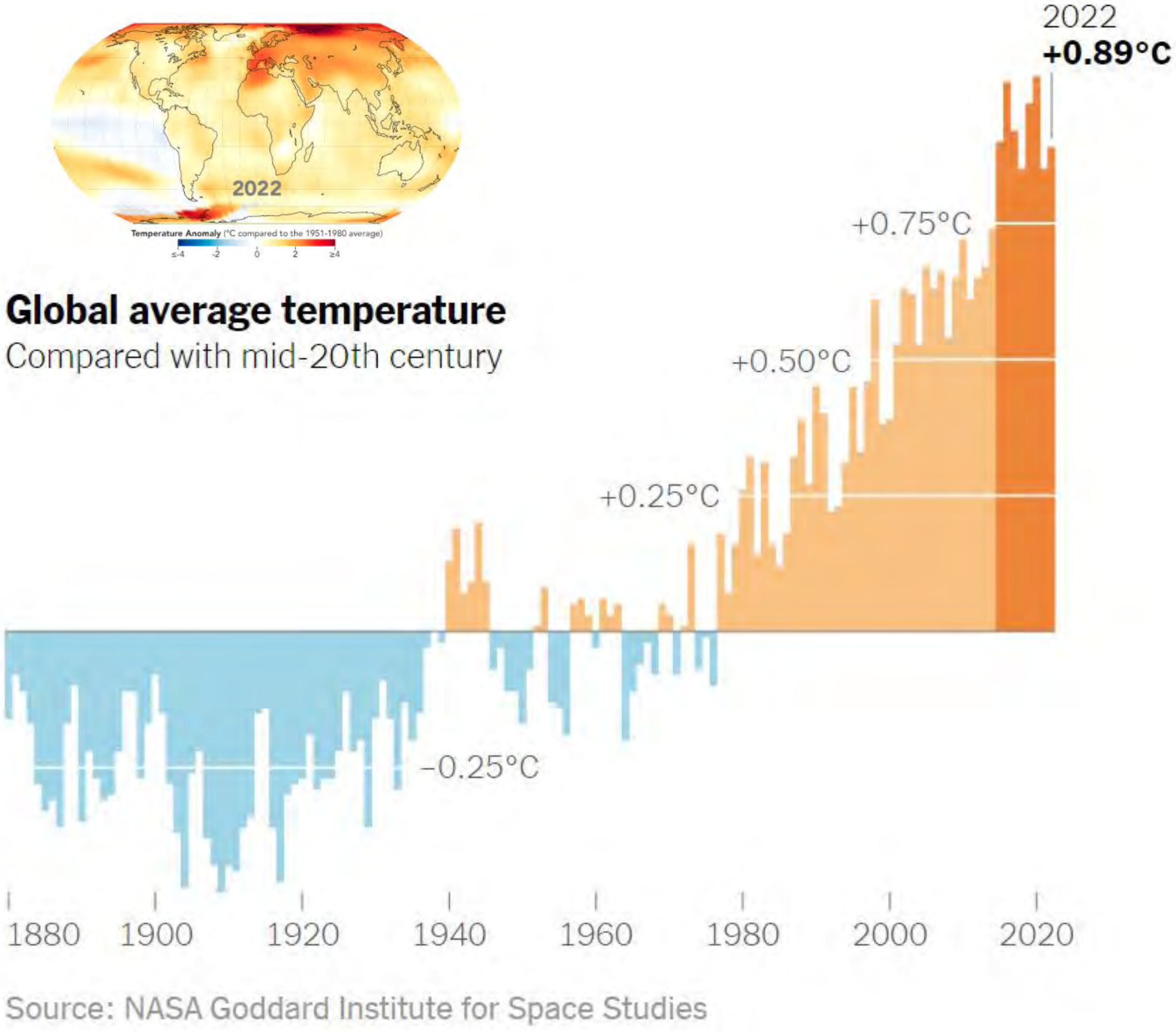
OITAF

Development and optimization of snow making systems for better resource management

eng. Franco Torretta

1- why & how
2- history
3- product & system evolution
4- data analysis for further optimization
5- efficiency in detail

1- why & how



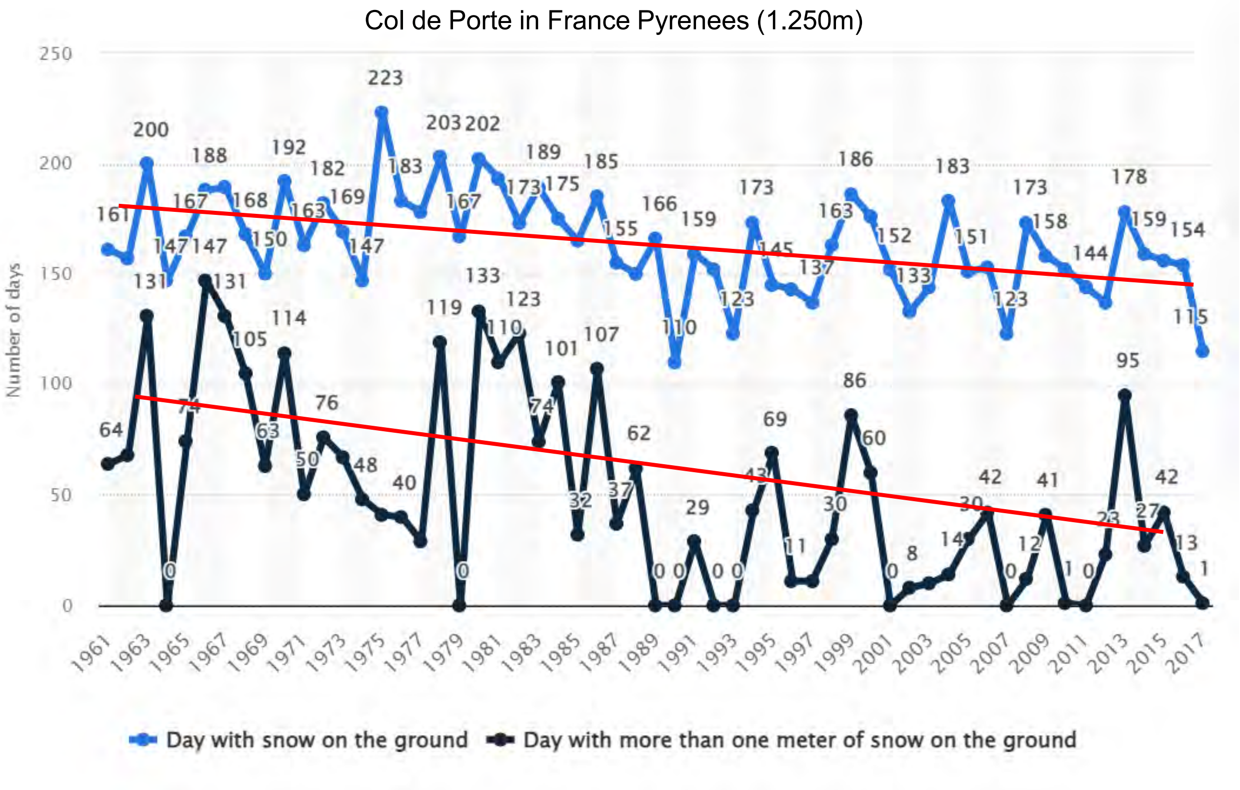
CLIMATE CHANGE

the biggest challenge of our times

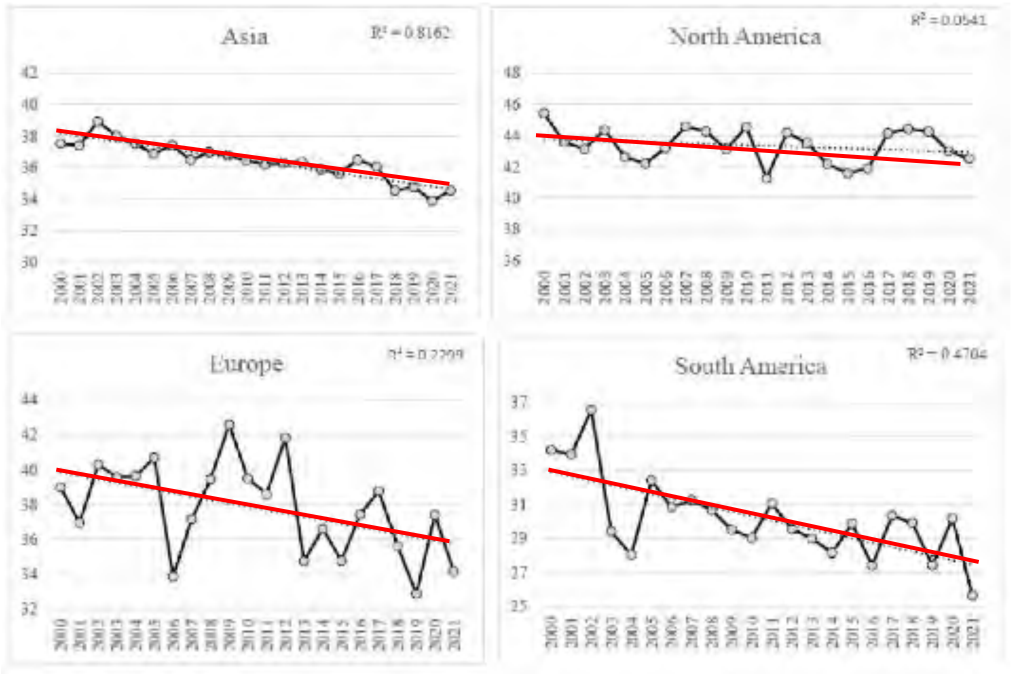
1- why & how

snow cover

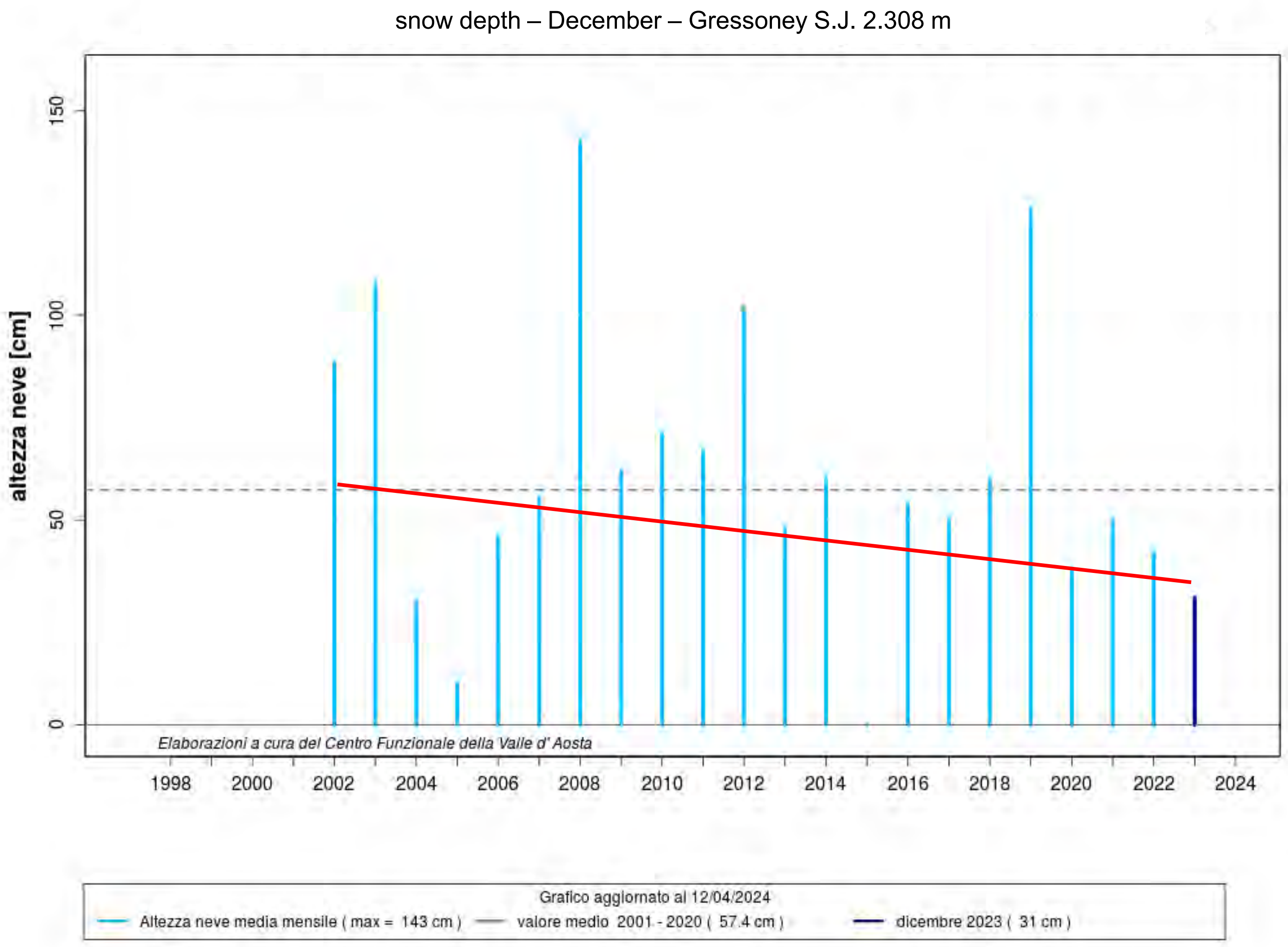
number of days of annual snowfall



snow cover extent



1- why & how

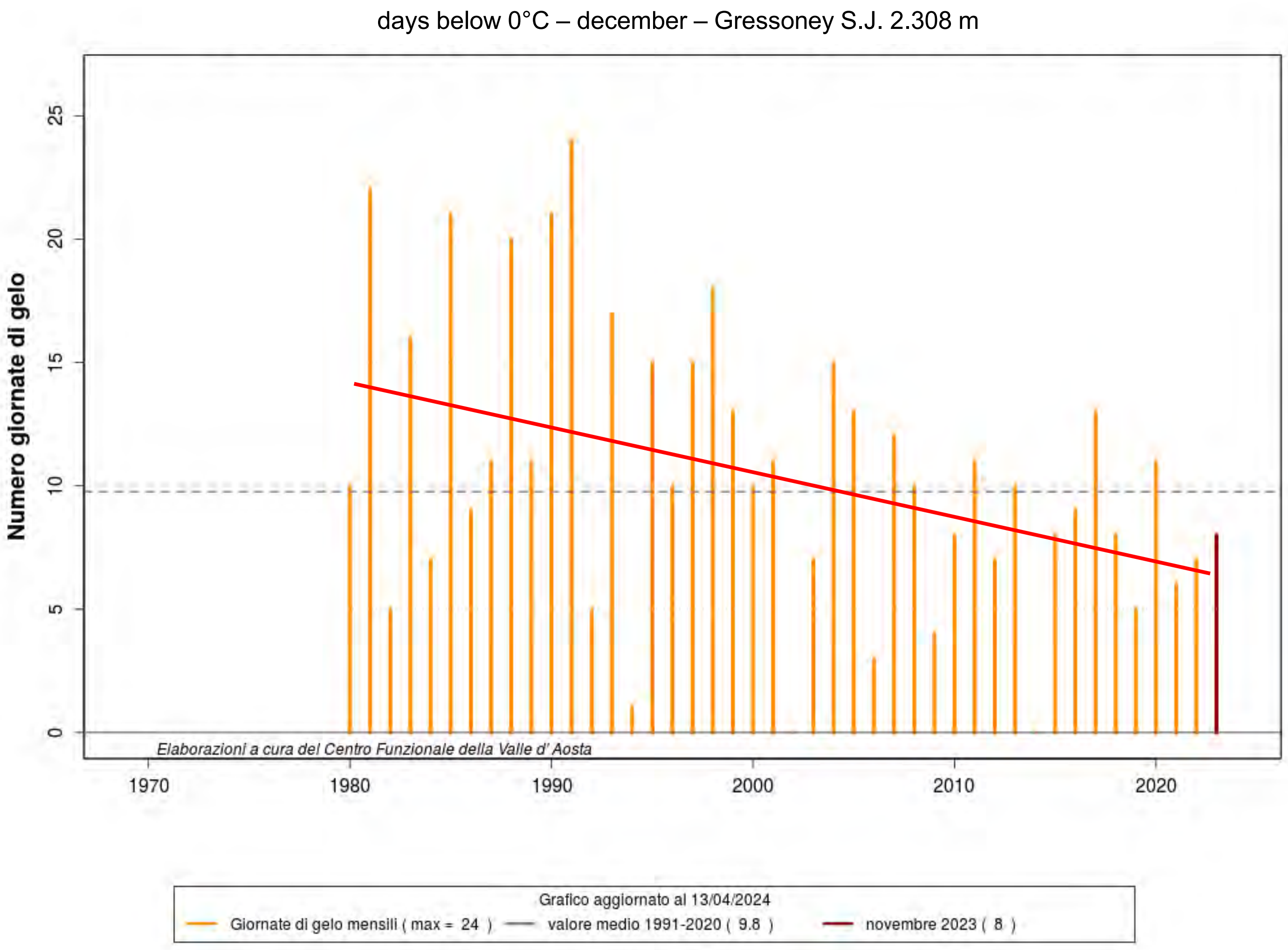


Europe – Italy - Western Alps conditions

insufficiency and decreasing quantity of natural snow

necessity of artificial snow

1- why & how



Europe – Italy - Western Alps conditions

reduction of ideal conditions

for artificial snow production

less time to carry out the work

1- why & how

artificial snow

<u>what is needed</u>

water

air

ambient conditions (temperature / humidity / wind)

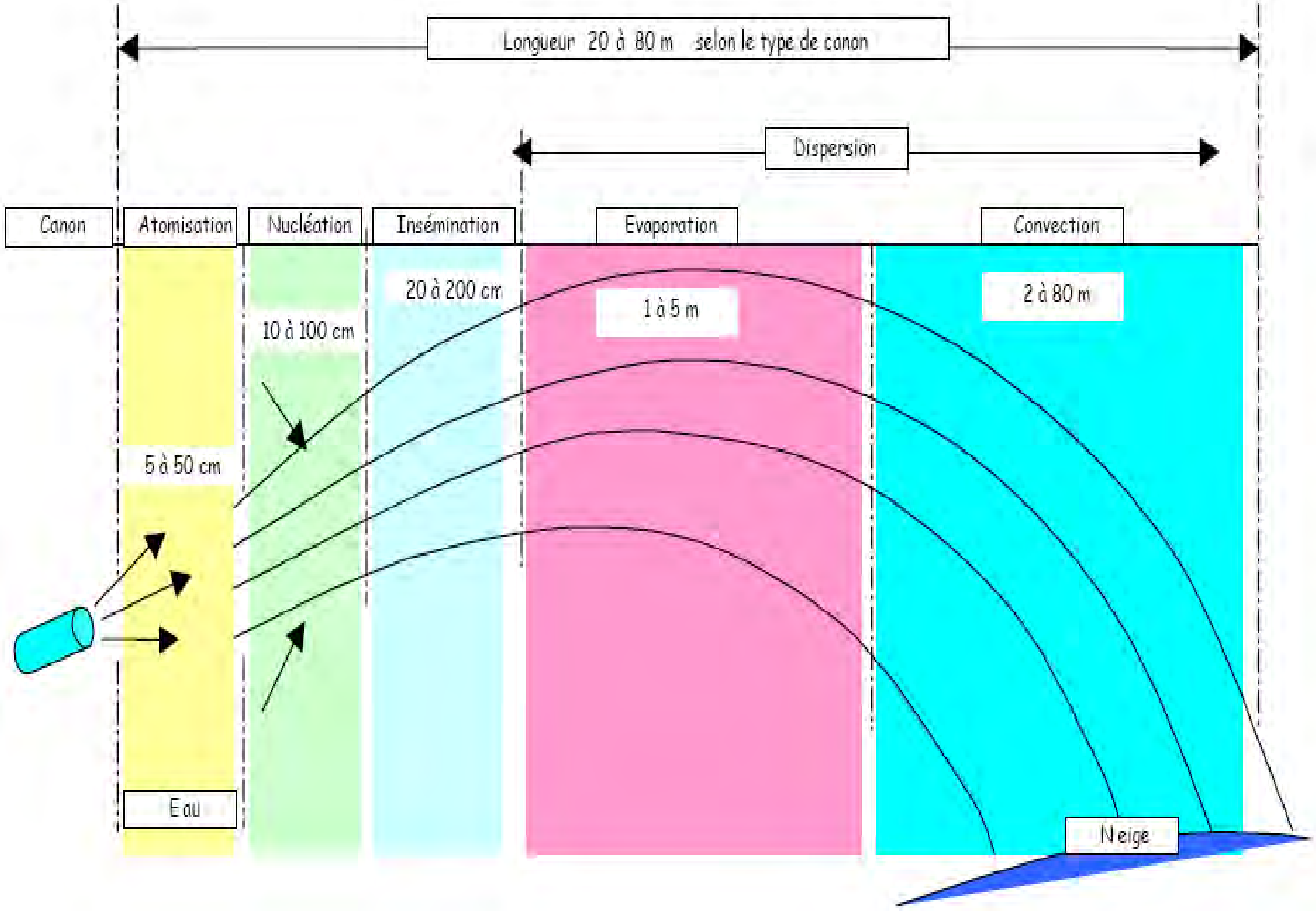
<u>how to make snow</u>

atomization (little drops formation)

nucleation (air expulsion / expansion => cooling)

insemination (water and air mix – grain formation)

dispersion (evaporation & convection)



1- why & how

ambient conditions

temperature

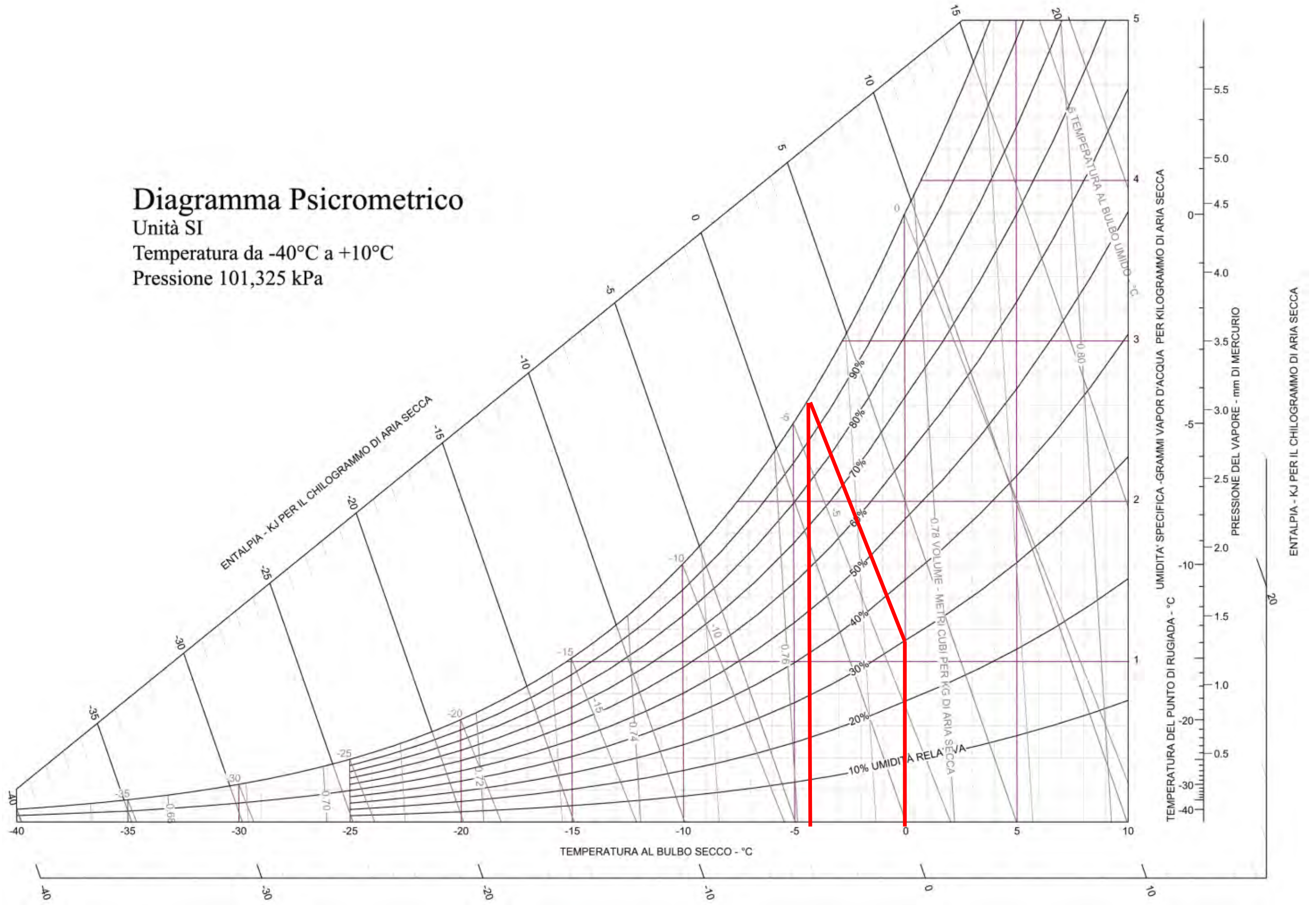
- dry temperature
- humidity

} wet bulbe temperature

for instance +0°C dry at 30% => -4°C wet

wind

- dispersion (i.e. loss) of snow
- clogging of the snow guns



2- history

the 70s – 80s

- integration of natural snow
- low flow rate
- high energy consumptions

the 2000s

- complete ski slope construction
- quantity (total & flow) => water availability

nowadays

- time factor
- cost factor (mainly energy)
- water resource management
- big data availability

3- product & system evolution

1950

70 years later …

2024

3- product & system evolution

snow lance performances

	wet temp. [°C]	water flow [m3/h]	water press. [bar]	air flow [Nm3/h]	air / water ratio
B3	-4	5,1	7,4	315,1	61,8
	-9	7,9	8,5	229,3	29,0
B6	-4	6,9	8,7	255,0	37,0
	-9	10,1	9,8	178,0	17,6
R10	-4	5,0	40,0	42,0	8,4
	-9	19,9	40,0	42,0	2,1
TL8	-4	7,6	40,0	49,0	6,5
	-9	19,8	40,0	49,0	2,5

2,5 times

1 air compressor 450 kW => 3.500 Nm3/h

11 first generation snow lances

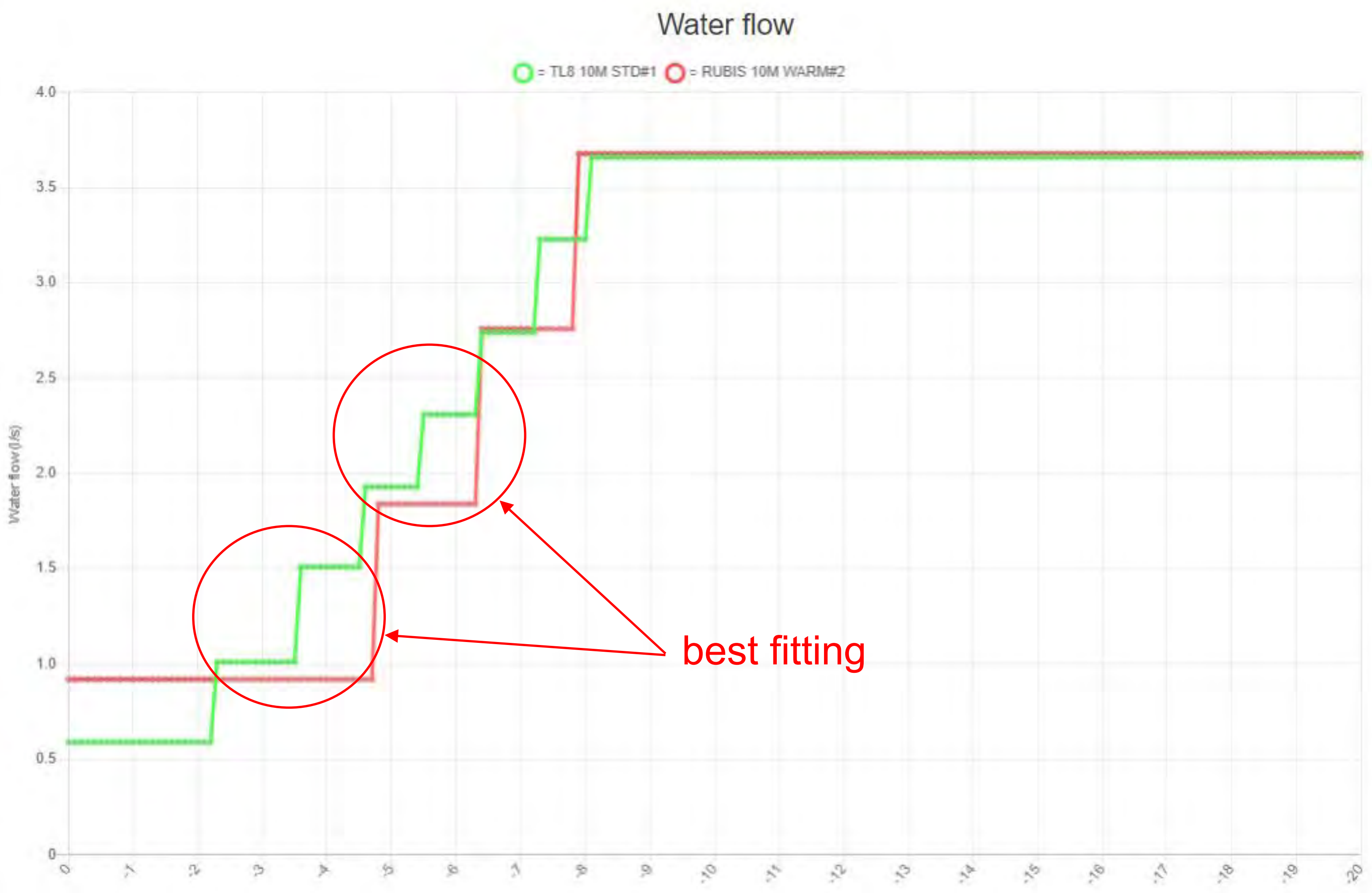
80 last generation snow lances

3- product & system evolution

snow lance performance

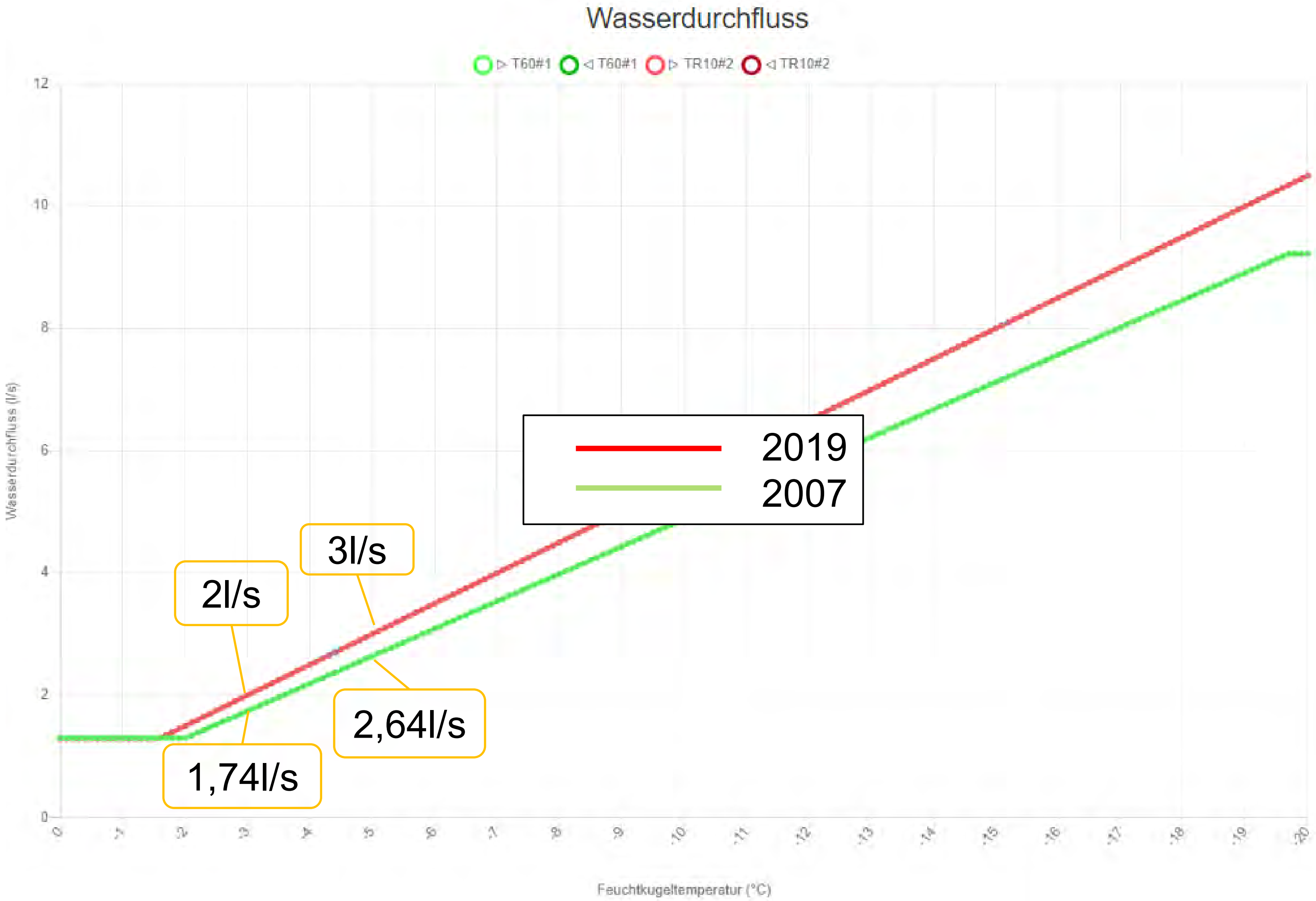
higher number of adjustable steps

nuzzles costruction material



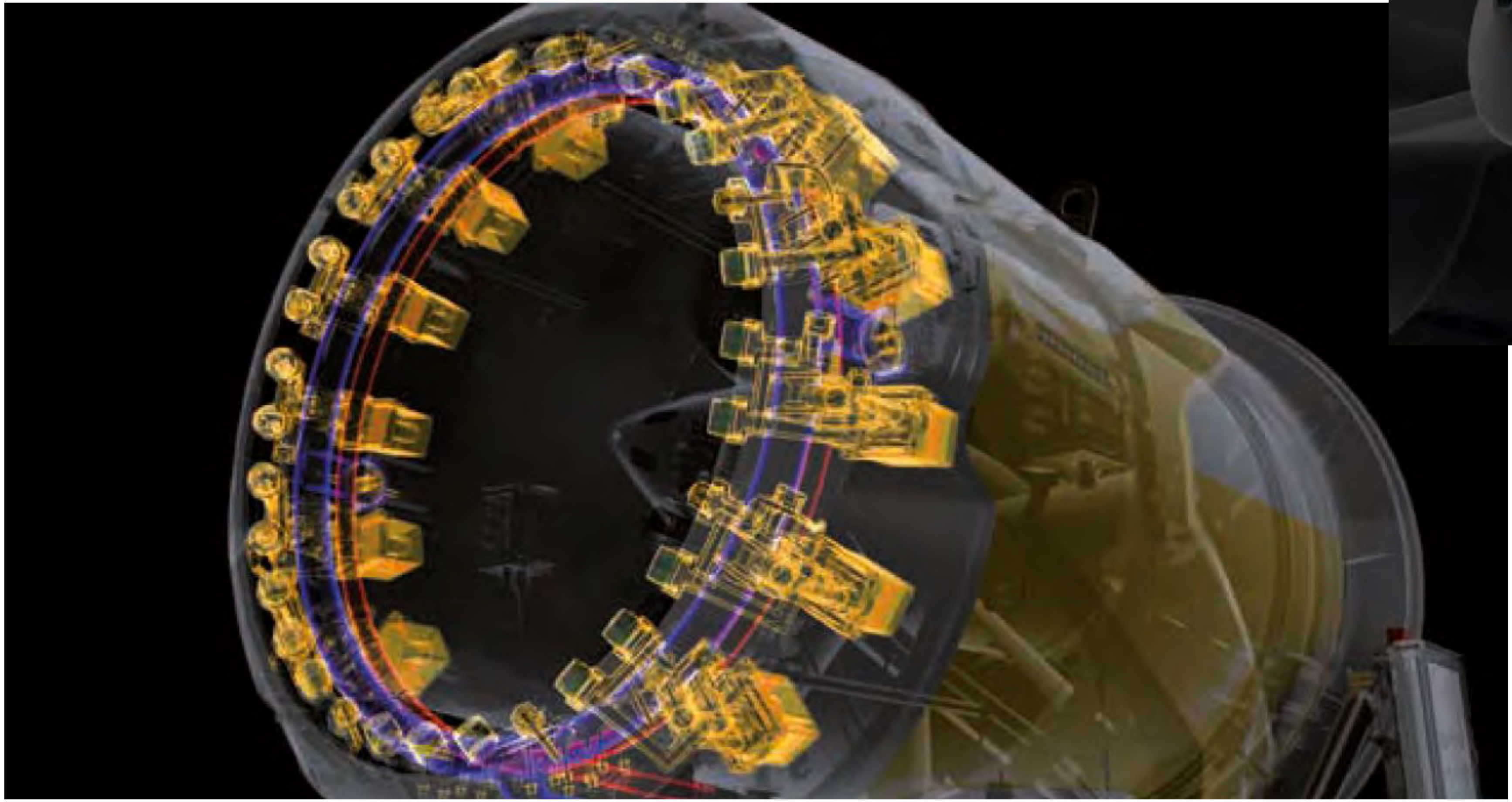
3- product & system evolution

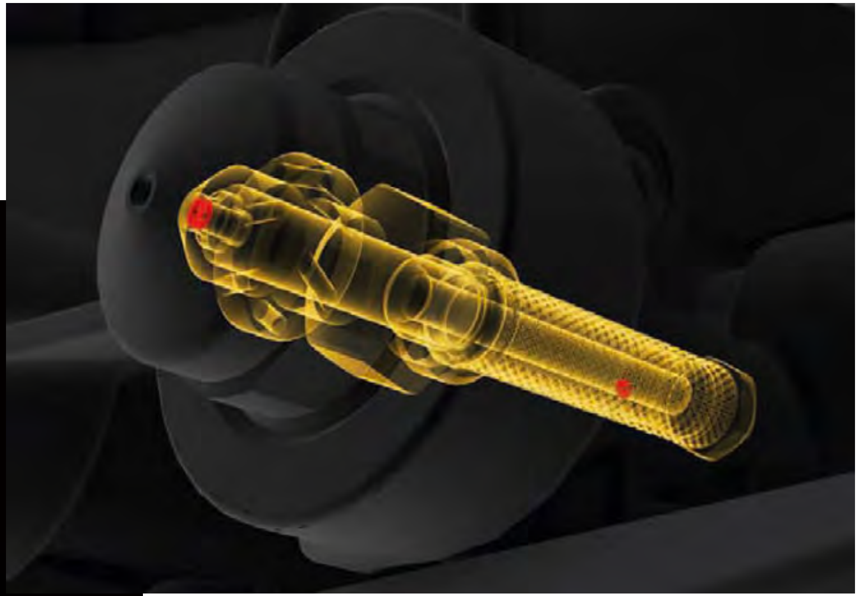
fan gun performance



3- product & system evolution

fan guns





single nozzle actuators

nuzzles costruction material

auto - adjustable position

3- product & system evolution

water reservoirs

3- product & system evolution

water reservoirs

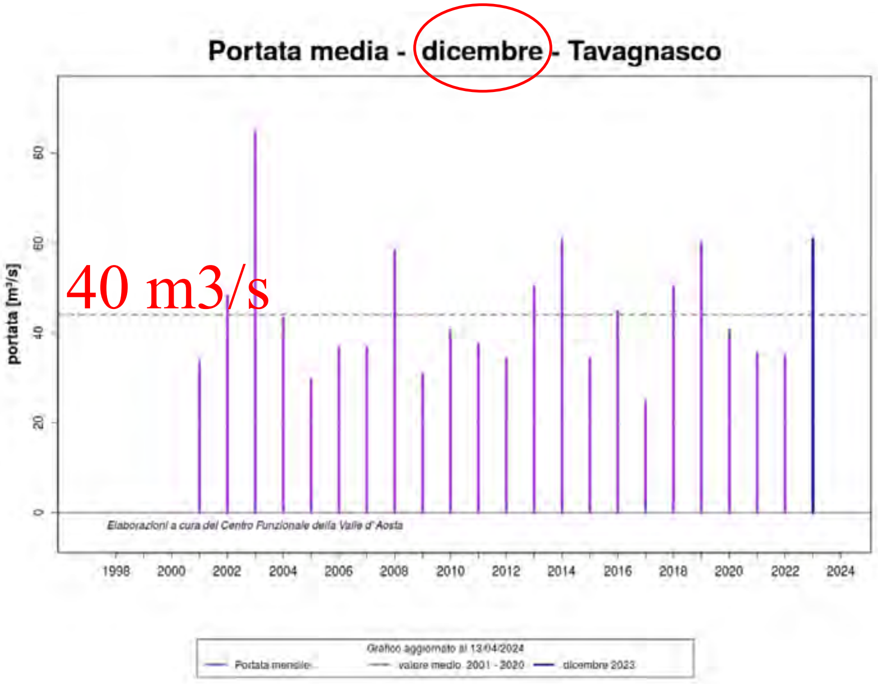
co-use:

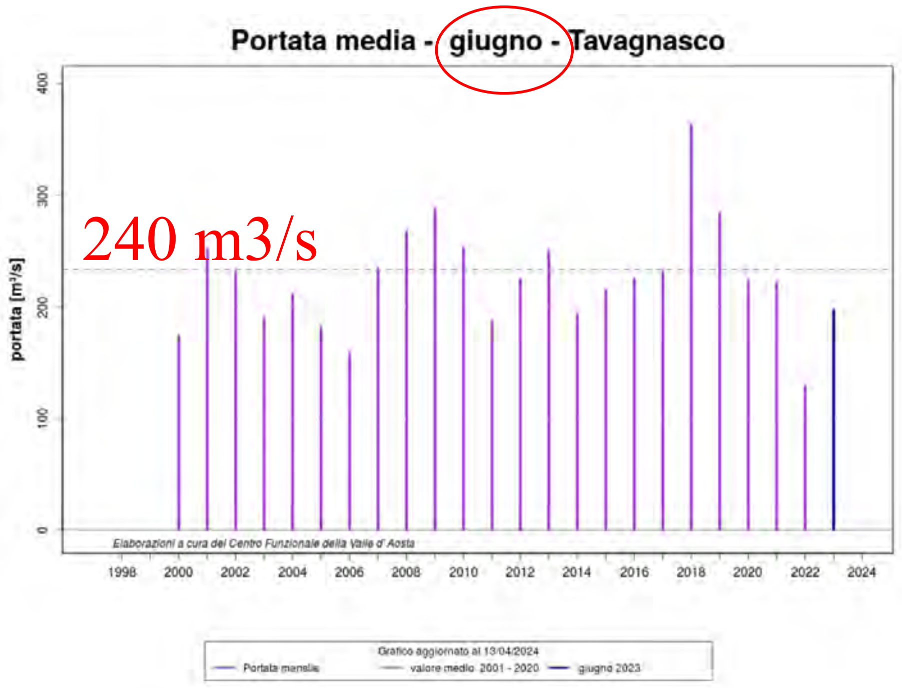
- agriculture
- hydro - electric (cost of water as lack of energy production)

3- product & system evolution

water reservoir benefits

– system: high flow rate availability for production
– environment: storage when water availability is maximal





3- product & system evolution

case study (Italy- western alps - 2019/20): impact of water location

	slopes extension [m2]	snow production [m3]	cost [€]									
			energy		personnel		water cost		grooming		TOT	TOT/m3
			cost	incidence	cost	incidence	cost	incidence	cost	incidence		
Frachey	352.000	136.994	151.083,82	1,10	15.390,72	0,11	0,00	0,00	27.286,05	0,20	193.760,59	1,41
				78%		8%		0%		14%		
Crest	209.000	92.900	241.008,27	2,59	13.904,11	0,15	0,00	0,00	22.556,58	0,24	277.468,96	2,99
				87%		5%		0%		8%		
Gressoney	565.600	170.736	139.083,46	1,02	26.494,50	0,19	68.294,10	0,50	30.888,14	0,23	264.760,20	1,55
				53%		10%		26%		12%		

water location:

- Crest: water at 1.500 m - top of the ski-area 2.700 m
- Frachey & Gressoney: water at 2.300 m – top of the ski-area 2.700/3.000 m

3- product & system evolution

energy efficiency

avarege operating hours 300 => high power demand but low energy consumption (compared to industry)

power consumption constant with temperature => bigger efficiency at colder temperature (max production) => big installation capable of taking advantage of the best conditions are the most efficient

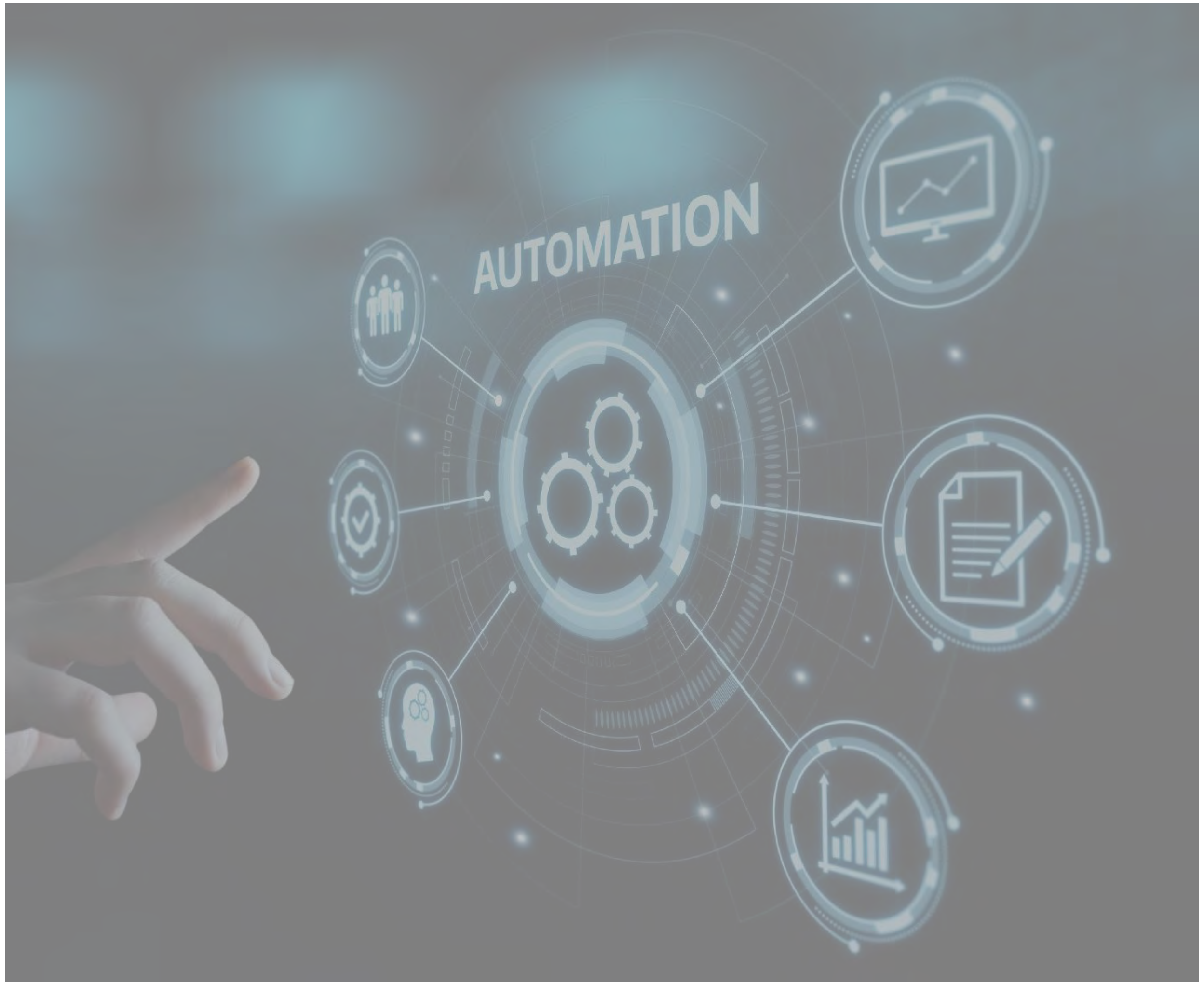
4- data analysis for further optimization

automation

adjust function parameters on actual ambient conditions (colder => more guns => quality up)

planning (target) based on historical and DigitalTerrainModel

planning adjustment based on snow depth measurement



4- data analysis for further optimization

snow depth

knowing exact snow depths use the snow in a targeted manner

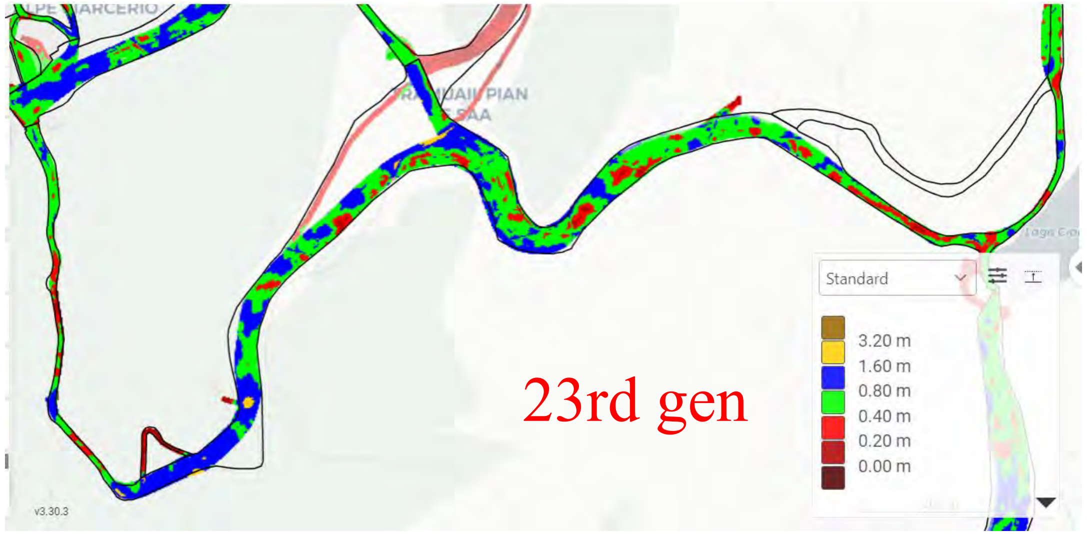
more productivity & conserves resources and protects the environment at the same time

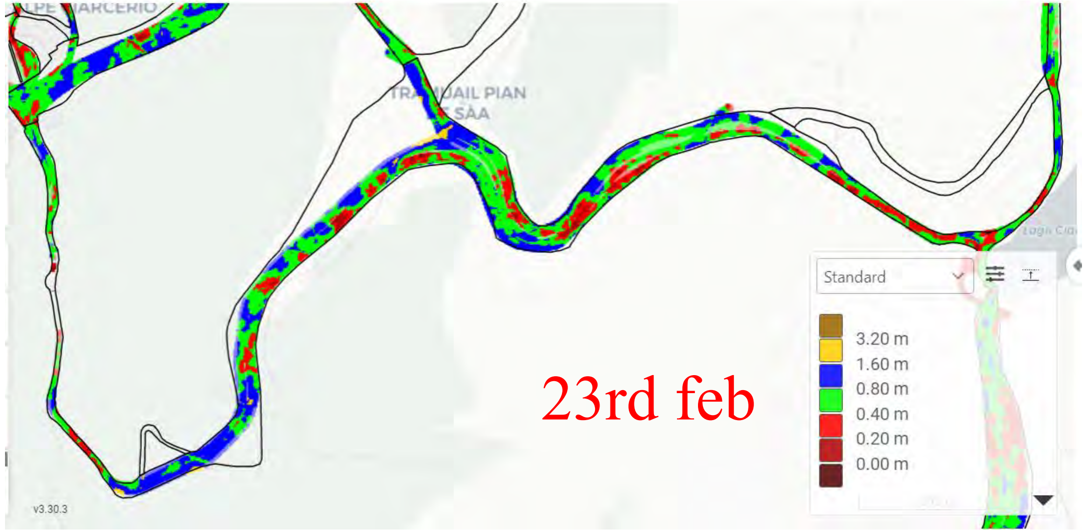
Take into account snow “consumption”:

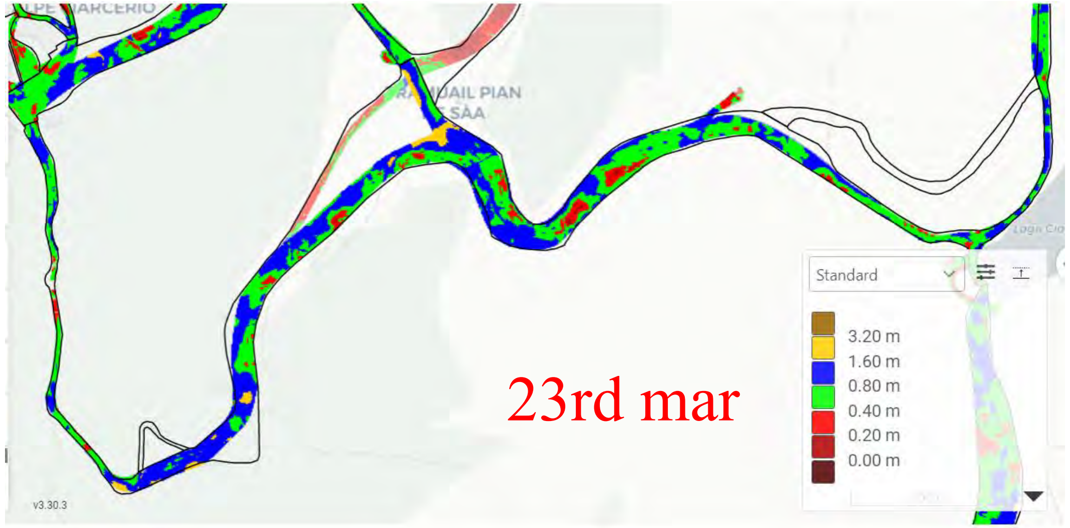
– melting
– sublimation
– skier transport
– wind

4- data analysis for further optimization

snow depth







4- data analysis for further optimization

weather forecast

should I produce tonight at - 3°C or should I wait for better conditions?

Local models fitted and improved with historical weather data from snow guns => customised weather forecasts

(no longer having to rely on large-scale weather data, which can differ greatly, especially in mountain areas)

better production

(take advantage of optimal conditions for maximal production & better snow quality)

better water utilisation

(do not empty water reservoir in non optimal conditions)

4- data analysis for further optimization

production analysis for product & system development

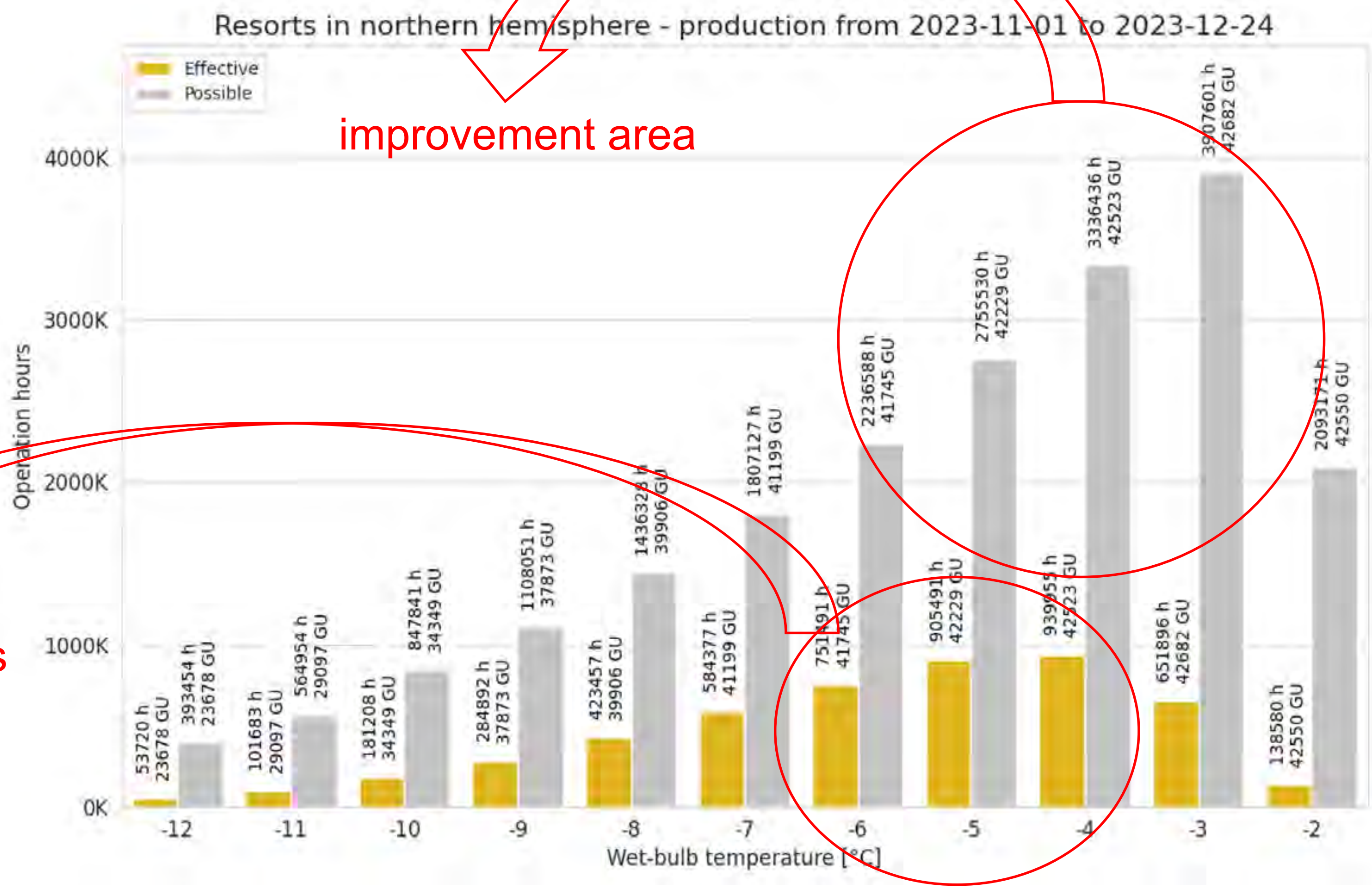
operating data from more than 40.000

focus mostly on utilized conditions and

non utilized conditions for optimal

new installation design and

product development



> 70 % of operating hours
> 60 % of annual volume

5- efficiency in detail

pump station

water & energy (65% of the electrical power is used to supply water to the plants)

pumps with frequency drive

snowmaking with guns in the upper part at colder temperatures => reduce running time of the pumps with more pressure and more power consumption

5 bar => 16% energy saving

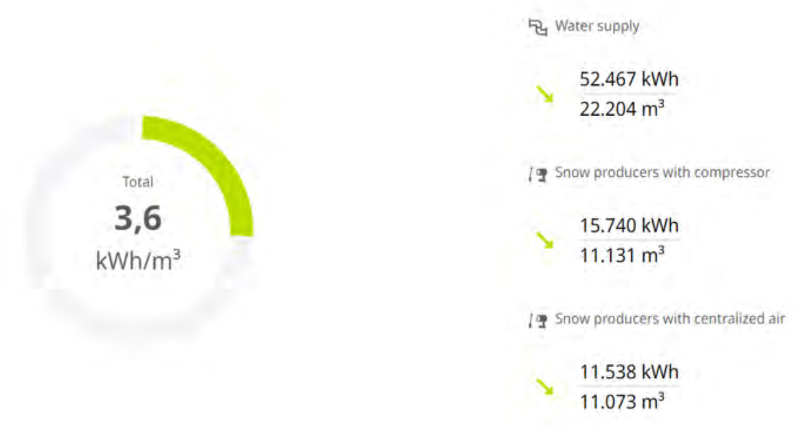
5- efficiency in detail

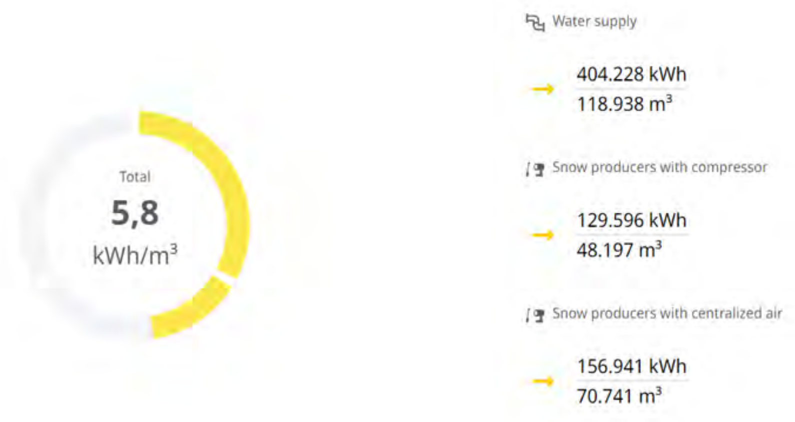
compressors central air

1 bar => 7% energy saving

check the pressure setpoint in order to minimize it (8bar - 1bar => 7bar - 2bar)

energy management





lake aeration

control of the running times

only switch on when it is effectively below 0°C

5- efficiency in detail

water temperature

for every 4°C warmer water, it takes 1°C WB temperature colder to produce the same snow

water temperature +1 °C => -2,0° C WB (real conditions)

water temperature +5 °C => -3,0° C WB

water temperature +9 °C => -4,0° C WB

cooling towers

water at the ideal temperature improves the performance of the individual snow guns and therefore increases energy efficiency

Thank you for your Attention!