2025 International Year of Glaciers' Preservation

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https://www.un-glaciers.org/

How glaciers react to global warming: the “Glacier cooling” effect

Franco Salerno

ISP Istituto di Scienze Polari Consiglio Nazionale delle Ricerche

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Pyramid metereorological network

Pyramid is the highest meteorological time series in Himalaya

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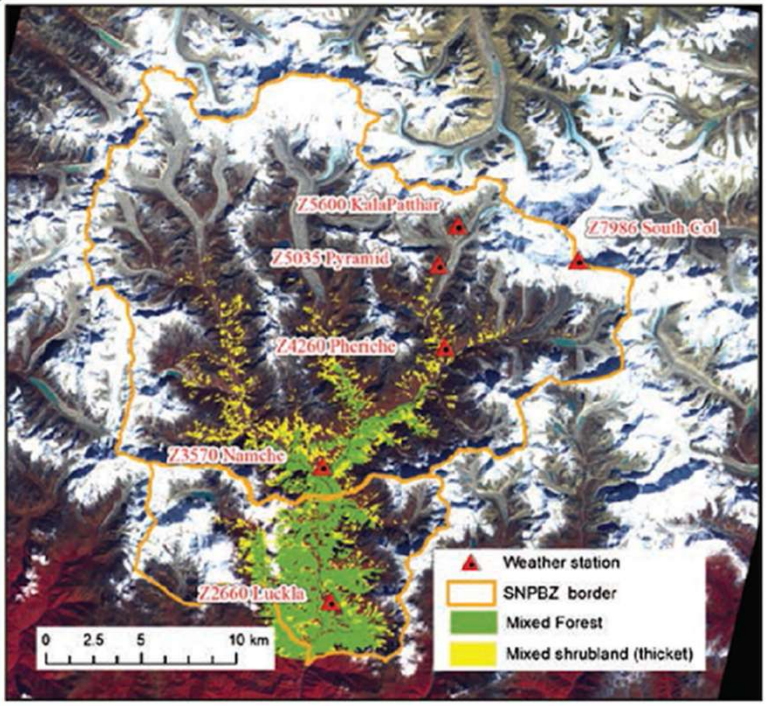
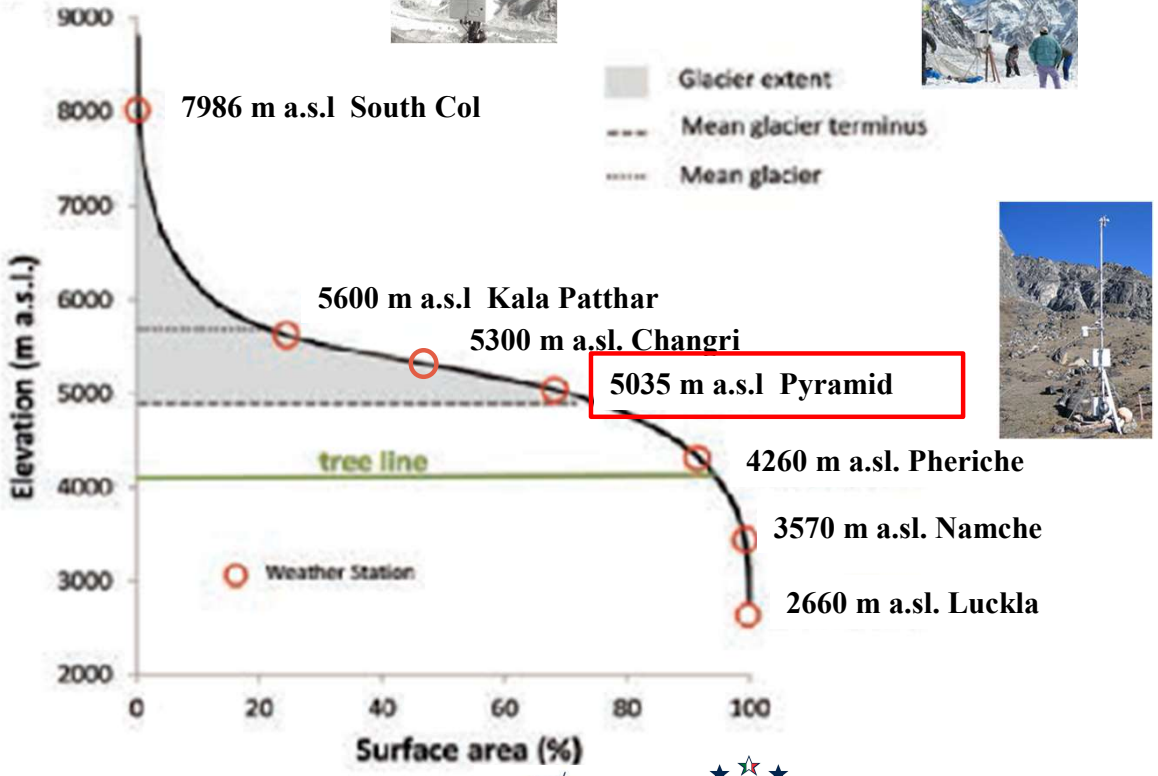
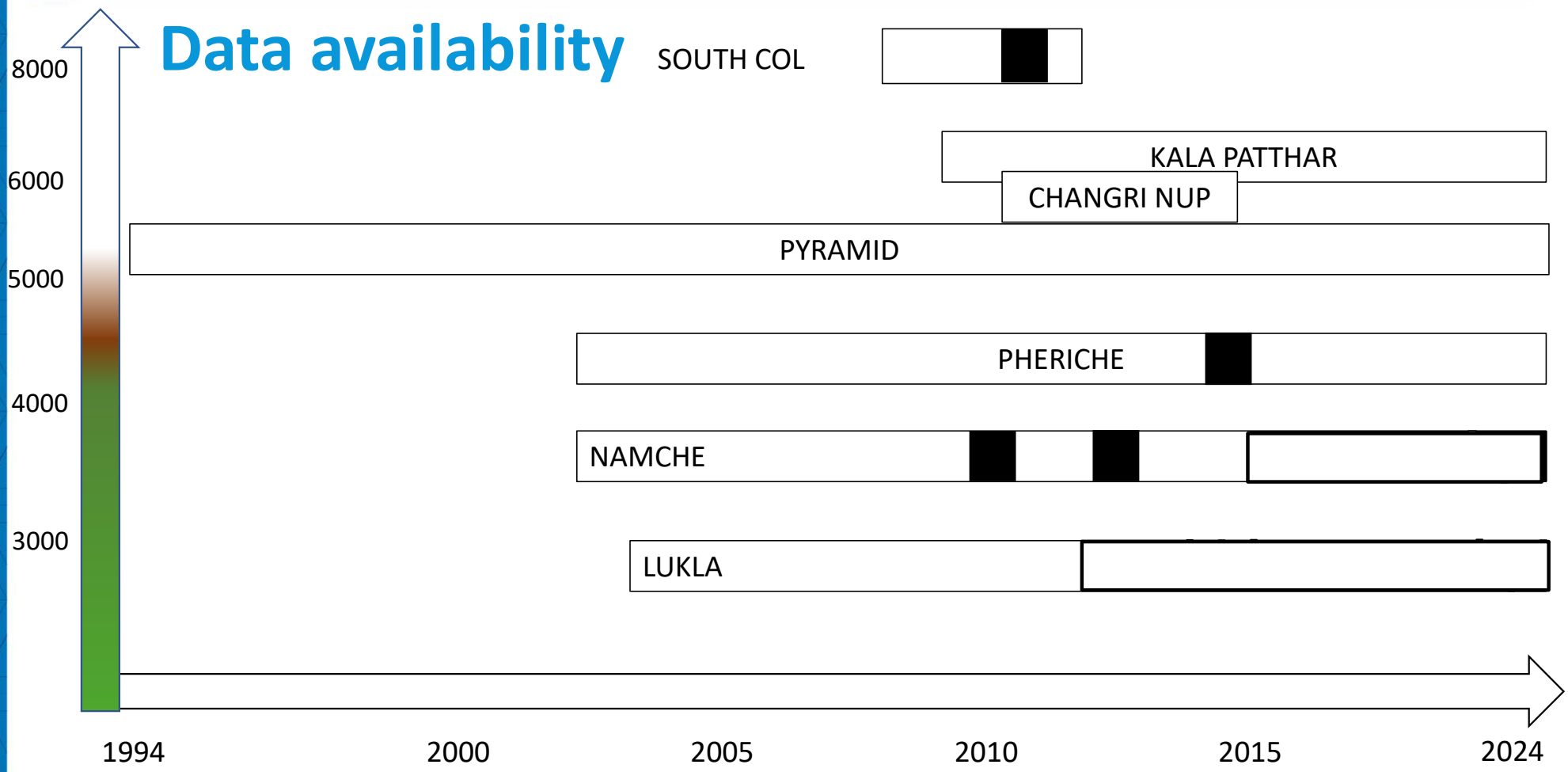

Z5600 KalaPatthar
Z7986 South Col
Z5035 Pyramid
Z4260 Pheriche
Z3570 Namche
Z2660 Luckla
Weather station
SNPBZ border
Mixed Forest
Mixed shrubland (thicket)
0 2.5 5 10 km


Elevation (m a.s.l.)
9000
8000
7000
6000
5000
4000
3000
2000
0
20
40
60
80
100
Surface area (%)
Glacier extent
Mean glacier terminus
Mean glacier
Weather Station
tree line
7986 m a.s.l South Col
5600 m a.s.l Kala Patthar
5300 m a.s.l. Changri
5035 m a.s.l Pyramid
4260 m a.s.l. Pheriche
3570 m a.s.l. Namche
2660 m a.s.l. Luckla

Data availability



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30 years of climatic data

- Air temperature
- Precipitation
- Wind
- Pressure
- Humidity
- Snow level
- Soil temperature
- Outcoming long/short radiation
- Incoming long/short radiation

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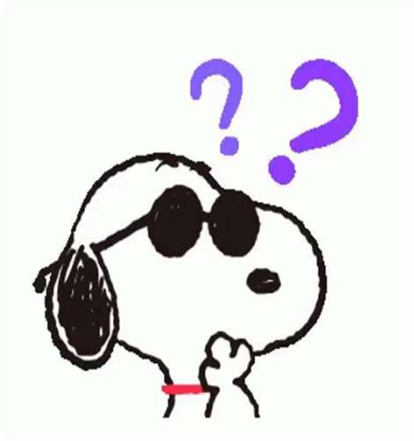
Research questions



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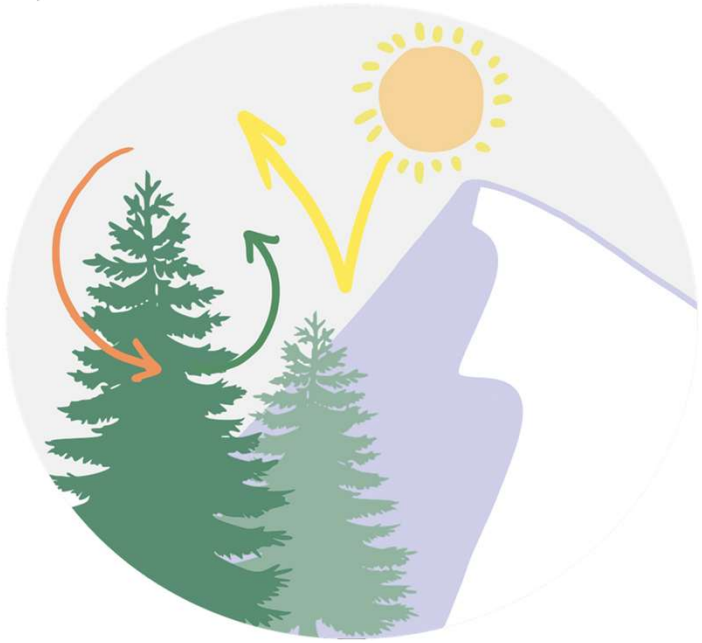
Does Elevation Dependent Warming exist in high mountain Asia?



There is some controversy about the EDW of high mountain Asia. Probably, EDW occurred in some areas, but not all of regions or all seasons.

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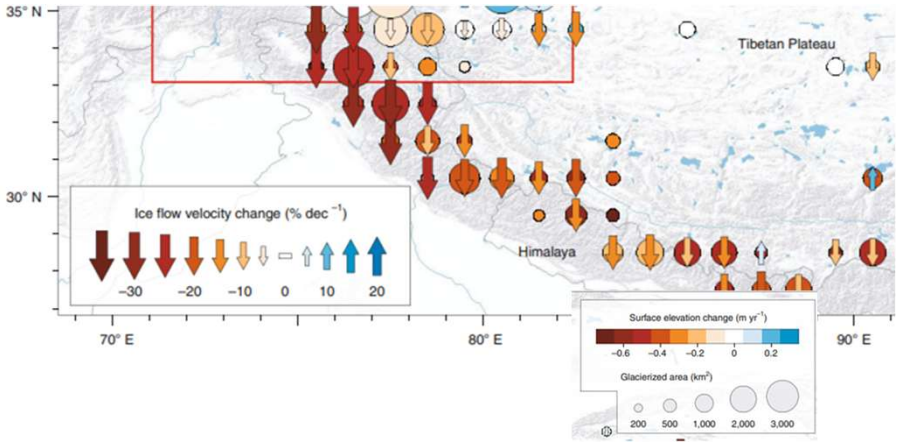
Why **Himalayan glacier are shrinking** in the last decades?

Himalayan glaciers have responded by generally losing mass and as a result have received considerable attention associated with their importance as a water supply



Farinotti et al., 2020

Increased temperaure are considered generally the main drive of change. However, many studies are starting considering **precipitation** as reponsible of regional differences on glacier changes

Yao et al., 2012; Salerno et al., 2015; Sherpa et al., 2017

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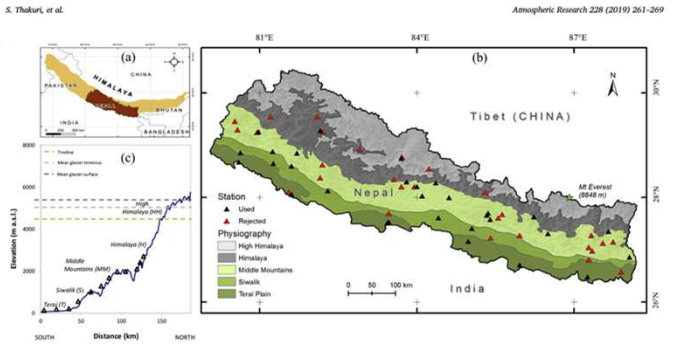
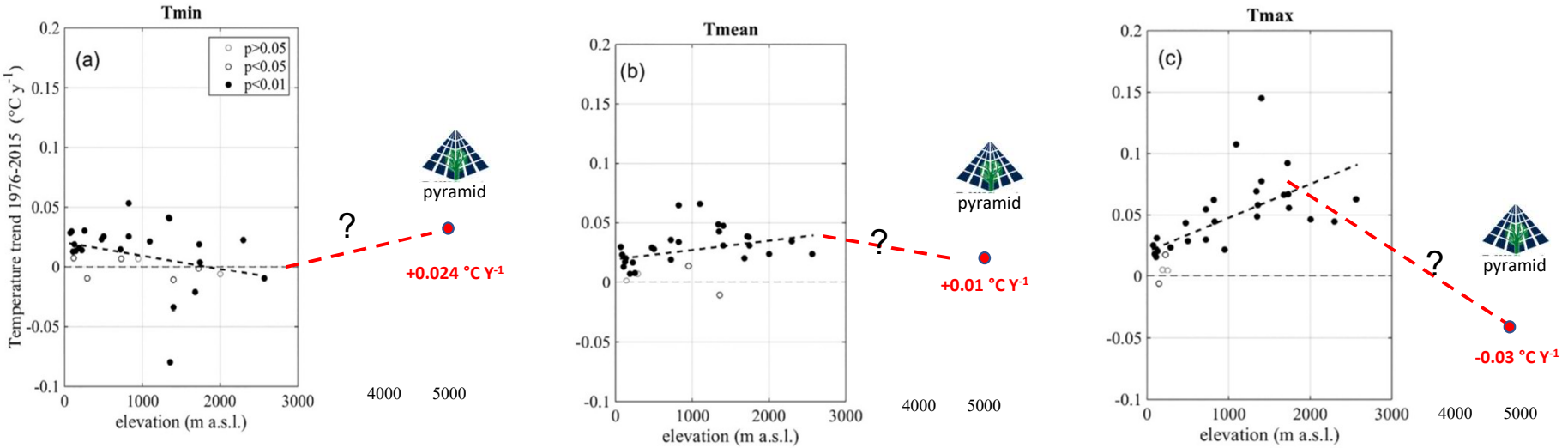
The Elevation Dependent Warming in Nepal?



Thakuri et al., 2019



Yes, it exists only for TMAX until 2000 m.
At higher elevation the trend decreases and becomes significantly negative

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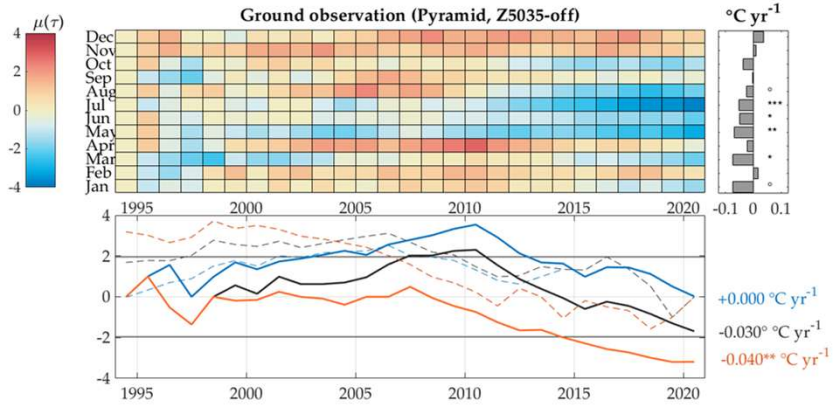
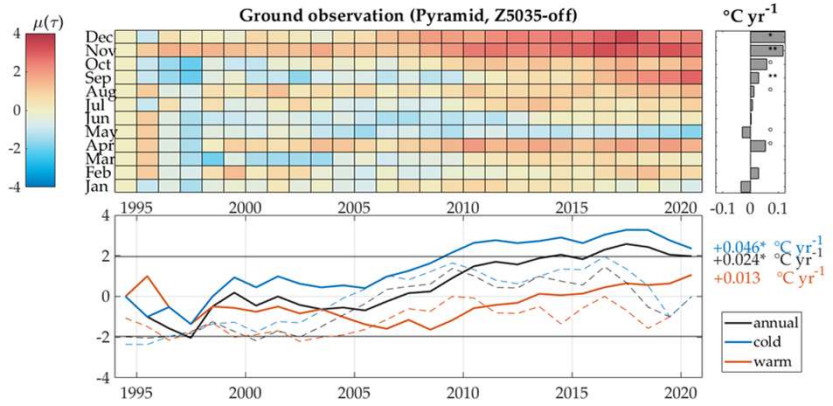
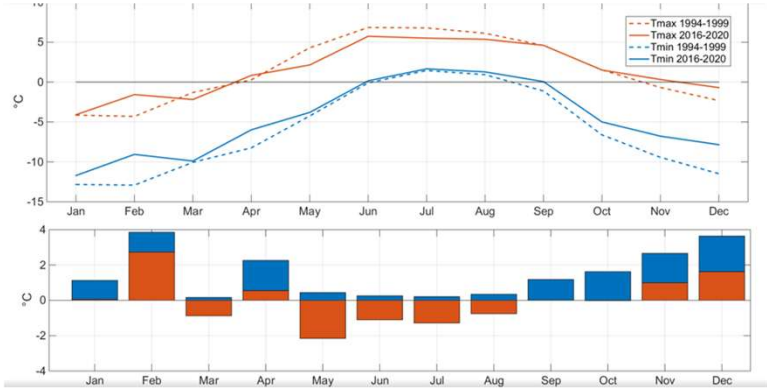
Seasonal trends at Pyramid (5000 m a.s.l.)

MAXIMUM TEMPERATURE



MINIMUM TEMPERATURE





There are other factors, over the temperature, responsible of the glacier shrinking

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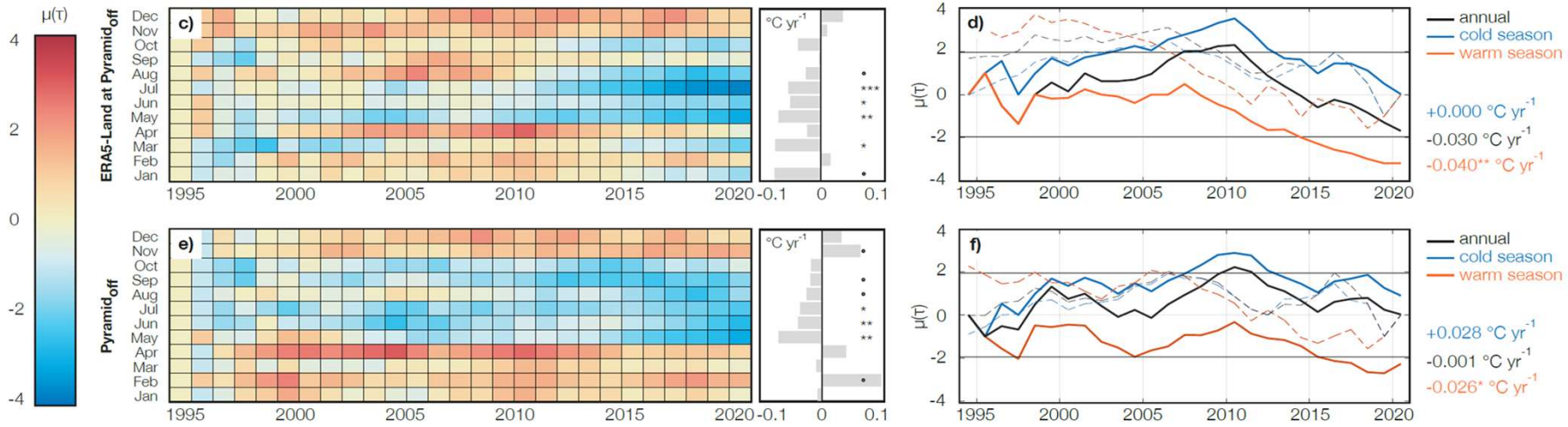
Pyramid metereorological network Comparison between Observations (Pyramid) and Reanalysis data (ERA5land)



Reanalysis data (like ERA5Land proposed here) provide the most complete picture currently possible of past climate

They are a blend of observations with past short-range weather forecasts rerun with modern weather forecasting models.

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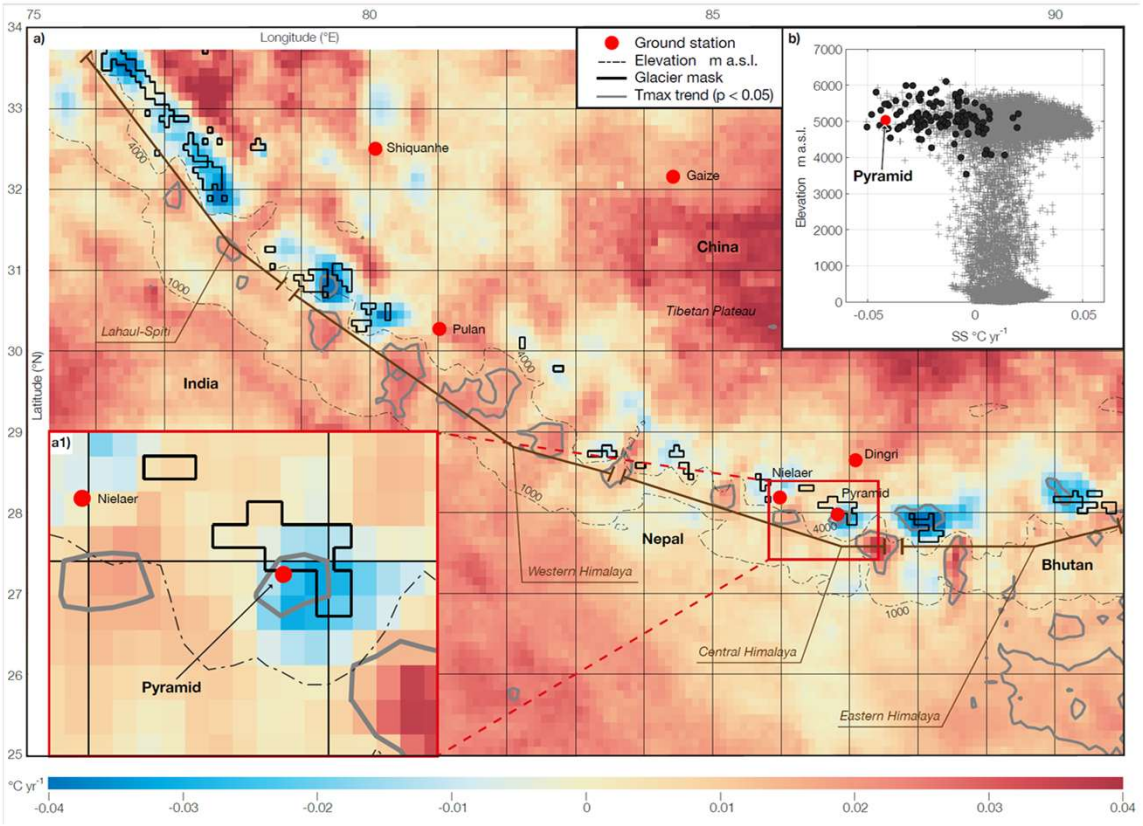
Era5Land summer maximum temperature trend for Himalaya



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The cooling observed with the Pyramid station is widespread in the entire hight Himalaya close to glacier masses

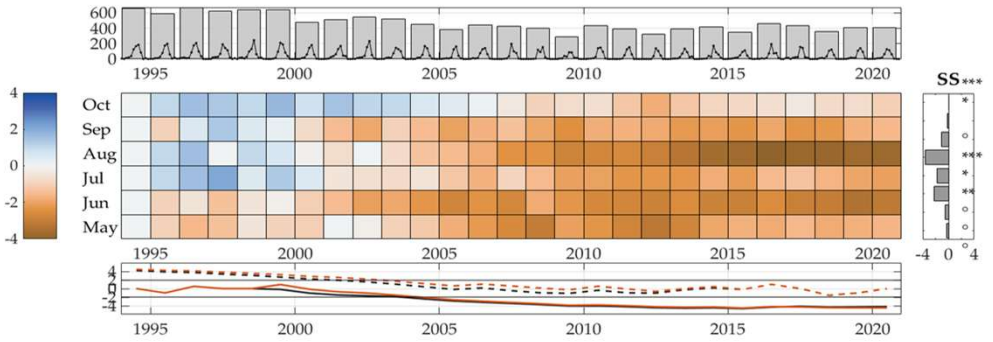
Summer Precipitation trends observed at Pyramid

The Cryosphere, 9, 1229–1247, 2015
www.the-cryosphere.net/9/1229/2015/
doi:10.5194/tc-9-1229-2015

The Cryosphere
Open Access

Weak precipitation, warm winters and springs impact glaciers of south slopes of Mt. Everest (central Himalaya) in the last 2 decades (1994–2013)

F. Salerno[1,4], N. Guyennon[2], S. Thakuri[1,4], G. Viviano[1], E. Romano[2], E. Vuillermoz[4], P. Cristofanelli[3,4], P. Stocchi[3], G. Agrillo[3], Y. Ma[5], and G. Tartari[1,4]



At Pyramid summer precipitation are decreased of -40% in 28 years

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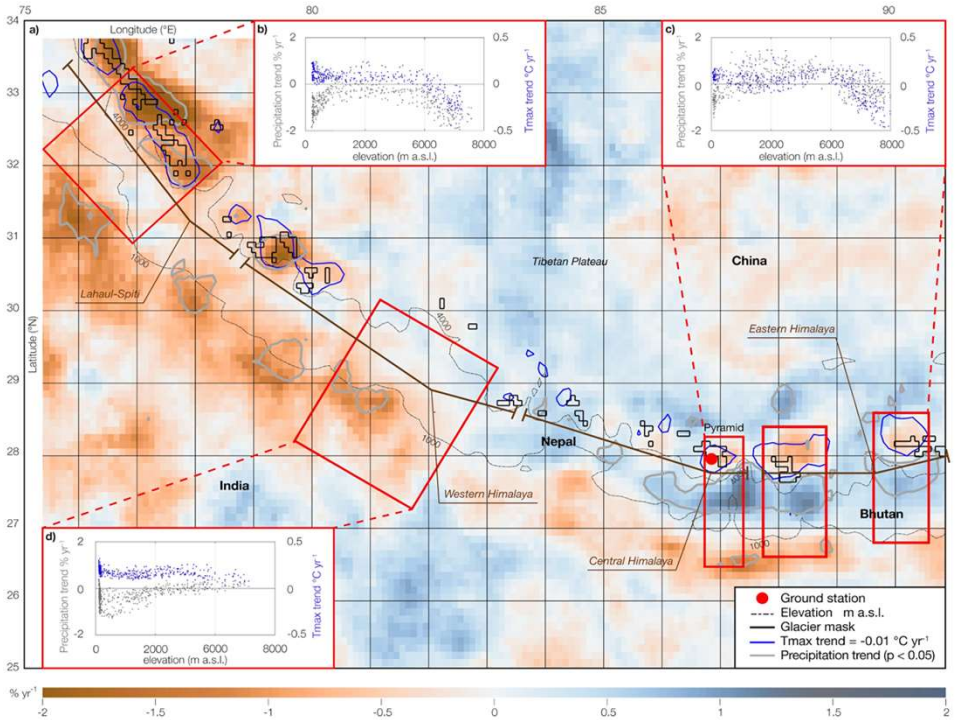
Pyramid metereorological network Era5Land summer precipitation trend for Himalaya



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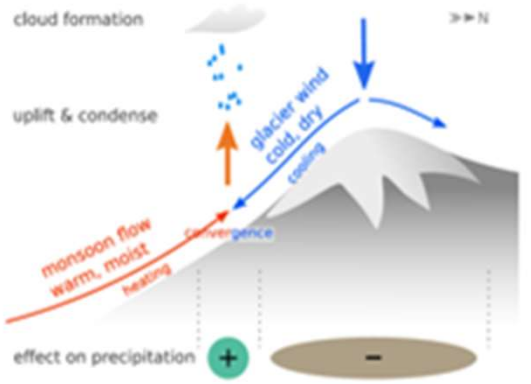
Atmospheric Research
Volume 259, September 2021, 105658

Summer afternoon precipitation associated with wind convergence near the Himalayan glacier fronts



Lin et al…(Salerno), 2021

This paper poses the basis of physical dynamics
explaining the observed cooling and the weakening of precipitation …..

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Increased katabatic winds move the glacier cooling and the convergence downglacier

stationary conditions

non-stationary conditions

nature geoscience

Article

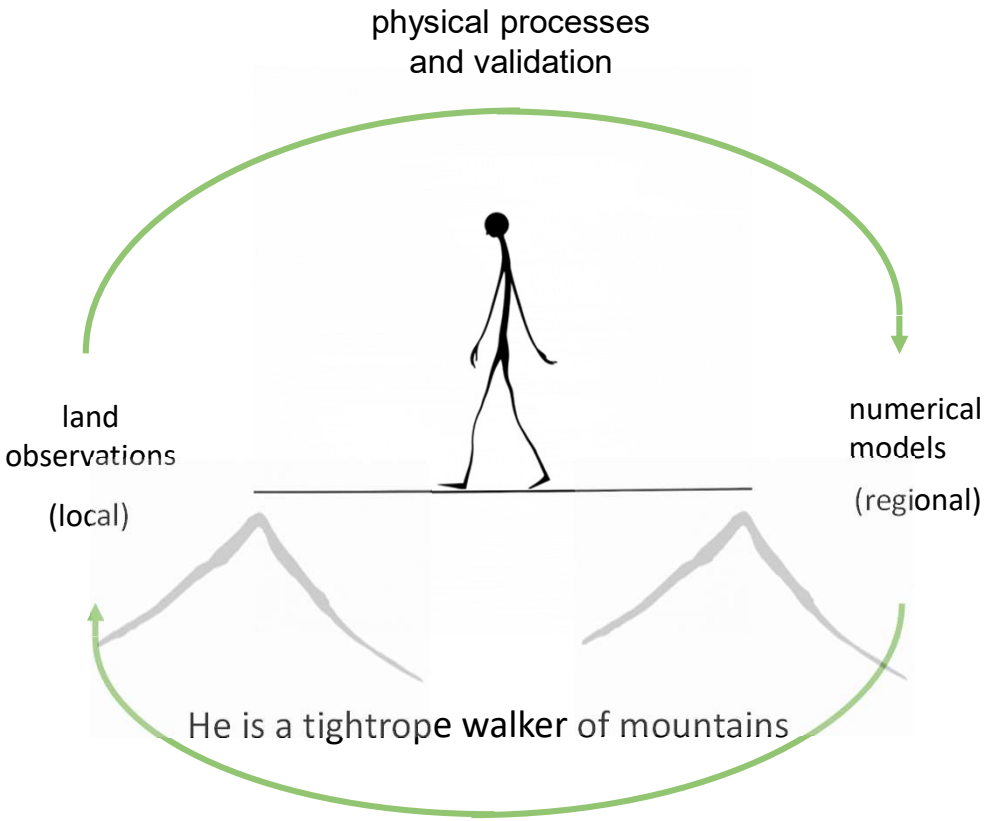
https://doi.org/10.1038/s41561-023-01331-y

Local cooling and drying induced by Himalayan glaciers under global warming

Franco **Salerno**[1,2,*,†], Nicolas **Guyennon**[3,**,†], Kun Yang[4,5], Thomas E. Shaw[6], Changgui Lin[7], Nicola Colombo[3,8], Emanuele Romano[3], Stephan Gruber[9], Tobias Bolch[10], Andrea Alessandri[11], Paolo Cristofanelli[11], Davide Putero[12], Guglielmina Diolaiuti[13], Gianni Tartari[2], Gianpietro Verza[14], Sudeep Thakuri[15], Gianpaolo Balsamo[16], Evan S. Miles[6], Francesca Pellicciotti[6,17]

https://www.un-glaciers.org/

Conclusions



This phenomenon is potentially valid worldwide, although we decided to limit our analysis considering the generalised **data scarcity** in high-elevation areas across the globe and by focusing on morphometric and climatic homogeneities on a regional basis.

Indeed, morphological (e.g., debris cover, local topography, total glacier area, and glacier energy balance) and climatic factors have a fundamental role in the processes analysed.

Currently, their coarse treatment due to coarse resolution in ERA5-Land, or absence (e.g., debris), are an obvious limit,

Future research should focus on filling the current knowledge gap about the factors determining the occurrence, the magnitude and the downward effects of katabatic processes

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THANKS

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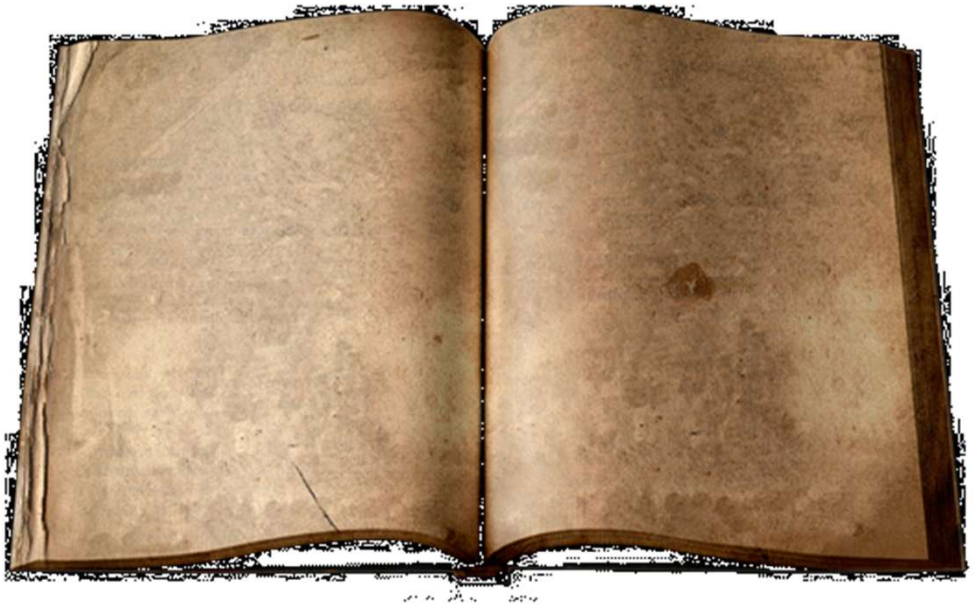
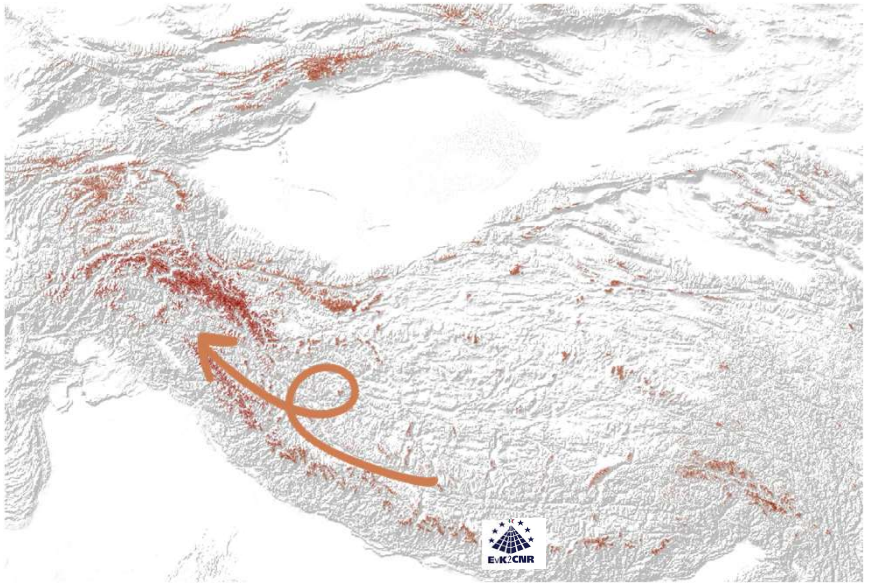
THE NEW HISTORY

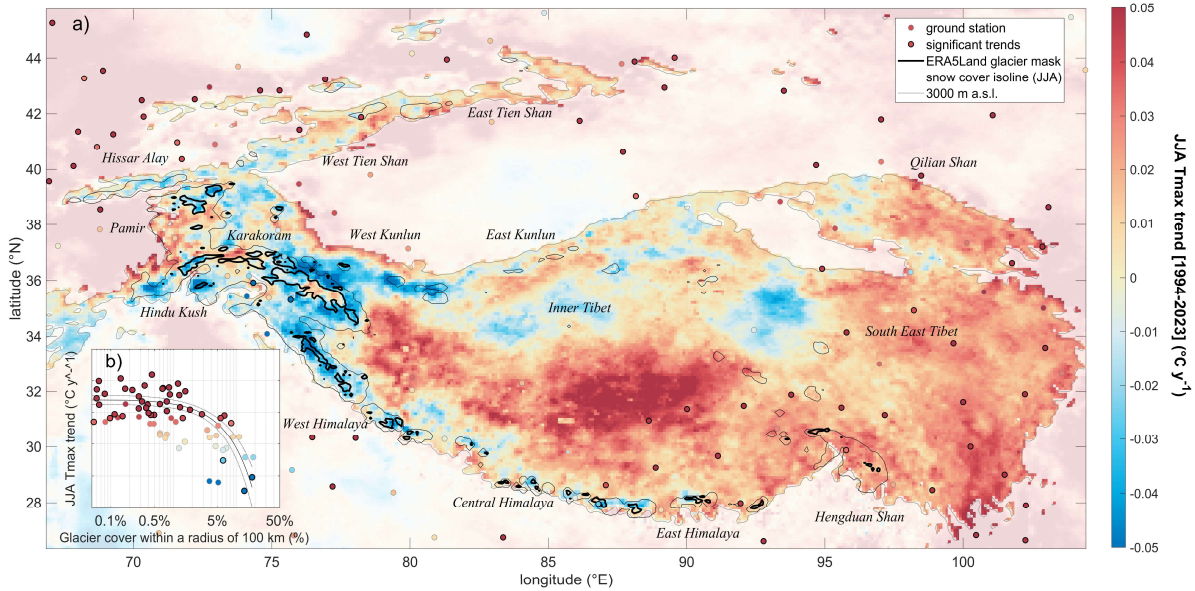
THE COOLING TREND IN KARAKORAM AND THE REST OF HMA





FIRST CHAPTER

Can the summer cooling in HMA be explained by the presence of glacier masses?



SECOND CHAPTER

Can the summer cooling be responsible of the different glacier mass changes in HMA?

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