
Marmot

How CHARIS has benefited Partners

- **JNU, India**: "better understand glacier dynamics by supporting weekly measurements of snow and ice on Chotta Shigri glacier"
- **Sherubtse College, Bhutan**: "enhanced and expanded research facilities and capabilities of faculty members" and "facilitated direct collaboration with Bhutan Department of Hydro-Met Services"
- **Kabul University, Afghanistan**: "Used materials developed and presented at CHARIS workshops for geoscience courses"
- **Institute of Water Problems & Hydropower, Kyrgyz Republic:** "reconstruction of research hut at Kara Batkak glacier allows researchers to remain on site for extended periods, several hydro-met stations repaired/re-placed, and digitize previous scientific reports"

CHARIS Socioeconomic Field Research in Kyrgyz Republic

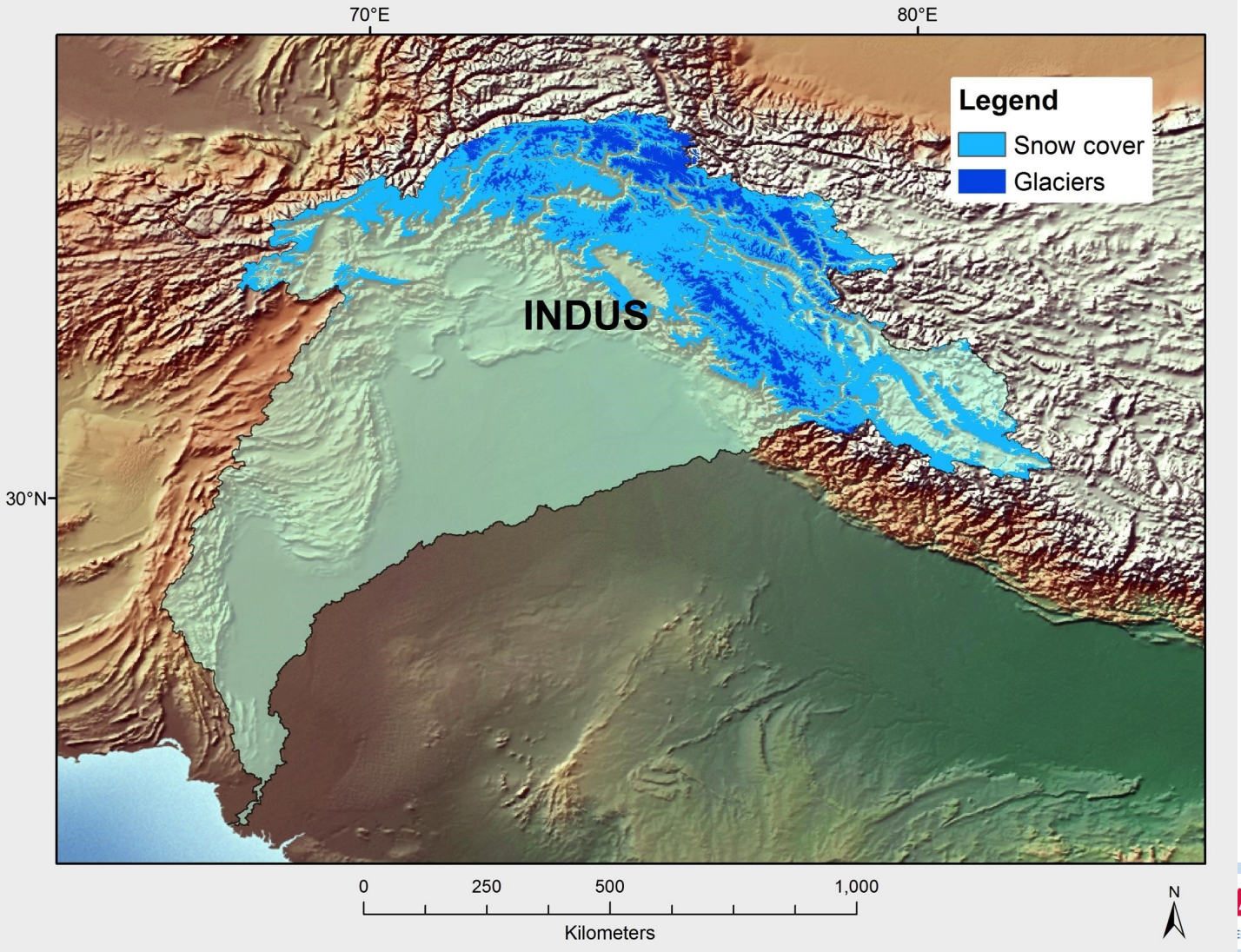
- **Hydrologic Controls and Water Vulnerabilities in the Naryn River Basin, Kyrgyzstan: A Socio-Hydro Case Study of Water Stressors in Central Asia:** In the summer of 2016, CHARIS team members collected water samples and conducted community surveys along the Naryn River Basin, a headwater stem of the Syr Darya. The resulting hydrological data show which sources are contributing to river discharge at 13 sites, while the socio-data sets illuminate how water availability and access has changed over time. Results published in: Hill, A. F., Minbaeva, C. K., Wilson, A. M., & Satylkanov, R. (2017) *Water*, *9*(5), 325.

At the SOHAM (Society of Hydrology and Meteorology-Nepal) conference in Kathmandu, April 10-11, 2017 CHARIS Asian partners gave 10 talks and presented 4 posters. (CHARIS University of Colorado participants gave 3 talks and presented 1 poster)

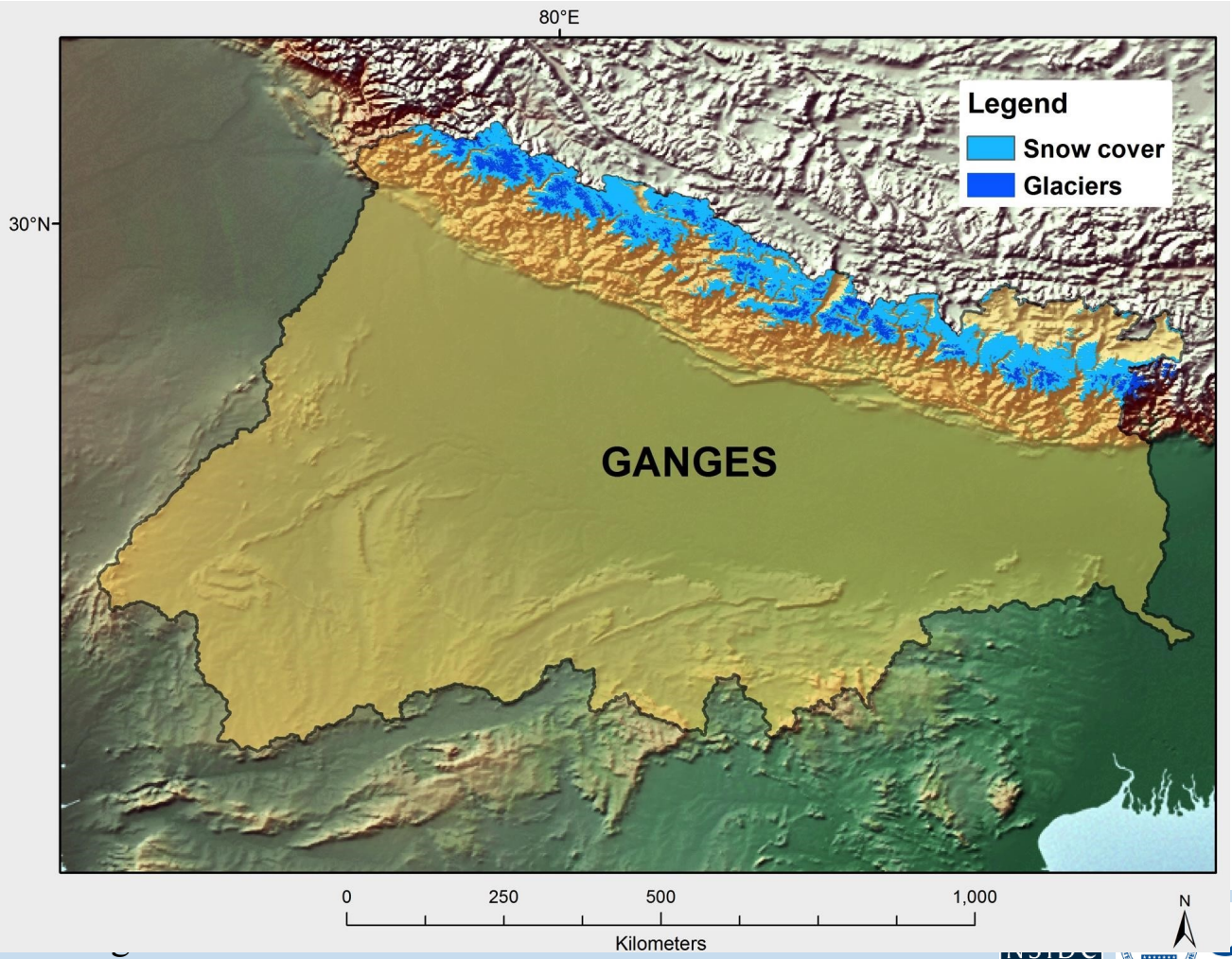
At the 2013 SOHAM conference, CHARIS partners were in attendance but they did not give talks or present any posters. Quite a difference in 4 years.

All CHARIS partners agreed that the two events briefly described above were successful by every measure, as evidenced by the lively scientific discussions, congeniality and friendship among the partners.

Indus


70°E
80°E
30°N
Legend
Snow cover
Glaciers
INDUS
0
250
500
1,000
Kilometers
N

Ganges


80°E
30°N
Legend
Snow cover
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0
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500
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Kilometers
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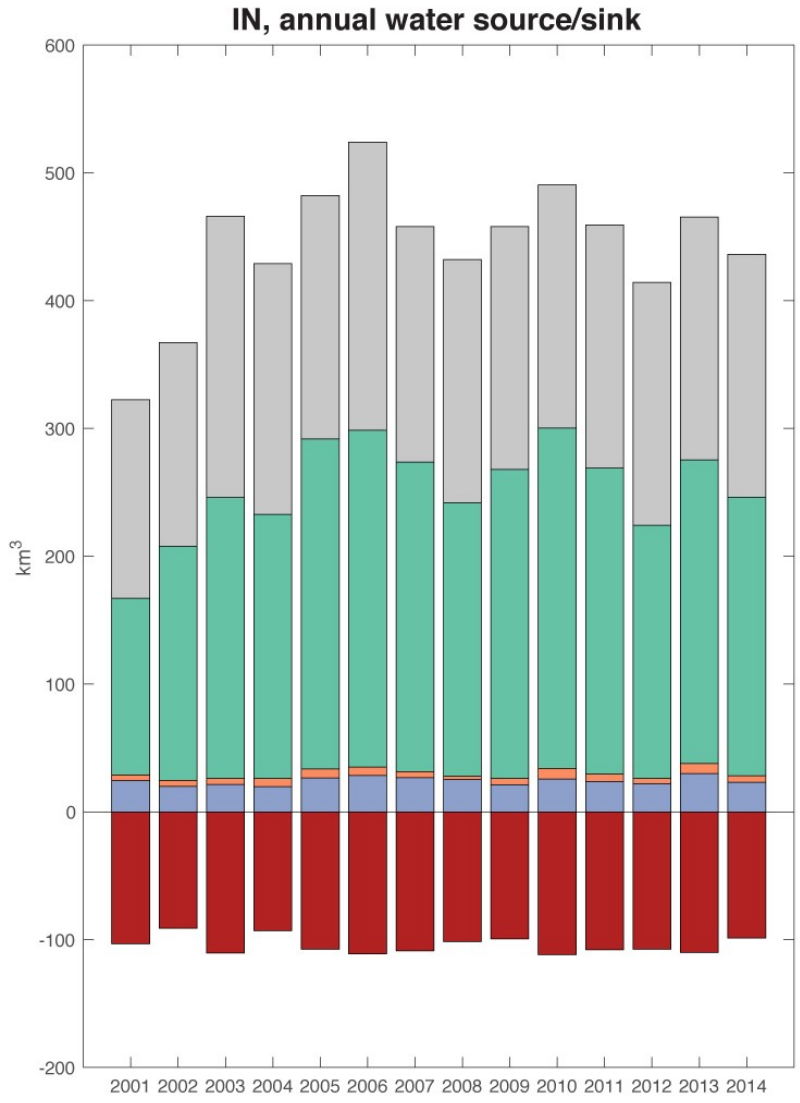
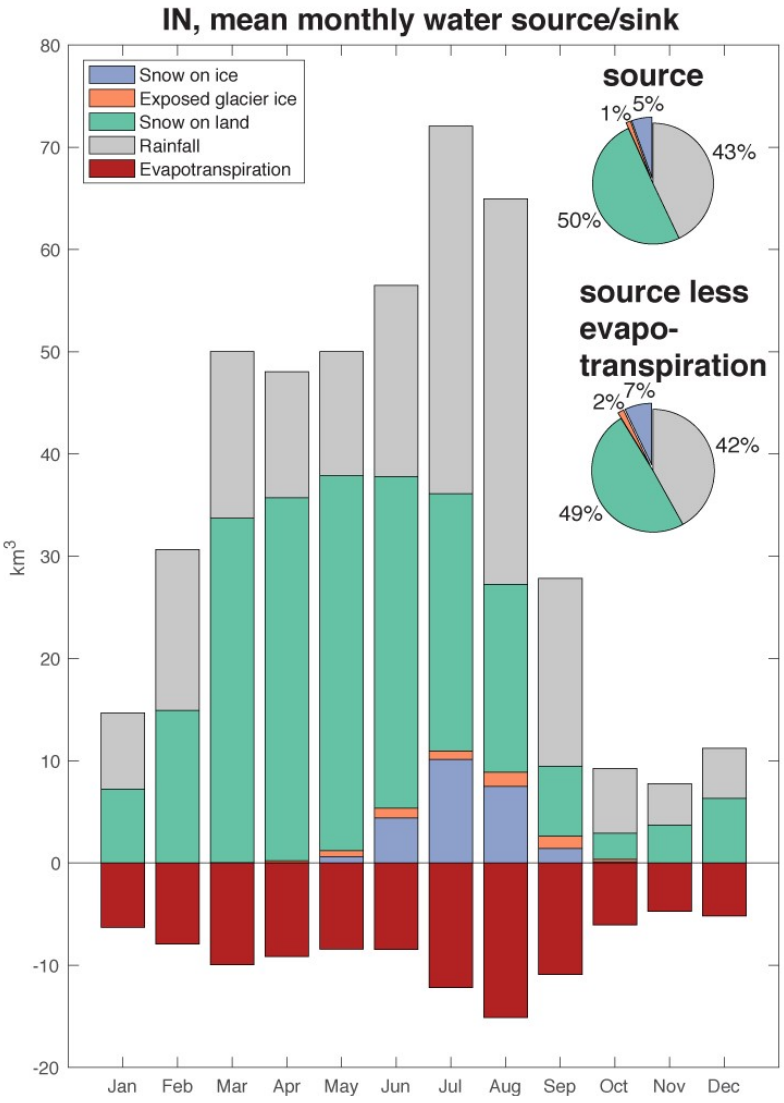
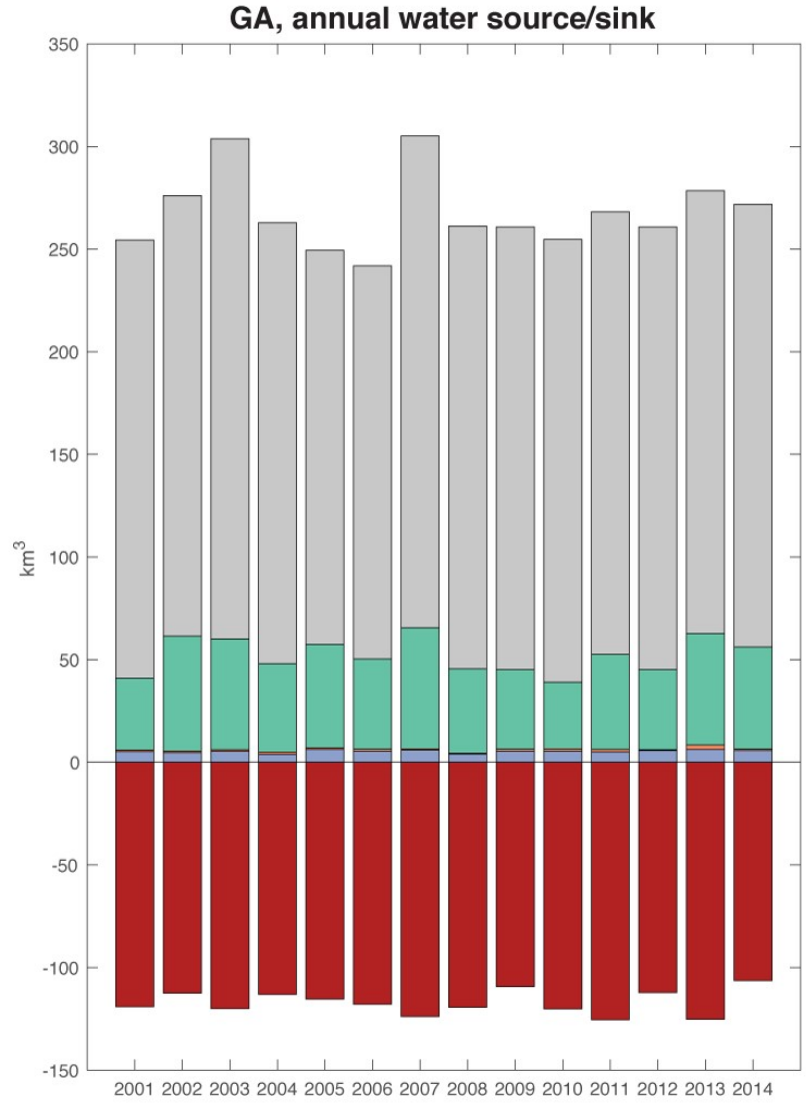
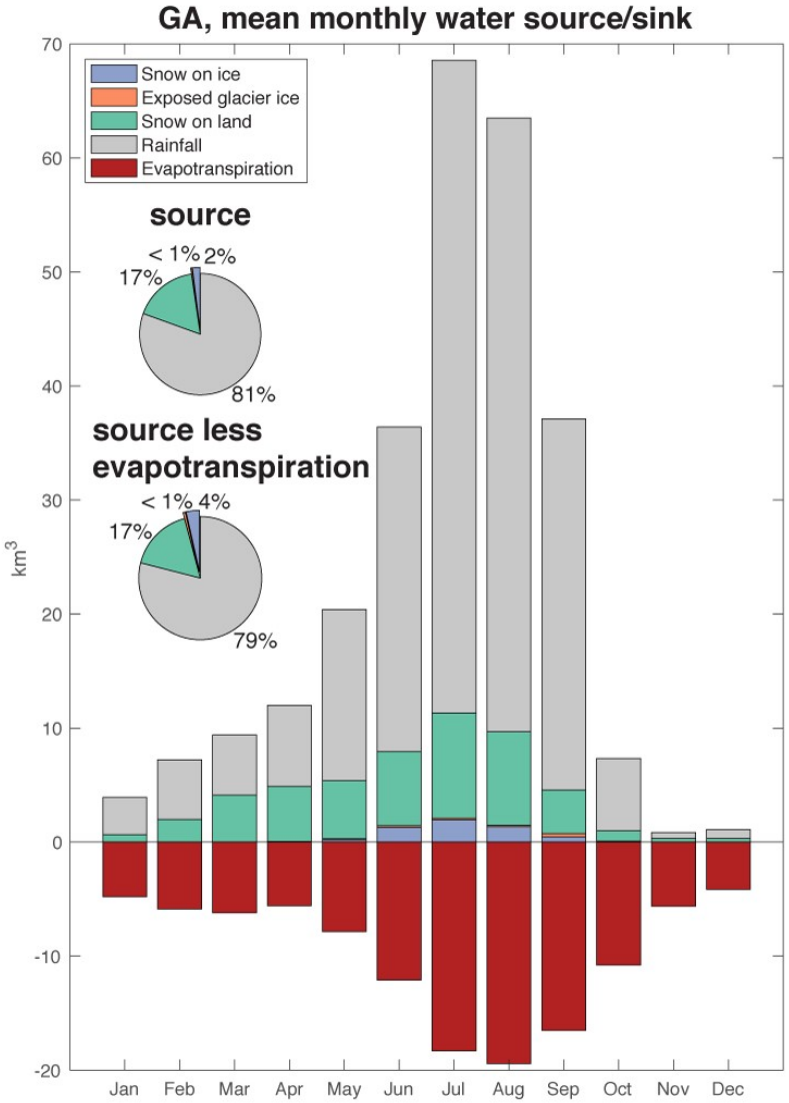
Indus melt w/ APHRODITE rainfall & MODIS ET





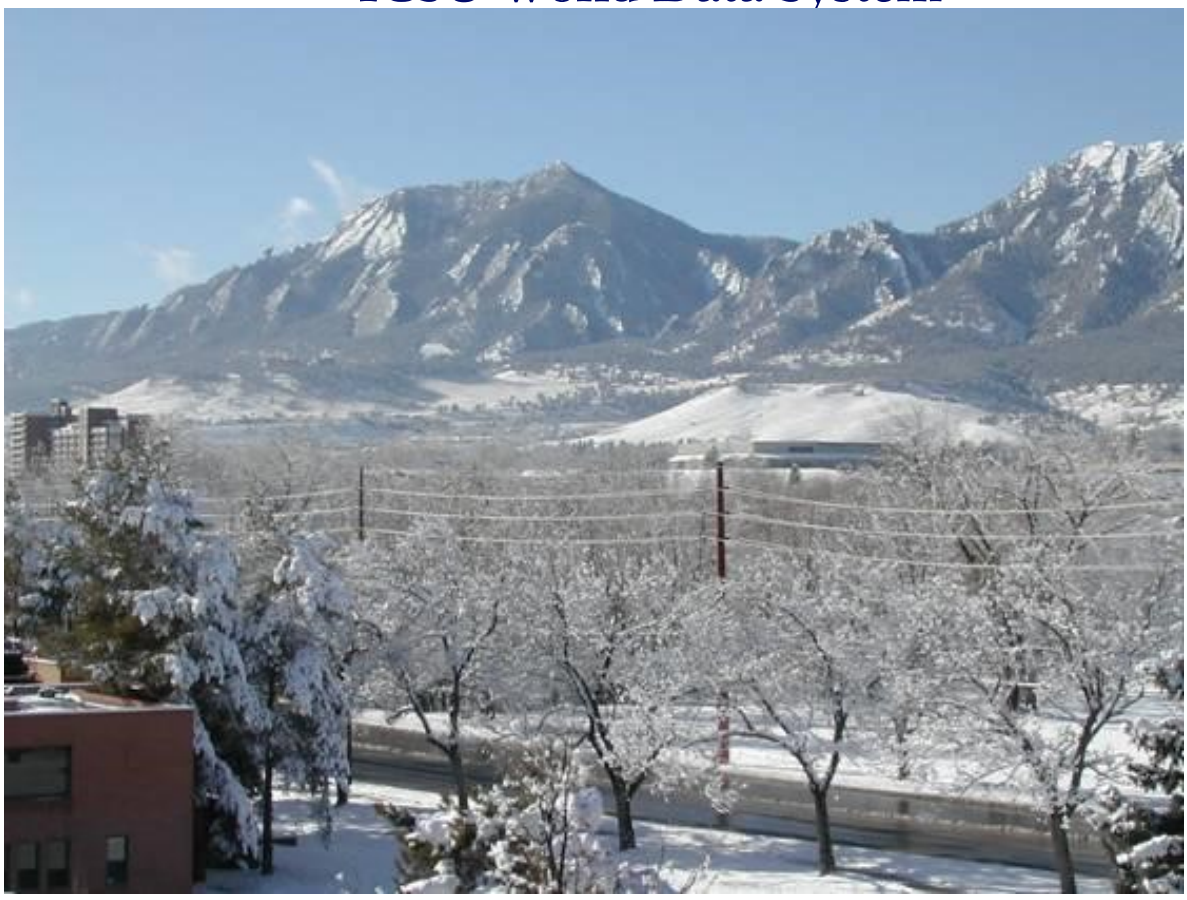
Ganges melt w/ APHRODITE rainfall & MODIS ET





The National Snow and Ice Data Center

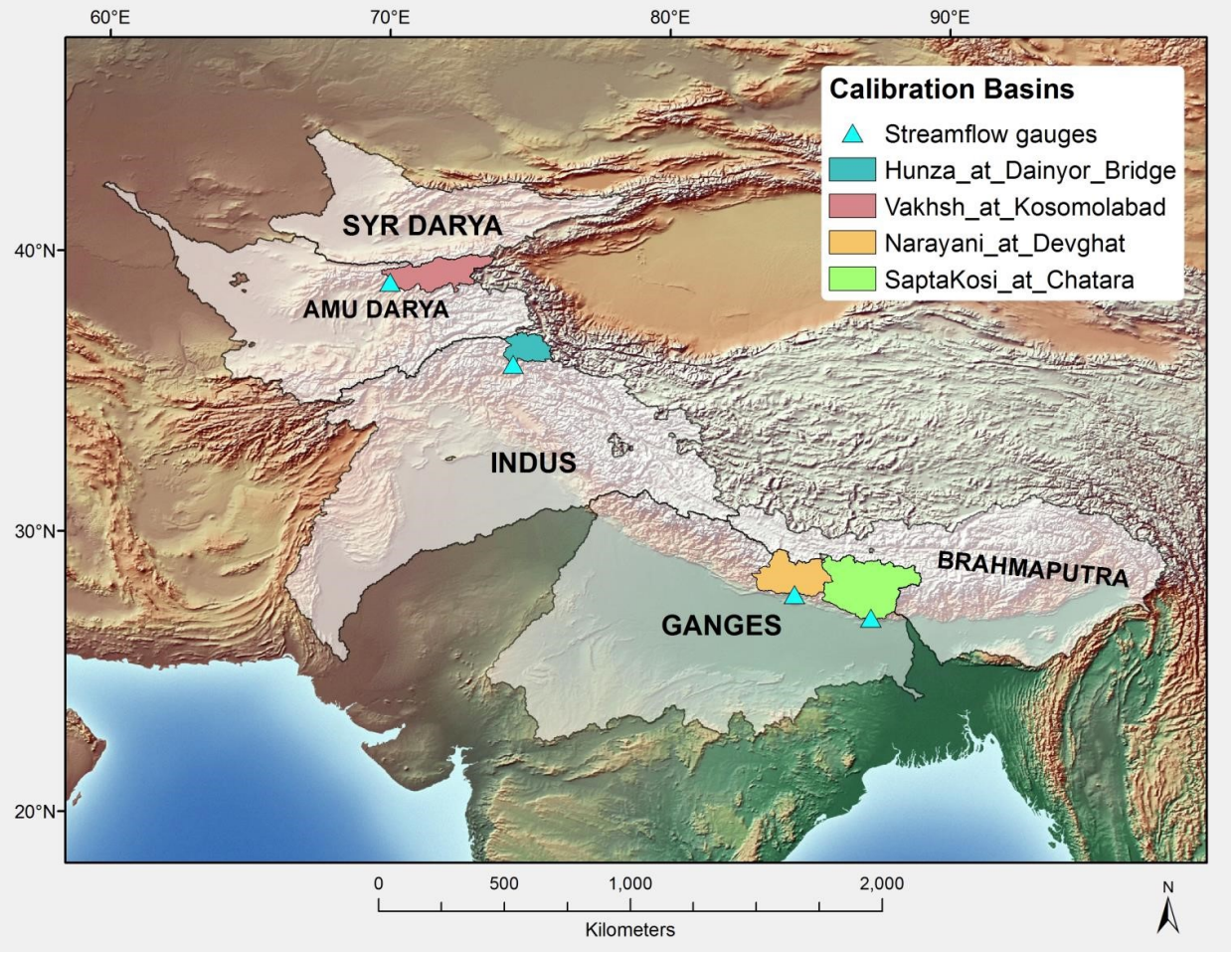
ICSU World Data System



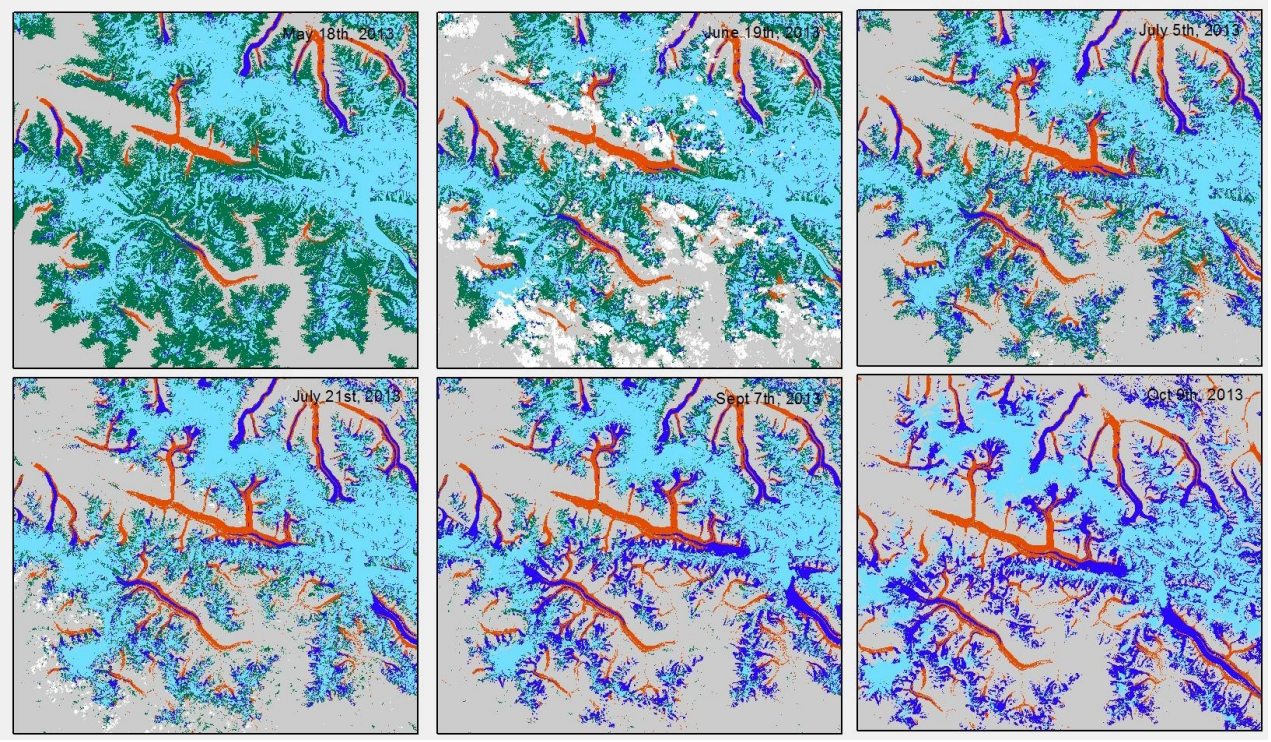
The view from NSIDC, Boulder Colorado

http://nsidc.org/charis

Calibration basins



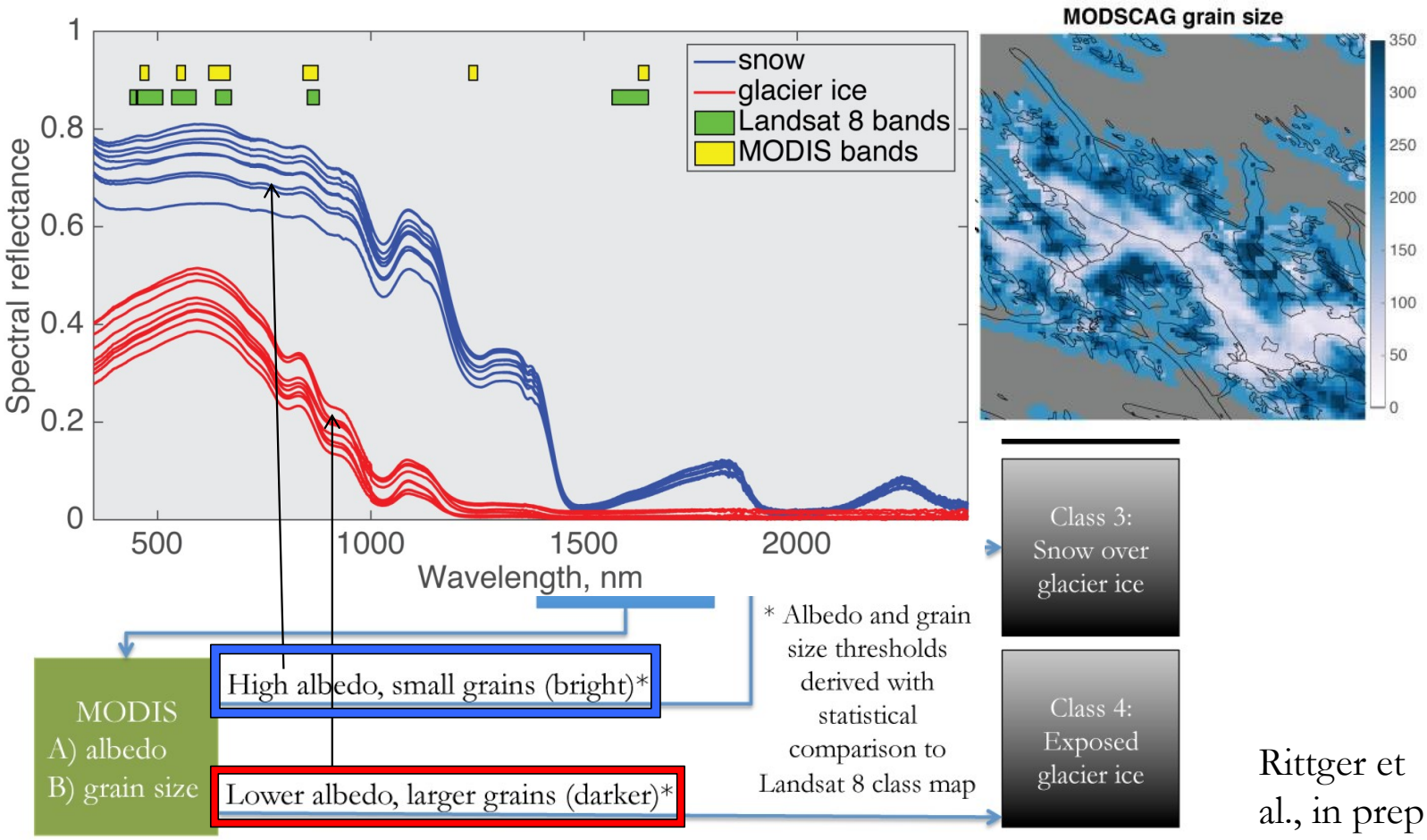
Partition areas of snow on land, snow on ice and exposed glacier ice: Hunza basin, Landsat OLI (30m) data



NoData | bare soil | exposed glacier ice | snow on ice | snow on land | debris covered ice

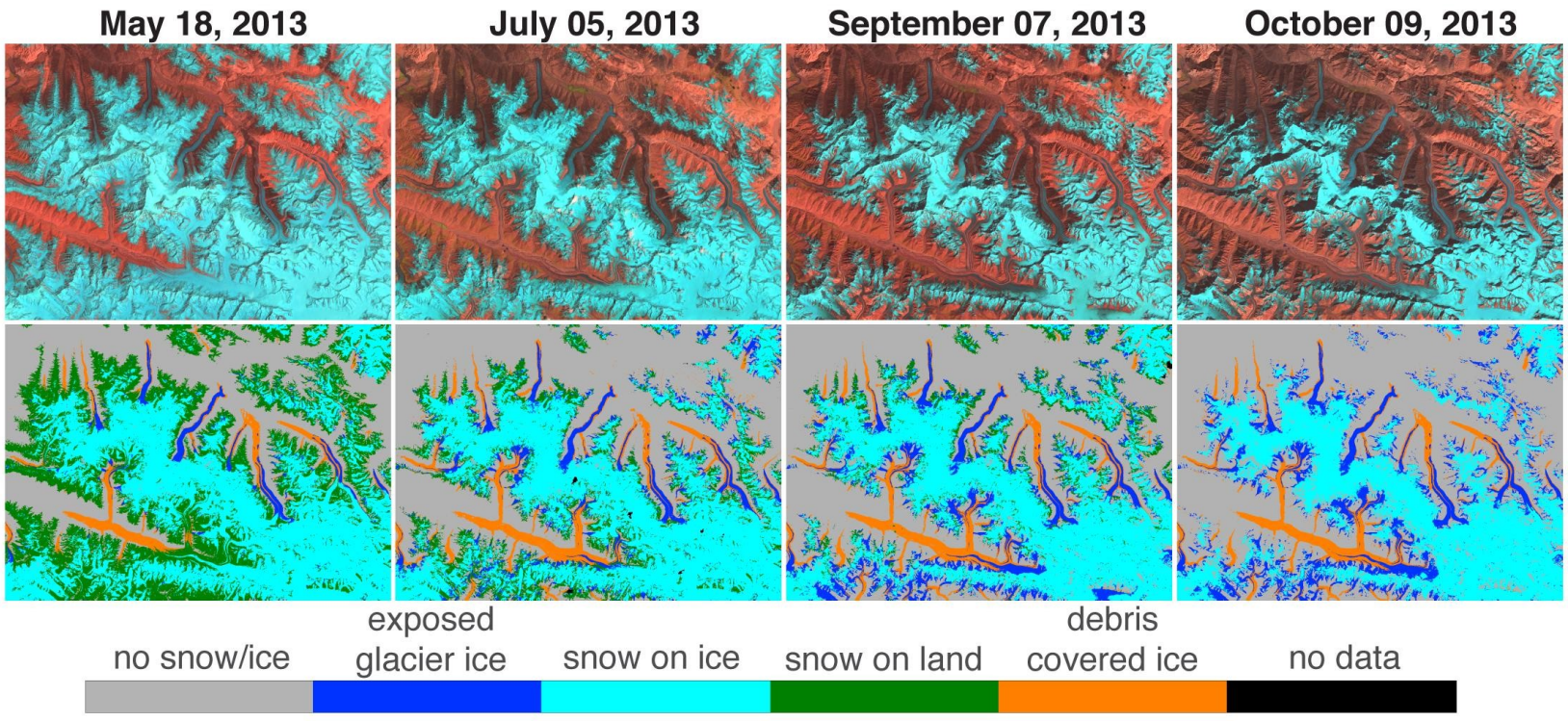
- Classes are derived from band thresholding combined with topography and thermal data
- Landsat-based classification (30m) is used determine threshold for grain sizes and albedo from MODIS (500m) to use in the melt model. (Racoviteanu, 2017)

Snow-ice classification from MODIS

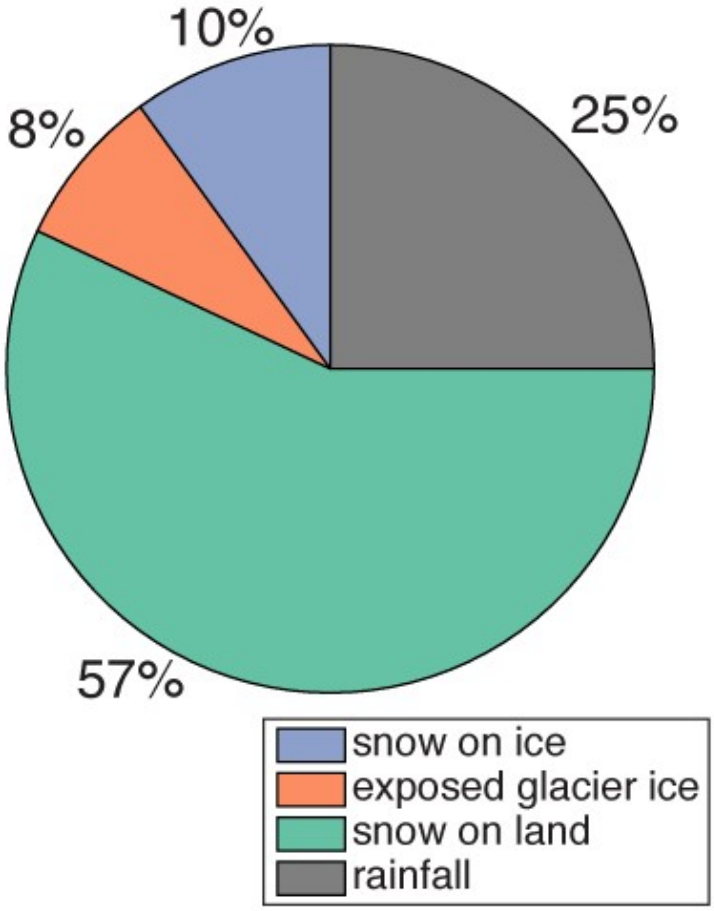


Rittger et al., in prep

Semi-automated classification for snow on ice (SOI), exposed glacier ice (EGI) and snow on land (SOL) and debris covered ice (DCI) from Landsat 8



Contributions from snow and ice melt and rainfall to runoff in the Upper Indus Basin – 2000 to 2015 average.



NSIDC

USAID
FROM THE AMERICAN PEOPLE

- **Glaciers are one of the most obvious, and seemingly simple, indicators of climate change. However, glaciers themselves are rather complex.**

- **Glacier data in the Himalaya are sparse and are mostly limited to terminus fluctuations.**

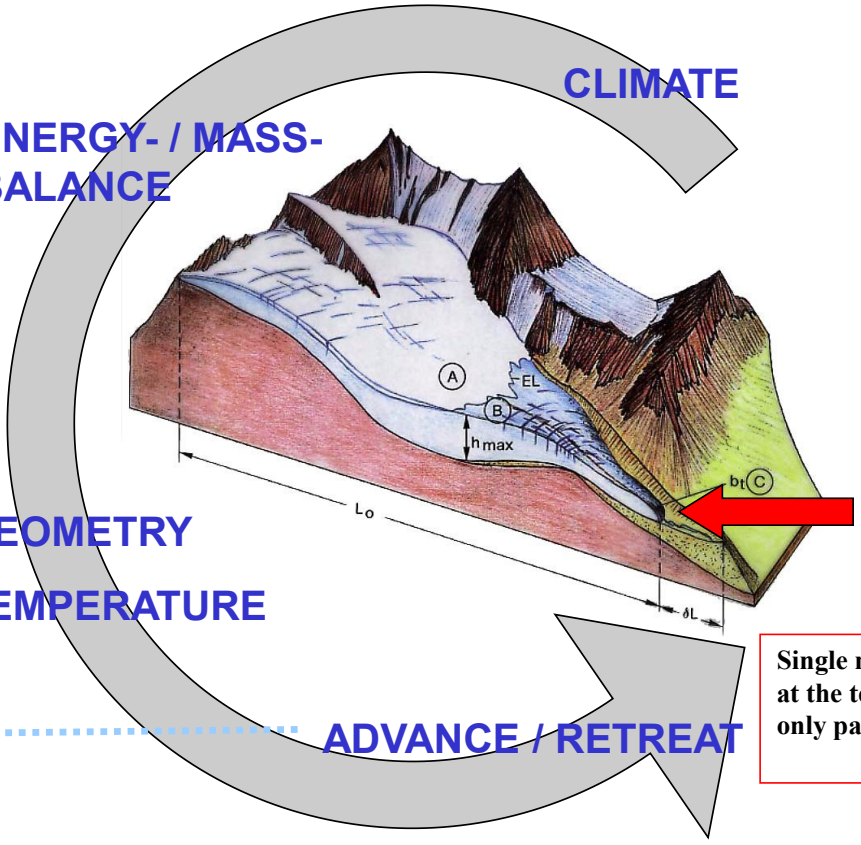
Opportunity to Contrast Little Ice Age Climate Conditions with the Present in Locations such as the European Alps and North America.

An 1870 postcard view of the Rhone glacier in Gletsch, Switzerland,

Dramatic statements that glaciers are smaller than they have been for over two hundred years are not particularly surprising or enlightening.

...

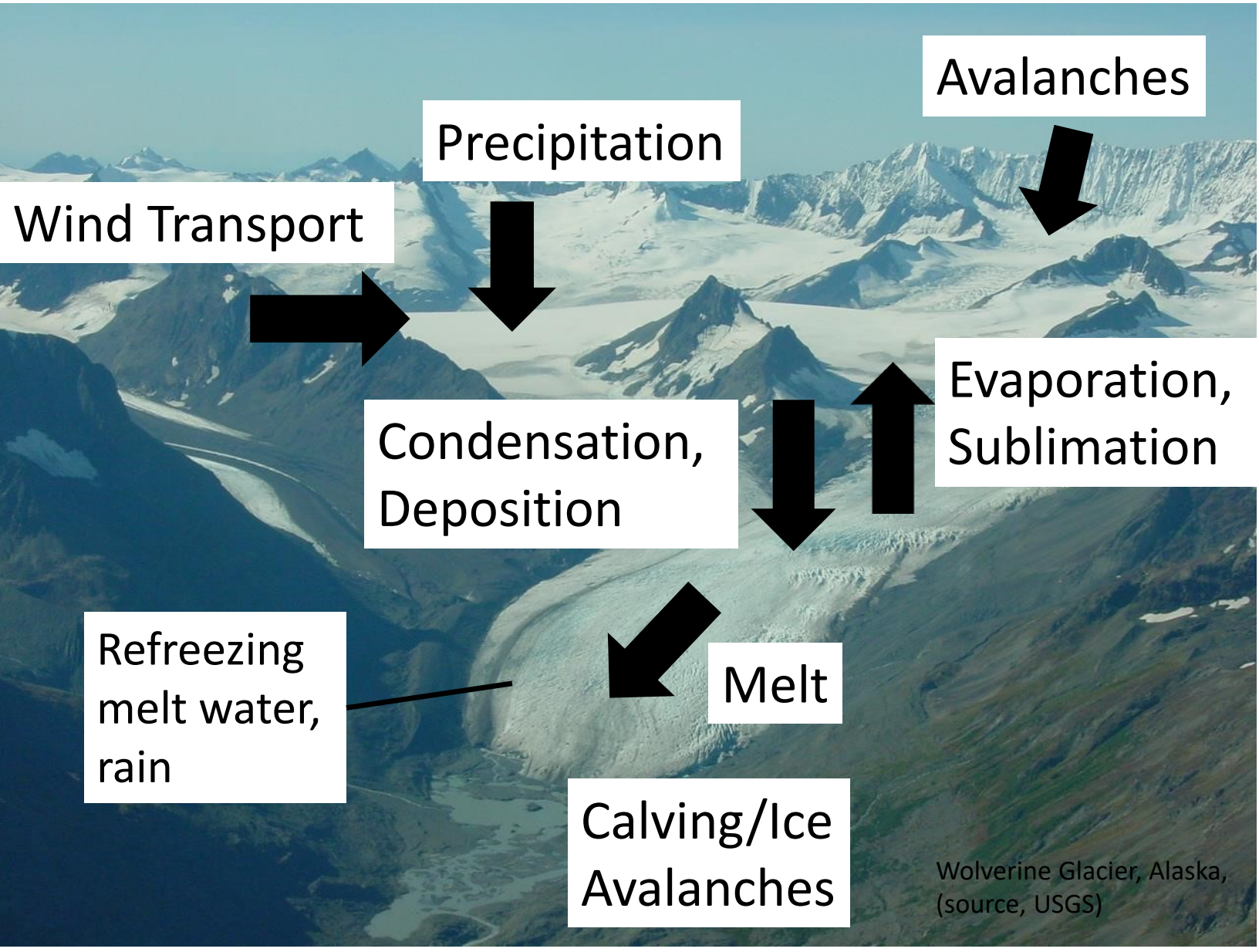
Glacier crash course: climate-glacier process chain



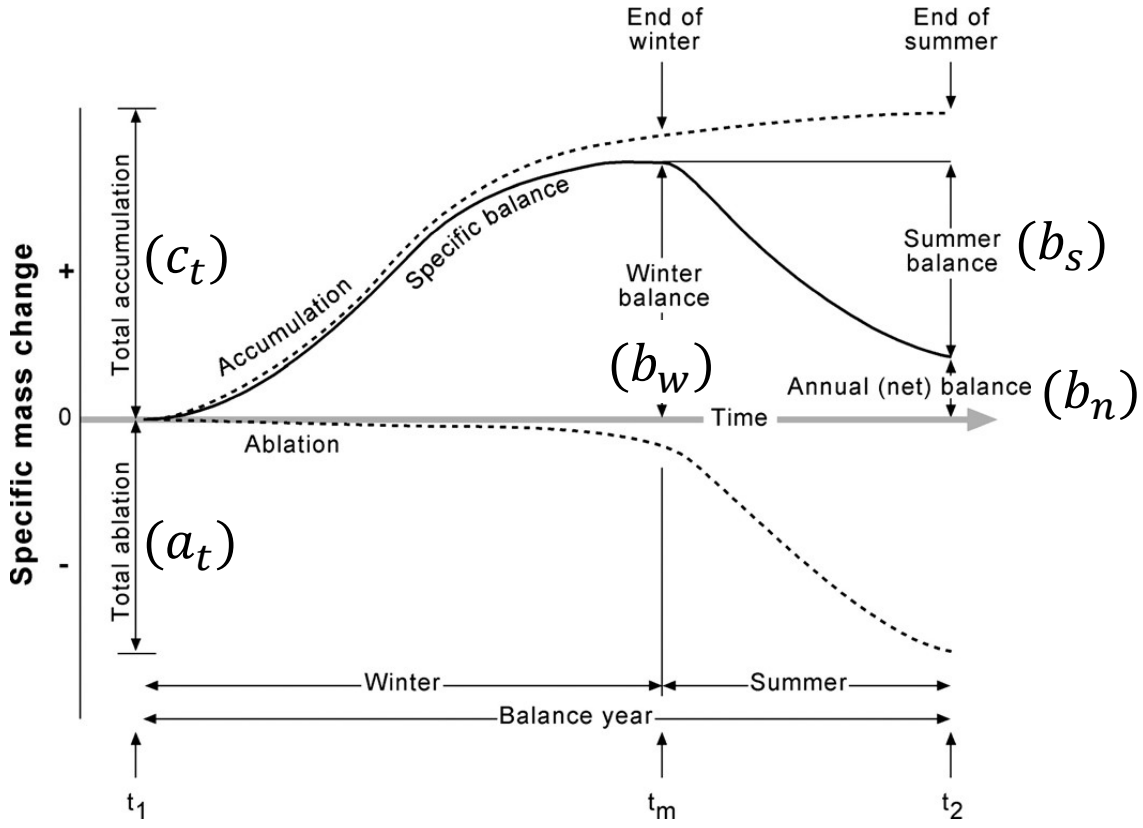
Single measurement at the terminus is only part of the story.

Haeberli (1998)

Armstrong, NSIDC/U. of Colorado

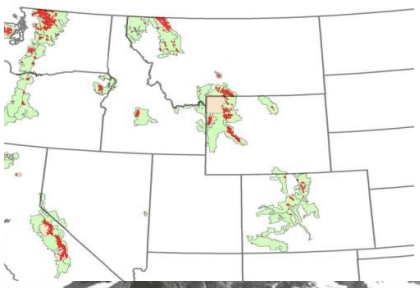

Avalanches
Precipitation
Wind Transport
Evaporation,
Sublimation
Condensation,
Deposition
Refreezing
melt water,
rain
Melt
Calving/Ice
Avalanches
Wolverine Glacier, Alaska,
(source, USGS)

Mass Balance



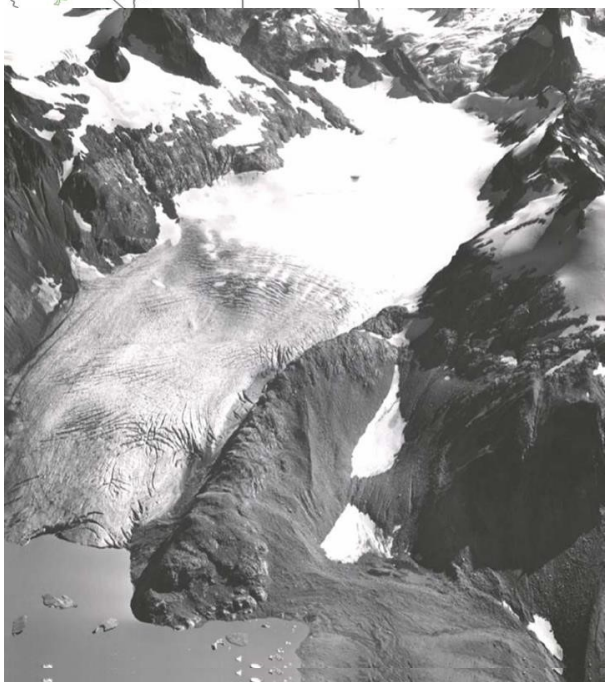
Seasonal balances are defined differently for summer accumulation glaciers

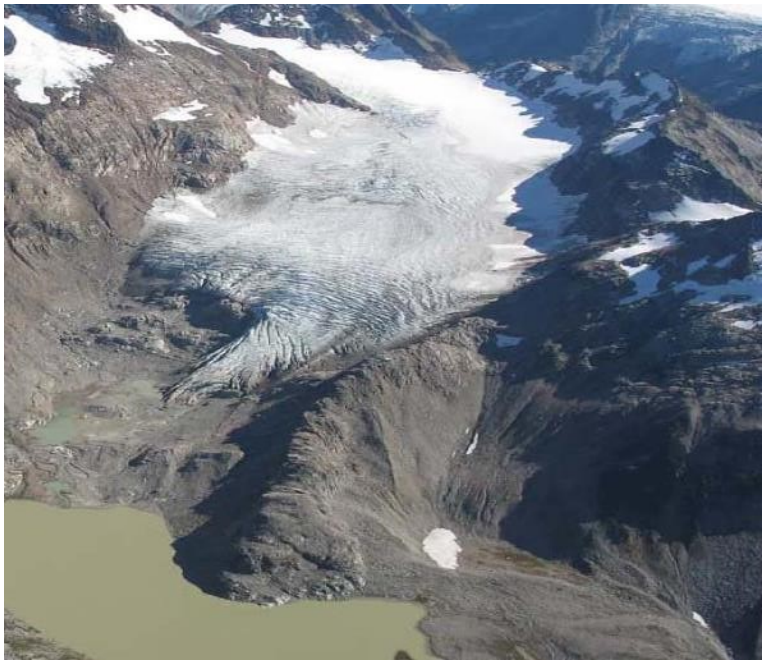
Location of Glaciers in CONUS



Fraction of Glacier Area Lost Western United States
Average ~40% since 1900.
Are such numbers representative of other locations in the world?

Data from A. Fountain
Portland State University





1960 South Cascade Glacier, Washington 2004

Terminus location data, the source of much of the information defining glacier status, are not always appropriate to describe the current health of total glacier systems.

Some Misconceptions and an Interpretation:

• Many of the recent statements found in the popular, and some "scientific" literature regarding glaciers in the Himalaya are based on very little data.

•They may reflect the truth, or close to it, at the specific locations where, and when, the measurements were made.

• They may not accurately reflect the average conditions prevailing across the entire region.

•Terminus location data, the source of much of the information defining glacier status, are not entirely appropriate to describe the current health of glacier systems, and existing mass balance data are totally inadequate to assess short term regional scale mass exchange.

Amu Darya, Central Asia – 47% seasonal snow, 3% glacier ice – total = 50%

Indus 49% seasonal snow, 1% glacier ice – total = 50%

In both of these two large basins for the summer period, June-July-August, runoff from glacier ice increases to approximately 15-20% of total runoff.

(Because this period coincides with the maximum monsoon rainfall in the Ganges and Brahmaputra, the percentage contribution from glacier melt in those two basins is generally less than 5%.)

Snow covered area on land decreases through these summer months, with melt contribution decreasing from approximately 70% to 40%.