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Outline

- Model setup and input,
  - Preliminary spatial/temporal GIC SMB and runoff results,
  - Preliminary GIC mass-balance contribution to global sea-level rise.
Model purpose:
To simulate GIC conditions in SnowModel:
- Surface air temperature,
- Precipitation,
- Evaporation/sublimation,
- Surface melting,
- Refreezing,
- Freshwater runoff,
- SMB, and
- SMB contribution to sea-level rise.

For each:
- Individual GIC,
- GIC complex, and
- GIC region.

Earlier studies: GIC contribution to sea-level:
- Hock et al. (2009),
- Radic and Hock (2011),
- Marzeion et al. (2012),
- Grinsted (2013),
- others…
Model setup and input:
- NASA MERRA (Modern-Era Retrospective Analysis for Research and Applications) atmospheric reanalysis data,
- Simulation period 1979 to 2009,
- 3-hour time step,
- NOAA GLOBE DEM (1-km horizontal grid),
- Randolph Glacier Inventory,
- Grid cells only included if covered by >50% of glacier ice,
- 15 GIC regions (IPCC),
- Obs GIC mass-balance time series (n=76) for verification.
Model verification and test:

- Individual GIC observed time series of winter, summer, and net balances were used for verification/adjustment of simulations,
- Regional verification/adjustment.
- GIC n=76 (long-term time series),
- For regions with less/no GIC observations: We used verification/adjustment mass balance coefficients as a surrogates from neighboring regions, where climate conditions were almost similar fx Greenland, Arctic Russia…

- FIG: Randomly shown examples of three GIC and regions,
- FIG: Individual GIC mean obs vs. sim SMB (able to reproduce mean annual SMB conditions and trends).
Simulation examples:

SE Greenland (Sermilik Fjord area)

Mean 1979–2009 for:
- MAAT,
- SU+E,
- P, and
- R
Simulation examples:

SE Greenland (Sermilik Fjord area)

Annual trends from 1979 to 2009 for:
- MAAT,
- SU+E,
- P, and
- R
Simulation examples:

Himalaya (Karakoram Range)

Mean 1979–2009 for:
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Annual trends from 1979 to 2009 for:
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Differences between decades
Regional annual and cumulative GIC mass-balance time series, and SLE contribution
Conclusions

• New era of simulations based on the Randolph Glacier Inventory.
• Spatial and temporal variability in surface conditions between individual GIC and regions.
• On regional scale, all 15 regions had cumulative mass-balance loss since 1979.
• Able to reproduce the positive GIC mass-balances for Scandinavia in the 1990s.
• For 1979-2009 GIC mass-balance contribution $\sim 0.59 \pm 0.08$ mm SLE yr$^{-1}$, and for the last decade 1999-2009 $\sim 0.85 \pm 0.12$ mm SLE yr$^{-1}$. 