

EXTERNAL DRIVERS
Temperature



Atmospheric Deposition

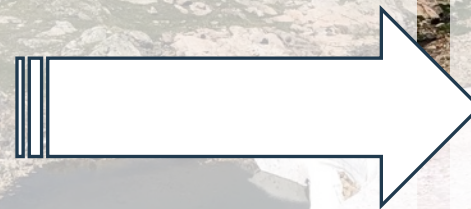



SPATIAL TEMPLATE

Terrain
Geomorphology
Biota



LANDSCAPE RESPONSE



Global  base cation and SO_4^{2-} concentrations in alpine lakes/streams

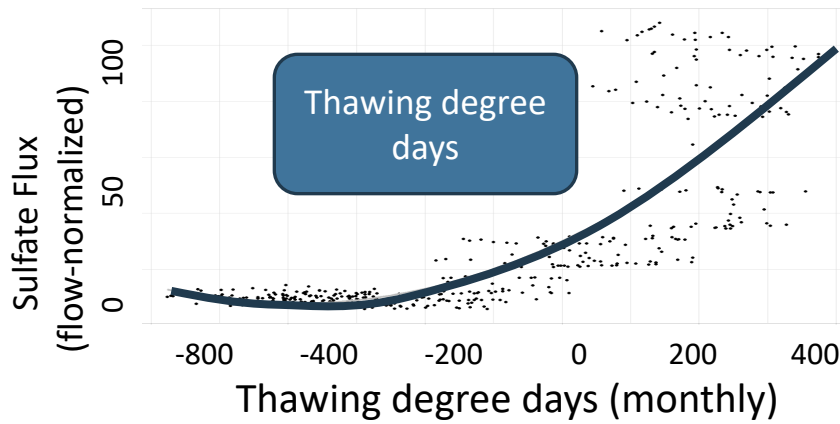
200%

increase in watershed SO_4^{2-} fluxes since 1984.

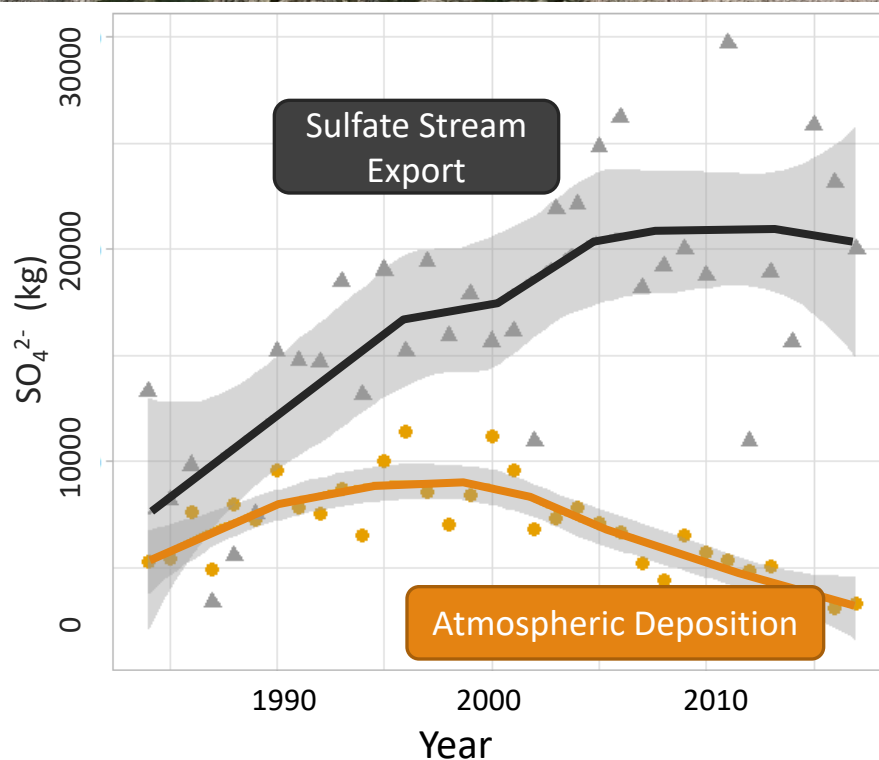
Niwot Ridge

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WARMING?



Flux positively related to **thawing degree days** particularly in fall

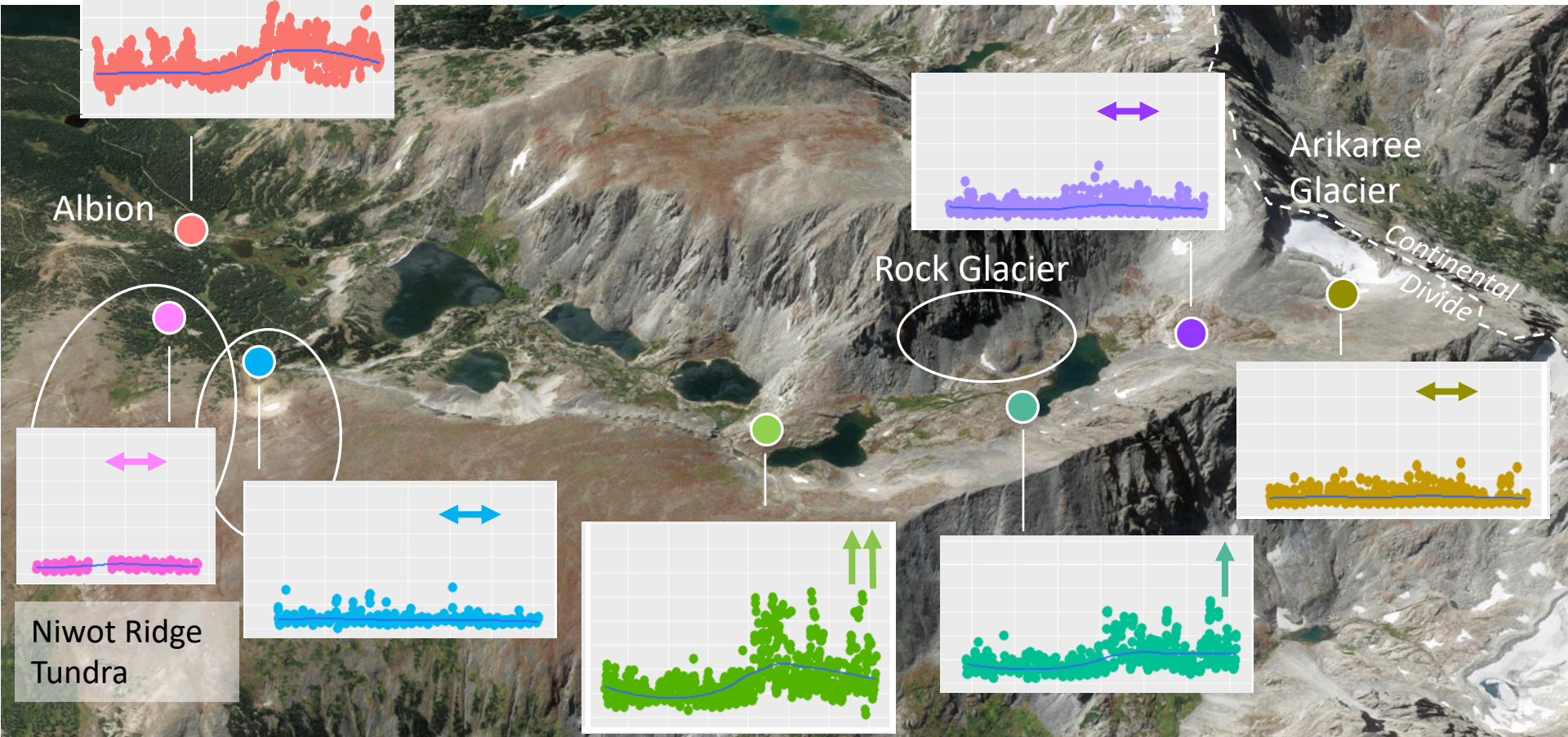


Despite decreasing SO₄²⁻ in **atmospheric deposition**

200%
increase in watershed SO₄²⁻ fluxes since 1984

SPATIAL SIGNATURE

[sulfite] since 1984



Recent warming → permafrost thaw → enhanced mineral weathering (SO_4^{2-} , Ca^{2+} , Mg^{2+})



THAW OF PATCHY PERMAFROST Green Lakes Valley

- Shift in stream chemistry
- Increased fall discharge



Niwot Ridge

- Tundra emission of CO₂: winter microbial activity, OM decomposition