



Modeling Dynamic Ice Loss on
the Greenland Ice Sheet Using Satellite Data

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SCI 489
OCTOBER 2024

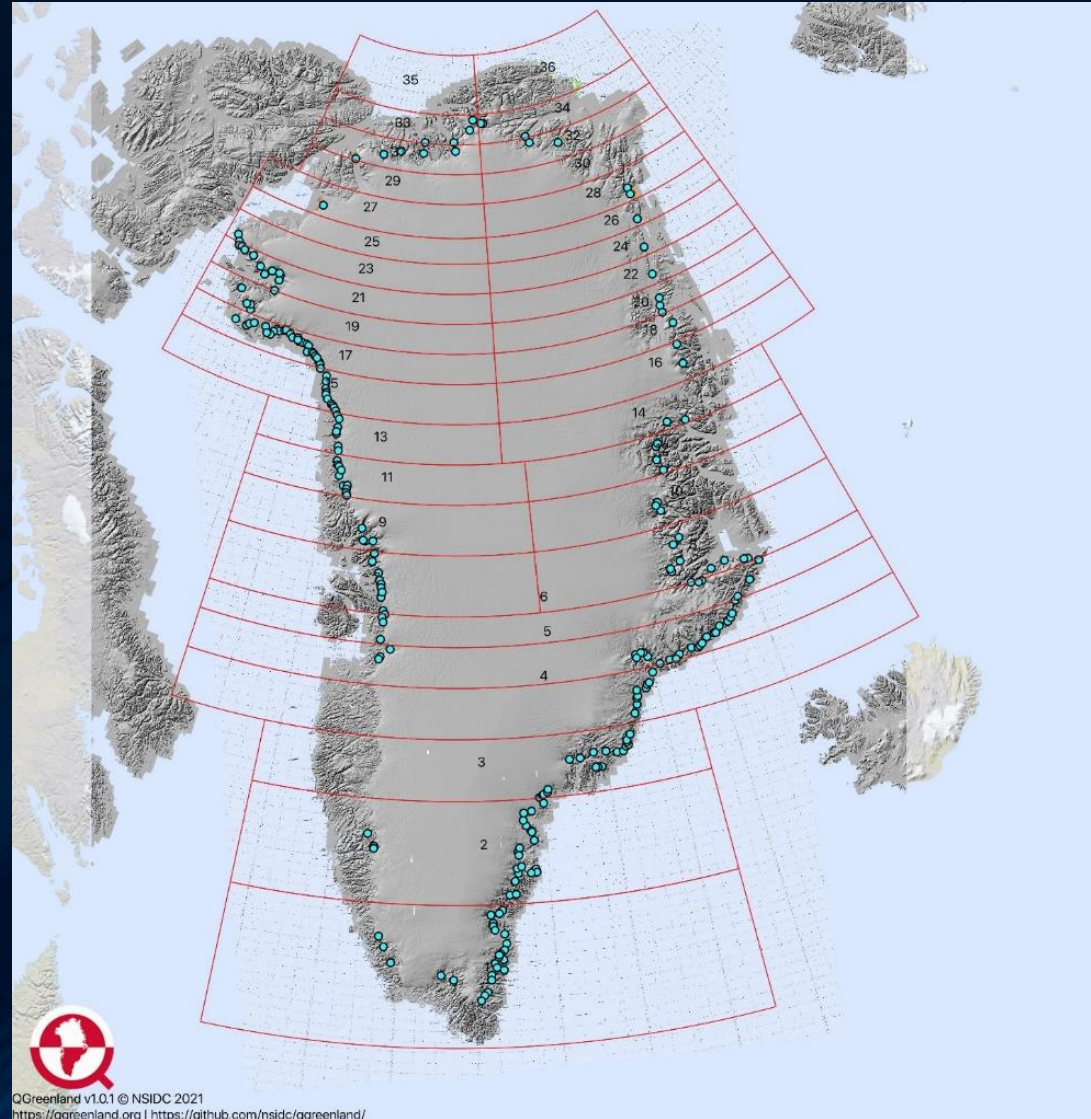
Statement of Problem

- Where has ice loss occurred in Greenland (limited to the northern part of the island)?
- How (if at all) is the rate of ice loss related to geographical features such as elevation or drainage basins?
- How (if at all) is the rate of ice loss related to ice flow velocities?

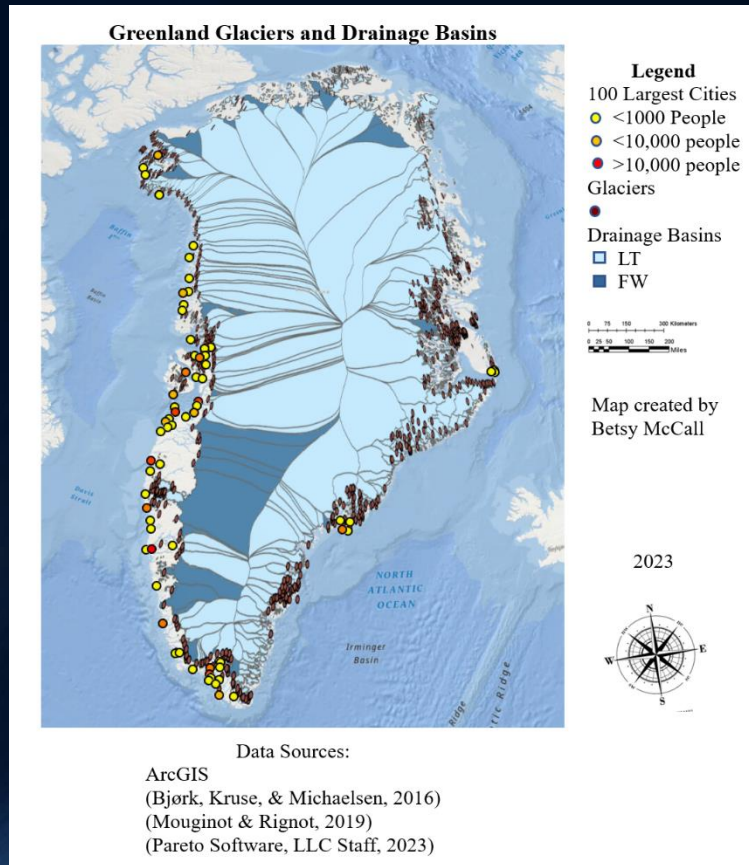
Region of Analysis

Tiles 30-36 in the northern part of the island were used for this analysis.

(map from Csatho research group)



Region of Analysis

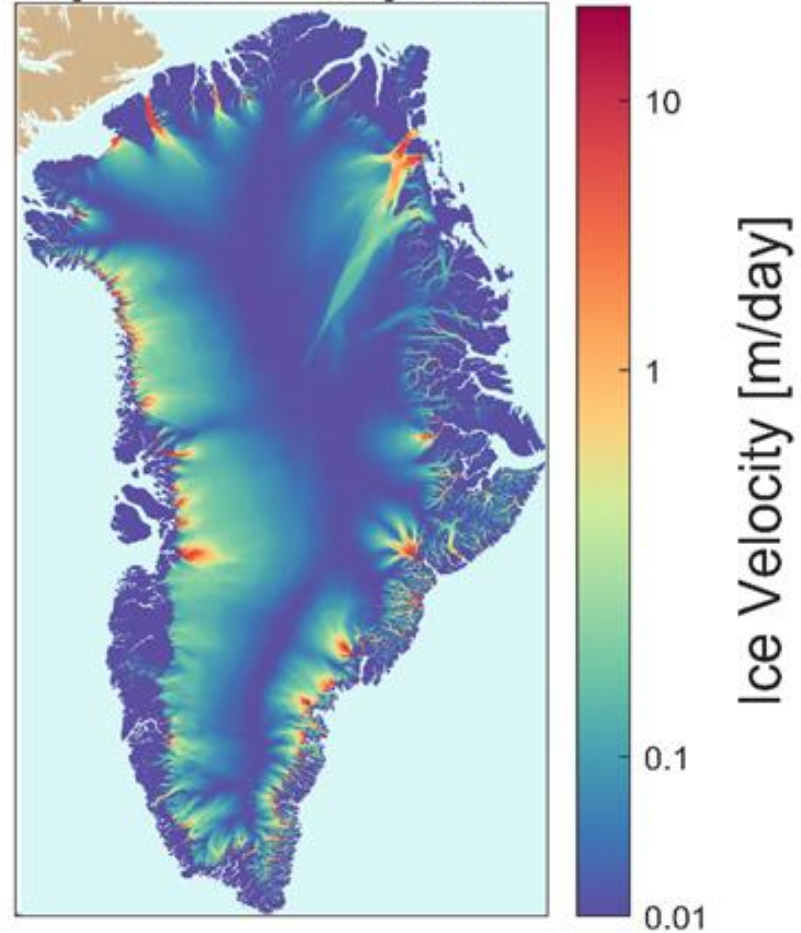


- Catchment (drainage) basin map produced in ArcGIS. Brown dots are outlet glaciers. Dark blue are high flow drainage basins while light blue are low flow basins.

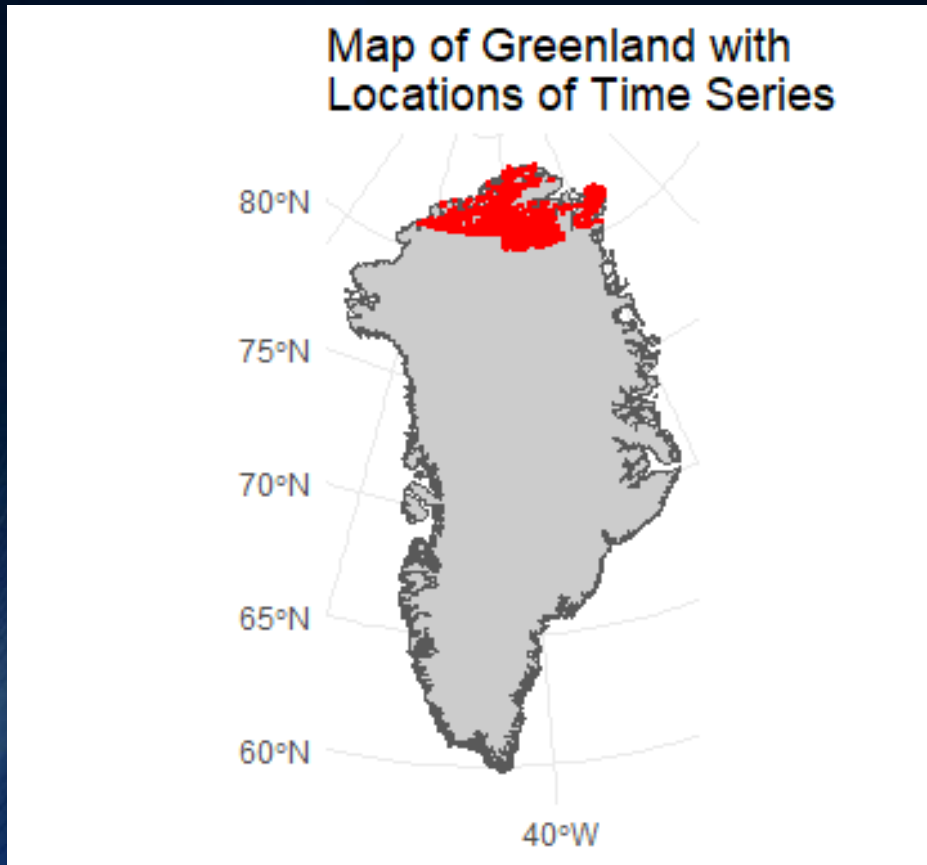
Region of Analysis

Ice flow velocity map. This map overlaps with the primary data set only for the last year or so of the data, but the high flow areas are consistent with high flow catchment basins. (obtained from the PROMICE project)

Sep 2016 - Sep 2021



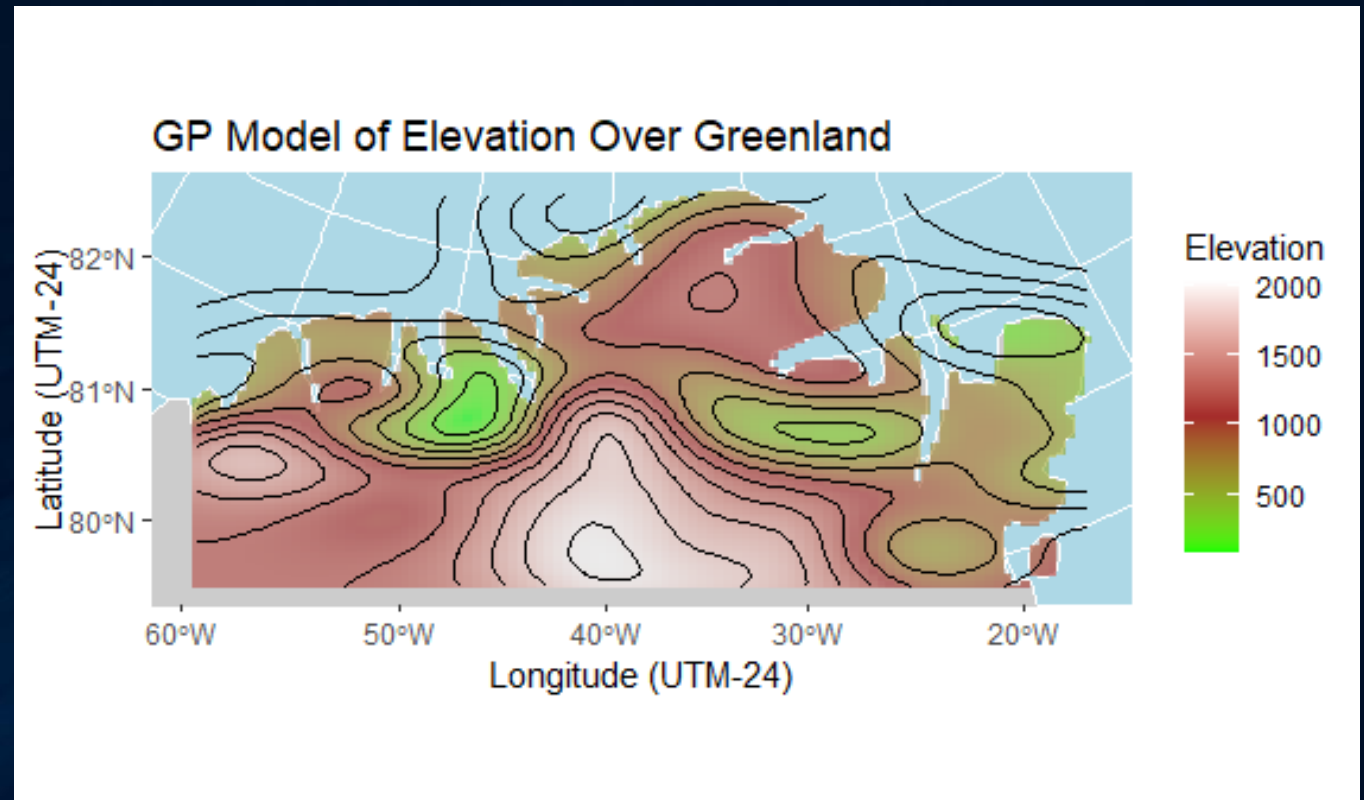
Region of Analysis



- Each red dot is the location of a time series measuring dynamic ice loss.

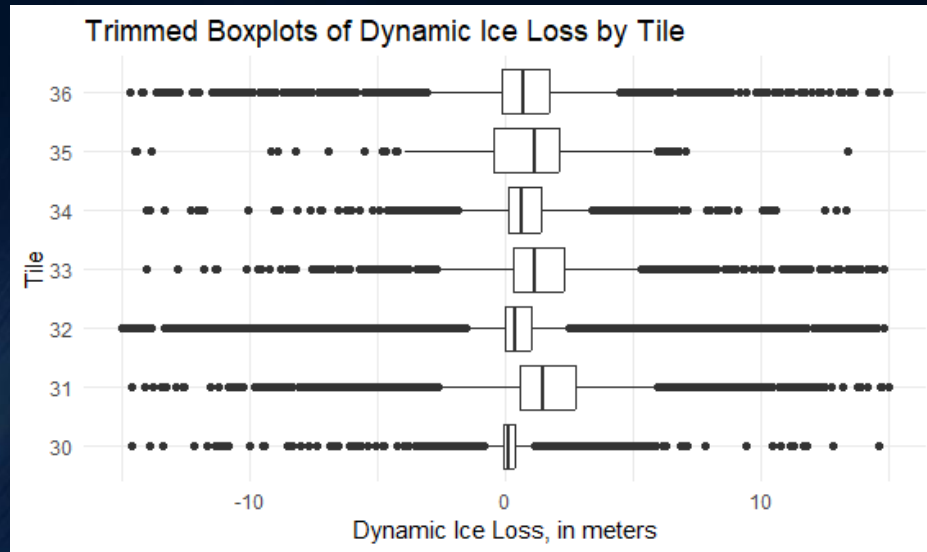
Elevation Model

Using Gaussian Process Regression

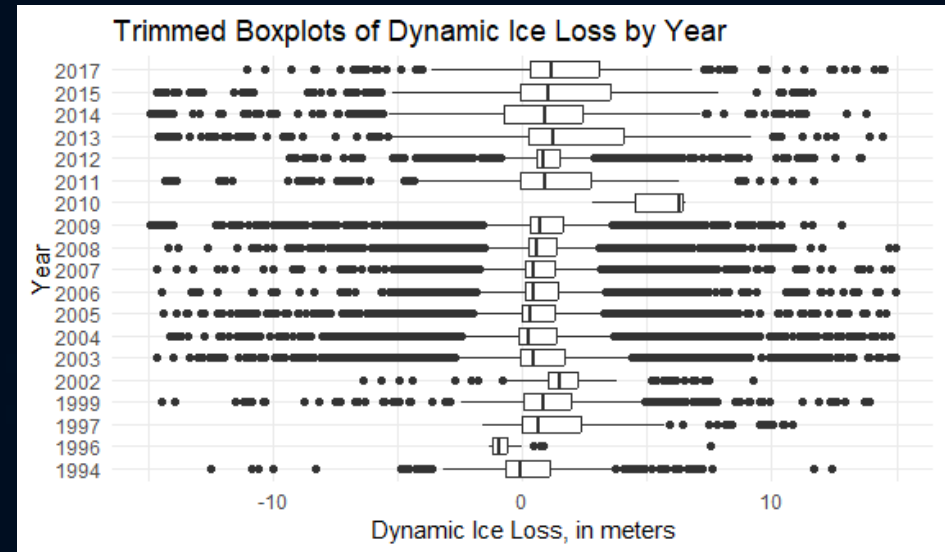


How the data breaks down

BY TILE



BY YEAR

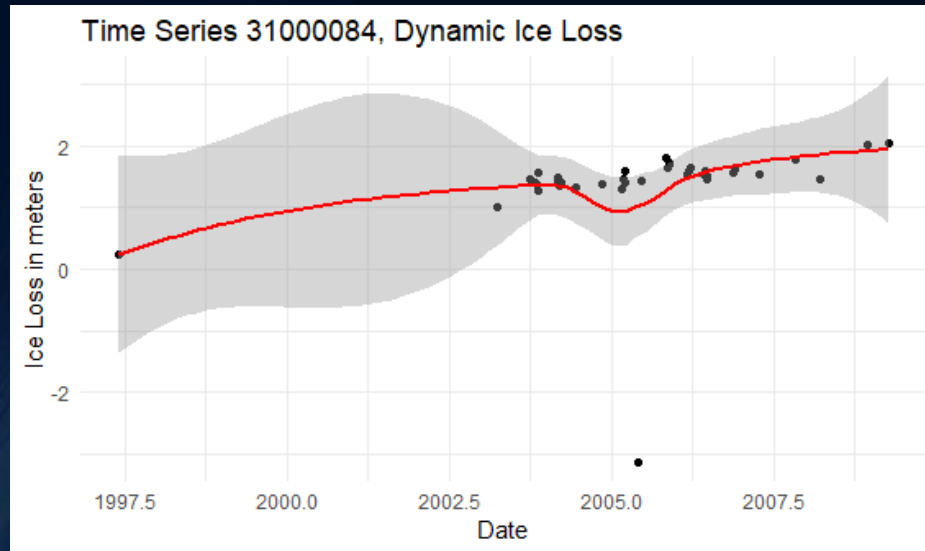


Counts of Observations by Tile and Year

- Some years are more sparse with observations
- Years with the most observations on each tile are 2003-2009, 2013
- The two northernmost tiles have the fewest observations

Year/Tile	30	31	32	33	34	35	36
1994	110	97	169	0	3	0	0
1996	0	38	0	0	0	0	0
1997	115	125	65	7	0	0	0
1999	114	615	212	31	18	0	0
2002	0	306	0	6	0	0	0
2003	1609	2599	1991	313	340	28	301
2004	3474	3685	3125	499	499	68	495
2005	3366	2949	3104	435	462	69	500
2006	3323	2926	2983	377	430	53	434
2007	2240	1872	2068	284	339	54	270
2008	2546	1927	2213	320	367	46	367
2009	1582	1237	1554	139	186	13	126
2010	0	6	0	0	0	0	0
2011	87	186	180	8	0	0	0
2012	616	307	471	26	71	0	0
2013	89	283	227	74	2	4	49
2014	21	124	325	37	24	0	5
2015	61	116	200	13	0	0	1
2017	50	91	188	10	25	0	0

Exemplar Time Series

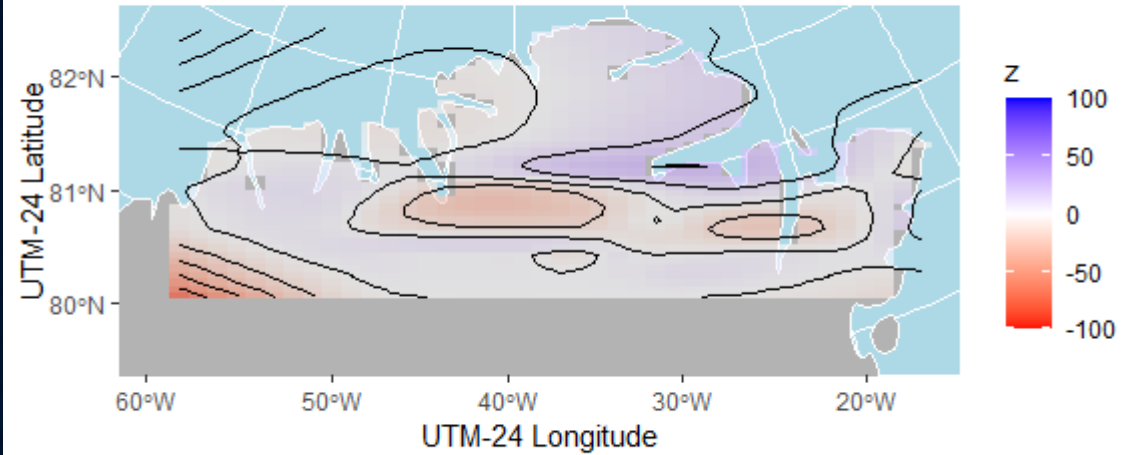


- Each location (from slide 6) represents the location of a time series of dynamic ice loss.
- This time series from Tile 31 is the longest time series on the tiles studied here.
- Some “time series” have only one observation in the present dataset.
- This, like the overall boxplots, suggest a slight increase in ice over the region as a whole.

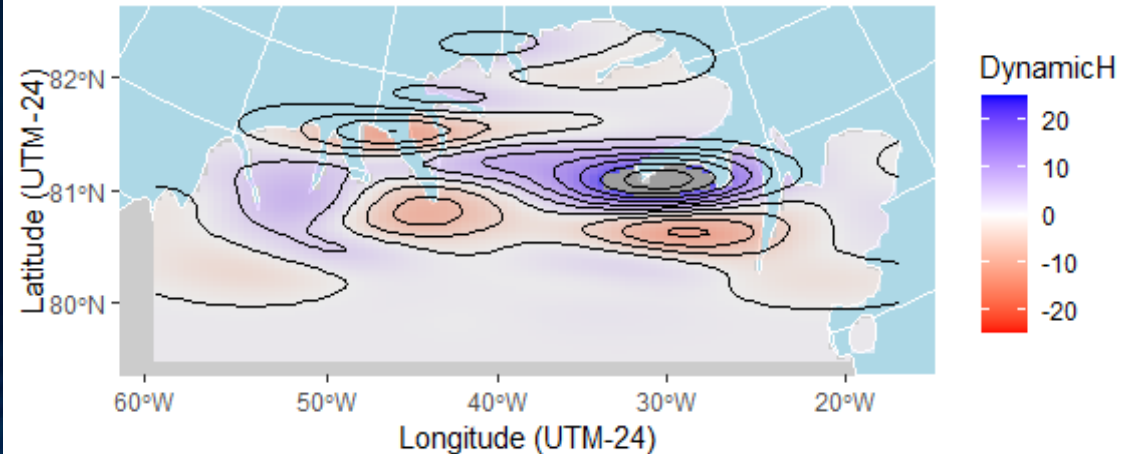
Comparing Two Types of Models

In this analysis, I compared a LOESS model of the ice loss with a Gaussian process model of the ice loss. These images show the comparison for 2013.

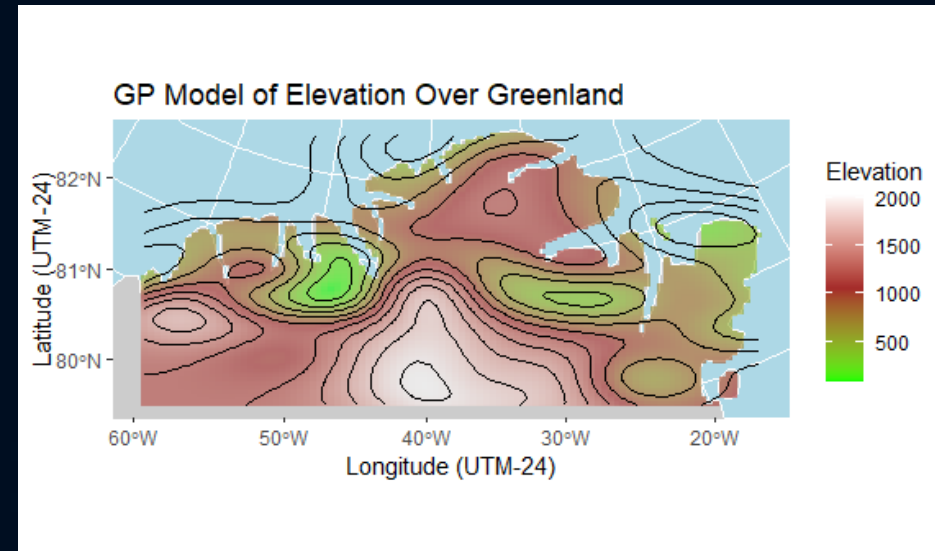
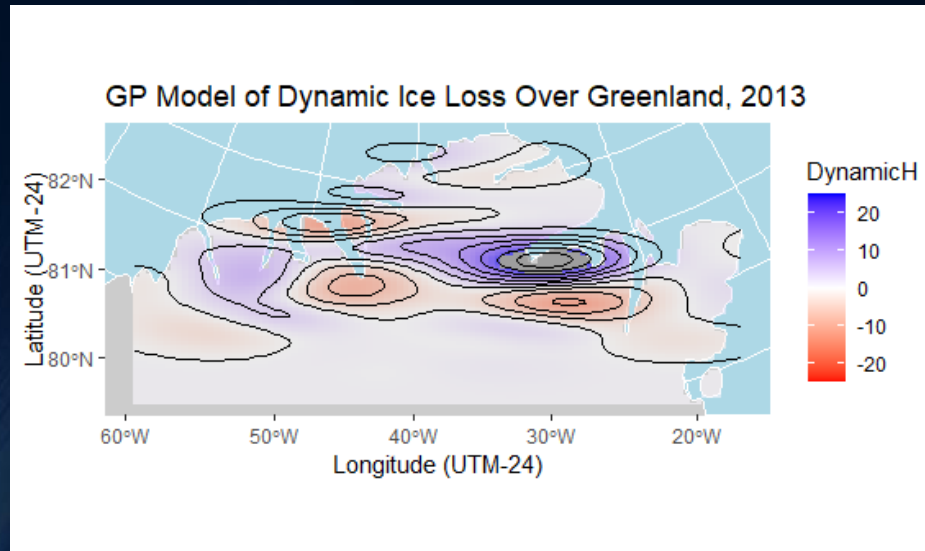
Dynamic Ice Loss on Tiles 30-36, 2013



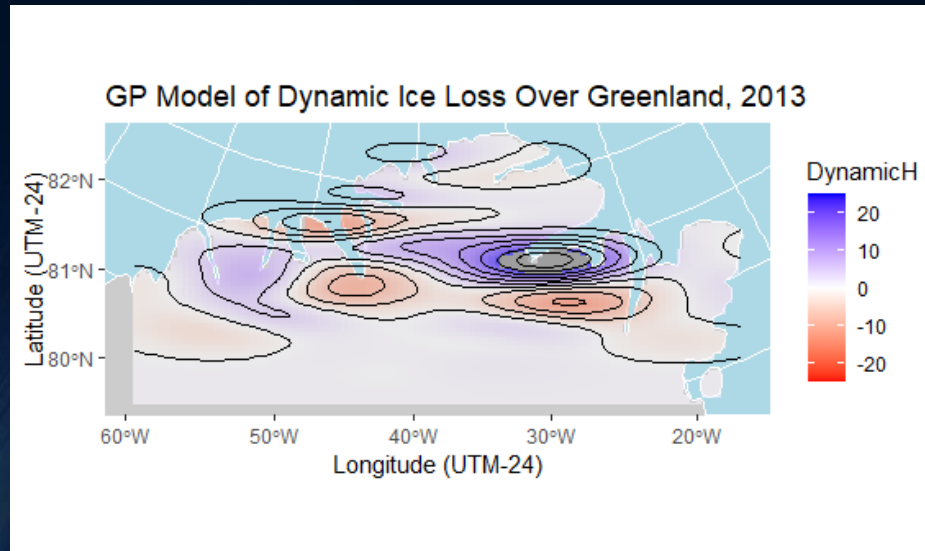
GP Model of Dynamic Ice Loss Over Greenland, 2013



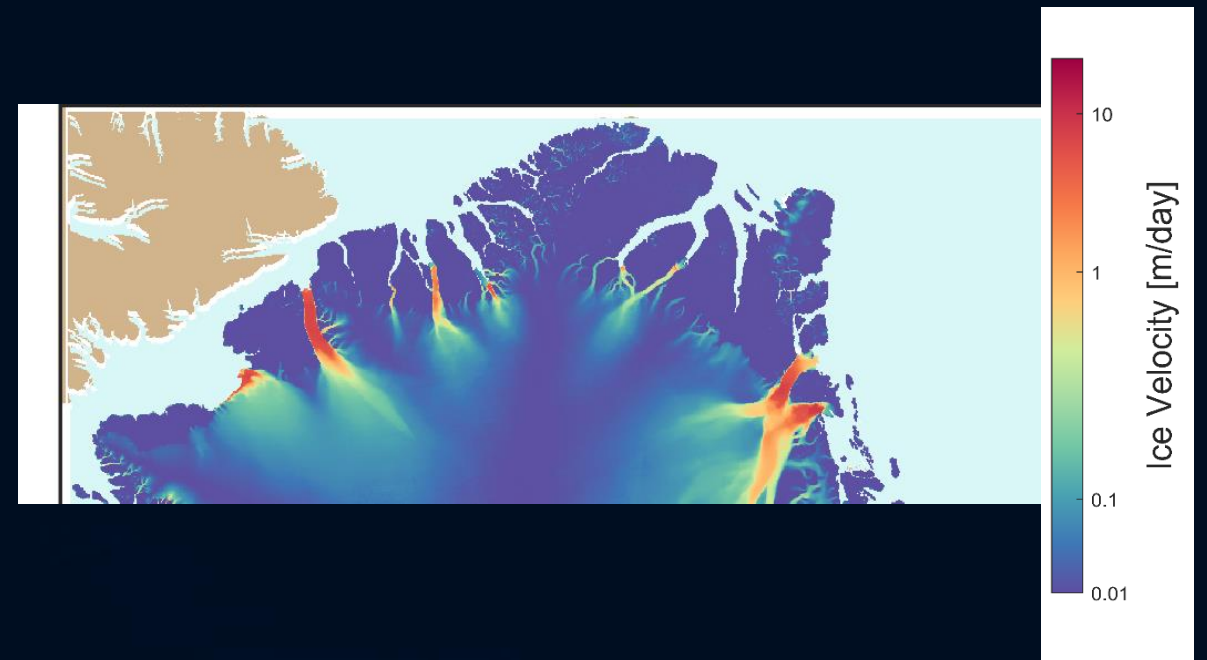
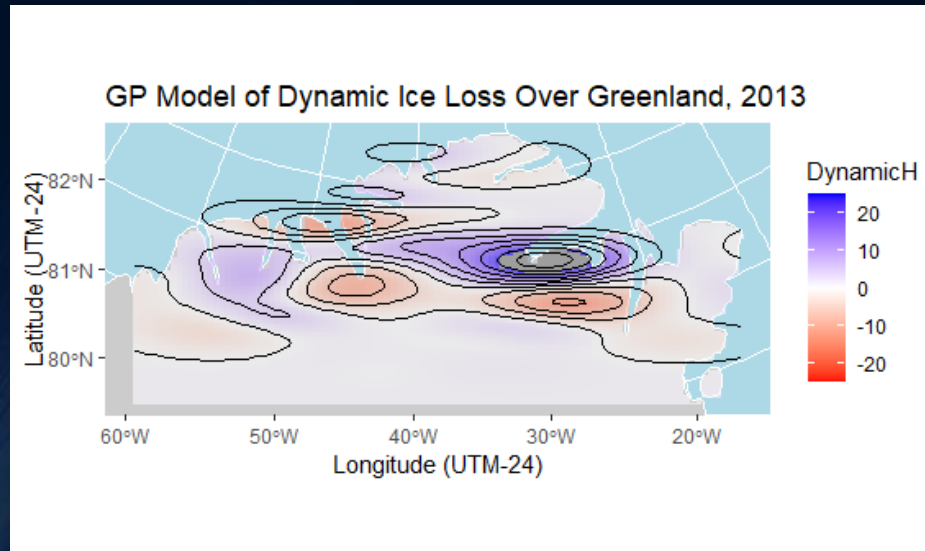
Comparison to Elevation



Comparison to Drainage Basins



Comparison to Ice Velocity Map



Conclusion

- The relationship to elevation seems somewhat mixed in this region of Greenland. Sometimes low elevation areas appear to be associated with high losses, while other low elevation areas do not.
- There appears to be a stronger connection to ice flow velocity and to specific catchment basins previously known to have generally high flow rates (indicated in dark blue on the catchment map and red on the ice velocity map).

References

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