# Runoff Modeling for the Gulf of Alaska Region

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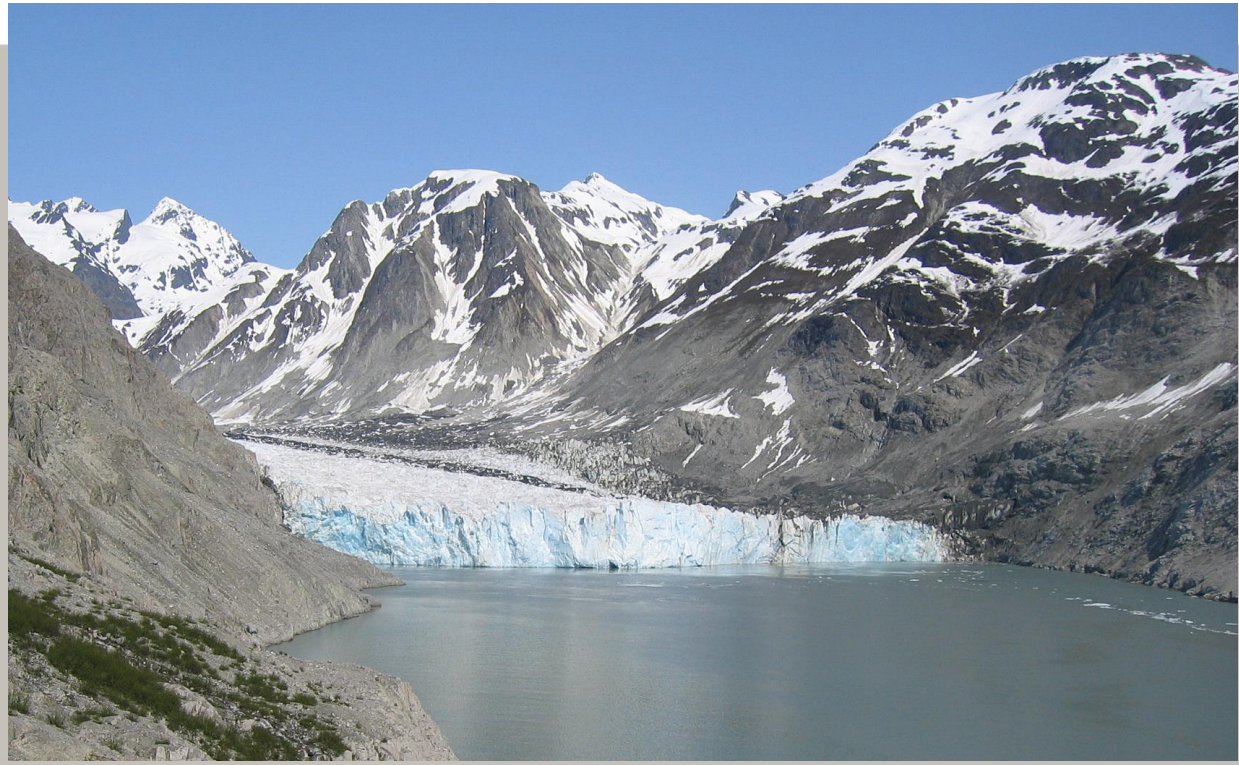

# Acknowledgements


**Students:**

Jordan Beamer (PhD Candidate)
Noa Bruhis, M.S.

**Collaborators:**

- Anthony Arendt, UW-APL
- Glen Liston, CSU
- Eran Hood, UAS
- Scott Luthcke, NASA
- Dan McGrath
- Christian Kienholz

**Funding:**








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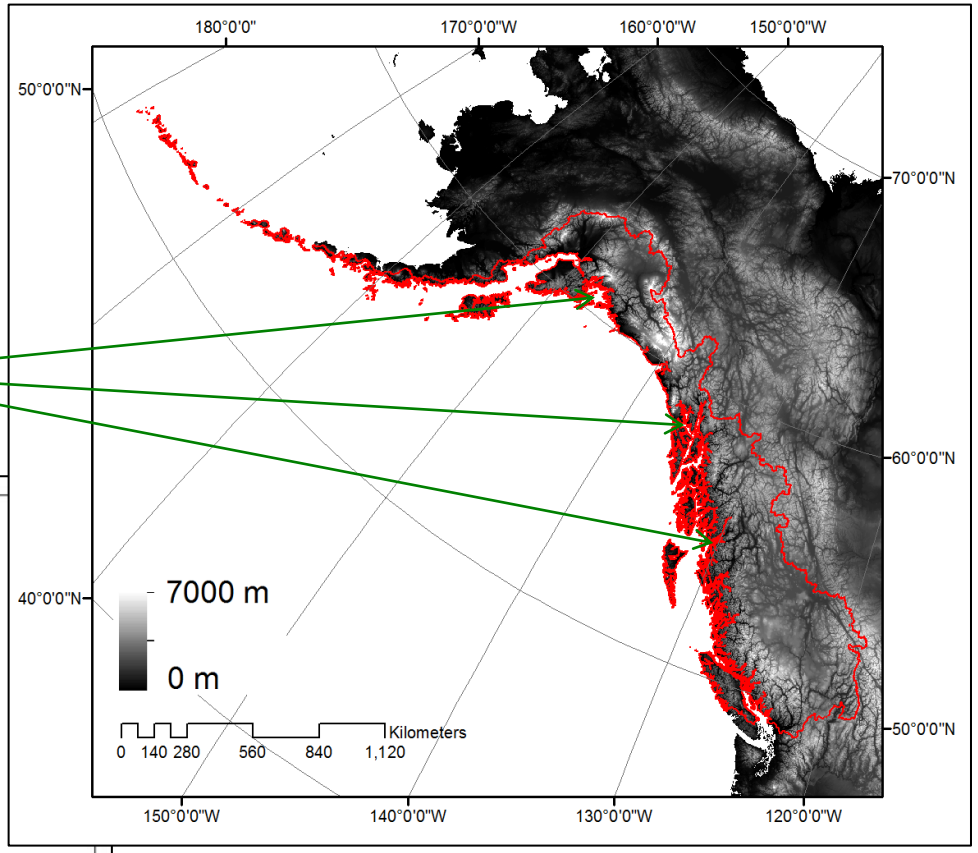
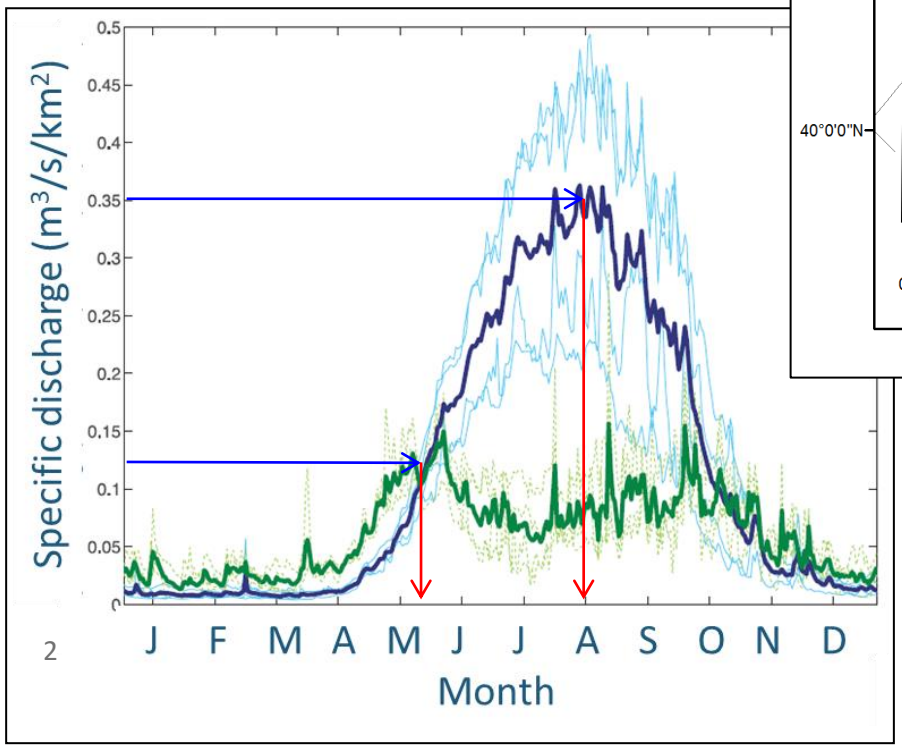
# How's the water?

How Much?

When does it arrive?

Where is it?




$$Q_{total} = Q_{rainfall} + Q_{snowmelt} + Q_{glacier\ mass}$$

O'Neel et al., 2015



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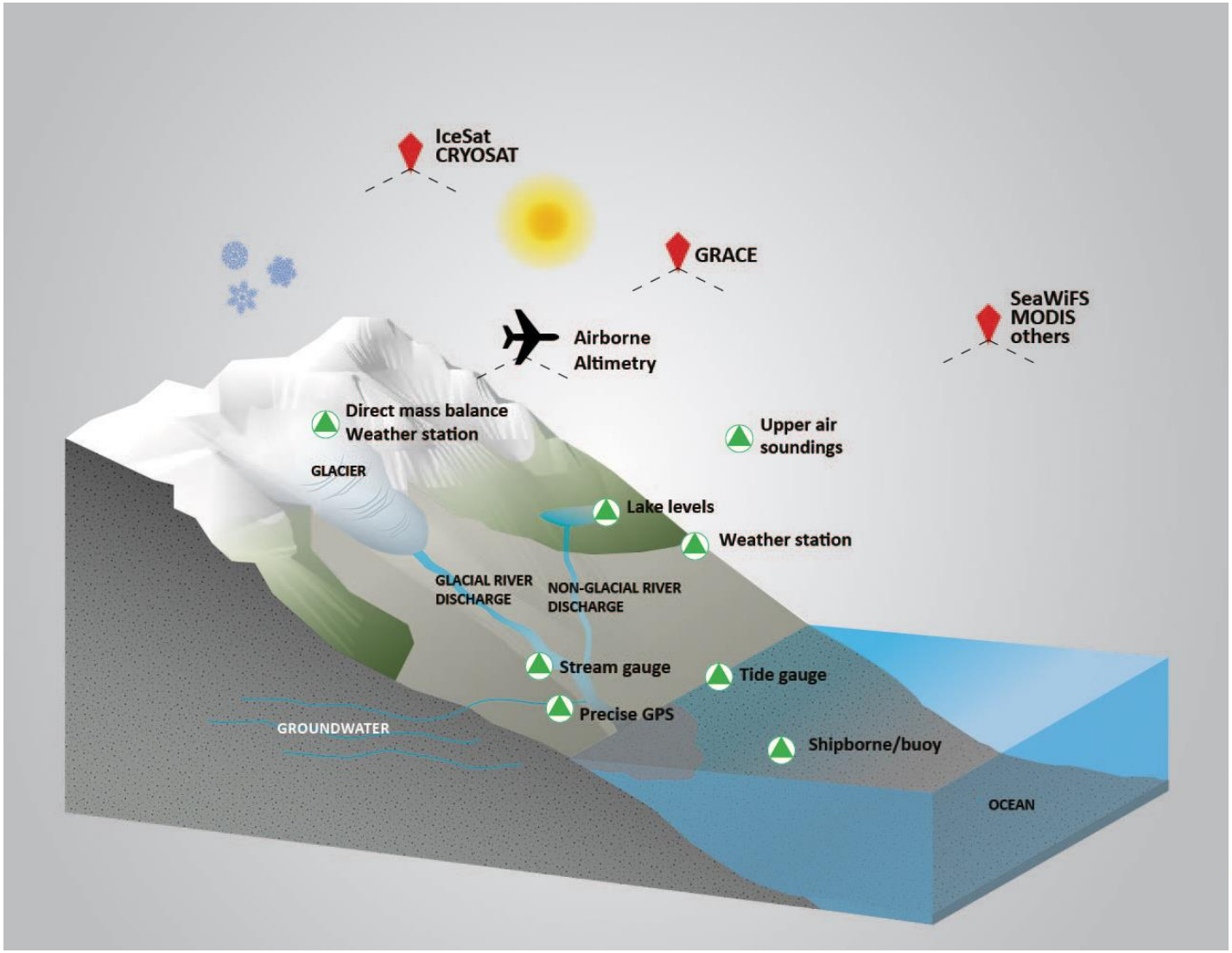
# What do we know?



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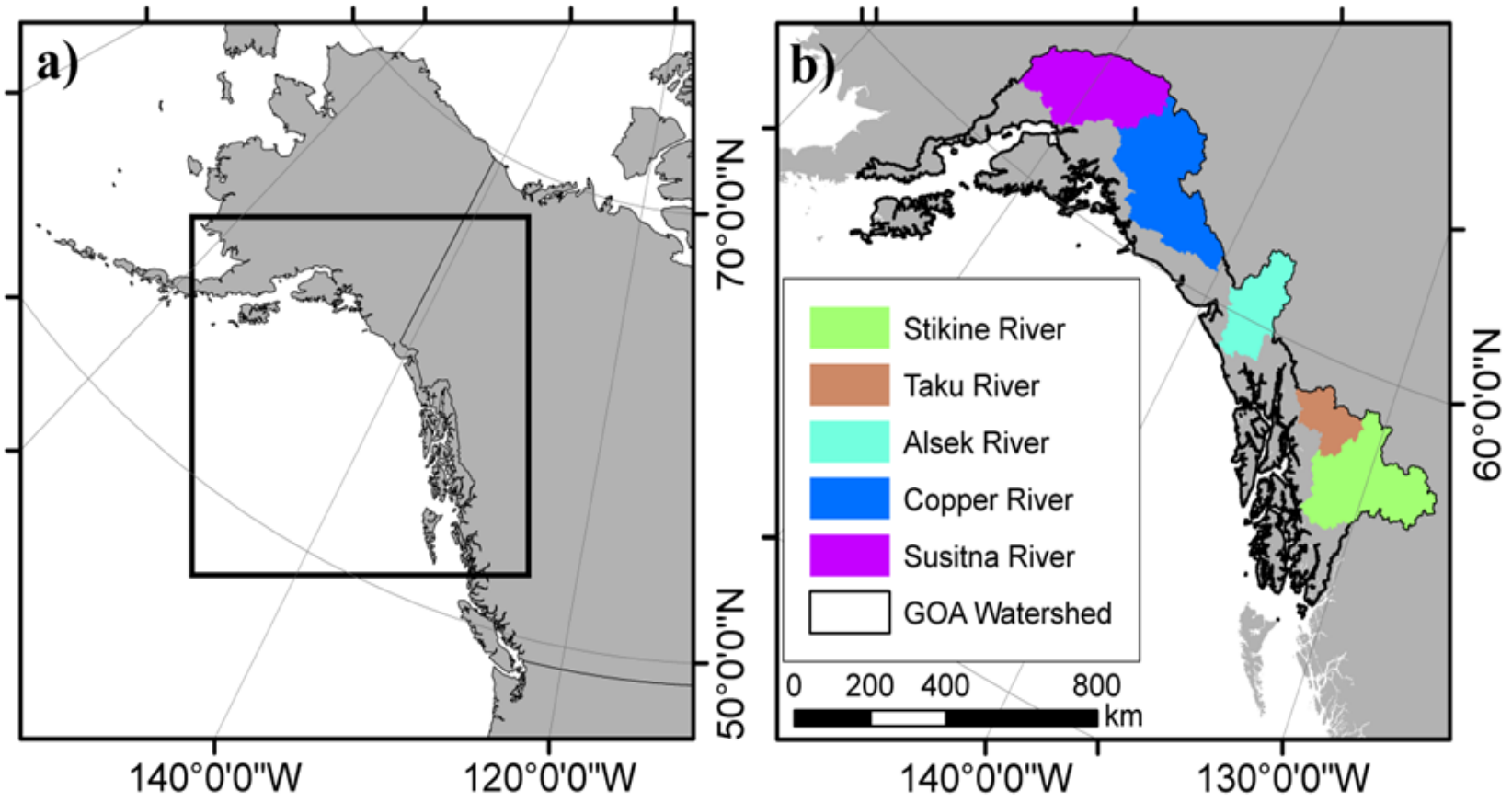
# What do we know?



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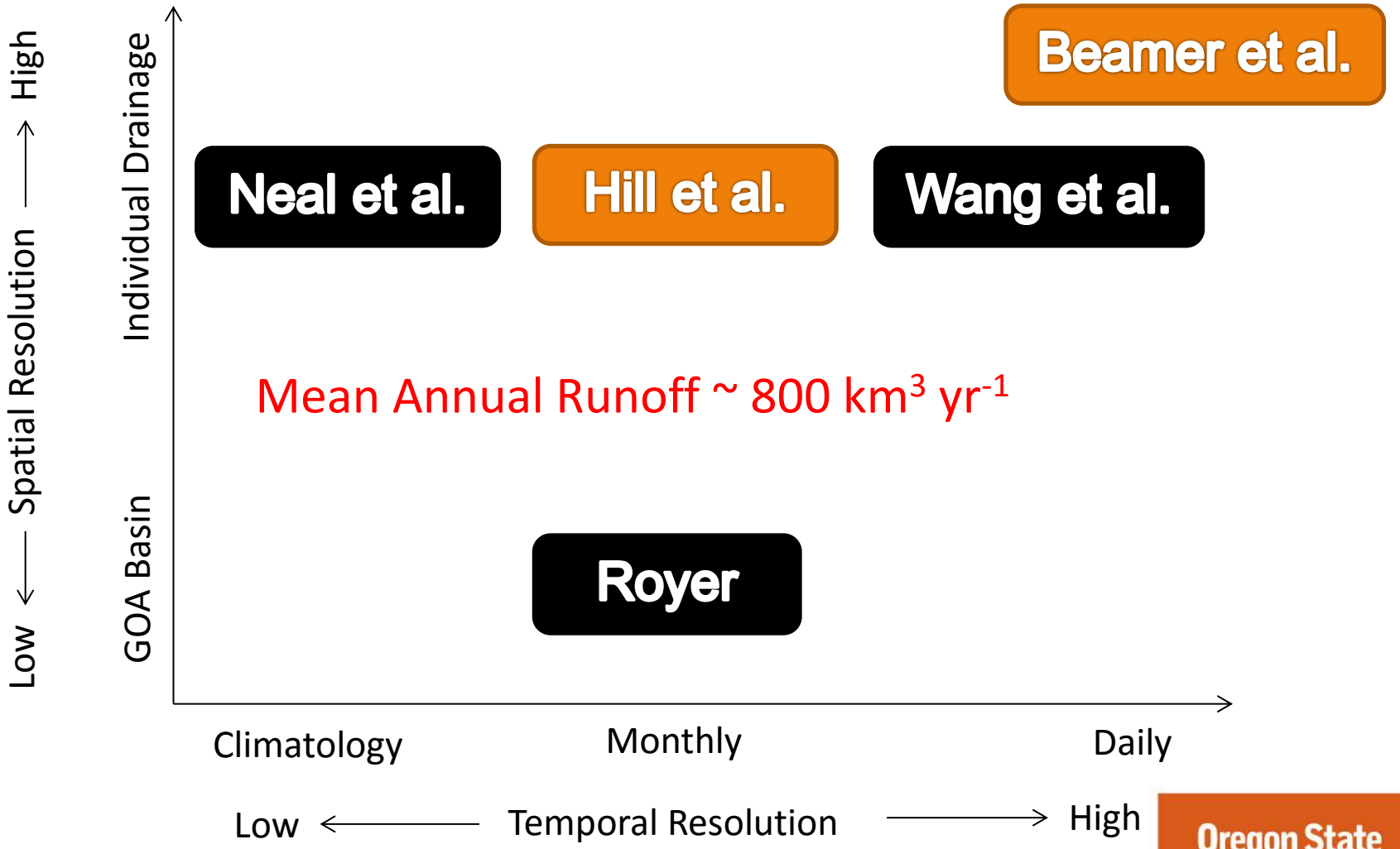
# What do models tell us?



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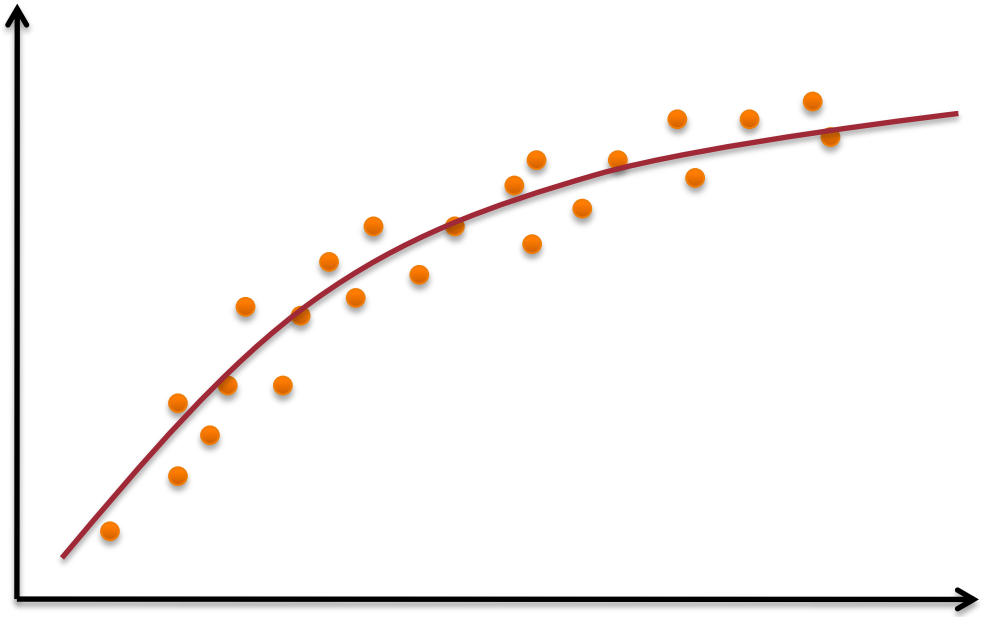
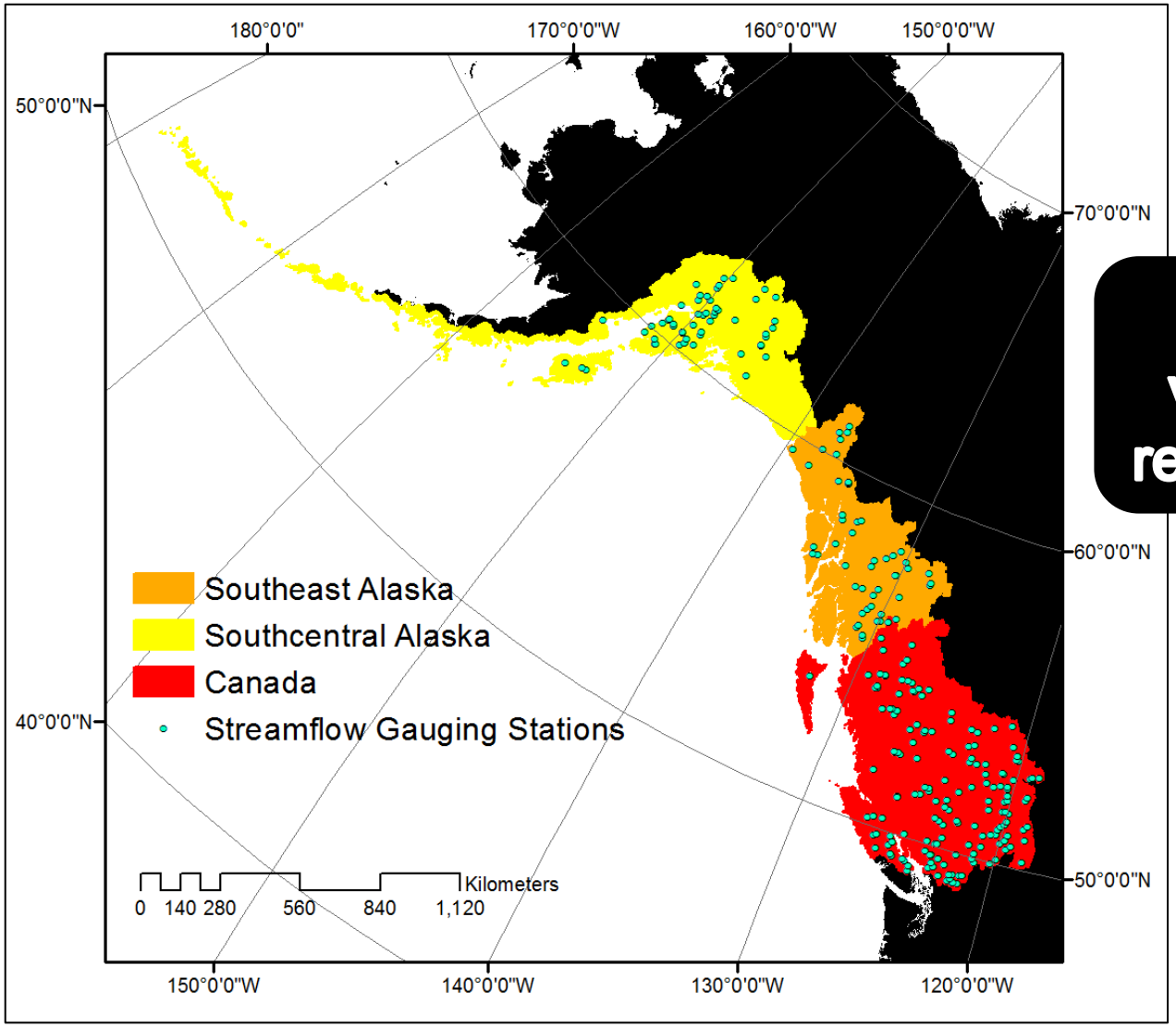
# Regression analysis

$$Q = Ax_1^{a_1} x_2^{a_2} x_3^{a_3} \ldots$$



Ingredients → accessible geospatial data
Outputs → monthly flows

# Regression analysis




**Dependent variable (Q) regionalization**



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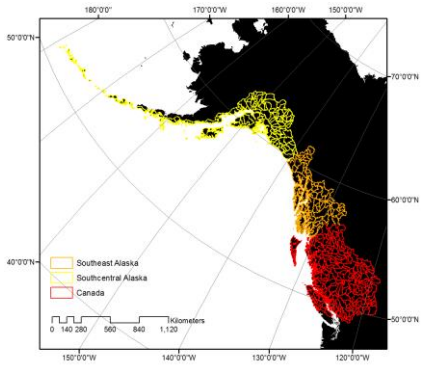
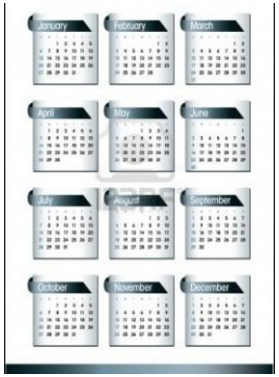
# Regression analysis




×




= **36**

| SE AK | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| const. | 1.44 | 0.75 | -1.68 | -8.02 | -13.78 | -7.49 | -3.06 | -4.55 | -4.16 | -6.20 | 0.87 | 2.46 |
| area | 1.04 | 1.04 | 1.04 | 0.99 | 0.98 | 0.96 | 0.93 | 0.89 | 0.91 | 0.90 | 0.96 | 0.99 |
| **elev** | **-1.58** | **-1.49** | **-1.29** | **-0.98** | **-0.05** | **0.55** | **0.65** | **0.19** | **-0.18** | **-1.16** | **-1.79** | **-1.94** |
| precip | 0.20 | 0.29 | 0.50 | 0.19 | 0.12 | -0.23 | -0.01 | 0.23 | 0.33 | 0.01 | -0.06 | -0.11 |
| cumul. precip | 0.54 | 0.53 | 0.35 | 0.51 | 0.79 | 0.87 | 0.69 | 0.46 | 0.63 | 0.13 | 0.14 | 0.17 |
| temp | 0.41 | 0.60 | 1.88 | 5.57 | 7.51 | 2.45 | -0.51 | 1.25 | 1.57 | 5.45 | 1.90 | 0.88 |
| glacier | -0.02 | -0.01 | 0.02 | 0.11 | 0.04 | 0.09 | 0.32 | 0.47 | 0.30 | 0.29 | 0.18 | 0.12 |

# Regression results?

Nash-Sutcliffe Efficiencies range from 0.75 – 0.85

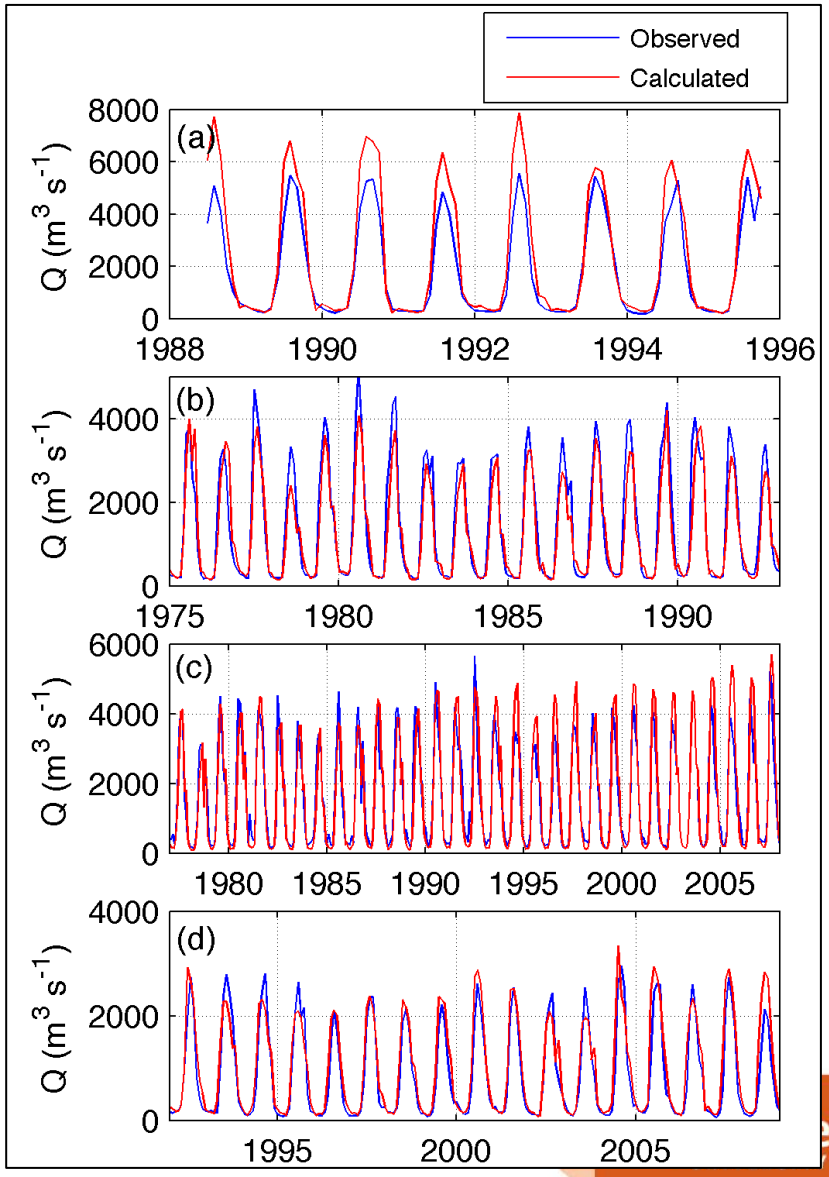
Mean Absolute Percent Error (MAPE) typically 15%

Copper

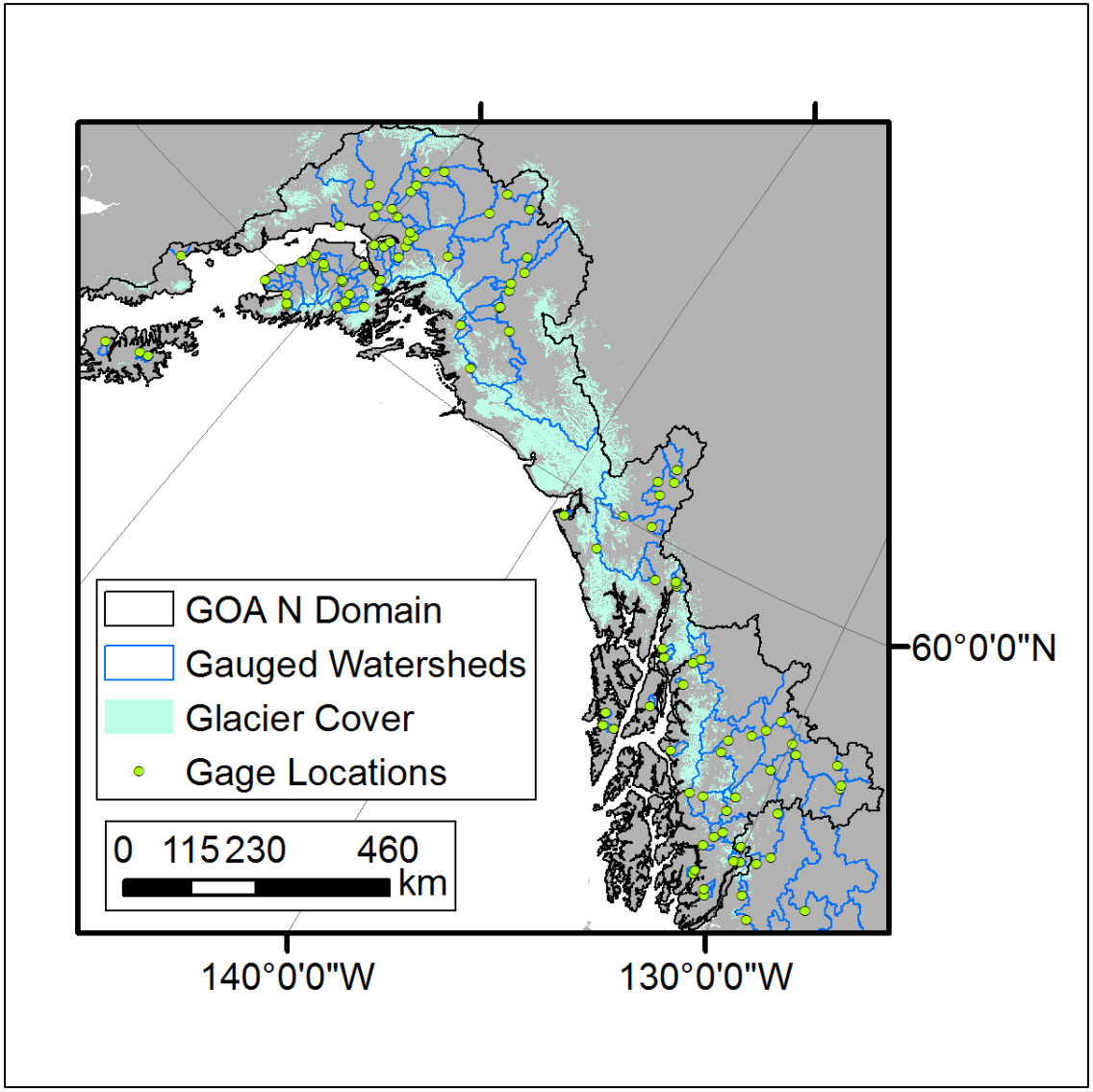
Susitna

Stikine

Alsek



# Why a physically-based model?



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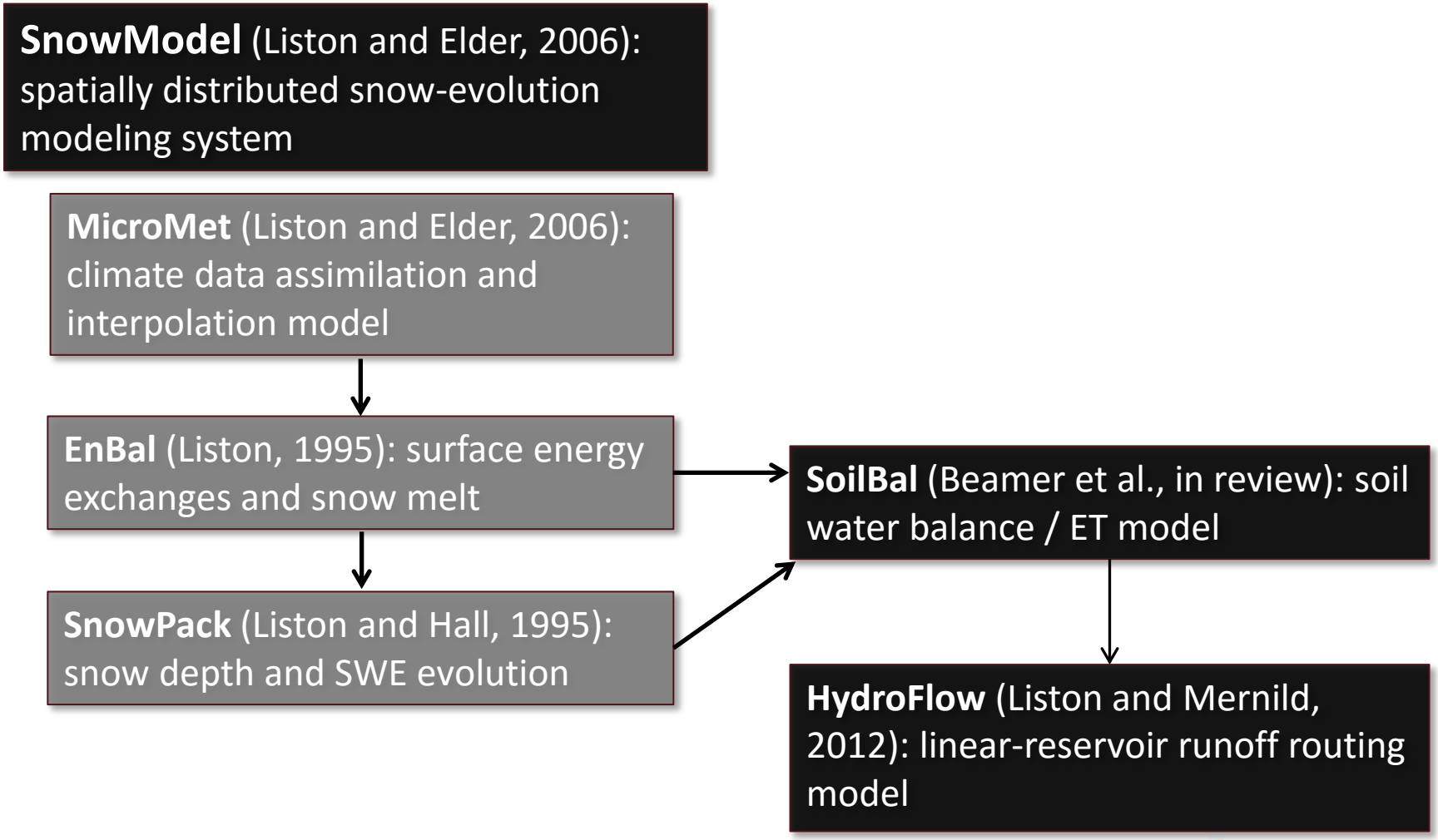
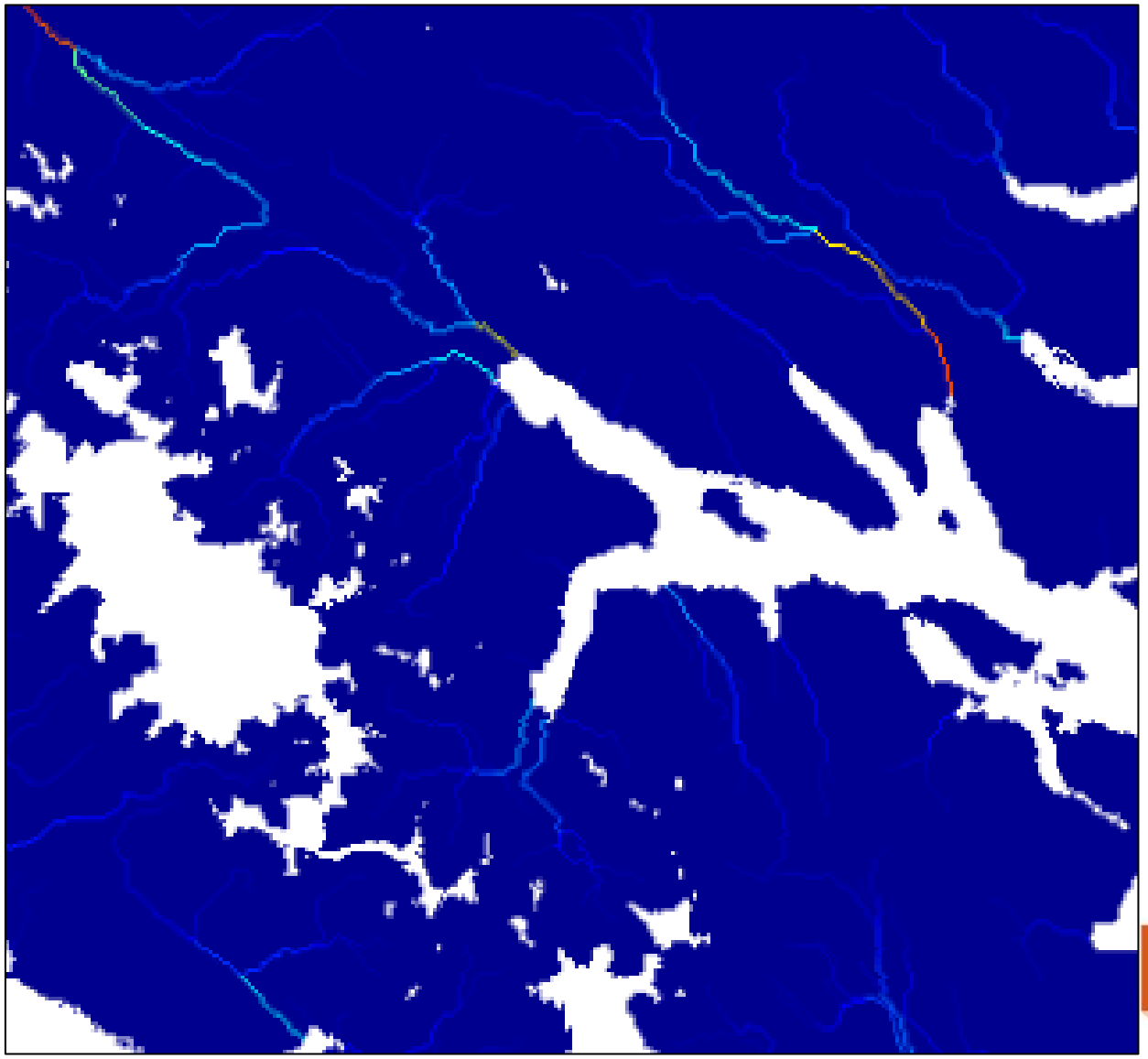
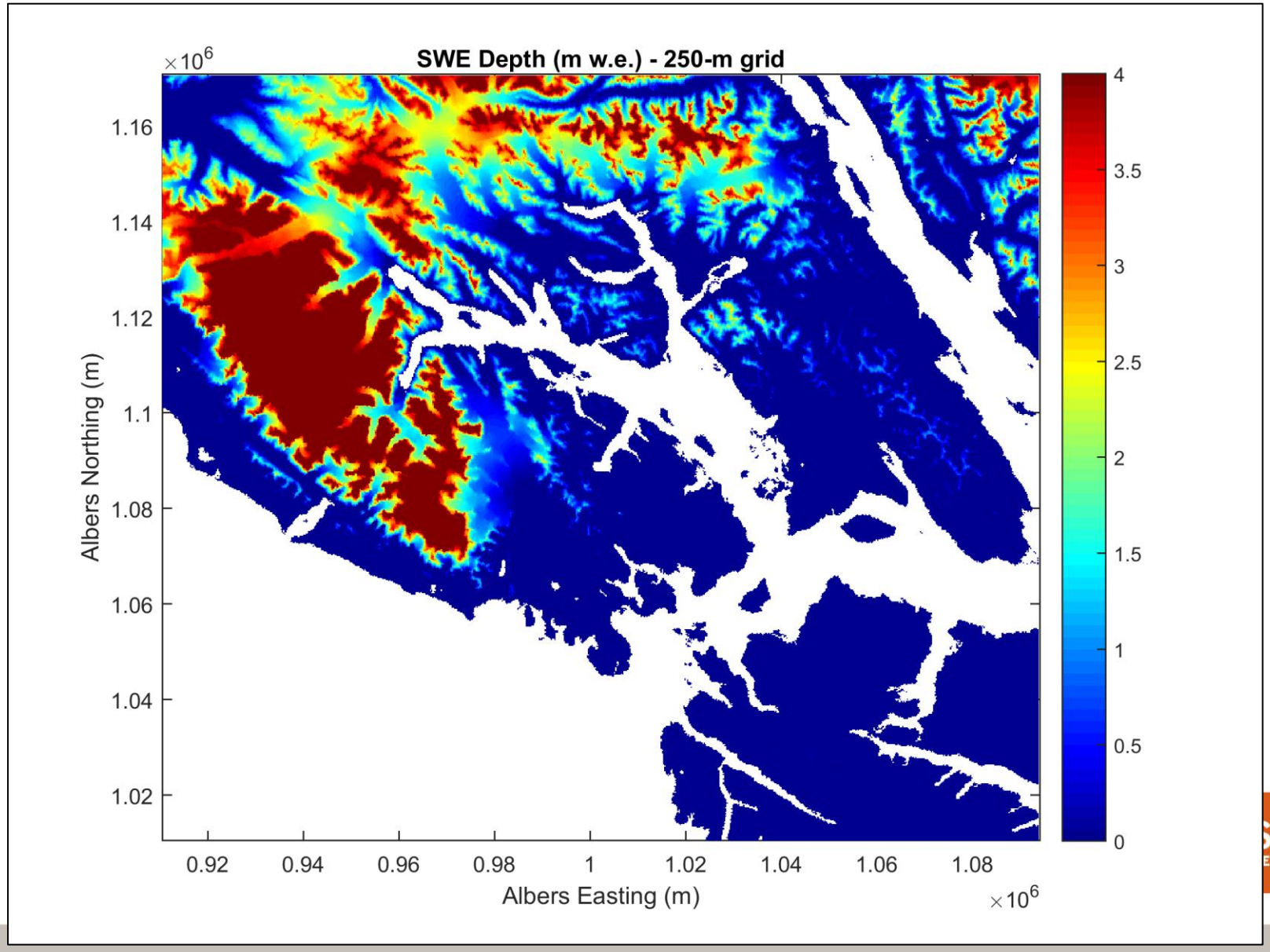
# Methods: modeling system



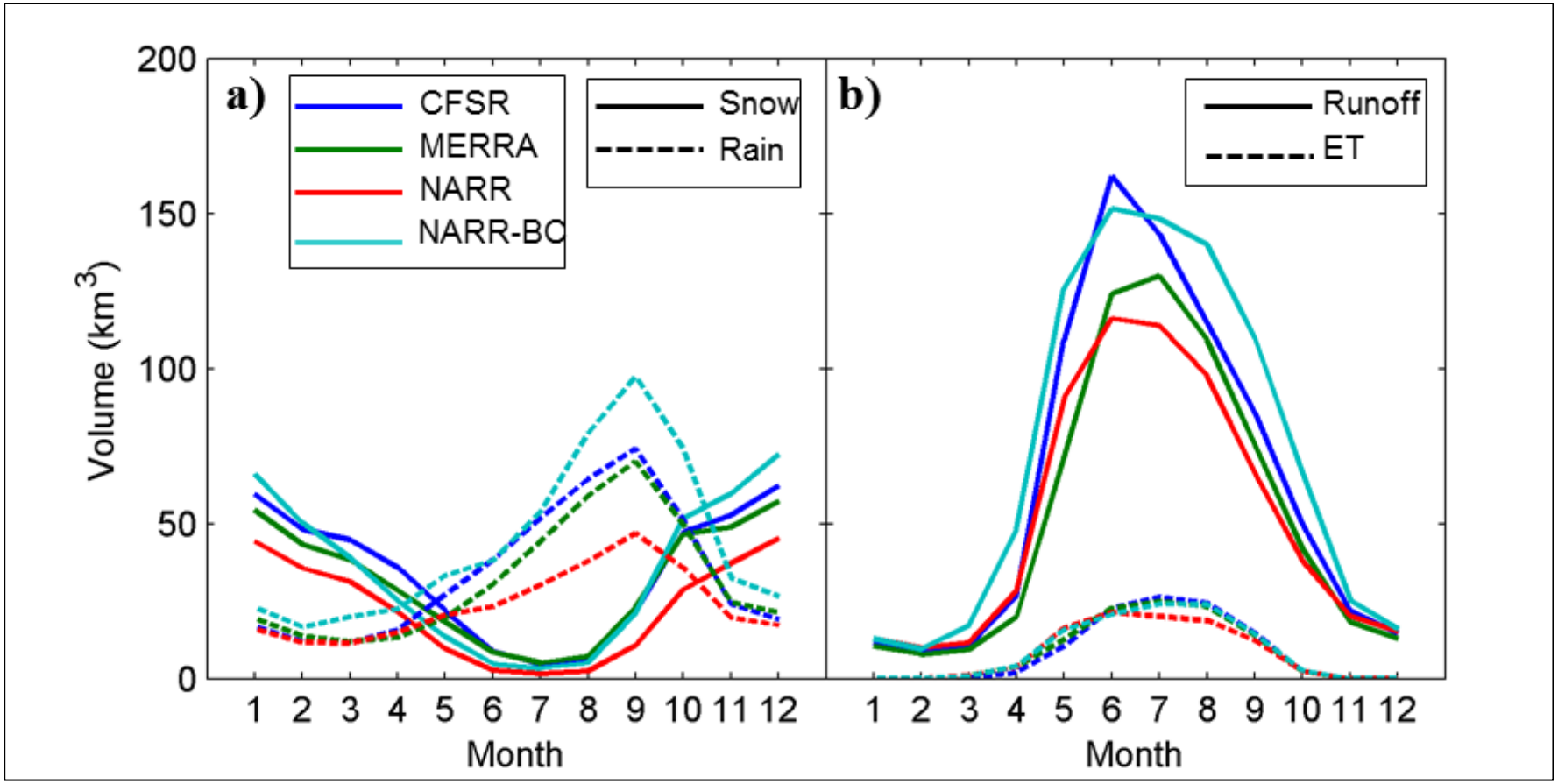
# Methods: model outputs



# Methods: model outputs



# GOA aggregated results



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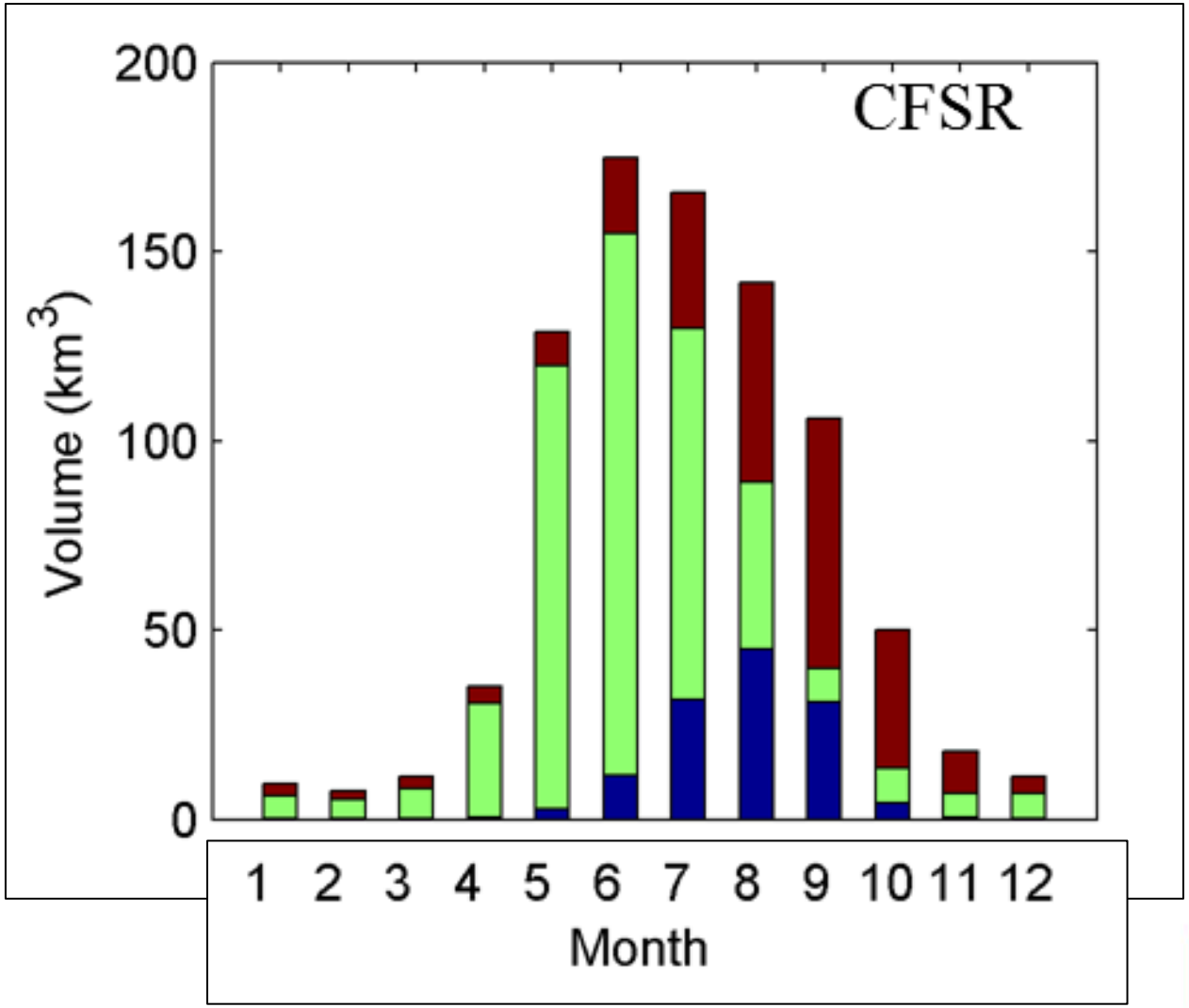
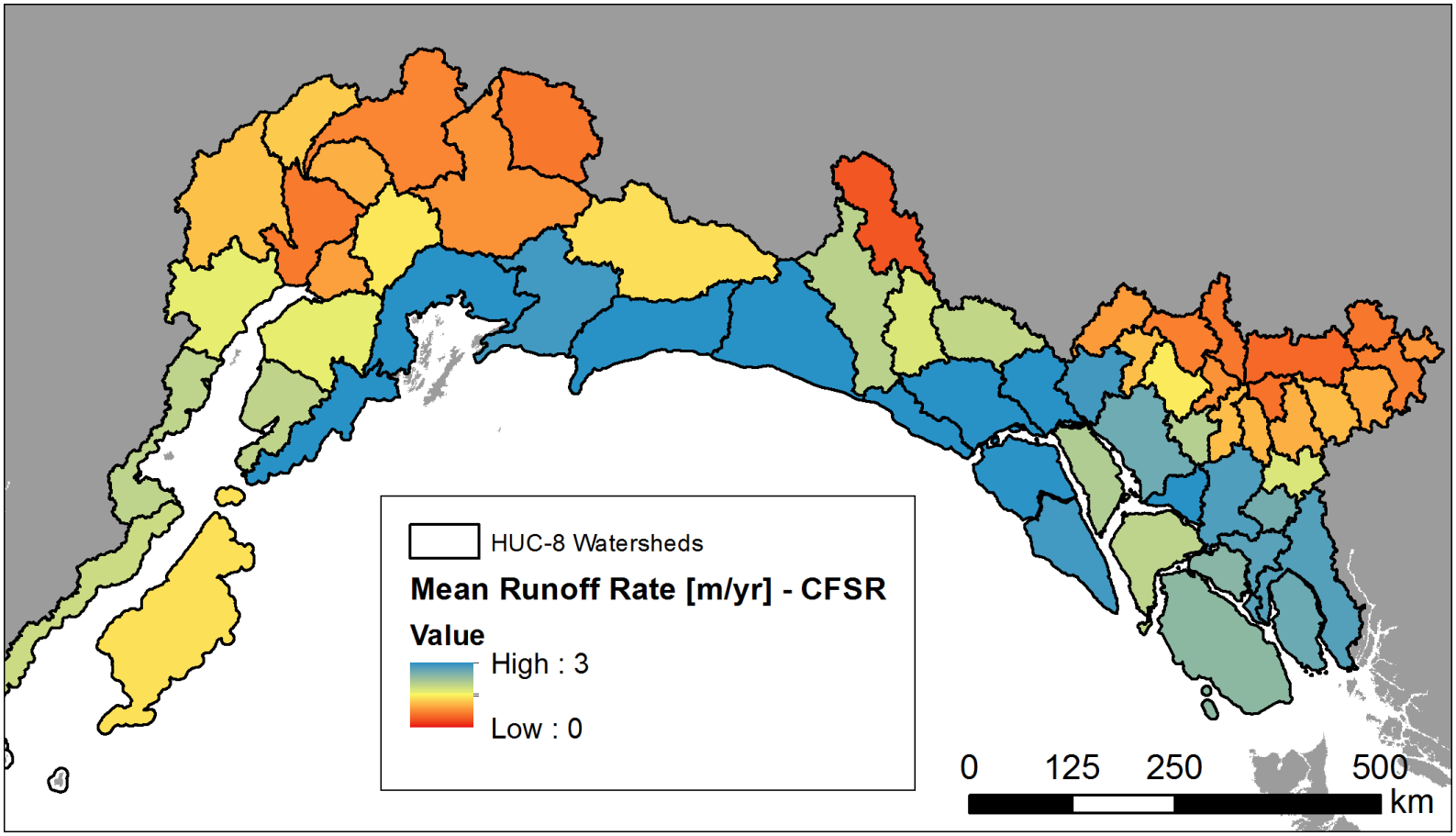


# HUC aggregated results



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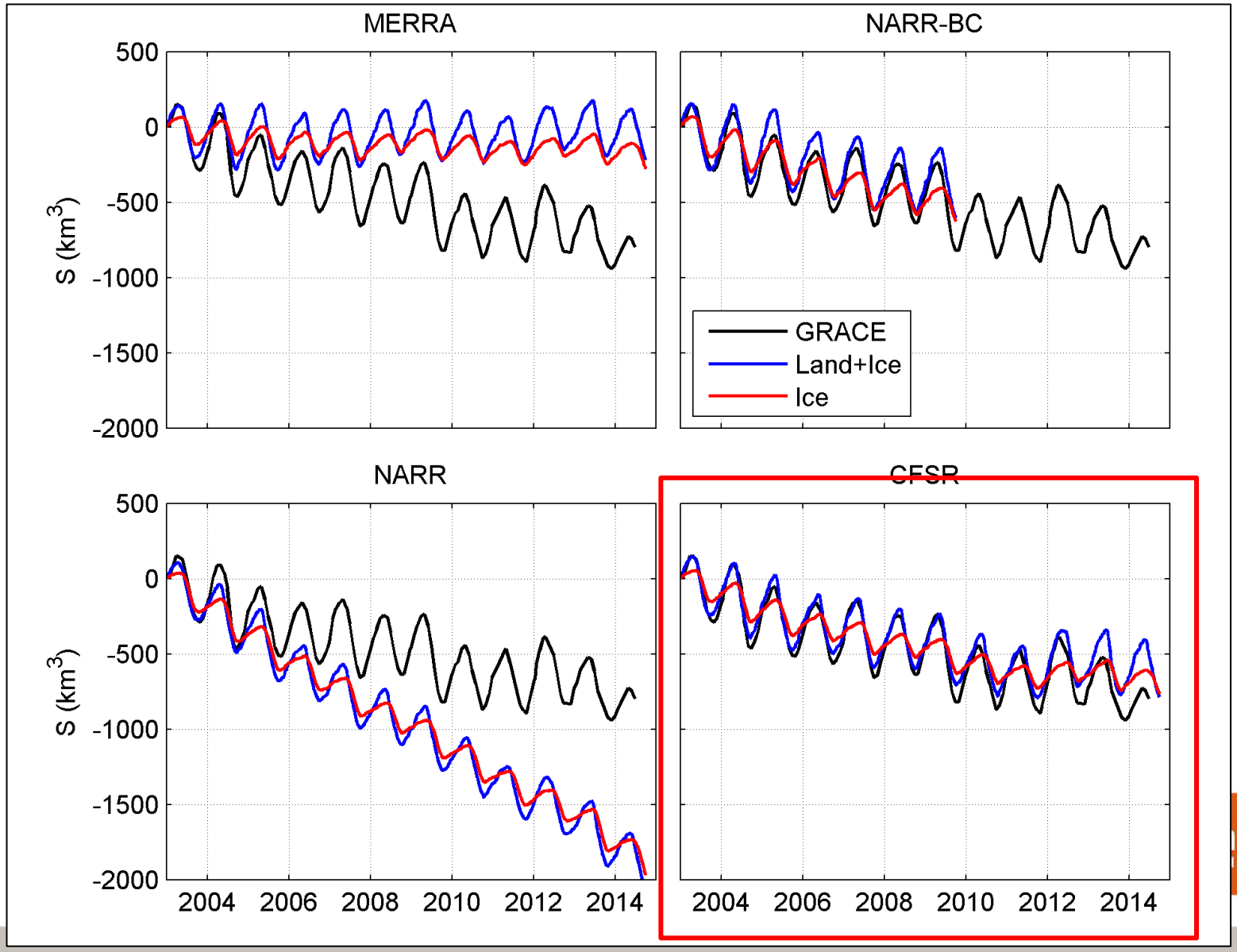
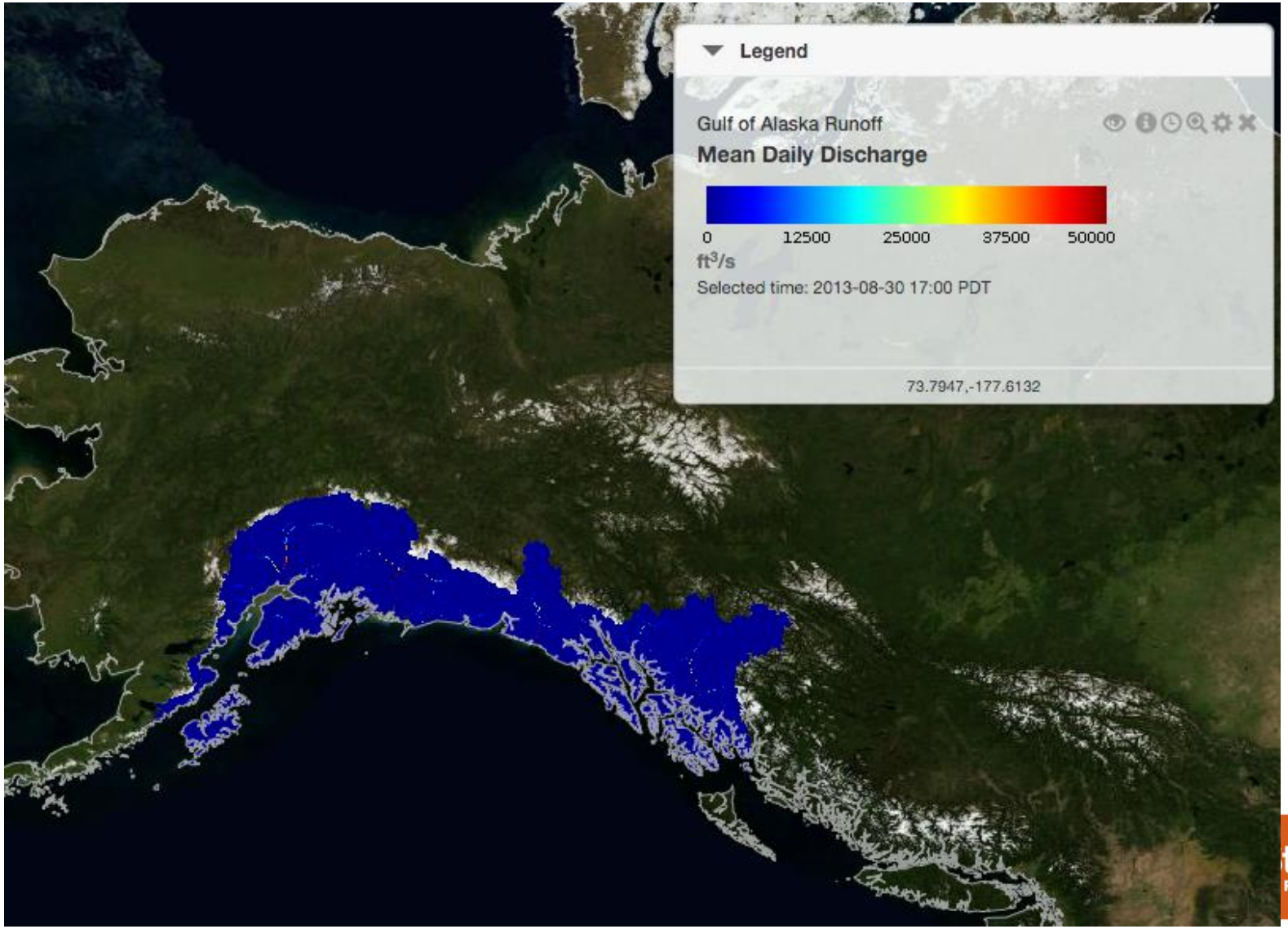
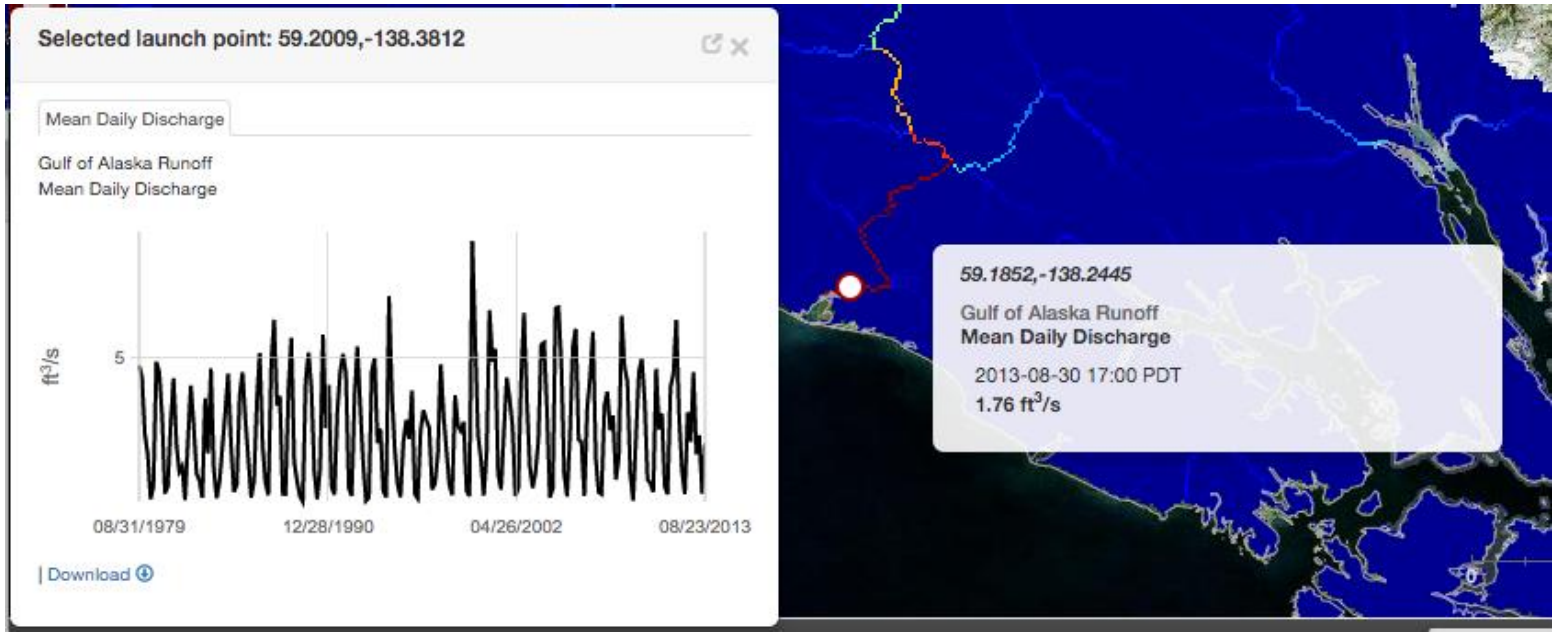
# Comparison to GRACE



# Data availability

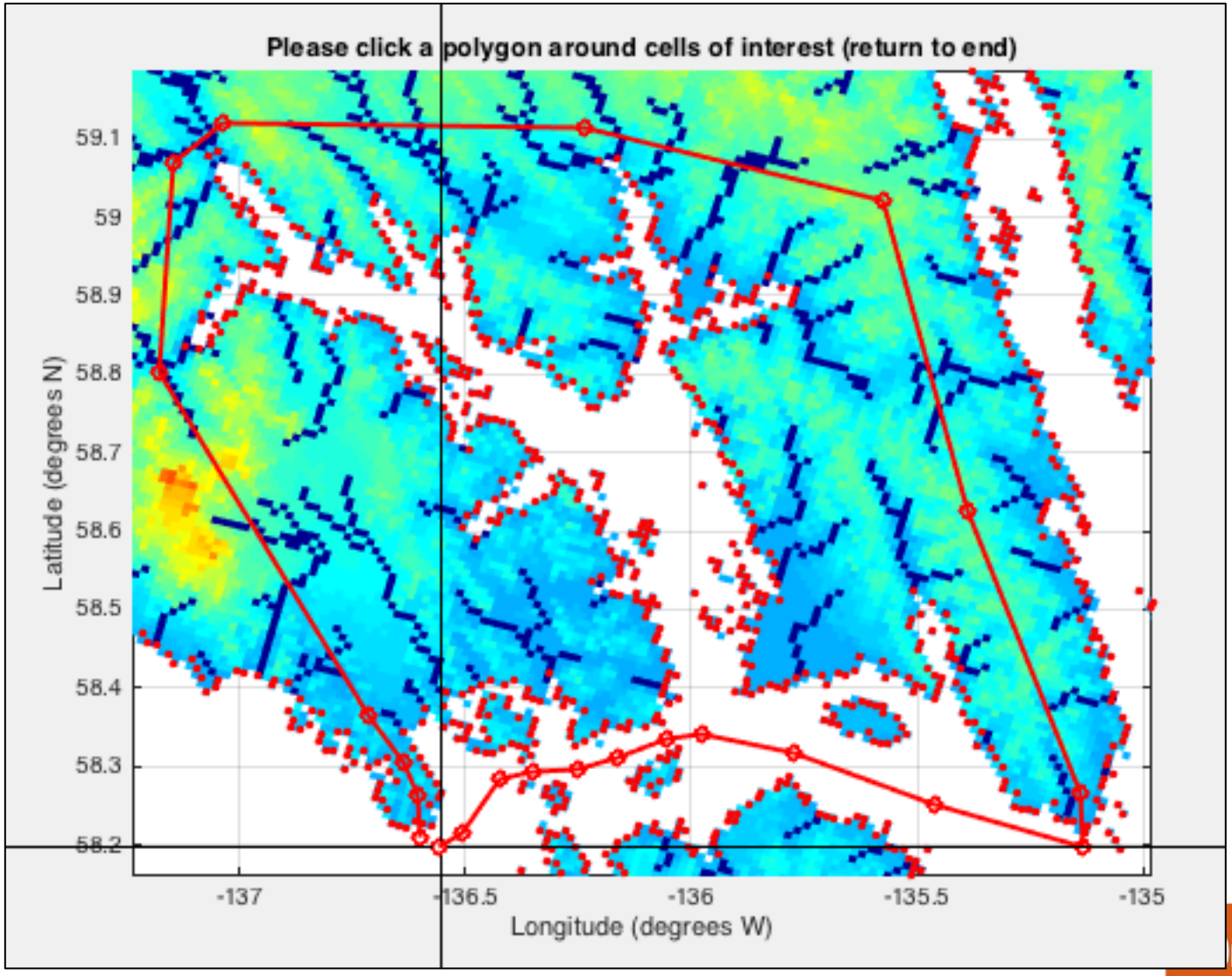


# Data availability

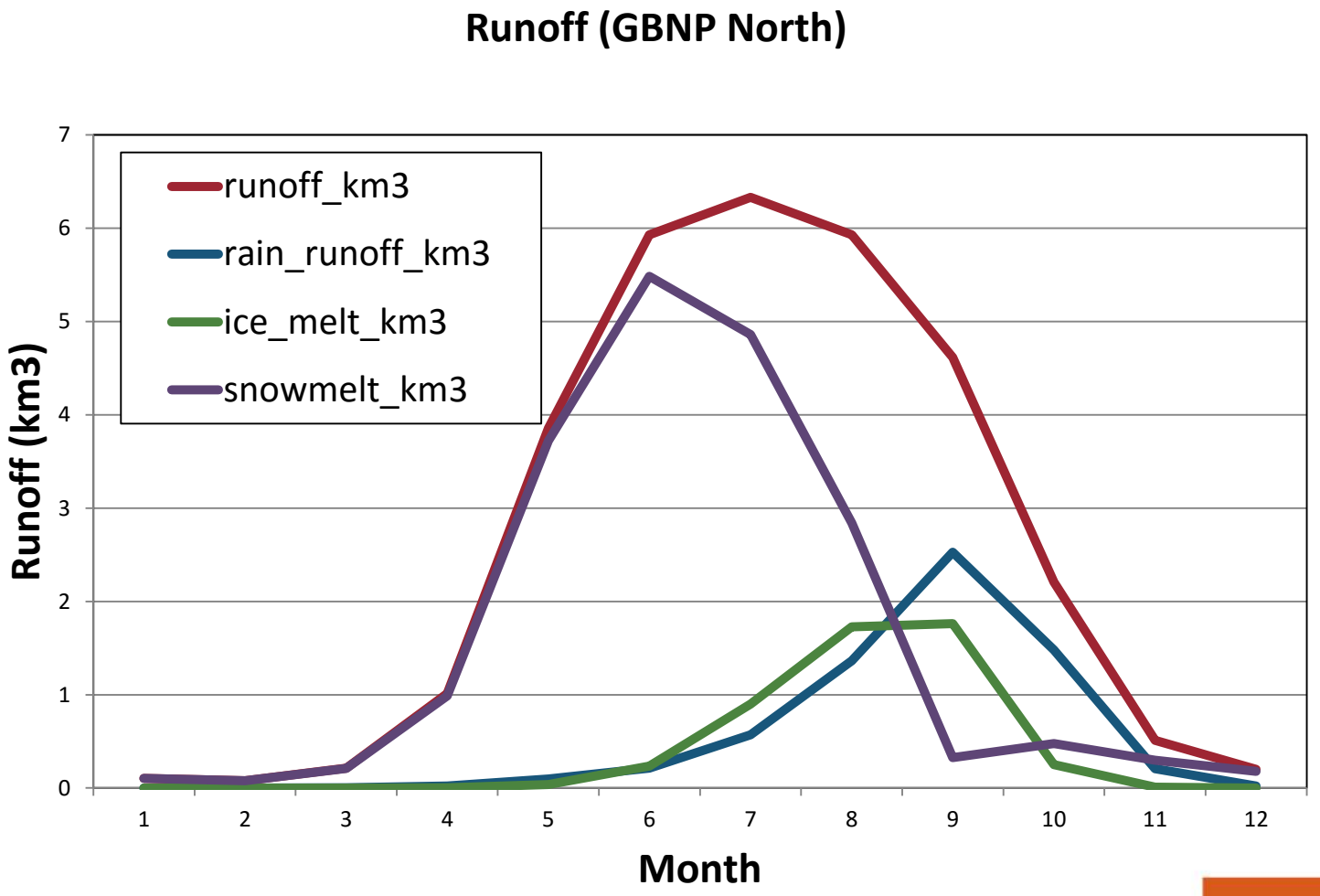



| | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | station_id | sensor_id | latitude (deg | longitude (de | date_time | http://mmisw.org/ont/ioos/parameter/river_discharge (ft3.s-1) | | | | |
| 2 | urn:ioos:stat | urn:ioos:sens | 59.2008534 | -138.38116 | 1979-09-01 | 0.49173473 | | | | |
| 3 | urn:ioos:stat | urn:ioos:sens | 59.2008534 | -138.38116 | 1979-09-02 | 0.55034394 | | | | |
| 4 | urn:ioos:stat | urn:ioos:sens | 59.2008534 | -138.38116 | 1979-09-03 | 0.56116651 | | | | |
| 5 | urn:ioos:stat | urn:ioos:sens | 59.2008534 | -138.38116 | 1979-09-04 | 0.60278002 | | | | |
| 6 | urn:ioos:stat | urn:ioos:sens | 59.2008534 | -138.38116 | 1979-09-05 | 0.59640442 | | | | |
| 7 | urn:ioos:stat | urn:ioos:sens | 59.2008534 | -138.38116 | 1979-09-06 | 0.57378688 | | | | |
| 8 | urn:ioos:stat | urn:ioos:sens | 59.2008534 | -138.38116 | 1979-09-07 | 0.56225732 | | | | |
| 9 | urn:ioos:stat | urn:ioos:sens | 59.2008534 | -138.38116 | 1979-09-08 | 0.54027675 | | | | |
| 10 | urn:ioos:stat | urn:ioos:sens | 59.2008534 | -138.38116 | 1979-09-09 | 0.51948676 | | | | |
| 11 | urn:ioos:stat | urn:ioos:sens | 59.2008534 | -138.38116 | 1979-09-10 | 0.50271149 | | | | |
| 12 | urn:ioos:stat | urn:ioos:sens | 59.2008534 | -138.38116 | 1979-09-11 | 0.21635847 | | | | |
| 13 | urn:ioos:stat | urn:ioos:sens | 59.2008534 | -138.38116 | 1979-09-12 | 0.36770141 | | | | |

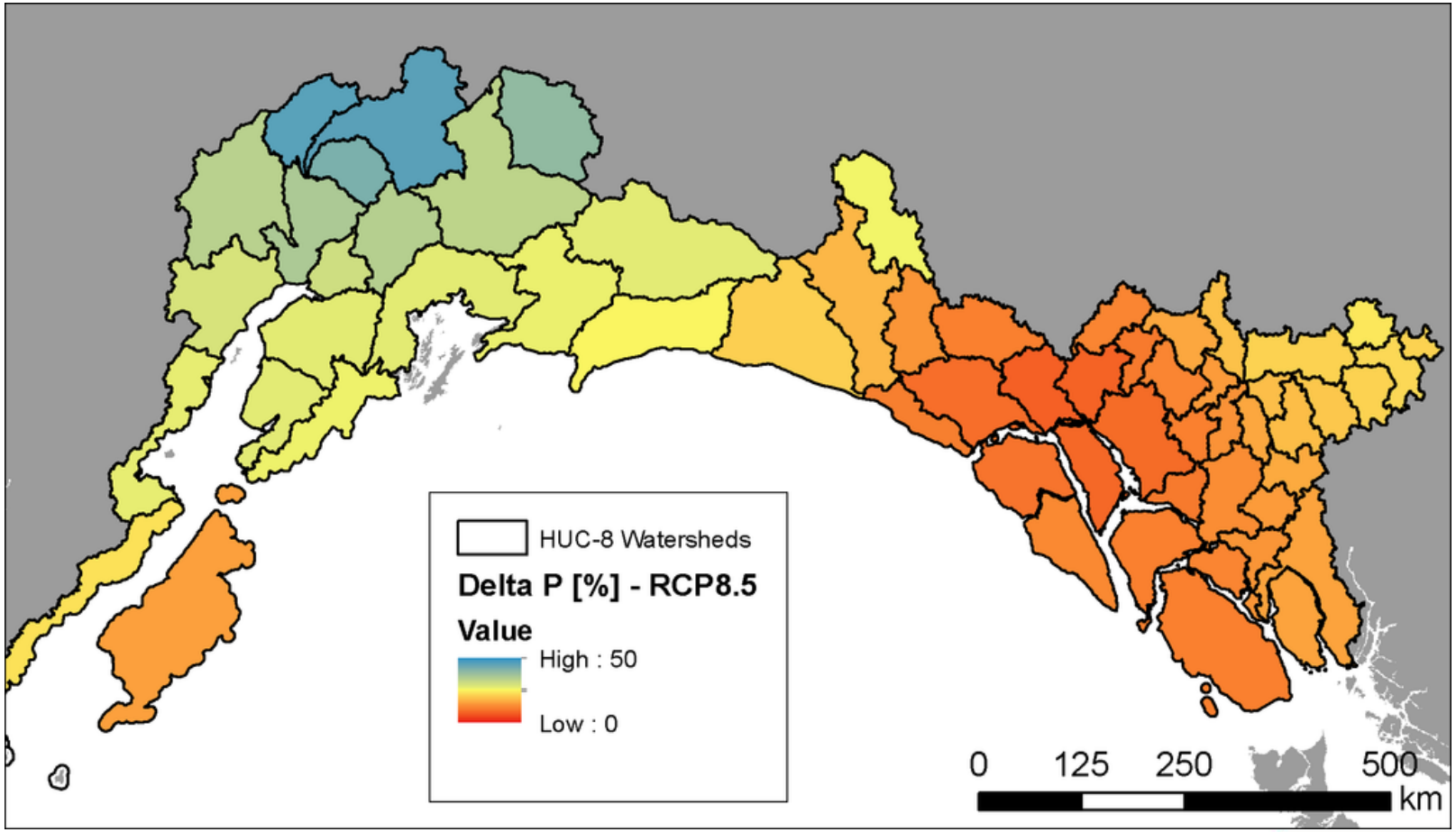
# Data availability (1km model)



# Glacier Bay aggregated results



# Drivers of change



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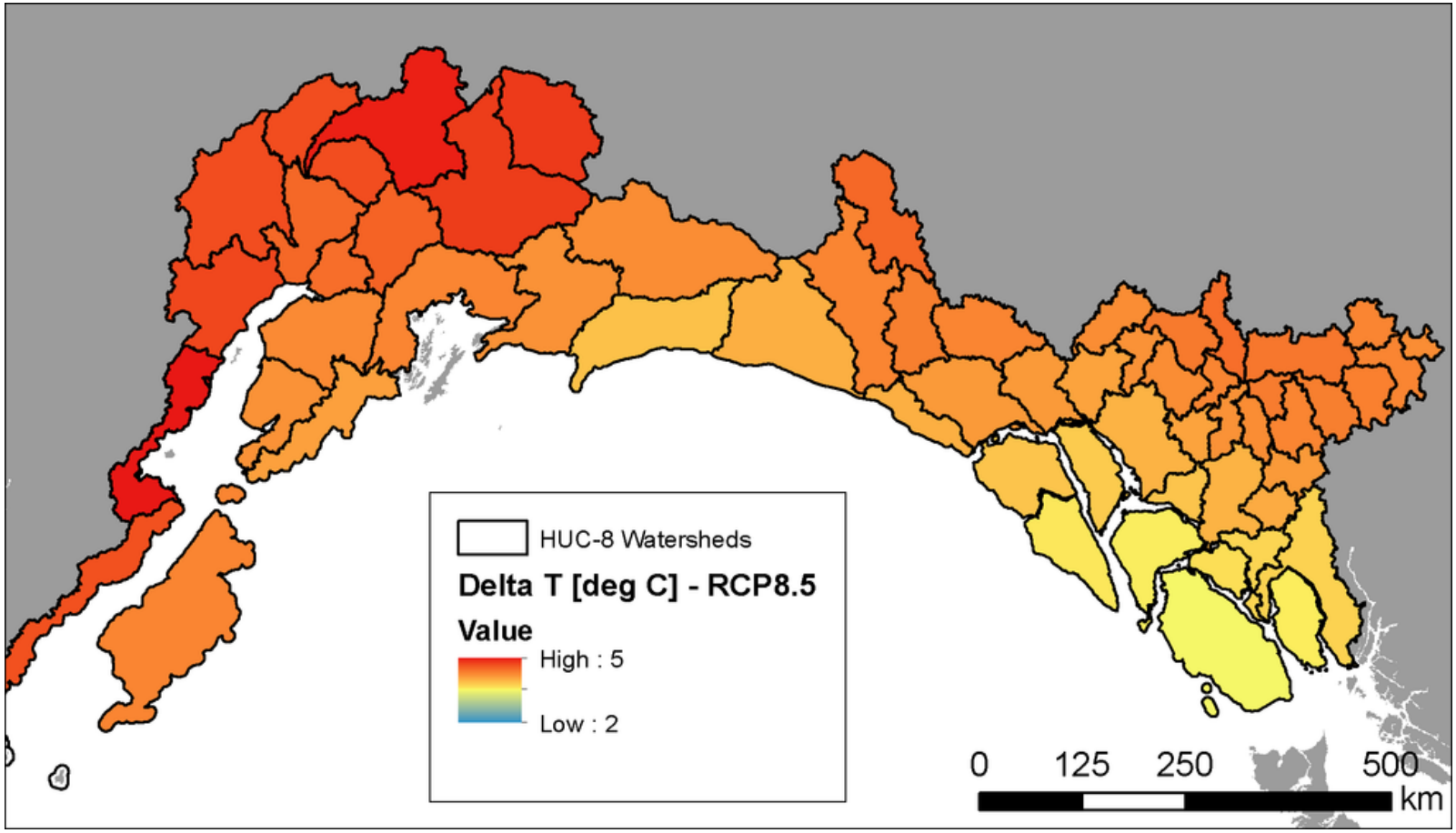




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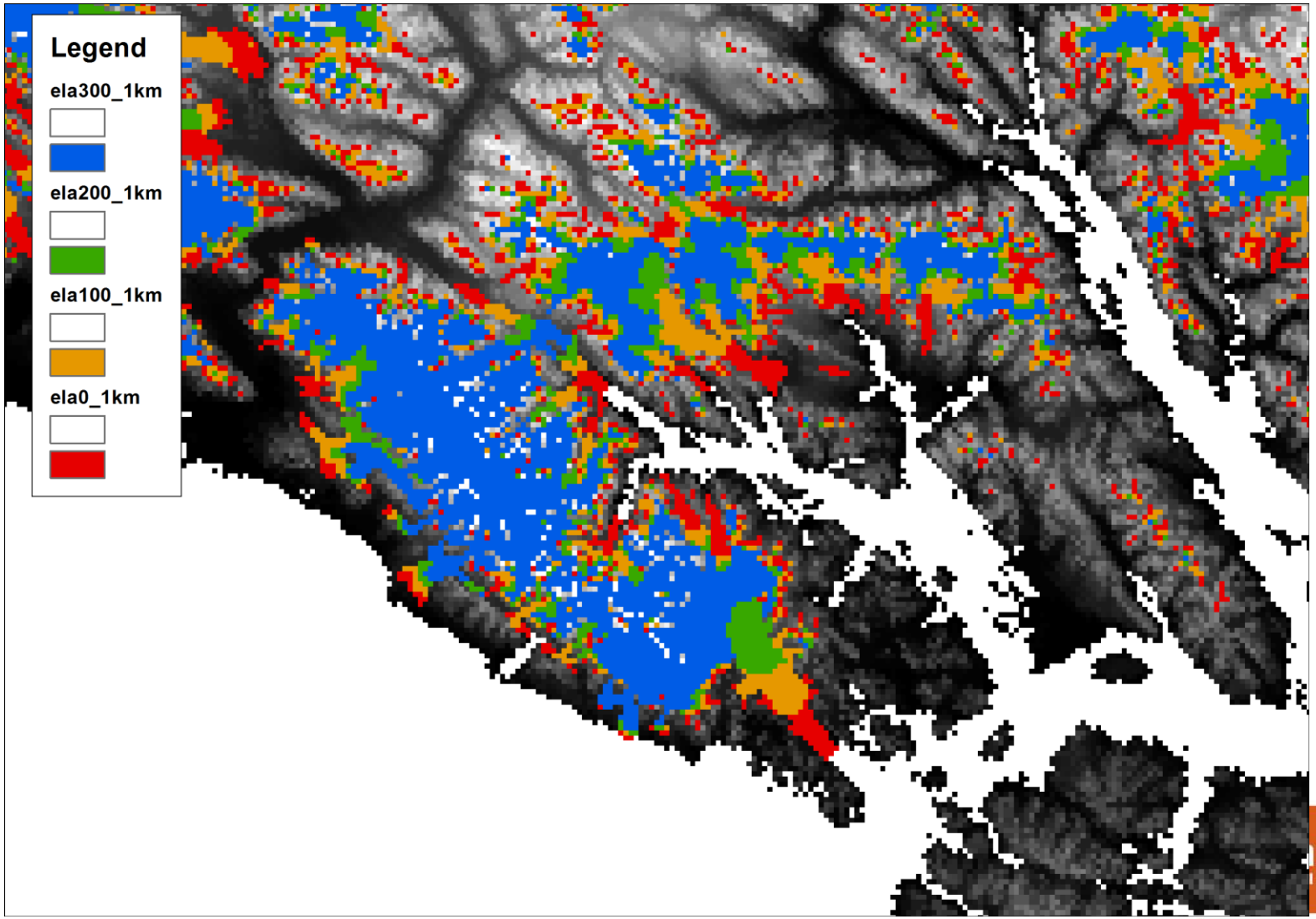
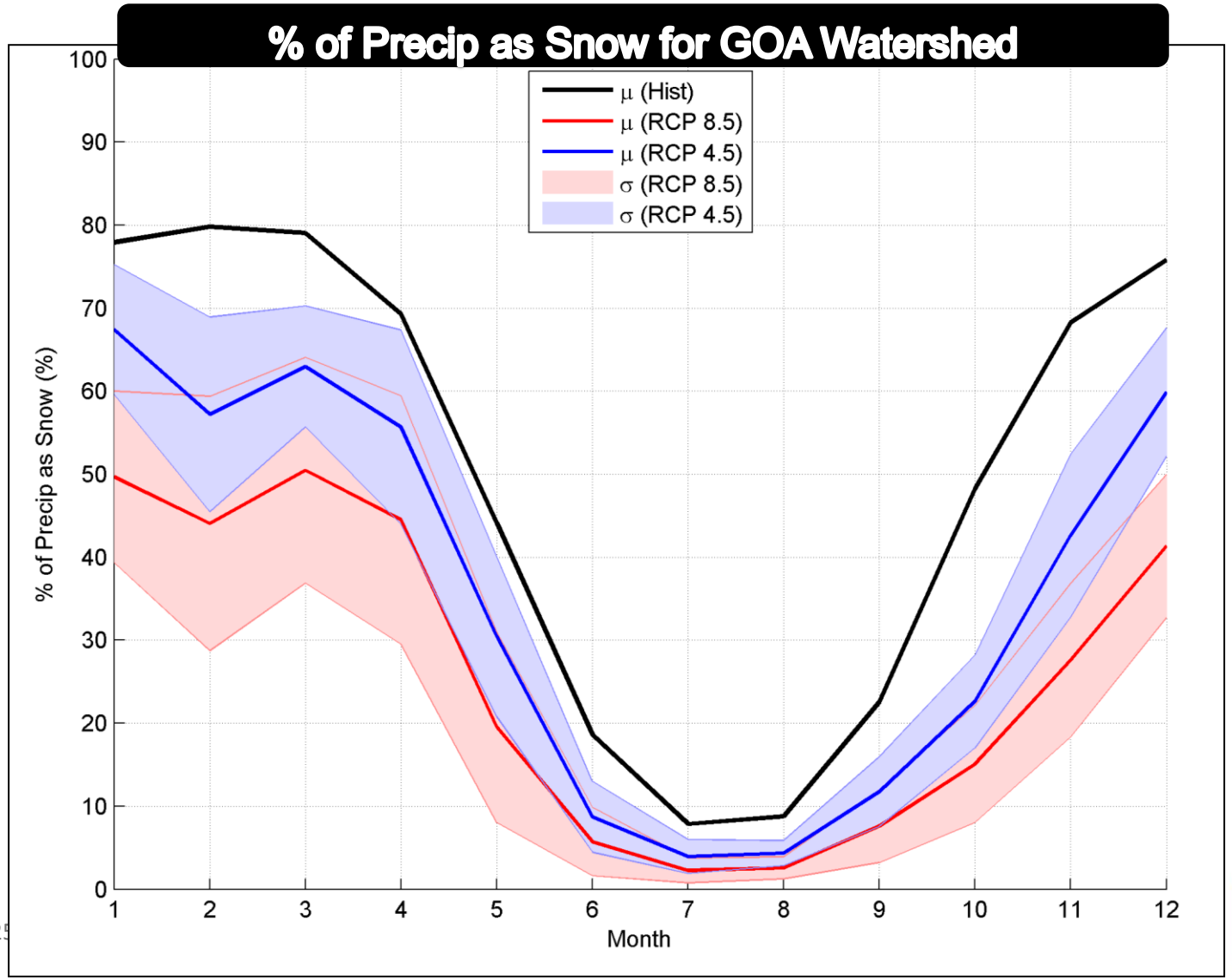
# Drivers of change



# Future snow in the GOA



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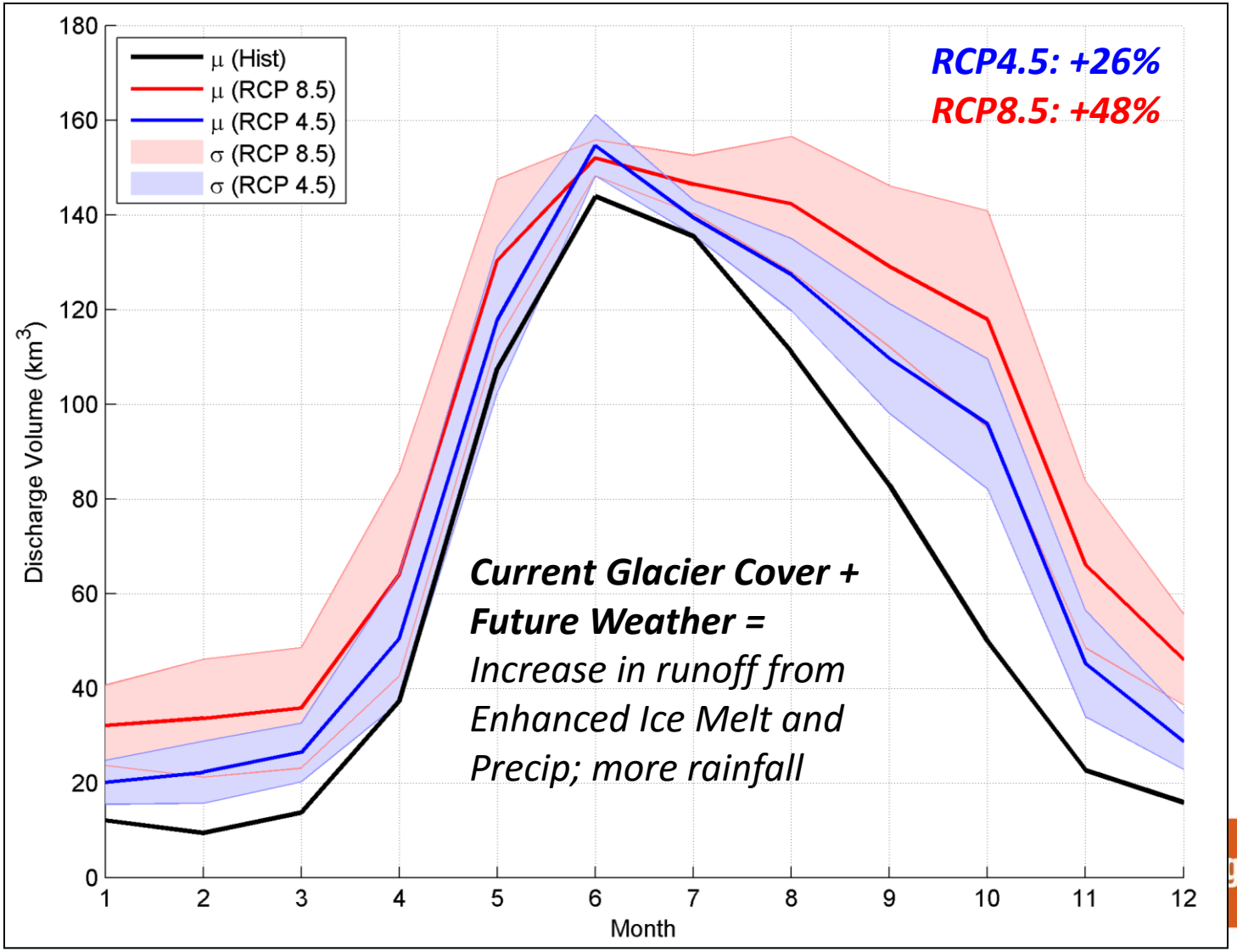
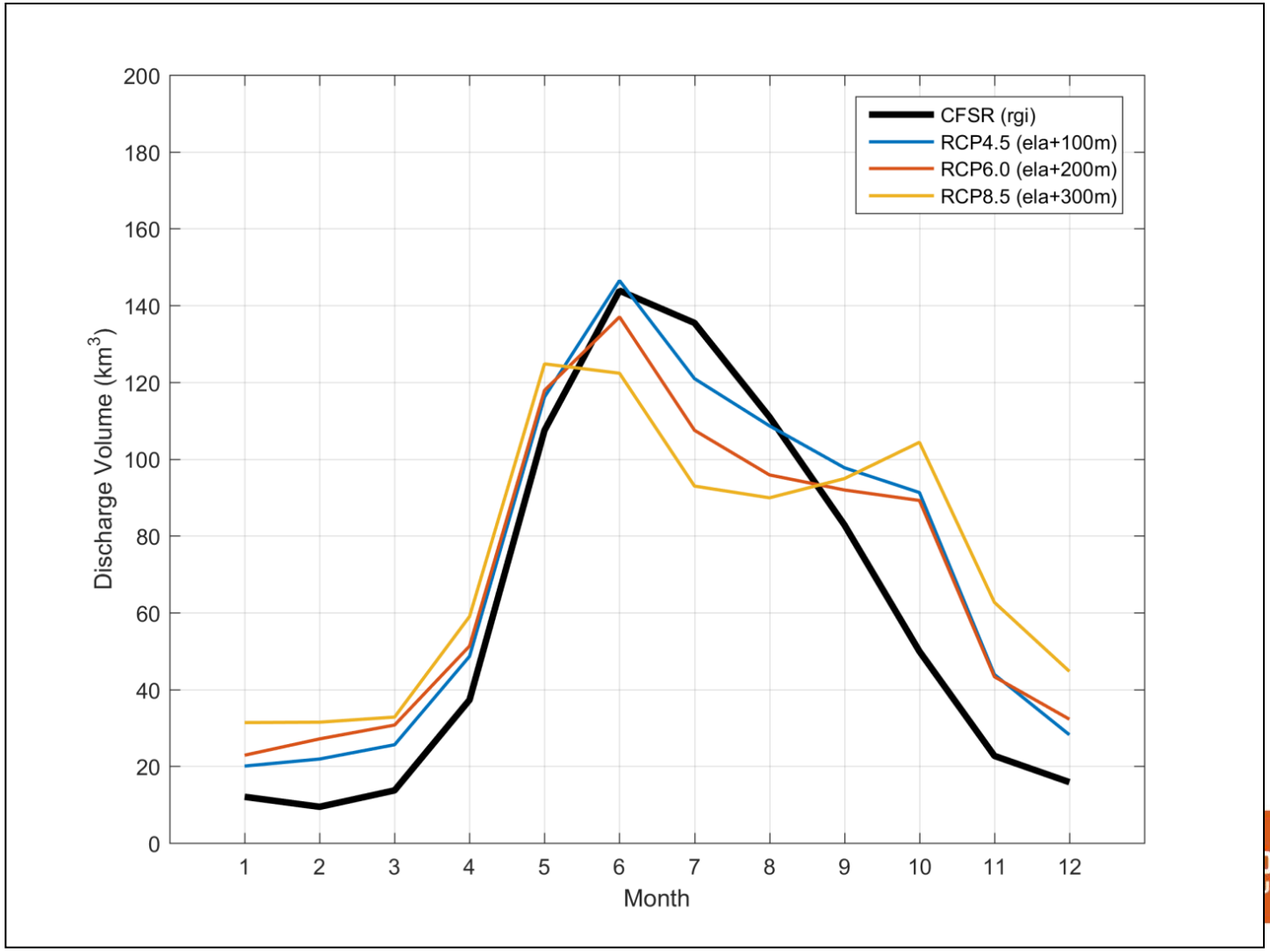
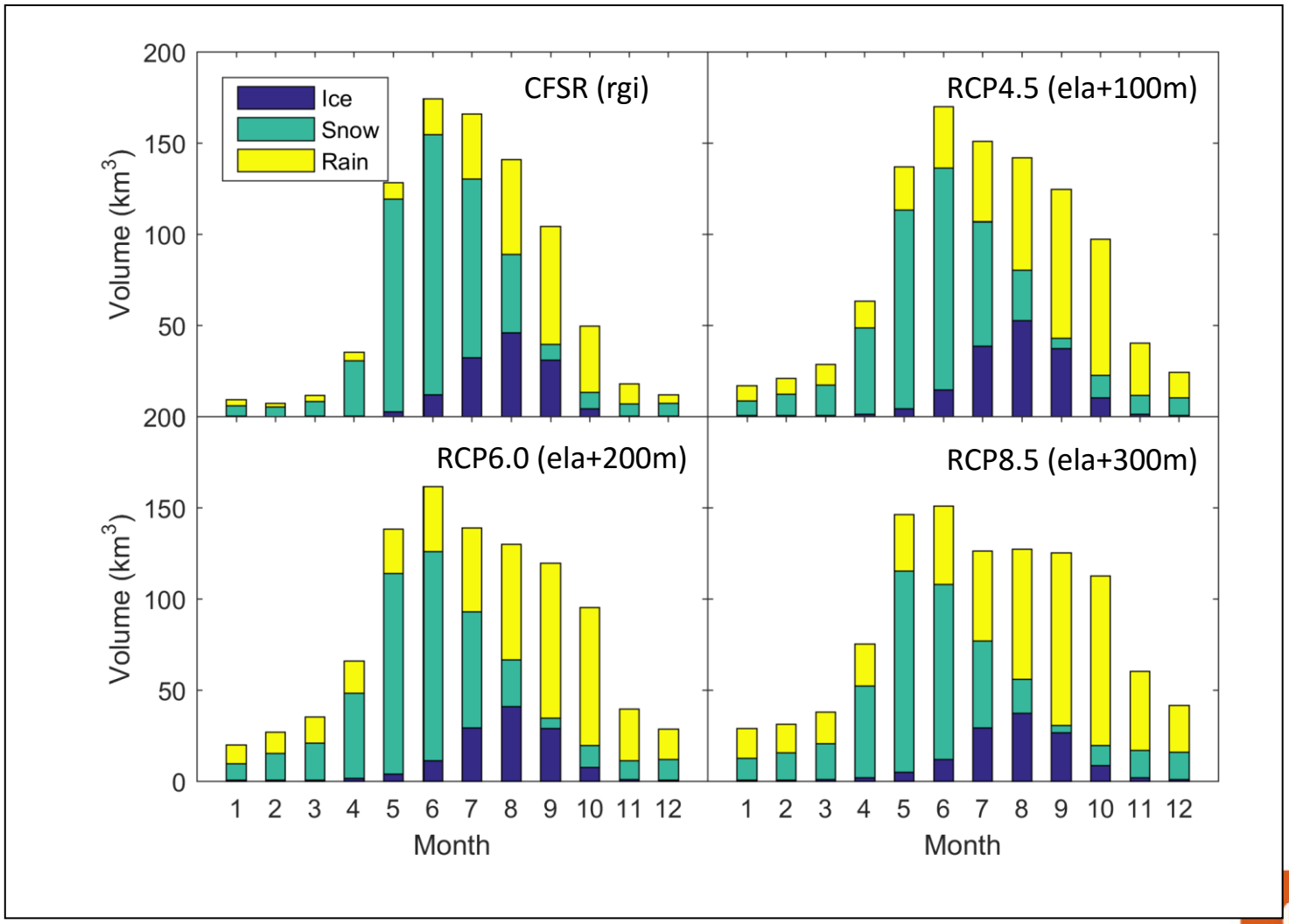
# Future GOA runoff (weather change only)



# Future GOA runoff (weather + landscape change)



# Future partitioning



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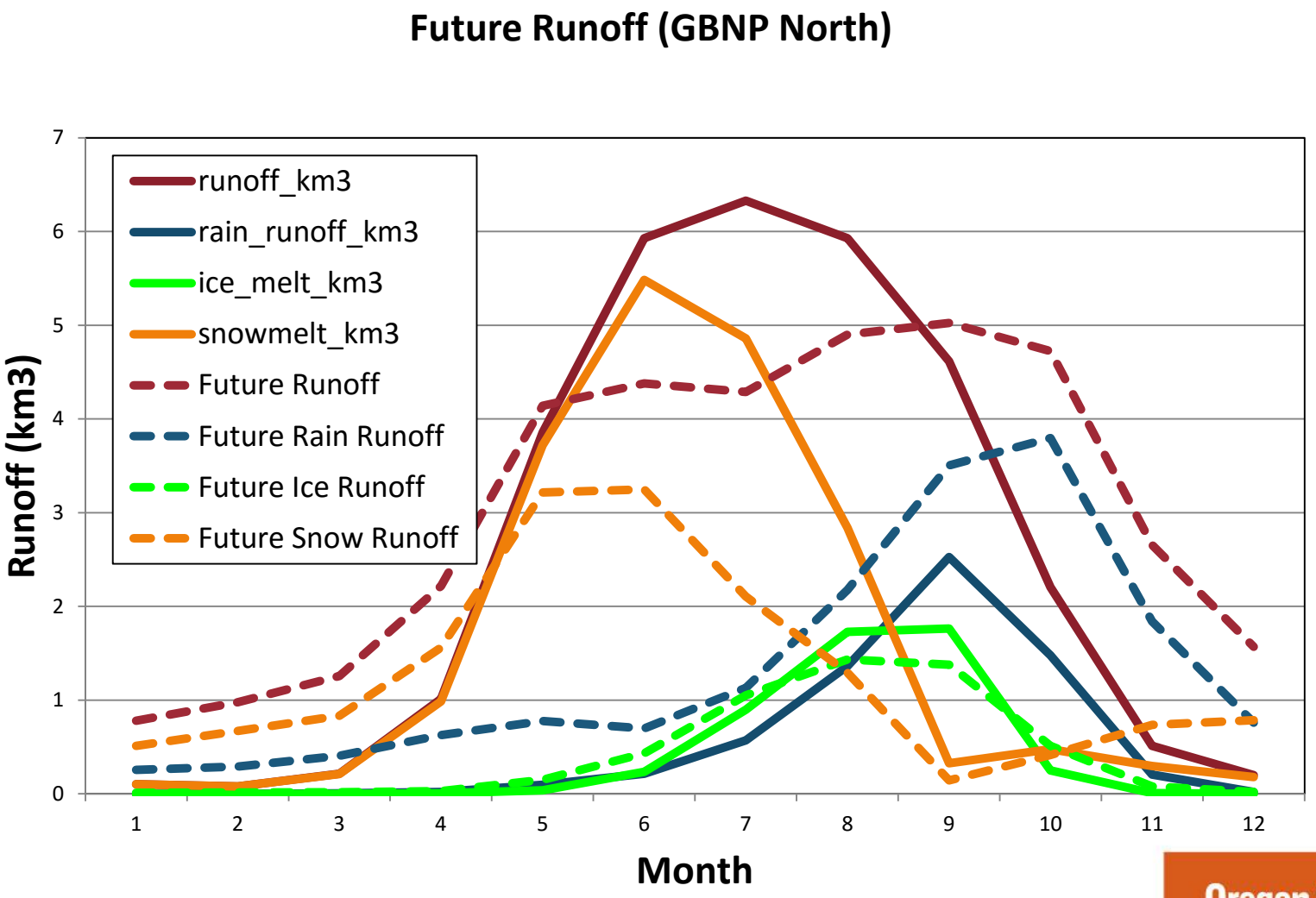
# Future Runoff (Glacier Bay)



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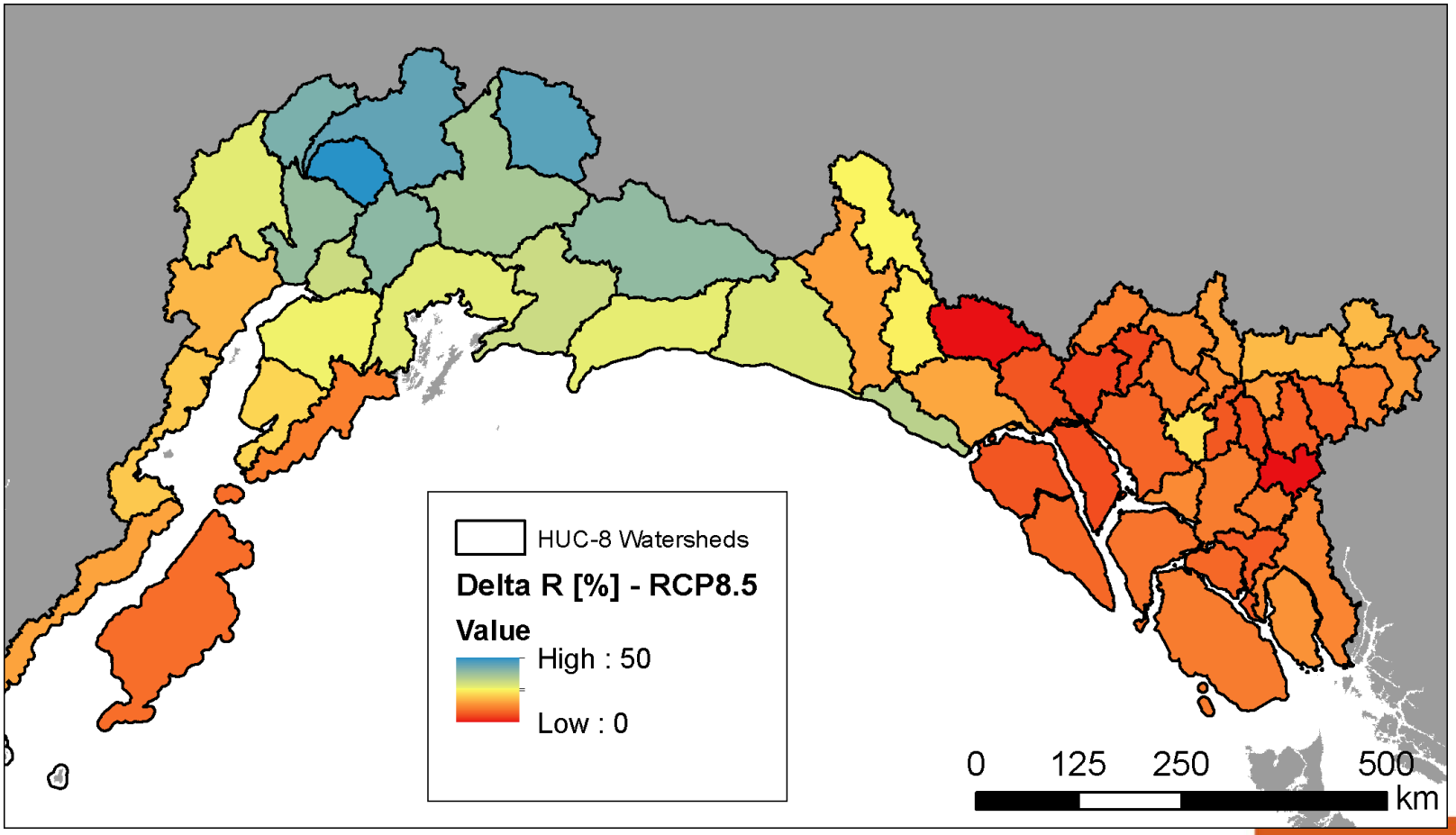
# Watershed runoff changes



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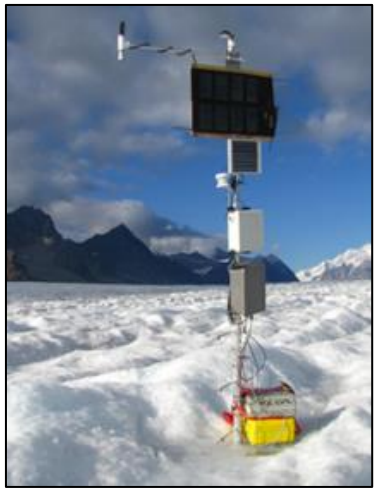
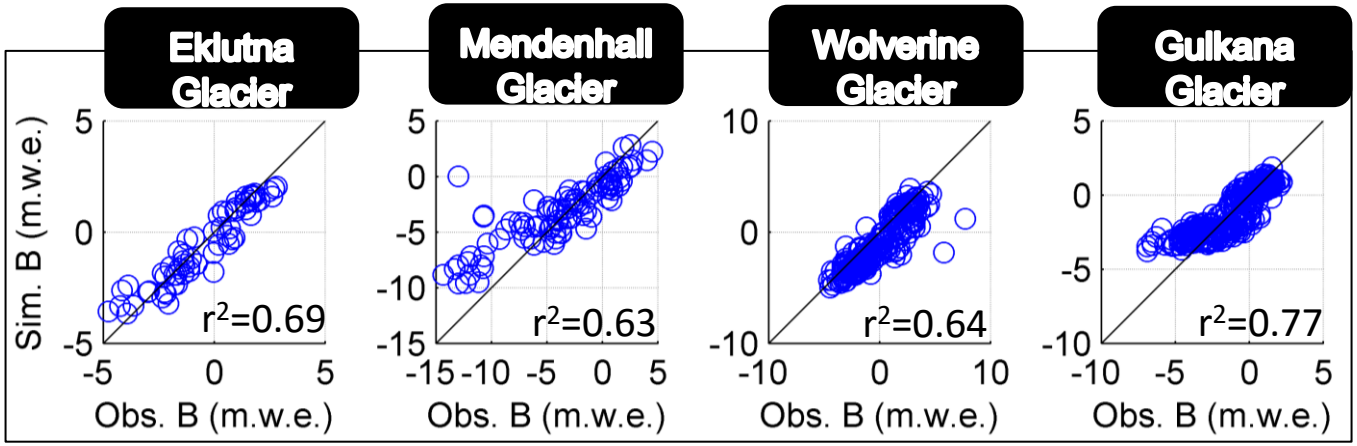
# Conclusions

- Alaskan hydrology is complex → the changes that are coming will be complex (in time and space)
- Overall, seasonal hydrographs will ‘flatten’ due to warmer, wetter conditions.
- We have NOT studied changes to extreme flows
- We have products (regression equations, map-based data products online) suitable for general audiences

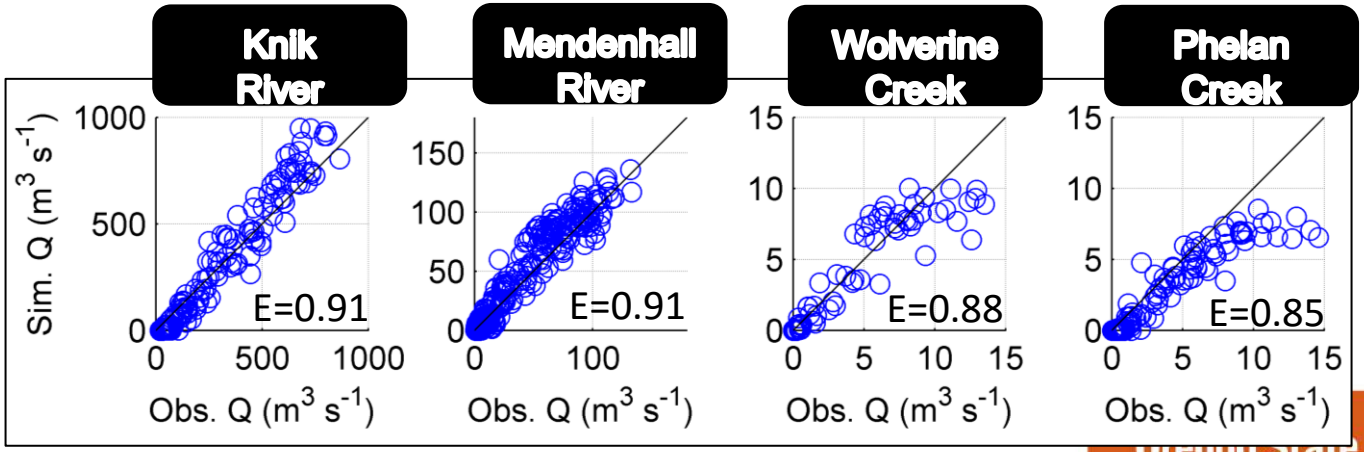
# Does the model work?

## Glacier Mass Balance






## Streamflow

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