



The Land-Ocean Freshwater Flux in the Regional Arctic System Model

Assessing Model Performance Using Streamflow

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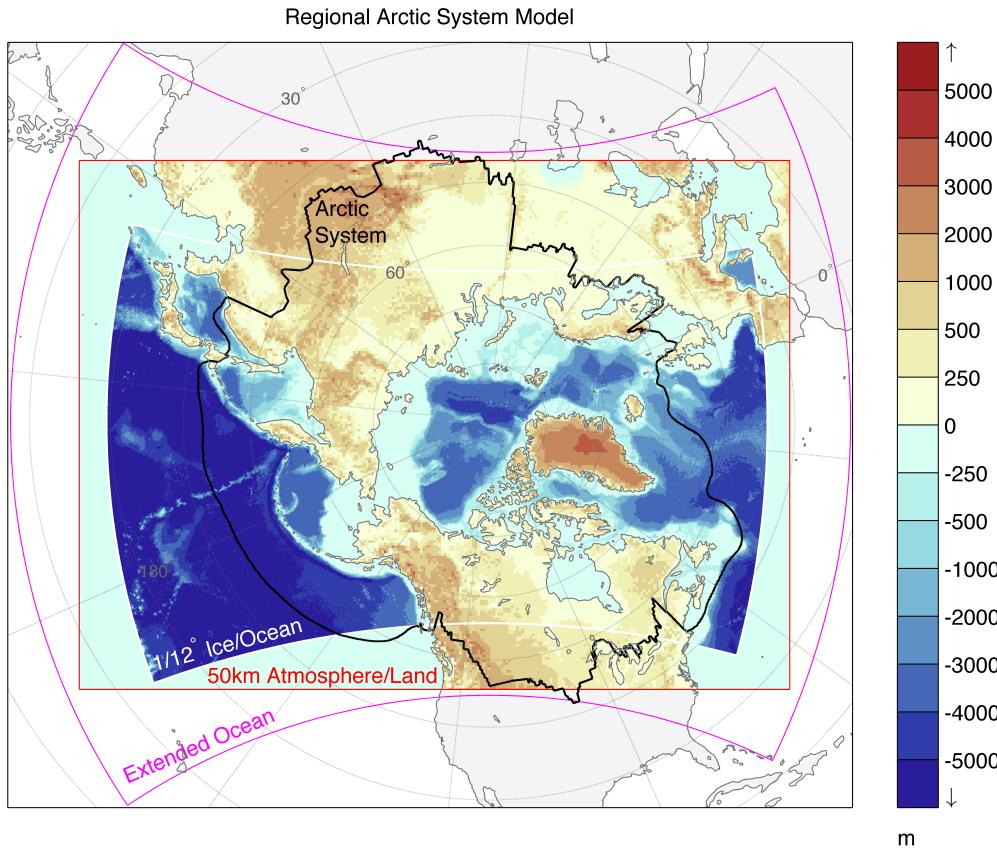
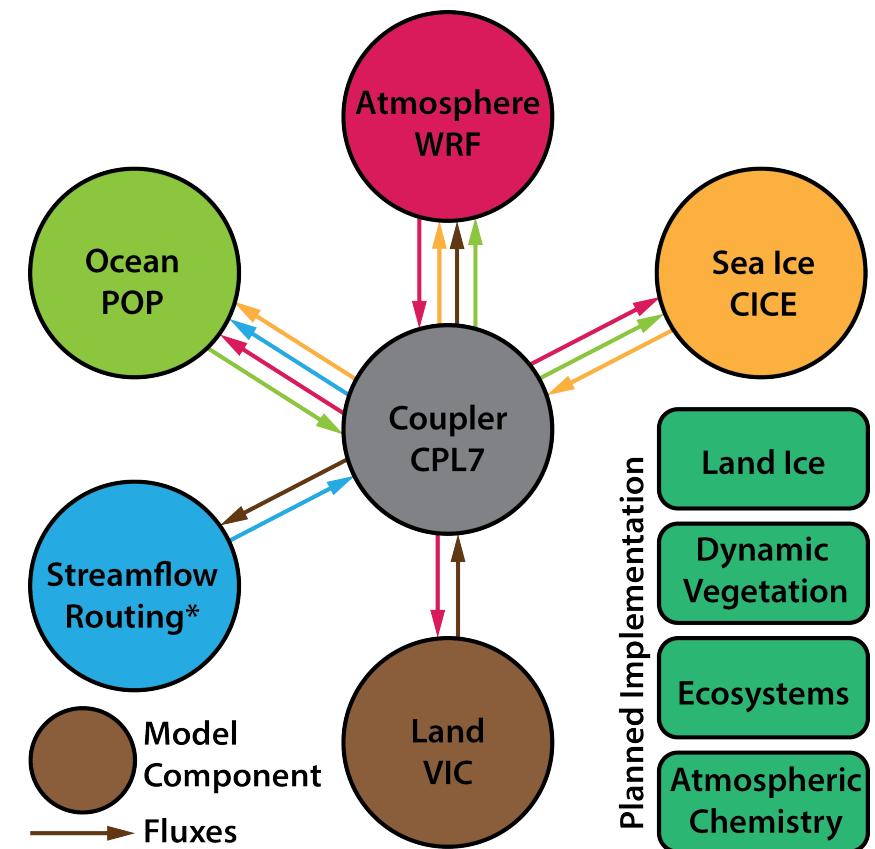
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Outline

1. Modeling Overview
2. Measuring Model Performance Using:
 - Mean annual streamflows
 - Monthly streamflow
3. Steps Toward Coupling

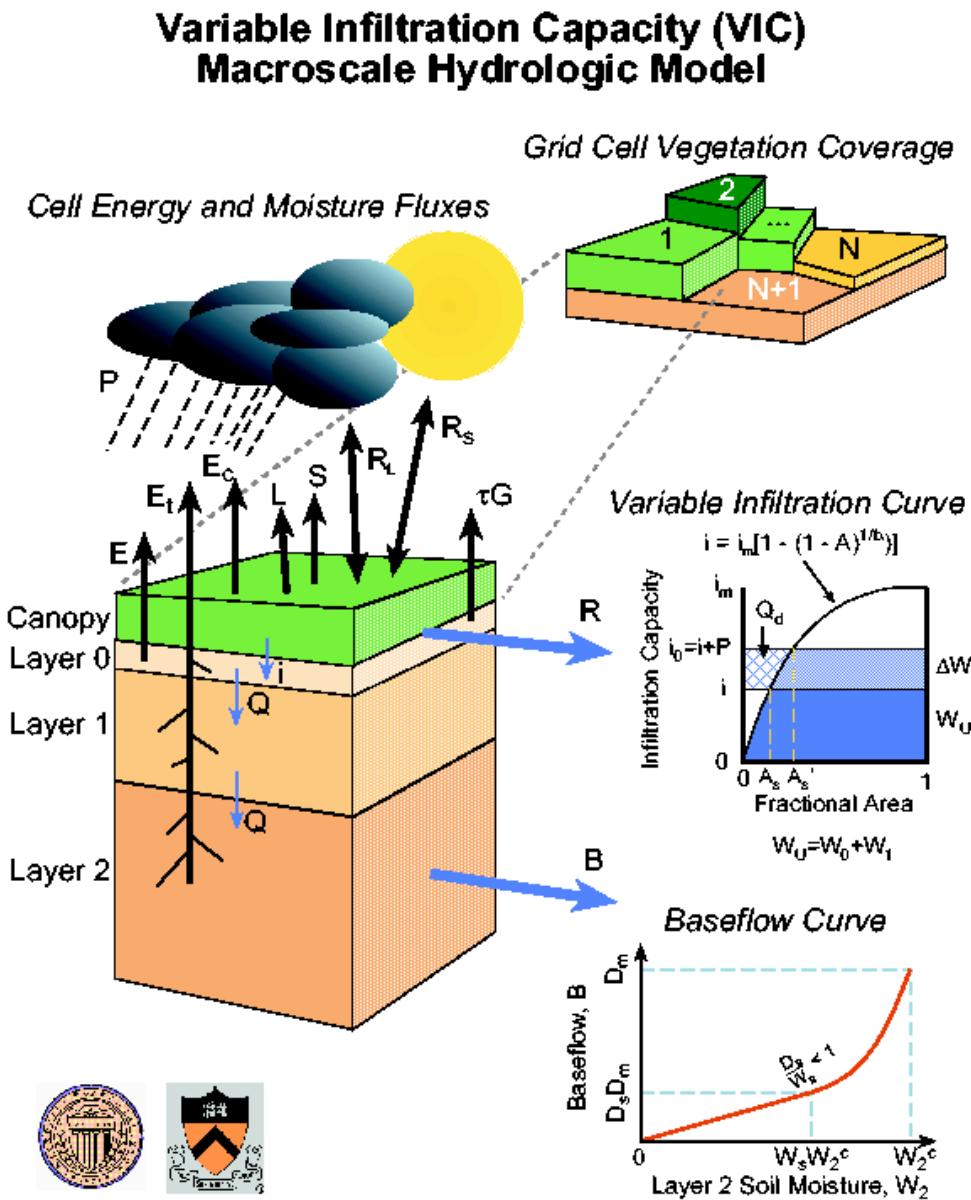
Coupling the Land-Ocean Freshwater Flux



- The direct coupling mechanism from the land to the ocean is through streamflow.
- Realistic river runoff is of high importance to the coastal ocean hydrography and dynamics as well as to sea ice formation and melt.

The Variable Infiltration Capacity Model

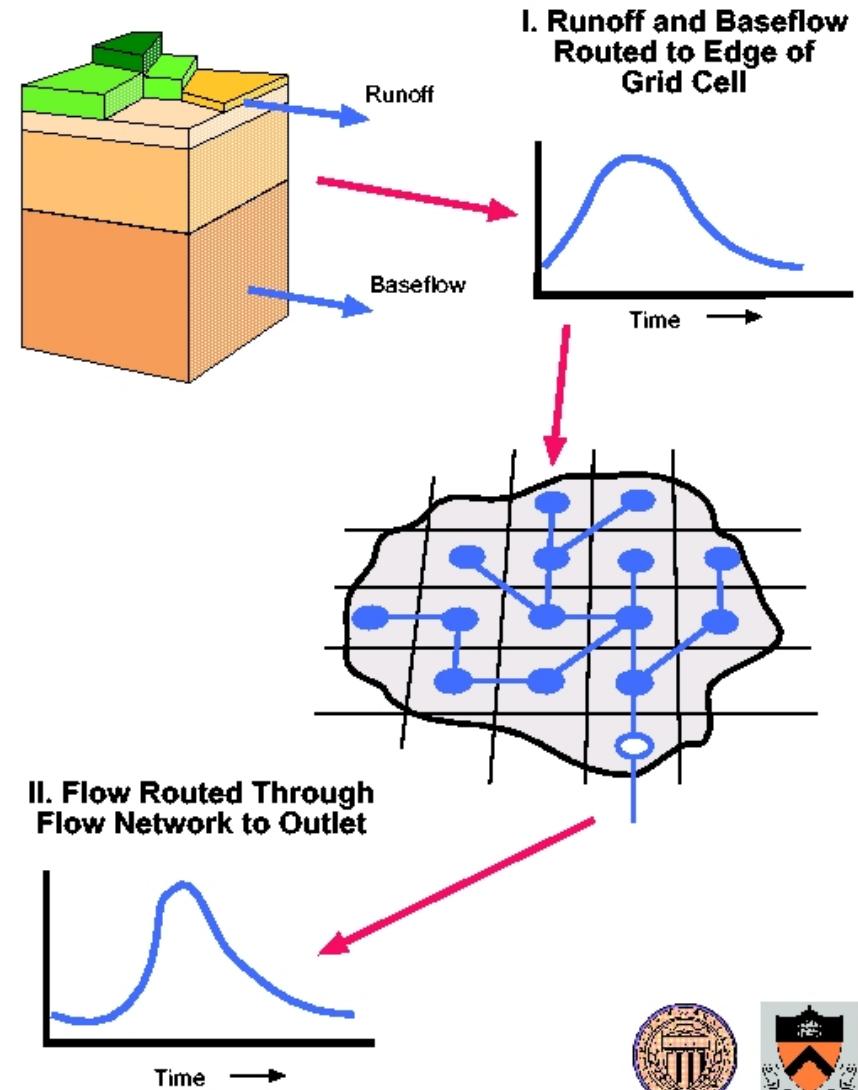
- Macro-scale semi-distributed hydrologic model (Liang et al., 1994).
- Simulates water and energy fluxes and storages.
- Large grid cells ($50\text{km} \times 50\text{km}$).
- Adjacent grid cells are not connected.



Typical VIC Routing Model

- Routing of stream flow is performed separately from the land surface simulation, Lohmann, et al. (1996; 1998)
- Flow is routed to the edge of each grid cell using a unit hydrograph.
- Each grid cell is represented by a node in the channel network
- Flow from the edge of each grid cell is routed through the channel using linearized St. Venant's equations

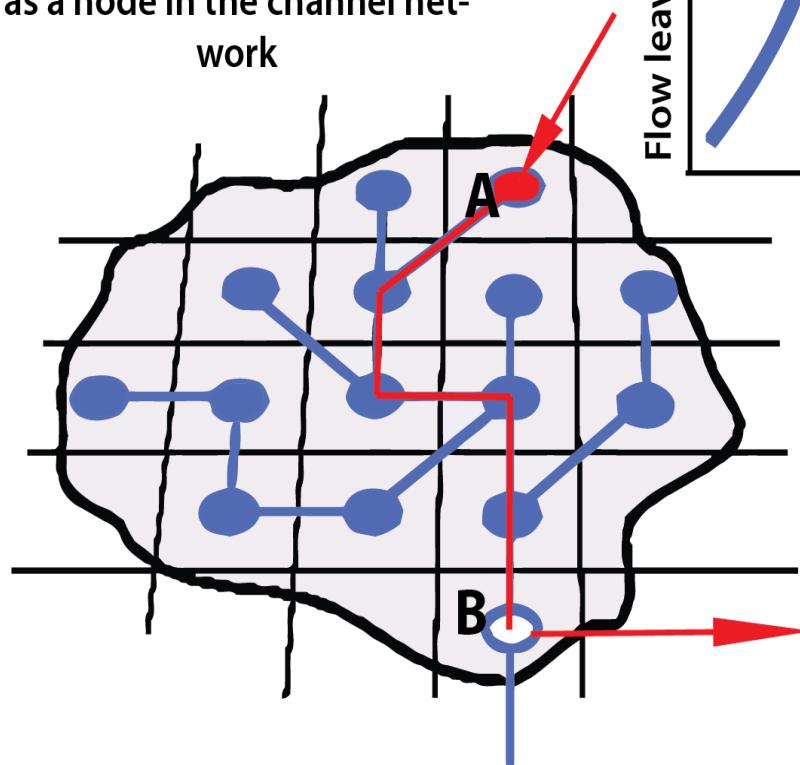
VIC River Network Routing Model



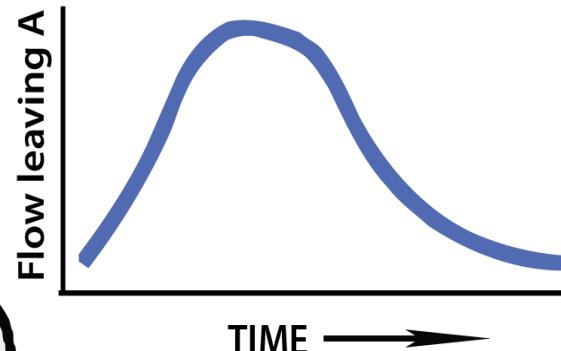
The Coupled Streamflow Routing Model

Development of Impulse Response Functions

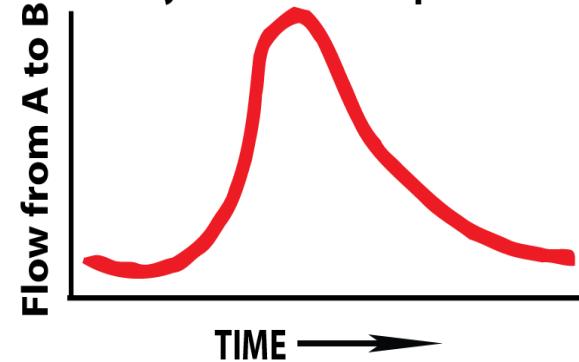
I. Each grid cell is represented as a node in the channel network



II. Flow is routed to the edge of each grid cell using a unit hydrograph

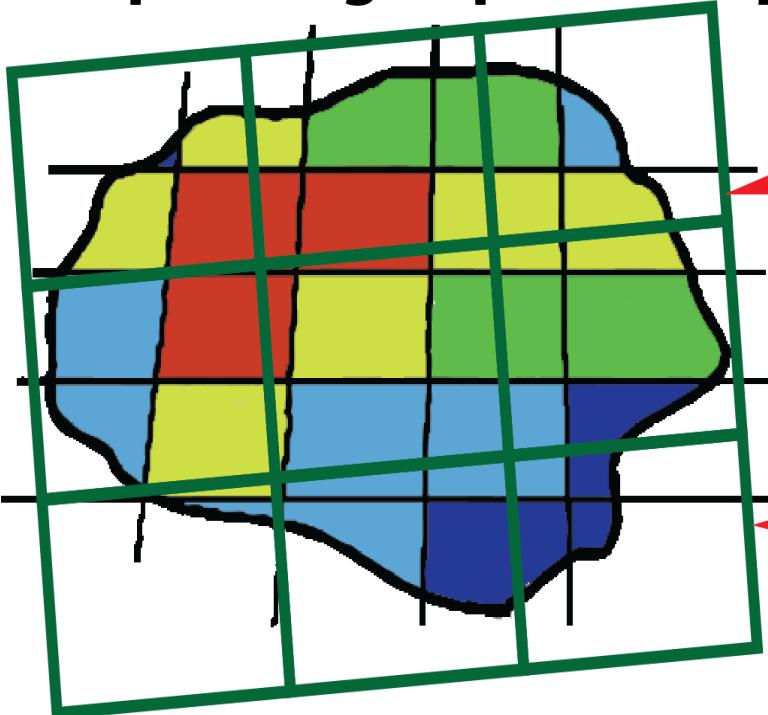


III. Flow from each grid cell in the basin is routed through network using velocity and diffusion parameters



The Coupled Streamflow Routing Model

Upscaling Impulse Response Functions



IV. Impulse response functions are developed on a high resolution grid (1/16° regular grid)

V. Impulse response functions are remapped to RASM grid (50 km x 50 km) using conservative area remapping techniques.

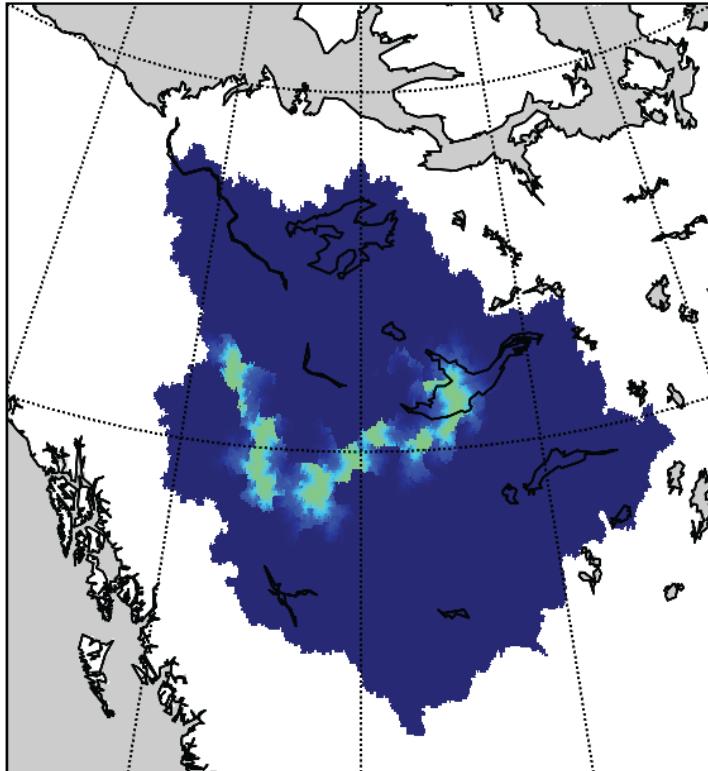
- Remapping
 - Preserves high-resolution response
 - Allows for convolution to be done on RASM grid

The Coupled Streamflow Routing Model

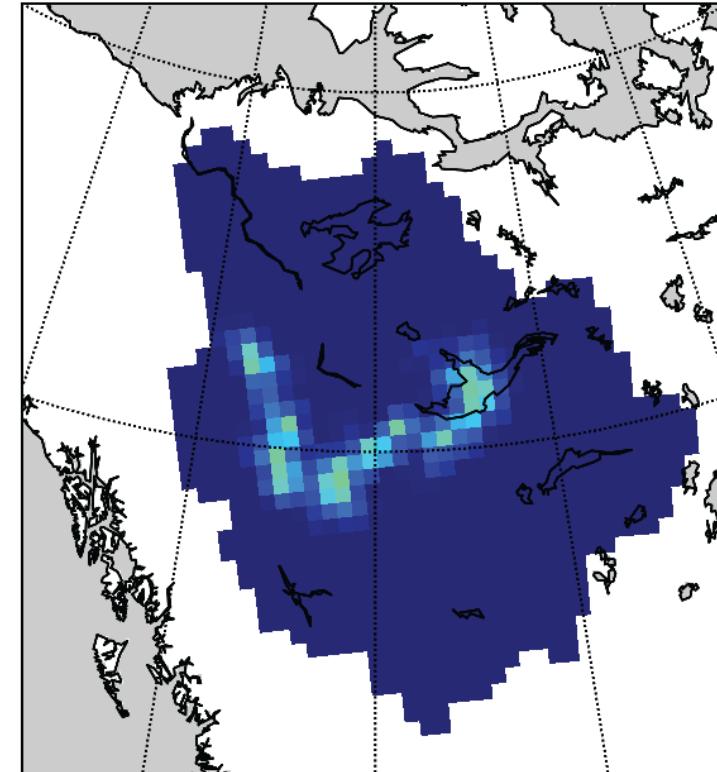
Upscaled Impulse Response Functions

Mackenzie River at Arctic Red River

1/16° Grid



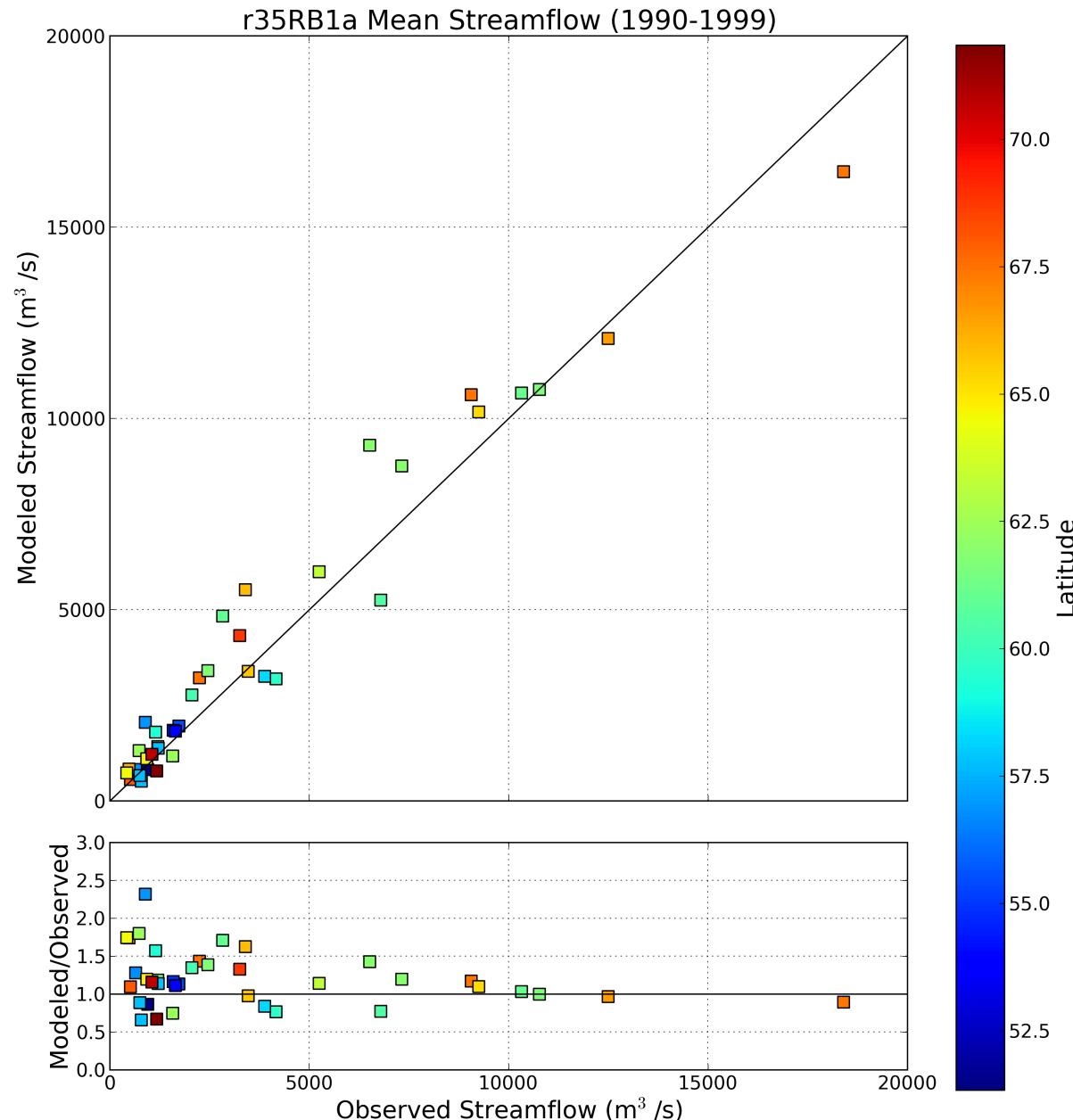
RASM Grid



0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

Fraction of runoff reaching basin outlet on day 25

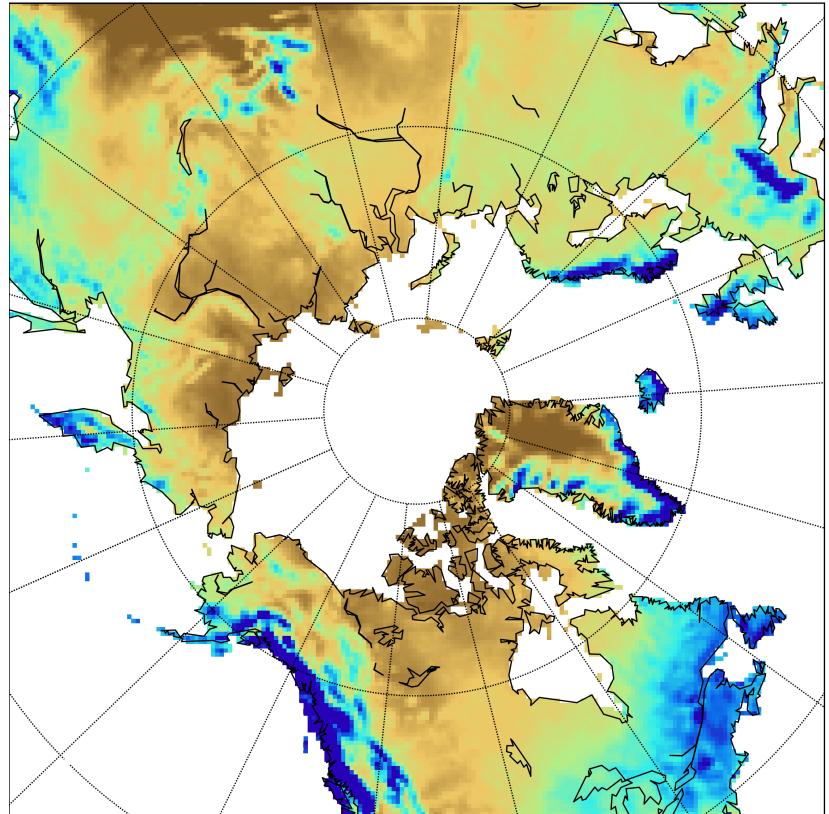
Mean Streamflow – Comparison to R-Arctic Net



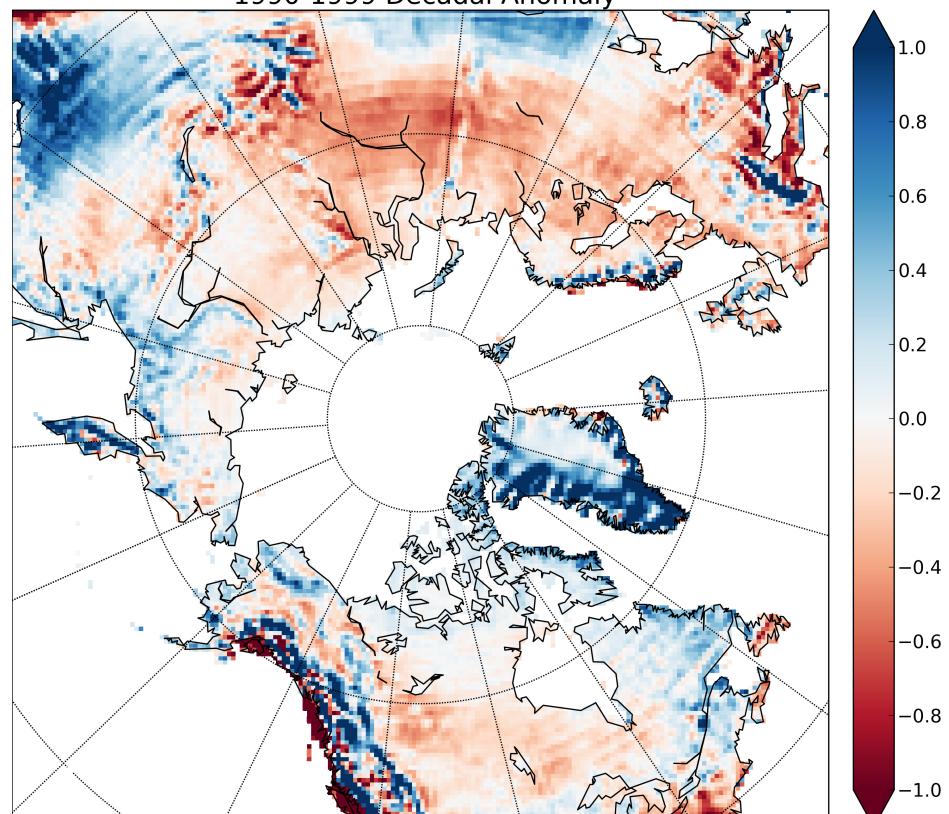
Model Performance – Comparison to ERA-Interim

Precipitation

r35RB1a Precipitation
1990-1999 Decadal Mean



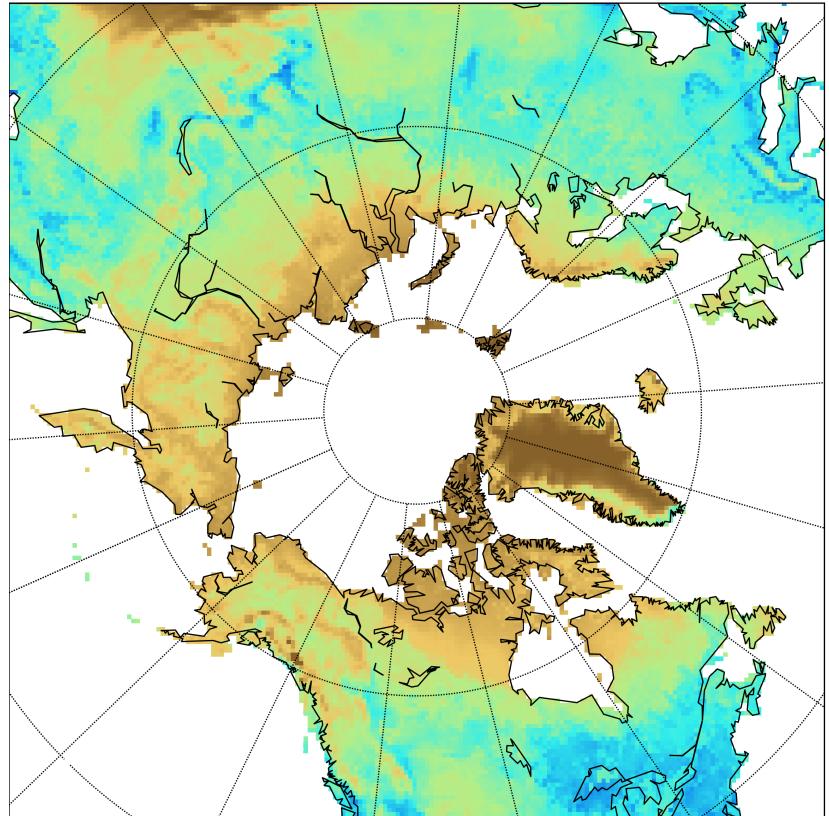
r35RB1a-ERA Precipitation
1990-1999 Decadal Anomaly



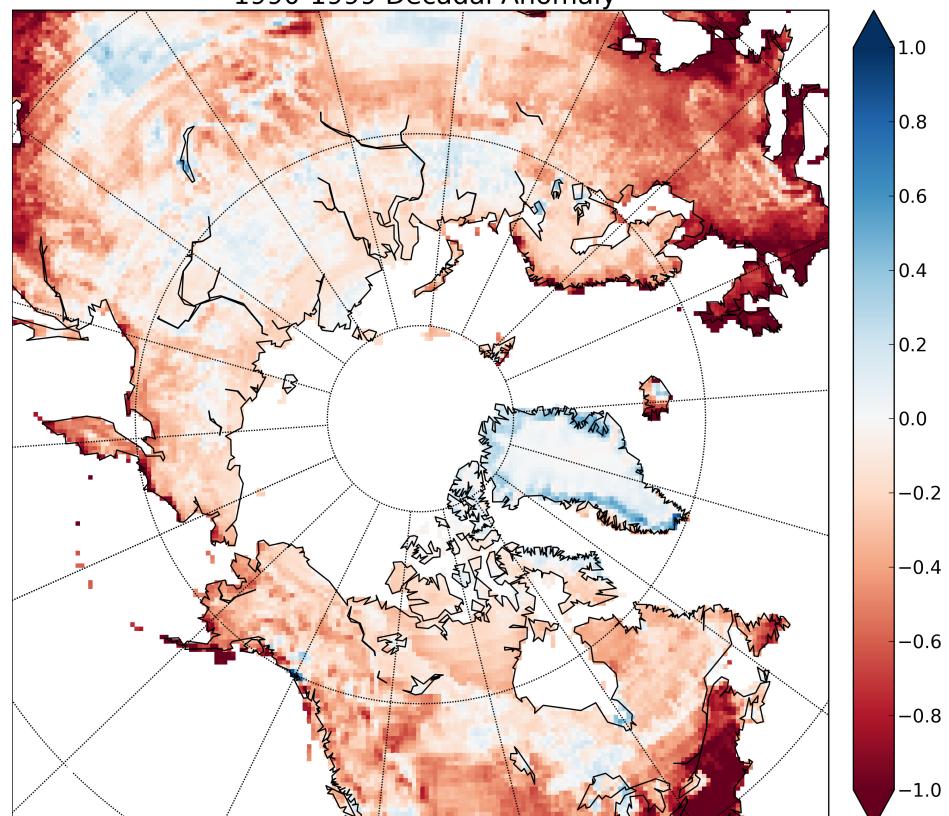
Model Performance – Comparison to ERA-Interim

Evaporation

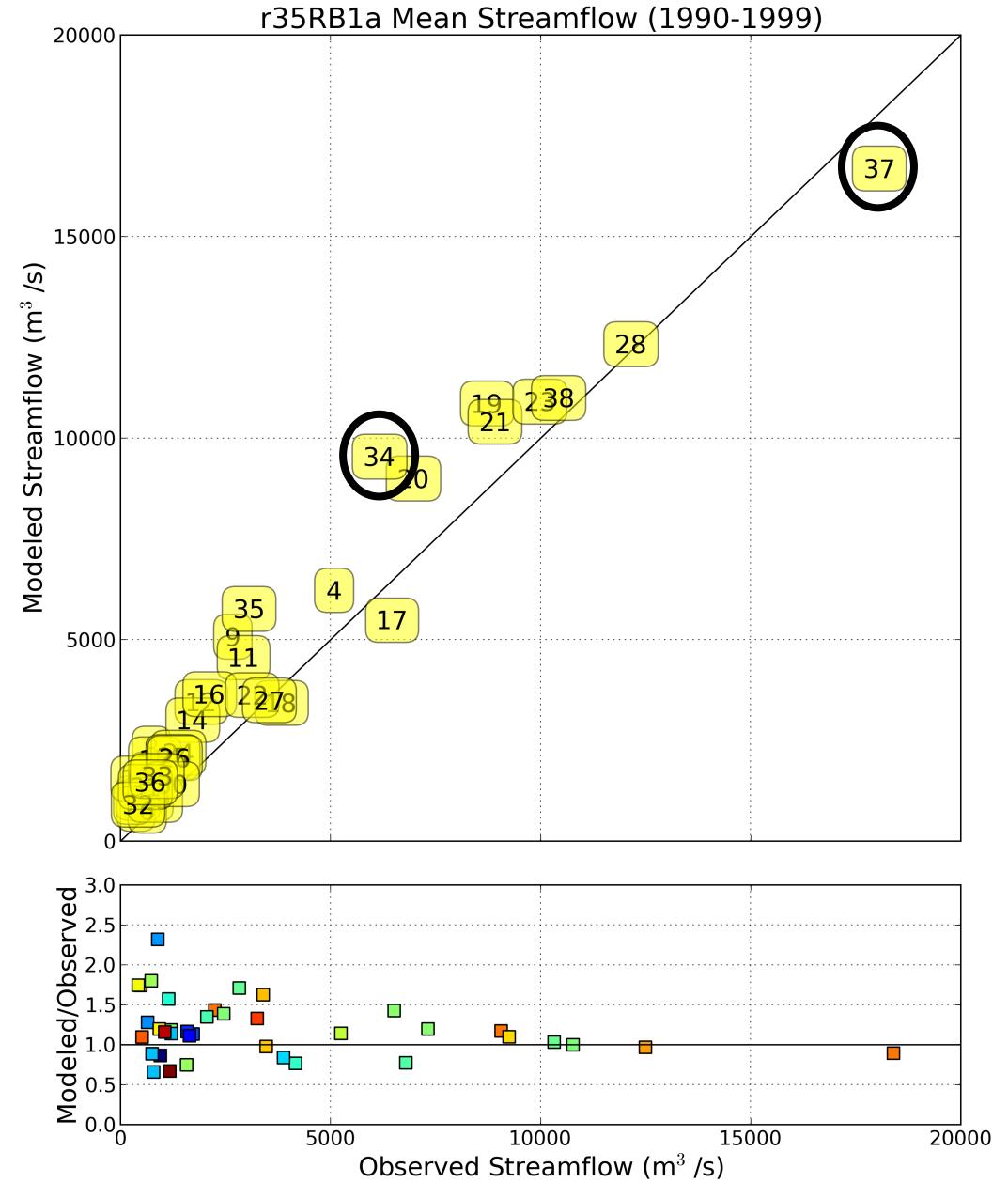
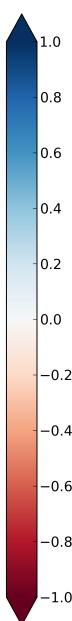
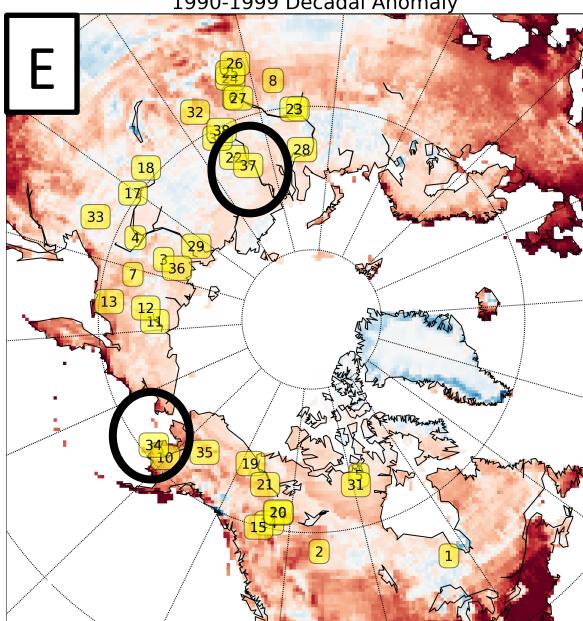
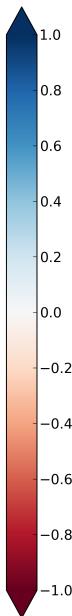
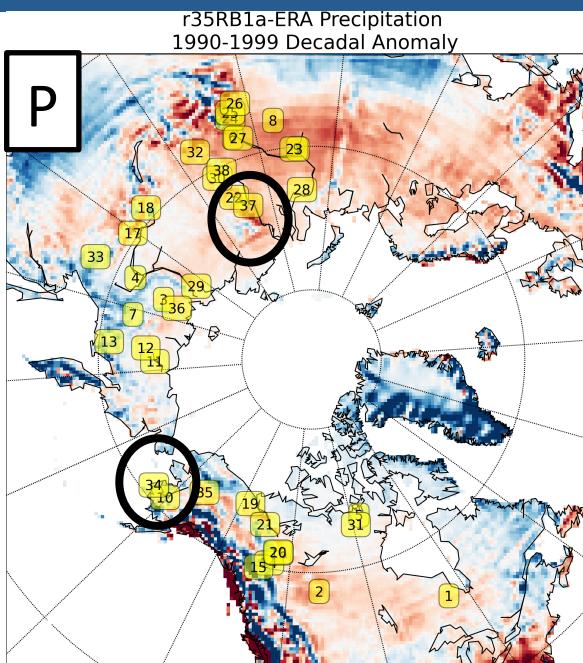
r35RB1a Evaporation
1990-1999 Decadal Mean



r35RB1a-ERA Evaporation
1990-1999 Decadal Anomaly

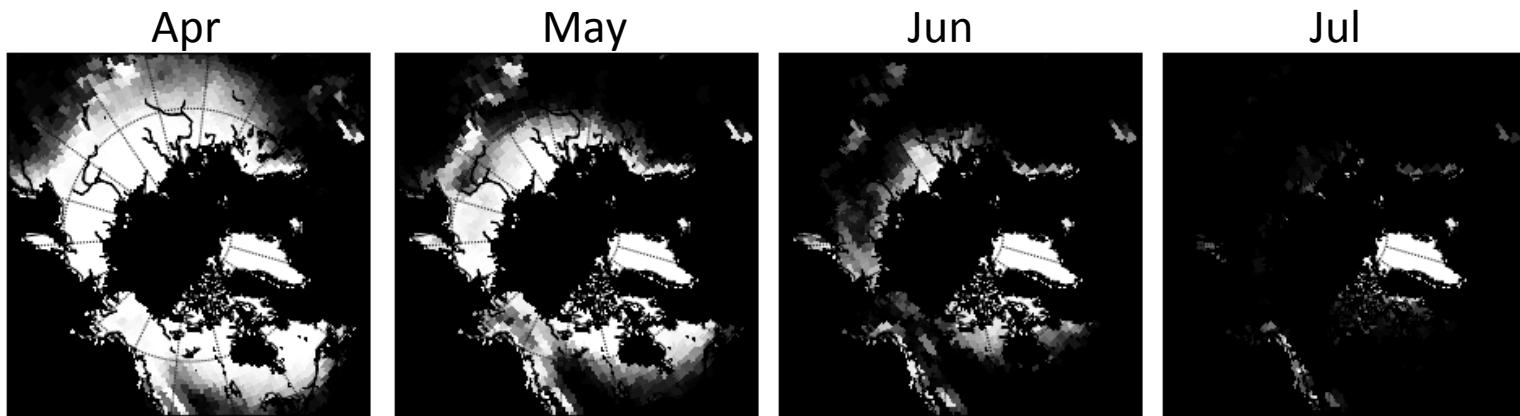


Mean Streamflow – Comparison to R-Arctic Net

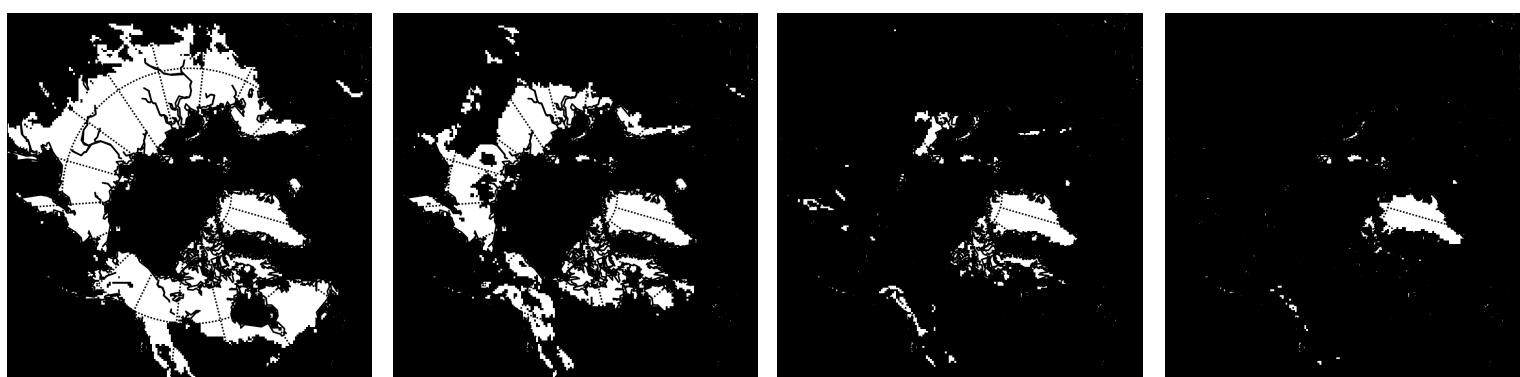


Snow extent (1990-1999) - Comparison with NSIDC

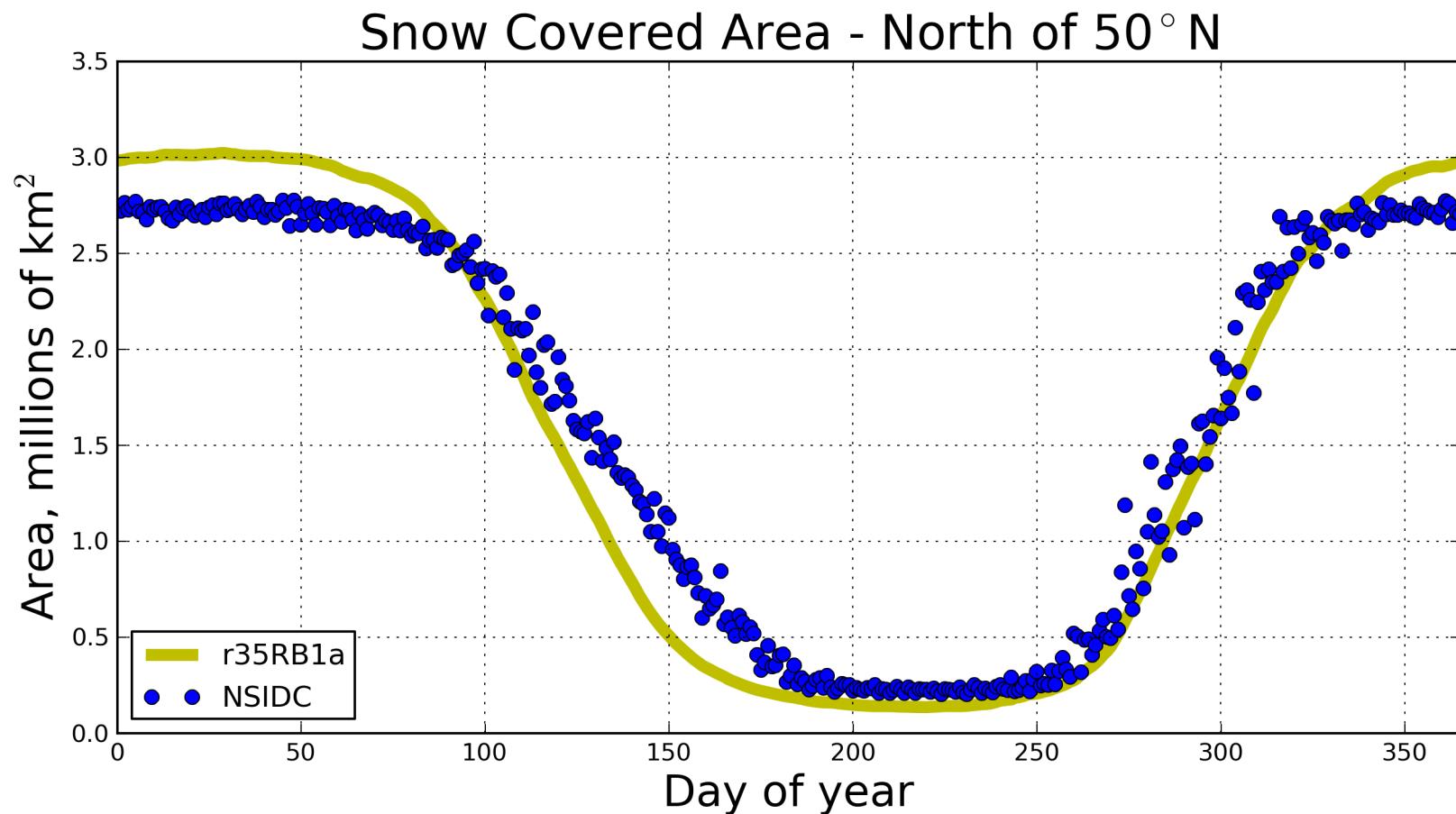
satellite



r35RB1a

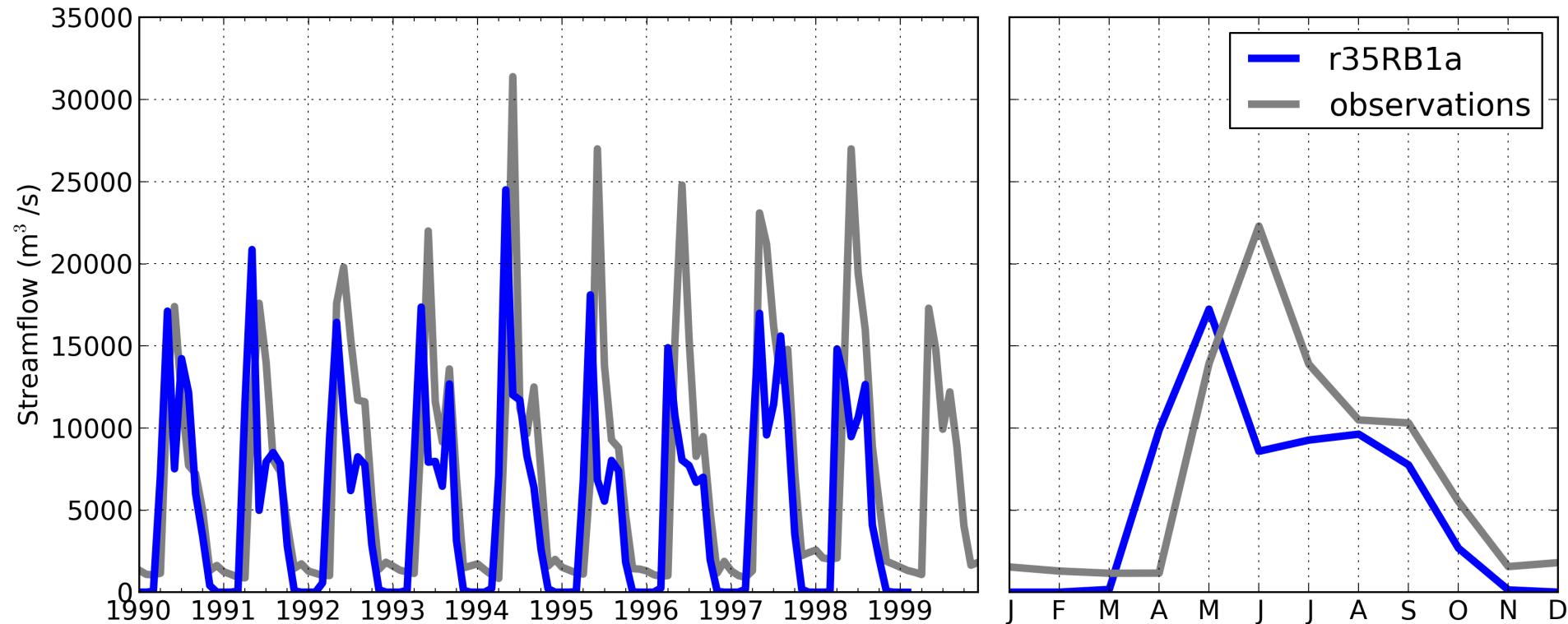


Snow extent - Comparison with NSIDC



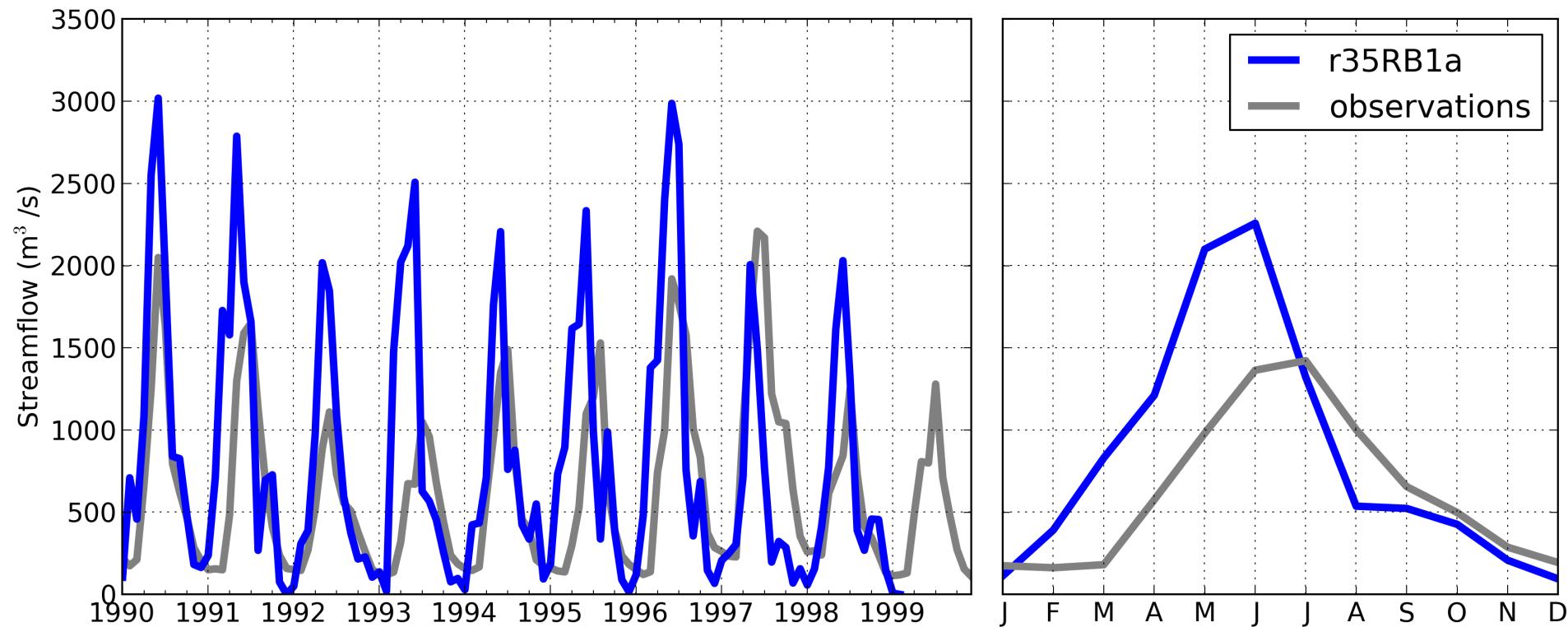
Monthly Streamflows

Lena At Solyanka



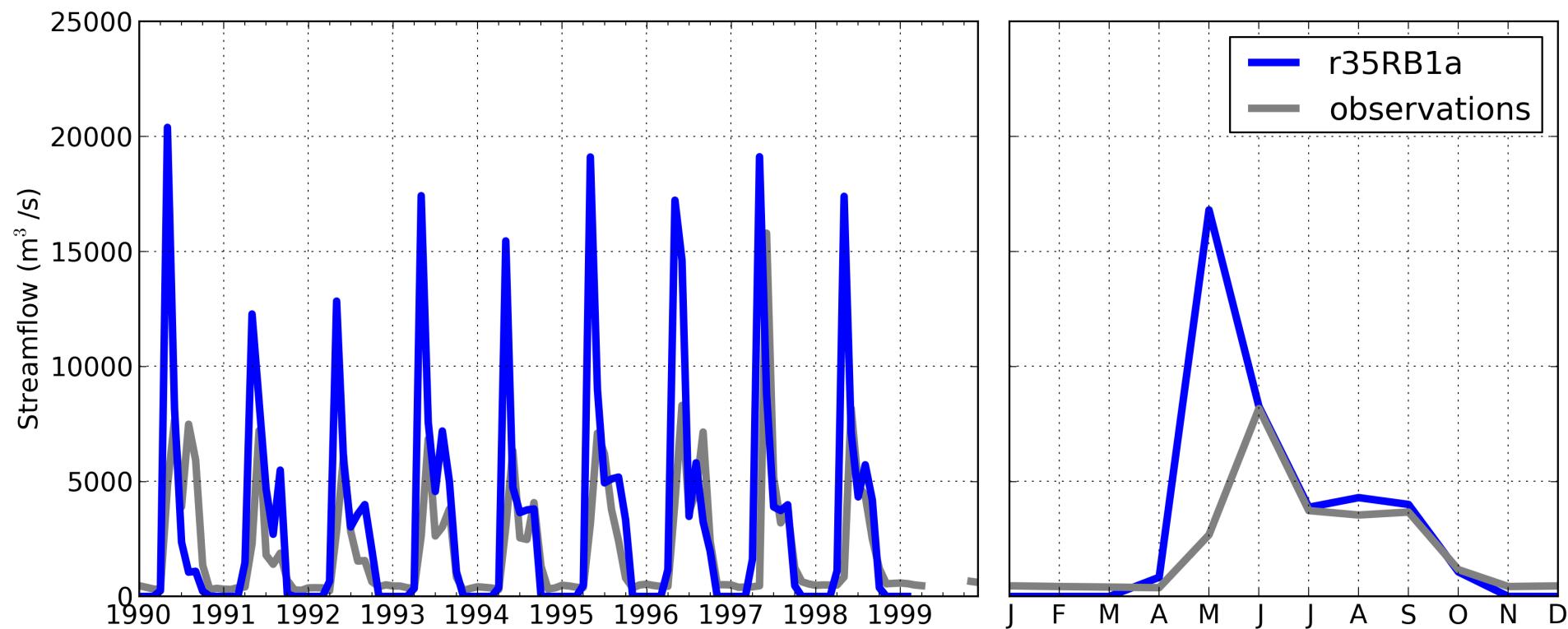
Monthly Streamflows

ATHABASCA RIVER BELOW MCMURRAY

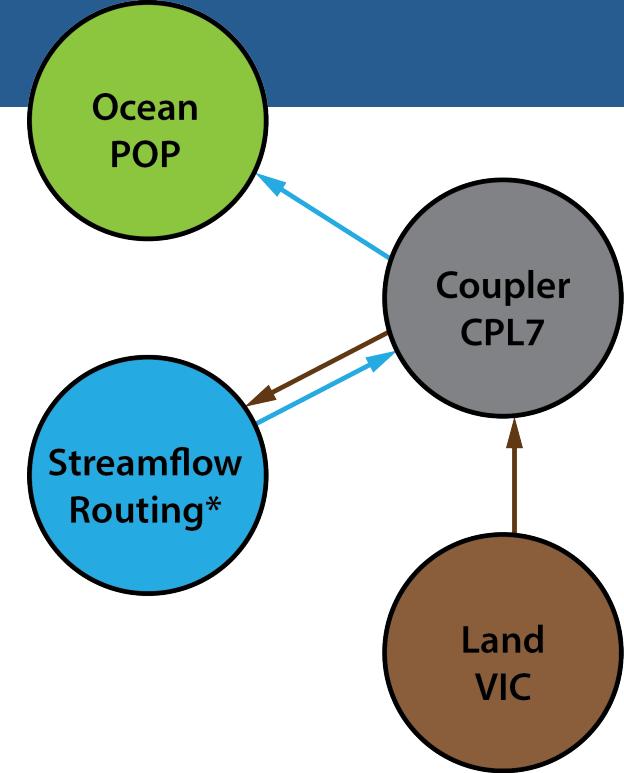
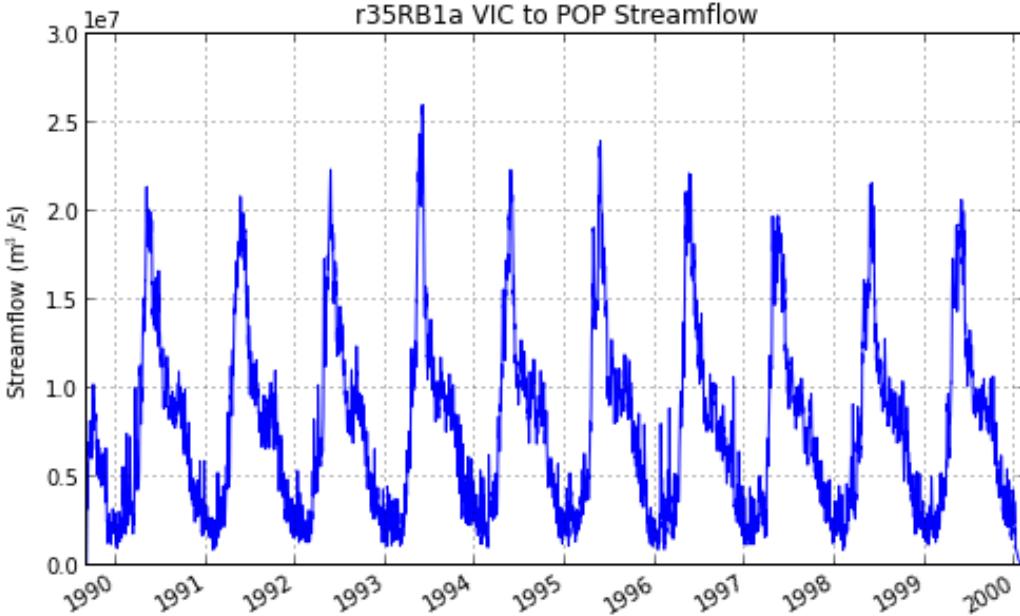


Monthly Streamflows

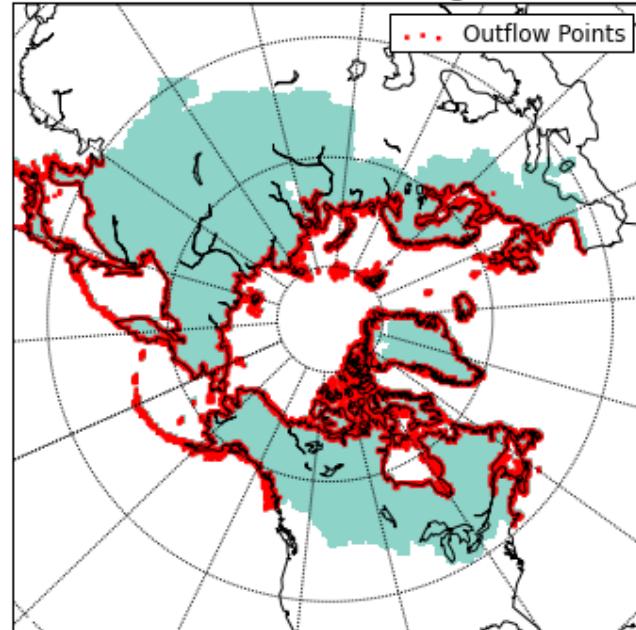
Kolyma At Srednekolymsk



Next Steps



RASM VIC to POP Drainage Basin



- Coupling within the CESM framework
- Final validation and calibration of offline model

Conclusions

- Upscaling/remapping of impulse response functions from high resolution grid to RASM land grid is conservative and produces expected results
- Mean annual streamflow compared to in-situ observations from gauging stations provides insight into persistent model biases
- Comparisons to observed monthly streamflow confirms hypothesis that RASM loses snow too soon/quickly