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

Assessing Model Performance Using Streamflow

AUTHORS: *Joe Hamman[1], Bart Nijssen[1], Andrew Roberts[2], and Dennis P. Lettenmaier[1]*

AFFILIATION: 1. Department of Civil and Environmental Engineering, University of Washington, Seattle, WA, USA, 2. Department of Oceanography, Naval Postgraduate School, Monterey, CA, USA

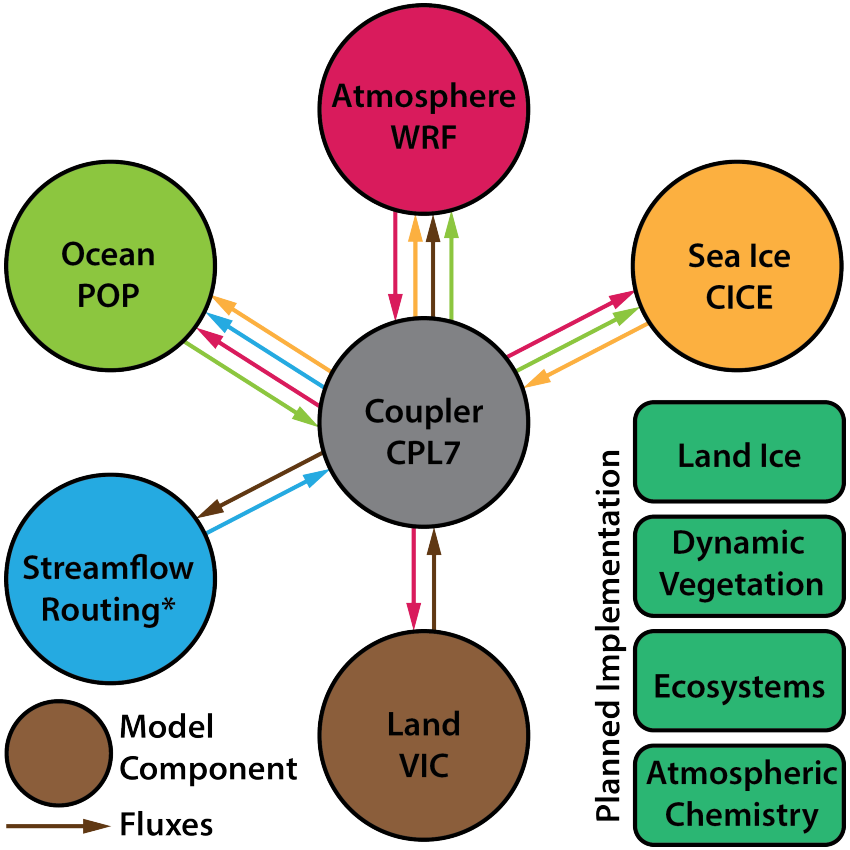
UNIVERSITY OF WASHINGTON

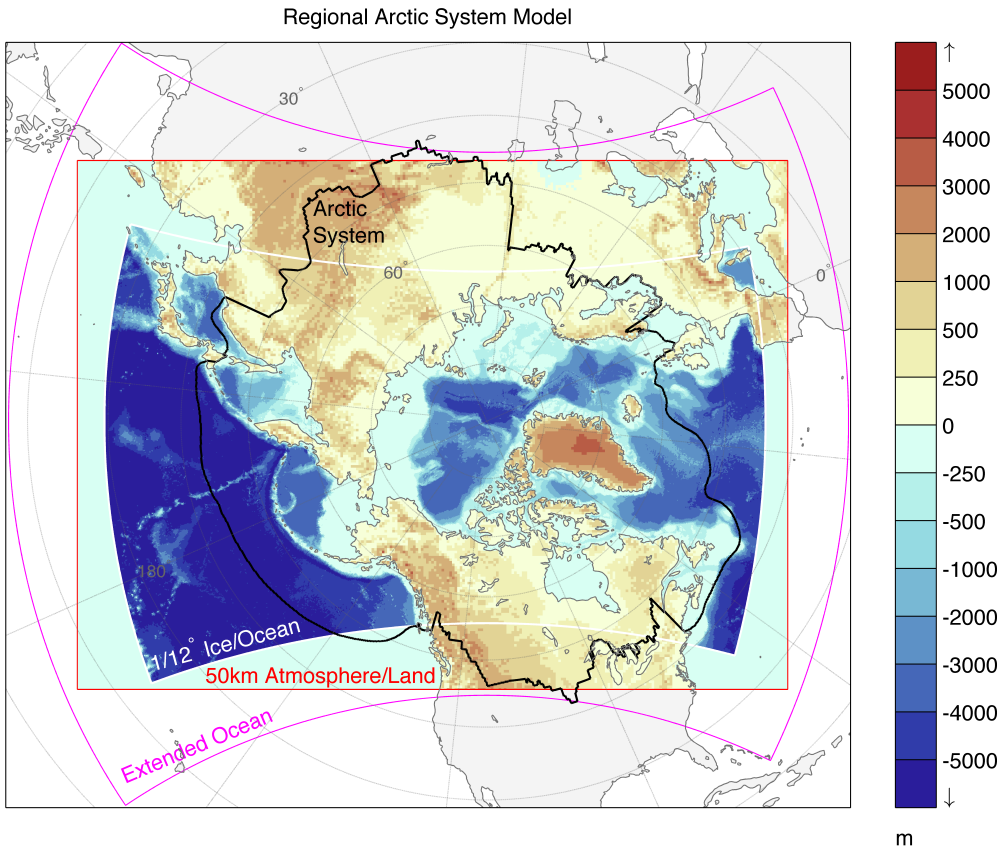
Department of Civil and Environmental Engineering

Outline

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

Coupling the Land-Ocean Freshwater Flux

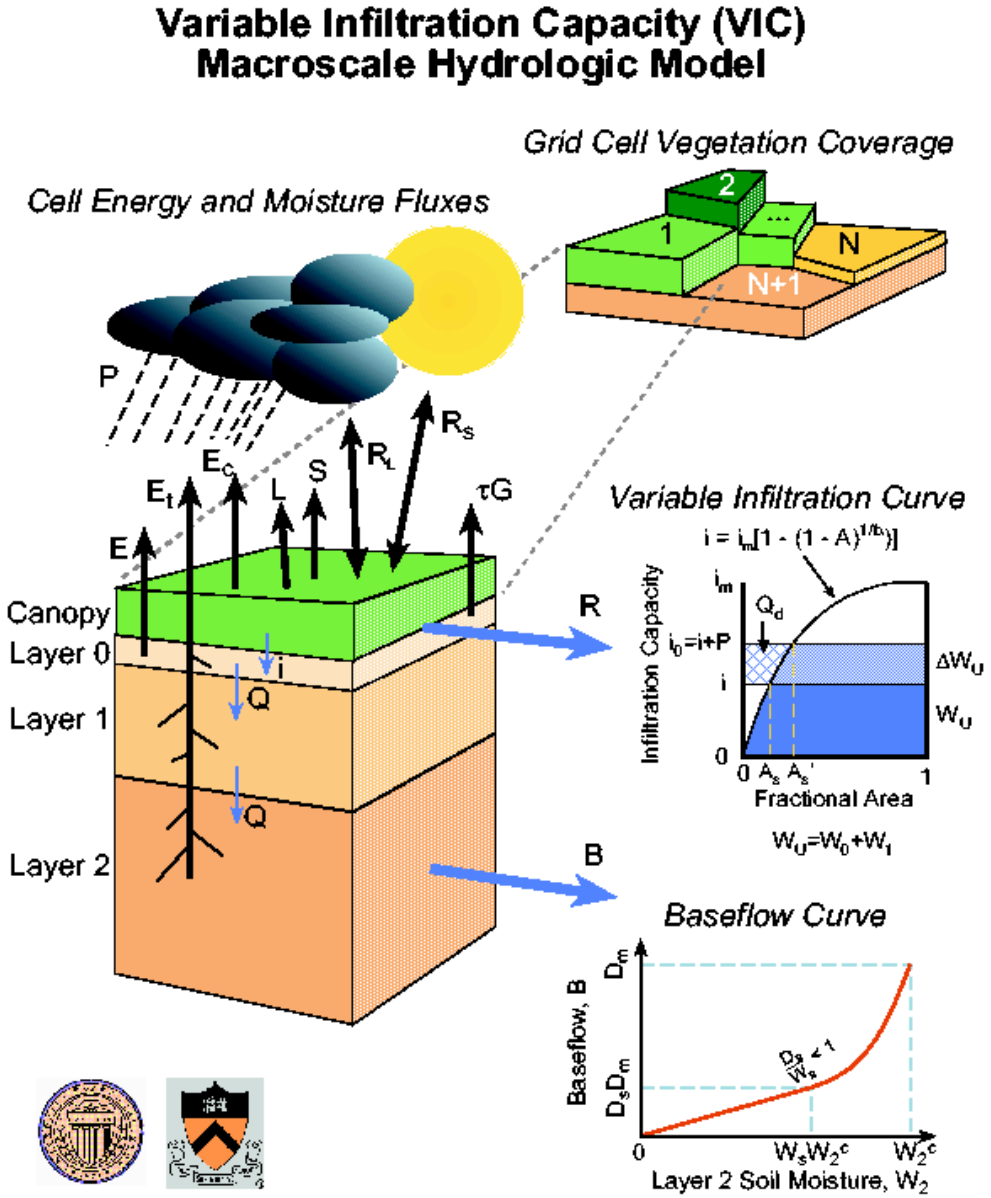




- The direct coupling mechanism from the land to the ocean is through streamflow.
- Realistic river runoff is of high importance to the coastal ocean hydrography and dynamics as well as to sea ice formation and melt.

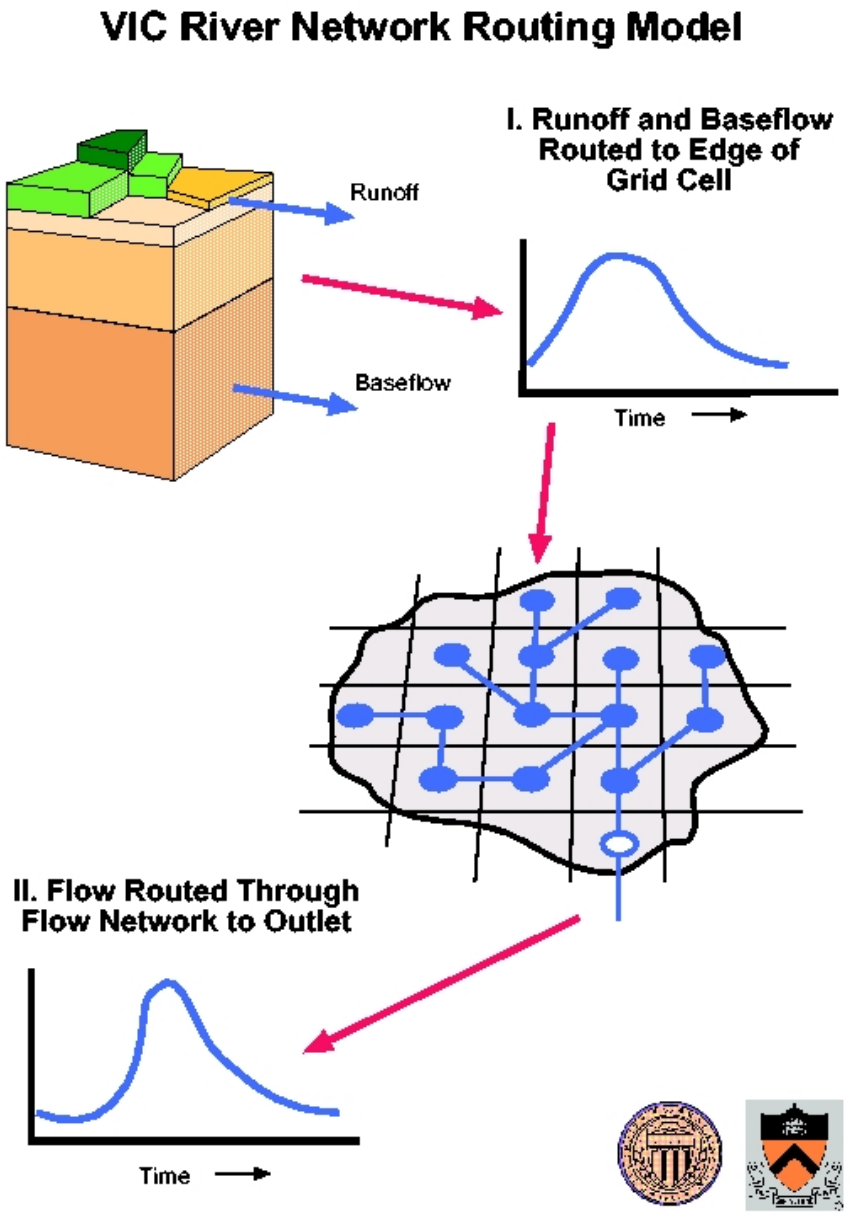
The Variable Infiltration Capacity Model

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



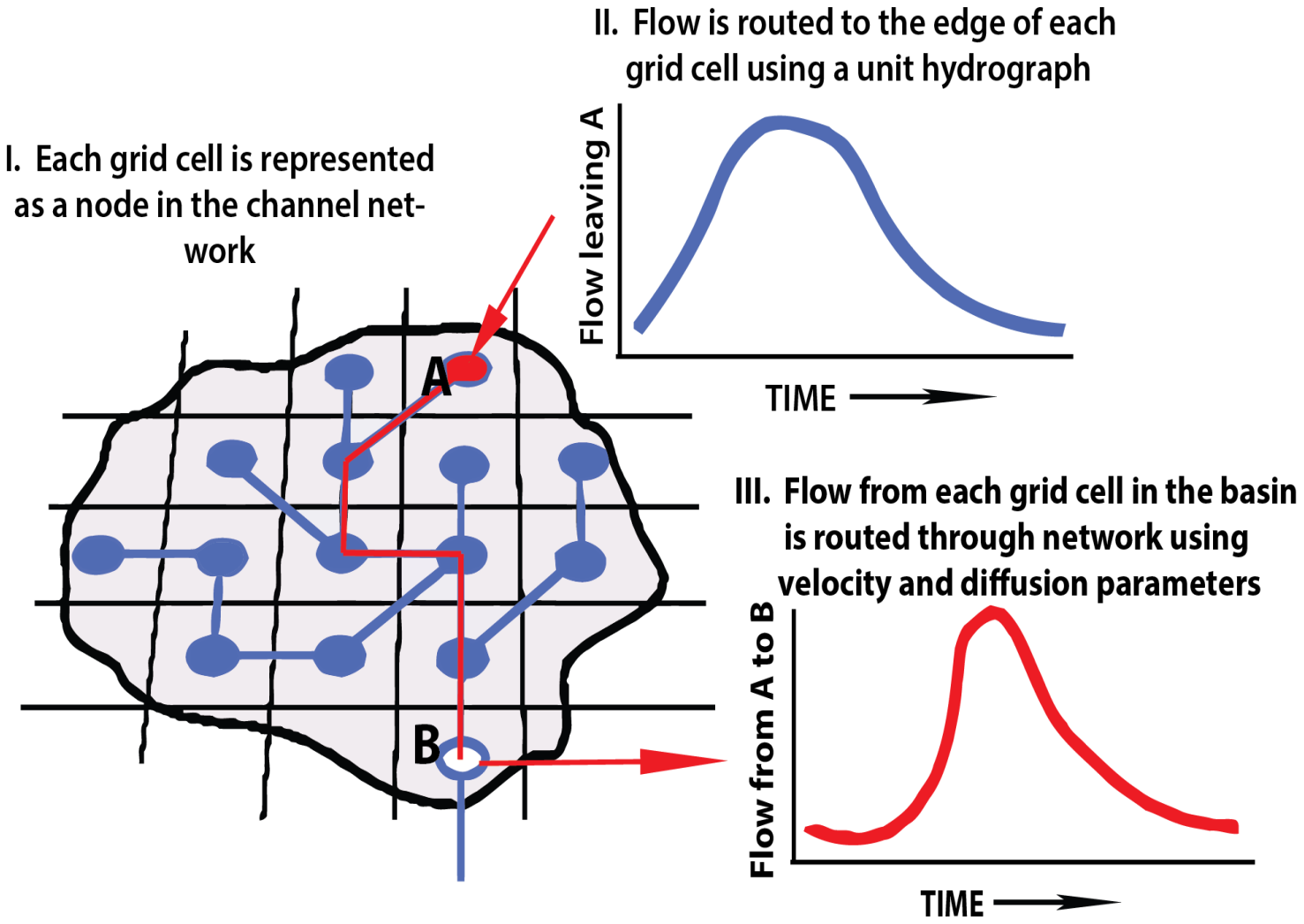
Typical VIC Routing Model

- 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

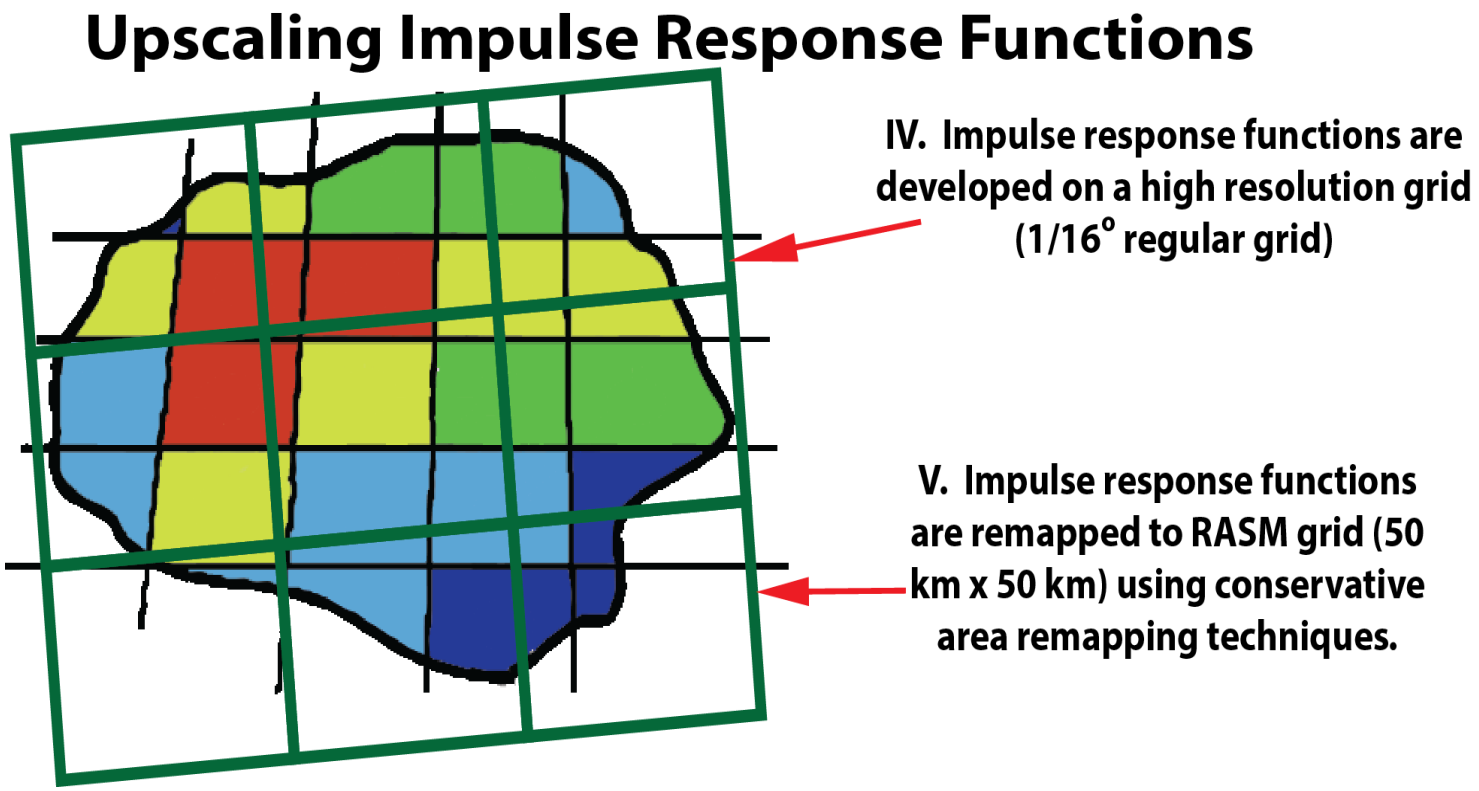


The Coupled Streamflow Routing Model

Development of Impulse Response Fuctions



The Coupled Streamflow Routing Model

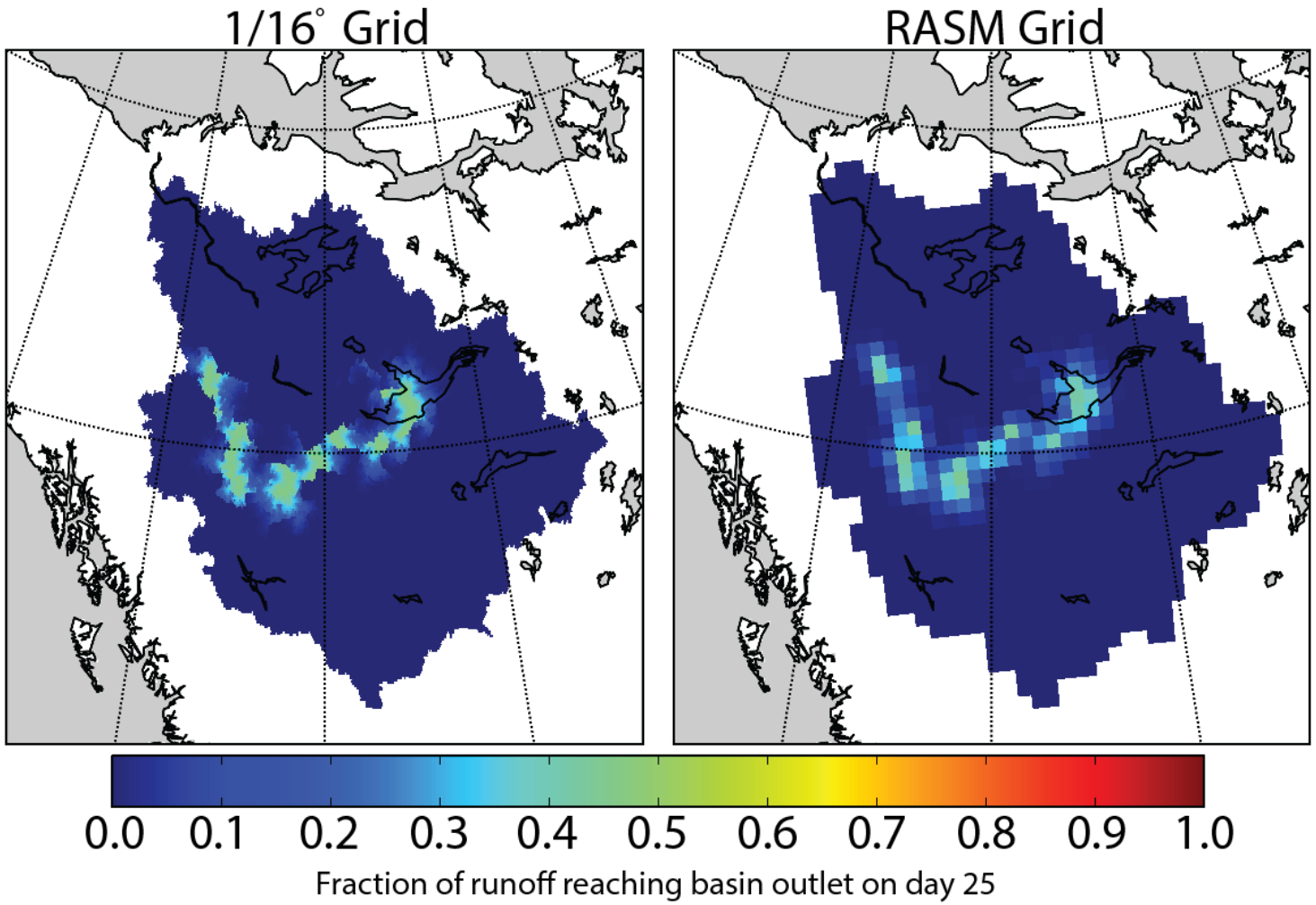


- Remapping
  - Preserves high-resolution response
  - Allows for convolution to be done on RASM grid

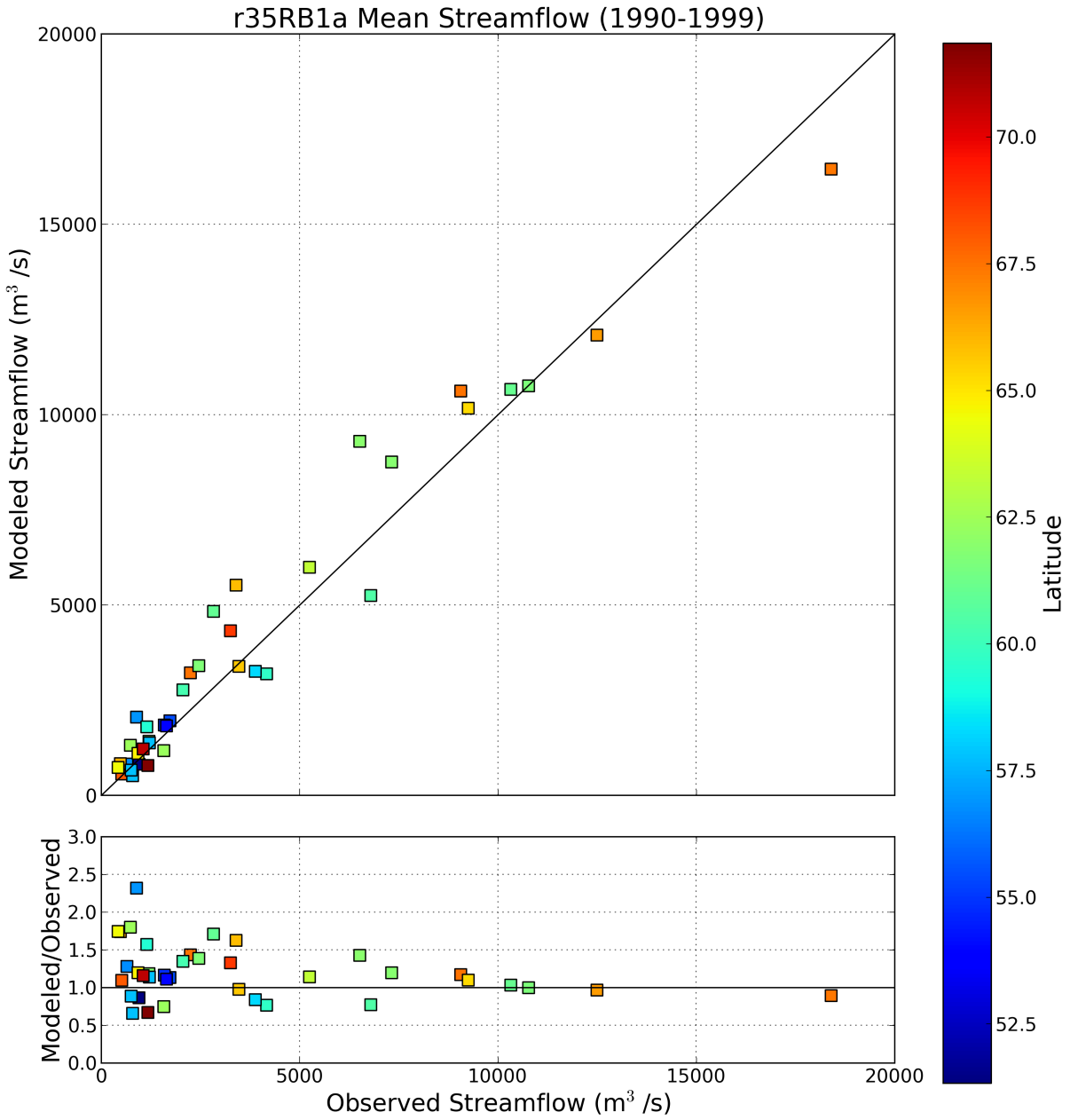
The Coupled Streamflow Routing Model

Upscaled Impulse Response Functions

Mackenzie River at Arctic Red River



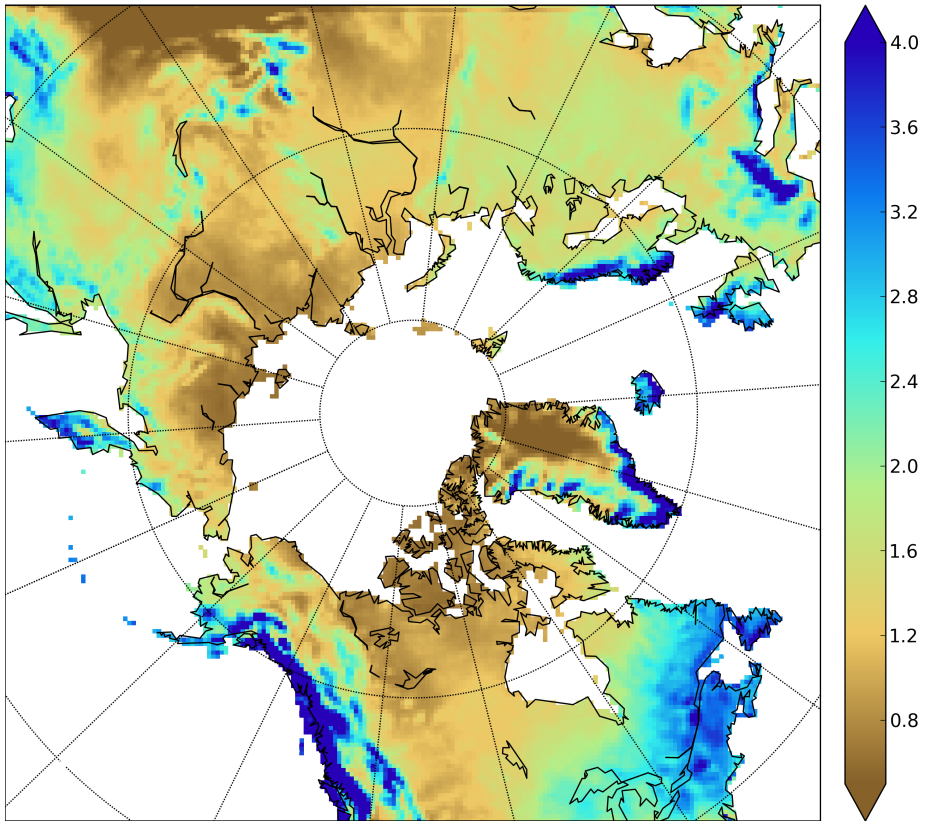
Mean Streamflow – Comparison to R-Arctic Net



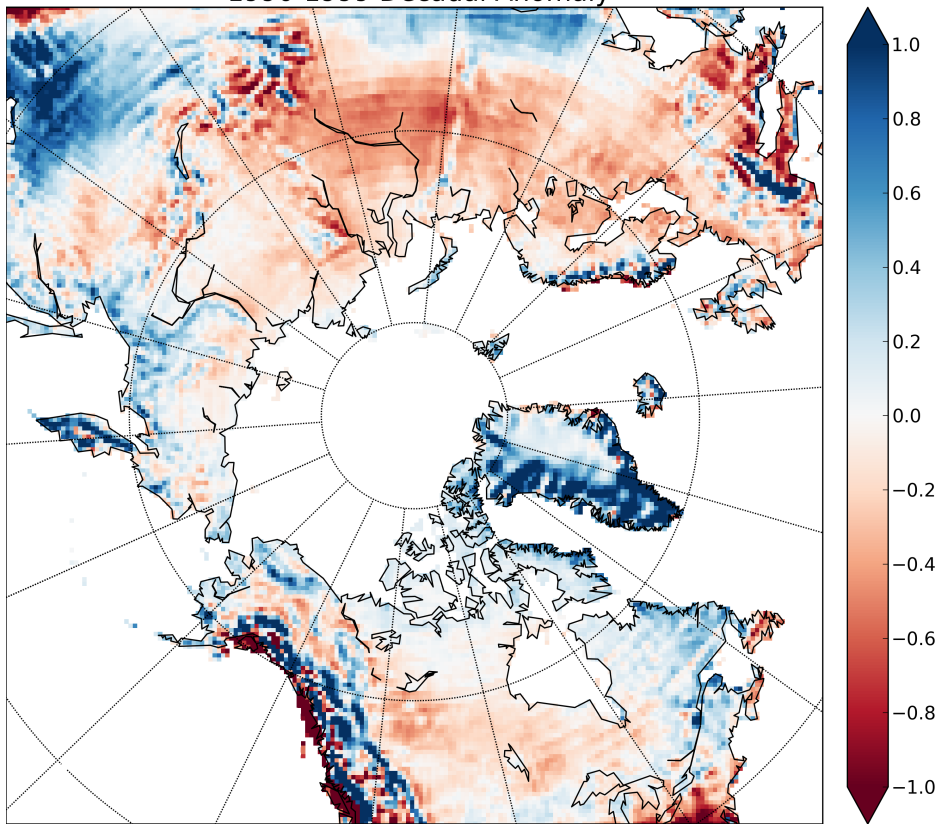
Model Performance – Comparison to ERA-Interim

Precipitation

r35RB1a Precipitation
1990-1999 Decadal Mean

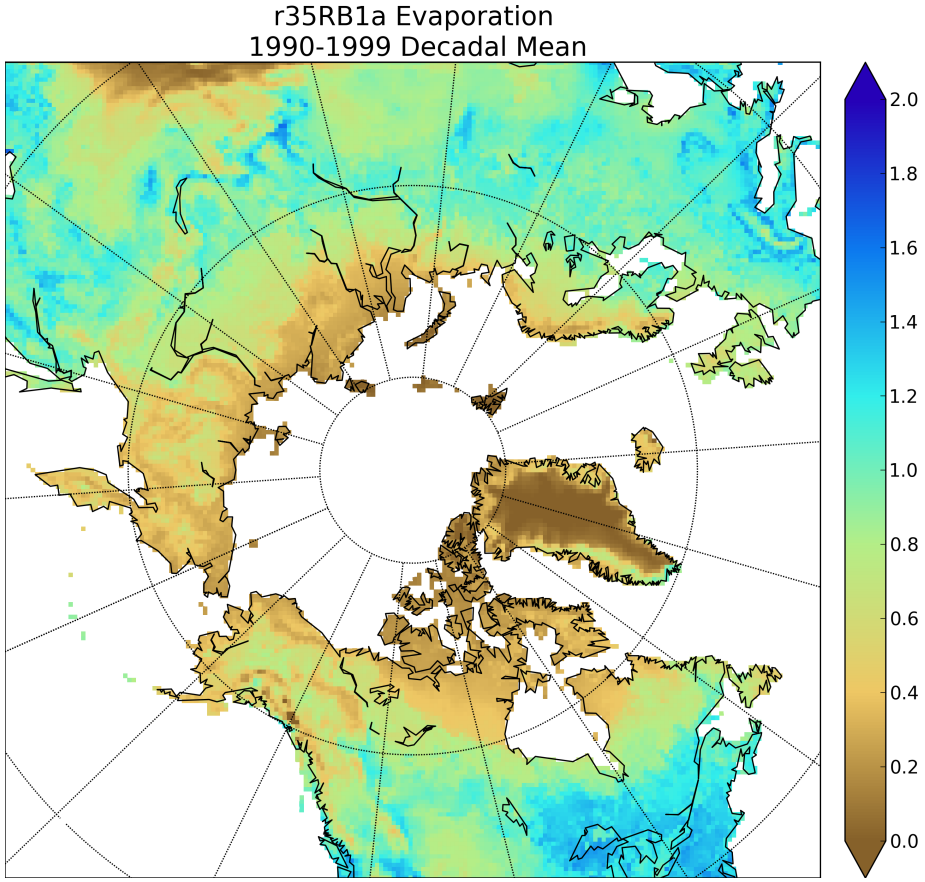


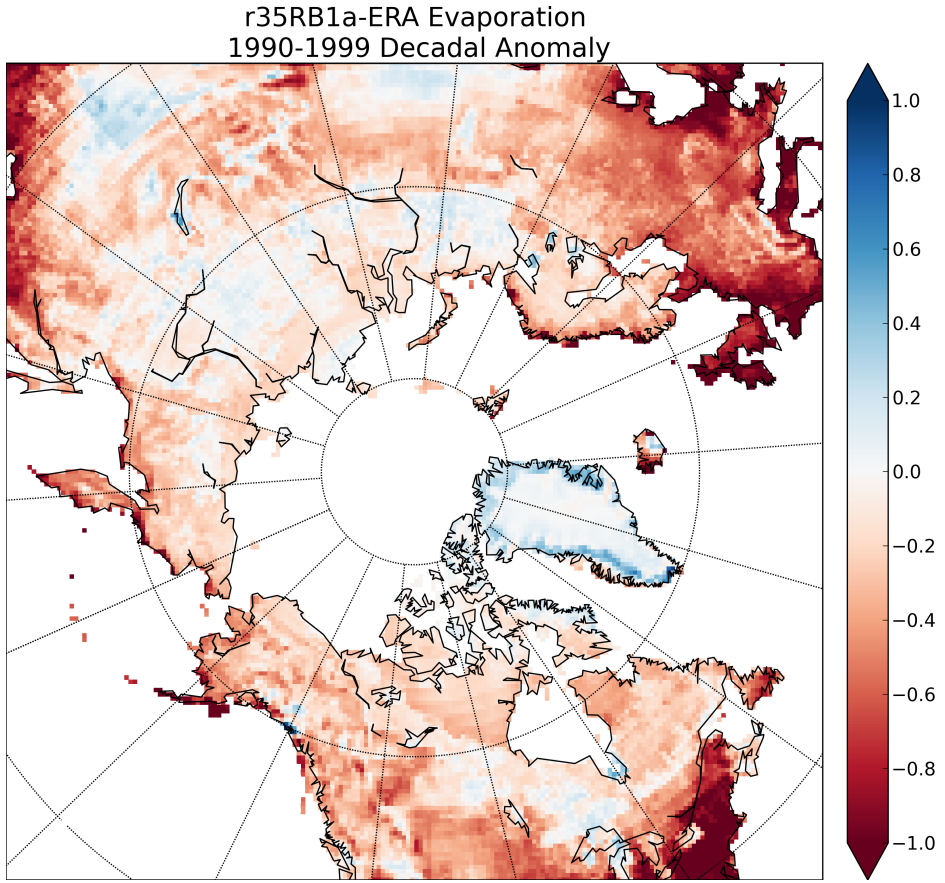
r35RB1a-ERA Precipitation
1990-1999 Decadal Anomaly



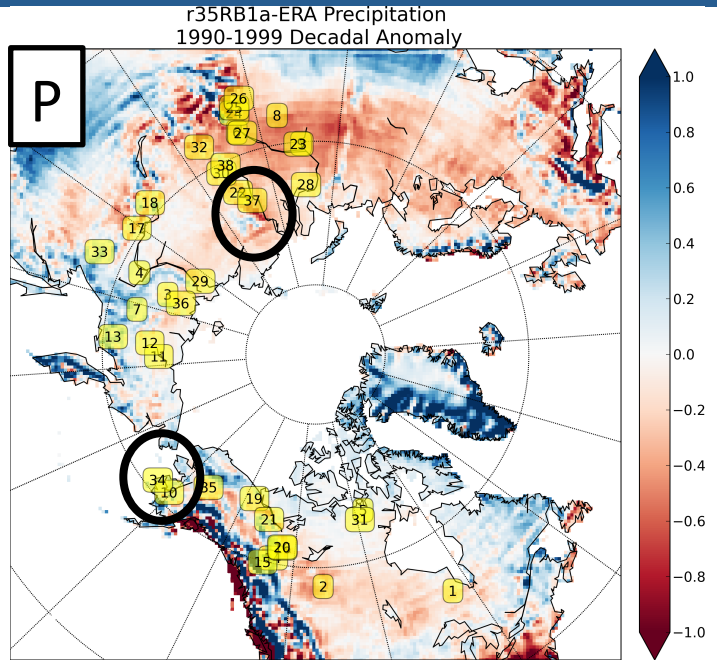
Model Performance – Comparison to ERA-Interim

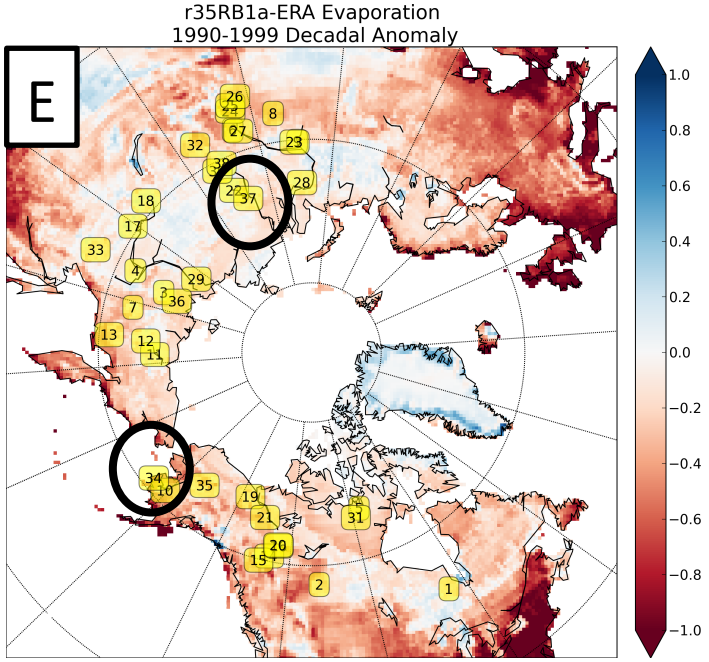
Evaporation

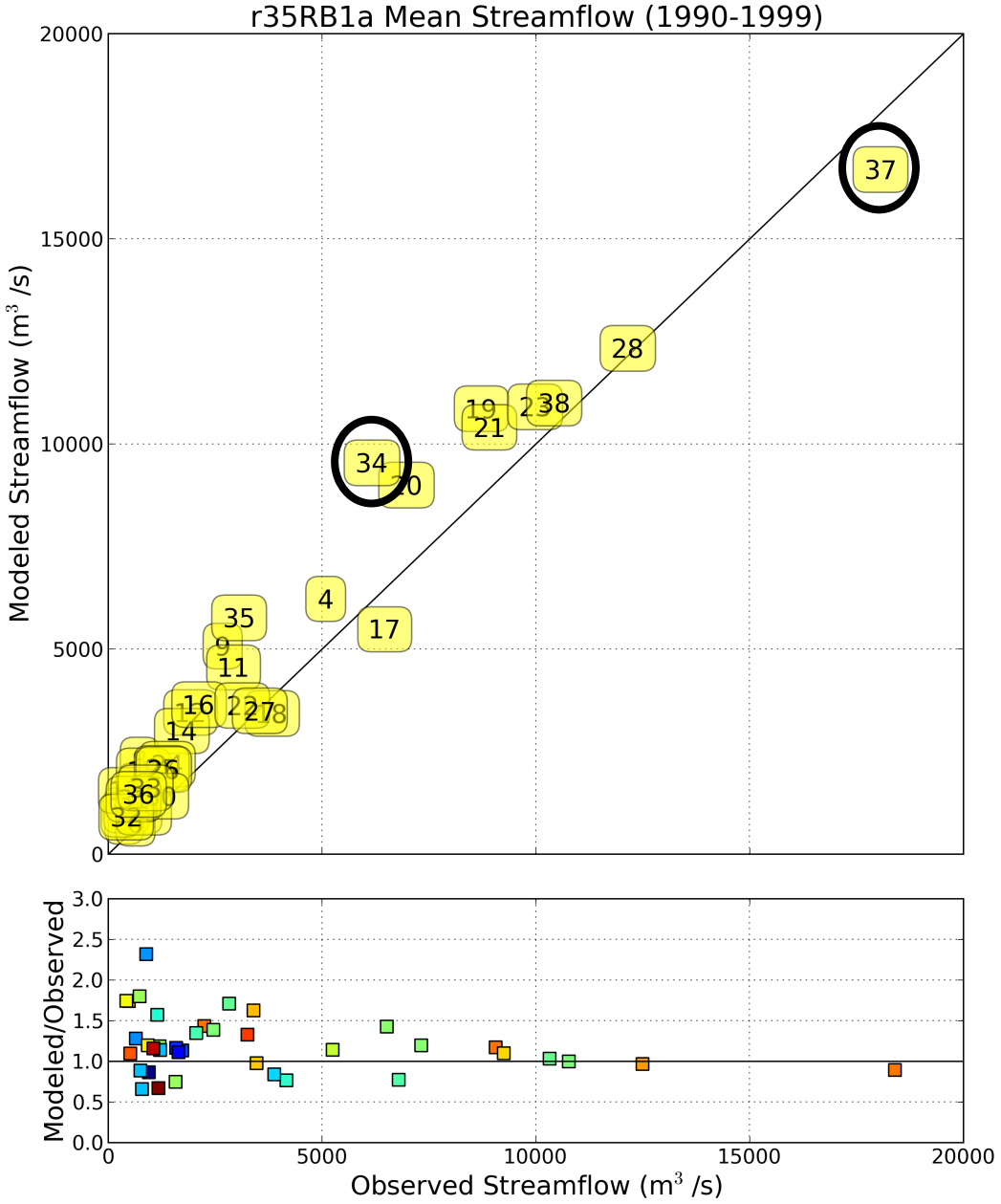




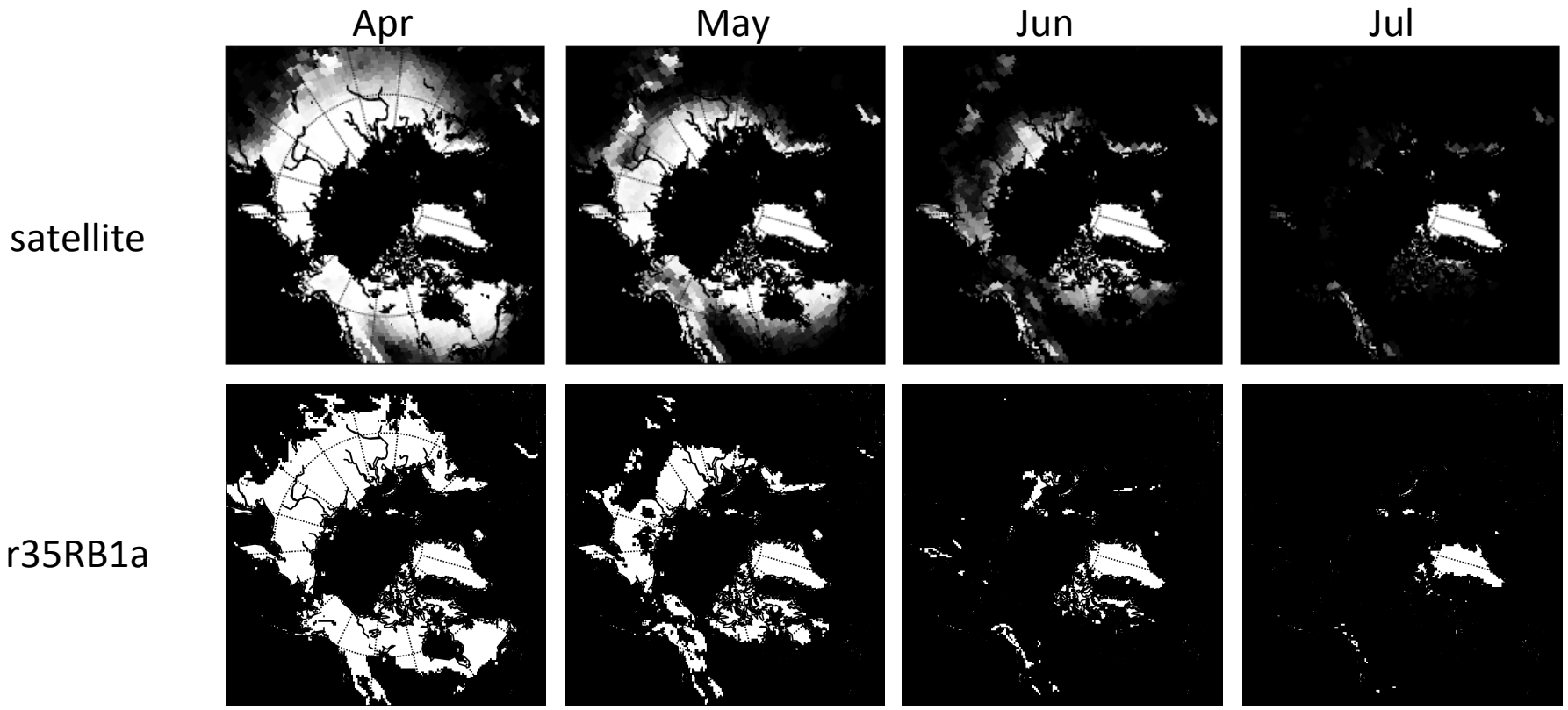
Mean Streamflow – Comparison to R-Arctic Net



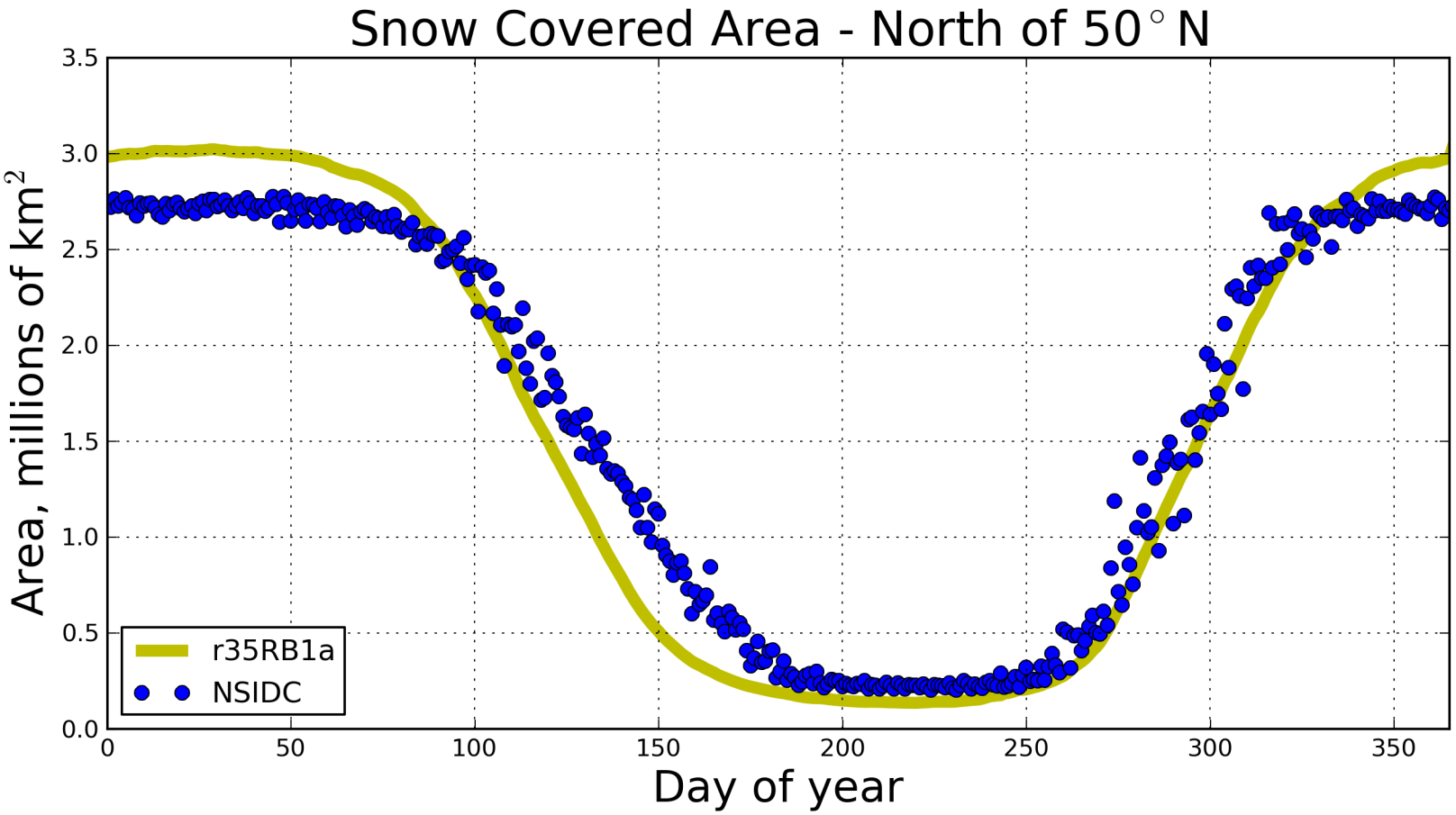




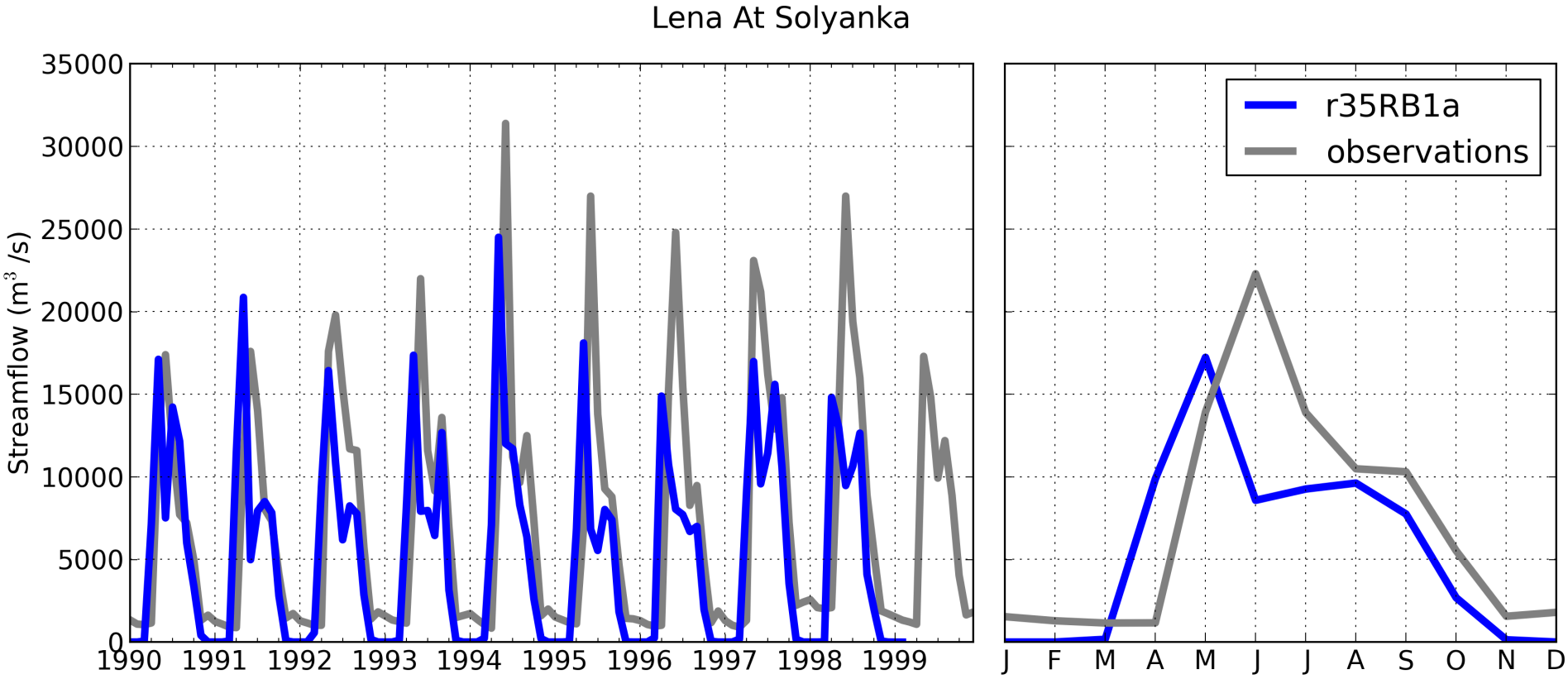
Snow extent (1990-1999) - Comparison with NSIDC



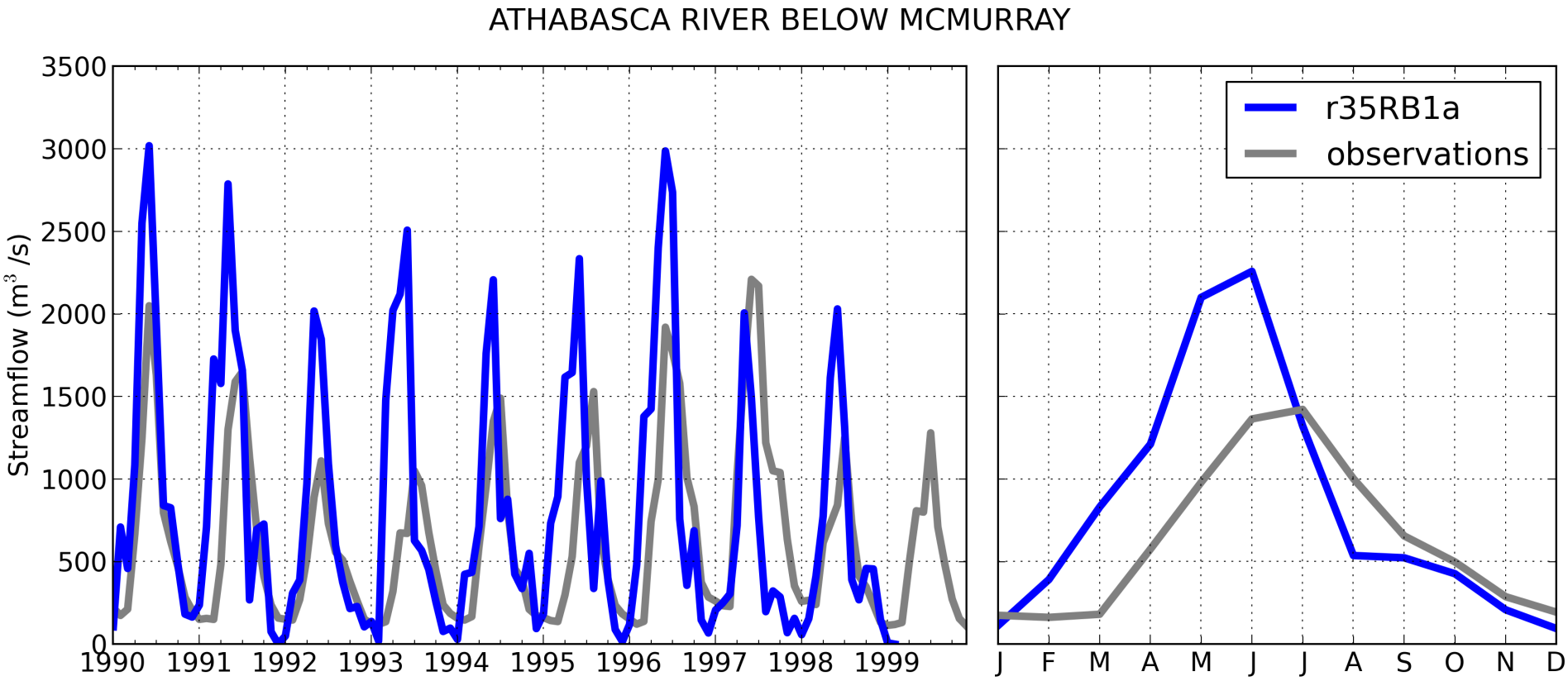
Snow extent - Comparison with NSIDC



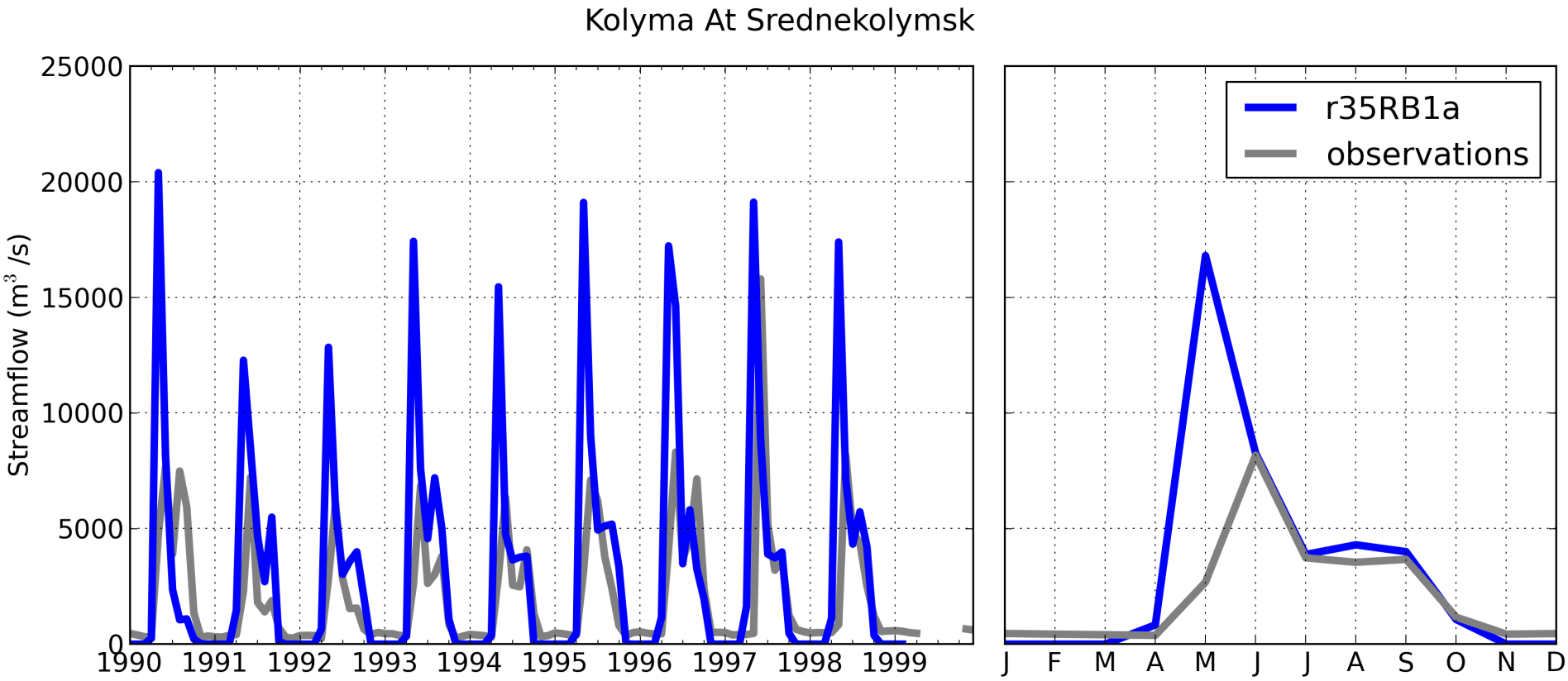
Monthly Streamflows



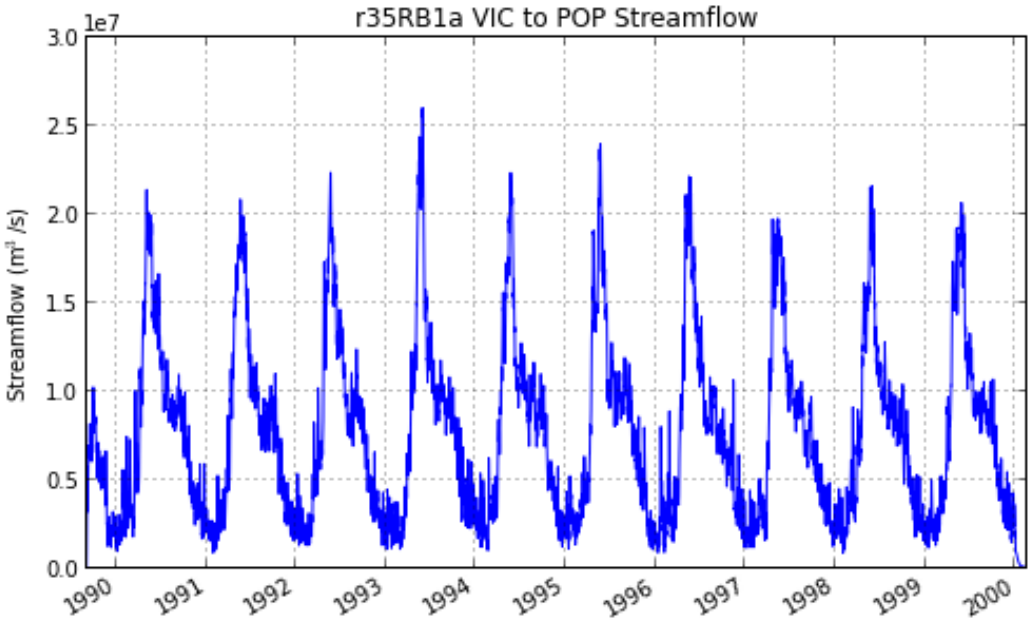
Monthly Streamflows

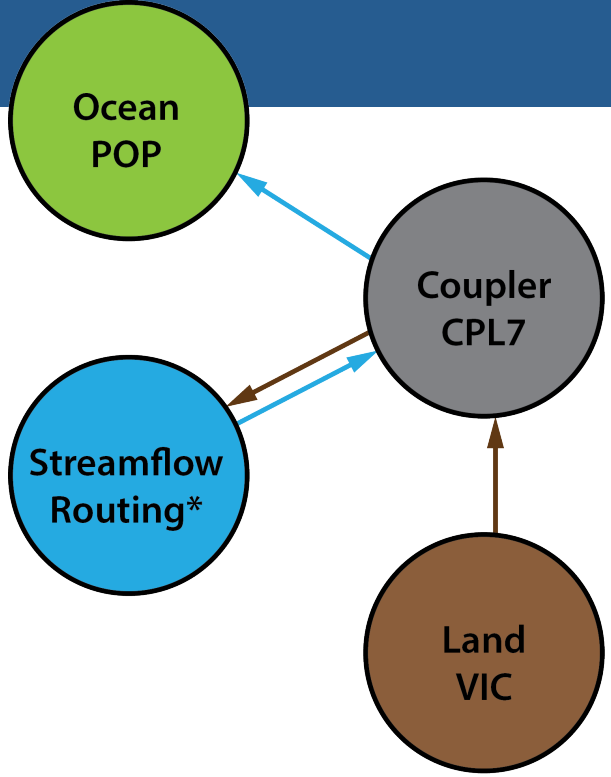


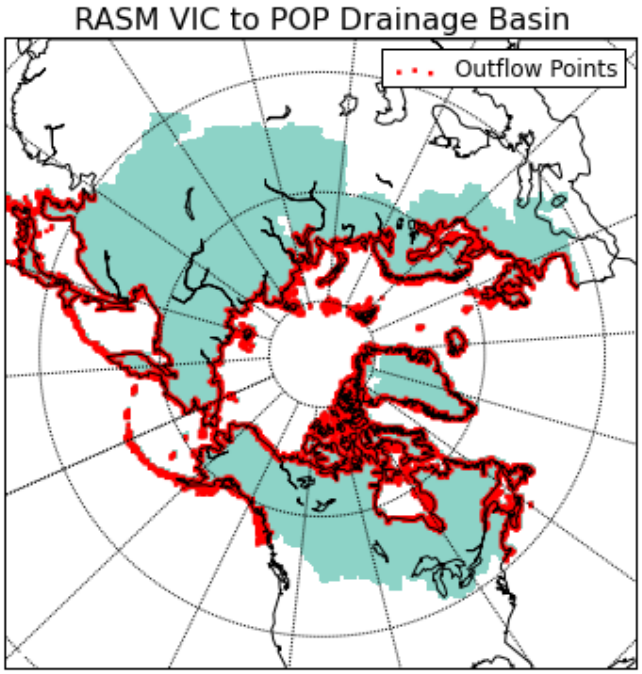
Monthly Streamflows



Next Steps







- 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 looses snow too soon/quickly