climate change and arctic river discharge: challenges of space and time

**Introduction**
- GCM’s predict increases in high-latitude precipitation due to rising global temperatures
- River discharge measurements provide an important data set to assess climatic changes
- Provide integrative measurement of terrestrial water balance
- Arctic rivers comprise largest single source of freshwater to the Arctic Ocean.
- Changes in Arctic river discharge have implications for:
  - Thermohaline circulation
  - Sea-ice formation
  - Biogeochemistry of aquatic ecosystems
- Documented trends in discharge vary spatially and temporally

**Regional Discharge Trends**

**Eurasian discharge**
- Increasing discharge
  - Predict 18-70% increase by 2100
  - Trends correlated with:
    - Global surface air temperature
    - North Atlantic Oscillation (NAO)
  - Positive NAO results in warm, wet winters

**North American discharge**
- Decreasing discharge
  - Trends correlated with:
    - Decreased precipitation
    - Northern Annular Mode (NAM)
    - El Nino Southern Oscillation (ENSO)
- Negative (NAM) and positive (ENSO) phases allow cold, dry arctic air to penetrate south
- But...
  - Drainage to:
    - Hudson Bay anticorrelated to NAM
    - Bering Strait correlated to NAM
    - Arctic Ocean correlated to ENSO
  - Highlights importance of investigating individual river systems

**Local Discharge Trends – North America**

**Mackenzie River, Canada**
- Increasing discharge
- Trends correlated with:
  - Increased precipitation (5% significance level)
  - Northern Annular Mode (NAM) (10% significance level)
- Positive phases of NAM allow mid-latitude storms to penetrate north resulting in wetter climatic conditions and increased discharge

**Yukon River, Alaska**
- Increasing discharge
- Trends correlated with:
  - Increased winter precipitation
  - Permafrost thawing

**Conclusions**
- Discharge trends vary spatially
  - Difficult to generalize trends over time
  - Important to assess range of scales
  - Limited historical records make it hard to identify the relationship between discharge and climate change over time
- Management implications for the Mackenzie Basin
  - Water resource planning predicated on historic resource availability
  - Impacts of warming & increased discharge:
    - Reduced flooding – early ice breakup
    - Reduced nutrients supplied to lakes in Mackenzie and Peace-Athabasca deltas
    - Hydroelectric power
    - Streambank erosion & land loss
    - Water quality – pollution from suspended sediment & organic pollutants
- Greenland implications
  - Different hydrology
  - Glacial meltwater driven
  - Discharges likely to increase with ice sheet & glacier melting
  - Spatial variability
  - Melting rates vary spatially (NASA)
  - Measure discharge from individual rivers

**Data sources:**
- Discharge: Water Survey of Canada Hydrometric Database
- US Geological Survey National Water Information System
- Climate:
  - National Center for Atmospheric Research
  - National Oceanic and Atmospheric Administration