Environment and Climate Change Canada
Environnement et Changement climatique Canada
Canada

Skillful seasonal forecasts of Arctic sea ice retreat and advance dates in a dynamical forecast system

Michael Sigmond

Canadian Centre for Climate Modelling and Analysis (CCCma)
Victoria, BC, Canada

Reader, Merryfield, Flato, Kharin (CCCma) Tivy (CIS)

International Conferences on Subseasonal to Decadal Prediction, NCAR, Boulder, 18-21 September 2018

Context

- Seasonal forecasting of sea ice a young field
  first systems with coupled sea ice component operational in ~2010
- First studies: area-integrated quantities such as Sea Ice Extent*Of little relevance to end-users (e.g. transport, tourism, Coast Guard, Northern Communities, resource extraction)*
- Community is moving toward (monthly mean) regional or local sea ice concentration/sea ice edge
- This study: quantifying skill of local dates at which ice melts (retreat) or forms (advance date)
  - *Based on daily data*
  - *Directly relevant to end users*

Outline

1) How far in advance can local sea ice retreat/advance date be skillfully predicted?

2) What are the sources of skill?

Sigmond et al. 2016, *Geophys. Res. Lett*

3) Initial attempts to produce operational forecasts

Model, data and method:

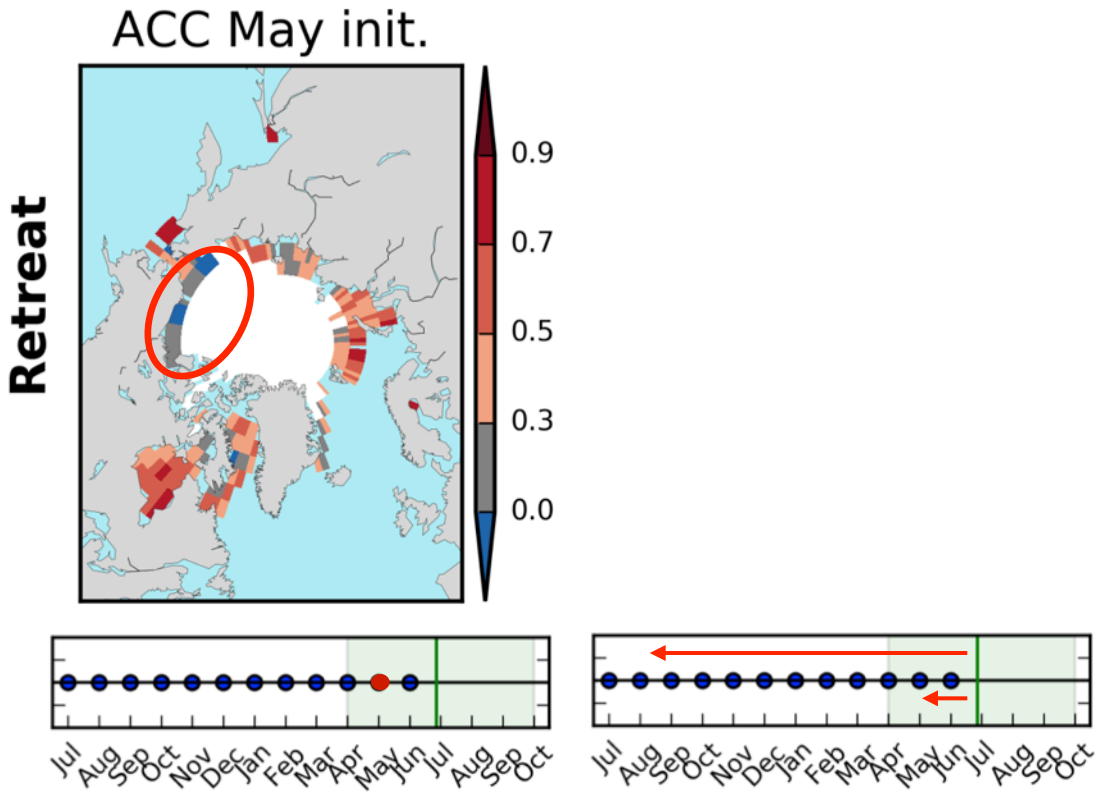
- Model: Canadian Seasonal to Interannual Prediction System
  - *based on 2 GCMs: CanCM3 and CanCM4*
    - *Same ocean and sea ice*
    - *Different atmosphere*
  - *10 ensemble members for each GCM*
  - *12 month forecast range*
  - *SI concentration initialized with (re)analyses (nudging)*
  - *SI thickness initialized with climatology (nudging)*
- Data: Hindcasts initialized every month between 1979-2010
- Retreat date: First calendar day with SIC < 50%
- Maximum lead time with skill:

  [climatological date] – [earliest initialization month with skill]

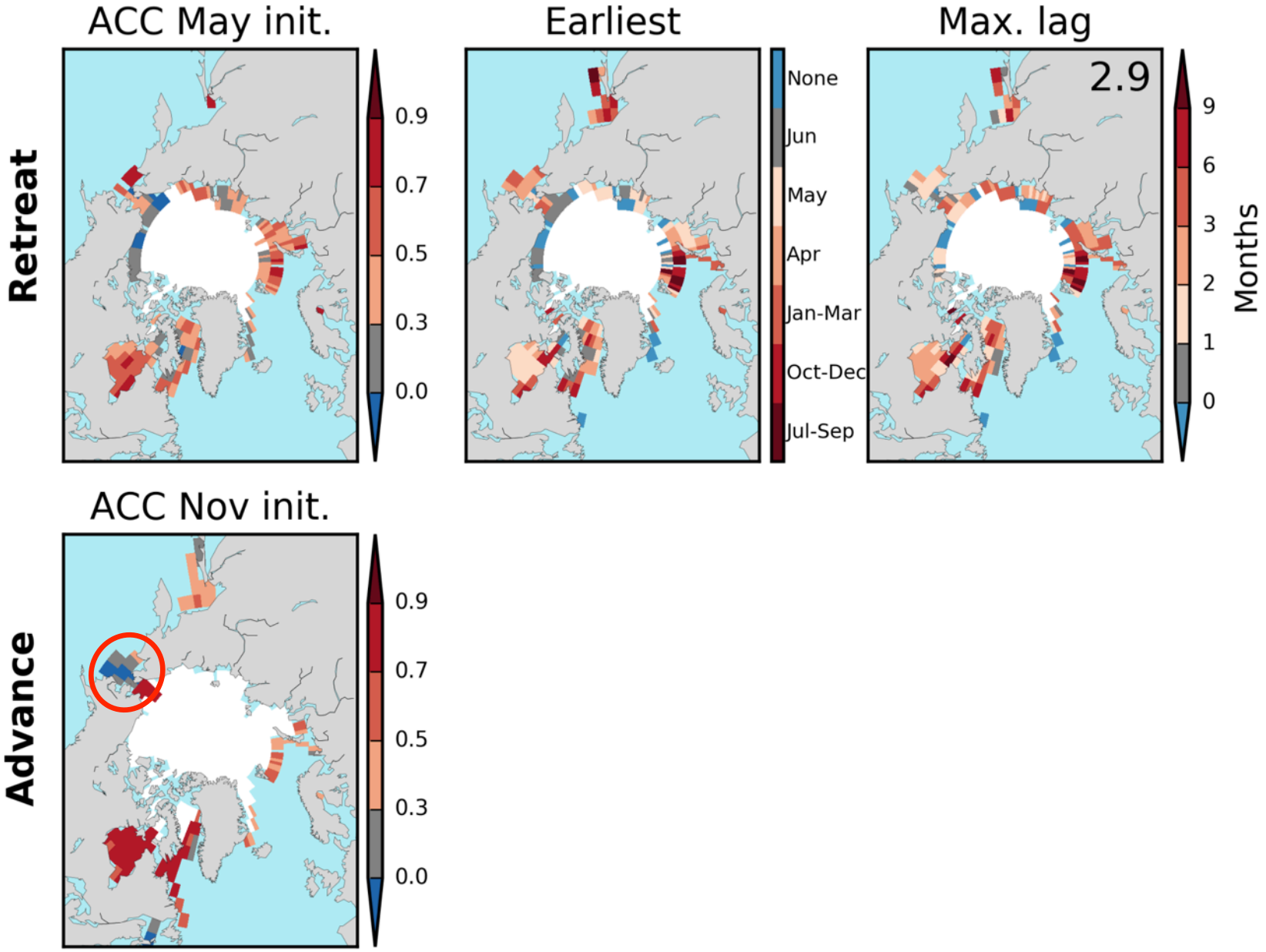
  ↑

  ACC>0.3 (p=0.05)

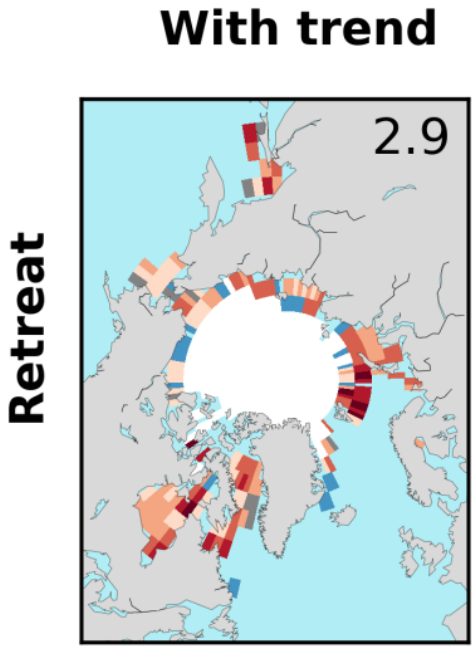
Forecast skill (ACC)



Forecast skill (ACC)

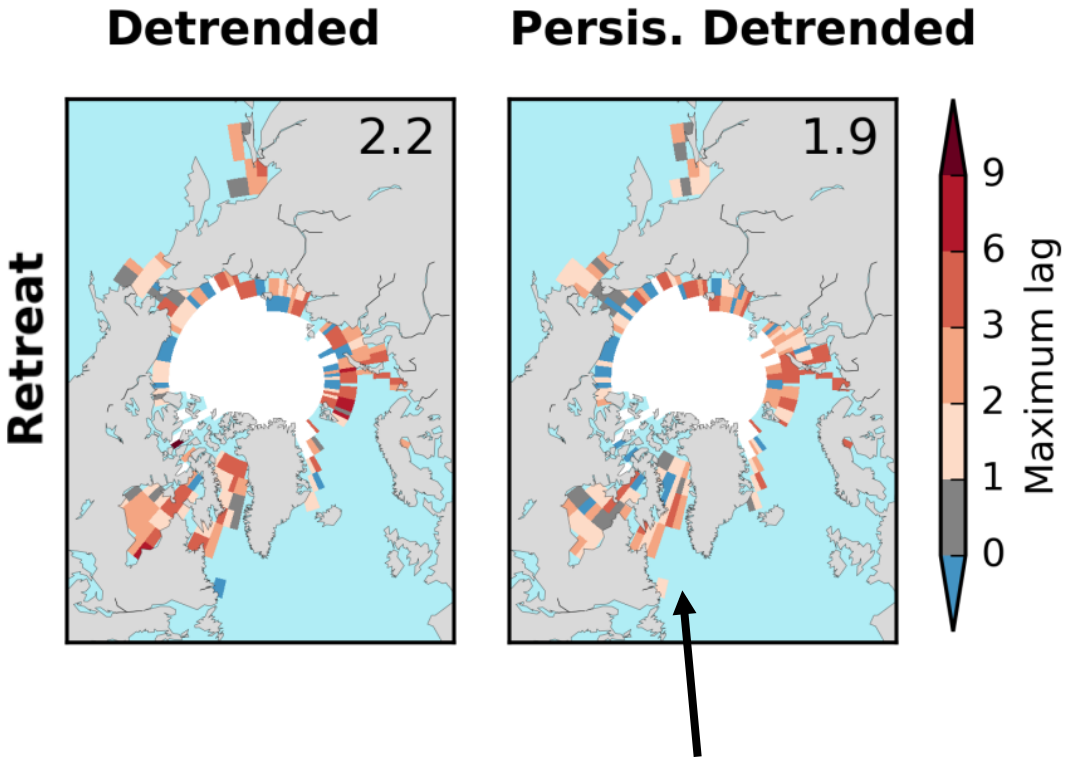


Sources of skill: Trend



Sources of skill: Persistence

- Retreat: most of obtained model skill explained by persistence
- But our model beats persistence

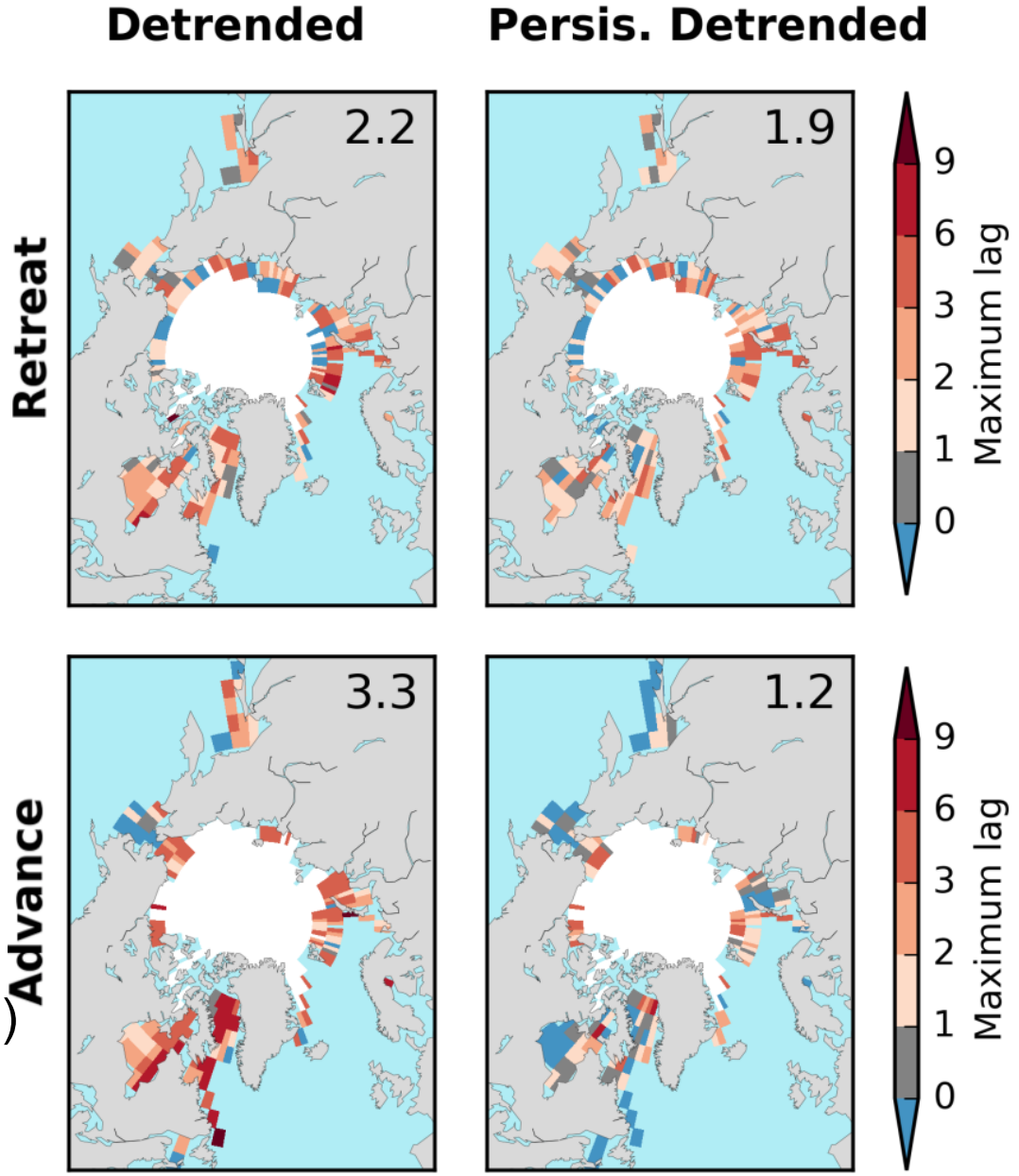


Maximum lag with skill of retreat date forecasts made by **persisting** initially observed **SIC anomaly**

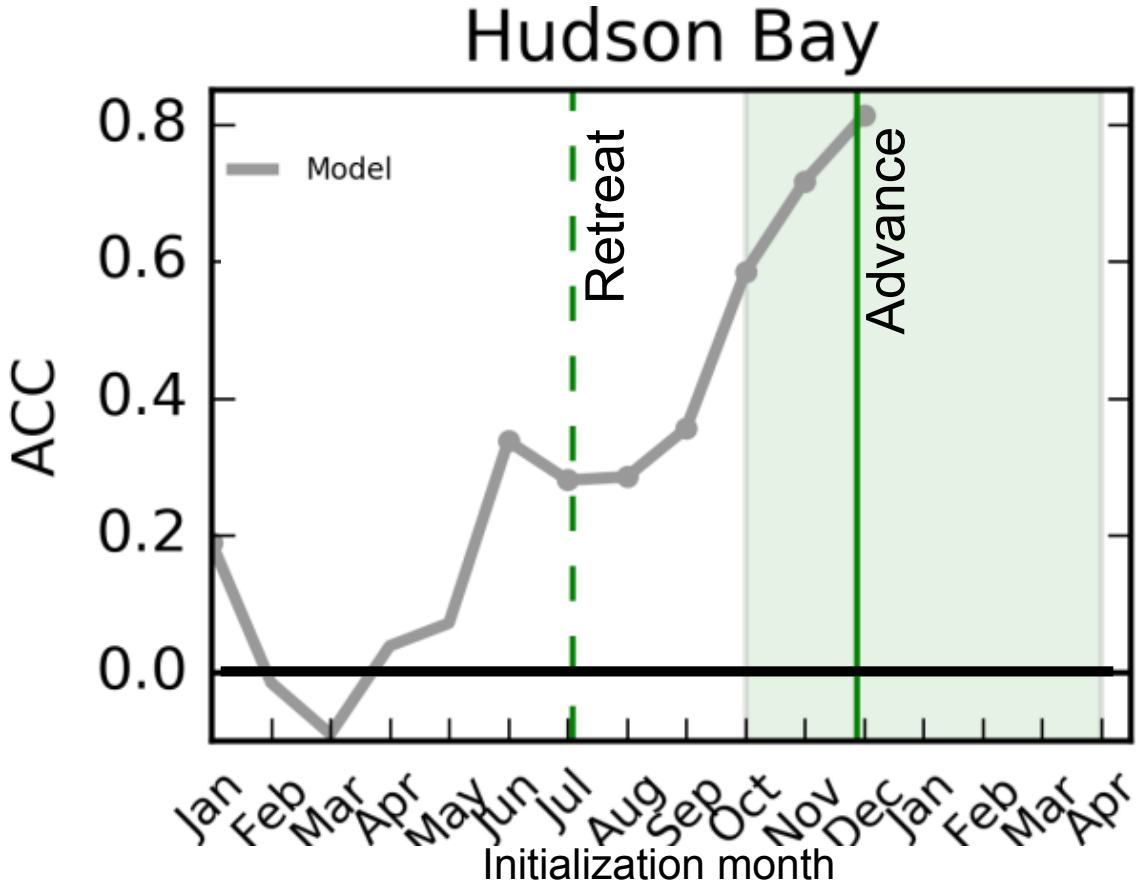
Sources of skill: Persistence

- Retreat: most of obtained model skill explained by persistence
- But our model beats persistence

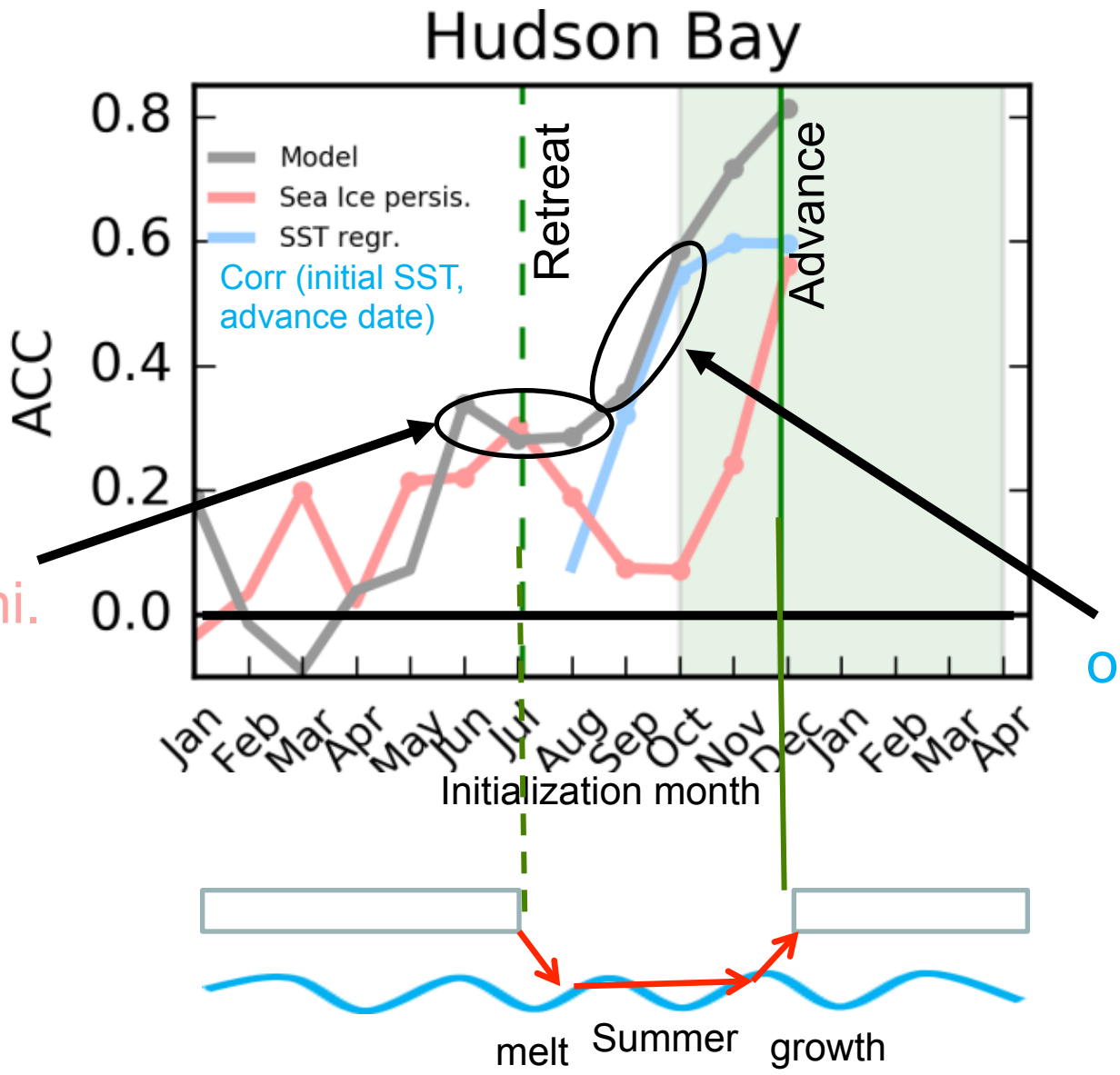
- Advance: Almost no skill from persistence
- Due to absence of sea ice prior to advance (no anomaly to persist→ persist.=clim.)
- **Additional value considerable!**



Sources of skill (advance): Reemergence



Sources of skill (advance): Reemergence



Sea-ice ini.

ocean ini.

Initial steps towards operational forecasts

- Problem: real-time CanSIPS forecasts not usable
  due to inconsistency between hindcasts and forecasts initial conditions
- Solved this by producing historical dataset that is closer to that used to initialize forecasts, and redoing the hindcasts
- Also improved SIT initialization

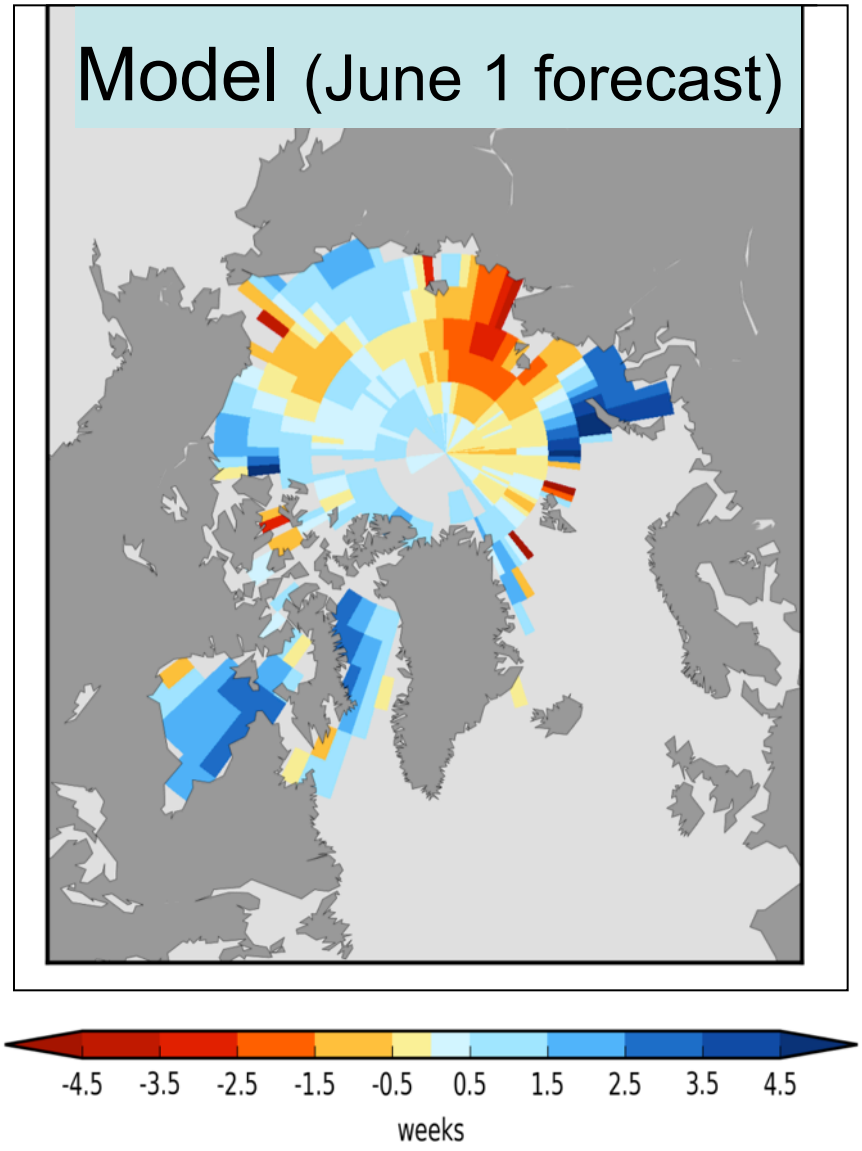
→ Usable sea ice forecasts

→ More skillful retreat/advance date forecasts

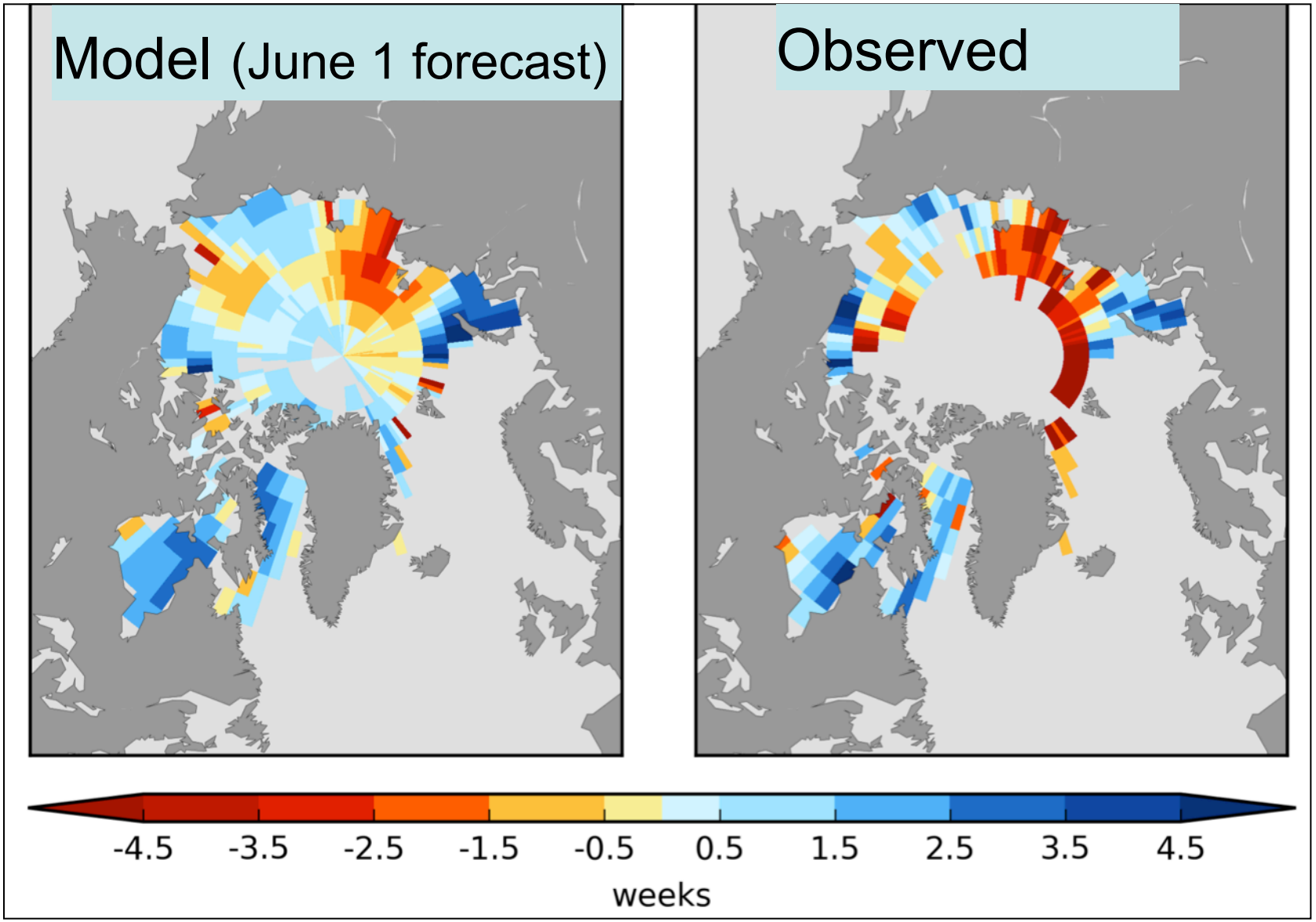
retreat: 3→5 month in advance

advance: 5→7 month in advance

First experimental forecast: 2018 retreat date anomaly (cf 2009-2017)



First experimental forecast: 2018 retreat date anomaly (cf 2009-2017)



Summary:

- Skillful seasonal forecasts of socio-economically relevant sea ice events
- Advance dates predictions more skillful (~5-7 months) than retreat dates (~3-5 months)
- Sources of skill: trend, persistence and re-emergence (SSTs)
- Working towards implementation into operations
- Working with end users (future: probabilistic forecasts)

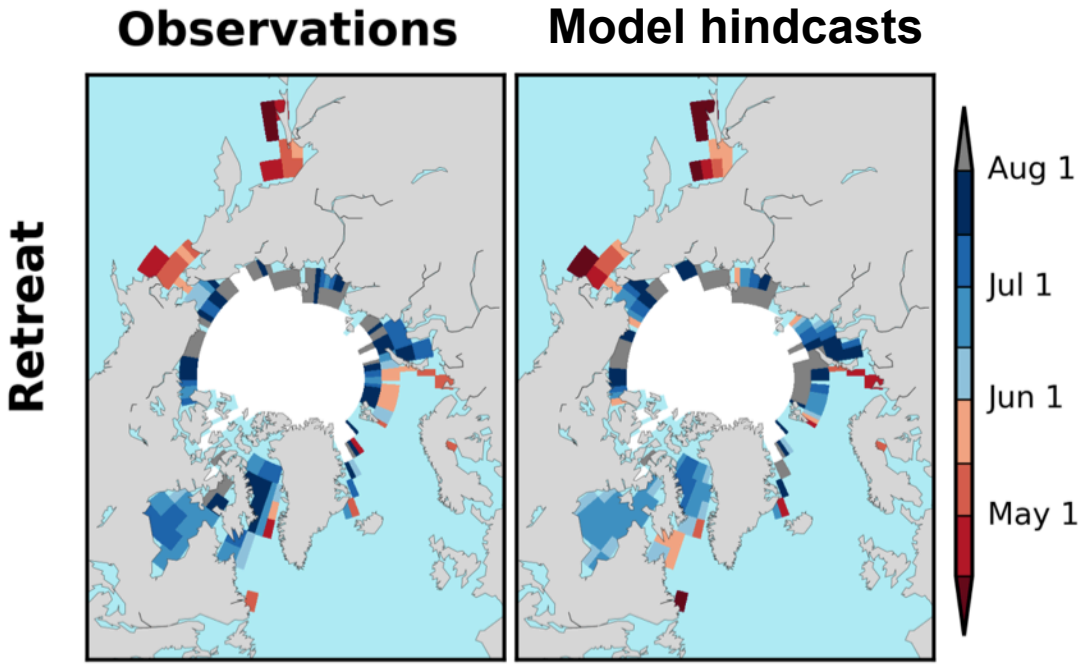
Thanks!

Michael.Sigmond@canada.ca

Sigmond et al. 2016, *Geophys. Res. Lett*

Extra slides

Climatology (1979-2010)

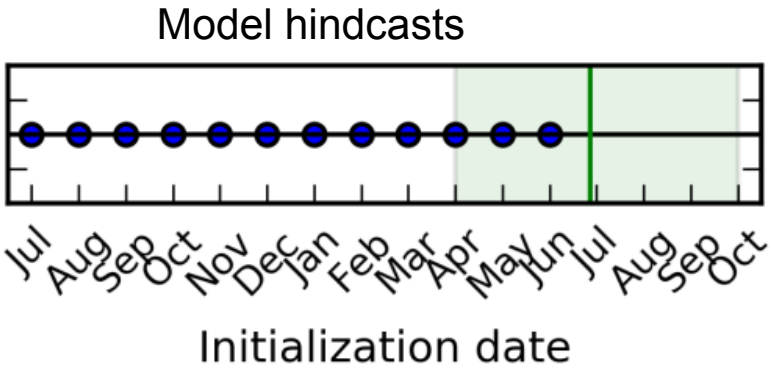


- Hindcast climatologies of retreat dates correspond well with obs

Methodology

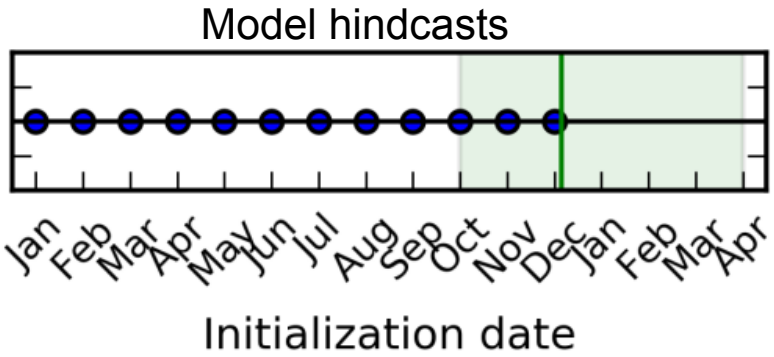
Retreat

First calendar day with SIC<0.5 for at least 10 days



Advance

First calendar day with SIC>0.5 for at least 10 days



- Skill metric: Anomaly correlation coefficient (stat. significant: >0.3)

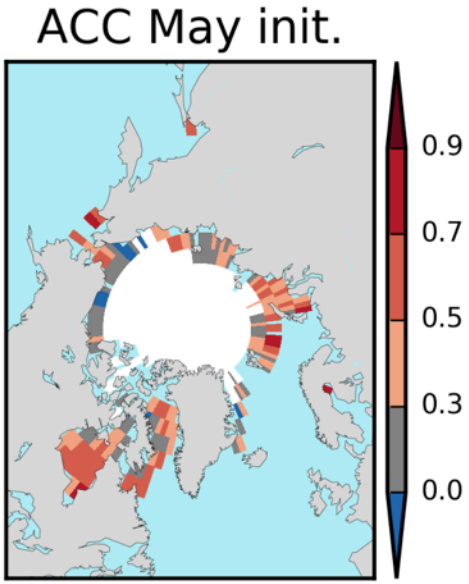
- Maximum lead time with skill:
  [climatological date] – [first initialization date with skill]

Initialization (hindcast/forecast):

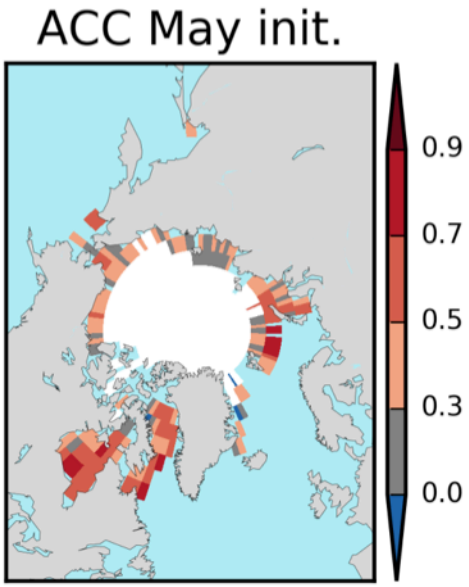
	Current	New
SIC	HadISST1/CMC	Had2CIS/CMC
SIT	Clim./Clim.	SMv3/SMv3
Subsurface ocean temp	GODAS/GIOPS	ORAp5/GIOPS

Forecast skill for retreat date (ACC)

Current



New



Forecast skill for advance date (ACC)