BREA Final Results Forum

Results from the Canadian Centre for Climate Modelling and Analysis

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Project Title:

FORECASTING OCEAN AND ICE CONDITIONS FOR THE BEAUFORT SEA REGION FROM ONE TO TWELVE MONTHS IN ADVANCE

Objective:

To provide a high-resolution forecasting system capable of predicting the detailed evolution of ocean and sea-ice conditions in the Beaufort Sea region from one to twelve months in advance.

This research is aimed at supporting offshore operations, regulatory development and decision making in the Beaufort region.

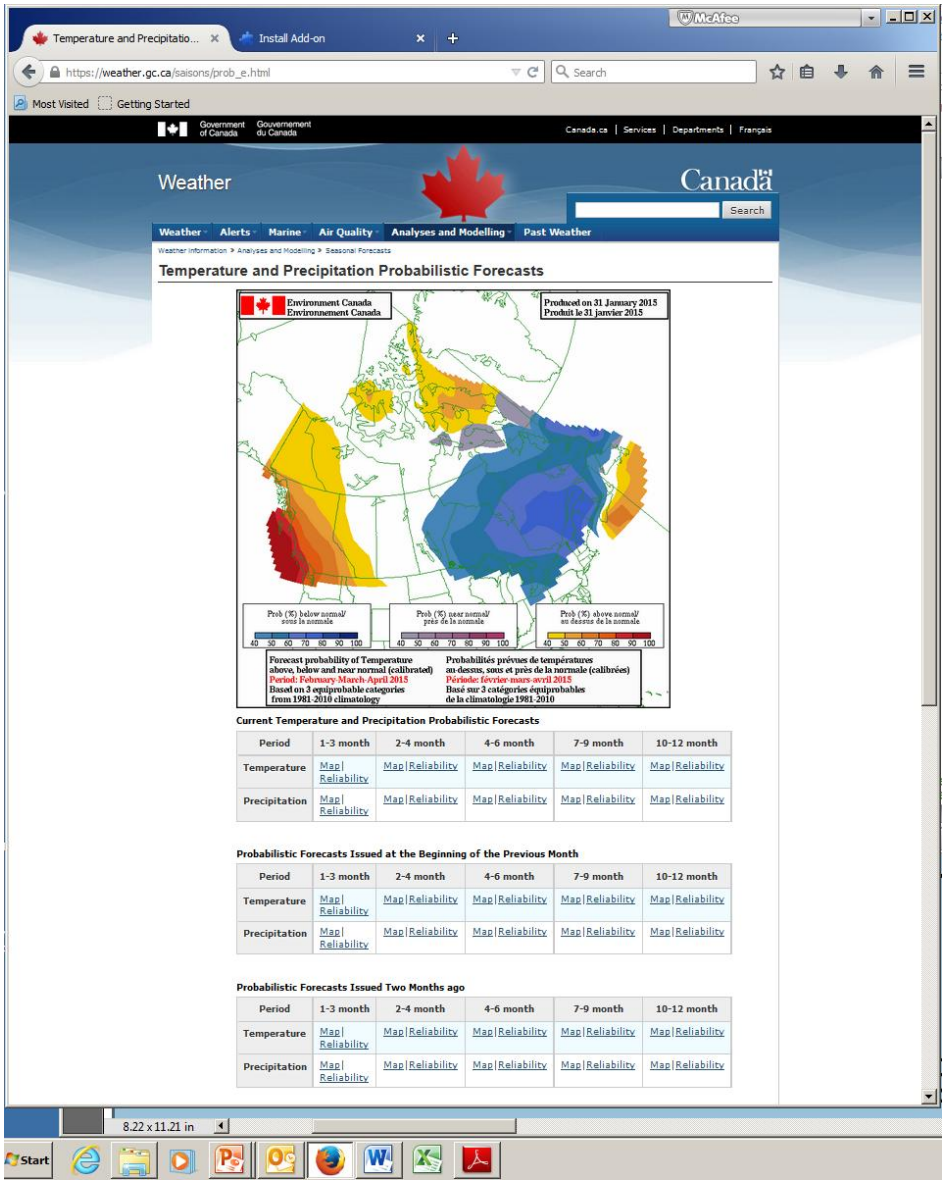
The research undertaken will provide enhanced regional detail in operational seasonal predictions, and will contribute directly to the development of improved operational seasonal climate prediction products that will serve operational and regulatory needs now and in the future.

Highlights

- CCCma participation in World Climate Research Program IceHFP project to study sea ice influence on seasonal forecasts
- Evaluation of CCCma/EC seasonal forecast skill for predicting Arctic sea ice concentration and extent
- Evaluation of CCCma/EC seasonal forecast skill for predicting Arctic sea ice melt/freeze dates
- Production of web-accessible sea ice seasonal forecast datasets for CCCma and North American Multi-Model Ensemble (NMME) data archives
- Evaluation of simulated 21st Century changes in Beaufort Sea extreme wind speeds and sea ice in 14 climate models
- Three datasets contributed to Polar Data Catalogue:

POLAR DATA CATALOGUE

Environment Canada's Operational Seasonal Forecast System



https://weather.gc.ca/saisons/prob_e.html

GEOPHYSICAL RESEARCH LETTERS, VOL. 40, 1–6, doi:10.1002/grl.50129, 2013

Seasonal forecast skill of Arctic sea ice area in a dynamical forecast system

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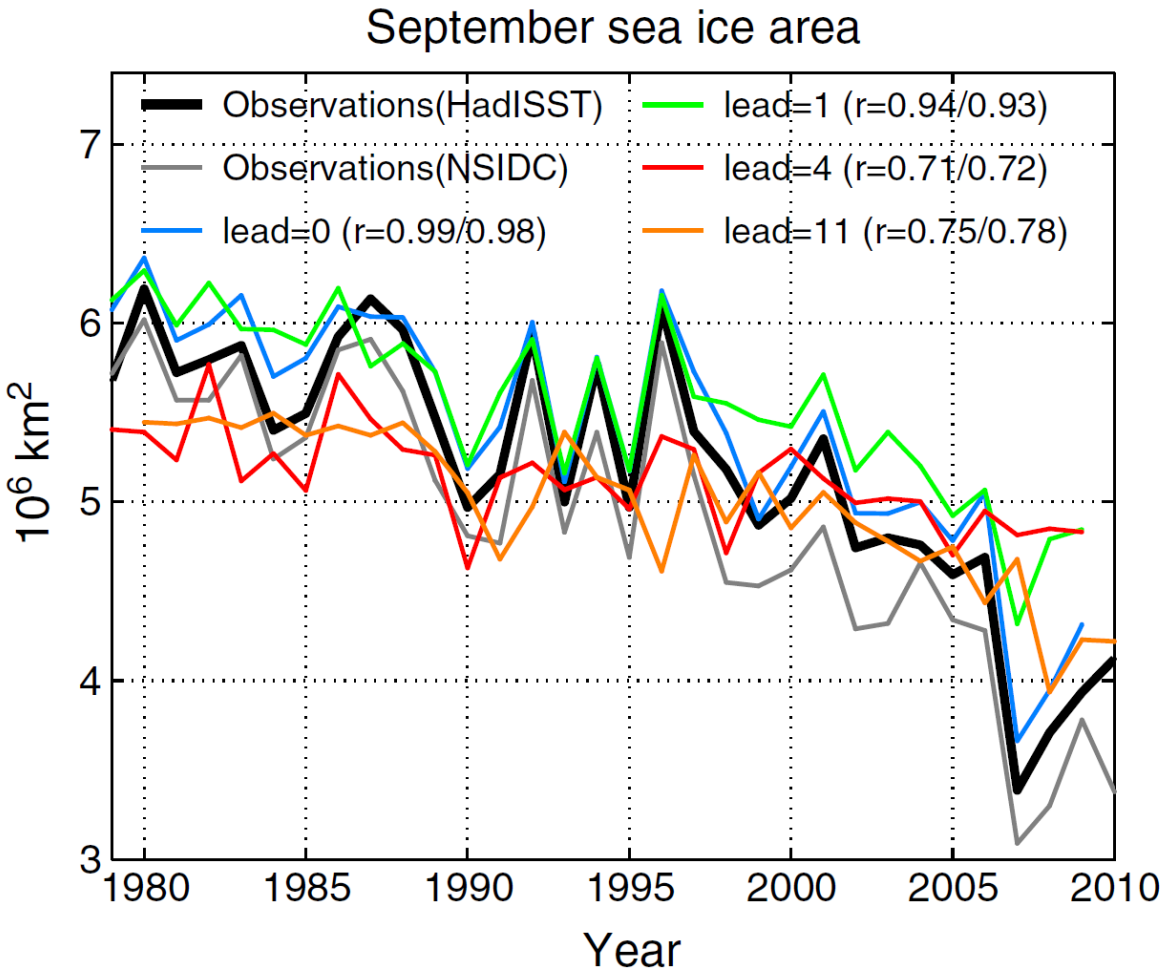
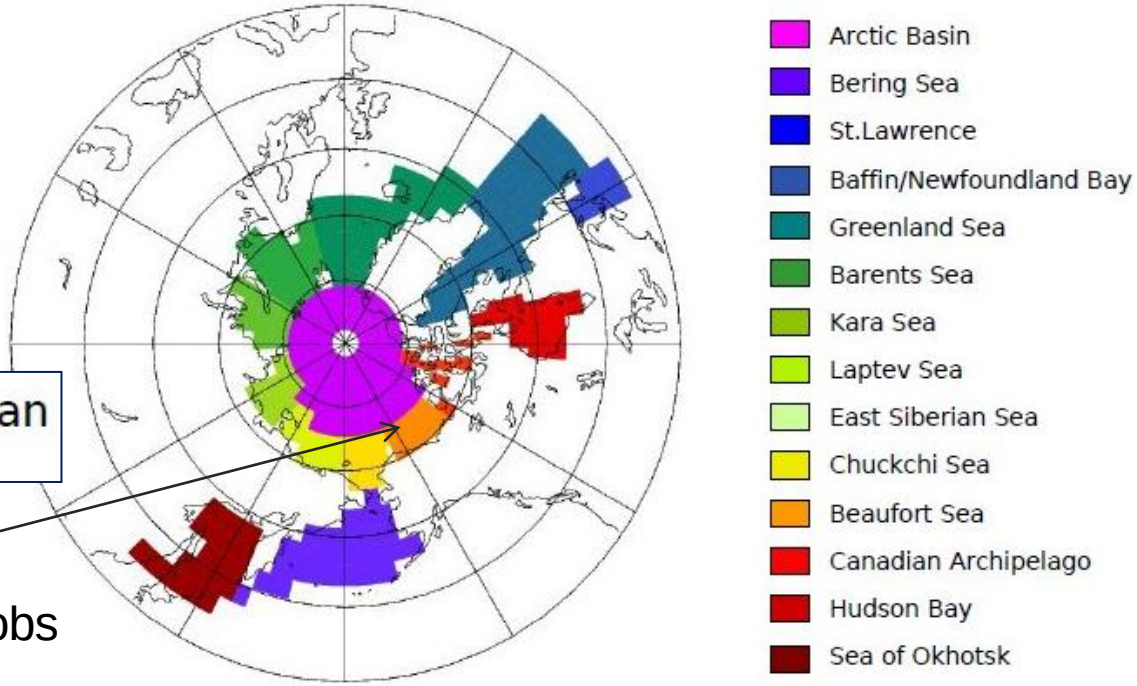


Project: evaluate CCCma/EC sea ice seasonal prediction skill for Arctic as a whole and 14 subregions

Results: Some skill (exceeding persistence) seen, mainly at shorter lead times. Opportunities for improving predictions identified.

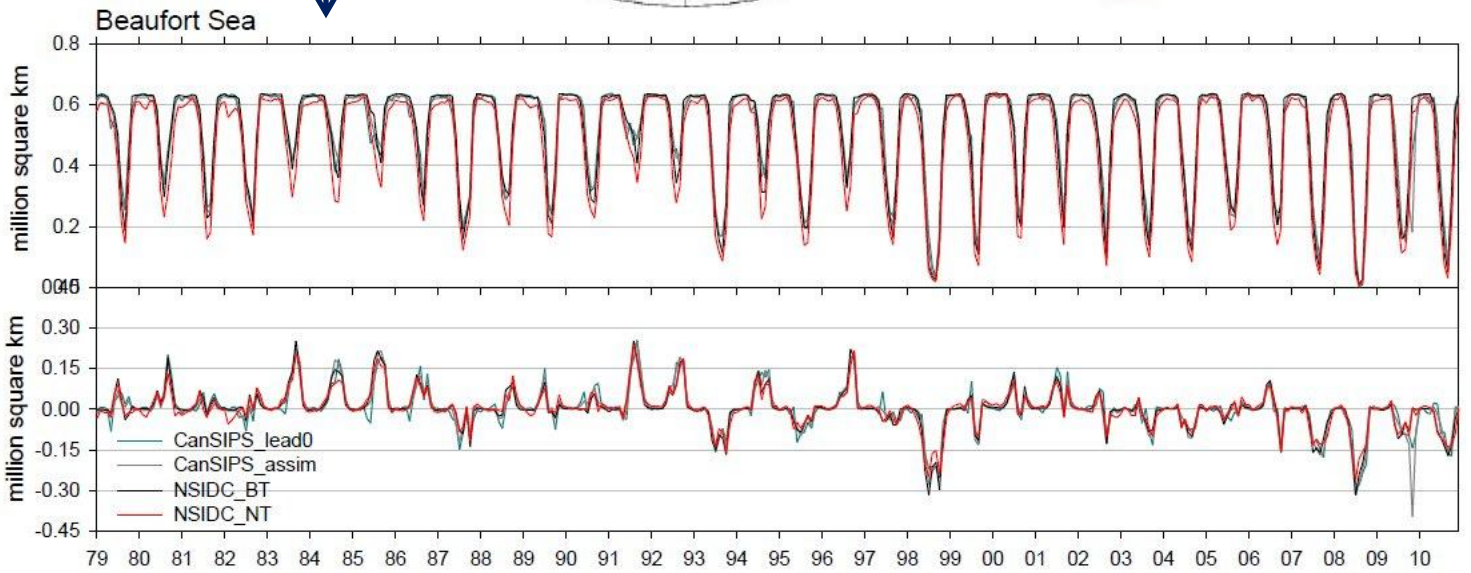


Subregions of the Arctic Ocean
as defined by the Navy/NOAA Joint Ice Center

Beaufort Sea ice area predictions (green) vs NASA obs (red/black), 1979-2011

total ice area

anomalies



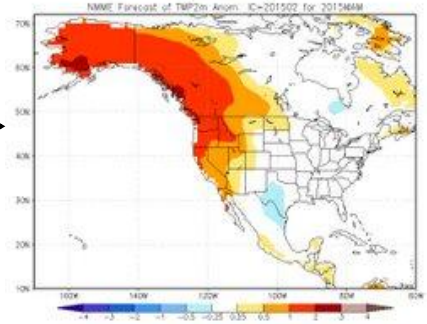
National Weather Service
Climate Prediction Center

NMME
The North American Multi-Model Ensemble

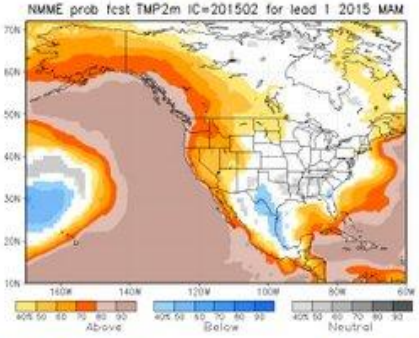
Real time NMME temperature forecast*: MAM 2015 from Feb 2015 initial conditions

Multi-model →

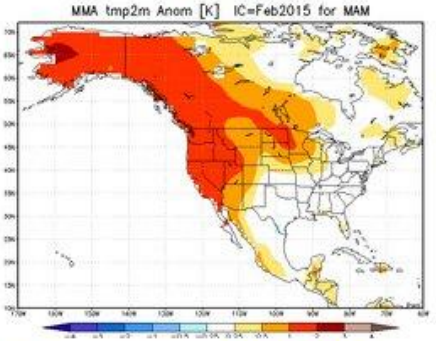
NMME



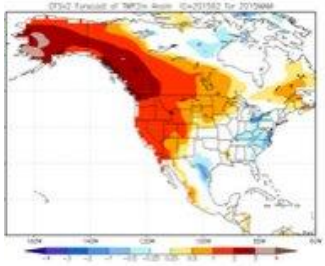
Prob fcst



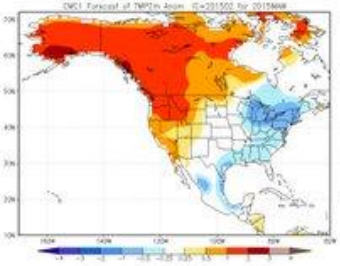
IMME



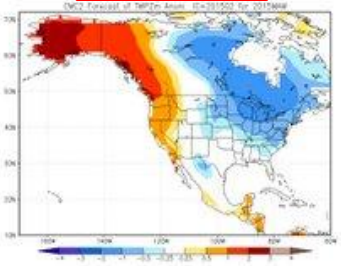
NCEP CFSv2



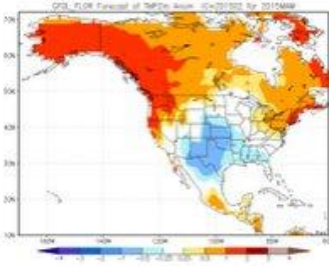
CMC1 CanCM3



CMC2 CanCM4

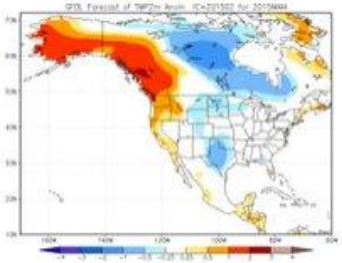


GFDL FLOR

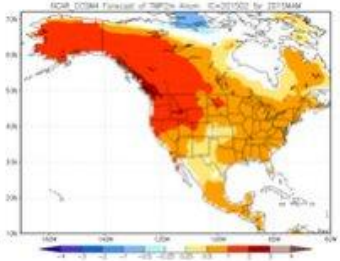


Individual models ↗ →

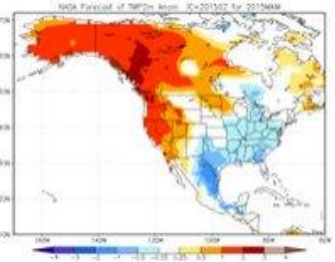
GFDL CM2.1



NCAR CCSM4



NASA GEOS5



*global maps also available

NMME Phase 2 Hindcast Data at NCAR

- ***Common 1° grid***
- ***NetCDF4***
- ***Available 2014-15***

Daily atmospheric and land surface fields (22)

Variable	Var. Name
Surface temperature (SST+land)	Ts
2m T daily max	Tasmax
2m T daily min	Tasmin
Mean sea level pressure	Psl
Snow water equivalent	swe
Total soil moisture	Mrsov
Total precipitation*	prlr
Downward surface solar	Rsds
Downward surface longwave	Rlds
Net surface solar	Rss
Net surface longwave	Rls
Top net solar	Rst
Top net longwave	Rlt
Surface latent flux	Hflsd
Surface sensible flux	Hfssd
Surface stress (x)	Tauu
Surface stress (y)	Tauv
2m temperature	Tas
Total cloud cover	Clt
10m wind (u)	Uas
10m wind (v)	Vas
Surface specific humidity	huss

Daily atmospheric pressure level fields (5)
Provided at 850, 500, 200, 100, 50 hPa

Variable	Var. Name
Geopotential	G
Temperature	Ta
Zonal velocity	ua
Meridional velocity	va
Specific humidity	hus

Monthly sea ice fields (2)

Variable	Var. Name
Sea ice concentration	sic
Sea ice thickness	sit

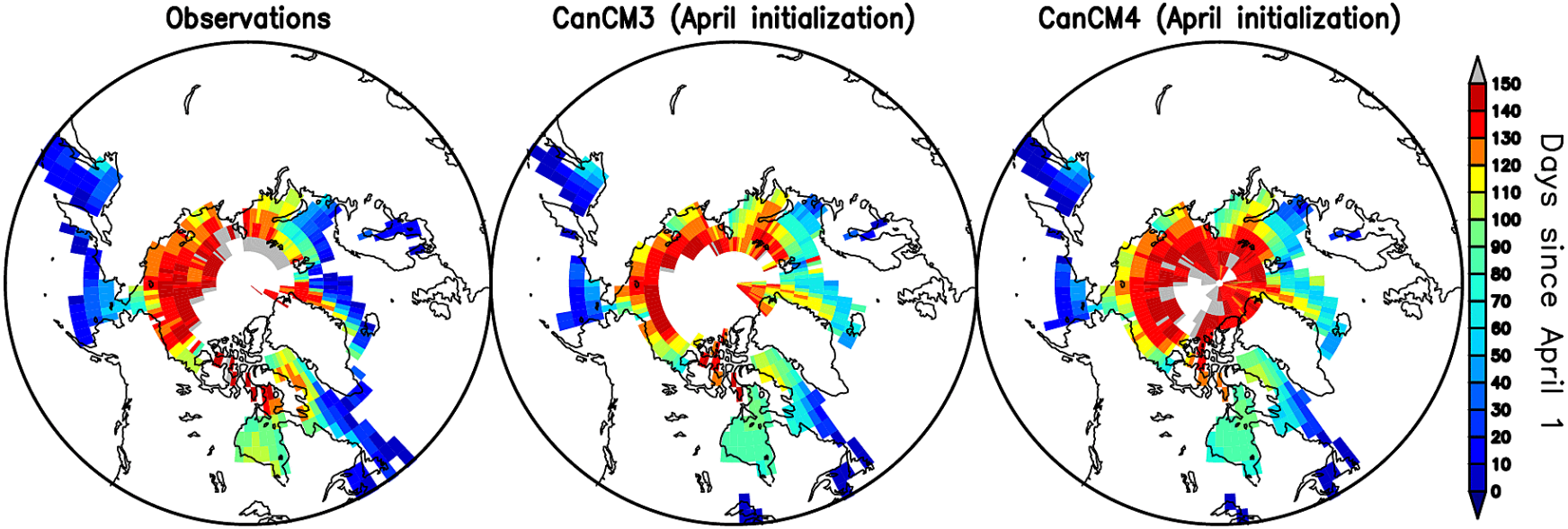
Monthly ocean fields (7)
3D ocean fields thetao/so/uo/vo/wo are provided at
125.0, 150.0, 200.0, 250.0, 300.0, and 400.0 m

Variable	Var. Name
Potential temperature	thetao
Salinity	so
Zonal velocity	uo
Meridional velocity	vo
Vertical velocity	wo
Sea level	zoh
Mixed layer depth	zmlo

Skill evaluation sea ice melt/freeze dates

- Previous studies focussed on area-averaged sea ice quantities
- Sea ice melt/freeze up dates much more relevant for stake holders (shipping, resource extraction, etc.)
- First study to evaluate skill in a dynamical seasonal forecasting system

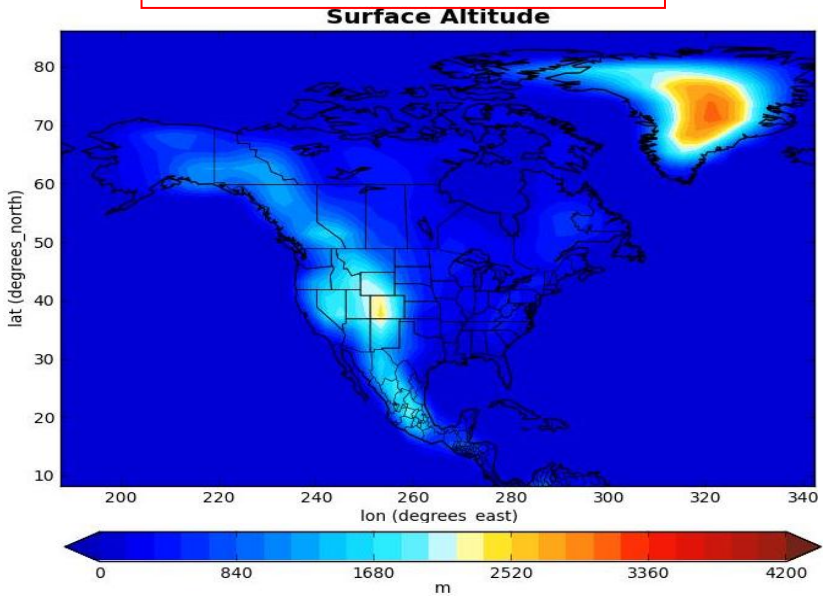
Climatology Ice free date (1979-2010)
(locations with melt date in any number of years)



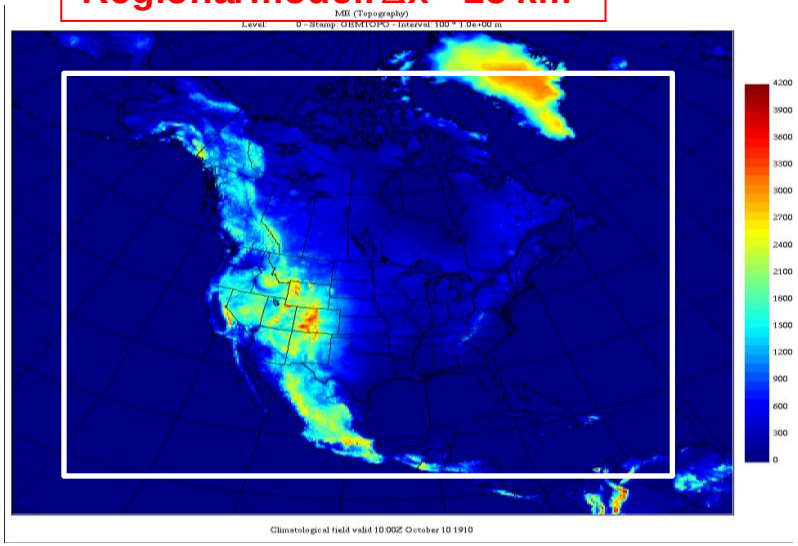
Downscaling of seasonal forecasts

- Project underway to downscale EC/CCCma seasonal forecasts from ~300km global model resolution to ~25km using CanRCM4 regional model
- Domain includes most of North American Arctic, Beaufort Sea

Global model: $\Delta x \approx 300$ km



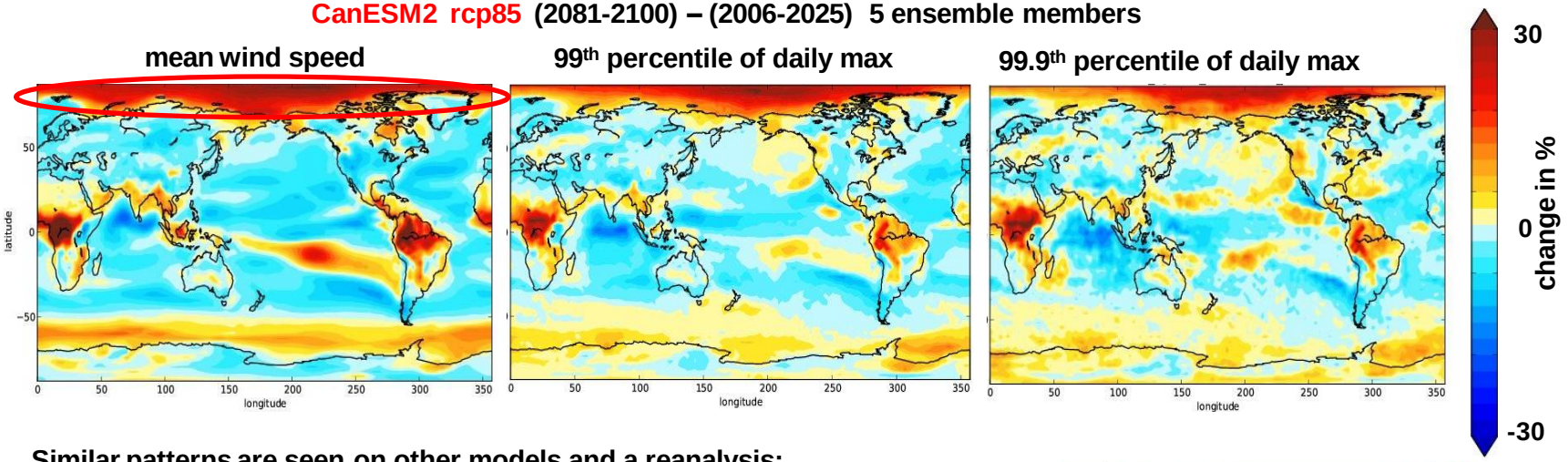
Regional model: $\Delta x \approx 25$ km



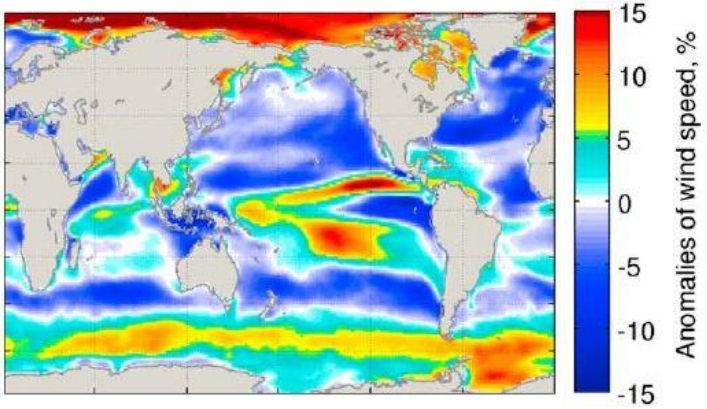
- Another project, at the Canadian Ice Service, is developing statistical downscaling methods to assess the ability to forecast more site-specific conditions (like dates of opening or closing of passages).

Modelled and observed Arctic wind speed changes

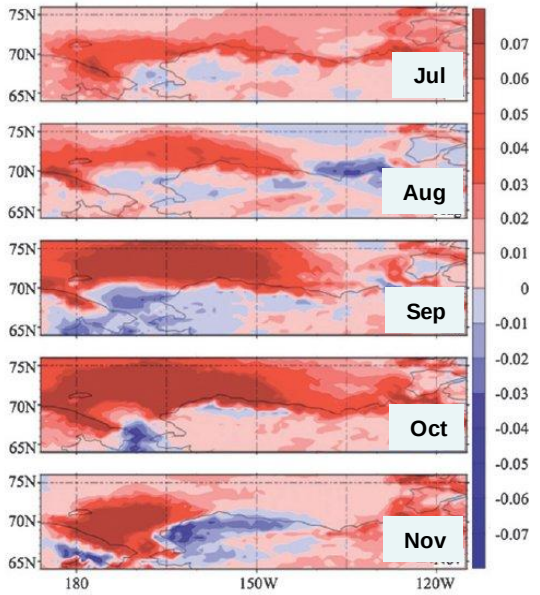
CanESM2 rcp85 (2081-2100) – (2006-2025) 5 ensemble members



Similar patterns are seen on other models and a reanalysis:



Dobrynin et al. GRL 2012 EC-EARTH

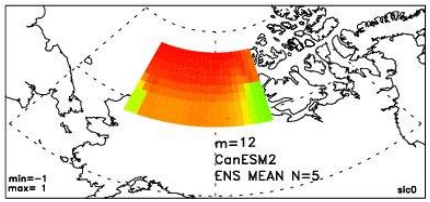


Stegall & Zhang J. Clim. 2012 NARR

→ **Arctic wind speed changes due to … increased storminess?**
or change in circulation?
or ?

CMIP5 Dataset for BREA/Polar Data Catalogue

- Interpolate model values to common grid in the Beaufort Sea region:



- Wind variables: Daily u = zonal wind
  v = meridional wind
  sfcWind = wind speed
  sfcWindmax = max wind speed
- Sea ice variables: Daily usi = zonal ice velocity
  vsi = meridional ice velocity
  sic = ice concentration
  sit = ice thickness
- Pressure: 6-hourly psl = sea level pressure
- 14 CMIP5 models:

CanESM2	HadGEM2-ES	MIROC-ESM-CHEM
CSIRO-MK3-6-0	INMCM4	MPI-ESM-LR
GFDL-ESM2G	IPSL-CM5A-LR	MPI-ESM-MR
GFDL-ESM2M	IPSL-CM5A-MR	MRI-CGCM3
HadGEM2-CC	MIROC5	

- historical/rcp45/rcp85