Arctic-Subarctic Ocean Fluxes from the Regional Arctic System Model

(work in progress)

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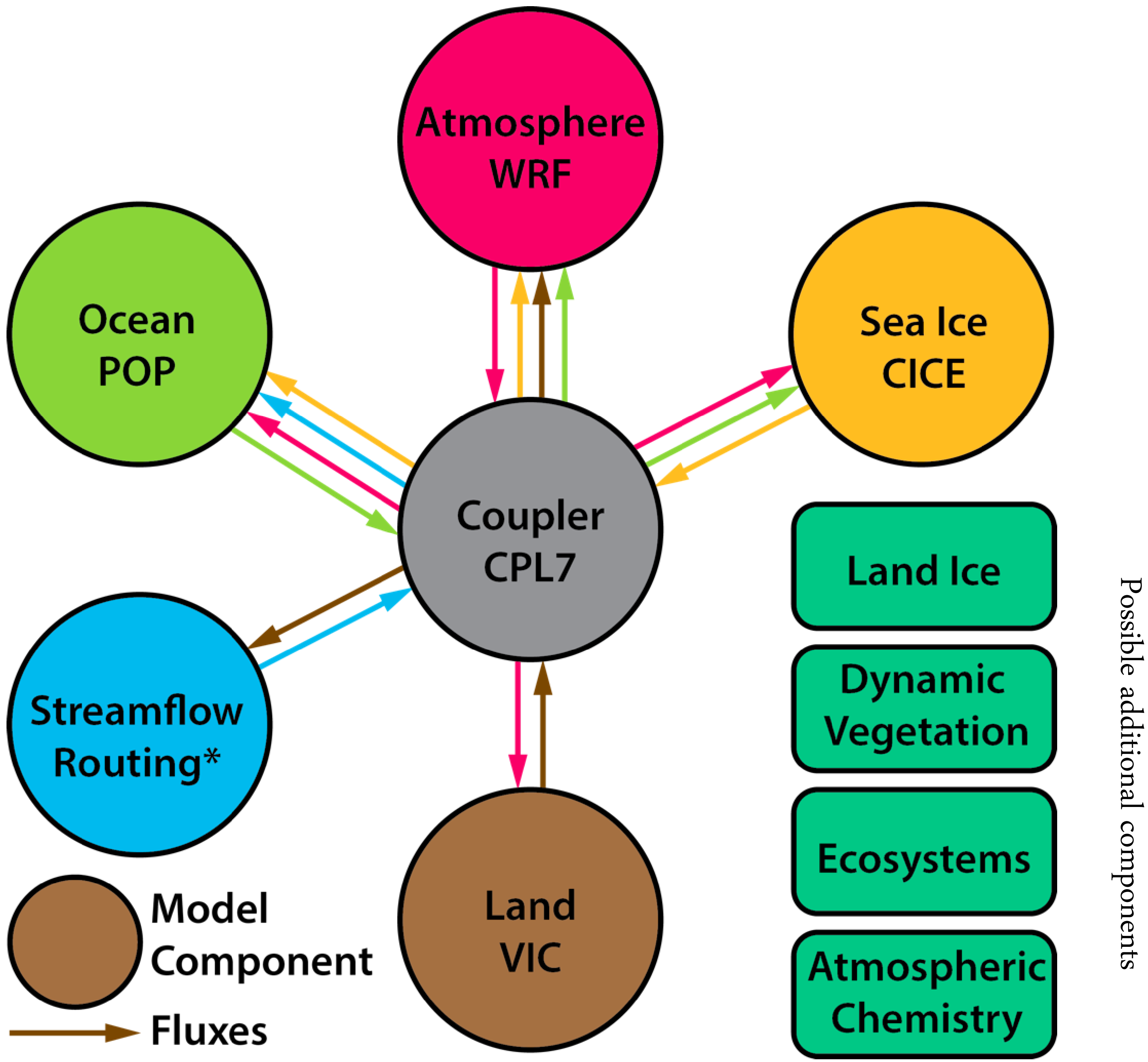
<http://www.oc.nps.edu/NAME/name.html>

OMWG, Boulder, CO, 16-17 January, 2014

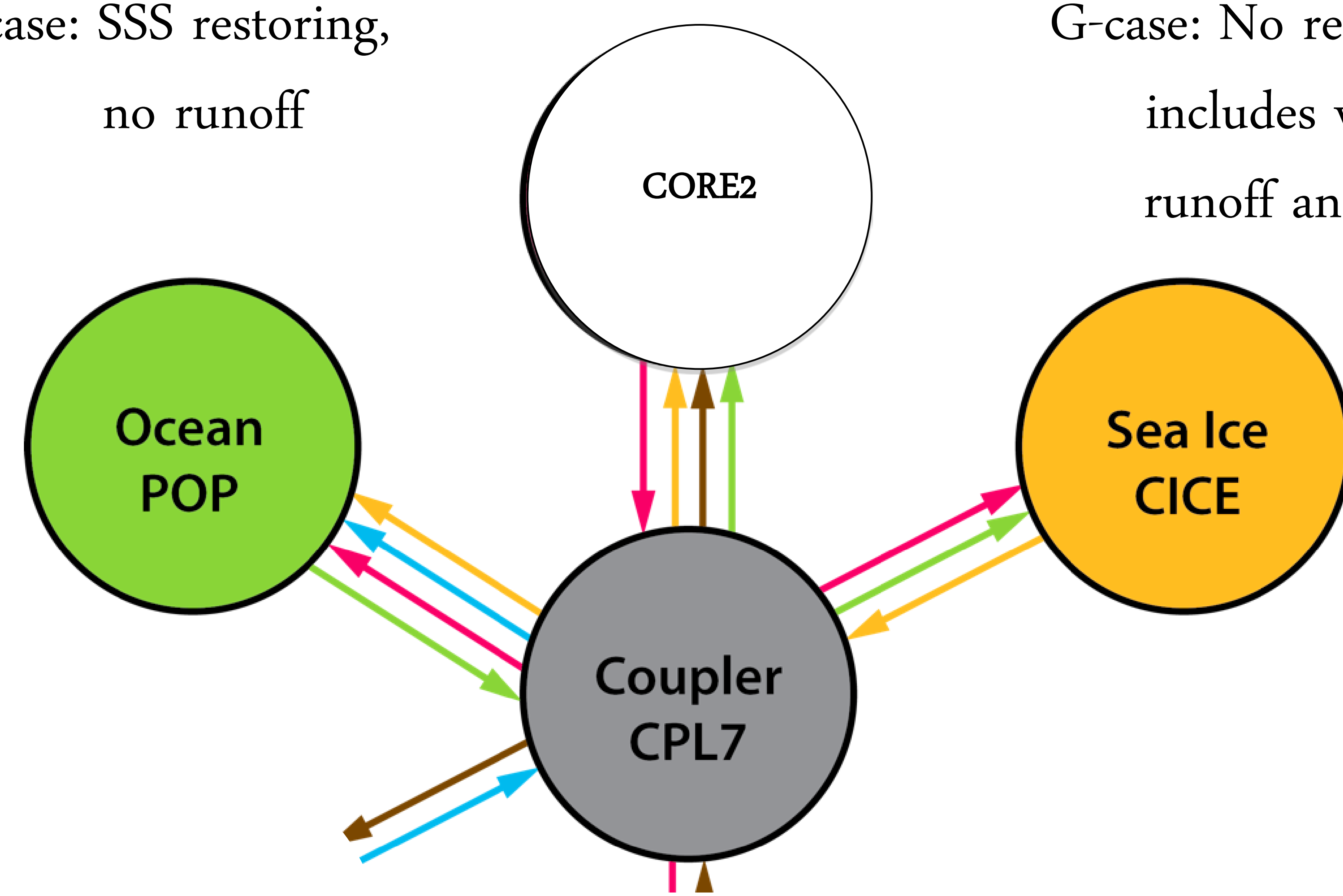
RASM wiring diagram



RASM H/G-case wiring diagram

H-case: SSS restoring, no runoff

G-case: No restoring, includes variable runoff and precip

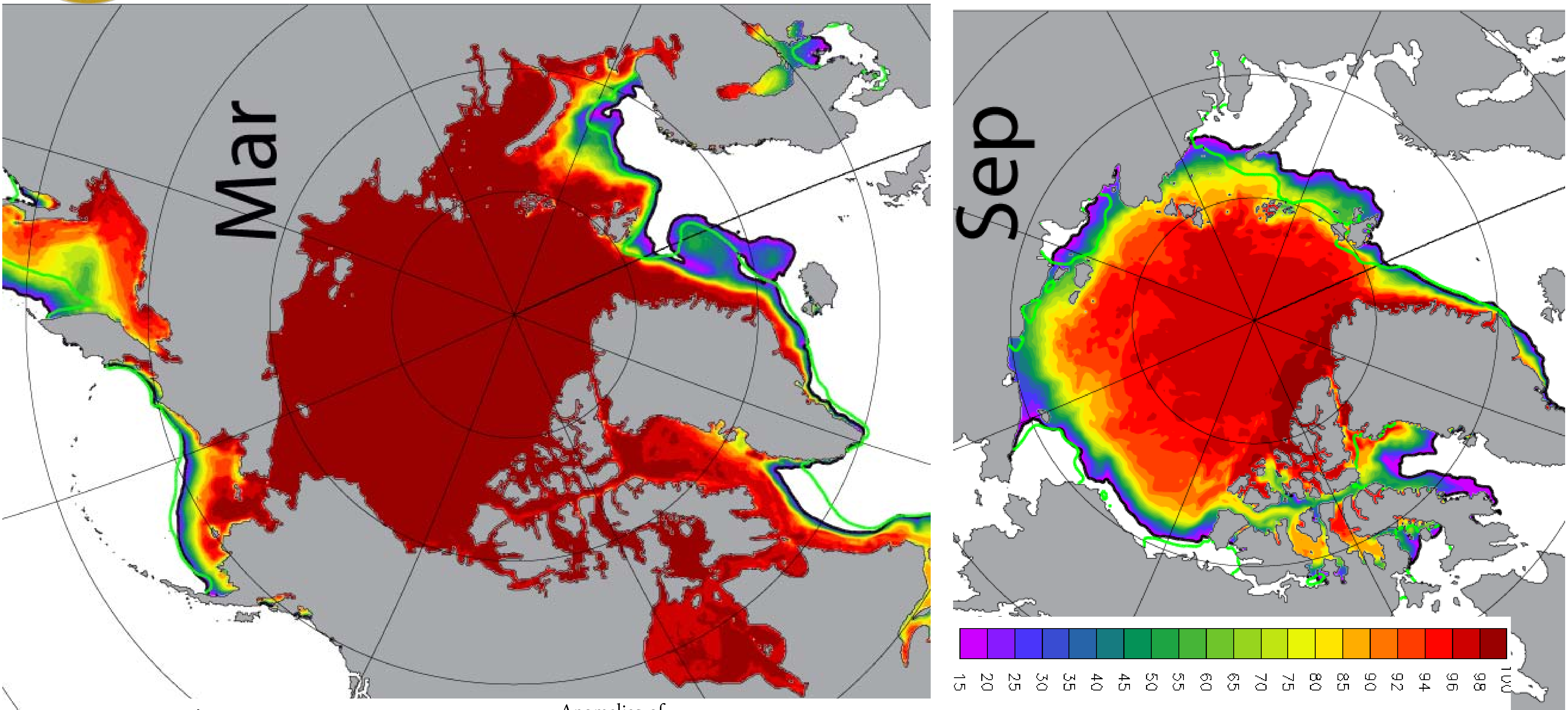


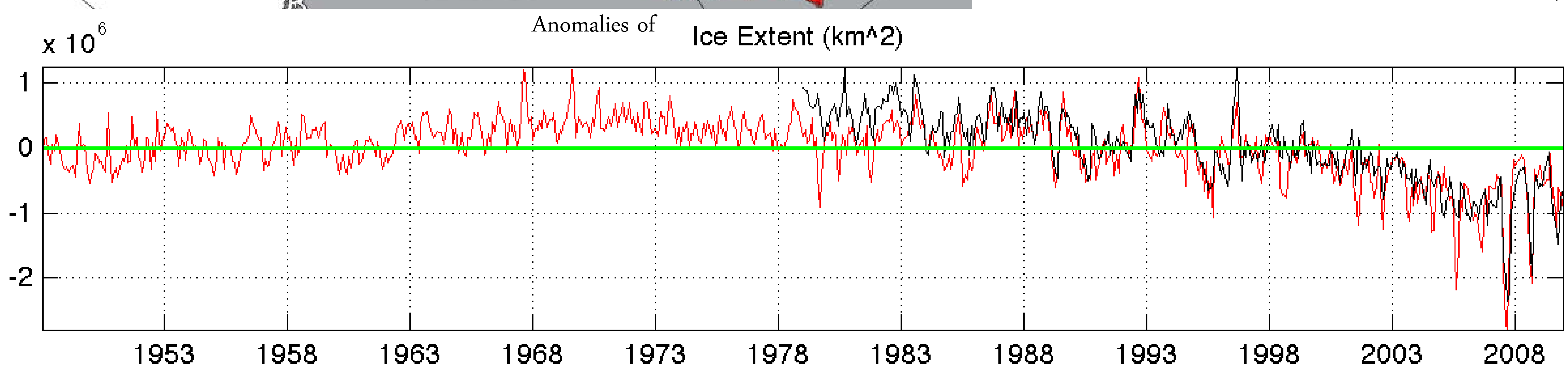
Motivation:

1. Evaluate ice-ocean simulations with atmospheric realistic forcing
2. Understand parameter sensitivity to changing spatial resolution
3. Optimize paramater space in sea ice / ocean and coupling between components
4. Provide guidance for fully coupled high-resolution regional and global climate model simulations

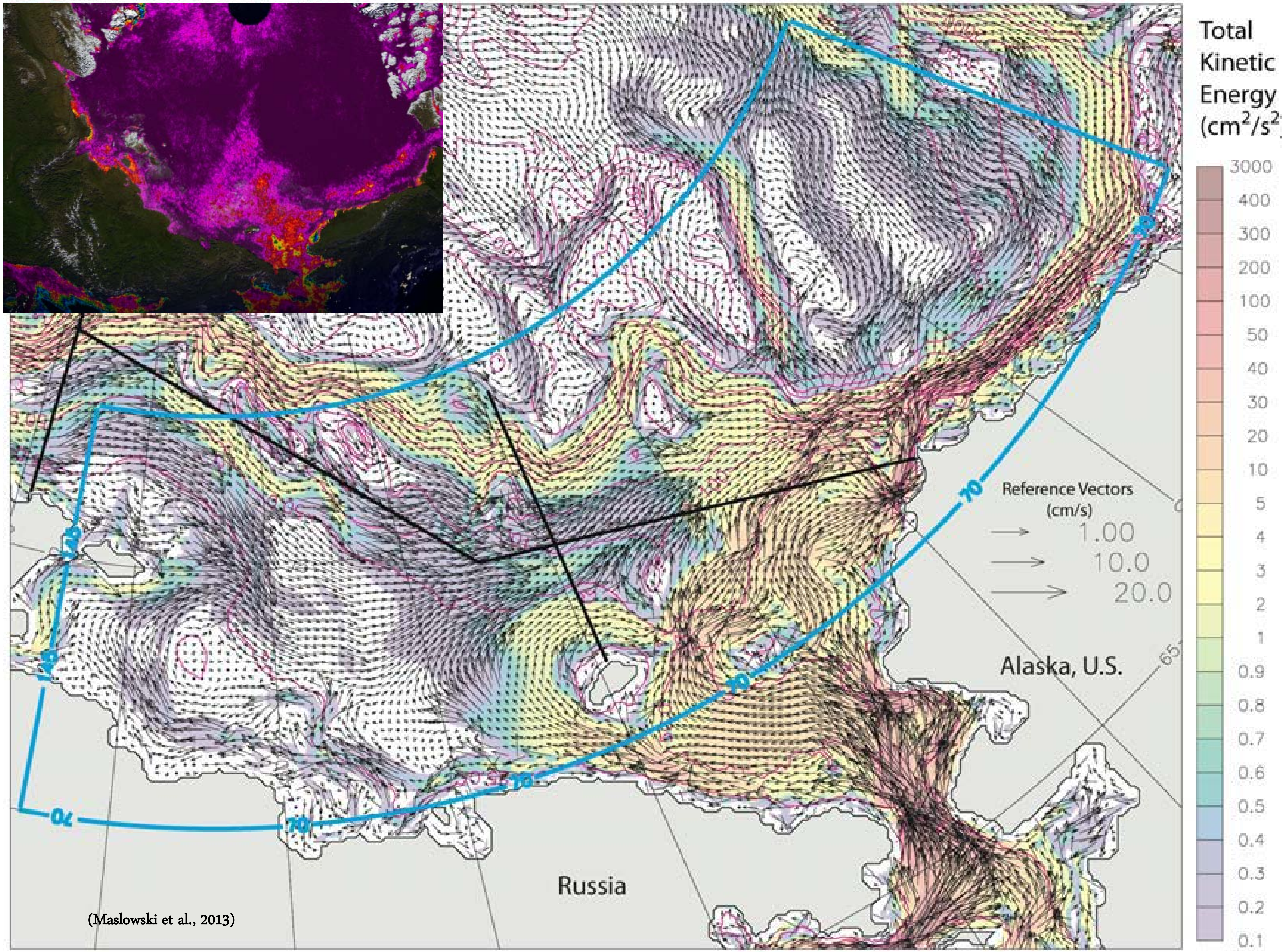
RASM-H sea ice analyses with observations

RASM 1979-1999 mean sea ice concentration and sea ice extent (black) vs SSM/I extent (green)





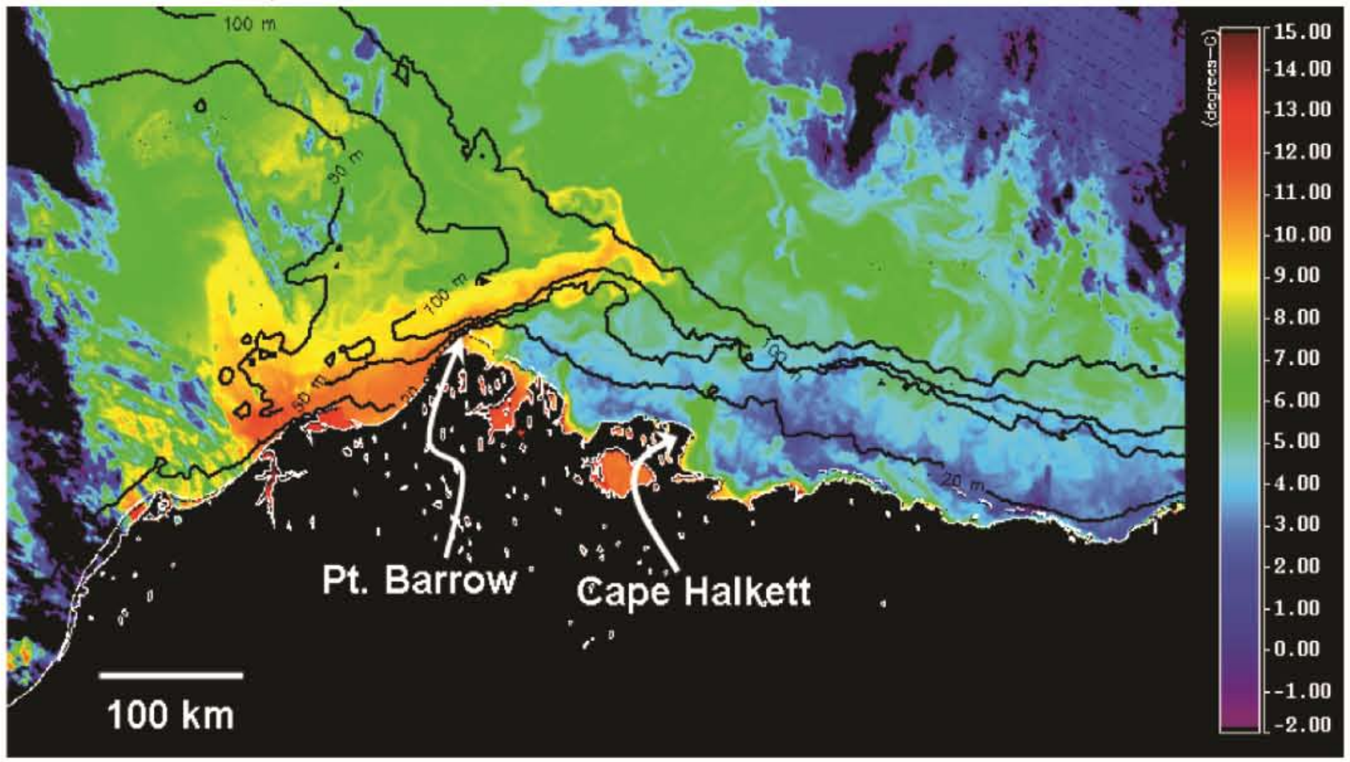
Time-Mean Ocean Circulation in the Western Arctic

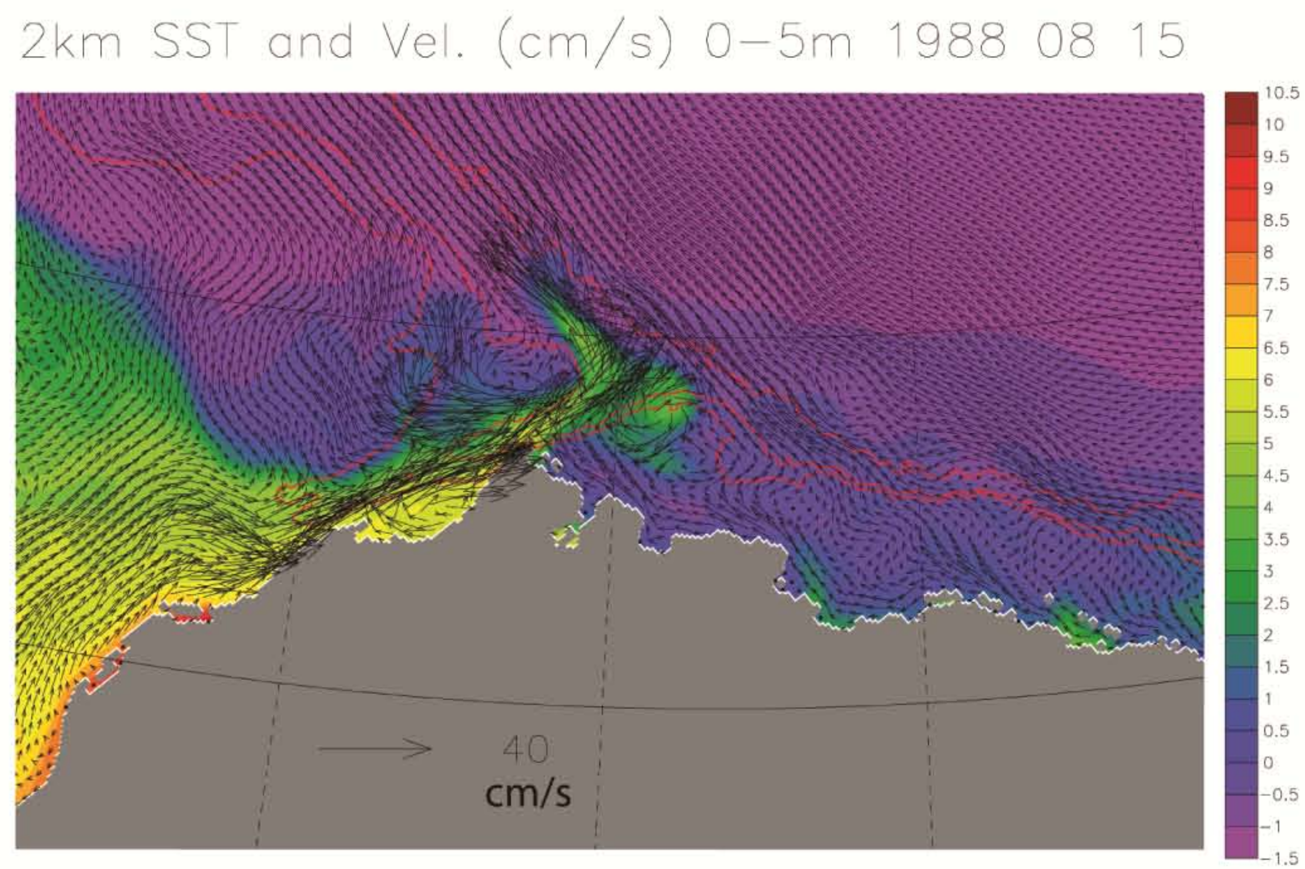


(Maslowski et al., 2013)

Ice-albedo versus ocean circulation

MODIS sea surface temperatures for 10 August 2007, 2335 UT. Vector-averaged winds for the 24-hour period preceding the image acquisition were from the east-southeast at 4.1 m s^{-1}. Okkonen et al., 2009.



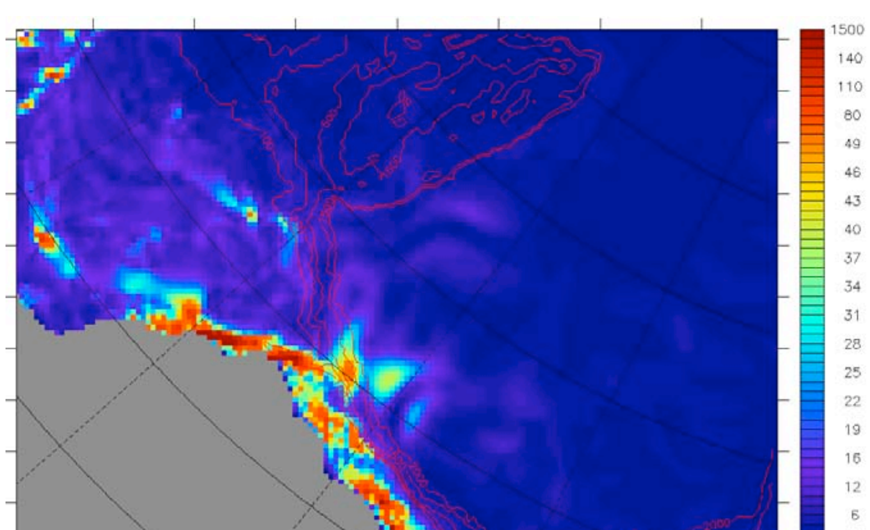


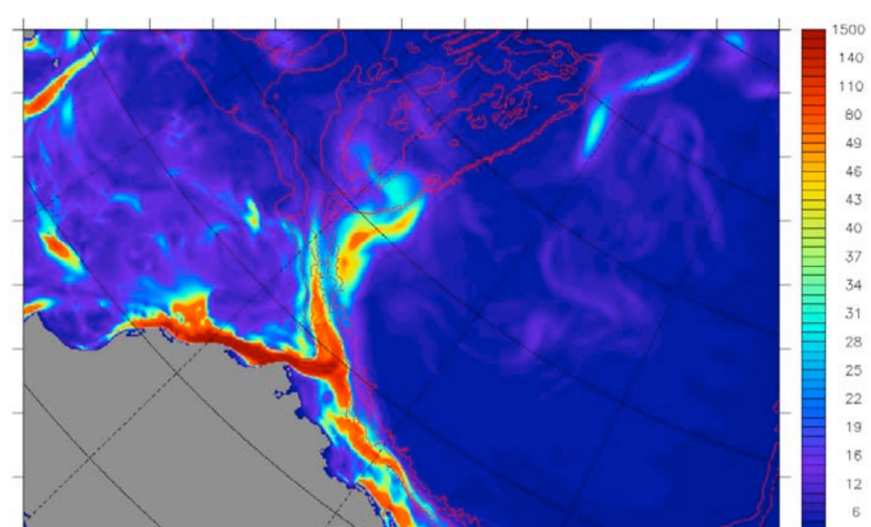
MODIS SST – 08/10/2007, 2335UT

Modeled SST and Velocity – 08/15/1988

(Maslowski et al., 2013)

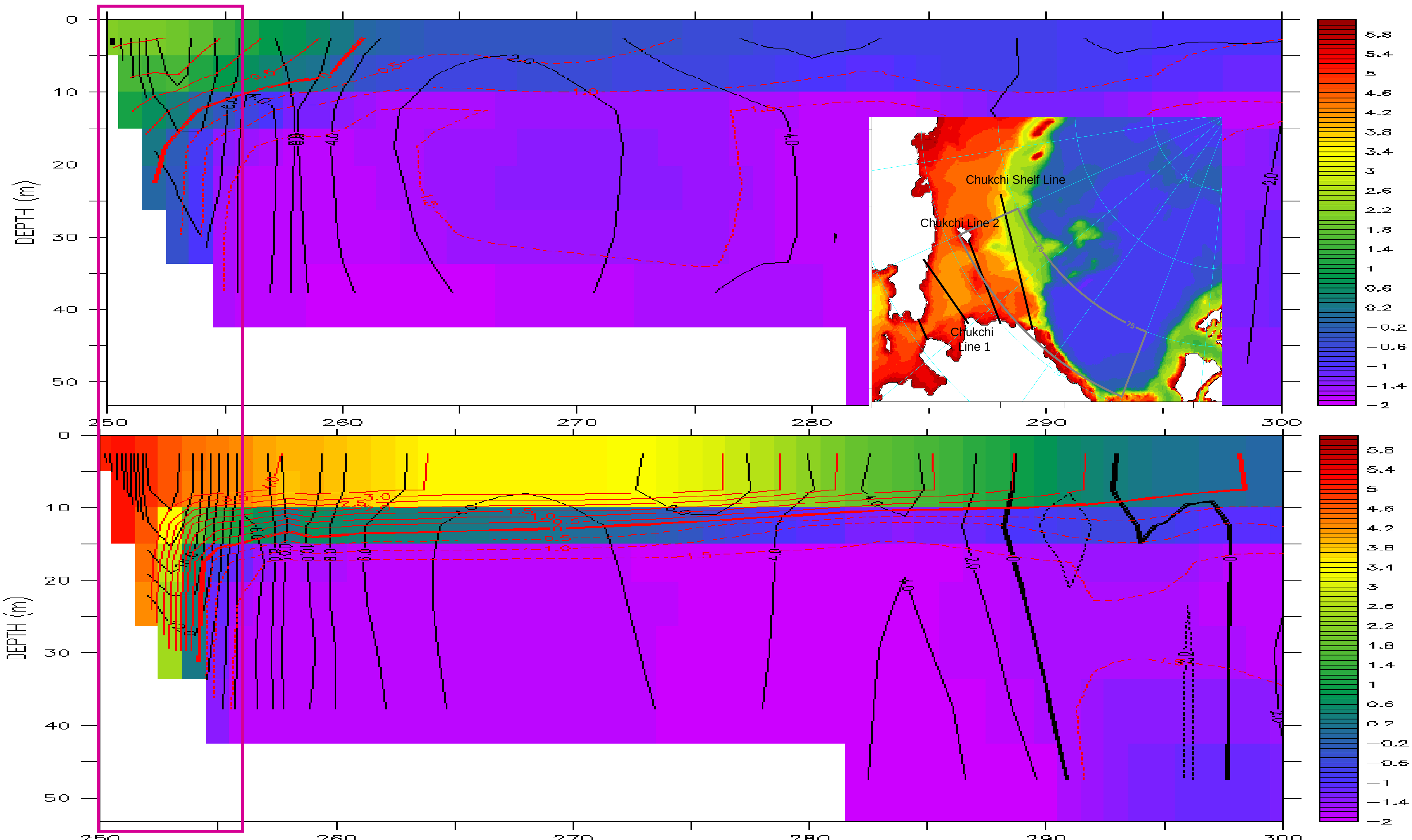
- Surface warming due to ice-albedo effect up to 7°C (local warming / limited flow)
- ACC carries water up to 13°C and it extends below the surface (strong advection)





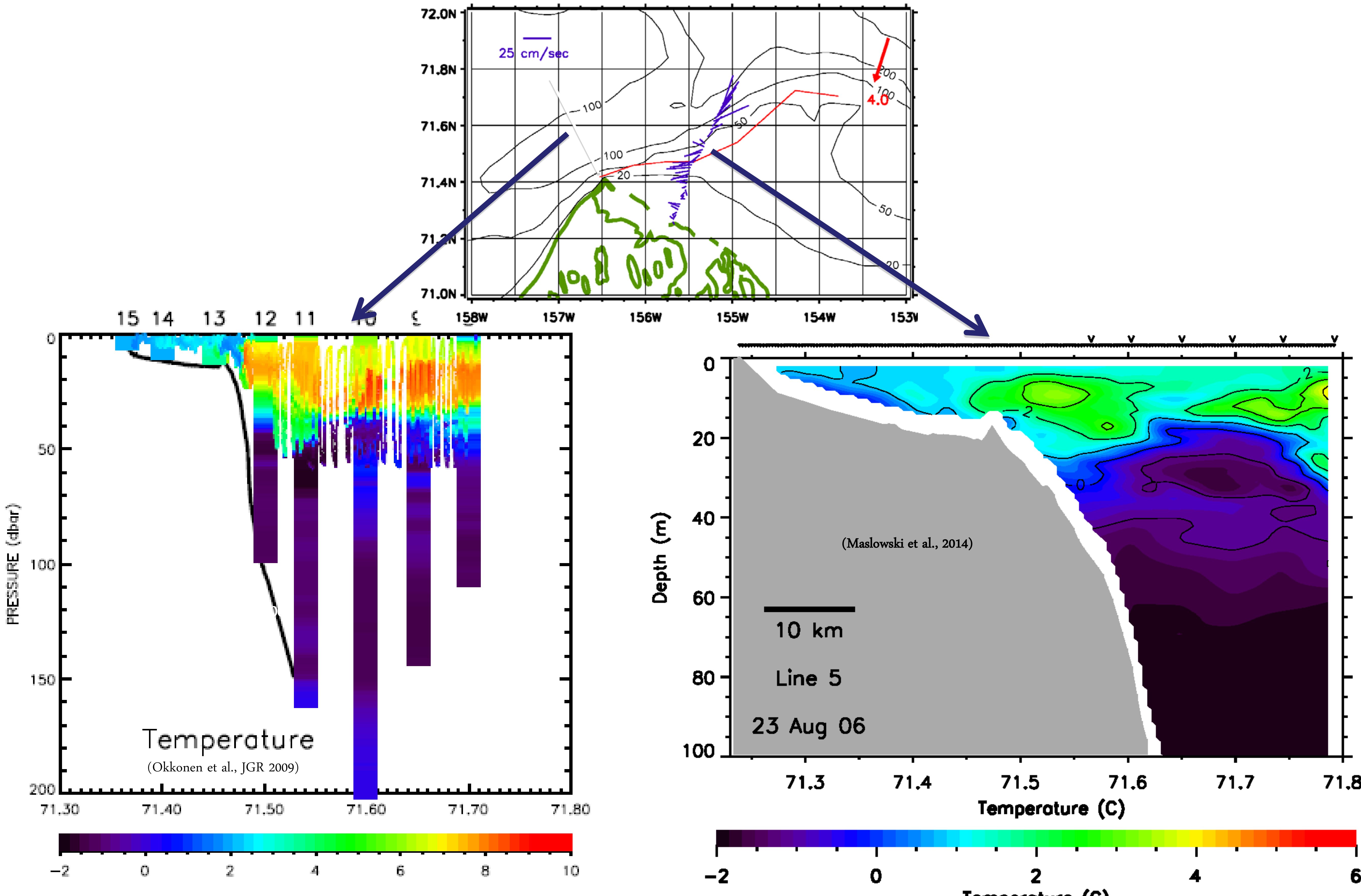
Mean summer (JAS) EKE in the upper 110m from 1/12° (left) and 1/48° (right) model

The importance of coastal currents: Alaska Coastal Current

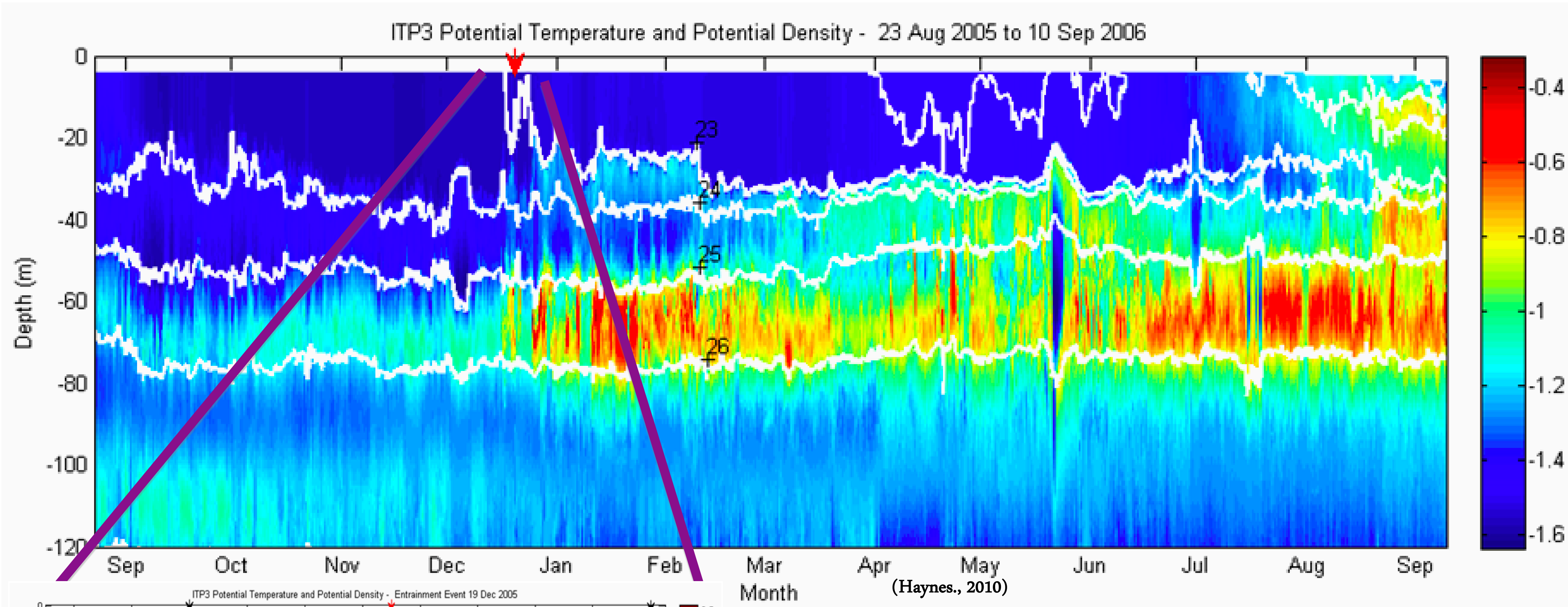


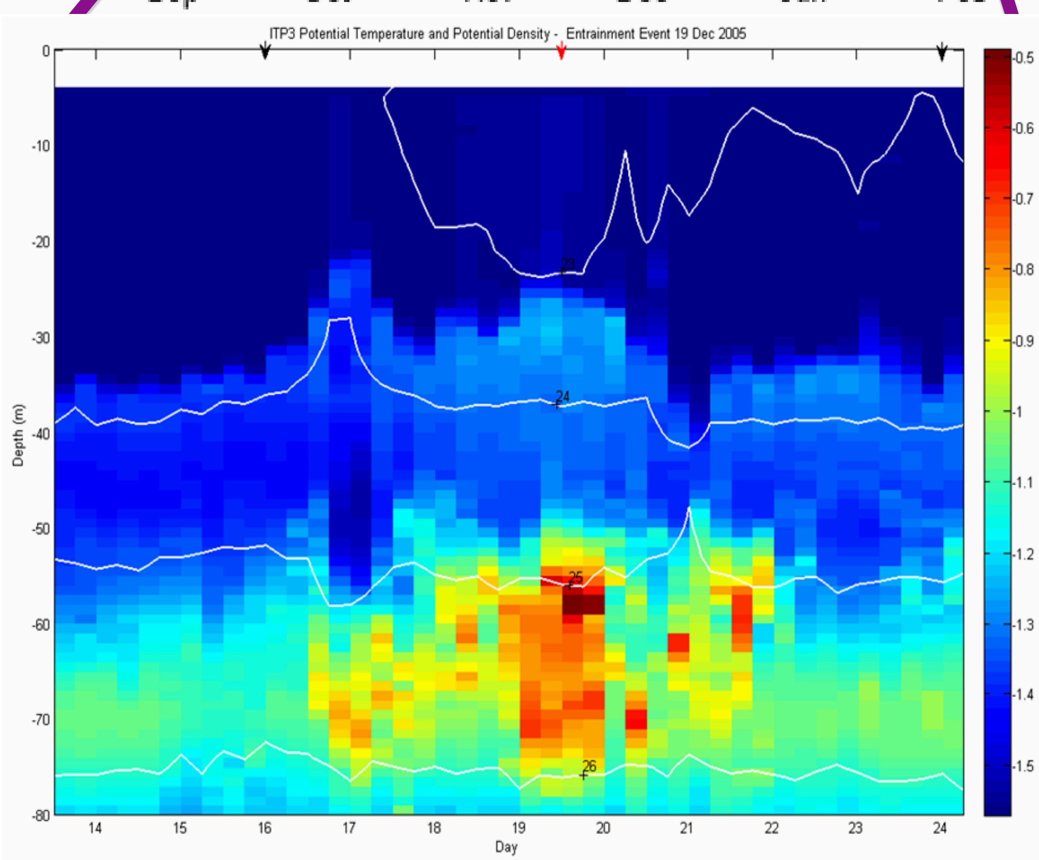
~67% of all oceanic heat from the Chukchi Sea is transported by the Alaska Coastal Current within 30-50 km along the coast

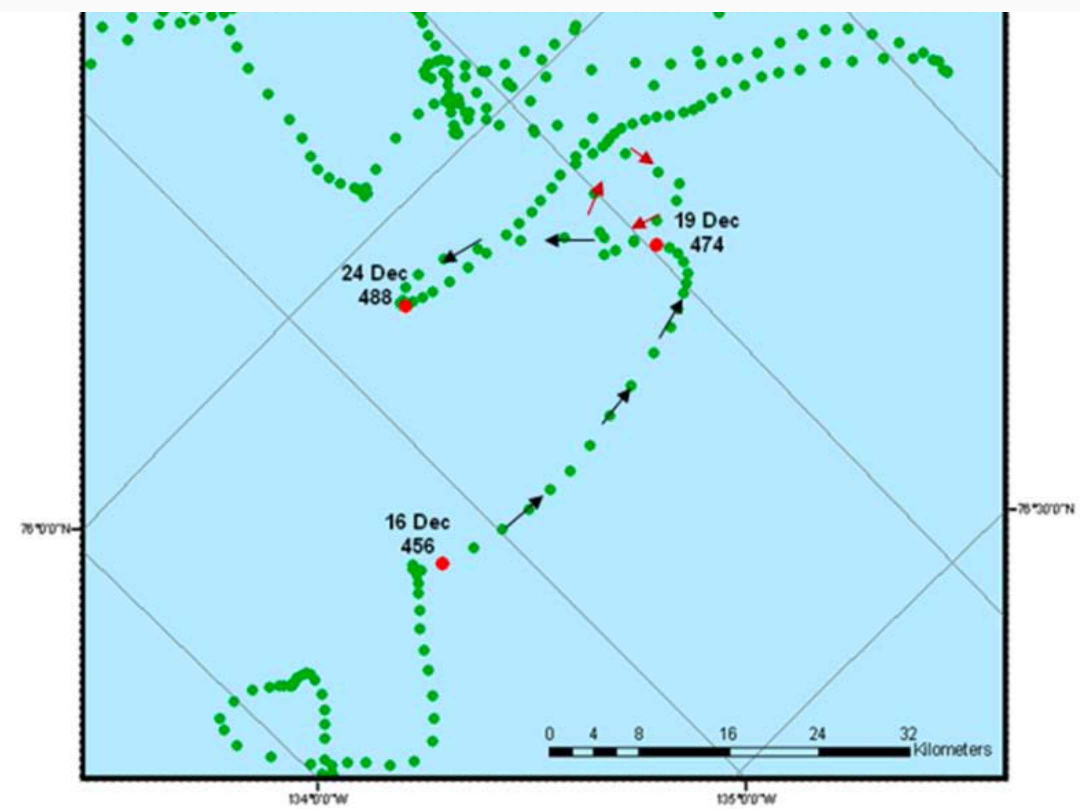
Oceanic advection and eddies transports heat (Pacific Summer Water) from the Chukchi Shelf towards and under the ice cover



Missing Heat Source - Arctic Upper Ocean Heat Content







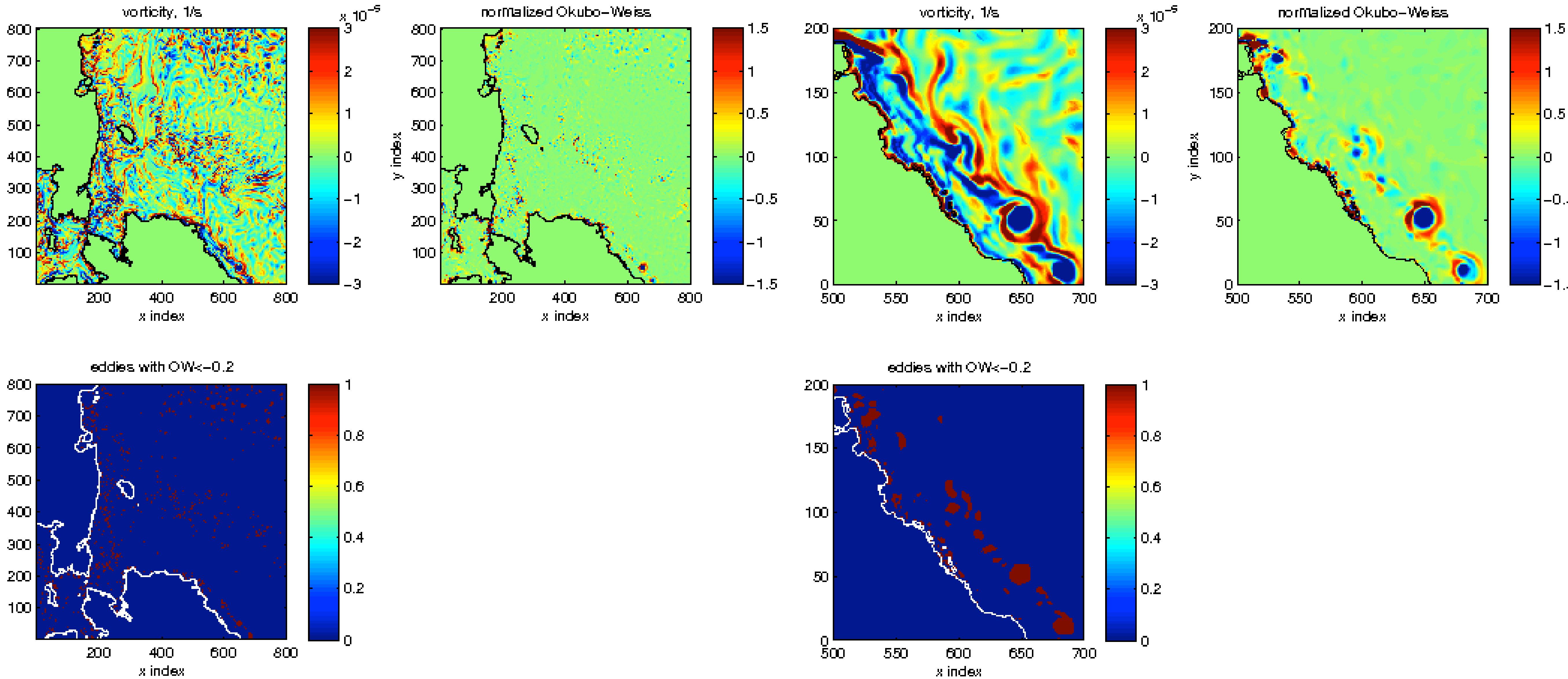
Oceanic heat in reality is removed only from the ocean mixed layer (10-40m) but not from the subsurface ocean (>40m)

Daily mean model output for 22 May 1983 for 9 km (top) and 2.3 km (bottom) models. Panels show EKE for depth 20 to 26m (left) and 65 to 80(81) m (right)

(Haynes., 2010)

Eddy diagnostics based on Okubo-Weiss parameter

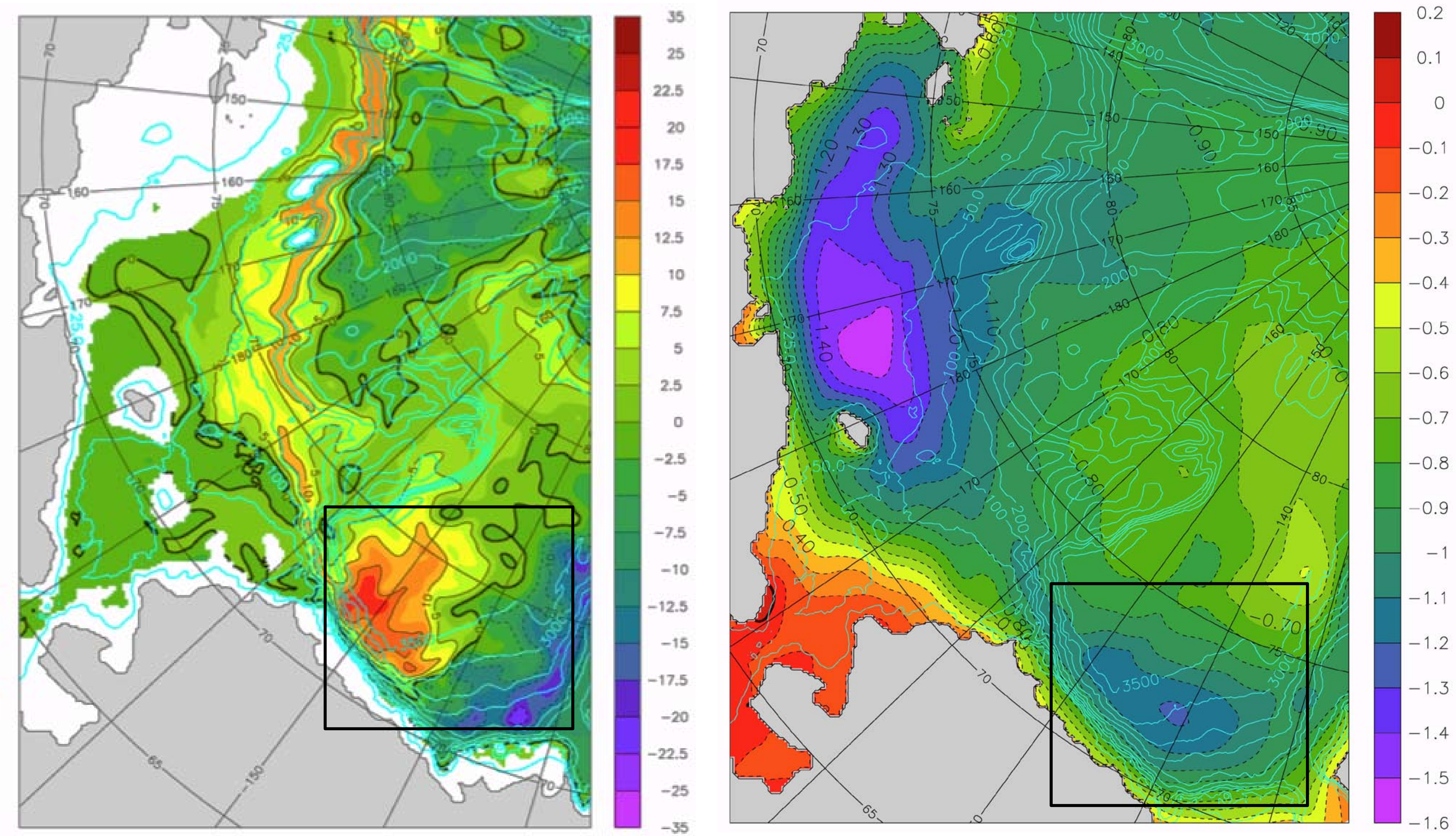
in 1/48° regional POP – 09/30/1983



Courtesy of

M. Petersen, S. Williams, M. Maltrud, M. Hecht, Los Alamos National Laboratory
B. Hamann, UC Davis

Modeled changes in (a) heat content (TJ) at depth 33-120 m and (b) sea ice thickness (m) between the mean of 1979-1998 and the mean of 1999-2004.

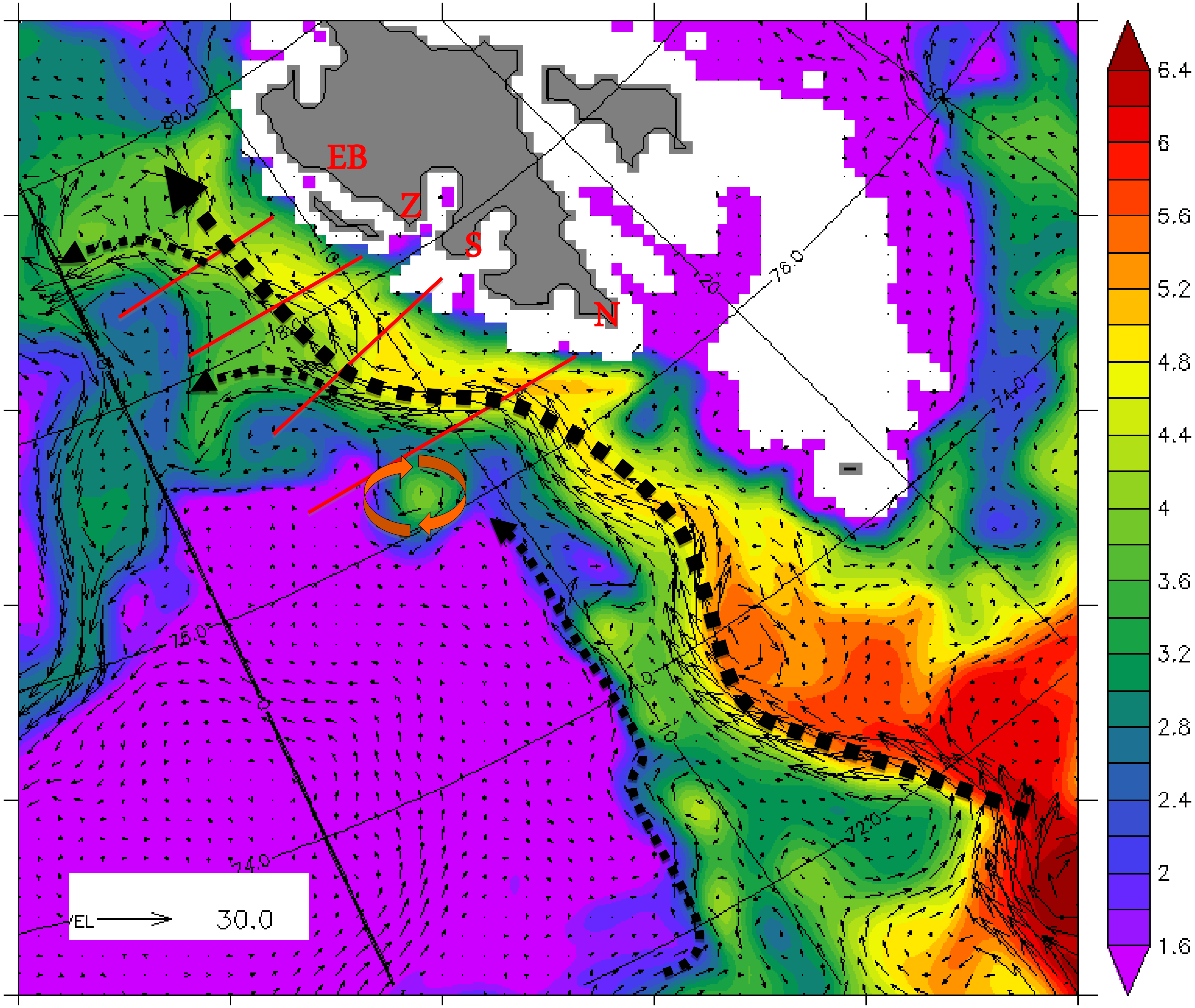


Increasing heat content due to local insulation, advection of warm water from shelves, anticyclonic eddies, slope upwelling or advection

(Maslowski et al, 2014)

Challenge of estimating Fram Strait / WSC transport

hly mean temperature (C deg) and velocity (cm/s) at 100m depth

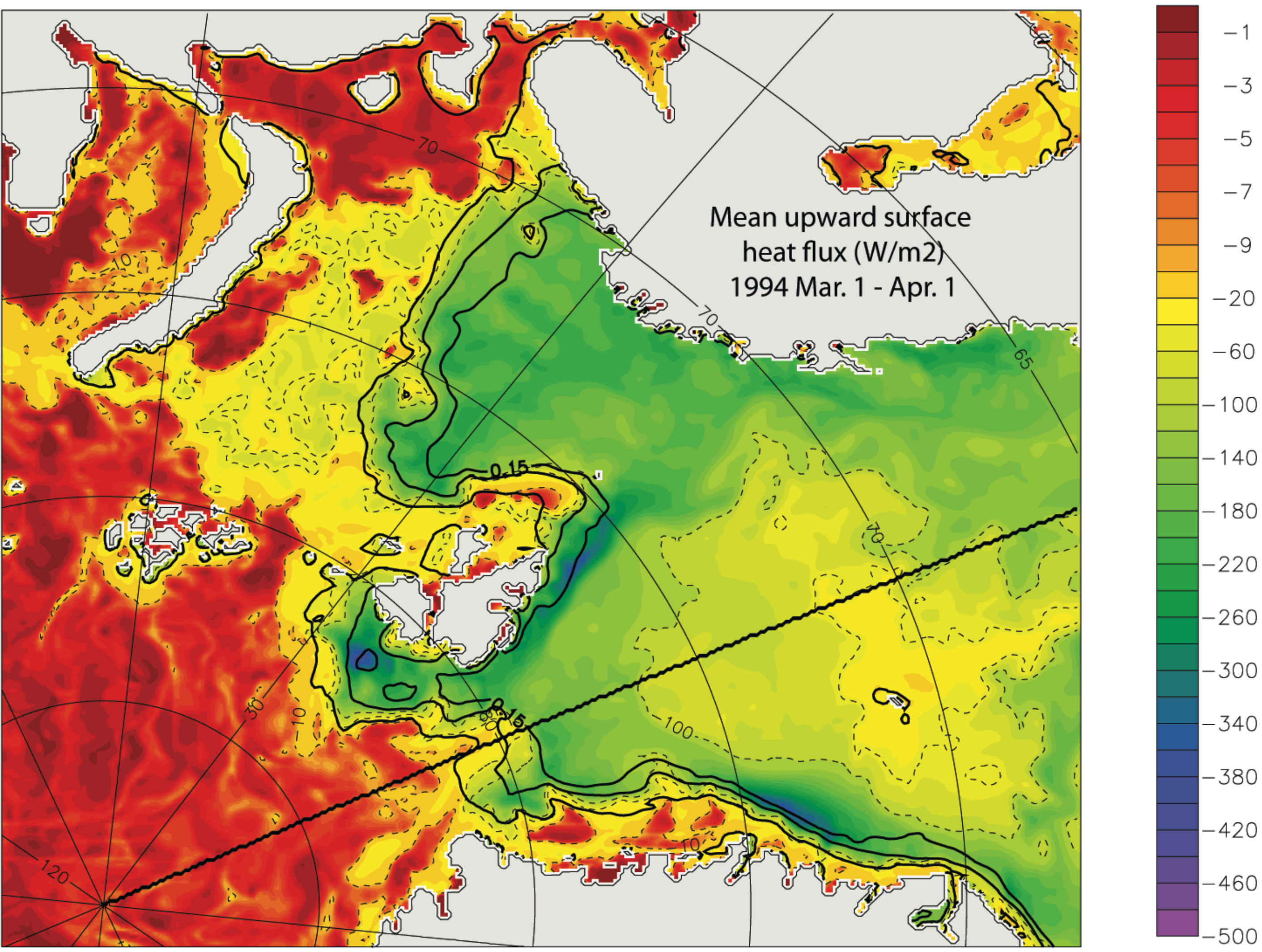


ADCP-referenced transport

Year	Net [Sv]
	TRANSECT N
2000	9.1±2
2002	9.1±2
	TRANSECT S
2000	8.5±1.5
2002	8.7±1.5
	TRANSECT Z
2000	5.9±1
2002	5.9±1

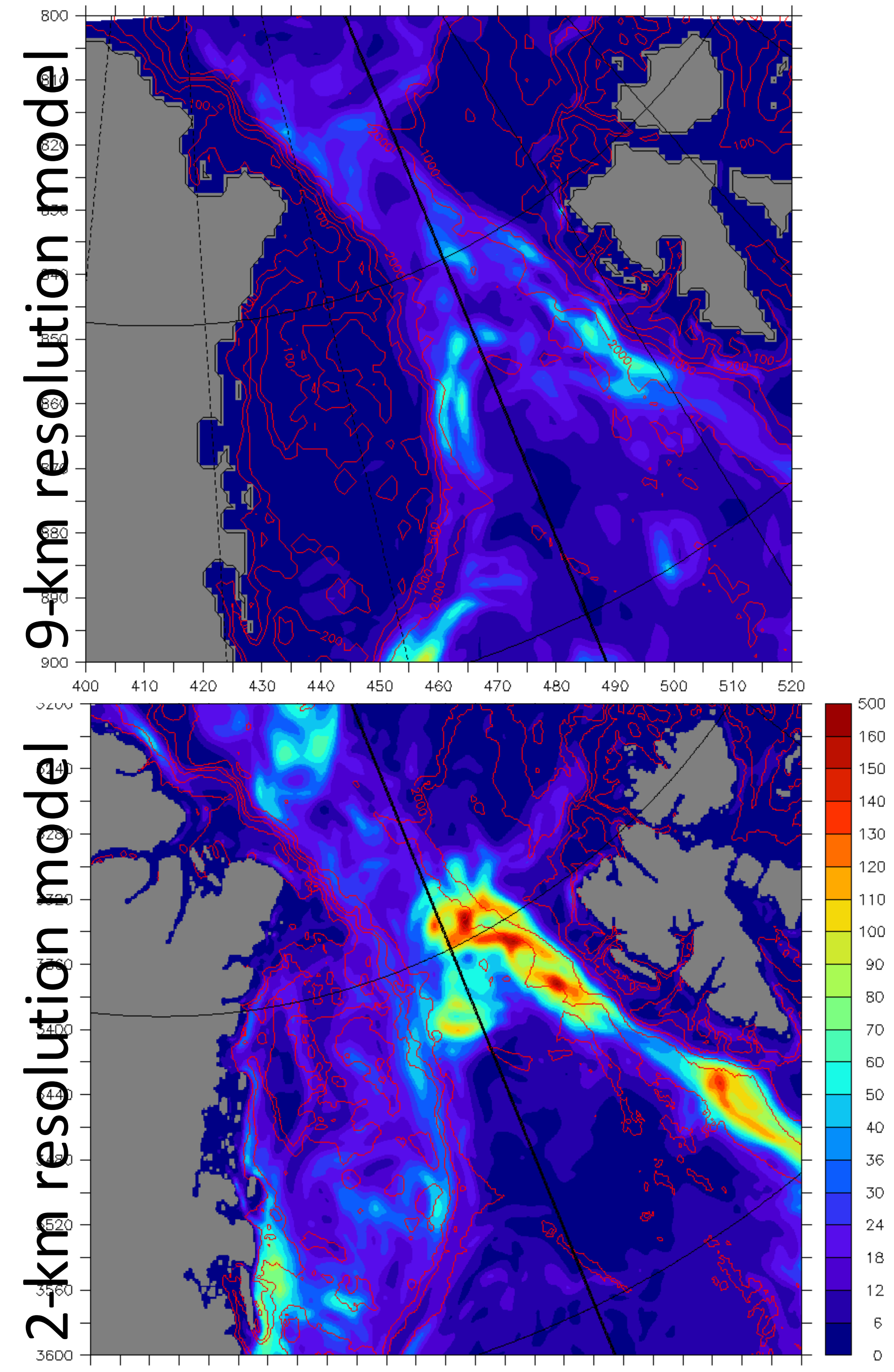
Osinski et al., 2003

RASM monthly mean upward sfc heat flux – 3/93 and mean EKE (cm^2/s^2; 0-223 m) – Fram Strait



(Maslowski et al., 2012)

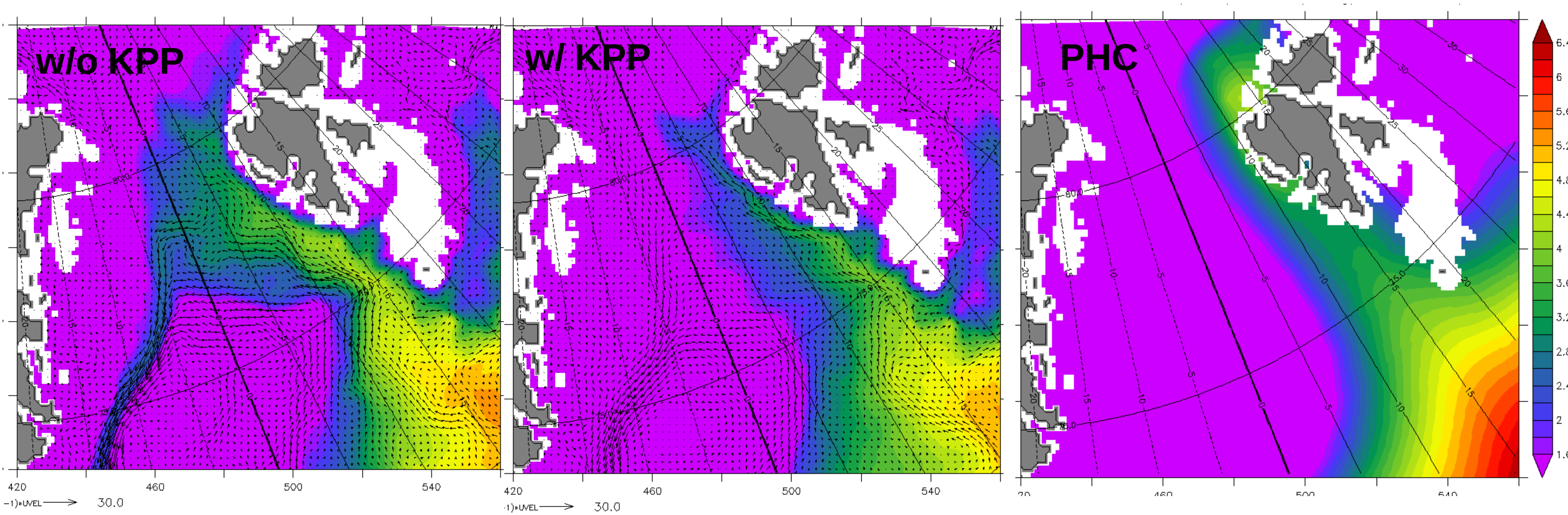
	obs	NAME	CCSM3
Fram Strait Vol Heat Flux (N)	6.8 Sv 36 TW	6.9 Sv 45 TW	2.0 Sv 17 TW
FJL – NZ Vol. Heat Flux (net)	NA Near zero	2.6 Sv 2.2 TW	4.35 Sv 31 TW



- Surface monthly-mean heat fluxes in excess of 350 W/m^2 along the marginal ice zone

RASM G-case sensitivity

Mean temperature at 100m in July

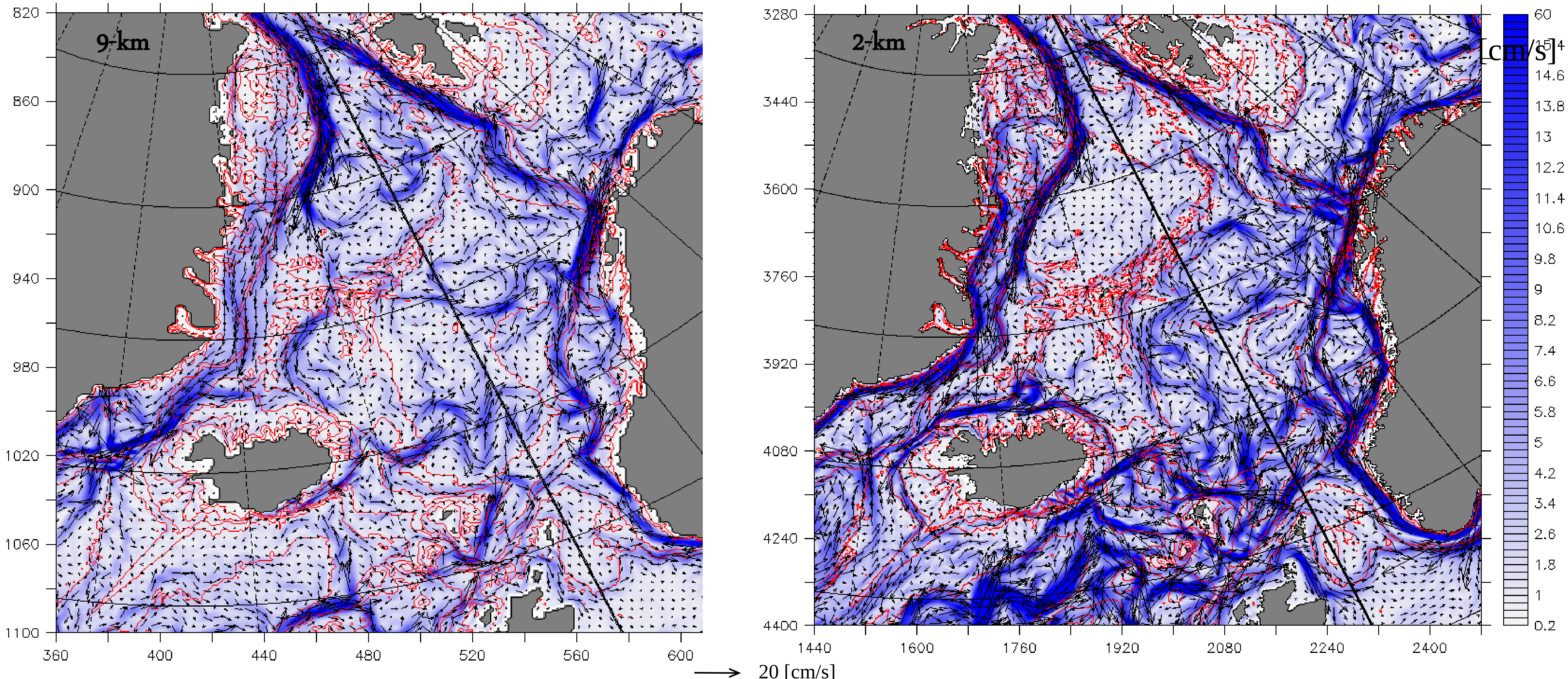


Fram Strait Mean Freshwater Flux

(mSv; positive south)

Exp	South	Net	North
9	60.4	17.16	-43.24
10	67.67	29.69	-37.98

1983 Annual mean velocity at 0-223 m in the Nordic Seas

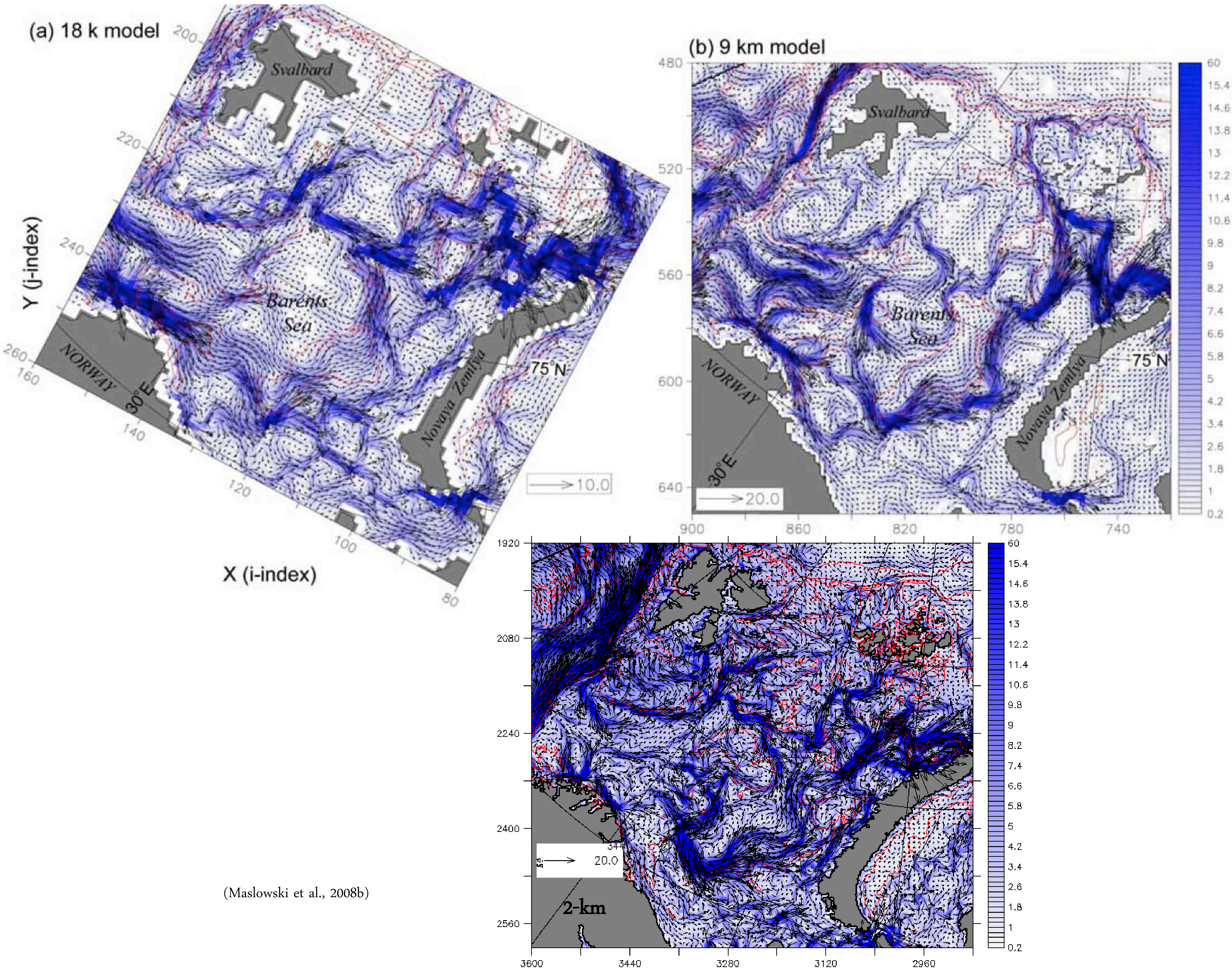


Main differences: EGCC and NCC; Irminger Current inflow into the Iceland Sea; better defined circulation across the Iceland-Scotland Ridge; western branch of Norwegian Atlantic Current

Table 2. Eddy Kinetic Energy (cm/s) Statistics for the 0- to 45-m Regional Snapshots Presented in Plates 4 and 5

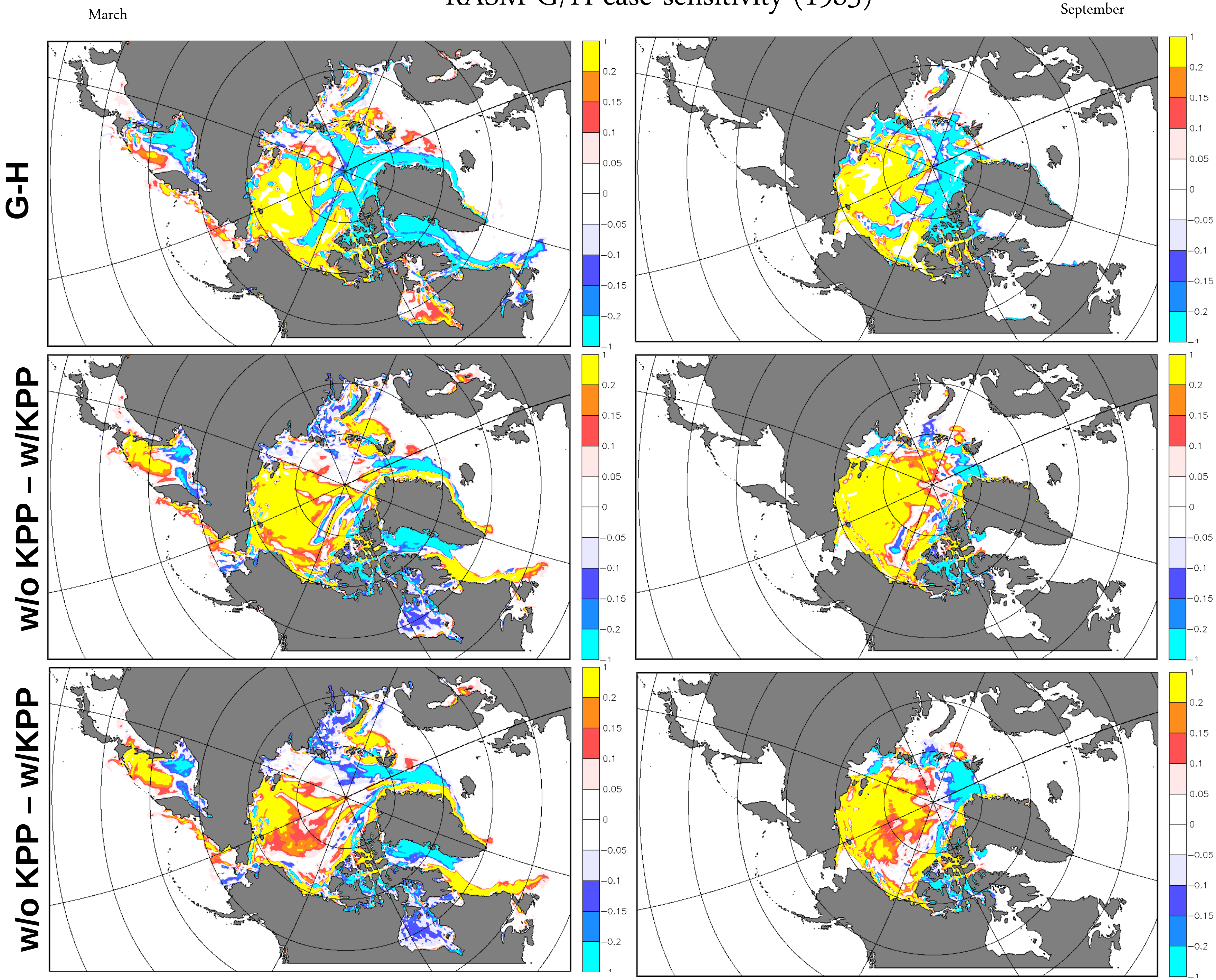
Model	Labrador Sea EKE			Nordic Seas EKE		
	Maximum	Mean	Std Dev	Maximum	Mean	Std Dev
PCAP58	132.50	4.90	9.20	269.40	4.70	13.30
PIPS	3998.00	70.40	203.70	4959.00	43.50	142.70

(Maslowski et al., 2008)

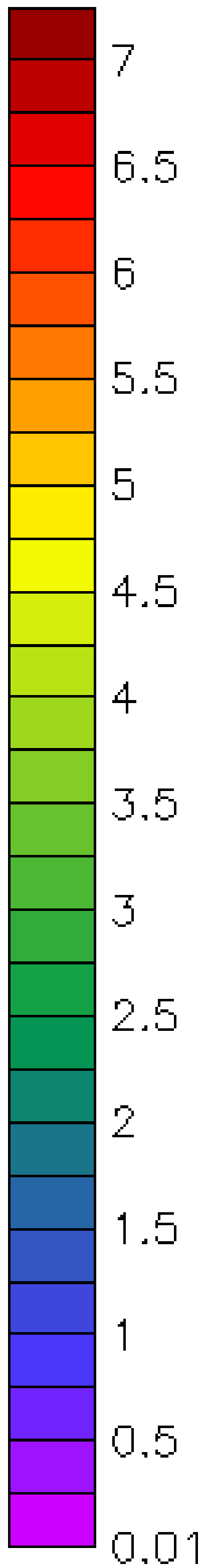


(Maslowski et al., 2008b)

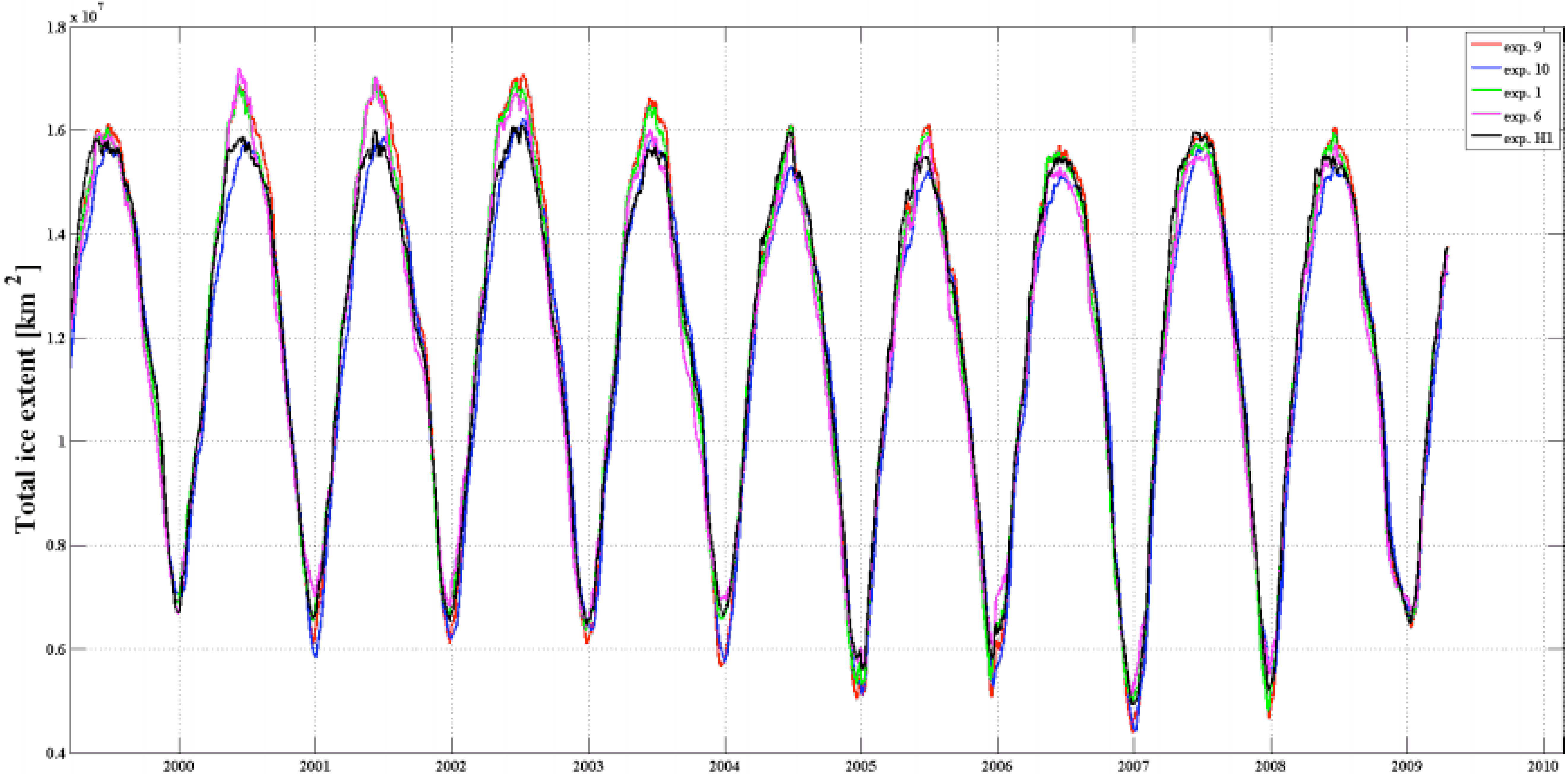
RASM G/H-case sensitivity (1985)



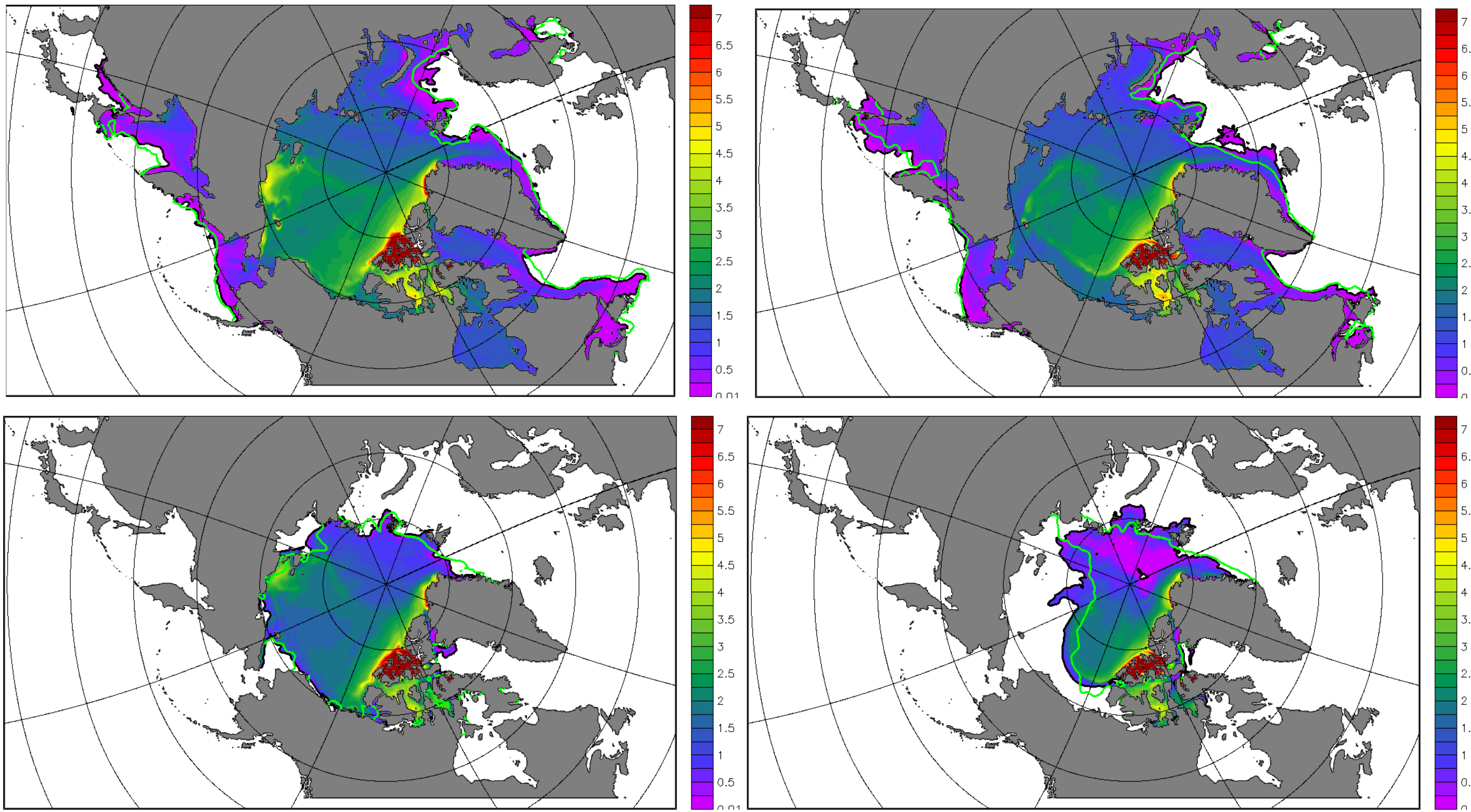
RASM G-case parameter sensitivity – sea ice thickness 09/2007



RASM G/H-case parameter sensitivity – sea ice volume



G-case semi-optimized sea ice thickness distribution at 1/12° in March (top) and September (bottom) 1985



... after ~25 G-case tests

Summary

Need to:

- resolve critical processes (e.g. eddies, coastal currents, sea ice deformation)
- Understand dependencies of space varying parameterizations
- Reduce computational cost / guide setup of future high-resolution coupled climate simulations
- Validation Data (e.g. eddy kinetic energy, mixed layer depth, upper ocean (0-150m) hydrography, air-sea fluxes)
- Process studies (e.g. subsurface heat content and entrainment into the surface mixed layer, seasonal pycnocline, marginal ice zone (MIZ), ice-wave interaction, air-sea fluxes)

Thank You!