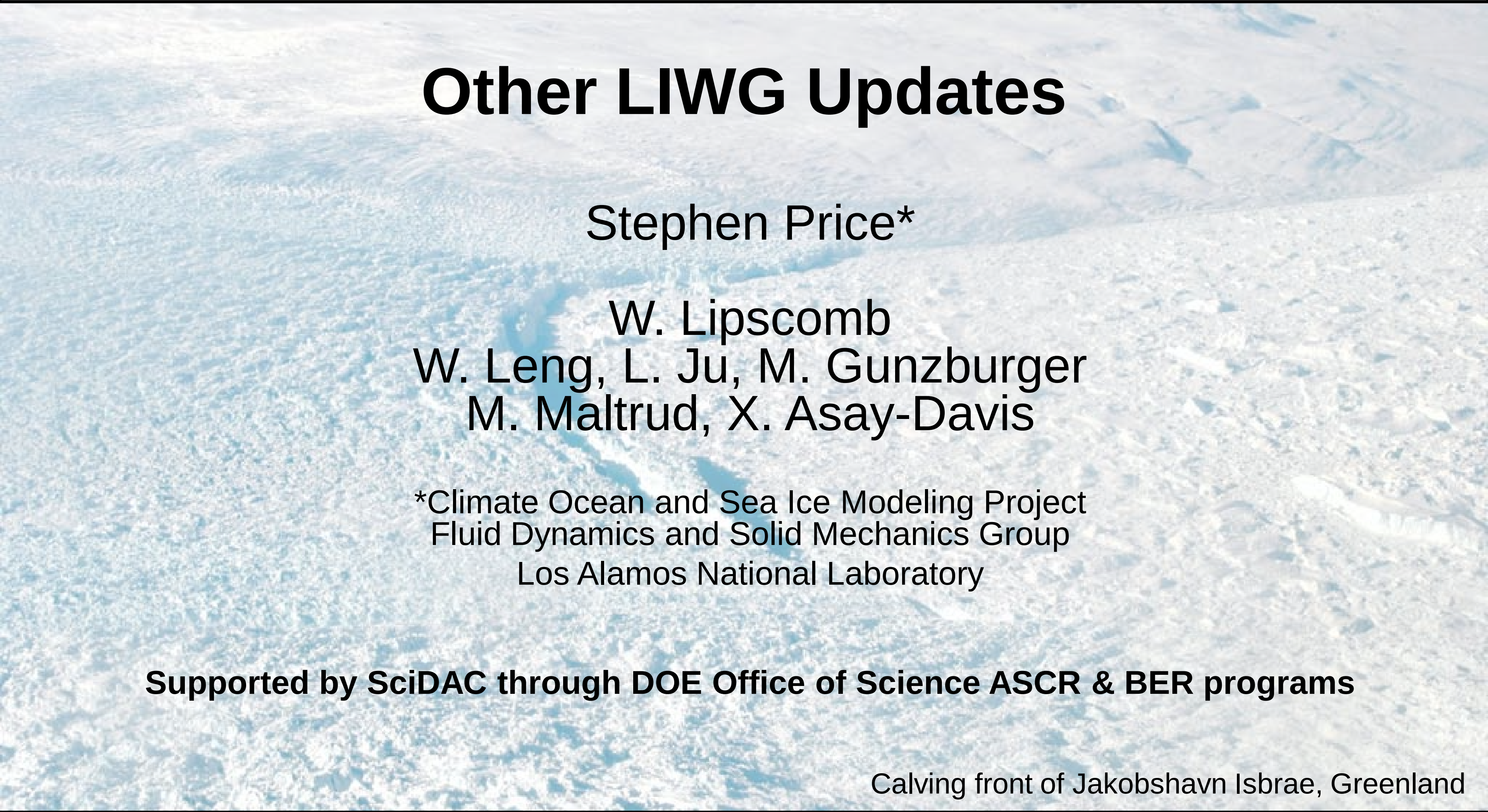
Other LIWG Updates

Stephen Price*

W. Lipscomb
W. Leng, L. Ju, M. Gunzburger
M. Maltrud, X. Asay-Davis

*Climate Ocean and Sea Ice Modeling Project
Fluid Dynamics and Solid Mechanics Group
Los Alamos National Laboratory

Supported by SciDAC through DOE Office of Science ASCR & BER programs

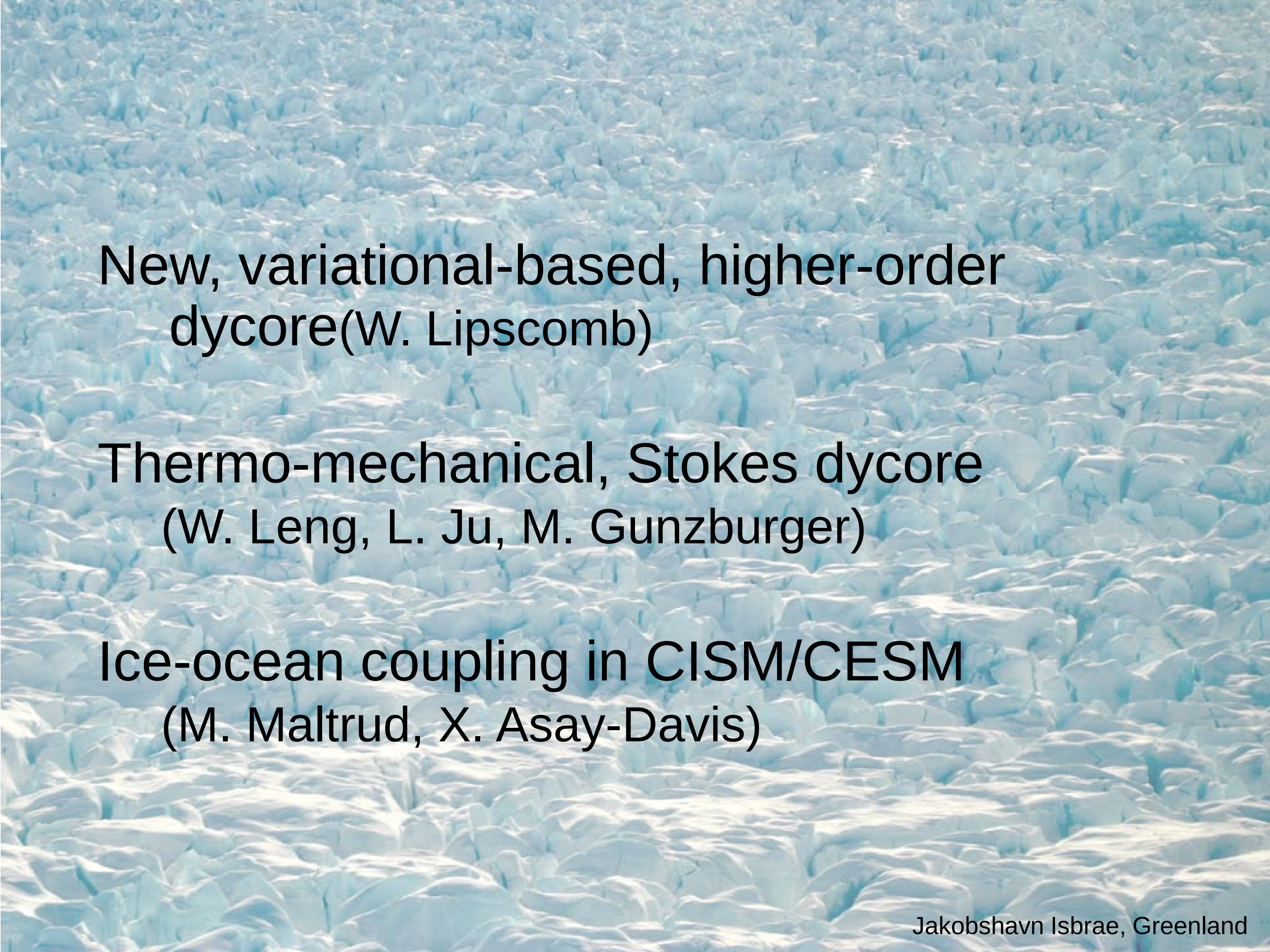


Calving front of Jakobshavn Isbrae, Greenland

New, variational-based, higher-order dycore (W. Lipscomb)

Thermo-mechanical, Stokes dycore (W. Leng, L. Ju, M. Gunzburger)

Ice-ocean coupling in CISM/CESM (M. Maltrud, X. Asay-Davis)



Jakobshavn Isbrae, Greenland

New, variational-based, higher-order dycore

Thermo-mechanical, Stokes dycore

Ice-ocean coupling in CISM/CESM

Jakobshavn Isbrae, Greenland

New, variational-based, 3d, 1st-order accurate dycore

Based on Dukowicz et al. (*J. Glac.*, **56**, 2010) - 3d, 1st-order accurate ("Blatter-Pattyn")

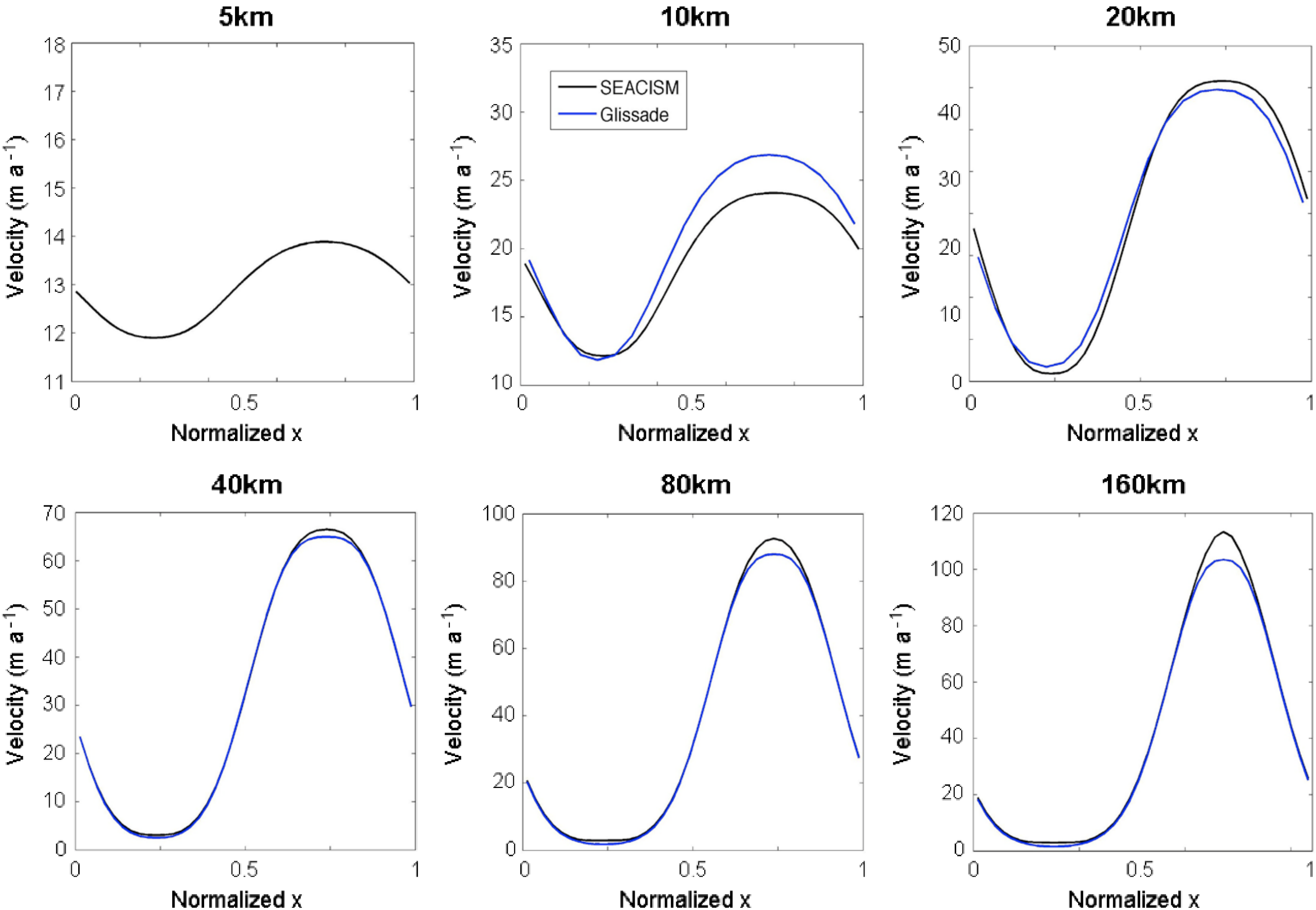
FEM approach similar to Perego et al. (*J. Glac.*, **58**, 2012) but in Fortran 90 on structured CISM grid

Current status:

- Uses Fortran 90 PCG solver (linear) and Picard (nonlinear)
- Fully parallel
- Currently stress free (surface) and no slip (basal) BCs only
- Good agreement with SEACISM and standard benchmark tests (e.g. ISMIP-HOM)

To do:

- additional BCs (sliding; floating ice)
- hooks to Trilinos & JFNK using SEACISM framework
- testing on large-scale, realistic geometries and BCs


5km
10km
20km
40km
80km
160km
SEACISM
Glissade
Velocity (m a -1)
Normalized x

New, variational-based, higher-order dycore

Thermo-mechanical, Stokes dycore

Ice-ocean coupling in CISM/CESM

Sastrugi, Jakobshavn Isbrae catchment, Greenland

3d, Thermo-mechanical, Nonlinear Stokes dycore

Additions to nonlinear Stokes dycore from Leng et al. (*JGR*, **117**, 2012)

- high-order accurate finite elements
- variable resolution grids (software hooks to MPAS)
- scalable, iterative solvers

Addition of FEM-based solvers for:

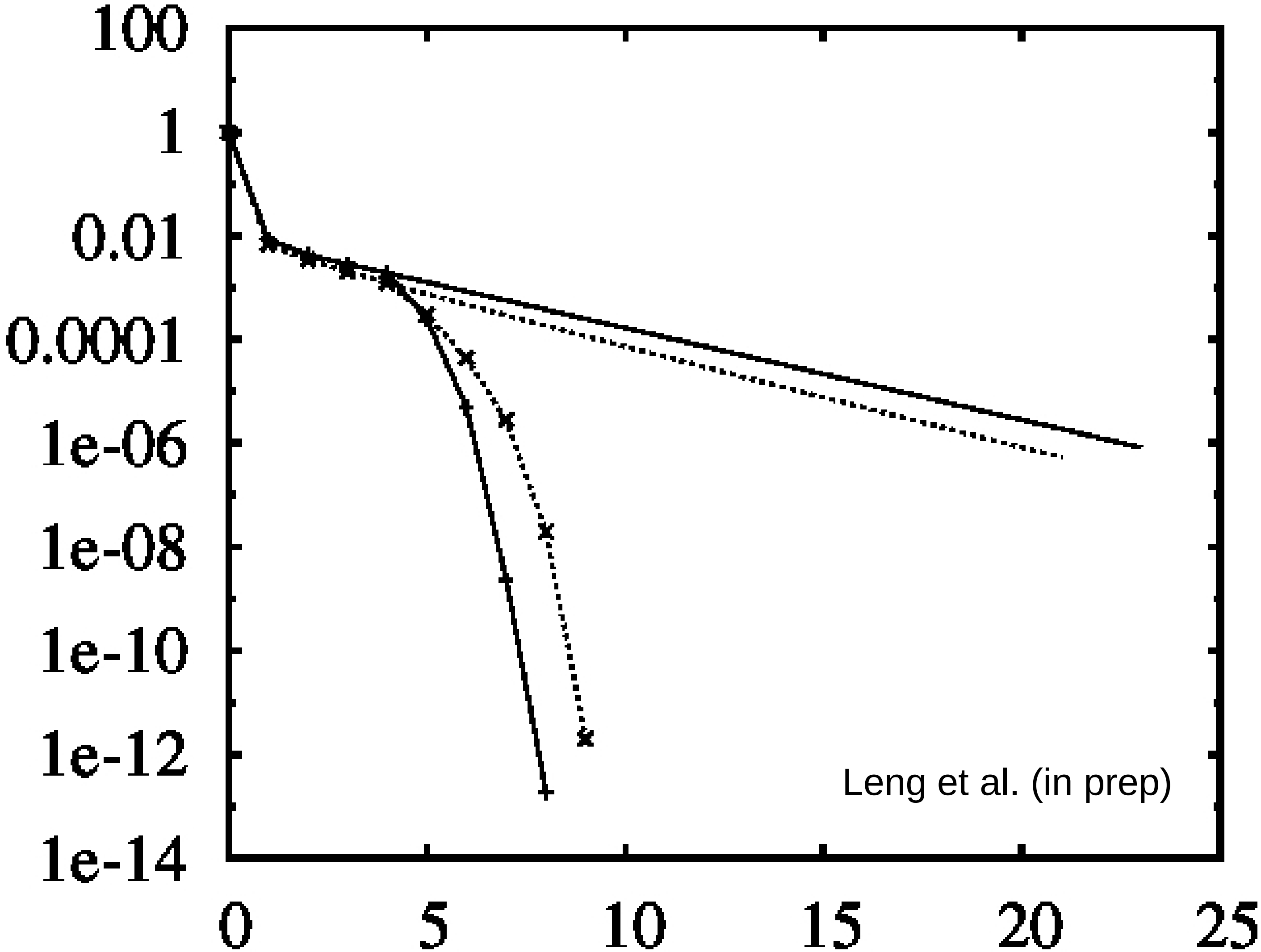
- temperature evolution
- thickness evolution (1^{st}-order upwinding)

Addition of hybrid Picard-Newton nonlinear solution

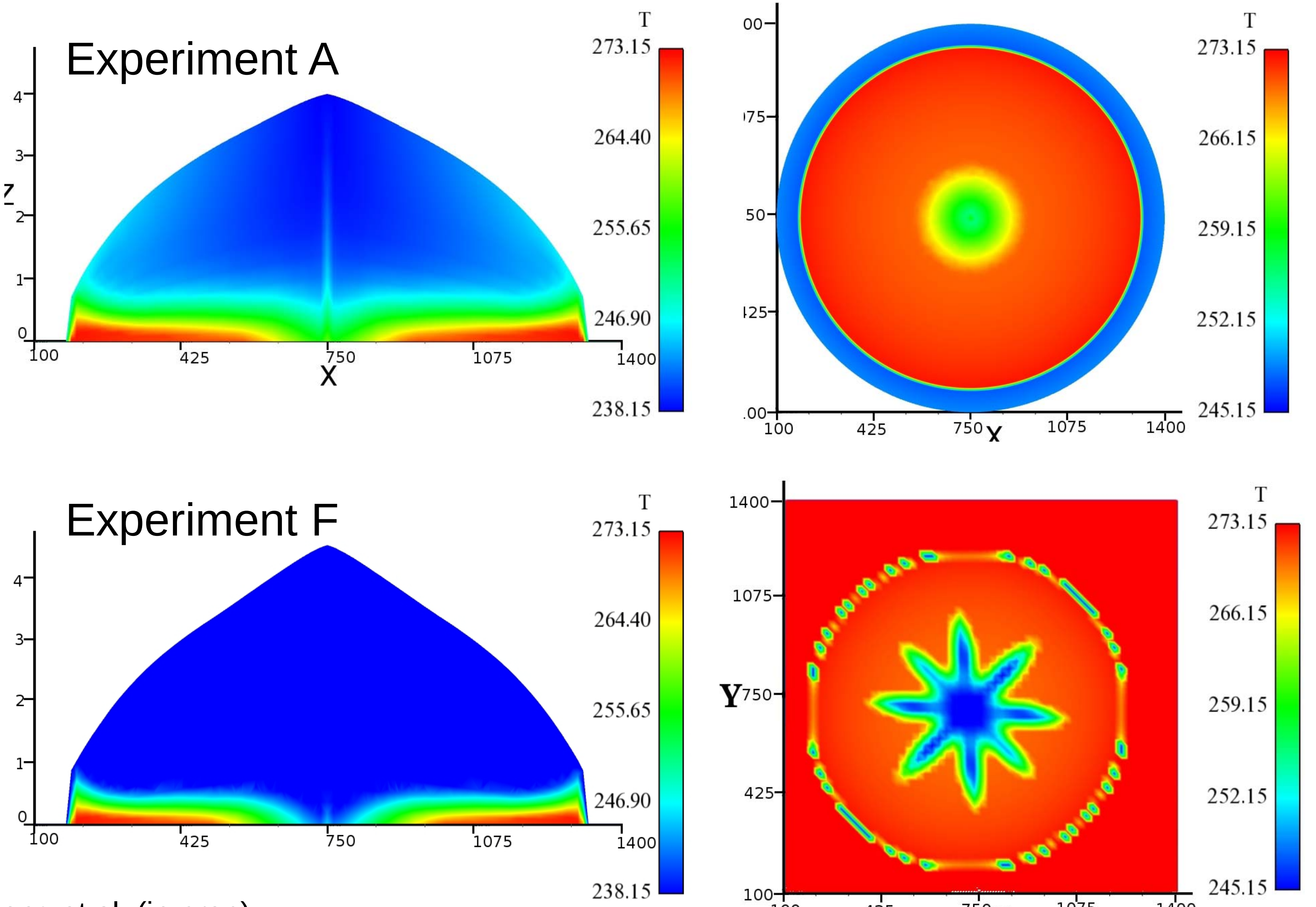
- globalization of solution using several Picard iterations
- followed by rapid convergence using Newton method

Stokes solver verified against manufactured solutions (Leng et al., *TC*, **7**, 2013) and compares well with standard benchmark solutions

Picard-only vs. Picard-Newton (ISMIP-HOM tests A,C)



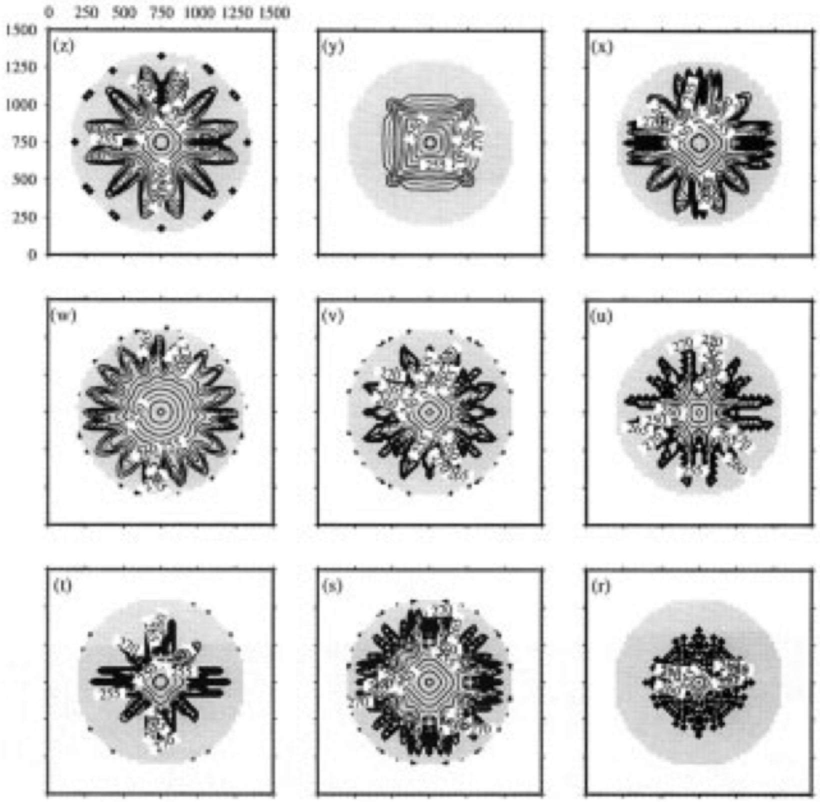
EISMINT II: thermo-mechanically coupled ice sheet evolution



Leng et al. (in prep)

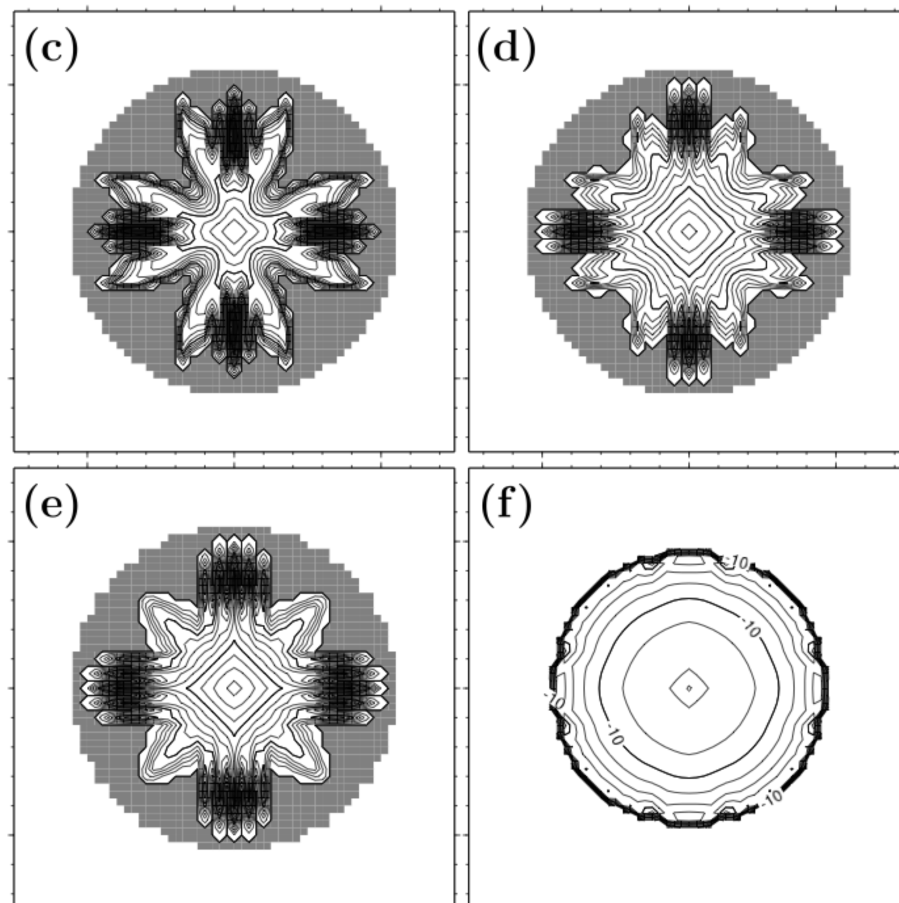
EISMINT II: thermo-mechanically coupled ice sheet evolution

SIA Models



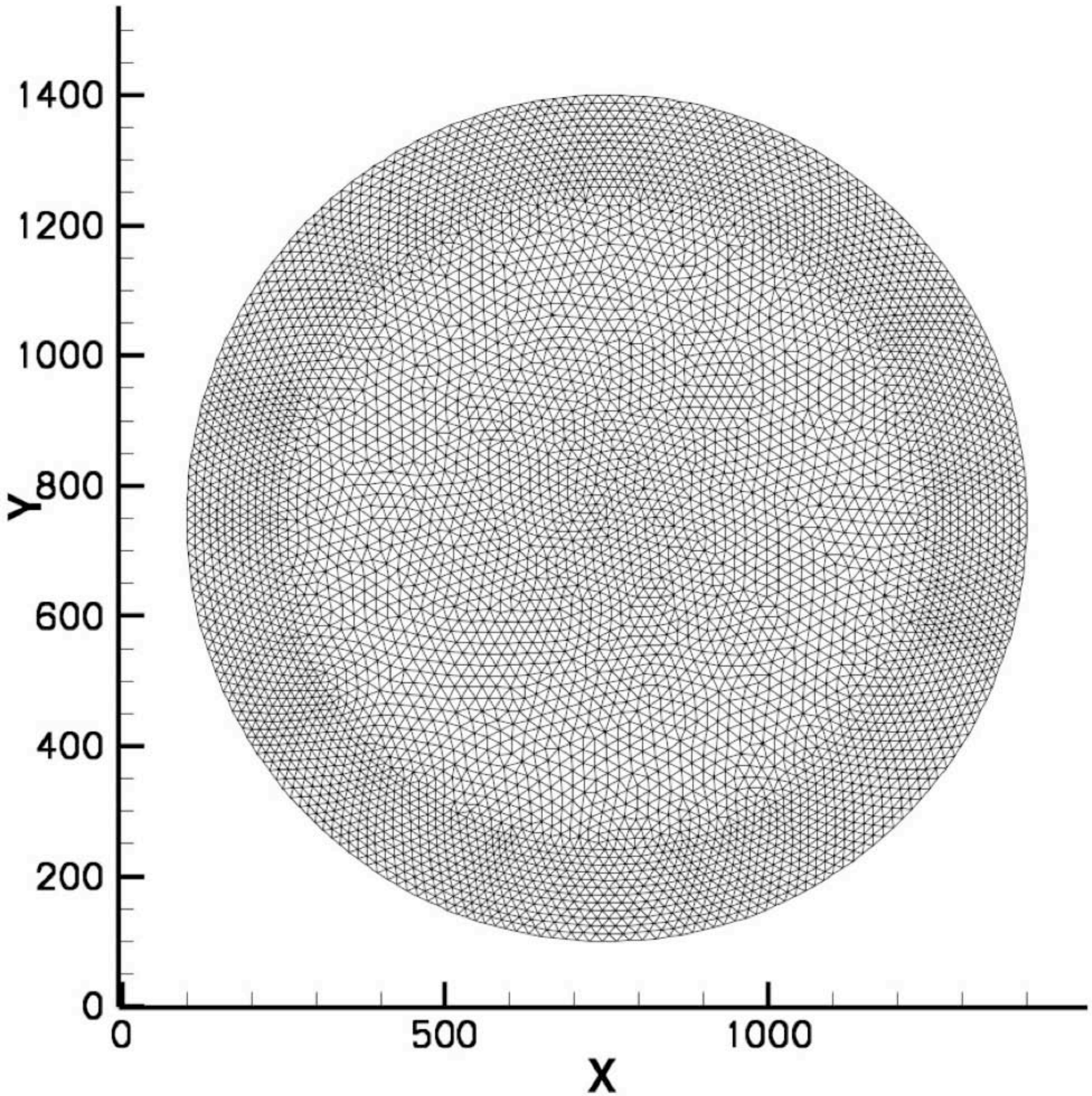
Payne et al. (*J. Glac.*, **46**, 2000)

1st-order Model



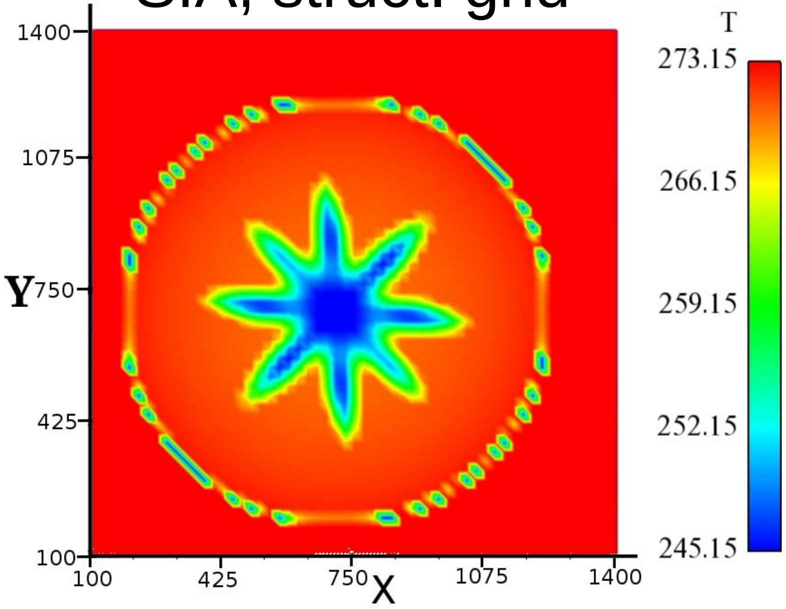
Saito et al. (*JGR*, **111**, 2006)

EISMINT II: thermo-mechanically coupled ice sheet evolution

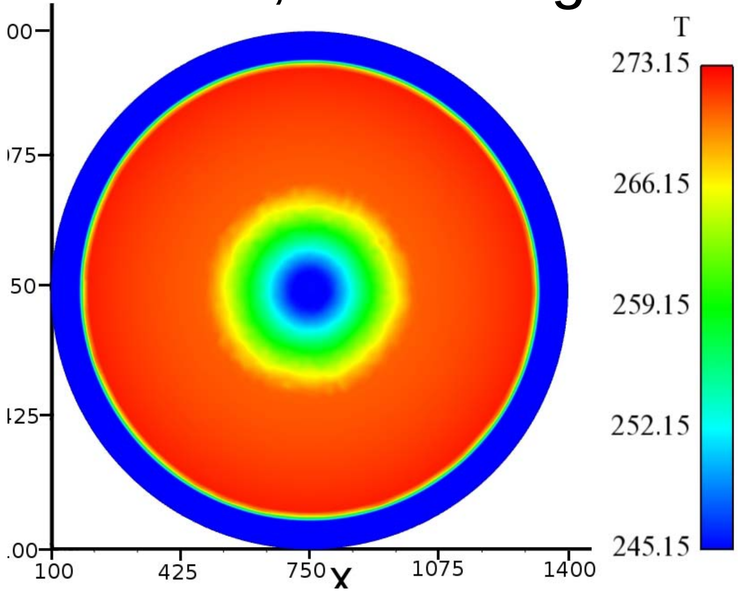


Leng et al. (in prep)

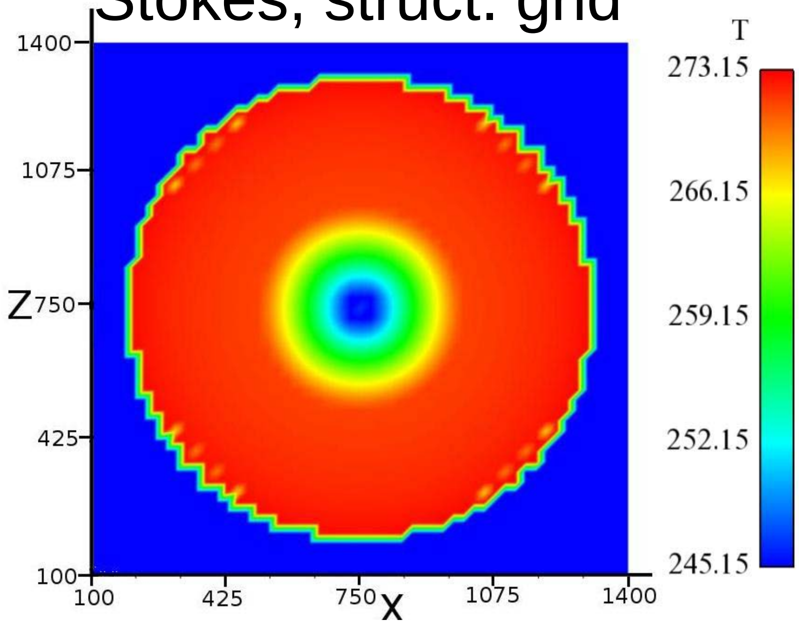
SIA, struct. grid



Stokes, unstruc. grid



Stokes, struct. grid

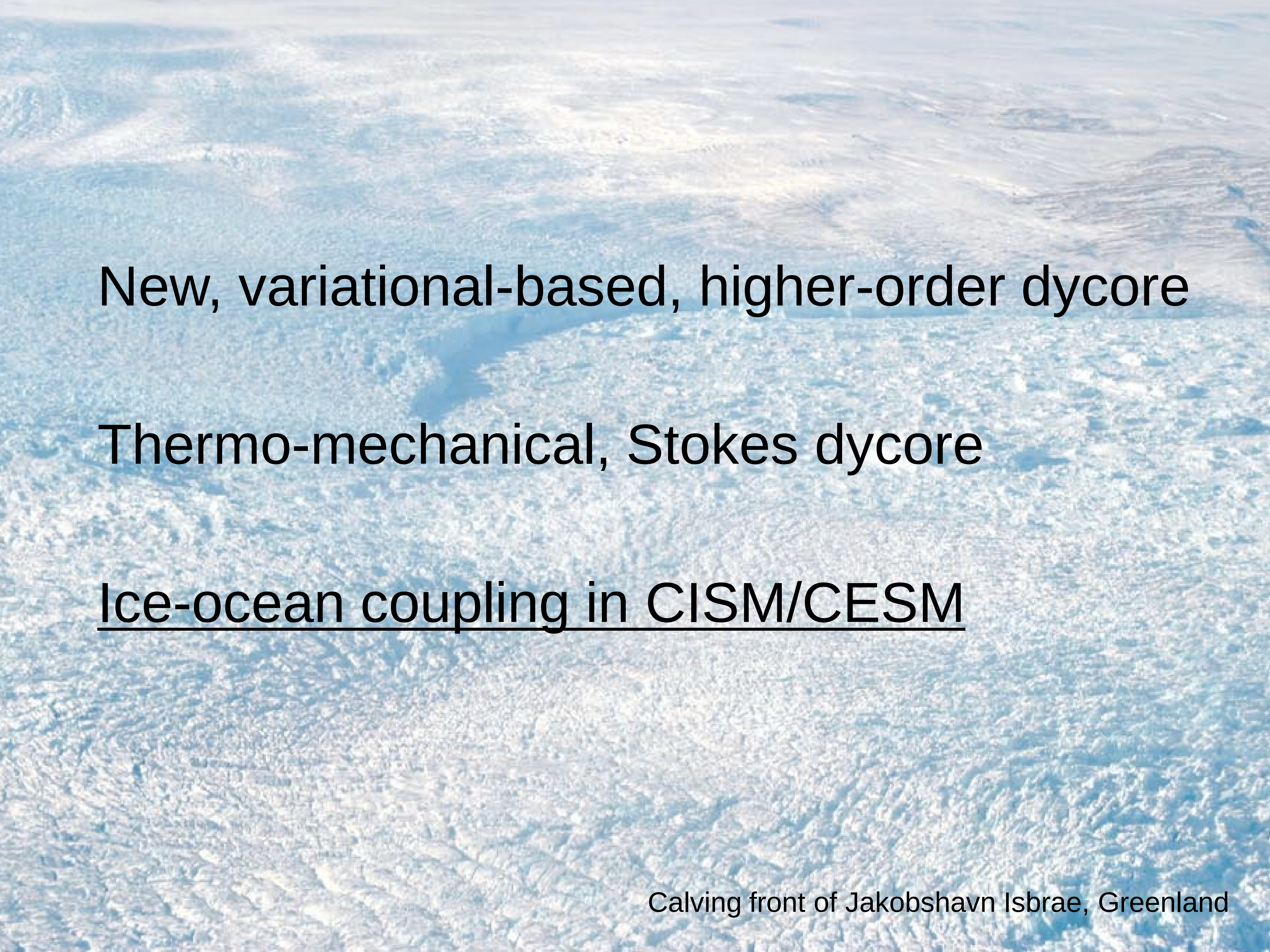


Leng et al. (in prep)

New, variational-based, higher-order dycore

Thermo-mechanical, Stokes dycore

Ice-ocean coupling in CISM/CESM

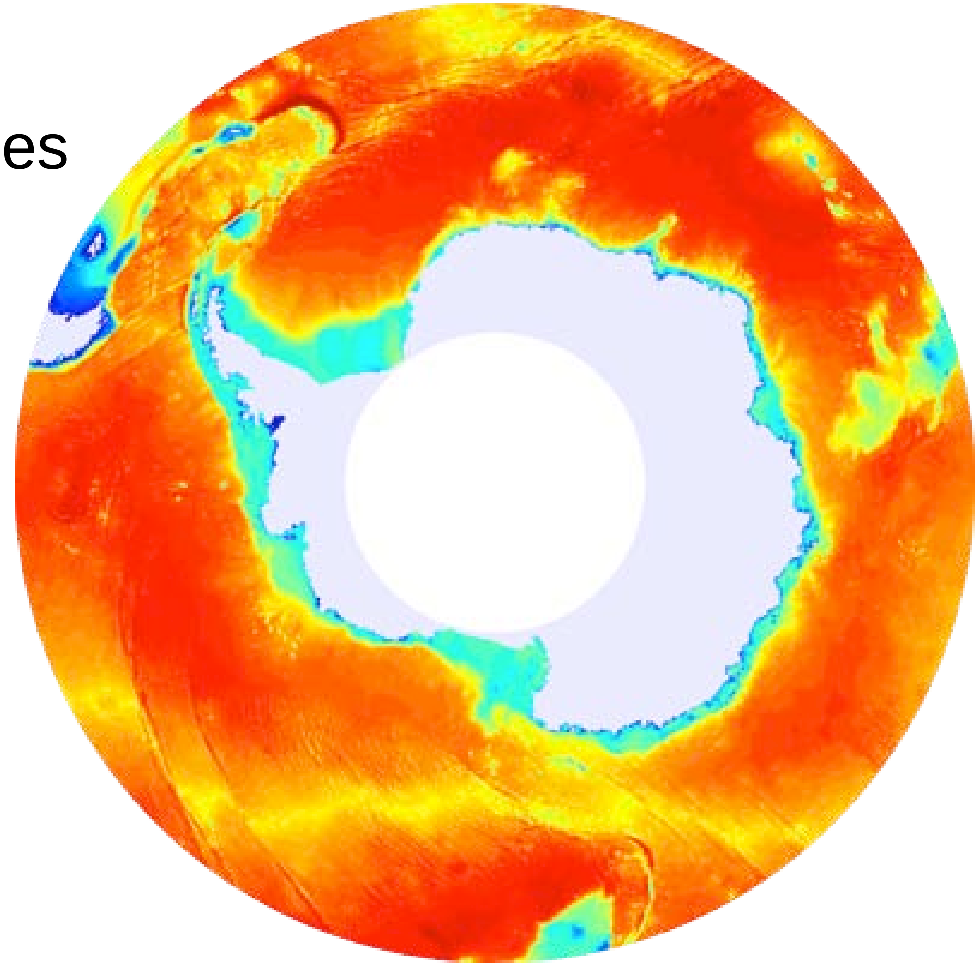


Calving front of Jakobshavn Isbrae, Greenland

New Ocean Model Grid

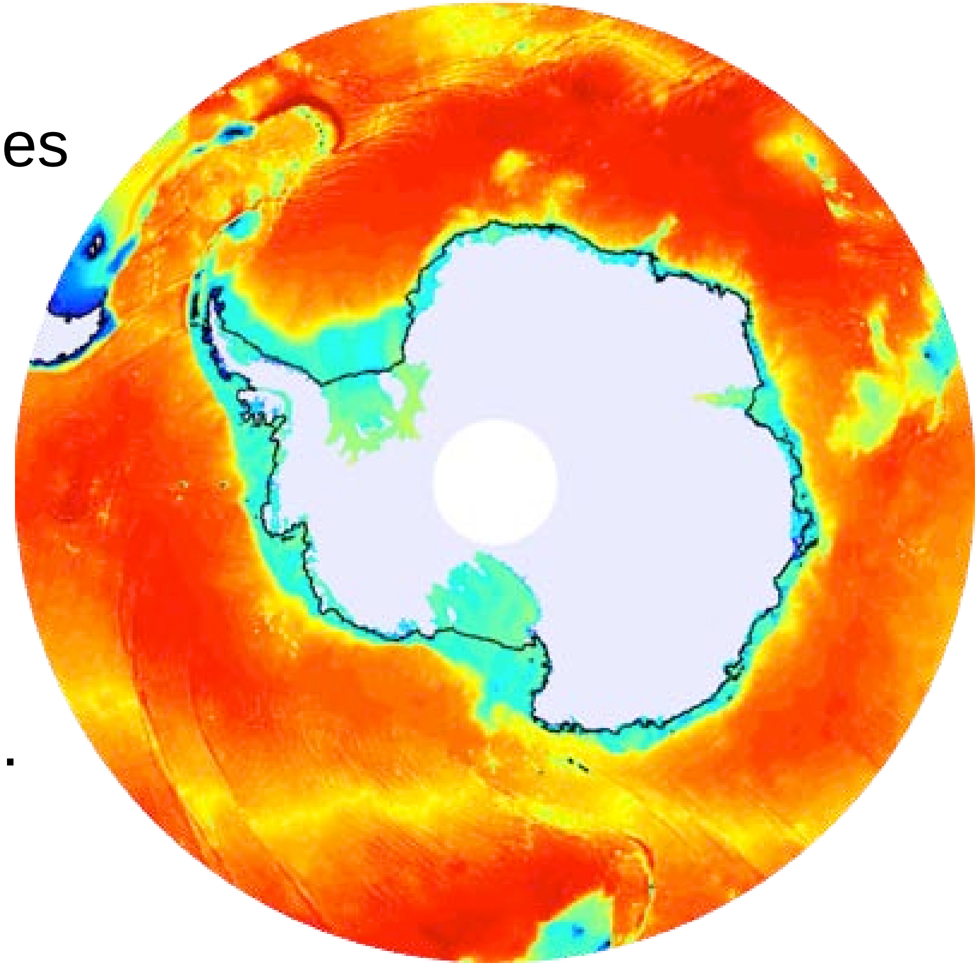
- X. Asay-Davis, M. Maltrud (LANL)

- Existing POP grid: No cavities under ice shelves



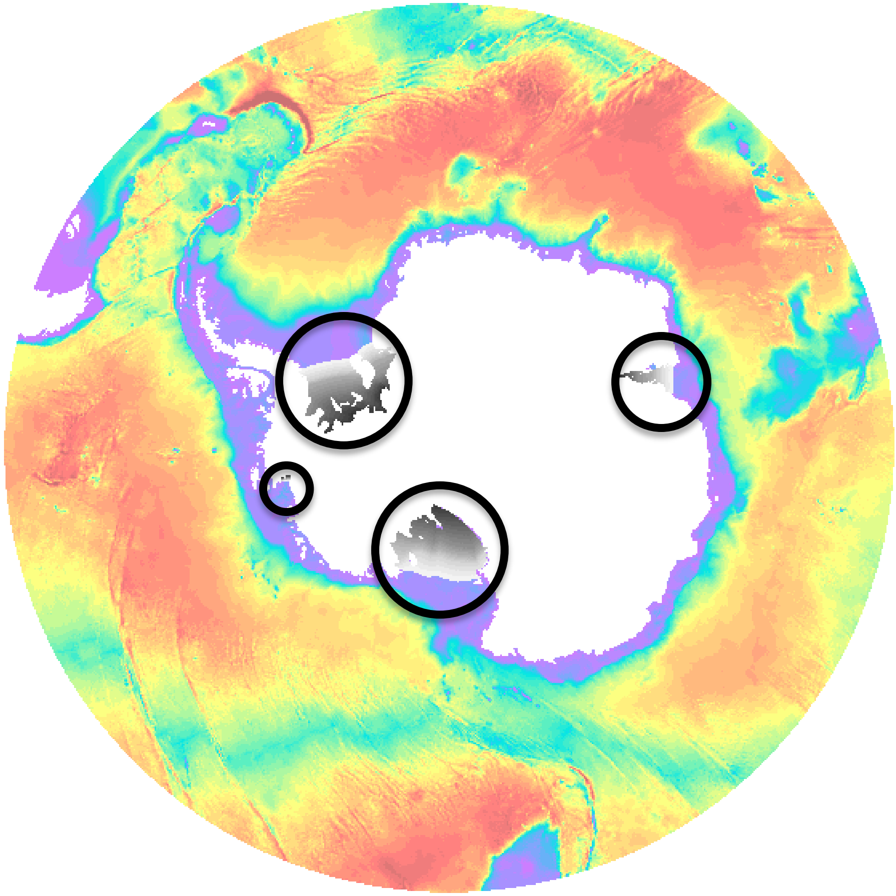
New Ocean Model Grid

- X. Asay-Davis, M. Maltrud (LANL)
- Existing POP grid: No cavities under ice shelves
- New POP grid: Ice shelves replace by open ocean
- Bathymetry from RTOPO-1 data set (Timmermann et al. 2010)

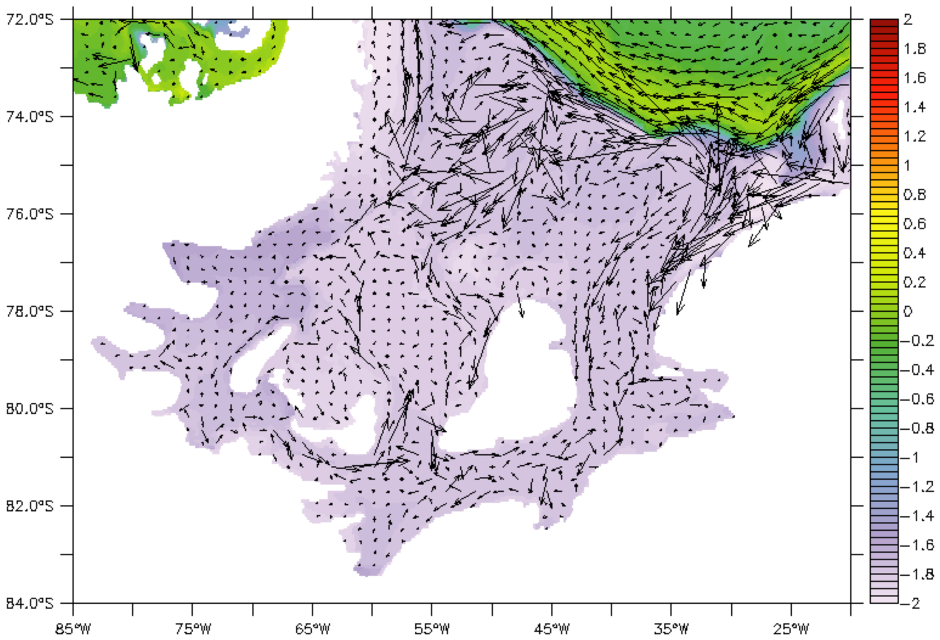


0.1° Southern Ocean

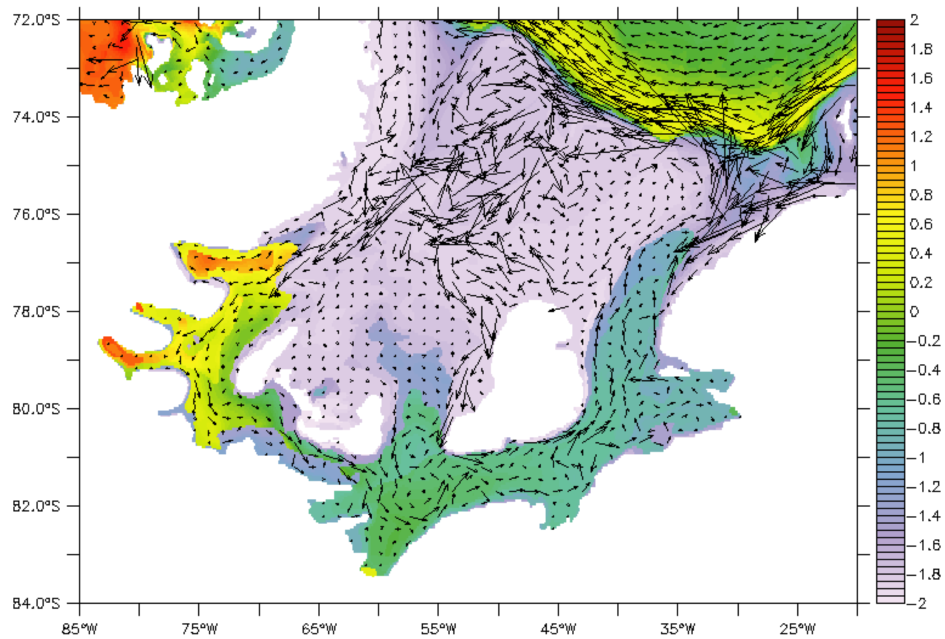
- 4 idealized ice shelves



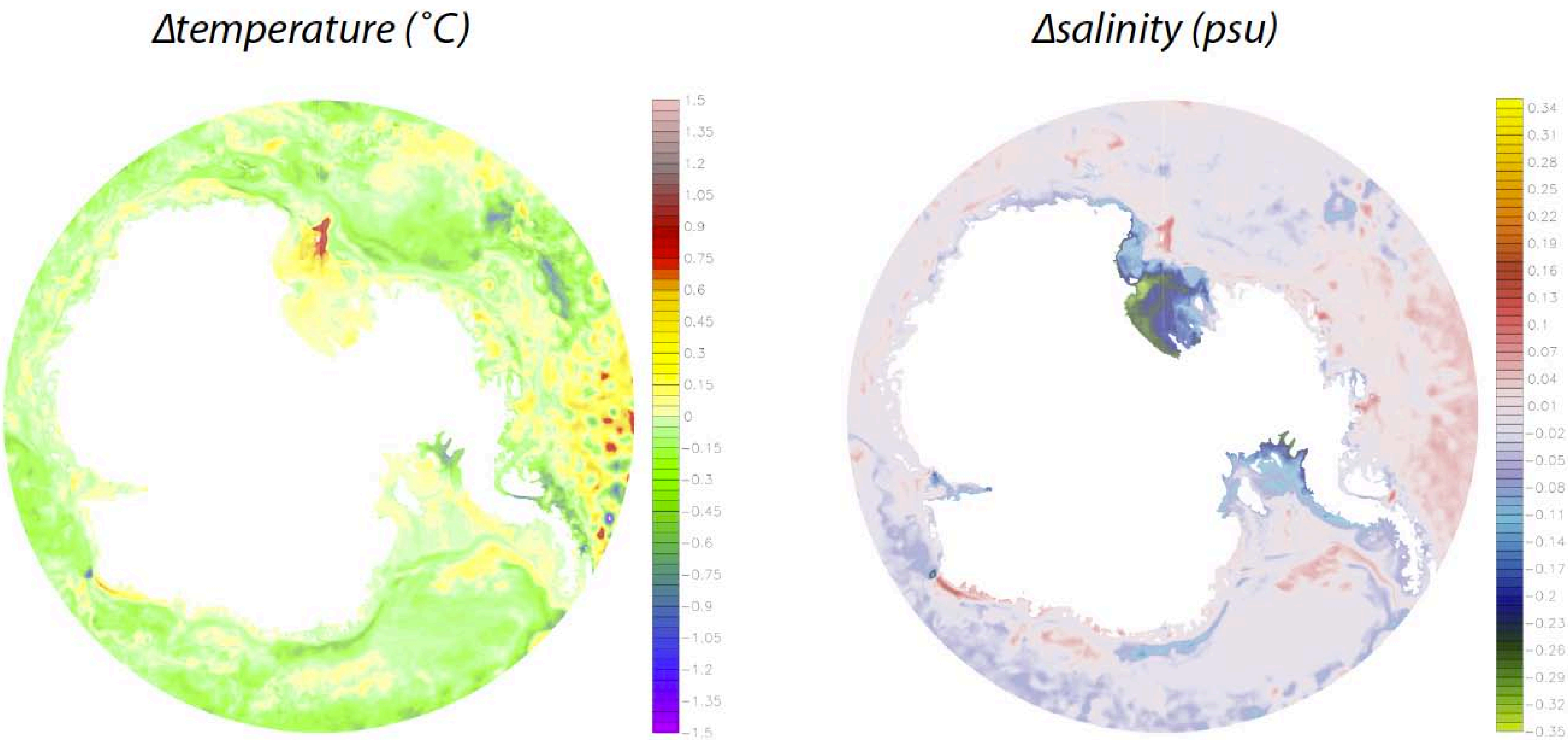
Weddell Sea Bottom Temperature (° C) and Depth-Averaged Velocity *years 20 -24 average*



No Ice Shelves



Idealized Ice Shelves

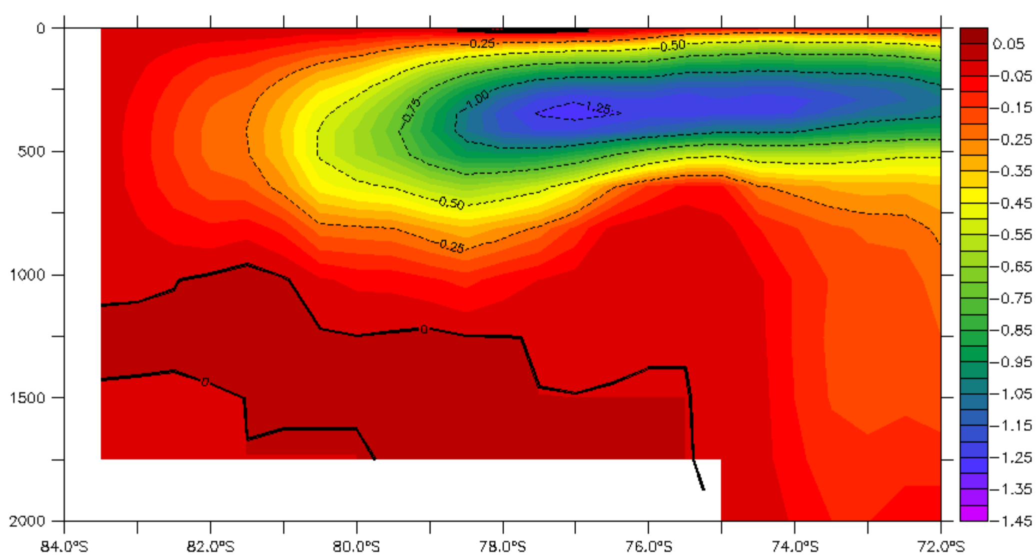


difference (SHELVES - CONTROL) in average temperature (left) and salinity (right) from year 10 at 250m

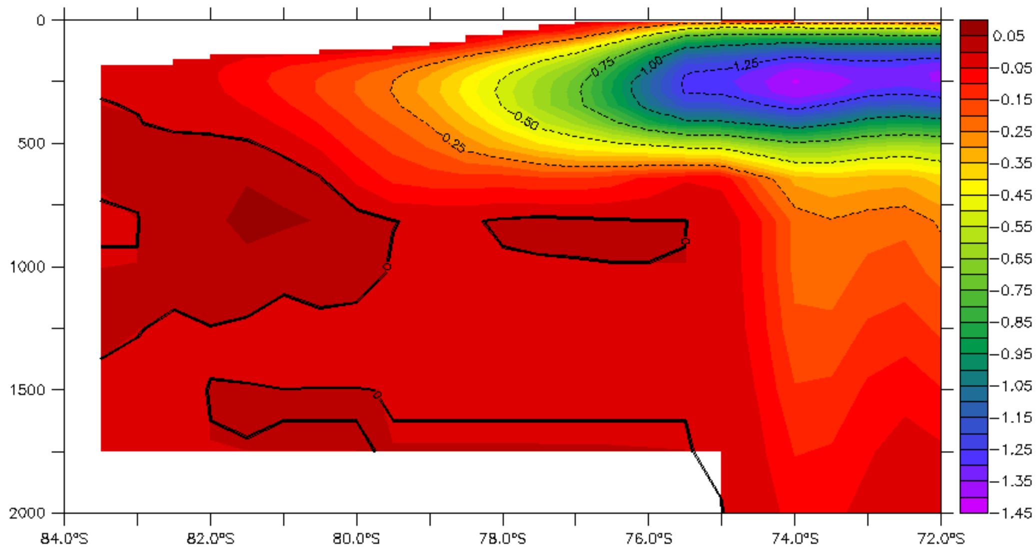
Weddell Sea Overturning (Sv)

years 20 -24 average

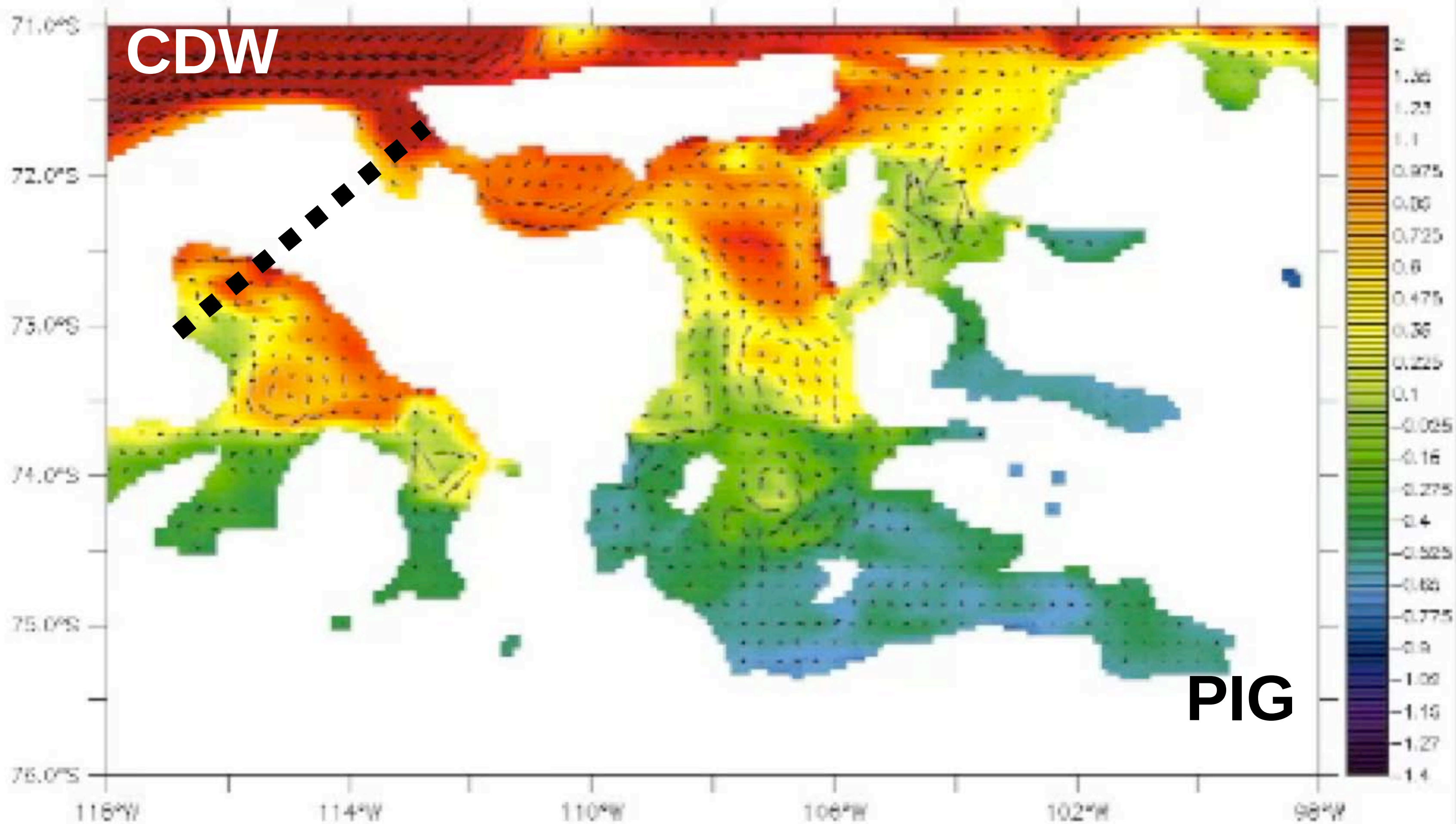
No Ice Shelves



Idealized Ice Shelves



POP: 10th degree WAIS Simulation

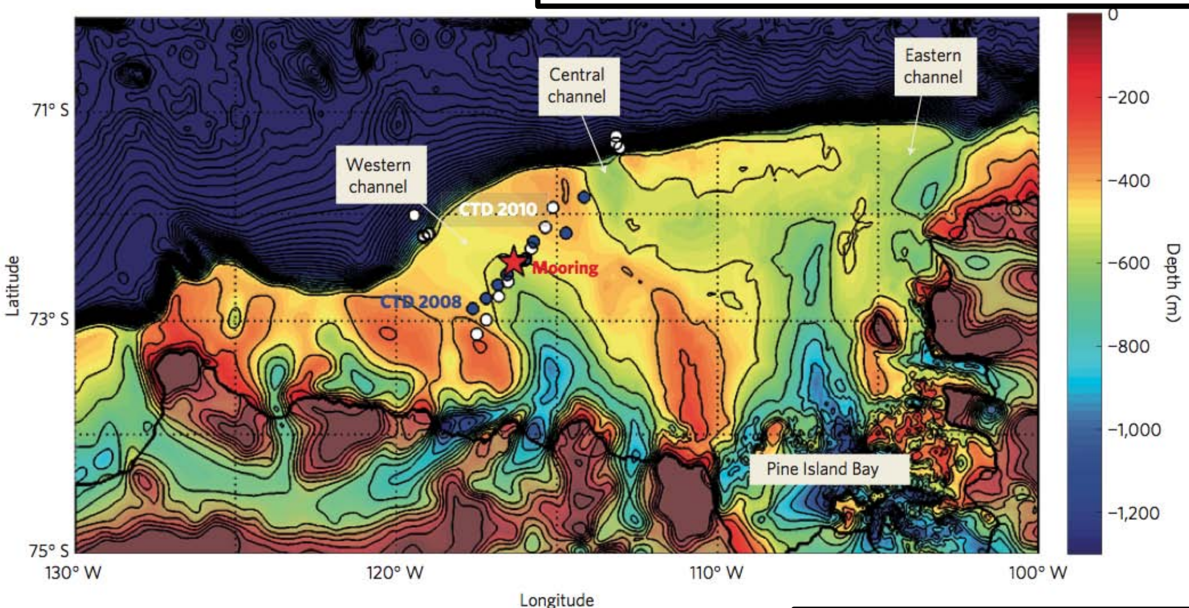


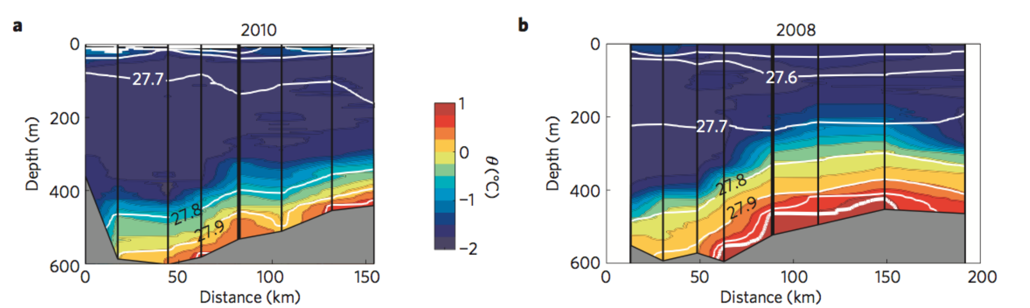
Movie courtesy of M. Maltrud (LANL)

LETTERS
PUBLISHED ONLINE: 25 NOVEMBER 2012 | DOI: 10.1038/NGEO1644
nature geoscience

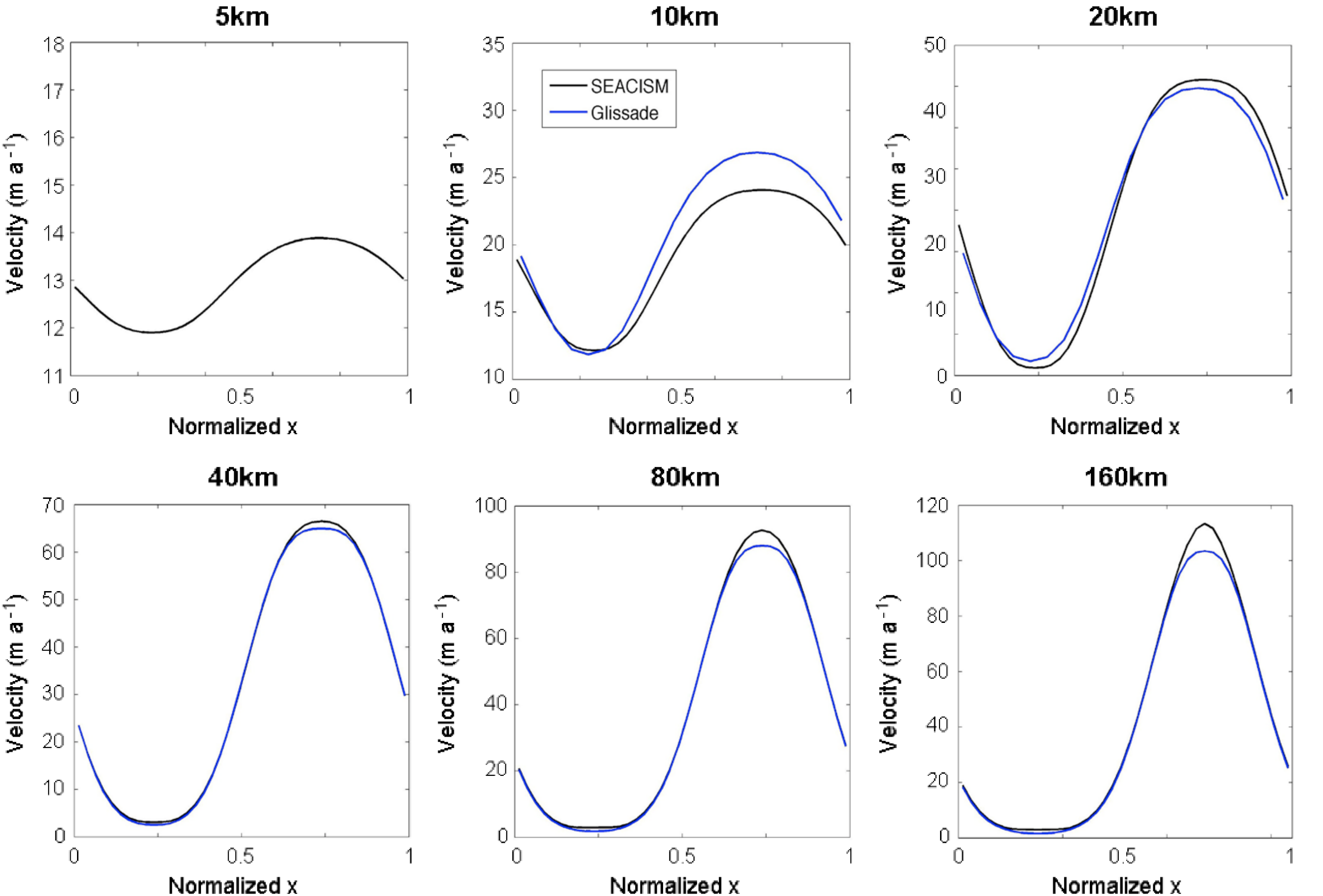
Persistent inflow of warm water onto the central Amundsen shelf

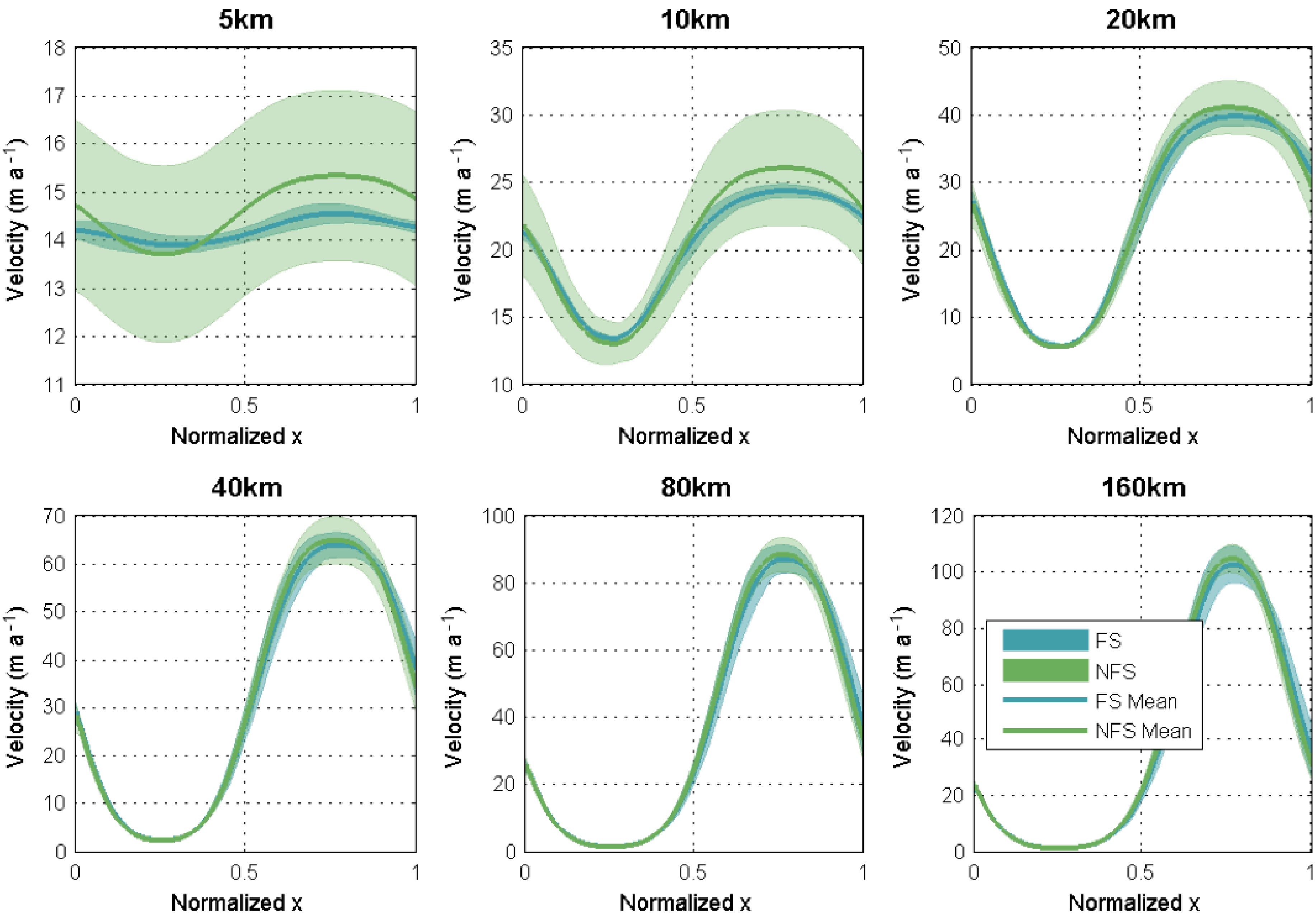
L. Arneborg[1]*, A. K. Wåhlin[1], G. Björk[1], B. Liljebladh[1] and A. H. Orsi[2]





Icebergs in Disko Bay, Greenland, 2012


5km
10km
20km
40km
80km
160km
SEACISM
Glissade
Velocity (m a⁻¹)
Normalized x


5km
10km
20km
40km
80km
160km
Velocity (m a⁻¹)
Normalized x
FS
NFS
FS Mean
NFS Mean