The Role of Ice Shelf - Ocean Interaction in the ECCO2 Data Synthesis

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Outline

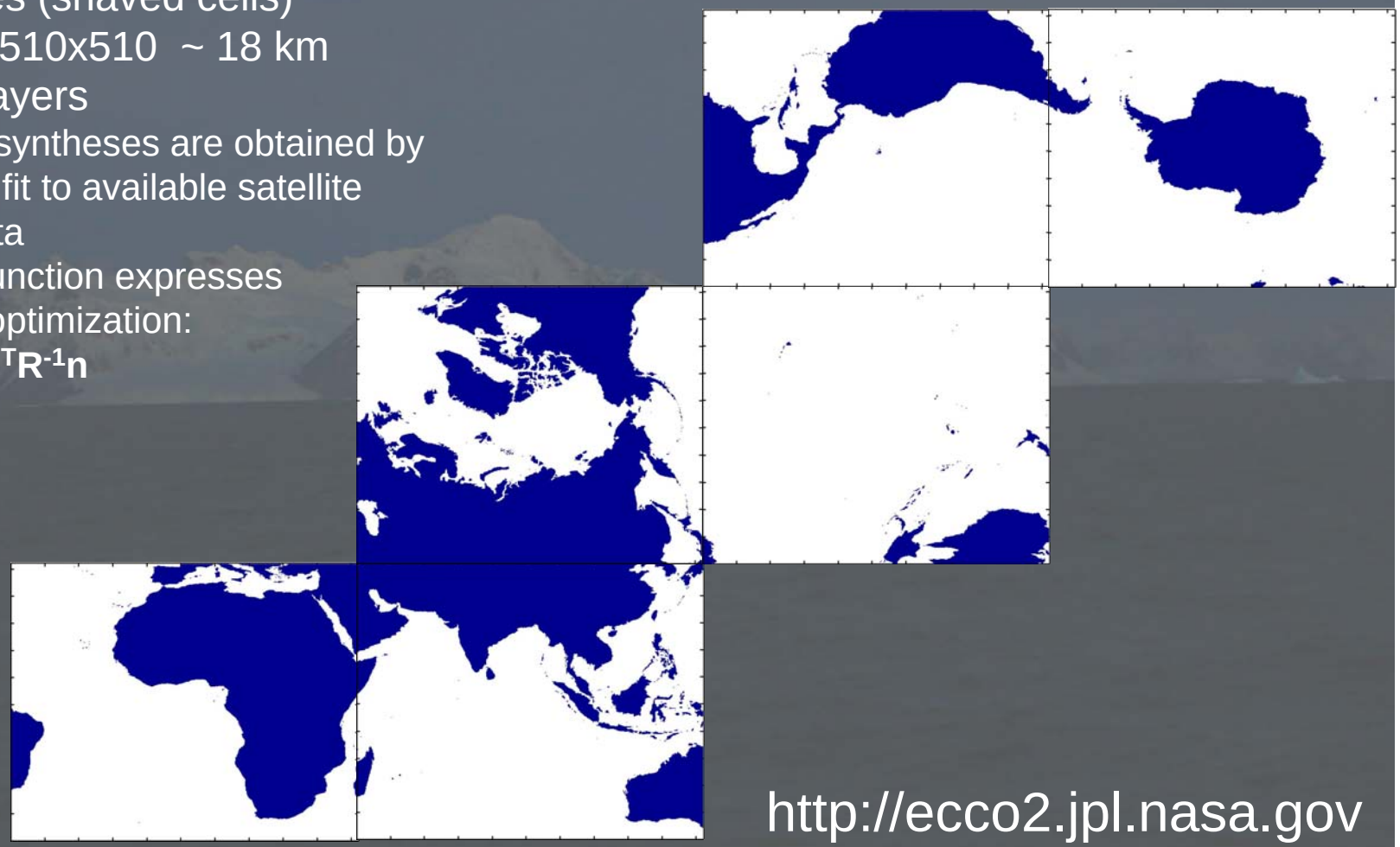
- ECCO2
- Model Set up
- Results
- Outlook

Estimating the Circulation and Climate of the Ocean, Phase II: High Resolution Global-Ocean and Sea-Ice Data Synthesis

Model Set up:

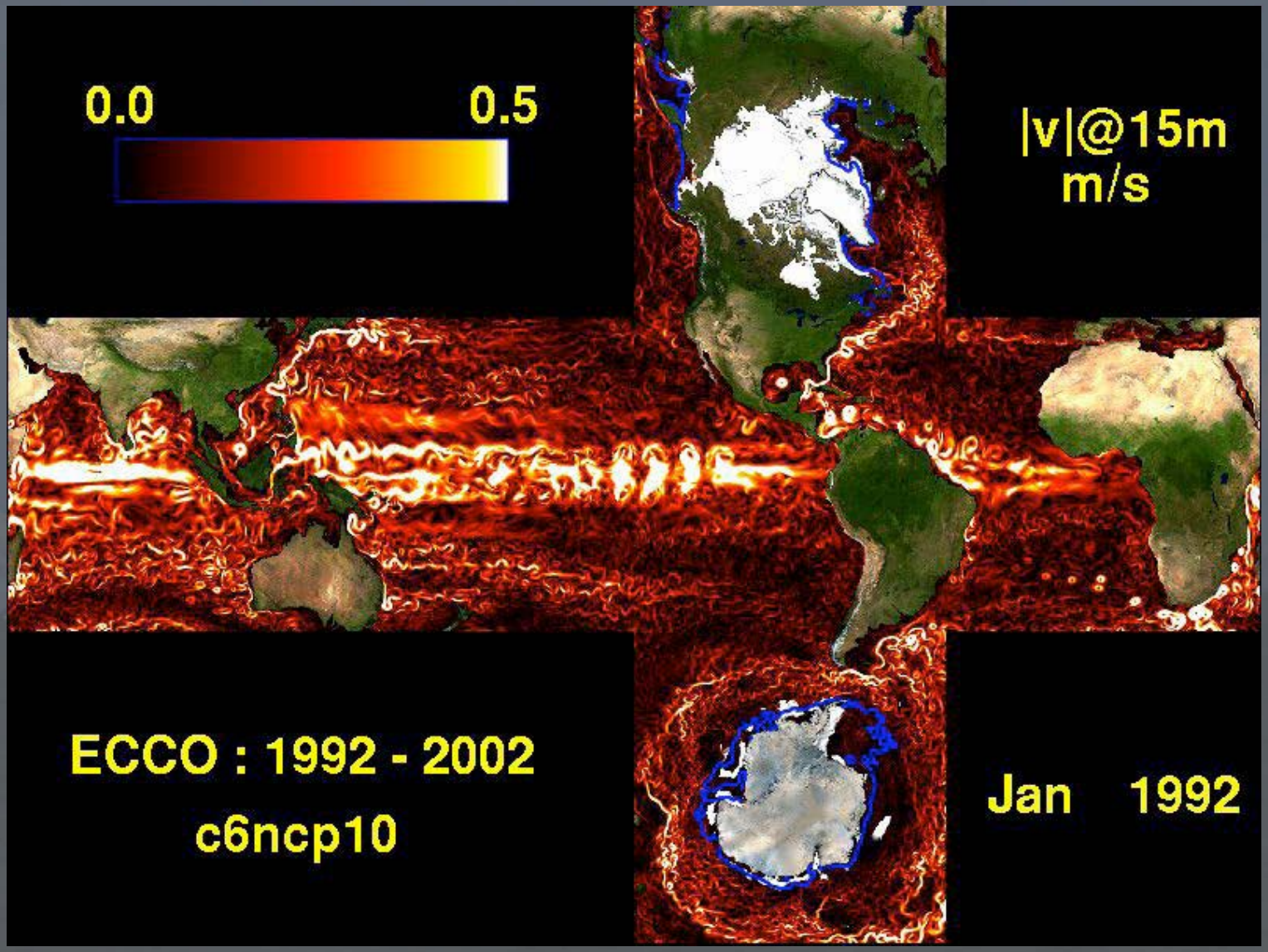
- Ocean model MITgcm
- z-coordinates (shaved cells)
- 6 `Faces` à 510x510 ~ 18 km
- 50 vertical layers
- ECCO2 data syntheses are obtained by least squares fit to available satellite and in-situ data
- An objective function expresses the extent of optimization:

$$J = u^T Q^{-1} u + n^T R^{-1} n$$



http://ecco2.jpl.nasa.gov

Early Model Results: Velocities at 15 m



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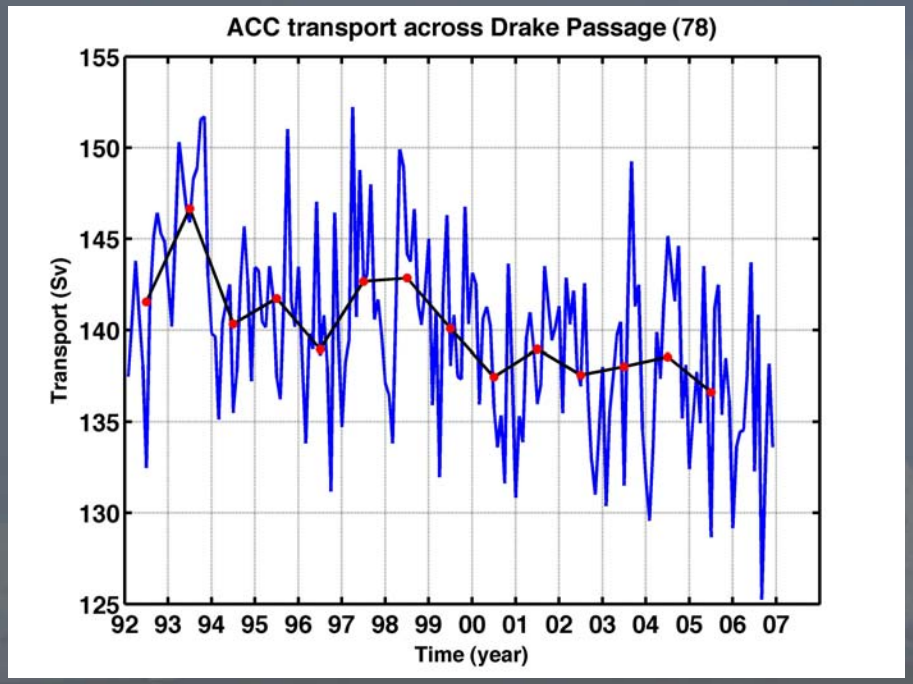
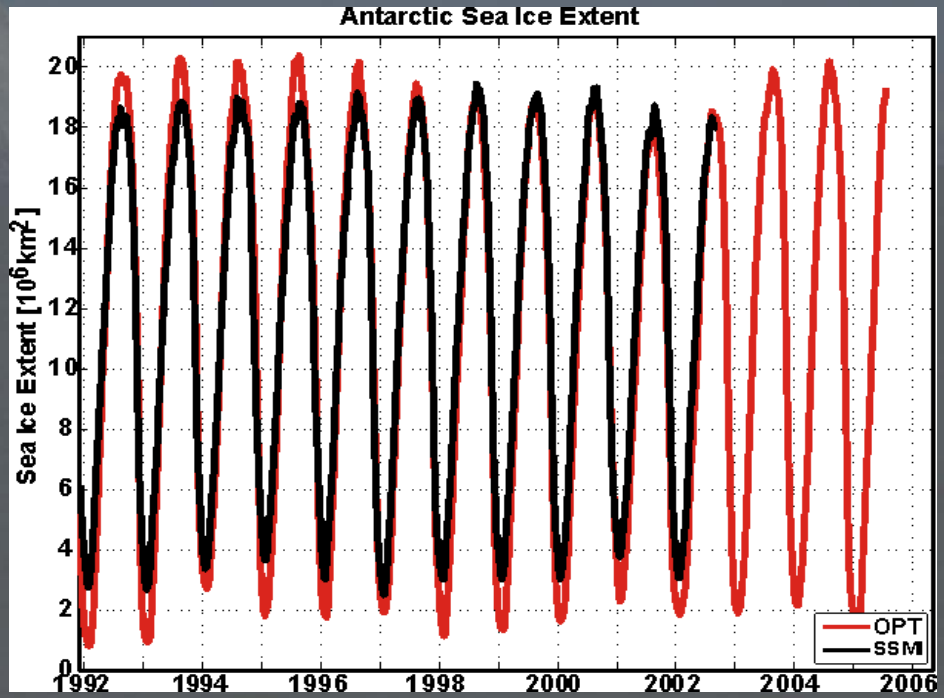
Latest Optimized Solution (Cube 78)

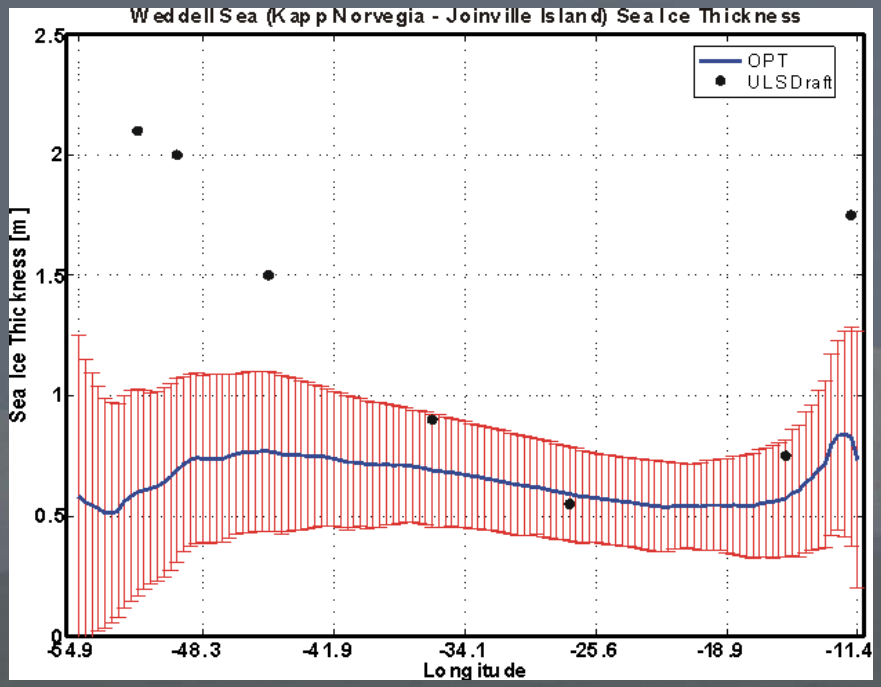


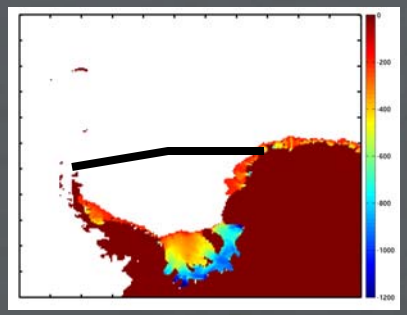


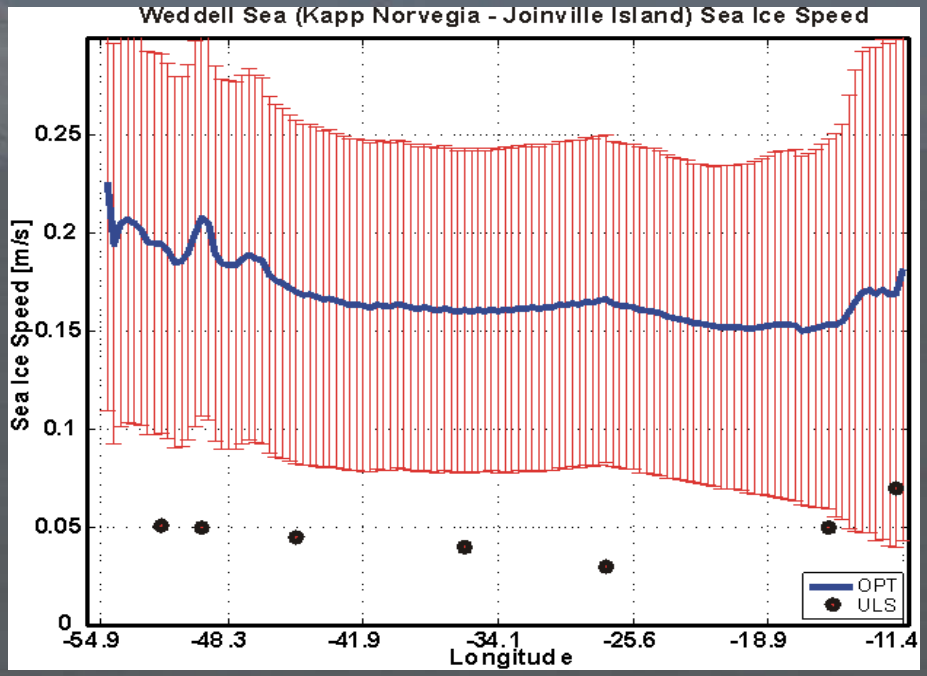
Sea Ice Thickness & Sea Ice Velocities

Section: Kapp Norvegia - Joinville Island

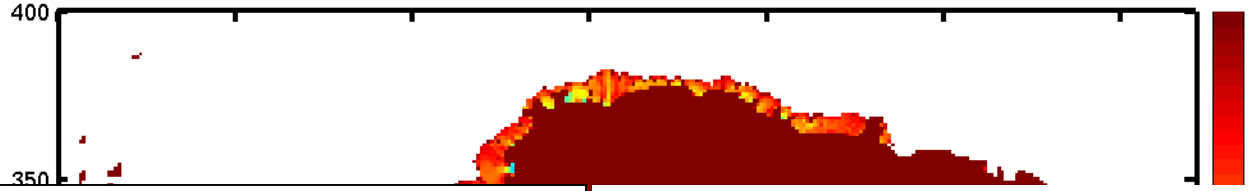
Model data vs AWI ULS data







Including Ice Shelves in the global model

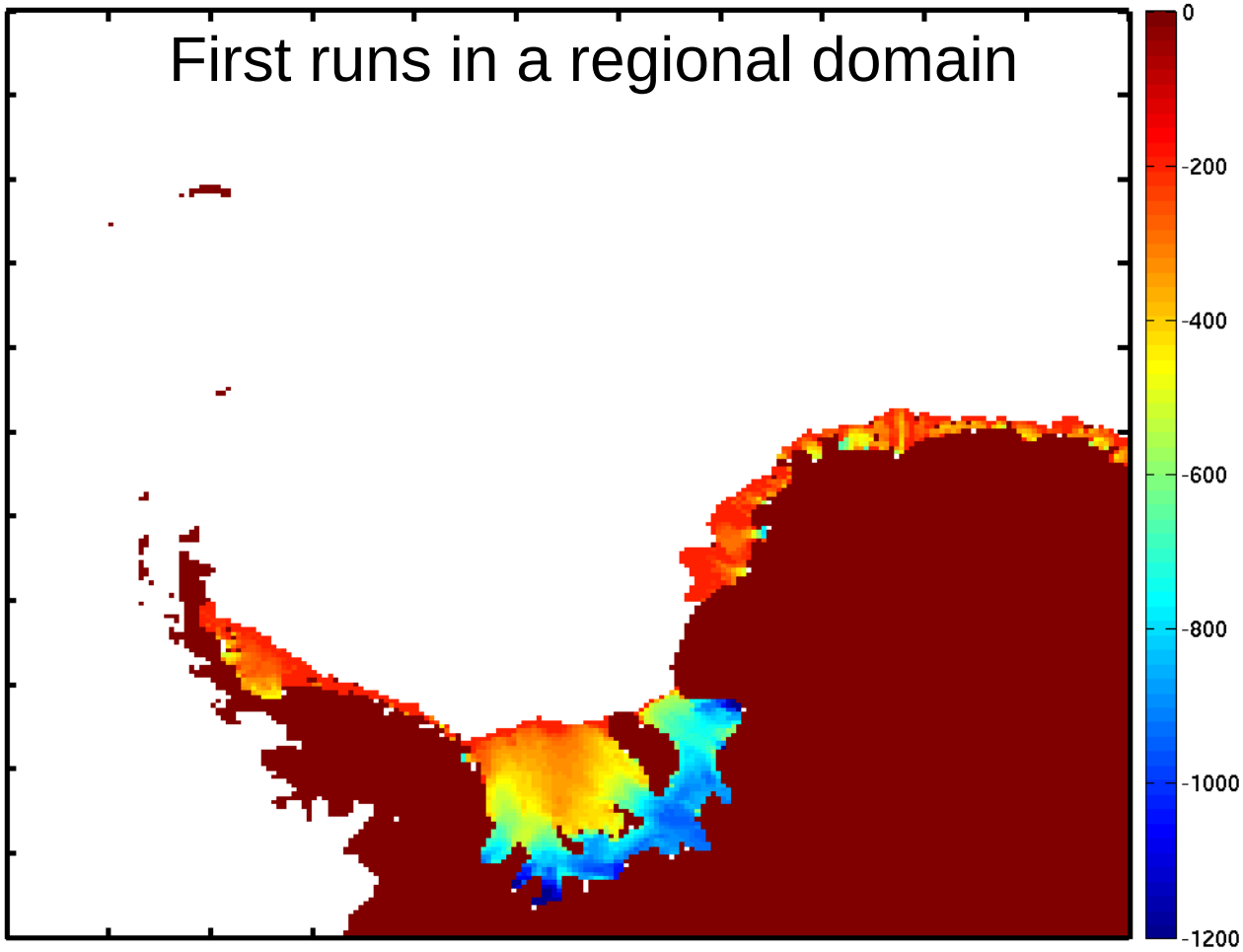


Regional Domain:

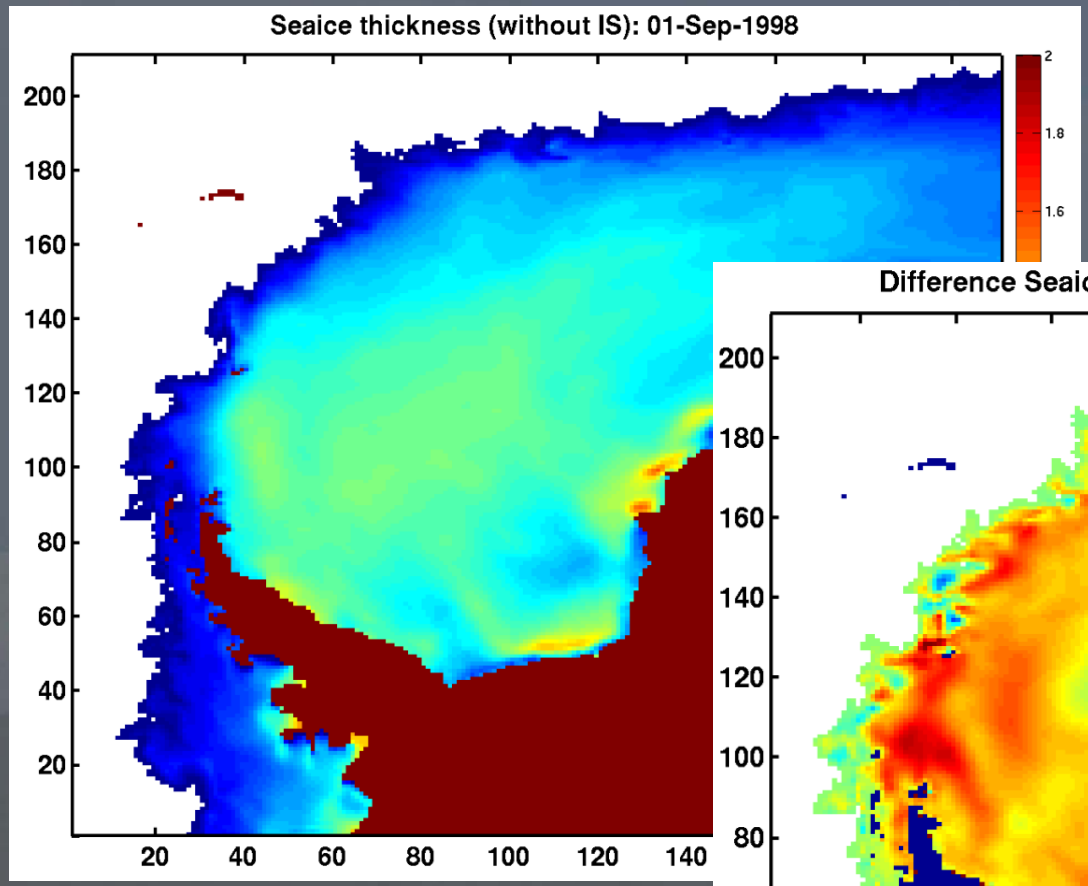
- Weddell Sea
- 220 x 220 x 50
- Boundary conditions from Cube 78
- Monthly Ocean Values
  - T, S, u, v
- Daily Sea Ice Values
  - H, A, Sn, Sl, u, v
- Ice shelf TD (Losch 2008)

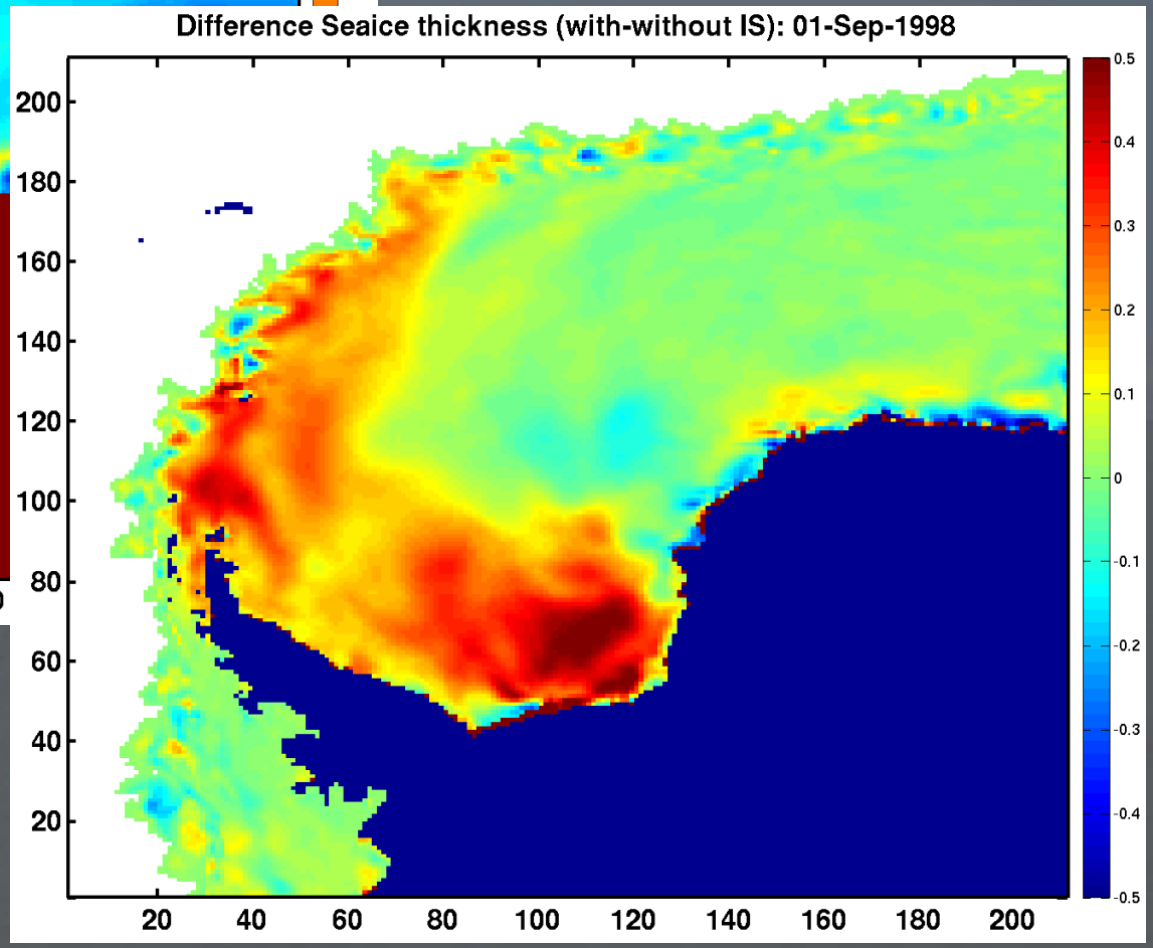
RUNS:

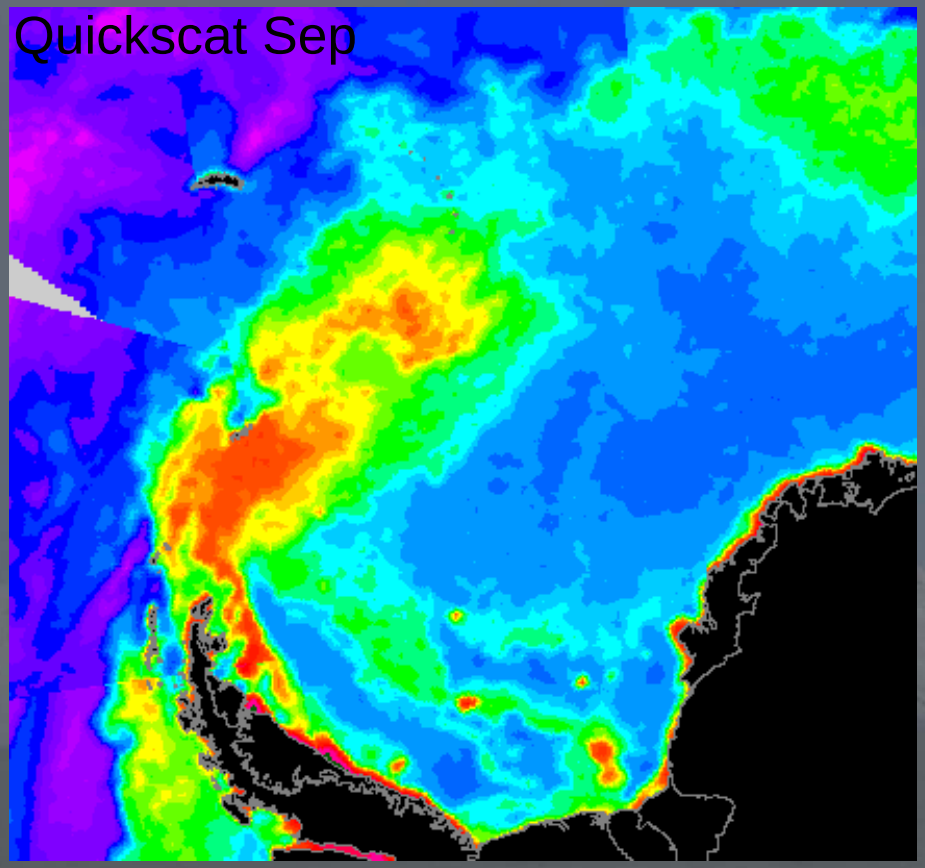
- control
- ISOMIP (Grosfeld et al., 1997)
- **BRIOS** (Hellmer and Olbers, 1989)
- Down slope flow (J-M Campin, pers. Comm.)



Sea Ice Thickness



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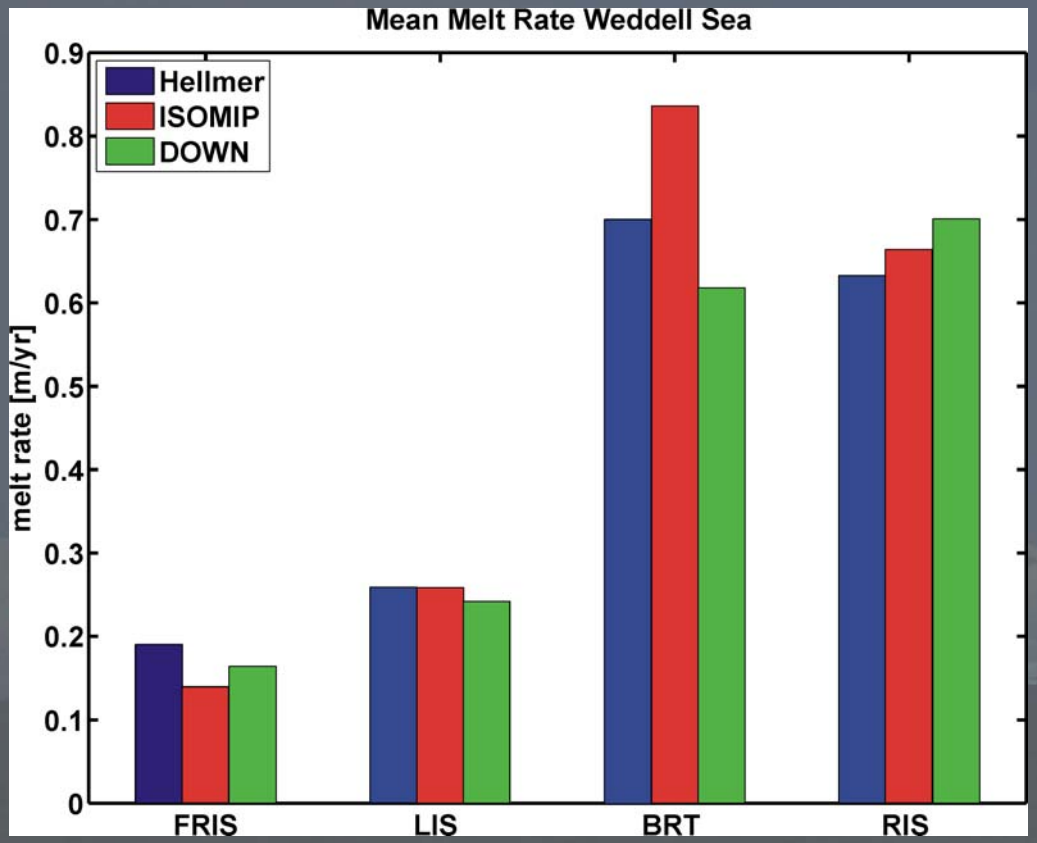
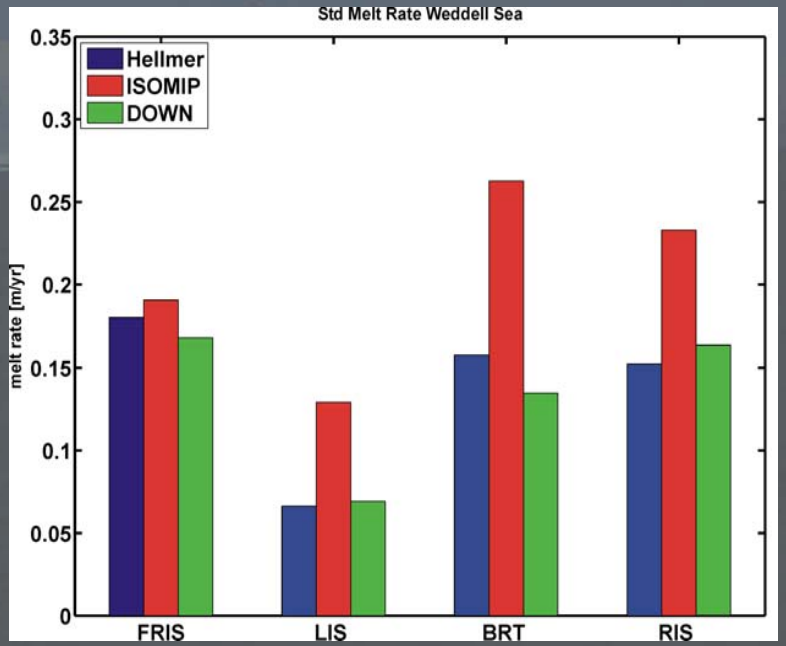
Weddell Sea Mean Ice Shelf Melt Rates (1992-1999)

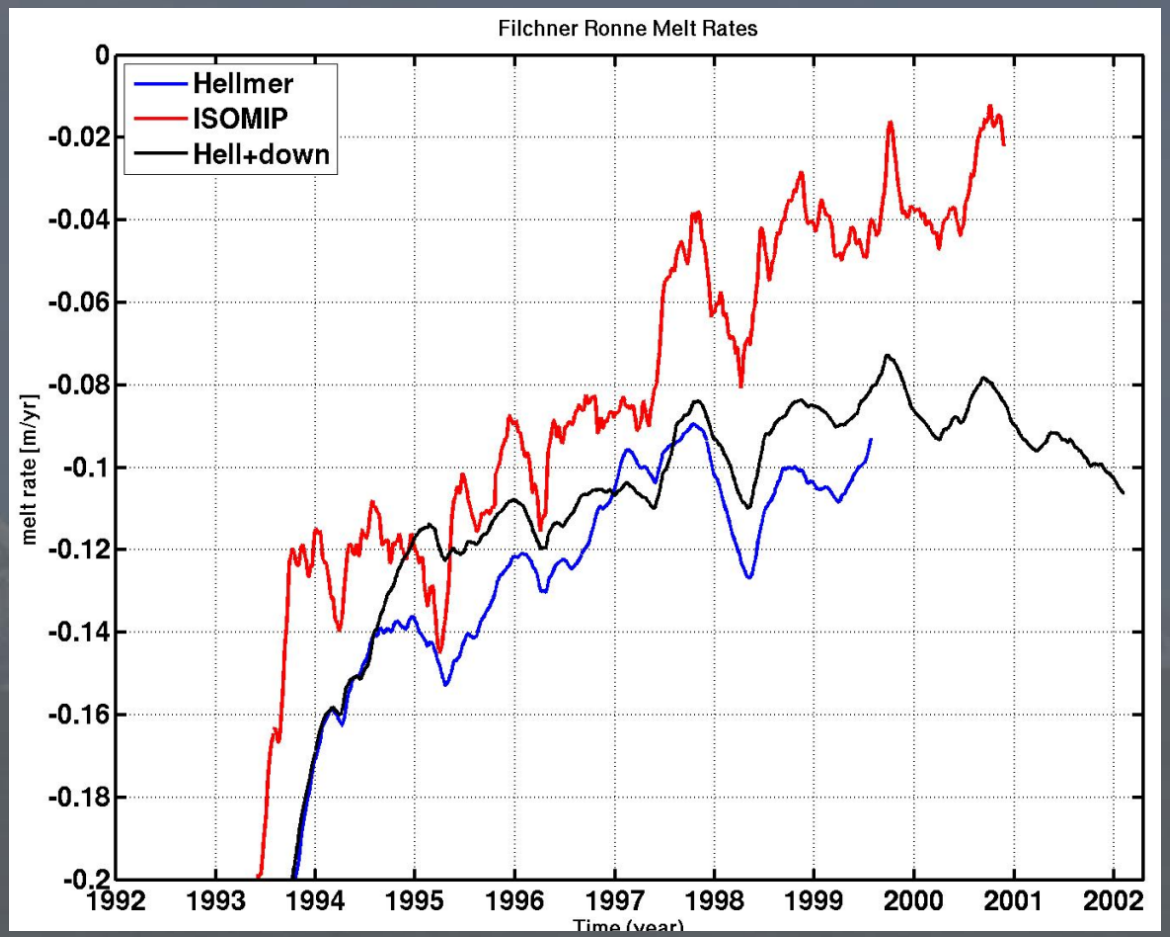




Substantially smaller than e.g. BRIOS
(**Beckmann et al., 1999, Schodlok et al., 2002, Timmermann et al., 2002**)
LIS in good agreement with estimates ()

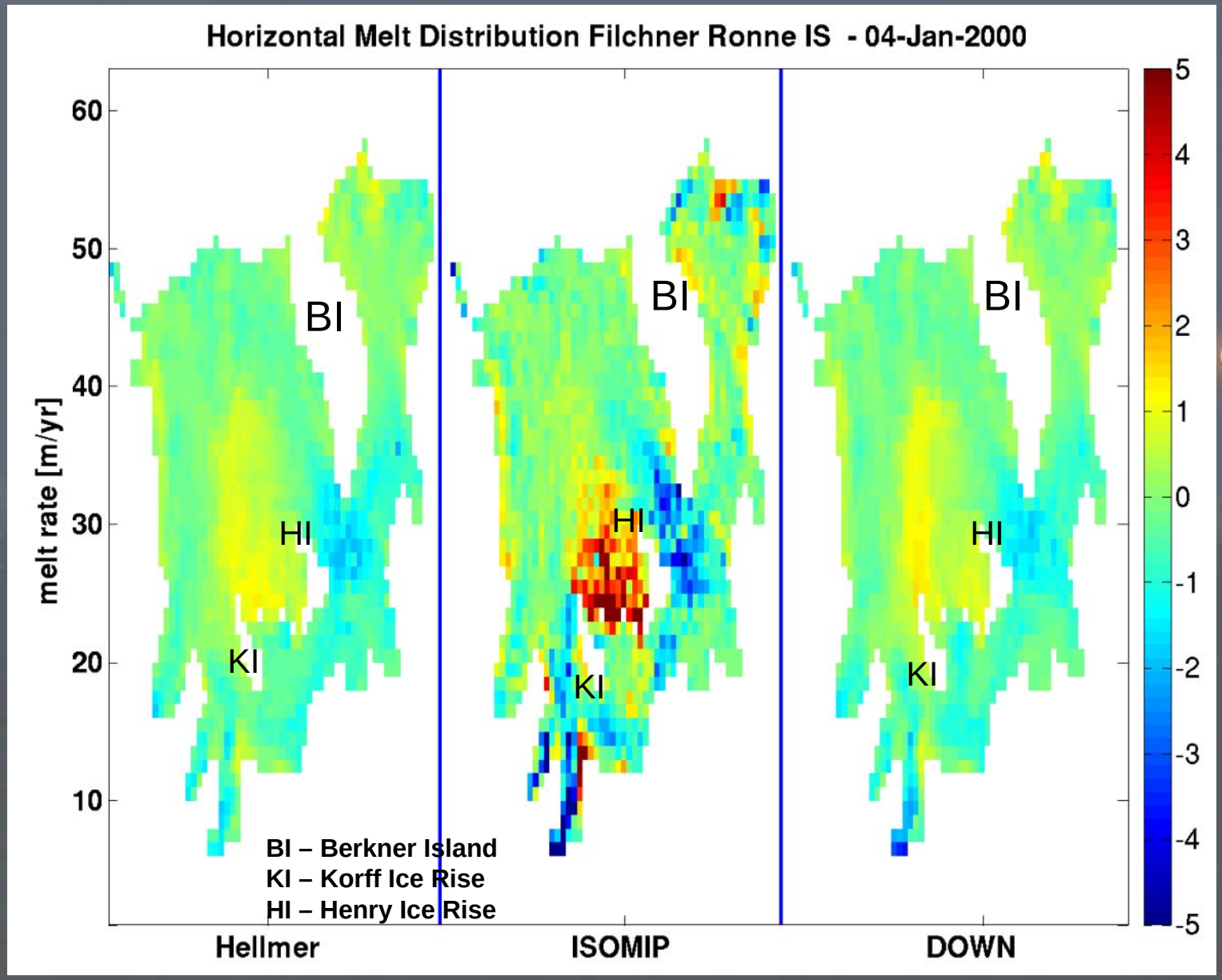
Standard deviation

Filchner Ronne Ice Shelf Melt Time Series

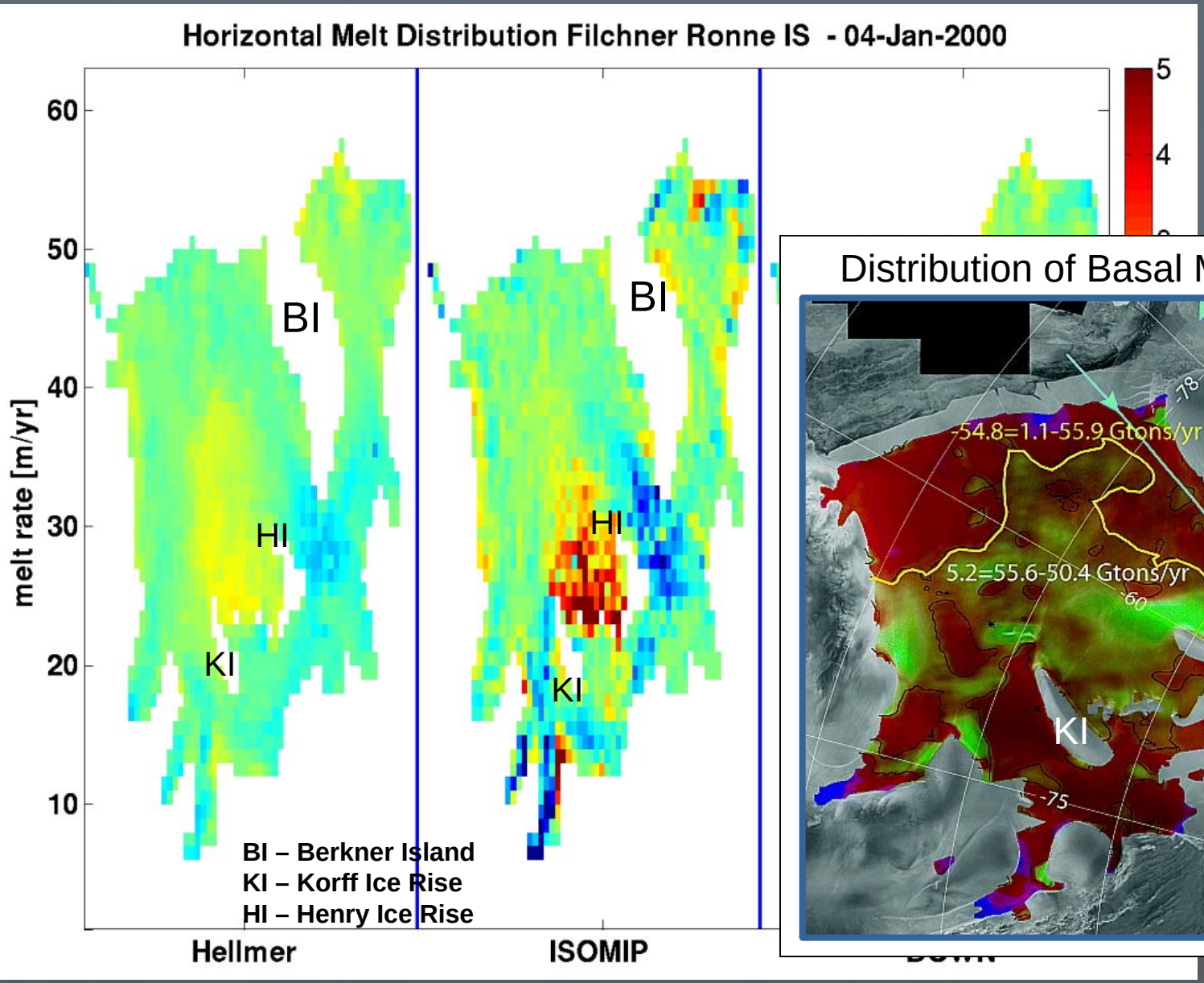


Trend:
ISOMIP: 0.017 m/yr
Hellmer: 0.012 m/yr

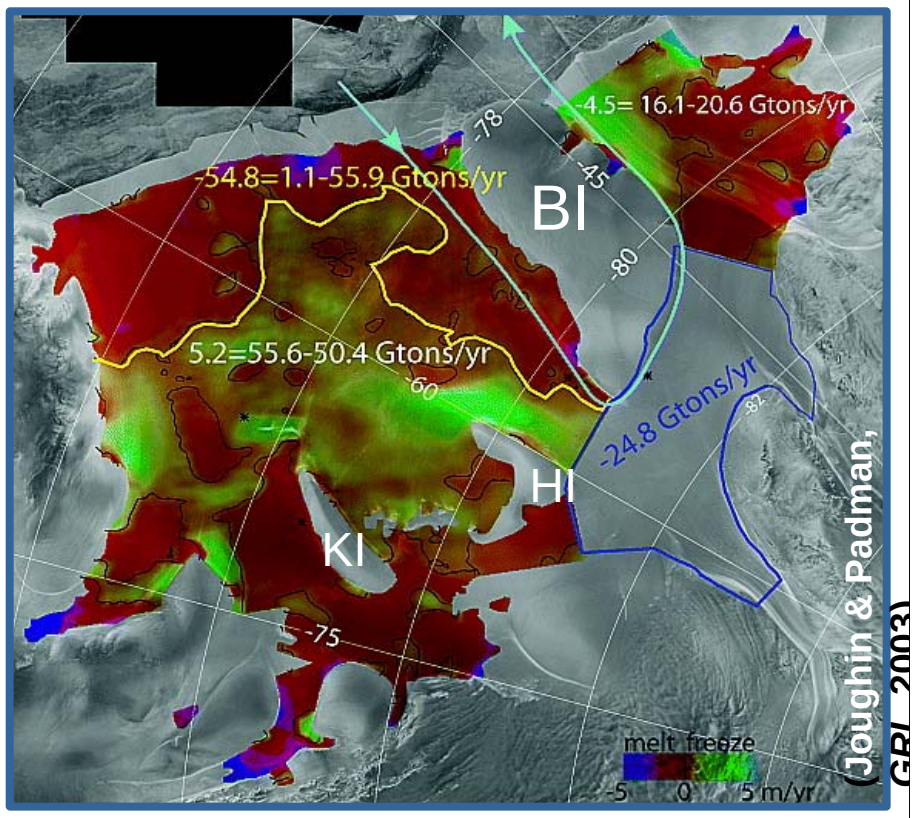
Filchner Ronne Horizontal Melt Distribution



Filchner Ronne Horizontal Melt Distribution

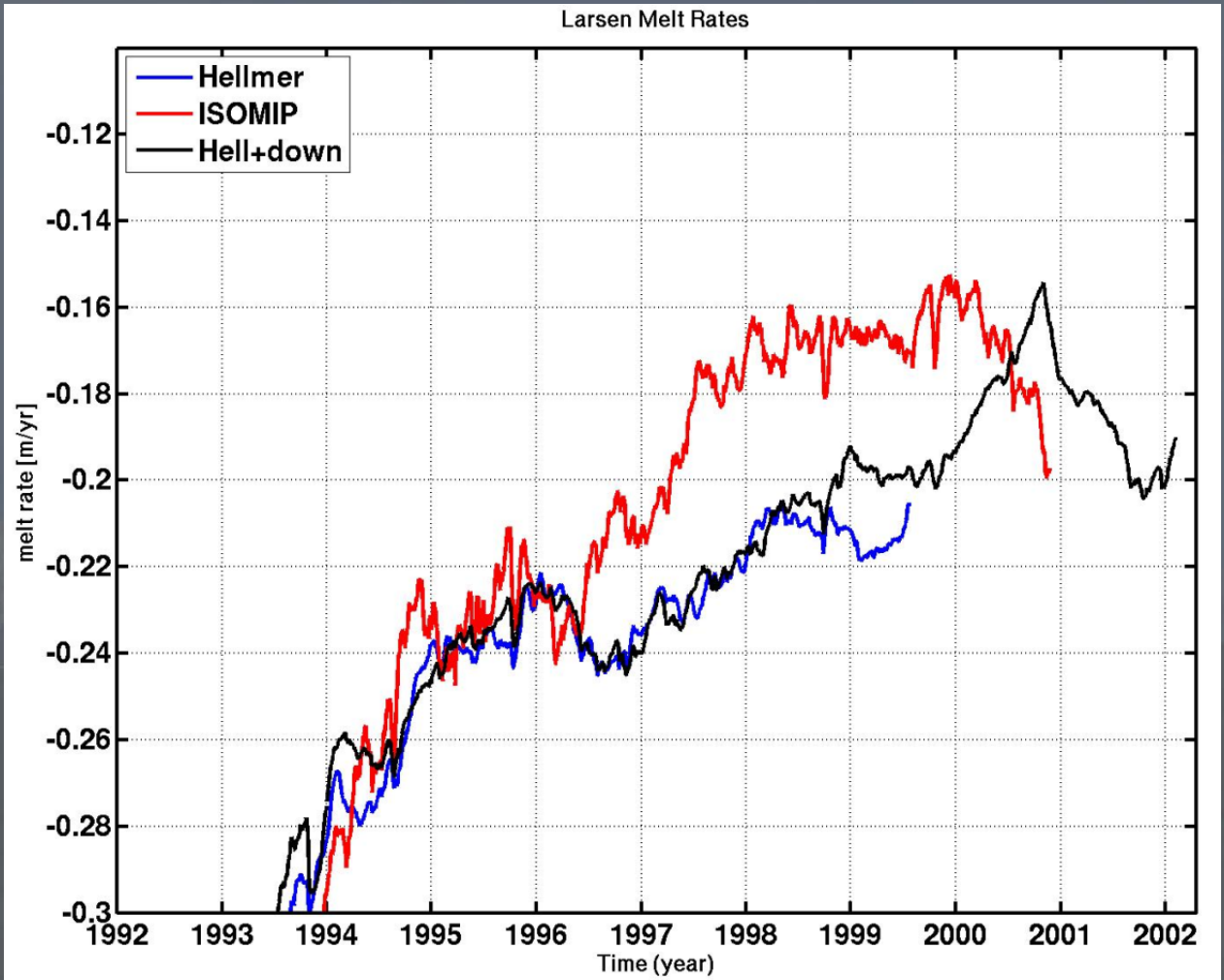


Distribution of Basal Melt/Freeze

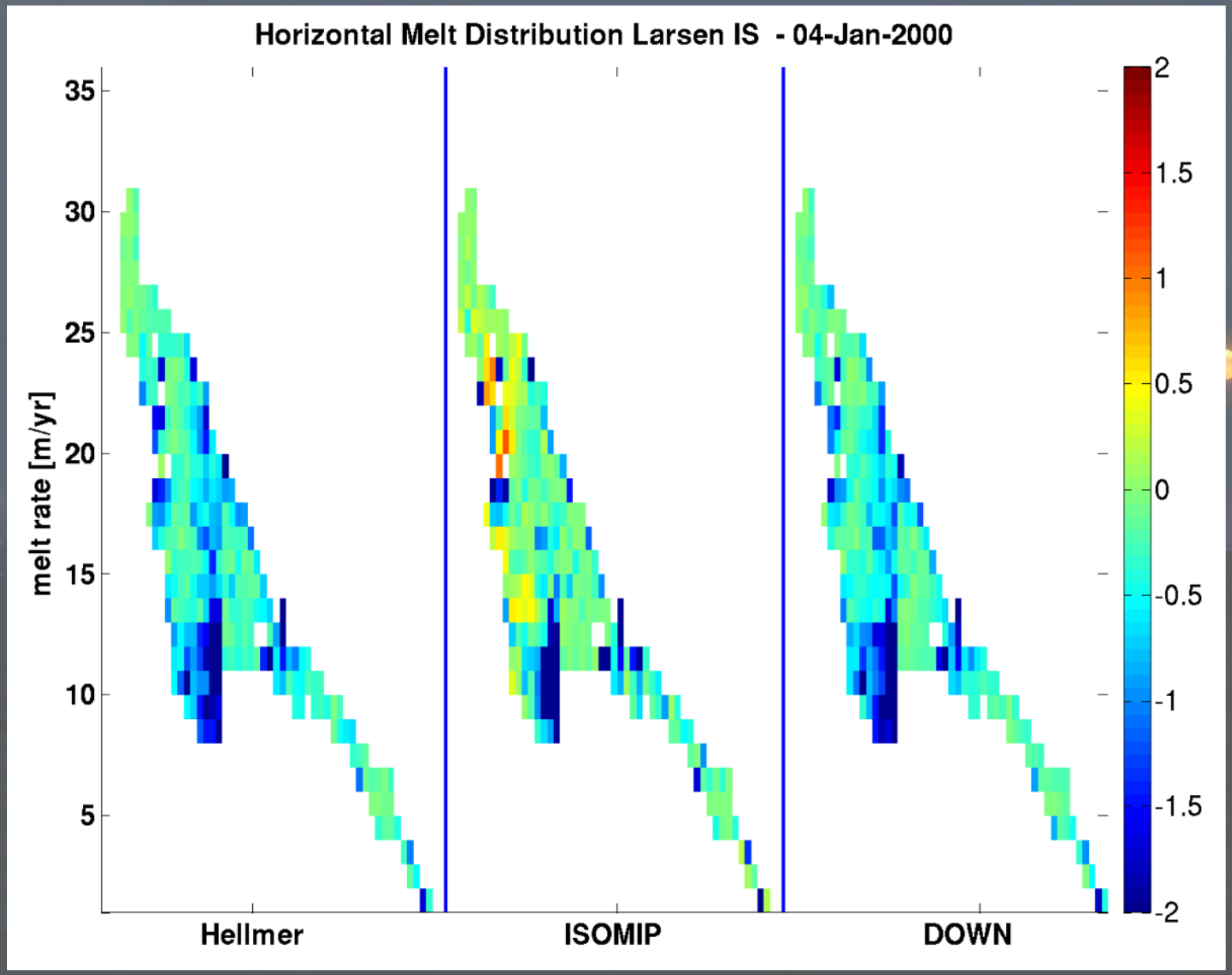


(Joughin & Padman, GRL 2003)

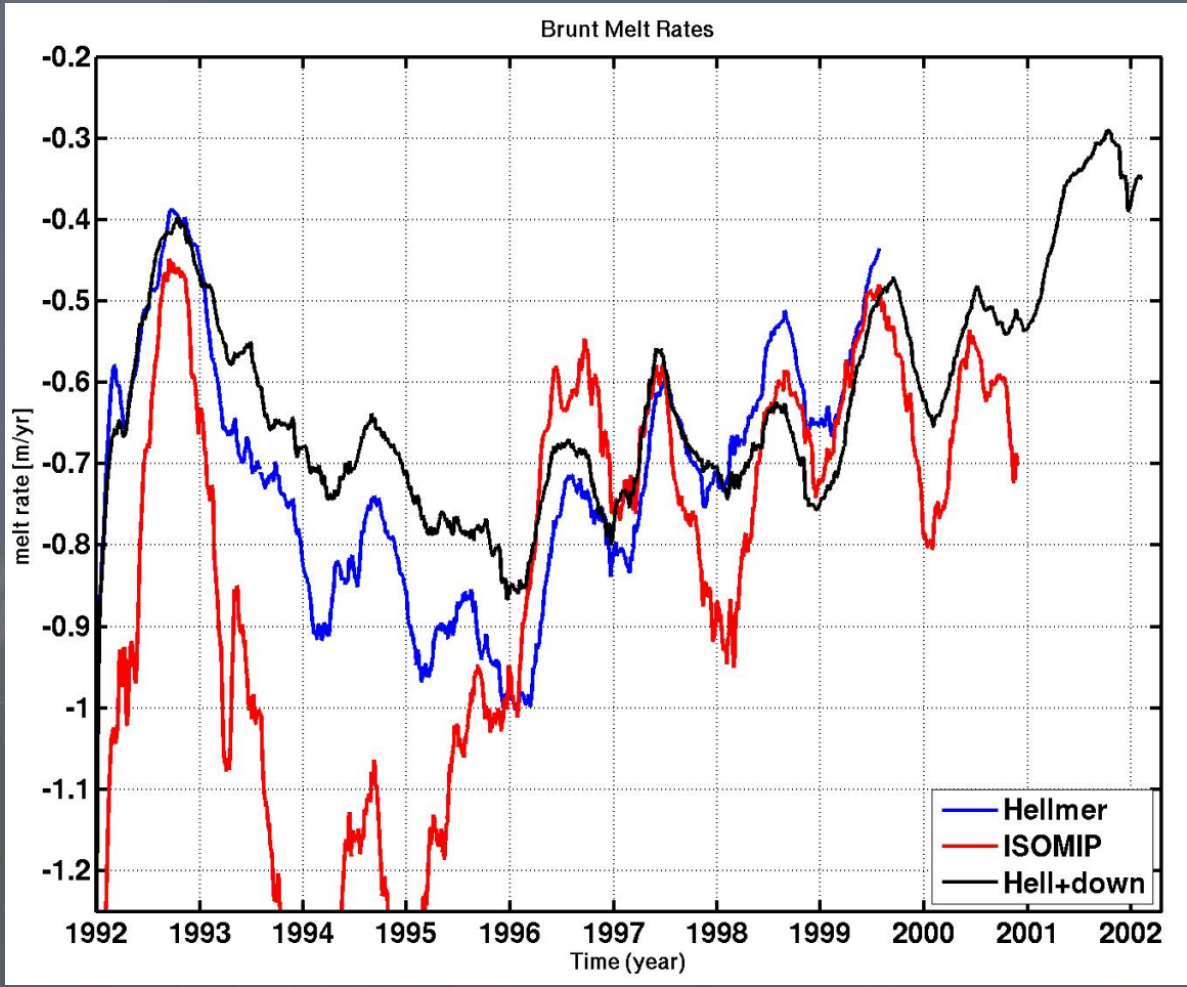
Larsen Ice Shelf Melt Rate Time Series



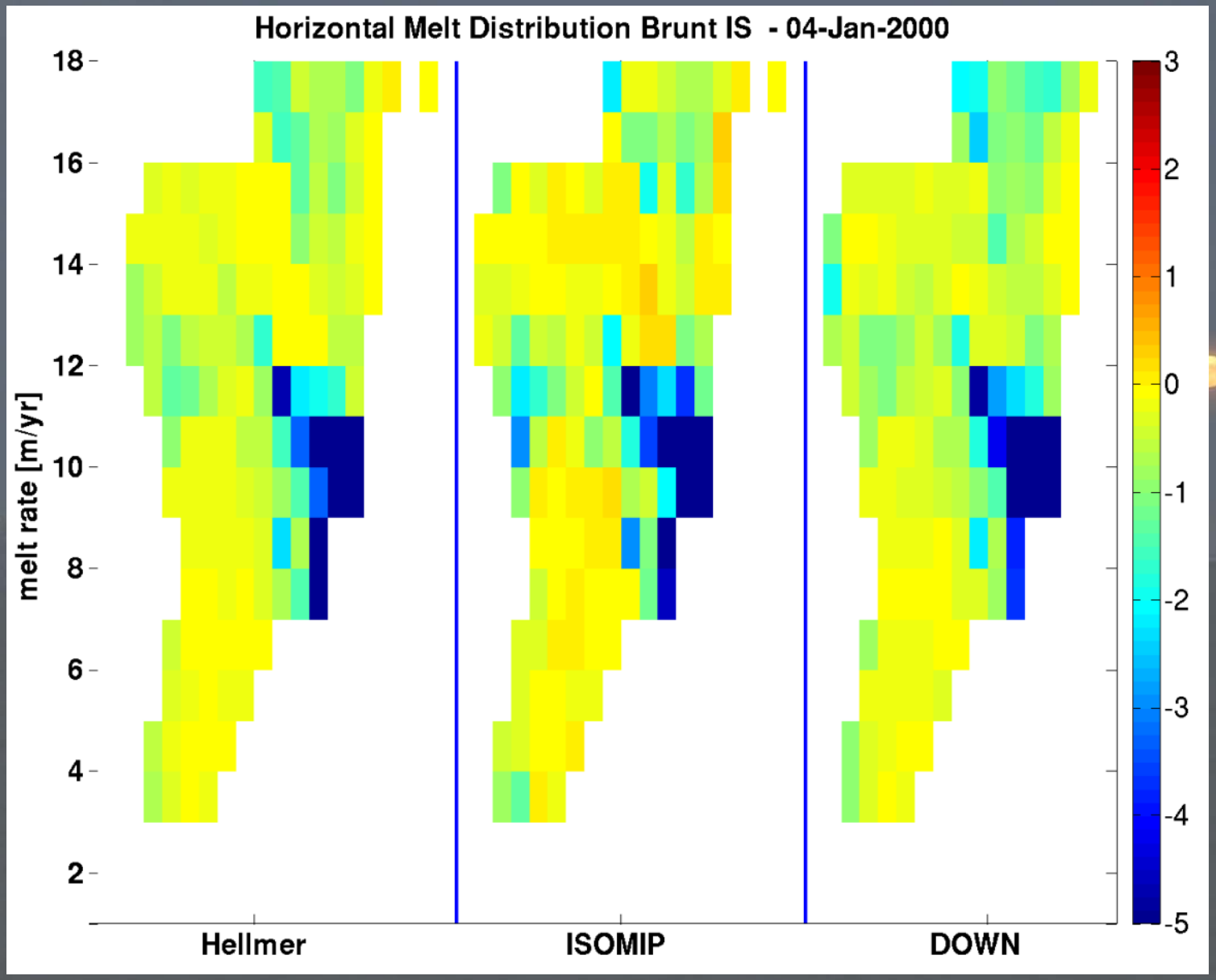
Larsen Horizontal Melt Distribution



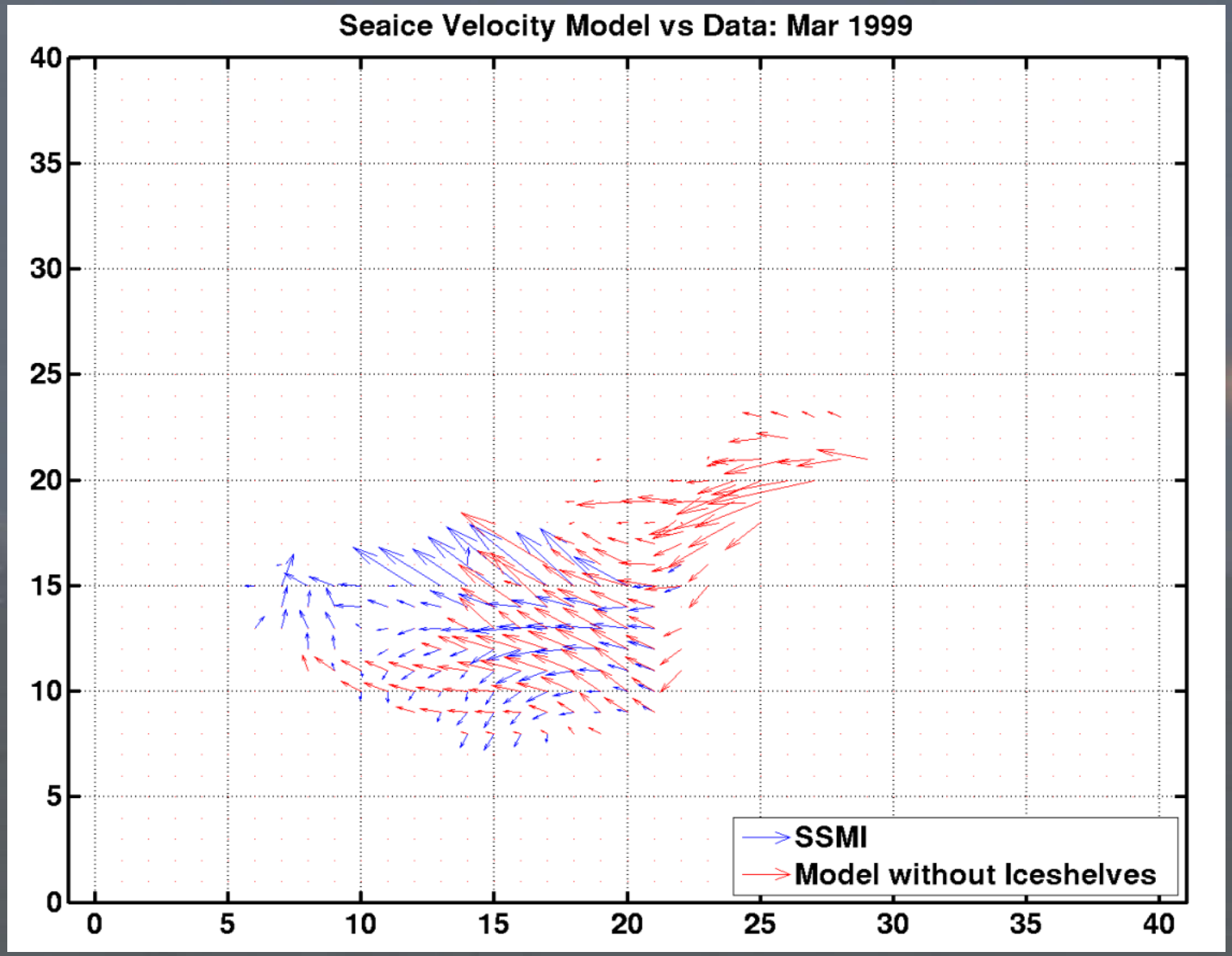
Brunt Ice Shelf Melt Rate Time Series



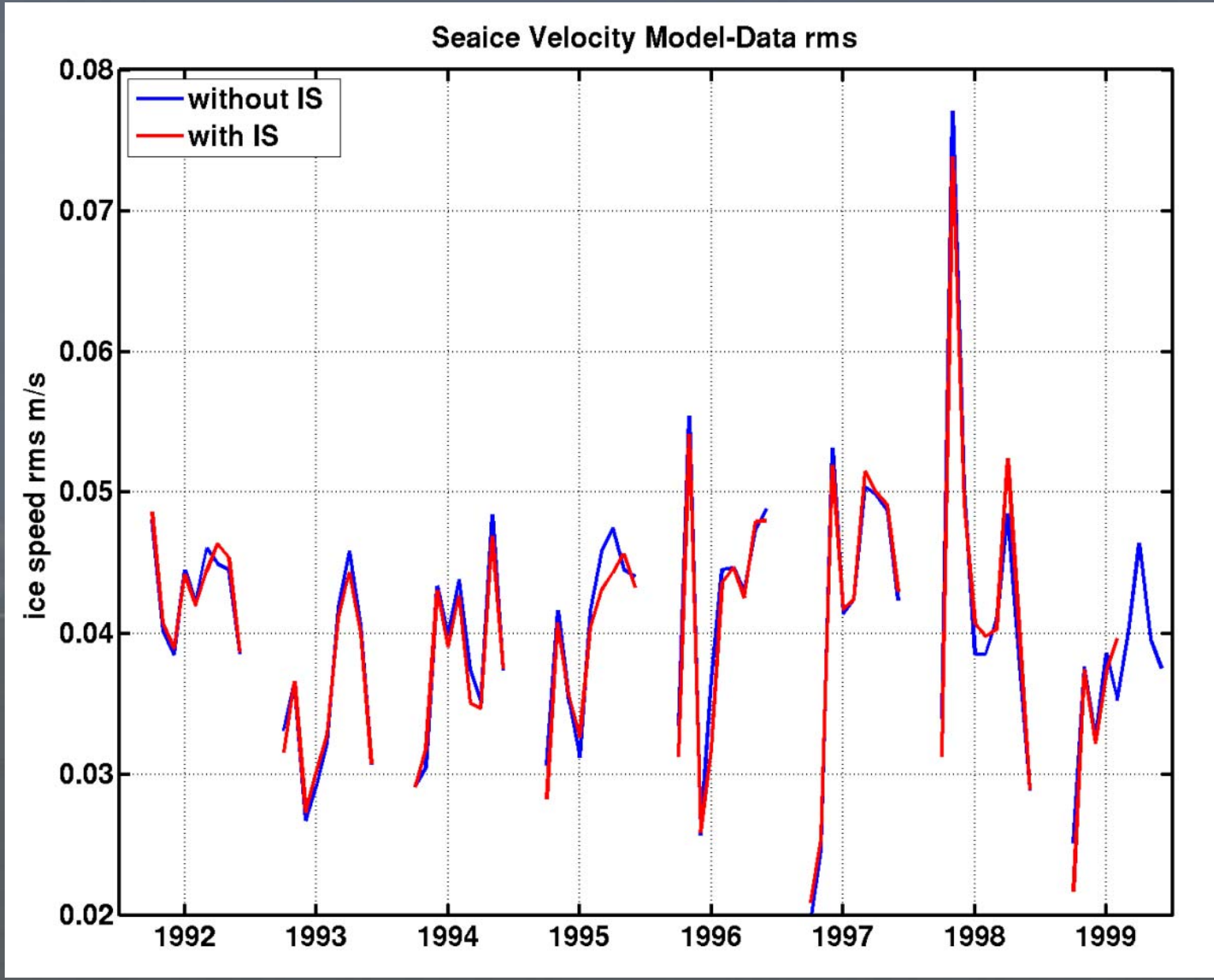
Brunt Horizontal Melt Distribution

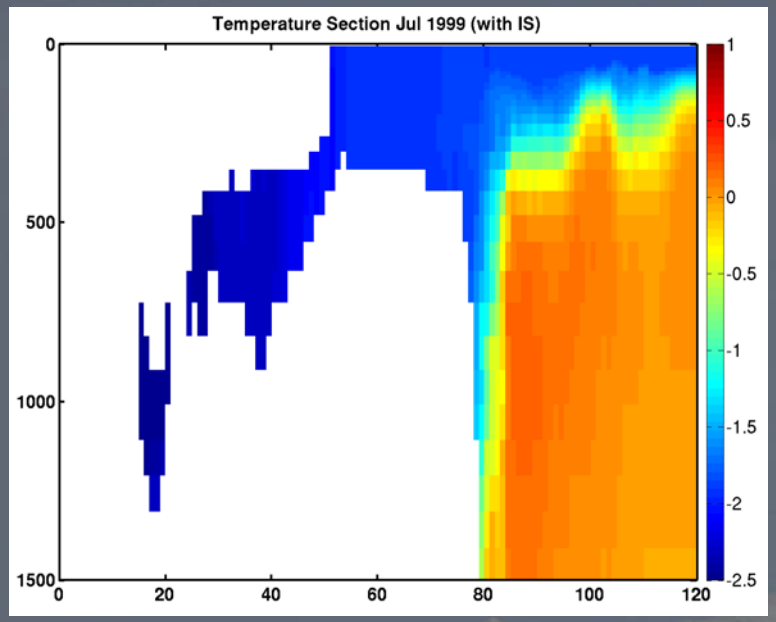


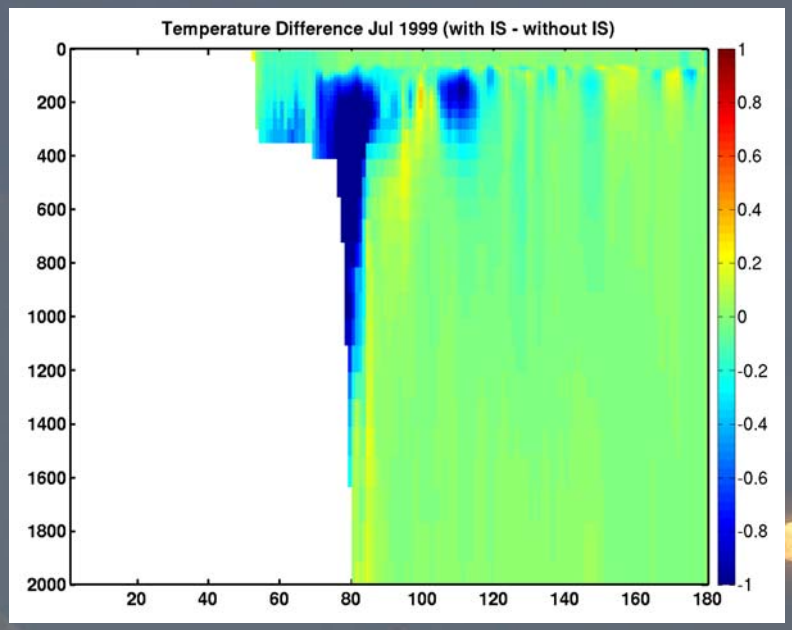
Model – Data comparison

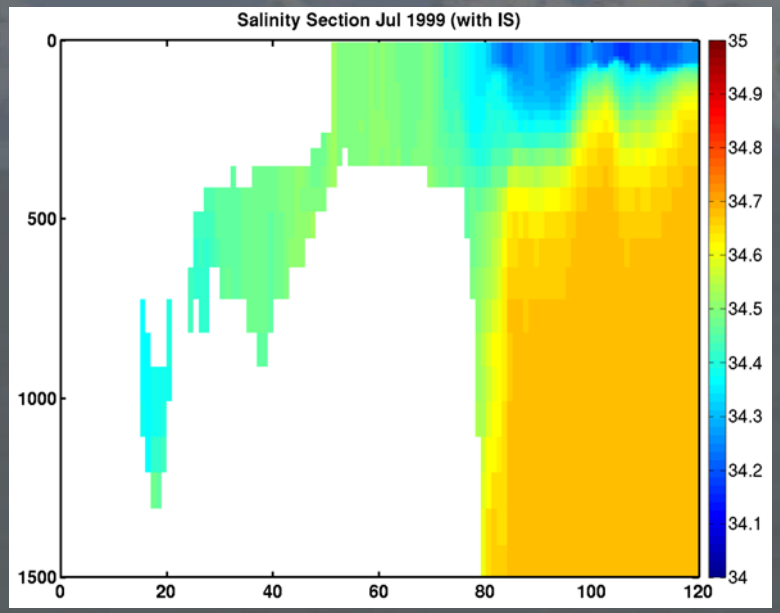


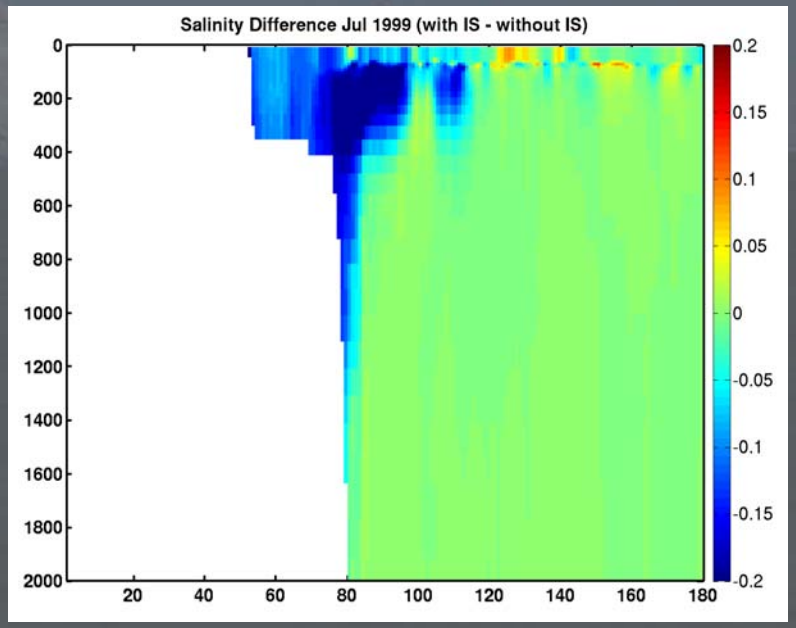
sea ice velocities from SSM/I data on 1° grid (R. Kwok)


Seaice Velocity Model-Data rms
without IS
with IS
ice speed rms m/s
0.08
0.07
0.06
0.05
0.04
0.03
0.02
1992
1993
1994
1995
1996
1997
1998
1999


Temperature Section Jul 1999 (with IS)
0
500
1000
1500
0
20
40
60
80
100
120
1
0.5
0
-0.5
-1
-1.5
-2
-2.5


Temperature Difference Jul 1999 (with IS - without IS)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
20
40
60
80
100
120
140
160
180
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1


Salinity Section Jul 1999 (with IS)
0
500
1000
1500
0
20
40
60
80
100
120
35
34.9
34.8
34.7
34.6
34.5
34.4
34.3
34.2
34.1
34


Salinity Difference Jul 1999 (with IS - without IS)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
20
40
60
80
100
120
140
160
180
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2

Summary and Outlook

- working Ice Shelf – Ocean Interaction Package
- smaller melt rates than previous estimates
- trend in the Filchner Ronne melt rates
- minor improvements to sea ice velocities

Summary and Outlook

- IceSat/Glas data set for ice shelf thickness
- improved version of downslope flow package
- parameter optimization for Weddell Sea domain
- global ECCO2 run with ice shelf package implemented

Thank You