New Synthesis of Arctic Freshwater Budget & Fluxes

Thomas Haine
Earth & Planetary Sciences,
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Cape Farewell, Greenland, Aug 2004

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FAMOS Meeting
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Thanks to:
Beth Curry, Edmond Hansen, Craig Lee,
Bert Rudels, Gunnar Spreen, Laura de Steur,
Kial Stewart, Rebecca Woodgate

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10th ASOF-ISSG Meeting and Workshop
Arctic Freshwater Export: Prospects, Impacts & Challenges
8—10 October 2012

Venue: Forte Santa Teresa, Pozzuolo di Lerici (SP), Italy

http://www.asof.awi.de/

Haine et al., review in prep. for Global & Planetary Change

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11th ASOF-ISSG Meeting and Workshop
4-6 November 2013
Finnish Meteorological Institute, Helsinki, Finland

FINNISH METEOROLOGICAL INSTITUTE

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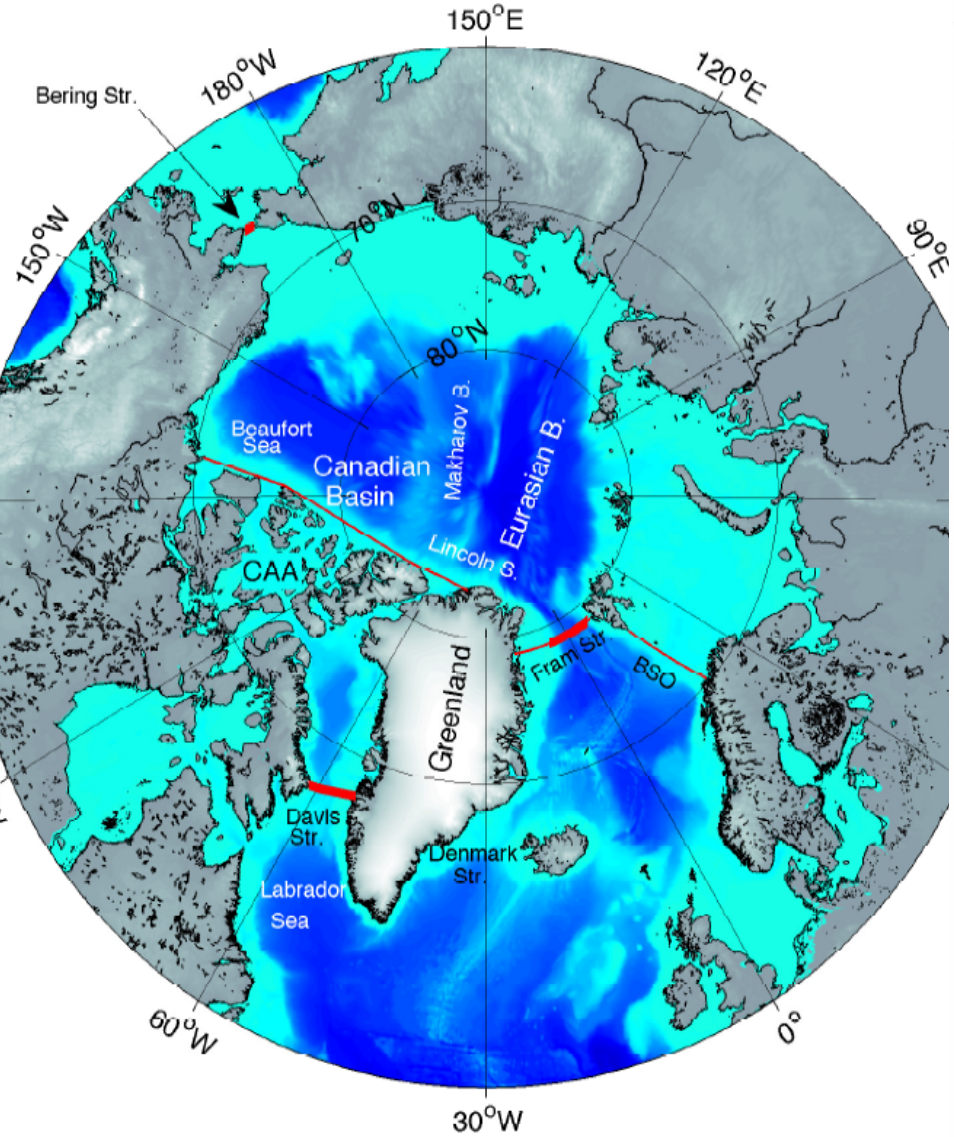
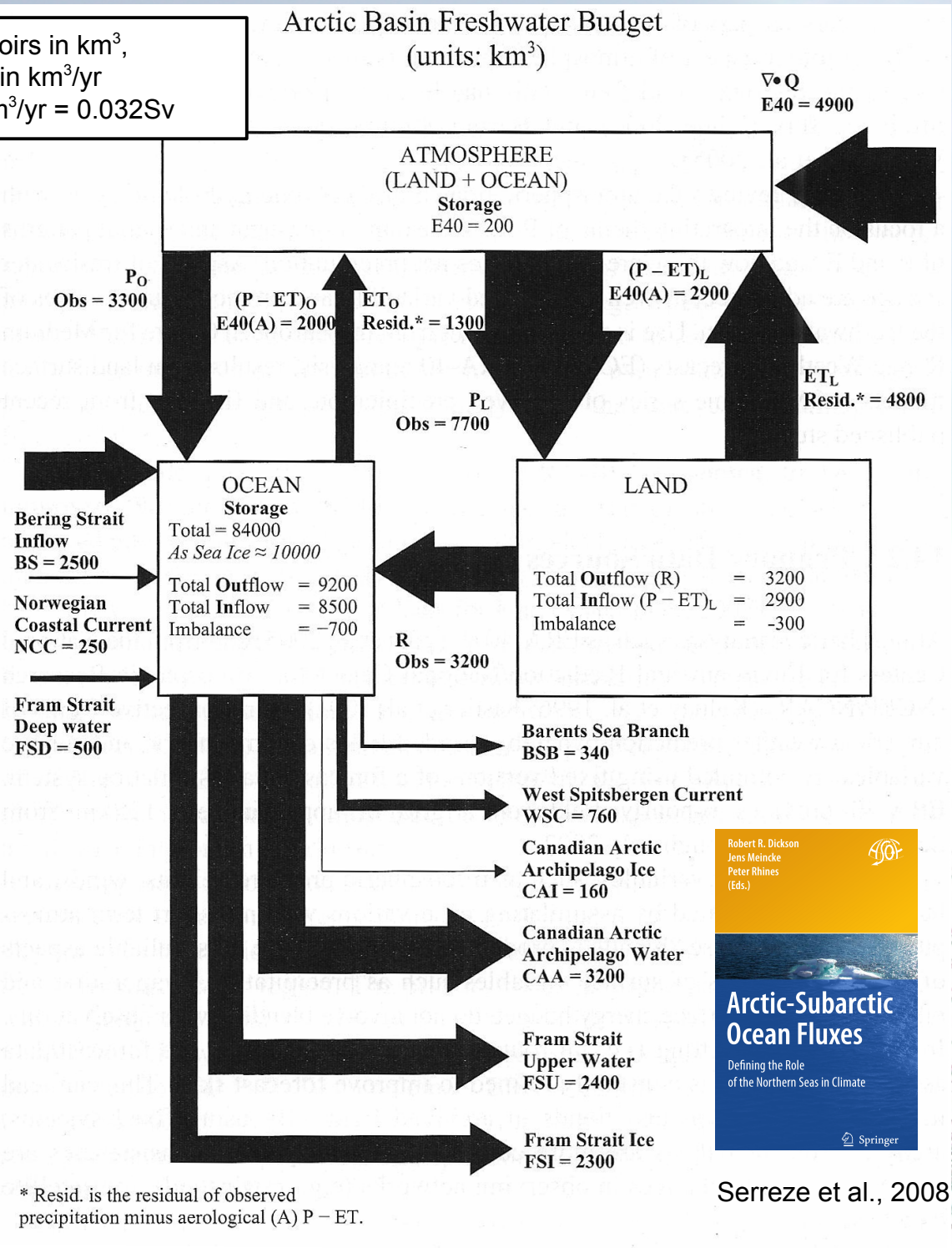
Arctic Freshwater Budget 1980-2000

Reservoirs in km^3,
Fluxes in km^3/yr
1000km^3/yr = 0.032Sv



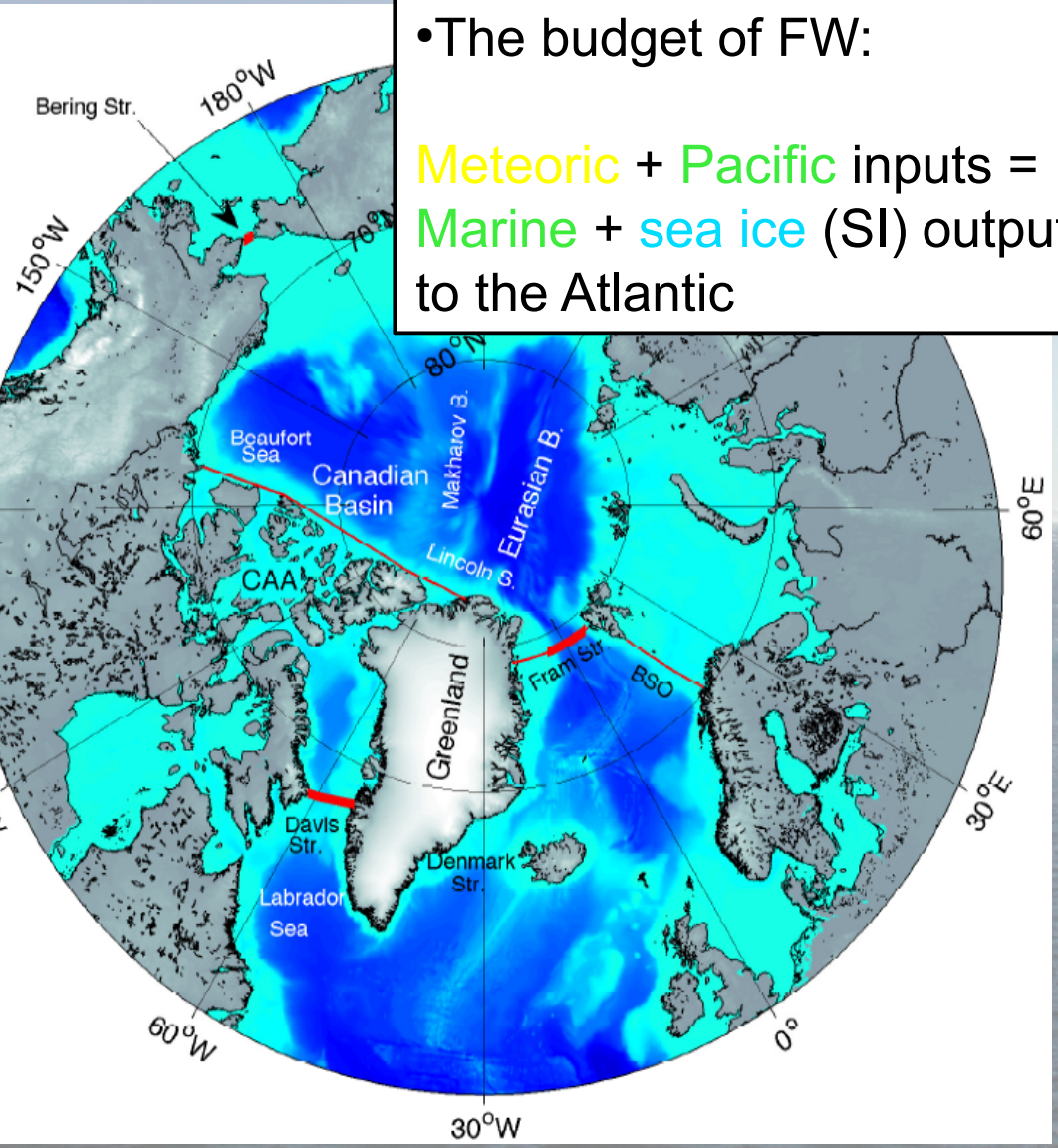


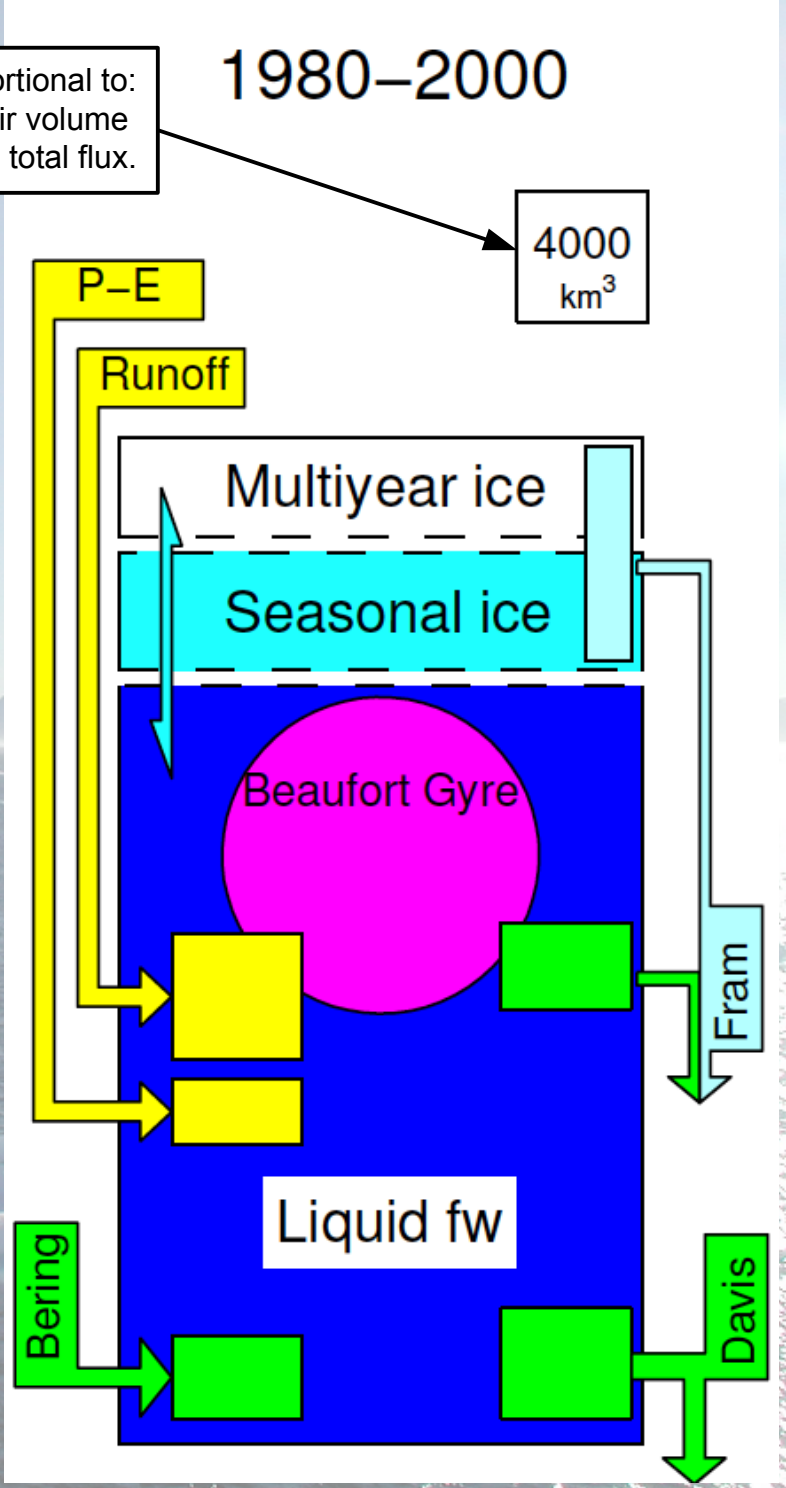
Serreze et al., 2008.

Arctic Freshwater Budget 1980-2000

- The budget of FW:

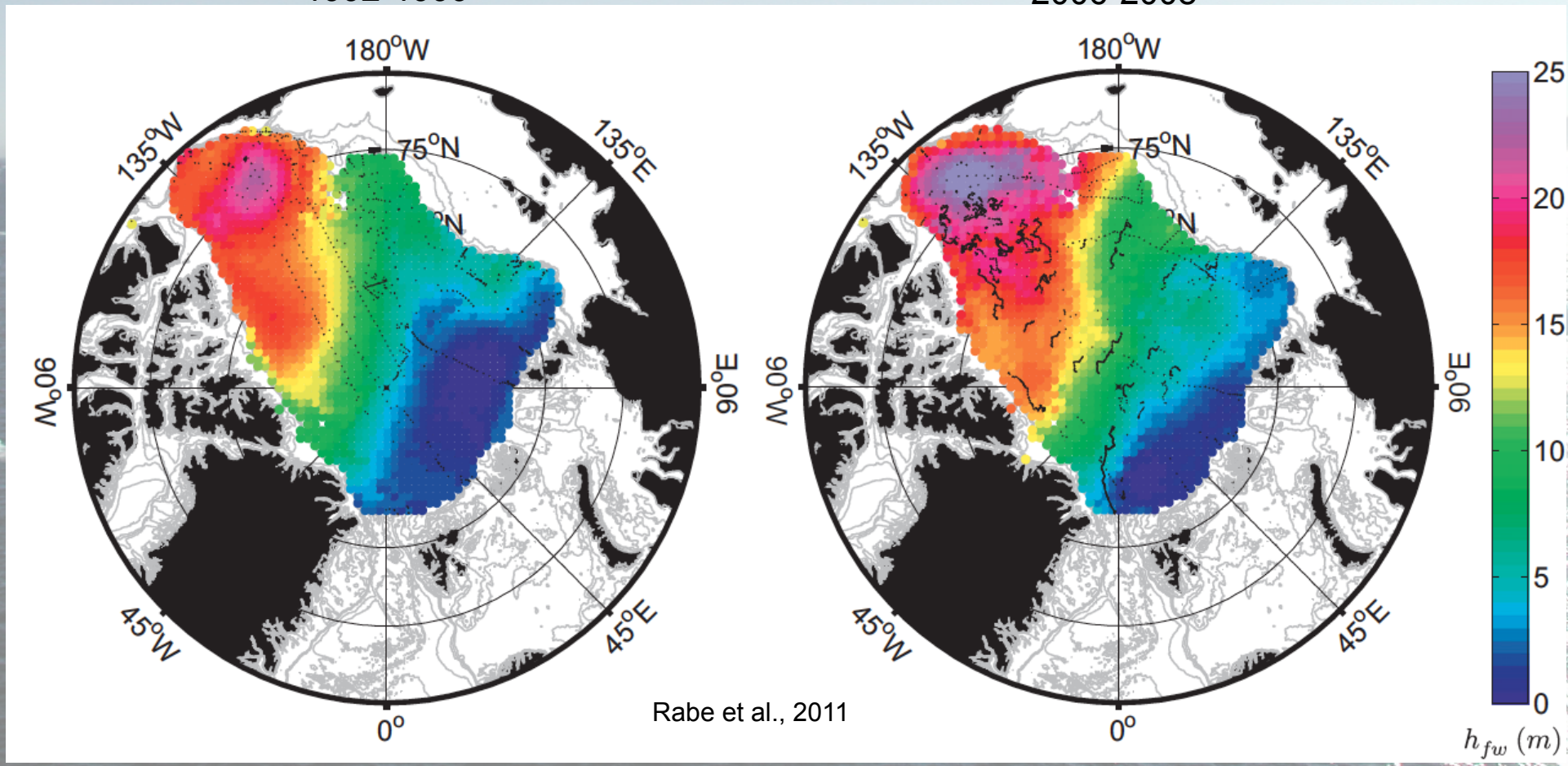
Meteoric + Pacific inputs = Marine + sea ice (SI) outputs to the Atlantic





Arctic freshwater is accumulating in the 2000s

Canada basin is 1-3psu fresher than pre-1990s climatology
Morison et al., 2012



Rabe et al., 2011

Arctic freshwater is accumulating in the 2000s

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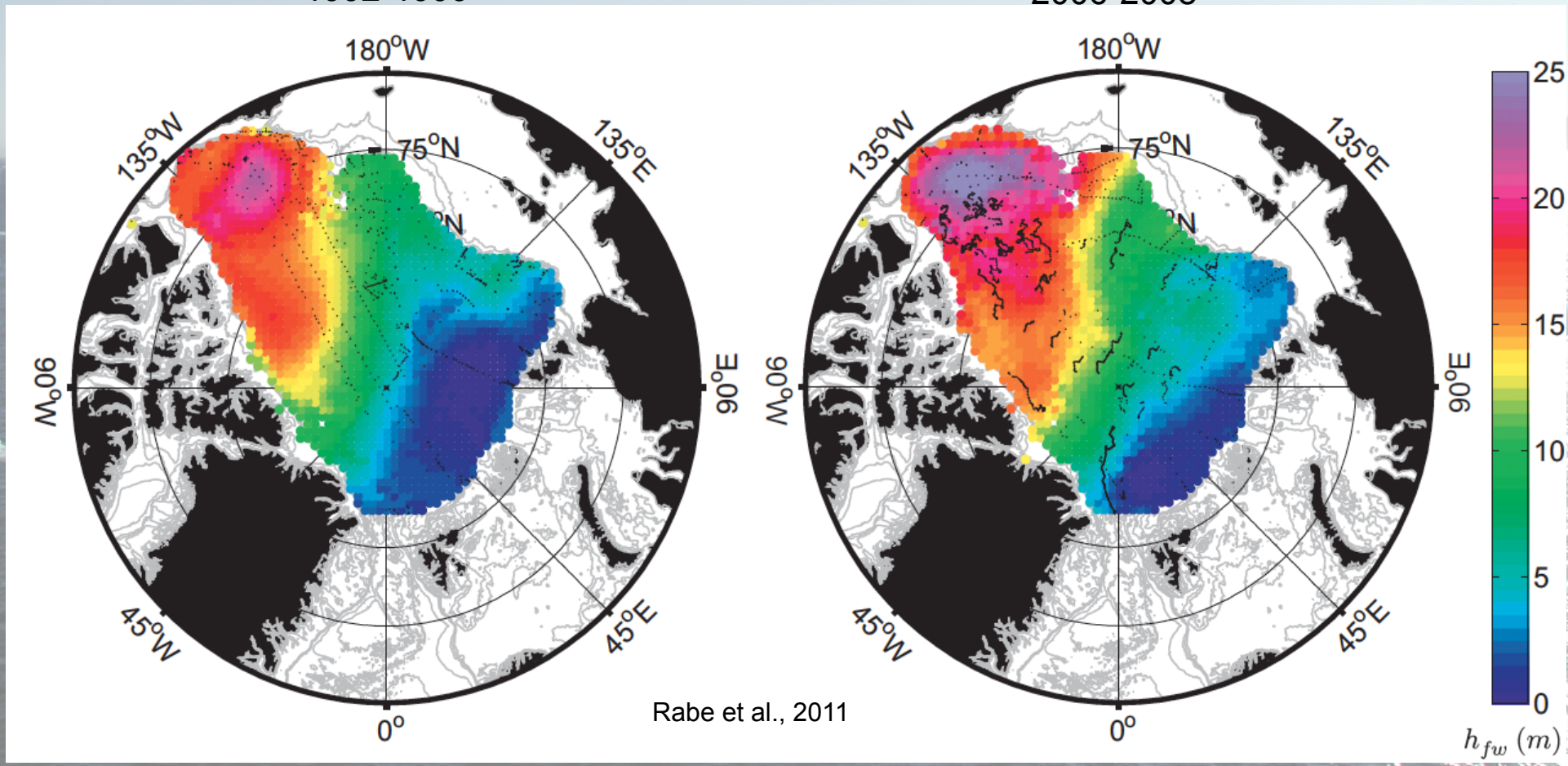
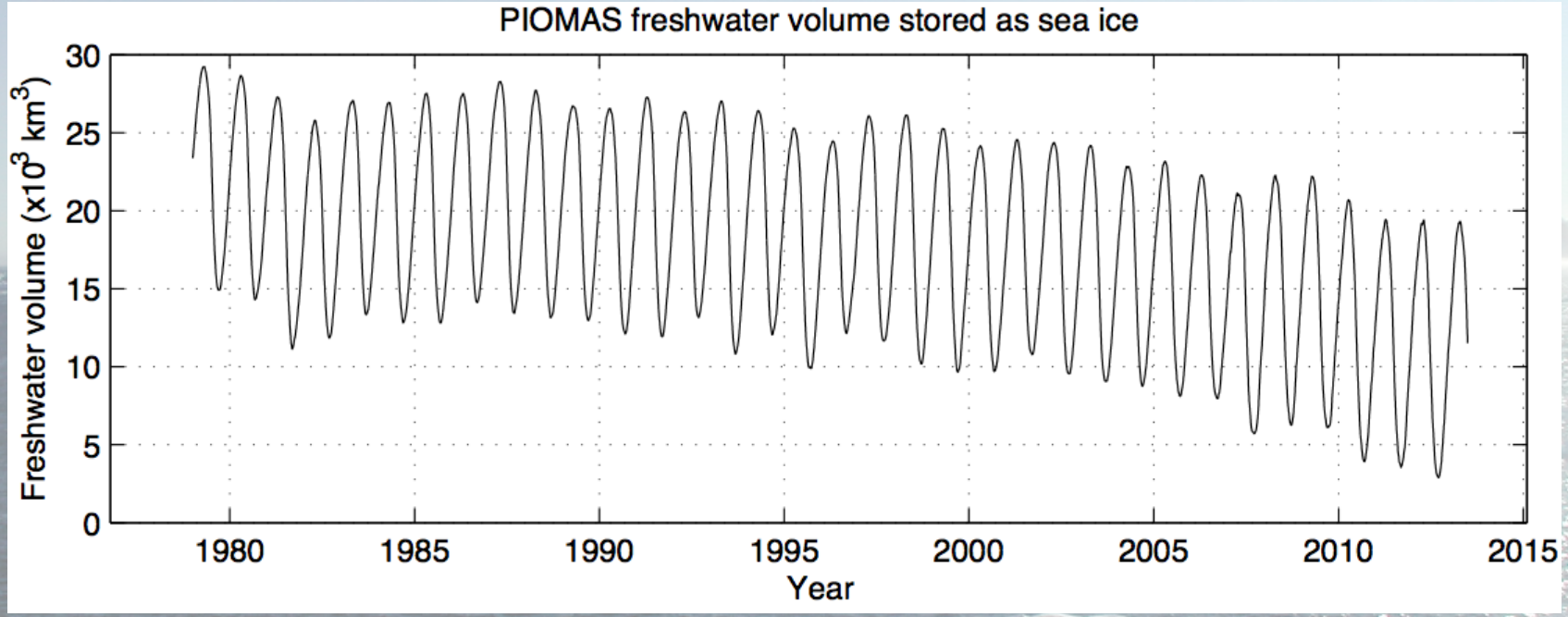
- Climatology to 2008: 8,500km^3 in Canada/Makarov Basins. McPhee et al., 2009.
- '92-'99 to '06-'08: 8,400km^3 in the Arctic ocean. Rabe et al., 2011.
- 1995 to 2010: 8,000±2,000km^3 in the W. Arctic Ocean. Giles et al., 2012.
- 1992 to 2012: 12,000km^3 in the Arctic ocean. Rabe et al., 2013.



Rabe et al., 2011

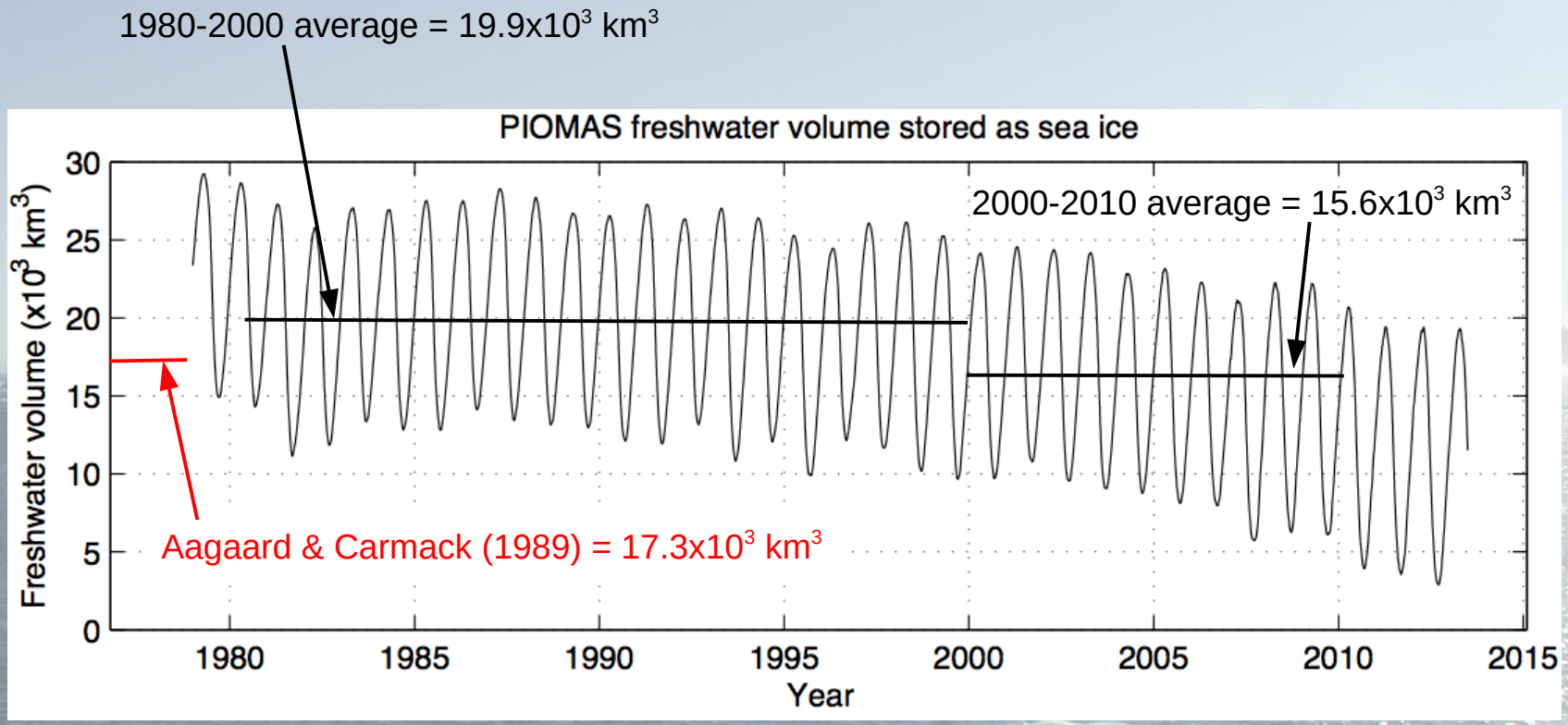
Sea ice volume changes in the 2000s



PIOMAS (Pan-Arctic Ice-Ocean Modeling and Assimilation System) data from UW-APL

Sea ice volume changes in the 2000s

- PIOMAS sea ice volume loss: -22% (4300km^3) for '00-'10 average minus '80-'00
- 3800km^3 for Oct-Nov '10-'12 minus '03-'08 (Laxon et al., 2013) – PIOMAS has 3600km^3

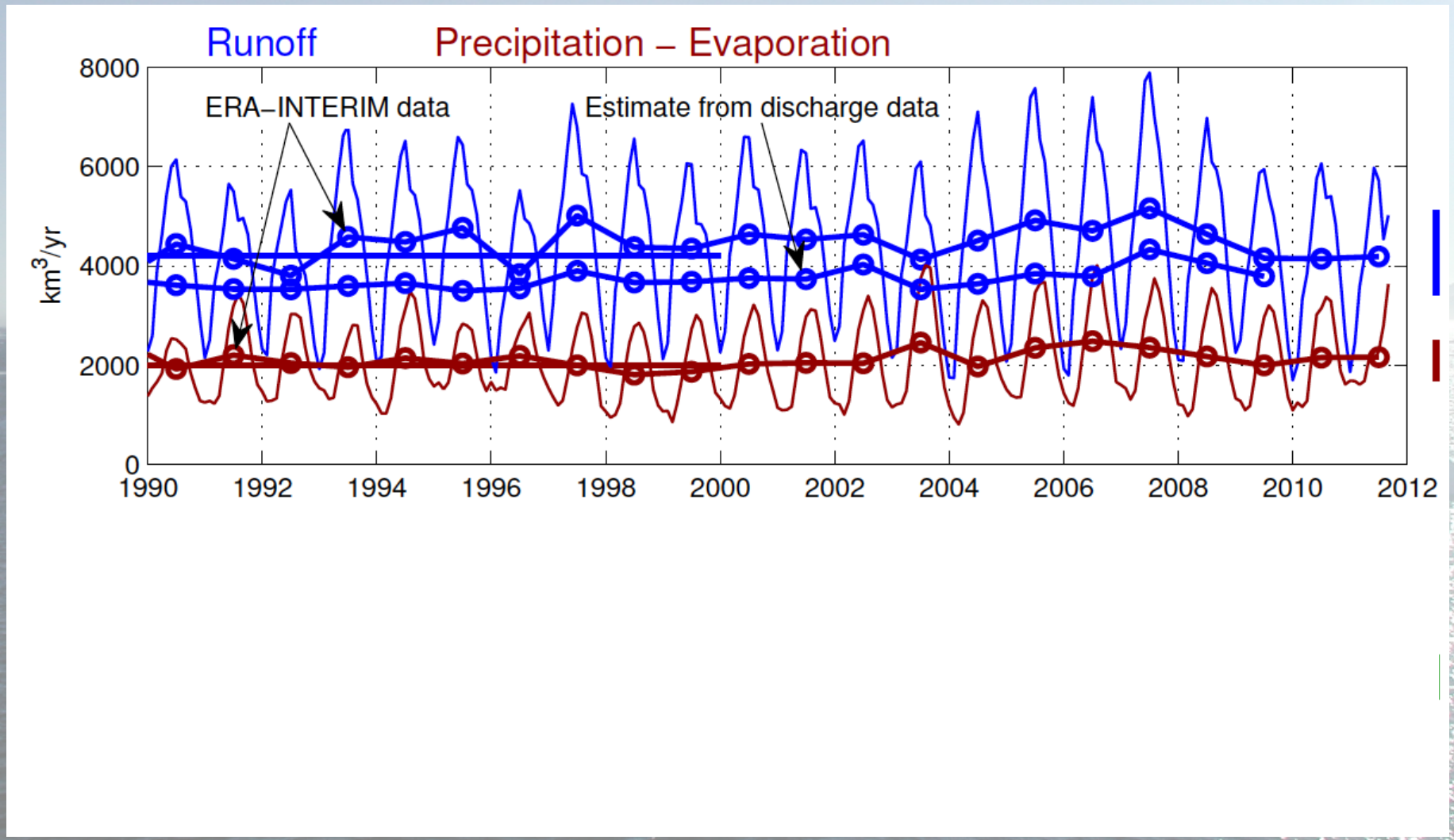


PIOMAS (Pan-Arctic Ice-Ocean Modeling and Assimilation System) data from UW-APL

Import flux changes in the 2000s

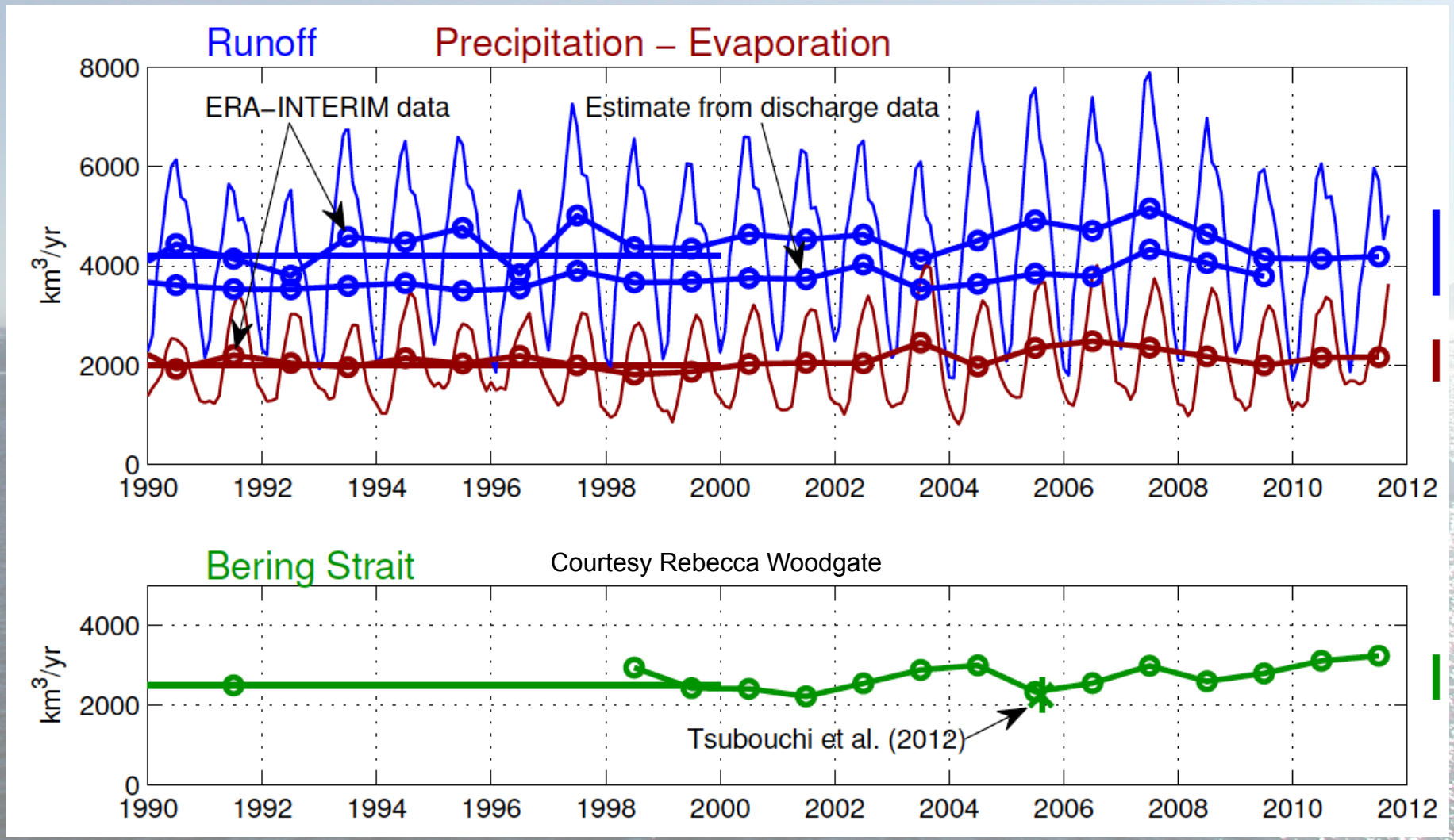
- P-E increases by 10%
- Runoff increases by 8%

for '00-'10 average cf. '80-'00



Import flux changes in the 2000s

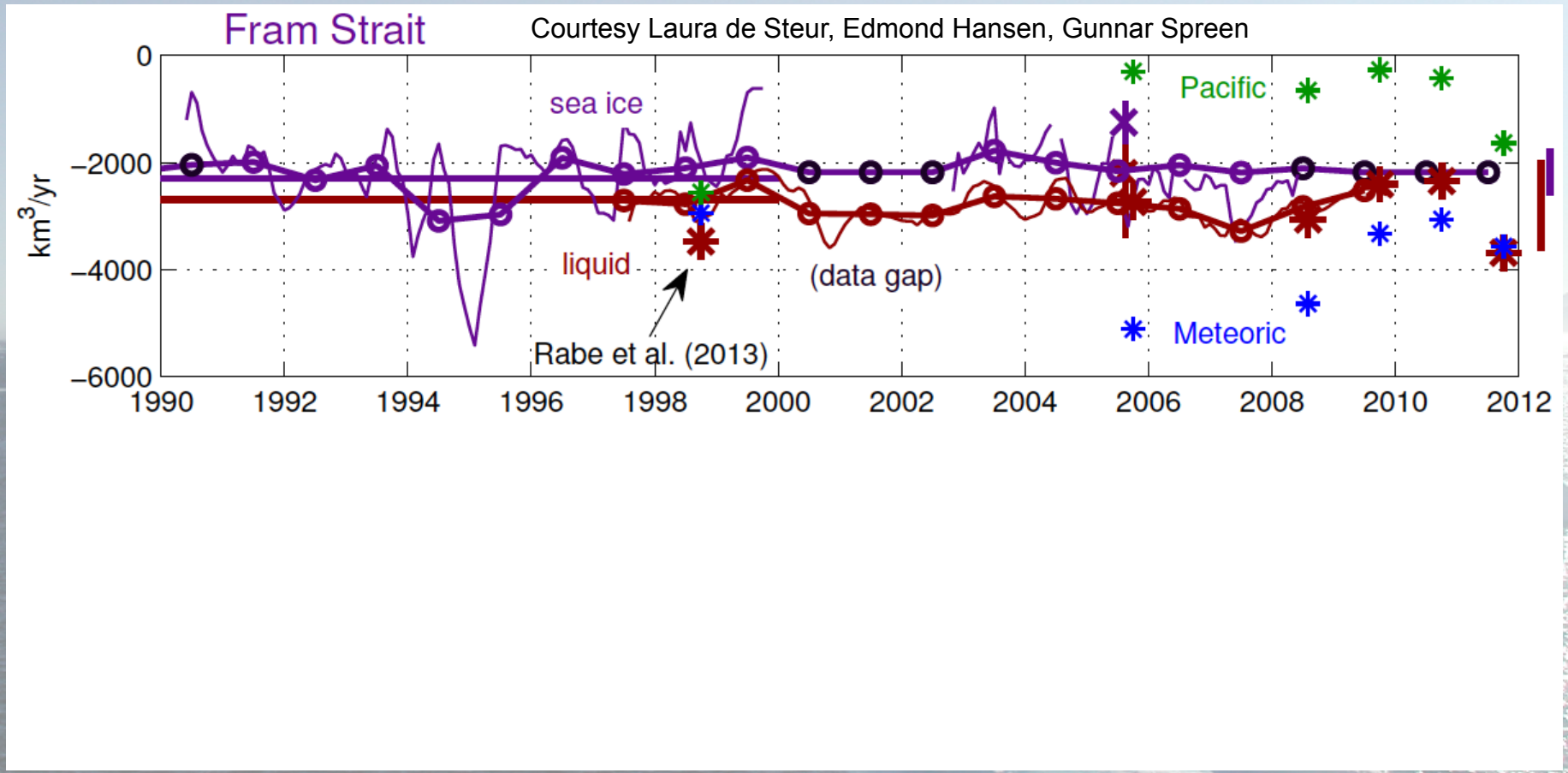
- P-E increases by 10%
- Runoff increases by 8%
- Bering Strait increases by 4%?
  for '00-'10 average cf. '80-'00



Export flux changes in the 2000s

- Fram Strait liq. increases 4%?
- Fram Strait SI decreases 9%?

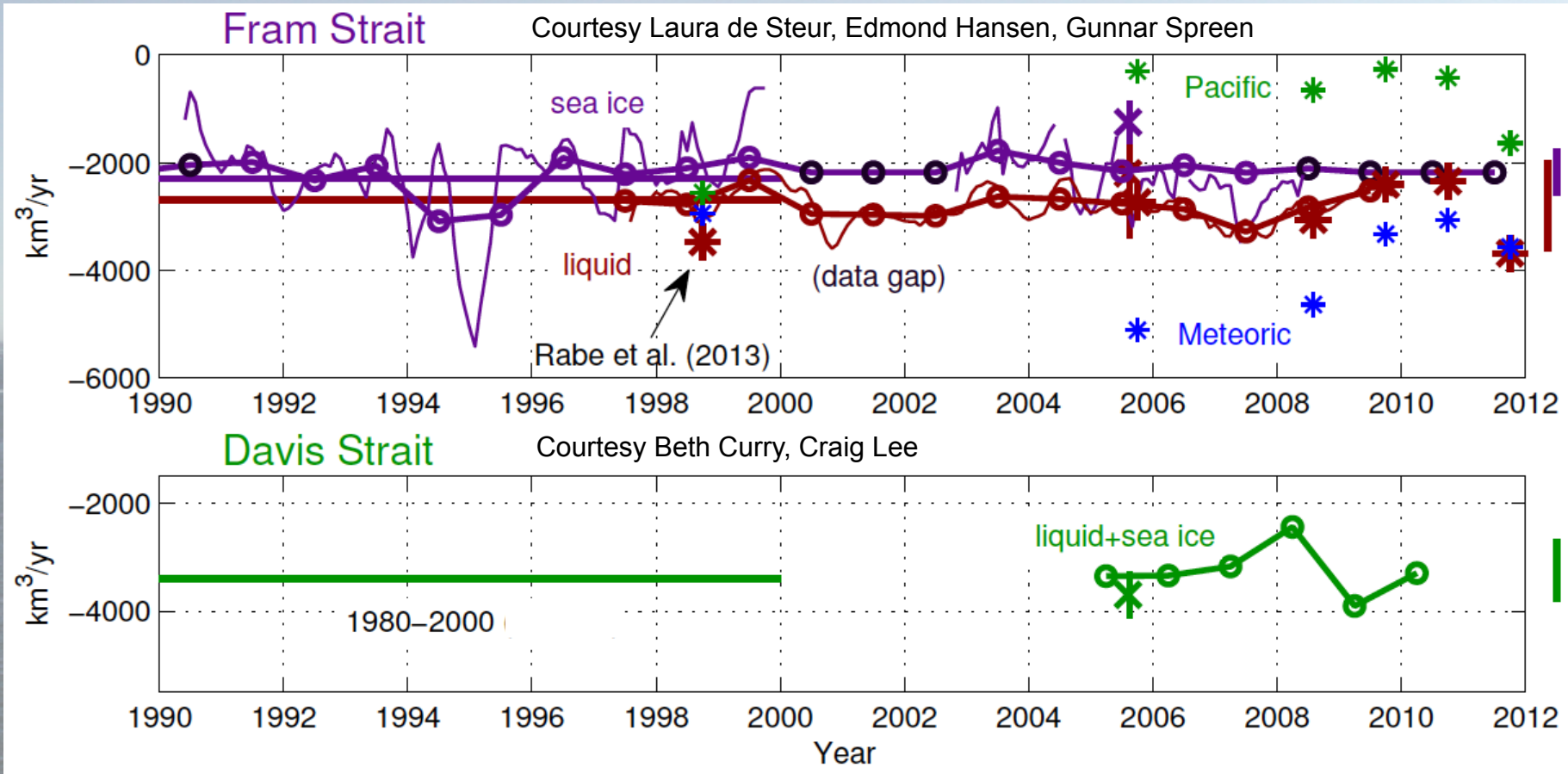
for '00-'10 average cf. '80-'00



Export flux changes in the 2000s

- Fram Strait liq. increases 4%?
- Fram Strait SI decreases 9%?
- Davis Strait decreases 6%?

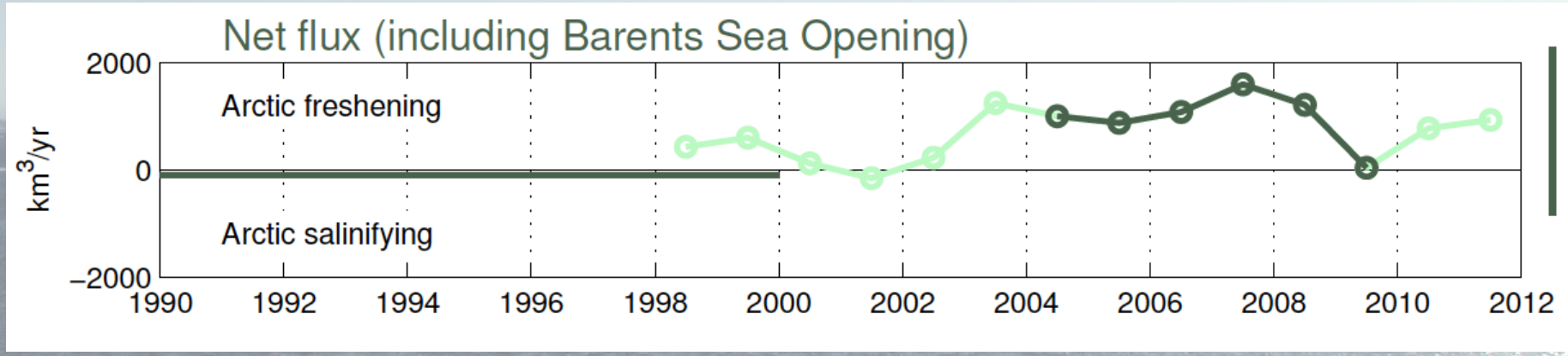
for '00-'10 average cf. '80-'00



Net flux change in the 2000s

- Imports increase by 7%
- Exports decrease by 4%

for '00-'10 average cf. '80-'00



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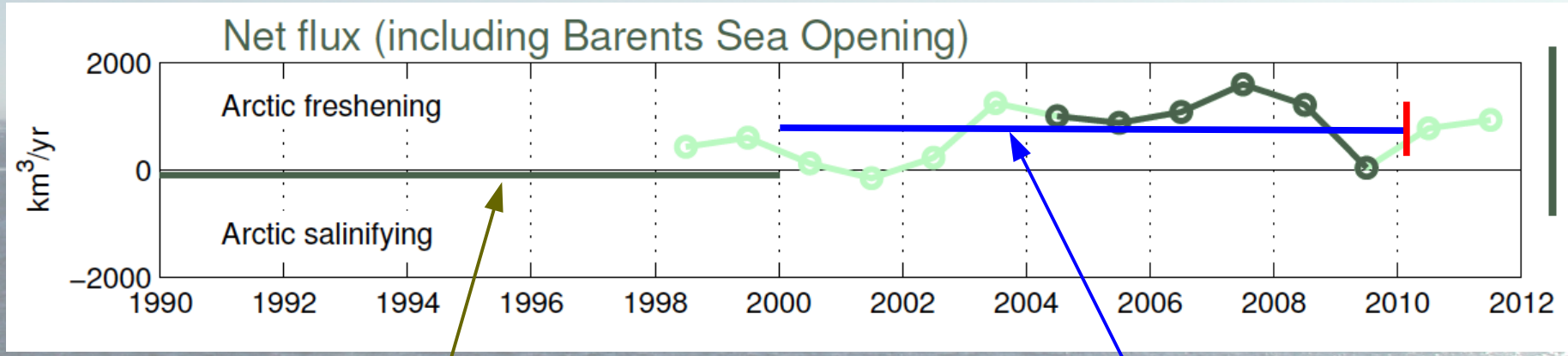

1980-2000 average = -100km^3/yr

2000s average = 800km^3/yr

600km^3/yr = 9000km^3 in 15yr, as observed in W. Arctic

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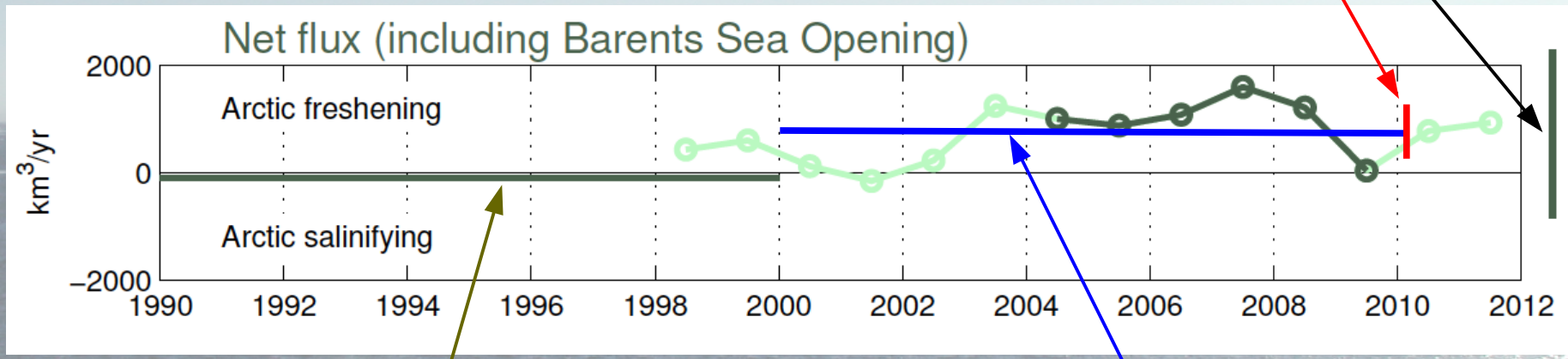
No change in fluxes cf errors (?)



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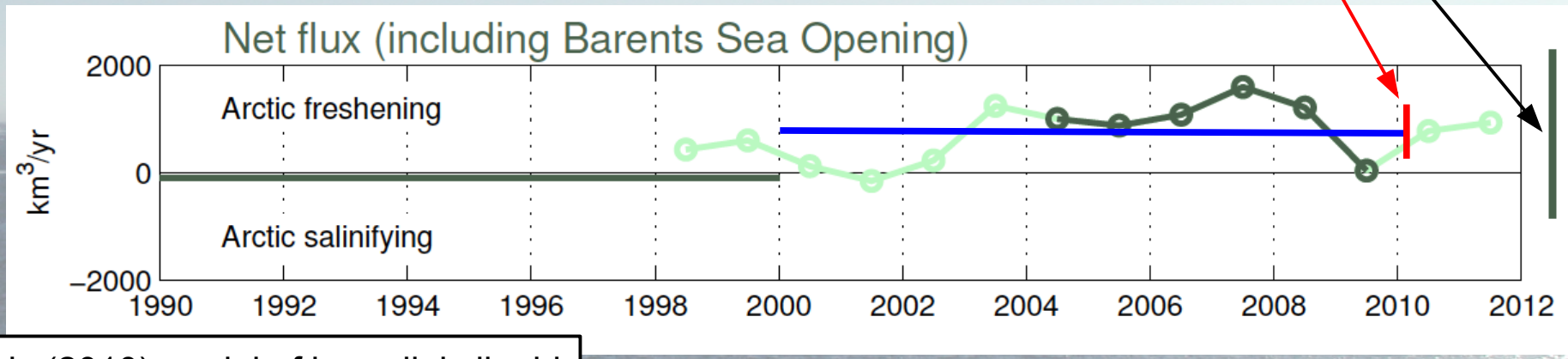
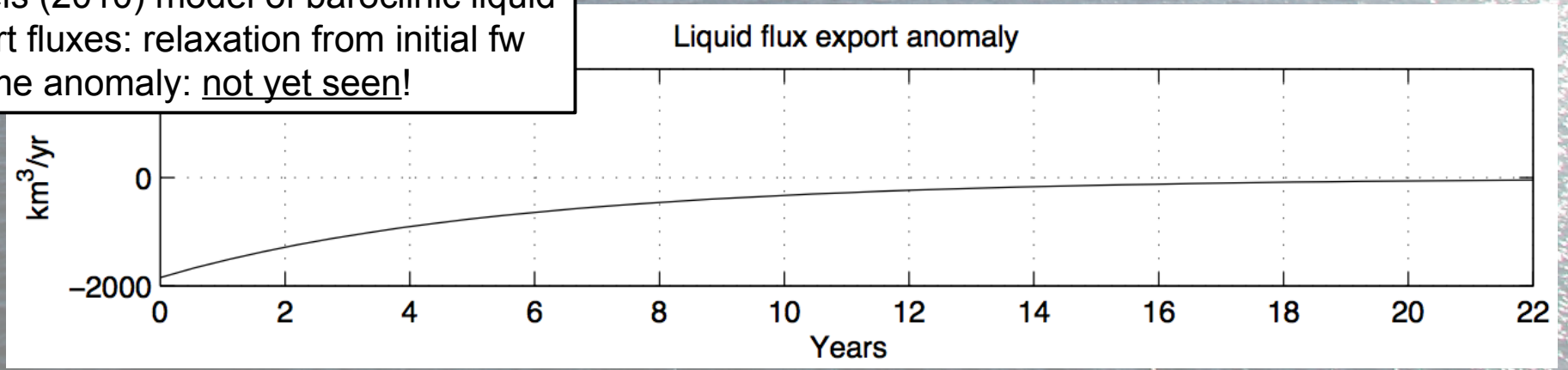
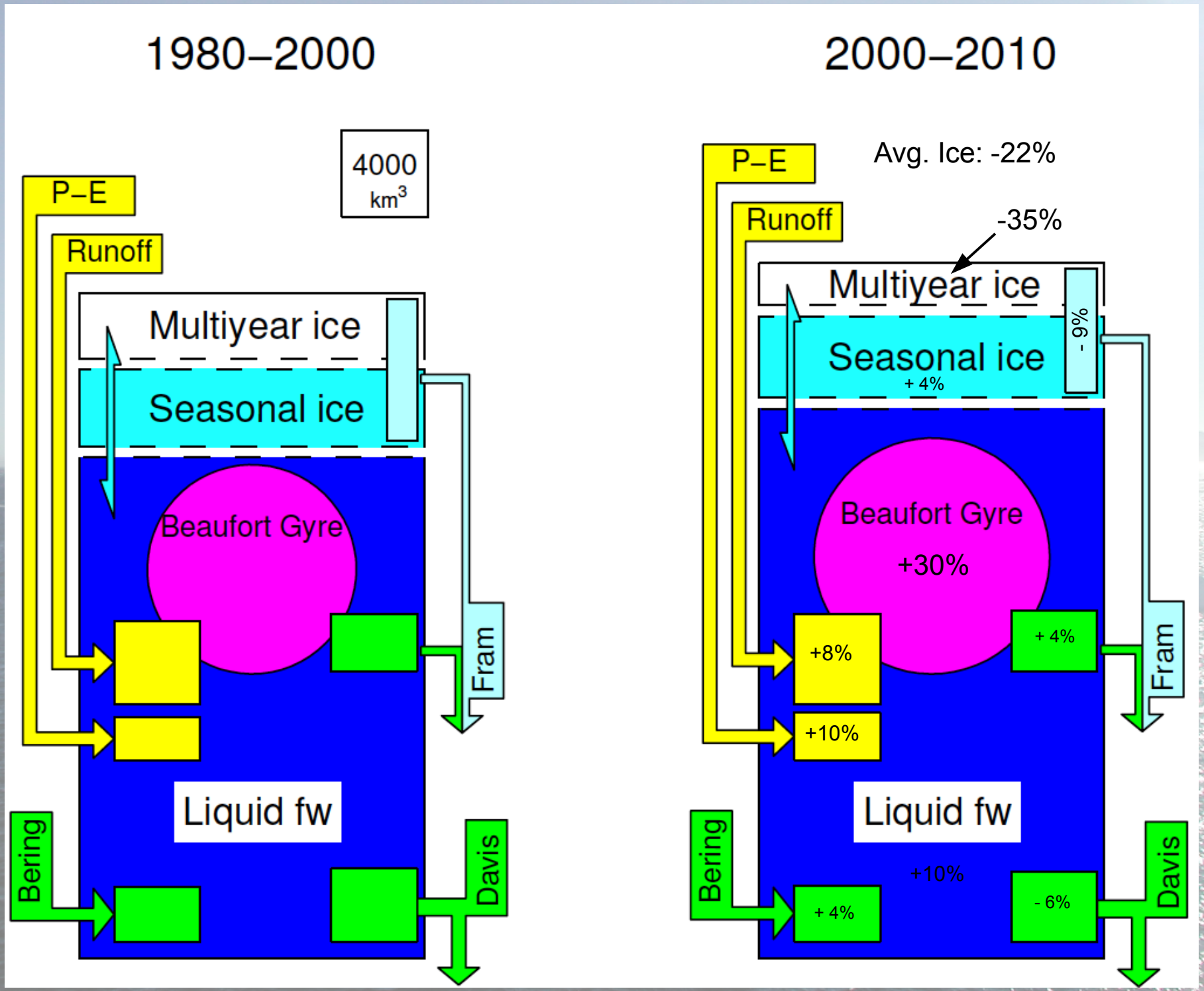


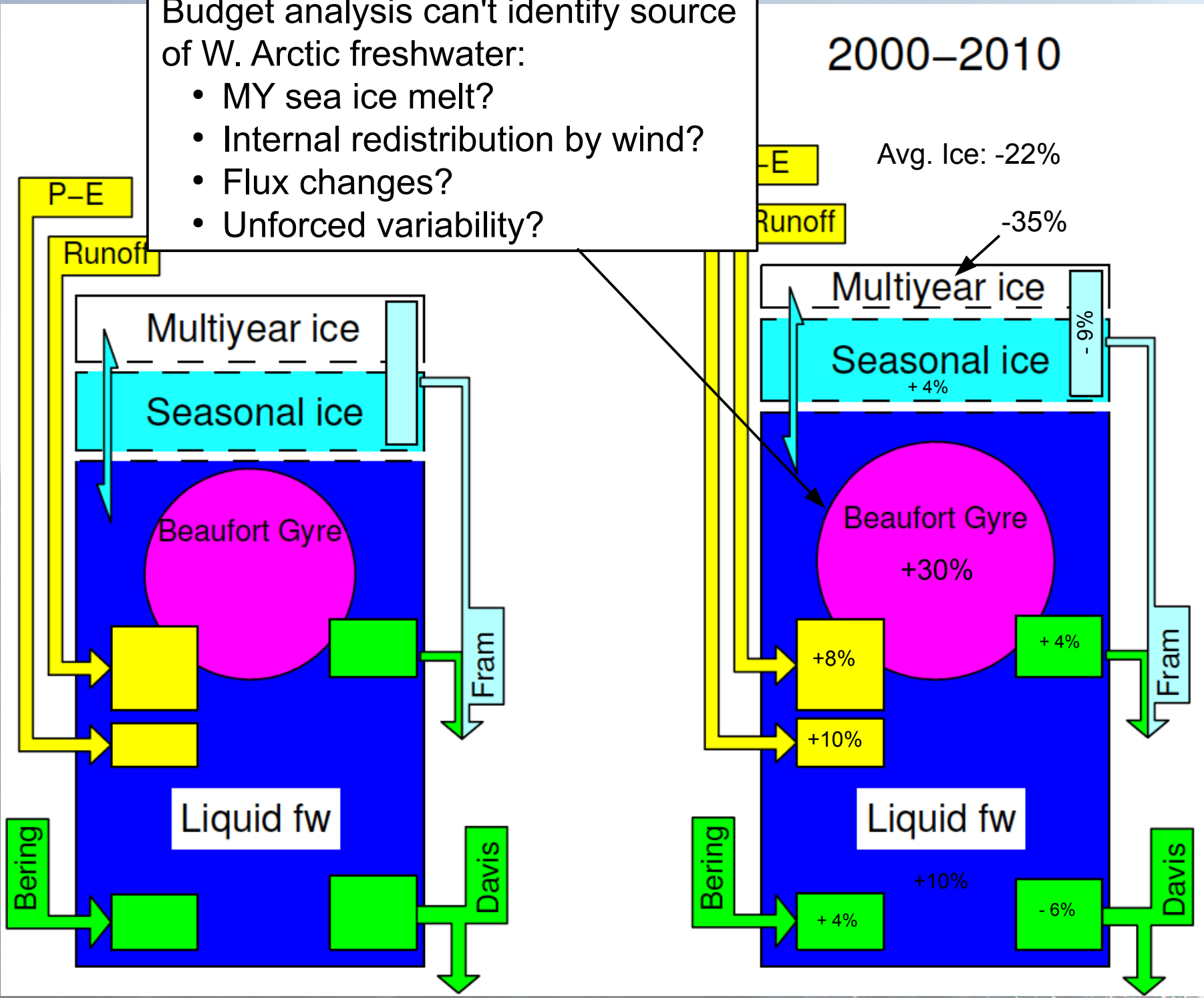
Rudels (2010) model of baroclinic liquid export fluxes: relaxation from initial fw volume anomaly: not yet seen!




1980–2000
4000
km3
P–E
Runoff
Multiyear ice
Seasonal ice
Beaufort Gyre
Fram
Liquid fw
Bering
Davis
2000–2010
Avg. Ice: -22%
P–E
Runoff
-35%
Multiyear ice
Seasonal ice
+ 4%
- 9%
Beaufort Gyre
+30%
+8%
+ 4%
+10%
Fram
Liquid fw
+10%
Bering
+ 4%
- 6%
Davis

Budget analysis can't identify source of W. Arctic freshwater:

- MY sea ice melt?
- Internal redistribution by wind?
- Flux changes?
- Unforced variability?



Conclusions

- During the 2000s freshwater accumulated in the western Arctic (~9000km^3 in ~15yr).
- Import & Export fluxes are not obviously different in 2000s. Perhaps a freshening of ~ 800km^3/yr occurred relative to 1980-2000.
- Source of extra freshwater is unclear from budget: multiple sources are possible.