Modeling Update

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PRISM
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Outline

- Scavenging Results
- 1.5km Model Update
- Future Plans
- Conclusion

Scavenging

- Parameterize scavenging in model
  - Set deep scavenging “threshold”
  - Set residence time
- Apply to glacial ice melt dye

Scavenging

- Parameterize scavenging in model
  - Set deep scavenging “threshold”
  - Set residence time
- Apply to glacial ice melt dye
- Parameter values:
  - Threshold - .4 nM to .6nM
  - Residence time - .005 yr^{-1} to .03 yr^{-1}
- Set up for sensitivity analysis

Scavenging Results

Inventories	All	Western	Central	Shelf Edge
Winter Fe (nM)	0.23±0.10	0.29±0.11	0.18±0.05	0.15±0.02
Winter NO_3 (μM)	30.0±1.4	30.3±0.7	29.6±1.6	29.8±2.0
NO_3:Fe drawdown 10^5 mol N / mol Fe	0.59±0.22	0.54±0.20	0.72±0.22	0.42±0.04
Nov-Feb mean mixed layer depth (m)				
	24.8	22.2	27.6	24.9
Fe Sources (μmol Fe m^{-2} yr^{-1})				
Drawdown of winter reserve	3.2±2.5	4.2±2.4	2.2±1.4	1.2±0.5
MCDW	1.3±0.2	1.4±0.3	1.9±0.3	1.6±0.3
Sea Ice	3.1±1.6	5.8±2.9	1.9±1.0	3.0±1.5
Glacial Ice	0.17±0.12	0.33±0.24	0.34±0.25	0.04±0.03
Sum	7.8±4.4	11.8±5.9	6.3±2.9	5.9±2.3
Fe Demand (μmol Fe m^{-2} yr^{-1})				
Satellite-based NP	8.8±6.4	8.5±6.2	9.9±7.1	6.6±4.8
Difference				
	1.0±10.8	-3.2±12.0	3.5±10.1	0.6±7.1

Table 1. Iron supply and demand for the Ross Sea and regional subdomains shown in Fig. 1a. Winter iron and nitrate concentrations estimated from PRISM data and ROMS hindcast mixed layer depths. Drawdown ratios are computed assuming cumulative inputs of iron and nitrate from MCDW, sea ice, and glacial ice simulated for the space-time location of each PRISM station. Iron sources for the mixed layer are calculated from drawdown of the winter reserve and cumulative seasonal inputs simulated for each domain. Mixed layer depths for the growing season (November-February) calculated from the climatology available at http://www7320.nrlssc.navy.mil/nmld/nmld.html. Iron demand estimated from a satellite-based algorithm for new production assuming an f-ratio of 0.5±0.1 and a C:Fe ratio inferred from the estimated NO_3:Fe drawdown and Redfield stoichiometry.

- Does not affect surface input – biology trumps
- Does not affect CDW input – end member is less than effective solubility

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- Only contributes to *Glacial Ice* term
- Most extreme case changed 6th significant digit

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Nov[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fe S[illegible]				
Dra[illegible]	[illegible]	[illegible]	[illegible]	[illegible]5
MC[illegible]	[illegible]	[illegible]	[illegible]	[illegible]3
Sea[illegible]	[illegible]	[illegible]	[illegible]	[illegible]5
Gla[illegible]	[illegible]	[illegible]	[illegible]	[illegible]03
Sun[illegible]	[illegible]	[illegible]	[illegible]	[illegible]3
Fe I[illegible]				
Sate[illegible]	[illegible]	[illegible]	[illegible]	[illegible]8
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Scavenging has no significant effect

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1.5km Model Updates

- Progress since last update:
  - Timing tests completed
  - Bathymetry updated and corrected for model
  - Runs for ~10 time steps (about 5 minutes)

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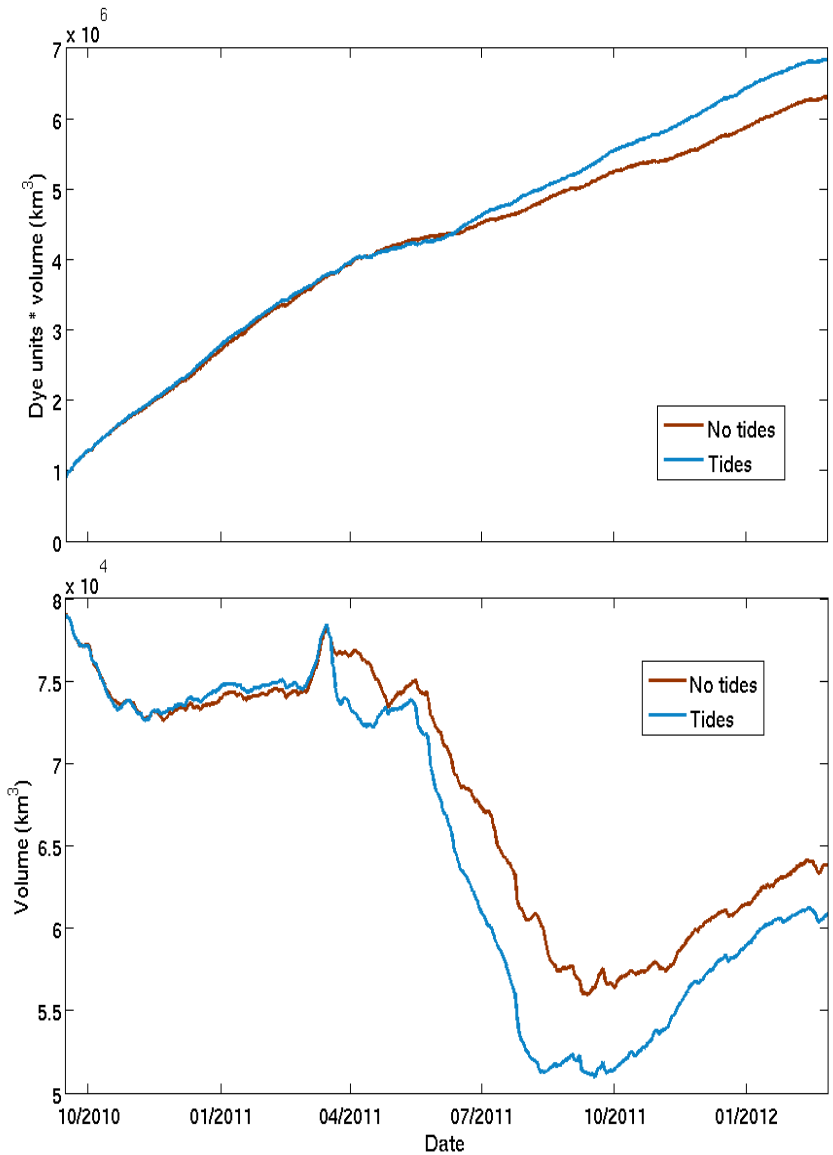
- Issues:
  - Data storage crash & loss
  - Model source code is safe, but some output gone

Future Plans

- Models to be incorporated into dissertation work with 3 main themes/papers:
  - Tides – The effect of tides on water mass transport and mixing
  - Eddies – The effect of eddies on water mass transport and mixing
  - Transport pathways – The path melt water (containing iron) takes to get to the surface ocean & how this path is influenced by eddies and mesoscale effects

Preliminary Results

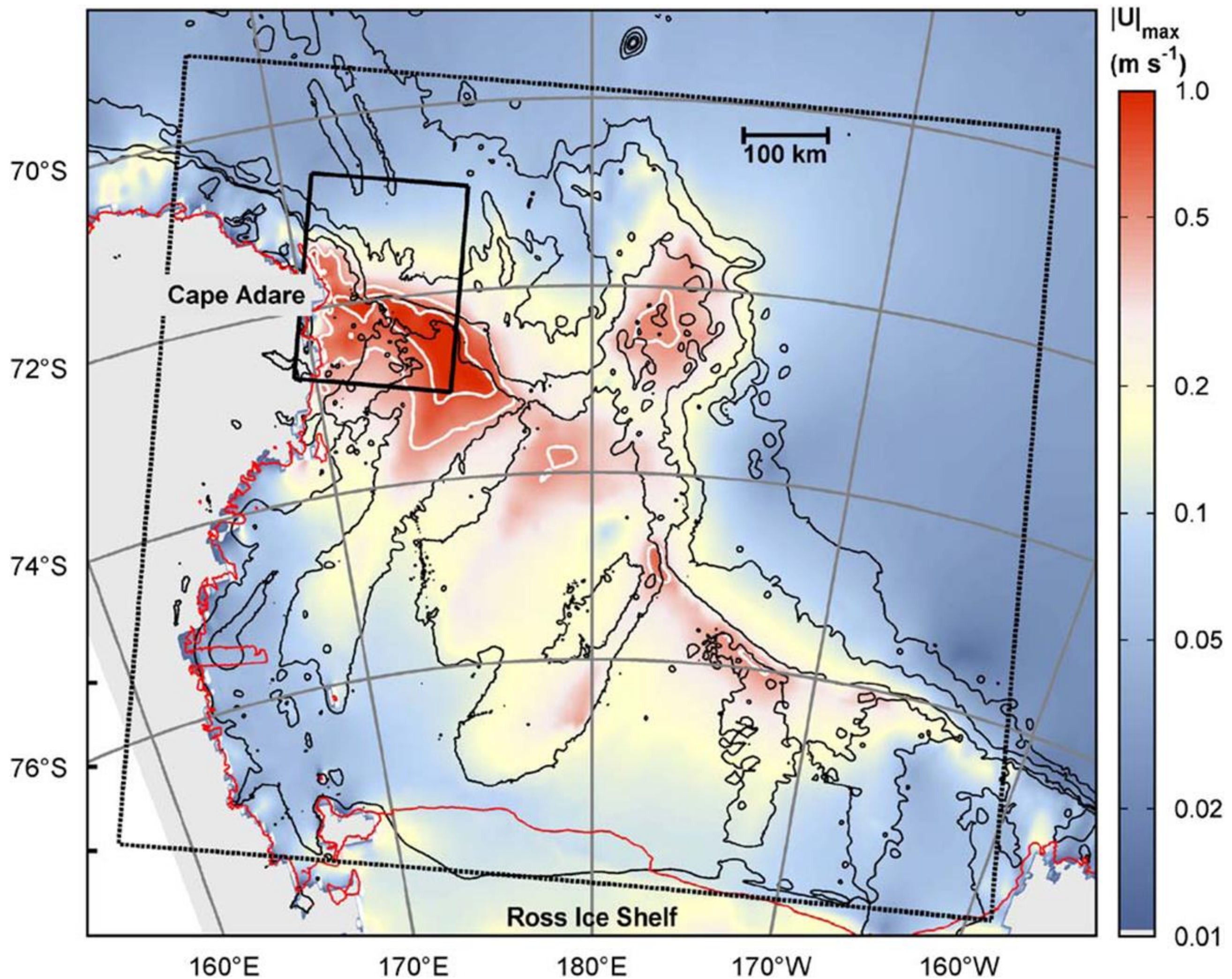
- Surface mixed layer appears *deeper* with tidal forcing
- CDW transport on shelf *increases* (dye)
- CDW volume on shelf *decreases* (increased mixing)



Conclusions

- Scavenging has no significant effect on the amount of dissolved Fe brought to the surface from glacial melt sources
- The 1.5km model is progressing, slowly, with hiccups
- Future plans include a 3-chapter dissertation focused on model results and supported by PRISM data

Ross Sea Tides



Padman et al, DSRII, 2009

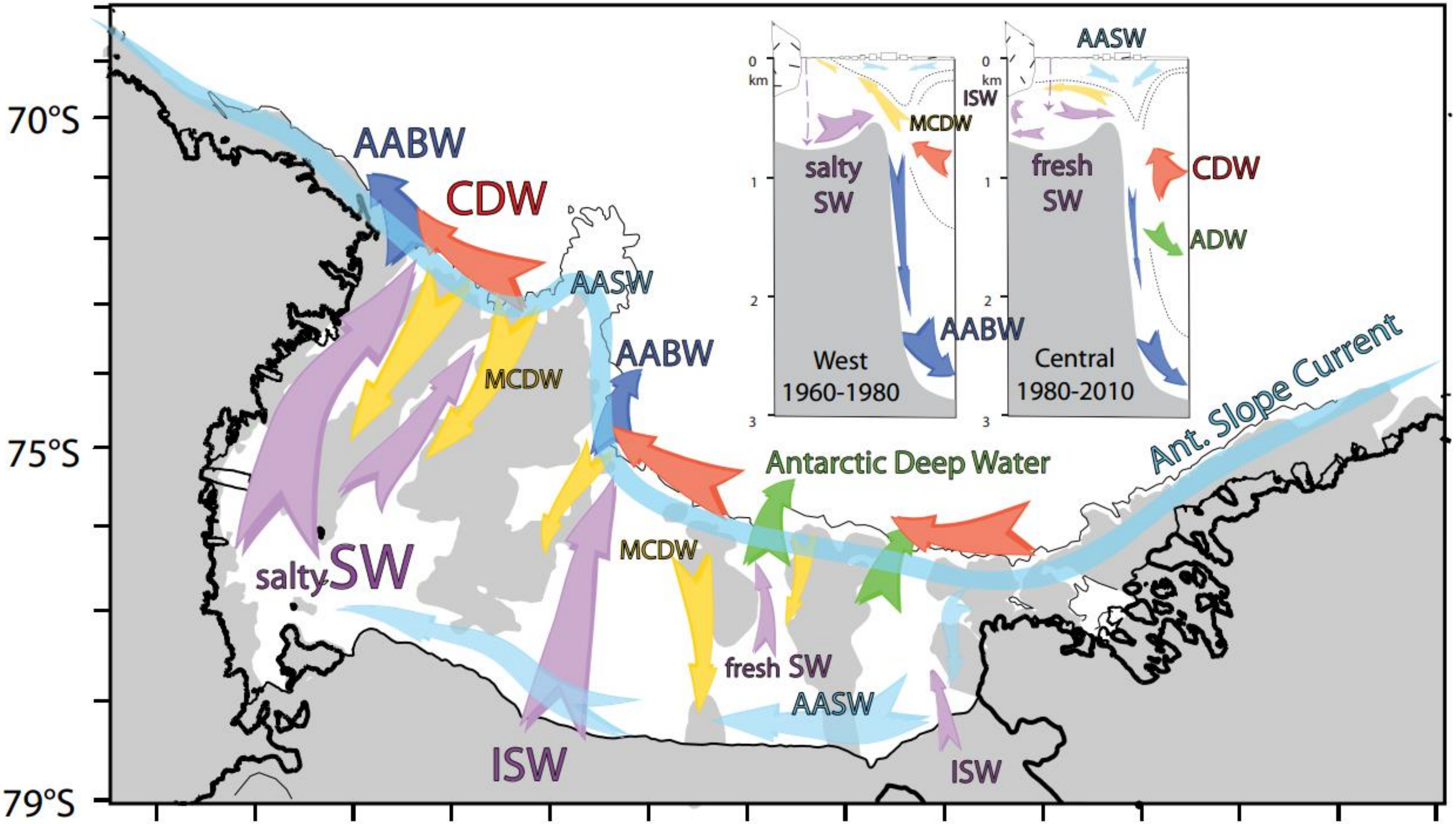
Ross Sea Model

- ROMS: 5 km horizontal resolution, 24 levels
- Ice shelves (mechanical and thermodynamic)
- Dynamic sea-ice
- Different wind forcing, but typically either from Antarctic Mesoscale Prediction System (AMPS) or ERA-Interim
- Lateral boundary conditions from WOA, OCCAM and SSM/I ice concentrations
- Bathymetry from BEDMAP and Davey
- Experiments w/ dye representing CDW

New Model Run for PRISM

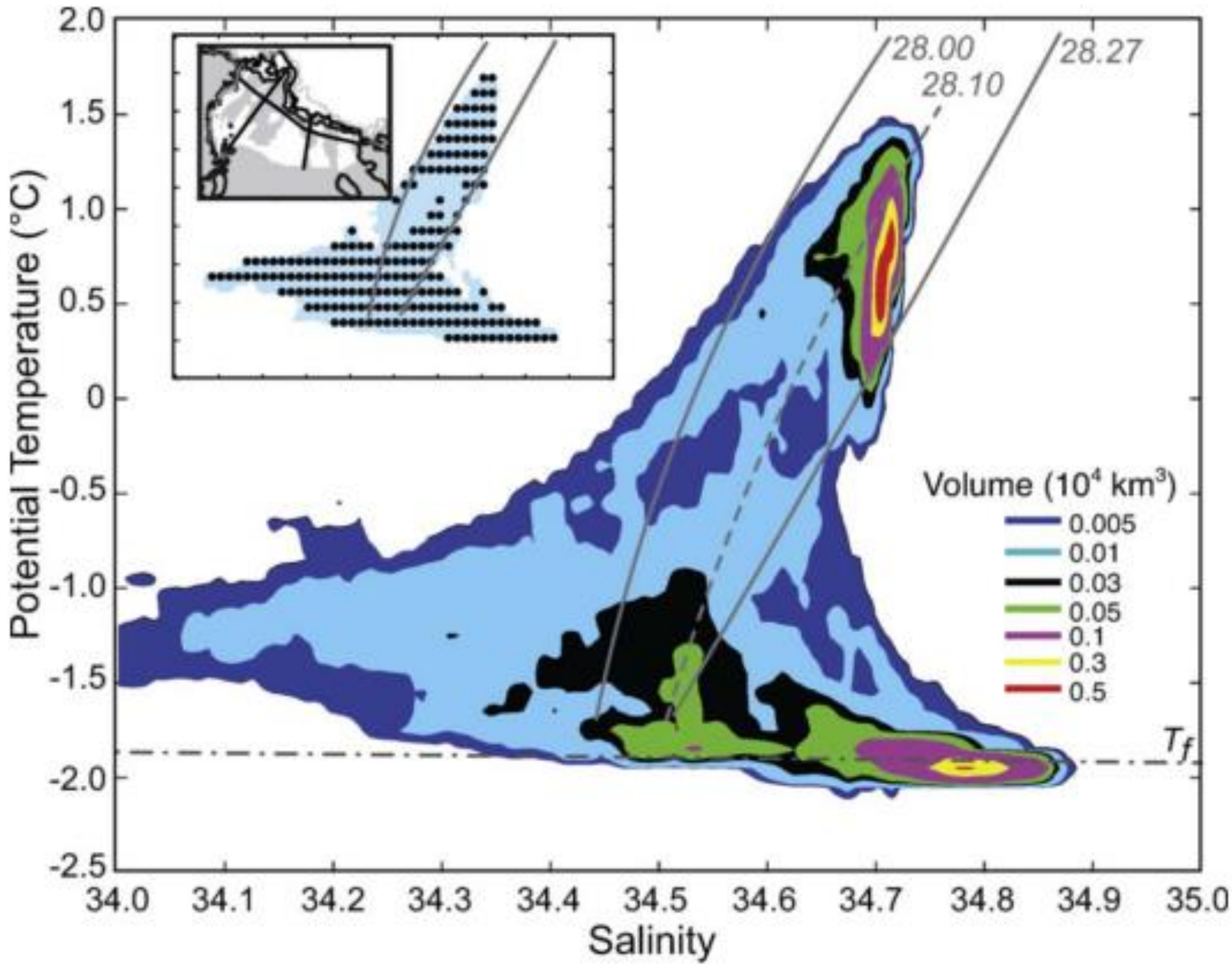
- Sept. 15, 2010 – Feb. 29, 2012
- Model fields saved every 12 hours for entire run
- Forced with 6-hourly winds and air temperatures from the new higher resolution (0.75°) ERA-Interim product
- Had to switch to coarser (25-km) SSMIS sea-ice from AMSR-E (12.5-km)
- Fixed small bug in the sea-ice code
- Two new dye tracers: Ice Shelf meltwater and sea-ice meltwater

Large Scale Circulation

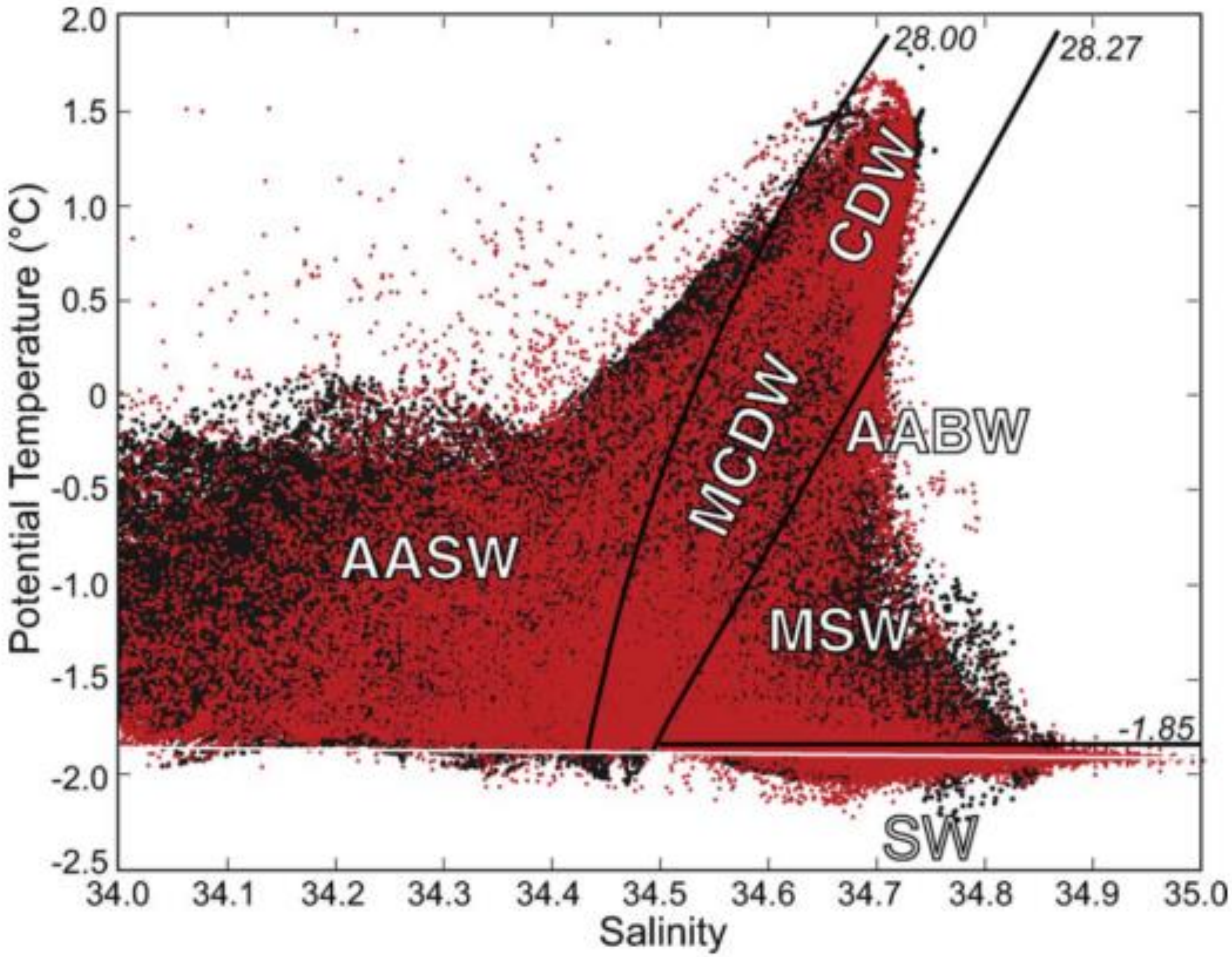


Smith et al, Oceanography, 2012

A.H. Orsi, C.L. Wiederwohl / Deep-Sea Research II 56 (2009) 778–795



Ross Sea Water Masses



Orsi & Wiederwohl, DSRII, 2009

Definitions of water masses

Water Mass	Density	Temperature	Salinity
AASW	<28.0	All	All
(M)CDW	[28, 28.27]	All	All
ISW	>28.27	<-1.95	All
MSW	>28.27	>-1.85	All
SW	>28.27	[-1.95, -1.85]	All
LSSW	>28.27	[-1.95, -1.85]	<34.62
HSSW	>28.27	[-1.95, -1.85]	>34.62

Orsi & Wiederwohl, DSRII, 2009