Isotopes in Southern Indian Ocean Waters

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Isotope tracers of oceanic processes

- 2H, 18O – water molecule –transport of water masses
- 3H - water molecule (HTO) – transport of water masses (T1/2 = 12.32 y)
- 14C – dissolved in seawater, inorganic carbon – exchange processes with the atmosphere + transport of water masses (T1/2 = 5730 y)
- 129I – dissolved in seawater - transport of water masses (T1/2 = 15.7 My)
- 137Cs – mostly dissolved in seawater - transport of water masses (T1/2 = 30.17 y)

Global fallout radionuclides in the World Ocean

Nuclide	Half-life (y)	Released activity (PBq)	Input to World Ocean (PBq)	Ocean Inventory in 2010 (PBq)
3H	12.32	186 000	113 000	8 000
14C	5730	213	130	130
90Sr	28.78	620	380	100
137Cs	30.07	950	600	170
129I	$15.7 \cdot 10^{6}$	$0.4 \cdot 10^{-3}$	$0.3 \cdot 10^{-3}$	$0.3 \cdot 10^{-3}$

Large scale radionuclide projects in the Indian Ocean

- **GEOSECS (1978) – 3H, 14C**
- **WOCE (1995) – 3H, 14C – the most comprehensive data sets**

IAEA – WOMARS (1996- 2000)

- **Indian Ocean Transect - Italica (1997)**
- **GEOSECS – revisiting the North Indian Ocean stations (1998)**
- **ANTARES- 4 - South Indian Ocean (1999)**
- **ISOTOPES: 3H, 14C, 90Sr, 129I, 137Cs, Pu isotopes, 2H, 18O**

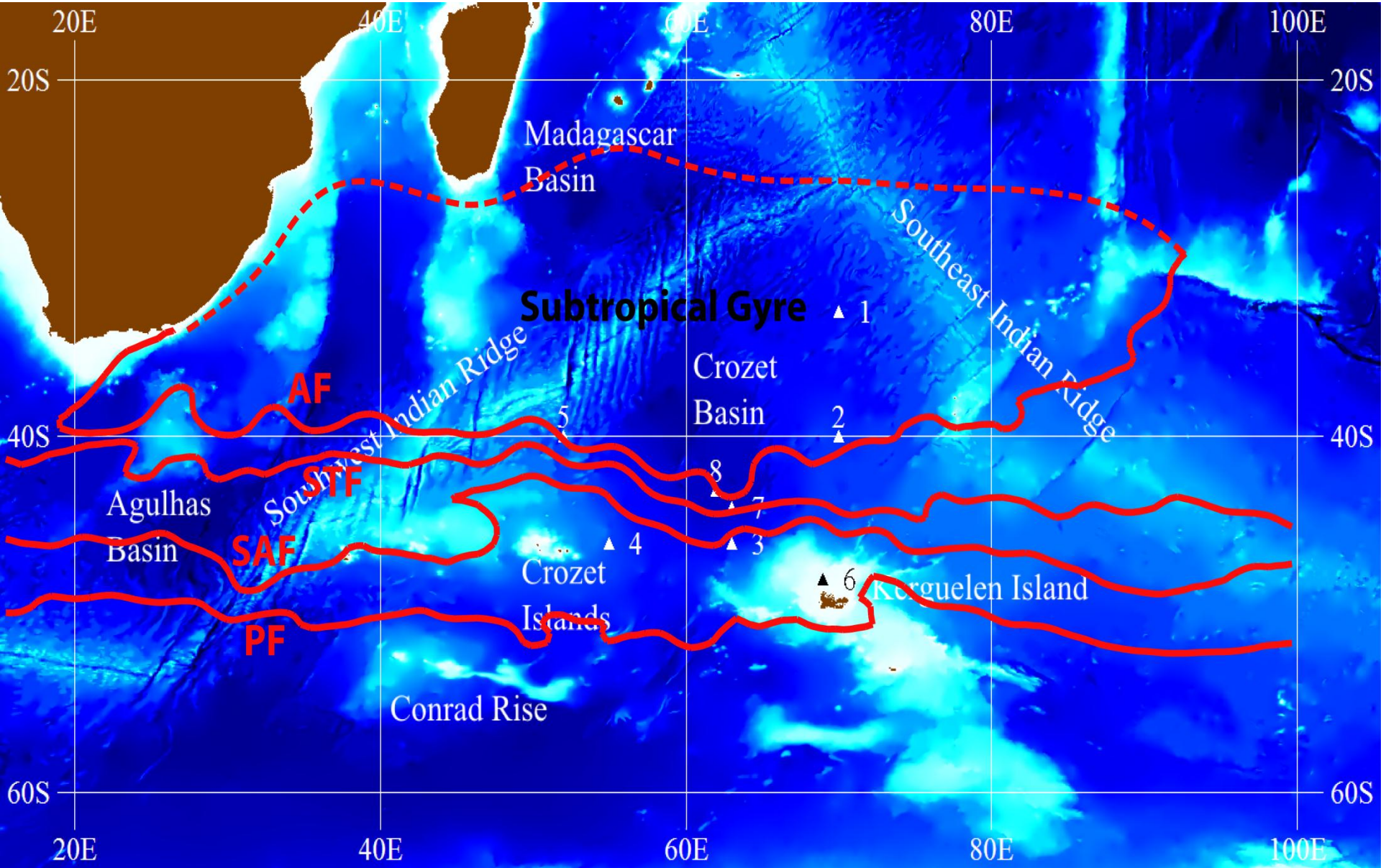
Southern Hemisphere Oceans Tracer Studies (2002-2010)

BEAGLE2003 - Global Ocean Expedition (JAMSTEC)

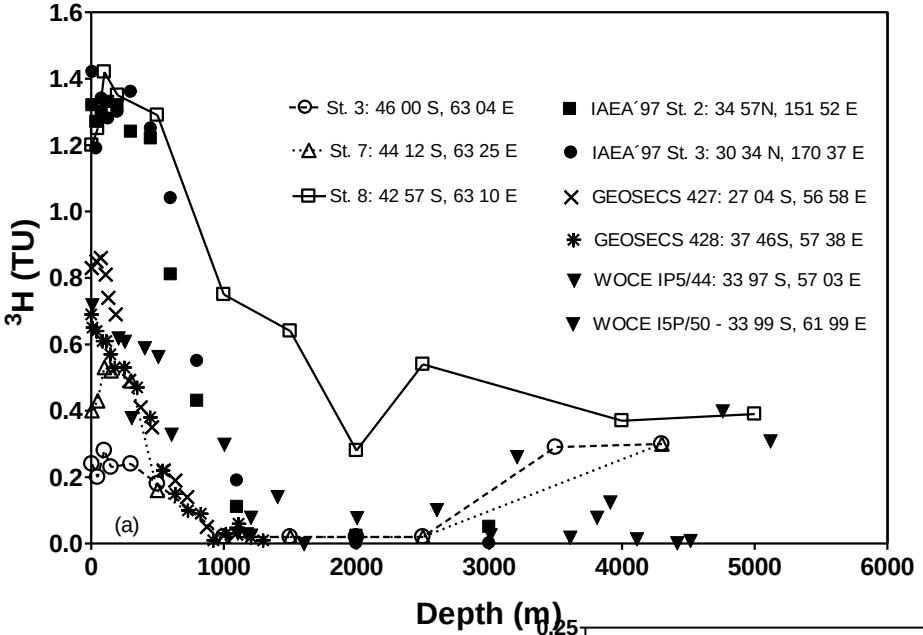
Indian Ocean (2003-2004)

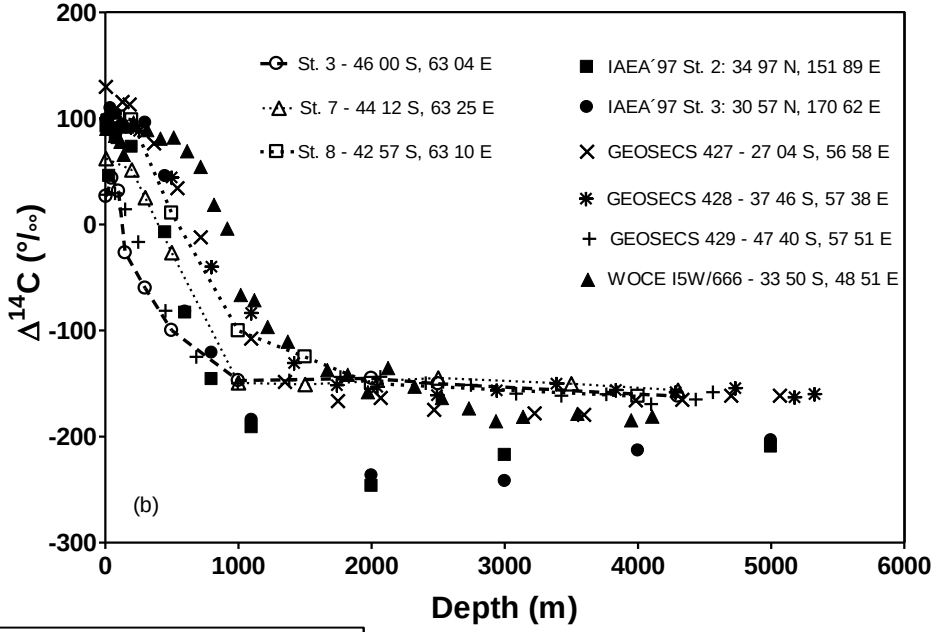
- **revisiting WOCE 20°S lines**
- **3H, 14C, 137Cs, Pu isotopes**

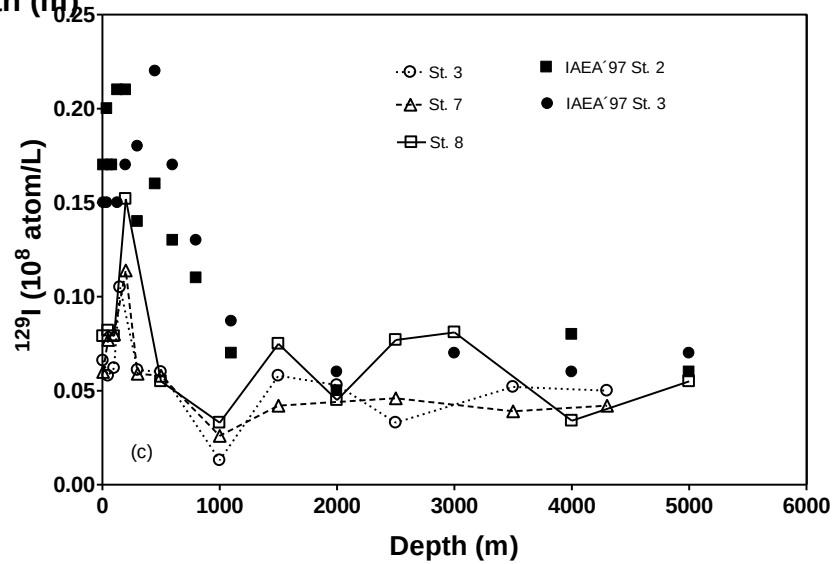
Water fronts and sampling stations – ANTARES´99



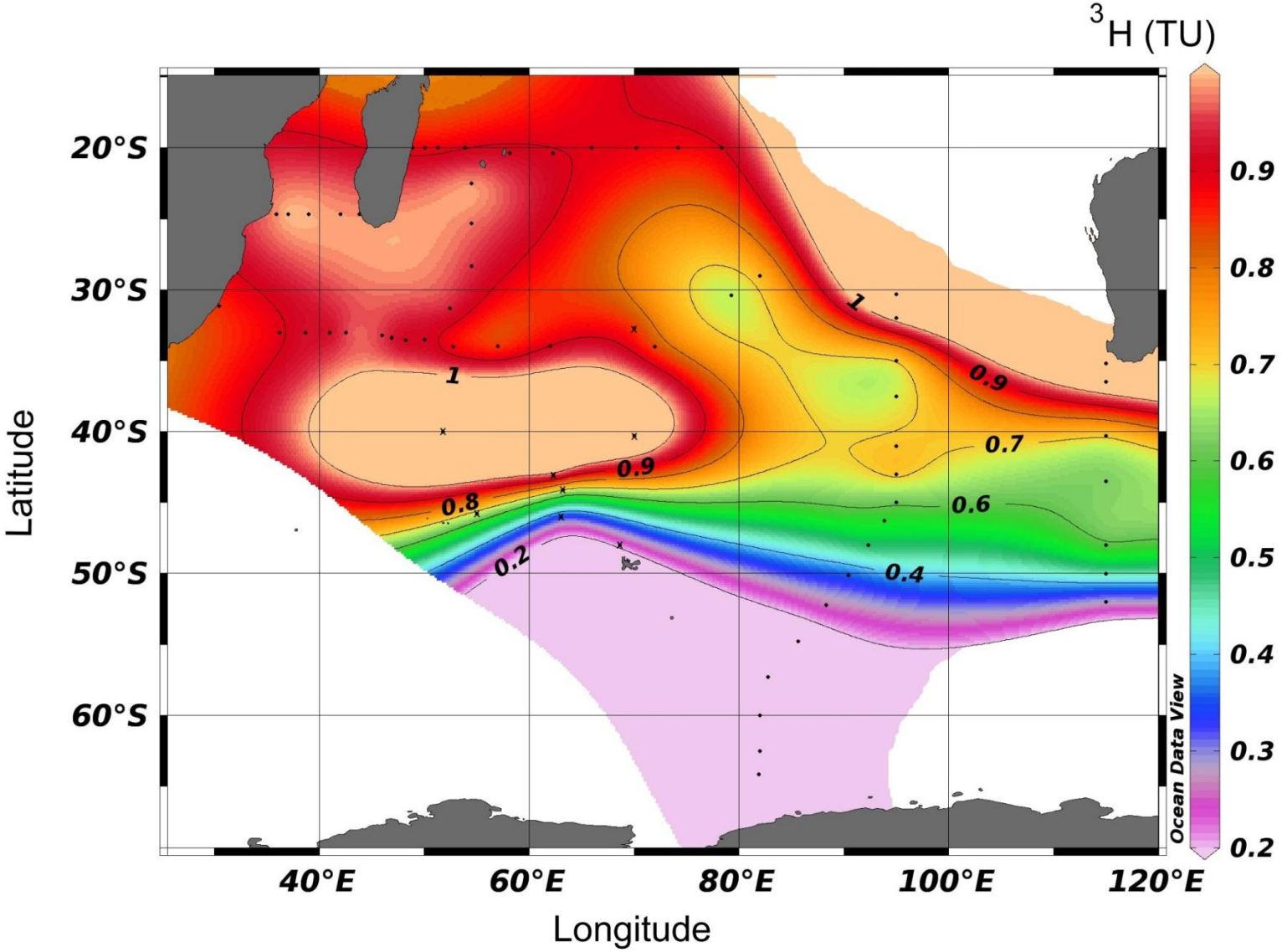
Water profiles in the southern Indian Ocean and NW Pacific (IAEA´97)



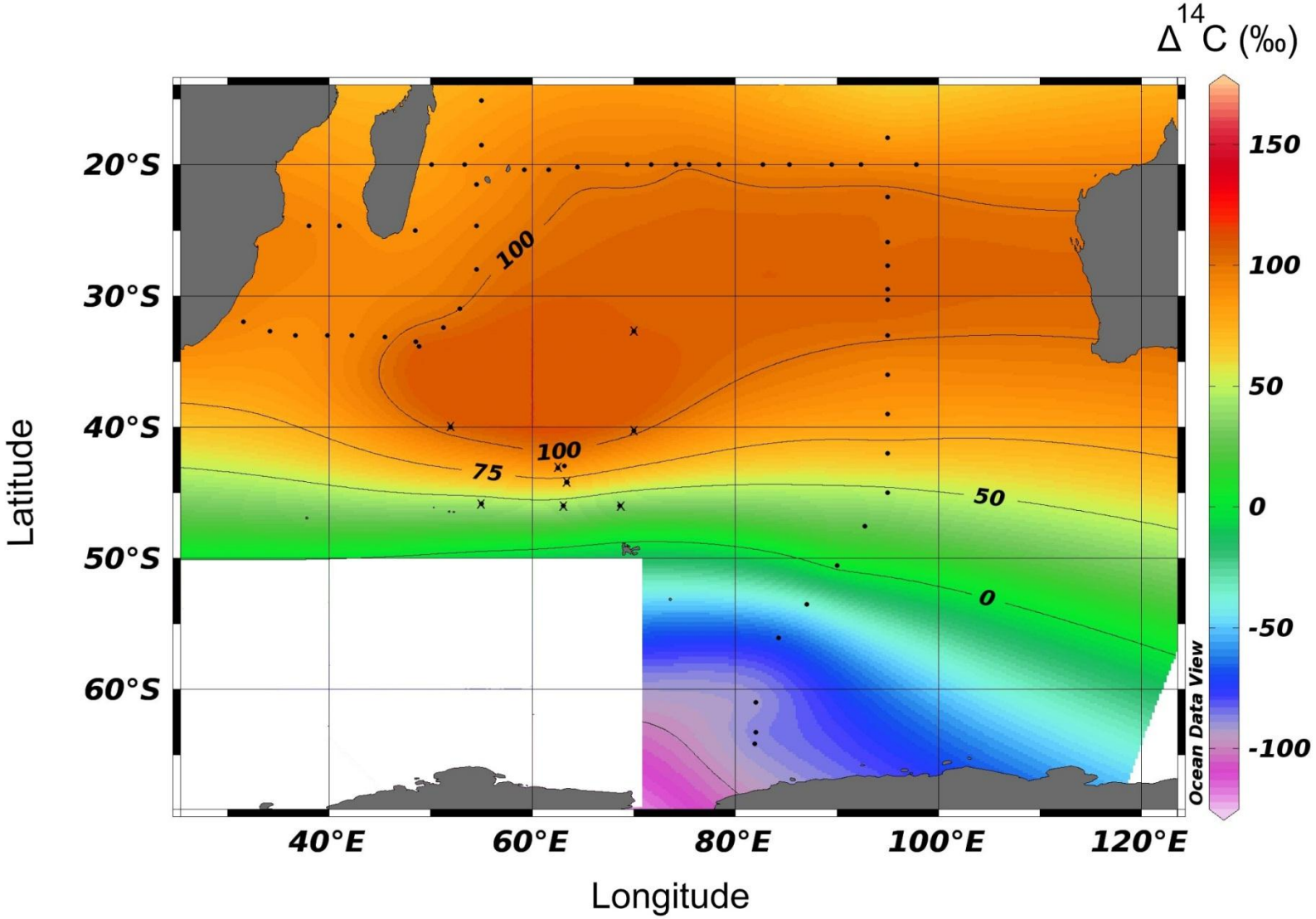




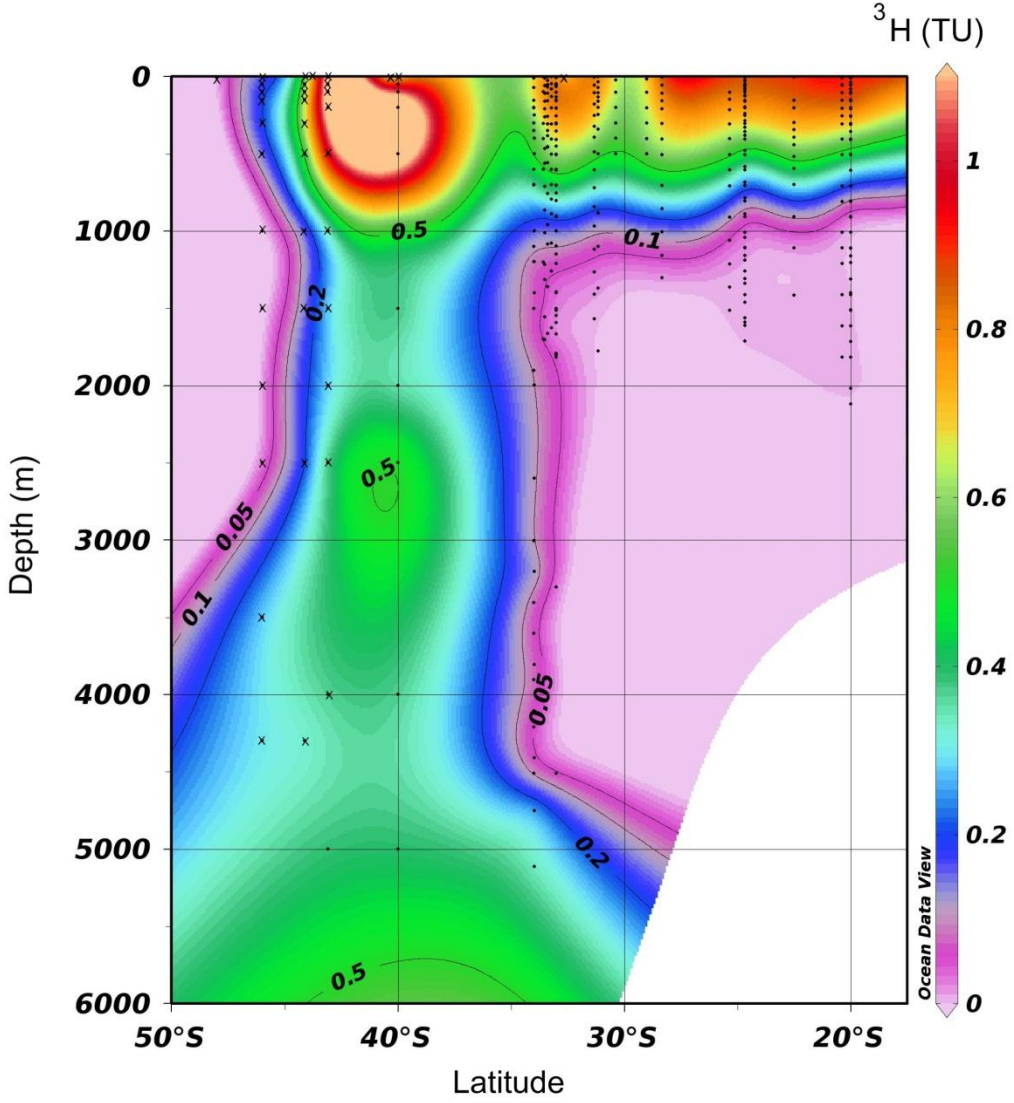
Surface distribution of 3H in the southern Indian Ocean (ANTARES´99 & WOCE´95)



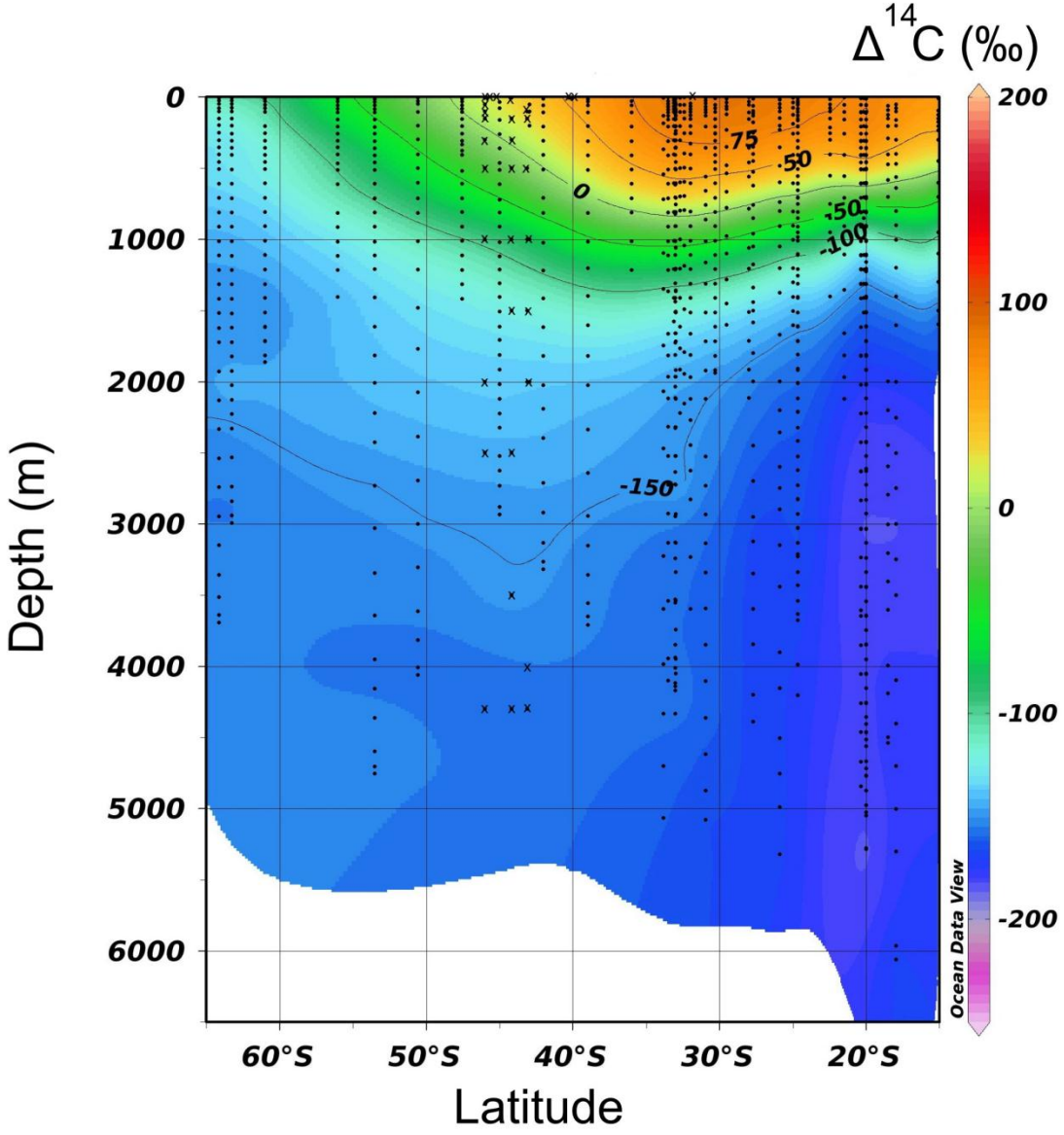
Surface distribution of 14C in the southern Indian Ocean (ANTARES´99 & WOCE´95)



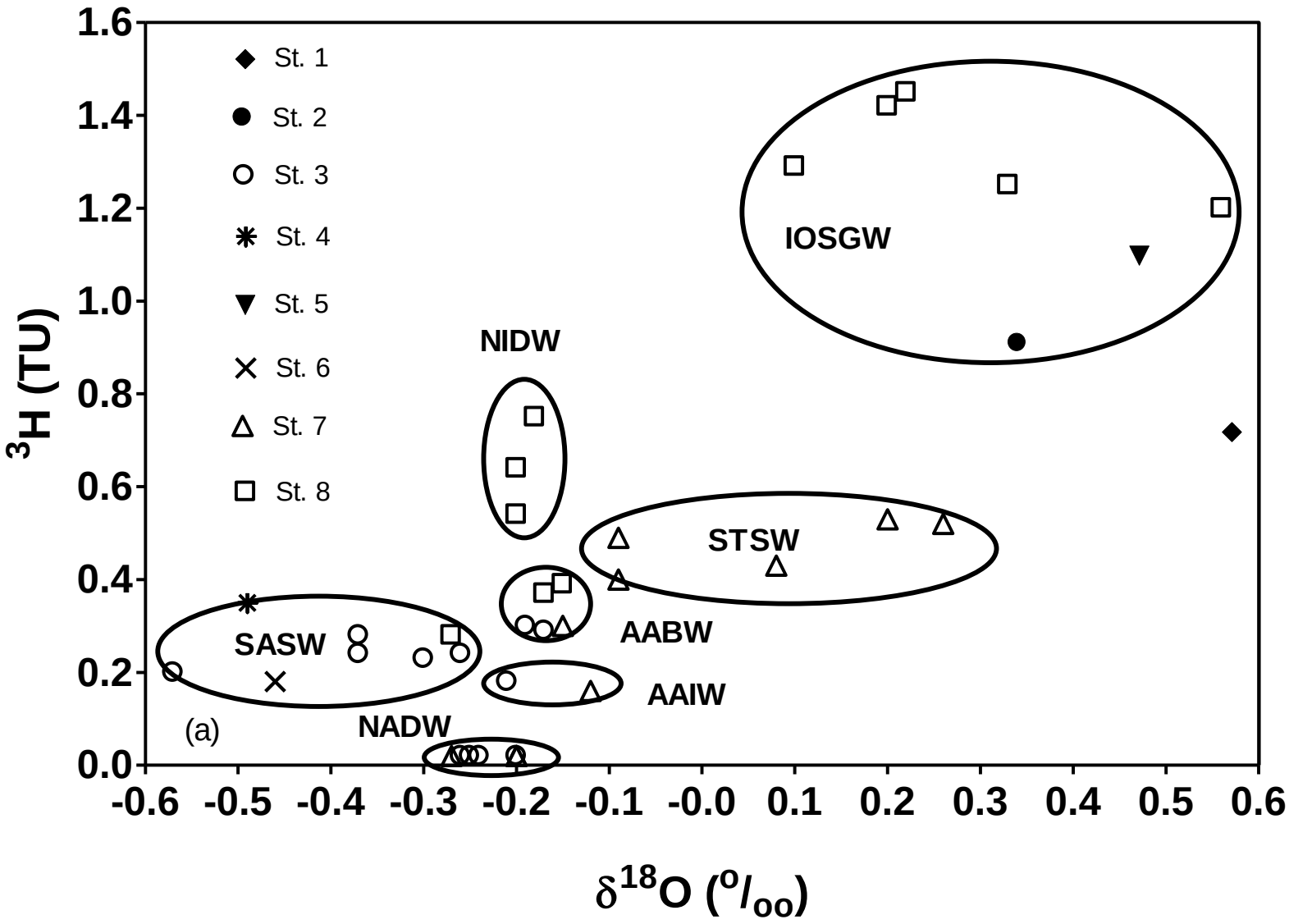
3H in the the southern Indian Ocean (ANTARES´99 & WOCE´95)

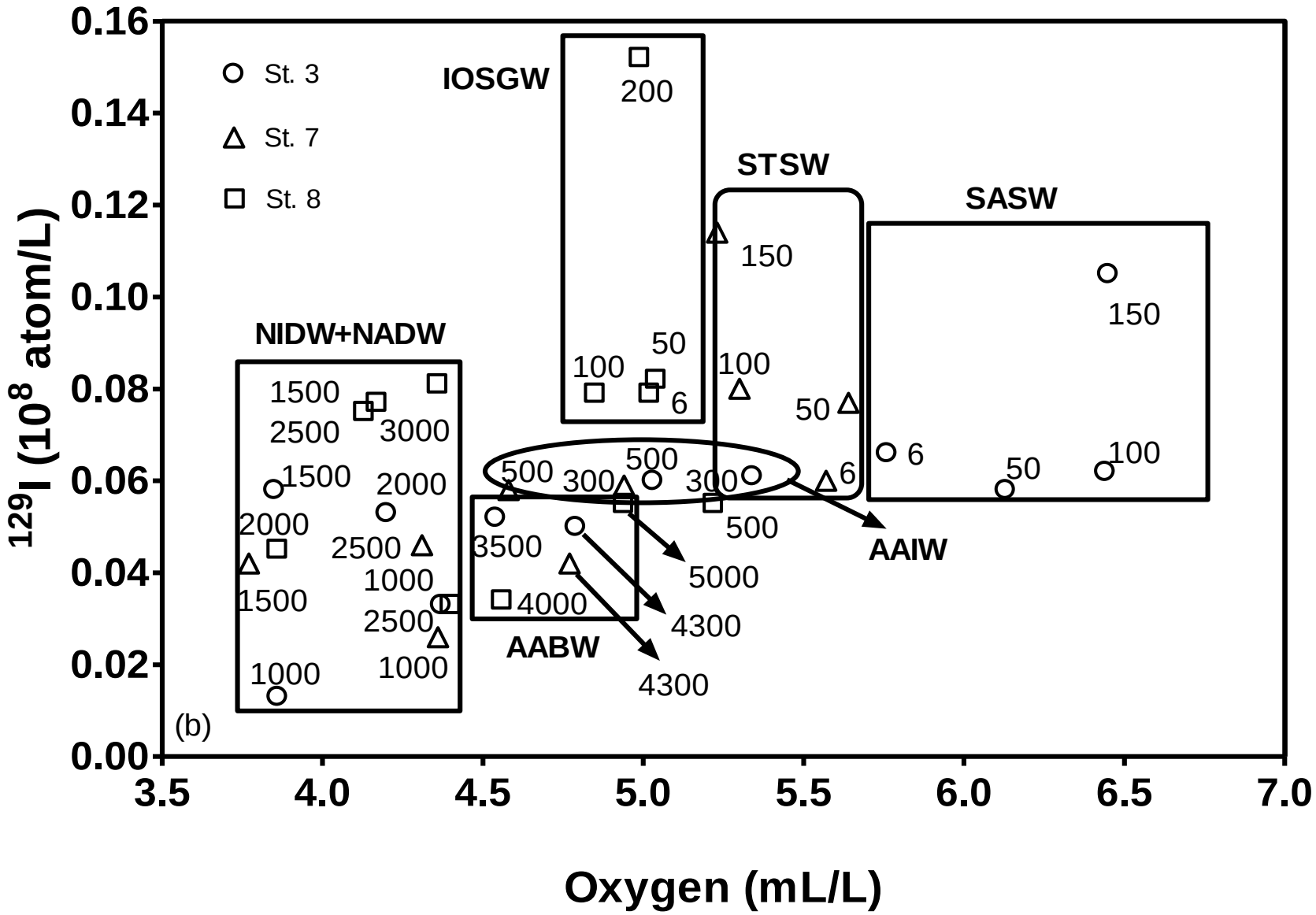


14C in the the S Indian Ocean (ANTARES´99 & WOCE´95)



Water masses in the southern Indian Ocean (ANTARES´99)




St. 3
St. 7
St. 8
IOSGW
STSW
SASW
NIDW+NADW
AABW
AAIW
(b)
^{129}I (10^8 atom/L)
Oxygen (mL/L)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
200
50
100
6
150
100
50
6
150
6
50
100
1500
2500
3000
1500
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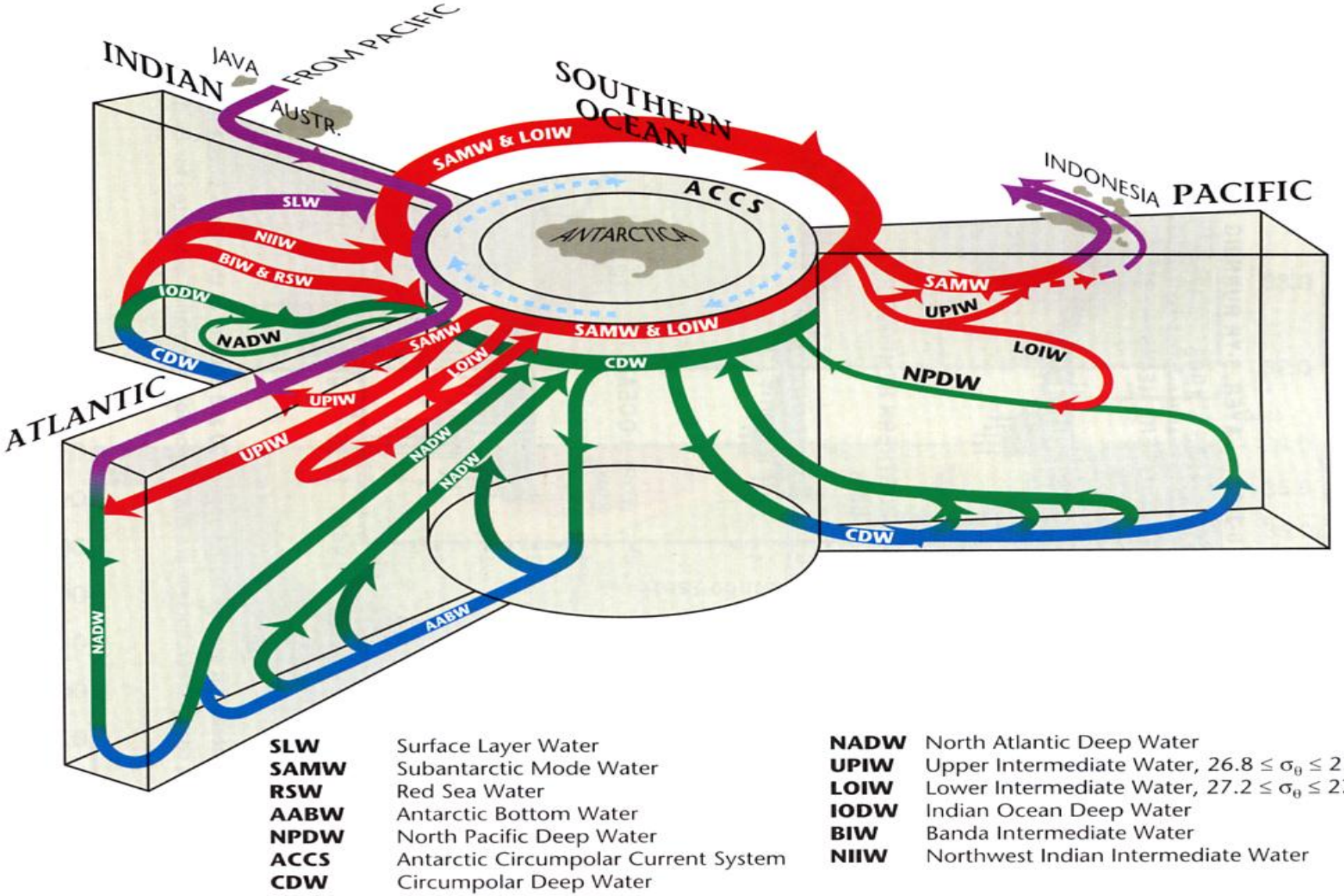
500
300
6
500
3500
4000
5000
4300
4300

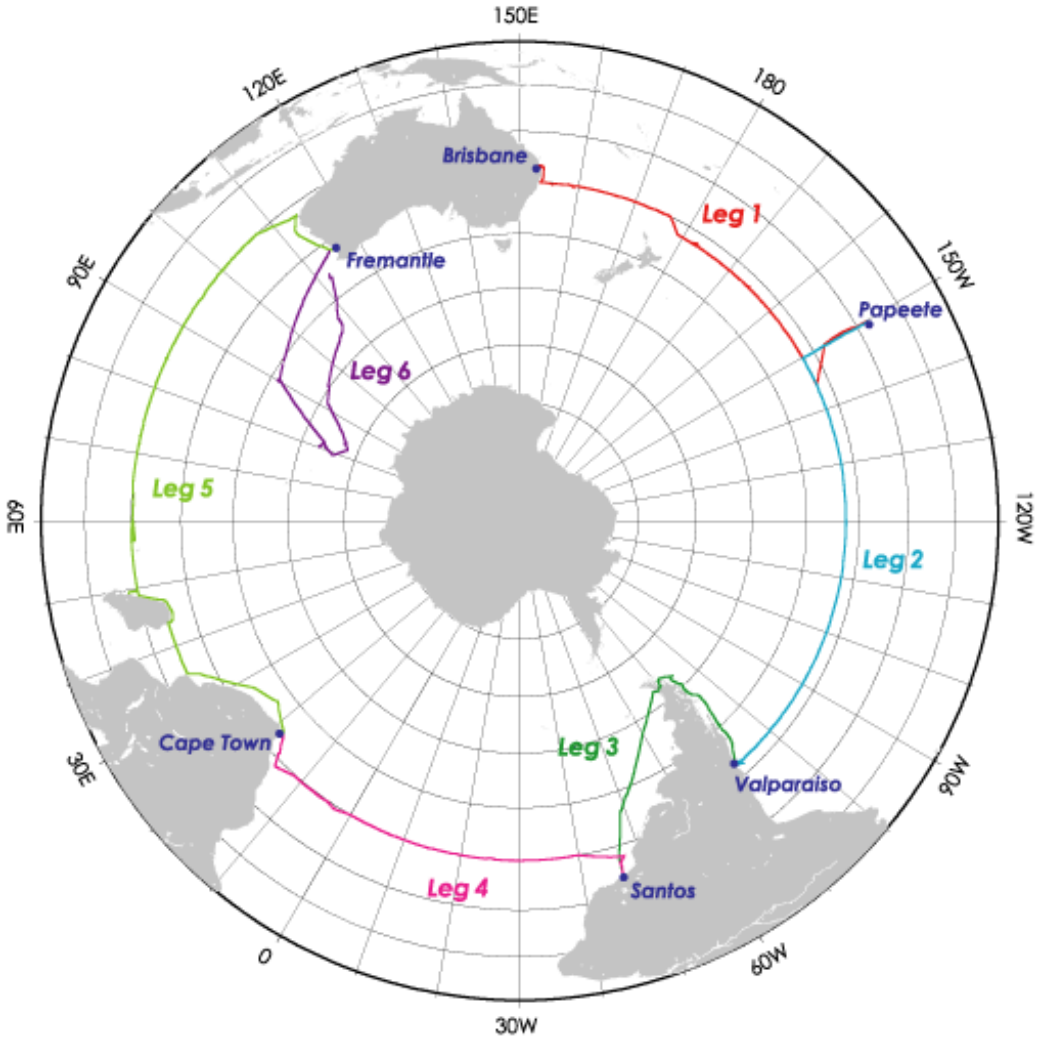


SLW	Surface Layer Water
SAMW	Subantarctic Mode Water
RSW	Red Sea Water
AABW	Antarctic Bottom Water
NPDW	North Pacific Deep Water
ACCS	Antarctic Circumpolar Current System
CDW	Circumpolar Deep Water

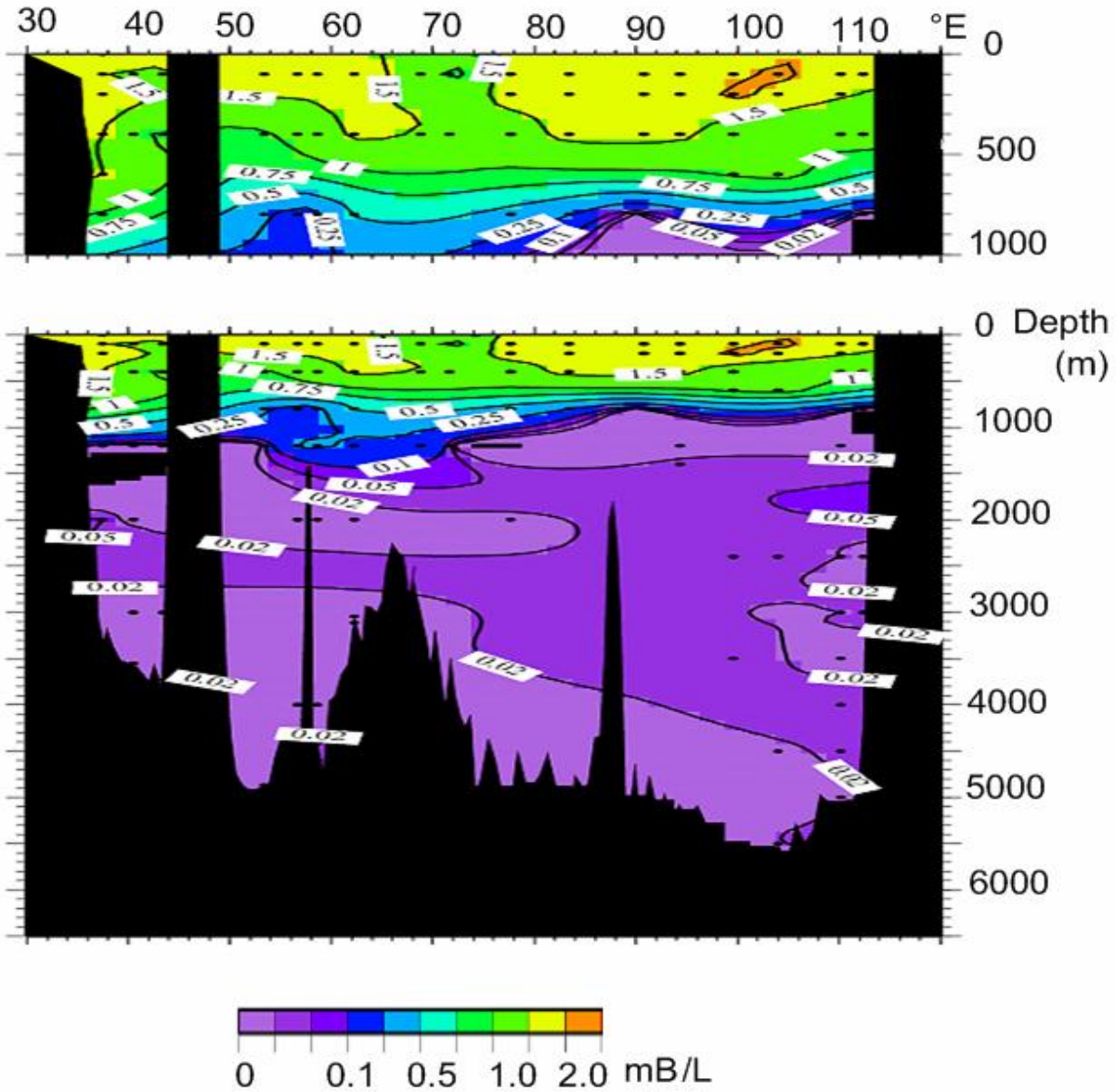
NADW	North Atlantic Deep Water
UPIW	Upper Intermediate Water, $26.8 \leq \sigma_\theta \leq 27.2$
LOIW	Lower Intermediate Water, $27.2 \leq \sigma_\theta \leq 27.5$
IODW	Indian Ocean Deep Water
BIW	Banda Intermediate Water
NIIW	Northwest Indian Intermediate Water

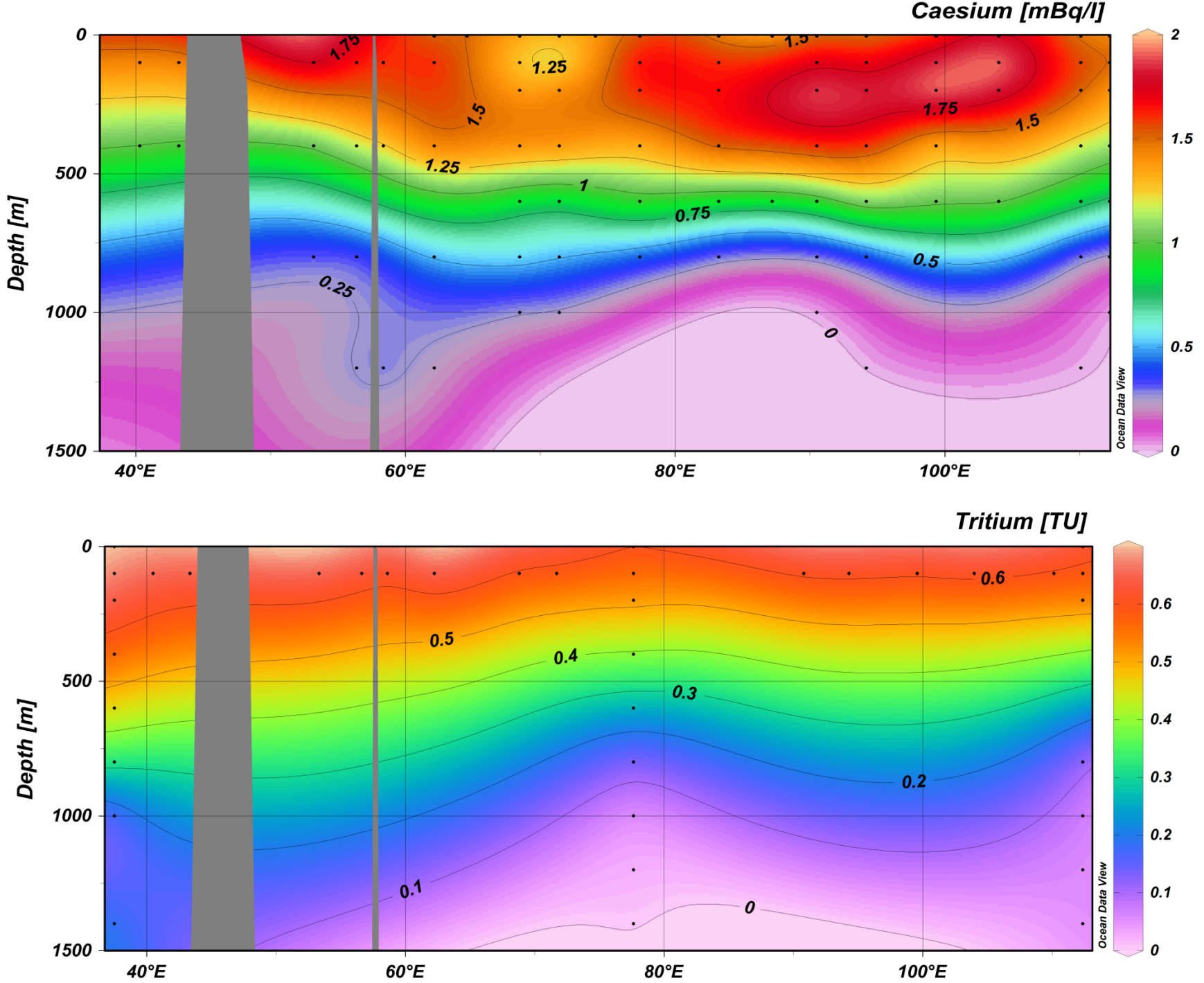
Plate 1.2.7 (see p. 22) A three-dimensional schematic showing the meridional overturning circulation in each of the oceans and the horizontal connections in the Southern Ocean and the Indonesian Throughflow. The surface layer circulations are in purple, intermediate and SAMW are in red, deep in green and near-bottom in blue. From Schmitz (1996b).

Sampling track of the JAMSTEC-BEAGLE2003 (2004) cruise

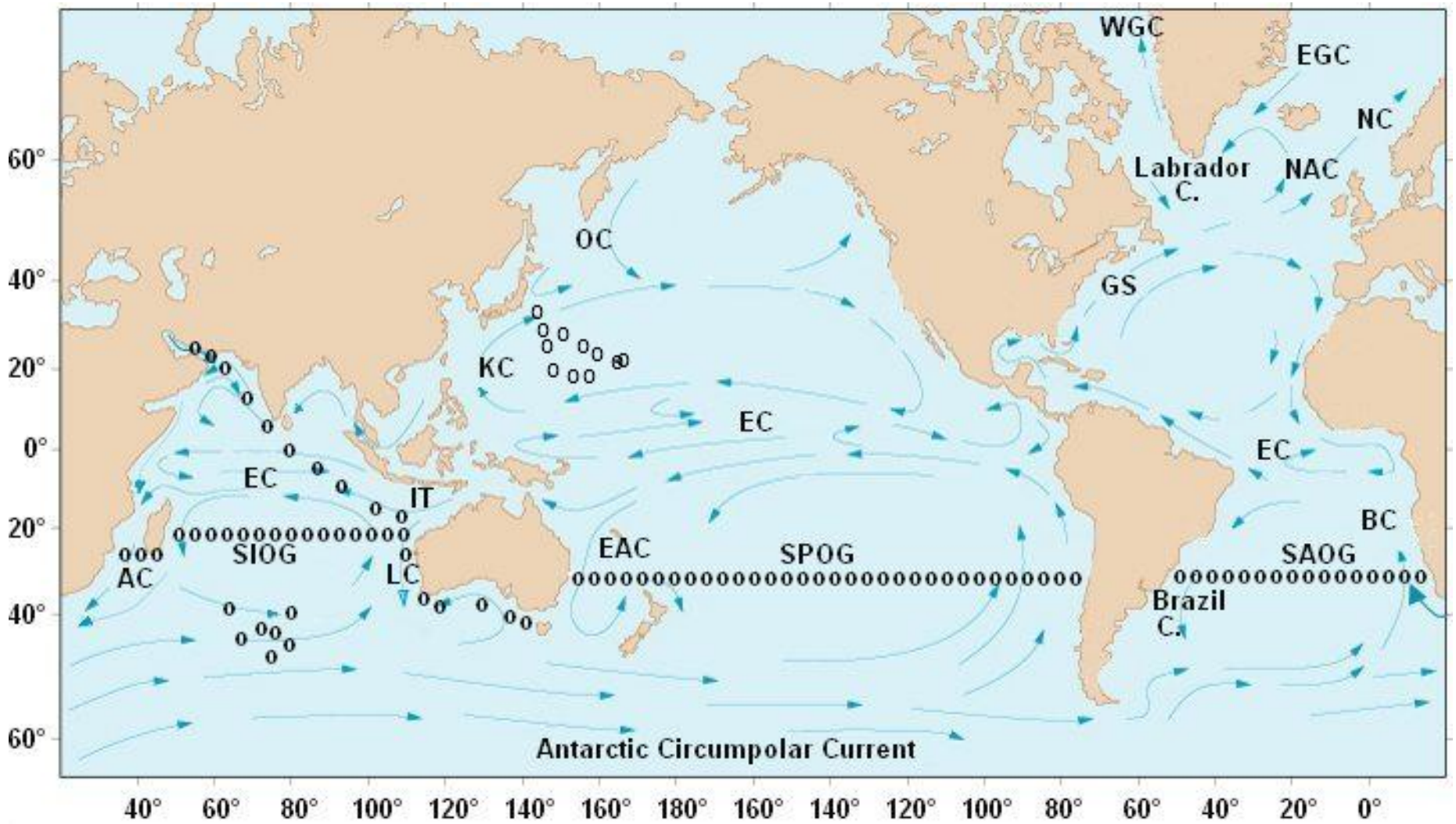


137Cs in the southern Indian Ocean (along 20°S) (BEAGLE´2004)




Caesium [mBq/l]
Depth [m]
0
500
1000
1500
40°E
60°E
80°E
100°E
1.75
1.25
1.5
1
0.75
0.5
0.25
0
2
1.5
1
0.5
0
Ocean Data View
Tritium [TU]
Depth [m]
0
500
1000
1500
40°E
60°E
80°E
100°E
0.6
0.5
0.4
0.3
0.2
0.1
0
0.6
0.5
0.4
0.3
0.2
0.1
0
Ocean Data View

The main surface currents in the World Ocean with sampling sites



Conclusions

- **Transport of radionuclides from the Central Pacific and N Indian Ocean to the S Indian Ocean**
- **Accumulation of radionuclides in the S Indian Ocean, implications for protection of the marine environment from land-based sources**
- **AMS and Underground facilities have opened window for detail investigations of the water column**

Acknowledgements

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