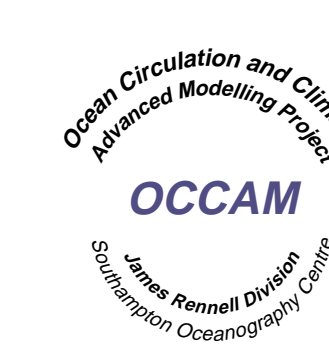


Results from

The OCCAM Global Ocean Model

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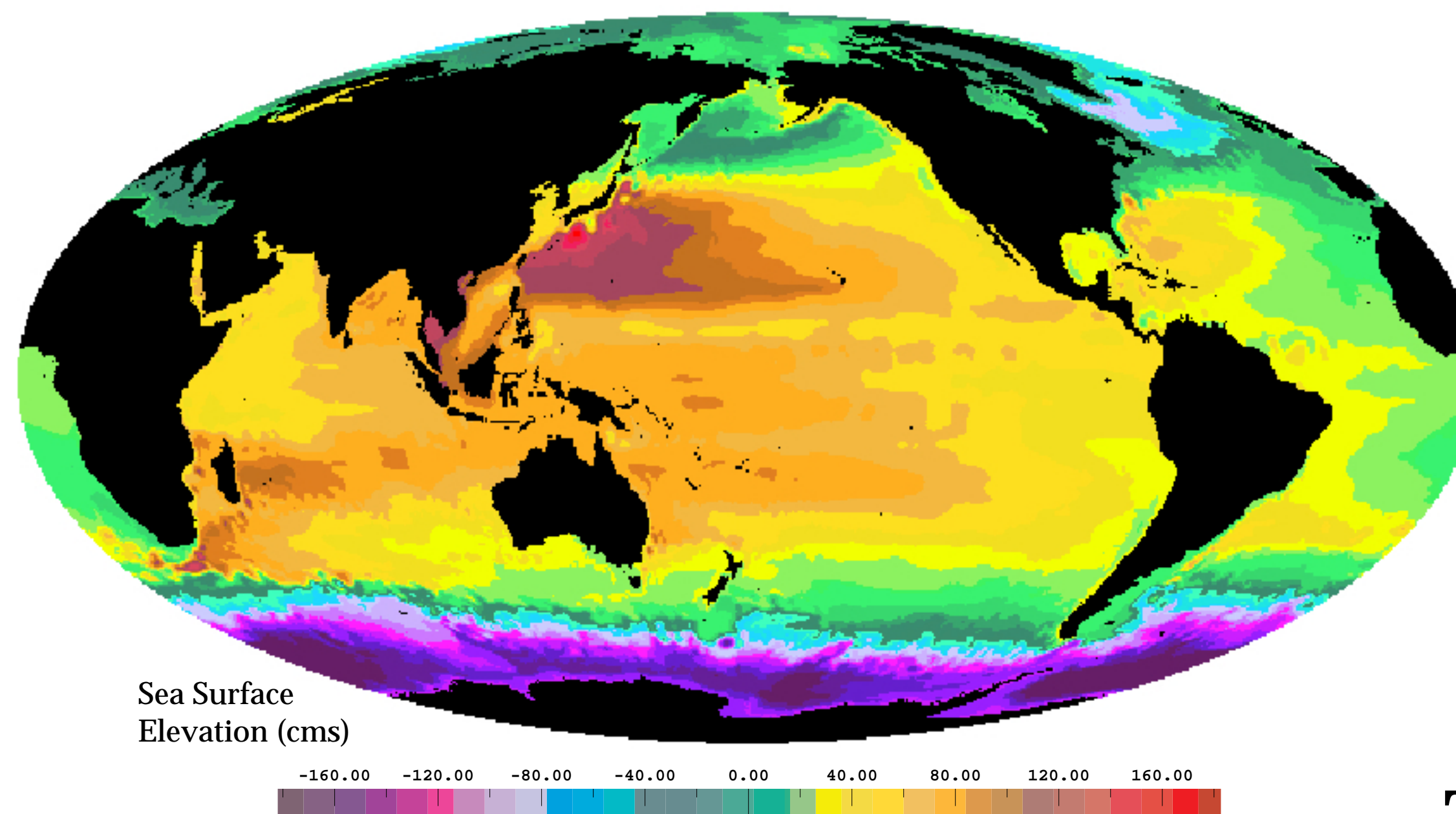


The OCCAM Model

The OCCAM global ocean model was developed as part of a UK Natural Environment Research Council Community Research Programme designed to build on the success of the Fine Resolution Antarctic Model.

OCCAM is a development of the MOM code, designed for running on a Cray T3D computer. The model has a free surface and has 36 levels in the vertical. In the horizontal it uses two grids, each with 0.25 degree resolution. The first is a standard latitude-longitude grid which covers the Indian, Pacific and South Atlantic Oceans. The second is a rotated grid which covers the North Atlantic and Arctic. The model includes marginal seas such as the Mediterranean and has a short channel model to join the Arctic and Pacific Oceans. The model uses an improved version of the Quick scheme for advecting both tracers and momentum in the vertical and horizontal. Because of the free surface the barotropic mode is represented by a tidal equation which is solved explicitly.

The model was initialised from the Levitus (1982) climatology using DBDB5 depths corrected at the major sills. It was forced by monthly average ECMWF winds averaged over the period 1986 to 1988 inclusive. Surface fluxes of heat and fresh water were represented by relaxing the top 20m thick layer of the ocean to the Levitus (1994) monthly surface values using a decay time of 30 days.



The OCCAM Runs

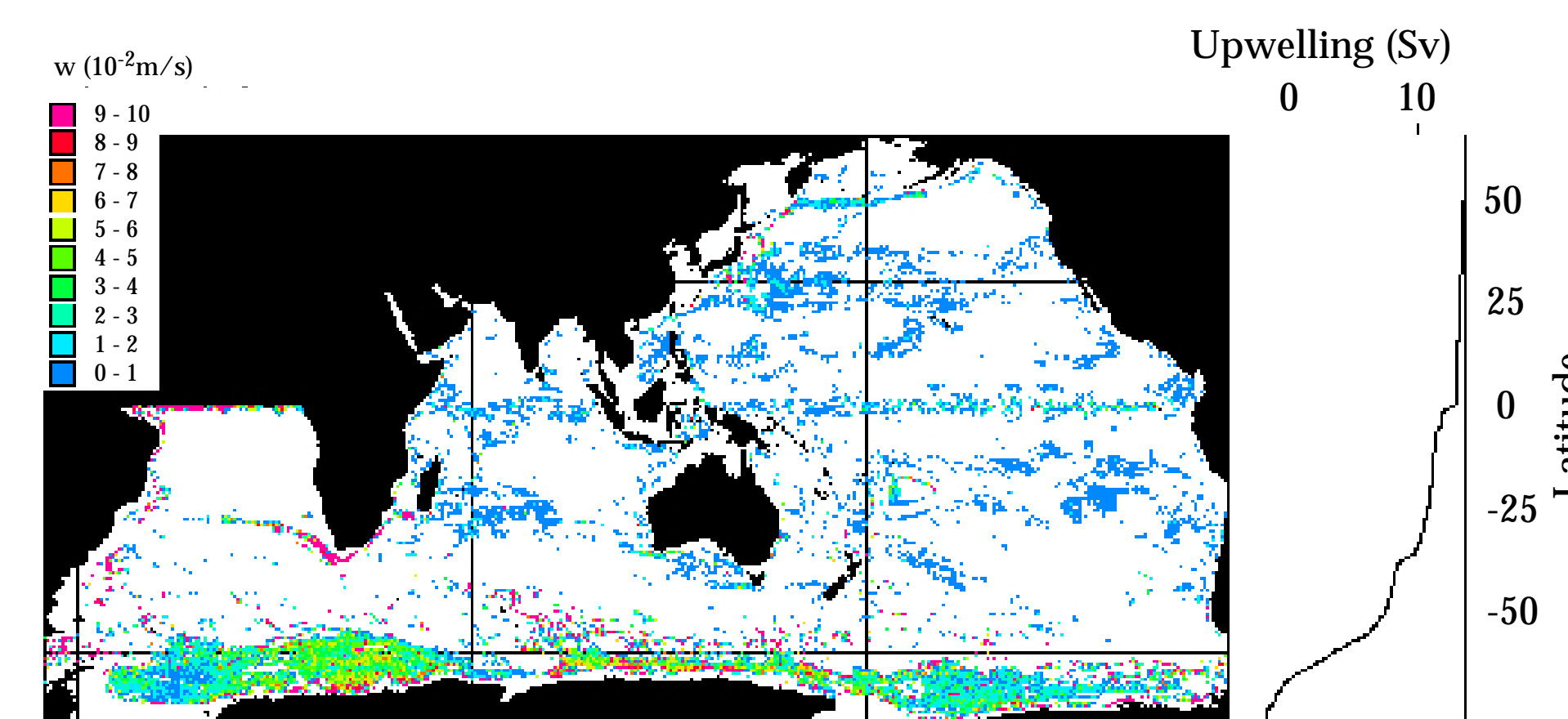
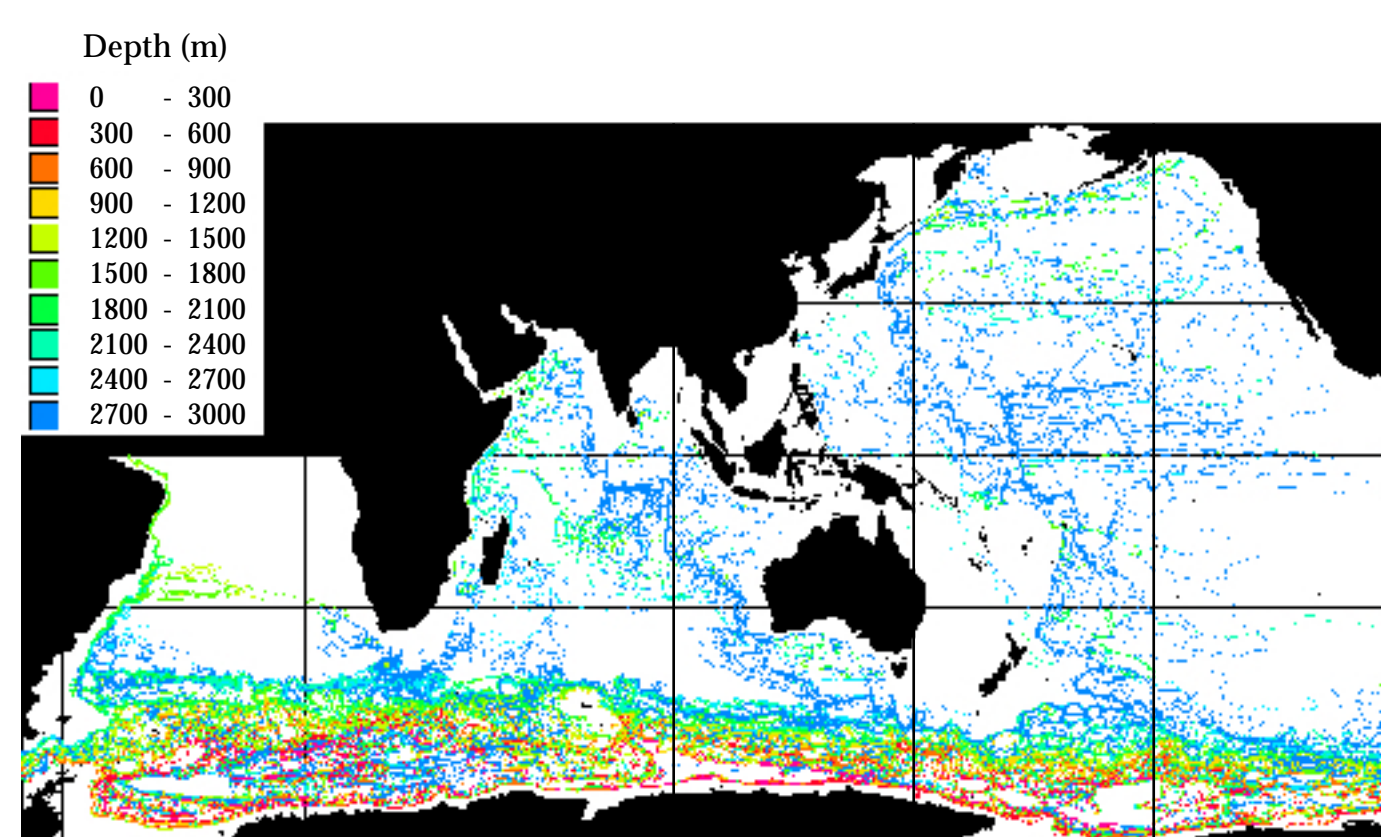
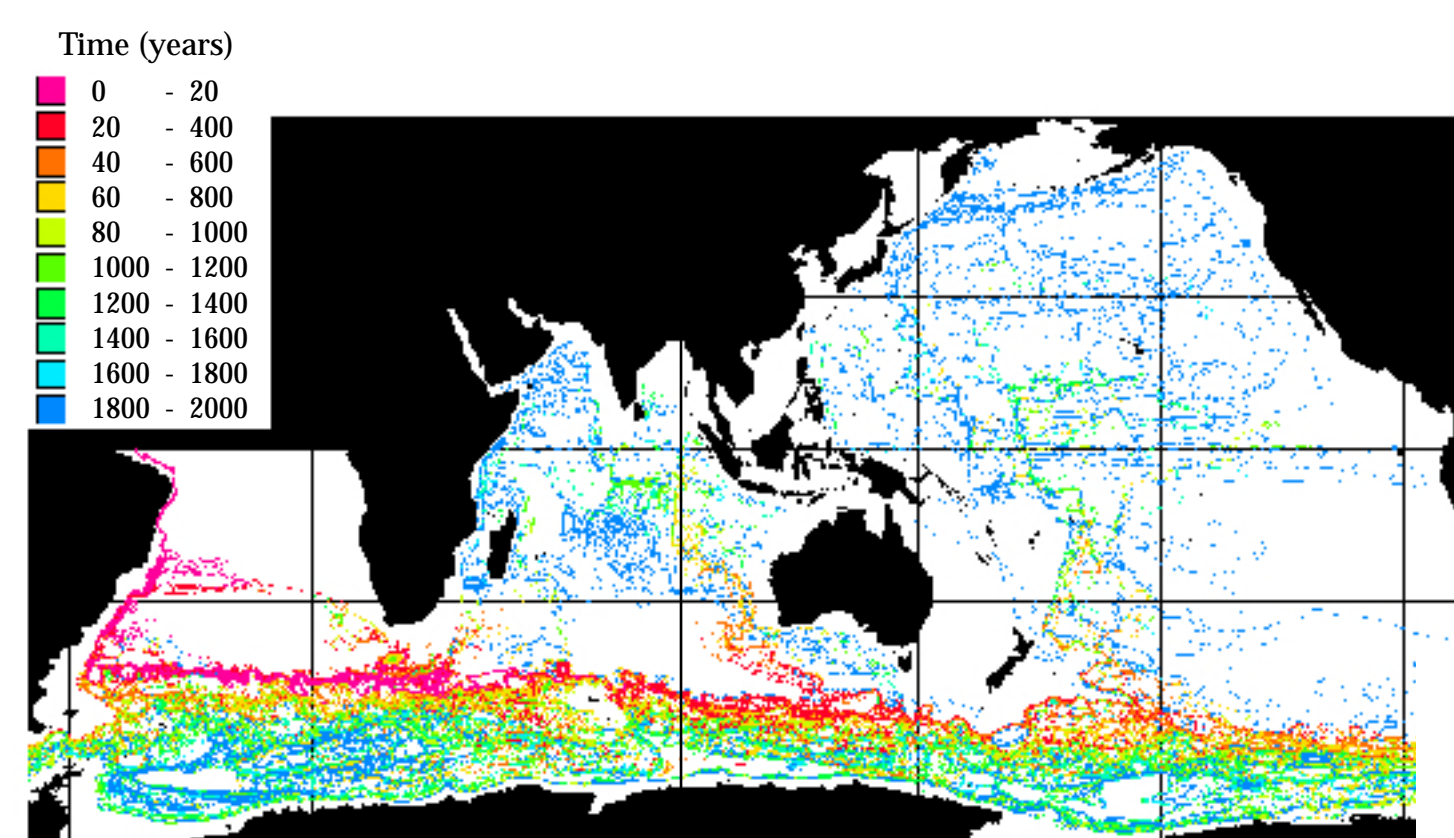
The main run of the OCCAM model consists of an seven year spin up phase followed by further seven year analysis phase. Further documentation and some data from the main run is available via the web page given at the bottom of this poster. For other data contact the authors.

A number of other short runs have been carried out starting from year 8.0. These include two year runs using 6-hourly ECMWF winds and runs also assimilating data from the Topex-Poseidon radar altimeter. Analysis is still underway so the results presented here should be treated as 'work in progress'.

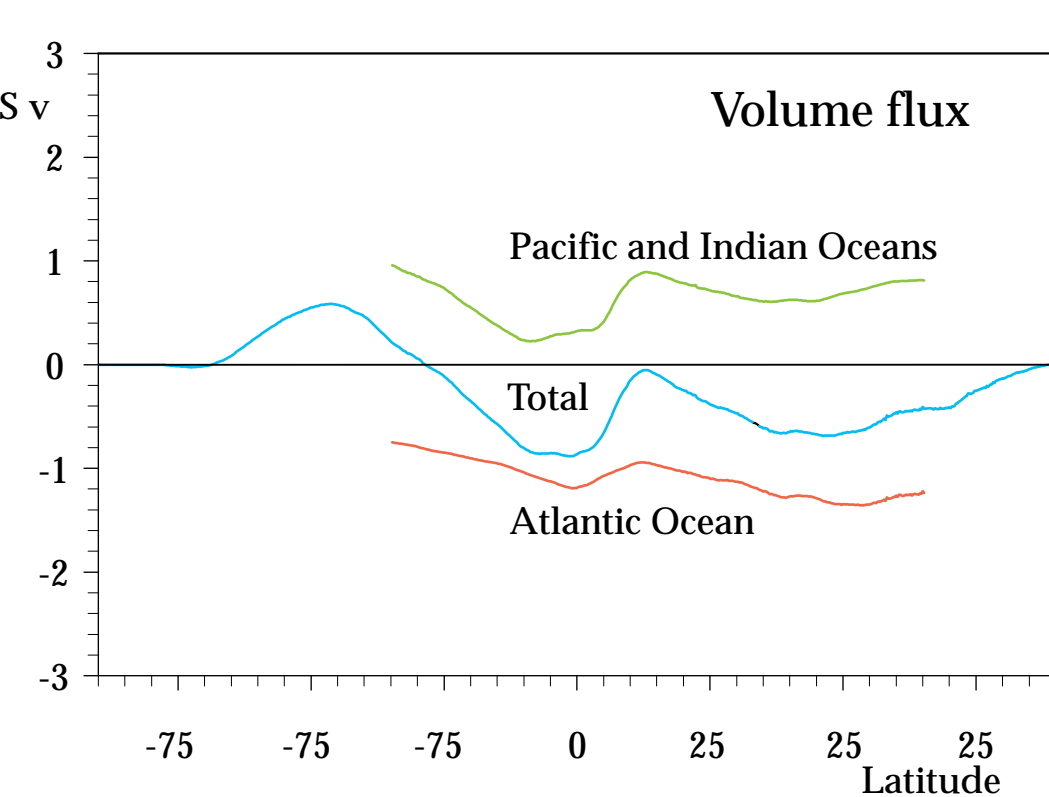
The Thermohaline Conveyor Belt

The upward branch of the thermohaline conveyor belt is normally believed to be controlled by vertical diffusion at depth in the major ocean basins. This has been checked using OCCAM data by following particles released in the North Atlantic Deep Water flowing southwards across the equator. The figures on the left show the paths of such particles until they become light enough to return northwards. The figure below shows the effective vertical velocity at the critical density.

The results show that little of the density change is due to vertical mixing in the deep ocean. Most is a result of heating and freshening in the surface Ekman layer of the Southern Ocean. Much of the water then goes to form the Intermediate Water underlying the southern sub-tropical gyres (Döös and Coward, 1997: International WOCE Newsletter, 27, 3-4).

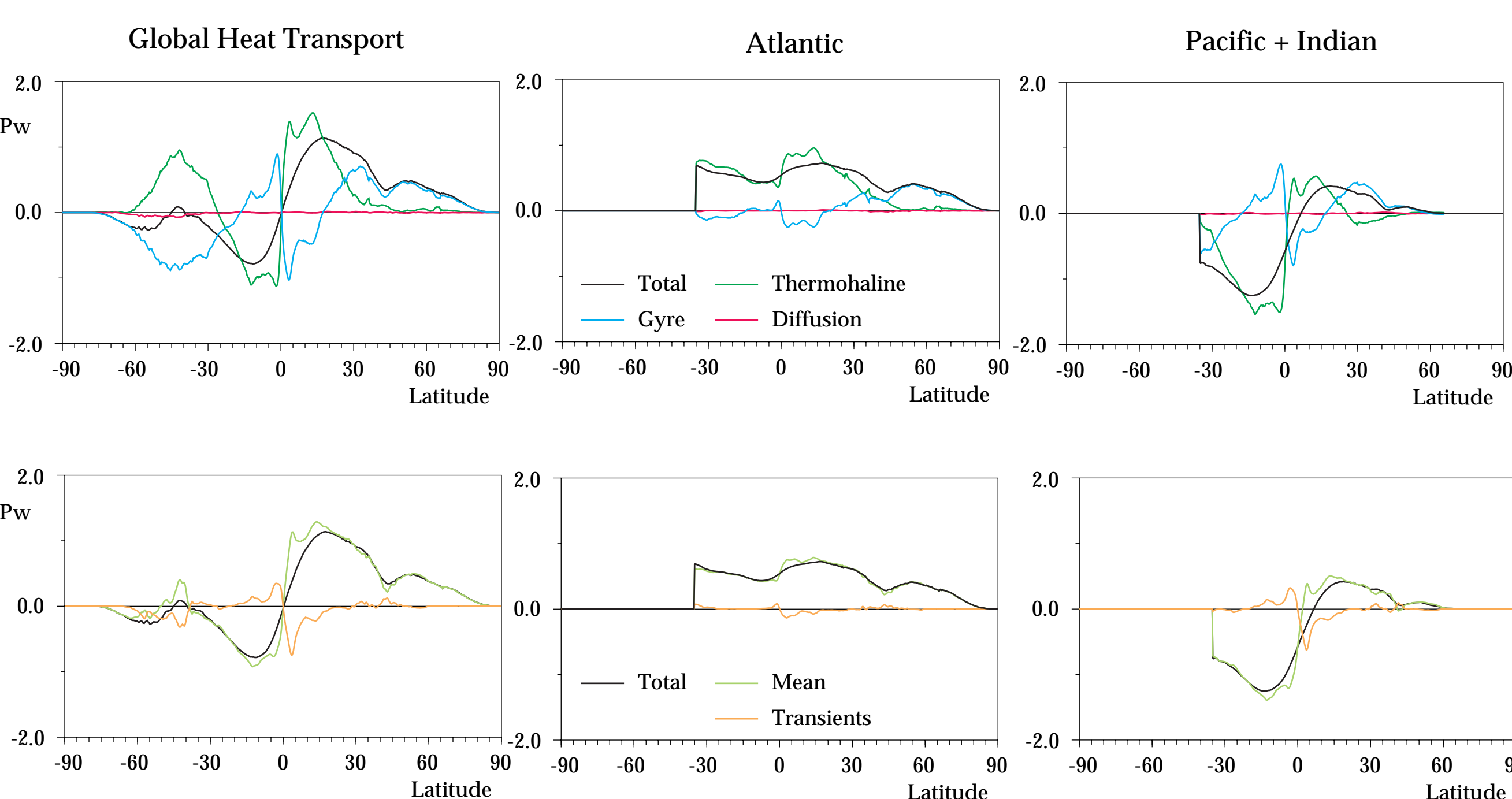


The Large Scale Heat and Fresh Water Flux



The top figure shows the meridional fresh water flux. There is a mean southward flow in the Atlantic and northward in the Pacific and Indian Oceans. Other changes are due to net evaporation in the sub-tropics and precipitation near the equator and at high latitudes.

The lower figures show the meridional heat transport split into the gyre, thermohaline and diffusive terms (top row) and the mean and transient terms (bottom row). The transient terms are not as important in OCCAM as they were in the FRAM model.

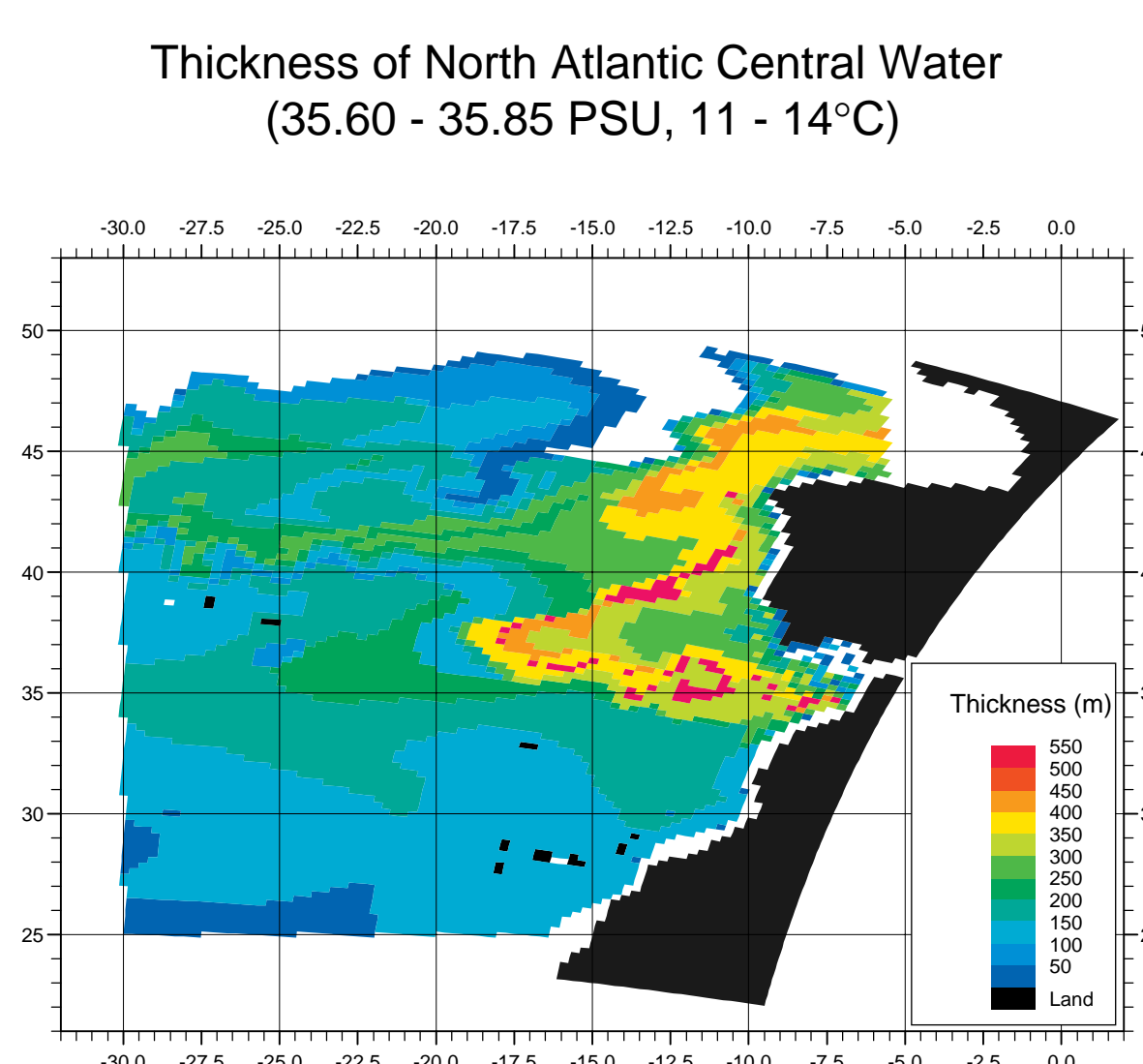
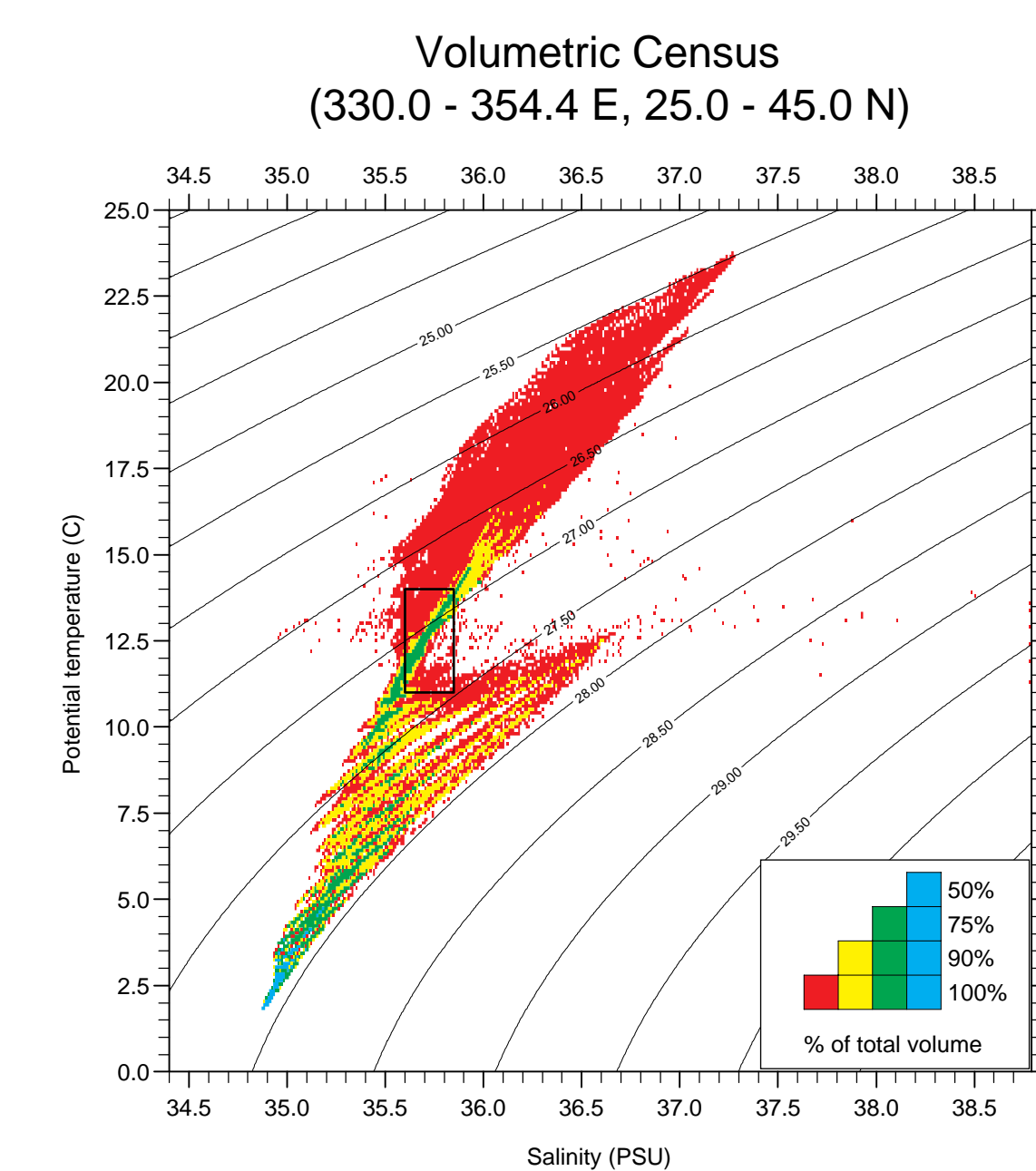
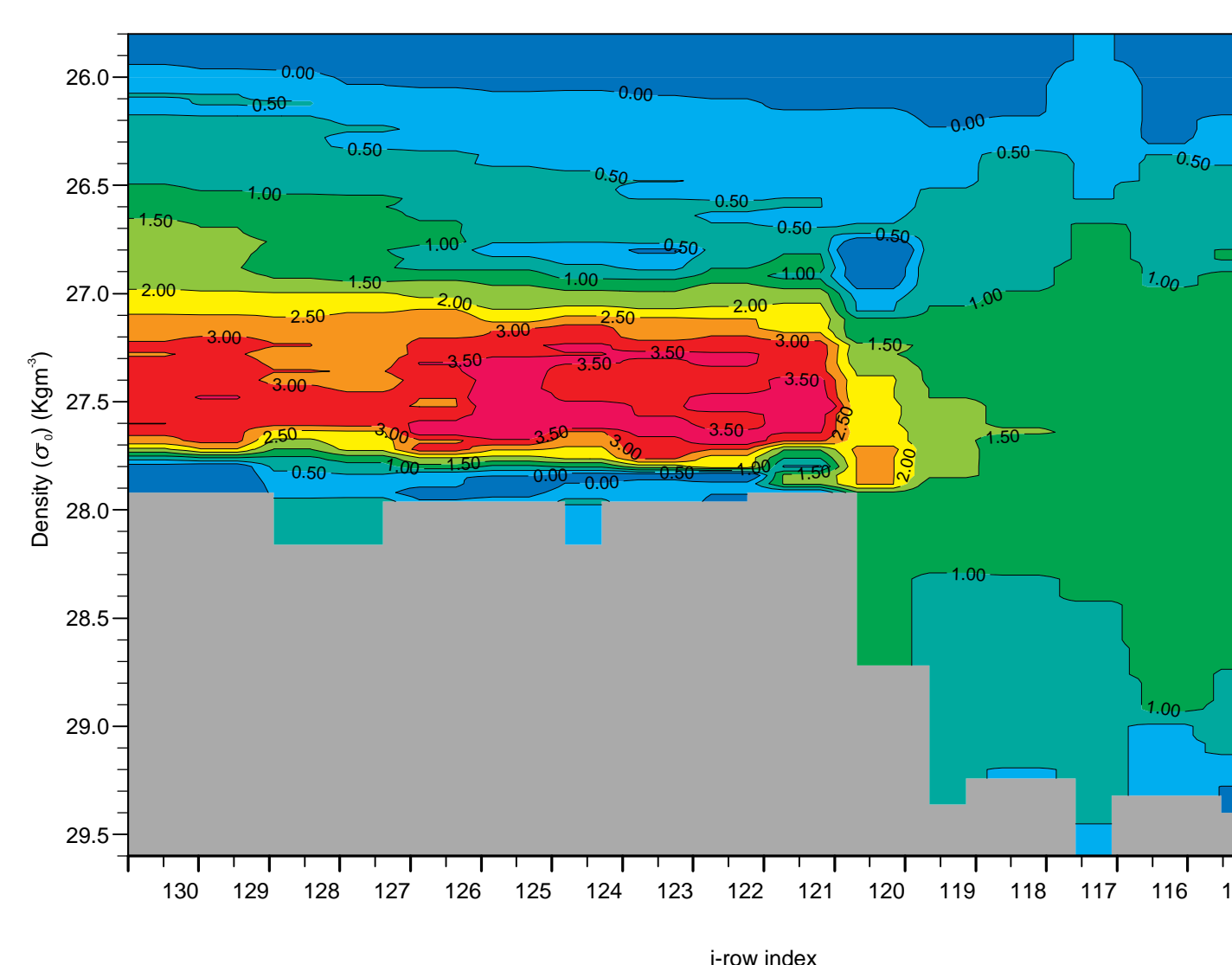


The Mediterranean Outflow

OCCAM contains a full representation of the Mediterranean and its outflow and despite its crude resolution of the Gibraltar region the results are not unreasonable. The figure on the left shows the overturning stream function on density surfaces in the region of the Straits. About 1 Sv ($\rho = 29$) flows out of the Mediterranean and is replaced by surface water ($\rho = 26.5$). The outflowing water mixes with 2 Sv of North Atlantic Central Water ($\rho = 27.2$) to form the plume of Mediterranean Water ($\rho = 27.7$). In OCCAM this entrainment of North Atlantic Central Water appears to be responsible for the formation of the Azores Current.

The central figure below shows the T-S plot for the region. The points on the extreme right, with temperatures near 13°C, represents the plume of Mediterranean water mixing with the North Atlantic Central Water in the Gulf of Cadiz. The Central Water is outlined by a black rectangle.

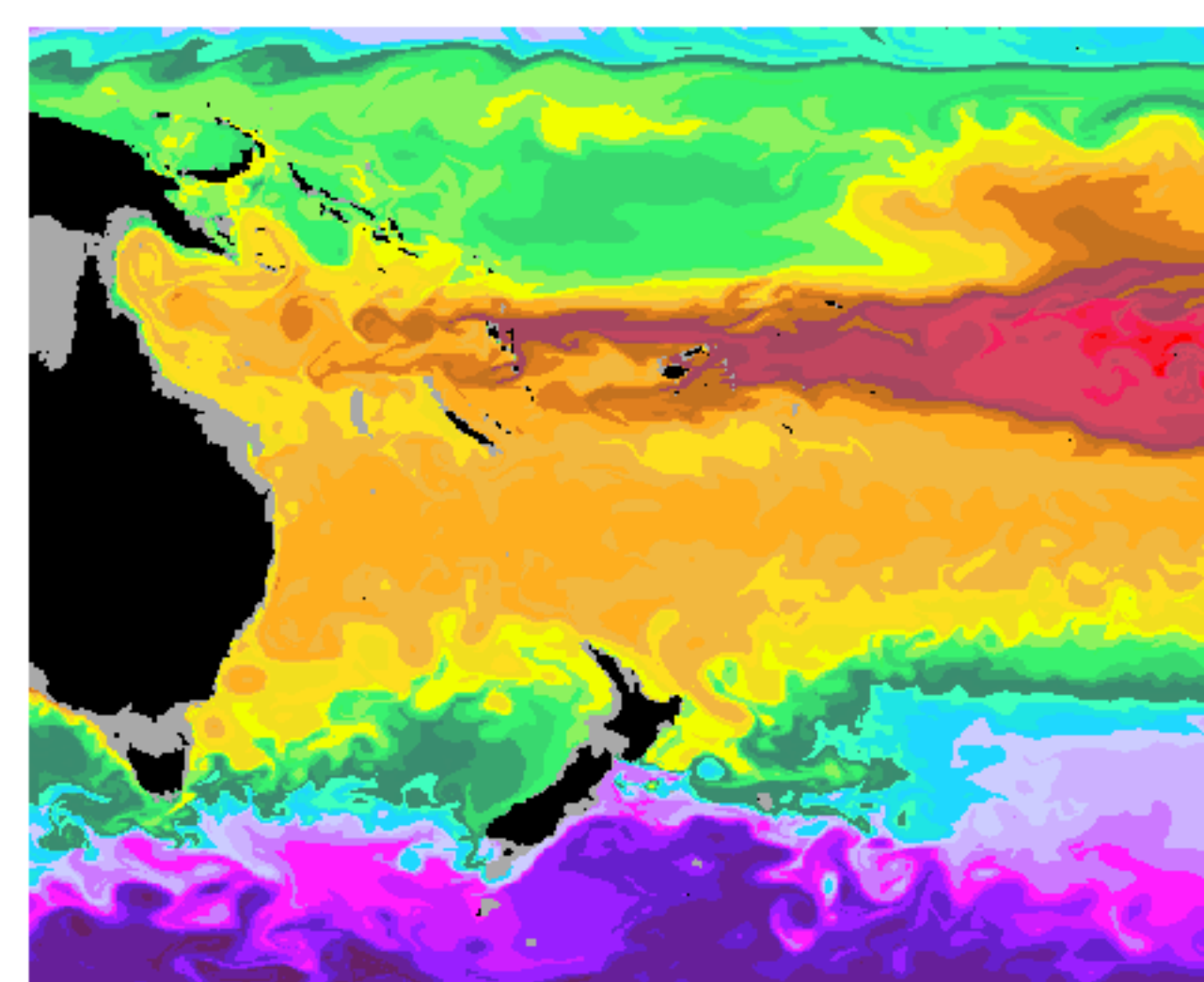
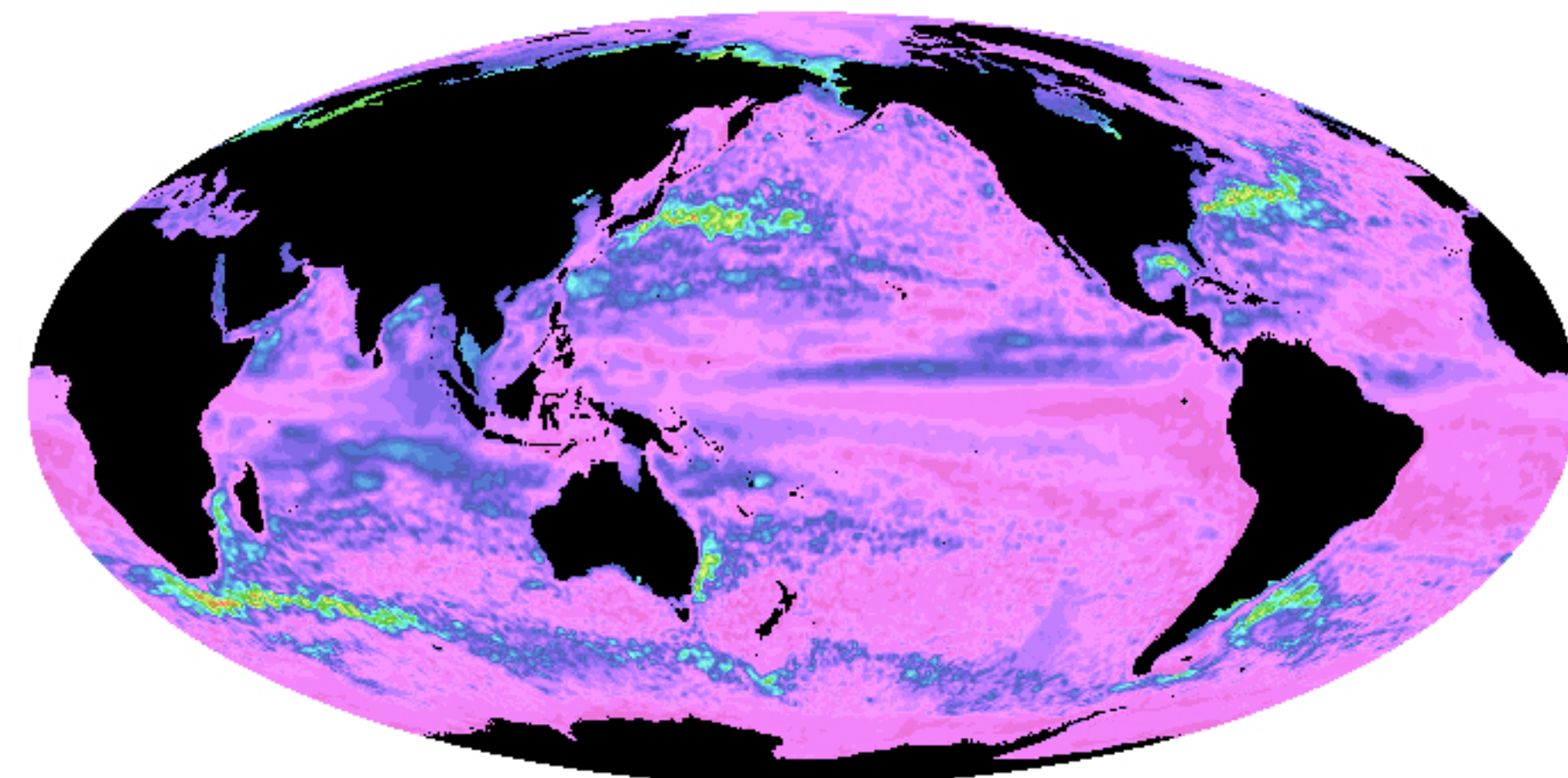
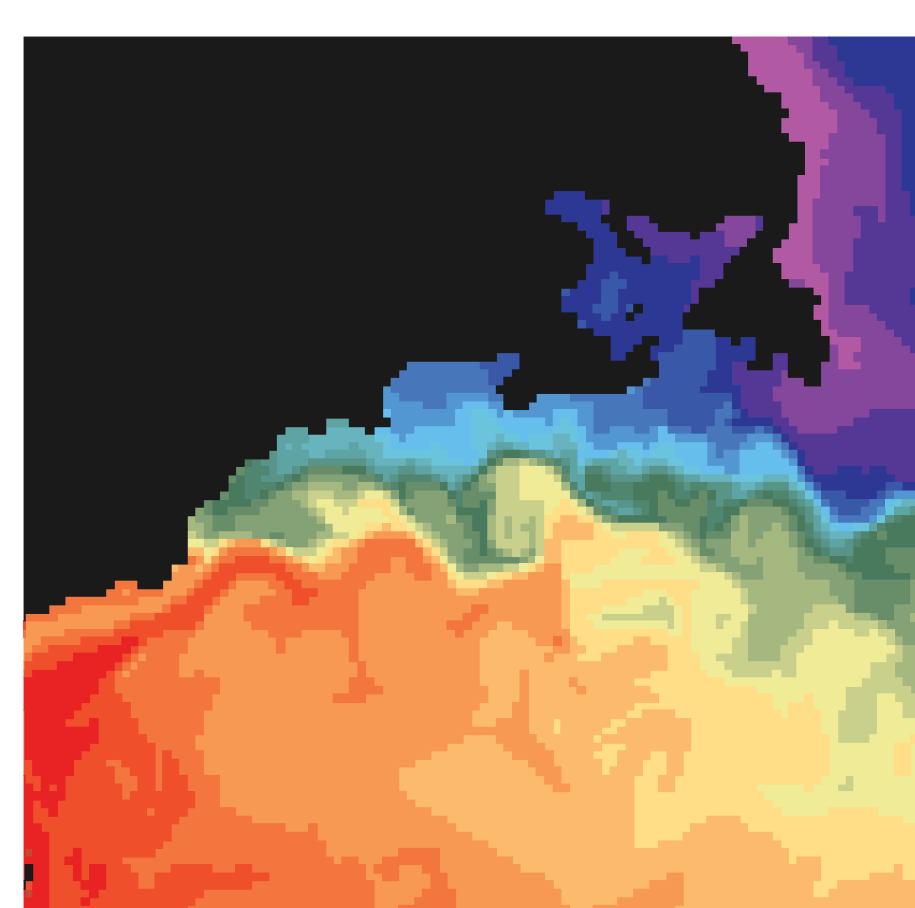
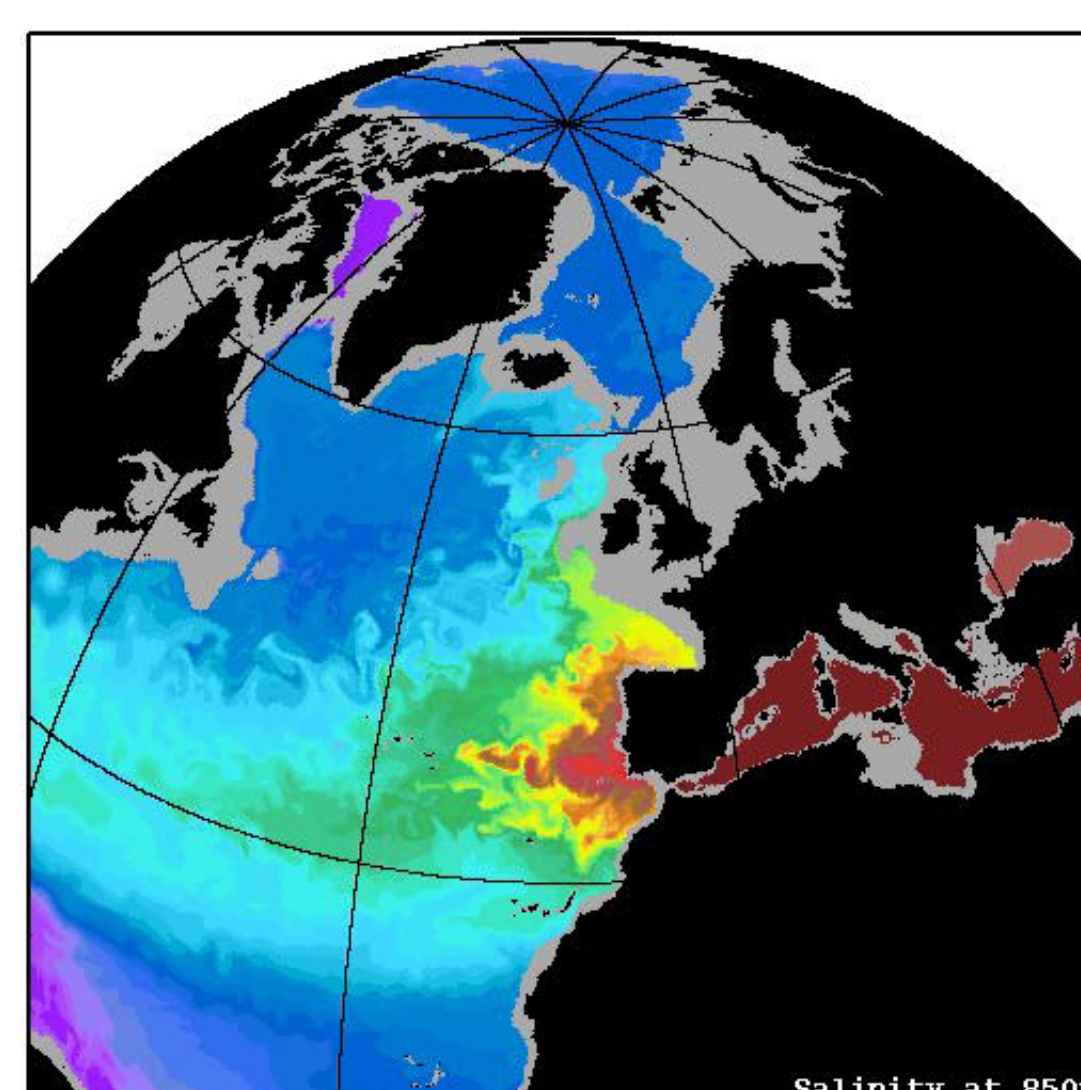
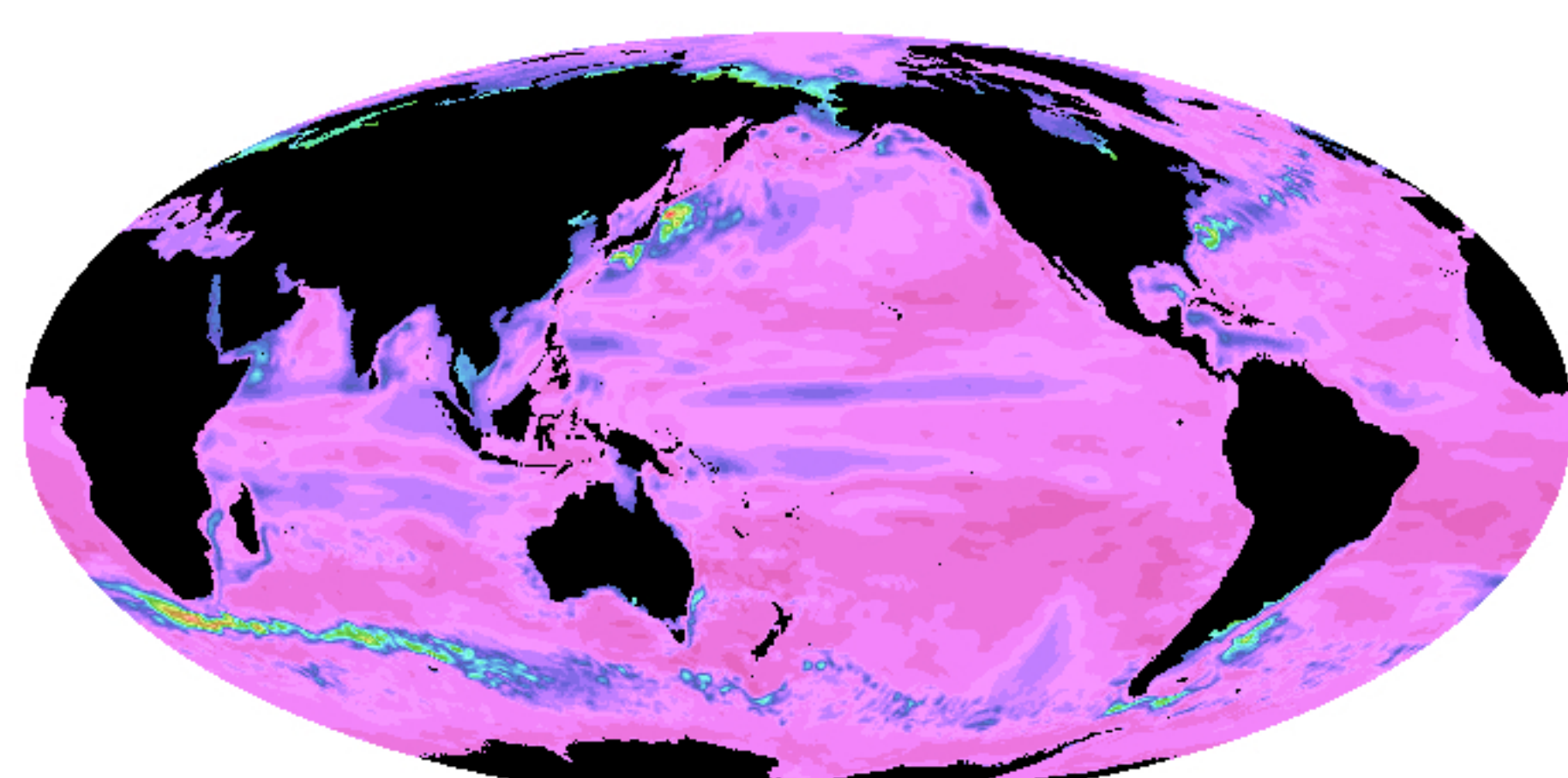
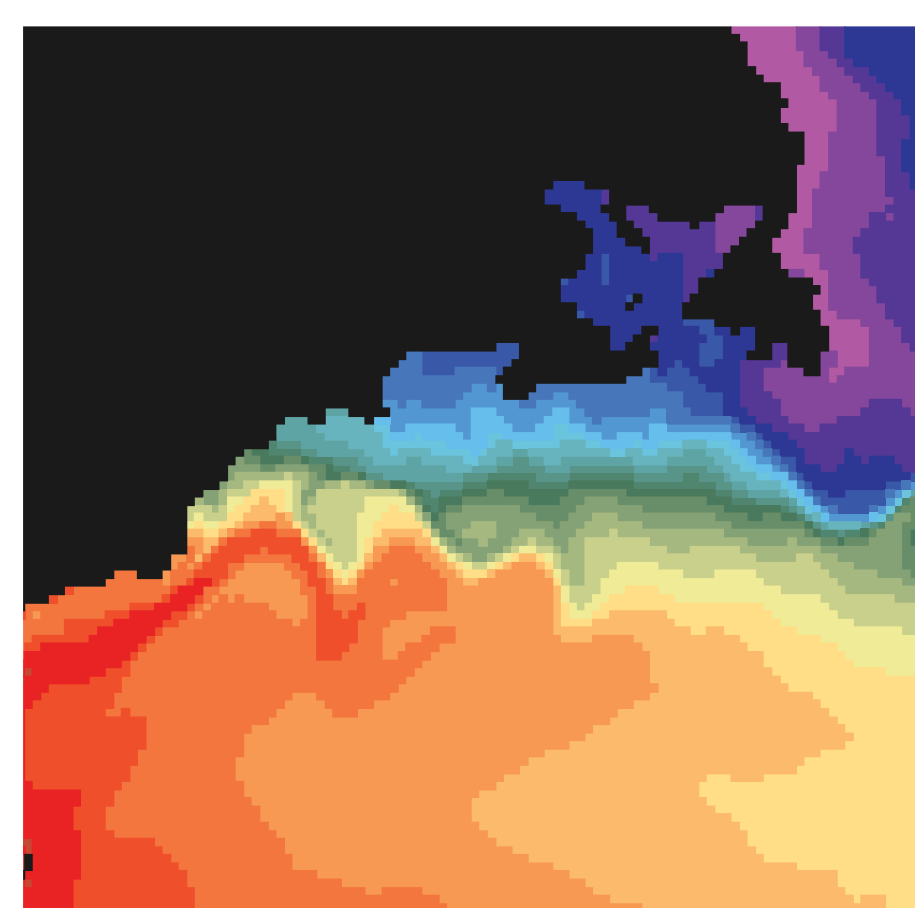
The distribution of North Atlantic Central Water is shown below right. It is formed in winter in the Bay of Biscay and enters the Gulf of Cadiz as part of the Azores Current. The lower left figure shows the spreading of Mediterranean Water in the Atlantic. Particle tracking shows that very little goes north; most is eventually entrained into the southward flowing North Atlantic Deep Water in the far west Atlantic.



Data assimilation

Data assimilation has been carried out in collaboration with Keith Haines at the University of Edinburgh using Topex-Poseidon data. The scheme works well in the sub-tropics where it results in an improved description of the Gulf Stream separation and a better eddy kinetic energy field in the quiet regions of the ocean. The scheme does less well at high latitudes where the ocean flow is more barotropic.

The pair of figures on the left show sea surface temperatures in the Gulf Stream separation region before (top) and after (bottom) assimilating satellite altimeter data. The figures on the right show the sea level variance before (top) and after assimilation (bottom).



... and Finally

Example of some results from the 1/8 degree model run. That on the left shows salinity jets at a depth of 100 metres in the South Pacific where the South Equatorial Current is blocked by a series of island groups.

The right shows the salinity at a depth of a few hundred metres in the Fram Strait. Saline North Atlantic Water in the West Spitsbergen Current splits into two branches. One enters the Arctic Ocean and turns east. The other turns west and mixes with relatively fresh water from north of Greenland. The resulting water masses then flow south as part of the East Greenland Current.

