The Maximum Salinity Core Layer Spreading in the South Pacific Ocean

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Abstract

Spreading and transport of the Maximum Salinity Core Layer (MSCL), defined as water with salinity higher than 36 psu, is investigated from hydrographic data sets collected along twelve cross-sections by the Sea education Association (SEA) between Tahiti and the equator from 2008 and 2015, the ARGO data objectively mapped from JAMSTEC and satellite remote sensing. Aquarius sea surface salinity data show that the MSCL occupied an area averaged over time of about 6.7 106 km^2 with an increase of the occupancy in 2015. The variation of the area occupied by the MSCL at the surface does not show any seasonal cycle. Hydrographic dataset are used to show the extent of the MSCL below the surface. The SEA dataset exhibits the spreading of the MSCL northward of Tahiti between isopycnals 24 σt and 25 σt and is observed as far north as 4°S. The MSCL is observed at the surface as far north as 12°S and the disappearance of the MSCL from the surface is due to input of fresher water from the equatorial region or from the west. Even tough ARGO data have a poorer vertical resolution, comparison with SEA dataset shows that the core of the MSCL is well determined. But ARGO data has a better time resolution and monthly data are available from 2001 to 2017. ARGO data allow us to visualize the whole volume of the MSCL and the westward extension of the MSCL. Geostrophic currents are calculated from ARGO data relative to the surface where surface currents are adjusted to velocities provided by the satellite derived OSCAR data set. The transport calculation shows that most of the water north of Tahiti is transported westward with the highest volume during an El Niño year.

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Objectives

- Study of the spreading and transport of the Maximum Salinity Core Layer (MSCL), defined as water with salinity higher than 36 psu.
- Data sets :
  - hydrographic and ADCP data along twelve cross-sections collected by Sea education Association (SEA)
  - ARGO data objectively mapped from JAMSTEC
  - SSS aquarius data
  - OSCAR surface current data set

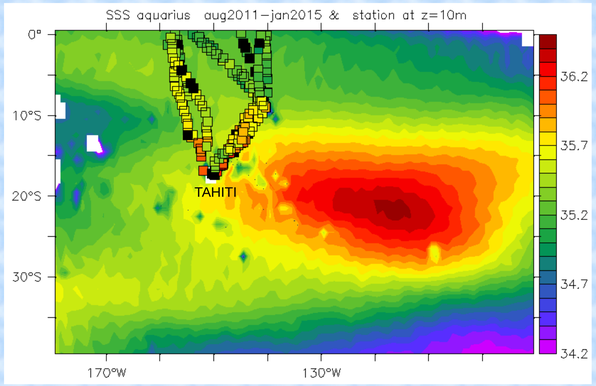

Figure 1. Map showing the extension of the 36 psu core as observed with Aquarius data. The squares are the position of CTD data collected by SEA. Aquarius sea surface salinity data show that the MSCL occupied an area averaged over time of about 6.7 1 million km² with an increase of the occupancy in 2015. The variation of the area occupied by the MSCL at the surface does not show any seasonal cycle. This map shows that around Tahiti, the MSCL is found at deeper level.

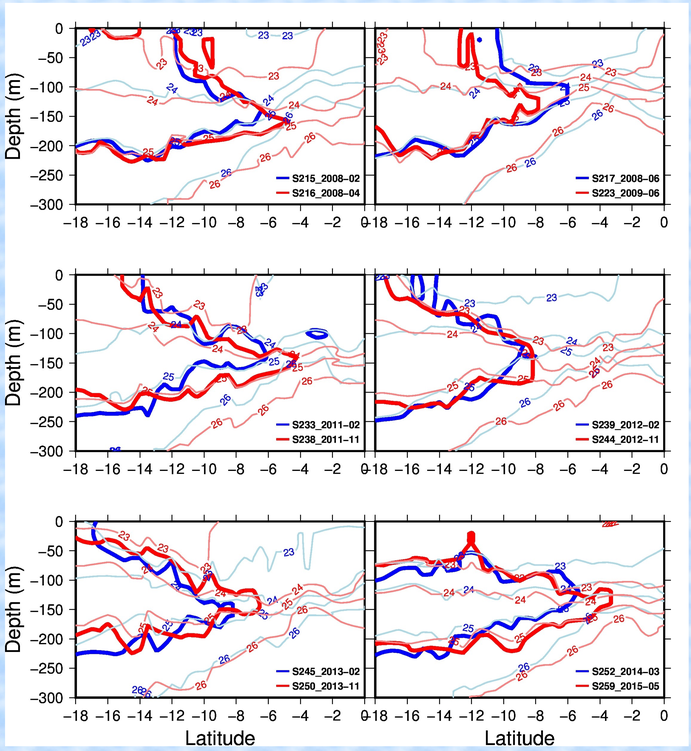

Figure 2. The MSCL as described by the SEA data set from Tahiti to the equator and from 2008 to 2015. Data are available from 12 cruises as reported on the graph with the corresponding date. Thick contours delineate the 36 psu of the MSCL. Thin contours represents the isopycnals. The SEA dataset exhibits the extension of the MSCL northward of Tahiti between isopycnals 24 σ_t and 25 σ_t and is observed as far north as 4°S. The MSCL is observed at the surface as far north as 12°S and the disappearance of the MSCL from the surface is due to input of fresher water from the equatorial region or from the west.

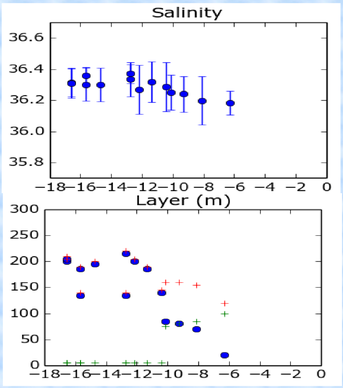

Figure 3. (Top) Average salinity and standard deviation within the salinity core layer versus latitude. The average salinity is almost constant from South to North. (Bottom) Layer thickness versus latitude (blue dot). Red and green crosses are respectively maximum and minimum depths of the MSCL

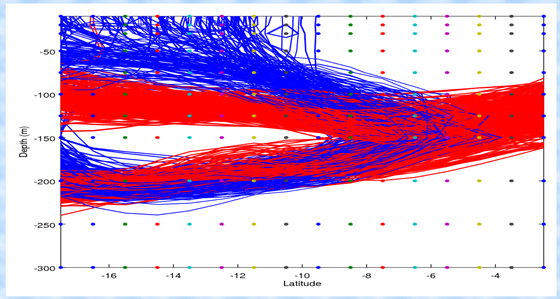

Figure 4. Isocontours representing the 36 psu-MSCL (blue) and isopycnals sigma-24 and sigma-25 (red). The dots are the locations of the objectively mapped ARGO data from 2001 to 2016. Even tough ARGO data have a poorer vertical resolution, comparison with SEA dataset shows that the core of the MSCL is quite well defined. But ARGO data has a better time resolution and monthly data are available from 2001 to 2017.

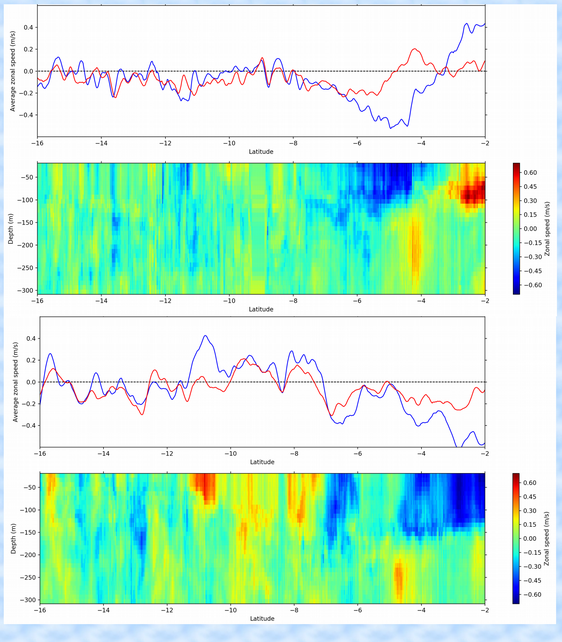

Figure 5. Zonal speed as measured by the ADCP for cruise S217_2008-06 (top) and S244_2012-11 (bottom). The average zonal speeds are for two layers, the top 100 m (blue curve) and the 100-200 m layer (red curve). The speed in these two layers vary more or less in the same way south of 8°S except when water from the west entered the region like in 2012-11. Great variations of speed between these two layers are found north of 8°S as it is closer to the equator.

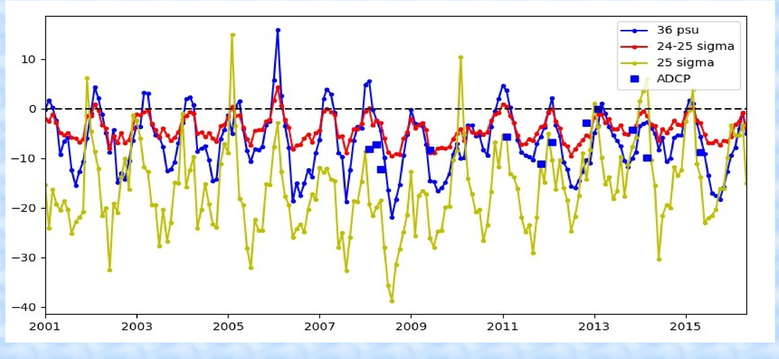

Figure 6. Time series of total water transport between 18°S and 2°S (in Sv = 10^6 m^3s^{-1}) : for the 36 psy MSCL (blue), for the 24-25 sigma-t layer (red) and for the layer above 26 sigma-t (yellow). Zonal geostrophic velocities are estimated with ARGO hydrographic data with reference to the surface where OSCAR surface current were added. Negative values represent water transported westward. Blue squares represent transport estimated with ADCP data. The long term average transport is westward (6.5 Sv for the MSCL). Eastward water transports are observable in all series with a better correlation between MSCL transport and transport for the 24-25 sigma-t layer. In all time series, the annual cycle is dominant. Longer term cycles are not observable in the transport of the MSCL.

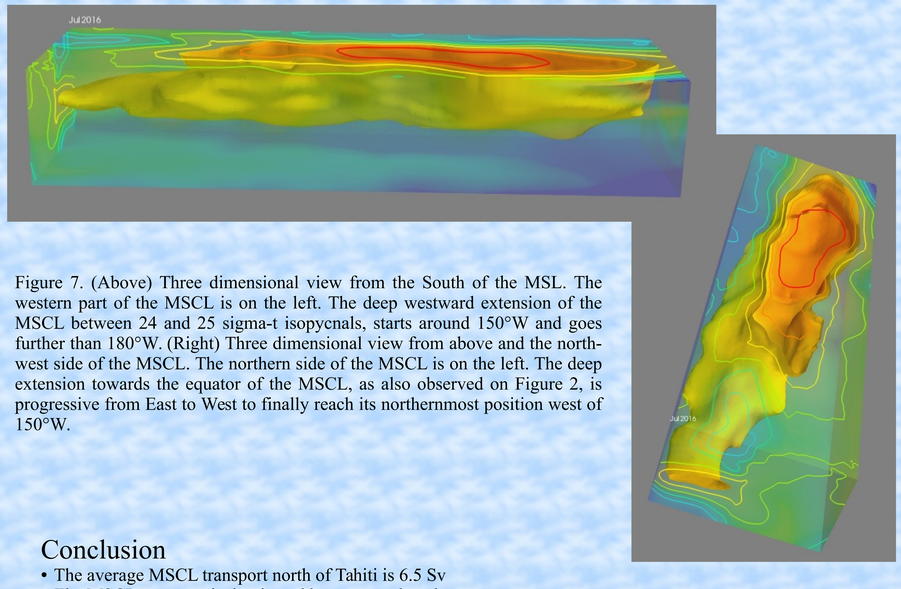

Figure 7. (Above) Three dimensional view from the South of the MSL. The western part of the MSCL is on the left. The deep westward extension of the MSCL between 24 and 25 sigma-t isopycnals, starts around 150°W and goes further than 180°W. (Right) Three dimensional view from above and the north-west side of the MSCL. The northern side of the MSCL is on the left. The deep extension towards the equator of the MSCL, as also observed on Figure 2, is progressive from East to West to finally reach its northernmost position west of 150°W.

Conclusion

- The average MSCL transport north of Tahiti is 6.5 Sv
- The MSCL transport is dominated by an annual cycle
- The ARGO dataset allows a three dimensional view of the core

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