OBSERVED SUBSURFACE SIGNATURE OF SOUTHERN OCEAN SEA LEVEL RISE

Rosemary Morrow, Guillaume Valladeau and Jean-Baptiste Sallee
LEGOS/OMP, Toulouse, FRANCE

1/ Background on global seal level rise

- STRONG INCREASE IN SEA LEVEL
- Where -> in the Southern Ocean
- When -> over the period 1993-2003

2/ Data

- 13 years of repeat hydrographic data (WOCE-SR3)
- SURVOSTRAL XBT and SSS data (Figure 2)
- Satellite data and surface meteorological forcing
- AVISO 1°/3° grid - altimetry, Reynolds SST, ERA-40 and QUICKSCAT winds, ECMWF heat flux, ECMWF precipitation and Xie & Arkin precipitation data

3/ Surface Salinity in the Antarctic Zone

- In the Antarctic Zone (AZ), S of the Polar Front (PF)
- Drop in salinity explained by F-P (~20 mm/month)


- In the SAZ:
  - STF (position of the 11°C isotherm at 250 m) shifted from 46°S to 47°S
  - SAF shifted from 50.5°S to 51.5°S

- In the AZ:
  - Nat warming and freshening in the surface mixed layer
  - Tongue of Winter Water is shallower and thinner at the end of the period - explains the alternate cooling and warming layers in the difference plot
  - Cooling of the layers from 80-120 m on the top of the tongue
  - Warming of the layers from 150-250 m at the base of the tongue

5/ Subsurface T and S Changes

- Net increase in the 0/2000 dB steric height in the AZ between 54-63°S by 1-4 cm

6/ Deeper Warming impacts on Steric Height and Sea level

- The deep warming of the steric height rise over 0/2000 dB by a factor of 2-3, compared to the steric height calculated from 0/500 dB

7/ Changes in wind forcing on the gyre-scale deep circulation

- A simple wind-forced Sverdrup model is used to calculate the changes in the large-scale, depth-integrated circulation over the period.

Result: weakened depth-integrated transport of cool, low salinity water in 2000-2004 means the deeper waters appear warmer and saltier in the AZ along the SURVOSTRAL/S3K line.

8/ Conclusion

We have examined the causes of the observed sea level rise in the region south of Australia, using a combination of satellite and in-situ data.

- The hydrographic data show a poleward shift in the position of the Subtropical and Subantarctic Fronts over the period.
- In the Antarctic Zone, the Antarctic Surface Water has become warmer and fresher, and the Winter Water tongue has become warmer, fresher, thinner and shallower. Increased freshening south of the Polar Front is linked to increased precipitation over the 1990s.
- Temperature changes over the upper 500 m account for only part of the steric sea level rise. The CTD sections show that the deeper layers are also warmer and slightly saltier and the observed sea level can be explained by steric expansion over the upper 2000 m.

Reference:
Email: rosemary.morrow@cnes.fr