Near-Surface Variability of Temperature and Salinity: Observations from Profiling Floats

Jessica E. Anderson and Stephen C. Riser

School of Oceanography
University of Washington
Ocean Salinity

Surface salinity, monthly composite from Aquarius

Salinity at 5 meters, estimated from the Argo dataset. (Dr. Li Ren)

• Generally, we have a poor understanding of the links between the water cycle and ocean circulation as well as their relation to climate.

• Aquarius/SAC-D will improve spatial resolution, however it senses only the uppermost ~1 cm.

• We need accurate, near-surface salinity data that can be used to connect Aquarius data at the sea surface to Argo at 5m and below.
Ocean Near-Surface Salinity

Smaller Scale Variability

\[ \Delta S: 0.15 \text{ PSU} \]

Shipboard CTD off the West Florida continental shelf.

Price, JPO, 1979
STS Float Design

SeaBird

**Surface Temperature & Salinity sensor (STS)**

T~0.005°C; S~0.05 PSU; Z~5cm

Iridium telemetry

7 minutes surface time
2-way communication
> 30 possible commands
STS Float Operation - Example Profile

Ascent rate 8 cm/sec

STS and SBE41 (1 Hz)
120 Samples

< 5 meters
STS Only (0.6 Hz)

5-25 meters
STS and SBE41 (0.6 Hz)

Float 6117
Profile 228
8/15/2009
To date, 31 STS floats have been deployed.
Regional Variations

STS(surface) - STS(4m)

All STS Floats

% of Profiles

\( T \ (°C) \)

85%
90%
80%
77%

All Floats (31)
Atlantic
Pacific
Indian

% of Profiles

\( S \ (PSU) \)

91%
93%
88%
88%
Float 6117 - Tropical Western Pacific

STS(surface) - STS(4m)

311 profiles
Mean $\Delta T = 0.09$ °C
Mean $\Delta S = -0.05$ PSU
311 profiles
Mean ∆T = 0.09 °C
Mean ∆S = -0.05 PSU
Float 6117 - Tropical Western Pacific

Temperature (°C)

Depth (m)

Salinity (PSU)

Depth (m)

Jul 2010 - Jan 2012

Upper 500 meters
Profile every 10 days

3/24/2009 - 1/28/2012
Float 6117 - Tropical Western Pacific

Temperature (°C)

Salinity (PSU)

Depth (m)

Upper 10 meters
Profile every 2 hours
3 week time period

Float 6117 - Tropical Western Pacific
Spectral Density

T (°C)

S (PSU)
Float 6117 - Tropical Western Pacific

STS - STS(15m)

311 profiles

T (°C)  S (PSU)
Float 6117 - Tropical Western Pacific

Composite Mean Anomalies
Float 6117 - Tropical Western Pacific

Upper 10 meters
Profile every 2 hours
3 week time period

Float 6117

TAO mooring
2°N, 147°E

TRMM
(3 hourly)

STS
Temperature

STS
Salinity

7/3/2009
Rainfall: 25mm
\( \Delta S : 0.15 \text{ PSU} \)
\( \Delta T : 0.18 \degree C \)
Float 5232 - Arabian

Profile every 10 days

Upper 500 meters

03/21/2010 - 2/28/2012
Float 5232 - Arabian

Upper 10 meters
Profile every 2 hours
1 week time period

Float 5232 - Arabian

Spectral Density

T (°C)

S (PSU)
Float 5232 - Arabian

STS - STS(15m)

181 profiles
Float 5232 - Arabian

Composite Mean Anomalies

T (°C)

S (PSU)

TRMM (mm/hr)

Hour (Local)
STS Completed Fast Cycle

T Diurnal Cycle Amplitude

S Diurnal Cycle Amplitude

- Pacific (F5066)
- Hawaii (F5131)
- Arabian (F5232)
- Pacific (F6115)
- Pacific (F6117)
- Atlantic (F6882)
- Atlantic (F6883)
Float 6920 - Bay of Bengal

Temperature (°C)

Salinity (PSU)

Upper 500 meters

Float 6920 - Bay of Bengal

Upper 30 meters

Conclusions

• STS sensors added to Argo-type floats allow for a high resolution evaluation of the near-surface layer.

• In general there is little difference in temperature and salinity in the upper 5 meters (~85/90% of the time), however
  • differences larger than 0.1 PSU and 0.1 °C are sometimes observed, especially in the Tropical Pacific
  • a strong diurnal signal in temperature is observed and is controlled primarily by solar radiation
  • a weak diurnal signal in salinity is observed and appears to be controlled by local precipitation and mixing.

• This work shows the promise of using Aquarius and Argo together to improve our knowledge of the freshwater cycle in the ocean.
Float 6922 - Bay of Bengal

Upper 500 meters

Float 6922 - Bay of Bengal

Upper 30 meters

Float 6924 - Bay of Bengal

Upper 500 meters

Float 6924 - Bay of Bengal

Upper 30 meters