Global climate change is predicted to alter the Earth’s water cycle, and with future wars the precipitation at Hydrostation ‘S’ and BATS as measured by the radar, is indistinguishable between Hydrostation ‘S’ and BATS, however there are some interesting differences:

1) Long term trends in the mixed layer salinity

Gordon and Giulivi (2008) found that surface salinity at BATS was related to El Niño, and the prolonged negative anomaly in MLM salinity for 1998 (and the shorter period around 2002) shown in Figure 3. corresponds to strong El Niño events. 2013 was a neutral year in terms of El Niño, so the large freshening seen in the autumn of 2013 contradicts what would have been forecast, and makes the case study of 2013 particularly interesting.

The same study also observed that the seasonal cycles of salinity are indistinguishable between Hydrostation ‘S’ and BATS, however there are some interesting differences:

- Hydrostation ‘S’ shows a greater range in MLM salinity anomaly.
- Trends in salinity at different depths are not the same at Hydrostation ‘S’ and BATS (Table 1). This becomes more pronounced at depth.

2) Case study of 2013

The radar data clearly captures the heterogeneous nature of precipitation, as seen in Figure 1. This is quantified in Figure 4, which shows the differences in the precipitation at Hydrostation ‘S’ and BATS as measured by the radar, compared to the precipitation observations on land.

Figure 3. Top: Mixed layer salinity anomaly for Hydrostation ‘S’. Blue line shows biweekly data, red line shows 12 month running mean, black dashed line shows the overall trend. Lower: Mixed layer salinity anomaly for BATS. Blue line shows monthly data, all other lines are as above.

Figure 4. Meteorological observations of daily precipitation compared to radar precipitation data for Hydrostation ‘S’ and BATS. Note the radar was down for the month of August and early September. The correlation coefficients between the radar and observations were 0.50 and 0.52 for Hydrostation ‘S’ and BATS respectively, both above 95% significant. The correlation coefficient for precipitation from the LMDZ to meteorological observations was 0.28, also above 95% significant.

All three precipitation measurements estimate the changes in MLM salinity well, as shown in Figure 5. The estimates are strong throughout the year, even as the MLM depth shoals during the summer months and deepens during the autumn. While there were increased volumes of precipitation during the autumn of 2013, no hurricanes passed over Bermuda.

Conclusions

1) Long term trends in the mixed layer salinity

While there are no significant trends in the mixed layer salinity, the fact that there are significant trends at depths shows that changes at the surface are being mixed into the water column.

2) Case study of 2013

a. Radar precipitation

Precipitation data from the radar used to estimate salinity gives good agreement to measured salinities, and can explain ~40% of the change in MLM salinity using a 1D approximation.

b. Meteorological observations

Land based observations of precipitation to predict the MLM salinity gives good agreement to the measured salinities, but typically over-estimates precipitation.

c. General circulation model

Estimates of MLM salinity made using the LMDZ data were found to be between those of the radar and observation.

Summary

This initial study making novel use of radar precipitation data is promising. Bermuda’s open ocean location, combined with the radar precipitation data, presents a unique opportunity to study the impact of wet deposition on wider biogeochemical systems.

References


Further Work

Efforts are underway to incorporate the radar precipitation data in to a 3D model. This has potential to be built on, and used to investigate the role “patchy” precipitation plays in determining spatial patterns in productivity.

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For more information about BATS see: http://www.bios.edu/research/ projects/bats