RESEARCH ARTICLE

A comparative study of satellite-based operational analyses and ship-based in-situ observations of sea surface temperatures over the eastern Canadian shelf

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Abstract: The satellite-based operational sea surface temperature (SST) was compared to the ship-based *in-situ* SSTs established by the Atlantic Zone Monitoring Program (AZMP) over the eastern Canadian shelf (ECS) for a 3-year analysis period (2005–2007). Two sets of operational SST analyses were considered in this study, with one set produced by the Canadian Meteorological Centre (CMC) and the other produced by the National Centers for Environmental Prediction (NCEP). The comparative study indicated that there was no appreciable systematic difference between the CMC and NCEP SST analyses over the ECS. The root mean squared difference (RMSD) between the AZMP ship-based *in-situ* SSTs and the satellite-based STT analyses over the ECS was about 1.0°C, without any obvious seasonal or geographic trend. The RMSDs were relatively larger over the outer flank of the Grand Banks than the other regions of the ECS, mainly due to dynamically complicated circulation and hydrographic conditions over this shelf break area associated with the Labrador Current.

Keywords: Atlantic Zone Monitoring Program (AZMP), Shelf break, Labrador Sea, SST products

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1. Introduction

Satellite-based sea surface temperature (SST) is one of the most useful data sources for many applications, particularly in meteorology and oceanography (Mesias, Bisagni and Brunner, 2007). The satellite-derived SST data, for example, were used in assisting the tuna fishing industry along the south-western coast of Australia (Myers and Hick, 1990), improving the performance of ocean circulation models (Ezer and Mellor, 1997), and specifying lower boundary conditions for numerical weather forecast models (Brasnett, 2008). In comparison to the in-situ SST measurements established from ships or buoys, a major advantage of the satellite-based SST is the global coverage and near real-time availability.

Significant efforts were made in the past in calibrating and validating the satellite-based SST with the in-situ measurements (Wick, Emery and Schluessel, 1992). Previous studies demonstrated the satellite-based SST data are less accurate than the in-situ data due to the complexity of the oceanic and atmospheric conditions (Robinson, Wells and Charnock, 1984; Brown, Brown and Evans, 1985; Minnett, 1991) although the errors in the satellite-based SSTs were found to vary regionally and temporally (Wick, Emery and Schluessel, 1992). In this study we compared the satellite-based operational SST analysis to the ship-based in-situ SST measurements made by the Atlantic Zone Monitoring Program (AZMP) over the eastern Canadian shelf. The main objective of this comparative study was to assess the performance of the satellite-based operational SST analysis using the ship-based in-situ SST measurements in representing the temporal and spatial variability of SSTs over the study region.

This paper is organized as follows. Section 2 exhibits the geographical and physical features of the study region. Section 3 discusses the data sources used in this study. Section 4 reveals the analysis results while section 5 comprises both the summary and discussion for the study.

2. Study region and SST distributions

The study region involves the eastern Canadian shelf (ECS), which is referred to, in this paper as the coastal and continental shelf waters from the Labrador Sea in the northeast to the western Gulf of Maine in the southwest (Figure 1). The Labrador Shelf is straight and rugged, and extends from Hudson Strait to the Strait of Belle Isle. The Newfoundland Shelf stretches from the northeastern coastline of Newfoundland between Belle Isle Bank and Laurentian Channel into the deep ocean. The Gulf of St. Lawrence is a semi-enclosed sea, which is connected to the North Atlantic Ocean through Cabot Strait and to the Labrador and Newfoundland shelves through the Strait of Belle Isle. The Scotian Shelf is connected to the Gulf of St. Lawrence to the northeast and to the Gulf of Maine to

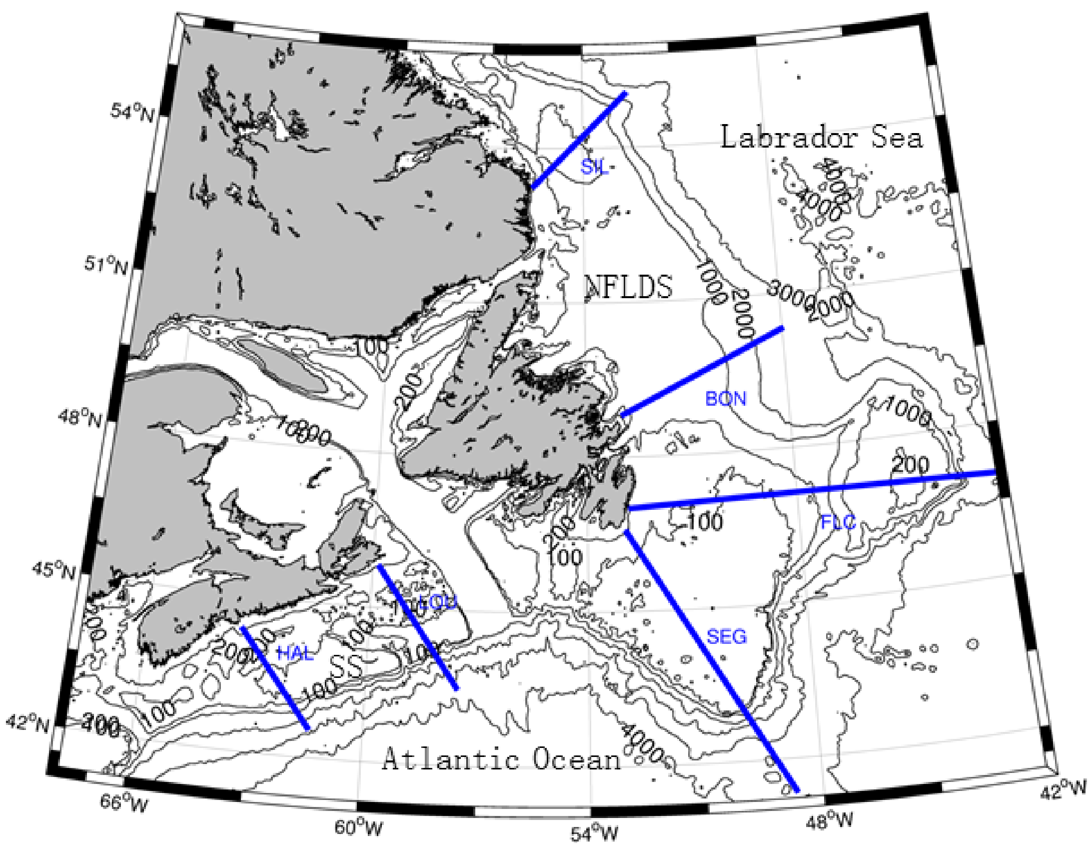

Figure 1. Map of major topographic features over the eastern Canadian shelf and locations of the six AZMP standards transect at which in-situ SSTs are used in the evaluation. Symbols description on the map: NFLDS: Newfoundland Shelf; SS; Scotian Shelf; SL: Seal Island section; BON: Bonavista section; FLC-Flemish Cap section; SEG: Southeast Grand Bank section; LOU: Louisbourg; HAL-Halifax Line.

the southwest. The Gulf of Maine is also a semi-enclosed sea bounded by Georges Bank, Nantucket Shoals and Browns Bank at its seaward (Lynch, Ip, Naime *et al.*, 1996; Urrego-Blanco and Sheng, 2012).

Dynamically, the ECS lies in the western boundary confluence zone of two large-scale gyre systems: the North Atlantic subpolar gyre and the North Atlantic subtropical gyre (Loder, Petrie, Gawarkiewicz *et al*., 1998). Previous studies demonstrated that the ECS is the most variable area of the North Atlantic and Pacific Oceans (Thomas and Turner, 1988), with the largest seasonal variations in water temperature, about 16°C, occurring over the Scotian Shelf and the Middle Atlantic Bight. Figure 2 presents the annual mean and instantaneous SSTs in 2006 over the ECS and adjacent deep waters, which were computed from the 1/12°-resolution, 3-hourly global ocean reanalysis produced by the data-assimilative ocean circulation model known as the Hybrid Coordinate Ocean Model (HYCOM) using the Navy Coupled Ocean Data Assimilation (NCODA). The HYCOM+NCODA reanalysis (run GLBu0.08/expt_19.1) was constructed on the GLBb0.08 computational grid and the output was archived on the uniform GLBu0.08 grid. The surface forcing used to drive the HYCOM includes the surface wind stress and heat/freshwater fluxes, which were calculated from Climate Forecast System Reanalysis (CFSR) at an hourly time with a horizontal resolution of 0.3125° produced by the National Centers for Environmental Prediction (NCEP). More information about the HYCOM+NCODA reanalysis can be found from https://hycom.org/data/glbu0pt08/expt-19pt1.

Due to the combined effect of local processes (such as the net heat fluxes at the sea surface and vertical mixing) and non-local processes (such as the horizontal advection carried by the above-mentioned subpolar and subtropical gyres), the annual mean SSTs in 2006 (as shown in Figure 2A) feature relatively large spatial gradients in the northwest-southeast direction, with relatively cold SSTs over coastal and shelf seas and relatively warm SSTs in the deep ocean off the ECS, particularly in the deep waters to the south of Newfoundland and Scotian Shelves. Associated with the equatorward advection of relatively cold and fresh surface waters over the ECS carried by the Labrador Current from high latitudes, the annual mean SSTs were 4—6°C over the Labrador and northern Newfoundland Shelves, and 8–10°C over the Grand Banks in 2006. The annual mean SSTs were 6–8°C over the Gulf of St. Lawrence. The annual mean SSTs

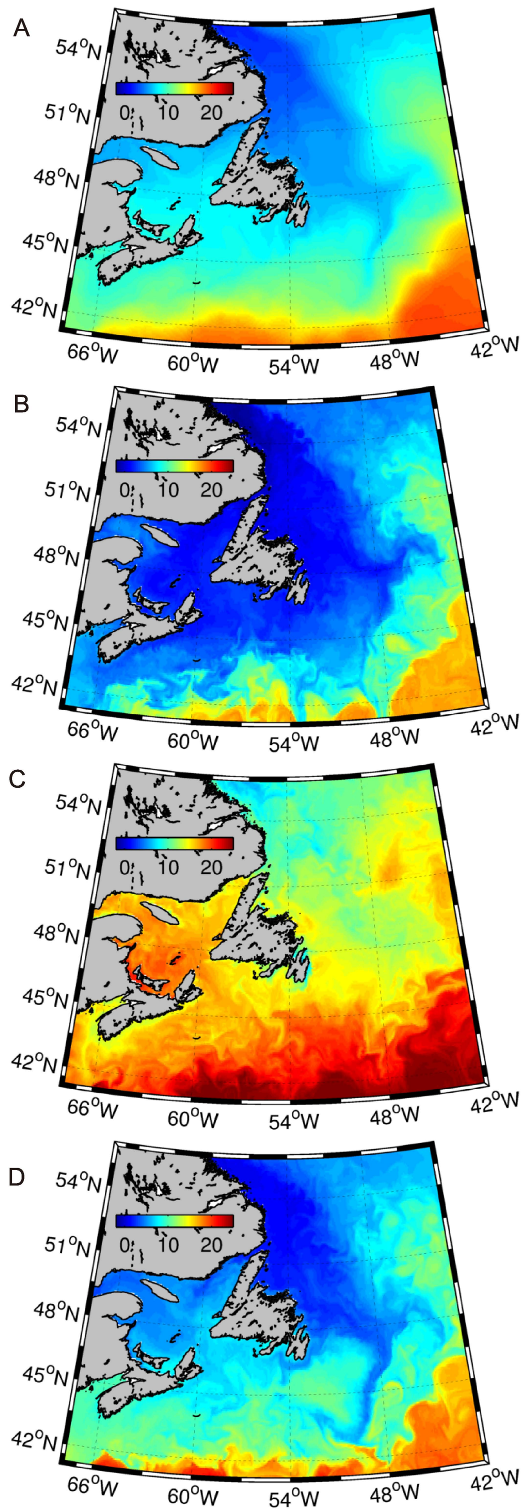

Figure 2. (A) Distribution of time-mean SSTs over the eastern Canadian shelf in 2006 calculated from the global ocean reanalysis produced by the Hybrid Coordinate Ocean Model (HYCOM) using the Navy Coupled Ocean Data Assimilation (NCODA). Distributions of instantaneous SSTs produced by HYCOM+NCODA on (B) 26 April, (C) 25 July and (D) 1 December 2006.

were about 8—12°C over the Scotian Shelf. One of the interesting features in the annual SSTs in 2006 is an advection tongue of cold surface waters along the eastern flank of the Grand Banks. The annual mean SST distributions in other years were very similar to the SSTs shown in Figure 2A.

The instantaneous SSTs in 2006 shown in Figure 2B-C demonstrated that the SSTs over the ECS have significant temporal and spatial variability. On 26 April 2006, the SSTs were spatially uniform and cold of about 2–4°C on the ECS, with warmer surface waters in the deep waters off the ECS (Figure 2B). On 25 July 2006, by comparison, the SSTs on the ECS were warm and spatially variable (Figure 2C), with surface waters of ~10—14°C on the Labrador and northern Newfoundland Shelves, 12–16°C over the northeastern Gulf of St. Lawrence and 16–18°C over the southwestern Gulf of St. Lawrence. The SSTs at this time were about 12—18°C and 16–18°C on the Grand Banks and the Scotian Shelf, respectively, except for low SSTs over some coastal waters mainly due to coastal upwelling. On 1 December 2006, due to largely intense surface cooling and strong vertical convection, the surface waters on the ECS were colder and spatially more uniform (Figure 2D), in comparison to the SSTs in summer months. The SSTs on 1 December 2006 were about 2–4°C on the Labrador and northern Newfoundland Shelves, about 6–10°C on the Grand Banks, about 6–8°C in the Gulf of St. Lawrence, and 8–10°C on the Scotian Shelf. The cold water tongue was well defined along the shelf break of the Grand Banks at this time (Figure 2D). It should be noted that the HYCOM+NCODA SST reanalysis was used in this study as the general reference for SST distributions over the ECS. Assessment of the satellite-based operational SST analyses was conducted using the ship-based in-situ SST observations and would be discussed in the next section.

3. Data

3.1 In-situ SST data

The in-situ SST data collected from AZMP were used in this study. The AZMP was implemented in 1998 with the aim of collecting and analyzing the biological, chemical, and physical field data over the ECS that are necessary to examine the causes of oceanic variability at the seasonal, inter-annual, and decadal scales, and also provide multidisciplinary data sets to establish relationships among the biological, chemical, and physical variables over the region (Petrie and Therriault, 2001). The oceanographic variables measured by the AZMP include temperature, salinity, nutrients, oxygen, chlorophyll, phytoplankton, zooplankton and light attenuation at specific locations or along specific transects. Figure 1 presents six AZMP standard transects at Seal Island (SIL), Bonavista (BON), Flemish Cap (FLC), South East Grand Banks (SEG), Louisbourg Line (LOU) and Halifax Line (HAL) from the northeast to the southwest over the ECS. Along these six transects, ship-based surveys have been conducted routinely by the AZMP since 1998 in spring, summer, and autumn, except for the southernmost part of the SEG transect, where the AZMP surveys have been limited to spring and autumn (Petrie and Therriault, 2001). The temperature and salinity measurements have been taken consistently by the Seabird SBE 9-11 high precision CTD system equipped with dual SBE-3 temperature sensors (accuracy of ±0.001°C with a stability of 0.002°C/year) using factory calibrations and SBE-4 conductivity sensors (accuracy ±0.0003 S/m) in a pumped TC-duct configuration.

As indicated by Casey *et al.* (1999), however, care must be taken when comparing the satellite-derived SSTs, which is a skin (<upper 1mm) temperature, with the ship-based SST data. The SST, commonly known as the bulk SST, from ships usually represents the temperature in the upper few meters (Schluessel, Emery, Grassl *et al.*, 1990; Thomas and Turner, 1995). Under normal oceanographic and meteorological conditions, we proposed that the skin layer was mostly destroyed by surface gravity waves and vertical mixing, and both the skin and bulk SSTs were comparable. Our argument was consistent with the observational practice during the AZMP surveys. The shallowest CTD records were typically taken at ~1.5–2 meters below the sea surface due to the physical configuration of the instrument. Generally the upper 5 m was observed to be well mixed (<0.1°C variability, often <0.05°C). Observations of near-surface temperatures made while retrieving the instrument suggested that the near-surface water in the top 2 m was usually well mixed. At the same time, we recognized that large differences between the skin and bulk SSTs could occur in the proximity to cold fresh water sources such as melting ice fields or icebergs which may resist mixing in low energy sea states. Over the ECS, large differences between the skin and bulk SSTs may occur in regions such as the Nose of the Grand Bank, Flemish Pass, Avalon Channel (western part of the Flemish Cap transect), and the inner part of the Bonavista and the Louisburg transect during the spring months, where the sea ice of some form is often present. Furthermore, large differences could occur in summer months over several isolated areas due to the localized surface solar heating during calm weather conditions as well as the occasional iceberg melt water. Regions such as the Flemish Cap are also subject to the convergence and interplay of several currents and water masses within a small area (~100 km) and are characterized by various transient eddies as well as horizontal shears on scales of 10 tens of km, possibly less than the resolution of the satellite data product that we have used.

3.2 Satellite-based operational SST products

Two sets of satellite-based operational SST analyses were used in this study. One of them was the daily operational SST analysis produced by the Canadian Meteorological Center (CMC). This analysis has been used as the lower boundary condition in the numerical weather prediction models at the CMC. This SST analysis uses the SST retrievals from the A/ATSR (Advanced/Along-track scanning radiometer) aboard the ENVISAT satellite and the AVHRR (Advanced very high resolution radiometer) aboard the NOAA-17 satellite, as well as the available in-situ SST measurements from ships, buoys and Argo floats. The analysis was updated every day on a global 1/3° (or ~30 km in the study region) grid using optimal interpolation. The first guess or background for the analysis was derived from the previous day's SST analysis field, which allows information from recent observations to be carried forward in time. Since retrievals from infrared radiometers were not available when cloud cover occurred, the analysis method employed by the CMC helps maintain the quality of the SST analysis when observations were not available for several days or weeks. Before satellite data were used in the analysis scheme, biases of daytime and night time satellite retrievals were estimated for each satellite and removed later. Biases were also estimated and removed for each ship report. A newer version of the analysis which includes retrievals from the AMSR-E (Advanced Microwave Scanning Radiometer for EOS) instrument aboard the Aqua satellite is currently being tested (see Brasnett (1997) and Brasnett (2008) for details).

The second set of the satellite-based operational SST analyses used in this study was the real-time global sea surface temperature analysis (RTG_SST) produced by the National Oceanic and Atmospheric Administration (NOAA). This analysis was a blend of the AVHRR with the availability of in-situ SST observations from ships and buoys, and is produced daily at a resolution of 1/12°. The RTG_SST has been used as the boundary condition of the weather forecast models at the National Centers for Environmental Prediction (NCEP) and European Center for Medium Weather Forecasting (ECMWF). Details about the development and validation of the RTG_SST dataset can be found from Gemmill *et al.* (2007).

It should be noted that the above-mentioned SST analyses were used in generating the real-time SST distributions for the global ocean. The performance assessment of these SST analyses in representing the meso-scale variability of SSTs over the ECS has not been conducted elsewhere before the implementation of the study.

4. Results

The ship-based AZMP SSTs and satellite-based SST analyses during the 3-year period (2005–2007) were considered in this study. The 3-days averaged SSTs from the operational analyses were used for two reasons. Firstly, the CMC SSTs available for this study were the daily product which has a time stamp of 0000 UTC. This time stamp represents the best estimated time of the data collection, but uncertainty in time was inherent in the product. A correlation analysis indicated that the time between the zero-crossings of the correlation function was approximately 3 days and averaging over this time period can reduce the random noise. Secondly, it normally took 1 to 3 days to complete each AZMP transect. In the case that a much longer time is required to complete CTD surveys along each transect, a different method should be used to analyze the data. A more rigorous way to generate gridded SST products from sparse ship-based observations is to perform a space-time optimal interpolation of the data based on ship locations and times, which is beyond the scope of the current study.

For the ship-based SSTs, the averaged in-situ temperature within the top 3 meters was used to represent the bulk SST at each observation site. In order to compare with the AZMP in-situ SST data, the 3-days averaged satellite-based CNC and NVCEP SST analyses were interpolated linearly with respect to the ship positions. As for illustration, Figure 3 presents comparisons of the AZMP in-situ SSTs to the CMC and NCEP satellite-based SST analyses along the Flemish Cap (FLC) transect at three different times in 2006. The satellite-based SST products and ship-based in-situ SSTs were in general agreement, but with some noticeable differences. The satellite-based SST analyses were spatially smoother with less spatial structure than the in-situ SST data along the FLC transect. In particular, the AZMP in-situ SSTs have large horizontal gradients at the shelf break (400–500 km from the shore), which were not seen in the satellite-based SST products. It should be noted that smoothness and weaker cross-shelf gradients in the satellite-based operational SST products were not caused by the 3-days average of the analysis field. The noticeable differences between the satellite-based and ship-based SSTs at the shelf break also appeared in the daily temperature fields, indicating that the CMC and NCEP operational SST analyses performed less well in representing the small-scale features such as the cold water tongue over the eastern flank of the Grand Banks as shown in Figure 2. It should also be noted that the AZMP SST data shown in Figure 3 may represent less well in the instantaneous SST distributions associated with highly-varying small-scale thermal features at the FLC transect. This is because, as mentioned earlier, it normally took about 3 days to complete the CTD surveys along each of the AZMP transects.

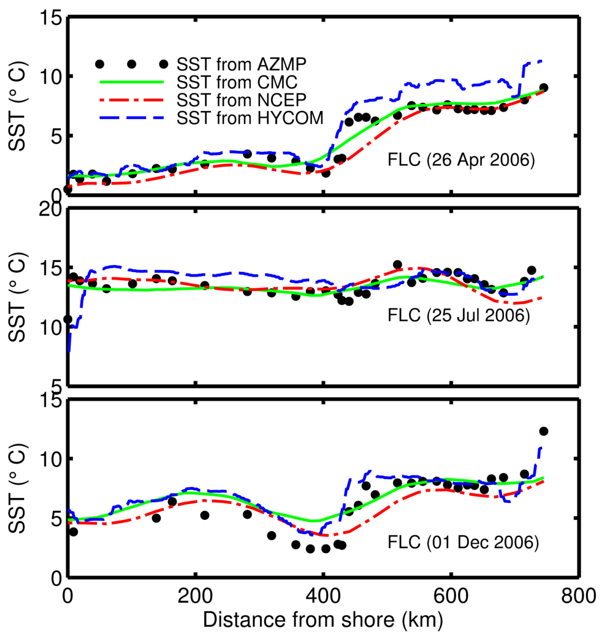

Figure 3. Comparisons between the CMC and NCEP satellite-based operational SST to the AZMP ship-based *in-situ* SSTs at the Flemish Cap (FLC) transect in 2006.

Figure 4 presents scatter plots for all the available ship-based AZMP SST observations and corresponding CMC and NCEP operational SSTs at 6 transects during the 3-year study period. In order to quantify the differences between the satellite-based operational SSTs and the ship-based in-situ SSTs, the following five statistical parameters were calculated from the data points as shown in Figure 4: the correlation coefficient, the root mean square difference (RMSD), the mean bias (i.e., the difference between the mean satellite-based SSTs and mean in-situ SSTs), and the slope and intercept of the best fitted line of the data points in the figure. The correlation coefficients for both the CMC and NCEP satellite-based operational SSTs are about 0.97. The mean biases are about 0.06°C and 0.05°C for the CMC and NCEP SSTs, respectively. The high correlation coefficients and small bias values indicated that the CMC and NCEP SST analyses reproduced reasonably well the annual cycle and spatial

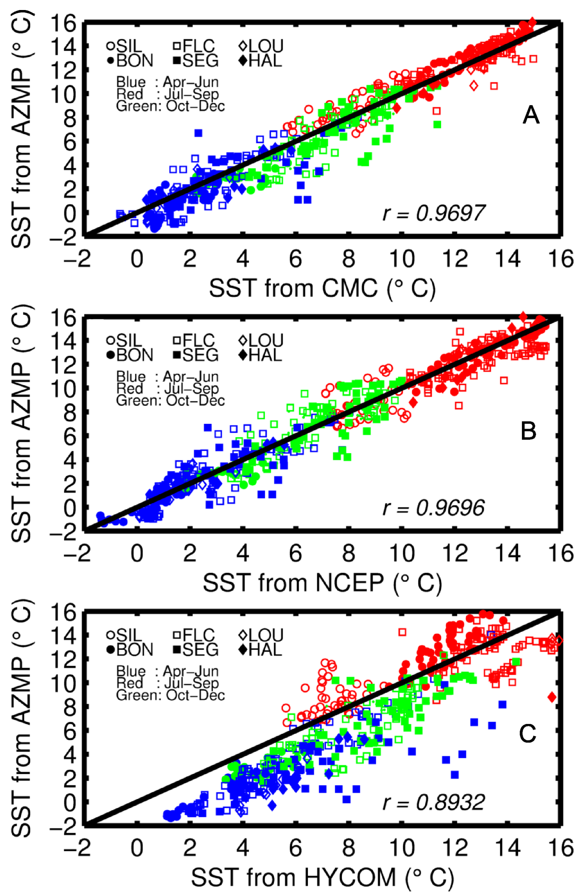

Figure 4. Scatter plots showing comparisons of (A) CMC SSTs, (B) NCEP SSTs, and (C) HYCOM+NCODA SSTs to the AZMP ship-based *in-situ* SSTs at 6 transects over the eastern Canadian shelf in three seasons: spring (Apr–Jun), summer (Jul–Sep) and autumn (Oct–Dec)

gradients of in-situ SSTs at the AZMP transects.

The slope and intercept of the best-fitting line listed in Table 1 can be used to further quantify systematic seasonal biases between the operational SST analyses and the AZMP in-situ SSTs. The seasonal bias will be zero if the slope is equal to unity and the intercept is zero. The slope of the line was greater than 0.88 for the CMC SSTs and greater than 0.85 for the NCEP SSTs in three seasons: spring (Apr–Jun), summer (Jul–Sep) and autumn (Oct–Dec), with the greatest value of 0.93 for the CMC SSTs in summer. The intercept of the best-fitting line was less than 1.6°C for the CMC SSTs and less than 1.42°C for the NCEP SSTs in the three seasons, with the smallest value of 0.33°C for the CMC SSTs in summer. Therefore, there were no obvious seasonal biases from spring to autumn between the satellite-based SST analyses with the ship-based in-situ SSTs. It should be noted that the slope and intercept in a linear fit are, in general, scale-dependent. If the data points are selected within a small temporal and spatial range, the range of the SST values will also be small. The slope and intercept calculated from such sub-set of data may deviate significantly from the slope and intercept of the overall data and hence were not very useful for correlation study.

The RMSD values were about 0.87–1.12°C between the CMC and AZMP SSTs and about 0.85–1.15°C between the NCEP and AZMP SSTs in the three seasons (Table 1), which are larger than many previous global SST analyses. The latter are typically about 0.4°C (e.g., Brasnett, 2008). Most previous global analyses utilized observed SSTs from ocean buoys at fixed locations. The average distance between the buoys was in the order of 150 km. As a result, small-scale ocean features such as sharp hydrographic gradients associated with strong currents may not be presented by the buoy data. The scatter plots shown in Figure 4A and b also demonstrated that largest differences in the CMC and NCEP SSTs occurred at the SEG and FLC transects in spring.

Table 1. Values of the root mean square difference (RMSD), the slope and intercept of the best-fitting line for the CMC and NCEP satellite-based operational SST analyses in comparison to the AZMP ship-based in-situ SSTs in three seasons of spring (Apr–Jun), summer (Jul–Sep) and Autumn (Oct–Dec), and corresponding mean values averaged over the three seasons.

Period	RMSD (°C)		Slope		Intercept (°C)	
	CMC	NCEP	CMC	NCEP	CMC	NCEP
Apr-Jun	0.90	0.85	0.88	0.85	0.50	0.35
Jul-Sep	0.87	1.15	0.93	0.88	0.33	1.42
Oct-Dec	1.12	1.02	0.84	0.89	1.60	0.77
Overall	1.04	1.00	0.92	0.96	0.67	0.32

For a direct comparison, the simulated SSTs produced by the HYCOM+NCODA were compared to the AZMP in-situ SSTs as found in Figure 4C. The simulated SSTs agreed less with the in-situ SSTs over the ECS during the study period, in comparison to the CNC and NCEP analyses. In particular, the circulation model overestimated significantly the SSTs over the ECS in spring and autumn. The exact reasons for the overestimations were not known.

We next examined the temporal and regional variability of the mean biases and RMSD values between the satellite-based SST analyses and ship-based in-situ SSTs at six AZMP transects: SIL, BON, FLC, SEG, LOU and HAL from north to south (see Figure 1 for their locations) in three different seasons (spring, summer and autumn). The left panel of Figure 5 presents the mean SST at each transect in three different seasons calculated from the AZMP ship-based in-situ SST data. The middle and right panels present the mean bias and RMSD values, respectively. In spring (Figure 5A), in all the six transects except for the FLC transect, the CMC SSTs were warmer than the AZMP SSTs, with the positive mean biases. By comparison, the NECP SSTs in spring were colder than the AZMP SST in the north (BON, FLC and SEG) and warmer in the south (LOU and HAL). The pattern of change of RMSD values from north to south was similar for both the CMC and NCEP SSTs. The RMSD values increased from the BON to SEG transects and then decreased. In summer (Figure 5B), the CMC SSTs were colder than the AZMP SSTs at the SIL, BON and FLC transects, but slightly warmer at the HAL transect. The NCEP SSTs were warmer than the AZMP SSTs in all the 6 transects except for the SIL transect. In autumn, the biases were in the range of −0.2° to 0.5° C, which were slightly smaller than the biases for spring and summer. The pattern of change of RMSD values was similar to that in spring where the maximum error occurred at the SEG transect (Figure 5C).

The results presented in Figure 6 and Table 1 indicated that there was no obvious seasonal trend and RMSDs between the AZMP in-situ observations and the CMC and NCEP satellite-based operational SST analyses which are of similar magnitudes. The biases of the two operational analyses were between −0.8° to

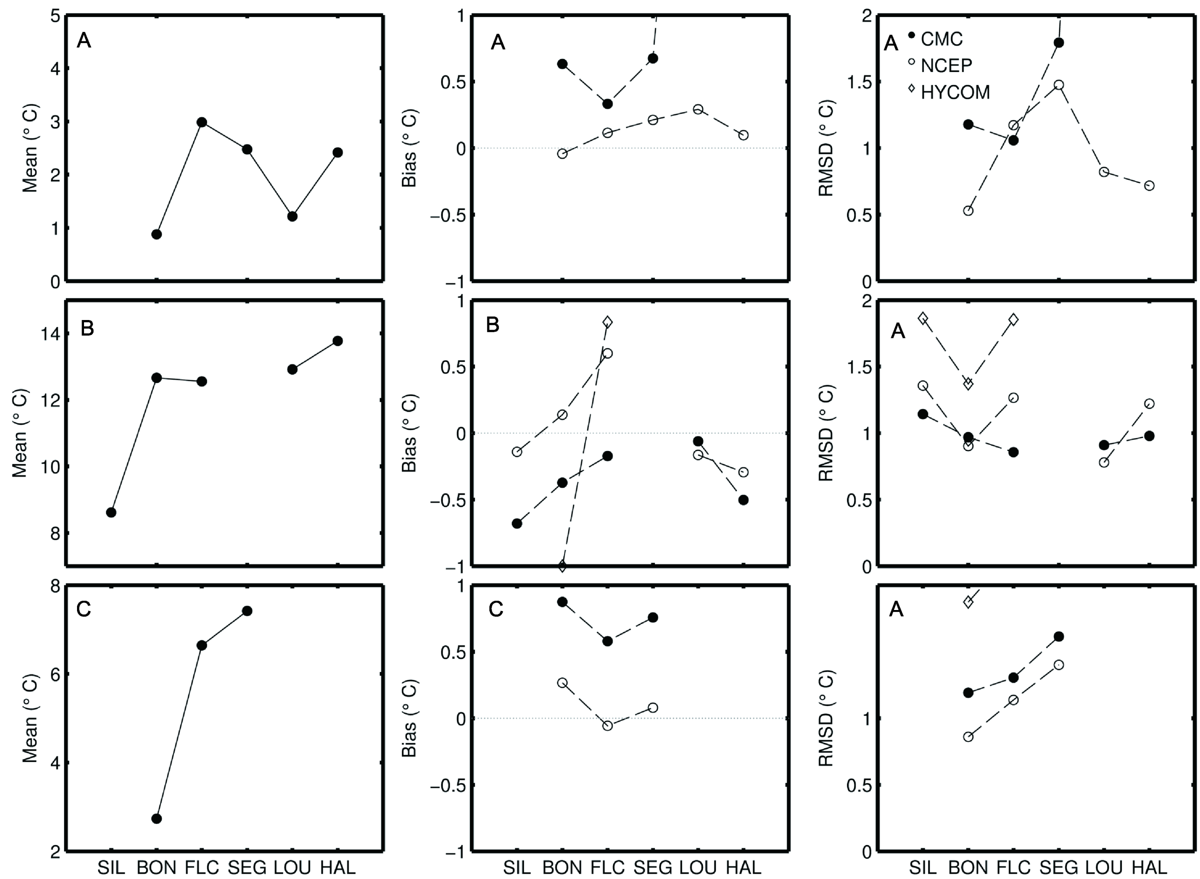

Figure 5. Distributions of the mean SST mean (left), bias (middle) and RMSD (right) of the CMC and NCEP satellite-based operational SSTs in comparison to the AZMP ship-based *in-situ* SSTs in spring (upper), summer (central) and autumn (lower).

0.8°C, and the RMSDs were between 0.3° and 1.7°C. The RMSD values that were greater than 1°C for the two SST analyses were found at the FLC and SEG transects. Large differences between the satellite-based operational SST analyses and the ship-based in-situ SSTs at the FLC and SEG transects also can be seen in the scatter plots of Figure 4. Despite the large RMSD at the FLC and SEG transects, their biases are comparable to those at other transects. This implied that the large differences between the satellite-based SST analyses and the ship-based in-situ SST measurements at these two transects occurred at horizontal scales much smaller than the transect length.

In order to examine the variation of the statistical properties at the FLC and SEG transects, the mean bias and RMSD were calculated for the CMC and NCEP SST analyses (Figure 6). Large biases and RMSDs were found in the shelf break areas, in which, the RMSD reaches about 3.0°C and 2.8°C at the SEG and FLC transects, respectively, and the mean bias reaches about 2.9°C and 1.6°C at these two transects, respectively. At the SEG transect, the large RMSDs occurred around the edge of the Grand Banks (460 km). At the FLC transect, there were two regions with large RMSDs, the Flemish Pass (440 km) and the eastern slope of the Flemish Cap (750 km). The edges of the Grand Banks and Flemish Pass have low surface temperatures and large horizontal temperature gradients associated with the Labrador Current (Figure 6B). There was a trend of RMSD values increment with higher horizontal temperature gradients. The Labrador Current along the edge of the Labrador Shelf and Grand Banks brings cold and fresh water from the northern Labrador Sea to the Newfoundland shelf. Both the CMC and NCEP SSTs in the Labrador Current were warmer than the AZMP SSTs by 1.6 to 2.9°C. The large RMSDs in the CMC and NCEP SST analyses may be associated with the large horizontal scale of the operational products relative to that of the Labrador Current. A correlation analysis of the operational SST data gave a correlation scale in the order of 300 km.

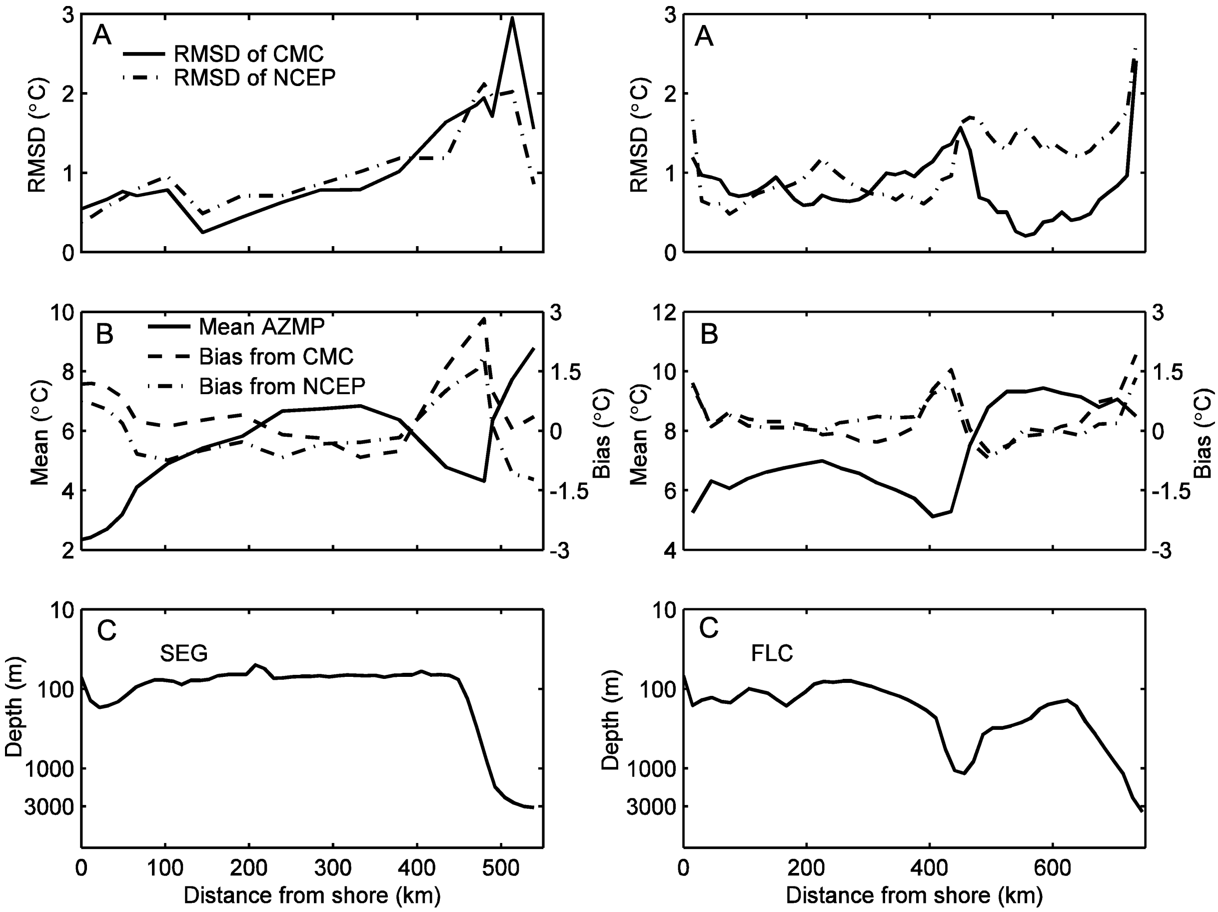

Figure 6. Distributions of RMSDs (upper), mean SSTs (central) and water depths (lower) at transects of the southeast Grand Banks (SEG, left) and Flemish Cap (FLC, right).

In comparison to the NCEP SSTs, the CMC SSTs have relatively larger RMSDs and biases over the shelf break but have smaller RMSDs and biases over the shallow regions of the Grand Banks (left panels of Figure 6). At the FLC transect (right panels of Figure 6), the CMC SSTs have significantly smaller RMSDs than the NCEP SSTs over the Flemish Cap. The biases of the two satellite-based SST analyses have comparable magnitudes.

5. Summary and conclusions

In this study, the satellite-based operational sea surface temperature (SST) analyses over the eastern Canadian shelf (ECS) produced by the Canadian Meteorological Center (CMC) and the National Centers for Environmental Prediction (NCEP) were compared to the ship-based in-situ SST measurements. The latter were made by the Atlantic Zone Monitoring Program (AZMP) during the 3-year analysis period (2005–2007). At the regional scale, both the CMC and NCEP operational SSTs were significantly correlated to the AZMP in-situ SSTs. The mean biases of the two SST analyses were small, which are about 0.06°C and 0.05°C for the CMC and NCEP operational SSTs, respectively. The root mean squared differences (RMSDs) were about 1.04°C between the CNC and AZMP SSTs, and about 1.00°C between the NCEP and AZMP SSTs over the ECS, respectively, which were relatively large in comparison to the global SST analyses. The large RMSDs are attributed to the high horizontal resolution of the AZMP in-situ SST data, which were not used in generating the operational SST analyses. Examination of these two SST analyses by season and by the six AZMP transects indicated that the RMSDs in the two analyses have no obvious seasonal or geographical trends and have similar magnitudes between these two analyses. Among these 6 transects, the CMC and NCEP SST analyses at transects of the Flemish Cap (FLC) and Southeast Grand Banks (SEG) have the largest RMSD. An examination of the statistics across these sections revealed that the RMSDs occurred at horizontal scales were much smaller than the width of the shelf. Both the CMC and NCEP analyses showed that these two SST analyses were warmer than the AZMP in-situ SSTs by about 1.6—2.9°C in the Labrador Current, and the biases in the two SST analyses on the shelf were typically less than 1°C. No appreciable difference was found between the CMC and NCEP SSTs.

Conflict of Interest

No conflict of interest was reported by all authors.

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