Marine Heat waves

James Munroe

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1 Introduction

In September 2019, a high temperature event in Fortune Bay resulted in the die-off salmon at an aquaculture site in Fortune Bay. The media reported this as significant event for the Newfoundland and Labrador [1] and the event and its clean up was the subject of public discussion.

The ocean temperature near the surface (known as the sea surface temperature or SST) under goes daily and monthly variability superimposed on both a daily and annual cycle. It important to understand how common a high temperature events are the ocean, how long they could last, and how significant the temperature anomaly is from the seasonal norms for a particular area. While the specifics of the September 2019 die-off are not investigated here, we look at some ocean temperatures the same geographic region and describe the frequency and severity of abnormally warm periods.

2 Methods

2.1 Dataset

There are many ways to measure SST include from instruments deployed from boat, remote observations from satellites, and moored buoys. In this report we will look at marine buoys are part of the Environment Canada Meteorological Service of Canada (MSC) buoy network. This data is available

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[1]https://www.cbc.ca/news/canada/newfoundland-labrador/fortune-bay-cleanup-1.5305994

for download from http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/waves-vagues/data-donnees/index-eng.asp as CSV files. The format of the CSV files is documented here http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/waves-vagues/formats-eng.html. In particular, depending on the model of the marine buoy, several data field are available as shown in Table 1. Measuring sea surface temperature is not straightforward since there are many definition of precisely where the temperature is being measured. For this report, we will focus on `SSTP` as the variable of interest.

Variable	Description and units
WDIR	Direction from which the wind is blowing (° True)
WSPD	Horizontal wind speed (m/s)
WSS$	Horizontal scalar wind speed (m/s)
GSPD	Gust wind speed (m/s)
ATMS	Atmospheric pressure at sea level (mbar)
DRYT	Dry bulb temperature (° C)
SSTP	Sea surface temperature (° C)
SLEV	Observed sea level
SST1	Average sea temperature from the non-synoptic part of WRIPS buoy data (° C)
HAT$	Water temperature from high accuracy temperature sensor (° C)

Table 1: Variables in marine buoy data

Specifically we look at the data from Station 44255 - NE Burgeo Bank. This marine buoy is owned and maintained by Environment and Climate Change Canada. It is 6-meter NOMAD buoy located at 47.270 N 57.340 W. There is data available for this buoy from 1998 until 2017.

2.2 Marine Heat Waves

To quantify whether SST for a particular area is indeed abnormally warm, we will use the Marine Heatwave (MHW) definition of Hobday et al. (manuscript submitted to Progress in Oceanography). An algorithm for detecting a MHW has been implemented in the Python package 'marineHeatWave'.
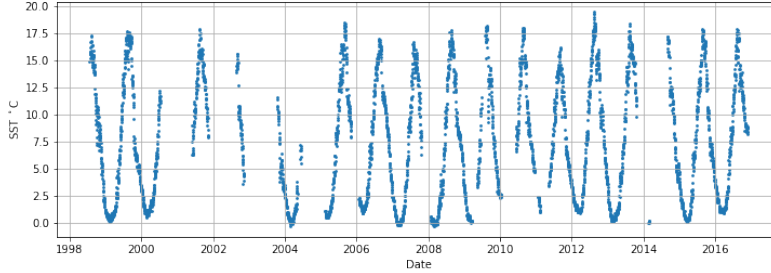
Figure 1: SST over time from at Station 44225

3 Results

As shown in Figure 1, the SST has a typical annual cycle between about 0° C and 20° C. There is some missing data between the years 2002 and 2004. In 2005, 2006, and 2008 there is increased noise in the data suggesting that something is wrong with the data. It would be strange for the SST to be considerably below zero. More significantly, the data from early 2010 is very suspicious as it suggests that the temperature is getting close to 80° C. Clearly we need to clean this dataset before continuing to analyze it.

This dataset from the Marine Environmental Data Section (MEDS) of the Department of Fisheries and Oceans (DFO) has already gone a quality control (QC) process. The results of QC are given by a numerical code as describe in Table 2.

Code	Label	Description
0	Blank	No quality control (QC) has been performed
1	Good	QC has been performed: record appears correct
3	Doubtful	QC has been performed: record appears doubtful
4	Erroneous	QC has been performed: record appears erroneous
5	Changes	The record has been changed as a result of QC
6	Acceptable	QC has been performed: record seems inconsistent with other records
7	Off Position	There is a problem with the buoy position or mooring. Data may still be useful.

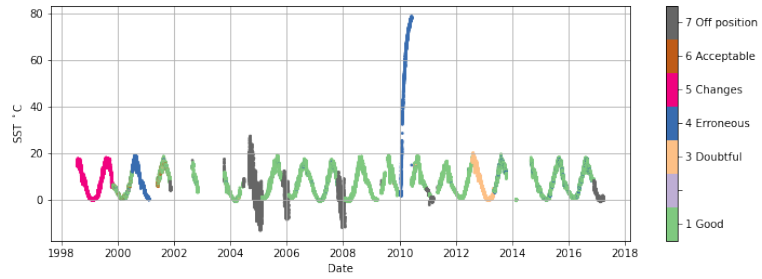Table 2: Quality control flags used in the marine buoy dataset

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Figure 2: SST over time from at Station 44225 with QC codes shown
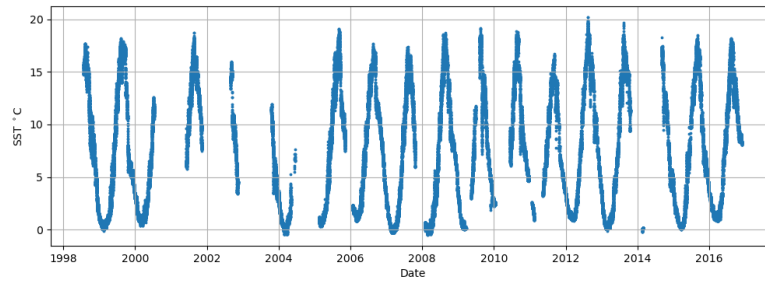

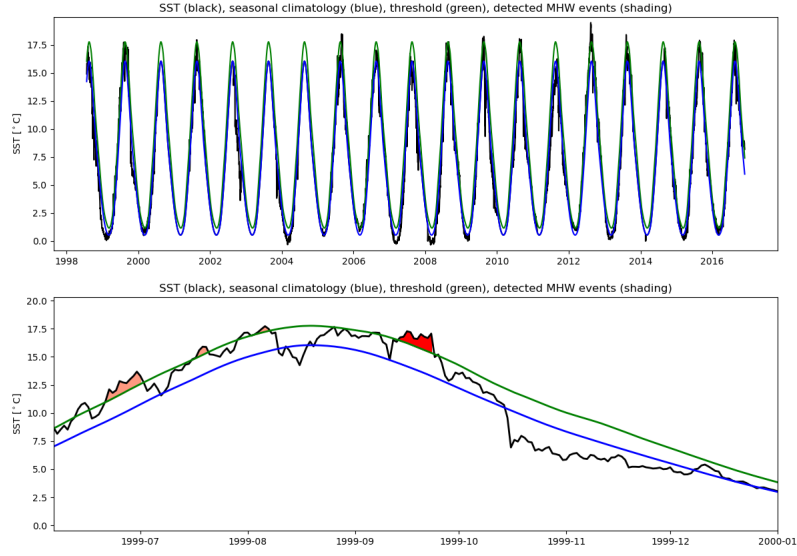Figure 3: SST over time from at Station 44225 with only QC codes of 1, 3, 5, or 6 shown
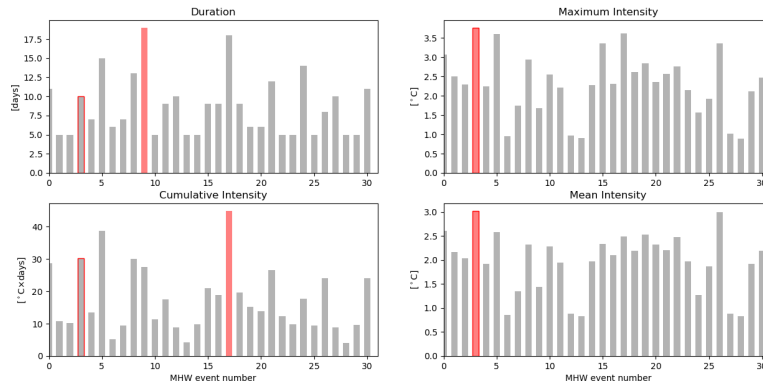
Figure 4: marine heat waves

Figure 5: Distribution of marine heat waves over time

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4   Conclusions