Bering Sea Climate Analysis

Ben Gaudiosi and Kayla Ippongi

Overview

We have collected Air and Water Temperature data from NOAA buoy 46305 located in the Bering Sea. In the following slides, you'll see a summary of what we've collected and some analysis about the climate. For the years 2012 and 2013 data was collected from the nearby buoy 46070 as our original buoy did not have data for during this time period.

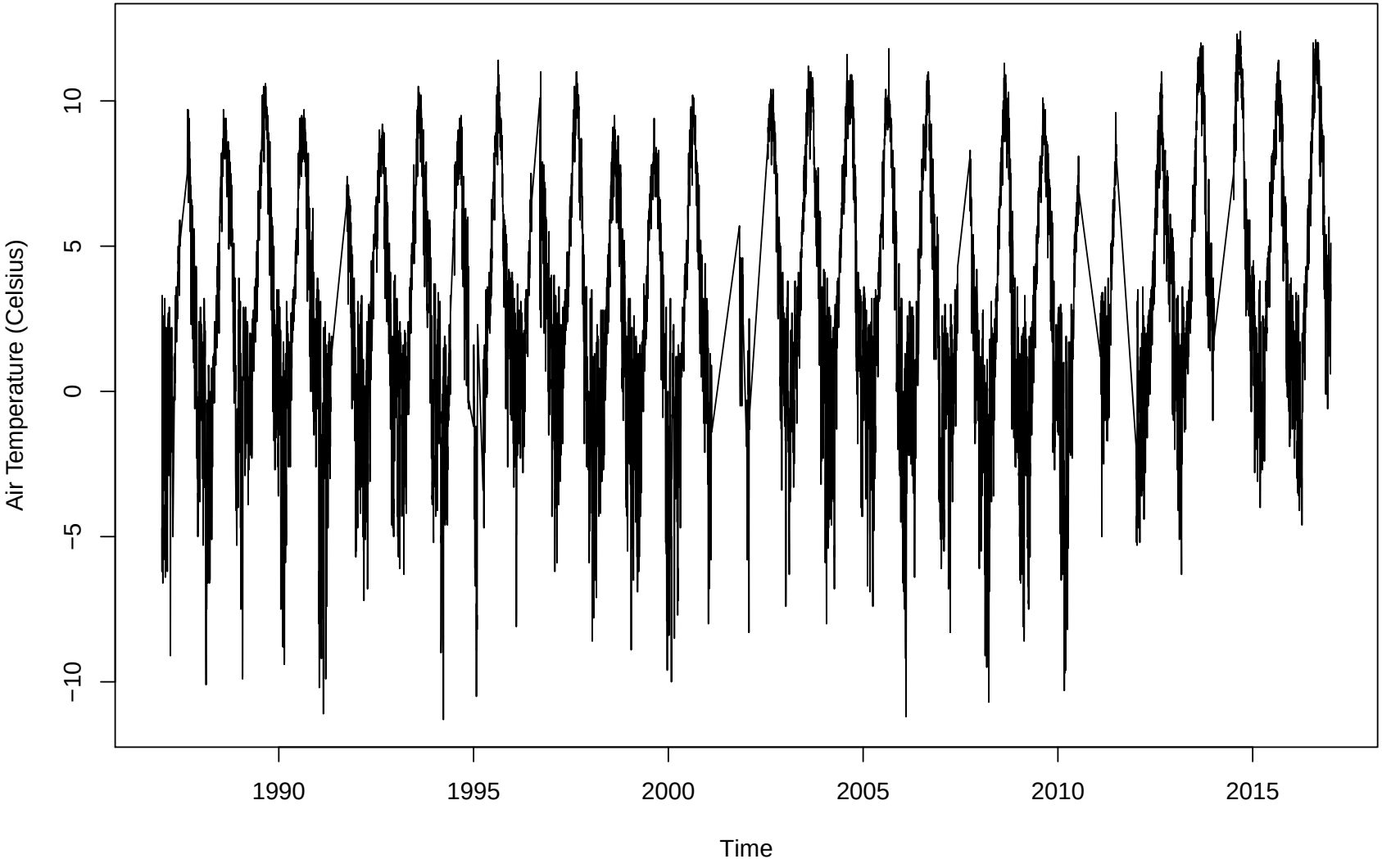
Air Temperature Statistics

	median	mean	std	min	max
1987	2.1	1.7750903	3.695384	-9.1	9.7
1988	2.0	2.3307479	4.427455	-10.1	9.7
1989	2.4	3.2736544	4.090810	-9.9	10.6
1990	2.8	3.0490305	4.125975	-9.4	9.7
1991	0.9	0.4066667	4.059051	-11.1	7.4
1992	2.7	2.5623955	3.980694	-7.2	9.2
1993	3.2	3.2314121	4.184166	-6.3	10.5
1994	2.2	2.5547038	4.317346	-11.3	9.5
1995	3.5	3.5907051	4.395943	-10.5	11.4
1996	2.5	2.6778947	2.859153	-8.1	11.0
1997	3.0	3.4734286	4.191369	-6.2	11.0
1998	2.1	2.1953488	4.236015	-8.6	9.5
1999	2.0	2.0337349	4.229733	-9.6	9.4
2000	2.7	2.8406557	4.284379	-10.0	10.2
2001	0.9	0.1295775	3.304992	-8.0	5.7

Air Temperature Statistics Cont.

	median	mean	std	min	max
2002	5.20	4.5388889	4.659639	-8.3	10.4
2003	3.80	4.1084932	4.169290	-7.4	11.2
2004	3.00	3.8126374	4.524747	-8.0	11.6
2005	3.20	3.5576923	4.183402	-7.4	11.8
2006	2.70	2.8107735	4.855898	-11.2	11.0
2007	1.30	0.7769231	3.077785	-8.3	8.3
2008	1.85	2.5038674	4.796517	-10.7	11.3
2009	2.60	2.6820513	4.498989	-8.6	10.1
2010	0.80	0.4099476	4.326072	-10.3	8.1
2011	2.55	3.0116438	2.929246	-5.0	9.6
2012	3.60	3.4306630	3.865663	-5.3	11.0
2013	3.50	4.3704420	4.195161	-6.3	12.0
2014	8.10	7.4620879	3.573961	-0.7	12.4
2015	3.70	4.1175824	3.953918	-4.0	11.4
2016	4.00	4.6786301	4.401652	-4.6	12.1

Air Temperature Time Series



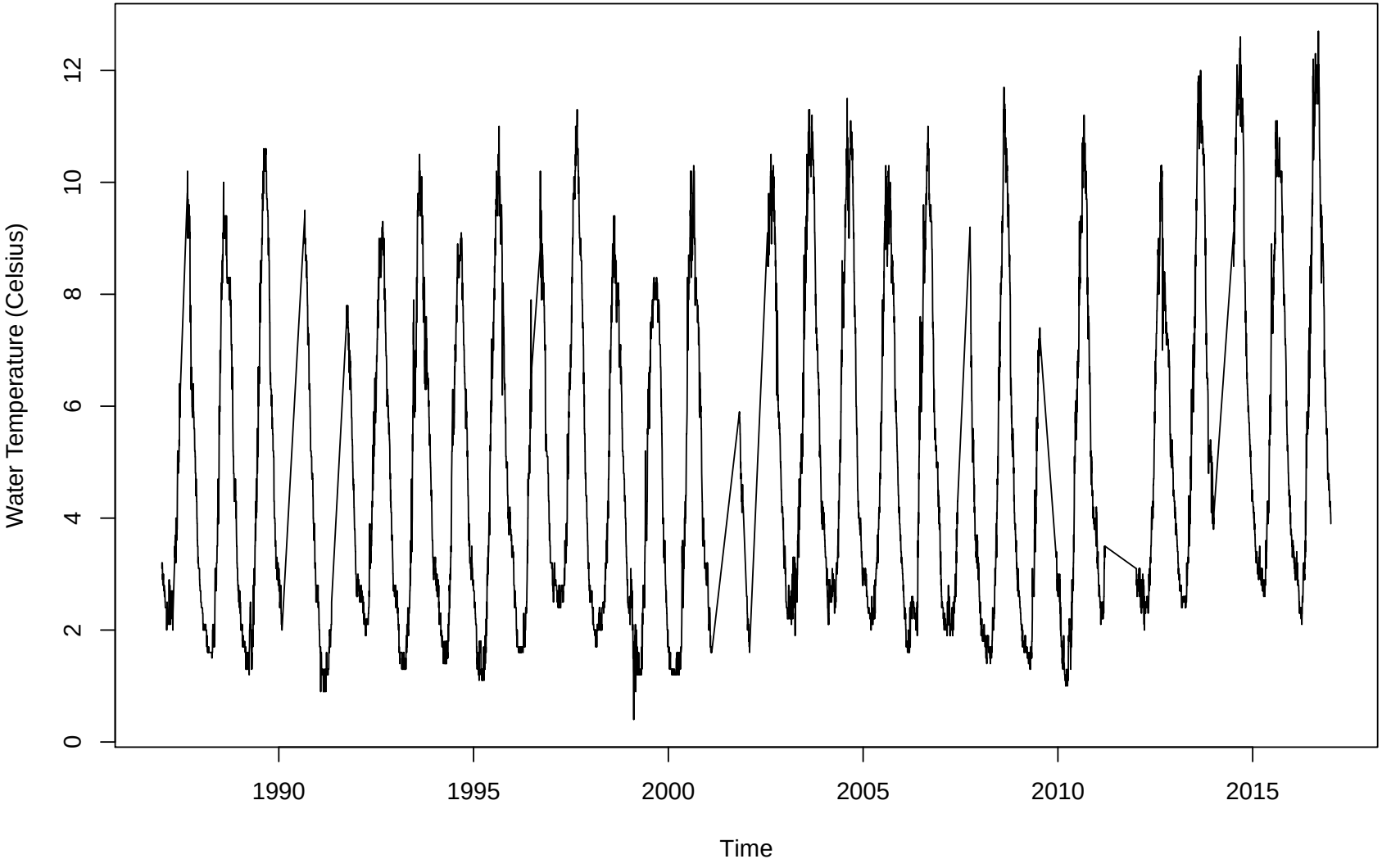
Water Temperature Statistics

	median	mean	std	min	max
1987	3.50	4.347482	2.168009	2.0	10.2
1988	3.50	4.572981	2.763685	1.5	10.0
1989	3.90	4.815143	3.052468	1.2	10.6
1990	4.70	4.946358	2.275633	2.0	9.5
1991	2.10	3.263556	2.268949	0.9	7.8
1992	4.10	4.771031	2.369144	1.9	9.3
1993	4.40	4.840634	2.889325	1.3	10.5
1994	3.20	4.458166	2.485816	1.4	9.1
1995	4.05	4.873204	3.041336	1.1	11.0
1996	3.35	4.117143	2.434385	1.6	10.2
1997	4.40	5.478797	2.919152	2.4	11.3
1998	3.50	4.484164	2.442296	1.7	9.4
1999	3.20	4.139394	2.542782	0.4	8.3
2000	3.60	4.654485	2.996079	1.2	10.3
2001	4.20	3.504348	1.436134	1.6	5.9

Water Temperature Statistics Cont.

```
##      median     mean       std min  max
## 2002   6.05 6.374242 2.9014075 1.6 10.5
## 2003   4.90 5.770330 2.9645191 1.9 11.3
## 2004   4.15 5.623626 2.9903227 2.1 11.5
## 2005   4.20 5.242582 2.7183541 2.0 10.3
## 2006   4.45 5.119890 2.9759967 1.6 11.0
## 2007   2.60 3.236032 1.5517487 1.9  9.2
## 2008   3.50 4.822161 3.2141366 1.4 11.7
## 2009   2.20 2.931163 1.7401810 1.3  7.4
## 2010   4.20 5.008215 3.0965185 1.0 11.2
## 2011   2.60 2.711429 0.3928871 2.1  3.6
## 2012   4.70 5.217729 2.4575318 2.0 10.3
## 2013   5.00 5.899444 3.0915285 2.4 12.0
## 2014   9.20 8.765385 2.7104177 4.3 12.6
## 2015   4.75 5.885714 2.7716817 2.6 11.1
## 2016   5.50 6.284110 3.2998035 2.1 12.7
```

Water Temperature Time Series



Are Air and Water Temperature correlated?

It would seem that there should be a relation between air temperature and sea temperature.

To confirm this, we must find the correlation coefficient between the two temperatures. The value is as follows:

```
## [1] 0.8767449
```

This implies that there is a strong positive correlation between the two, which is exactly what we'd expect.

Climate Change Analysis

Has the mean temperature of water and air in the Bering sea changed over the past 30 years?

We performed two tailed t-tests on the data from 1988 and 2016 to help find the answer to this question.

The alternative hypothesis in this case is that the true difference in means is not equal to 0.

Air Temperature Change

For air temperature, the t-value is:

```
##           t
## -19.73067
```

And the p-value is:

```
## [1] 3.219761e-59
```

Water Temperature Change

For water temperature, the t-value is:

```
##           t
## -40.72793
```

And the p-value is

```
## [1] 2.993355e-136
```

Conclusions

These values imply that it is extrremely likely that temperatures have changed over the past 30 years, confirming the results of most scientists.

Notes on Data Selection

In our analysis, we use only one sample per day day out of 24 daily hourly temperature readings, specifically at noon.

Though it's more computationally expensive to find the data, using the full range of data gives much more conclusive results when doing the t-test.

For air temperature, we get the much more conclusive t-value of -40.728, nearly indisputable evidence.

However, since our results were already fairly conclusive, this seems unnecessary. Thus we believe our results to still be worth consideration.