Background

Her Majesty's Ship (HMS) *Plover*

- Stationed at Point Barrow, Alaska from 1852 to 1854
- Hourly air temperature measurements
- Thermometer used was encapsulated in a radiation screen (results in bias) [2]

Figure 1a Location of Point Barrow, Alaska

***Plover* screen**

- Shelters instruments within it from outside environment
- Biases measurements recorded within it [6]

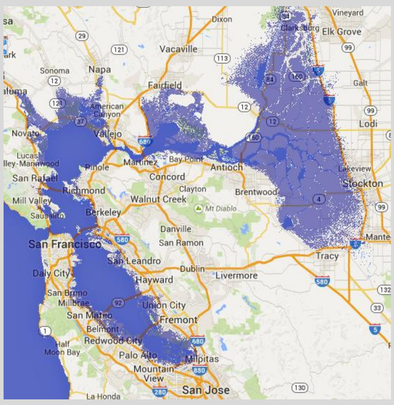


Figure 1b Blue areas demonstrate inundation zones in the San Francisco Bay Area, CA with a 1 m sea level rise based on elevation. (http://geology.com/sea-level-rise/san-francisco.shtml)

Arctic Climate change

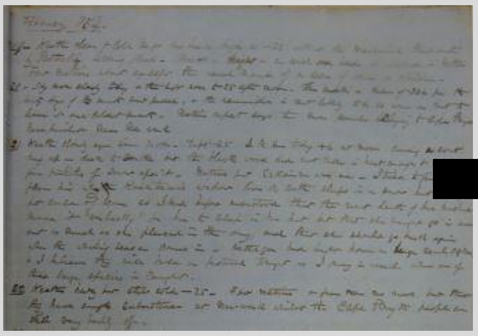
- Characterized by a change of a few degrees (1 – 3 °C) [13]
- Intergovernmental Panel on Climate Change (IPCC) projected that during the 21st century, sea level will rise another 18 to 59 cm [5]
- 8.5 million Americans are in inundation zones (59 cm rise) [4]
- Estimated $9 billion per year of damage from weather extremes caused by climate change [5]
- Arctic is warming twice as quickly as world average [9]

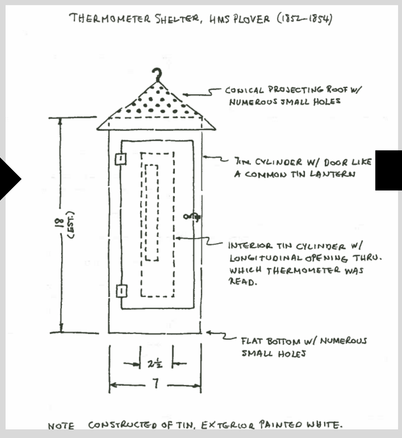
Purpose

- To determine the screen bias of the *Plover* screen on temperature readings under certain environmental conditions
- To correct inaccuracies present in the original *Plover* data set

Replica *Plover* screen

- Schematics and diagrams derived from the HMS *Plover's* report





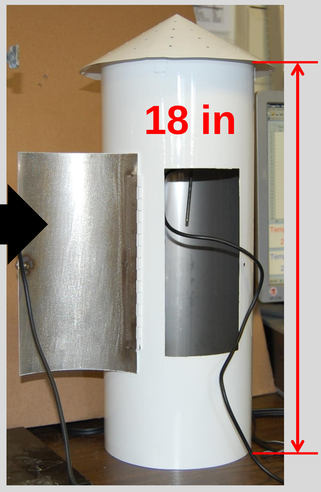


Figure 2 Development of Plover screen from Dr. Simpson's journal entries (1854)

Experimental set-up

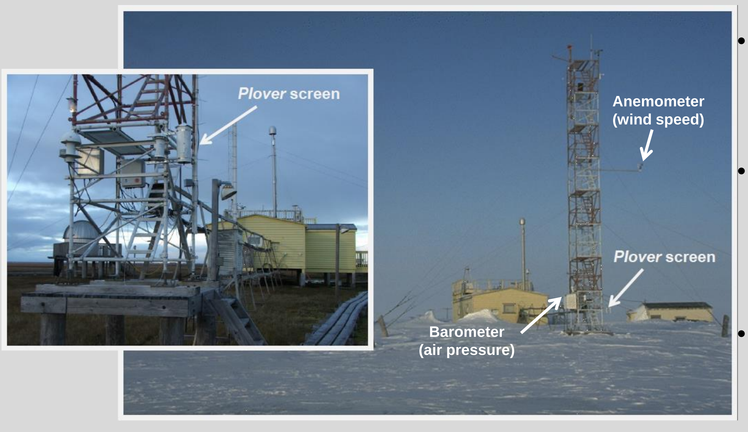
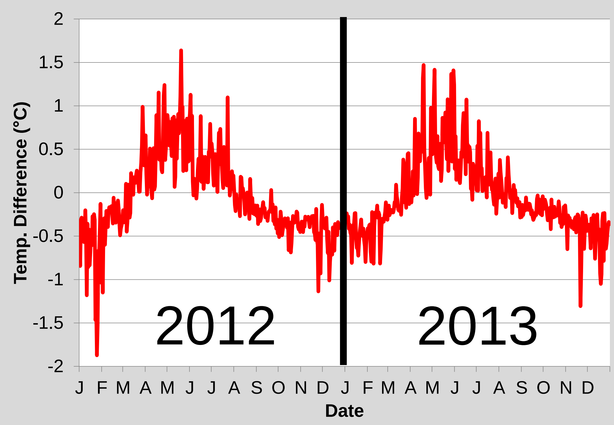


Figure 3 Site of data collection. Replica *Plover* screen RTD and exposed RTD are noted

- Data collected at Barrow, Alaska at the National Oceanic and Atmospheric Administration (NOAA) Observatory
- Two Resistance Thermocouple Devices (RTDs) recorded air temperature measurements at both inside and outside of the replica *Plover* screen
- Replica *Plover* screen sent to the NOAA observatory
  - Houses an RTD alongside an exposed RTD
- Modern day meteorological equipment recorded atmospheric pressure, wind speed at 10 m, and wind direction at 10 m

Experimental Assessment of Screen Bias in an Early Arctic Air Temperature Time Series

Results



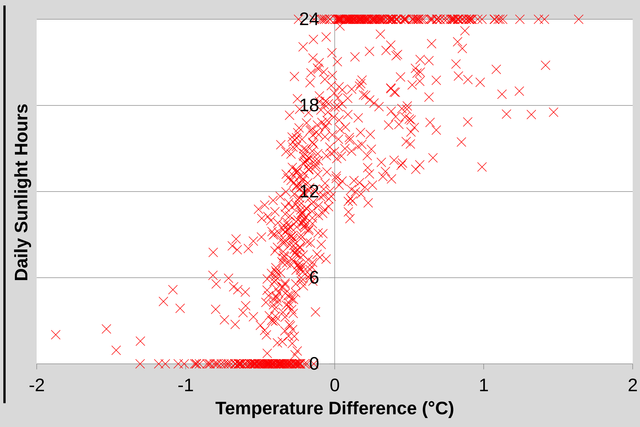
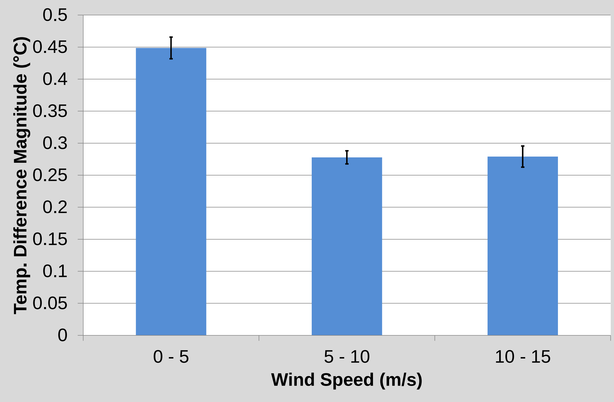


Figure 4a (left) Plot of temperature difference (°C) of Plover RTD and RTD 2m for 2 years (2012-2013) by Julian day
Figure 4b (right) Temperature difference (°C) of Plover RTD and RTD 2m against daily sunlight hours



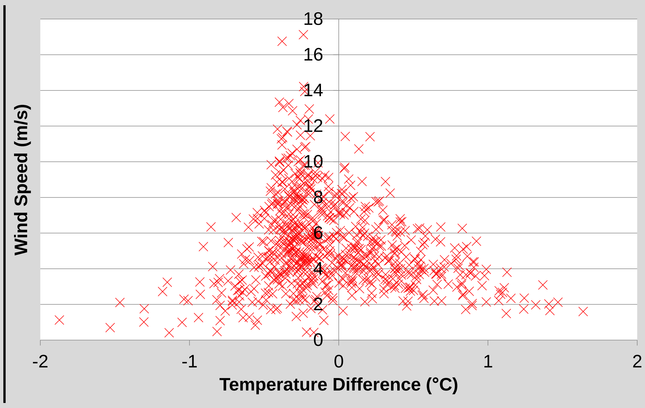
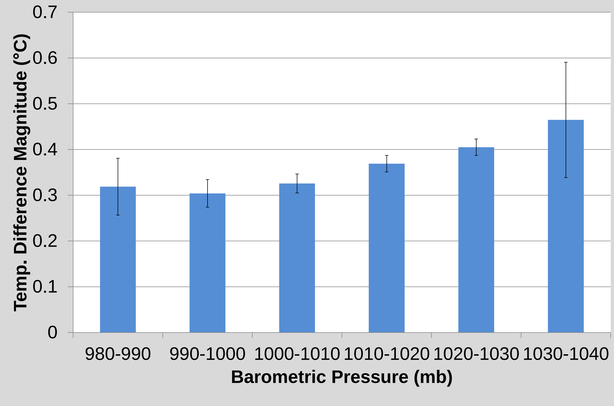


Figure 5a (left) Average temperature difference (°C) at different wind speed intervals; **P < 0.05** (Error bars = standard error)
Figure 5b (right) Temperature difference (°C) of Plover RTD and RTD 2m against wind speed (m/s)



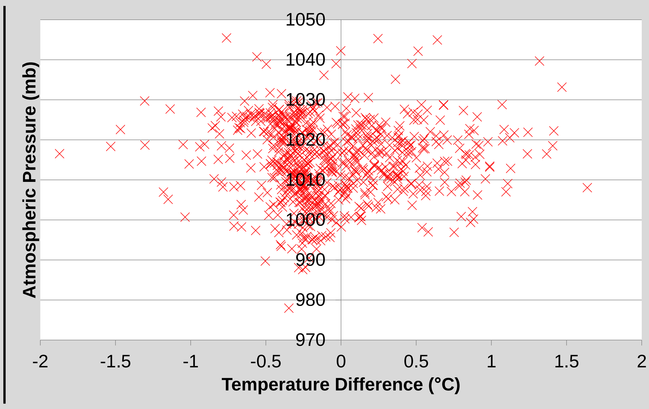
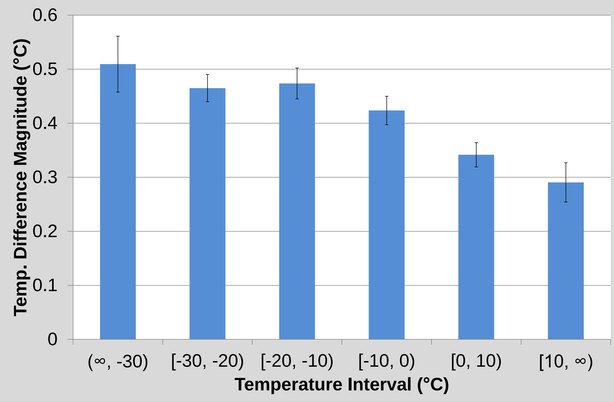


Figure 6a (left) Average temperature difference (°C) at different air pressure intervals; **P < 0.05**; (Error bars = standard error)
Figure 6b (right) Temperature difference (°C) of Plover RTD and RTD 2m against atmospheric pressure (mb)



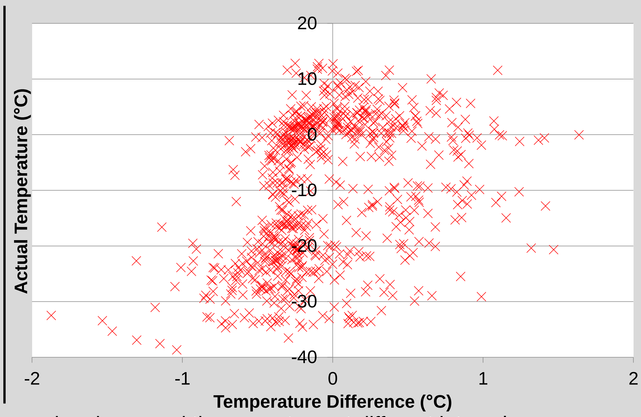
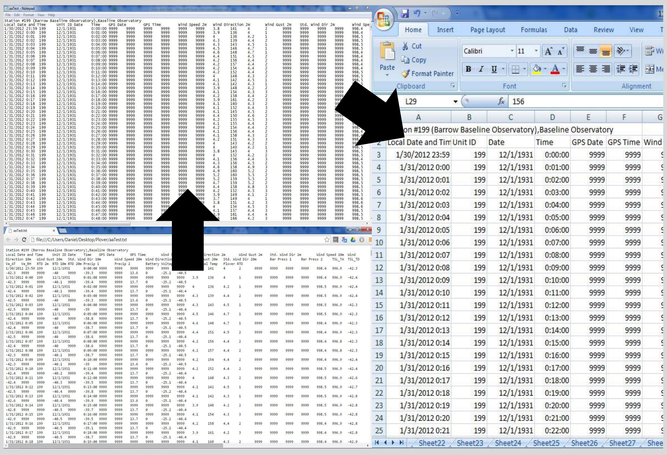


Figure 7a (left) Average temperature difference (°C) of exposed and encased thermometers at different intervals; **P < 0.05**; (Error bars = standard error)
Figure 7b (right) Temperature difference (°C) of Plover RTD and RTD 2m against actual temperature (°C)

Automated Data Organization



Data posted on NOAA FTP database

↓

Files downloaded and converted to Excel Files

↓

A Java computer program was designed to organize and analyze ~10^7 data points

Figure 8 Data conversation for weather data collected throughout 2012-2013 at the NOAA Observatory at Barrow, Alaska. The bottom-left window represents the original data on the FTP database. The upper-left window represents the data after being converted to a .txt file format in Notepad. The right window represents the data after being converted into a .xls file.

Conclusions

Effects of seasonal solar radiation

- During summer months, screen records higher temperatures
  - Possibly due to more sun exposure
  - Barrow, Alaska is above Arctic circle; sun never sets in summer (midnight sun)
- During winter months, screen records lower temperatures
  - Lack of sun exposure removes heating element

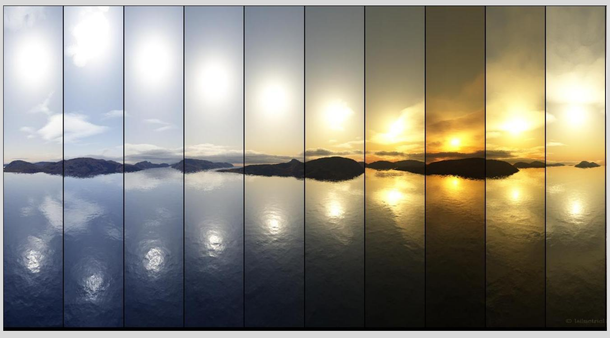


Figure 9 During Midnight Sun, the sun never dips below the horizon

Screen bias is highest under conditions of:

- *Lower wind speeds (Fig. 5)*
  - Lack of facilitation of air through the device results in an environment inside the screen that being less representative of the surrounding conditions

No significantly evident screen bias under conditions of:

- *Higher barometric pressures (Fig. 6))*
  - Barometric pressure may be correlated to cloud coverage and sun exposure
- *Lower temperatures (Fig. 7)*

Implications and Future Research

- *Plover* screen bias is on average 0.35°C while climate change is on the scale of a change of 2°C
  - Data can rectify old weather data (*Plover* data)
- Conduct rare comparison study between *Plover* data (located at Duke Special Collections Library) and modern data to seek changing climate patterns in the Arctic

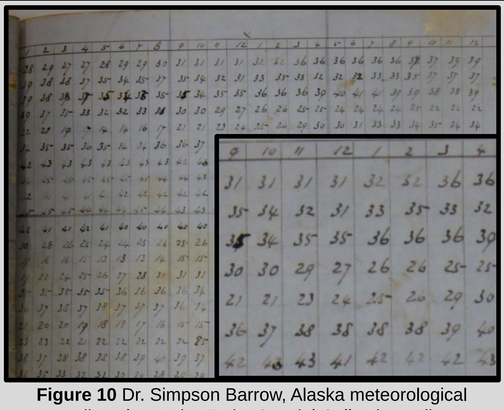


Figure 10 Dr. Simpson Barrow, Alaska meteorological recordings located at Duke Special Collections Library

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