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title: "iButton Temperature Data from 2021-2023 NIRPO Plots in Prudhoe Bay, Alaska"

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output:

word\_document: default

html\_document: default

pdf\_document: default

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```{r setup, include=FALSE}

knitr::opts\_chunk$set(echo = FALSE, warning = FALSE, message = FALSE)

```

```{r message = FALSE}

library(dplyr)

library(tidyr)

library(readr)

library(ggplot2)

library(scales)

library(here)

library(stringr)

library(tinytex)

library(readxl)

library(lubridate)

library(hms)

```

## File prep

- Save all data with datetime info in csv before bringing into r (do not use readxl package)

- Format all times as yyyy-mm-dd before importing into r

```{r}

# Read the CSV file

ibtn\_temp <- read.csv("data/ibtn\_data\_1922L.csv")

```

```{r}

# view output

head(ibtn\_temp)

```

```{r}

# transform data table from wide to long format

temp\_long <- ibtn\_temp %>%

pivot\_longer(cols = c(-Date, -Time), names\_to = "iBtn\_ID", values\_to = "temp\_c")

# view output

head(temp\_long)

```

```{r}

# convert date col from char to date format

date\_temp\_long <- data.frame(temp\_long)

date\_temp\_long$Date <- as.Date(date\_temp\_long$Date)

```

```{r}

#read in plot type table

plot\_type <- read.csv("data/ibtn\_summary.csv")

```

```{r}

# join both tables together

ibtn\_summaryX <- left\_join(date\_temp\_long, plot\_type, by = c("iBtn\_ID"))

# view output

head(ibtn\_summaryX)

```

```{r}

#read in plot type table

plot\_var <- read.csv("data/plot\_enviro\_data.csv")

```

```{r}

# view output

head(plot\_var)

```

```{r}

# join both tables together

ibtn\_summary <- left\_join(ibtn\_summaryX, plot\_var, by = c("Plot\_ID"))

# view output

head(ibtn\_summary)

```

```{r}

write.csv(ibtn\_summary, "data/ibtn\_summary\_all.csv")

```

### Average Daily Temperature calculated (4320 rows)

```{r}

# calculate average daily temp

avg\_daily\_temp <- ibtn\_summary %>%

group\_by(Date, iBtn\_ID, Plot\_ID, Veg\_type, Plot\_type, Depth, Transect.x, Moisture) %>%

summarize(avg\_daily\_temp = mean(temp\_c, na.rm = T), .groups = "drop") %>%

mutate(across(where(is.numeric), ~ round(., 1)))

knitr::kable(head(avg\_daily\_temp[, 1:9]), "simple", col.names = c("Date","iBtn ID","Plot ID","Veg Type","Plot Type","Depth","Transect","Moisture","Avg Daily Temp (\u00B0C)"))

```

### Average Daily Temperature calculated (4320 rows)

```{r}

# calculate average daily temp

avg\_daily\_temp <- ibtn\_summary %>%

group\_by(Date, Veg\_type, Location, Moisture, Surf\_Geol, Transect.x, Plot\_ID) %>%

summarize(avg\_daily\_temp = mean(temp\_c, na.rm = T), .groups = "drop") %>%

mutate(across(where(is.numeric), ~ round(., 1)))

knitr::kable(head(avg\_daily\_temp[, 1:8]), "simple", col.names = c("Date","Veg Type","Location","Moisture","Surf Geol","Transect","Plot\_ID","Avg Daily Temp (\u00B0C)"))

```

```{r}

# calculate avg daily temp for each day by veg type

adt\_veg\_type <- ibtn\_summary %>%

group\_by(Date, Veg\_type) %>%

summarize(avg\_daily\_temp = mean(temp\_c, na.rm = T), .groups = "drop")

```

```{r}

# calculate mean for all days by veg type

mean\_veg\_type <- ibtn\_summary %>%

group\_by(Veg\_type) %>%

summarize(avg\_daily\_temp = mean(temp\_c, na.rm = T), .groups = "drop") %>%

mutate(across(where(is.numeric), ~ round(., 1)))

```

```{r}

# plot mean veg type

p <- ggplot(mean\_veg\_type, aes(Veg\_type, avg\_daily\_temp)) +

geom\_col(fill="salmon") +

labs(title = "Mean Temperature by Veg type", x = "Veg Type", y = "Mean Temp (\u00B0C)") + theme(panel.background = element\_blank(), plot.title = element\_text(hjust = 0.5)) +

geom\_text(aes(label = avg\_daily\_temp), vjust = -0.5)

p

knitr::kable(head(mean\_veg\_type[, 1:2]), "simple", col.names = c("Veg Type", "Mean Temp (\u00B0C)"))

p.mean\_sensor <- p

```

```{r}

# calculate avg daily temp by ibtn position

adt\_location <- ibtn\_summary %>%

group\_by(Date, Location) %>%

summarize(avg\_daily\_temp = mean(temp\_c, na.rm = T), .groups = "drop")

```

```{r}

# calculate mean for all days by ibtn position

mean\_location <- ibtn\_summary %>%

group\_by(Location) %>%

summarize(avg\_daily\_temp = mean(temp\_c, na.rm = T), .groups = "drop") %>%

mutate(across(where(is.numeric), ~ round(., 1)))

```

```{r}

# plot mean for all ibtns by position

p <- ggplot(mean\_location, aes(Location, avg\_daily\_temp)) +

geom\_col(fill="salmon") +

labs(title = "Mean Temperature by iBtn Position", x = "iBtn Position", y = "Mean Temp (\u00B0C)") + theme(panel.background = element\_blank(), plot.title = element\_text(hjust = 0.5)) +

geom\_text(aes(label = avg\_daily\_temp), vjust = -0.5)

p

knitr::kable(head(mean\_veg\_type[, 1:2]), "simple", col.names = c("iBtn Position", "Mean Temp (\u00B0C)"))

p.mean\_sensor <- p

```

```{r}

# subset to remove sensors not assoc with plots

# then calculate average daily temp for each day by plot type

ibtn\_summary\_geol <- subset(ibtn\_summary, Surf\_Geol!="N/A")

adt\_surf\_geol <- ibtn\_summary\_geol %>%

group\_by(Date, Surf\_Geol) %>%

summarize(avg\_daily\_temp = mean(temp\_c, na.rm = T), .groups = "drop")

```

```{r}

# calculate mean for all days by plot type

mean\_surf\_geol <- ibtn\_summary\_geol %>%

group\_by(Surf\_Geol) %>%

summarize(avg\_daily\_temp = mean(temp\_c, na.rm = T), .groups = "drop") %>% mutate(across(where(is.numeric), ~ round(., 1)))

```

```{r}

# plot mean plot type for season

p <- ggplot(mean\_surf\_geol, aes(Surf\_Geol, avg\_daily\_temp)) +

geom\_col(fill="darkolivegreen3") +

labs(title = "Mean Temperature by Surficial Geology", x = "Surf Geol", y = "Mean Temp (\u00B0C)") + theme(panel.background = element\_blank(), plot.title = element\_text(hjust = 0.5)) +

geom\_text(aes(label = avg\_daily\_temp), vjust = -0.5)

p

knitr::kable(head(mean\_surf\_geol[, 1:2]), "simple", col.names = c("Surficial Geology", "Mean Temp (\u00B0C)"))

p.mean\_plot <- p

```

```{r}

# calculate mean for all days by veg type and surficial geology

mean\_veg\_geol <- ibtn\_summary\_geol %>%

group\_by(Veg\_type, Surf\_Geol) %>%

summarize(avg\_daily\_temp = mean(temp\_c, na.rm = T), .groups = "drop") %>%

mutate(across(where(is.numeric), ~ round(., 1)))

p <- ggplot(mean\_veg\_geol, aes(x = Veg\_type, y = avg\_daily\_temp, fill = Surf\_Geol)) +

geom\_col(position = "dodge2") +

labs(title = "Mean Temperature by Veg Type and Surface Geology", x = NULL, y = "Mean Temp (\u00B0C)") + theme(panel.background = element\_blank(), plot.title = element\_text(hjust = 0.5), legend.title = element\_blank())

p

knitr::kable(mean\_veg\_geol[, 1:3], "simple", col.names = c("Veg Type","Surf Geol","Mean Temp (\u00B0C)"))

p.mean\_veg\_geol <- p

```

```{r}

# calculate mean for all days by veg type and iBtn position

mean\_veg\_loc <- ibtn\_summary %>%

group\_by(Veg\_type, Location) %>%

summarize(avg\_daily\_temp = mean(temp\_c, na.rm = T), .groups = "drop") %>%

mutate(across(where(is.numeric), ~ round(., 1)))

p <- ggplot(mean\_veg\_loc, aes(x = Veg\_type, y = avg\_daily\_temp, fill = Location)) +

geom\_col(position = "dodge2") +

labs(title = "Mean Temperature by Veg Type and iBtn Position", x = NULL, y = "Mean Temp (\u00B0C)") + theme(panel.background = element\_blank(), plot.title = element\_text(hjust = 0.5), legend.title = element\_blank())

p

knitr::kable(mean\_veg\_geol[, 1:3], "simple", col.names = c("Veg Type","iBtn Position","Mean Temp (\u00B0C)"))

p.mean\_veg\_loc <- p

```

```{r}

#plot adt all ibuttons

p <- ggplot(avg\_daily\_temp, aes(x = Date, y = avg\_daily\_temp)) +

geom\_point(alpha = 0.3, color = "dodgerblue2") +

labs(title = "Average Daily Temperature", x = NULL, y = "Temperature (\u00B0C)") +

theme(plot.title = element\_text(hjust = 0.5))

p

p.adt\_all\_ibtn <- p

```

### Let's look at the data in more detail.

Here is a plot of the average daily temperature of each iButton from all vegetation types at soil surface and the base of the organic layer.

```{r}

# plot by iBtn location

p <- ggplot(avg\_daily\_temp, aes(x = Date, y = avg\_daily\_temp, color=Location)) +

geom\_point(alpha = 0.3) +

labs(title = "Average Daily Temperature by iBtn Position", x = NULL, y = "Temperature (\u00B0C)", color = "iButton Position") +

theme(plot.title = element\_text(hjust = 0.5))

p

p.adt\_ibtn\_loc <- p

```

Now we can look at the just the surface data colored to indicated the vegetation type of the plot.

```{r}

# subset to remove sensors at the base of the organic layer

adt\_veg\_surface <- subset(avg\_daily\_temp, Location!="base org layer")

```

```{r}

# plot by Veg type at soil surface

p <- ggplot(adt\_veg\_surface, aes(x = Date, y = avg\_daily\_temp, color=Veg\_type)) +

geom\_point(alpha = 0.5) +

labs(title = "Average Daily Temperature at Soil Surfact by Veg Type", x = NULL, y = "Temperature (\u00B0C)", color = "Location") +

theme(plot.title = element\_text(hjust = 0.5))

p

p.adt\_veg\_surface <- p

```

```{r}

# plot by Transect

p <- ggplot(adt\_veg\_surface, aes(x = Date, y = avg\_daily\_temp, color=Transect.x)) +

geom\_point(alpha = 0.3) +

labs(title = "Average Daily Temperature by Transect at Soil Surfact", x = NULL, y = "Temperature (\u00B0C)", color = "Transect") +

theme(plot.title = element\_text(hjust = 0.5))

p

p.adt\_trans\_surface <- p

```

Now we can look at the just the base of the organic layer data colored to indicated the vegetation type of the plot.

```{r}

# subset to remove sensors at the soil surface

adt\_veg\_base <- subset(avg\_daily\_temp, Location!="surface")

```

```{r}

# plot by Veg type at base of org layer

p <- ggplot(adt\_veg\_base, aes(x = Date, y = avg\_daily\_temp, color=Veg\_type)) +

geom\_point(alpha = 0.5) +

labs(title = "Average Daily Temperature at Base of Organic Layer by Veg Type", x = NULL, y = "Temperature (\u00B0C)", color = "Location") +

theme(plot.title = element\_text(hjust = 0.5))

p

p.adt\_veg\_base <- p

```

Here is a plot of the average daily temperature of each iButton by site moisture

```{r}

# plot by moisture gradient

p <- ggplot(adt\_veg\_surface, aes(x = Date, y = avg\_daily\_temp, color=Moisture)) +

geom\_point(alpha = 0.3) +

labs(title = "Average Daily Temperature at Soil Surface by Site Moisture", x = NULL, y = "Temperature (\u00B0C)", color = "Site Moisture") +

theme(plot.title = element\_text(hjust = 0.5))

p

p.adt\_surf\_moisture <- p

```

```{r}

# plot by moisture gradient

p <- ggplot(adt\_veg\_base, aes(x = Date, y = avg\_daily\_temp, color=Moisture)) +

geom\_point(alpha = 0.3) +

labs(title = "Average Daily Temperature at Base of the Organic Layer by Site Moisture", x = NULL, y = "Temperature (\u00B0C)", color = "Site Moisture") +

theme(plot.title = element\_text(hjust = 0.5))

p

p.adt\_base\_moisture <- p

```

```{r}

# Facet plot by sensor type

p <- ggplot(adt\_veg\_surface, aes(x = Date, y = avg\_daily\_temp)) +

geom\_point(alpha=0.2, color = "firebrick") +

facet\_wrap(~Veg\_type, ncol=2) +

labs(title = "Average Daily Temperature by Veg type", x = NULL, y = "Temp (\u00B0C)") +

theme(plot.title = element\_text(hjust = 0.5))

p

p.adt\_veg\_facet <- p

```

```{r}

# filter out some plots for smaller facet set

transect\_filter <- avg\_daily\_temp %>%

filter(Transect.x == "T6", Location == "surface")

```

```{r}

# Facet plots by select plots

p <- ggplot(transect\_filter, aes(x = Date, y = avg\_daily\_temp)) +

geom\_point(alpha = 0.3, color = "hotpink2") +

facet\_wrap(~Plot\_ID, ncol = 4) +

labs(title = "Avg. Daily Temp at Soil Surface in T6 Plots", x = NULL, y = "Temperature (\u00B0C)") +

theme(plot.title = element\_text(hjust = 0.5), axis.text.x = element\_text(angle=45, hjust = 1))

p

p.t6\_surface\_facet <- p

```

### That's it! (for now)