Temperature and Relative Humidity: Cripple Creek and Chatanika River, Interior Alaska

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Abstract

Ice formation is a critical part of broader ecosystem health in water bodies and their surrounding riparian areas. Two of the biggest factors that influence stream ice formation are temperature and Relative Humidity. Cripple Creek near Fairbanks in Interior Alaska is of particular interest to this area of research as the stream was recently diverted back into its original channel after decades of artificial channelization. To begin to gain an understanding of the effects of these variables on ice formation at Cripple Creek a Hobo monitoring device was placed near Cripple Creek for a period of 5 days in late October-Early November and collected temperature and relative humidity measurements. This time frame is when ice formation is beginning to accelerate in Interior Alaska. To further put the data into perspective measurements were retrieved from a Desert Research Institute Remote Automated Weather Station located near the Chatanika river, also in Interior Alaska. Data analysis showed an apparent positive correlation between temperature and relative humidity at the Cripple Creek site and an apparent negative correlation between temperature and relative humidity at the Chatanika site. Further research is needed to understand the dynamics of Cripple Creek in its original channel as well as the effects that temperature and relative humidity have on ice formation in Interior Alaska.

Introduction and Research Question

Ice formation is a critical component of ecosystem health in watersheds. Stream ice acts as a travel corridor for both people and animals. It's important for researchers and managers to take a holistic approach to understanding the natural mechanisms in these areas. What we have found is that there are many factors that often dominate the conversation such as temperature, deforestation, and improper waste management. In an attempt to conduct a more well-rounded body of research, we decided to focus on relative humidity (RH) as well as temperature to analyze ice formations along the Happy Creek and Cripple Creek drainage area and compare it to data collected in an upland riparian environment at the Chatanika River RAWS Station.

RH is defined as the saturation of water vapor in the air at a given temperature, expressed as a percentage, but before diving into RH and temperature, it is important to understand the role of the cryosphere in environmental health. The cryosphere includes ice formations on seas, rivers, and lakes, as well as snow and other frozen formations within the ground itself, and it acts as a link between several other natural processes such as the water cycle, global energy budget, surface gas exchange, and alterations in sea level (Lemke et al., 2007). Noting this, drainage areas are intrinsically linked to the cryosphere. Due to their constant flow and increased sensitivity, rivers and streams are regarded as climate change indicators (Lind et al., 2011, Lemke et al., 2007). There is much research conducted that links temperature and other climate variables to ice formation on these bodies of water, however we found fewer studies about the relationship between relative humidity and ice formation.

While there is a plethora of research available for how temperature and dissolved solutes affect sea ice formation, there is shockingly little research available on RH's effect. Seeing this gap, we took it upon ourselves to start what will be a longer term research question. We decided to study both temperature and RH in the Happy and Cripple Creek drainage to see how changes in humidity affect river ice formation.

Methods

To collect data for this project we employed a Hobo Pro V2 data logger to collect temperature and relative humidity measurements at the Cripple Creek site for a period of 5 days between October 29th and November 3rd. This period was chosen due to the timing of ice formation in Interior Alaska. Measurements were taken every 10 minutes during this period. To collect data for the Chatanika site, open source data was taken from the Desert Research Institutes Remote Automated Weather Station (RAWS) site located outside of Fairbanks Alaska.

Figure 1. Cripple Creek Research Site. Credit: Eli Knapp, October 28, 2023

Figure 2. Cripple Creek Research Site. Credit: Michelle Morris, November 3, 2023

Figure 3. Cripple Creek Research Site with embedded picture of site. Map by Michelle Morris

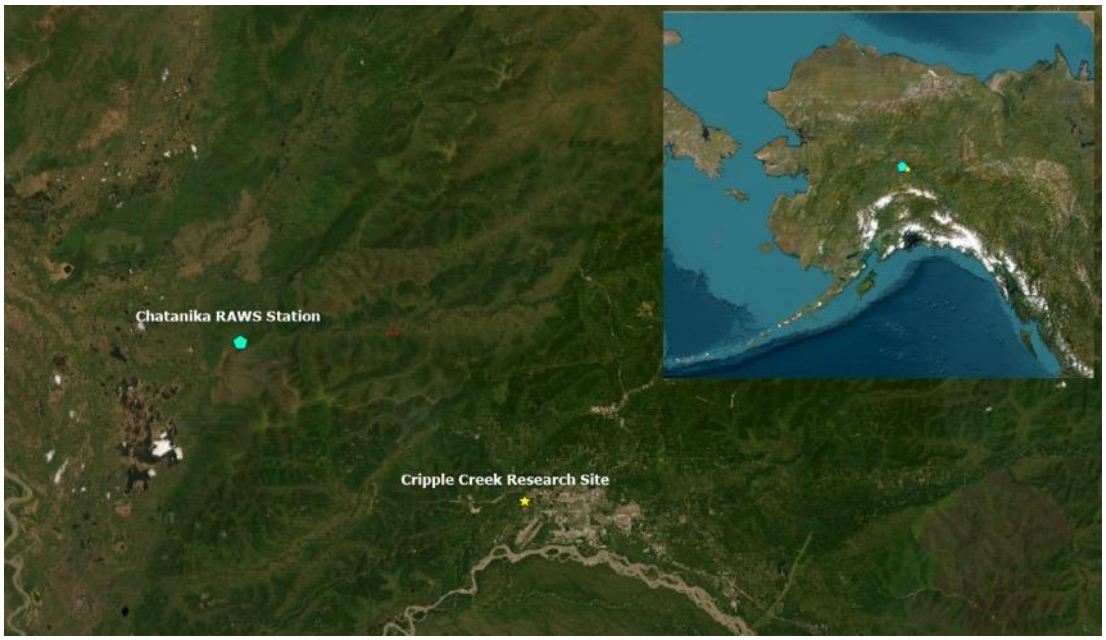

Figure 4. Cripple Creek Research Site and Chatanika RAWS station. Map by Michelle Morris

Results

The resulting graphs from our data showed some interesting correlations between temperature and relative humidity at the two sites. At the Chatanika site, an apparent negative correlation was observed, as temperature dropped relative humidity rose. However, at the Cripple Creek site an opposite positive correlation was observed, as temperature rose so did relative humidity.

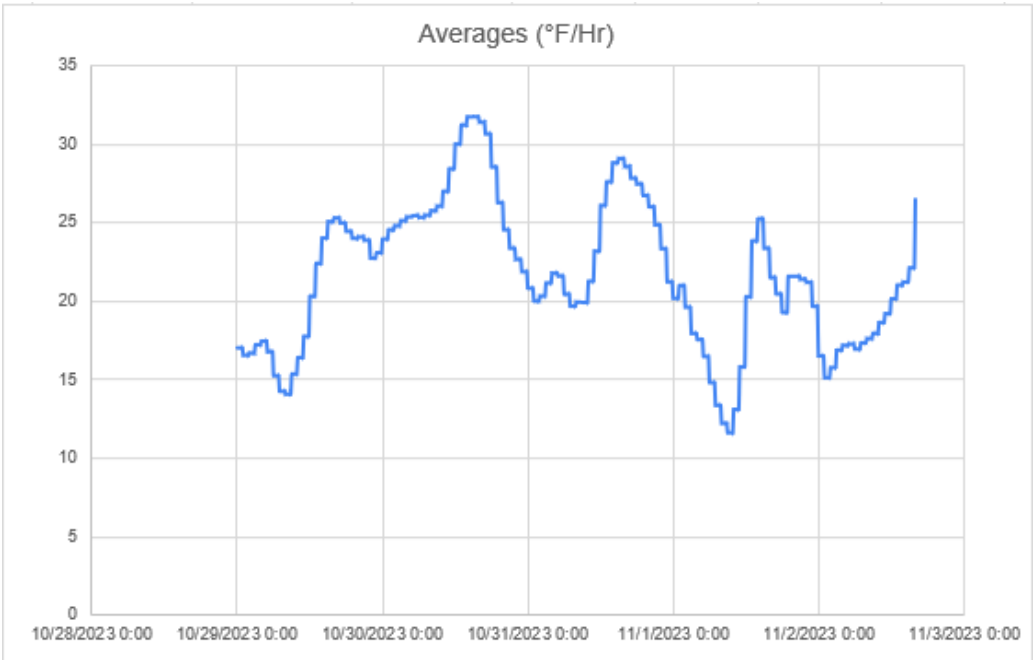

Figure 5. Graph of average temperatures at Cripple Creek between 10/29/2023-11/03/2023

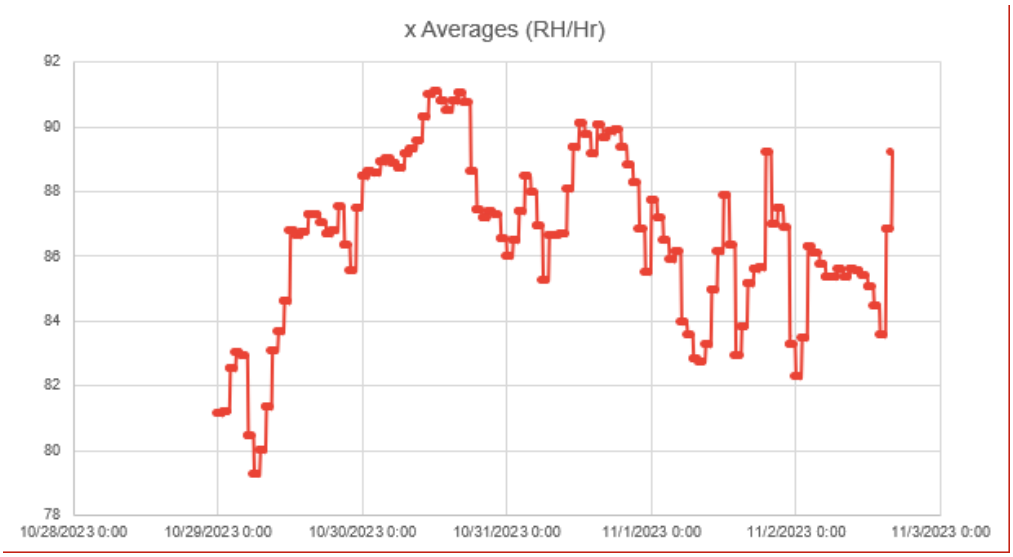

Figure 6. Graph of average RH at Cripple Creek between 10/29/2023-11/03/2023

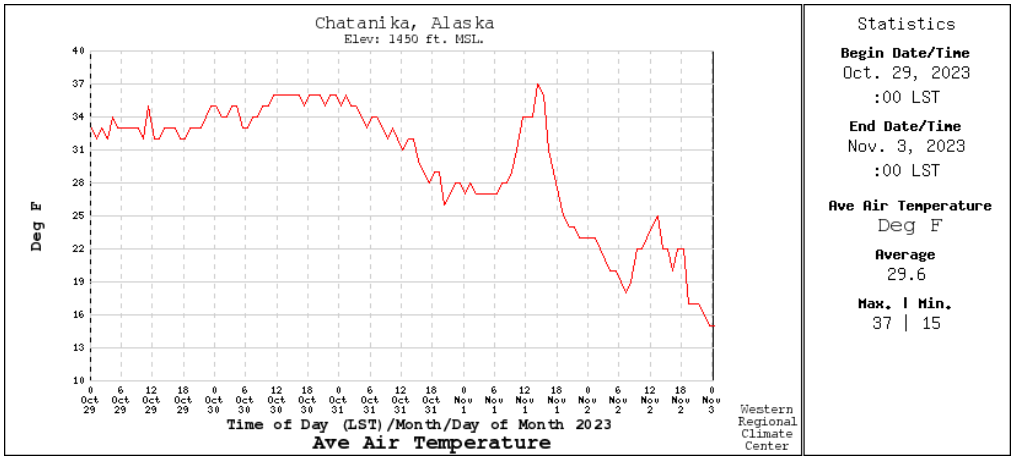

Figure 7. Graph of average temperature at Chatanika RAWS between 10/29/2023-11/03/2023

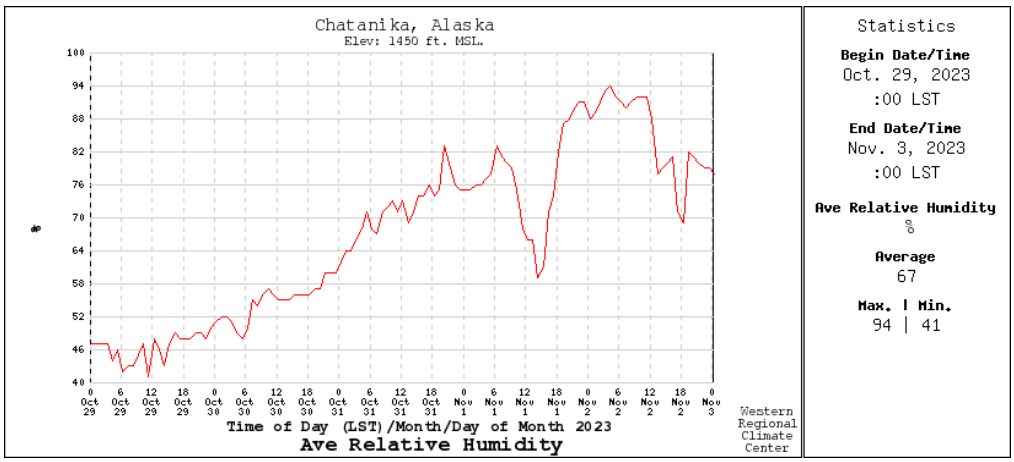

Figure 8. Graph of average RH at Chatanika RAWS between 10/29/2023-11/03/2023

Discussions and Conclusions

While this project was primarily an exploration, some basic conclusions can still be drawn. The biggest conclusion is that the relationship between temperature and relative humidity differs between these two watersheds. The apparent negative correlation observed at the Chatanika site is what is typically expected in measurements of temperature and relative humidity. The positive correlation at Cripple Creek is the surprising result here.

This difference can be explained by a variety of factors. One possible cause for this is the presence or lack of an inversion. The Fairbanks area is prone to winter inversions which cause higher elevation areas to experience warmer temperatures, however the time period studied is generally before the winter inversions tend to start forming. Another possible cause may be a

difference in canopy cover between the two sites. Since we were only able to physically observe the Cripple Creek drainage study site, we are unable to comment on the potential impact of the Chatanika RAWS Station's surroundings. There is a correlation between canopy cover and RH, studies show that canopy RH can have an increase of up to 25% in comparison to ambient RH (van Westreenen et. al., 2020). It is highly unlikely that native flora between these two sites differs all that much, since both areas are within a subarctic boreal forest. Another factor to consider is the significant lack of foliage on many of the trees during this time, since data was collected well into freeze-up and most non-evergreens had lost their leaves many weeks prior. Ultimately, more research is needed in this area to conclusively determine the factors that affect the relationship between temperature, relative humidity, and ice formation at these sites.

References

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