Estimating Antarctic Firn Average Emissivity Trends at the Ski Hi Automatic Weather Station

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ABSTRACT

Firn is compacted, near-surface snow enduring for more than one season not yet compressed into glacial ice. Knowledge of firn surface temperature trends across the Antarctic ice sheet is useful for documenting and quantifying change and providing a temporal and spatial context for research during the Antarctic International Polar Year (IPY). Satellite passive microwave radiometer data can provide surface temperature trend estimates across limited temporal and spatial gaps in Automatic Weather Station (AWS) coverage. Techniques to derive surface temperatures from passive microwave data have been pioneered by Jezek et al., (1993) and. Shuman et al., (1995).

Using the methods of previous researchers, the Summer 2006 Undergraduate Research Experience (URE) Antarctic Temperature Mapping Team, is comparing archived surface temperature data from an AWS on the West Antarctic Ice Sheet with coincident daily brightness temperature data collected by the Special Sensor Microwave Imager (SSM/I) aboard the Defense Meteorology Satellite Program (DMSP) polar orbiting meteorology satellite series. The ratio of passive microwave brightness temperature and AWS in-situ near surface temperature provides the firn emissivity estimate necessary to extrapolate surface temperature trends across temporal and spatial gaps in either the AWS or SSM/I record. The relationship between emissivity and surface temperature is generally known as the 'Rayleigh-Jeans Approximation' (Hall and Martinec, 1985). The spatial and temporal variability of firn emissivity is not well understood but known to be much less variable than daily temperature. AWS temperatures at 3 hourly intervals for the "Ski Hi" AWS site (75º South Latitude, 71 º West Longitude) in West Antarctica were obtained from the AWS Project data archive at the University of Wisconsin's Space Science and Engineering Center (SSEC). The passive microwave time-series of daily DMSP SSM/I brightness temperatures, geographically and temporally coincident with the Ski Hi site were obtained from Dr. Chris Shuman at NASA Goddard. Daily SSM/I brightness temperatures and corresponding Ski Hi AWS surface temperatures were tabulated in a Microsoft EXCEL spread sheet. The daily ratio of the SSM/I brightness temperature to the AWS surface temperature provided an emissivity trend from which to extrapolate surface temperatures The Ski Hi AWS operated from late February 1994 until late November 1998. The team will develop mathematical/statistical techniques to robustly estimate the surface emissivity trend at the Ski Hi site for the period January 1, 1995 through November, 1998, and use it to obtain a continuous estimate of surface temperature during data gaps in either the SSM/I or the AWS archive. Future work will establish emissivity trends at other AWS sites. These values will be combined with surface elevation data to extrapolate emissivity values beyond the locale of the AWS stations. Average surface temperatures can then be calculated from SSM/I brightness temperature records as well as data from other satellite sensors observing the Antarctic continent during the last 30 years.

This work is thus a preliminary step to deriving a surface temperature trend across the entire Antarctic ice sheet from 1981 through to the present.

I. INTRODUCTION

A. Overview

The summer 2006 Antarctic Temperature Mapping team project was to do conduct follow up research from the 2005 Polar Ice Team. The study activities intended for the upcoming International Polar Year (IPY) has exposed a lack of essential historical data on Surface Temperatures across majority of the Antarctic Ice Sheets. The team examined archived records of Ski-Hi Automatic Weather Station (AWS) and Special Sensor *Microwave/Imager (SSM/I) data to determine surface temperatures over the Antarctic Ice Sheets .*

(AWS) automatic Weather Station

Julian Day-Intended to provide astronomers with a single system of dates that could be used when working with different calendars

B. Data Collection

Date- Temperature is take 8 times in an 24 hour span.

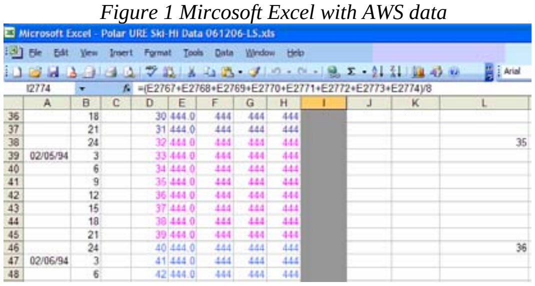
Time- Temperatures taken every three hours.

Temperature-

Three hour list of Data (Antarctic Temperature Ski High)

C. Excel

Figure 1 Mircosoft Excel with AWS data



	A	B	C	D	E	F	G	H	I	J	K	L
36		18		30	444.0	444	444	444				
37		21		31	444.0	444	444	444				
38		24		32	444.0	444	444	444				35
39	02/05/94	3		33	444.0	444	444	444				
40		6		34	444.0	444	444	444				
41		9		35	444.0	444	444	444				
42		12		36	444.0	444	444	444				
43		15		37	444.0	444	444	444				
44		18		38	444.0	444	444	444				
45		21		39	444.0	444	444	444				
46		24		40	444.0	444	444	444				36
47	02/06/94	3		41	444.0	444	444	444				
48		6		42	444.0	444	444	444				

METHODOLOGY

The methods that are needed to create this document successfully are as follow:

1. **Go to,** start menu, and click programs, then click Microsoft Excel.
2. Once Microsoft Excel is open, click on the word DATA drop down menu, then click " get external data", then click import text file. From where ever you saved your info at.
3. Be sure you setup is as followed {1} Fix width dot filled in {2} Start row: is at one {3} file origin window (ANSI) then, click next until the word finish comes up. {4} then click the ok button.
4. Once info has been loaded select the latitude column only & completely {1} First copy {2} then click your retabulation of AWS tab & paste Latitude into the **E** column of your page under AWS Temperature per hr.
5. Then label after every month of input data, starting, with the first day only and the last day only on the side. Then repeat step for every month added.
6. Then once you achieved putting a whole year of days in. Next, you put –10.5 into column **I,** and paste it by every last day of the 24 hour: 3 hour measure span and divide by 8 for the day there.
7. If data completely unavailable then, move on to the next day of that month.
8. If not, then divide by how many temperature measurements are available to during that specific day of 24 hour span measure span.

D. Latitude purpose within this project was to measure the temperature variations within time intervals of every three hours.

E. Average Temperature

Negative 10.5 to divide by eight days to determine an average temperature.

II.

A.

B.

C.

D.

E.

III Results

A. Emissivity Trends The team was able to extend the continuous record of firn emissivity at the Ski Hi AWS site through September 5, 1995 by adding nine months of data to the previous record begun on 2/22/1994 Significant gaps in the AWS and SSMI coverage were filled in the process.

B. We now have a 600 day continuous record of Surface Air Temperatures at the Ski Hi AWS site, representing one third of the operational life of the station.

C.

IV. FUTURE WORK

A. To continue calculating and inputting data to identify the location and frequency of melt events across the continent were constant through the history of Antarctica.

B. Future researcher to interpret the data that could not be collected at the Automated Weather Station displayed by 444 columns.

C. There has been data collected from the Ski Hi AWS from February 22, 1995-1996. Ski Hi AWS was replaced by the Ski Blue AWS about 0.5 miles from the original Ski Hi site. The researchers calculated the emissivity of the Antarctic region from January 22, 1995 to December 31, 1996.

The remaining statistics can now be used to determine emissivity trends at this locale from January 1, 1997 to June 30, 2001.

ACKNOWLEDGEMENTS

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REFRENCES

[1] Jezek, Kenneth C., Carolyn Merry, Don J. Cavalieri, Comparison of SMMR and SSM/I Passive microwave data collected over Antarctica, Annals of Glaciology, 17, 1993, pp 131-136.

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Emissivity trends can be used to extrapolate the surface or brightness temperatures at the AWS site, and in surrounding regions, between the wide spatial gaps in AWS coverage or any temporal gaps in the coverage provided by either data set. Performing the same analysis for every AWS site on the Antarctic continent would ultimately provide a complete history of surface temperature through out the entire continent since 1978. The result will be a 28 year record for the entire continent with values associated with spatial coverage in a grid of 25 km square cells from which an animation can be created to view surface temperatures trends which can be compared to data collected in the future, particularly during the upcoming IPY.

To create an simulation presentation of the Surface temperature of the Antarctic continent. The researcher would have to obtain each measurement in increments ranges of 25km pixel of Antarctica. Knowing that the approximate size of Antarctica is 14,000,000 sq. km the researcher would have to divide 14,000,000 sq. km by 625 sq. km totaling an overall total measurement of 22400 sq. km pixels. By doing this each frame will be placed together to create an overall animation of the surface temperatures.