TEMPERATURE BEHAVIOR during WINTER in ANTARCTICA

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The temperature behaviour during winter in Antarctica was investigated. Special attention was devoted to anomalous strong warmings, ranging between 20 ° and 40 °C. These events occur quasi-periodically (with periods of 6-12 days) during the winter season with higher intensity in the inner part of the continent.

The data from the AWS Dome C II for 1996-2004 as well from the South Pole, Dome Fuji, Halley and Port Martin stations were analysed.

Widely accepted that during the winter in the interior of Antarctica the well known phenomenon called "coreless" winter occurs. This phenomenon consists in increasing temperature trend for a few months after the spring leading to a maximum early in the winter. More detailed studies showed that the increase of the temperature during the austral winter is **not monotonic** and strong sudden **warming** episodes may occur (*Astapenko* [1964], *Carroll* [1982, 1983], *Hogan et al.* [1982], *Stone et al.* [1989], *Stone and Kahl* [1991], *Stone* [1993], *Neff* [1999]). These quasi-periodic warming events during the winter have a major role on the circulation and should then be considered in general circulation models. Some mechanisms for surface warming such as downward mixing of warmer upper-layer air accompanied with warm-air advection, transport of heat, moist air and aerosols, cloudiness from coastal regions were considered in these papers.

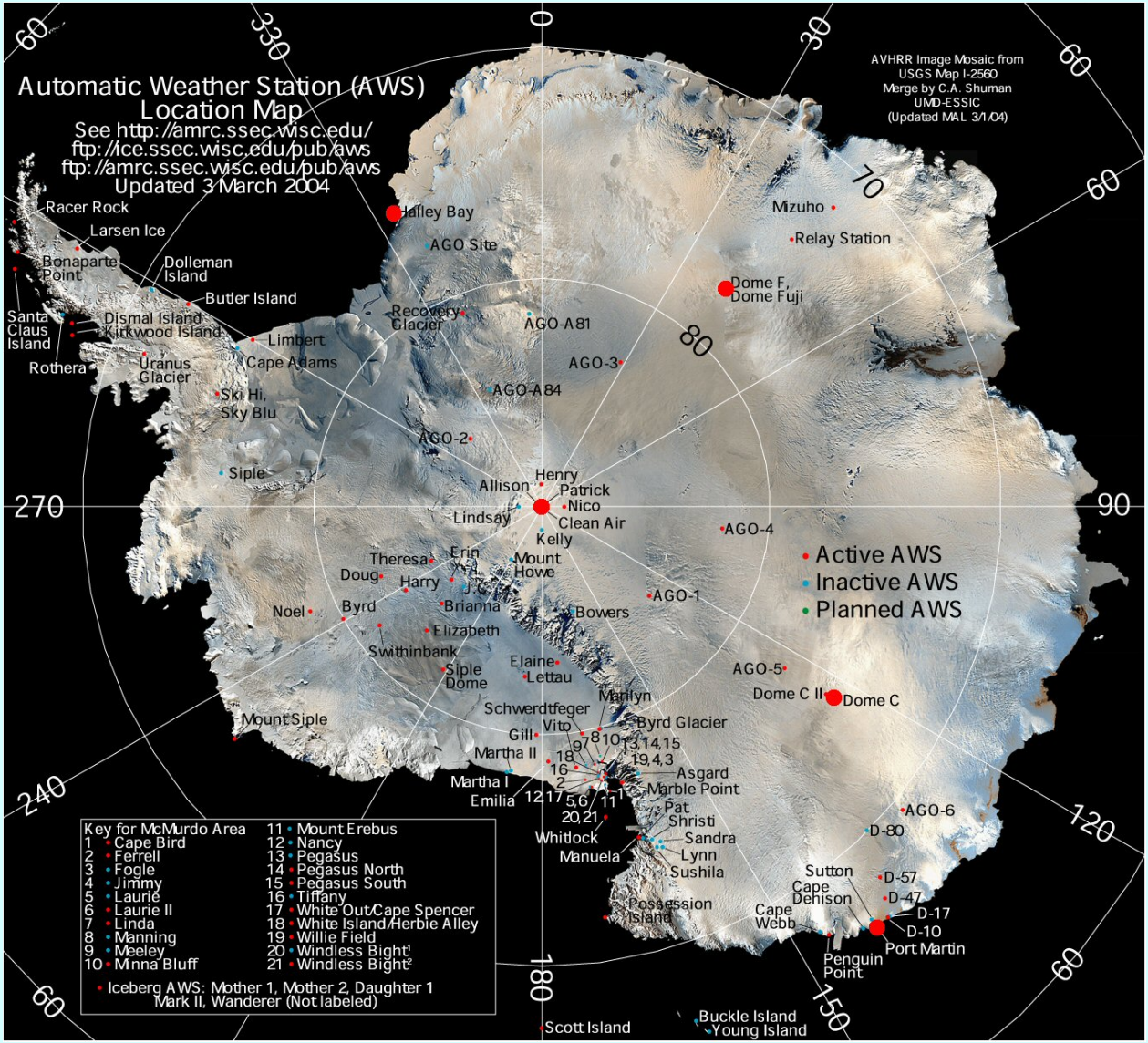
But still now the mechanisms of the alteration of two preferable regimes (one warming and one cooling) are not clear determined.

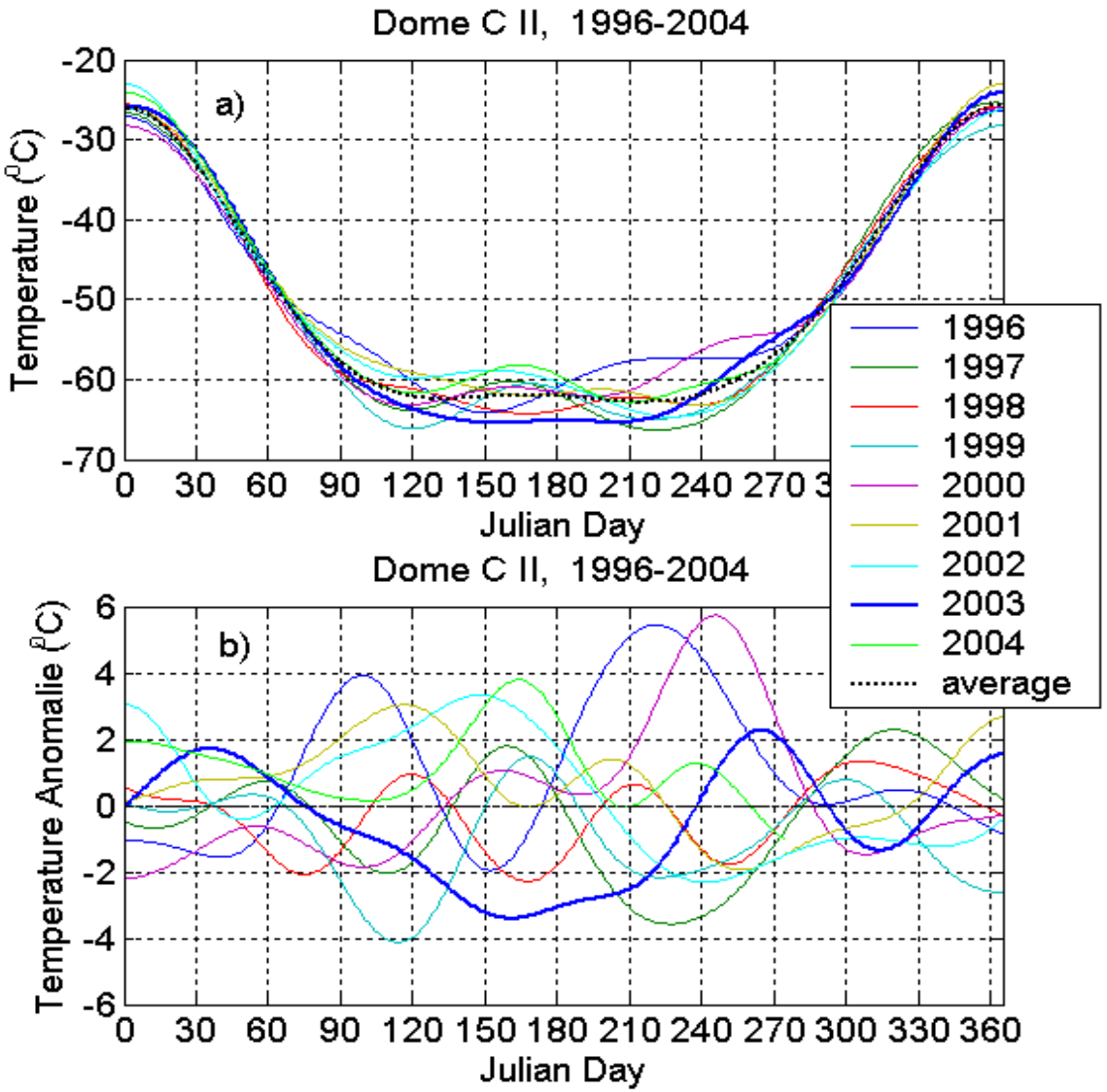
The temperature behavior during winter for several sites in East Antarctica was investigated in details by *Argentini et al.* [1999, 2000]. Three-hourly meteorological data (temperature, pressure, wind speed and direction) measured during 1994 at the AWSs Dome C and D-80, and at Dumont d'Urville meteorological station were processed. Special attention was devoted to abnormally strong warming episodes, occurring quasi-periodically during the winter season. These events were shown to have a periodicity of about 10 to 11 days, and a duration of 6 to 8 days with amplitude ranging from 20 ° to 40 °C. It was evidenced that these warmings at Dome C and D-80 are more often associated with high-pressure anomalies and follows the variation of the pressure with a delay varying from some hours to one day. Sharp changes in wind speed and direction generally occur when the temperature increases. In such cases the wind has the tendency to blow from the W-NE sector, deflecting from the dominant katabatic flow direction. Meanwhile, at the coastal station Dumont d'Urville no certain correlation between temperature, pressure and wind velocity was found.

The purpose of the presented study was to extend the analysis to several sites in Antarctica for several years to determine the similarity and differences of the characteristics of this phenomenon at different zones.

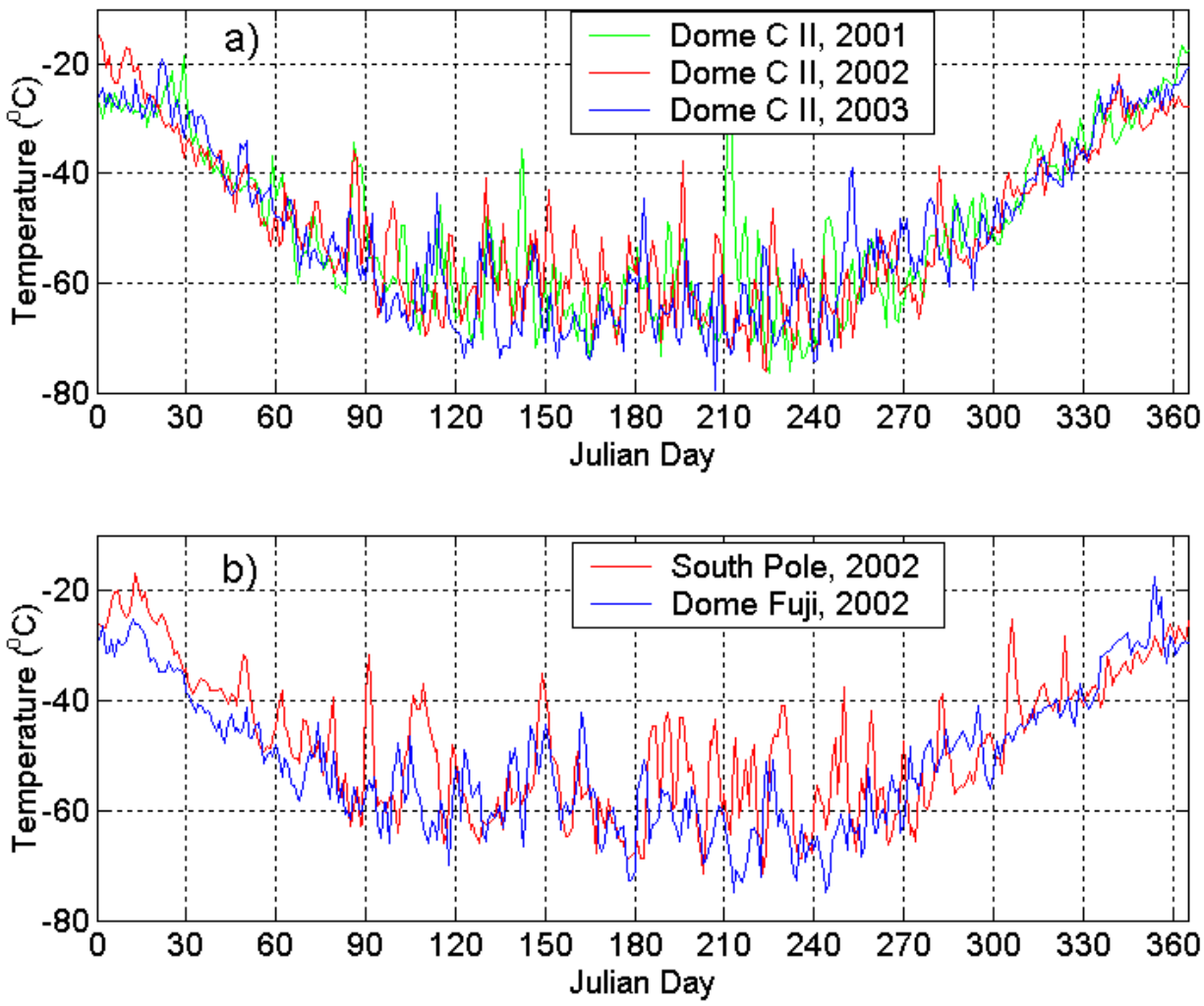
Probably this study can be useful for

1) Modelling the synoptic processes in Antarctica during winter.
2) Astronomical site testing

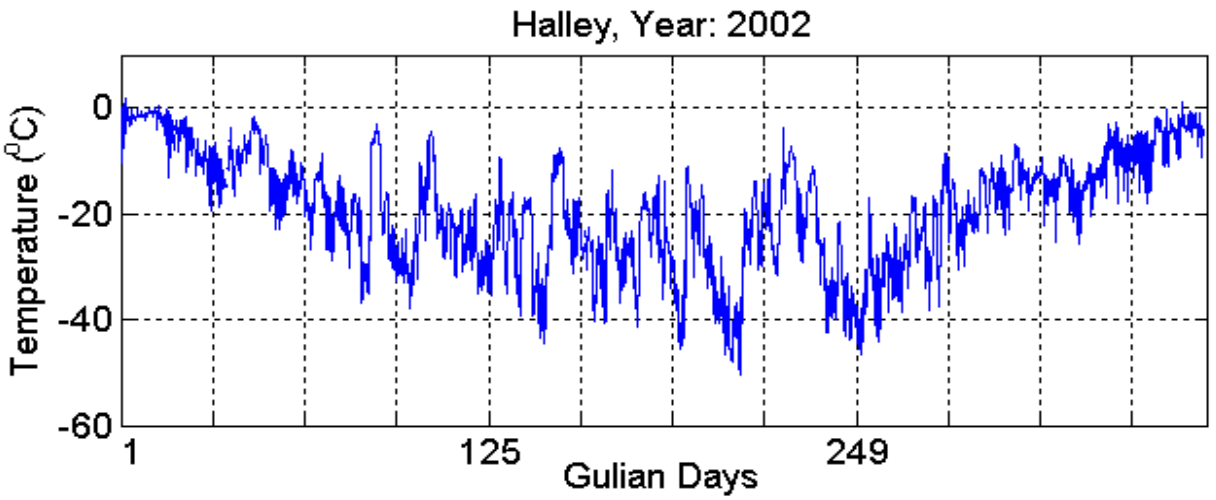

Automatic Weather Station (AWS)
Location Map
See http://amrc.ssec.wisc.edu/
ftp://ice.ssec.wisc.edu/pub/aws
ftp://amrc.ssec.wisc.edu/pub/aws
Updated 3 March 2004
AVHRR Image Mosaic from
USGS Map I-2560
Merge by C.A. Shuman
UMD-ESSIC
(Updated MAL 3/1/04)
Active AWS
Inactive AWS
Planned AWS
Racer Rock
Larsen Ice
Bonaparte Point
Dolleman Island
Butler Island
Santa Claus Island
Dismal Island
Kirkwood Island
Limbert
Cape Adams
Uranus Glacier
Rothera
Ski Hi
Sky Blu
Siple
Halley Bay
AGO Site
Recovery Glacier
AGO-A81
AGO-3
AGO-A84
AGO-2
Mizuho
Relay Station
Dome F
Dome Fuji
AGO-4
Henry
Patrick
Allison
Nico
Lindsay
Clean Air
Kelly
Theresa
Erin
Mount Howe
Doug
Harry
C
Noel
Byrd
Brianna
Bowers
AGO-1
Elizabeth
Swithinbank
Elaine
Siple Dome
Lettau
AGO-5
Dome C II
Dome C
Marilyn
Schwerdtfeger
Mount Siple
Vito
Byrd Glacier
Gill
Martha II
Martha I
Emilia
Asgard
Marble Point
Pat
Shristi
Whitlock
Sandra
Lynn
Manuela
Sushila
AGO-6
D-80
Sutton
D-57
Cape Dehison
D-47
D-17
Possession Island
Cape Webb
D-10
Port Martin
Penguin Point
Scott Island
Buckle Island
Young Island
Key for McMurdo Area
1 Cape Bird
2 Ferrell
3 Fogle
4 Jimmy
5 Laurie
6 Laurie II
7 Linda
8 Manning
9 Meeley
10 Minna Bluff
11 Mount Erebus
12 Nancy
13 Pegasus
14 Pegasus North
15 Pegasus South
16 Tiffany
17 White Out/Cape Spencer
18 White Island/Herbie Alley
19 Willie Field
20 Windless Bight1
21 Windless Bight2
Iceberg AWS: Mother 1, Mother 2, Daughter 1
Mark II, Wanderer (Not labeled)

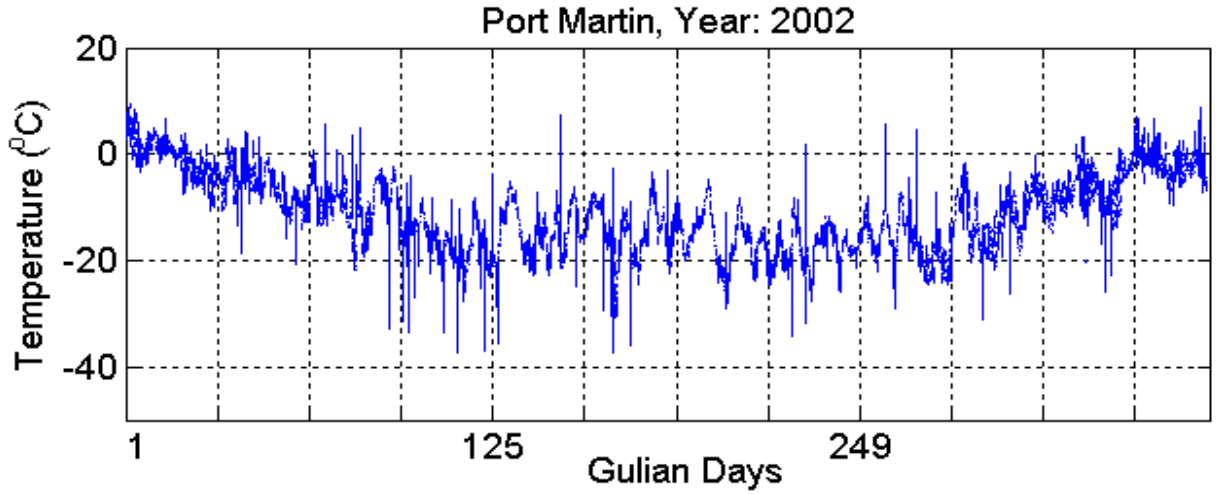


Smoothed annual behavior of temperature and temperature anomalies measured at Dome C in the period 1996-2004. The strongest anomalies are observed during the winter.

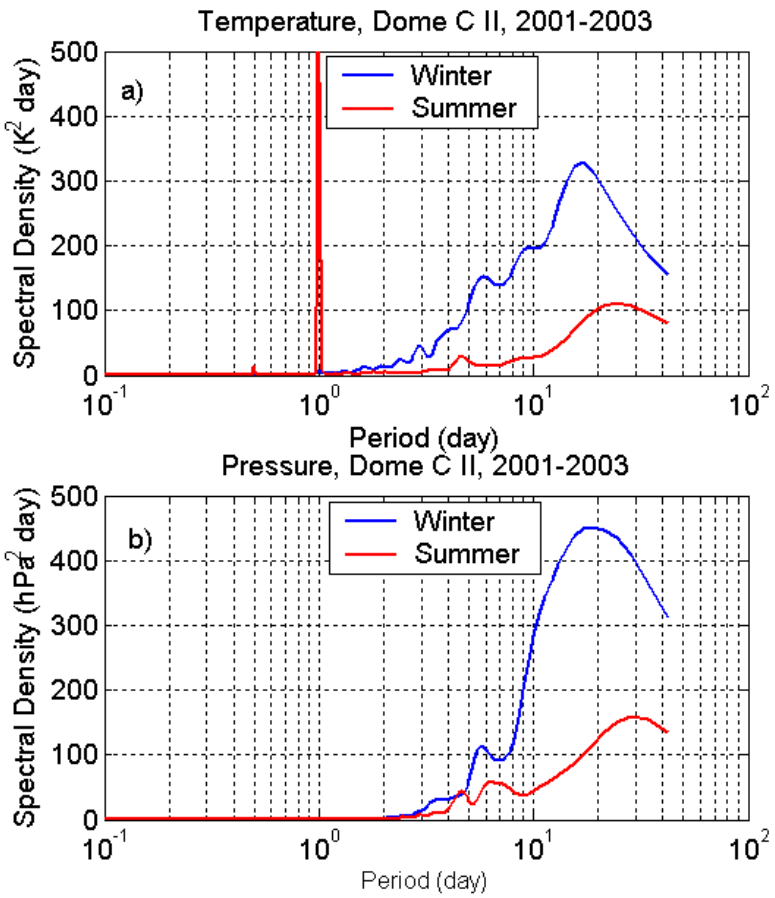


Annual behavior of the mean diurnal temperature at different continental stations: Dome C during the period 2001-2003 (a), South Pole and Dome Fuji (b) in 2002. Strong warming events are observed during winter at all sites.

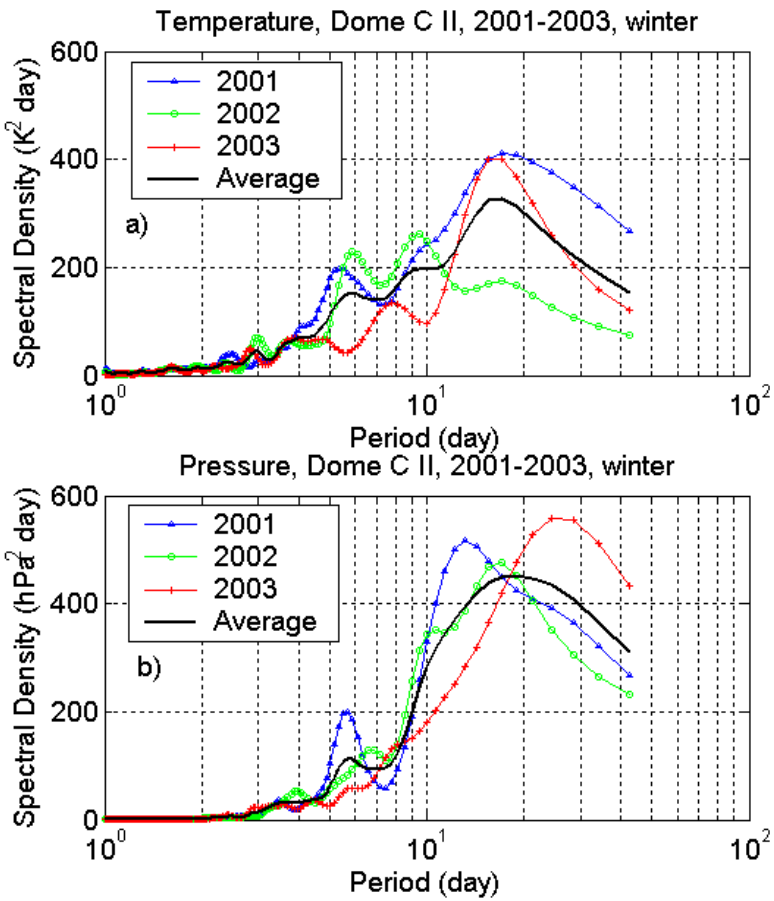




Annual behavior of the temperature at costal stations Halley and Port Martin in 2002. Stronger warming events are observed during winter at Halley.

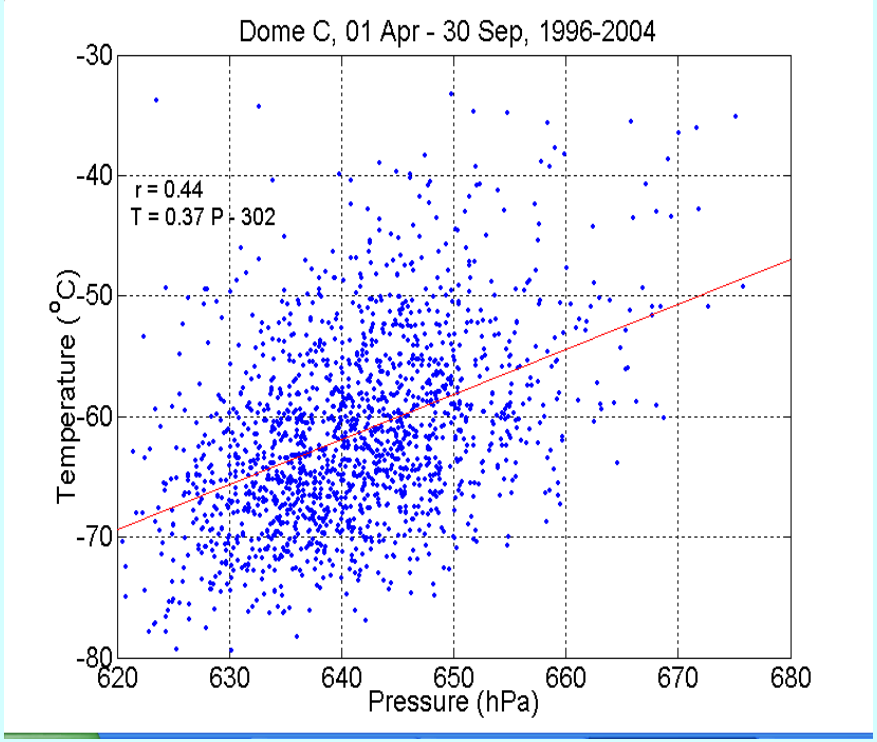


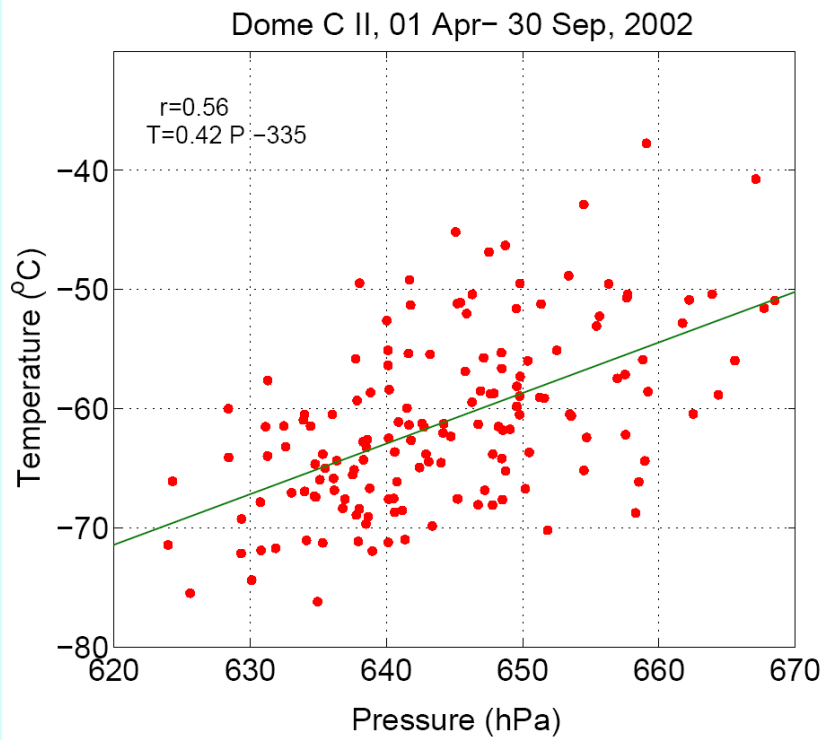
Power spectra of temperature (top) and pressure (bottom) at Dome C during winter (blue) and summer (red) averaged over the period 2001-2003. Synoptic variations during winter are stronger than those observed in the summer.



Power spectra of temperature (top) and pressure (bottom) at Dome C during winter of 2001, 2002, 2003. Peaks are observed at periods of 6-14 days.

Correlation between Temperature and Pressure

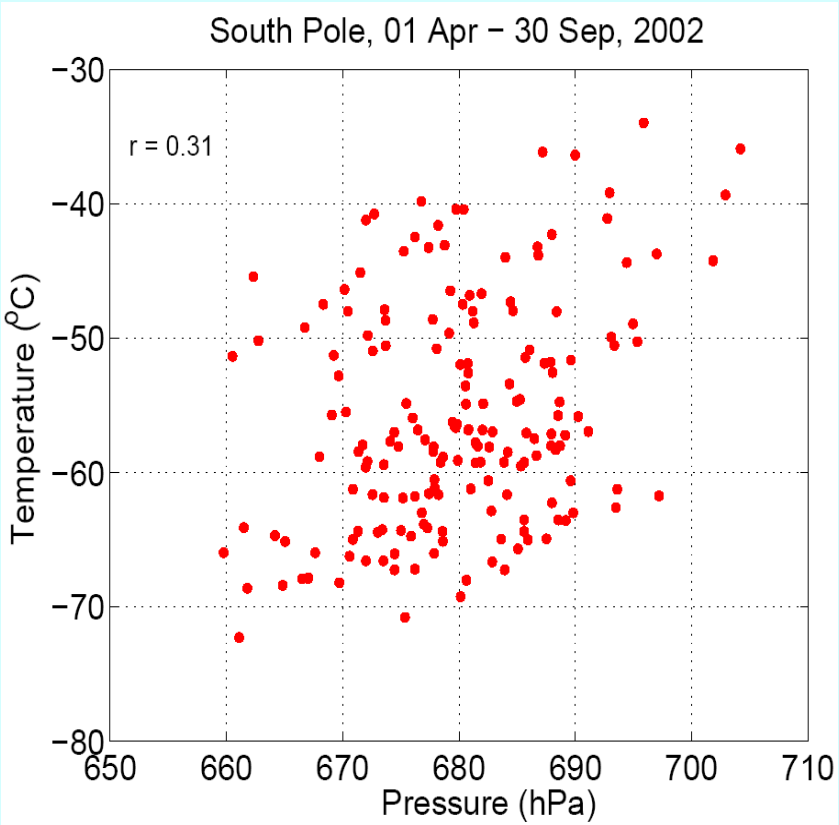


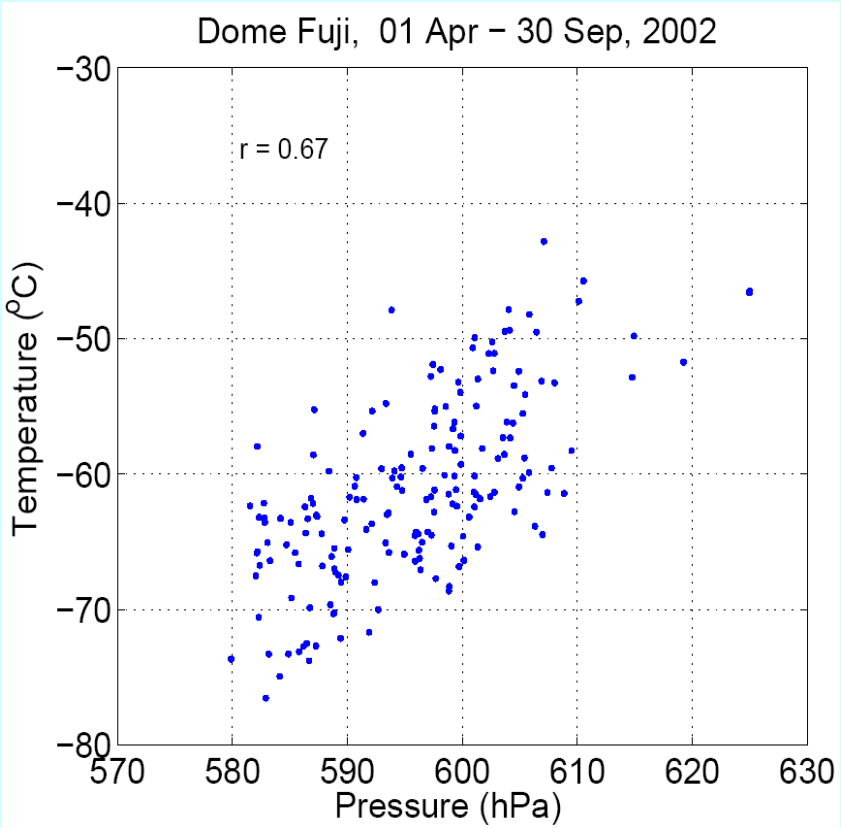


Scatter plot of temperature versus pressure at Dome C (left) in 1996-2004 and in 2002 (right).

The highest temperatures are observed for the highest pressure values.

Correlation between Temperature and Pressure

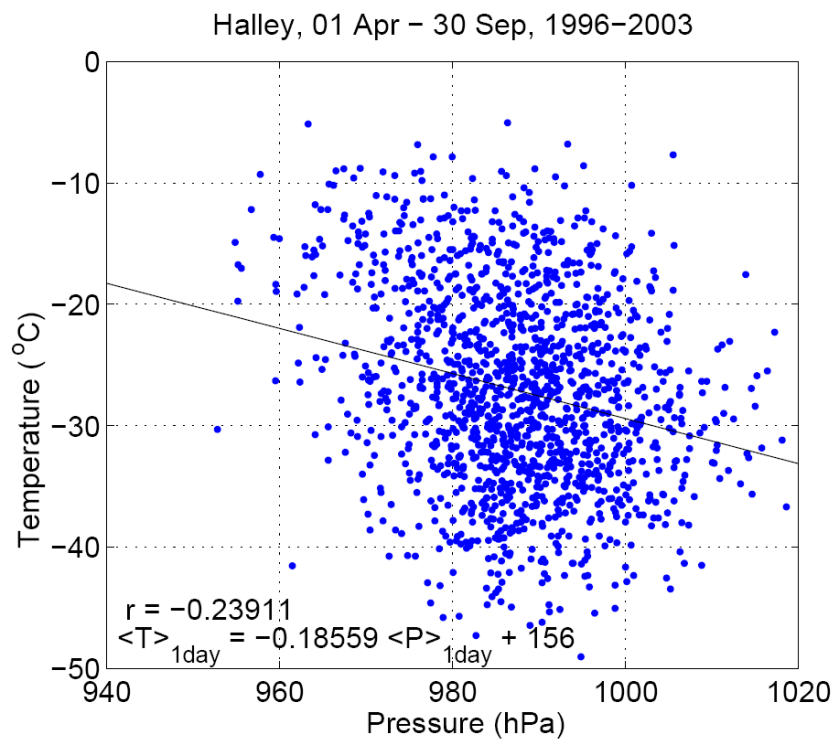


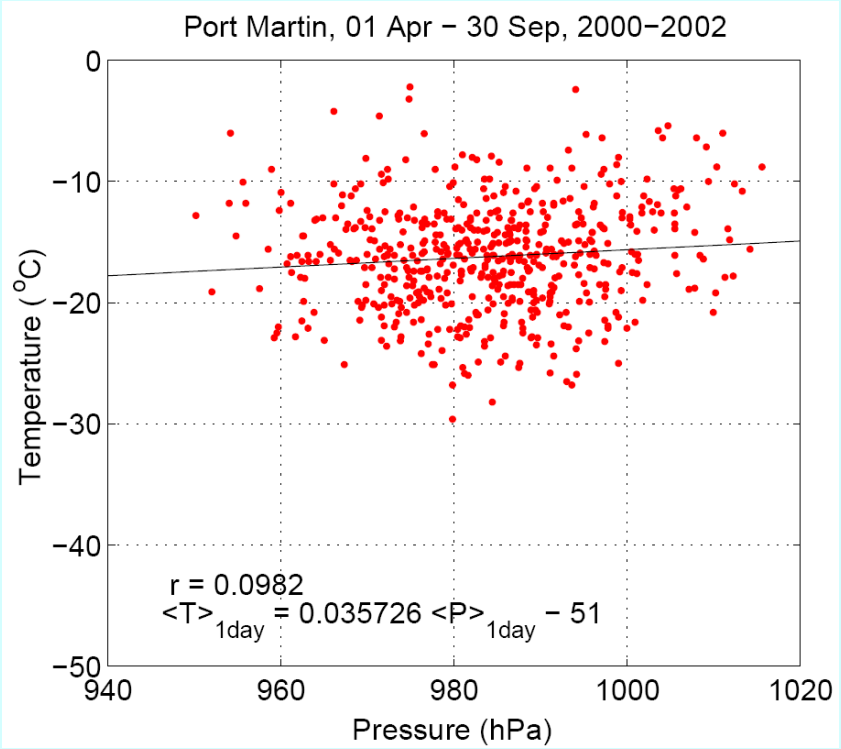


Scatter plot of temperature versus pressure at Dome Fuji (left) and South Pole in 2002 (right).

The highest temperatures are observed for the highest pressure values.

Correlation between Temperature and Pressure

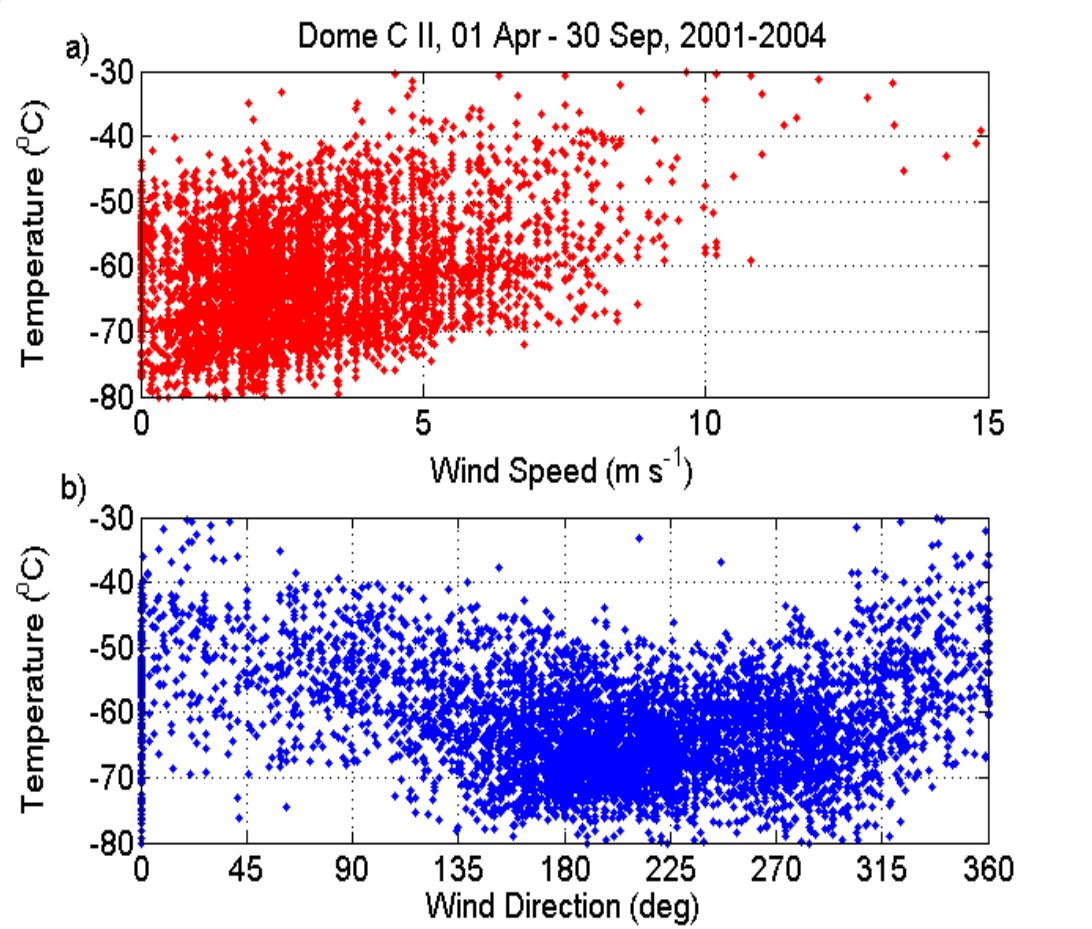




Scatter plot of temperature versus pressure at Halley (left) in 1996-2003 and Port Martin in 2000-2002 (right).

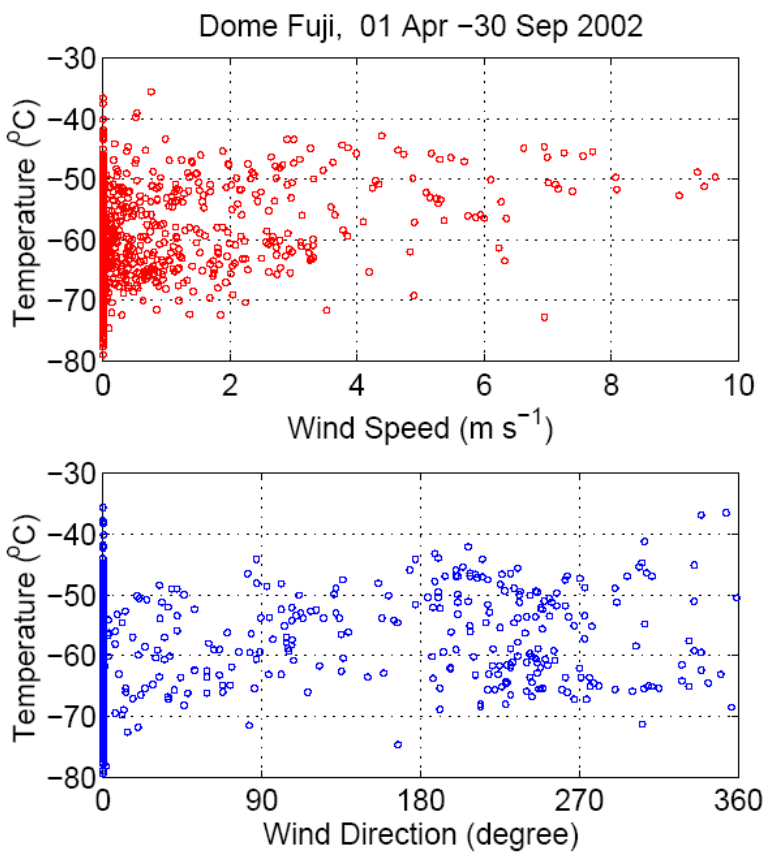
The highest temperatures at Halley are observed for the lowest pressure values. There is no dependence at Port Martin.

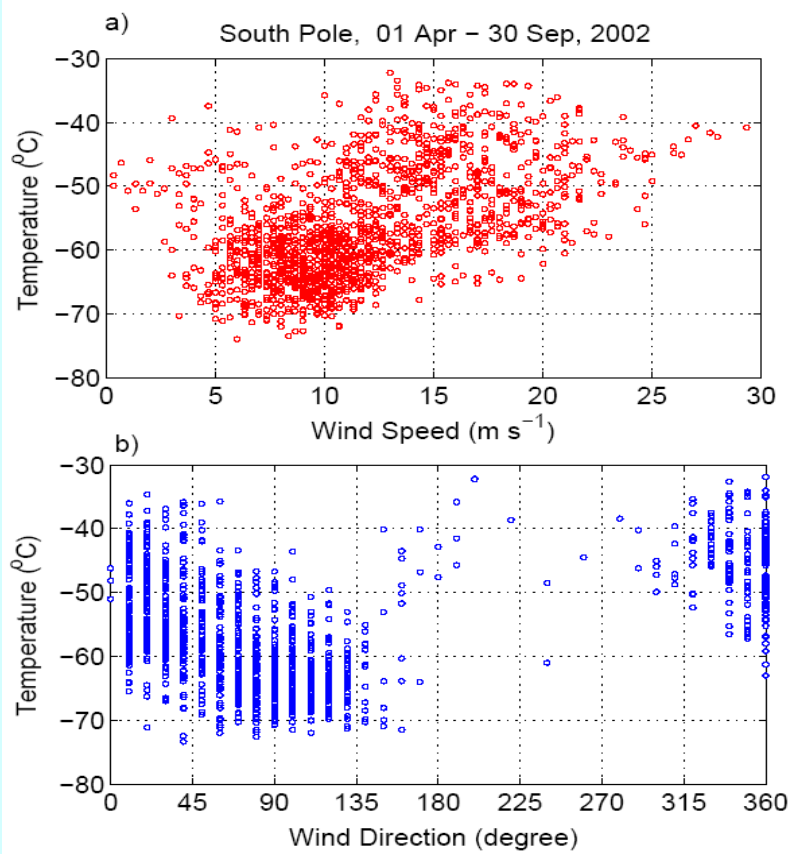
Correlation between Temperature and Wind



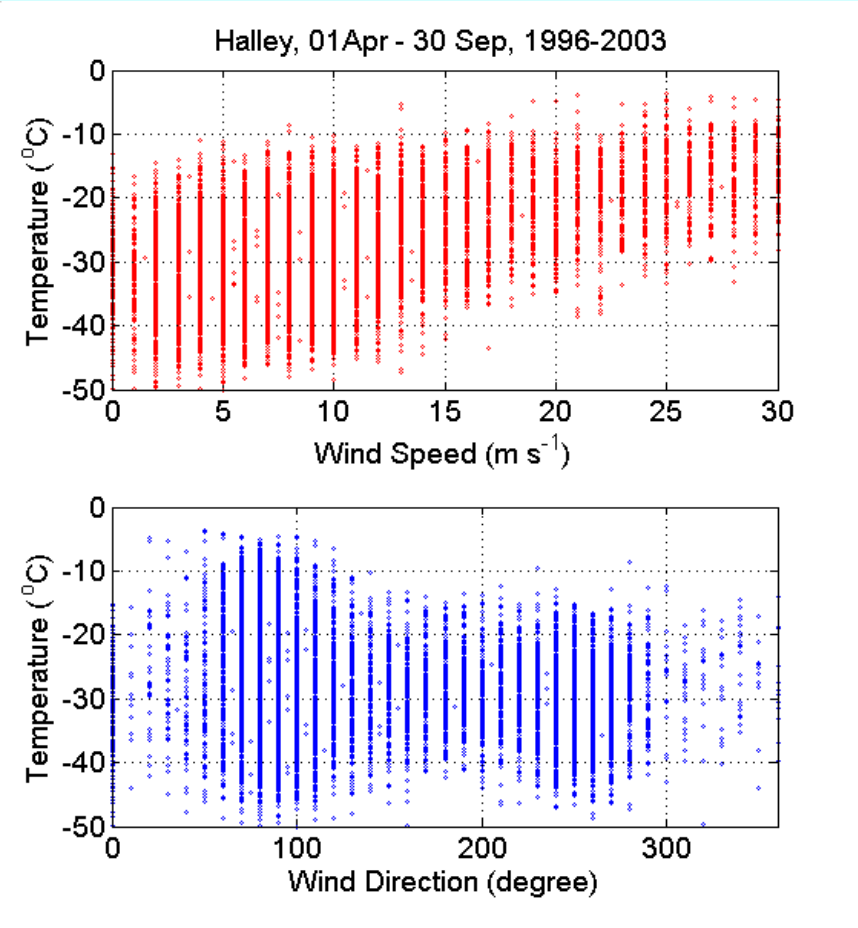
Scatter plot of temperature versus wind speed (top), and wind direction (bottom) at Dome C in 2001-2004. The warmest temperatures are observed for wind blowing from NW-NE sector.

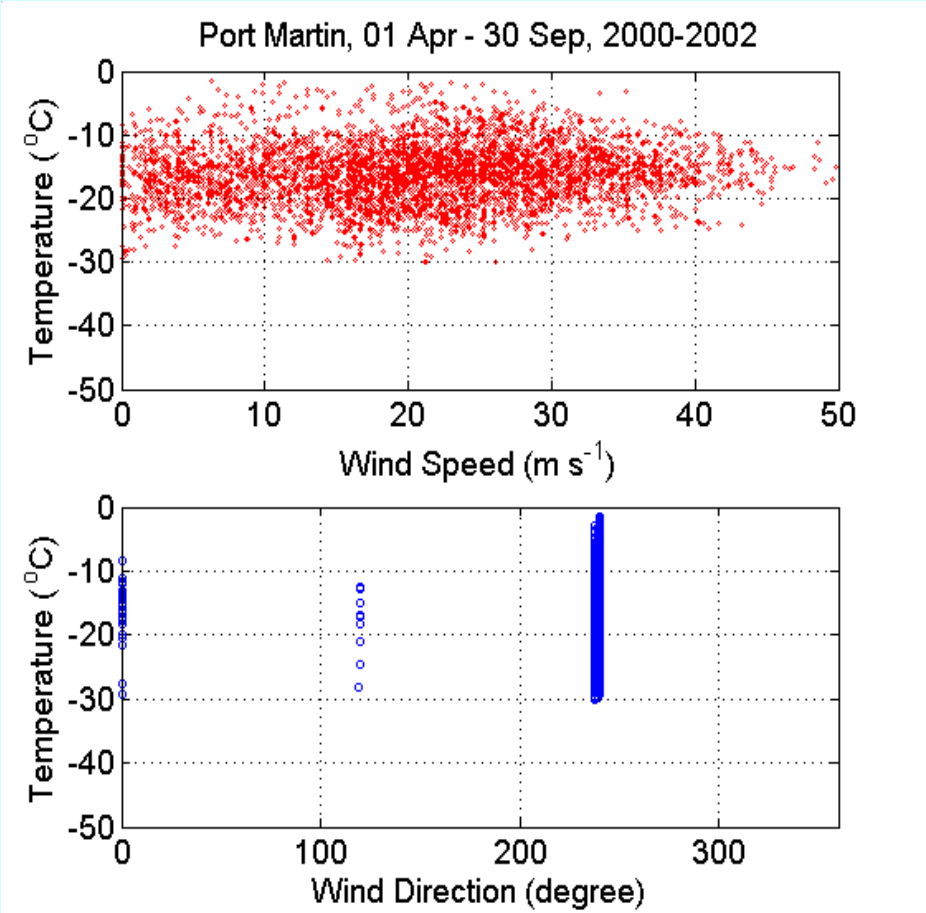
Correlation between Temperature and Wind

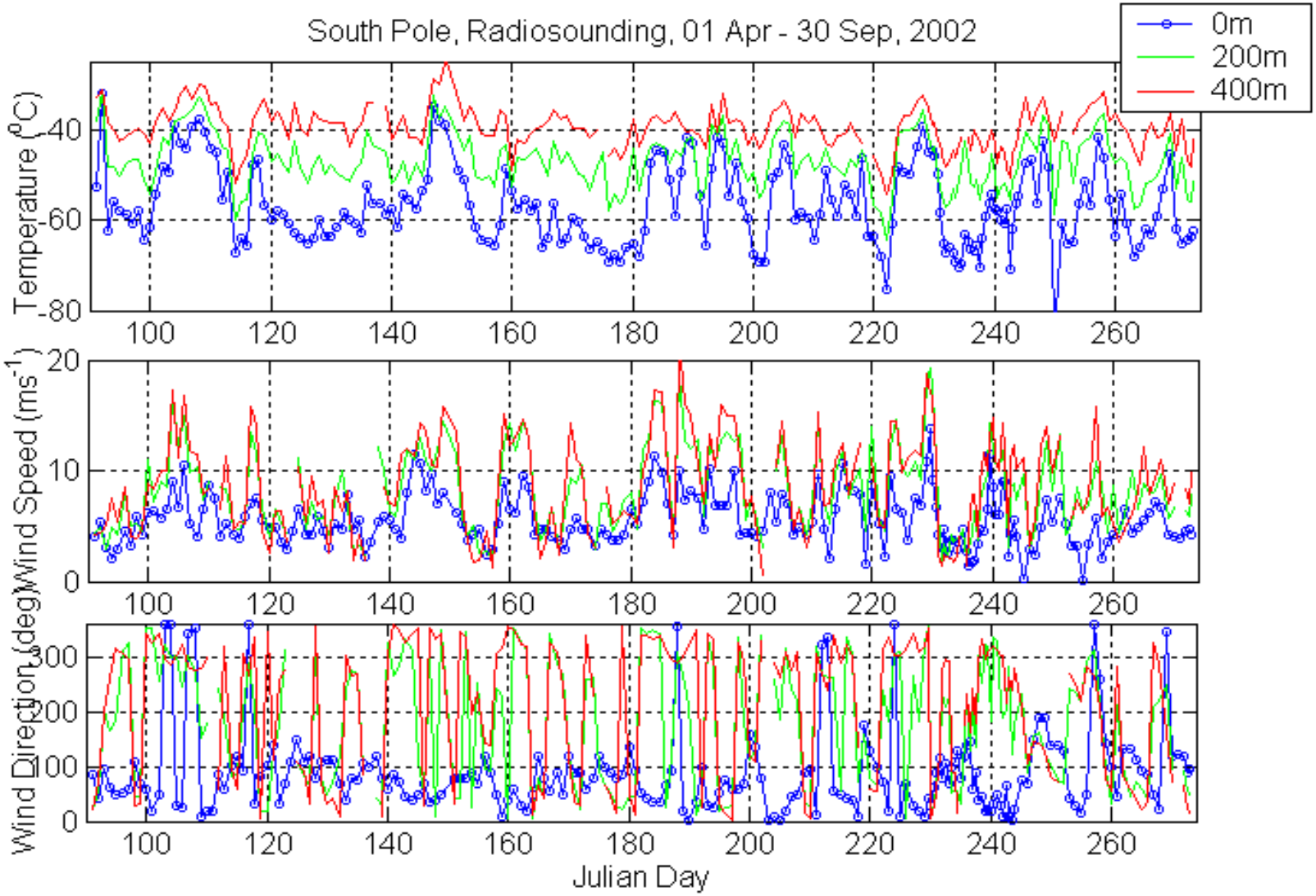


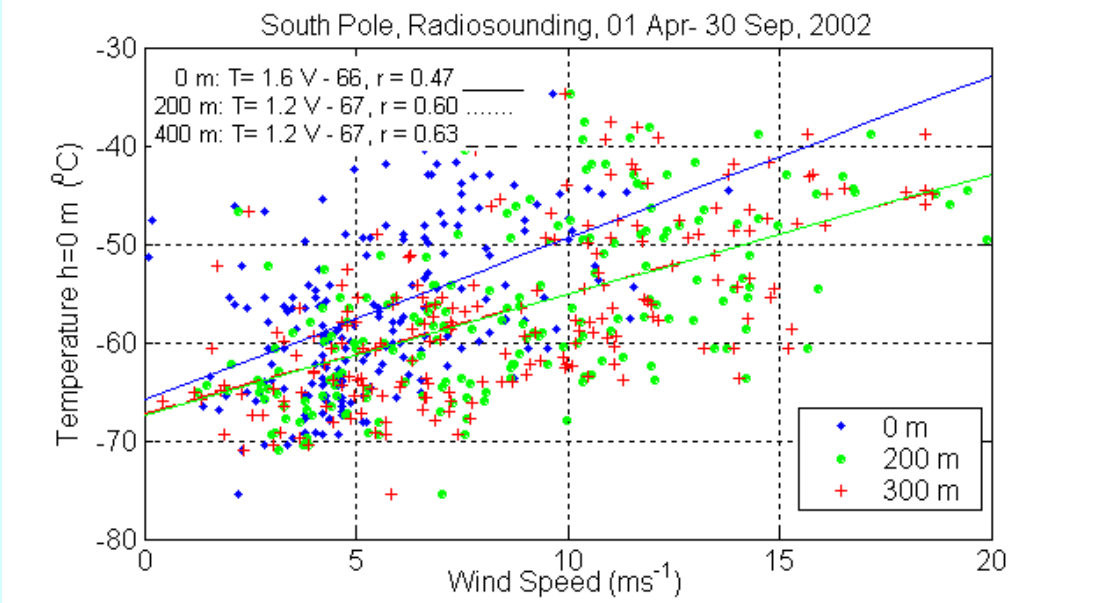


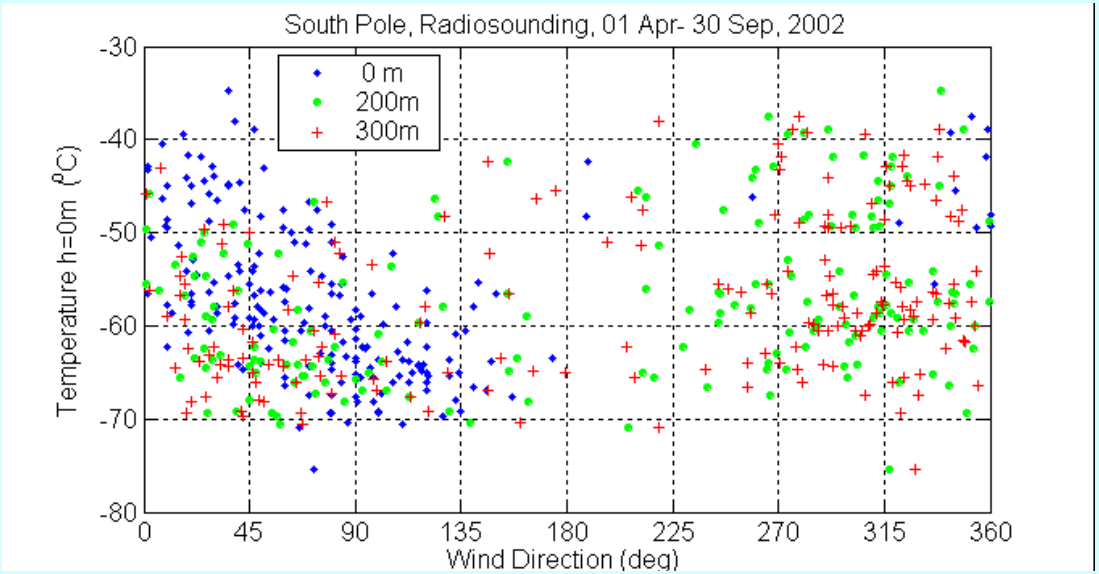
Correlation between Temperature and Wind





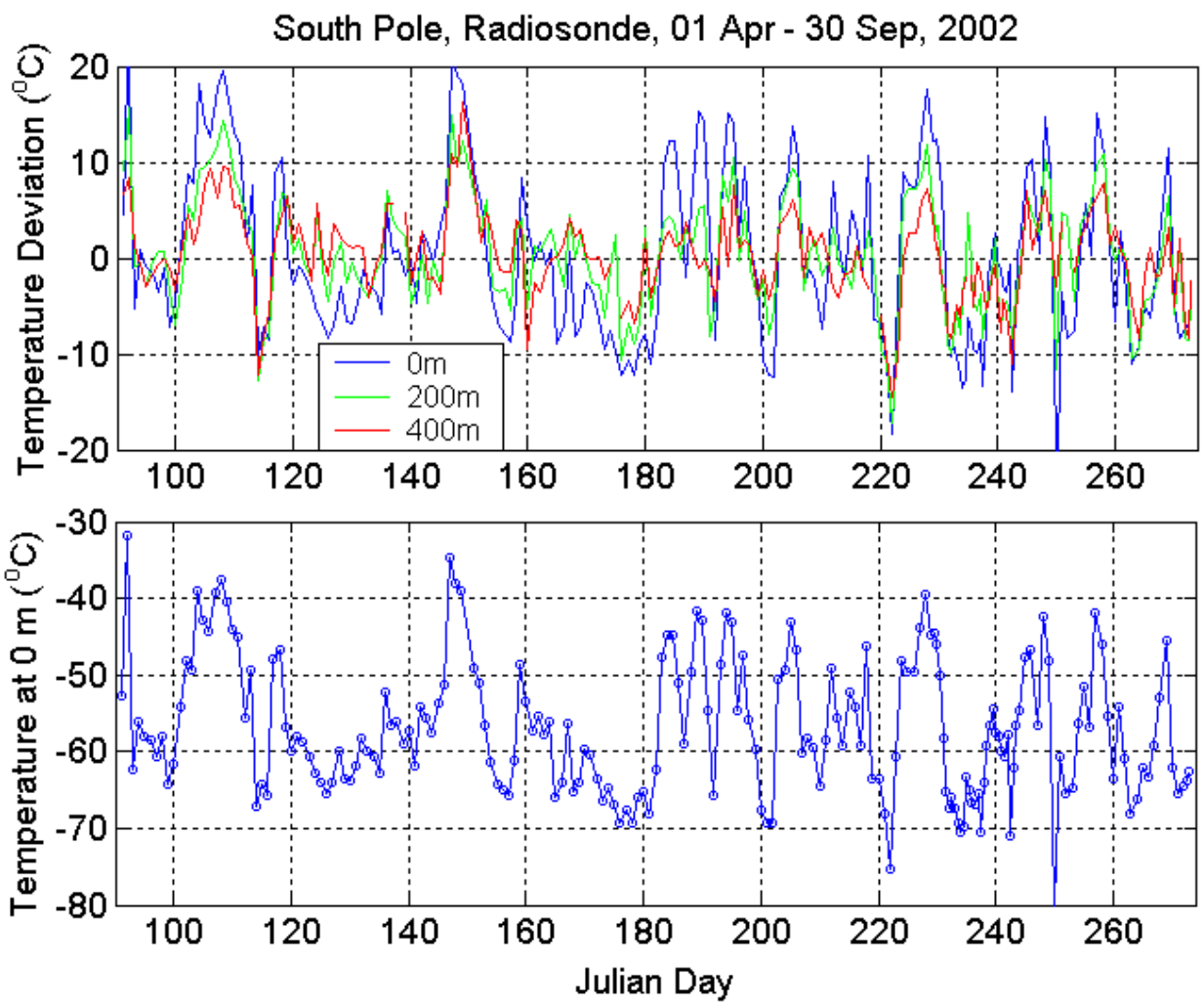

South Pole, Radiosounding, 01 Apr - 30 Sep, 2002
0m
200m
400m
Temperature (°C)
-40
-60
-80
Wind Speed (ms-1)
20
10
0
Wind Direction (deg)
300
200
100
0
100
120
140
160
180
200
220
240
260
Julian Day





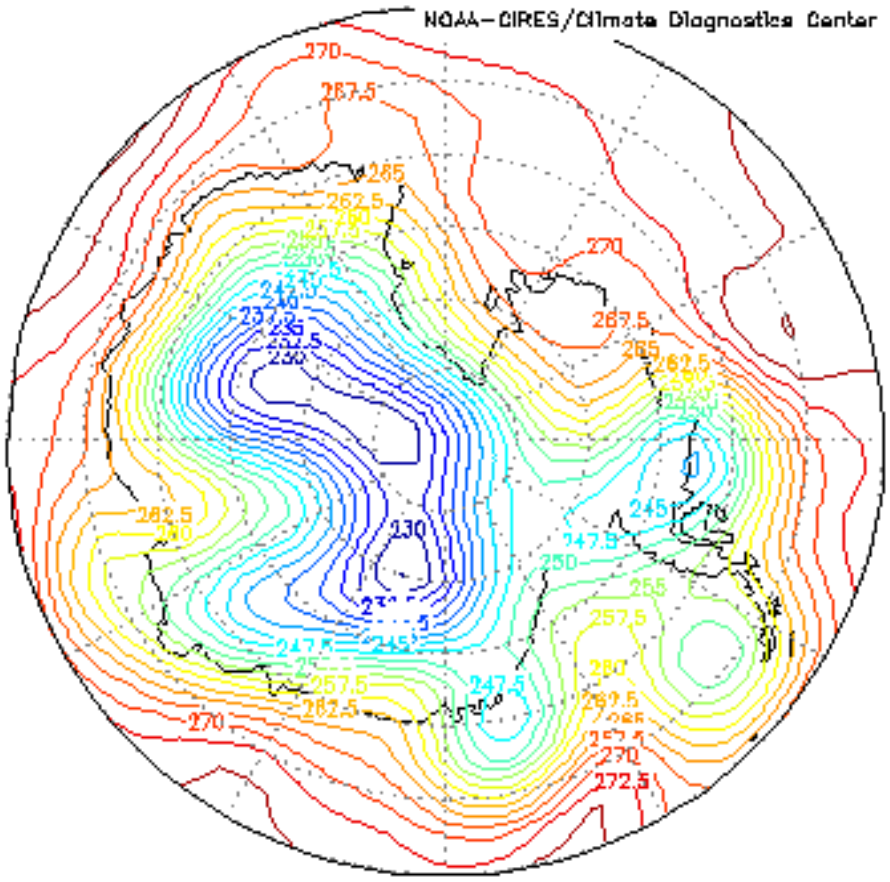
Scatter plot of temperature versus wind speed (top), and wind direction (bottom) at South Pole in 2002. The warmest temperatures are observed for wind blowing from NW-NE sector.

Temperature Deviation at Different Heights

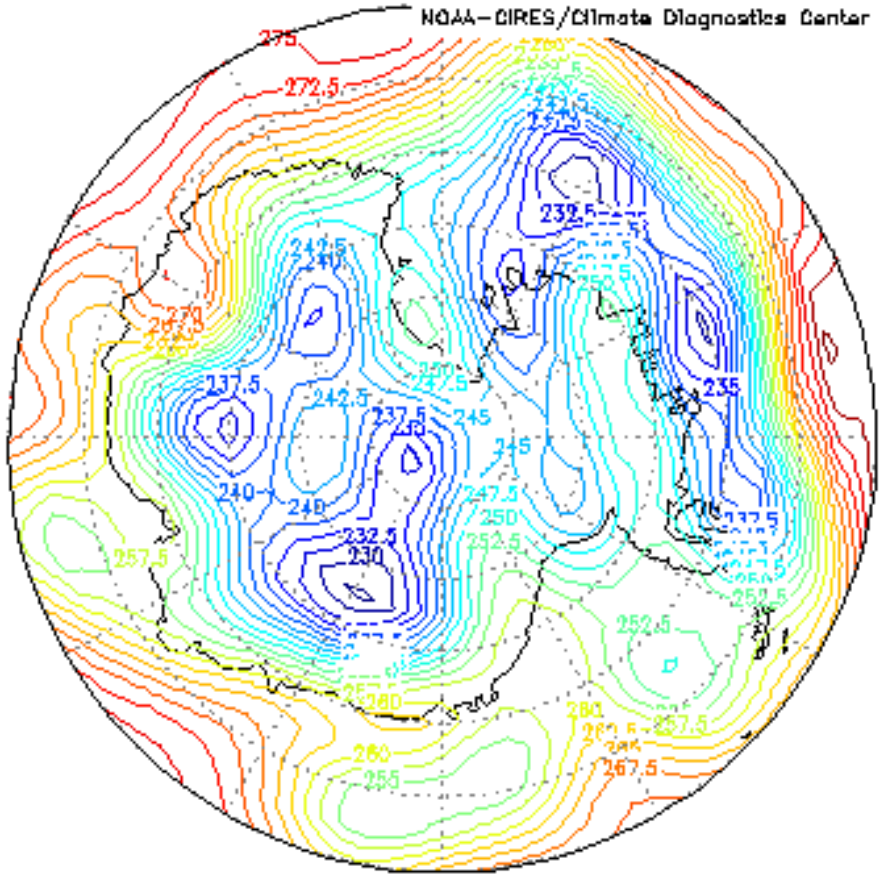


Conclusions

- Synoptic perturbations in Antarctica during winter are more intense than those in summer.
- The behaviour of the temperature in the many zones of Antarctica during the winter is characterized by regular warming events ranging from 20 to 40 ^{o}C. These events occur quasi-periodically with periods of 6-14 days being more intense at sites at higher altitudes.
- The warmings in the interior part correlate with increasing pressure. Meanwhile, the different behavior is observed in the western and eastern coastal zones.
- During the warming events the wind has the tendency to intensify and deflects from the dominant katabatic flow direction.
- Preliminarily, we can hypothesize that the warming events during winter are due to the passage of warm air masses accompanied by clouds coming from the ocean when the pressure anomalies over East Antarctica favor their intrusion to the inner parts of the continent.

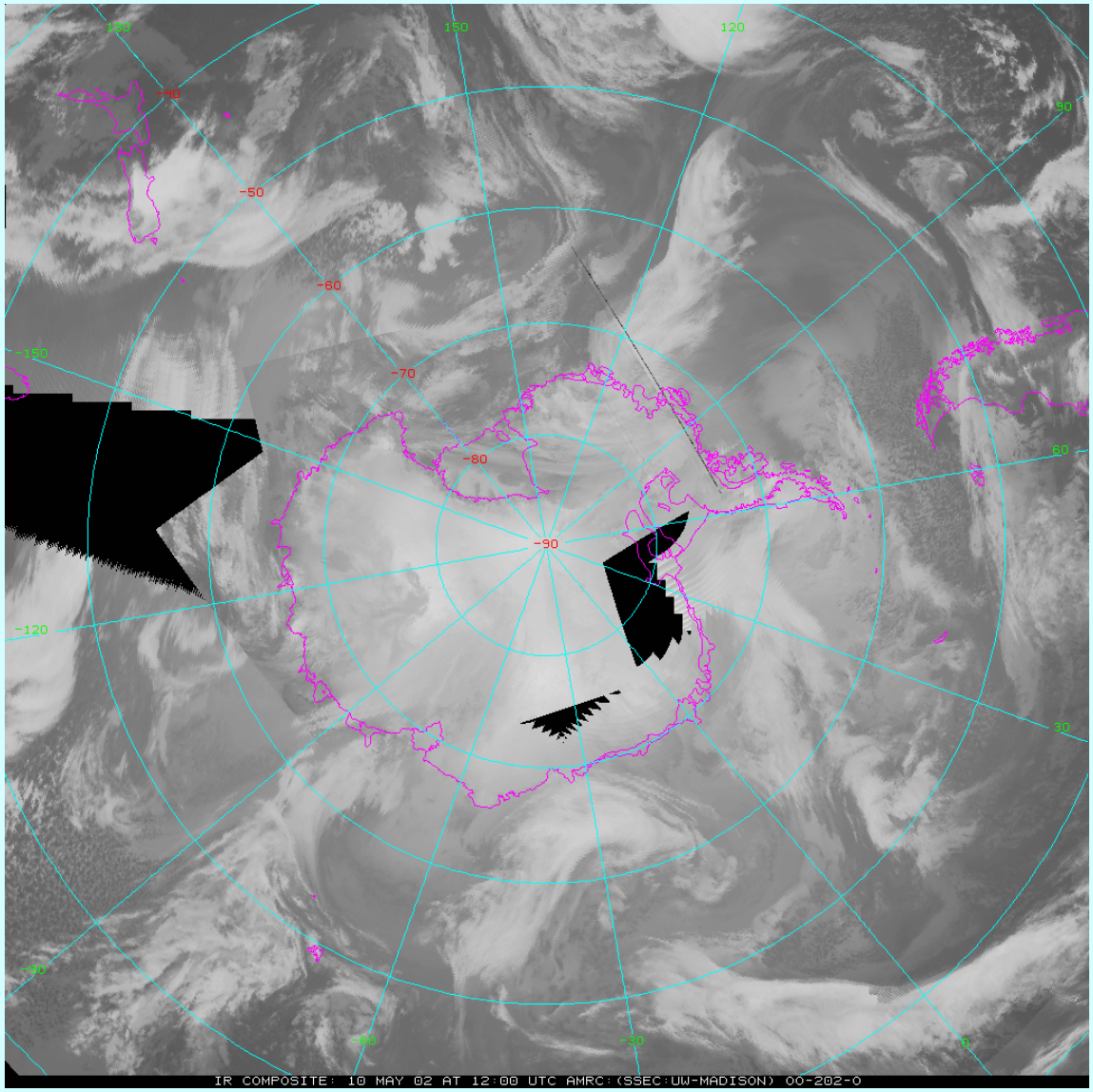

lon: plotted from 0.00 to 360
lat: plotted from -90 to -60
lev: 1000.00
t: May 10 2002
Mean air degK
NOAA-CIRES/Climate Diagnostics Center
MAX=278
GrADS image

lon: plotted from 0.00 to 360
lat: plotted from −90 to −60
lev: 1000.00
t: Jul 15 2002
Mean air degK

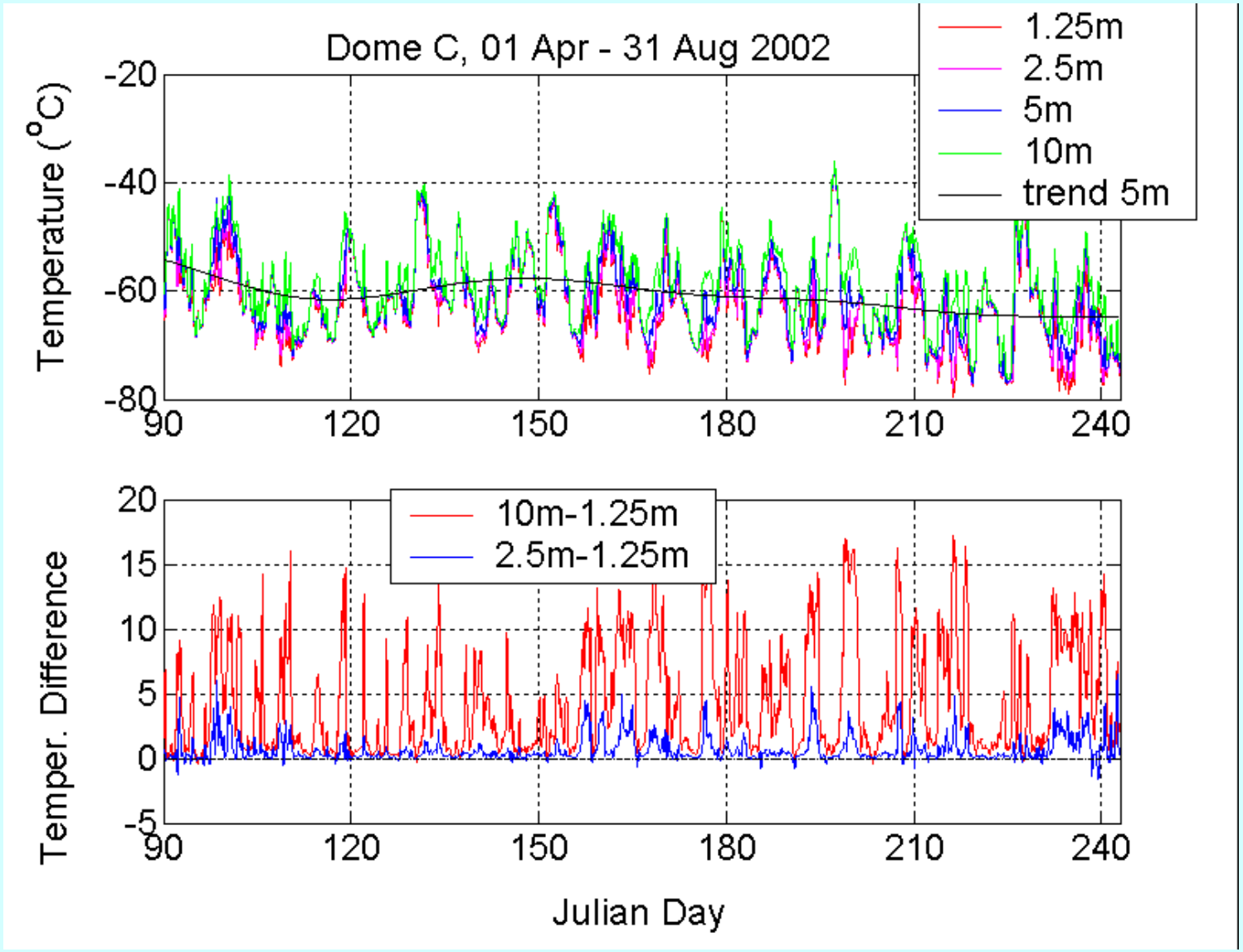


MAX=280.25
MIN=227.03

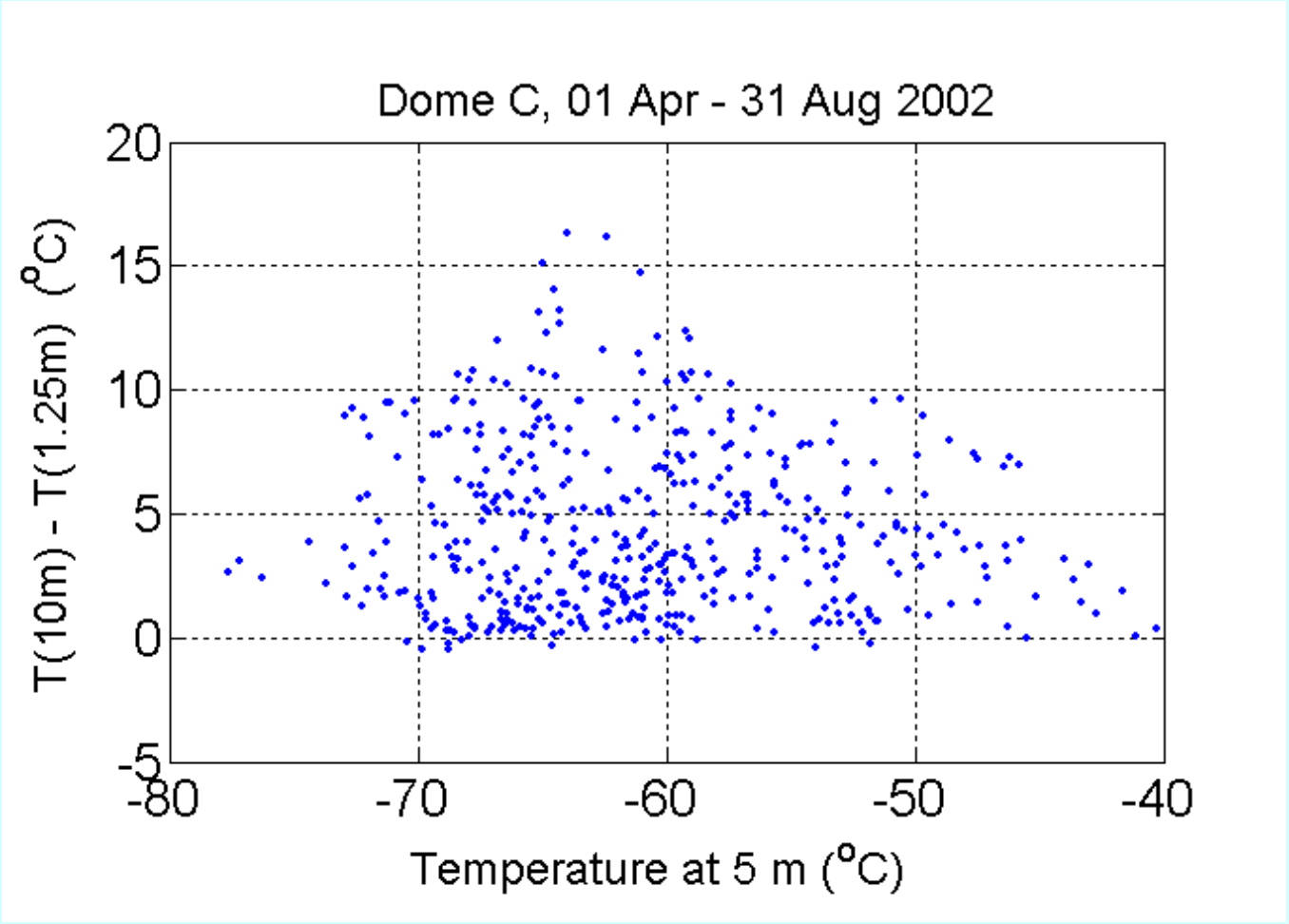
GrADS image


IR COMPOSITE: 10 MAY 02 AT 12:00 UTC AMRC:(SSEC:UW-MADISON) 00-202-0

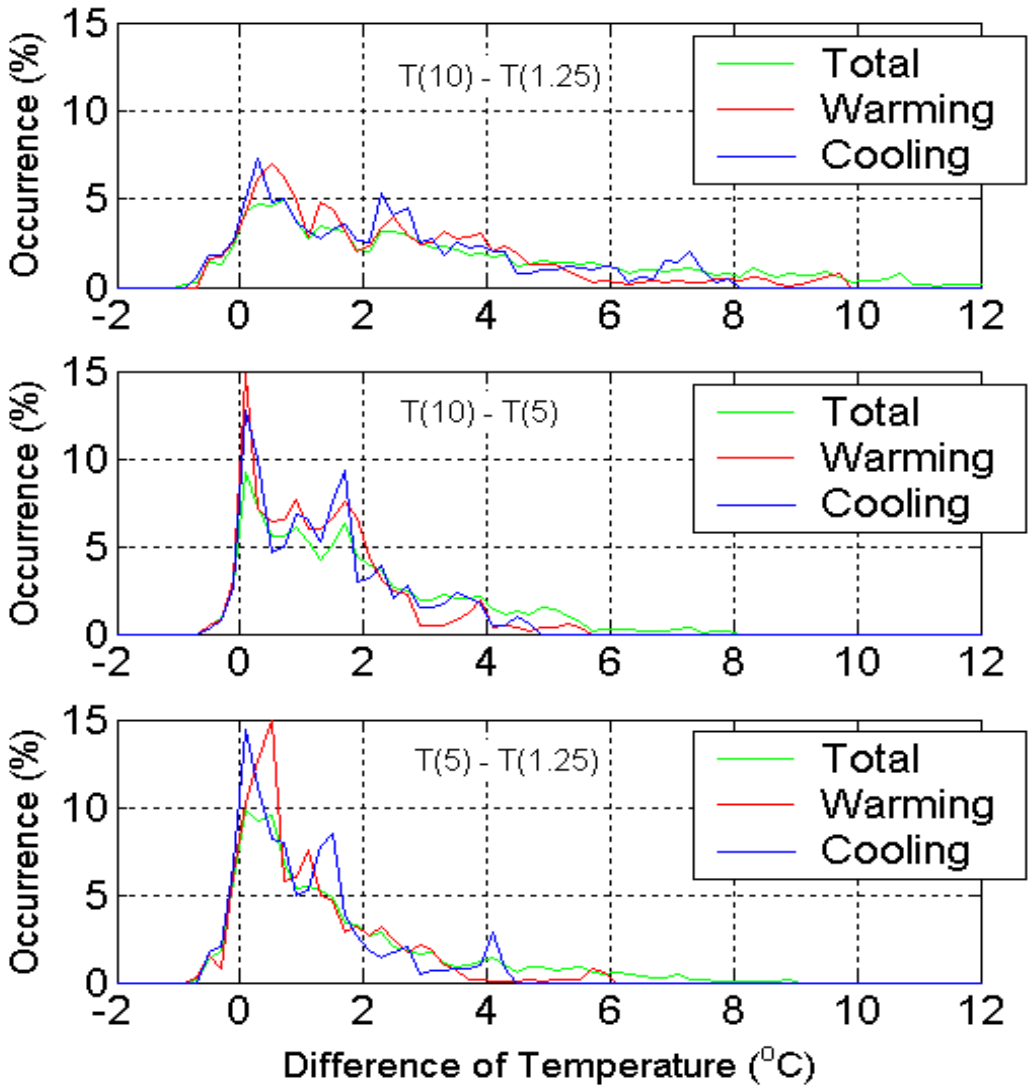
Correlation between Temperature and Wind



Time series of temperature measured at 4 heights from a meteorological mast and the differences between different levels (Dome C, winter 2002).



Scatter plot of the temperature difference between 10 and 1.25 m versus temperature at 5 m. The gradient of temperature decreases during warming events.



Histograms of the temperature differences between different levels. The occurrence of large gradients of temperature during warming events is lower than during the other periods.