An Antarctic Cloud Mass Transport Climatology

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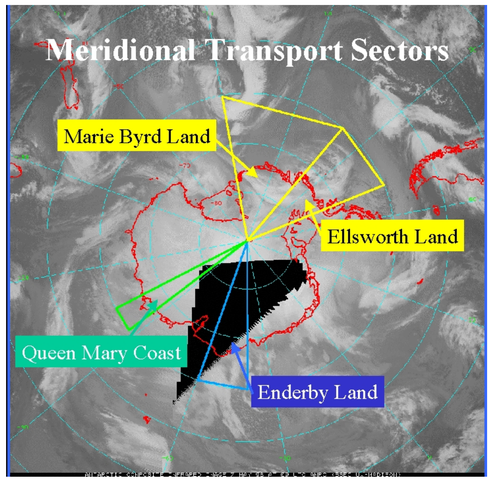
Introduction

- Antarctica presents researchers a challenge in understanding meteorology in the region.
- Research Question: Cloud Mass Transport (CMT) Events
  - What are they and where are they occurring in Antarctica?
  - Can a correlation be made between CMT events and a well known climate signal?

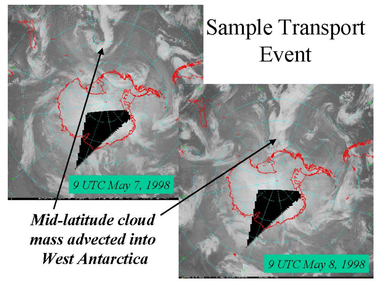
Cloud Mass Transport Search

Antarctic Composite Satellite Images have been created from October 31, 1992 to August 18, 2001 (Lazzara et al., 2003). In viewing these composite images, evidence of Cloud Mass Transport (CMT) has been found. Cloud Mass Transport is defined as an event in which a cloud mass travels from an oceanic region perpendicularly onto the continent, particularly in four main regions. A connection has been made between CMT and several other well-known events, such as El Niño – Southern Oscillation (ENSO).



An Antarctic infrared satellite composite of the four main meridional transport sectors studied; Marie Byrd Land and Ellsworth Land in West Antarctica, and Queen Mary Coast and Enderby Land in East Antarctica.

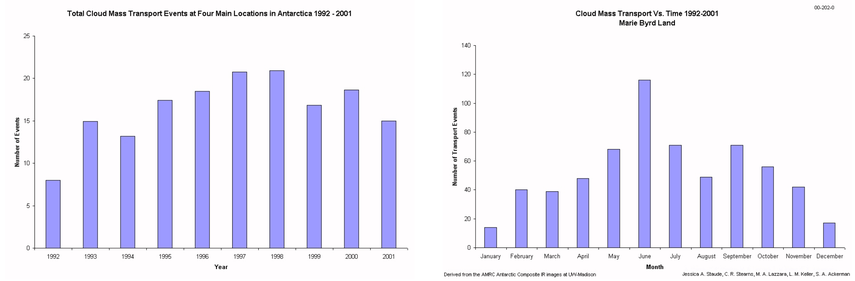
A Cloud Mass transport event was defined as cloud transport onto the continent of Antarctica in a pre-defined region for a period of at least two days. The Cloud Mass Transport was obtained by first viewing the Antarctic Composite video at several different animation speeds. The viewing of the tape brought primary attention to the four sectors studied in this research. Next, the tape was reviewed several more times, focusing on a different sector of Antarctica each time to identify any cloud transport present in the specific sector or area. Once a transport event was identified, the section of the tape was reviewed several times to obtain the correct length of time of the event. The data was tallied according to each month within the four different sectors. A record of the specific days per month was also recorded.



Above: Two infrared satellite composites showing a cloud mass transport event over a period of one day.

Bottom Left: Total Cloud Mass Transport Events per year.

Bottom Right: Cloud Mass Transport Events per year at Marie Byrd Land.



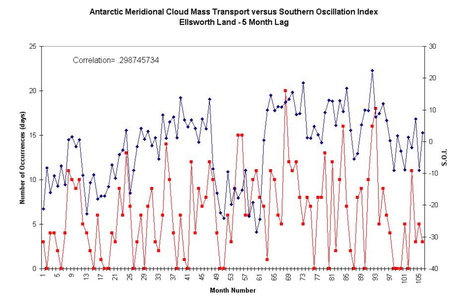
Once this data was recorded, the results were tabulated and a correlation coefficient was calculated. The equation used is as follows:

Correlation Coefficient Equation:

$$\frac{\sum((Xn - X0)(Yn - Y0))}{\sqrt{(\sum(Xn - X0)2\ \sum(Yn - Y0)2)}}$$

where Xn is a specific data value from data set #1, X0 is the average of data set #1, Yn is a specific data value from data set #2, and Y0 is the average of data set #2.

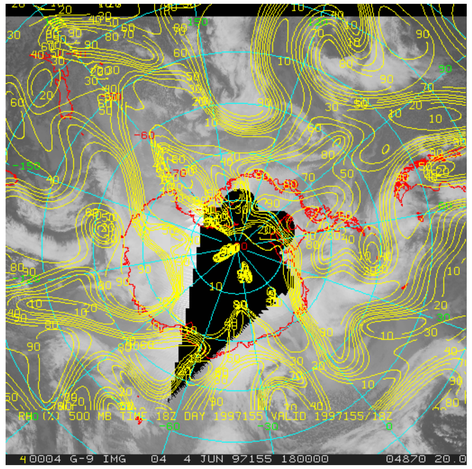
The main focus examined the 'Number of Occurrences' per month for all years versus the cumulative Southern Oscillation Index (SOI) to determine if any visible connection could be found between the two. Results of this research indicate a relationship between the Cloud Mass Transport (or CMT) and SOI. When CMT is high, SOI is also high, but only until a certain peak. After reaching this peak, the relationship will shift and transform into a negative correlation in which it varies between a low SOI and low amount of CMT.



An example graph of cloud mass transport (red) compared to the Southern Oscillation Index (blue).

Reanalysis Data

The next focus of this research involves the use of reanalysis data from the National Centers for Environmental Prediction (NCEP). The reanalysis data is a retroactive record of more than 50 years of global analyses of atmospheric fields (Kistler, 2001) . Overlaying different variables on top of a cloud mass transport event from June 4, 1997 to June 13, 1997 was the first step. Variables such as relative humidity, geopotential heights, and the V component of the wind at 700 mb and 500 mb have been considered. The primary focus is to determine if a validation of the NCEP reanalysis data can be made by using cloud mass transport events in connection with the actual forecast data.



Sample event of infrared satellite composite overlaid with NCEP relative humidity reanalysis data at 500 mb.

Conclusion and Future Work

Investigation of the relationship between the NCEP reanalysis data and a cloud mass transport event is an on-going process.

- Although a relationship has been found between cloud mass transport and ENSO, it is not strong enough to base a solid conclusion
- Further analysis of the NCEP reanalysis data is needed.
- Evidence of a correlation will lead to an improved understanding of Antarctic weather that can help improve weather forecasting.

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References

Kistler, R., et al., 2001: The NCEP-NCAR 50-year Reanalysis. Bull. Amer. Meteor. Soc., **82**, pp. 247-267.

Lazzara, M.A., C.R. Stearns, J.A. Staude, and S.L. Knuth, 2003: 10 Years of Antarctic Composite Imagery. 7th Conference on Polar Meteorology and Oceanography and Joint Symposium on High-Latitude Climate Variations. AMS, Boston, MA, 9.4.