# Seasonal Snow Extent and Snow Mass in South America Using SSM/I Passive Microwave Data (1988-2003)

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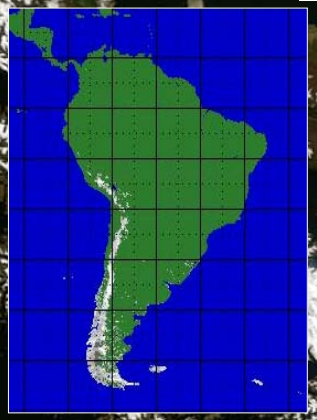
**ABSTRACT**

**Seasonal snow cover in non tropical areas of South America was examined in this study using passive microwave satellite data from the Special Sensor Microwave Imagers (SSM/I) on board Defense Meteorological Satellite Program (DMSP) satellites. For the period from 1988-2003, both snow cover extent and snow mass were investigated during the month of July, typically the coldest winter month. Most all of the seasonal snow in South America is in the Patagonia region of Argentina. The average snow cover and snow mass for the 16-year period was 284,492 km$^2$ and 0.763 x 10$^{13}$ kg, respectively. The year with the greatest average snow extent and snow mass during the 16-year period of record was 1992 -- 551,875 km$^2$ and 2.073 x 10$^{13}$ kg, respectively. If the strong El-Nino years of 1991-1992 and 1997-1998 are excluded, the July snow mass shows a linear trend of 28% over the 16 year period, with a p-value of 0.0098,which is significant at the 85% level.**

**INTRODUCTION**

Exclusive of Antarctica, seasonal snow in the Southern Hemisphere is, for the most part, confined to southern South America, which is the only continent in the Southern Hemisphere where an extensive, seasonal snow cover may occur. In this study, using data from the SSM/I sensors on board DMSP satellites, seasonal snow extent and snow water equivalent (SWE) have been calculated in South America for the period from 1988-2003.

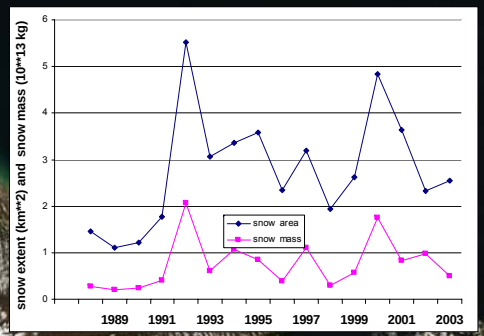


MODIS 8-day map for mid July 2000

Snow depth (in cm) measured from meteorological stations and derived from SSM/I observations for the period from July 11-15, 2000

| | Lago Argentino | | Esquel | |
|---|---|---|---|---|
| | station | satellite | station | satellite |
| 11 | 8 | 5 | 8 | 13 |
| 12 | 8 | 5 | 8 | 18 |
| 13 | 15 | 8 | 5 | 13 |
| 14 | 15 | 10 | 10 | 10 |
| 15 | 13 | 10 | 10 | 10 |

The plot at right shows the time series of the July snow cover extent and snow mass (SWE). A linear trend analysis was found of the form SWE = α t +β, where t is time in steps of years and α is the slope and β the intercept of the regression. The linear trend is considered significant if α is significantly different from zero. If all of the data are considered, α is found to be 0.00955 with a standard error of 0.006, which is not significantly different from zero. We next consider the effect of El Nino/Southern Oscillation (ENSO) on the snow data (1991-1992 and 1997-1998 events). If the data for the years 1992 and 1998 are excluded from our trend analysis, the slope becomes α = 0.0138 with standard error of 0.0045 and a p-value of 0.00987. This trend is significant at 95% level and translates into an increase of 28% of the mean snow mass over the 16 year period.




**CONCLUSIONS**

This study demonstrates that passive microwave radiometry is especially useful in estimating the snow cover extent and snow mass in the Patagonia region of South America where clouds are a major mapping problem and where the snow is often ephemeral in nature. The passive microwave observations show sharp year-to-year differences in the seasonal snow extent over the Patagonia region of South America.

South American snow data will soon be available at this URL – **http://neptune.gsfc.nasa.gov/southamericasnowcover**