# Diagnosing Antarctic Fog

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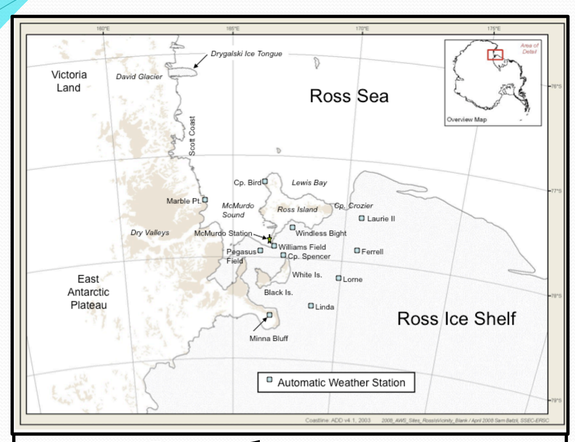
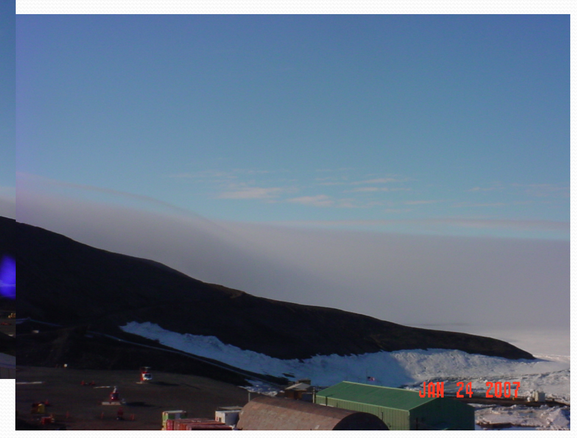
**Abstract:**
Fog affects aviation and other logistical operations in the Antarctic; however, limited studies have been conducted to understand fog behavior in this part of the world. A study has been conducted in the Ross Island region of Antarctica, the location of McMurdo Station and Scott Base – the main stations of the United States and New Zealand Antarctic programs, respectively. Using tools such as multi-channel satellite observations and supported by in situ radiosonde and ground-based automatic weather station observations, combined with back trajectory and mesoscale numerical models, this study discovered that austral summer fog events are advective. The diagnosis finds a primary source region from the southeast over the Ross Ice Shelf (over 72% of the cases studied) while a minority of cases point toward a secondary fog source region to the north along the Scott Coast of the Ross Sea with influences from the East Antarctic Plateau. Part of this examination confirms existing anecdotes from forecasters and weather observers, while refuting others about fog and its behavior in this environment. This effort marks the beginning of our understanding of Antarctic fog behavior.

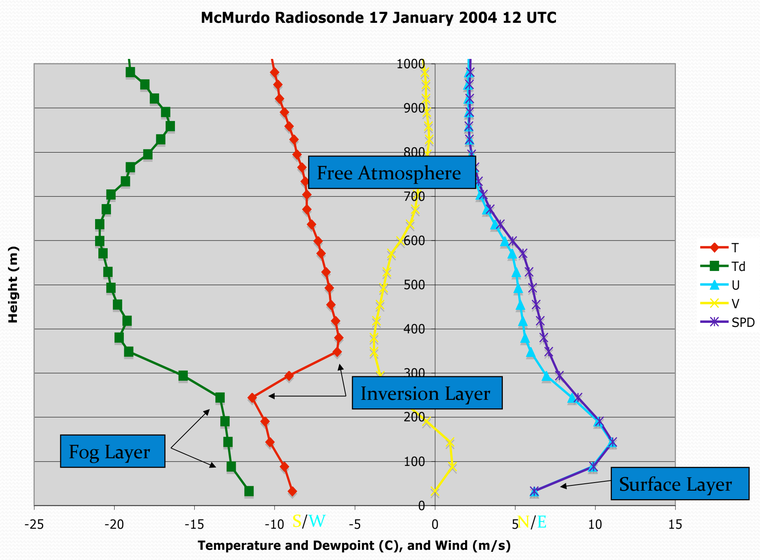



## Study Area


**Fog at Observation Hill, McMurdo Station, Antarctica**




## Boundary Layer Analysis




**Fog Behavior –** This study is the first to formally study fog in the Ross Island region of Antarctica. This poster presents only partial highlights from that effort. A surface climatological analysis of observations from McMurdo Station and the nearby air fields while the first to characterize fog events (roughly 4 events per month – on average, etc.) did not find a different behavior of fog from the climatological mean. Analysis of radiosonde observations, which did not often temporally coincide with peak fog, revealed classic "goal post" pattern of the dewpoint and temperature profile: saturated fog layer and inversion layer above. To gain a more complete understanding, areal analysis from satellite and numerical weather prediction models were utilized along with a back trajectory analysis to capture fog behavior in the Ross Island area.

### Input Satellite Observations

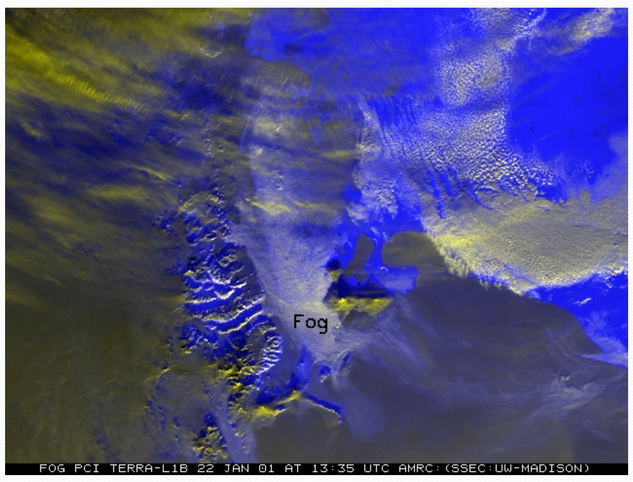



### Principal Component Analysis Imagery (PCI)




## Satellite Observations

### Red-Green-Blue PCI Fog Depiction

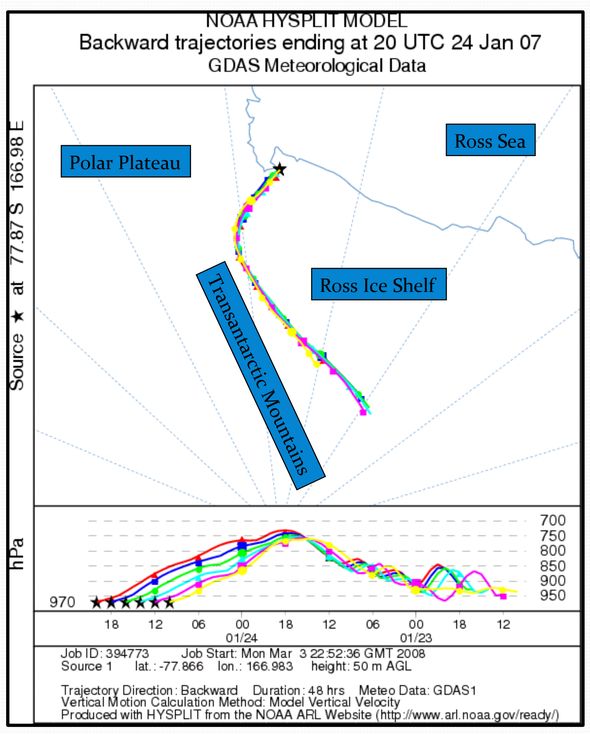



**Satellite Analysis** - To aid in this study, polar orbiting satellite observations from the MODIS (MODerate resolution Imaging Sectroradiometer) on the Terra and Aqua Satellites were analyzed with a Principal Component method. The top two components are combined via a red-green-blue combination (with weighting on the second component) to generate a display with fog highlighted in white, ocean in blue and ice in sepia tones. A validation was conducted using the University of Wisconsin Automatic Weather Station (AWS). Comparing the relative humidity values of 90% plotted atop the satellite reveals skill in this satellite depiction method.

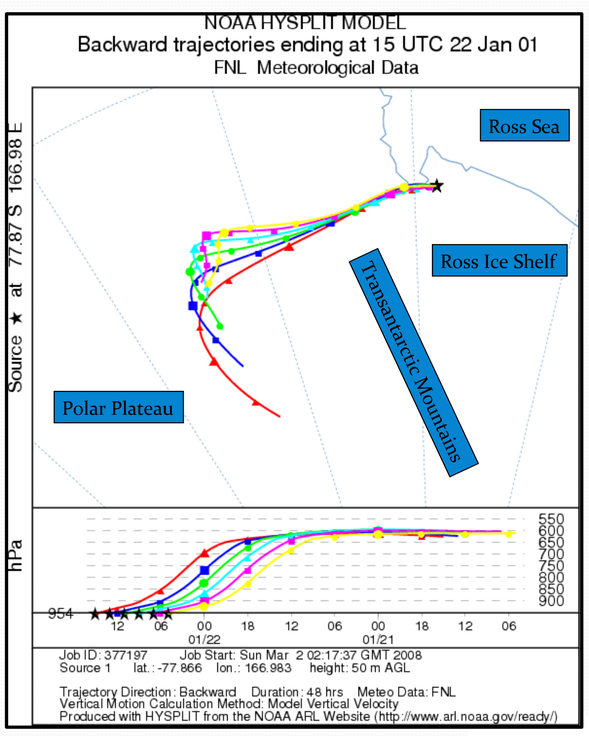
### Input Satellite Channel List

| MODIS Band | Wavelength | Description |
|---|---|---|
| 1 | 0.64 µm | Visible channel |
| 6 | 1.62µm | Near infrared |
| 7 | 2.11µm | Near infrared |
| 20 | 3.78µm | Shortwave infrared |
| 31 | 11.0µm | Infrared window |

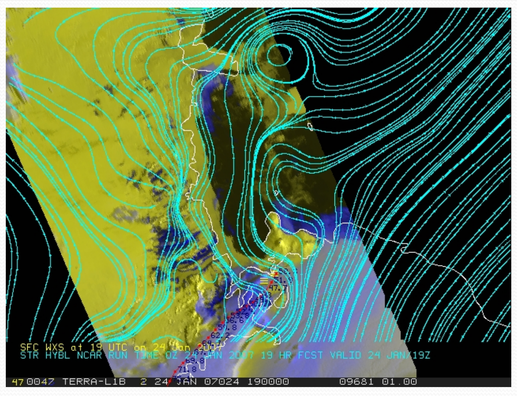
## Back Trajectories, Model Streamlines, Satellite Observations

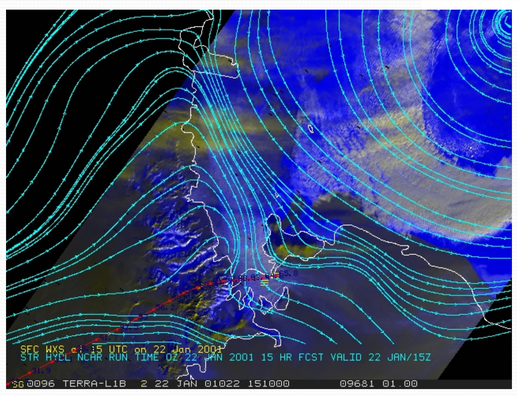


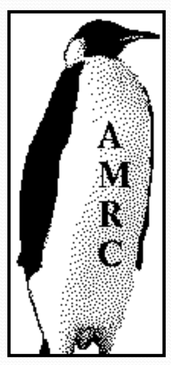

**Source: South -** The majority of fog events come from over the Ross Ice Shelf. Here, the back trajectories try to take the air over the Transantarctic Mountains –an unlike situation. The Antarctic Mesoscale Prediction System (AMPS) model correctly has the flow move along and around The mountains and small scale features. Satellite analysis confirms the source.




**Source: "West" -** The minority of fog events are from the North and really West of the station, with westward air originating on the Polar Plateau, and then turning south into McMurdo Sound. The back trajectories from the courser model smooth out what is better depicted by the Antarctic Mesoscale Prediction System (AMPS) model and the satellite observations.



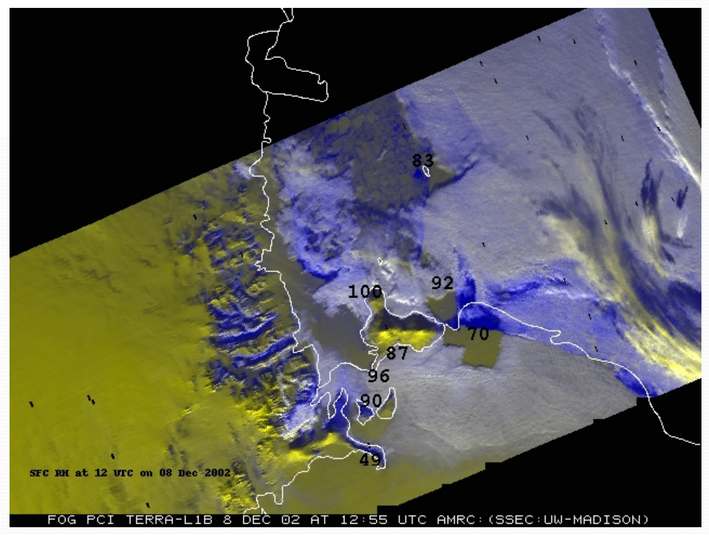




### Validation

| Fog/Low Cloud Hit | Fog/Low Cloud Miss | Clear/Dry Hit | Clear/Dry Miss | Uncertain |
|---|---|---|---|---|
| 567 | 311 | 528 | 234 | 127 |

| Source region | Percentage Occurrence |
|---|---|
| Southern Ross Ice Shelf | 45% |
| Southern Ross Ice Shelf & East Antarctic Plateau mix | 27% |
| East Antarctic Plateau | 23% |
| South with circle over McMurdo Sound | 5% |




**Conclusions:**
The examination of fog occurrence in the Ross Island region of the Antarctic has found most austral summer fog events to be "advective." Satellite observations along with corroborating model and back trajectory analyses reveal austral summer fog events often form outside the current Mac Weather AWS fog network. The analysis identifies two key source areas. The primary region is from the south and east of Ross Island over the Ross Ice Shelf. A secondary region, of very few events not shown here, is from the north and east along the northern Scott Coast of McMurdo Sound.

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