Diagnosing Antarctic Fog

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 75% 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 influence from the East Antarctic ice shelf. Part of this examination confirms existing anecdotes from forecasters and weather observers, while offering others about fog and its behavior in this environment. This effort marks the beginning of our understanding of Antarctic fog behavior.

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Fog at Observation Hill, McMurdo Station, Antarctica

Study Area

Boundary Layer Analysis

Fog Behavior – This study is the first to formally study fog in the Ross Island region of Antarctica. This paper presents only partial highlights from that effort. A surface climatological analysis of observations from McMurdo Station and the nearby airfields 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, aerial 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.

Back Trajectories, Model Streamlines, Satellite Observations

Source: South – The majority of fog events come from the Ross Ice Shelf. Here, the back trajectories try to take the air over the Transantarctic Mountains—a similar situation. The Antarctic Mesoscale Prediction System (AMPS) model correctly has the flow move almost red around The mountains and small scale features. Satellite analyses confirm the source.

Source: “West” – The majority 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 coarse model smooth out what is a better depiction by the Antarctic Mesoscale Prediction System (AMPS) model and a satellite image. 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 major source areas. The primary region is from the south and east of Ross Island over the Ross Ice Shelf. A secondary region, of very low events (shown here, is from the north and east along the northern Scott Coast of McMurdo Sound.

Input Satellite Observations

Principal Component Analysis Imagery (PCI)

Input Satellite Channel List

Satellite Observations

Red-Green-Blue PCI Fog Depiction

Validation

Conclusions: The examination of fog occurrences 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 major source areas. The primary region is from the south and east of Ross Island over the Ross Ice Shelf. A secondary region, of very low events (shown here, is from the north and east along the northern Scott Coast of McMurdo Sound.

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