

Challenges in Remote Forecasting for Deep-field Camps

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1. INTRODUCTION

Space and Naval Warfare Systems Center (SPAWAR) Atlantic, Office of Polar Programs (SOPP) stood up its Remote Operations Facility (ROF) in Charleston, South Carolina during the months prior to the 2005/2006 austral summer operating season. Part of its mission was to take over the forecasting and briefing services formerly provided by SOPP forecasters at the USAP Deep Freeze Weather Office in Christchurch, New Zealand, and also some of the forecasting services from the McMurdo Weather Office, i.e. issuing the Terminal Aerodrome Forecasts (TAFs) for the deep-field camps where Hercules LC-130 aircraft from the 139th Expeditionary Airlift Squadron were scheduled to fly, and those camps designated as operating hubs for the Twin Otter DHC-6 or Basler BT-67 aircraft of Kenn Borek Air Ltd. (KBA) and providing in-flight weather updates to the KBA aircraft.

Remote forecasting in data-sparse polar regions inherently has its challenges, especially in view of the demanding performance metrics that evaluate forecast accuracy and mission effectiveness that rival other organizations blessed with a network of rich observations and advanced METSAT imaging. One of the forecast performance benchmarks set by SOPP is to maintain at least an 80-percent monthly TAF accuracy rate (90-percent for McMurdo) with respect to ceiling/visibility categories of 1000 ft/3 miles, 500 ft /2 miles, and 300 ft/1 mile at the 4, 8, 12, and 16-hour forecast intervals; also, weather forecasts will not inaccurately compel aircraft commanders to delay, cancel, or abort a total of 40 missions for the operating season.

2. AVAILABLE REAL-TIME DATA

The ROF has access to camp observations and University of Wisconsin Antarctic Automatic Weather Stations (UWAAWS). The camp observations are accessed via a locally developed application that displays the observation in textual form. Additionally, the observations are ingested into Marta Yosemite™ Viewer that plots the observations, along with UWAAWS observations, on regional or continental map overlays.

Selected METSAT imagery is provided by the TeraScan® ground-stations at McMurdo and Palmer Stations. The HRPT receiver captures X-band data from Terra and Aqua EOS satellites, L-/S-band AVHRR data from NOAA TIROS-N satellites, and S-

band data from DMSP satellites. Unfortunately, the TeraScan system processors create single-channel products only.

Our NWP system of choice is AMPS, followed by the Joint Air Force/Army Weather Information Network (JAAWIN).

3. CHALLENGES

a. Providing aviation forecasts for deep-field camps or unmanned sites where no weather observations are available

Many sites to which the Twin Otter DHC-6 or Basler BT-67 aircraft fly are unmanned and extremely remote, as these aircraft set up a fuel cache in many locations and often refuel there during the course of the operating season. KBA aircraft are also the first to "put in" at sites where new camps are set up. Sites that are manned oftentimes consist of small field parties with personnel typically not trained to take weather observations.

Forecasts for these types of missions are based on single-station analyses (if there is an AWS in the region), METSAT imagery, and NWP forecasts. ROF forecasters maintain surveillance over the region for which the route-of-flight is overflying and provide in-flight weather updates as the situation dictates.

b. Forecasting visibility in blowing snow

Several studies have investigated the correlation between wind speed and blowing snow events, and also discuss the dynamics involved in these processes. Wind speed thresholds for overcoming the dependent variables of snowpack resistance, and for initiating snow transport and blowing snow have been offered in these studies. SOPP forecasts for restricted visibility in blowing snow, using these wind speed thresholds as guidance, do not verify well for those sites in Marie Byrd Land. A somewhat higher degree of success occurs for sites in East Antarctica.

c. Forecasting for low and very low ceilings

Low ceilings, e.g. < 1000 feet, and very low ceilings, e.g. < 300 feet are frequently reported with fog conditions and precipitation. South Pole and Siple Dome are permanent sites where ceilings can rapidly fluctuate between low and very low ceilings, sometimes several times an hour and for periods of up to 6 to 12 hours. The upper-air sounding from

South Pole is the only site in the continental interior that forecasters can analyze and from which to ascertain the vertical extent of the boundary layer and saturated layers. Guidance from METSAT imagery is used, but again, single-channel images limit interpretation and analysis. The AMPS cloud ceiling forecasts are also used as guidance, with better success in Marie Byrd Land than over East Antarctica.

d. Interpreting single-channel detection METSAT imagery for analyzing fog and low clouds

The current real-time METSAT files from the TeraScan® ground stations at McMurdo and Palmer Stations are processed exclusively with single-channel detection for creating all its products. Forecasters use the TeraScan® TeraVision interface to display these products, and use either manual contrast stretch enhancements or automatic RGB enhancements. Single-channel infrared detection of fog and low clouds is difficult because of the relatively similar radiative properties between it and the surface in its ambient environment, and also because of the relatively broad range of values that define the channel's spectrum. Single-channel visible channel detection of these features is easier than using infrared channels because the differences in albedo are greater than the radiative difference; however, low sun angle images resolve fog and low clouds as dark featureless layers.

Advanced METSAT imagery, as discussed by Lazzara (2006), will allow forecasters to exploit multi-channel and differential multi-channel color combination imagery to mask fog, low clouds, water clouds, and ice clouds in its environment; thereby improving detection and analysis, and subsequent forecasts

e. Forecasting high wind speed events for McMurdo

Forecasting for McMurdo Station and its airfields is not a task currently performed by the ROF; however, the SOPP strategic plan envisions the ROF providing all forecasting services from Charleston within the next few years. One of the forecast tools used for guidance in forecasting high wind speed events at McMurdo is a locally-developed application referred to as WindAlert, an Excel Visual Basic Application that uses empirical guidelines developed by Holmes et al. 2000 that uses UWAAWS data to forecast high wind speed events at Pegasus Ice Runway. The UWAAWS units used for the empirical guidelines are Minna Bluff, Pegasus North, Marilyn, Schwerdtfeger, and Elaine. A stipulation of these empirical guidelines is the changes in temperature, wind direction, and the Δ -pressure between two AWS units occur within the last 18 h.

The application is loaded on the forecaster's computer workstation and automatically downloads the AWS observations from the SSEC server in McMurdo. The forecaster must periodically clear the

data from the application because there is no script to do so. Another shortcoming of this application is that the application does not know the current time, so it cannot truncate its database to the most recent 18 hours in keeping with the "18-hour" stipulation. Having stated these shortcomings however, the application does provide good guidance when used in conjunction with AMPS.

Motivation for raising this subject is twofold:

- 1) With the network of UWAAWS expanding in the northwest Ross Ice Shelf, and the ice shelf drift of the "older" AWS units used in the study, is it feasible to reinvestigate this study if provided a grant by NSF?
- 2) Is it possible to create a better application than the WindAlert Excel VBA, and if so, might this be something for the BPRC Polar Meteorology Group to take on if provided a grant by NSF?

4. SUMMARY

Some of the challenges of remote forecasting can be mitigated by the ongoing commitment of the Antarctic meteorological community; i.e. the continual improvement of AMPS, and the outstanding research studies that are published in various journals. A commensurate level of commitment in upgrading the meteorological satellite ground stations in McMurdo and Palmer Stations to provide advanced imagery as discussed in this abstract and Lazzara (2006), and improving the SOPP WindAlert application as discussed here, will also improve forecast performance.

5. REFERENCES

- Holmes, R. E., C. R. Stearns, G. A. Weidner, and L. M. Keller, 2000: Utilization of automatic weather station data for forecasting high wind speeds at Pegasus Runway, Antarctica. *Wea. Forecasting*, **15**, 137–151.
- Lazzara, M.A., 2006: Satellite Application Report: Fog Detection/Monitoring. UW SSEC Publication No.06.07.L1. Space Science and Engineering Center, University of Wisconsin-Madison, 44 pp. [Available from The Schwerdtfeger Library, University of Wisconsin-Madison, 1225 W. Dayton St., Madison, WI 53706.]