The Front

April 2004 National Weather Service Volume 3, Number 2

Forecast Process: Genesis of Gap Wind Weather Advisory

Colin D. Sells, Meteorologist, Center Weather Service Unit, Anchorage, AK
Colin.Sells@noaa.gov

On March 30, 1982, 1,780 U.S. Army paratroopers from the 82nd Airborne Division jumped into drop zones at Ft. Irwin.

One of the drop zones was two miles long. Before the training jump, wind measurements were taken at either end of the drop zone. The wind speeds read 7 mph at one end, and 11.5 mph at the other. the maximum safe wind speed for peacetime training drops was thought to be 14.9 mph.

In what looked like a safe situation, 6 jumpers were killed and 158 injured, dragged by winds gusting up to an estimated 40 mph.

An investigation concluded the two locations where the winds had been measured were sheltered by high terrain. In between these points was a gap in the mountains. Winds gusted causing what the Army called a "Mass Casualty Incident." Someone had blundered.

Continued on Page 2

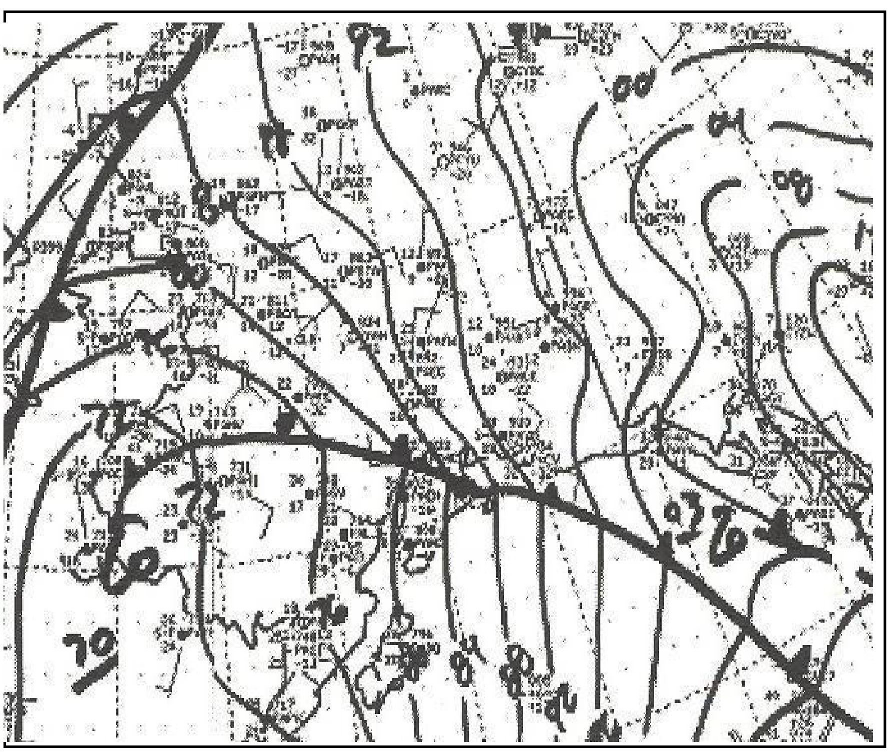

Figure 1. *Surface map, January 20, 2000*

In this Issue:

When's the Next *Front?*

Would you like an email when a new edition of **The Front** *is published? Write melody.magnus@noaa.gov*

The Front

Managing Editor: Michael Graf
Contributing Editor: Craig Sanders
Editor/Layout: Melody Magnus
Melody.Magnus@noaa.gov

Mission Statement

To enhance aviation safety by increasing the pilot's knowledge of weather systems and processes and National Weather Service products and services.

For the paratroop jump master, the variable outcomes resulting from this mix of weather and terrain were of lethal importance. This type of situation should constrain training activities like the paratroop jump.

Aviation meteorologists encounter similar forecasting constraints for air traffic over elevated terrain and for pilots flying in the proximity of the terrain. This is a context in which theory meets reality.

Forecast Reality

Just as a pilot recognizes certain patterns when flying and acts on the basis of past knowledge, so to does a forecaster.

"The guidance stream may present an outcome that is not accounted for in the forecaster's mental model," said Curtis in 1998. It is still incumbent on the forecaster to recognize the applicable variables for the specific situation, weigh their values accordingly and produce an accurate and timely product.

Alaska has more aircraft, per capita, than any other state in the United States. These aircraft fly through an environment of constantly changing weather patterns, through 5,180,000 square kilometers.

Many of these aircraft operate out of Anchorage and fly in close proximity to the rugged local mountain ranges. Anchorage's major airport, Ted Stevens International, has more than 240 daily arrivals, encompassing a variety of domestic and international passenger and cargo carriers.

Adjacent Lake Hood is the world's busiest seaplane base, with as many as 800 takeoffs and landings on a typical summer day.

The local general aviation airport, Merrill Field, is one of the busiest in the nation, recording more than 230,000 takeoffs and landings annually. The varied meteorological conditions, the local terrain and the varied

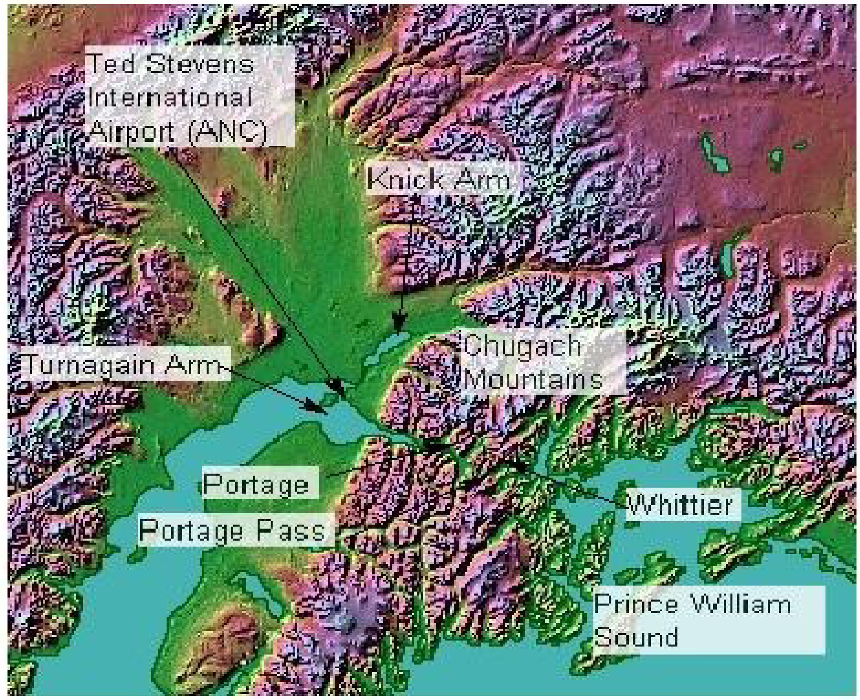

Figure 2. Relief map of southwest continental Alaska

air activity, provide ample opportunity for terrain induced weather to adversely affect aviation operations throughout the state of Alaska, especially in and around Anchorage.

One rapidly developing phenomenon involving the confluence of weather and terrain is the gap wind, one example of which killed the paratroopers in 1982.

Gap winds can impact much larger airborne objects than paratroopers, making these wind events of paramount importance to all aviation near hilly or mountainous terrain. Here is a more detailed look at a special gap wind pattern that affected Anchorage air traffic.

Pattern Recognition

The meteorological situation on January 26, 2000, as indicated in **Figure 1**, (Page 1) involved an occluded front moving north over the Kenai Peninsula.

As the front progressed up the peninsula, the orientation of the frontal boundary was northwest to southeast. Such an orientation is relatively uncommon and was an important element in the forecast, particularly given the local terrain.

Figure 2 shows a portion of the local terrain, including Prince William Sound, northern Kenai Peninsula, Portage Pass and Turnagain Arm, which extends from Portage to Anchorage.

The municipality of Anchorage occupies a triangle of land bordered by the Chugach Mountains to the east, Knik Arm to the northwest and Turnagain Arm to the southwest. Ted Stevens airport is located on the western apex of the triangle.

Portage Pass, connecting the communities of Whittier and Portage at its eastern and western ends respectively, is a 16 kilometer gap in the Chugach Mountains. The elevation of this neck of land is only 155 meters. The adjacent portion of the Chugach, a range more than 50 kilometers in width, has an average elevation of 1300+ meters.

At the northern edge of Prince William Sound the wall of mountains is even higher, averaging about 2000 meters elevation.

Time	Site	Wind	Peak Wind
15z	PANC	N/A	
	PATO	N/A	
	PAWR	07020G30KT	N/A
16z	PANC	00005KT	
	PATO	1133G48KT	71
	PAWR	07020G30KT	N/A
17Z	PANC	100009G17KT	34
	PATO	1230G49KT	57
	PAWR	07020KT	N/A
18Z	PANC	28010KT	
	PATO	N/A	
	PAWR	06020KT	N/A
19Z	PANC	31005KT	
	PATO	06027G44KT	53
	PAWR	06015G25KT	N/A
20Z	PANC	14009KT	
	PATO	11013G18KT	38
	PAWR	06015G25KT	N/A
21Z	PANC	21003KT	26
	PATO	05017KT	31
	PAWR	06020G25KT	N/A

Table 1. *Wind observations from PANC (Anchorage, AK), PATO (Portage, AK), and PAWR (Whittier, AK)*

Table 1 shows the observations for the morning of January 26. Note that at 15Z winds at Whittier (PAWR) were out of the east at 20 knots with gusts up to 30 knots, actually not all that unusual for that particular location; however, an hour later, Portage, at the other end of the pass, was reporting a peak wind of 71 knots.

Meanwhile, 65 kilometers away at the other end of Turnagain Arm, the winds at Ted Stevens were variable at 5 knots. Computer generated model guidance products were unable to resolve such a local incongruity.

The duty forecaster at the Anchorage Center Weather Service Unit (CWSU) believed that the front would continue to progress to the north. The forecaster was certain the front's angle of orientation, parallel to Portage Pass and relatively perpendicular to the mountains at the north end of Prince William Sound, would be a primary contributor to the winds coursing through the pass.

The density differential between the frontal mass and that of the air mass it was displacing had trapped a large pool of air in Prince William Sound. Unable to escape through the northern end of the sound because of the higher mountains there, the trapped mass of air was squeezing through the only exit available, the much lower Portage Pass. The air mass was picking up velocity, as it did so, in a classic example of the Bernoulli's Theorem at work.

The comparatively lower pressure at the Portage end of Portage pass, combined with the frontal pressure on the pool of air trapped in Prince William Sound, resulted in an increased velocity of flow from Whittier through the pass to Portage. In effect, the approach of the front was generating a gap wind event. The forecaster then determined that the phenomena would intensify as the front moved north, and end only after the front itself had pushed past Portage Pass.

Despite the modest 16Z winds at Anchorage, the forecaster issued a Center Weather Advisory (CWA) for low level wind shear at 1615Z (Table 2). As he was composing it, the first urgent pilot reports (PIREP), **Table 3**, started coming in. Shortly afterwards wind speeds jumped sharply at Anchorage, wind sheer increased and a B747 reported Mdt-Svr turbulence.

Figure 3, Page 4, is a 0.5 velocity scan taken at 1749Z from the Kenai WSR-88D, clearly showing a distinct finger of higher velocity winds traversing Portage. On the basis of this and other observational data available, staff renewed the CWA at 1815Z.

CWAs are warnings issued by the NWS CWSU Meteorologist, in accordance with NWS Directive 10-803 Support to Air Traffic Control Facilities. They are designed as a short range forecast "primarily for use by air crews to anticipate and avoid adverse weather conditions in the en route and terminal environment."

```
ZAN1 CWA
ZAN1 CWA 261815
ZAN CWA 102 VALID UNTIL 262015
VCNTY ANC
STRONG LLWS OF +/-15 TO 30 KTS WITHIN
25 NM RAD
OF PANC...AND WITHIN 020 AGL OBS AND
FCST THE NEXT TWO HOURS.

CDS JAN 00+

ZAN1 CWA
ZAN1 CWA 261615
ZAN CWA 102 VALID UNTIL 261815
VCNTY ANC
STRONG LLWS OF +/-15 TO 30 KTS WITHIN
25 NM RAD
OF PANC...AND WITHIN 020 AGL OBS AND
FCST THE NEXT TWO HOURS.

CDS JAN 00+
```

Table 2. *Center Weather Advisories (CWAs)*

```
ANC UUA/OV ANC/TM 1533/FL005/TP B737/RM -15 KTS IAS DURD
ANC UUA/OV ANC/TM 1554/FL006/TP MD80/R +/-15 KTS IAS DEP 24L
ANC UUA/OV ANC/TM 1555/FLDURC/TP B747/RM +/-15 KTS IAS AT 005 DEP 24L
ANC UUA/OV ANC/TM 1600/FLDURD/TP MD11/RM +/-10KT LLWS 005-SFC FINAL APCH
RY14
ANC UUA/OV ANC/TM 1629/FLDURC/TP B747/TBCONT MOD/RM +15 KIAS AT MIDFIELD
DEP RY6R
ANC UUA/OV ANC/TM RY 6R/TM 1643/FLDURC/TP MD11/TB MOD-SEV 012-016
ANC UUA/OV ANC/TM RY 6R/TM 1636/FLDURC/TP DC10/TB LGT/RM +/- 20KT LLWS
ANC UUA/OV ANC/TM 1710/FLDURC/TPB747/TB MDT-SVR SFC-060/RM LLWS +40/25KT
```

Table 3. *Urgent PIREPS.*

Although these advisories can be issued for the same phenomena described by advisories from WFOs, they also regularly address meteorological conditions that do not meet national In-Flight Advisory criteria; conditions that, in the opinion of the CWSU Meteorologist, adversely impact aviation safety.

Summary

Over the course of a career, an aviator may not see many frontal induced gap winds as compared with land and sea breezes, diurnal mountain and valley winds, thunderstorm outflow winds, glacier induced katabatic winds, down slope wind events or mountain wave turbulence; however, this is exactly the kind of event pilots and meteorologists need to watch out for.

The Alaskan gap wind event cited here was not common wind event and therein lies the danger. A subtle change in the orientation of the front, by just a few degrees so that it was not parallel to the pass, would have altered the local wind flow with entirely different consequences.

The CWA, in addition to other aviation warnings and advisories, can help the pilot make informed decisions; however, the most important concept addressed here is not to take weather conditions for granted. Just as a good meteorologist must learn to account for patterns not in his "database," so too must a pilot.

References

Curtis, Joel C., 1998: The Forecast Process: One Forecaster's Perspective. Reprint from First Conference on Artificial Intelligence January 1998, Phoenix Arizona by the American Meteorological Society, Boston, MA.

Sells, Colin D. 1992: Some Statistics with Respect to Alaskan Aviation in which Weather is a Cause/Factor. Alaska Region Technical Attachment T-92-27.

National Weather Service Weather Service Procedural Directive 10-803, Support to the Air traffic Control Facilities and NWS Procedural Statement WR15-2003 Support tp Air Trafic Facilities.

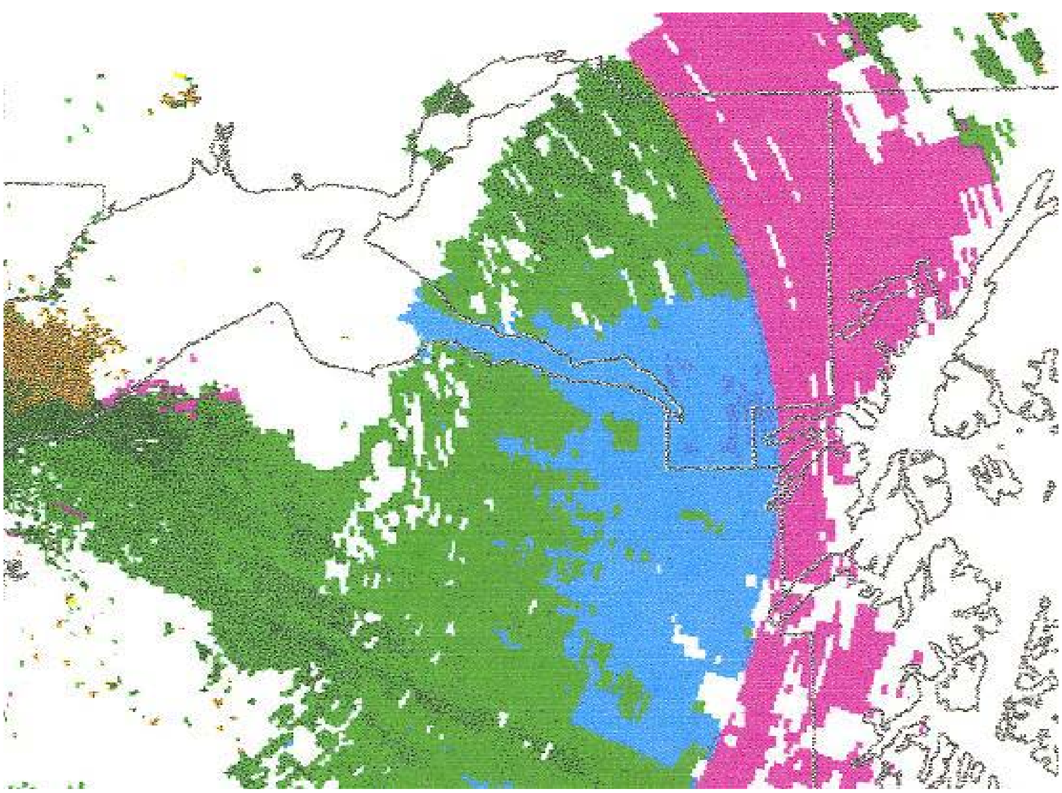

Figure 3. Velocity scan of the Kenai Peninsula

The Alaska Aviation Weather Unit:

Providing Aviation Weather Products and Services to the Alaskan Aviation Community

Jeff Osiensky, Meteorologist In Charge, Alaska Aviation Weather Unit, Anchorage
Jeffrey.Osiensky@noaa.gov

Weather is very complex in Alaska. Weather conditions can vary dramatically within only a few miles. Take a high latitude location, combine it with extreme terrain over short distances, and add proximity to a large ocean body. It all adds up to produce some of the most extreme weather conditions observed on earth.

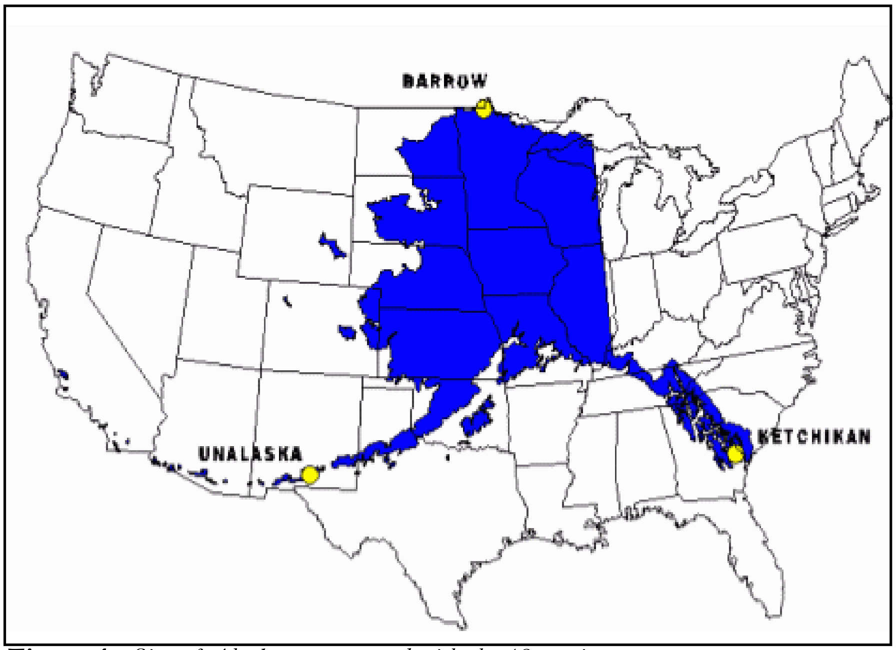

Figure 1. *Size of Alaska as compared with the 48 contiguous states.*

The size of Alaska is remarkable, covering nearly 20 percent of the land area in the lower 48 contiguous states, see **Figure 1**. Add the fact that Alaska averages 16 times more aircraft per capita than any other state in the nation.

Most of Alaska is reachable only by aircraft. The lifeline to these "bush" communities comes from pilots, who provide the essentials: food, clothing, building materials and mail. Aviation is essential to the Alaskan way of life.

The vast areas of Alaska, with its diverse weather conditions and high dependence on aviation required specialized aviation weather services. Who would be better qualified and experienced to provide these services than the meteorologists who live in Alaska?

Before the mid 1990s, the Weather Service Forecast Offices (WSFOs) in Anchorage, Juneau and Fairbanks provided services by issuing Area Forecasts (FAs), SIGMETs (WSs), AIRMETs (WAs) and Terminal Forecasts (FTs). These NWS text products were available to pilots mainly through the FAA Flight Service Stations.

Major changes began to appear in the 1990s as use of the Internet exploded. Maturing PC and communication technology allowed people to access weather information in their homes.

The aviation community asked for more direct, real time access to weather over the Web, and NWS answered with new and expansive Web pages.

Traditional aviation text products provided good information, but the focus shifted toward the need for aviation weather graphics.

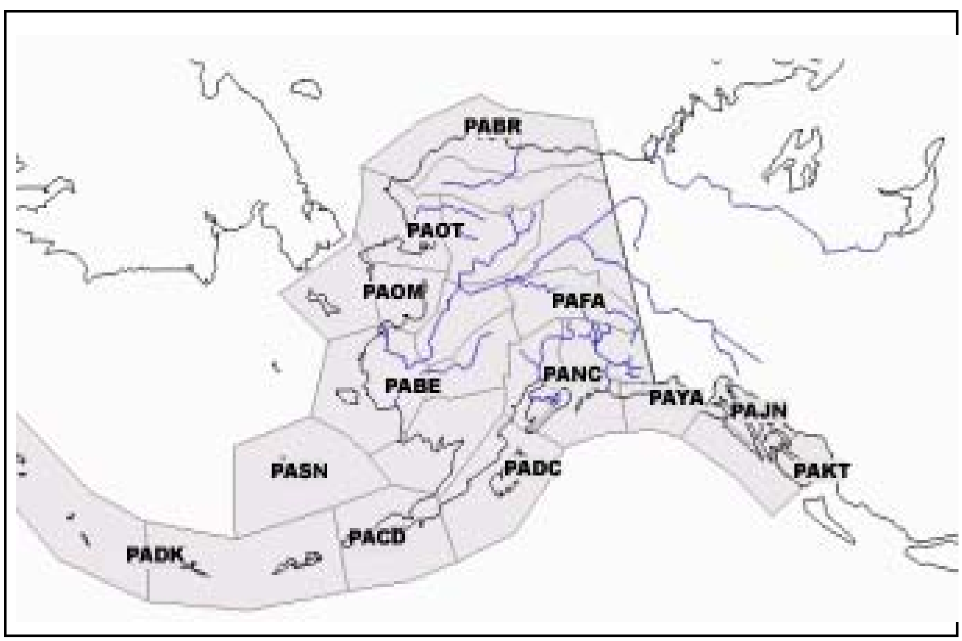

Figure 2. *Map depicting the 25 area forecast zones within Alaska.*

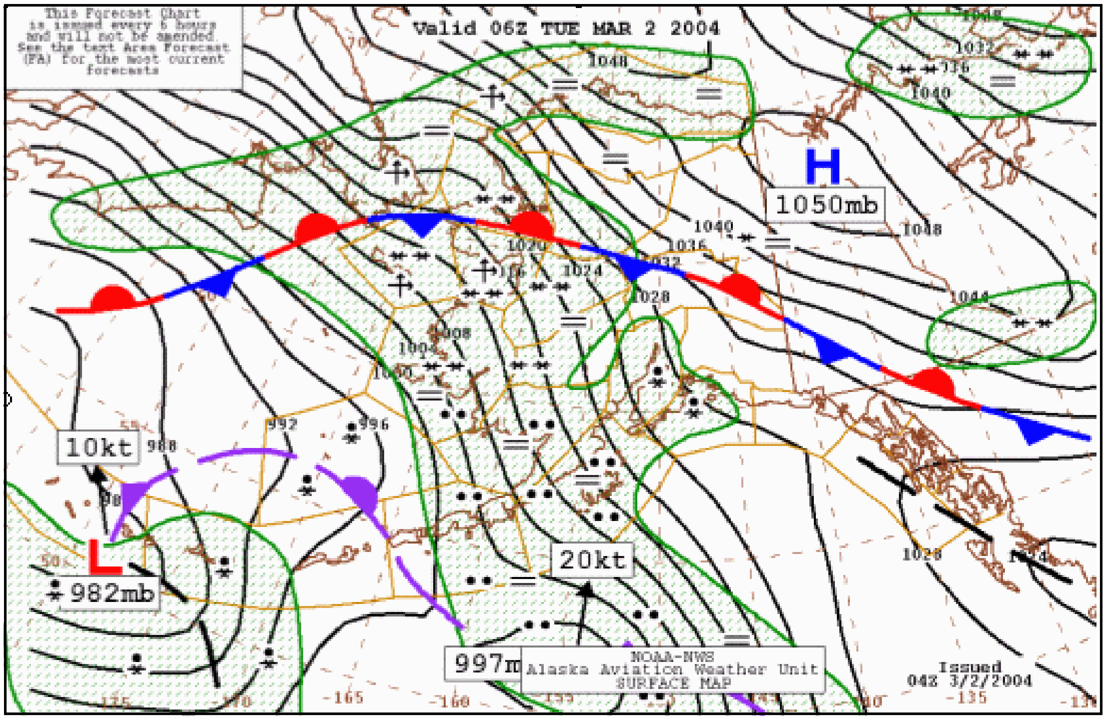

***Figure 3.** Example of an AAWU Surface Weather graphic.*

Aviators quickly began to request even more graphical products. In 1995, with the help of aviation organizations WSFOs and political efforts, the idea of a specialized aviation weather unit in Alaska became a reality.

The new Alaska Aviation Weather Unit (AAWU), staffed 24/7 with highly trained NWS forecasters, focuses on providing aviation weather text and graphics exclusively for Alaska.

A great deal of customer interaction and outreach occurred to insure that the aviation community was fully involved in the process. One of the first significant changes in services was the routine production and issuance of graphical aviation weather charts for Alaska.

The AAWU is staffed by 12 meteorologists. Each shift has two forecasters, responsible for issuing and updating the Area Forecasts, AIRMETs, SIGMETs and graphical products.

The areas of responsibility of forecasters are divided into two sections with the Alaska Range serving as the dividing line.

One forecaster is responsible for southern Alaska and the Volcanic Ash Advisory Center (VAAC). This forecaster deals with all products and services associated with volcanic ash. The second forecaster is responsible for all of interior and northern Alaska, north of the Alaska Range.

Alaska is divided into 25 forecast areas or zones. The size and shape of these zones were determined by similar climatological characteristics, **see Figure 2, Page 5.**

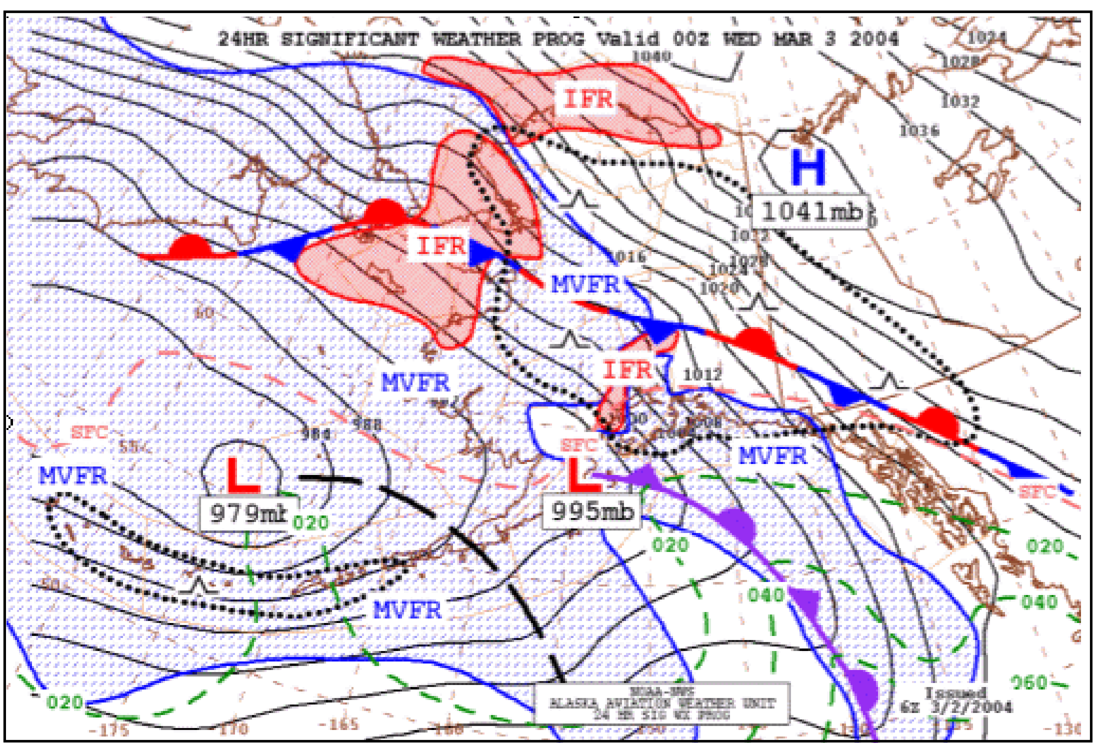

***Figure 4.** Example of an AAWU 24 hour Significant Weather graphic.*

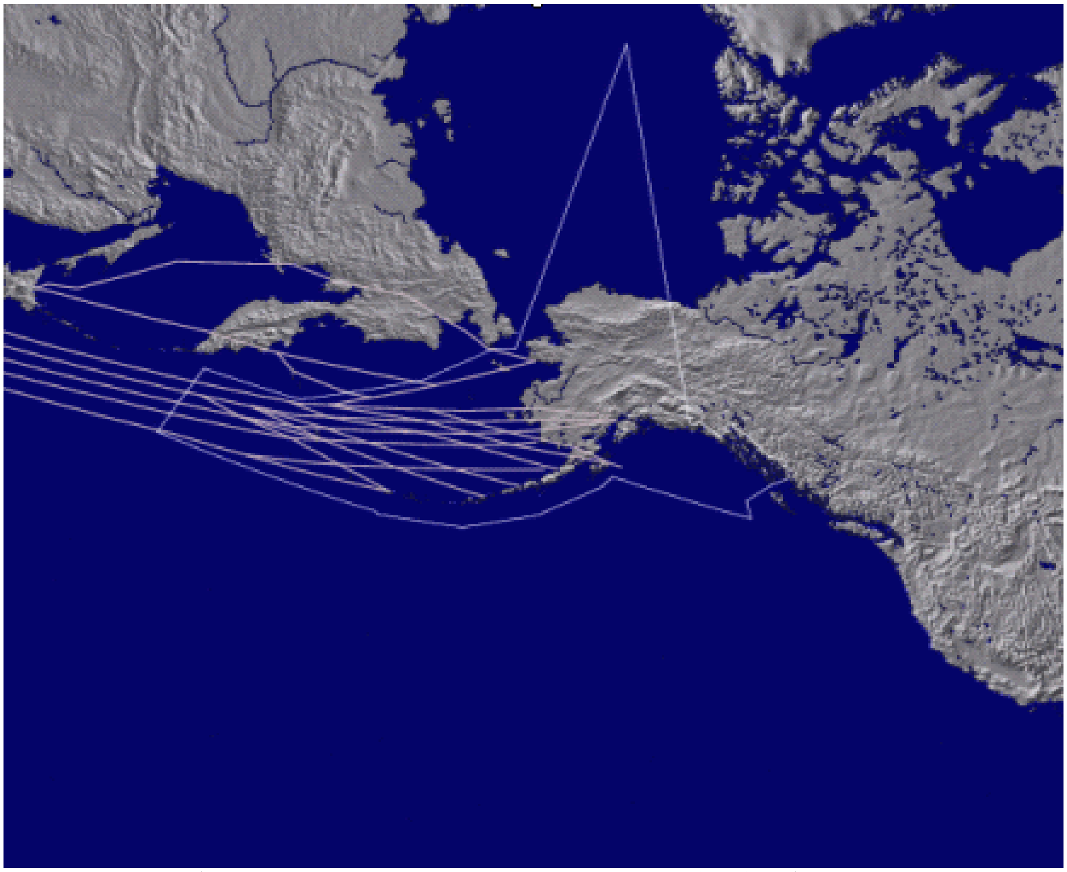

Figure 5. *Map depicting the Anchorage Flight Information Region (FIR) and major North Pacific Jet Routes.*

In other words, each zone should experience common weather conditions across its area on any given day; however, it is not quite that simple. Because of the diverse topography there are many sub-climatic zones within the state.

Each forecast zone may consist of several sub-zones, with even more diverse weather conditions. AAWU forecasters have a difficult task of conveying this variability while keeping the product concise. A pilot who may be flying from Northway to Tanana, for example, might fly through as many as three sub-regimes of weather even though the flight is traversing a single forecast zone.

AIRMETs are significant meteorological messages located in areas where occasional moderate or greater turbulence and icing would exist. SIGMETs are issued for severe turbulence and icing.

The AAWU also produces a variety of graphics products. Every 6 hours a series of four graphics is produced, **see Figure 3**. The MVFR/IFR chart, Turbulence, Icing and Surface Weather charts are posted to the AAWU Web site at **http://aawu.arh.noaa.gov**.

Every 12 hours, a Significant Weather Chart is produced and posted on the Web for 24, 36, 48 and 60 hours, **see Figure 4**, **Page 6**. These charts include surface weather, MVFR/IFR, moderate or greater turbulence and freezing levels.

The AAWU is also one of four Meteorological Watch Offices (MWOs) along with the Aviation Weather Center in Kansas City, MO, WFOs Honolulu and Guam.

Each MWO has warning or SIGMET responsibility for one or several Flight Information Regions (FIR). The AAWU area of responsibility is the Anchorage FIR which encompasses 2.4 million square miles, **see Figure 5, Page 7.**

The AAWU is also designated as the VAAC. The Anchorage VAAC is one of nine international centers that monitor and forecast the dispersion of volcanic ash.

The gritty and chemical nature of volcanic ash poses significant dangers to aviation because of the damage it causes to aircraft engines.

VAAC forecasters are trained to use a suite of cutting edge remote sensing tools, including GOES, AVHRR and MODIS satellite imagery to detect volcanic ash plumes.

Certain bands on the satellite's spectrum of information are more sensitive to volcanic ash and are used to identify the plume.

Forecasters use meteorological model wind field data and volcanic ash plume dispersion models to prepare a forecast of ash plume movement.

The Anchorage VAAC area of responsibility encompasses the entire Anchorage FIR in addition to far eastern Russia. The VAAC works closely with the Federal Aviation Administration (FAA) Air Route Traffic Control Center's Center Weather Service Unit meteorologists and air traffic managers to warn aircraft of possible ash encounters.

The VAAC also works very closely with volcanologists from the Alaska

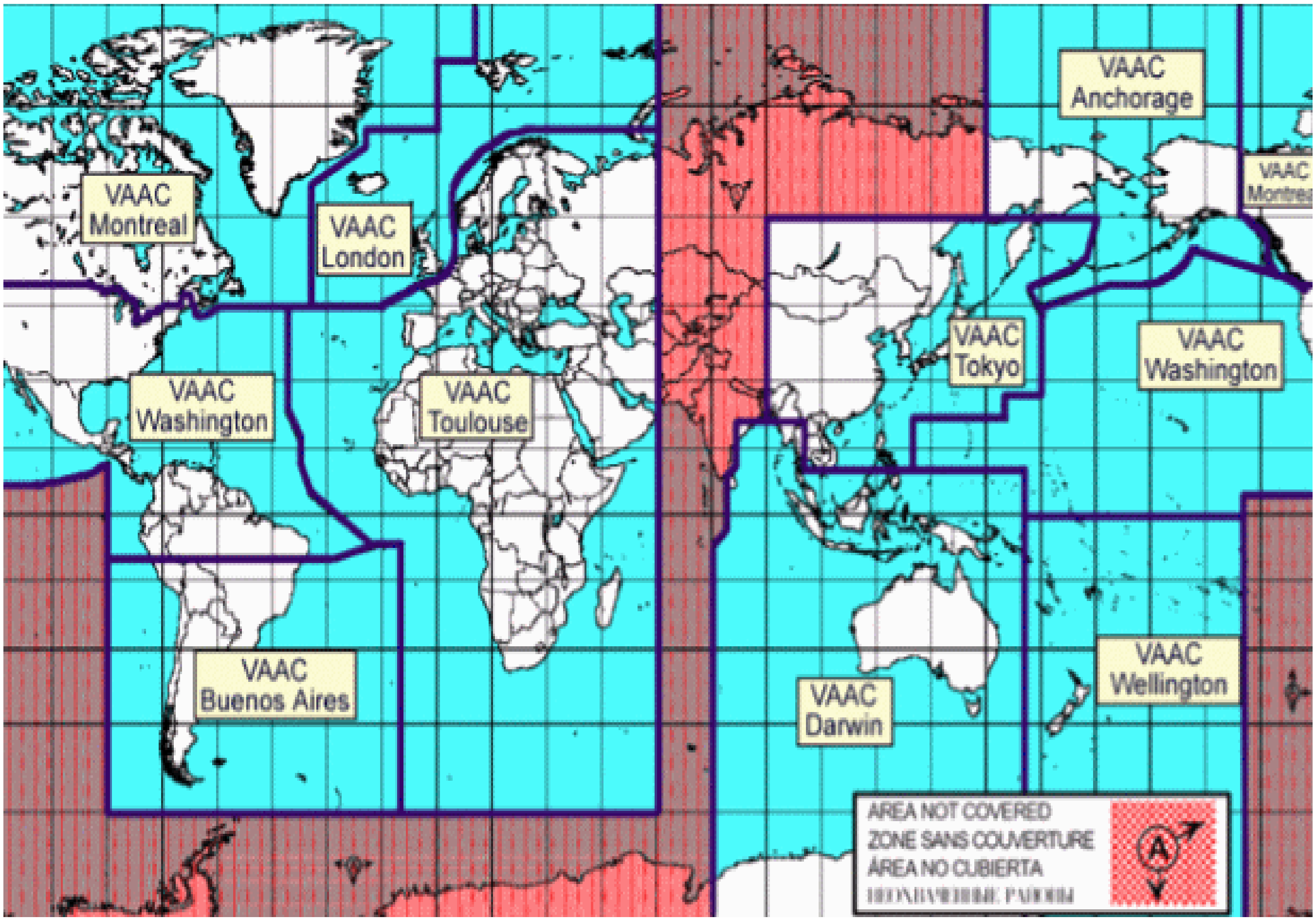

Figure 6. *Map depicting the 9 Volcanic Ash Advisory Centers and their respective areas of responsibility.*

Volcano Observatory in Anchorage and Fairbanks.

The VAAC provides guidance to the MWOs that have SIGMET responsibility on the projected movement of the ash. Its products are available on the Web at: **http://aawu.arh.noaa.gov/vaac.php**.

In Alaska, the AAWU is the Meteorological Watch Office and the VAAC. The principle product of the VAAC is the Volcanic Ash Advisory (VAA).

This text product gives specific information about the volcano including elevation, latitude and longitude, **see Figure 6**.

This product also provides an initial, 6, 12 and 18 hour forecast of the ash plume including plume height. The VAA is posted on the Web as well and is used quite extensively by the airlines.

Looking Toward the Future...

The AAWU is committed to serving its customer customers and partners with excellence as we move forward in the development of new and improved forecast products and services.

The future of the AAWU is very exciting as it embraces the digital forecast era. The gridded aviation database of the future will allow customers to access site specific weather information across Alaska.

In the meantime, the AAWU will continue to improve upon its current product suite in concert with the changing requirements of its aviation customers.

Author Biography

Jeff Osiensky is the Meteorologist In Charge of the Alaska Aviation Weather Unit in Anchorage. Prior to this position, Jeff served for 2 ½ years as Meteorologist In Charge of the Center Weather Service Unit located at the Anchorage Air Route Traffic Control Center. Jeff has spent more than 5 years in aviation weather forecastinin Alaska.