Forecasting Breakout of Low Stratus and Fog
on 08 March 2004
A WES Exercise

Clinton Rockey
WFO Portland

Introduction.
Instrument Flight Rules (IFR) and Low IFR conditions wreak havoc on forecasters and the aviation community.

Flight Category	Visibility (sm)	Ceilings (ft)
VFR / Visual FR	over 5	over 3000
MVFR / Marginal VFR	3 to 5	1000-3000
IFR / Instrument FR	1 to < 3	500 - 900
LIFR / Low FR	under 1	under 500

** FR is shortened to flight rules*

Financial impact to the aviation community resulting from conditions worse than IFR spirals up rapidly, especially with continued rising costs of fuel and the need for airlines to maintain peak efficiency and on-time schedules. This impact can be exasperated when such flying conditions are not forecast, or worse yet, are forecast but do not occur. Recent new tools, including model data, have armed forecasters with better guidance tools for these forecast conditions, and when these conditions will improve. This is one of many cases where such tools aided forecasters.

Synoptic and Mesoscale Environment.
Upper high pressure ridge over the Pacific Northwest and western US, with axis extending from western Washington to western Nevada. At the same time, an upper level low was cutting off from the mean flow about 525 miles west of San Francisco. Upper level flow over the county warning area (CWA) was southerly, and generally 25 to 30 knots (rather light). The main jet was well north of the CWA over British Columbia. Closer to the surface, thermal low pressure over northwest California extended north along the southern Oregon coast. At the same time, a 1040 mb high was centered over central Idaho.

Skies were mostly clear with only a few strands of thin cirrus in the flow. The only exception was along the immediate coastline where a deck of IFR (ceilings of 300 to 600 feet MSL) clouds hugged the beaches. Very dry air was sitting not far above the interior valleys. Soundings showed a very shallow pool of moist air, generally below 950 mb (~1800 feet). Station observations across much of the area showed temperatures in the lower 50s, but dew point temperatures were in the upper 40s to near 50. By 08 UTC, many locations were saturated with both temperatures and dew points in the mid to upper 40s. Pressure gradients were too light to produce much low level wind. Most stations reported light north winds, except light east winds at the coastal stations.

Select Pressure Gradients on 08 March:

	OTH-GEG	AST-PDT
03 UTC	+ 0.3 mb	+ 1.8 mb
06 UTC	+ 0.2 mb	- 0.2 mb
09 UTC	- 1.3 mb	- 0.2 mb
12 UTC	- 3.6 mb	- 1.8 mb

Discussion.
As the rest of the night continued (06 UTC to 12 UTC), low stratus and fog formed in many locations, but especially over the interior valleys. Again, light winds supported by moist lower levels of the atmosphere aided in the development of IFR conditions.

Models indicated that this would happen, and suggested it would break out to VFR conditions by 18 to 20 UTC. However, as always, some of the details are never apparent or readily accessible through model data. By 14 to 15 UTC, many locations in the interior were socked in by LIFR conditions, with visibility reported under ½ mile and ceilings of 100 feet. Now, the main question posed to forecasters was “when would conditions improve to MVFR or VFR?”

Several amendments were necessary on 8 March, in order to reflect more persistent fog and/or stratus in the interior valleys. Fog/stratus lifted rapidly between 1830 and 1850 UTC, which was later than the original 12 UTC TAFs had forecast. Could the 12 UTC TAFs have been better? Timely amendments later in the morning could have been issued to reflect better forecasts, and thus impacting aviation community less adversely.

Once the stratus became established, which for the most part was by 12 UTC, forecasters could enter data into a local stratus breakout program. This program, created by Bob Jackson of the FAA's Center Weather Advisory Unit in Seattle, has enjoyed good success over the years with breaking out stratus and/or fog.

Bob Jackson's breakout program computes the breakout of stratus, based on sun angles, season, as well as the depth of the fog/stratus layer. However, several assumptions must be satisfied in order to best utilize the program's output:

1) Must maintain the status quo of the atmosphere. There can be little if any advection of drier air or moist air.
2) Maintain continued rather clear skies above the fog/stratus layer. Even thin cirrus can slow the stratus breakout process.
3) No fronts. Again, maintain status quo.
4) Winds remain calm, or light and variable.

Using the observational data (shown in tables 1 and 2) along with estimates of stratus tops, derived from satellite imagery and pilot reports, we can run the Stratus Breakout to provide guidance for the 12 UTC TAFs:

Breakout Run at 1130 UTC, for Portland:
Input: Observed Tops: 800 feet
Observed Base: 100 feet
Time of PIREP: 1130 UTC
Output:
1820 UTC OVC becomes BKN
1850 UTC Stratus Breakout

Combined with the model data, this output would offer a large amount of confidence to forecast persistent LIFR through at least 18 UTC for Portland.

What about Eugene? This would have been a bit more troublesome, as the ceiling in Eugene was still in flux. Between 08 and 11 UTC (*see table 2*), the ceiling ranged from 100 to 300 feet, and at times going up to 900 feet. As a result, we can weight the 300 foot ceiling a bit more and use it as our input.

Breakout Run At 1130 UTC, for Eugene:
Input: Observed Tops: 1000 feet
Observed Base: 300 feet
Time of PIREP: 1130 UTC
Output:
1607 UTC OVC becomes BKN
1722 UTC Stratus Breakout

However, re-running the program at 1330 UTC, when the ceiling finally rests at 100 feet:

At 1330 UTC, for Eugene:
Input: Observed Tops: 1200 feet
Observed Base: 100 feet
Time of PIREP: 1330 UTC
Output:
1837 UTC OVC becomes BKN
1907 UTC Stratus Breakout

This second run for Eugene can give the forecaster a better time for breakout, thus allowing the forecasters to amend the TAF to reflect a better forecast.

Table 1: Portland Intl. Airport Observations

UTC	Wind	VIS	Ceiling (msl)
1056	Calm	1/4sm	OVC001
1111	Calm	1/4sm	OVC001
1120	Calm	1/4sm	BKN001 OVC006
1155	W 4 kts	1/4sm	VV001
1255	Calm	1/4sm	BKN001 OVC008
1355	Calm	1/4sm	OVC001
1423	Calm	1/16sm	VV001
1455	NW 3 kts	1/16sm	VV001
1555	NW 3 kts	1/16sm	VV001
1638	NW 3 kts	1/16sm	VV001
1655	W 6 kts	1/16sm	OVC001
1727	NW 4 kts	1/4sm	OVC001
1755	NW 5 kts	1/4sm	VV001
1803	NW 4 kts	1/4sm	VV001
1819	NW 5 kts	1/4sm	OVC002
1823	W 4 kts	1/4sm	OVC003
1829	W 5 kts	3/4sm	BKN003
1833	W 4 kts	1 1/2sm	SCT003
1835	Vrb 4 kts	2sm	SCT003
1855	W 4 kt	10sm	SCT003
1955	Calm	10sm	Clear

Table 2: Eugene Airport Observations

UTC	Wind	VIS	Ceiling (msl)
1054	NW 4 kts	1/4sm	VV001
1154	Calm	3/4sm	BKN001 OVC009
1202	Calm	1/4sm	SCT001 OVC009
1211	Calm	3/4sm	FEW001 OVC009
1215	Calm	1 1/2sm	BKN005 OVC009
1222	Calm	3sm	BKN005 OVC009
1230	W 3 kts	2 1/2sm	OVC005
1244	W 3 kts	1 3/4sm	OVC005
1254	Calm	3sm	OVC003
1314	Calm	1 3/4sm	OVC003
1318	Calm	3/4sm	OVC003
1327	Calm	1/4sm	VV002
1334	Calm	1/4sm	VV001
1354	Calm	1/4sm	VV001
1454	Calm	<1/4sm	VV001
1554	Calm	<1/4sm	VV001
1654	NE 3 kts	1/4sm	VV001
1709	N 3 kts	1/4sm	VV001
1719	Vrb 3kts	1/4sm	VV001
1754	N 5 kts	1/2sm	OVC001
1759	NE 4 kts	1 1/2sm	OVC003
1823	N 5 kts	1 1/2sm	OVC003
1831	N 5 kts	2 1/2sm	OVC003
1846	N 4 kts	3sm	BKN003
1854	NE 6 kts	3sm	BKN005
1940	N 4 kts	8sm	SCT008
1954	N 5 kts	9sm	Clear
2054	Vrb 5kts	10sm	Clear

Another local program for utilization by forecasters is the recently developed Conditional Climatology for TAFs (CC-TAF) created by Andrew Rorke of the Oxnard WFO. This program has been highlighted in various National Weather Service aviation workshops over the last two years. In this program, input would observed visibility and ceiling, with the output being conditional probabilities of categories for the visibility and ceilings. Using a stratified 30-year observations database, the CC-TAF program produces a probabilistic forecast for the next nine hours for a specified TAF site. The results essentially confirmed what the models and Stratus Breakout program suggested---rapid breakout of stratus between 18 and 20 UTC, with higher likelihood of improving to VFR conditions by 19 UTC at Portland (*table 3*) and 20 UTC at Eugene (not shown, but similar CC-TAF output).

Table 3. Partial CC-TAF output for Portland (*at 1130 UTC*)

12Z	Cig002 83%	Cig007 13%	NO CIG 3%
13Z	Cig002 80%	Cig007 7%	Cig060 3%
14Z	Cig002 77%	NO CIG 10%	Cig007 7%
15Z	Cig002 60%	Cig007 13%	NO CIG 10%
16Z	Cig002 57%	Cig150 17%	NO CIG 10%
17Z	Cig002 53%	Cig150 20%	Cig007 10%
18Z	Cig002 30%	Cig150 23%	Cig007 20%
19Z	NO CIG 27%	Cig150 23%	Cig007 20%
20Z	NO CIG 40%	Cig150 27%	Cig007 13%
21Z	NO CIG 50%	Cig150 30%	Cig007 7%

Note: *Cig002 = ceilings of 100 to 400 ft*
Cig007 = ceilings of 500 to 900 ft
Cig150 = ceilings more than 12,000 ft

Summary.

Model guidance has improved in quality, allowing for better forecasts. However, finer details are not always shown in the guidance. Other guidance can be utilized to either add details, or confirm trends indicated by the models. Both the Stratus Breakout and the CC-TAF programs offered additional guidance that resulted in better forecasts.

References.

University Center for Atmospheric Research (UCAR), 2003: AWIPS-based Conditional Climatology Program (CCTAF). *Distance Learning Aviation Course* http://meted.ucar.edu/dlac/lesson2c/3.htm