To Forecast or Not: LIFR or IFR
Forecasting Fog/Stratus 20-21 October 2005

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Introduction.
All forecasters can forecast low clouds, especially when environmental and computer models are suggesting such conditions. However, what is more difficult is forecasting whether the conditions will be LIFR (limited instrument flight rules) or IFR (instrument flight rules). Table one breaks down the definitions of flight condition categories.

Local office verification of aviation forecasts has shown over the last several years that LIFR flight conditions are forecast well during the first six hours of the aviation aerodrome terminal forecasts, or TAFs. However, the ability of forecasters to accurately forecast IFR has proven more elusive. This need to improve the IFR forecasts has been further motivated by GPRA goals recommended by the National Weather Service headquarters. In short, forecastersneed to better forecast when conditions will be predominantly IFR or LIFR.

This WES exercise explores a typical early autumn weather pattern in northwest Oregon. Fog may or may not form, but computer models and actual weather conditions suggest there is a possibility of fog. Forecaster-designed procedures on AWIPS also contributed to earlier and correct analysis that lead to better forecasts.

This exercise will help forecasters determine which stations will be affected, whether or not to expect fog and/or low clouds, where and when the conditions may be IFR or LIFR dominated.

	Visibility	Ceiling
	(statue miles)	*(feet)*
LIFR	less than 1	less than 500
IFR	1 to < 3	600 to < 1000
MVFR	3 to < 5	1000 to < 3000
VFR	5 or more	3000 or more

Table1 **:** *Flight conditions categories, as defined by the FAA, Federal Aviation Administration***.**

Current synoptic and mesoscale conditions.
Overall, weather on the 20th of October was still mild. A Pacific frontal system had moved across the region on the 19th and 20th. Rainfall was generally from 0.20 inch to 0.40 inch, with the least falling across the southern part of the Portland county warning area. Prior to rainfall, temperatures were in the upper 60s over much of the interior. The ground was damp, as several fronts moved across the region earlier in the month.

On the afternoon of the 20th, an upper level ridge was building offshore, with west to northwesterly flow into the Pacific Northwest. Meanwhile, deep low pressure was over the Gulf of Alaska. Surface high pressure was over the coastal waters, giving light onshore flow on the afternoon of the 20th. Temperatures were in the upper 50s to mid 60s on the 20th, with dew point temperatures mostly in the middle 40s. Winds were light, but onshore, with most near five knots. Weak thermal low pressure is forming along the south Oregon coastline.

Earlier in the day, low clouds and fog blanketed much of inland southwest Washington and parts of northwest Oregon. IFR conditions were reported at Portland, Troutdale, Hillsboro, and points northward along the Interstate-5 corridor. To the south of the metro area, conditions were MVFR, with VFR observed along the coastline.

Discussion of Forecast Model Guidance.
Model guidance was examined, and during the operational shift, the ETA12, RUC and MesoEta runs were found to be the most useful.

Model soundings, as well as cross-sectional views could have added more confidence to the aviation forecast outcome.

Model guidance and observational data indicated that fog would likely form during the overnight hours between the 20th and 21st of October.

Oct 21	00 Z	06 Z	12 Z	18 Z
AST-PDT	+2.1	-0.8	-2.9	-6.0
AST-DLS	+0.7	-1.9	-4.0	-5.1
OTH-GEG	+1.1	-1.6	-4.4	-6.1
TTD-DLS	+1.1	-1.4	-2.9	-4.1
PDX-DLS	+1.3	-0.9	-2.4	-4.4

Table2 **:** *Pressure Gradients (mb) across the Pacific NW (negative are offshore, positive are onshore.)*

As the surface high pushed inland early in the evening, the onshore gradient would slowly collapse. As models indicated, the high moved further east and the pressure gradient would slowly turn offshore and increase. Table 2 illustrates the values of 4 pressure gradients, at various times during the night. Notice that around 04 UTC to 06 UTC, pressure gradients across the Pacific NW became offshore. By 18 UTC on the 21st, pressure gradients would be much higher.

All models, including the ETA12 and RUC, indicate this shift in the surface pressure patterns. With this shift, it was likely that a light east wind would develop between 06 and 10 UTC. Preliminary studies that correlate wind speeds with pressure gradients indicate that Troutdale would develop east winds of at least 8 kts once the Portland to The Dalles (PDX-DLS) pressure gradient reached 3.0 mb (millibars) offshore. This gradient did reach that theshold between 15 UTC and 16 UTC. The gradient at 16 UTC was 3.8 mb offshore. Light east winds started at Troutdale around 07 UTC and remained light east until 15 UTC, when the stronger east wind arrived, with winds gusting over 20 mph.

Another feature of worth notice was the development of the moderately strong inversion over the western interior lowlands. Figures 1 and 2 show the lower atmosphere, along a line from south of Eugene to just north of Portland. Both RUC and ETA12 model soundings indicate low level moisture trapped in the lowest levels, with an inversion developing around 1500 to 2000 feet agl (above ground level). Other cross-sections and time-heights graphics over various locations in the interior indicated abundant moisture trapped below 950 mb, or roughly 1500 feet above ground. If a forecaster were only looking at basic levels, such as plan-views of moisture at 925 mb (~2500 agl), or 850 mb (~4500 ft agl), they would not see the low level moisture and may assume that it is too dry.

Figure 1 shows the moist layer developing near the surface, with an inversion forming above, at roughly 950 mb. Closer examination of the 850 and 925 mb level charts shows humidity only to 40 to 50 percent, rather than 90 percent or more shown below 950 mb.

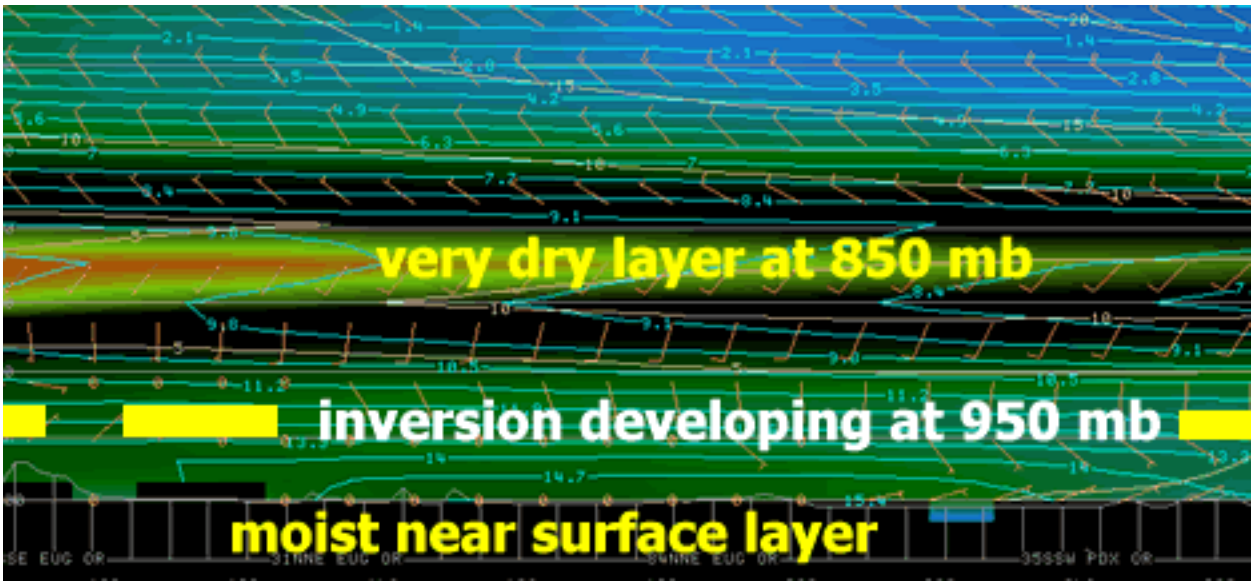

Fig1 **:** *Cross-section of the Willamette Valley, valid at 06UTC, from ETA model. Notice developing inversion around 950 mb, with very dry layer above. Near the inversion, winds are light and from the east-southeast.* **Blue lines are temperature. Shaded areas are relative humidity -- green = moist, red = dry.**

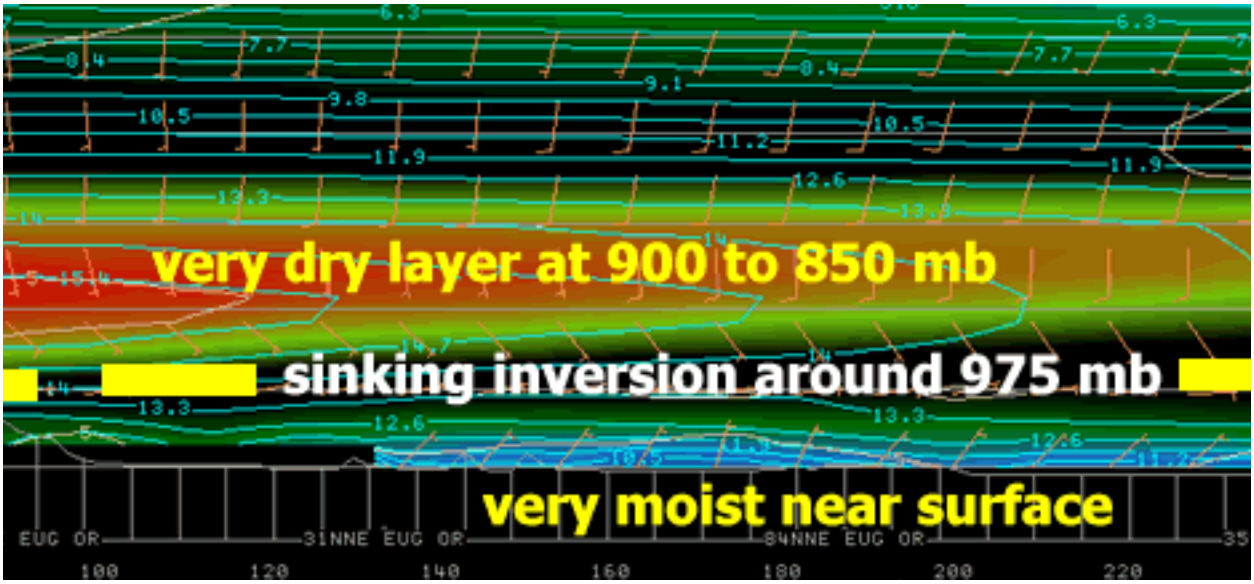

Fig2 **:** *Cross-section of the Willamette Valley, valid at 15UTC, from ETA model. Notice the inversion is a bit stronger, and is sinking towards the surface.* **Blue lines are temperature. Shaded areas are relative humidity -- green = moist, red = dry.**

By 15 UTC, the inversion is continuing to sink, with very dry air above (*figure 2*). The layer near the surface has become very moist, suggesting fog and low clouds.

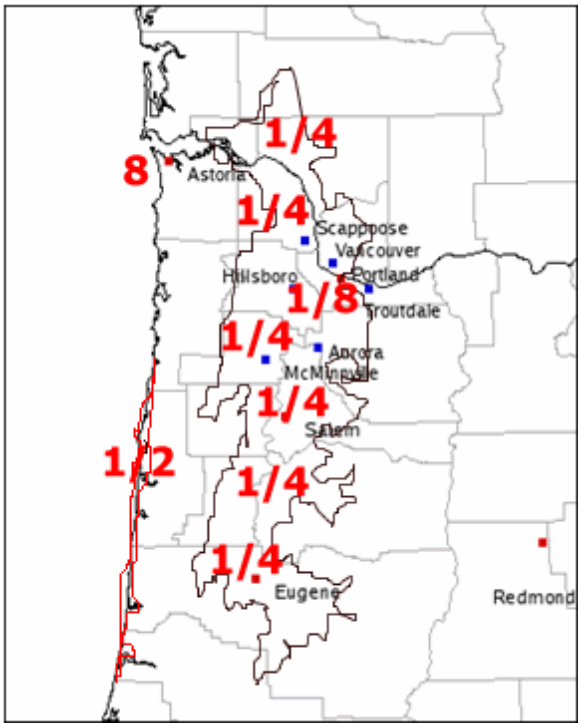

Fig3 **:** *Locations with LIFR dominated weather (02UTC – 12 UTC on 21 October 2005), with lowest visibility value.*

In addition, the inversion will be strengthened by the warmer southerly winds just above 850 mb (~4500 ft agl). This warm layer will further stabilize the air mass over the interior valleys.

Overall, it appears that much of the fog, which is likely to form, will be quite dense.

Outcome.

Dense fog and low clouds did indeed form over much of the area. Model guidance provided ample clues that this would be LIFR-dominated event, rather than IFR. Such clues included the low inversions, dry air mass aloft with developing offshore flow, and moist soil. All these pointed to keeping the moisture quite close to the ground.

Figure 3 shows the extent of the fog and low clouds across the local area. Notice that the visibility at nearly all airports fell to one-half of a mile or lower during the event. For many locations, this remained steady for many hours. Of interest is Astoria (8 miles) and Troutdale (6 miles) where the fog formed between 03 UTC and 04 UTC. Again, light east winds developed by 06 UTC, keeping these stations fog-free. True, brief fog with visibility of 6 to 8 miles did occur, but it did not last more than 1 hour before improving to ten or more miles. Stronger east winds arrived at coastal stations and at

Troutdale between 12 UTC and 13 UTC. Figure four shows the times at which the LIFR/IFR conditions began. Nearly all stations dropped quickly to LIFR, generally within one hour.

Conditions improved along the coastline, where the only major area of fog was between Lincoln City and Florence. Newport became fog-free around 10 UTC, with any remaining fog on the central Oregon coast dissipating by 11 UTC. Again, this dissipation was due to developing offshore surface flow (light east winds). Inland, the only improvement prior to 15 UTC was Troutdale, where fog hardly formed. All other inland stations remained in LIFR conditions well into the morning hours of the 21st. Hillsboro fog lifted between 14 UTC and 15 UTC. Other stations saw marked improvement as the fog lifted between 18 UTC and 19 UTC. Eugene was the exception, as the LIFR conditions persisted after 19 UTC.

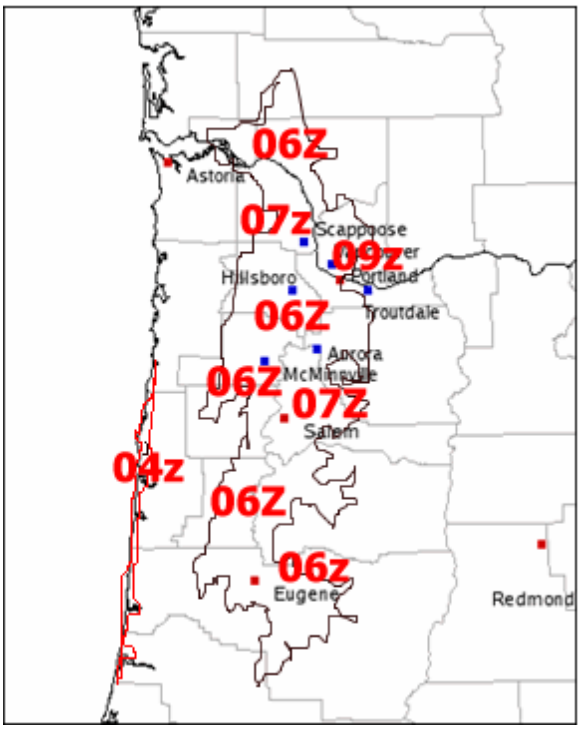

Fig 4 **:** *Onset of LIFR/IFR conditions (02UTC – 12 UTC on 21 October 2005).*

Summary.

Pattern recognition will give good confidence as to whether or not a fog/low cloud event will occur. However, armed with careful analyses of mesoscale features, such as low level inversions, and profiles of boundary level and lower atmospheric wind and temperature profiles, forecasters may be better able to anticipate where and when LIFR and/or IFR conditions will form. As part of the national verification program, this particular problem is key to boosting forecasters' scores, as well as their skill in this ever challenging realm of aviation forecasting.

References.

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NOAA/National Weather Service's UCAR/COMET Center, 2003-04: Distance Learning Aviation Course (*DLAC*), Forecasting Fog and Low Stratus for Aviation Operations.

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