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VERIFICATION OF NGM VERSUS AVIATION MODEL OUTPUT

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Introduction

Verification of the 48 hour NGM versus Aviation model output for Washington was completed for the period June through November 1992. The study was designed to update a previous study, conducted in 1986, between the four operational models used at that time: the LFM, NGM, Aviation (AVN), and an older spectral model. The previous study found close agreement between the LFM and NGM, as well as between the two spectral models, with the spectral models showing overall superiority. Since then the NGM and Aviation model have undergone refinements, while the older spectral model is extinct and the LFM will soon be phased out.

Parameters verified in this study are: Quillayute (UIL) to Wenatchee (EAT) pressure gradient, 500-1000 mb thickness at Quillayute and Spokane, and a subjective impression of the surface and 500 mb model forecasts.

Quillayute to Wenatchee Pressure Gradient

This parameter was originally chosen to verify the ability of the models to forecast summertime marine pushes into Puget Sound and the interior valleys of western Washington. The longer baseline from Quillayute to Wenatchee was chosen over the usual Quillayute to Bellingham baseline to minimize sampling errors when interpolating from the model graphics. However, this proved to be a mistake since the model errors in forecasting the end point sea-level pressures were at least as great as the marine air mass effects. Table 1 summarizes these errors.

The pressure errors of the models at Wenatchee appear due to their simplified terrain. Neither depicts the Cascades (Fig. 1) which block most marine air masses from reaching eastern Washington. These marine air masses are usually colder and denser than the air farther inland, contributing to higher surface pressures. The models allow the cool marine air (probably modified by surface heating) to sweep into Wenatchee, and thus should forecast surface pressures too high.

Indeed, Table 1 shows that both models forecast the Wenatchee pressure too high the majority of the time. The Aviation model had slightly less average error (1.9 mb) than the NGM (3.1 mb). The Aviation model also forecast the diurnal cycle a little better, with 0000 UTC pressures lower than 1200 UTC (not shown).

However, both models also forecast the Quillayute pressure too low by a similar amount. Perhaps the models underforecast the depth of the dense marine layer when extrapolating from the model terrain surface down to sea level. The net effect of these pressure errors (Wenatchee too high and Quillayute too low) was to underforecast the amount of onshore flow (westerly pressure gradient).

Table 2 shows a verification of the model pressure gradient for various months of the year. "Too strong" corresponds to an onshore gradient (pressure at Quillayute minus pressure at Wenatchee) greater than observed, while "too weak" corresponds to an onshore gradient less than observed.

Both models were similar in their average error and biases. The most striking feature was the reversal in bias for both models as strong solar insolation at Wenatchee in summer gave way to net radiational heat loss during the long November nights. Wenatchee has a more continental climate than the models recognize, due to their lack of a Cascade mountain barrier (Fig. 1), contributing to surface pressures too high in the summer and low in the winter. Note that the models were relatively unbiased during October, shortly after the equinox.

Table 3 depicts the ability of the models to forecast an unusual but significant case (offshore flow). "Offshore flow" for the purposes of this study is defined as [pressure (UIL) < pressure (EAT)] when surface winds usually have an easterly component. "Yes" refers to the percentage of cases when observed offshore flow was correctly forecast, while "no" refers to cases when offshore flow was observed but not forecast. The Aviation model performed somewhat better than the NGM, especially in late fall, and forecast most of the occurrences correctly.

500 - 1000 mb Thickness

Tables 4 and 5 summarize the model errors (in decameters) and biases for Quillayute and Spokane. "Too warm" means the model forecast thickness values were too large. Both models had an overall bias towards being too cold at Spokane. The largest bias came during the summer with the Aviation model verifying a little better. Once again, this seasonal change in bias reflected the inability of the models to forecast the continental climate of Spokane due to the simplified terrain within the models. The cold bias almost disappeared by November as the air began to cool east of the Cascades.

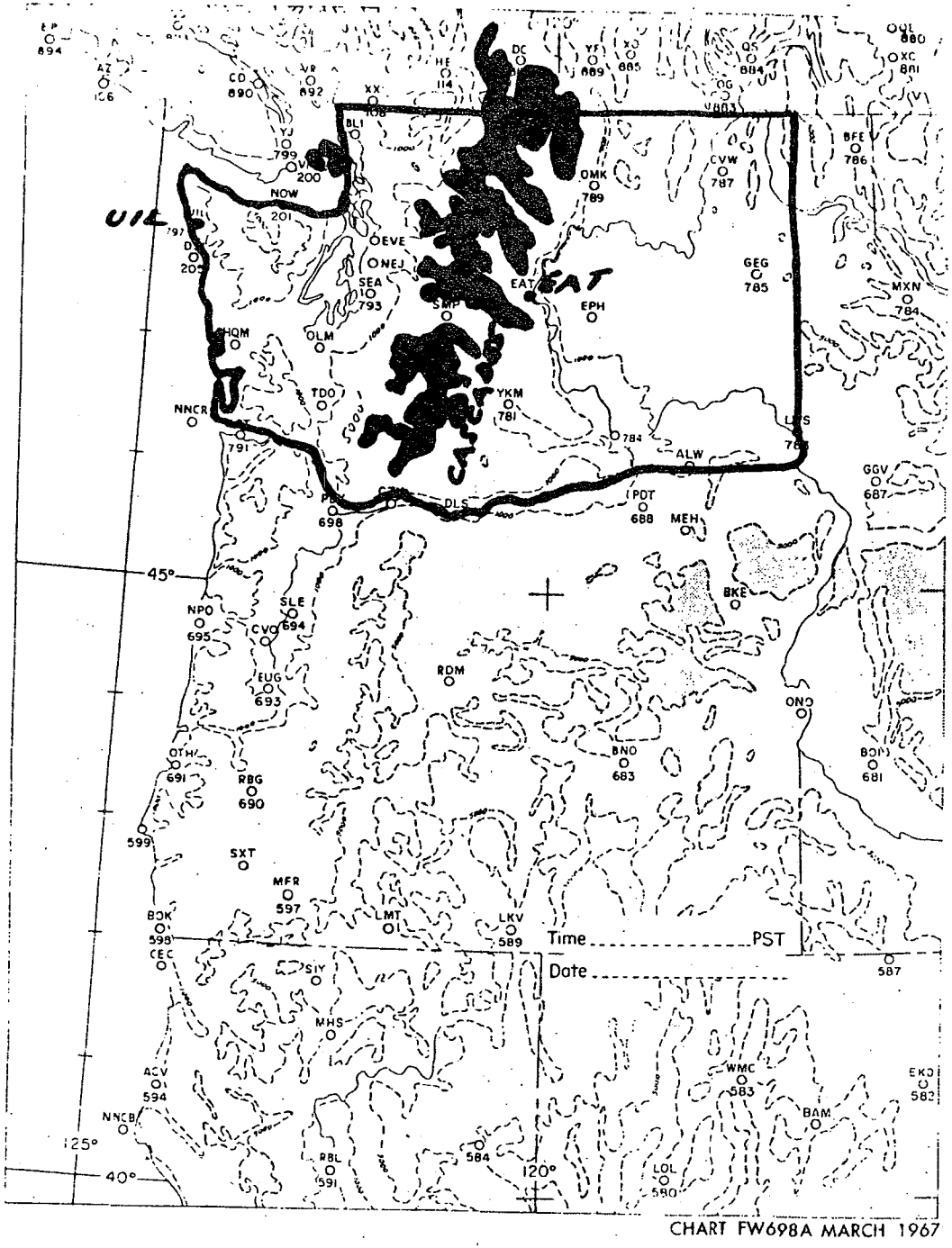
Quillayute also showed a cold bias, which was not as pronounced, suggesting that model terrain wasn't the only problem. Note that the bias changed little from July to November, reflecting the marine climate and relatively constant sea surface temperatures. The source of individual anomalies, such as the slight warm bias for the NGM in October and the strong cold bias shown by the Aviation model in November, could not be identified.

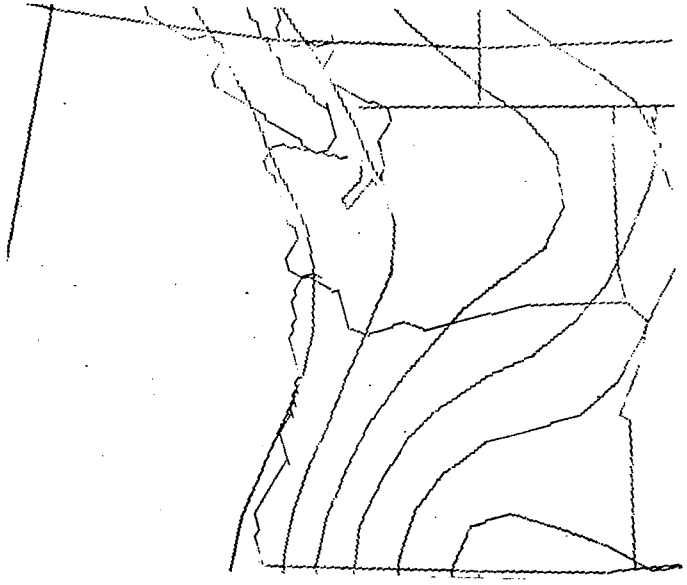
Subjective Impressions

Finally, Table 6 tallies a subjective verification of the 48 hour surface and 500 mb heights. The prognostic charts were compared to the observed pressure/height fields and a decision made which model would have provided a better forecast. This included such factors as onshore versus offshore flow, in addition to the position and strength of short wave troughs. There was little difference between models in the cases not listed, including a majority of cases at 500 mb.

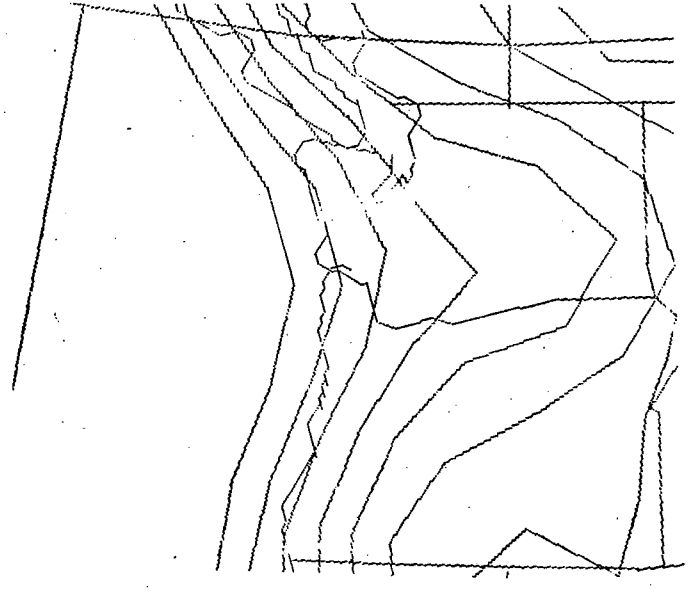
Conclusion

Overall, the Aviation model remained superior to the NGM, with a larger percentage of cases with little difference between models in comparison to the 1986 results. One area where the Aviation model had significantly more skill was the surface pressure pattern during summer. The NGM had two recurring biases that will be the subject of a later investigation.





NGM Model Terrain



AVN Model Terrain

Fig. 1: Actual versus NGM and AVN Model Terrain

	QUILLAYUTE		WENATCHEE	
	NGM	AVN	NGM	AVN
AVERAGE ERROR	2.7 MB	2.2 MB	3.2 MB	1.9 MB
PERCENT TOO HIGH	35%	10%	71%	58%
PERCENT TOO LOW	55%	71%	26%	29%

TABLE 1: Forecast Errors for UIL & EAT Pressures during July 1992

	**** NGM ****			**** AVN ****		
	AVG. ERROR	TOO STRONG	TOO WEAK	AVG. ERROR	TOO STRONG	TOO WEAK
JUNE	4.0 MB	06%	94%	4.0 MB	06%	94%
JULY	3.5 MB	03%	90%	2.9 MB	03%	90%
AUGUST	3.6 MB	14%	80%	3.2 MB	10%	81%
SEPTEMBER	3.0 MB	17%	69%	2.9 MB	24%	69%
OCTOBER	3.2 MB	52%	45%	2.8 MB	45%	45%
NOVEMBER	3.7 MB	68%	20%	3.3 MB	57%	27%
TOTAL	3.5 MB	27%	66%	3.2 MB	24%	68%

TABLE 2: Forecast Errors* for UIL - EAT Pressure Gradient

*Percent Correct Not Shown

	**** NGM ****			**** AVN ****		
	OFFSHORE FLOW FORECAST?			**OFFSHORE FLOW FORECAST?**		
	ERROR	**YES**	**NO**	**ERROR**	**YES**	**NO**
JUNE	7.0 MB	00%	100%	8.0 MB	00%	100%
JULY	no cases					
AUGUST	2.0 MB	43%	57%	1.1 MB	86%	14%
SEPTEMBER	2.0 MB	86%	14%	2.3 MB	71%	29%
OCTOBER	2.9 MB	65%	35%	2.6 MB	82%	18%
NOVEMBER	4.3 MB	63%	38%	3.3 MB	81%	19%
TOTAL	3.5 MB	63%	38%	2.8 MB	81%	19%

TABLE 3: Model Skill When UIL - EAT Pressure Gradient Was Negative

	**** NGM ****			**** AVN ****		
	AVG. ERROR	**TOO WARM**	**TOO COLD**	**AVG. ERROR**	**TOO WARM**	**TOO COLD**
JUNE	3.3 dam	25%	57%	3.0 dam	28%	60%
JULY	2.5 dam	27%	62%	2.5 dam	35%	62%
AUGUST	3.0 dam	18%	67%	2.9 dam	27%	67%
SEPTEMBER	2.0 dam	14%	82%	1.6 dam	32%	58%
OCTOBER	2.3 dam	45%	35%	3.0 dam	39%	52%
NOVEMBER	4.0 dam	29%	69%	3.3 dam	11%	75%
TOTAL	3.0 dam	26%	62%	2.8 dam	27%	64%

TABLE 4: Errors* in 500-1000 mb Thickness Values for Quillayute

* Percent Correct Not Shown

	****** NGM ******			***** AVN ******		
	AVG. ERROR	**TOO WARM**	**TOO COLD**	**AVG. ERROR**	**TOO WARM**	**TOO COLD**
JUNE	5.2 dam	12%	88%	4.8 dam	00%	96%
JULY	4.7 dam	00%	100%	3.6 dam	08%	92%
AUGUST	5.1 dam	06%	91%	3.9 dam	15%	74%
SEPTEMBER	3.8 dam	00%	86%	3.4 dam	10%	90%
OCTOBER	3.0 dam	32%	55%	4.7 dam	19%	81%
NOVEMBER	3.0 dam	39%	41%	3.0 dam	41%	45%
TOTAL	4.1 dam	17%	74%	3.8 dam	18%	76%

TABLE 5: Errors* in 500-1000 mb Thickness Values for Spokane

* Percent Correct Not Shown

	****** SURFACE ******		****** 500 MB ******	
	NGM BETTER	**AVN BETTER**	**NGM BETTER**	**AVN BETTER**
JUNE	21%	34%	00%	25%
JULY	04%	78%	15%	33%
AUGUST	11%	35%	00%	32%
SEPTEMBER	05%	33%	14%	19%
OCTOBER	07%	36%	22%	19%
NOVEMBER	18%	39%	09%	30%
TOTAL	11%	42%	09%	27%

TABLE 6: Tally of Subjective Impressions