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VERIFICATION OF THE (EDGAR) JOHNSON TEMPERATURE FORECAST AID AT SEATTLE

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[Editor's Note: This study almost fell into the "fruitless" file, however, a new use was found for it. Although this dated research project is no longer a major contributor to the day-to-day forecast operations at WSFO Seattle, it points to the importance of documenting rules of thumb/forecast techniques so that others may test or refine them in the future. This paper also illustrates the strides MOS has made in the last several years.]

Introduction

Many forecast offices have a collection of old forecast studies developed by the staff over the years to predict such things as temperature changes. Some of these forecast aids are still useful; others have been superseded by improvements in the numerical models and model output statistics. It is worthwhile to conduct a verification of these studies to see if they are still competitive with MOS guidance.

One of these studies at Seattle is the Johnson forecast aid. The Johnson aid is used by the staff during the summer to forecast the following day's high temperature during "marine pushes". Marine pushes occur when ocean air invades Puget Sound as a thermal trough migrates east of the Cascades. The change from warm sunny to often cool drizzly weather is one of the more dramatic events of the summer season and can make outdoor vacationers unhappy.

The Johnson Forecast Aid

The Johnson forecast aid was designed by Edgar Johnson in 1972, to forecast Seattle's high temperatures the following day based on 00Z sea-level pressures. The parameters he found most useful were:

(1) The pressure difference [North Bend, Oregon minus Seattle] or [Astoria, Oregon minus Seattle], whichever is greater, and

(2) The 24-hour pressure change at North Bend minus the 24-hour pressure change at Omak.

The first parameter measures the present strength of the southwesterly, or onshore, pressure gradient. The second measures movement of surface pressure systems, especially the summertime thermal trough, and crudely tracks changes in the upper atmosphere. The study was based on data from 1962 through 1967, while 1968 through 1971 data were used to test the scheme. Using the test data, Johnson found a 2.5 degree error for his forecast aid, 4.6 degrees for the local forecast, and 5.9 degrees for the Klein (perfect prog) guidance, which was a predecessor to MOS.

The Johnson aid has a couple of deficiencies. The North Bend to Seattle gradient uses a rather long baseline that may hide a slow moving or quasi-stationary thermal trough in between. Second, there is no upper-air data so the scheme doesn't measure the contribution to marine pushes from approaching upper troughs. Further, the study was confined to summer days with above normal temperatures and "fair" weather, no rain or upper troughs, and no marine pushes from the northwest (through the Strait of Juan de Fuca). Meanwhile, the numerical models and their derived MOS have improved over the years.

The Verification Study

A verification was run during the summer (June - September 22) of 1989 to see if the Johnson aid still provided skill compared to MOS guidance. Errors for the Johnson aid and LFM MOS follow, with the Johnson aid not doing so well except in September.

MONTH	JOHNSON	LFM MOS
June	4.5	3.4
July	4.1	3.4
August	4.3	3.4
September	3.6	4.9

However, the Johnson aid was designed only for days with above normal temperatures and "fair" weather. So, assuming summer days with above normal temperatures are most always "fair" around Seattle, the errors were recomputed using only those days, with the Johnson aid faring much better.

MONTH	JOHNSON	LFM MOS	NGM MOS
June	3.6	3.8	
July	3.6	3.6	
August	2.9	4.3	4.3
September	3.3	5.3	4.2

The Johnson aid outperformed LFM MOS guidance by an average of one degree. The LFM MOS had a consistent cold bias on sunny days which became worse during an unusually warm, sunny September. Even the NGM MOS, once it came on line, did not fare as well as the Johnson aid.

The Johnson aid is used by Seattle forecasters most often to forecast the "marine push" when cool marine air follows a thermal trough inland. The marine push isn't rigidly defined in terms of temperature, and its cooling effect may be spread over two days, depending on the depth of the marine layer and cloud cover. For the purposes of this verification, a marine push was defined as a drop in high temperature of at least 10 degrees, over one or two days, from an initial value of at least 80 degrees. There were eleven days that met the criteria. The Johnson aid had an average error of 3.5 degrees while the LFM MOS was 2.6 degrees. MOS beat the Johnson aid on seven out of the eleven days.

A verification was also made of the opposite case: A rapid warm up of at least 10 degrees over one or two days. There were eight such days. The Johnson aid had an average error of 7.1 degrees while the LFM MOS averaged 5.6. MOS beat the Aid on five out of the eight days.

Conclusion

The Johnson aid is no longer as good as MOS for the purpose that it is originally used, that is, forecasting marine pushes. It also lags behind MOS on major warmups. However, it is surprisingly competitive for the more mundane warm summer days without much change in air mass.