CAN COSPA IMPROVE THE PREDICTION OF C&V EVENTS?

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1. INTRODUCTION

Accurately predicting the onset and conclusion of hazardous ceiling and visibility (C&V) events continues to be a significant challenge. A key tactic toward forecast improvement is to leverage the skill of a variety of complementary forecast resources – and one such resource is the Consolidated Storm Prediction for Aviation (CoSPA) product (Wolfson et al., 2008).

CoSPA draws upon a sophisticated methodology for time-based extrapolation and trending of radar observations, and blends these extrapolations with hourly numerical model output from the High Resolution Rapid Refresh (HRRR) model. While HRRR data can be used directly for C&V forecasting, the information provided by the radar extrapolation process is unique to CoSPA itself, and is not easily derived independently. Thus, our interest here is to assess whether CoSPA's radar extrapolation capability (which is most dominant for short-term forecasts of 1-4 hours) offers an opportunity to improve the skill of short term probabilistic C&V forecasts.

This paper outlines our preliminary examination of the relationship between CoSPA 1-3 hour forecasts and corresponding ceiling impacts.

2. METHODOLOGY

Data Description

Specifically for this effort, CoSPA 0-hr analyses and 1-3 hour forecasts of precipitation represented as vertically integrated liquid (VIL) were collected.

CoSPA VIL values reside in 3km horizontal resolution gridded datasets that spanned the eastern 2/3 of the CONUS during 2009. The gridded data were queried for VIL values at selected METAR sites, and those VIL values were formatted into time series output.

Top of the hour METAR observations of ceiling and visibility were collected from an in-house historical database into their own site-specific time series output.

Data Evaluation

After aligning the CoSPA and METAR data by valid time, thresholds were applied to the VIL and the C&V data at forecast initiation and valid times to test relationships among them.

A majority of tests were conducted on ceiling conditions and will be the focus of discussion below. The thresholds chosen for the ceiling data were 12,000ft, 3,000ft and 1,000ft, referred to as H, M and L hereafter.

A valid forecast was declared when each of the following conditions was met:

- VIL at the forecast site was zero at initiation time
- ceiling at the forecast site was above a specified threshold at initiation time
- VIL at the forecast site was greater than or equal to a specified threshold at a particular forecast valid time. A VIL value of 16 was tested most extensively as the valid time condition.

A hit was defined as the situation in which the forecast criteria were met and when ceilings at valid time dropped below a specified target threshold.

In this way, cases consisted of conditions that were not impacted either by VIL or ceilings at initiation time, but were impacted to some degree by both at the forecast valid time.

The metric used to evaluate the relationship between the two datasets was the ratio of hits to forecasts, or the hit rate.

VIL and ceiling data were evaluated on a month-by-month basis from July 2009 through early December 2009 (data after 10 Dec. were not tested for this part of the study) for 202 stations in IA, IL, IN, OH and PA. Monthly data were then assembled into longer periods. July through September constitute a warm season

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sample. October through December make up a cool season sample. A third sample was formed by combining the warm and cool seasons and is labeled "All" in Table 2.

Three sets of ceiling condition tests were conducted using the same VIL thresholds. The first test examined ceilings greater than or equal to 12,000ft at the initiation time and ceilings less than 1,000ft at the valid time and is identified as "H-L" in Table 1, below. The second tested a change in ceilings from 12,000ft or higher to 3,000ft or lower, identified as "H-M", and the third tested ceilings 3,000ft or higher at the initiation time and 1,000ft or lower at the valid time, "M-L".

Test Designation	Init. Time Condition	Valid Time Condition
H-L	C ≥ 12kft.	C < 1kft.
H-M	C ≥ 12kft.	C < 3kft.
M-L	C ≥ 3kft.	C < 1kft.

***Table 1**: Ceiling Thresholds Used at Initiation & Valid Times and Test Designations.*

A limited number of tests were conducted using different initial and final VIL thresholds, revealing some sensitivity to those thresholds. For instance, the number of forecasts increased when a range of VIL values, such as 0-6, were used to constrain initial conditions, as opposed to limiting the initial value to be exactly zero. This sensitivity will be tested more fully in order to better understand the potential value of VIL forecasts for C&V prediction.

3. RESULTS

Overall, a weak relationship was found to exist between forecasts of VIL and initiation of impacted ceiling conditions.

An increasing number of forecasts were made as the forecast length increased within all the tests because the number of opportunities for the forecast criteria to be met grew with lead time. Tests at a handful of sites indicated that this characteristic held true through 6-hr forecasts.

Six-month Results

Table 2 presents the results from the Jul-Dec period of study. The H-L test (top) produced very low hit rates. Relaxing the valid time ceiling criteria (as is done for H-M tests) yielded a larger increase in the hit rate than relaxing the initial time criteria (as is done for the M-L tests.

2009 All: H-L Test			
Hour	Forecasts	Hits	Hit Rate
1	3989	44	1.10%
2	6794	123	1.81%
3	8440	196	2.32%
2009 All: H-M Test			
Hour	Forecasts	Hits	Hit Rate
1	3989	249	6.24%
2	6794	521	7.67%
3	8440	827	9.80%
2009 All: M-L Test			
Hour	Forecasts	Hits	Hit Rate
1	7460	131	1.76%
2	11510	322	2.80%
3	13520	527	3.90%

***Table 2**: Results from Jul-Dec (all data). Ceiling thresholds for H-L, H-M and M-L tests are as given in Table 2 (at left).*

Warm and Cool Season Results

The results from the warm season (Jul-Sep) and cool season (Oct-Dec) are shown in Tables 3 and 4, respectively. As was the case for the entire six-month study period, the lowest hit rates were generated by the H-L tests for each season. Hit rates were again found to be highest in the H-M tests, regardless of the time period considered.

Seasonal comparisons reveal that the majority of forecasts occurred during the warm season for all ceiling tests. More hits also occurred during the warm season, and in higher proportions than the forecasts in the H-L and H-M tests. These results indicate that ceiling prediction might benefit more from VIL forecasts during warmer parts of the year.

2009 Warm: H-L Test			
Hour	Forecasts	Hits	Hit Rate
1	3177	39	1.23%
2	5061	105	2.07%
3	5934	161	2.71%
2009 Warm: H-M Test			
Hour	Forecasts	Hits	Hit Rate
1	3177	217	6.83%
2	5061	426	8.42%
3	5934	645	10.87%
2009 Warm: M-L Test			
Hour	Forecasts	Hits	Hit Rate
1	5131	93	1.81%
2	7663	213	2.78%
3	8622	324	3.76%

***Table 3**: Results from Jul-Sep (warm season). Ceiling test conditions are the same as those described in Table 2 (above).*

2009 Cool: H-L Test			
Hour	Forecasts	Hits	Hit Rate
1	812	5	0.62%
2	1733	18	1.04%
3	2506	35	1.40%
2009 Cool: H-M Test			
Hour	Forecasts	Hits	Hit Rate
1	812	32	3.94%
2	1733	95	5.48%
3	2506	182	7.26%
2009 Cool: M-L Test			
Hour	Forecasts	Hits	Hit Rate
1	2329	38	1.63%
2	3847	109	2.83%
3	4898	203	4.14%

***Table 4**: Results from Oct-Dec (cool season). Ceiling test conditions are the same as those described in Table 2 (above).*

Tables 2-4 show that, for each given time period, hit rates were approximately five times higher for H-M tests than for H-L tests; which is evidence of ceiling criteria sensitivity. However, these limited results do not provide a definitive picture regarding ceiling sensitivity. Therefore, testing additional combinations of ceiling criteria is another likely avenue of further study.

4. SUMMARY

This paper presents preliminary results of an assessment of CoSPA's potential utility toward C&V forecasting. We focus on CoSPA VIL forecasts for durations of 1-3 hr, since at these durations CoSPA forecast data rely most heavily upon extrapolation of real-time radar observations - a data source that has not been previously examined for value in C&V forecasting.

CoSPA forecast data were found to be weakly related to the onset of impacted C&V conditions in 1-3 hour forecasts at 202 sites over a six-month time period. The forecast relationship (as indicated by hit rate) was stronger in the warm season than the cool season, and stronger for the transition from high- to mid-level ceilings than for other transitions examined.

While the CoSPA data examined thus far yielded unremarkable *overall* skill toward C&V forecasting, the weak relationship found does suggest that CoSPA data may offer incremental skill to a forecast process when used appropriately. Thus, future study will further examine CoSPA utility by explicitly blending its forecast data with resources such as LAMP and Rapid Refresh time-lagged ensembles and testing the skill of the resultant blend.

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REFERENCES

Wolfson, M., W. Dupree, R. Rasmussen, M. Steiner, S. Benjamin, S. Weygandt, 2008: Consolidated Strom Prediction for Aviation. *13th Conf. on Aviation, Range and Aerospace Meteor*., 21-24 January 2008, New Orleans, LA., Amer. Met. Soc.