Development of a Rapid-Update Real-Time Mesoscale Analysis of Ceiling and Visibility

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Objective and background

A Rapid-Update Real-Time Mesoscale Analysis (RU-RTMA) system is an extension of RTMA from an hourly analysis to a 15 minute analysis, which is developed primarily to provide a near-real time grid analysis of surface visibility and ceiling height for the Helicopter Emergency Medical Services (HEMS) tool running at the Aviation Weather Center, NOAA.

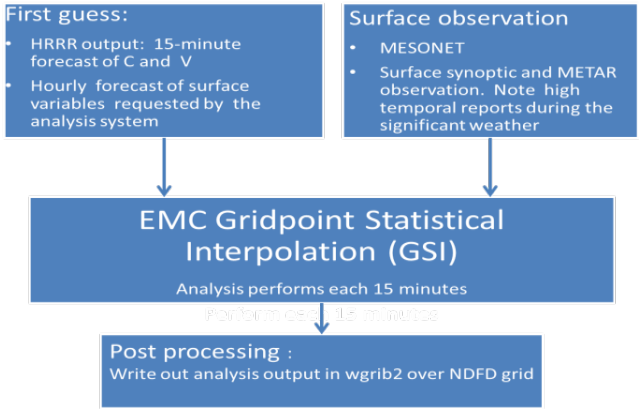
The full set of products comprise a gridded analysis of surface visibility and ceiling height (C and V), surface pressure, temperature and moisture at 2 meters, and wind speed and direction, as well as wind gust, all at 10m. The products are available for the contiguous United States (CONUS).

The following three aspects enable the development of RU-RTMA: (1) The advent of the HRRR, a high resolution numerical weather forecast model with a sophisticated cloud prediction scheme; (2) the existence of a reliable and dense network of observations; and (3) the prior development of the RTMA, which includes an hourly analysis of C and V. (Pondeca et al. 2016a, 2016b)

Considerable effort has been devoted to RU-RTMA's computing efficiency in order to deliver the analysis products no later than 20 minutes past the analysis time. With the emphasis on C and V, the observation selection algorithm of the original RTMA was modified to select only one observation per site, specifically, the one closest to the analysis time. Most C and V observations are from METAR sites, which are normally reported hourly. However, in the advent of affecting-flight weather systems, sub-hourly special reports (SPECIs) are also generated. Although SPECI reports are not particularly numerous, they are extremely important to RU-RTMA by reflecting the current weather conditions. The modified algorithm ensures the SPECIs always get the strongest weight in the analysis. The typical window of the observations ranges from 30 minutes before to 8 minutes after the analysis time.

RU-RTMA system

RU-RTMA includes four components: preparation of the first guess for the analysis; preparation of the observation files; the analysis itself, which is performed with EMC's gridpoint statistical interpolation (GSI) system; and the post processing, which converts the analysis to GRIB2 format. Below is a schematic illustration of the RU-RTMA components.



Preliminary Results

The quality of the RTMA depends on several aspects, including accuracy of the estimated forecast error covariance and observation error covariance. In particular, the known non-normal distribution of the observation innovations for C and V as well as the discrete nature of these parameters renders the analysis particularly challenging. Of note is that currently only static error statistics are used in RTMA. RU-RTMA faces similar challenges as the hourly RTMA. In addition, because of the small observation time window, fewer observations are included in the RU-RTMA assimilation than in RTMA, which has a dump window of roughly +/- 30 minutes around the center of each hour.

Our first overall check is to compare the number of observations read in and the observations assimilated between RU-RTMA and RTMA, as shown in the Table below for the selected analysis time of 0000Z 17 December 2016. The number of observations for each 15-min window is less than that in RTMA, but the sum is more than that in the RTMA, as expected. The behavior of RTMA and RU-RTMA is similar in the number of assimilated observations.

RU-RTMA: Total number of obs read in for each 15-min analysis (Top). Number of assimilated obs when only one ob per site is selected (bottom). VIS denotes visibility, CIG denotes ceiling height.

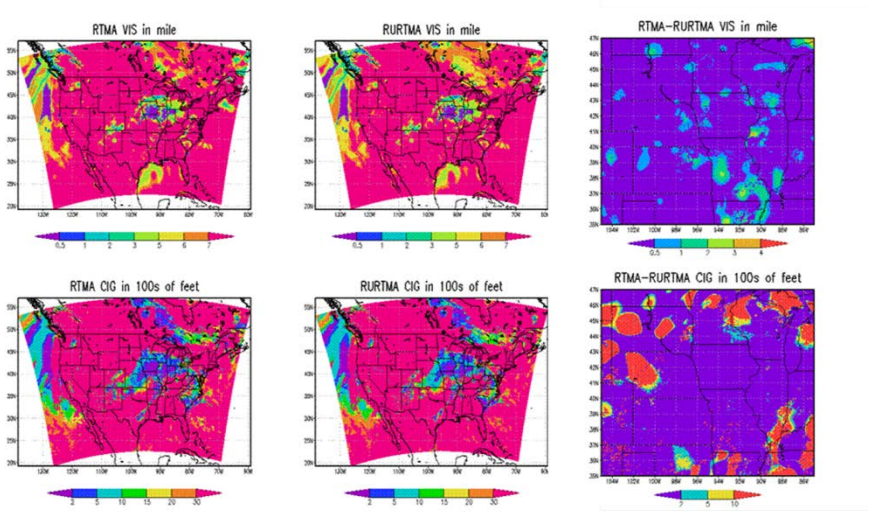
RURTMA	00min	15min	30min	45min	SUM
VIS	87356	104171	63212	60031	314770
CIG	83213	97509	57254	56424	294400
RURTMA	**00min**	**15min**	**30min**	**45min**	**SUM**
VIS	49534	53648	33508	30509	167199
CIG	42409	44882	28341	26849	142481

RTMA: Total number of obs read in within a one hour window (top). Number of obs assimilated (bottom). VIS denotes visibility, CIG denotes cloud

Hourly RTMA	One hour dump window @ 00min
VIS	280639
CIG	132122

Hourly RTMA	assimilated
VIS	102258
CIG	97777

Figure 1 Comparison of surface visibility (in miles, top panels) and ceiling height (in 100's of feet, bottom panels) between hourly RTMA (left column) and RU-RTMA (middle column) for 0000Z 17 Jan. 2017. The pattern and magnitude are quite similar. Note that both systems show a center of low C and V over the Midwest States. The third column shows the difference plot (RTMA minus Ru-RTMA) over this center. No significant differences are seen.



On-going work

Continue to assess the quality of the initial 15-min C&V products for CONUS. Compute verification statistics using independent data. Extend RU-RTMA to Alaska.

For RU-RTMA data information, contact Runhua.Yang@noaa.gov or Steven.Levine@noaa.gov

Reference

Pondeca et al. 2016a: Research Activities in Atmospheric and Oceanic Modeling (Blue Book).
Pondeca et al. 2016b: RTMA/URM v2.5.0
https://docs.google.com/presentation/d/1NQt_FIeS082uPwEzpZ7Ec4pEfI7s6Ly9F81CDM78GX0/edit#slide=id.p

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