Proceedings of ERAD (2004): 525–527 © Copernicus GmbH 2004

ERAD 2004

The HydroMet Decision Support System: new applications in hydrology

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Abstract. Weather Decision Technologies has integrated technologies from the National Severe Storms Laboratory (NSSL) and McGill University into a HydroMet Decision Support System. The HydroMet Decision Support System consists of numerous algorithms which integrate radar, satellite, surface, and numerical modelling to provide precipitation typing and accumulation. The basis of product delivery is through a Web based display. This paper describes the setup and algorithms of the HydroMet Decision Support.

1 Introduction

Weather Decision Technologies (WDT) has integrated technologies developed at the National Severe Storms Laboratory (NSSL) and McGill University to provide the HydroMet Decision Support System (HDSS). HDSS integrates several data sources including radar, satellite, numerical model, and surface data to provide Quantitative Precipitation Estimates (QPE) and Quantitative Precipitation Forecasts (QPF). WDT has licensed the McGill Algorithm for Precipitation nowcasting by Lagrangian Extrapolation (MAPLE) from McGill University in Montreal Canada (Turner and Zawadzki, 2003). WDT has additionally licensed NSSL's Quantitative Precipitation Estimation and Segregation Using Multiple Sensors (QPESUMS) (Gourley et al., 2001). WDT has combined these two core technologies into a Web based package that addresses the needs of the hydrological community. This paper will discuss these two technologies and their applications within HDSS.

2 The NSSL Three-dimensional Mosaic Algorithm

The premise of the radar based QPE and QPF within HDSS is the mosaicing of radar data across a given radar installation network. NSSL has developed a quality control mosaicing scheme that can be applied to any network (see Zhang et al., 2001, 2002). Several steps are taken during the mosaic process to assure data quality is as pristine as possible. These include the use of topographically based hybrid scans, radar calibration corrections, clutter filtering, filling of concentric rings inherent in the scan-by-scan collection of radar data, and bright-band filtering (see Maddox et al., 2002; Gourley et al., 2003). The final result is a three-dimensional radar mosaic that is suitable for use by QPE and QPF applications.

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3 The McGill Algorithm for Precipitation nowcasting by Lagrangian Extrapolation (MAPLE)

MAPLE is a radar reflectivity extrapolation algorithm developed at McGill University that provides forecasts of the predictive scales of precipitation through scale-dependence separation, variational echo tracking, and a semi-Lagrangian advection scheme (see Germann and Zawadzki, 2001; Turner and Zawadzki, 2003). MAPLE forecasts are used as both absolute values and as probabilistic forecasts. WDT uses mosaics of radar data as described in Sect. 2 as input to MAPLE. The reflectivity forecasts generated by MAPLE are at 5 min increments out to 4 h in advance. As part of HDSS, WDT has developed applications that use the MAPLE forecasts in conjunction with surface information from numerical forecast models and varying Z-R and Z-S relationships to provide radar based QPEs and QPFs. The Z-R and Z-S relationships are segregated by geography, derived precipitation typing, convective/stratiform typing, and tropical vs continental typing. Figure 1 shows a 4 h forecast of QPF using reflectivity forecasts from MAPLE, applying surface conditions forecast at that time from numerical model data, and applying the variational Z-R/Z-S relationships. These types of forecasts can in turn be integrated within other applications

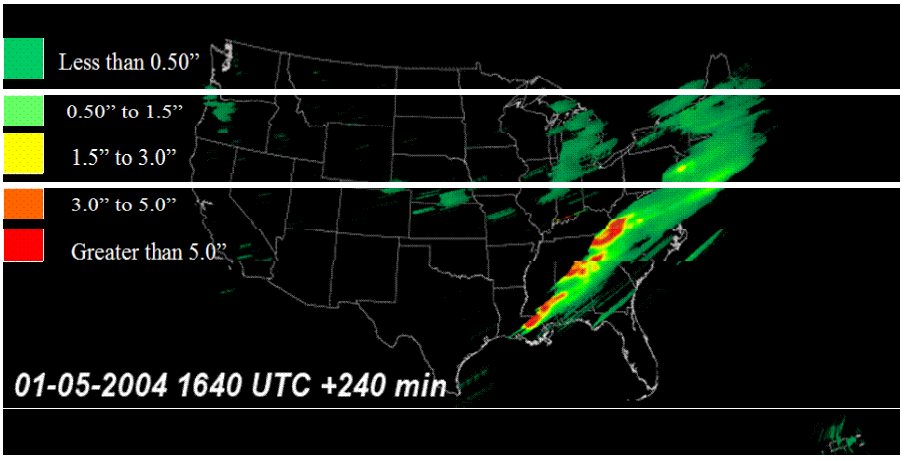

Fig. 1. Example of 4 h QPF using MAPLE forecast.

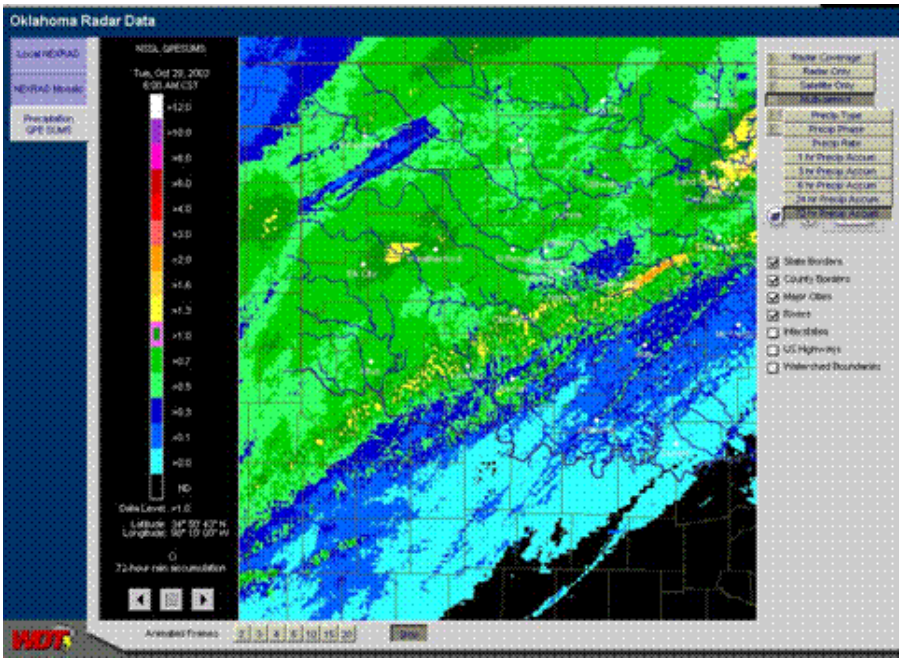

Fig. 2. Example of QPESUMS output within HDSS Web based display. Panel shows storm total accumulated precipitation based on QPESUMS processing.

4 The NSSL Quantitative Precipitation Estimation and Segregation Using Multiple Sensors (QPESUMS)

QPESUMS is a sophisticated QPE package that utilizes a suite of algorithms to arrive at a set of precipitation estimates. QPESUMS integrates the 3-D mosaic described above with satellite, rain gauge, sounding, and numerical model data to provide a final precipitation estimate that can be integrated over any time period. A convective-stratiform segregation algorithm that combines satellite IR temperature data with numerical model and sounding data. This algorithm is run at each gridpoint in the mosaic. In this manner the correct Z-R relationship can be applied to each grid point based on whether the point is convective or stratiform in nature. Radar data on the grid are calibrated using satellite data. It is reognized that the accuracy of surface based radar derived precipitation estimates are strongly range dependent. A regression technique is applied to the radar data based on satellite estimates of rainfall for the same locations. This regression is of particular importance in areas of straiform rain estimates at longer ranges. Provided the regression correlation between a grid cell and its satellite based QPE is resonable, the grid cell QPE is adjusted based on the satellite information.

Finally, Rain gauges are used to calibrate the combined radar/satellite precipitation estimates. The rain gauge data are collected at least hourly and at time resolutions of 5

minutes if available. In the vicinity of each rain gauge, radar/satellite estimated rainfall data are compared to rain gauge data over an hour time period. If there is a difference between the mean rain gauge estimates and the mean radar/satellite precipitation estimates the radar/satellite precipitation estimates are adjusted appropriately.

Figure 2 shows an example of QPESUMS output within the HDSS Web based display.

5 Conclusions

This paper has briefly described WDT's HydroMet Decision Support System. The core technologies of QPESUMS and MAPLE not only provide basic hydrological applications but their results can also provide QPE and QPF that can then be extended to other applications. The integration of these technologies has provided operational decision makers with management tools across several applications including water resource management, flash flood and river flood management, and hydrological modelling. HDSS will be described in greater detail at the conference and statistical results of MAPLE, QPESUMS, and HDSS will be provided.

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