NWS PRECIPITATION ANALYSIS PRODUCT

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Introduction

NWS Weather Forecast Offices (WFO) and River Forecast Centers (RFC) are tasked with monitoring the hydrometeorological status of the continental United States (CONUS) and Puerto Rico. The NWS RFCs utilize the Weather Surveillance Doppler Radar (WSR-88D) and observed precipitation amounts to create gridded precipitation estimates. The addition of the WSR-88D precipitation estimates to observed precipitation values from first order stations and Co-Operative Observation locations gives a spatial resolution to rainfall distribution that is not available when using gage only information. Each RFC quality controls the WSR-88D precipitation estimates as part of their routine duties to ensure that WSR-88D precipitation estimates align with observed values from gauges which report hourly. If needed, a bias adjustment is calculated for each radar. The product covers the entire CONUS and Puerto Rico. The product is initially updated daily at approximately 14300GMT to encompass the observed precipitation for the 24 hour period ending at 1200GMT. The data is displayed in a GIS format at the following website: http://water.weather.gov

In addition, derived precipitation products are available for certain user selectable time frames. Individual daily files are available going back to 2005. Also, individual shape files with a resolution of 4x4 kilometers (km) can be downloaded on demand by users to create customized products on demand.

Observed Precipitation

"Observed" data is derived from output from 12 NWS RFCs and is displayed as a gridded field with a spatial resolution of 4x4 km. "Observed" data is expressed as a 24 hour total ending at 1200Z (or GMT), with longer periods simply being a summation of multiple 24 hour periods. 1200 GMT is used as the ending time for the 24 hour total because it is the end of the "hydrologic day", a standard used in river modeling. Additionally, 1200GMT closely coincides with the reporting time for most of the NWS Cooperative Observers whose data are used as a quality control on the dataset. 1200GMT coincides with 8AM EDT, 7AM EST, 7AM CDT, 6AM CST, etc.

Observation Methods

East of the Continental Divide, RFCs derive the "Observed" Precipitation field using a multisensory approach. Hourly precipitation estimates from WSR-88D radars are compared to ground rainfall gauge reports, and a bias (correction factor) is calculated and applied to the radar field. The radar and gauge fields are combined into a "multi sensor field", which is quality controlled on an hourly basis. In areas where there is limited or no radar coverage, satellite precipitation estimates (SPE) can be incorporated into this multisensory field. The following links provide additional information about the programs used to derive these multi sensor fields:

http://www.srh.noaa.gov/abrfc/p1vol.html
http://www.srh.noaa.gov/abrfc/prism1.htm
http://www.nws.noaa.gov/os/whfs/HydroView/AMS_Paper.pdf

This method of precipitation processing optimizes the accuracy of physical measurements while maintaining the variability of intensity that the WSR-88D estimates provide. At gauge locations, the gridded value is set to the observed value and a WSR-88D bias is calculated. Between gauge locations, a double linear interpolation technique is applied to a triangulated irregular network (TIN) to vary the bias for each grid. The result is a unique bias for each 4x4 km grid.

In mountainous areas west of the Continental Divide, a different method is used to derive the "observed" data. Gauge reports are plotted against long term climatologic precipitation (PRISM data), and derived amounts are interpolated between gauge locations. The following link provides more information about the process and program used to derive observed precipitation for the western US.

http://www.cnrfc.noaa.gov/products/rfcprismuse.pdf

Normal Precipitation

"Normal" precipitation is derived from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) developed by Dr. Chris Daly of Oregon State University. The PRISM gridded climate maps are considered the most detailed, highest-quality spatial climate sets currently available. The 30 year PRISM normal from 1971-2000 is used for precipitation since 2004.

The PRISM data is expressed as a monthly normal rainfall. For durations less than one month, the value for that month is divided by the total days in that month and multiplied by the number of days in the selected field. For example, a 7 day normal for March 10th (ending at 1200GMT) would be 7/31 of the total rainfall for March, while a 14 day normal would be 9/31 of March's normal plus 5/28 of February's normal.

Derived Precipitation Products

"Departure from Normal" and "Percentage of Normal" graphics are generated by simple grid mathematics, where the "Normal" dataset is respectively subtracted from or divided into the "Observed" dataset.

Data Formats

The precipitation fields are provided in GIF format for viewing, and shapefile and netCDF formats for download and use in other projects and research.

Production/Update Times

The precipitation analysis pages are routinely updated three times per day at approximately 1430GMT, 1830GMT, and 2130GMT. Data for the western US are usually available by the second update. The data for the first two updates are preliminary and subject to change based on more thorough quality control. While the data in the final update are much less likely to change, it is neither official nor certified.

Quality of Data

"Observed" data, and by extension the derived data is vulnerable to inaccuracies that can be caused by either radar or precipitation gauges. For radar, problems would include freezing or frozen precipitation, low topped convection, bright banding, the reflectivity/rainfall (i.e. Z/R) relationship in use, the calibration of the radar, radar location and elevation, range degradation, and the radars effective coverage. For precipitation gauges, problems come from freezing precipitation, windy conditions, gauge siting, gauge maintenance, and under measurement by tipping bucket gauges in high intensity rainfall.

Strengths and Weaknesses

Gauge observations of precipitation are by and large reliable and accurate. However, existing gauge networks are not dense enough to provide an accurate estimate of the spatial distribution of precipitation. While WSR-88D precipitation estimates leave much to be desired quantitatively, they are generally accurate in their depiction of the spatial distribution of precipitation. This product incorporates the accuracy of physical measurements of precipitation with the spatial resolution offered by WSR-88D estimates. On a daily basis, in an operational setting, this is the most accurate method of estimating precipitation. It does not show the long-term negative biases which have been observed in studies (Stellman, 1999, and Wang, 2000).

The largest weakness is in the western US where mountains reduce the effectiveness of the WSR-88D data resulting in a disproportionate need of interpolating between rain gauge values to derive precipitation amounts. In addition, close in beam blockage by obstructions (i.e. water towers) can reduce the spatial resolution of WSR-88D estimates along the radial where the blockage occurs. This is difficult to ascertain and correct for in real time. However, cumulatively, over a long period of time, this results in a deterioration of the quality of the precipitation estimate along the radial where the blockage occurs.

Acknowledgments

The authors would like to thank James Paul, Senior Hydrologist of the Arkansas Basin RFC, Frank Bell, Senior Hydrologist of the West Gulf RFC, and Seann Reed, Research Hydrologist, Research Hydrologist at the NWSH Office of Hydrology for their help in writing the software which makes this product possible. In addition, Keith Stellman and Paul Kirkwood of the NWS Southern Region have made the availability of this data possible prior to its inclusion into the NWS Advanced Hydrologic Prediction Service suite of products.

References

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Stellman, K., Fuelberg, H, Garza, R., and Mullusky, M., 1999: “Investigating Forecasts of Streamflow Utilizing Radar Data”.

Wang, D., Smith, M., Zhang, Z., Reed, S., and Koren, V., 2000: “Statistical Comparison of Mean Areal Precipitation Estimates from WSR-88D, Operational and Historical Gauge Networks”.