P1.27 AUTOMATED SPATIAL PRECIPITATION ESTIMATOR (PrecipVal)

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ABSTRACT

A new spatial precipitation estimator is under development at the National Climatic Data Center (NCDC) and scheduled for implementation operationally in January 2004. The system uses rules-based GIS technology and multiple external data sources to estimate precipitation totals for any point in the continental United States. The estimated values provide an independent assessment for the quality assurance of daily and hourly in-situ precipitation data.

External data sources consist of, but are not limited to, the National Weather Service (NWS) Automated Surface Observing System Network (ASOS), Climate Reference network (CRN), National Center for Environmental Predication Rapid Update Cycle (RUC) model, Geostationary Operational Environmental Satellite (GOES), and Weather Surveillance Radar 1988 Doppler (WSR-88D). The Precipitation estimator module known as “PrecipVal” replaces the current interactive graphical validation processes that often require manual review of suspect data, limiting the amount of data that receives spatial inter-comparison. Higher confidence in PrecipVal is attributed to a change in methodology (using multiple external layers) and access to higher quality data for use as "ground truth."

Additionally, PrecipVal is able to estimate hourly or daily precipitation values for all missing days whereas the current validation process can only generate estimated precipitation values under certain conditions. Evaluation of the new system using statistical analysis and manual verification is ongoing. The results of the tests will be shown.

1. INTRODUCTION

The NCDC is responsible for acquisition, quality assurance, and archive of the Nation’s weather and climate information. Today’s climate related issues dictate the need for high quality homogenous precipitation data sets. In response to that need, NCDC takes advantage of advancements in information technology, easier access to data sources and leveraging existing data products to develop grid estimates to spatially validate both daily and hourly precipitation point data. Previous spatial quality assurance of precipitation data was predominantly an interactive and somewhat subjective process.

The new processing module is rules-based, fully automated, and objective. Therefore for the first time precipitation quality assurance makes use of new independent data sources.

2. CONCEPT OF PRECIPVAL

PrecipVal is a near-real-time, fully automated, “plug in” module that is designed to return an estimated precipitation value for any location in the continental United States. Hourly values are derived, at 4.7 kilometer nominal resolution. Multiple data sources (referred to as “layers”) are used to increase confidence in the derived value. A modular design allows for new layers to be added as they become available. The flexibility of PrecipVal allows its application to be applied to any data source where estimated precipitation values are useful.

3. DATA SETS (LAYERS)

3.1 *Remote Sensing and Model Data*

The quality of the data used by PrecipVal as “truth” is essential to its performance. To ensure high confidence, data values are screened for outliers by comparing an individual layer to all other remaining layers. Data values that pass the “inter-layer comparison test” are averaged to produce a single blended gridded value. Currently layers include, but are not limited to radar, satellite, and model based estimates.

Statistics for each grid cell are created and stored in an identical grid format. Each statistical grid cell contains information on the different data sources (layers) used to create the corresponding precipitation estimated value. This information is useful in assigning a confidence level to the estimated precipitation value. Statistical grids include, the number of layers available (Figure 4), number of layers used (passed inter-layer comparison) (Figure 5), the standard deviation of layers used (Figure 6), range (Figure 7), and inner quartile range (Figure 8) for all layers used.

3.2 *Point Data*

PrecipVal adds a separate spatial element by utilizing precipitation point data as ground truth. Point data sources are interchangeable depending on the application of PrecipVal. Examples of precipitation point data include ASOS, CRN, and other existing mesoscale precipitation networks.
PrecipVal utilizes in-situ (gage) point data independently from the other data source grid estimates.

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4. PRECIPVAL FLEXIBILITY

4.1 *Data Processing*

The inherent flexibility of PrecipVal allows for application in any situation where estimated precipitation values are beneficial. PrecipVal generates statistics for each grid cell, so that a confidence level can be assigned, appropriate to the situation. For example, point precipitation data that agrees or disagrees with a "layer" where twelve data sources are available and all twelve are used will have high confidence in regards to validation. Point precipitation data that is compared to a "layer" with lower ratios (i.e., six of twelve used, four of twelve used) has lower validation confidence or may not validate at all.

4.2 *Hourly Gridded Data*

Gridded estimates can be generated via user defined date range and return type. Gridded element return types include: For example,

- Total = Sum of grid values for the specified summary period. Returned values include the number of non-missing values used to calculate the total.

- Average = Average of grid values for the specified date range. Returned values include the number of non-missing values used to calculate the average.

- Maximum = Maximum value in the specified date range. Returned values include the day and hour of the maximum value.

- Minimum = Minimum value for the specified range. Returned values include the day and hour of the minimum value.

4.3 *Individual Layer Statistics*

Two statistical grids are generated from each layer. The first grid tracks the number of times a layer value is available (Figure 4). The second grid tracks the number of times a layer value is used (Figure 5, passed inter-layer comparison).

Statistics for a specific layer can be derived at a point, over a specified area, or over the entire grid. These statistics identify potential large scale and regional biases and may result in the removal of a non-performing layer.

4.4 *Point Data*

The point data component of PrecipVal returns precipitation and distance values from any location to the point data network defined as ground truth.

Limits can be manipulated to return any number of sites within a variable search radius.

The point data component is useful when independent data sources are in the same vicinity of the location in question.

5. BENEFITS

Benefits to the precipitation validation quality assurance processing system introduced by PrecipVal include:

(1) Elimination of subjectivity and inhomogeneities caused by interactive quality assurance.

(2) Edits based on PrecipVal are uniform and systematic and not open to a validator's interpretation.

(3) Validation accuracy is improved due to the use of multiple data sources as "ground truth".

(4) PrecipVal is applicable to any system where estimated precipitation values are useful.

(5) PrecipVal can report on the performance of precipitation products such as radar, satellite, or model data. This information can assist developers in product improvements.

(6) PrecipVal is scaleable and reanalysis may be run on the data if modifications to PrecipVal are made.

(7) PrecipVal's accuracy will automatically improve with advancements in remote sensing technology.

(8) PrecipVal is part of a larger spatial quality assurance program at the NCDC. TempVal (Angel et al. 2002) is a spatial module applied to temperature data in the same paradigm as PrecipVal.

6. LIMITATIONS

PrecipVal is limited by the quality and availability of multiple data sources. Confidence assessments of estimated values are diminished as the number of data sources covering a particular location decrease.

7. EXAMPLES OF USE

7.1 *Inter-Layer Comparison*

The strength of PrecipVal is based largely on the use of multiple external data sources. For example, Figure 1 shows an area with suspect precipitation estimates caused by ground clutter surrounding individual radar sites.

PrecipVal determines these values are invalid and removes them from the inter-grid estimate. Figure 2 displays the same area after PrecipVal performed the "inter-layer comparison test."

7.2 ***Data Sets***

The first data sets processed through PrecipVal include NWS' Cooperative Observer Network which reports daily observation and the NWS ASOS.

The independent assessment of PrecipVal has greatly improved our ability to detect errors associated with the Cooperative Observer Network precipitation reports, that are often assigned to the wrong calendar day (i.e. time shifting).

As in all data processing at NCDC original data values are always maintained. Suggested edit values are published along with the original reported value.

8. SUMMARY

We have found PrecipVal to be an effective tool in the spatial quality assurance of precipitation data. It reduces manual effort and eliminates subjectivity introduced through the current interactive process.

Estimating precipitation by developing grids using multiple external data sources is a viable spatial quality assurance tool. PrecipVal is capable of producing reliable hourly precipitation estimates.

9. REFERENCES

Angel, William E., Michael L. Urzen., Stephen A. DelGreco., Matthew W. Bodosky 2002: Automated Validation For Summary Of The Day Temperature Data (*TempVal)* Session 15.3 19th Conference on IIPS. Long Beach, CA

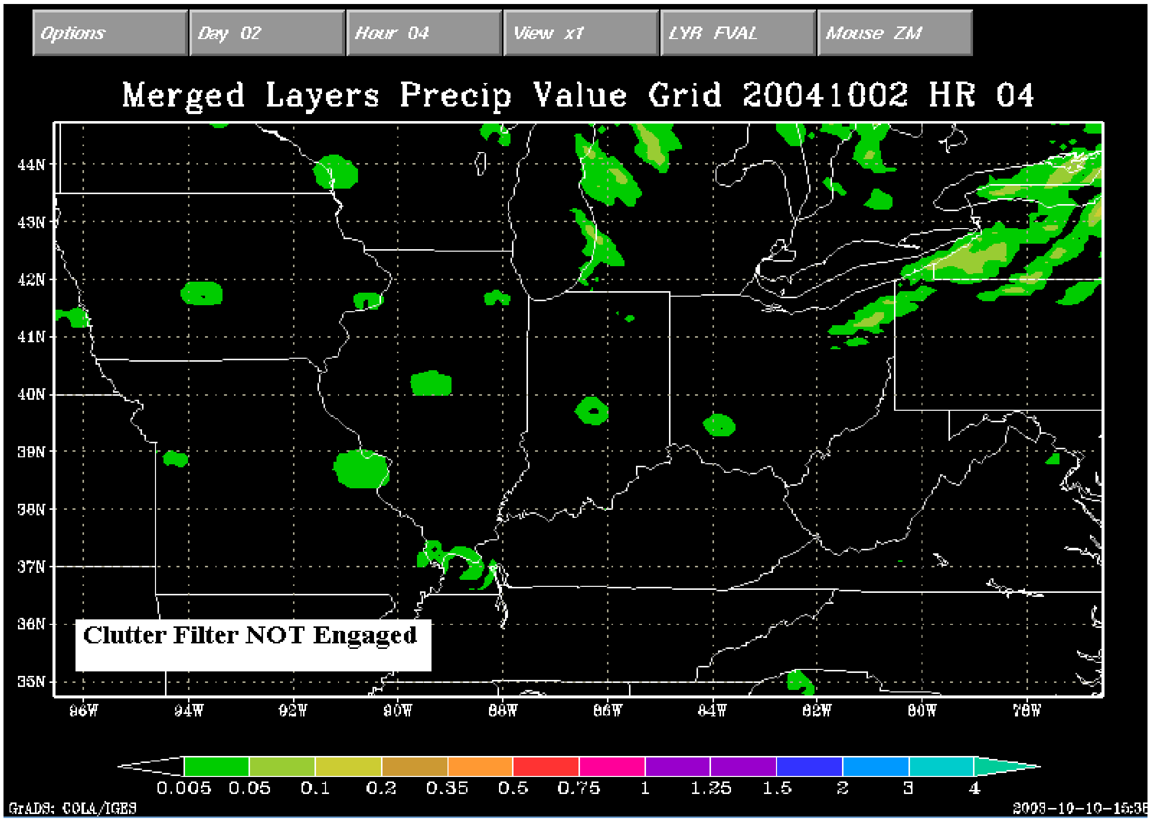

Figure 1. Erroneous precipitation estimates (ground clutter)

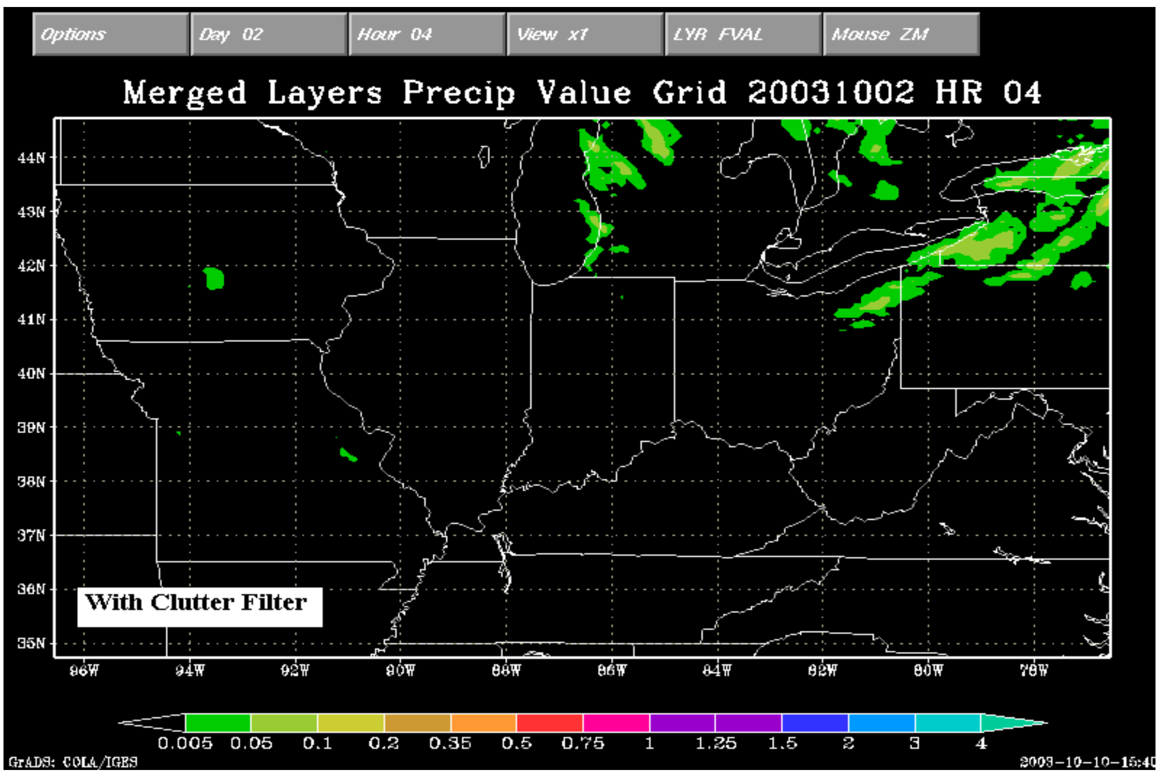

Figure 2. Erroneous precipitation estimates (ground clutter) filtered from PrecipVal grid estimates.

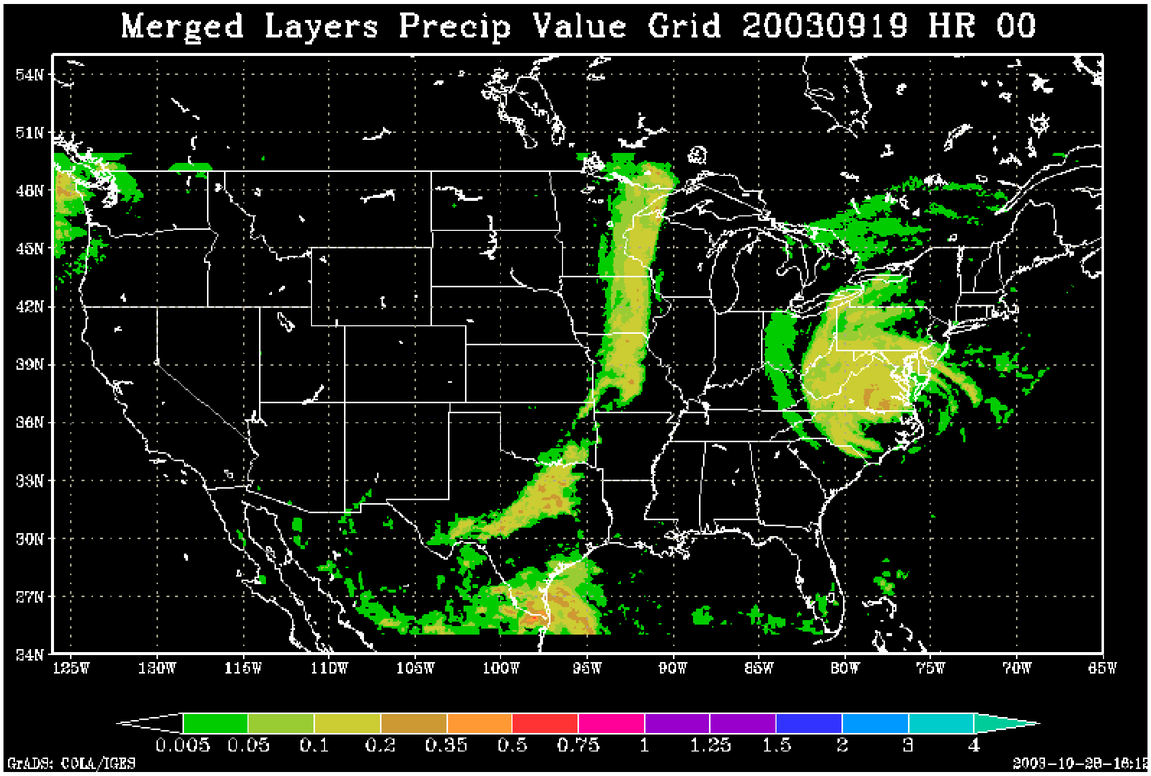

Figure 3. PrecipVal gridded precipitation estimates depict Hurricane Isabel.

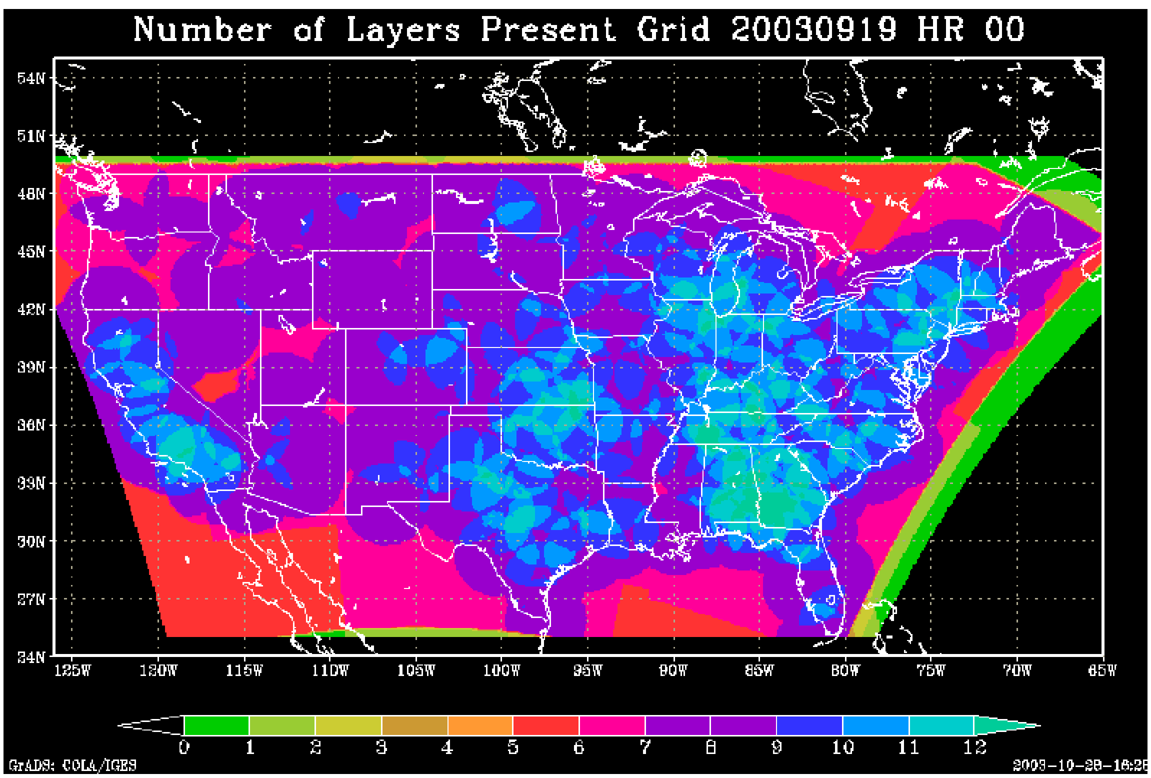

Figure 4. Depicts the number of layers available for PrecipVal grid creation.

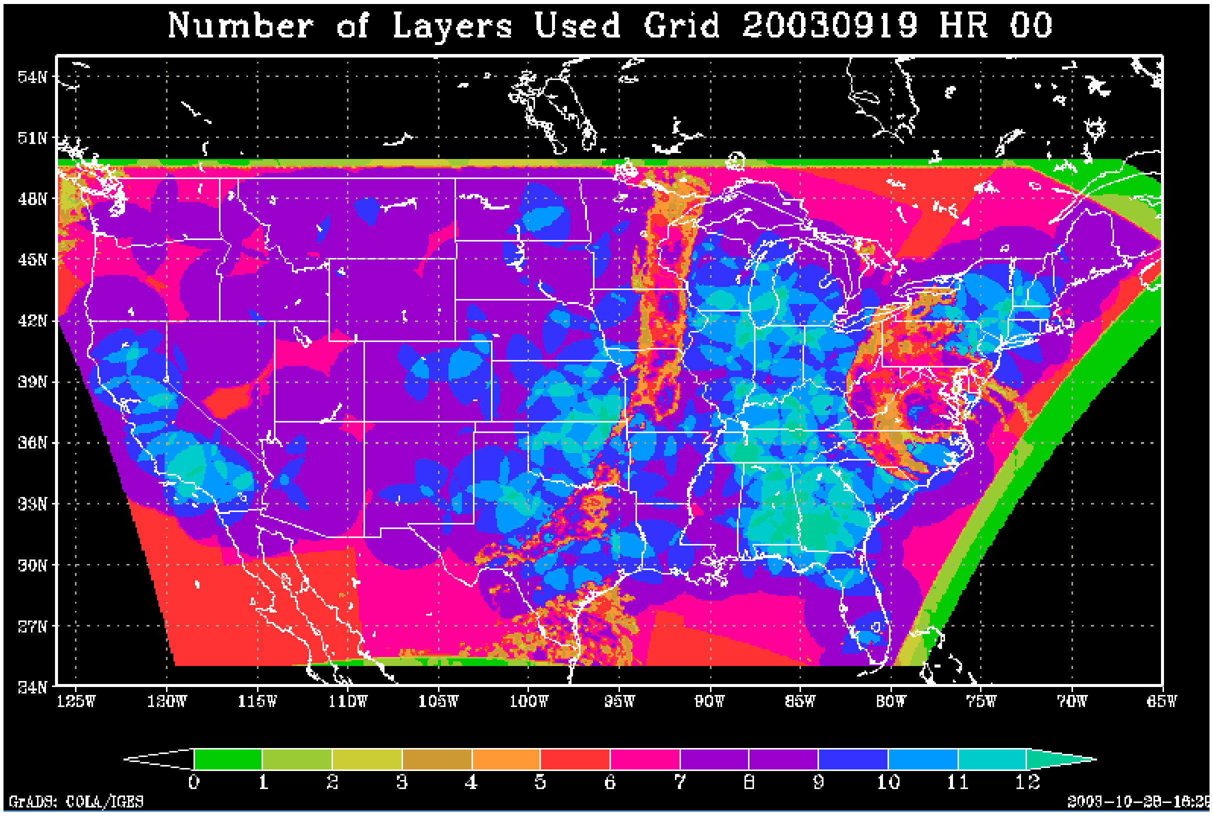

Figure 5. Depicts number of layers used for PrecipVal grid creation (Passed internal-layer comparison).

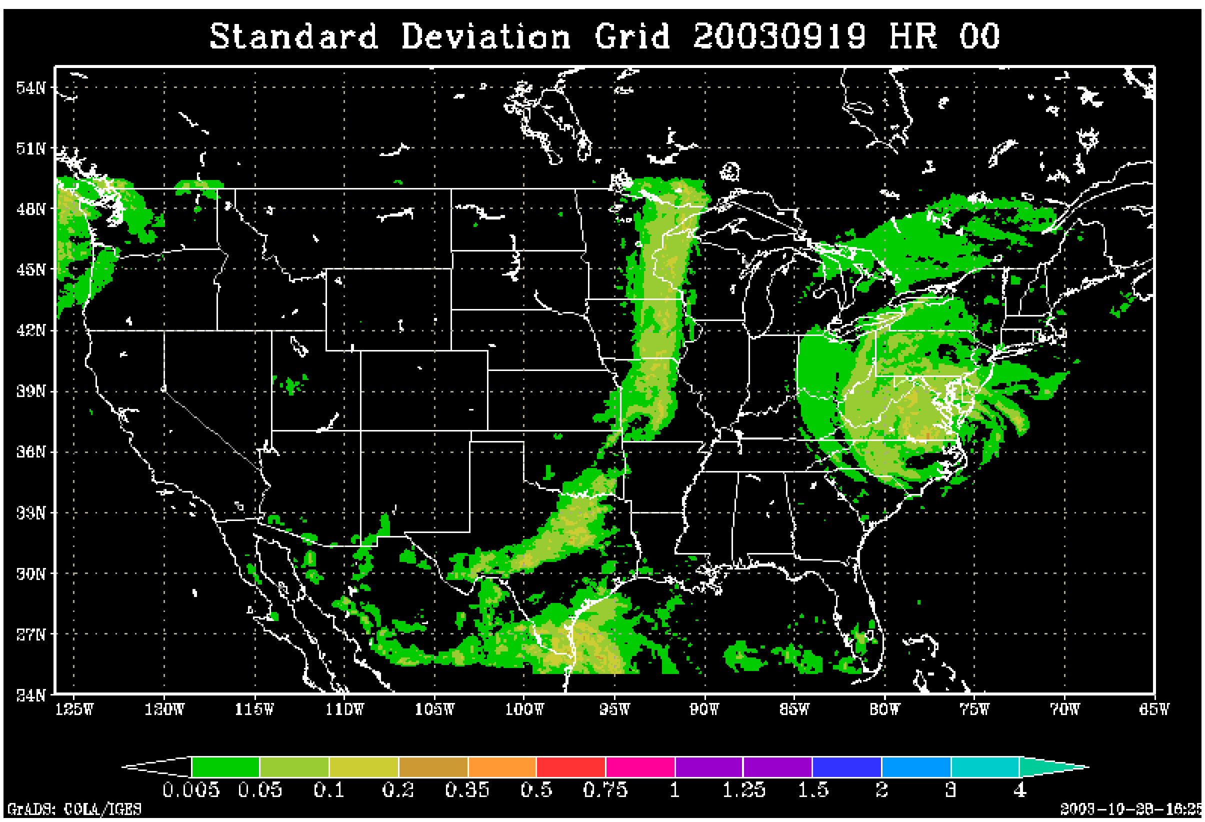

Figure 6. Standard Deviation between layers used.

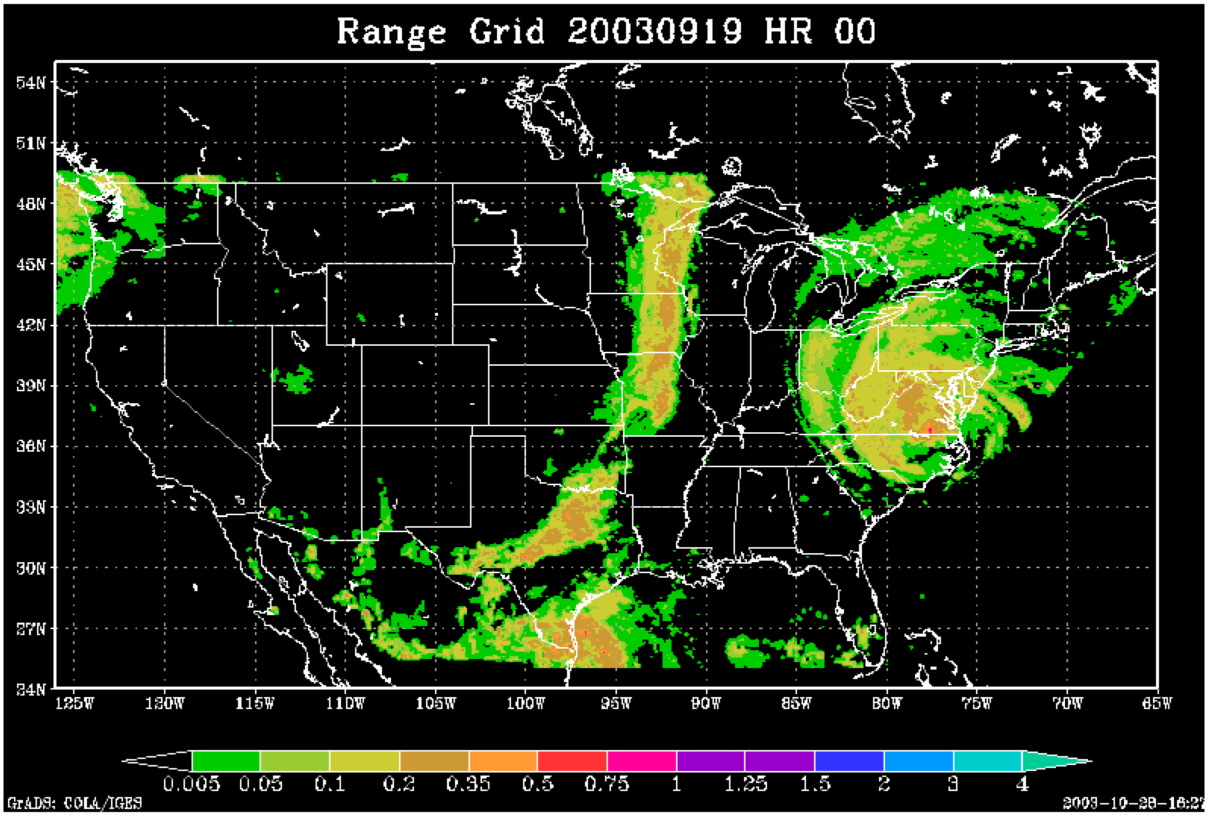

Figure 7. Precipitation estimates Range of Layers used (inches).

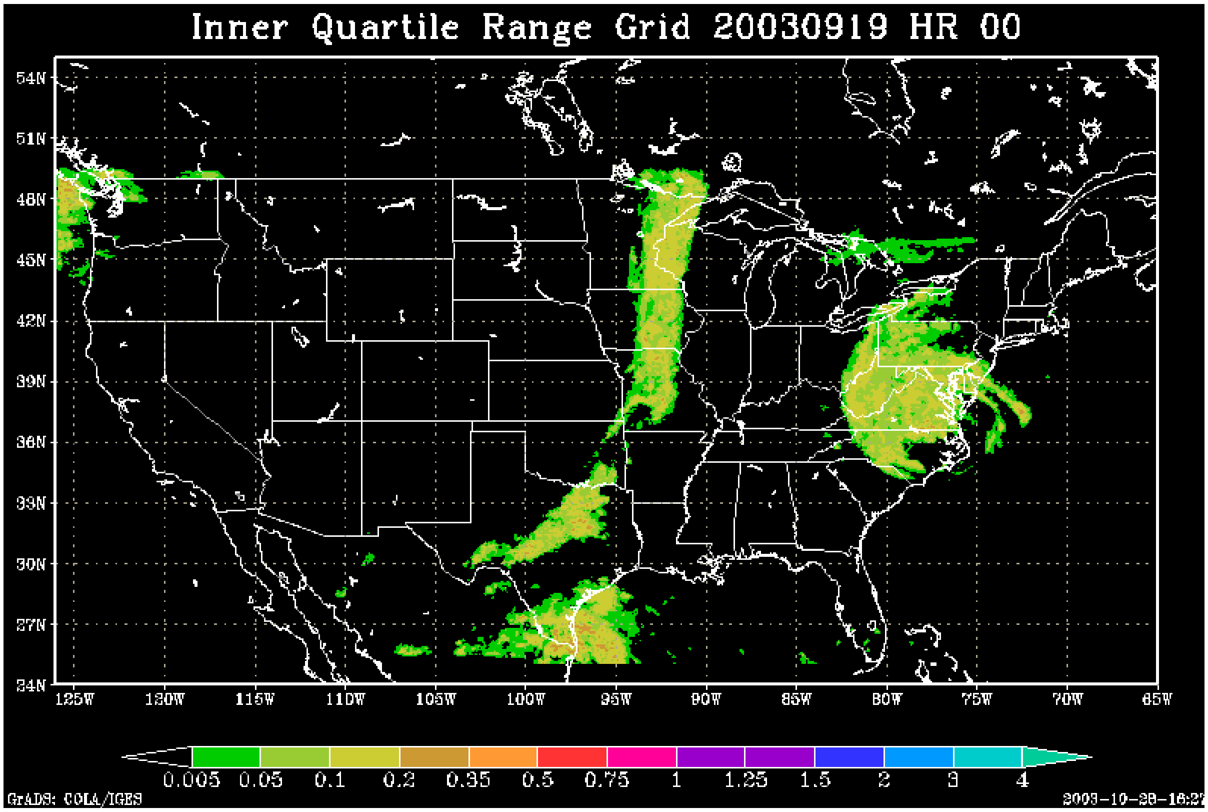

Figure 8. Precipitation estimates Inner Quartile Range of layers used (inches).