# NREPS Applications for Water Supply and Management in California and Tennessee.

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## Introduction

**Knowing the rainfall distribution (where and how much) is critical in determining how to best distribute that water throughout the watershed. Rain gauges have long been the standard used by water resource management organizations to provide rainfall measurements across their watershed. However, maintaining a large rain gauge network can be costly and budget cutbacks are driving water management organizations to investigate other, less expensive means for measuring rainfall.**

## NREPS Origins and Methodology

**First developed by NASA MSFC and UAHuntsville, the NEXRAD Rainfall Estimation Processing System (NREPS) was developed to use weather radar to estimate rainfall for water resources management in the Tennessee Valley.**

- **Uses volume scan information from radars (WSR-88D) through LDM feed.**
- **Quality controls the data.**
- **Computes rainfall rates from a tailored Z-R relationship.**
- **Grids and merges rainfall.**
- **Produces a 2 km hourly rainfall grid.**
- **In event of LDM outage, NCEP StageII used as backup.**

**NREPs can be tailored to meet customer needs on spatial and temporal scales relevant to the hydrologic or land-surface models of the end-user.**

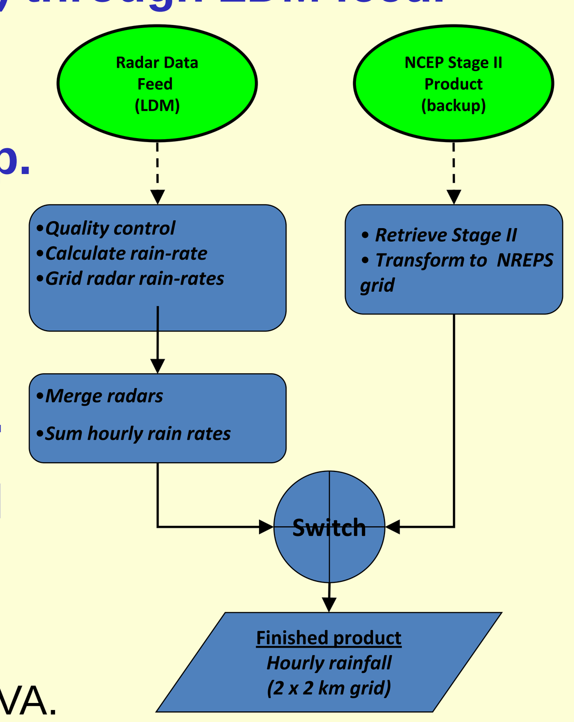



Figure 1: Layout of NREPS software system design for TVA.

## NREPS Applications

**The NREPS has been estimating rainfall across the Tennessee River watershed for the Tennessee Valley Authority (TVA) since 2007 and for NASA's Water Supply and Management Project in the San Joaquin Valley of California during the winter months of 2010-2011.**

### TVA

**TVA is the nation's largest public power provider. Maintaining a network of 189 rain gauges results in around $1 million in maintenance costs. These costs, along with advances in rainfall-mapping by radar, motivated TVA to investigate the feasibility of replacing rain gauges with weather radar rainfall estimates. For the TVA, NREPS produces hourly basin total rainfall used as input into streamflow models.**

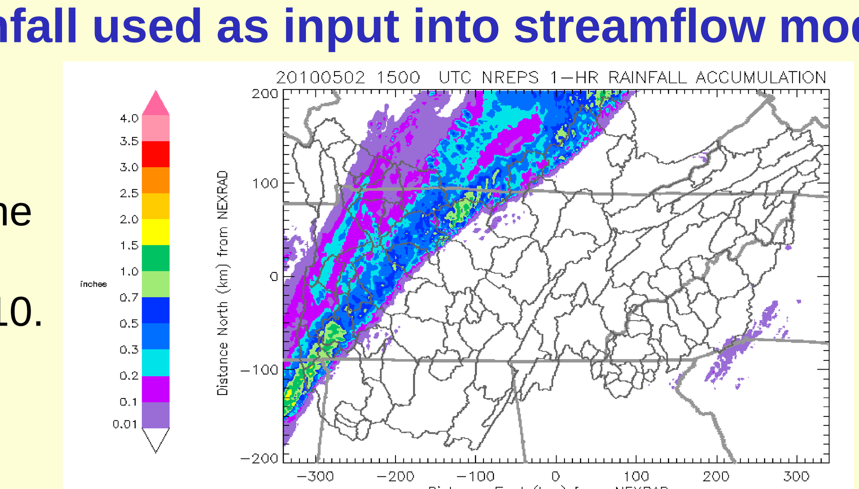



Figure 2. NREPS 1-hr rainfall estimate during the historic Tennessee flooding of early May 2010.

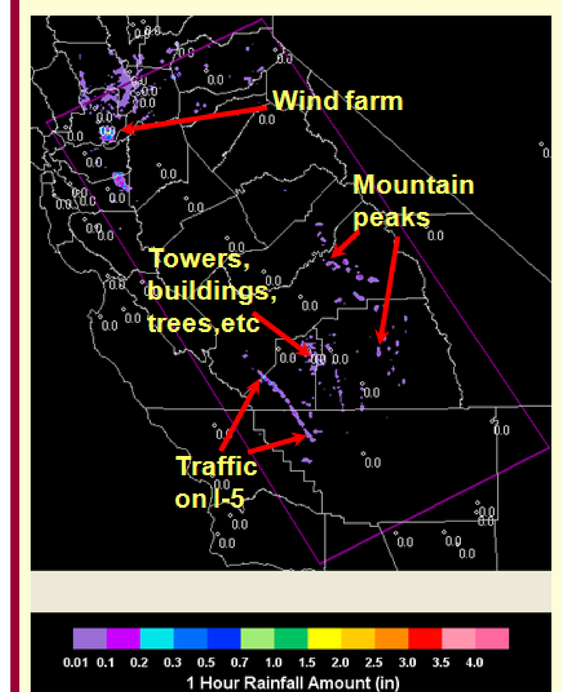
### San Joaquin Valley

**Through funding from the American Recovery and Reinvestment Act NREPS was adapted and optimized over central California from November 15, 2010 through May 14, 2011. NREPS hourly rainfall estimates were integrated into NASA MSFC's SHEELS land surface model.**

## Improving NREPS Rainfall Estimates

**•There have been several updates over the last year including:**

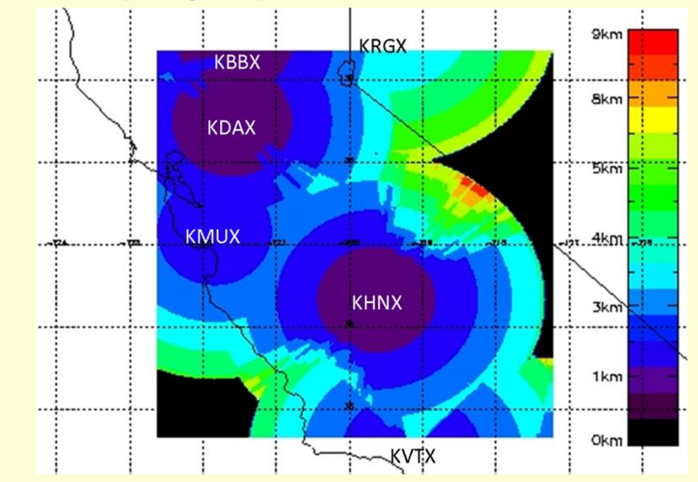
**•Non-precip mitigation:**




**•To reduce the impact of non-precipitation in the radar data, methods devised by Steiner & Smith (2000) were employed as well as a "climatological" non-precipitation mask (areas that showed persistent rainfall during dry periods).**

Figure 2: Persistent non-precipitation features in central California removed from NREPS estimates.

**•Topographic Occultation:**




**•A DEM and beam model were used to find locations where the radar beam intersects the terrain, similar to Lang et al. (2009), and correct for any partial occultation of the beam. For locations with >90% blockage, a higher available elevation angle was used.**

Figure 3: Height of the lowest available unblocked radar beam over central California.

**•Accounting for the vertical profile of reflectivity (VPR).**

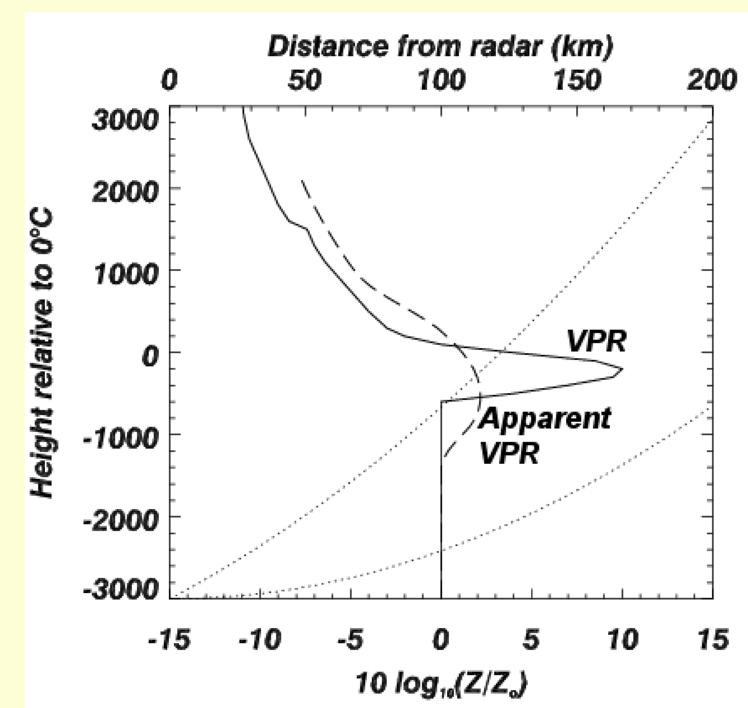



Figure 4. Model VPR (solid) and apparent VPR at 100 km range (dashed) used by NREPS in Central California. Also shown is the 3dB radar beam at 0.5° elevation (dotted).

**•A VPR was modeled after vertically pointing S-band radar observations in California by Neiman et al. (2005) and Martner et al. (2008), and adjusted for the PPI scanning strategy of WSR-88Ds (i.e., apparent VPR) relative to the RUC analysis of the 0°C level.**

**•Before incorporating the VPR, NREPS overestimated rainfall 50-75 km from the radars (due to the melting layer) and underestimated rainfall in the higher elevations, further from radars (in the ice above melting layer). The VPR correction greatly improved NREPS rainfall estimates when compared to rain gauges.**

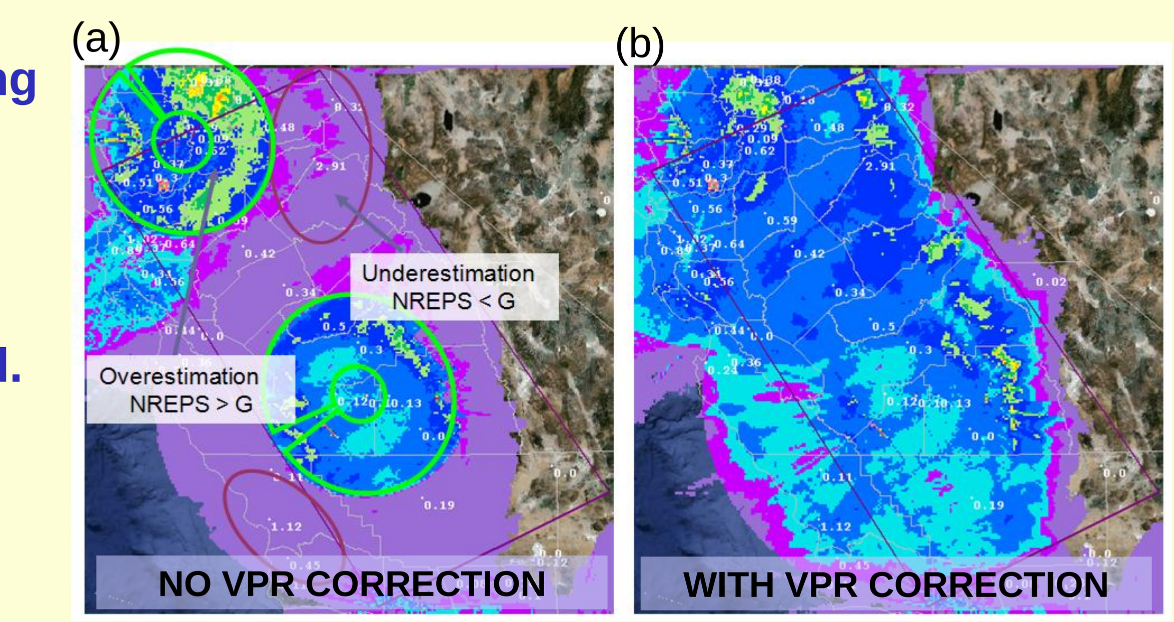



Figure5: Rainfall over the California domain (a) before and (b) after VPR correction.

## Performance Assessment Results

**Tennessee Valley**

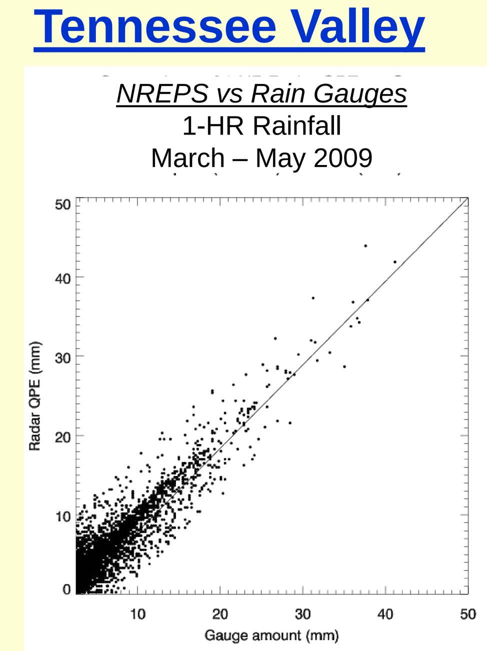



**Figure 6. Hourly NREPS performance relative to rain gauges in the Tennessee Valley during March-May 2009.**

**San Joaquin Valley**

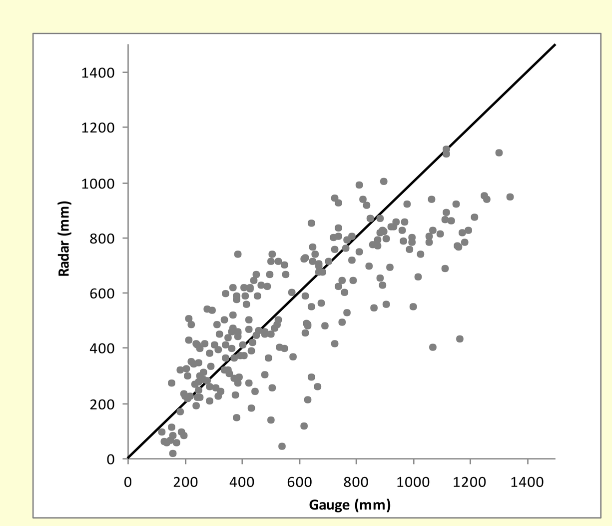



**Figure 7. Monthly NREPS performance relative to rain gauges in the San Joaquin Valley during Nov 2010-Mar 2011.**

## Future Applications and Implementations

**Future algorithm developments could include :**

- **Regional biases of the NREPS estimates can be partly attributed to the use of a unique VPR model and *Z-R* relation for the entire NREPS domain. Thus employing a locally varying VPR (e.g., Zhang et al. 2009) and *Z-R* could further reduce the regional bias.**
- **Gauge-tuning of NREPS estimates in near real time.**
- **Satellite-based precipitation radars (e.g., TRMM PR, GPM DPR) act as a secondary source that can be used to verify and/or enhance VPR identification and correction as well as *Z-R* relations employed.**
- **Geostationary IR combined with LEO passive microwave satellite-based QPE. These techniques could extend and enhance NREPS in regions difficult for accurate ground-based radar QPE such as in extremely complex or mountainous terrain or areas with sparse radar coverage.**

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