Bias Correction of NEXRAD Rainfall Product

$T(s, t)$: gauge measurement (precipitation "truth") at site $s$ and time $t$.

$R(s, t)$: radar rainfall estimate at site $s$ and time $t$; ideally, the bias corrected radar estimate should be close to $T(s, t)$.

The conditional probability of $T$ given that radar estimate $R$ is available can be expressed as follows:

$$P(T|R) \propto P(R|T) P(T)$$

where $P(T|R)$ is the posterior probability of $T$ occurring given that $R$ is true; $P(R|T)$ is the likelihood of $R$ occurring given that $T$ is true; $P(T)$ is the prior probability of $T$. In applications, it is reformulated in a continuous form:

$$f(T|R) \propto f(R|T)f(T)$$

where $D$ stands for the conditional distribution of $R|T$ derived from various distribution families, and $\theta = (\theta_1, \theta_2, \ldots, \theta_n)$ indicates the associated collection of $n$ distribution parameters.

Each conditional distribution $D$ can be expressed to incorporate the spatial and temporal covariates: $\theta \rightarrow g(\theta; T, \gamma)$, where $g$ is the linked function; $\beta$ represents the parameter set of the linked function; $\gamma$ is the collection of covariates (i.e., radar rainfall estimates, and/or terrain and wind information).

The $q$-quantiles of the posterior predictive distribution of $T^*$ is used to correct $R^*$, the radar estimates at the new site and/or time. The posterior distribution of $T^*$ given $R^*$ occurring is:

$$f(T^*|R^*, T, R) = \int f(T^*|Y^*, T, R) d\beta$$

### Summary

- A downscaling procedure is applied to the NEXRAD rainfall product in order to match the high-resolution AQPI radar observations.
- A Bayesian model is developed for bias correction of NEXRAD rainfall product using surface rain gauge measurements.
- An integrated QPE system is designed based on multi-scale data over the Bay Area.
- The integrated QPE is being implemented into the real-time AQPI system.

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**Real-time, Integrated QPE Product**

**Bias Corrected QPE**

**Training Data**
- Radar Rainfall Estimates $\mathcal{R}$
- Rain Gauge Measurements $\mathcal{T}$

**Model Application**
- $f(T^*|R^*, T, R) = \int f(T^*|Y^*, T, R) d\beta$

**Testing/New Data**
- Radar Rainfall Estimates $\mathcal{R'}$

**Fig. 4. Demonstration study domain (Russian River basin in Northern California). The basin boundaries are highlighted in white. The black and white dots denote training and test gauge sites.**

**Fig. 5. Evaluation results of hourly rainfall estimates during the 7 February 2017 precipitation event.**

**Fig. 6. Radar-derived hourly rainfall over the Russian River watershed on 02 February 2017, at 13UTC.**

**Fig. 7. Hourly rainfall at 2019-02-14 21UTC: (a) AQPI radar only; (b) combined AQPI radar with NEXRAD product without bias correction; (c) combined AQPI radar with bias corrected NEXRAD product.**

**Fig. 8. Rainfall total for the 2019 Valentine’s event (96 hrs from 2019-02-13 00UTC): (a) AQPI radar only; (b) combined AQPI radar with NEXRAD product without bias correction; (c) combined AQPI radar with bias corrected NEXRAD product.**

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**Real-time, Integrated QPE Product**

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**Model Application**
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