Recent Findings from the NAME Event Raingauge Network

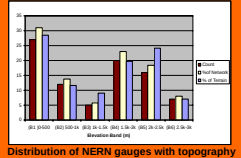
David J. Gochis[1], C.J. Watts[2], J.C. Rodriguez[3], J. Garatuza-Payan[4], I. Cardenas[4]

[1]NCAR//RAL (E-mail: gochis@rap.ucar.edu); [2]UNISON, Hermosillo, Sonora; [3]IMADES, Hermosillo, Sonora; [4]ITSON, Cd. Obregon, Sonora

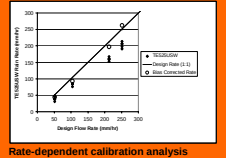
Abstract:

The NAME Event Raingauge Network (NERN) provides event rainfall measurements at more than 90 locations in the core North American Monsoon region of northwest Mexico. The value of the NERN data archive continues to grow with the acquisition of each new season of data. Recent analyses using NERN data have focused on characterizing the variability of precipitation intensity, frequency and total accumulations as functions of time-scale and season. These analyses characterize a precipitation regime that shows significant variability at between seasons and an evolution of the precipitation-elevation relationship as a function the annual cycle. The NERN has also recently been used to assess remotely sensed estimates of precipitation characteristics from the PERSIANN product. Combined, NERN analyses are leading to a greatly improved process understanding of precipitation in northwest Mexico and highlight the utility of the network as a critical component of a regional climate observing system.

The NAME Event Raingauge Network (NERN) in Northwest Mexico



Distribution of NERN gauges with topography

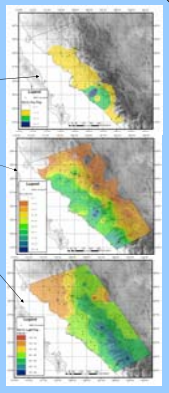


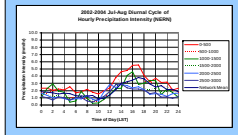
Rate-dependent calibration analysis

- The NAME Event Raingauge Network (NERN see Gochis et al., 2004) has been in operation since the summer of 2002. There now exist 92 rain gauges distributed across a range of elevations in northwest Mexico.
- A main objective of the NERN has been to quantify the relationship of precipitation characteristics as a function of elevation. To this end NERN sites were selected in order to match the distribution of the underlying topography.
- Since 2006 the NERN data is collected, quality-controlled and processed annually and is archived within the NAME data archive at the NCAR Earth Observing Laboratory.
- Generally, error characteristics from raingauges are significant and widely variable. A rate dependent calibration procedure has been applied to the NERN gauges to account for undercatch during high intensity rainfall events. (see Gochis et al., 2006 for details)

Spatial Distribution of Precipitation Intensity

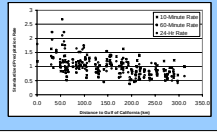
- Occurrence of 'heavy' rain days (R>50.8 mm) restricted to western slope and coastal plains
- 'Moderate' rain days (25.4 < R < 50.8 mm) occur in most locations but most often along westslope and coastal regions
- 'Light' rain days (R < 25.4 mm) show highest count overlying the crest of the Sierra Madre Occidental





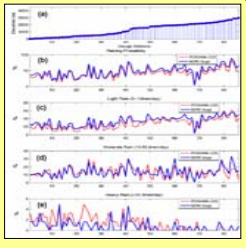
There is a modest lagging of the diurnal cycle of intensity proceeding from high to low elevations. Maximum rainfall rates at high elevations occur comparatively early in the afternoon and progressively later, and with increasing intensity at lower elevations. The maximum average hourly intensity at nearly all hours occurs in the 0-500 m el. Band, which also has a distinct nocturnal signal.

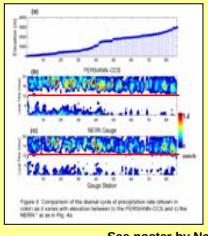
The standardized precipitation rate varies as a function of the distance from the Gulf of California. Each time period is normalized by the time period mean maximum observed precipitation rate. It is also evident that the variance in precipitation rate is greatest closest to the coast.



Evaluation of PERSIANN with the NERN (See Hong et al., JHM)

- At all precipitation thresholds PERSIANN slightly underestimates the frequency of precipitation at high elevations
- PERSIANN underestimating the frequency of light precipitation (0-10 mm/d) events at nearly all sites and elevations
- No systematic bias appears for moderate precipitation events (10-50 mm/d)
- PERSIANN significantly overestimates the frequency of heavy precip. events at low elevations. There is a notable lack of heavy events at elevations greater than 2000 m.

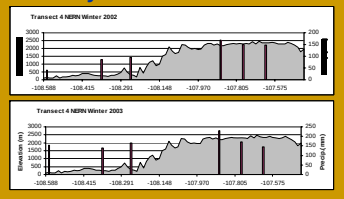




- The diurnal cycle of PERSIANN estimated precipitation in high el. is delayed with respect to the NERN data
- Early afternoon precipitation estimates at high elevations intensity are somewhat light compared with NERN observations
- Conversely, low elevation, nocturnal intensities estimated by PERSIANN are too heavy and overly persistent in the morning hours

See poster by Nesbitt et al. for more NERN-satellite comparisons

Variability on Inter-Seasonal and Inter-Annual Timescales



Since the NERN has now been collecting data for 4 to 5 years, depending on the site, we can now begin to explore interseasonal and interannual variations in precipitation behavior

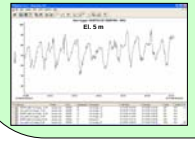
1. Interannual variations in each season are appreciable and needs to be better quantified
2. Preliminary evidence that there is an annual cycle to the precipitation elevation relationship. Relatively more precip. occurs at lower elevations in the summer compared with winter. Precip. appears be more evenly distributed across a wider range of elevations in the summer (season of greatest precip) while most winter precip. occurs at highest elevations.

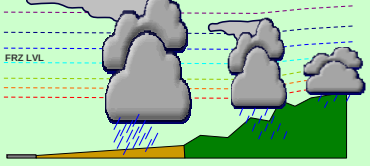
Conceptual Model of Warm Season Precipitation Over Northwest Mexico

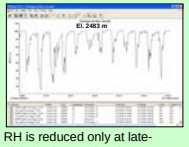
- Precipitation characteristics as diagnosed by the NERN and the elevation-dependent error structures as diagnosed by NERN comparison with IR products such as PERSIANN and HydroEstimator lead to the hypothesis of a conceptual model for climatological precipitation structure in western Mexico:

a. Frequent, light precipitation events over high terrain are comparatively shallow and cloud tops are warm
b. Organization (of less frequent storms at low elevations) fosters deeper development and colder cloud top temperatures
c. surface observations of the diurnal cycle of humidity between high and low elevation sites in the southern NERN domain differ significantly with the high elevation site near saturation nearly all day and the low elevation site showing more typical afternoon boundary layer entrainment
d. IR-based products are 'missing' many shallow-warm events while overestimating frequency and extent of deep-heavy events

RH peaks in the morning hours and is reduced at mid-day







RH is reduced only at late-night/early morning times potentially in phase with katabatic flow

Conclusions and Recommendations:

- The NERN event monitoring network continues to provide a wealth of precipitation intensity and frequency information useful for diagnosing various aspects of the North American Monsoon precipitation regime as well as their respective interseasonal and interannual variations
- The heaviest precipitation events, especially at hourly and daily timescales, are most commonly found along the low elevation regions west of the Sierra Madre Occidental
- As with other mountainous environments there appears to be a significant evolution of the precipitation-elevation relationship over the annual cycle
- As compared with NERN observations IR-based remotely-sensed precipitation estimates exhibit elevation dependent biases which are hypothesized to be linked to strong variations in precipitation formation processes occurring in northwest Mexico
- Sustained operation of the NERN as a component of a regional climate observing system provides quantifiable benefit to the documentation and process understanding of precipitation variability in the core region of the North American Monsoon

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