Analysis and Verification of Multi-Sensor Precipitation Estimates for the Texas Coastal Bend

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Abstract

Until the initiation of NEXRAD (Next Generation Radar) in 1988, precipitation analysis was based mostly on single point estimations. NEXRAD is a high resolution radar detecting precipitation by scanning the sky at different speeds and elevation angles. The data retrieved is processed through the MPE (multi-sensor precipitation estimator) algorithm, which uses NEXRAD, rain gauge, and satellite data to create higher spatial resolution precipitation maps. Precipitation drives coastal processes including water quality, water resources, and flooding, and this new data could be useful in many applications such as the prediction of indicator bacteria concentration in coastal recreational waters or the onset of thunderstorms. Analyses of MPE estimations have previously been conducted but to our knowledge not specifically for the Texas Coastal Bend. The study area consists of a 2 degree square that includes a portion of the Gulf of Mexico, Corpus Christi, Victoria, Baffin Bay, and Matagorda Bay. The MPE data is used to create movies that help visualize precipitation patterns. The MPE data is then compared to the records of 11 rain gauges for the period of 1997 to 2007. The results show an average absolute percent difference of 21.4% and a maximum yearly percent difference of -69% for the Sarita station (1999). There are larger differences in the months from June to November, while coastal to inland and North to South differences are not significant. Regional precipitation patterns indicate a shore parallel gradient with tropical storms having a significant impact on temporal and spatial distributions. Precipitation heterogeneity along the Corpus Christi shoreline showed differences increasing with distance from the local airport from 7% (5mi) to 19% (12mi) absolute average difference. Up to 110 hourly differences greater than 0.5" were observed for the furthest station from the Corpus Christi Airport over the 11 year data set.

Project Goals

Rain gauge and MPE Comparisons
- Calculate rain gauge and MPE estimate differences

MPE Analysis
- Use MPE to observe temporal and spatial patterns
- Estimate potential regional precipitation gradients

MPE Comparisons
- Test coastal precipitation heterogeneity in urban watershed

Methods and Data

- Study area: 27º to 29º N and 96º to 98º W
- Download MPE data from TAMUCC Center for Water Supply Studies (Fulton ,1998, Hoke et al.,1981)
  - MPE divides study area into approximately 2.5 mi x 2.5 mi (4km x 4km) areas (Fulton et al., 1998)

Rain gauge and MPE Comparison
- Download and organize rain gauge points from National Climatic Data Center (NCDC)
- Determine MPE square encompassing rain gauge
- Run monthly and yearly statistics: bias, average absolute difference, average absolute percent difference

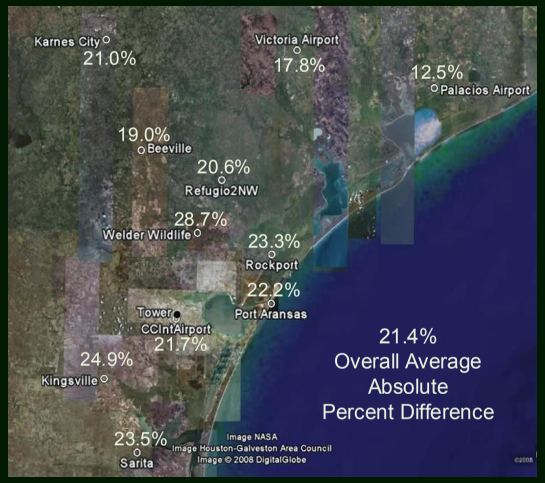
MPE Analysis
- Run monthly and yearly summations
- Create visualizations using MPE estimates: graphs and movies

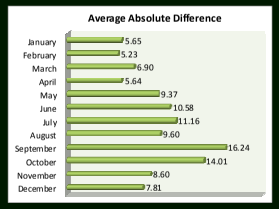
MPE Comparisons
- Compare a single rain gauge station to a series of MPE points
- Compare a single MPE point to a series of MPE points

Software
- All analysis and graphics computed with Matlab (The MathWorks Inc.)
- Texas Coast images from Google Earth (Google Inc.)

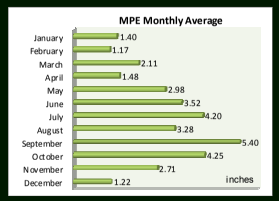
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
MPE	0	0.662	0	0	0	0.011	0	0.694	0	0	0
Beeville	0	0	0	0	0	0	0.022	0.011	0	0	0
CCIntAirport	0	0	0	0	0	0	0	0	0	0	0
KarnesCity	0.003	0.008	0.019	0.044	0.367	0.003	0.008	0.085	0.019	0.088	NaN
Kingsville	0	0.003	0	0.003	0.008	0.008	0.077	0.005	0	0.170	0
PalaciosAirport	0	0	0	0	0	0	0	0.082	0	0	0
PortAransas	0.005	0	0	0	0	0	0	0	0	0	0
Refugio2NW	0.005	0	0	0	0	0	0.003	0.011	0.027	0.014	0.011
Rockport	0	0.003	0.003	0	0	0	0.003	0.005	0	0	0
Sarita	0	0	0	0	0	0	0	0	0.005	0	0
VictoriaAirport	0	0	0	0	0	0	0	0	0	0	0
WelderWildlife	0	0	0	0	0	0	0.011	0.008	0	0	0

Table 1 - *Data Quality Table:* Percent missing from MPE and rain gauge stations. (left)





Graph 1 - *Average Absolute Difference* (above)



Graph 2 - *MPE Monthly Average* (above)
Figure 1 – *Average Absolute Percent Differences* (left)

point	dist - mi from 1840	Abs%Diff	Max Diff [inches]	events with diffs > .5"
1843	7.0	10.00	1.66	83
1844	9.3	11.28	2.50	100
1845	11.6	18.77	3.69	110
1907	5.2	6.93	1.29	79
1908	7.3	12.31	2.41	85
1973	8.4	11.90	2.73	93

Figure 4 – *Locations for MPE Comparisons*
Table 2 - *MPE Comparison Table* (above)**:** Difference in MPE estimates between several shoreline locations and Airport MPE grid (1840). Statistics based on hours with precipitation only, 1997-2007. (left)

Rain gauge and MPE Comparisons

- For the eleven stations over the eleven years we have an average absolute difference of 9.29 HI and a small positive bias for ten out of the eleven station with gauge precipitation on average 1.7 HI higher than MPE estimates. The average absolute percent differences is 21.4%. similar with recent publications reporting agreement between gauges and monthly MPE estimates within +/- 25% (Westcott et al., 2007), and a difference of 15% for Corpus Christi over 1995 to 1999 (Jayakrishnan et al., 2004).
- However on several occasions large daily difference are observed; the largest being 9.66" at Port Aransas in 1999.
- At Corpus Christi International Airport for years 1999 to 2007 49 days had differences greater than 1". These differences are mostly due to the precipitation distribution as on 41 of those day thunderstorms occurred.
- The MPE-Gauge differences do not vary from coast to inland, North to South, or distance from NEXRAD tower (Figure 1).
- For the eleven years, month by month comparisons show that on average there is a higher average absolute difference for the months from May to October (Graph 1). This correlates to the average monthly summations of MPE estimates (Graph 2).

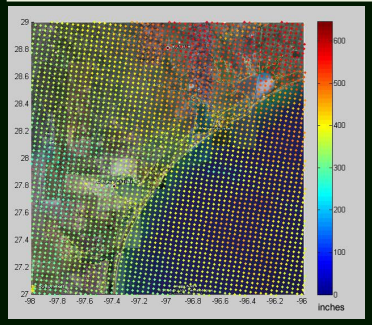


Figure 2 – *11 Year Summation Graph*: South West to North East gradient

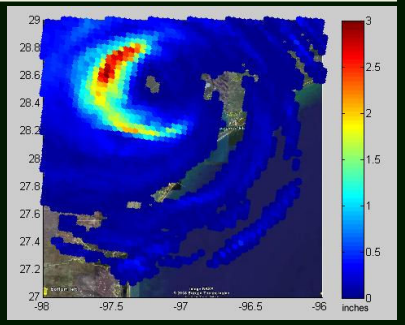


Figure 3 – *Hurricane Claudette*: 1 hour still of 2003 Hurricane Claudette

MPE Analysis

- Figure 2 shows a South West to North East gradient with a difference of 32 in/yr across the study area.
- Monthly and yearly summations showed that tropical storms have a significantly effect on temporal and spatial precipitation patterns. MPE precipitation maps allow to measure and visualize the distributions (Figure 3).
- For the eleven year period, Corpus Christi International Airport averaged 28.8 inches of rain per year which is similar to the published value for a ninety-four year average of 27.8 inches (Tunnell et al., 2002).

MPE Comparisons

MPE estimates are compared for contiguous locations along an urban coastal area and with estimates at the Corpus Christi International Airport. Differences increase with distance up to 18.8% absolute difference for a location 11.6 mi away from the airport (Table 2).

Conclusions

- Overall differences between MPE estimates and rain gauges are all smaller than 29% average absolute difference for study area (1997-2007)
- No significant pattern in differences between locations
- Yearly differences up to 69% correlating with the passage of Hurricane Brett
- South West to North East gradient but no coastal to inland gradient
- Spatial precipitation heterogeneity observed along an urban watershed
- Using the higher resolution MPE should lead to better models for recreational water quality and other precipitation dependant models

Acknowledgements

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