Toward the Development of Climate Data Records for Precipitation: Characterization of CONUS Rainfall Using a Suite of Satellite, Radar, and Rain Gauge Quantitative Precipitation Estimates (QPE) Products

Task Leader: Olivier Prat
Task Code: NC-CDR-12_NCICS-OP
NOAA Sponsor: Brian Nelson
NOAA Office: NESDIS/NCDC/RSAD
Contribution to CICS Themes (%): Theme 1: 20%; Theme 2: 75%; Theme 3: 5%
Main CICS Research Topic: Climate Data and Information Records and Scientific Data Stewardship
Contribution to NOAA Goals (%): Goal 1: 80%; Goal 2: 20%; Goal 3: 0%; Goal 4: 0%; Goal 5: 0%

Highlight: This task uses a suite of quantitative precipitation estimates (QPEs) derived from satellite, radar, surface observations, and models to derive long-term precipitation characteristics at fine spatial and temporal resolution over CONUS for the period 2002-2012. This work is part of a broader effort to evaluate long-term multi-sensor QPEs in the perspective of developing Climate Data Records (CDRs) for precipitation.

BACKGROUND
The comparison effort includes satellite multi-sensor datasets of TMPA, CMORPH-ADJ, and PERSIANN-CDR along with their respective unadjusted/near-real time version (TMPA-RT, CMORPH, PERSIANN). The satellite based QPEs are compared over the concurrent period with the NCEP Stage IV product, which is a near-real-time product providing precipitation data at the hourly temporal scale gridded at a nominal 4-km spatial resolution. In addition, remotely sensed precipitation datasets are compared with surface observations from the Global Historical Climatology Network (GHCN-Daily) and from the PRISM (Parameter-elevation Regressions on Independent Slopes Model), which provides gridded precipitation estimates that are used as a baseline for multi-sensor QPE products comparison.

Figure 1. From top left to bottom right. Annual precipitation for the period 2002-2012 derived from Stage IV, TMPA-RT (Real Time), TMPA, PRISM, CMORPH, and CMORPH-ADJ (Adjusted). Figure 1 displays the annual precipitation derived from radar (Stage IV), surface
observation and model (PRISM), unadjusted (TMPA-RT, CMORPH) and adjusted (TMPA, CMORPH-ADJ) satellite QPEs.

ACCOMPLISHMENTS
The comparisons were performed at the annual, seasonal, monthly, and daily scales and at the river forecast center level (major river basins) (Fig. 2).

Figure 2: Comparison (Quantile-Quantile plot) of TMPA, TMPA-RT, CMORPH-ADJ, CMORPH, St-IV, and PRISM with surface observations from GHCN-daily for the annual precipitation over CONUS. While a good agreement is found for PRISM (expected because incorporate surface observation including GHCN) and TMPA and CMORPH-ADJ present a severe underestimation at higher rain rates (R>4 mm/day). Differences can be even more important when looking at the river basin scale (or River Forecast Center: RFC) in particular in the West (Fig. a) and at the seasonal scale (Winter: Fig. b; Summer: Fig. c). Please note the different scales for the figures.

The most widely used satellite QPEs have been compared at the annual, seasonal, and daily scales. We are currently extending this effort to other precipitation products. In addition to the evaluation of each of the aforementioned products in the perspective of developing Climate Data Records (CDRs) for precipitation, this work will serve as a benchmark to evaluate the newly available NMQ/Q2 reanalysis over the same period.
PLANNED WORK
- Continue work to include other precipitation datasets (PERSIANN-CDR, GPCP).
- Continue work to investigate the impact of differing spatial and temporal resolutions with respect to the datasets ability to capture extreme rainfall events.
- Use the current work as a benchmark for comparison with the newly available NMQ/Q2 reanalysis.
- Use the Satellite Product Evaluation Center (SPEC) and develop new functionalities to help with QPE products comparison (L. Vasquez).
- Coordinate effort with CICS-MD (R. Ferraro, S. Rudlosky) to extent the ground validation/QPE products comparison to other datasets (Hydro-Estimator, SCA/MRP, MIRS, MSPPS, GPI).

PUBLICATIONS

DELIVERABLES
- Complete assessment of the differences between all the QPE products for the period 2002-2012 at the annual, seasonal, and daily scale;
- Metrics quantifying each dataset ability to capture precipitation patterns and extreme precipitation events;
- Software system (SPEC) tailored for comparison of precipitation datasets with differing formats, spatial and temporal resolution; and
- Manuscript summarizing the results of this comparison effort.

PRESENTATIONS


### PERFORMANCE METRICS

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PERFORMANCE METRICS EXPLANATION
This year, we participated in the PERSIANN-CDR adjustment to comply with CDR requirements (1). This development concerned the transition from research to operations (1). One journal article on the precipitation characteristics in the Southeastern United States using long-term remotely sensed data has been published (1). We coauthored one journal article describing the PERSIANN-CDR algorithm (1), and two other journal publications on Stage IV (1) and on multi-sensor QPE (1) are under preparation (2). Five presentations have been made or co-authored on the project (5), and three others have been submitted (3).
Mapping the World’s Tropical Cyclone Rainfall Contribution Over Land Using Satellite Data: Precipitation Budget and Extreme Rainfall

Task Leader: Olivier Prat
Task Code: NC-CDR-13_NCICS-OP
NOAA Sponsor: Brian Nelson
NOAA Office: NESDIS/NCDC/RSAD

Contribution to CICS Themes (%): Theme 1: 50%; Theme 2: 50%; Theme 3: 0%
Main CICS Research Topic: Climate Data and Information Records and Scientific Data Stewardship

Contribution to NOAA Goals (%): Goal 1: 60%; Goal 2: 0%; Goal 3: 0%; Goal 4: 40%; Goal 5: 0%

Highlight: This work examines the over-land rainfall contribution originating from tropical cyclones for basins around the world for the period 1998-2009. Using the global database International Best Track Archive for Climate Stewardship (IBTrACS) and satellite precipitation data from the Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA) product 3B42, the precipitation budget and extreme rainfall were determined for different Tropical Cyclone (TC) basins around the world.

BACKGROUND

Tropical cyclones constitute one of the major natural disasters around the world as well as an important source of fresh water over areas prone to tropical cyclones. Annually, an average of 119 million people are exposed to tropical cyclone hazards (United Nation Development Program 2004). In this work, we estimated the over-land rainfall contribution of tropical cyclones for basins around the world, using NOAA’s NCDC global database IBTrACS and satellite precipitation data from the Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA 3B42V7).

Figure 1. Tropical cyclone (TC) contribution (a), tropical cyclone rainfall (b), and total rainfall (c) for North and Central America (NCA), East Asia (EAS), South and West Asia (SWA), Oceania (OCE) and East Africa (EAF) for 1998-2009. The TC tracks are from the IBTrACS database (Knapp et al. 2010). TC Contribution (a) = 100 x TC Rainfall (b) / Total Rainfall (c).
Results showed that TCs accounted for 6-10% of the annual rainfall over areas prone to cyclonic activity for the different basins (Fig. 1a). At the local scale, tropical cyclones contributed to more than 25% and up to 60% (Baja California Sur) of the average annual rainfall over very different climatic areas with arid or tropical characteristics (Fig. 1a). East Asia (EAS) presented the higher and most constant tropical cyclone rainfall, while East Africa (EAF) displayed the highest year-to-year variability, and the Americas (NCA) exhibited the lowest average (Fig. 1b). Throughout the year, the maximum monthly contribution (8-11%) was found later in the TC season and depended on the peak of cyclonic activity, the cyclone associated rainfall, and the transition between dry and wet regimes, if any. Current work consists of quantifying precipitation extremes in relation with cyclonic activity.

ACCOMPLISHMENTS

A comparison between two versions of the algorithm, TMPA 3B42V7 (version 7: used in Prat and Nelson 2013, Water. Resour. Res.), and, TMPA 3B42V6 (version 6: used in Prat and Nelson 2013, J. Climate), was performed. The differences between V7 and V6 were mostly significant in terms of total and non-TC rainfall with a negative bias for V6 when compared to V7 (linear regression coefficient: 0.77<a<0.94). The largest differences were observed for the NCA (a=0.77: Fig. 2) and the SWA (a=0.79) domains. The differences in terms of TC rainfall (0.85<a<1.03) and TC contribution (0.93<a<1.08) were less important.

This study was the first that quantifies the tropical cyclone rainfall contribution over land for the different basins around the world. Current work consists of quantifying precipitation extremes in relation with cyclonic activity. Annual and monthly precipitation extremes have been extracted from TMPA 3B42V7 and the period of study was extended to 1998-2012. A manuscript summarizing the findings is currently being finalized for publication.

PLANNED WORK

- Finalize the manuscript on precipitation extremes associated with cyclonic activity.

PUBLICATIONS


**DELIVERABLES**
- Manuscript summarizing the findings on tropical cyclone rainfall and extreme rainfall.

**PRESENTATIONS**

**PERFORMANCE METRICS**

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**PERFORMANCE METRICS EXPLANATION**
One journal article on the contribution of tropical cyclone rainfall for basins around the world was published (1), and one manuscript on the link between tropical cyclones and extreme rainfall is under preparation (1). Some of the results described above were included in a collaborative poster presentation describing NOAA’s applications in connection with the Global Precipitation Mission (GPM).