# AQPI Users Group Meeting – Hayward, CA, 31 October 2019

AQPI Radar Status and QPE Operations for 2019/2020 Storm Season

Background

Mitigation of negative impacts associated with heavy rainfall events requires accurate precipitation monitoring (quantitative precipitation estimation - QPE) and forecasting (QPF) to provide forecasters with sufficient understanding of rapidly changing conditions. In the SF Bay Area, terrain blockages limit the effectiveness of the National Weather Service (NWS) NEXRAD radars in providing accurate, rainfall estimates. Moreover, there is little to no radar coverage "upstream" over the ocean to monitor approaching storms. These limitations are further compounded by the complex precipitation processes as a result of land-ocean interaction in the coastal zones and orographic enhancement in the mountainous regions. The AQPI project addresses these problems through deployment of gap-filling X-band radars to cover the Bay area and a C-band radar to look over the ocean.
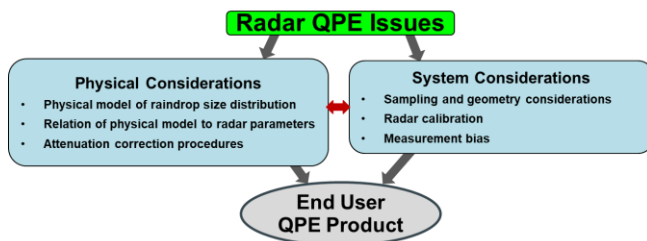
AQPI and NEXRAD radar coverages in the SF Bay Area. Small (large) circles are 40 (150) km coverage rings, and dashed circles indicate NEXRAD coverages.

AQPI Users Flood and Water Management Programs

Flood and water management agency staff currently use various means to obtain information on current rainfall conditions. Many counties have ALERT gauge networks that report accumulated rainfall in real-time. The gauge data is informative but does not provide complete areal coverage for non-gauged locations or situational awareness on what's coming. The NWS and other agencies provide rain reports for their gauges. The NWS NEXRAD radars provide rainfall estimates, but these are generally of poor quality in the SF Bay area. Also, SF Bay television stations portray radar images which qualitatively show where rainfall is falling, but not how much.

AQPI Radar Objectives

- Deployment of four gap-filling X-band radar units strategically located to provide high-resolution coverage over populated and flood prone urban areas throughout the San Francisco Bay region.
- Deployment of a coastal C-band radar along the Sonoma County coast which will point offshore to improve tracking of incoming storms.
- Demonstration of the gap-filling radar methodology for rainfall estimation and distribution of real-time QPE products to end users.
- Collaboration with local, state and federal agencies to document the improved capabilities for rainfall monitoring, and to solicit their feedback on the radar-rainfall QPE products.
- Enhancing short-term prediction of precipitation, runoff, and coastal flooding through ingesting the gap-filling radar data into atmospheric and hydrologic models.
- Integration of AQPI radar data into NWS

Radar & QPE Operations Plan for 2019/2020 Storm Season

- Radar deployment status: a permanent X-band radar has been deployed at Santa Clara Penitencia Water Treatment Plant (37.3989N, 121.8334W); a temporary radar has been deployed near Sonoma County Airport (38.5216N, 122.8023W); another two X-band radars may be deployed for the 2019/2020 storm season, one near the Montara Peak and another near the Rocky Ridge in East Bay.
- QPE products that will be created during 2019/2020 storm season
  - A high-resolution QPE system is currently operating as part of AQPI, producing rain rate and accumulated hourly rainfall at 250mX250m resolution every 2 minutes.
  - High QPE confidence under the coverages of two AQPI X-band radars.
  - Lower-quality NEXRAD radar-only QPE products are used to fill gaps beyond the AQPI radar coverages.
  - A gauge-based bias correction scheme has been developed for NEXRAD radar-only product; the bias correction scheme will be implemented in AQPI by the end of 2019/2020 storm season; the corrected NEXRAD products will replace the lower-quality NEXRAD radar-only product.
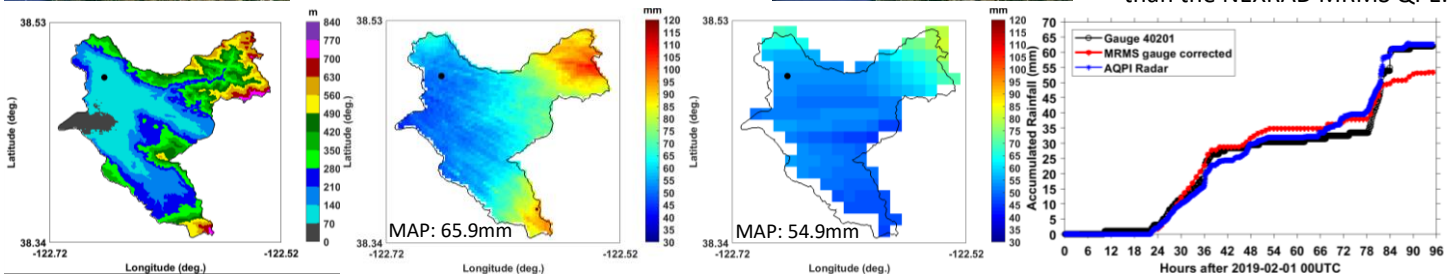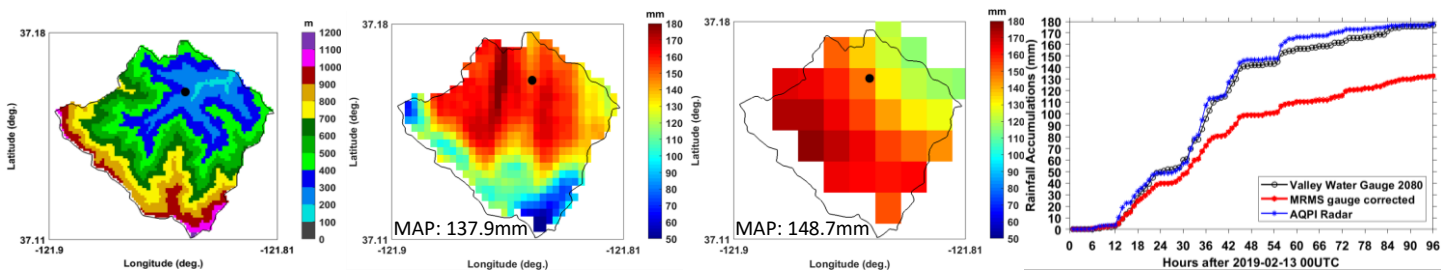
AQPI Radar QPE Performance: Case Studies
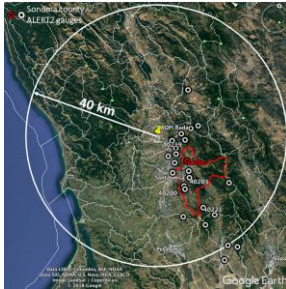
- White and red contours indicate natural watersheds in Sonoma County.
- The 96-hr AQPI QPE and MRMS[1] gauge corrected QPE at a selected sub-watershed are shown below.
- The AQPI QPE has much higher resolution so it sees much more rainfall variability within the watersheds.

- AQPI radar deployed in Santa Clara.
- White and red contours indicate natural watersheds in Santa Clara.
- Mean areal precipitation (MAP) estimates are computed.
- AQPI radar QPE has better agreement with the gauges than the NEXRAD MRMS QPE.

AQPI radar QPE case study in Sonoma County during 01-04 Feb 2019:(a) DEM; (b) AQPI QPE; (c) MRMS QPE; (d) accumulated rainfall at a gauge site.

AQPI radar QPE performance in Santa Clara during 13-16 Feb 2019: (a) DEM; (b) AQPI QPE; (c) MRMS QPE; (d) accumulated rainfall at a gauge site.

AQPI Radar QPE Applications

- The AQPI gap-filling radars are providing high quality rainfall estimates that perform better than NEXRAD.
- QPE accumulations can be provided that match local agency zone or watershed boundaries.
- The high-quality QPE from AQPI system can serve as critical forcing for hydrologic models to monitor and predict urban runoff.

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References and Links

- AQPI Project Webpages: http://www.esrl.noaa.gov/psd/aqpi/ and https://www.sonomawater.org/aqpi/.
- AQPI Radar Display: https://www.esrl.noaa.gov/psd/data/obs/sitemap/ScanRadar/scan_radar_dual.php#
- Chen, H., R. Cifelli, V. Chandrasekar, and Y. Ma, 2019: A flexible Bayesian approach to bias correction of radar-derived precipitation estimates over complex terrain: Model design and initial verification. *J. Hydrometeor.*, 10.1175/JHM-D-19-0136.1
- Chen, H., R. Cifelli, and V. Chandrasekar, 2019: Improving quantitative precipitation estimation in complex terrain over the San Francisco bay area using gap-filling radar network. *The 99th AMS Annual Meeting*, Phoenix, AZ, 6-10 January 2019.
- Cifelli, R., V. Chandrasekar, H. Chen, and L. E. Johnson, 2018: High resolution radar quantitative precipitation estimation in the San Francisco bay area: rainfall monitoring for the urban environment. *J. Meteor. Soc. Japan*, **96A**, 141–155.

[1]MRMS refers to the Multi-Radar/Multi-Sensor QPE system currently operational in NWS.