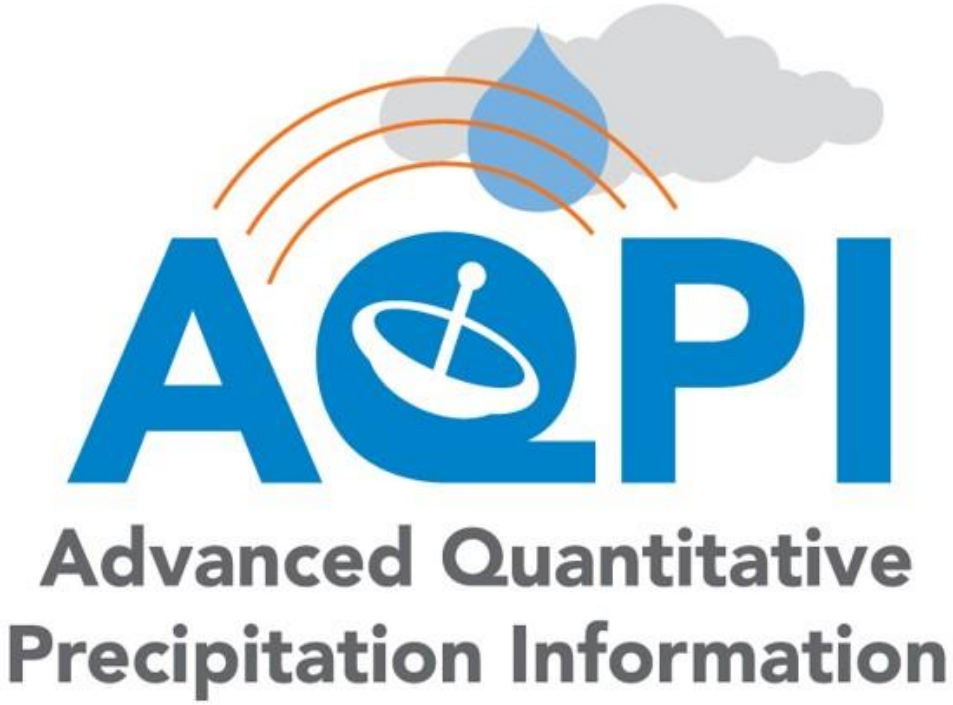
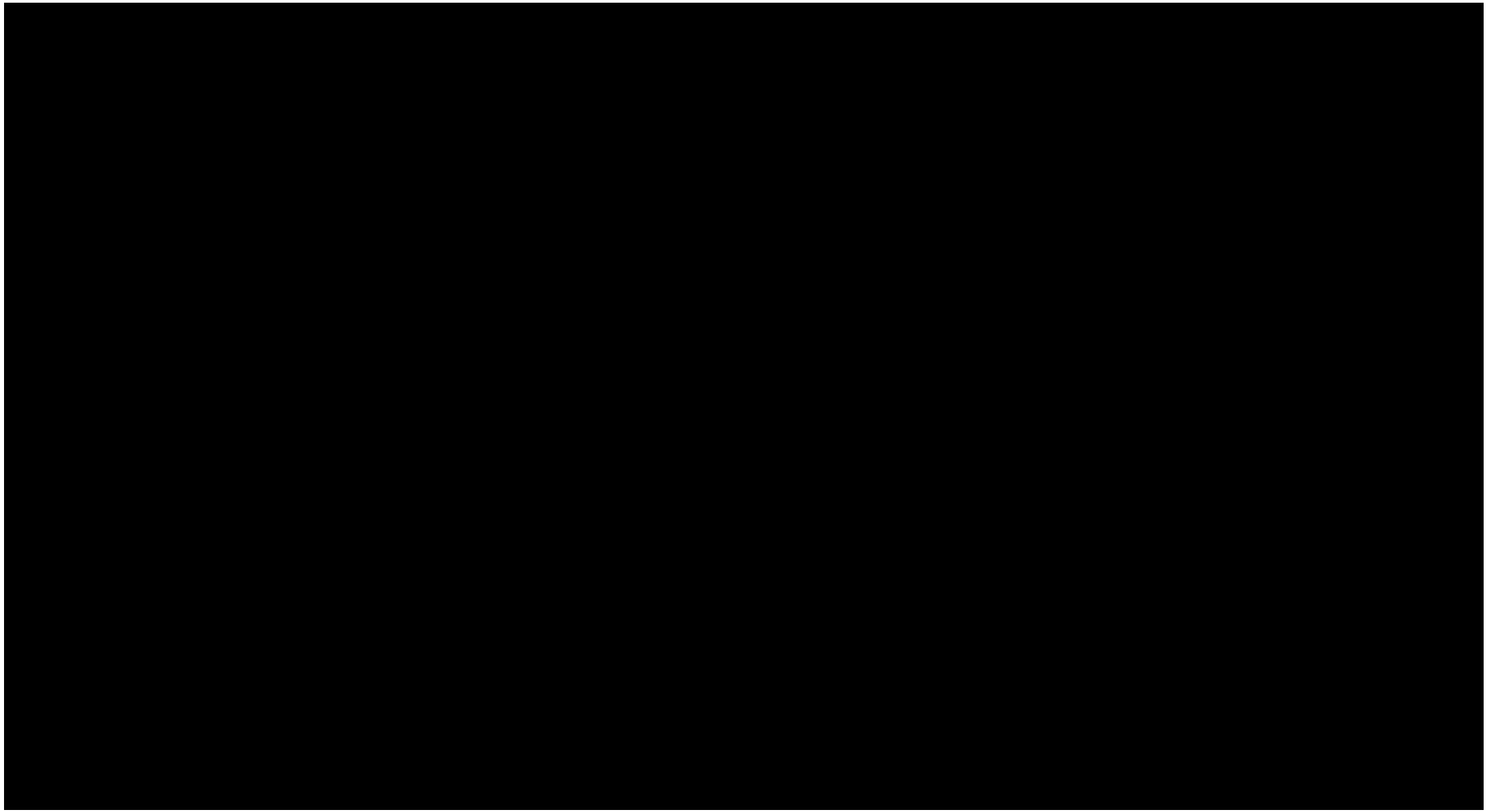



# NBWA Presentation
# November 2017



SCWA AQPI Introduction

# Project Partners

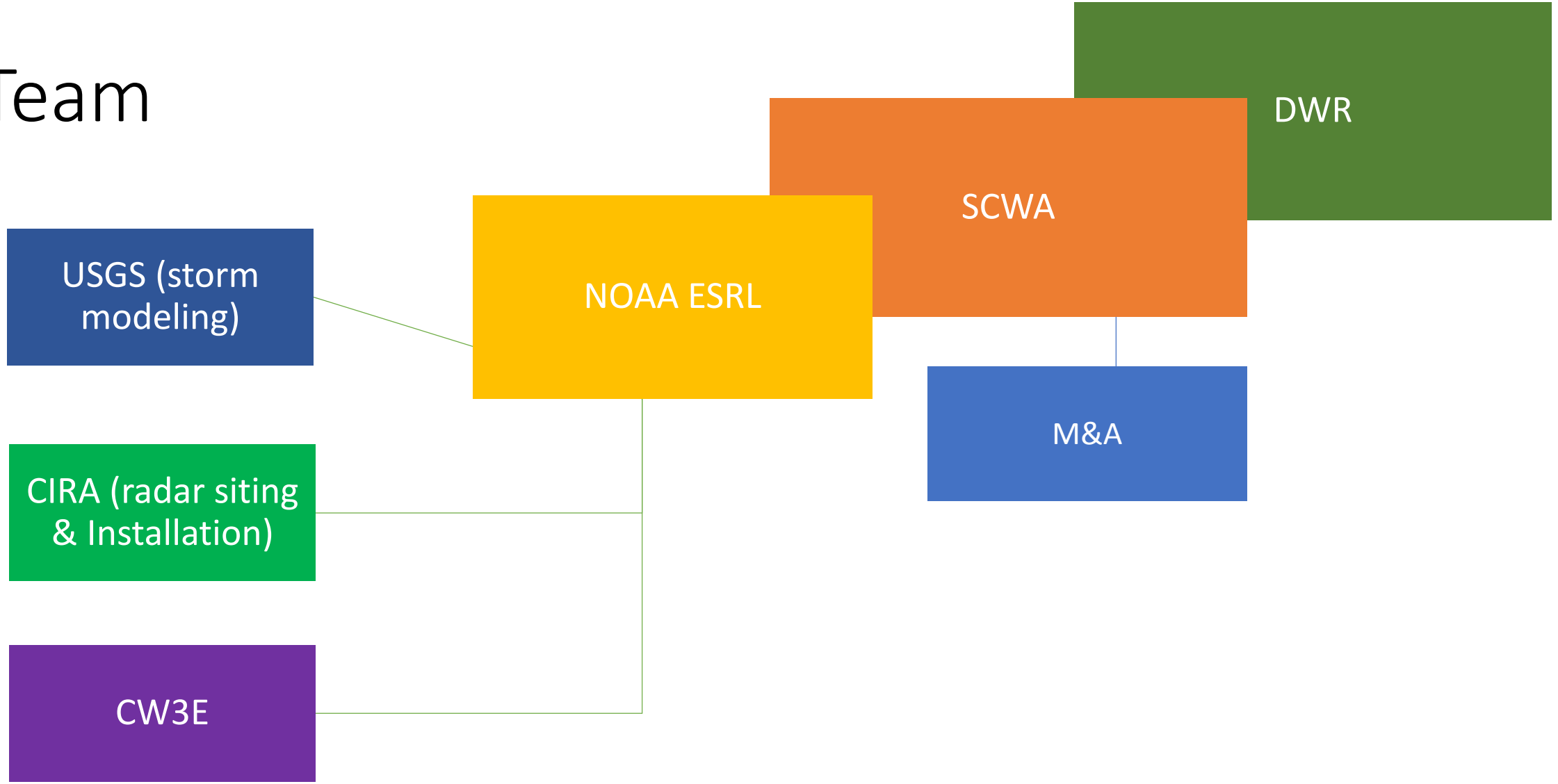








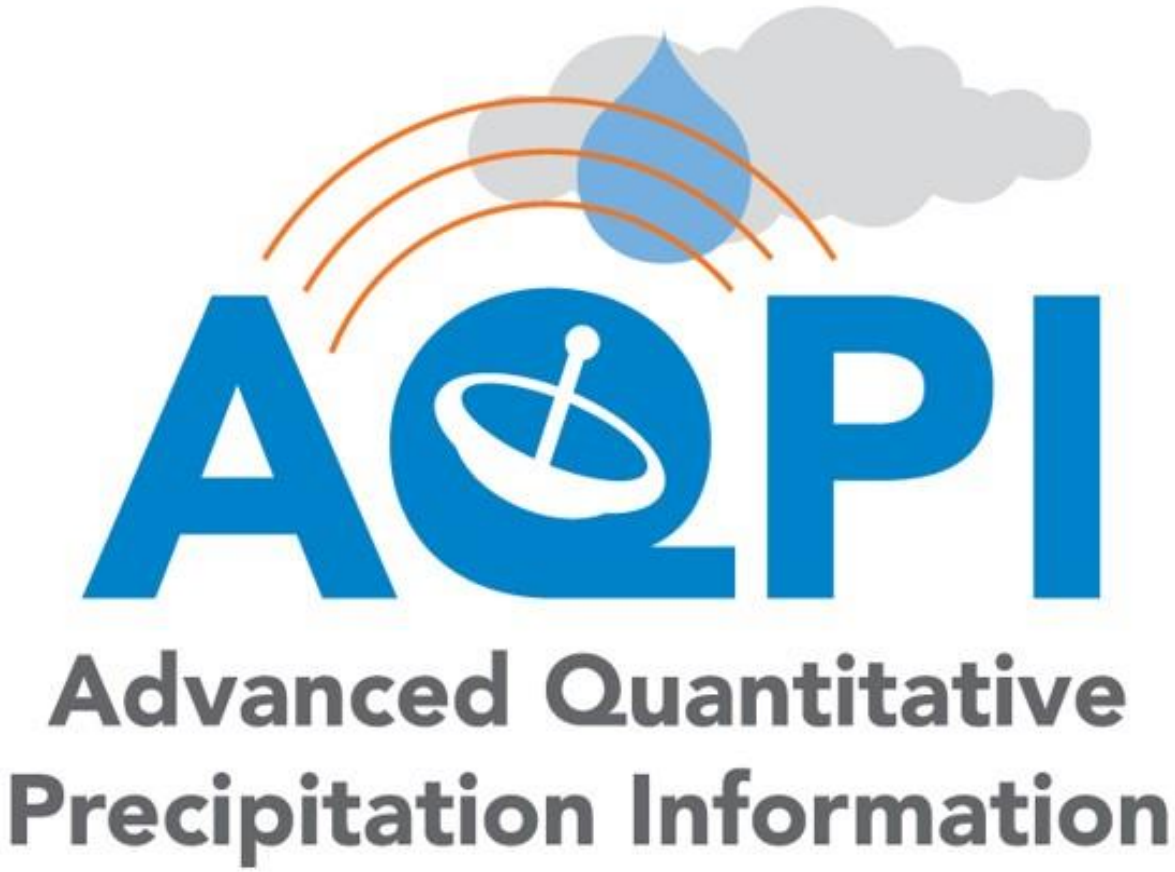

# Team


DWR
SCWA
NOAA ESRL
USGS (storm modeling)
M&A
CIRA (radar siting & Installation)
CW3E

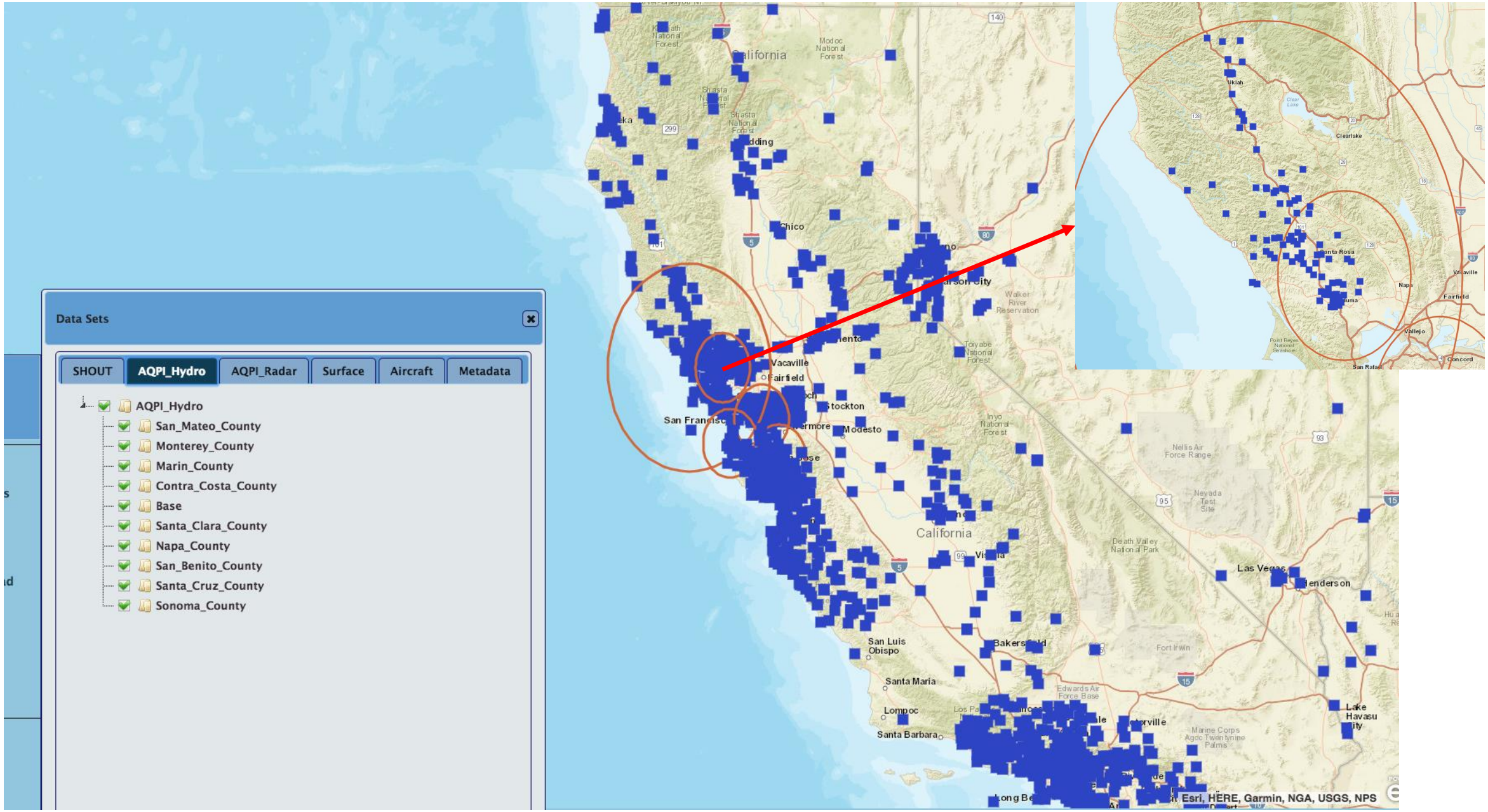
# Communications

| Committee | Outreach | Stakeholder | TAC |
|---|---|---|---|
| Role/Goal: | Inform Bay Area on project purposes, radar siting issues | Provide input on user needs and requirements | Work closely with the AQPI technical team to facilitate project implementation – radar siting, etc. |
| Who: | • SCWA Public Affairs Lead<br>• Project Team<br>• DWR & TAC Representatives | • NOAA/SCWA Lead<br>• TAC Members<br>• DWR<br>• Emergency Service Managers (Police, Fire, OES, Cal-OES, FEMA, PG&E) +<br>• Transportation Managers (Caltrans, BART, Buses, Ferry Services, Airports, Ports, RRs)<br>• Others | • NOAA Lead<br>• Reps of Water Resource Managers, including DWR, IRWMP CC, Flood Control [BAFPAA], Supply [BAWAC], Wastewater [BACWA], Stormwater [BASMAA]<br>• Others |

# Developing the AQPI System

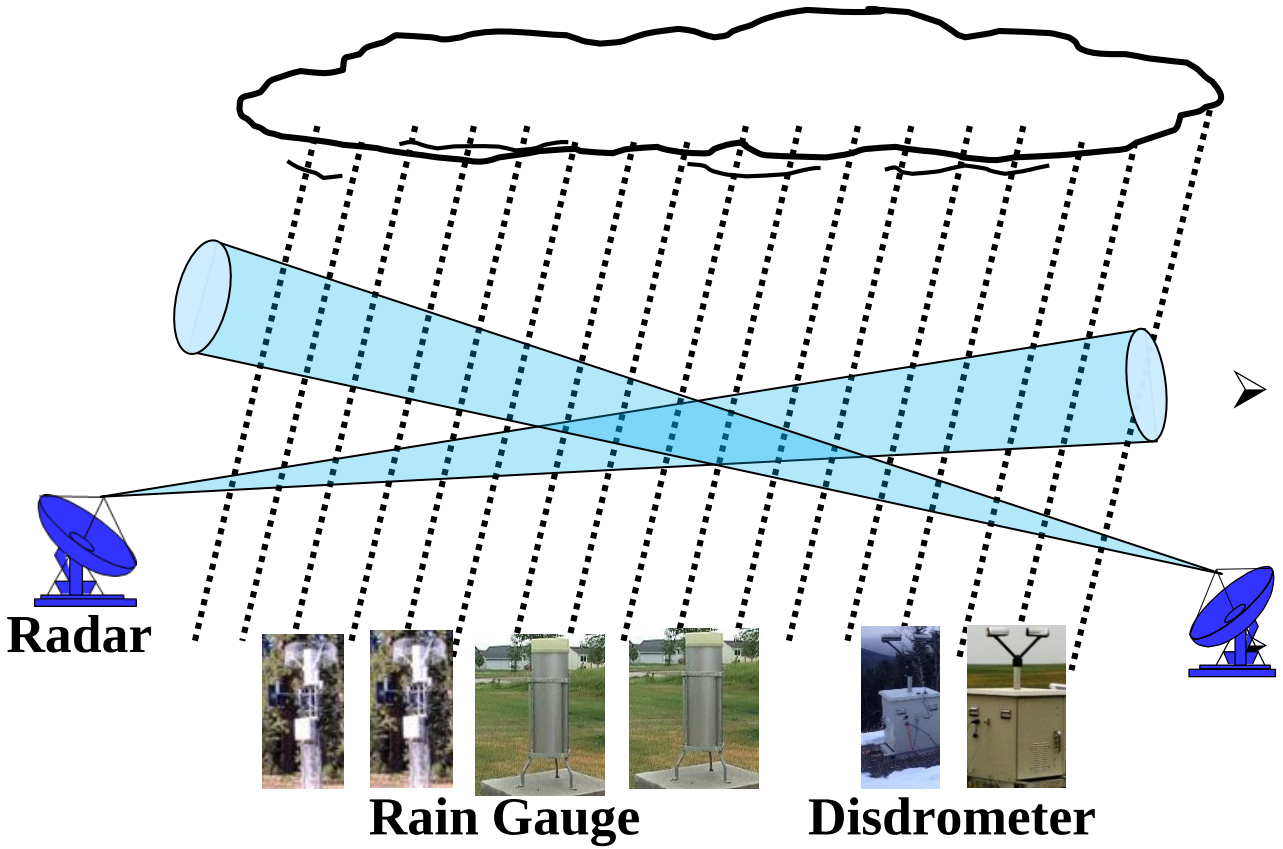


# Current Observational Assets



# *In Situ* and Remote Measurement of Rainfall

## Rain Gauge ● Disdrometer ● Weather Radar




- Several types of rain gauges (e.g., weighing gauges, tipping-bucket gauges)
  - *systematic error*
  - *sampling interval and the bucket volume*
  - *arduous deployment and maintenance*
- Commonly used disdrometers: Parsivel and 2-D video disdrometer (2DVD)
- Point measurements, hard to capture the complex distribution of precipitation

***"The total area measured globally by all currently available rain gauges is surprisingly small, equivalent to less than half a football field or soccer pitch." from Kidd et al. (2017)***

# Radar Rainfall Estimation

**Reflectivity:**

$$Z_h = \frac{\lambda^4}{\pi^5 |K_w|^2} \int \sigma_h(D) N(D) dD$$

$$Z_v = \frac{\lambda^4}{\pi^5 |K_w|^2} \int \sigma_v(D) N(D) dD$$

**Differential Reflectivity:**

$$Z_{dr}(dB) = 10 \log_{10} \frac{Z_h}{Z_v}$$

**Specific Differential Propagation Phase:**

$$K_{dp} = \frac{180}{\pi} \lambda \mathrm{Re} \int [f_h(D) - f_v(D)] N(D) dD$$

$\boldsymbol{\lambda}$: radar wavelength
$\boldsymbol{\sigma_{h,v}}$: radar cross section at H/V polarization
$|\boldsymbol{K_w}|^2 = |(\varepsilon_r - 1)/(\varepsilon_r + 2)|^2$: dielectric factor of water ($\varepsilon_r$ is the complex relative dielectric constant of water)
$\boldsymbol{D}$: particle equivalent diameter
$\boldsymbol{N(D)dD}$: number of drops per unit volume with sized in the interval $D$ to $D + dD$
$\boldsymbol{f_{h,v}}$: complex forward scattering amplitudes at H/V polarization

**Rainfall Rate:**

$$R = 0.6\pi \times 10^{-3} \int v(D) D^3 N(D) dD$$

$\boldsymbol{v(D)}$: raindrop terminal velocity

## *Radar Rainfall Relations:*

$$R(Z_h) = aZ_h^b$$

$$R(Z_h, Z_{dr}) = aZ_h^b Z_{dr}^c$$

$$R(\mathrm{A}_h) = a\mathrm{A}_h^b$$

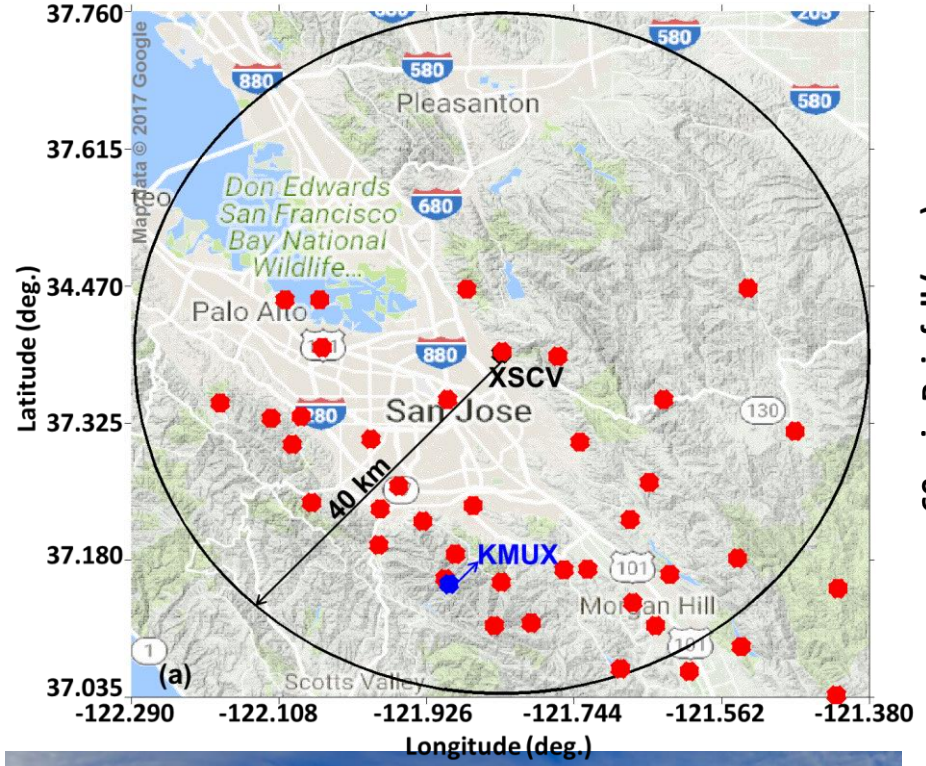
$$R(K_{dp}) = aK_{dp}^b$$

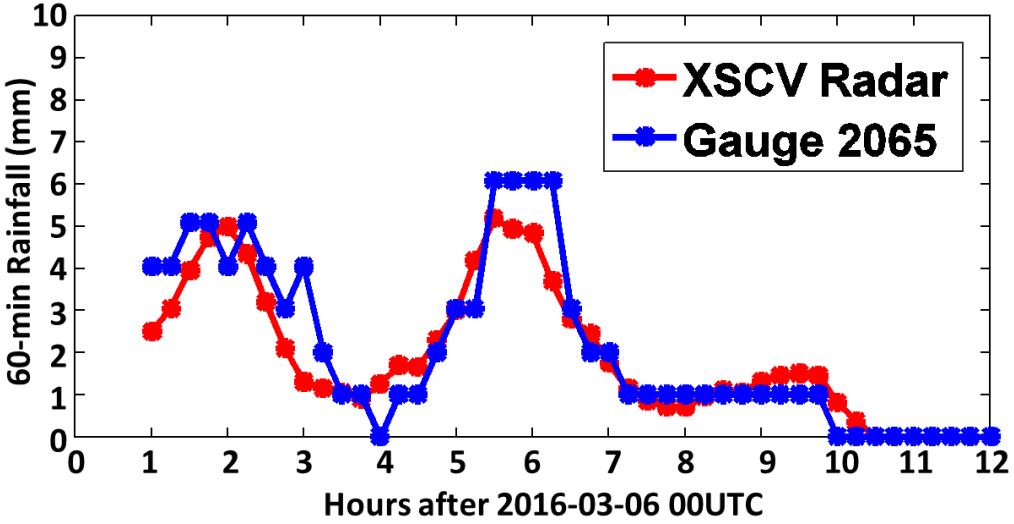
$$R(Z_{dr}, K_{dp}) = aZ_{dr}^b K_{dp}^c$$

The coefficients are determined by radar frequency and rainfall regimes.

# Dense Urban Radar Network for Rainfall Monitoring

## *e.g., X-band Radar in Santa Clara*




# Proposed Radar Sites

# AQPI System

## Existing Observations

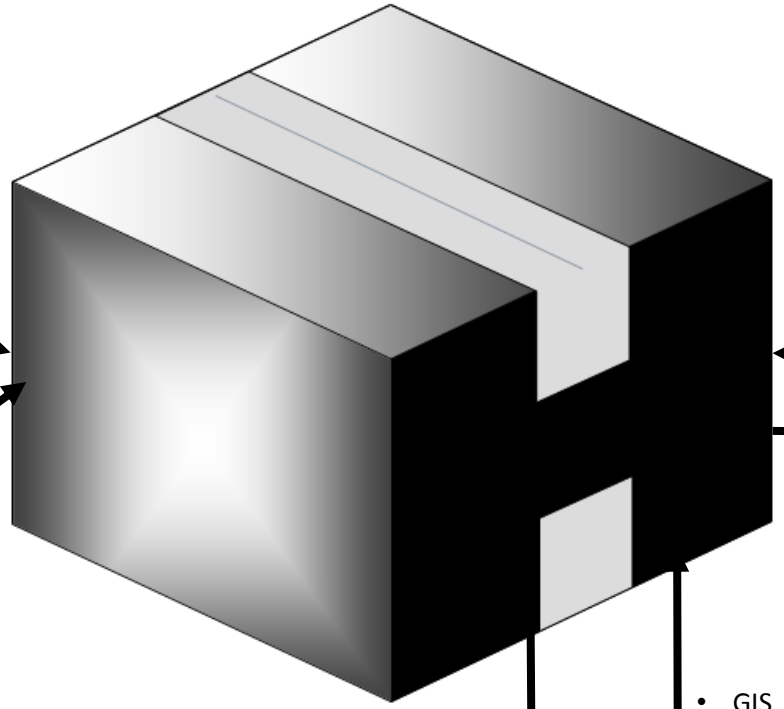
- Rain Gauge Networks
  - NOAA
  - City Networks
  - Alert Networks
  - HADS/AFWS
- SNOW
- Surface Mesonets
- Road Weather Information Systems
- 1-Minute ASOS
- Atmospheric River Observations
- Profilers
- Radiometer
- GPS
- Soil Moisture
- Stream Gauge
- Aircraft

- X-Band Radars
- C-Band Radar
- Additional Gauges:
  - Rain
  - River Stage
  - River Flow

Observations

Observations

AQPI System Black Box



Forecast

Observations

## Forecast Modeling

- **Atmospheric**
- **Watershed**
- **CoSMoS**

- High-Res Current Conditions
  - QPE
  - Costal Conditions
  - Streamflow
- Forecast
  - QPF
  - Storm Surge
  - Stream Flow
- System Monitoring

- GIS
- Thresholding
- Control

## Users

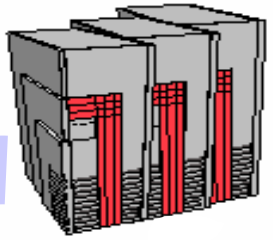
- Water Resource Managers

# NOAA Next-Generation model development

## RAPID REFRESH

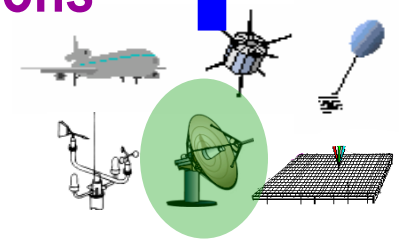
https://rapidrefresh.noaa.gov/hrrr/HRRR

Hourly cycling model

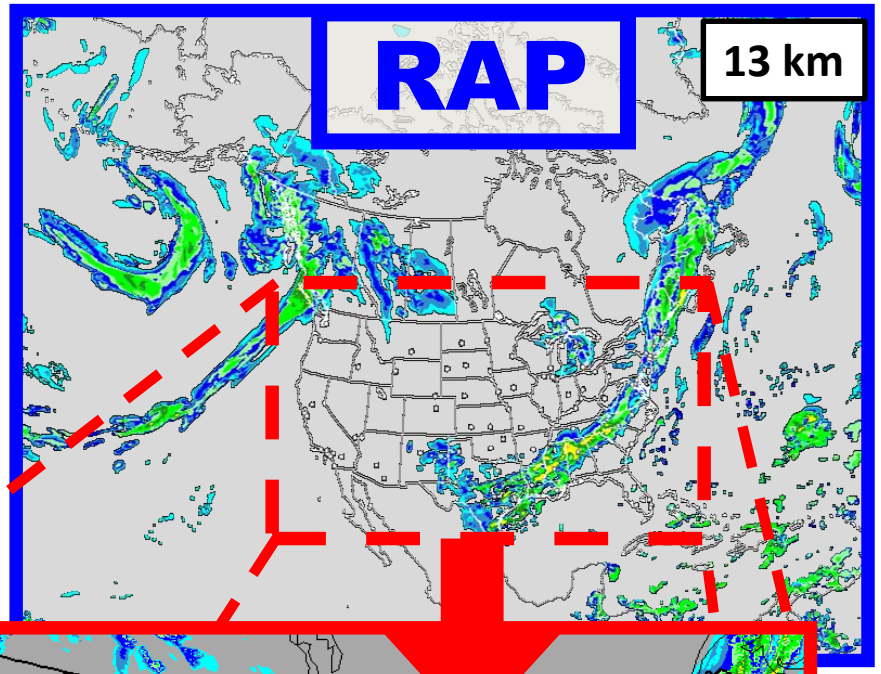


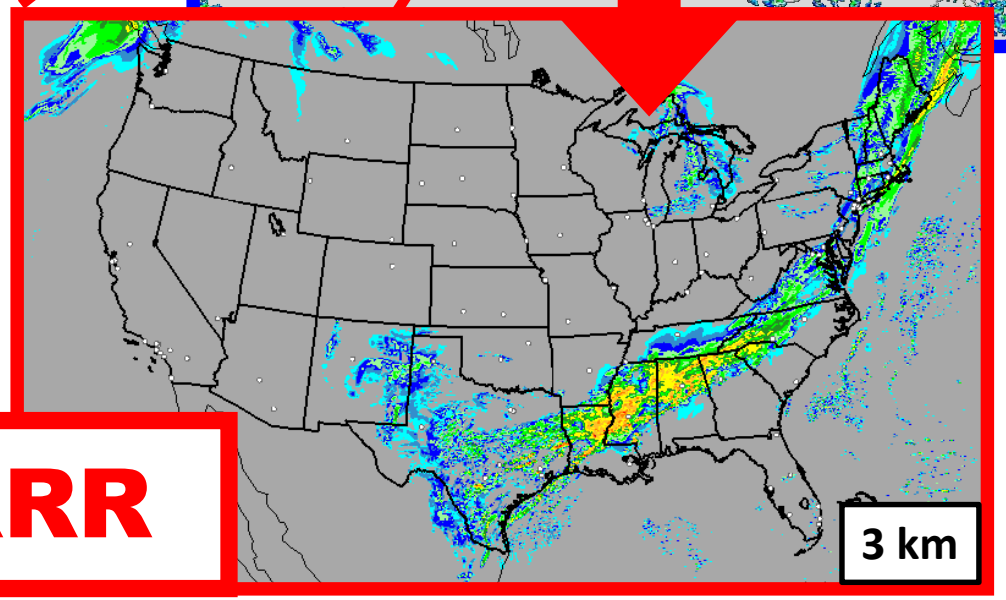
Data Assimilation Cycle

Observations



Radar data



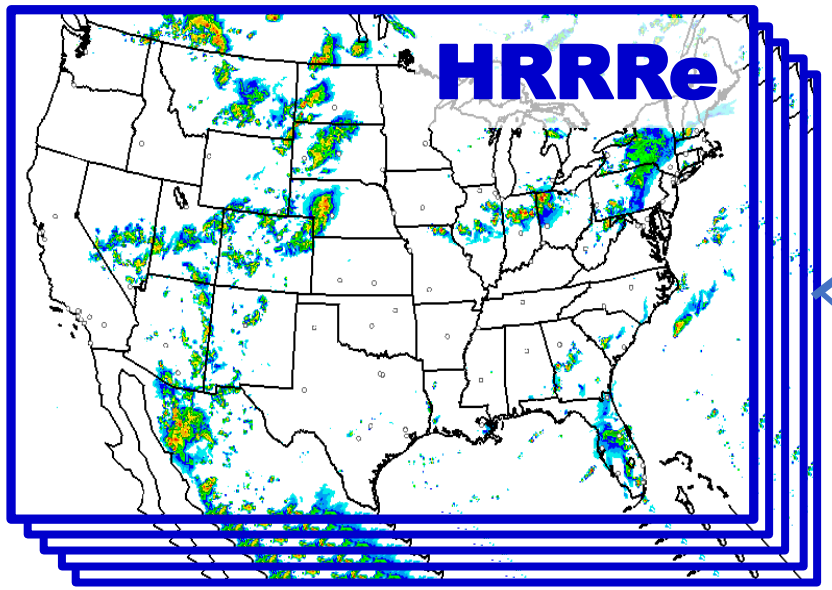

## HIGH RESOLUTION RAPID REFRESH

## HRRR

Run operationally at NCEP

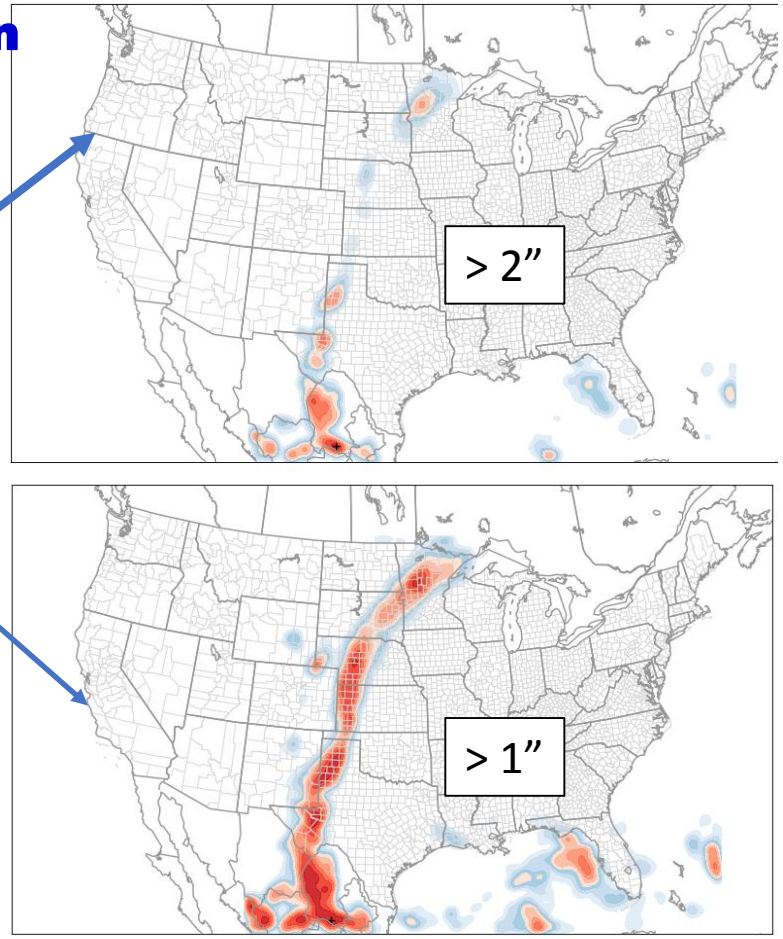
# NOAA Next-Generation model development

## HRRR Ensemble
## Provides Forecast Uncertainty Information




*Under development now*
*Anticipate implementation as early as 2020*

**Probability of 6-hr rainfall**
**(24-hour forecast)**

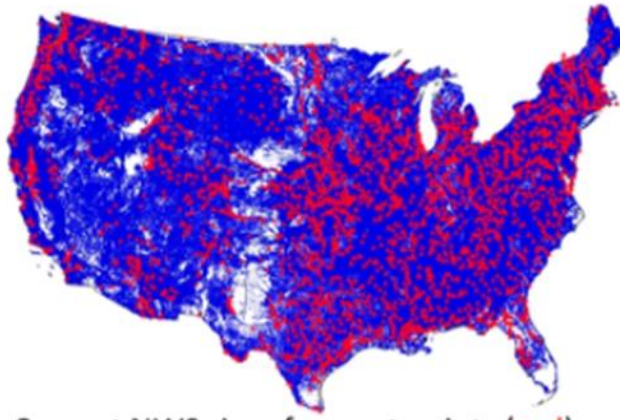


# Hydro-CoSMoS: Integrated Coastal Flood Forecast Model

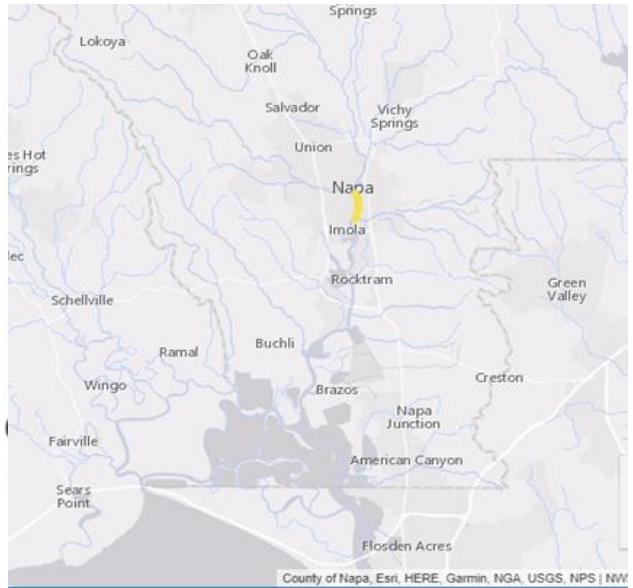
## Watershed Component: NOAA National Water Model

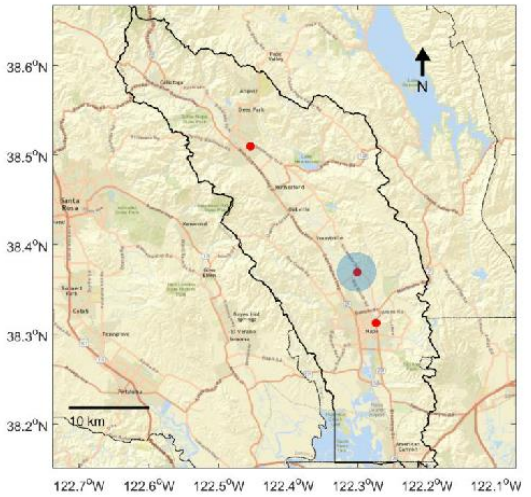
### Overview

- Hydrologic Output
  - River channel discharge and velocity at 2.6 million river reaches
  - Surface water depth and subsurface flow (250 m CONUS+ grid)
- Land Surface Output
  - 1km CONUS+ grid
  - Soil and snow pack states
  - Energy and water fluxes
- Direct-output and value-added geointelligence products

Current NWS river forecast points (red)
NWM forecast points (blue)




**Station ID: Napa O**

USGS 11458000

Napa R NR Napa CA

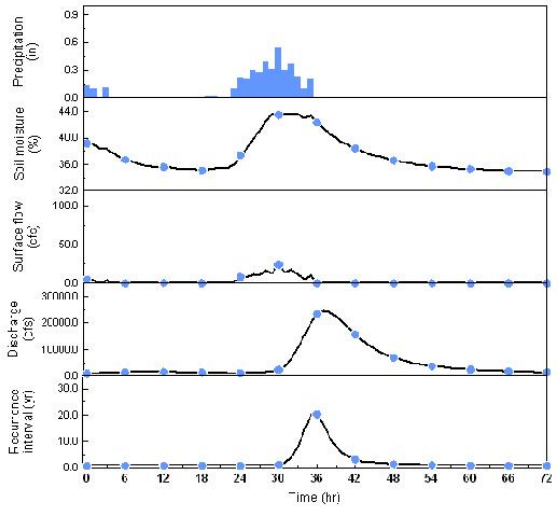
DESCRIPTION:

Latitude 38°22'06"

Longitude 122°18'08"

Drainage area

: 218 square miles




Total Precipitation (in)

: 4.1

Mean/Max. soil moisture (%)

: 35.6/43.5

Maximum surface flow (cfs)

: 24.1

Peak flow of discharge (cfs)

: 24,676

Time to peak (hr)

: 36

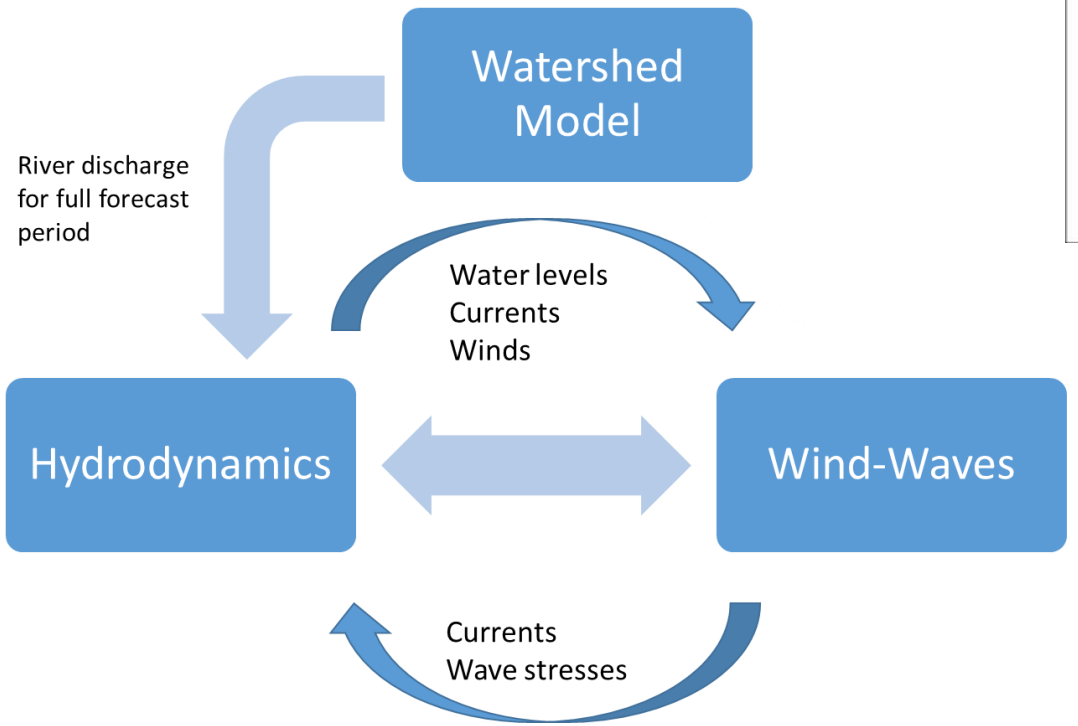
Maximum recurrence interval (year)

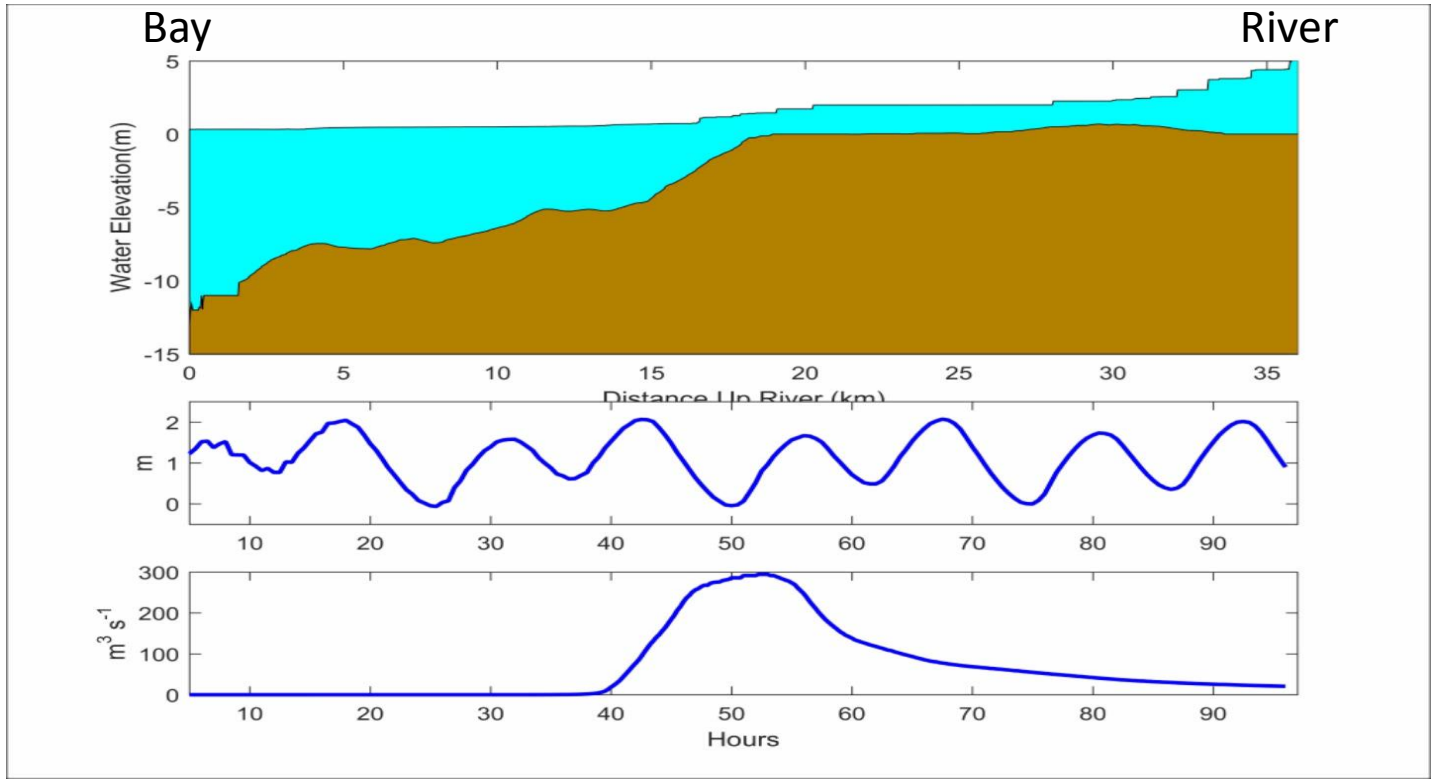
: 20.4

# Hydro-CoSMoS

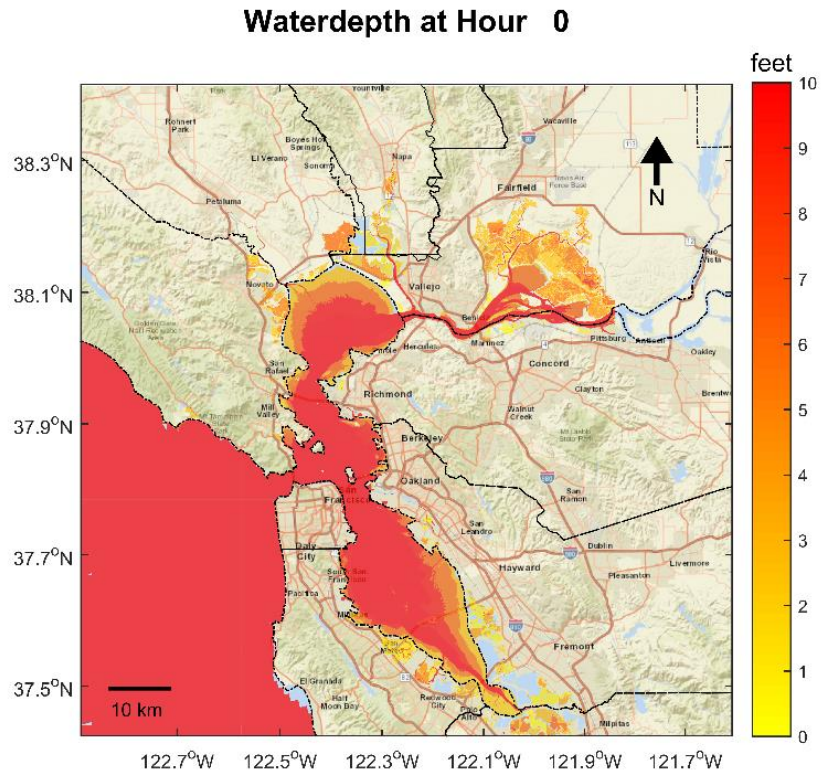
An Integrated Flood Forecast Model for San Francisco Bay based on 10 years of research and development in partnership with leading oceanographic research institutions

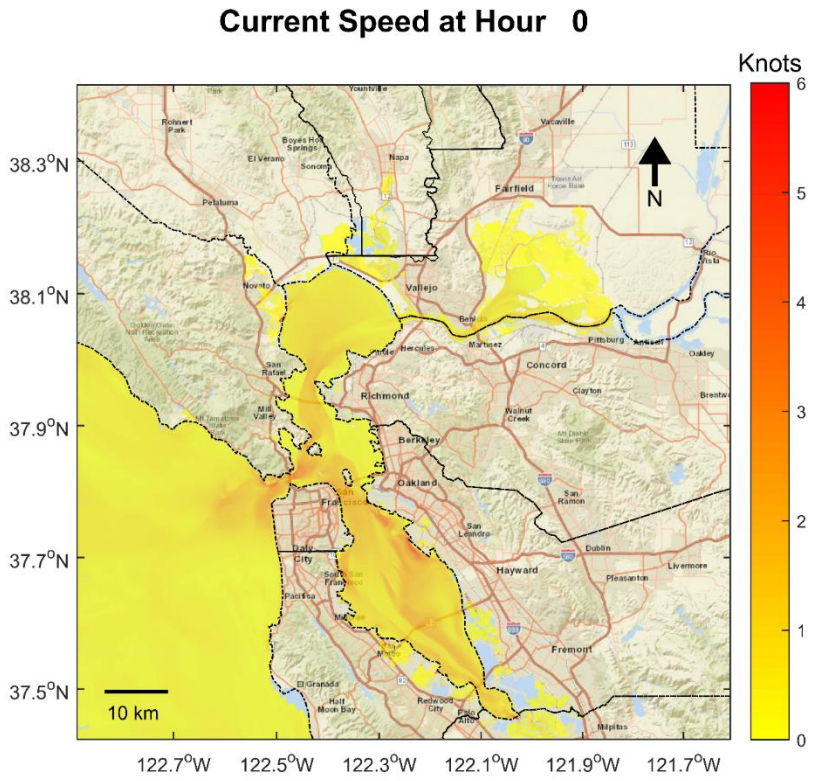
Applications throughout California with public and private sector end-users

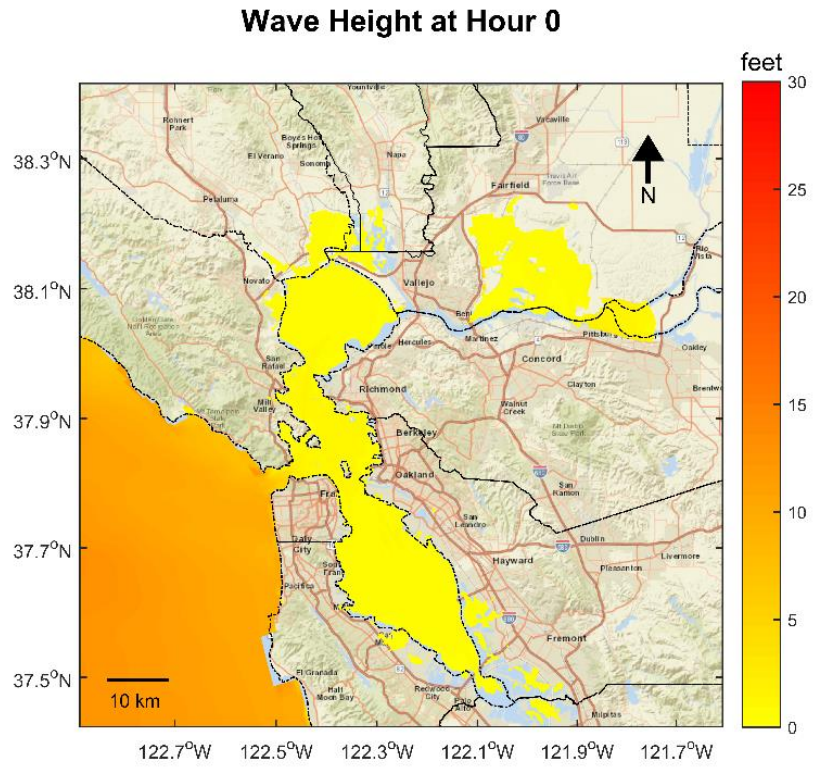



# Model Output: Maps of Relevant Flood Hazards



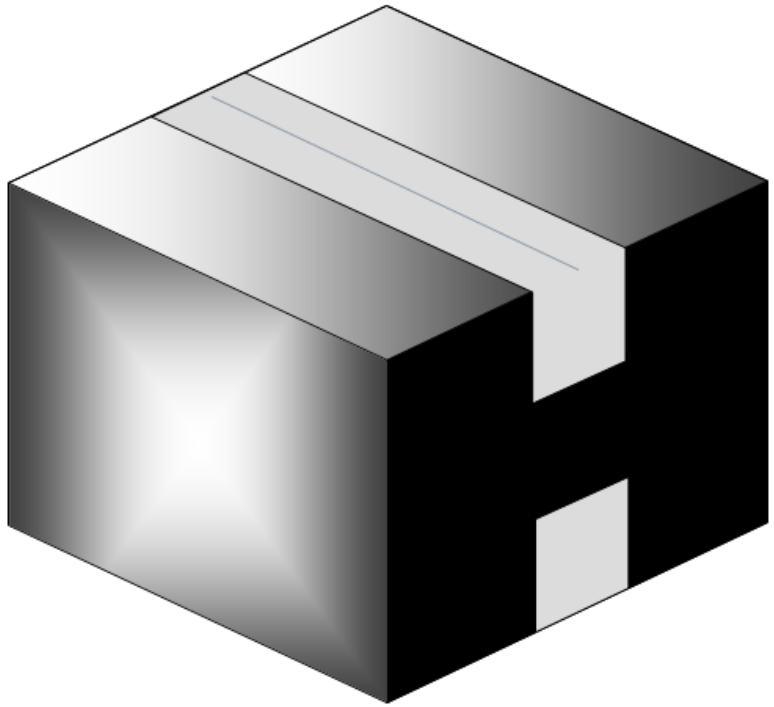




As part of the design process we want information on what types and formats of output are useful!

# Timeline

- 2016 Project Kickoff
- 2017 Contracting, Start Up, installation of Radar in South Bay
- 2018 First information deliveries to water managers, installation of addtional radar units
- 2019 Refinements in information and product deliveries
- 2020 Refinements in information and product deliveries
- 2021 Project Completion

# Q&A



# Website

- http://www.scwa.ca.gov/aqpi/ or www.aqpibayarea.com
- Fact Sheets
- Movie
- Presentations