

Rain intensity and storm duration predicted to increase for damaging rainstorms in San Francisco Bay Area:

To help predict local flooding and infrastructure damage, we modeled climate change effects on severe rainstorms through end of century

Damaging rainstorms, also called “Compound Precipitation-Wind Events” (CPWEs) are frequent across the Bay Area

Occurring mostly from October to April, CPWEs are somewhat common, with a severe damaging rainstorm occurring anywhere from once in 2 years to as often as twice per year.

- ◆ These damaging storms that combine high winds (“extreme wind event”) with heavy rain (“extreme precipitation event”)
- ◆ In California, the storms are often driven by atmospheric river events, which – although themselves important for water supply – are projected to intensify in the changing climate
- ◆ Damaging storms are characterized by three factors: Frequency, Intensity and Duration

Parameter	Extreme wind	Extreme rain
Frequency	3 - 5 per year	3 - 5 per year
Intensity	14 - 23 mph	¾ - 2 in/day
Duration	1 - 5 days	1 - 5 days

CPWE: a “severe damaging rainstorm” that combines high winds with heavy rain (daily total), where each exceed their 98th percentile.

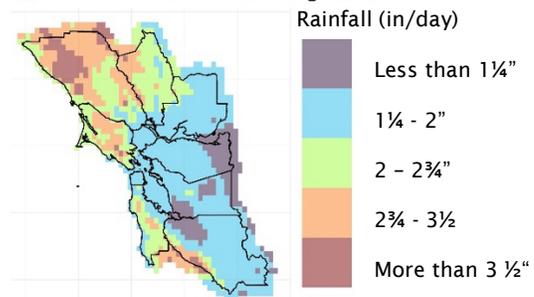
It is the co-occurrence and interaction of the two elements that causes amplified damage; thus these damaging storms represent a distinct phenomenon.

Both the wind & the rain matter

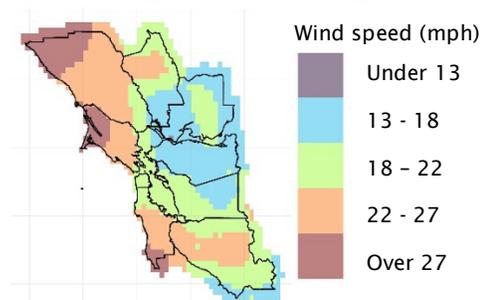
Observed Storm Patterns in the San Francisco Bay Area (1982–2022)

Based on observed daily rain and wind data from gridMET dataset

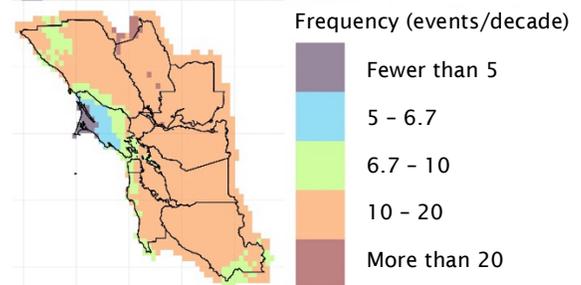
How Much Rain Falls During Storms?



How Strong Are the Winds During Storms?



How Often Do these Storms Hit?



Individually the wind speeds and rain rates are higher in coastal areas; however, storms are slightly more frequent in inland areas.

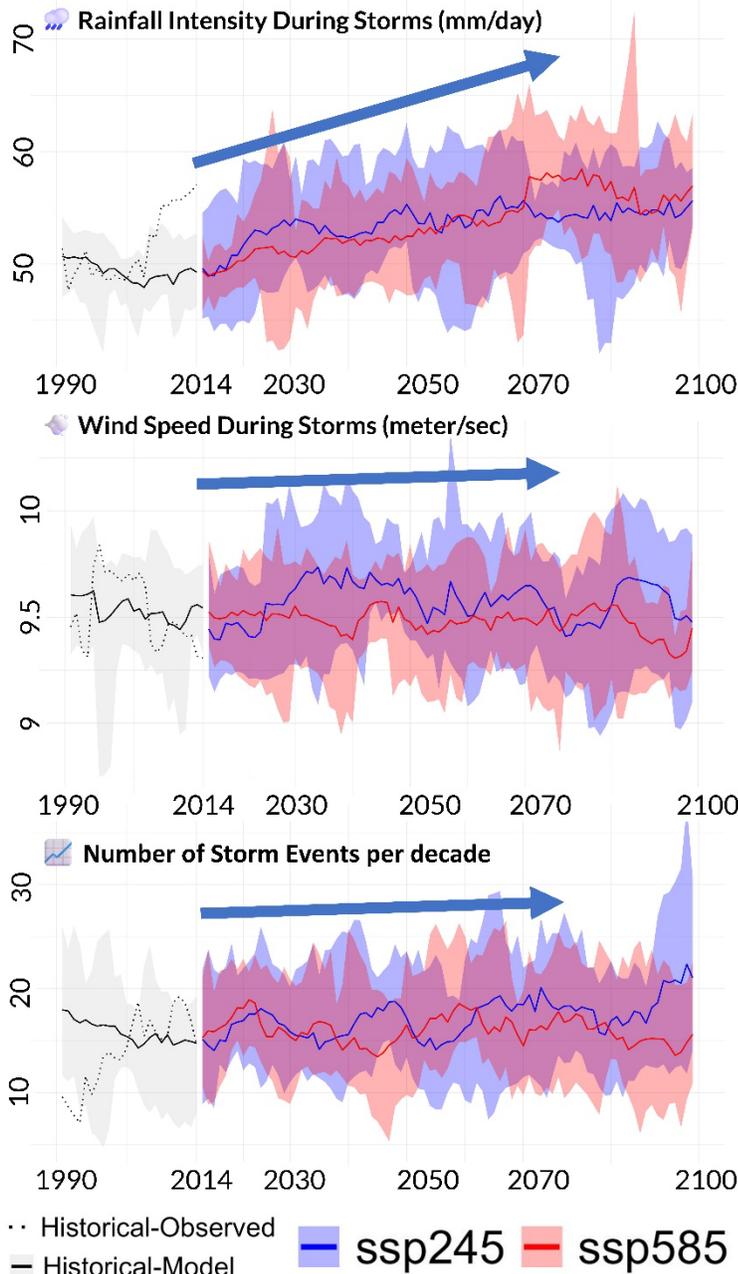
Year 2099 projection: higher rainfall, but no change to wind and storm frequency



How Will Bay Area Storms Change by year 2100?

Projections Show Wetter Storms, Stable Winds, and Similar Frequency

Based on CMIP6 model simulations under SSP2-4.5 and SSP5-8.5 scenarios



Policy implications

The overall intensity of damaging rainstorms is projected to increase, driven by more intense rainfall. The storm frequency and wind speeds are projected to remain similar to today.

This understanding can help inform

~ **risk awareness**: e.g., timely flood alerts may become more critical in the future, given the increased rainfall;

~ **decision-making and cost-benefit analysis**: e.g., deciding to invest in increased storm drain maintenance or stream corridor restoration (debris management)

~ **prioritization of efforts**: especially regarding the homeless populations in stream corridors, who may need to be relocated in advance of the storms

~ **long-term adaptation**: increased rain rates will affect both our water management system, and our natural stream habitats and urbanized ecosystems.

References

Nikhil Kumar, G. B. Pasternack, Y. Jin, S. Alexander, Z. Wang, C. Rampini, R. Storesund, C. Lim, S. Moreno, I. Lacan. 2025. Intensification of Compound Precipitation-Wind Extremes in the San Francisco Bay Area

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