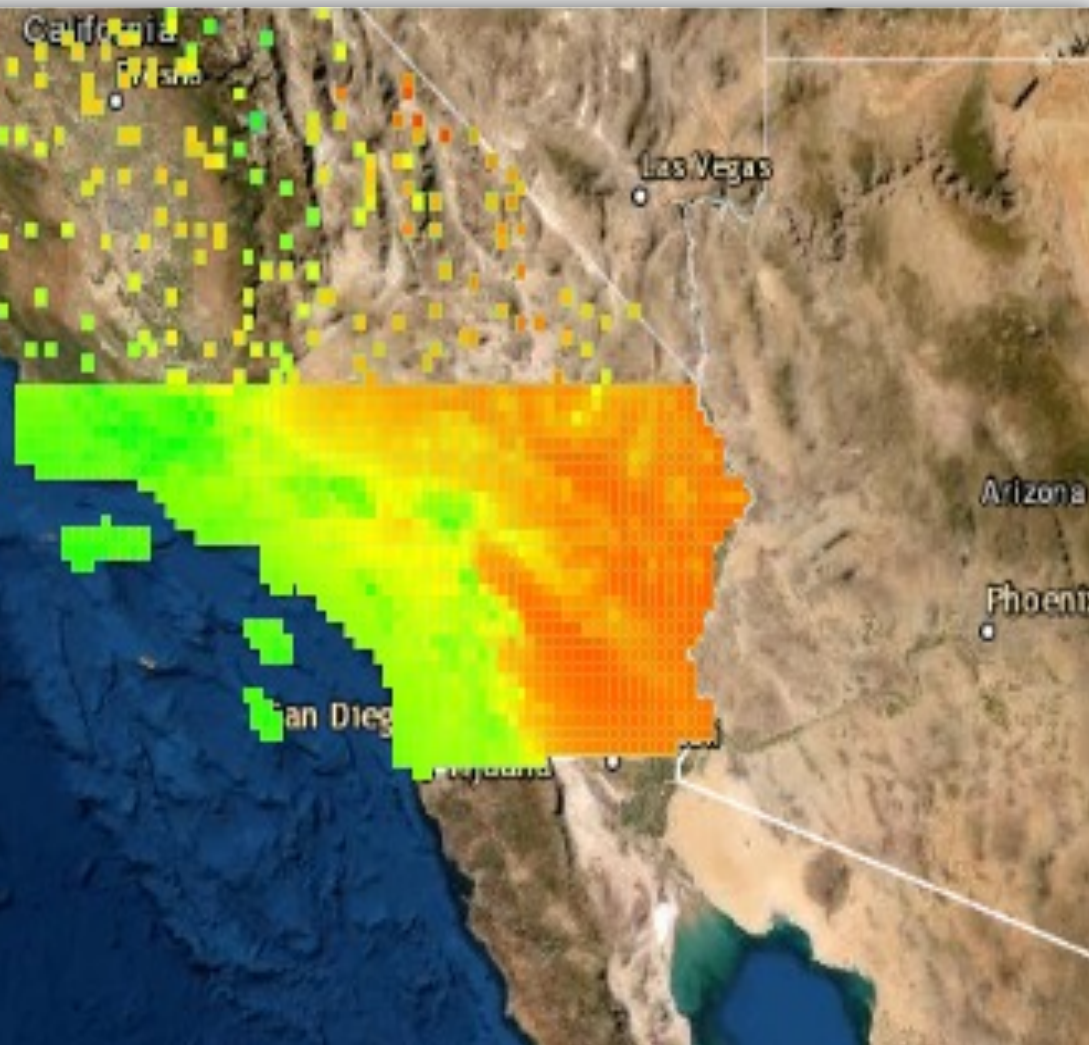


*Using AI to predict future climate
to drive better business decisions*

SUBARNA BHATTACHARYYA (CEO)
& DETELINA IVANOVA (CSO)

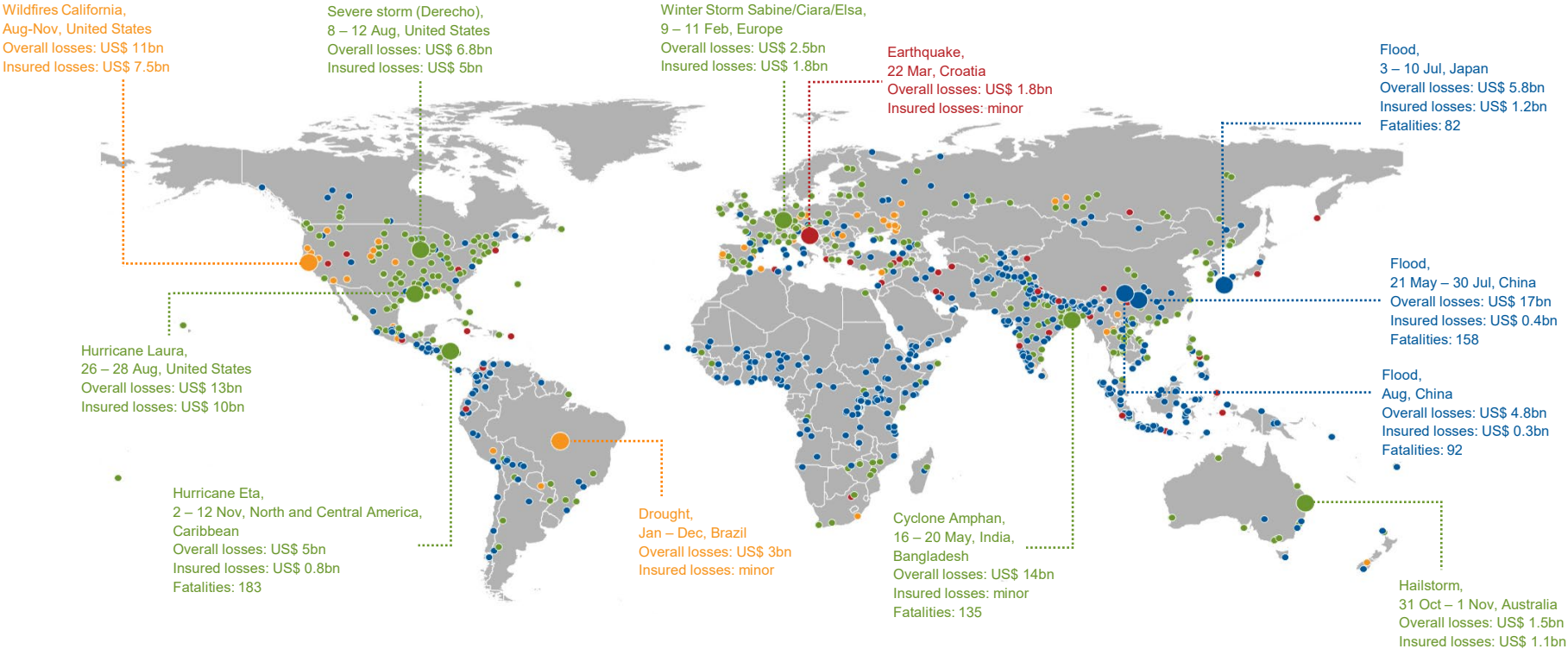
<http://www.climformatics.com/>



Natural Disasters in 2021 cost US\$210 Billions in losses

NatCatSERVICE

Natural disasters caused overall losses of US\$ 210bn
Relevant natural catastrophe loss events worldwide 2020



Geophysical events
Earthquake, tsunami, volcanic activity

Meteorological events
Tropical storm, extratropical storm, convective storm, local storm

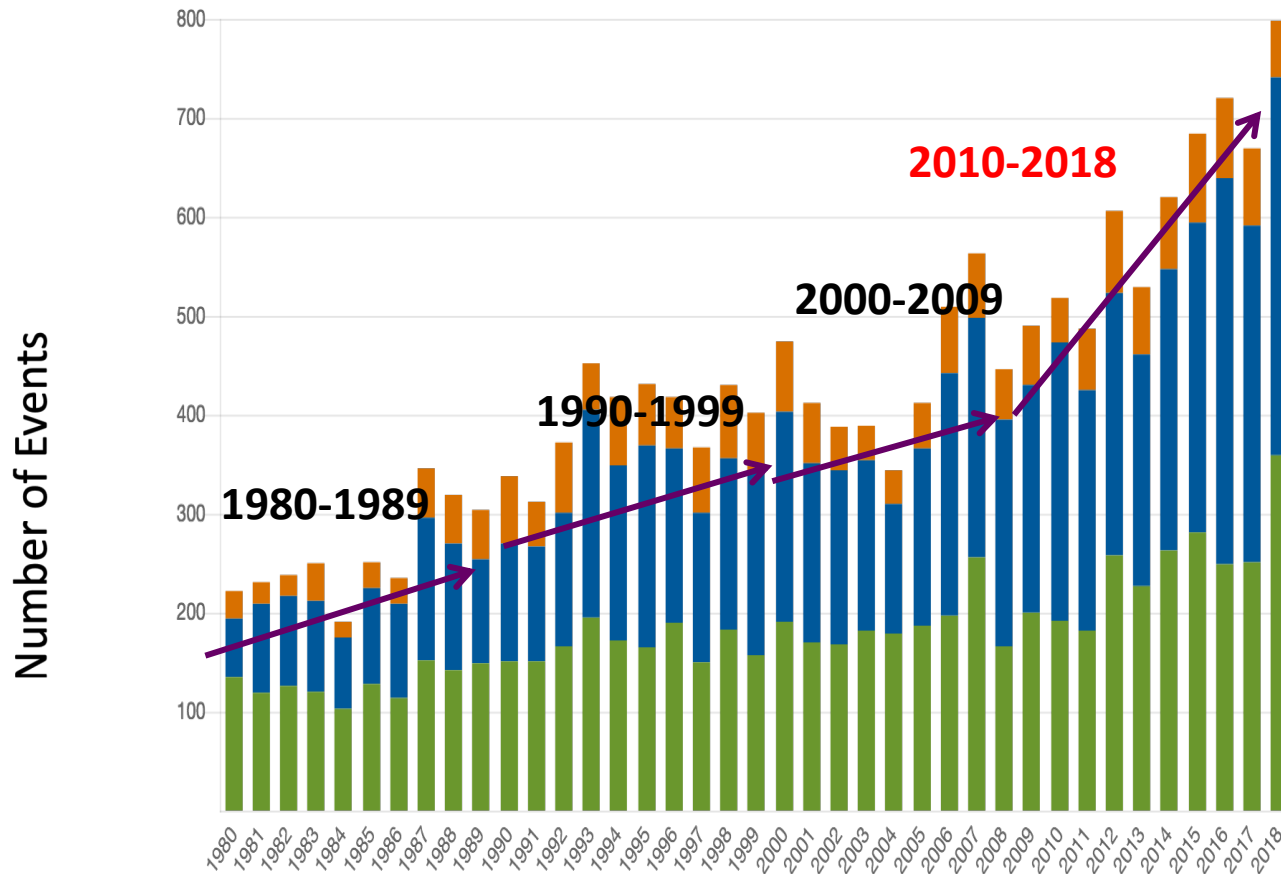
Hydrological events
Flood, mass movement

Climatological events
Extreme temperature, drought, wildfire

Significant catastrophes
 Small, medium and large loss events

Source: Munich Re, NatCatSERVICE, 2021

Rising Weather Driven Loss Events Worldwide 1980-2018



- Climatological events Losses: Overall US\$ 677 bn, Insured US\$ 135 bn
- Hydrological events Losses: Overall US\$ 1046 bn, Insured US\$ 127 bn
- Meteorological events Losses: Overall US\$ 2128 bn, Insured US\$ 964 bn

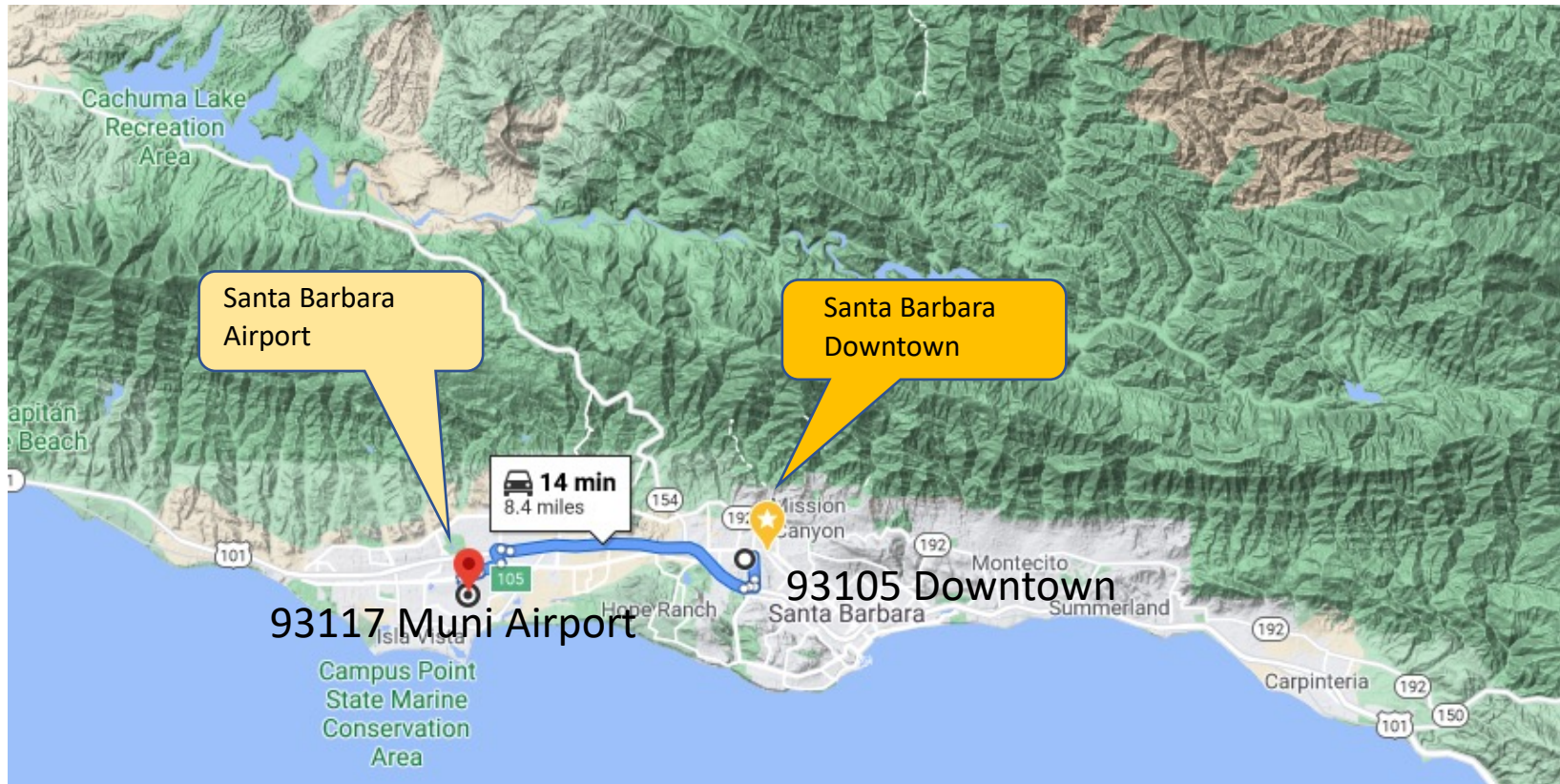
Extreme Climate is not a rare possibility but an inevitability !!!

Source: Munich Re NatCatSERVICE

What is the Problem we are trying to solve? Say, for Santa Barbara

Zipcodes

93105 (Downtown Area) & 93117 (Santa Barbara Municipal Airport Area)



Note the difference in the terrain.
Downtown – valley
Airport - coast

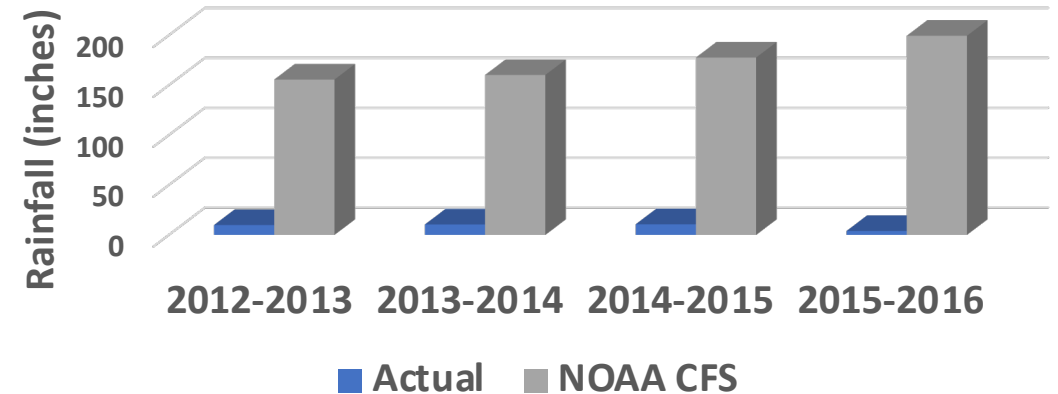
What Is The Problem We Are Trying To Solve?



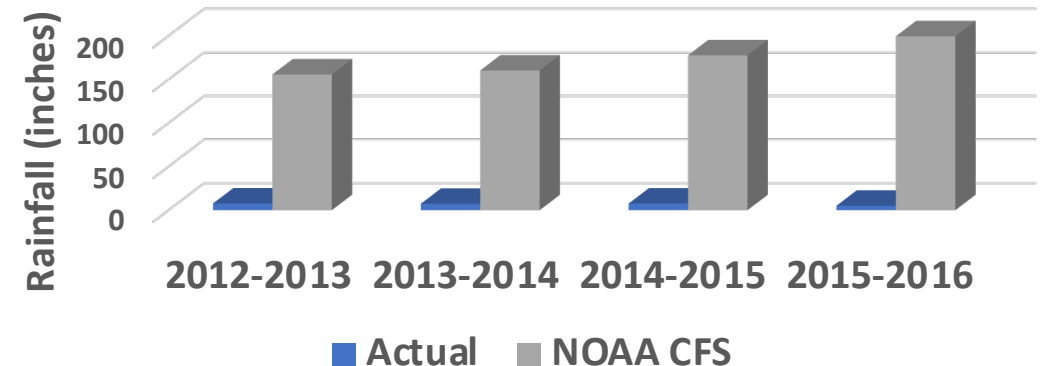
- Spatial resolution of NOAA Climate Forecast Service (CFS) is limited to ~ 30 miles;
- not able to resolve Santa Barbara Airport from Santa Barbara Downtown ~ 8 miles apart

Current climate forecasting is not precise enough to meet needs of risk management

Total Oct-May Rainfall, Santa Barbara Downtown

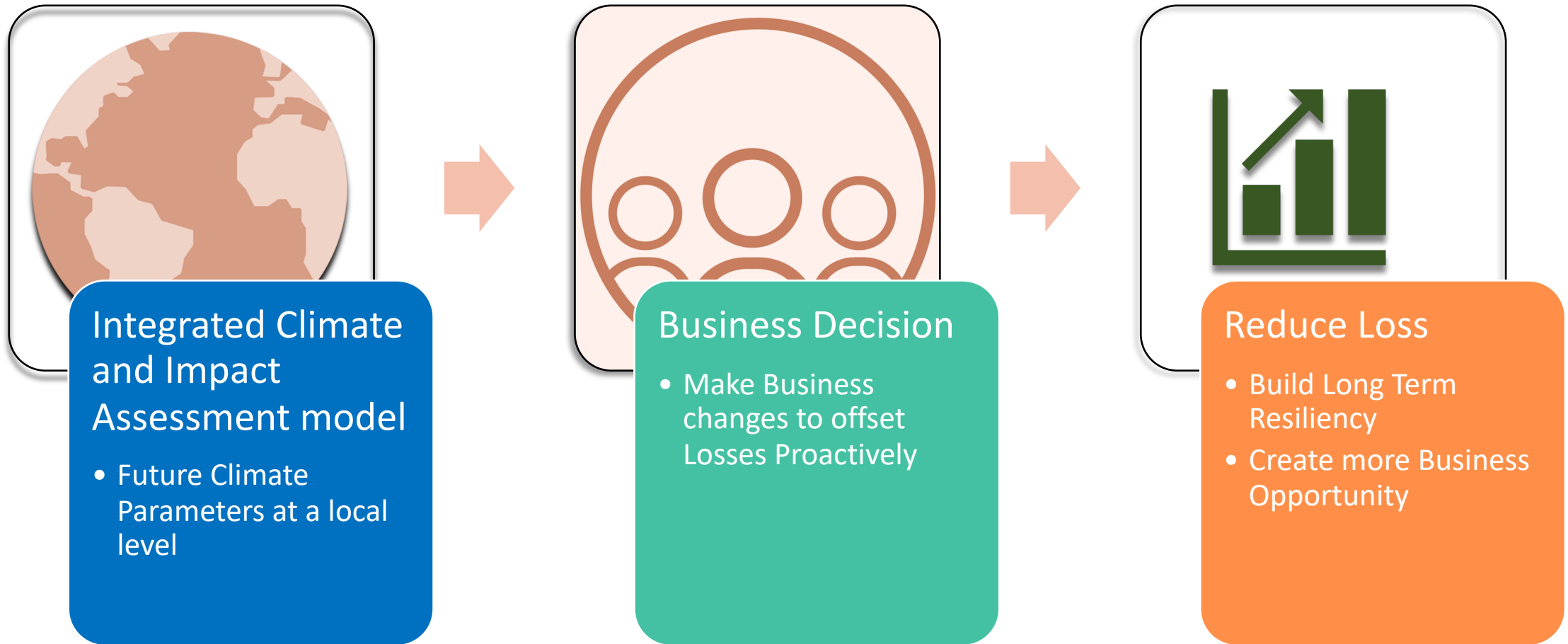


Total Oct-May Rainfall, Santa Barbara Airport



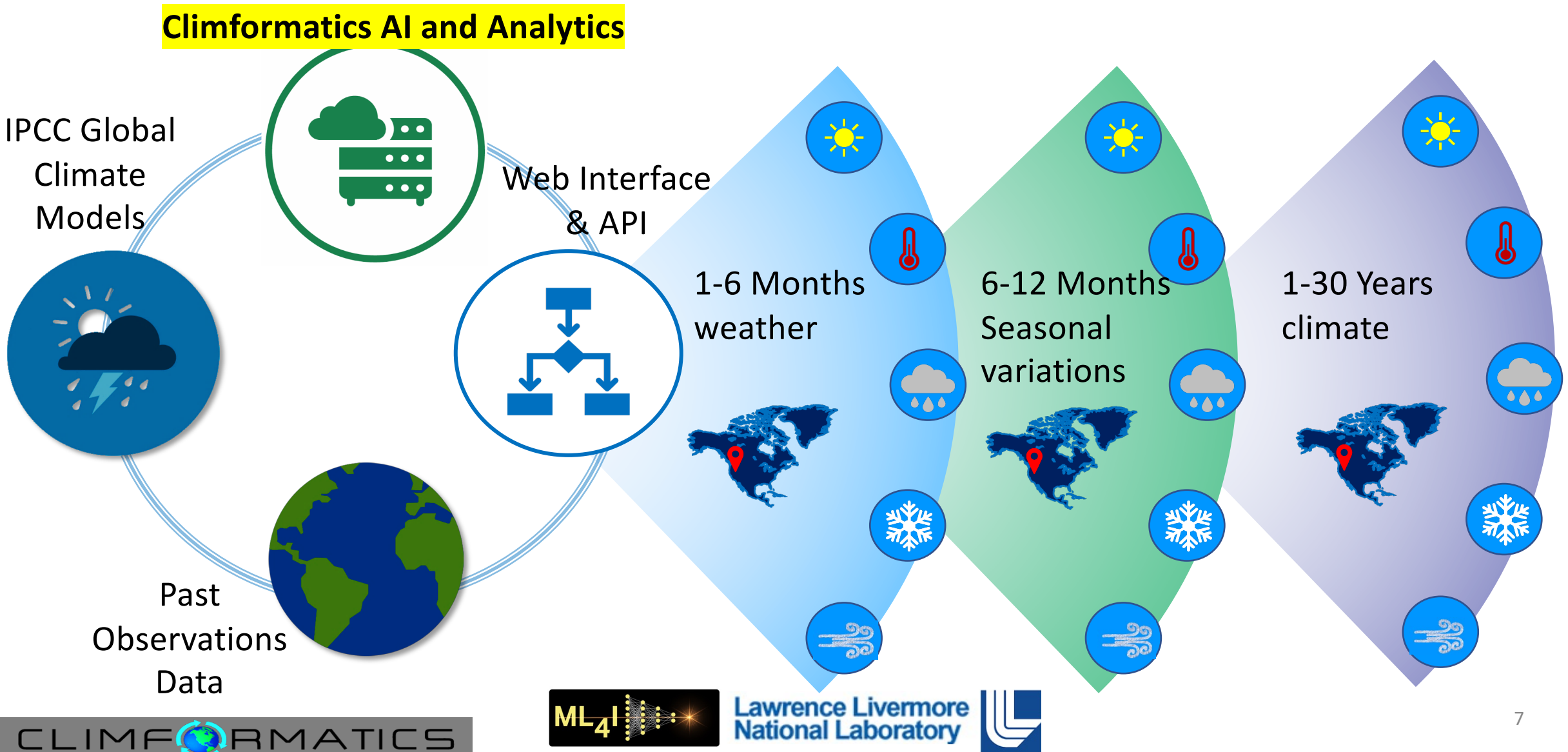
- The rainfall predicted by NOAA CFS forecast is significantly overestimating the **Actual** : ~ 170 inches/season

Solution: Long term weather and climate forecasting



We integrate across climate and weather scales.

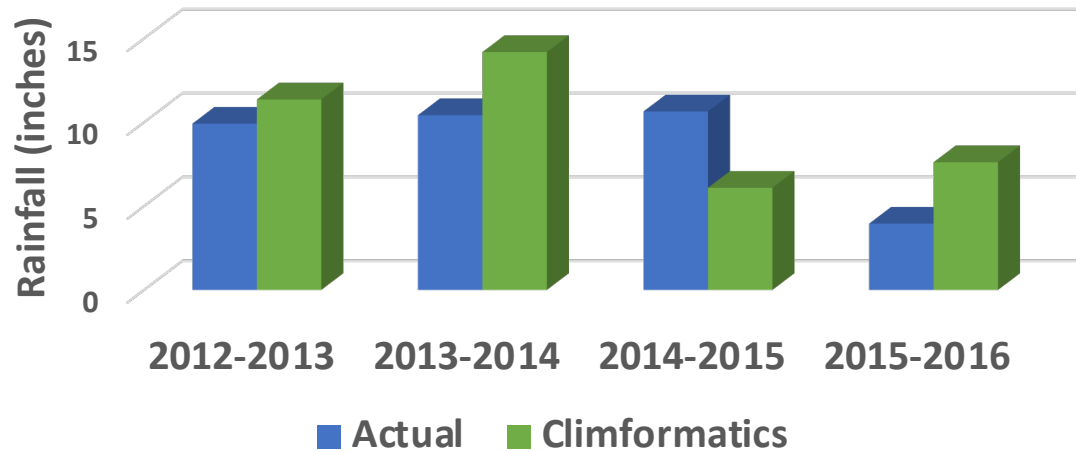
Predictions for Localized Climate Variables: 1 month to 30 years



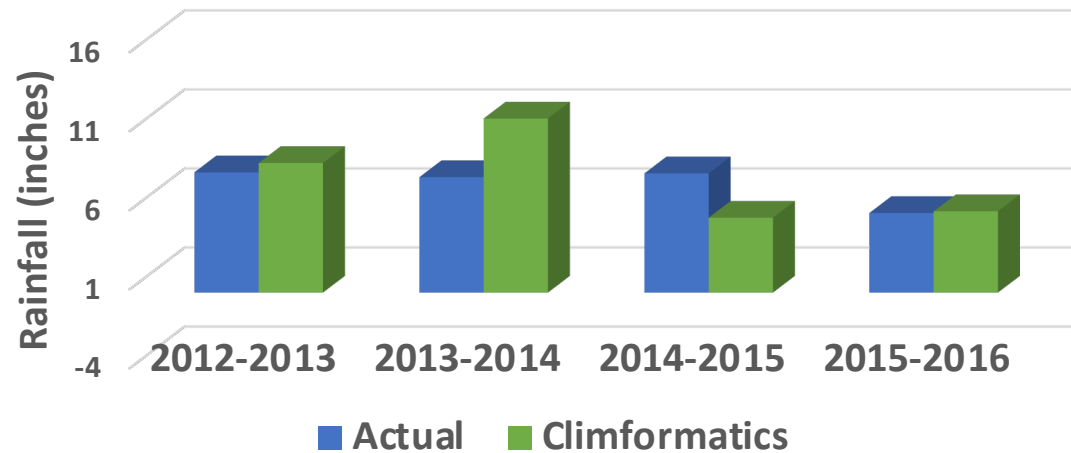
Dramatic improvements in accuracy and resolution

Annual to inter-annual

Total Oct-May Rainfall, Santa Barbara Downtown



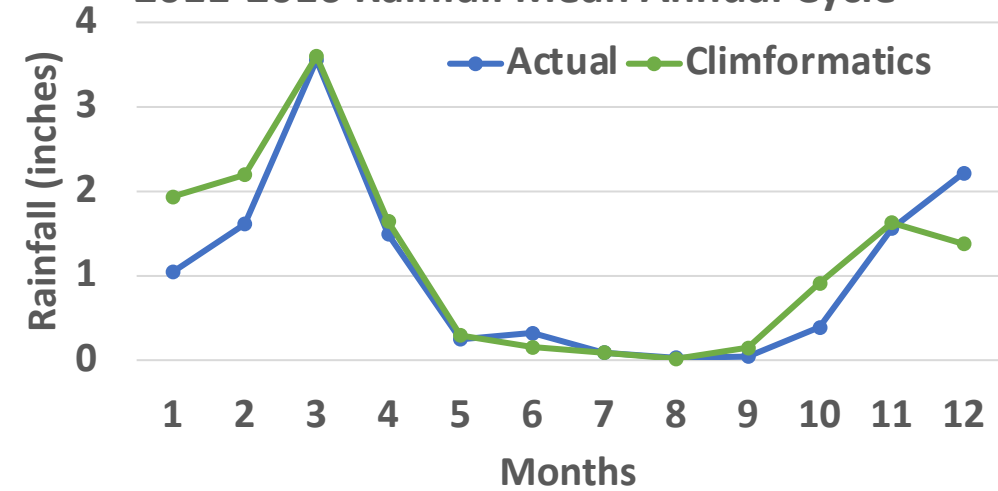
Total Oct-May Rainfall, Santa Barbara Airport



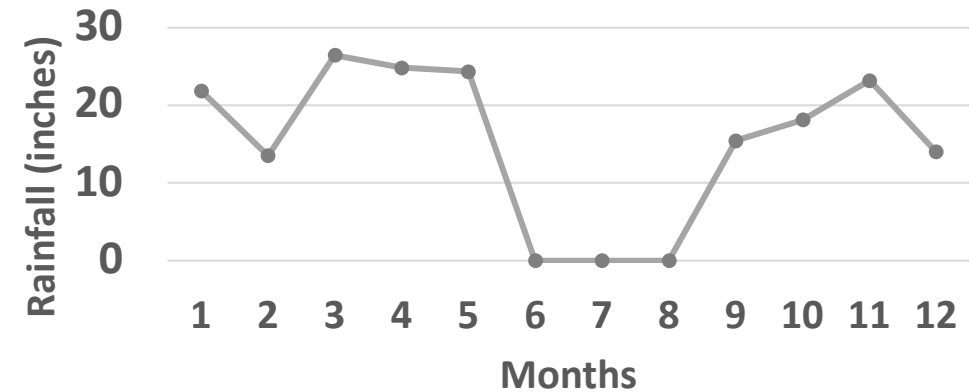
Average **Climformatics** - **Actual** difference ~4inches/season

Sub-seasonal to Seasonal

2011-2016 Rainfall Mean Annual Cycle

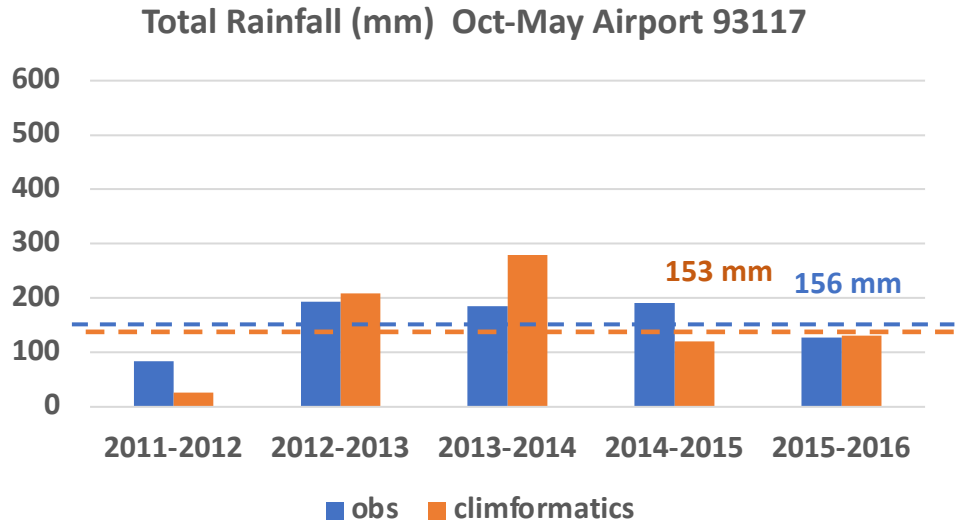
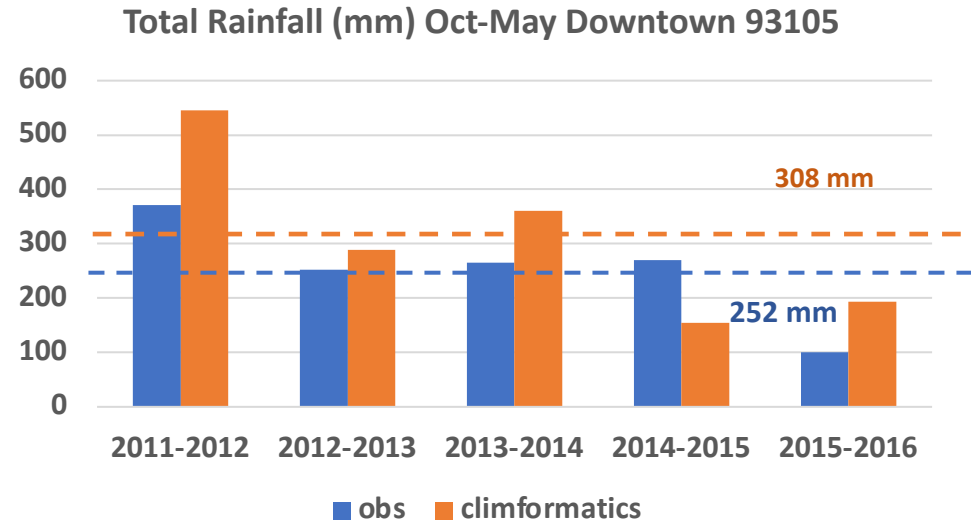


NOAA CFS

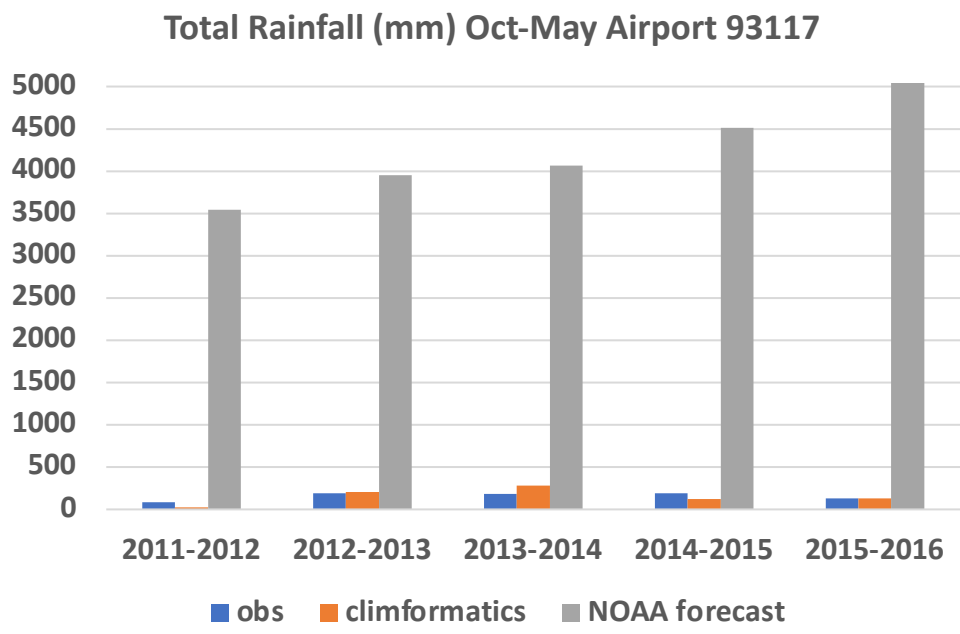
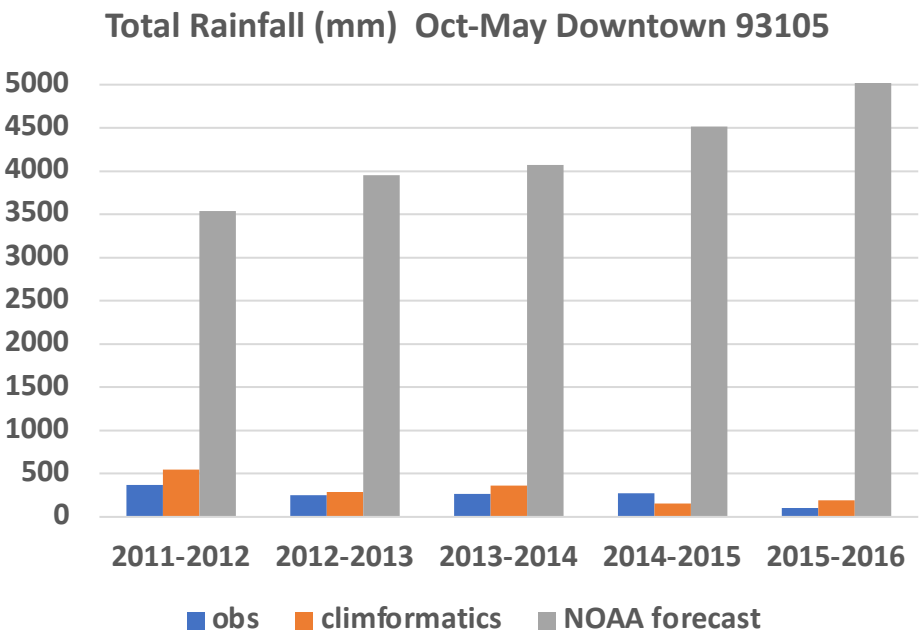


Climformatics tools enable
a new level of accuracy in
“near term” rainfall forecasting

Oct-May Rain Season Total: Climformatics, NOAA, Observations

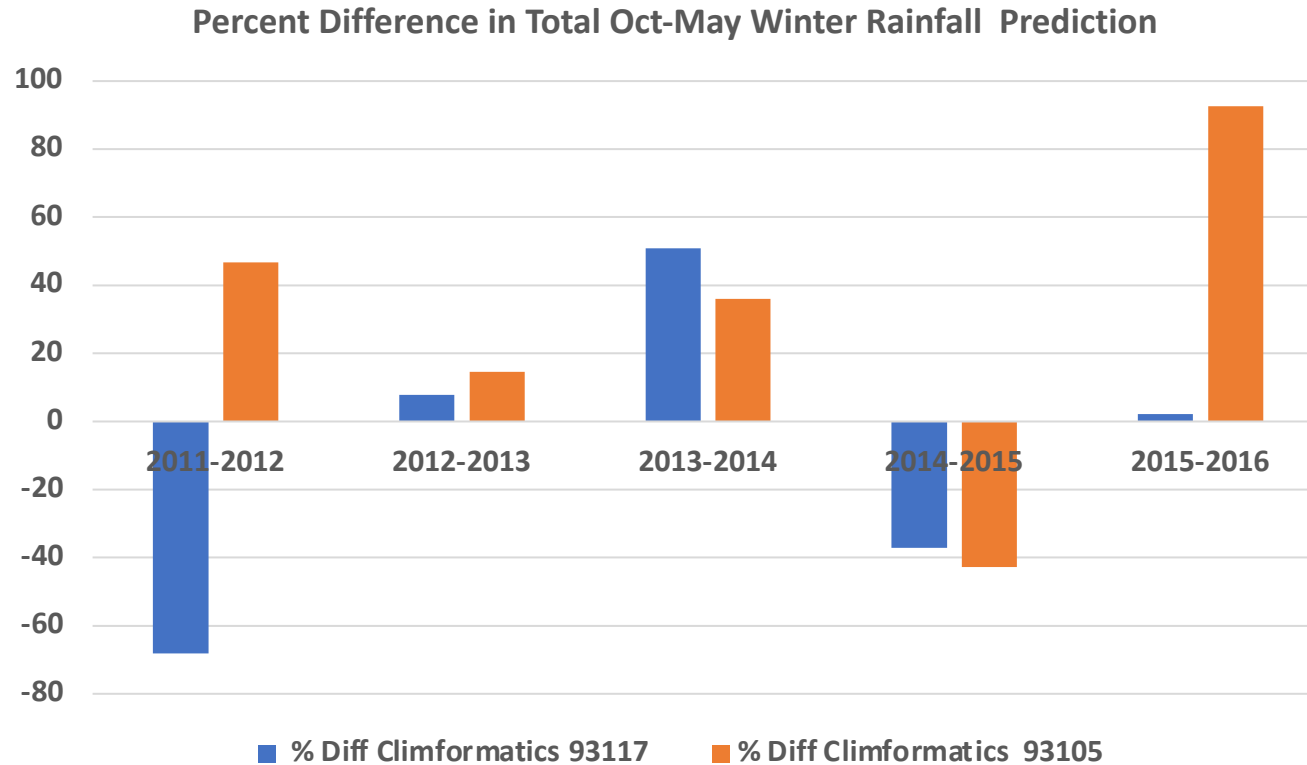


Climformatics predictions follow the observed rainfall in both locations (5 year annual means shown in dashed lines).

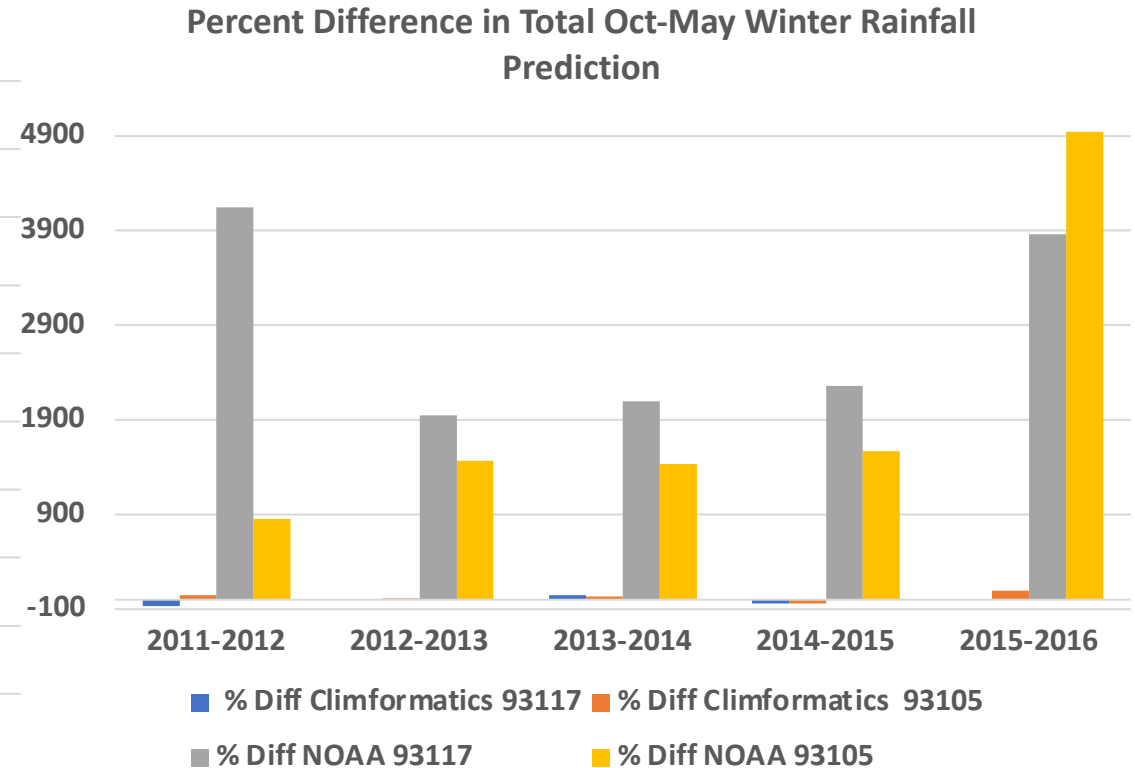


NOAA predictions do not follow the observed rainfall and they are the same for both locations. Poor spatial resolutions.

Summary: Prediction Accuracies of Climformatics & NOAA



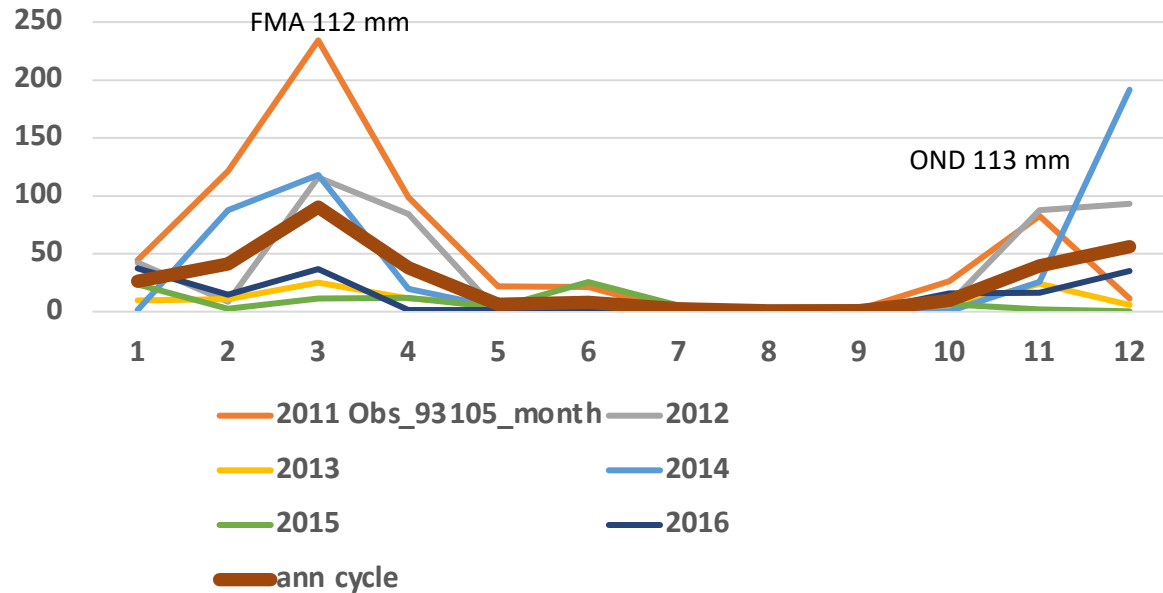
For zipcode locations in Santa Barbara 93105, 93117, percentage difference in **Climformatics prediction** with respect to observations **are within +/- 100%**



For zipcode locations in Santa Barbara 93105, 93117, percentage difference in prediction for NOAA forecasts with respect to observations are **over-predicting by average of 2500%.**

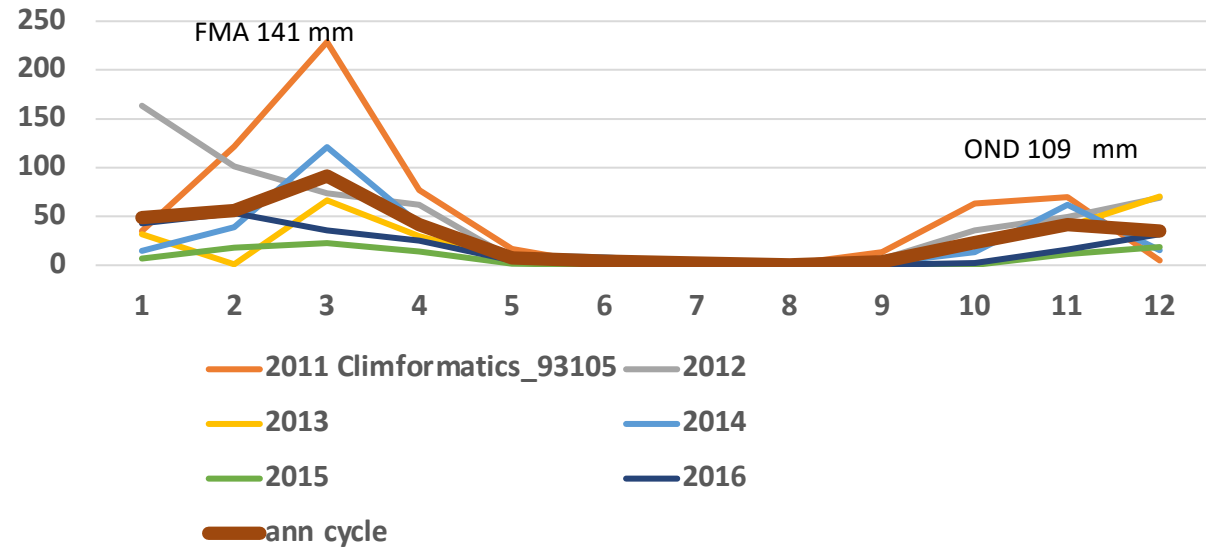
Climformatics & NOAA Predicted Rainfall Annual Cycle for Santa Barbara 93105

Santa Barbara 93105 Observed Annual Cycle Rainfall mm

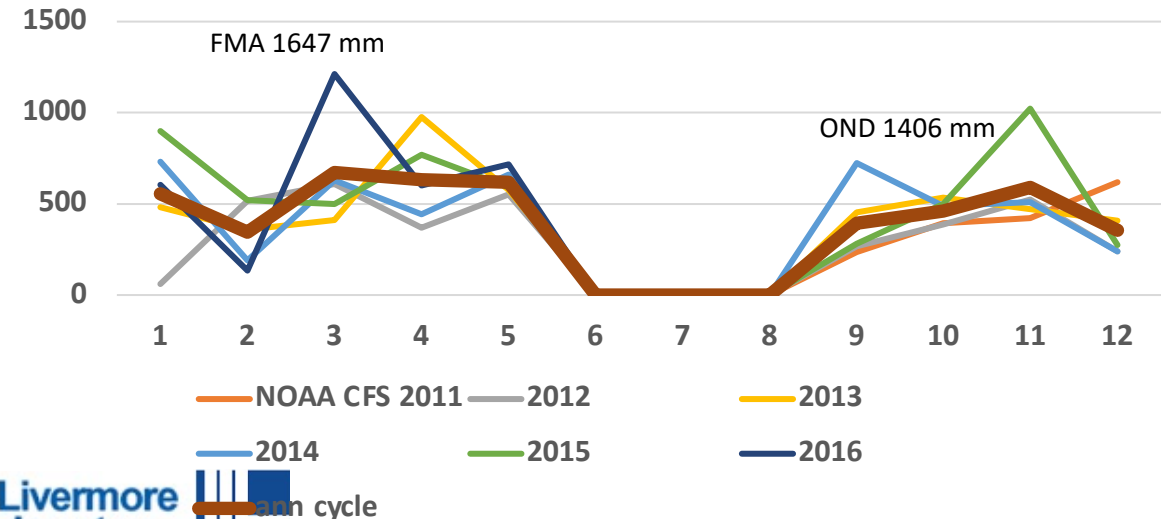


- Two rainfall peaks in SB 93105 5 year climatology, in Nov and Feb seen in observations
- **Climformatics Predictions** capture the two peaks in observations (with **26 % and 4 % accuracy** respectively)
- **NOAA forecasts** show continuous rainfall over the seasons, and do not show distinct peaks (**1369% and 1139% accuracy** respectively for OND and FMA)

Santa Barbara 93105 Climformatics Predicted Rainfall Annual Cycle (mm)



Santa Barbara 93105 NOAA Forecast Annual Cycle Rainfall mm



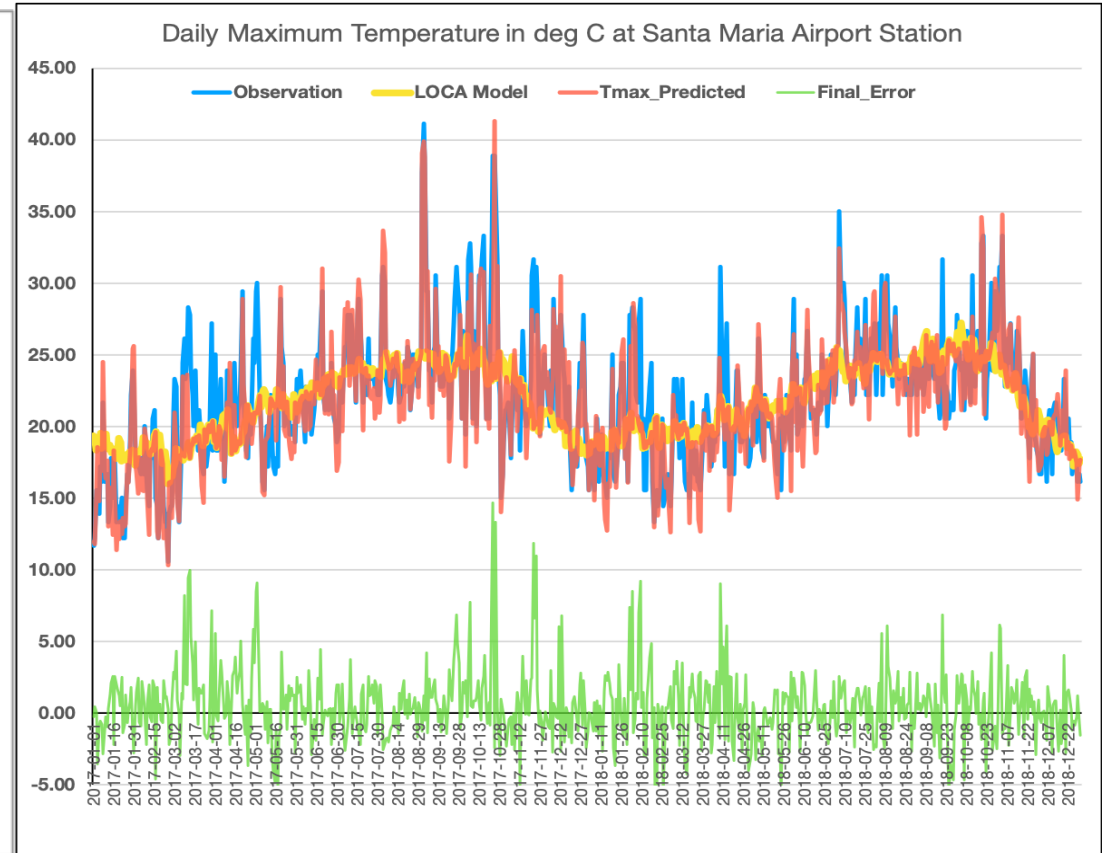
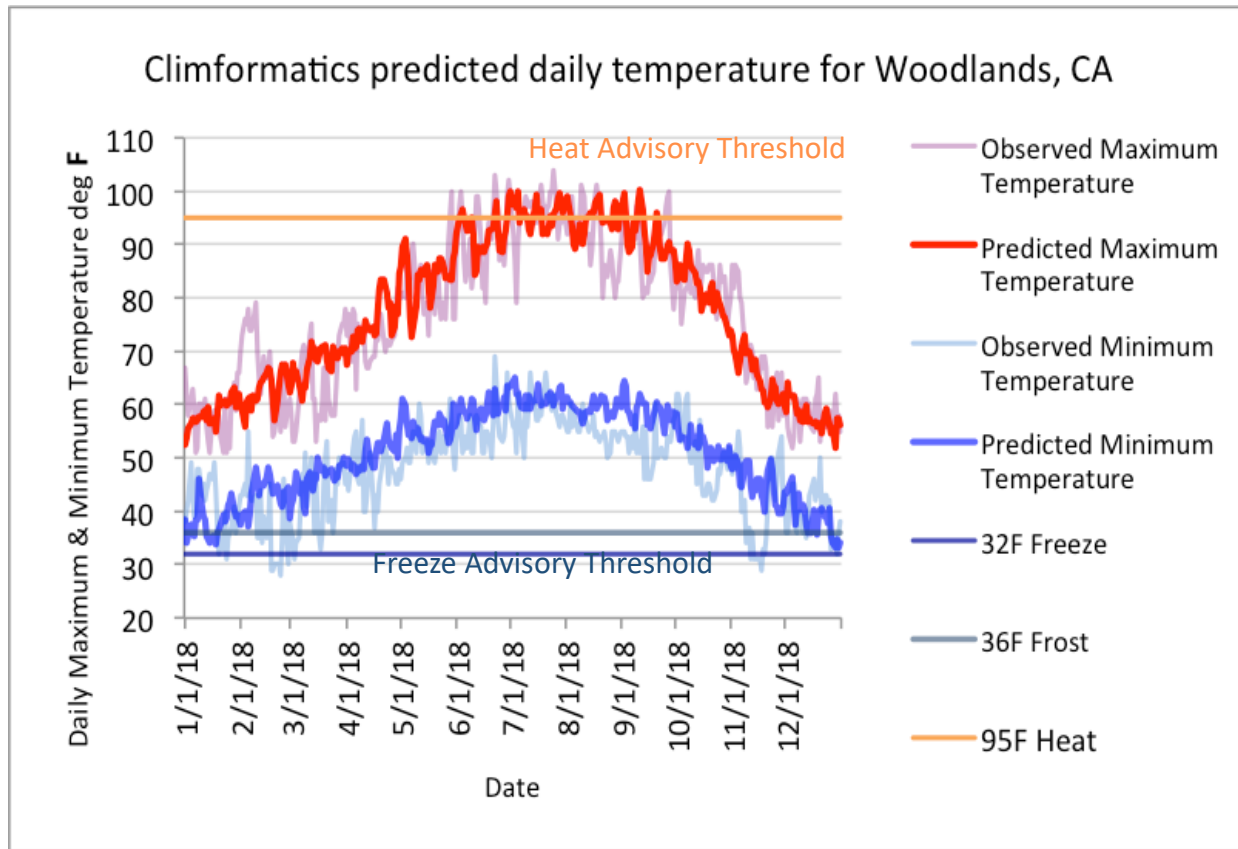
Note the difference in shape of annual cycle curves and scale between Climformatics and NOAA



Lawrence Livermore
National Laboratory



Validation: we are as accurate as the daily forecast! – but one year out



2018 daily max & min temp Predictions for Woodland

2017 & 2018 daily max temp Predictions for Santa Maria, CA

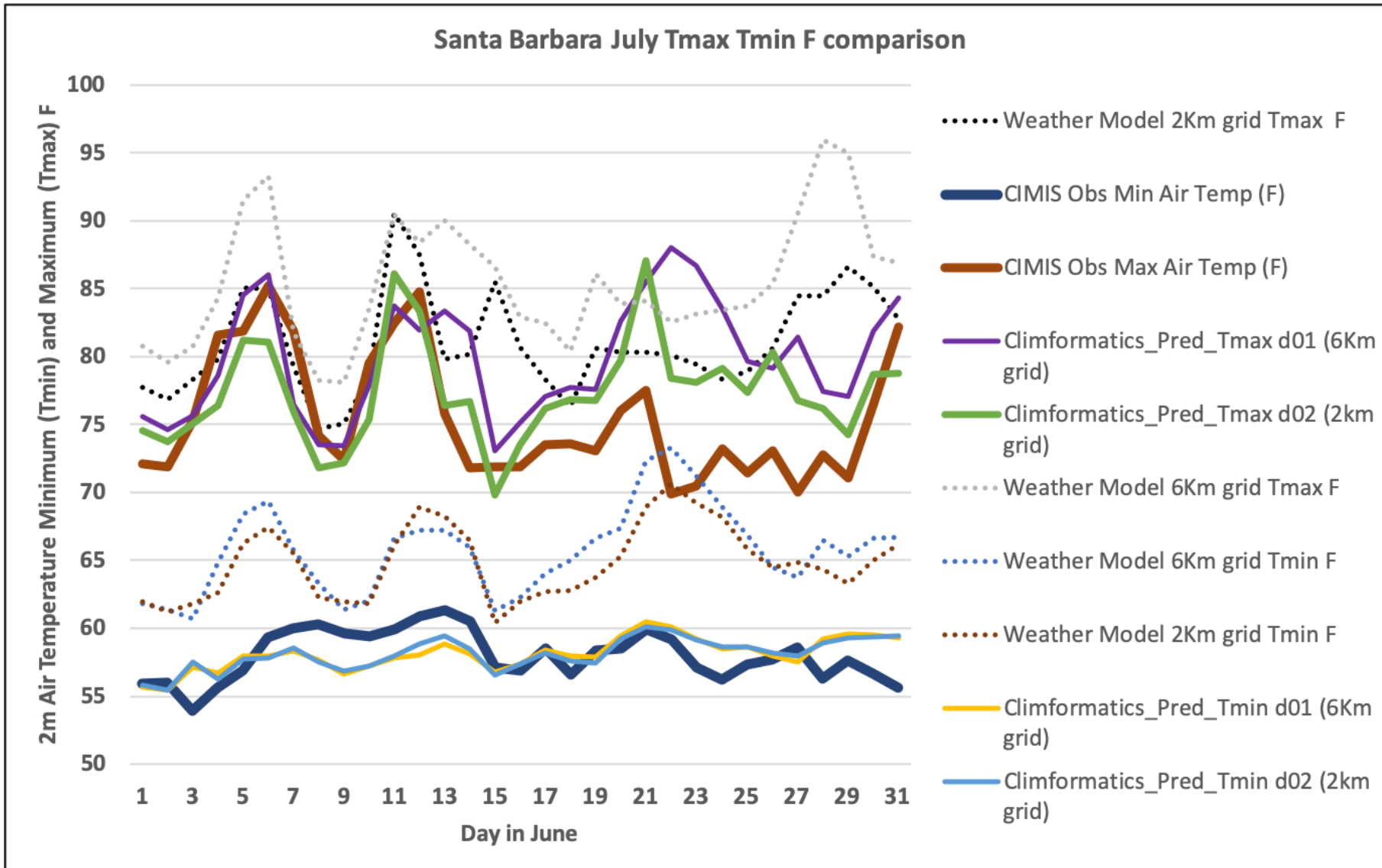
Weather forecasts ➡ 7-10 days ahead.

Climformatics daily predictions made one year ahead enables long range decision making.

Climformatics monthly prediction validation for 300 zipcodes in California available at

<http://35.164.143.67/index.html>

2020 Daily Max and Min Temperature Predictions



Testing location: Santa Barbara

For the month of July 2020, we ran the state – of-the-art WRF (Weather Research Forecasting) model at two spatial resolutions of 6 km and 2 km resolution.

The predictions show that **Climformatics predictions are more accurate** than the state of art WRF

Fire Weather Prediction Validation

Four Zipcode Locations Nearest to Where Wildfire Occurred in 2016
for which Climformatics prediction data exists

1. Chimney Fire, San Luis Obispo County, 93451
2. Canyon Fire, Lompoc, Santa Barbara County, 93437
3. Soberanes Fire, Monterey County 93920
4. Sand Fire, Santa Clarita, Los Angeles County 91342

Source: <https://glff.mesowest.org/tools/fwi/>

Climformatics climate predictions are fed into the above tool to predict the fire weather indices

Build -Up Index – BUI

This index shows how much fuel is available for combustion.

Fire Weather index - FWI

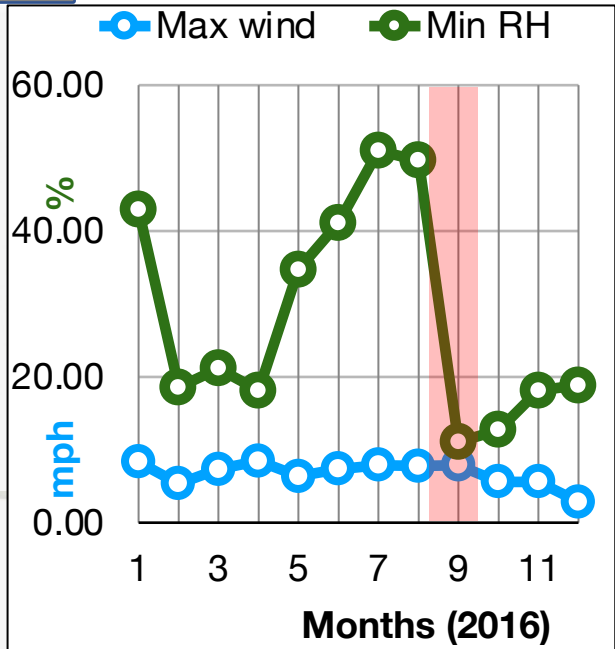
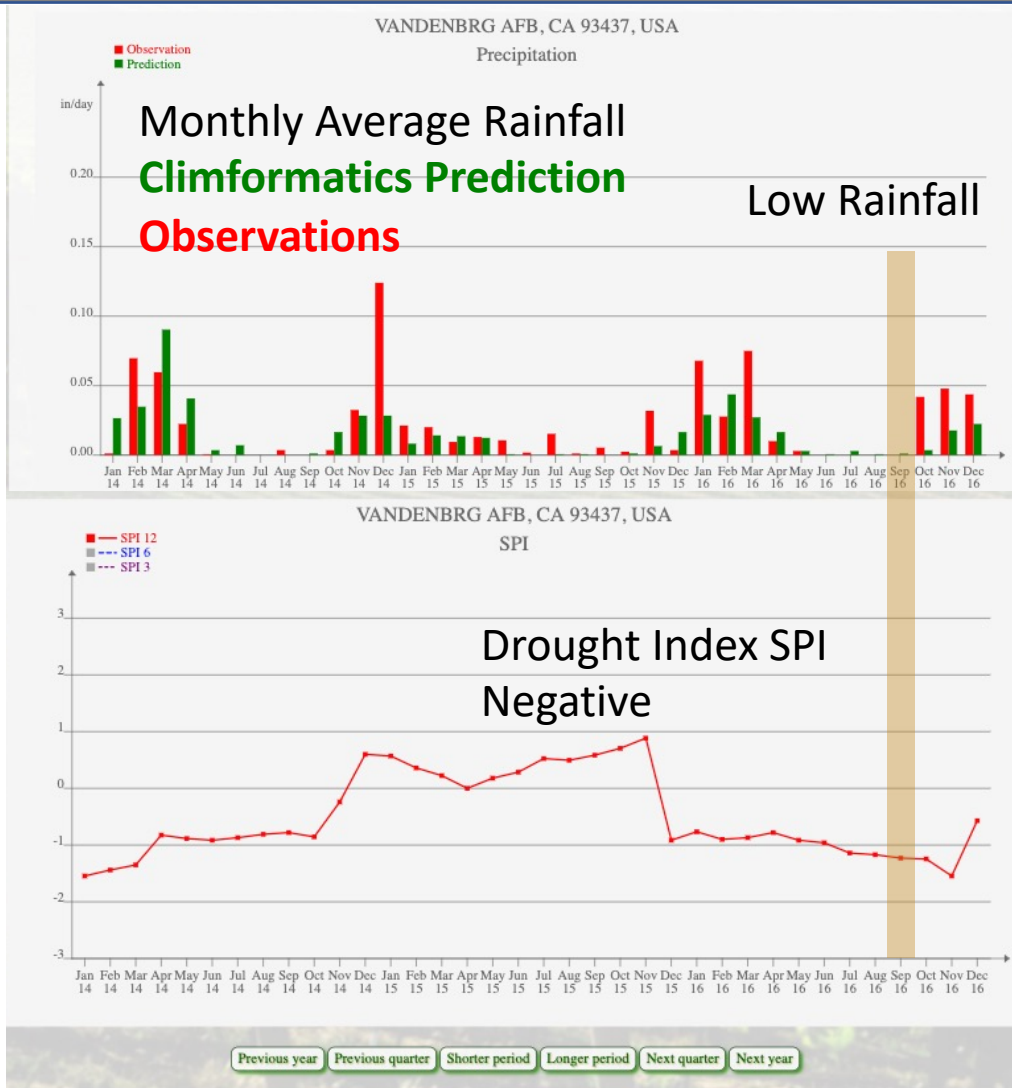
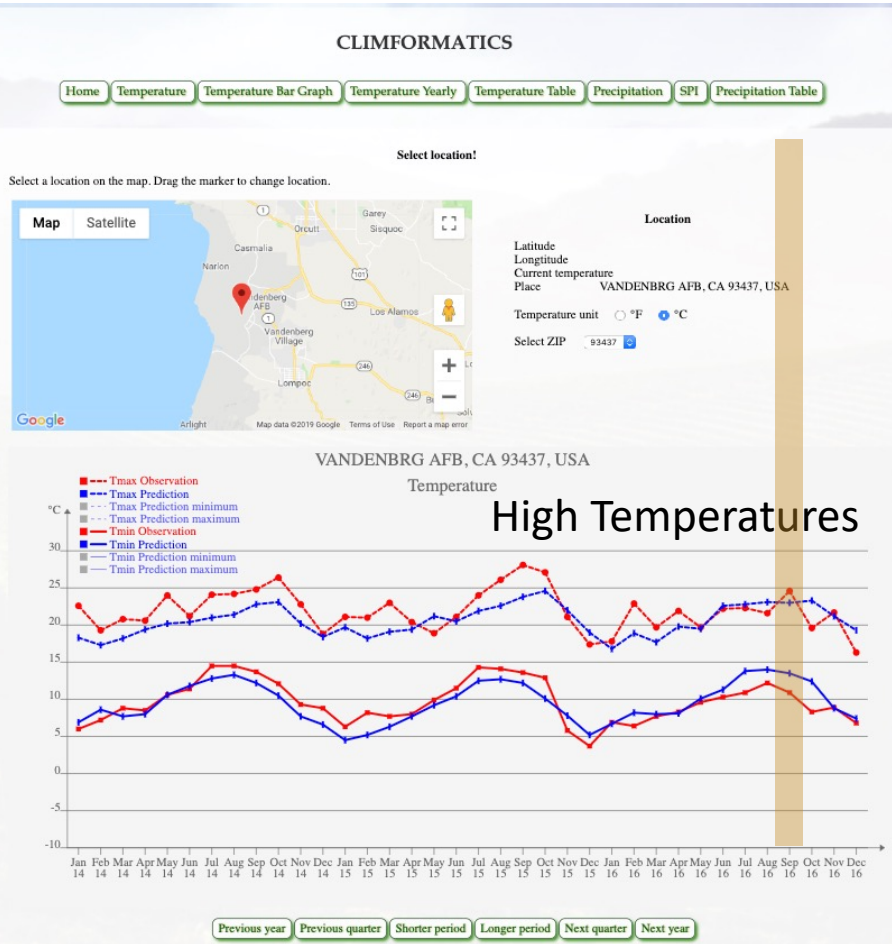
BUI, wind, initial spread intensity is combined to obtain a numerical rating of fire intensity - the Fire Weather Index.

Source: <http://www.pogoda-niesiolowice.kaszuby.pl/fwi/fwistronaen.html>

Index	Low	Moderate	High	Very High	Extreme
BUI	0-19	19-34	34-54	54-77	77+
FWI	0-5	5-14	14-21	21-33	33+

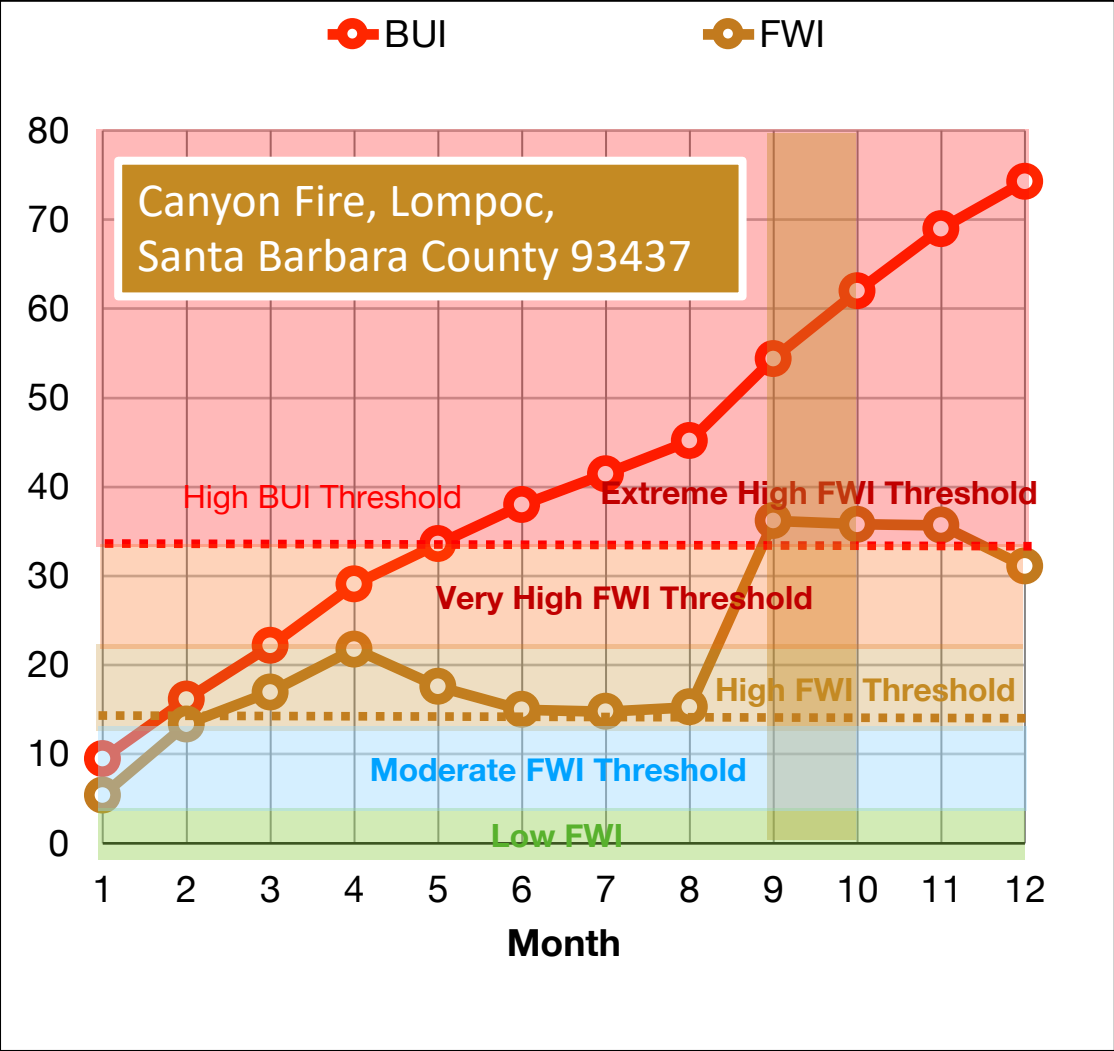
Climformatics prediction for Canyon Fire zipcode for 2014-2016

Max & Min Monthly Temperatures.
Climformatics Prediction **Observations**



Extreme weather: High temperatures, Low rainfall & humidity, high winds, successive drought conditions lead to 2016 Canyon Fire

2016 Fire Weather Index Hindcast Prediction



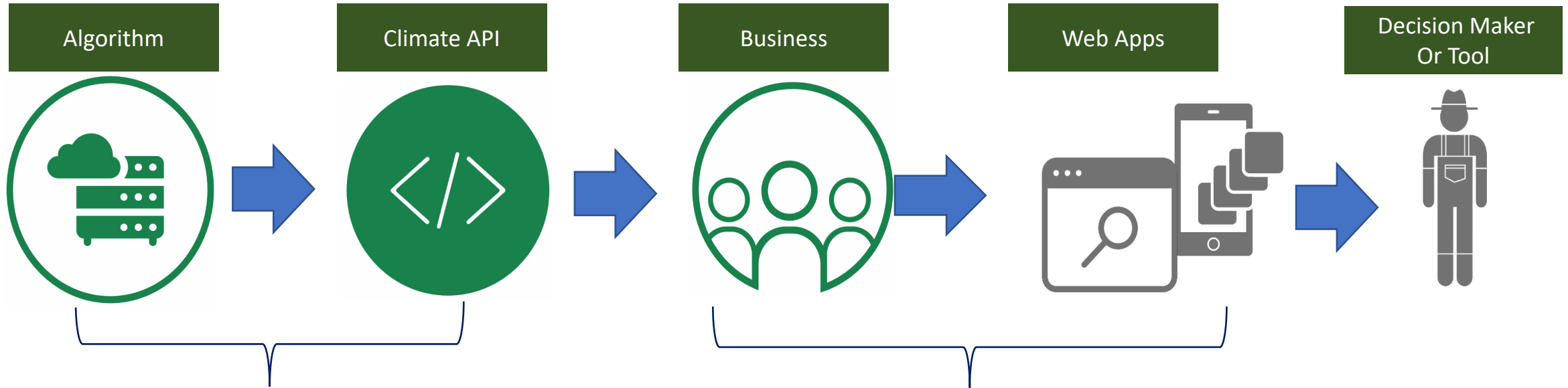
Canyon Fire: (Vandenberg Airforce Base)

Cost	\$12 million
Fire Duration	September 17 -- September 24, 2016
Burned area	12,742 acres (51.6 km ²)
Fatalities	1

Co-occurrence of high BUI and extreme high FWI conditions during September of 2016 (predicted by Climformatics) may have caused the Canyon Fire.

Enterprise Solution Deployment

IBM We are an IBM Business Partner



CLIMFORMATICS

Large/Bulk Data User (Enterprise level clients)

Solutions can be easily integrated with Business Intelligence/Risk Management Tool

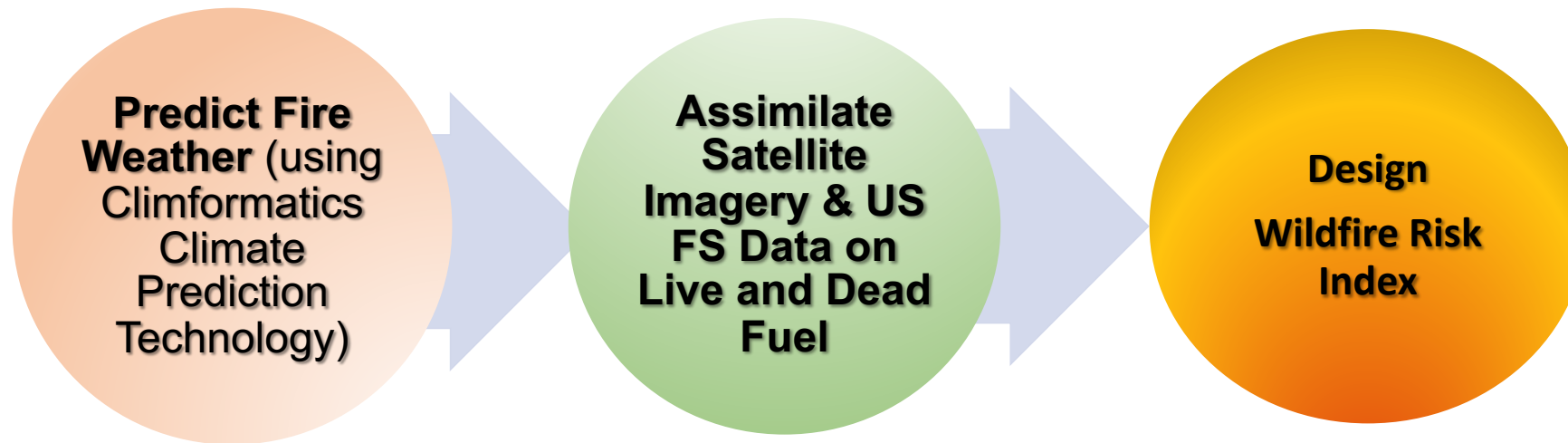
Improve operational logistics, catastrophe risk assessment, mitigation and adaptation plans. It can be used to evaluate impact of climate restoration technologies.

Technology can be easily scaled up for global locations, regional and hyper-local resolutions to forecast **extreme weather events like floods, droughts and wildfires**

Climformatics API to disseminate product portfolio for use of Decision makers and Tools

WildFire Resiliency Index Design for Home Insurance

Climformatics is a Member of SVIA's Insurance Innovation Consortium Extreme Weather Group Working on PoC Home-Safety Calculator



Resiliency Index
Characterisitcs:

Wildfire Risk Index

1 – 5 years

Zip Code

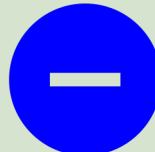
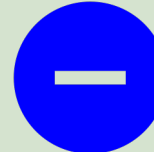
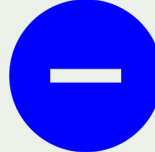
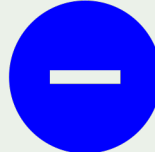
Thank You

At Climformatics we are building a tool to predict future climate at any custom location for any future timescale (daily, seasonal to years ahead).

- Climformatics was 2014 finalist at  for western US region
- Climformatics is a semifinalist at global  sustainable cities 2021 competition
- Climformatics is now a member of  UN Disaster Risk Resiliency US Chapter

Our massive transformational purpose is to help humanity prepare for the inescapable impact of climate change.

Our Competition

Customer Attributes					
Forecast modeling type	dynamic & AI	dynamic	statistical	statistical	statistical
Spatial Accuracy	2-4km	~100km	point locations	250m	Zip code, point locations
Sub-seasonal forecast	Daily, Monthly	Monthly	Daily, Weekly, Monthly	Weather (1-15days)	Weather (1-15days)
Forecast Lead Time	1 year	9 months	11 months	5-7 months	3 months
Seasonal (3 months) to Long-term (>3 months – 30 years)					
Custom Climate Modeling (future projections, microclimate)					

Team Climformatics



Subarna
Bhattacharyya

Co-founder
Climate Data
Scientist, Risk
Modeler



Detelina
Ivanova

Co-Founder
Oceanographer
& Climate
Modeler



Marc
Gottschalk

Legal & Business
Advisor, Founder
CTO, ex partner
Sidley Austin LLP



Sourav
Mazumder

Advisor: AI
Strategy, IBM
Distinguished
Data Scientist



Peter Williams

Business Advisor,
Rtd IBM
Distinguished
Engineer



Georgi
Georgiev

Software Developers



Aleksander
Ivanov

Former Employees of Lawrence Livermore National Laboratory

Need to hire:
Software & Web developers
Marketing & Sales

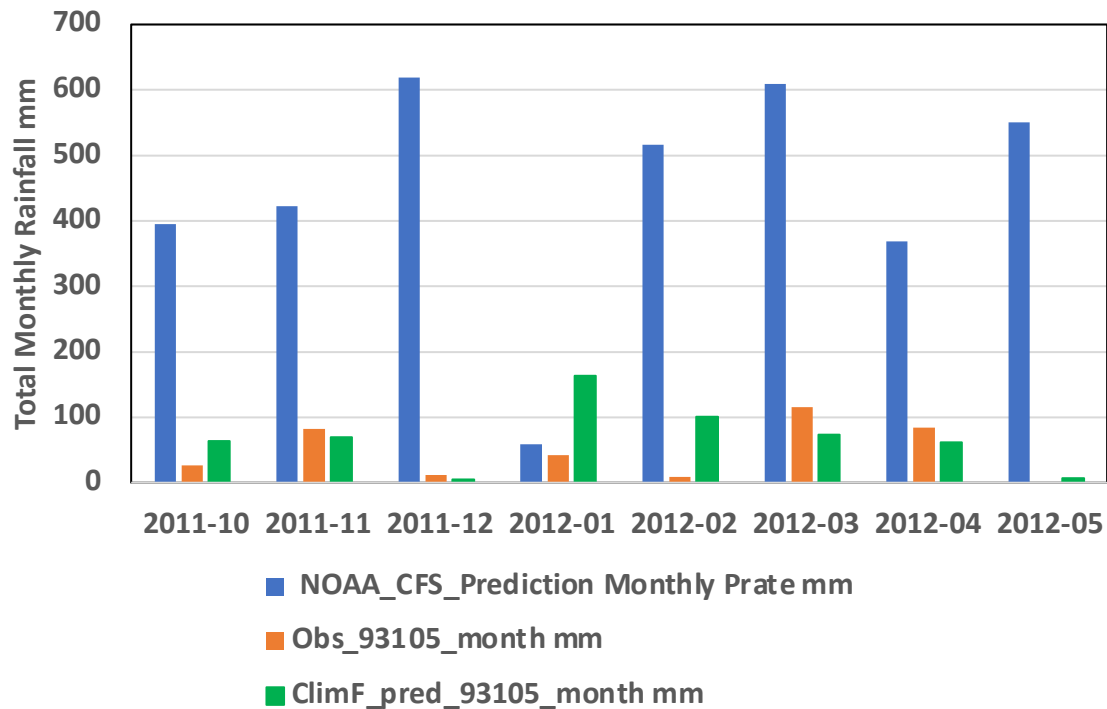


V. Paige
Smith

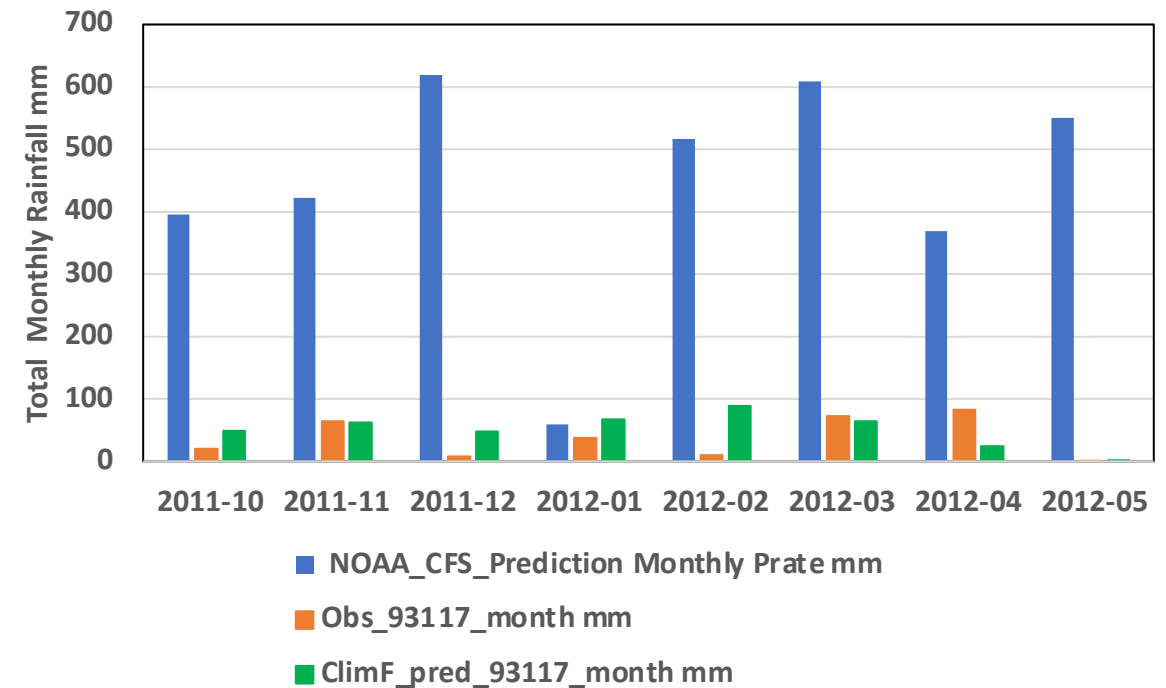
Legal Counsel
Corporate Associate Attorney, Stradling

2011-2012 Winter Rainfall Comparison

2011-2012 Winter Rainfall in Santa Barbara 93105

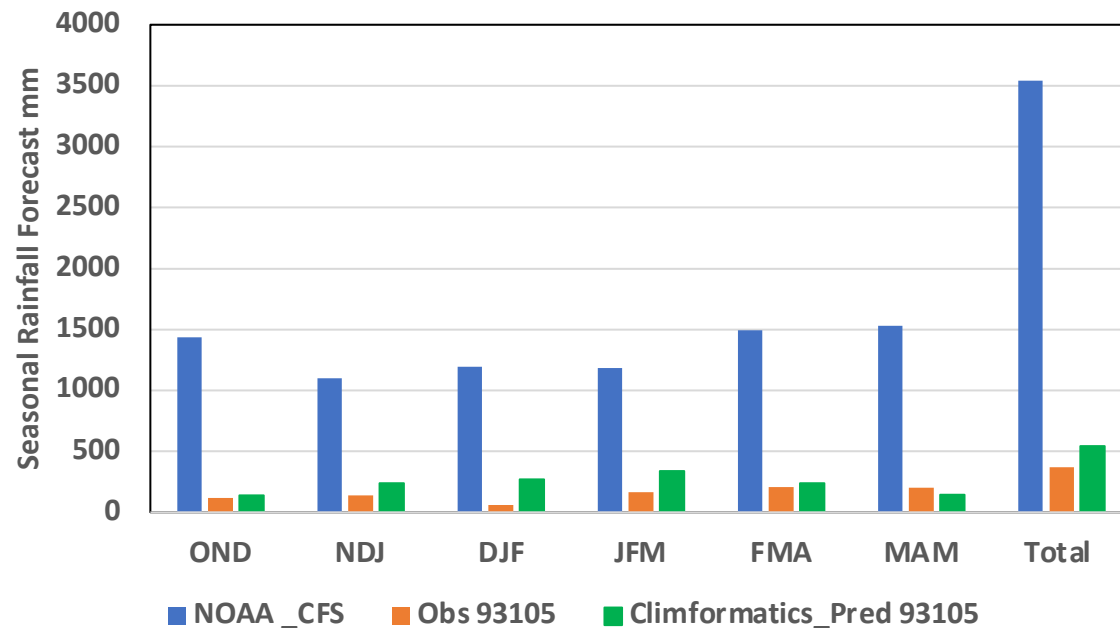


2011-2012 Winter Rainfall in Santa Barbara 93117

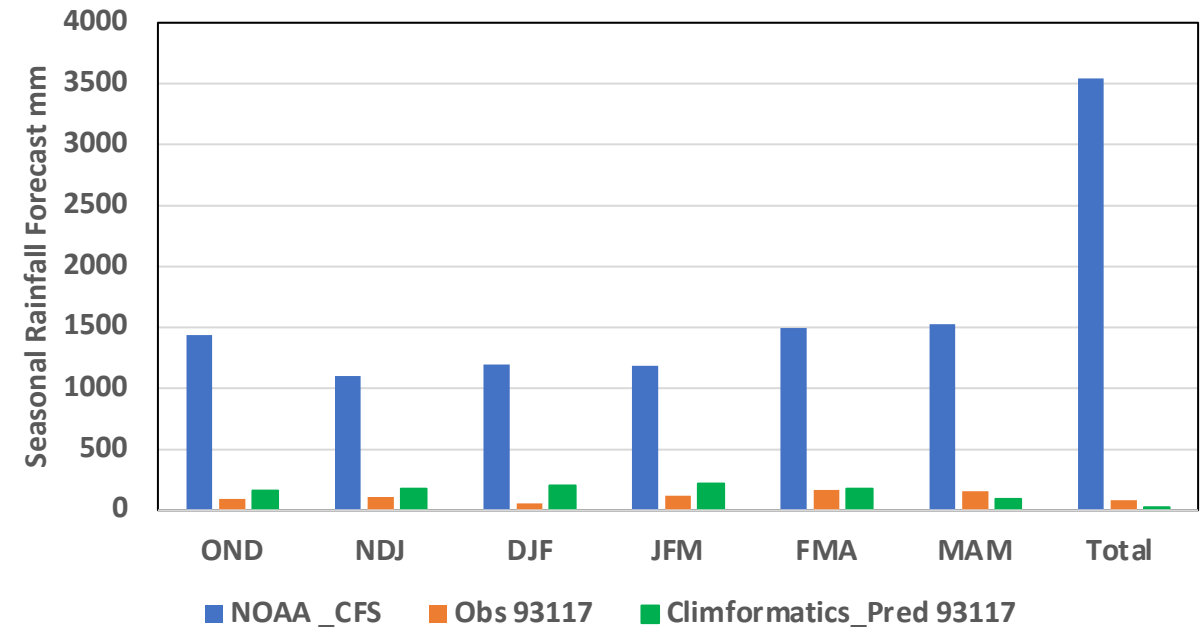


2011-2012 Seasonal Forecast Comparison

Seasonal Rainfall Forecast Comparison Santa Barbara 93105

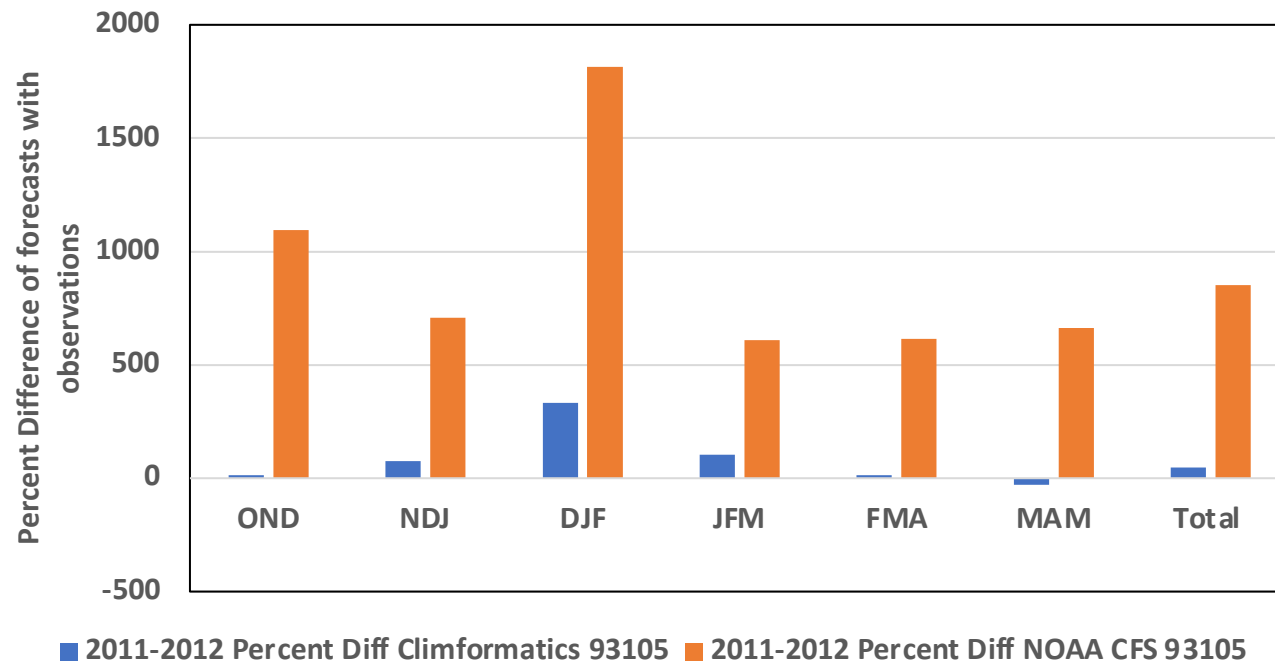


Seasonal Rainfall forecast Comparison Santa Barbara 93117

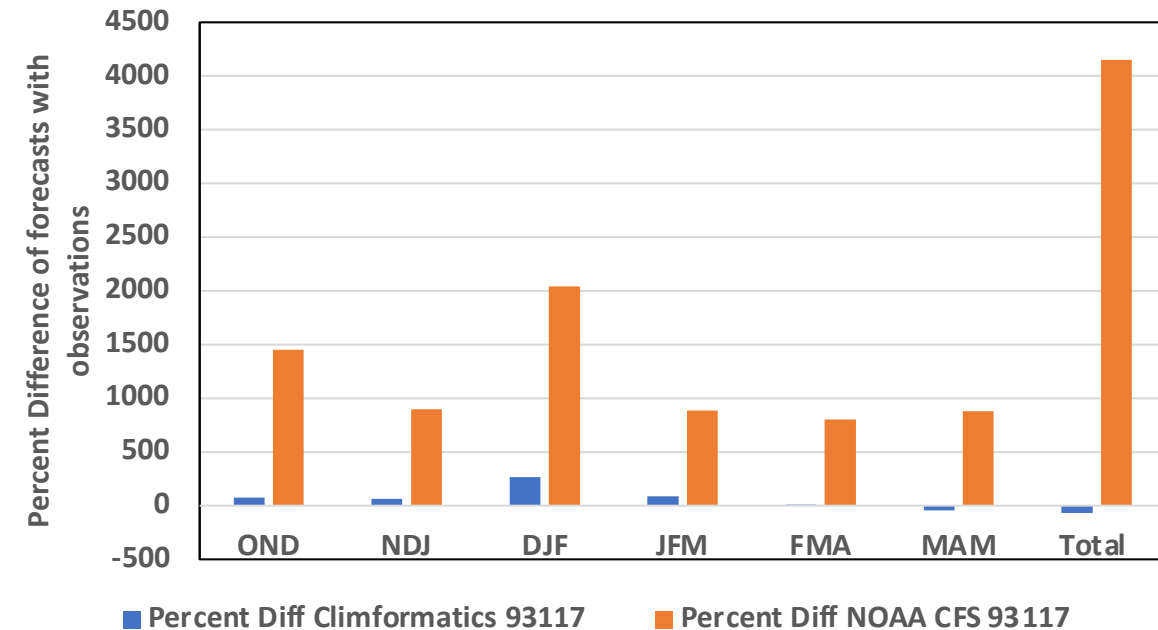


2011-2012 Seasonal Forecast Accuracy Comparison

Comparing percent difference in forecast with observations Santa Barbara 93105

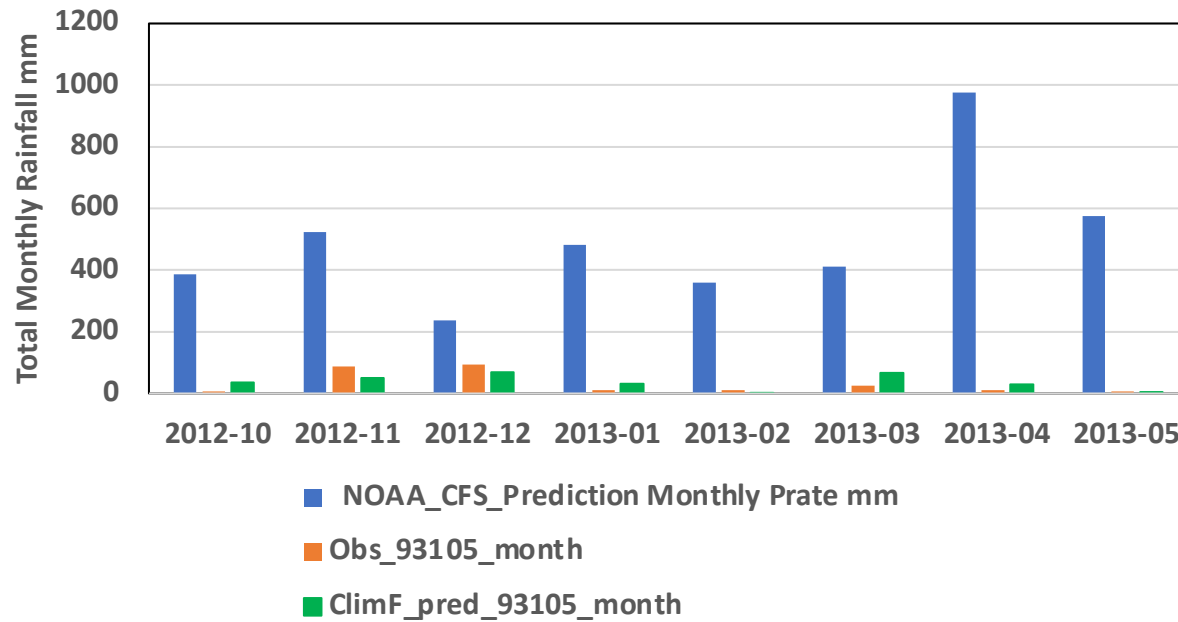


Comparing percent difference in forecast with observations for Santa Barbara 2011-2012 rainfall 93117

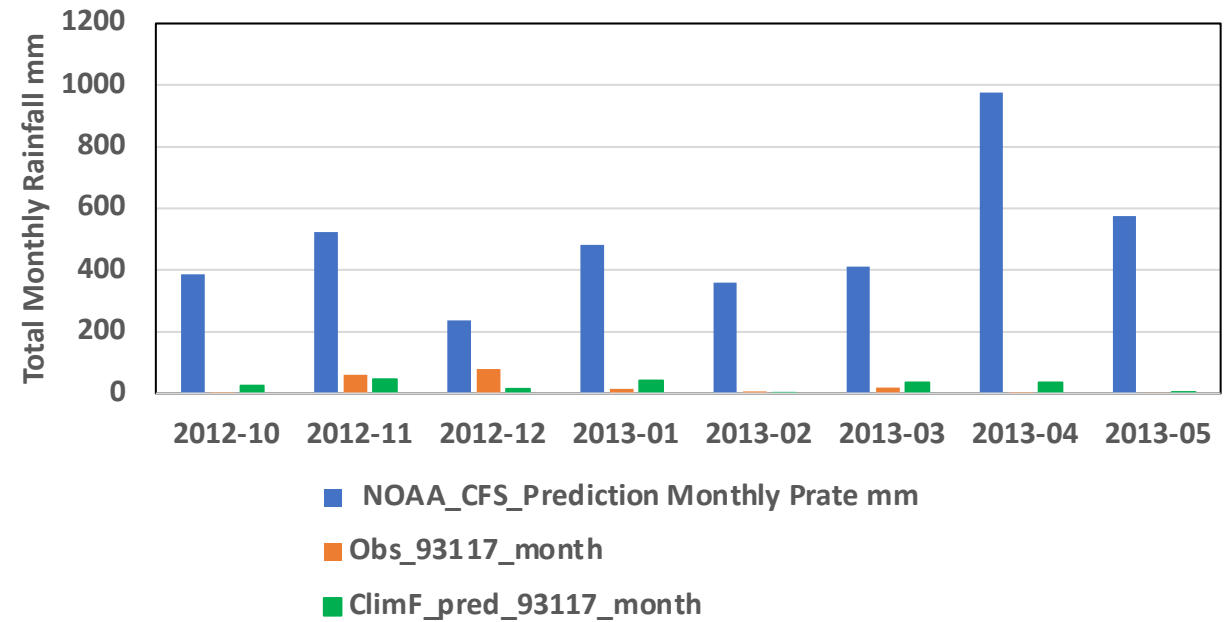


2012-2013 Winter Rainfall Comparison

2012-2013 Winter Rainfall Santa Barbara 93105

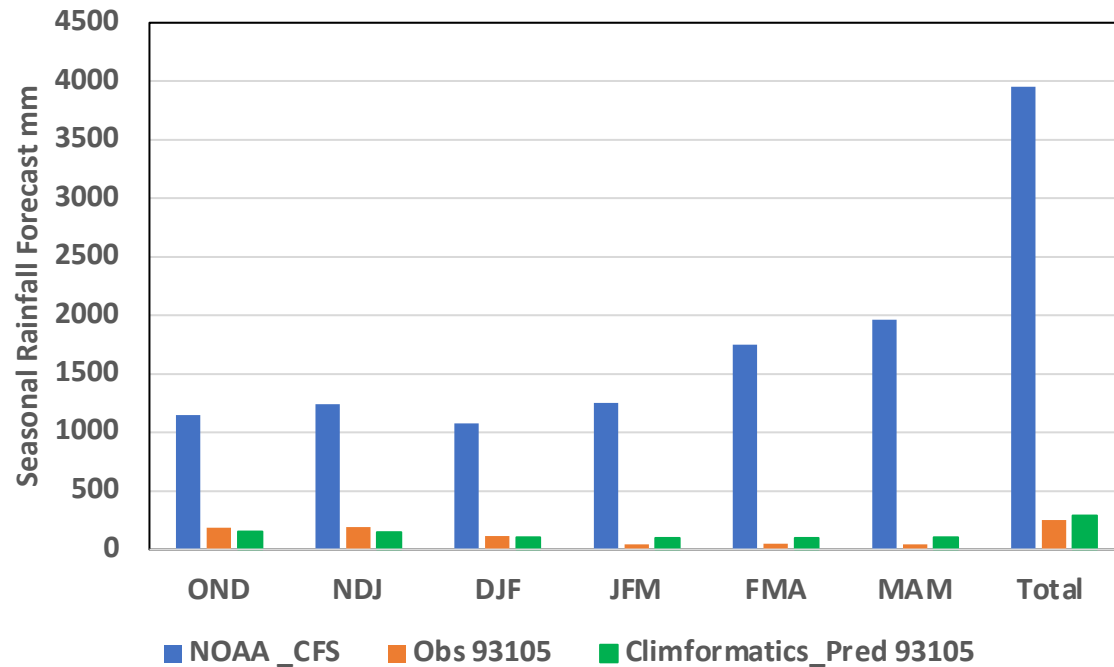


2012-2013 Winter Rainfall Santa Barbara 93117

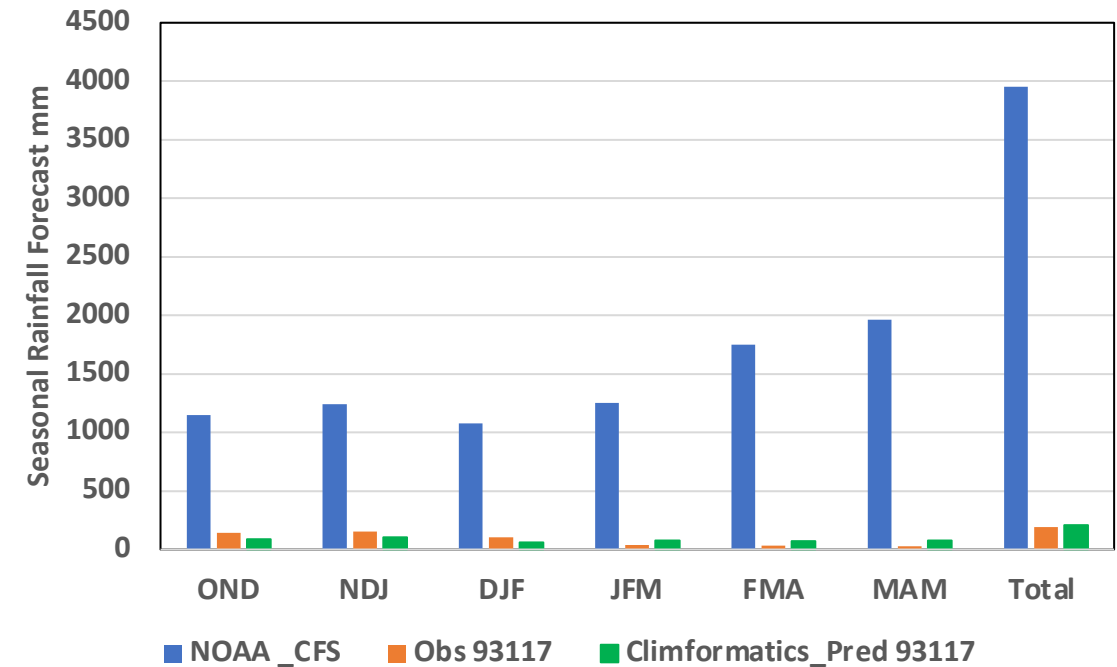


2012-2013 Seasonal Forecast Comparison

Seasonal Rainfall forecast Comparison Santa Barbara 93105

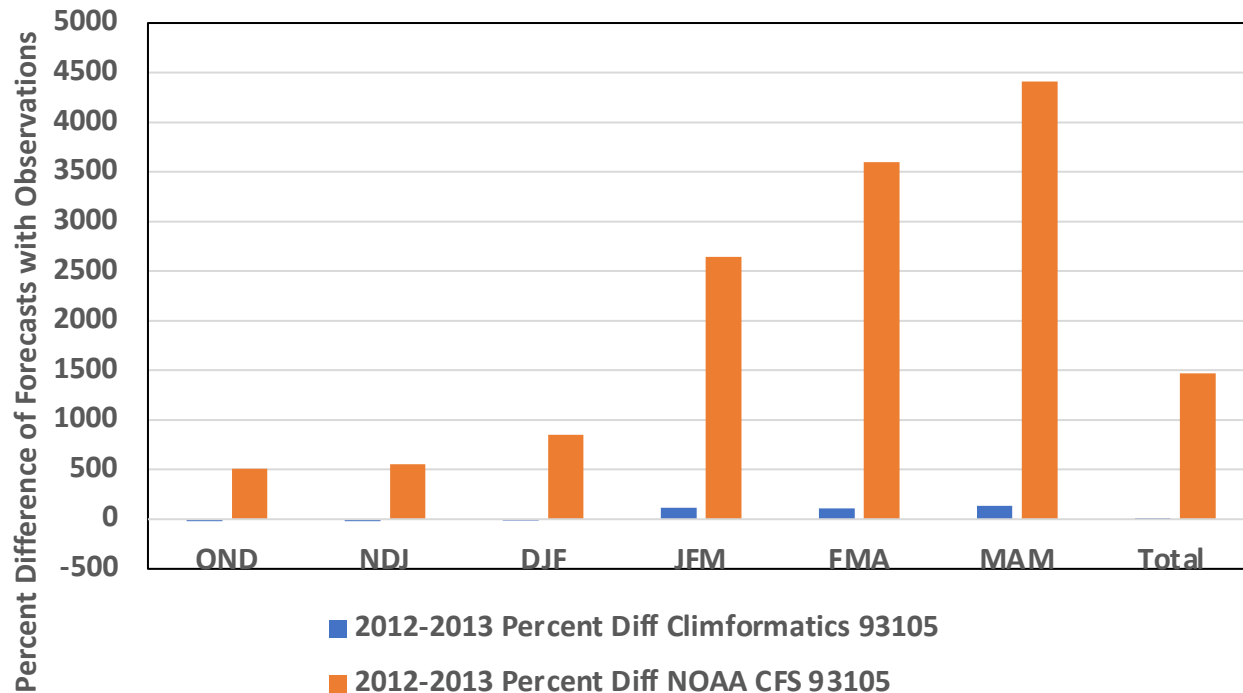


Seasonal Rainfall forecast Comparison Santa Barbara 93117

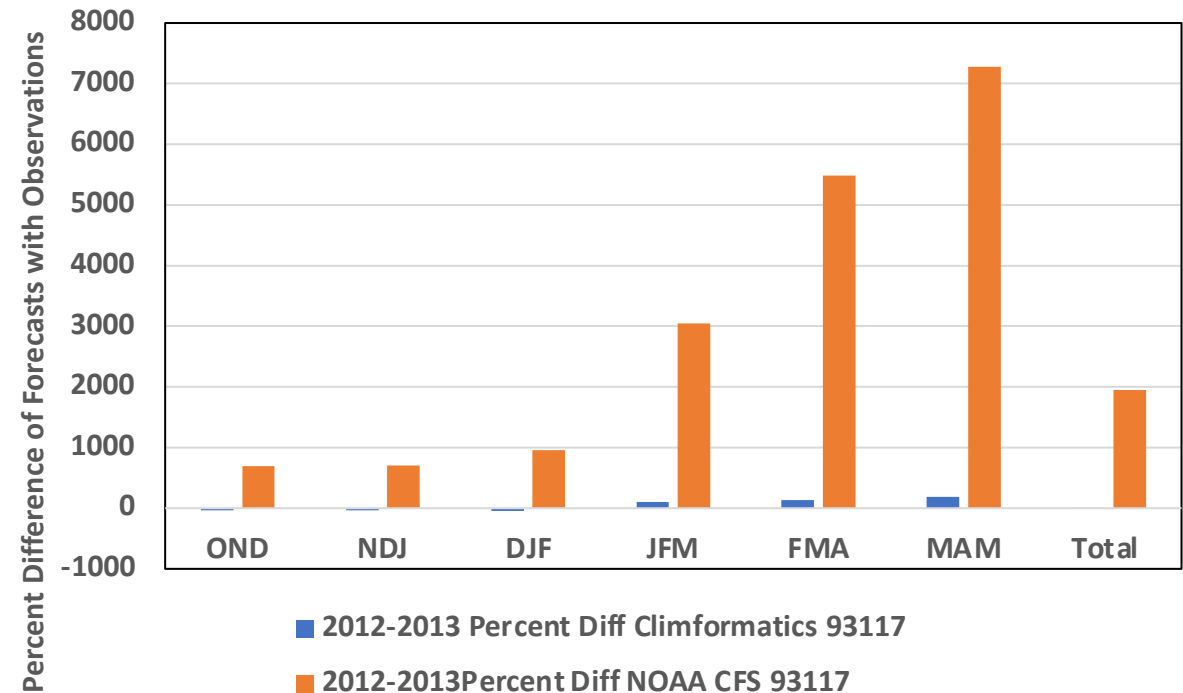


2012-2013 Seasonal Forecast Accuracy Comparison

Comparing percent difference in forecast with observations for Santa Barbara 2012-2013 rainfall 93105

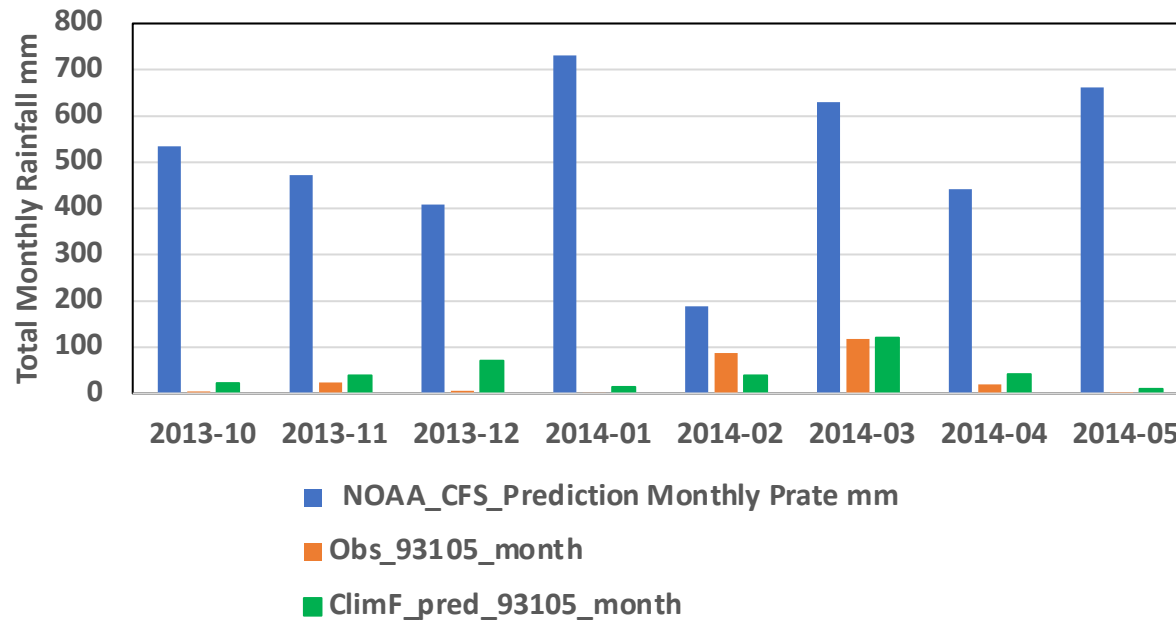


Comparing percent difference in forecast with observations for Santa Barbara 2012-2013 rainfall 93117

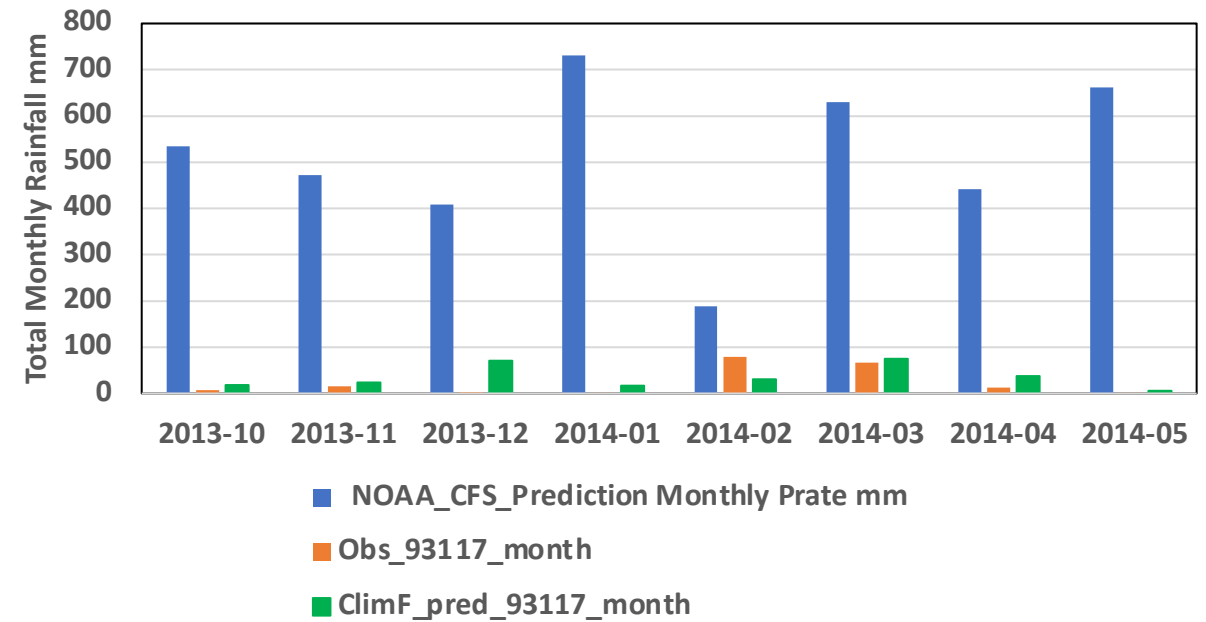


2013-2014 Winter Rainfall Comparison

2013-2014 Winter Rainfall Santa Barbara 93105

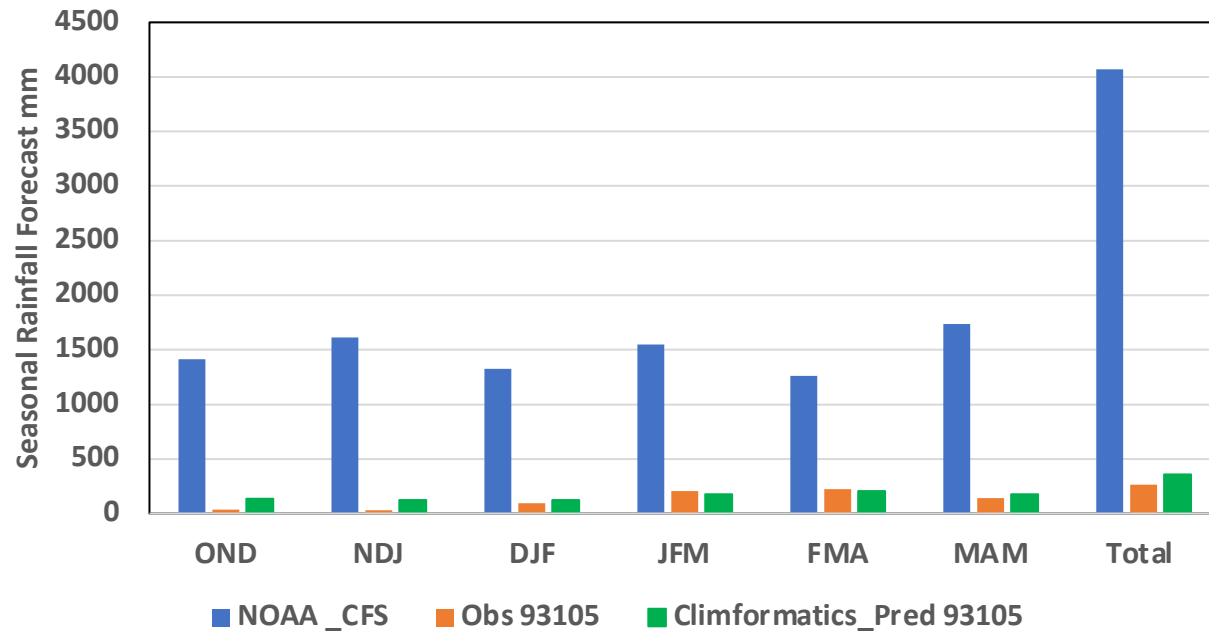


2013-2014 Winter Rainfall Santa Barbara 93117

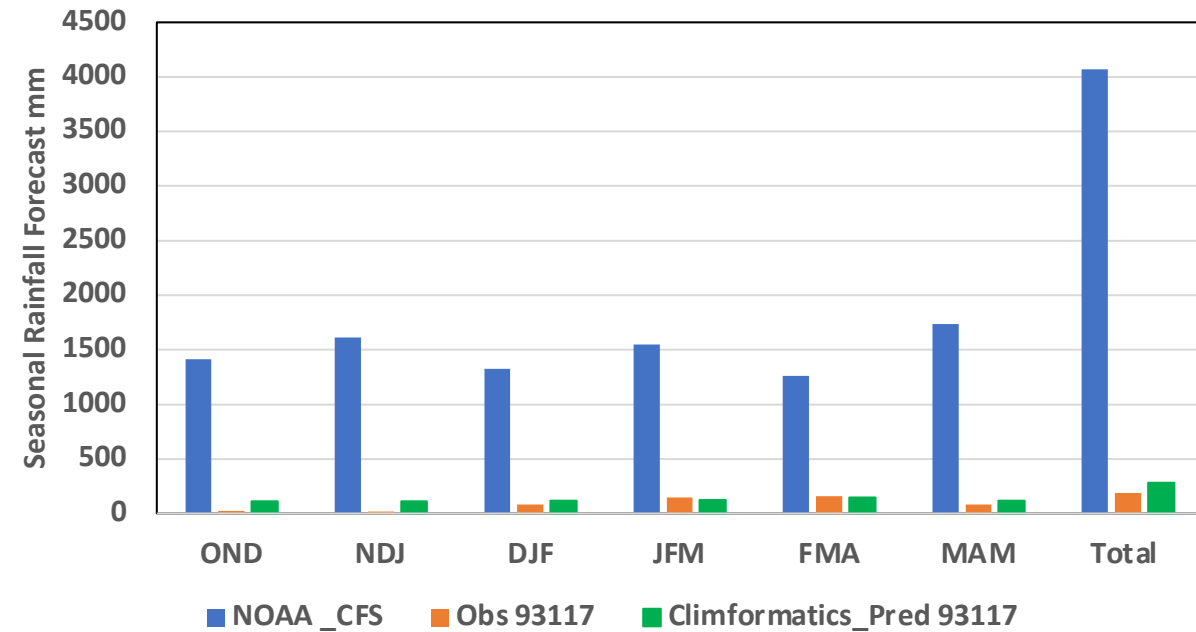


2013-2014 Seasonal Forecast Comparison

Seasonal Rainfall forecast Comparison Santa Barbara 93105

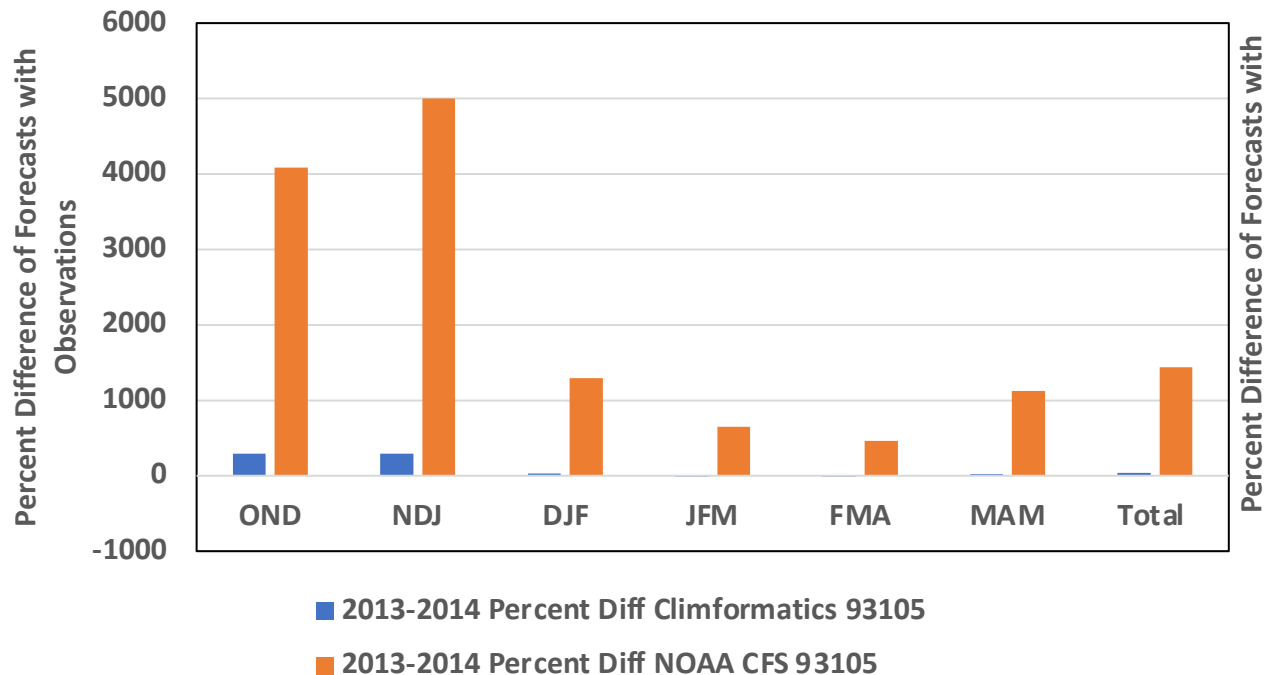


Seasonal Rainfall forecast Comparison Santa Barbara 93117

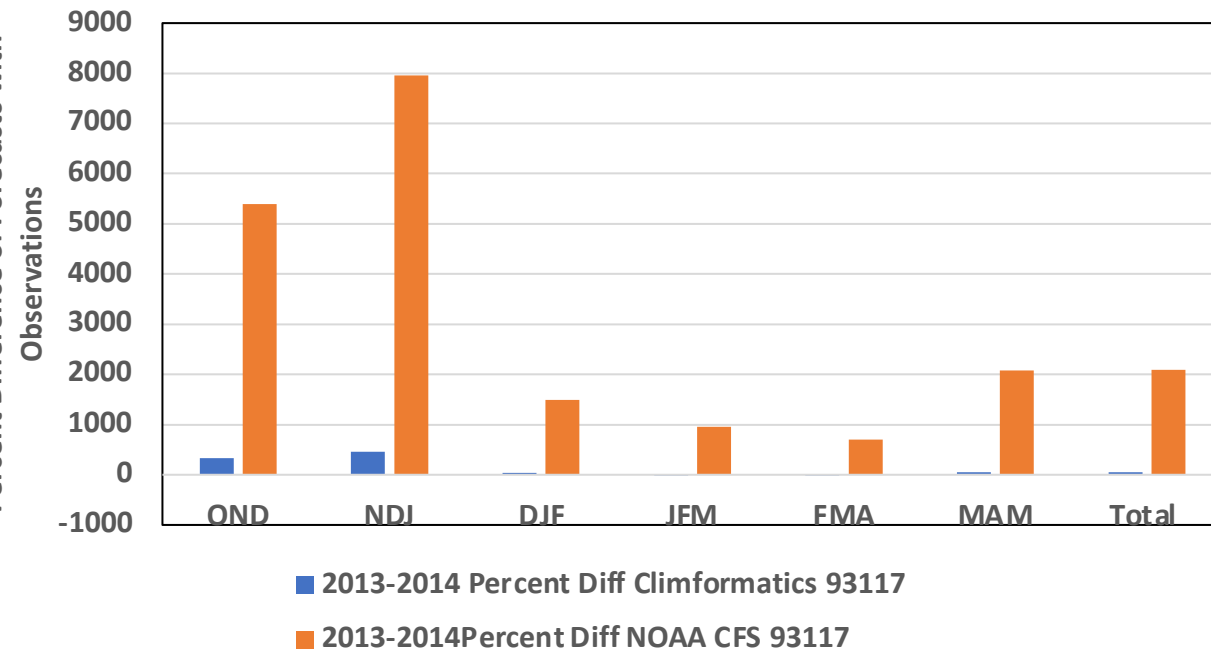


2013-2014 Seasonal Forecast Accuracy Comparison

Comparing percent difference in forecast with observations for Santa Barbara 2013-2014 rainfall 93105

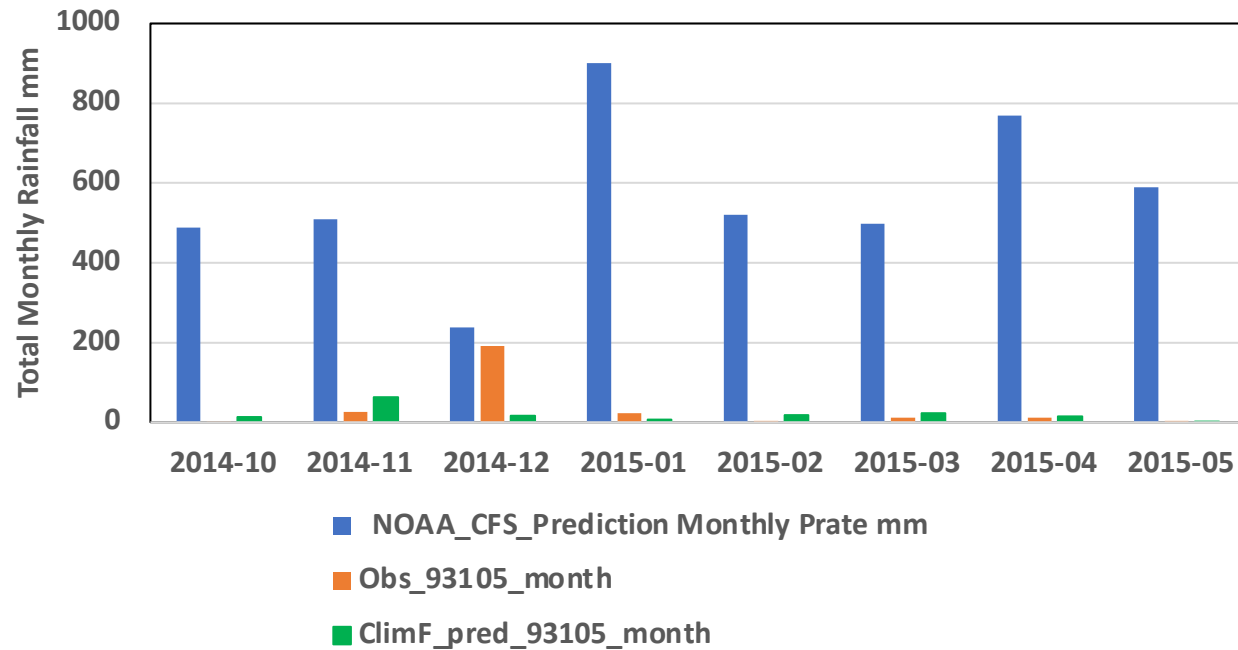


Comparing percent difference in forecast with observations for Santa Barbara 2013-2014 rainfall 93117

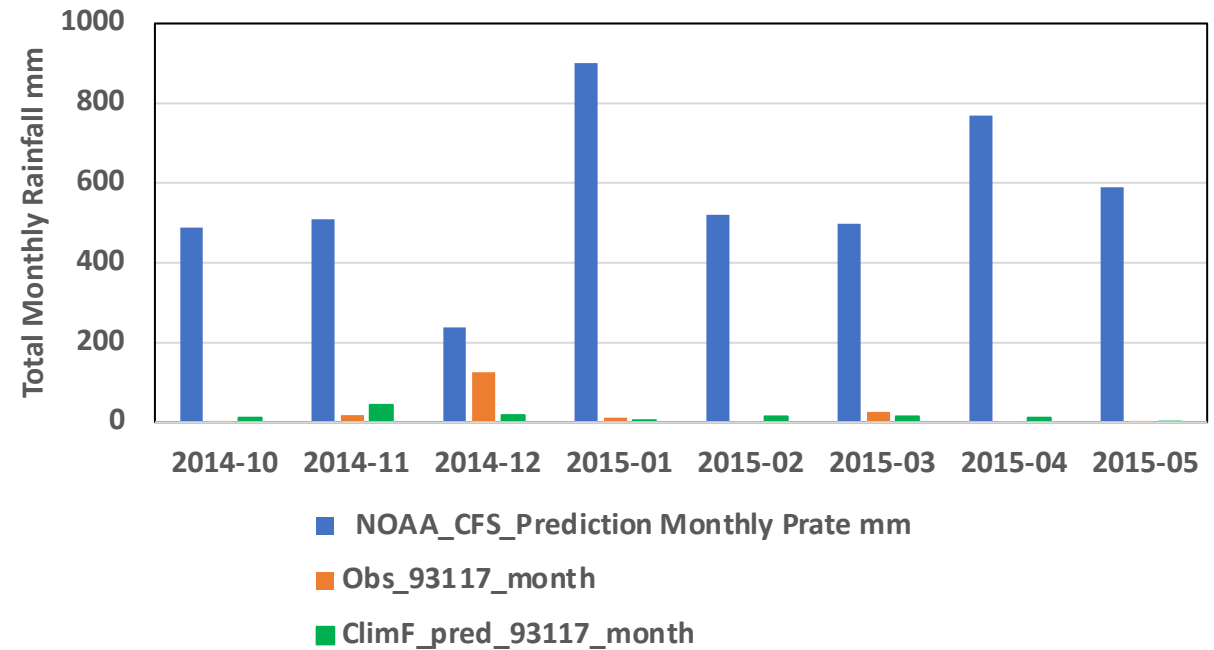


2014-2015 Winter Rainfall Comparison

2014-2015 Winter Rainfall Santa Barbara 93105

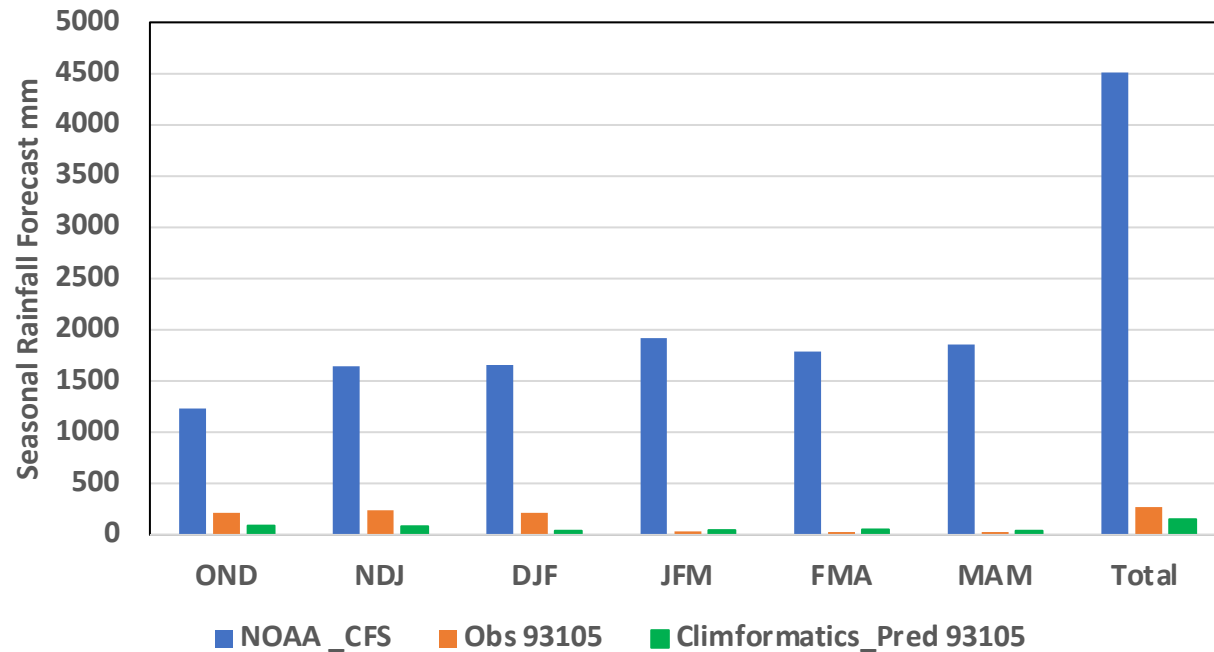


2014-2015 Winter Rainfall Santa Barbara 93117

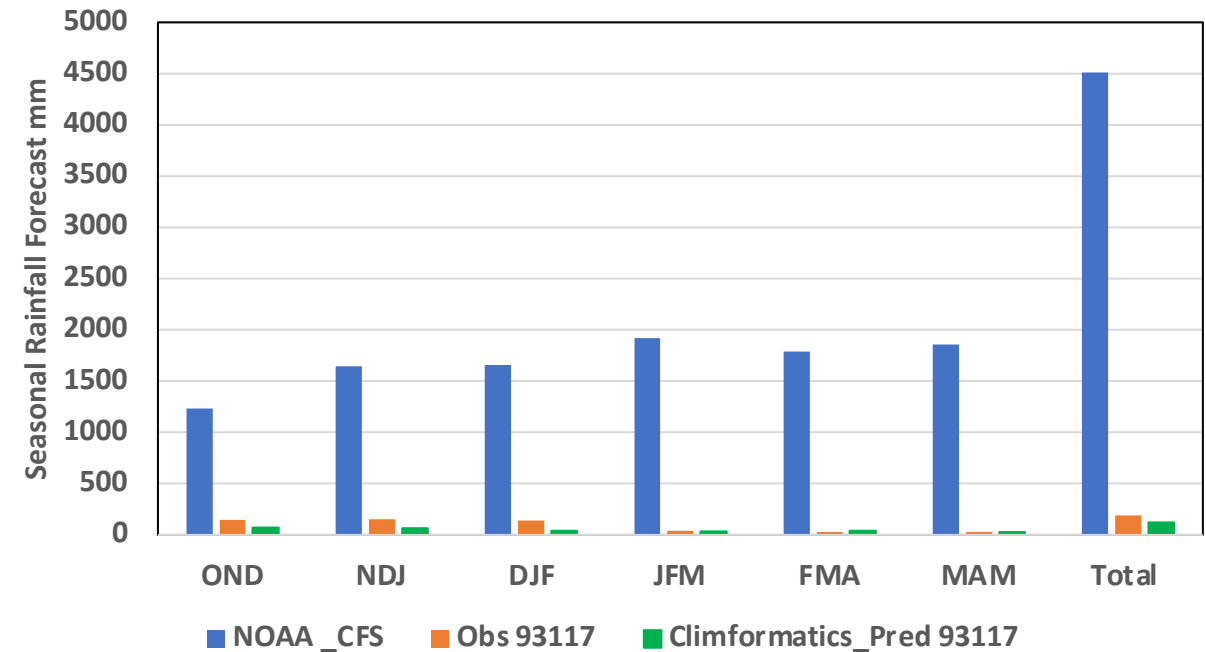


2014-2015 Seasonal Forecast Comparison

Seasonal Rainfall forecast Comparison Santa Barbara 93105

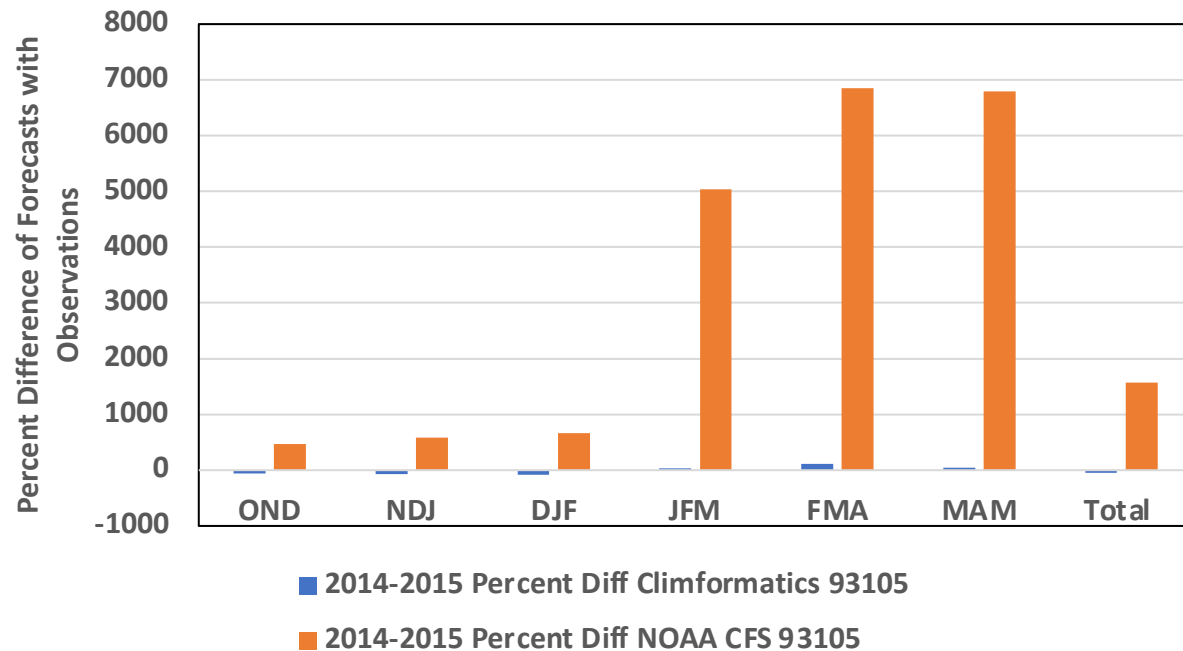


Seasonal Rainfall forecast Comparison Santa Barbara 93117

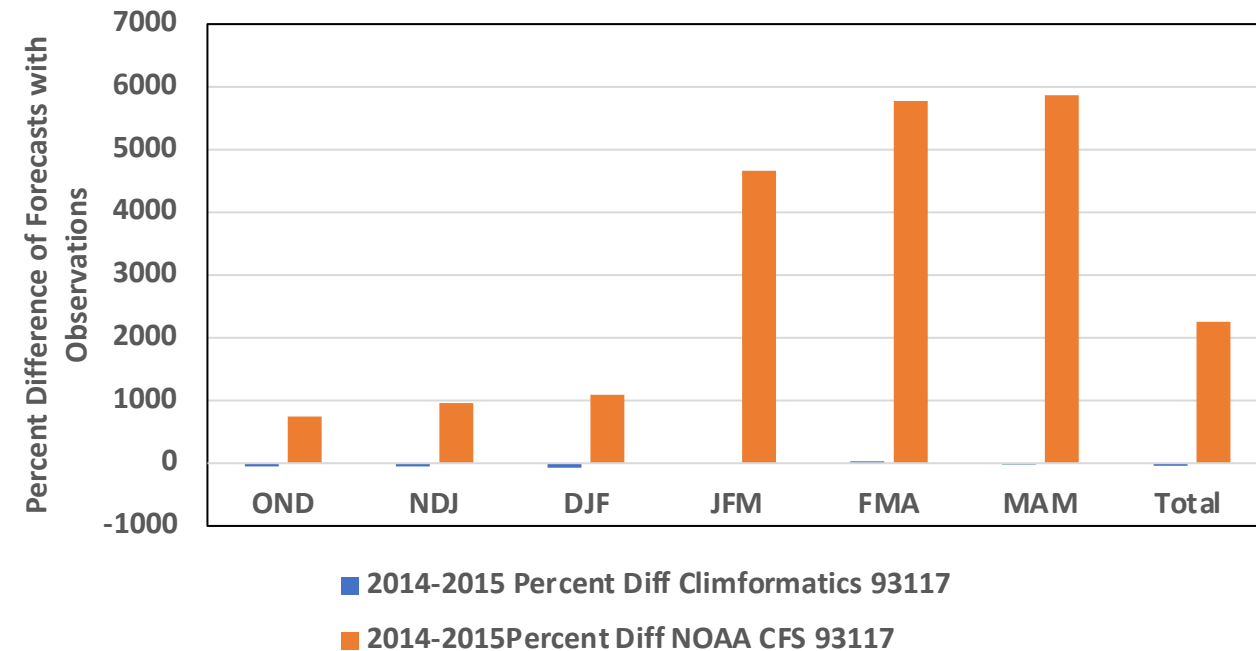


2014-2015 Seasonal Forecast Accuracy Comparison

Comparing percent difference in forecast with observations for Santa Barbara 2014-2015 rainfall 93105

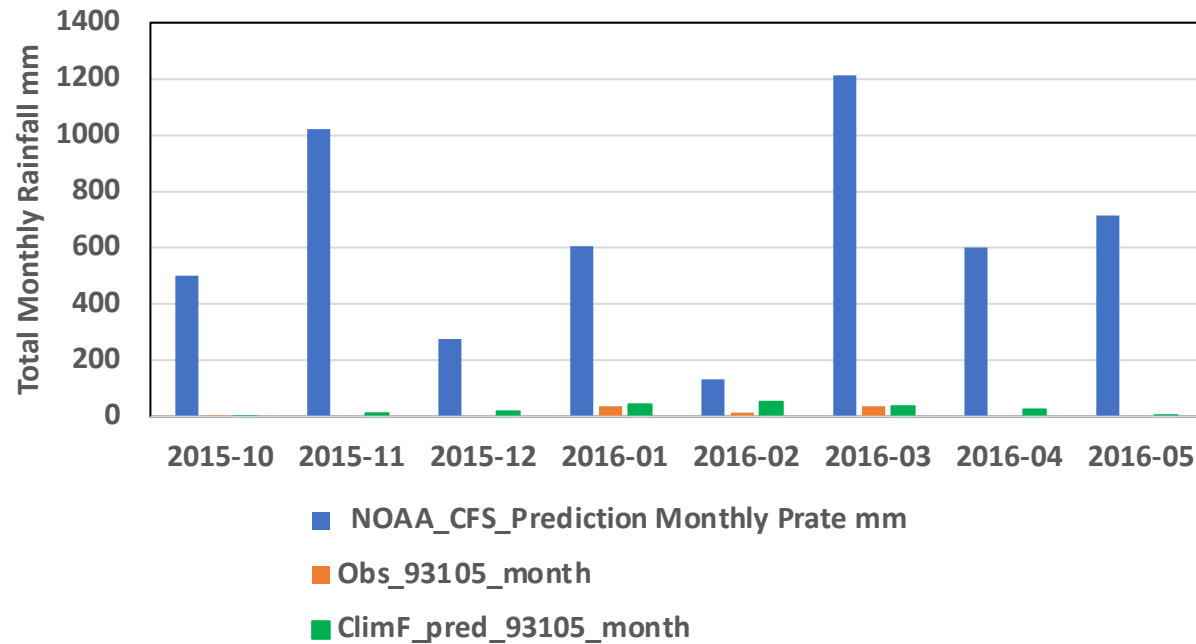


Comparing percent difference in forecast with observations for Santa Barbara 2014-2015 rainfall 93117

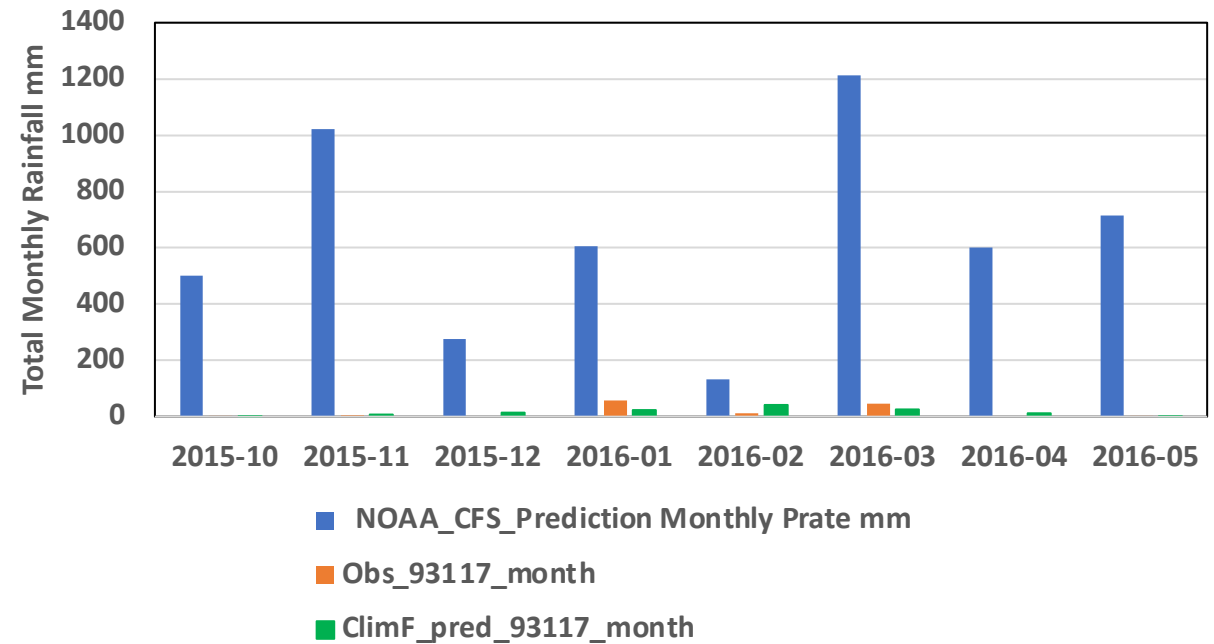


2015-2016 Winter Rainfall Comparison

2015-2016 Winter Rainfall Santa Barbara 93105

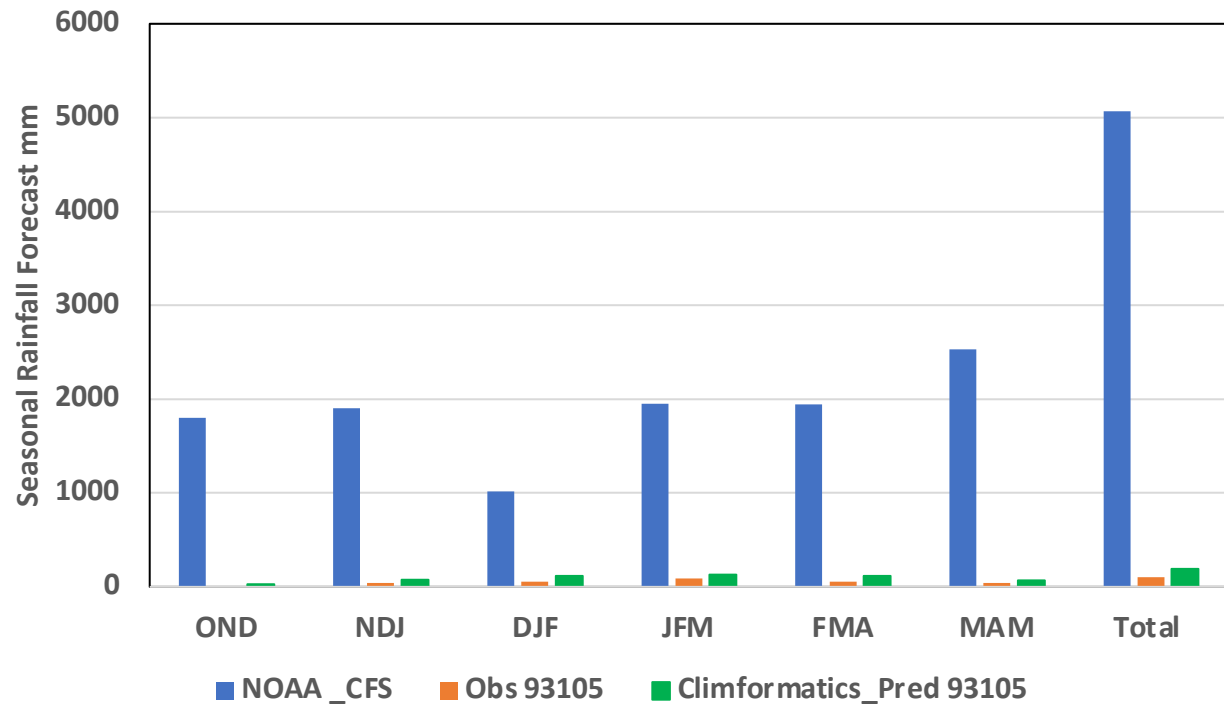


2015-2016 Winter Rainfall Santa Barbara 93117

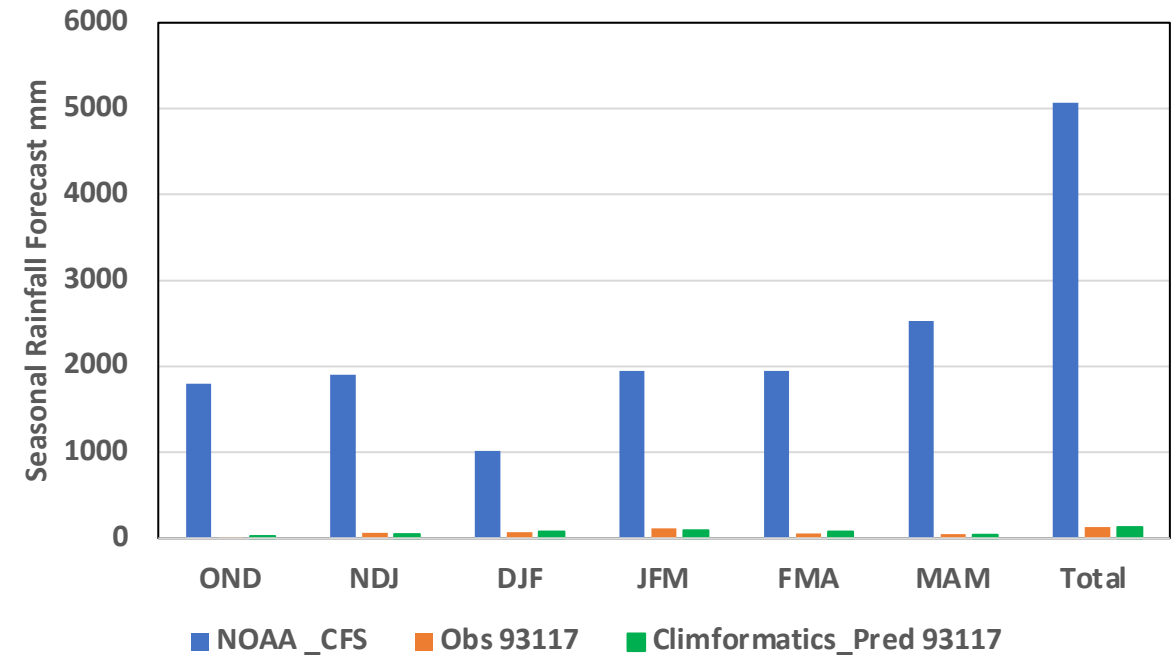


2015-2016 Seasonal Forecast Comparison

Seasonal Rainfall forecast Comparison Santa Barbara 93105

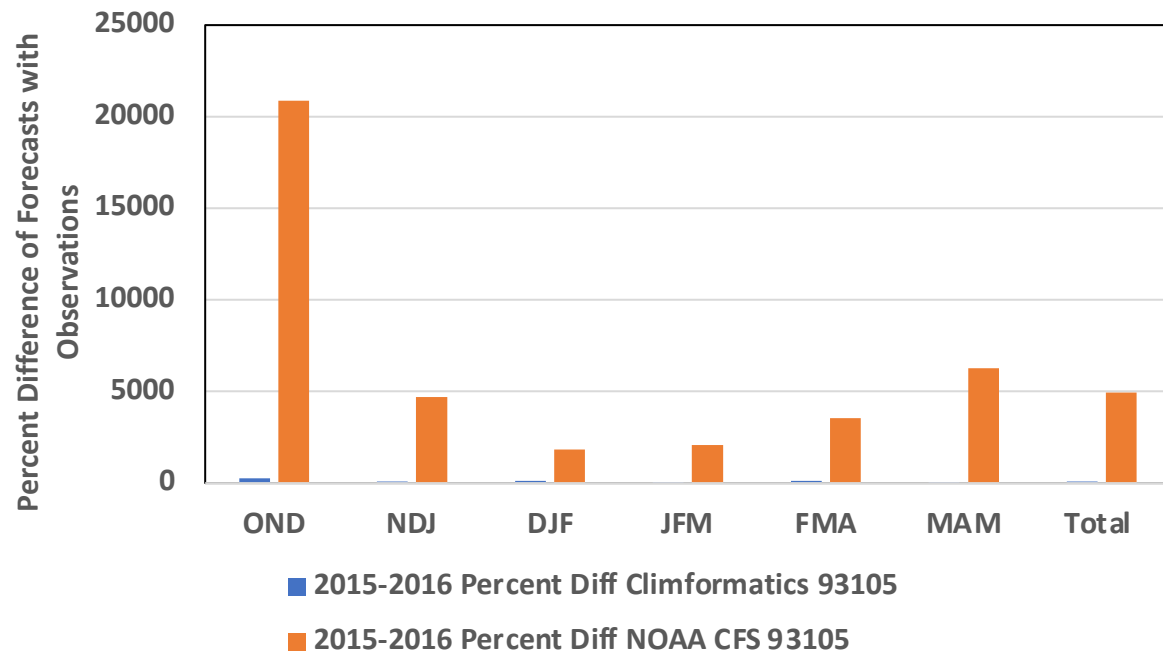


Seasonal Rainfall forecast Comparison Santa Barbara 93117

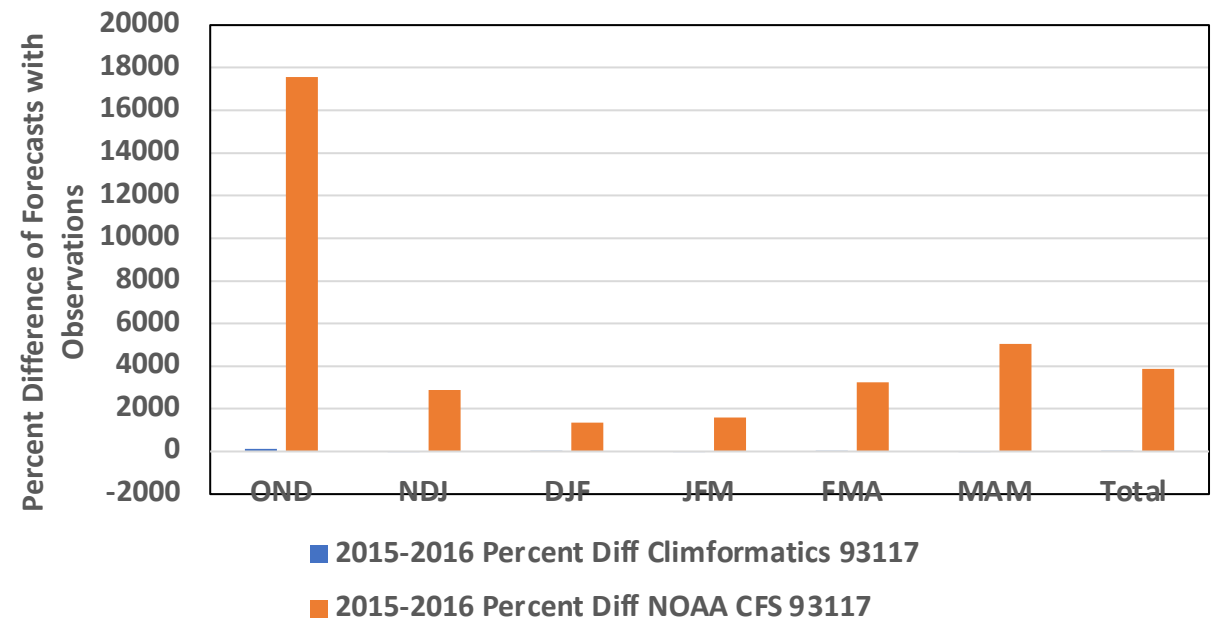


2015-2016 Seasonal Forecast Accuracy Comparison

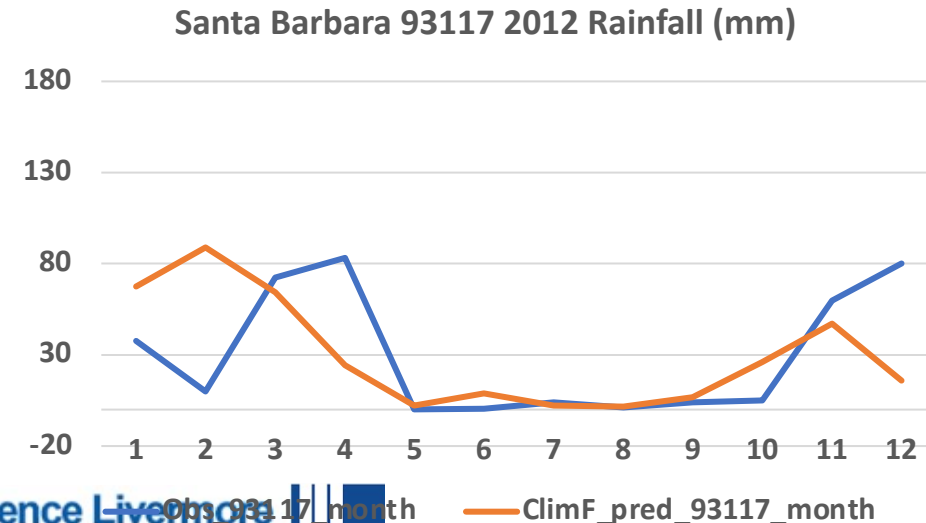
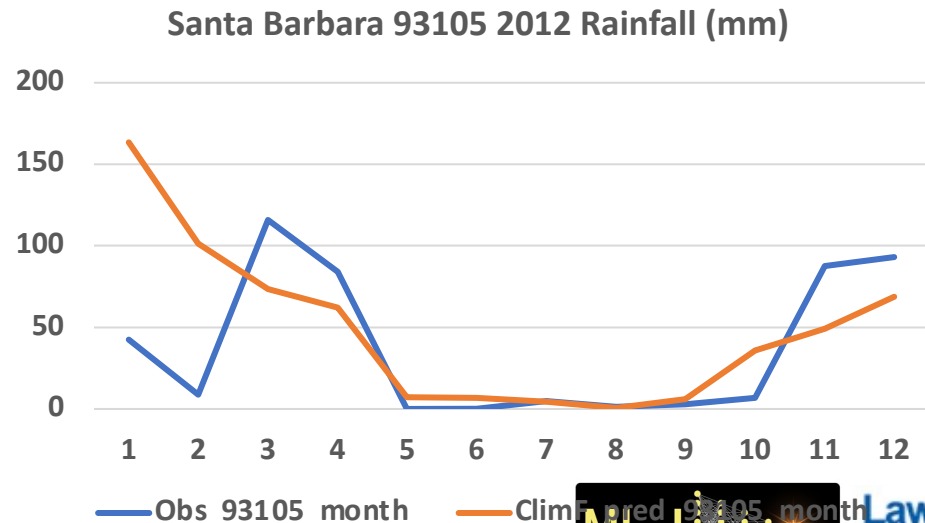
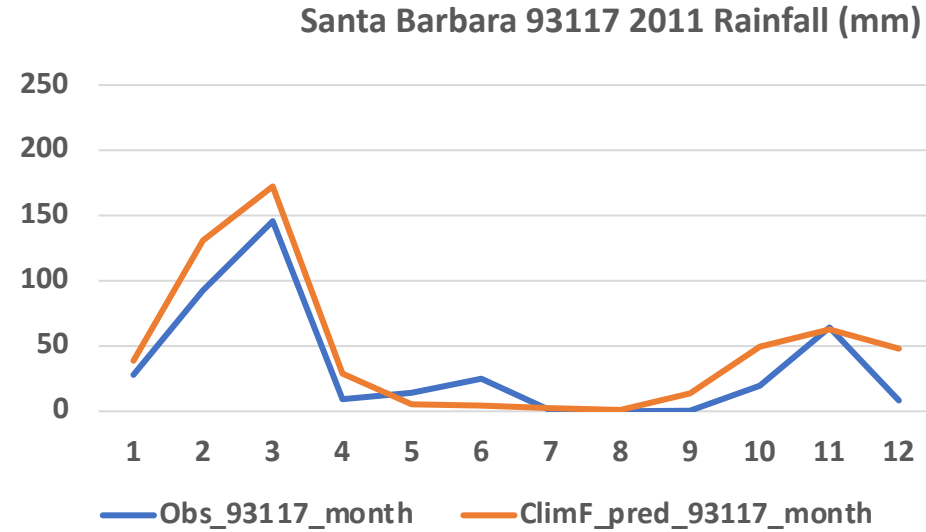
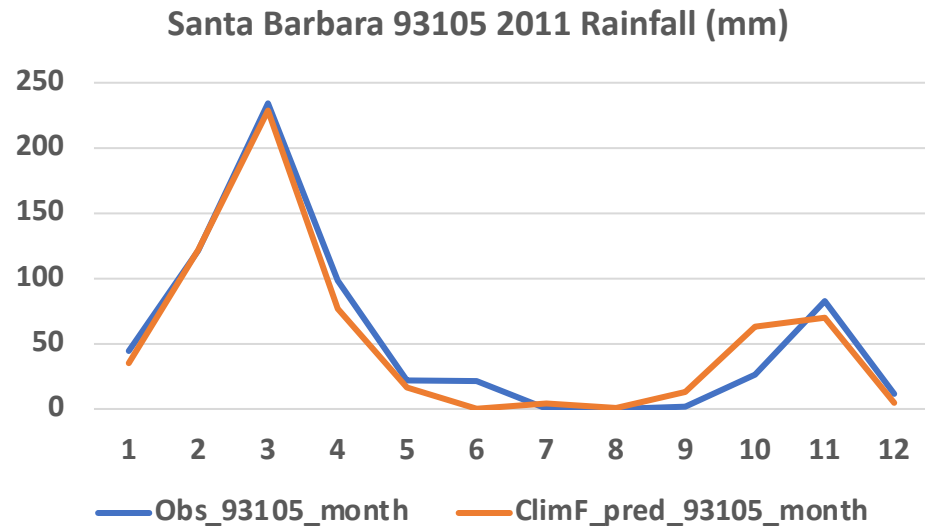
Comparing percent difference in forecast with observations for Santa Barbara 2015-2016 rainfall 93105



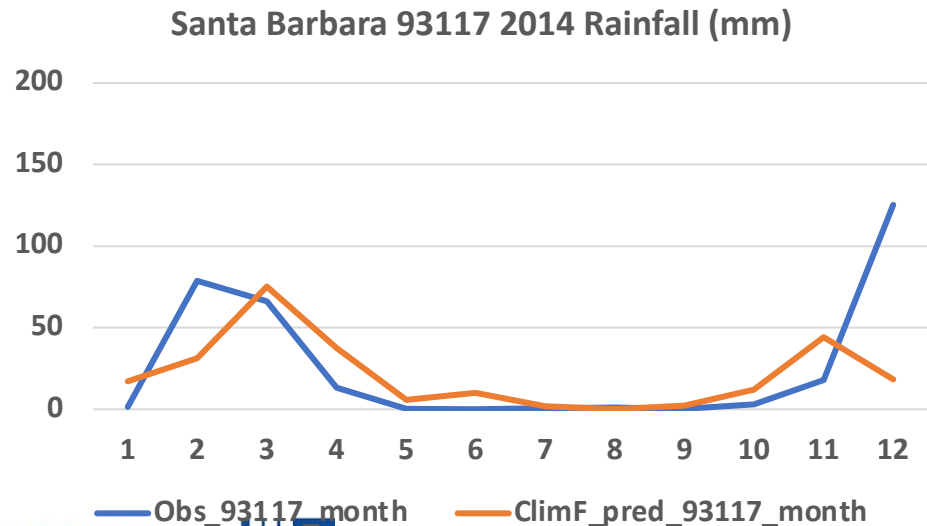
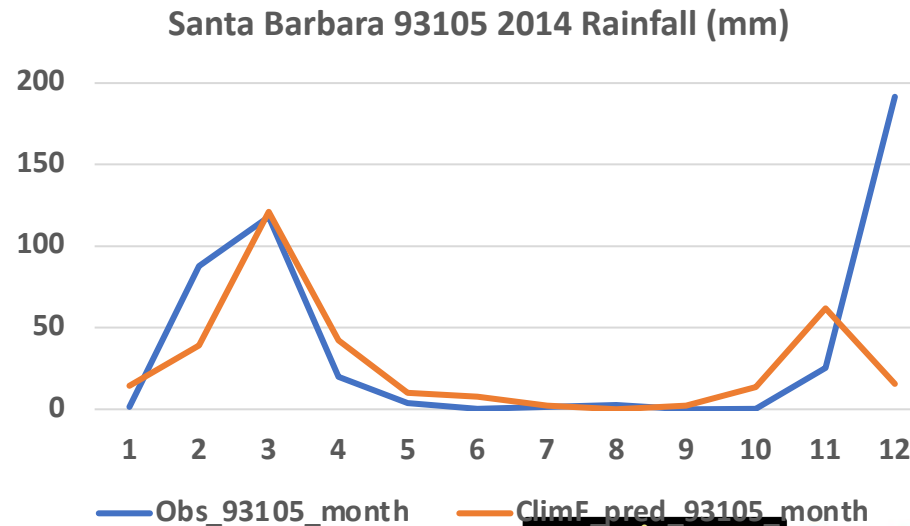
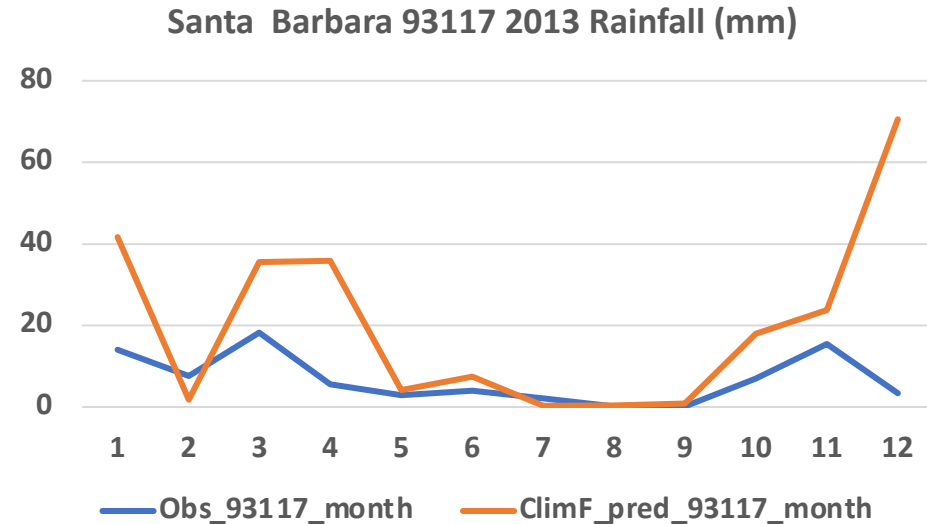
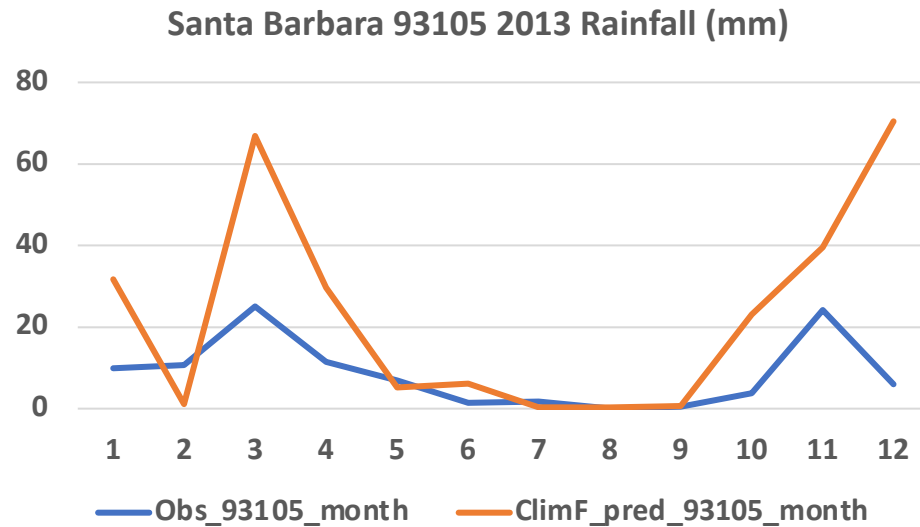
Comparing percent difference in forecast with observations for Santa Barbara 2015-2016 rainfall 93117



Comparing annual Cycle of Rainfall

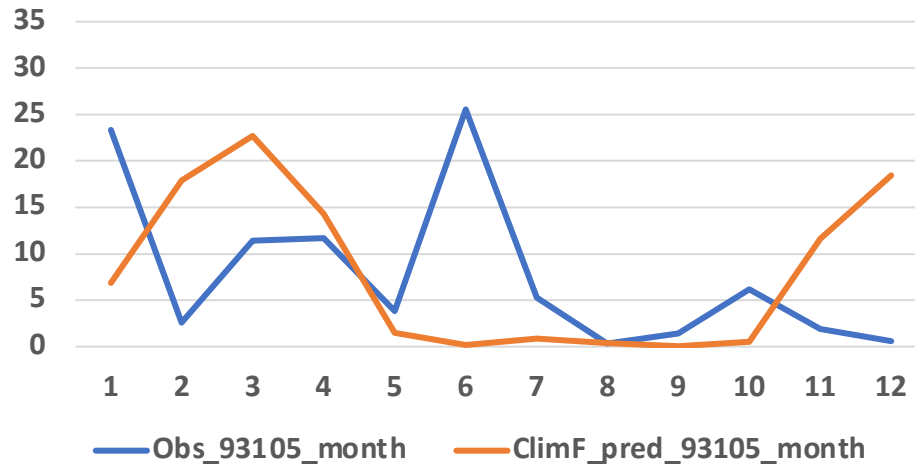


Comparing annual Cycle of Rainfall (contd)

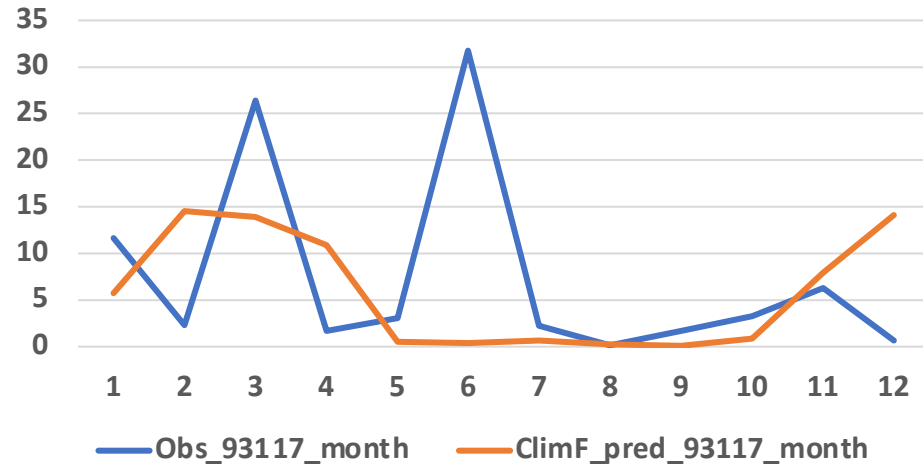


Comparing annual Cycle of Rainfall (contd)

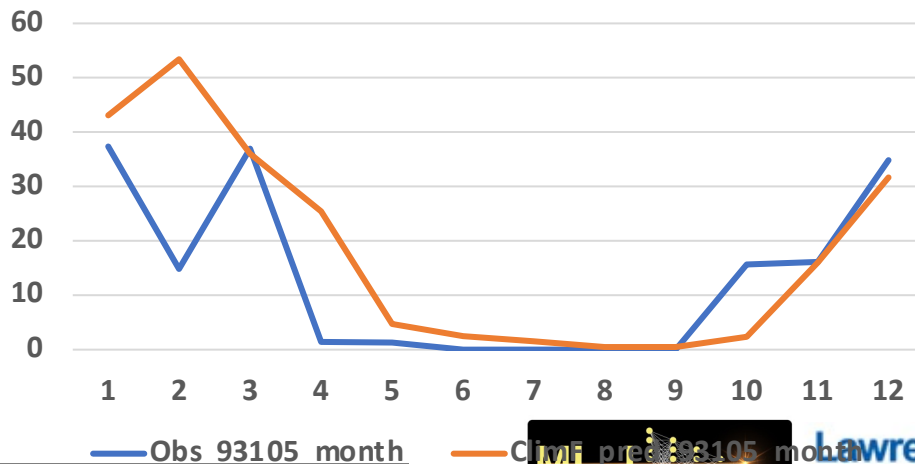
Santa Barbara 93105 2015 Rainfall (mm)



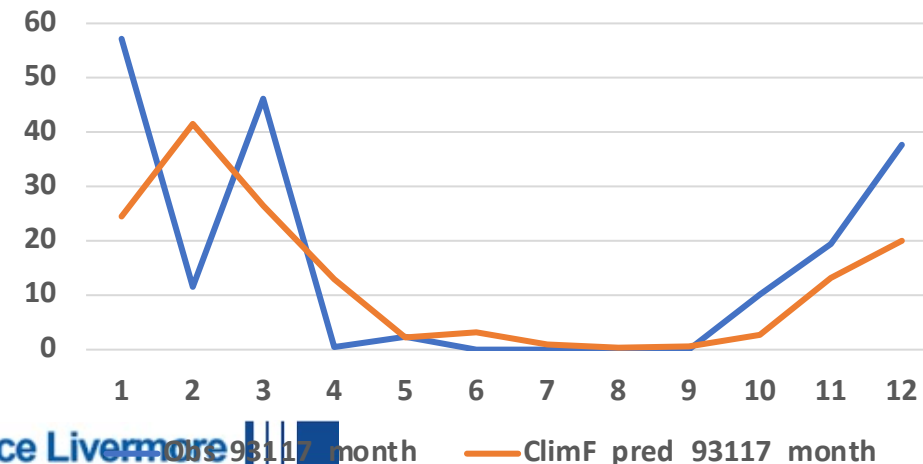
Santa Barbara 93117 2015 Rainfall (mm)



Santa Barbara 93105 2016 Rainfall (mm)



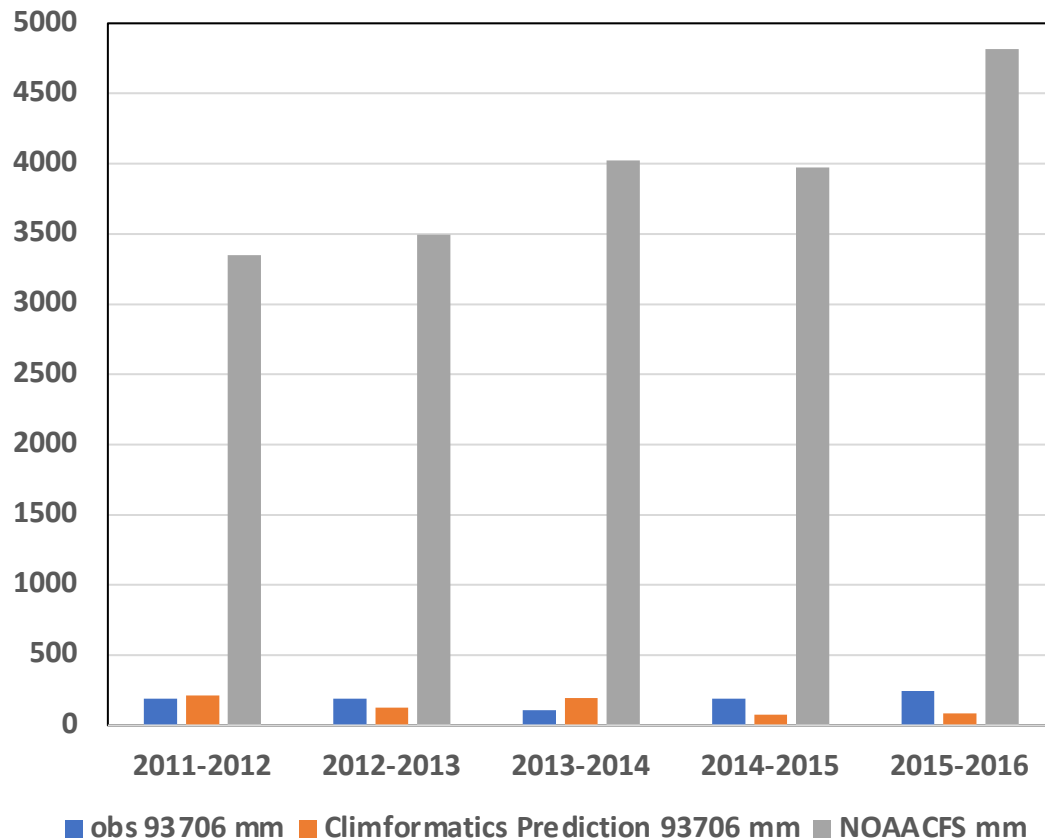
Santa Barbara 93117 2016 Rainfall (mm)



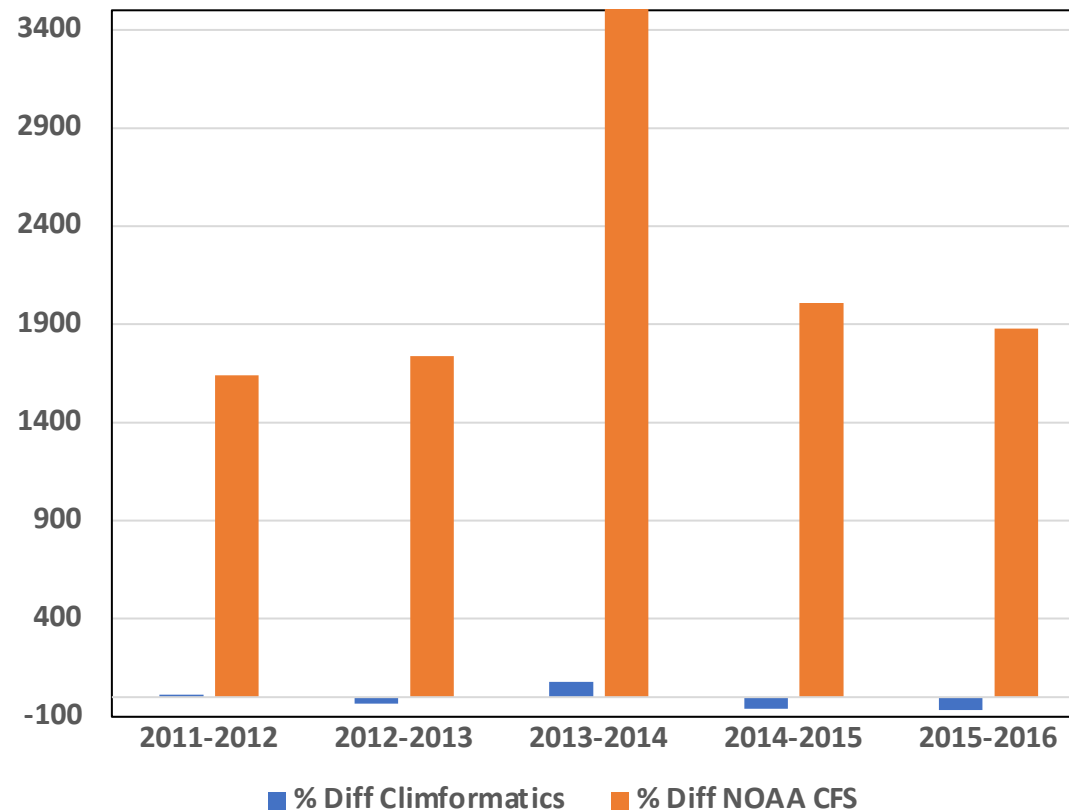
Oct-May Fresno Rain Total: Prediction

Climformatics, NOAA, Observations Accuracy Summary

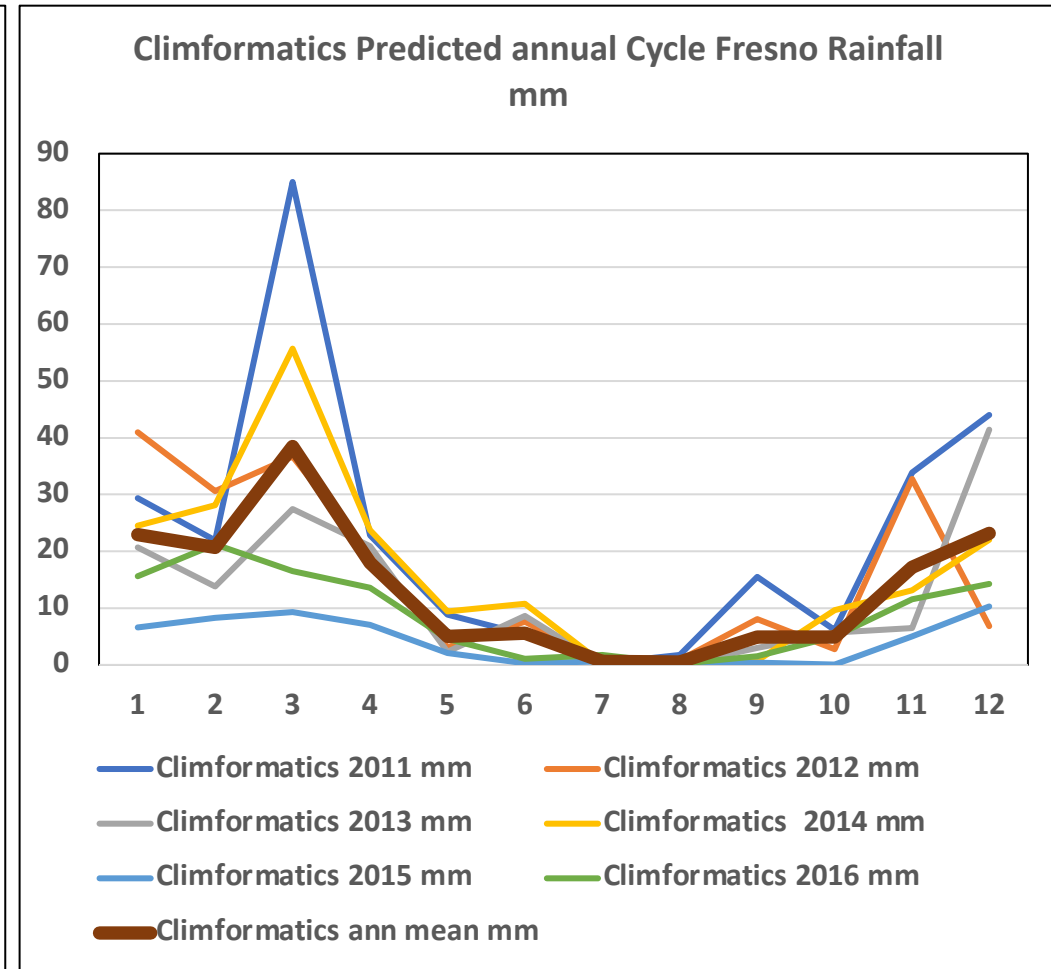
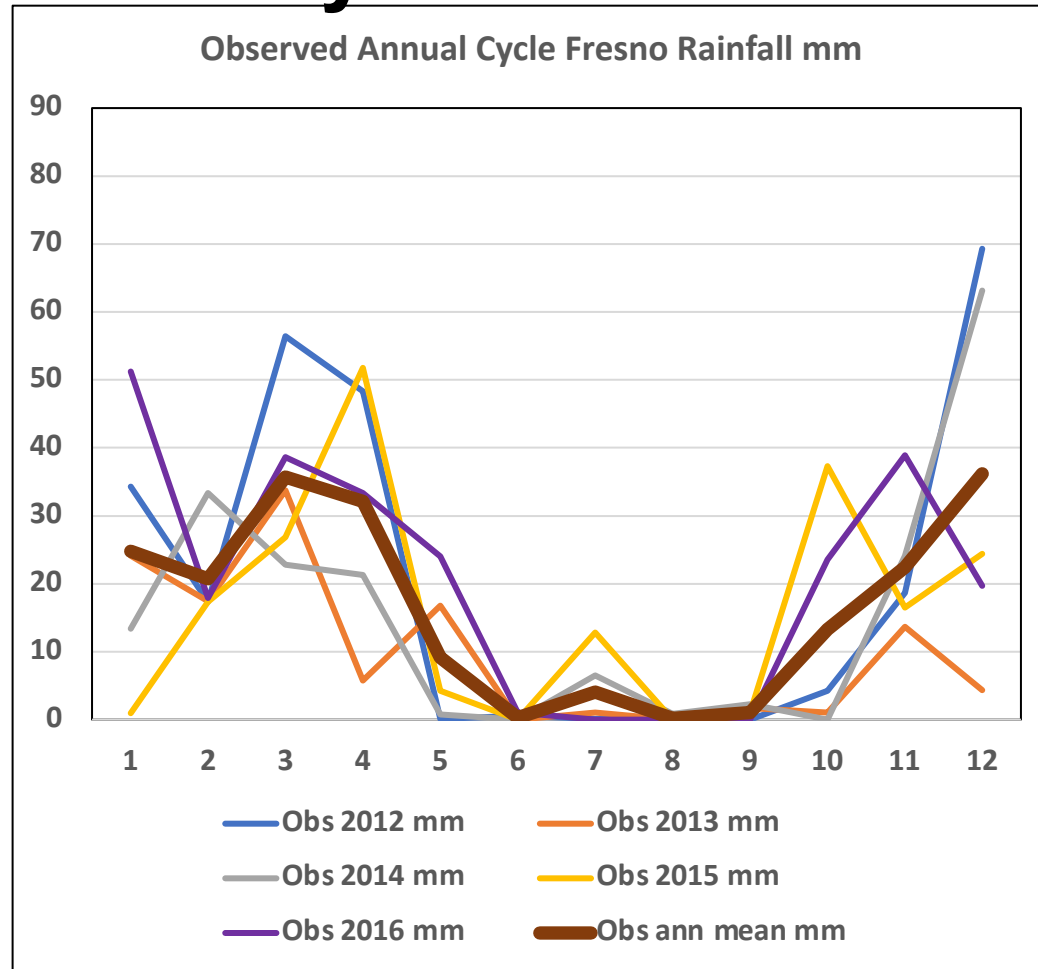
Fresno Total Winter Rainfall OCT-MAY mm



Percentage Difference in Total Winter Rainfall
Prediction for Fresno



Climformatics Predicted & Observed Fresno Rainfall Annual Cycle 93706



Climformatics Short Term Prediction Atmospheric Rivers January 2021

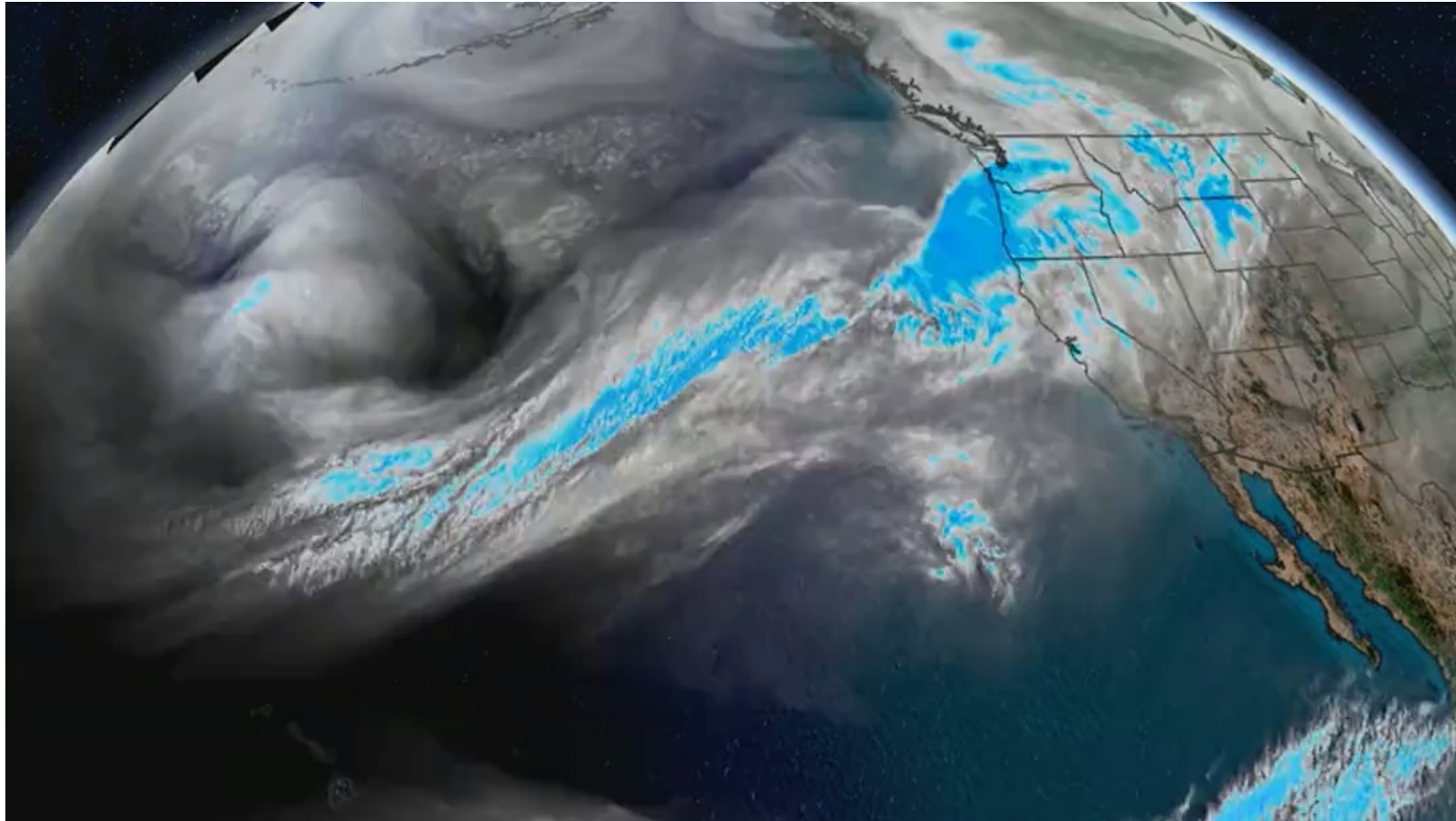
Atmospheric Rivers - Main Water Source for California

January 12, 2021 Category 5 Atmospheric River

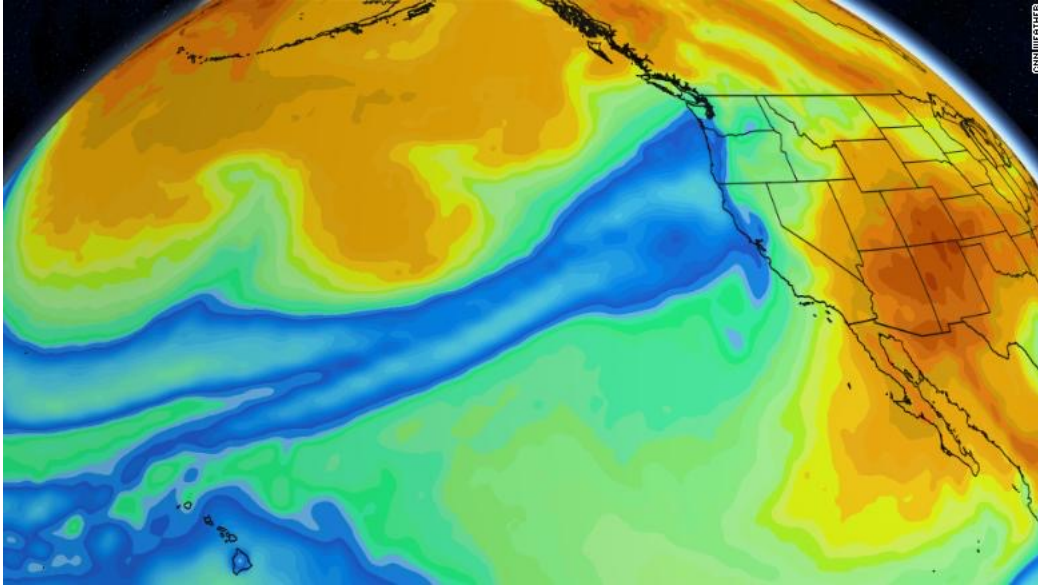
predicted to supply 30% of the California water resource for 2021

Atmospheric River Category 5

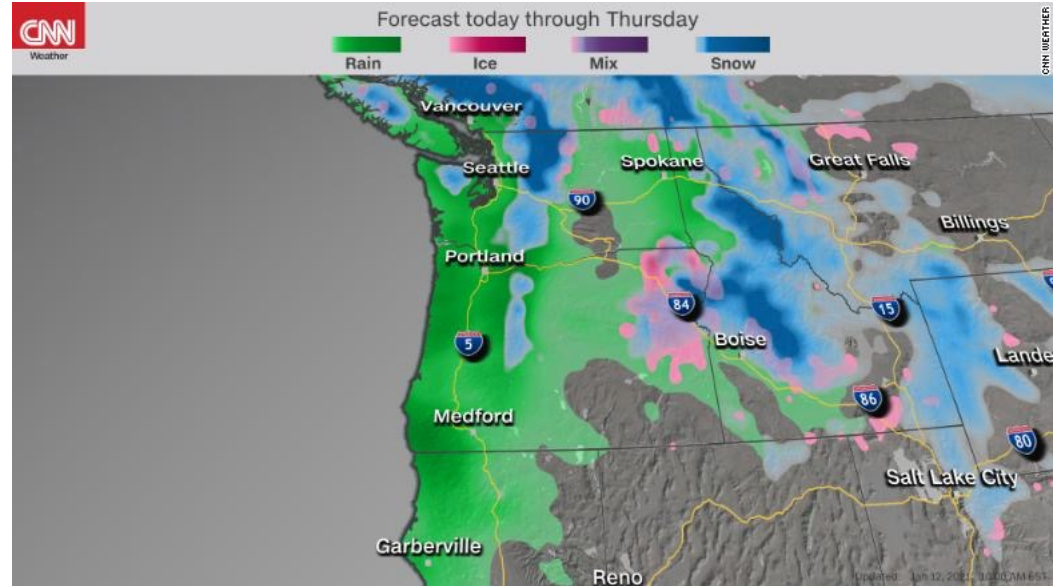
January 12, 2021, Satellite Data of Water Vapor Transport



NOAA rainfall prediction for Jan 12-14, 2021 (CNN news)



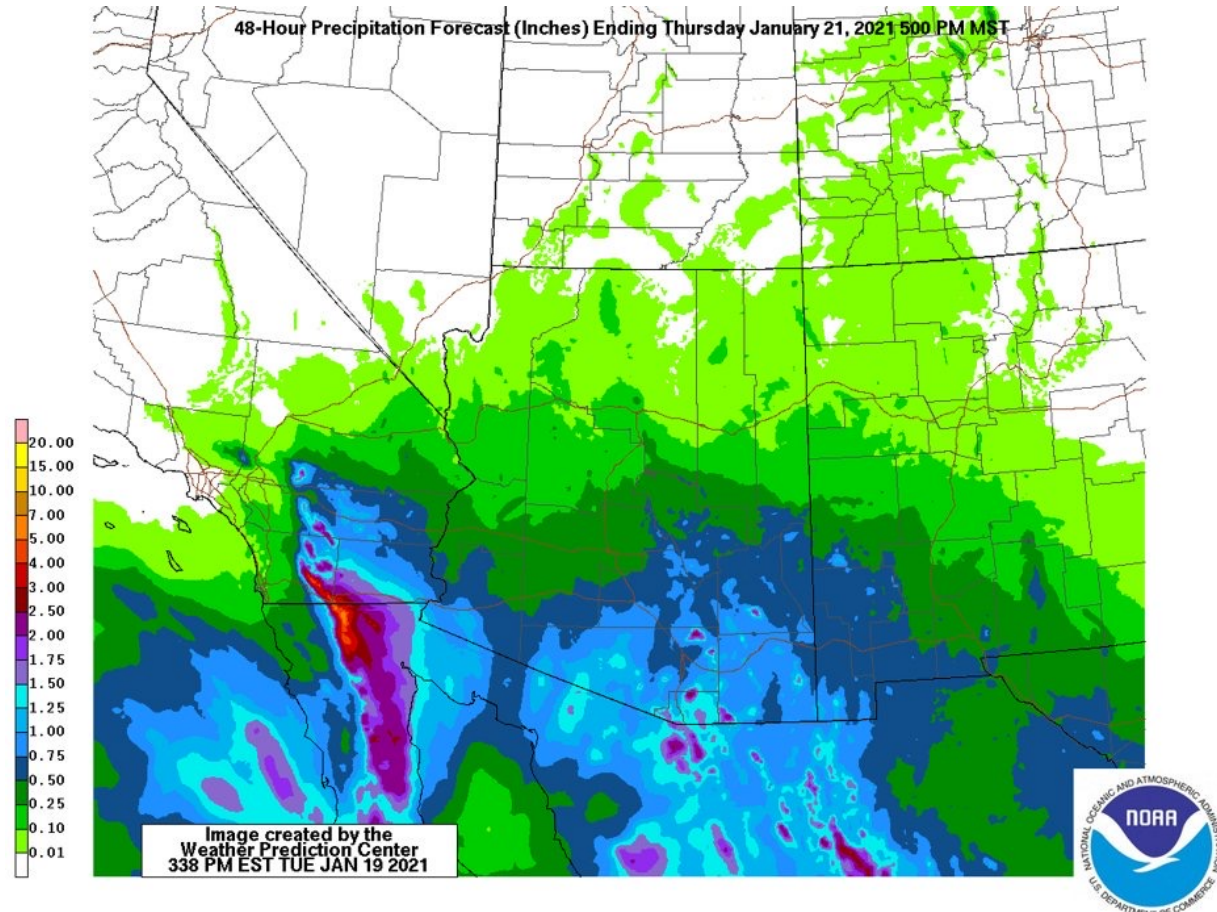
NOAA forecast model prediction:
Atmospheric river stretching about 2700 miles
across Pacific ocean. Landfall over West Coast of
Washington, Oregon and California



NOAA Rainfall forecast Jan 12-14 over Washington
and Oregon

NOAA rainfall prediction Jan 19-21, 2021

Pacific Storms over Southern California with large amount of rainfall of about 4-5 inches



Climformatics Prediction – Total Precipitation Jan 1-15 2021

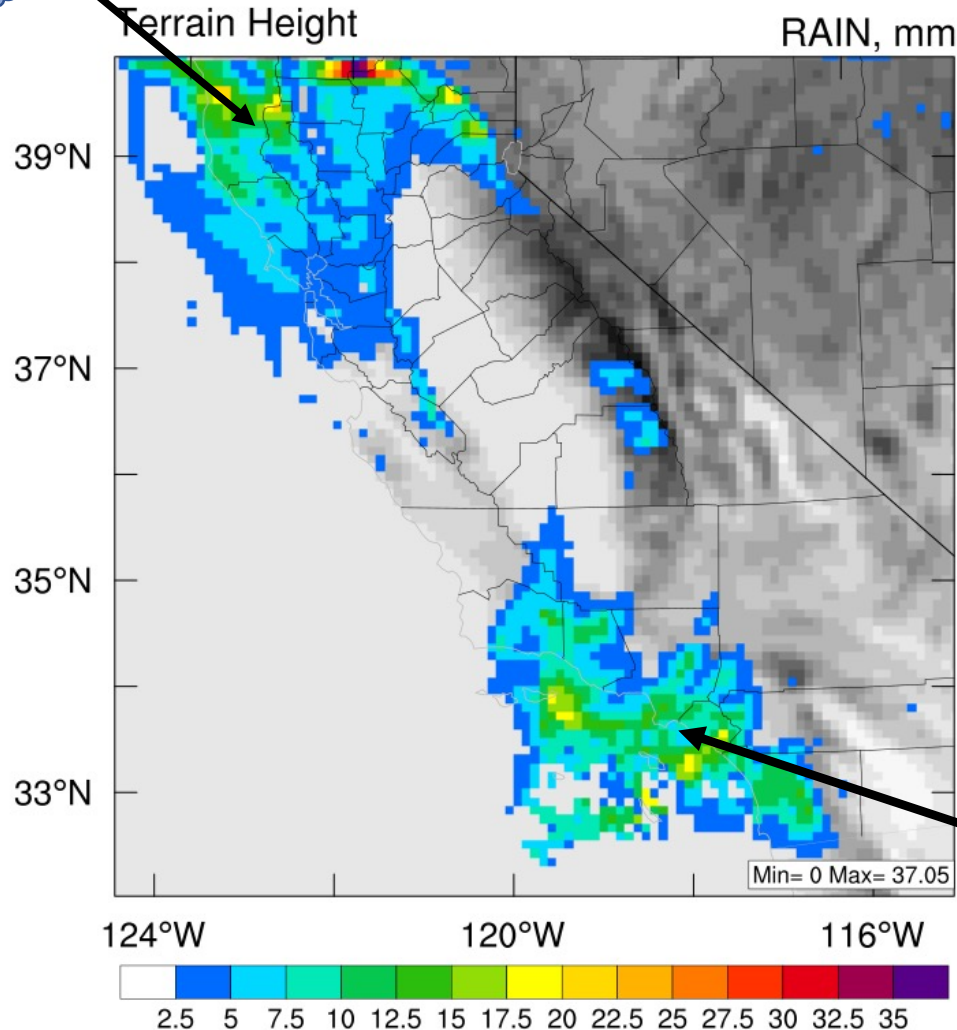
atmospheric river

9km domain

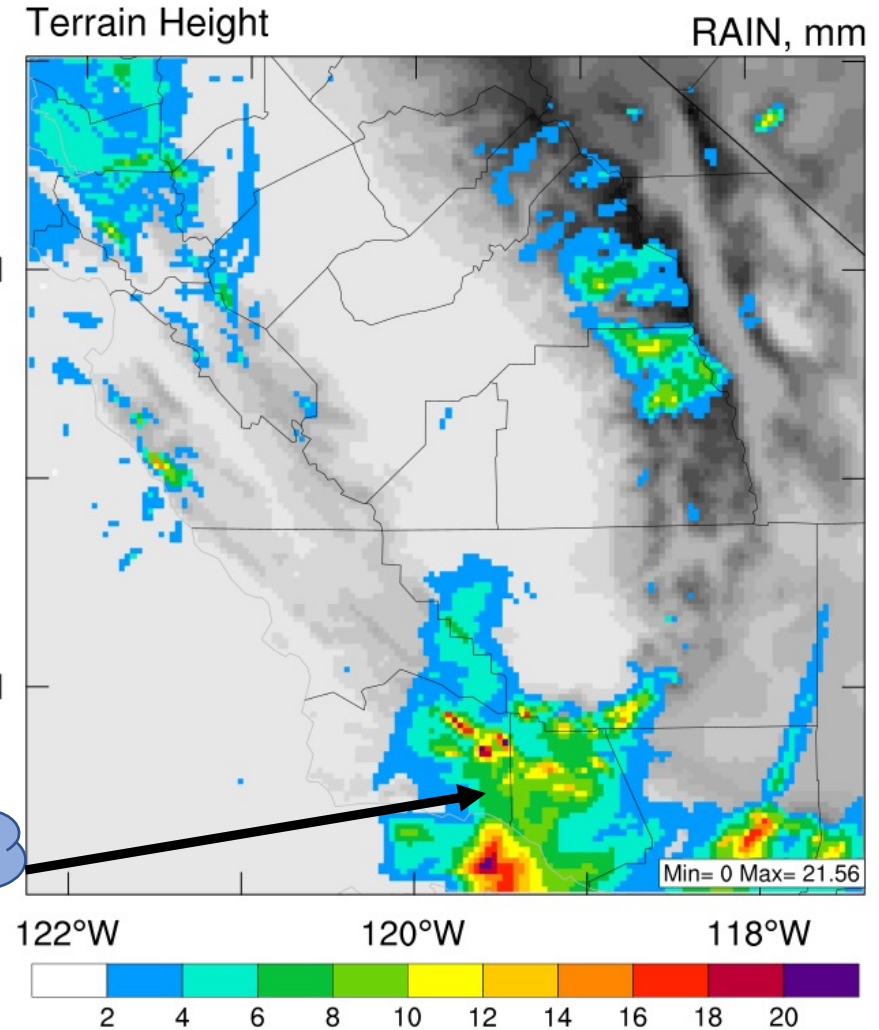
3km domain

Total Precipitation Jan 1-15 2021

Total Precipitation Jan 1-15 2021

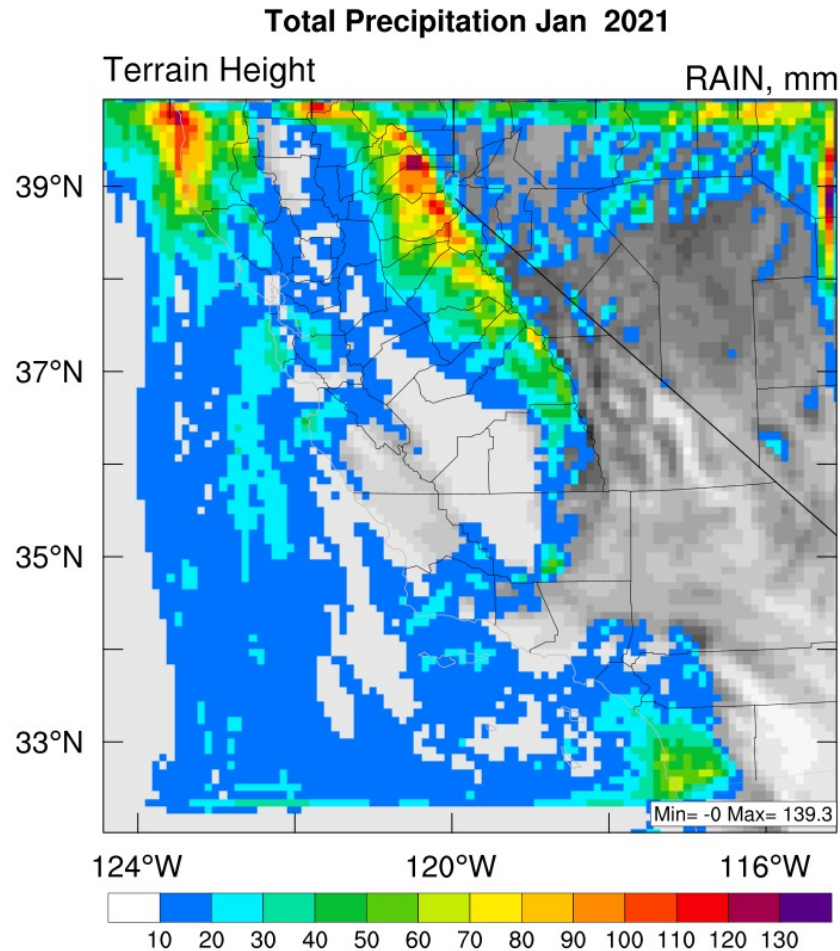


Pacific Storms

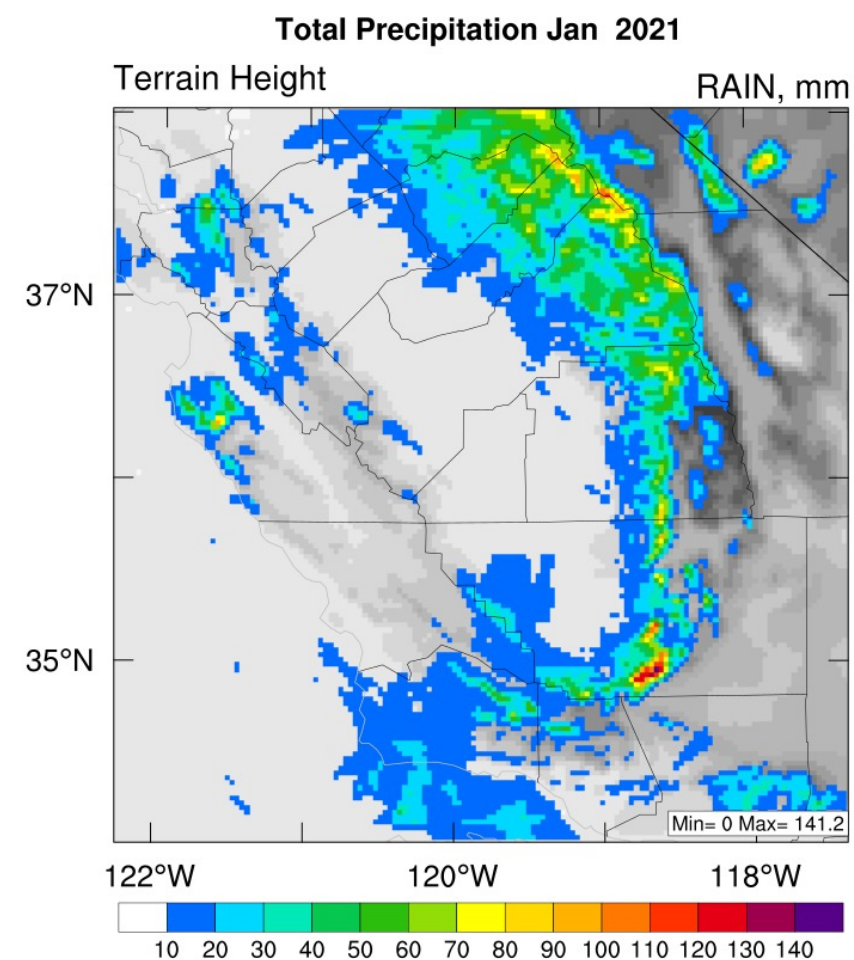


Climformatics prediction – Total Precipitation in Jan, 2021

9km domain



3km domain

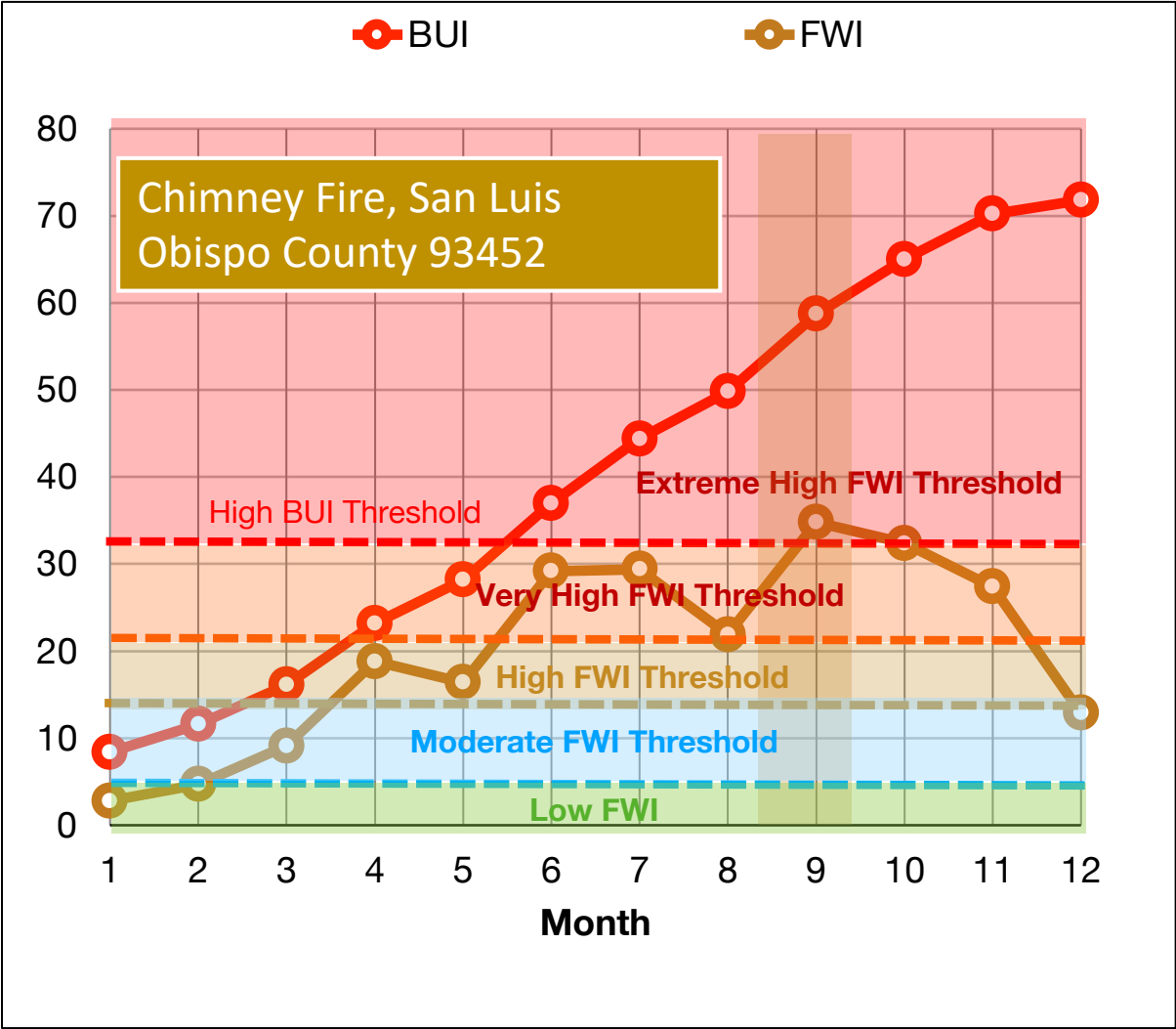


Total Precipitation in Jan, 2021 over the Sierras ~40- 120mm, over Southern California 20-110mm

Dec2020-May2021 Winter Rainfall Prediction

- Santa Barbara Downtown 93105 – 7.7” **obs -9”**
NOAA operational forecast – 82”
- Fresno 93706 -6.4” **obs-8”**
- Arroyo Seco – 5.5 “ **obs-6.5”**
NOAA operational forecast - 114”

2016 Fire Weather Index Hindcast Prediction

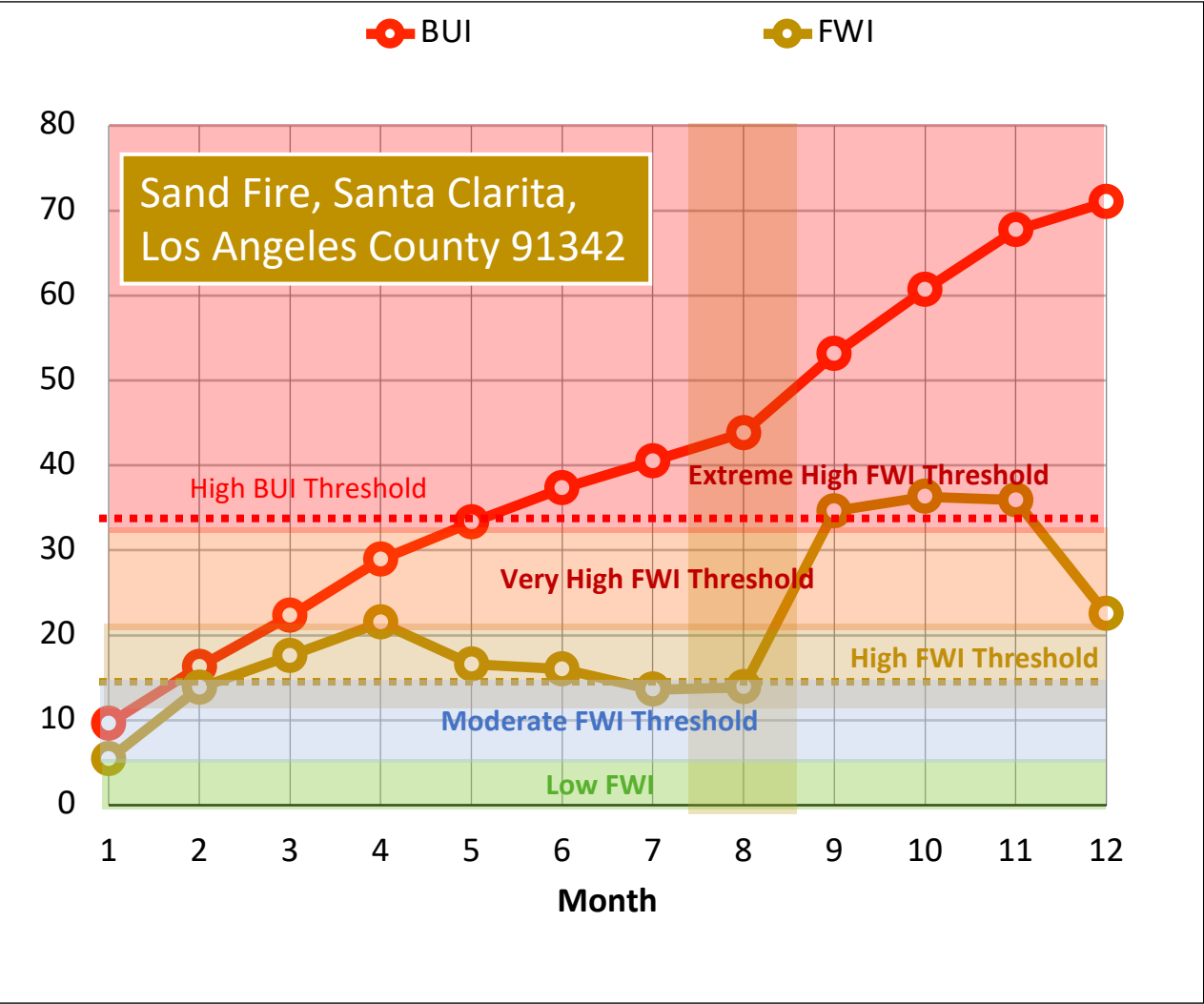


Chimney Fire: (near Hearst Castle)

Fire Duration	August 13 - September 6, 2016
Burned area	46,344 acres (188 km ²)
Buildings destroyed	70
Buildings damaged	8

Co-occurrence of high BUI and extreme high FWI conditions during August-September of 2016 (predicted by Climformatics) may have caused the Chimney Fire.

2016 Fire Weather Index Hindcast Prediction

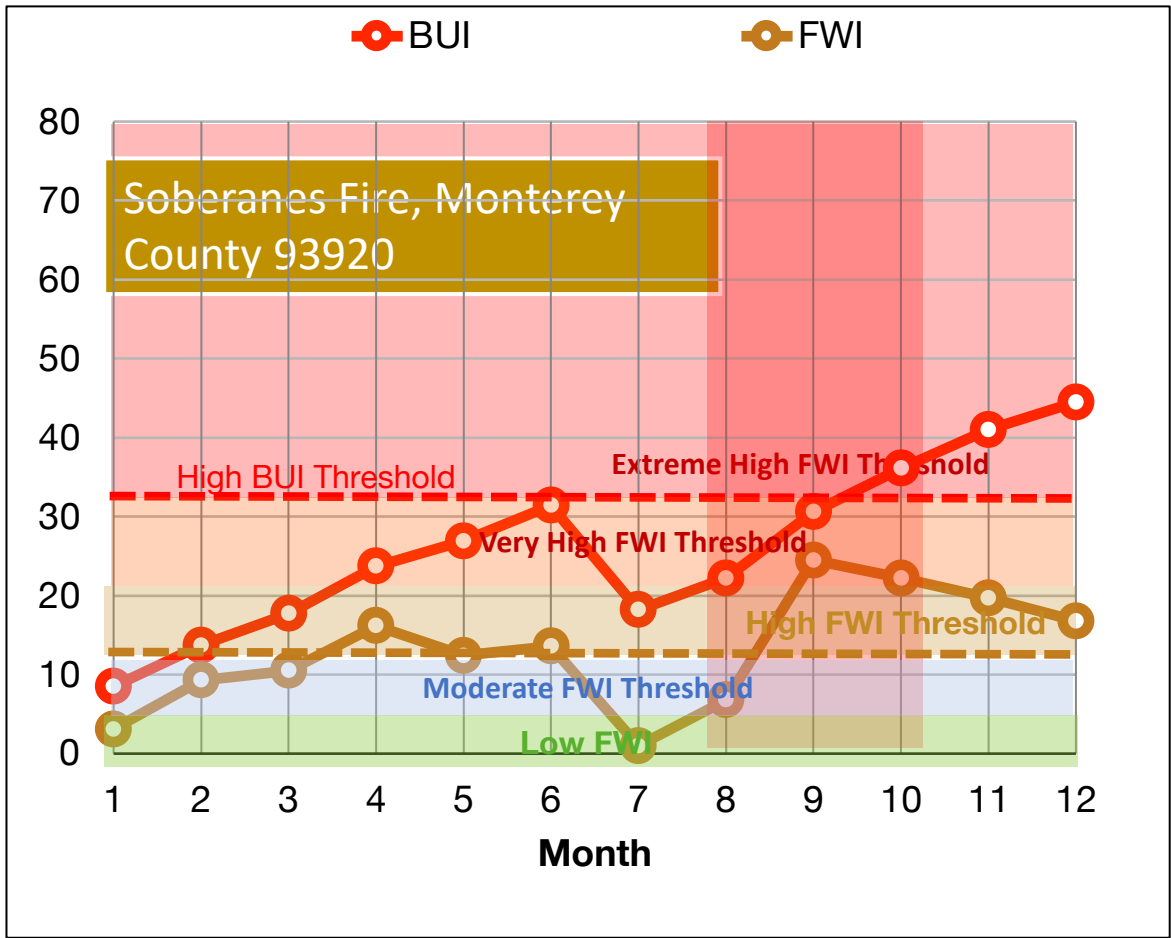


Sand Fire: (Angeles National Forest, Santa Clarita)

Fire Duration	July 22 – August 3, 2016
Burned area	41,432 acres (168 km ²)
Buildings destroyed	18
Fatalities	2

Co-occurrence of high BUI and moderate to high FWI conditions during July-August of 2016 (predicted by Climformatics) may have caused the Sand Fire.

2016 Fire Weather Index Hindcast Prediction



Soberanes Fire: Monterey County

Fire Duration	July 22 – October 12, 2016
Burned area	132,127 acres
Cost	\$260 million (2016 USD)
Buildings destroyed	57

Co-occurrence of moderate to high BUI and extreme high FWI conditions during August-October of 2016 (predicted by Climformatics) may have caused the Soberanes Fire.

Problem: Climate Change Impacts our World



Extreme and Severe
Weather Events



Impacts
lives, livelihood,
Food Security,
Shelter, Business,
Communications...



Causes
Loss of Home,
Productive land,
Business loss, Higher
health care cost,
Investment loss,
Insecure Future ...

Climate variability drives an uncertain future.