How to use climate projections data on Cal-Adapt for building web applications and visualizations

CalGIS LocationCon 2017

Oakland, California · May 22 - 24, 2017

Download GitHub Repo:

https://github.com/berkeley-gif/calgis2017

Cal-Adapt

GEOSPATIAL INNOVATION FACILITY

Cutting-Edge Mapping Technology at UC Berkeley

STATE OF CALIFORNIA ENERGY COMMISSION

Workshop Goals

- Learn about Cal-Adapt
- Get an overview of climate data in Cal-Adapt API
- Why Jupyter Notebook?
- Hands-on learning:
  - Search for resources (datasets) on Cal-Adapt API
  - Get data for a location
  - Generate summary statistics from data using Pandas
  - Export data into different formats

Download GitHub Repo:

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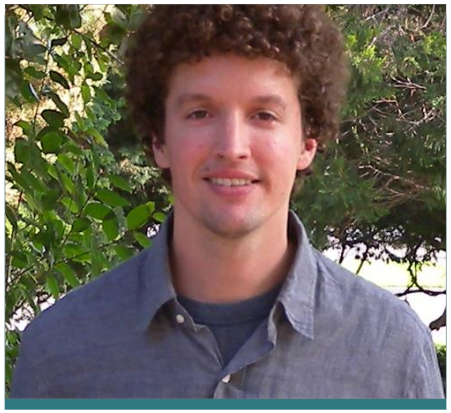
About Us

GEOSPATIAL INNOVATION FACILITY
Cutting-Edge Mapping Technology at UC Berkeley

Shruti Mukhtyar
Web Developer



Brian Galey
Senior Web Developer

Nancy Thomas
Executive Director

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Faculty Director

Eric Lehmer
Web Developer

Introduction to Cal-Adapt

Cal-Adapt

Exploring California's Climate Change Research

GEOSPATIAL INNOVATION FACILITY

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STATE OF CALIFORNIA ENERGY COMMISSION

Developed by University of California's Geospatial Innovation Facility

- Nancy Thomas (Executive Director)
- Maggi Kelly (Faculty Advisor)
- Brian Galey (Senior Web Developer)
- Shruti Mukhtyar (Web Developer)
- Eric Lehmer (Web Developer)

Funding and oversight by California Energy Commission

- Susan Wilhelm
- Guido Franco
- Advisory Committee

SCRIPPS INSTITUTION OF OCEANOGRAPHY

PACIFIC INSTITUTE

UNIVERSITY of WASHINGTON

UCMERCED

google.org

USGS science for a changing world

CALIFORNIA natural resources AGENCY

California Climate Change Assessments

California produces periodic scientific assessments on the potential impacts of climate change in California and reports potential adaptation responses.

Required by Executive Order #S-03-05, these assessments influence legislation and inform policy makers.

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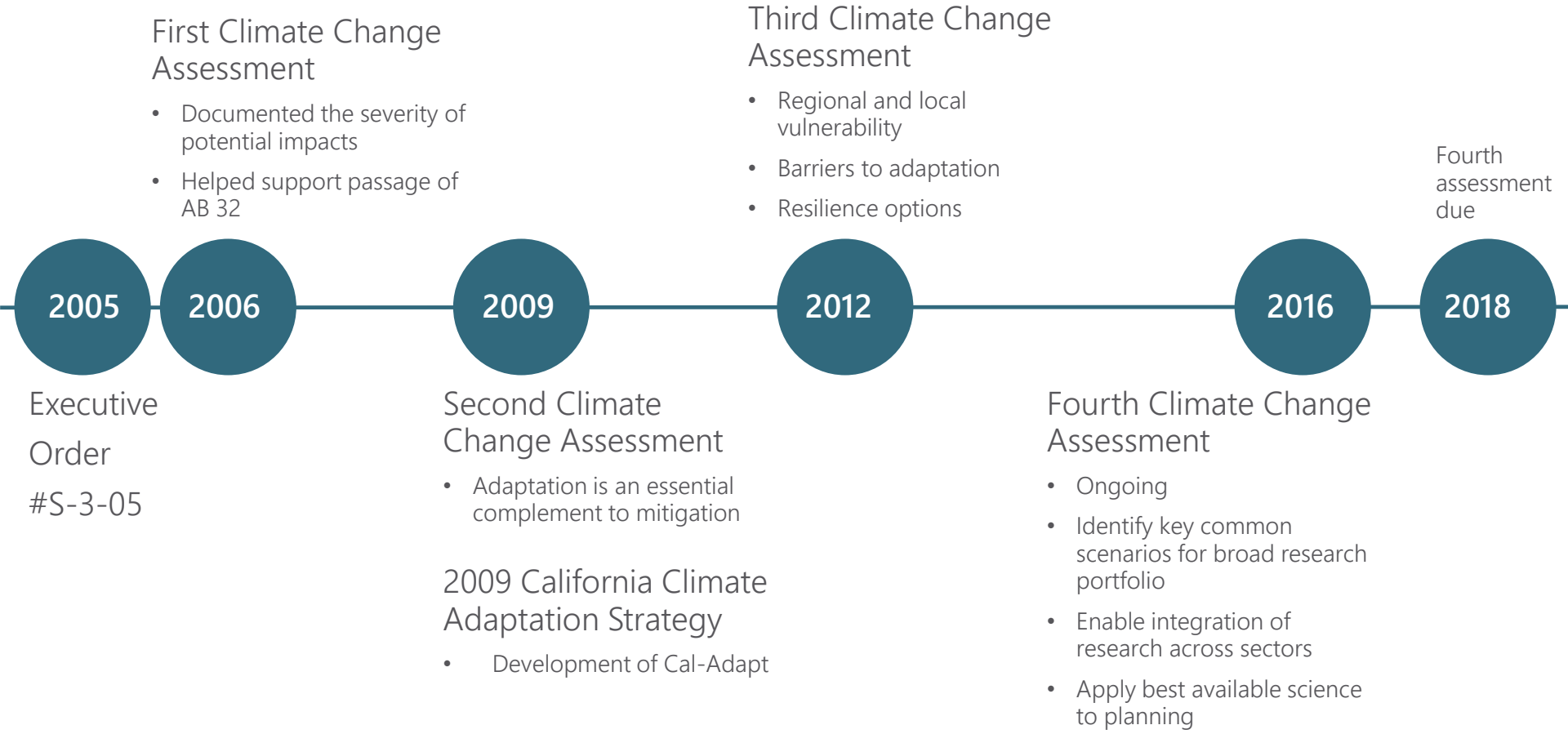
California Climate Change Assessments



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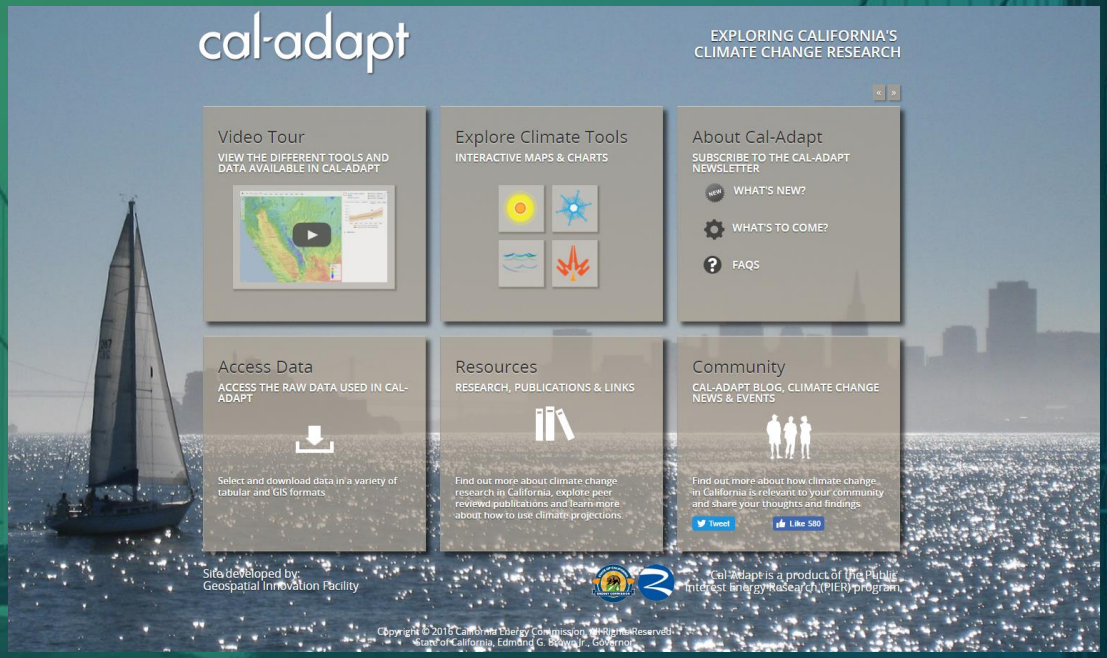
What is Cal-Adapt?

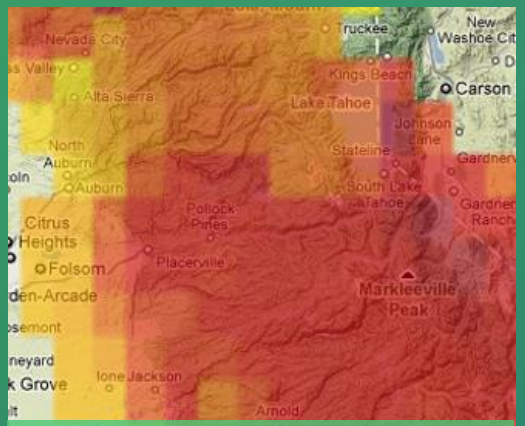
- Launched June 2011
- Resource created by State of California under contract with UC Berkeley's Geospatial Innovation Facility to convey local climate risks based on peer-reviewed science
- Users
  - Local planners and technicians
    - obtain meaningful information and data to help guide locally relevant climate action plans and adaptation strategies
  - General public
    - learn about climate change data relevant to their area
  - Scientific community
    - access primary data relevant to an area of interest

Cal-Adapt

cal-adapt.org

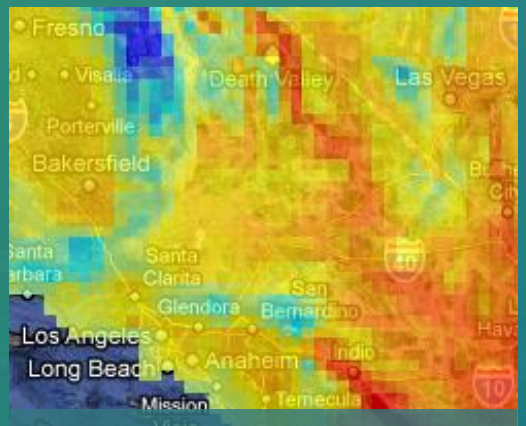


Tools & Visualizations on Cal-Adapt

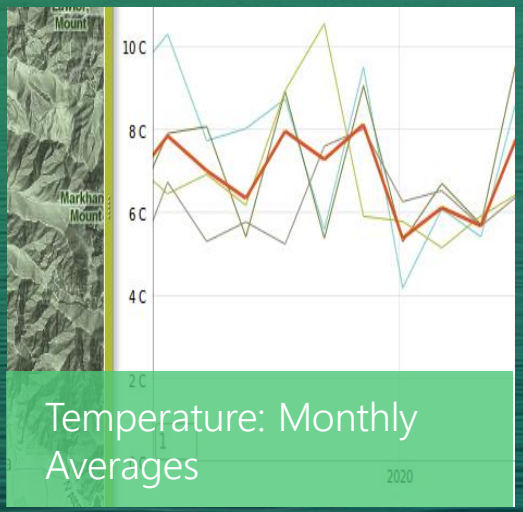


Wildfire Risk

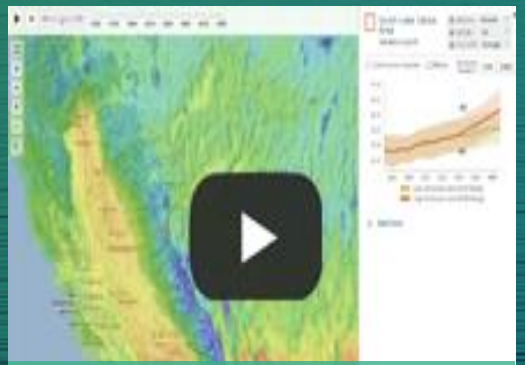
Local Climate Snapshots



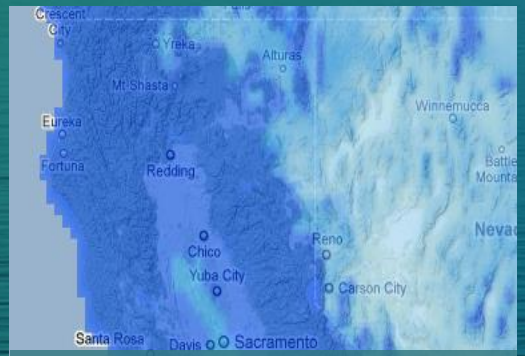
Temperature: Decadal Averages



Temperature: Monthly Averages



Video Tour



Precipitation: Decadal Averages

cal-adapt.org

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Cal-Adapt 2.0

beta.cal-adapt.org

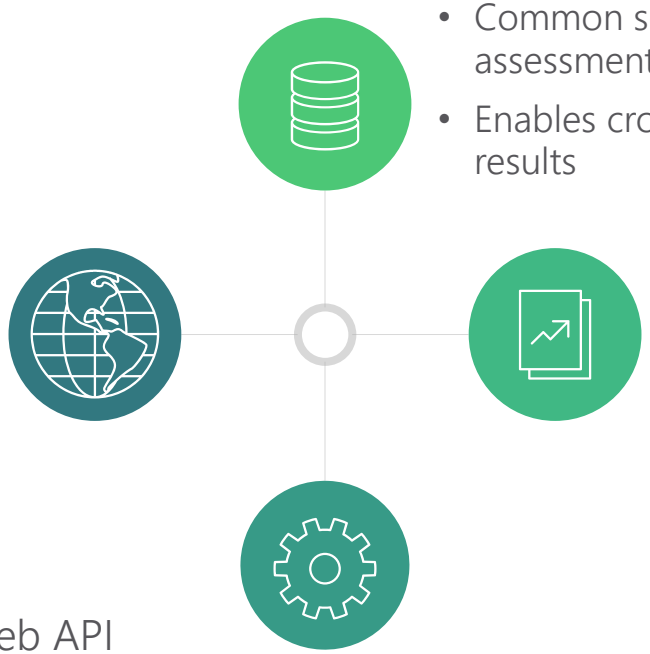
How Does Cal-Adapt Support the 4th Assessment?

Serve Data

- Climate, hydrological, sea-level rise, snowpack, wildfire risk
- Common scenarios basis for 4th assessment research portfolio
- Enables cross-sector integration of results

Build Tools & Visualizations

- Focus on the energy sector
- Support decision-making
- Communicate results of 4th assessment research



Provide Resources & Outreach

- Interface with resilience planning
- Webinars and training sessions
- Focus on energy sector

Web API

- Enable access to common scenarios for other organizations
- Build domain specific planning tools using the Cal-Adapt API

Cal-Adapt 2.0: Public API

- Open source architecture powered by Django, Django REST framework and Django-Spillway, an open source library developed at the GIF
- Dynamic temporal aggregation of time series data
- Spatial aggregation by counties, climate regions, watersheds, census tracts, legislative districts, etc.
- Allows other organizations to access climate data and build domain specific visualization and planning tools

Cal-Adapt 2.0: Tools & Visualizations

- New tools with enhanced usability
- Built using modern data visualization libraries (e.g. D3) and the Cal-Adapt API
- Goal of enhancements
  - Use latest peer-reviewed data
  - Add support for interpreting data and visualizations
  - Increase responsiveness to utilities resilience needs

New

- Annual Averages (Tmax, Tmin, Precipitation)
- Extreme Heat Days
- Sea Level Rise (Radke et al. 2016)

Under development

- Snowpack
- Hourly Sea Level Rise

Upcoming

- Wildfire Risk

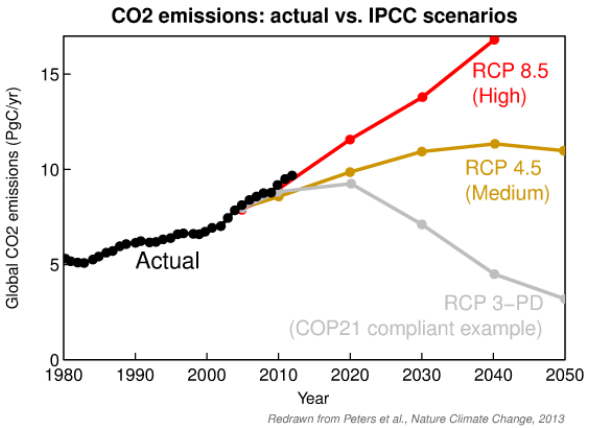
Future

- Probabilistic forecasting at seasonal and decadal scales
- Sea Level Rise (CoSMoS)
- Update existing tools with new data

Quick Overview of Climate Data on Cal-Adapt and the API

Underlying Data

- 32 global climate models from institutions all around the world
- Daily data
- Historical run from 1950–2005
- 2 future GHG emissions scenarios from 2006–2100 (or 2099)
  - Middle: "RCP 4.5"
  - High: "RCP 8.5"
- Atmospheric component (temp, precip) and a land surface component (snowpack, soil moisture, evapotranspiration, etc.)
- Problems with global models:
  - Errors (biases) -> bias correction
  - Coarse resolution -> downscaling
  - Land surface models in GCMs vary in quality



Source: David W. Pierce, Daniel R. Cayan*
Division of Climate, Atmospheric Sciences, and Physical Oceanography,
Scripps Institution of Oceanography; *and USGS, La Jolla, CA

Downscaled Climate Projections for CA

Scripps Institution of Oceanography, UC San Diego

- LOCA statistical downscaling technique (loca.ucsd.edu)
- 10 models which are good performers in California
  - Recommended by CA state agencies
  - ACCESS1-0, CCSM4, CESM1-BGC, CMCC-CMS, CNRM-CM5, CanESM2, GFDL-CM3, HadGEM2-CC, HadGEM2-ES, MIROC5
- If still too many, analysis (over 2015-2050) suggests 4 models to use:
  - HadGEM2-ES "warm/dry" model
  - CNRM-CM5 "cool/wet" model
  - CanESM2 "average" model
  - MIROC5 "Complement/Covers range of outputs" model

- Other downscaled projections:
  - Dynamic downscaling (Alex Hall, UCLA)
  - NEX-DCP30 (NASA Earth Exchange)

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Data on Cal-Adapt API

- Maximum Temperature, Minimum Temperature, Precipitation
  - (1) LOCA downscaled CMIP5 data from Scripps Institution of Oceanography (Pierce et al. 2014), 10 GCM, 3 scenarios; (2) Gridded observed historical data for 1950–2013 (Livneh et al. 2015)
  - Daily and Annual averages
  - 1/16th degree (~ 6km) spatial resolution
- VIC (land surface model) derived variables – Snow Water Equivalent
  - (1) Forced by LOCA, 10 GCM, 3 scenarios; (2) Forced by observed historical
  - Monthly averages
  - 1/16th degree (~ 6km) spatial resolution
- Inundation depths for SF Bay, Sacramento-San Joaquin River Delta and California coast for different SLR projections :
  - No rise, 0.5 m, 1.0 m, 1.41 m
  - Radke et al. 2016, UC Berkeley
- Wildfire Risk (LeRoy Westerling, UC Merced)

netCDF files for all 32 GCMs available through the Cal-Adapt Data Server

Why Jupyter?

Jupyter Notebook

- Web based, open source
- Jupyter notebooks are a series of "cells" containing executable code or explanatory text
  - Text is written using Markup, a popular HTML language
  - LaTeX support for mathematical equations
- Support for Python, R, Julia and other programming languages
- "Literate programming" - emphasizes a prose first approach where explanation with human-friendly text is punctuated with code blocks
- Great for demonstration, research, and teaching
- Easy to share
- Python
  - High-level, general-purpose, interpreted
  - Rich ecosystem for data analysis and scientific computing
    - NumPy, Pandas, SciPy, matplotlib,

Exercises

Hands-on Exercises

- Download repo from GitHub
  - Use git or download zip file and extract it
- For Anaconda users
  - Open Anaconda Navigator
  - Launch Jupyter Notebook app
  - Navigate to calgis2017 folder on your computer
  - Open index.ipynb
- For JupyterHub users
  - Open http://35.185.246.188 in a web browser
  - Login with any username and pwd (remember these if you want to login again)
  - Upload all .ipynb files one at a time
  - Open index.pynb

https://github.com/berkeley-gif/calgis2017

Thank you

Questions? We welcome your feedback.

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