

Display and analysis of weather data from NCDC using ArcGIS

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Abstract

This project describes the application of ArcGIS to the mapping of weather and climate data. Historical daily climate data for the U.S. have been obtained from the National Oceanic and Atmospheric Administration's National Climate Data Center, including data from individual cooperative stations dating back to the late 1800s. These data include precipitation, snowfall and minimum and maximum temperature. For some stations more attributes are available. Station locations have been mapped into ArcGIS shapefiles for display in ArcMAP. A menu-driven interface has been programmed within the GIS system to retrieve data for individual and selected stations. Data averaged over a month, a season or a year can be selected, as well as data averaged over many (user-specified) years. In addition single daily records of data can be selected. These data are brought into ArcMAP as a shapefile for display, interpolation and gridding to produce weather and climate maps.

- **GOAL**

- Mapping of daily historical climate data in ArcGIS for use in climate studies

- **METHOD**

- VBA module programmed in ArcGIS to read NCDC (National Climate Data Center) data files, calculate means and variances over a variety of time periods for selected weather stations, store information to shapefiles for display and manipulation in ArcGIS.

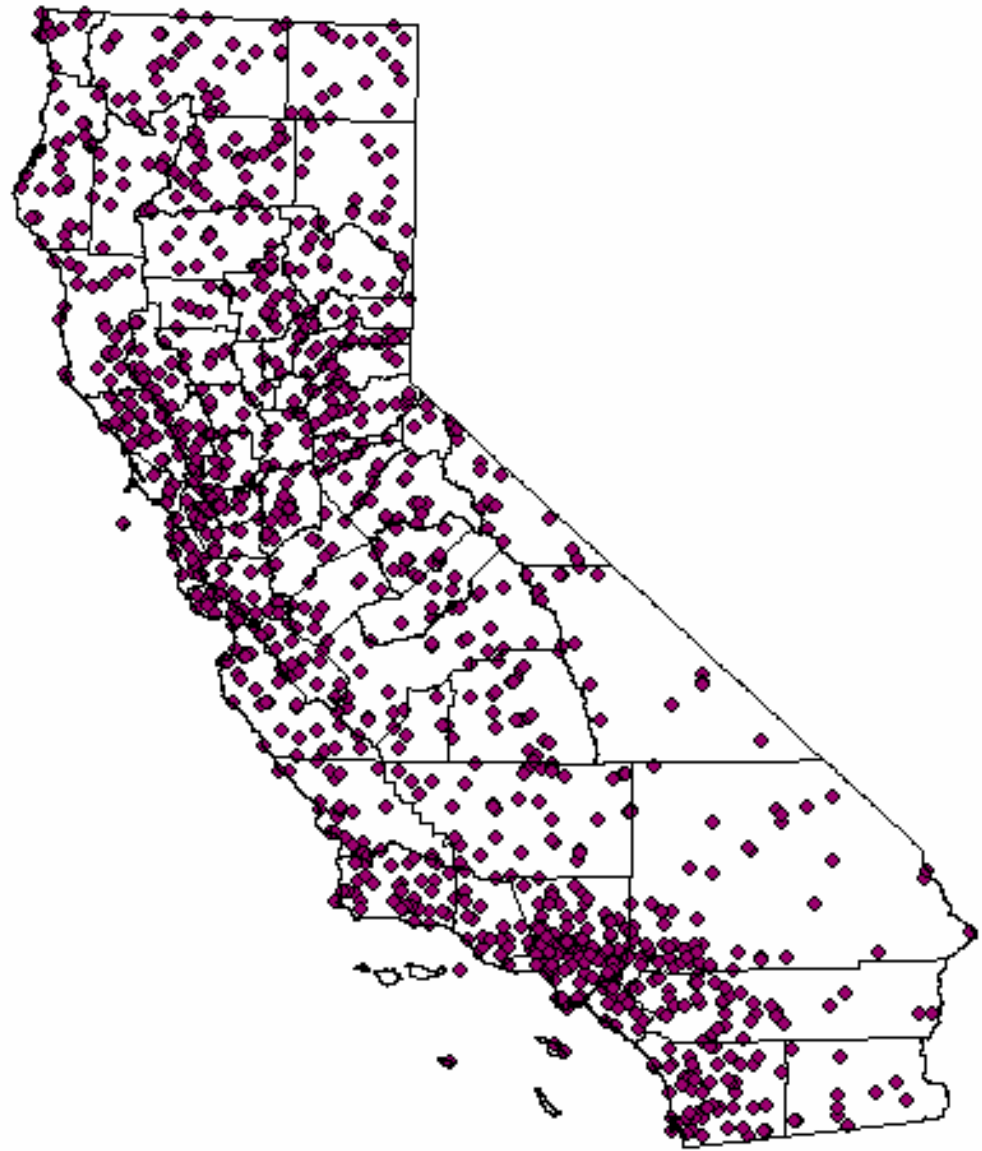
- **PURPOSE**

- Climate change studies:

- Analysis of warming – urban heat island effect

- Impact assessment – energy demand, land use change, water demand

Weather stations in California with historical data



User Interface Design

Allow user to select one of the following options:

- specific date
- specific month (avg of daily data)
- specific season (DJF, MAM, JJA, SON)
- specific year
- average of date, month, season or year over a range of user-specified years

The screenshot shows a dialog box titled "Type of Data" with a close button (X) in the top right corner. The dialog contains the following elements:

- A label "Choose the type of data you want:" followed by a dropdown menu currently showing "specific date". The dropdown menu is open, displaying a list of options: "specific date", "specific month", "specific season", "specific year", "daily average", "monthly average" (highlighted with a mouse cursor), "seasonal average", and "annual average".
- A label "Choose a day, month and year" followed by three input fields: "Day:" with a dropdown menu showing "1", "Month:" with a dropdown menu, and "Year:" with a text input field.
- A label "Enter year:" followed by a text input field containing "1990".
- A checkbox labeled "Include all stations that have some data within dates" which is currently unchecked.
- An "OK" button in the bottom right corner.

User Interface Design

Seasonal averages are useful for:

- precipitation studies (DJF in Southwest) – El Nino
- minimum temperature (winter, DJF) – diurnal variation
- maximum temperature (summer, JJA) – water, energy demand

User enters range of years for averages. Option to include only those stations with data available for all years, or all stations for which at least one year of data is available.

Type of Data

Choose the type of data you want: seasonal average

Choose a season and range of years

Day: 1 Month: July Season: DJF

Enter starting year: 1961 Enter ending year: 1990

Include all stations that have some data within dates

OK

User Interface Design

User selects State from a drop-down menu, and is then provided with a list of stations having available data.

User then selects one or multiple stations from this list.

Choose Stations

Choose State and then choose stations from list below, or Click on "Use Selected Stations from Map".

Use Selected Stations from Map

Choose State: California 355 stations available

0014 - ACTON ESCONDIDO FC261
0029 - ADIN RS
0115 - ALISO CANYON OAT MTN FC446
0136 - ALPINE
0144 - ALTADENA
0161 - ALTURAS RANGER STATION
0212 - ANGVIN PAC UNION COL

Back Press OK when done. OK

Choose Stations

Choose State and then choose stations from list below, or Click on "Use Selected Stations from Map".

Use Selected Stations from Map

Choose State: California 355 stations available

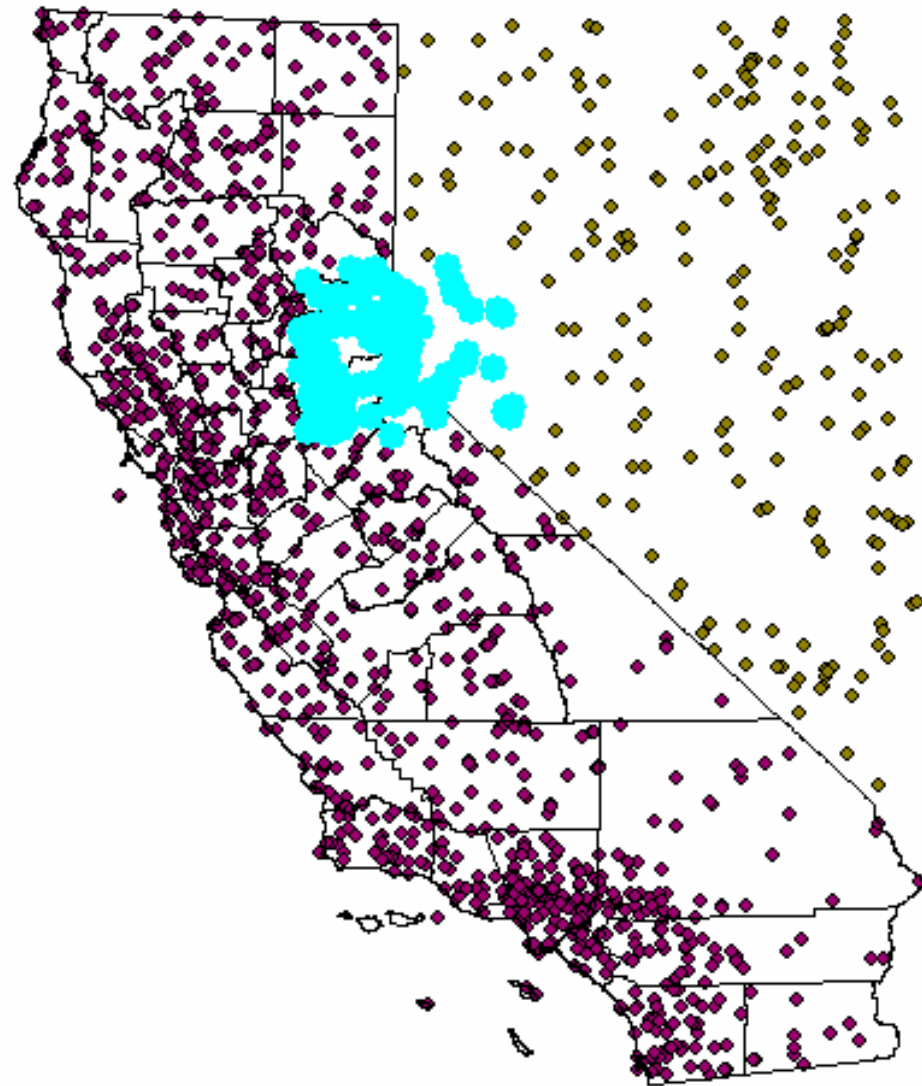
0014 - ACTON ESCONDIDO FC261
0029 - ADIN RS
0115 - ALISO CANYON OAT MTN FC446
0136 - ALPINE
0144 - ALTADENA
0161 - ALTURAS RANGER STATION
0212 - ANGVIN PAC UNION COL

Back Press OK when done. OK

User Interface Design

Alternatively, the user can display the State shapefiles for all weather stations and select the desired stations directly from the map.

This allows for the option of choosing stations from more than one State. Of those stations selected, only those for which the relevant data is available will be processed.



User Interface Design

Press OK when done!

Choose Stations

Choose State and then choose stations from list below, or Click on "Use Selected Stations from Map".

Choose State: California 355 stations available

Use Selected Stations from Map

Starting Date: 196012

Ending Date: 199002

0014 - ACTON ESCONDIDO FC261
0029 - ADIN RS
0115 - ALISO CANYON OAT MTN FC446
U136 - ALPINE
0144 - ALTADENA
0161 - ALTURAS RANGER STATION
0212 - ANGWIN PAC UNION COL

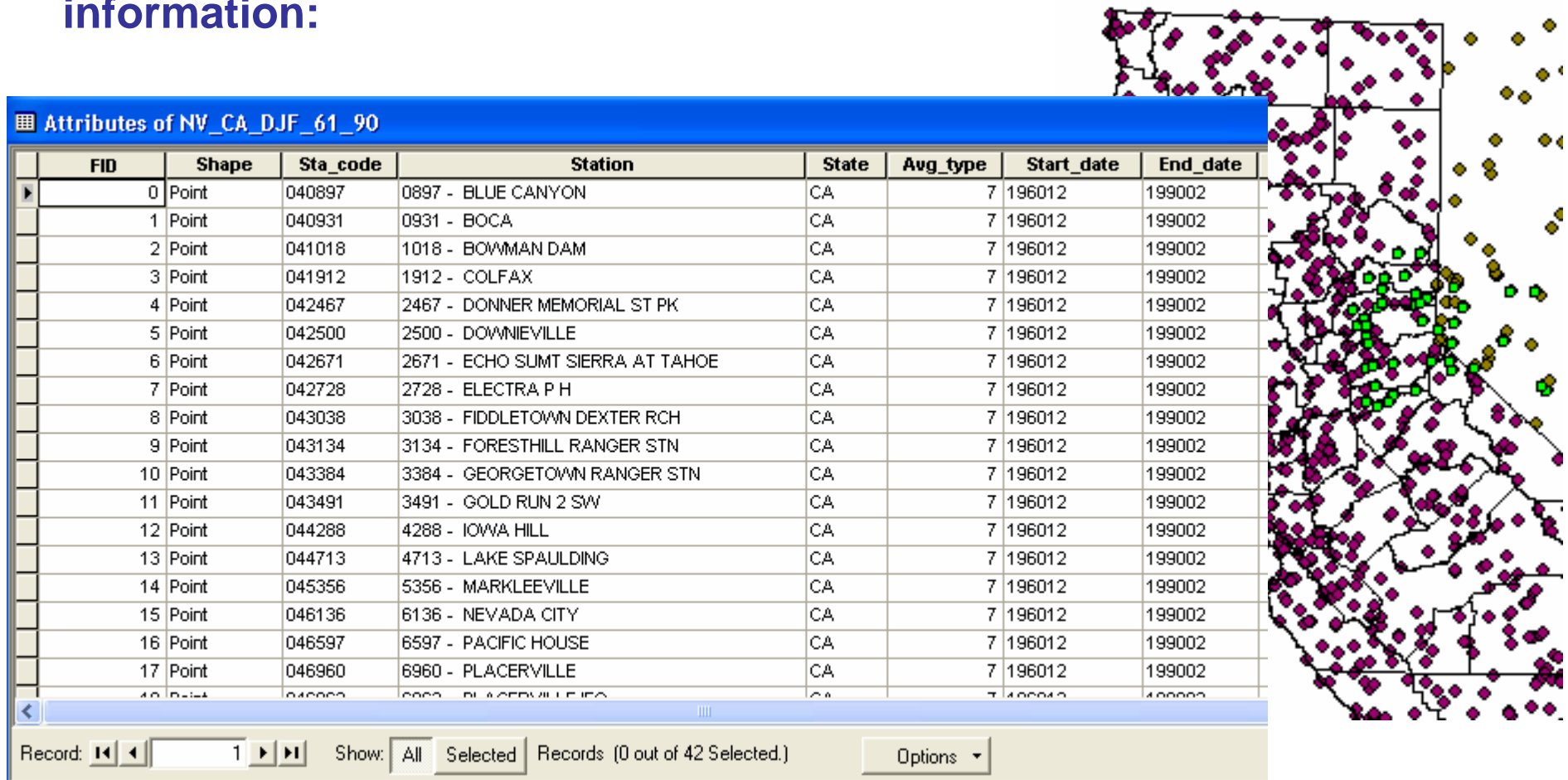
Back Press OK when done. OK

NCDC Data

- Relevant NCDC data files are identified for reading.
- Available parameters are precipitation, snowfall, snowdepth, minimum daily temperature, maximum daily temperature, temperature at observation time. (Not all stations have all parameters.)
- NCDC data are stored as one line per month, and parsed for daily values and flag information.
- Averages and variances are calculated per station for the requested range of dates.
- A shapefile is created with a field for each parameter. The calculated means are stored in these. Additional fields include the station identifier, and start and end dates for the averages.

Attribute Tables for Shapefiles

For each data average requested, a shapefile is created. Its attribute table contains the following information:



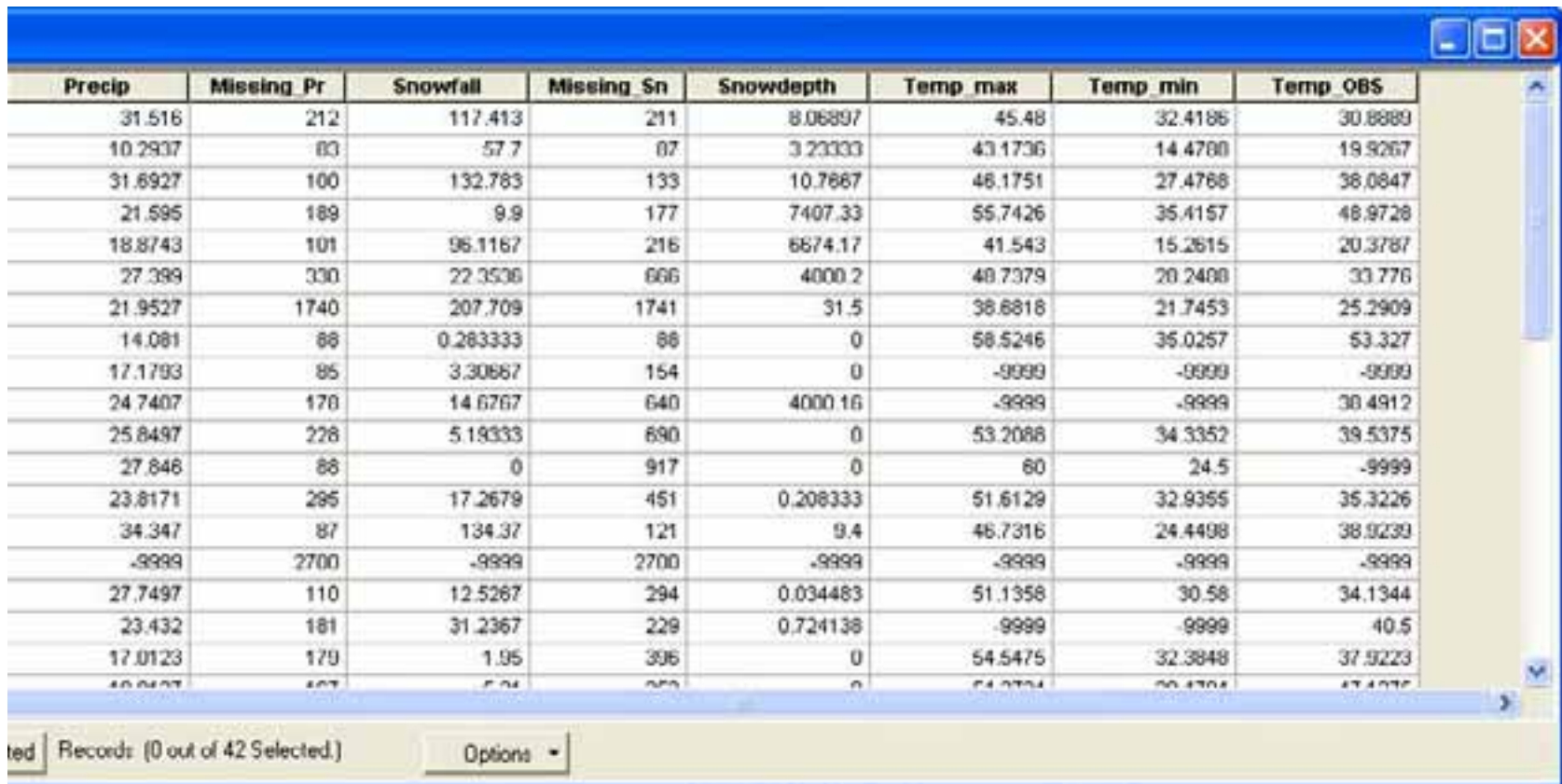
Attributes of NV_CA_DJF_61_90

FID	Shape	Sta_code	Station	State	Avg_type	Start_date	End_date
0	Point	040897	0897 - BLUE CANYON	CA	7	196012	199002
1	Point	040931	0931 - BOCA	CA	7	196012	199002
2	Point	041018	1018 - BOWMAN DAM	CA	7	196012	199002
3	Point	041912	1912 - COLFAX	CA	7	196012	199002
4	Point	042467	2467 - DONNER MEMORIAL ST PK	CA	7	196012	199002
5	Point	042500	2500 - DOWNIEVILLE	CA	7	196012	199002
6	Point	042671	2671 - ECHO SUMT SIERRA AT TAHOE	CA	7	196012	199002
7	Point	042728	2728 - ELECTRA P H	CA	7	196012	199002
8	Point	043038	3038 - FIDDLETOWN DEXTER RCH	CA	7	196012	199002
9	Point	043134	3134 - FORESTHILL RANGER STN	CA	7	196012	199002
10	Point	043384	3384 - GEORGETOWN RANGER STN	CA	7	196012	199002
11	Point	043491	3491 - GOLD RUN 2 SW	CA	7	196012	199002
12	Point	044288	4288 - IOWA HILL	CA	7	196012	199002
13	Point	044713	4713 - LAKE SPAULDING	CA	7	196012	199002
14	Point	045356	5356 - MARKLEEVILLE	CA	7	196012	199002
15	Point	046136	6136 - NEVADA CITY	CA	7	196012	199002
16	Point	046597	6597 - PACIFIC HOUSE	CA	7	196012	199002
17	Point	046960	6960 - PLACERVILLE	CA	7	196012	199002
18	Point	046960	6960 - PLACERVILLE	CA	7	196012	199002

Record: 1 Show: All Selected Records (0 out of 42 Selected.) Options

Attribute Tables for Shapefiles

For each data average requested, a shapefile is created. Its attribute table contains the following information:



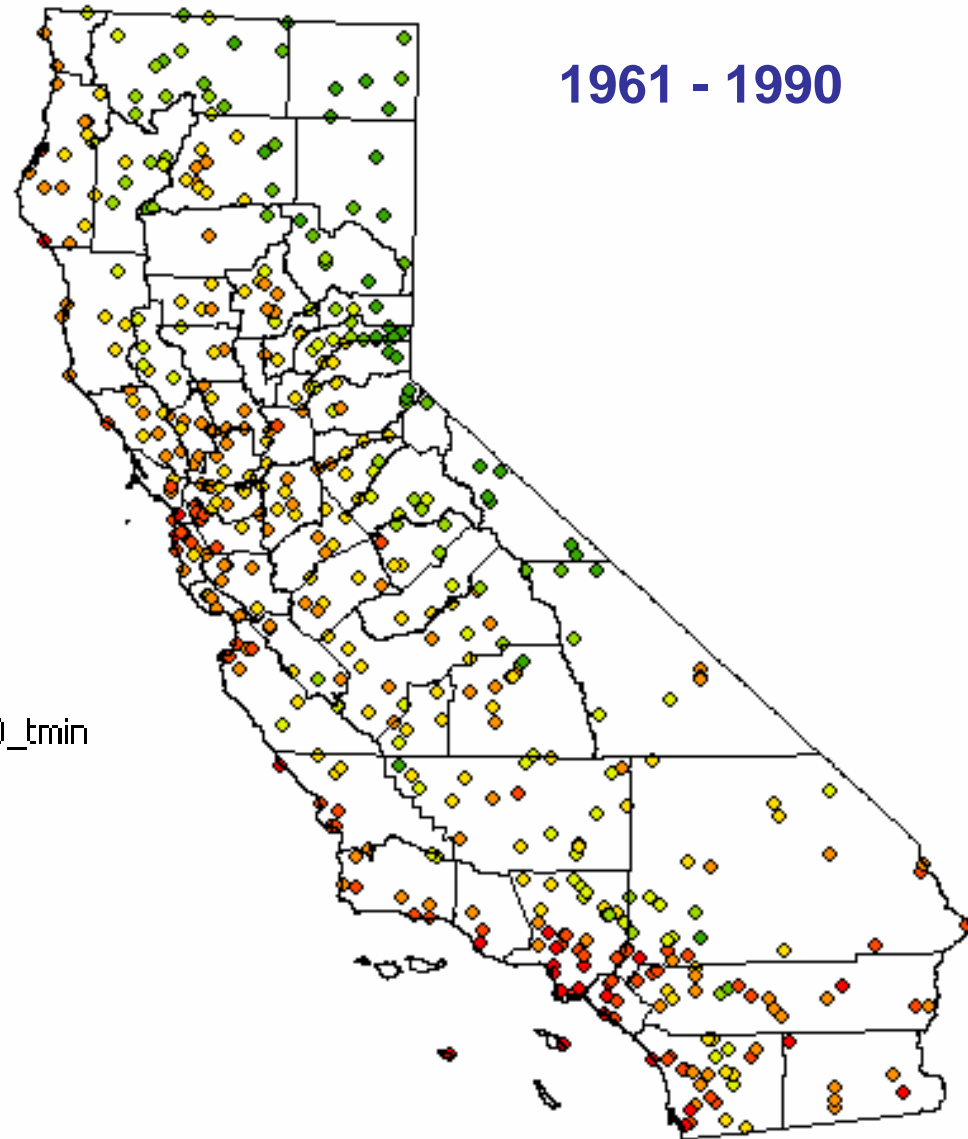
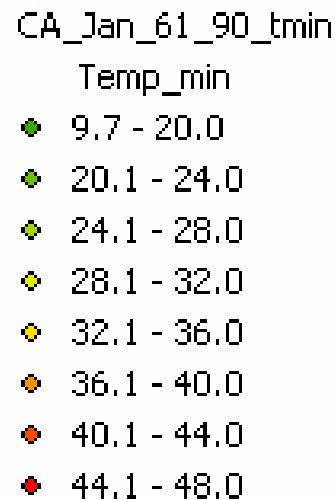
Precip	Missing Pr	Snowfall	Missing Sn	Snowdepth	Temp_max	Temp_min	Temp OBS
31.516	212	117.413	211	8.06897	45.48	32.4186	30.8889
10.2907	83	57.7	87	3.23333	43.1736	14.4780	19.9267
31.8927	100	132.783	133	10.7867	48.1751	27.4768	38.0847
21.595	189	9.9	177	7407.33	55.7426	35.4157	48.9728
18.8743	101	96.1167	216	6674.17	41.543	15.2615	20.3787
27.399	330	22.3538	666	4000.2	48.7379	28.2400	33.776
21.9527	1740	207.709	1741	31.5	38.6818	21.7453	25.2909
14.081	88	0.283333	88	0	58.5246	35.0267	53.327
17.1793	85	3.30667	154	0	-9999	-9999	-9999
24.7407	170	14.6767	640	4000.16	-9999	-9999	38.4912
25.8497	228	5.19333	690	0	53.2088	34.3352	39.5375
27.848	88	0	917	0	60	24.5	-9999
23.8171	295	17.2679	451	0.208333	51.6129	32.9355	35.3226
34.347	87	134.37	121	9.4	46.7316	24.4498	38.9239
-9999	2700	-9999	2700	-9999	-9999	-9999	-9999
27.7497	110	12.5267	294	0.034483	51.1358	30.58	34.1344
23.432	181	31.2367	229	0.724138	9999	-9999	40.5
17.0123	179	1.95	396	0	54.5475	32.3848	37.9223
48.8427	487	5.94	488	0	54.9734	38.4704	47.4276

ted | Records: (0 out of 42 Selected.) | Options ▾

Climate maps

30-year mean January minimum temperature for California stations.

Temperatures are in °F



PRISM Data

The maps generated were compared with those from the PRISM[®] (Parameter-elevation Regressions on Independent Slopes Model) climate mapping system.

PRISM[®] maps can be found online at:

<http://www.ocs.oregonstate.edu/prism/index.phtml>

Climate maps

Overlay of 30-year mean January minimum temperature for California stations on PRISM¹ map.

Temperatures are in °F

CA_Jan_61_90_tmin

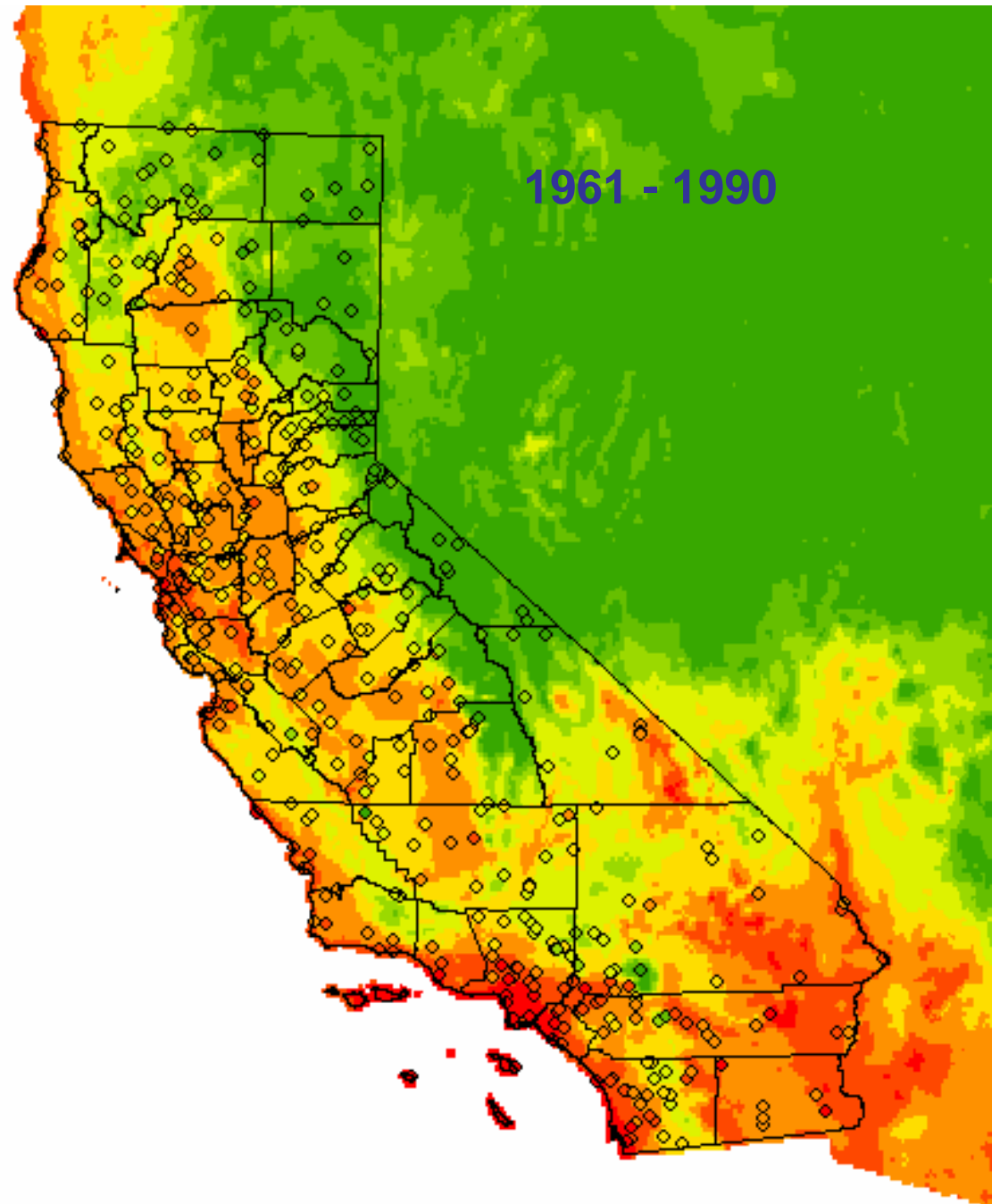
Temp_min

- ◆ 9.7 - 20.0
- ◆ 20.1 - 24.0
- ◆ 24.1 - 28.0
- ◆ 28.1 - 32.0
- ◆ 32.1 - 36.0
- ◆ 36.1 - 40.0
- ◆ 40.1 - 44.0
- ◆ 44.1 - 48.0

tmin_61_90_01

Value

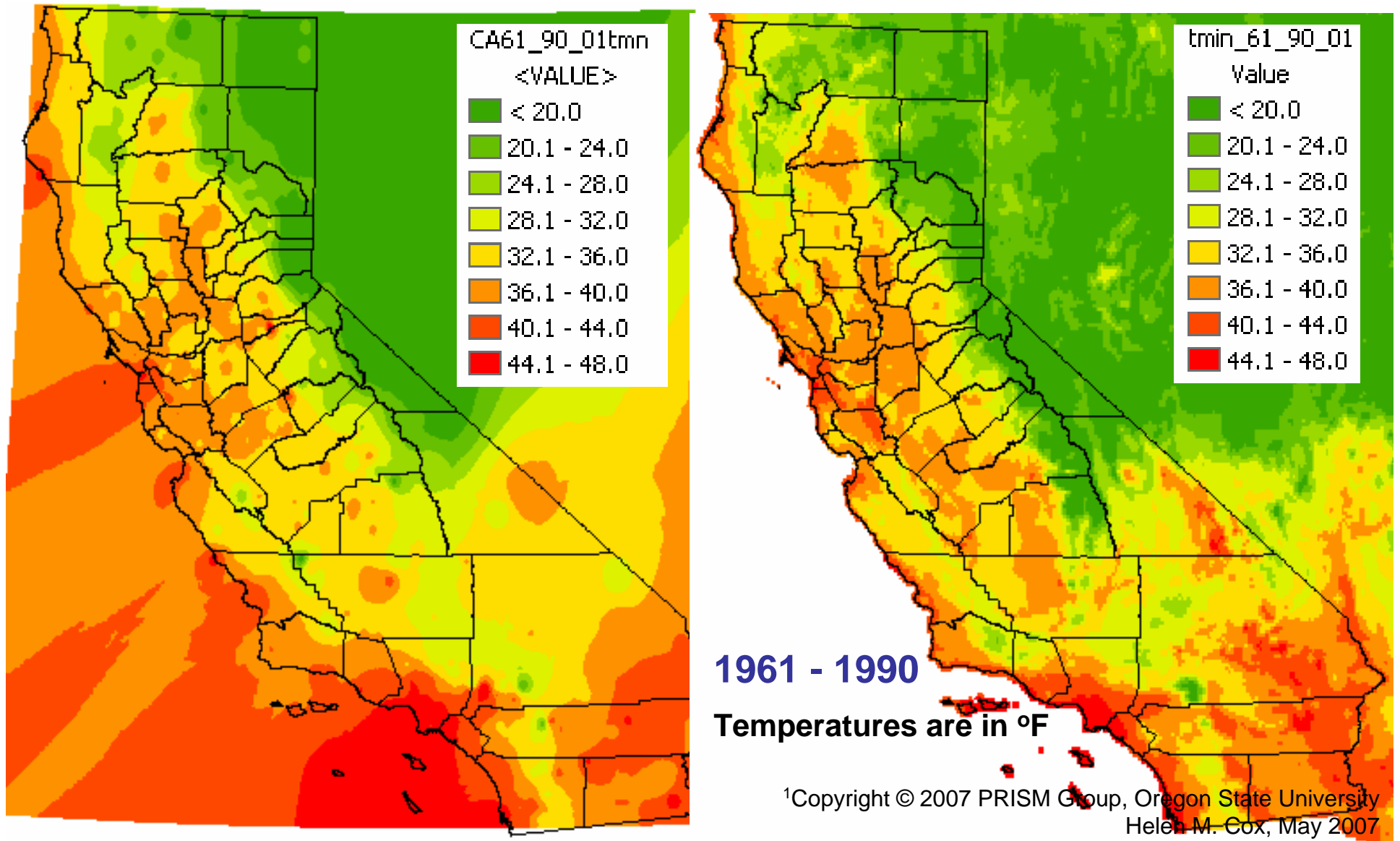
- < 20.0
- 20.1 - 24.0
- 24.1 - 28.0
- 28.1 - 32.0
- 32.1 - 36.0
- 36.1 - 40.0
- 40.1 - 44.0
- 44.1 - 48.0



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Climate maps

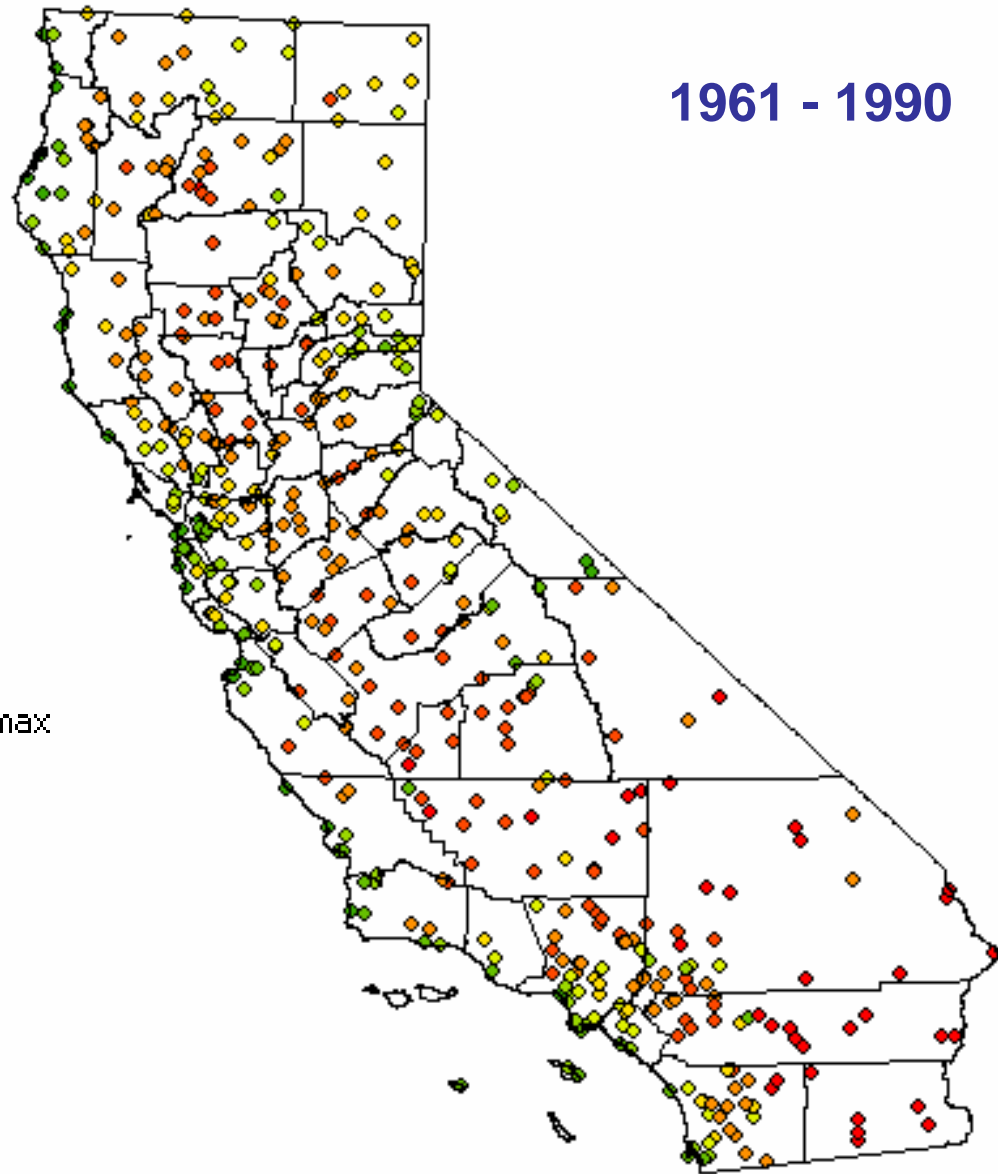
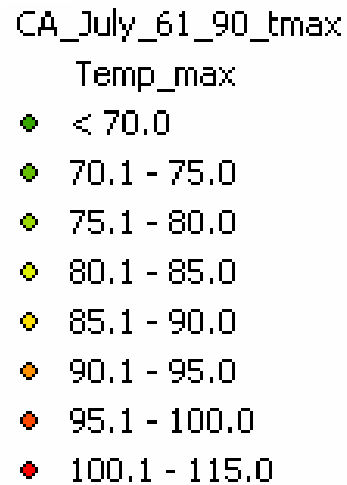
Comparison of 30-year mean January minimum temperature map generated using IDW interpolation with PRISM¹ map.



Climate maps

30-year mean July
maximum temperature
for California stations.

Temperatures are in °F

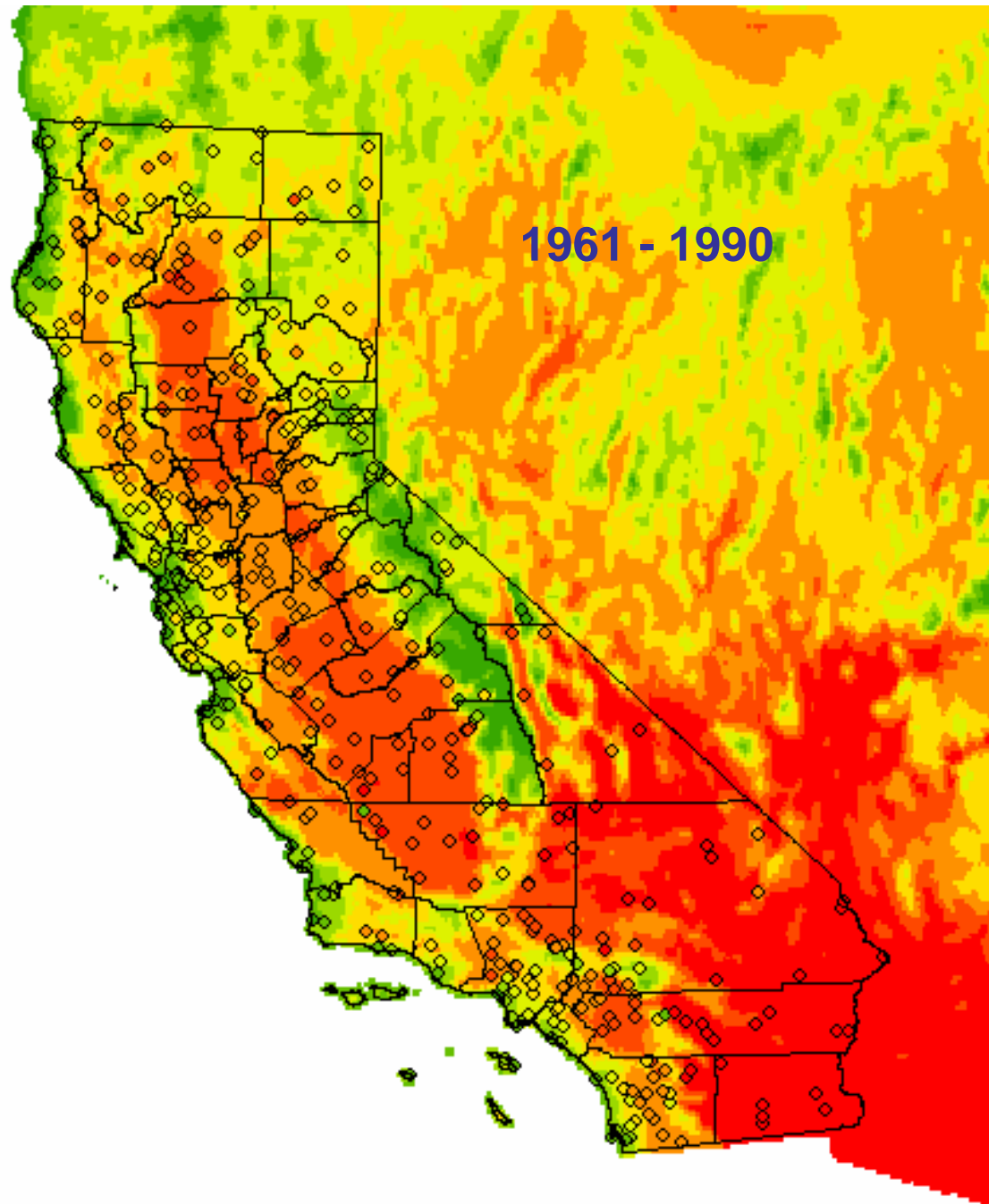


Climate maps

Overlay of 30-year mean July maximum temperature for California stations on PRISM¹ map.

Temperatures are in °F

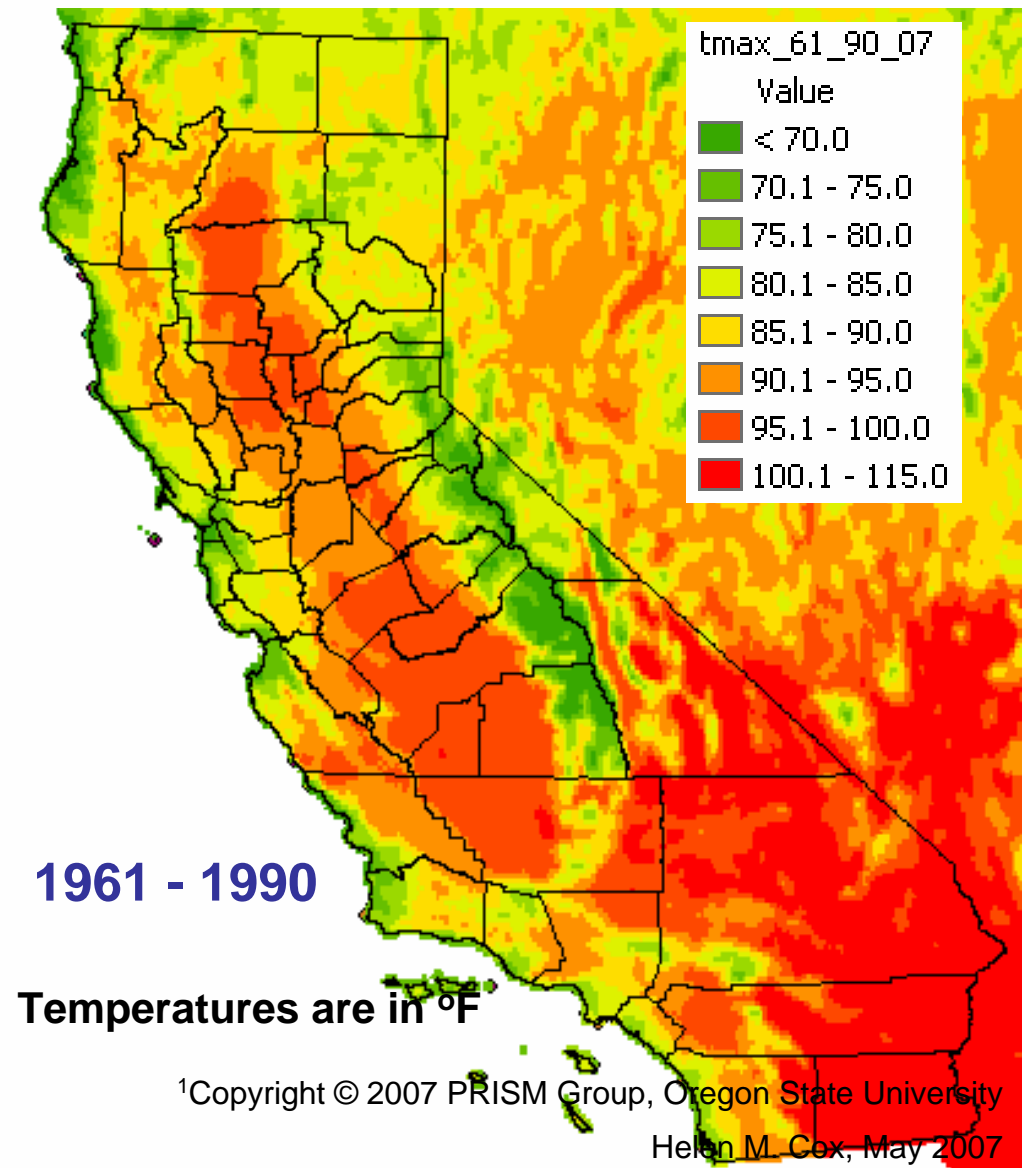
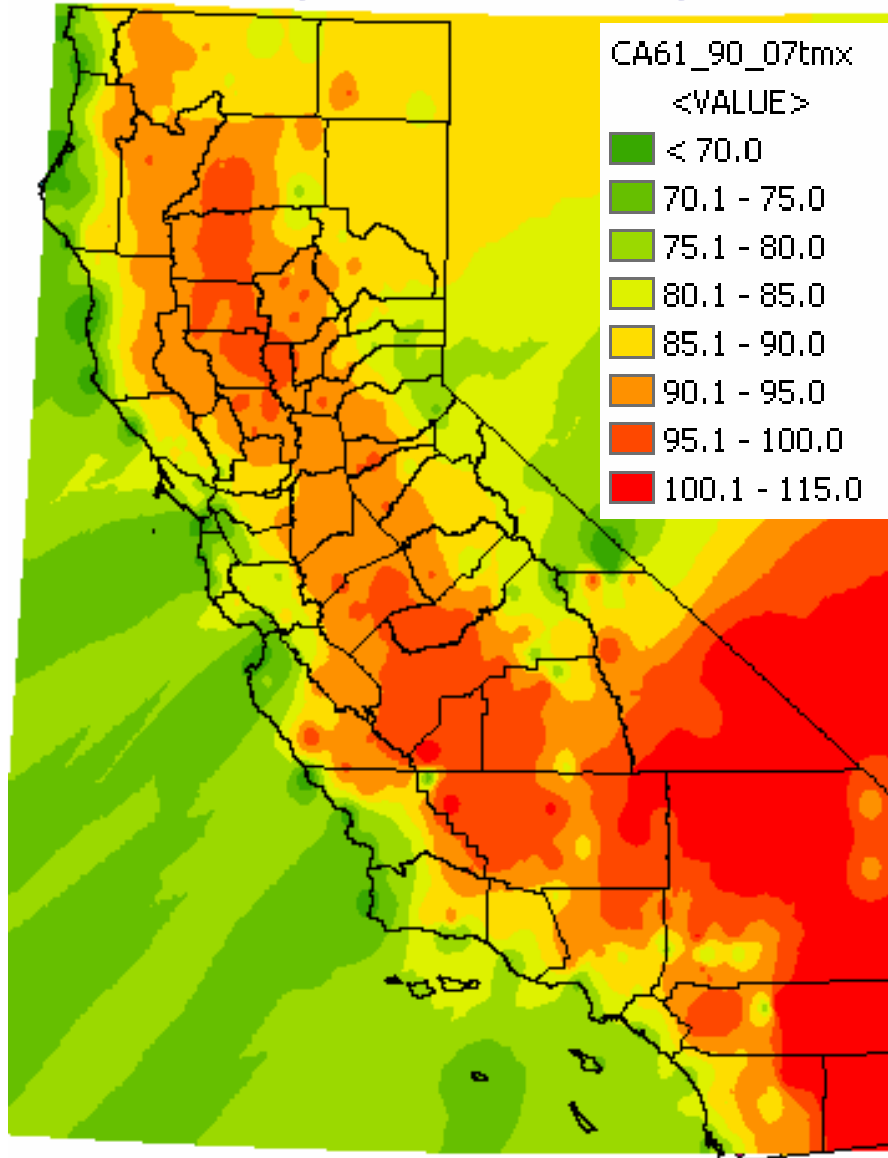
CA_July_61_90_tmax Temp_max	tmax_61_90_07 Value
◆ < 70.0	■ < 70.0
◆ 70.1 - 75.0	■ 70.1 - 75.0
◆ 75.1 - 80.0	■ 75.1 - 80.0
◆ 80.1 - 85.0	■ 80.1 - 85.0
◆ 85.1 - 90.0	■ 85.1 - 90.0
◆ 90.1 - 95.0	■ 90.1 - 95.0
◆ 95.1 - 100.0	■ 95.1 - 100.0
◆ 100.1 - 115.0	■ 100.1 - 115.0



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Climate maps

Comparison of 30-year mean July maximum temperature map generated using IDW interpolation with PRISM¹ map.



Climate maps

30-year mean annual precipitation for California stations.

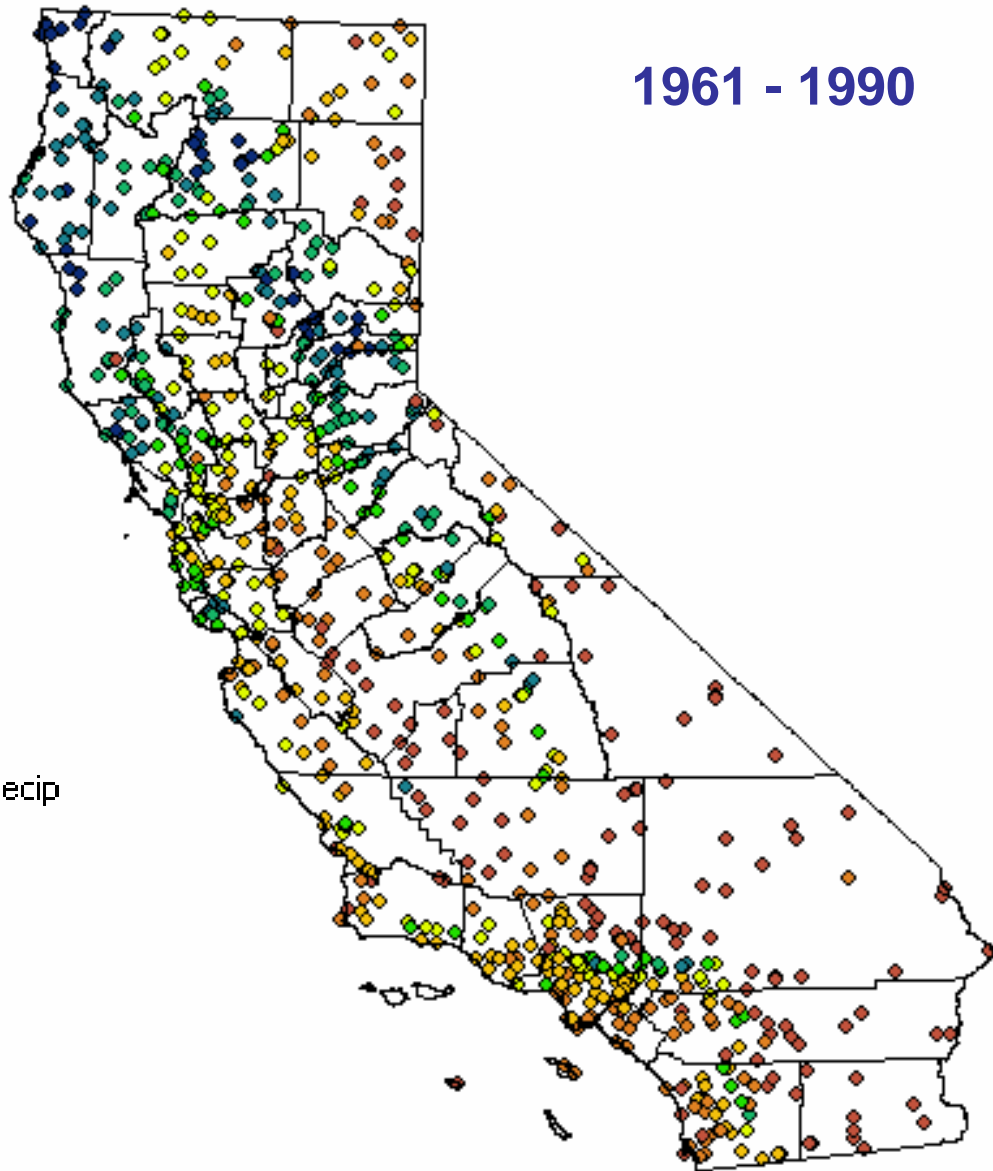
Precipitation is in inches

1961 - 1990

CA_annavg_61_90_precip

Precip

- ◆ 0.0 - 8.0
- ◆ 8.1 - 13.0
- ◆ 13.1 - 18.0
- ◆ 18.1 - 24.0
- ◆ 24.1 - 32.0
- ◆ 32.1 - 40.0
- ◆ 40.1 - 60.0
- ◆ 60.1 - 100.0

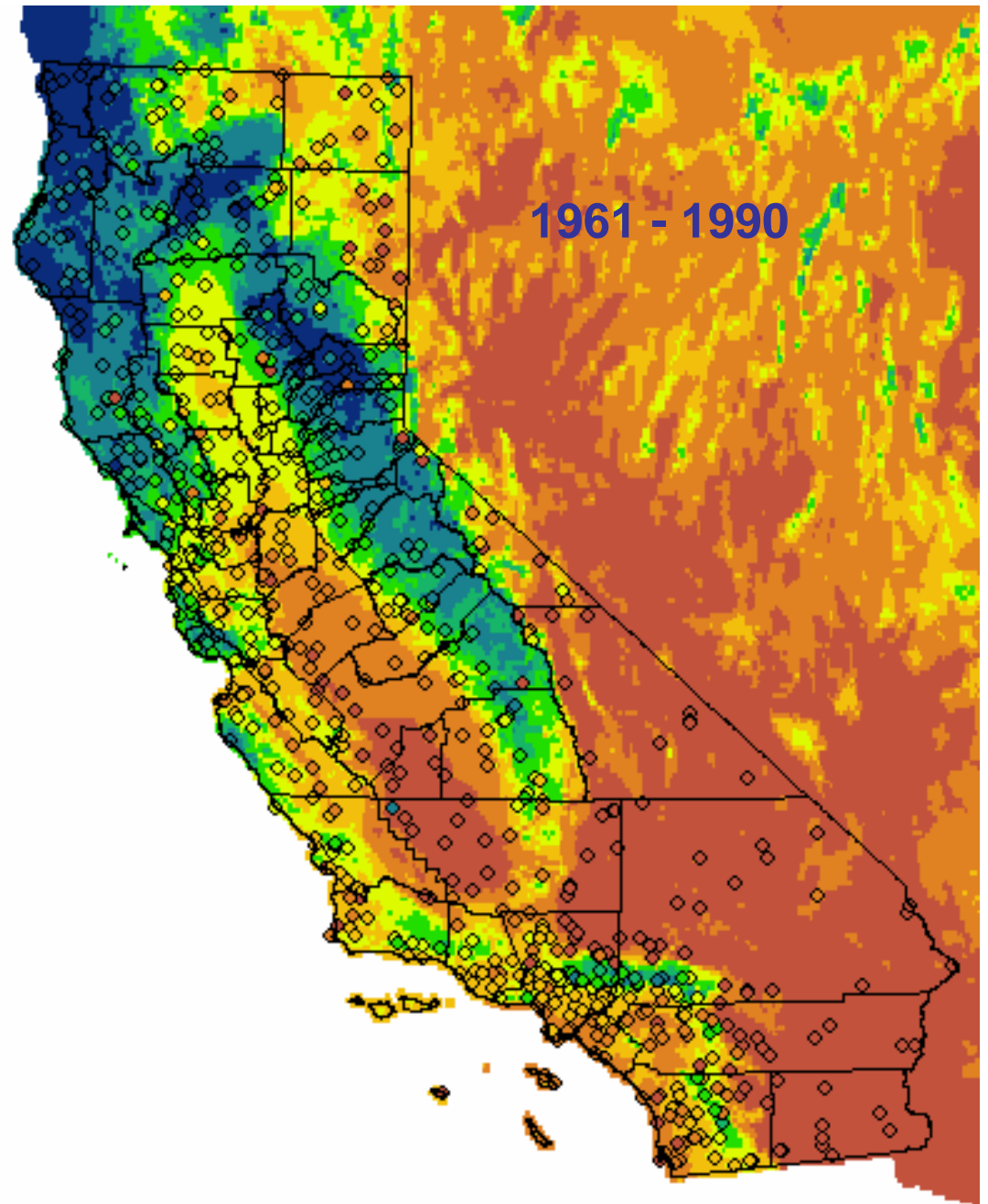


Climate maps

Overlay of 30-year mean annual precipitation for California stations on PRISM¹ map.

Precipitation is in inches

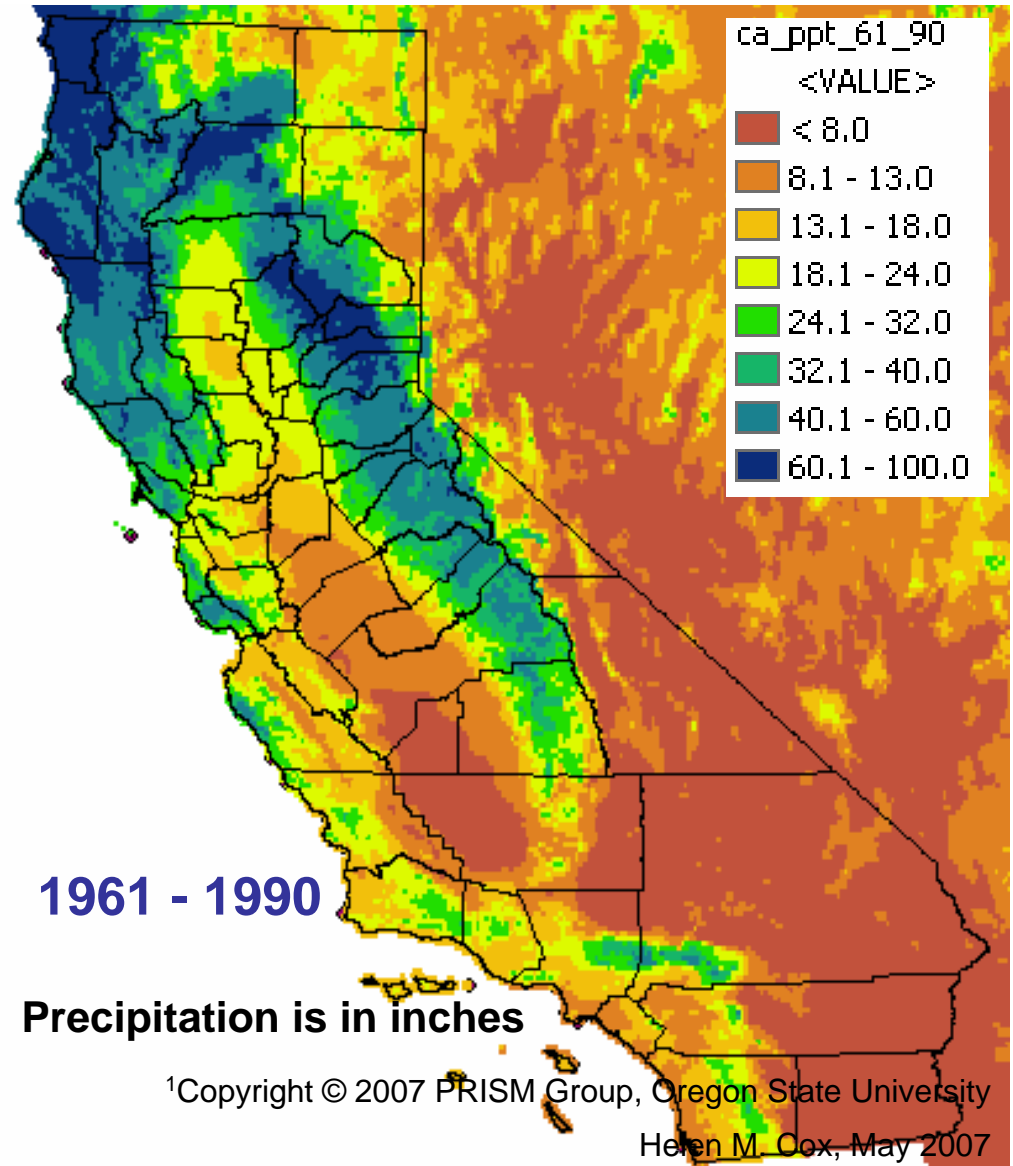
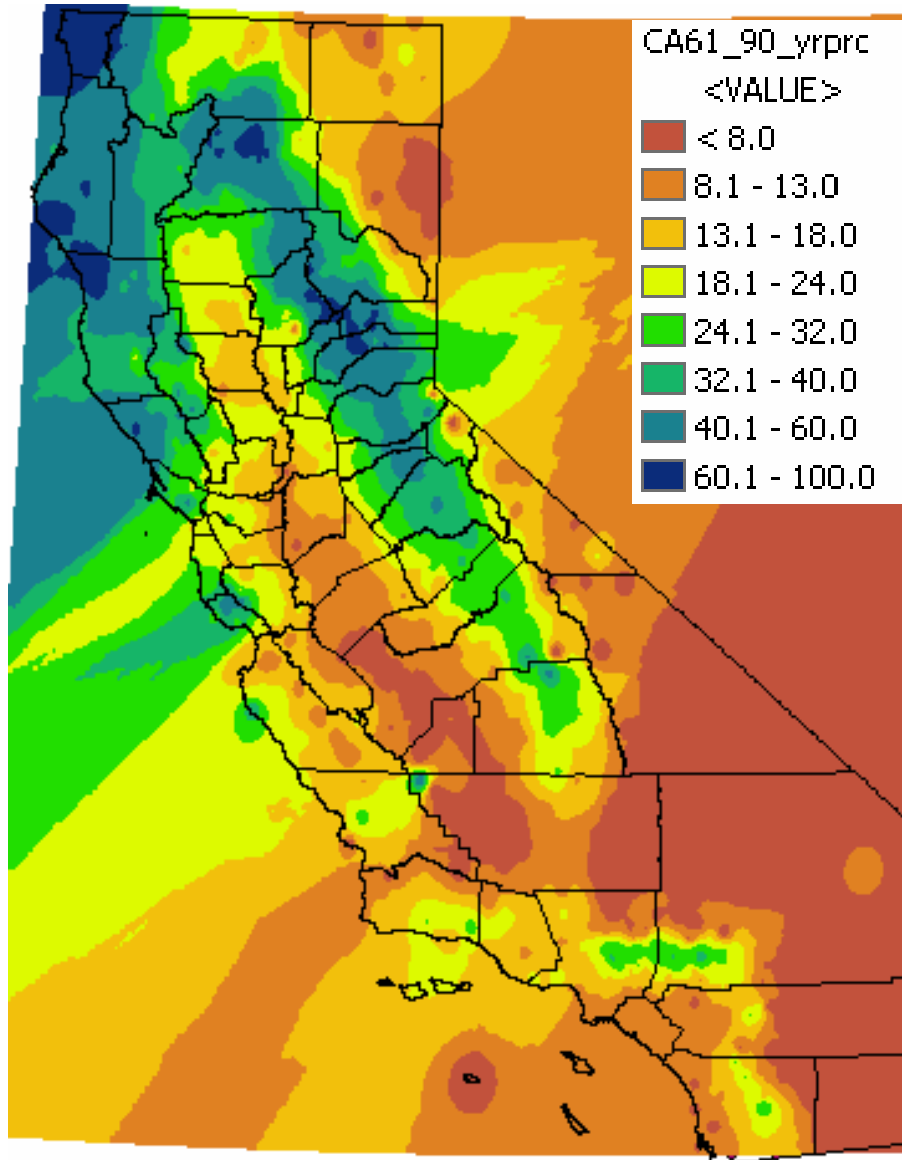
CA_annavg_61_90_precip	ca_ppt_61_90
Precip	<VALUE>
0.0 - 8.0	< 8.0
8.1 - 13.0	8.1 - 13.0
13.1 - 18.0	13.1 - 18.0
18.1 - 24.0	18.1 - 24.0
24.1 - 32.0	24.1 - 32.0
32.1 - 40.0	32.1 - 40.0
40.1 - 60.0	40.1 - 60.0
60.1 - 100.0	60.1 - 100.0



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Climate maps

Comparison of 30-year mean annual precipitation map generated using IDW interpolation with PRISM¹ map.



Applications

- Ongoing projects include the application of this climate analysis module to:
- Examine the effect of El Niño and La Niña on West Coast climate
- Examine evidence for the urban heat island effect
- Use historical climate data to examine the relationship between climate and vegetation. Using models of future climate, predict its effect on land cover and invasive species.

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