Data-enhanced Investigations for Climate Change Education (DICCE) dicce.sri.com

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SRI International

Principal Investigator

Ask US – 1/15/15

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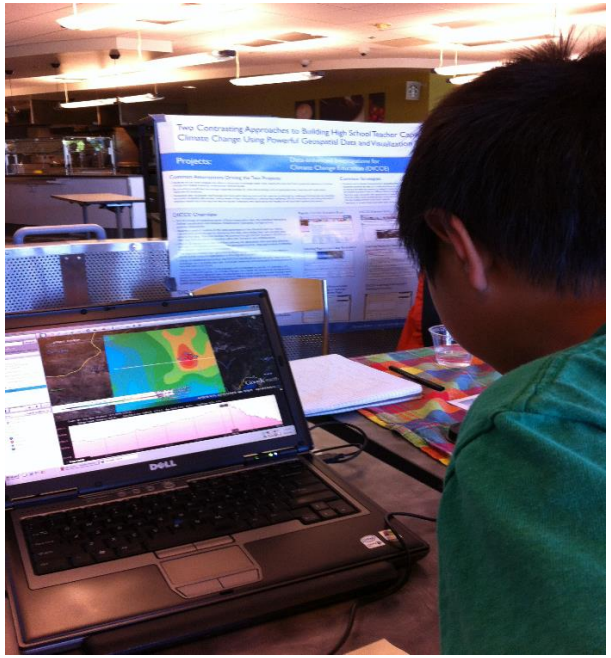
Metrics

- DICCE offers access to 39 monthly and 29 daily data sets related to climate change
- 85 teachers and others are registered to use the DICCE Learning Environment to author curricula around the data
- Over 500 middle school and high school students in four different states have been observed carrying out inquiry activities with DICCE data
- 56 nationwide teachers have been trained about DICCE in workshops and countless others have heard presentations about DICCE at professional conferences.
- In just 21 months, there were 41,756 visits to the various DICCE websites

High school environmental science students studying images from DICCE showing the distribution of carbon dioxide in the atmosphere over central California one year,



Young boy at a science fair studies DICCE data maps that he generated about snow accumulation. He wants to see how much snow California gets compared to his home city Beijing. With one click on the DICCE site, he puts the Beijing data into Google Earth, then creates an elevation profile across the greater Beijing area so that he can examine the relationship between the topography and the amount of snow. Later he does the same with California.

Page from student informal report about flash flooding in CA in the past and future, using DICCE data about rainfall rate, cloud fraction, and air temperature at flood sites. Students are upper elementary and middle school aged.

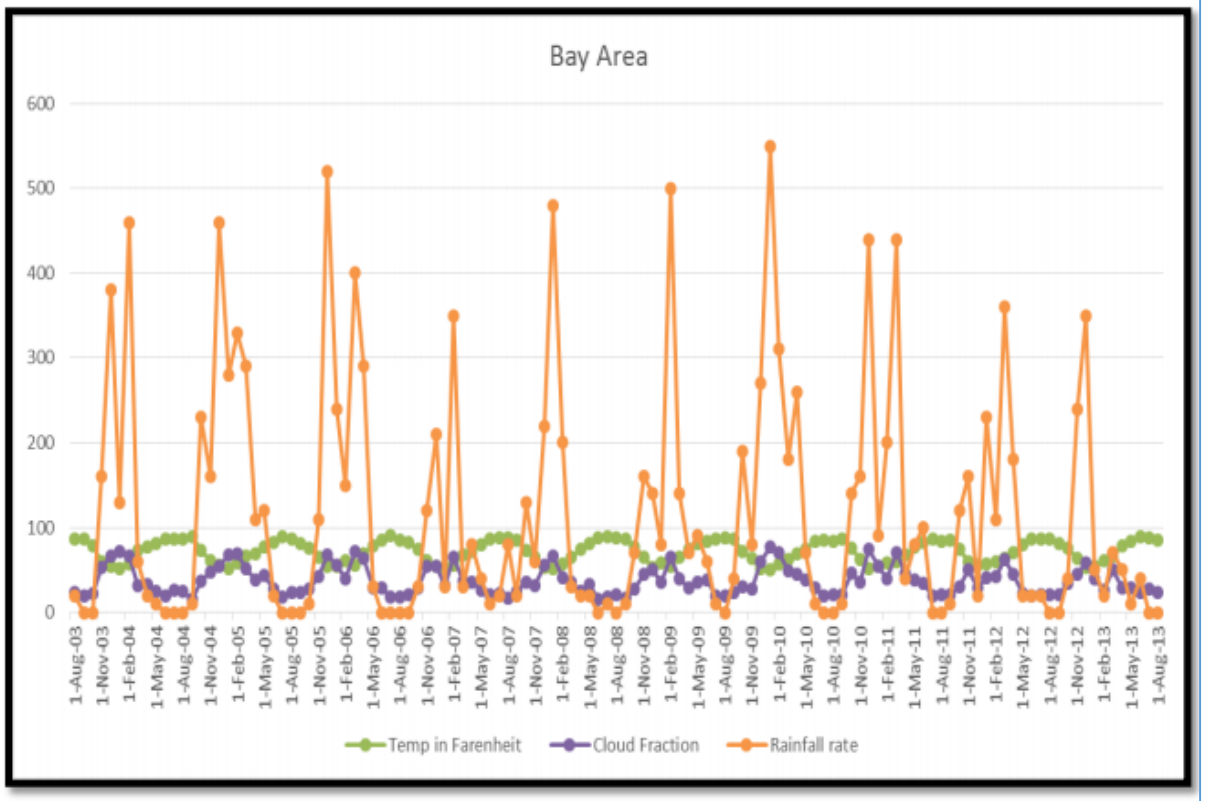
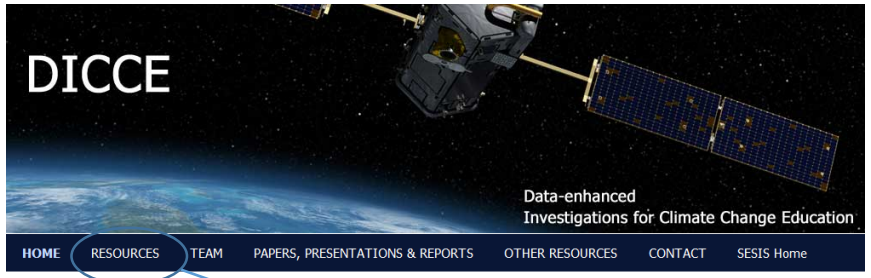


Figure 8: Bay Area - Overlay of all 3 parameters

After we observed all the parameters individually we then combined them to see if our theories and hypothesis were true. By overlaying all three parameters on one graph, it helps to see a much clearer picture on the inter-dependencies of these parameters. In the past data from 2003 to 2013 for Bay Area, we can clearly see that whenever there was peak temperatures, the rainfall rate was almost negligible, thus we have not experienced a flash flood in this region during this time frame. The high rainfall rates

What you can do with DICCE



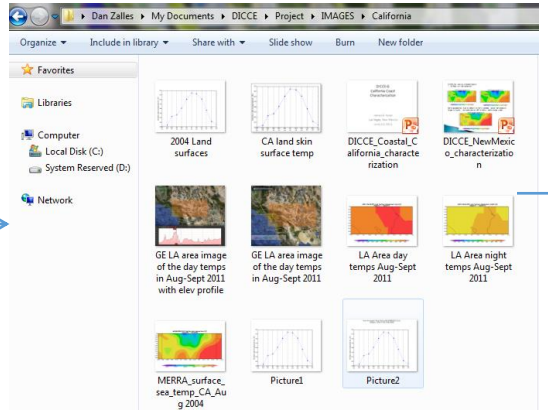
Welcome to Data-enhanced Investigations for Climate Change Education (DICCE)

The NASA-funded project Data-enhanced Investigations for Climate Change Education (DICCE) is making it much easier and more technologically feasible for middle and high school teachers and students to study climate change and related Earth system phenomena using data products from the Goddard Interactive Online Visualization and Analysis Infrastructure (GIOVANNI). This three-year research and development project began in November 2010 and will end on October 31, 2013. Yet, the resources the project produces will remain available to the public afterwards.

GIOVANNI is a powerful portal of Earth observation data that provides access to numerous data products on Earth system phenomena covering land biosphere, physical land, ocean biosphere, physical ocean, physical atmosphere, atmospheric gases, and energy and radiation system. These daily and monthly data products are derived from remote-sensing instruments on satellites, ground stations, and data assimilation models. DICCE is creating high school teacher and student access to some of these data to enable student investigations of about their local climates. Teachers and students can query the Giovanni data archive, then save the results as map images, time series plots, vertical profiles and data tables. The map images can

Central web site:
http://dicce.sri.com

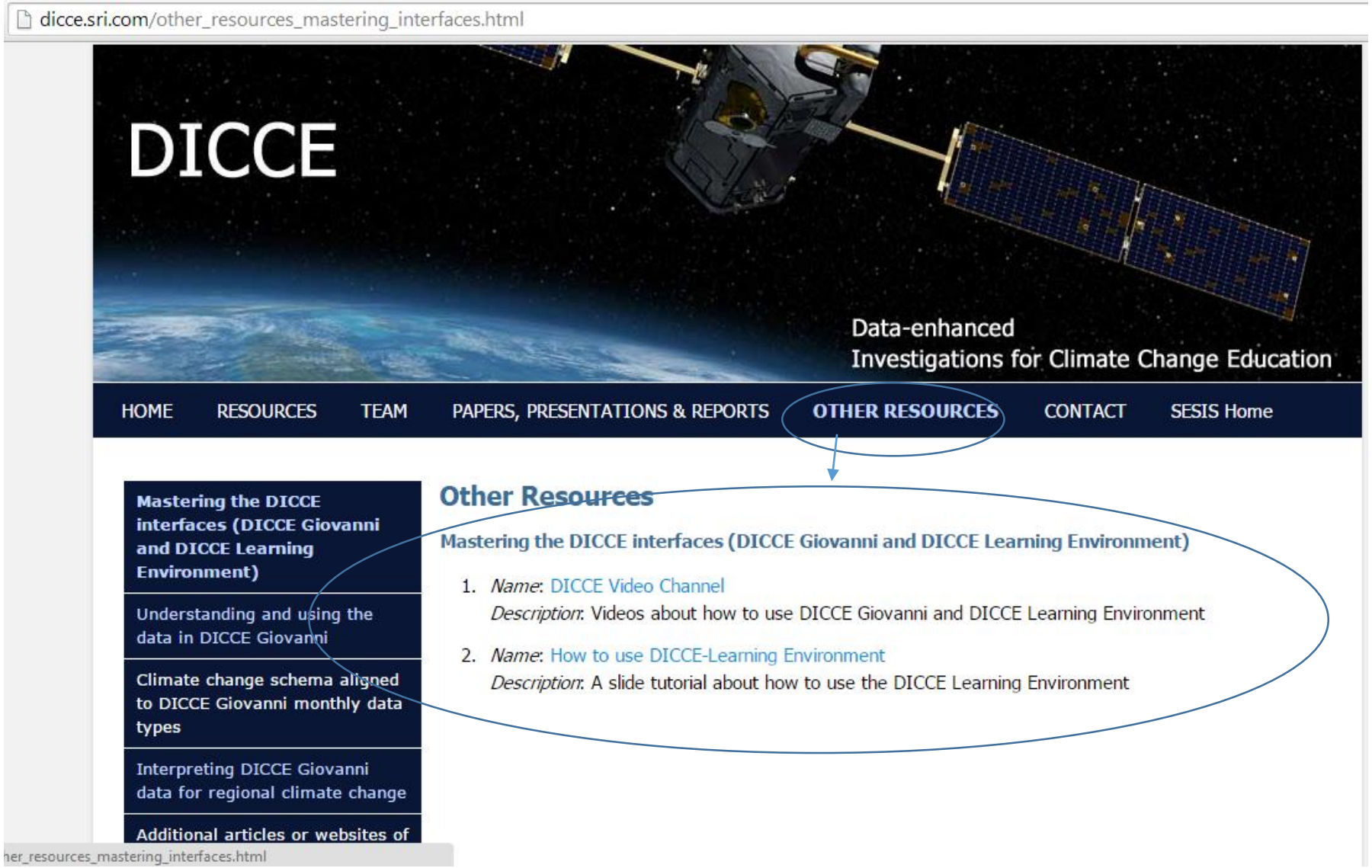
1. Select NASA data and generate images for Earth system and climate investigations



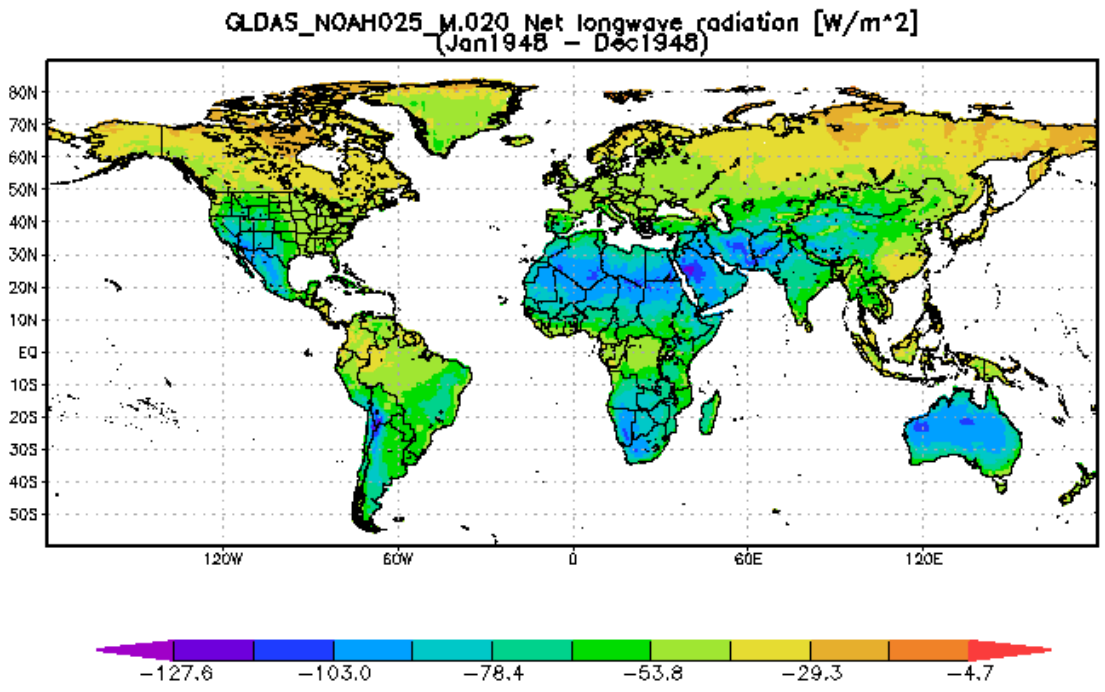
2. Download the images to a storage device of your choice
(i.e., hard drive, thumb drive, etc.)

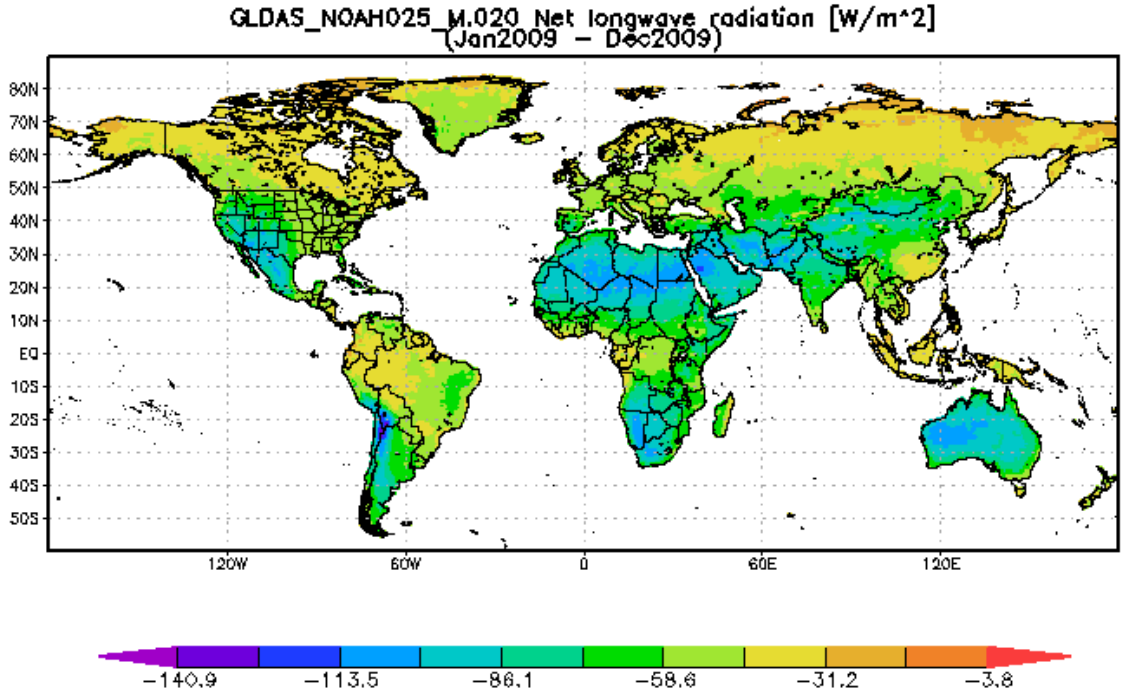
3. Use DICCE authoring privileges to upload images into your own curriculum projects. Contact daniel.zalles@sri.com to obtain authoring privileges for

On the home site (http://dicce.sri.com) click “Other Resources” tab to access video tutorials and presentation about for how to navigate DICCE



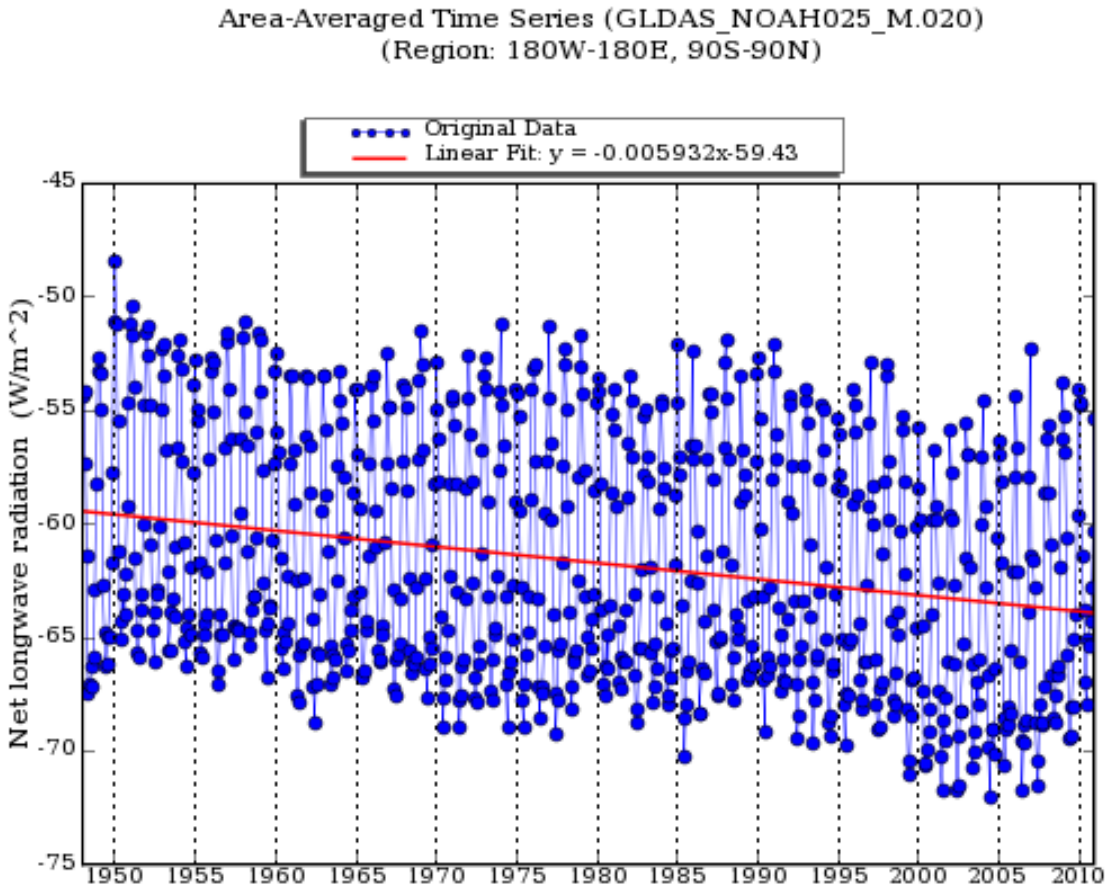
Net longwave radiation: 1948 and 2009





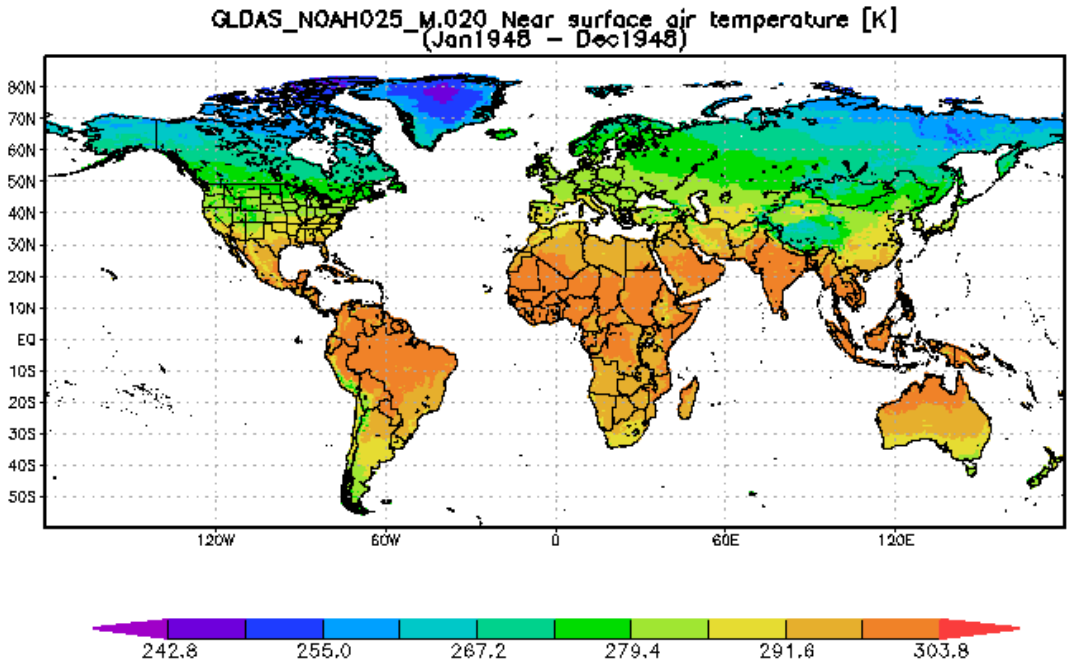
Similar geographic distributions - shift of range of values for how much longwave (infrared) radiation is being emitted at the Earth's surface

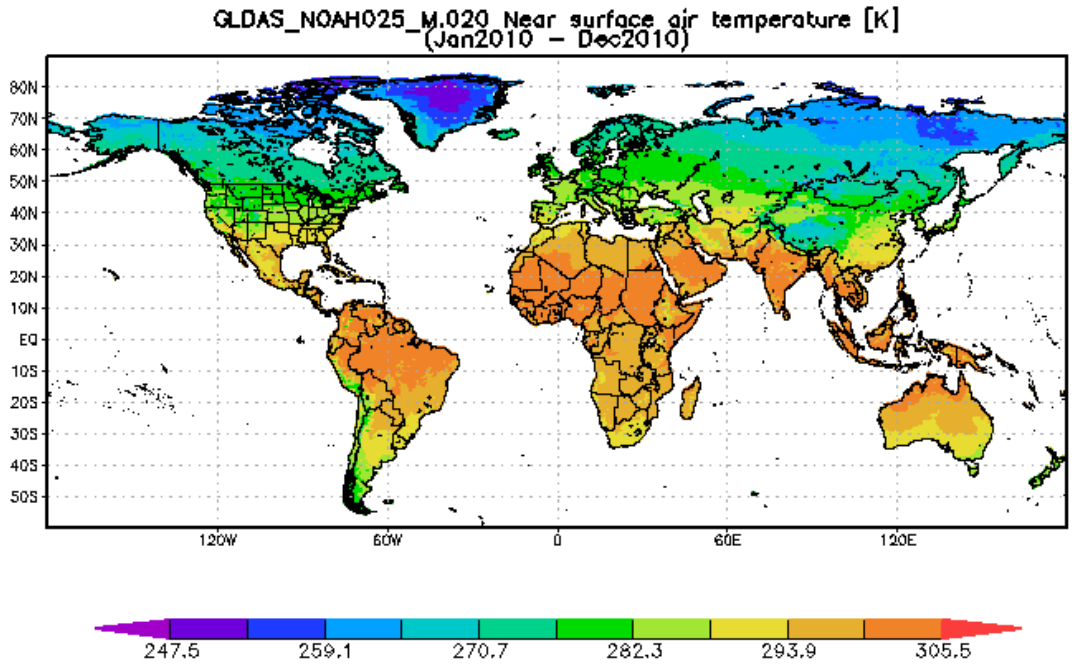
Net longwave radiation: 1948 - 2009



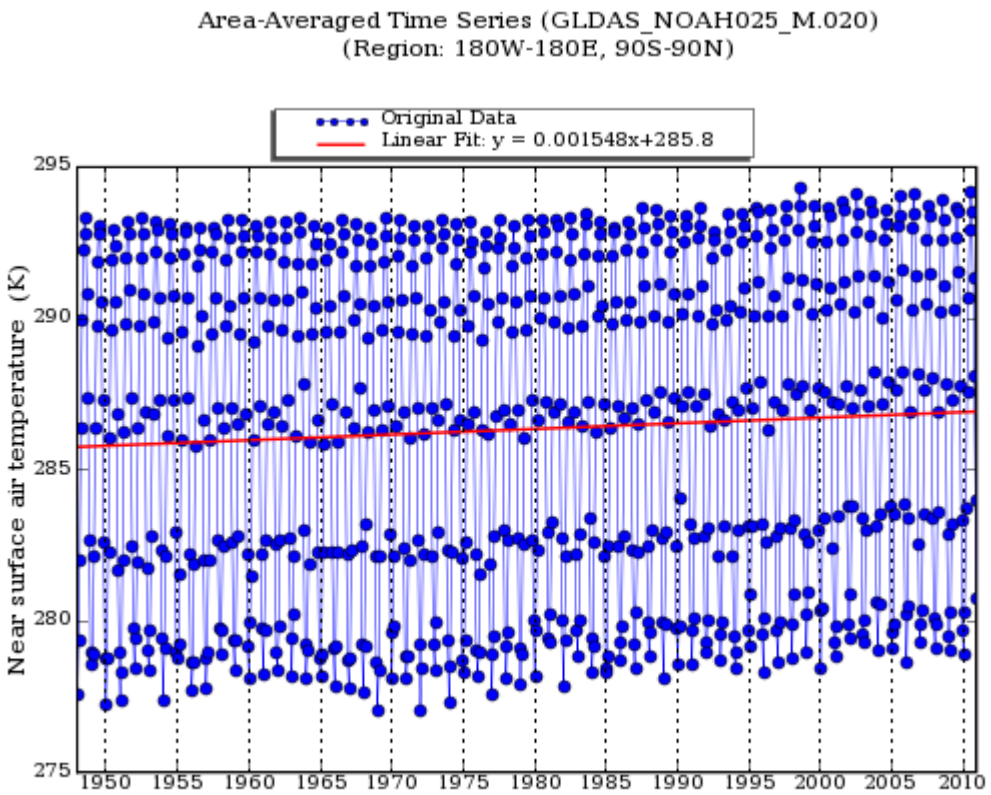
1948 and 2009 were part of a trend, not exceptions.

New surface temperatures: 1948 and 2009



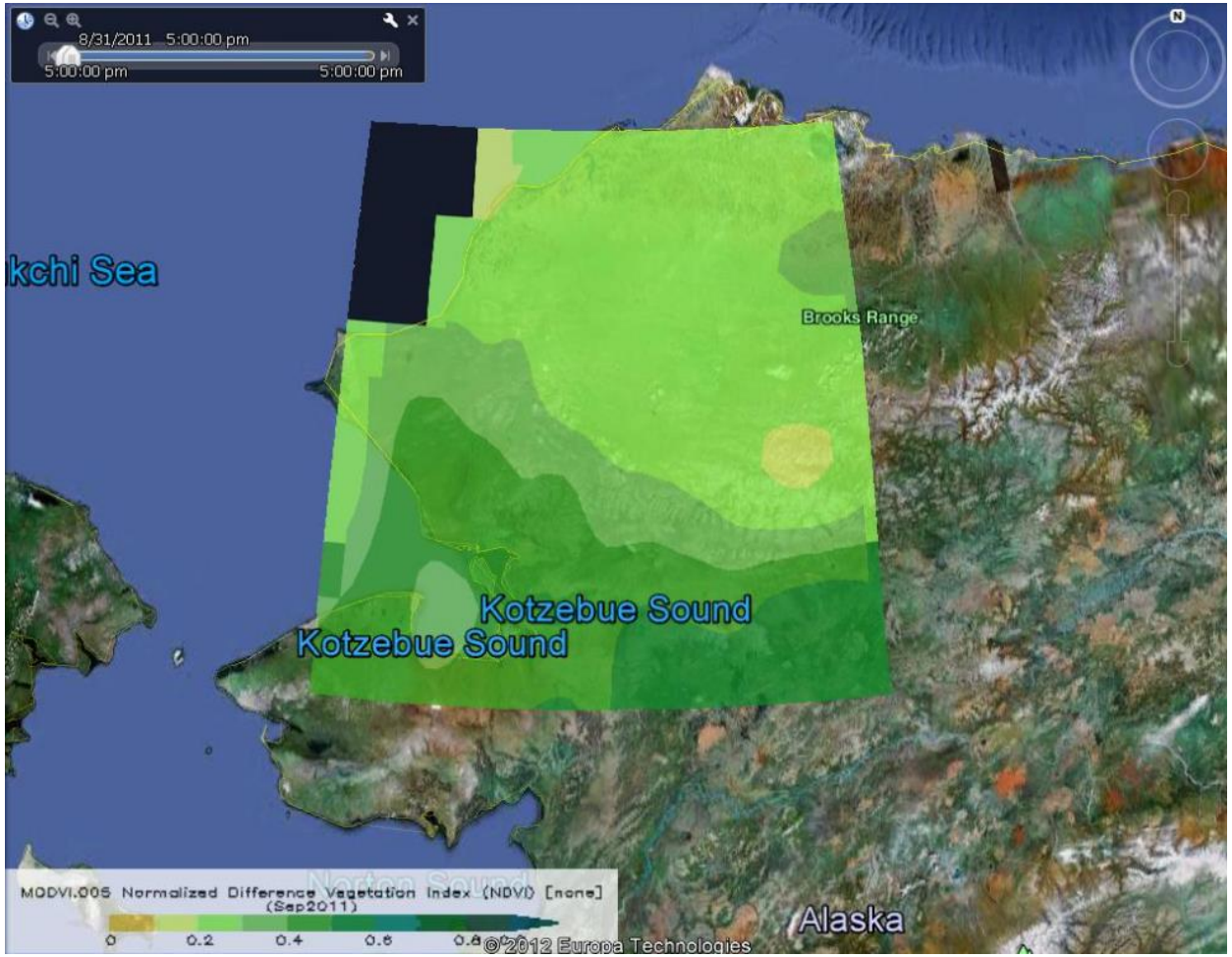


Similar geographic distributions - shift of range of values for temperatures near the Earth's surface

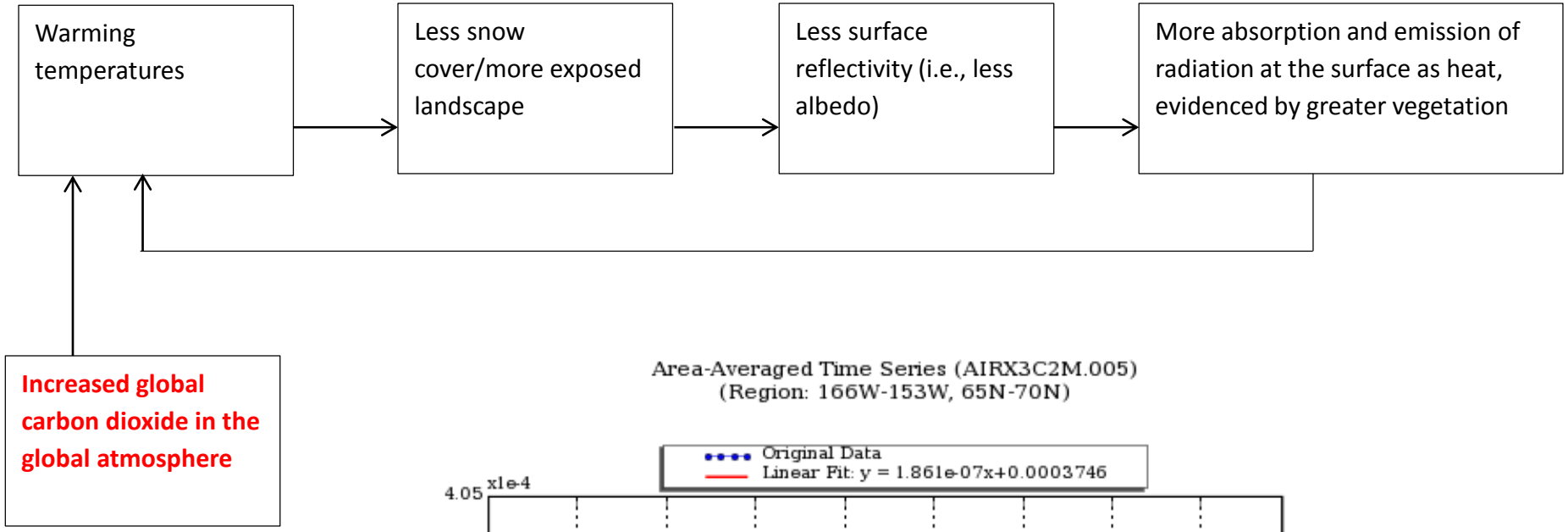


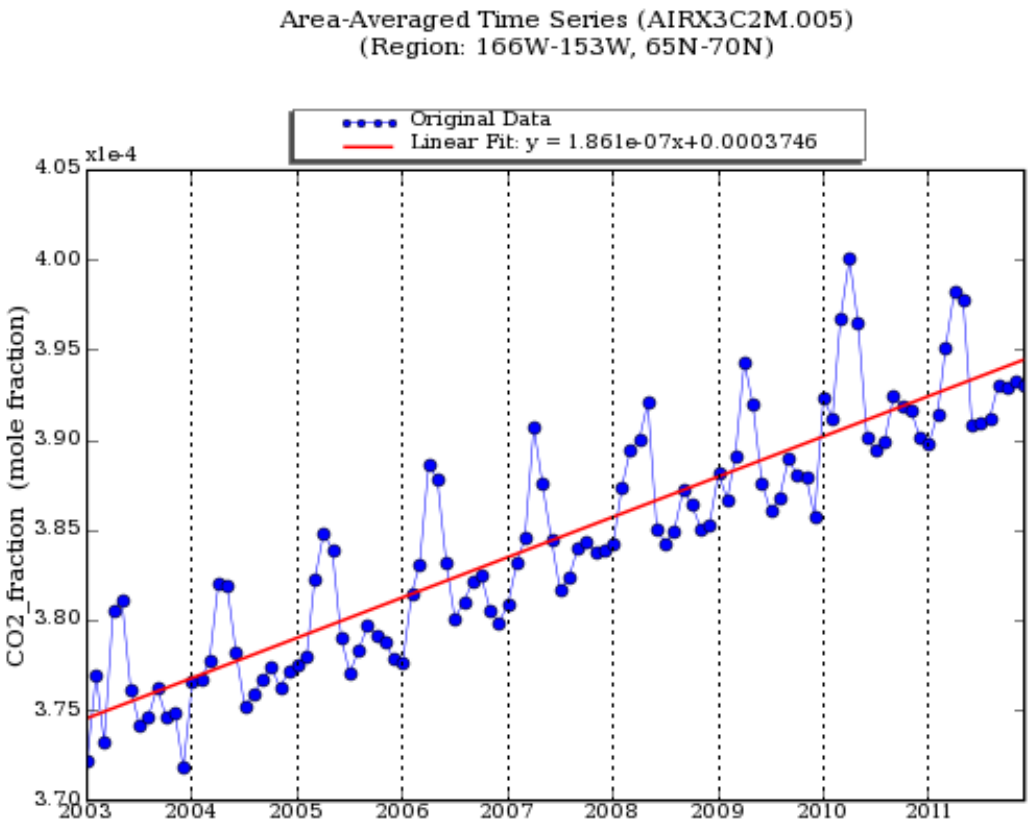
Again, 1948 and 2009 were part of a trend, not exceptions.

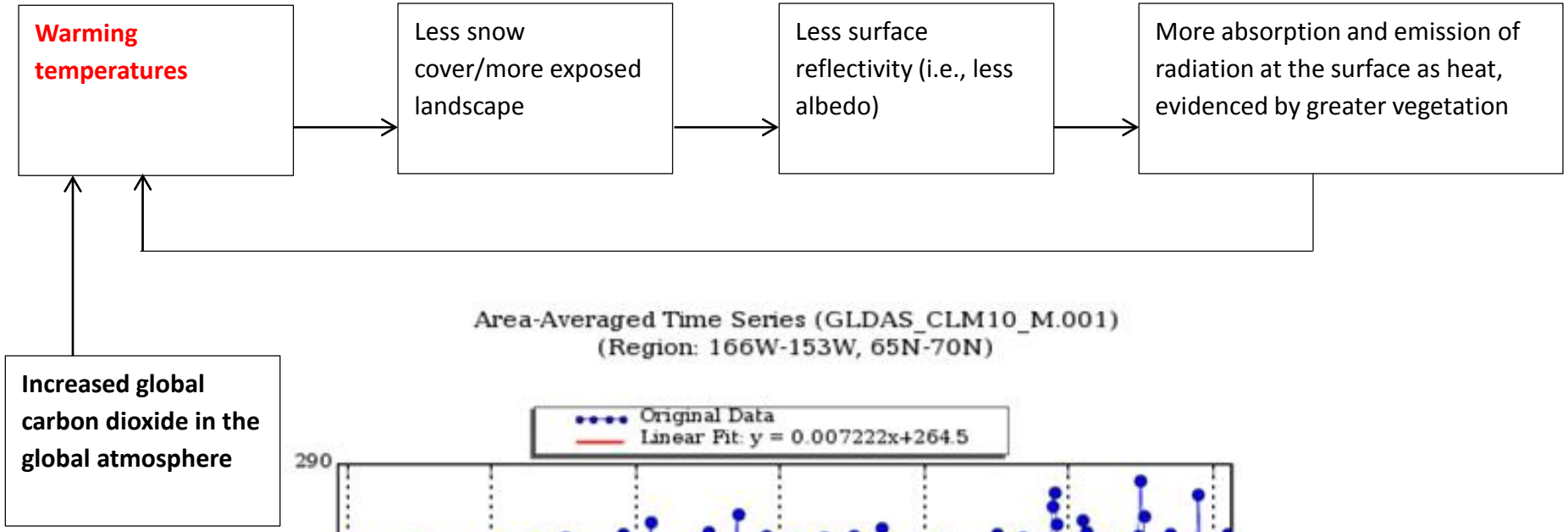
A real world example of positive feedbacks in action in Northwestern Alaska



Ask students to explain how the visualizations instantiate a feedback loop model…


Warming temperatures
Less snow cover/more exposed landscape
Less surface reflectivity (i.e., less albedo)
More absorption and emission of radiation at the surface as heat, evidenced by greater vegetation
Increased global carbon dioxide in the global atmosphere


Area-Averaged Time Series (AIRX3C2M.005)
(Region: 166W-153W, 65N-70N)
Original Data
Linear Fit: y = 1.861e-07x+0.0003746
x1e-4
4.05
4.00
3.95
3.90
3.85
3.80
3.75
3.70
CO2_fraction (mole fraction)
2003
2004
2005
2006
2007
2008
2009
2010
2011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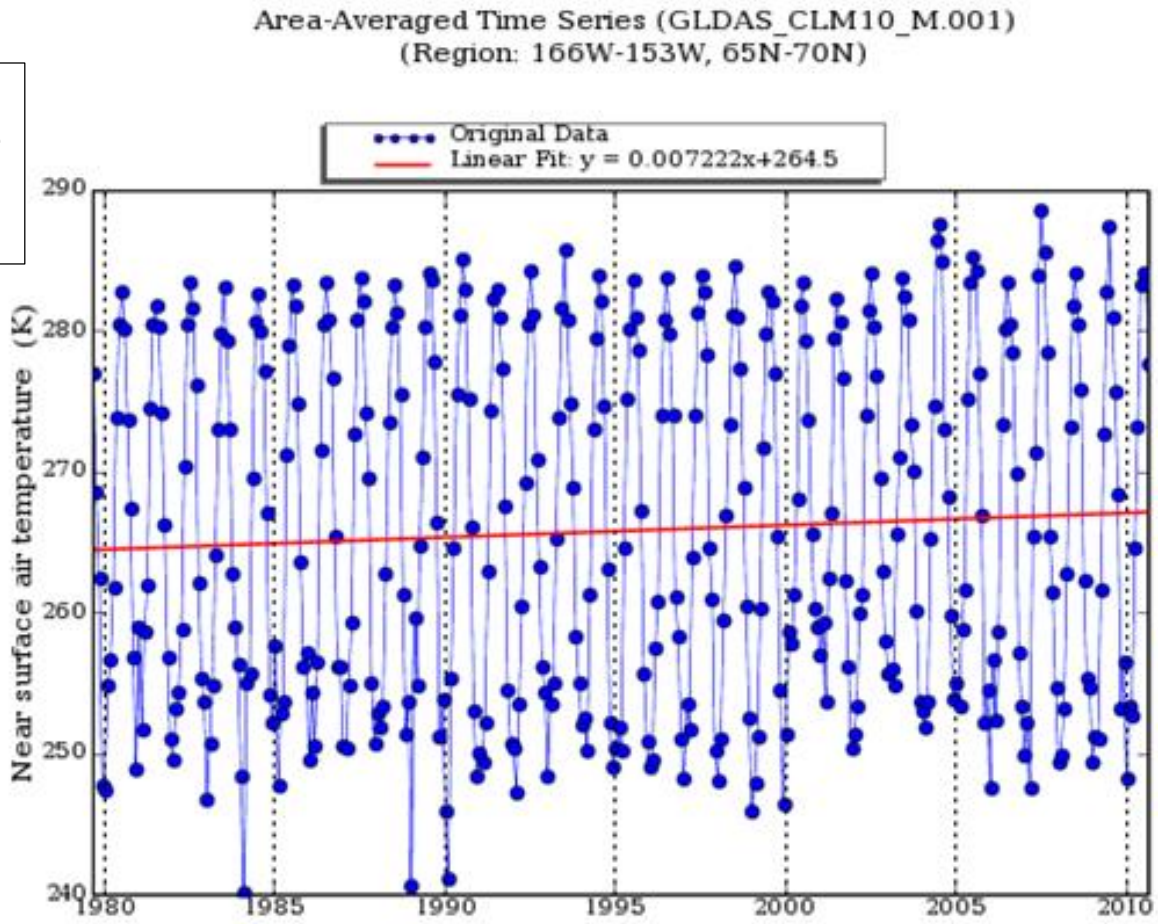
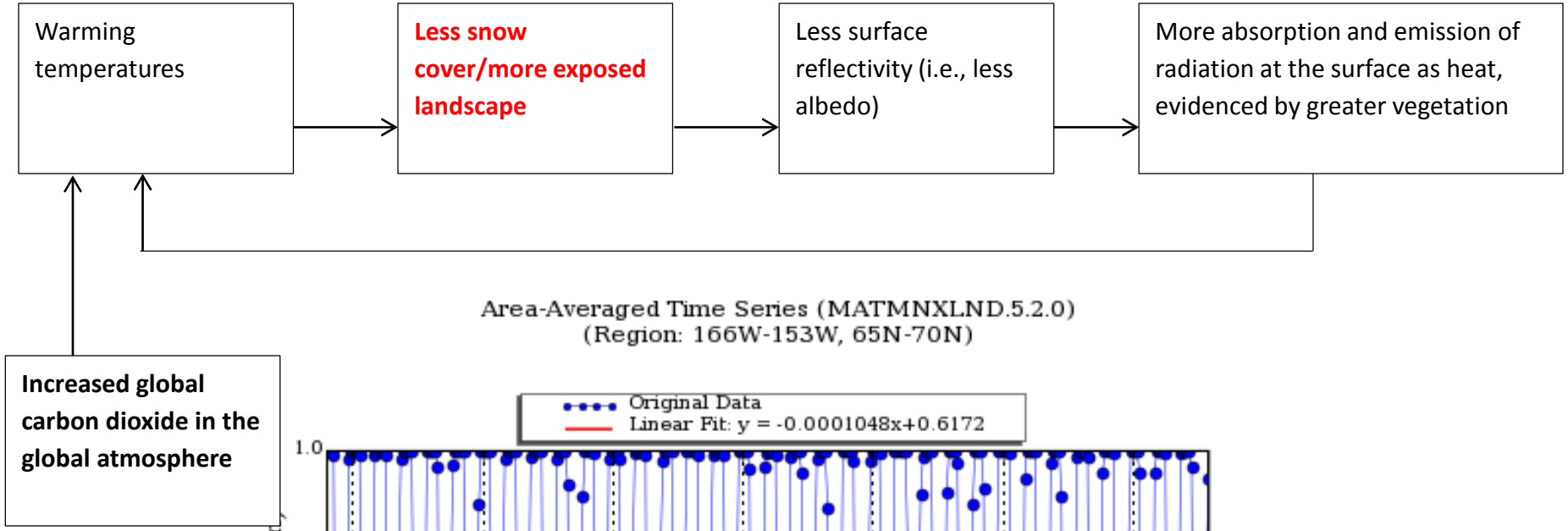

Area-Averaged Time Series (GLDAS_CLM10_M.001)
(Region: 166W-153W, 65N-70N)
Original Data
Linear Fit: y = 0.007222x+264.5
Near surface air temperature (K)
290
280
270
260
250
240
1980
1985
1990
1995
2000
2005
2010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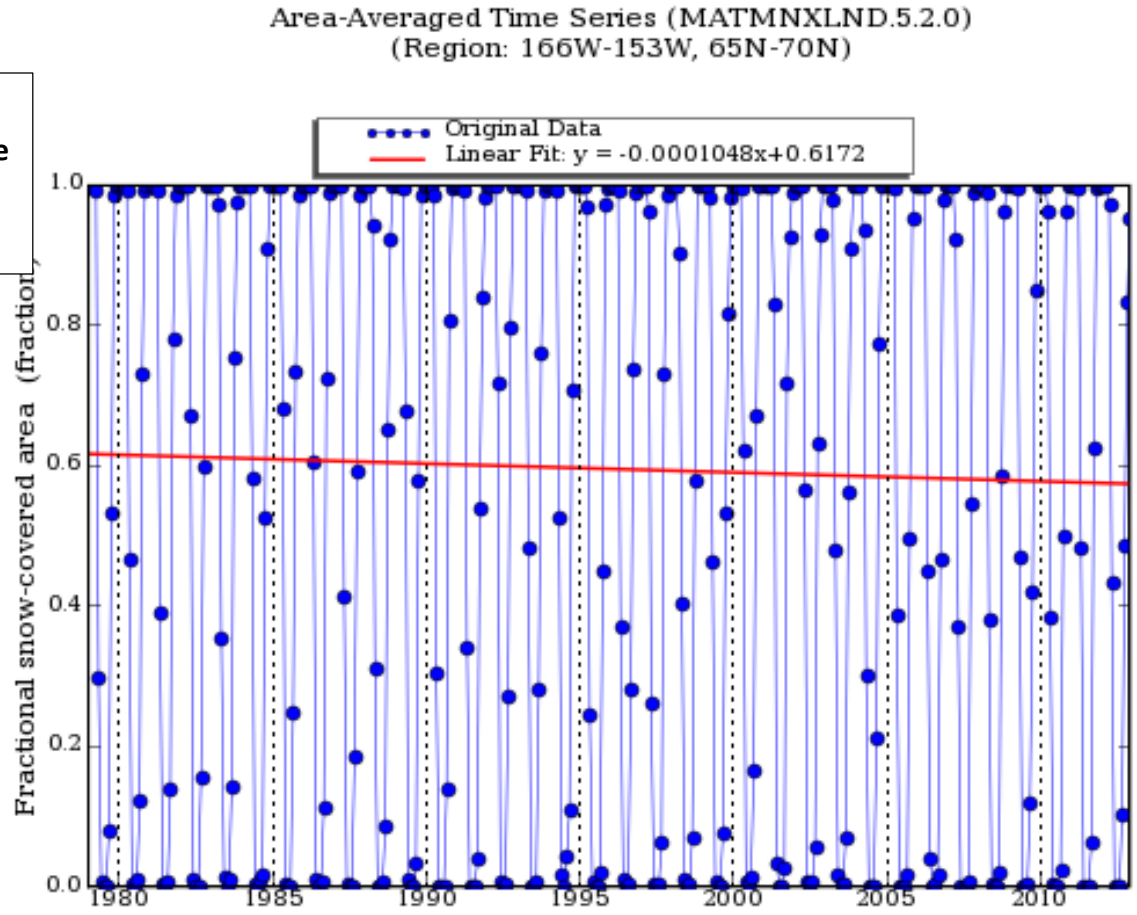
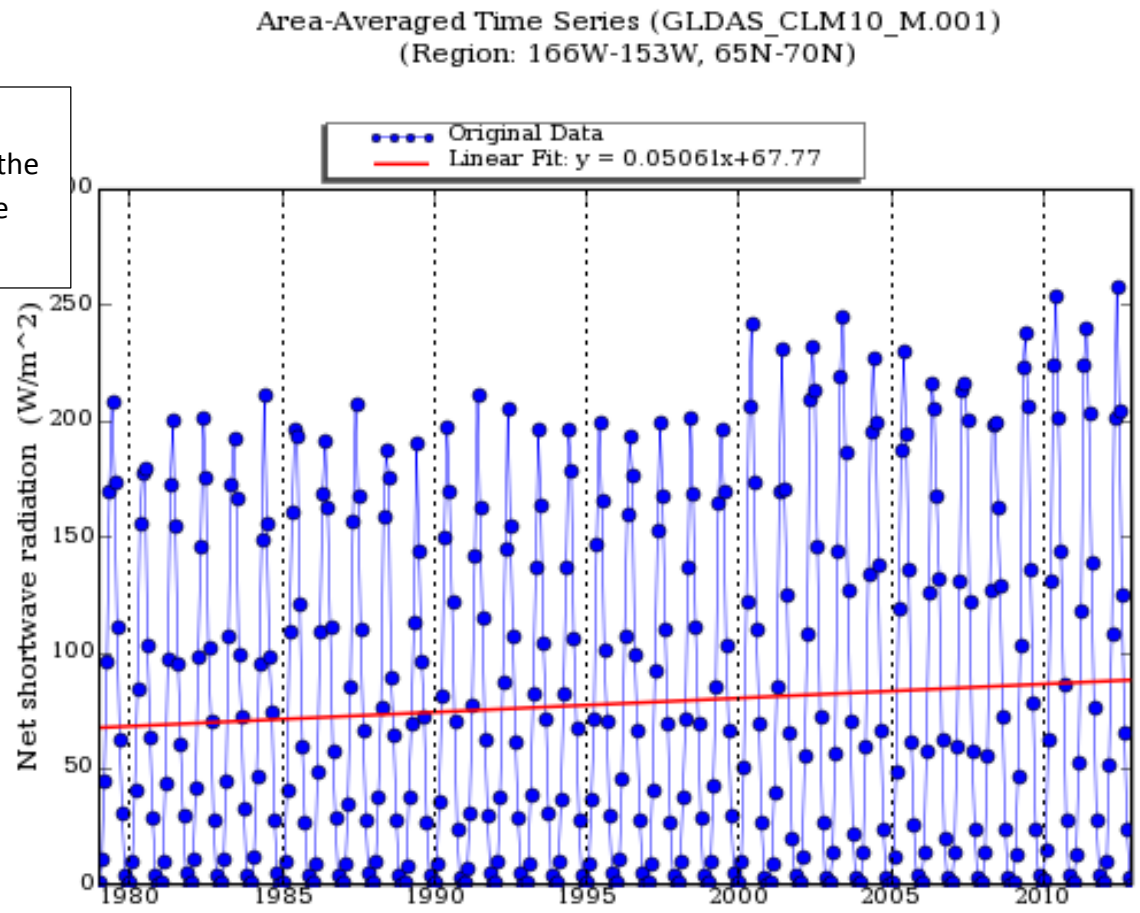

Area-Averaged Time Series (MATMNXLND.5.2.0)
(Region: 166W-153W, 65N-70N)
Original Data
Linear Fit: y = -0.0001048x+0.6172
Fractional snow-covered area (fraction)
1.0
0.8
0.6
0.4
0.2
0.0
1980
1985
1990
1995
2000
2005
2010

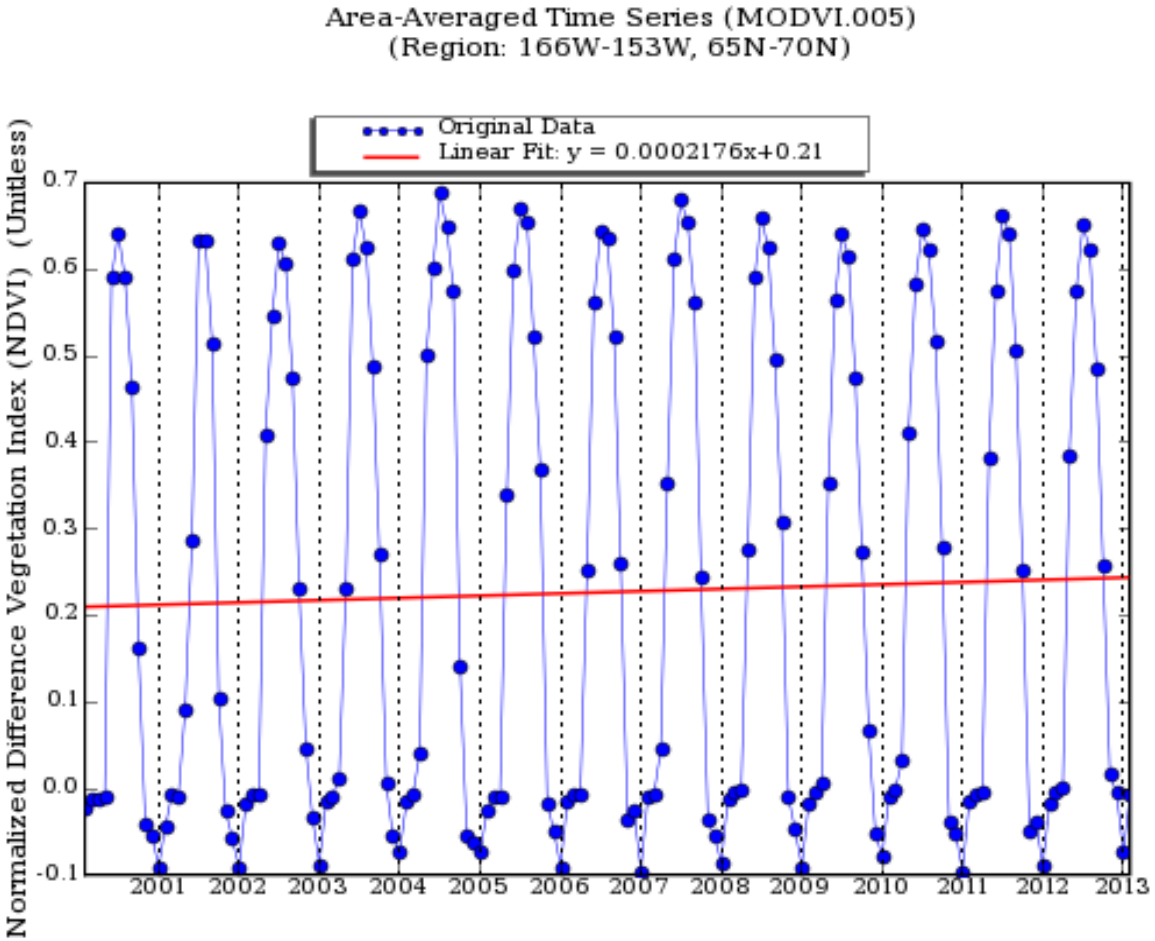
Warming temperatures → Less snow cover/more exposed landscape → **Less surface reflectivity (i.e., less albedo)** → More absorption and emission of radiation at the surface as heat, evidenced by greater vegetation

Increased global carbon dioxide in the global atmosphere



Warming temperatures → Less snow cover/more exposed landscape → Less surface reflectivity (i.e., less albedo) → **More absorption and emission of radiation at the surface as heat, evidenced by greater vegetation**

Increased global carbon dioxide in the global atmosphere



Learning about the data through “Enhanced Help”

Energy

The Energy and Radiation System(1948/01/01 - 2010/12/31)

Parameter	*Data Product Info*		
Net longwave radiation	GLDAS_NOAH025_M.020	Noah Model	1948/01 - 2010/12
Net shortwave radiation	GLDAS_NOAH025_M.020	Noah Model	1948/01 - 2010/12
Photosynthetically Available Radiation	SWFMO_PAR.CR	SeaWiFS	1997/09 - 2010/12
Surface incident longwave radiation	GLDAS_NOAH025_M.020	Noah Model	1948/01 - 2010/12

Net Shortwave Radiation

Definition: **Net shortwave radiation** is a measure of the difference between incoming solar shortwave radiation and outgoing shortwave radiation from the Earth's surface (outgoing shortwave radiation is primarily due to reflection, rather than the result of the absorption into the land or water on the Earth's surface of radiation and the subsequent re-radiation back out into the air that takes the form of longwave radiation). Net shortwave radiation can be expressed by the amount of incident solar shortwave radiation absorbed on the earth surface per unit of area:

net shortwave radiation (W/m^2) = {direct shortwave radiation (W/m^2)
+ diffused shortwave radiation (W/m^2)} (1 – surface albedo)

Expanded definition:

Put more simply, Net SW = (Incoming SW) (1-albedo)

So, if the albedo (reflectivity) is high (as it is for snow) then the "1-albedo" term is low, so Net SW will be low. Correspondingly, if albedo is low (as it is for grass or trees or dirt), then "1-albedo" is high, and Net SW is high.

Therefore, net shortwave radiation is roughly the total amount of shortwave radiation absorbed by the land, For highly reflective areas, like snow or sand, less shortwave radiation is absorbed than for less reflective areas, like areas with vegetative cover.

Summary: Net shortwave radiation is low for high reflective (high albedo) areas, high for low reflective (low albedo) areas. Net Shortwave Radiation is expressed this way because this is the radiation that gets absorbed by the land surface and then re-radiated as longwave radiation — the radiation that gets increasingly trapped in the atmosphere as greenhouse gas concentrations go up.

Trend Guides

SRI International

		Means...	Which could in turn be a sign of...	Could this trend be an effect of climate warming?	Could this trend also be contributing to more climate warming in the region?	Could this trend also be contributing to less climate warming in the region?	Other reasons for the trend?
Higher values of...	**Net Shortwave Radiation** (a measure of the difference between the amount of incoming short wave ultraviolet radiation being absorbed at the Earth surface and the amount reflected back into space - expressed in absolute values)	More of the incoming ultraviolet radiation is being absorbed and re-emitted by the land as heat (i.e., infrared radiation) than is being reflected back into space.	Less albedo, hence increasing the amount of heat in the troposher e	Yes because global warming is contributing to the melting of ice and snow surfaces the reflect solar radiation	Yes, because the greater heat that comes from less albedo would in turn contribute to even more melting of snow and ice and even more decreases in albedo - a "positive feedback."	Only if a greater abundance of plant life resulted from the melting of the snow and ice, since plants remove much carbon from the troposphere via photosynthesis.	More of the short wave radiation may be reaching the ground due to fewer clouds in the atmosphere blocking it, hence increasing both the amount of it reaching the ground and the amount of it being reflected back up into space (and thus increasing the absolute value of the difference).
Lower values of...	**Net Shortwave Radiation** (a measure of the difference between the amount of incoming short wave ultraviolet radiation being absorbed at the Earth surface and the amount reflected back into space - expressed in absolute values)	Less of the incoming ultraviolet radiation is being absorbed and re-emitted by the land as heat (i.e., infrared radiation) than is being reflected back into space.	More albedo, hence decreasin g the amount of heat in the troposphe re	Unlikely.	Unlikely.	Yes, because more reflection back into space means less being re-emitted as heat into the troposphere.	Less of the short wave radiation may be reaching the ground due to greater numbers of clouds in the atmosphere blocking it, hence lowering both the amount of it reaching the ground and the amount of it being reflected back up into space (and thus decreasing the absolute value of the difference).

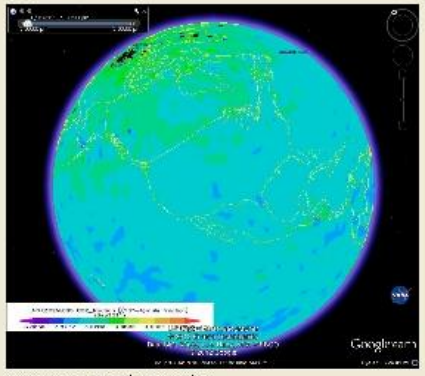
Additional supports

Global carbon dioxide in Sept 2011

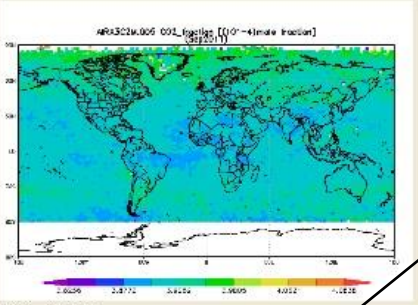
Directions

These images show levels of carbon dioxide (CO2) in September 2011.

Images



CO2 over North America



Global CO2

Questions

1. Do you see a relationship between the amount of carbon dioxide in the troposhere and geographical location? If so, what relationship do you see, and how do you explain the relationship?

Help Tools Available

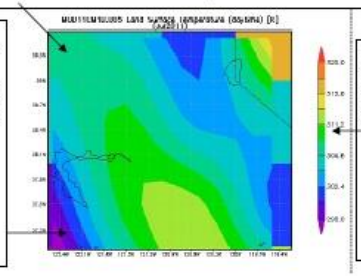
- Map Legend Help
- Time Series Help
- Vertical Profile Help

HOW TO INTERPRET A DICCE MAP

A DICCE map shows a geographical area that has been colored or shaded to show the range of values across the area for a certain set of data. Below are two images about the average daytime land surface temperatures in an area of California stretching from the Pacific Ocean on the west through the Sierra Nevada Mountains and into Nevada on the east. Map 1 below shows the average values in this area for one month, July 2001. The data were collected daily, then averaged.

In this Central California area (shaded in pale green), the average daytime temperature in July 2011 was between 311.2 and 313.4° Kelvin (i.e. 100.8 to 104.7° Fahrenheit)

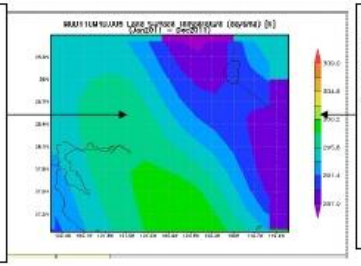
Along this small section of the California coast (shaded in dark purple) the average daytime temperature in July 2011 was between 298 and 300.2° Kelvin (i.e. 77 to 81° Fahrenheit)



The legend shows what values each color represents

Map 2 below shows the same area but over a whole year. Each color-represented value *is the average of all of the monthly temperatures*. Each value was calculated by taking the total degrees of all 12 months in the year divided by 12.

In this Central California area (shaded in pale green), the average daytime temperature across all 12 months in 2011 was between 300.2 and 302.4° Kelvin (i.e. 80.7 to 84.9° Fahrenheit)



This section of the legend indicates what range of values pale green represents on the map.

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