Introduction to the USDA California Climate Hub

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California Central Valley Drought and Climate Outlook
UC Merced Fresno Center, Fresno, CA
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USDA
United States Department of Agriculture
California Climate Hub

The basic challenge and our basic solution

Climate research

Climatic Change
DOI 10.1007/s10584-007-9367-8

Accumulated winter chill is decreasing in the fruit growing regions of California

Dennis Baldocchi · Simon Wong

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PLoS one

Climatic Changes Lead to Declining Winter Chill for Fruit and Nut Trees in California during 1950–2099

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California perennial crops in a changing climate

David B. Lobell · Christopher B. Field

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Abstract Perennial crops are among the most valuable of California's diverse agricultural products. They are also potentially the most influenced by information on future climate, since individual plants are commonly grown for more than 30 years. This study evaluated the impacts of future climate changes on the 20 most valuable perennial crops in California, using a combination of statistical crop models and downscaled climate model projections. County records on crop harvests and weather from 1980 to 2005 were used to evaluate the influence of weather on yields, with a series of cross-validation and sensitivity tests used to evaluate the robustness of perceived effects. In the end, only four models appear to have a clear weather response based on historical data, with another four presenting significant but less robust relationships. Projecting impacts of climate trends to 2050 using historical relationships reveals that cherries are the only crop unambiguously threatened by warming, with no crops clearly benefiting from warming. Another robust result is that almond yields will be harmed by winter warming, although this effect may be counteracted by beneficial warming in spring and summer. Overall, the study has advanced understanding of climate impacts on California agriculture and has highlighted the importance of measuring and tracking uncertainties due to the difficulty of uncovering crop-climate relationships.

1 Introduction

Agriculture is an important component of California's economy, landscape, and culture, and is among the human activities most vulnerable to impending climate changes. Two particularly unique and relevant features of agriculture in California are (1) the diversity of crops grown, with California the leading U.S. producer of over 80 crops, and (2) the substantial fraction of agricultural value (roughly one-third

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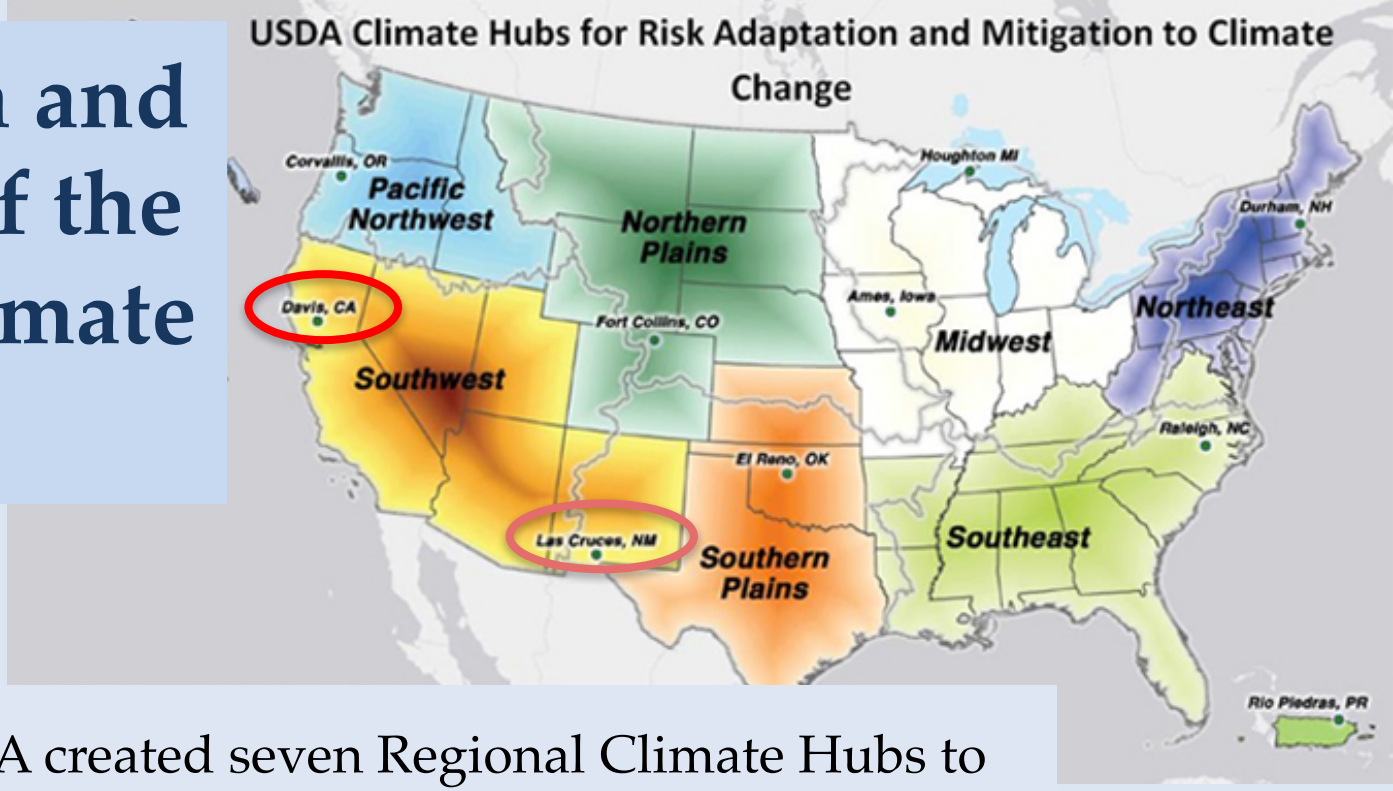
Boundary organizations such as the USDA Climate Hubs

Producers

Formation and location of the USDA Climate Hubs



In early 2014, USDA created seven Regional Climate Hubs to cover the whole nation, plus three additional Hubs to focus on unique issues and locations. The California Hub focuses on **specialty crops, Western forests, rangelands and livestock**.

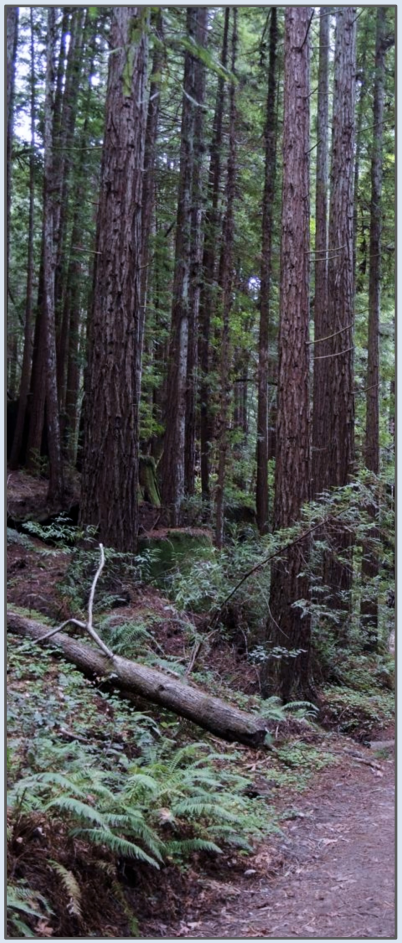
We are located at the **University of California, Davis**, and we collaborate with the Southwest Regional Hub (located at New Mexico State University in Las Cruces, NM).

Focus areas of the California Sub Hub

Specialty crops

Rangeland

Livestock & dairy



Forests

We depend on our partners

Partners are essential to our work, and we aim to add value to their work. We are working with three types of partners:

1. **Key partners** (organizations with whom we collaborate closely and from whom we draw core members);
2. **Subject experts** (usually individuals, e.g. from university or national lab);
3. **Information-sharing partners**.

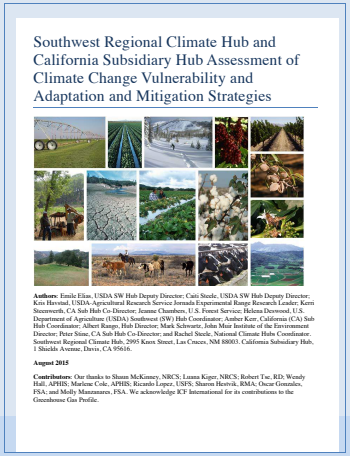
- California Department of Food and Agriculture (CDFA)
- California Landscape Conservation Cooperative (CA LCC)
- California Natural Resources Agency
- California Nevada Climate Applications Program (CNAP)
- Southwest Climate Science Center (SWCSC)
- USDA Agricultural Research Service (ARS)
- USDA Forest Service (Pacific SW Region and Pacific SW Research Station)
- USDA Natural Resources Conservation Service (NRCS)
- University of California Agriculture and Natural Resources (UCANR)
- UC Davis College of Agriculture and Environmental Sciences
- UC Davis John Muir Institute of the Environment (JMIE)
- Western Regional Climate Center (WRCC)

Extension: our key link to producers

- Because we currently lack resources to work with a large number of individual land users, we are working to create and disseminate climate-relevant information in **partnership with extension agencies**.
- We are working closely with **University of California Cooperative Extension** and the **USDA Natural Resources Conservation Service**, and in the future we hope to work with Resource Conservation Districts.
- Extension is also our **key link back *from* producers**, to help us craft relevant, practical outputs.
- At a February 2015 meeting in Davis, CA, **Western Extension directors were supportive** of working with the Climate Hubs to bring better climate information to extension educators and their clients.

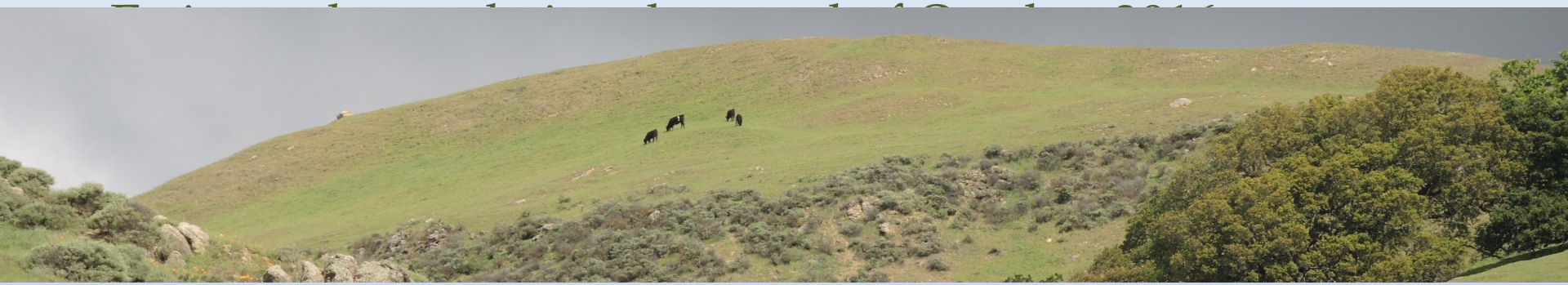
Climate vulnerability assessment of Southwest working lands

- One of our major outputs so far, in collaboration with the SW Regional Hub, has been a **climate vulnerability assessment for the Southwest** (completed 12/2014).
- All Regional Climate Hubs were required to complete a Vulnerability Assessment to **review existing knowledge** and **help identify regional priorities**.
- We created three different types of outputs for **three different audiences**:
  - A **75-page report** for the Climate Hubs national office
  - A **special issue of the journal *Climatic Change*** (in review) for the academic community
  - **Fact sheets** for extension, producers, and the public


Southwest Regional Climate Hub and California Subsidiary Hub Assessment of Climate Change Vulnerability and Adaptation and Mitigation Strategies

CA rangelands vulnerability assessment

- CA rangelands are economically, ecologically, and culturally important, and distinct from rangelands of the arid SW.
- The California Hub is leading a climate vulnerability assessment of CA rangelands (lead author Pelayo Alvarez, former director of CA Rangeland Conservation Coalition).
- The process includes advisory and review committees comprised of academics, government agencies, extension, NGOs, and ranchers.



UC ANR Forest Stewardship Series update

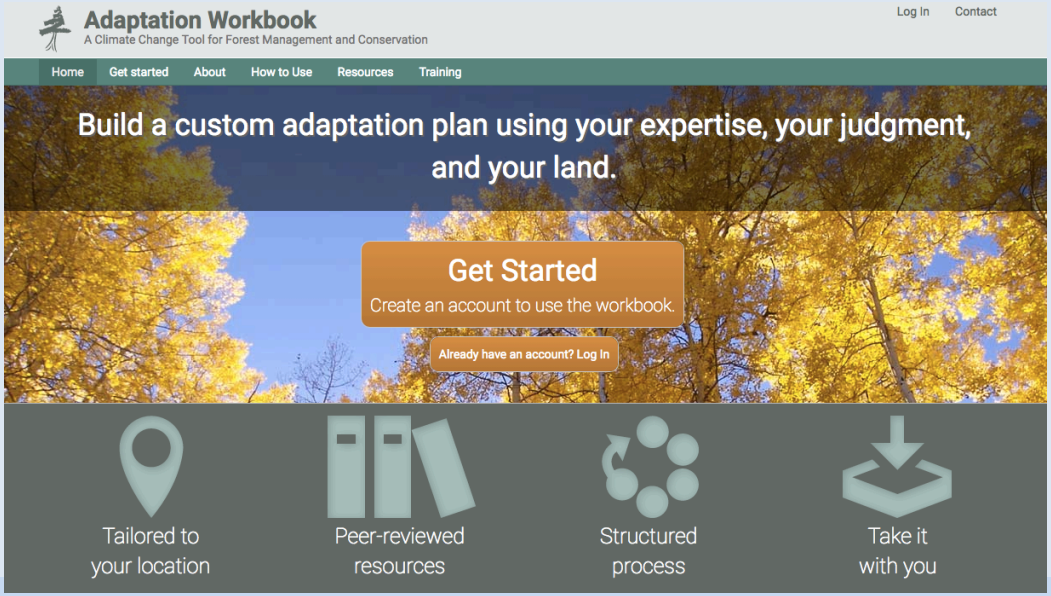
In collaboration with UC ANR forestry advisor Susie Kocher and UC Berkeley graduate student Adrienne Marshall (via Graduate Students in Extension), we have completed...

- Writing two new 12-page briefs for for the UC ANR Forest Stewardship series, for owners of California forestland, on climate adaptation and mitigation in California forests
- Evaluating the existing 24 briefs in the series for necessary updates related to climate change
- Sharing the results of this research at the 2015 UC ANR Strategic Initiatives Conference

Forest Adaptation Workbook

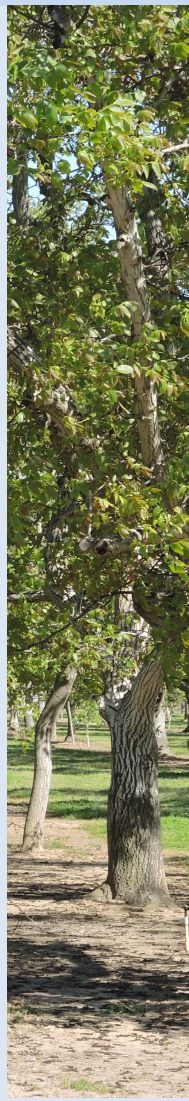
Collaborating with Northern Forests Hub to update for CA:

- www.adaptationworkbook.org and **USFS NRS-GTR-87-2**
- Voluntary adaptive management framework
- Encourages organized decision-making rather than overwhelm or avoidance



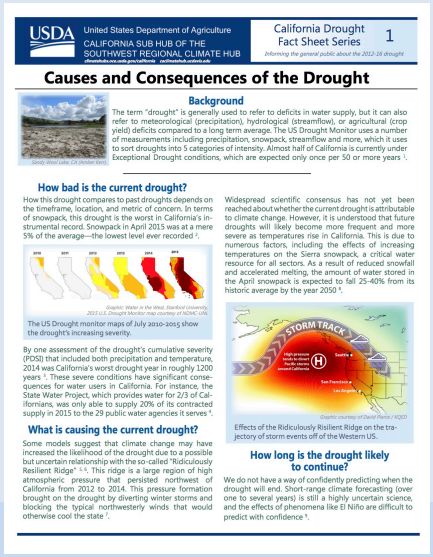
Other current CA Hub projects

- With Peter Nico (LBL) and postdoc Alison Marklein, we are supporting a project on **physiological impacts of climate change on California specialty crops**.
- With Tapan Pathak (UC Merced) and GSE doctoral student Kripa Jagannathan (UC Berkeley), we are advising a project on **climate-based decision making by California almond farmers**.
- With CDFA and CU Boulder, we are collecting **data for California specialty crops** that can be used in the **COMET-Farm greenhouse gas accounting model**.
- We are helping **plan the upcoming 2016 Natural Areas Conference** (Davis, October 17-20, 2016).



Our focus on drought in 2015-2016

- The **current California drought** has profoundly affected all of our focus sectors.
- We have published a series of **six drought fact sheets** for the general public and are working on six more.
- **Your ideas** on other useful drought-related projects are welcome.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California Drought Fact Sheet Series 1
Informing the general public about the 2012-16 drought

Causes and Consequences of the Drought

Background

The term "drought" is generally used to refer to deficits in water supply, but it can also refer to meteorological (precipitation), hydrological (streamflow), or agricultural (crop yield) deficits compared to a long term average. The US Drought Monitor uses a number of measurements including precipitation, snowpack, streamflow and more, which it uses to sort droughts into 5 categories of intensity. Almost half of California is currently under Exceptional Drought conditions, which are expected only once per 50 or more years [1].

How bad is the current drought?

How this drought compares to past droughts depends on the timeframe, location, and metric of concern. In terms of snowpack, this drought is the worst in California's instrumental record. Snowpack in April 2015 was at a mere 5% of the average—the lowest level ever recorded [2].

The US Drought monitor maps of July 2010-2015 show the drought's increasing severity.

By one assessment of the drought's cumulative severity (PDSI) that included both precipitation and temperature, 2014 was California's worst drought year in roughly 1200 years [3]. These severe conditions have significant consequences for water users in California. For instance, the State Water Project, which provides water for 2/3 of Californians, was only able to supply 20% of its contracted supply in 2015 to the 29 public water agencies it serves [4].

What is causing the current drought?

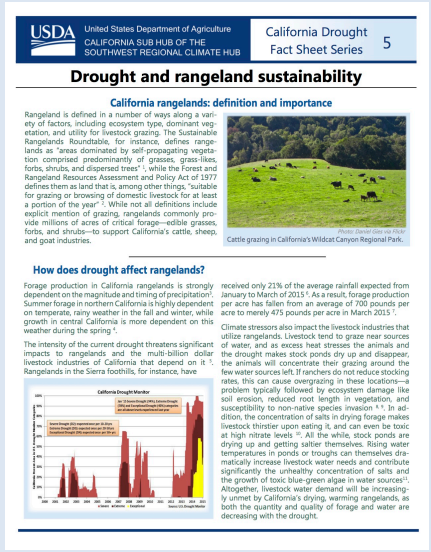
Some models suggest that climate change may have increased the likelihood of the drought due to a possible but uncertain relationship with the so-called "Ridiculously Resilient Ridge" [5,6]. This ridge is a large region of high atmospheric pressure that persisted northwest of California from 2012 to 2014. This pressure formation brought on the drought by diverting winter storms and blocking the typical northwesterly winds that would otherwise cool the state [7].

Widespread scientific consensus has not yet been reached about whether the current drought is attributable to climate change. However, it is understood that future droughts will likely become more frequent and more severe as temperatures rise in California. This is due to numerous factors, including the effects of increasing temperatures on the Sierra snowpack, a critical water resource for all sectors. As a result of reduced snowfall and accelerated melting, the amount of water stored in the April snowpack is expected to fall 25-40% from its historic average by the year 2050 [8].

Effects of the Ridiculously Resilient Ridge on the trajectory of storm events off of the Western US.

How long is the drought likely to continue?

We do not have a way of confidently predicting when the drought will end. Short-range climate forecasting (over one to several years) is still a highly uncertain science, and the effects of phenomena like El Niño are difficult to predict with confidence [9].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California Drought Fact Sheet Series 5

Drought and rangeland sustainability

California rangelands: definition and importance

Rangeland is defined in a number of ways along a variety of factors, including ecosystem type, dominant vegetation, and utility for livestock grazing. The Sustainable Rangelands Roundtable, for instance, defines rangelands as "areas dominated by self-propagating vegetation comprised predominantly of grasses, grass-likes, forbs, shrubs, and dispersed trees" [1], while the Forest and Rangeland Resources Assessment and Policy Act of 1977 defines them as land that is, among other things, "suitable for grazing or browsing of domestic livestock for at least a portion of the year" [2]. While not all definitions include explicit mention of grazing, rangelands commonly provide millions of acres of critical forage—edible grasses, forbs, and shrubs—to support California's cattle, sheep, and goat industries.

Photo: Daniel Gies via Flickr
Cattle grazing in California's Wildcat Canyon Regional Park.

How does drought affect rangelands?

Forage production in California rangelands is strongly dependent on the magnitude and timing of precipitation [3]. Summer forage in northern California is highly dependent on temperate, rainy weather in the fall and winter, while growth in central California is more dependent on this weather during the spring [4].

The intensity of the current drought threatens significant impacts to rangelands and the multi-billion dollar livestock industries of California that depend on it [5]. Rangelands in the Sierra foothills, for instance, have received only 21% of the average rainfall expected from January to March of 2015 [6]. As a result, forage production per acre has fallen from an average of 700 pounds per acre to merely 475 pounds per acre in March 2015 [7].

Climate stressors also impact the livestock industries that utilize rangelands. Livestock tend to graze near sources of water, and as excess heat stresses the animals and the drought makes stock ponds dry up and disappear, the animals will concentrate their grazing around the few water sources left. If ranchers do not reduce stocking rates, this can cause overgrazing in these locations—a problem typically followed by ecosystem damage like soil erosion, reduced root length in vegetation, and susceptibility to non-native species invasion [8,9]. In addition, the concentration of salts in drying forage makes livestock thirstier upon eating it, and can even be toxic at high nitrate levels [10]. All the while, stock ponds are drying up and getting saltier themselves. Rising water temperatures in ponds or troughs can themselves dramatically increase livestock water needs and contribute significantly the unhealthy concentration of salts and the growth of toxic blue-green algae in water sources [11]. Altogether, livestock water demand will be increasingly unmet by California's drying, warming rangelands, as both the quantity and quality of forage and water are decreasing with the drought.

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California Climate Hub

Next steps: Improving our process

- With our new director Steve Ostoja on board as of 9/2016, the Hub is currently assessing our efforts so far and planning how to move forward.
- A key success so far is establishing strong communication among USDA personnel and partners via the CA Hub Advisory Committee. We hope to continue this success.

Our priorities and challenges

- Make the most of our limited resources and staff via mutually beneficial collaborations with partners
- Clearly add value to the data, research, and advice that we get from partner agencies, and disseminate our products efficiently and widely
- Ensure thorough and fair representation of California's diverse land users in all sectors
- Complement, rather than overlap with, the existing constellation of climate-change-related organizations in California
- Place climate change in the context of land users' many other priorities and concerns

Contact and credits

We are grateful for support from our partners that have made the Hub's work possible.

Contact us:

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All photos by Amber Kerr except as specified below:

- Slide 2 (Tom Cooper, Michigan cherry farmer): USDA NRCS (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/home/?cid=nrcs143_023447
- Slide 3 (Climate Hub regions): from http://www.usda.gov/oce/climate_change/regional_hubs.htm
- Slide 13 (lettuce, Salinas Valley): Kerri Steenwerth, USDA/ARS