Southern Oregon Climate Action Now
SOCAN
Confronting Climate Change

Climate Change in the Oregon 2nd Senate District

July 2017

History, Projections, and Consequences

1. The last half of the 20th Century has witnessed a temperature increase of about 1°F while projections suggest compared to the average for that period, a further rise of over 8°F is possible during this century.
2. Although annual average precipitation is expected to remain steady, seasonally winters are expected to be a little wetter and summers drier, with more heavy downpours promoting floods and soil erosion.
3. Snowfall and snowpack accumulation, already dwindling, are projected to reduce further, possibly to 10% of historic levels threatening agriculture as snowmelt arrives earlier and summer and fall water availability dwindles.
4. Wildfires, already exhibiting a 2.5 month longer season that in the 1970s, are expected to become more serious, with 200 to 300 percent greater area being consumed by mid-century.
5. Increased wildfires will likely pose a substantially greater problem for forest and human health.
6. Climatic shifts themselves will likely compromise the viability of important forest and timber species such as Douglas fir and Ponderosa pine in the district.
7. With reduced snowpack and summer/fall stream flow, warmer water will likely compromise the ability of streams and rivers to support iconic freshwater species of the region.
8. Economically important wine varietals may be compromised as the growing season warms.
9. At the current emissions trajectory, we will exhaust our emissions allowance in 17 years if we wish to limit global temperature increase below 2°C (3.6°F) as international agreements dictate.
10. Main health impacts are likely to be: drought, wildfire, heat, and infectious disease. The top health concerns will be: poor air quality, poor water quality, respiratory illness, occupational and recreational hazards, heat-related illness, residential displacement, contaminated drinking water, water insecurity, food insecurity, vector-borne disease, income loss, economic instability, and mental health impacts. Vulnerable communities will be: low-income households, American Indians, private well users, people working in agriculture and outdoor recreation, firefighters and first responders, and children and pregnant women.

Compiled by Meghan Fagundes & Alan Journet (fagundes.meghan@deq.state.or.us, 541-973-5144) (alanjournet@gmail.com, 541-301-4107) April, 2014

For more information on these points, see the full summary at: http://socan.eco/oregon-legislative-districts/

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Global and Regional Temperature:

Data from NASA reveal that the Global and U.S. atmospheric temperatures have increased substantially since 1880 (Figures 1 and 2).

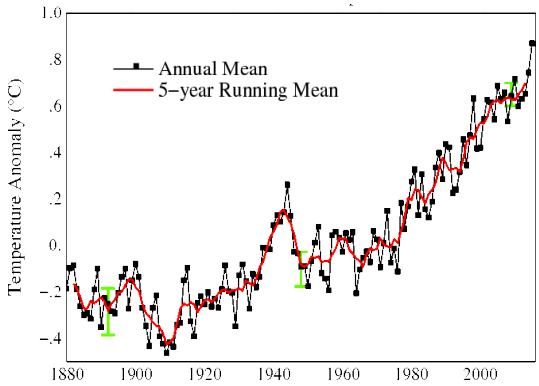


Figure 1. Historic global temperature trend NASA Goddard Institute for Space Studies 2017.

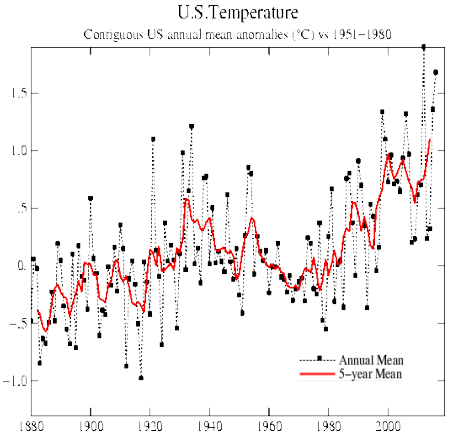


Figure 2. Historic U.S temperature trend. NASA Goddard Institute for Space Studies 2017.

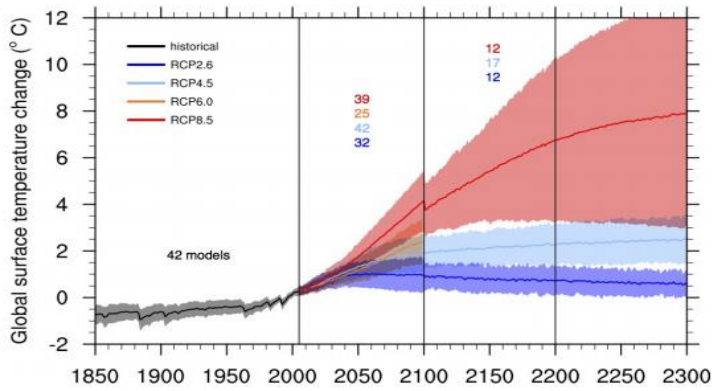


Figure 3. Intergovernmental Panel on Climate Change 2013 global projections. http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_Chapter12.pdf

Depending on the RCP (Representative [Carbon] Concentration Pathway) we follow globally (Fig. 3), this century may result in from a 2^0F increase, assuming immediate action, to a high of over a 9^0F increase. The trajectory beyond the century offers an even more challenging high extreme with an extreme 20^0F hotter. Meanwhile, temperature projections for the Pacific Northwest (Figure 4) suggest a similar range of temperature increases are possible, reaching – as an average – nearly a 12^0F increase by the end of the century

under the Business as Usual scenario (RCP 8.5) in which we continue the current trajectory of accelerating emissions.

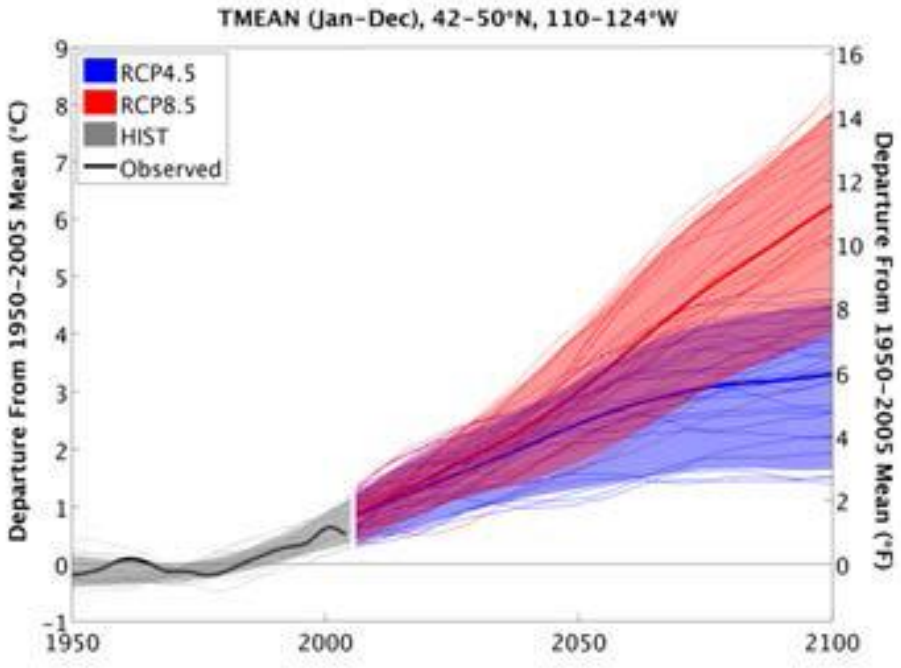


Figure 4. Oregon temperature history and projections through the century (Dalton *et al.* 2013).
http://library.state.or.us/repository/2010/201012011104133/summaries.pdf

The higher range of temperature increase would be unmanageable. It would devastate natural systems (forests, woodlands, shrub lands and the species they support) and simultaneously threaten our climate dependent agricultural, ranching, and forestry activities. Bark beetle and other pest destruction of forests would likely increase as warmer temperatures enhance insect growth and development rates and enable greater overwintering populations. Similarly, invasion of natural and agricultural systems by drought tolerant invasive species and pests will likely be enhanced.

The lower range for continued temperature increase resulting from the greenhouse gases already released is inevitable; for this we will simply have to prepare and adapt.

Regional Precipitation:

The 2013 US Climate Change Assessment (Melillo *et al.* 2014) provides projections for future precipitation (Figure 5) according to the 'business as usual' scenario.

The region generally is expected to exhibit fall and spring seasons that are little different from historical patterns, with winters possibly a little wetter. Notably, however, summers will likely be considerably drier.

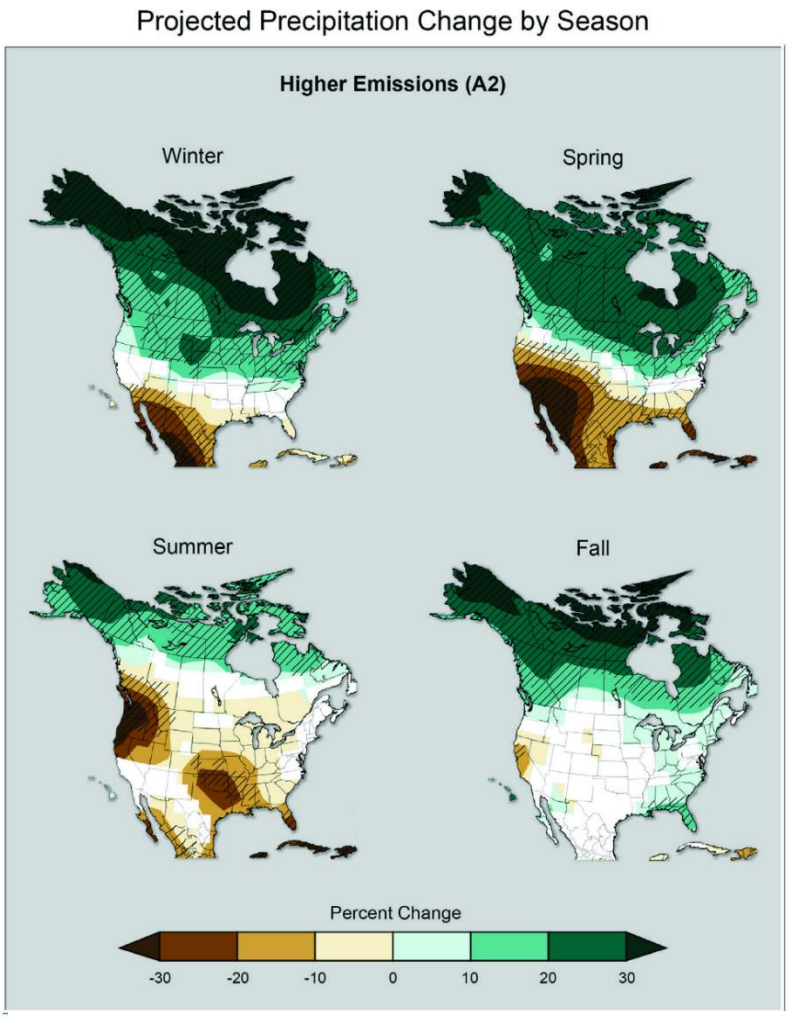


Figure 5. Projected precipitation patterns in the U.S. comparing 2071 – 2099 to the 1900 – 1960 average (Melillo *et al.* 2014). http://www.globalchange.gov/what-we-do/assessment

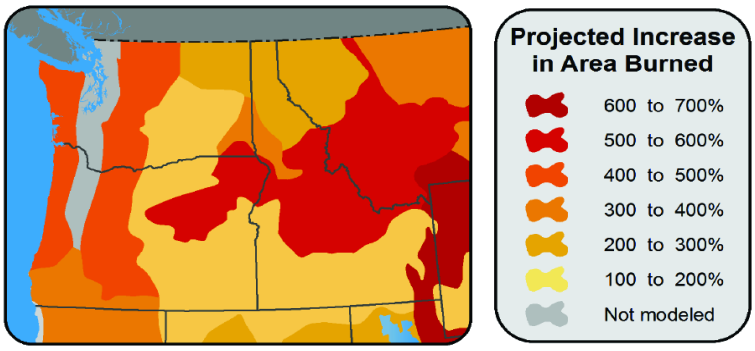


Figure 6. Anticipated wildfire consequences of a 2.2^{0}F warming in area burned (Melillo *et al.* 2014). http://www.globalchange.gov/what-we-do/assessment

Water resources, already severely compromised in many locations, will become more threatened as snowpack declines and precipitation occurs as severe storms rather than the typical light drizzle that rejuvenates soil moisture. This trend will likely enhance floods, soil erosion and potentially landslides.

The reduced stream and river flow occurring during summer/fall will be warmer compromising many iconic Pacific Northwest cold-water aquatic species.

Melillo *et al.* (2013) also offered wildfire projections accompanying just a 2.2^{0}F warming, a condition potentially evident by mid-century (Figure 6).

The fire season, already extended by 2.5 months since 1970 (Westerling *et al.* 2006), will likely become longer and more severe in Oregon, with two to six times as many acres burned. Both human safety and human health will likely be threatened.

Coastal Concerns:

Though much of Oregon is land-locked, and will suffer little directly as a result of ocean consequences, coastal regions and economies will have to contend with warming oceans, sea level rise, and increasing ocean acidification.

Warming Oceans. Although there is considerable seasonal fluctuation in ocean temperature, warming of oceans in the Northwest between 1900 and this century are already documented with further increases to 2.0 ^{o}F by mid-century expected. Besides influencing species directly, temperature changes impact such events as algal blooms and shellfish poisoning.

Sea Level Rise. Sea levels are rising and will continue to rise for two reasons. First, water expands as it warms from 4^{o}C (approximately 37^{o}F). As the ocean warms, it expands and sea level rises. Second, as land borne ice enters the ocean, whether as water or ice, it increases the volume of the ocean. Both these phenomena have already caused sea level to rise and are expected to continue this impact. The impact is influenced by the pattern of land adjustment: if land is rising, the impact is reduced, whereas a subsiding coastal plate will exacerbate the impact. Projections for Newport suggest a potential century rise of between 6" and nearly five feet. Higher sea level poses a greater threat than merely its impact on tidal level. During storm surges, a higher sea level will generate conditions that promote far greater storm damage and flooding than would otherwise have been the case. The impact of Hurricane Sandy is a perfect illustration of this problem. Not long ago, the suggestion that New York subways could be flooded by a coastal storm would have not received any serious consideration – yet it happened! Consequences of ocean rise such as increased erosion and compromised coastal habitat integrity for tidal flat, estuary, and marsh natural communities could become serious.

Ocean Acidification. Serious as climatic consequence are, they do not constitute the sum total of the impacts of our emitting carbon dioxide into the atmosphere. Because carbon dioxide is absorbed by our oceans, and is transformed into carbonic acid, our oceans are increasing in acidity. This is detrimental for marine organisms with carbon-based shells since they are unable to form shells in acid conditions, or they lose shells already established. Oysters suffering directly, and salmon indirectly, have been noted as particularly threatened by acidification. Acidosis, a build-up of acidic conditions in the tissues, threatens many marine life forms.

The 2nd Oregon Senate District Climate History and Projections:

Temperature history and projections for the Rogue River Basin are presented in Figure 7. The warming trend of the last century is seen to extend into the future according to the three models employed with an impact of between 5 and 9°F by the end of the century.

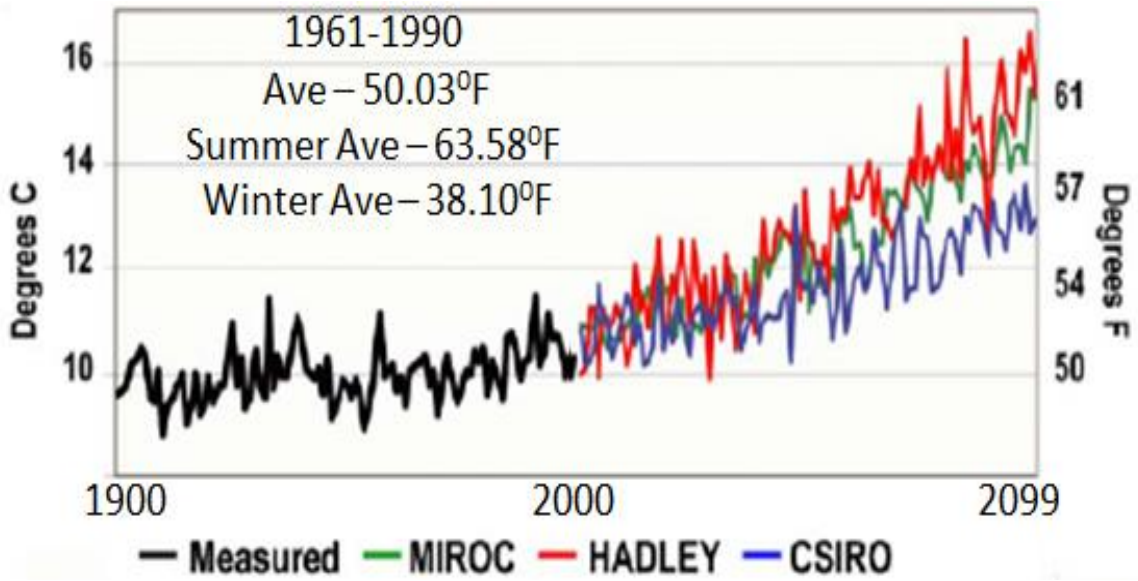


Figure 7. Rogue Valley historic temperature in black with projections from three models for the balance of this century. MIROC is the Japanese model, HADLEY is British, CSIRO is Australian. The projections are based on the 'business as usual' scenario: continuation of the current trend in increasing greenhouse gas emissions.

Medford Historic Patterns:

Variable	Century Trend
Annual Average High	+ 0.1°F
Annual Average	+ 1.8°F
Annual Average Minimum	2.8°F
Growing Degree Days (Base 50°F)	+ 502 Degree Days
Frost Free Period (>36°F)	+ 31.5 Days
Ave Freeze Free period (>33°F)	+ 27.2 Days
Freq. of Freezing Days (<33°F)	-23.4 Days
Freq. of 100 Degree days	+3.6 Days
Annual Ave pptn. inches	+2.1 inches
Annual snowfall inches	-5.6 inches

Table 1. Summary of the Medford climate trends through the last 100 years from Medford weather station data provided by NOAA.

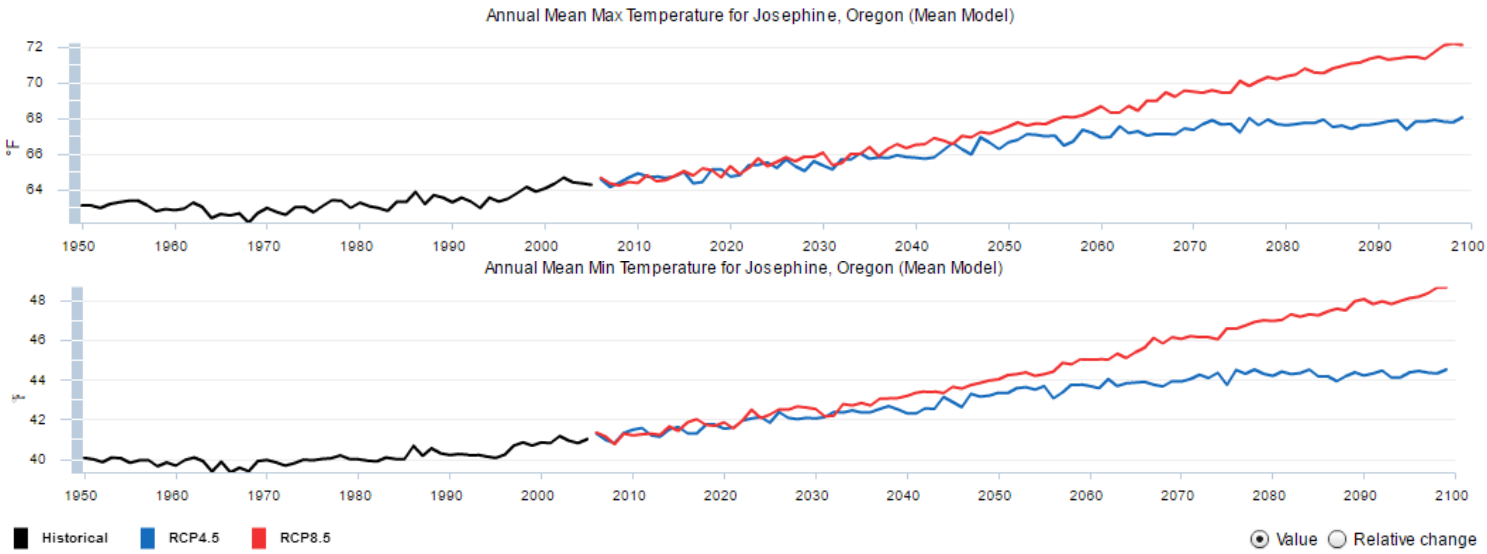


Figure 8. Mean maximum (above) and mean minimum temperatures for Josephine County
http://www.usgs.gov/climate_landuse/clu_rd/apps/nccv_viewer.asp

For Josephine County (Figure 8), the temperature trend for the last century was comparable to that for Medford (Table 1): about a 1.8ºF increase. The low emissions scenario (blue) projection for late this century suggests about an 2ºF rise in average temperature above current, while the high emissions scenario (red) projects over a 8ºF rise.

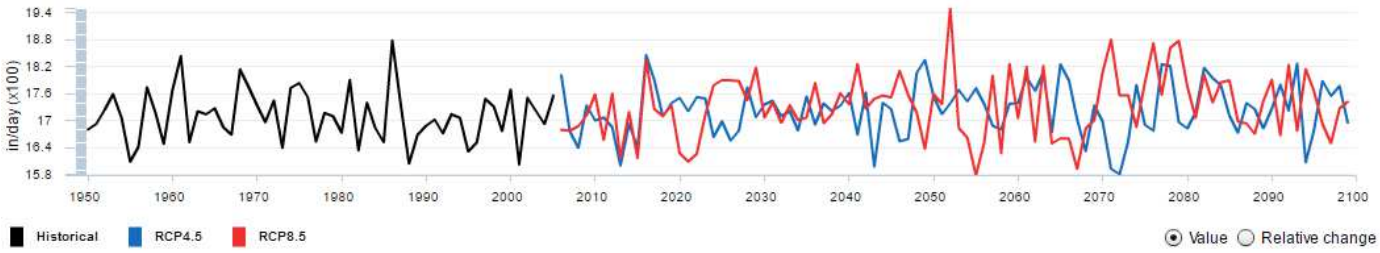


Figure 9. Precipitation trend and projection for Josephine County
http://www.usgs.gov/climate_landuse/clu_rd/apps/nccv_viewer.asp

Both the historic trend and the projection through the cetury in precipitation (Figure 9) seem to be flat. However, as summers warm and summer precipitation drops Figue 5), the potential for regional drought will likely increase.

Snowfall and consequent snowpack accumulation have been declining for decades both at Crater Lake and in the northern Siskiyous compromising water supplies through the summer.

Meanwhile, snowfall (Figure 10) in Jackson County has been declining since the late 1900's, a trend that has many adverse impacts on the valley such as reduced water for natural communities, crop irrigation, and human consumption. The lack of high elevation snowpack suggests a more severe wildfire season. The projected trend in snowpack is for a continued

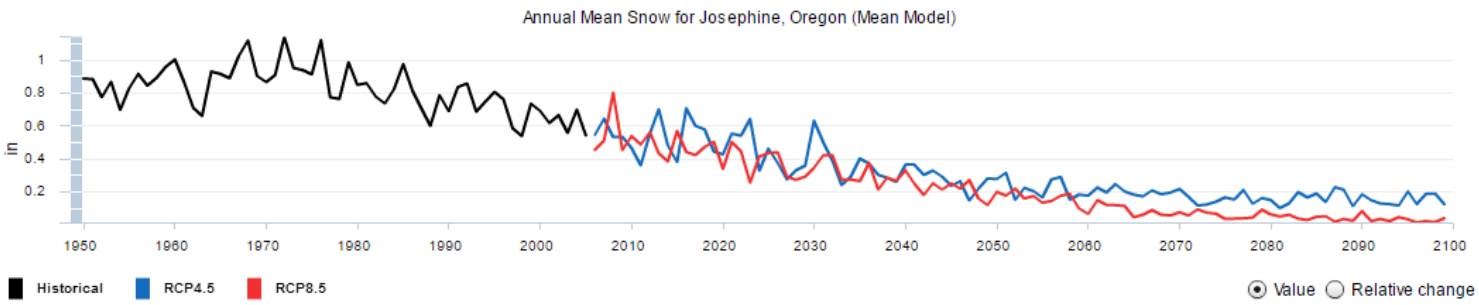


Figure 10. Annual trends and projections for snowfall in Josephine County.
http://www.usgs.gov/climate_landuse/clu_rd/apps/nccv_viewer.asp

decline, possibly to only 10% of historical levels by late century. Combined with the trend towards precipitation falling in heavy downpours on more days rather than light rain on many days as seen historically, this will likely result in earlier and decreased stream flow, a consequence that poses a serious threat to those agricultural activities dependent on late summer and early fall snowmelt as an irrigation source.

Federal Congressional District Historic Temperature Trend:

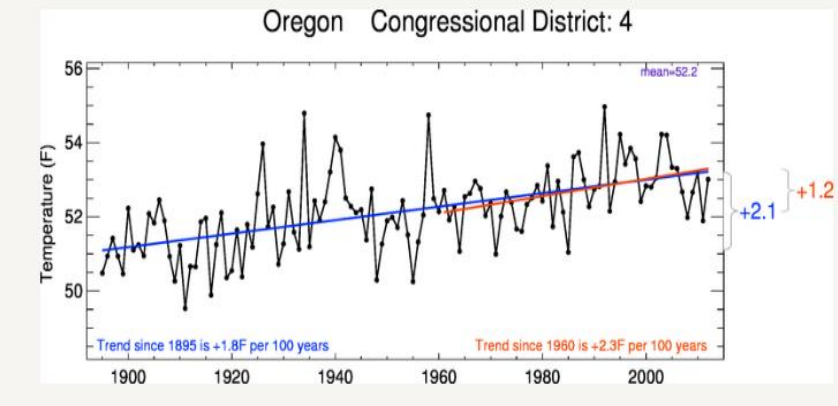


Figure 11. Average temperature within the 4th Congressional District
http://temperaturetrends.org/district.php?district=4&state=OR

Much of the 2nd Senate District is located within Oregon's 4th Federal Congressional District. Figure 11 shows that the historical temperature trend within the 4th Congressional District exhibits a similar increase of over 2°F to that reported locally.

Oregon 2nd Senate District Economy:

The economy of Oregon's 2nd Senate district involves healthcare, agriculture, forestry, manufacturing, and tourism. Even though timber/lumber production has declined it is still a significant component of this district's economy.

Forests and Climate Change: Like all natural systems, forests are influenced by the key variables of temperature and precipitation, the two factors most influenced by climate change.

At the same time, because forests store carbon in their biomass, they can also have a profound direct impact on climate change, as they either store this carbon or release it through fire and logging operations. An important forest - climate interaction exists where each influences the other.

The most important commercial tree species in the 2nd senate district are Douglas fir and Ponderosa pine. Their current distributions, and the location of these climate conditions through the century have been analyzed at the USDA Forest Service Labs in Moscow Idaho. Projections for these tree species are presented in Figures 12 and 13 for models that assume a continuation of the current trend of increasing atmospheric carbon dioxide emissions. High tree viability is indicated in red, low viability in green and absence in areas without color.

These projections suggest conditions for these species may be less favorable than is currently the case- meaning the forests and timber industry of the district could be severely challenged as the century unfolds, especially if we do nothing to mitigate the climate trends already evident.

In addition, given the ability of many Oregon forests to store carbon (Hudiburg *et al.* 2009), it is critical that climatic conditions not diverge such that these important species are compromised.

Figure 12 Douglas fir (*Psuedotsuga menzeisii*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/

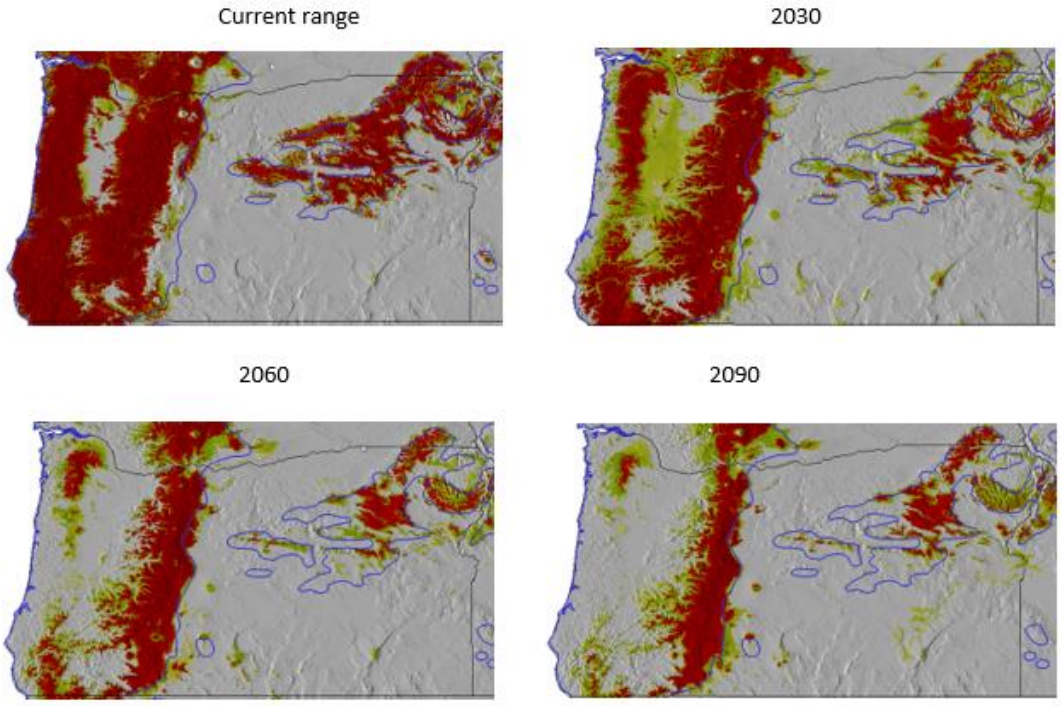
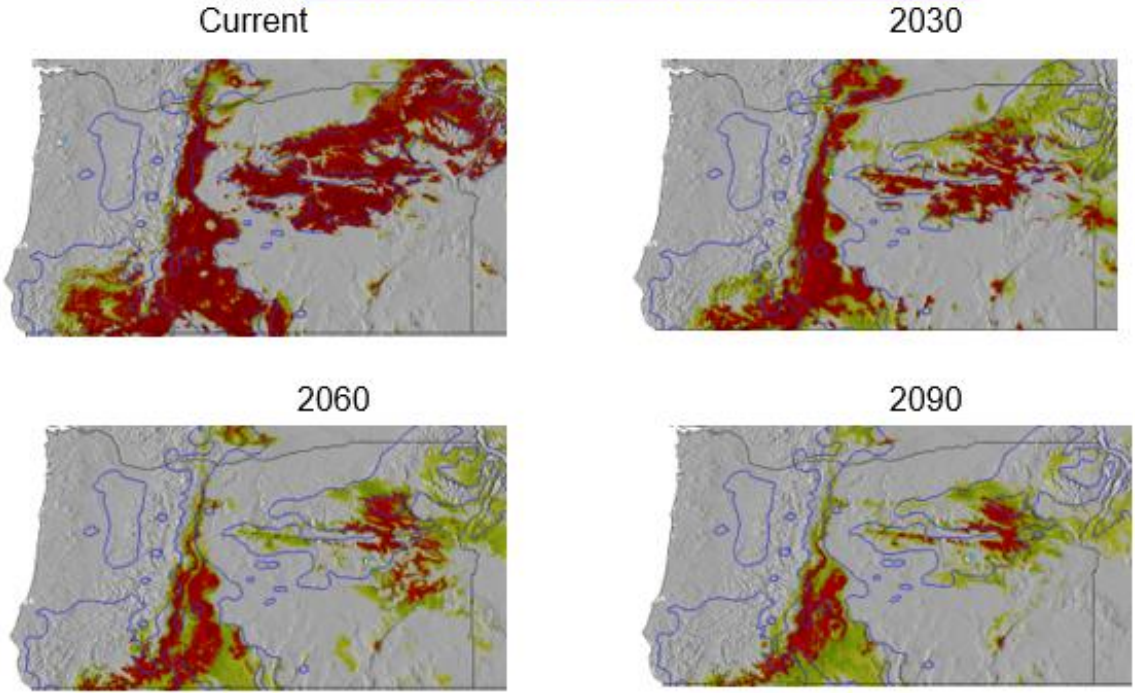


Figure 13 Ponderosa pine (*Pinus ponderosa*) Current and Projected Distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/



Future climate patterns as projected would negatively impact the economy through a reduction in crop yields since increasing temperature consistently reduces crop productivity and a potential for lost tourism due to wildfire. The blossoming wine industry and the pears produced by and for Harry and David would also be affected by the altered growing season. A potential problem for pear growers is the need for a solid winter chill period. This is decreasing. While not immediately a problem, if the trend of decreasing chill hours continues the consequences for pear production could become relevant.

The predominant wine varietals in this area are Pinot Gris, Syrah, Merlot, Cabernet Sauvignon, Pinot Noir, and Chardonnay. Figure 14 depicts the growing season optimal temperatures for varietals grown in the region including the impact climate change will likely have on wine growing. While many of the grape varietals grown in this area seem reasonably well-adapted to mid-century growing season temperatures, even some of the warm climate varietals could be compromised by late century. However, of particular note are the cooler growing season varietals of the region (especially Illinois Valley wines) such as Pinot gris, and Gewürtstraminer, which could be severely compromised even by mid-century.

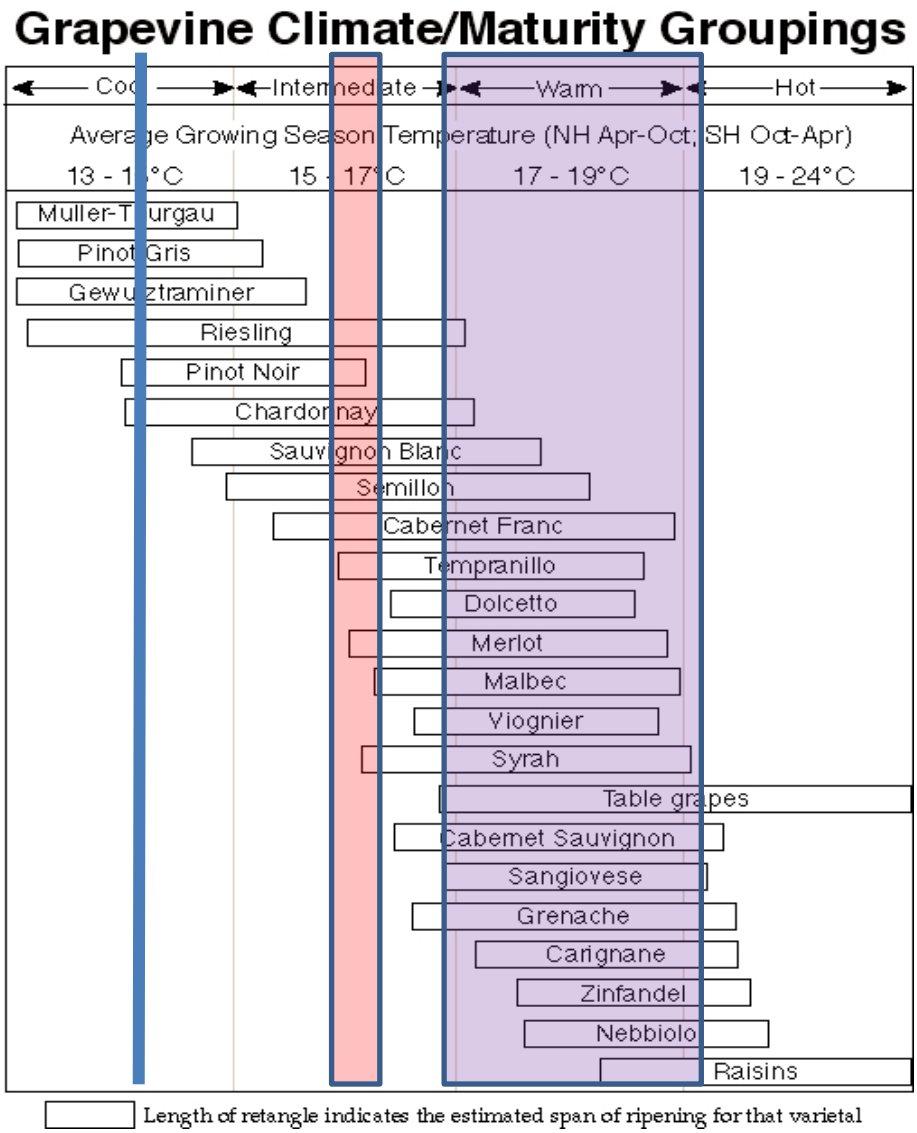


Figure 14. Grape varietal optimum growing season temperatures with Rogue Basin historic (Blue) and projected (2035-2045 in red; 2075-2085 in purple) temperatures as reported in Fig 7 for the Rogue Valley inserted by Alan Journet on the basic varietal growing season.

http://www.sou.edu/envirostudies/gjones_docs/GJones%20Climate%20Change%20Geoscience%20Canada.pdf

Oregon Senate District 2 and surrounding areas have become increasingly popular as retirement locations; Climate change and its consequences target the most vulnerable - such as the young and the old. The consequences depicted here could have a severe impact on the health of the elderly. Many of the health consequences are involve respiratory problems for this vulnerable segment of the population. Heat waves and

particulates emitted by wildfires can be particularly hazardous to those with respiratory problems. Not only will the projected climate change be negative for our economy, it will also change the lives of people in the 2nd district.

If climate trends continue as projected, Oregon's 2nd Senate District will experience considerable natural and economic disruption. In order to sustain a vibrant economy, the region will find it necessary to adapt. Avoiding the worst case scenario depicted in these projections will require the concerted effort of elected leaders at all levels of government, regional, national, and international

Potential Agricultural Impacts:

Our field crops are planted in soil and climatic conditions to which they are well adapted. This means adjustments from current climate can be detrimental. The agricultural 'one-degree problem' occurs because increasing temperature generally reduces crop yield. For each degree C temperature rise c,rop yield drops some 5 - 10% (Brown 2006). Meanwhile, the 'business as usual' scenario of increasing greenhouse gas emissions suggests that throughout Oregon the temperature will likely increase 5 or more degrees C with decreasing soil moisture (USGS 2014) posing a great risk of extended drought. Farmers and home gardeners in Oregon should be concerned about a compromised future.

Potential Health Risks:

According to the Oregon Health Authority (2014), the main climate impacts to health are likely to be: drought, wildfire, heat, and infectious disease. The top health concerns will be: poor air quality, poor water quality, respiratory illness, occupational and recreational hazards, heat-related illness, residential displacement, contaminated drinking water, water insecurity, food insecurity, vector-borne disease, income loss, economic instability, and mental health impacts. Communities that will be especially vulnerable will be: low-income households, American Indians, private well users, people working in agriculture and outdoor recreation, firefighters and first responders, and children and pregnant women.

A Timeline For Action

Based on the projected consequences of a warming climate, International agreements (e.g. UN 2009) have established 2^{o}C as a limit beyond which we should not allow the global temperature to climb. This limit is echoed by the World Bank (2012, 2013, 2014) and the International Energy Agency (IEA 2009).

Table 1 Carbon Dioxide Emissions and Temperature Consequences		
Emissions	**Gigatons CO_2 added to atmosphere**	**Temperature increase**
1850 – 2000	**1035**	**0.8°C**
2000 – Now	**440**	**1.5°C**
Further Allowed	**825**	**2°C**
Fossil Fuel Reserves	**725**	**3 - 4°C**
Accessible Reserves	**780**	**5 - 6°C**
Additional Reserves	**1280**	**??**

The trends and consequences discussed here are based on readily available data. An overall summary of our global temperature trajectory is depicted in Table 1 (from Quick M 2014) This shows that emissions of greenhouse gases to date have induced a temperature rise and inevitable continued rise totaling 1.5°C to 1.6°C (2.7 - 2.9°F) (Dixon 2001). If we wish to avoid an increase over 2°C the math tells us that we can only allow another 825 gigatons (billions of tones) of Carbon dioxide and equivalent emissions. Given that the current annual rate of global emissions is 37 gigatons (Le Quéré *et al.* 2014) and assuming the 'business as usual' scenario of accelerating emissions is followed into the future as it has been to date, we will exhaust this budget in about 17 years. Unfortunately, if known and suspected fossil fuel reserves were extracted and burned, the temperature impact would be far in excess of that agreed 2°C upper limit. In relation to shooting beyond 2°C, the World Bank (2012) acknowledged there is: "no certainty that adaptation to a 4°C world is possible."

There can be little doubt that substantial urgency must be attached to addressing this issue.

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