Southern Oregon Climate Action Now
SOCAN
Confronting Climate Change

Climate Change in the Oregon 9th Senate District

July 2017

History, Projections, and Consequences

1. The last half of the 20th Century witnessed an increase in temperature of about 1˚F while projections suggest a further rise of up to 8-9˚F beyond the average for that period is possible during this century.
2. Although annual average precipitation is expected to hold steady, seasonally winters are expected to be wetter and summers drier, with more heavy downpours.
3. With declining snowfall, snowpack accumulation is already dropping and is projected to dwindle further, possibly to 10% of historic levels by the end of the century.
4. Wildfires already exhibiting a 2.5 month longer season than in the 1970s, are expected to become more serious, with some 200% to 300% greater area being consumed by mid-century posing a substantially greater problem for forest and for human health.
5. Climatic shifts themselves will likely compromise the viability of important forest and timber species in the district, especially Douglas fir, posing a threat to timber activities.
6. Agriculture will suffer as water supplies for irrigation decrease, the incidence of pests and disease attacks increases, and growing competition from weeds threaten crops.
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. At the current emissions trajectory, we will exhaust our allowance in 17 years if we wish to maintain the global temperature increase below 2°C (3.6°F) as International Agreements dictate.
9. Main health impacts are likely to be: heat, allergens, and storms and floods. The top health concerns will be: poor air quality, respiratory illness, heat-related illness, harmful algal blooms, recreational hazards, increased allergens, displacement, landslides, economic instability, and mental health impacts. Vulnerable communities will be: low-income households and neighborhoods, communities of color, older adults, people living on steep slopes, people working in agriculture, first responders, and children and pregnant women.

Compiled by Elaine Bianchi & Alan Journet (bianchielainem@gmail.com, 509-630-2358) (alanjournet@gmail.com, 541-301-4107) May, 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).

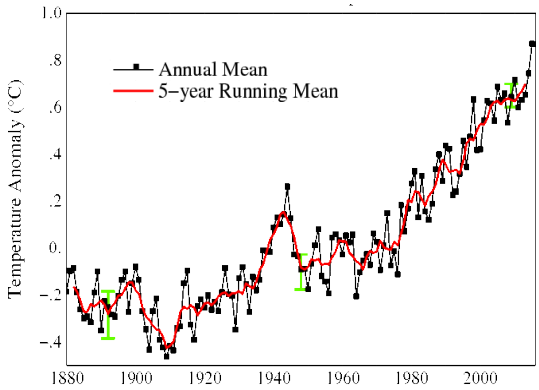


Figure 1. Historic global temperature trend NASA Goddard Institute for Space Studies 2017.

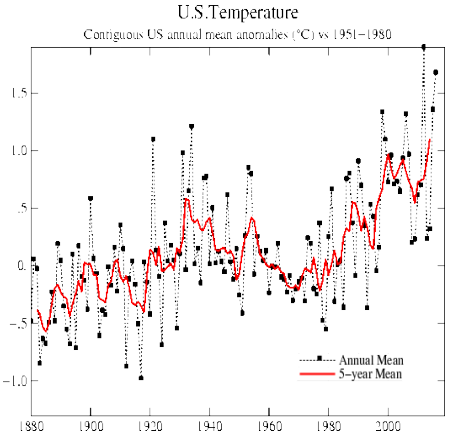


Figure 2. Historic U.S temperature trend. NASA Goddard Institute for Space Studies 2017.

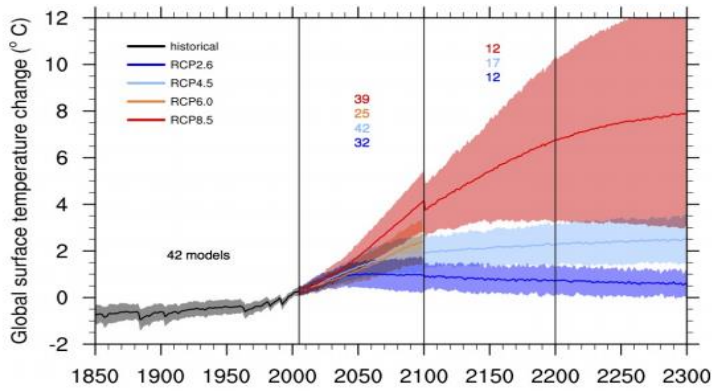


Figure 3. Intergovernmental Panel on Climate Change 2013 global projections. http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_Chapter12.pdf

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.

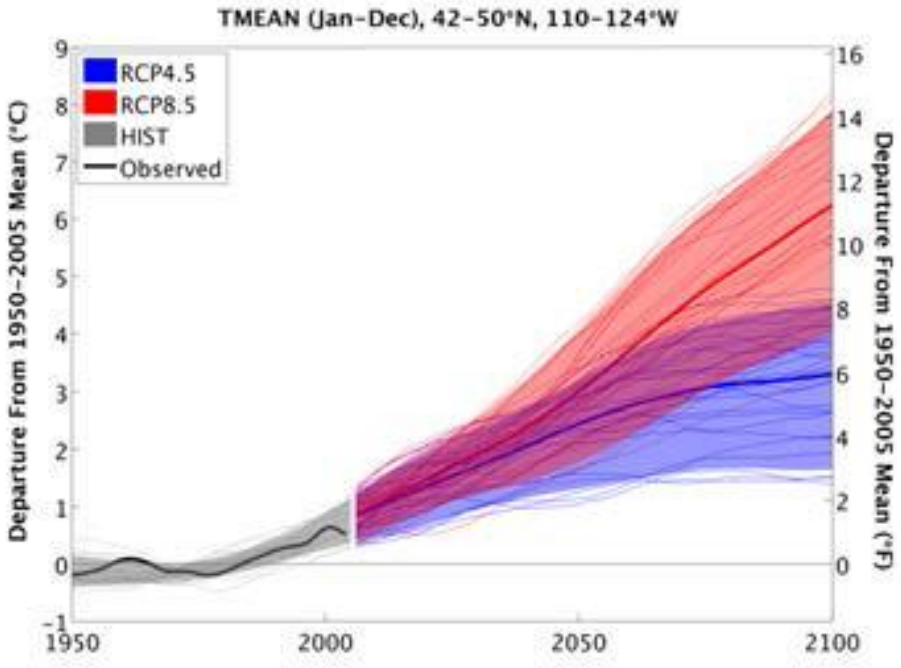


Figure 4. Oregon temperature history and projections through the century (Dalton *et al.* 2013).
http://library.state.or.us/repository/2010/201012011104133/summaries.pdf

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.

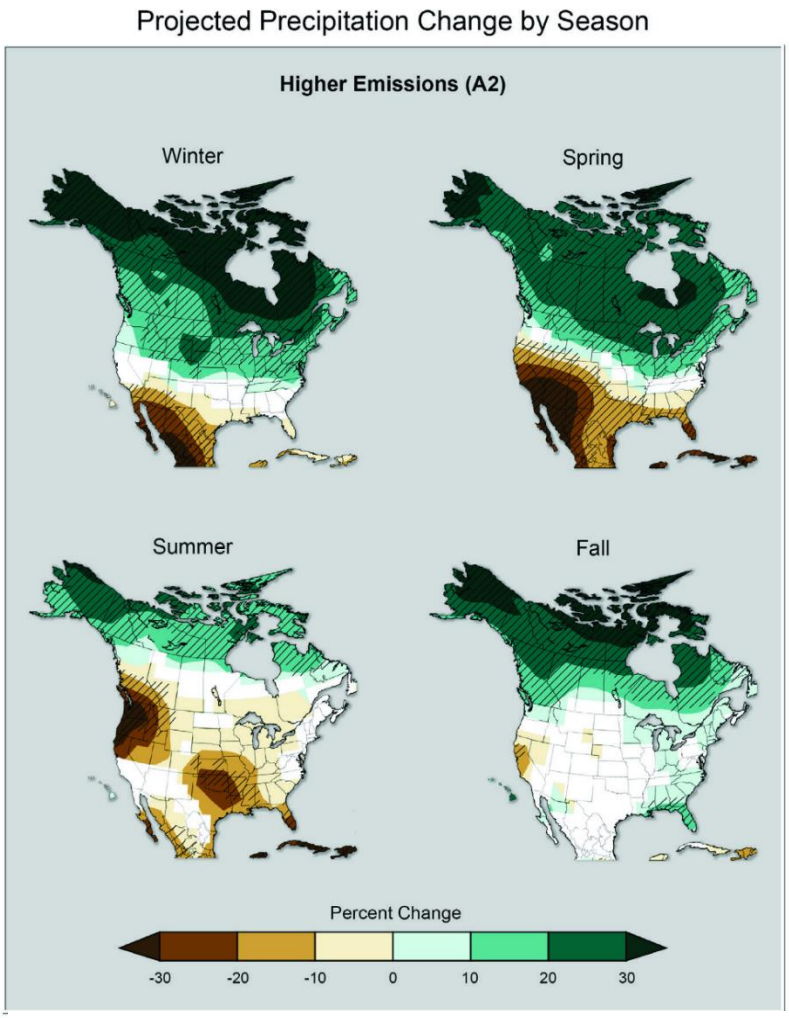


Figure 5. Projected precipitation patterns in the U.S. comparing 2071 – 2099 to the 1900 – 1960 average (Melillo *et al.* 2014). http://www.globalchange.gov/what-we-do/assessment

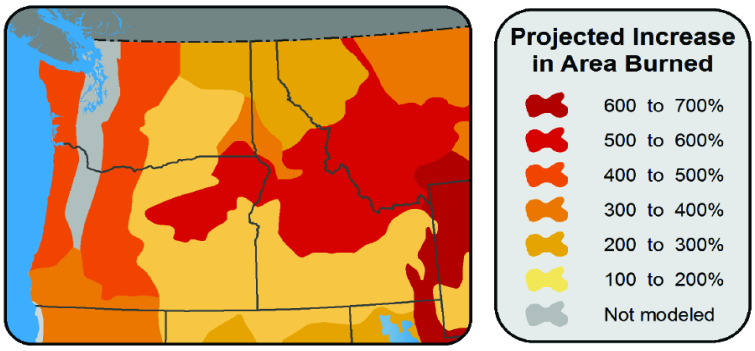


Figure 6. Anticipated wildfire consequences of a 2.2^{o}F warming in area burned (Melillo *et al.* 2014). http://www.globalchange.gov/what-we-do/assessment

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 9th Oregon Senate District Climate History and Projections

Temperature history and projections for the town of Three Lynx are presented in Figure 7. Red represents the business as usual scenario of increasing fossil fuel use while the blue line assumes some reduction in that trajectory. According to the former scenario, Marion County will likely exhibit nearly a 9 degree F increase from late 20th Century average temperatures.

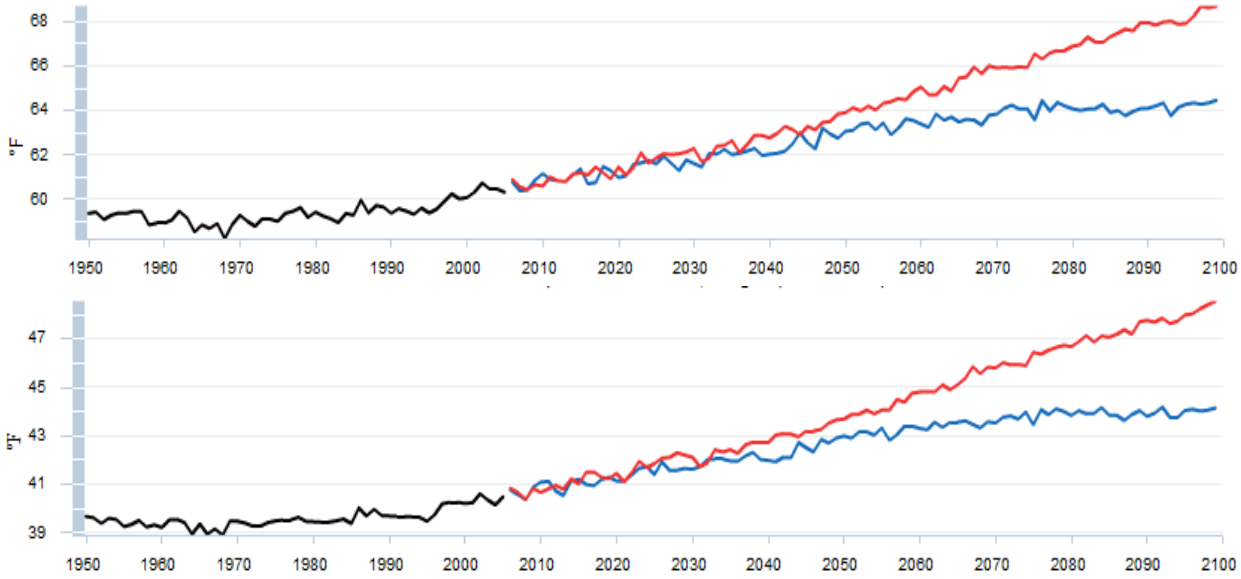


Figure 7. Temperature trends and projections for Marion County. Linn and Clackamas Counties exhibit similar trends. USGS 2017.

The precipitation trend and projection for Marion County are depicted in Figure 8 where the average remains generally flat but greater variability is seen through the century. This indicates more severe dry and wet years.

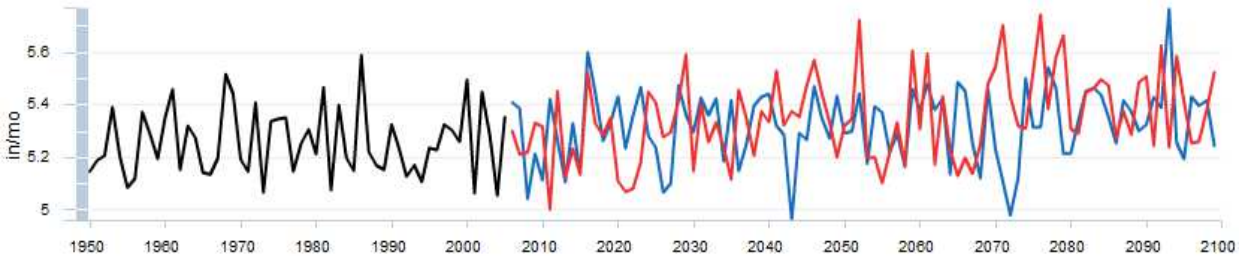


Figure 8. Historical and future projections of precipitation for Marion County. Linn and Clackamas Counties exhibit similar trends. USGS 2017.

Snowfall and consequent snowpack accumulation have been declining for decades in Marion County and will continue to do so at an alarming rate, as seen in Figure 9 regardless of emissions scenario (business as usual – red; emissions reduction – blue). Trends in the other counties of District 9 exhibited parallel patterns

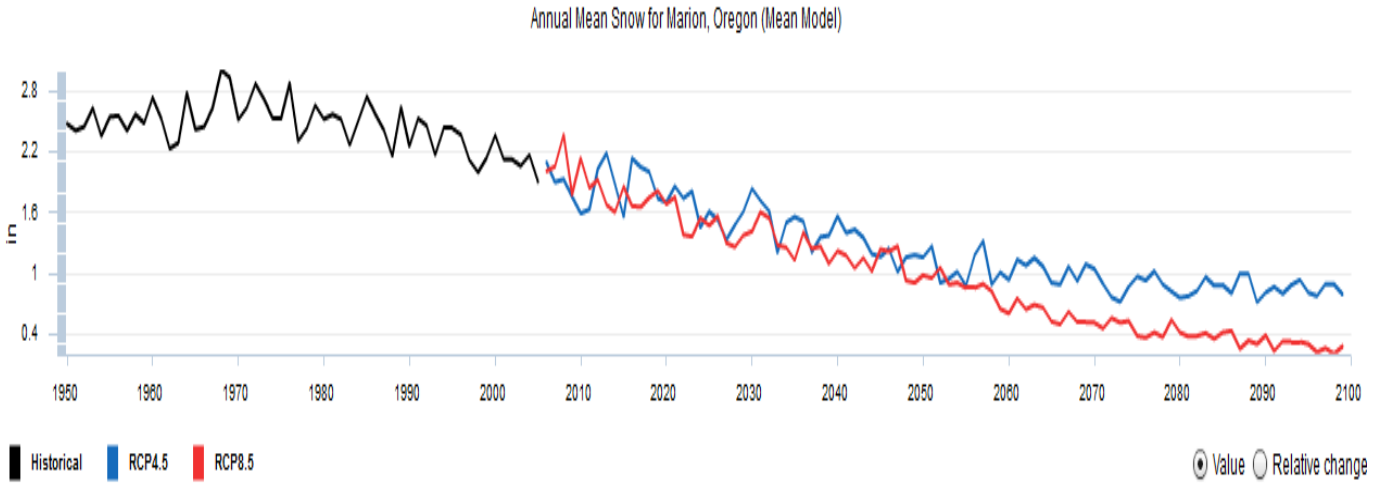


Figure 9. Marion County historic annual average snowpack in inches is presented in black with projections in blue and red. The projections are based on greenhouse gas concentration trajectories; blue assumes some redress in emissions while red assumes continued business as usual. https://www2.usgs.gov/climate_landuse/clu_rd/nccv/viewer.asp

Federal Congressional District Historical Temperature Trend

The 9th Senate District is located within Oregon's Federal Congressional Districts 4 and 5. The data indicate (Figure 10a and b)that the 4th Congressional District has been warming at a rate of 2.4°F per century, a rate faster than that of the state (1.2°F per century) as well as the United States average rate of 2.2°F for the century.

The 5th Congressional District has been warming at a rate of 1.4°F per century, a rate faster than that of Oregon but slower than the United States average.

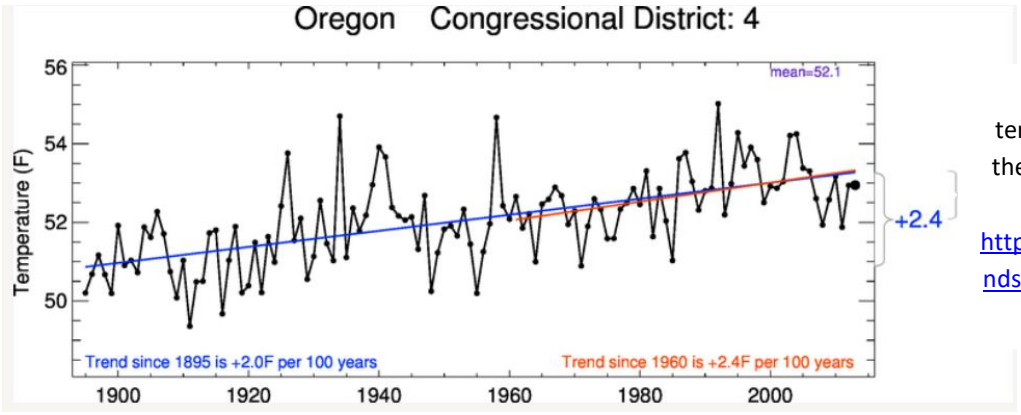


Figure 10a. Average temperature trend within the 4th U.S. Congressional District. http://www.temperaturetrends.org/district.php?district=4&state=OR

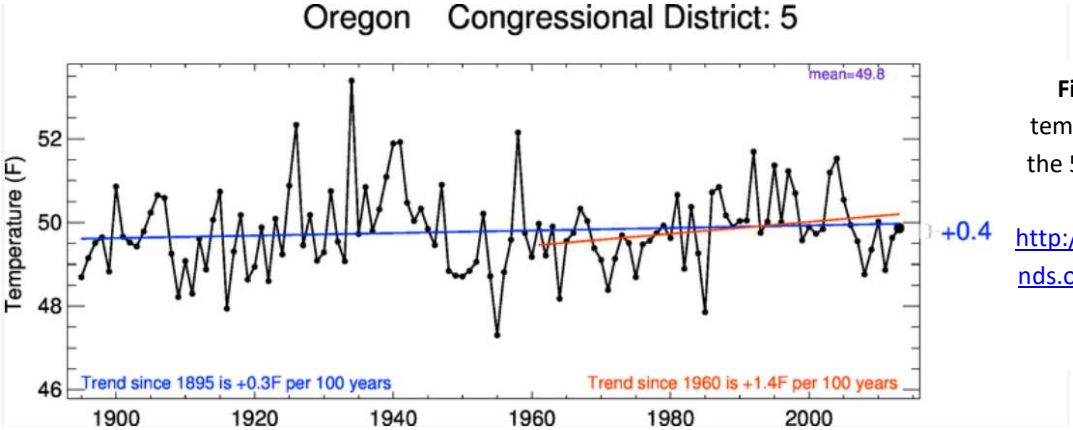
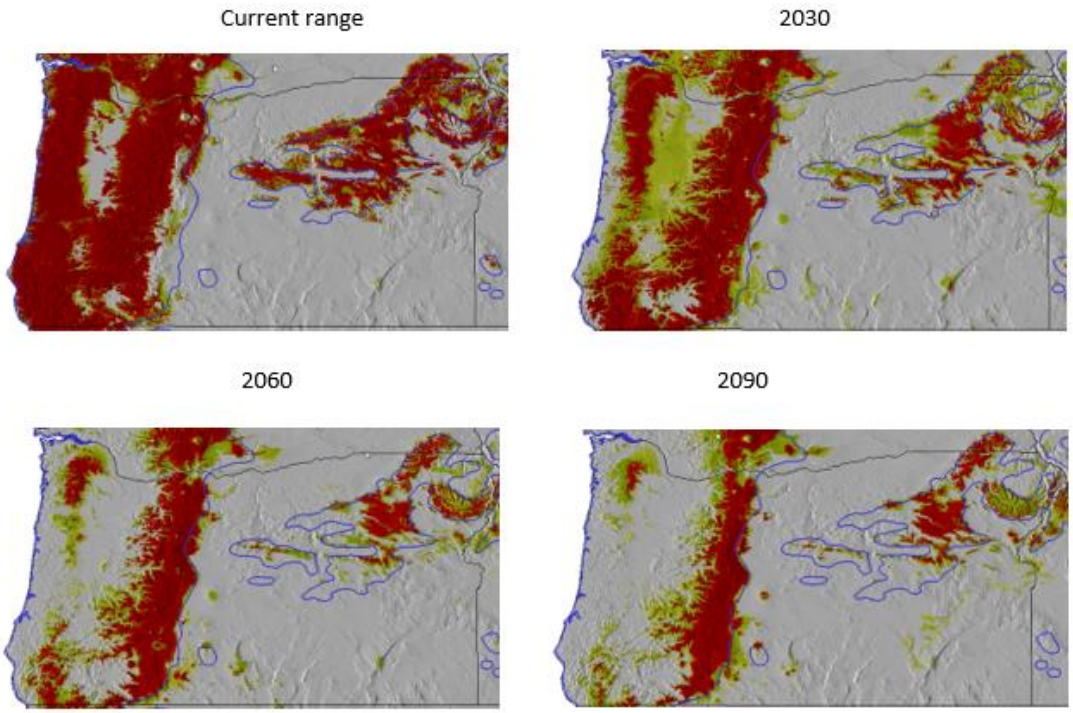


Figure 10b. Average temperature trend within the 5th U.S. Congressional District. http://www.temperaturetrends.org/district.php?district=4&state=OR

Oregon's 9th Senate District Economy

The local economy of Senate District 9 is made up of agriculture, healthcare, manufacturing and forestry. Agriculture will likely suffer considerably due to climate change. Decreasing supplies of water for irrigation, increasing incidence of pests and disease attacks, and growing competition from weeds threaten local agriculture.

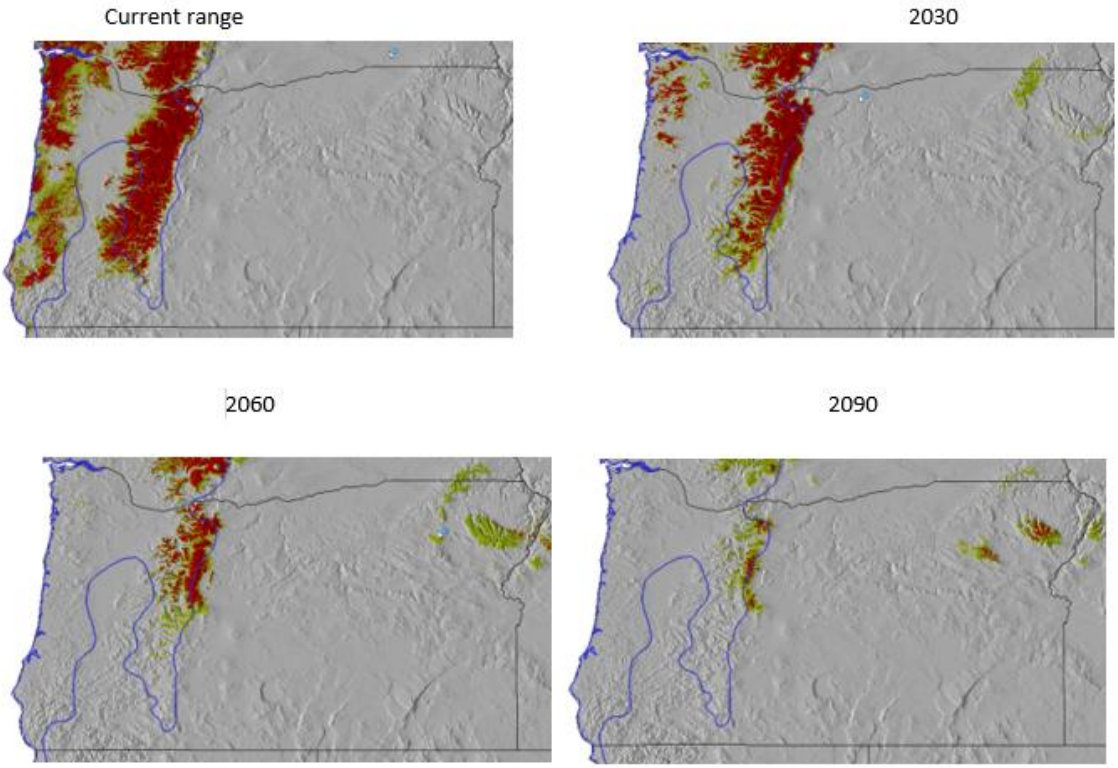
Figure 11 Douglas fir (*Psuedotsuga menzeisii*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/



Although timber/lumber production has declined it is still a significant component of this district's economy. The most important commercial tree species in District 9 are Douglas fir and

Western hemlock. With Douglas fir making up about 75%-80% of timber sales and Western hemlock at about 15% (Figure 11, 12). Their projected viabilities through this century indicate a likely reduced range for both species (high tree viability is indicated in red, low viability in green

Figure 12 Western hemlock (*Tsuga heterophylla*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/



and absence in areas without color).

These projections suggest conditions for these species may be less favorable than currently-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.

Forests, Wineries and Climate Change: Like natural systems generally, 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. Projected climate change impacts also threaten forests due to higher forest fire risk, decreasing tree growth, and increasing insect attacks. Higher summer temperatures, earlier spring snowmelt, and potential reductions in summer soil moisture would contribute to wildfire risk. Drought stress and higher temperatures would likely impede tree

growth, though high-elevation forests may experience increased growth in the short term. These climate impacts would also contribute to increased frequency and intensity of attacks from mountain pine beetles and other insects. These attacks would worsen fire risk and reduce timber production. 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.

Wine is another economically important industry in Senate District 9. The majority of Oregon's wineries can be found here in the Willamette Valley, capitalizing on both the international fame of its Pinot Noir and the easy access to Portland. It is the coolest of Oregon's wine regions, the Willamette Valley's climate is perfectly suited to certain grape varieties that don't require intense sun and heat to ripen, typically varieties originating in Northern Europe such as Pinot Noir and Chardonnay; Riesling, Gewurztraminer, Pinot Blanc and Pinot Gris. The Willamette Valley is also a beacon for wine tourism in Oregon, due to its easy access to the urban population and travel destination of Portland Oregon. The projected increase in temperatures along with longer summers and less rain would

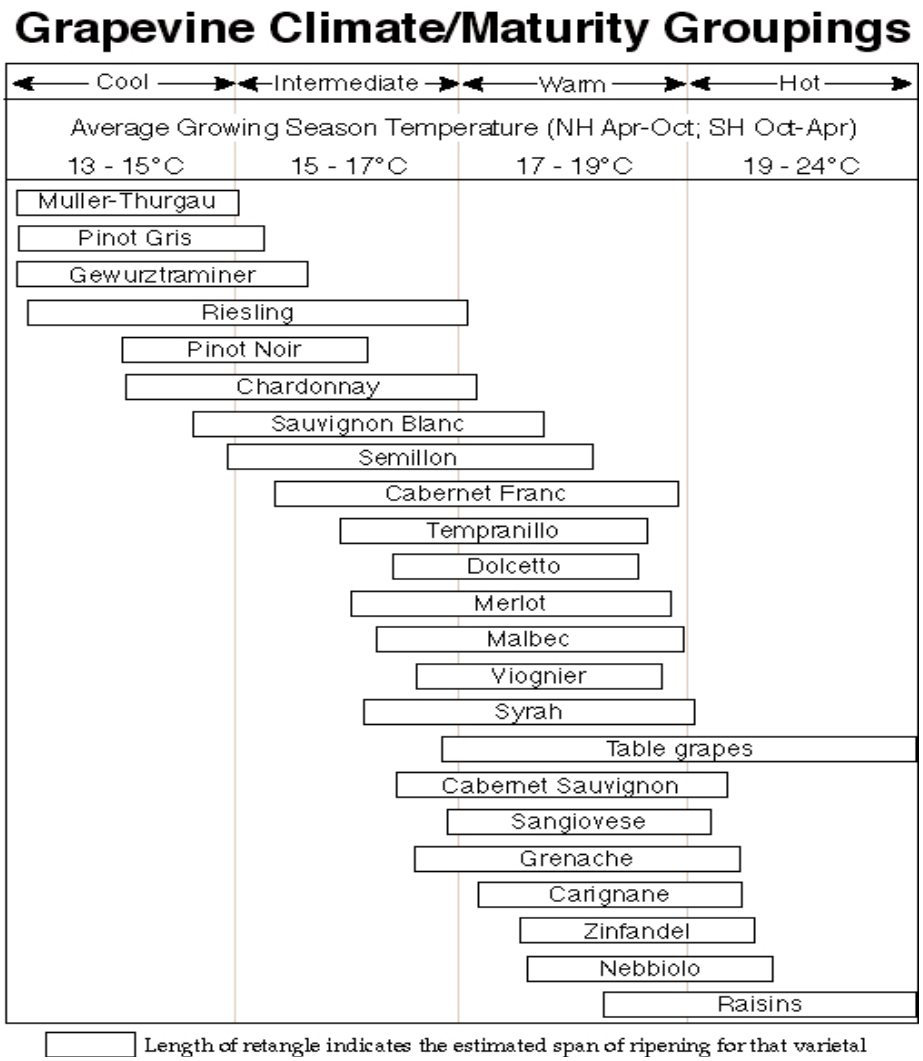


Figure 12. Grape varietals grow optimally where climatic conditions suit them. This graph depicts optimal growing season (April – October) temperatures for the varietals commonly grown in western Oregon. http://www.sou.edu/envirostudies/gjones_docs/GJones%20Climate%20Change

greatly alter the growing season and make it difficult to continue to grow these varieties of grapes. Figure 12 depicts the optimal temperatures for varietals grown in the region including the impact climate change will have on wine growing. Wineries will likely have to turn to warmer season grapes to stay in business.

Oregon's 9th Senate District Recreation

Outdoor recreation, a popular pastime in District 9, is extremely dependent on the natural resource base and the weather. Nearby Mount Hood, the only year-round ski resort in the United States, is a major attraction for recreating and tourism. The projected decrease in snow cover seen in Figure 9 along with a shorter winter season could potentially hurt business. The mountain and its rivers and forests offer outdoor recreation activities, from skiing and rafting to fishing and camping. A longer summer poses a threat to winter activities such as cross-country and downhill skiing, snow shoeing, skating, ice fishing, etc. Climate change will also affect summer recreation activities. Fish populations may dwindle due to a decrease in stream flow and warmer temperatures. Camping, hiking and rafting may become more difficult due to forest fires, increased temperatures and low stream flow. Rapid climate change could mean that many plant and animal species are unable to adapt and may become extinct in the process. Hunters and wildlife enthusiasts will more than likely follow the wildlife north or learn to hunt and view other forms of wildlife that move into the areas that they themselves usually frequent. The indirect effects of this include the loss of tourism revenues to local restaurants, hotels and other forms of amusement as well as the loss of jobs for people within the community.

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, in fact for each degree C temperature rise crop 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: heat, allergens, storms, and floods. The top health concerns will be: poor air quality, respiratory illness, heat-related illness, harmful algal blooms, recreational hazards, increased

allergens, displacement, landslides, economic instability, and mental health impacts. Communities that will be especially vulnerable will be: low-income households and neighborhoods, communities of color, older adults, people living on steep slopes, people working in agriculture, first responders, Native Americans, young 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^{o}C**
2000 – Now	**440**	**1.5^{o}C**
Allowed	**825**	**2^{o}C**
Fossil Fuel Reserves	**725**	**3 - 4^{o}C**
Accessible Reserves	**780**	**5 - 6^{o}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^{o}C to 1.6^{o}C (2.7 - 2.9^{o}F) (Dixon 2001). If we wish to avoid an increase over 2^{o}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^{o}C upper limit. In relation to shooting beyond 2^{o}C, the World Bank (2012) acknowledged there is: "no certainty that adaptation to a 4^{o}C world is possible."

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

Contact your Senator: Fred Girod

Capitol Phone: 503-986-1709
Capitol Address: 900 Court St NE, S-401, Salem, OR, 97301
Email: Sen.FredGirod@state.or.us
Website: http://www.oregonlegislature.gov/girod

House District 17: Representative Sherries Springer

Capitol Phone: 503-986-1417
Capitol Address: 900 Court St NE, H-388, Salem, OR 97301
Email: Rep.SherrieSprenger@oregonlegislature.gov
Website: http://www.oregonlegislature.gov/sprenger

House District 18: Representative Rick Lewis

Capitol Phone: 503-986-1418
Capitol Address: 900 Court St NE, H-479, Salem, OR 97301
Email: Rep.RickLewis@oregonlegislature.gov
Website: http://www.oregonlegislature.gov/lewis

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