Southern Oregon Climate Action Now
SOCAN
Confronting Climate Change

Climate Change in the Oregon 28th Senate District

July 2017

History, Projections, and Consequences

1. The last half of the 20th Century witnessed a district temperature increase of some 1°F
2. Projections suggest a further increase during this century up to 10°F
3. Snowfall and snowpack, already declining, are expected to fall further by the end of the century, possibly to less than 20% of historic patterns
4. Although annual rainfall average may remain steady, the seasonal pattern will likely shift to slightly wetter winters and somewhat drier summers with rain falling as heavier downpours inducing floods and erosion rather than soil moisture replenishment.
5. The wildfire season, already 2.5 months longer than in the 1970 will likely expand further with a 500 – 600% greater area being burned as wildfire risk increases.
6. Both tourism and commercial forestry may be compromised by the impact of warming on critical forest species.
7. Reduced snowpack and warming waters may compromise the ability of regional waters to support the current array of cold water fish and aquatic species.
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. The main likely health impacts are: wildfire, drought, and infectious disease. The top health concerns will be: poor air quality, respiratory illness, occupational hazards, displacement, contaminated drinking water, water insecurity, vector-borne disease, economic instability, and mental health impacts. The most vulnerable communities will be: low-income households, American Indians, private well users, rural households, people working in agriculture, firefighters and first responders, children and pregnant women.

Compiled by Emily Patrick & Alan Journet
(patricke@sou.edu, 541-880-6563 alanjournet@gmail.com, 541-301-4107)
For a more complete summary, including sources, from which these points are taken, visit: 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).

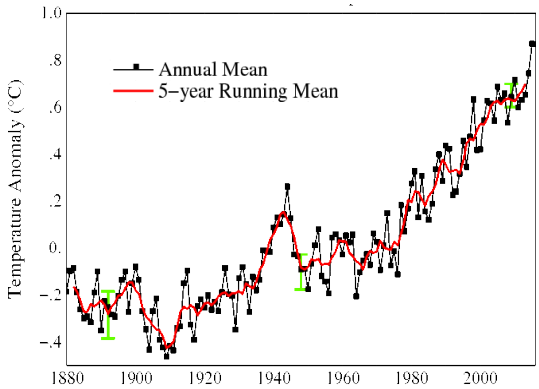


Figure 1. Historic global temperature trend NASA Goddard Institute for Space Studies 2017.

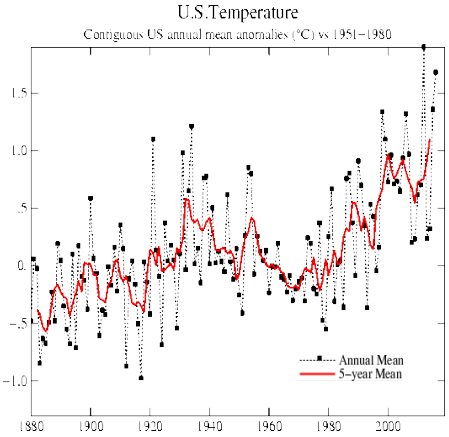


Figure 2. Historic U.S temperature trend. NASA Goddard Institute for Space Studies 2017.

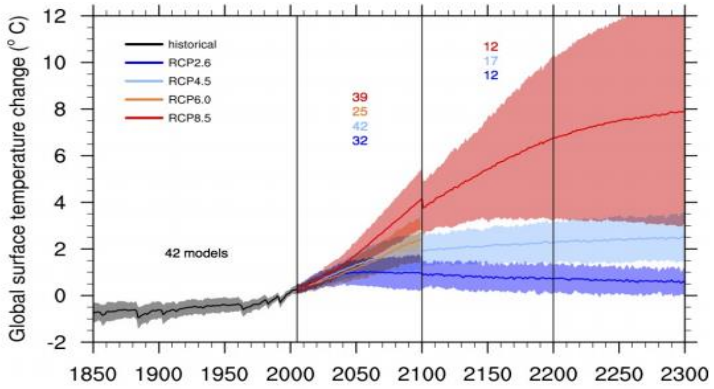


Figure 3. Intergovernmental Panel on Climate Change 2013 global projections.
http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_Chapter12.pdf

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.

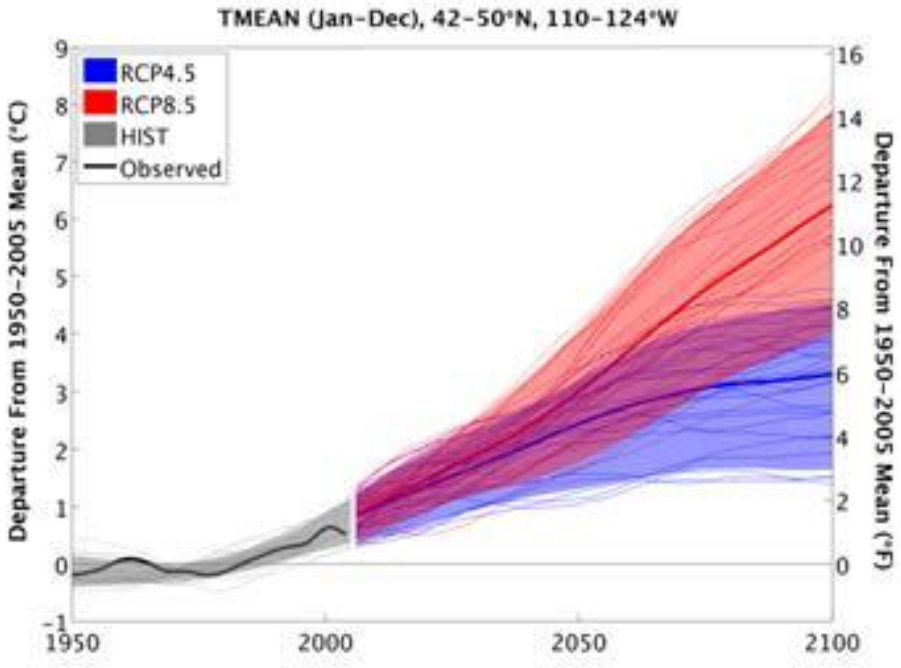


Figure 4. Oregon temperature history and projections through the century (Dalton *et al.* 2013).
http://library.state.or.us/repository/2010/201012011104133/summaries.pdf

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.

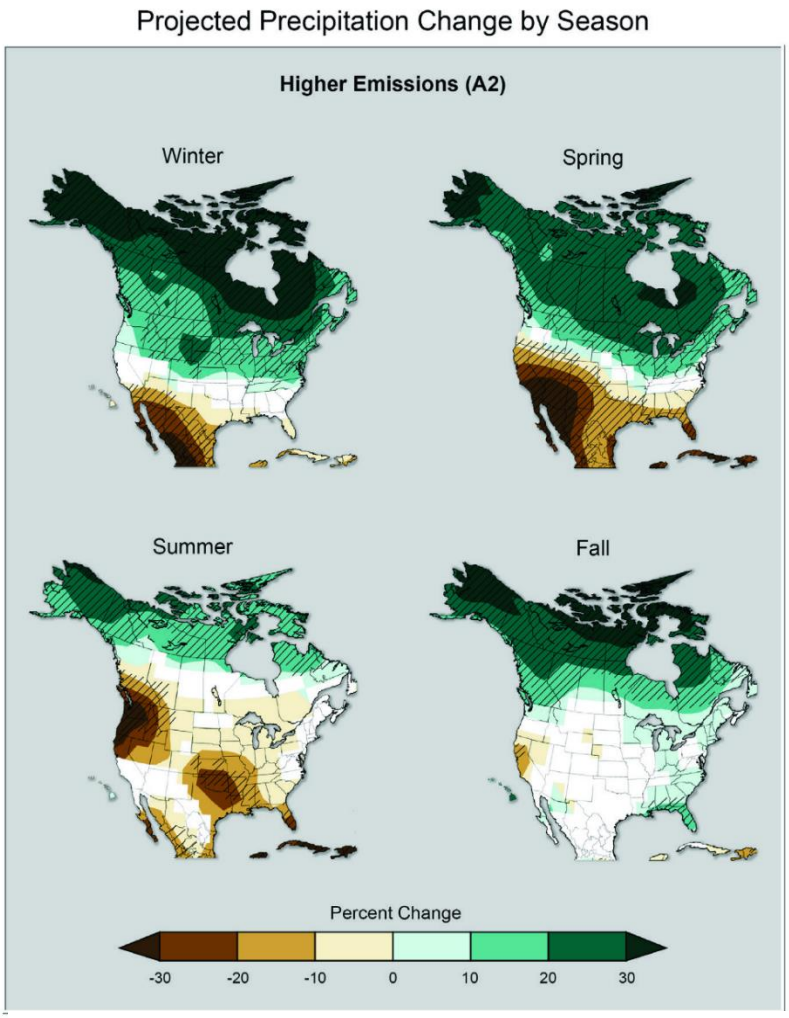


Figure 5. Projected precipitation patterns in the U.S. comparing 2071 – 2099 to the 1900 – 1960 average (Melillo *et al.* 2014). http://www.globalchange.gov/what-we-do/assessment

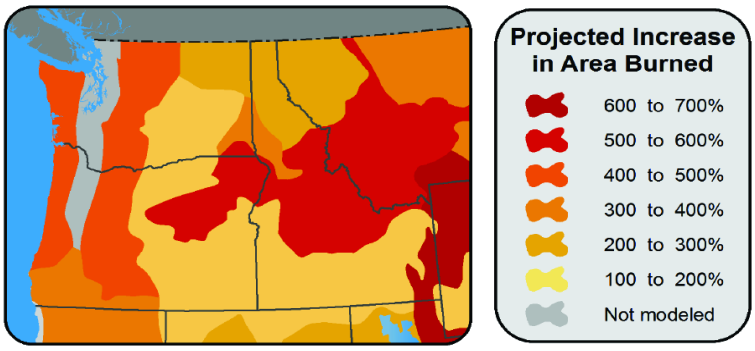


Figure 6. Anticipated wildfire consequences of a 2.2^{0}F warming in area burned (Melillo *et al.* 2014). http://www.globalchange.gov/what-we-do/assessment

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 28th Oregon Senate District Climate History and Projections:

Although climate change is a complex issue, current models indicate several important trends in weather and climate that Oregon's 28th Senate District is likely to experience if carbon emissions continue to increase. These trends include an increase in mean annual temperature and a decrease in overall precipitation (including both rain and snowfall).

For Klamath County (Figure 7), the temperature trend for the last half of the 20th Century shows nearly about a 1°F increase. The Business As Usual scenario (red line) representing continued accelerating fossil fuels use and greenhouse gas emissions suggests that by the end of this century, the temperature may be nearly 10°F above the mean for that period. Reducing the emissions trajectory (blue line) may result in an increase only about half that. The rising temperature trend grades from the 7 - 8°F range above late 20th century average for coastal Oregon to some 10°F above that average for Eastern counties.

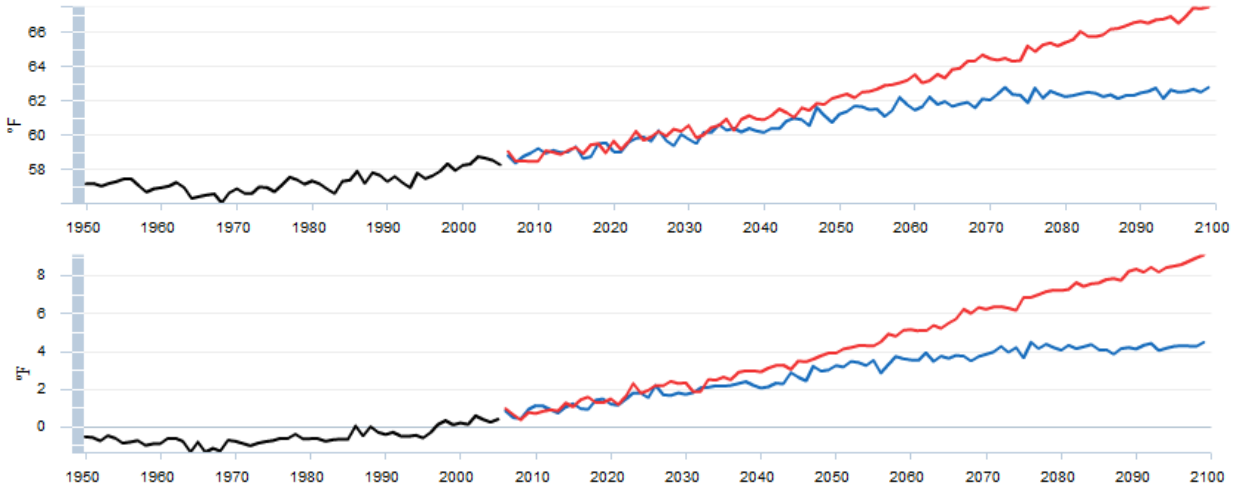


Figure 7. The historical and projected annual mean maximum (upper) and minimum (lower) temperatures for Klamath County (USGS 2017).

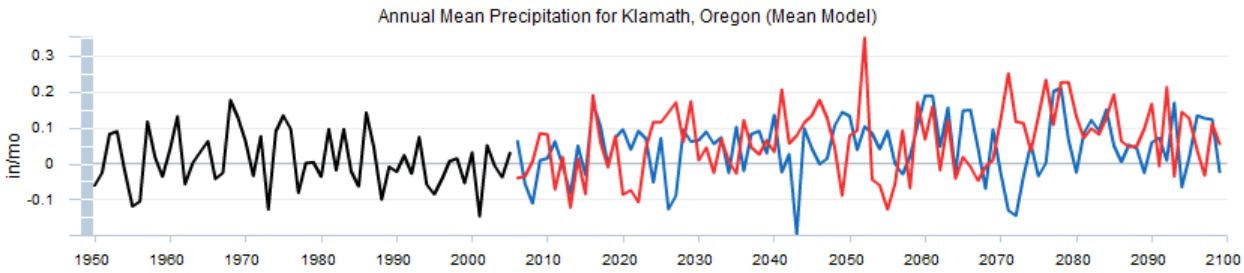


Figure 8. Historical and projected precipitation for Klamath Falls (USGS 2017).

The historic trend in precipitation for Klamath County (Figure 8) indicates variability but an essentially level trend. The future, regardless of scenario, suggests a similar level trend but with greater variability, meaning wetter and drier years. In combination with the seasonal pattern (Figure 5) where drier summers are expected, the risk of summer - fall drought will likely increase.

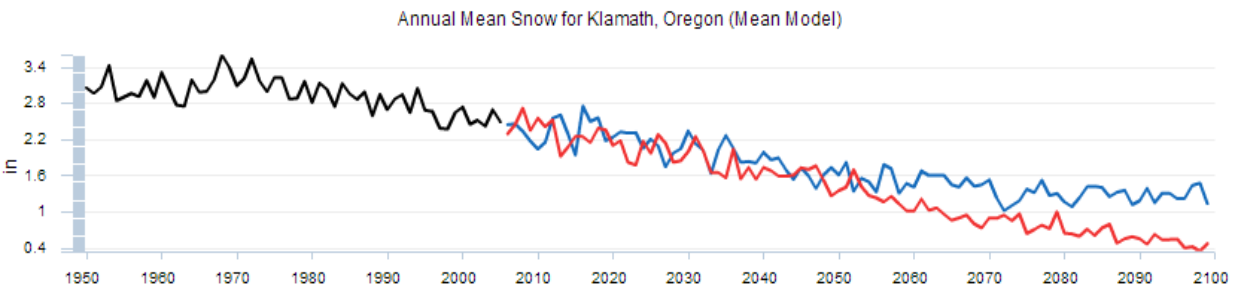


Figure 9. Historical and projected trend for snowfall in Klamath County, Oregon (USGS 2017).

According to park data, snowfall in the mid elevation Cascades of Crater Lake National Park has been falling consistently since the 1930s, having dropped 25% since then. As shown in Figure 9, the past and projected trend in snowpack for Klamath County is one of decline, possible to only 10% of historical levels by late century. The future reduction in high elevation snowpack suggests a more severe wildfire season. Combined with the current and projected trend of precipitation falling more often as heavy downpours rather than light rain, this will likely result in more flooding and 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.

Oregon 28th Senate District Economy:

Oregon's 28th Senate District is home to a suite of natural resources, and its economy reflects that. The economy is based in large part around timber, agriculture, livestock, and tourism and recreation. Additionally, the healthcare industry is a large employer in the region, as parts of Oregon's 28th senate district have experienced a boom in their retiree population as older folks have flocked from California to enjoy their "golden years."

Agriculture, livestock production and the timber industry are likely to be negatively affected by climate change. Because climate change, as was discussed earlier, is expected to increase temperatures in the region over the next century, lengthen the summer drought period, and reduce winter snowpack and the winter chill period, it will likely become increasingly difficult for farmers to grow certain crops. Some orchard crops, such as pears, require a lengthy winter chill period in order for them to thrive. Furthermore, many crops grow in a restricted temperature range, and increasing temperatures may make Oregon's 28th senate district a less favorable place for these crops over the century. Irrigation is largely what makes livestock and hay production possible in this region of Oregon, and an increasing summer drought period will likely result in even scarcer summer water in the coming decades

While Ponderosa pine is one of the region's most valuable commercial timber products, other species processed in the region are Western hemlock, Incense cedar, Lodgepole pine, White fir, and Douglas fir. Current and projected distributions of these species under the influence of the changing climate are depicted in Figures 10 – 15: purple represents high viability, green medium viability and clear zero viability conditions (Rehfeldt *et al.* 2006).

The projections suggest that many important commercial tree species will suffer reduced viability and distribution through the coming century, compromising the forest and the timber economy. Given the ability of many Oregon forests of to store carbon (Hudiburg *et al.* 2009), it is critical that climatic conditions not diverge such that these important species are compromised.

Outdoor recreation is also an important part of Oregon's 28th Senate District's economy. The Klamath National Wildlife Refuge has been heralded as a "birdwatcher's paradise." However, the ranges of many local bird species are expected to shift dramatically in the coming decades as temperatures increase and habitats shift.

Figure 10 Douglas fir (*Psuedotsuga menzeisii*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/

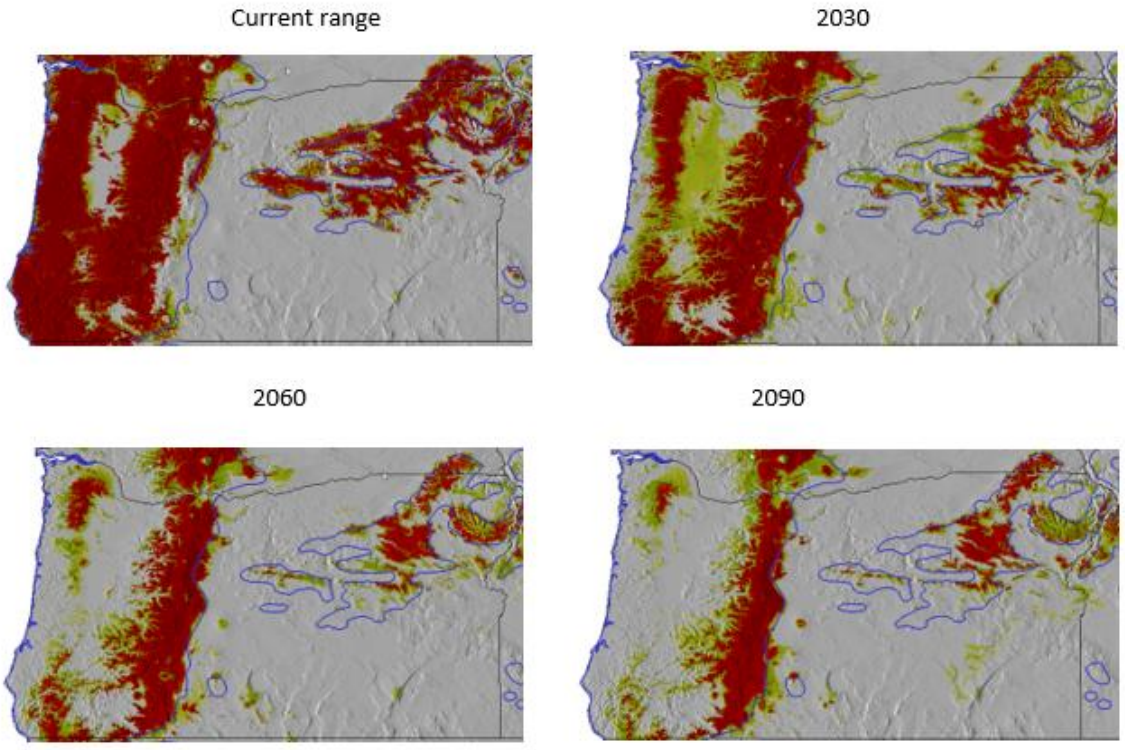


Figure 11 Western hemlock (*Tsuga heterophylla*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/

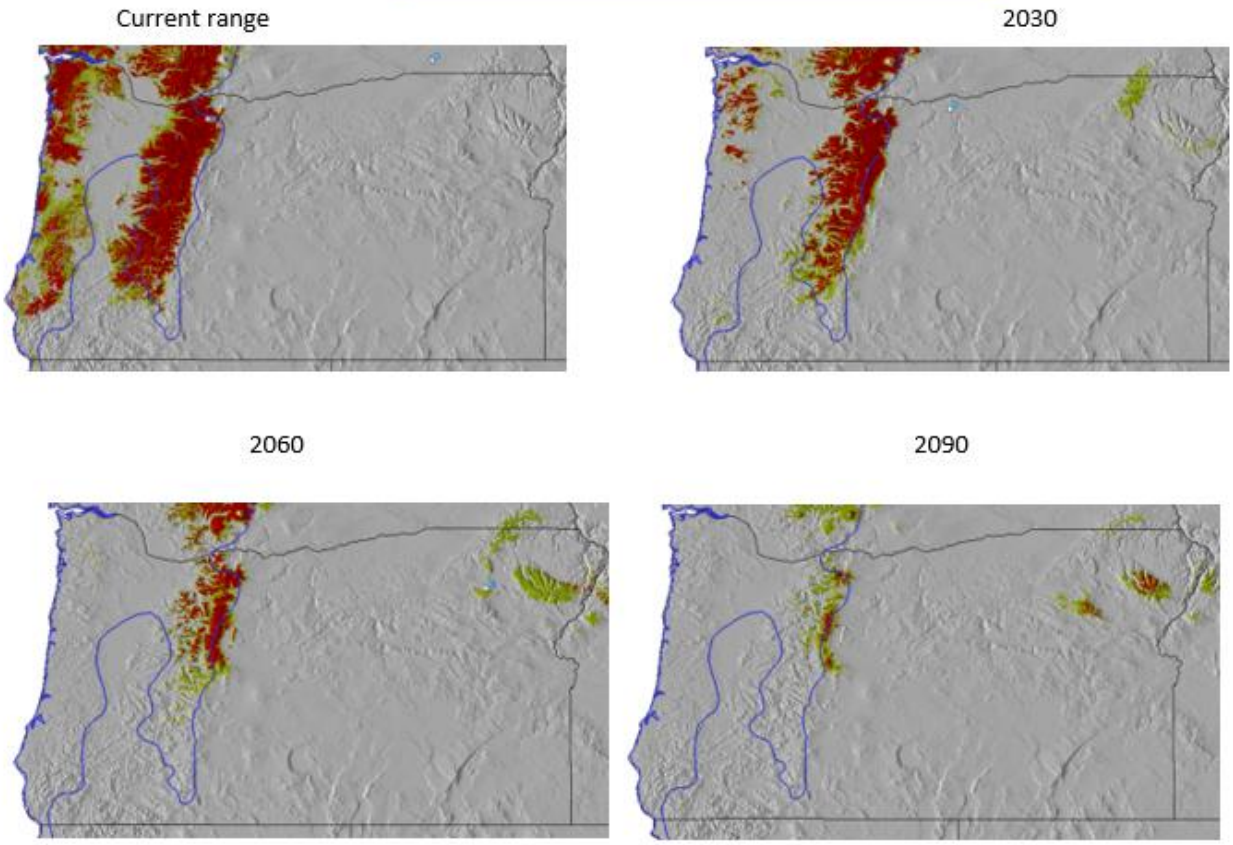


Figure 12 Incense cedar (*Calocedrus decurrens*) Current and Projected Distribution http://charcoal.cnre.vt.edu/climate/species/

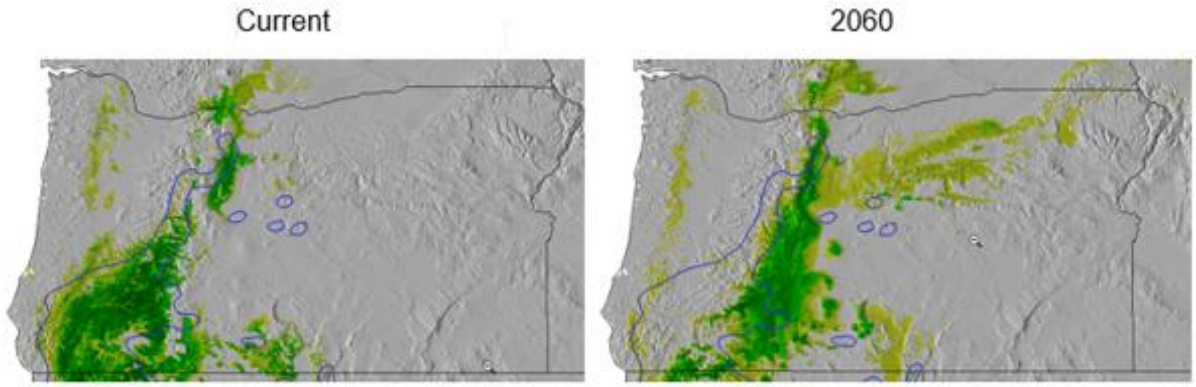


Figure 13 Lodgepole pine (*Pinus contorta*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/

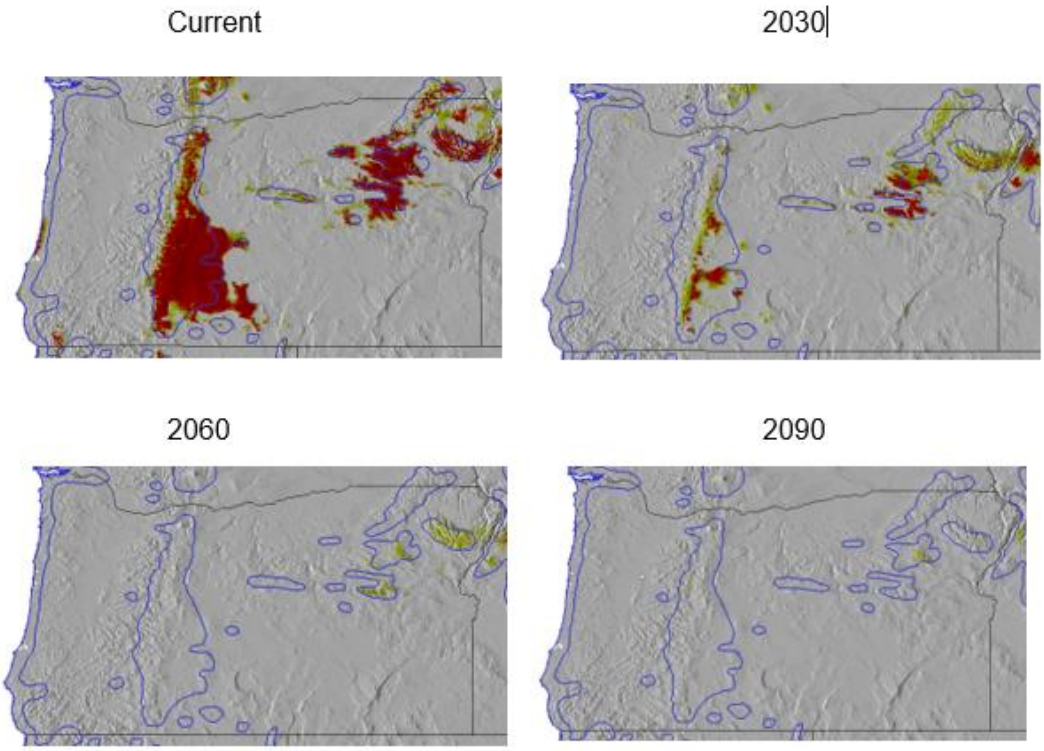


Figure 14 White fir (*Abies concolor*) Current and Projected distribution
http://charcoal.cnre.vt.edu/climate/species/

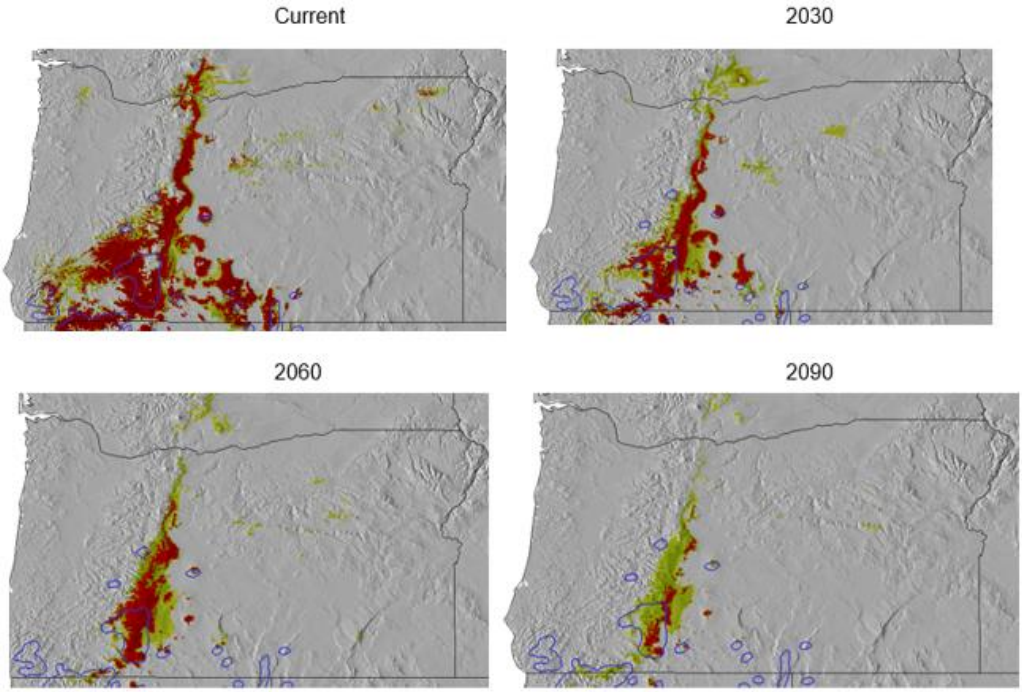
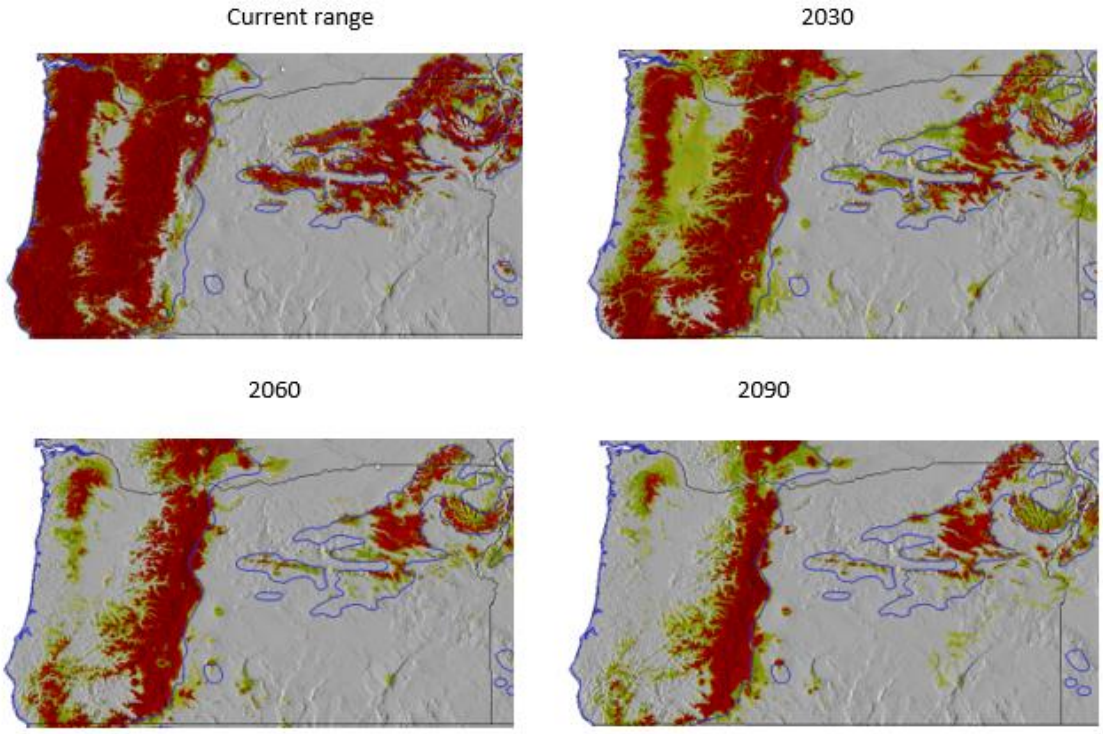


Figure 15 Douglas fir (*Psuedotsuga menzeisii*) current and projected distribution through the 21st Century
http://charcoal.cnre.vt.edu/climate/species/



Since Oregon's 28th Senate District lies on the edge of the Great Basin, trends for that region are potentially relevant. Water resources are expected to experience enhanced winter stream flow but suffer negatively from lower summer stream flow. Warmer winter will delay the start of winter sports seasons, shorten it and increase the likelihood of rain.

Although not necessarily as intuitive, climate change will also likely affect the retirees who have chosen Southern Oregon as their home. The heat and probability of increases in wildfires will likely make it harder for elderly Oregonians to breathe during the summer months. Health costs in the area are likely to rise as a result, and the wave of retirees that have recently bolstered the economy may diminish.

It's not a question of if climate change will negatively affect the 28th senate district's natural resources, its citizens and its economy, but a question of when and how. Scientists can help to answer some of these questions, but it's up to government officials at every level of government to act now to prevent problems before they arise.

Oregon 2nd Congressional District Historic Temperature Trend cf Oregon and US:

Since the Oregon Senate 3rd District falls within the Second Federal Congressional District, it is instructive to see how historic patterns have fared across that district.

The

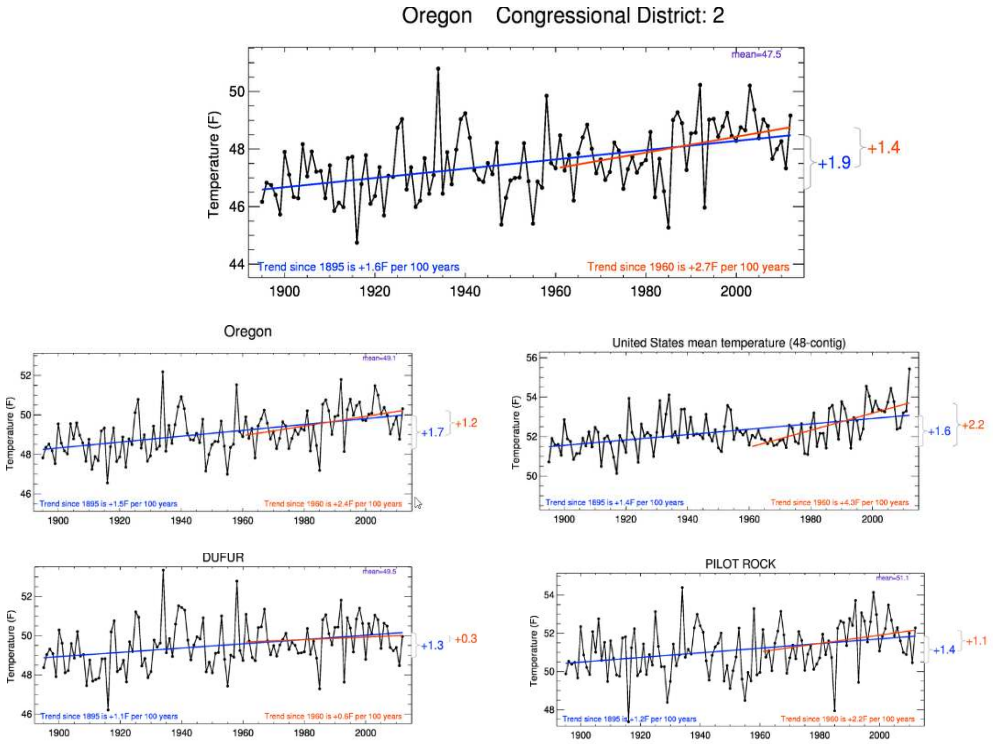


Figure 16. Temperature trends through the Second US Congressional District
http://temperaturetrends.org/global.php?district=2&state=OR

data indicate (Figure 16) that the second Congressional District has been warming at a rate of 1.4°F per century, a rate faster than that of Oregon as a whole (1.2°F per century) but slower than the United States average rate of 2.2°F for the century. This entire district is clearly experiencing the consequences of climate change.

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 Impacts:

According to the Oregon Health Authority (2014), the main climate impacts to health are likely to be: wildfire, drought, and infectious disease. The top health concerns will be: poor air quality, respiratory illness, occupational hazards, displacement, contaminated drinking water, water insecurity, vector-borne disease, economic instability, and mental health impacts. Communities that will be especially vulnerable will be: low-income households, American Indians, private well users, rural households, people working in agriculture, 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^{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**

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 Senator Dennis Linthicum

Capitol Phone: 503-986-1728
Capitol Address: 900 Court St NE, S-305, Salem, OR, 97301
Email: Sen.DennisLinthicum@oregonlegislature.gov
Website: http://www.oregonlegislature.gov/linthicum

House District 55: Mike McLane:

Capitol Phone: 503-986-1455
Capitol Address: 900 Court St NE, H-381, Salem, OR 97301
Email: Rep.MikeMcLane@state.or.us
Website: http://www.oregonlegislature.gov/mclane

House District 56: Werner Reschke:

Capitol Phone: 503-986-1456
Capitol Address: 900 Court St NE, H-384, Salem, OR 97301
Email: Rep.EWernerReschke@oregonlegislature.gov
Website: http://www.oregonlegislature.gov/reschke

Literature:

Brown L 2006 *Plan B 2.0: Rescuing a Planet Under Stress and a Civilization in Trouble.* W.W. Norton, & Co. N.Y. London 365 pp

Chamber JC., 2008 Climate Change and the Great Basin. USDA Forest Service, Rocky Mountain Research Station, Reno NV: http://www.fs.fed.us/rm/pubs/rmrs_gtr204/rmrs_gtr204_029_032.pdf

Crowe, EA., BL. Kovalchik, and MJ. Kerr. 2004. Riparian and Wetland Vegetation of Central and Eastern Oregon. Oregon State University, Portland, OR. 473 pp.

Dalton, MM., PW. Mote, and A.K. Snover [Eds.] 2013. *Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities.* Washington, DC: Island Press, 230 pp.

Dixon 2001 Global Warming Commitment: Temperatures Would Rise Even with No Further Additional Greenhouse Gas Increases. NOAA. http://www.gfdl.noaa.gov/cms-filesystem-action?file=/user_files/kd/pdf/onepageb01.pdf

Hudiburg T, Law B, Turner D, Campbell J, Donato D, Duane M. 2009. Carbon dynamics of Oregon and Northern California forests and potential land-based carbon storage. *Ecological Applications* 19: 163 – 180.

IEA 2009, *World Energy Outlook*, International Energy Agency, Paris, France, 691 pp

IPCC 2013. Climate Change 2013: The Physical Science Basis; Summary for Policymakers WGI IPCC Switzerland.

Le Quéré C, Moriarty R. Andrews R, Peters G, Ciais P, Friedlingstein P, Jones S, Sitch S, Tans P, Arneth A, Boden T, Bopp L, Bozec Y, Canadell J, Chevallier F, Cosca C, Harris I, Hoppema M, Houghton R, House I, Johannessen T, Kato E, Keeling R, Kitidis V, Klein Goldewijk K, Koven C, Landa C, Landschützer, Lenton A, Lima I, Marland G, Mathis J, Letzl N, Nojiri Y, Olsen A, Ono T, Peters W, Pfeil B, Poulter B, Raupach M, Regnier P, Rödenbeck C, Saito S, Salisbury J, Schsuter U, Schwinger J, Séférian R, Segcshneider J, Steinhoff T, Stocker B, Sutton A, Takahashi T,

Tilbrook B, van der Werf G, Viovy N, Wang Y 2014 Global Carbon Budget 2014 Earth System Science Data 7: 521-610.
Melillo, JM., TC. Richmond, and GW Yohe, [Eds.] 2014: *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.
Miller SM, Wofsy SC, Michalak AM, Kort EA, Andrews AE, Biraud SC, Dlugokencky EJ, Eluskiewicz J, Fischer ML, Janssens-Maenhout G, Miller BR, Miller, JB, Montzka SA< Nehkorn T, Sweeney C. 2013, Anthropogenic emissions of methane in the United States. Proceedings of the National Academy of Science, 110 (50) http://calgem.lbl.gov/Miller-2013-PNAS-US-CH4-Emissions-9J5D3GH72.pdf
NASA Goddard Institute for Space Studies July 2017 *GISS Surface Temperature Analysis.* Retrieved from NASA Goddard Institute for Space Studies: https://data.giss.nasa.gov/gistemp/graphs_v3/Fig.A2.gif and http://data.giss.nasa.gov/gistemp/graphs_v3/Fig.D.gif
Oregon Health Authority 2014: Oregon Climate and Health Profile Report, Climate and Heath Program, Public Health Division, Oregon Health Authority. Summary provided by Emily York MPH, Climate & Health Program Coordinator, Oregon Public Health Division, Oregon health Authority http://public.health.oregon.gov/HealthyEnvironments/climatechange/Documents/oregon-climate-and-health-profile-report.pdf
Quick M, 2014 How Many Gigatons of Carbon Dioxide…? http://www.informationisbeautiful.net/visualizations/how-many-gigatons-of-co2/
Rehfeldt G, Crookston N, Warwell M, Evans J 2006 Empirical Analyses of Plant-climate Relationships for the Western United States, *International Journal of Plant Science* 167 (6): 1123 – 1150.
UN 2009 United Nations Framework Convention on Climate Change: Copenhagen Accord. United Nations, Stockholm, Sweden. http://unfccc.int/resource/docs/2009/cop15/eng/11a01.pdf
USGS 2017 National Climate Change Viewer (NCCV) United States Geological Survey https://www2.usgs.gov/climate_landuse/clu_rd/nccv/viewer.asp
Westerling A, Hidalgo H, Cayan D, Swetnam D, 2006 "Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity" *Science* 313 no. 5789 pp. 940-943.
World Bank 2012, *Turn Down the Heat: Why a 4^{o}C Warmer World Must be Avoided*. The World Bank, Washington DC. 84pp
World Bank 2013, *Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience*. The World Bank, Washington DC. 213pp
World Bank 2014, *Turn Down the Heat: Confronting the New Climate Normal*. The World Bank, Washington DC. 275pp