

California at a Crossroads: Climate Change Science Informing Policy
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Abstracts

Title: Overview of the California climate change scenarios project
Authors: Cayan, DR; Luers, AL; Franco, G; Hanemann, M; Croes, B; Vine, E
Author Full Names: Cayan, Daniel R.; Luers, Amy L.; Franco, Guido; Hanemann, Michael;
Croes, Bart; Vine, Edward
Source: CLIMATIC CHANGE 87: S1-S6 Suppl. 1 MAR 2008

Abstract: In response to an Executive Order by California Governor Schwarzenegger, an evaluation of the implications to California of possible climate changes was undertaken using a scenario-based approach. The "Scenarios Project" investigated projected impacts of climate change on six sectors in the California region. The investigation considered the early, middle and later portions of the twenty-first century, guided by a set of IPCC Fourth Assessment global climate model runs forced by higher and lower greenhouse gas emission scenarios. Each of these climate simulations produce substantial impacts in California that would require adaptations from present practices or status. The most severe impacts could be avoided, however, if emissions can be held near the lower end of global greenhouse gas emissions scenarios.

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Title: Linking climate change science with policy in California
Authors: Franco, G; Cayan, D; Luers, A; Hanemann, M; Croes, B
Author Full Names: Franco, Guido; Cayan, Dan; Luers, Amy; Hanemann, Michael; Croes, Bart
Source: CLIMATIC CHANGE 87: S7-S20 Suppl. 1 MAR 2008

Abstract: Over the last few years, California has passed some of the strongest climate policies in the USA. These new policies have been motivated in part by increasing concerns over the risk of climate-related impacts and facilitated by the state's existing framework of energy and air quality policies. This paper presents an overview of the evolution of this increased awareness of climate change issues by policy makers brought about by the strong link between climate science and policy in the state. The State Legislature initiated this link in 1988 with the mandate to prepare an assessment of the potential consequences of climate change to California. Further interactions between science and policy has more recently resulted, in summer of 2006, in the passage of Assembly Bill 32, a law that limits future greenhouse gas emissions in California. This paper discusses the important role played by a series of state and regional climate assessments beginning in 1988 and, in particular, the lessons learned from a recently completed study known as the Scenarios Project.

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Title: Climate change scenarios for the California region

Authors: Cayan, DR; Maurer, EP; Dettinger, MD; Tyree, M; Hayhoe, K

Author Full Names: Cayan, Daniel R.; Maurer, Edwin P.; Dettinger, Michael D.; Tyree, Mary; Hayhoe, Katharine

Source: CLIMATIC CHANGE 87: S21-S42 Suppl. 1 MAR 2008

Abstract: To investigate possible future climate changes in California, a set of climate change model simulations was selected and evaluated. From the IPCC Fourth Assessment, simulations of twenty-first century climates under a B1 (low emissions) and an A2 (a medium-high emissions) emissions scenarios were evaluated, along with occasional comparisons to the A1fi (high emissions) scenario. The climate models whose simulations were the focus of the present study were from the Parallel Climate Model (PCM1) from NCAR and DOE, and the NOAA Geophysical Fluid Dynamics Laboratory CM2.1 model (GFDL). These emission scenarios and attendant climate simulations are not "predictions," but rather are a purposely diverse set of examples from among the many plausible climate sequences that might affect California in the next century. Temperatures over California warm significantly during the twenty-first century in each simulation, with end-of-century temperature increases from approximately +1.5 degrees C under the lower emissions B1 scenario in the less responsive PCM1 to +4.5 degrees C in the higher emissions A2 scenario within the more responsive GFDL model. Three of the simulations (all except the B1 scenario in PCM1) exhibit more warming in summer than in winter. In all of the simulations, most precipitation continues to occur in winter. Relatively small (less than similar to 10%) changes in overall precipitation are projected. The California landscape is complex and requires that model information be parsed out onto finer scales than GCMs presently offer. When downscaled to its mountainous terrain, warming has a profound influence on California snow accumulations, with snow losses that increase with warming. Consequently, snow losses are most severe in projections by the more responsive model in response to the highest emissions.

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Title: Identification of external influences on temperatures in California

Authors: Bonfils, C; Duffy, PB; Santer, BD; Wigley, TML; Lobell, DB; Phillips, TJ; Doutriaux, C

Author Full Names: Bonfils, Celine; Duffy, Philip B.; Santer, Benjamin D.; Wigley, Tom M. L.; Lobell, David B.; Phillips, Thomas J.; Doutriaux, Charles

Source: CLIMATIC CHANGE 87: S43-S55 Suppl. 1 MAR 2008

Abstract: We use nine different observational datasets to estimate California-average temperature trends during the periods 1950-1999 and 1915-2000. Observed results are compared to trends from a suite of climate model simulations of natural internal climate variability. On the longer (86-year) timescale, increases in annual-mean surface temperature in all observational datasets are consistently distinguishable from climate noise. On the shorter (50-year) timescale, results are sensitive to the choice of observational dataset. For both timescales, the most robust results are large positive trends in mean and maximum daily temperatures in late winter/early spring, as well as increases in minimum daily temperatures from January to September. These trends are inconsistent with model-based estimates of natural internal climate variability, and thus require one or more external forcing agents to be

explained. Observational datasets with adjustments for urbanization effects do not yield markedly different results from unadjusted data. Our findings suggest that the warming of Californian winters over the twentieth century is associated with human-induced changes in large-scale atmospheric circulation. We hypothesize that the lack of a detectable increase in summertime maximum temperature arises from a cooling associated with large-scale irrigation. This cooling may have, until now, counteracted summertime warming induced by increasing greenhouse gases effects.

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Title: Climate change projections of sea level extremes along the California coast
Authors: Cayan, DR; Bromirski, PD; Hayhoe, K; Tyree, M; Dettinger, MD; Flick, RE
Author Full Names: Cayan, Daniel R.; Bromirski, Peter D.; Hayhoe, Katharine; Tyree, Mary; Dettinger, Michael D.; Flick, Reinhard E.
Source: CLIMATIC CHANGE 87: S57-S73 Suppl. 1 MAR 2008

Abstract: California's coastal observations and global model projections indicate that California's open coast and estuaries will experience rising sea levels over the next century. During the last several decades, the upward historical trends, quantified from a small set of California tide gages, have been approximately 20 cm/century, quite similar to that estimated for global mean sea level. In the next several decades, warming produced by climate model simulations indicates that sea level rise (SLR) could substantially exceed the rate experienced during modern human development along the California coast and estuaries. A range of future SLR is estimated from a set of climate simulations governed by lower (B1), middle-upper (A2), and higher (A1fi) GHG emission scenarios. Projecting SLR from the ocean warming in GCMs, observational evidence of SLR, and separate calculations using a simple climate model yields a range of potential sea level increases, from 11 to 72 cm, by the 2070-2099 period. The combination of predicted astronomical tides with projected weather forcing, El Nino related variability, and secular SLR, gives a series of hourly sea level projections for 2005-2100. Gradual sea level rise progressively worsens the impacts of high tides, surge and waves resulting from storms, and also freshwater floods from Sierra and coastal mountain catchments. The occurrence of extreme sea levels is pronounced when these factors coincide. The frequency and magnitude of extreme events, relative to current levels, follows a sharply escalating pattern as the magnitude of future sea level rise increases.

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Title: Adaptability and adaptations of California's water supply system to dry climate warming
Authors: Medellin-Azuara, J; Harou, JJ; Olivares, MA; Madani, K; Lund, JR; Howitt, RE; Tanaka, SK; Jenkins, MW; Zhu, T
Author Full Names: Medellin-Azuara, Josue; Harou, Julien J.; Olivares, Marcelo A.; Madani, Kaveh; Lund, Jay R.; Howitt, Richard E.; Tanaka, Stacy K.; Jenkins, Marion W.; Zhu, Tingju
Source: CLIMATIC CHANGE 87: S75-S90 Suppl. 1 MAR 2008

Abstract: Economically optimal operational changes and adaptations for California's water supply system are examined for a dry form of climate warming (GFDL CM2.1 A2) with year 2050 water demands and land use. Economically adaptive water management for this climate

scenario is compared to a similar scenario with the historical climate. The effects of population growth and land use alone are developed for comparison. Compared with the historic hydrology, optimized operations for the dry climate warming scenario raise water scarcity and total operation costs by \$490 million/year with year 2050 demands. Actual costs might be somewhat higher where non-economic objectives prevail in water management. The paper examines the economical mix of adaptation, technologies, policies, and operational changes available to keep water supply impacts to such modest levels. Results from this screening model suggest promising alternatives and likely responses and impacts. Optimized operations of ground and surface water storage change significantly with climate. Dry-warm climate change increases the seasonal storage range of surface reservoirs and aquifers. Surface reservoir peak storage usually occurs about a month earlier under dry-warm climate change.

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Title: Progress on incorporating climate change into management of California's water resources
Authors: Anderson, J; Chung, F; Anderson, M; Brekke, L; Easton, D; Ejeta, M; Peterson, R; Snyder, R
Author Full Names: Anderson, Jamie; Chung, Francis; Anderson, Michael; Brekke, Levi; Easton, Daniel; Ejeta, Messele; Peterson, Roy; Snyder, Richard
Source: CLIMATIC CHANGE 87: S91-S108 Suppl. 1 MAR 2008

Abstract: This paper presents preliminary efforts by agencies managing California's water resources to incorporate climate change research into their planning and management tools. Projected increases in air temperature may lead to changes in the precipitation patterns, runoff timing and volume, sea level rise, and changes in the amount of irrigation water needed due to modified evapotranspiration rates. Historical observations of climate change related to California's water resources are shown. Results from preliminary modeling studies of potential impacts of climate change to operations of the State Water Project and Central Valley Project, Delta water quality and water levels, flood forecasting and evapotranspiration rates are presented. Future directions to incorporate risk assessment are discussed.

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Title: Robust analysis of future climate change impacts on water for agriculture and other sectors: a case study in the Sacramento Valley
Authors: Purkey, DR; Joyce, B; Vicuna, S; Hanemann, MW; Dale, LL; Yates, D; Dracup, JA
Author Full Names: Purkey, D. R.; Joyce, B.; Vicuna, S.; Hanemann, M. W.; Dale, L. L.; Yates, D.; Dracup, J. A.
Source: CLIMATIC CHANGE 87: S109-S122 Suppl. 1 MAR 2008

Abstract: As part of the 2006 Climate Change Report to Governor Schwarzenegger and the California Legislature, an application of the Water Evaluation and Planning (WEAP) system in the Sacramento River Basin was deployed to look at the impact of climate change on agricultural water management and the potential for adaptation. The WEAP system includes

a dynamically integrated rainfall runoff hydrology module that generates the components of the hydrologic cycle from input climate time series. This allows for direct simulation of water management responses to climate change without resorting to perturbations of historically observed hydrologic conditions. In the Sacramento River Basin, the four climate time series adopted for the 2006 Climate Change Report were used to simulate agricultural water management without any adaptation and with adaptation in terms of improvements in irrigation efficiency and shifts in cropping patterns during dry periods. These adaptation s resulted in lower overall water demands in the agricultural sector, to levels observed during the recent past, and associated reductions in groundwater pumping and increases in surface water allocations to other water use sectors.

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Title: Climate change impacts on high elevation hydropower generation in California's Sierra Nevada: a case study in the Upper American River
Authors: Vicuna, S; Leonardson, R; Hanemann, MW; Dale, LL; Dracup, JA
Author Full Names: Vicuna, S.; Leonardson, R.; Hanemann, M. W.; Dale, L. L.; Dracup, J. A.
Source: CLIMATIC CHANGE 87: S123-S137 Suppl. 1 MAR 2008

Abstract: Climate change is likely to affect the generation of energy from California's high-elevation hydropower systems. To investigate these impacts, this study formulates a linear programming model of an 11-reservoir hydroelectric system operated by the Sacramento Municipal Utility District in the Upper American River basin. Four sets of hydrologic scenarios are developed using the Variable Infiltration Capacity model combined with climatic output from two general circulation models under two greenhouse-gas emissions scenarios. Power generation and revenues fall under two of the four climate change scenarios, as a consequence of drier hydrologic conditions. Energy generation is primarily limited by annual volume of streamflow, and is affected more than revenues, reflecting the ability of the system to store water when energy prices are low for use when prices are high (July through September). Power generation and revenues increase for two of the scenarios, which predict wetter hydrologic conditions. In this case, power generation increases more than revenues indicating that the system is using most of its available capacity under current hydrologic conditions. Hydroelectric systems located in basins with hydrograph centroids occurring close to summer months (July through September) are likely to be affected by the changes in hydrologic timing associated with climate change (e.g., earlier snowmelts and streamflows) if the systems lack sufficient storage capacity. High Sierra hydroelectric systems with sufficiently large storage capacity should not be affected by climate-induced changes in hydrologic timing.

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Title: Climate change and electricity demand in California
Authors: Franco, G; Sanstad, AH
Author Full Names: Franco, Guido; Sanstad, Alan H.
Source: CLIMATIC CHANGE 87: S139-S151 Suppl. 1 MAR 2008

Abstract: The potential effect of climate change on California's electric power system is an issue of growing interest and importance to the state's policy makers. Climate change-induced temperature increases may exacerbate existing stresses on this system. Detailed recent data are used to estimate the relationships between temperature and both electricity consumption and peak demand at a sample of locations around California. These results are combined with new projections of regional climate change affecting California obtained by statistically downscaling recent global projections generated by two general circulation models, to yield estimates of potential impacts of future temperature changes on electricity consumption and peak demand, and illustrative economic cost estimates in several cases. Both current and prospective coping strategies, and priorities for further research, are summarized.

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Title: Accumulated winter chill is decreasing in the fruit growing regions of California
Authors: Baldocchi, D; Wong, S
Author Full Names: Baldocchi, Dennis; Wong, Simon
Source: CLIMATIC CHANGE 87: S153-S166 Suppl. 1 MAR 2008

Abstract: We examined trends in accumulated winter chill across the fruit growing region of central California and its internal coastal valleys. We tested the hypothesis that global warming is in motion in California and is causing accumulated winter chill to decrease across the fruit and nut growing regions of California. The detection of potential trends in accumulated winter chill (between 0 and 7.2 degrees C) was determined using two complementary climate datasets. The California Irrigation Management Information System (CIMIS) contains hourly climate data and is suitable for computing accumulated chill hours and chill degree-hours. But, its longest data records extend back only to the 1980s. The National Weather Service Coop climate record is longer, extending beyond the 1950s at many sites. But its datasets only contain information on daily maximum and minimum temperatures. To assess long term trends in winter chill accumulation, we developed an algorithm that converted information from daily maximum and minimum temperature into accumulated hours of winter chill and summations of chill-degree hours. These inferred calculations of chill hour accumulation were tested with and validated by direct measurements from hourly-based data from the CIMIS network. With the combined climate datasets, we found that the annual accumulation of winter chill hours and chill degree hours is diminishing across the fruit and nut growing regions of California. Observed trends in winter chill range between -50 and -260 chill hours per decade. We also applied our analytical algorithm to project changes in winter chill using regional climate projections of temperature for three regions in the Central Valley. Predicted rates of reduced winter chill, for the period between 1950 and 2100, are on the order of -40 h per decade. By the end of the 21st century, orchards in California are expected to experience less than 500 chill hours per winter. This chronic and steady reduction in winter chill is expected to have deleterious economic and culinary impact on fruit and nut production in California by the end of the 21st Century.

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Title: Climate change effects on poikilotherm tritrophic interactions

Authors: Gutierrez, AP; Ponti, L; d'Oultremont, T; Ellis, CK

Author Full Names: Gutierrez, Andrew Paul; Ponti, Luigi; d'Oultremont, Thibaud; Ellis, C. K.

Source: CLIMATIC CHANGE 87: S167-S192 Suppl. 1 MAR 2008

Abstract: Species of plants and animals have characteristic climatic requirements for growth, survival and reproduction that limit their geographic distribution, abundance and interactions with other species. To analyze this complexity requires the development of models that include not only the effects of biotic factors on species dynamics and interactions, but also the effects of abiotic factors including weather. The need for such capacity has appreciably increased as we face the threat of global climate change. In this paper, bi- and tri-trophic physiologically based demographic models of alfalfa, cotton, grape, olive and the noxious weed yellow starthistle systems are used to explore some of the potential effects of climate change. A general model that applies to all species in all trophic levels (including the economic one) is used to simulate the effects of observed and projected weather on system dynamics. Observed daily weather and that of climate model scenarios were used as forcing variables in our studies. Geographic information system (GRASS GIS) is used to map the predicted effects on species across the varied ecological zones of California. The predictions of the geographic distribution and abundance of the various species examined accords well with field observations. Furthermore, the models predict how the geographic range and abundance of the some species would be affected by climate change. Among the findings are: (1) The geographic range of tree species such as olive that require chilling to break dormancy (i.e. vernalization) may be limited in some areas due to climate warming, but their range may expand in others. For example, olive phenology and yield will be affected in the southern part of California due to high temperature, but may expand in northern areas until limited by low winter temperatures.

Pest distribution and abundance will also be affected. For example, climate warming would allow the cold intolerant pink bollworm in cotton to expand its range into formerly inhospitable heavy frost areas of the San Joaquin Valley, and damage rates will increase throughout its current range. The distribution and abundance of other cold intolerant pests such as olive fly, the Mediterranean fruit fly and others could be similarly affected. In addition, species dominance and existence in food webs could change (e.g. in alfalfa), and the biological control of invasive species might be adversely affected (e.g. vine mealybug in grape). The distribution and abundance of invasive weeds such as yellow starthistle will be altered, and its control by extant and new biological control agents will be difficult to predict because climate change will differentially affects each. (2) Marginal analysis of multiple regression models of the simulation data provides a useful way of analyzing the efficacy of biological control agents. Models could be useful as guides in future biological control efforts on extant and new exotic pest species. (3) Major deficiencies in our capacity to predict the effects of climate change on biological interactions were identified: (1) There is need to improve existing models to better forecast the effects of climate change on crop system components; (2) The current system for collecting daily weather data consists of a patchwork of station of varying reliability that often record different variables and in different units. Especially vexing, is the dearth of solar radiation data at many locations. This was an unexpected finding as solar energy is an important driving variable in biological systems.

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Title: Climate change impacts on forest growth and tree mortality: a data-driven modeling study in the mixed-conifer forest of the Sierra Nevada, California

Authors: Battles, JJ; Robards, T; Das, A; Waring, K; Gilless, JK; Biging, G; Schurr, F
Author Full Names: Battles, John J.; Robards, Timothy; Das, Adrian; Waring, Kristen; Gilless, J. Keith; Biging, Gregory; Schurr, Frieder
Source: CLIMATIC CHANGE 87: S193-S213 Suppl. 1 MAR 2008

Abstract: We evaluated the impacts of climate change on the productivity and health of a forest in the mixed-conifer region in California. We adapted an industry-standard planning tool to forecast 30-years of growth for forest stands under a changing climate. Four projections of future climate (two global climate models and two emission forecasts) were examined for forests under three management regimes. Forest structural and tree demographic data from the Blodgett Forest Research Station in El Dorado County were used to fit our projections to realistic management regimes. Conifer tree growth declined under all climate scenarios and management regimes. The most extreme changes in climate decreased productivity, as measured by stem volume increment, in mature stands by 19% by 2100. More severe reductions in yield (25%) were observed for pine plantations. The reductions in growth under each scenario also resulted in moderate increases in susceptibility to non-catastrophic (i.e., non fire) causes of mortality in white fir (*Abies concolor*). For the worst case, median survival probability decreased from the baseline rate of 0.997 year⁻¹ in 2002 to 0.982 year⁻¹ by the end of the century.

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Title: Response of vegetation distribution, ecosystem productivity, and fire to climate change scenarios for California

Authors: Lenihan, JM; Bachelet, D; Neilson, RP; Drapek, R
Author Full Names: Lenihan, James M.; Bachelet, Dominique; Neilson, Ronald P.; Drapek, Raymond
Source: CLIMATIC CHANGE 87: S215-S230 Suppl. 1 MAR 2008

Abstract: The response of vegetation distribution, carbon, and fire to three scenarios of future climate change was simulated for California using the MC1 Dynamic General Vegetation Model. Under all three scenarios, Alpine/Subalpine Forest cover declined, and increases in the productivity of evergreen hardwoods led to the displacement of Evergreen Conifer Forest by Mixed Evergreen Forest. Grassland expanded, largely at the expense of Woodland and Shrubland, even under the cooler and less dry climate scenario where increased woody plant production was offset by increased wildfire. Increases in net primary productivity under the cooler and less dry scenario contributed to a simulated carbon sink of about 321 teragrams for California by the end of the century. Declines in net primary productivity under the two warmer and drier scenarios contributed to a net loss of carbon ranging from about 76 to 129 teragrams. Total annual area burned in California increased under all three scenarios, ranging from 9-15% above the historical norm by the end of the

century. Annual biomass consumption by fire by the end of the century was about 18% greater than the historical norm under the more productive cooler and less dry scenario. Under the warmer and drier scenarios, simulated biomass consumption was initially greater, but then at, or below, the historical norm by the end of the century.

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Title: Climate change and wildfire in California
Authors: Westerling, AL; Bryant, BP
Author Full Names: Westerling, A. L.; Bryant, B. P.
Source: CLIMATIC CHANGE 87: S231-S249 Suppl. 1 MAR 2008

Abstract: Wildfire risks for California under four climatic change scenarios were statistically modeled as functions of climate, hydrology, and topography. Wildfire risks for the GFDL and PCM global climate models and the A2 and B1 emissions scenarios were compared for 2005-2034, 2035-2064, and 2070-2099 against a modeled 1961-1990 reference period in California and neighboring states. Outcomes for the GFDL model runs, which exhibit higher temperatures than the PCM model runs, diverged sharply for different kinds of fire regimes, with increased temperatures promoting greater large fire frequency in wetter, forested areas, via the effects of warmer temperatures on fuel flammability. At the same time, reduced moisture availability due to lower precipitation and higher temperatures led to reduced fire risks in some locations where fuel flammability may be less important than the availability of fine fuels. Property damages due to wildfires were also modeled using the 2000 U.S. Census to describe the location and density of residential structures. In this analysis the largest changes in property damages under the climate change scenarios occurred in wildland/urban interfaces proximate to major metropolitan areas in coastal southern California, the Bay Area, and in the Sierra foothills northeast of Sacramento.

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Title: Predicting the effect of climate change on wildfire behavior and initial attack success
Authors: Fried, JS; Gillless, JK; Riley, WJ; Moody, TJ; de Blas, CS; Hayhoe, K; Moritz, M; Stephens, S; Torn, M
Author Full Names: Fried, Jeremy S.; Gillless, J. Keith; Riley, William J.; Moody, Tadashi J.; de Blas, Clara Simon; Hayhoe, Katharine; Moritz, Max; Stephens, Scoff; Torn, Margaret
Source: CLIMATIC CHANGE 87: S251-S264 Suppl. 1 MAR 2008

Abstract: This study focused on how climate change-induced effects on weather will translate into changes in wildland fire severity and outcomes in California, particularly on the effectiveness of initial attack at limiting the number of fires that escape initial attack. The results indicate that subtle shifts in fire behavior of the sort that might be induced by the climate changes anticipated for the next century are of sufficient magnitude to generate an appreciable increase in the number of fires that escape initial attack. Such escapes are of considerable importance in wildland fire protection planning, given the high cost to society of a catastrophic escape like those experienced in recent decades in the Berkeley-Oakland, Santa Barbara, San Diego, or Los Angeles areas. However, at least for the three study areas considered, it would appear that relatively modest augmentations to existing firefighting

resources might be sufficient to compensate for change-induced changes in wildland fire outcomes.

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Title: A preliminary assessment of the sensitivity of air quality in California to global change

Authors: Kleeman, MJ

Author Full Names: Kleeman, Michael J.

Source: CLIMATIC CHANGE 87: S273-S292 Suppl. 1 MAR 2008

Abstract: A regional air quality model was used to quantify the effect of temperature, humidity, mixing depth, and background concentrations on ozone (O₃) and airborne particulate matter during three air quality episodes in California. Increasing temperature with no change in absolute humidity promoted the formation of O₃ by +2 to +9 ppb K⁻¹ through increased reaction rates. Increasing temperature with no change in relative humidity increased predicted O₃ concentrations by +2 to +15 ppb K⁻¹ through enhanced production of hydroxyl radical combined with increased reaction rates. Increasing mixing depth promoted the formation of O₃ in regions with an over-abundance of fresh NO emissions (such as central Los Angeles) by providing extra dilution. Increasing temperature with no change in absolute humidity reduced particle water content and promoted the evaporation of ammonium nitrate at a rate of -3 to -7 μg m⁻³ K⁻¹. Increasing temperature with no change in relative humidity maintained particle water content and moderated ammonium nitrate evaporation rates to a maximum value of -3 μg m⁻³ K⁻¹ during warmer episodes and increased ammonium nitrate condensation by +1.5 μg m⁻³ K⁻¹ during colder episodes. Increasing mixing depth reduced the concentration of primary particulate matter but increased the formation of secondary particulate matter in regions with an over-abundance of fresh NO emissions. O₃ transported into California from upwind areas enhanced the formation of particulate nitrate by promoting the formation of N₂O₅ and HNO₃ at night. A 30 ppb increase in background O₃ concentrations (roughly doubling current levels) increased maximum PM_{2.5} concentrations by +7 to +16 μg m⁻³ even when temperature was simultaneously increased by +5 K with no change in absolute humidity (most unfavorable conditions for nitrate formation).

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Title: Climate change impact on California on-road mobile source emissions

Authors: Motallebi, N; Sogutlugil, M; McCauley, E; Taylor, J

Author Full Names: Motallebi, Nehzat; Sogutlugil, Mihriban; McCauley, Eileen; Taylor, Jonathan

Source: CLIMATIC CHANGE 87: S293-S308 Suppl. 1 MAR 2008

Abstract: Continued climate change could have widespread impacts on California's economy and ecosystems, and on the health of its citizens. Climate change can impact meteorology, emissions, and chemical processing and thereby influence air quality and its associated effects on public health and welfare. Some mobile source emission control technologies in the distant future are likely to be very different than current ones; it is not

possible to make quantitative predictions of California's mobile source emissions inventory for 2050 and 2100. However, investigating the response of the current on-road mobile source inventory to possible future temperatures can provide insights for the near future and suggest actions which are needed to protect California's air quality. The results of this study indicate that for California surface temperatures predicted by the B1 and A2 IPCC-carbon dioxide (CO2) emissions scenarios, summer-time on-road total (exhaust plus evaporative) reactive organic gases (ROG) emissions from the 2005 motor vehicle fleet will increase by 4 to 5% using temperature projections for mid-century and by 13 to 16% for end-of-century temperature projections. Increases of as much as 30% are seen in evaporative emissions in 2100. California Air Resources Board's (CARB) mobile source emission factor model (EMFAC) predicts decreases of similar magnitudes for oxides of nitrogen (NOX) emissions. The medium-high emissions scenario results in a positive feedback loop for greenhouse gas (GHG) emissions from on-road motor vehicles, with 4 to 5% increase in methane and 8 to 9% increases in CO2 by 2100. These emissions estimates are strictly a test of the sensitivity of the current California mobile sources emission inventory model to temperature increases, as they do not take into account future growth in mobile source activity, new control regulations, or possible vehicle or fuel technological advances.

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Title: Managing climate risks in California: the need to engage resource managers for successful adaptation to change

Authors: Moser, SC; Luers, AL

Author Full Names: Moser, Susanne C.; Luers, Amy Lynd

Source: CLIMATIC CHANGE 87: S309-S322 Suppl. 1 MAR 2008

Abstract: In this paper we propose a framework for evaluating how prepared California resource managers are for risks of continued climate change. The framework presented suggests three critical dimensions of preparedness - awareness of climate-related risks, analytic capacity to translate such climate risks information into specific planning and management activities, and the extent of actions taken to address the risks. We illustrate the application of this framework in this paper through preliminary research of California coastal managers where we identify limited awareness of climate-change related risks, limited analytic capacity, and significant constraints on the abilities of institutions and individuals to take adaptation actions. Our analysis suggests that for California to realize its significant adaptive capacity and be able to manage the unavoidable impacts of climate change, resource managers need to be engaged more effectively in future discussions of managing climate risks in the state.