L.A. Regional Temperature Projections
Summary of Findings – June 21, 2012

Summary of Hall, et al. study "Mid-Century Warming in the Los Angeles Region." Prepared by Paul Bunje PhD

The first results from the "Climate Change in the Los Angeles Region" project, sponsored by the City of Los Angeles and US Department of Energy covers temperature changes. Future results will cover other elements of climate change (precipitation, snowpack, winds, clouds, etc.). These studies are expected to be released throughout the summer and autumn of 2012.

BACKGROUND

- Global climate models (GCMs) are too coarse for our geography – they break the globe up into grid cells that are 100-200km wide (~62-124 miles).
- L.A. County is about 100km wide, which has mountains, coastline, and a climate that varies considerably – Santa Monica and Pomona have very different ecosystems.
- Climate change estimates must be done for a timeframe of relevance to policy makers; the end of the 21st Century is too far away. Appropriate planning timeframes follow a 30-50 year horizon.

METHOD

This study addresses these issues by modeling temperature change at high-resolution (2km as opposed to 200km) and for a useful timeframe (mid-century; the years 2041-2060).

- 2 GHG emissions scenarios: The model estimates temperature change for different amounts of greenhouse gas emissions: business-as-usual and an aggressive emissions mitigation (reduction) effort.
    - Business-as-usual is called RCP 8.5 and the mitigation scenario is called RCP 2.6. These are new terms for the new IPCC 5th Assessment Report, and represent the high and low range of policy options being discussed in international negotiations (representing GHG concentrations of approximately 1200 ppm or 460 ppm of CO_2 equivalent concentration by 2100, respectively.)
- 19 Global Climate Models downscaled for L.A.: State-of-the-art regional modeling techniques:
    - The regional focus of the model is produced through a technique called dynamical downscaling. This technique uses intense computation to model the physical processes of the climate at a high-resolution, including the specific climate features of this region (similar to a GCM but for the Greater Los Angeles Region).
        - While the dynamical downscaled model provides a more accurate representation of our region's climate than the Global Climate Models, it takes months of super computer time. One GCM was dynamically downscaled, and three additional GCMs were then dynamically downscaled in order to validate the statistical model.
    - The second step of the downscaling was performed statistically, which are very fast to run on a computer. These models were trained using the statistical relationships derived from the initial dynamical downscaling procedure, and run for all available GCMs. These were then used to estimate climate change for all 19 Global Climate Models. This is important because:
        - GCMs all differ in how they model features of the climate.

- Averaging the results for all 19 GCMs (referred to as the "ensemble-mean") is regarded as the most accurate projection of future climate conditions.

RESULTS

- For the years 2041-2060, dynamical modeling, under the business-as-usual GHG scenario, shows great variation in temperature from the coast to the deserts. Three elements drive this pattern:
    1. Warming over the ocean is slower because water has a very high heat capacity (it can absorb a lot of energy without changing temperature much) and evaporation cools.
    2. Warming over the deserts is faster because it is dryer resulting in a build up of energy that leads to higher temperatures (the opposite of when there is a lot of water).
    3. Local processes due to land/sea breezes and mountains/valleys change how the ocean and desert airs move throughout the region.
- The ensemble (average) prediction of all GCMs, statistically downscaled for the L.A. region and under business-as-usual GHG emissions shows annual average temperature increases between 3.7°F and 5.4°F, depending on location (area average of 4.6°F over land).
    - All areas of the region are projected to get warmer by mid-century, mountains and desert areas warm the most, coastal areas warm the least and summer gets warmer faster than any other season.
    - Uncertainty in future warming is represented by range projections. For example, the uncertainty range for the warming averaged over the region's land areas is from 1.7 to 7.5°F. This is a 95% uncertainty range, so that there is a 19 out of 20 chance that the correct value lies in this range. The uncertainty is due to variation in the global models and the complex seasonal and topographical features of the L.A. regional climate. Even the lower bound is positive though, indicating extremely high confidence in the likelihood of warming by mid-century.
- Coast and oceans warm more slowly than the deserts and mountains; (values are all ±~2.5-3°F)
    - Oceans and coasts are likely to warm ~3.5-4°F.
    - The dense urban portions of the region warm ~4-4.5°F.
    - Mountains and deserts warm ~4.5-5.5°F on average.
- Hot months warm more: warming is greater in summer and fall than in winter and spring and the contrast between the coasts and inland areas is also greater in summer/fall than in winter/spring.
- The hottest places of the region, during the hottest times of year, will get hotter at a faster rate
- Mountains create significant differences in the rate of climate warming
    - The Santa Monica Mountains, which are fairly low, are enough of a barrier to ocean influence that the San Fernando Valley warms ~10% more than the L.A. Basin (~4.2-4.3°F for the Valley vs. 3.8-4°F for most of the L.A. Basin).
    - Warming also increases with distance from the coast.
    - Cities separated from the coast by high mountains (Lancaster, Palmdale) show warming of about 4.9-5.2°F.
    - The tops of the San Gabriel and San Bernardino mountains warm the most—more than 5°F in the annual average.
- Looking broadly, the number of "extreme hot days" (defined as those that are as warm as the 7 warmest days of the year in each location) is expected to increase substantially.
    - Coastal areas and central L.A.—the areas with the largest populations—will see the number of extremely hot days approximately triple

    - The San Fernando Valley and San Gabriel Valley will see extreme hot days almost quadruple (3.5 to 4 times the current number reaching the local high temperature).
    - Desert and mountain areas will see extreme hot days increase by 4.5 to 6 times the current number.
- Specifically, the number of days where the temperature reaches over 95°F will increase by 2-5 times; the number of projected days is a range, see the report's tables for the exact range of values.
    - Coastal areas are already cooler and thus additional warming is unlikely to increase the number of days that surpass the absolute 95°F threshold in the future (which is why the relative definition for extreme heat is used above—different communities are used to different temperatures.
    - Santa Monica, Venice, San Pedro: from ~0 days to ~1 day
    - Downtown LA: from 1.4 days to 4.6 days (±4)
    - Long Beach: from 1 day to 2.5 days (±2)
    - Santa Ana: from 1 days to 3.1 days (±3)
    - Woodland Hills: from 4 days to 16.7 days (±13)
    - Eastern and Northern San Fernando Valley (Sylmar, San Fernando, Porter Ranch): from 7-8 days to 25-30 days (±18)
    - Pasadena: from 3 days to 9.5 days (±8)
    - Riverside: from 10 days to 34.2 days (±21)
    - Lancaster: from 20 days to 55.7 days (±25)
    - Palm Springs: from 75 days to 119 days (±20)
- Even under the aggressive GHG mitigation (reduction) scenario (RCP 2.6), temperatures are likely to nonetheless increase throughout the L.A. Region.
    - Generally, warming is about 30% less under this scenario (the values are ~70% of those reported for RCP 8.5).

MEANING

- Significant warming is projected in Los Angeles between the years of 2041-2060.
    - To accurately predict future climates modeling at a regional scale as opposed to a global scale is very important for places that have complex climates due to mountains, seasonal variation, and a coastal location such as L.A.
- The amount of warming varies considerably across the complex geography of the L.A. region, but everywhere gets significantly warmer.
- Inland areas will get hotter faster than the coast.
- The warming shows strong seasonality meaning there will be greater warming in summer and fall and less in winter and spring.
- The number of extreme hot days is likely to triple or quadruple for the vast majority of people living in Southern California. In some places like the mountains and deserts, days with extremely hot temperatures may quintuple (up to 5 times as many super-hot days.)
- Warming will impact the L.A. region even if the world slows the rate of GHG emissions.
- Adaptation to a changing climate is a necessity in the Los Angeles region.