Global Temperature Part II: Future Projections

Bulletin Synopsis *March 2015*

Climate Modeling Explained

Today's global climate models have many coupled components, including atmosphere, land surface, ocean and sea ice, aerosols, the carbon cycle, dynamic vegetation, atmospheric chemistry, and land ice. Their 'performance' is tested by evaluating how well they reproduce the actual variations we have observed in the past, and they perform particularly well with simulations of average global temperature.

Future Global Temperature

In the near-term (2016-2035), it is expected that the average global surface temperature will warm between 0.5-1.3^{0}F (0.3-0.7^{0}C), with larger changes projected for later in the century when it is likely we will exceed 2.7^{0}F (1.5^{0}C) of warming. Other expected changes include:

- More frequent hot and fewer cold temperature extremes
- Likely increase in the length, frequency, and/or intensity of heat waves
- Greater warming over land and at high latitudes

Downscaling is necessary to develop detailed regional projections from global-scale climate models.

Simulation of Feedbacks

Estimating the actual amount of warming from an increase in CO_2 is complicated by the fact that feedbacks in the climate system can amplify or dampen the warming effect. Climate models diverge in their temperature projections because they have slightly different ways of simulating feedbacks, from sources such as clouds, melting permafrost, or changes in albedo (reflectivity). The best estimates suggest that the likely range of warming is between 2.7 and 8.1^{0}F (1.5-4.5^{0}C) for a doubling of CO_2.

Emissions Scenarios

We know cumulative CO_2 emissions will determine total warming by the end of this century, but we don't know the exact global emissions trajectory. This is why we utilize different emissions scenarios that are based on assumptions about future global economic activity, population growth, the types of energy we will use, and how efficiently we will use it.

Forest Impacts

Temperature changes will impact forests in positive and negative ways, through the direct effect of temperature or the indirect effect of temperature on other stressors, such as insects and disease.

Extreme Heat

There is ample evidence that extreme heat can have a wide variety of effects on tree function from the molecular level to the entire tree. Heat waves are a particular concern because they can have negative effects on growth that are more severe than the same amount of heat applied as a change in average temperature. See the full bulletin for a discussion of the physiological and morphological responses trees use to cope with extreme heat stress.

Longer Growing/Frost-Free Season

The U.S. growing season is expected to lengthen by as much as 30 to 80 days by the end of the century, with the largest changes expected in the mountainous regions of the western U.S. This will increase growth and productivity (where moisture is not limiting) and have other operational impacts related to the timing of planting, herbicide application, and harvest.