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University of California
Agriculture and Natural Resources
Making a Difference for California

The Green Scene

UCCE

June 2022

Meetings and Announcements

Weekly Horticulture Zoom Talks, Thursdays at 4:30 pm

Horticulture Zoom talks will run through the end of June followed by a summer break. For June 16, the topic is a return to Ireland to see landscapes and gardens in four locations, and then June 23 a discussion of the landscapes of Crete and view of artifacts from the ancient Minoan civilization, including photos from the palace at Knossos. I don't have a Zoom link to share in this newsletter, but I welcome your participation, and if you to send me an email and I'll send you a link. If you were on past Hort Zoom talks, you'll receive an invitation from Travel Gallery, which is acting as host.

A Note About Air Pollution

The term pollutant can refer to a substance or molecule not normally found in nature but deleterious to humans or other life in the ecosystem. However, pollutant can and often means elevated concentrations of a molecule that may be benign at some level but damaging at a higher level. It's about dose, as is true in so many instances when we speak about toxicology.

As we enter summer, we also enter the smog season. Smog, a word coined from smoke and fog, has several components. In California, we are usually talking about photochemical smog with ozone as the principal pollutant. Ozone, O_3, is a metastable and highly reactive form of oxygen that damages lungs and impairs breathing at part per billion levels. Ozone also damages plants. Yield reductions of crops have been measured by comparing those grown in filtered air to those grown in ambient air. It's difficult for us to easily observe ozone damage in crop fields, since all the plants are exposed to the same air—we don't have other plants for comparison.

In the clean lower atmosphere, there is a low (~ 40 ppb) level of ozone. Levels can rise if precursors are emitted in sufficient concentration, and those are oxides of nitrogen (NOx) and volatile organic compounds (VOC). Emission of these compounds allows them to enter into photochemical reactions, where plenty of sunlight, warm temperatures, and a confined air mass (think surrounding mountains) means the lower atmosphere becomes a giant gas-phase reactor with ozone as one of the products.

Note that ozone in the lower atmosphere is the same molecule as is found in the upper atmosphere (stratosphere) and there protects Earth from damaging ultraviolet radiation from the Sun. However, the formation processes in the stratosphere are different from the ozone-forming processes in the lower atmosphere, and ozone formed in the stratosphere is essentially confined to that region. We want that ozone, and that's a reason air conditioning coolants are different than they were years ago—and more expensive. The

older compounds were found to persist in the atmosphere long enough to migrate to the stratosphere where they entered into reactions that destroyed ozone.

But we don't want extra near-surface ozone. The California Air Resources Board (ARB) has been supported by decades of research by UC groups and others to better understand the sources of NOx (mostly motor vehicles and stationary engines—high temperatures needed for formation) and VOC, which comes from both anthropogenic (human) and natural sources. My work locally has involved measuring VOC emissions from green plants, an important background source. As a consequence, ARB has formulated effective policies that have resulted in reduction of ozone concentrations in the Central Valley as well as the LA Basin, despite a doubling of population and tripling of vehicle miles over time in the SoCal area.

Another air pollutant important in Kern County air is particulate matter, which has both natural and anthropogenic sources. This has been a more difficult pollutant to reduce. Particulate matter can be primary, that is emitted into the atmosphere as-is, or secondary, which means formed from precursors, such as gas-to-particle reactions. And it's the very small particles rather than visible dust that have the greatest health effects.

Although we may look and see or not see the mountains—it's particulates that interfere with visibility—the greatest effect on visibility is from a subset of particles. The visual effect on visibility is dominated by particles in the 0.1 - 2 micrometer size range. We have relevant experience with fog, which illustrates that a concentration of water in the atmosphere may have little effect on visibility, but when small fog droplets form that same concentration of water as droplets can result in a sharp reduction in visibility. Visibility is not a reliable indicator of overall particulate number or atmospheric concentration.

Climate change is a topic distinct and separate from urban air pollution. The atmospheric concentrations of CO_2 and other greenhouse gases, principally CH_4, methane, and N_2O, nitrous oxide, are central to this discussion. These, too, are naturally occurring, but can be considered deleterious if in high concentrations or resulting in unwanted effects. Sure, CO_2 is naturally occurring, but its concentration continues to increase, now about 420 ppm, and it does trap infrared radiation, as do CH_4 and N_2O. Absorption of light across various wavelengths is a function of the electronic structures of these molecules and is relatively easy to measure.

Greenhouse gases do not injure plants. CO_2 is necessary for plant growth, and elevated levels of CO_2 can result in increased growth, although plant species do not respond equally.

Climate change discussion falls into two areas that are often conflated in news articles. These two areas are positive and normative claims. Positive claims can be established by data; for example, the past and current concentrations of CO_2 as well as its molecular properties. Normative claims are about what something should be. How or whether atmospheric greenhouse gas concentrations should be reduced is a matter of policy.

I shall not enter here into further discussion about climate change. There is broad agreement in the atmospheric science community about the positive claims. Policy decisions and courses of action are another matter.

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