### Hashtags: #earth, #leafmealone

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### Tags: Citizen Science, Imagery

Ground-level ozone causes more damage to plants than all other air pollutants combined, including damage to food crops. (See [the effect of ozone pollution on plants](http://www.ars.usda.gov/Main/docs.htm?docid=12462) for background.) One way to see the effects of this air pollution is to evaluate the damage to leaves, also called stippling. Develop a tool to quantify and classify the amount of injury to the leaves of ozone-sensitive plants.

**Background**

The U.S. Department of Agriculture describes [the effect of ozone pollution on plants](http://www.ars.usda.gov/Main/docs.htm?docid=12462) as follows: Ozone is formed in the troposphere when sunlight causes complex photochemical reactions involving oxides of nitrogen (NOx), volatile organic hydrocarbons (VOC) and carbon monoxide that originate chiefly from gasoline engines and burning of other fossil fuels. Woody vegetation is another major source of VOCs. NOx and VOCs can be transported long distances by regional weather patterns before they react to create ozone in the atmosphere, where it can persist for several weeks.

Ozone enters leaves through stomata during normal gas exchange. As a strong oxidant, ozone (or secondary products resulting from oxidation by ozone such as reactive oxygen species) causes several types of symptoms including chlorosis and necrosis. It is almost impossible to tell whether foliar chlorosis or necrosis in the field is caused by ozone or normal senescence. Several additional symptom types are commonly associated with ozone exposure, however. These include flecks (tiny light-tan irregular spots less than 1 mm diameter), stipples (small darkly pigmented areas approximately 2-4 mm diameter), bronzing, and reddening.

Ozone symptoms usually occur between the veins on the upper leaf surface of older and middle-aged leaves, but may also involve both leaf surfaces (bifacial) for some species. The type and severity of injury is dependent on several factors including duration and concentration of ozone exposure, weather conditions and plant genetics.

Ozone exposure can lead to lower crop yields. The results of studies show that dicot species (soybean, cotton and peanut) are more sensitive to yield loss caused by ozone than monocot species (sorghum, field corn and winter wheat).

The Ozone-Induced Foliar Injury Guide (in the resources section) includes many details related to this challenge.

**Solution Ideas**

Here are some ways for you to frame this solution:

Take a picture, then calculate and display percent results. Advanced options would add display of surface ozone data for that location for the last five days. If possible, you can add or display a satellite image for that area to provide context (i.e., Landsat Leaf Area Index or Normalized Difference Vegetation Index).

The app could: guide a user through a protocol for taking a single leaf image; acquire a picture of a leaf through a smartphone camera; use the colors in the photo to calculate the area of the leaf and determine the fraction of the leaf that has been injured by ozone. Present the results of the analysis using the classification described on page 69 of the Ozone-Induced Foliar Injury Guide (link below) and present the last 5 days of surface ozone for the user’s location.

**Sample Resources**

* Ozone-Induced Foliar Injury Guide: <http://science-edu.larc.nasa.gov/ozonegarden/pdf/Bio-guide-final-3_15_11.pdf>
* Ozone Garden website: (<http://science-edu.larc.nasa.gov/ozonegarden/>
* MY NASA DATA: <http://mynasadata.larc.nasa.gov>
* LANDSAT 8: <http://landsat.usgs.gov/landsat8.php>
* ASTER: <http://asterweb.jpl.nasa.gov/data.asp>
* EO-1: <http://eo1.usgs.gov/>
* MODIS: <http://modis.gsfc.nasa.gov/gallery/>