Future impacts of ozone driven damages on agricultural systems

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Abstract

Current ozone (O3) concentration levels entail significant damages in crop yields around the world. The reaction of the emitted precursors (mostly methane and nitrogen oxides) with solar radiation contribute to O3 levels that exceed established thresholds for crop damage. This paper shows current and projected (through 2080) relative yield losses driven by O3 exposure for different crops and the associated economic damages applying crop prices that are calculated per region and period. We adjust future crop yields in the Global Change Assessment Model (GCAM) to reflect the RYLs and analyse the effects on agricultural markets. We find that the projected decreases in O3 precursor emissions in a reference scenario would reduce the agricultural damages, compared to present, for most of the regions, with a few exceptions including India, where higher future O3 concentrations have large negative impacts on crop yields. The annual economic impact of O3 driven losses from 2020-2080 are 5.0-6.0, 9.8-18.8, 6.7-10.6 and 10.4-12.5 B$ (2015) for corn, soybeans, rice and wheat, respectively, with the large losses for wheat and soybeans driven by their comparatively high sensitivity to O3. When O3 effects are considered, the projected change on O3 levels and the subsequent variations of yields, would directly affect future agricultural markets. Therefore, the aggregated net present value (NPV) of the crop production would be reduced around 116 B$ (2015). However, these changes are not distributed evenly across regions, and the net present market value of the crops would increase up to 270 B$ (2015) or decrease up to 120 B$2015 (China)
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BACKGROUND

- Ozone is the most hazardous pollutant for crop yields: visible foliar injuries, reduced photosynthesis, gene alteration, and a reduction in yields
- It always produces negative impacts
- Mitigation actions for decreasing NOx or CH4 would be the most effective to reduce O3 concentration
- Climate policies and changes in meteorological conditions affect future O3 concentration levels

METHODOLOGY

1- EMISSIONS and O3 CONCENTRATIONS

2- RELATIVE YIELD LOSSES (RYLs)

3- ECONOMIC DAMAGES

4- DECOMPOSITION ANALYSIS OF EFFECTS IN AGRICULTURAL MARKETS

MAIN FINDINGS

- Projected emissions of O3 precursor reduce the agricultural damages, compared to present, except for some regions (India)
- Annual economic impact of O3 driven losses from 2010-2080 (SB) are 5.0-6.0, 9.8-18.8, 6.7-10.6 and 10.4-12.5 for corn, soybeans, rice and wheat, respectively
- When O3 effects are considered, cumulative NPV of crop production would decrease up to $90.8B at a global level, with large differences between regions