Impact of COMET version changes on greenhouse gas estimates

September 26, 2022

The September 2022 new version releases of COMET-Farm (Version 4.0) and COMET-Planner (Version 3.0) contain a number of updates and bug fixes, but the major difference between these versions and the prior versions is a switch from the 20 cm depth version of the DayCent biogeochemical model to the 30 cm depth version of DayCent. The DayCent model is used in COMET-Farm (and by extension COMET-Planner) to estimate changes in soil C stocks and soil nitrous oxide emissions as a function of changes in management practices, including adoption of soil conservation practices. Further, the methods for estimating direct soil nitrous oxide emissions for use in COMET-Planner deviated from the USDA Methods for Entity-Scale Inventory guidance, and instead followed methodology used in the U.S. National Greenhouse Gas Inventory. In this method, direct soil N_2O emissions are modeled in DayCent. It should be noted that the prior (20 cm) version of COMET-Farm used an empirical method described in the USDA Methods guidance for estimating direct soil N_2O emissions. Therefore the comparisons of the new versus prior versions of COMET-Planner for N_2O estimates are not analogous to the version comparisons for COMET-Farm.

In order to provide an overall view of the differences between versions, we've made regional-scale comparisons to inform users on the average impact of these changes, based on thousands of individual points distributed across major agricultural regions in the US. To do this comparison, we looked at greenhouse gas emissions reductions generated in COMET-Planner Version 2.1 (20 cm DayCent) and Version 3.0 (30 cm DayCent). COMET-Planner utilizes the COMET-Farm API and so is essentially a meta-model of COMET-Farm. A full methods description for COMET-Planner can be found in the methods report, linked on www.comet-planner.com. In addition to the DayCent model change, the other change in COMET-Planner that likely impacts modeled results is the addition of an irrigation dataset that allowed points to be classified as irrigated or non-irrigated. In the earlier version of COMET-Planner, irrigation data was not available so we modeled all points as irrigated and non-irrigated scenarios. Defining points based on their 'actual' irrigation status better reflects reality in that crop rotations tend to be different on irrigated vs. non-irrigated fields, especially in dry regions. In general, non-irrigated systems in dry regions tend to have more frequent fallowing (lower cropping intensity) and irrigated systems tend to use continuous cropping (higher cropping intensity). Non-irrigated systems with fallowing will have lower carbon inputs than irrigated systems.

To keep the comparison easier to compile and digest, we present average results at the Land Resource Region (LRR) scale and include a map below (Figure 1) to use as a reference for the graphs. We model a number of conservation practices in COMET-Planner, however in this presentation we chose three common practices to illustrate version differences: 1) addition of non-legume cover crops to annual cropland (Figures 2-3), 2) conversion from intensive till to no-till (Figures 4-5), and 3) conversion of annual cropland to permanent grass cover (similar to the Conservation Reserve Program) (Figure 6). Emission estimates are given in the same units as COMET-Planner, which are 'Emissions Reductions' (Mg CO_2e/ac/yr), i.e., the difference between the adoption scenario and the baseline (BAU) scenario, averaged over the 10-year projection period. Positive values indicate a net GHG benefit of the practice (i.e. carbon sequestration and/or emission reductions), relative to the baseline, and negative values indicate a net GHG emission increase due to practice adoption. Standard errors of the mean are included to show a measure of modeled variability across sites due to weather, soil, cropping system, etc. LRRs not included in this analysis had a very small sample size due to limited cropland area or having crops that cannot be evaluated in COMET.

In general, predicted emission changes due to conservation adoption are comparable between versions, with some LRRs having greater emission reductions in Version 3 (30 cm DayCent) and others having greater values in Version 2 (20 cm DayCent). However, conversion of croplands to permanent grassland (CPS 327) has greater emission reductions for soil organic carbon (SOC) for most LRRs in Version 3.

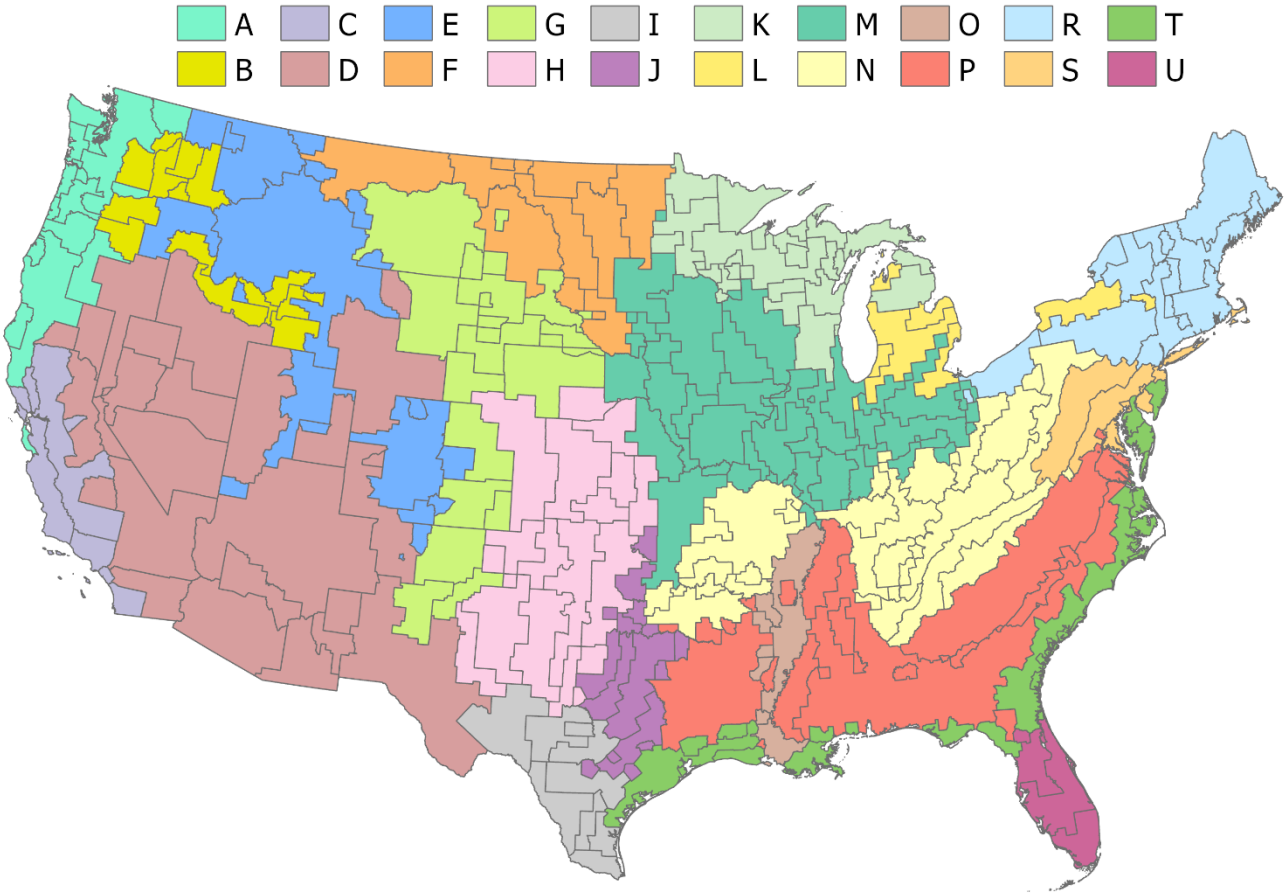

Figure 1. USDA Land Resource Regions (LRR) rectified to county boundaries. Land Resource Regions contain Major Land Resource Areas (MLRA) (also rectified to county boundaries), which are the primary analysis scale for COMET-Planner.

Cover Crops (CPS 340) - Add Non-Legume Seasonal Cover Crop (with 25% Fertilizer N Reduction) to Non-Irrigated Cropland

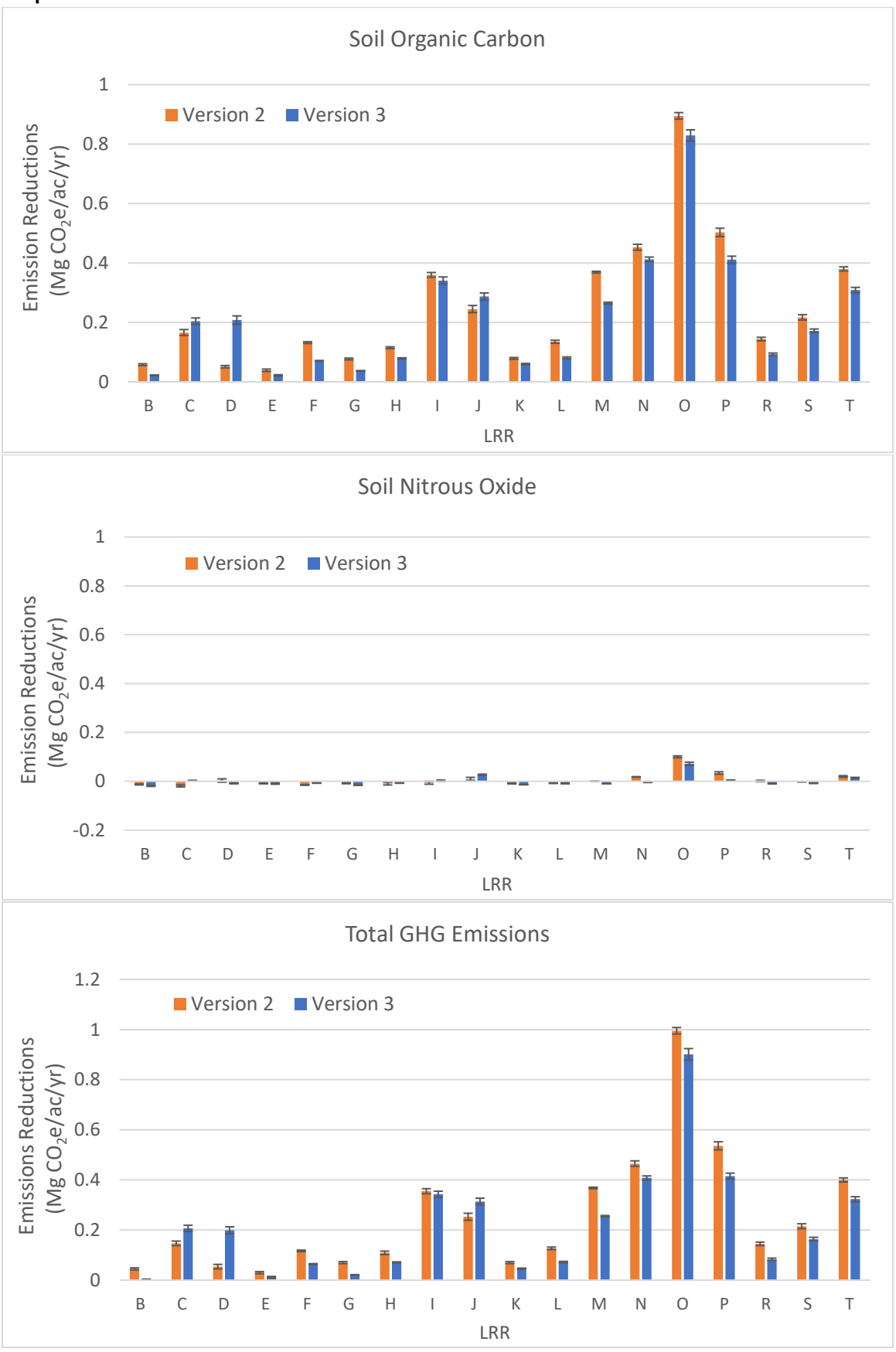

Figure 2. Emissions reductions for soil carbon (top), soil nitrous oxide (middle) and total emissions (bottom) by LRR for addition of non-legume cover crops (CPS 340) to non-irrigated annual cropland.

Cover Crops (CPS 340) - Add Non-Legume Seasonal Cover Crop (with 25% Fertilizer N Reduction) to Irrigated Cropland

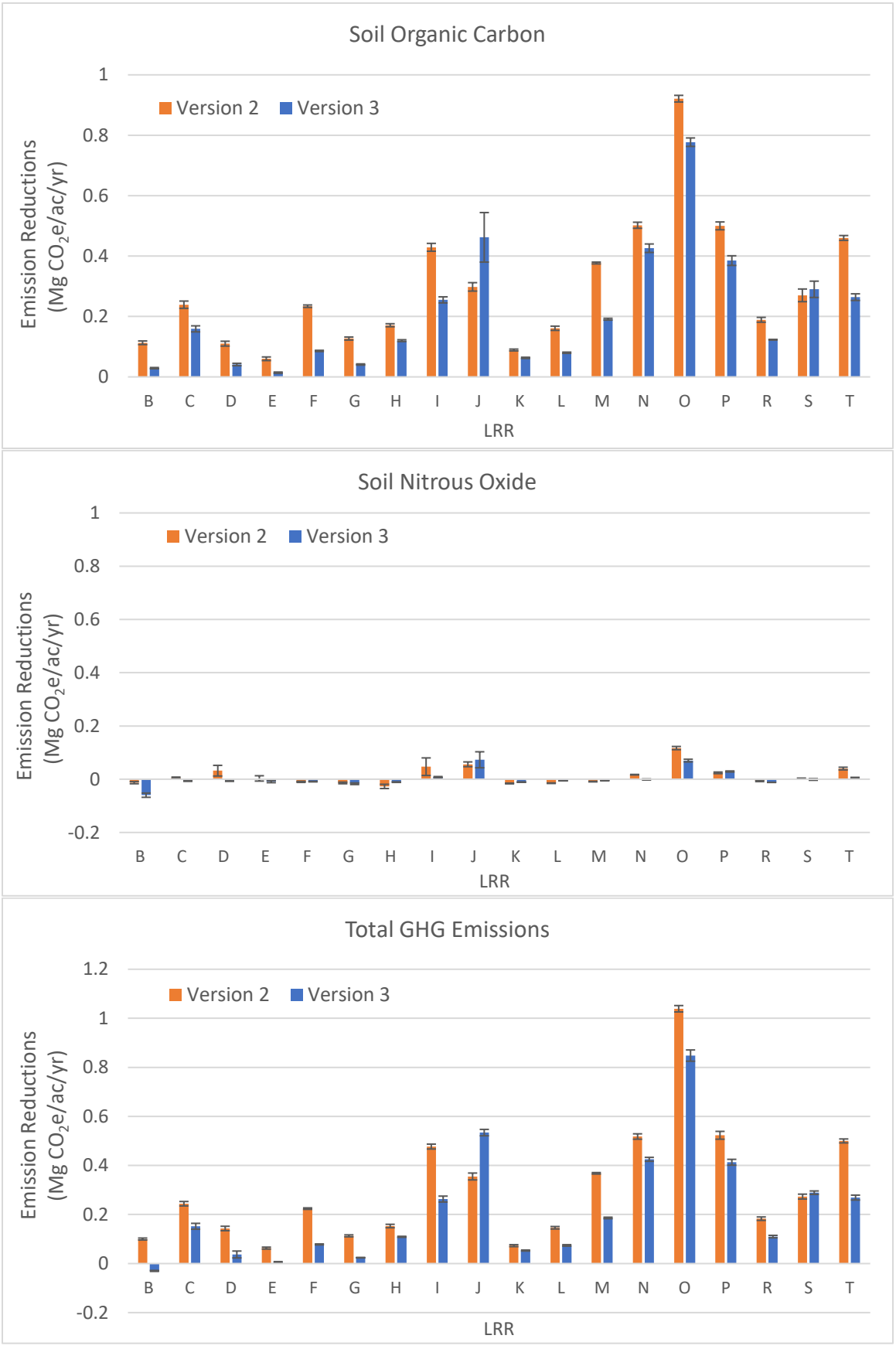

Figure 3. Emissions reductions for soil carbon (top), soil nitrous oxide (middle) and total emissions (bottom) by LRR for addition of non-legume cover crops (CPS 340) to irrigated annual cropland.

Residue and Tillage Management - No-Till (CPS 329) - Intensive Till to No Till or Strip Till on Non-Irrigated Cropland

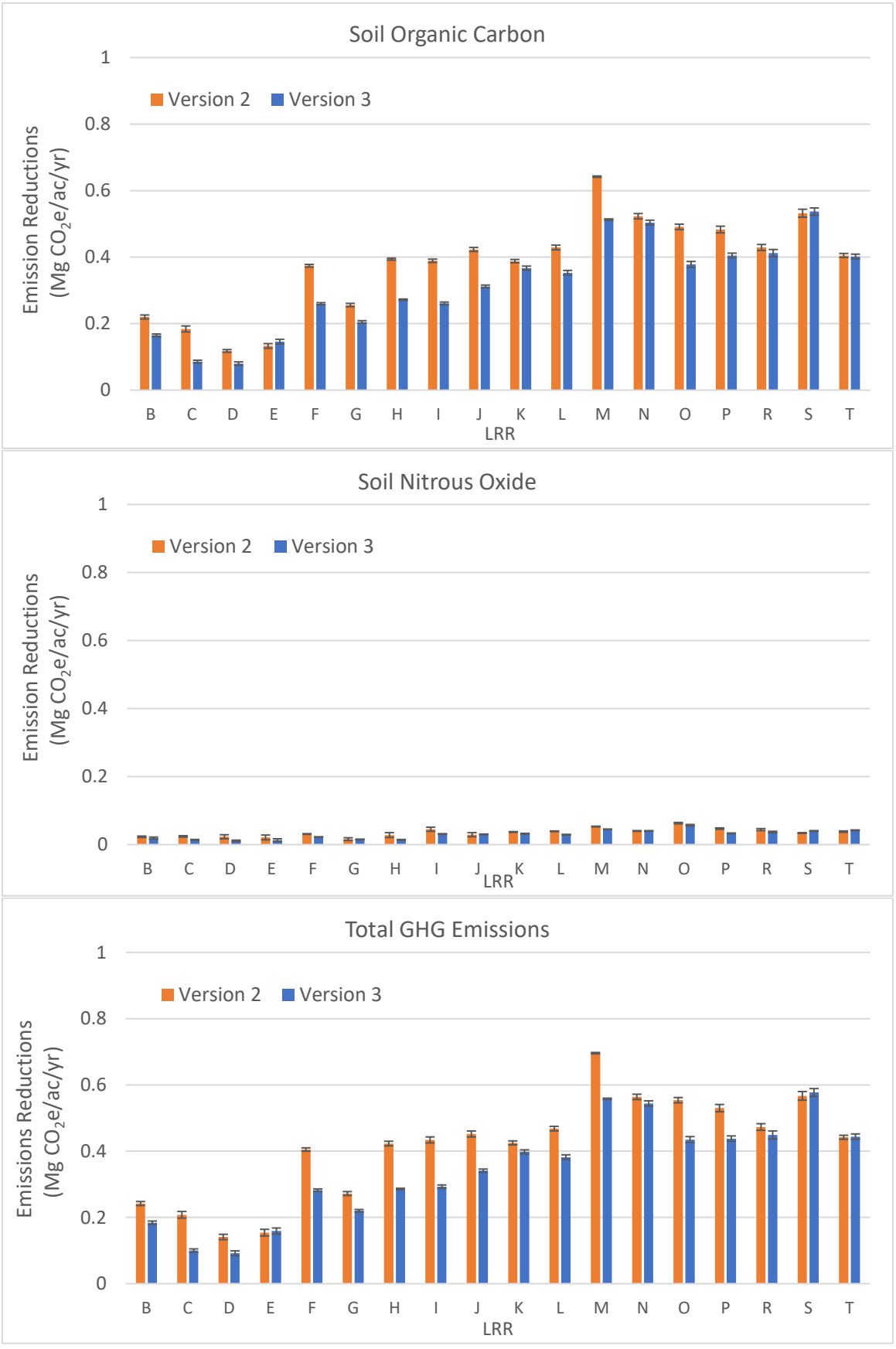

Figure 4. Emissions reductions for soil carbon (top), soil nitrous oxide (middle) and total emissions (bottom) by LRR for intensive tillage to no-till (CPS 329) on non-irrigated annual cropland.

Residue and Tillage Management - No-Till (CPS 329) - Intensive Till to No Till or Strip Till on Irrigated Cropland

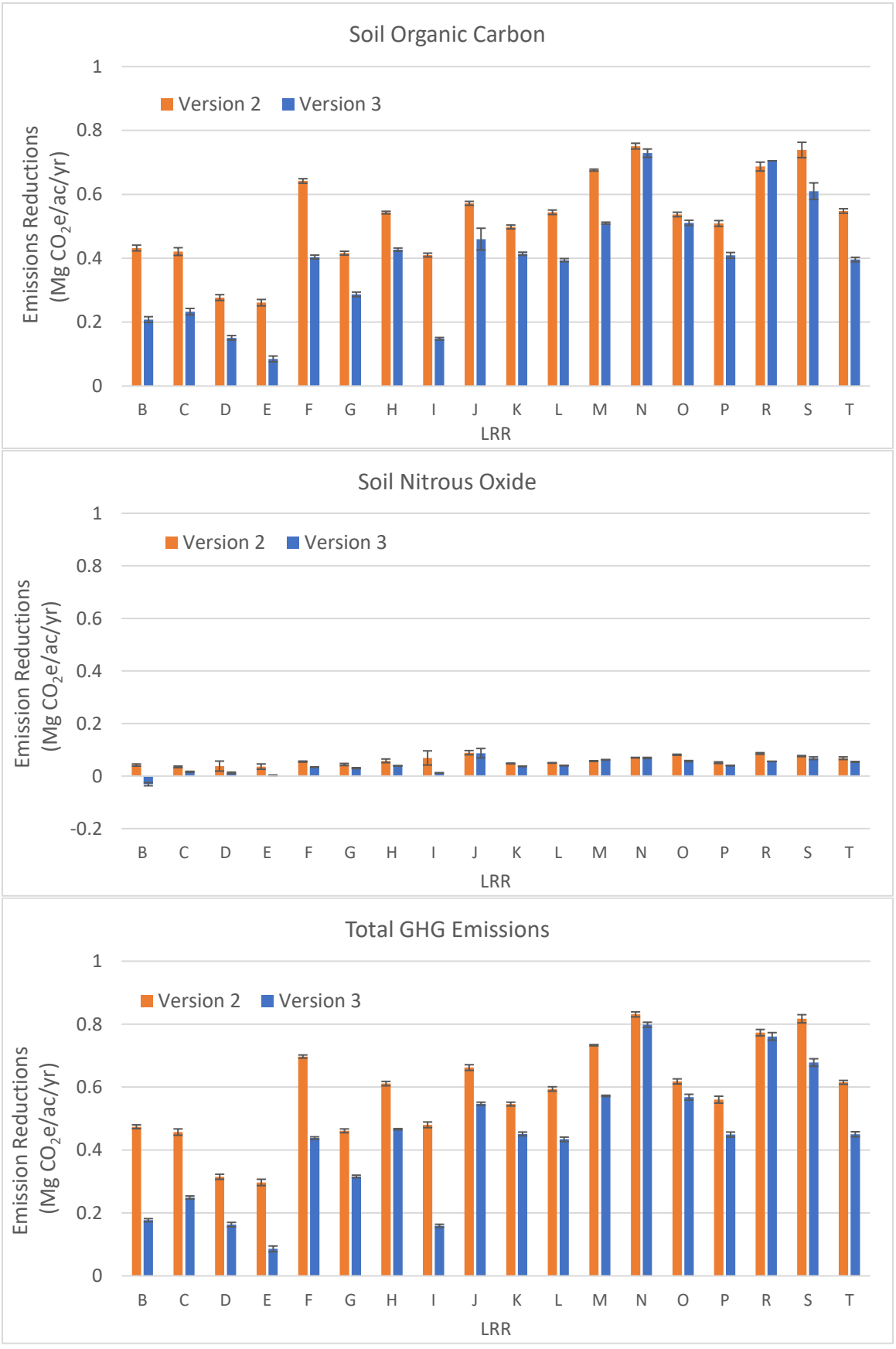

Figure 5. Emissions reductions for soil carbon (top), soil nitrous oxide (middle) and total emissions (bottom) by LRR for intensive tillage to no-till (CPS 329) on irrigated annual cropland.

Conservation Cover (CPS 327) - Convert Non-Irrigated Cropland to Permanent Unfertilized Grass Cover

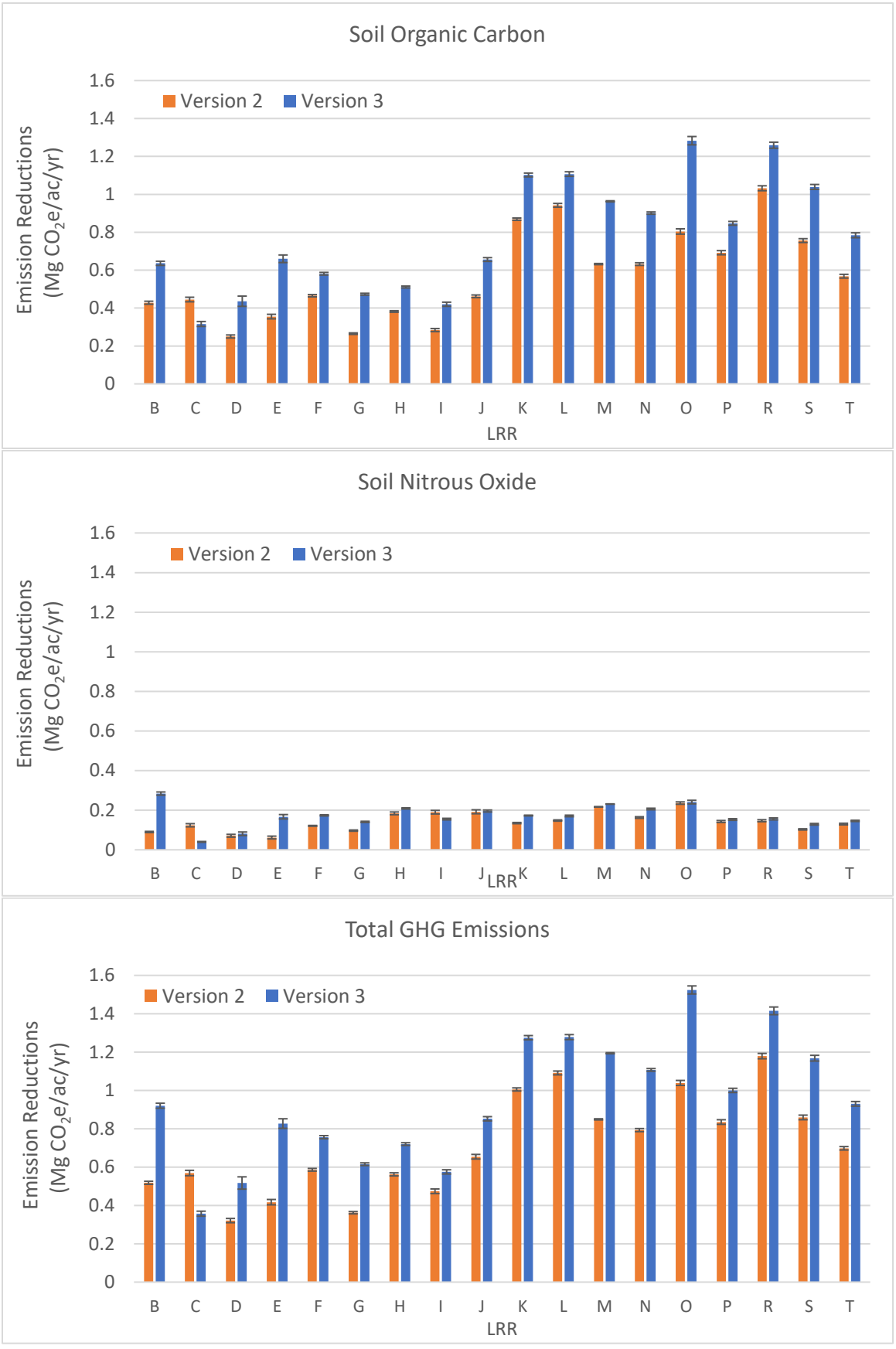

Figure 6. Emissions reductions for soil carbon (top), soil nitrous oxide (middle) and total emissions (bottom) by LRR for conversion of non-irrigated annual cropland to unfertilized, permanent grass cover (CPS 327).