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# The use of CLMS products for improving the spatialization of greenhouse gases emissions from LULUCF and agriculture sectors

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The Land Use, Land-Use Change, and Forestry (LULUCF) and agriculture sectors are increasingly central to global climate policy. They play a crucial role in climate mitigation strategies, as land acts as a carbon sink that needs to be enhanced and as a source of greenhouse gas (GHG) emissions that must be reduced. In the European context, the LULUCF Regulation (EU 2018/841), revised in 2023, aims for 310 Mt CO2eq net removals by 2030 and requires spatially explicit land-use representations to monitor land dynamics and assess policy impacts.

Within the Horizon project AVENGERS (Attributing and Verifying European and National Greenhouse Gas and Aerosol Emissions and Reconciliation with Statistical Bottom-up Estimates), a methodology was developed to generate an IPCC-compliant land-use map by integrating multiple Copernicus Land Monitoring Service (CLMS) products. In national GHG inventories, the operational use of spatial explicit data is often limited due to restricted temporal coverage, inconsistencies with national statistics, and challenges in interpreting mixed classes and land-use/land cover definitions. This methodology provides a transparent approach to reconcile inventory data with high-resolution spatial datasets.

The approach combines the CLC Plus Backbone geometry with CORINE Land Cover (CLC) and ancillary CLMS datasets, including the High-Resolution Layer Crop Types and Priority Areas monitoring products (e.g., Coastal Zones, Riparian Zones, and Protected areas). Multiple layers were integrated using overlay techniques and priority rules, resulting in an harmonized map at 10-m spatial resolution. CLC attributes were aggregated to IPCC land use categories, allowing direct comparison between mapped areas and inventory surfaces.

Preliminary validation involved cross-checks with national land-use activity data to ensure reliability of mapped areas across LULUCF categories. The resulting maps enable the spatialization of inventory-based LULUCF and agriculture emissions, producing gridded emission datasets based on improved spatially explicit land-use information. These datasets are suitable for use as input (priors) in atmospheric inversion modelling, a top-down emissions estimation method supporting policy evaluation.

The methodology is designed to be replicable across all European countries covered by CLMS data and to be updated approximately every 2–3 years, in line with the regular update cycle of CLMS

products. The methodological framework is modular and flexible, based on a spatial data storage and management scheme developed by ISPRA, which allows the integration of additional datasets and adaptation to different territorial contexts. The approach was applied and tested in three national case studies for the year 2018—Italy, Sweden, and the Netherlands—with specific adaptations introduced to account for distinct territorial characteristics. This first implementation represents a promising step and provides a solid foundation for further refinements and future developments, supporting the production of high-resolution land-use maps helpful for national inventory agencies and inversion modelling experts.