Road Transportation Emissions Estimation and Tipping Points

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Abstract

The Intergovernmental Panel on Climate Change, or IPCC, is predicting a high risk of several climate tipping points occurring at even 1 or 2 degrees Celcius of global warming. The Johns Hopkins Applied Physics Laboratory (APL) is tackling the problem of road transportation emissions as part of its role on the Climate TRACE coalition. This is key to understanding current greenhouse gas emissions globally and to informing climate tipping point analysis and discussion.

Description

The Intergovernmental Panel on Climate Change, or IPCC, is predicting a high risk of several climate tipping points occurring at even 1 or 2 degrees Celsius of global warming (Lenton et al. 2019). There are many sources of greenhouse gases (GHGs) causing this warming, including power plants, agriculture, transportation, industrial processes, and mining (Intergovernmental Panel on Climate Change 2006). In order to avoid warming levels that lead us to climate tipping points, a reliable third party emissions data inventory is required to provide detailed emissions data that is open, transparent, and accessible. Current emissions inventories are labor intensive to create, can contain significant gaps, are often outdated, and/or rely on proprietary data sources. A reliable, frequently updated, and transparent inventory would allow policymakers to set targets for reduction and know to what extent they are being met.

The Climate TRACE coalition is revolutionizing how scientists and governments think about greenhouse gas emissions tracking. Climate TRACE is a non-profit collaboration of organizations leveraging satellite imagery and other forms of remote sensing, artificial intelligence and data science to track human-caused GHG emissions globally and annually.

The Johns Hopkins Applied Physics Laboratory (APL) is tackling the problem of road transportation emissions as part of its role on the Climate TRACE coalition. In the US, the transportation sector accounts for roughly 27% of GHG emissions and road transportation is a large portion of that (U.S. Environmental Protection Agency 2022). We independently estimate road transportation emissions at a global scale using machine learning, satellite imagery (Drusch et al. 2012; Planet Labs Inc. 2022) and road network data (Haklay and Weber 2008). Our method breaks emissions estimates into both activity and emissions factors. For road transportation, we interpret activity as the number of vehicles traveling on a given road segment on a daily basis. This type of road activity data is difficult and expensive to acquire, and is not widely available globally. Thus, we use machine learning to automate activity prediction. The predicted activities are then paired with emissions factors – such as length of road or vehicle mix – to obtain a total emissions estimate for that region. The emissions factors are very powerful, helping us understand how different cities are moving towards a beneficial social and technological tipping point – that of electric vehicle (EV) adoption. When EV adoption increases in a jurisdiction, there is often a corresponding growth of charging infrastructure, and an increase in pro-EV incentives and policies. Some countries, like Norway, have provided strong incentives to accelerate this tip early, and now roughly 80% of new car sales are electric (Motavalli 2023). This is an example of a pattern of activity we cannot easily spot with satellites, but is a key driver in changing transportation emissions. By keeping activity and emissions factors separate, we can examine the impact of changing emissions factors on overall emissions estimates. This could eventually lead to policy changes that accelerate the onset of positive tipping points, such as increased EV adoption.

We estimated city level emissions from road transportation for 500 cities around the world and expect that number to increase significantly this year. This city level data is free and openly available through the Climate TRACE website, providing actionable information to make progress towards emissions reduction.

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