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Screening differences between a local inventory and the Emissions Database for Global Atmospheric Research (EDGAR)

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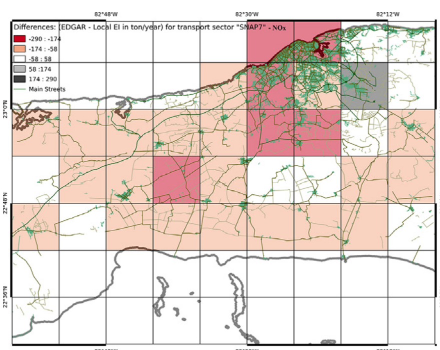
HIGHLIGHTS

- A local inventory was compared with EDGAR CO, NMVOC, PM10, NOx, SO2 and CH4 data by applying benchmarking tools.
- Overall, EDGAR provided spatially smoother results and has relatively lower values in hotspot areas.
- Main discrepancies are related to differences in the use of emission factors.

GRAPHICAL ABSTRACT



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ABSTRACT

In the vast majority of Latin American and South American countries, global emission inventories (EIs) are often used for modelling air quality. In particular the Emission Database for Global Atmospheric Research EDGAR is widely deployed but several studies have pointed to some gaps in comparison with national/regional inventories which incur errors in interpreting results. In Cuba, due to scarcity of a spatially distributed national inventory, EDGAR has been used as entry for air quality modelling without verifying their reliability over the region. Our goal in this article is to compare and contrast EDGAR with a local inventory and to evaluate similarities or discrepancies. We use advanced comparison techniques developed by the Forum for Air Quality Modelling in Europe–FAIRMODE. This approach differs from others in the detailed way in which it points out the differences and gets insights in possible explanations.

Overall, EDGAR provided spatially smoother results and relatively lower values in hotspot areas. Coarse differences in terms of activities were low for all analyzed sectors. However, EDGAR overestimates emission factors (EFs) of stationary sources for CO by a factor of 3 and SO_2 by a factor of 1.5 while underestimates those of PPM_{10} by a factor of 25. Most of the road transport EFs are overestimated in EDGAR; PM_{10}, CO and NOx are 2 times higher, while CH_4 and SO_2 are 5 to 20 times higher. Large differences were found on the spatial distribution of energy and industrial sources.

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EDGAR can be regionally accepted as a reference but it is not recommended for air quality simulation over Cuba. A more complete reporting must be expected when more official national data are due. A review and evaluation of local emission inventories over Cuba can be useful for identifying potential areas for future improvement.

1. Introduction

Air quality problems currently affect many cities worldwide. To mitigate this crisis, governments are developing policies to control air pollution emission sources (cf. Bel & Joseph, 2015; Font & Fuller, 2016; Gil-Alana & Solarin, 2017; Grigoroudis et al., 2016; Zhanga & Wanga, 2017). Policies are usually supported by air quality models able to predict the effect of changes on the sources' emission rate. Studies point out to emissions as the most uncertain factor among different components of air quality models; e.g. meteorology, boundary conditions, model parameters (François et al., 2005; Russell and Dennis, 2000; Viaene et al., 2012). A good understanding of all sources (i.e. anthropogenic and biogenic emission sources) and the quantification of their pollution rate is required. This information is commonly reported in emission inventories (EIs).

At continental scale, various inventories have been developed (Zhao et al., 2017) including the Emission Database for Global Atmospheric Research (EDGAR, JRC/PBL, 2011), the inventory of the Intergovernmental Panel on Climate Change (IPCC, Penman, Gytarsky, Hiraishi, Irving, & Krug, 2006), the inventory of Reanalysis of TROpospheric chemical composition over the past 40 year (RETRO, Pulles et al., 2003) and the new global emission inventory from the Community Emission Data System (CEDS, Smith et al., 2015). They are all useful for many reference purposes, especially for geographical areas in which data are not available, such as is the case in the vast majority of countries in South America (Alonso et al., 2010) and Latin America. Among them, most air quality simulations have relied on EDGAR (Alonso et al., 2010; Garcia et al., 2015; Kumar et al., 2010; Mena-Carrasco et al., 2009). EDGAR is considered unique in its provision of historical emission data for 20 year prior to 1990, and has been widely used by the global scientific community and by policy makers worldwide ((JRC), 2009). Nevertheless, EDGAR project uses scientific information and data from international statistics in order to model emissions for all countries of the world in a comparable and consistent manner. This fact can be a source of significant uncertainties-especially where there is no officially registered nation based emission data; and therefore it limits their use on decision support analysis.

At country-scale, with the exception of a group of countries (i.e. group world 2-mostly developing countries), national inventories are reported to the United Nations Framework Convention on Climate Change (UNFCCC). In addition, increasing attentions have been paid on regional/local inventories, motivated mainly by the urgent needs for haze pollution mitigation (Fu et al., 2013; Wang et al., 2010; Zhao et al., 2015; Zheng et al., 2009; Zhou et al., 2017).

Given the diversity in terms of methodology and data sources, global and local/regional inventories often do not lead to comparable emission estimates. Inventories' comparison has become a useful approach to quickly scan inventory data for such gaps, mistakes or differences. Specific comparisons over EDGAR have been performed worldwide. For example, Amstel et al. (1999) compared national inventories as reported to the Climate Convention Secretariat with EDGAR CO_2 and CH_4 data. For CO_2, differences were >10% in Eastern Europe + former USSR, and the Rest of the World Group 1, mostly developing countries. Large differences were found in some Latin American countries: emissions from fossil fuels were 24% higher in Bolivia national estimates, while EDGAR estimates were 90% and 23% higher than Costa Rica and Venezuela estimates. For CO_2 from biofuels, EDGAR estimates were 175% and 124% of Bolivia and Costa Rica national estimates.

Emissions mostly agree within the scope of 5% for Australia, Czechoslovakia, Germany, Italy Iceland, Hungary, Romania and United Kingdom. Substantial differences on CH_4 global emissions from coal, oil and gas were also observed; EDGAR estimates were almost a half of global total of national estimates. In contrast, global total methane emissions from fossil fuel combustion were lower in a factor of 10 in national data with respect to EDGAR. In most of the cases, differences were traced down to the use of different emission factors or the use of national statistic that differed from the internationally available ones. Parrish et al. (2009) indicated that the substantial decrease (something like an order of magnitude) in US non-methane hydrocarbons (NMHC) emissions experienced between 1975 and 2005 is inconsistent with the EDGAR inventory; EDGAR suggests increasing emissions until a maximum reached in 1995. This is probably due to misapprehensions of successful emission control strategies within the period. Regarding spatial patterns, Sheng et al. (2017) results have shown large differences with EDGAR oil/gas emissions in Canada and Mexico; EDGAR largely misses areas of production, and instead allocates total oil/gas emissions mainly according to population. Methane emissions from non-oil/gas anthropogenic sources in EDGAR are higher for Canada (14%) as compared to Environment Canada (2015), and for Mexico (12%) as compared to INECC (2015). EDGAR error patterns for other anthropogenic sectors including livestock and waste resulted smaller. Abdallah et al. (2016) highlighted high discrepancies in terms of emission estimates and spatial distribution: EDGAR emissions were higher than regional estimates for NH_3 and SO_2 by a factor about 3, and lower for CO, PPM_{10} and PM_{25} by a factor between 2 and 4. These differences were mainly due to the use of global datasets, occasionally inconsistent with respect to the base year, for the estimations of key factors such as the quantity of fuel, the distributions of fleet compositions and population. This led to high spatial differences in the modeled O_3 and PM_{25} concentrations, compared to a regional EI. Jena et al. (2015) indicated that over large NOx emitting point sources simulated daytime 8-h, averaged O_3 mixing ratios with EDGAR NOx emissions during winter shows the lowest O_3 values compared to ensemble mean of other four inventories (i.e. Intercontinental Chemical Transport Experiment-Phase B INTEX-B (Zhang et al., 2009), MACCity Indian National Emission Inventory INDIA_NOX (Zhang et al., 2009), the MAACity emission inventories developed for chemistry-climate studies (Granier et al., 2011) and Regional Emission Inventory in Asia REAS (Ohara et al., 2007)). This study argued that it is likely due to the very high NOx emissions in EDGAR inventory which leads to titration of O_3 during coolest winter months. Janssens-Maenhout et al. (2015) pointed out that EDGAR can be recommended as a global baseline emission inventory, which is regionally accepted as a reference.

In Cuba, there have been national EIs since 1990 (cf. ONEI, 2015). They report total emissions by compound and activity sector but no the temporal/spatial disaggregation. Instead EDGAR has been used as reference for national emissions disaggregation (Contreras Peraza et al., 2014) and even as entry for air quality modelling over the country (Turtós Carbonell et al., 2011). Thus, far not evidences about their reliability over Cuba have been provided.

The aim of this article is to evaluate the differences between EDGAR and a local emission inventory developed in Havana Cuba. We use advanced comparison techniques developed by the Forum for Air Quality Modelling in Europe–FAIRMODE. This approach differs from others in the detailed way in which it points out the differences and gets insights in possible explanations.