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Estimation of emission factors of climate forcers and air pollutants from improved wood-burning cookstoves distributed in Mexico

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Biomass is used as fuel for cooking and heating in several countries around the world, traditional methods of indoor biomass burning are inefficient combustion processes that generate important quantities of pollutants such as: carbon monoxide (CO), nitrogen oxides (NO_x), hydrocarbons or volatile organic compounds (VOC), and particulate matter (PM), in addition to certain short-lived climate forcers such as: carbon dioxide (CO_2), methane (CH_4) and black carbon, also identified as elemental carbon (EC). Some of these compounds, such as black carbon and methane, contribute significantly to climate change and remain in the atmosphere for a relatively short time, which is why they are known as short-lived climate forcers (SLCFs). The burning of residential fuels for cooking has been identified as a major source of BC emissions but improved cookstoves have been considered to have potential for mitigating the impacts of climate change.

In Mexico, approximately 28 million people live in rural areas and use firewood as a source of energy, the vast majority to cook food in an intramural environment. Government programs were implemented some years ago to introduce improved wood-burning stoves that include chimneys in rural households with the aim of preventing the accumulation of emissions in the indoor environment from the combustion of firewood with traditional methods. This new option makes it possible to send emission gases and particulate matter outside of homes. The estimation of emissions inventories of climate forcing species and of air pollutants from activities such as the burning of biomass when cooking food in rural environments in Mexico presents some degree of uncertainty due to the lack of proper emission factors; emissions estimates were generally obtained with other types of biomass and cookstoves. We present the results of emission factors for gases (CO_2, CH_4, CO, NMHC, NO_x, and SO_2) and PM2.5 (and its components, elemental carbon (EC) and organic carbon (OC)) from improved wood-burning stoves (Patsari, Onil and Ecoestufa) compared with a three stone using a controlled dilution system to obtain them. The sampling experiment combines measurements of PM2.5 and gases from a diluted stream of emissions, with carbon mass balance methods and concentration ratios of CO_2 and CO to obtain average emission factors under the Water Boiling Test (WBT) protocol. The ranges of average emission factors obtained for the improved cookstoves in grams / Kg of wood consumed were: CO_2, 1309-1375; CH_4, 3-4; CO, 63 - 103; PM2.5, 3.17 – 4.12 EC, 0.19 – 1.39, and NO_x, 798 -872 mg/Kg and are within the ranges reported in the literature. The efficiency of combustion or emission of CO_2 followed the order: Onil> Patsari> Ecoestufa> Three stone. These improved cookstoves emitted more CO_2 but these emitted lower amount of EC and OC than the three stone, then these generate lower amounts of CO, ozone precursors and other air pollutants.