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Marine plastic waste input between 1990-2015 and potential beaching scenarios

Charlotte Laufkoetter^{1,2}, Kevin Lang³, Fabio Benedetti³, Victor Onink^{1,2}, and Meike Vogt³

¹Climate and Environmental Physics, Physics Institute, University of Bern, Switzerland

²Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland

³Environmental Physics, ETH Zürich, Zürich, Switzerland

Marine plastic pollution has been recognized as a serious issue of global concern with substantial risks for marine ecosystems, fisheries, and food supply to people. Yet, the amount of plastic entering the ocean from land and rivers is barely understood. Currently, estimates exist for the coastal plastic input in the year 2010 on country-level resolution and for riverine plastic input for the year 2017. Key limitations are the restricted data availability on plastic waste production, waste collection and waste management. In addition, the transport of mismanaged plastic via wind and rivers is currently not well understood.

We present a model to estimate the global plastic input to the ocean for the years 1990-2015 on a 0.1x0.1° raster. To this end, we first train a machine learning model (random forests) and a linear mixed model to predict plastic waste production on country level, using data of municipal waste collection and several socio-economic predictor variables. We then estimate the amount of plastic waste that enters the environment, using high resolution population data and waste management data of each country. This is combined with distance-based probabilities of land and river transport to obtain the annual amount of plastic entering the ocean on a 0.1x0.1° spatial resolution. Our results indicate that global plastic waste production increased roughly linearly between 1990 to 2015. However, estimating the amount of mismanaged waste and the subsequent transport towards the ocean is afflicted with high uncertainties.

We then use the estimated plastic input into the ocean to force several Lagrangian model runs. These Lagrangian simulations include different parameterizations of plastic beaching, in particular they vary in terms of the beaching probabilities and the assumed residence time of plastic on beaches. We present the global distribution of beached plastic and the size of the reservoir of beached plastic in these model scenarios.