

Global and regional wildfire emissions of toxic pollutants contribute to health risks



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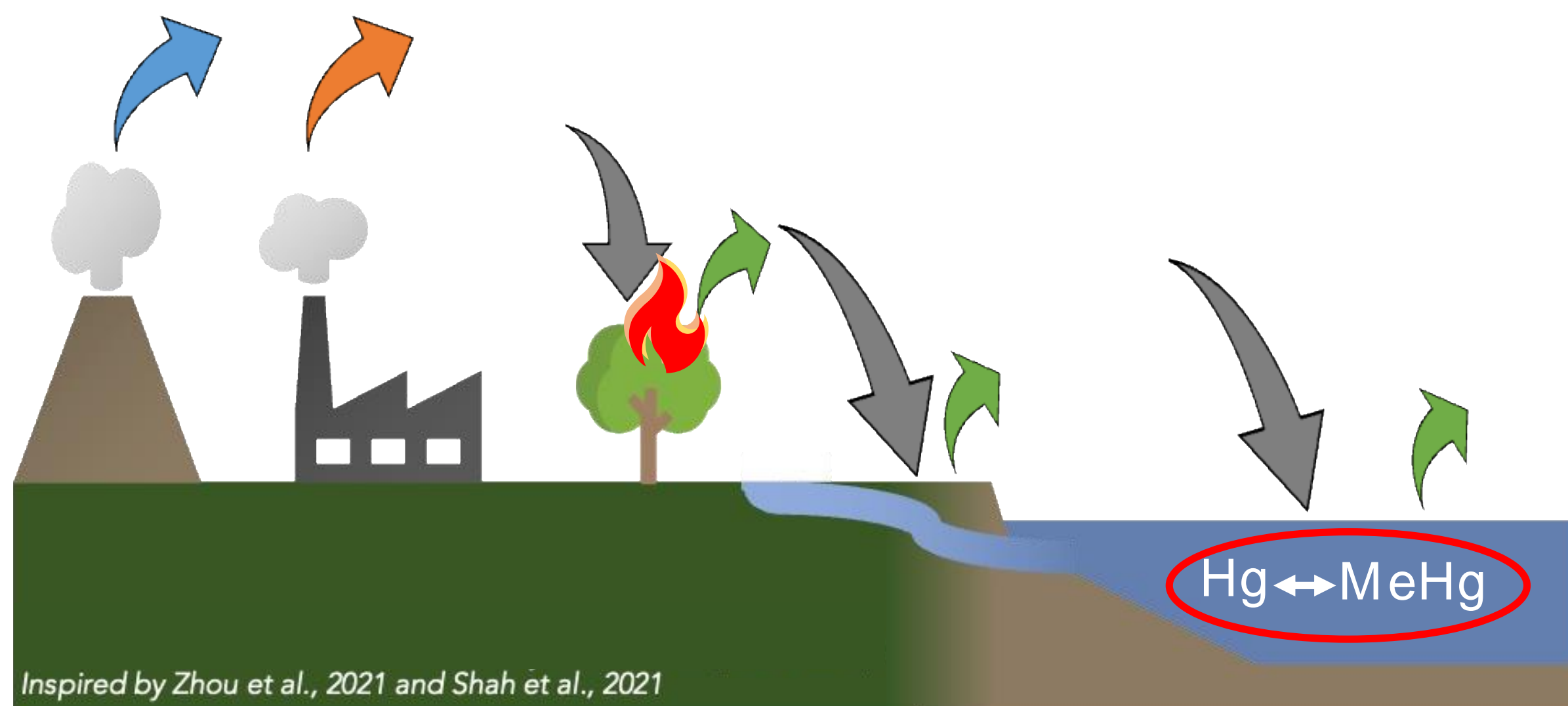
Motivation

Mercury (Hg) and Polycyclic Aromatic Hydrocarbons (PAHs) are toxic environmental pollutants that are subject to global transport, resulting in spatially diffuse health impacts. Wildfire emissions are a significant source of Hg and PAHs to the atmosphere, contributing an estimated 10%¹ and 8%² of global emissions, respectively. Ongoing reductions in anthropogenic emissions spurred by national³ and international⁴ actions suggest that the relative importance of these emissions will increase in the future, irrespective of climate-induced changes to wildfire behavior.

In this work, we seek to quantify the contribution of wildfires to total exposure of global populations to both Hg and PAHs using the GEOS-Chem chemical transport model. We also evaluate the impacts of the record-breaking 2017 Portugal wildfire season with respect to non-wildfire contributions.

Mercury (Hg) Cycling

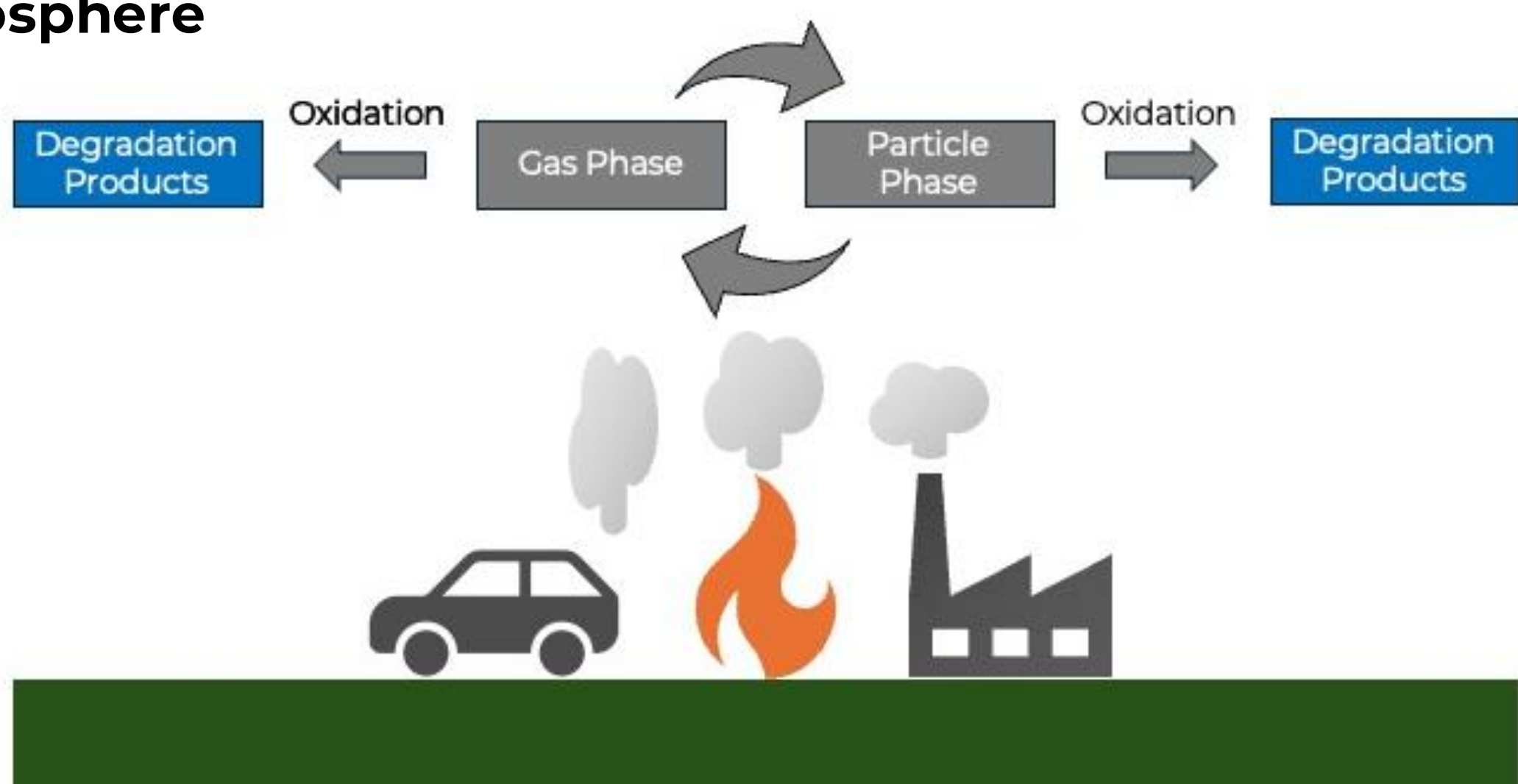
Fig. 1: Ongoing and historical Hg emissions contribute to risks



Hg introduced to the environment by natural or anthropogenic sources will cycle through environmental reservoirs for hundreds to thousands of years⁵. Once in aquatic ecosystems, Hg can be converted to bioavailable methylmercury (MeHg) that can bioaccumulate in upper trophic levels of food webs. Understanding the spatial distribution of Hg deposition provides identifies areas subject to high Hg loading.

Polycyclic Aromatic Hydrocarbon (PAH) Cycling

Fig. 2: PAH emissions undergo complex chemistry in the atmosphere



PAHs are composed of multiple fused aromatic rings with hundreds of molecules falling under this class of toxic and often carcinogenic compounds. They are emitted from incomplete combustion processes, such as wildfires, and in the atmosphere partition between the gas and particulate phase. These molecules can either deposit out of the atmosphere or oxidize to form toxic degradation products.

Global wildfire impacts

Fig 3: Annual contribution of wildfire Hg emissions to total deposition (2017)

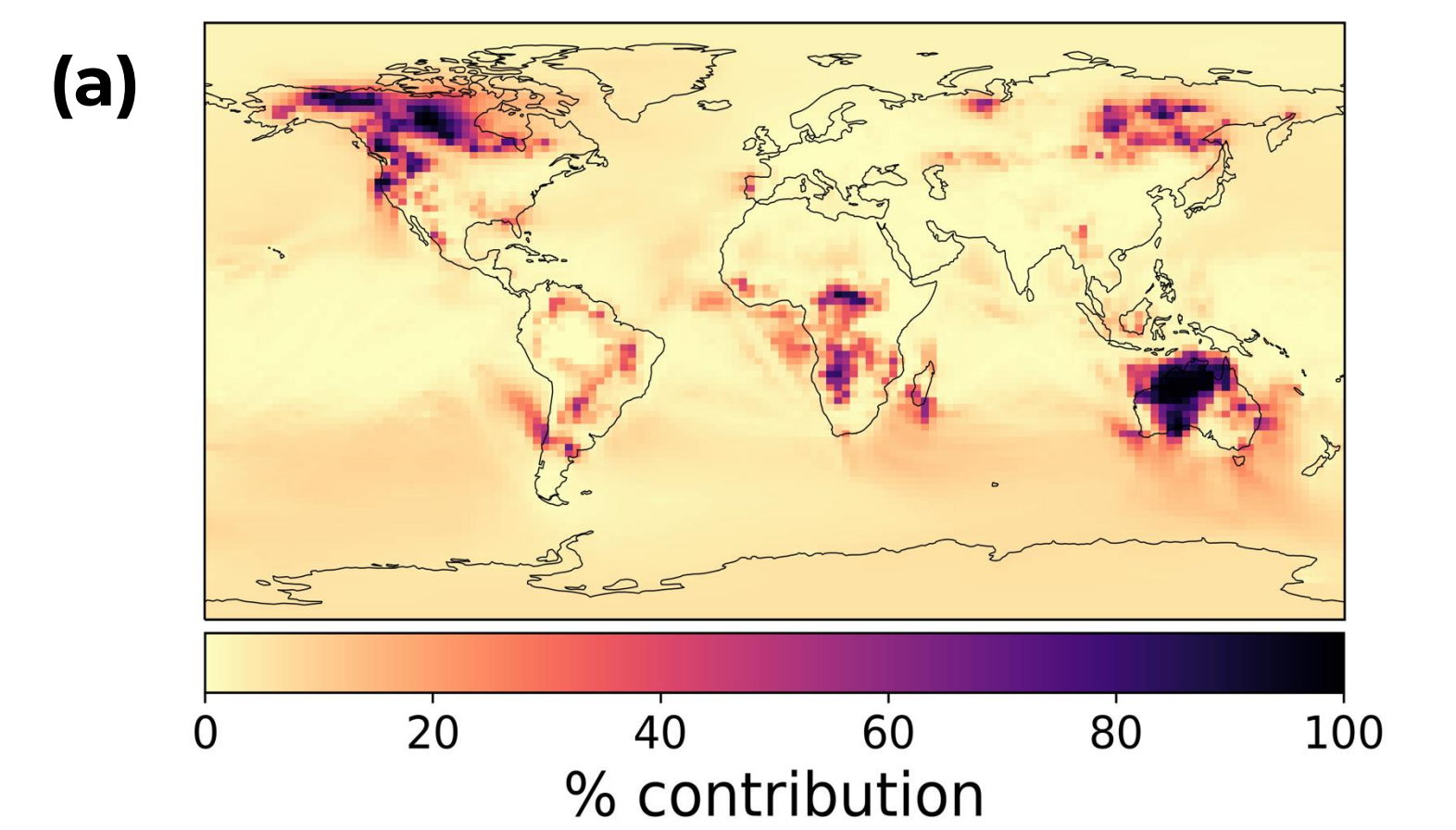
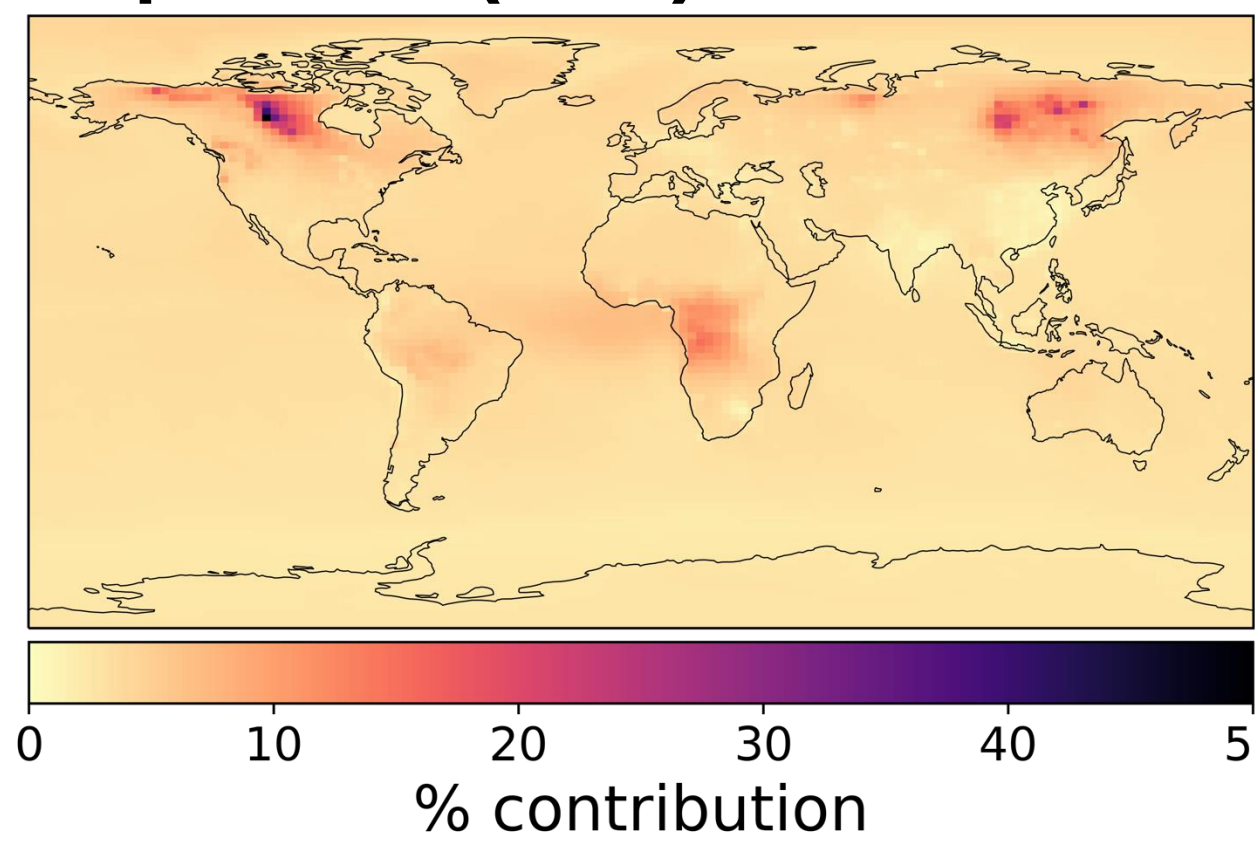
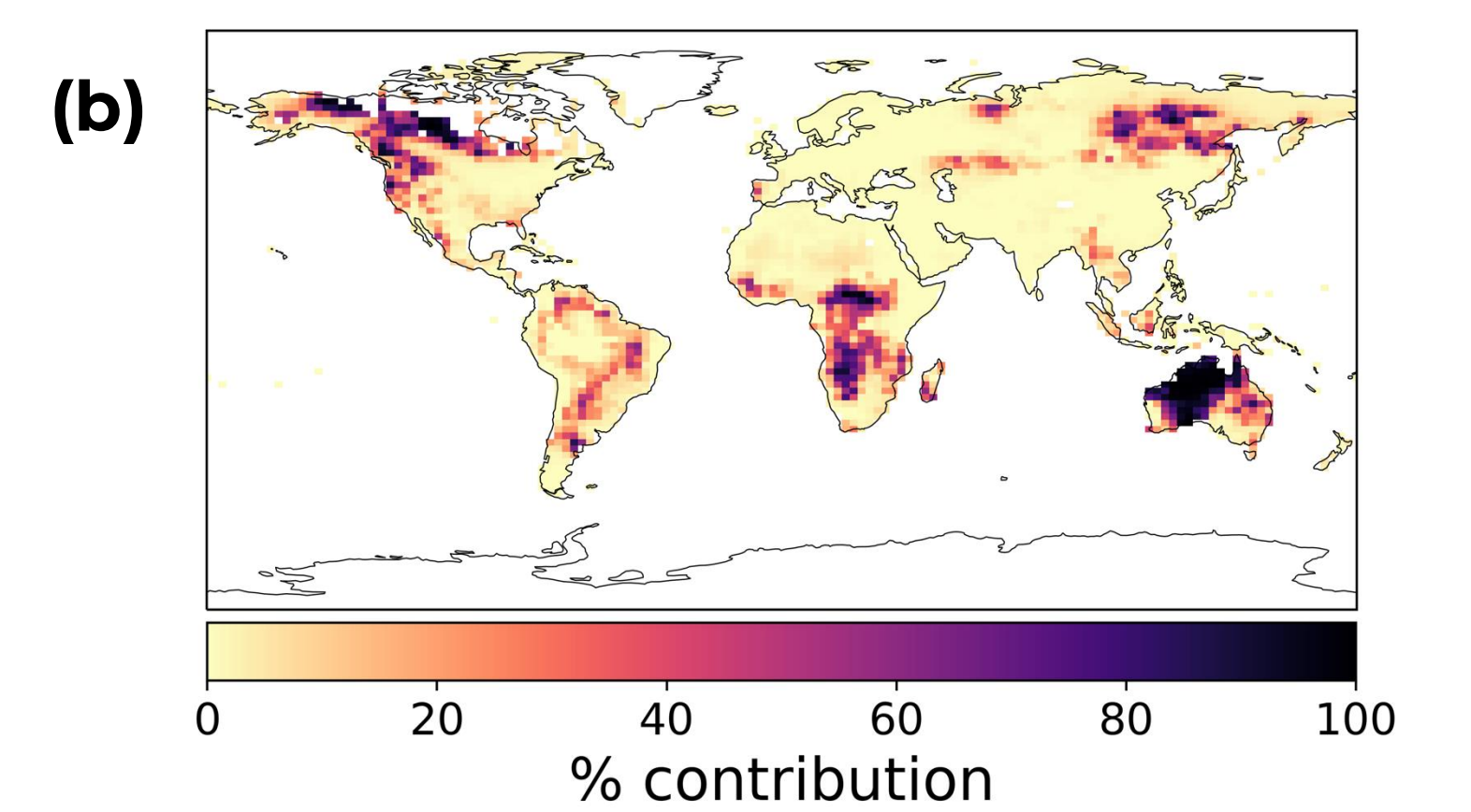


Fig 4: Annual contribution of wildfire PAH emissions to total PAH exposure (a) and cancer cases (b) (2017)



Case study: Portugal wildfire impacts

Fig 5: Contribution of Iberian Peninsula wildfire Hg emissions to total deposition (October 2017)

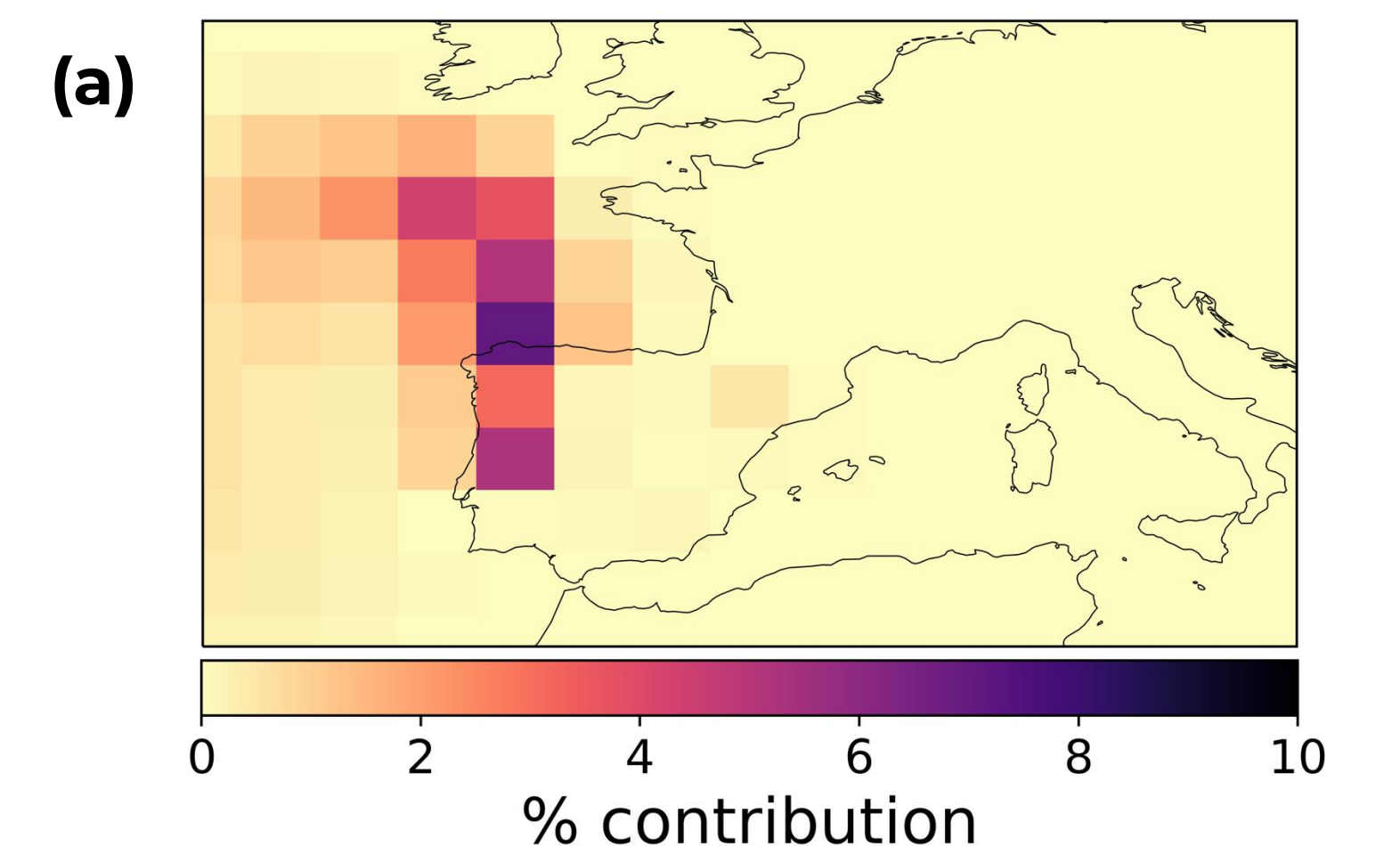
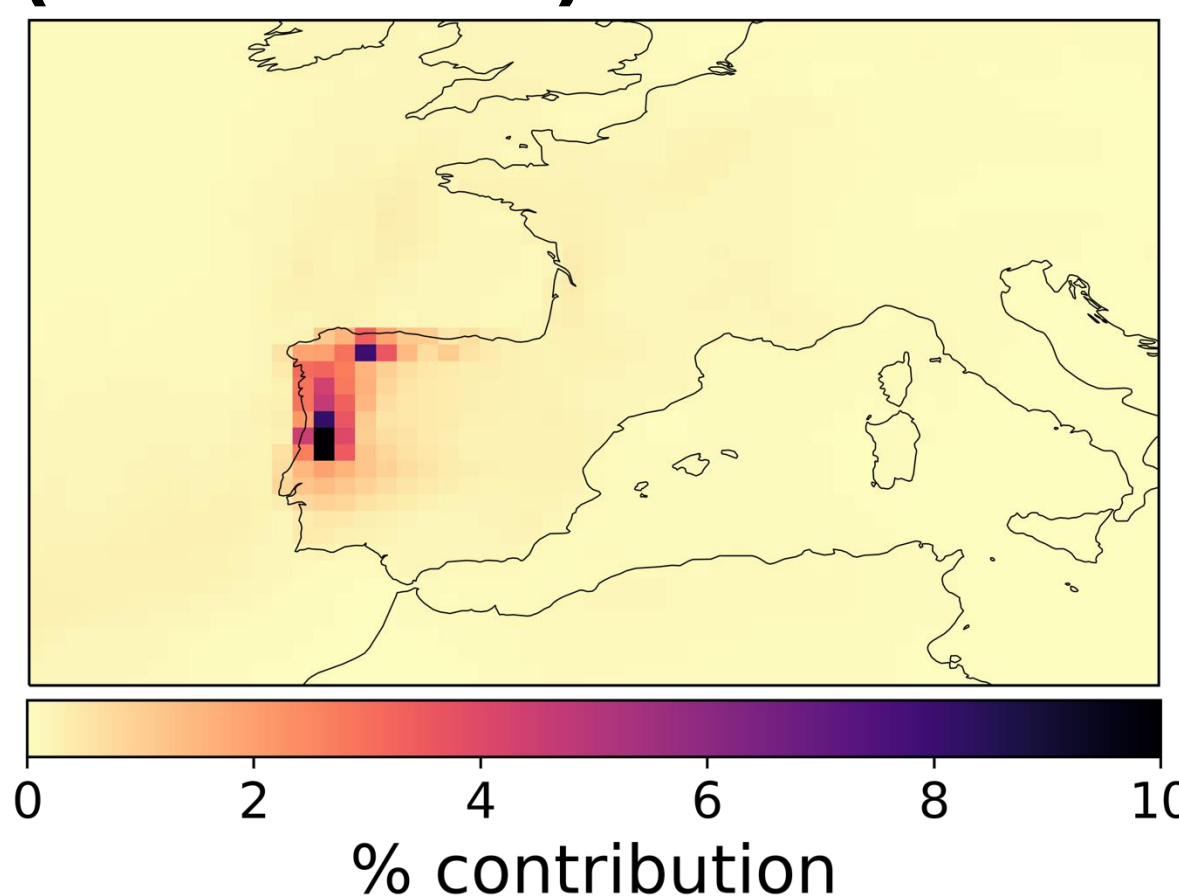
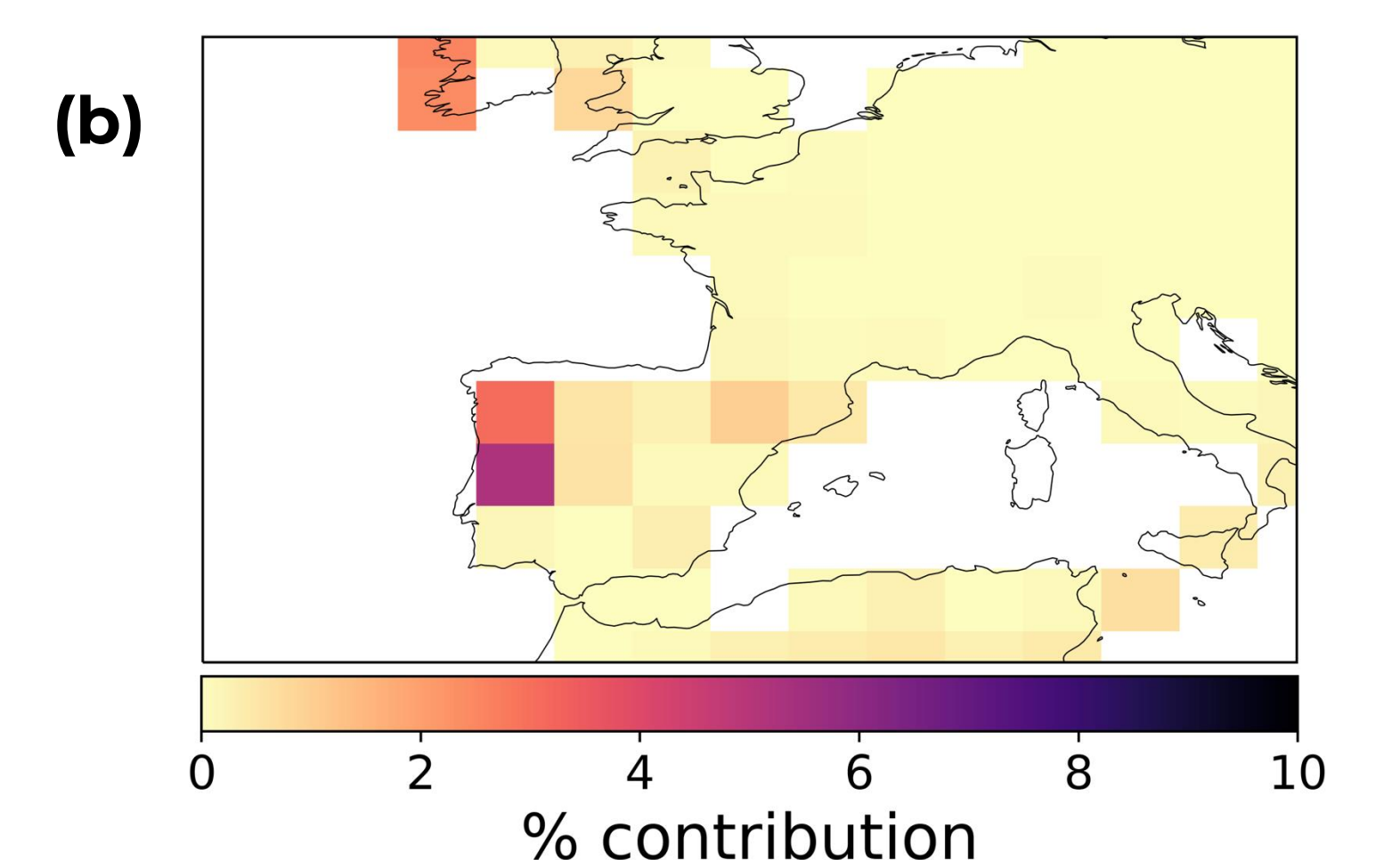


Fig 6: Contribution of Iberian Peninsula wildfire PAH emissions to total PAH exposure (a) and cancer cases (b) (October 2017)



Conclusions

- Wildfire emissions contribute a large fraction of annual Hg deposition and PAH exposure regionally, with global influence controlled by the atmospheric lifetimes of respective species.
- Case study of extreme 2017 Portugal wildfires indicate the noteworthy regional influence on toxic exposure.

Future work:

- Collaboration with University of Aveiro collaborators will evaluate the impact of model resolution on implied health impacts.
- Conduct sensitivity test of health impacts to model configuration by using different biomass burning inventories and model parameterizations.

References:

¹Global Mercury Assessment 2018, UNEP; ²Shen et al. (2013, <https://doi.org/10.1021/es400857z>); ³Giang and Selin (2016, <https://doi.org/10.1073/pnas.1514395113>); ⁴Aarhus Protocol on Persistent Organic Pollutants 1998, UNECE; ⁵Amos et al. (2013, <https://doi.org/10.1002/gbc.20040>); ⁶van der Werf et al. (2017, <https://doi.org/10.5194/essd-9-697-2017>)

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