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A robust scientific workflow for assessing fire danger levels using open-source software

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Modelling forest fires is theoretically and computationally challenging because it involves the use of a wide variety of information, in large volumes and affected by high uncertainties. In-situ observations of wildfire, for instance, are highly sparse and need to be complemented by remotely sensed data measuring biomass burning to achieve homogeneous coverage at global scale. Fire models use weather reanalysis products to measure energy release and rate of spread but can only assess the potential predictability of fire danger as the actual ignition is due to human behaviour and, therefore, very unpredictable. Lastly, fire forecasting systems rely on weather forecasts to extend the advance warning but are currently calibrated using fire danger thresholds that are defined at global scale and do not take into account the spatial variability of fuel availability. As a consequence, uncertainties sharply increase cascading from the observational to the modelling stage and they might be further inflated by non-reproducible analyses. Although uncertainties in observations will only decrease with technological advances over the next decades, the other uncertainties (i.e. generated during modelling and post-processing) can already be addressed by developing transparent and reproducible analysis workflows, even more if implemented within open-source initiatives. This is because reproducible workflows aim to streamline the processing task as they present ready-made solutions to handle and manipulate complex and heterogeneous datasets. Also, opening the code to the scrutiny of other experts increases the chances to implement more robust solutions and avoids duplication of efforts. In this work we present our contribution to the forest fire modelling community: an open-source tool called "caliver" for the calibration and verification of forest fire model results. This tool is developed in the R programming language and publicly available under an open license. We will present the caliver R package, illustrate the main functionalities and show the results of our preliminary experiments calculating fire danger thresholds for various regions on Earth. We will compare these with the existing global thresholds and, lastly, demonstrate how these newly-calculated regional thresholds can lead to improved calibration of fire forecast models in an operational setting.