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Updating the assessment of climate change at decadal scale and consolidating with CMIP6 future projections

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NASA's scientist James E. Hansen (named 'The father of climate change') has become widely recognized due to his many relevant contributions to climate change topics. In particular, his studies of recent changes of temperature at the decadal-scale published in 2012 and 2016, detected the emergence of a new kind of summertime extremely hot events which would not have occurred in the absence of global warming. Here, we update and extend the analysis of these studies using the latest reanalysis data from ECMWF (ERA5) from 1951 to 2020, at a higher spatial resolution. In addition, we put these results in context of state-of-the-art climate change modelling studies by considering future climate projections through the Coupled Model Intercomparison Project Phase 6 (CMIP6) Global Climate Models (GCMs).

Climate spatio-temporal variability for each continent is studied by evaluating the decadal frequency distributions of monthly 2-m temperature anomalies for the 1951-2020 historical period and for 2015-2100 future period. To achieve this, monthly averaged daily temperature data from ERA5, and the historical, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5 future climate scenarios from an ensemble of CMIP6 GCMs are used. For producing spatial analyses, all ERA5 and CMIP6 data were previously regridded to a common 100 km lat/lon regular grid using conservative remapping.

The results of ERA5 show a decadal shift in the mean temperature anomalies towards warmer values at continental scale, much more pronounced in the last decade (2011-2020), and larger in summer than in winter. By using a frequency distribution-based score, it is seen that the CMIP6 model ensemble is able to reproduce this historical warming, at a climatological timescale, with a large degree of agreement for all continents. Furthermore, climate projections strongly indicate that this warming will continue in the future under any climate change scenario and will be larger by the end of the century. The two most likely scenarios (SSP2-4.5 and SSP3-7.0) show significant evidences that extremely hot temperatures (anomalies of more than three standard deviations (3σ) warmer than the climatology of the 1951–1980 base period) will become the normal climate in Africa and South America regions for the 2071-2100 period. In this work, it is seen that the regional mean temperature anomalies will increase in weak, moderate and strong forcing scenarios, reaching climatic extremes with expected major implications on the water cycle, agriculture, ecosystems, society and human health.

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