New research indicates likely hydrological implications of rapid global warming

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Sediments in northern Spain showing the change from fine-grained sandstones to thick pebble conglomerates characteristic of massive and repeated flood events. Credit: Dr Rob Duller, University of Liverpool

Researchers studying a rapid global warming event, around 56 million years ago, have shown evidence of major changes in the intensity of rainfall and flood events. The findings indicate some of the likely implications should current trends of rising carbon dioxide and global warming continue.

It follows much discussion on the nature of global change in a warmer 21st Century at the COP23 Climate Negotiations in Bonn last week.

The new research, submitted to *Climate of the Past* Discussions, led by a team at the University of Birmingham, and involving multiple UK institutions and the British Geological Survey, sought to address this question using records from a major warming event in the Earth's past.

The rapid global warming event, ~56 million years ago, known as the "Paleocene Eocene Thermal Maximum" or PETM has provided such insights.

The team developed detailed records of the PETM event from a sequence of marine sedimentary rocks, now exposed on the coast of the Basque country of northwest Spain.

Before, during and after the PETM, these sediments were laid down on the sea floor at the edge of the Atlantic Ocean, at depths of ~1000m, on the boundary between the continents and the open ocean. The sediments are made up of microscopic calcium carbonate shells and fine-grained clay and silt sediment that is washed in from the nearby European continent.

Remarkably, the new records show that the sediment delivery from land to this deep ocean location increased four-fold during the PETM event. The team associate this with major changes in the patterns of rainfall on land, with warming causing more extreme rainfall events, with floods and the associated erosion and transport of sediments into the oceans.

"There are stunning records of the PETM event in northern Spain" says lead author Dr Tom Dunkley Jones, "including records of ancient land environments that experienced major changes in response to increased rainfall intensity at the start the start of the event. Now we have a direct link to the deep ocean, where some of the material eroded from land finally ends up."

Dr Stephen Grimes of Plymouth University, who initiated the research project, highlighted the climate changes that must have caused this increase in sediment erosion and transport - "We have climate model simulations of the effect of warming on rainfall during the PETM event, and they show some changes in the average amounts of rainfall, but the largest change is how this rainfall is packaged up - it's concentrated in more rapid, extreme events - larger and bigger storms."

This fits with what the team see in the rate of sediment accumulation in the deep sea - large flood events transporting more sediment, and moving it further.

Professor Melanie Leng, of the British Geological Survey and University of Nottingham, and co-author on the study is concerned about what this represents for the future, "From records of the PETM, like this one, it has become very clear that global warming causes major changes in the patterns and intensity of rainfall events. These changes are so large that we see evidence of them in the geological record, as a many-fold increase in the mass of sediments transported from land to the oceans. This has the potential for profound impacts on shallow marine ecosystems, and that is exactly what we see at the PETM."

Although the world warmed by more than 4ºC during the PETM, and this happened very rapidly for a period of natural climate change (between five and ten thousand years), it was slower than what is being observed in 21st Century warming.

"We're now facing the potential for a warming of 2ºC or more in less than two centuries," said Dr Dunkley Jones, "this is more than an order of magnitude faster than warming at the start of the PETM. The geological record shows that when the planet warms this much and this fast, there will be major changes in floods, erosion and sediment transport."

More information: *Climate of the Past*, DOI: 10.5194/cp-2017-131