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# NDVI anomalies associated with the European drought and heat wave of 2003

Suzanne Bevan, Sietse Los, and Peter North
College of Science, Swansea University, Swansea, United Kingdom (s.l.bevan@swansea.ac.uk)

The European drought and heat wave of 2003 is commonly used as an example of extreme summer climate conditions that are likely to become more common towards the end of the 21st century, under predicted climate change scenarios. The extreme conditions are known to have had an impact on biomass primary productivity as reflected in remotely sensed vegetation indices and fAPAR, flux-tower measurements, and the results from a variety of modelling approaches.
Early remote sensing analyses were based on relatively short time series of data, 4 or 5 years only. We are now able to make use of 12 years of MODIS observations to highlight the statistical significance of the widespread and persistent anomalies in vegetation greenness in 2003 compared with other summers so far this century. Anomalies in excess of 2 standard deviations initially occur at the start of June in central and eastern France. By the end of July they are common also over Germany, by mid August have spread to the French border with Spain, and by the end of August are common over the north-western corner of France, England and eastern Scotland.
Using the One-Degree Daily resolution Global Precipitation Climatology Project precipitation data and European Re-Analysis Interim 2 m air temperatures we are able to show where and whether either precipitation or temperature has the greatest impact on summer vegetation greenness. With the exception of mountainous regions such as the Alps and northern and western parts of the United Kingdom, summer NDVI anomalies are highly correlated with precipitation anomalies of the preceding month. The picture for temperature is more geographically variable with summer NDVI anomalies in southern France, Italy and central England and north-eastern Scotland being negatively correlated with temperature, and northern and western coasts of France and Germany being positively correlated with temperature.
In addition, we analyse the anomalies in conjunction with vegetation height from ICESat GLAS measurements, and Global Land Cover Facility classifications.
Attempts have been made to fit linear trends to global biomass production since 2000, following reports of an increasing trend during the 1990s. It is clear that events as significant as the 2003 European drought will complicate attempts to identify long-term changes in biomass and carbon uptake.