architecture of the international climate governance regime. Solutions that improve the current international regime have been the focus of many prominent climate change policy scholars[4,5]. It is not a matter of which states belong to a particular political alliance, such as those that pledge carbon neutrality, it is rather the future actions of these alliances within the current international governance regime. Pledges only mean something if they are translated into firm political action[6].

It has also been argued that greater collective political assertiveness on climate mitigation is just around the corner because more countries are becoming democratic[7]. However, Wallerstein's world systems theory argues that the way in which states act on the international stage is principally underpinned by economic rather than cultural or ideological factors.

If liberal democracy is founded on the economic self-determination and sovereignty of individual states (which is also enshrined in the United Nations Charter) there is a fundamental paradox. If individual states have a particular economic interest, then they would naturally gravitate towards a mutually benefitting extra-territorial alliance where domestic economic interests could be attained. For over 20 years now, international climate governance — the UNFCCC, the Kyoto process and the annual Conference of the Parties — has been dominated by such economic arguments. These economic arguments continually transcend bounded state territories through political alliances[8].

So while Flagg's four hypotheses for states hold true, the study does not address the main overarching issue in international climate politics: that these pledge states could just be one more grouping in the tranche of political alliances in the paradoxical international climate governance 'game'. The international climate governance regime either needs to change, or the self-interested attitudes of the majority of nation states that comprise the member parties of the UNFCCC treaty must alter.

The former is complex, the latter nigh on impossible — though pledge states cannot be criticized for a lack of effort ahead of the next battle in Paris in December. ❐

Andrew Kythreotis is at the School of Planning and Geography, Cardiff University, Glamorgan Building, King Edward VII Avenue, Cardiff CF10 3WA, UK. e-mail: KythreotisA@cardiff.ac.uk

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WARMING TRENDS

Saharan desert warming

A key element of the West African monsoon is changing faster than in the surrounding areas but the reason is unknown. Now research assesses the specific behaviour of the temperature over the Saharan desert.

Christophe Lavaysse

The West African monsoon is less well known than the Indian one but its seasonal cycle of precipitation provides the water resources for the ~320 million people living in the region. In summertime, a thermal depression in response to the seasonal surface warming in the lower troposphere is located over the Sahara desert. This low pressure, combined with the relative high pressure over the Guinean coast, produces a low-level pressure gradient that corresponds to the main component of the West African monsoon system — a driver of regional precipitation. Put more simply, the warmer the Sahara, the stronger the thermal depression, and the more intense the monsoon flow[1]. Therefore, assessing and understanding the evolution of temperature over the Sahara desert is an important step in identifying the future trend of the West African monsoon. Writing in the *Journal of Climate*, Kerry Cook and Edward Vizy[2] analyse the recent warming of the Sahara and its cause.

Previously the low pressure over the Sahara desert and the latitudinal position of the monsoon were linked in reanalysis products (Fig. 1), and this feature has been also captured by climate models[3]. In this context, the recent observed recovery in Sahelian rainfall[4] is consistent with an intensification of the temperature over the Sahara. In the CMIP5 climate models, a robust tendency to warming over the region is seen — and is 10–50% larger than global warming. It should be noted that the dispersion among the models in simulating the surface air temperature were larger over these areas[3]. In terms of precipitation, for this century, most of the climate models predict wet conditions in the Sahel, but the large spread of the models suggests uncertainties in the intensity and sign of the trend[5]. Analysis of the increase in precipitation over the Sahel indicates that it is through the direct effect of the increase in greenhouse gas concentrations on net radiation at the surface, and so through the increase in temperature[6]. In addition, it has been suggested that the trends were amplified by anomalous night-time longwave heating of the surface due to the increase in integrated water vapour[7].

The work by Cook and Vizy assesses the increase in temperature over the Sahara for 1979–2012 in detail by comparing linear trends in temperature. Several datasets (three reanalysis products and two observational) are used to account for the uncertainties due to the sparse ground-based observations over the desert. The annual warming trend in the Sahara exceeds the global and tropical warming rates by, on average, a factor of 2.5 and 4, respectively. The same increase in temperature is observed throughout the year over the desert without seasonal amplification. This increase is concentrated in the lower part of the troposphere (under 500 hPa). However, the spatial distributions of this increase are very different across the datasets. The origins of these spatial differences are not discussed in the paper, and should be addressed in future work. This spatial distribution influences the thermal gradient, which in turn will affect the wind direction and intensity, and so the monsoon flow. In addition, the assumption of a linear trend can misstate the observed tendency[8], so the validity of this hypothesis should be investigated in future research.

Examination of each component of the equilibrium surface heat balance allows the potential origins of the amplified warming over the desert to be investigated[2]. The effect of the solar radiation absorbed at the surface is uncertain. This could be explained by poor representation of the radiative properties of aerosols, such as light scattering and light absorption, and of the surface reflectivity in the arid region. These data are not assimilated in the reanalysis datasets. The longwave back radiation — radiation emitted by the atmosphere towards the Earth's surface — shows a positive effect and could explain the increase in temperature. The modification of this longwave radiation may be associated with the increase in atmospheric greenhouse gas concentrations from human activity, as shown previously[9]. Owing to the large spread of the results from the reanalysis products, the authors did not link the increase to the contribution from atmospheric water vapour, contradictory to a recent study[7]. Instead Cook and Vizy conclude that one of the primary mechanisms responsible for the increase in atmospheric temperature over the desert is the increase in the upward longwave radiation from the surface. Previous studies reached the conclusion that the primary mechanism was the longwave back radiation component but various results in the recent literature cited above leave the exact origin of the rising temperatures an open question. This is mainly due to the lack of observations over this region.

The results of Cook and Vizy contribute to an ensemble of studies that are involved in the assessment of the future trend of the West African monsoon and temperature in the Saharan region. Their study[1] considers the impacts of the temperature increase, both for the 3 million people living in the desert and the atmospheric dynamics. The authors highlight that in the summer, the increase in temperature strengthens the thermal low and the latitudinal gradient leading to an increase in several components of the monsoon, such as mid-altitude jets and the monsoon flow.

Cook and Vizy liken the amplified warming over the Sahara to Arctic amplification, as the strong coupling between surface and the atmosphere, the upward and downward longwave radiation, enhances the warming with no way for the heat to escape upward. This is comparable to the vertical stability of the polar atmosphere. The amplification has been suggested to be related to the observed partial recovery of Sahel precipitation during the last decade, but this has not been definitively shown. Another open question is the potential impact of this trend on the increase in intensity of extreme precipitation events[10].

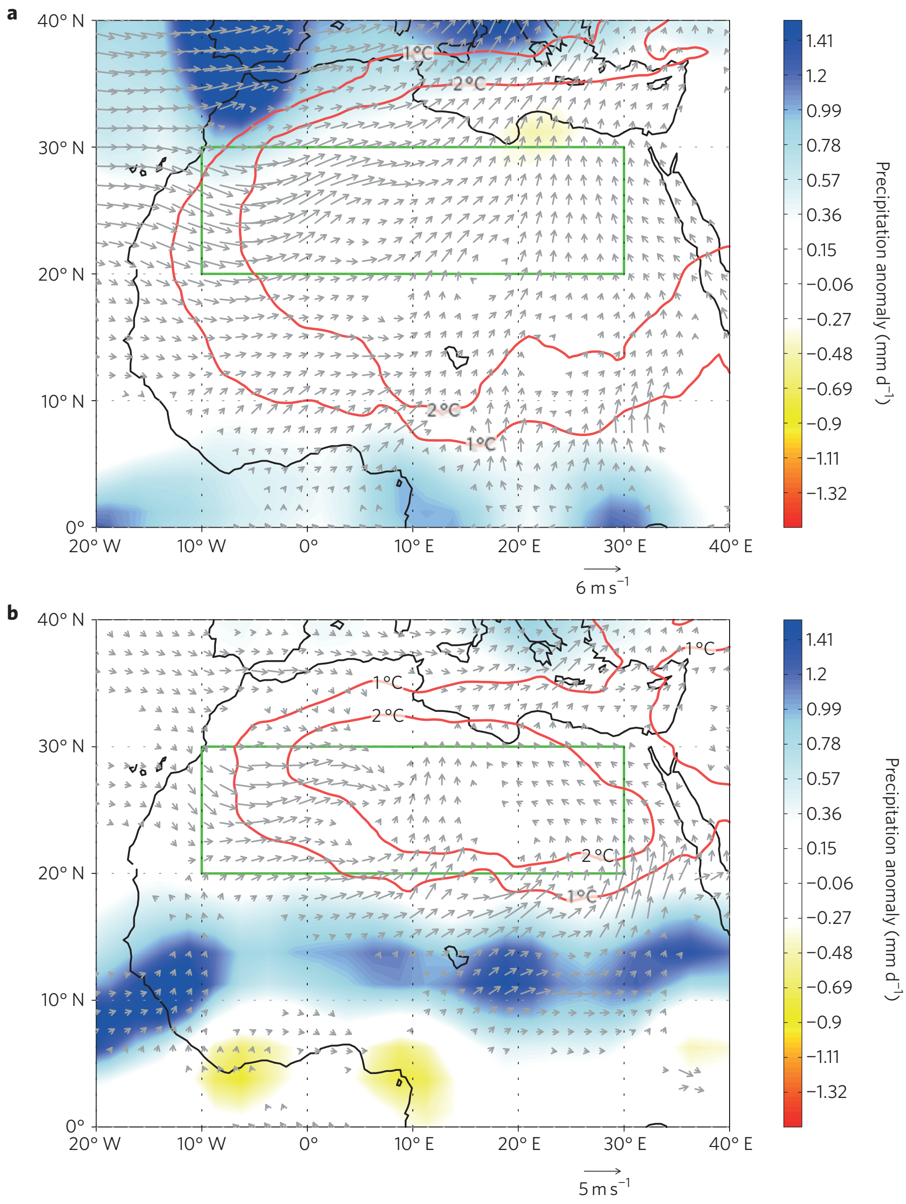

Figure 1 | Temperature, wind and precipitation anomalies during warm versus cold periods over the Saharan desert. **a**,**b**, Composite anomalies of the precipitation from the Global Precipitation Climatology Project (color shading), using the 5 warmest and the 5 coldest yearly Saharan surface temperatures, averaged in the green box between 1979 and 2012, in winter (**a**) and summer (**b**). The red contours indicate the temperature anomalies at 850 hPa (from ERA Interim reanalysis) associated with the Saharan low pressure, and the vectors show the wind anomalies at 925 hPa (from ERA interim reanalysis).

To answer to these questions, future work should focus on climatological change at intraseasonal timescales. ❐

Christophe Lavaysse is at the European Commission, Joint Research Centre, 21027 Ispra Varese, Italy.
e-mail: christophe.lavaysse@jrc.ec.europa.eu

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