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Popular perception and climate change: mapping the varying experience of precipitation

The Problem

The idea of climate change necessitates that there is a climate in the first place. The word 'climate' implies some average or expected state of affairs, within the bounds of normal variation. This immediately implies that we have to say who is doing the expecting, who is defining normal. Thus, for a climate scientist to operationalise the idea of annual change in the global climate, (s)he will average the spatially varied values of a parameter around the world. The 'experience' of this global climate is intellectual.

Since the general public does not experience global averages, to most people the idea of climate, and thus also the idea of climate change, is bound up with their experience, in a particular locality, of variation over time, possibly measured in decades. This means that people will also have an expectation that this spring will not be exactly like the last, that, in general, there will be unusual conditions that are not necessarily abnormal. Thus I stake the claim that the kind of local variability in weather that different people experience in different places will impact upon their construction of climate change.

This project has at its core the ambition to provide global maps, not of average climate conditions, but of the variation in climatic conditions over time at a place, so that we can begin to appreciate what might be the public's idea of normal variation. So far, this ambition has been realised for one variable only, precipitation, because the world is not well observed, and for much of the analysis I would like to undertake, the data sets simply do not yet exist.

Seasonality

Since the industrial revolution and the harnessing of new sources of power, instead of settlement being adapted to precipitation, water has been increasingly spread between seasons, for new industries and cities, and for irrigation. The strength or intensity of seasonality therefore matters. Some authors have clearly identified a link between seasonality and poverty (Gill (1991), Chambers et al. (1981), Devereux et al. (2008), Thomson, Garcia-Herrera and Beniston(2008)) but restrict their analyses to developing parts of the world. Clearly we should not expect that the seasonal differences are equally strong all over the globe. Part of the expectation of what is normal, or what is unusual will depend on how strong is the seasonal signal.

Available Data Sets

The longest good record for a single climatic variable, is the central England monthly temperature record going back 350 years, reconstructed painstakingly from a variety of sources. Many records date from the first half of the C20th at best, and are mostly from the developed rather than the developing world. By the end of the C20th the number of observing stations was in fast decline, as more reliance has been put on weather satellites. They, however, provide proxies for surface measurements. For example, rainfall cannot be measured by a satellite, even if algorithms estimate rainfall from data on cloud height and thickness. Thus, to create a historical series for many points around the globe requires a huge amount of work, collating information from scattered stations using different instruments and methods, and the result is a data set of uneven spatial coverage. But in the last decade such records have been created, and then, using sophisticated interpolation procedures, data has been re-expressed as values for latitude and longitude grid squares at different levels of resolution. The best option for the current paper proved to be to download a single variable, precipitation, at a 1° x 1° resolution, on a monthly basis for the years 1951-2000, from the Global Precipitation Climate Centre (National Meteorological Service of Germany). This is for land surface areas only. Since some grid cells only just cover a small part of the land surface, the coast lines in the following maps are impressions rather than exact.

Results

Map 1 concerns the degree of intra-annual variability of precipitation – based on the idea of a standard climatic year. The standard deviation of the average monthly rainfall for each month is standardised by the overall annual mean, to provide the coefficient of variation of average monthly rainfall. The map therefore shows the extent to which, for whatever value of the mean, precipitation is seasonally ‘bunched’. The dry Sahara and the wet monsoon lands are grouped together, because on this measure both have strong seasonal signals. The non-tropical areas with low levels of intra-annual variability are very clearly Europe, the eastern seaboard of the USA, south-eastern South America, the tip of Cape Province in South Africa, south-eastern Australia and New Zealand. All of these just happen to be areas of white European colonization, and perhaps lend support to Tvedt's (2008) hypothesis, that the year-round water supply of these areas played a significant role in their early adoption of industrialisation.

Map 2 shows the coefficient of variation of total annual rainfall, over the fifty years. It is a proxy indicator for the 'reliability' of the annual average rainfall. The latitudinal structure is fairly strong, marked by specific longitudinal contrasts – e.g. between (reliable versus unreliable) central Amazon versus north-east Brazil; West Africa/Congo versus East Africa; Assam, Bangladesh, Burma, China nexus versus Pakistan. Australia and New Zealand contrast with each other starkly.

The same statistic is calculated separately for each month of the year. August is shown (Map 3), which illustrates the reliability of the monsoon in East India and Indo-China, but the great unpredictability of rainfall south of the ITCZ (Inter-Tropical Convergence Zone) in Africa and Australia, and north of the ITCZ in Africa. On all maps, Europe retains its same middle values. Unlike in India, the time of year in Europe is no indicator of the predictability of precipitation.

Each month can be construed as a sample, so that the variation within months (over 50 years) can be contrasted with the variation between months. The two sources of variance were calculated, and the ratio of the between-sample/within sample (the statistic used in an F-test) plotted, in Map 4. Where the between-sample signal dominates (intra-annual variation over inter-annual variation), the public may be less concerned with ideas of climate change; whereas, where the within-sample signal dominates, people will be more aware of the possibility of annual change. The map clearly picks out the massive seasonal signals in Brazil and tropical Africa, and also the South Asian and Chinese monsoon.

Conclusions

These maps make of sense of the common aphorism that "Britain has no climate, only weather". The contrast of Northwest Europe with the seasonality of India is extreme – and it helps understand remarks by a distinguished Indian environmental journalist, Darryl D'Monte: "Climate change.. this is not a problem India is going to worry about………We know what change is all about. Nobody can threaten us with any change greater than we've already had." (Chapman et al, 1997:76). In England, this logic can be reversed. There is far less expectation of an extreme, so when one happens, it can easily be taken as 'proof' of climate change. Indeed, summer floods in 2007 were taken by journalists to be evidence of global catastrophe – a claim rebuffed by the official analysis of the events (Marsh and Hannaford, 2007), which stated it was a normal kind of unusual event.

People around the world will relate their short-term experiences of weather to ideas of climate change in very different ways (Hulme et al., 2008). This in turn will effect the seriousness with which they do or do not respond to warnings of climate change, and the ranking they give it, in the hierarchy of their current problems and needs.

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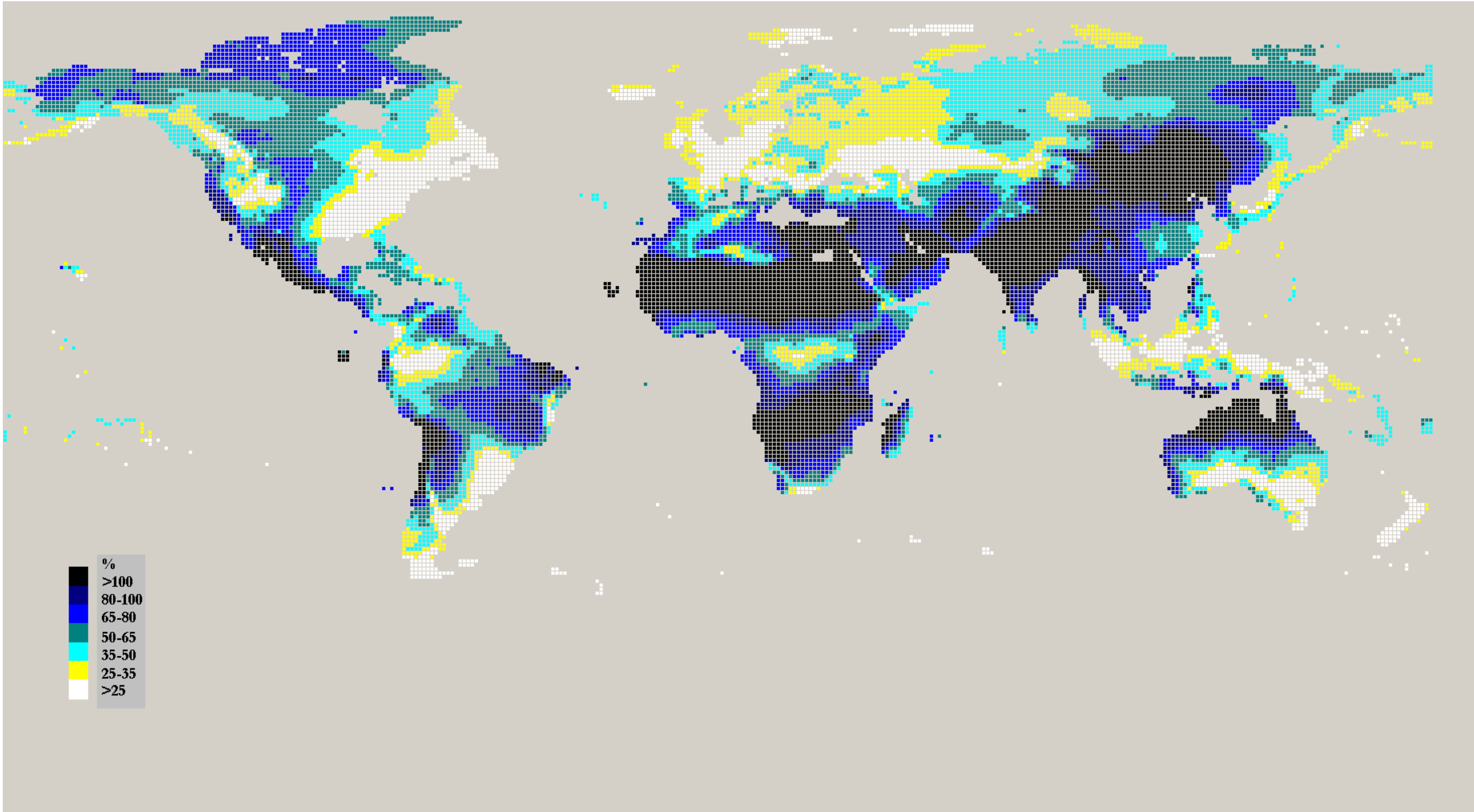
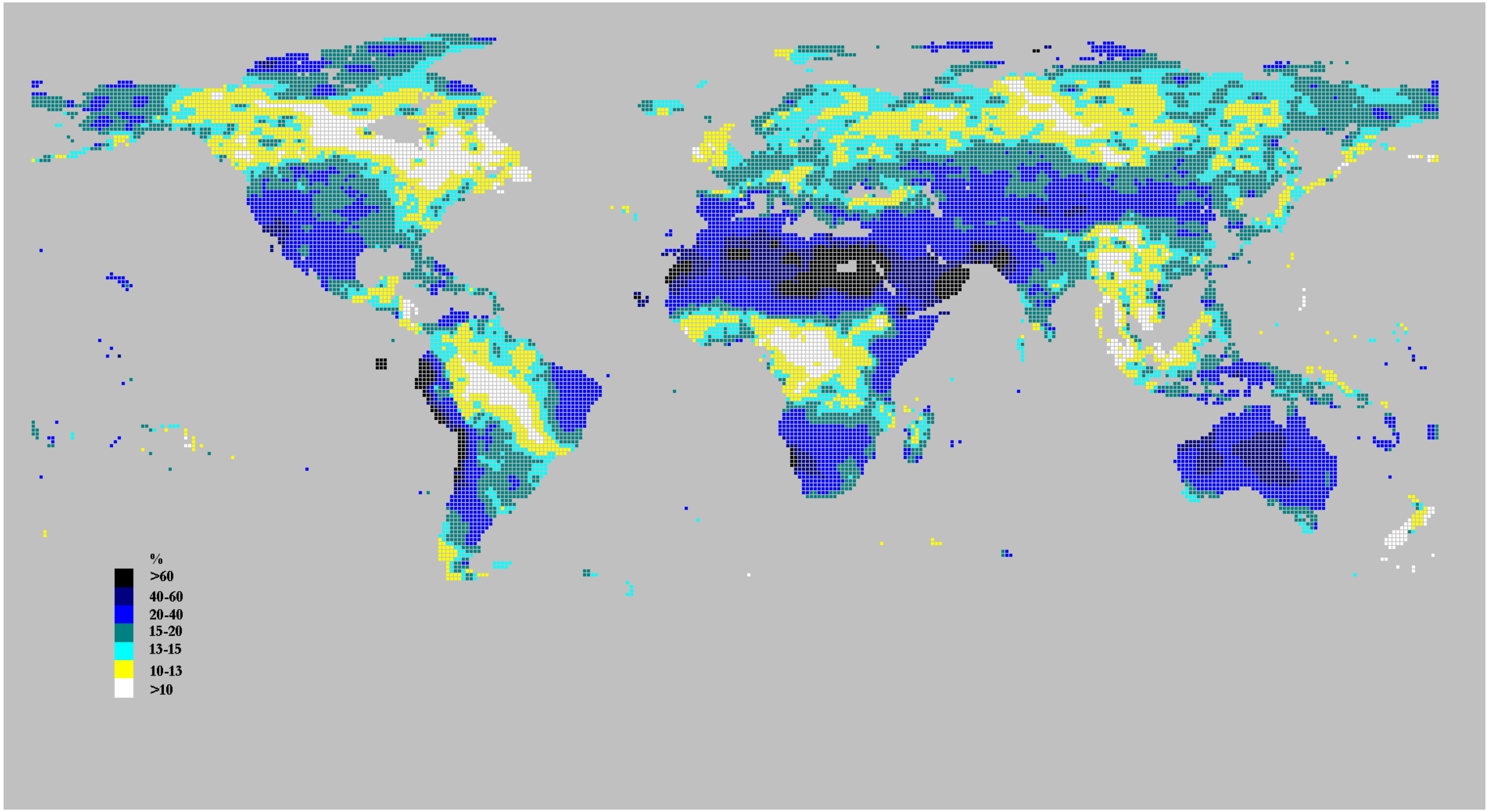
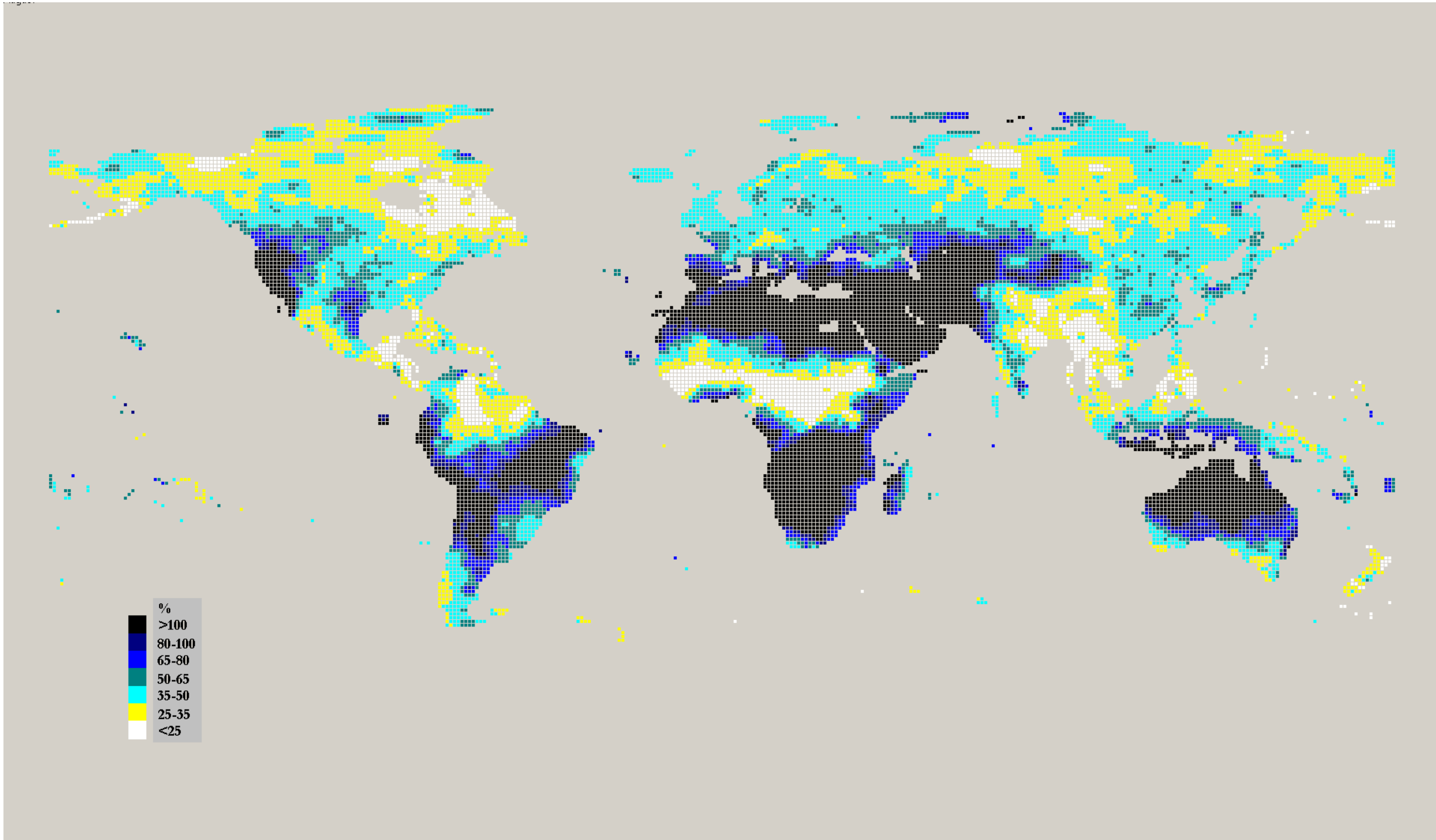


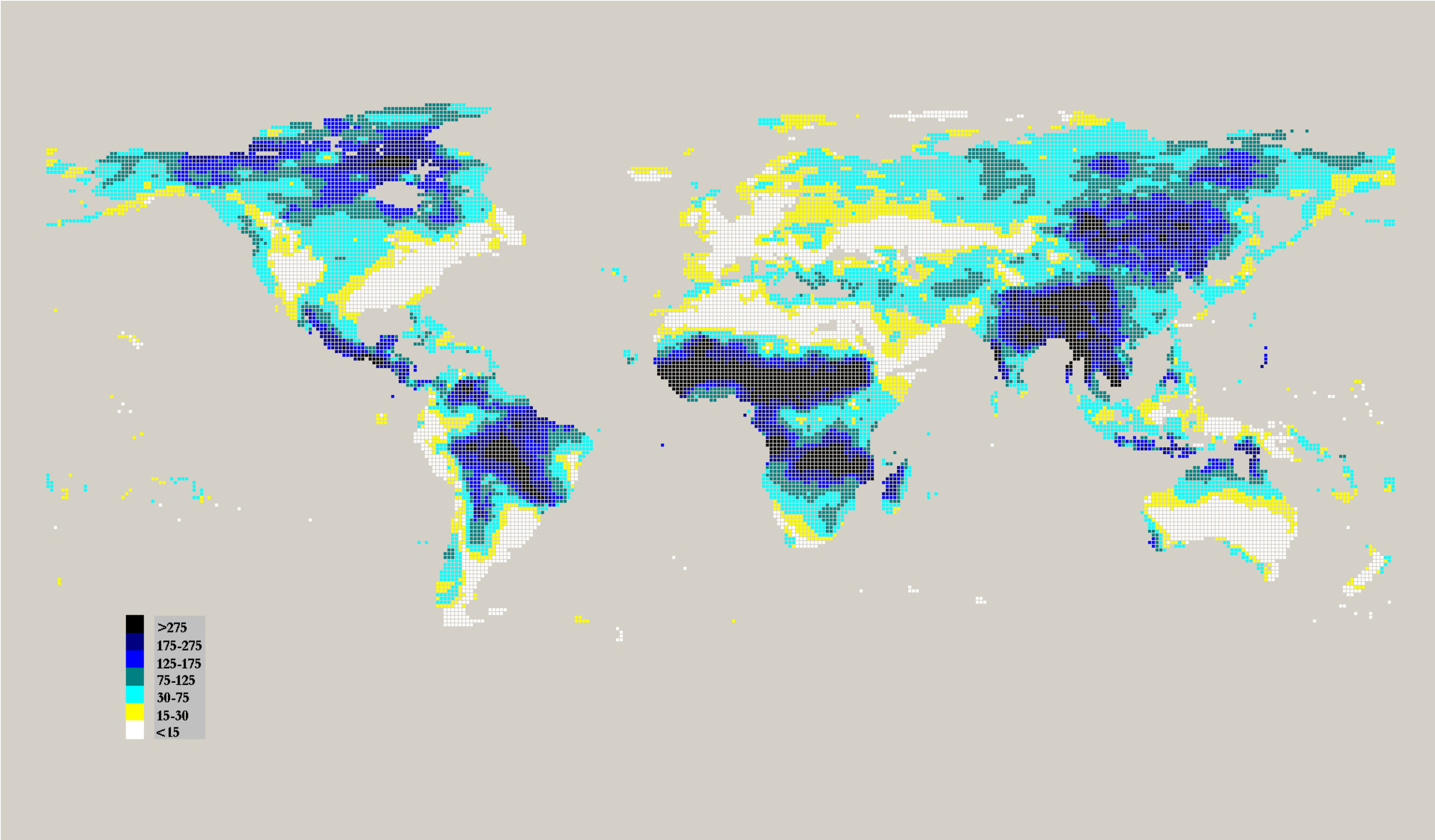
Map 1. Intra-annual coefficient of variation of precipitation. Based on GPCC 1 degree grid, 1951-2000



Map 2. Coefficient of variation of annual rainfall. Based on GPCC 1 degree grid, 1951-2000



Map 3 Coefficient of variation of August rainfall. Based on GPCC 1 degree grid, 1951-2000



Map 4 Within year variance/ between year variance. Based on GPCC 1 degree grid, 1951-2000