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Links between violence and high temperatures

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INTRODUCTION

Scientists have known for a long time that humans tend to be more violent at extreme temperatures: for example, there are generally more homicides in cities in summer than at other times of year. There are also regional variations in crime rates, between and within countries: for example, Rosenfeld found violent crimes such as murder higher in Southern USA cities, whereas non-violent crimes such as theft showed no significant north/south difference. Studying juvenile crime in 29 U.S. cities, Jacob & Lefgren found crime rates rise to a peak at about 3pm (with a spike around midnight), then fall to the lowest rate at about 6am – aggressive behaviour is more common at the hottest time of day.

Different explanations have been put forward to explain why crime rates vary. Nisbett & Cohen claim that cultural differences explain why homicide is twice as high in small cities in the South and Southwest as the rest of USA ["Men, honor and murder" by R. E. Nisbett and D. Cohen, SCIENTIFIC AMERICAN, Summer 1999]. It has been claimed that firearms, combined with the Southern 'culture of honor', explain why homicide rates are high in the former Confederate states ["By the numbers: the roots of homicide" by Rodger Doyle, SCIENTIFIC AMERICAN, October 2000]. Similarly, Van de Vliert et al blame high rates of violence on a 'culture of masculinity' in some countries. Our explanation for the link between temperature and crime is medical, rather than cultural: adrenaline, the 'fight or flight' hormone. Adrenaline level in the blood is higher in very hot conditions, in both men and women (adrenaline is thought to be part of a mechanism by which humans avoid overheating). Other hormones, such as noradrenaline, could also be related to temperature and violence. We think adrenaline causes a culture of 'masculinity' in some regions and countries.

In addition to questions about causality, there is disagreement on the shape of the relationship between temperature and crime. Van de Vliert et al suggest a 'curvilinear hypothesis': as temperature rises, violence becomes more prevalent, but only up to a certain temperature (perhaps 24^oC) – above that point, further increases in temperature tend to reduce violence. We disagree: we think violent crime is approximately a linear function of temperature (except that violence may increase at cold temperatures – perhaps below about 8^oC).

The case for the 'curvilinear hypothesis' (Van de Vliert et al):
Van de Vliert et al study political violence in 136 countries (riots and armed attacks, from 1948 to 1977). We use their data to create Figure 1, in which each symbol represents one country.

Figure 1: political violence versus temperature (cross-country)

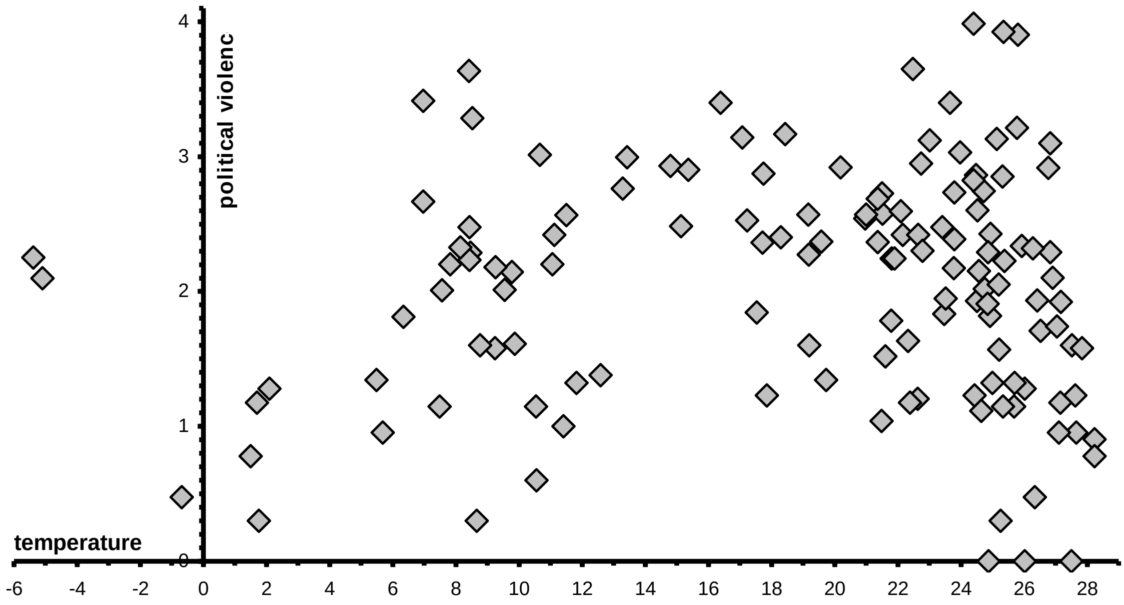
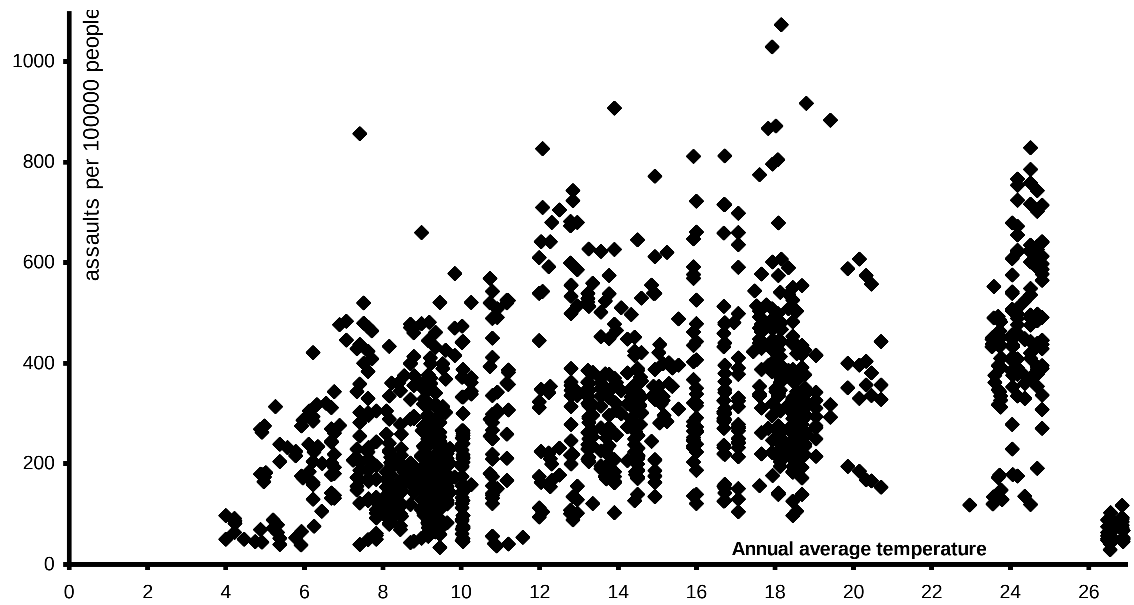


Figure 1 seems to show approximately an inverted-V shape, in which violent political crimes tend to become less frequent at high temperatures: it appears to support the 'curvilinear hypothesis'. More cross-section evidence is shown in Figure 2, which uses FBI data on 'aggravated assault'. There are five points in Figure 2 for each city, except where data are missing: each symbol represents one U.S. city in one year.

Figure 2: assault rate versus temperature – USA, 1999 to 2003



The bottom-right corner of Figure 2 shows a cluster of points, all in Puerto Rico. This seems to support the claims of Van de Vliert et al, in that crime rates are lower on the right-hand-side of Figure 2. But Puerto Rico is unusual in respects other than just temperature, such as rainfall (see below). If Puerto Rico is excluded, we lose all locations with temperatures above 25°C – so Figure 2 isn't very persuasive evidence for the curvilinear hypothesis.

Evidence in support of Simister & Cooper (2005)

To justify our viewpoint, we use time-series (monthly) data for crime and temperature. Figure 3 uses temperature data from the Climate Research Unit (CRU) UK, and crime data for Los Angeles. For Figure 3, we use what we call the "FBI method", which is to calculate each month's crimes as a fraction of all crime in that calendar year, to avoid the distorting effects of falling crime-rates in the 1990s [explained in "The case of the unsolved crime decline" by Richard Rosenfeld, SCIENTIFIC AMERICAN, February 2000].

Figure 3: assaults and temperatures in Los Angeles (monthly data, 1988 to 2003)

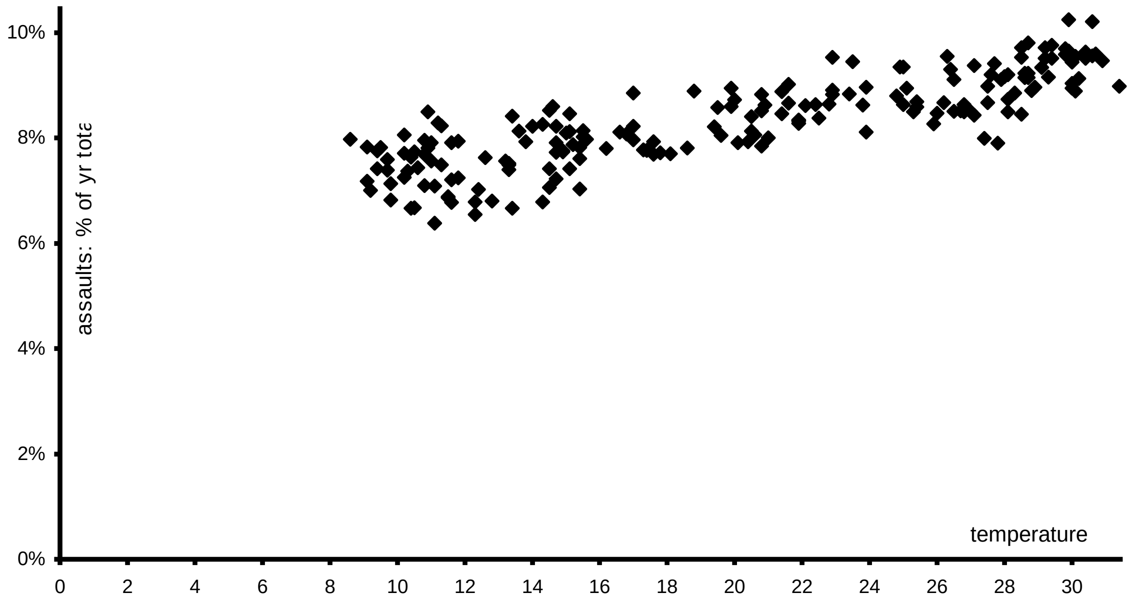


Figure 3 shows a fairly clear upward trend in murders, across the whole temperature range. There is no support here for the curvilinear hypothesis: as temperatures rise, murder rates tend to increase as we go from left to right. We now consider the rate (per 100,000 people, per year) of murders/attempted murders in Pakistan, in Figure 4.

Figure 4: Murder rate, Pakistan (monthly data, 1988-2001)

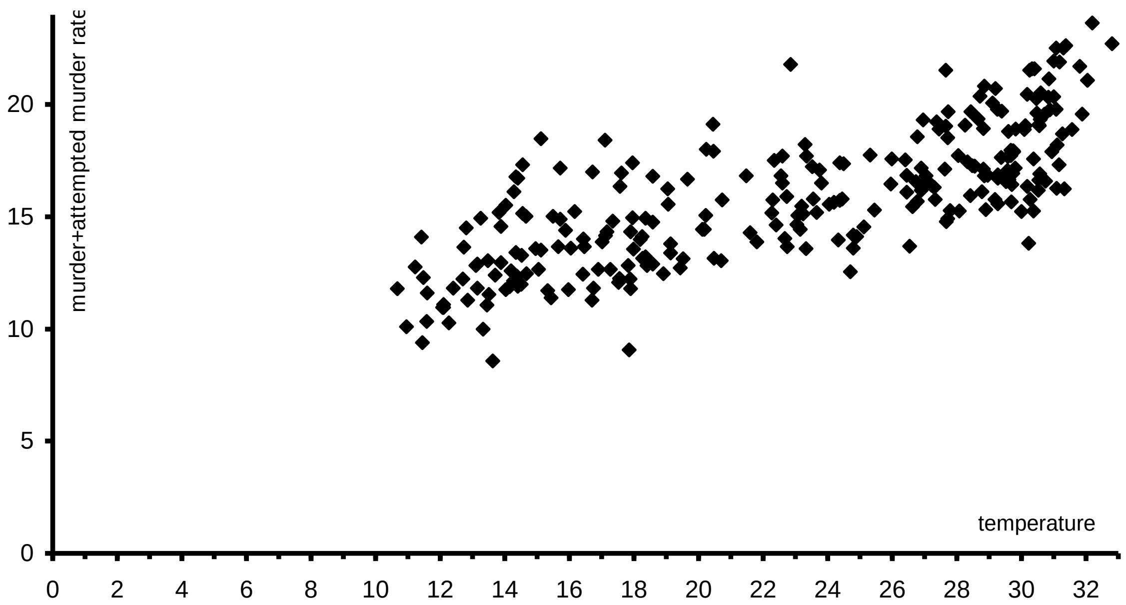
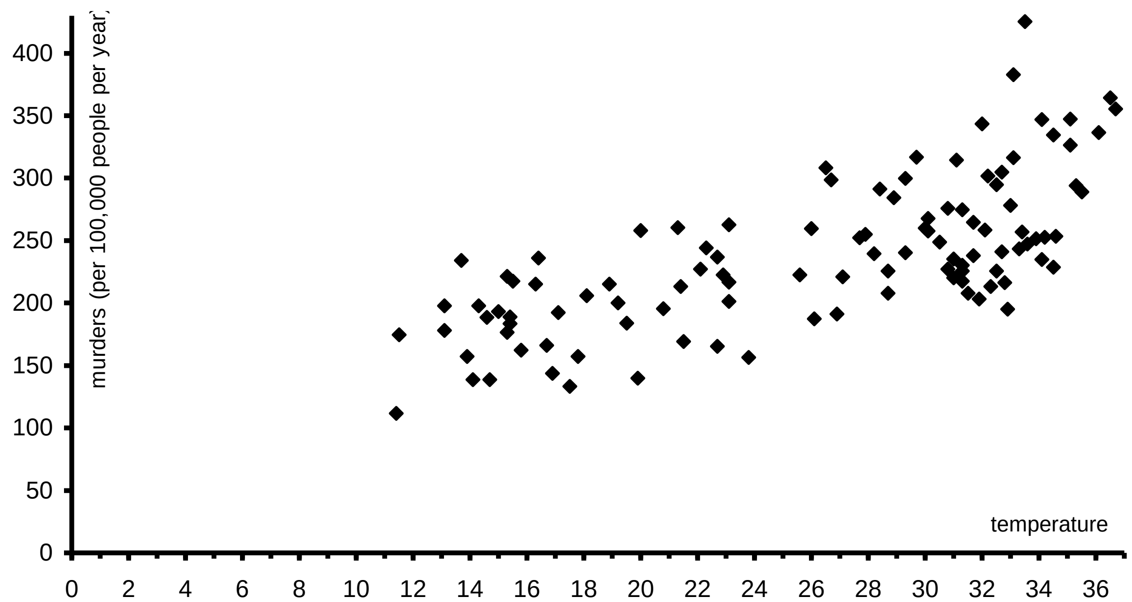


Figure 4 clearly has two outliers (November 1989, and April-May 1990). But the general pattern is similar to our Figure 3 above: there is a general increase in murder rates in the hottest months, and no support for the claims of Van de Vliert et al. Next, we consider murders in Rajasthan (North-West India), in Figure 5: again, we see an increasing crime-rate at the highest temperatures, which seems to reject the curvilinear hypothesis.

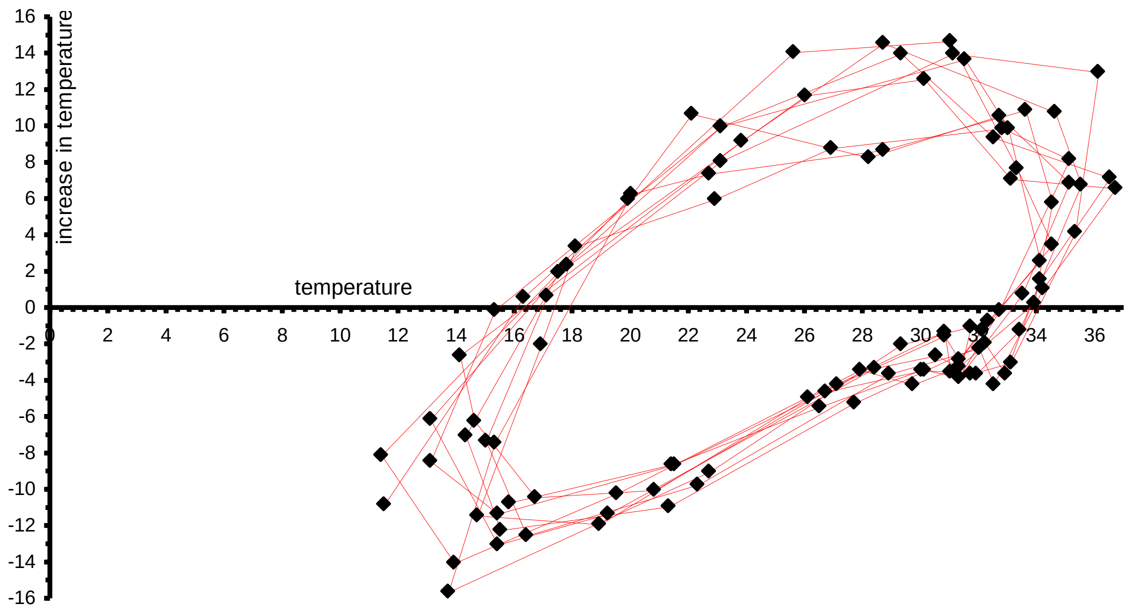
Figure 5: Murders and temperature in Rajasthan, India (monthly data, 1964-72)



Trying to reconcile these findings

How a particular temperature "feels" depends on many factors, including humidity; air movement; clothing; and work intensity. For example, we expect hot weather to be more stressful if the temperature rose dramatically in the last few days. Acclimatisation is about how people respond to *changes* in temperature. Figure 5 seems to have a dip in murder rates over the temperature range about 30 to 33°C; this might be spurious, but it reminds us of the drop in murders in Figure 3 over a temperature range about 24 to 27°C. Perhaps people find it less stressful when temperatures remain approximately constant: the range 24 to 27°C (Los Angeles), and the range 30 to 33°C (Rajasthan), occur in periods when temperatures are not rising quickly. To illustrate this, we report Figure 6 below. It compares temperature with the rate of change of temperature (this graph looks reminiscent of a 'hysteresis' graph in magnetism). In Figure 6, rate of change is measured by increase in temperature from last month to this month. It would be interesting to consider other time-periods (for example, perhaps considering change in temperature from day to day).

Figure 6: temperature versus temperature change: Rajasthan



In Figure 6, temperatures rise most quickly when the temperatures is about 28°C – at this temperature (typically about March or April), temperatures sometimes rise almost 12°C from one month to the next. By the time we got to the hottest months, though, temperature rise is less dramatic: when temperatures reach 35°C, they usually only increase by a few degrees per month. There is an interesting feature at about 31°C, when temperatures almost reach a standstill: this occurs about August to September in Rajasthan, so these months may feel less stressful than the (fairly hot) temperature of about 31°C suggests. At that time of year, Rajasthani residents will have acclimatised to the heat of the summer, and hence may cope better then than they do at 31°C when temperatures are rising (about April or May). However, we do not know exactly how to model this: perhaps acclimatisation takes several months, in which case we would need a complicated equation to estimate thermal stress (in terms of current temperature, and temperature in recent months).

Other possible ways to reconcile the divergent results (between Figures 1 & 2, and Figures 3, 4 & 5) include rainfall and humidity. We expect these to have opposing effects, if temperatures are high: rainfall should reduce stress, because water cools clothes & skin as it evaporates; whereas humidity (without rainfall) should increase thermal stress, because it reduces the human body's ability to lose heat by sweating. Hence rain in summer should reduce thermal stress, but rain in winter could increase stress.

There are other complications which could be considered. Our first two charts use the annual average temperature, in each country (in Figure 1) or region of USA (in Figure 2); but this may be an inappropriate measure of temperature. Figures 3, 4, and 5 suggest most violence occurs in the hottest months, so perhaps we should use the temperature in the hottest month (in Figures 1 and 2). However, Los Angeles, Pakistan and Rajasthan are all fairly hot; in cold countries, perhaps we should also consider the temperature in the coldest month. Another factor which seems relevant is wind speed, such as 'wind chill factor' in cold weather.

Another possible explanation of why Figures 1 and 2 don't look like straight-line graphs (as Figures 3, 4, and 5 do) is that countries with small populations provide 'noisy' data. In the data used to create Figure 1, no riots or assaults (from 1948 to 1977) are reported in three countries; all three countries have small populations: Barbados; Central African Republic; and The Gambia. However, these three countries do experience violence, and we think they would report political violence if we had data for more years. Similar problems apply in other small countries; it may be safer to exclude countries with small populations, to avoid being misled.

HOW CAN WE MAKE PROGRESS IN THIS RESEARCH TOPIC?

We're confident that there are links between temperature and violence. But we don't know the details – for example, we can't tell why our results differ from Van de Vliert et al; we're not sure if violence is more common in extremely cold conditions; and we don't know an effective way to measure which countries (or parts of countries) have a 'culture of masculinity'. There is too much information for any one scientist to examine it all.

You may know of SETI@home – their software analyses data, when a volunteer's computer isn't busy. We'd like to do something similar, but your computer isn't enough: we also need your brain. We want you to investigate the effects of temperature on violence and culture. Unlike SETI, we don't provide data or software: a typical spreadsheet package is sufficient, and you can find the data yourself on websites. If you discover something, the best place for your insights are academic journals – or bulletin boards allow you to post provisional results, if you don't have time to write an academic paper. We suspect the best hope for progress is for a group of friends to collaborate.

There are many different ways to investigate this topic. You could compare different countries with each other, like Van de Vliert et al; or, within a large country (such as USA or India), you can compare different parts of the country to see if crime rates vary with temperature. Alternatively, you could use time-series data: perhaps monthly data, to see if there's more crime in hot months. Data on what time of day most crimes are committed could help. Statistics on recorded crime isn't the only way to investigate violence: some household surveys, such as the 'British Crime Survey', could give insights. The 'Demographic and Health Surveys' (www.measuredhs.com/), in various countries, ask about domestic violence – and give other information on the household, such as region of the country, and whether they own a fan. The idea of a 'culture of masculinity' could be tested by examining attitudes to gender roles, in (for example) 'World Values Survey' data.

Knowledge of human geography, natural geography, meteorology, or criminology, could give you an advantage in this research. Medically-trained scientists with access to laboratory equipment could measure levels of hormones in blood, at different temperatures: we think this would take about two days' research, preceded by twelve months to persuade your ethics committee. PubMed (www.ncbi.nlm.nih.gov/entrez/query.fcgi) is an excellent way to find what's already known.

We don't suggest all aggression is due to thermal stress – violence stems from many factors, including the personality of the aggressor, the aggressor's relationship to the victim, and the immediate situation leading to the violence. It appears that there are two types of aggression ["Cooling hot aggression" by Jamie Talan, SCIENTIFIC AMERICAN Mind, June 2005]: planned violence, such as armed robbery; and unplanned violence, where an aggressor over-reacts to a situation. Talan uses the term 'hot aggression' to refer impulsive violence, without suggesting a link with thermal stress. But the implication is that only certain types of people (for example, people with autism, ADHD, or mood disorders) become violent when under stress; and it is possible that medication could break the link between heat and violence.

Obviously, societies must tackle underlying causes of violence. But no doubt some children and adults are hit by parents because excessive temperature is the 'last straw', for a person predisposed to violence; violence might be reduced by regulating temperatures in homes & workplaces, using fans or air-conditioning. Political violence such as riots are more likely at high temperatures, as cross-country comparisons make clear; if political violence can be managed, democracies will work better. Organisers of political demonstrations should avoid arranging protests at the hottest time of year.

The motivation for this research is to understand violence, so it can be prevented. Societies worldwide need to know if they should focus on school education, to discourage violent behaviour; or adult education, to discourage victims from putting up with domestic violence; or anger management, for all ages. Alternatively, future research may suggest air-conditioning in homes and public spaces, or offering a cool drink to a potentially violent person, are better ways to avoid aggression. We should all be aware that high temperatures increase the risk of a violent response to stress.

CRIME DATA

The FBI website is helpful – although FBI data has been criticised ["By the numbers: measuring bad behavior" by Rodger Doyle, SCIENTIFIC AMERICAN, September 2001]. Many U.S. cities and states have crime data on their own website; but if the population is much smaller than Los Angeles, they give 'noisy' data. Many U.S. cities do not experience very hot temperatures, so they are of limited help in assessing what happens to violence rates if temperatures exceed 24°C. Other countries also make crime data available on-line, such as the governments of Indian and Pakistan. To get as many observations as possible, I combine recent data from websites with earlier printed data in libraries.

CLIMATE DATA

The Climate Research Centre (University of East Anglia, UK: www.cru.uea.ac.uk/cru/data/) is the best website I know, for climate data. It has monthly data on all parts of the world, for over a hundred years; and not just temperature – for example, it has data on wet days per month, humidity, and wind speed. But other websites are easier to use, if you're focusing on one specific area: for example, Pierce College provides climate data for one location near Los Angeles (www.piercecollege.com/offices/weather/index.asp).

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