A set of observations that mostly match what a sensible-sounding theory predicts may seem a strong case. But not everyone is convinced. One problem is that the changes in atmospheric thickness and wind speed Dr Francis observed have become apparent only since the mid-1990s, which gives fewer than 20 years of data to work with. Another difficulty concerns the blocking patterns. Dr Francis's theory suggests there will be more of them in future, as the world warms. But climate models unanimously disagree, saying that global warming will produce fewer of them. Someone has to be wrong.

Trying to apply the theory to this year's batch of wild weather causes even more headaches. America's cold snap was indeed produced partly by a wayward jet stream. But Dr Francis herself points out that Britain's gales and rain are a different story, and that this year's North Atlantic jet stream has in fact been stronger than normal. That illustrates one of the chief frustrations of climate science. The weather is naturally changeable, which means many years of data are needed to extract a clear trend from among all the noise. Were the American freeze and the British floods caused by a weaker jet stream? No one can say for sure. But if Dr Francis and her colleagues are right, the odds on a repeat performance will get shorter every year. ■

Solar energy

Stacking the deck

CHICAGO

A way to double the efficiency of solar cells is about to go mainstream

SUNLIGHT is free, but that is no reason to waste it. Yet even the best silicon solar cells—by far the most common sort—convert only a quarter of the light that falls on them. Silicon has the merit of being cheap: manufacturing improvements have brought its price to a point where it is snapping at the heels of fossil fuels. But many scientists would like to replace it with something fundamentally better.

John Rogers, of the University of Illinois, Urbana-Champaign, is one. The cells he has devised (and which are being made, packaged into panels and deployed in pilot projects by Semprius, a firm based in North Carolina) are indeed better. By themselves, he told the AAAS, they convert 42.5% of sunlight. Even when surrounded by the paraphernalia of a panel they manage 35%. Suitably tweaked, Dr Rogers reckons, their efficiency could rise to 50%. Their secret is that they are actually not one cell, but four, stacked one on top of another.

Solar cells are made of semiconductors,

Power and beauty

and every type of semiconductor has a property called a band gap that is different from that of other semiconductors. The band gap defines the longest wavelength of light a semiconductor can absorb (it is transparent to longer wavelengths). It also fixes the maximum amount of energy that can be captured from photons of shorter wavelength. The result is that long-wavelength photons are lost and short-wave ones incompletely utilised.

Dr Rogers gets round this by using a different material for each layer of the stack. He chooses his materials so that the bottom of the band gap of the top layer matches the top of the band gap of the one underneath, and so on down the stack. Each layer thus chops off part of the spectrum, converts it efficiently into electrical energy and passes the rest on.

The problem is that the materials needed to make these semiconductors (including arsenic, gallium and indium) are costly. But Dr Rogers has devised a way to overcome this. Normal solar-cell modules are completely covered by semiconductor, but in his only 0.1% of the surface is so covered. The semiconducting stacks, each half a millimetre square, are scattered over that surface as a matrix of dots, meaning that a panel with an area of 125 square metres has half a million of them. Each stack then has a pair of cheap glass lenses mounted over it. These focus the sun's light onto the stack, meaning that all incident light meets a semiconductor.

The semiconductor stacks themselves are printed onto a cell one layer at a time by a rubber stamp, which picks them up from a crystal wafer of the appropriate material. This wafer has been grown as a series of layers, separated by a substance which can easily be dissolved away. By scoring a chequerboard of cuts through the layers to create squares of the correct size, and then dissolving the filler, layer after layer of semiconductor squares are created, which the rubber stamp peels away and places on the cell. Repeat the process with the other three semiconductors, and package the whole thing with electrical connectors and a transparent protective coat, and—presto!—you have a highly efficient solar panel.

Semprius's panels are now being tested at 14 sites around the world. How much they will cost to make when manufacturing is running at full tilt is not yet clear, but Dr Rogers said that Siemens, a big German firm which is one of Semprius's investors, reckons that they have the potential to produce cheaper electricity than coal-fired generators can. Solar energy obviously cannot replace fossil fuels completely until the problem of banking some of what is collected during the day, for use at night, is solved. But at this sort of cost it can make a useful (and unsubsidised) contribution.

The new panels have aesthetic advantages, too. The 99.9% of them not covered by stacks can be used for art. Seen from the sun's point of view (ie, straight ahead), they appear black because the lenses are focused on the stacks, which absorb all the light falling on them. Viewed obliquely, however, their foci are on other parts of the panel. The result, as the picture shows, can be quite pleasing—and certainly prettier than a coal-fired power station. ■

Olfactory communication

Spot the difference

CHICAGO

Hyenas talk to each other, as it were, through their backsides

TO TELL a hyena it stank would not be an insult. It has been known for decades that these animals communicate using a pungent material called hyena butter. This forms in pouches next to their anuses and they smear it onto plants for other hyenas to sniff and draw conclusions about the depositor.

It has also been long suspected that the smell—mainly the result of small fatty-acid, ester and alcohol molecules—is generated not directly by hyenas themselves, but rather by bacteria that live in the pouches. The details, however, are obscure. They are less obscure now, though, thanks to the work of Kevin Theis of Michigan State University, who has spent much of his career analysing the contents of hyena pouches. And, at a session at the AAAS meeting, he shared his conclusions with an eager audience.

There are four species of hyena, three of which are solitary and one gregarious. Dr Theis compared one of the solitary species, ▸▸