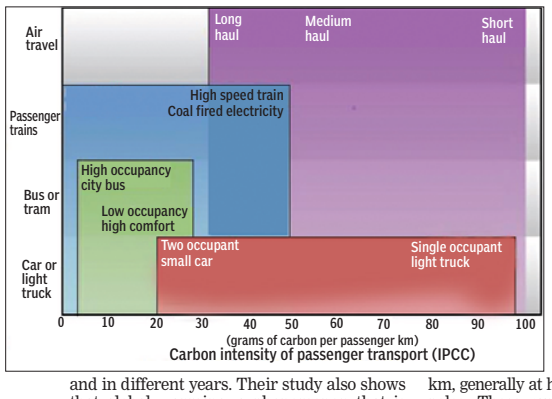
Blowing hot and hot

THE IMPACT OF AIR TRAVEL ON GLOBAL WARMING HAS BEEN FOUND TO GET WORSE, WRITES **S ANANTHANARAYANAN**

That air travel leads to emitting more CO_2 than any other form of getting about is well known. While travelling by air thus leads to more global warming and the ills that go with it, it has now been discovered that global warming, in turn, leads to increasing carbon cost of air travel, which will then spur warming and so on.

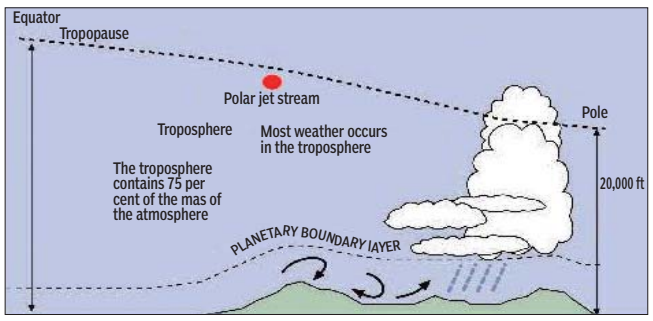
Kristopher B Karnauskas, Jeffrey P Donnelly, Hannah C Barkley and Jonathan E Martin of the Woods Hole Oceanographic Institution, Massachusetts, MIT and the University of Wisconsin at Madison report in the journal *Nature Climate Change* their study of how earth's atmospheric conditions affect high altitude aircraft speeds and, hence, how much fuel aircraft burn at different times of the year and in different years. Their study also shows that global warming, a phenomenon that is aggravated by the emissions arising from air travel, has an effect of retarding aircraft speeds and, hence, leading to more emissions.

This would have serious implications, as air travel already has the highest emission of all modes of travel. According to an Intergovernmental Panel on Climate Change report, air travel generates from 30 gm to 110 gm of CO_2 per passenger kilometre. This is to say that every 1,000 km by air could cause emission of up to 110 kg of CO_2, which amounts to burning 30 kg of coal. This is about the same as two occupants in a small car, but in contrast the carbon cost of doing 1,000 km by bus would be just 20 kg of CO_2 and by train it could be as low as five kilos. Air travel also leads to emission of other greenhouse gases and the effects are rendered more serious by the emission being at high altitudes. Air travel is, hence, the most environmentally damaging and although it now accounts for some 3.5 per cent of the total greenhouse gas emission, it has been increasing and is estimated to double by 2030 and account for 15 per cent of greenhouse gas emission by 2050.



Differing speeds

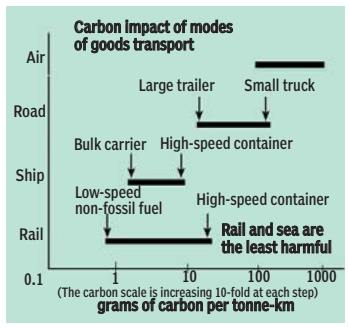
The study by the Woods Hole group, however, was not about the effect of air travel on the environment but the other way around. It is generally known that high altitude winds that blow from the west to the east help air travel in that direction, but retard flights that are against the wind. This effect is because of the *jet stream*, a set of currents of air that can be as fast as 500 kmph at a height of some seven to 12 km, generally at higher latitudes and nearer the poles. These currents are caused primarily because of the west-to-east rotation of the earth and also because of the inclination of earth's axis of rotation, because of which the poles are substantially cooler than the equator. There is, thus, convection of warm air towards the poles and of cool air towards the equator. The effect of earth's rotation is that the stream towards the poles carries on with the higher west-east speed of the equator and swings to the east at higher latitudes. Air coming from the poles blows to the west and where the two streams make contact the result is a stream that blows powerfully to the east. This happens at about nine kilometres above sea level, which is the height, called the *tropopause*, at which the cooling of the atmosphere with altitude, due to expansion, changes to warming by being closer to the sun.



East-flying aircraft thus make use of the currents of the jet stream to get better speed. At the same time, on their return flight the jet stream acts as a retarder and the flight takes longer. The Woods Hole research made use of a vast data base of actual flight times of all aircraft, some 250,000, over 19 years from 1995 to 2013, by four different operators, between a set of airports, of study variations in aircraft speeds and wind conditions that affected them. To be able to get only the effects of climatic environment, unaffected by other factors, even day to day weather, the study was not of the flight time itself but the difference in the time taken for the flight one way and the return flight.

The remarkable result of the survey was that the difference in the time taken, referred to as △t, which changed quite a lot from season to season and from year to year, was the same for all operators and all routes. "That the observed fluctuations in flight times are synchronous throughout the sector regardless of route or carrier suggests a common driver, which we hypothesise to be climate variability," the authors say in the paper.

The study was then extended to matching the high and low values of △t with actual wind conditions, as known from meteorological records. Here again, it was found that the highs and lows of the △t corresponded closely with speed changes in data of the wind at the cruising altitude. And then, what was a remarkable observation was that the tropical and high latitude climatic variation corresponded closely with the timing of *El Nino* events in the southern Pacific. El Nino is the reversal, every few years, of the usual warm state of the sea at the eastern coast of Australia with surface winds blowing from the eastern end of the Pacific Ocean. Usually, water shores up at Australia end, and deep water and nutrients rise to the surface around the coast of Peru. During, El-Nino, however, the Peruvian coast warms, which spoils the fishing, but brings plenty of rain.



The observation that the difference in west- and east-bound flight times, which can be longer than 30 minutes, is correlated with wind conditions and climate indices, and also El Nino events would enable integration of climate and El Nino forecasts with flight scheduling, the authors say.

Dependence on warming

Another alarming observation made is that while there are variations between flight times in the two directions, the time lost in one direction is not the same as the time gained in the return journey. Thus, while there are changes in △t when there are changes in wind speeds, which may happen because of the oscillatory nature of the forces in balance, or due to warming effects, there are also changes in the total time of flight and, hence, the total fuel consumed. It was, therefore, important to see what effect global warming had on the nature of high altitude winds, the authors say.

How warming may affect the winds was investigated by simulation, using 34 accepted *Global Climate Models* of how the atmosphere would respond to warming. While trials using GCMs have generally not yielded clear results of what changes warming would bring about, half the GCMs do say that there would be a clear change in wind speeds, not much, but leading to an increase of 5.5 hours in flying time, daily, for each route, for each carrier, every year! Even for just the four carriers considered in this study, for three routes and only two flights a day, this increase amounts to 133 additional flying hours and 4.6 million kg of CO_2.

Although direct extrapolation of this result to all airline operations would not be justified, estimation based on increase of one minute in round trip flying time for all commercial flights leads to an increase in CO_2 emission by 10,000 million kg. This is still negligible compared to the total global emissions, but it does show that global warming feeds back to increase one of its own causes, and calls for more study of the underlying mechanism, the authors say.

THE WRITER CAN BE CONTACTED AT simplescience@gmail.com

WHAT CAUSES CANCER?

IT'S ABOUT CELLS WITH THE ABILITY TO CAUSE DNA MUTATIONS, WRITES **TAPAN KUMAR MAITRA**

The uncontrolled proliferation of cancer cells, combined with their ability to metastasise to distant sites, makes cancer a potentially life-threatening disease. What causes the emergence of cells that have such destructive properties? Scientific investigations have shown that cancers are caused mainly by environmental agents and lifestyle factors, most of which act by triggering DNA mutations.

The first indication that a particular agent may cause cancer is usually provided by an approach called epidemiology— the branch of medical science that deals with the frequency and distribution of diseases in humans. Epidemiological studies have revealed that cancers occur with differing frequencies in different parts of the world. For example, stomach cancer is frequent in Japan, breast cancer in the US, and liver cancer in Africa and south-east Asia. To determine whether differences in heredity or environment are responsible for such differences, scientists have examined cancer rates in people who move from one country to another. By way of an example, when Japanese families move to the US, their cancer rates come to resemble the ones in their new country, indicating that they are determined more by environmental and lifestyle factors than by heredity.

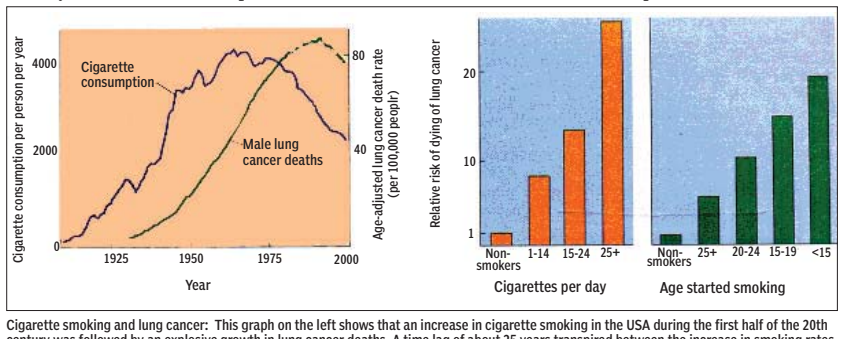
Epidemiological data have played an important role in identifying environmental factors that can cause cancer. The most striking statistics involve lung cancer. It was discovered that virtually all patients share one trait—a history of smoking cigarettes. A lag period of about 25 years separated the observed increase in lung cancer rates from the earlier increase in smoking rates, which is typical of the time required for most human cancers to develop after exposure to a cancer-causing agent.

Although the association between cigarette smoking and cancer was first discovered through epidemiological studies, definitive proof of a cause-and-effect relationship requires direct experimental evidence. In the case of cigarettes and lung cancer, such evidence has come from studies showing that smoke contains chemicals that cause cancer when administered to animals. The idea that certain chemicals, such as those found in tobacco smoke, can cause cancer was first proposed more than 200 years ago. In the 18th century, a British physician, Percival Pott, observed an elevated incidence of scrotum cancer among men who had served as chimney sweepers in their youth. He speculated that the chimney soot became dissolved in the natural oils of the scrotum, irritated the skin, and eventually triggered the development of cancer. This theory led to the discovery that scrotum cancer could be prevented among chimney sweepers through the use of protective clothing and regular bathing practices.

In the years since, the list of known and suspected carcinogens (cancer-causing agents) has grown to include hundreds of different chemicals. This does not mean, however, that each of these substances causes cancer through its own direct action. For example, consider the behavior of 2-naphthylamine — a potent carcinogen that causes bladder cancer in industrial workers and present in tobacco smoke. As might be expected, feeding 2-naphthylamine to laboratory animals induces a high incidence of bladder cancer. But if it is implanted directly into an animal's bladder, cancer rarely develops. The explanation for the apparent discrepancy is that when 2-naphthylamine is ingested (by animals) or inhaled (by humans) it passes through the liver and is metabolically converted into chemical compounds that are the actual causes of cancer.

But how do such substances actually act? The idea that carcinogenic chemicals act by triggering DNA mutations was first proposed around 1950, but there was little evidence at the time because nobody had systematically compared the mutagenic potency of different chemicals with their ability to cause cancer. The need for such information inspired Bruce Ames to develop a simple, rapid laboratory test for measuring a chemical's mutagenic activity. Called the Ames test, it utilises bacteria as a test organism for their rapid growth in enormous numbers.

As many carcinogenic chemicals only become so after they have been modified by liver enzymes, the Ames test includes a step in which the chemical being tested is first incubated in an extract of liver cells to mimic the reactions that normally occur. The resulting chemical mixture is then tested for its ability to cause bacterial mutations. When the Ames test is performed in this way, a strong correlation is observed between a chemical's ability to cause mutations and consequently, cancer.



Cigarette smoking and lung cancer: This graph on the left shows that an increase in cigarette smoking in the USA during the first half of the 20th century was followed by an explosive growth in lung cancer deaths. A time lag of about 25 years transpired between the increase in smoking rates and the subsequent increase in cancer deaths, which is typical of the time required for most human cancers to develop after exposure to a cancer-causing agent. The histograms on the right show that lung cancer rates increase as a function of the number of cigarettes smoked per day, and that long-term smokers develop lung cancer more frequently than do short-term smokers.

THE WRITER IS ASSOCIATE PROFESSOR, HEAD, DEPARTMENT OF BOTANY, ANANDA MOHAN COLLEGE, KOLKATA, AND ALSO FELLOW, BOTANICAL SOCIETY OF BENGAL, AND CAN BE CONTACTED AT tapanmaitra59@yahoo.co.in

Better, faster, longer

APPLE IS READYING A NEW VERSION OF SOFTWARE AND IT COMES FOR FREE, WRITES **DAVID POGUE**

Come September and Apple will launch a new version of the software that drives its iPhones, iPads, and iPod touches. Called the iOS 9, it will be free and it runs on the iPhone 4s, iPad 2, iPad mini, the iPod touch fifth generation or later models. The new iOS version looks and feels just the same as before, and everything is in the same places; nothing new will confuse you. But you know what they say about appearances.

Apple's software plastic surgeons have made hundreds of little tweaks that are intended to make its mobile devices faster, smarter and more stable.

If you want an early look at the iOS 9, you'll be able to download the public beta version now; just understand that it's not finished and may be buggy. But I've already been playing with the beta and thought you might appreciate a guide to what's new and useful — including, by the way, a slew of new features that Apple "hasn't" announced publicly.

You can pretty much fit all of them into six categories: Basics, Apps, Brains, Mail, Camera, and iPad Specials. Talking about the basics, it offers an efficient app-switching screen and beefed up phone security by using a six-digit simple code to unlock the phone. More security means you can turn off the little pop-up balloons that appear above your fingertips in Settings, so people can't learn your passwords. Every iPhone will get a full hour more of life from every battery charge.

The new Low Power Mode alerts you when the battery sinks first to 20, and then to 10 per cent. Here, the phone stops fetching new mail and updating apps, the processor slows down, and the battery indicator turns yellow. You can use your phone or tablet for almost three hours in this mode. For upgrading, you need only 1.3 free gigabytes. The phone will even ask if it can delete some of your apps to make some temporary room for the upgrade process, restoring the apps after. And there's Continuity over Cellular, which lets you take calls on your Mac or iPad even if your iPhone is somewhere else in the world!

There's also Move to iOS — a new app that brings nearly all your stuff: contacts, emails, texts, photos, etc, from an Android phone or tablet over to your iPhone or iPad, wirelessly. And another called News that collects all the stories you want to read, based on topics you're most interested in. The Notes app now includes a to-do checklist, a photo, map, web link, or a sketch you draw with your finger. The new Attachments Browser lets you view everything you've added in all your notes. Any changes you make in Notes are automatically synchronised to all your other Apple gadgets and Macs.

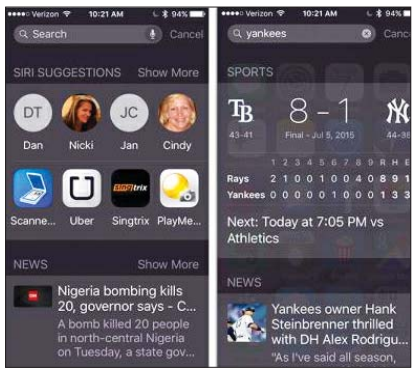
The Maps app has an extra feature — public-transportation directions. Siri takes more specific spoken commands. If you're looking at a Web page or a text message on your phone, you can even say, "Remind me about this when I get home."

But how can all these function without "brains". Well, Apple's proactive assistant uses its "common sense" to figure out iOS 9 for you. It suggests names of recipients based on the subject of your mail. When you plug in your earphones, the phone automatically suggests the music service you were listening to the last time you put on earphones.

As our phones become our cameras, photo and video options become increasingly important. There are zillions of helpful touches in iOS 9, like you can attach upto 15 photos to an outgoing email message. You can finally zoom in on a video using the same pinching gesture you use on photos. And also turn the video-recording light on and off at will, while capturing a single video.

This is cool, too – if you drag *two fingers* across the onscreen keyboard, it acts as a giant trackpad. After you spend a minute learning it, you've got yourself a more efficient way to select, edit or move text forever. The bigger deal is that you can now split the screen between two apps — a first for iPads. If you're watching a video or conducting a FaceTime video chat, you can shrink the video window into a little picture-in-picture screen. It continues playing even as you use a different app.

It's an awful lot of stuff crammed into a very small screen, for sure. Fortunately, very little of it gets in your way.



THE WRITER IS FOUNDER OF YAHOO TECH AND CAN BE CONTACTED AT poguester@yahoo.com

PLUS POINTS

'Mini ice age'

We are now able to predict solar cycles with far greater accuracy than ever before, thanks to a new model that shows irregularities in the sun's 11-year heartbeat. It shows that solar activity will fall by 60 per cent between 2030 and 2040, causing a "mini ice age", according to solar scientists. The conditions predicted have not been experienced since the last "mini ice age" which lasted from 1645 to 1715, called the Maunder Minimum. The findings are being presented by Professor Valentina Zharkova at the National Astronomy Meeting in Llandudno.

In 1843, scientists first discovered that the sun's activity varied over a cycle of 10 to 12 years. Fluctuations within that cycle have been difficult to predict, although many solar physicists knew that the variations were caused by a dynamo of moving fluid deep inside the sun.

Ice floes fill the Hudson river as the Lower Manhattan skyline is seen during the "Polar vortex" last January in New York.

Professor Zharkova's team of researchers has found that adding a second dynamo close to the surface of the sun creates a far more accurate model. They found magnetic waves in two different layers of the sun's interior that fluctuate between the northern and southern hemispheres. "Combining both waves together and comparing to real data for the current solar cycle, we found that our predictions showed an accuracy of 97 per cent," Professor Zharkova said.

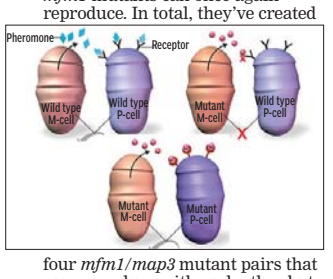
The magnetic wave patterns show that there will be fewer sunspots in the next two solar cycles. Cycle 25, which peaks in 2022 and Cycle 26, from 2030 to 2040 will both have a significant reduction in solar activity.

ALICE HARROLD/THE INDEPENDENT

Creating species

The emergence of one species from another occurs when the two groups can no longer interbreed. Such reproductive isolation is considered a key evolutionary process, and yet our knowledge of the mechanisms and mutations by which it actually occurs has been confined to conjecture. "We can speculate on the history of evolution from various observations," says Masayuki Yamamoto, director-general of the National Institute for Basic Biology in Okazaki, Japan. "However, it is virtually impossible to reproduce it experimentally."

Virtually, but not entirely, impossible, it seems. Chikashi Shimoda's team at Osaka City University in Japan has achieved experimental speciation in the yeast *Schizosaccharomyces pombe*. The two sexes of *S. pombe* — M and P, for "minus" and "plus" — each secrete a pheromone (M factor and P factor), which binds to a corresponding receptor on cells of the opposite sex. This interaction is essential for successful mating. Shimoda's team had previously made mutants of the M-factor gene, *mfm1*, which prevented M cells from mating with wild-type P cells. Now the team has randomly mutated the gene for the M-factor receptor, map3, in P cells to produce individuals with which the *mfm1* mutants can once again reproduce. In total, they've created four *mfm1/map3* mutant pairs that can reproduce with each other but not with their wild-type forebears.



"Although their observation may not reflect the real natural history, it supports the concept that changes in the mechanism to select mating partners can be an initial step for speciation," says Yamamoto, who did not participate in the research.

Pheromone-receptor interactions that drive reproduction have been studied in a variety of life-forms, particularly amphibians and insects, says Shimoda. He, therefore, suggests pheromone mutagenesis might allow researchers to "extend our achievement to other organisms".

RUTH WILLIAMS/THE SCIENTIST