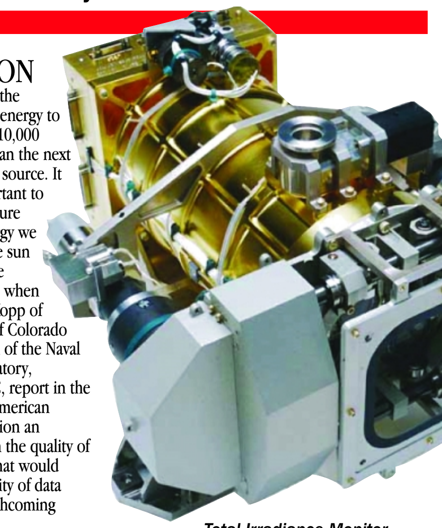
Sunshine under the spotlight

More accurate monitoring of radiation from the sun may help manage the climate, says s ananthanarayanan

Gregg Kopp.

Judith Lean.



Total Irradiance Monitor.

RADIATION from the sun is the largest input of energy to the earth, over 10,000 times greater than the next most important source. It is, hence, important to accurately measure how much energy we receive from the sun and see how the climate changes when it varies. Greg Kopp of the University of Colorado and Judith Lean of the Naval Research Laboratory, Washington, DC, report in the journal of the American Geophysical Union an improvement in the quality of measurement that would increase reliability of data collected in forthcoming experiments.

The energy received from the sun is about 1.3 KW for every square metre. The radius of the earth is about 6,800 km. This makes the area of the disk it presents to the sun about 3.14 x (6,800 x 6,800) x 1,000 x 1,000 = 145 million x 1,000 x 1,000 square metres, by applying area = pi x radius squared and multiplying by 1,000 metres to the kilometre. The energy coming in is then about 1.8 x 10^{14} kilowatts. The total energy the earth consumes, in modern times, is 16 billion kilowatts, which is 100,000 times less.

The current problem is not that we are producing and consuming great energy but that we are trapping more and more of the sun's radiant energy, which is leading to warming and climate change. So, yes, we need to stop generating greenhouse gases that trap heat, but we also need to know accurately how much heat is coming in from the sun so that we are able to correctly estimate the rate of energy gain and loss that drives global warming or cooling.

The standard instruments to measure energy from the sun were the *pyrheliometer* and the *pyranometer*. The former consists of a window that lets sunlight strike a device that senses the sun's heating and keeps the window pointed in the direction of the sun, which, in turn, keeps another instrument pointing in a fixed relative direction. The pyrheliometer is used in meteorology, often along with the other standard instrument, the pyranometer. The latter is a flat thermal sensor encased in a glass dome and it measures the total radiation falling upon it from all directions. The glass dome allows the full range of frequencies to enter and also protects the sensor from convection currents.

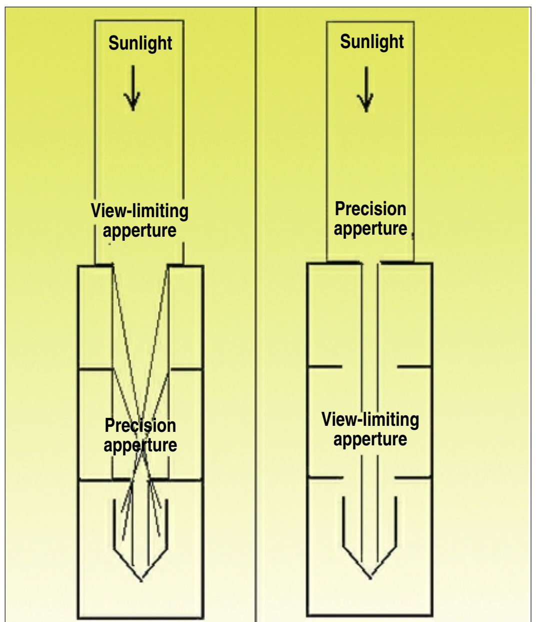
These two instruments together have contributed much to the understanding and mapping of climate by recording solar irradiation, both direct and diffuse, for use with other data of distribution of winds, temperature gradients, humidity and so on. But the instruments were meant for *gross* energy measurement and only broadly agreed with each other, leaving the accepted figure of about 1,360 watts per square metre as admittedly approximate. As ground-based measurements are affected by variations in the atmosphere, the best measurements are satellite-based, which began in 1978. These measurements, in 1980, yielded a figure of 1,367.2 watts/square metre and the current estimate, of the 1990s, is 1,365.4 ± 1.3 watts per square metre, which is the figure used in modelling climate and the balance of energy received and lost by the earth.

Sorce spacecraft

The *Solar Radiation and Climate Experiment* is a National Aeronautics and Space Administration-sponsored satellite mission that measures incoming X-ray, ultraviolet, visible, near-infrared and total solar radiation. The measurements specifically address long-term climate change, natural variability and enhanced climate prediction, atmospheric ozone and UV radiation in the range that affects human life.

One of the four instruments on board is the *Total Irradiance Monitor,* which measures the total solar irradiance or the integrated solar radiation at the top of the earth's atmosphere, continuing the climate record which began in 1978.

While the Tim is a superior arrangement with state-of-the-art sensors and electronics, it also incorporates design features that ensure accurate measurement of just the radiation of interest. An important improvement in the device concerns the placement of the detector behind a narrow precision aperture to limit the entry of scattered radiation, which affected earlier measurements. The paper in the American Geophysical Union journal reports significant improvement in the accuracy and consistency of data.



The older arrangement had the precision apperture nearer the heat sensor, which allowed entry to scattered radiation.

The total Irradiance Monitor has the precision apperture at a distance from the sensor, which limits the amount of scattered radiation.

The findings

The measurement of the Tim has resulted in a materially lower figure of the Total Solar Irradiance, at 1,360.8 ± 0.5 watts/square metre, which revises the current best figure of 1365.4 ± 1.3 watts/square metre. Apart from the correction of the figure of energy received, the reliability of the finding enables more sensitive analysis of measurements in conjunction with variations in solar activity, such as the appearance of sunspots or "bright spots" (called *faculae*), variation in the sun-earth distance, in the 32-year space-based record. Analysis of the data base is enabling connecting the appearance of solar signals and climate records, which in turn enables estimates of changes in radiation received during the past millennium and evaluating climate models and simulations of climate behaviour.

The demonstrated greater reliability of the data from the Tim also assures greater consistency and value of data to be gathered in forthcoming experiments. "Improved accuracies and stabilities in the long-term total solar irradiance record mean improved estimates of the sun's influence on earth's climate," says Greg Kopp. The new work will help advance scientists' ability to understand the contribution of natural versus anthropogenic causes of climate change. "We are eager to see how this lower irradiance value affects global climate models, which use various parameters to reproduce current climate: incoming solar radiation is a decisive factor…" says Judith Lean.

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Punch hole clouds

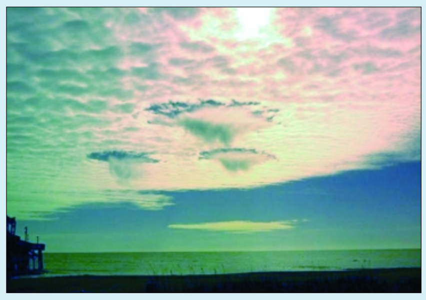
Viewed with interest by UFO-gazers and scientists alike, these intriguing formations give rise to a variety of theories, writes rivu mukherjee

MOST every child imagines cloud battleships and elephants up in the sky. What's more, growing up on Isaac Asimov and Arthur Clarke makes for imperative stray thinking on the extra-terrestrial world. So when the Triple Punch Hole Cloud was sighted at Myrtle Beach, South Carolina, on 17 January 2011, people called it a UFO, a KGB object and many things in between. It was quite like the Moscow Halo of October 2009 and similar sightings in 2007 and 2003. On 11 December 2003, the sky was resplendent over Mobile County, Alabama, and later in Washington County on 29 January 2007.

But what is a "Punch Hole Cloud"? Picture a big hole, spanning hundreds of metres across, punched in a cloud. What's left is a peculiar structure with a void at the centre of the cloud body. We don't see them very often. So how are these formed and how and when can we see these curious cloud formations?

These odd gaps have been a topic of research since the 1940s. A 1968 article in *Weatherwise* magazine called them a "Meteorological Whodunit"! Years later, in October 2009, "Mystery UFO Halo over Moscow" made UFO-gazers and scientists rack their brains. New research shows that airplanes punch these holes in clouds and make them precipitate. As jet planes or propellers pass through the clouds, they make the liquid water droplets freeze and immediately drop as snow, thus leaving a circular void behind. The cloud is, thus, heavily cooled and water droplets remain in liquid state despite the ambient sub-freezing temperature (around -15 degree Celsius). Besides, only about 7.8 per cent of earth's surface is covered with clouds at that exact elevation so as to form super-cooled droplets. So even in some cases only punch holes are formed by jet aircraft, but no snowfall is observed because jets don't usually fly at those altitudes.

Andrew J Heymsfield of the National Center for Atmospheric Research and colleagues conducted experiments near Denver International Airport in 2007 to study cloud patterns. They noted the ice formations in clouds and examined the flight record of a particular aircraft (which flew an hour before their tests) and could link the developed hole and the snow that fell directly below the hole in a patch of altocumulus cloud. The obvious deduction was that aircraft produced these punch holes.



Three punch hole clouds in the same place at Myrtle Beach, South Carolina.

The spectre of three rare cloud holes in one small area now can suggest a busy air-domain near Myrtle Beach. Indeed, the airport is only a few miles from where these rare Triple Punch Hole clouds could be seen. So we can rely on the theory of the passing jet and the domino process of evaporation.

But an electromagnetic theory raises its head. We might be pleased with the "sub-freezing cloud phenomenon", but looking at the amazing shapes of the clouds, a deeper explanation seems necessary. We know about ice crystals, snowflakes falling to create the void – but what forms them? The electromagnetic effect changes the physical properties of water. So what if an electromagnetic field is somehow created that, in turn, changes the property of the plasma (in this case, the atmosphere) locally! We can even link it to the "jet theory" – the contrails (continued trails) of a jet engine (jet) are nothing but energised gas: plasma. In Volume 91, Issue 6 (June 2010) of the American Meteorological Society journal, an article tilted "Aircraft Induced Hole Punch and Canal Clouds", by Andrew J Heymsfield and other research workers, says, "(The) passage of commercial aircraft through super-cooled altocumulus can induce a freezing of droplets by homogenous nucleation and induce holes and channels, increasing the previously accepted range of temperatures for aviation-induced cloud effects." Hence, whether in the USA or elsewhere, jets are the reason behind these phenomena: either passing through the clouds and seeding them or because jets, given their plasmatic behaviour being influenced by some dynamic "electromagnetic universe" force the clouds to cool to subzero and then the subsequent processes follow.

However, jet aircraft have been in convention for the last 70-80 years, so why haven't these ever been seen before? Again, if only the jets create these cloud-formations, then shouldn't we also notice them near all the airports situated in similar geographical locations and conditions? Besides, most of these amazing spectres have been witnessed either in the USA or Russia, so can we not speculate on some sort of communication between US or Russian agencies and life outside earth? Taking the idea forward, we could speculate on advanced secret warfare by these two superpowers. Further, if plasma and electromagnetic dynamics are the reasons behind these formations, then why can't there be some extra-terrestrial technologically-advanced supersonic aircraft?

To be fair, where there is room for logic, there is also ample room for negating it. And therein lies the recipe for innocuous mystery.

The writer is a freelance contributor

Biology of a record-breaker

Behind medal-winning performances on the track or in the pool, today's sports are driven by discoveries made in the laboratory. nick duerden **explains**

Who knew, for example, that Michael Phelps's ability to swim like a slippery fish is all well and good, but that the swimming pool itself plays a crucial part in his performance?

FOR the past four years, 39-year-old John Brenkus has been hosting a TV show in America called Sport Science. Being American, it's primarily concerned with the biggest and the best, and has an endless obsession with statistical data. Who punches hardest, putts the furthest? And just how far can a hulking great baseball player thwack a ball? The series, perhaps inevitably, has been a big hit. "It's a watercooler show," says Brenkus. "People love to discuss sport together, but more than that they love to argue about it. And the science of it is one of the great tools for a really great argument."

He has now written a book, *The Perfection Point*, which is in many ways a natural extension of the show. Essentially, it expounds upon mankind's incessant craving for going one better than their nearest competitor, however improbable that achievement appears on paper. Published in the USA last August, it has been a bestseller. Though ostensibly written for the armchair fanatic, it doesn't shy away from hard science. In one particularly memorable paragraph, Brenkus speaks of "high levels of mitochondrial density and aerobic enzyme activity". Eh?

"I didn't want to bog it down with too much scientific detail," he says, "but, look, there is a certain amount of it you have to understand in order to buy into the arguments I am putting across." He puts across a great many, and they make for frequently fascinating reading. Who knew, for example, that Michael Phelps's ability to swim like a slippery fish is all well and good, but that the swimming pool itself plays a crucial part in his performance? The importance of the pool's depth cannot, it seems, be overstated, nor lane width or water temperature. Without such optimum conditions, Phelps is merely just another contender.

"If you ask 100 scientists whether the earth is heating up or cooling down, you would very likely get 100 different answers," he points out. Each one of us, he insists, can improve our own perfection points, even the more sedentary among us. There is one chapter here, for example, which teaches us the winningly pointless exercise of holding your breath. This requires much practice in the stretching of the lungs, and is something that, theoretically, anyone can do. The world record, though, currently stands at 19 minutes 21 seconds, a high ceiling in anybody's book.

The Independent, London

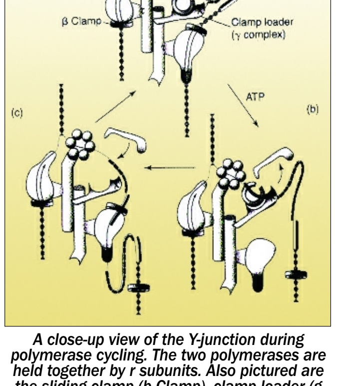
Events at Y-junction

What is the Okazaki fragment and how is it linked to DNA replication? tapan kumar maitra **explains**

WE have the image of DNA replication proceeding as a primosome moves along the lagging-strand template, opening up the DNA (helicase activity) and creating RNA primers (primase activity) for Okazaki fragments.

One DNA polymerase III moves along the leading-strand template, generating the leading strand by continuous DNA replication, whereas a second DNA polymerase III moves backward, away from the Y-junction, creating Okazaki fragments. Single-strand binding proteins (ssb proteins) keep single-stranded DNA stabilized (open) during this process, and DNA polymerase I and ligase connect Okazaki fragments.

This simple picture is slightly complicated by the fact that the lagging — and leading — strand synthesis is coordinated. B Alberts suggested an explanation: the replisome model, in which both copies of DNA polymerase III are attached to each other and work in concert with the primosome at the Y-junction.

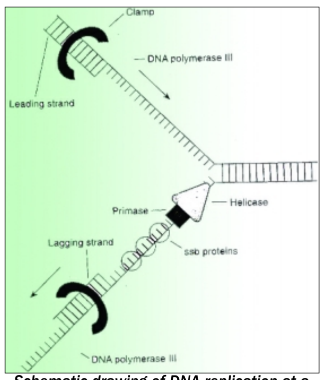


A close-up view of the Y-junction during polymerase cycling. The two polymerases are held together by r subunits. Also pictured are the sliding clamp (b Clamp), clamp loader (g complex), primase, helicase and ssb proteins. In (a), the primase has just finished creating a primer. The x subunit of the clamp loader contacts the ssb protein touching the primase. The primase is then dislodged (b). The clamp is loaded at the new primer and the polymerase on the lagging strand is cycled to the clamp to begin the next Okazaki segment (c).

According to this model, a single replisome, consisting of two copies of DNA polymerase III, a helicase and a primase, moves along the DNA. The leading-strand template is immediately fed to a polymerase, whereas the lagging-strand template is not acted on by the polymerase until an RNA primer has been placed on the strand, meaning that a long (1,500 base) single strand has been opened up.

As the replisome moves along, another single-stranded length of the lagging-strand template forms. At about the time that the Okazaki fragment is completed, a new RNA primer has been created.

The Okazaki fragment is released and a new Okazaki fragment is begun (polymerase cycling), starting with the latest primer. This takes the replisome back to the same configuration, but one Okazaki fragment farther along.



Schematic drawing of DNA replication at a Y-junction. Two copies of DNA polymerase III, ssb proteins and a primosome (helicase + primase) are present.

The figures give us a closer look at the details of the Y-junction at the moment of polymerase cycling.

Primase, which is not highly processive, must be in touch with an ssb protein to stay attached to the DNA when brining a printer. At the appropriate moment, after the printer is brined, the clamp loader contacts the ssb, dislodging the primase.

The clamp loader also loads a sliding clamp, which then recruits — attaches to — the polymerase that is creating the lagging strand. The polymerase then continues, creating the Okazaki fragment.

It can later attach at a new point on the lagging-strand template to create the next primer.

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