Skydiving on Saturn

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Illustration of Saturn skydiving. Lower image: Observation of the 2010 Saturn storm in infrared. Credit: OU/ESO/Fletcher/Barry.

Daredevils regularly bail out at high altitude to skydive through Earth's atmosphere but what would it be like to skydive on Saturn?

Would you jump in summer into an atmosphere shrouded in a yellow-ochre haze, aim for winter when the planet is tinged blue, or maybe leap into the shadow of those famous rings?

These thoughts were prompted by new research from an international team led by Oxford University scientists into a powerful storm on Saturn first spotted in December 2010.

"What we see when we look at Saturn in visible light is the top of the cloud decks – that's near the top of the troposphere or 'weather zone' – made up of ammonia clouds and other hazy materials," Leigh Fletcher of Oxford University's Department of Physics, who led the work, tells us.

"This top layer of cloud is a bit like the skin of an apple, it stops us seeing the body and 'core' of the planet underneath." What lies beneath is a mystery, but Saturn sometimes shows its true colours in spectacular fashion.

Seeing (infra)red

As the team report in this week's *Science*, for the first time scientists have been able to study a major storm on Saturn using both observations from an orbiting spacecraft (NASA's Cassini) and ground-based telescope (ESO's VLT) at thermal infrared wavelengths.

These wavelengths are longer than the visible light we normally see reflected from Saturn's clouds and enable researchers to figure out the temperatures, winds and composition of the atmosphere, helping them to build up a picture of its weather in 3D.

So the first question when imagining a Saturn skydive is: where do you start?

Like the Earth, Saturn's upper atmosphere – its stratosphere – is relatively stable. This stratosphere extends way above the troposphere and the visible cloud deck, radiating energy generated within the planet out into space.

But whilst Earth's stratosphere starts around 10km above the surface of our planet (a few kilometres above the clouds) on Saturn the stratosphere extends hundreds of kilometres above the clouds.

Saturn's stratosphere should be a 'weather-free' zone, relatively unaffected by the turmoil of storm clouds churning deep below, "but this turns out to be completely wrong" Leigh explains.

Instead, the new observations spotted 'beacons' in the stratosphere that, at 15-20 degrees Kelvin hotter than their surroundings (120-140 Kelvin), stand out like the beacons of a lighthouse. In fact, the spectacular effects of Saturn's giant storm were being felt in the stratosphere almost 300km above the visible clouds, "that's almost as far as the International Space Station orbits above the surface of the Earth' Leigh adds."

"It's as if the storms in the troposphere are giving the normally stable stratosphere a punch – hitting it and causing the hotspots we've been able to pick up in infrared.'

Light the beacons

These beacons are thought to be created when 'air' (87% hydrogen, 12% helium, 1% other trace gases) wells up and then descends; becoming compressed and heating up like the air in a bicycle pump. It's the emission from the other 1%, gases such as methane, ethane, and acetylene, which makes the beacons visible.

Our skydiver would have to plummet some 300kms from the stratospheric beacons to reach the troposphere where convection rules and energy is turned into powerful air currents. Here, at the topmost layer of the clouds, the bright white areas we see in visible light are plumes of fresh material as yet untainted by Saturn 'smog'.

But of course, this being Saturn, these aren't ordinary storm clouds: instead they are clouds mostly made up of crystals of ammonia ice and other exotic materials.

"It's as if, by injecting these plumes of fresh material up into the troposphere, the planet is doing a gigantic experiment for us; injecting a visible tracer that we are then able to use to track Saturn's jet streams as they travel from east to west around the planet," Leigh tells us.

These top layers of clouds that 'cloak' the planet - shielding the lower reaches of the atmosphere from view - vary in colour from the pristine, bright and new, to old, dark clumps that have accumulated 'dirt' or contaminate as they circulate in the turbulent currents of the giant storm.

Yet the journey of our intrepid skydiver is nowhere near over even now she's reached the top of the visible clouds. She would have to plunge even deeper, into cloud decks normally hidden from telescopes and orbiting spacecraft, to find the source of the powerful storms and beacons observed by the team.

"The storms don't begin in the troposphere with these ammonia clouds, we think that they start around 200-300km below the top of the troposphere, possibly within clouds of water hidden deep within Saturn's atmosphere," explains Leigh.

Stormy weather

Here, over 500km below the beacons in Saturn's stratosphere, is where bad weather is brewed. An injection of energy into this cloud deck can form giant bubbles or plumes which rise upwards. These drag with them material that will eventually form the visible tropospheric clouds, and it's the response to this powerful convection that is likely to be generating those hot beacons which show up in infrared in Saturn's stratosphere.

If our skydiver has made it this far, she's reached the part of the atmosphere scientists would really like to study – one possible source of the incredible phenomena seen on giant planets.

These latest observations are just the beginning of the story of Saturn's stormy weather. Since the work reported in Science the team have been continuing to monitor the behaviour of the beacons and hope that they can reveal much more about the planet's atmosphere.

Leigh comments: "We've taken what people think of as a serene and beautiful astronomical object and moved it into the messy and volatile realm of meteorology. It's a nice thought when you look up at a blue sky on Earth filled with fluffy clouds of water vapour that the same physics of weather is driving vast storms on another, very different, planet."

Our imaginary skydiver has taken us on a wild ride deep into the heart of this gas giant but she's still only scratched the surface. Saturn's deep churning atmosphere extends another 58,000km to the core – that's 3.5 times the diameter of the Earth. Assuming she survived the incredible heat, pressure, and poisonous fumes she'd still be faced by one final problem: how do you land on a planet that has no solid surface?

Provided by Oxford University

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