STORY ARCHIVE

Space storms occur when the Sun erupts, sending out a ball of plasma. Graham Phillips heads to the University of California Berkeley and Big Bear Solar Observatory to meet the extra terrestrial weathermen who show us how a space superstorm could occur and what effect it would have on our communication and energy networks.

Space storms

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Topics: Space
Comments

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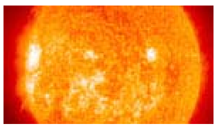
TRANSCRIPT



Narration:
The sun belches a ball of charged particles. It flies through space at over a million kilometres an hour. The Earth gets in the way. Around the world cities' power grids crash, cutting off electricity to many millions. It's a natural disaster like we've never seen. Could the sun do this? Well yes – it already has in the pre-electricity days – the telegraph systems were affected.

DR GRAHAM PHILLIPS:
The tower on the hill behind me is built on San Francisco's' Telegraph Hill. That was the place the first electronic telegraph was built here about a century and a half ago. Now here's the interesting thing. Shortly after, in 1859, the Earth was hit by a massive space storm. Indeed we haven't seen a space storm that big since. It devastated the fledgling telegraph system.

Narration:
A space storm is a huge magnetic cloud of mainly protons and electrons from the sun. It plays havoc with the voltages in long stretches of wire.

Dr Charlie Lineweaver:
If you have a very, very, very long wire then you're creating a high voltage. So you have high voltage low voltage as the thing swings over the wires.

Narration:
The random voltages changes not only made it hard to send telegraphs, newspapers at the time reported an eerie side-effect.

Prof. Philip Goode:
The telegraph systems in England and the east of the United States ran on their own for a few days without needing any batteries.

Narration:
A space-storm belch is known coronal mass ejection, and the sun produces them relatively frequently. But 1859 was a superstorm…a one-in-a-few-centuries event.

Narration:
The disturbing thing is, unlike 1859, today life is dependent on electronics. If we had another one of those now?
Prof. Philip Goode:
Oh, it could be real fun.

Narration:
Real fun! When the power grids crash, they could take months to repair because transformers are melted by the high voltages induced by the space storm. And GPS satellites could be taken out by the charged particles.

Dr Charlie Lineweaver:
When somebody has been relying on a satellite for communications, a coronal mass ejection comes and the satellite goes grblgrblgrblgrbl a big garbled noise and out of business.

Narration:
Space storms are also beautiful…they create the Auroras.

Narration:
But when it comes to predicting this stormy weather we're surprisingly ignorant.

Dr Stuart Bale:
We've really only had space weather as a kind of concept for 10 or 20 years.

Dr Charlie Lineweaver:
We're very much in the situation with space weather as we were with Earth weather in the 1950s.

Dr Charlie Lineweaver:
In the 1950s, to find a hurricane, you'd have to say "here comes one Joe, let's get into the house and cover up". But now we have satellites to tell us when these hurricanes are coming – days and weeks in advance sometimes.

Narration: With our electronic age riding on it, the race is on to accurately predict space weather…which brings us to Big Bear in California. It's a ski resort only a few hours drive from Los Angeles. But it's also home to the biggest sun-observing telescope in the world.

Prof. Philip Goode:
The locals here call this their Taj Mahal. They don't know what it is but they like it!

Narration:
The Taj has just been refurbished with the most powerful solar telescope ever built.

DR GRAHAM PHILLIPS:
Now the thing about the biggest solar telescope in the world is that it's not that big. The collecting mirror is 1.7 metres across. Now compare that to some of the big star observing telescopes which have ten metre miorrors, it's not very big. But of course the sun is very bright. Indeed the image from the light that this telescope collects, if you focused that onto your hand it would burn a hole straight into it.

Narration:
An advanced cooling system to get rid of that tremendous heat is a key to building a telescope this big. There are three fundamentally different ways to observe the sun. Much smaller telescopes can be used to create full-disk images like these. They show sunspots, which are relatively cool patches, and prominences, which are loops of plasma anchored to the Sun's surface.

Narration: A second way to observe the sun is to use a coronagraph…this involves blocking the disk of the sun out like during an eclipse…and you can clearly see the enormous coronal mass ejections leaping off.

Prof. Philip Goode:
The mass has ejected is about equal to the mass of all the motor vehicles on earth and the energy is enough to power all of us for the next 10 thousand years, all of us in earth so it's a huge amount of energy.**Narration:** But to understand how a coronal mass ejection - a CME - actually forms there's the third method for observing the sun…using a powerful telescope to look at the finest detail in a tiny patch.

Prof. Philip Goode:
And that's what's exciting about this telescope is and we'll be able to see the origins of space weather.

Prof. Philip Goode:
We'll be able to resolve the fundamental scale of the sun's magnetic field – it comes in straws that float and we'll be able to see inside those straws.

Narration:
CMEs are born as the magnetic field is stretched by the sun's rotation.

Prof. Philip Goode:
So imagine you're a magnetic field and you're being pulled by this rotation and you're being pulled a little bit more in one direction than in another and the field gets stretched and the field finally says I've had enough of being stretched and it pops.

Narration:
Exploded out is a coronal mass ejection.

Narration:
To study CMEs on their way from the Sun to Earth, it's best to go into space. There is a pair of satellites doing that job –the Stereo Mission. The two satellites orbit the Sun like the Earth does: one ahead of us and one behind. Just as two eyes give us 3D vision, the two stereo craft allow CMEs to be studied in 3D. At the University of California Berkeley, Stuart Bale designed instruments on the stereo craft, to measure how a CME propagates through space.

DR GRAHAM PHILLIPS:
Ok, so if you can study that shock front, you can work out how fast it's travelling, you can predict when CMEs will hit Earth more accurately.

Dr Stuart Bale:
That's the idea.

Narration:
At the moment we don't even know if a CME speeds up or slows down through space. The Stereo satellites have measured for the first time how much matter is in a CME…vital information for predicting the size of a space storm. And this is Mission Control for another set of space weather satellites – Themis. They take measurements very close to Earth while a CME is actually hitting us. There are five satellites placed in different parts of the magnetosphere…that's the Earth's protective magnetic force field. It shields us from the solar wind: a constant stream of particles leaking from the Sun. But a coronal mass ejection can open up the protective shell, and the Themis satellites are trying to find out how.

DR GRAHAM PHILLIPS:
Now this is a scale model of one of the Themis satellites. And one of its jobs is to measure really weak electric fields in space. So to stop the electronics of the spacecraft interfering with that it needs a very long antenna. In fact this long…25 metres when it's fully deployed.

Narration:
And the deployment mechanism is ingenious.

Dr John Bonnell:
It's spring loaded.

DR GRAHAM PHILLIPS:
Gee that's a simple deployment mechanism.

Dr John Bonnell:
It is. It's sophisticated but simple. You want them to be simple so they are easy to test and so that there are very few ways for them to fail. Because once they're up there you can't do anything about it.

Narration:
The antennas have to measure the tiniest changes in electric field as the CME rolls in over Earth… to try to work out precisely what's happening, so that space storms can be predicted. And the Themis satellites have already worked out some of the key details. The sun ejects a CME, and after a few days it hits the protective lines of the Earth's magnetic field. The CMEs charged particles and magnetic field then flow over us.

Dr John Bonnell:
It takes that flow energy and turns it into electrical energy just like you'd do with a generator you know taking the flow of water over a dam and turning it into electrical energy.

Narration:
The Earth's magnetic field is pushed out into a long tail. The tail eventually snaps and the CME's energy penetrates down to the Earth, causing the many disturbances of a space storm, including the Auroras. They're caused by charged particles colliding with the atoms in our atmosphere, which produces beautiful light. If we can predict space storms we can protect ourselves.

Dr Charlie Lineweaver:
What these satellites will do is they will know something's coming they'll just close down. They'll say ok close shop guys and get in the hurricane cellar and then they can protect themselves. The grids can do the same thing. If you know something is going to attack you can shut down for two hours and put the power on very low.

Narration:
Hopefully, between the satellite observations and the new telescope we'll be able to accurately predict space weather, and avoid a disaster when the next 1859 super-storm arrives.

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