



PHYTOPLANKTON

1
00:00:01,868 --> 00:00:04,037
Between September 2019 and March

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00:00:04,037 --> 00:00:09,442
2020, wildfires killed billions of animals
and decimated more than 200,000

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00:00:09,442 --> 00:00:14,981
square kilometers of Australian forest,
an area larger than the size of Nebraska.

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00:00:15,482 --> 00:00:18,418
Some thousands of kilometers
away, in the Southern Ocean,

5
00:00:18,451 --> 00:00:23,857
massive algae blooms covering a surface
larger than the area of Australia itself.

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00:00:24,858 --> 00:00:28,261
Just how are these wildfires
and ocean blooms connected?

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00:00:28,495 --> 00:00:31,731
To untangle that,
we look to the carbon cycle.

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00:00:31,731 --> 00:00:34,567
The carbon cycle is the flow of carbon
between reservoirs

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00:00:34,567 --> 00:00:38,538
in the atmosphere, plants
and animals, land and ocean.

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00:00:38,538 --> 00:00:41,708
It's one of the key processes
that keeps life sustainable on Earth.

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00:00:41,941 --> 00:00:46,479

And at the heart of all this are land plants and aquatic phytoplankton.

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00:00:46,479 --> 00:00:49,249

On land, most carbon is stored in forests.

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00:00:49,249 --> 00:00:53,586

Here, plants absorb carbon dioxide from the atmosphere into their cells.

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00:00:53,653 --> 00:00:55,021

With energy from the Sun

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00:00:55,021 --> 00:00:59,626

plants combine carbon dioxide and water to form carbohydrates, such as sugar,

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00:00:59,626 --> 00:01:01,528

and oxygen through photosynthesis.

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00:01:02,629 --> 00:01:05,965

In this process, carbon dioxide is converted to carbon-based

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00:01:05,965 --> 00:01:07,700

cellular material.

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00:01:07,700 --> 00:01:10,770

Carbon stored in those plants can be transferred when animals eat

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00:01:10,770 --> 00:01:13,139

the plants, the plants die and decay,

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00:01:13,773 --> 00:01:17,644

or, in the case of Australia, fire consumes the plants.

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00:01:17,644 --> 00:01:20,447

And once again, carbon based cellular material becomes

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00:01:20,447 --> 00:01:22,916

carbon dioxide that ends up in the atmosphere.

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00:01:23,750 --> 00:01:27,420

If we look to the ocean reservoir, carbon dioxide is also absorbed

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00:01:27,420 --> 00:01:32,025

by phytoplankton, microscopic organisms that convert carbon dioxide, water

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00:01:32,025 --> 00:01:36,896

and sunlight into carbohydrates like sugar and oxygen through photosynthesis.

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00:01:38,064 --> 00:01:40,467

Carbon dioxide released into the atmosphere

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00:01:40,467 --> 00:01:44,370

eventually becomes available for aquatic photosynthesis.

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00:01:44,370 --> 00:01:47,674

In general, any change that shifts carbon out of one reservoir

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00:01:47,974 --> 00:01:50,343

puts more into other reservoirs.

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00:01:51,478 --> 00:01:53,313

But photosynthesis also requires

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00:01:53,313 --> 00:01:56,349

nutrients

such as nitrogen, phosphorus and iron.

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00:01:56,783 --> 00:01:59,052

Without the right proportions
of these nutrients,

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00:01:59,419 --> 00:02:02,088

photosynthesis doesn't happen,
which can be seen in

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00:02:02,088 --> 00:02:06,459

the iron-limited parts of the ocean,
such as far offshore of Australia.

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00:02:06,960 --> 00:02:10,930

Atmospheric aerosols released by fires,
however, contain carbon

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00:02:10,930 --> 00:02:14,667

as well as other nutrients
essential for plant growth like iron.

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00:02:15,468 --> 00:02:18,838

When these aerosols are deposited
on the ocean's surface,

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00:02:18,838 --> 00:02:21,774

these nutrients become available
for photosynthesis.

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00:02:21,941 --> 00:02:26,279

This iron from the Australian wildfires
is now thought to have stimulated

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00:02:26,279 --> 00:02:31,518

the massive southern Ocean phytoplankton
blooms, blooms of such magnitude

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00:02:31,518 --> 00:02:35,188

that they converted an almost equivalent

volume of carbon dioxide

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00:02:35,188 --> 00:02:39,626

released by the fires
into carbohydrate and cellular material.

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00:02:41,161 --> 00:02:42,362

And here is why having a

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00:02:42,362 --> 00:02:44,430

vantage point from space is crucial.

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00:02:45,331 --> 00:02:48,935

From satellites, we can observe how
the movement of carbon changes

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00:02:48,935 --> 00:02:51,704

when large scale events like wildfires
occur.

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00:02:52,472 --> 00:02:56,009

The connection between the Australian
wildfires and Southern Ocean

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00:02:56,009 --> 00:02:59,445

bloom could not have been made
without satellites.

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00:02:59,612 --> 00:03:03,716

NASA's Plankton, Aerosol, Cloud, and ocean
Ecosystem, or PACE,

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00:03:03,716 --> 00:03:07,787

mission, is specifically designed
to better measure parts of the atmosphere

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00:03:07,787 --> 00:03:11,257

and ocean connection
with unprecedented resolution.

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00:03:11,791 --> 00:03:15,361

PACE's instruments will shed new light
on the composition and distribution

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00:03:15,361 --> 00:03:20,166

of these massive mixtures of tiny aerosol
particles and aquatic microorganisms.

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00:03:21,234 --> 00:03:25,338

Onboard are two polarimeters, instruments
that measure specific angles

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00:03:25,338 --> 00:03:29,542

of light reflected, which, for example,
allows researchers to tease apart

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00:03:29,542 --> 00:03:33,613

the specific type of aerosols
in these kinds of massive fire events.

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00:03:34,214 --> 00:03:39,118

PACE's flagship sensor, the Ocean
Color Instrument, or OCI, will cover vast

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00:03:39,118 --> 00:03:43,056

swaths of the ocean, measuring
concentrations of photosynthetic pigments,

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00:03:43,323 --> 00:03:46,859

allowing researchers to decipher
the different types of phytoplankton.

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00:03:47,260 --> 00:03:49,262

With an instrument like OCI,
where you're measuring

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00:03:49,262 --> 00:03:52,031

this full spectrum of color,
all the colors of the rainbow

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00:03:52,031 --> 00:03:55,835

you can imagine,
we can start teasing apart the species

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00:03:55,835 --> 00:03:59,205

and the different functional groups
and different communities that exist.

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00:03:59,772 --> 00:04:02,475

The data from PACE
will help define those communities,

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00:04:02,709 --> 00:04:06,646

allowing for clearer connections
within the reservoirs of the carbon cycle.

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00:04:07,013 --> 00:04:09,415

These fires
emitted a huge amount of carbon

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00:04:09,415 --> 00:04:13,720

and other aerosols into the atmosphere,
with some estimates suggesting volumes

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00:04:13,720 --> 00:04:18,725

greater than Australia's annual emissions
from fire and fossil fuels combined.

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00:04:19,525 --> 00:04:22,362

Those aerosols contained
essential nutrients that are thought

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00:04:22,362 --> 00:04:26,666

to have stimulated the rapid growth
of phytoplankton in the Southern Ocean.

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00:04:26,866 --> 00:04:30,003

And these kinds of connections
can have big impacts.

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00:04:30,203 --> 00:04:31,537

It's really important to know

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00:04:31,537 --> 00:04:33,873

where the carbon is going
and where your food source is going.

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00:04:33,906 --> 00:04:38,144

This is important for not just climate
studies, but food security.

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00:04:38,778 --> 00:04:41,581

The fires that tore through
Australia are just one example

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00:04:41,581 --> 00:04:45,752

of how Earth systems are linked in ways
we're only beginning to fully understand.

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00:04:46,753 --> 00:04:50,223

With data from PACE, we'll get a clearer
picture of carbon as it links

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00:04:50,223 --> 00:04:55,261

land use and fires, atmospheric aerosols
and marine communities