

Topic 3c - Part 1: High altitude balloon measurements - Overview

You work on ways of sensing the atmosphere in places that are very difficult to reach. So your solution to this problem is to do something that people might not associate with modern science, which is to use balloons. Tell me why you would use a balloon to study the atmosphere.

Balloons have been invented a long time ago. CNES has run a balloon program-- large balloon programs-- for more than 50 years. And it is still very popular among the scientists, and it brings really unique features.

It helps what we call the calibrating, validating the satellites. The balloon will allow observation with a high resolution, space-wise and time-wise. So the balloon is the perfect mean to calibrate the spaceborne instruments and also to make a measurement, for instance, around day and night conditions of the same situation.

To have a high resolution, the balloon move slowly. So you are really in the system. And you can follow it.

And in addition, the super-pressure balloons follow isotopic trajectories. So it follows the same air mass at first order. So it's the ideal tool to see the revolution of one air mass, depending on what the air mass is subject to for the environment.

So in this case, you went to Antarctica, and you launched balloons. But these are not the sort of hot air balloon that people go for a holiday trip in. These are very special. Tell me about the different types of balloon that you can use.

So on this picture, we have the whole family of balloons. On the upper right, we have what you call a zero pressure balloon. These are huge plastic bags, which are not subject to mechanical constraint.

By design, it's zero pressure. So it can carry heavy payload, up to 35, 40 kilometers altitude. And this brings high-capacity instruments up in the air. But it cannot fly very long, except in very special cases, like continuous sunny situation.

So this balloon-- it goes up. It goes very, very high.

It goes very--

But then it sort of dips down, and then it comes back down.

When night occurs, it will usually lose altitude. And if altitude isn't quite correct for you, you have to release ballast. And then the next day, you will have to release ballast.

But it would move higher. It's a divergent process. You cannot maintain it a long time. You have then on the left super pressure balloons.

That's this one here.

This one. And this is a balloon, which is designed to fly several months. What you need to fly several months, you have to be extremely gas tight.

And we also designed the balloon so that it won't expand. It's a stiff film, and it's also a strong film because to reach that goal to be over pressure all along the three-months flight, you have to go through very variable thermal situations. And the super pressure may vary greatly. And you have to withstand this high pressure.

So this one's a bit like a giant football. It inflates it. It's got this much gas. And then it stays exactly the same.

Yeah.

And this can stay aloft for three months.

Three months at constant air density. That means that it follows roughly the same air mass during three months. So it's a perfect tool to study dynamics, to study chemical, physical changes, to study atmospheric processes and dynamics. This is the ideal tool.

And so that's what you were using here.

That's what we were using here.

So where were these balloons going in the polar night?

So it's caught in the winter vortex here. It's a high-speed winter vortex is the data here. And we see each black line is a balloon during--

So if we stop that just a second here, so each of these black lines-- this is each one is a single balloon. So it's going along a track.

It's a single balloon over 10 days' trajectory.

And so they're just going round and round and round.

Yeah. And with the season here, we are early December. We see that already the winter vortex has started to dilute.

So it's great because you had to go out in the cold to put the balloons up. But then you just leave them there. And they just keep going round.

Yeah. But we have a control center in France. And there, we have also one in US for a special payload.

So what have we got here?

So we have a balloon, which was inflated on a long table. We inflated it already. We removed half of the table.

We have the payload ready for launch. And we will release the balloon here at the end of the table. And people have to be very quick.

So it's going. And so this is the payload here. That's the important bit.

This is a service.

Oh no, that's the payload.

And this is the payload. And this is a US payload, which drifts on.

Right.

We could really--

So that just goes up into the atmosphere. And you watch it go.

Yeah, little bit tricky. We tried to improve that, for STRATEOLE-2 to our next project.

And how many of these balloons were launched?

So 19 of these balloons were launched during Concordiasi. And the average duration two months and something.

This balloon campaign was in 2010, 2011. What's coming next? What are the next studies?

So scientists did change their priority after focusing much on the South Pole for ozone depletion and for here the improvement. The next priority is the equatorial region. And in particular, they want to understand how the water transfer from our atmosphere-- I mean the troposphere-- to the stratosphere.

It's very important because it drives the concentration of water vapor in the stratosphere. And water vapor is-- the most important ingredient is gas. So for that, this is a demonstration we made to show that STRATEOLE-2 was visible just before Concordiasi.

We launch a balloon from Seychelles islands. And the goal is that they keep in a 15 degree north, 20 degree south latitude bandwidth. And we will launch 20 of them.

We have drifting balloons. We do not pilot the balloons. So you can see that sometimes a balloon can leave--

Yeah, it goes round and round in circles a bit.

Yeah, yeah.

But you want to measure this region here. And how long will it take one of these balloons to go all the way round?

It depends on when you are in the season and the quasi-biennial oscillation occurring there in the lowermost stratosphere. It takes usually three weeks to form a circle.

So in three months, they'll go around the world four times.

Yeah, yeah, yeah.

So during those years, there'll be balloons all the way around the equator, just drifting along, watching what's going on. And that's really valuable data, isn't it? Because there's no other way to get that.

Yeah, in particular for the dynamics, as I explained earlier, and to study the process-- how water transfer from troposphere to stratosphere.

It's a big question, isn't it? Yeah.

It's not understood. So we measure water vapor, aerosols, temperature gradients, ozone as a cast tracer, the proxy of the air, the carbon dioxide. And we make remote measurements with LIDAR, where we make sounding through a GPS radio condition. We have a wide range of instruments.