Topic 1e - The importance of field research and data validation (part 1) - Overview

We are doing a lot of ground measurements on the Greenland Ice Sheet. And why are we monitoring these parameters? And most of it, actually, we want to understand processes. But even same importance is to calibrate models. Models can actually take our point measurements we measure in one location to a bigger area.

And for this, we have a network of stations. And in Greenland, I have 18 stations, similar like this. It's called an automatic weather station.

And this is direct from Swiss camp, what we have measured the temperature at two meter level from 2010 to 2016, as the time period we have been there. And it shows you that the temperature ranges from minus 40 to plus five degrees. You see the dark red line on the graph. That is when melting occurs.

And it's not obvious when you look at that variability, but the summer temperatures are way above zero. That means we have melt occurring. And this actually is a good way to combine modeling and point measurements. Most of our measurements are there to understand the processes, but the next step is to devise physical models that reproduce what we observe on the surface, and then to expand it to larger areas.

And that has been done to a lot of our measurements all over Greenland. That's how we inferred when we saw the Greenland ice sheet moving faster towards the coast. It was actually that the melt penetrates through crevasses, or through moulins, this is the opening where the water drops, all the way through the ice sheets, lubricates the underside of the ice, and then it moves further and faster towards the coast.

The whole network here is actually funded by the space agencies. And it is one of the targets to calibrate satellites. When you have a satellite, like a laser altimeter, you only measure a height of the entire ice sheet. But you need to understand the processes that relate to a change in height.

And the change in height, for example here, can be the temperature change in the snow. And these measurements we actually record measure long term the variability of the temperature change. It also relates to how much melt we do we have. We can calculate the melt by these stations, verify by the satellite, and then apply for the entire ice sheet, because here we only make point measurements.

So we need both. We need the satellite coverage of these individual measurements, radar, LIDAR, temperature, and the calibration of the stations at certain points in different areas around Greenland. And the two then give us the entire picture of the change in Greenland.

It's very hard to actually make long term measurements. What we did in the last 25 years, every three years, we wrote a new proposal giving a science idea as validation for satellites, for models, for processes. And that's how we were able to maintain a network of 20 stations.

Now it became so valuable, people understand, oh, we want these networks. They give us not only an insight into the climate, they give us decadal changes over decades. And this is actually needed, because the climate is variable from one season to the next.

The climate is variable over a decade, because we have decadal forcing from the oceans. And we need longer term than decades. We need 20, 30 years to describe the state of the climate. Therefore, its crucial to make and continue these measurements.

This is one of 20 stations on the ice sheet that measures the local climate again. Similar than the 10 meter tower, but this was specifically made for surface flux measurements. We always measure at two levels, one meter apart, temperature, humidity, wind speed, the pressure.

We have a cable that goes 10 meters into the ice. And we have the radiation balance. That means we can measure the turbulent fluxes, that is the flux that warms up the atmosphere, or heats actually the snow, the atmosphere is heating the snow, or evaporation. We can measure these by the difference in humidity and temperature beneath the wind velocity at two levels for that.

This data is used for describing the local climate. And again, we have seen here in the last 20 plus years of warming of over two degrees centigrade. As an annual mean, winter temperatures are very variable.

Summer temperatures get warmer and warmer. That means we lose more and more ice here in the summer. Because this 25 years ago was an area where the amount of snow that fell was melting during the summer. Now, its no longer the case. We lose every year one to two meters of ice.

And the ELA has moved uphill, which is this direction by about 30 to 40 kilometers. This also means 30 to 40 kilometers all around Greenland, you have an additional area that produces meltwater. And that is an additional ice loss. And that's why we have a negative balance right now. We are losing more ice in Greenland than we accumulate by the snow during the winter and the cold months.