Matt Eastland:
Hi everyone, I'm Matt Eastland. Welcome to one of our special docu-episodes. In these explorative deep dives, we tackle the big questions within the food system, uncovering fascinating stories of innovation and change. Time to further explore the groundbreaking ideas and incredible people driving the future of food.

Connor Morrin:
Who knew that watching a movie could change the course of the planet's future?

Max Gulde:
My first memory of space and science fiction, I must confess, was probably Star Wars. It took me quite a while to figure out which parts are real and which parts are not real. What fascinated me was the vastness of the universe and just the amount of crazy ideas in there. This was something which sparred my interest in space.

Connor Morrin:
Fast forward a few decades, and that boy, now a physicist, innovator, and CEO, is using space to tackle one of humanity's biggest challenges, climate change. What would the young Max see?

Max Gulde:
He would be super interested to see if he could somehow leverage that knowledge of going into space himself and be free floating through space. On the other hand, he would be quite happy that I'm using my time and resources for something which has purpose and makes sense. I'm Max Gulde or Guld, however you like it. I am the CEO of Constellr Constellr is a company which is in the food security space and what we're basically doing is building additional twin of the planet to support better resource allocation with a focus on agriculture and urban development.

Connor Morrin:
Let's explore how Constellr is using cutting-edge satellite technology to address what's broken, and how their fight against climate change is pushing innovation to new heights.

Max Gulde:
So in my academic career, I built microscopes for about 10 years, and space was something which was on the other side of the scale. The reason I eventually changed from one side to the other was that I didn't really feel that my work there made a meaningful contribution to society. The most meaningful thing I saw back then, and I still subscribe to that, was the fight against climate change. My logic, which might be a bit naive, was, well, in order to first

quantify climate change, we need an outside perspective. That's where we need space from. And then we'll generate a lot of data. We probably need big data methods or machine learning, AI, whatever it is, to process this data. And in the end, we probably need something, robots or some high degree of automation to execute on that. And the common denominator was that I had no clue of any of these things. So I tried my best and eventually ended up in space. My understanding of climate change in a quantitative way came a bit lighter than for most. We had quite a pot of money to develop a satellite for Fraunhofer. And I was the mission scientist for that, so I was looking at the applications and so on. And one of the applications identified as feasible and viable for this type of satellite was the detection of intercontinental ballistic missiles from low Earth orbit. That doesn't have anything to do with climate change. But in order to do that, what was technically needed was the measurement of very faint thermal signatures as part of the rocket plume when it is launched. And there was a challenge associated with that since the platform we wanted to use and the type of payload we wanted to use would not have been able to pick up these tracers. So part of the work I did was trying to figure out how to do good temperature measurement, but again, in view of a defense intelligence topic. I like technology, I was not fully subscribed to the application, but during that time, it dawned to me that, wow, there are a lot of other things you could do with it. And the more I looked into this, the more I looked into, hey, what would this mean for picking up forest fires? What would this mean for improving urban planning? Let's say picking up or locating Benid Islands. What would it mean in terms of our food security when it comes to water use and so on? The more I looked into this, the more interested I became. And this was the first time where I got a more quantitative, less qualitative view of what climate change actually means. And the numbers were staggering and actually alarming. So, I remember one night I was sitting in front of my PC and I just went through an impact assessment. So, if we would do this, assuming what this wild idea back then, and we didn't even have a company, this wild idea of Consular of doing this in a commercial setting for the mitigation of climate change, assuming it would work, what would this actually mean? And I remember that I sat back looking at the number which came out and then turned to Margot and said, hey, until now it was a thing I want to do. Now it's a thing I have to do. And she didn't quite understand. So I showed her the number and she was like, wow, maybe did a mistake. I was like, yeah, okay, let's look again. But no, the impact of what we can be delivering with this tool is just mind boggling. And I think this was the point in time when it went from a hey, that's a nice thing to do, and it's interesting, and I believe I do something interesting too. Wow, it's a duty to do this. Otherwise, I'll probably feel bad for the rest of my life if I don't use that chance. Let's maybe start with a rather grim outlook. What could the world be looking like if we don't get our grips on the food system? Basically, there's three cycles we need to look at. The water cycle, it's where things grow. The energy cycle, how fast things grow. Whatever anything grows, it's in the carbon cycle. And the food system rests on these three cycles. If you increase temperatures by about 1.5 degrees global average, let's take the two

degree mark. This means that in the next 25 years, you'll lose about 46% of all crops. Basically, you wipe out half of the world's food, because you're moving out of a zone where plants are comfortable growing, so they will not grow as fast. If you have too hot temperatures, too low temperatures, things won't grow as fast. At the same time, we're increasing our population by 25%, from about 8 billion to 10 billion. And at the same time, we're also increasing the per capita calorie need. So mathematically, it doesn't add up, right? So more people who have more caloric demand and you basically wipe out half of the food. So it simply doesn't work. So what does this mean in the near future? In the near future, It means that we're already seeing or expect an increase of water prices between 2020 and 2030, so the next five years, of six to 12 times to the 2020 baseline. This means that food prices, and I'm speaking of basic food like paddy, wheat, maize, will increase by three to four times. Let's take one more specific example to give you an idea. If we look at maize, and maize is one of the main calorie providers in Africa, for example, and actually all over the world. If you have one degree above 30 degrees Celsius on average, this is a generalization, right? There are different varieties. But on average, if you have one degree above 30 degrees Celsius for one day, you are losing 1% of the yield. So assume you have a week at, let's say, 35 degrees. This means that one third of your harvest is wiped out. And to give you the dual numbers, if you have a 2 degree Celsius or centigrade increase in temperature on global average, what does it mean for cities where we live? It means that there might be an increase between 6 and 12 degrees Celsius. All the stuff we eat and the places where most of us live will be affected most strongly. And we're assuming that we have about a quarter of a million more heat-related climate deaths in cities in the next couple of years. Every single year. So that is the dystopian view on what we're looking at. And this is not a problem which will manifest itself in the next 20 years or 30 years. This is happening over the next years. Let's look at the other side. What can we do if we succeed? And I'm not saying that we are the only, we're not the silver bullet, right? We all need to work together. It is a collaborative approach. But part of what we need to do is gain knowledge and understand what's really happening on the planet and be able to quantify it. Let's imagine the following scenario. A couple of years from now, I can't tell you if it's five years, 10 years, 15 years. You have a mobile phone. Your mobile phone is connected to a stewarding AI, and the stewarding AI uses data such as the data provided by Consular, for example, temperature data. You might get a message which tells you, hey, look, based on the evapotranspiration profile of your gardening, you're overwatering by 15%. You can save 200 bucks if you reduce the irrigation, and here's how we do this on your smart irrigation system. Okay, nice. That's on a single-person level. You could have a similar text going like, hey, we looked at the energy output of your building and correlating this with the energy input of your building, we believe that the insulation is flawed and you'd have a three and a half year payback period if you change the insulation up. So the ability to suddenly have changes on a single person level, on a single house level, on a single farm level, this is something which will come in the next 10

to 15 years latest. If we now look at, for example, Let's say a farmer, anywhere. Again, message on the tablet could be, hey, in the northwestern part of your field, we've seen that soil moisture levels are dropping. Since you don't have irrigation, you can maybe apply a fungicide to get the plants in hibernation mode so they don't lose as much water and you'll save, you'll reduce the crop loss from maybe 50% to only 10%. Again, yield saved. And if we zoom out a little bit, and we could do this suddenly for every single field, for every single building, for every single city, for every single region in the world, this is quite massive. So we could massively increase our governance, our ability to use natural resources in a proper context. if we just make it database and data-driven. And I think at the age where we are marrying Earth observation data, which is a large, large, large data set, and in particular data sets which have chemical, so hyperspectral data, or physical, so thermal data properties, and you marry this with the increase of capabilities of AI, you actually get to the level where suddenly you have personalized recombinations for things, let's say, on a scale which you can, as a single person, influence. then I think this will be an absolute game-changer in the future, and I bank on that future. That's the future we want to create. Okay, so let's talk a little bit about the technology and how we got it to work. In principle, it is a constellation of satellites. That is at the core of it, so it's a hardware asset, and we're sending the swarm of satellites into the orbit, and the swarm of satellites has a very specific capability, which is currently highly underserved. The capability is to sense infrared radiation, so heat emission from the surface of the planet. And this heat emission can then be translated into a temperature scale. So we're kind of building a temperature map. The interesting part about temperature is that compared to, for example, visual data, visual data might change very quickly, might not change at all. If you look at the barren landscape, might not change at all. If you look at, let's say, a parking spot somewhere, it might change very quickly. Temperature data also changes, but it has a strong correlation to the diurnal circle. It's the hottest time of the day, which is in the early afternoon, and then it's the coolest time of the day, which is usually at night. And it's repeating the cycle over and over and over again. This means it won't be enough to do a temperature image at some point by itself insulated, but you need to see what the time series, the evolution of the temperatures. So what you're basically building is the underlying framework on top of these satellites, which have these unique capabilities, of temperature sensing at a very high resolution, very high frequency, to build a platform which allows you to look at the evolution of temperature over time. And this will be interpolated spatially, this will be interpolated in a time-wise fashion. And imagine, if you look at Google Earth, for example, it's a fantastic representation of the globe and has so much information. But it's relatively old imagery, usually seen. So imagine you would suddenly get a similar kind of atlas, but in real time. We can really see if there's, for example, an anomaly happening, if there's someone leaving, let's say, polluted water into a river, if there's an urban heat island happening, if there's a drought approaching. All these things suddenly become visible. So

we're building on the one hand side a technology which is situated in space, hardware-based, our own satellites which control and operate. And funnily enough, just last Friday, the first satellite was completed and shipped to the launch provider. And just today, the second satellite has arrived and was fully assembled. There's a lot of stuff going on at the moment. Then on top of this, we are building a platform which is, on the one hand side, allowing customers to access the data set, which initially will be a temperature data set. And there's a lot of IP going into the actual processing of data and making sure that the data is of the highest possible quality. The challenges, but also, let's say, the opportunity for temperature data in particular, is that it is less about the resolution, less about the frequency, as about the quality. If you don't get the shade of green or red in a visual image perfectly right, you might still be okay, you might still be able to detect the feature. But temperature data is not about detection of features, it's detection and bringing a value of, let's say, accurate measurements on a single pixel level, which is a big advantage, but also comes as a big challenge. So we need to be exactly sure that what we measure is actually what the reality on the surface really is. So building that platform, and then at some point, we add another layer, which will then be an analytics layer on top. So we're kind of building this atlas, as we call it, layer by layer. Initial layer is going to be temperature layer, then it's going to be, let's say, evapotranspiration layer, a soil moisture layer. There might be chemical layers, carbon layers, and so on and so forth. What can I recommend to young innovators? So maybe a few things. I've been told so many times that what we're doing is impossible and it can't work. And I actually see this as a positive sign. So if you hear people telling you this can't work, this is nonsense, this will never fly, you might be onto something. That's a very good indicator. If people don't immediately jump on the train, that's a good indicator that there might be something to be done. So, I mean, obviously, stay within reason, right? But don't get disheartened from people telling you it's not working. It's usually a good indicator that they can't imagine it's working, which could be a good indicator that it's difficult to imagine it working, and if you have a solution, perfect, go for it. The second thing is that Going out of existing industry, doing something new, always needs courage. But there's a reward to it, right? You learn a lot, and there's no problem in failing. I'll give you one example. I tried initially to write proposals to get this thing funded within an R&D context, and I got declined 14 times in a row. It's never happened to me before. Then I decided, OK, that's not the way, so let's do it some different way. But the point is that you will probably fall a few times, But that's not the problem. The problem is not getting up again. So always get up and keep walking. And maybe the last thing is that everybody sees climate change as a gigantic threat, and it is, but it's also a gigantic opportunity. It's a gigantic, maybe the biggest opportunity humankind ever had. I don't know if this is, maybe it's the first quadrillion dollar market or something, I don't know, in finance speak. But there's an opportunity to do something what the world needs, to do something where people will be able and willing to pay for it. To do something which feels really good and

you love doing, and if you are not so good at it and you create your niche, I think you are arriving in a place which is quite privileged to be. So I can only recommend to you work in climate, work in the climate space. That's what really matters. Because if we don't get this fixed, a lot of the other dimensions of our market or the other industries won't matter at all anymore. They simply won't matter anymore. We'll be fighting for survival. So do what matters and do it in the right sector. And then maybe to extend this not only to the young innovators, but also maybe to the older innovators, If you don't work for something which is contributing positively to fighting this, consider quitting your work. And I mean it. Consider quitting your work because it might be that what you're doing right now won't exist anymore if you don't navigate to another trajectory right now and do something which is purposeful.

Matt Eastland:
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