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Mastering the Weather Challenge

(Part 2)

New Space Economy

meteomatics

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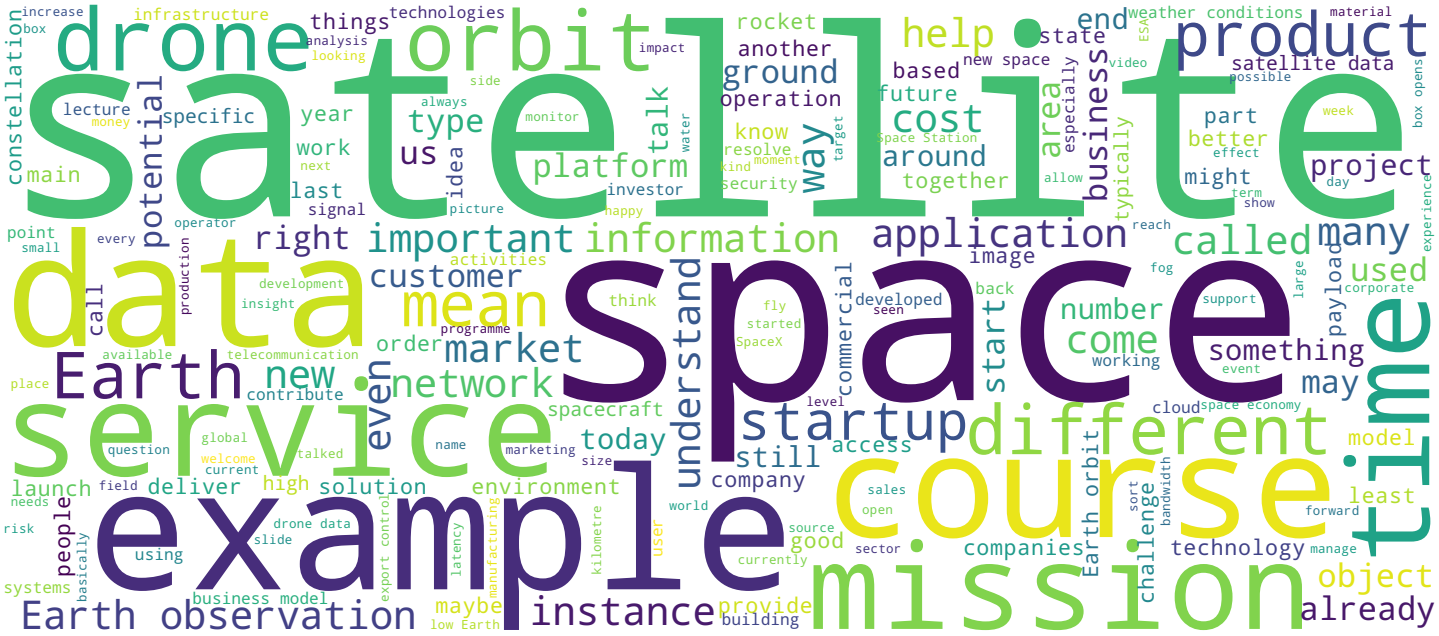

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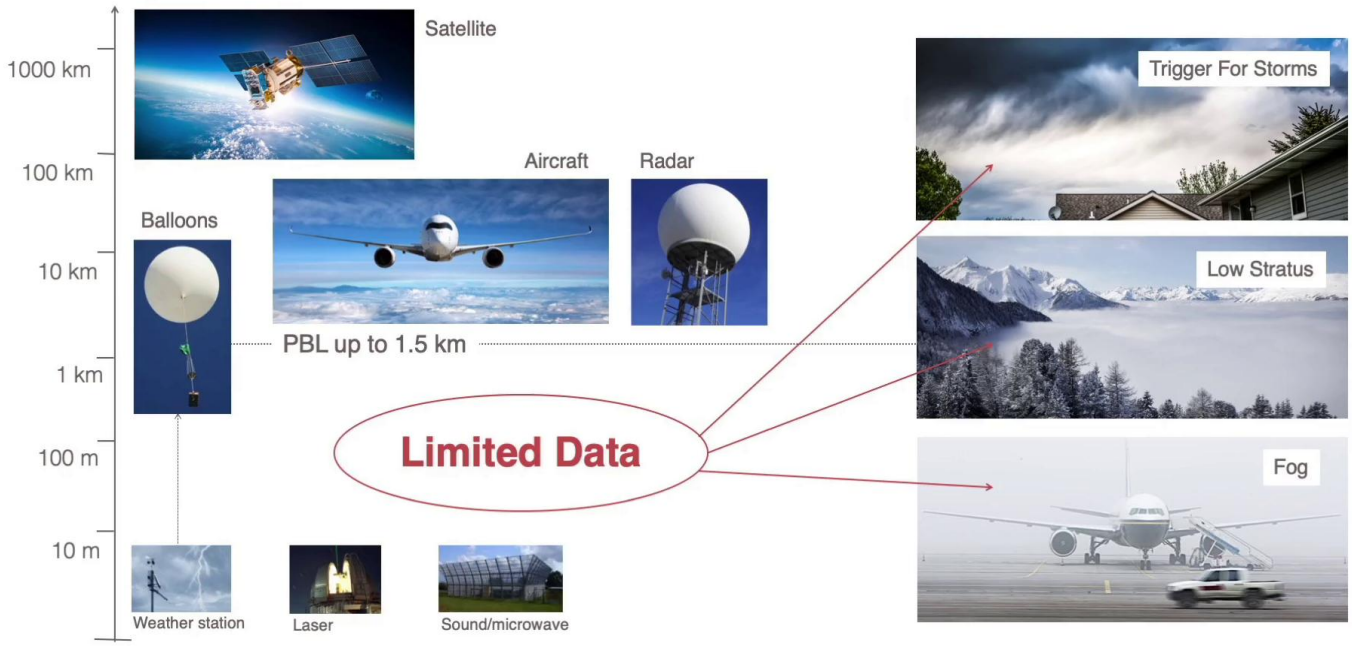
Video

EPFL

Current Data Situation



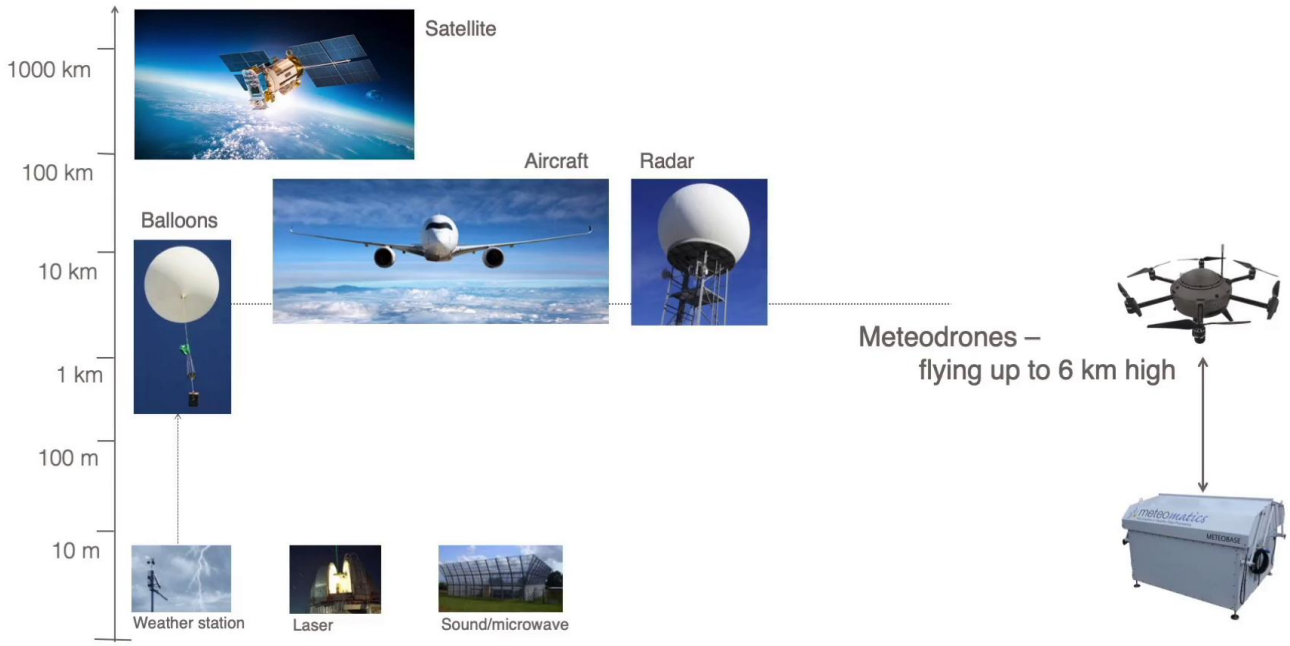
Hello, everybody. I welcome you to today's lesson on the mastering of the weather challenge. We have talked a lot about the data situation. We talked about about the weather model, and how we build an entire business around that, and how we distribute those data to our customers. But it's worth stepping back and asking what could we do to improve the data situation and maybe also the models, because everyone from us has experiences before that hear complaints about the formation of fog, low stratus, or even storms. And this is, of course, something which is still an open challenge. And the problem that you are facing in modern weather forecasting is typically not that you are lacking the computational power, but that you have no idea how the weather conditions are right now. This means that meteorology is currently flying blindly in the low atmosphere, especially in the first half of the atmosphere out to, let's say, five kilometres. There are no measurements available, which is, of course, a bit irritating to layman. And yeah, this is something where we decided to jump in with the drone technology.

Notes

Summary

0m 05s

Current Data Situation



We have developed over the last 10 years, drone systems that are certified to fly under beyond visual line of sight conditions, and here now currently out to six kilometres. Again, of course, there's a lot of satellite technology involved, mainly using GPS data, for instance. But you could also easily think about other satellite communication links that contribute to such an operation. Important is that we have those mobile systems. But of course, if you have such a box solution, you could even get rid of the operator in front of it.

Notes

Summary

1m 35s

Meteodrone MM-670M

Ø : 70 cm; : 5 kg

PixHawk autopilot

You have an example of one of our most recent models. We call it the Meteodrone MM-670M. It has a size of around 70 centimetres, a total lift-off weight of about five kilograms. It comes with a parachute rescue system, has meteorological sensors attached to it and runs a PixHawk autopilot system. It's worth mentioning that this drone is also able to fly under icing conditions and that we have integrated a propeller heating system to our drones.

Notes

Summary

2m 22s

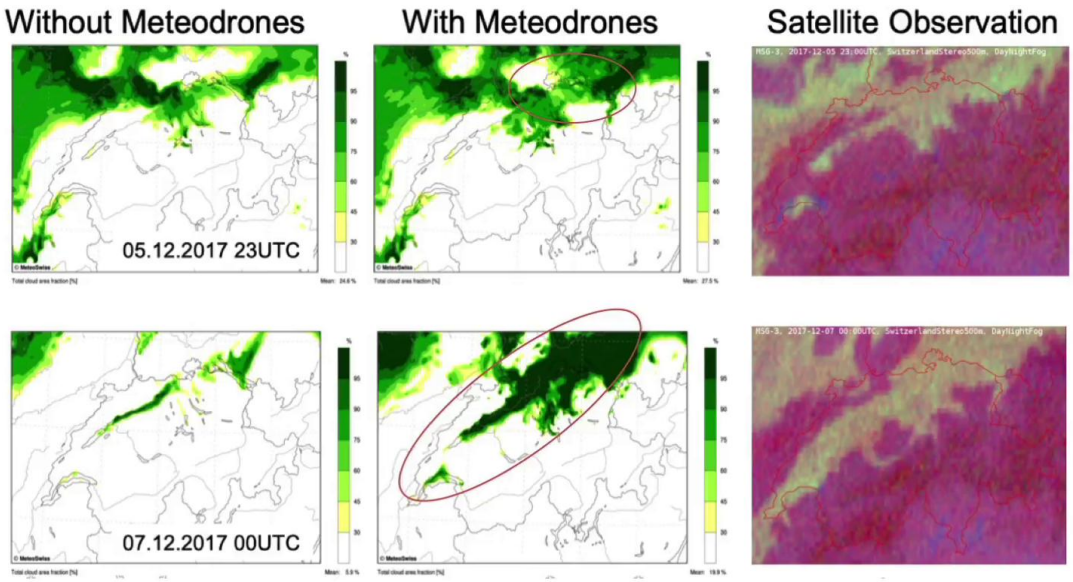
And here you can see an example of a drone that flies out to five and a half thousand metres. The video was taken in the very early morning in June and you can see, of course, this is some sort of fast forward here. Now the drone passes the first cloud deck, the second, and then this looks a bit shaky that's because of the fast forward and of course, strong winds. And then it's returning to the landing site. It looks as if the drone is flying forward, but it's actually the clouds that are moving. And this was a very windy night, so the clouds are also moving pretty fast. Unfortunately, on the way down, you see some moisture that condensed on the lens.

Notes

Summary

3m 01s

Impact on Analysis Mean Cloudiness



Source: Leuenberger et al., 2019: Improving High-Impact Numerical Weather Prediction with Lidar and Drone observations, BAMS

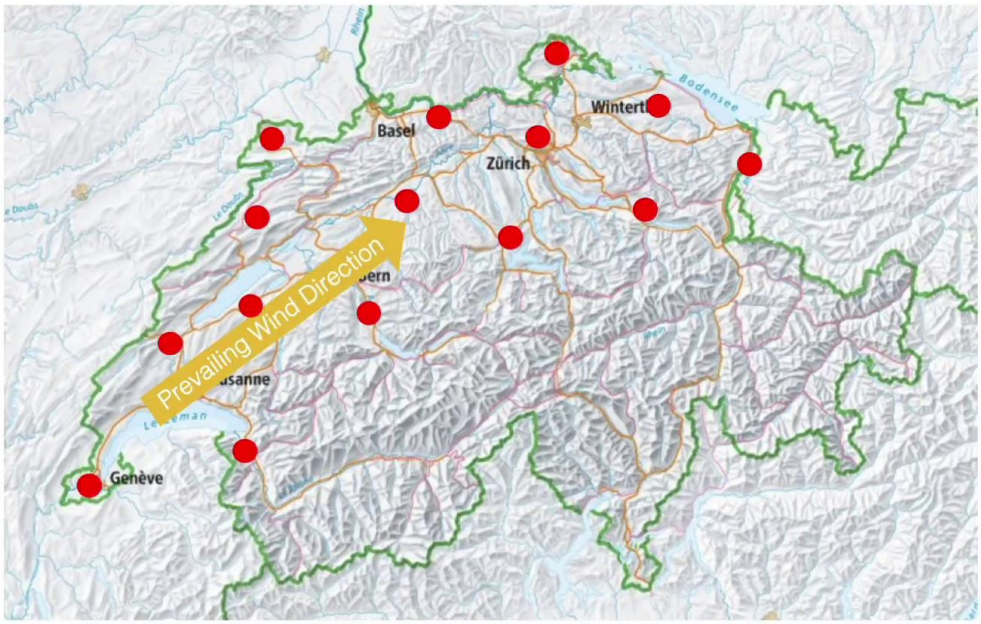
Now, the interesting question is, how can these drone data contribute to the weather forecast? And this is something that you could easily verify. So you let your weather model run without the Meteodrone data. And of course, with Meteodrone data. And in this pilot project, in this very first one called DETAF One, and the acronym stands for Drone Enhanced Terminal Aerodrome Forecast. And this project was sponsored by Swiss International Airlines, the Zurich Airport, and the Federal Office of Civil Aviation. We operated drones here in that area, and these six drones operated simultaneously. One drone inside Zurich Airport at night. And then you can see how well we resolve the fog, and especially the model with the drone data was able to resolve the fog in the Swiss plateau much better than the model without the drones. Yes, of course, it's worth comparing it with the satellite observations if we take this as a ground truth for the time being. But often enough, satellite data fail to resolve those effects of the planet boundary layer. And especially in that case, it's not 100 percent clear at the first glance whether it's fog or low stratus.

Notes

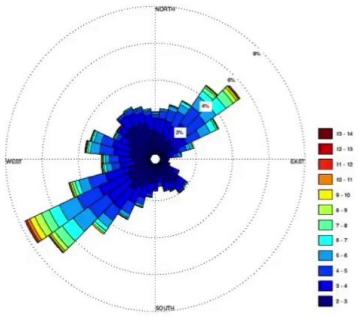
Summary

4m 21s

DETAF 2.0 Planned Meteobase Setup



→ Improving weather forecasts across Switzerland



Wind Speed > 2 m/s

This is why we are now setting up a network of Meteobase platforms. This project is funded by the Federal Office of Civil Aviation, again, that we are now setting up a network consisting out of 15 of these meteor bases that are remotely operated, and data are fed into a high resolution model.

Notes

Summary

5m 52s

Operational Meteodrone Flights

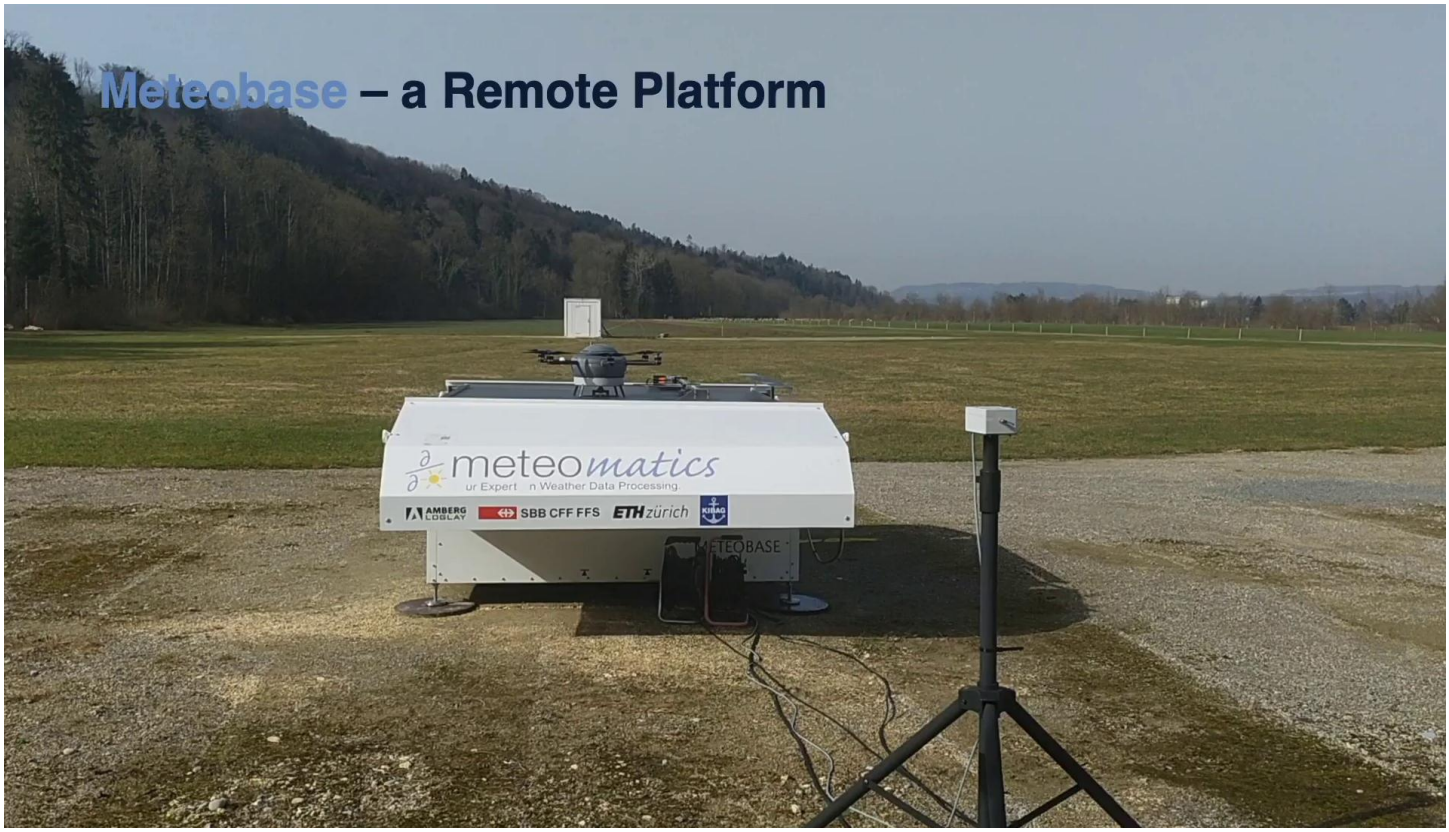
- Operational flights controlled from an operations control center by a remote pilot.
- The pilot monitors air traffic, flight weather and of course flight parameters
- Live weather data is fed back to the pilot as telemetry

The operator's perspective is here in our office in St. Gallen, that he has multiple screens to monitor the surrounding of the meteor base. And of course, he has also information on the surrounding air traffic, the weather conditions, and lots of information around the current state of the drone and the telemetry data that help him to assess a situation around the drone and to manage the entire operation.

Notes

Summary

6m 15s



Here's an example of such a Meteobase, and this video nicely shows how this is operated. The box opens, and as you can see, the drone initializes now its mission, run through some final checks looks for GPS reception, for instance, and checks the health state of different components. And if it comes to the conclusion that everything looks good, it starts it's mission. The drone, under normal conditions, especially at night, flies out to around six kilometres. And then during execution of this mission, the box closes, and on the way back, the box gets a signal and opens the roof again so that it can safely land and gets recharged. While the drone is flying, it permanently transmits its telemetry data, but also the weather information, so that the drone operator, who is for instance, in our facilities in St Gallen, is able to assess the current weather conditions, and in case of really really strong winds, that he is able to abort the mission so that the drone can safely return to its base station. The drone gets centred, and then a connector comes up and docks with the drone to recharge it. So at the moment, there's no battery swapping implemented, but just the charging of the drone. So typically, we can execute one of these profiles per hour.

Notes

Summary

6m 46s

Setting Up Operations

- Setting up the Meteobase at MeteoSchweiz, Payerne

We have already started to roll out the first Meteobase systems and we expect to have their network up and running by end of next year. And in this particular example,you see in the first installation at MeteoSwiss in Payerne and some impressions from night time operations that we conduct here to do inter-comparisons with the remote sensing devices that are installed with the research labs. So this is video footage of a camera operated at night time, infrared enhanced, and you can nicely see how the box opens again and the drone flies out of the box. The lower right video shows how the box opens in case of landing. What you see in the centre of the box, this bright spot, is an infrared beacon, which helps the drone to do the final approach. Again, the drone gets centred and recharged.

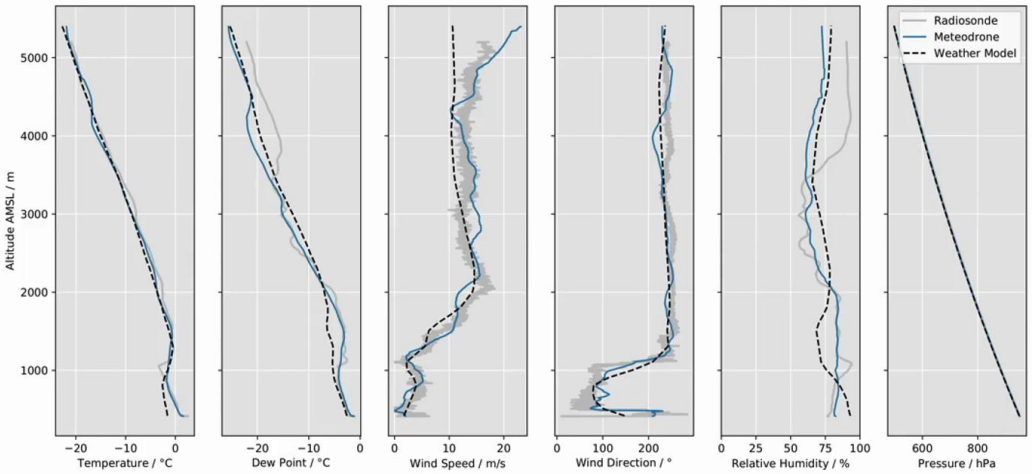
Notes

Summary

9m 47s

Comparing Meteodrone vs. Radiosonde

- The data on the right show a comparison of weather parameters measured by radiosonde and Meteodrone together with model data
- An excellent agreement between all three sources can be seen
- For relative humidity the Meteodrone agrees with radiosonde up to 3500 m, then it is closer to model data
- The same behavior can be seen for the dew point, where again the non-locality plays an important role



- For the temperature the advantage of the radiosonde is evident, as the sharp edge at the upper cloud level is only resolved with the slow moving radiosonde; faster sensors can help overcome this and are part of the developments
- In conclusion: The spatial locality of the Meteodrone is a great advantage of the Meteodrone

Last but not least, it's worth doing inter-comparations with the drone data and Radiosonde. We have direct measurements, which is directly comparable with Radiosonde data that are typically lost with each launch, and of course drifting apart, but still the Radiosonde can be considered as being the gold standard in Meteorology. So it's worth combining that information and to do some sort of analysis how well this fits together, and you can already see in this example, really good agreement with temperature, dew point, wind speed, direction, and so forth. So this is very exciting, and of course, there are ongoing inter-comparations with dozens of other Radiosonde launches, and there will be a scientific paper that is going to be published quite soon.

Notes

Summary

11m 23s

Contact us

meteomatics
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Yeah, last but not least, I'd like to say thank you for giving me the opportunity to talk about Meteomatics and how we tackle the weather challenge. And of course, I'm happy to answer detailed questions. Just reach out to me, and I'm happy to give you more insights how this weather information could contribute to some of your projects. Thank you very much.

Notes

Summary

12m 35s