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Swiss Confederation

Federal Department of Home Affairs FDHA  
Federal Office of Meteorology and Climatology **MeteoSwiss**

# PPP meteorological services in Switzerland:

## a win-win experience, and the specific Drone profiling study

WMO-RECO-RA VI 2022, Bertrand Calpini and Maxime Hervo

Automatic Stations MeteoSwiss  
Manual Stations MeteoSwiss  
Automatic Stations Partner

**1. Why building a weather station where it already exists?**

**OK, but ...**

**2. What about its «Data/Siting Quality» ?**





- **Quality label** any weather stations
- **Compare** between NMHs and Partner stations
- **Create trust** for extreme values
- **Publish metadata** on a regular basis

**MeteoSwiss**

## Quality Assessment using METEO-Cert

The MeteoSwiss Classification Procedure for  
Automatic Weather Stations

J. Fisler, M. Kube, C. Stocker, E. Grüter (Switzerland)



WORLD  
METEOROLOGICAL  
ORGANIZATION



# The PPP Surface based in situ met network in Switzerland

- Quality Assessment using METEO-Cert: The MeteoSwiss Classification Procedure for Automatic Weather Stations (IOM Report-No. 126), 2017
- Chapter 7 “Guidance on WIGOS Data Partnerships” in the Guide to the WMO Integrated Global Observing System (WMO-No. 1165), updated 2021
- WMO Compendium of Good National Practices for Public-Private Engagement: MeteoSwiss-MeteoGroup partnership for data sharing, 2020

*win win vs run the business*

@ lower overall costs

@ known QA (fit-for-purpose)

Continuously improving



*Run the business OK, and what about PPP vs*  
*CHANGE the business*

# The «raison d'être» for pollen monitoring...

...and a paradigm change

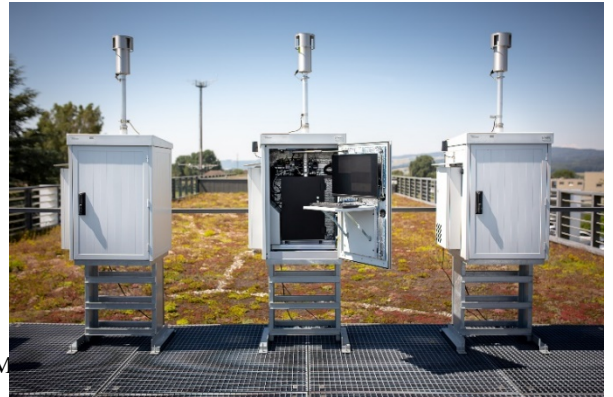
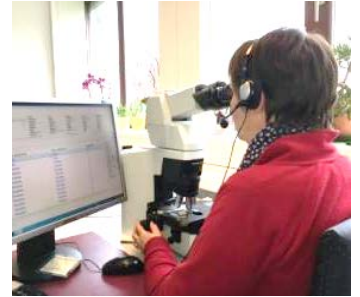


Pollen monitoring networks were first started by **medical doctors** as...

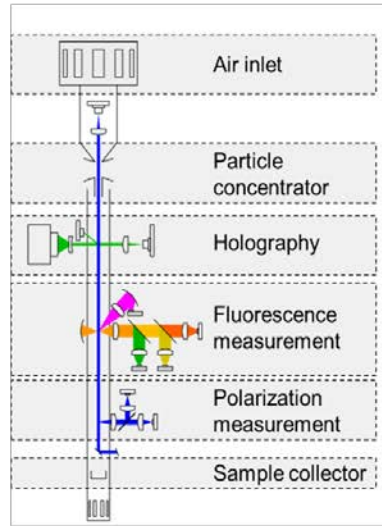
...allergies **increased dramatically** over the past decades, affecting more than **100 million Europeans**...



...costing an estimated **€50-150 Billion/year** in Europe alone for direct and indirect health costs.



# SwissPollen: real-time pollen monitoring network



Two images at 90° from each other

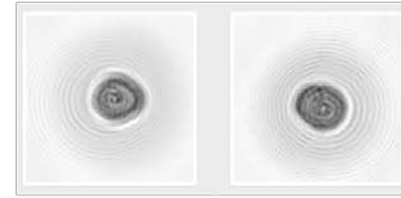
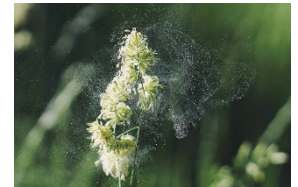


Image classification using  
Deep Learning algorithm

Taxa prediction (e.g. Grass Pollen)

**Technology: in-flight identification** of pollen grains using digital holography

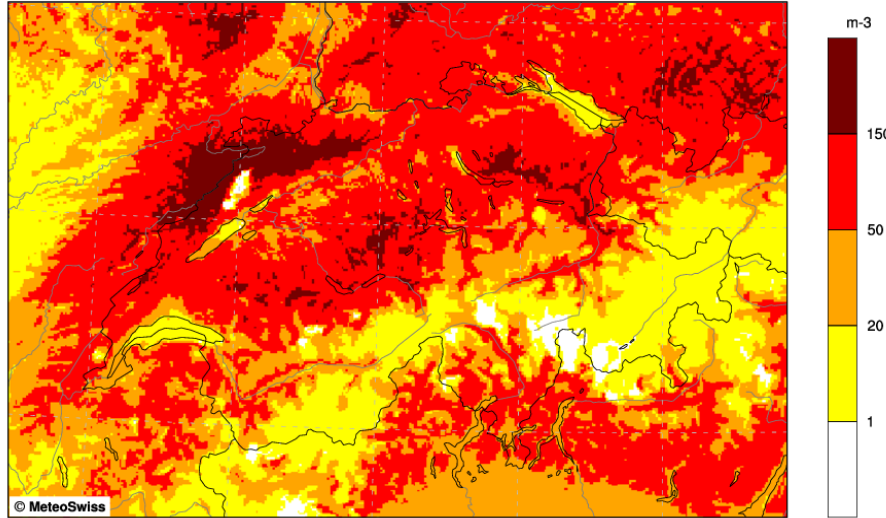




# SwissPollen: an end-to-end real-time pollen information system

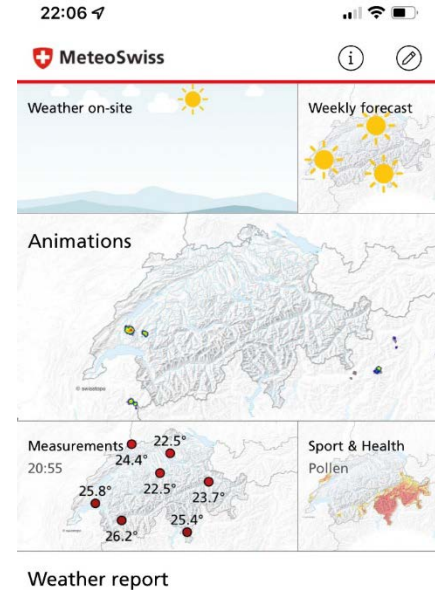
COSMO-1E ENSEMBLE\_FORECAST  
Grass Pollen Concentration (CTRL)

Wed 16 Jun 2021 13UTC  
15.06.2021 03UTC +34h



Grass (poaceae) pollen concentration [m-3]

Max: 379.1 m-3



Real-time measurements are **integrated in numerical weather model** to deliver high resolution forecasts: improved information system at **identical running cost**



# PPP as a win win experience vs ...

- ✓ ... run the business
- ✓ ...change the business
- ❖ ...building the future:
  - ❖ Drone and Remote sensing profiling



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# *Toward automatic drone profiling*



M. Hervo, T. Weusthoff, A. Haefele, B. Calpini  
L. Hammerschmidt, J. Pasquier, M. Fengler



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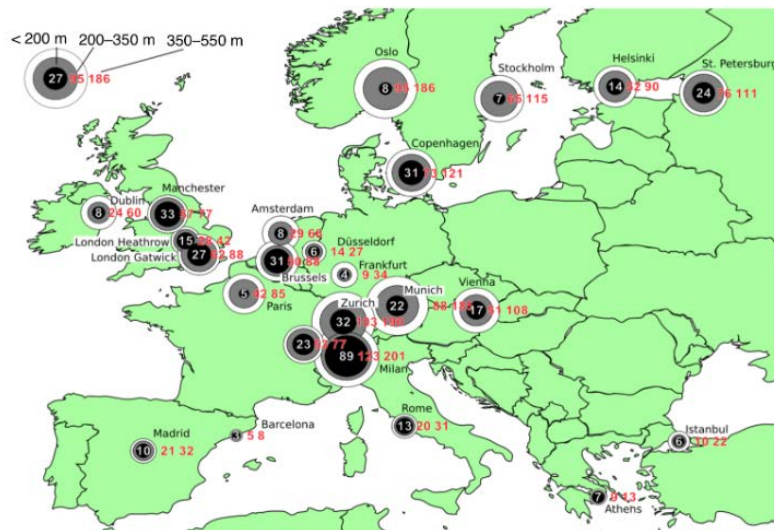


## Why fog needs to be monitored and forecasted ?

- Zurich is the 2<sup>nd</sup> European airport for the number of hours with visibility lower than 350m. (Vajda et al., 2011)
- Fog can double the number of fatalities per 100 car accidents (Duthon et al., 2020)

## How to anticipate fog ?

- NWP struggle to reproduce the timing of fog onset, its spread and its depth (Steenveld et al., 2016)



Hours per year of low visibility at some European airports (Vajda et al., 2011)

# Are Meteorodrone observations fit-for-purpose ?



# Long-term PPP

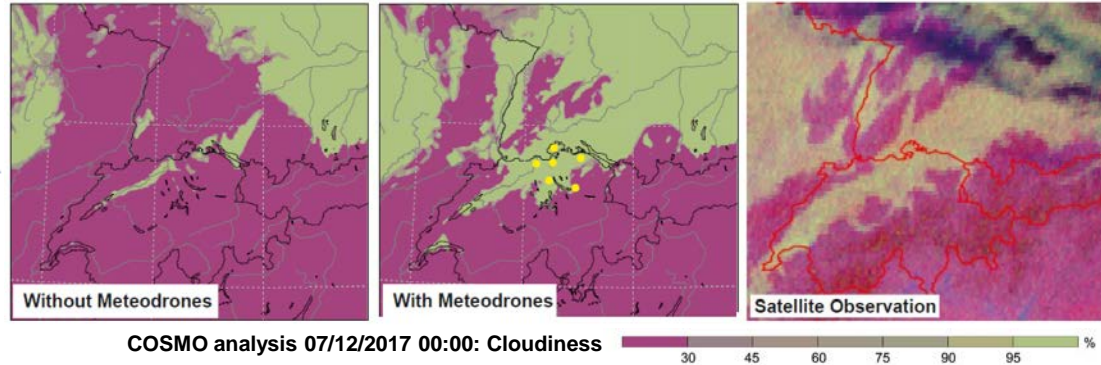


Swiss Confederation  
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- 2014: Testing prototypes at Payerne
- 2017: Drone Enhanced Terminal Aerodrome Forecasts (DETAf)
- 2020: Improving High-Impact Numerical Weather Prediction with Lidar and Drone Observations

**BAMS**  
Article  
Leuenberger et al.



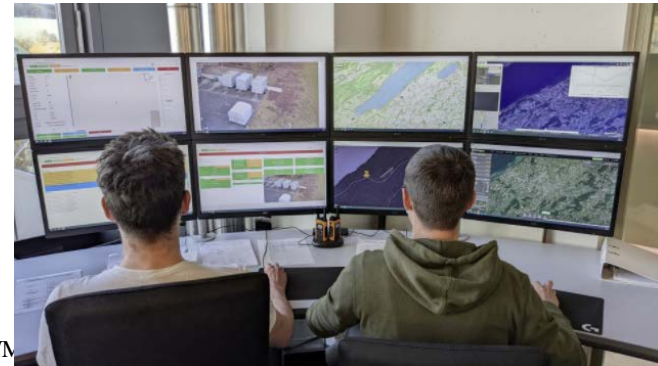
- 2022: 6 months operational proof-of-concept





# 6-months operational proof-of-concept

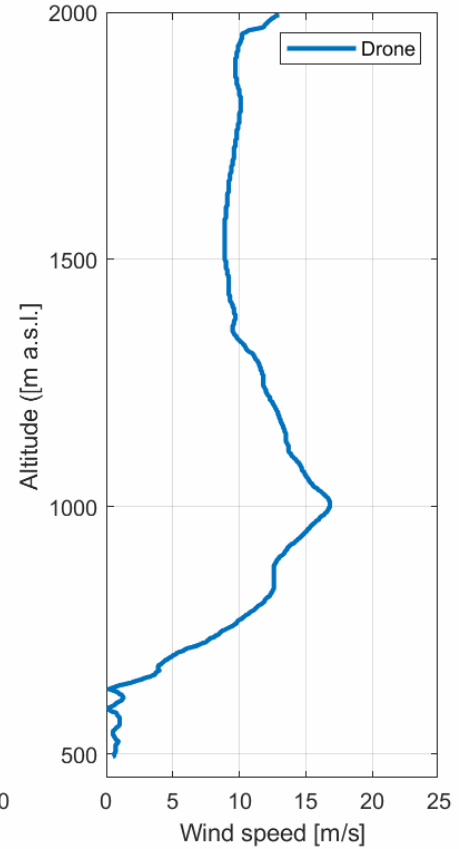
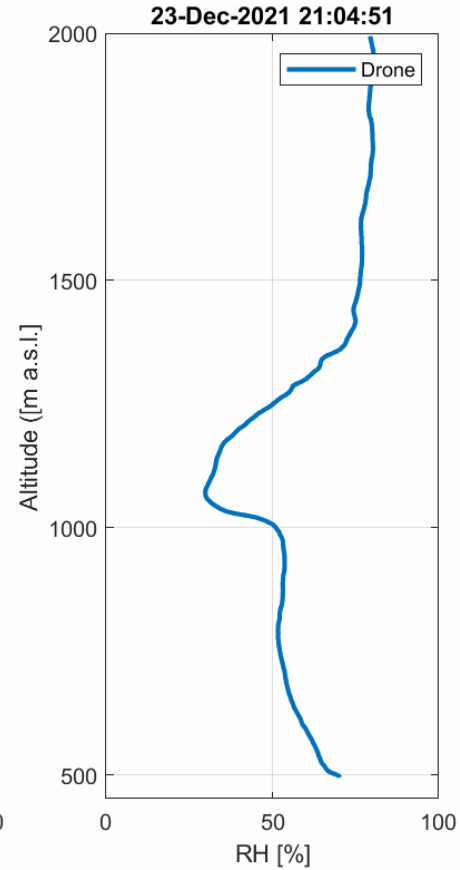
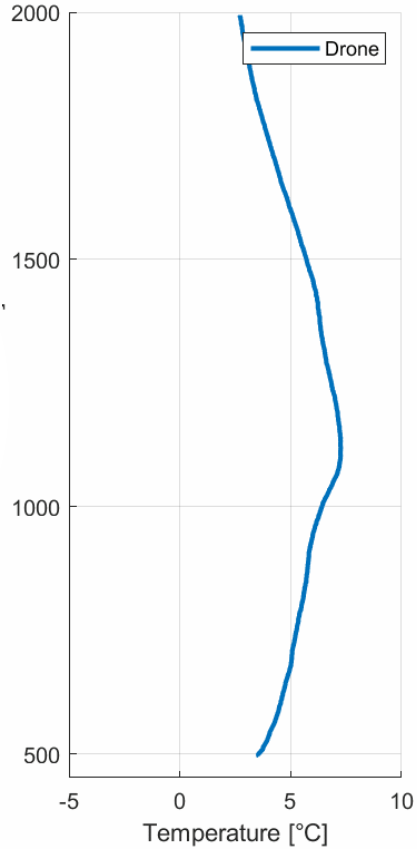
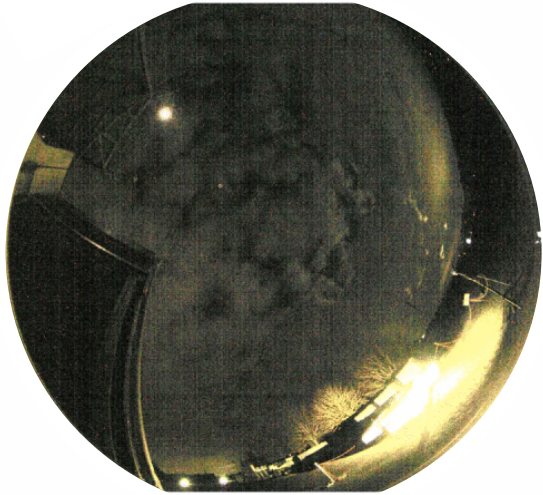
- At least 8 flights per night, except during week-ends
- Autopilot
  - Automatic take-off, flight, landing
  - Meteobase automatic opening and drone charging
- Manual remote verification (200km)





# Flight pattern

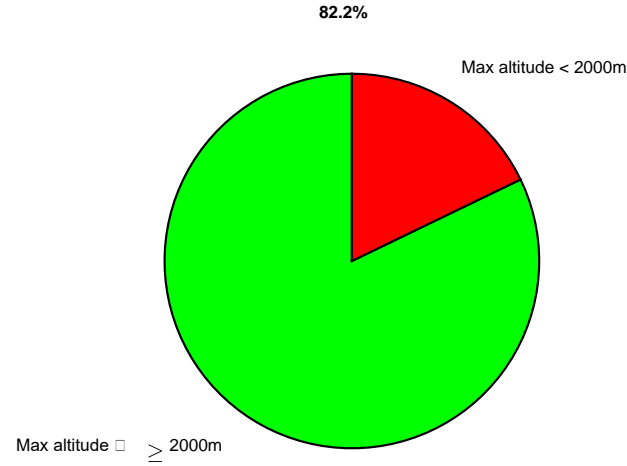
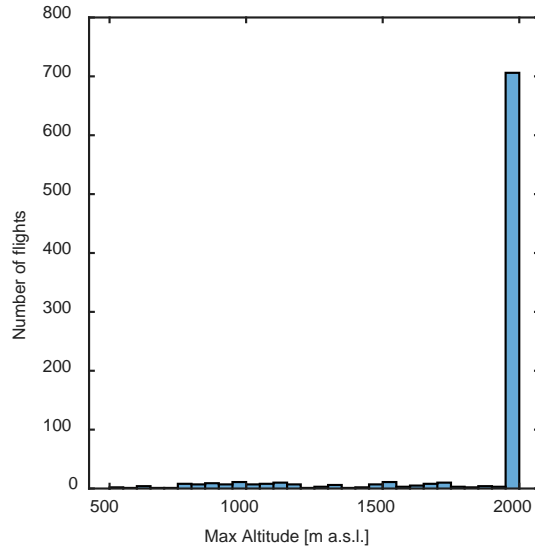
23-Dec-2021 21:01:03







# Altitude of the flights

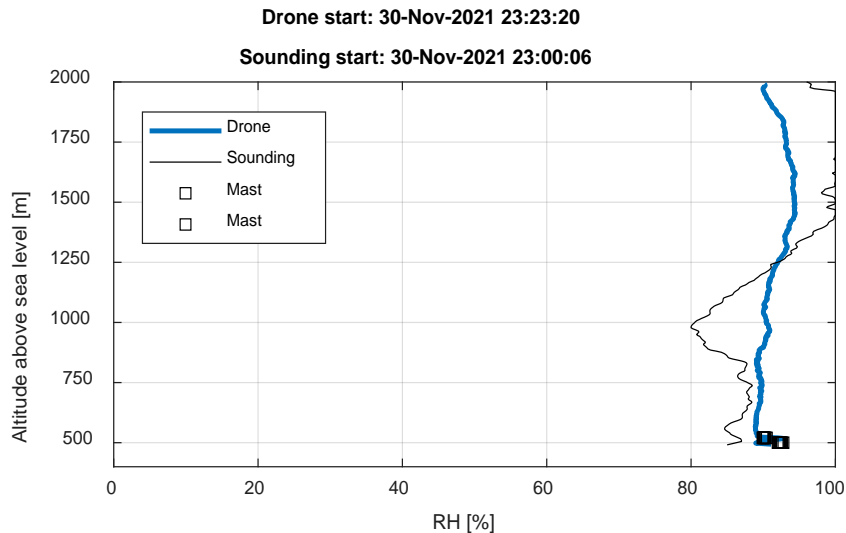


- Drone can fly with winds up to 90km/h, in precipitation and icing conditions
- 82% of the flights reached 1500 m above ground (~2000 m above sea level)
- Flights were interrupted in case of bad weather conditions



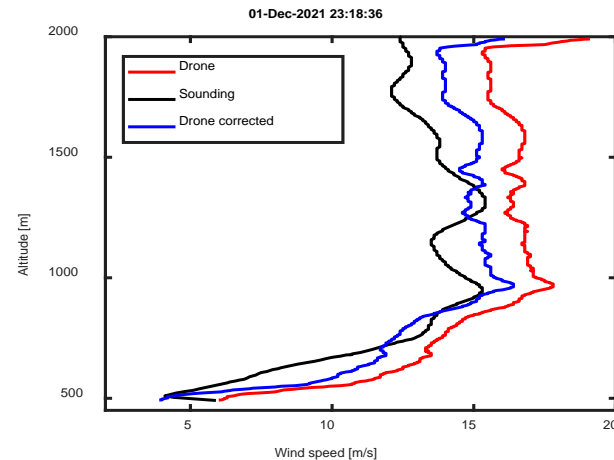


# The main improvements



## High humidity:

- At the beginning of the campaign, humidity never reached 100% because of defective sensor
- Strong improvement after replacement of sensor



## Wind speed:

- Wind speed over-estimation
- Not a measurement with wind sensor (no anemometer) but wind is derived from the energy used to keep the drone on track
- Meteomatics working on algorithm improvement



# Quality evaluation



	Goal	Breakthrough	Threshold	MeteoDrone
<u>Atmospheric temperature</u>	0.5 K	1 K	3 K	0.68K
<u>Specific humidity</u>	2%	5%	10%	8.3%*
<u>Wind speed (horizontal)</u>	1m/s	2m/s	5m/s	3.12m/s



\*8 profiles with technical problems excluded



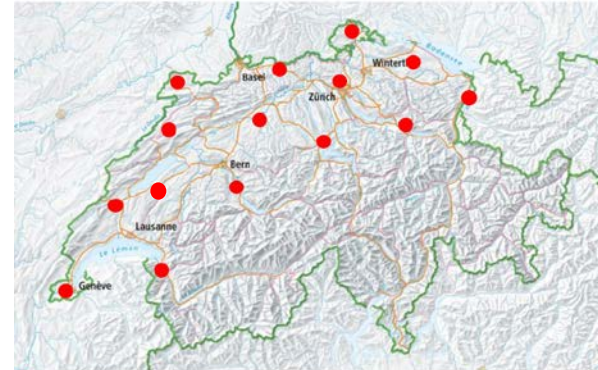
# Perspectives

- Preparing for WMO UAS (2024)
- MeteoSwiss NWP assimilation
- Drone Network deployment DETAF 2.0
- MCH Payerne + Meteomatics PPP
- On-demand Meteodrone profiling?



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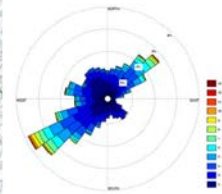
World Meteorological Organization  
Uncrewed Aircraft Systems  
Demonstration Campaign  
March - August 2024



● MeteoBase

## DETAF 2.0

→ Improving weather forecasts across Switzerland



Wind Speed > 2 m/s



# PPP as a win win experience vs ...

- ✓ ... run the business
- ✓ ...change the business
- ✓ ...building the future

**But PARTNERSHIP means...**  
**...ENGAGEMENT on both side**  
**(NO off-the-shell solution)**





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