# User Consultation 2023

## Flugwetter MeteoSchweiz

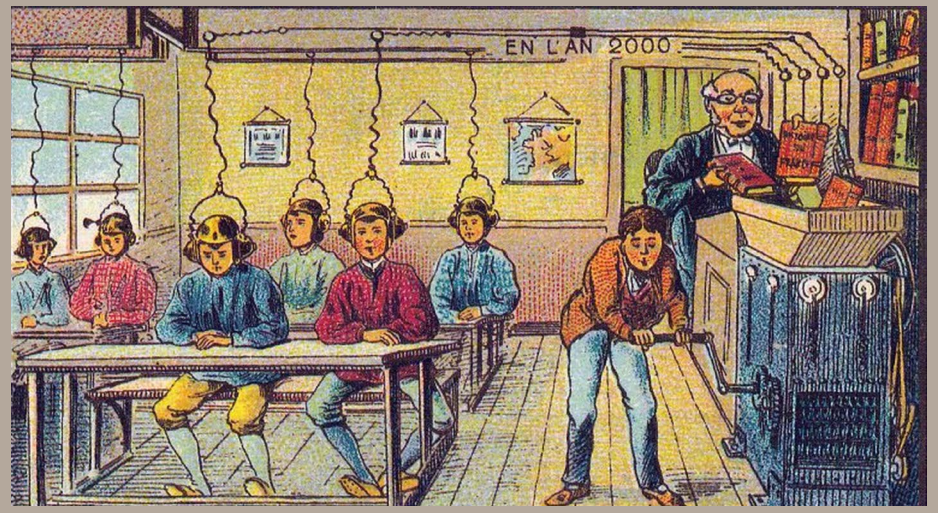
# Opening

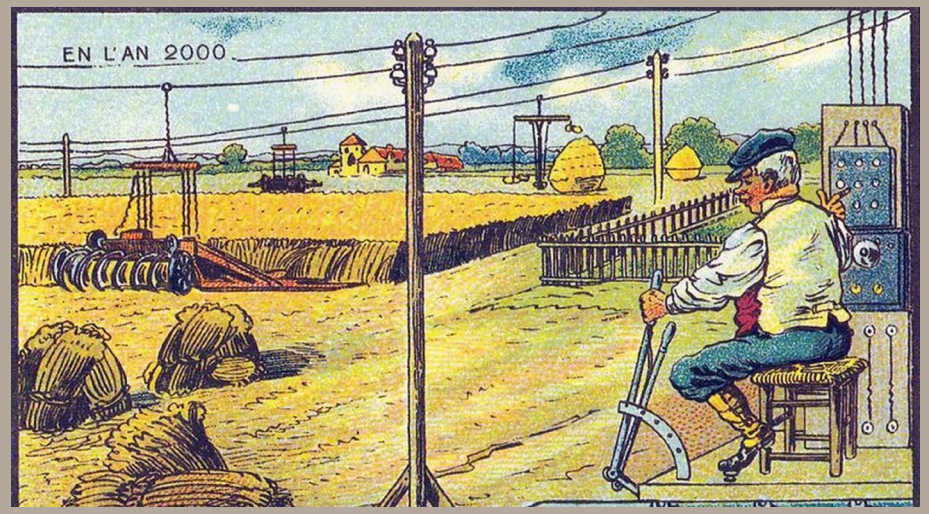
## «from vision to action»

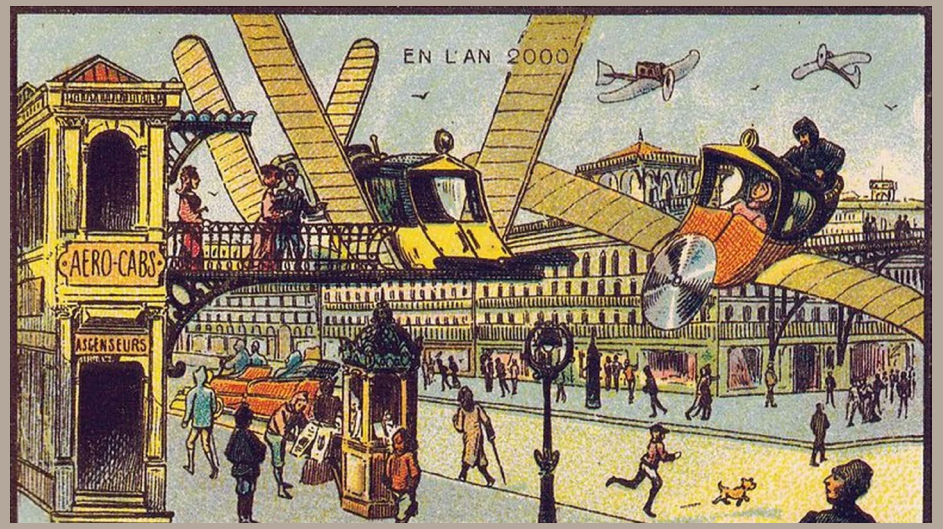
Markus Aebischer

Head of Key Account Management and Distribution

# «from vision at that time…»





quelle: preconstruct / high level photog

# «from today's vision…»


Information Management & Architecture

Vision 2020-2035 for a skyguide-MeteoSwiss Weather Data Exchange Service

version/lang. 1.1/E
status Released
date of issue 2021-09-23


Vision

ZRH³
Zurich is the most integrative airport system in Europe by 2030.

Zurich Airport · SWISS · skyguide · swissport · dnata · AAS Airline Assistance Switzerland · MeteoSchweiz · AOC zurich airport

**Letter of Intent**
Collaboration on the development of a cross-stakeholder Airport Operations Plan (AOP)

**Intention**

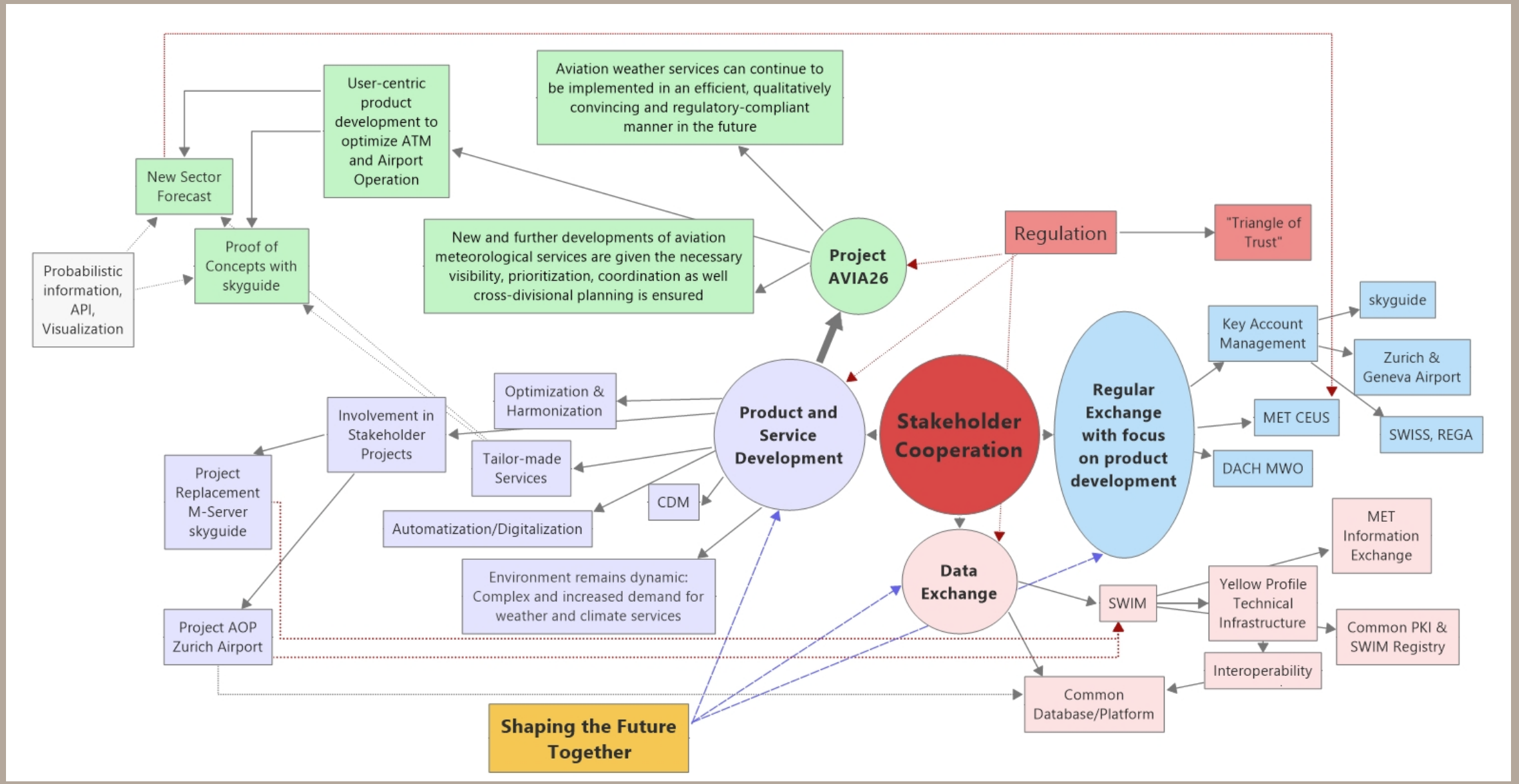
SWISS, skyguide and Flughafen Zürich AG (FZAG) have expressed their intention to intensify their cross-company operational collaboration by establishing the common vision "ZRH³ - Zurich is the most integrative airport system in Europe by 2030", adopted at the COO Summit in January 2020. Their main goals are to strengthen the cross-company collaboration in the operational area, increase efficiency of the ZRH airport system and optimize the overall economic efficiency via the development of a common approach to a holistic data strategy, which requires a bi-directional exchange of data among the airport system partners and proactive approach to new potentials.

In parallel, the European Commission has issued the coordinated and synchronous introduction of operational changes for air traffic management in the European network by creating legally binding frameworks such as the ATM Master Plan and the Common Project 1 Regulation (CP1). The implementation of an Airport Operations Plan (AOP) is required in two phases by 31.12.2023 (initial AOP) and 31.12.2027.

To meet the regulatory requirements as well as to reach the common vision, SWISS, Skyguide and FZAG have agreed on the stepwise development of a local AOP under the leadership of FZAG and with the involvement of additional local airport partners: Swissport, dnata, AAS, Federal Office of Meteorology and Climatology (MeteoSchweiz) and Airline Operators Committee (AOC).

*We are the reliable partner for data and services on weather and climate. We are innovative, progressive and agile. For our future. For Switzerland.*

# «…to action»

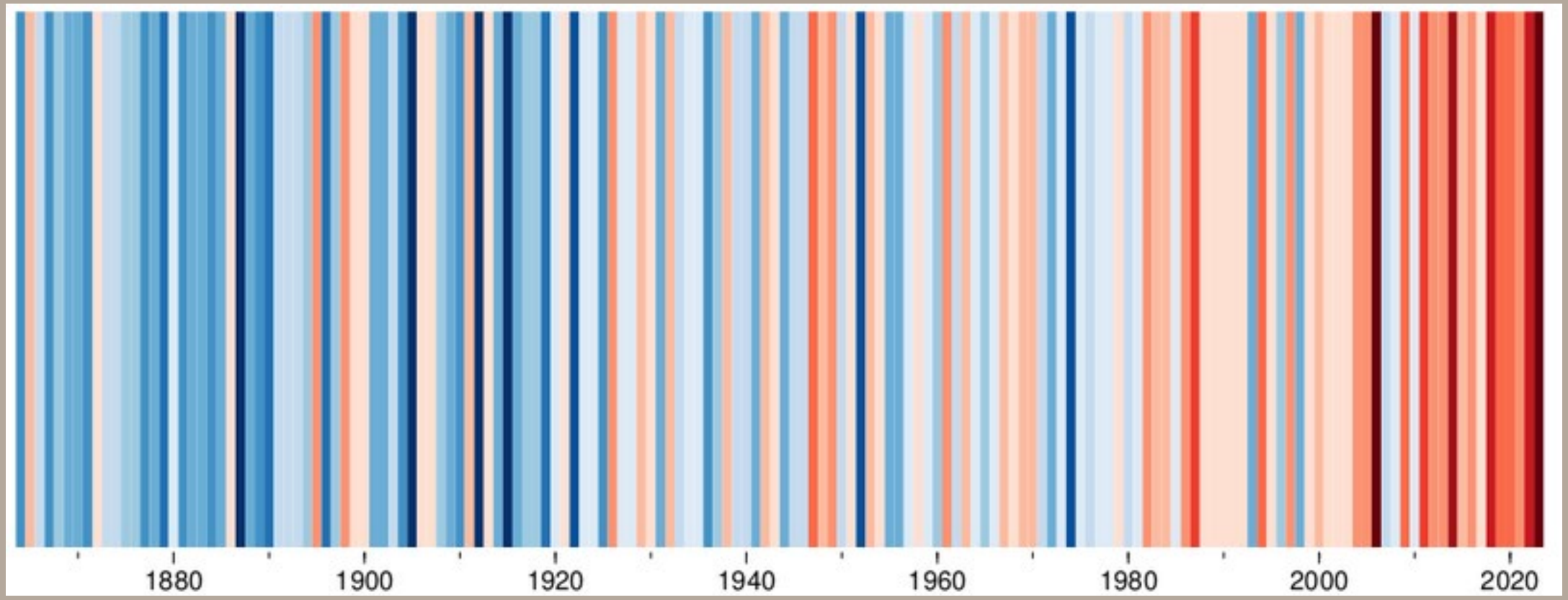

User-centric product development to optimize ATM and Airport Operation
Aviation weather services can continue to be implemented in an efficient, qualitatively convincing and regulatory-compliant manner in the future
New Sector Forecast
Proof of Concepts with skyguide
Probabilistic information, API, Visualization
New and further developments of aviation meteorological services are given the necessary visibility, prioritization, coordination as well cross-divisional planning is ensured
Project AVIA26
Regulation
"Triangle of Trust"
Optimization & Harmonization
Involvement in Stakeholder Projects
Tailor-made Services
CDM
Automatization/Digitalization
Product and Service Development
Stakeholder Cooperation
Regular Exchange with focus on product development
Key Account Management
skyguide
Zurich & Geneva Airport
SWISS, REGA
MET CEUS
DACH MWO
Project Replacement M-Server skyguide
Project AOP Zurich Airport
Environment remains dynamic: Complex and increased demand for weather and climate services
Data Exchange
SWIM
Yellow Profile Technical Infrastructure
MET Information Exchange
Common PKI & SWIM Registry
Interoperability
Common Database/Platform
Shaping the Future Together

# Welcome

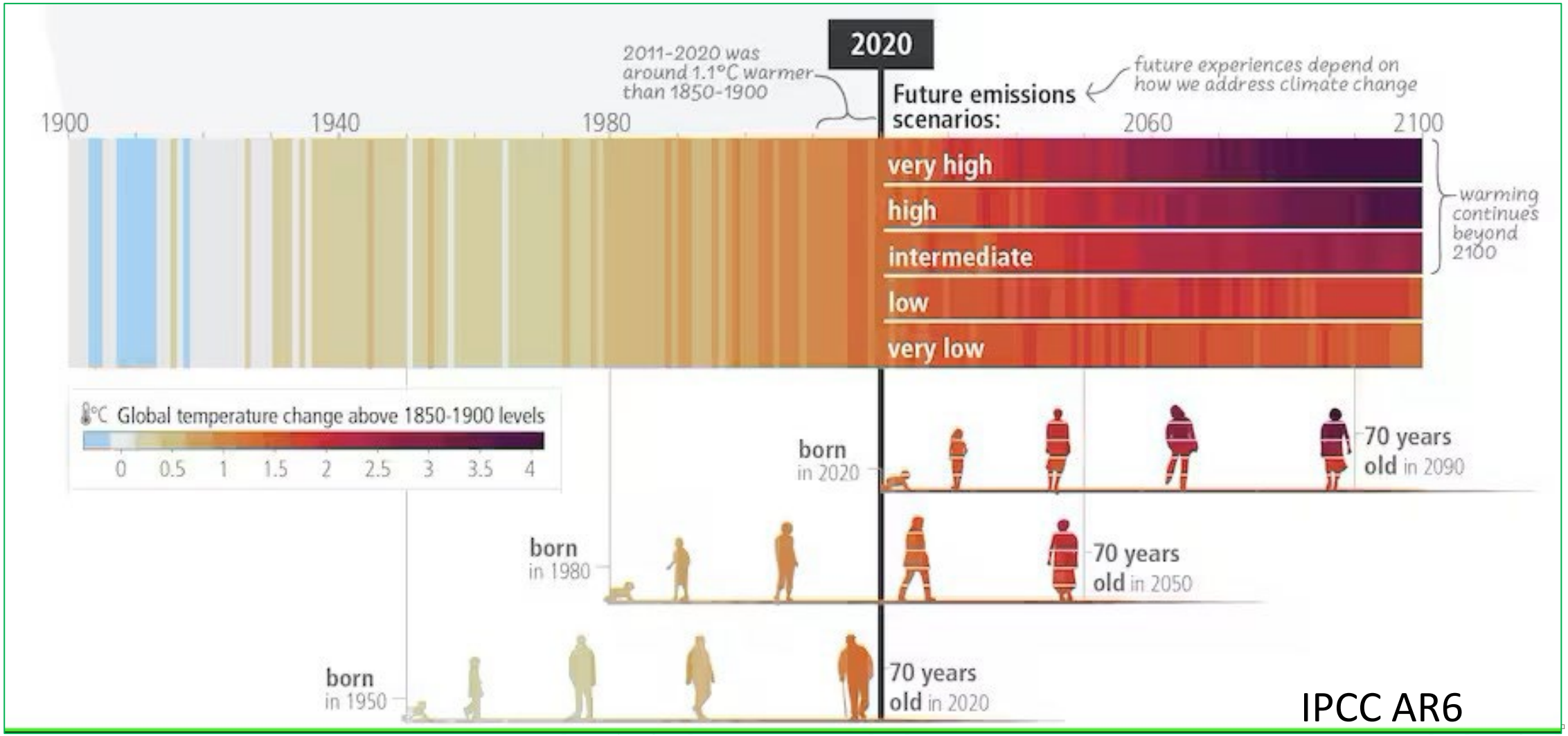
## «our contribution to the future development of aviation services»

Christof Appenzeller
Director

# Temperature in Switzerland (autumn mean)



# Observed and possible future

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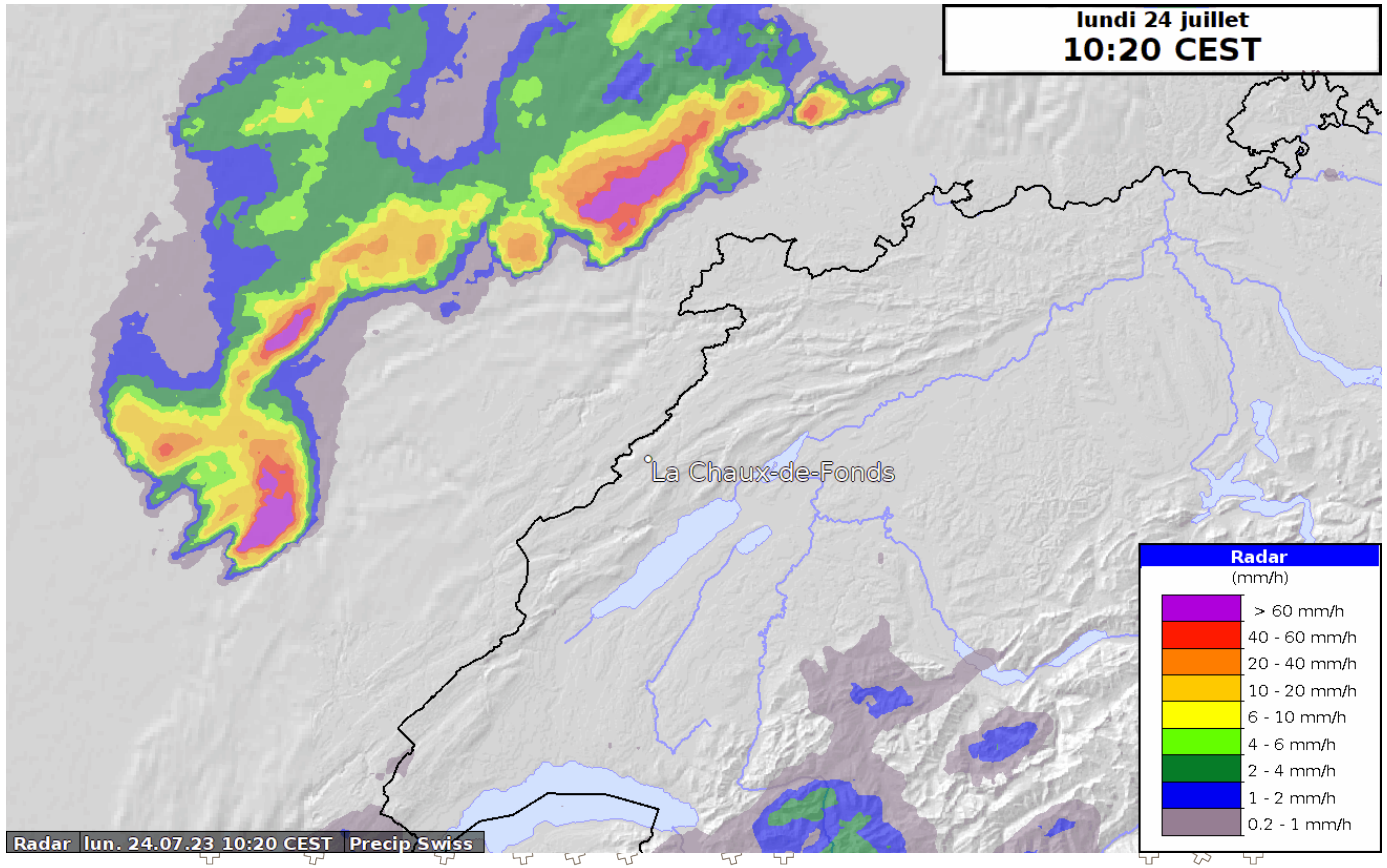
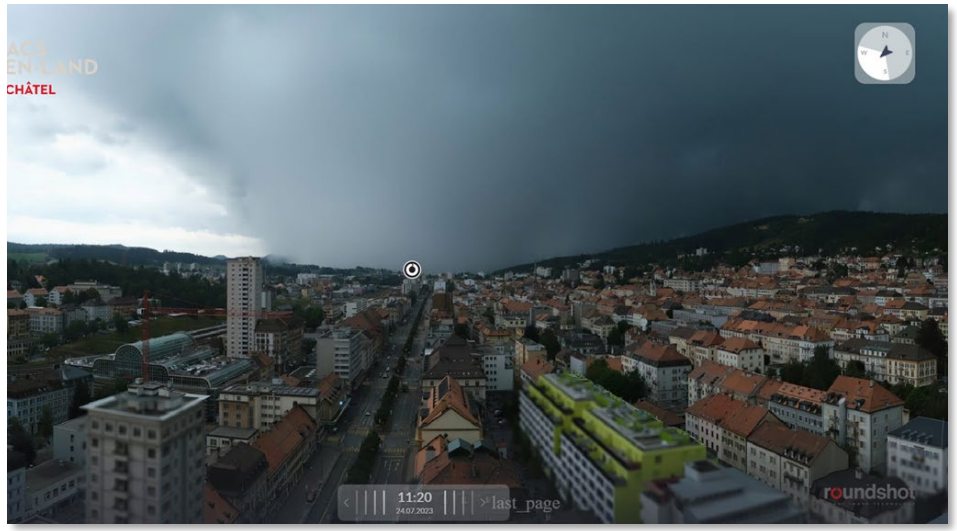
# Thunderstorm La Chaux-de-Fonds 24.07.2023

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# Social relevance and significance



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# MeteoSwiss strategy






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# Climate change – Mitigation & Impact


## Impact on aviation

**Figure 17** / Summary of the principal climate change impacts on aviation

| Climate Effect | Aviation Impact |
|---|---|
| **Temperature** | |
| Europe continues to warm more quickly than the global average: Scandinavia more in Winter, southern Europe in Summer. | Aircraft performance<br>Seasonal and geographical changes in tourism demand patterns<br>Heat damage to infrastructure |
| **Changes to Rain & Snow Patterns** | |
| Less snow overall, but heavier events<br>Less rain in the South, more in the North<br>More heavy rainfall events | Delays and cancellations<br>Flooding of airports and access routes<br>Change in snow clearance needs |
| **Changes to storm patterns** | |
| More uncertainty in the climate modelling here, but increase in frequency of strong and damaging storms | Delays, re-routing, increased fuel burn<br>Loss of en route capacity<br>Convective weather affecting multiple airports simultaneously |
| **Sea Level** | |
| Over longer term, sea level rise<br>Uncertainty over storm surges | Permanent or temporary loss of airport capacity, infrastructure and access.<br>Network disruption |
| **Changes to wind patterns** | |
| Change in jet stream strength, position and curvature<br>Shifts in prevailing wind direction<br>Increase in extreme wind speeds in North and centre. | Increase in clear air turbulence<br>Increased variability in trans-Atlantic times and routes<br>Crosswind changes affecting airport capacity<br>Operational disruption |

Source: EUROPEAN AVIATION IN 2040 - CHALLENGES OF GROWTH - ADAPTING AVIATION TO A CHANGING CLIMATE, EUROCONTROL

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# MeteoSwiss business cycle


MeteoSwiss

# Regulation and development of services

## (EU) 2021/116 (CP1) of 1 February 2021

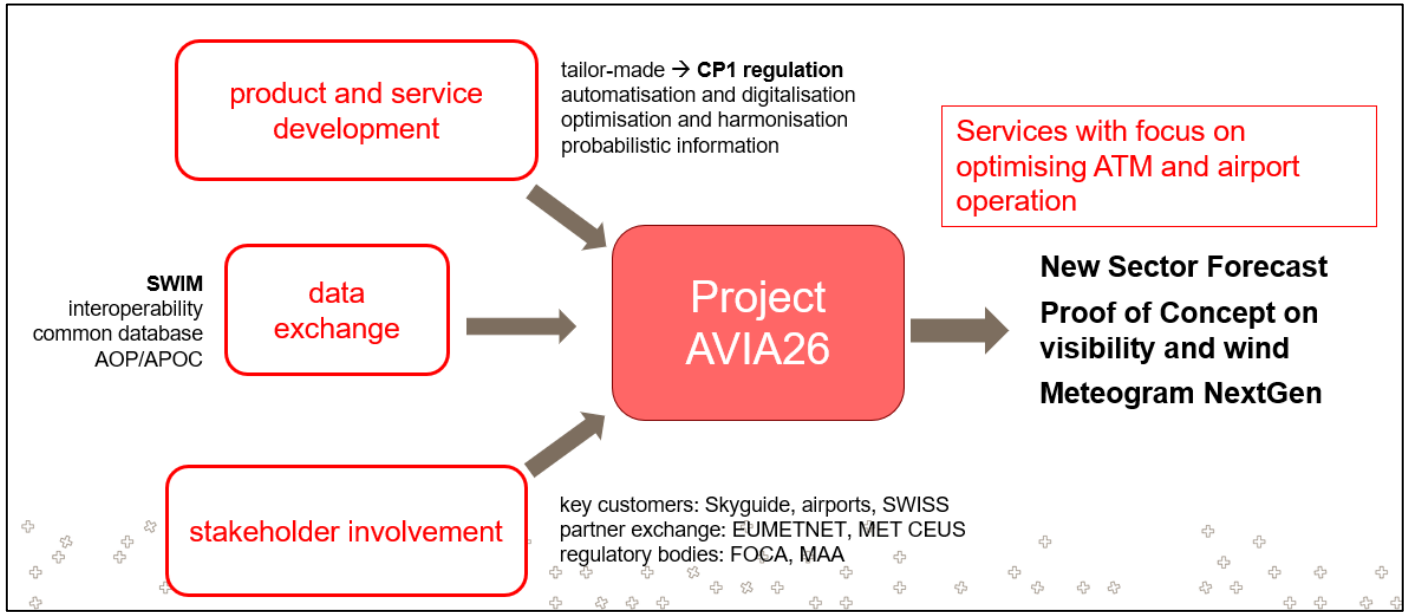
The SWIM-functionalities, -infrastructure components and -advanced meteorological information services are to be provided and operated by the end of 2025. These are prescribed in the regulation as follows:

- AF 5: SYSTEM WIDE INFORMATION MANAGEMENT
  - 5.1.1. ATM sub-functionality on Common infrastructure components

  (SWIM-Registry and Common Public Key Infrastructure)
  - 5.1.2. ATM sub-functionality on SWIM yellow profile technical infrastructure and specifications
  - 5.1.4. ATM sub-functionality on Meteorological information exchange

  (Exchange of certain MET information through the application of SWIM services using SWIM TI yellow profile).

  → Requirement: Development of ***"new advanced aeronautical meteorological information services"*** providing users with tailored information content with higher accuracy and enhanced functionality, and replacing the current OPMET products in the long term.

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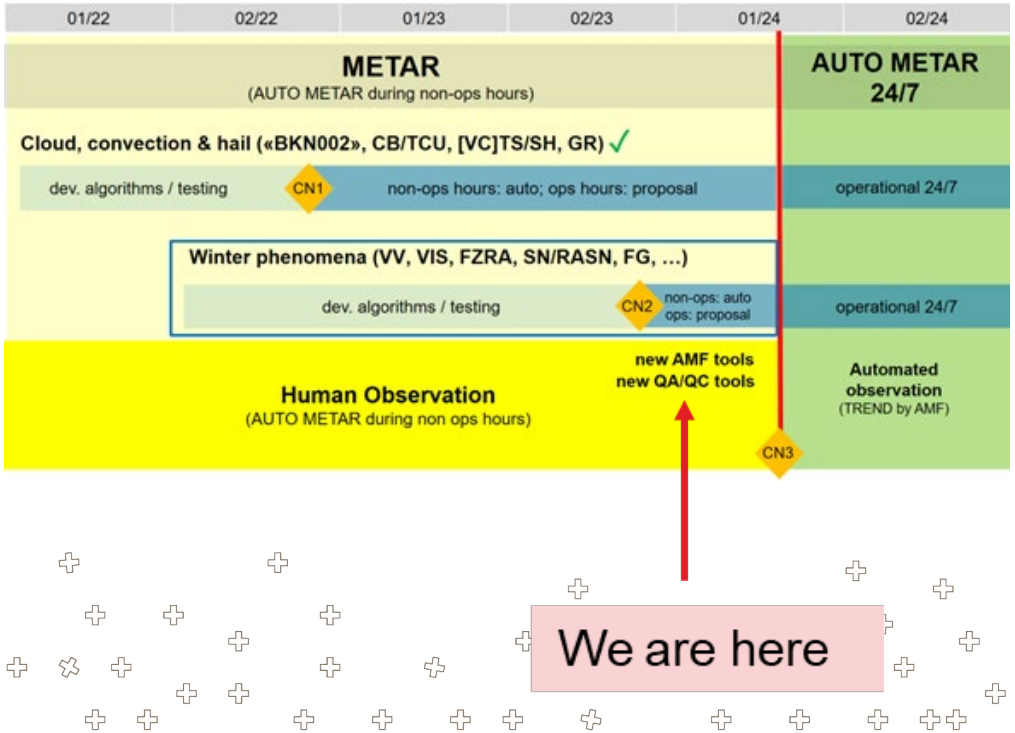
# Automatization: AUTO METAR 24/7

Geneva: ready for final sprint

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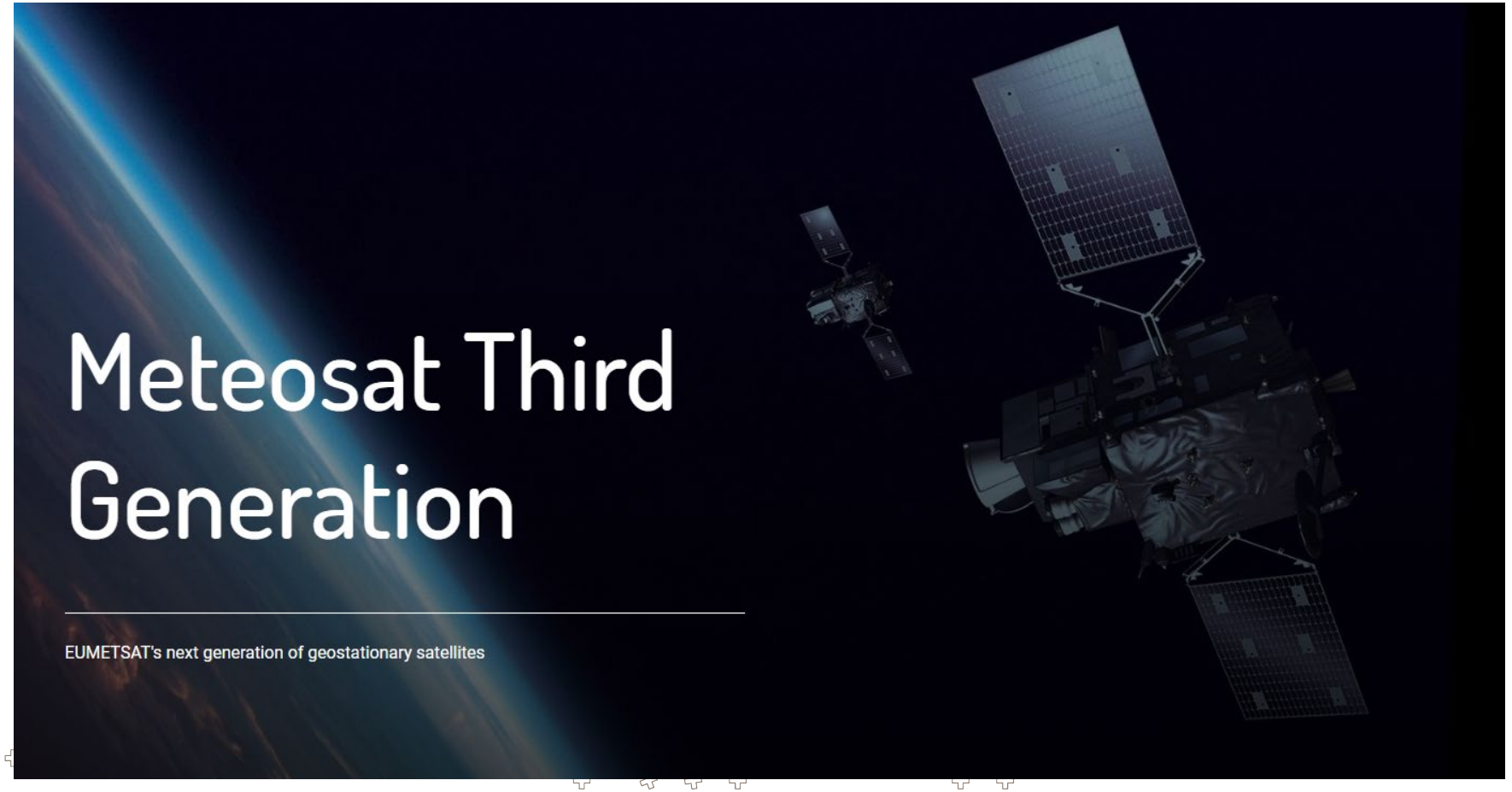
# EUMETSAT:
# New generation of weather satellites

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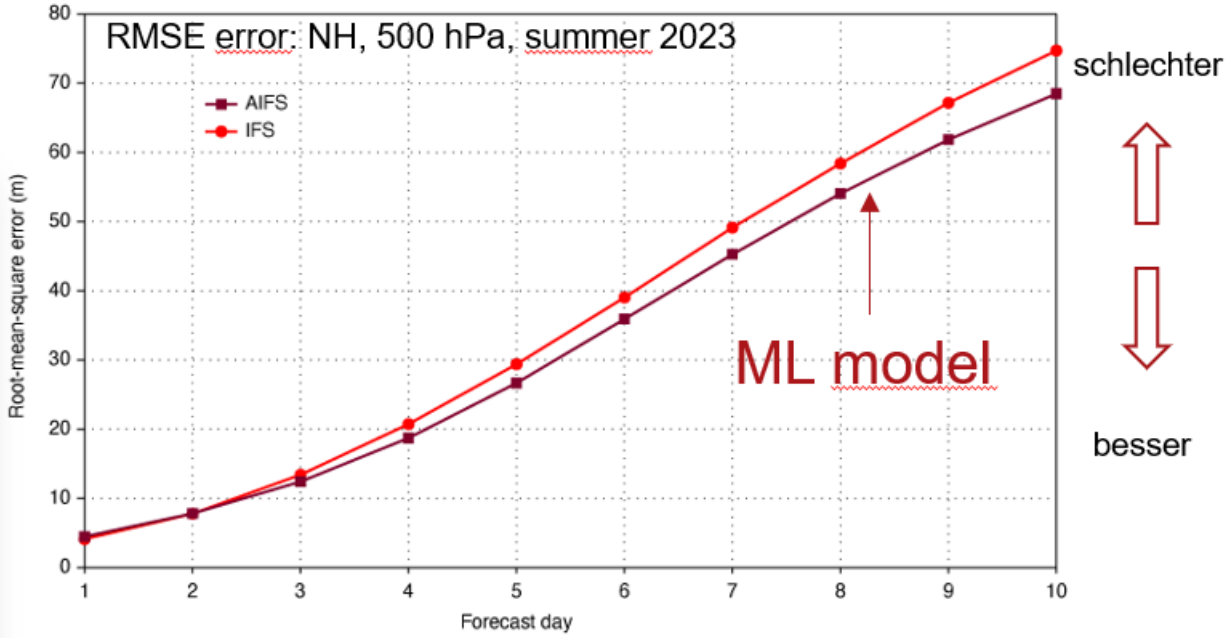
# AI/ML: Revolution in the numerical weather prediction


## ECMWF: neues ML model AIFS

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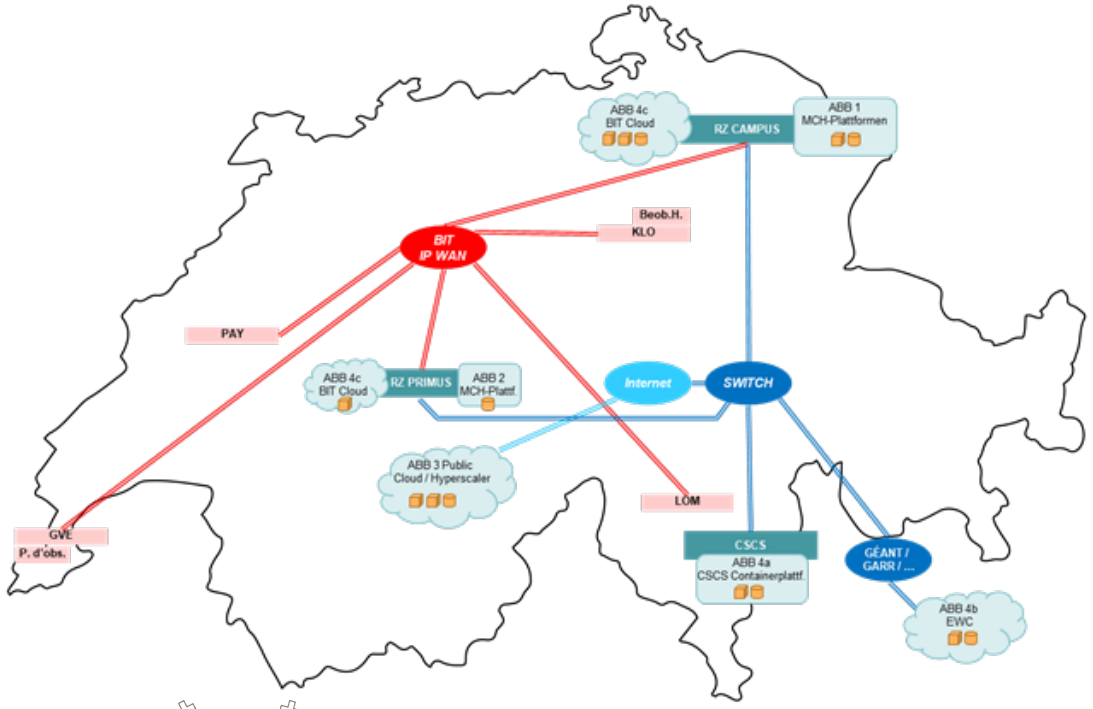
# Computing and data centre

→ Increasing reliability




<u>Program RZPlus</u>

establish geo-redundancy

+

implement cloud strategy

+

provide replacement solution RZ1 ZRH

+

keep IT operations robust

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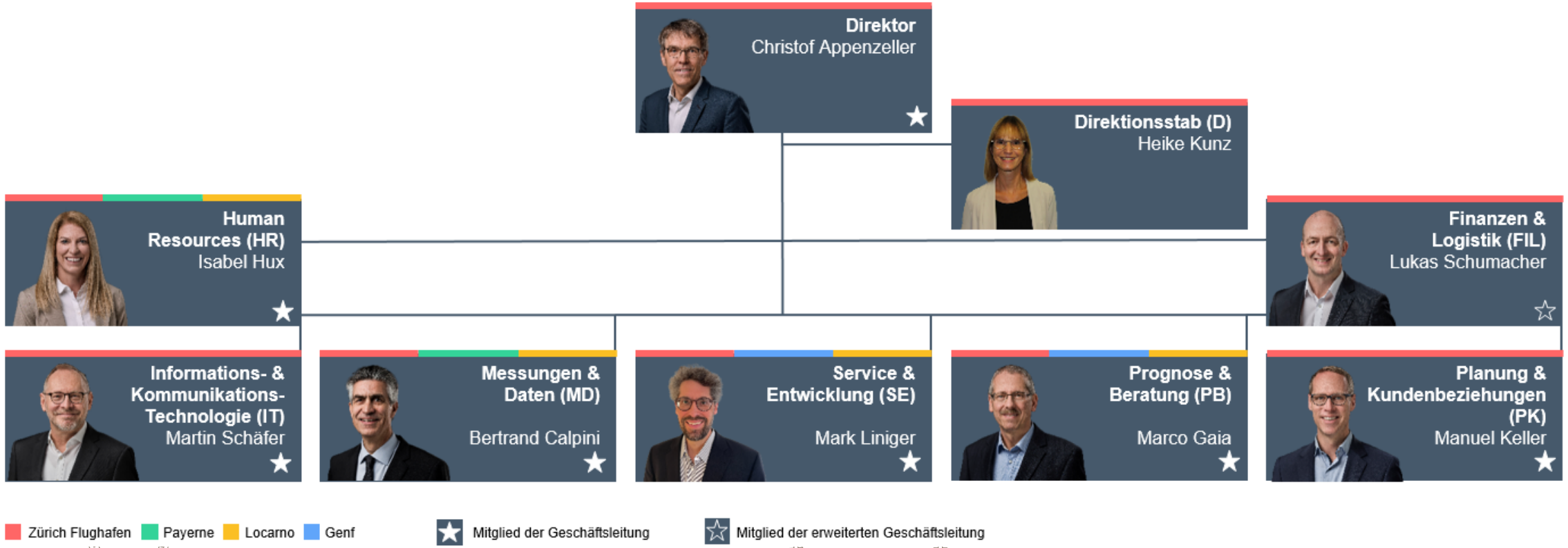
# New organigram

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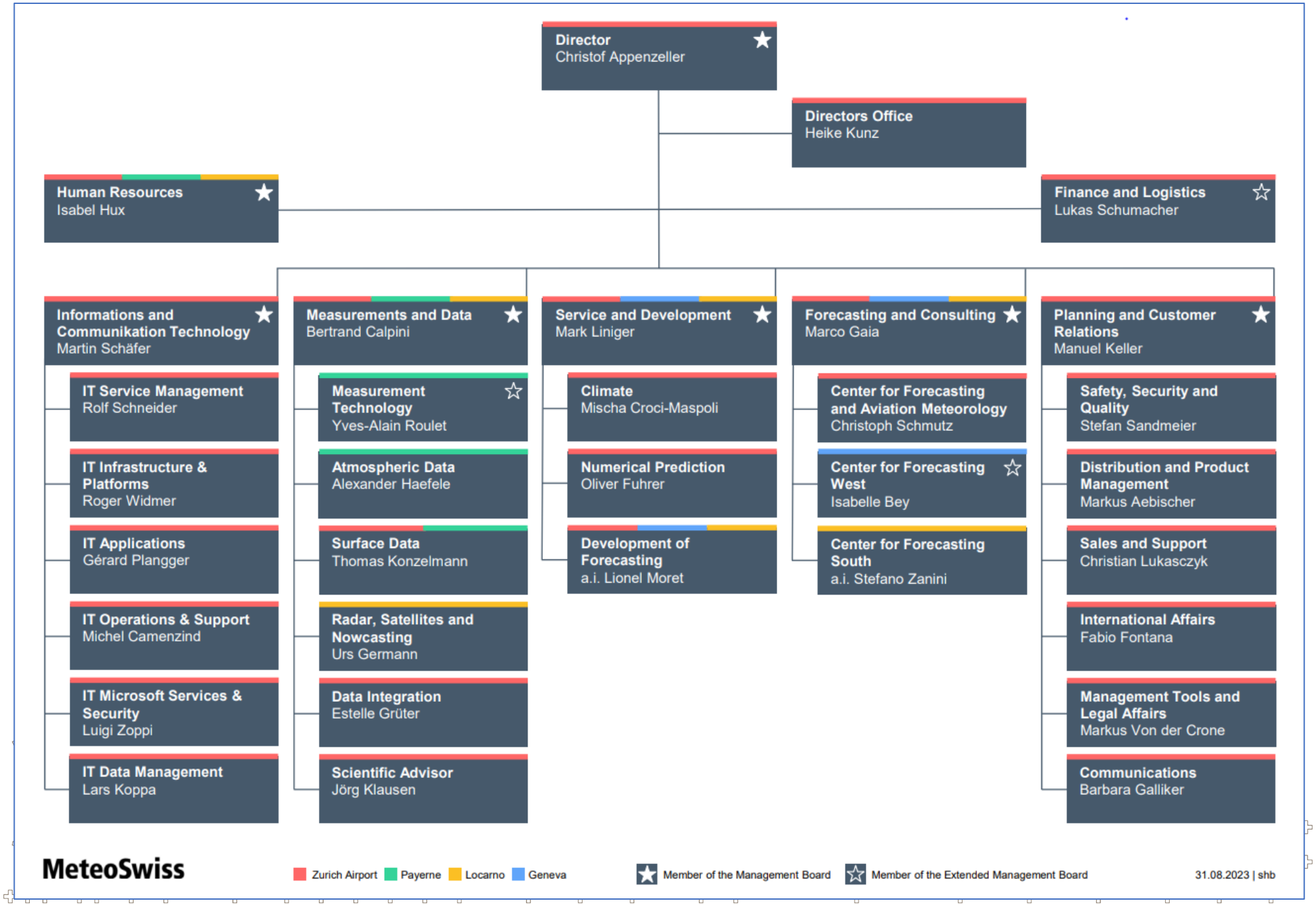
Director
Christof Appenzeller
Directors Office
Heike Kunz
Human Resources
Isabel Hux
Finance and Logistics
Lukas Schumacher
Informations and Communikation Technology
Martin Schäfer
IT Service Management
Rolf Schneider
IT Infrastructure & Platforms
Roger Widmer
IT Applications
Gérard Plangger
IT Operations & Support
Michel Camenzind
IT Microsoft Services & Security
Luigi Zoppi
IT Data Management
Lars Koppa
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Bertrand Calpini
Measurement Technology
Yves-Alain Roulet
Atmospheric Data
Alexander Haefele
Surface Data
Thomas Konzelmann
Radar, Satellites and Nowcasting
Urs Germann
Data Integration
Estelle Grüter
Scientific Advisor
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Numerical Prediction
Oliver Fuhrer
Development of Forecasting
a.i. Lionel Moret
Forecasting and Consulting
Marco Gaia
Center for Forecasting and Aviation Meteorology
Christoph Schmutz
Center for Forecasting West
Isabelle Bey
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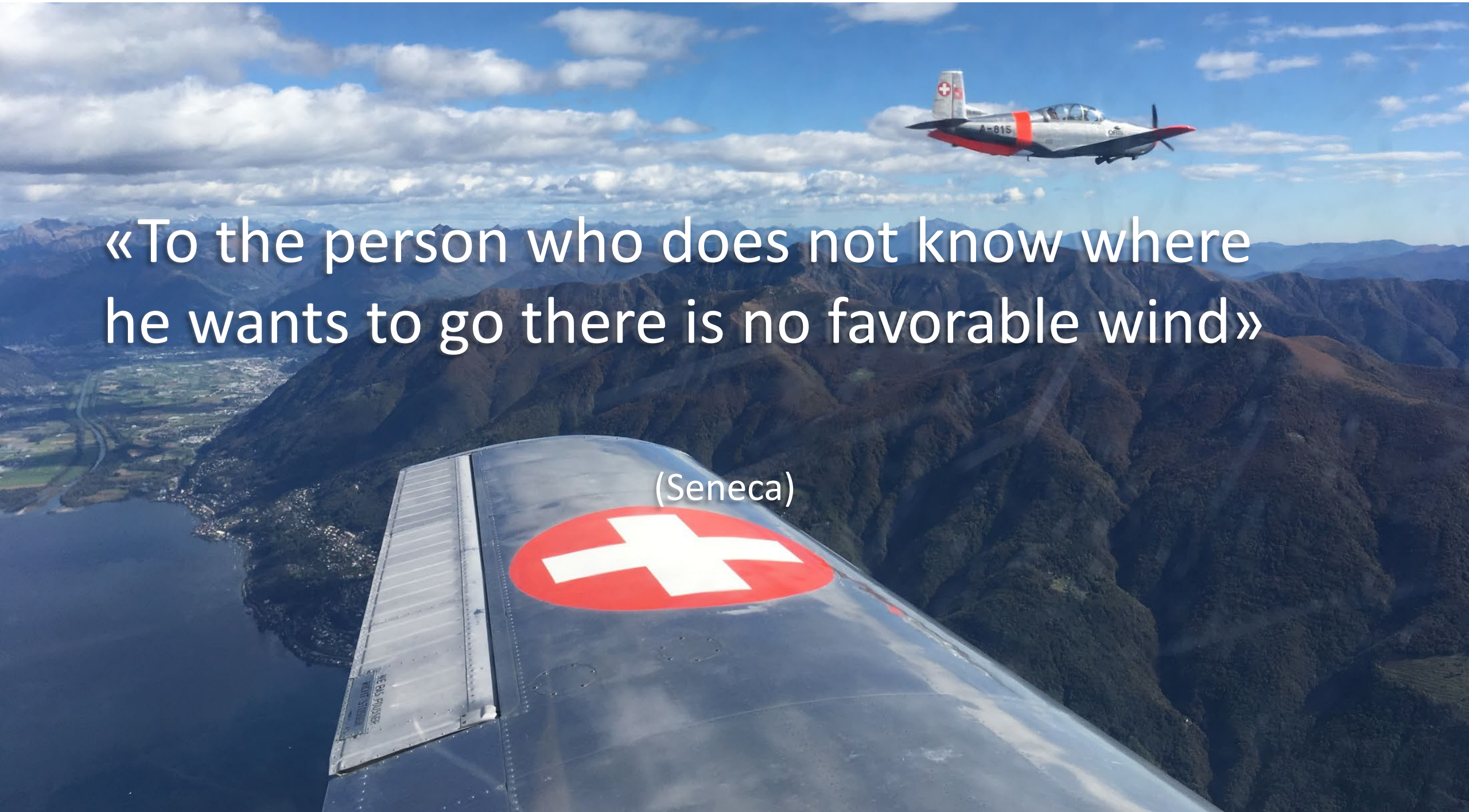
Fabio Fontana
Management Tools and Legal Affairs
Markus Von der Crone
Communications
Barbara Galliker
MeteoSwiss
Zurich Airport
Payerne
Locarno
Geneva
Member of the Management Board
Member of the Extended Management Board
31.08.2023 | shb

# User Consultation 2023

## Flugwetter MeteoSchweiz



«To the person who does not know where he wants to go there is no favorable wind»

(Seneca)

# Agenda

13:50 – AUTO METAR 24/7

14:15 – Project AVIA26

14:50 – Change Management Procedures

15:10 – Coffee break

15:40 – Project e-Sling & Project H2

16:00 – Measurement campaign DD4ZRH

16:25 – MeteoSwiss News

16:45 – Apéro

# AUTO METAR 24/7

Loris Foresti & Sebastian Meier
Project Management

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

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

# AUTO METAR 24/7 @ Geneva

## Ready for the final sprint

14.12.2023

**Project management**: Z. Schauwecker, L. Foresti, S. Meier, I. Bey, B. Calpini
**Scientists**: D. Regenass, P. Juda, S. Balmelli, M. Aregger, F. Vitali, F. Vogt
**Software developers**: N. Tarin Burriel, M. Bibby, P. du Preez,
T. Hanselmann, D. Furrer, S. Réthoré, D. Hässig, P. Senn
**Regulation**: K. Bucher-Studer
**AMO/AMF practice**: L. Cretenoud, E. Thürig, M. Giroud
**Additional support**: M. Boscacci, A. Hering, U. Germann, A. Haefele, E. Grüter
**Cameras, sensors**: T. Konzelmann, L. Cretenoud, Y-A. Roulet

Introduction AUTO METAR

Project AUTO METAR Geneva

Conclusion and Outlook

Introduction AUTO METAR

Project AUTO METAR Geneva

Conclusion and Outlook

# From semi-automatic observation…

Automatic Measurements

SMART

Manual Observation (AMO)

Manual Forecast (AMF)

METAR + TREND

International Distribution (OPMET)

Distribution Customers (Skyguide, Airport, Airlines etc)

SMART

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# …towards a fully automated solution

Extended Automatic Measurements

SMART

AUTO METAR
+
TREND

Manual Forecast
(AMF)

International Distribution
(OPMET)

SMART

Distribution Customers
(Skyguide, Airport,
Airlines etc)

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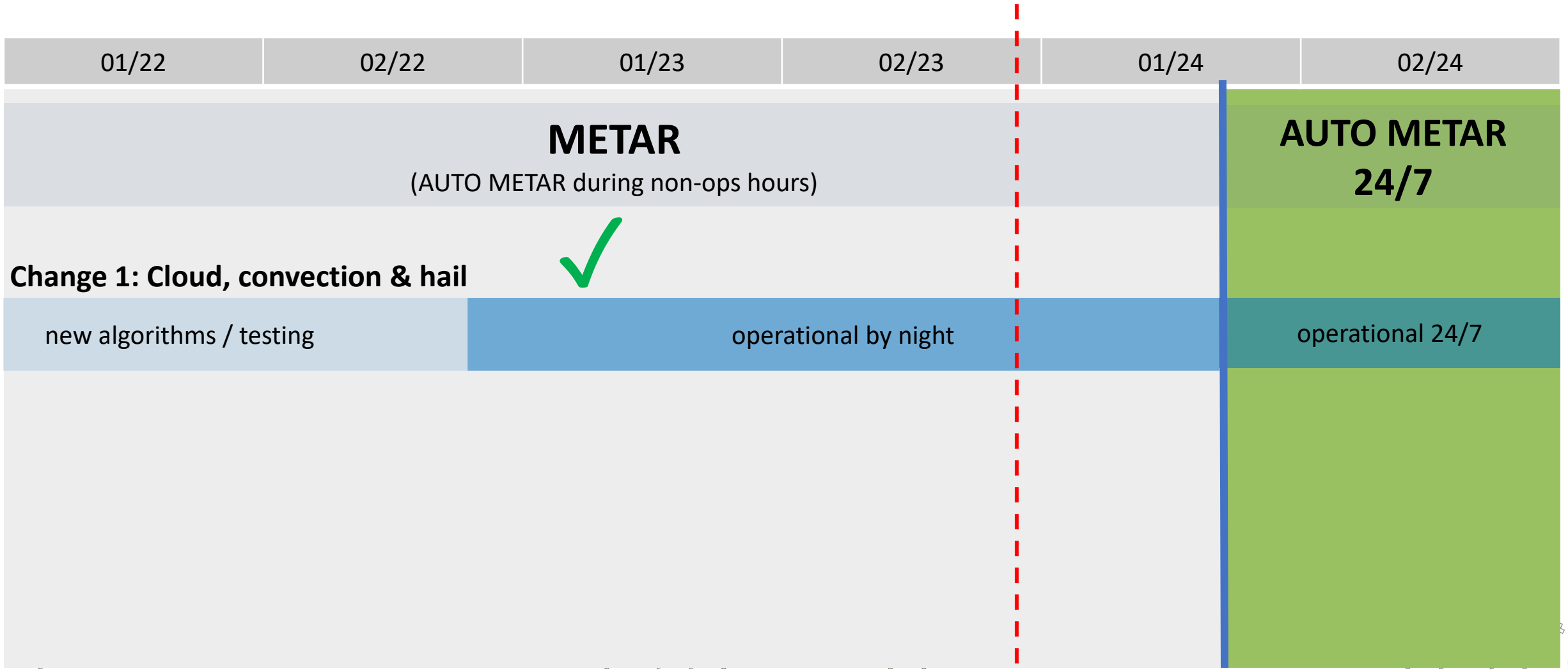
Introduction AUTO METAR

Project AUTO METAR Geneva

Conclusion and Outlook

# Planning: AUTO METAR 24/7 LSGG

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# Change 1: continuously improved

## Cloud amount & height

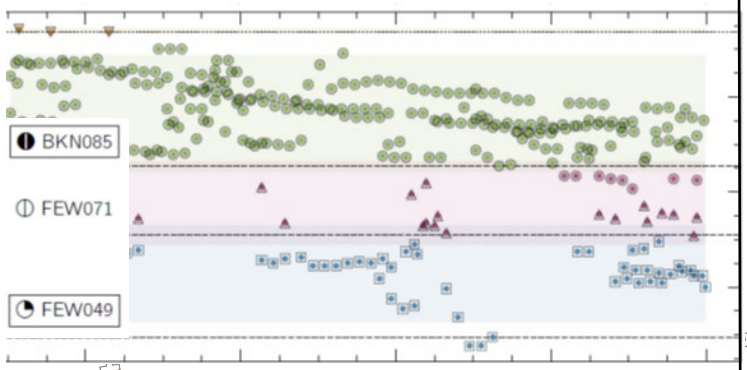
Deployed: 31.10.22

Robust **clustering** of ceilometer cloud base hits

Output examples:

**NCD**

**FEW001 BKN006**

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## Convection

Deployed: 31.10.22

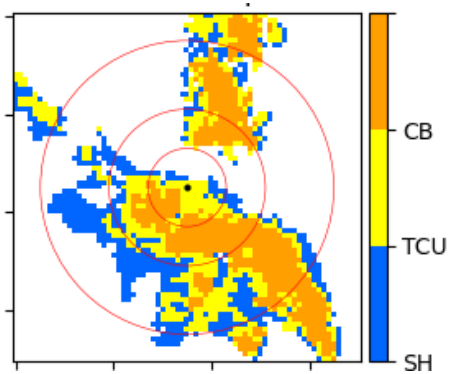
Integration of 3D+2D **weather radar** and lightning data

Output examples:

**VCTS**, **VCSH**

**TS**RA, **SH**RA

FEW///**TCU,** SCT010**CB**




## Hail

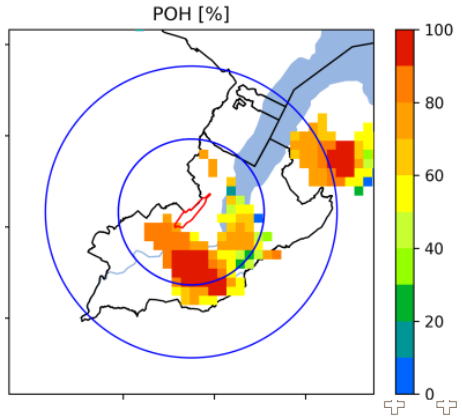
Deployed: 21.02.23

Fully based on **weather radar** (sensors on the way)

Output examples:

TSRA**GR**, -TSRA**GR**

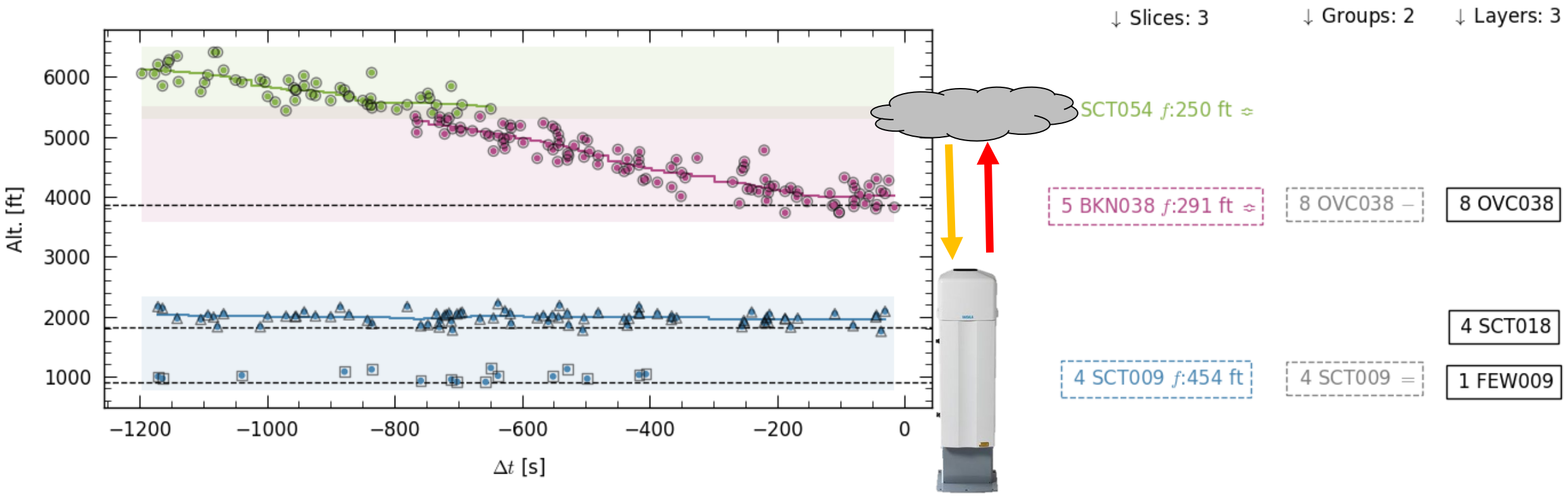
+TS**GR**RA, TS**GR**



# Advanced clustering of ceilometer hits

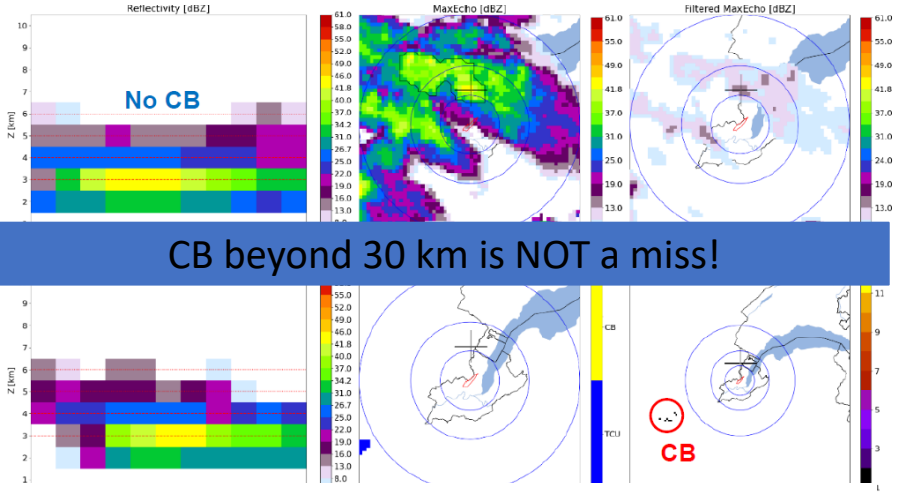
Robust three-step algorithm with **scientifically-motivated design** & parameters

- **87-94 %** probability to detect a cloud ceiling (vs observer)
- **7-11 %** probability to make a ceiling false alarm (vs observer)



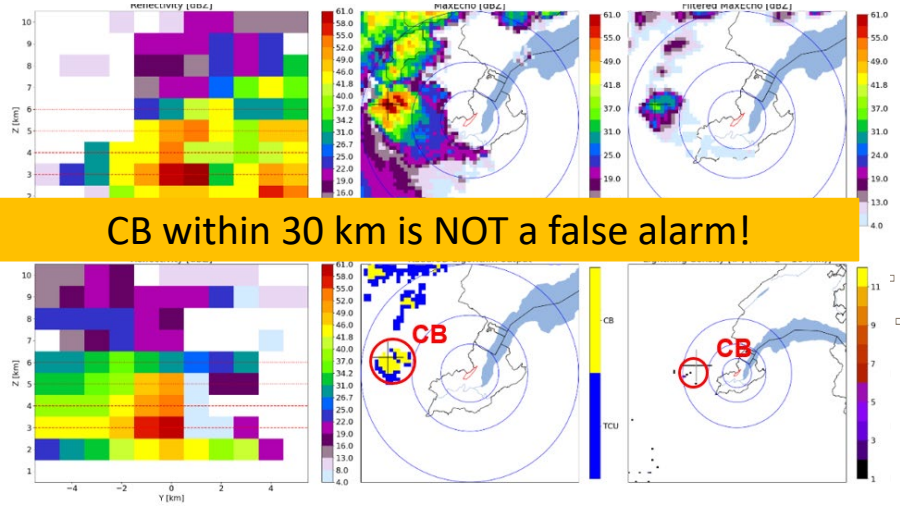
# CB accuracy evaluation

METAR: … FEW045CB BKN090 …
AUTOMETAR: FEW045 BKN090




CB beyond 30 km is NOT a miss!

METAR: … FEW040 SCT080 …
AUTOMETAR: FEW040CB BKN080




CB within 30 km is NOT a false alarm!

Comparison after approving AUTO METAR:

- 95 % probability to detect a CB
- 10 % probability to make a CB false alarm

AUTO METAR accurately reproduces its specifications (30 km radius), while detection area by observers is subjective

# Hail events 2023

8 (!) detected hail events between 21.2. and 7.8.2023

Evaluation of automated detection:

- **4** detected events **confirmed**
- **4** detected events **considered as plausible**

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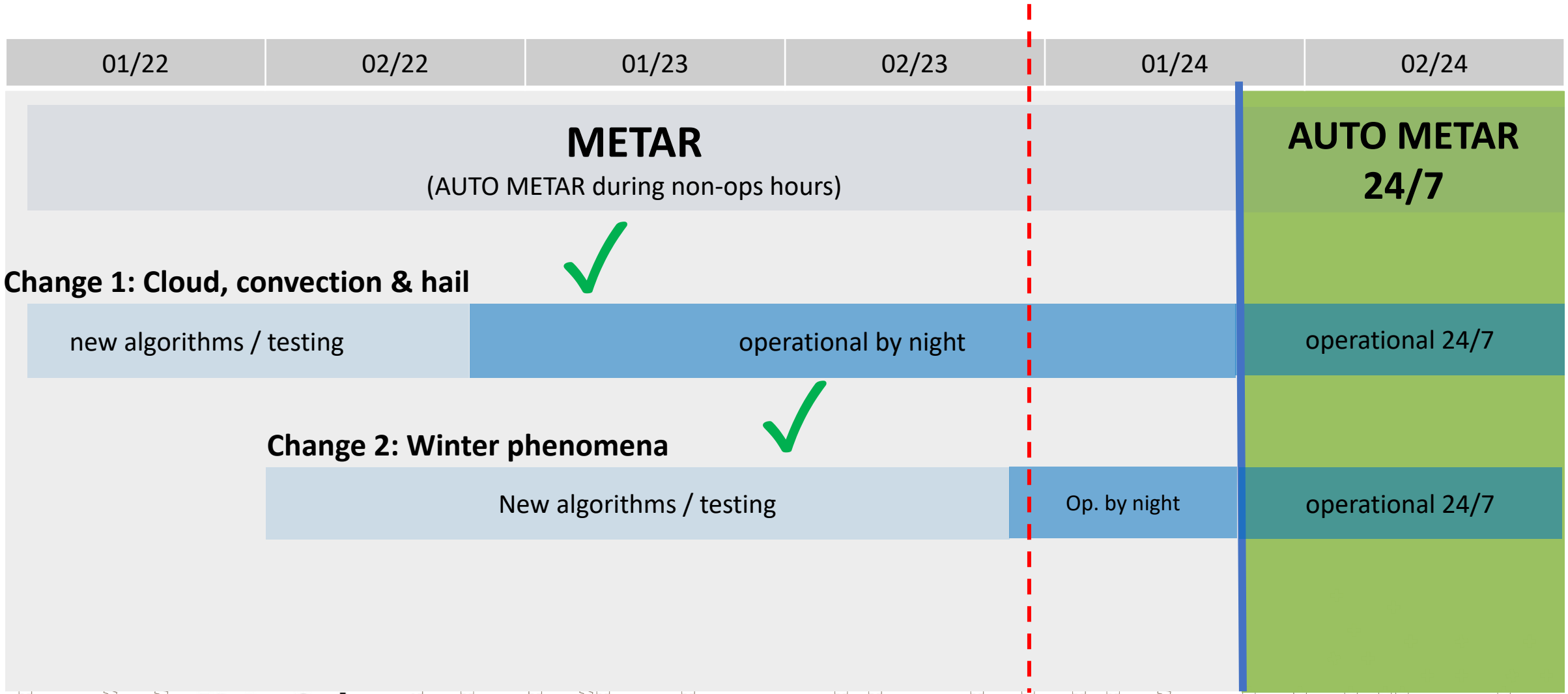
# Planning: AUTO METAR 24/7 LSGG

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# Change 2: Winter phenomena

Deployed on 07.11.2023

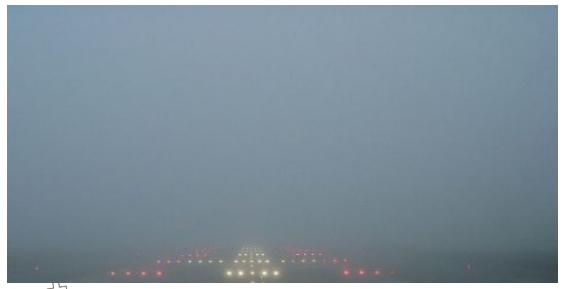
## Vertical visibility

Integration of **ceilometer measurements** into existing algorithm

Output examples:

**VV004**

**CLD OBSC VER VIS 400FT**



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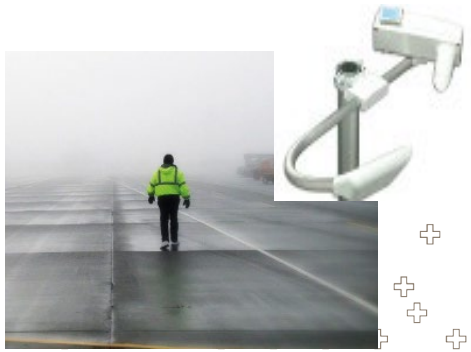
## Visibility

Combination of **10-min sensor values** for **prevailing & minimum visibility and 1-min for TDZ visibility,** as required by **regulation**

Output examples:

**5000 800**

**RWY 04 TDZ 800M**



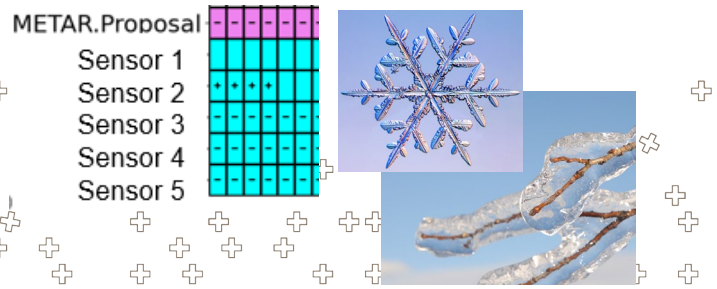
## Present Weather

**Localized combination** of 1-min sensor values for fog & precipitation type detection + **optimization of thresholds**.

Output examples:

**FZFG, FG, PRFG, BCFG, BR, HZ** (obscuration)

**FZRA, FZDZ, RA, DZ, PL, SN, RASN, etc** (precipitation)



# Vertical visibility (VV): new algorithm

**Old algorithm**

Conversion of horizontal to vertical visibility

→ **INDIRECT VV estimation**

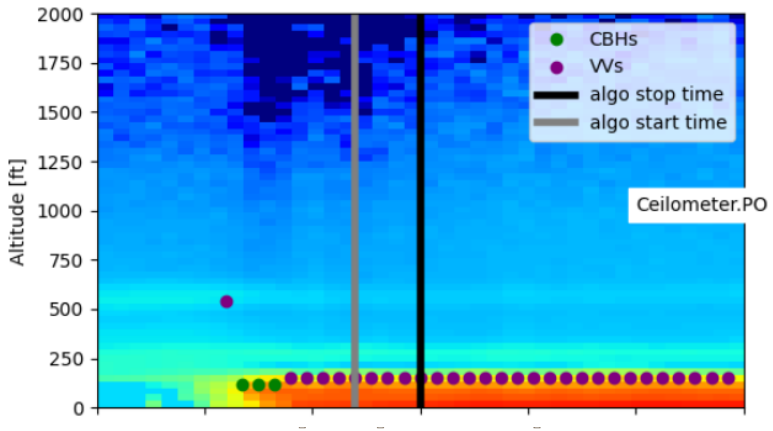
Likely developed in the ‘60s and calibrated to pilot reports

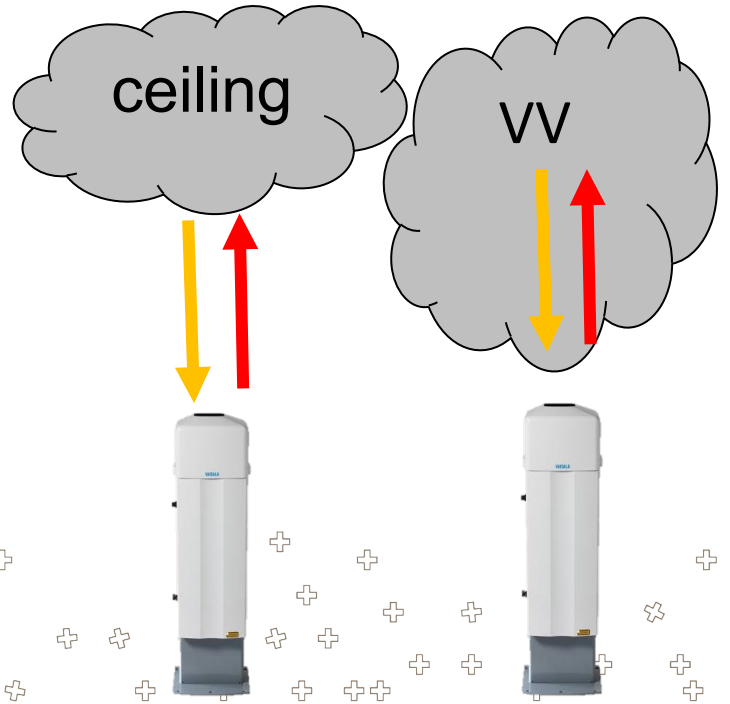
| Horizontal visibility → Vertical visibility | | |
|---|---|---|
| 100-249 m | → | VV000 |
| 250-449 m | → | VV001 |
| 450-500 m | → | VV002 |
| … | | |

**New algorithm**

Integration of ceilometer measurements for vertical visibility detection and estimation

→ **DIRECT VV measurement** → As required by regulation

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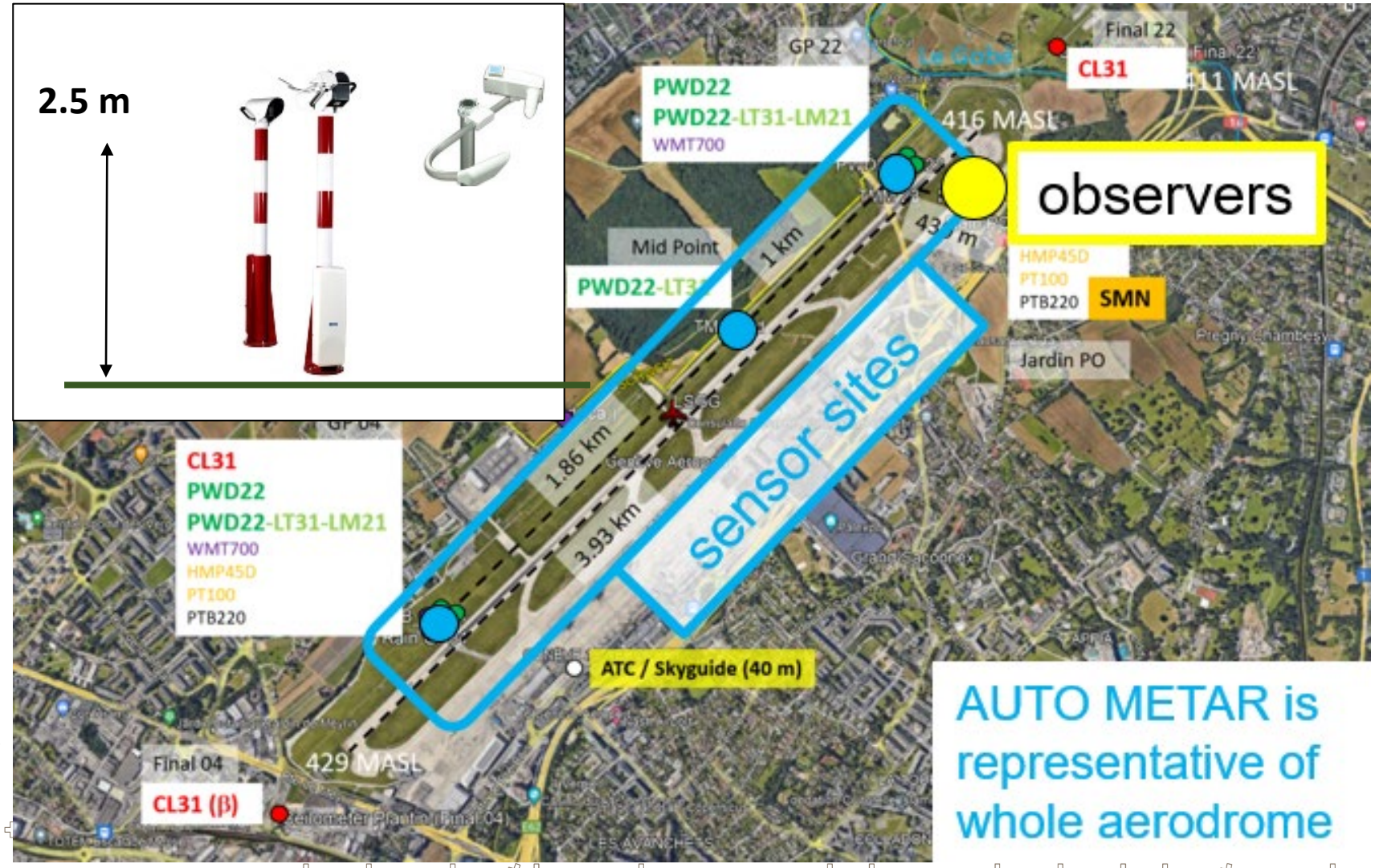
# Visibility measurements

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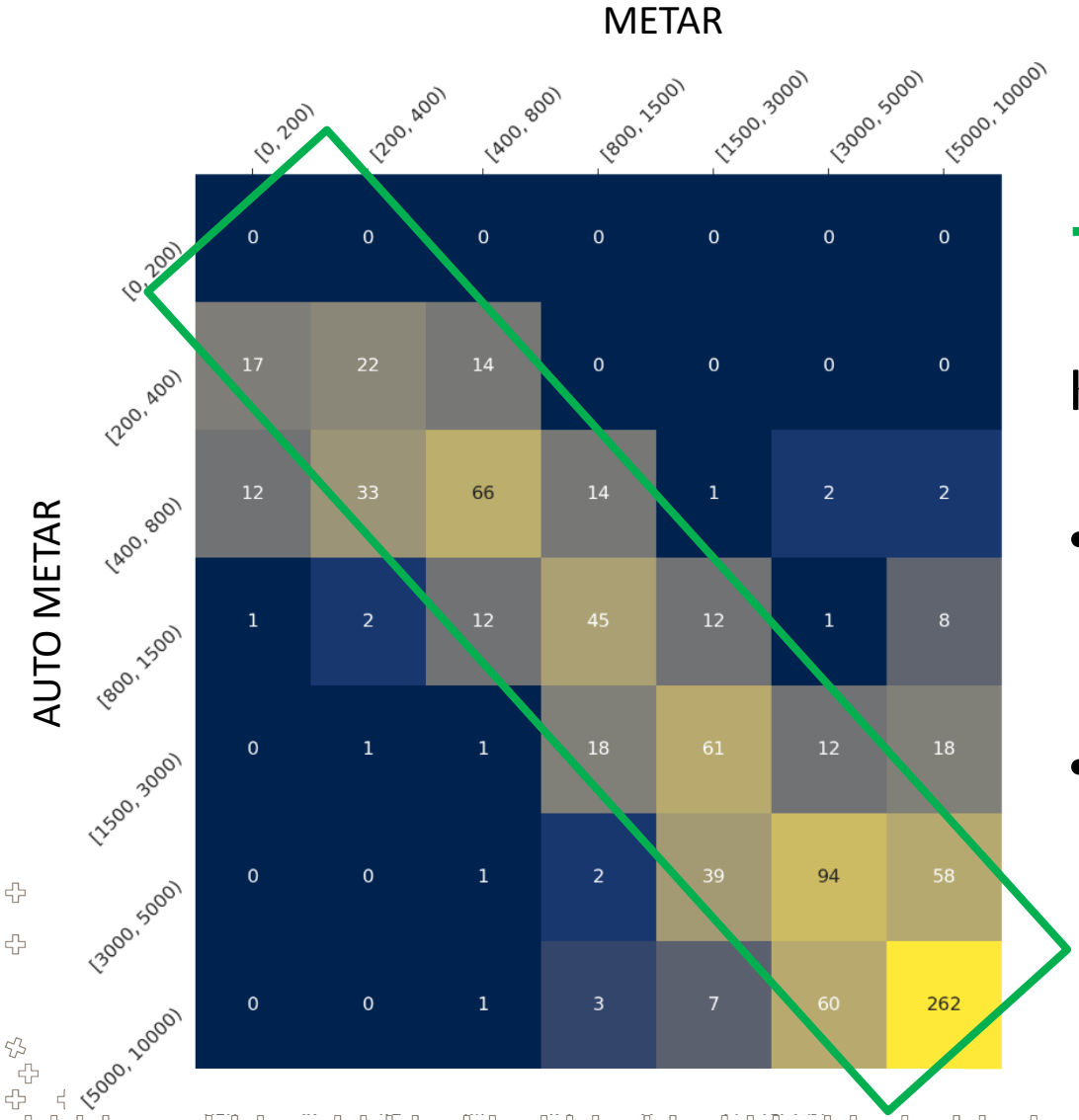
# Prevailing visibility: accuracy



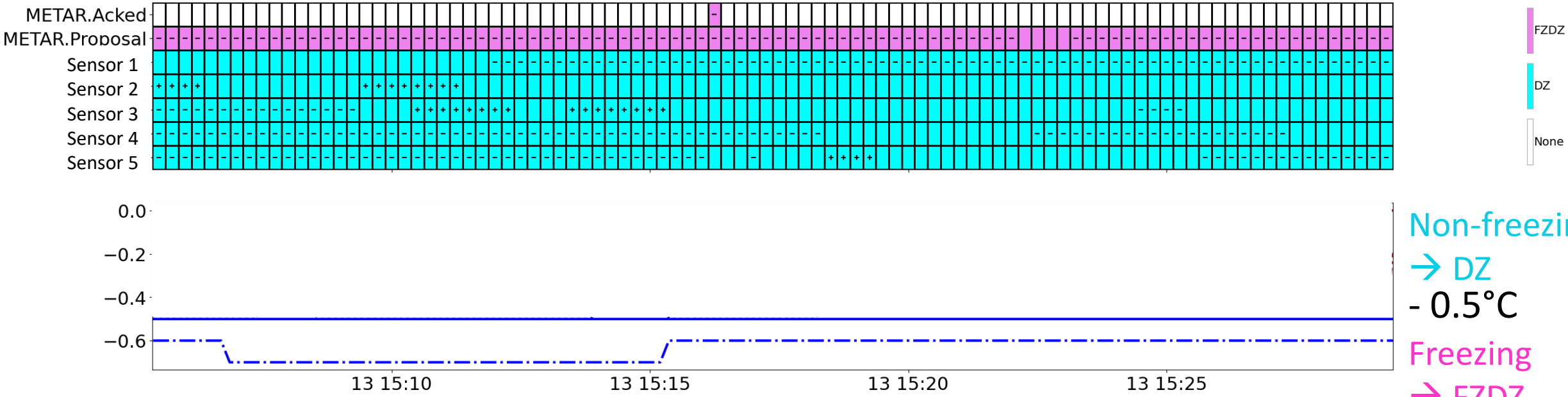

→ **Reliable and precise detection**

Known differences:

- When the observers are in a fog bank, they report a lower visibility
- When sensors are in “shallow” fog, they report a lower visibility

# Example: Freezing precipitation event

2022-12-13 15:16:20 METAR LSGG 131520Z VRB02KT 3300 -FZDZ FEW002 OVC006 M00/M01 Q1005 REDZ NOSIG=



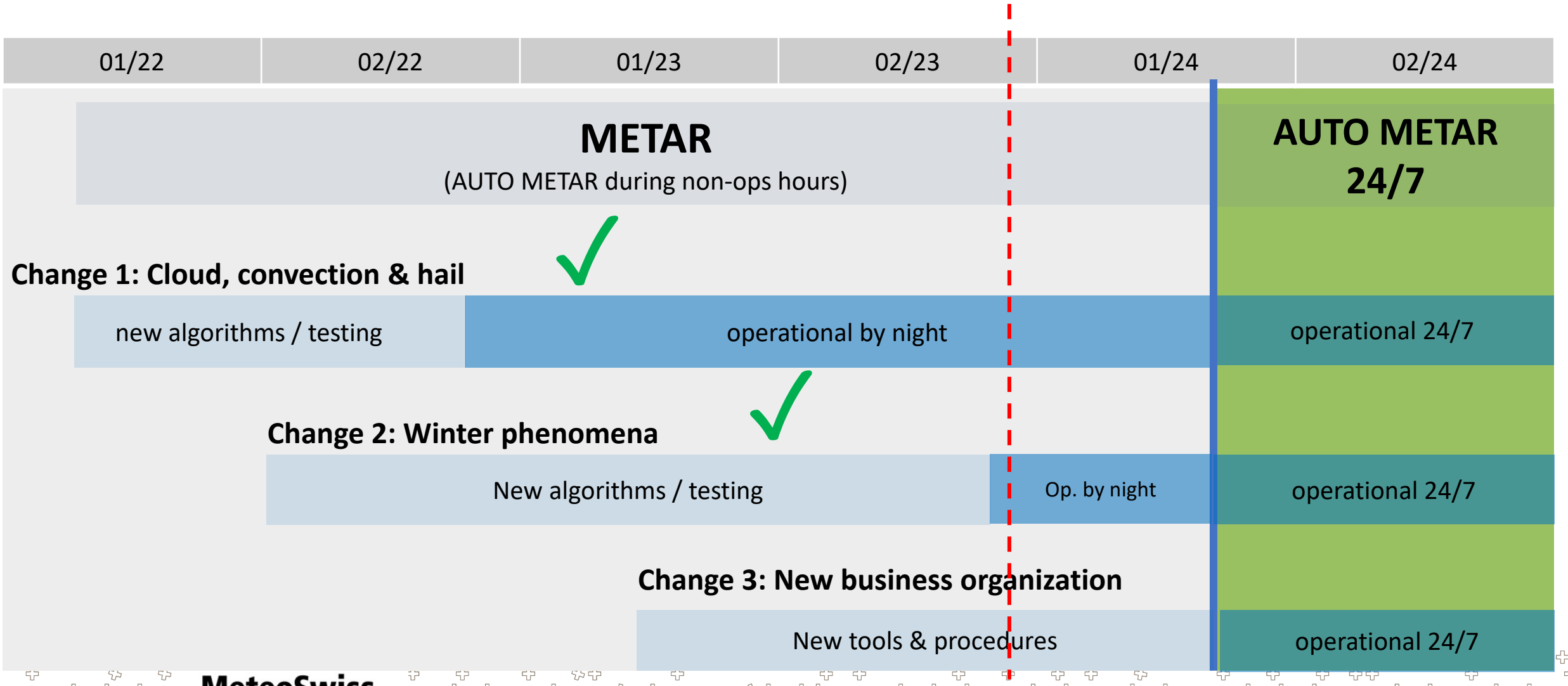

Vaisala sensors completely miss the FZDZ, but:

**→ SMART algorithm detected it correctly.**

# AUTO METAR vs METAR differences

| Parameter | METAR | AUTO METAR |
|---|---|---|
| **Random error** | Subjective + human error | **Objective/reproducible** + measurement error + human error (software, hardware) |
| **Systematic error** | Day vs night visibility biases, etc | **Unbiased** (rare exceptions) |
| **Temporal representativity** | Observation 3-4 min before hh:20/50 | **Exactly at min hh:20/50**, but integrating data for last 1-15 min |
| **Spatial representativity** | Observer close to RWY22<br><br>Observer ~3-6 m height above threshold<br><br>Variable ellipses for CB, TCU, etc | **Sensors** along RWY **at 3 different sites**<br><br>Visibility measured at 2.5 m AGL<br><br>Exact circles for CB, TCU, etc |

# Planning: AutoMETAR 24/7 LSGG

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# Change 3: New operational organization

**SMART team** (Zürich)

- **24/7 pikett service** for technical support AUTO METAR
- **Extended SMART team** for system maintenance and development

**Forecasting team** (Geneva, WMO)

- **24/7 weather watch and consulting**
- **TREND** production

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# Change 3: New operational organization

**New supporting tools** for Forecaster:

- **4 Webcams** for TREND / weather watch
- **SMART Webclient** to visualize measurements, AUTO METAR + editor for TREND and supplementary information

Introduction

Project AUTO METAR Geneva

Conclusion and Outlook

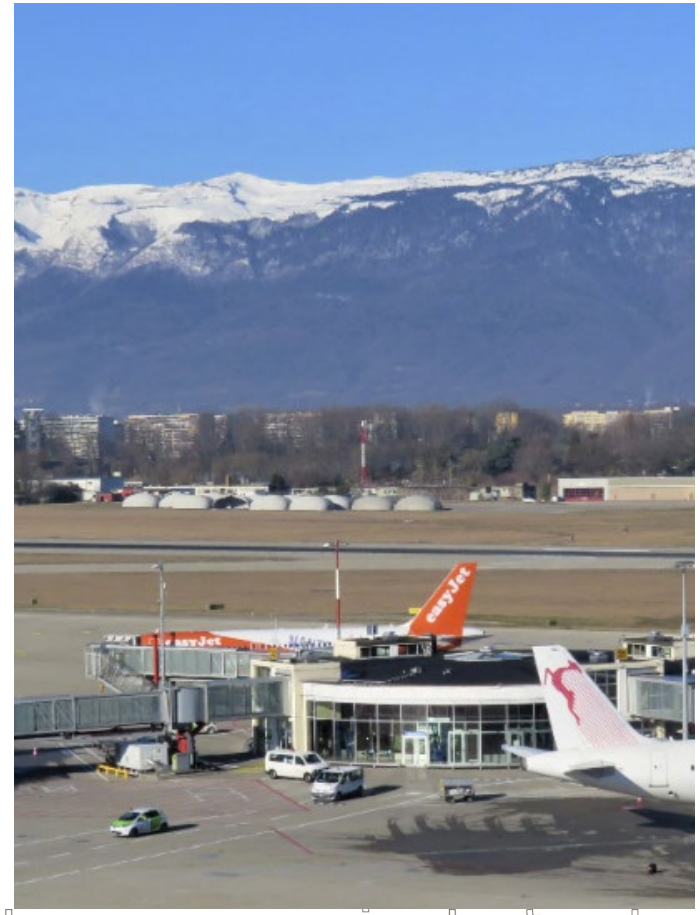
# Conclusion and Outlook

Key elements for AUTO METAR 24/7 in LSGG

Integration of **Weather Radar data** and **new algorithms** for improved robustness and accuracy

A dynamic **software development** for a per-formant and **continously improved** AUTO METAR Service

**Gradual introduction** in 3 steps has proved successful

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# Conclusion and Outlook

In 2024, in parallel to implementation of AUTO METAR 24h/7 in Geneva:

Start with Project **AUTO METAR LSZH 24h/7**

**Kick-off meeting** with stakeholder in **Q2 2024**

**Planned implementation by 2026**


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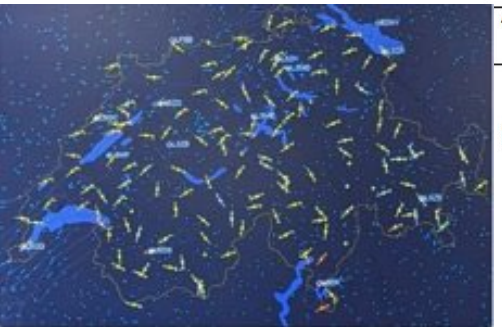
# Project AVIA26

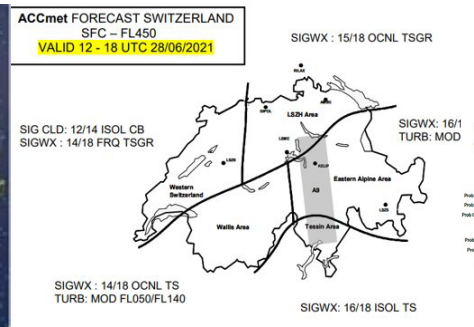
H. Barras, K. Wehrli, R. Attinger,
J. Landmann, G. Aznar
Project Team

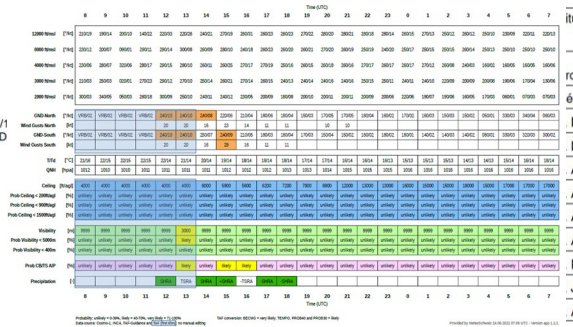
# Next generation of customized products

AVIA26 ...

- Coordinates activities for aviation weather forecasts as a service.
- Fosters:
  - Automation and digitalisation.
  - Cooperation with aviation customers as well as national and international partners.
  - Harmonisation of meteorological services and processes for efficient service provision.
- First developments:
  Exploitation of available measurements and the latest forecasting methods to improve the prediction and communication of aviation-relevant weather phenomena.





| ituation générale | Traîne active | Perturbation | Marais barométrique | Autre |
|---|---|---|---|---|
| | ☐ | ☒ | ☐ | ☐ |

robabilité d'orages

| égion / heure (UTC) | 06-09 | 09-12 | 12-15 | 15-18 | 18-21 | 21-24 | 00-03 | 03-06 |
|---|---|---|---|---|---|---|---|---|
| Bourgogne | 20-40 | 0-20 | 0-20 | 40-60 | 60-80 | 40-60 | 20-40 | 0-20 |
| Lyon sud | 0-20 | 0-20 | 0-20 | 0-20 | 0-20 | 0-20 | 0-20 | 0-20 |
| Alpes françaises | 0-20 | 0-20 | 0-20 | 20-40 | 40-60 | 40-60 | 20-40 | 20-40 |
| Alpes italiennes | 0-20 | 0-20 | 0-20 | 20-40 | 40-60 | 40-60 | 20-40 | 0-20 |
| Alpes valaisannes | 0-20 | 0-20 | 0-20 | 20-40 | 40-60 | 60-80 | 40-60 | 0-20 |
| Alpes bernoises | 0-20 | 0-20 | 0-20 | 20-40 | 40-60 | 40-60 | 40-60 | 0-20 |
| Plateau | 0-20 | 0-20 | 0-20 | 0-20 | 20-40 | 0-20 | 20-40 | 0-20 |
| Jura | 0-20 | 0-20 | 0-20 | 20-40 | 40-60 | 20-40 | 20-40 | 0-20 |
| Alsace | 20-40 | 0-20 | 0-20 | 0-20 | 40-60 | 40-60 | 20-40 | 0-20 |

# Goal «New Sector Forecast»

- **Automatic convection product** for skyguide
- **Harmonize and automate** MeteoSwiss' convection products for aviation
- **Probabilistic convection forecast** based on ICON-CH1-EPS
- **Use machine learning to improve reliability** (what you see is what you get) of NWP
  → reduce false positives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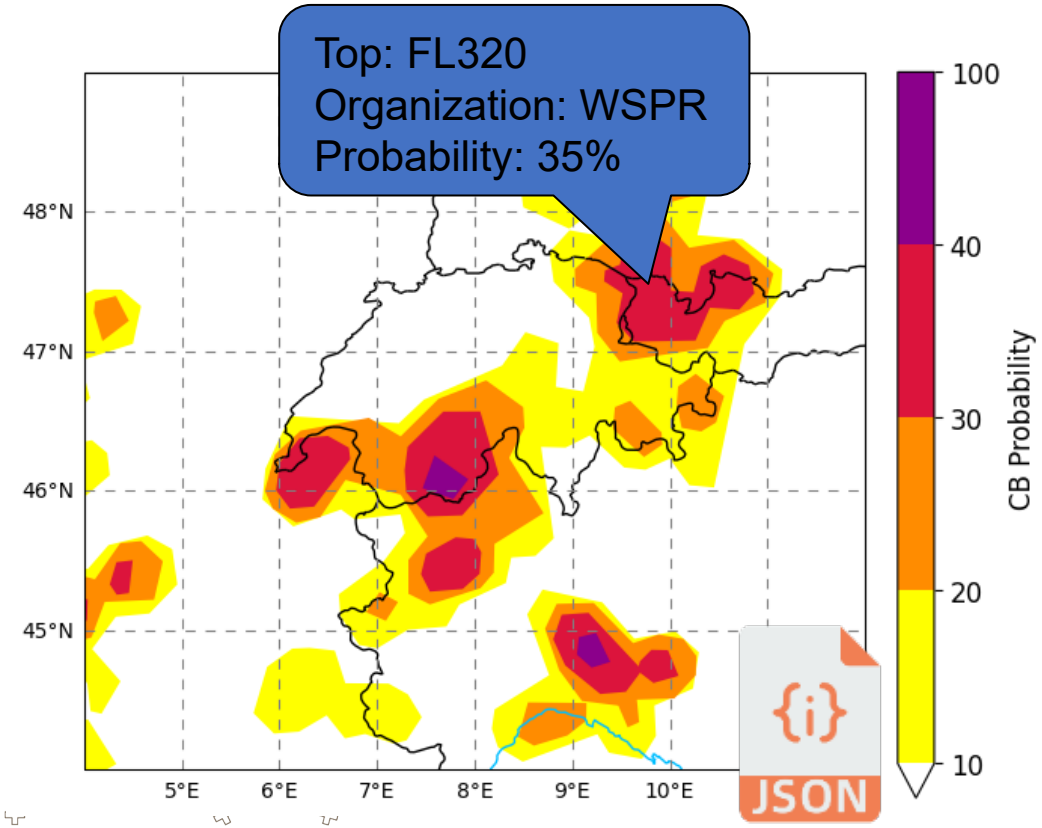
# Product Definition




- **CB / TCU polygons**
  - FL100 until FL450
  - 4 likelihood levels
  - Height of convection
  - Organization
- Validity: T+2h until T+16h (up to T+33h possible)
- Temporal resolution: 30min (first 7 hours)
- Update frequency: every 3 hours
- Area: Swiss radar domain
- Availability: JSON via API

→ Product is visualized in user system

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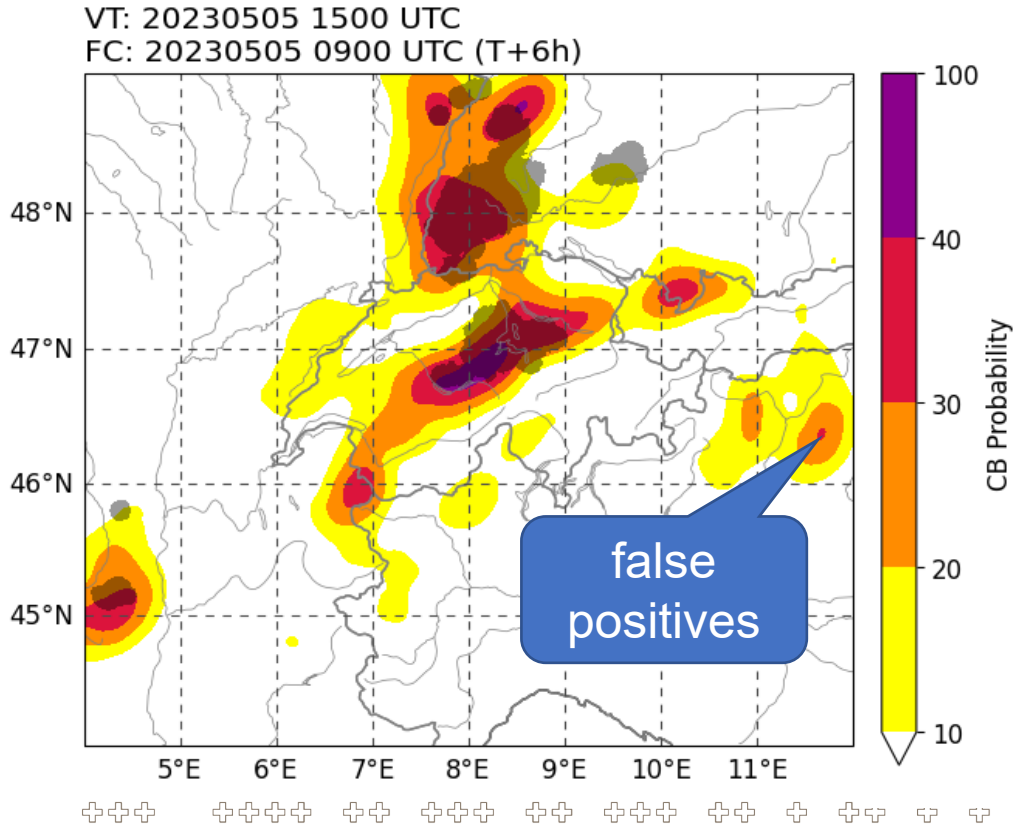
# Improving Convection Forecasts

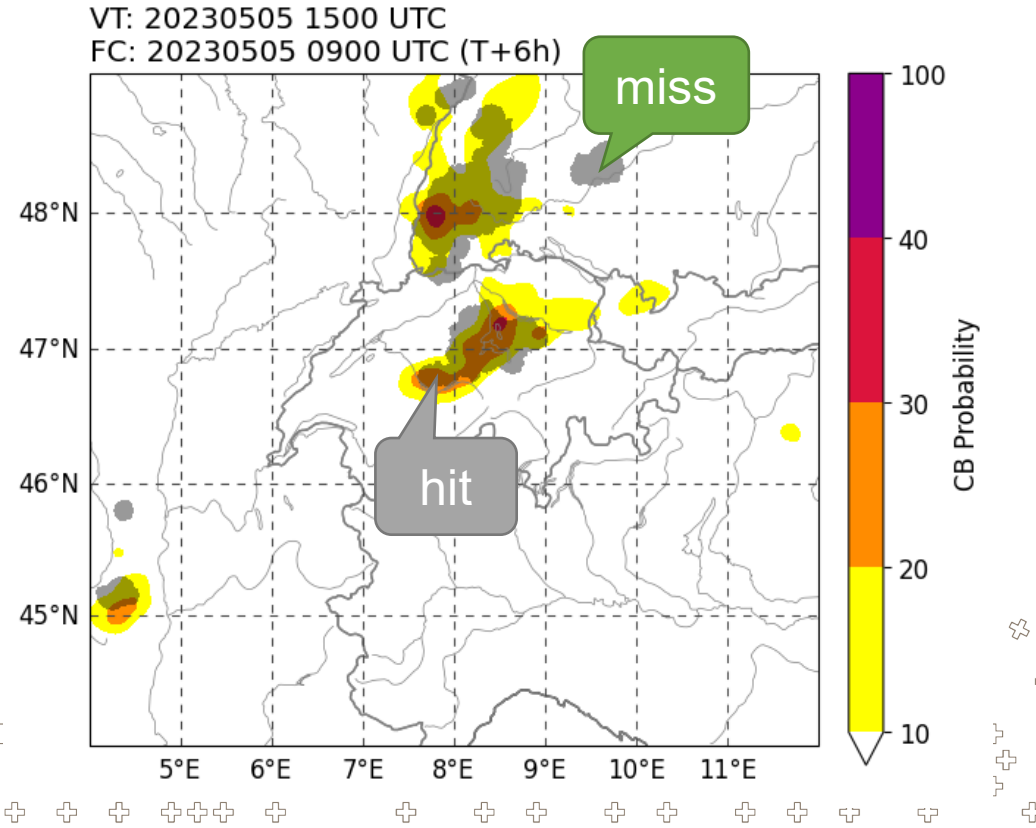
## Numerical Weather Prediction

- Explicit NW convection prediction
- NWP model overconfident
- Based on simple threshold (prob >40dBZ)

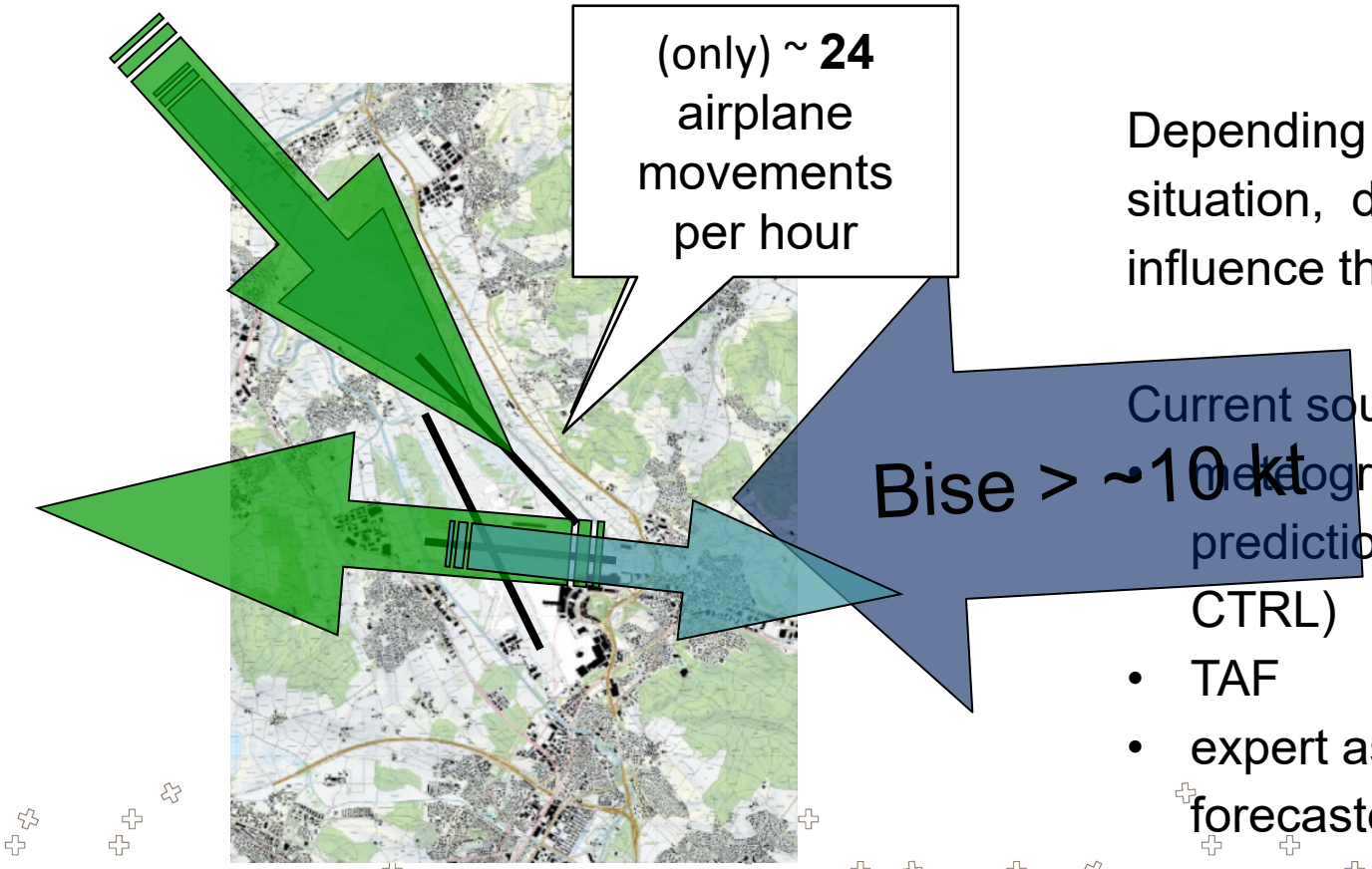



## Machine Learning Prediction

- ML model trained with lightning observations
- Optimized to reduced false positives
- Black box & requires a lot of data for training



# proof of concept "improved probabilistic wind predictions for airports"




Depending on the time of day and weather situation, different runway concepts apply, which influence the airport traffic capacity.

Current sources of wind predictions at the TWR:

- meteogram with **hourly deterministic** wind predictions **updated every hour** (COSMO-1E CTRL)
- TAF
- expert assessments from MeteoSwiss forecasters via phone call

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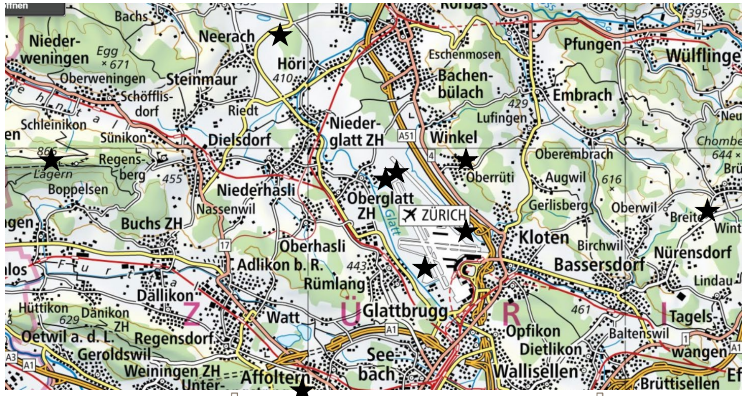
# machine learning prediction for wind

meteogram with ~~**hourly**~~ **probabilistic** ~~**deterministic**~~ wind predictions **updated every** ~~**hour**~~ **10 min** (COSMO-1E CTRL)

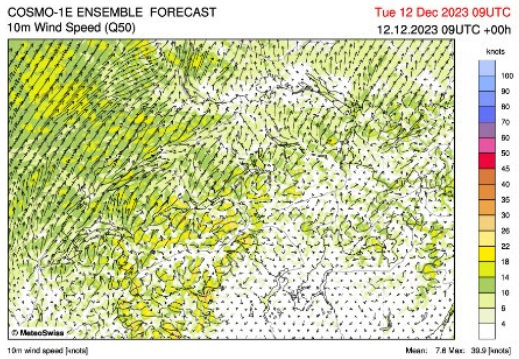
higher temporal resolution:
- **10 min up to T + 3 h**
- after that hourly up to T + 33 h

How ? With..

the most recent measurements




the operational numerical weather predictions




state-of-the-art ML methods

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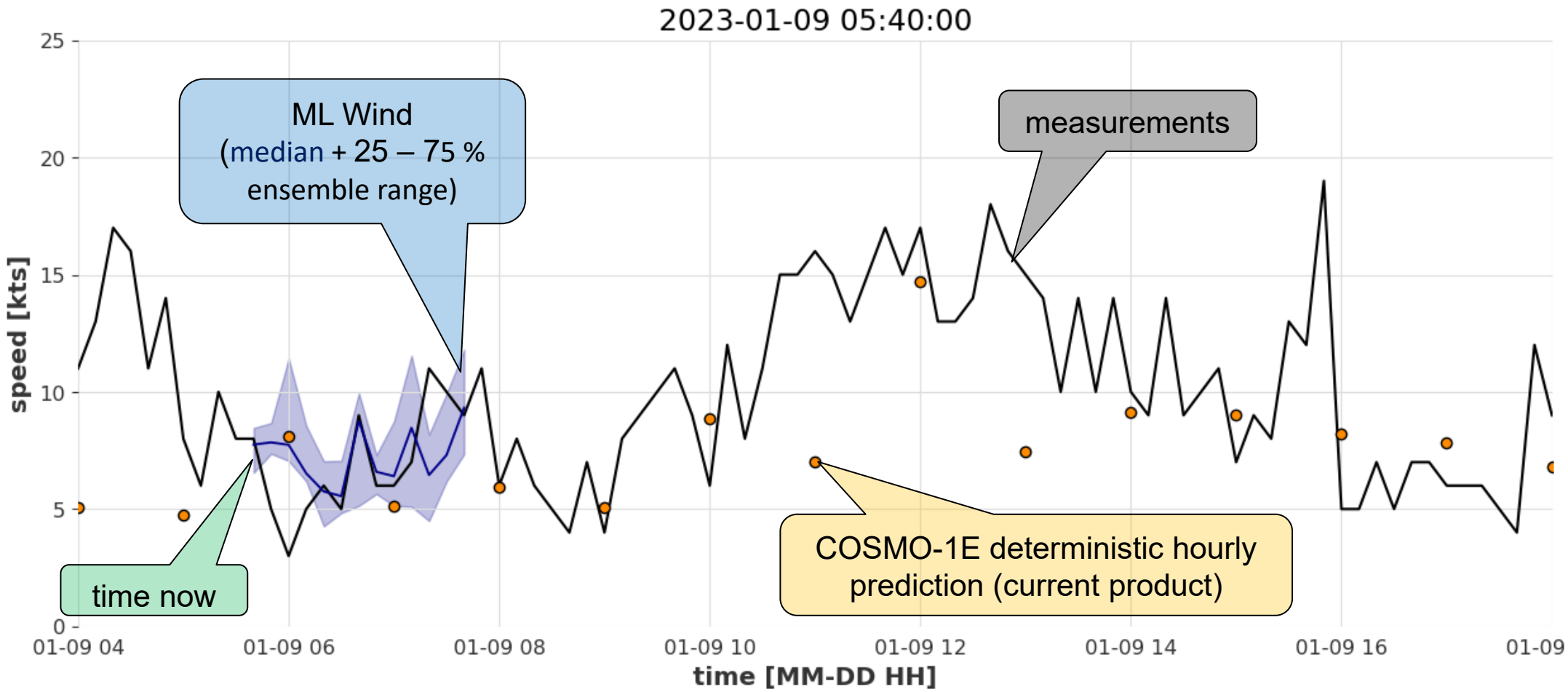
# machine learning prediction for wind

(currently work in progress at one location in the north of the airport LSZH)

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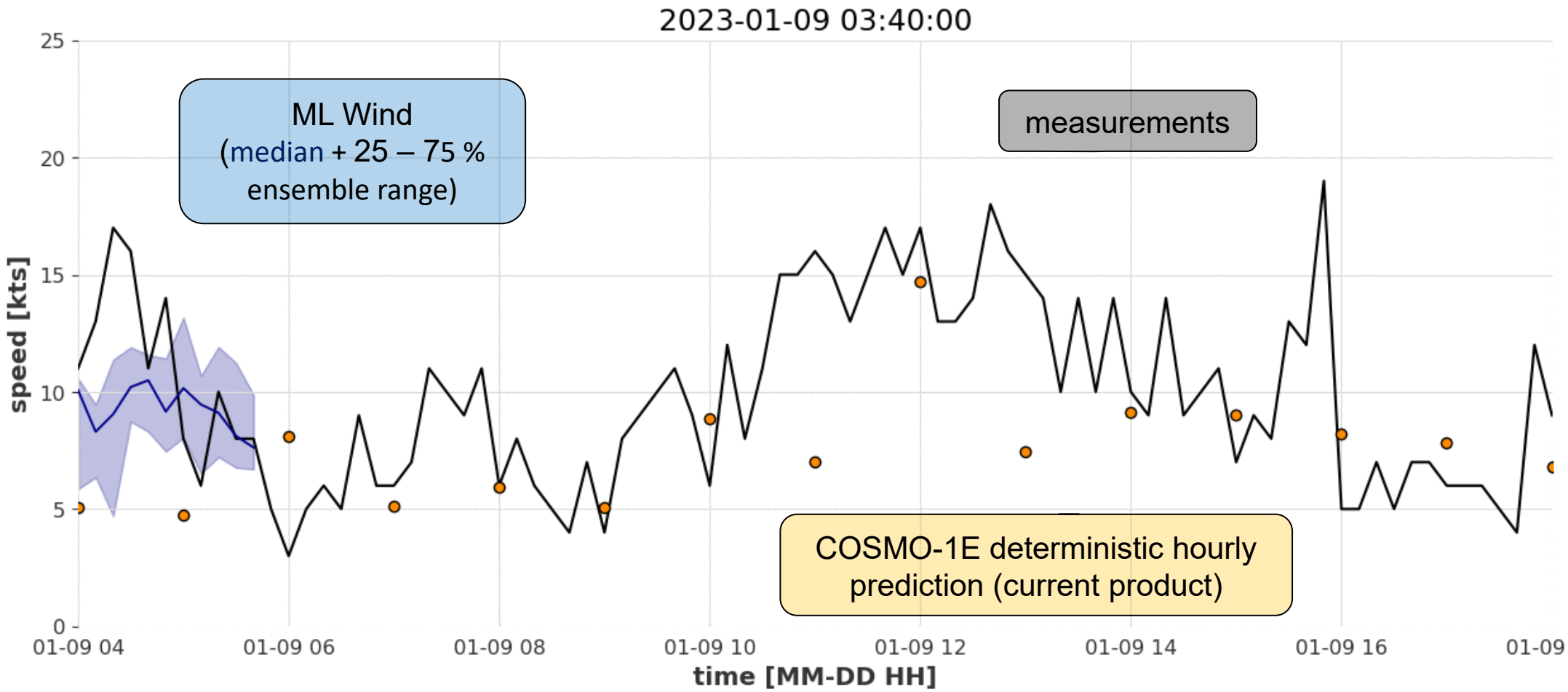
# machine learning prediction for wind

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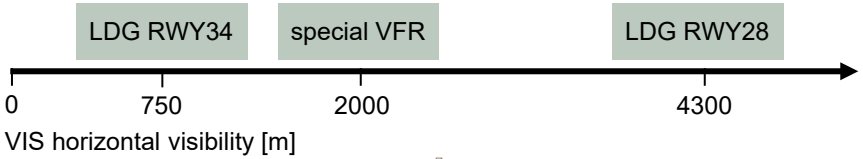
# Proof of Concept «high-resolution probabilistic visibility forecasts for airports»


**Challenges**

- Spatial and temporal variability of visibility reductions
- Different phenomena leading to low visibilities
- Rare but high-impact event for the airports
- Operations depend on specific thresholds

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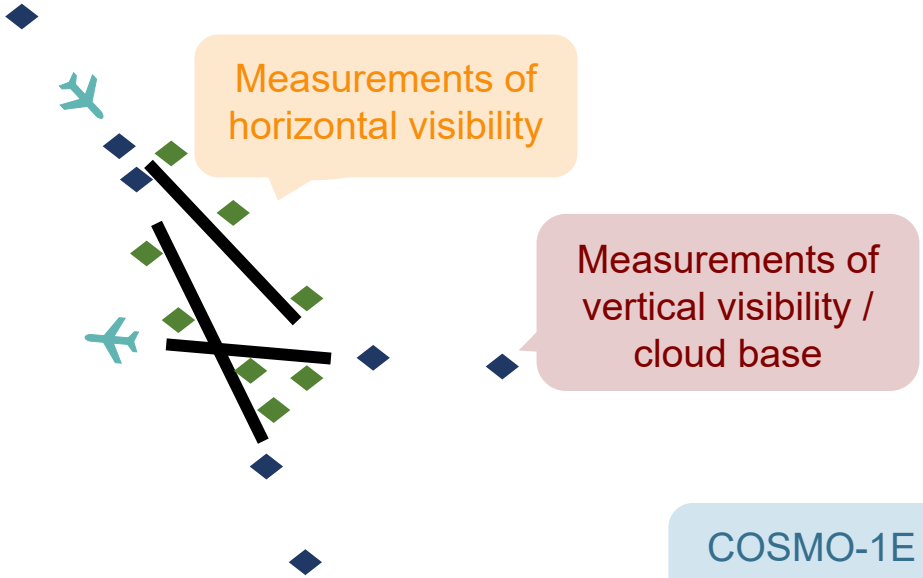
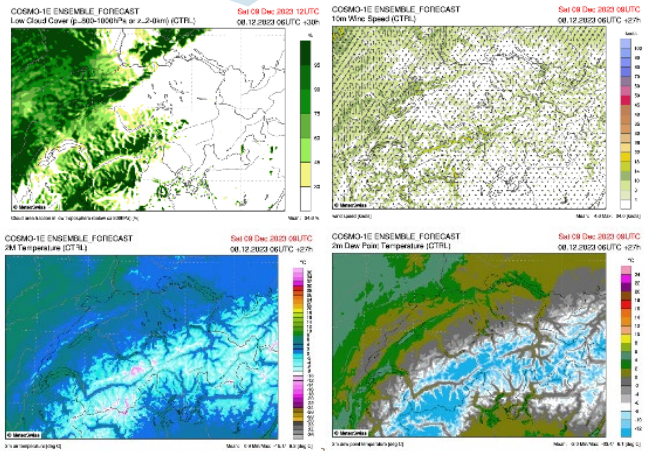
# machine learning prediction for visibility




COSMO-1E prediction



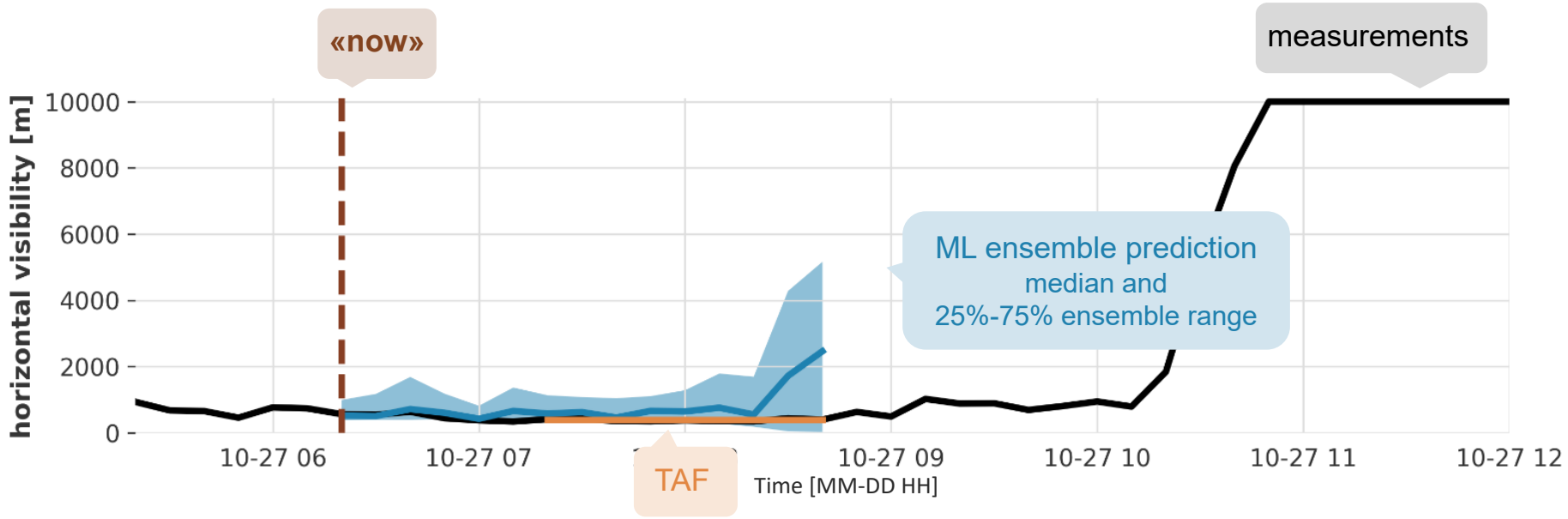
Measurements of other meteorological variables

ML model to bridge missing information and deficiencies of current predictions

- Use all available airport measurements
- Rapid update to adapt to changing conditions
- Provide uncertainty information
- Tailored to thresholds used at airport

# machine learning prediction for visibility

work in progress – prediction for touchdown zone runway 14

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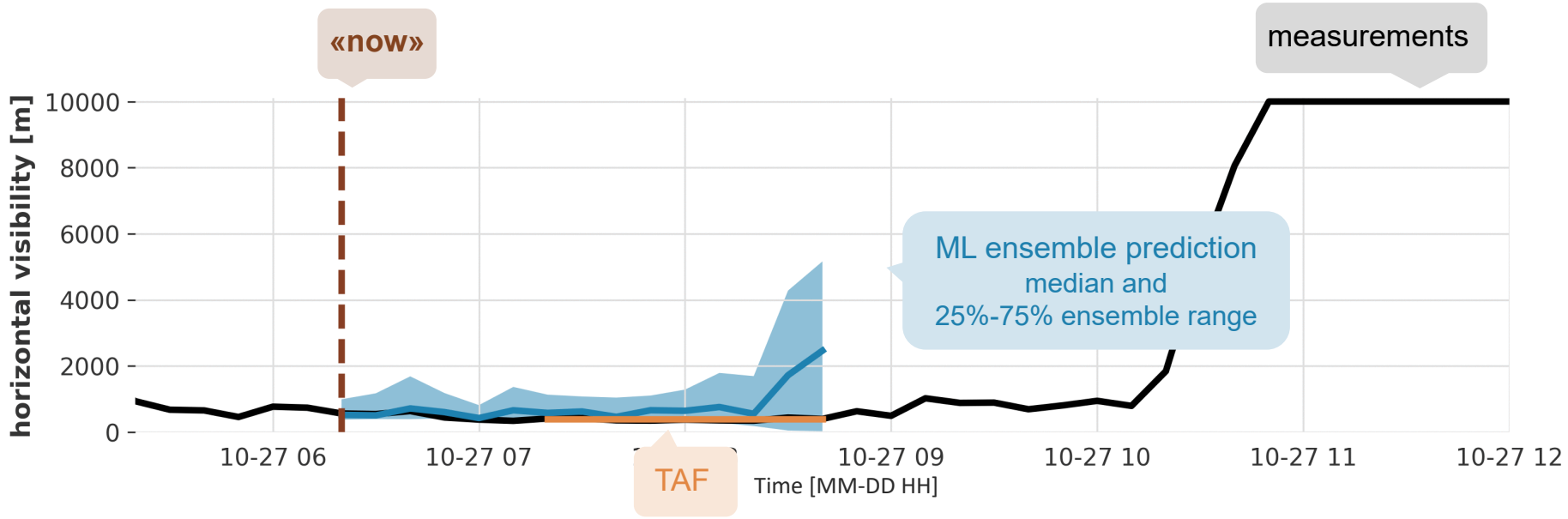
# machine learning prediction for visibility

work in progress – prediction for touchdown zone runway 14




- Validity: T+10 min until T+120 min (extension to 180 min ongoing)
- Temporal resolution and update: 10 min
- Hourly predictions up to T+33h pending

➡ Predictions to be displayed in the new Meteogram

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# from visibility and wind PoCs to costumized products

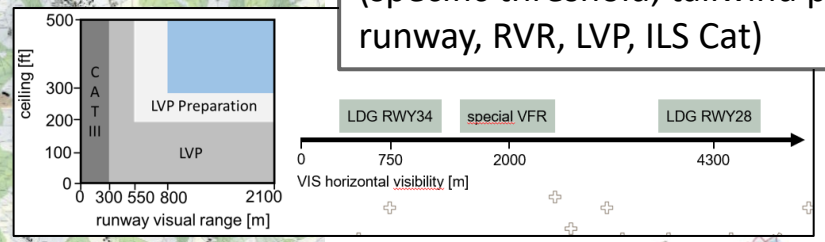
more prediction locations ?

predictions at the ground

wind predictions at ~3000 – 4000 ft ?

Customized predictions ?
(specific threshold; tailwind per runway, RVR, LVP, ILS Cat)

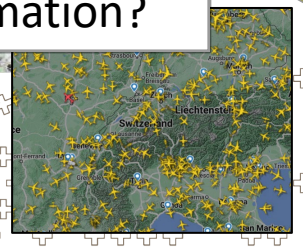
2024: integrate new numerical weather model ICON-CH1-EPS




include AMDAR, MODE-S, satellite data and others?

models for specific events?

use air traffic movement information?



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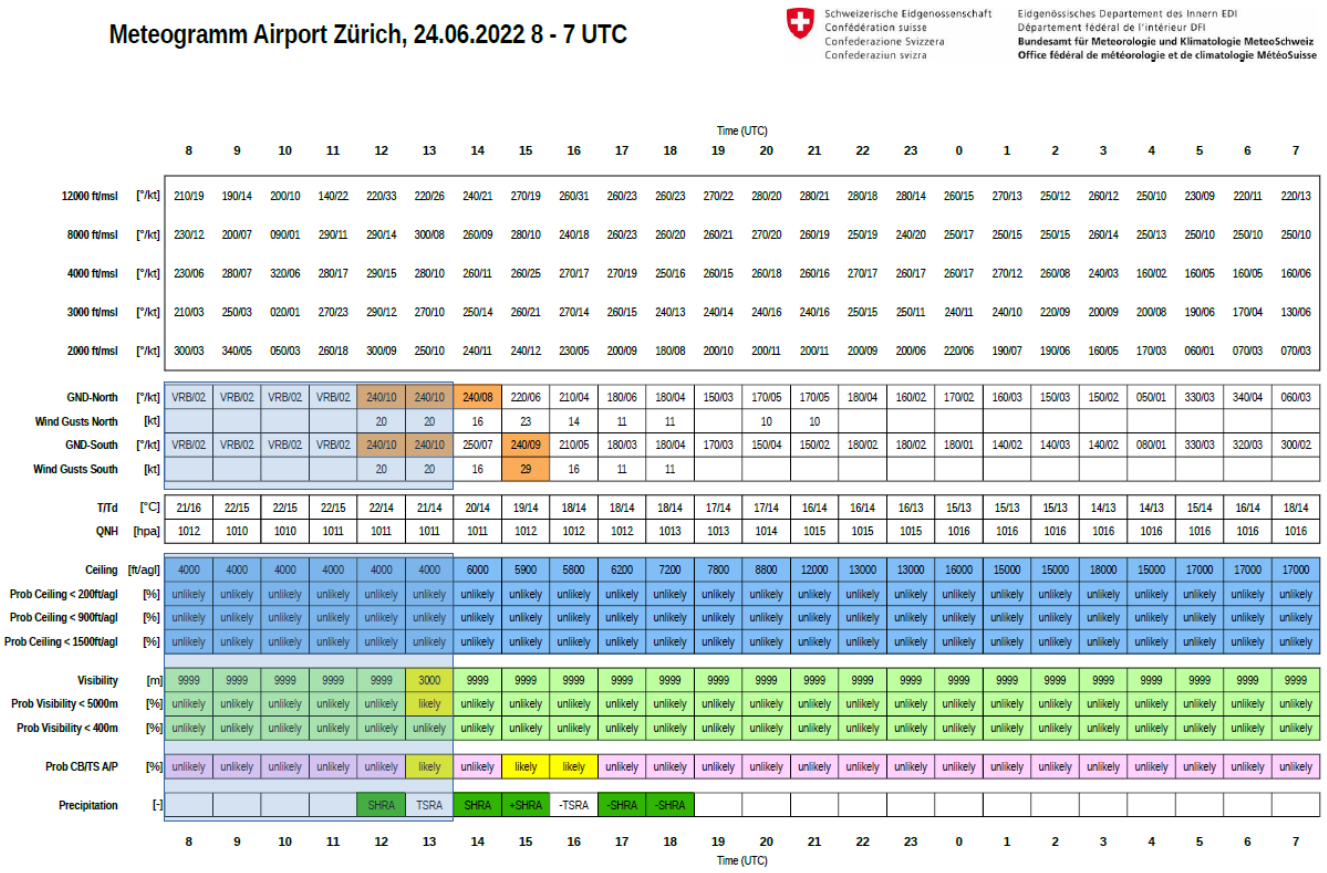
# Meteogram NextGen

**Visualize data and refurbish the old „PDF meteogram“**



Meteogramm Airport Zürich, 24.06.2022 8 - 7 UTC

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement des Innern EDI
Département fédéral de l'intérieur DFI
**Bundesamt für Meteorologie und Klimatologie MeteoSchweiz**
**Office fédéral de météorologie et de climatologie MétéoSuisse**

Time (UTC)

| | | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12000 ft/msl | [°/kt] | 210/19 | 190/14 | 200/10 | 140/22 | 220/33 | 220/26 | 240/21 | 270/19 | 260/31 | 260/23 | 260/23 | 270/22 | 280/20 | 280/21 | 280/18 | 280/14 | 260/15 | 270/13 | 250/12 | 260/12 | 250/10 | 230/09 | 220/11 | 220/13 |
| 8000 ft/msl | [°/kt] | 230/12 | 200/07 | 090/01 | 290/11 | 290/14 | 300/08 | 260/09 | 280/10 | 240/18 | 260/23 | 260/20 | 260/21 | 270/20 | 260/19 | 250/19 | 240/20 | 250/17 | 250/15 | 250/15 | 260/14 | 250/13 | 250/10 | 250/10 | 250/10 |
| 4000 ft/msl | [°/kt] | 230/06 | 280/07 | 320/06 | 280/17 | 290/15 | 280/10 | 260/11 | 260/25 | 270/17 | 270/19 | 250/16 | 260/15 | 260/18 | 260/16 | 270/17 | 260/17 | 260/17 | 270/12 | 260/08 | 240/03 | 160/02 | 160/05 | 160/05 | 160/06 |
| 3000 ft/msl | [°/kt] | 210/03 | 250/03 | 020/01 | 270/23 | 290/12 | 270/10 | 250/14 | 260/21 | 270/14 | 260/15 | 240/13 | 240/14 | 240/16 | 240/16 | 250/15 | 250/11 | 240/11 | 240/10 | 220/09 | 200/09 | 200/08 | 190/06 | 170/04 | 130/06 |
| 2000 ft/msl | [°/kt] | 300/03 | 340/05 | 050/03 | 260/18 | 300/09 | 250/10 | 240/11 | 240/12 | 230/05 | 200/09 | 180/08 | 200/10 | 200/11 | 200/11 | 200/09 | 200/06 | 220/06 | 190/07 | 190/06 | 160/05 | 170/03 | 060/01 | 070/03 | 070/03 |
| GND-North | [°/kt] | VRB/02 | VRB/02 | VRB/02 | VRB/02 | 240/10 | 240/10 | 240/08 | 220/06 | 210/04 | 180/06 | 180/04 | 150/03 | 170/05 | 170/05 | 180/04 | 160/02 | 170/02 | 160/03 | 150/03 | 150/02 | 050/01 | 330/03 | 340/04 | 060/03 |
| Wind Gusts North | [kt] | | | | | 20 | 20 | 16 | 23 | 14 | 11 | 11 | | 10 | 10 | | | | | | | | | | |
| GND-South | [°/kt] | VRB/02 | VRB/02 | VRB/02 | VRB/02 | 240/10 | 240/10 | 250/07 | 240/09 | 210/05 | 180/03 | 180/04 | 170/03 | 150/04 | 150/02 | 180/02 | 180/02 | 180/01 | 140/02 | 140/03 | 140/02 | 080/01 | 330/03 | 320/03 | 300/02 |
| Wind Gusts South | [kt] | | | | | 20 | 20 | 16 | 29 | 16 | 11 | 11 | | | | | | | | | | | | | |
| T/Td | [°C] | 21/16 | 22/15 | 22/15 | 22/15 | 22/14 | 21/14 | 20/14 | 19/14 | 18/14 | 18/14 | 18/14 | 17/14 | 17/14 | 16/14 | 16/14 | 16/13 | 15/13 | 15/13 | 15/13 | 14/13 | 14/13 | 15/14 | 16/14 | 18/14 |
| QNH | [hpa] | 1012 | 1010 | 1010 | 1011 | 1011 | 1011 | 1011 | 1012 | 1012 | 1012 | 1013 | 1013 | 1014 | 1015 | 1015 | 1015 | 1016 | 1016 | 1016 | 1016 | 1016 | 1016 | 1016 | 1016 |
| Ceiling | [ft/agl] | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 6000 | 5900 | 5800 | 6200 | 7200 | 7800 | 8800 | 12000 | 13000 | 13000 | 16000 | 15000 | 15000 | 18000 | 15000 | 17000 | 17000 | 17000 |
| Prob Ceiling < 200ft/agl | [%] | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely |
| Prob Ceiling < 900ft/agl | [%] | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely |
| Prob Ceiling < 1500ft/agl | [%] | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely |
| Visibility | [m] | 9999 | 9999 | 9999 | 9999 | 9999 | 3000 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 | 9999 |
| Prob Visibility < 5000m | [%] | unlikely | unlikely | unlikely | unlikely | unlikely | likely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely |
| Prob Visibility < 400m | [%] | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely |
| Prob CB/TS A/P | [%] | unlikely | unlikely | unlikely | unlikely | unlikely | likely | unlikely | likely | likely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely | unlikely |
| Precipitation | [-] | | | | | SHRA | TSRA | SHRA | +SHRA | -TSRA | -SHRA | -SHRA | | | | | | | | | | | | | |

Time (UTC)

Probability: unlikely = 0-39%, likely = 40-70%, very likely = 71-100%
Data source: Cosmo-1, INCA, TAF-Guidance and TAF (first 6hrs), no manual editing

TAF conversion: BECMG = very likely, TEMPO, PROB40 and PROB30 = likely

Provided by MeteoSchweiz 24.06.2022 07:05 UTC - Version app 1.2.2

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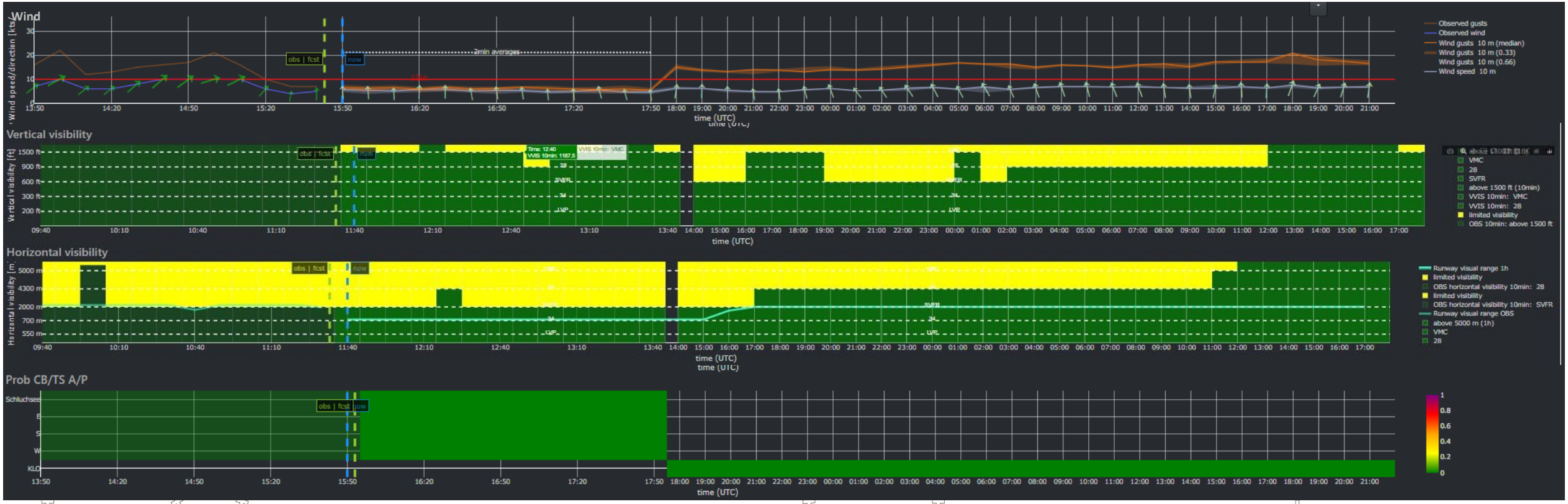
- Clear layout
- Color-coding helps interpretation

- Deterministic
- Categorized („likely“ etc.)
- Low temporal resolution
- „Old World“ technical setup
- Some wind gusts dropped (TAF problem)

# A visualization prototype

An example




+ temperature, dew point, precipitation, QNH, AND:

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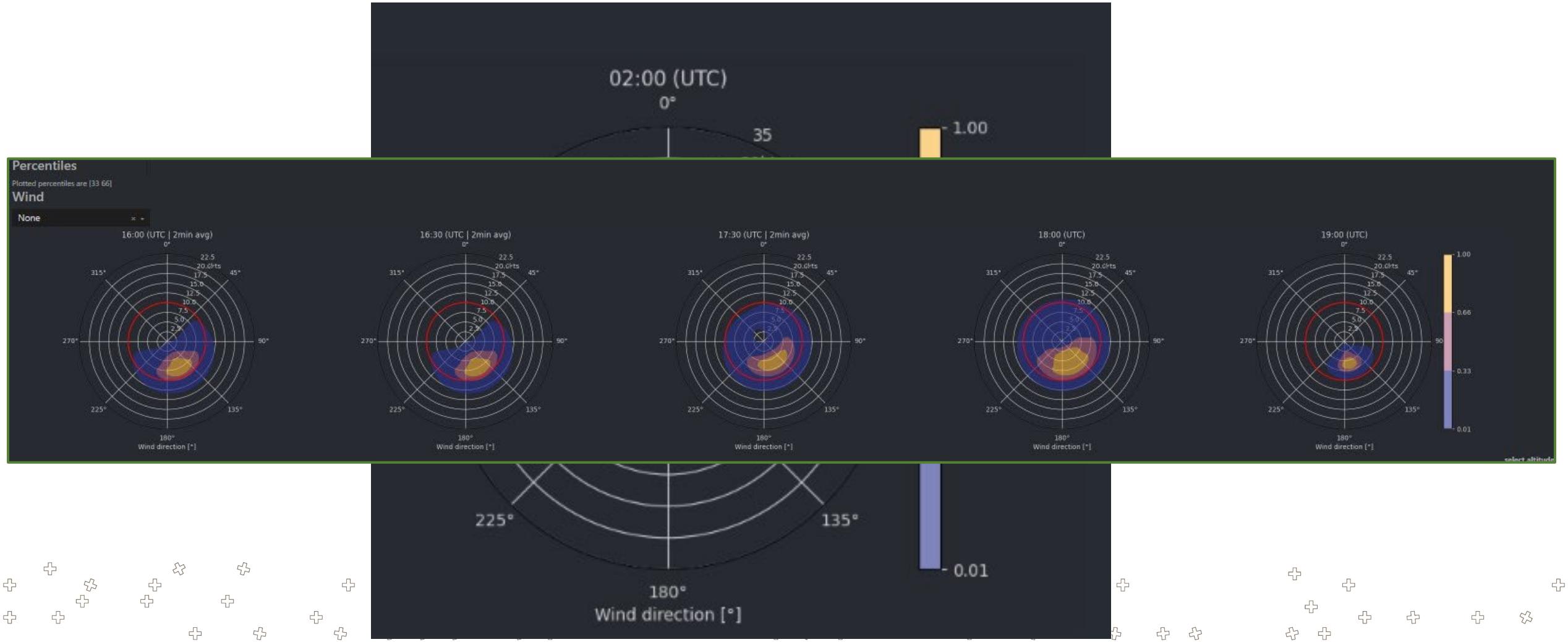
# Example challenge: the wind rose

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# Change Management Procedures

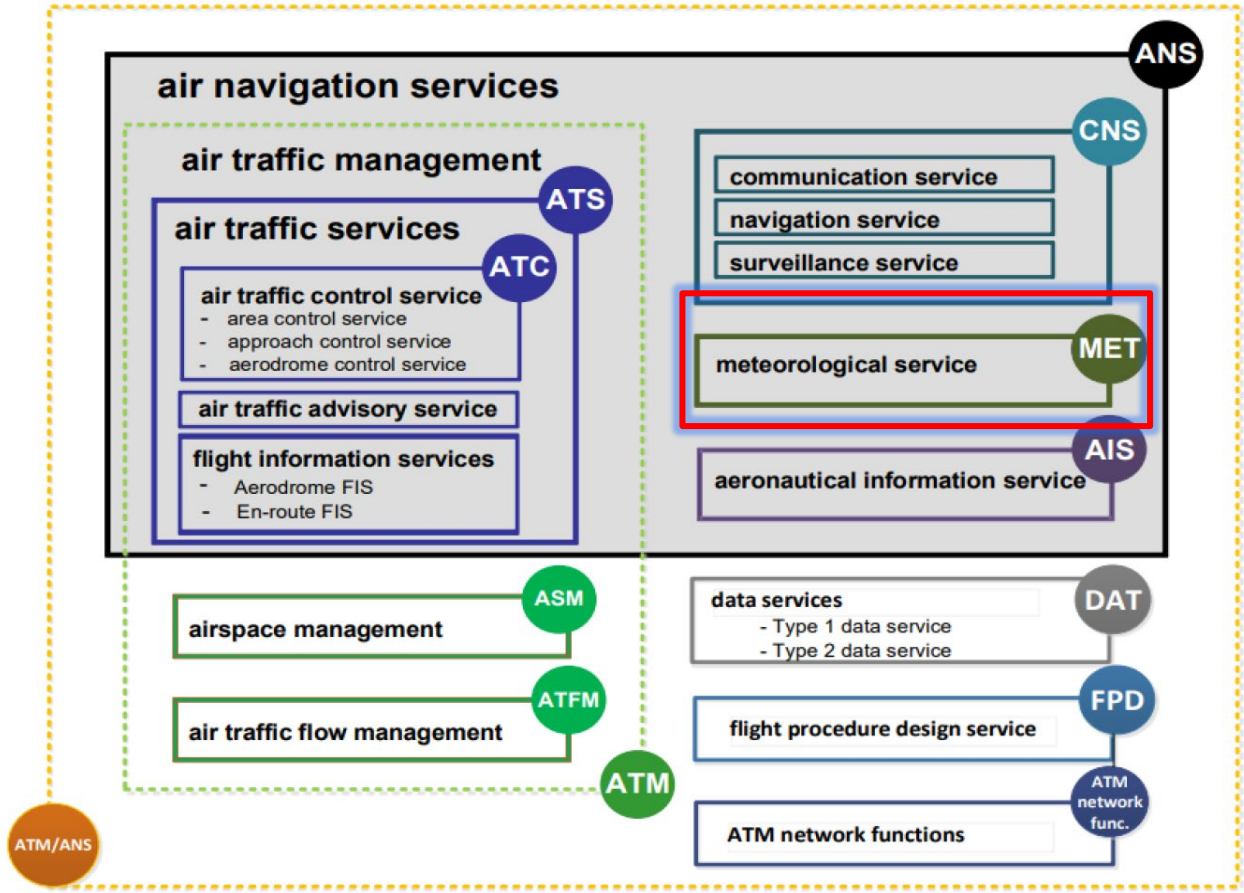
Catherine Streule
Compliance and Safety Manager

# Agenda

1. Purpose
2. Procedures
3. Results & Outlook

Aeronautical meteorology is part of air navigation services (ANS) and is subject to various regulatory requirements from ICAO, EU, WMO and the federal government.

# 1 - MET as part of air navigation services

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# 1 - Regulatory requirements 1/2

- COMMISSION IMPLEMENTING REGULATION (EU) 2017/373
  of 1 March 2017
  laying down common requirements for providers of air traffic management / air navigation services and other air traffic management network functions and their oversight, repealing Regulation (EC) No 482/2008, Implementing Regulations (EU) No 1034/2011, (EU) No 1035/2011 and (EU) 2016/1377 and amending Regulation (EU) No 677/2011

- The SOAP Directive of FOCA provides with further specifications

*SOAP = Safety Oversight in Air Navigation Service Provision

# 1 - Regulatory requirements 2/2

**ATM/ANS.OR.A.045 Changes to a functional system**

(a) A service provider planning a change to its functional system shall:

(1) notify the competent authority of the change;

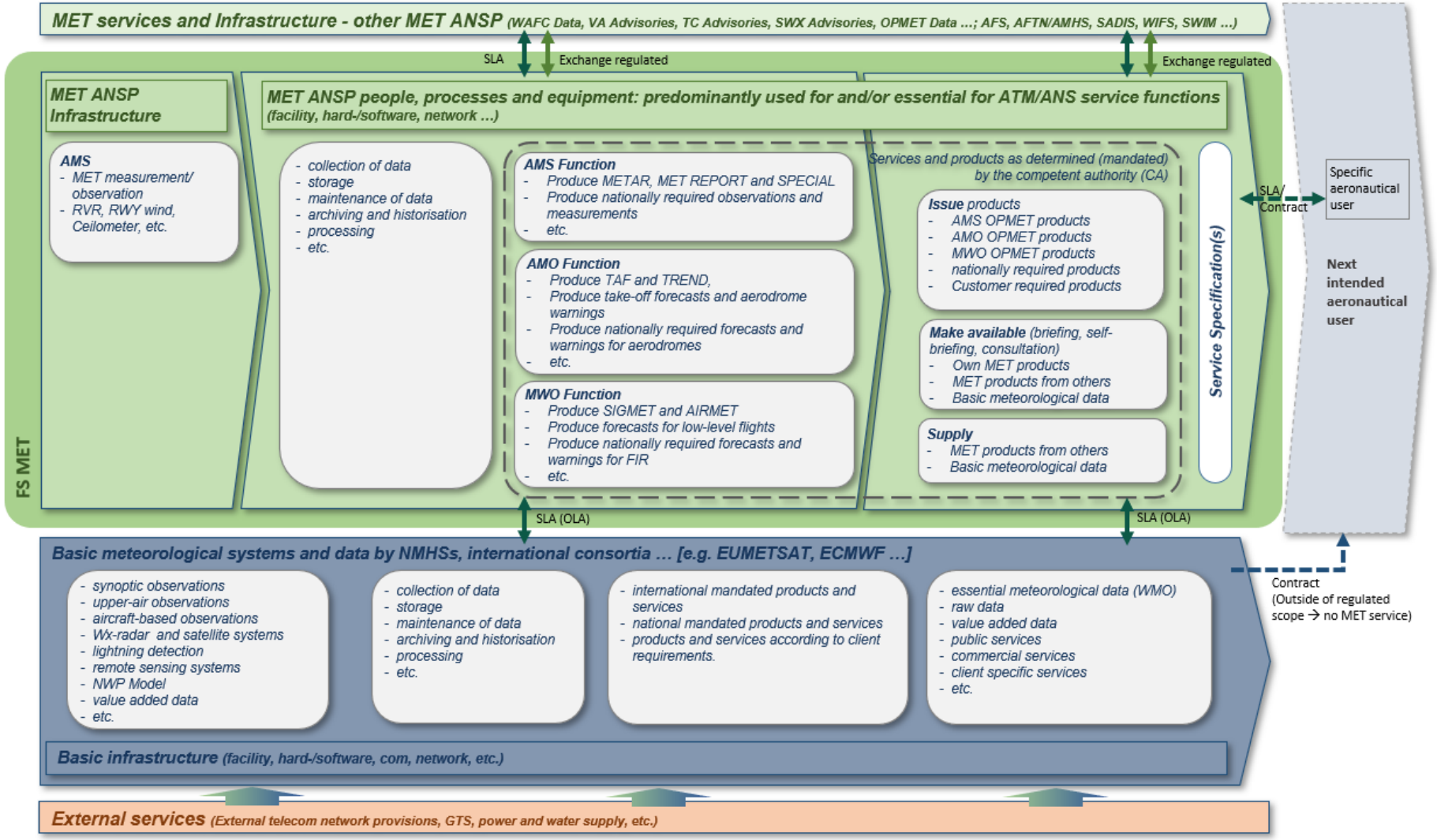
(2) provide the competent authority, if requested, with any additional information that allows the competent authority to decide whether or not to review the argument for the change;

(3) inform other service providers and, where feasible, aviation undertakings affected by the planned change.

# 1 - Functional System 1/2

'*functional system*' means a combination of procedures, human resources and equipment, including hardware and software, organised to perform a function within the context of ATM/ANS and other ATM network functions;

# 1 - Functional System 2/2

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# 1 - Service Specifications

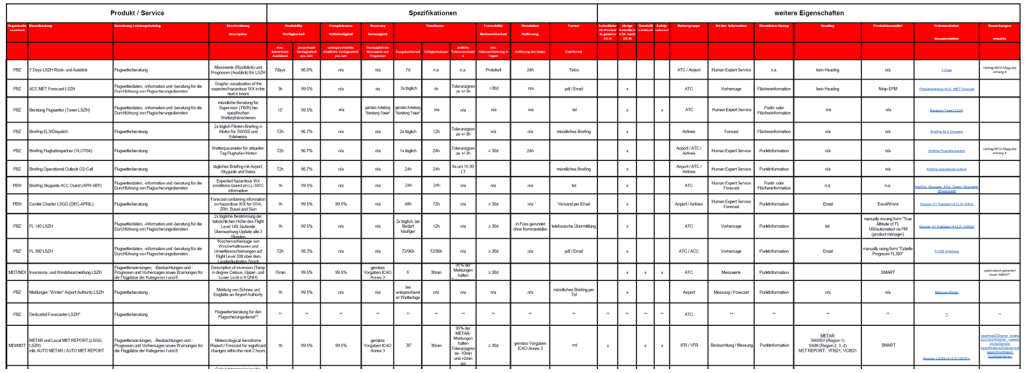
- Availability
- Completeness
- Accuracy
- Timeliness
- Traceability
- Resolution
- Format
- Integrity

**Beschreibung der Servicespezifikationen (Qualitätsanforderungen)**

| | |
|---|---|
| **Availability*** | Ability of a service to perform its agreed function when required. Availability is determined by reliability, maintainability, serviceability, performance and security. Availability is usually calculated as a percentage. A related concept is the maximum tolerable downtime of a service given in a time unit. |
| **Accuracy** | Degree of conformity of a measured or calculated quantity to its actual, nominal, or some other reference, value.<br>The required accuracy of a particular data element should be based upon its intended use. Accuracy is usually specified for data elements that are derived from measured values, and are not specified for data elements which have a defined value. |
| **Resolution** | The required resolution of a particular data element should be based on its intended use. Resolution only applies to data elements that are derived from measured values, and does not apply to data elements that are defined. Since the resolution may also affect the accuracy of the data, it must be considered in relation to the accuracy requirement. |
| **Integrity** | The degree to which data is complete and free from errors in respect to other data quality properties, whether errors are introduced at source or subsequent processes in the Data Chain. |
| **Traceability** | User requirements for traceability are typically stated in terms of the duration of time that specific data elements must be traceable. Data traceability should be retained as long as the data is in use. |
| **Timeliness** | Many data elements have an identified period for which the data is valid. The period of validity may be based upon an update period from the supplier or the underlying characteristics of the data itself. |
| **Completeness** | Includes defining any requirements that define the minimum acceptable set of data to perform the intended function. One minimum set may be defined at time of equipment approval, while a larger set may be identified by the end-user. |
| **Format** | The format of delivered data must be adequate to ensure that the data, when loaded into the end application, is interpreted in a manner that is consistent with the intent of the data. The format of the data will also define the transmission resolution of data. |

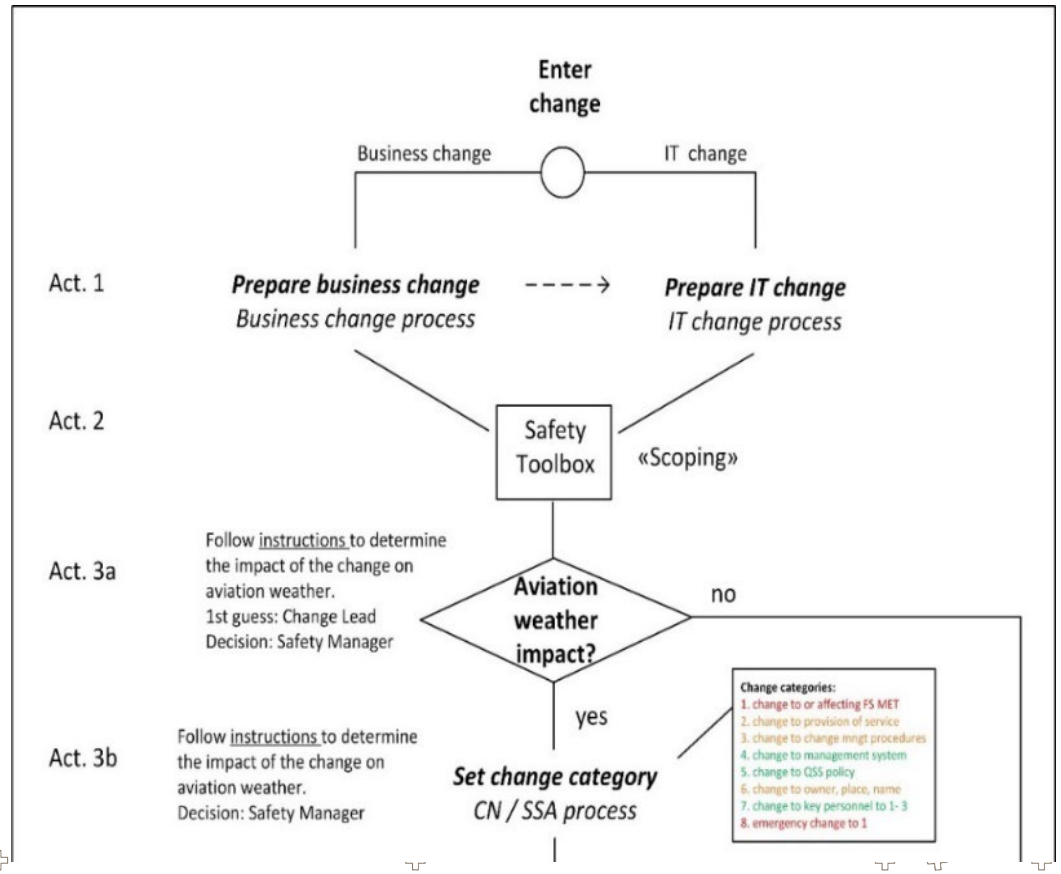
Tabelle 3: Servicespezifikationen (Qualitätsanforderungen) einer Dienstleistung
Quellen: EUROCONTROL / EUROCAE ED76/ RTCE DO200A Standards for Processing Aeronautical Data und *IT Infrastructure Library (ITIL)

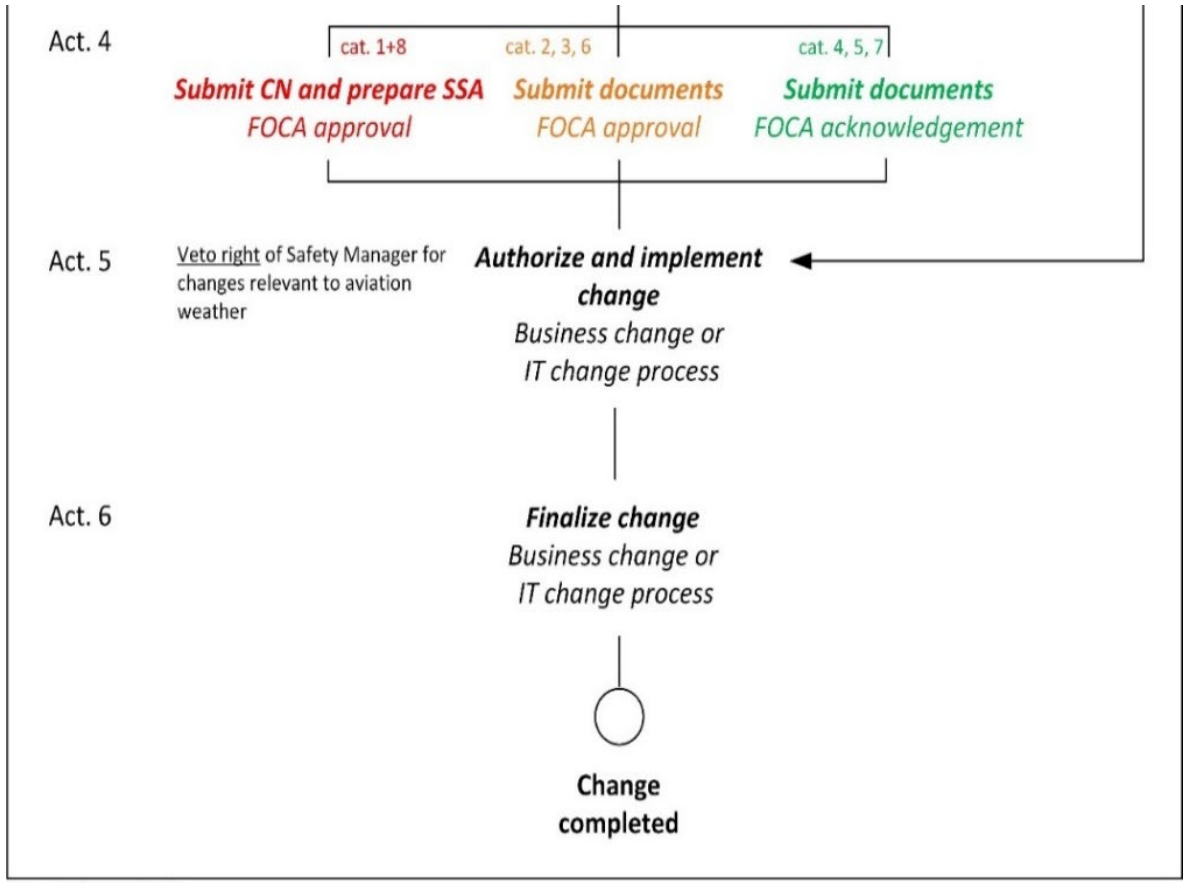
# 1 - Service Catalog



- An excerpt from the service catalog
  - Beratung Flugwetter TWR ZRH
  - Briefing skyguide ACC ouest
  - FL140 LSZH
  - Take-off-Forecast/Meteogramm (LSGG/LSZH)
  - METAR Regionalflugplätze inkl. AUTO METAR/ AUTO MET REPORT
  - Flugwetterprognose Motorflug d / Prévision pour le vol à moteur f
  - Datenlieferung Skybriefing

# 2 - Aeronautical Meteorology Change Management

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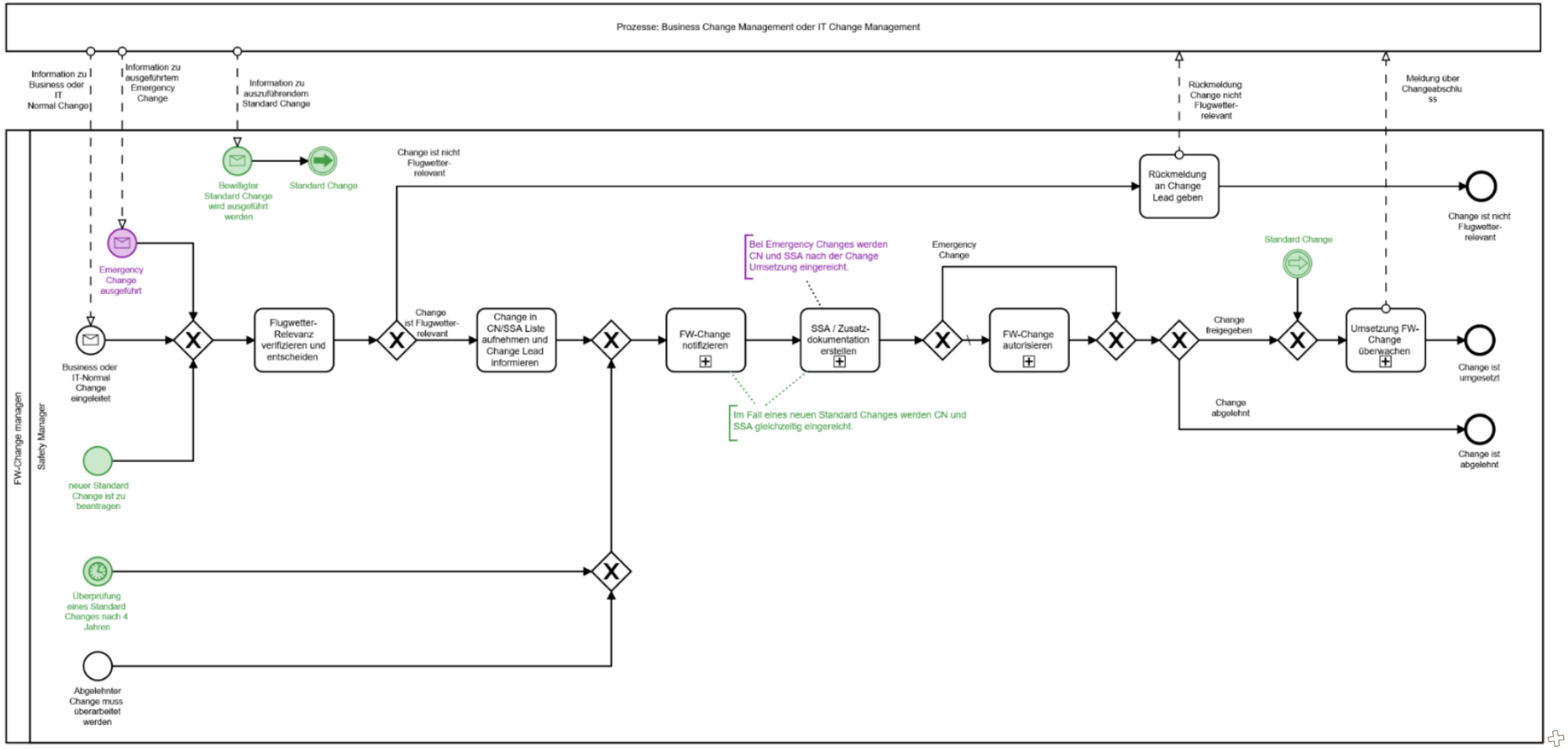
# 2 - Aeronautical Meteorology Change Management Process

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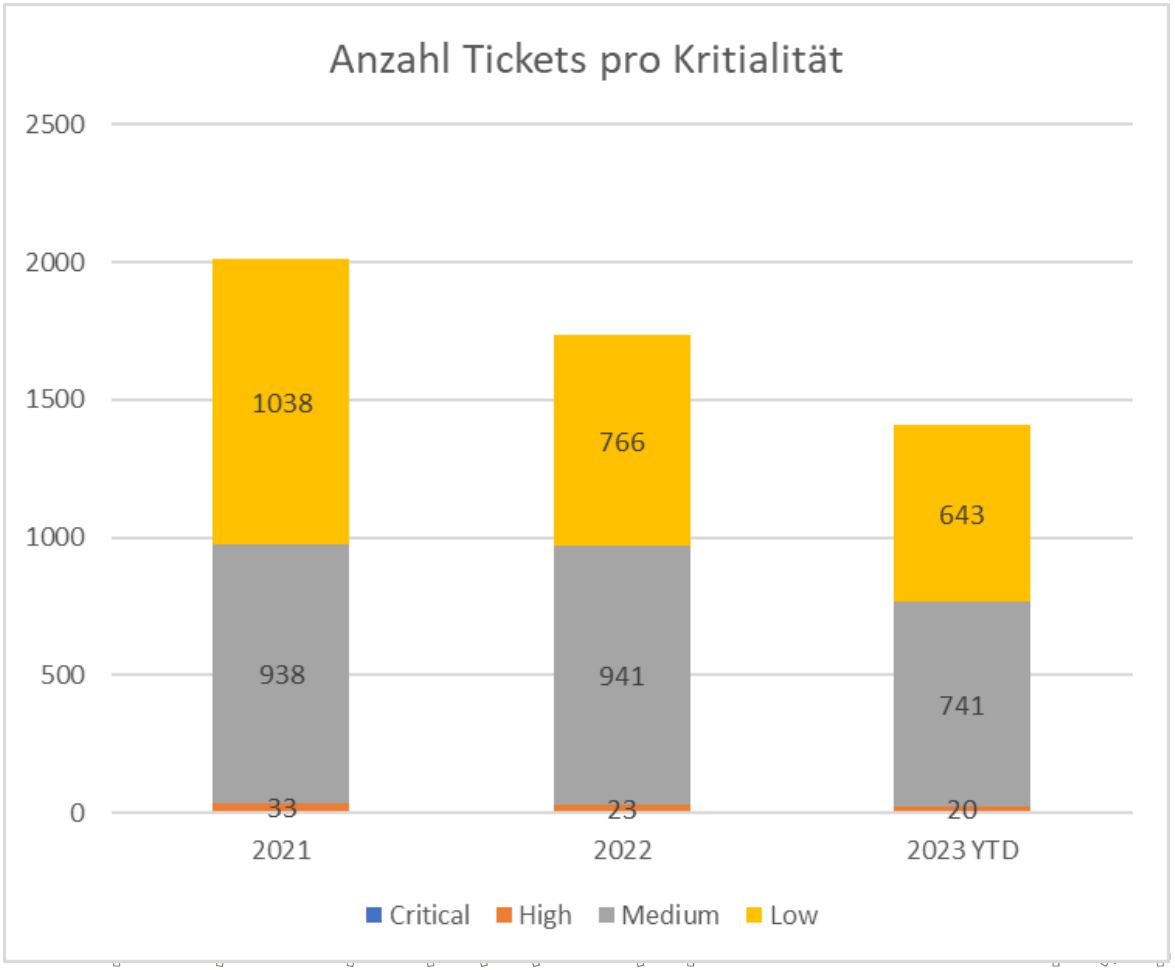
# 3 - Results - Outlook


- Cultural Change
- Resistance – Acceptance
- Challenges
- Benefit

# 3 - Results – Outlook




| | 2021 | 2022 | 2023 |
|---|---|---|---|
| Critical | 2 | 4 | 3 |
| High | 33 | 23 | 20 |
| Medium | 938 | 941 | 741 |
| Low | 1038 | 766 | 643 |
| Gesamtergel | 2011 | 1734 | 1407 |

Observation:

- Number of tickets decreased by 30% over the last 3 years (2023 Jan. – Oct.)
- Possible reason: coordinated implementation of changes.

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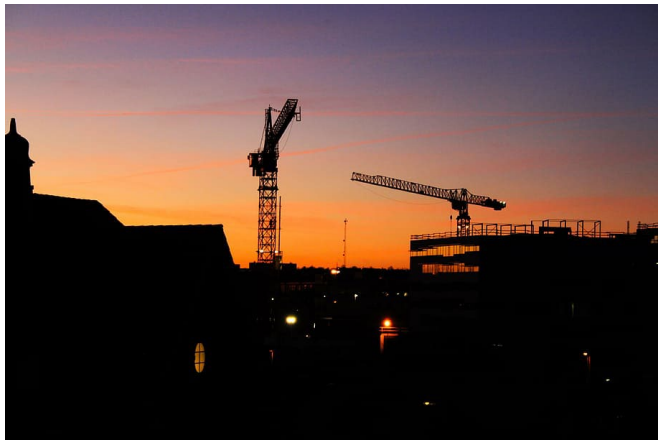
# 3 – Results - Outlook



- Further development in
  - Enterprise Architecture Management
  - BCM and IT Service Continuity