User Consultation 2021

Flugwetter MeteoSchweiz

Eröffnung

«Preparing for the Future»

Markus Aebischer
Leiter Produktmanagement und Distribution

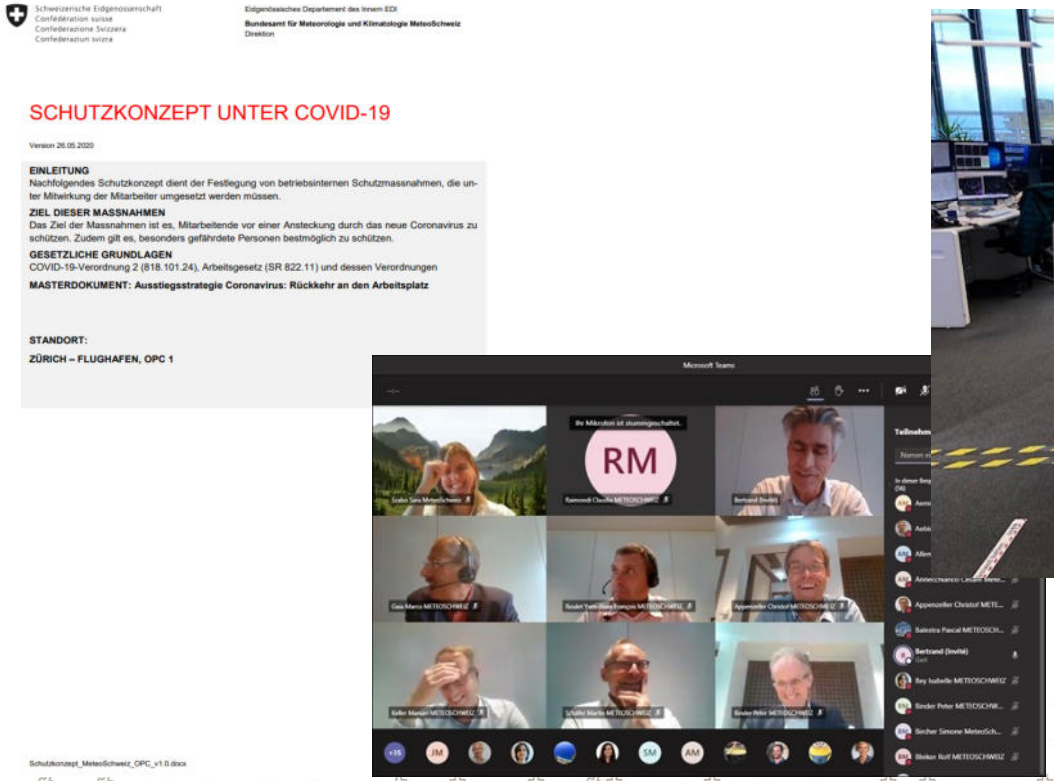
Welcome

«Preparing for the Future»

Manuel Keller
Leiter Planung und Kundenbeziehungen

BR Berset – Chef der MeteoSchweiz

COVID-19



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement des Innern EDI
Bundesamt für Meteorologie und Klimatologie MeteoSchweiz
Direktion

SCHUTZKONZEPT UNTER COVID-19

Version 26.05.2020

EINLEITUNG
Nachfolgendes Schutzkonzept dient der Festlegung von betriebsinternen Schutzmassnahmen, die unter Mitwirkung der Mitarbeiter umgesetzt werden müssen.

ZIEL DIESER MASSNAHMEN
Das Ziel der Massnahmen ist es, Mitarbeitende vor einer Ansteckung durch das neue Coronavirus zu schützen. Zudem gilt es, besonders gefährdete Personen bestmöglich zu schützen.

GESETZLICHE GRUNDLAGEN
COVID-19-Verordnung 2 (818.101.24), Arbeitsgesetz (SR 822.11) und dessen Verordnungen

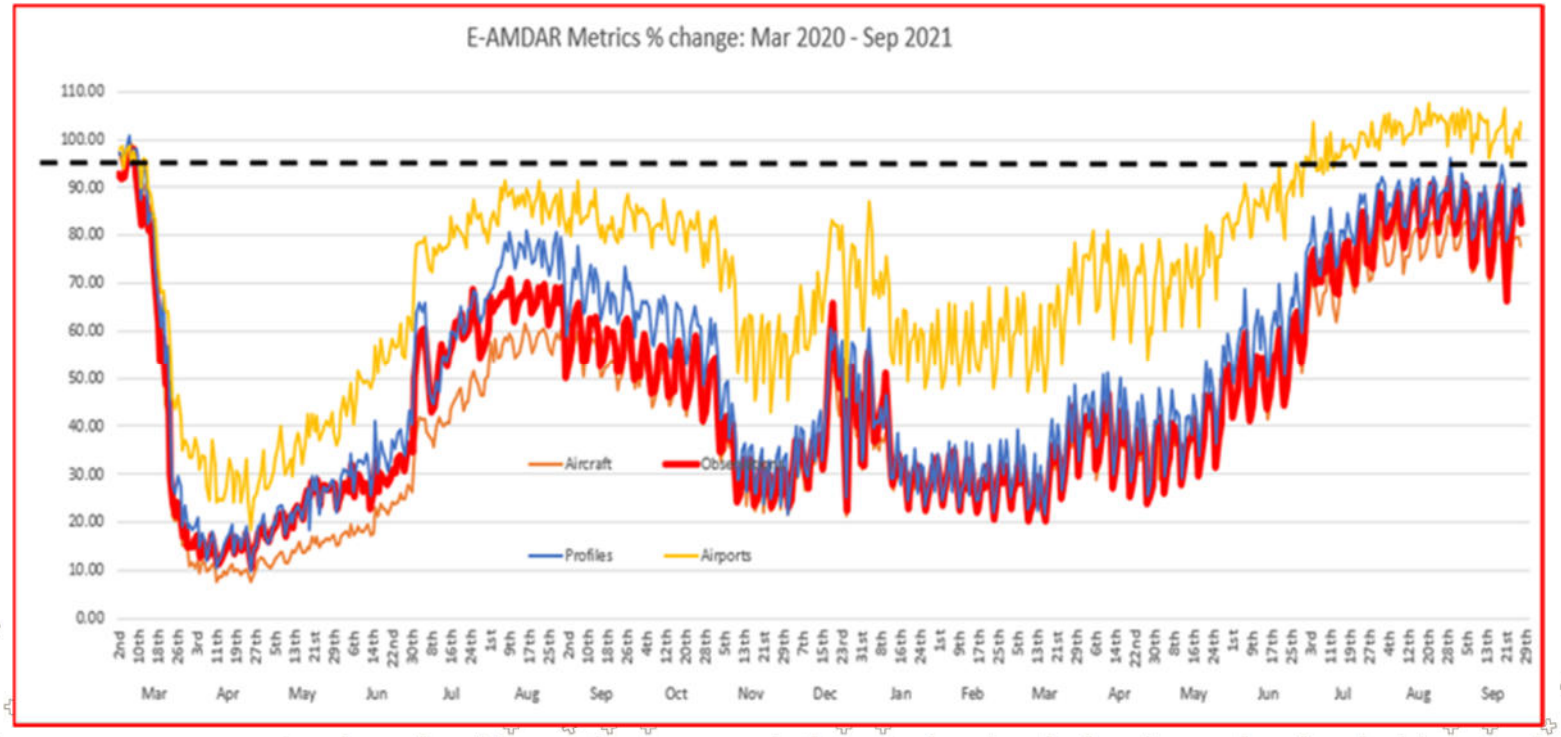
MASTERDOKUMENT: Ausstiegsstrategie Coronavirus: Rückkehr an den Arbeitsplatz

STANDORT:

ZÜRICH – FLUGHAFEN, OPC 1

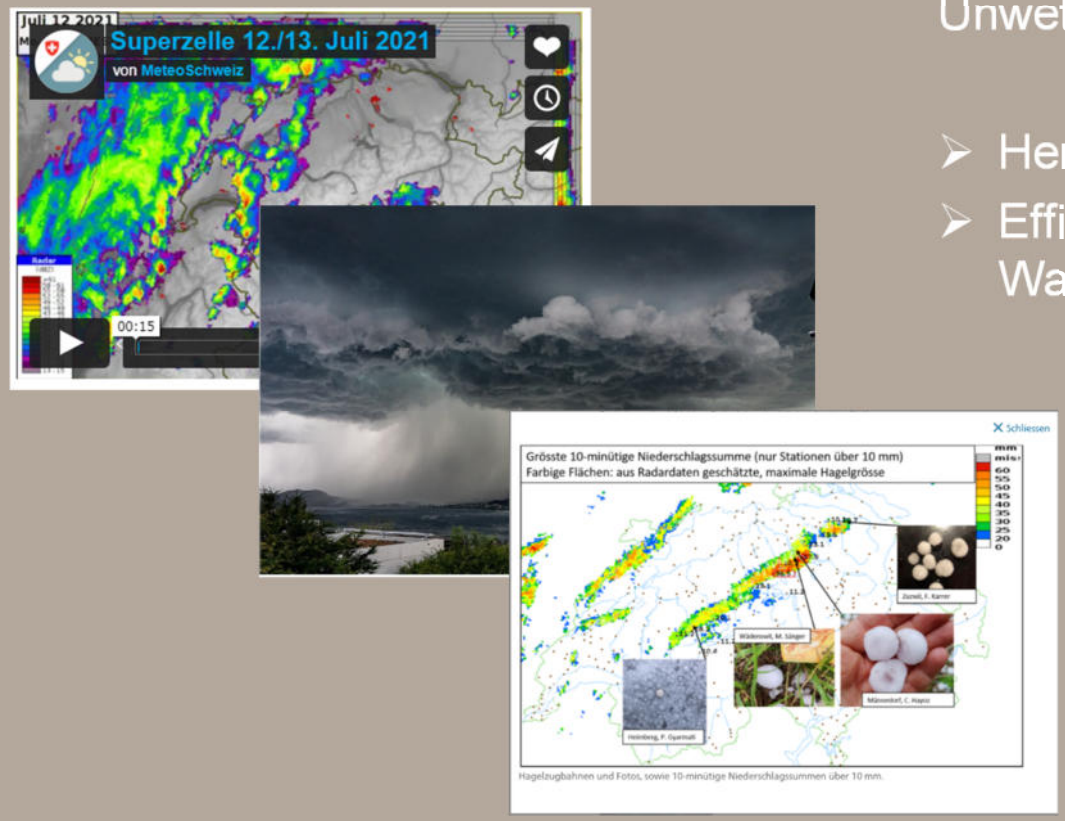
Schutzkonzept_MeteoSchweiz_OPC_v1.0.docx

COVID-19 Auswirkungen auf AMDAR



MeteoSwiss

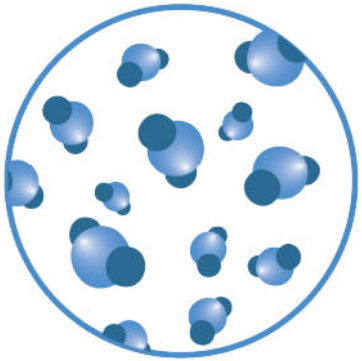
autoMETAR LSZH



Unwettersommer 2021:

- Herausfordernde Wetterlagen
- Effizientes und effektives Warnwesen in der Schweiz

CO_2
concentration



Highest

in at least

2 million years

Sea level
rise

Fastest rates

in at least

3000 years

Arctic sea ice
area

Lowest level

in at least

1000 years

Glaciers
retreat

Unprecedented

in at least

2000 years

[Credit: Yoda Adaman | Unsplash]

"It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

Auswirkungen auf den Luftverkehr

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 Seasonal and geographical changes in tourism demand patterns Heat damage to infrastructure
Changes to Rain & Snow Patterns	
Less snow overall, but heavier events Less rain in the South, more in the North More heavy rainfall events	Delays and cancellations Flooding of airports and access routes 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 Loss of en route capacity Convective weather affecting multiple airports simultaneously
Sea Level	
Over longer term, sea level rise Uncertainty over storm surges	Permanent or temporary loss of airport capacity, infrastructure and access. Network disruption
Changes to wind patterns	
Change in jet stream strength, position and curvature Shifts in prevailing wind direction Increase in extreme wind speeds in North and centre.	Increase in clear air turbulence Increased variability in trans-Atlantic times and routes Crosswind changes affecting airport capacity Operational disruption

Quelle: Eurocontrol; «European Aviation in 2040» (2018)

Strategie 2022 – 2026

Operativen Betrieb robust halten und Resilienz stärken

Digitalisierung und moderne Technologien produktiv nutzen

Hochwertige Leistungen produzieren und aktiv kommunizieren

Nationale und internationale Partnerschaften und Kooperationen sichern und gezielt ausbauen

Zusammenhalt und Zusammenarbeit stärken

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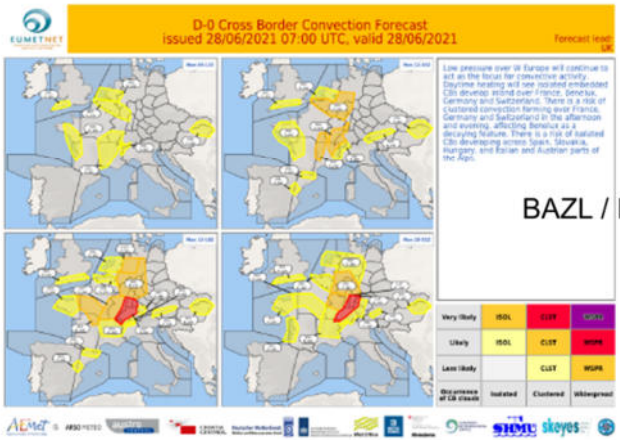
Strategie 2022 - 2026; «Flugwetterleistungen in der Schweiz und im europäischen Rahmen»

metalliance

EUROCONTROL

EUMETNET



Kunden/Partner

BAZL / MAA

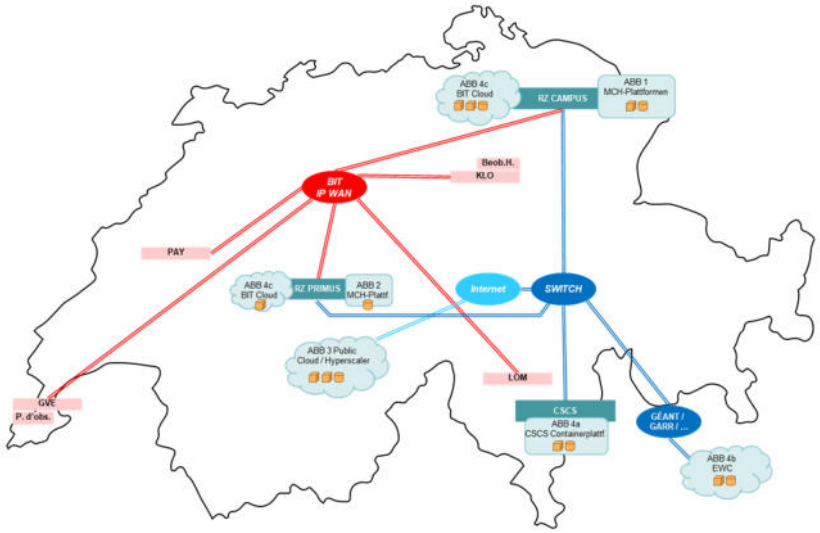
MeteoSchweiz

skyguide

GENÈVE AÉROPORT

Strategie 2022 - 2026; «Cloudbasierte Rechenleistung»

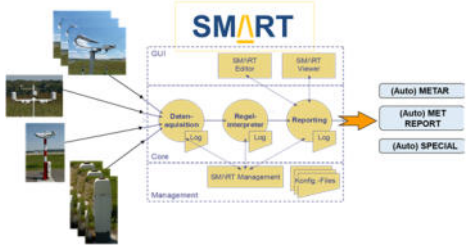
«Georedundanz zeitnah herstellen»
+
«Cloudstrategie umsetzen»
+
«Ersatzlösung RZ1-ZRH bereitstellen»
+
«IT-Betrieb robust halten»
=
Projekt RZPlus

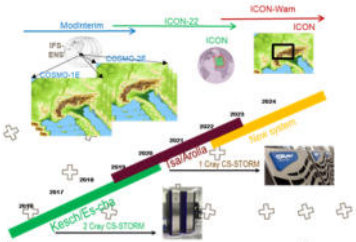


Unsere Leistungen -> auf unsere Kunden ausgerichtet und für Kunden weiterentwickelt

Aeronautical Climatological Information

AMAROC
AutoMetar /
AutoReport round
the clock





MeteoSwiss

Modelldaten

PoC Drohnen

MeteoSchweiz – «trusted and certified» Partner

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Office of Civil Aviation FOCA

A member of the European Aviation Safety Agency

Service Provider

Certificate

Reference: CH.ANSP.0002 / Issue 1

Pursuant to Implementing Regulation (EU) 2017/373 and subject to the conditions specified below, the Federal Office of Civil Aviation hereby certifies:

MeteoSchweiz
Flugwetterdienstleistungen

P.O. Box 257, CH-8058 Zürich

as a Service Provider with the privileges, as listed in the attached service provision conditions.

CONDITIONS

This certificate is issued subject to the conditions and the scope of providing services and functions as listed in the attached service provision conditions. This certificate is valid whilst the certified service provider remains in compliance with Implementing Regulation (EU) 2017/373 and the other applicable regulations and, when relevant, with the procedures in the service provider's documentation. Subject to compliance with the foregoing conditions, this certificate shall remain valid unless the certificate has been surrendered, limited, suspended or revoked.

Date of issue: 30.06.2020

Christian Hegner
Director General
Board of Directors

Marco Gamegger
Director
Head of Safety Division - Infrastructure

EASA Form 10? Issue 1 — Page 1 of 2

Vielen Dank für Ihre Partnerschaft – vielen Dank für Ihr Vertrauen

User Consultation 2021

Flugwetter MeteoSchweiz

«Unsere Zukunft hängt davon ab, wie
wir unsere Gegenwart gestalten.»
(Dalai Lama)

Agenda

09:25 – Aeronautical Climatological Information

09:45 – Programm AMAROC

10:05 – Pause

10:10 – Meteodrohnen

10:30 – Modellentwicklung

10:50 – Pause

11:00 – Breakout-Sessions

11:35 – MeteoSchweiz News

11:55 – Abschluss

12:00 – Ende der Veranstaltung

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Interaktiver Austausch

Stellen Sie uns Ihre Fragen via Slido!

Link und QR-Code:

#463089

https://app.sli.do/event/26ql8r1u

Interaktiver Austausch

Tauschen Sie sich mit unseren Experten in den virtuellen Breakout-Sessions über wonder.me aus!

1. Wetter, Prognose und Klima
2. Remote Sensing Upper Air & Modelldaten (NWP)
3. Freizeitaviatik
4. Distribution
5. Open Exchange

Link:
https://app.wonder.me/?spaceId=1127092b-7c5b-45d3-8856-16b13aa3adda

Breakout-Sessions – wonder.me

Aeronautical Climatological Information

Francesco Isotta
Wissenschaftlicher Mitarbeiter
Team Klimagrundlagen

Inhalt

- Einführung
- METAR-Daten und Herausforderungen
- Analyse - neues Instrument
- Kurze Übersicht der Resultate
- Zusammenfassung

Einführung

aviationpros.com

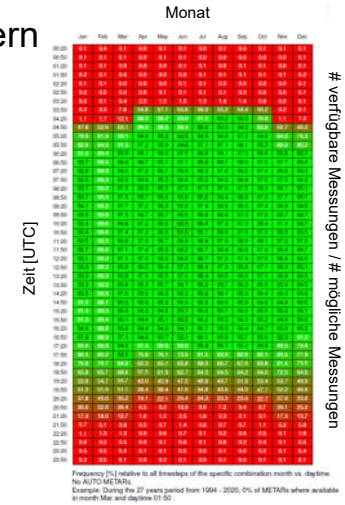
- Welches Wetter ist eine potentielle Gefahr für Aviatik?
  - Detektiert, beschrieben.
  - Wie oft kommt es überhaupt vor? ➔ Flughafenklimatologie.

- Vorgängige Berichte:
  - 2004: C. Schmutz, D. Schmuki, S. Rohling, Arbeitsbericht «Aeronautical Climatological Information Zurich LSZH».
  - 2013: P. du Preez, F. Mangold, Technical Report, «Aeronautical Climatological Information», Altenrhein, Bern, Genf, Grenchen, Lugano, Sion, Zürich. Nicht offiziell herausgegeben.
- Wunsch nach Überarbeitung und Aktualisierung.
- Neu: METARs von einigen Flughäfen «entschlüsselt» und in eigenen Parametern digital ins data warehouse der MeteoSchweiz abgespeichert (ab 1990, sofern verfügbar)

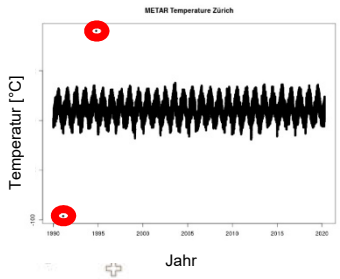
  (Zürich LSZH, Genf LSGG, Bern-Belp LSZB, Sion LSGS, Les Eplatures LSGC, Lugano LSZA, Buochs LSZC, Grenchen LSZG, St.Gallen-Altenrhein LSZR, Samedan LSZS)

METARs – Daten, Herausforderungen

Bern



- Unterschiedliche Datenverfügbarkeit in der Zeit, zwischen Flughäfen und je nach Parametern. Zudem spezielle Verhältnisse (z.B. 00:20 in Zürich) → klar ausgewiesen (NA Angabe).
- Einführung automatische METARs
- Juli 1993 neues METAR Format eingeführt → ab 1994
- Messungen sind nicht für Klimaanalysen gedacht (inhomogen,…)
- Messfehler
- Korrigierte, verspätete, zusätzliche Meldungen (CCx, RRx, AAx)
- Codierte Werte (Wolkenhöhe → Umrechnungstabellen), viele Kombinationen von Wetterphänomenen (–FZRA, FZRA, +FZRA), variierende Pistenangaben, sich ändernde Pistenbezeichnungen,…
- Sehr unterschiedliche Analysen/Tabellen



Hilfsmittel (R-Paket) mit Barbara Scherrer

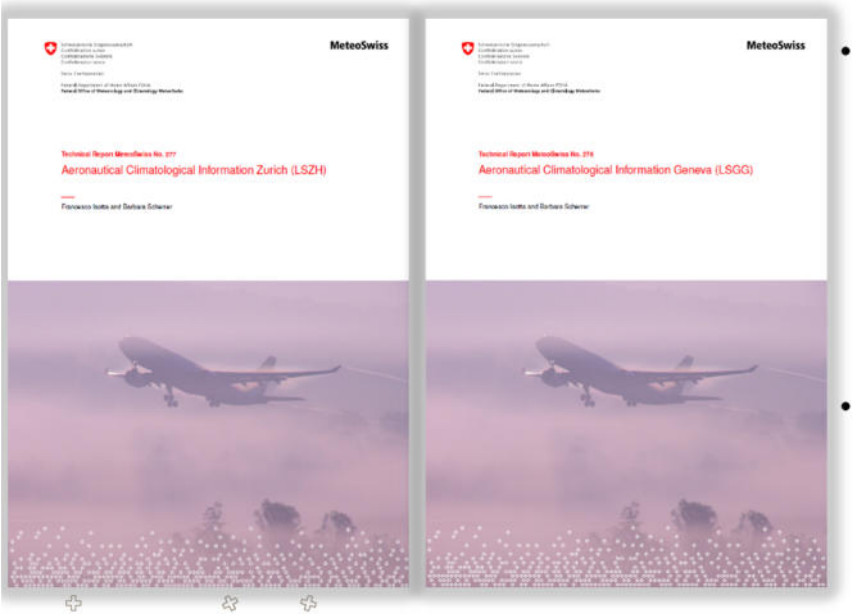
Paket in der R-Sprache entwickelt: sehr flexibel, 460 unterschiedliche Grafiken (Berichte LSZH und LSGG) und bereit für weitere Analysen (modularer Aufbau).

- Qualitätskontrolle
- Einarbeitung CCx, RRx, AAx
- Windrosen
- Tabellen (Kondensation der Daten)
- Verschiedene Zeitaggregationen

→ Viel automatisiert

→ Viele Möglichkeiten für Personalisierung

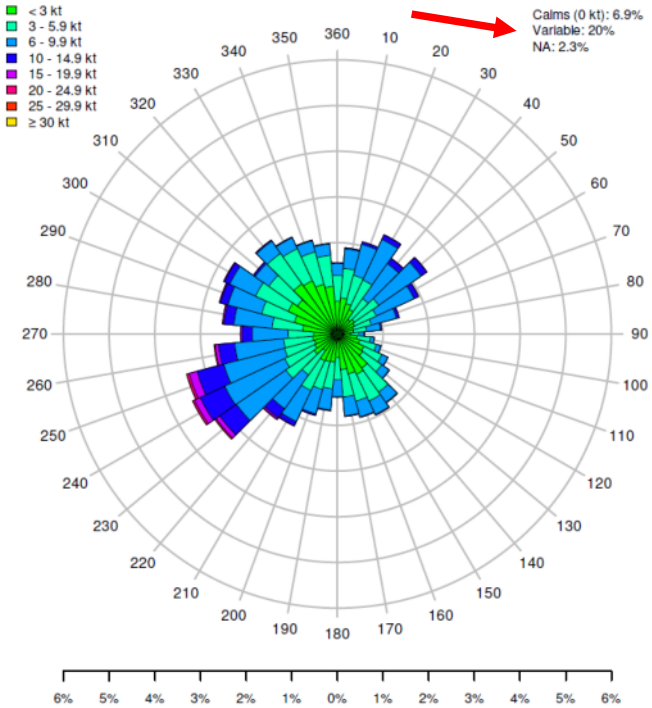
Kurze Übersicht der Berichte



- Erster Teil: Klimatologie
  - Aufgeteilt nach Strömungslagen (W,N,E,S) und Drucklagen (flache Druckverteilung, Hochdruck)
    - Synoptik (grossräumige Wetterbeobachtung)
    - Saisonales Auftreten
    - Lokale Phänomene und Gefahren für die Aviatik
- Zweiter Teil: Tabellen und Grafiken
  - Analysen für die gesamte Periode (27 Jahre) sowie saisonal, monatlich und stündlich getrennt

Windrosen

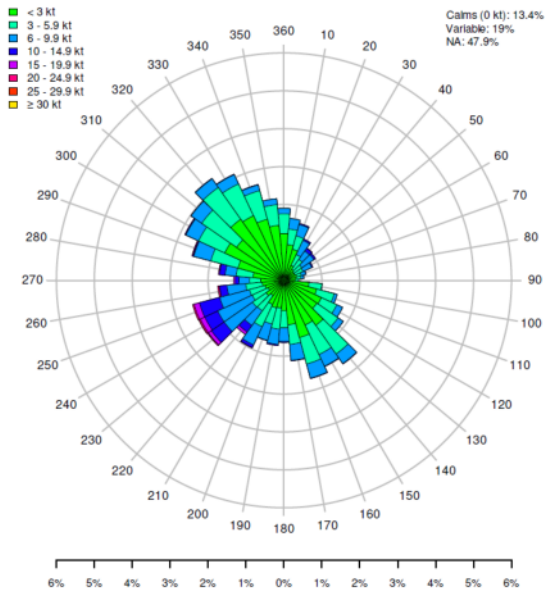
Wind rose during the 27 years period
from 1994 - 2020, measured in ZRH (METAR)



NA: Percentage of not available METARs. No AUTO METARs.
Example: During the 27 years period from 1994 - 2020, 0.9% of all available METARs showed a wind speed between 6 - 9.9 kt with a wind direction of 40 degrees.

00-01 UTC

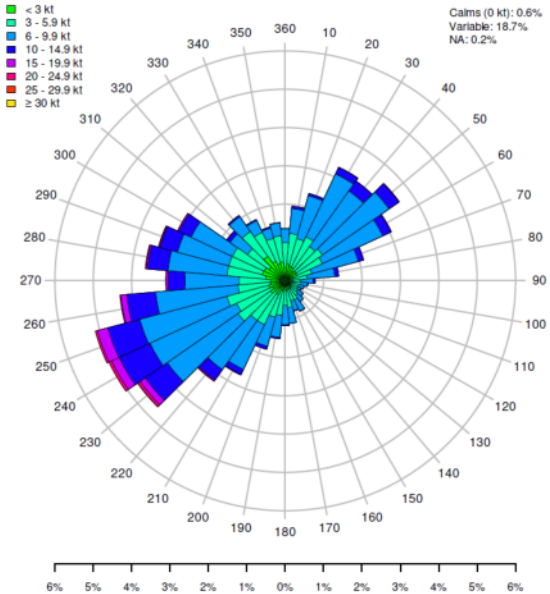
Wind rose btw. 00 - 01 UTC during the 27 years period
from 1994 - 2020, measured in ZRH (METAR)



: Percentage of not available METARs. No AUTO METARs.
ample: During the 27 years period from 1994 - 2020, 0.3% of all available METARs btw. 00 - 01 UTC
owed a wind speed between 6 - 9.9 kt with a wind direction of 40 degrees.

12-13 UTC

Wind rose btw. 12 - 13 UTC during the 27 years period
from 1994 - 2020, measured in ZRH (METAR)



NA: Percentage of not available METARs. No AUTO METARs.
Example: During the 27 years period from 1994 - 2020, 1.8% of all available METARs btw. 12 - 13 UTC showed a wind speed between 6 - 9.9 kt with a wind direction of 40 degrees.

Wind

Wind speed and direction during the 27 years period from 1994 - 2020 measured in ZRH (METAR)

Wind Speed [kt]

Wind Direction [°]	0	>0 - 1	1 - 2	3 - 5	6 - 10	11 - 15	16 - 20	21 - 25	26 - 30	31 - 35	36 - 40	41 - 45	46 - 49	≥ 50
Calm	6.9	-	-	-	-	-	-	-	-	-	-	-	-	-
Variable	-	7.6	11.5	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
350-360-010	-	0.5	2.1	1.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
020-030-040	-	0.3	1.4	1.9	2.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
050-060-070	-	0.2	1.0	1.6	2.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
080-090-100	-	0.2	0.9	0.8	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
110-120-130	-	0.2	1.6	1.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
140-150-160	-	0.4	2.4	1.9	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
170-180-190	-	0.3	1.6	1.7	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
200-210-220	-	0.2	1.5	2.0	2.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
230-240-250	-	0.3	1.4	2.2	4.1	1.8	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0
260-270-280	-	0.3	1.6	1.9	2.7	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
290-300-310	-	0.5	2.7	2.3	1.7	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
320-330-340	-	0.7	3.1	2.3	0.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Frequency [%] relative to all available METARs. No AUTO METARs.
Not available METARs: 2.3%, missing values: 0.0% (speed), 0.0% (direction).
Example: During the 27 years period from 1994 to 2020, 1.4% of all available METARs showed a wind speed between 1 - 2 kt with wind direction in sector 020-030-040 degrees.

Kumuliert

Cumulative wind speed and direction during the 27 years period from 1994 - 2020 measured in ZRH (METAR)

Wind Speed [kt]

Wind Direction [°]	0	>0 - 1	>0 - 2	>0 - 5	>0 - 10	>0 - 15	>0 - 20	>0 - 25	>0 - 30	>0 - 35	>0 - 40	>0 - 45	>0 - 49	>50
Calm	6.9	-	-	-	-	-	-	-	-	-	-	-	-	-
Variable	-	7.6	19.1	19.9	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
350-360-010	-	0.5	2.6	4.5	5.4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
020-030-040	-	0.3	1.7	3.6	6.2	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
050-060-070	-	0.2	1.2	2.8	5.4	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
080-090-100	-	0.2	1.1	1.8	2.3	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
110-120-130	-	0.2	1.8	3.1	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
140-150-160	-	0.4	2.8	4.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
170-180-190	-	0.3	1.9	3.6	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
200-210-220	-	0.2	1.7	3.7	6.0	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
230-240-250	-	0.3	1.7	3.9	8.0	9.8	10.1	10.2	10.2	10.2	10.2	10.2	10.2	10.2
260-270-280	-	0.3	1.8	3.7	6.4	7.2	7.3	7.4	7.4	7.4	7.4	7.4	7.4	7.4
290-300-310	-	0.5	3.2	5.5	7.3	7.6	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
320-330-340	-	0.7	3.8	6.1	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0

Cumulated frequency [%] relative to all available METARs. No AUTO METARs.
Not available METARs: 2.3%, missing values: 0.0% (speed), 0.0% (direction).
Example: During the 27 years period from 1994 to 2020, 1.7% of all available METARs showed a wind speed between >0 - 2 kt with wind direction in sector 020-030-040 degrees.

Wind pro RWY

Wind RWY 16 (34) in Winter (DJF) during the 27 years period
from 1994 - 2020, measured in ZRH (METAR)

Wind Speed [kt]

Wind Direction relative to RWY 16	0	>0 - 1	1 - 2	3 - 5	6 - 10	11 - 15	16 - 20	21 - 25	26 - 30	31 - 35	36 - 40	41 - 45	46 - 49	≥ 50
Calm	5.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Variable	-	7.0	9.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Headwind	-	1.0	6.9	7.2	4.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Right Cross	-	0.8	4.7	5.4	9.9	5.3	1.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Tailwind	-	1.4	7.0	5.3	2.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Left Cross	-	0.6	3.5	4.0	4.6	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Frequency [%] relative to all available METARs. No AUTO METARs.
Not available METARs: 2.4%, missing values: 0.1% (speed), 0.1% (direction).
Example: During the 27 years period from 1994 - 2020, 6.9% of all available observations in Winter (DJF) showed a Headwind relative to runway 16 (180° opposite for runway 34) with a wind speed between 1 - 2 kt.

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Windböen

Wind gusts during the 27 years period
from 1994 - 2020, measured in ZRH (METAR) [‰]

Wind Direction [°]	Wind Speed [kt] 10 - 15	16 - 20	21 - 25	26 - 30	31 - 40	41 - 60	> 60
Variable	0.13	0.06	0.00	0.00	0.00	0.00	0.00
0	0.01	0.01	0.00	0.00	0.00	0.00	0.00
10	0.01	0.01	0.01	0.00	0.00	0.00	0.00
20	0.02	0.04	0.01	0.00	0.00	0.00	0.00
30	0.02	0.14	0.07	0.03	0.00	0.00	0.00
40	0.05	0.19	0.15	0.05	0.01	0.00	0.00
50	0.06	0.32	0.28	0.06	0.00	0.00	0.00
60	0.05	0.33	0.26	0.07	0.00	0.00	0.00
70	0.05	0.32	0.18	0.05	0.00	0.00	0.00
80	0.03	0.16	0.10	0.02	0.00	0.00	0.00
90	0.01	0.04	0.02	0.00	0.00	0.00	0.00
100	0.00	0.02	0.00	0.00	0.00	0.00	0.00
110	0.00	0.01	0.00	0.00	0.00	0.00	0.00
120	0.00	0.01	0.00	0.00	0.00	0.00	0.00
130	0.00	0.00	0.00	0.00	0.00	0.00	0.00
140	0.00	0.00	0.01	0.00	0.00	0.00	0.00
150	0.00	0.01	0.00	0.01	0.00	0.00	0.00
160	0.00	0.00	0.01	0.01	0.00	0.00	0.00
170	0.01	0.01	0.00	0.00	0.00	0.00	0.00
180	0.02	0.02	0.01	0.01	0.00	0.00	0.00
190	0.01	0.02	0.01	0.00	0.00	0.00	0.00
200	0.02	0.05	0.04	0.01	0.00	0.00	0.00
210	0.03	0.08	0.11	0.06	0.01	0.01	0.00
220	0.02	0.11	0.26	0.25	0.10	0.01	0.00
230	0.02	0.22	0.54	0.73	0.29	0.03	0.00
240	0.03	0.31	0.76	1.02	0.44	0.03	0.00
250	0.03	0.30	1.01	1.48	0.62	0.06	0.00
260	0.03	0.29	0.68	0.75	0.27	0.04	0.00
270	0.03	0.16	0.25	0.25	0.10	0.00	0.00
280	0.03	0.16	0.25	0.16	0.08	0.02	0.00
290	0.02	0.10	0.13	0.12	0.06	0.01	0.00
300	0.02	0.05	0.16	0.08	0.03	0.00	0.00
310	0.00	0.02	0.04	0.02	0.00	0.00	0.00
320	0.01	0.03	0.02	0.02	0.00	0.00	0.00
330	0.01	0.02	0.02	0.00	0.00	0.00	0.00
340	0.01	0.00	0.00	0.02	0.00	0.00	0.00
350	0.01	0.02	0.00	0.00	0.00	0.00	0.00

Frequency [‰] relative to all available METARs. No AUTO METARs.
Not available METARs: 2.3%, missing values: 0.0% (direction).
Example: During the 27 years period from 1994 - 2020, 0.04‰ of all available observations showed a wind gust between 16 - 20 kt with a wind direction of 20 degrees.

Maximum wind gust during the 27 years period from 1994 - 2020, measured in ZRH (METAR)

	Time [UTC] 00 - 03	03 - 06	06 - 09	09 - 12	12 - 15	15 - 18	18 - 21	21 - 24	Day	NA [%]
January	56.0	50.9	46.1	48.0	41.0	50.9	53.1	45.1	56.0	2.6
February	48.0	39.1	47.0	48.0	57.0	42.0	42.0	50.0	57.0	2.8
March	41.0	41.0	48.0	48.0	43.0	40.0	43.9	36.9	48.0	2.2
April	33.0	33.0	32.1	35.0	43.0	41.0	34.0	28.0	43.0	2.4
May	29.9	28.0	29.9	34.0	34.0	39.1	30.9	34.0	39.1	2.2
June	33.0	36.9	47.0	33.0	33.0	48.0	37.9	28.0	48.0	2.2
July	33.0	30.9	35.0	29.9	36.9	37.9	48.0	29.0	48.0	2.2
August	29.9	36.0	25.1	34.0	34.0	45.1	37.9	40.0	45.1	2.2
September	28.0	28.0	35.0	33.0	46.1	35.0	33.0	29.0	46.1	2.2
October	49.0	41.0	46.1	40.0	43.9	46.1	46.1	37.9	49.0	2.3
November	35.0	43.9	39.1	36.9	40.0	34.0	33.0	37.9	43.9	2.4
December	41.0	42.0	36.9	60.1	46.1	47.0	36.9	39.1	60.1	2.3
Year	56.0	50.9	48.0	60.1	57.0	50.9	53.1	50.0	60.1	-
NA [%]	16.1	0.3	0.4	0.3	0.3	0.3	0.5	0.4	-	-

NA: Not available METARs [%]. No AUTO METARs.
Example: During the 27 years period from 1994 - 2020 the maximum wind gust reported in April between 09 - 12 UTC was 35 kt.

On the 26.12.1999 at 10:50 UTC a maximum wind gust of 60.1 kt was reported.

Visibility, Runway Visual Range (RVR)

Visibility during the 27 years period from 1994 - 2020, measured in ZRH (METAR)

Time [UTC]	Prevailing Visibility [m] < 50	< 100	< 150	< 350	< 600	< 800	< 1500	< 3000	< 5000	< 8000	< 10000	≥ 10000	CAVOK	NS [%]	NA [%]
00-01	0.1	0.1	0.4	2.3	3.7	4.3	5.4	8.7	15.7	28.3	35.7	38.3	25.9	0.0	47.9
01-02	0.0	0.1	0.4	2.5	4.0	4.7	5.9	9.5	16.9	30.4	37.6	38.2	24.1	0.0	0.3
02-03	0.0	0.2	0.5	2.8	4.5	5.1	6.6	10.6	18.7	32.8	40.3	38.3	21.3	0.1	0.2
03-04	0.0	0.1	0.6	3.3	5.1	6.0	7.7	11.8	20.7	35.7	43.7	38.3	18.0	0.1	0.2
04-05	0.0	0.1	0.6	3.4	5.4	6.3	8.0	12.4	22.1	37.4	45.5	37.0	17.4	0.0	0.2
05-06	0.0	0.1	0.5	3.4	5.3	6.1	8.0	12.7	22.5	38.2	46.3	35.3	18.3	0.1	0.2
06-07	0.0	0.1	0.4	3.1	4.7	5.4	7.3	12.4	22.3	37.3	45.1	36.2	18.6	0.0	0.2
07-08	0.0	0.1	0.3	2.6	3.8	4.4	6.3	11.6	20.5	34.7	42.3	39.5	18.1	0.1	0.2
08-09	0.0	0.0	0.1	1.8	2.9	3.4	4.8	9.6	17.6	30.9	38.6	44.3	17.1	0.1	0.2
09-10	0.0	0.0	0.1	0.9	1.6	2.0	3.2	7.0	14.3	26.4	33.9	50.1	16.0	0.0	0.2
10-11	0.0	0.0	0.0	0.3	0.7	1.0	1.9	4.8	11.1	22.4	29.3	56.5	14.2	0.1	0.2
11-12	0.0	0.0	0.0	0.2	0.4	0.6	1.2	3.4	8.6	19.0	25.5	61.3	13.2	0.1	0.2
12-13	0.0	0.0	0.0	0.1	0.2	0.3	0.9	2.6	6.7	16.2	22.4	64.5	13.1	0.0	0.2
13-14	0.0	0.0	0.0	0.1	0.2	0.3	0.7	2.1	5.6	14.6	20.2	65.5	14.2	0.1	0.3
14-15	0.0	0.0	0.0	0.2	0.3	0.3	0.7	2.2	5.5	14.2	19.5	64.7	15.7	0.1	0.2
15-16	0.0	0.0	0.1	0.3	0.4	0.4	0.9	2.6	6.4	14.7	20.0	62.4	17.5	0.1	0.2
16-17	0.0	0.0	0.1	0.3	0.4	0.5	0.9	2.5	6.8	15.7	21.1	58.7	20.2	0.1	0.2
17-18	0.0	0.0	0.1	0.4	0.5	0.5	0.8	2.4	7.0	16.6	22.3	54.0	23.6	0.1	0.2
18-19	0.0	0.0	0.0	0.4	0.6	0.7	1.1	2.6	7.5	17.7	23.8	49.4	26.7	0.1	0.2
19-20	0.0	0.0	0.0	0.4	0.8	1.0	1.3	3.1	8.1	18.8	25.1	46.8	28.0	0.1	0.9
20-21	0.0	0.0	0.1	0.7	1.0	1.2	1.8	3.8	8.9	20.2	26.8	44.5	28.6	0.1	0.3
21-22	0.0	0.1	0.1	0.9	1.5	1.8	2.5	4.8	10.2	21.8	28.3	42.6	29.1	0.0	0.2
22-23	0.0	0.1	0.2	1.2	2.1	2.4	3.3	5.9	11.7	23.6	30.4	41.2	28.4	0.0	0.3
23-24	0.0	0.1	0.3	1.7	2.7	3.2	4.2	7.2	13.7	26.1	33.0	39.4	27.5	0.1	0.5

Frequency [%] relative to all available METARs in a specific hour interval. No AUTO METARs.
NA: Not available METARs [%]. NS: Values not supplied in METAR [%].
Example: During the 27 years period from 1994 - 2020, 3.3% of all available METARs between 03-04 UTC showed a visibility < 350 m.

Runway Visual Range RWY 16 during the 27 years period from 1994 - 2020, measured in ZRH (METAR)

Runway Visual Range RWY 16 [m] < 50	< 100	< 200	< 350	< 550	< 800	< 1000	< 1200	< 1500	NS [%]	NA [%]
0.0	0.0	0.0	0.7	2.0	3.5	4.3	4.8	5.3	92.9	47.9
0.0	0.0	0.0	0.8	2.1	3.6	4.6	5.3	5.7	92.2	0.3
0.0	0.0	0.0	0.7	2.2	4.0	5.1	5.7	6.2	91.3	0.3
0.0	0.0	0.0	0.8	2.4	4.7	5.8	6.4	6.9	90.1	0.2
0.0	0.0	0.0	0.7	2.5	4.8	6.1	6.7	7.3	89.6	0.3
0.0	0.0	0.0	0.8	2.4	4.5	5.6	6.3	6.8	90.0	0.3
0.0	0.0	0.0	0.8	2.5	4.0	4.8	5.2	5.8	91.5	0.3
0.0	0.0	0.1	0.8	2.1	3.4	4.0	4.4	4.9	92.8	0.3
0.0	0.0	0.0	0.6	1.5	2.5	3.0	3.4	3.8	94.4	0.3
0.0	0.0	0.0	0.3	0.8	1.4	1.8	2.1	2.5	96.1	0.3
0.0	0.0	0.0	0.2	0.4	0.6	0.8	1.0	1.4	97.7	0.3
0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.6	0.8	98.4	0.3
0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.5	98.9	0.3
0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	99.1	0.3
0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.3	0.4	99.2	0.3
0.0	0.0	0.0	0.1	0.2	0.3	0.3	0.4	0.5	98.9	0.3
0.0	0.0	0.0	0.1	0.2	0.4	0.5	0.5	0.6	98.9	0.3
0.0	0.0	0.0	0.1	0.3	0.5	0.6	0.6	0.7	98.9	0.3
0.0	0.0	0.0	0.1	0.3	0.6	0.7	0.8	1.0	98.5	0.3
0.0	0.0	0.0	0.1	0.4	0.8	1.0	1.2	1.4	98.0	1.0
0.0	0.0	0.0	0.2	0.6	1.1	1.4	1.7	1.9	97.1	0.3
0.0	0.0	0.0	0.3	0.8	1.7	2.0	2.3	2.6	96.2	0.3
0.0	0.0	0.0	0.4	1.0	1.9	2.5	2.9	3.2	95.3	0.4
0.0	0.0	0.0	0.6	1.6	2.8	3.3	3.7	4.0	94.2	0.5

Frequency [%] relative to all available METARs in a specific hour interval. No AUTO METARs.
NA: Not available METARs [%]. NS: Values not supplied in METAR [%].
Example: During the 27 years period from 1994 - 2020, 0.8% of all available observations between 03-04 UTC showed a runway visual range< 350 m.

Ceiling

Ceiling during the 27 years period from 1994 - 2020, measured in ZRH (METAR)

	Ceiling [m]									
	< 60	< 90	< 150	< 200	< 300	< 350	< 450	≥ 450	NS [%]	NA [%]
January	0.2	1.1	4.5	7.6	12.1	15.2	19.8	51.5	28.7	2.5
February	0.1	0.4	1.3	2.3	4.0	5.9	8.4	51.1	40.4	2.8
March	0.0	0.1	0.3	0.6	1.3	2.2	3.6	46.4	50.0	2.2
April	0.0	0.0	0.1	0.3	0.8	1.3	2.4	44.7	52.8	2.4
May	0.0	0.1	0.2	0.3	0.6	1.1	2.3	47.5	50.3	2.1
June	0.0	0.0	0.1	0.2	0.4	0.7	1.0	43.1	55.8	2.1
July	0.0	0.1	0.1	0.2	0.3	0.5	0.8	39.0	60.2	2.2
August	0.0	0.1	0.2	0.4	0.7	0.9	1.3	39.0	59.7	2.1
September	0.1	0.3	0.7	1.2	1.9	2.6	3.5	42.2	54.3	2.1
October	0.1	1.0	2.5	4.3	7.0	8.6	11.0	44.0	45.0	2.2
November	0.2	1.8	5.0	7.7	12.0	14.8	18.2	47.3	34.5	2.3
December	0.2	2.1	5.8	9.5	13.9	16.7	20.2	51.6	28.2	2.1

Frequency [%] relative to all available METARs in a specific hour interval.
No AUTO METARs.
NA: METAR not available [%]. NS: values not supplied in METAR [%].
Example: During the 27 years period from 1994 - 2020, 0.8% of all available observations in April showed a base height
of the lowest cloud layer of BKN or OVC < 300 m.

Kombiniert: Visibility and Ceiling, RVR+Ceiling

Visibility and Ceiling during the 27 years period from 1994 - 2020, measured in ZRH (METAR)

Visibility [m] and Ceiling [m]

Time [UTC]	Vis < 800 OR Ceil < 60	< 1500 < 150	< 3000 < 300	< 5000 < 450	< 8000 < 600	≥ 8000 & ≥ 600	CAVOK	NS [%]	NA [%]
January	3.8	9.1	20.2	34.6	50.8	31.2	9.2	8.8	2.5
February	2.1	4.5	10.8	21.3	39.5	31.5	17.6	11.4	2.8
March	1.2	2.2	5.1	11.4	24.6	34.5	25.5	15.4	2.2
April	0.6	0.8	2.2	5.8	14.7	35.4	31.4	18.5	2.4
May	0.6	0.9	1.7	4.7	11.3	40.2	25.3	23.2	2.1
June	0.3	0.5	1.1	2.9	7.8	37.7	24.7	29.8	2.1
July	0.4	0.6	1.0	2.4	6.6	34.8	28.7	30.0	2.2
August	0.6	1.0	1.9	4.2	10.2	33.2	27.3	29.3	2.1
September	3.1	4.1	6.4	11.0	20.7	33.6	22.5	23.1	2.1
October	6.6	9.6	16.3	25.8	39.9	29.6	15.7	14.8	2.2
November	6.6	12.1	21.8	33.6	49.2	29.5	9.9	11.3	2.3
December	5.3	11.9	23.1	34.8	50.1	32.6	8.2	9.1	2.1

Frequency [%] relative to all available METARs in a specific hour interval. No AUTO METARs.
NA: METAR not available [%]. NS: values not supplied in METAR [%].
Example: During the 27 years period from 1994 - 2020, 5.8% of all available observations in April showed a base height of the lowest cloud layer of BKN or OVC < 60 m or a visibility < 5000 m.

Runway Visual Range RWY 16 and Ceiling during the 27 years period from 1994 - 2020, measured in ZRH (METAR)

Runway Visual Range RWY 16 [m] and Ceiling [m]

Time [UTC]	RVR < 50 OR Ceil	< 200	< 350 < 30	< 550 < 60	< 1500 < 90	≥ 1500 & ≥ 90	CAVOK	NS [%]	NA [%]
January	0.0	0.0	0.9	2.0	5.3	1.1	9.2	84.4	2.5
February	0.0	0.1	0.6	1.3	3.0	0.9	17.6	78.5	2.8
March	0.0	0.0	0.4	0.8	1.8	0.5	25.5	72.3	2.2
April	0.0	0.0	0.1	0.3	0.8	0.1	31.4	67.7	2.4
May	0.0	0.0	0.1	0.3	0.8	0.1	25.3	73.7	2.1
June	0.0	0.0	0.1	0.2	0.4	0.1	24.7	74.7	2.1
July	0.0	0.0	0.0	0.1	0.5	0.1	28.7	70.8	2.2
August	0.0	0.0	0.1	0.3	0.8	0.1	27.3	71.8	2.1
September	0.0	0.0	0.5	1.5	3.8	0.3	22.5	73.3	2.1
October	0.0	0.0	1.0	3.1	8.3	0.6	15.7	75.3	2.2
November	0.0	0.0	0.6	2.6	8.7	0.9	9.9	80.4	2.3
December	0.0	0.0	0.3	1.6	7.6	1.3	8.2	82.8	2.1

Frequency [%] relative to all available METARs. No AUTO METARs.
NA: METAR not available [%]. NS: values not supplied in METAR [%].
Example: During the 27 years period from 1994 - 2020, 0.3% of all available observations in April showed a base height of the lowest cloud layer of BKN or OVC < 60 m or a runway visual range < 550 m.

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Temperatur

Temperature in July during the 27 years period from 1994 - 2020, measured in ZRH (METAR)

Time [UTC]	Temperature [°C] <-20	-20 - -16	-15 - -11	-10 - -6	-5 - -1	0 - 4	5 - 9	10 - 14	15 - 19	20 - 24	25 - 29	30 - 34	35 - 39	≥ 40	NS [%]	NA [%]
00-01	0.0	0.0	0.0	0.0	0.0	0.0	1.3	35.4	58.4	4.9	0.1	0.0	0.0	0.0	0.0	47.8
01-02	0.0	0.0	0.0	0.0	0.0	0.0	2.0	39.2	54.7	3.9	0.1	0.0	0.0	0.0	0.1	0.2
02-03	0.0	0.0	0.0	0.0	0.0	0.0	2.9	43.2	50.6	3.3	0.1	0.0	0.0	0.0	0.0	0.1
03-04	0.0	0.0	0.0	0.0	0.0	0.0	3.9	46.7	46.9	2.4	0.1	0.0	0.0	0.0	0.1	0.1
04-05	0.0	0.0	0.0	0.0	0.0	0.0	3.4	43.6	50.6	2.4	0.0	0.0	0.0	0.0	0.0	0.2
05-06	0.0	0.0	0.0	0.0	0.0	0.0	0.5	27.1	63.5	8.8	0.1	0.0	0.0	0.0	0.0	0.2
06-07	0.0	0.0	0.0	0.0	0.0	0.0	0.1	15.2	57.7	26.0	1.0	0.0	0.0	0.0	0.0	0.2
07-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6	46.9	38.9	5.6	0.0	0.0	0.0	0.0	0.1
08-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9	36.9	43.0	14.0	0.3	0.0	0.0	0.0	0.0
09-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	29.4	42.5	21.9	2.0	0.0	0.0	0.0	0.1
10-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	23.7	39.3	28.9	4.8	0.0	0.0	0.0	0.1
11-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	19.8	36.6	32.6	8.3	0.0	0.0	0.0	0.3
12-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	17.3	33.6	34.2	11.8	0.2	0.0	0.1	0.0
13-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	16.6	33.4	33.8	13.4	0.8	0.0	0.0	0.1
14-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	16.6	31.0	34.7	14.0	1.1	0.0	0.0	0.1
15-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	16.3	31.6	34.1	13.7	1.0	0.0	0.0	0.1
16-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	17.1	32.9	34.1	11.0	0.7	0.0	0.0	0.2
17-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	20.3	36.0	30.9	7.7	0.1	0.0	0.0	0.2
18-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2	27.6	40.6	23.1	2.4	0.0	0.0	0.1	0.0
19-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1	39.5	42.2	9.0	0.2	0.0	0.0	0.0	0.8
20-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.0	50.4	34.5	1.9	0.1	0.0	0.0	0.0	0.1
21-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.6	57.3	25.3	0.8	0.0	0.0	0.0	0.0	0.2
22-23	0.0	0.0	0.0	0.0	0.0	0.0	0.2	22.6	61.5	15.3	0.2	0.0	0.0	0.0	0.0	0.3
23-24	0.0	0.0	0.0	0.0	0.0	0.0	0.8	26.8	63.0	9.2	0.2	0.0	0.0	0.0	0.0	0.5

Frequency [%] relative to all available METARs. No AUTO METARs.
NA: METAR not available [%]. NS: values not supplied in METAR [%].
Example: During the 27 years period from 1994 - 2020, 2.7% of all available METARs in July between 11-12 UTC showed a surface temperature between 10 - 14°C.

Maximum temperature during the 27 years period from 1994 - 2020, measured in ZRH

Time (Month)	Time Period [UTC] 00 - 03	03 - 06	06 - 09	09 - 12	12 - 15	15 - 18	18 - 21	21 - 00	Day	NS [%]	NA [%]
January	13	13	14	15	16	15	13	13	16	0.0	2.5
February	15	13	13	17	19	19	16	15	19	0.0	2.8
March	14	13	18	21	22	23	18	17	23	0.0	2.2
April	25	24	23	29	29	27	25	23	29	0.0	2.4
May	21	22	26	30	32	31	28	23	32	0.0	2.1
June	24	25	30	35	36	35	32	28	36	0.0	2.1
July	26	25	30	34	36	36	33	28	36	0.0	2.2
August	24	24	30	36	38	37	32	27	38	0.0	2.1
September	21	20	24	29	31	31	24	22	31	0.0	2.1
October	18	18	22	25	26	26	20	19	26	0.0	2.2
November	15	15	16	21	22	20	17	16	22	0.0	2.3
December	12	13	13	15	15	13	13	12	15	0.0	2.1
Year	26	25	30	36	38	37	33	28	38	0.0	-
NS [%]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-
NA [%]	16.1	0.2	0.2	0.2	0.2	0.2	0.5	0.3	-	-	-

No AUTO METARs.
NA: METAR not available [%]. NS: values not supplied in METAR [%].
Example: During the 27 years period from 1994 - 2020 the maximum temperature reported in April between 09 - 12 UTC was 29°C.

On the 13.08.2003 at 14:50 UTC a maximum temperature of 38°C was reported.

Average maximum temperature during the 27 years period from 1994 - 2020, measured in ZRH

Time (Month)	Time Period [UTC] 00 - 03	03 - 06	06 - 09	09 - 12	12 - 15	15 - 18	18 - 21	21 - 00	NS [%]	NA [%]
January	8.2	8.0	8.6	10.4	11.3	10.6	9.3	8.8	0.0	2.5
February	7.9	7.7	8.5	12.5	14.0	13.5	10.4	8.8	0.0	2.8
March	11.1	10.6	13.1	17.4	19.5	19.3	15.0	12.3	0.0	2.2
April	13.4	13.1	18.0	22.4	23.7	23.5	19.8	16.0	0.0	2.4
May	17.1	17.5	22.4	26.2	27.7	27.8	24.4	19.8	0.0	2.1
June	19.7	21.1	26.1	30.0	31.5	31.4	28.4	23.1	0.0	2.1
July	21.0	21.2	27.0	30.9	32.7	32.9	29.4	23.4	0.0	2.2
August	21.1	20.4	25.7	30.1	31.9	31.6	27.6	23.4	0.0	2.1
September	17.6	17.1	21.0	25.3	27.0	26.6	21.5	18.8	0.0	2.1
October	15.3	15.2	17.2	21.1	22.3	21.3	17.0	15.9	0.0	2.2
November	11.0	11.0	11.9	14.9	15.8	14.5	12.3	11.6	0.0	2.3
December	9.1	9.5	9.7	11.7	12.0	10.4	9.7	9.2	0.0	2.1
NS [%]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-
NA [%]	16.1	0.2	0.2	0.2	0.2	0.2	0.5	0.3	-	-

No AUTO METARs.
NA: METAR not available [%]. NS: values not supplied in METAR [%].
Example: During the 27 years period from 1994 - 2020 the average maximum temperature reported in April between 09 - 12 UTC was 22.4°C.

Dasselbe für die minimum Temperatur

Druck

Average pressure during the 27 years period from 1994 - 2020, measured in ZRH (METAR)

Time (Month)	Time Period [UTC] 00 - 03	03 - 06	06 - 09	09 - 12	12 - 15	15 - 18	18 - 21	21 - 24	Day	NS [%]	NA [%]
January	1018.5	1018.3	1018.8	1018.9	1017.9	1018.1	1018.6	1018.6	1018.5	0.0	2.5
February	1017.5	1017.3	1017.7	1017.9	1017.0	1017.0	1017.6	1017.7	1017.5	0.0	2.8
March	1016.7	1016.6	1017.1	1017.0	1016.0	1015.9	1016.7	1017.0	1016.6	0.0	2.2
April	1014.5	1014.6	1015.1	1014.8	1013.9	1013.5	1014.3	1014.8	1014.4	0.0	2.4
May	1015.9	1016.0	1016.5	1016.1	1015.3	1015.0	1015.8	1016.3	1015.9	0.0	2.1
June	1017.5	1017.7	1018.0	1017.7	1016.9	1016.4	1017.2	1017.8	1017.4	0.0	2.1
July	1017.4	1017.6	1017.9	1017.5	1016.8	1016.4	1017.1	1017.7	1017.3	0.0	2.2
August	1017.5	1017.6	1018.0	1017.7	1016.9	1016.6	1017.3	1017.8	1017.4	0.0	2.1
September	1018.1	1018.0	1018.6	1018.4	1017.5	1017.3	1018.1	1018.3	1018.0	0.0	2.1
October	1018.0	1017.9	1018.5	1018.5	1017.5	1017.5	1018.1	1018.2	1018.0	0.0	2.2
November	1016.6	1016.4	1016.9	1016.9	1016.1	1016.3	1016.8	1016.8	1016.6	0.0	2.3
December	1018.5	1018.3	1018.8	1018.9	1018.1	1018.4	1018.8	1018.8	1018.6	0.0	2.1
Year	1017.2	1017.2	1017.7	1017.5	1016.7	1016.5	1017.2	1017.5	1017.2	0.0	-
NS [%]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	-
NA [%]	16.1	0.2	0.2	0.2	0.2	0.2	0.5	0.3	-	-	-

No AUTO METARs.
NA: METAR not available [%]. NS: values not supplied in METAR [%].
Example: During the 27 years period from 1994 - 2020 the average pressure reported in April between 09 - 12 UTC was 1015hPa.

Dasselbe für min. und max. Druck

Wetterphänomene

- Freezing Rain
- Freezing Drizzle
- Snowfall
- Hail
- Snow
- Pellets
- Thunderstorm
- Fog
- Shallow and Vicinity Fog
- Freezing Fog
- Rain
- Drizzle

Snow pellets during the 27 years period from 1994 - 2020, measured in ZRH

Time (Month)

Time [UTC]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	NS [%]	NA [%]
00 - 03	0	0	1	0	0	0	0	0	0	0	1	0	2	0.0	16.1
03 - 06	2	2	1	2	0	0	0	0	0	0	0	1	8	0.0	0.2
06 - 09	3	4	5	0	1	0	0	0	0	0	1	2	16	0.0	0.3
09 - 12	8	3	5	3	0	1	0	0	0	0	1	4	25	0.0	0.3
12 - 15	6	7	10	4	1	0	0	0	0	0	6	3	37	0.0	0.3
15 - 18	3	6	8	5	0	0	1	0	0	0	0	2	25	0.0	0.3
18 - 21	1	1	1	0	0	0	0	0	0	0	0	4	7	0.0	0.5
21 - 24	0	1	0	2	0	0	0	0	0	0	0	1	4	0.0	0.4
Day	23	24	31	16	2	1	1	0	0	0	9	17	124	0.0	-
NS [%]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	-
NA [%]	2.5	2.8	2.2	2.4	2.2	2.1	2.2	2.2	2.2	2.3	2.3	2.2	-	-	-

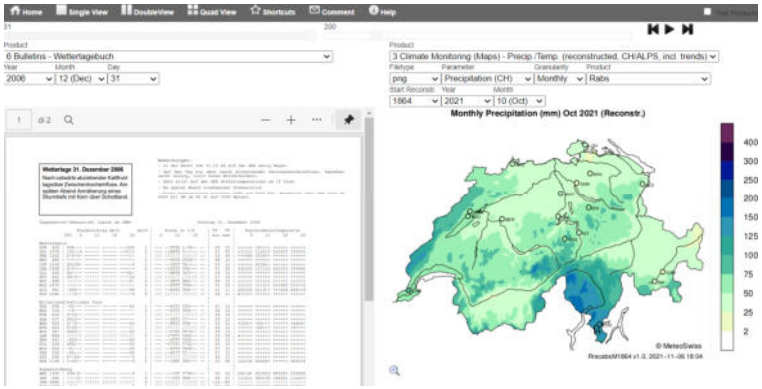
Fog (without shallow and vicinity fog) during the 27 years period from 1994 - 2020, measured in ZRH

Time (Month)

Time [UTC]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	NS [%]	NA [%]
00 - 03	11.7	10.5	7.8	6.9	10.7	9.4	8.6	16.4	29.3	29.9	20.9	15.5	14.8	0.0	16.1
03 - 06	11.9	11.8	14.1	10.6	12.3	9.2	10.3	21.0	33.5	29.0	20.2	14.1	16.5	0.0	0.2
06 - 09	10.0	9.0	5.2	1.2	0.7	0.2	0.3	1.1	8.8	17.4	15.6	11.8	6.8	0.0	0.3
09 - 12	5.6	2.6	0.4	0.0	0.0	0.0	0.0	0.0	0.1	2.4	5.3	5.7	1.8	0.0	0.3
12 - 15	1.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.2	2.4	0.5	0.0	0.3
15 - 18	2.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	3.5	4.5	1.0	0.0	0.3
18 - 21	5.7	1.7	0.7	0.3	0.2	0.2	0.2	0.2	3.1	13.2	12.5	9.4	4.0	0.0	0.5
21 - 24	9.4	5.1	2.8	1.9	3.0	2.0	1.9	3.3	14.6	24.7	18.8	13.8	8.4	0.0	0.4
Day	7.2	5.0	3.8	2.5	3.2	2.5	2.5	5.0	10.8	14.4	12.1	9.5	6.6	0.0	-
NS [%]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	-
NA [%]	2.5	2.8	2.2	2.4	2.2	2.1	2.2	2.2	2.2	2.3	2.3	2.2	-	-	-

MeteoSwiss

Zusammenfassung



- Neue Berichte LSZH, LSGG, überarbeitet

→ Im Web verfügbar (MeteoSchweiz)

Service & Publikationen > Publikationen >

Aeronautical Climatological Information Zurich (LSZH)

- Neues Instrument, viele Analysemöglichkeiten

- Zukunft
  - Webapplikation statt 300-450 seitige Berichte (update einfacher, schneller Zugriff)
  - Berichte zu weiteren Regionalflughäfen?

- Feedback willkommen

Fragen?

Programm AMAROC

Loris Foresti
Wissenschaftlicher Mitarbeiter

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

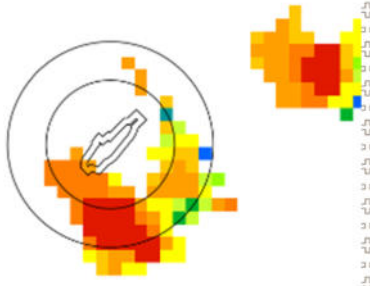
Swiss Confederation

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

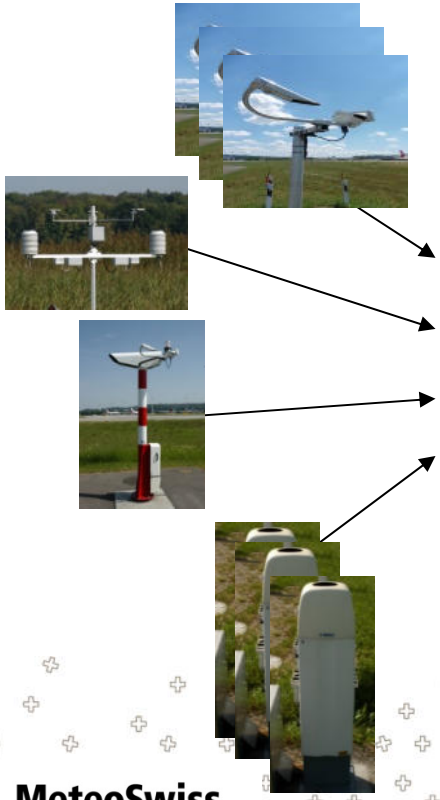
AutoMETAR 24/7: is innovation necessary to meet regulation?

The example of hail

Loris Foresti, Martin Aregger, Alessandro Hering, Catherine Stocker, Sebastian Meier, Eliane Thürig, SMART team, Marco Boscacci, Urs Germann, Alexander Haefele, Bertrand Calpini



METAR vs AutoMETAR



SMART

observer

METAR

MET REPORT

SPECIAL

---------- 5:50-23:20Uhr----------

SMART

AutoMETAR

Auto MET REPORT

AutoSPECIAL

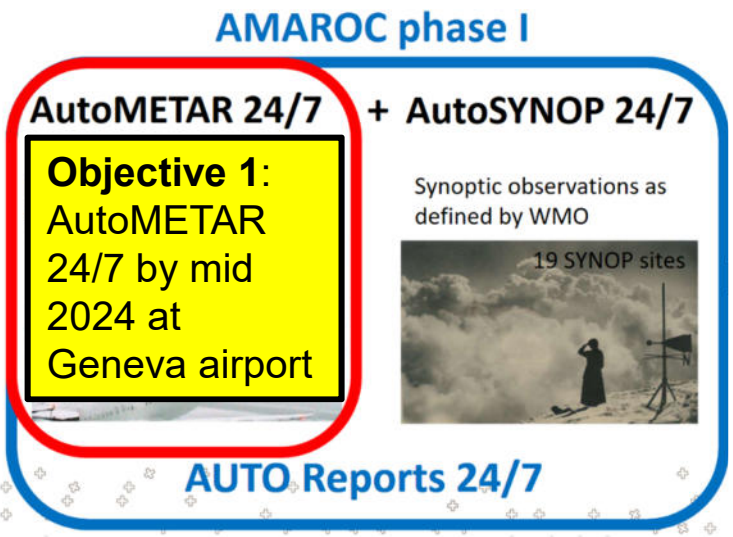
Since October 2016 @ Geneva
Since April 2021 @ Zürich

---------- 23:20-5:20Uhr----------

MeteoSwiss

Program AMAROC:

AutoMETAR / AutoReport rOund the Clock



«Do the best we can to provide a cost-efficient service compliant with regulation»

«Further improve services to respond to additional customer needs»

AMAROC phase I + II illustrated with the example of hail

Hail reporting according to ICAO Annex 3

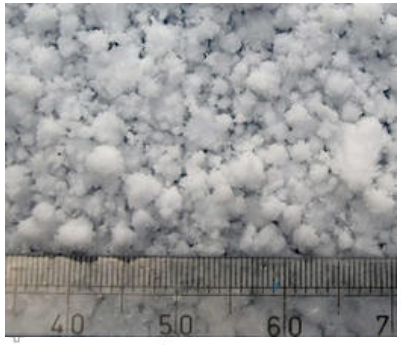
To report at the **aerodrome** (within **approximately 8 km** from airport reference point):

- **GR** → Hail (diameter ≥ 5 mm)
- **GS** → Small hail (diameter 1-4 mm) and snow pellets
- Intensity (e.g. +GR, GR, -GR) and mixed precipitation (e.g. RAGR)
- SMART does not produce yet automatic hail reports outside operational hours

Focus of talk

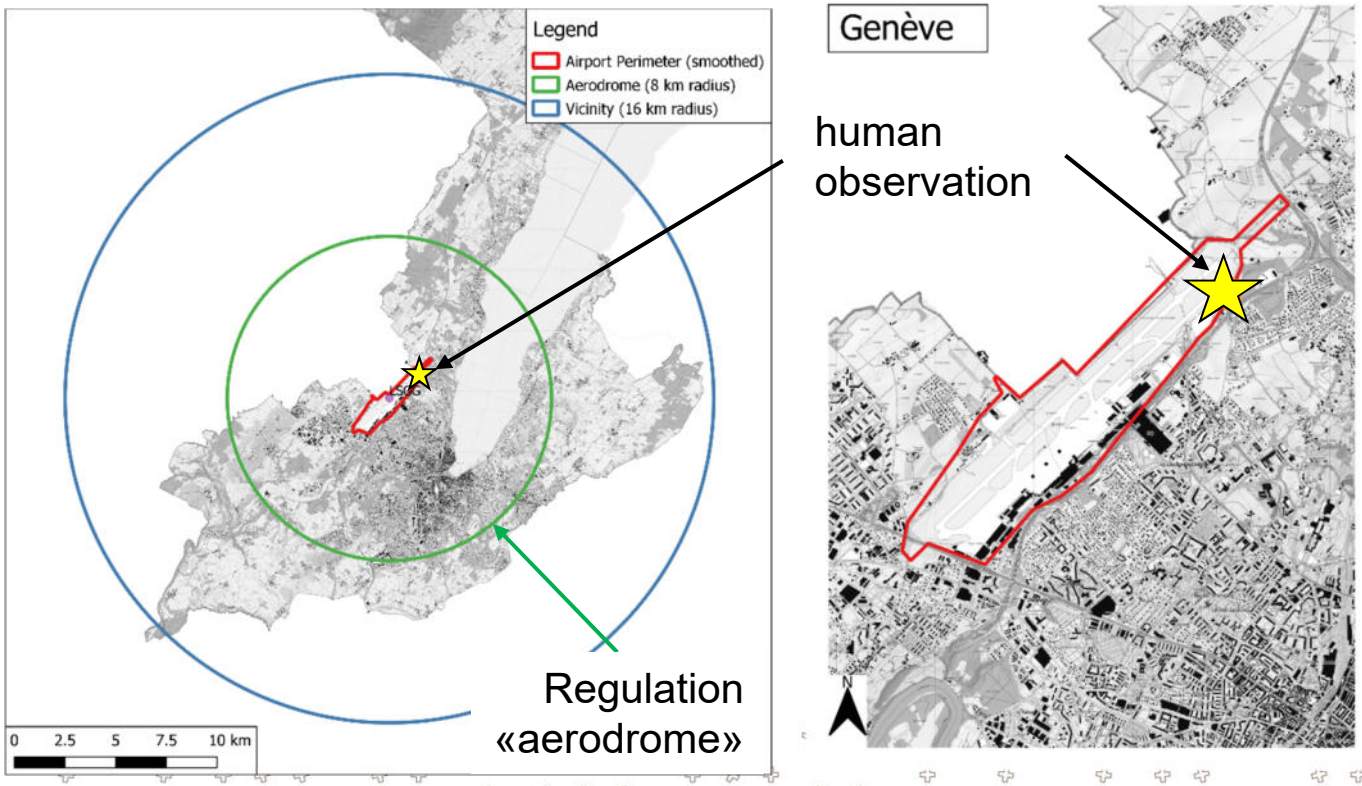
Hail (GR)

Small hail (GS)

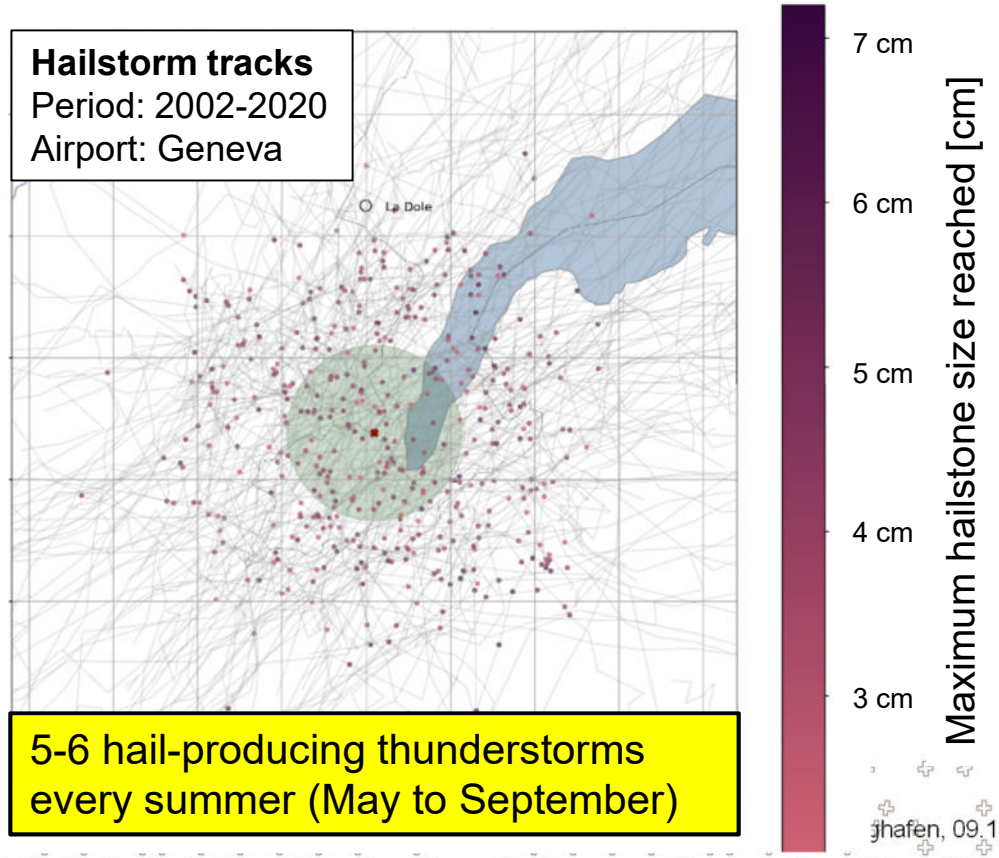


Snow pellets (GS)

A spatial representativity problem



How many hailstorms occur within 8 km?



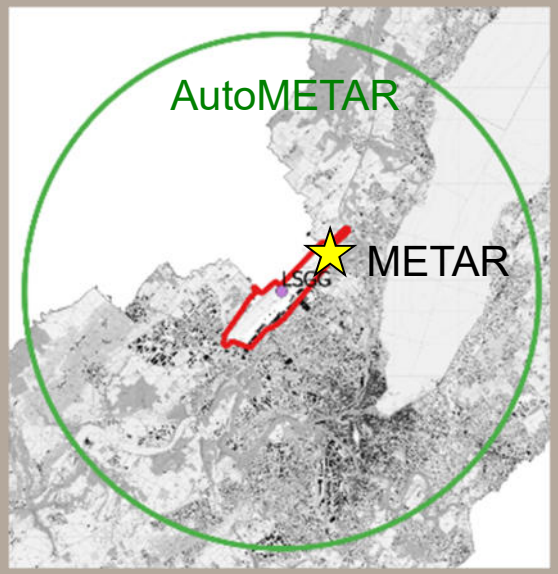
Hailstorm tracks
Period: 2002-2020
Airport: Geneva

5-6 hail-producing thunderstorms every summer (May to September)

Courtesy of Katharina Schroeer

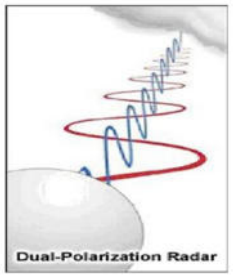
MeteoSwiss

Automatic hail reports within 8 km will be more frequent than human observations (single point)



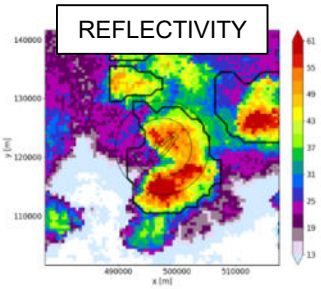
General concept for hail reporting

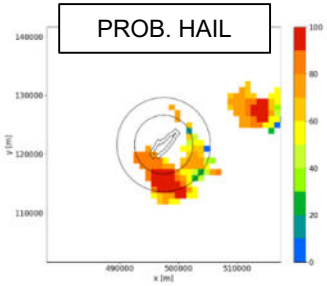
RADAR
«Hail probable»

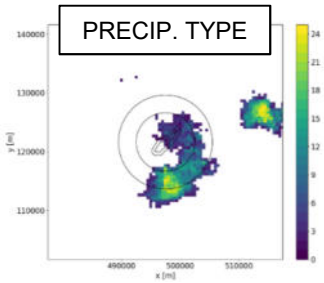


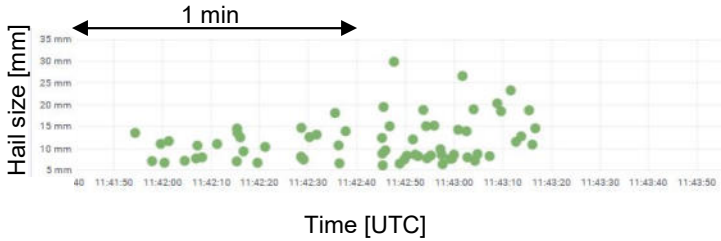
+

HAIL SENSOR
«Hail measured»









Radar + sensors = 1 + 1 = 3

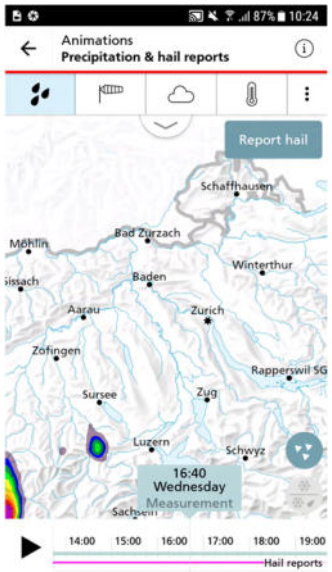
RADAR	SENSORS	TOGETHER
Spatial representativity	Spatial representativity (6 sites)	
Measures >> 1600 MASL	Measures at the ground	
GR > 15 mm	GR > 15 mm	
GR 5-15 mm (e.g. winter)	GR 5-15 mm (any season)	
GS 1-5 mm	GS 4-5 mm	

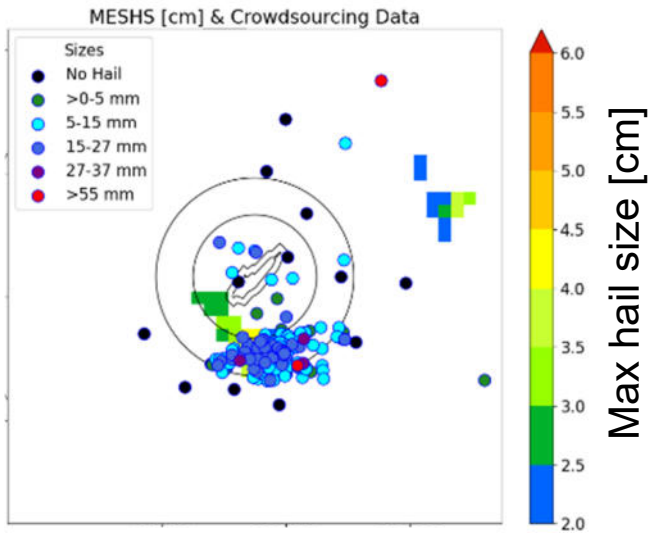
- **Redundancy** in case La Dôle radar is down (BCM)
- **Better quality** (especially for GR 5-15 mm)
- **Continuous verification and optimization** of radar algorithms

Expert meteorological knowledge is key to extract information from evolving measurement technology

Reference data: METAR + crowdsourcing

→ Too few hail METARs at observation site for robust statistical evaluation





Number of crowdsourcing hail reports* (Jan 2018 – Jul 2021):

- Geneva: 784 → 66 hail events
- Zürich: 1697 → 65 hail events

* quality-controlled within 8 km radius and with diameter ≥ 5 mm

Quality of radar algorithm (in development)

Large hailstones (d ≥ 15 mm)

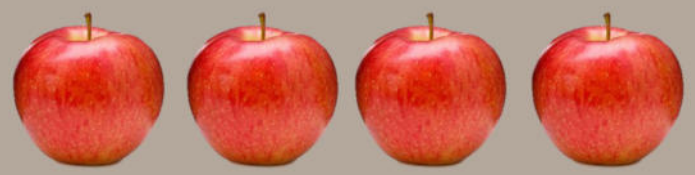
- Probability of detection (POD) = 90-95 %
- False alarm ratio* (FAR) = 80-90 %

*True FAR is unknown and lower → no crowdsourcing data during the night, on the lake and outside of Swiss borders

- All hailstones (d ≥ 5 mm) POD = 65-80 %

© Zürich-Flughafen, 09.12.2021

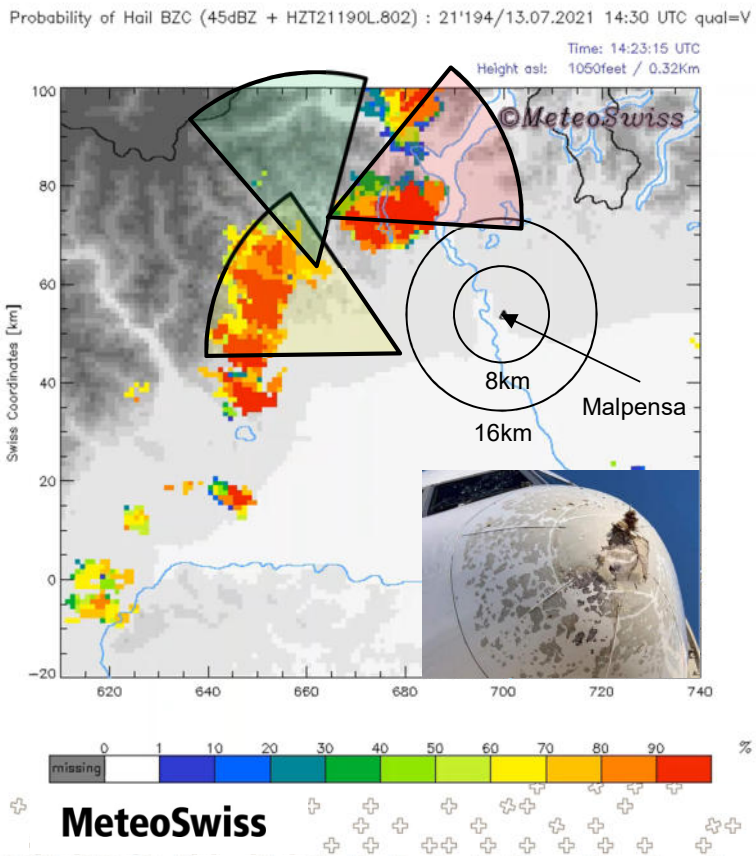
Comparing AutoMETAR vs METAR is sometimes like comparing apples and pears: they are different products



AutoMETAR

METAR

AMAROC phase II: beyond AutoMETAR



- AutoMETAR is not the right product to communicate this event (> 8 km)
- On-board radar has narrow field of view
- ATM cannot support everyone

- MeteoSwiss has radar products for hail (and more): they are not yet used for automatic products in aviation

Take-home messages

WEATHER RADAR AS A PRIMARY SOURCE OF INFORMATION

- Complemented by in-situ measurements (hail sensors)
- Hail and more…
- Beyond AutoMETAR

HAIL WILL BE REPORTED IN A RADIUS OF 8 KM

- Instead of a single point like the METAR

CROWDSOURCING WAS NOT JUST A GAME

- It is an integral part of QA / QC

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Fragen?

Kaffeepause

Meteodrohnen

Martin Fengler
CEO Meteomatics

Meteodrones

Dr. Martin Fengler
CEO

Meteodrone MM-670M

Ø : 70 cm; : 5 kg

PixHawk autopilot

Meteodrone sensors & flight profile

Pressure
Accuracy: 0.1 hPa
Response time: 250 ms

Dew point
Accuracy: 0.2 °C
Response time: < 4 s

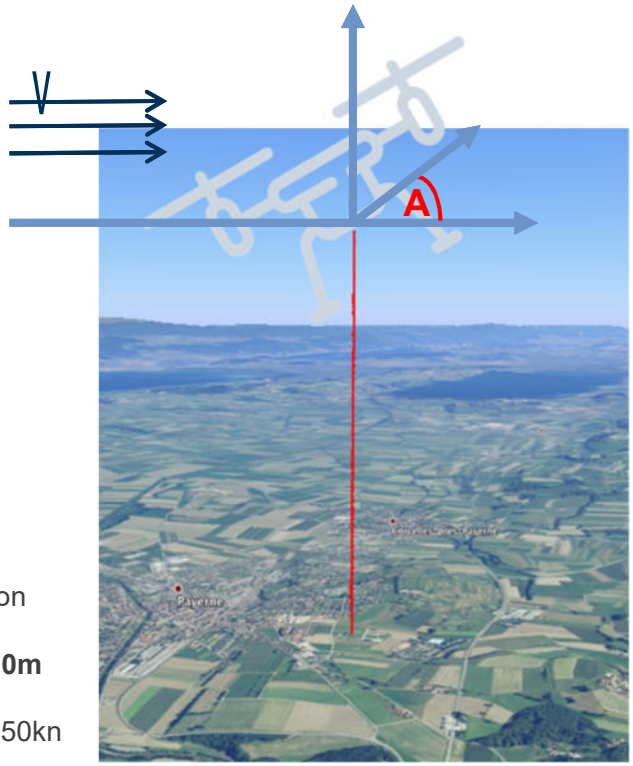
Temperature
Accuracy: 0.1 °C
Response time: 1 s

Wind speed & direction
Accuracy: < 1 m/s
Response time: 250 ms

The aircraft automatically compensates wind drag:

- Compute wind speed and direction from roll, nick & yaw
- **Vertical flight profile up to 6’000m AMSL / 500hPa / 20’000ft**
- Maximum sustained wind speed 50kn / 92km/h

Relative humidity
Accuracy: < 2 %
Response time: < 4 s
Sensors are heated.



Sensors are radiation-shielded and aspirated.

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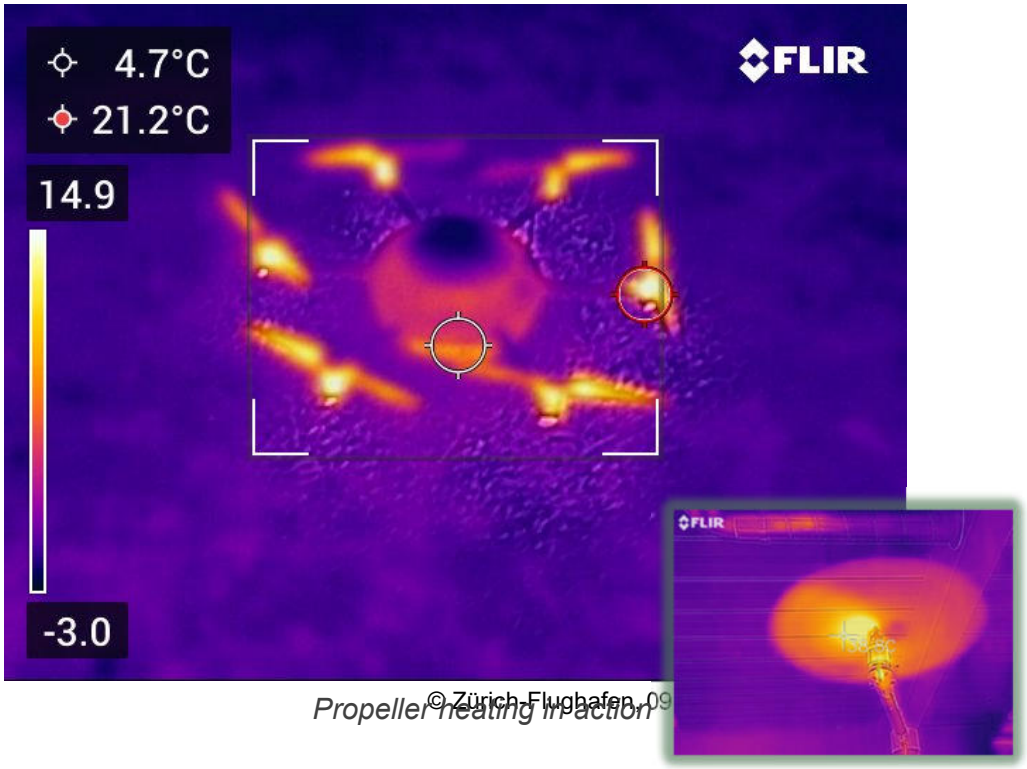
Flying under icing conditions

Propeller Heating System:

The Meteodrone MM-670M comes with a propeller heating system which allows for flying under icing conditions.

Without propeller heating system it takes only 90 sec. to see ice accretion.



Propeller heating in action

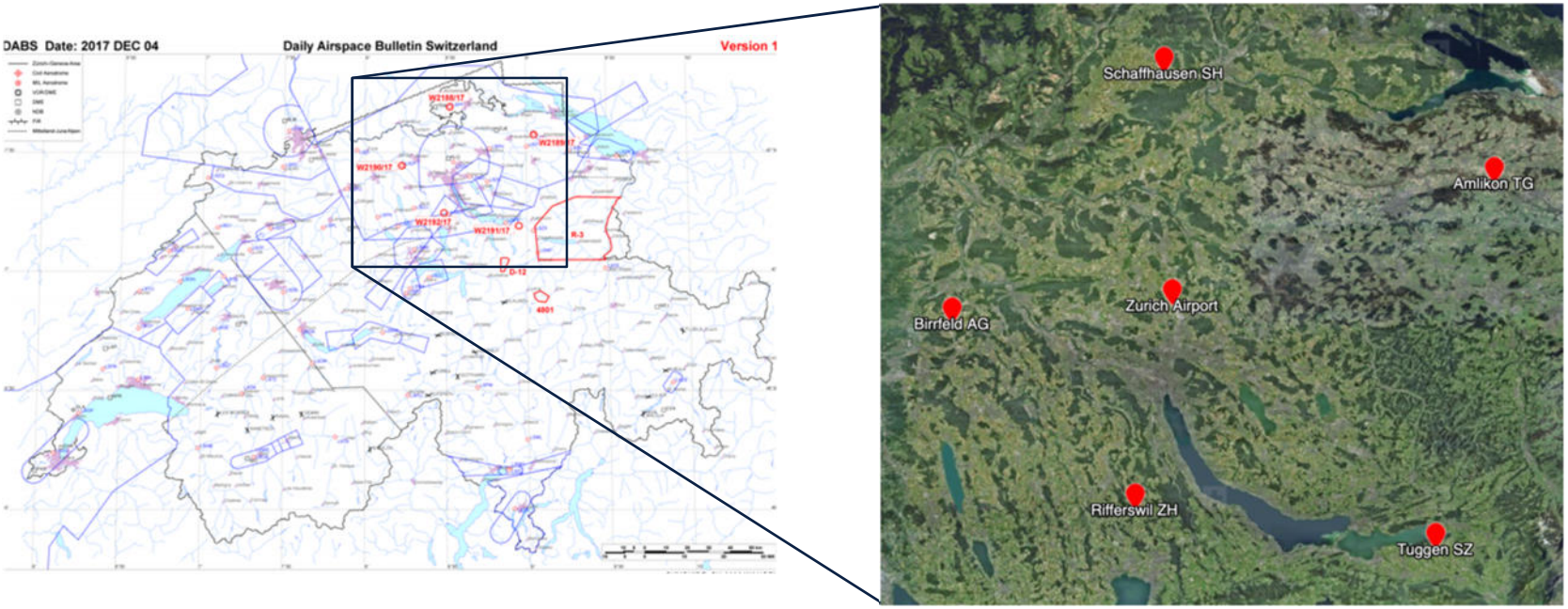
© Zürich Flughafen 09

Project DETAF 1.0

DETAF (Drone Enhanced Terminal Aerodrome Forecasts)

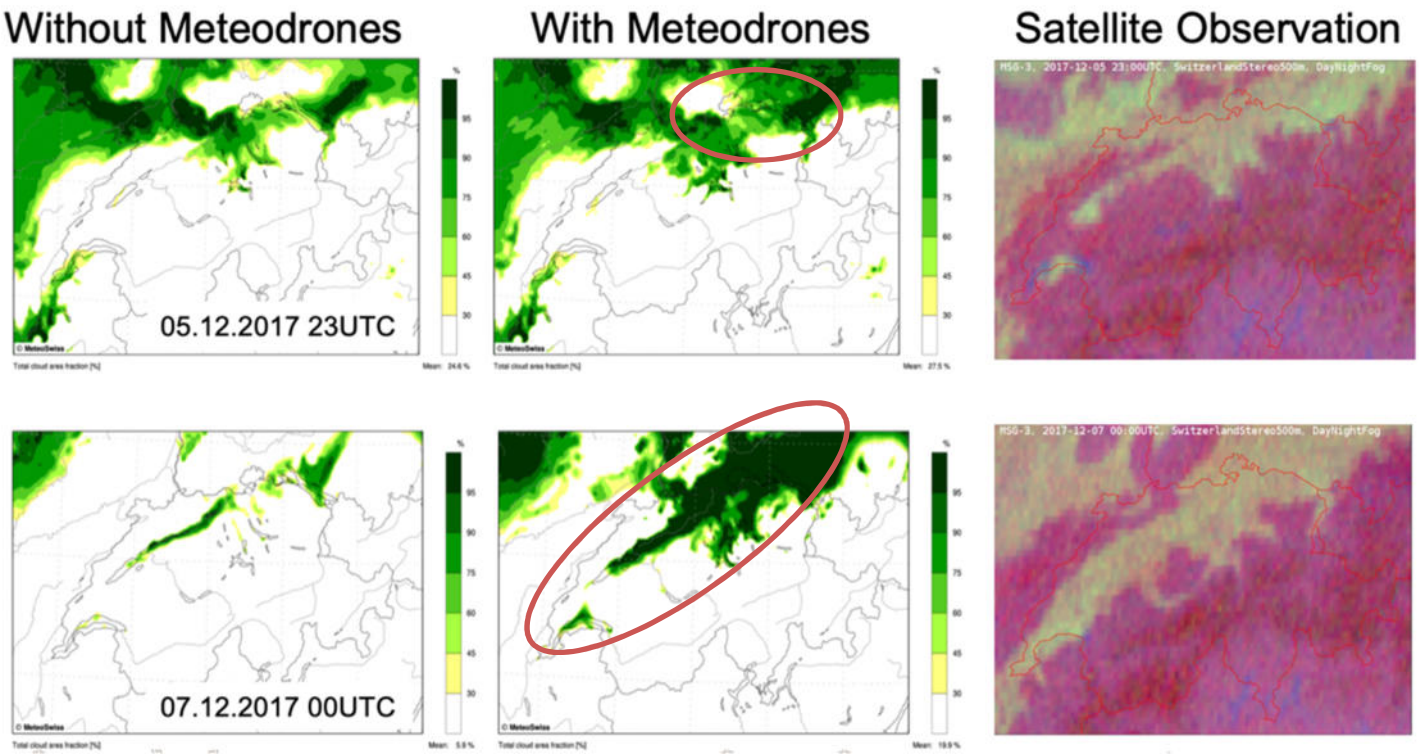
- Operating drones in 6 locations in the vicinity of and at Zurich airport
- Feeding data in real-time into SwissIk
- Sending visibility & ceiling forecasts to Skyguide

DETAF 1.0 Setup



Meteodrone data are not yet operationally assimilated into COSMO-1 or aviation weather products.

Assimilation studies with COSMO-1



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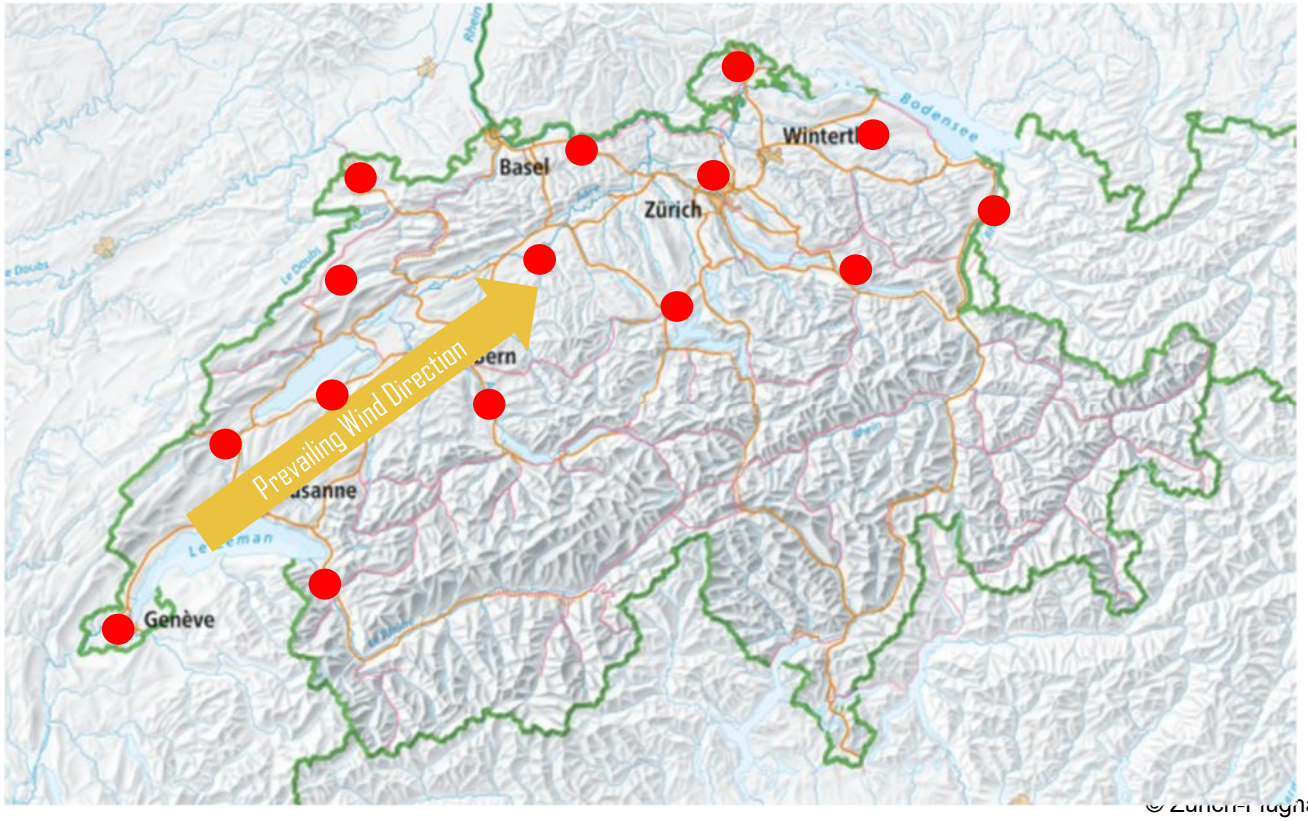
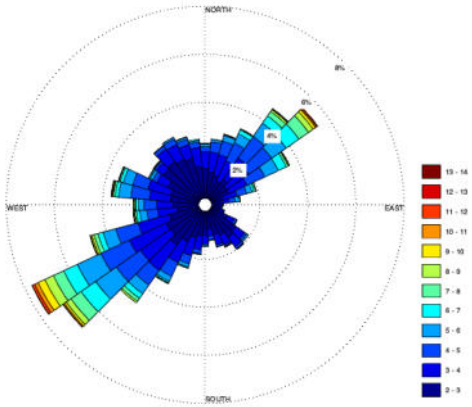
Source: Leuenberger et al., 2019:

DETAF 2.0 Planned Meteobase Setup



→ Improving weather forecasts across Switzerland



Wind Speed > 2 m/s

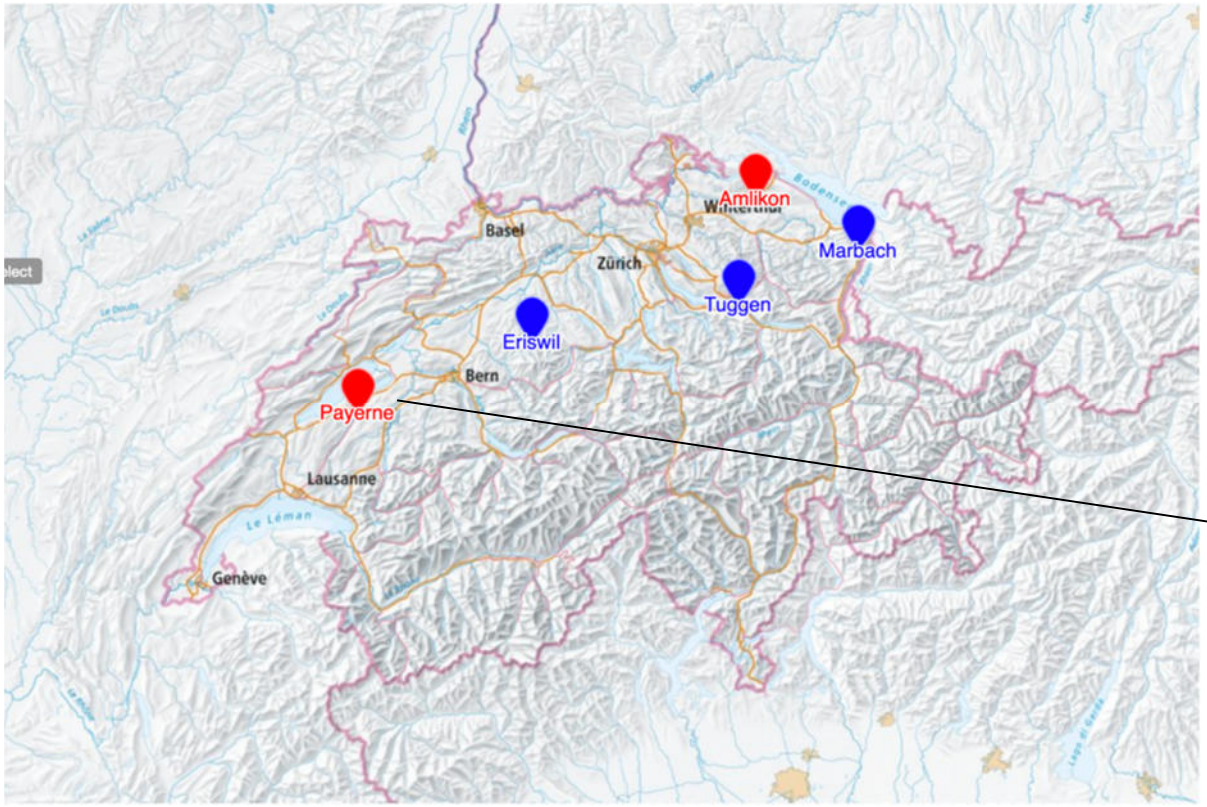
● MeteoBase

Drone – Meteobase

Operational Meteodrone Flights

- Operational flights controlled from a operations control center by an operations 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 Project **Roll-Out**



Operational location collecting weather data each night

Planned locations for roll out; next Meteobases currently in production

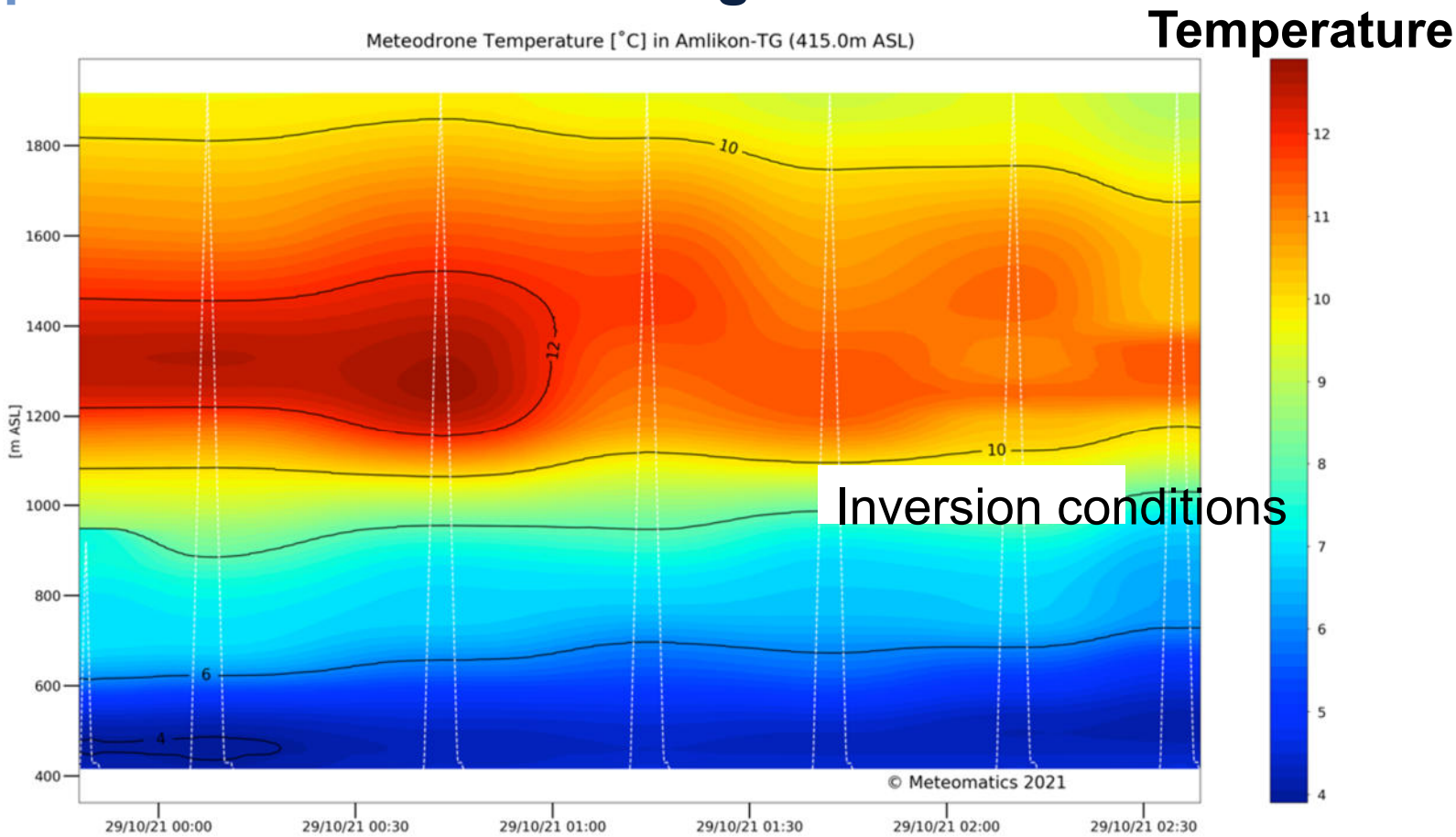
Currently 6-months intercomparison study.

Setting Up Operations

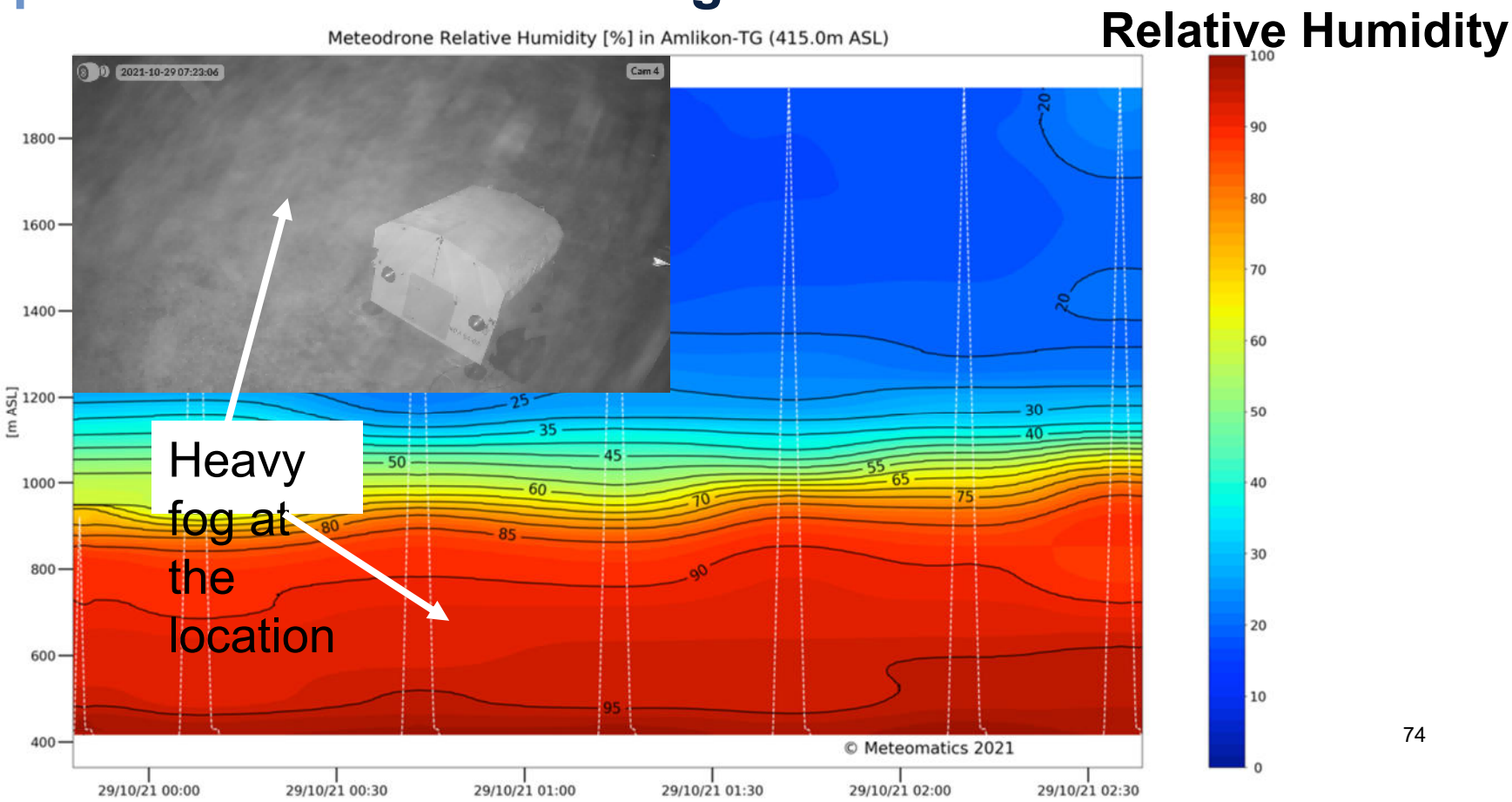
© Zürich-Flughafen, 09.12.2021

- Setting up the Meteobase at MeteoSchweiz, Payerne

Operational Meteodrone Flights

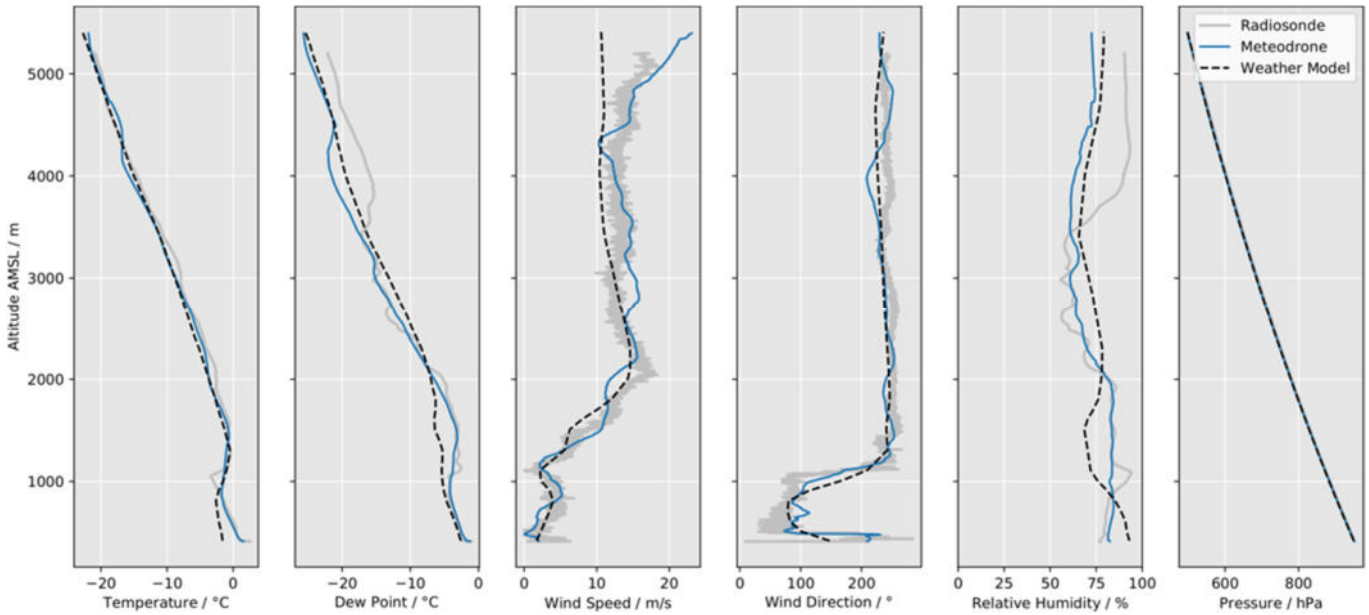


Operational Meteodrone Flights



Verifying 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

Contact us

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Fragen?

Modellentwicklung

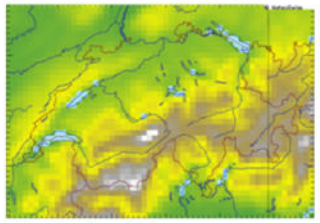
André Walser
Projektleiter ICON-22
(In Zusammenarbeit mit D. Leuenberger,
A. Haefele und S. Westerhuis)

Themenblöcke:

- Ablösung von COSMO durch ICON
- Nutzen von Ensembles
- Entwicklungen in der Datenassimilation

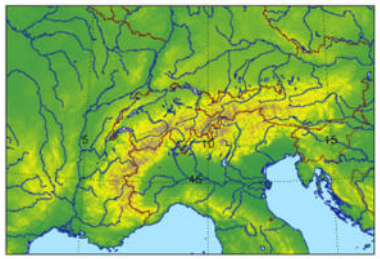
20 Jahre COSMO Modell…

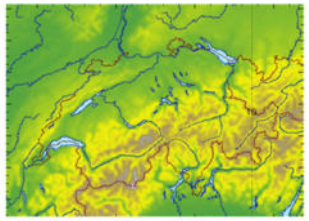
2001: COSMO-7



Mesh size: 7km
highest point 3100m

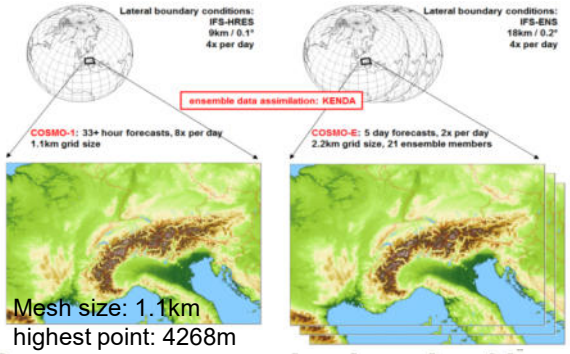
2008: COSMO-2





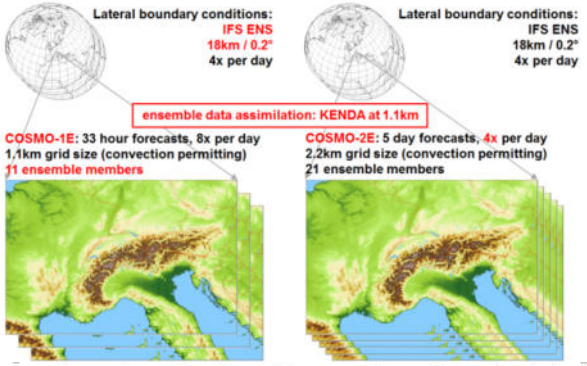
Mesh size: 2.2km
highest point 3944m

2016: COSMO-1 und COSMO-E

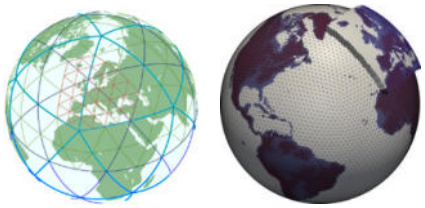


Mesh size: 1.1km
highest point: 4268m

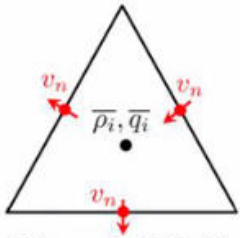
2020: COSMO-1E & COSMO-2E



…abgelöst durch ICON



- **ICO**sahedral **N**onhydrostatic model
- vom DWD und Max-Planck-Institut für Meteorologie entwickelt
- gehört zur neusten Generation von Wettervorhersagemodellen
- verwendet Dreiecksgitter
- als globales und lokales Modell einsetzbar
- unterstützt steilere Orographie
- sehr grosse Entwicklungs-Community



Triangular C-Grid

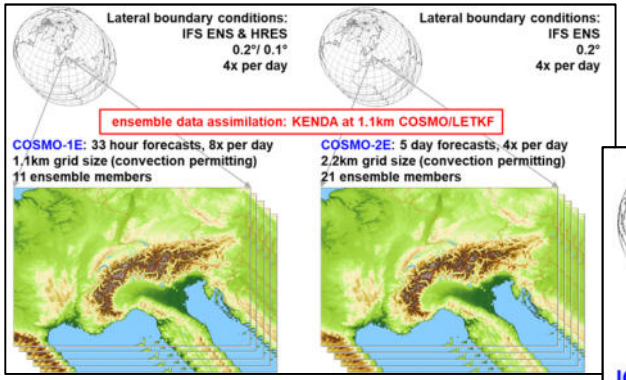
Projekt ICON-22

- Umstellung von COSMO auf ICON
  Die neuen Modelle werden so entwickelt, dass mindestens die gleichen Bedürfnisse der MeteoSchweiz und der Kunden erfüllt werden können, die bereits COSMO-1E und COSMO-2E erfüllen, und diese abgelöst werden können.

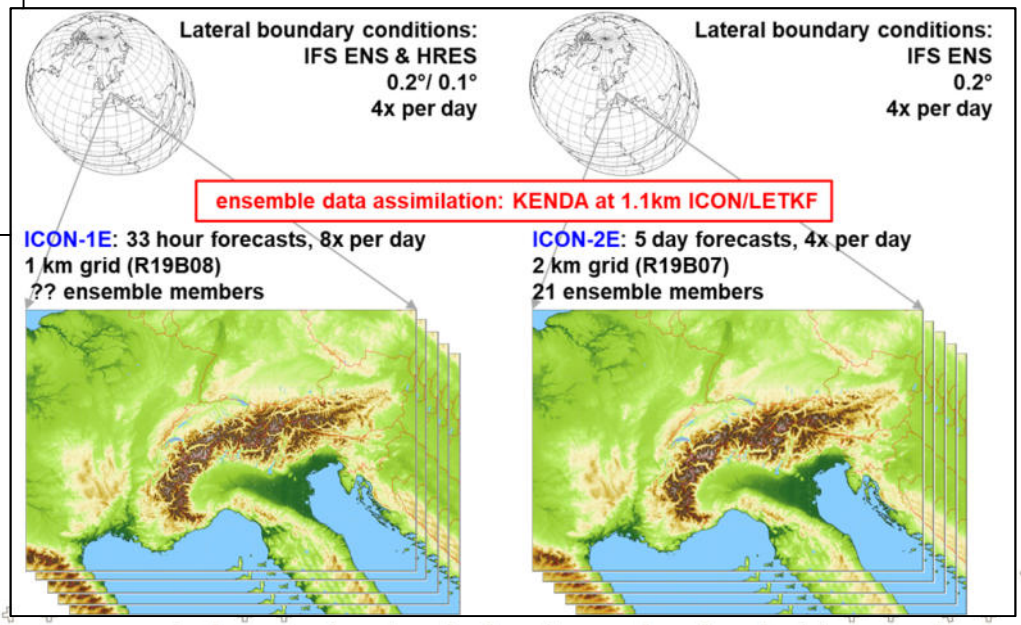
- Bereitstellung der Rechnerinfrastruktur
  Die erforderliche Rechenkapazität für die neuen Modell-Systeme wird bereitgestellt.

- Migration auf die neue Infrastruktur Mitte 2023
  Alle Anwendungen und Kundenprodukte werden auf die neuen Modell-Systeme migriert. Möglichst transparent für Kunden → Produkte auf den gleichen Modellgittern möglich (Normalfall).

Neue Modelle: ICON-1E & ICON-2E



«quasi 1:1-Ablösung»



Nutzen von Ensembles

Wettervorhersagen sind nicht perfekt

Fehlerquellen in der numerischen Wettervorhersage:

- Anfangsbedingungen
  → genauere Analysen durch Fortschritte in der Datenassimilation

- Randbedingungen

- Modell berücksichtigt nicht alle physikalischen Prozesse exakt
  → Weiterentwicklungen in ICON, höhere Auflösung (rechenintensiv!)

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Wettervorhersagen sind nicht perfekt (2)

Grenzen der Vorhersagbarkeit:

- die Genauigkeit ist abhängig von der Wettersituation
- minimale Fehler führen nach einer gewissen Vorhersagezeit zu ungenauen numerischen Wettervorhersagen

→ **Eine Reduktion der Fehler kann die Grenzen der Vorhersagbarkeit nur verschieben, aber nicht eliminieren!**

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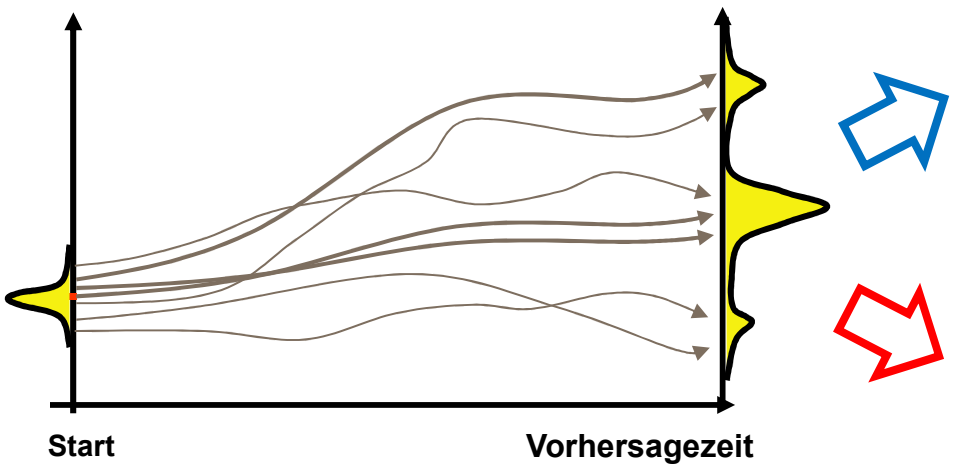
Ensemble Vorhersagen



Vorhersage der Unsicherheit [m/s],...

- grosse Bandbreite = grosse Unsicherheit
- kleine Bandbreite = gute Vorhersagbarkeit

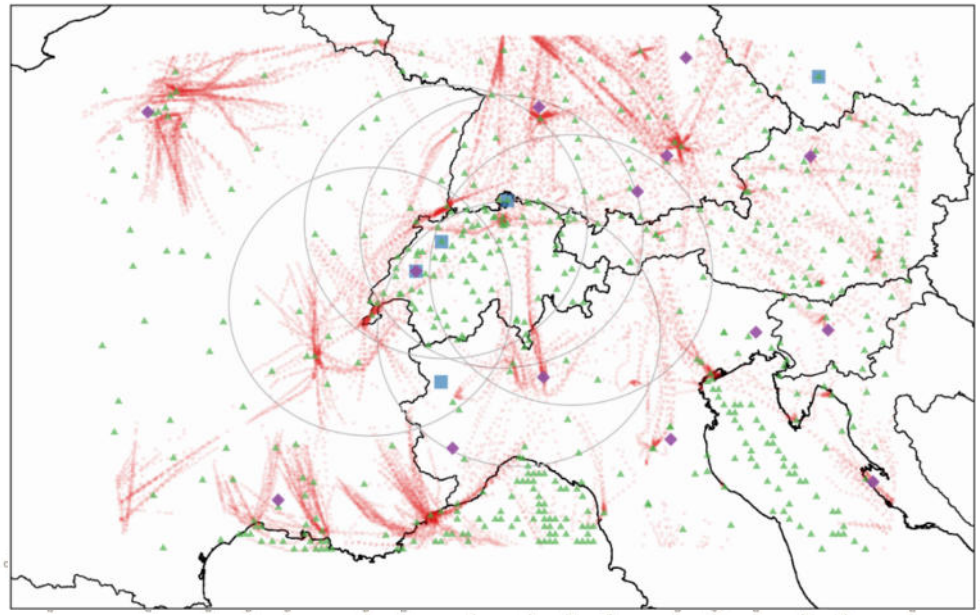
Probabilistische Vorhersage
→ [%] für kundenspezifisches Risikomanagement

- durch Störungen in den Anfangs- und Randbedingungen sowie der Modellphysik
- alle Einzelläufe («members») gleich realistisch

Entwicklungen in der Datenassimilation

Datenassimilation

"Verwendung aller verfügbaren Informationen, um den Zustand der Atmosphäre so genau wie möglich zu bestimmen", d.h. (spärliche) Beobachtungen und ein numerisches Modell.



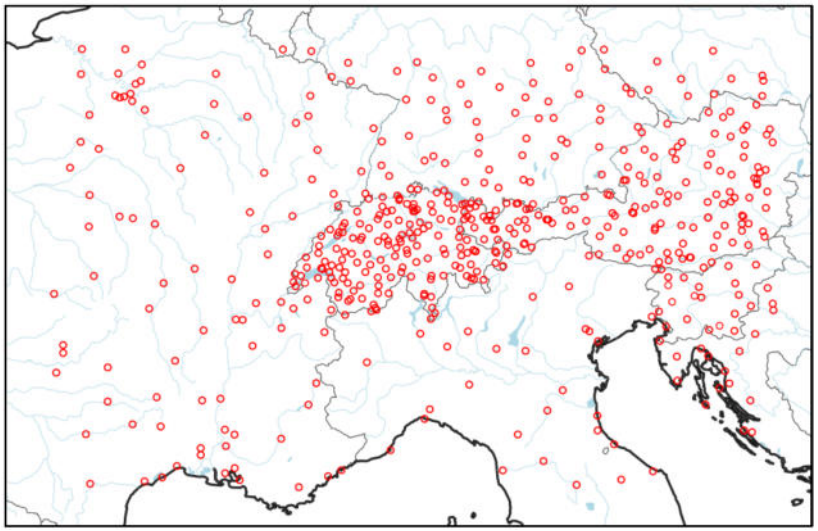
Beobachtungen, die in COSMO assimiliert werden
(gesammelt über einen Monat)

- Radiosondes
- Surface stations
- Windprofiler
- Aircrafts
- Radar

Fortschritte in der Nebel- & Hochnebel-Vorhersage

Foto: Sebastian Benz

Assimilation 2m Temperatur und Feuchte



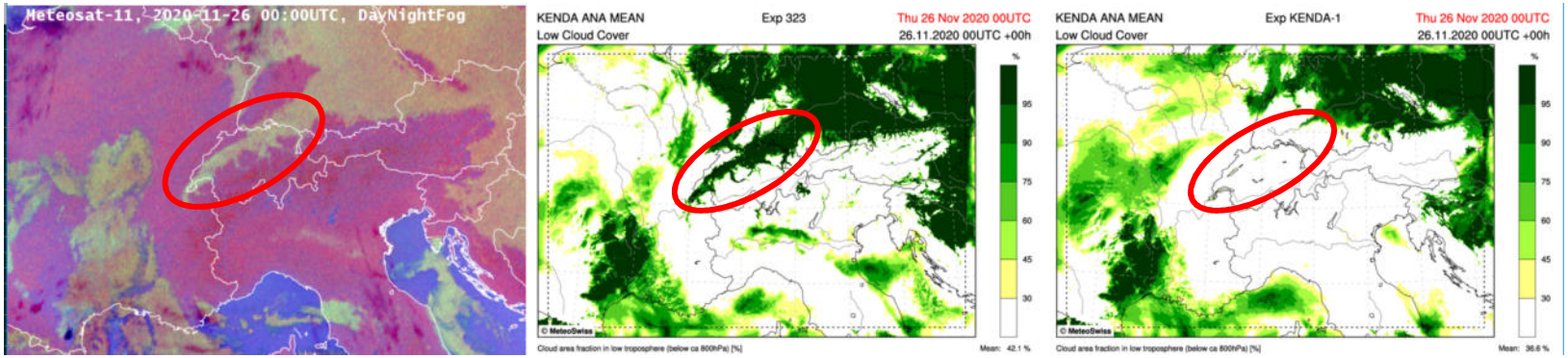
Bodenstationen (SYNOP) mit Temperatur (T2m) und relativer Feuchte (RH2m) auf 2m

- **Operationell seit 27.9.2021**
- Test-Periode: 21.11. bis 21.12.2020

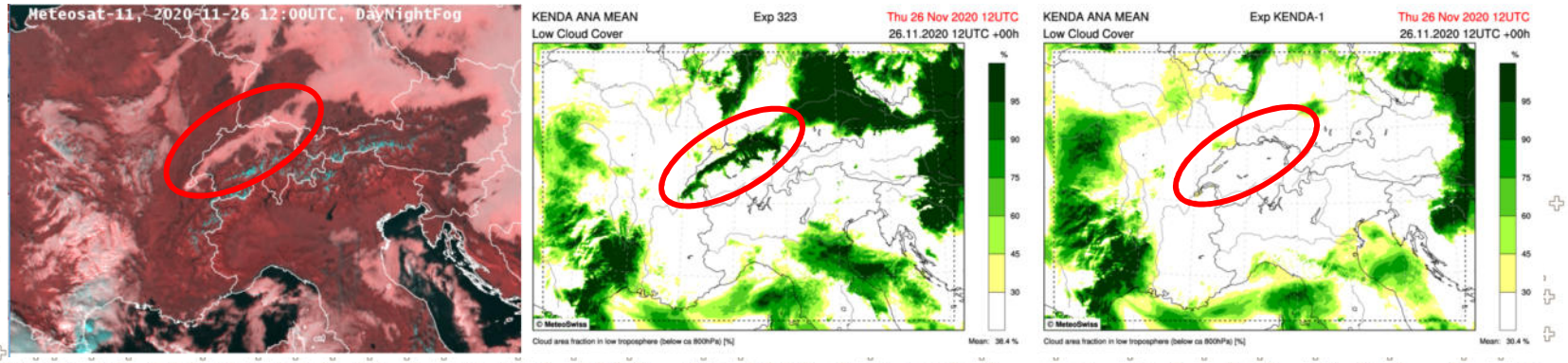
Einfluss auf Analyse: Hochnebel

Satellite | mit T2m/RH2m Assim. | ohne T2m/RH2m Assim.

26.11.2020
00UTC

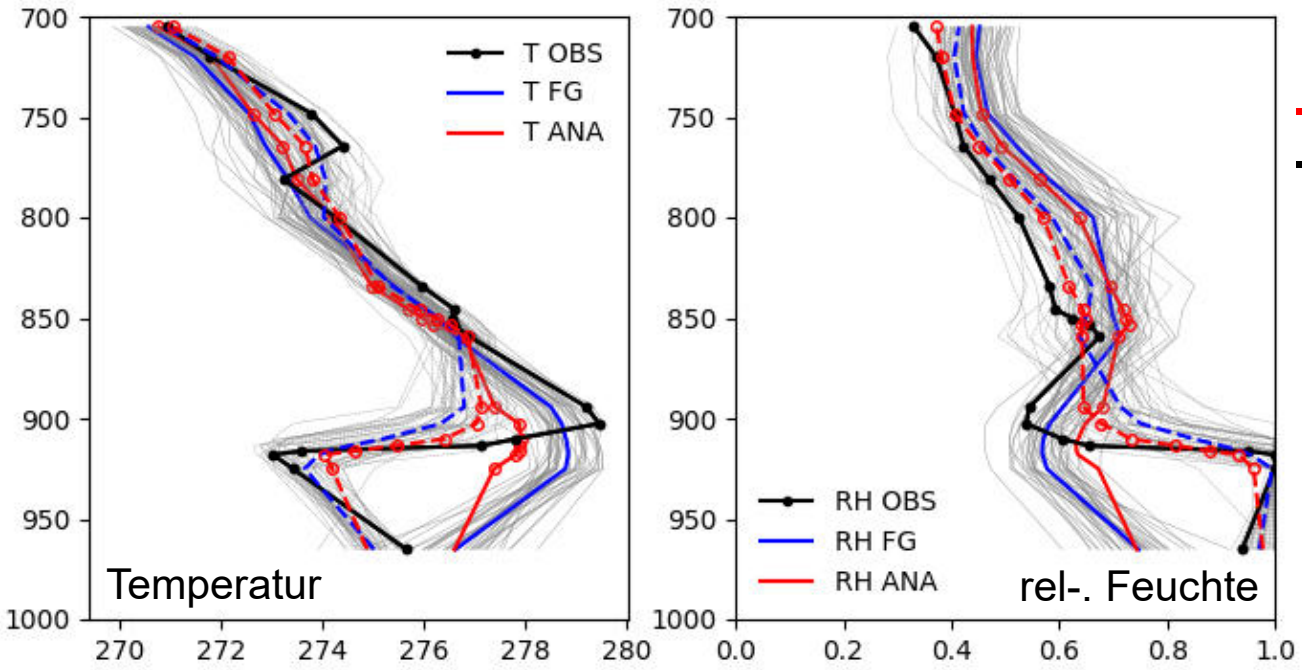


26.11.2020
12UTC



Einfluss auf Analyse: vertikale Struktur

Radiosonde Payerne, 26.11.2020 00UTC



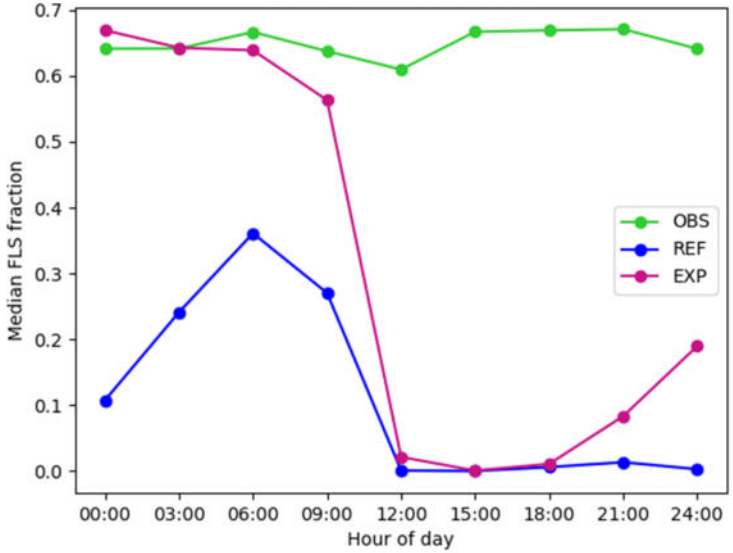
Analyse
Beobachtung

ohne
mit T2m/RH2m Assimilation

Einfluss auf COSMO-1E Vorhersagen

Anteil des mit Hochnebel bedeckten Mittelands

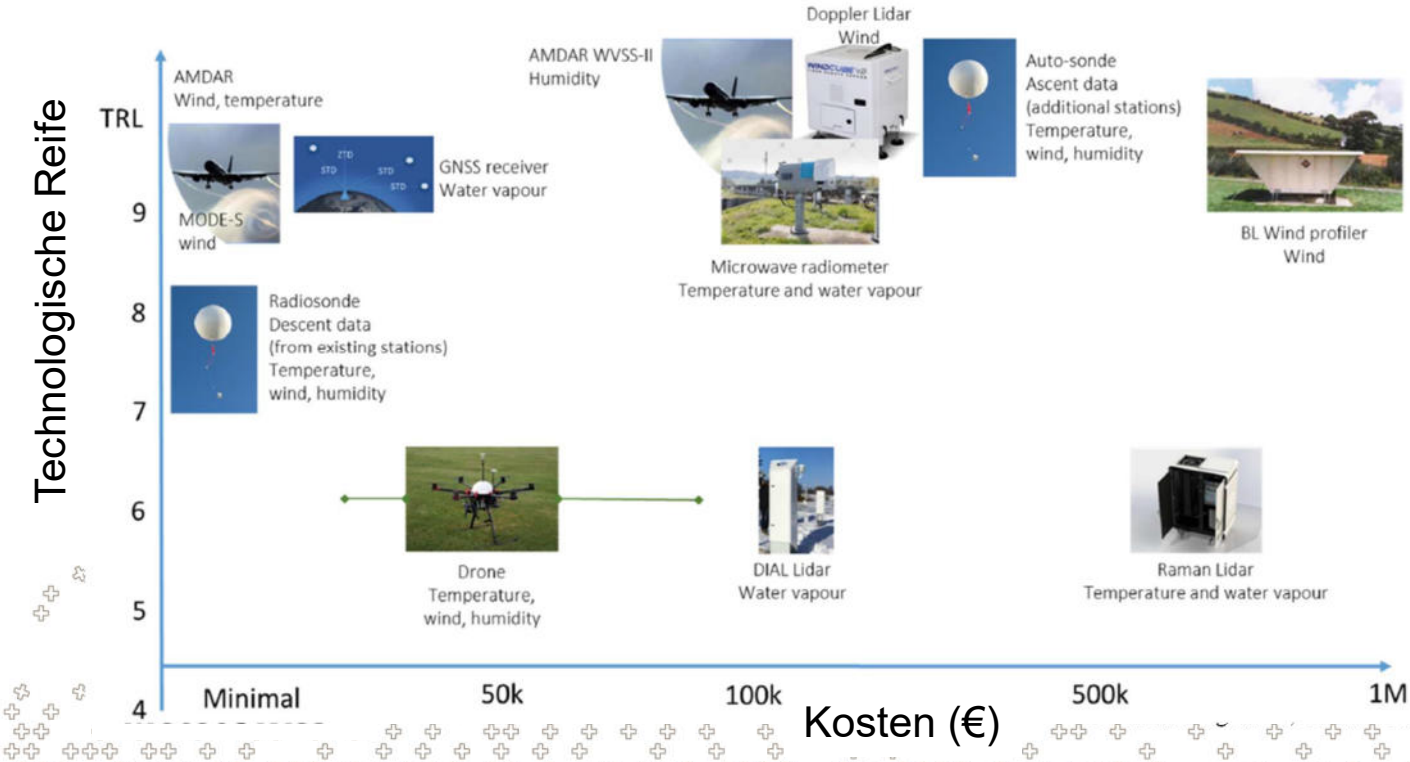
00 UTC Vorhersagen



- Deutliche Verbesserung in den ersten ~9 Vorhersagestunden
- Hochnebelauflösung am Mittag wird weiterhin stark überschätzt
- weitere Verbesserungen nur durch Modellfortschritte möglich → ICON und glättere Modelllevels (LOSVEC)

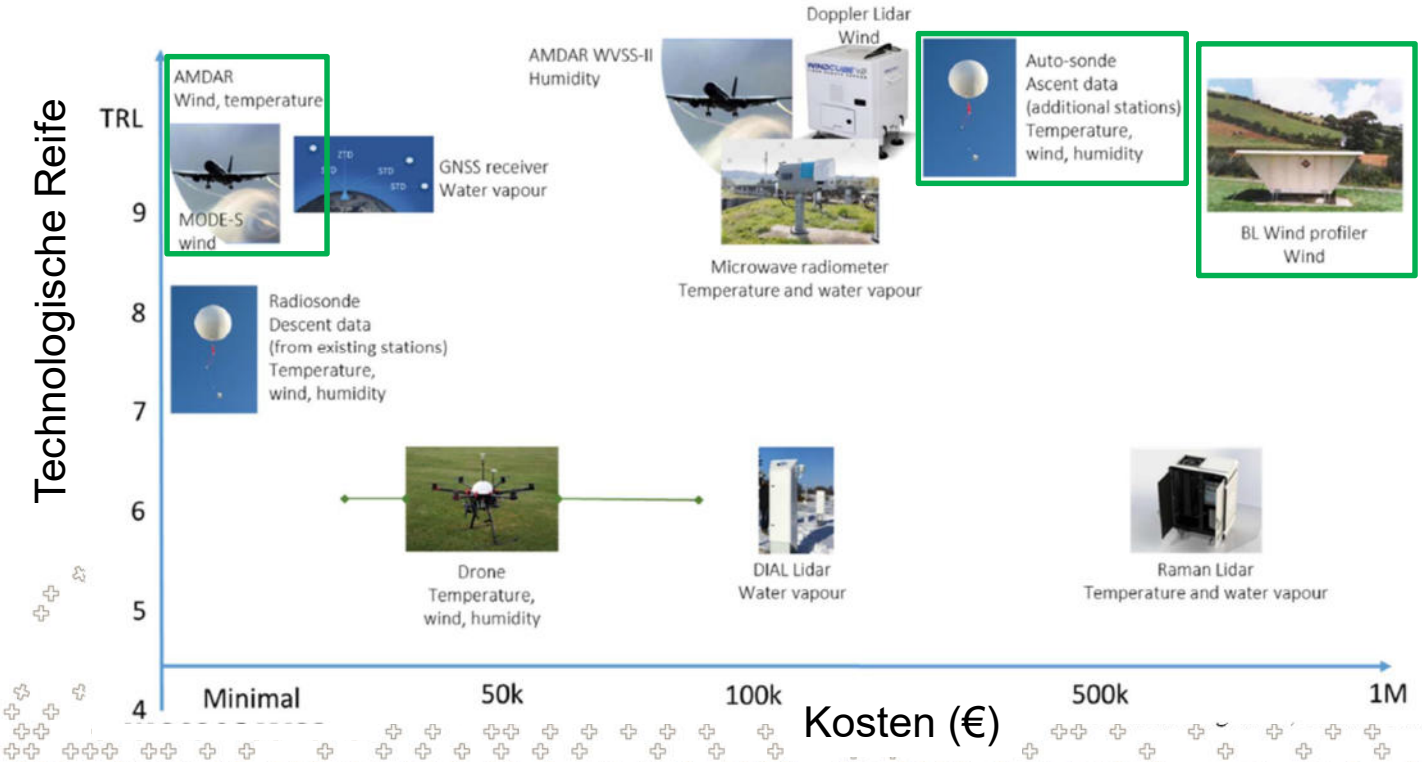
Beobachtungslücke in Boundary Layer

Sugier and Truscott (2019): EUMETNET Observations R&D Plan 2019-2023:



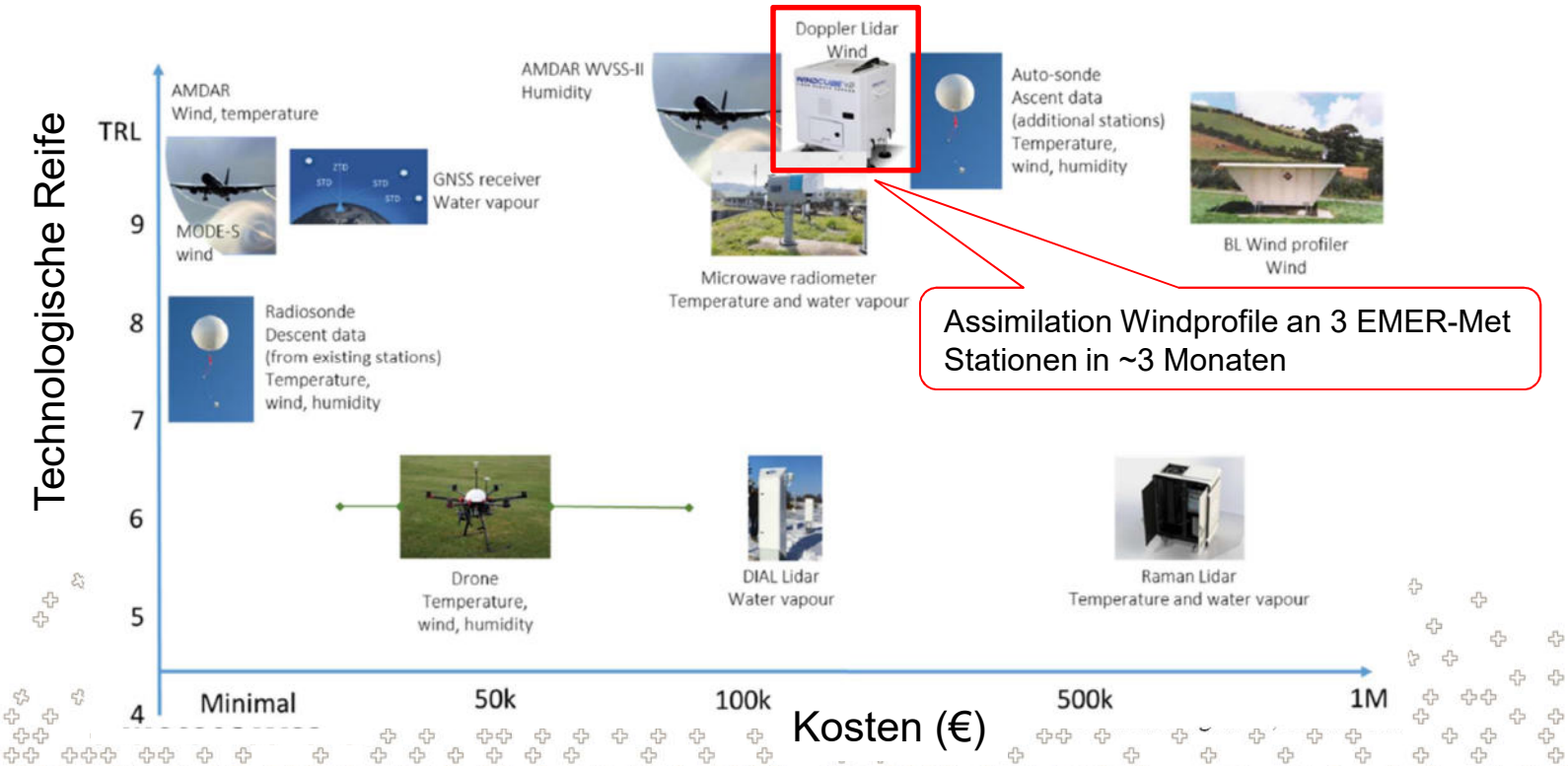
Beobachtungslücke in Boundary Layer

Sugier and Truscott (2019): EUMETNET Observations R&D Plan 2019-2023:



Beobachtungslücke in Boundary Layer

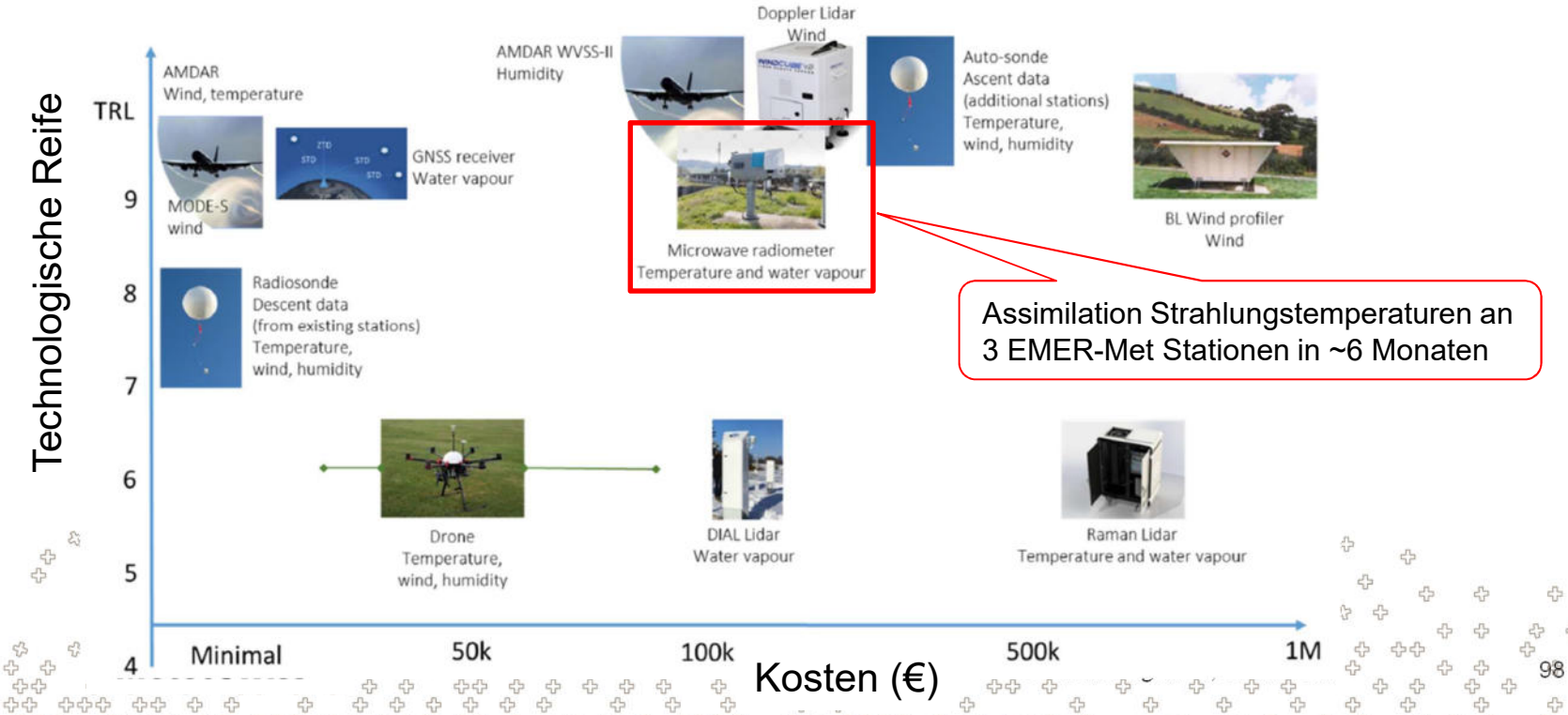
Sugier and Truscott (2019): EUMETNET Observations R&D Plan 2019-2023:



Assimilation Windprofile an 3 EMER-Met Stationen in ~3 Monaten

Beobachtungslücke in Boundary Layer

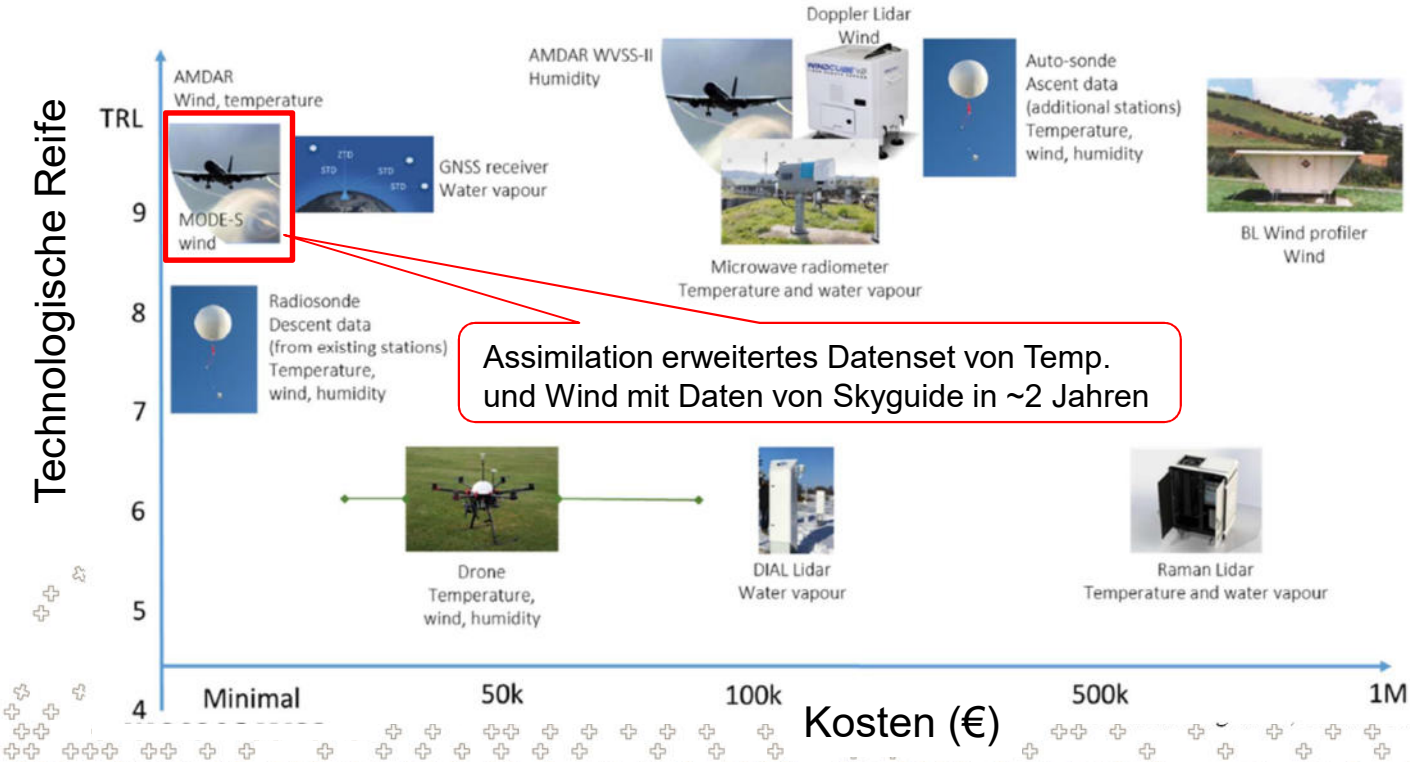
Sugier and Truscott (2019): EUMETNET Observations R&D Plan 2019-2023:



Assimilation Strahlungstemperaturen an 3 EMER-Met Stationen in ~6 Monaten

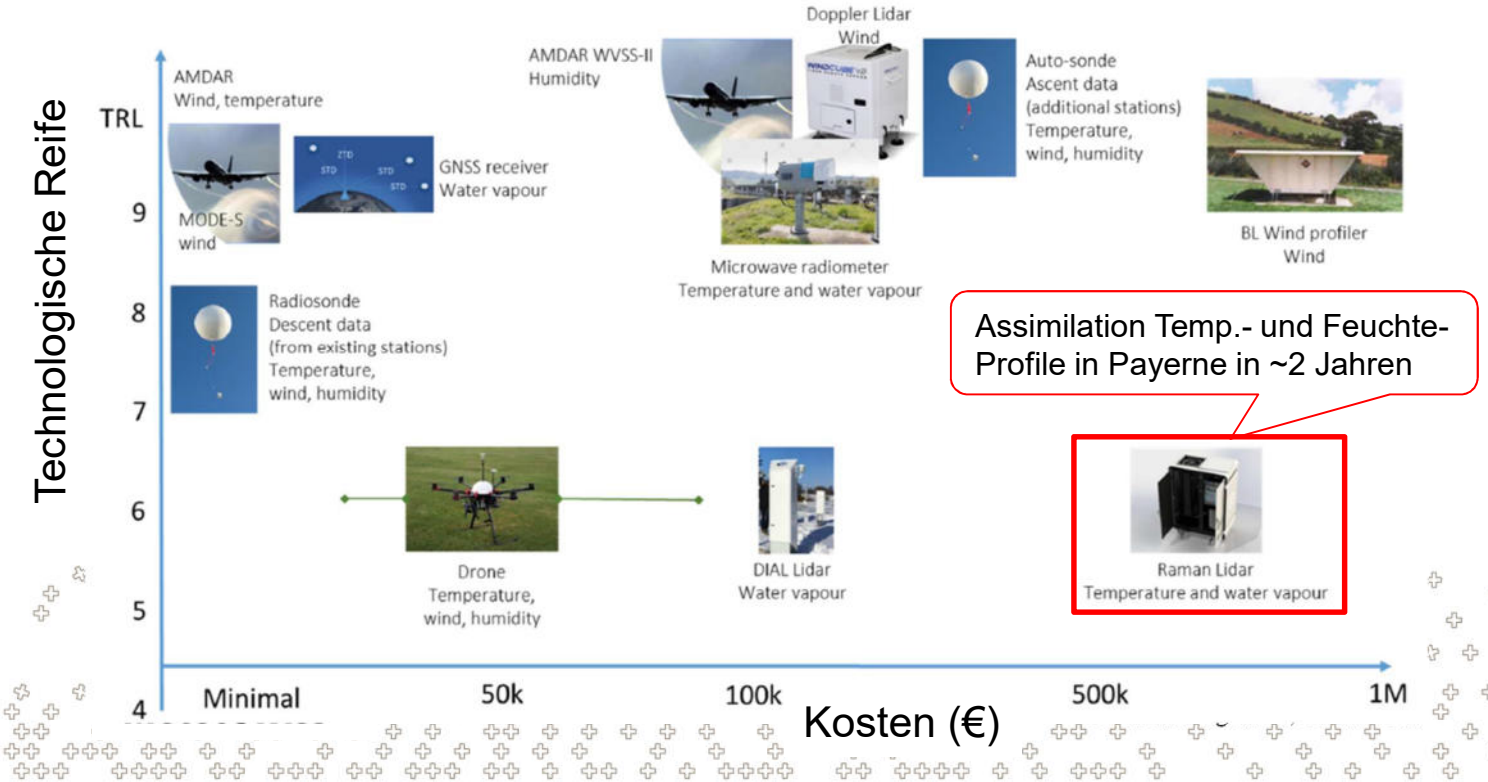
Beobachtungslücke in Boundary Layer

Sugier and Truscott (2019): EUMETNET Observations R&D Plan 2019-2023:



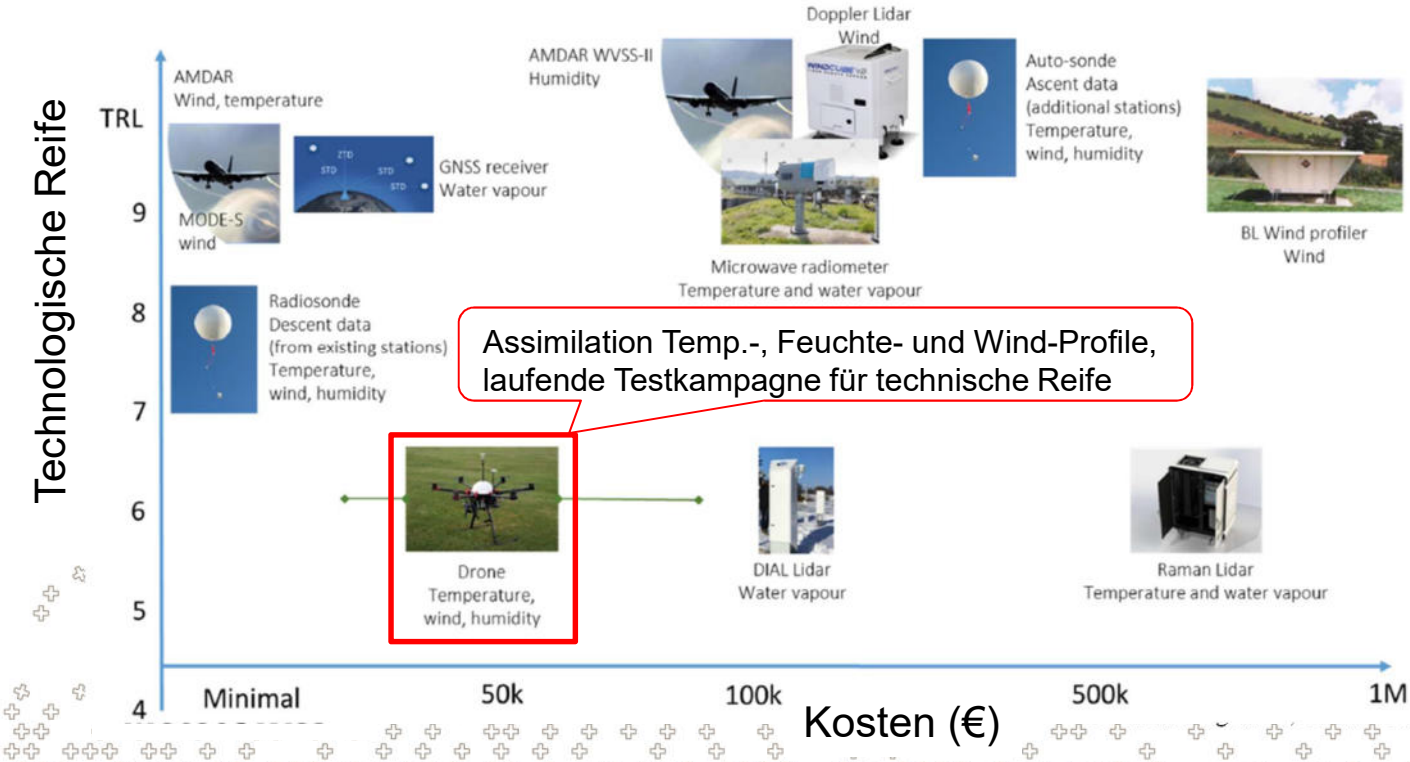
Beobachtungslücke in Boundary Layer

Sugier and Truscott (2019): EUMETNET Observations R&D Plan 2019-2023:



Beobachtungslücke in Boundary Layer

Sugier and Truscott (2019): EUMETNET Observations R&D Plan 2019-2023:

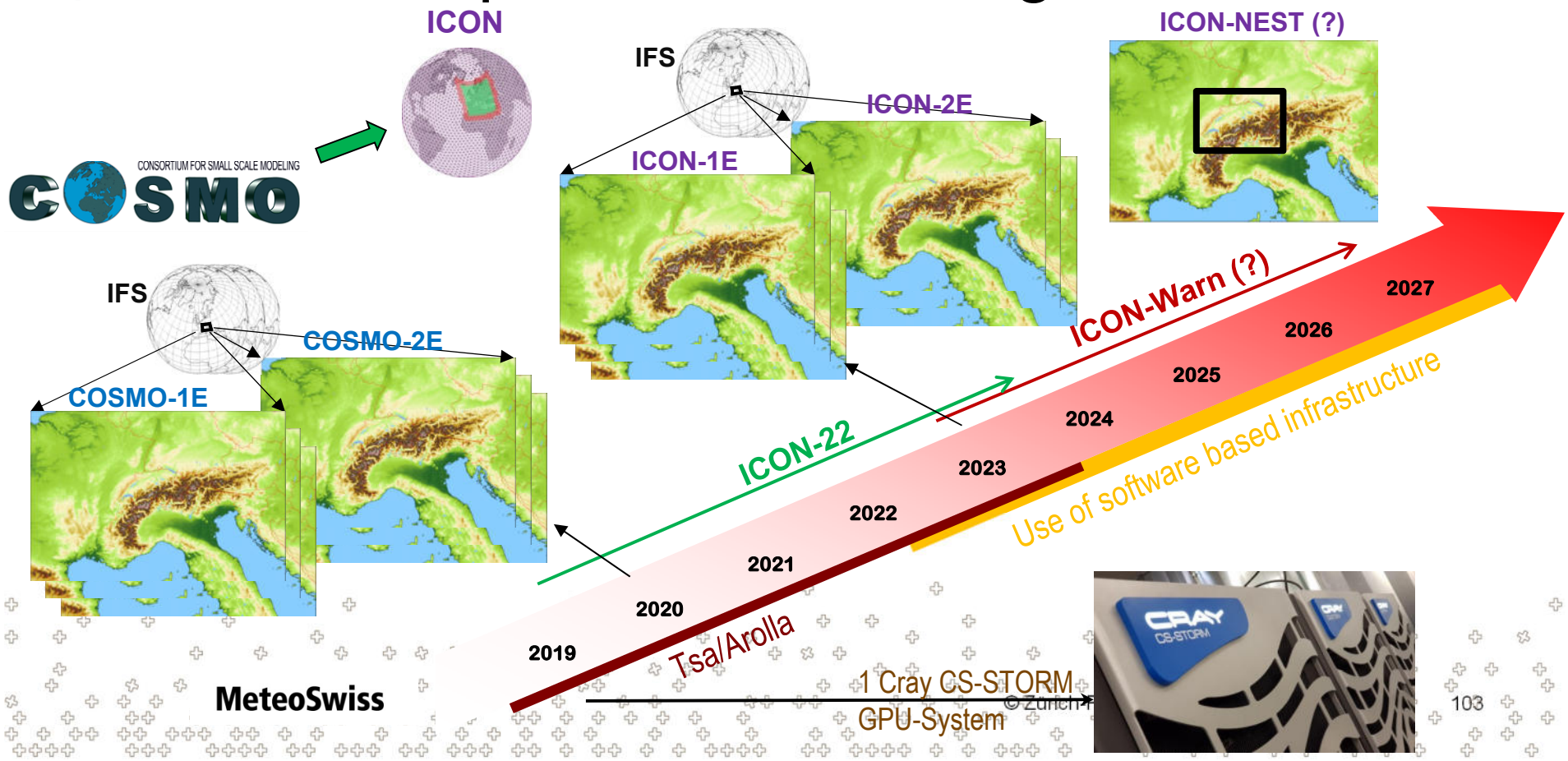


Schlussfolgerungen

- Umstieg auf ICON bietet die Grundlage für weitere Fortschritte in den numerischen Wettervorhersagen
- Ensemble Vorhersagen erlauben eine Quantifizierung der Prognosesicherheit
- Neue Entwicklungen bei Messinstrumenten ermöglichen viele zusätzliche Beobachtungen, sind jedoch teuer und deren Integration in die Datenassimilation ist komplex

- Weitere Verbesserung von Nebelvorhersagen und Konvektion durch:
  - Assimilation von zusätzlichen Profildaten in den nächsten 3 - 24 Monaten
  - Assimilation von Drohnen-Profildaten wird untersucht

Roadmap Wettervorhersagemodelle



MeteoSwiss

Fragen?

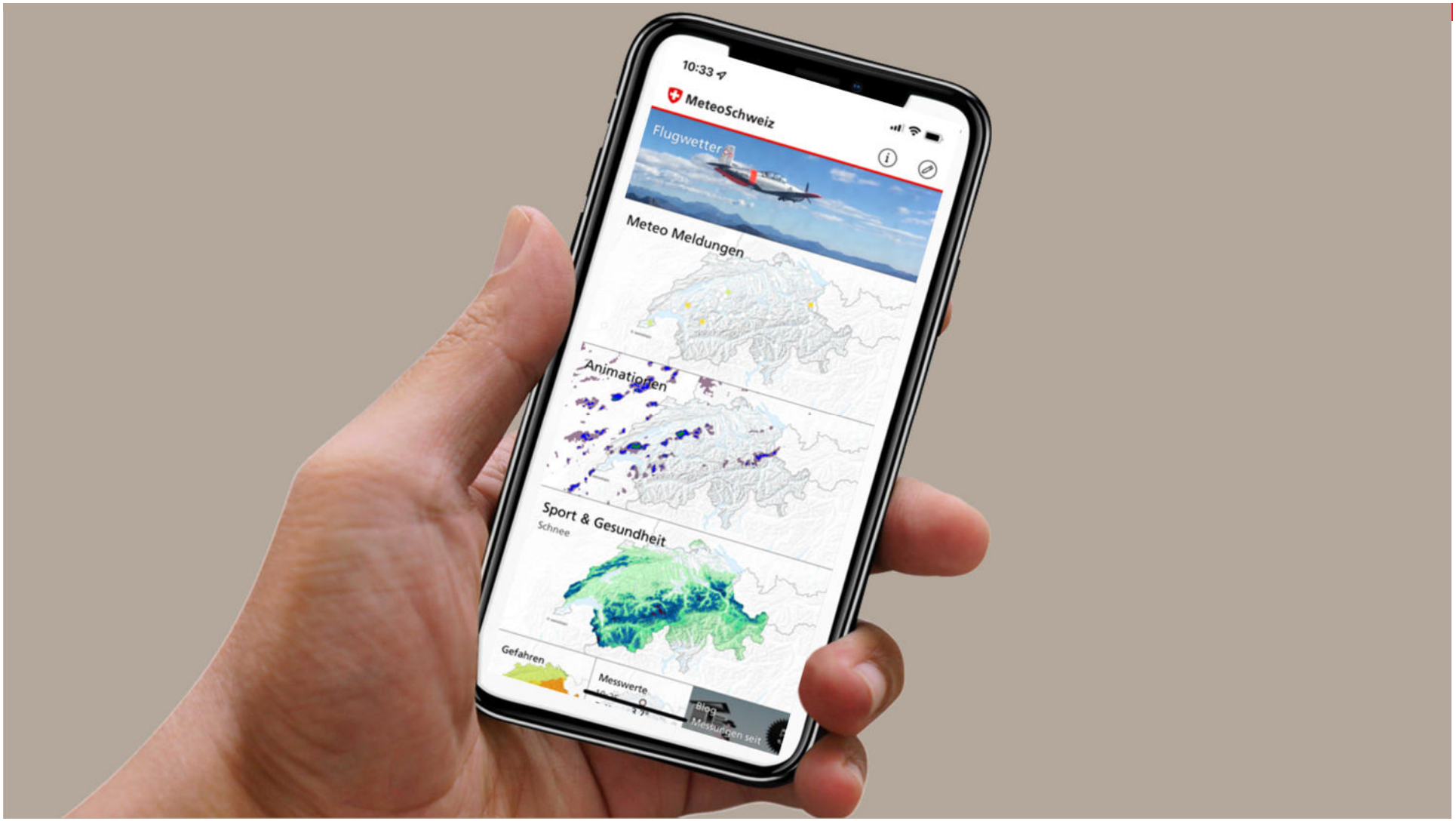
Kaffeepause

Breakout-Sessions
https://app.wonder.me/?spaceId=1127092b-7c5b-45d3-8856-16b13aa3adda

MeteoSchweiz News

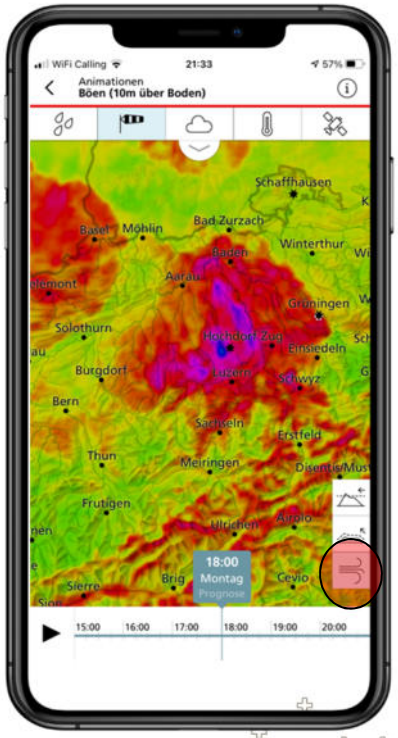
MeteoSwiss App
Neuigkeiten

Markus Aebischer
Leiter Produktmanagement & Distribution


10:33
MeteoSchweiz
Flugwetter
Meteo Meldungen
Animationen
Sport & Gesundheit
Schnee
Gefahren
Messwerte

Flugwetter → Animation: Böen als Standardwert

neu



bisher

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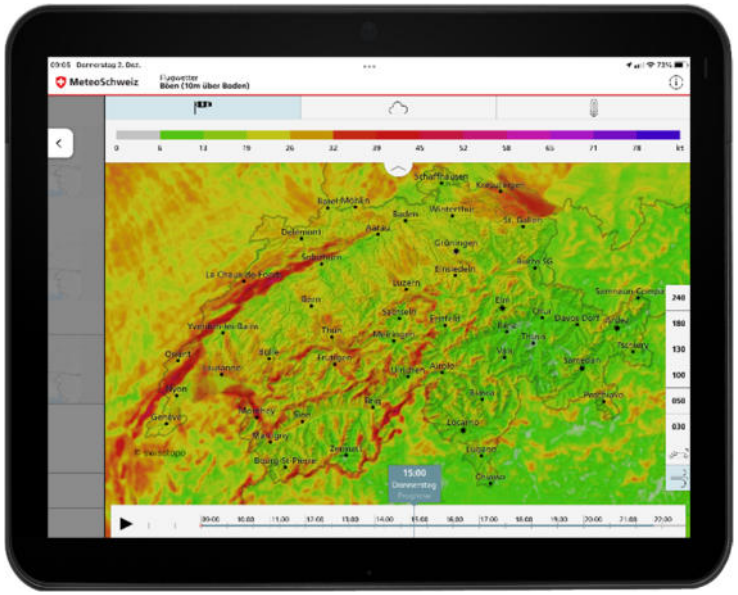
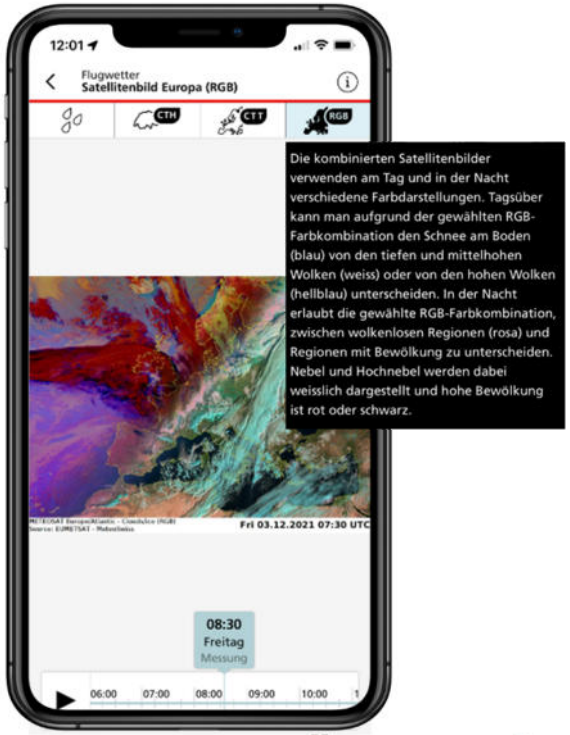
Flugwetter → Animation: Böen als Standardwert



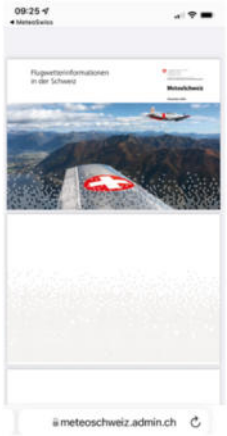
Flugwetter → Animation → Satellitenbilder

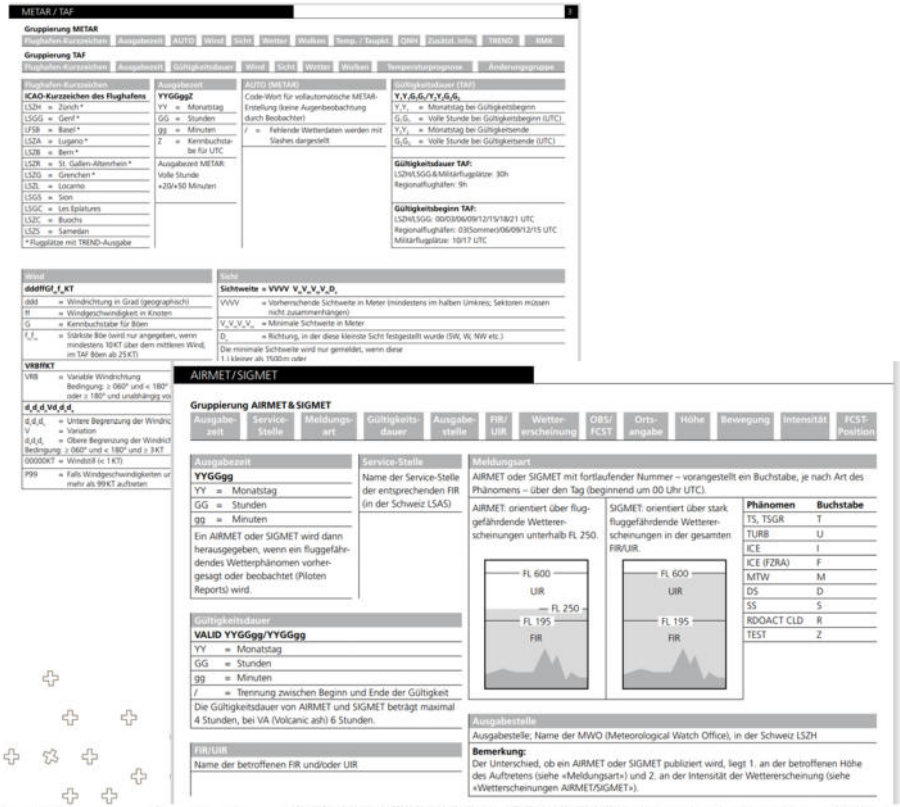


Animation → Satellitenbilder

Die kombinierten Satellitenbilder verwenden am Tag und in der Nacht verschiedene Farbdarstellungen. Tagsüber kann man aufgrund der gewählten RGB-Farbkombination den Schnee am Boden (blau) von den tiefen und mittelhohen Wolken (weiss) oder von den hohen Wolken (hellblau) unterscheiden. In der Nacht erlaubt die gewählte RGB-Farbkombination, zwischen wolkenlosen Regionen (rosa) und Regionen mit Bewölkung zu unterscheiden. Nebel und Hochnebel werden dabei weisslich dargestellt und hohe Bewölkung ist rot oder schwarz.

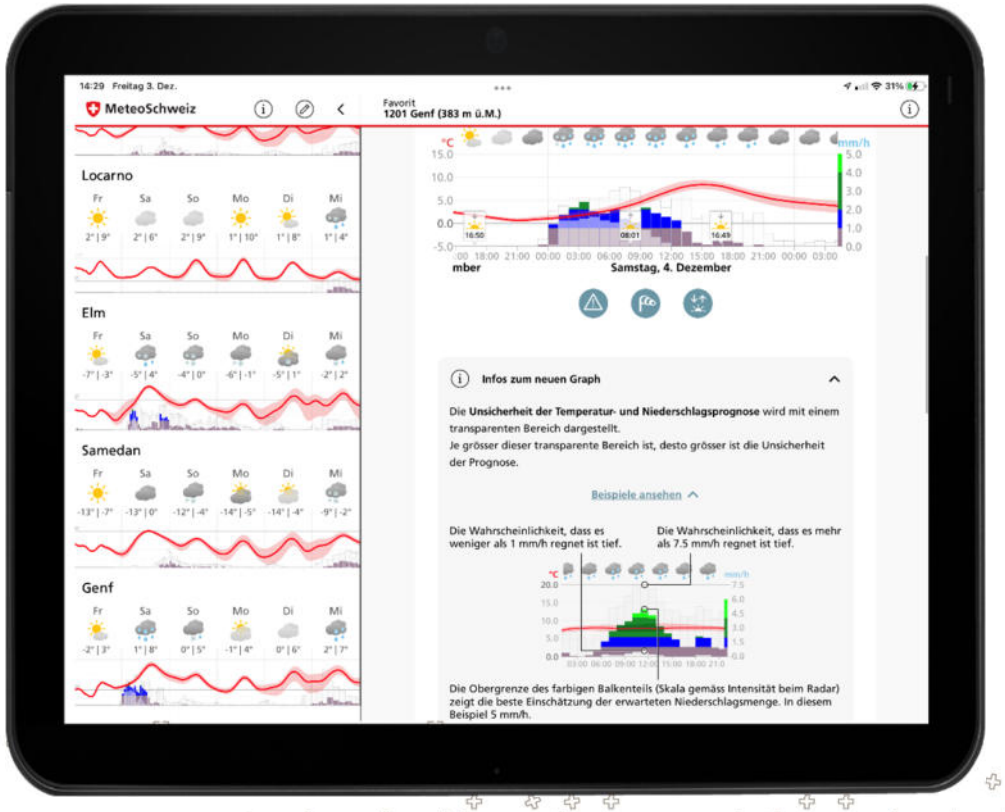
Flugwetterinformationen in der Schweiz





Animation → Blitze

Lokalprognose → Niederschlagswahrscheinlichkeit



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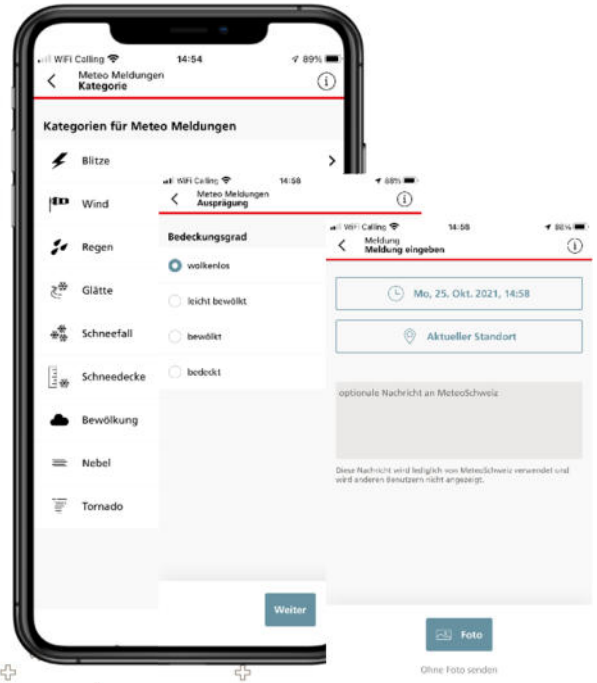
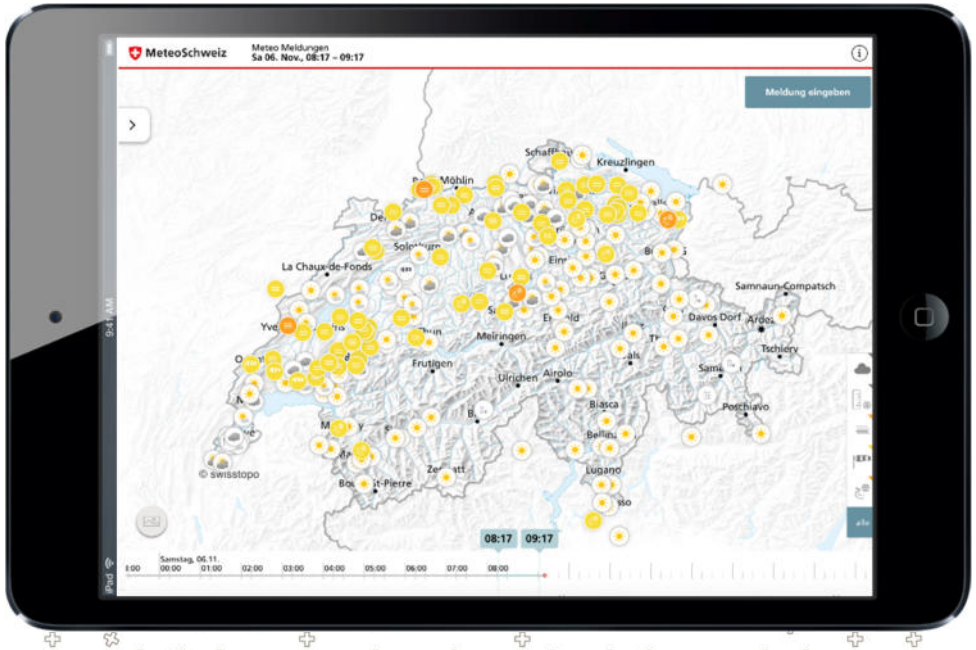
Meteo Meldungen



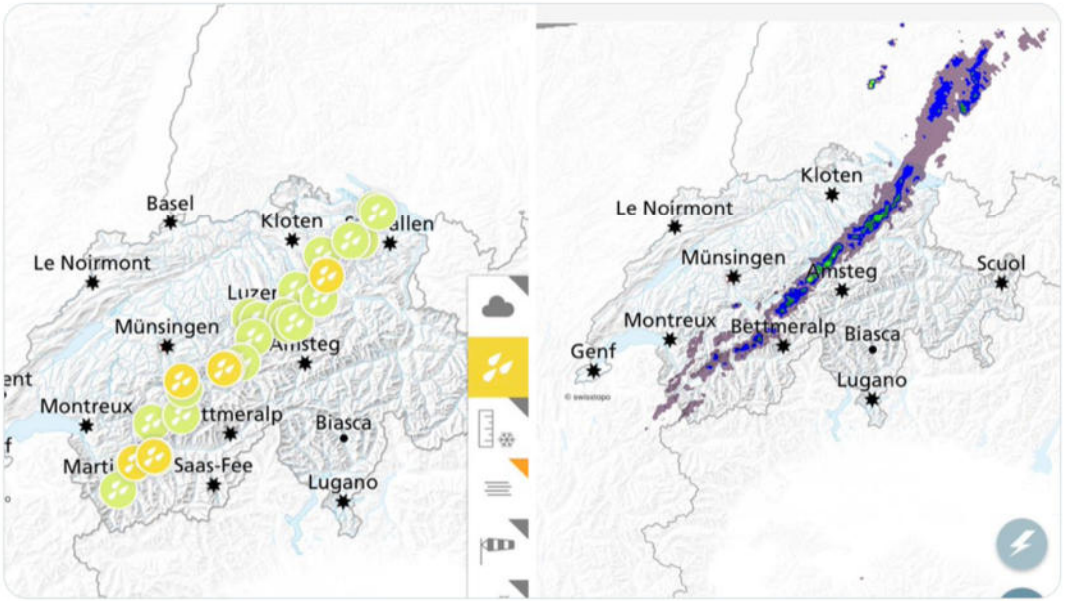


Meteo Meldungen

Angehefteter Tweet

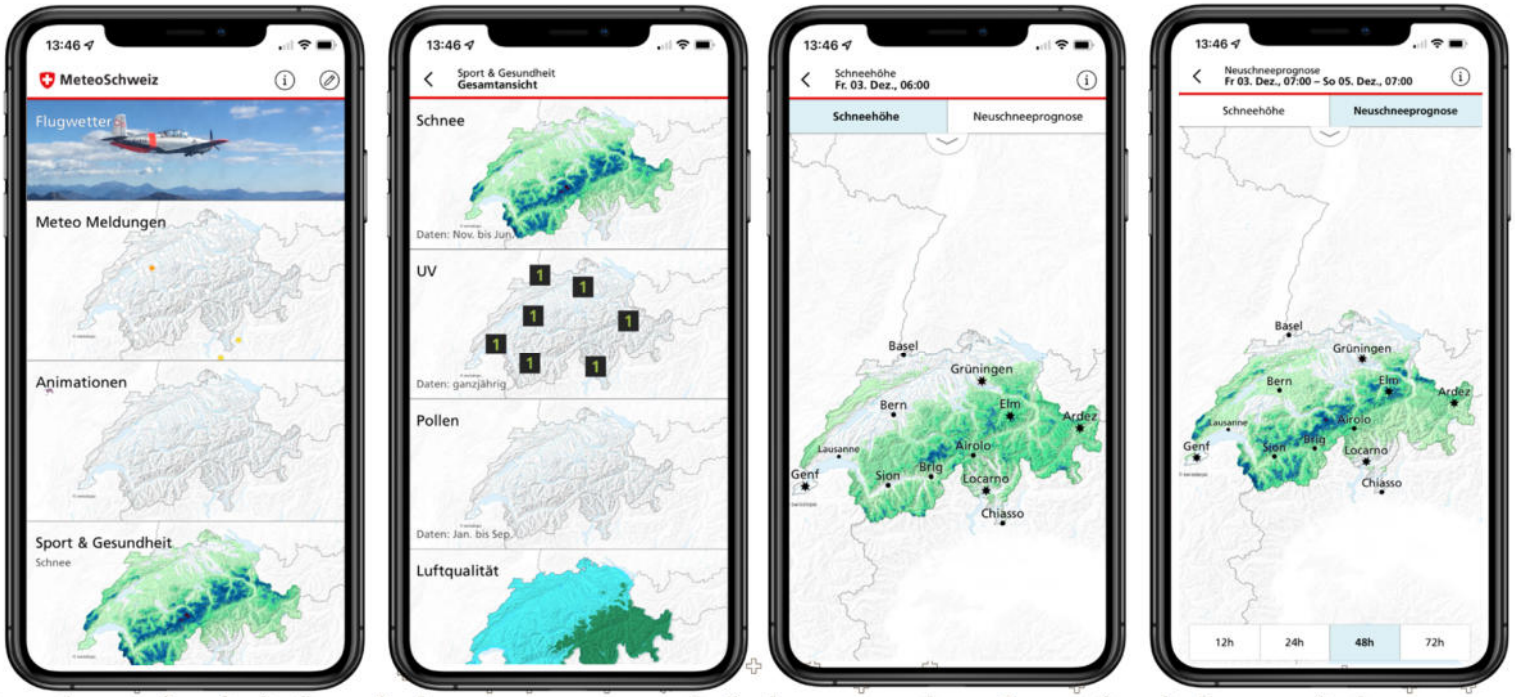
Christoph Schmutz @Heiterluft · 13.11.21

Crowdsourcing at its best. in der @meteoschweiz App. 👍👌👏



Bilder © Meteo Meldungen

Sport & Gesundheit → Schnee



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Finanzen
Flugwetterkosten

Lukas Schumacher
Leiter Finanzen und Logistik

Neue Kosten- und Leistungsrechnung (I)

- Ist-Kostenrechnung
  - Vollständige Abbildung der Istkosten im SAP
  - Täglich/wöchentlich erfassen alle MA ihre Leistungszeiten im SAP WebCATS (Vorgabe Bund)
  - Monatliche Kontrolle der erfassten Zeiten durch Vorgesetzte, Projektleitende, Kostenstellenverantwortliche
- Hohe Transparenz (Kostenklarheit und Kostenwahrheit)
- Relativ einfaches Handling (dynamische, verursachergerechte Umlageschlüssel)

Neue Kosten- und Leistungsrechnung (II)

- Prinzip der Vollkostendeckung (gemäss Verordnung über den Flugsicherungsdienst VFSD)
- Klare Definition der Prozesse, Kompetenzen und Verantwortlichkeiten
- Konzeption der neuen KLR zusammen mit KPMG

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Stand der Umsetzung

- Ausarbeitung KLR Konzept im Zeitraum Herbst 2019 bis Sommer 2020
- Überprüfung des neuen KLR Konzeptes durch das BAZL zwischen November 2020 und Januar 2021
- Bericht des BAZL zu den Ergebnissen dieser Überprüfung im April 2021
- Anpassungsarbeiten am Konzept und Umsetzung im SAP bis Oktober 2021
- Nächste Überprüfung BAZL im Hinblick auf die Referenzperiode 4 noch offen

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Flugwetterkosten 2021

- Seit 2019 gilt das neue, vom BAZL festgelegte Kostendach für das zivile Flugwetter:
  - CHF 14.5 Mio. pro Jahr
  - Plafond gilt für die gesamte Referenzperiode 3 (2020-2024)
- Rückverrechnung der in den Jahren 2015 - 2018 zu viel belasteten zivilen Flugwetterkosten in den Jahren 2020 - 2022 (CHF 2.8 Mio. pro Jahr) → Entlastung der Flugwetterkosten in den entsprechenden Jahren

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Finanzentwicklung 2019 – 2021 und Finanzausblick 2022

Kosten Flugwetter Zivilluftfahrt (in Mio. CHF)	2019	2020	2021 Erw.	2022
Voranschlag	**14.51**	**14.51**	**14.51**	**14.51**
IST	**14.173**	**10.85 ***	*noch offen*	-
Abweichung	**- 0.337**	**- 3.66**	-	-

*** inkl. Rückerstattungen 2020-22 (CHF 2.85 Mio.) und Reduktion Datenkosten (CHF 0.8 Mio.)**

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Fragen?

«Wenn Spinnen vereint weben, können sie einen Löwen fesseln.»
(Äthiopisches Sprichwort)

Save the date: 08. Dezember 2022

Auf Wiedersehen!

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

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

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