



Machine Learning for Weather Prediction

Introduction

William Becker

Training coordinator in Machine Learning

william.becker@ecmwf.int



About ECMWF

ECMWF's role is to address the critical and most difficult research problems in medium-range NWP that no one country could tackle on its own



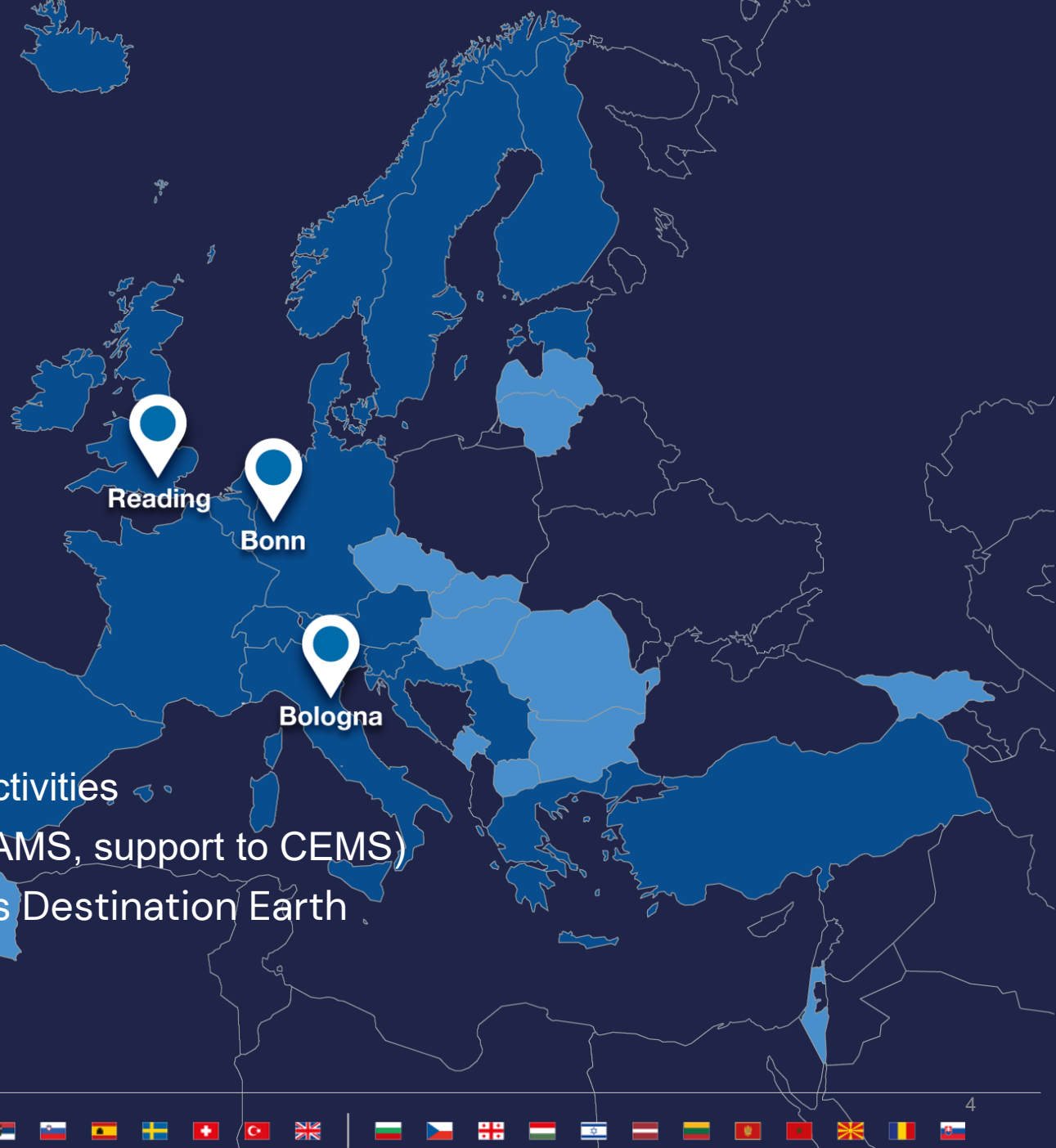
European Centre for Medium-Range Weather Forecasts (ECMWF)

ECMWF is an international organisation with

- 23 Member States
- 12 Cooperating States

Three sites in UK, Italy and Germany

- Both research institute & 24/7 operational centre
- Established in 1975
- Advanced training = one of ECMWF's strategic activities
- Entrusted entity for Copernicus services (C3S, CAMS, support to CEMS)
- One of three Entrusted Entities delivering EU's Destination Earth



FULL, FREE AND OPEN
ACCESS TO DATA



ATMOSPHERE MONITORING



MARINE ENVIRONMENT MONITORING



LAND MONITORING



CLIMATE CHANGE

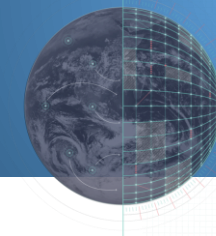


EMERGENCY MANAGEMENT

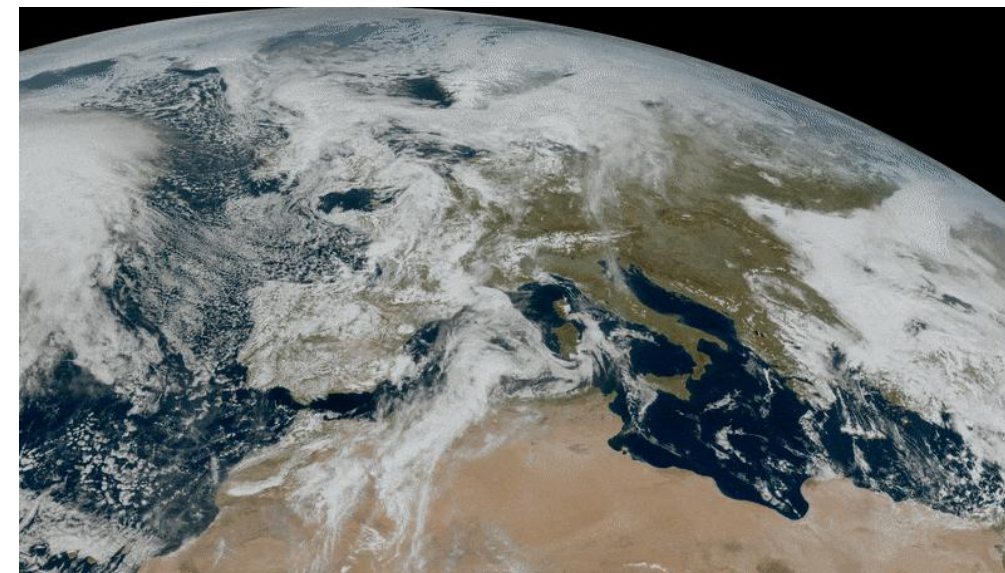
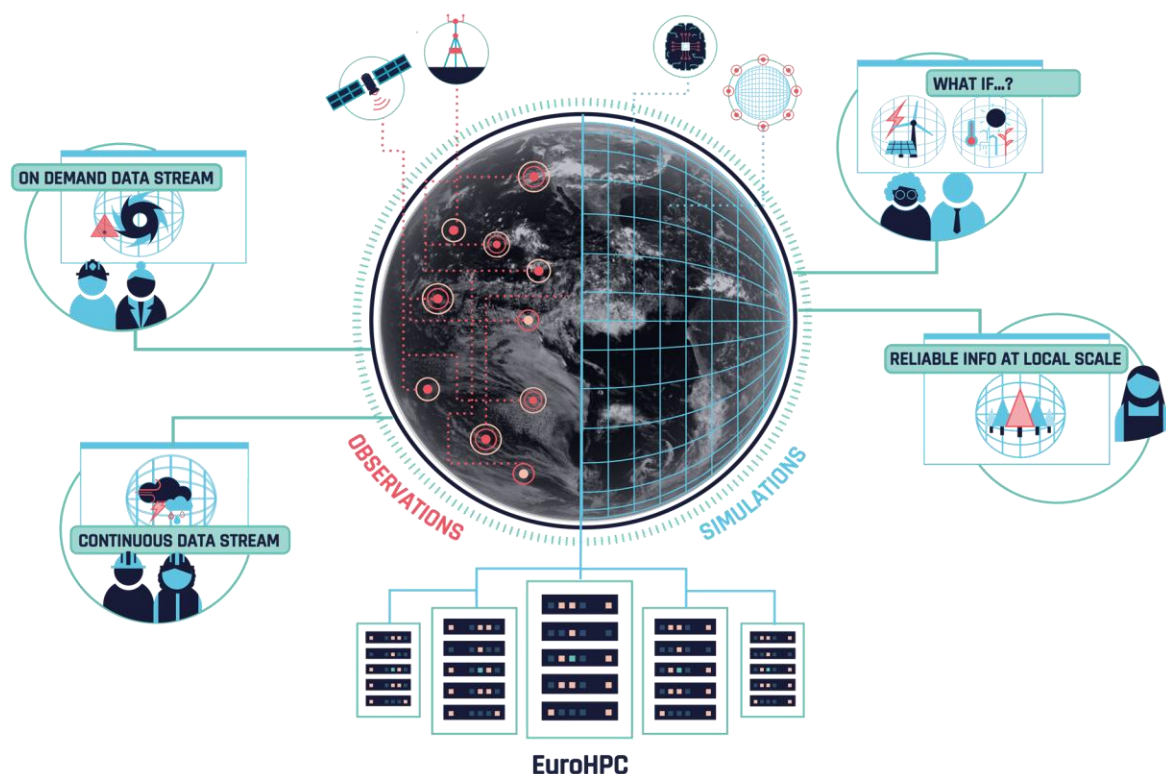


SECURITY

 **copernicus**
Europe's eyes on Earth



The Destination Earth System



Digital twins

- Climate change adaption
- Weather-induced extremes
- Machine learning components

<https://destine.ecmwf.int/ai-in-destination-earth/>

ARTIFICIAL INTELLIGENCE FORECASTING SYSTEM (AIFS)



1. Observe

Every day, we collect **800 million** observations of Earth's atmosphere, wind, temperature and beyond

2. Absorb

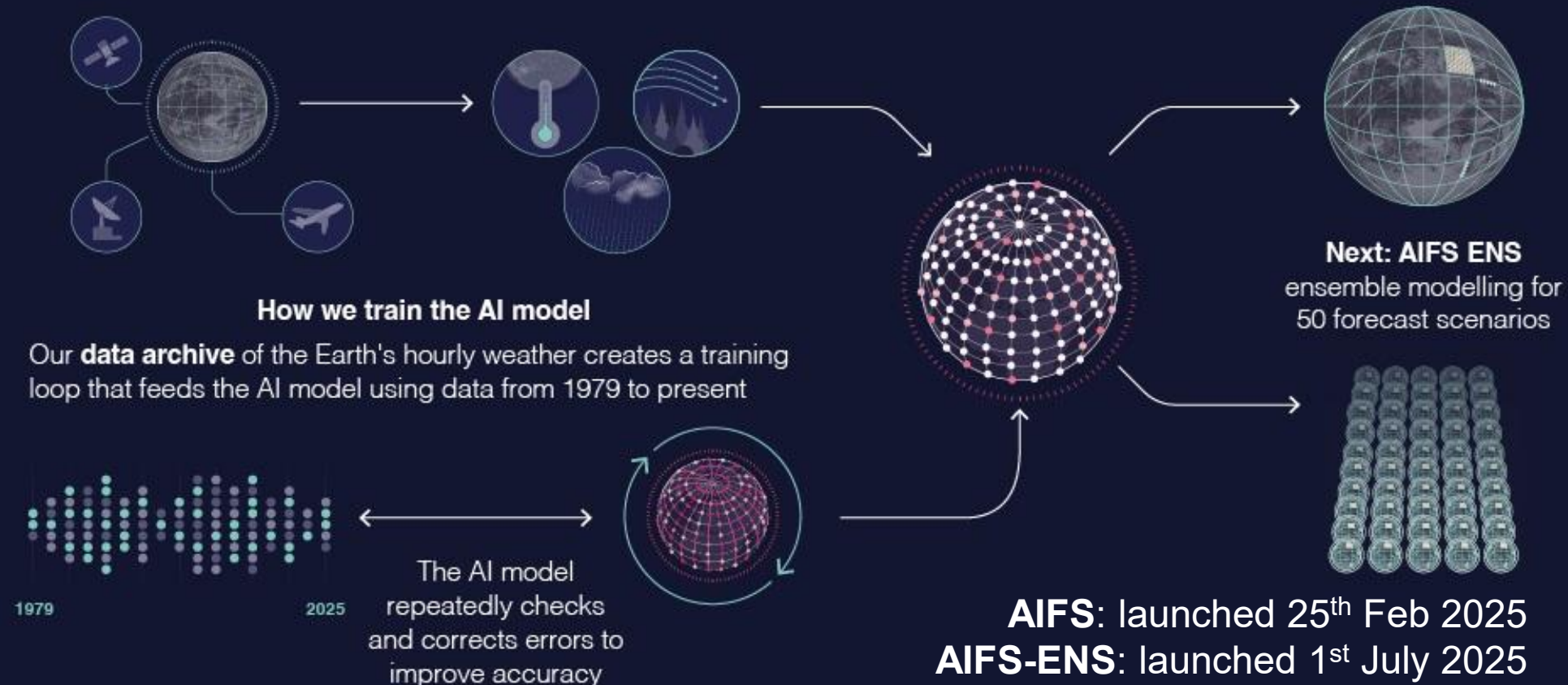
60 million quality-controlled observations are absorbed by our physics-based Integrated Forecasting System

3. Model

They feed the **AIFS'** new AI model, which predicts Earth's weather for the coming days

4. Predict

Now: AIFS Single one forecast at a time





Training at ECMWF

In-person events

- ✓ Approx. 8 multi-day courses per year in Reading
- ✓ Events also held in Member and Cooperating States, and in collaboration with EUMETSAT, WMO and others

<https://www.ecmwf.int/en/learning>

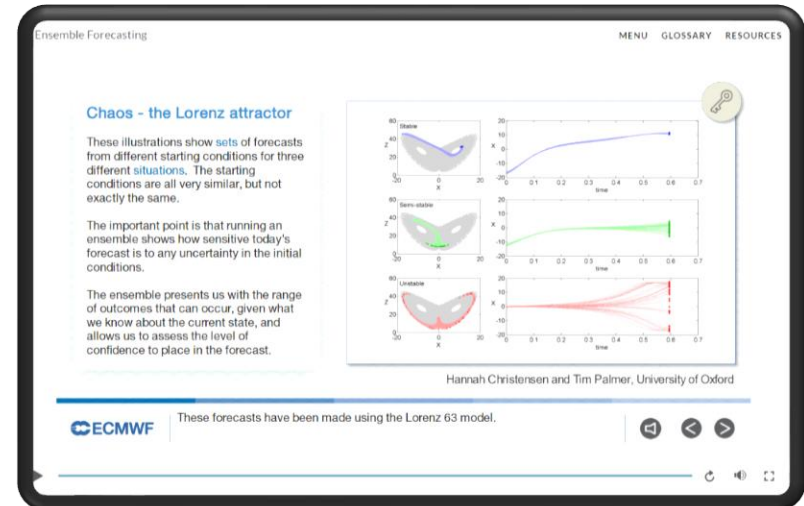
Online training

- ✓ Material available on demand
- ✓ Courses on ML, research, forecasting, C3S

Plus: Jupyter notebooks, Jupyterbooks, Webinars

<https://learning.ecmwf.int/>

More to come in 2026!



PROGRAMME OF
THE EUROPEAN UNION

Europe's eyes on Earth

IMPLEMENTED BY



On this course

Timetable: Mon/Tue

Monday, 27 October

08:30 → 09:00	Registration opens	📍	🕒 30m	✎
09:00 → 09:30	Welcome and course general information Speaker: William Becker (ECMWF)	📍	🕒 30m	✎
09:30 → 10:30	Overview/Motivation Speaker: Christian Lessig (ECMWF)	📍	🕒 1h	✎
10:30 → 11:00	Coffee break	📍	🕒 30m	
11:00 → 12:00	Machine Learning Foundations Speaker: Sara Hahner (ECMWF)	📍	🕒 1h	✎
12:00 → 13:00	Decision Trees and Random Forests Speaker: William Becker (ECMWF)	📍	🕒 1h	✎
13:00 → 14:00	Lunch break	📍	🕒 1h	
14:00 → 15:00	Neural Networks and Deep Learning Speaker: Mario Santa Cruz Lopez (ECMWF)	📍	🕒 1h	✎
15:00 → 15:15	Coffee break	📍	🕒 15m	
15:15 → 16:30	Hands-on: ML Basics with Neural Networks Speakers: Julian Kuehnert (ECMWF), Matthias Karlbauer (ECMWF), Sebastian Hickman (ECMWF), William Becker (ECMWF)	📍	🕒 1h 15m	✎

16:30 → 18:00 **Ice-breaker cocktail** 📍 Conference room
WR - Weather room

Tuesday, 28 October

09:00 → 10:15	ML Evaluation and Data Leakage Speaker: Julian Kuehnert (ECMWF)	📍	🕒 1h 15m	✎
10:15 → 11:00	Coffee break & Group photo	📍	🕒 45m	
11:00 → 12:00	Data Handling and Infrastructure Speaker: Ewan Pinnington	📍	🕒 1h	✎
12:00 → 13:00	Convolutional Neural Networks Speaker: Vera Gahlen (ECMWF)	📍	🕒 1h	✎
13:00 → 14:00	Lunch break	📍	🕒 1h	
14:00 → 15:00	Transformers Speaker: Matthias Karlbauer (ECMWF)	📍	🕒 1h	✎
15:00 → 15:15	Coffee break	📍	🕒 15m	
15:15 → 17:00	Hands on: Debugging ML Models Speakers: Gabriel Ionut Moldovan (ECMWF), Mario Santa Cruz Lopez (ECMWF), Matthias Karlbauer (ECMWF), Sebastian Hickman (ECMWF)	📍	🕒 1h 45m	✎

Timetable: Wed/Thurs

ML Training Course dinner - Thursday night



Thursday, 30 October

09:00 → 10:15	Anemoi 1: Datasets and Inference Speakers: Harrison Cook (ECMWF), Matthew Chantry (ECMWF)	📍	🕒 1h 15m	✎
10:15 → 10:45	Coffee break	📍	🕒 30m	
10:45 → 12:00	Hands on: Run the AIFS Speakers: Harrison Cook (ECMWF), Jakob Schlör (ECMWF), Sara Hahner (ECMWF)	📍	🕒 1h 15m	✎
12:00 → 13:00	Hands on: Explainable AI with AIFS Speakers: Mario Santa Cruz Lopez (ECMWF), Sara Hahner (ECMWF), Sebastian Hickman (ECMWF)	📍	🕒 1h	✎
13:00 → 14:00	Lunch break	📍	🕒 1h	
14:00 → 15:00	Anemoi 2: Graphs and Models Speakers: Mario Santa Cruz Lopez (ECMWF), Matthew Chantry (ECMWF)	📍	🕒 1h	✎
15:00 → 15:15	Coffee break	📍	🕒 15m	
15:15 → 16:00	Anemoi 3: Training Speaker: Helen Theissen (ECMWF)	📍	🕒 45m	✎
16:00 → 17:00	Hands-on: Anemoi Speakers: Gabriel Ionut Moldovan (ECMWF), Harrison Cook (ECMWF), Helen Theissen (ECMWF), Julian Kuehnert (ECMWF), Mario Santa Cruz Lopez (ECMWF), Matthew Chantry (ECMWF)	📍	🕒 1h	✎

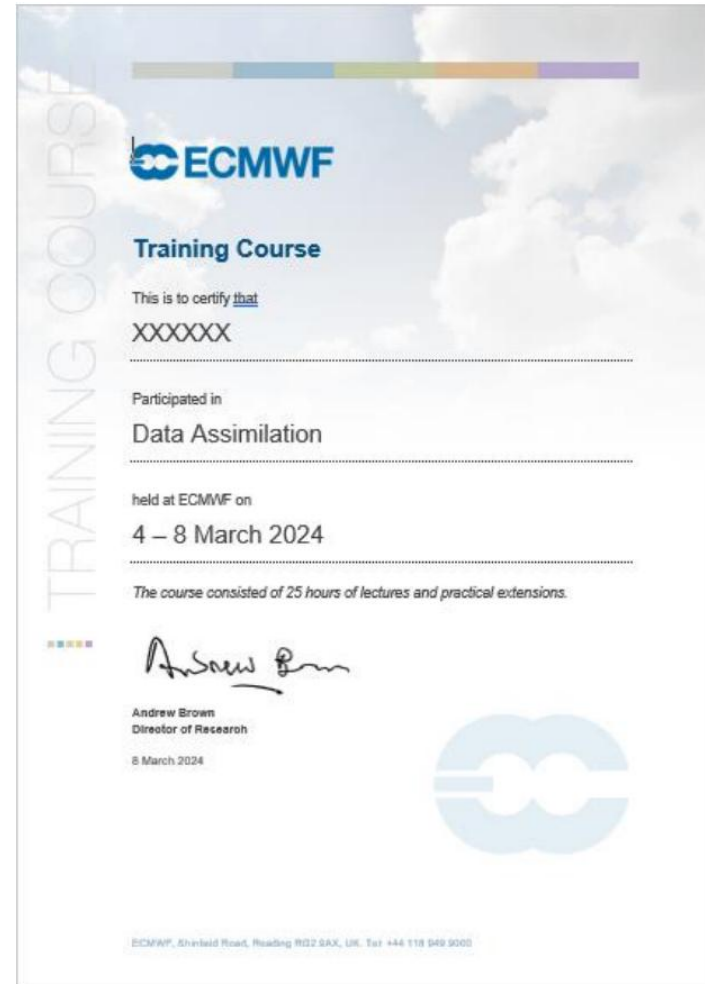
Dinner from about 6.30pm, Market House

Timetable: Fri

Friday, 31 October				
09:00 → 10:15	Hands on: Anemoi Speakers: Harrison Cook (ECMWF), Helen Theissen (ECMWF), Jakob Schlör (ECMWF), Julian Kuehnert (ECMWF), Matthew Chantry (ECMWF)	📍	🕒 1h 15m	✎
10:15 → 10:45	Coffee break	📍	🕒 30m	
10:45 → 12:00	Demo: Anemoi Profiling Speakers: Cathal O'Brien (ECMWF), Jan Polster (ECMWF)	📍	🕒 1h 15m	✎
12:00 → 12:30	Course wrap-up, final discussion Speaker: Matthew Chantry (ECMWF)	📍	🕒 30m	✎

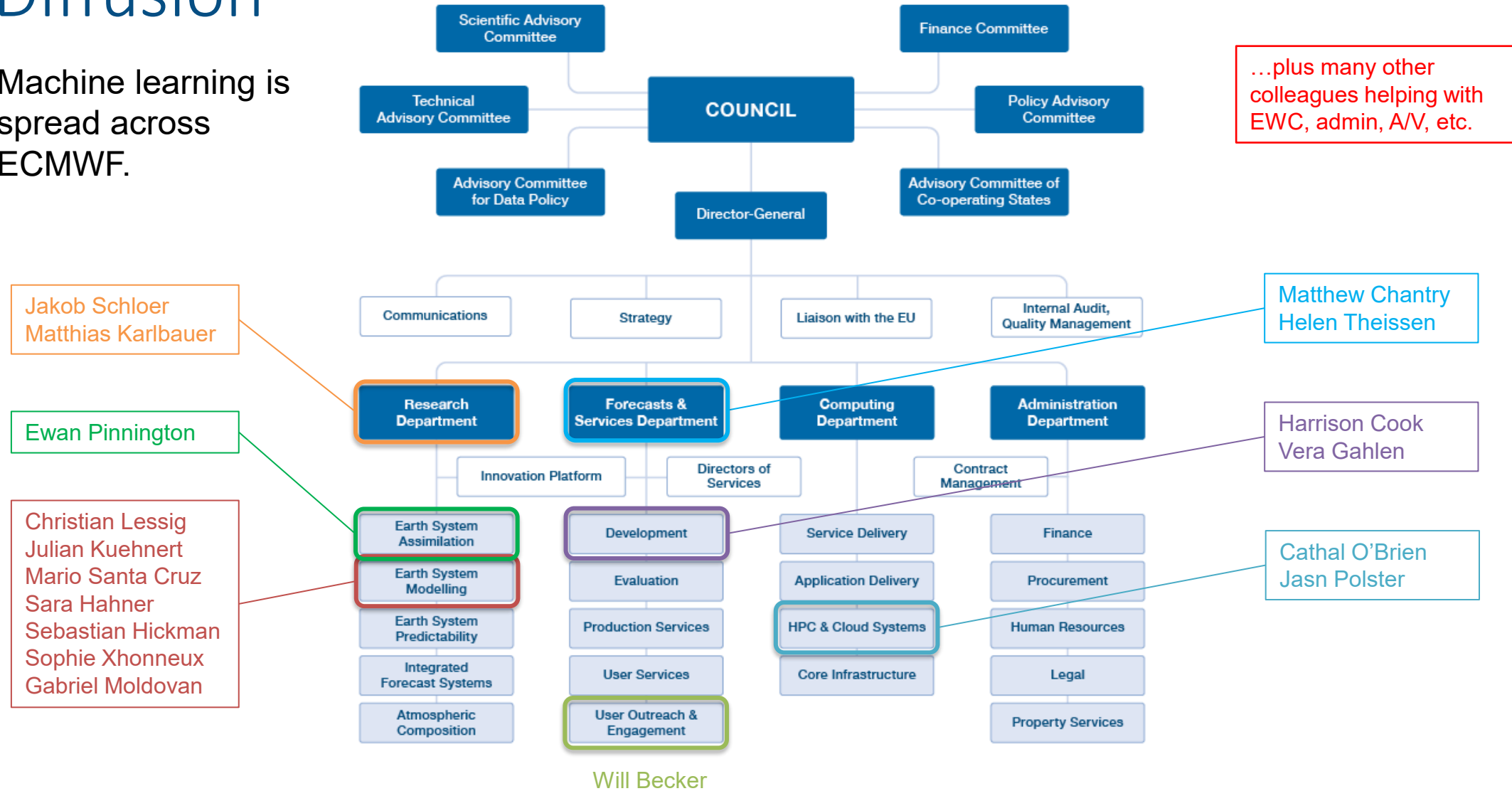
Certificate of attendance & course material

- Course web page: <https://events.ecmwf.int/event/436/>
- Presentations: <https://events.ecmwf.int/event/436/timetable/>
- Certificate of attendance awarded at end of course



Diffusion

Machine learning is spread across ECMWF.





<https://www.menti.com/alvd2hyqmuxg>

Housekeeping

General Housekeeping

Access to Centre

- Please sign in/out each day at reception

Personal belongings

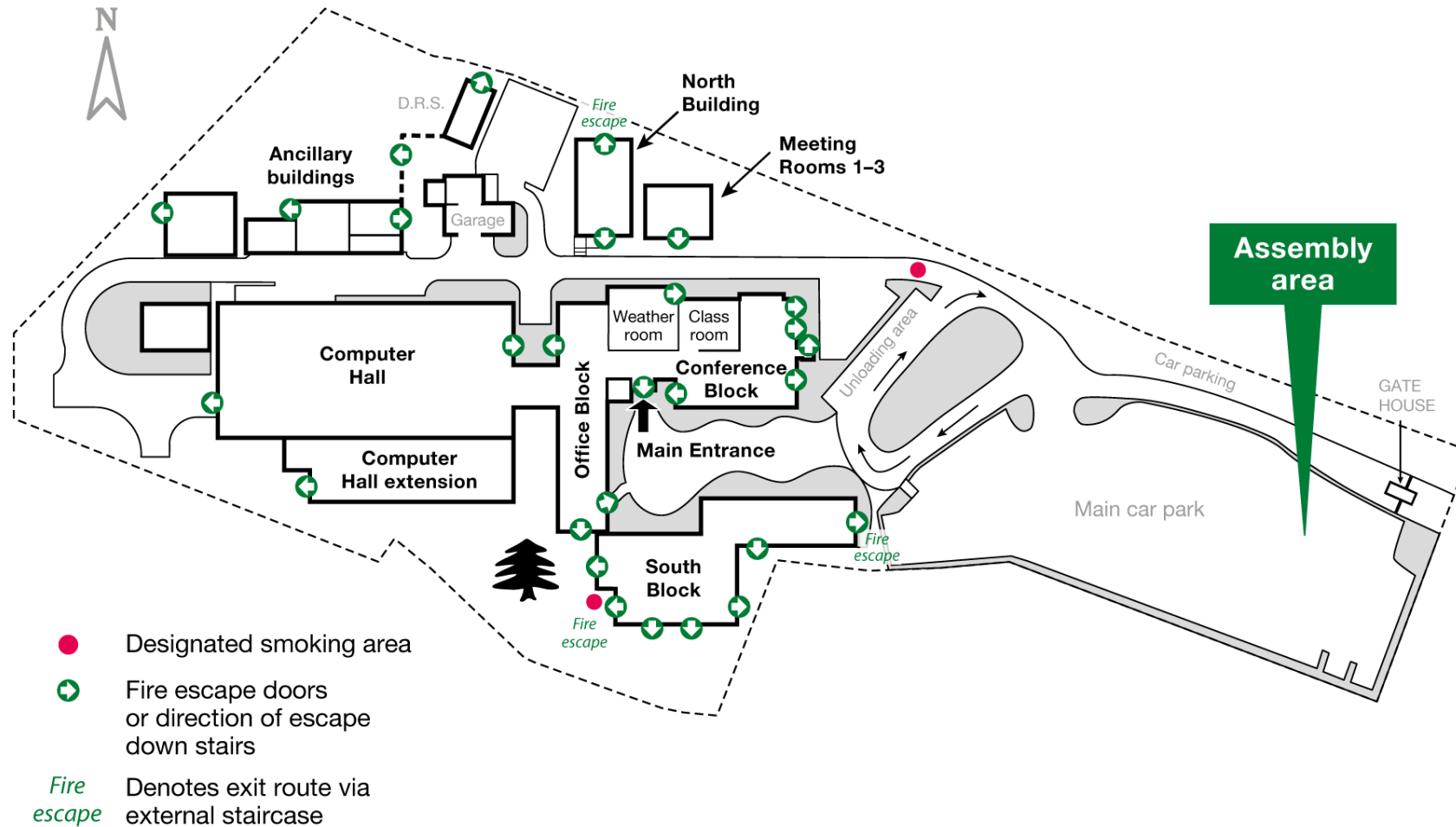
- Do not leave any personal belongings at ECMWF outside office hours.
- We recommend that you do not leave valuables unattended in the classroom or any other part of the building.
- ECMWF will not take any responsibility for items lost at the premises.

Smoking

- Smoking is not allowed inside the building. Please ask at Reception Desk and you will be directed to the outside smoking area.

General Housekeeping

Fire Escapes and Assembly Area



Visitor WiFi

Follow these steps to use the visitor WiFi.

1. From the list of available SSIDs, select "ECMWF-Visitors"
2. Log in with password (we will provide)
3. Enter your details in the appropriate boxes on the registration screen, and ECMWF email (we will provide) and press the Register button.
4. You will be redirected to a page that informs you of a successful registration and provides your personal Access key.

Restaurant

- The restaurant provides the following daily services:
 - Light breakfast from 08:00
 - Lunch: hot counter choices, salads, sandwiches, soup and desserts.
- Please speak to the restaurant staff if you have any special dietary requirements.
- The restaurant can only accept chip and pin and contactless card payments.
- Coffee/tea will be supplied during the breaks as specified on the programme.

General Housekeeping

Recording and photos

- Lectures are hybrid and streamed to some colleagues, so please use microphones where possible
- We may take some photos during the training

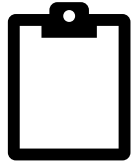
Enquiries

- If you have any questions, please contact the Reception Desk who will liaise with the course organisers.

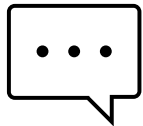
Make the most of the training!

- There are no stupid questions!
- Please feel free to talk to us and get to know each other 😊

Feedback



Survey at the end of the training



Talk to me any time or email contacts:

- william.becker@ecmwf.int for anything related to ML training and the present course
- training@ecmwf.int for general training enquiries.



Good luck with the training!