ECMWF Data assimilation & Machine Learning Training

Introduction

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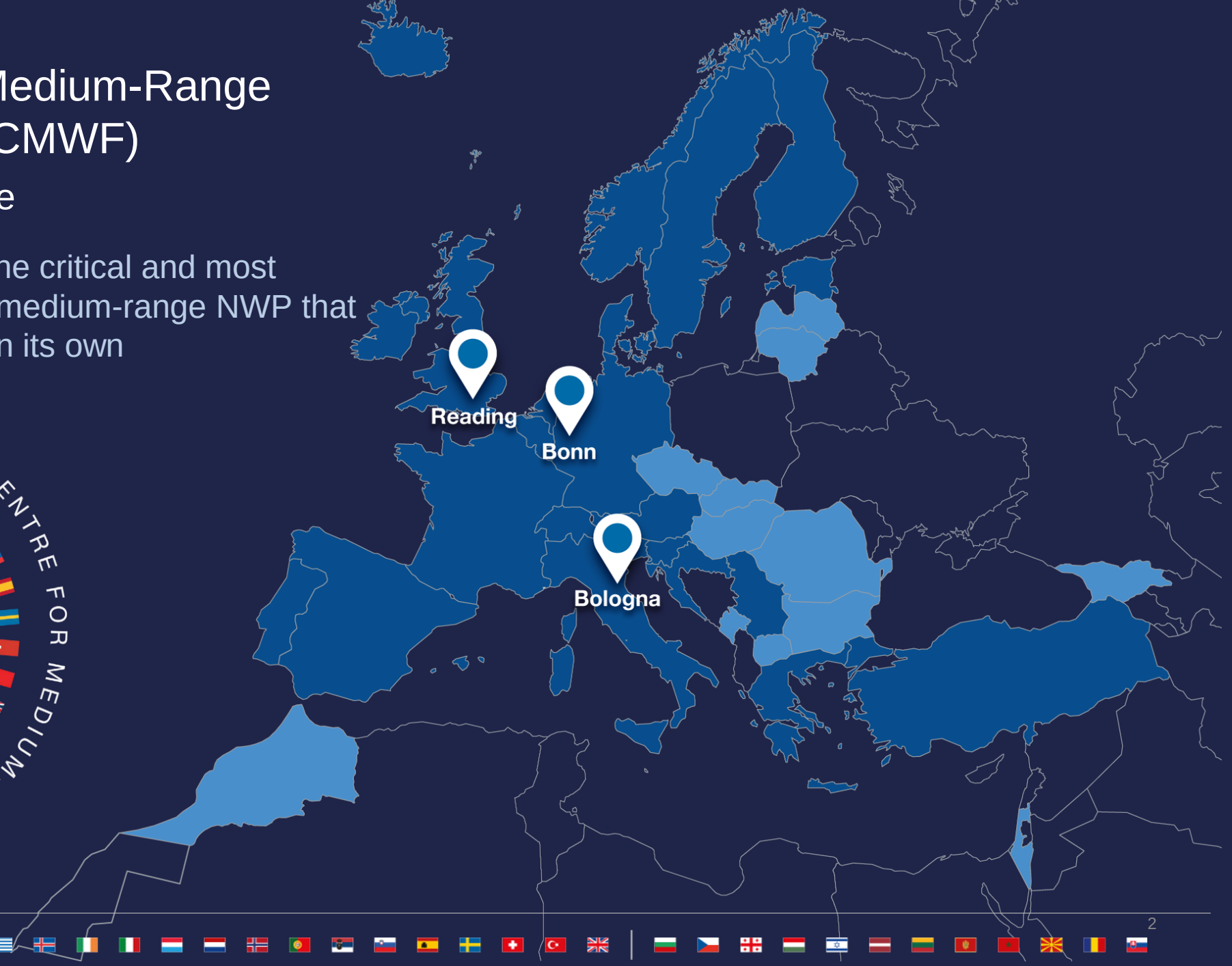
European Centre for Medium-Range Weather Forecasts (ECMWF)

Three sites: one unique role

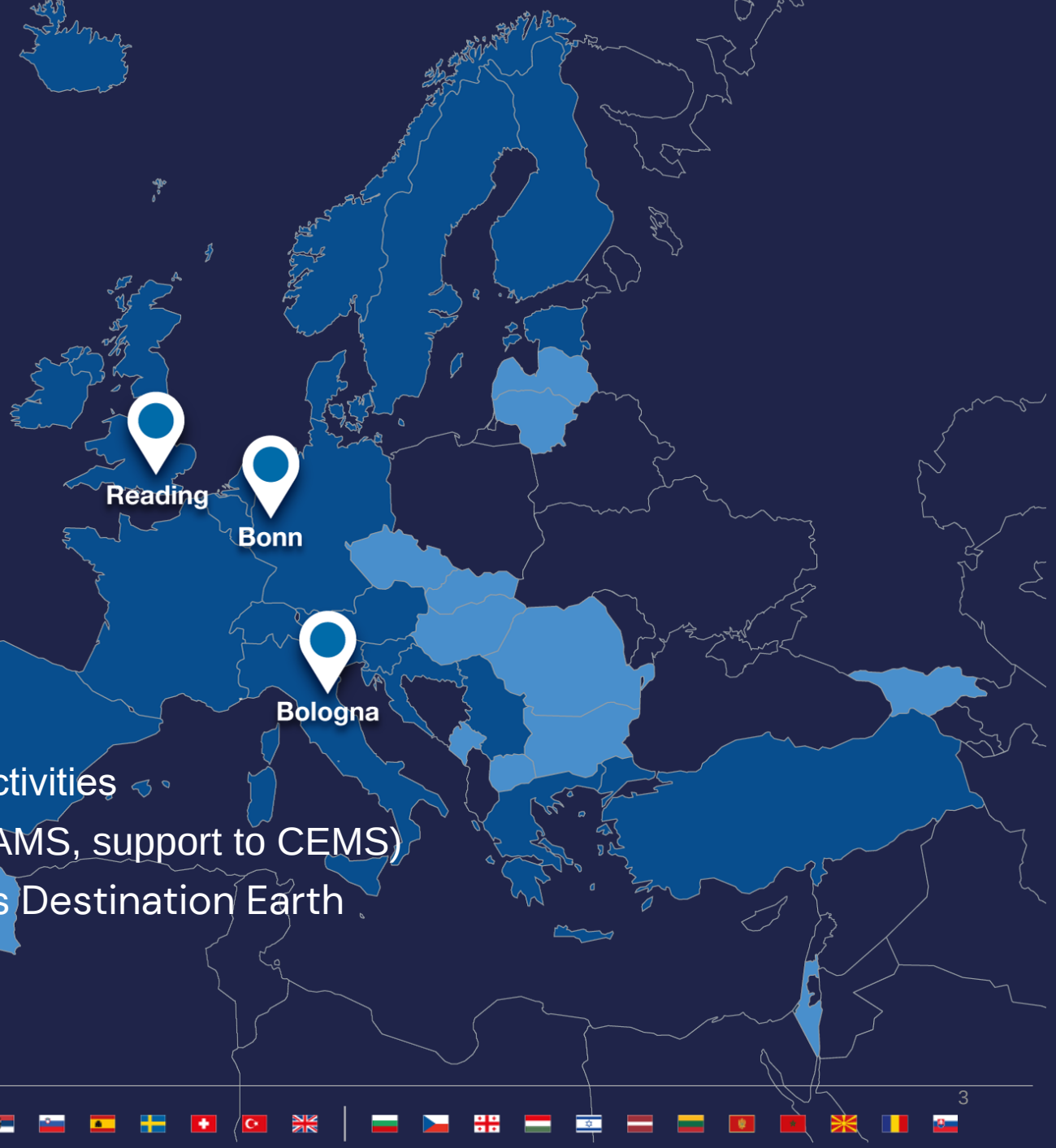
ECMWF's role is to address the critical and most difficult research problems in medium-range NWP that no one country could tackle on its own



European Centre for Medium-Range Weather Forecasts (ECMWF)

ECMWF is an international organisation with

- 23 Member States
- 12 Cooperating States

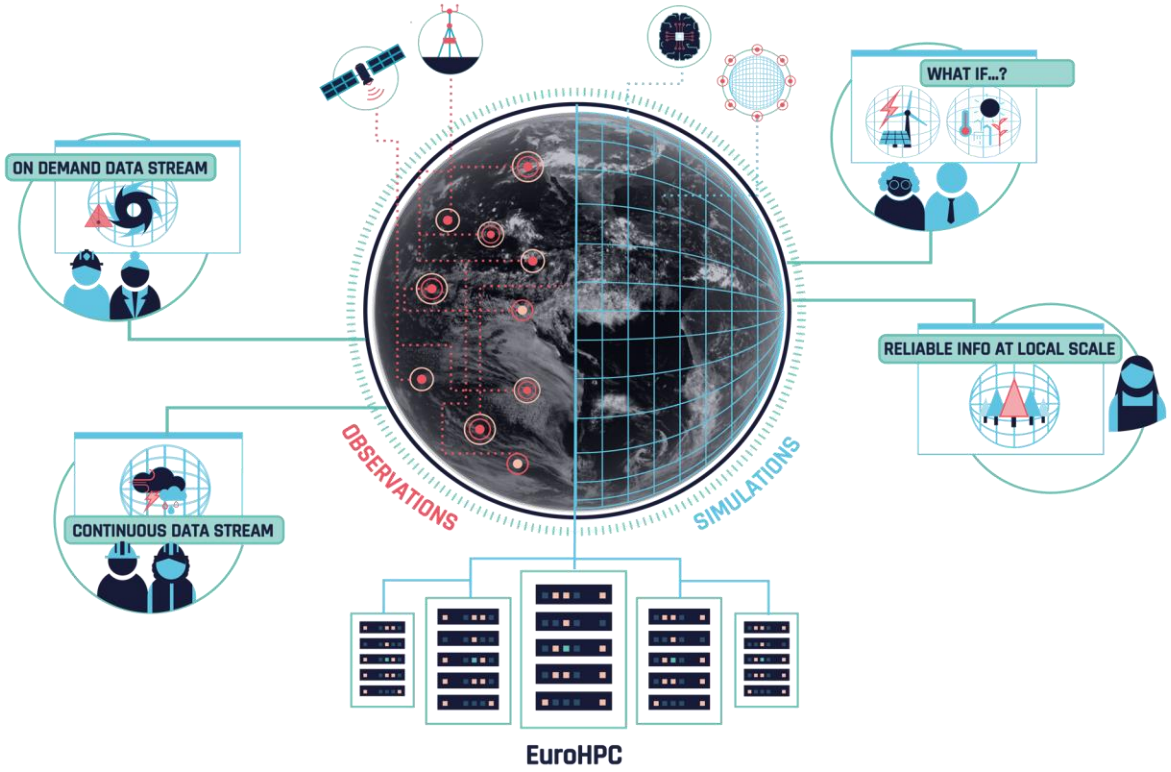


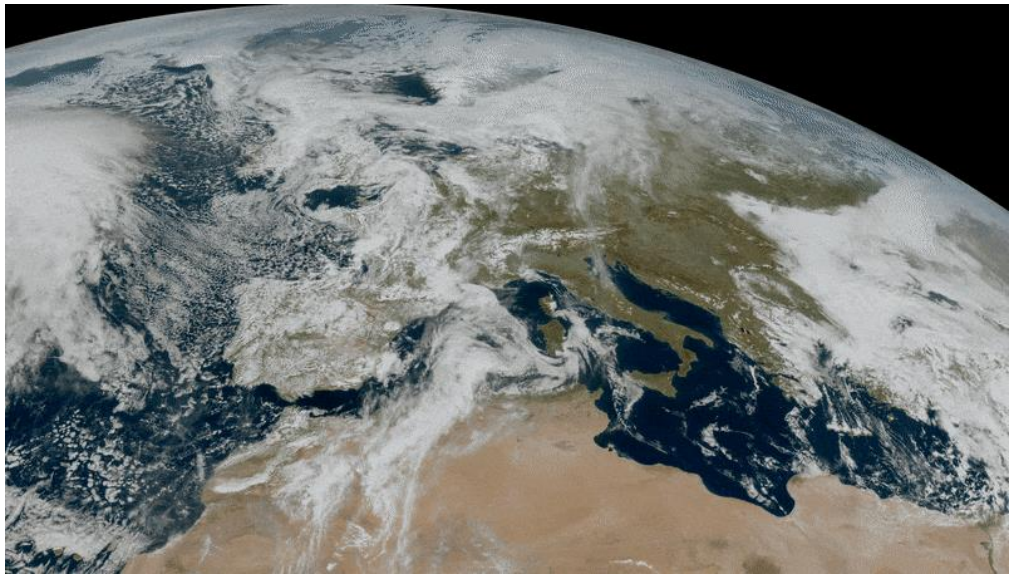
Three sites in UK, Italy and Germany

- 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
opernicus
Europe's eyes on Earth

The Destination Earth System





Digital twins

- Climate change adaption
- Weather-induced extremes

ARTIFICIAL INTELLIGENCE FORECASTING SYSTEM (AIFS)

ECMWF

1. Observe	2. Absorb	3. Model	4. Predict
Every day, we collect **800 million** observations of Earth's atmosphere, wind, temperature and beyond	**60 million** quality-controlled observations are absorbed by our physics-based Integrated Forecasting System	They feed the **AIFS**' new AI model, which predicts Earth's weather for the coming days	**Now: AIFS Single** one forecast at a time

How we train the AI model

Our **data archive** of the Earth's hourly weather creates a training loop that feeds the AI model using data from 1979 to present

The AI model repeatedly checks and corrects errors to improve accuracy

Next: AIFS ENS
ensemble modelling for 50 forecast scenarios

Launched 25th Feb 2025

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

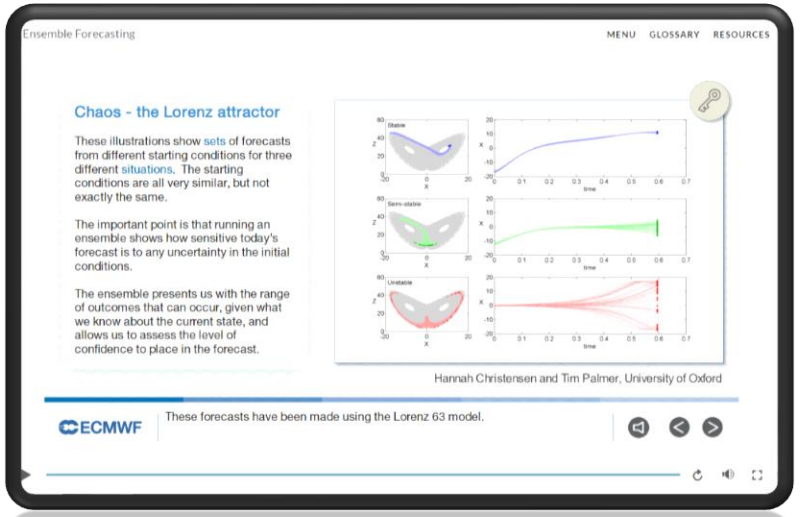
https://www.ecmwf.int/en/learning

Online training

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

Plus: Jupyter notebooks, Jupyterbooks, Webinars

https://learning.ecmwf.int/



ECMWF

PROGRAMME OF THE EUROPEAN UNION

Europe's eyes on Earth

IMPLEMENTED BY ECMWF

TRAINING COURSE

Data Assimilation & Machine Learning

17-21 March 2025

	Monday 17 March	Tuesday 18 March	Wednesday 19 March	Thursday 20 March	Friday 21 March
09:00-10:00	Welcome and introductions **Andy Brown, Stephen English, Massimo Bonavita, Will Becker**	Assimilation Algorithms (3) 4D-Var **Sebastien Massart**	Background error modelling in Data Assimilation **Elias Holm**	Reanalysis Methods **Hans Hersbach**	Monitoring of Observations and Data Assimilation System **Mohamed Dahoui**
10:00-10:20		Group Photo	***Coffee break***		
10:20-11:20	Overview of Assimilation methods **Massimo Bonavita**	Observation bias correction **Patrick Laloyaux**	Radiance observations **Tony McNally**	Ocean Data Assimilation and coupling **Hao Zuo/Phil Browne**	Data Assimilation and Machine Learning **Alan Geer**
11:20-11:30			***Comfort break***		
11:30-12:30	Assimilation Algorithms (1) Basic concepts **Sebastien Massart**	Assimilation Algorithms (4) Ensemble and Hybrid Methods **Massimo Bonavita**	Model bias correction **Patrick Laloyaux**	Data Assimilation of Atmospheric Composition **Melanie Ades**	Machine Learning in the NWP workflow **Massimo Bonavita**
12:30-13:30			***Lunch break***		
13:30-14:30	Conventional and actively sensed observations **Sean Healy**	Parametrization and Data Assimilation **Philippe Lopez**	Data Assimilation Diagnostics – Forecast Sensitivity **Bruce Ingleby**	Land Data Assimilation and Coupling **Patricia de Rosnay**	Final Discussion, Q&A **Panel of lecturers**
14:30-14:50			***Coffee break***		
14:50-15:50	Assimilation Algorithms (2) 3D-Var **Sebastien Massart**	Tangent Linear and Adjoints **Marcin Chrust**	Practical Session: DA experiments **Patrick Laloyaux, Marcin Chrust, Massimo Bonavita**	Practical Session: DA experiments **Patrick Laloyaux, Marcin Chrust, Massimo Bonavita**	
15:50 – 16:45	Ice breaker cocktail	Practical session: Tangent Linear and Adjoints **M. Chrust, S. Massart**	Practical Session continued		

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

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

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

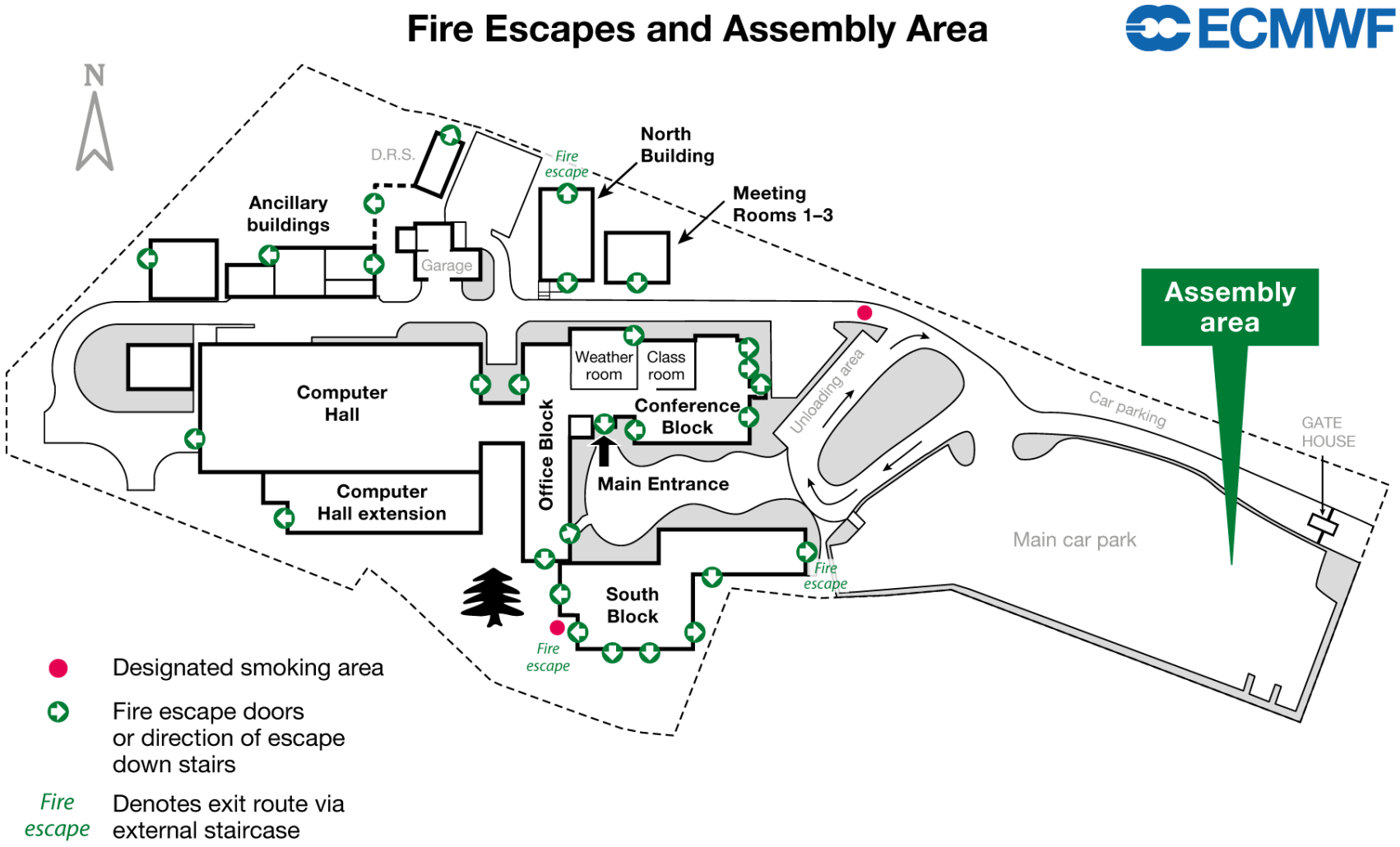
Enquiries

- 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 ☺

General Housekeeping



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

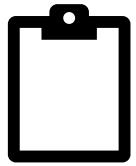
- The restaurant provides the following daily services:
  - Light breakfast from 08:00
  - Lunch: hot counter choices, salads, sandwiches, soup and desserts.

- 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.

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!