OpenIFS

A portable version of IFS for research and education and an outreach activity at ECMWF

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ECMWF

- Founded in 1975, based in Reading UK.
- Independent intergovernmental organisation, funded by 34 states
- ECMWF is both a research institute and 24/7 operational forecast centre
- Archive and provide meteorological data / reanalyses

- **Operational forecasts**
  - **HRES** : highest resolution, 9km, global forecast to **10** days, twice daily
  - **ENS** : 51 member ensemble, 18km, up to **15** days
  - **Extended** range: based on ENS, twice weekly to **32** days ahead (36km)
  - **Long** range: **seasonal** forecast 51 member ensemble
  - **Annual** range: 4 times a year (extended long-range)

- More information: www.ecmwf.int

What is OpenIFS?

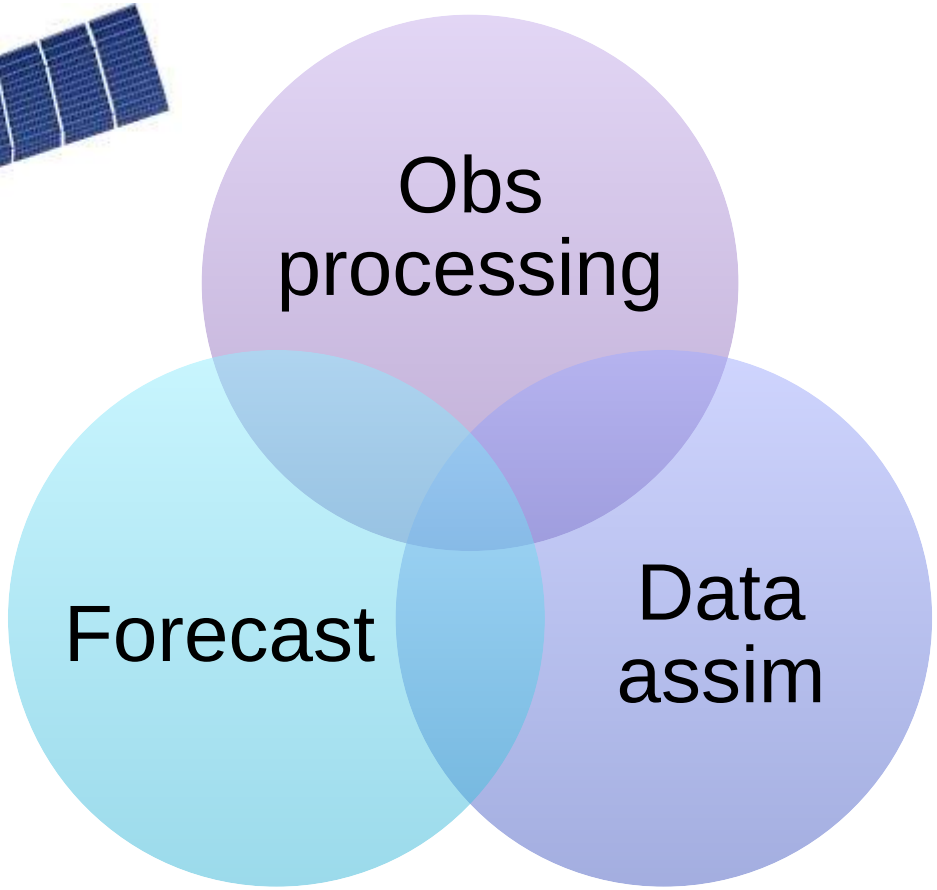
The **OpenIFS programme** provides a **supported, portable** version of the ECMWF IFS **operational model** to academic and research institutions, for **research and education**.

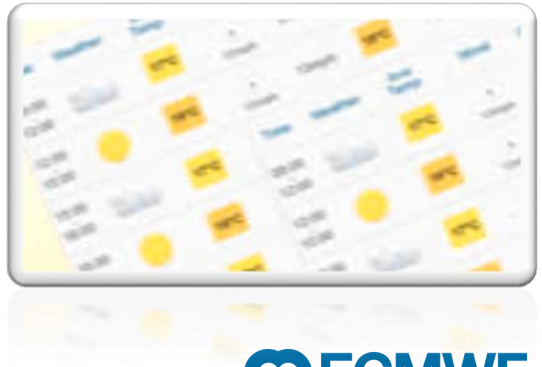
- **Objectives**
  - Increase scientific research using IFS.
  - Increase collaborations with ECMWF on topics of interest.
  - Improve research and training focusing on NWP and researchers trained on IFS.

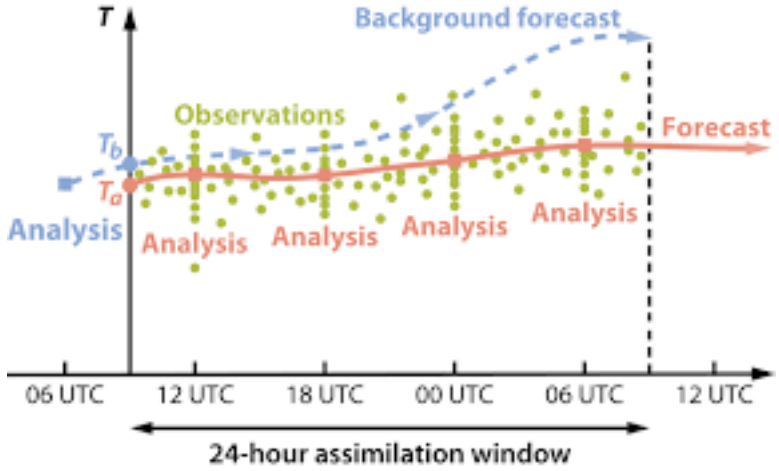
- **Also promotes**: ECMWF scientific methods and tools for visualization etc

ECMWF IFS: Integrated Forecast System

- Development began in 1987, based on previous spectral model in use since 1983
- IFS has **3 main components**.

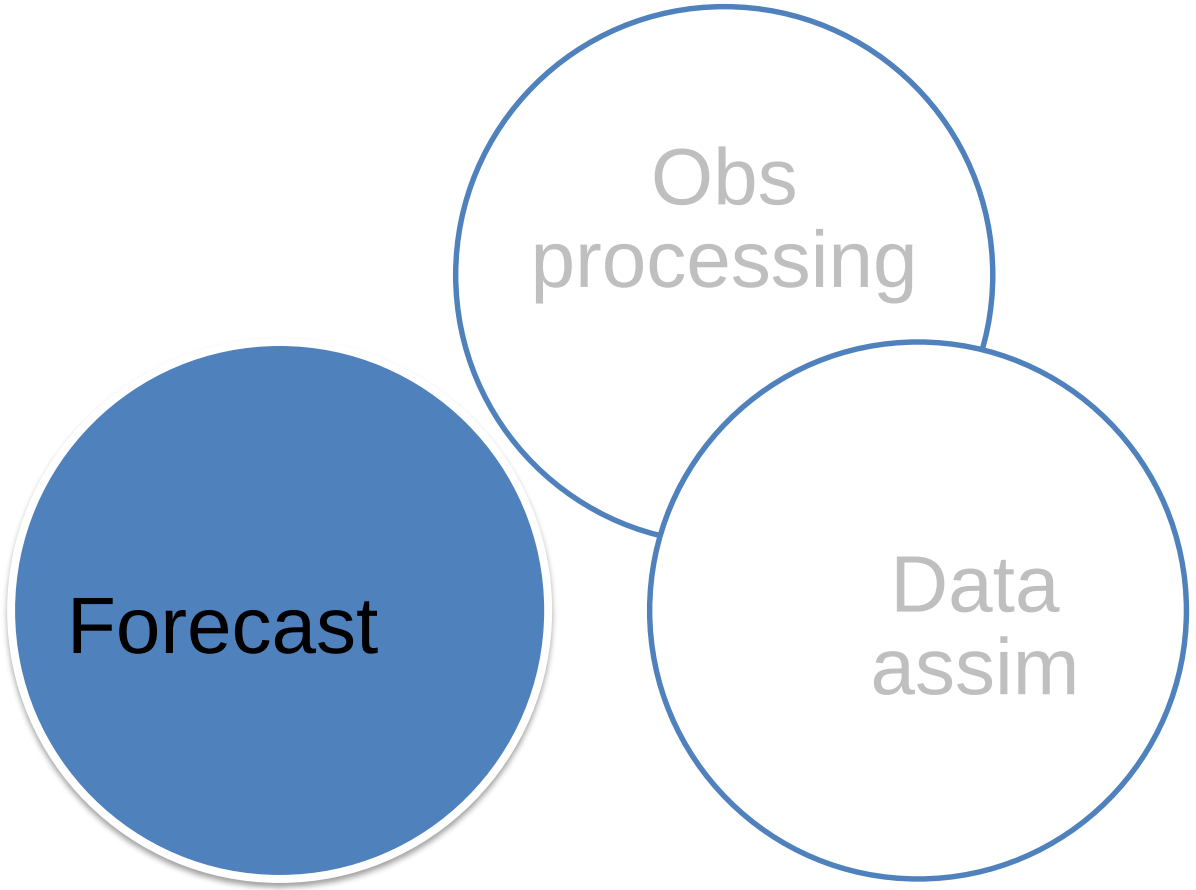






ECMWF OpenIFS

The **OpenIFS model** has the **same forecast capability as IFS** but no data assimilation or observation handling capability.



OpenIFS key features:

2.5 million lines of code.

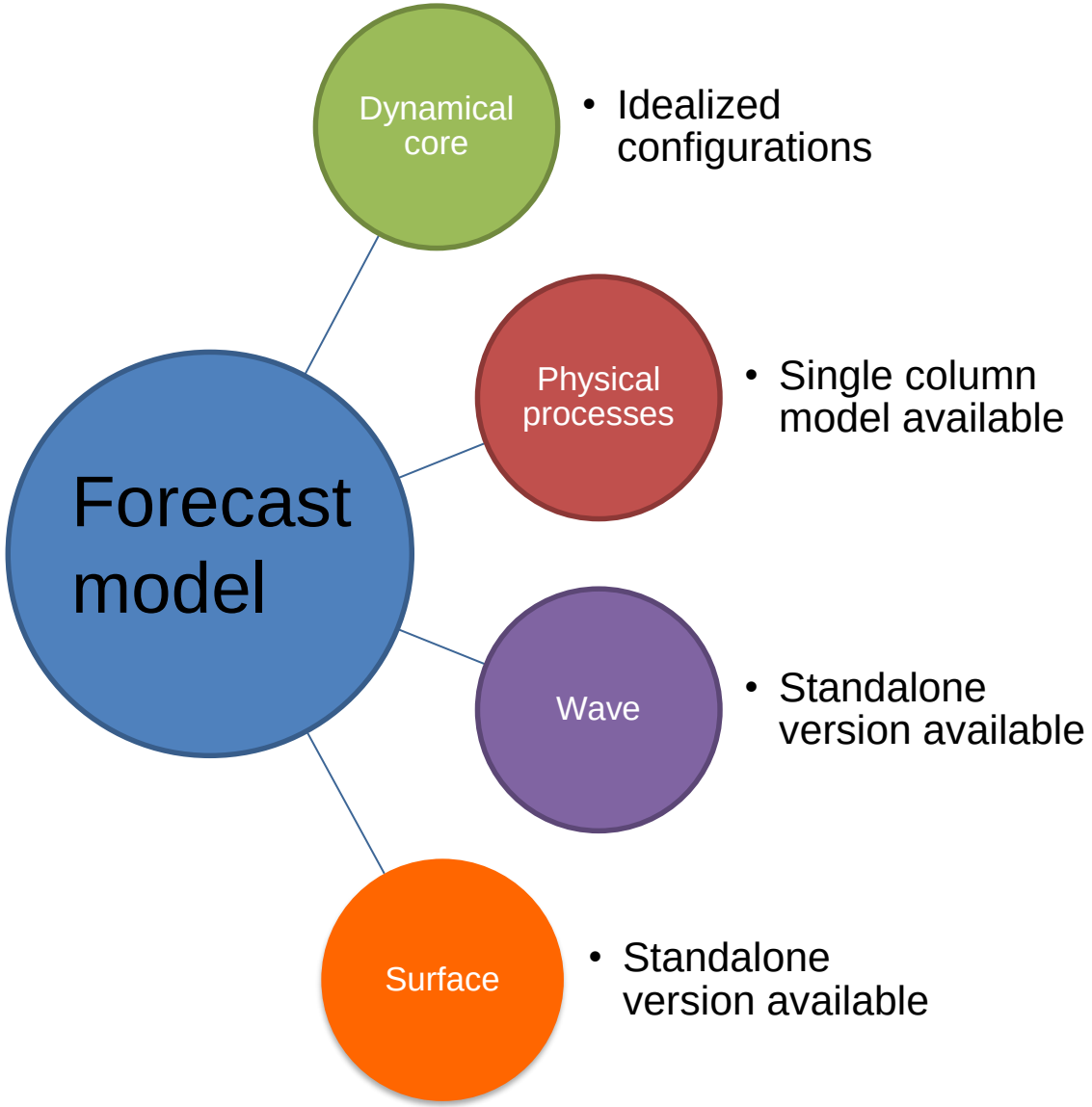
Runs on laptops, desktops, clusters and HPC.

Supports all IFS resolutions.

Supports ensemble forecasts.

OpenIFS updated every 3 yrs, IFS updated yearly.

ECMWF OpenIFS components



Idealized configurations

- Shallow-water.
- Aqua-planet.
- Held-Suarez.

IFS includes the NEMO ocean model.

OpenIFS provides the coupling code but not NEMO itself.

OpenIFS releases and licensing

- **Release policy**
  - New versions every ~3yrs to suit university research timescales.
  - Aim to release versions when key scientific changes in IFS are made.
  - Can only release operational versions after they have been replaced.

- **Licensing**
  - Not open source, restricted to research & teaching only.
  - Perpetual site licence (not a personal licence).
  - Licenses are limited to manage support capability.
  - A single license covers the OpenIFS forecast model, single column model, standalone surface model (HTESSEL) and the standalone wave model.

Email: openifs-support@ecmwf.int for requests.

OpenIFS model version timeline

38r1

- First OpenIFS model released 2012.
- Did not include the coupled wave model.

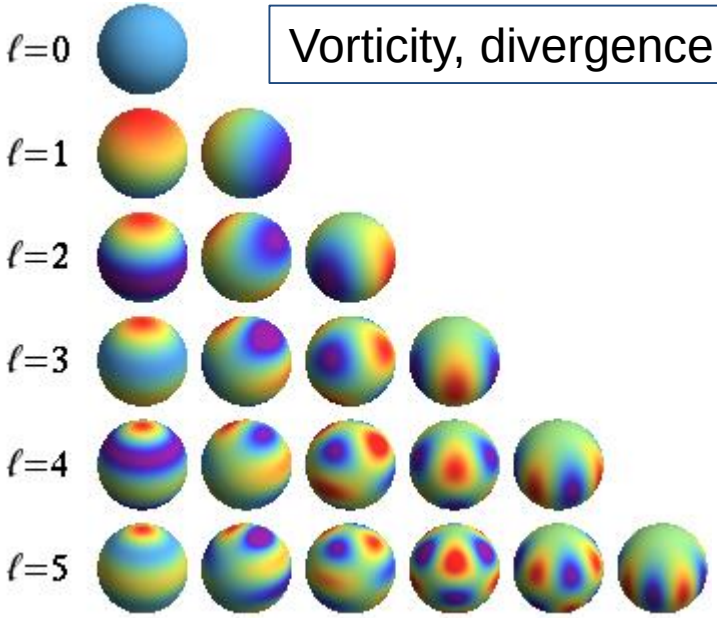
40r1

- Operational model from Nov 2013 to May 2015
- Released 2016.
- Included coupled wave model.

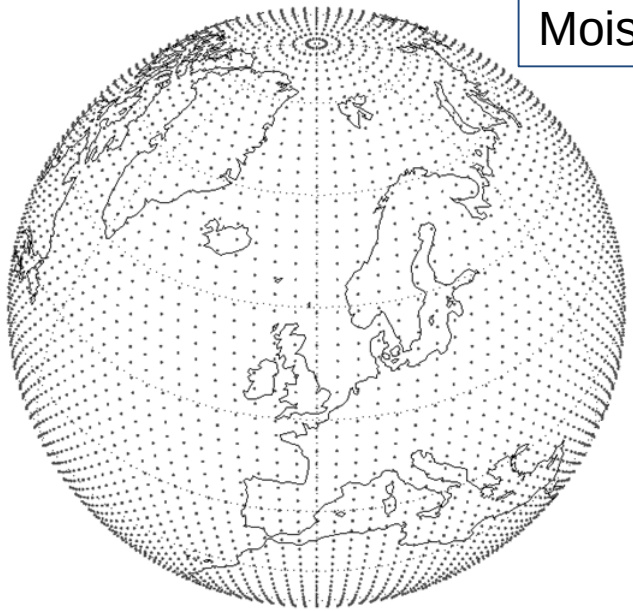
43r3

- Released 2019.
- Aligns closely with IFS versions used for ERA5 & S5.
- Significant update in scientific and technical performance.

IFS: Spectral dynamical core



Vorticity, divergence, T, Ps



Moisture, cloud variables, tracers

Spectral resolution

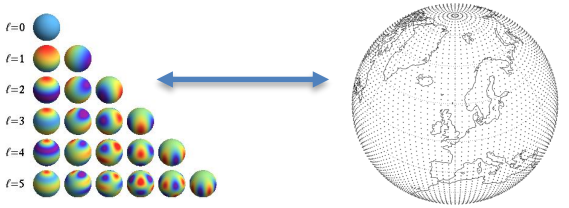
Global spherical harmonics.
'T' denotes the spectral resolution
e.g. T1279

Gridpoint resolution

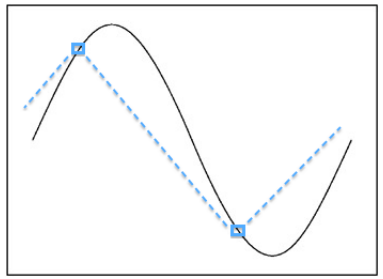
N denotes the gridpoint resolution
e.g. N640 = 640 lats between pole & equator

Latitudes are 'Gaussian' but **choice** of longitudes.

IFS Grids: linear, quadratic & cubic

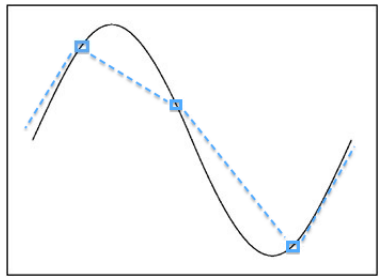


Relates how shortest waves are represented on the grid



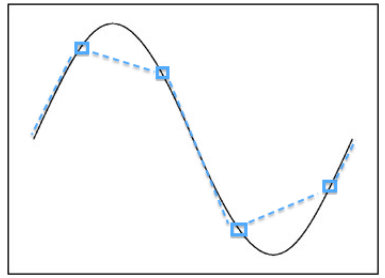
Linear grid. $T_l1279 \rightarrow N_l640$

- **2** pts sample shortest waves at the equator.
- **Old operational** grid, as used in OpenIFS 38r1 & 40r1.
- But, non-linear interactions can result in **aliasing** of waves



Quadratic grid. $T_Q1279 \rightarrow N_Q960$

- **3** pts sample shortest waves at the equator.
- No aliasing for quadratic terms (non-linear product of 2 variables)
- Not used operationally.

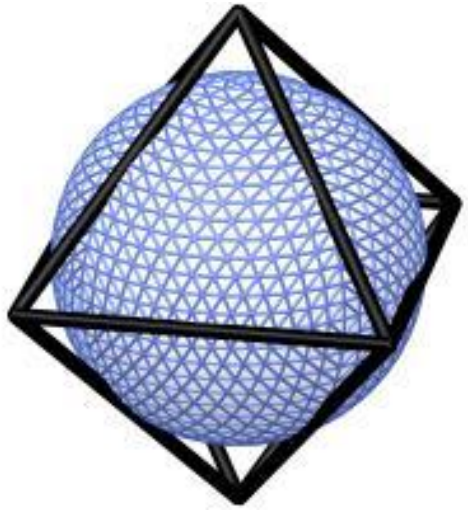


Cubic octahedral grid. $T_{Co}1279 \rightarrow N_{Co}1280$

- **4** pts sample shortest waves at the equator.
- **Current operational** grid, supported by OpenIFS 43r3.
- No aliasing for cubic terms (non-linear product of 3 variables)

New features of OpenIFS 43r3

- **Cubic octahedral grid**
  - More gridpoints to describe retained spectral waves, more accurate forecasts.



- **New radiation scheme: ecRad**
  - More efficient and accurate radiation scheme.

- **New lake model**
  - Correct representation of inland water bodies reduces 2m temperature errors.

For all other changes, see:

https://www.ecmwf.int/en/forecasts/documentation-and-support/changes-ecmwf-model

How can ECMWF help researchers?

An outline

- ECMWF learning for research
- ECMWF research datasets

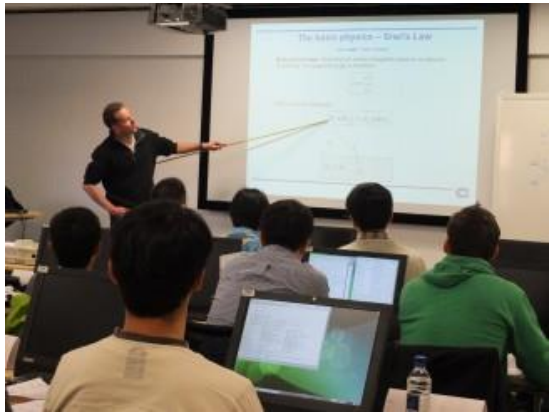
Training

Annual training courses that cover:

- Advanced Numerical Weather Prediction:
  numerical methods, parametrization of physical processes, data assimilation.
- Use of our products, software and systems.

Courses are open to all:

- Free to participants from ECMWF member states.
- Face to face training given by ECMWF scientists and staff.
  Opportunities to meet and discuss research with ECMWF staff.
- Course notes are available online.



For more information:

https://www.ecmwf.int/en/learning/training
Sarah.Keeley@ecmwf.int (DTP contact point)

Learning

Annual Seminar (NWP focus)

– Part of ECMWF's educational programme aimed at young scientists and established scientists that want to engage more with NWP.

Workshops

– Focus on specialist subjects related to weather prediction, climate monitoring and high performance computing.

– Summarise state-of-the-art and set future priorities.

2019 Annual Seminar: Seasonal forecasting

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

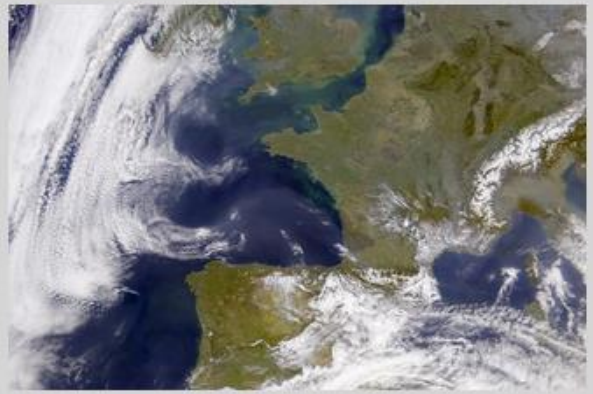
e-Learning

ECMWF online modules

- Presents foundation material from ECMWF NWP training courses.
- Self-paced, learn anywhere-anytime.
- Developed with ECMWF research scientists, not a collection of powerpoint slides or recorded talks!

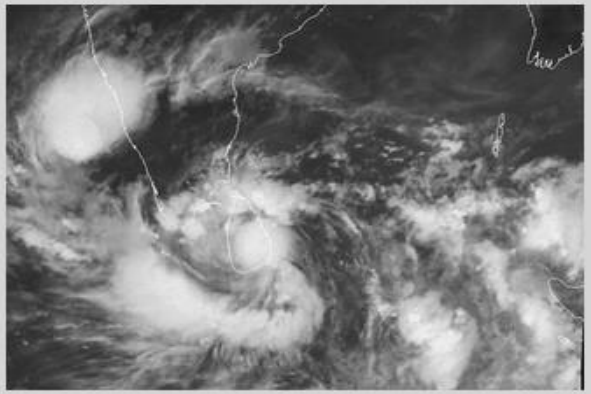
Parametrization of diabatic processes

1 hour

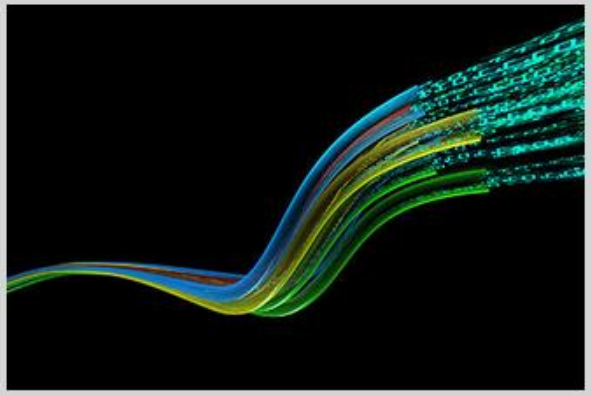


Parametrization of diabatic processes: case studies

30 minutes



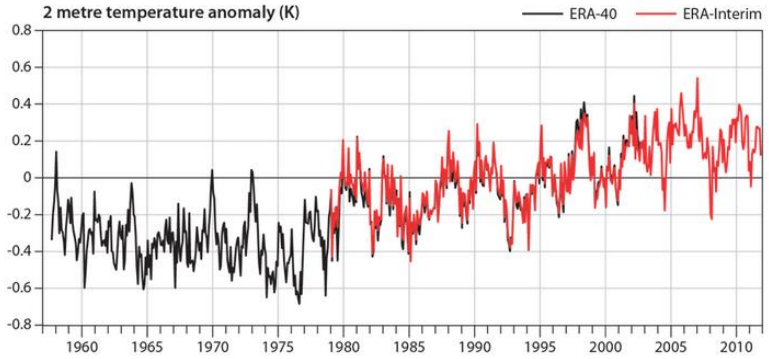
The mass flux approach and the Integrated Forecasting System (IFS) scheme



Ensemble Forecasting: sources of forecast uncertainty

1 hour

ECMWF Datasets for research



Atmospheric, Land and Ocean reanalyses

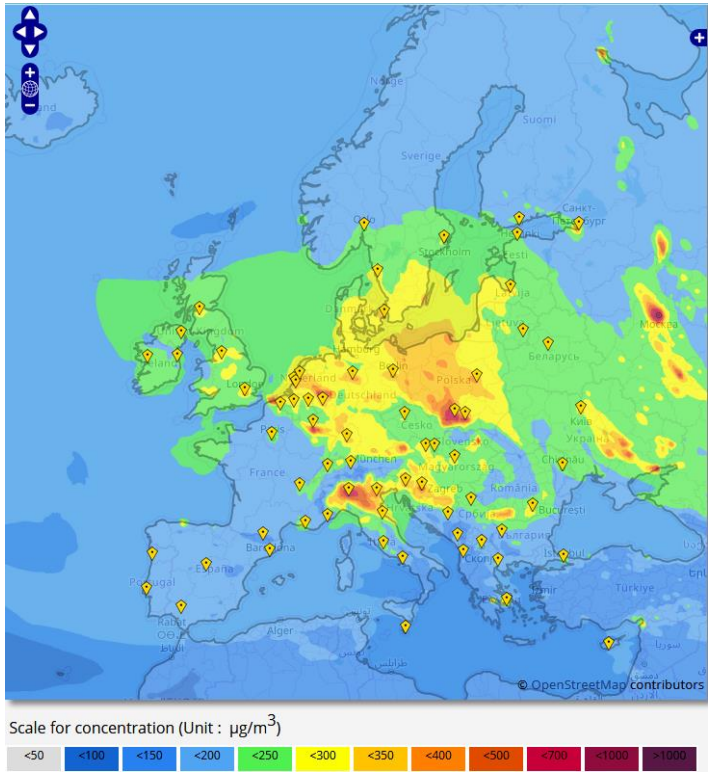
- Uses fixed versions of ECMWF's Integrated Forecast System (IFS).
- ERA products: land and atmosphere.
- ORA products: ocean and sea-ice.

https://www.ecmwf.int/en/forecasts/datasets/browse-reanalysis-datasets

Copernicus: Atmosphere Monitoring Service (CAMS)

- Based on IFS combined with atmospheric composition models.
- Global atmospheric composition and European air quality datasets.

https://atmosphere.copernicus.eu/



All available to download for free

ECMWF Special Projects

Researchers can apply for time and storage on ECMWF HPCF

- For “Scientific investigations likely to be of interest to general scientific community”.
- Collaborative projects favoured.
- Need to apply via the National Met Service (e.g. UK Met Office).
- Deadline is 30th June.
- Maximum duration is 3 yrs.

Search ‘ECMWF special projects’ for more details.

Final remarks

- OpenIFS is a **long term**, **supported core activity** to provide IFS to member and co-operating states

- **Research / training**
  - Links to University teaching programmes essential
  - Develop pool of talented young scientists with expertise in European modelling

- **Partnerships** and **collaboration**
  - Opens new possibilities for collaboration with member state met sevices, Universities and research institutes

- ECMWF would like to see **community develop around OpenIFS**
  - **With significant involvement** of member and co-operating states