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

- **Dynamical core**
  - Idealized configurations

- **Physical processes**
  - Single column model available

- **Wave**
  - Standalone version available

- **Surface**
  - Standalone version available

**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

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.** $T_1 1279 \rightarrow N_1 640$
- 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.** $T_Q 1279 \rightarrow N_Q 960$
- 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.** $T_C 1279 \rightarrow N_C 1280$
- 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
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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!
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 services, Universities and research institutes

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