The ECMWF OpenIFS model

Filip Váňa1, Glenn Carver1
Walter Zwieflhofer1, Erland Källén1, Peter Bauer1, Umberto Modigliani1, Deborah Salmond1
Abdel Hannachi2, Joakim Kjellsson2, and Michael Tjernström2

1. ECMWF, Reading, UK
2. Dept. of Meteorology (MISU), Stockholm University, Sweden.

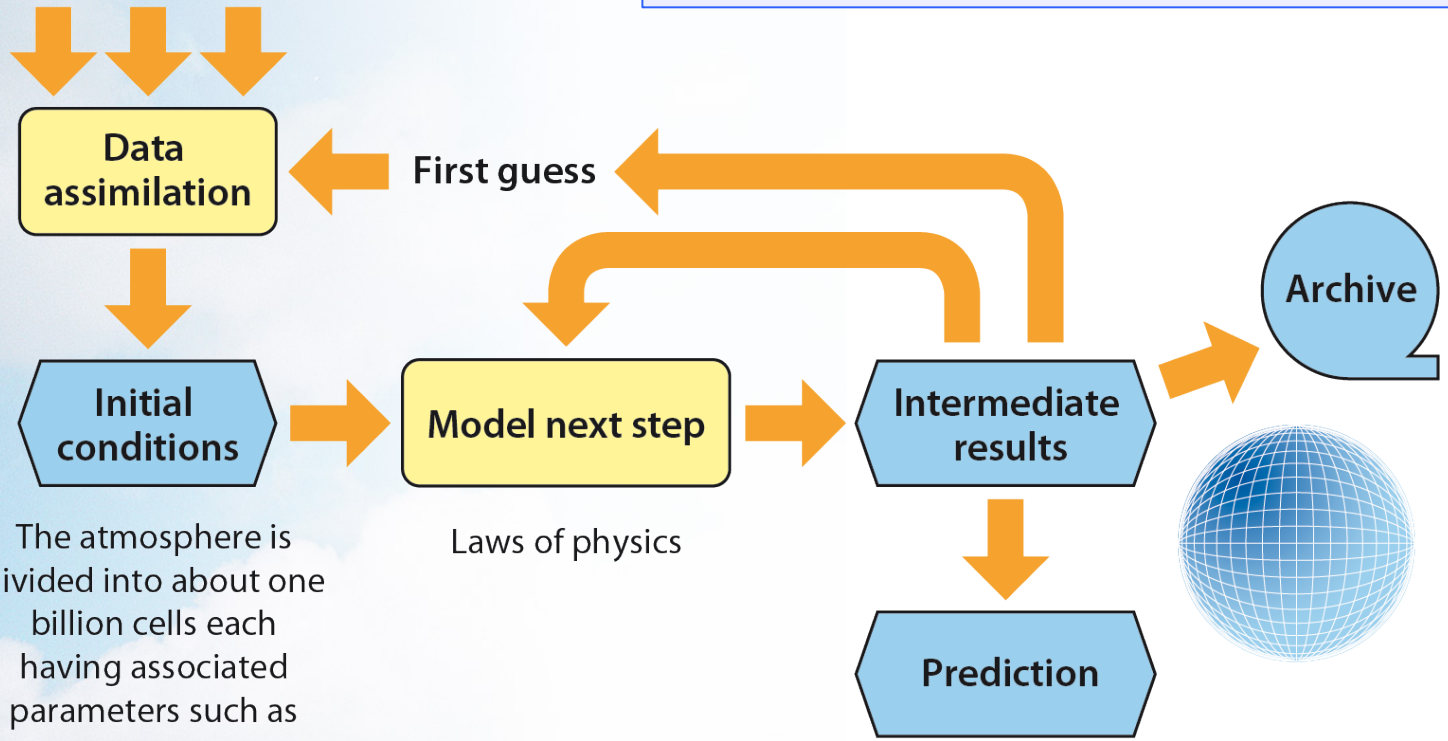
http://www.ecmwf.int/

A basic description of IFS

Atmosphere global forecasts

- Forecast to ten days from 00 and 12 UTC at 16 km resolution and 91 levels “Deterministic”.
- 4D-Var Data Assimilation.
- 50 ensemble forecasts to fifteen days from 00 and 12 UTC at 32 km resolution.

Aproximately 20 million observations



The ECMWF OpenIFS project

- **New Project for ECMWF**.
  - Started Dec 2011.
  - In development phase.

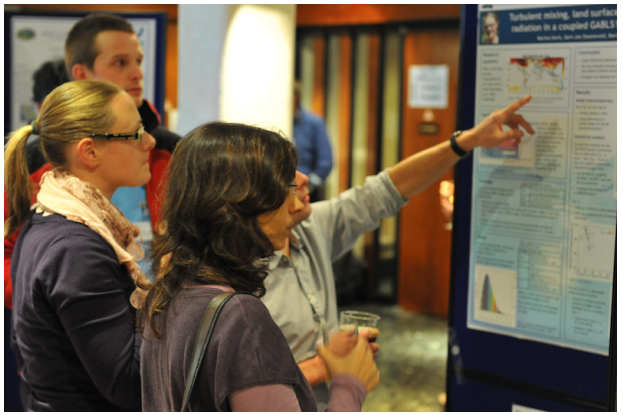
- **Key Objectives**.
  - Release version of IFS to academic & research users.
  - Increase scientific research undertaken using IFS.
  - Increase NWP training with IFS.

- **Other aims**.
  - Ease of use on external computer systems.
  - Identify user requirements.
  - Dedicated support.

The OpenIFS model

- **OpenIFS is free licensed software** (not open source)
  - Not for use on ECMWF systems.
- **Limited support**
  - 2 people at ECMWF.
  - Range of hardware & compilers.
  - Up to operational resolution.

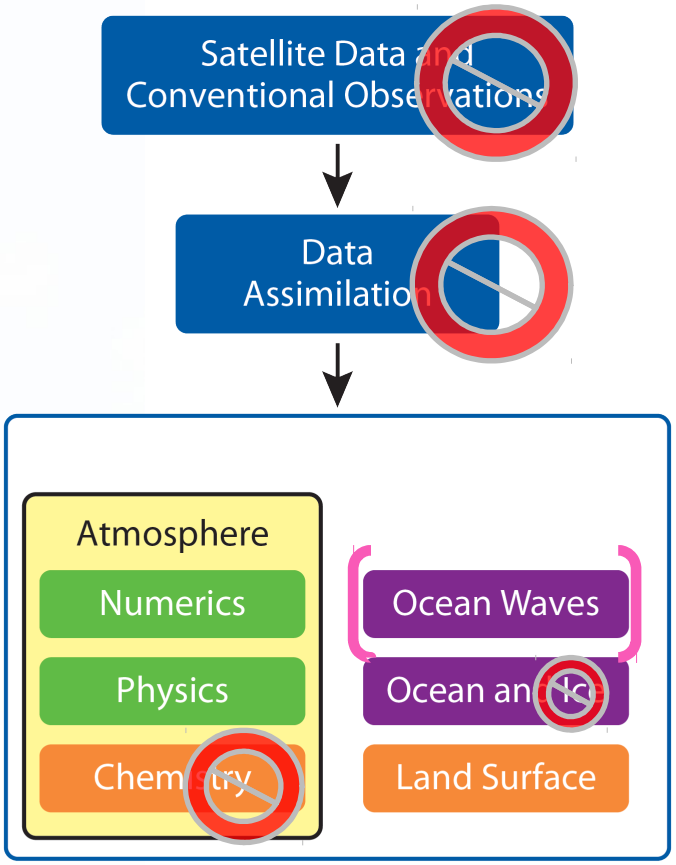
- **Range of research and teaching purposes:**
  - Studies of synoptic events.
  - Forecast errors.
  - Process modelling / parametrizations.
  - Academic courses: practicals.
  - NWP training courses.



The OpenIFS model (2)

- **OpenIFS .v. IFS**
  - Based on current operational model.
  - Reduced version of full IFS.
  - Only forecasts are possible (c001).

- **Model distribution does/will include**:
  - ECMWF physics.
  - Example case study.
  - MetView tools.
  - Online documentation (wiki).
  - (wave model)
  - (single column model)



Code implications

- FCM build system
- Replacement of licenced code (NR in Fortran,…); Palamida scan
- Code cleaning
  - Ongoing F77 -> F90 conversion
  - Support for other platforms (intel, gfortran,…)
  - Tidier code organization (*.nam.h, unique treatment of *.h files,…)
  - Cleaning of physics-dynamics interface
    - Transparent numerics (SL physics, sequential/parallel)
    - SCM upgrade – same code of physics like in 3D (radiation, numerics,…)
    - Flexible design with derived types, uniform updating tools, any possible configuration within physics automatically secured,…
    - *Documentation*
    - *Allow compatibility with flexible physics-dynamics interface (Arome, Alaro, MF)*

New model to physics interface (EC_PHYS_DRV -> EC_PHYS -> CALLPAR)

- Significant simplification of the code
- Any process related code encapsulated to a block

```
IF (LEVDIF) THEN
        IF (LPHYLIN) THEN
        CALL TURBULENCE_S_LAYER(...)
         ENDIF
              CALL TURBULENCE_LAYER(...)
        ENDIF
        CALL UPDATE_STATE(...)
ELSE
        CALL NOTURBULENCE(...)
ENDIF
```

- Existing code in the process specific routines almost unmodified -> layers
- Same rules of tendencies update imposed for every parametrization
- Assimilation code moved out from the CALLPAR
- Maintain (or improve) the existing code performance
- CALLPAR_CY38R2 (3829 lines, 329 arguments)
  -> CALLPAR_CY39R1 (1593 lines, 18 arguments)

First use: Teaching with OpenIFS at Stockholm University

Abdel Hannachi, Joakim Kjellsson, Michael Tjernström

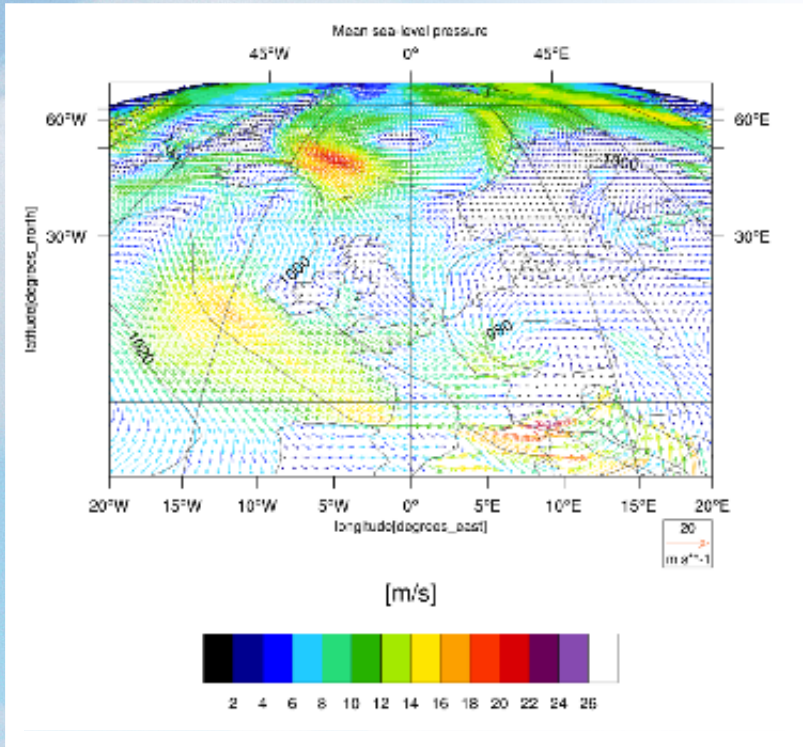
See: ECMWF Newsletter 134 – Winter 2012/13.

- **Department of Meteorology, MISU**
  - Extensive research programme.
  - Offers undergraduate & postgraduate degrees.

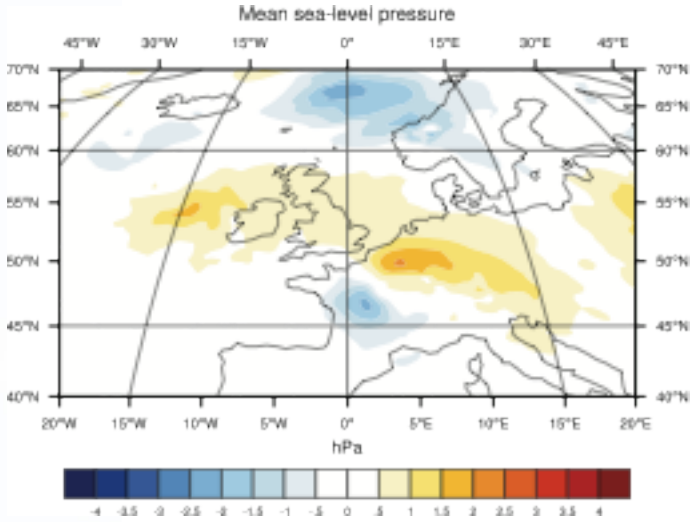
- **OpenIFS used by MSc students November 2012 for NWP course**
  - Model was run on the Swedish academic HPC facility.
  - Students given short projects consisting of:
  - Installing model.
  - Performing control and modified forecasts.
  - Write short report.

OpenIFS at MISU: Lothar storm case study

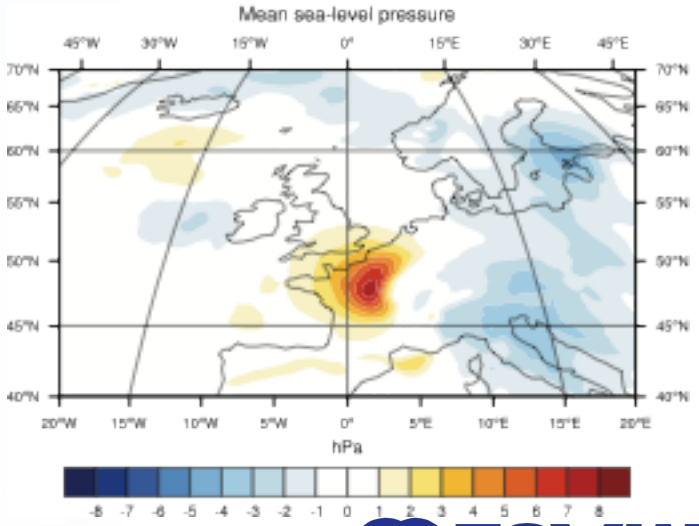
- **Students ran T511 control forecast**
  Changed: resolution, GW drag and surface drag globally.



T511 control forecast: 10m wind & MSLP (contours)



Above: Change in MSLP from doubling GW drag.
Below: change in MSLP from reduced surface drag.



Figures from MSc students:
Sara Broomé, Kristoffer Molarin and Nina Svensson

Licenced OpenIFS users

- U. Ghent – research & teaching
- U. Helsinky – teaching
- U. ELTE Budapest - teaching
- Uni College Dublin – NWP course and Msc research projects
- U. Ljubljana - research
- U. Stockholm – teaching
- U. Manchester – Tropical convection, Precipitation & sea-ice
- U. Reading – High resolution convection & MJO
- U. Oxford – Stochastic processors
- Stony Brook U., NY – Superparametrization of convection

Identified requirements & plans

- 1D model.
- Wave model.

- Surface model (stand alone off-line mode).
- Validation tools (long run to check the model climate).
- Possibility to use ECMWF verification.
- Web forum.

- Request for TL/AD code.
- Request for NH dynamics (small planet).
- Request for Ocean & Ice models.
- Request for Chemistry mode.

- Frequency of updates,…

Summary

- **OpenIFS model**
  - New project at ECMWF, still under development.
  - Forecast only part of IFS.
  - Dedicated but limited support.

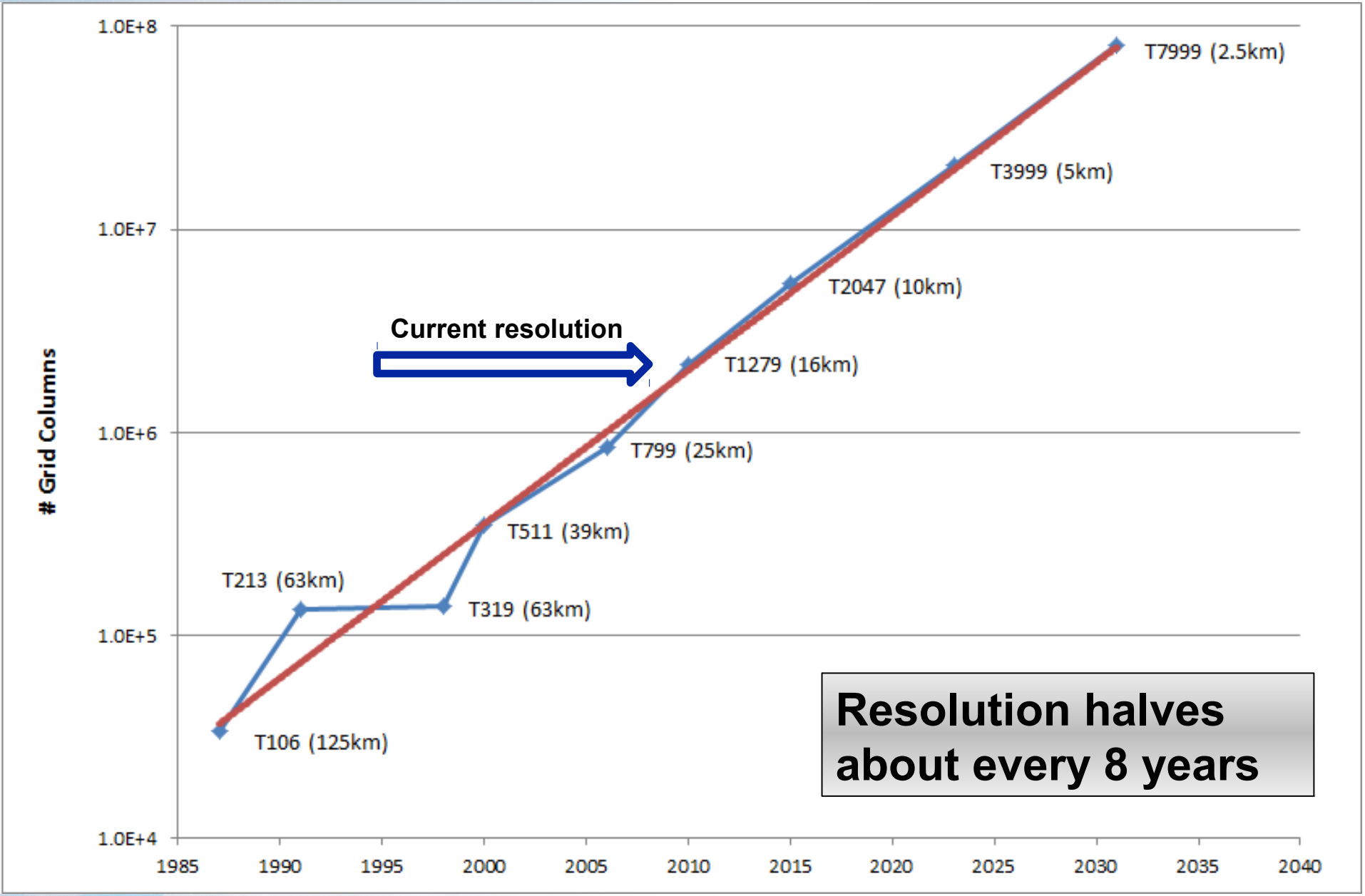
- **Future**
  - Growing interest in the model for use in teaching and research.
  - Welcome discussion with anyone interested.
  - Welcome feedback on potential user needs.

Please contact: Glenn.Carver@ecmwf.int
or Filip.Vana@ecmwf.int

OpenIFS website: http://software.ecmwf.int/oifs/

End

Evolution of ECMWF IFS forecast resolution



OpenIFS at MISU: case study

- Lothar storm December 1999 (*Ulbrich et al., 2001, ECMWF Newsletter no. 133*)
  - Severe storm affecting France, Switzerland, Germany. Characterized by rapid progression & development across the Atlantic and across Europe.
  - Not well forecast by ECMWF and others at the time.
  - Some of the highest wind speeds ever were recorded (75m/s, Singen, Germany)

11-hr forecast of wind gust & 10m windspeed for:
(a) 16km current operational model.
(b) 2.5km NH model.

T7999 model provides closer match to observed wind-speeds. Note improved orography.