The ECMWF Extended range forecasts

Laura.Ferranti@ecmwf.int

ECMWF, Reading, U.K.
The operational forecasting system

- High resolution forecast: twice per day
  16 km 91-level, to 10 days ahead

- Ensemble Prediction System (ENS): twice daily
  51 members, 30/60 km 62-level, to 15 days ahead

- Extended range forecasts / ENS extension:
  twice a week (Mon/Thursdays)
  51 members, 32/64 km 91 levels, to 1 month ahead

- Long range forecasts: once a month (coupled to ocean model)
  51 members, ~80 km 91 levels, to 7 months ahead
Extended range forecast / ENS extension

Ens. m. range  twice daily  ENS Extended range Mon/Thu
TL639  (32Km)  TL319 (64Km)

Init. cond.  Day 10  Day 15  Day 32

Atmosphere

Initial uncertainties  T42L91 SVs+ T399L137 EDA perturbations
Model uncertainties  Stochastic physics (SPPT and SKEB schemes).
The central analysis is the TL1279L137 4DVAR coupled to wave model (WAM) every time step

Ocean

NEMO (about 1 degree resolution) coupled to IFS every 3 hours.
Ocean initial conditions provided by 5-member NEMOVAR analysis
Extended-range weather forecasting: Beyond 10 days and up to 30 days description of weather parameters, usually averaged over a period of 5-7 days and expressed as a departure from climate values for that period.

A particularly difficult time range: In fact at this time range is generally too long for the atmosphere to keep a memory of its initial conditions, and too short for the ocean variability to have an impact on the atmospheric circulation.
The ECMWF extended forecasts consists of 2 elements:

• Real time forecasts

• A set of re-forecasts covering the most recent 20 years period
  - the same configuration of the real time forecasts
  - 5-member ensemble integrated at the same day and same month as the real-time time forecast
  - It runs once every week
  - Used to estimate the model drift
After 10 days of forecast, model biases cannot be ignored, and the real time forecasts need to be biased corrected.

The set of re-forecast is used to estimate the model biases.

The bias is removed from the real time forecast during the post-processing.
Weekly mean anomalies
Probabilities for weekly mean anomalies:
Weekly mean multiparameter outlook:

Day 12-18 20150202 - 20150208
Sources of predictability for the extended forecasts:

- Land Surface conditions: Snow cover, Soil Moisture
- Ocean conditions: Sea surface temperature, Sea ice
- Stratospheric Initial conditions
- The Madden-Julian oscillation
- Atmospheric dynamical processes (Rossby wave propagations, weather regimes...)
Cold spell over Europe Nov-Dec 2012

- 19-25/11/2012
- 26/11-2/12 2012
- 3-9/12/2012
- 17-12/12 2012

Analysis

5-11d

12-18d
Cold Weather over Europe: SSW Index
Forecast starting on:
22/11/2012 – green line
15/11/2012 – orange line

Days
SSW Index
Cold Weather over Europe
SSW Index - Forecast starting on 22/11/2012

Strong SSW

Weak SSW
Impact of soil moisture:

**Temperature forecasts**: Increase in skill due to land initialization (JJA) (conditioned on Z-score of initial soil moisture anomaly)

Koster et al, GRL 2010
The Madden Julian Oscillation (MJO)

MJO life cycle

(From NASA)


ECMWF
MJO impact on European weather:

The MJO impact is the strongest about 10 days after the MJO is in the phase with:

- suppressed convection over Indian Ocean
- enhanced convection over Western Pacific are conducive to negative NAO


Conv. Over Indian Ocean +10 days
Conv. Over Western Pacific+10 days
Cold March 2013 – 14 Feb 2013 -Day 26-32

Analysis

10 best MJO forecasts

10 worse MJO forecasts
**MJO Teleconnections**  
Evolution of NAO skill scores day 19-25

NAO index is computed as projection onto a reference pattern
MJO forecast:
Probabilistic skill scores – NDJFMA 1989-2008

Reliability Diagram
Probability of 2-m temperature in the upper tercile
Day 19-25

N. Extratropics
- MJO in IC
  - 0.04
  - 0.06

EUROPE
- MJO in IC
  - 0.03
  - -0.09

ECMWF
Weekly mean Accumulated Cyclone Energy (ACE)
ROC for 2mt in the upper tercile since Oct 2004
Evolution of skill scores based on the re-forecasts
RPSS – Probability of 2mt in upper tercile NDJFM

All the re-forecasts produced since 2002 have the period 1995-2001 in common.

RPSS scores have been computed for all the re-forecasts produced between April of a given year and March of the following year and covering the period 1995-2001 (once a week, 5-member ensemble).
New re-forecast twice a week 11 members

Impact on verification
T850- Upper terciles – Week 4
Conclusion

- SSTs, Soil moisture, stratospheric initial conditions and MJO are source of predictability at the intra-seasonal time scale. In particular the MJO has a significant impact on the forecast skill scores beyond day 20. Model improvements, particularly in simulating the MJO activity are likely to be beneficial for monthly forecasting.

- The monthly forecasting system produces forecasts for days 12-18 that are generally better than climatology and persistence of day 5-11. Beyond day 20, the monthly forecast is marginally skilful. For some applications and some regions, these forecasts could however be of some interest.
Extended range ensemble system

ENS includes 51 forecasts with resolution: TL639L91 from day 0 to 10 and TL319L91 from day 10 to 15.

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The ECMWF monthly forecasting system

- **Atmospheric initial conditions**: ECMWF operational analysis

- **Oceanic initial conditions**: “Accelerated” ocean analysis

- **Perturbations**:
  - **Atmosphere**: Singular vectors + stochastic physics
  - **Ocean**: Wind stress perturbations during the data assimilation
Skill of the ECMWF Monthly Forecasting System

ROC score: 2-meter temperature in the upper tercile

Day 5-11

Day 12-18

Day 19-25

Day 26-32
Skill of the ECMWF Monthly Forecasting System

ROC scores over the Northern extratropics

2-metre temperature

Mean sea-level pressure

Precipitation

Day 5-11

Day 12-18

Day 19-25

Day 26-32
Monthly Forecast: Northern extratropics

ROC score: 2-metre temperature in the upper tercile

- Monthly Forecast
- Persistence of day 5-11
- Monthly Forecast
- Persistence of day 5-18

Day 12-18

Day 19-32
Madden Julian Oscillation

Improvement due to revised organised convective detrainment term and the revised convective momentum transport.
Probabilities (temperature)
Tropical storm density

Climatology

MJO Phase 2+3

OBS

2012

2002