Verifying deterministic and probabilistic forecasts of objectively clustered Weather Regimes

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Table of Contents

• Objectively clustered weather regimes
• Applying weather regimes to forecasts
• Verifying the forecasts
Weather Regimes

Requirement:-

A weather regime forecast system (to aid forecasters and decision makers) - which is objective and relocatable and can be applied across multiple timescales.

The requirement for relocatability means that we need the ability to generate a bespoke set of weather regimes for each model area using a similar method. Therefore have to avoid pre-existing weather regime types (e.g Grosswetterlagen or Lamb Weather Types) which are specific to certain regions.
Generate weather regimes using Objective Clustering

• Create some weather regime patterns over the specified area - which situations occur most often?
• Need 2 things – A Dataset and a Clustering method.
• Used the EMULATE* gridded dataset of 1850-2003 – MSLP over North Atlantic and Europe. (~5° resolution)
• Use Simulated Annealing** (variation of k-means)
• Created 30 clusters (and then 8)


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Regime MSLP and anomaly composites

Wide spread of pressure patterns and anomaly intensities.

Each has been given a UK-centric description by a forecaster.
8 Combined Regimes - MSLP

- 30 clusters into 8 regimes
- Combine highly correlated regimes
- Long-range, large-scale patterns
- Ensures larger data sets when we start verifying... and makes verification a little bit easier!
Assign forecasts to regimes

- Now can take a forecast and work out which regime is being forecast for any particular day (at 12Z).
- Similarly generate a ‘Truth’ Regime for each day.
- Regime assignment is based on the member and regime pairing with the smallest area average grid-point difference (with latitudinal weighting) between member PMSL anomalies and regime PMSL anomalies.

- Run for 4 different models (for Jan 2010-June 2014)
  - Met Office Global Model (Days 1-6) (Deterministic)
  - ECMWF (Days 1-15) (Ensemble)
  - MOGREPS-15 (Days 1-15) (Ensemble)
  - GloSea (Days 1-51) (Coupled seasonal ensemble)
Regime assignment is based on the member and regime pairing with the smallest area average grid-point difference between member PMSL anomalies and regime PMSL anomalies.
## Example of 8-regime output

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Verifying the behaviour of the underlying forecasts in regime space – not the regimes themselves.

How well do the models forecast the regimes with leadtime?

Do different models behave differently?

Can we generate a simple score for the systems?

How does the starting regime influence the skill of the regime forecasts?
Frequency – ECMWF (8 regimes)

Met Office Global Model Deterministic Values

Underforecasting

Overforecasting
Frequency - Mogreps-15 (8 regimes)

Overforecasting

Underforecasting
Reliability – EC day 12

- Overforecasting
- Underforecasting
- Few high probabilities

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Deciles are clustered in the bottom corner. Low HR/FAR for these low frequency probabilities.

But still show overall skill.

At shorter leadtimes we see the generation of higher probabilities and increased skill.
Scoring the regimes

• Multi-event contingency table (for each leadtime)
• Data is not ordinal
• Heidke Skill score or Peirce Skill score

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Total: 26700 22870 27339 13815 15878 19297 22184 19041

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Brier score and decomposition

- Use the probabilistic information

Sample Climatology

Mean Brier Score

Can resolve more frequent regimes better than less frequent ones.

Resolution tails off with leadtime

Good Reliability

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We can compare the Brier Skill scores from two different models to see the differences

**ECMWF** appears to score better than **Mogreps-15** for all regimes

**Mogreps-15** has fewer members and coarser resolution
Skill conditioned on starting regime

Variable Baseline with leadtime

Starting in Regime 1 better at mid-leadtimes than starting in Regime 3

Drop in skill

When forecasting regime 1: starting in regime 4 gives more skill at days 6-10 than starting in regime 6
Further Work

• Seasonal breakdown.
• Focussed subsets of the 30-regimes.
• Weather Impacts - Investigate impacts associated with each weather regime.
• Regime durations.
Questions and answers