

Creating maps of probabilistic forecasts

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Outline

- 1 Acknowledgements
- 2 Probabilistic forecasts
- 3 Triangles and colours
- 4 Skill
- 5 Conclusions

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Acknowledgements

This is work in progress, involving:

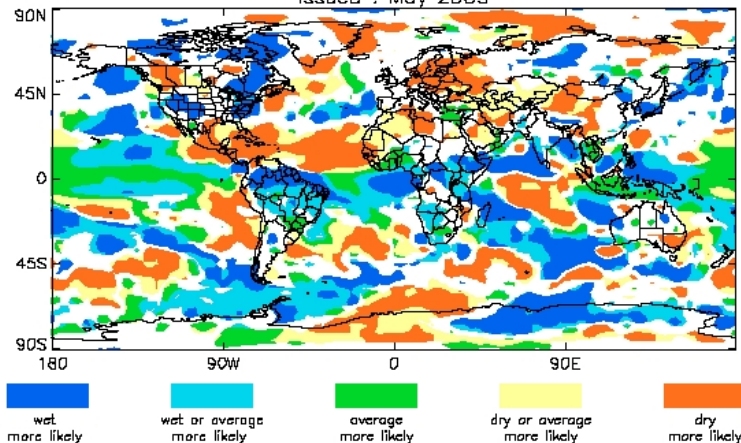
- Rachel Lowe
- Caio Coelho
- David Stephenson

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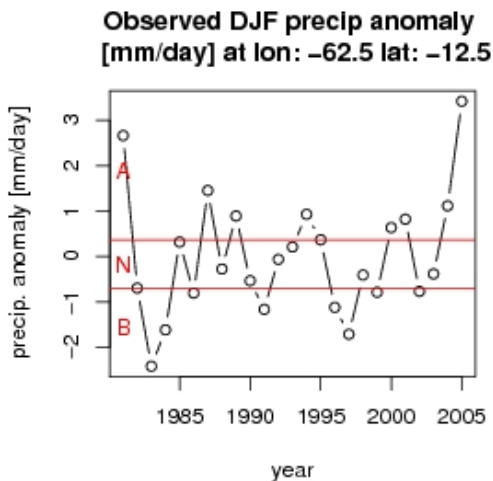
Probabilistic Forecasting

Met Office : More likely precipitation tercile categories Jun/Jul/Aug
 Issued : May 2009



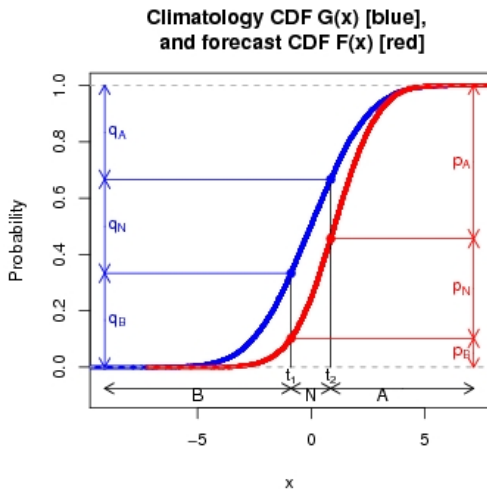
- the forecast at each point is a *distribution*
- How should we assign *colours* to *distributions*?

The terciles of a climatology



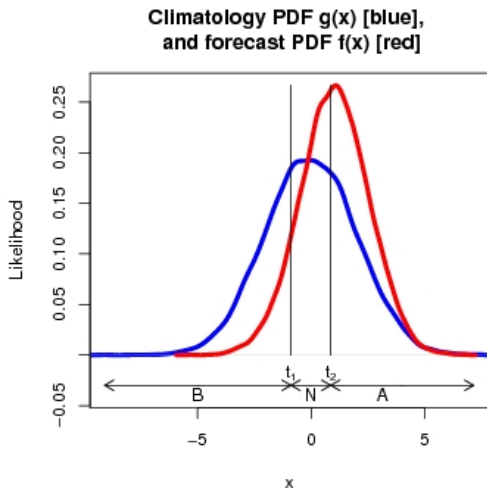
- the categories B , N and A are *observed* with equal frequency

Continuous distributions (CDF)



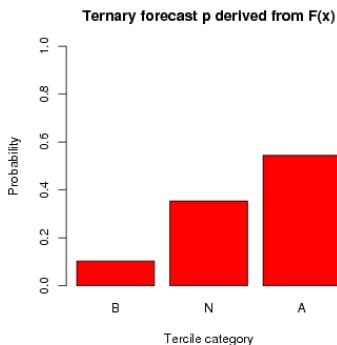
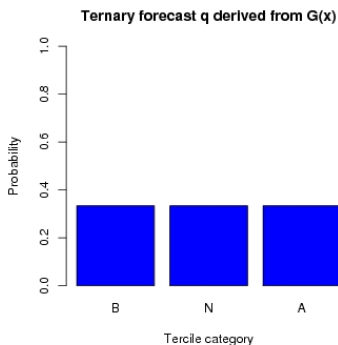
- climatology: $G(x)$, forecast: $F(x)$

Continuous distributions (PDF)



- climatology: $g(x)$, forecast: $f(x)$

Ternary forecast



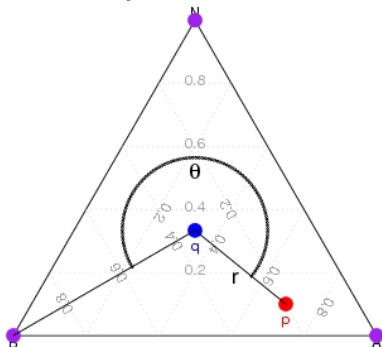
- ternary climatology: $\mathbf{q} = (1/3, 1/3, 1/3)$
- ternary forecast: $\mathbf{p} = (p_B, p_N, p_A)$

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Barycentric coordinates

Ternary forecasts
in barycentric coordinates



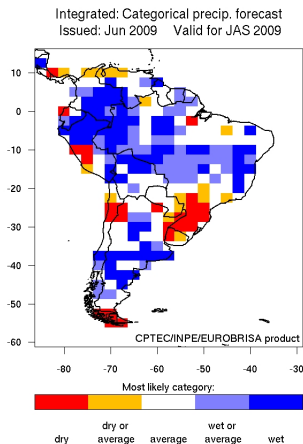
- every ternary forecast is a point in the triangle, including
- the climatology \mathbf{q}
- the observed state \mathbf{o}

Current visualisation methods

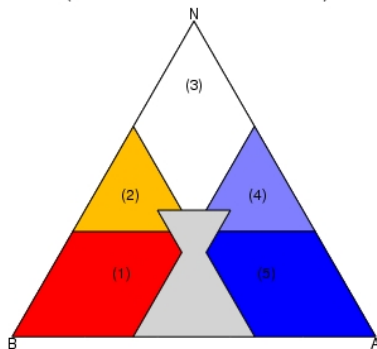
Usually based on a discretisation of ternary forecast space. For example:

- 1 (Dry): ($p_B > 2/5$ and $p_N < 1/3$ and $p_A < 1/3$).
- 2 (Dry or normal): ($p_B > 1/3$ and $p_N > 2/5$) or ($p_B > 2/5$ and $p_N > 1/3$).
- 3 (Normal): ($p_B < 1/3$ and $p_N > 2/5$ and $p_A < 1/3$).
- 4 (Wet or normal): ($p_N > 1/3$ and $p_A > 2/5$) or ($p_N > 2/5$ and $p_A > 1/3$).
- 5 (Wet): ($p_B < 1/3$ and $p_N < 1/3$ and $p_A > 2/5$).

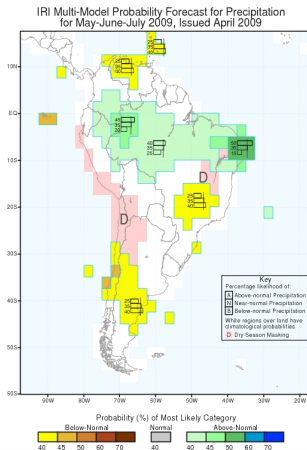
Current visualisation methods (EUROBRISA categorical)



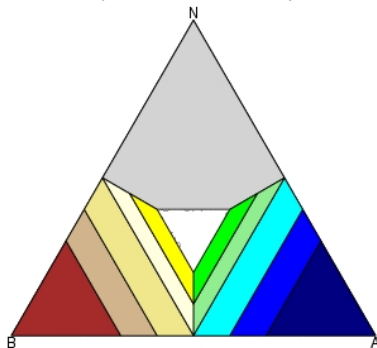
'Categorical forecast'
 (Eurobrisa colour scheme)



Current visualisation methods (IRI)

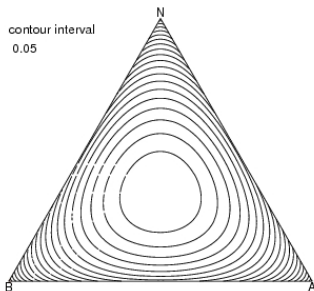


'Most likely' categories
(IRI colour scheme)

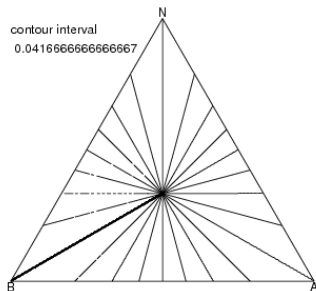


A continuum of colours in forecast space

Lines of constant $H(\mathbf{p})$



Lines of constant $\theta(\mathbf{p})/2\pi$

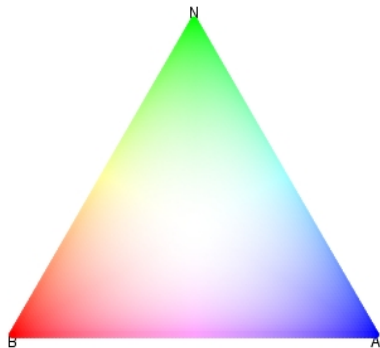


$$H(\mathbf{p}) = \frac{1}{\log 3} \sum_{i \in \{B, N, A\}} p_i \log 3p_i$$

- $H(\mathbf{p})$ is a measure of the *subjective certainty* in a forecast

Our proposed colour scheme

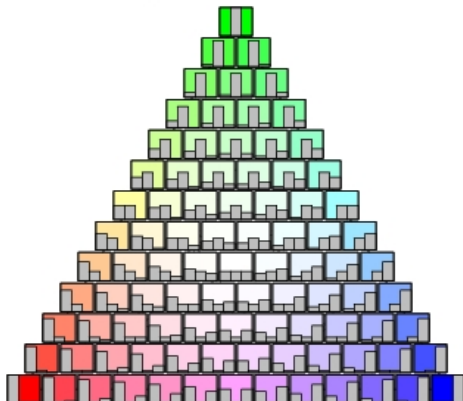
Assignment of colours to ternary forecasts



- use HSV (hue–saturation–value) colour space
- hue $\propto \theta(\mathbf{p})$
- saturation $\propto H(\mathbf{p})$

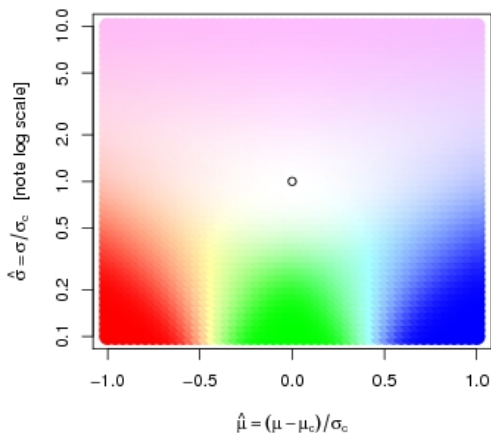
Colours \Leftrightarrow barplots

Ternary barplots in
barycentric coordinates



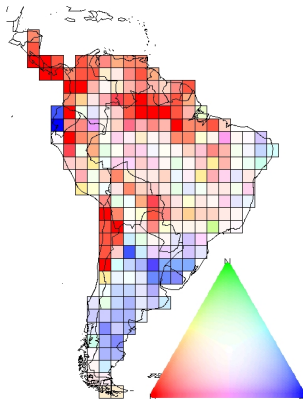
Special case: climatology $\sim N(\mu_c, \sigma_c^2)$, forecast $\sim N(\mu, \sigma^2)$

Colour of forecast $N(\mu, \sigma^2)$ with climatology $N(\mu_c, \sigma_c^2)$



An example

Integrated: Probabilistic tercile forecast
Issued: Nov 1997 Valid for DJF 1997



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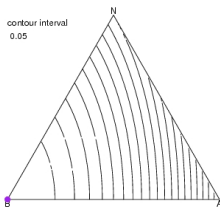
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Measuring skill: the ranked probability score

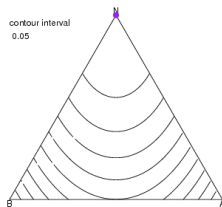
Compare forecast \mathbf{p} with subsequent observation \mathbf{o}

$$R(\mathbf{p}; \mathbf{o}) = \frac{1}{2} [(p_B - o_B)^2 + (p_B + p_N - o_B - o_N)^2]$$

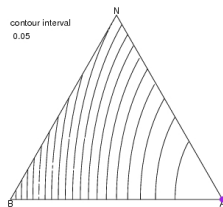
Lines of constant $R(\mathbf{p}; \mathbf{o})$, $\mathbf{o} = (1, 0, 0)$



Lines of constant $R(\mathbf{p}; \mathbf{o})$, $\mathbf{o} = (0, 1, 0)$

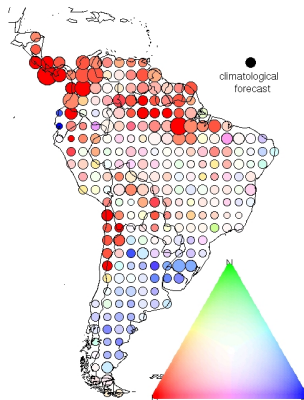


Lines of constant $R(\mathbf{p}; \mathbf{o})$, $\mathbf{o} = (0, 0, 1)$



Set radius $\propto 1/RPSS$

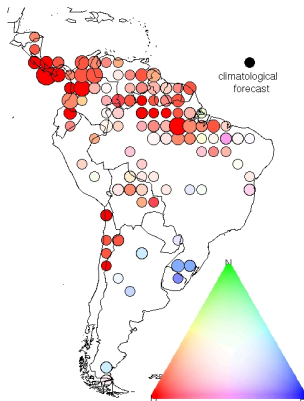
Integrated: Probabilistic tercile forecast
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Set radius $\propto 1/RPSS$ with masking

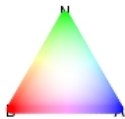
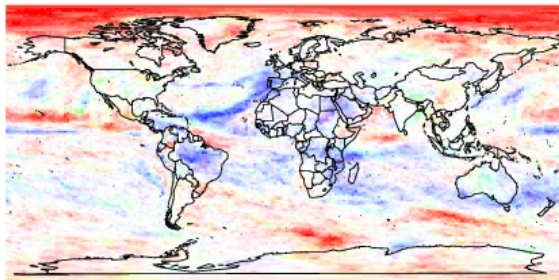
Integrated: Probabilistic tercile forecast
Issued: Nov 1997 Valid for DJF 1997



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Decadal climate forecasting?

Precip: change in tercile probabilities over C21
nexp = 1 model = ukmo_hadgem1 month = oct



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Conclusions

- assign unique colour to each ternary forecast
- barycentric coordinates aid understanding
- greater subjective certainty \Rightarrow stronger colour
- forecasts close to climatology have weak colours