Creating maps of probabilistic forecasts

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Outline

Outline

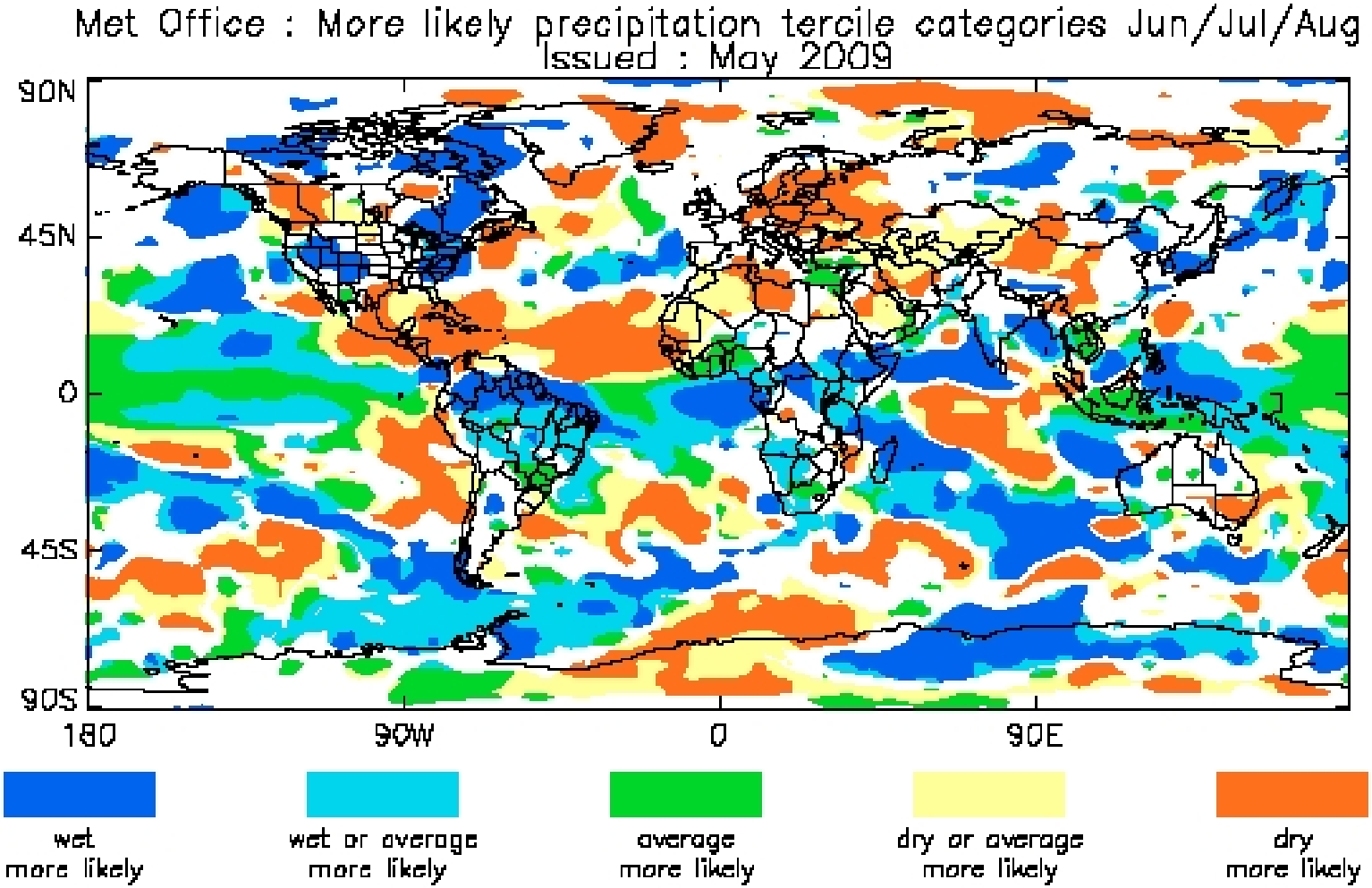
Acknowledgements

This is work in progress, involving:

- Rachel Lowe
- Caio Coelho
- David Stephenson

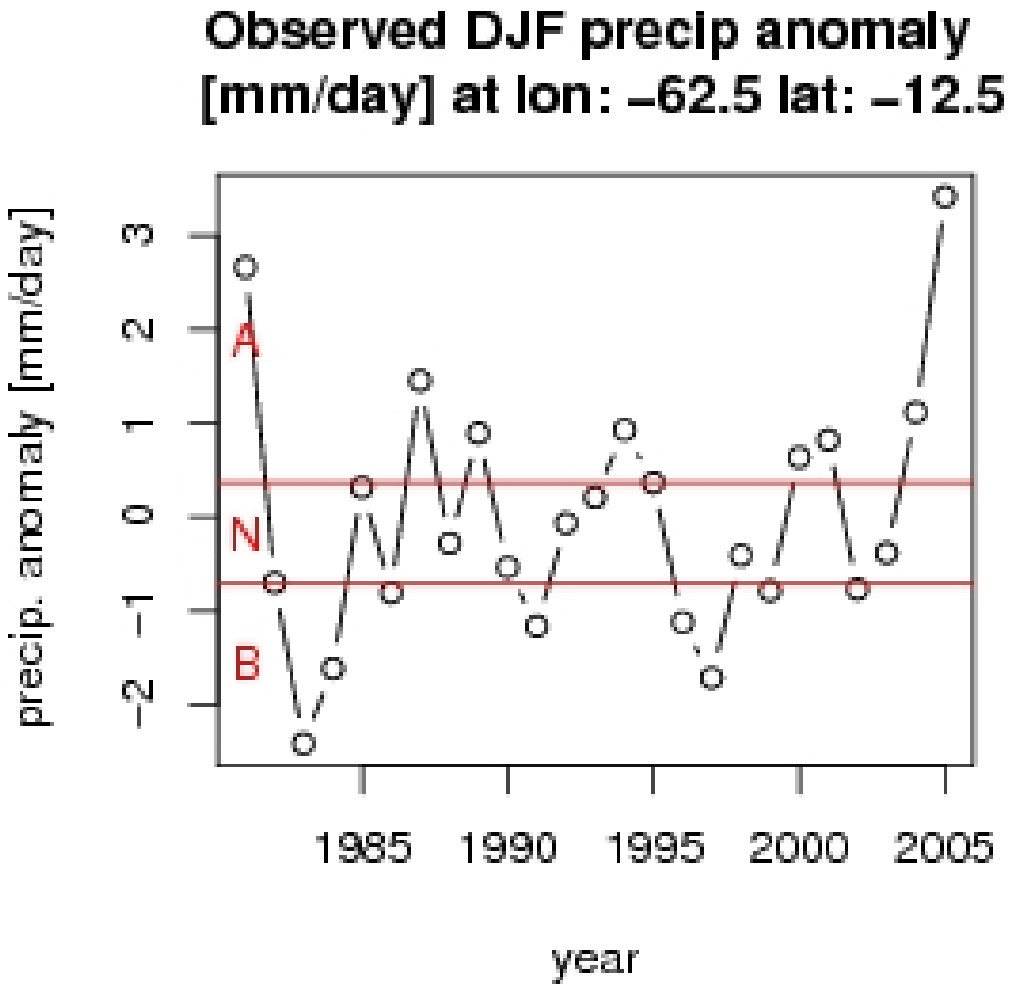
Outline

Probabilistic Forecasting



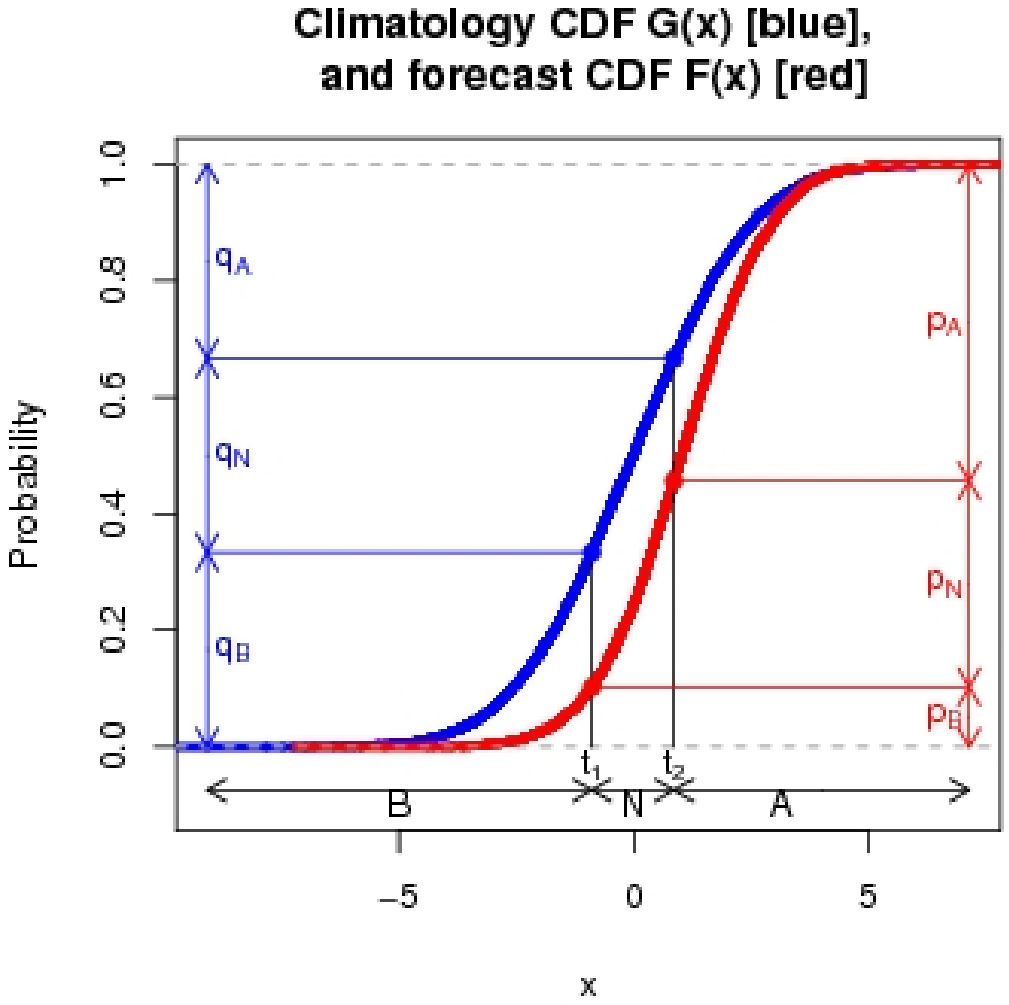
- the forecast at each point is a *distribution*
- How should we assign *colours* to *distributions*?

The terciles of a climatology



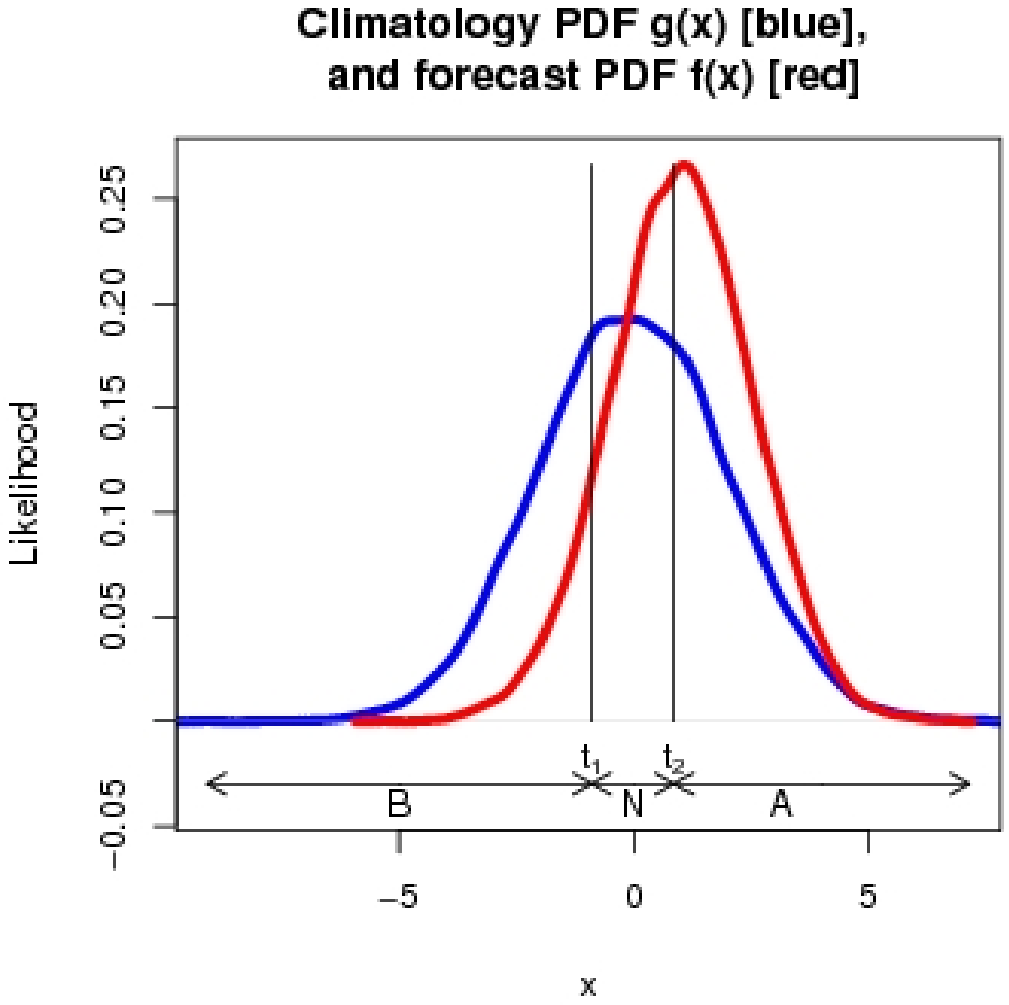
- the categories *B*, *N* and *A* are *observed* with equal frequency

Continuous distributions (CDF)



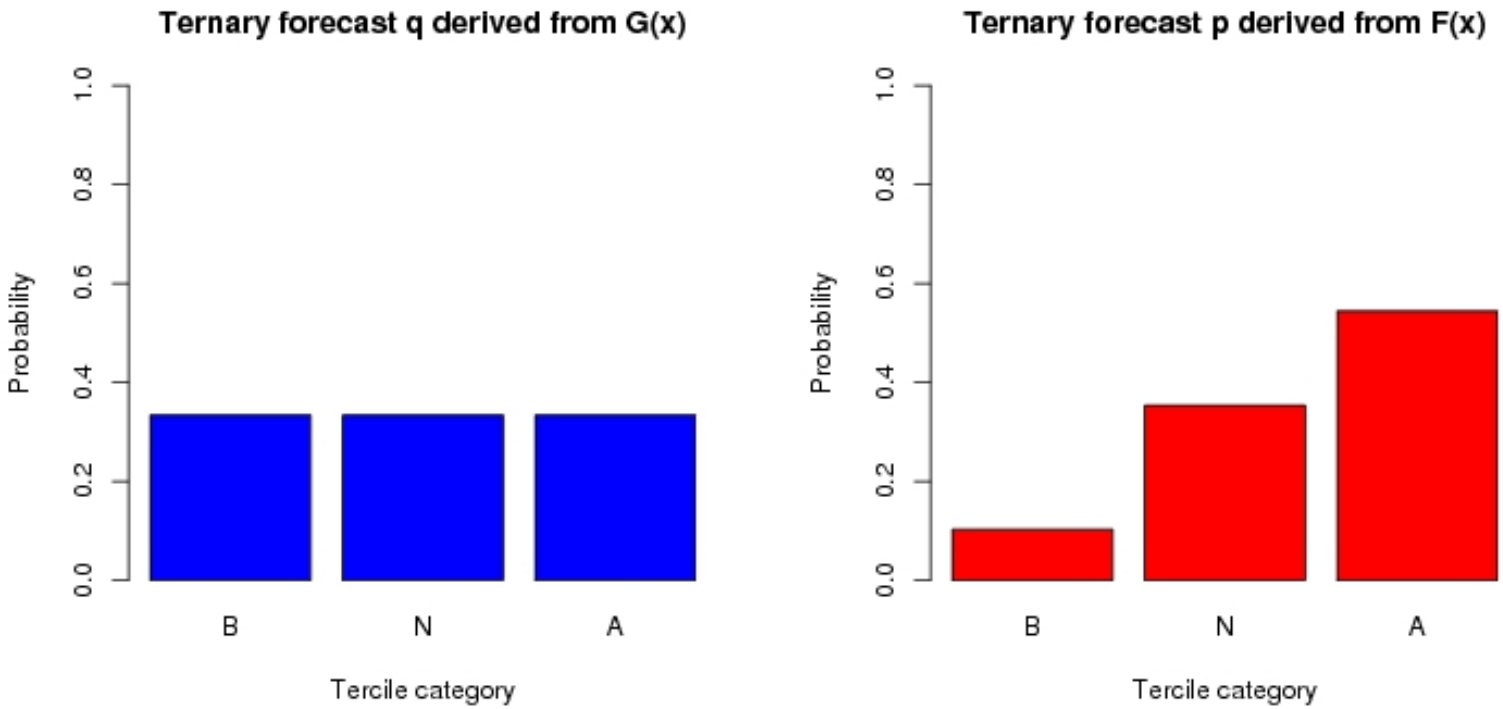
- climatology: $G(x)$, forecast: $F(x)$

Continuous distributions (PDF)



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

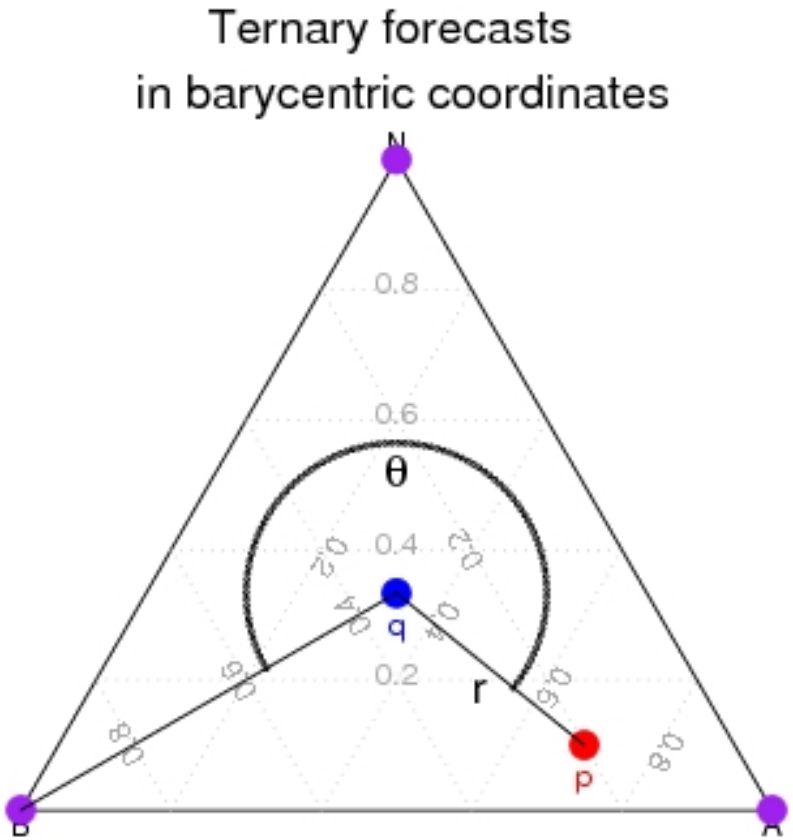
Ternary forecast



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

Outline

Barycentric coordinates



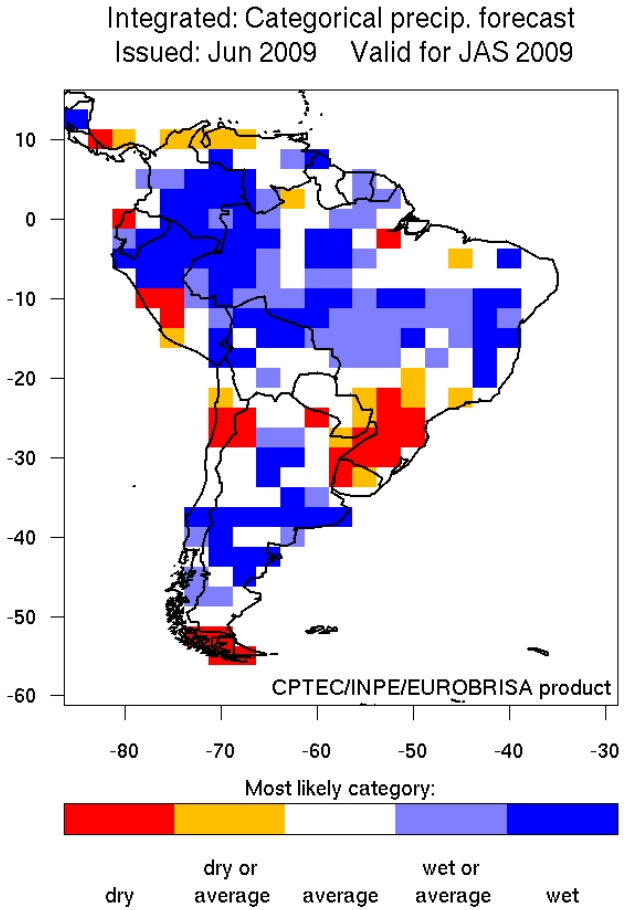
- every ternary forecast is a point in the triangle, including
- the climatology **q**
- the observed state **o**

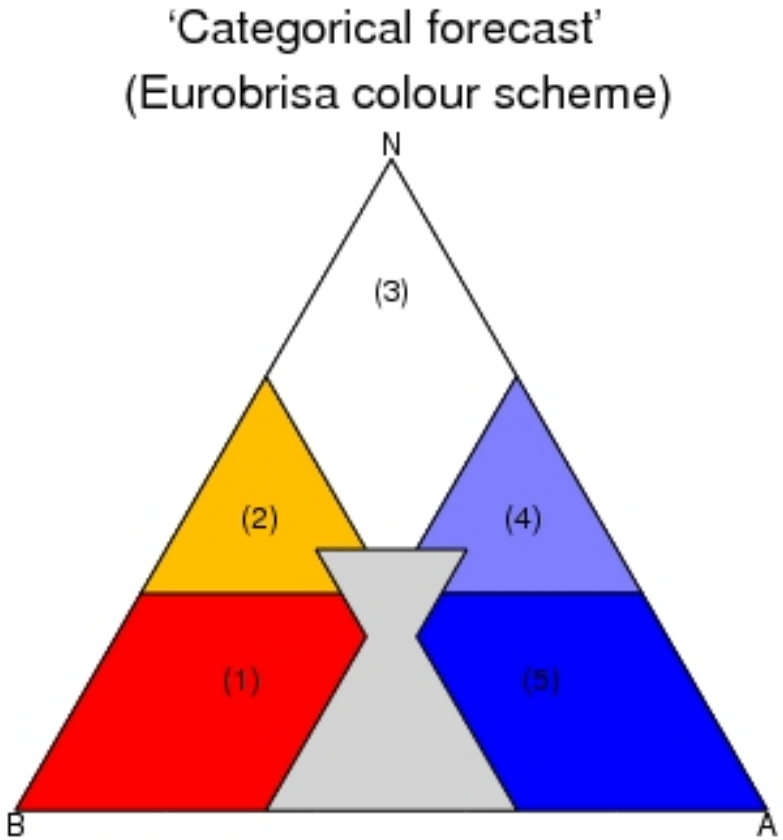
Current visualisation methods

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

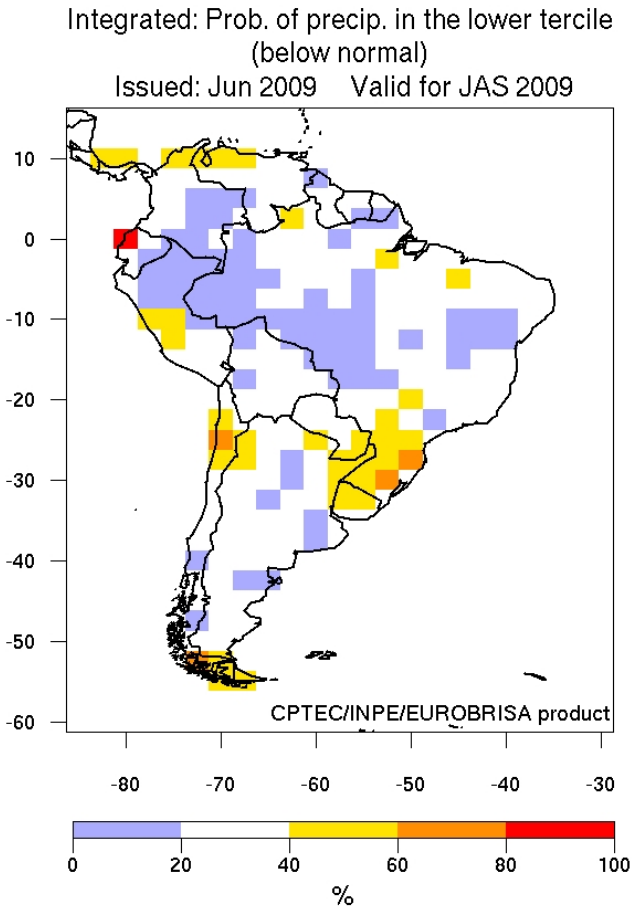
- 1 (Dry): ($p_B > 2/5$ and $p_N < 1/3$ and $p_A < 1/3$).
- 2 (Dry or normal): ($p_B > 1/3$ and $p_N > 2/5$) or ($p_B > 2/5$ and $p_N > 1/3$).
- 3 (Normal): ($p_B < 1/3$ and $p_N > 2/5$ and $p_A < 1/3$).
- 4 (Wet or normal): ($p_N > 1/3$ and $p_A > 2/5$) or ($p_N > 2/5$ and $p_A > 1/3$).
- 5 (Wet): ($p_B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

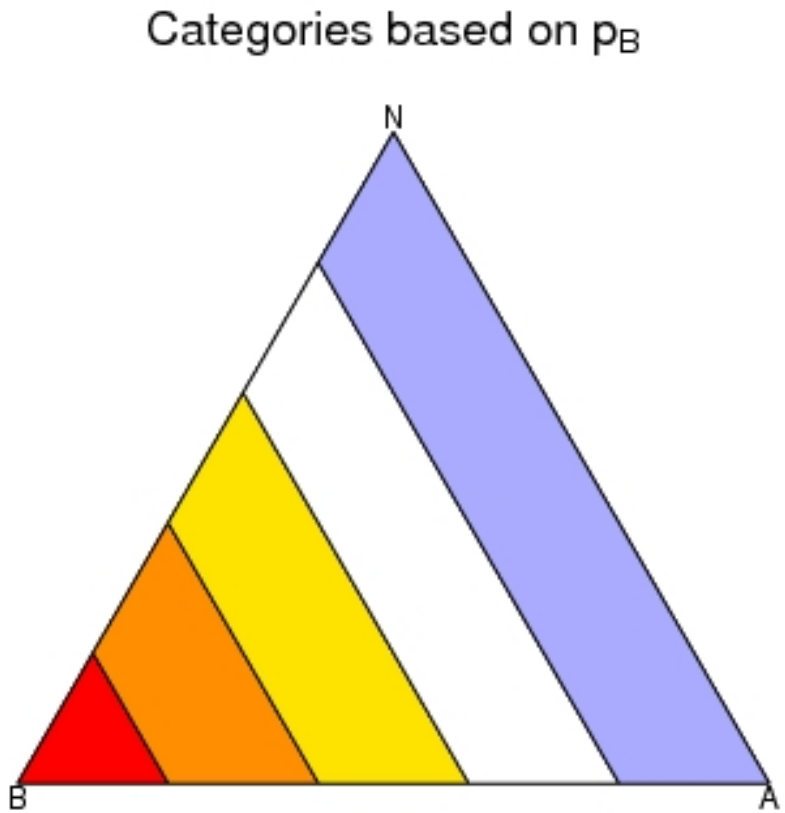
Current visualisation methods (EUROBRISA categorical)



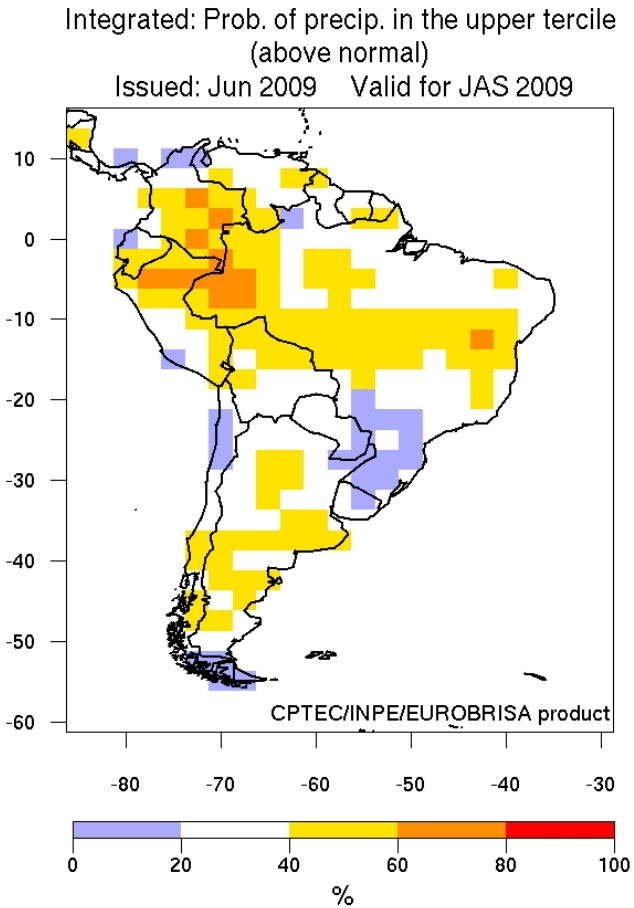


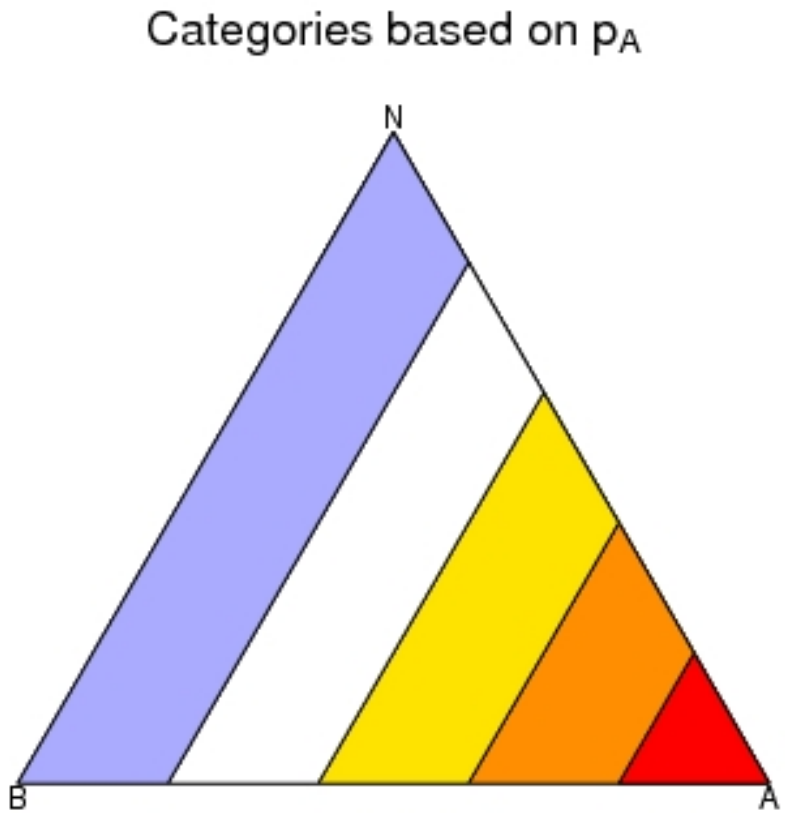
Current visualisation methods (EUROBRISA lower)



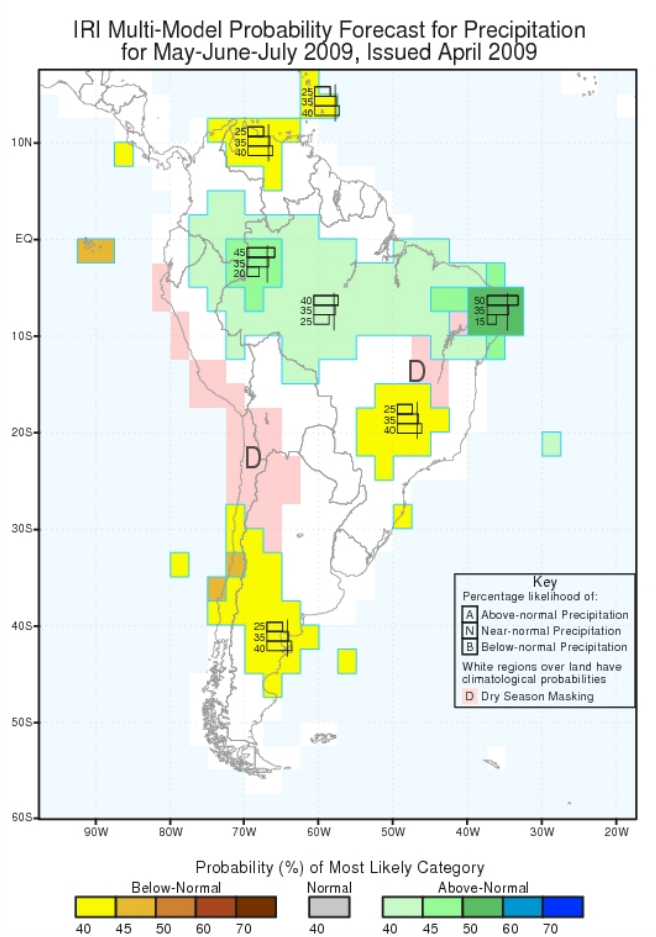


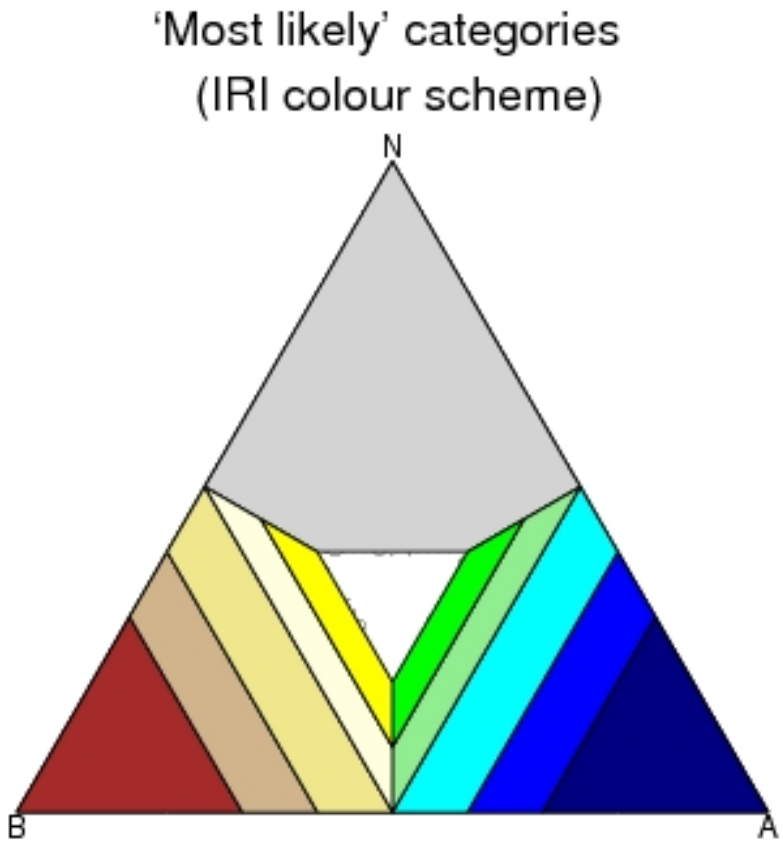
Current visualisation methods (EUROBRISA upper)



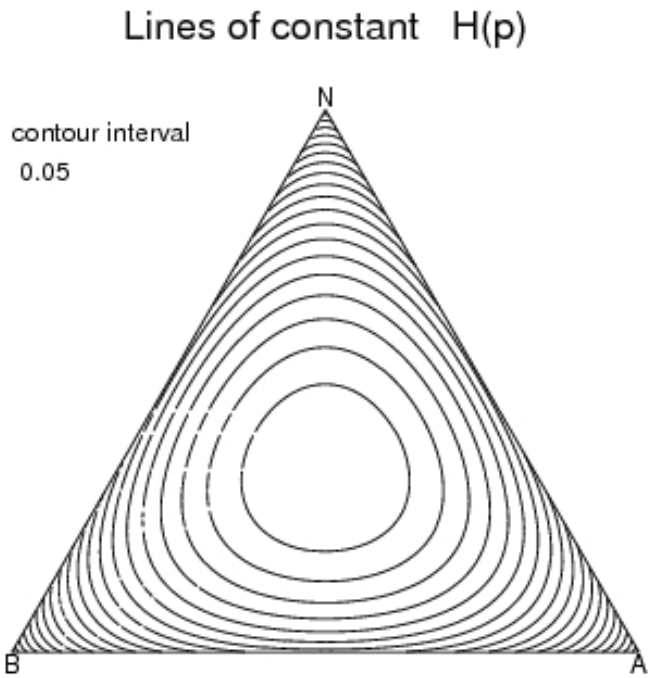


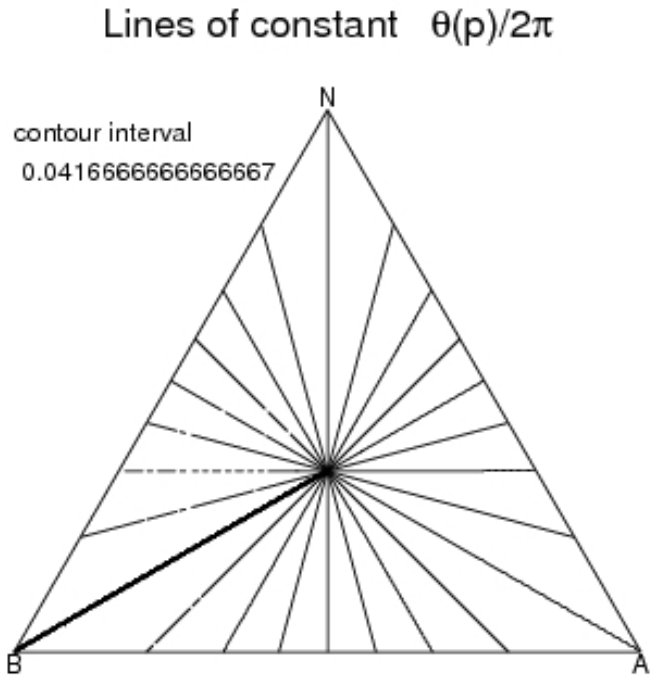
Current visualisation methods (IRI)





A continuum of colours in forecast space

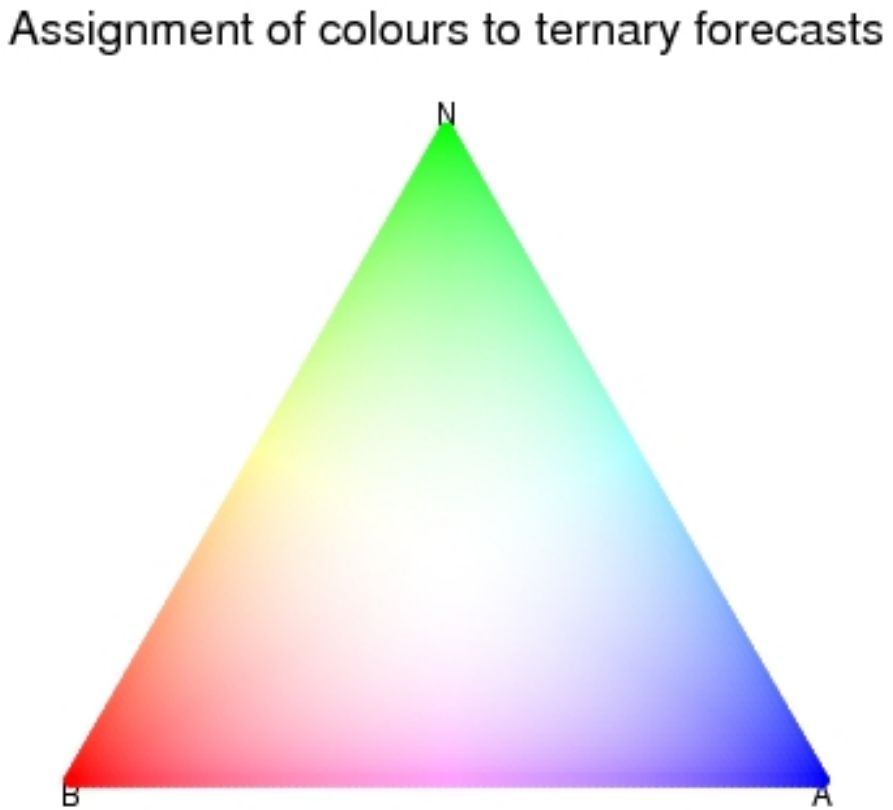




$$H(\mathbf{p}) = \frac{1}{\log 3} \sum_{i \in \{B,N,A\}} p_i \log 3p_i$$

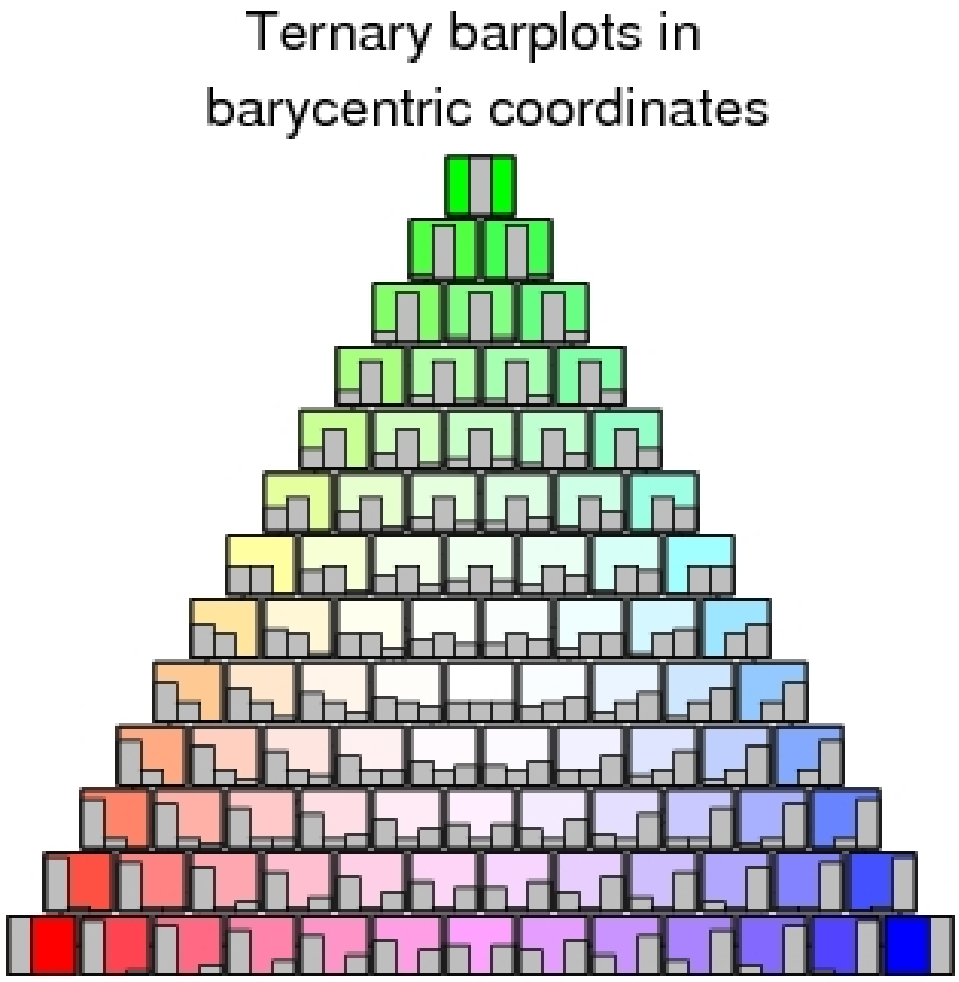
- $H(\mathbf{p})$ is a measure of the *subjective certainty* in a forecast

Our proposed colour scheme

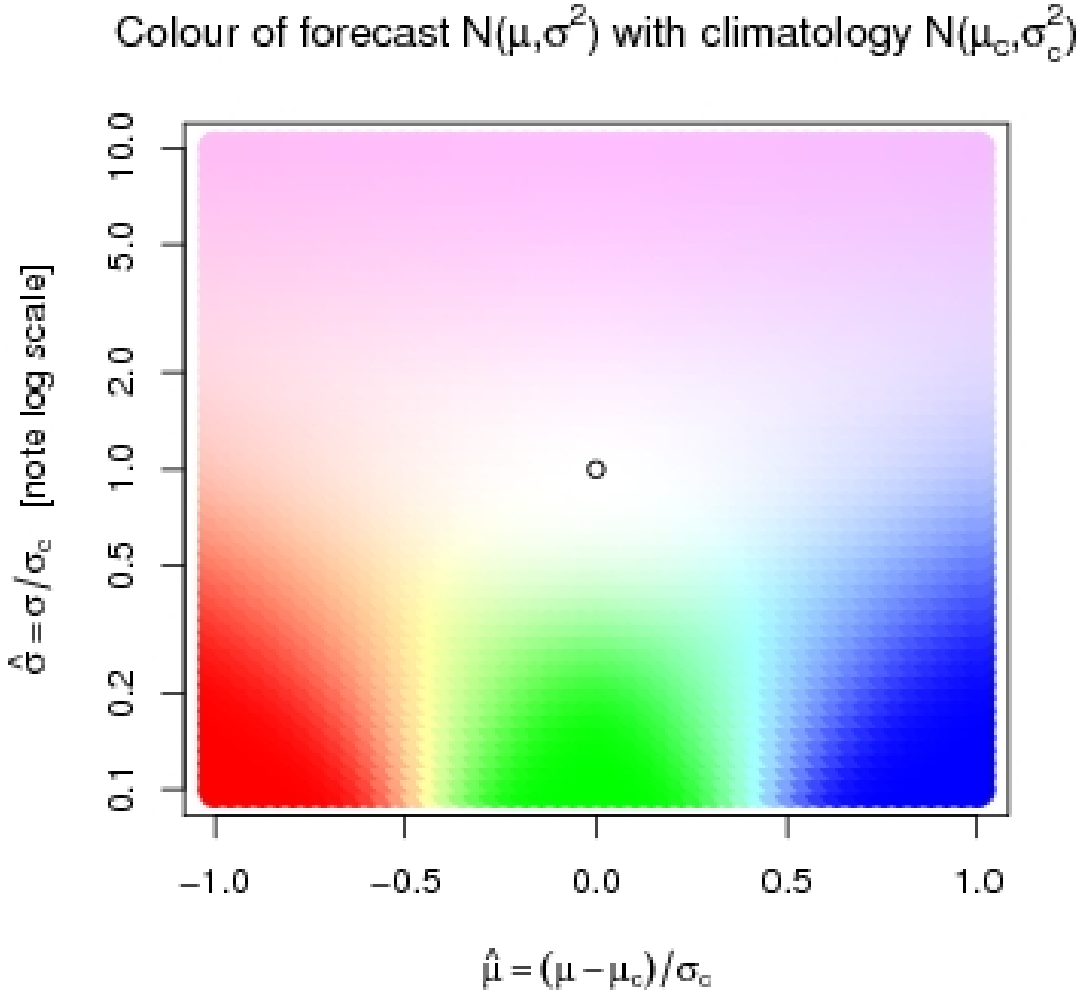


- use HSV (hue–saturation–value) colour space
- $\text{hue} \propto \theta(\mathbf{p})$
- $\text{saturation} \propto H(\mathbf{p})$

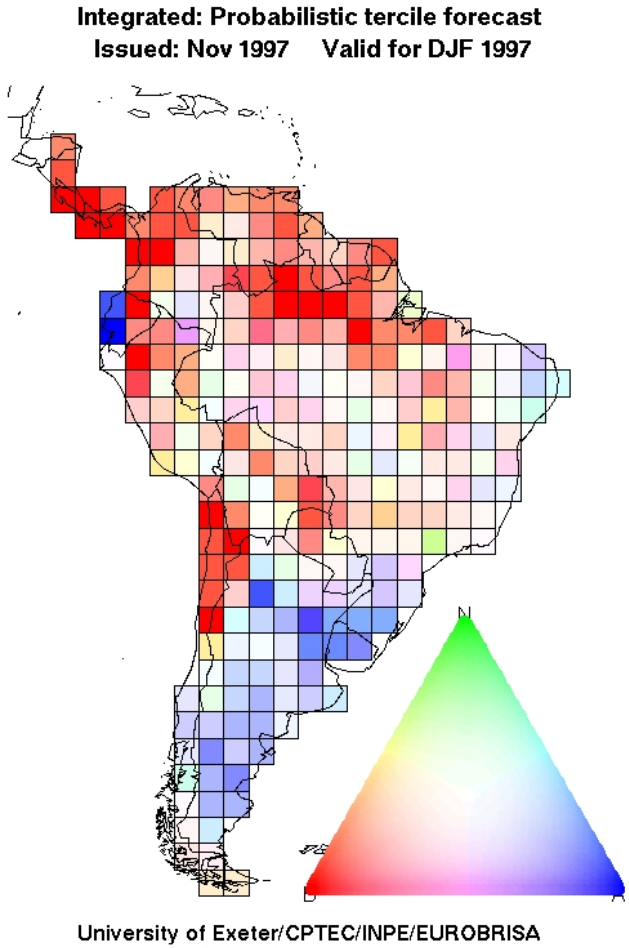
Colours $\Leftrightarrow$ barplots



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



An example


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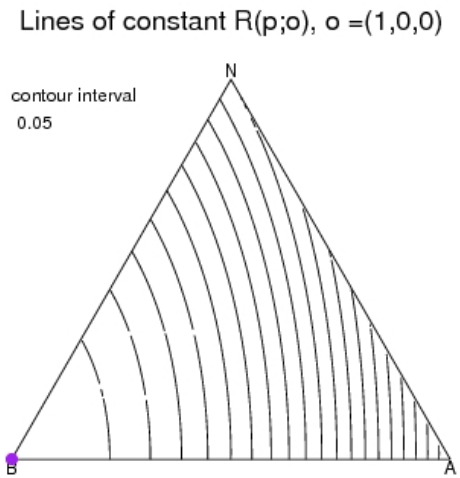
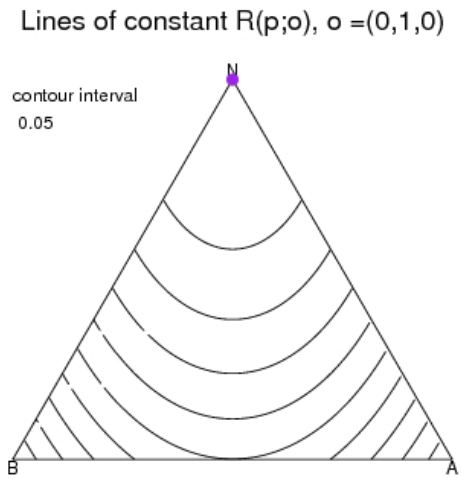
Outline

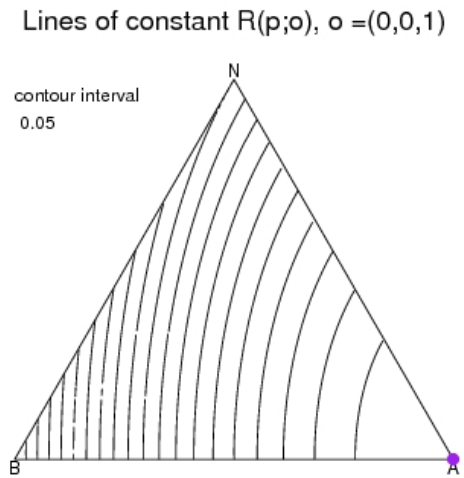
Measuring skill: the ranked probability score

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

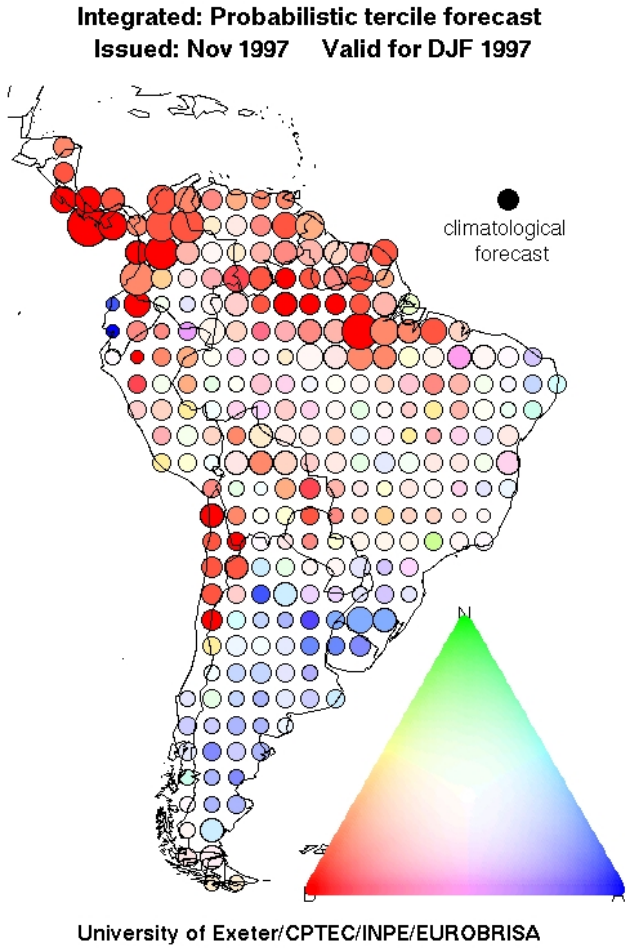
$$R(\mathbf{p};\mathbf{o}) = \frac{1}{2}\left[(p_B - o_B)^2 + (p_B + p_N - o_B - o_N)^2\right]$$



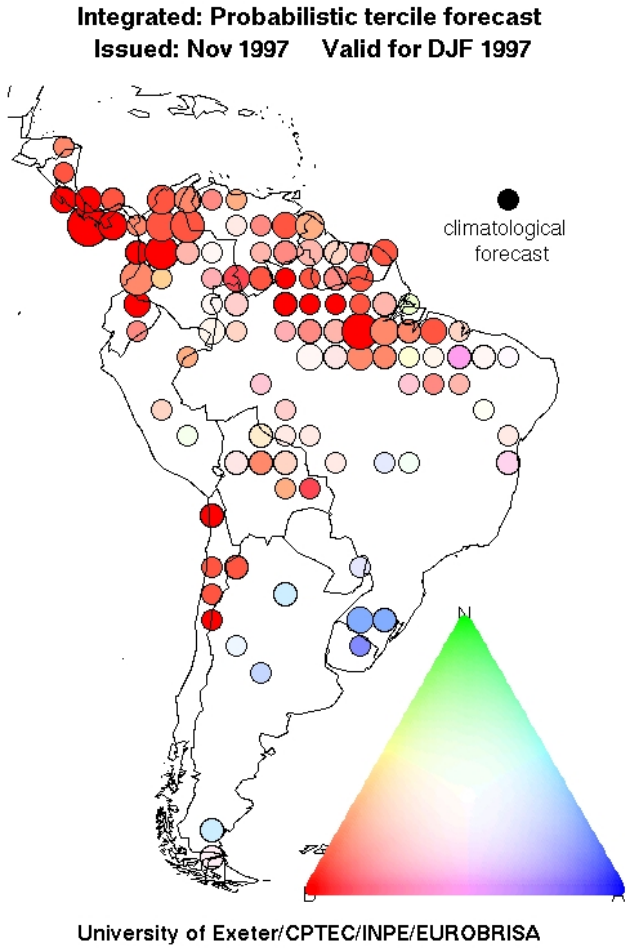




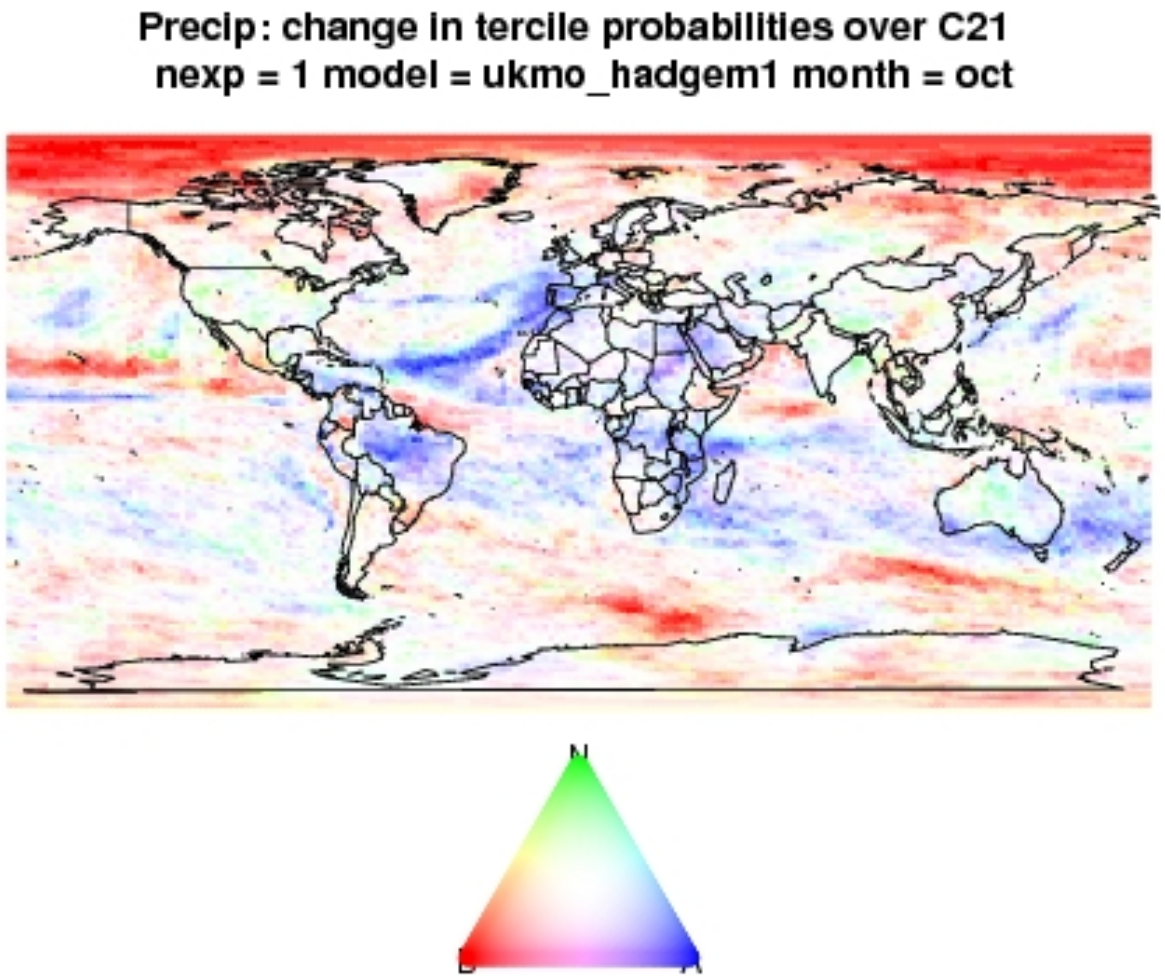
Set radius $\propto 1/RPSS$



Set radius $\propto 1/RPSS$ with masking



Decadal climate forecasting?



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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