Communicating uncertainty in seasonal and interannual predictions: An exploration of user needs amongst organisations in Europe

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European Provision Of Regional Impacts Assessments on Seasonal and Decadal Timescales

Work Package 33

Communicating levels of confidence and uncertainty

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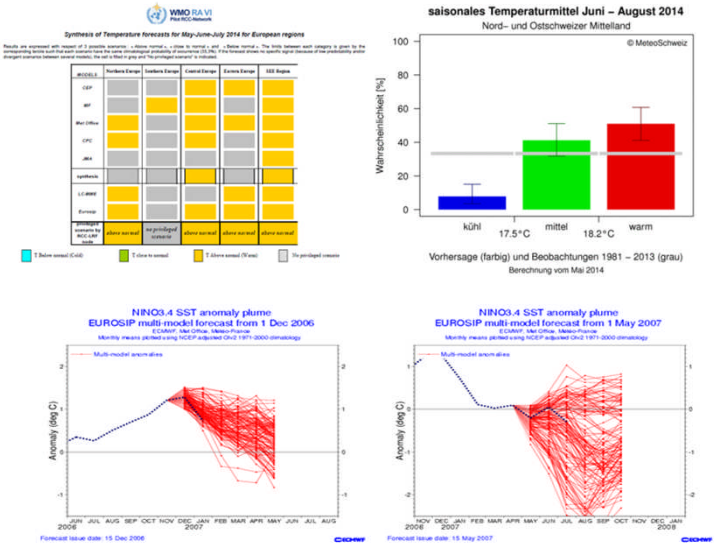
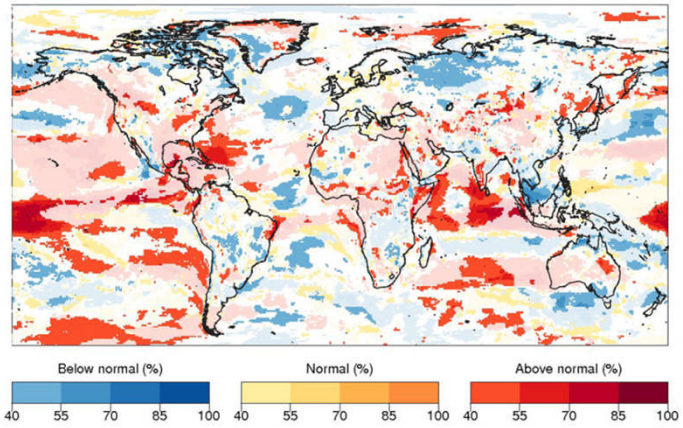
Communicating confidence and uncertainty in Seasonal and interannual climate forecasts



*Visualisation provided by **Top Left** Jean-Pierre Ceron, Meteo-France; **Top right** MeteoSwiss; **Bottom** Jean-Pierre Ceron, Meteo France..*

- As skill relative to climatology improves, European organisations may increasingly make use of seasonal and interannual climate predictions.
- Uncertainty in these predictions arises from multiple sources.

- Many methods of communicating uncertainty in seasonal predictions exist, but few have been empirically tested.



Visualisation provided by Melanie Davis, IC3.

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Reviewing the broader literature on communicating uncertainty

- Interpretation and use of uncertain information may be influenced by a number of factors:
  - 'ambiguity aversion' *(e.g. Ellsberg, 1961)*
  - institutional protocol *(e.g. Demeritt et al., 2010; Ramos et al., 2010)*
  - tolerance for "misses" and "false alarms" *(e.g. Allen & Eckel, 2012)*
  - technical and statistical expertise *(e.g. Gregory et al., 2012)*
  - cognitive biases *(e.g. Kahneman, 2011)*
  - use of colour in visualisations *(e.g. Kaye et al., 2012)*
  - need for clearly marked thresholds (such as Act/Don't Act signals) *(e.g. McCown, 2012)*

- Tradeoffs between richness (amount of detail), robustness (reliability and skill), and ease of understanding *(Stephenson et al., 2012)*

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Surveying user needs

Sample

50 respondents from both stakeholder organisations and non-stakeholders organisations expressing an interest in the EUPORIAS project took part in the survey. 45 provided full completions.

Use weather forecast	*n* = 45
Use seasonal prediction	*n* = 33
Use interannual prediction	*n* = 18

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Surveying user needs

Key questions

1. How accessible, understandable and useful do users perceived seasonal forecasts to be relative to other types of ‘uncertain’ information?

2. What information about uncertainty in S2D do users currently receive, and what would they like to receive?

3. When it comes to representing uncertainty what are respondents’ preferences?

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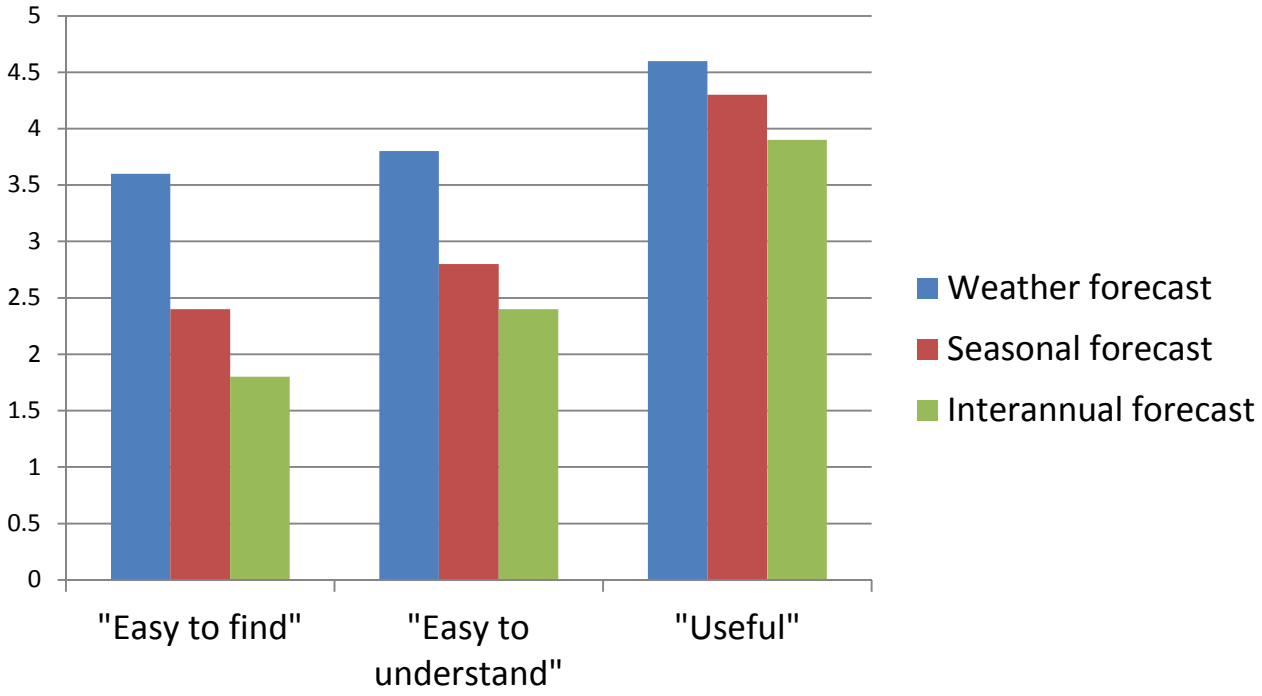
How accessible, understandable and useful do users perceived climate predictions to be?



Mean ratings of accessibility, understandability and usefulness amongst survey respondents.

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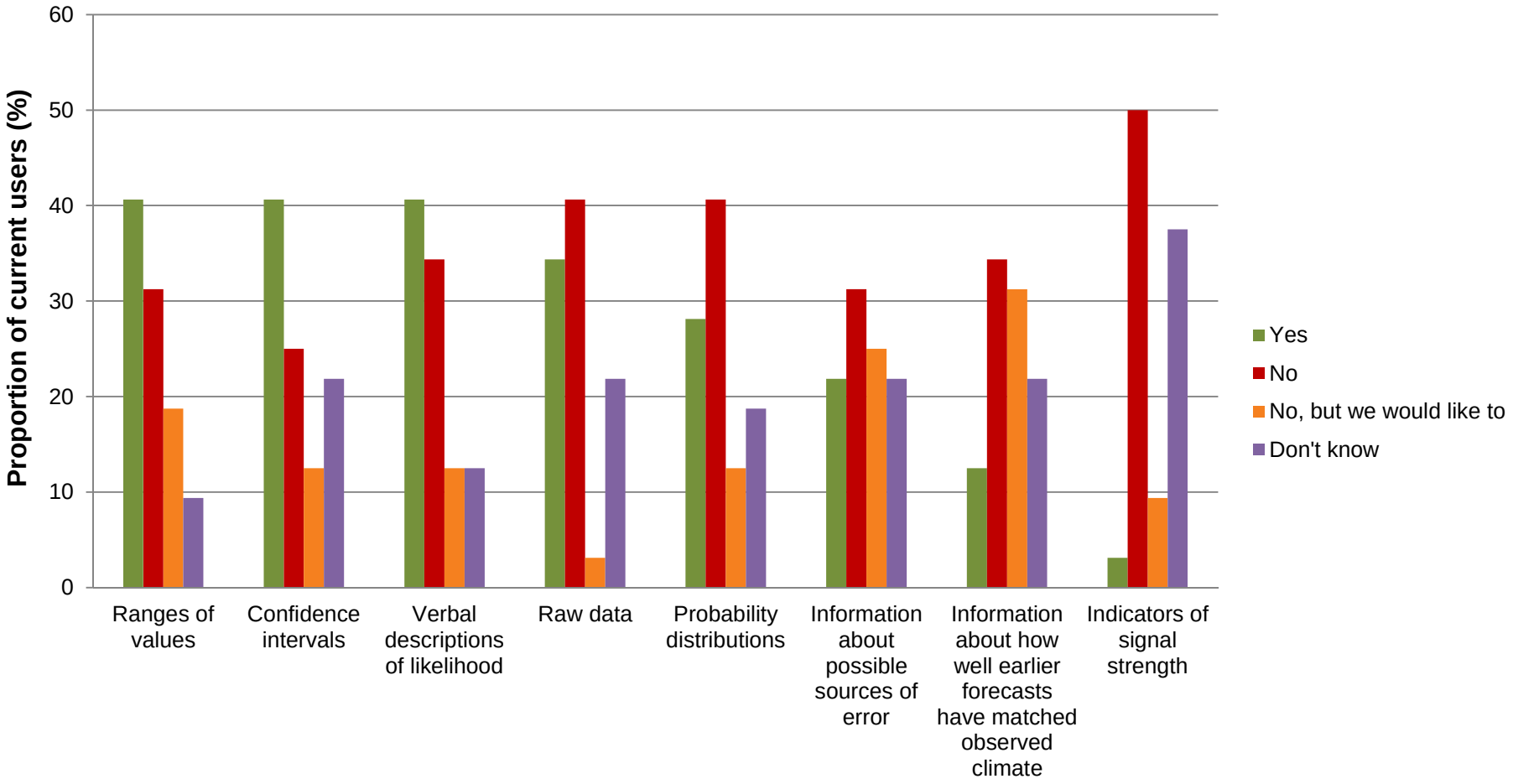
"Does your organisation get any of the following types of information about **uncertainty** in its seasonal to decadal climate forecasts?"



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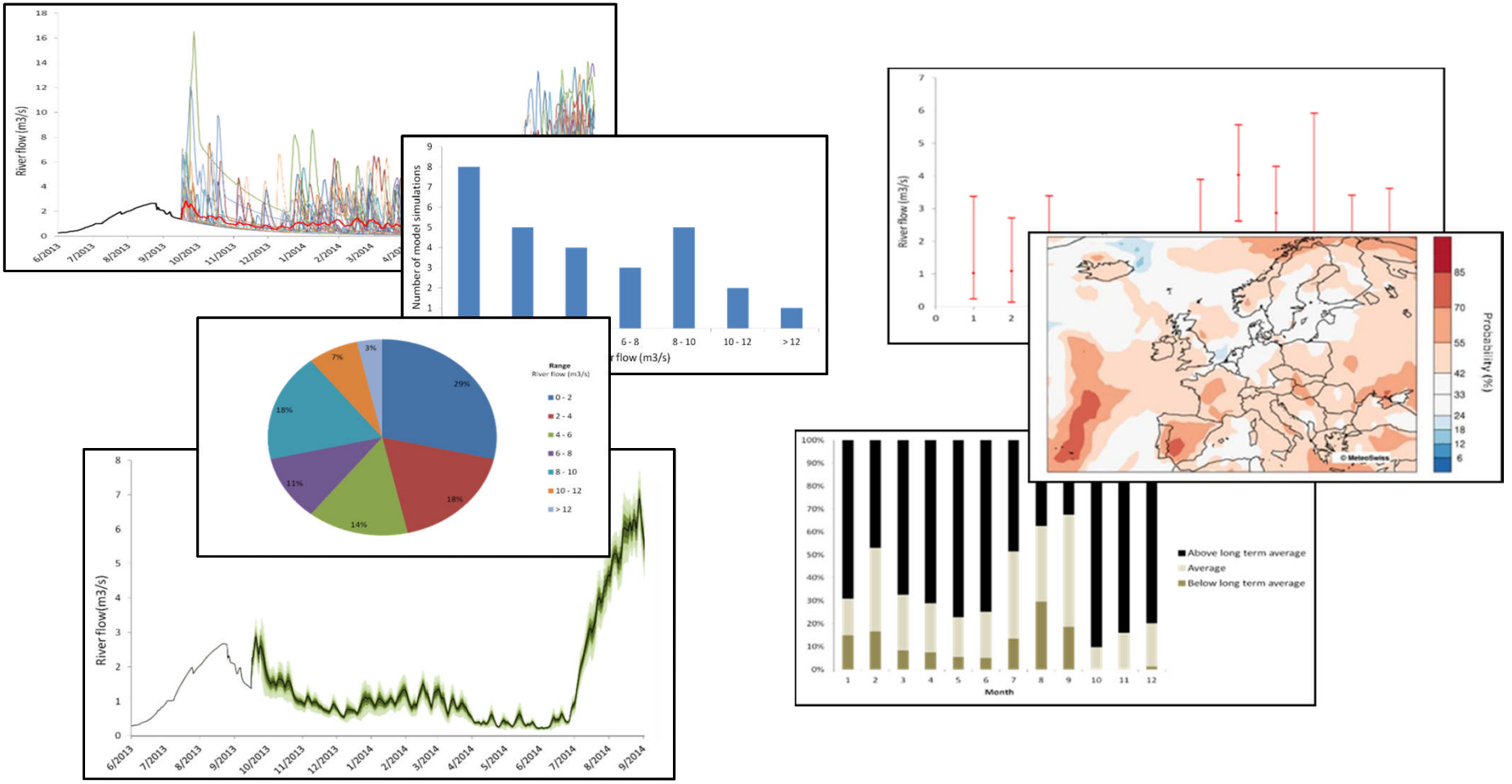
When it comes to representing uncertainty what are respondents' preferences?



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When it comes to representing uncertainty what are respondents' preferences?

Mean ratings of preference and familiarity for the probability visualisations presented to participants, along with correlations between preference, familiarity and statistical comfort

			Correlations (Spearman's ρ)		
	Preference Mean (SD)	*Familiarity Mean (SD)*	*Preference with Familiarity ρ*	*Preference with statistical comfort ρ*	*Familiarity with statistical comfort ρ*
Map	*3.9 (0.7)*	*3.3(1.1)*	*.60****	*-.22*	*-.06*
Fan chart	*3.9 (0.7)*	*3.4(1.1)*	*.52****	*.24*	*.18*
Error bar	*3.7 (0.7)*	*3.5(1.1)*	*.74****	*.38***	*.34**
Bar graph: Distribution	*3.4 (0.8)*	*3.0(1.1)*	*.52****	*.26†*	*.19*
Pie chart	*3.2 (0.9)*	*2.9(1.1)*	*.71****	*-.21*	*-.17*
Spaghetti plot	*3.1 (1.0)*	*3.0(1.2)*	*.69****	*.02*	*.13*
Bar graph: Tercile	*3.0 (0.9)*	*2.5(1.1)*	*.76****	*.08*	*.26†*

*†Marginally significant at p ≤ .10 *Significant at p ≤ .05 **Significant at p ≤ .01 ***Significant at p ≤.001*

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Challenges identified

- While seasonal forecasts are widely perceived as highly useful they are not widely perceived as easy to access or understand.
- Second order uncertainty (i.e. reliability, skill) is not being clearly communicated to many current S2D users.
- Preference for different types of visualisation influenced by both familiarity and statistical expertise.

Taylor, A. L., Dessai, S, & Bruine de Bruin, W (Accepted). Communicating uncertainty in seasonal and interannual climate forecasts in Europe. *Philosophical Transactions of the Royal Society A.*

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Developing communication strategies

- Progressive disclosure of information (Kloprogge, 2007)
  - Simple 'Top line' followed by more complex detail.
- Making the extent to predictions have matched observations salient
- Representing spread

Taylor et al. (2015). Report describing formulation of strategies for communicating confidence levels for S2D forecasts. *Euporias Project Deliverable.* http://euporias.eu/system/files/D33.3.pdf

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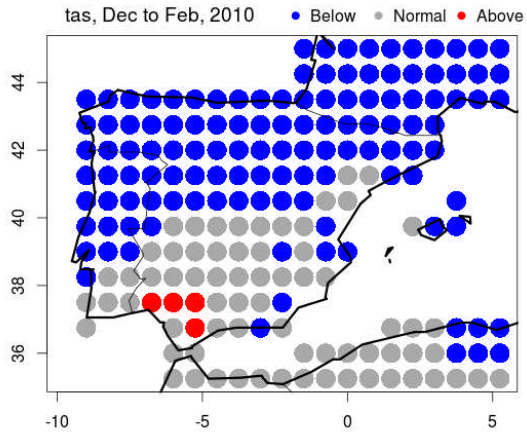
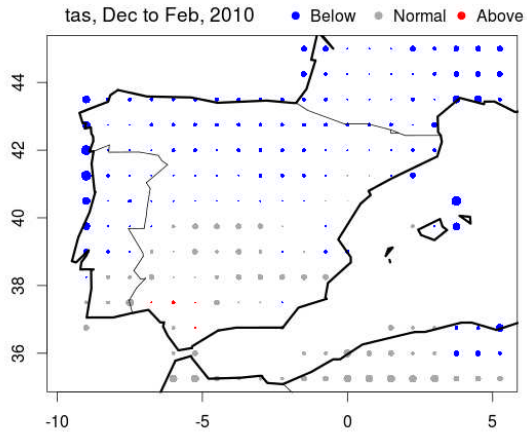
Progressive increase in complexity: Bubble plot

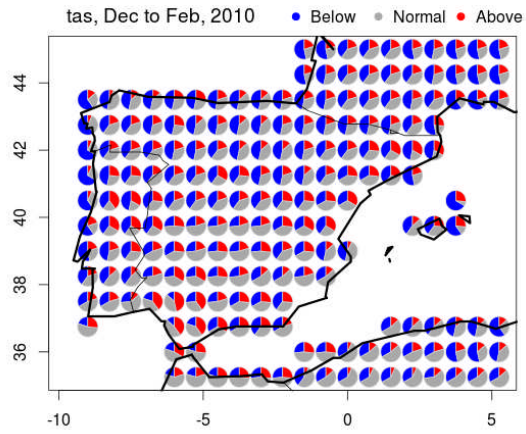
(a)



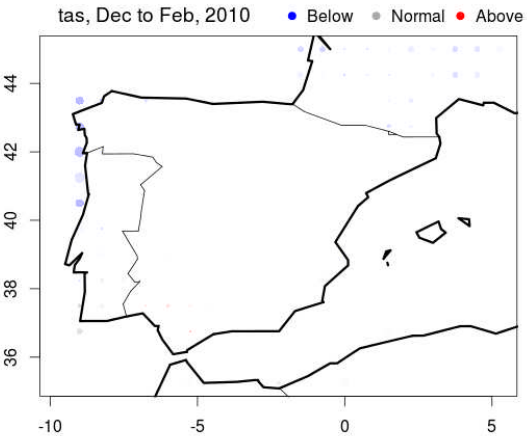
(b)



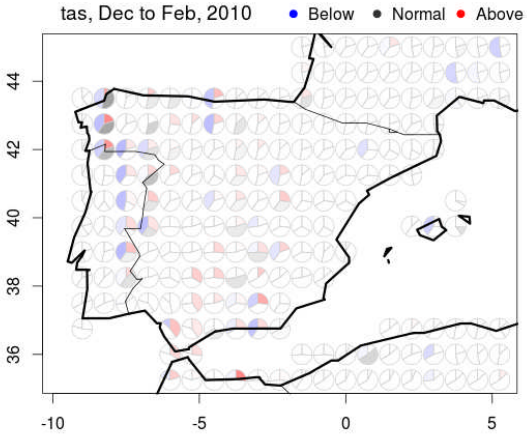
(c)



(d)



(e)



(a) Most likely tercile only
(b) Likelihood of most likely tercile represented by size of 'Bubble'
(c) Likelihood of all terciles
(d) Skill (ROCSS) associated with most likely tercile represented by transparency
(e) Skill associated with all terciles

Concept proposed by Aiden Slingsby, City University
Visualisation produced by Maria Dolores Frias and Jesus Fernandez, University of Cantabria

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Progressive increase in complexity: Confidence Index

Top line

More detailed explanation

Forecast

"Temperatures will be over 25°C on average next june"

Confidence index
Or 2

Confidence index scale

		Skill		
		Low	**Medium**	**High**
Likelihood	**Low (30-40%)**	No signal	No signal	
	Medium (40-50%)	No signal	X	
	High (>50%)			

		Low	**Medium**	**High**
Likelihood	**Low (30-40%)**	No signal 0	No signal 1	2
	Medium (40-50%)	No signal 1	2	3
	High (>50%)	2	3	4

Concept proposed by Ghislain Dubois, TEC

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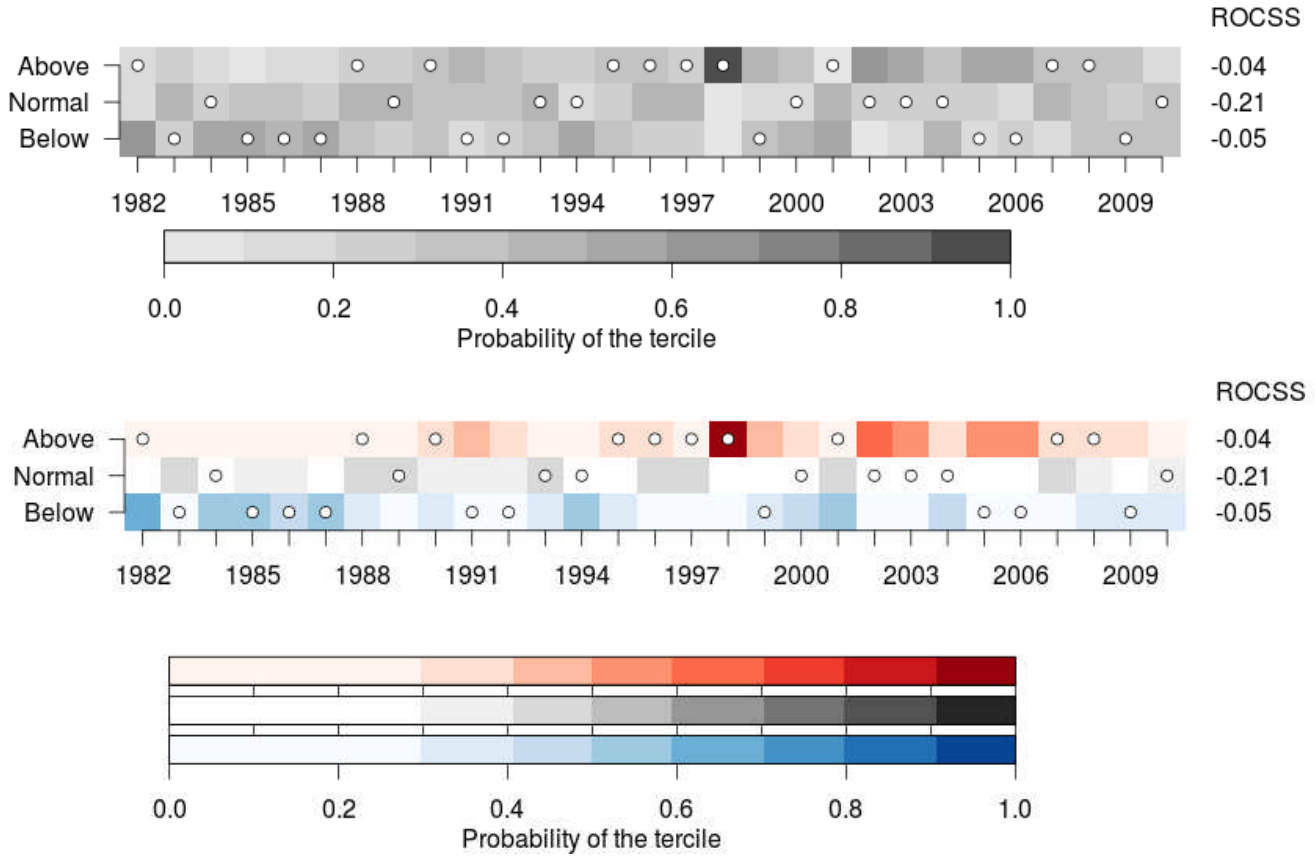
Making skill salient: Tercile plot



Visualisations produced by Maria Dolores Frias and Jesus Fernandez, University of Cantabria

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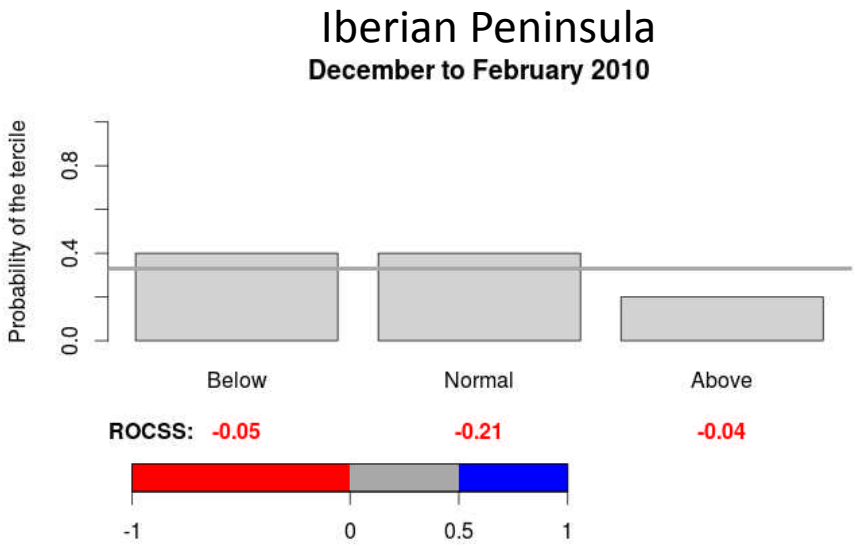
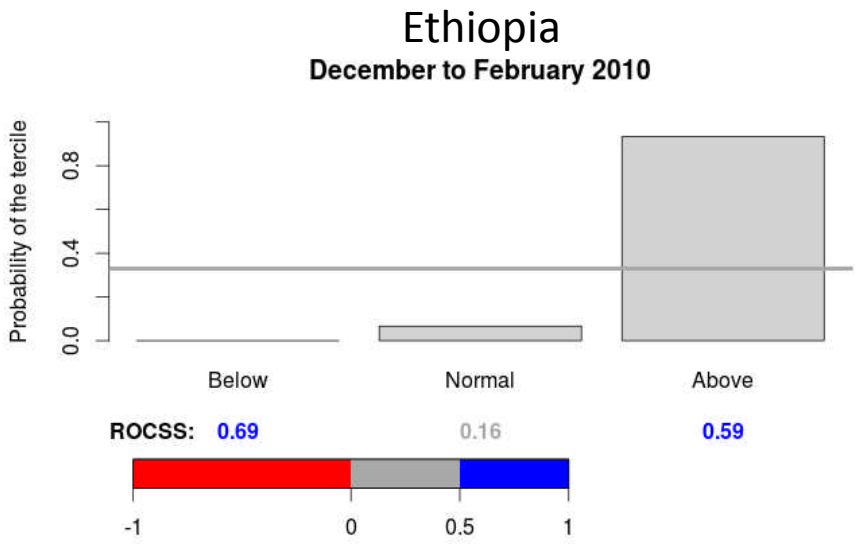
Making skill salient: Tercile bar graph





Visualisation produced by Maria Dolores Frias and Jesus Fernandez, University of Cantabria

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Making skill salient: Evaluative categories for non-expert users?

Confidence Rating

No useful information RPSS ≤ 0

"The forecast does not offer any useful information at this time"

Low Confidence RPSS > 0 and < 0.2

*"The forecast is better than chance, but the actual likelihood of temperatures being above average is **very often** different than predicted"*

Medium Confidence RPSS ≥ 0.2 and < 0.5

*"The forecast is better than chance, but the actual likelihood of temperatures being above average is **often** different than predicted"*

High Confidence RPSS ≥ 0.5

*"The forecast is better than chance, but the actual likelihood of temperatures being above average is **sometimes** different than predicted"*

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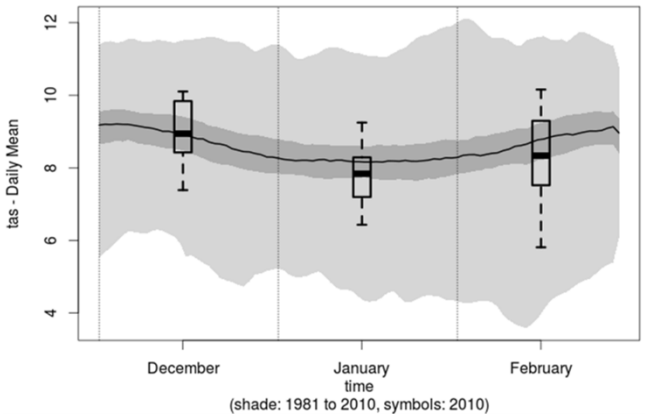
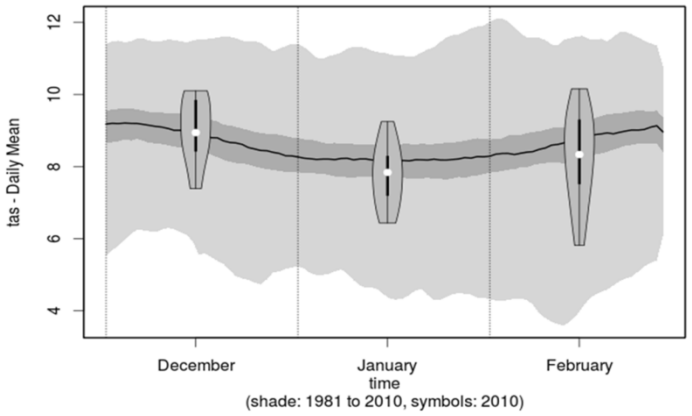
Representing Spread

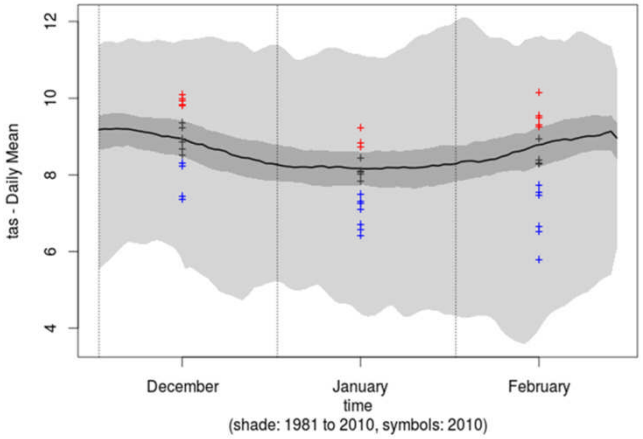
(a) Boxplot



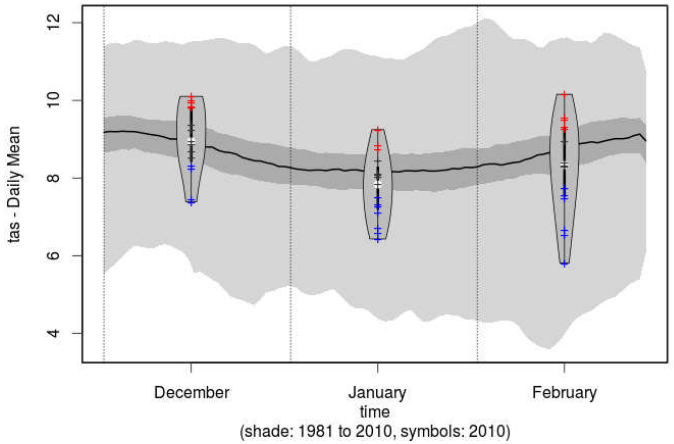
(b) Violin plot



(c) Dot plot



(d) Dot plot overlaid on violin plot



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Testing strategies with end users

1. Measure objective understanding
2. Identify and address points where misunderstandings occur
3. Identify the extent to which objective understanding corresponds with preference, perceived ease of understanding, and perceived usefulness
4. Establish how these formats would be used in decision making

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In summary

1. End users currently perceive seasonal forecasts to be more useful than they are accessible or understandable.

2. Information about skill is not always communicated effectively.

3. Preference for particular visualisations is associated with familiarity and existing statistical expertise.

4. We have developed and built upon strategies for addressing some of the challenges identified in the user needs survey.

5. These will be tested to ensure that future recommendations for communicating uncertainty in seasonal and interannual forecasts are empirically supported.

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Acknowledgements

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