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Communicating confidence and uncertainty in seasonal forecasts

Andrea L. Taylor
(a.l.taylor@leeds.ac.uk)

University Academic Fellow, Sustainability Research Institute and Centre for Decision Research, University of Leeds.

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Work Package 33

"Test the effectiveness of different approaches to communicating the confidence and uncertainty associated with S2D predictions."

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European Provision Of Regional Impacts Assessments on Seasonal and Decadal Timescales

http://www.euporias.eu/

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Seasonal Forecasts: The challenge of communicating uncertainty

- To use make informed decisions about how to use forecasts users should be aware of…
  - **The fact that forecasts are probabilistic**
  - **How well the forecast performs (i.e. skill, reliability)**

- Failing to communicate uncertainty can have negative consequences
  - **A false sense of certainty (Brezis, 2011)**
  - **Maladaptive decision making (Macintosh, 2013)**
  - **A loss of trust in forecast providers (LeClerc and Joslyn, 2015)**

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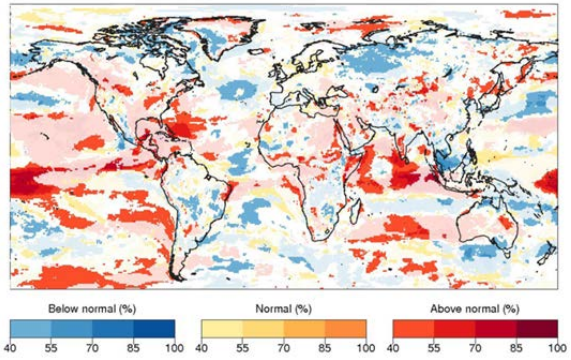
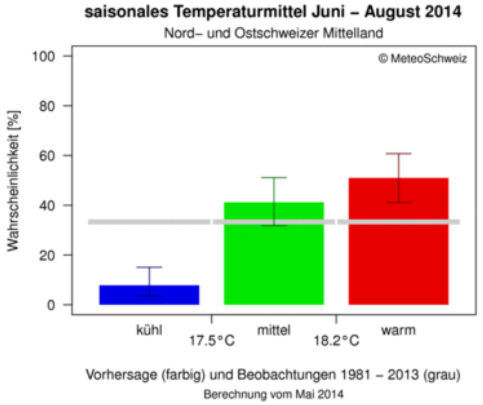
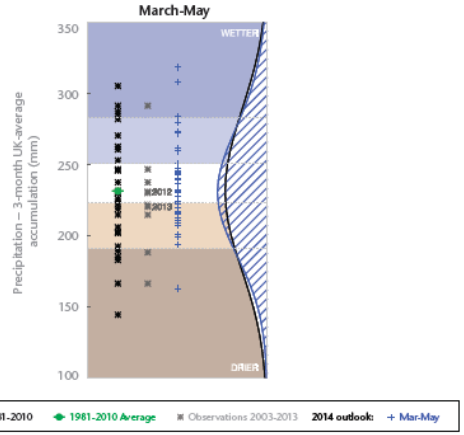
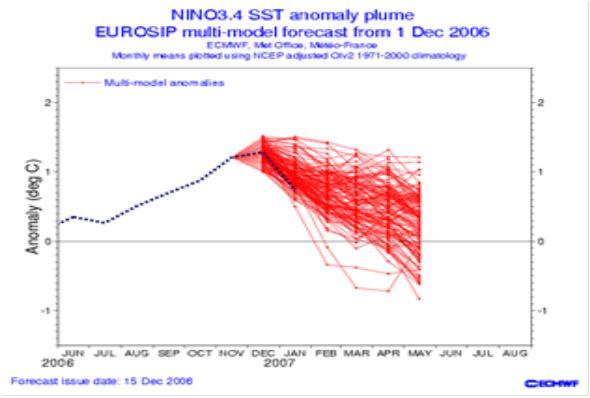
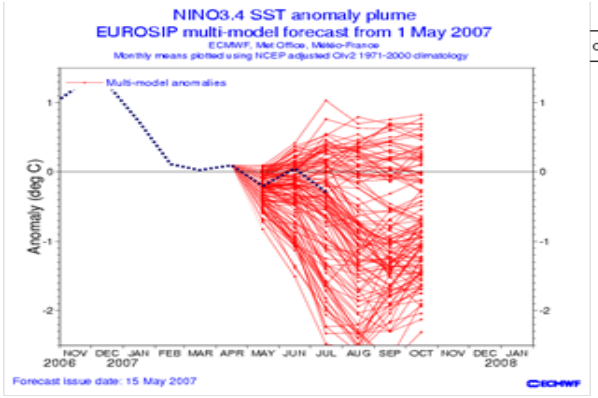
Different ways of representing seasonal forecasts….











Top left example wind forecast (IC3). **Top middle** seasonal temperature forecast (MeteoSwiss), **Top right** precipitation forecast (Met Office). **Bottom left** Temperature anomaly forecast (ECMWF)

… but until recently relatively little testing with users

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Seasonal Forecasts: The challenge of communicating uncertainty

- Differences in expertise (Taylor et al., 2014)
- Trade-off between “richness”, “robustness”, and “salience” (Stephens et al., 2012)

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Preliminary user needs survey: Key findings

- Seasonal predictions are judged to be more useful than they are easy to understand.
- Information about skill is not being clearly communicated to many current users.
- Preference for different types of visualisation influenced by both familiarity and statistical expertise.

Taylor, A. L., Dessai, S., & Bruine de Bruin, W (2015). Communicating uncertainty in seasonal and interannual climate forecasts in Europe. *Phil. Trans. R. Soc. A*, *373*(2055), 20140454.

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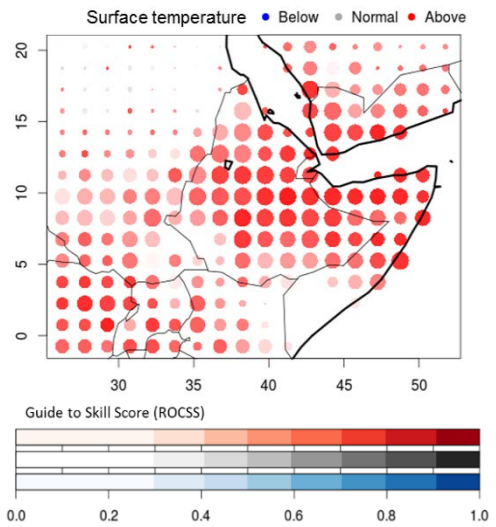
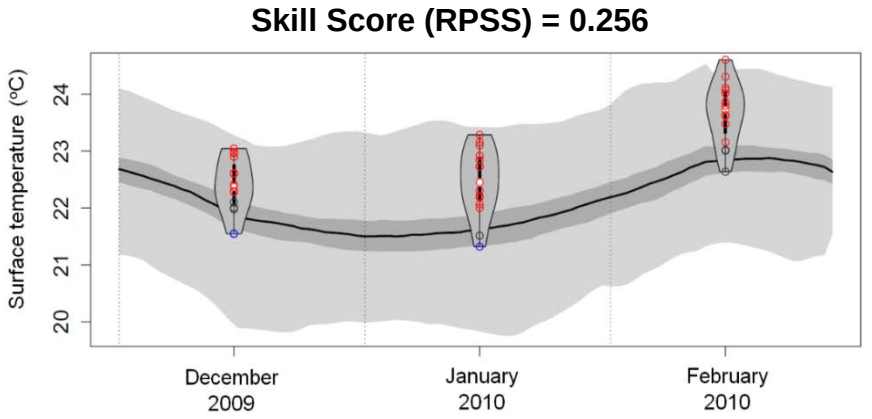
Developing communication strategies

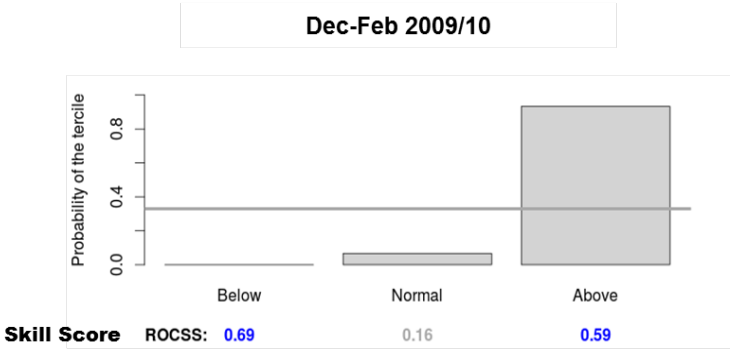
- Selection informed by user needs survey and discussion with partners and external advisors.
- Formats for those with high and low ‘stats experience’.
- Assigned qualitative categories (e.g. none, some, high) to skill scores.
- Visualisations produced by Maria Dolores Frias and Jesus Fernandez (University of Cantabria)
  - see Taylor et al. (2015) for accompanying R code: http://euporias.eu/system/files/D33.3.pdf

Formats: Higher stats experience





City	Cooler than average	Average	Warmer than average	Skill (RPSS)
Addis Ababa	0%	0%	100%	0.373
Adama	0%	0%	100%	0.480
Gondar	0%	0%	100%	0.232
Mekele	0%	7%	93%	0.308
Awassa	0%	0%	100%	0.512
Dire Dawa	0%	0%	100%	0.288



Sample surface temperature data retrieved from ECOMS -UDG (https://meteo.unican.es/trac/wiki/udg/ecoms). Predictions are retrieved from System 4 (15 ensemble members) and observations from WFDEI (Weedon et al., 2014).

See Appendix of Taylor et al. (2015) for accompanying R code: http://euporias.eu/system/files/D33.3.pdf

Formats: Lower stats experience

Confidence that winter temperatures will be warmer than average in Addis Ababa | 3

Confidence Score Guide

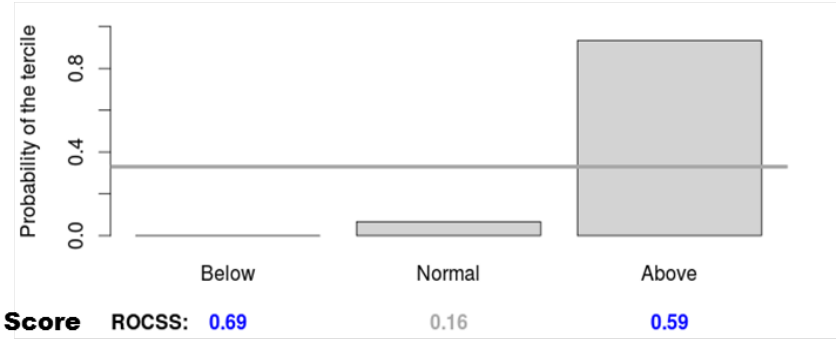
1	No clear indication yet
2	Small indication that temperatures will be warmer than average
3	Moderate indication that temperatures will be warmer than average
4	Strong indication that temperatures will be warmer than average

How the confidence Score is calculated

		Skill			
		None	Low	Medium	High
Likelihood	Very Low (under 30%)				
	Low (30-39%)				
	Medium (40-49%)				
	High (50% or more)			X	

Temperature	Likelihood	Skill
Colder than average	0%	Medium
Average	0%	
Warmer than average	100%	

Dec-Feb 2009/10



Sample surface temperature data retrieved from ECOMS -UDG (https://meteo.unican.es/trac/wiki/udg/ecoms). Predictions are retrieved from System 4 (15 ensemble members) and observations from WFDEI (Weedon et al., 2014).

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Online decision labs

1. To test objective understanding of the different communication formats.
2. To examine the factors predicting preference for particular formats.
3. To examine subjective interpretation of the different communication formats.

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Methodology

- DL1: Within groups with highly engaged stakeholders (*n*=95, *n*=58 completed)
  - Low stats experience (*n*=11), High stats experience (*n*=84)
- DL2: Between groups with participants from relevant sectors (*n*=284, *n*=264 completed)
  - Low stats experience (*n*=162), High stats experience (*n*=122)
- Participants were presented with **High Skill** and **No Skill** visualisations

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Measures

- Objective understanding
  - Tercile likelihood
  - Skill
- Preference
  - e.g. *"I like this graph [map/table]"* (1="strongly disagree", 5="strongly agree")
- Familiarity
  - *"I already use graphs [maps/tables] like this in my work"* (1="strongly disagree", 5="strongly agree")
- Subjective interpretation
  - "*Looking at the forecast and its skill how likely do you think that it is that temperatures will be warmer than average?"* (1 = very unlikely, 10 = very likely)

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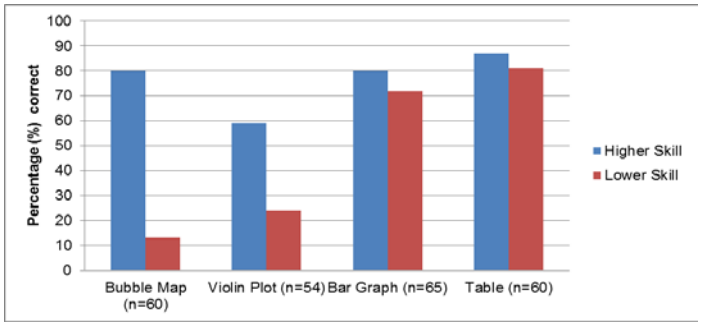
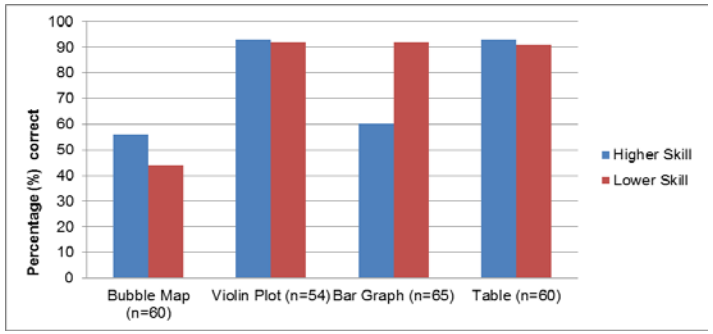
Objective understanding: High stats experience

Decision Lab 1: Engaged users

Likelihood (upper tercile)

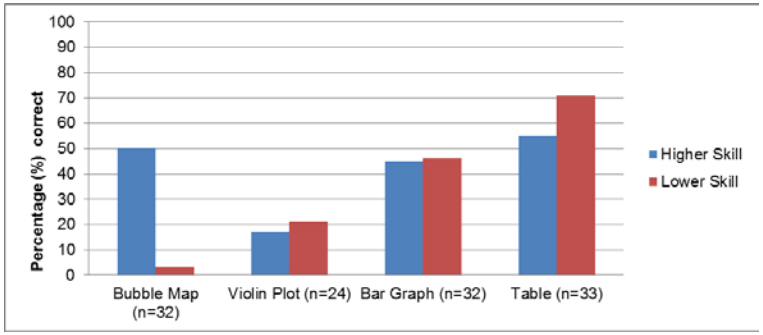


Skill

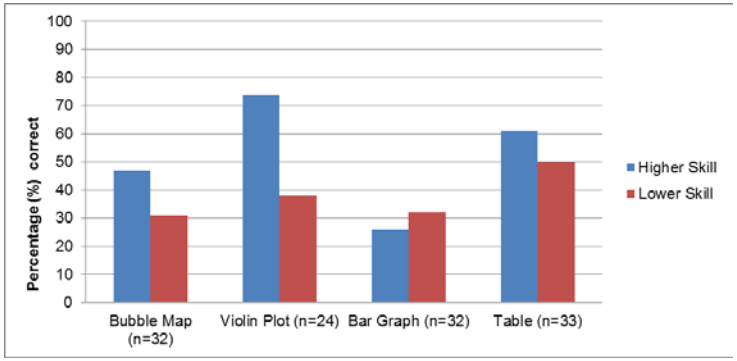


Decision Lab 2: General sample of decision makers

Likelihood (upper tercile)

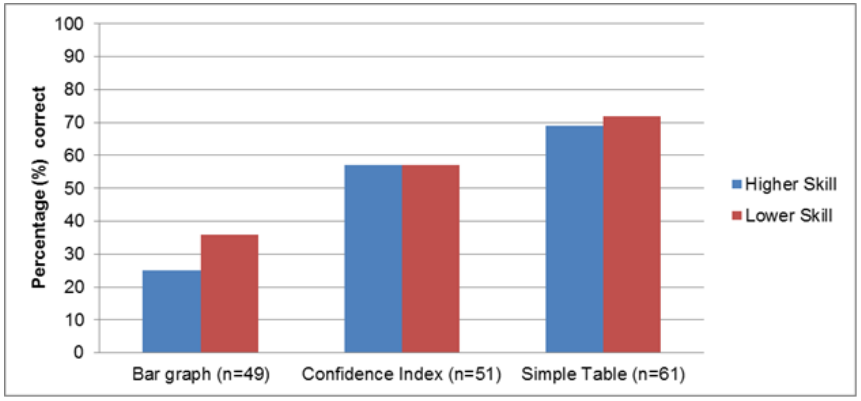


Skill

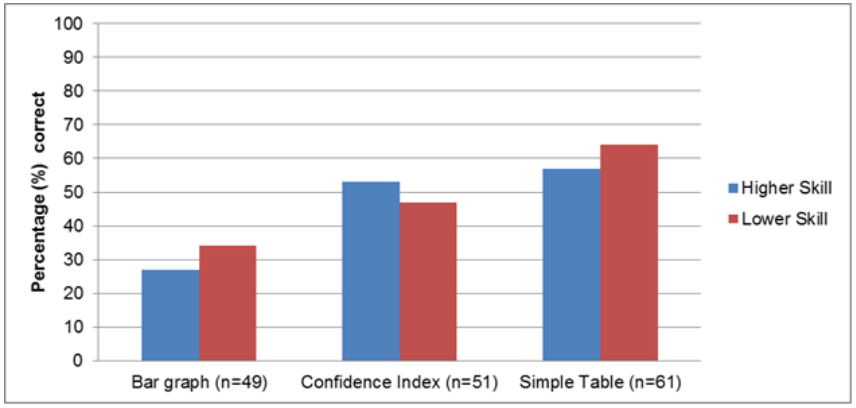


Objective understanding: Low stats experience

Likelihood (upper tercile)



Skill



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Decision Lab 1: Association of preference with familiarity and understanding amongst engaged stakeholders?

	Bubble Map		Violin Plot		Bar Graph		Table	
	B (SE)	β	B (SE)	β	B (SE)	β	B (SE)	β
Objective understanding	-.02 (.11)	-.02	.23 (.14)	.26	.01 (.09)	.01	.08 (.08)	.12
Familiarity	.29 (.14)	.28*	.24 (.13)	.29†	.22 (.08)	.36**	.06 (.10)	.07
ANOVA	2.3		2.27		3.68		.45	
R^2	.08		.10		.13		.02	

OLS regression
†Marginally significant at $p \leq .10$ *Significant at $p \leq .05$ **Significant at $p \leq .01$
***Significant at $p \leq .001$

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Decision Lab 2: Association of preference with familiarity and understanding amongst decision makers in relevant sectors?

	Model 1		Model 2	
	B (SE)	β	B (SE)	β
Objective Understanding	.04 (.03)	.07	.09 (.03)	.14**
Familiarity	-	-	.46 (.04)	.55***
ANOVA	F(1,261)=1.4		F(2,260)=54.7	
ΔR^2	.01		.30	

OLS regression
*Significant at $p \leq .05$ **Significant at $p \leq .01$ ***Significant at $p \leq .001$

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Additional observations

- Even when forecasts had no skill, information about likelihood still influenced interpretation.
- Skill scores and climatology sometimes confused with information about forecast likelihood.
- Participants struggled to interpret information about skill when multiple scores were used.
- Assigning qualitative categories to skill scores seems to help those with less experience of using statistics.
- Placing many types of information onto the same visualisation can render it unclear.

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Discussion

- When it comes to presenting likelihood of conditions falling into a particular category, tables may be better understood by less experienced users.
- Where decision makers have less experience of using climate information perceived familiarity may actually hinder objective understanding.
- Even when forecasts do not provide useful information, stated “likelihoods” still affect judgement.

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Broader lessons from the EUPORIAS project

- Users may not have pre-existing ideas as to how information should be presented.
- Iterative process of user feedback can help to identify areas for improvement.
- Tailored information is optimal.
- Where this is not feasible a ‘tiered’ approach may be considered.

See Taylor et al. (2016) for full summary

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Recommendations

- People tend to like familiar formats, but this should not be assumed to to denote better understanding.
- Forecasts that have “no skill” should not be presented by default.
- Tailored communication strategies are optimal, but if these are not possible consider ‘layering’ information.
- **Validate communications by testing them with intended users.**

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Work Package partners

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Thank you!

For more details…

User needs survey

http://rsta.royalsocietypublishing.org/content/373/2055/20140454.abstract
http://www.euporias.eu/sites/default/files/deliverables/D33.1_Final.pdf

Review of existing approaches

www.euporias.eu/system/files/D33.2_Final.pdf

Development of visualisations and R code

www.euporias.eu/system/files/D33.3.pdf

Decision Lab

www.euporias.eu/system/files/D33.4_Final.pdf

Recommendations and lessons learnt

www.euporias.eu/system/files/D33%205_Final.pdf