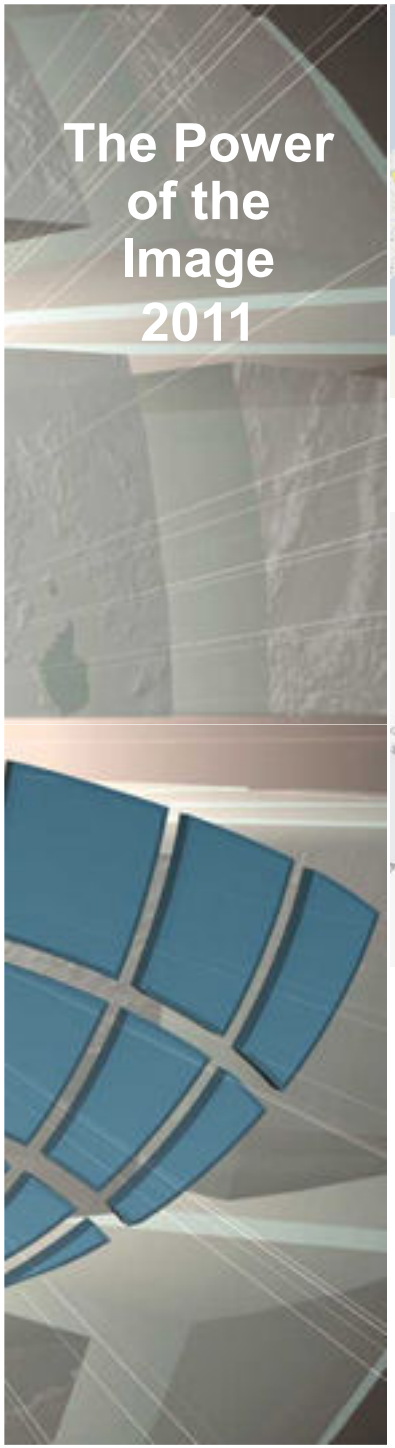
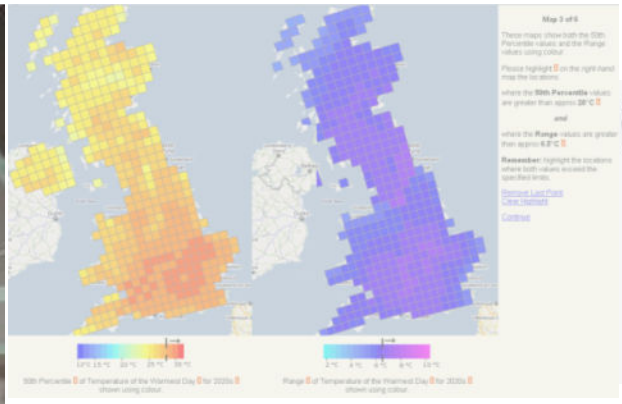
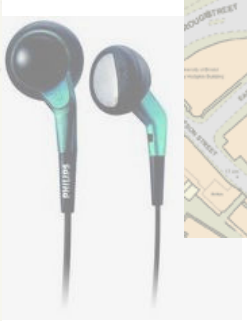
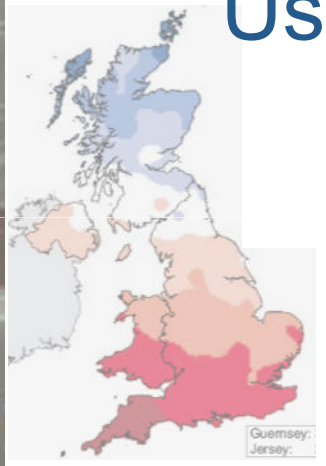


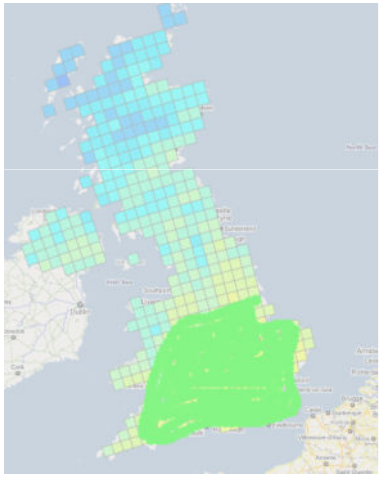





# Using Sound to Augment ‘the Image’




Nick Bearman
University of East Anglia



University of East Anglia

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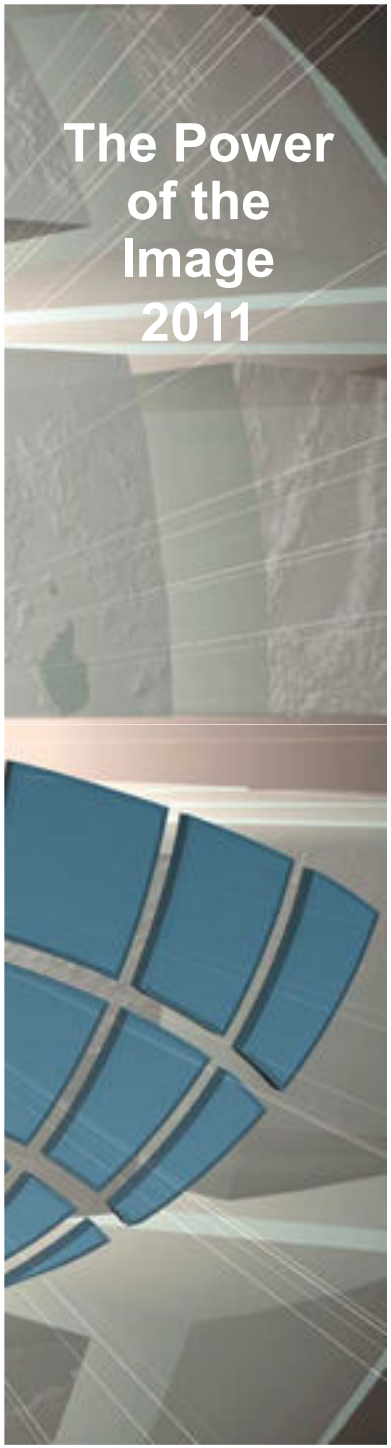
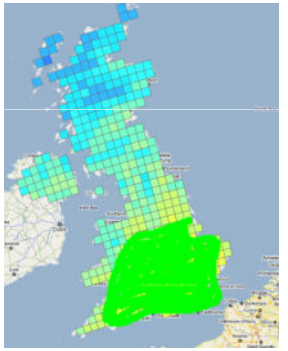
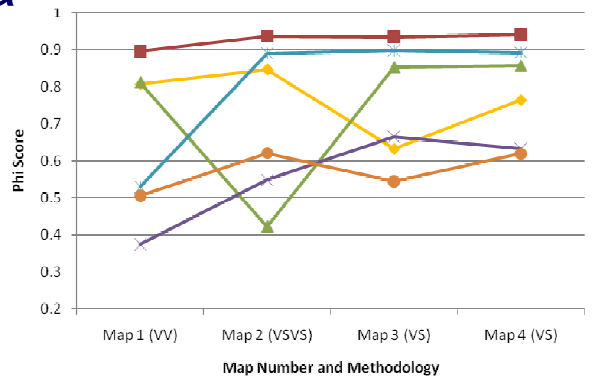





# Using Sound to Augment 'the Image'

- Using sound to represent uncertainty in spatial data
- Visual representation
- The need for alternatives
- Visual & sonic comparison
  - UKCP09 Data
  - Google Maps
- Results
- Conclusion



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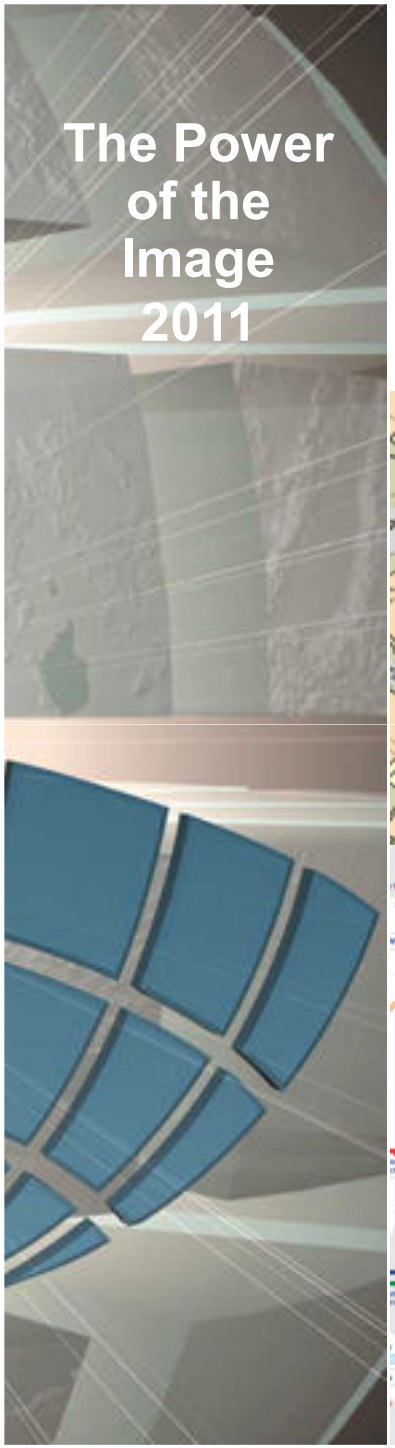
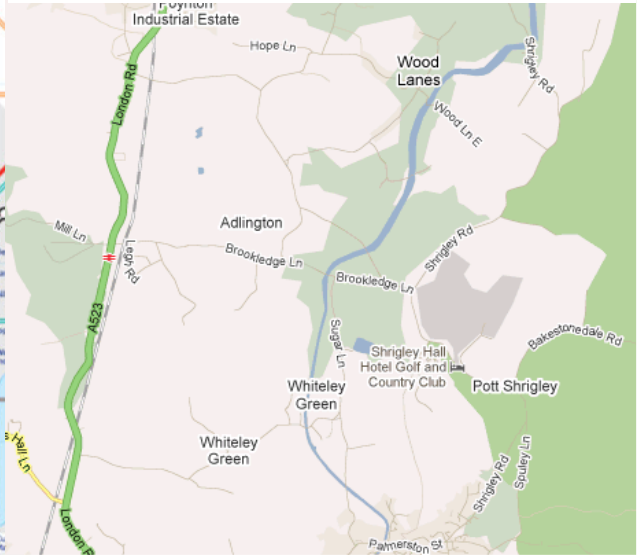
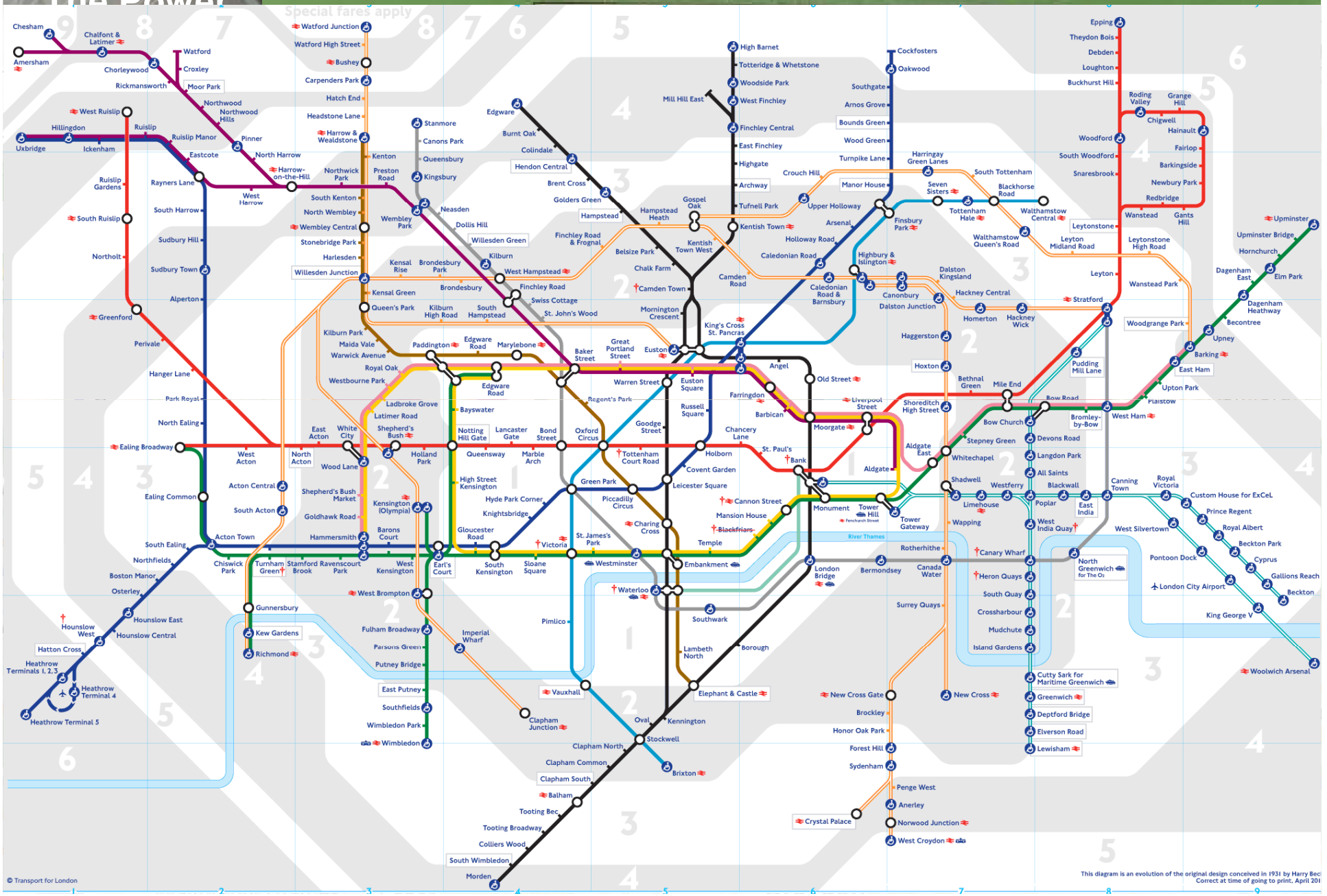





# Spatial Data is usually shown Visually



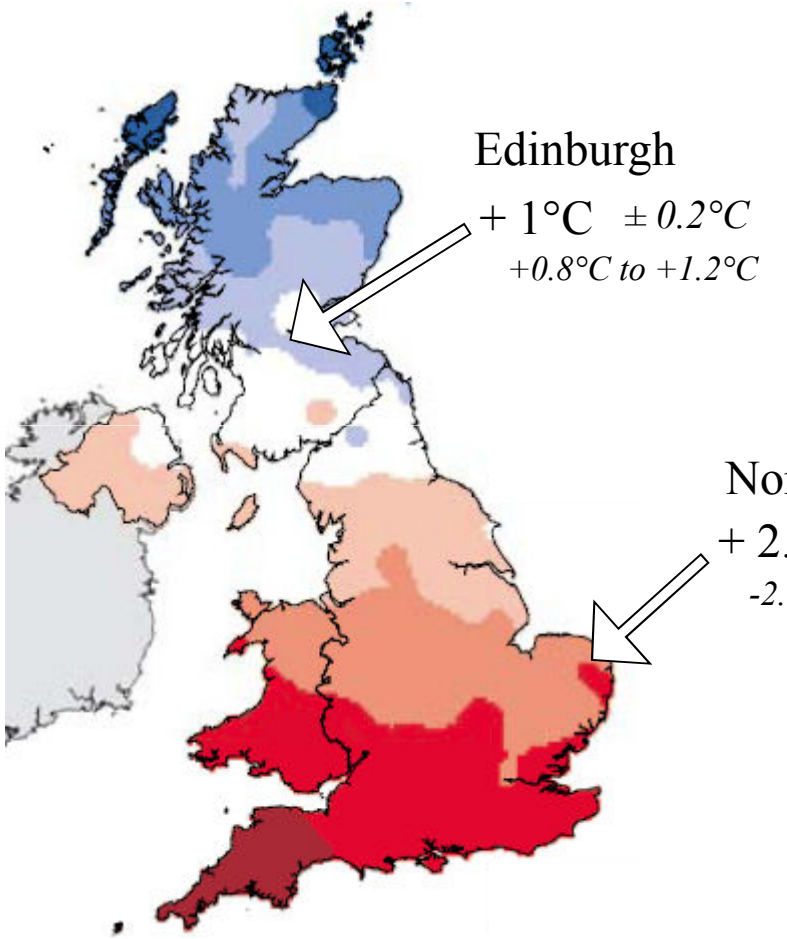



This diagram is an evolution of the original design conceived in 1931 by Harry Beck
Correct at time of going to print, April 201

The Power of the Image 2011



# Future Climate Predictions




How do we show all of this info?

Use another sense

Jenkins, G. J., Perry, M. C. & Prior, M. J. (2008) Figure 2.63d

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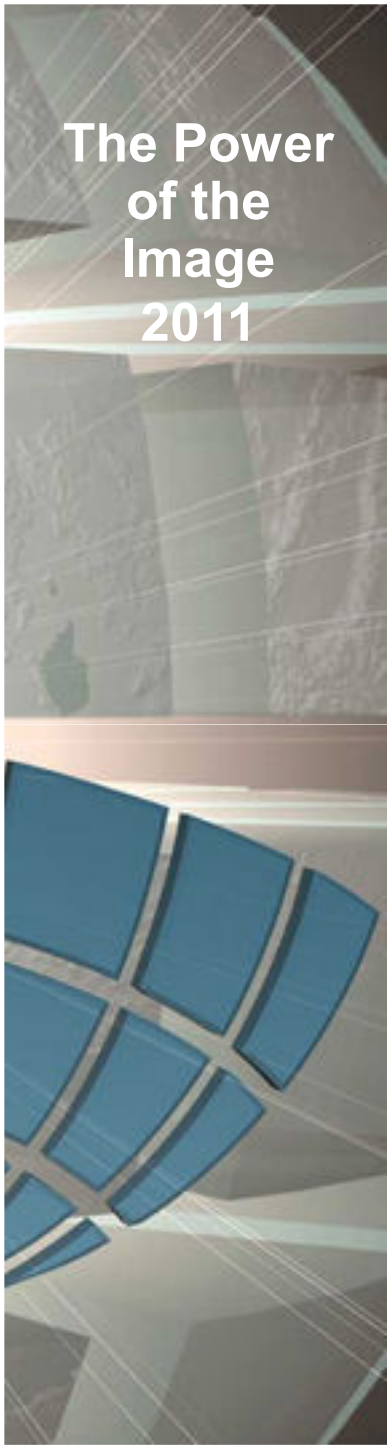
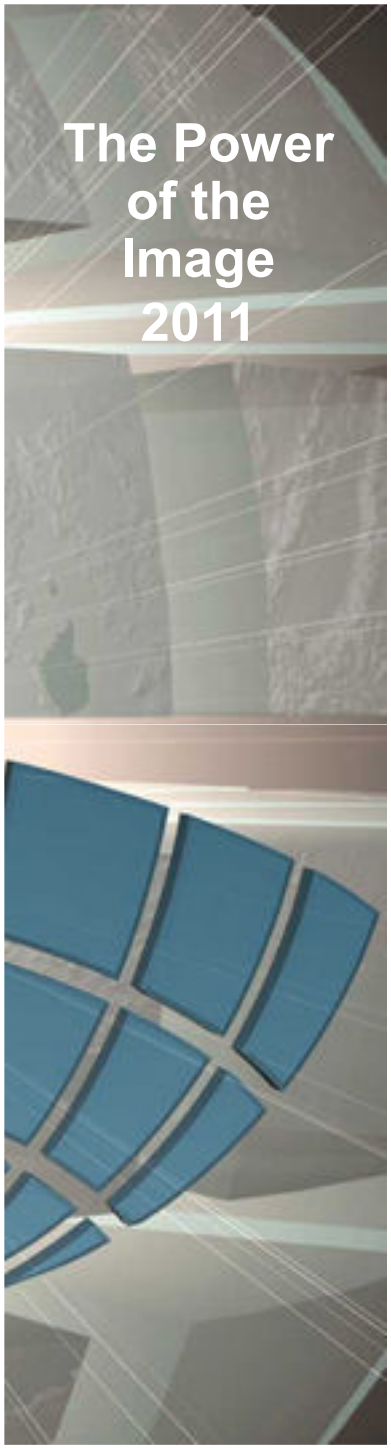





# Use Another Sense

~~Vision~~ Sound ~~Taste~~ ~~Touch~~ ~~Smell~~

- Vision is visually saturated
- Haptic is expensive
- Smell & taste are difficult!
- Sound is easy & cheap






# Sound Facts

- After vision, sound is next most powerful sense (Minghim, 1995; Fortin et al., 2007)
- Most people are capable of greater sonic differentiation that they utilise (Loomis et al., 1993; Klatzky & Golledge, 1995)
  - People can tell the difference between any 2 of 400,000 different sounds
  - People can remember up to 49 unique sounds Brewster (1994)

There should be some potential...

However, limited work and very limited testing

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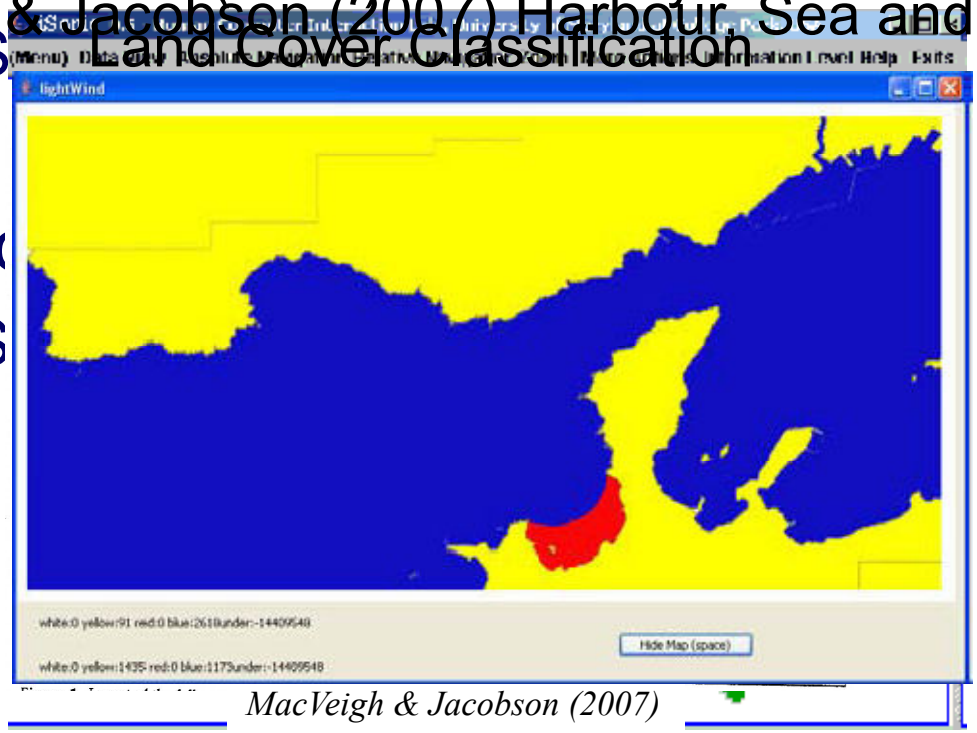
# Previous Examples

- Often used for visually impaired
- Zhao (2008) Read Aloud
- Fisher (1994) Uncertainty and
- MacVeigh & Jacobson (2007) Harbour, Sea and Land Cover Classification
- S
- I'm
  visi
  - S




*MacVeigh & Jacobson (2007)*

*Fisher (1994)*

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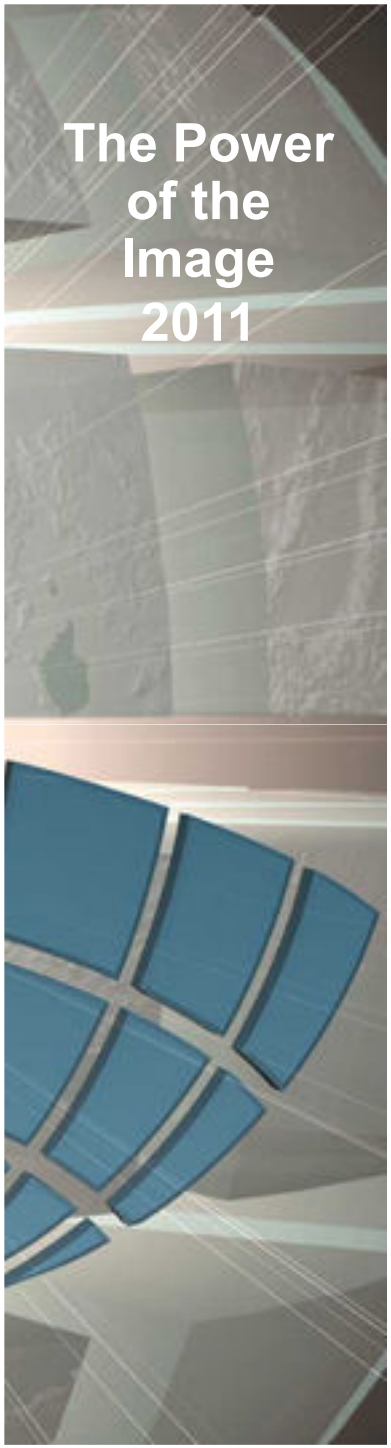




# Method

- Compare visual & sonic methods
- Used UKCP09 data

- Participants in small groups
  - Questionnaire
  - Google Maps API
  - Discussion session

UK CLIMATE PROJECTIONS

Google maps UK

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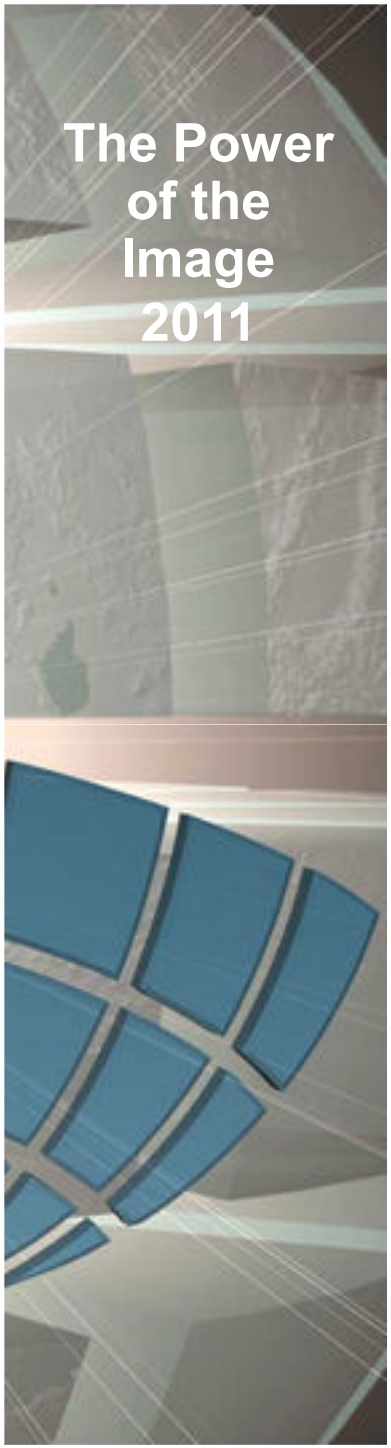
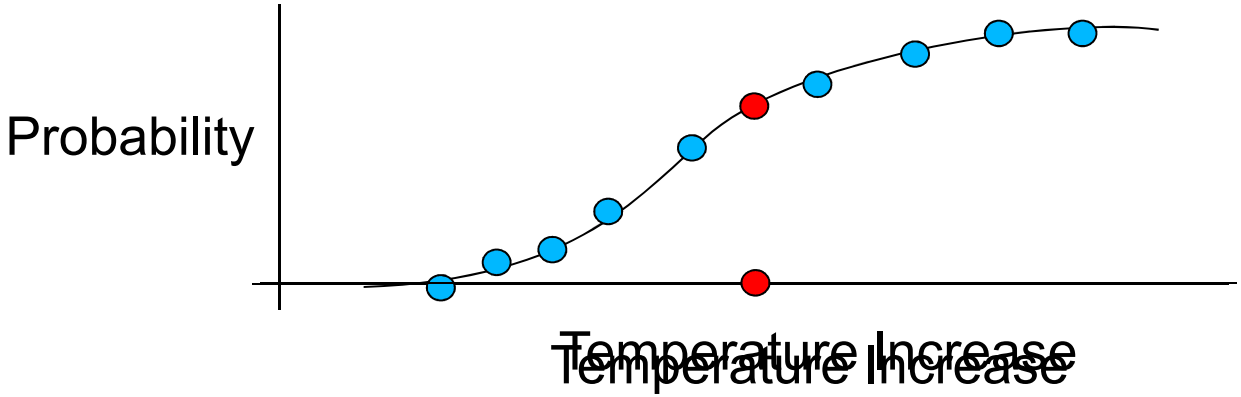





# UK Climate Projections 2009

- Future climate for UK up to 2080s
- Latest in the series
- First set to include uncertainty




- Uncertainty is useful
- But users have to change their workflow to make use of UKCP09
- How do we represent this?

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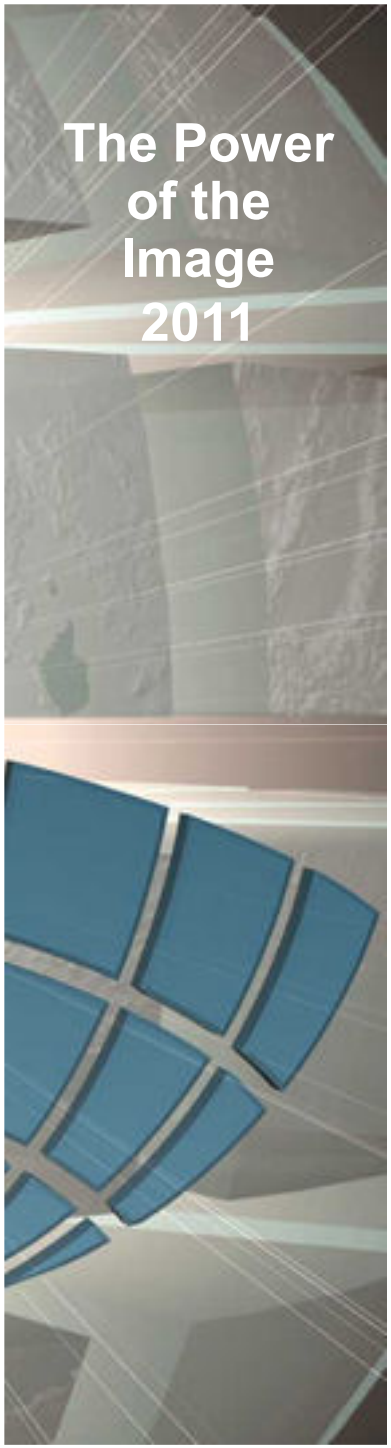
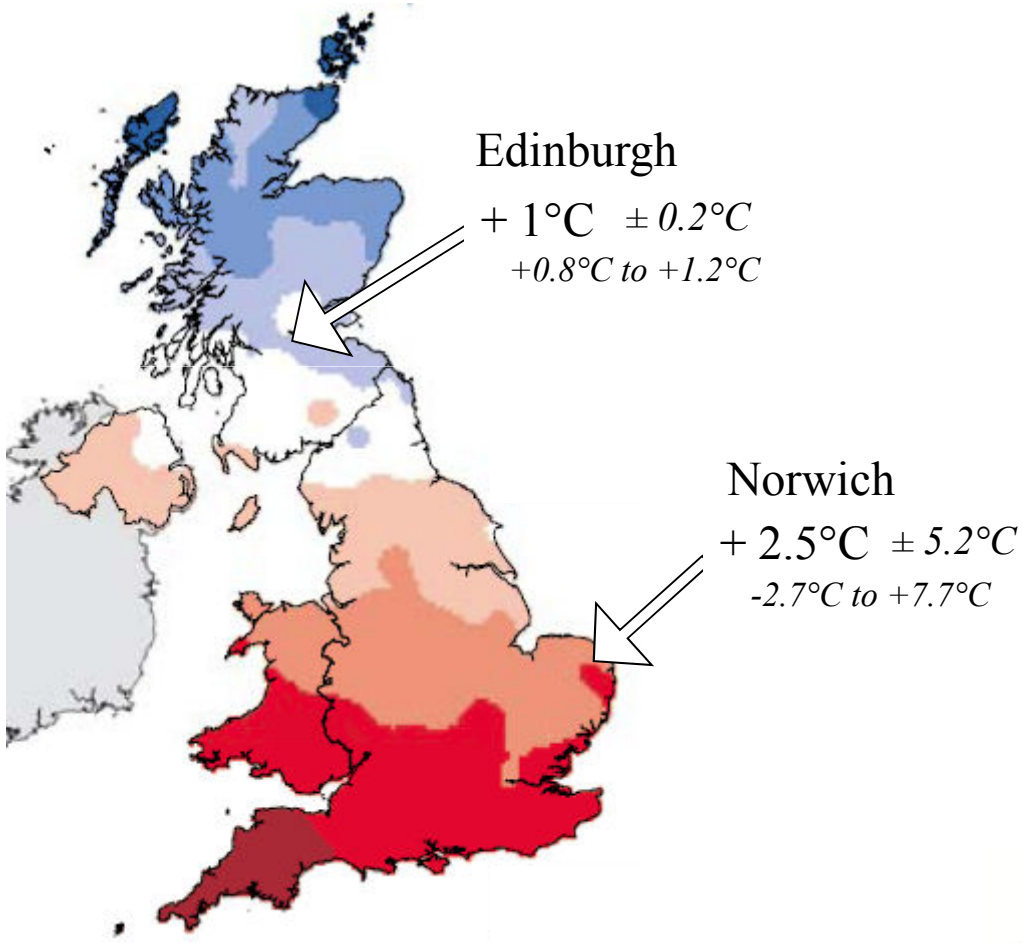





# Uncertainty in UKCP09




Jenkins, G. J., Perry, M. C. & Prior, M. J. (2008) Figure 2.63d

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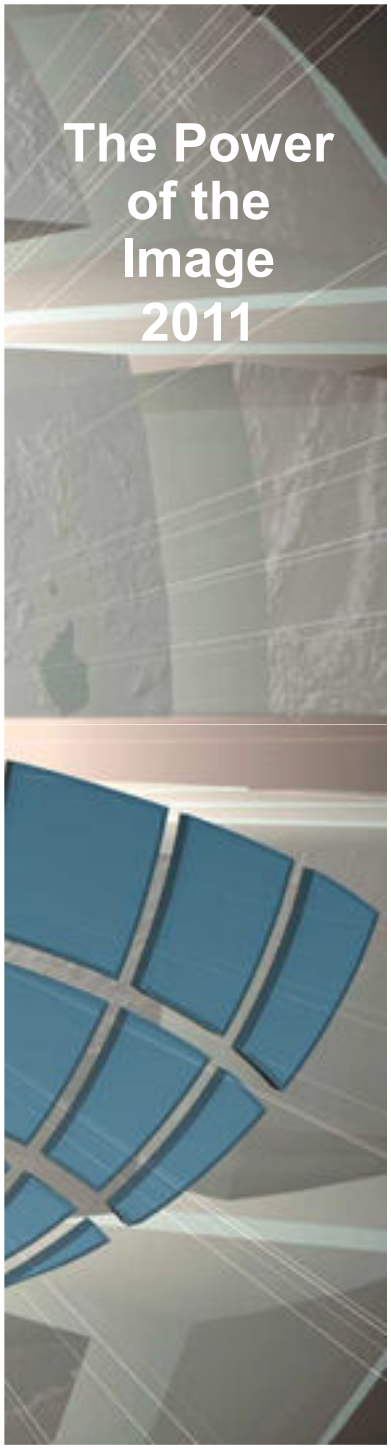
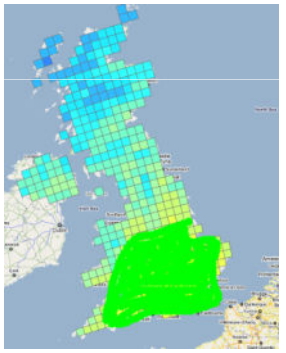





# Methods

- Comparing visual and sonic methods of representing the uncertainty



- Showed users the data
  - visually and/or sonically
- Asked users to highlight specific areas where temperature and uncertainty over thresholds

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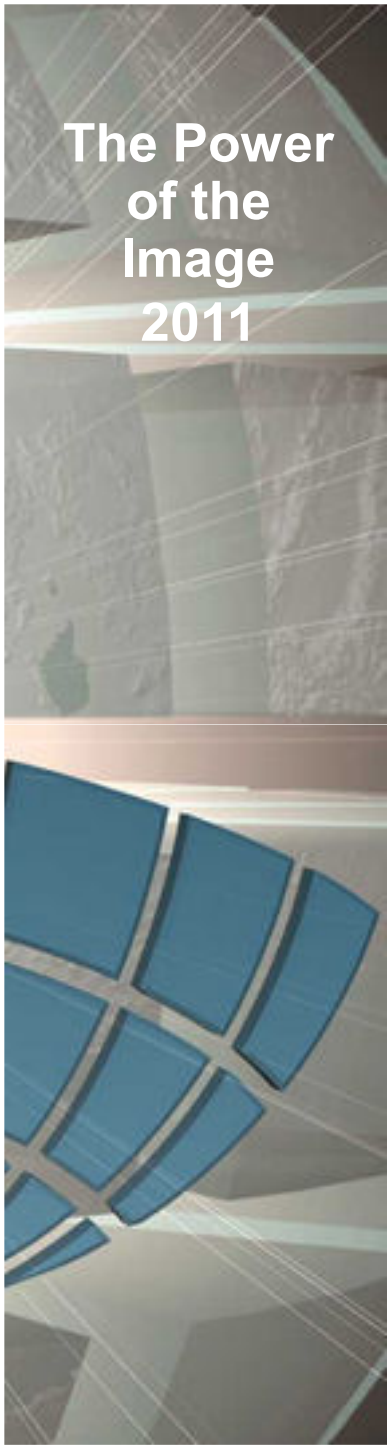
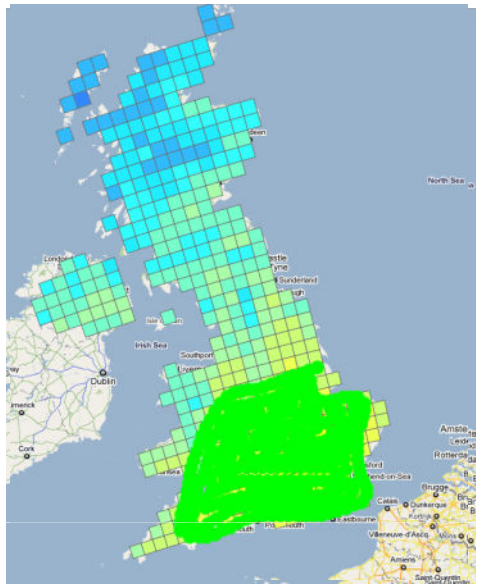





# How to compare?

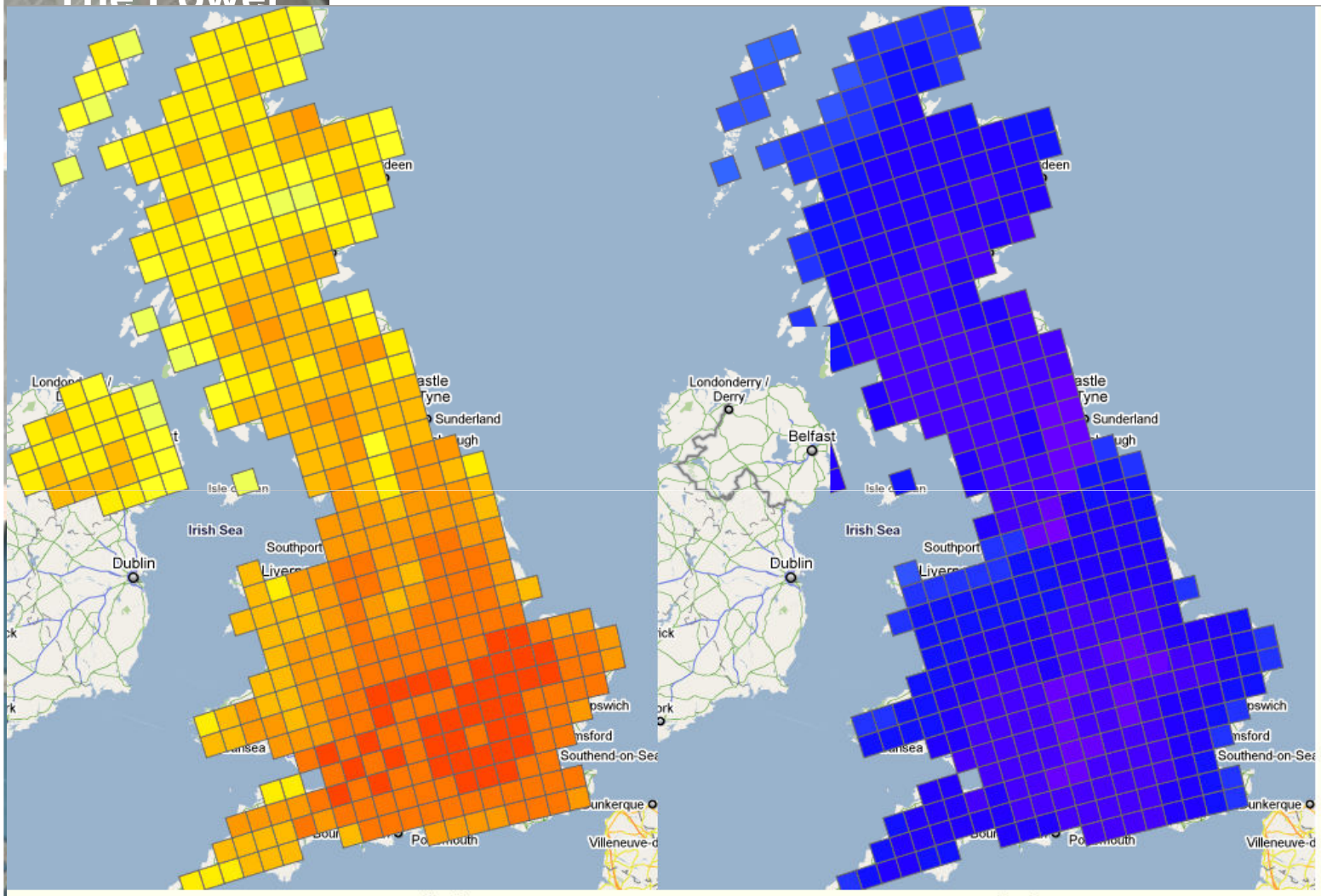
- Online evaluation
- Web based mapping
  - Show UKCP09 data
  - Collect responses
- Google Maps
  - Familiar to most users
  - Good API docs & support
- How?
  - Lots of tutorials
  - Took about 6 months



Google maps UK

The Power

Visual Representation | Alternative Sense | Method | UKCP09 | Google Maps | Results




50th Percentile of Temperature of the Warmest Day for 2020s shown using colour.

Range of Temperature of the Warmest Day for 2020s shown using colour.

**Map 3 of 6**

These maps show both the 50th Percentile values and the Range values using colour.

Please highlight on the *right-hand* map the locations

where the **50th Percentile** values are greater than approx **28°C**

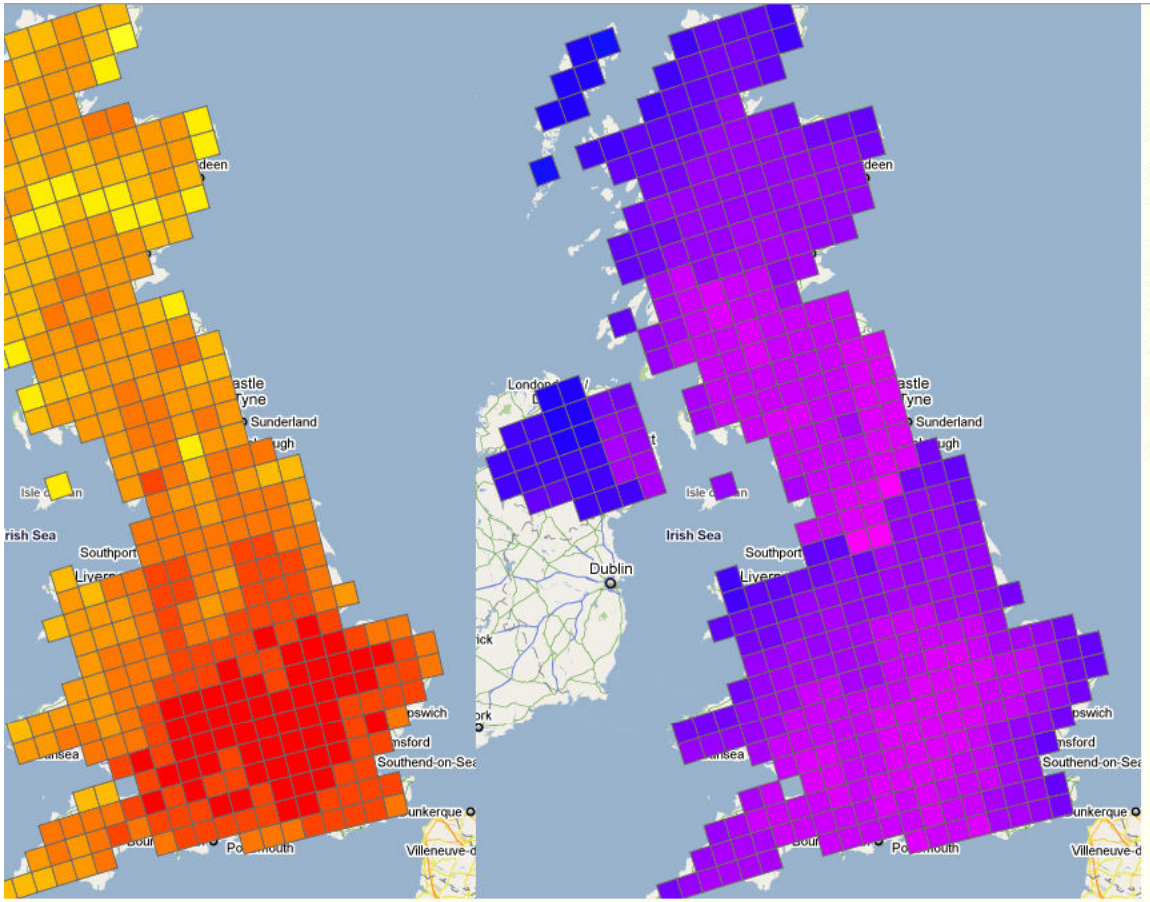
***and***

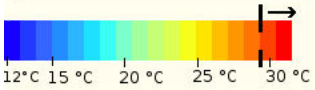
where the **Range** values are greater than approx **6.5°C**.

**Remember:** highlight the locations where both values exceed the specified limits.

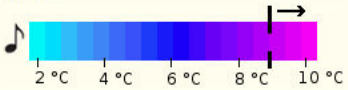
Remove Last Point
Clear Highlight

Continue




of Temperature of the Warmest Day for 2050s shown using colour and sound.




Range of Temperature of the Warmest Day for 2050s shown using colour and sound.

**Map 4 of 6**

These maps show both the 50th Percentile values and the Range values using colour and sound.

Please highlight on the *right-hand* map the locations

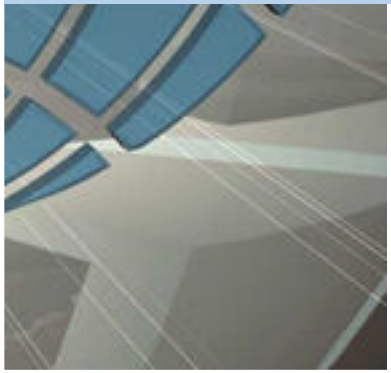
where the **50th Percentile** values are greater than approx **29°C**
*and*
where the **Range** values are greater than approx **9°C**.

Remove Last Point
Clear Highlight

Continue

VSVS

*Sound is not muted.*



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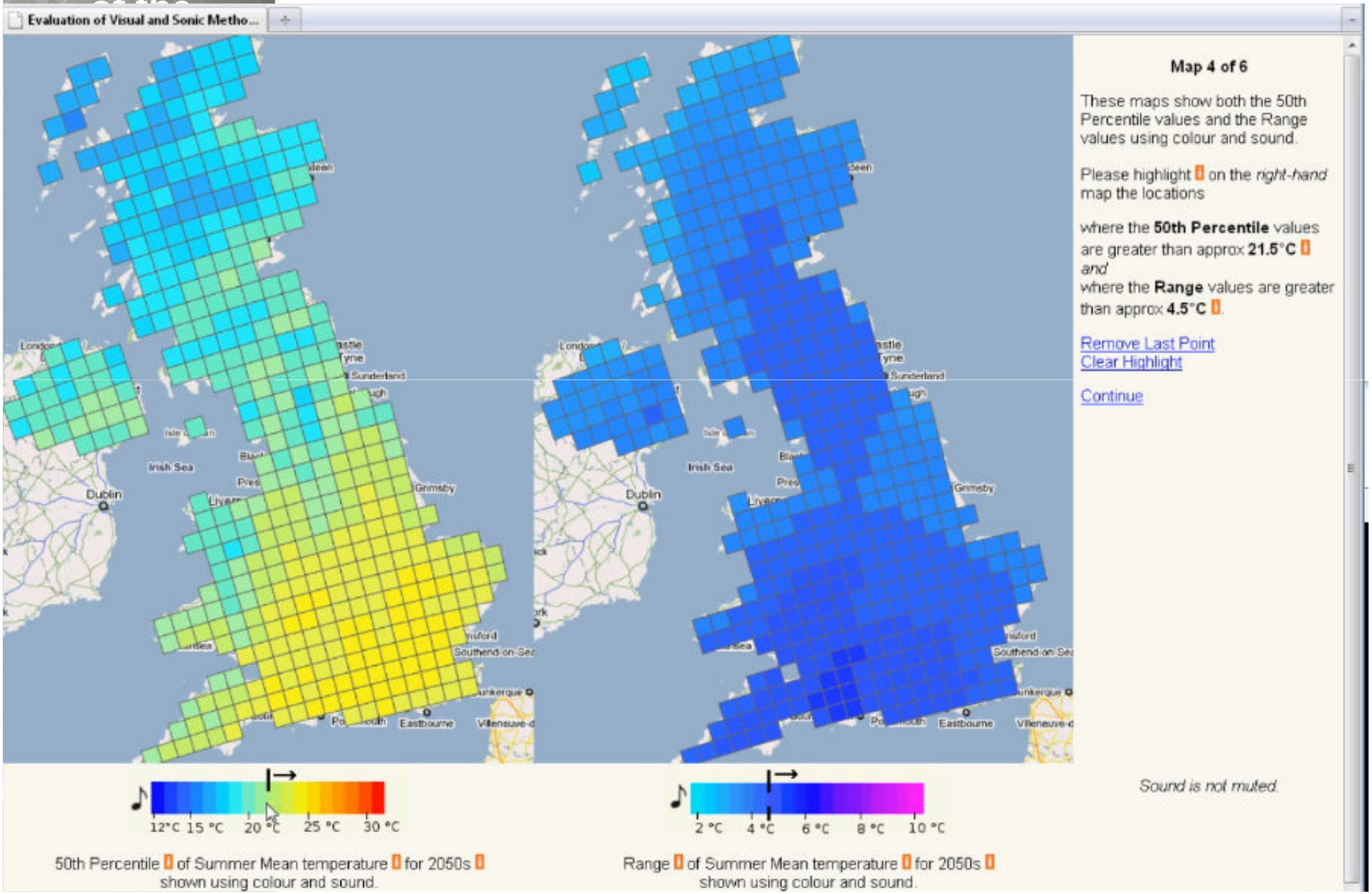
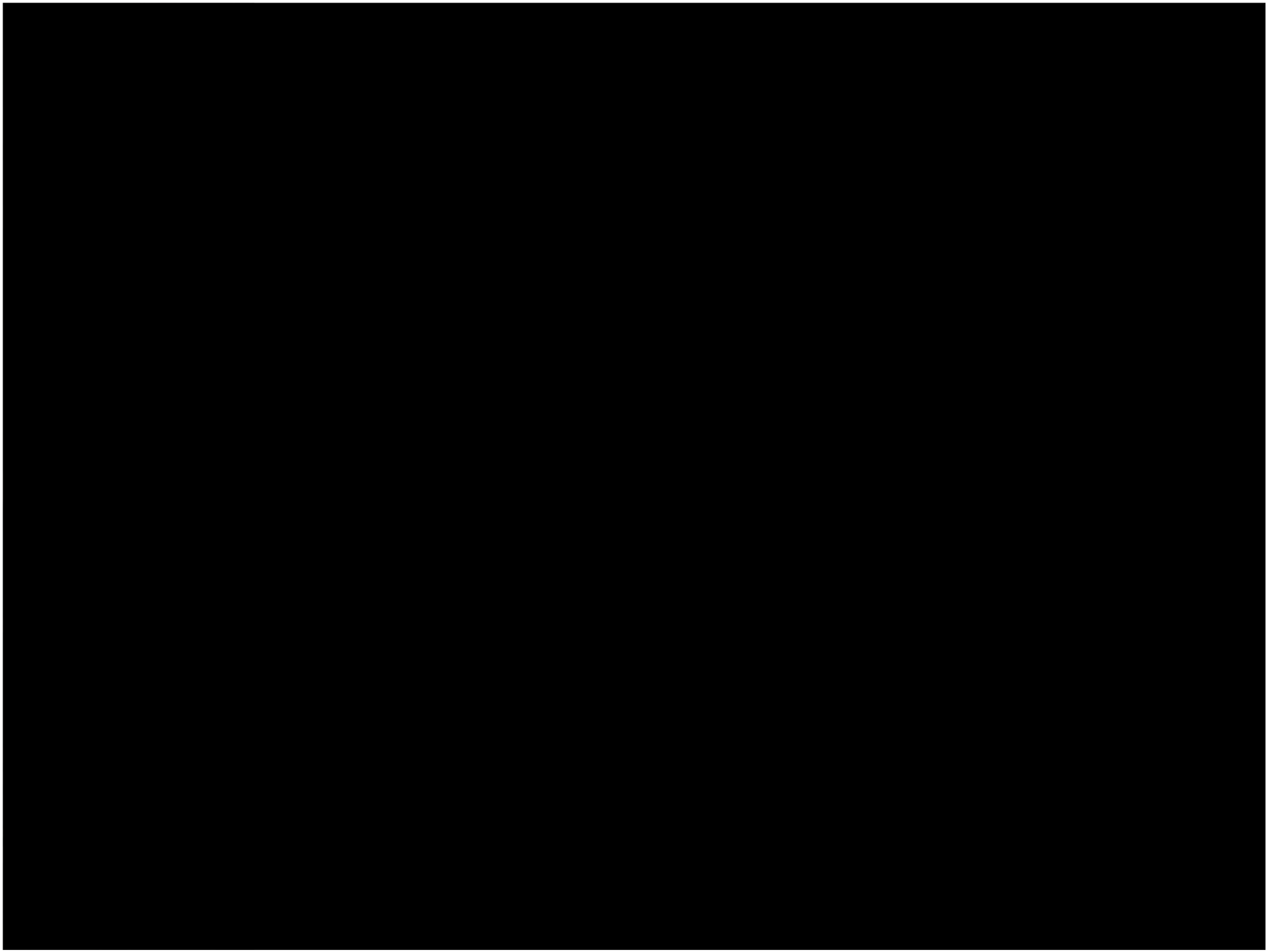
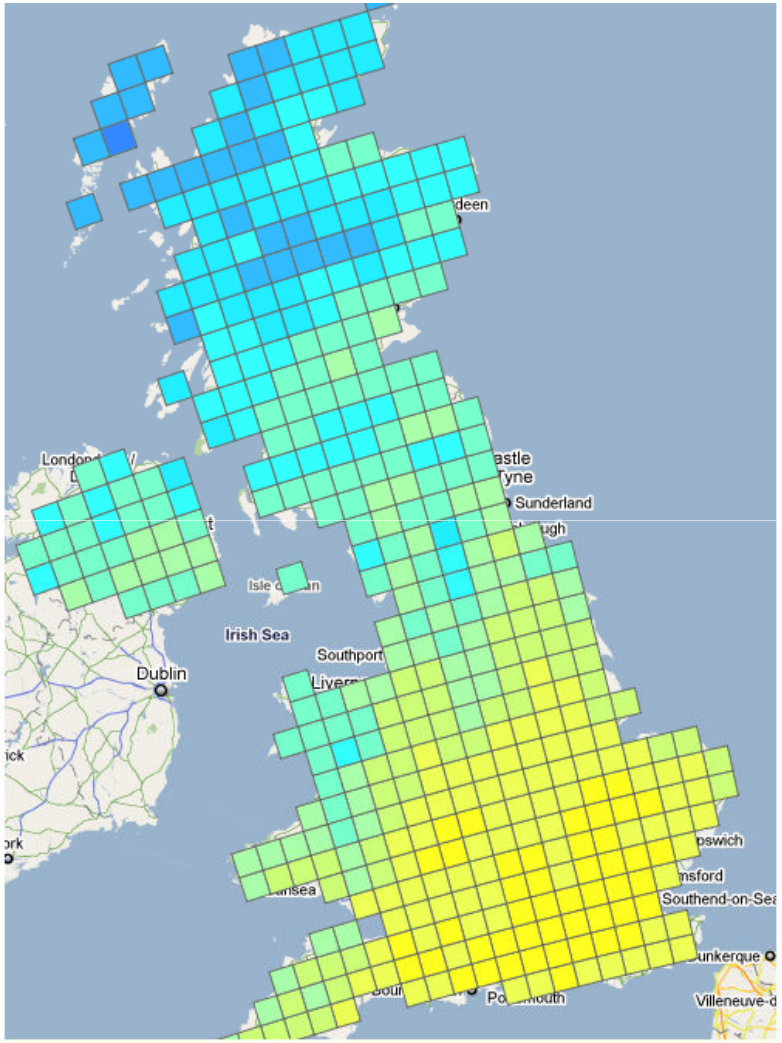

Evaluation of Visual and Sonic Metho...
Map 4 of 6
These maps show both the 50th Percentile values and the Range values using colour and sound.
Please highlight on the right-hand map the locations
where the 50th Percentile values are greater than approx 21.5°C and
where the Range values are greater than approx 4.5°C.
Remove Last Point
Clear Highlight
Continue
Sound is not muted.
12°C 15 °C 20 °C 25 °C 30 °C
2 °C 4 °C 6 °C 8 °C 10 °C
50th Percentile of Summer Mean temperature for 2050s shown using colour and sound.
Range of Summer Mean temperature for 2050s shown using colour and sound.
Dublin
Irish Sea
Sunderland
Grimsby
Southend-on-Sea
Eastbourne



# The Power of the






Summer Mean temperature for 2050s: 50th Percentile shown using colour and Range shown using sound.

**Map 5 of 6**

This map shows the 50th Percentile values using colour and the Range values using sound.

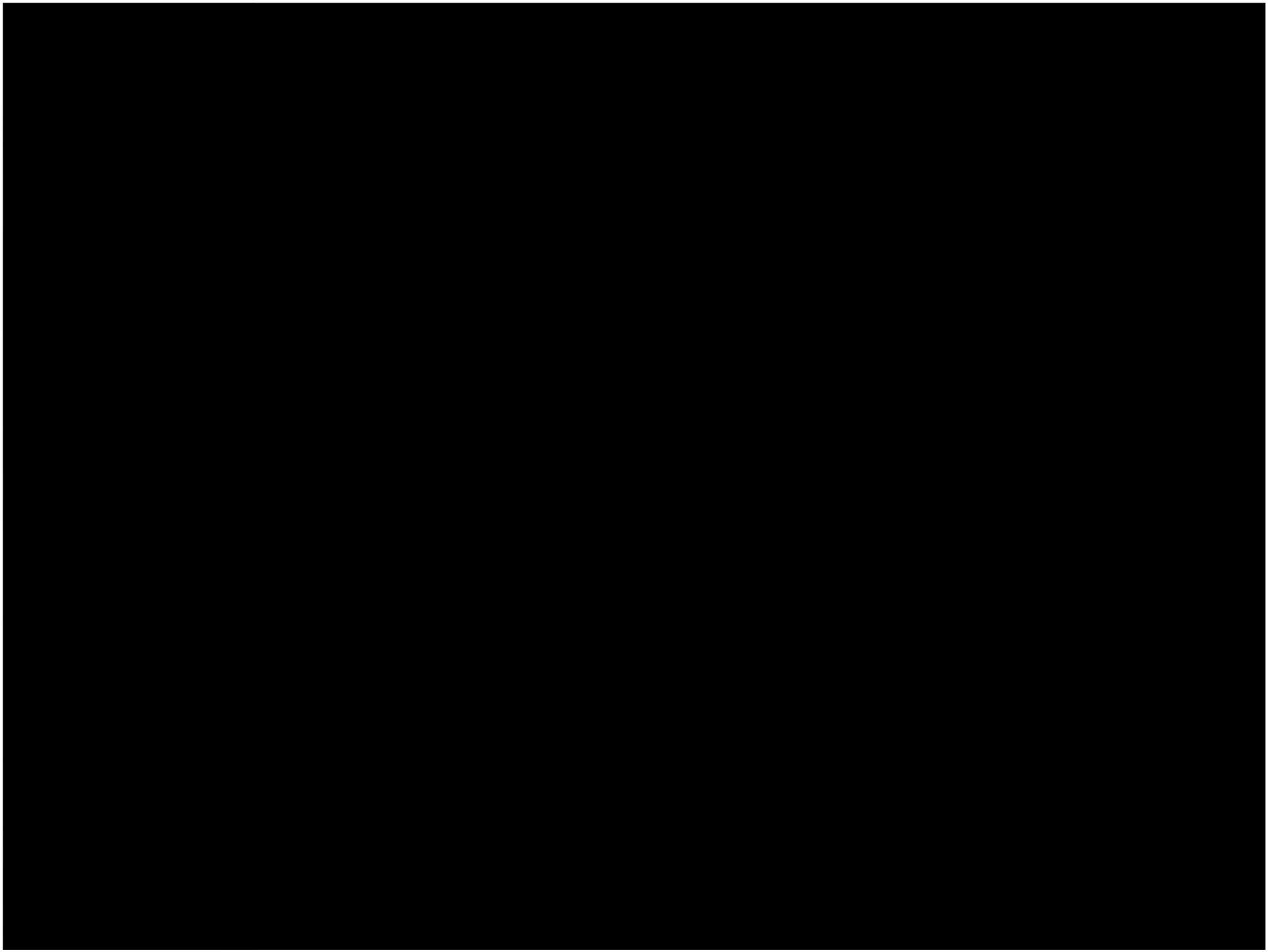
Please highlight the locations

where the **50th Percentile** values are greater than approx **21.5°C**
*and*
where the ***Range*** values are greater than approx **4.5°C**.

Remove Last Point
Clear Highlight

Continue

*Sound is not muted.*



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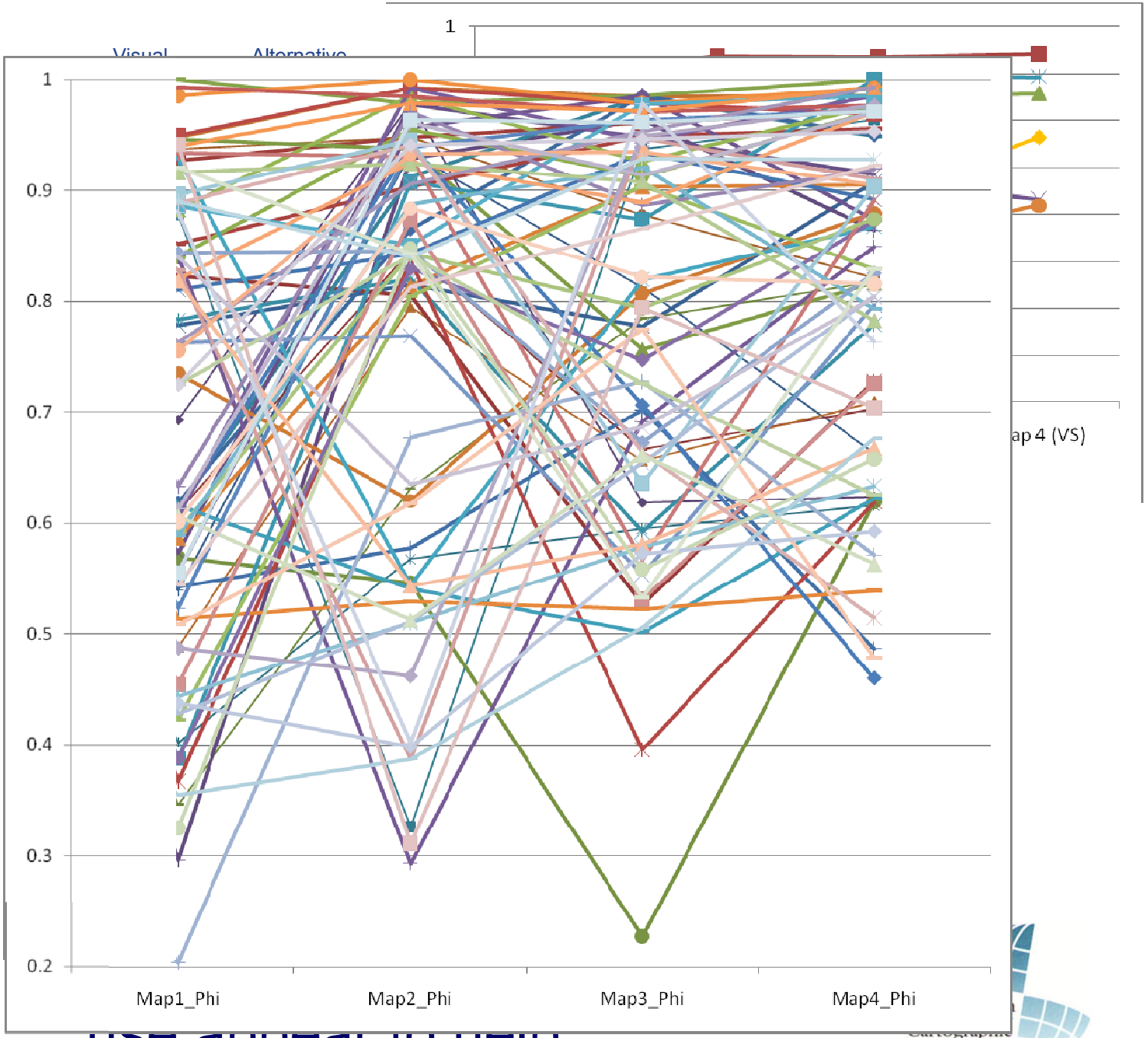
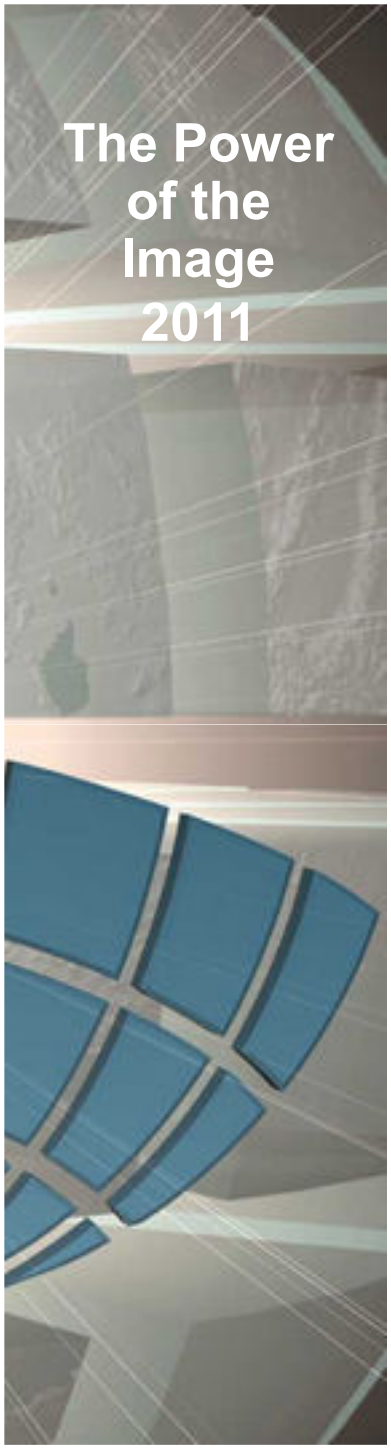



use appeal to help

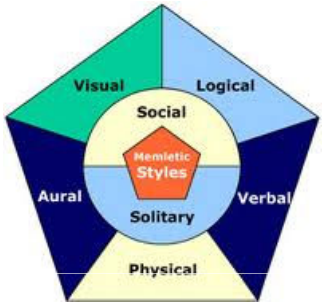
Society



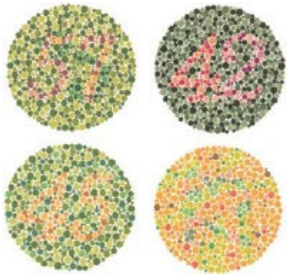



# Results

- Learning Style may have an impact
  - Visual or aural
  - Slight trend for visual
  - Currently unclear based on these results




- Could be very useful to colour blind users
  - But not the focus of this research



- Lots of views on the sound
  - Not all consistent!

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# Overall

*Using sound to represent uncertainty in spatial data*

- Compared different methodologies
  - Vision, sound and both
- Using Uncertainty in UKCP09
- Sound can be useful
- Awareness of the data is important
- Reinforcing vision with sound helps

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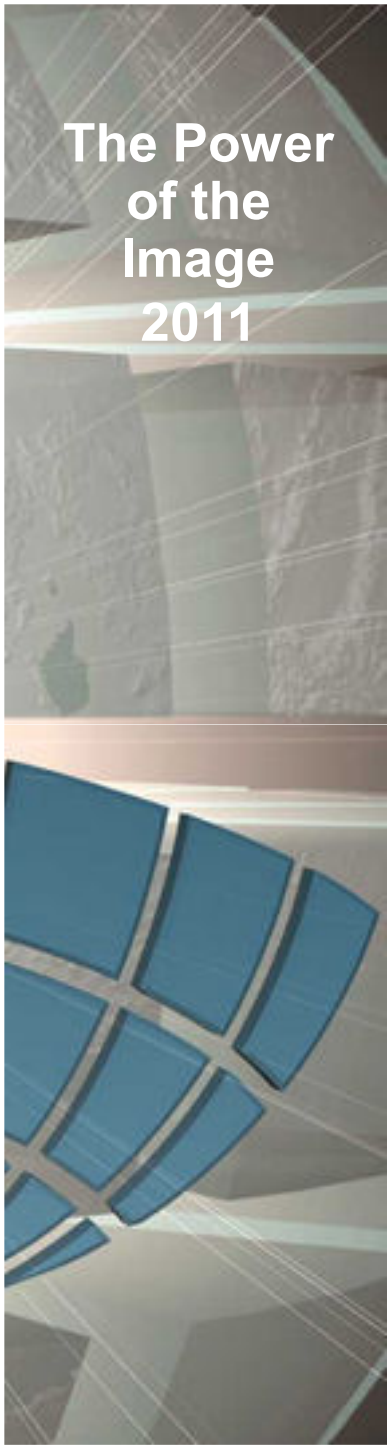


# Thanks & Questions

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