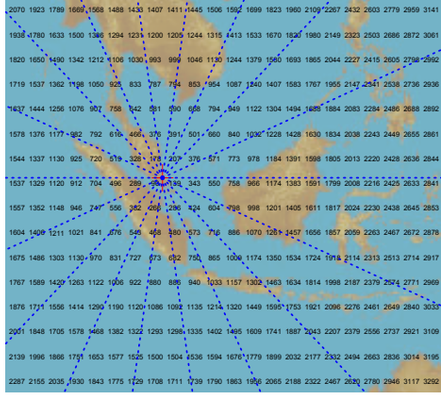


Hearing is Believing: Interactive Sonification of Weather Data from South-East Asia 1960-2099.

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Webpages: http://www.permagnus.net, http://www.permagnus.tk

Text

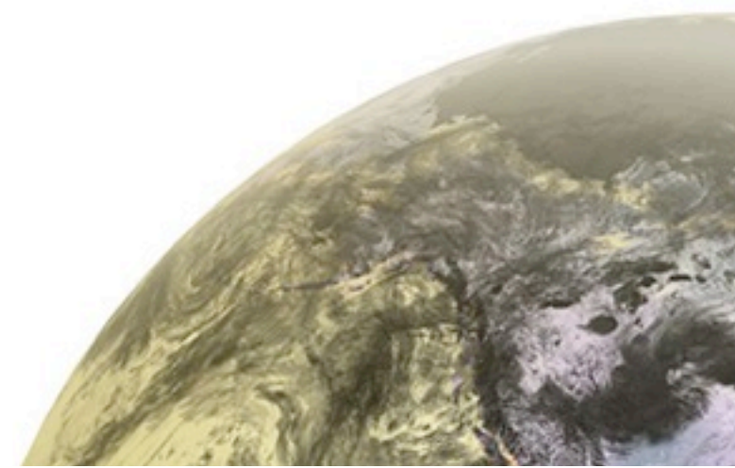
Abstract

The Locust Wrath is a multimedia dance performance (Liong A., Koh, & Lindborg 2013) with interactive sonifications of climate data. A software for interactive sonification was programmed (Lindborg 2013) using Max (Cycling 74) allowing an open-ended approach to mapping strategies. The Tropical Marine Science Institute at NUS (Liong S-Y et al.) provided meteorological records for 1961-2000 and predictions for 2081-2099 covering a large region of South-East Asia. This talk gives a brief overview of current research themes in sonification, a presentation of the software, and plans for future work.

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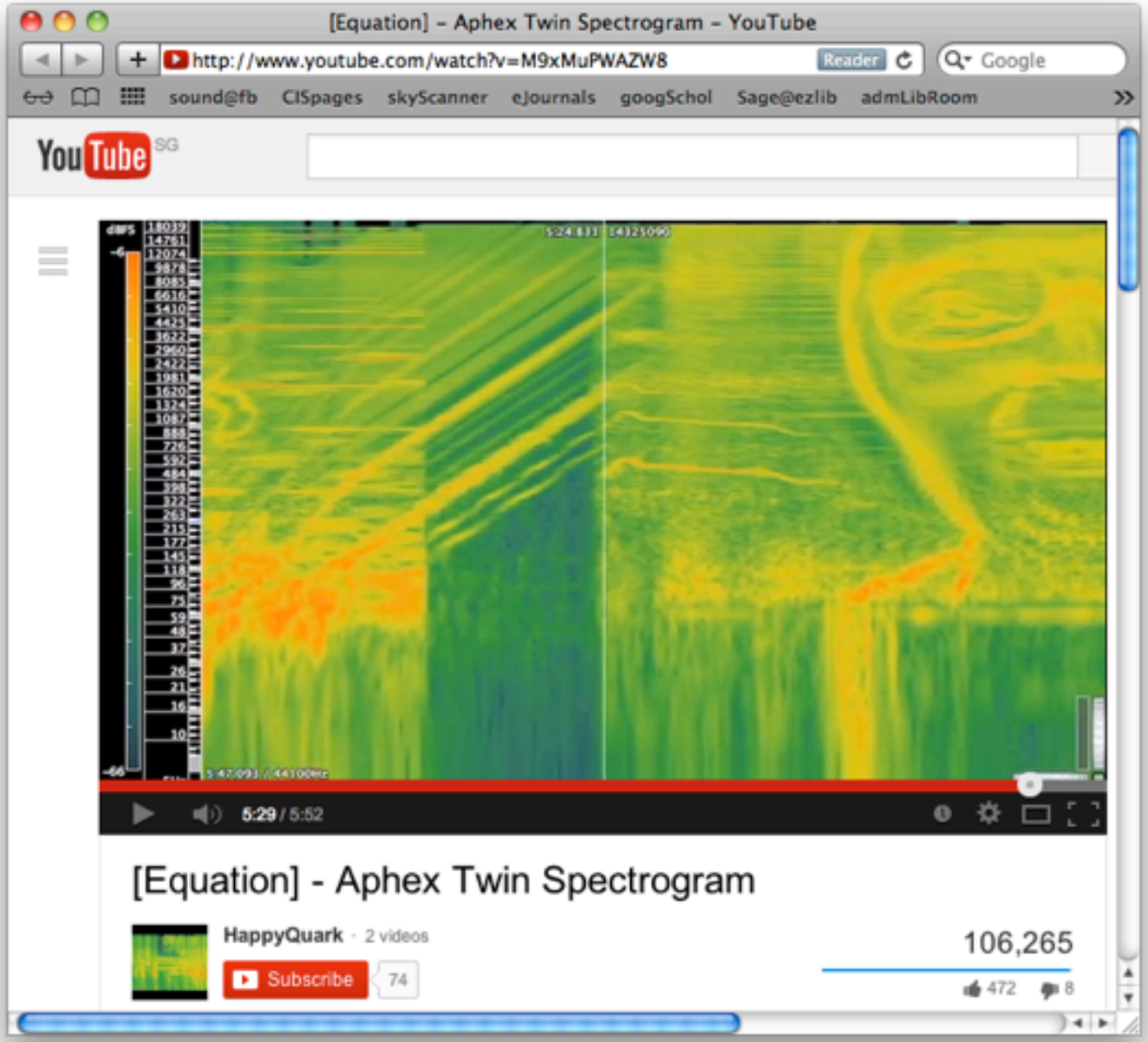
Hearing is Believing... Locust Wrath Sonifications

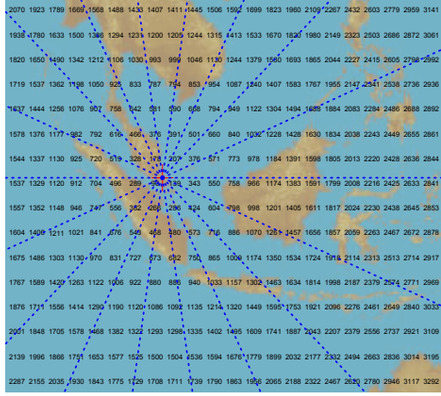
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Sonification - example ['pop']

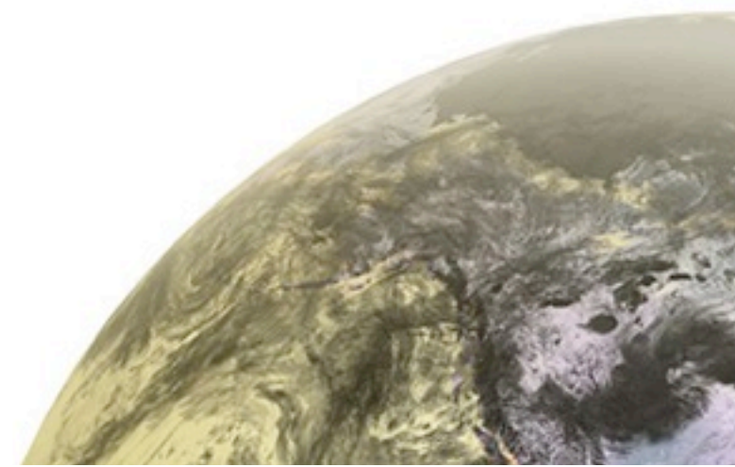
$$\Delta M_i^{-1} = -\partial \sum_{n=1}^{N} D_i[n] \left[\sum_{j \in C[i]} F_{ji}[n-1] + F\,ext_i\left[n^{-1}\right] \right]$$





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Sonification - definitions

Auditory system: excellent temporal resolution + pattern detection acuity (cf. Ballora 2000; Schnupp, Nelken & King 2011)

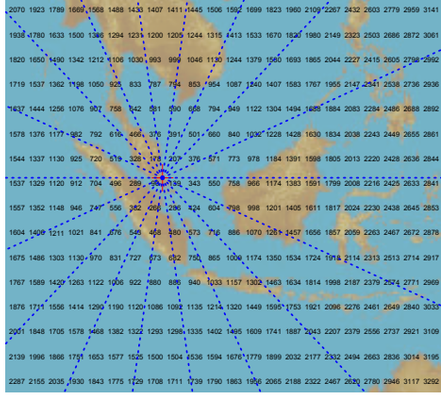
"Perceptualization of scientific data" (Grinstein & Smith 1990; Ferguson, Martens, & Cabrera 2011 [TSH p. 176]): more general concept (than visualisation)

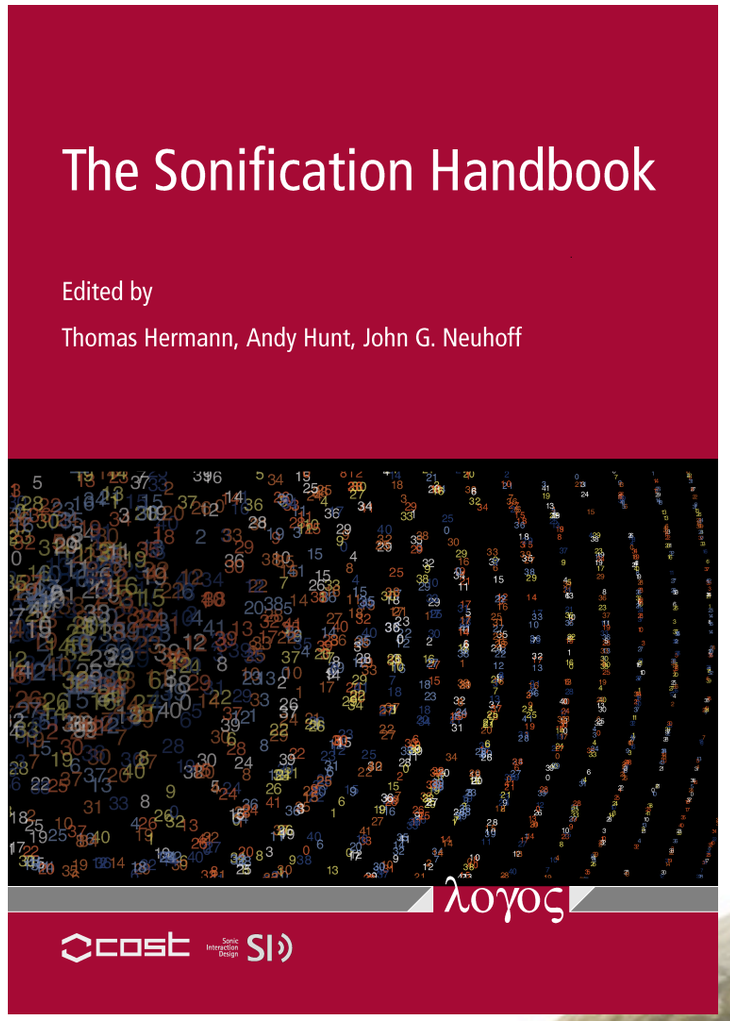
"Sonification is the use of nonspeech audio to convey information.... the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation." (Kramer 1994)

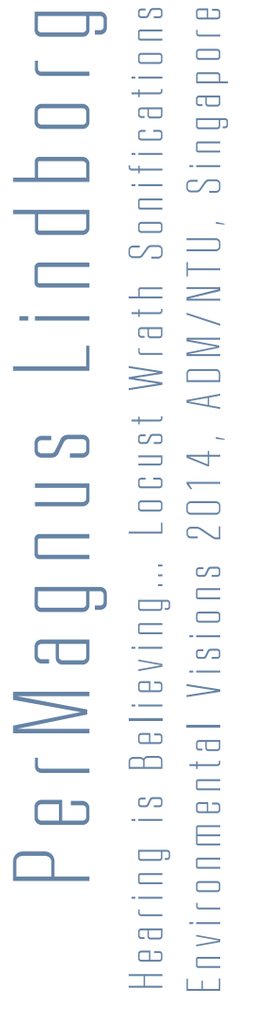
"Sonification is the data-dependent generation of sound, if the transformation is systematic, objective and reproducible, so that it can be used as scientific method." (Hermann 2008)

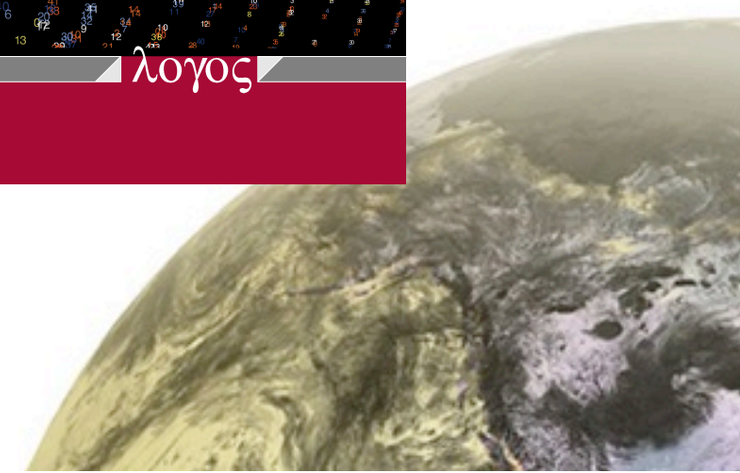
"Auditory Display [Pollack & Ficks 1954] encompasses all aspects of a human-machine interaction system, including the setup, speakers or headphones, modes of interaction with the display system, and any technical solution for the gathering, processing, and computing necessary to obtain sound in response to the data. [...] Sonification is a core component of an auditory display..." (Hermann, Hunt & Neuhoff 2011 [TSH p. 21])

Audification = rendering sound from data which produce time-ordered sequential streams
- Geiger meter, heart beat monitoring, seismography etc.



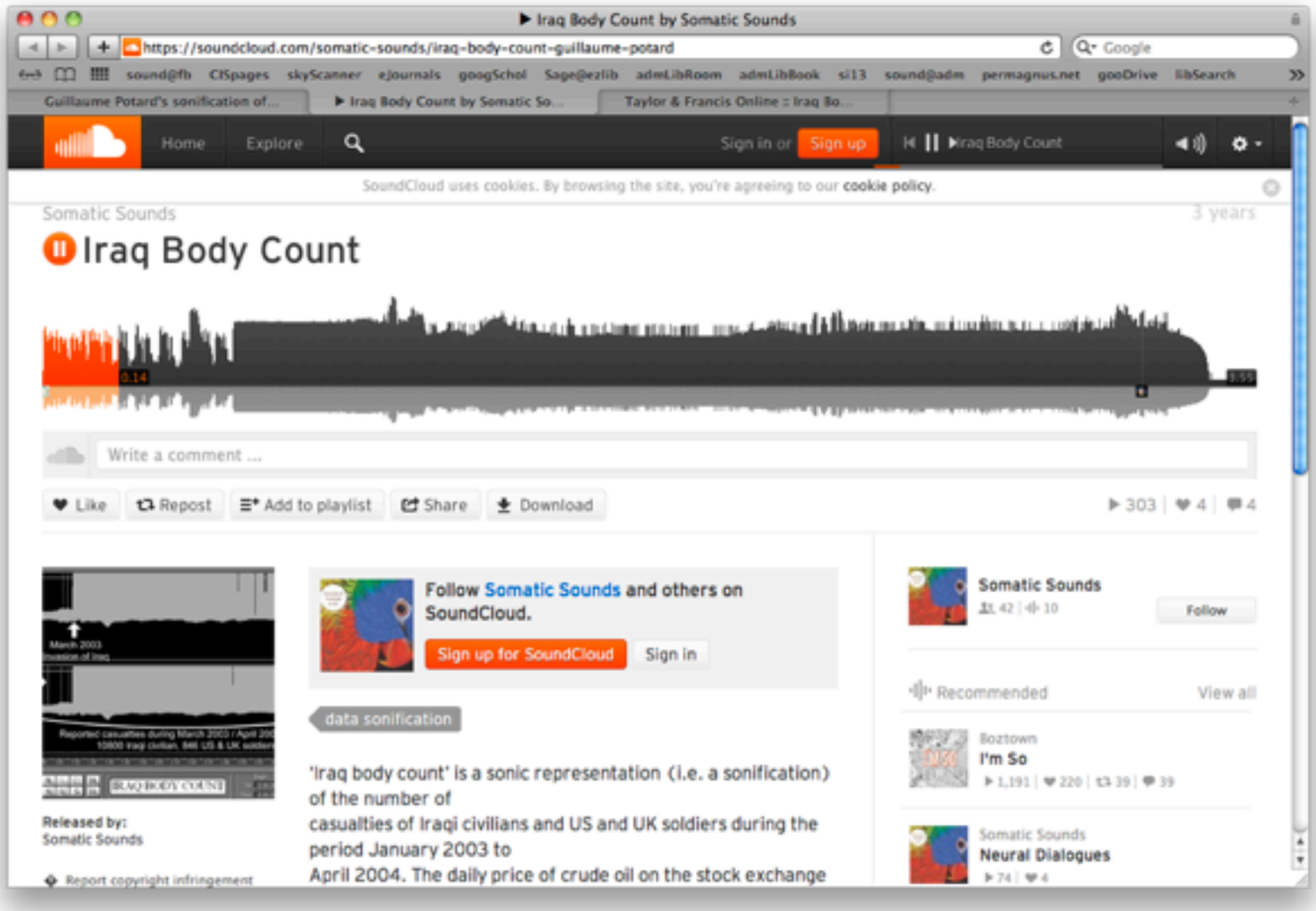


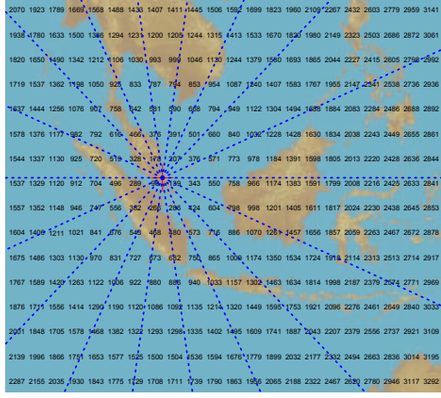


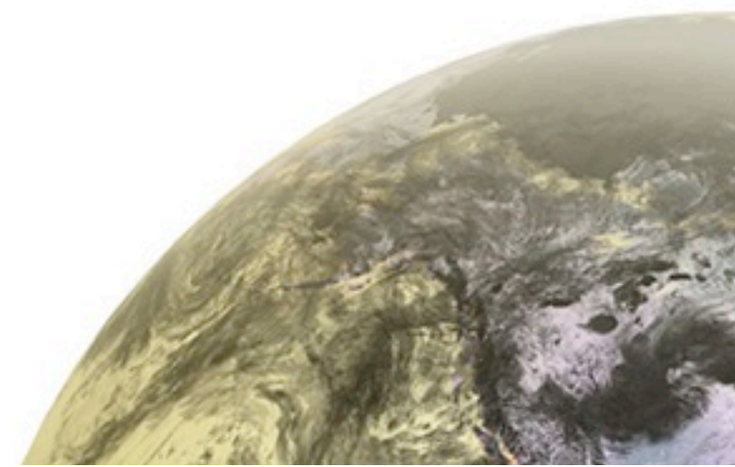


Sonification - example ['politics']

Guillaume Potard's sonification of the Iraq Body Count... sonification as political medium (cf. Polli 2012)







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Sonification - theory

Function of auditory displays (Walker & Nees, TSH p. 11-15)

1. alarms, alerts, and warnings; (e.g. categorization of seismic events)
2. status, process, and monitoring messages; (e.g. earcons, Brazil & Fernström 2011, McGookin & Brewster 2011)
3. (scientific) data exploration (see below, from Walker & Nees, TSH p. 20-22, p. 27-31)
4. art, entertainment, sports (Bresin 2011)

Aims with [scientific] sonification

Point estimation
- analytic listening extracting information regarding a single datum (visualisation more effective?)

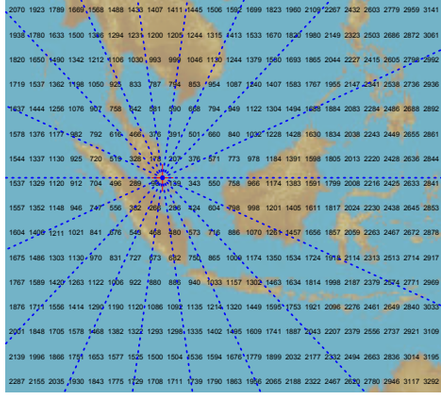
Trend identification
- holistic listening task (cf. Tuuri & Eerola 2011) to identify overall patterns in quantitative data

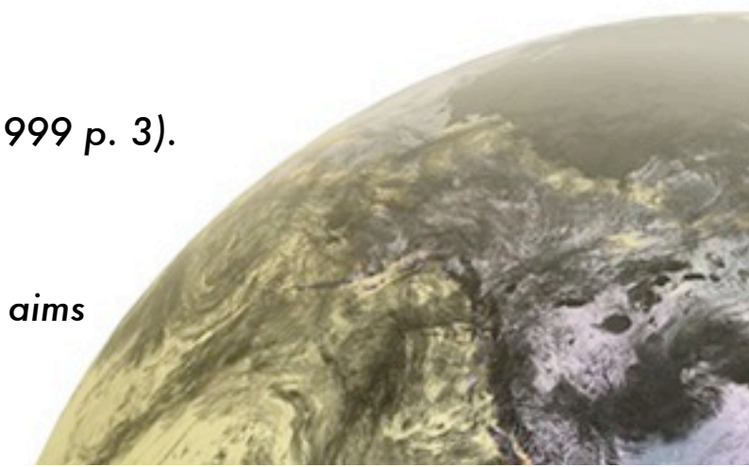
Identification of structure
- model-based sonifications –> overall structure of the data and complex relationships among multiple variables (cf. interactive sonification)

Exploratory inspection
- examination of data with "no a priori questions in mind" (Kramer 1994)

Dual task performance
- user can detect changes in auditory events with "their eyes free for other tasks" (Kramer et al., 1999 p. 3).

UX considerations:
- user individual differences (cognitive, impairment), training (perceptual, musical) and aims





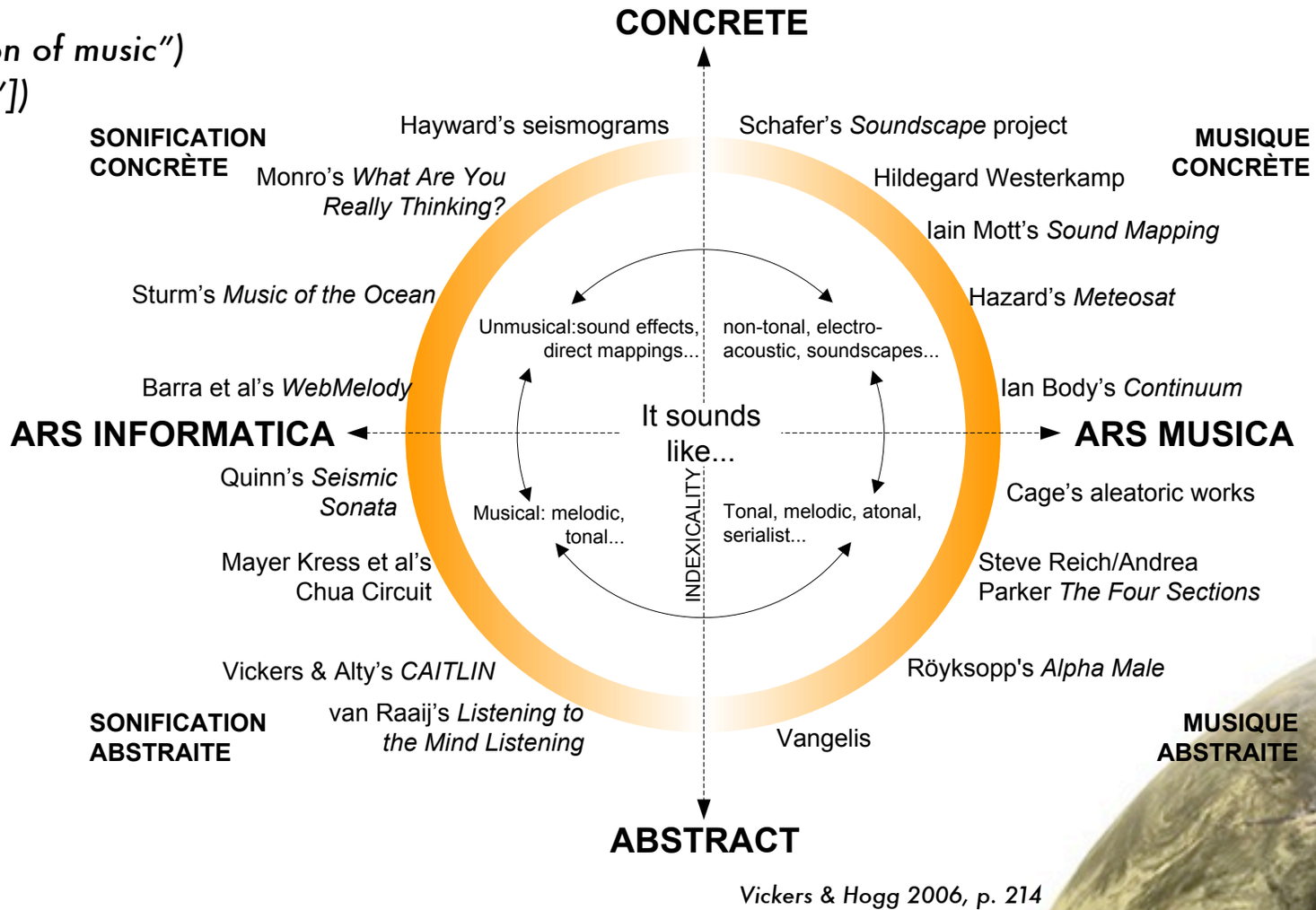
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Sonification - æsthetics

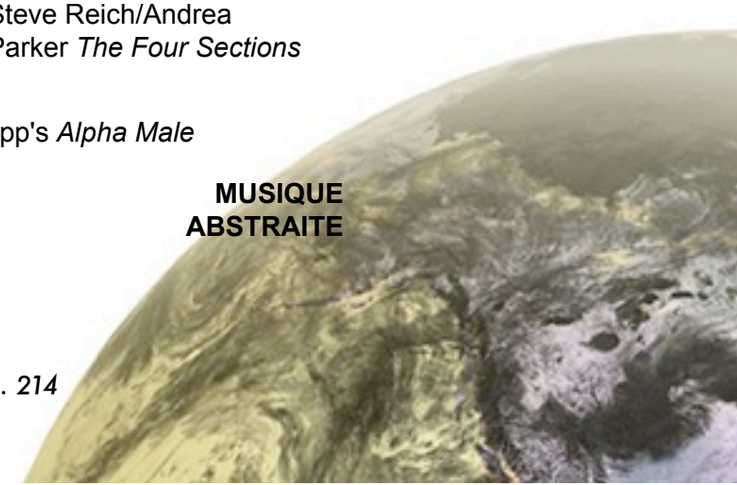
"Questions of aesthetics and musicality remain open in the field of sonification." (Barrass & Vickers 2011)

"more attention to aesthetics would facilitate ease of listening with sonifications, which would in turn promote comprehension of the intended message of the displays" (Vickers & Hogg 2006; cf. Gresham-Lancaster 2012, Supper 2014)

Historically, music + mathematics = TRUE:
- *Pythagoras (~550 BC, geometrical ratios)*
- *Josquin (~1450, combinatorics)*
- *Mozart (~1770, probability)*
- *Schillinger (~1920, "scientification of music")*
- *Hiller (~1950, heuristic rules ['AI'])*
- *Xenakis (~1960, stochastics)*



Vickers & Hogg 2006, p. 214



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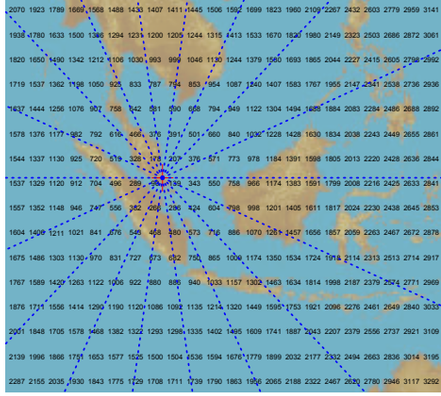
Sonification - weather data

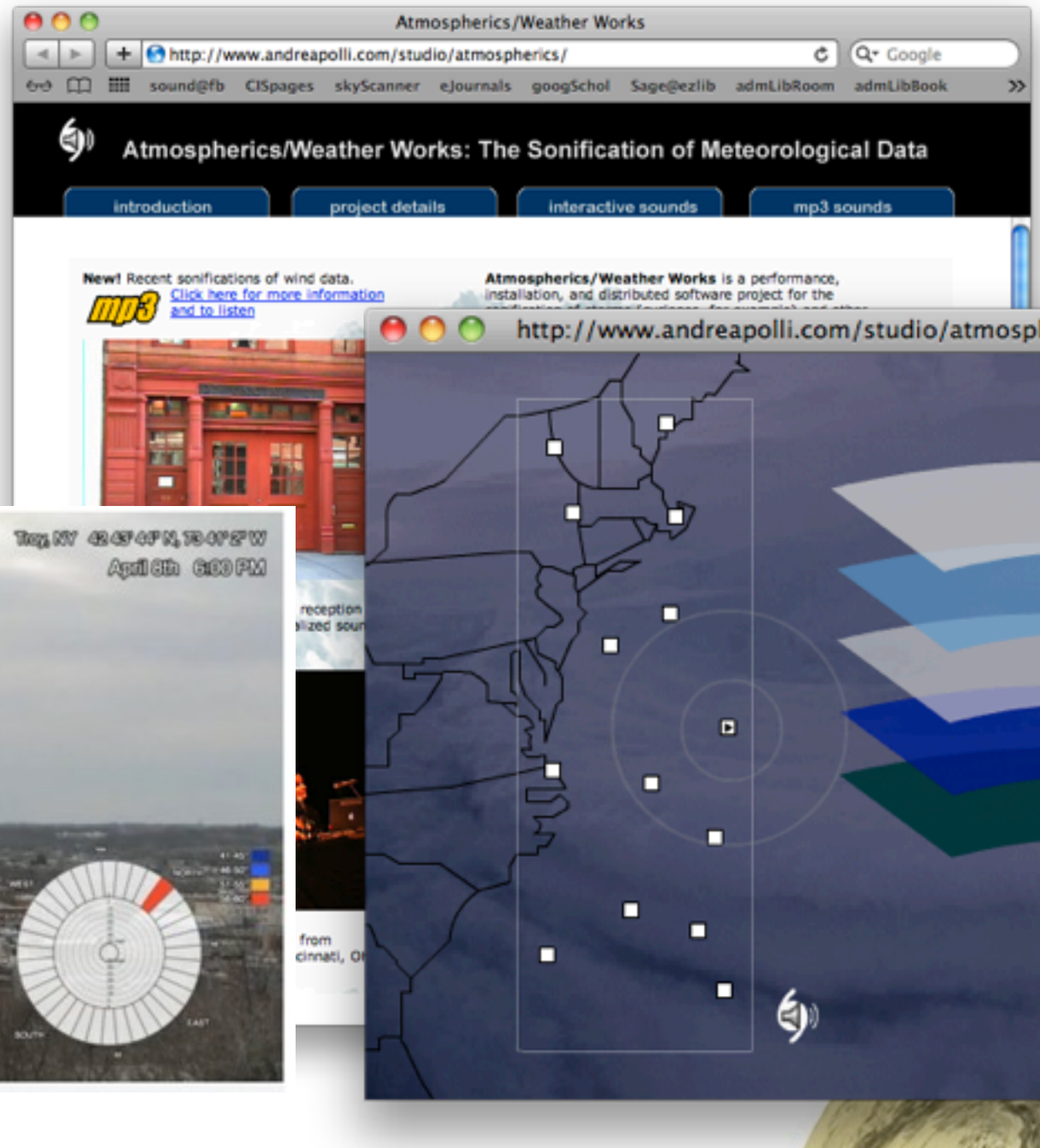
Andrea Polli: interactive interface for Atmospherics/Weather Works - sonification describing the temperature, pressure, wind, and moisture of Hurricane Bob August 18, 1991 at various geographical points (Polli 2012).

Cunningham (2013): concurrent audio-visual perceptualisations (time compression) with Max (Cycling 74)

Childs & Pulkki (2003): multi-channel spatialisation using VBAP (Max, Pd)

Flowers et al. (2001): consideration to meaning (ergonomics, traffic safety) of data in mapping strategies (musical timbre)







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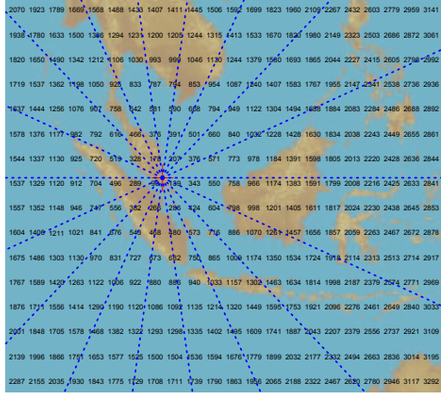
The Locust Wrath - multimedia dance performance

Sonic Design project: to create surround soundscapes for The Locust Wrath, a multimedia dance performance (Liong, Koh, & Lindborg 2013) using interactive sonifications of climate data (38.5 million values). The meteorological records express the weather for 1961-2000 and predictions for 2081-2099 in South-East Asia. Sonification compresses time; weeks of data can pass by every second. The climate is rendered as a music, whose form - gesture, timbre, intensity, harmony, spatiality - is determined by the data.

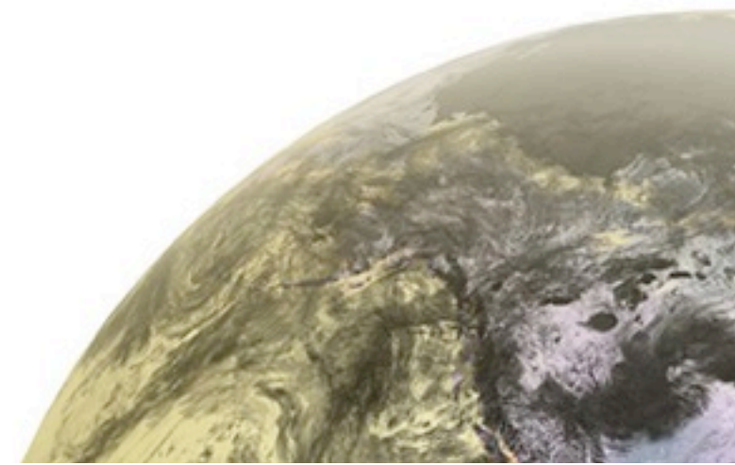


Liong, Angela, Koh, Joyce Beetuan, Lindborg, PerMagnus, ArtsFission Dance Company. The Locust Wrath, multimedia dance performance. HeloTrans gallery, Singapore (September 2013).
Webpages: http://permagnus.net/pm/artwork/sonifications/LocustWrath/index.html

SI13 Symposium on Sound and Interactivity 2013. Excerpt presented in Gallery Exhibition (www.si13.tk)
Binaural sound clip (use headphones): http://youtu.be/QHf1RjylfPY



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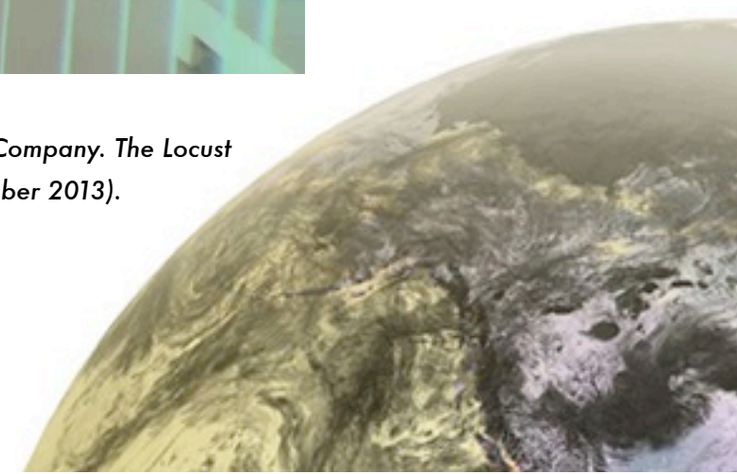
The Locust Wrath - multimedia dance performance



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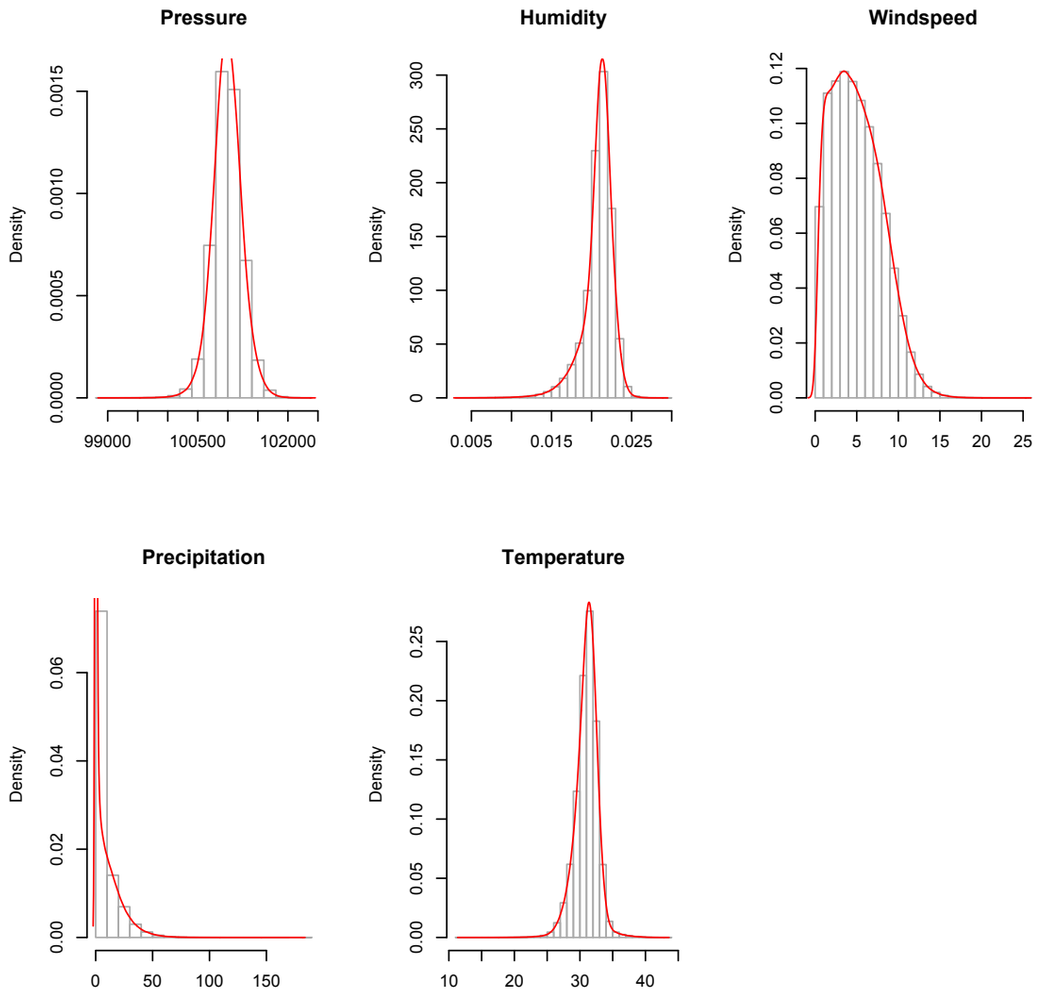
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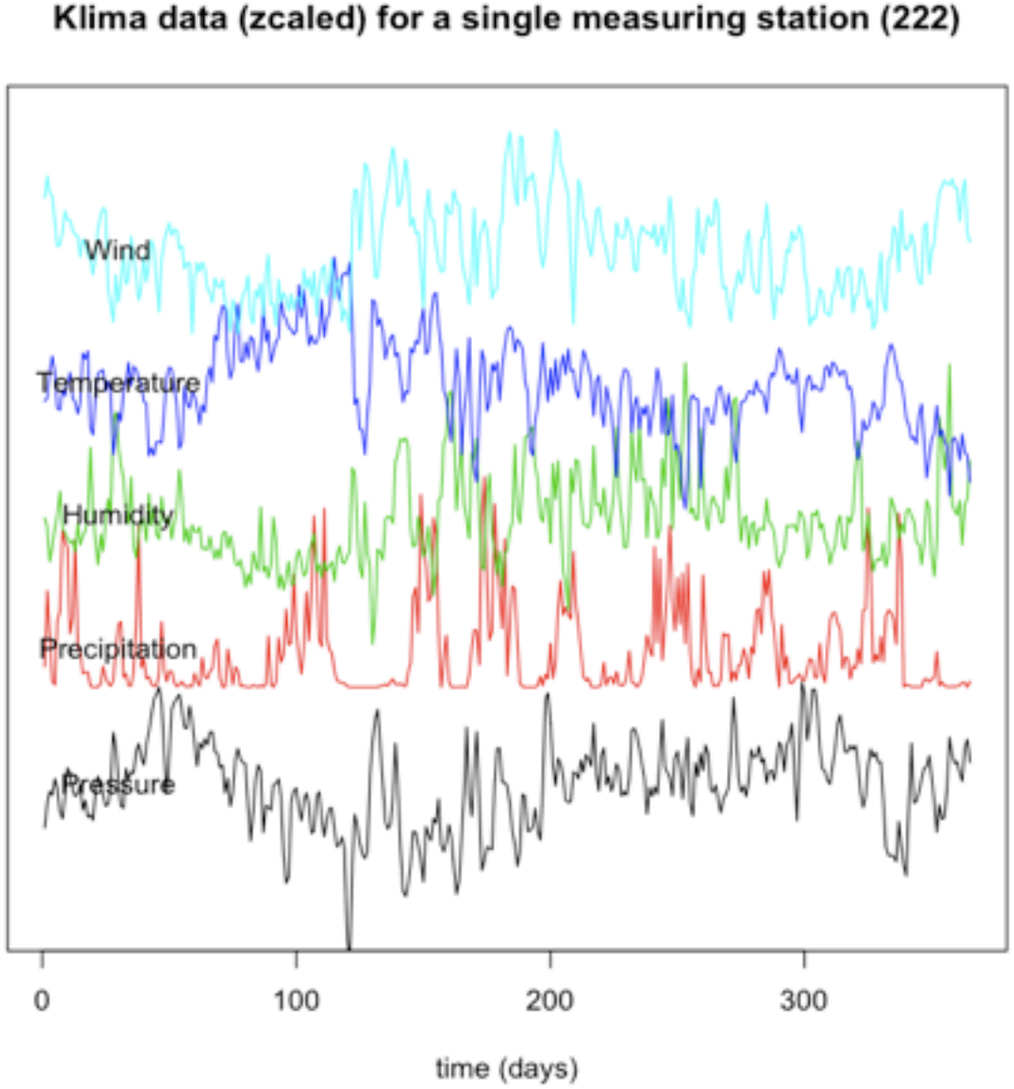
Locust Wrath - weather data

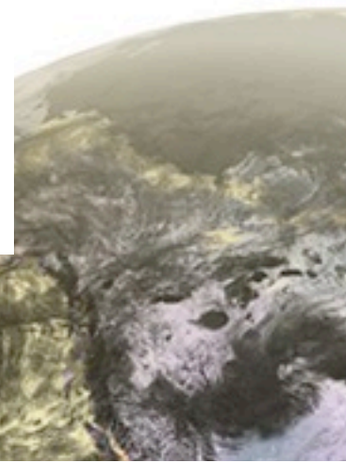
Tropical Marine Science Institute at NUS (Liong S-Y et al.) provided meteorological records for 1961-2000 and predictions for 2081-2099 covering a large region of South-East Asia.

Pre-processing and analysis in R (CRAN)



Histograms 1961-2000





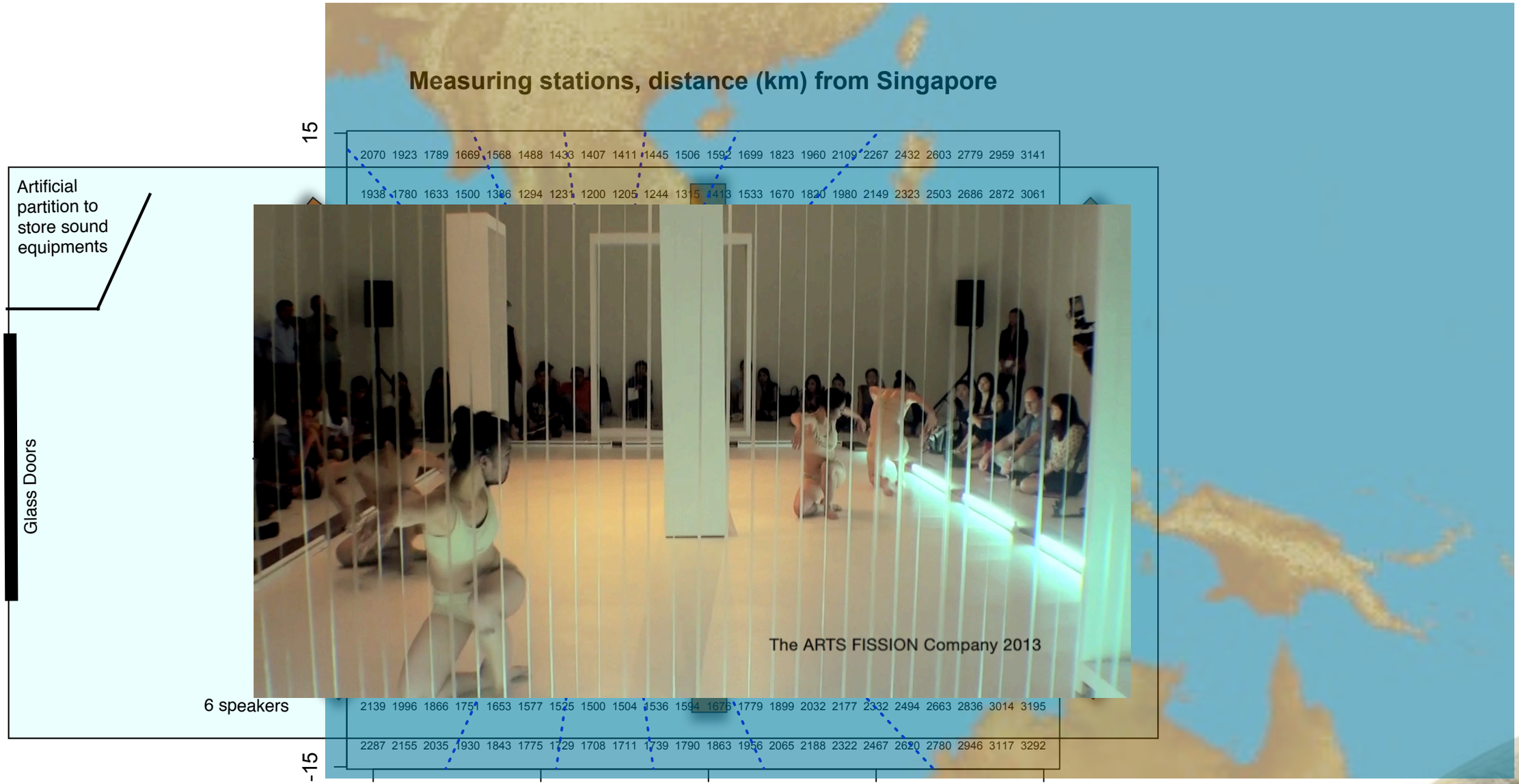
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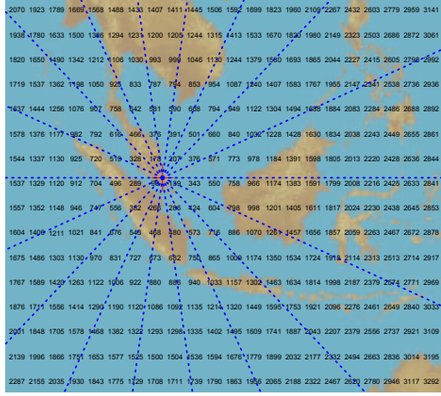
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Locust Wrath - spatialisation

performance space is specific (room acoustic considerations)



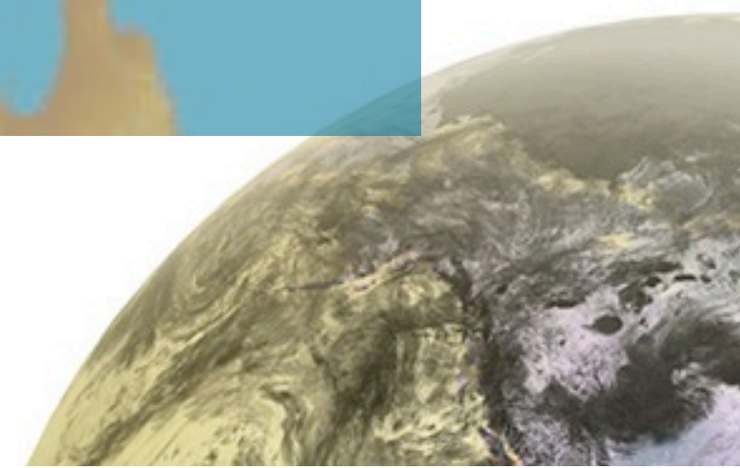
Aerial view of speakers and installation



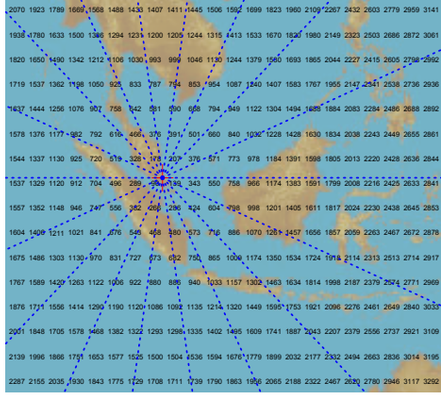
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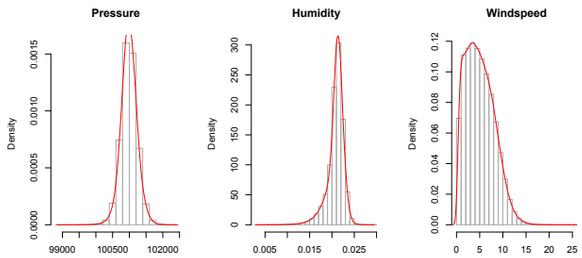
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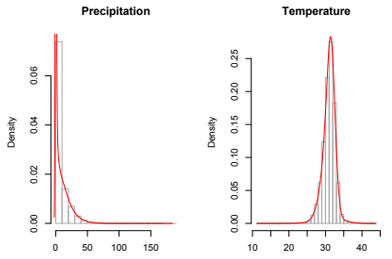


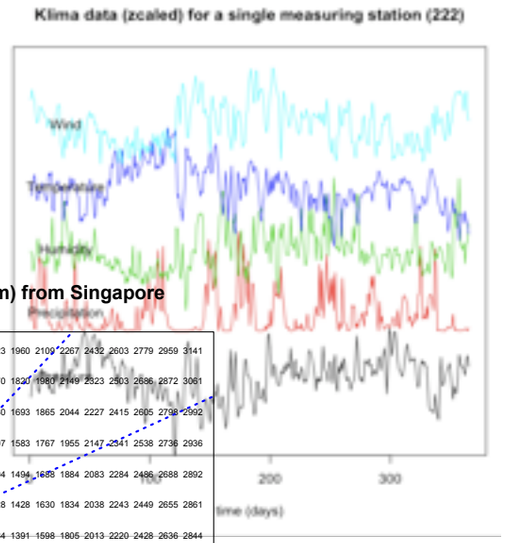
Locust Wrath - mapping

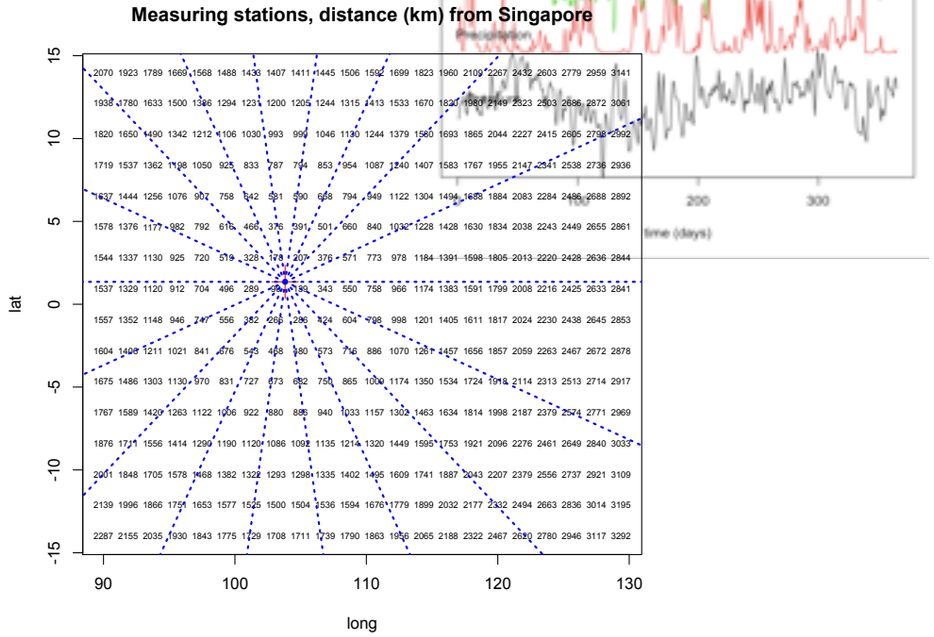


Pre-processing and analysis in R (CRAN)



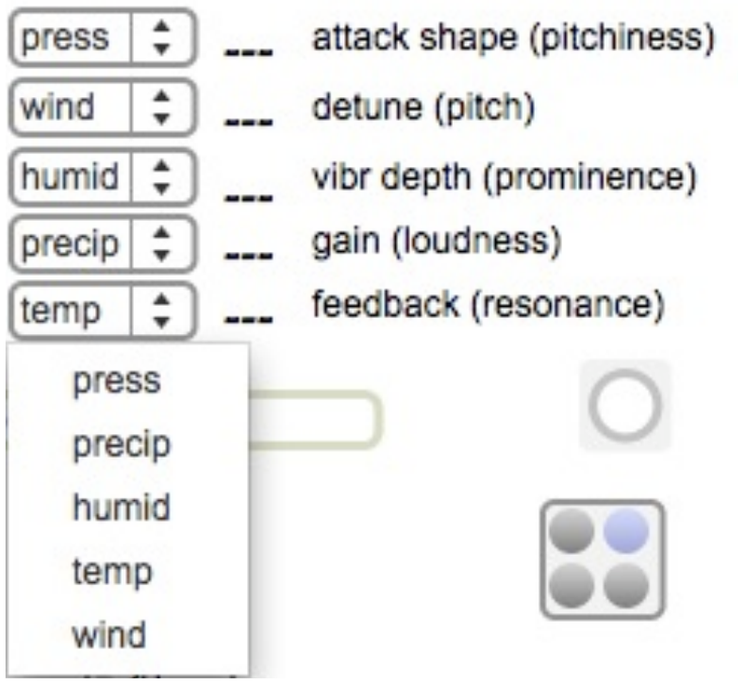


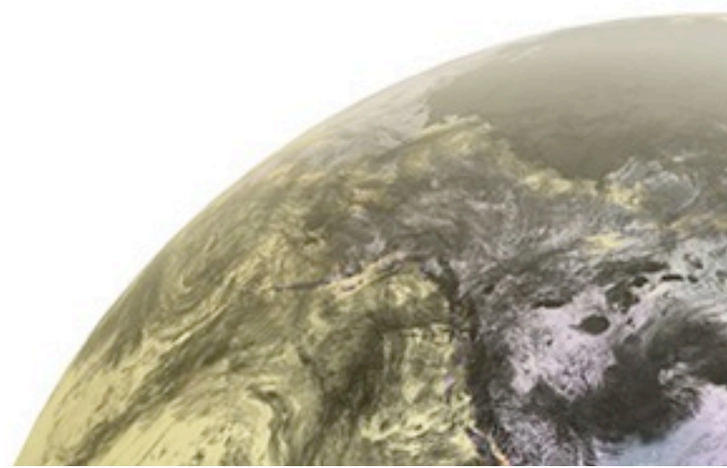




Interface and synthesis in Max (Cycling 74)

- interactive parameter mapping





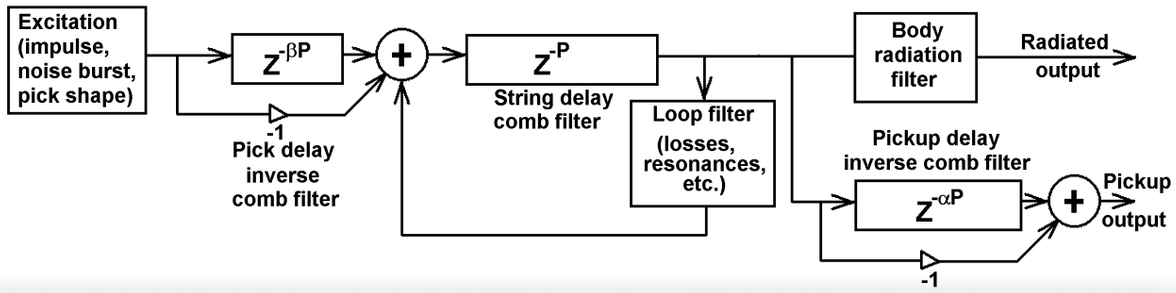
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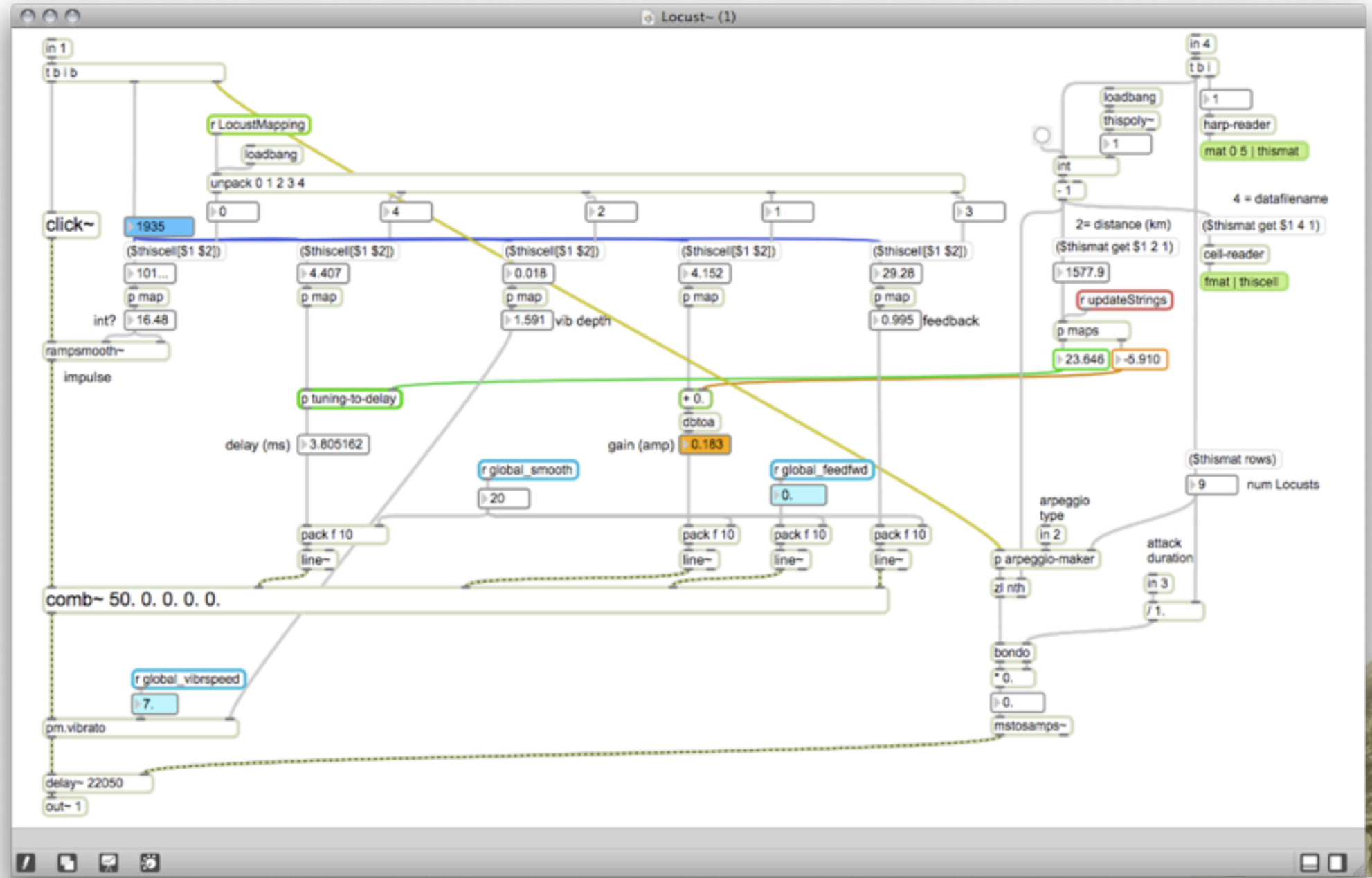
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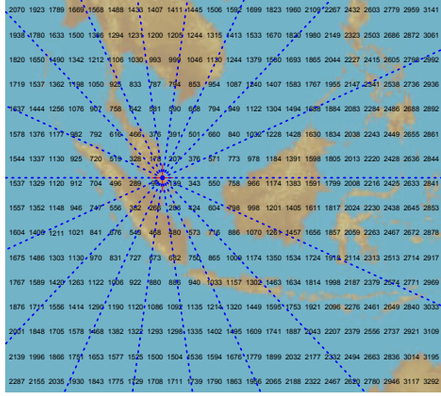
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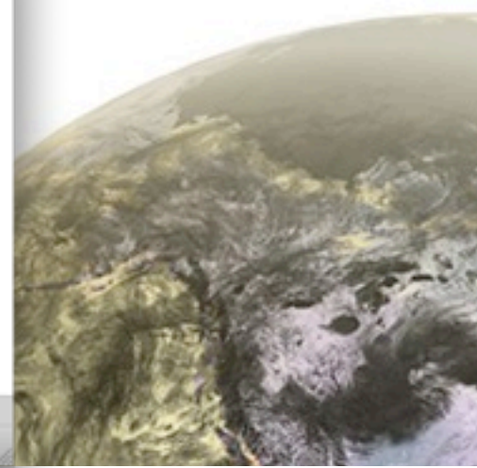
Locust Wrath - synthesis

- *plucked-string synthesis model*
- *18 banks of virtual strings (352 units)*
- *shaped click excites a tunable comb filter*
- *vibrato*









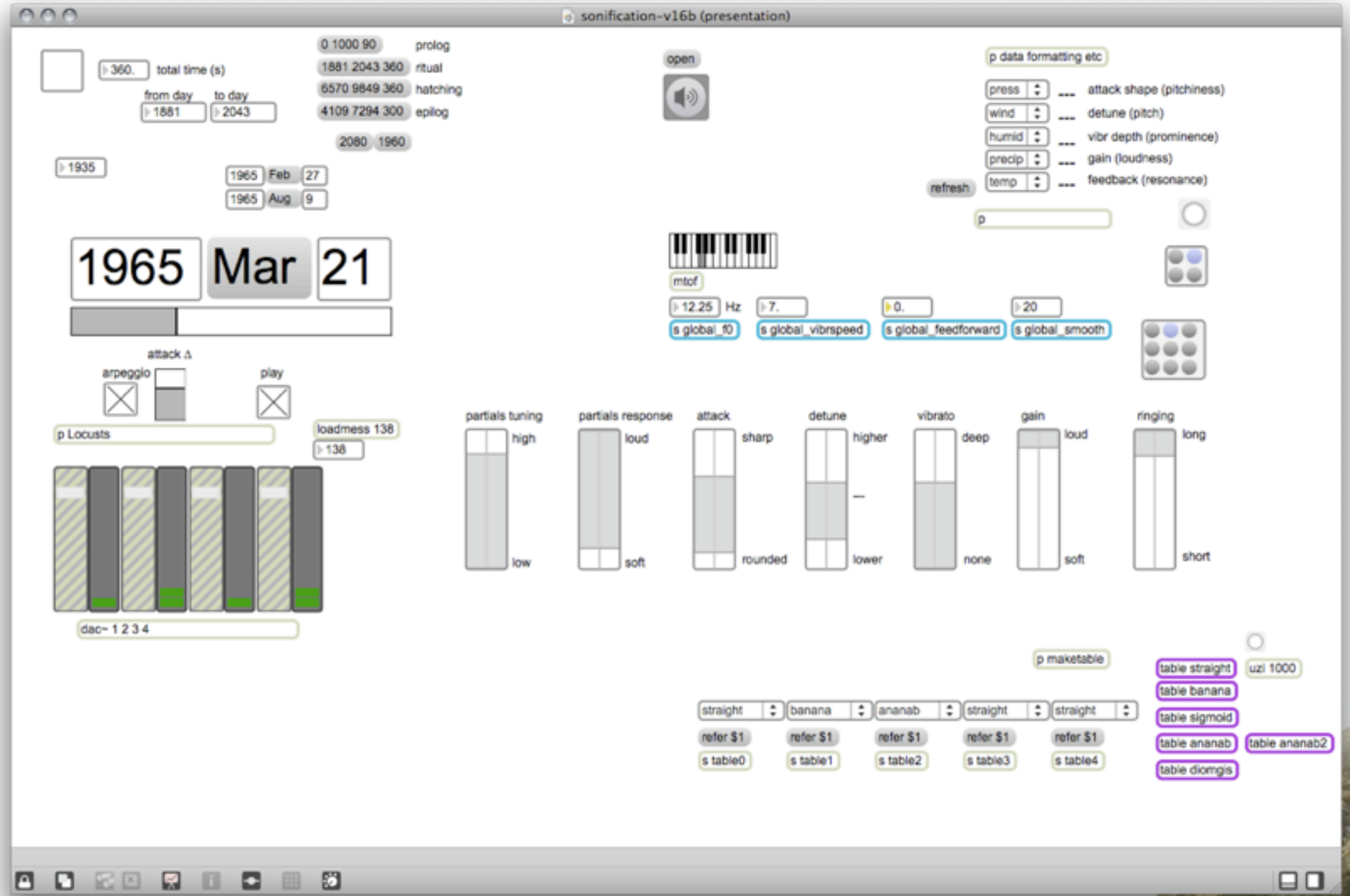
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Locust Wrath - software

Graphical User Interface for rendering audio



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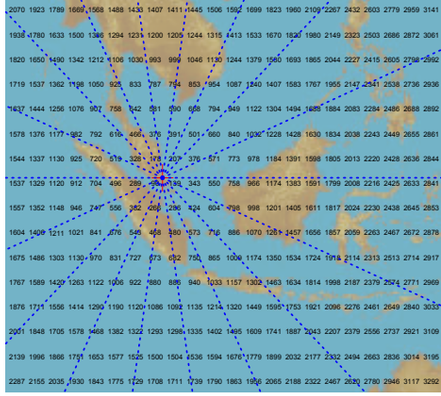
Locust Wrath - future work

Aim: to develop the LW-sonification patcher into tool for scientific & pedagogic discovery of patterns in the TMSI data

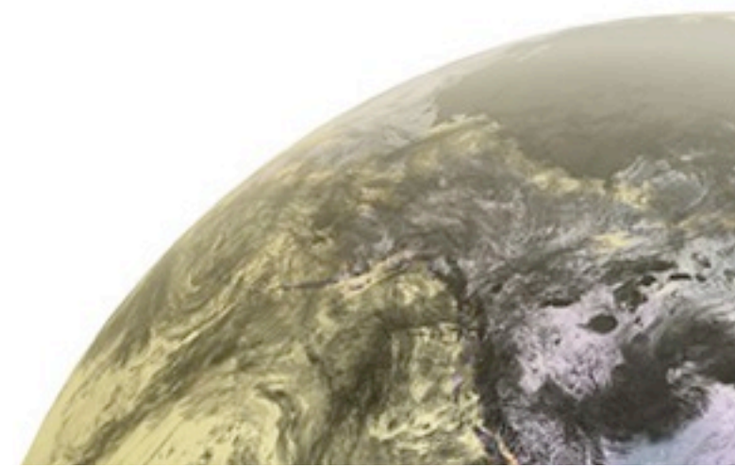
GUI development
- simplify interactive top-level timbre controls
- interactive spatialisation, i.e. "walk the space"

code optimisation
- parametric mapping (instead of hash tables)
- distributed synthesis (352 units)
- resolve dropout/ 'hard timing' issues

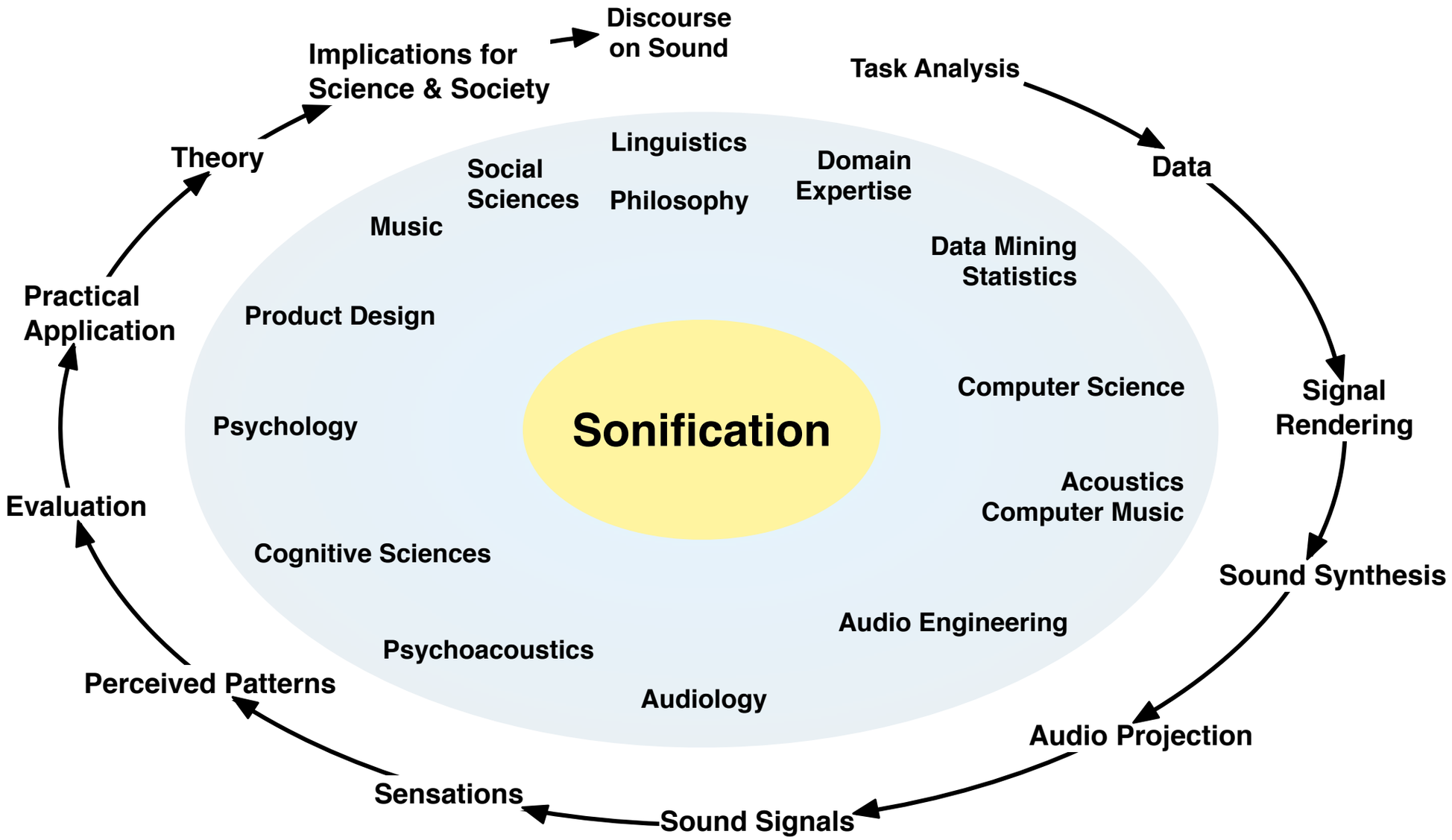
UX evaluation
- perceptual tests to evaluate "discovery efficiency" (Neuhoff, Kramer, Gregory & Wayand 2010; Flowers & Grafel 2002)
- design feedback
- compare with [concurrent] visualisation



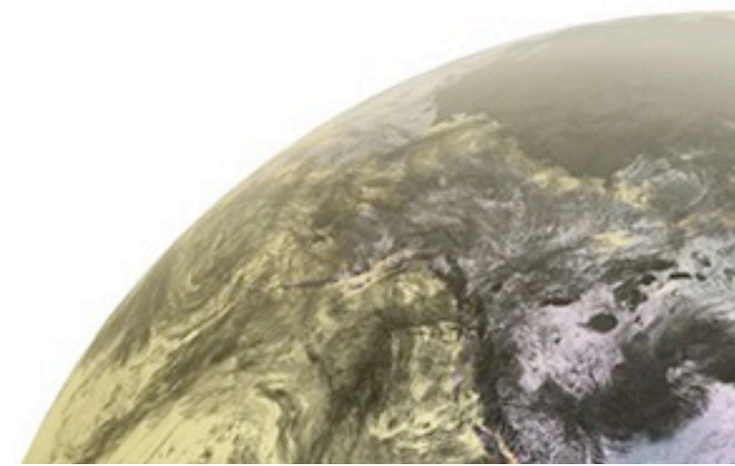
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Sonification - an interdisciplinary field

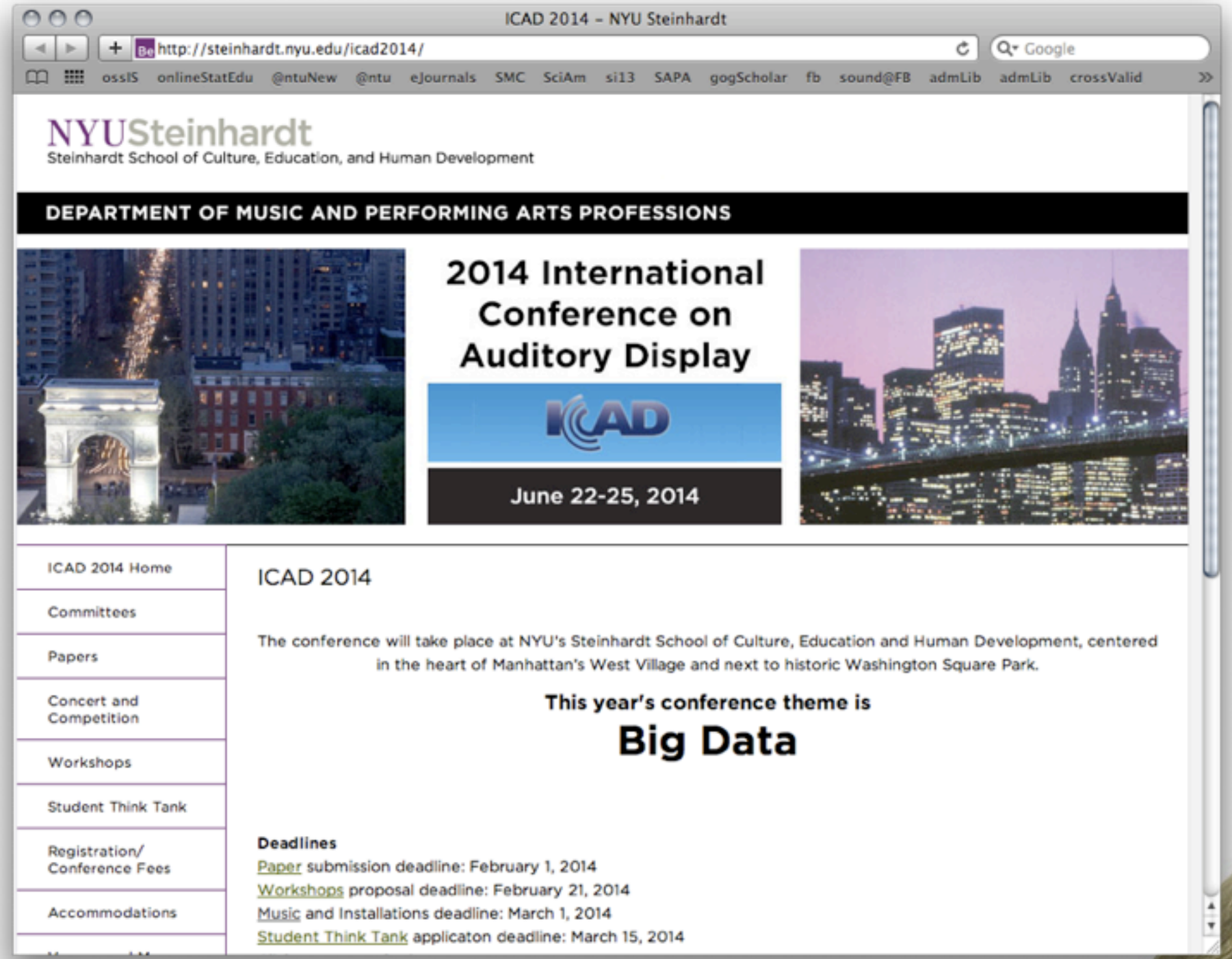


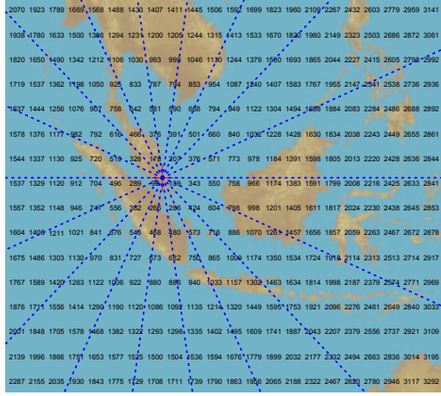
Hermann, Hunt & Neuhoff, TSH p. 2



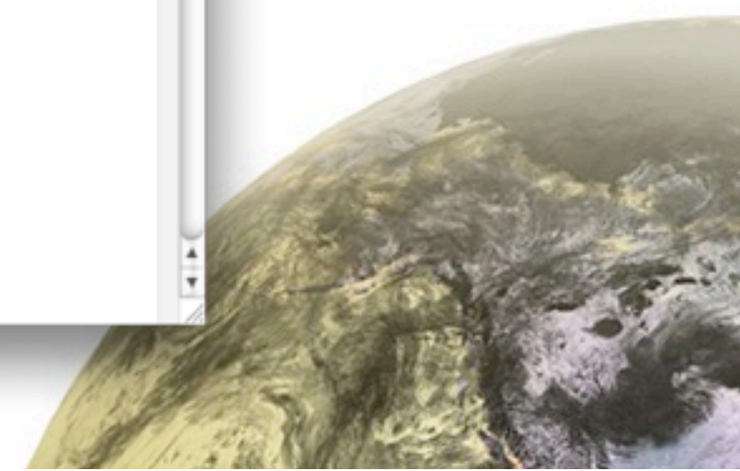
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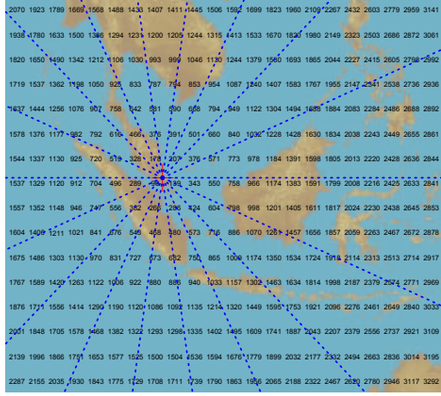
Forthcoming





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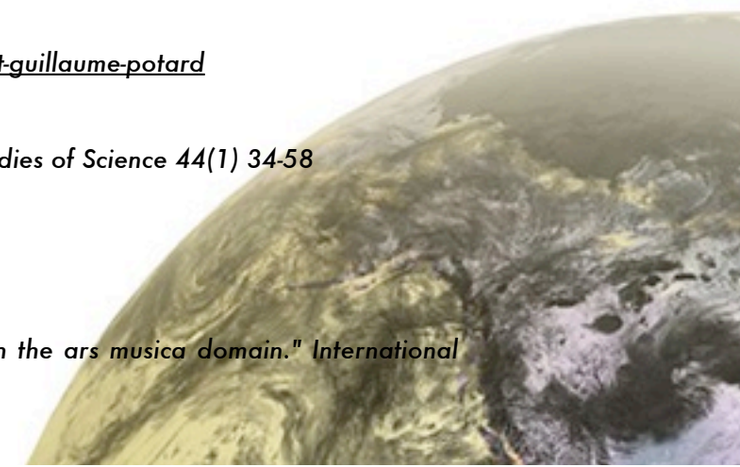
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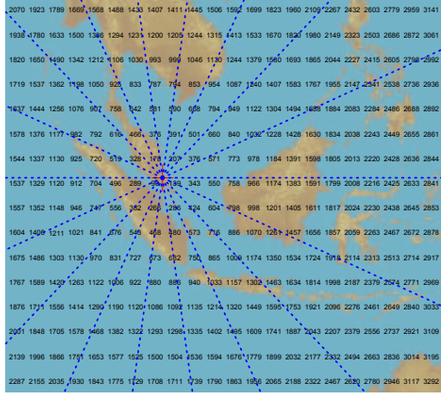
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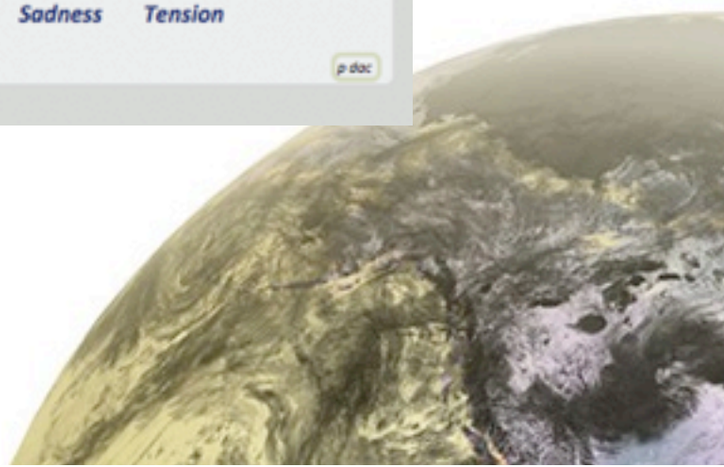
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Locust Wrath - binaural version at EV2014!







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