EGU23-8540

Sharing is encouraged

Composing music for string quartet from earth observation datasets

– how does the composer's intervention enrich sonification works?

Hiroto NAGAI, Ph.D
Associate Professor
Department of Geography, Rissho Univ. (Apr. 2023~)

#geosonif

Acknowledgement This research project was financially supported by the Remote Sensing Technology Center of Japan (RESTEC). The first performance was completed by PRT Quartet. The author expresses great appreciation for these contributions.

1

2

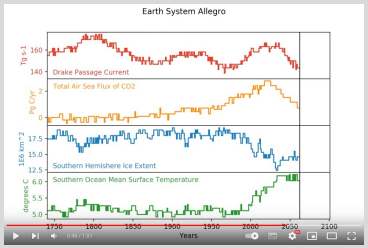
Introduction | Sonification of geoscience

Sonification: Convert data/information to non-verbal sound

"A Song of Our Warming Planet" (2013)
by Daniel Crawford (University of Minnesota)

CC; https://youtube.com/watch?v=5l08Ct-czdK4&si=EnSlkaIECMiOmarE&t=75

"Earth System Allegro" (2019)
by Lee de Mora (Plymouth Marine Laboratory)



© Lee de Mora; https://youtu.be/RxBhLNPH8is

3

Purpose | Find meanings of geoscience sonification

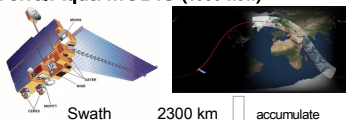
What is benefits of sonification for earth science and Musical Art?

1. Aim to **establish a basic method** of sonification from satellite data
2. Consider possibility and challenges through **actual composition and performance**
3. Discuss meaning of composer (**human intervention**) to be a music piece

4

Data | Satellite remote sensing and global climatic dataset

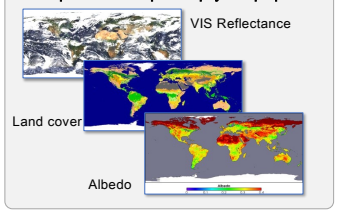
Terra/Aqua MODIS (1999-now)



Swath 2300 km
Resolution 500 m

accumulate and merge

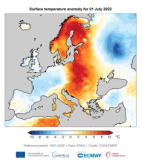
Global product for respective physical properties



ERA5 (1980-now)

Various types of observation

Fill the gaps by using numerical simulation

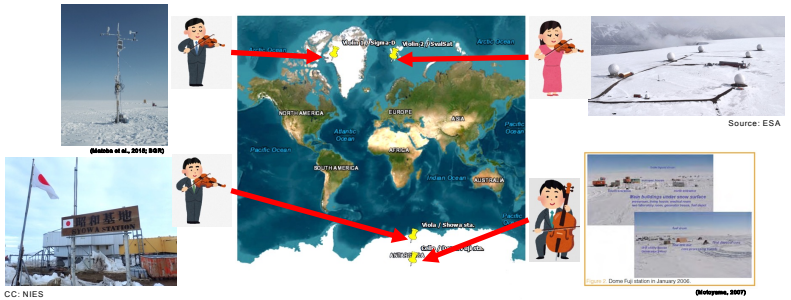


Climate reanalysis dataset
Hourly-to-monthly changes on global climate to visualize

5

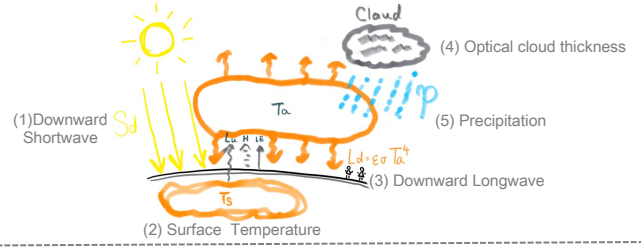
Data | Location of data sampling for a string quartet

Violin 1st	Greenland icesheet / "SIGMA-D" ice-core drilling site	[59.1°W, 78.6°N]
Violin 2nd	Svalbard islands / Satellite com. station (SvalSat.)	[15.4°E, 78.2°N]
Viola	Antarctica / Showa Station (NIPR, Japan)	[39.6°E, 69.0°S]
Cello	Antarctica / Dome-fuji station (NIPR, Japan)	[39.7°E, 77.3°S]



6

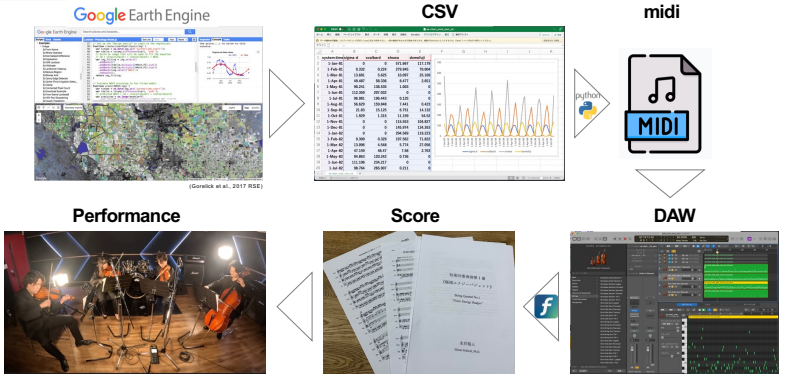
Data | Physical parameters about global energy budget



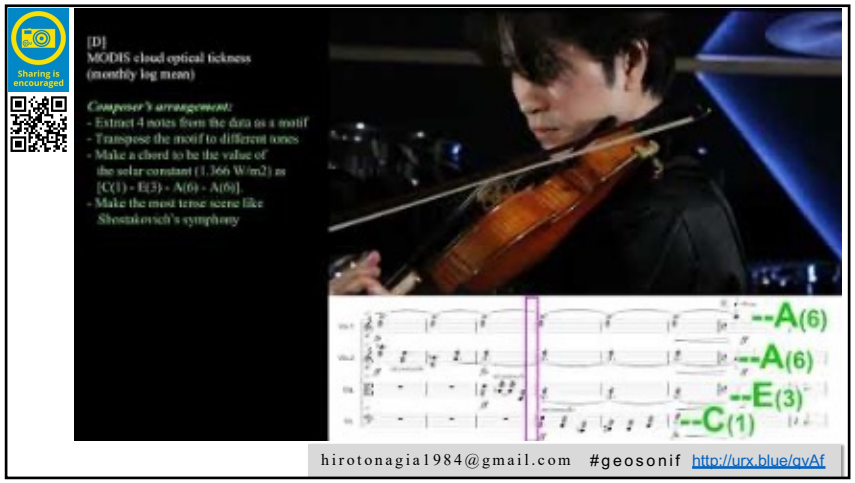
[Intro]	ERA5	Downward **Shortwave Radiation**, monthly averaged (Sd, W/m^2)
[A]	MODIS	**Surface Temperature**, 8-days averaged (Ts, K)
[B]-[C]	ERA5	Downward **Longwave Radiation**, monthly averaged (Ld, W/m^2)
[D]-[F]		A motif, **[C-E-A-A],** from the solar-constant value **(So, 1.366 kW/m^2)**
[G]	MODIS	**Cloud optical thickness**, monthly averaged
[H]-[I]	ERA5	**Precipitation**, monthly averaged (p, mm)

7

Methodology | Google Earth Engine, python, DAW, and artis



8

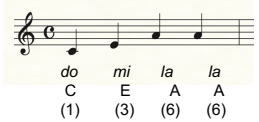


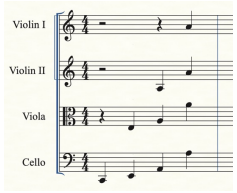
9

Findings and Feedback | Composition for acoustic instrument

(1) Motif definition

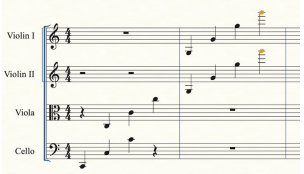
The solar constant (1366 W /m^2) to [C-E-A-A]





(2) Tone ranges for instruments

- **3-octave** is the best range for a quartet.
  - Higher tones still available
  - Many duplicated tones in a narrow range
  - Difficult leaping tones in a wide range

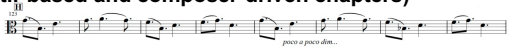


10

Findings and Feedback | Three types of feature

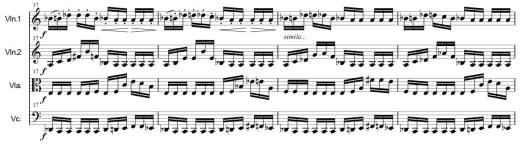
(1) Cyclicity 100% (e.g. motif-based and composer-driven chapters)

(e.g. typical classic music)



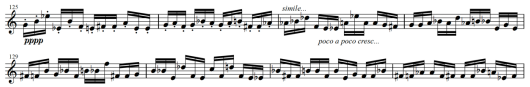
(2) Dominant cyclicity with small random variations (e.g. shortwave/longwave radiation)

"Minimal music with irreproducible swaying"



(3) Dominant randomness with slight cycle (e.g. precipitation)

"Mathematically" (e.g. π, random numbers..)



11

Summary | We got an infinite jukebox to tell geoscience!

- Basic method established for further composition (for me and others!)

For Artist;

- Infinite melodies generated from data through cloud computing
- Select of material data and arrangement reflecting artist's originality
- Acoustic instruments requiring careful adjustments, especially for tone ranges, where composers' skill should be reflected

For scientists;

- Not only "Stop global warming", but any scientific features to talk about! (e.g. energy budget, water cycle, geohazard, paleo environment, etc.)
- Easy finding of slight anomaly by playing and/or listening to

hirotonagia1984@gmail.com #geosonif http://urx.blue/qvAf

12