

弦楽四重奏曲第1番
《極域エネルギーバジェット》

String Quartet No.1
“Polar Energy Budget”

永井裕人

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| Concert Note |

"Listen to the sound of the earth turning." – this is a quote of instructional art published by Yoko Ono in 1963. At first glance, this may be seen as an unrealizable instruction and a metaphor of some kind. In the present age, it is possible to observe the earth, collect digital data, convert it into audible feature, and listen to it.

Such process is called sonification. Familiar examples are heart rate monitors in hospitals and radiation dosimeters (Geiger counters). The National Aeronautics and Space Administration (NASA) has converted observation data from space-borne telescopes and planetary probes into sounds. Although it is now possible to listen to the data or information that could not be heard directly by people, can they really be called "music"? What is needed for the sonified parts to be incorporated into major music works? These questions are the motivations behind the creation of this work.

The materials for this work are originated from satellite-based earth observation data and climatic reanalysis datasets. They quantify the temporal changes of multiple physical quantities (i.e. shortwave and longwave radiation, surface temperature, cloud optical thickness, and precipitation). Four polar-regional points (i.e. an ice-core drilling site in the Greenland ice sheet, satellite communication facilities at Svalbard Islands, Showa Station in Antarctica, and Dome Fuji Station in Antarctica) are set for data sampling for two violins, a viola, and a cello. The composer's artificiality is added very little in the introduction chapter, whereas it appears more intensively in the latter chapter of the piece.

In meteorology and other earth science, we know that almost all atmospheric phenomena and ecosystem are fundamentally driven by the solar radiant energy. The solar energy transmitted in different forms causes the balance and order on the terrestrial surface, resulting in human's civilization. Not only focusing on outreach against the global warming, but the composer here intends to express great possibilities to tell about numerous aspects of earth science with artistic expression supported by the sonification technique.

| Concert Note |

“Listen to the sound of the earth turning.”—これは1963年にオノ・ヨーコが発表したインストラクション・アートの言葉である。一見、実現できない指示であり、何らかのメタファーとも捉えられる。しかし様々なデジタル処理が可能になった現代では、地球を観測し数値データに直したものを音響や旋律に変換し、人間にも知覚可能な空気振動(=音)として聴くことができるようになった。

このようなデータの可聴化はソニフィケーション (Sonification) と呼ばれる。身近には病院の心拍数モニターや放射線の線量計 (ガイガーカウンター) が含まれ、米国航空宇宙局 (NASA) は宇宙望遠鏡や惑星探査機の観測データを音に変換したものを公開している。直接に聞こえなかった響きを人間の可聴範囲に持ってくることはできるようになったが、果たしてそれが「音楽」と呼べるものであるのか、また広く「音楽」と呼ばれるためにはどのような作為を加えなければいけないのか、それが本作品を創作するに至った知的好奇心である。

本作品の素材は人工衛星などによる地球観測データについて、北極・南極周辺にある4地点の各種物理量の時間変化を数値化したものである。具体的には、短波および長波放射・地表面温度・雲による日射減衰率・降水量である。四重奏の高音パートから順に、グリーンランド氷床・スバル諸島・南極昭和基地・南極ドームふじ基地の各地点が割り当てられ、楽曲後半になるほど作曲者の作為性が介入している。

気象学や地球科学では、ほぼ全ての気象現象やエコシステムが太陽の放射エネルギーを根源として成り立っていることを学ぶ。太陽からのエネルギーが形を変えながら伝わっていき、地球表層上のバランスと秩序、そして我々人間自身の営みを作り出している様を念頭に、音を編み込んでいった。「地球温暖化の警鐘を鳴らす」や「環境保護の重要性を訴える」という安直なテーマに限定せず、芸術表現としての可能性を広げることを重視する。

| Locations for sampling |

Violin 1st	[59.1°W, 78.6°N]	Greenland icesheet / SIGMA-D ice-core drilling site グリーンランド氷床 SIGMA-D 氷床コア掘削サイト
Violine 2nd	[15.4°E, 78.2°N]	Svalbard islands / Satellite communication facilities スバルバード諸島 衛星追跡管制局 (SvalSat)
Viola	[39.6°E, 69.0°S]	Antarctica / Showa Station (NIPR) 南極 昭和基地
Cello	[39.7°E, 77.3°S]	Antarctica / Dome Fuji Station (NIPR) 南極 ドームふじ基地

| Input Parameters |

[Intro]	ERA5	Downward shortwave radiation, monthly mean (W/m ²) 地上月平均下向き短波放射量 (W/m ²)
[A]	MODIS	Land surface temperature, 8-days mean (K) 地表面温度 8 日間平均値 (K)
[B]-[C]	ERA5	Downward longwave radiation, monthly mean (W/m ²) 地上月平均下向き長波放射量 (W/m ²)
[D]-[E]-[F]		Classic arrangements based on a motif (G-B-E-E) derived from the solar constant value (1.366 kW/m ²) and top notes from Chapter [G] below. 太陽定数 (1.366 kW/m ²) の音列 (C-E-A-A) および後述[G]の先頭音列をモチーフとする古典的アレンジメント
[G]	MODIS	Cloud optical thickness, monthly mean 月平均雲の光学的厚さ
[H]-[I]	ERA5	Precipitation, monthly mean (mm) 月平均降水量 (mm)

ERA5 : Climate reanalysis dataset provided by the European Centre for Medium-Range Weather Forecasts

欧州中期気象予報センター (ECMWF: European Centre for Medium-Range Weather Forecasts) が公開する気候再解析データセット

MODIS : An optical multispectral sensor, the Moderate-Resolution Imaging Spectroradiometer, onboard Terra/Aqua satellites (NASA)

Terra/Aqua 衛星 (NASA) に搭載された中分解能スペクトル放射計 (Moderate-Resolution Imaging Spectroradiometer)

| Acknowledgement |

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弦楽四重奏曲第1番《極域エネルギーバジェット》

永井裕人

Intro. ♩=80 ca. (♩.=107 ca.)

Vln.1

Vln.2

Vla.

Vc.

pp

simile...

cresc.

5

Vln.1

Vln.2

Vla.

Vc.

p

simile...

9

Vln.1

Vln.2

Vla.

Vc.

cresc.

cresc.

13

Vln.1

Vln.2

Vla.

Vc.

mf

simile...

cresc.

cresc.

mf

cresc.

弦楽四重奏曲第1番《極域エナジーパジェット》

17 *f* *simile...*

Vln.1
Vln.2
Vla.
Vc.

21

Vln.1
Vln.2
Vla.
Vc.

A
25 *mp* *mp*

Vln.1
Vln.2
Vla.
Vc.

29 *mp*

Vln.1
Vln.2
Vla.
Vc.

弦楽四重奏曲第1番《極域エナジーバジェット》

33

Vln.1

Vln.2

Vla.

Vc.

37

Vln.1

Vln.2

Vla.

Vc.

B

41

Vln.1

Vln.2

Vla.

Vc.

47

Vln.1

Vln.2

Vla.

Vc.

弦楽四重奏曲第1番《極域エナジーバジェット》

53

Vln.1

Vln.2

Vla.

Vc.

59

Vln.1

Vln.2

Vla.

Vc.

C arco

pizz.

65

Vln.1

Vln.2

Vla.

Vc.

73

Vln.1

Vln.2

Vla.

Vc.

arco sul tasto

p

弦楽四重奏曲第1番《極域エナジーバジェット》

81 *sul tasto*

Vln.1 *p* *ff* *ff* *sul ponticello*

Vln.2 *p* *ff*

Vla. *p* *ff*

Vc. *arco sul tasto* *p* *ff*

87 *fp* *ff* *ff* *♩ = 66 ca.*

Vln.1 *ff*

Vln.2 *ff* *sul ponticello* *ff* *ff*

Vla. *ff* *sul ponticello* *ff*

Vc. *ff* *sul ponticello* *fp* *ff*

95 *sul tasto* *f* *mf* *pp* *F*

Vln.1 *f* *mf* *pp*

Vln.2 *f* *mf* *pp*

Vla. *f* *mf* *pp*

Vc. *f* *mf* *mp*

105 *mp* *pp*

Vln.1 *mp*

Vln.2 *pp*

Vla. *pp*

Vc. *pp*

弦楽四重奏曲第1番《極域エナジーパジェット》

♩ = 88 ca. (♩. = 117 ca.)

G

Vln.1 113 *pp* *simile...*

Vln.2 113 *pp* *simile...*

Vla. 113

Vc. 113 *pp* *simile...*

Vln.1 117 *p* *mf*

Vln.2 117 *p* *mf*

Vla. 117 *p* *simile...* *mf*

Vc. 117 *p* *mf*

H

Vln.1 121 *sub.p* *f*

Vln.2 121 *sub.p* *f*

Vla. 121 *sub.p* *f*

Vc. 121 *sub.p* *f*

Vln.1 125 *pppp* *simile...* *poco a poco cresc...*

Vln.2 125 *pppp* *simile...* *poco a poco cresc...*

Vla. 125 *poco a poco dim...*

Vc. 125 *simile...* *poco a poco dim...*

弦楽四重奏曲第1番《極域エナジーバジェット》

129

Vln.1

Vln.2

Vla.

Vc.

133

Vln.1

Vln.2

Vla.

Vc.

137

Vln.1

Vln.2

Vla.

Vc.

I

pppp *ff* *simile...*

141

Vln.1

Vln.2

Vla.

Vc.

弦楽四重奏曲第1番《極域エネルギーバジェット》

145

Vln.1

Vln.2

Vla.

Vc.

cresc.

ff

cresc.

ff

cresc.

ff

cresc.

ff

The image shows a musical score for a string quartet, specifically measures 145 to 150. It features four staves: Violin 1 (Vln.1), Violin 2 (Vln.2), Viola (Vla.), and Violoncello (Vc.). The key signature has one sharp (F#) and one flat (Bb). The score includes dynamic markings such as *cresc.* (crescendo) and *ff* (fortissimo). The Vln.1 part has a melodic line with some rests. The Vln.2, Vla., and Vc. parts have more rhythmic, textured passages. The Vc. part starts with a *cresc.* marking and reaches *ff* by measure 148. The Vln.2 and Vla. parts also reach *ff* by measure 148. The Vln.1 part has a *ff* marking in measure 148. The score ends with a double bar line in measure 150.

Vln.1

弦楽四重奏曲第1番《極域エナジーバジェット》

永井裕人

Intro. ♩=80 ca. (♩.=107 ca.)

16 *f*

19 *simile...*

23 **A**

27 *mp*

31

37 **B** *f* *arco* *mf*

43

49 *pizz.* *simile...*

57 **C** *arco*

63 *sul tasto* *p* 16

83 **D** *ff* *sul ponticello* *fp*

91 **E** ♩=66 ca. *ff* *sul tasto* *f* *mf*

101 **F** *pp* *mp*

111 **G** ♩=88 ca. (♩.=117 ca.) *pp* *simile...*

弦楽四重奏曲第1番《極域エネルギーバジェット》

117 *p* *mf*

121 *sub.p* *f* **H**

125 *pppp* *simile...* *poco a poco cresc...*

129

133

137 *ff* **I**

141

145 *cresc.* *fff*

Detailed description: This is a page of a musical score for a string quartet, specifically measures 117 through 145. The music is written in a single staff with a treble clef and a key signature of one flat (B-flat major or D minor). The score features a variety of dynamic markings, including *p* (piano), *mf* (mezzo-forte), *sub.p* (sub-piano), *f* (forte), *pppp* (pianissimo), *ff* (fortissimo), and *fff* (fortississimo). There are also performance instructions such as *simile...* and *poco a poco cresc...*. The score includes several repeat signs and a section marked with a boxed 'H' at measure 121 and a boxed 'I' at measure 137. The music consists of eighth and sixteenth notes, often beamed together, with some rests and fermatas. The overall texture is dense and rhythmic.

Vln.2

弦楽四重奏曲第1番《極域エネルギーバジェット》

永井裕人

Intro. ♩=80 ca. (♩.=107 ca.)

The musical score for Violin 2 consists of 10 staves of music. It begins with an introduction marked 'Intro.' with a tempo of approximately 80 beats per minute (♩=80 ca.) and a note value of 107 ca. The key signature has one flat (B-flat major or D minor). The score includes various dynamics such as *mf*, *f*, *mp*, *f*, *mf*, *p*, *ff*, and *pp*. Performance markings include *simile...*, *cresc.*, *pizz.*, *arco*, *sul ponticello*, and *sul tasto*. There are also performance directions like '12', '8', and '2' indicating specific techniques or durations. The score is divided into sections labeled A, B, C, D, and E. Section A starts at measure 23, B at 39, C at 61, D at 85, and E at 95. The piece concludes with a final dynamic of *pp* at measure 105.

弦楽四重奏曲第1番《極域エナジーバジェット》

105

113 **G** ♩ = 88 ca. (♩. = 117 ca.)

pp *simile...*

117 *p* *mf* **H**

121 *sub.p* *f* 2

125 *pppp* *simile...* *poco a poco cresc...*

129

133

137 **I** *ff*

141

145 *cresc.* *fff*

Detailed description: This is a page of a musical score for a string quartet. It consists of nine staves of music. The first staff (measures 105-112) features a melodic line with a long note and a fermata. The second staff (measures 113-120) is marked *pp* and *simile...*. The third staff (measures 117-120) is marked *p* and *mf*. The fourth staff (measures 121-124) is marked *sub.p* and *f*, with a double bar line and a '2' indicating a second ending. The fifth staff (measures 125-128) is marked *pppp* and *poco a poco cresc...*. The sixth staff (measures 129-132) continues the melodic line. The seventh staff (measures 133-136) continues the melodic line. The eighth staff (measures 137-140) is marked *ff* and has a section marker **I**. The ninth staff (measures 141-144) continues the melodic line. The tenth staff (measures 145-152) is marked *cresc.* and *fff*.

Vla.

弦楽四重奏曲第1番《極域エナジーバジェット》

永井裕人

Intro. ♩=80 ca. (♩.=107 ca.)

4

p

7

simile...

11

cresc. *mf*

15

cresc. *f*

19

23

A

mp

29

35

f

B

41 *pizz.* *mf* *simile...*

49

57

C *arco*

63

8

arco sul tasto *p*

75

D

81

p *ff* 4

弦楽四重奏曲第1番《極域エナジーバジェット》

89 *sul ponticello* E ♩ = 66 ca. *ff* *ff* *sul tasto*

97 *f* *mf* *mp* F

105 *pp*

113 G ♩ = 88 ca. (♩. = 117 ca.) *p*

119 *simile...* *mf* *sub.p* *f* H

123 *poco a poco dim...* I

131 *pppp*

139 *ff* *simile...*

143 *cresc.*

147 *fff*

Vc. 弦楽四重奏曲第1番《極域エネルギーバジェット》

永井裕人

Intro. ♩=80 ca. (♩.=107 ca.)

pp *cresc.* *simile...*

5

p

9

cresc.

13

mf *cresc.*

17

f

21

A

25

29

33

37

B

41 *pizz.* *simile...*

mf

49 *arco*

55

C

61 *pizz.*

弦楽四重奏曲第1番《極域エナジーバジェット》

67

81 arco sul tasto
p *ff*

90 sul ponticello *ff* *fp* *ff* *f*
sul tasto

99 *mf* *pp*

111 *pp* *simile...*

117 *p* *mf*

121 *sub.p* *f* *simile...*

127 *poco a poco dim...*

133 *pppp*

139 *ff*

145 *cresc.* *fff*

8

D

E ♩ = 66 ca.

F

G ♩ = 88 ca. (♩. = 117 ca.)

H

I