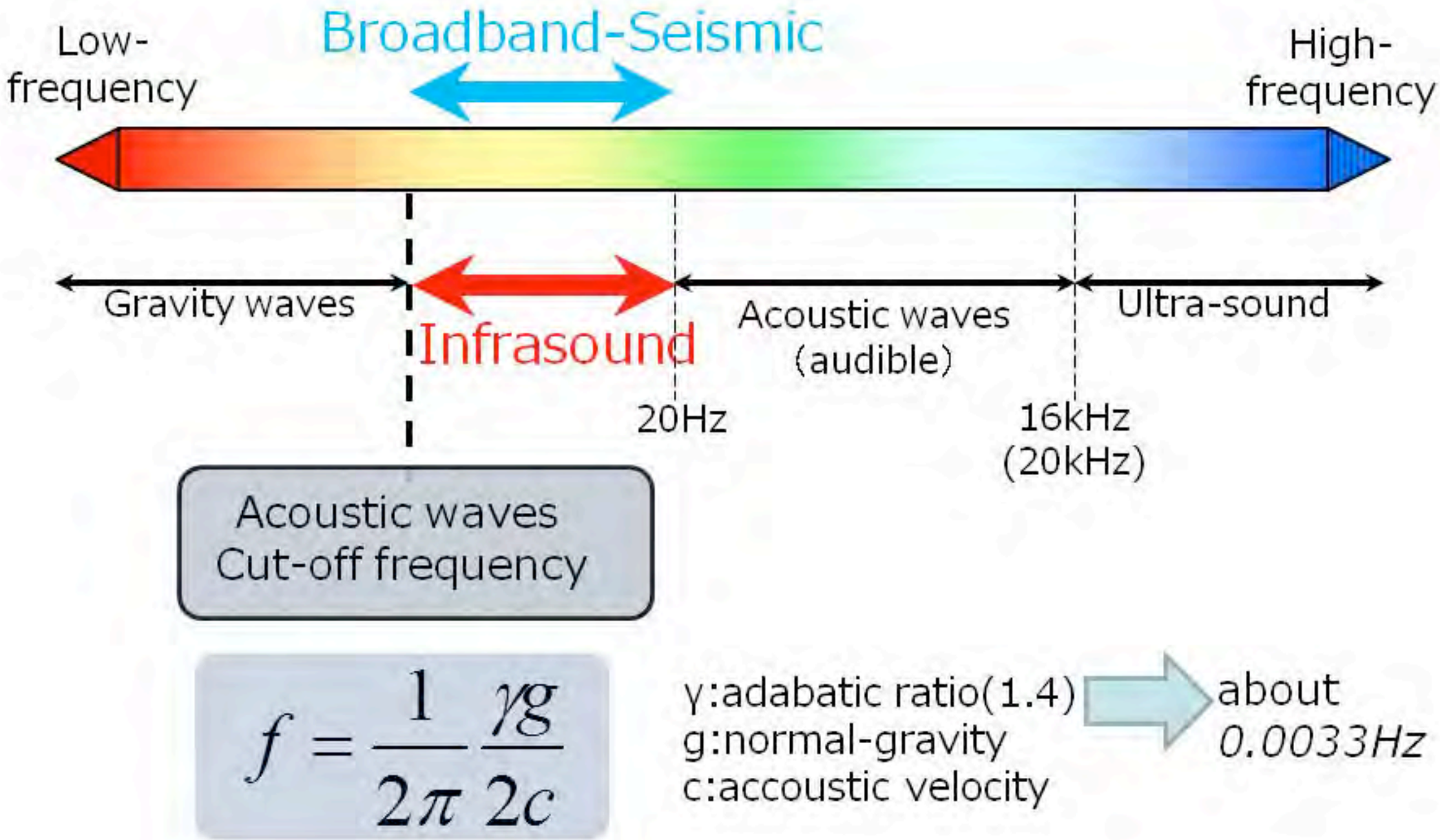
南極昭和基地及び周辺露岩域でのインフラサウンド計測 :11年の観測成果・データ公開

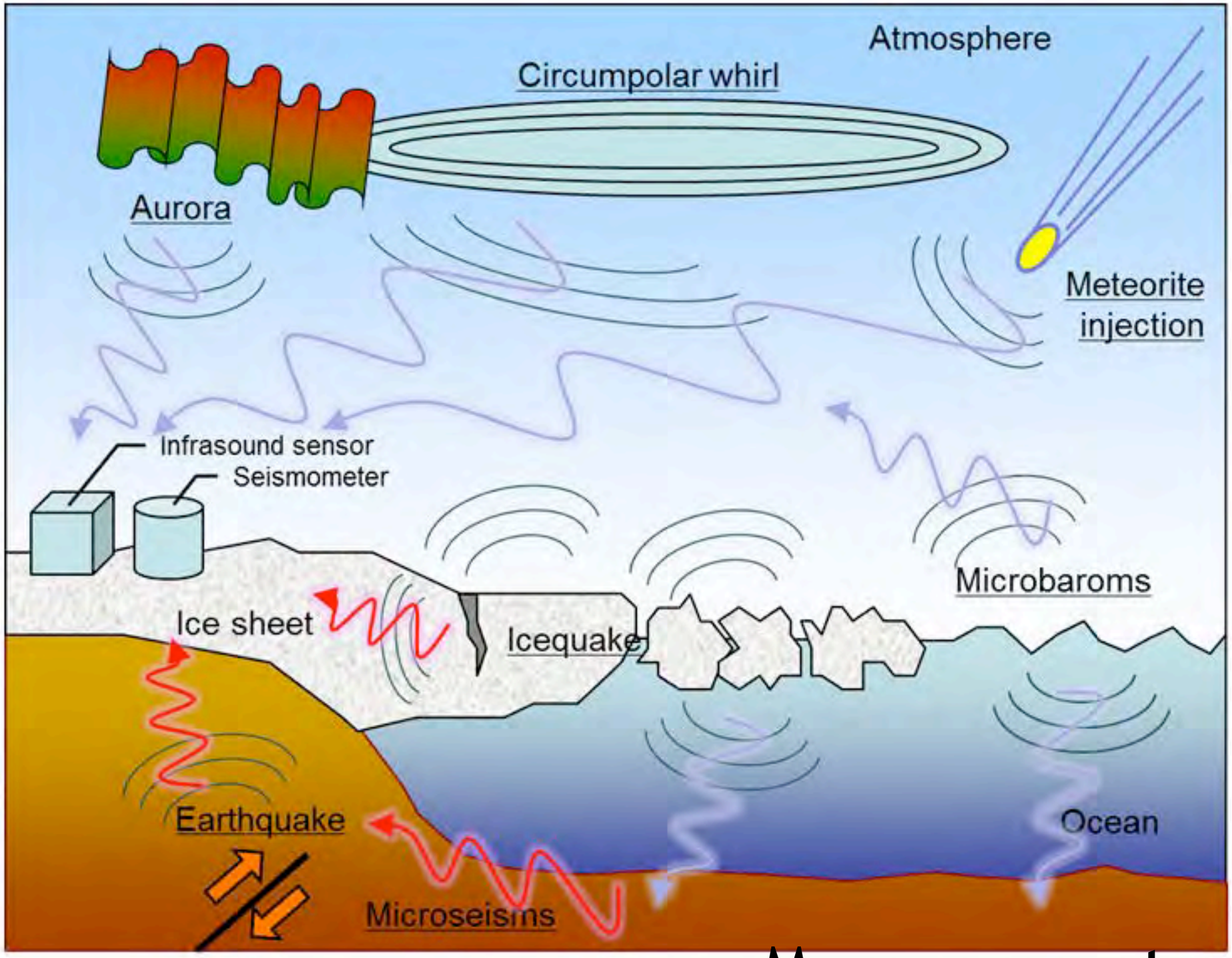
石原吉明（NIES）

What is Infrasound…



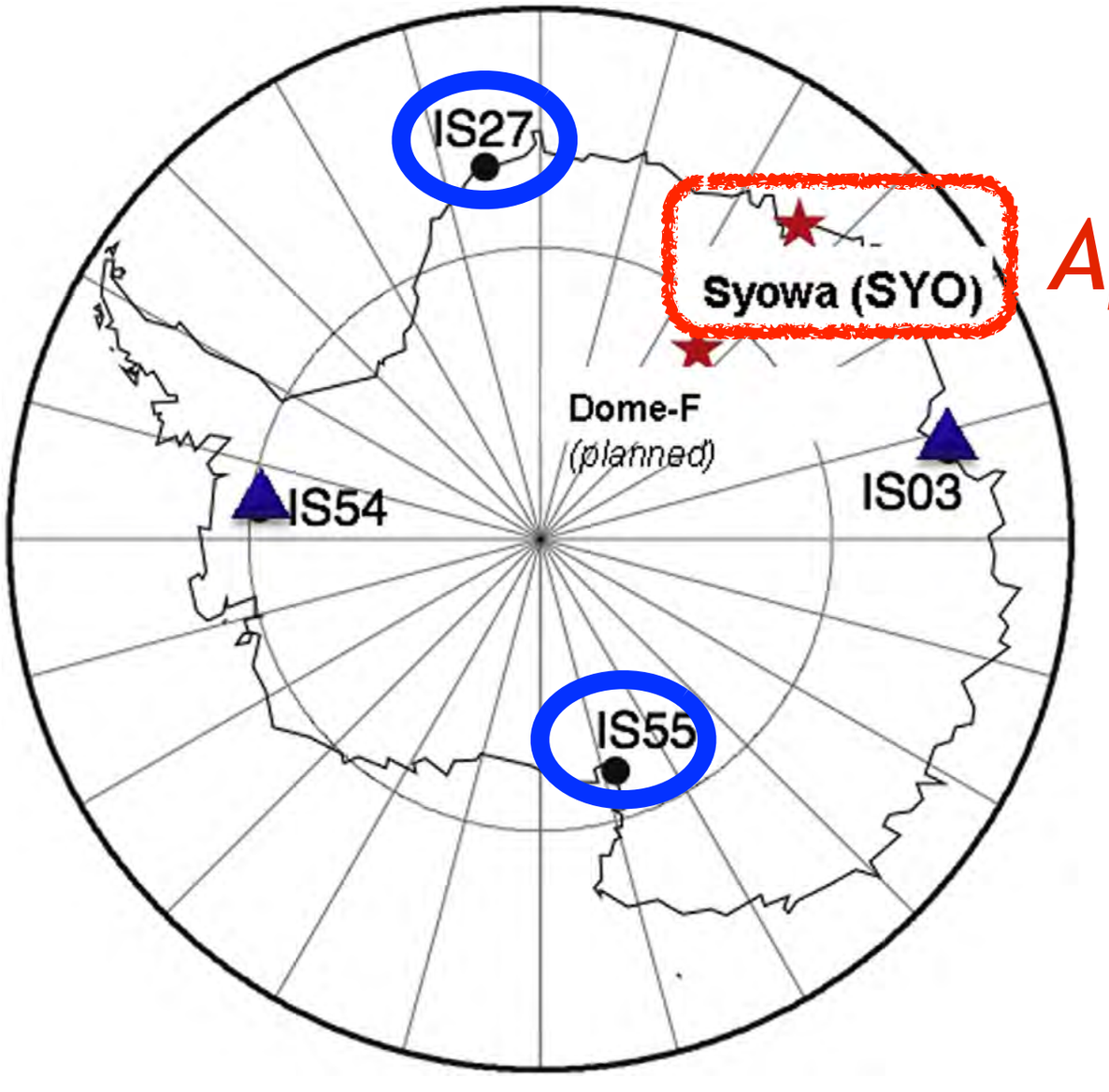
Murayama et al. 2014

Objectives for Infrasound Observation at Antarctica



Murayama et al. 2014

Infrasound Stations at Antarctica



Apr. 2008 ~

Figure 2. Infrasound stations currently operating in Antarctica (solid circles; IS27, IS55), together with planned ones (blue triangles; IS03, IS54), respectively. The Japanese Stations of Syowa (SYO; mentioned in this paper) and Dome-F (as planned) are indicated by the red stars.

Ishihara et al. 2015

History of Infrasound Observation at Syowa Station

- Installed at Apr. 2008
  - One Chaparrall Physics Model-2
- Re-installed at Jan. 2013
  - Three Chaparall Physics Model-25 as triangle array (aperture size: 200 m)
  - Wind noise reduction system (Porous Hose Array) is re-designed.

Infrasound Station at Syowa Station

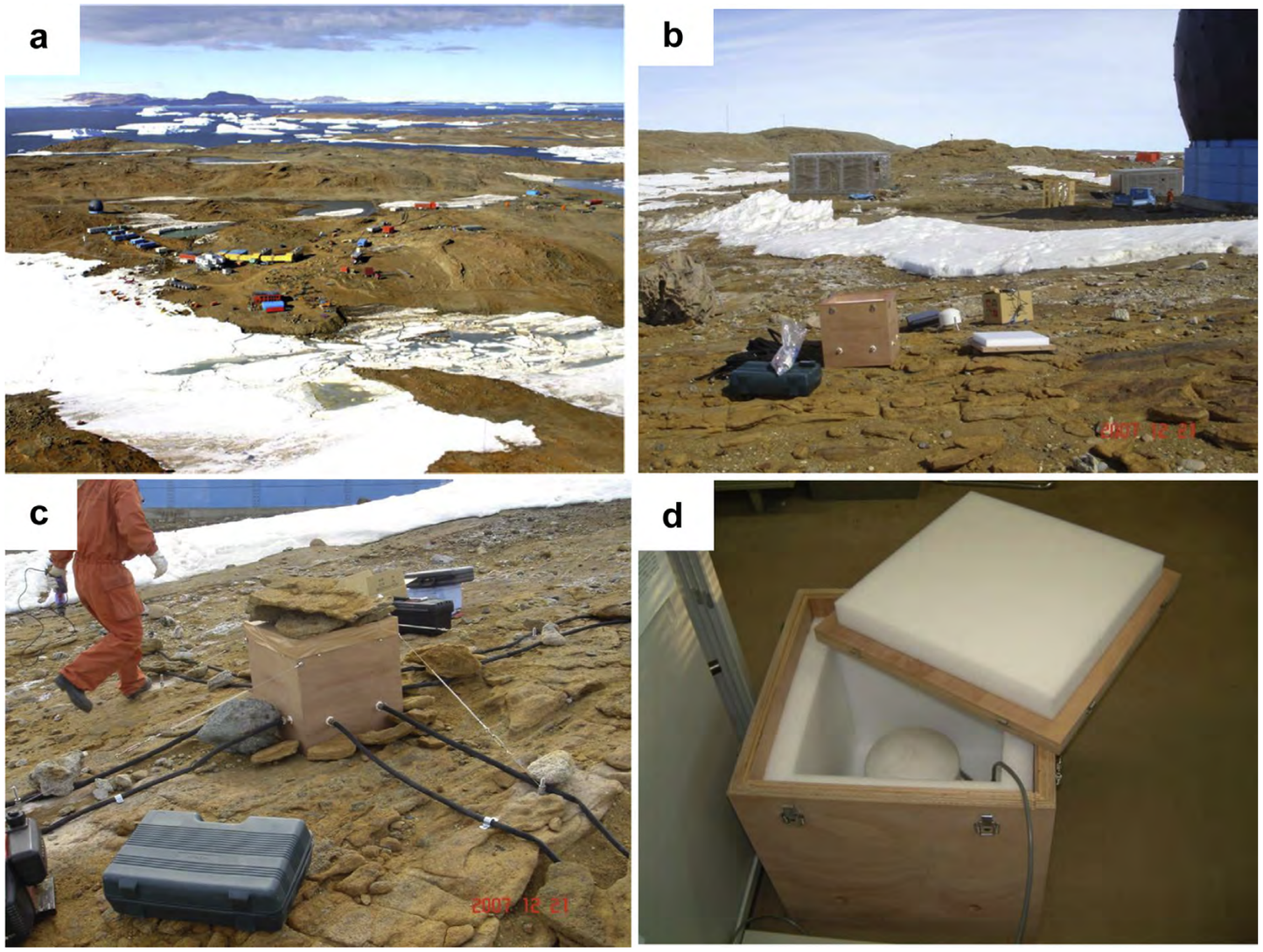
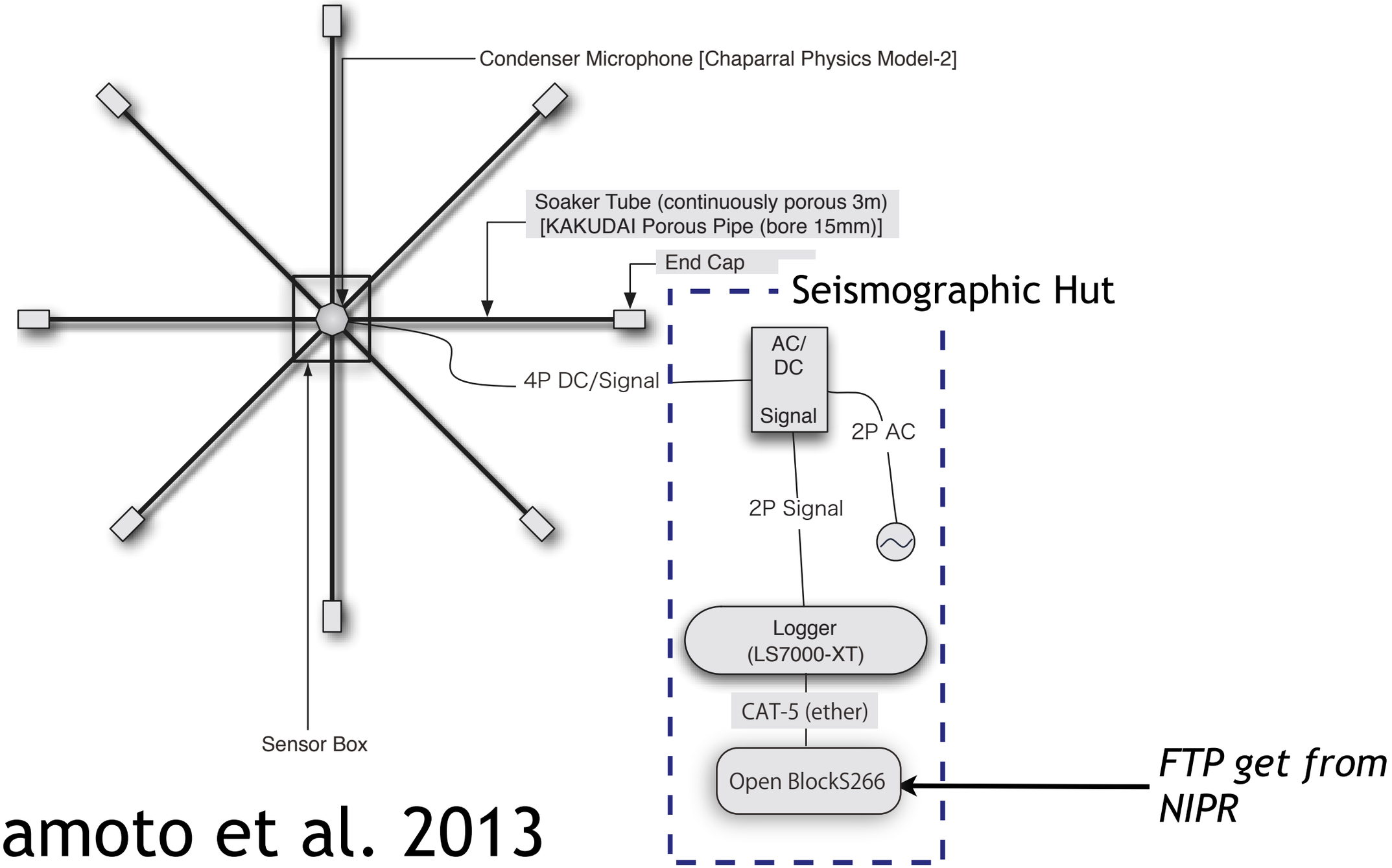


Figure 3. Several photos of the infrasound observation at Syowa Station (SYO), in the Lützow-Holm Bay, East Antarctica. (a) Overview of SYO in East Ongul Island. (b) Infrasound station near the seismological hut and VLBI satellite antenna. The recording system is installed in the seismological hut. (c) The infrasound sensor inside the adiabatic wooden box, attached with eight air-pipes (hoos array system). (d) The Chaparral Physics Model-2 type sensor is installed inside the wooden box.

Ishihara et al. 2015

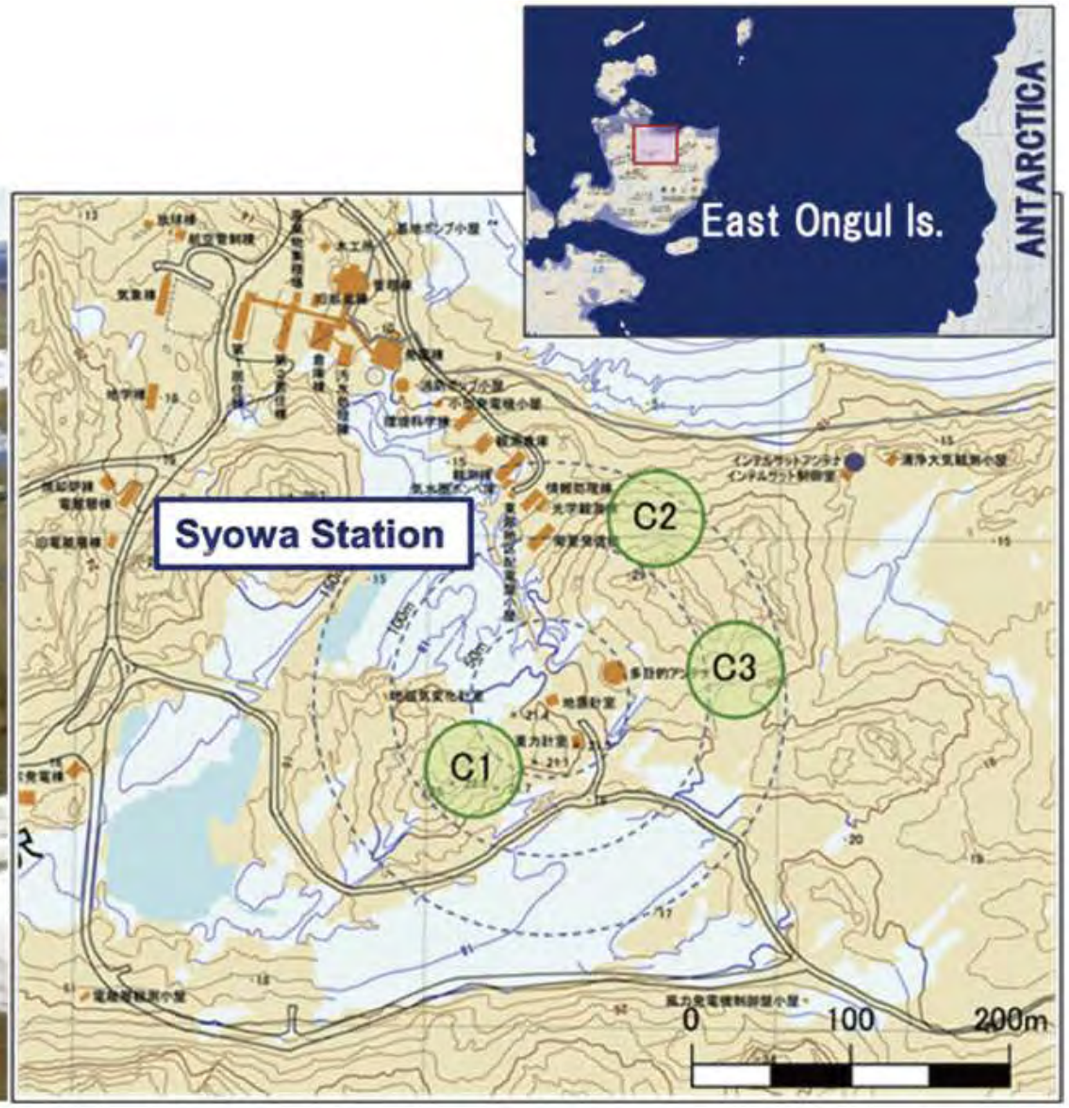
Schematics of Observation System for Syowa Station



Yamamoto et al. 2013

History of Infrasound Observation at Syowa Station

- Installed at Apr. 2008
  - One Chaparrall Physics Model-2
- Re-installed at Jan. 2013
  - Three Chaparall Physics Model-25 as triangle array (aperture size: 200 m)
  - Wind noise reduction system (Porous Hose Array) is re-designed.


ANTARCTICA
East Ongul Is.
Syowa Station
C1
C2
C3
0
100
200m

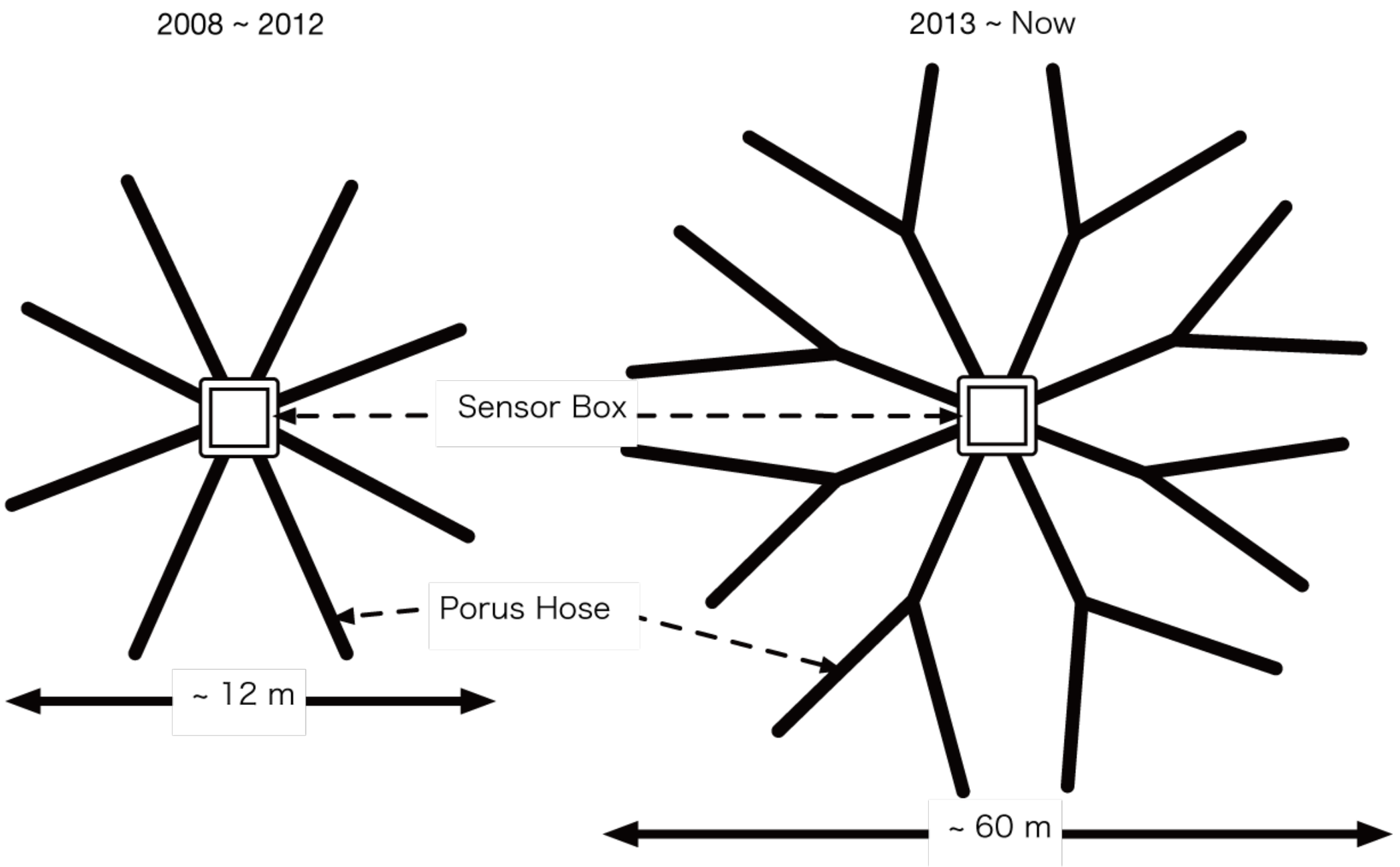
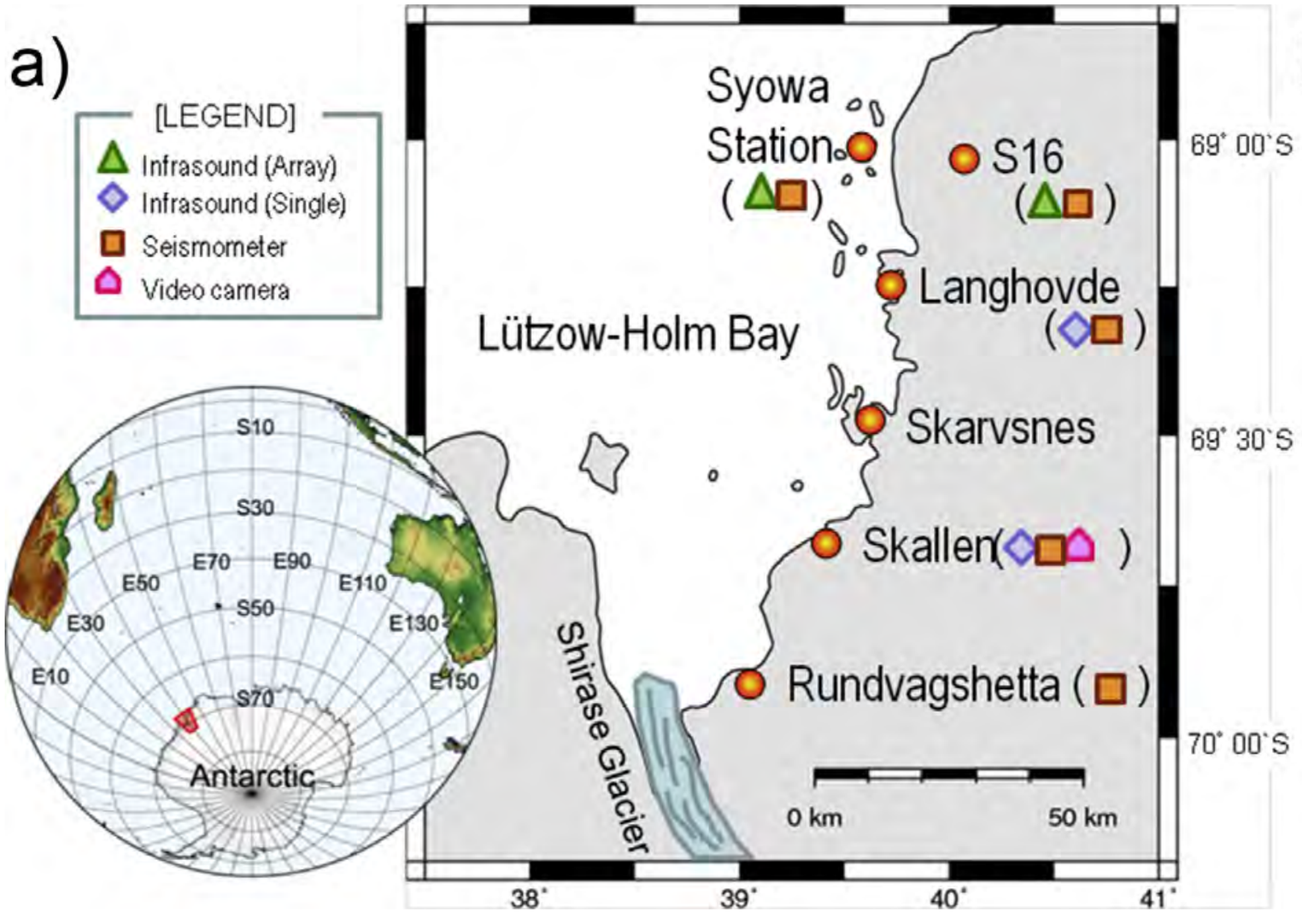
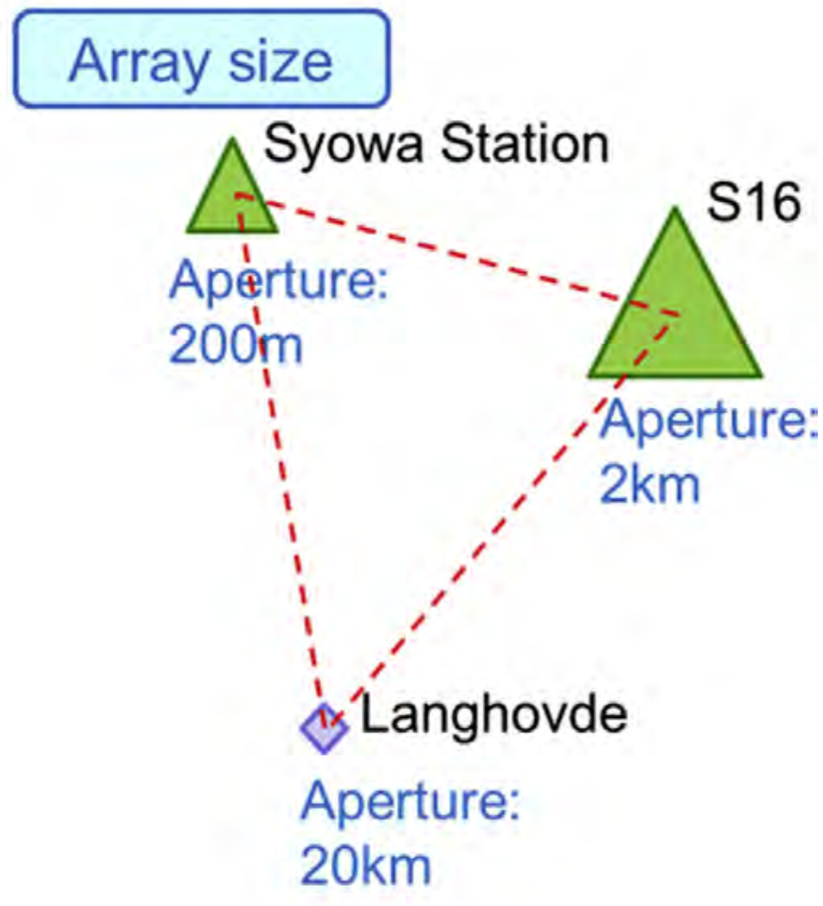
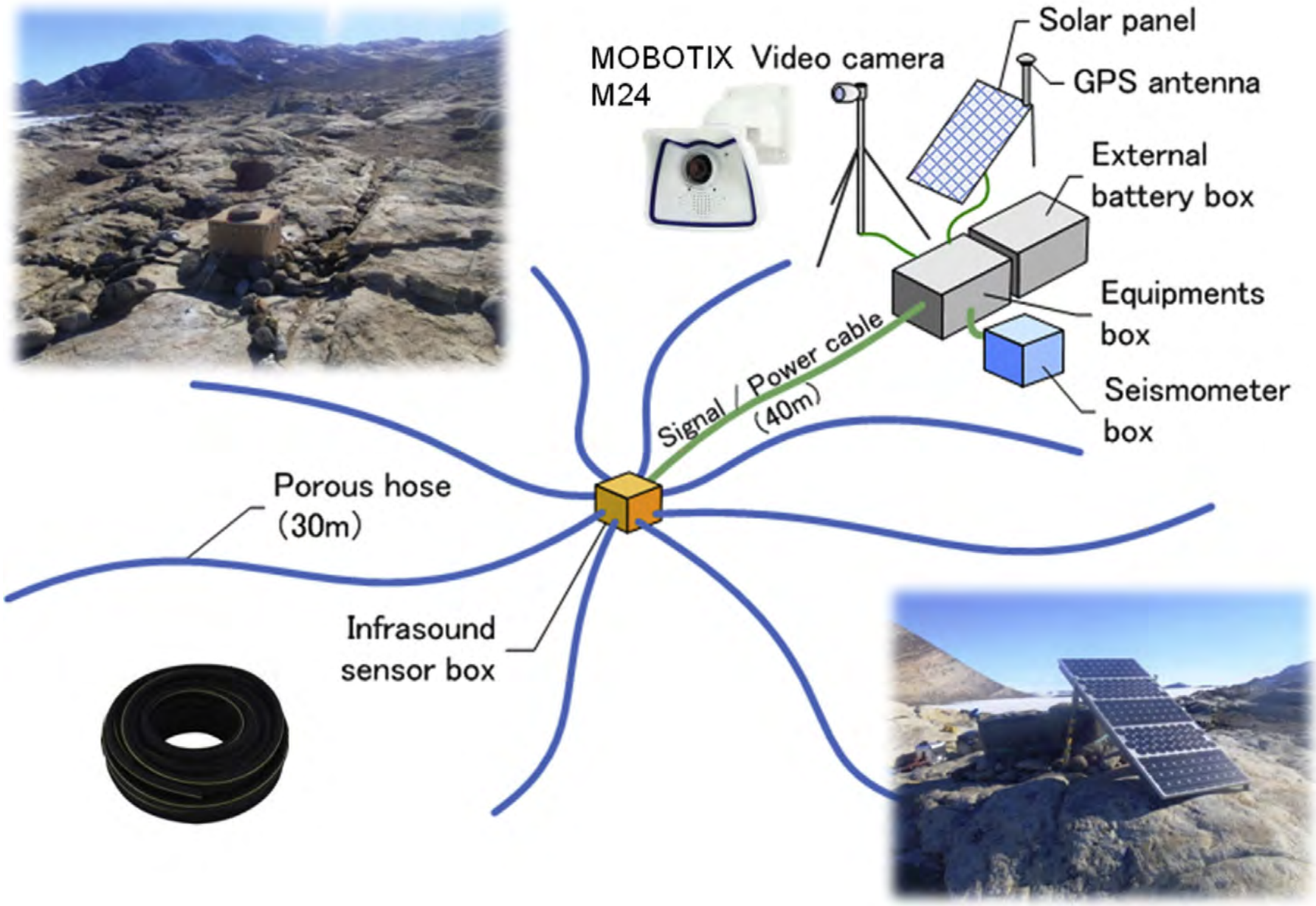


Figure 3: Schematic diagram of the observation with wind noise reducing hose array system at Syowa Station. (Left) Simple connection type porous hoses (8 set, 6 m each, the total diameter of hose array system is about 12 m) was used in the pilot observation periods. (Right) Multi-connection type porous hoses (8 set, total diameter of hose array system is about 60 m) is used in current array observation.

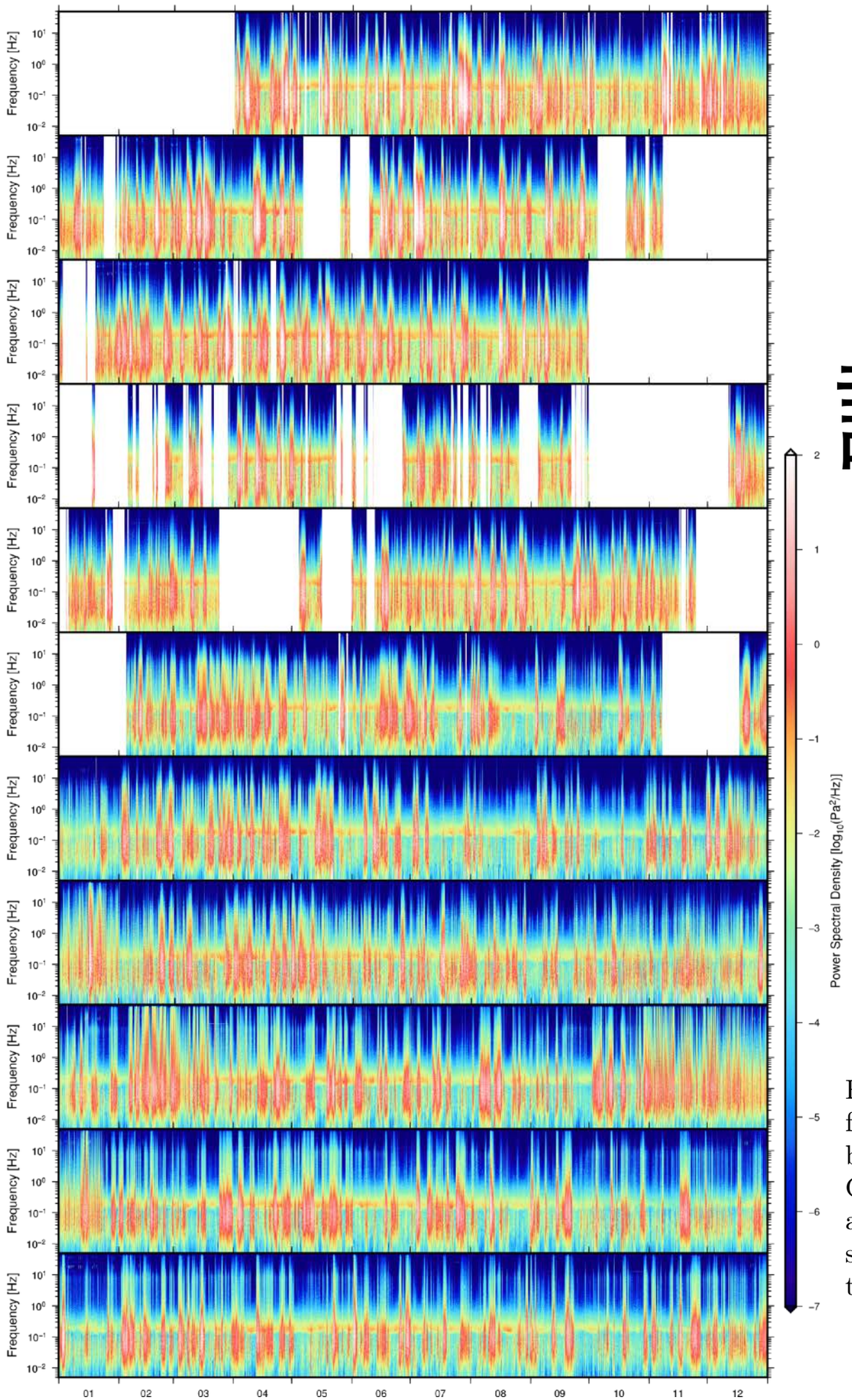
昭和基地及び露岩観測点






MOBOTIX Video camera
M24
Solar panel
GPS antenna
External
battery box
Equipments
box
Seismometer
box
Power cable
Signal / Power
(40m)
Porous hose
(30m)
Infrasound
sensor box

昭和基地での
インフラサウンド
記録（スペクトル）



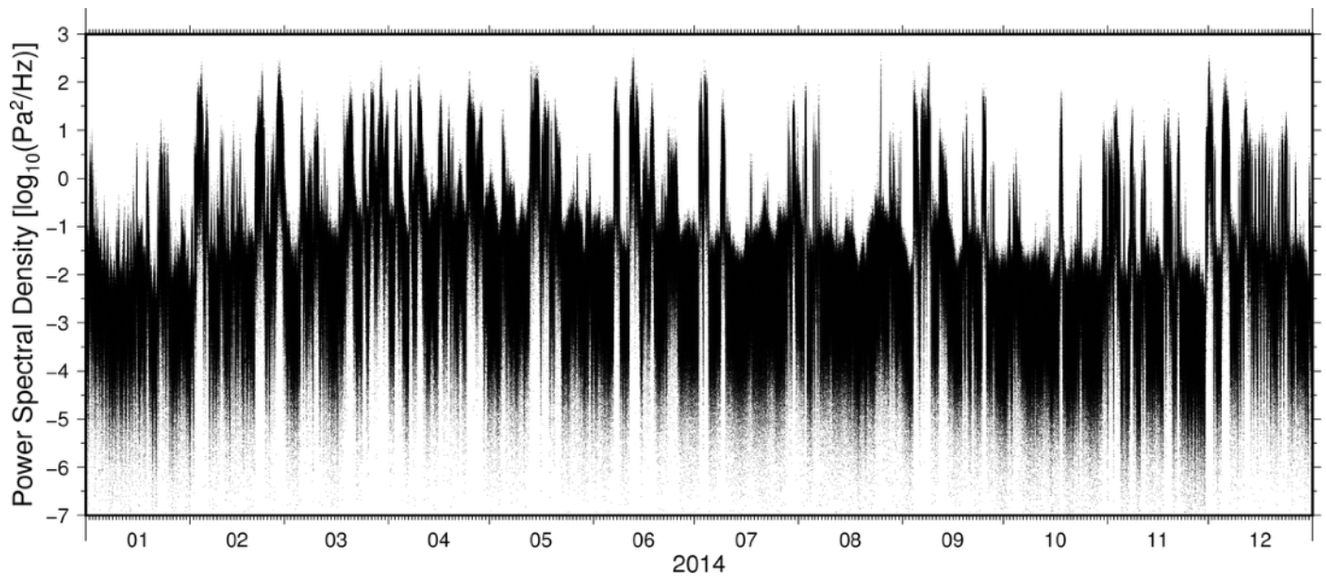


Figure 1: Spectrogram (Power spectral densities (PSD) of infrasound signals for eleven years (2008 (uppermost frame) to 2018 (bottom frame)) from the beginning of pilot observations at Syowa Station (SYO; one of the array sites; C1). The white-colored time zones correspond to the lack of data, otherwise, any errors occurred during the PSD processing. Predominant frequencies corresponding to the microbaroms (0.1 to 0.3 Hz bands) are clearly identified during the recording periods. The horizontal axis is the month of the year.

Ishihara et al. PDJ, inpress.

氷震

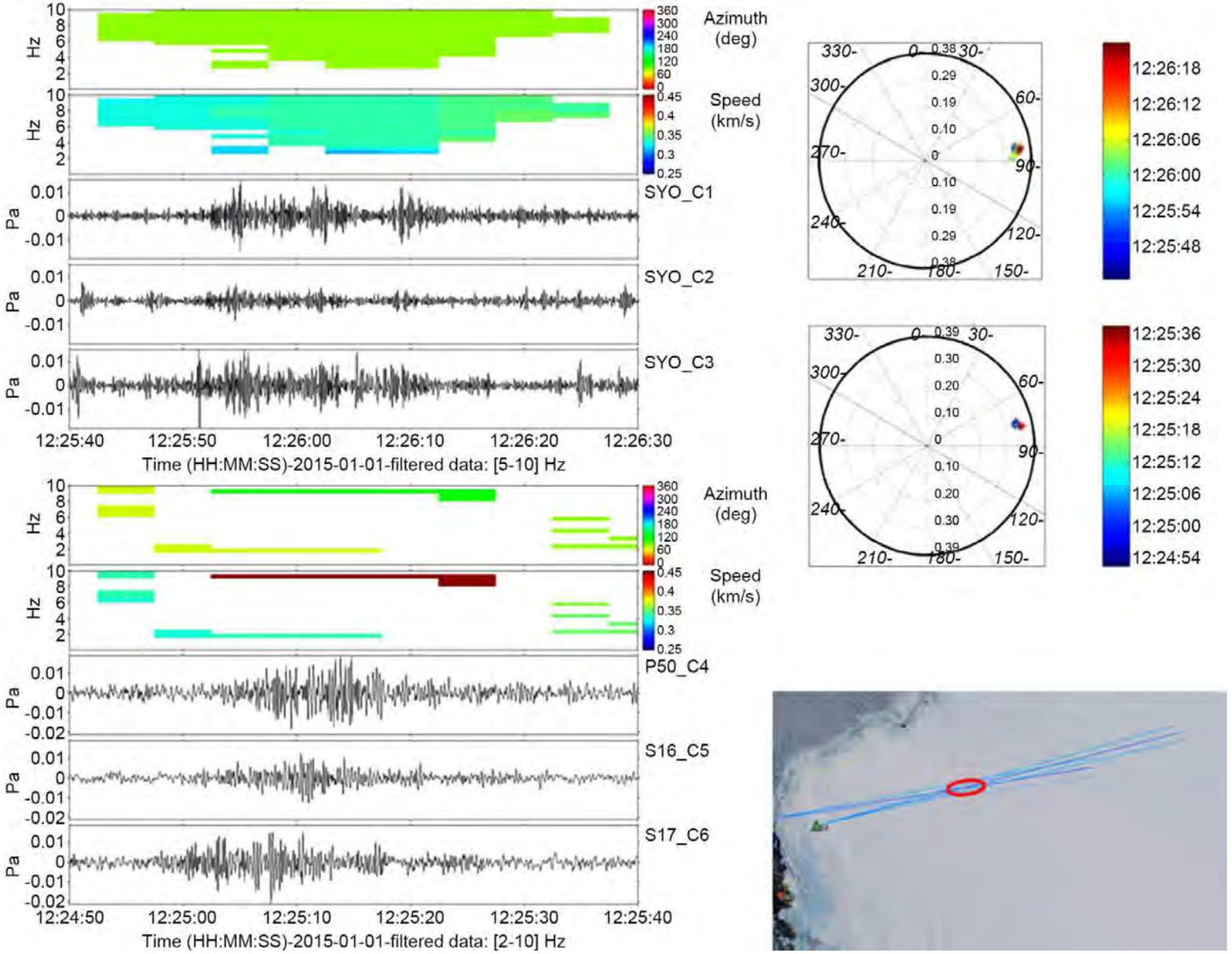


Figure 3. Detection of infrasonic signals associated with the ice-quake on the continental ice sheet on January 1, 2015 (forecasted origin time: 12:22 UTC). The left panels are band-pass-filtered waveforms observed at SYO and S16 arrays, respectively. The upper-right and middle-right panels are the results of PMCC analysis. The diagram shows the back-azimuth (station-to-source) direction and the apparent velocities. The lower-right panel is local area (on Google map) of the estimated event location. Colored lines show the back-azimuth directions from both SYO and S16. Open red circle corresponds to the area of hypocenter of the event.

Murayama et al. 2017

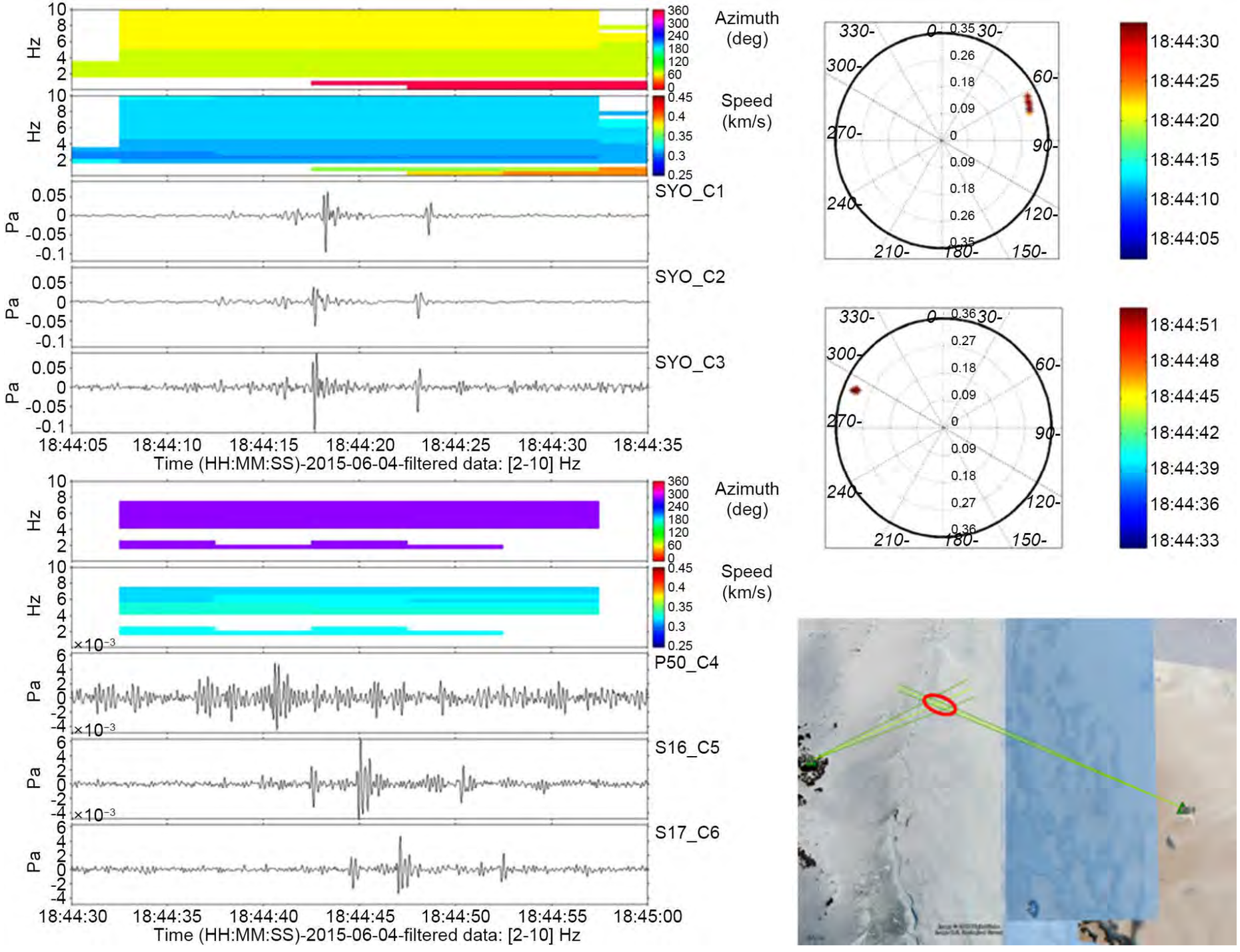


Figure 4. Detection of infrasonic signals generated by the calving event at a margin of continental ice sheet on June 4, 2015 (forecasted origin time: 18:43 UTC). The left panels represent band-pass-filtered waveforms observed at SYO and S16 arrays. The upper-right and middle-right panels are the results of PMCC analysis. The lower-right panel is local area (on Google map) of the estimated event location. Colored lines show the back-azimuth directions from both SYO and S16. Open red circle corresponds to the area of hypocenter of the event.

Murayama et al. 2017

データ転送と自動処理

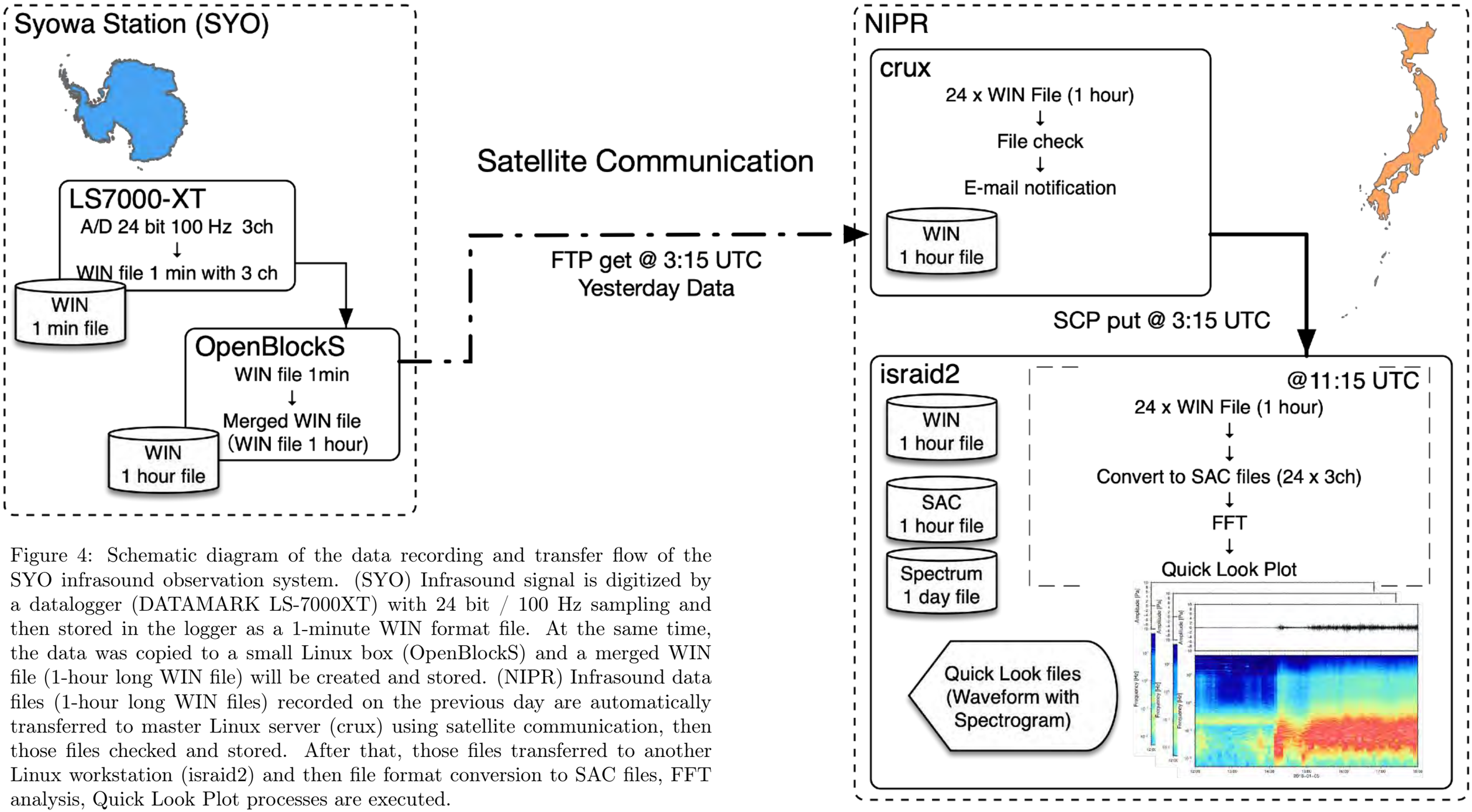


Figure 4: Schematic diagram of the data recording and transfer flow of the SYO infrasound observation system. (SYO) Infrasound signal is digitized by a datalogger (DATAMARK LS-7000XT) with 24 bit / 100 Hz sampling and then stored in the logger as a 1-minute WIN format file. At the same time, the data was copied to a small Linux box (OpenBlockS) and a merged WIN file (1-hour long WIN file) will be created and stored. (NIPR) Infrasound data files (1-hour long WIN files) recorded on the previous day are automatically transferred to master Linux server (crux) using satellite communication, then those files checked and stored. After that, those files transferred to another Linux workstation (israid2) and then file format conversion to SAC files, FFT analysis, Quick Look Plot processes are executed.

Ishihara et al. PDJ inpress

```
================================================
 Retrieve Infrasound Data from SYOWA Station
================================================
  Data Transfer Summary
------------------------------------------------
   FTP Start :  2018-03-26T12:15:02
   FTP End   :  2018-03-26T12:24:47
   24 files were transfered .

------------------------------------------------
  Data File Check
------------------------------------------------
winfile = /HSFS/isound/data/SYO/2018/18032500
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032501
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032502
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032503
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032504
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032505
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032506
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032507
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032508
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032509
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032510
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032511
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032512
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032513
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032514
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032515
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032516
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032517
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032518
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032519
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032520
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032521
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032522
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)

winfile = /HSFS/isound/data/SYO/2018/18032523
ch 0000 : 3600 / 3600 (100%)
ch 0001 : 3600 / 3600 (100%)
ch 0002 : 3600 / 3600 (100%)
```

データ転送と自動処理

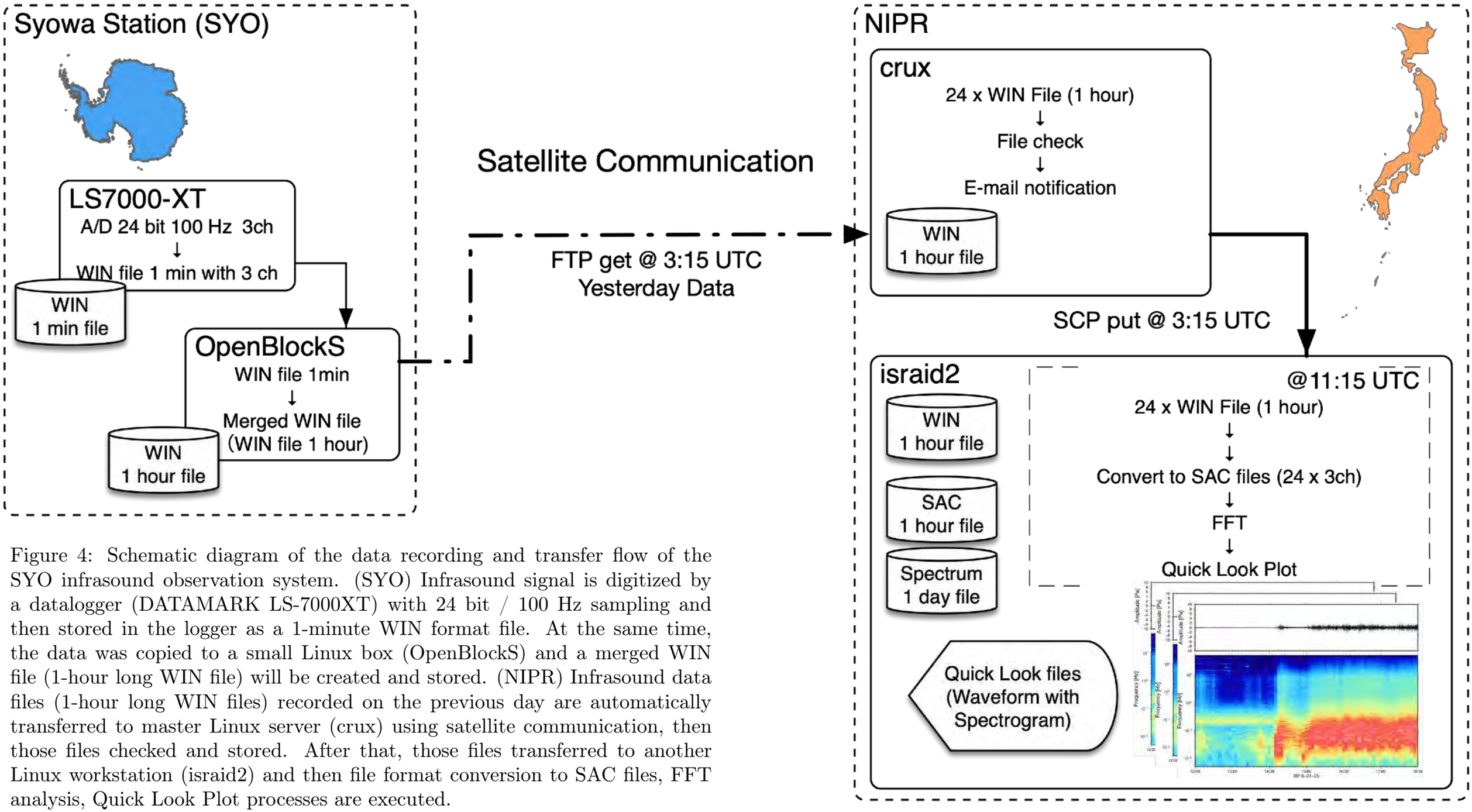


Figure 4: Schematic diagram of the data recording and transfer flow of the SYO infrasound observation system. (SYO) Infrasound signal is digitized by a datalogger (DATAMARK LS-7000XT) with 24 bit / 100 Hz sampling and then stored in the logger as a 1-minute WIN format file. At the same time, the data was copied to a small Linux box (OpenBlockS) and a merged WIN file (1-hour long WIN file) will be created and stored. (NIPR) Infrasound data files (1-hour long WIN files) recorded on the previous day are automatically transferred to master Linux server (crux) using satellite communication, then those files checked and stored. After that, those files transferred to another Linux workstation (israid2) and then file format conversion to SAC files, FFT analysis, Quick Look Plot processes are executed.

Ishihara et al. PDJ inpress

Amplitude [Pa]

10
8
6
4
2
0
−2
−4
−6
−8
−10

Frequency [Hz]

10^{1}
10^{0}
10^{-1}
10^{-2}

00:00
01:00
02:00
03:00
04:00
05:00
06:00

2020−01−25

Amplitude [Pa]
10
8
6
4
2
0
−2
−4
−6
−8
−10
Frequency [Hz]
10^{1}
10^{0}
10^{-1}
10^{-2}
06:00
07:00
08:00
09:00
10:00
11:00
12:00
2020−01−25

Amplitude [Pa]

10
8
6
4
2
0
−2
−4
−6
−8
−10

Frequency [Hz]

10^{1}
10^{0}
10^{-1}
10^{-2}

12:00
13:00
14:00
15:00
16:00
17:00
18:00

2020−01−25

Amplitude [Pa]

10
8
6
4
2
0
−2
−4
−6
−8
−10

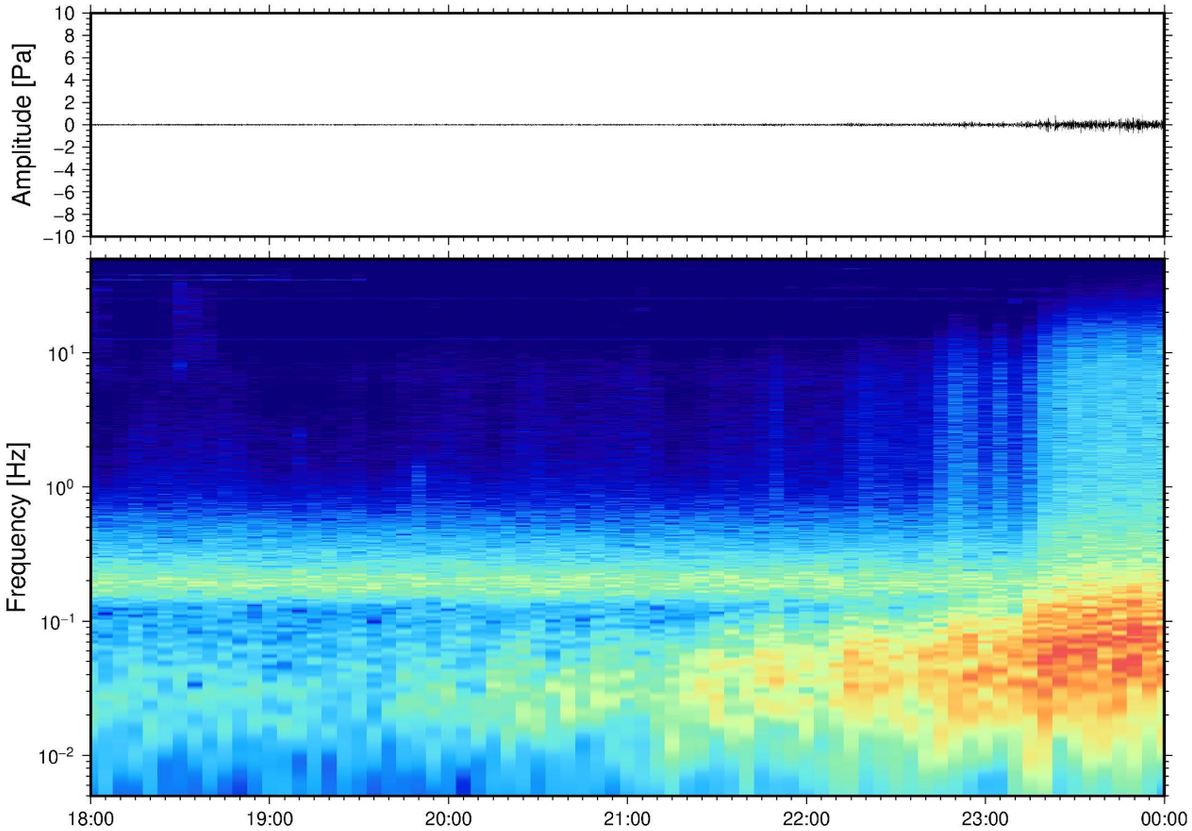
Frequency [Hz]

10^{1}
10^{0}
10^{-1}
10^{-2}

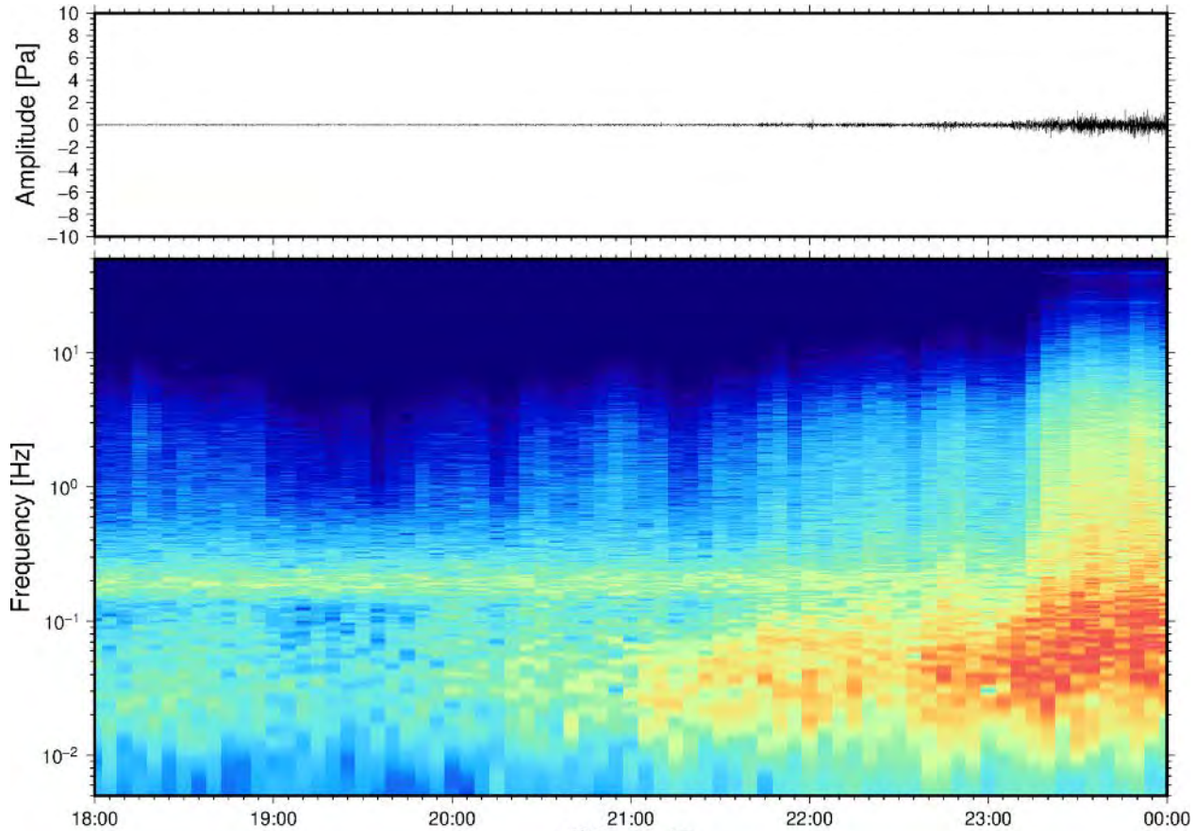
18:00
19:00
20:00
21:00
22:00
23:00
00:00

2020−01−25

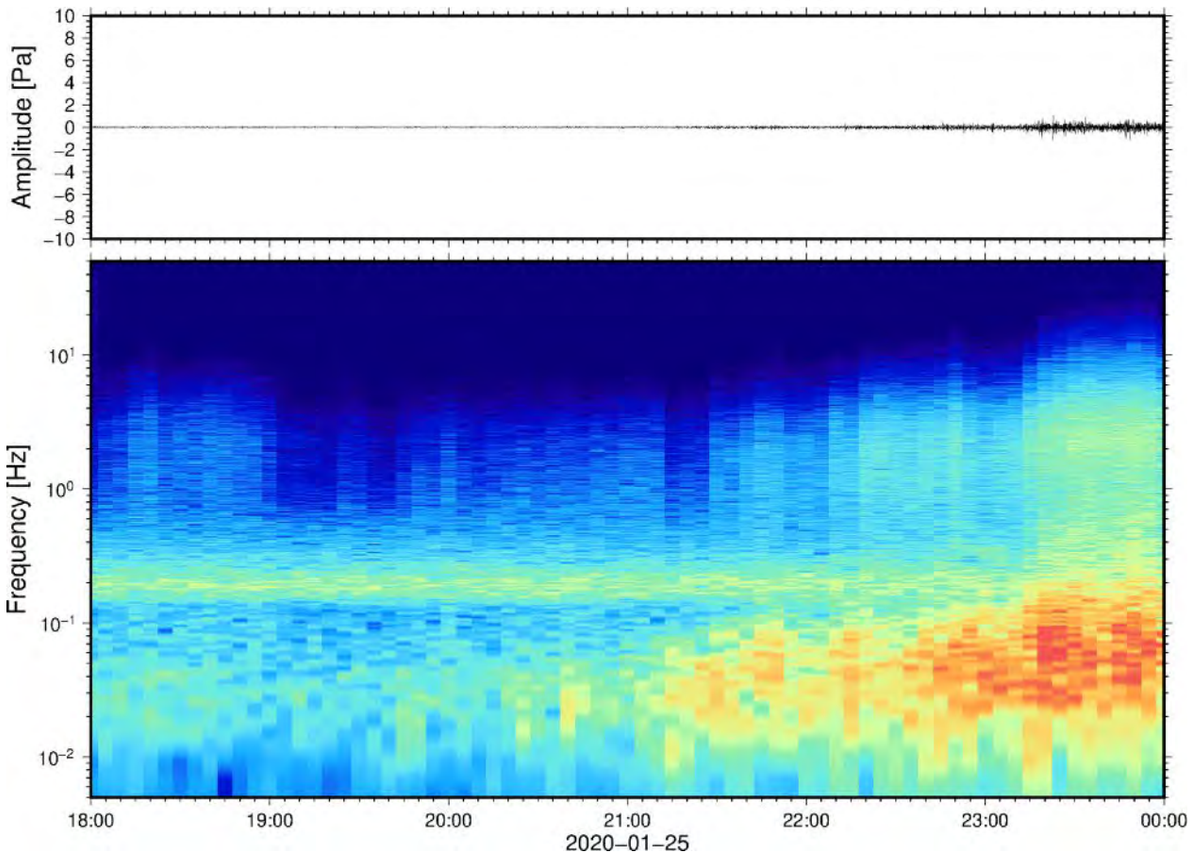
C1



C3



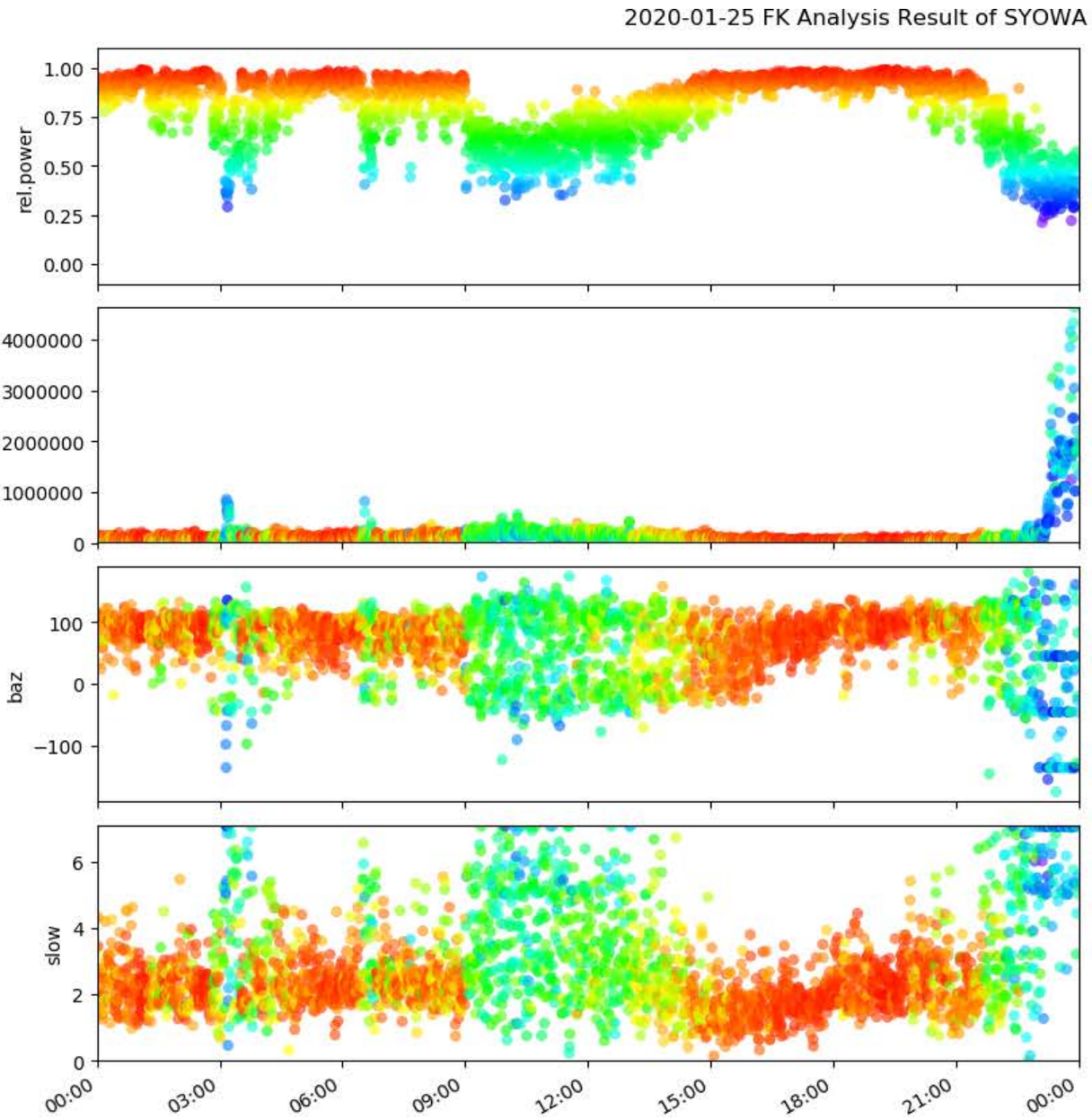
C2

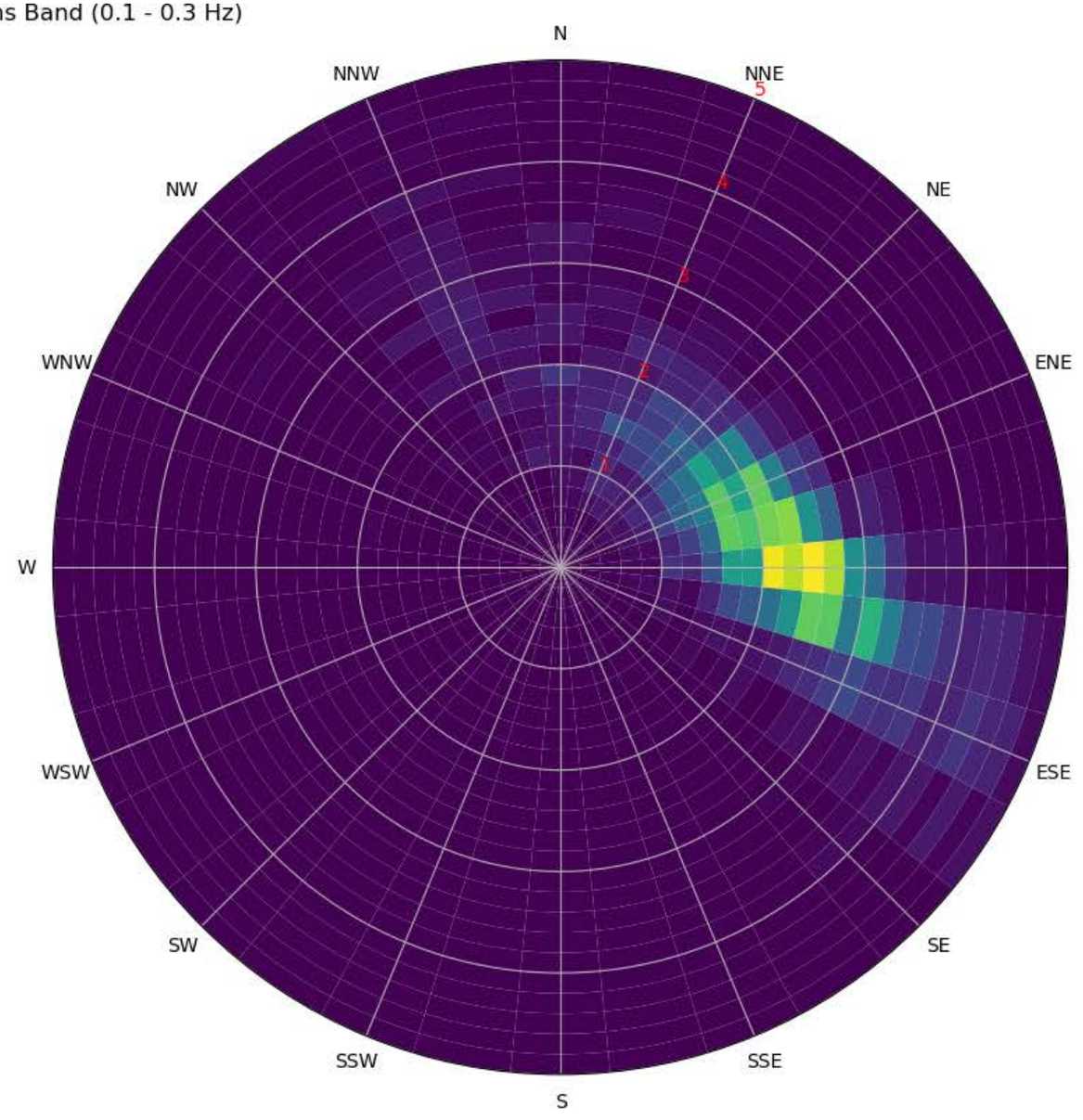


2020-01-25 18:00-24:00

ノイズレベルはC3が他の2要素と比べ高い

現在試行中のQL処理(FK解析)





インフラサウンドデータ公開

- https://ads.nipr.ac.jp/dataset/A20190705-001
    - Ishihara et al., PDJ, inpressに対応 2008-2018の11年分の昭和基地のデータ
- http://polaris.nipr.ac.jp/~isound/
    - 2008- 昭和基地のデータは1日遅れ、露岩データは夏隊で回収したデータを約1年遅れで公開（ディレクトリ公開）
- http://infrasound.mydns.jp/isound2/
    - ROIS研究費で開発中のGUIを持ったデータサイト