以一階峰寬度進行高頻雷達徑向流速之品質控制

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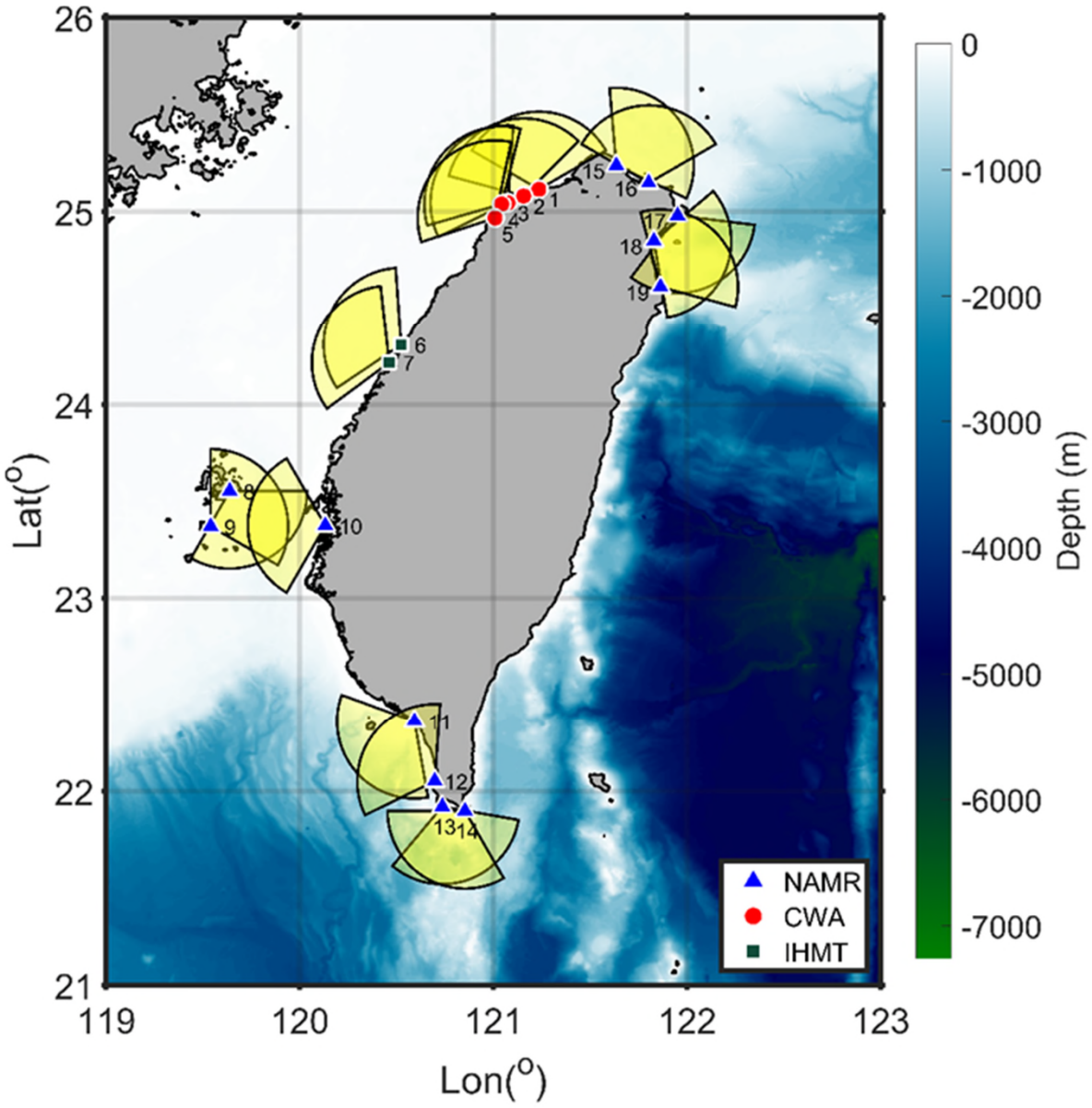
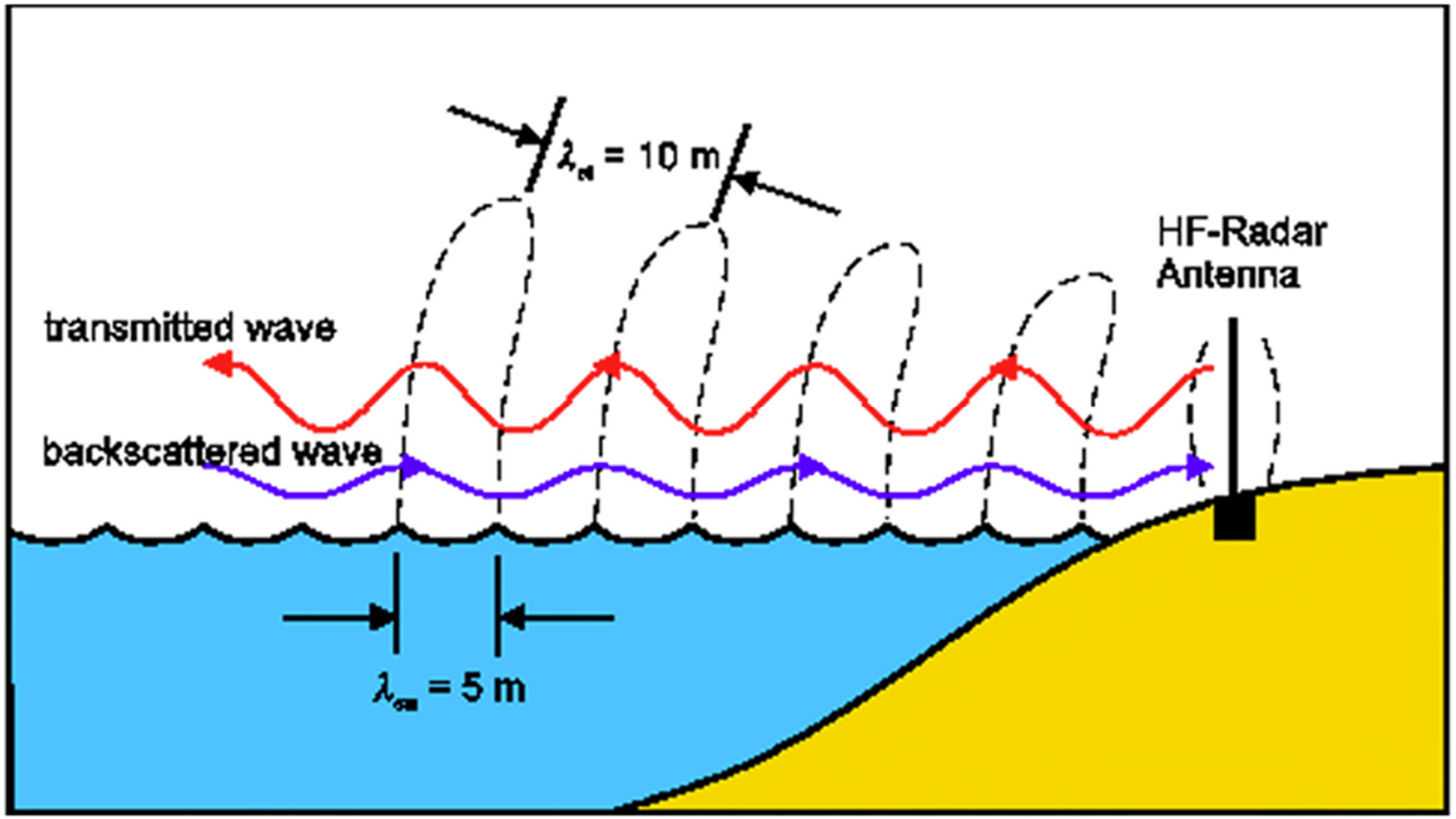
2025氣象署天氣分析與預報研討會

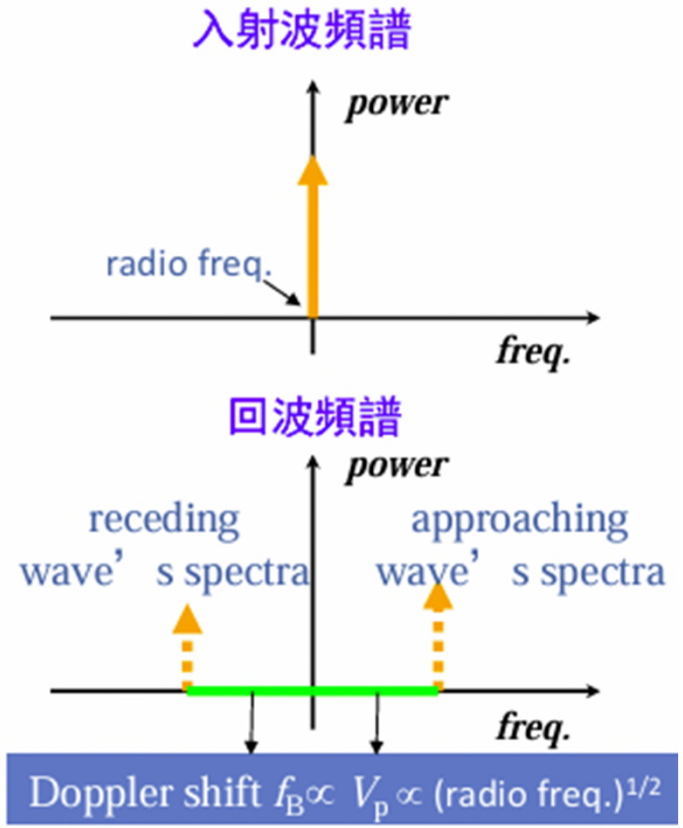
研究背景

- 為什麼需要高頻地基雷達
- 為什麼需要品質控制
- 現有品管方法不足之處



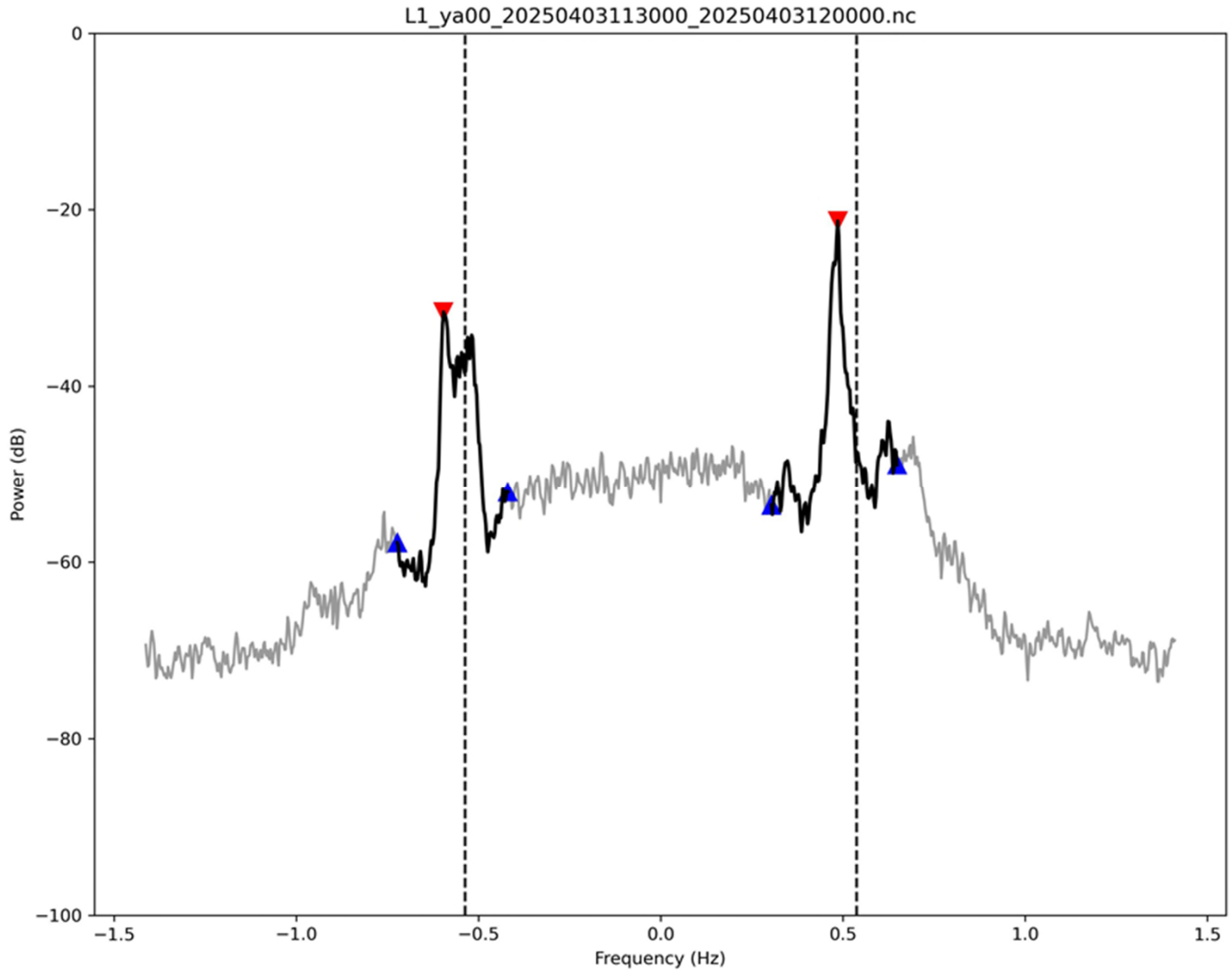
Bragg Resonant Backscatter





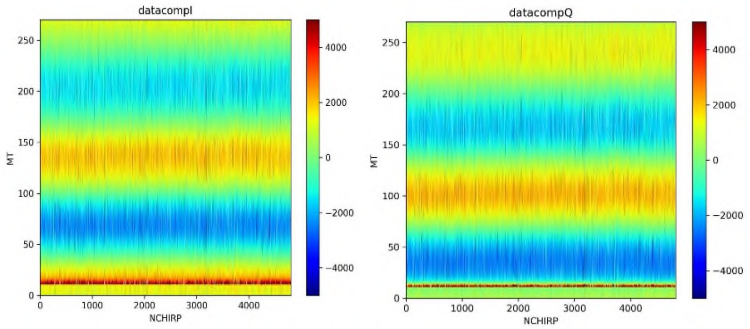
研究目的

- 一階峰寬計算方法探討
- 峰寬與資料品質之關聯性



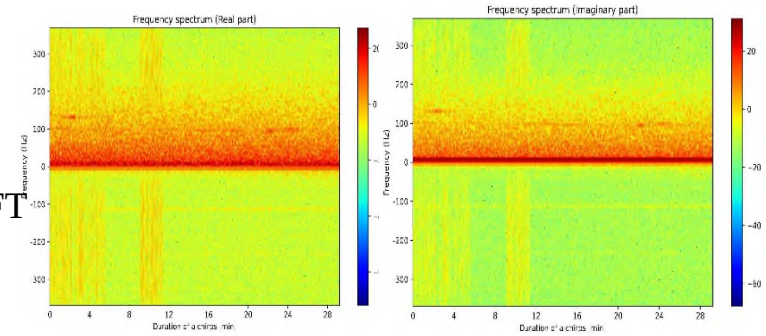
雷達資料處理流程

I、Q timeseries data(**Level 0**)



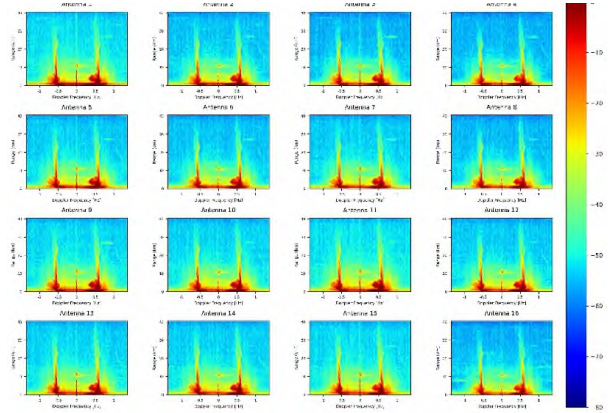
First FFT

Time-Range spectrum



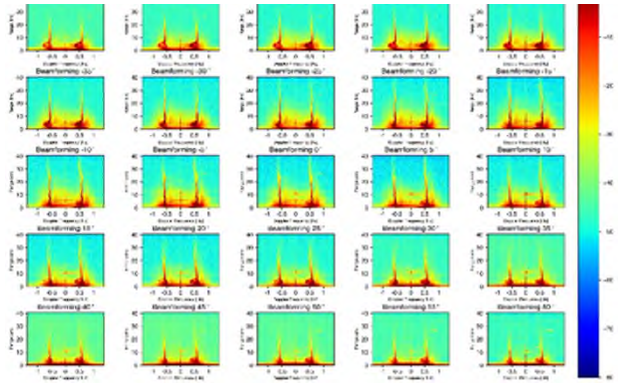
Second FFT

Per-antenna Doppler Spectrum



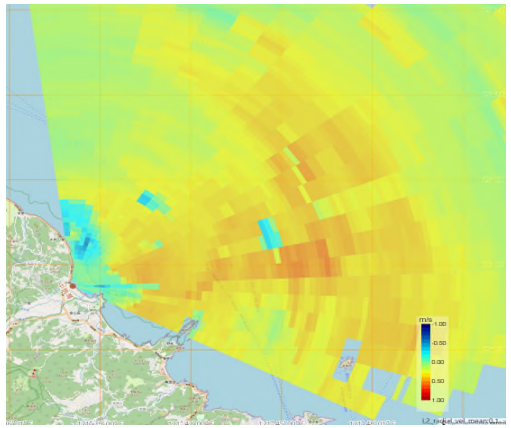
Azimuth estimation
（Beamforming）

Directional Doppler Spectrum
(**Level 1**)



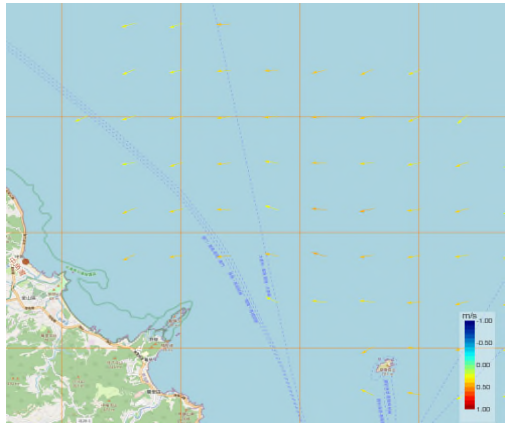
Retrieval of ocean-atmosphere parameters

Ocean-atmosphere from a single-station radar (**Level 2**)



Ocean current synthesis、Gridding of ocean-atmosphere parameters

Ocean-atmosphere parameters from multi-station radar (**Level 3**)



雷達品管流程

現有品管項目

L1品管		
項目	說明	門檻
SNR1st SNR1 rLR SNR2 p2 / m2 Rp21 rAv21	一階峰SNR SNR左右差值 二階峰最大及平均SNR 一二階峰強度比例 一二階峰平均能量比值	[10, 15] dB [6 ,12] dB [3 , 8] [5, 10] [1, 10]

海流

波浪

L2品管		
項目	說明	上下限
Curr Hs Tm WS	海流參數範圍 波浪參數範圍 週期參數範圍 風速參數範圍	[-1.2,1.2] [0.05, 9] [1.5, 30] [0.5, 40]

L0 (原始訊號)

L1 (都卜勒譜)

L1 品管

- 一階峰流速左右差值(海流)
- 一階峰左右是否分岔(海流)
- 一階峰寬度(海流)
- **SNR覆蓋面積(海流、波浪)**

L2 (參數計算)

L2 品管

- 時空間上連續性品管
- **空間變異性品管(波浪)**
- GDOP (海流)

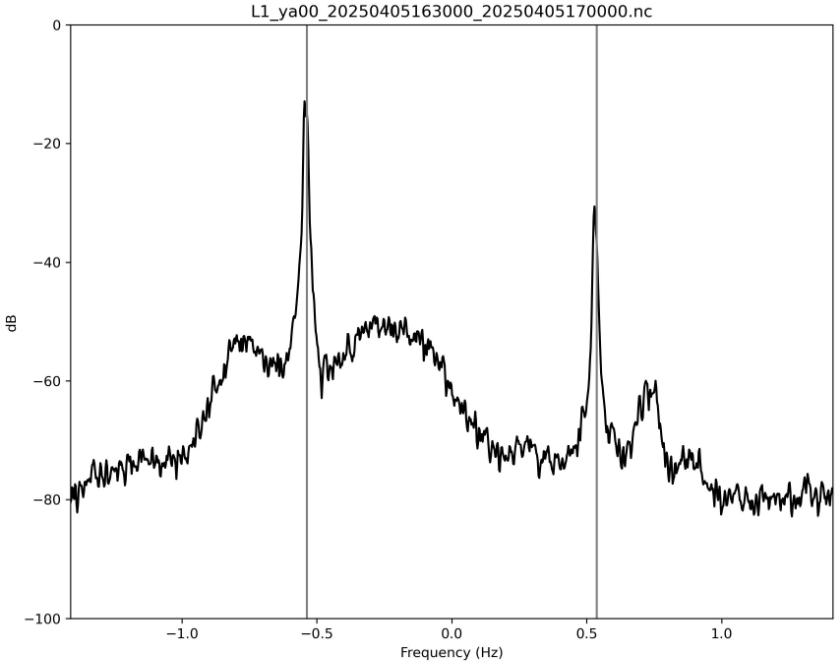
L3 (網格化)

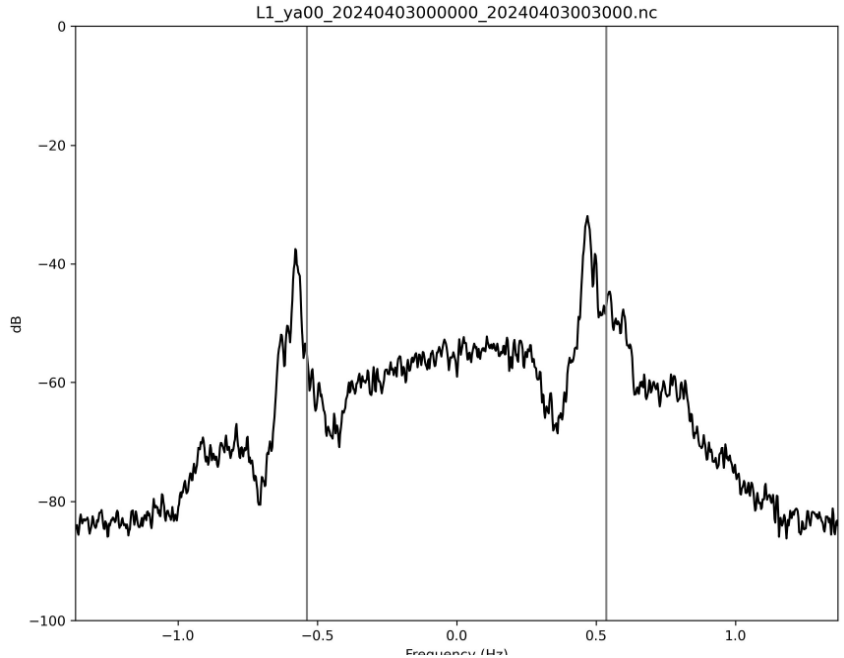
L3 品管

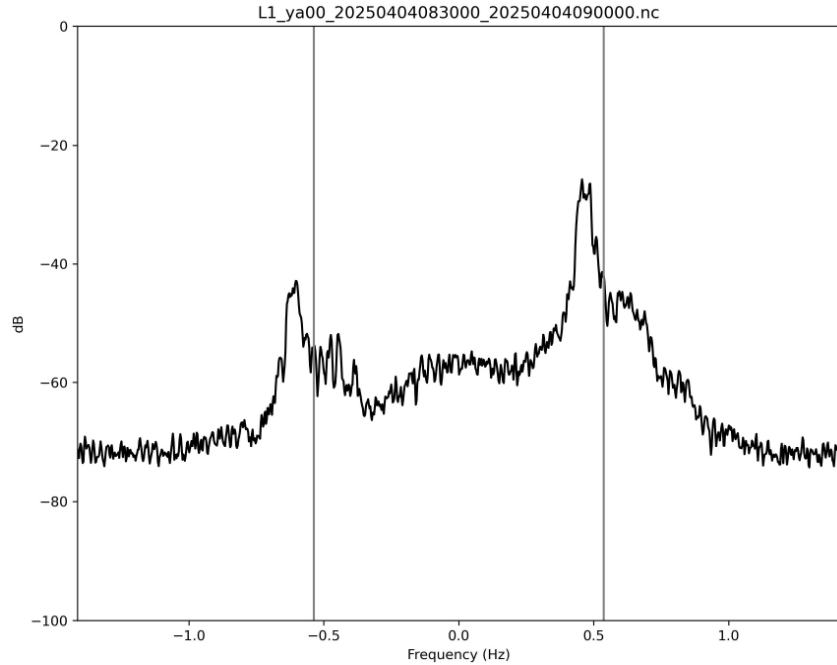
- 潮汐橢圓 (海流)
- 資料密度(海流)
- **時間連續性品管(波浪)**

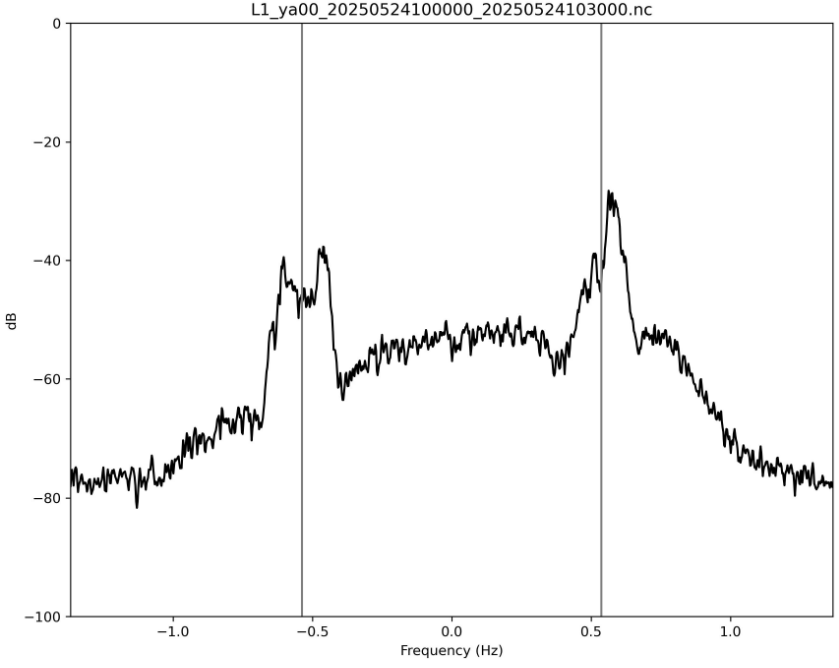
網格化、單點產品

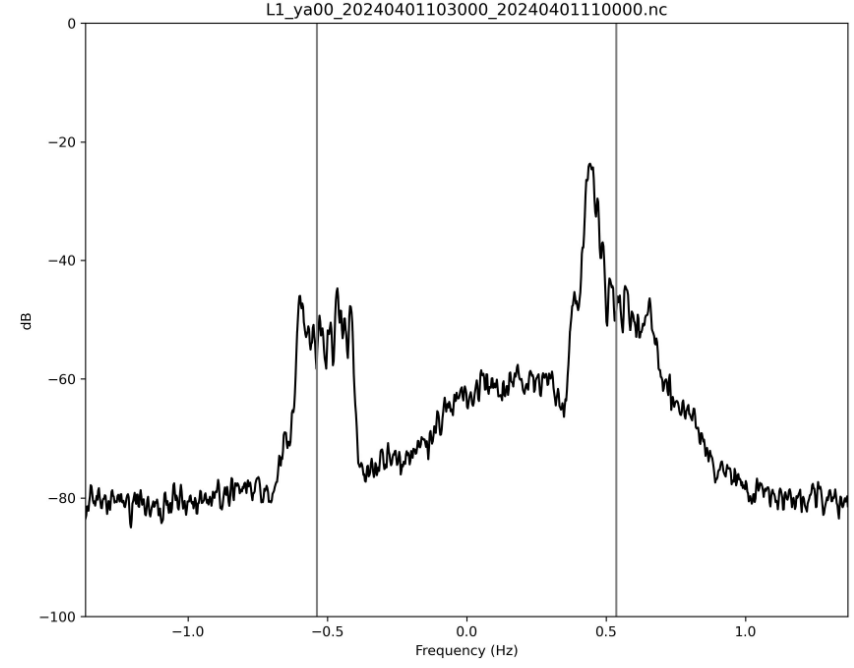
評估增加/修正項目


L1_ya00_20250405163000_20250405170000.nc
dB
Frequency (Hz)


L1_ya00_20240403000000_20240403003000.nc
dB
Frequency (Hz)

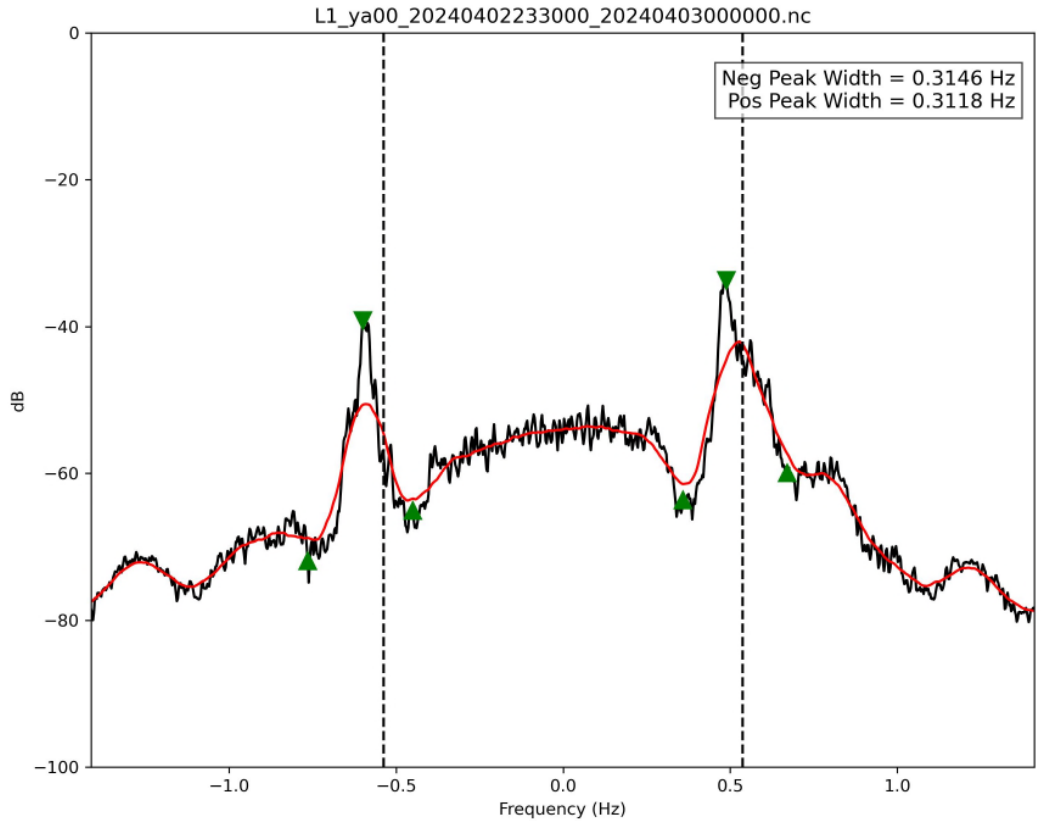

L1_ya00_20250404083000_20250404090000.nc
dB
Frequency (Hz)


L1_ya00_20250524100000_20250524103000.nc
dB
Frequency (Hz)

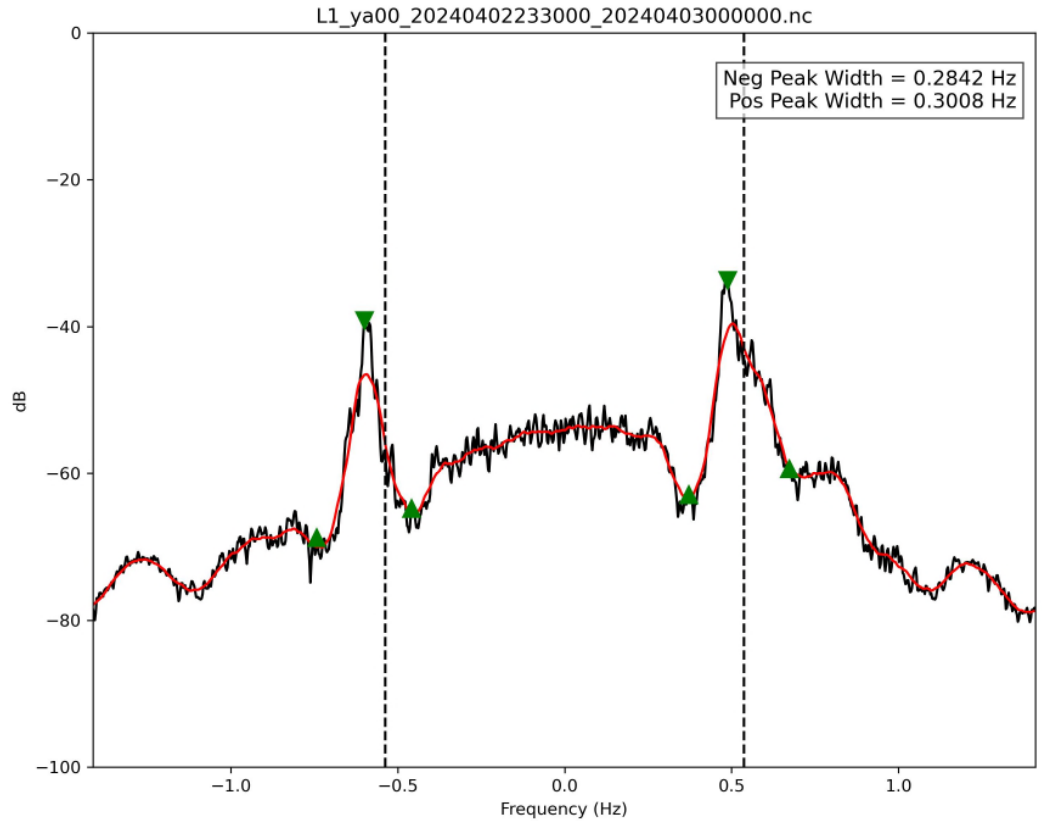

L1_ya00_20240401103000_20240401110000.nc
dB
Frequency (Hz)

方法比較

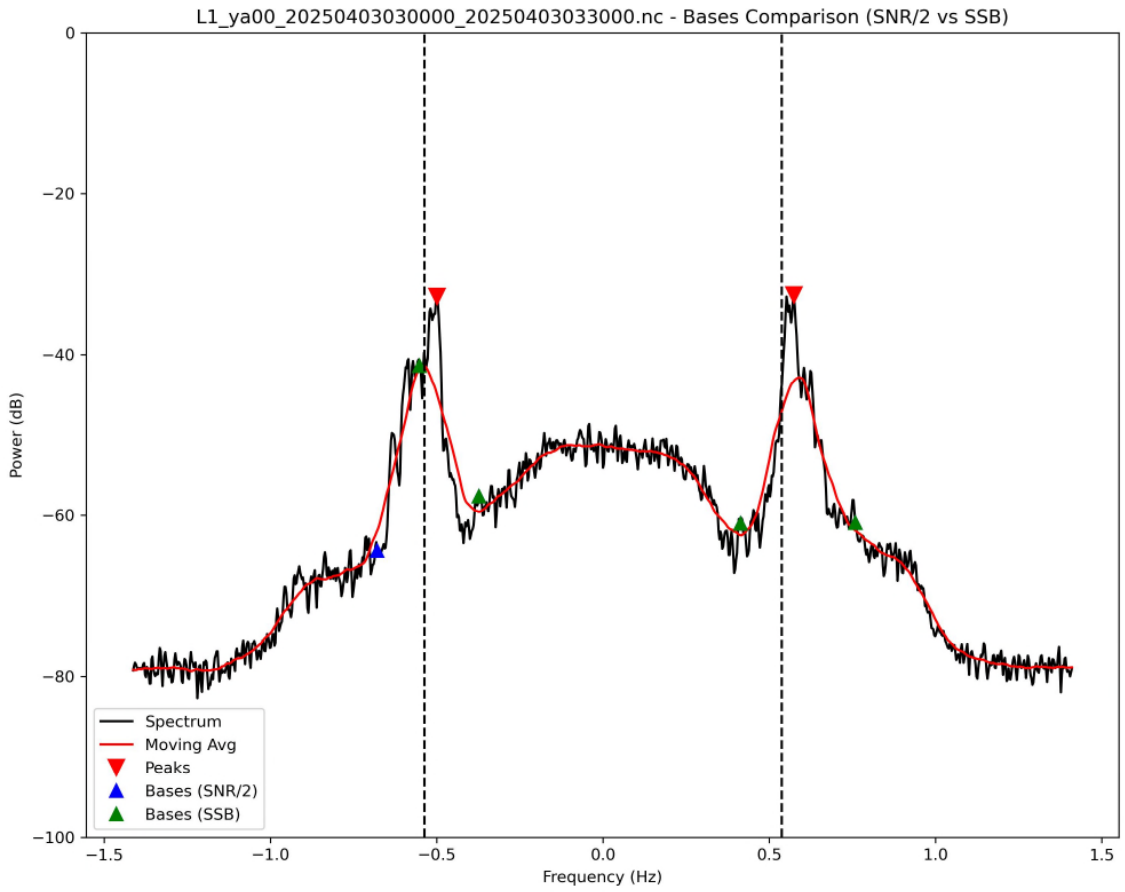
- SSB方法

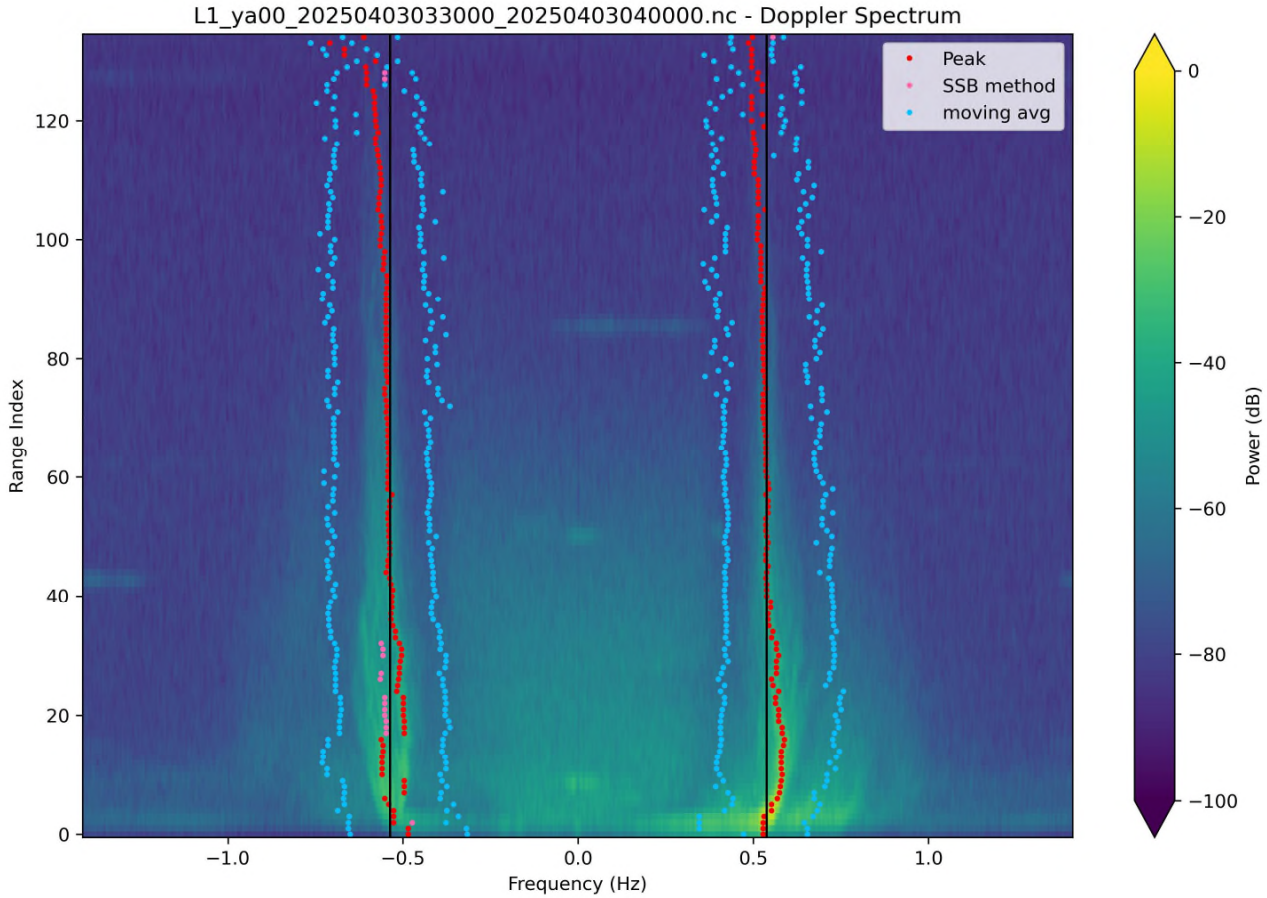


- 本研究方法

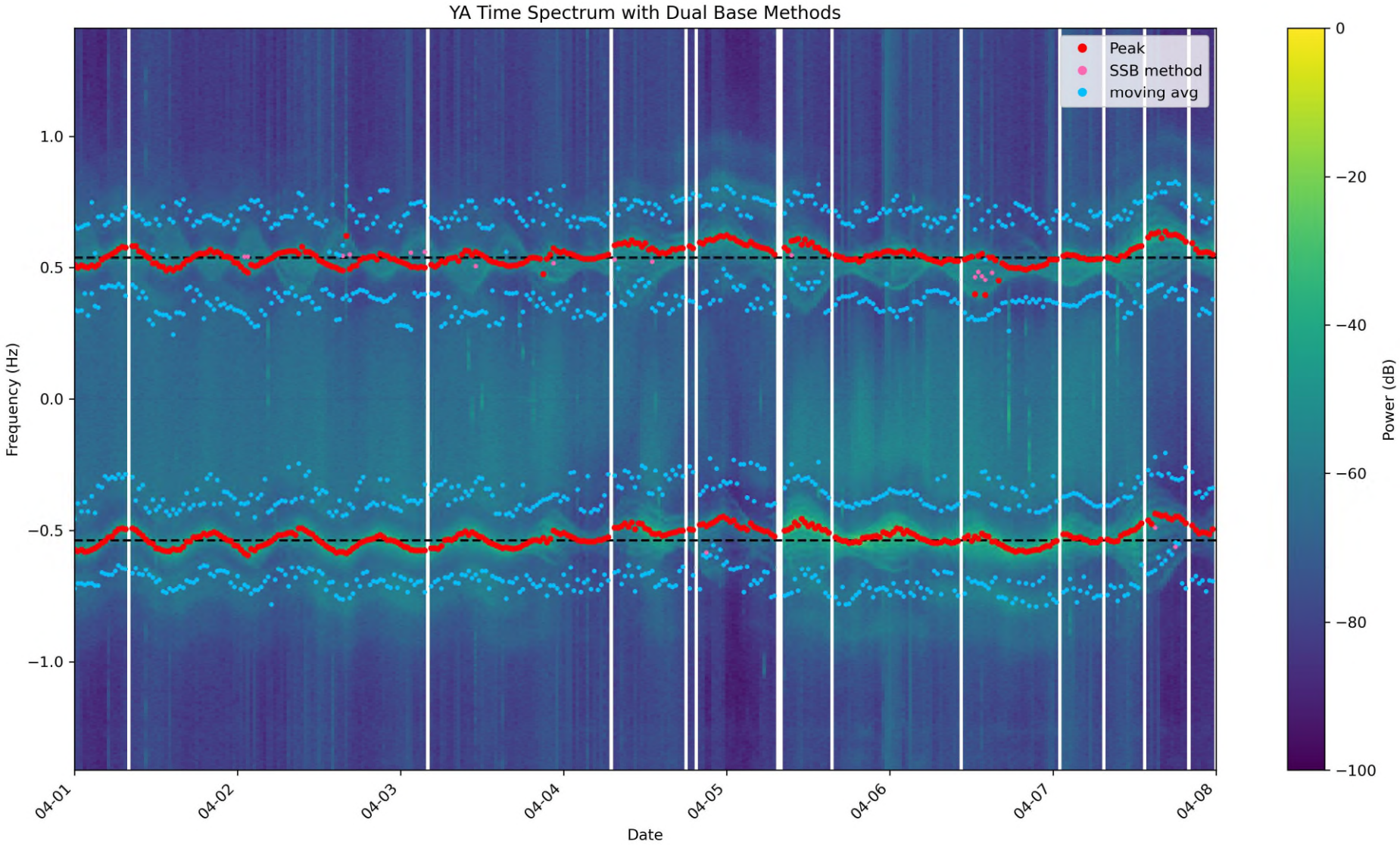


不同方法比較結果

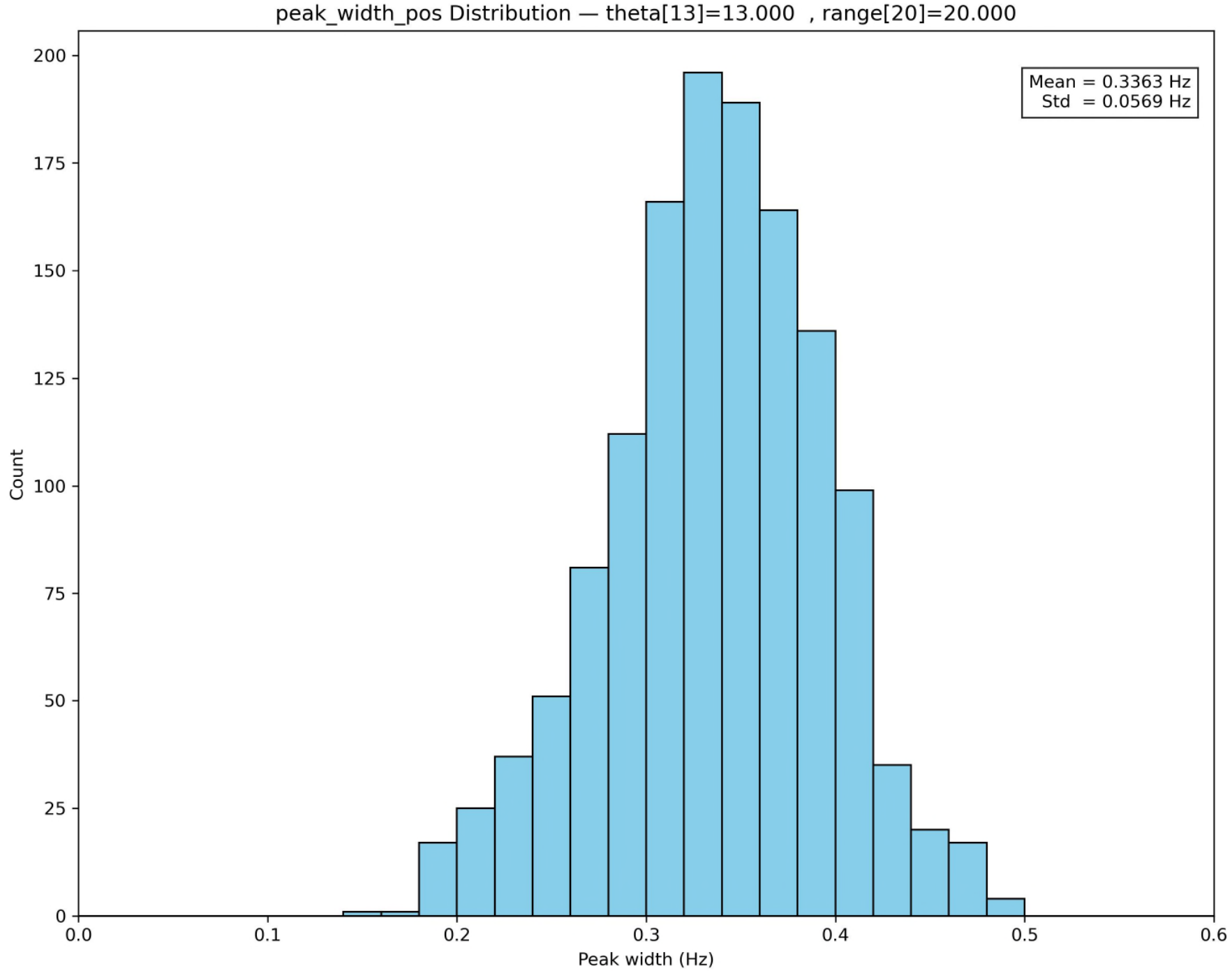

L1_ya00_20250403030000_20250403033000.nc - Bases Comparison (SNR/2 vs SSB)
Power (dB)
Frequency (Hz)
Spectrum
Moving Avg
Peaks
Bases (SNR/2)
Bases (SSB)


L1_ya00_20250403033000_20250403040000.nc - Doppler Spectrum
Range Index
Frequency (Hz)
Power (dB)
Peak
SSB method
moving avg

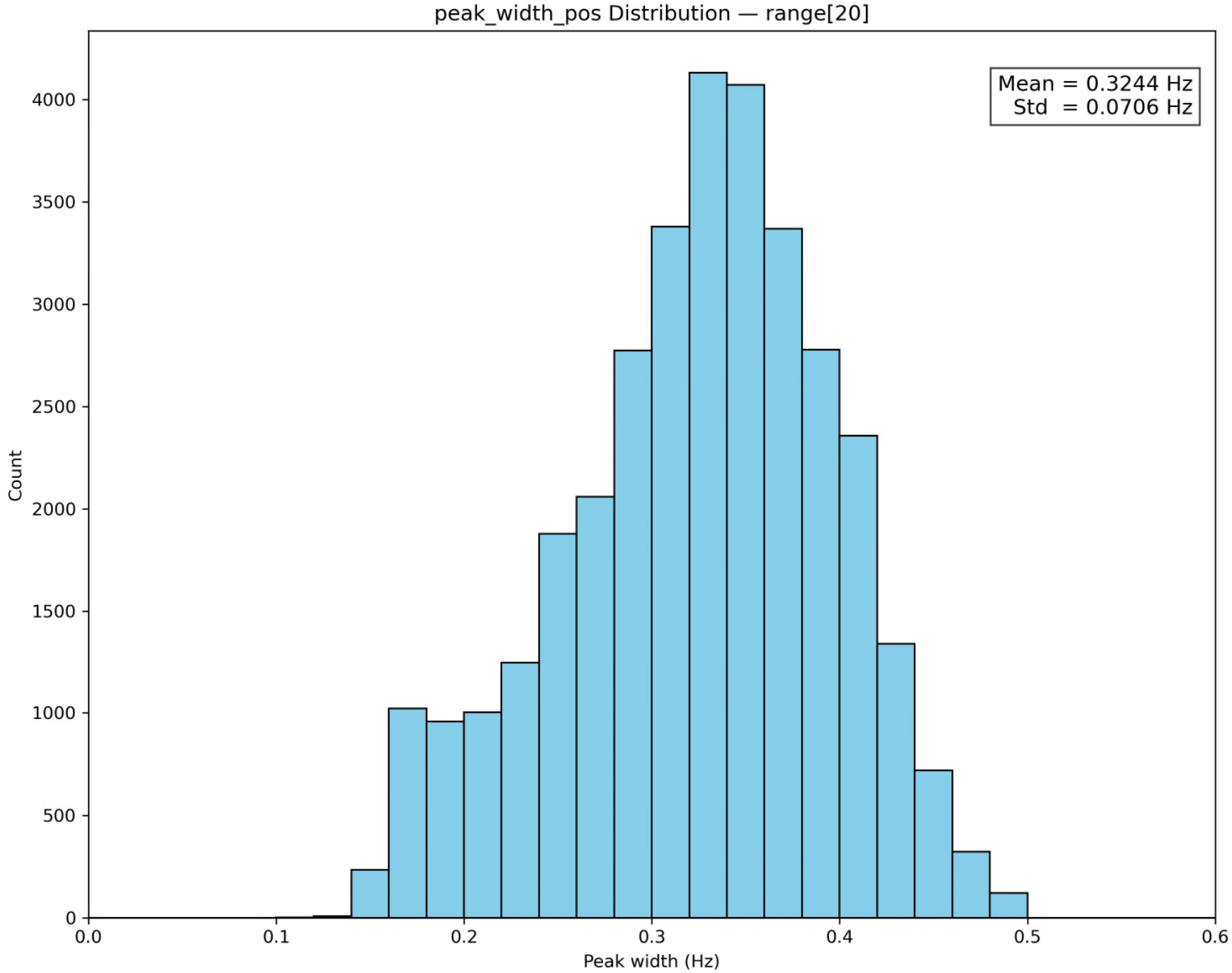
都普勒譜時序列圖


YA Time Spectrum with Dual Base Methods
Peak
SSB method
moving avg
Frequency (Hz)
1.0
0.5
0.0
−0.5
−1.0
04-01
04-02
04-03
04-04
04-05
04-06
04-07
04-08
Date
Power (dB)
0
−20
−40
−60
−80
−100

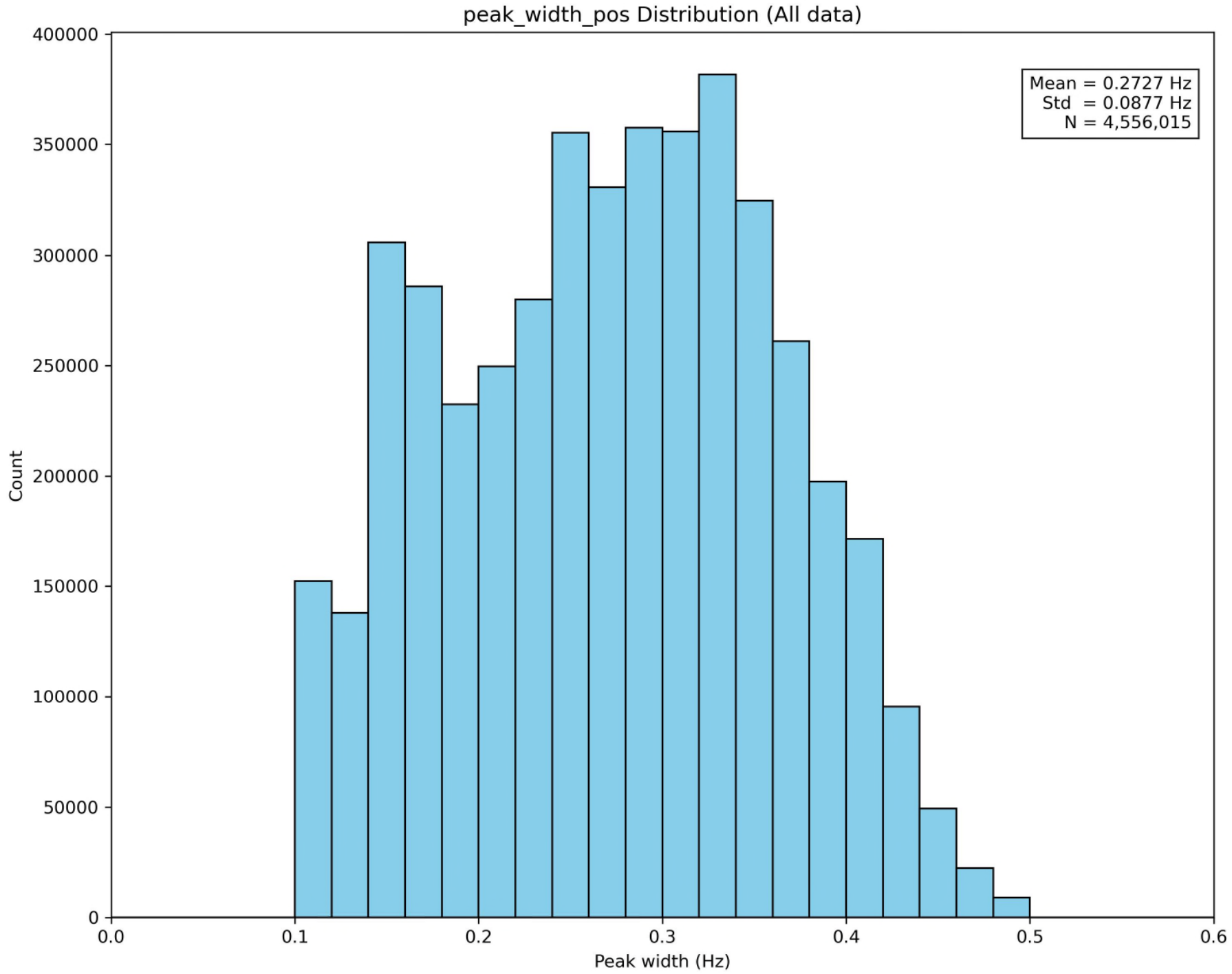
YA 2025/4一階峰寬分布柱狀圖
(單一距離單一角度)



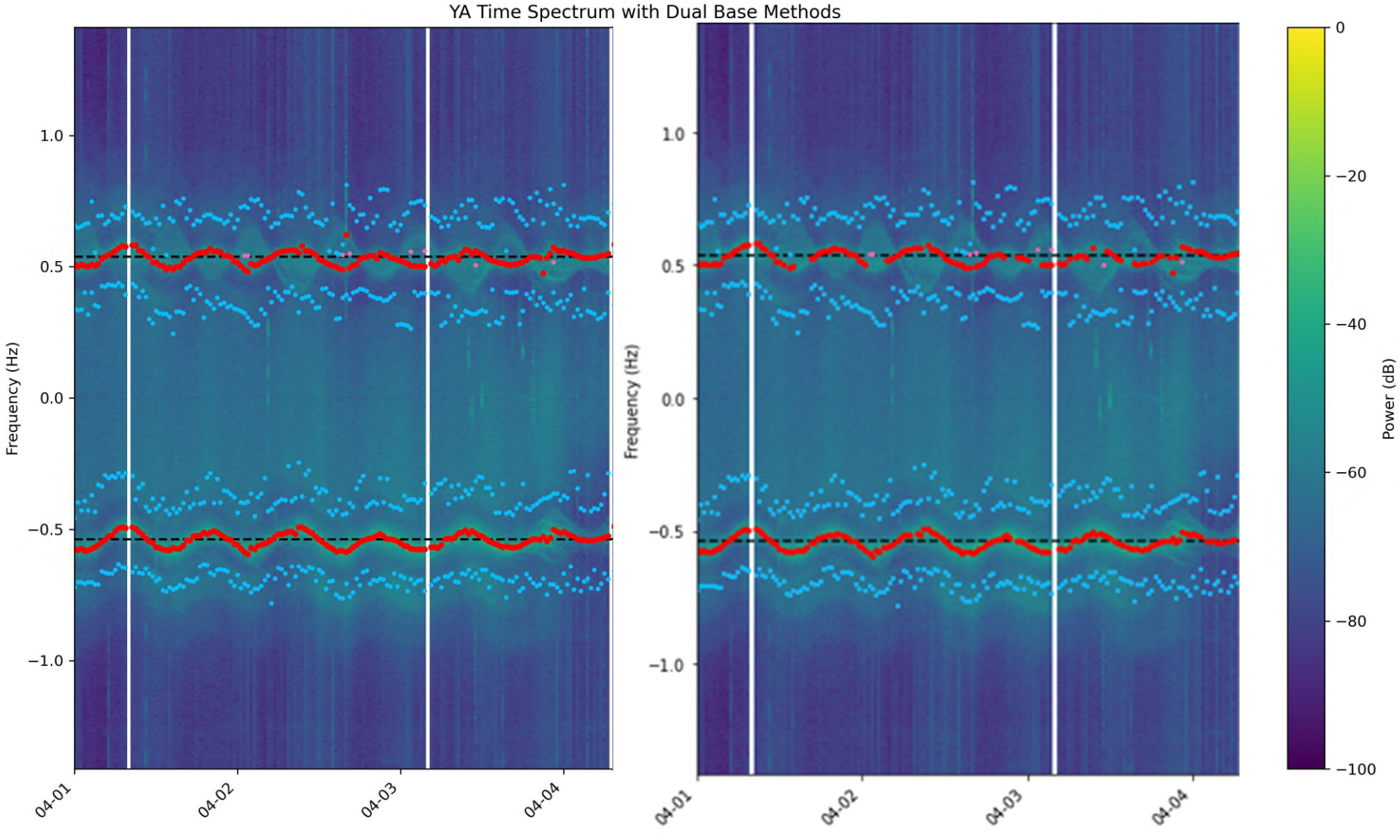
YA 2025/4的一階峰寬分布柱狀圖
(不同距離)



YA 2025/4的一階峰寬分布柱狀圖
(全部距離角度)



品管前後都普勒譜時序列圖

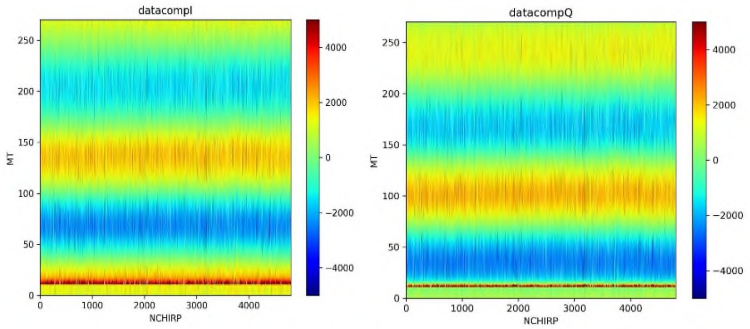


結論

- 一階峰寬度能作為去除徑向流速異常資料的品管指標
- 有比文獻資料更適合我們雷達的一階峰寬計算方式
- 建立一個一階峰可應用於高頻雷達品管的新標準及閥值
- 未來展望：與浮標資料比對、結合自動化品管流程

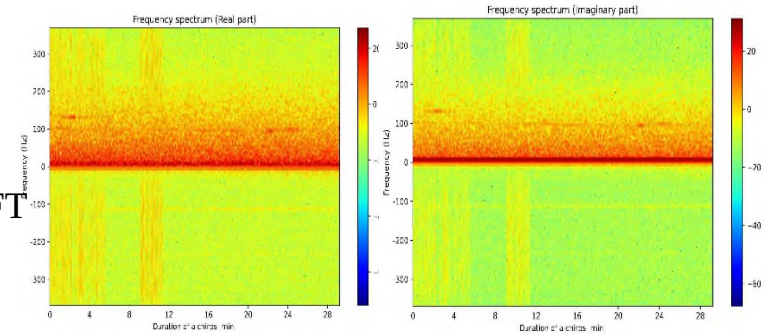
Radar Data Retrieval Process

I、Q timeseries data(**Level 0**)



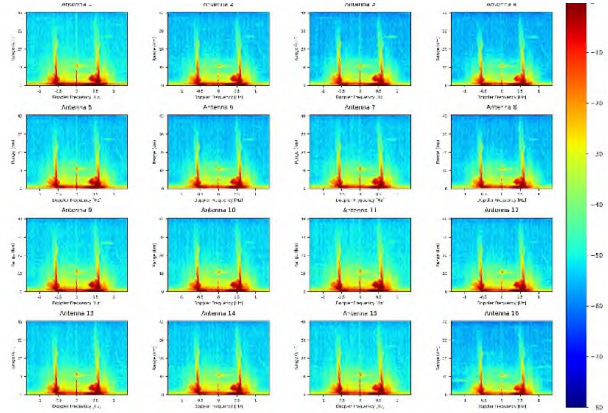
First FFT

Time-Range spectrum



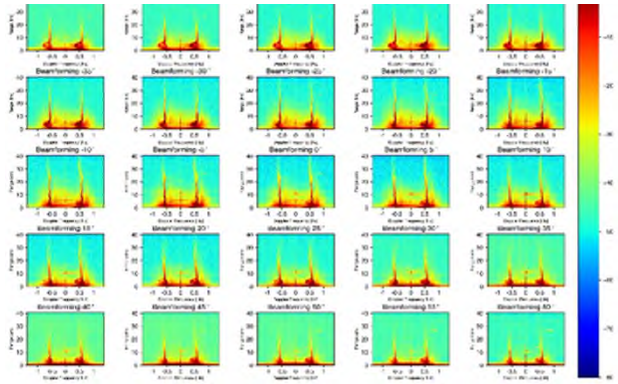
Second FFT

Per-antenna Doppler Spectrum



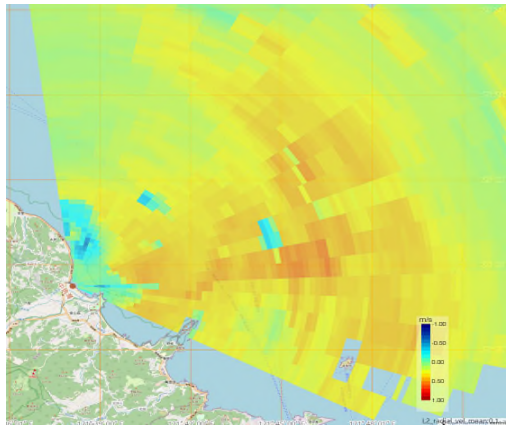
Azimuth estimation
（Beamforming）

Directional Doppler Spectrum (**Level 1**)



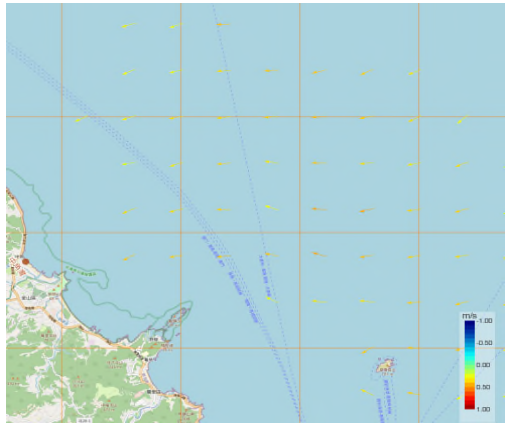
Retrieval of ocean-atmosphere parameters

Ocean-atmosphere from a single-station radar (**Level 2**)

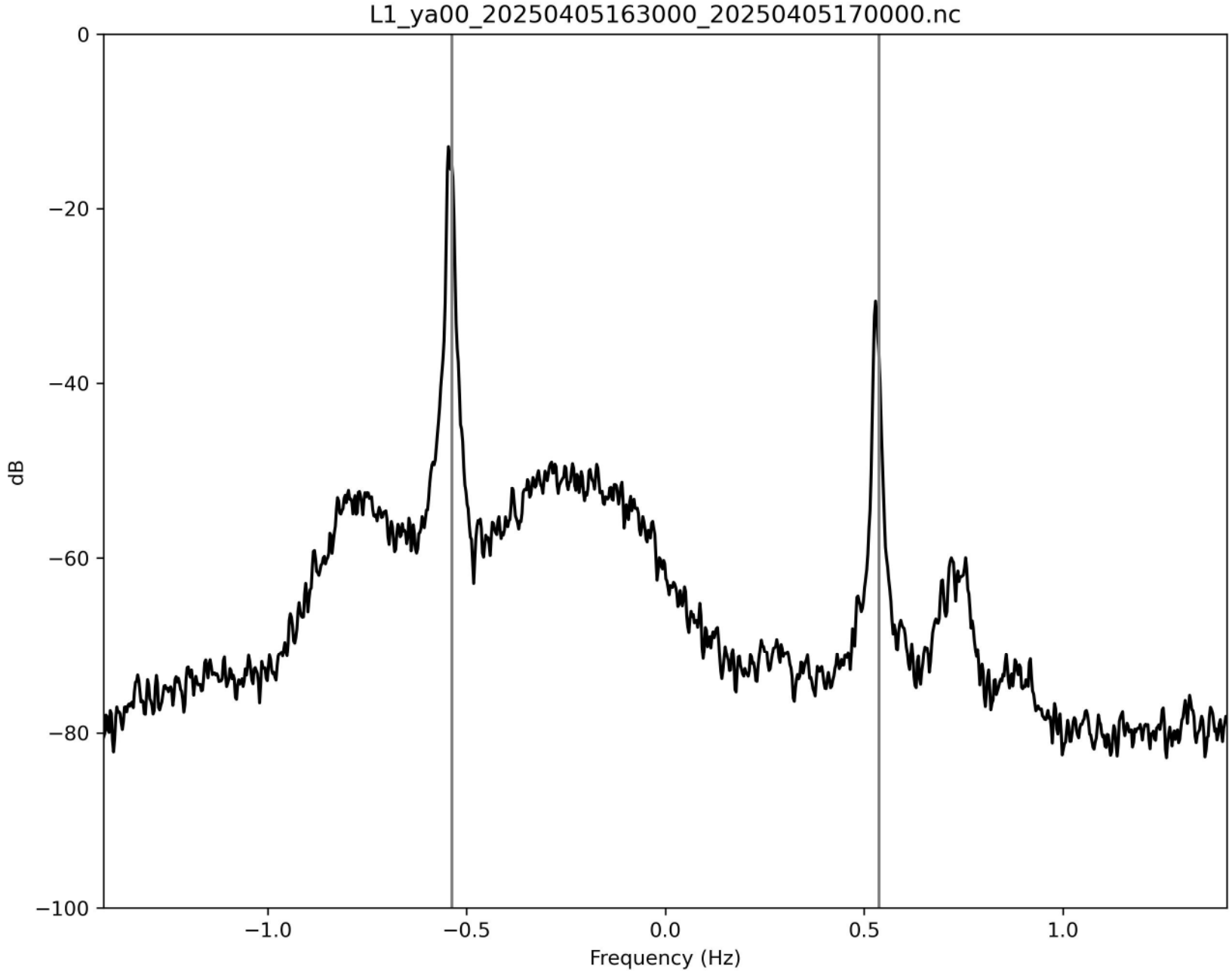


Ocean current synthesis、Gridding of ocean-atmosphere parameters

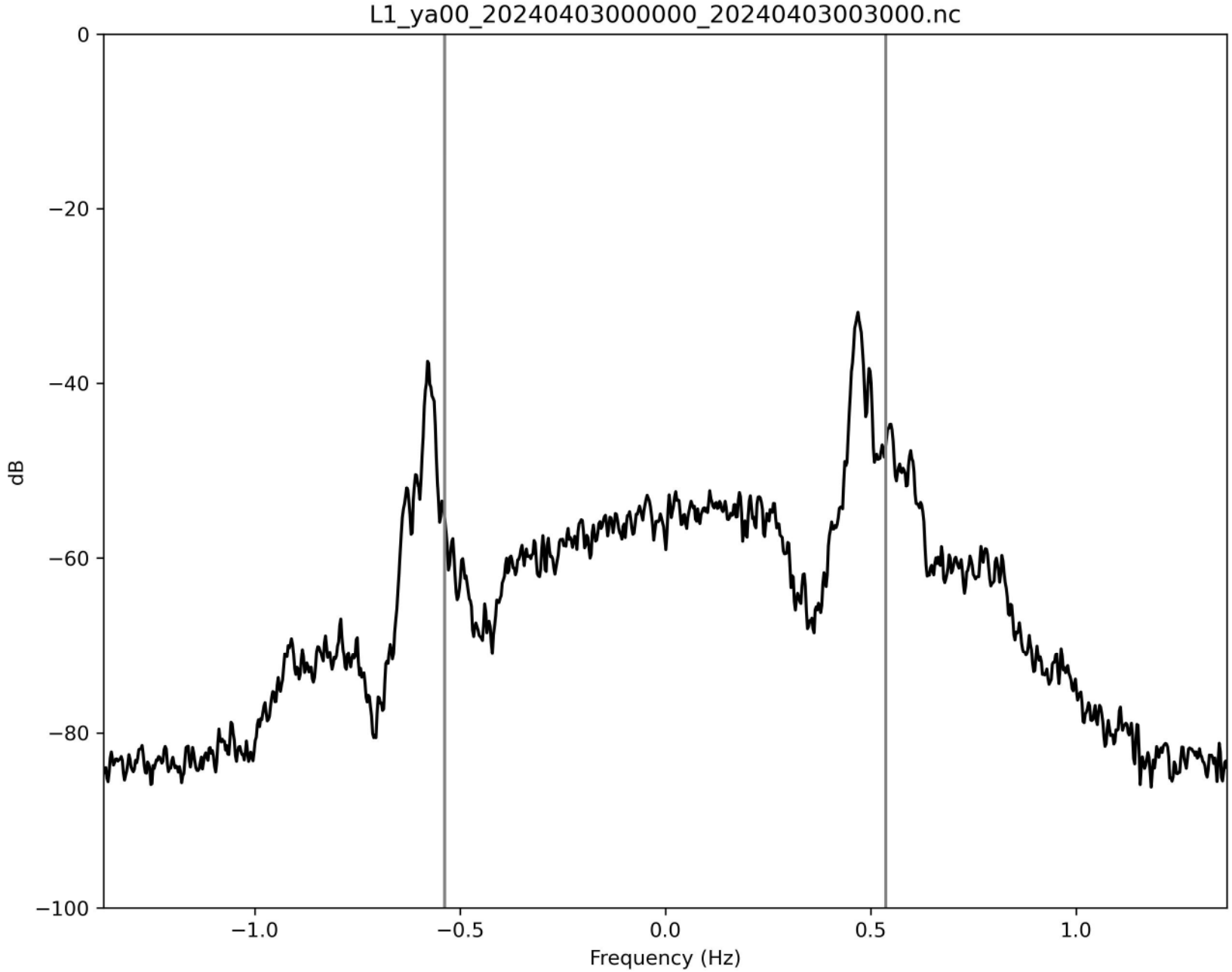
Ocean-atmosphere parameters from multi-station radar (**Level 3**)



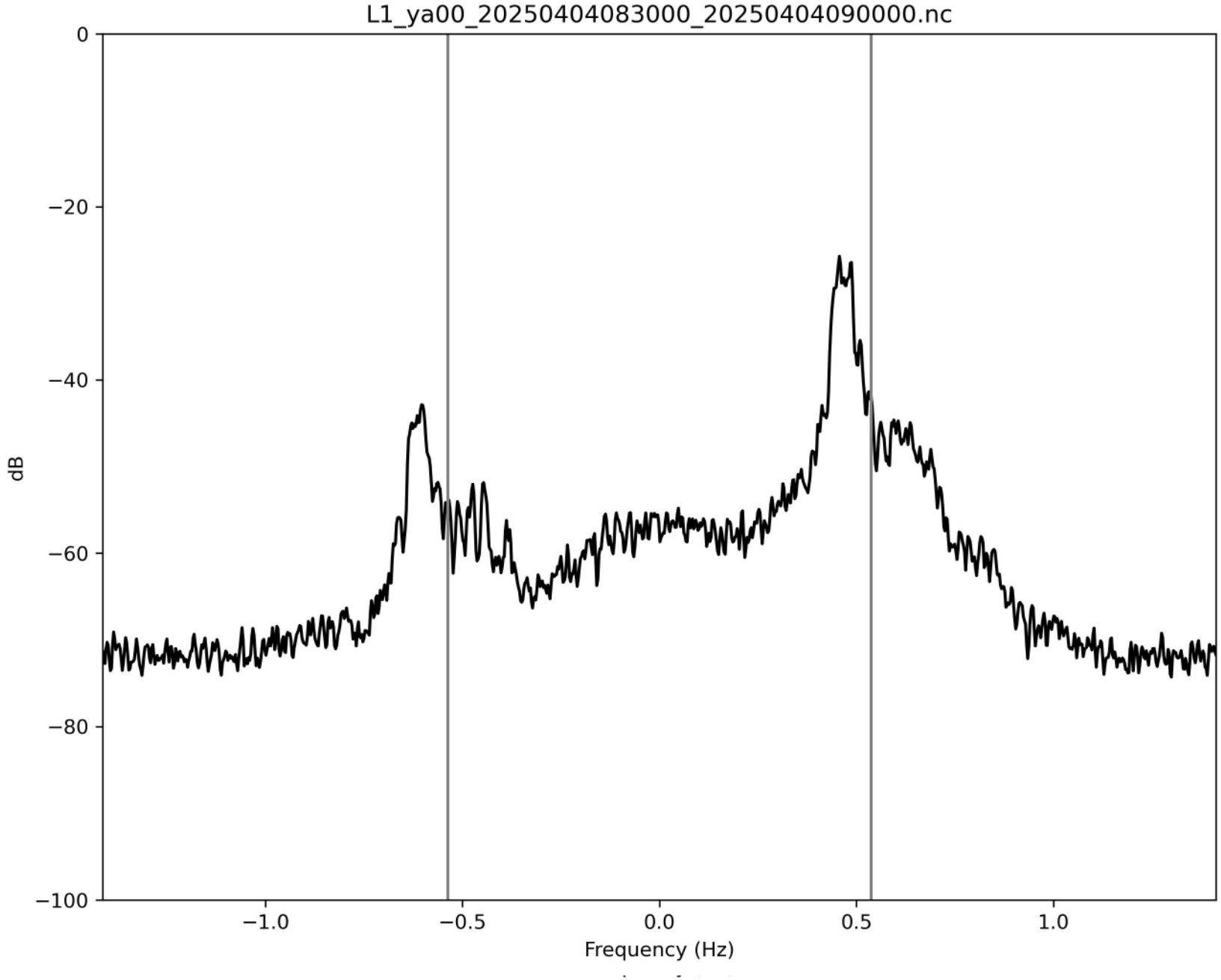
最理想的一階峰


L1_ya00_20250405163000_20250405170000.nc
0
−20
−40
−60
−80
−100
dB
−1.0
−0.5
0.0
0.5
1.0
Frequency (Hz)

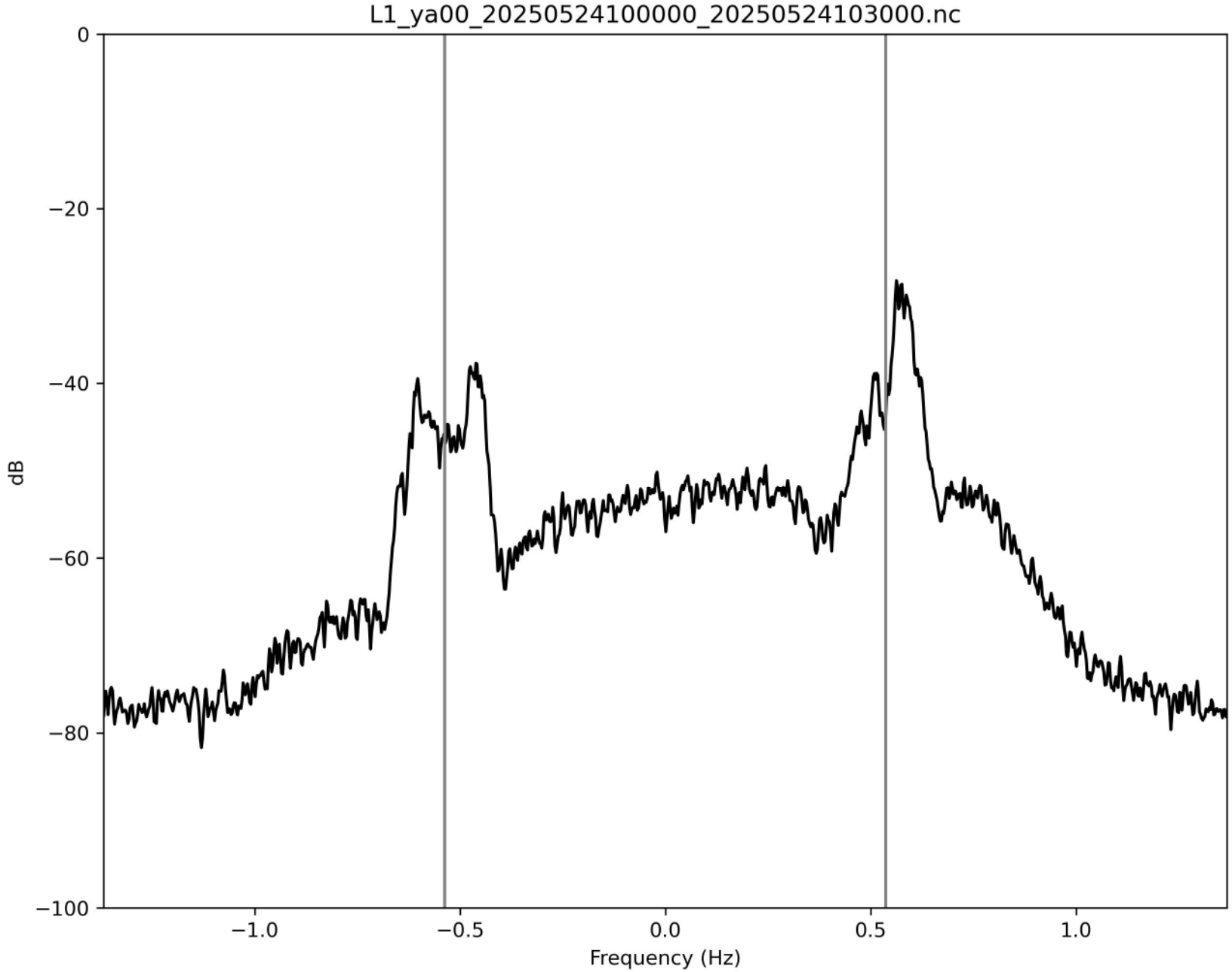
一階峰較寬


L1_ya00_20240403000000_20240403003000.nc
0
−20
−40
−60
−80
−100
dB
−1.0
−0.5
0.0
0.5
1.0
Frequency (Hz)

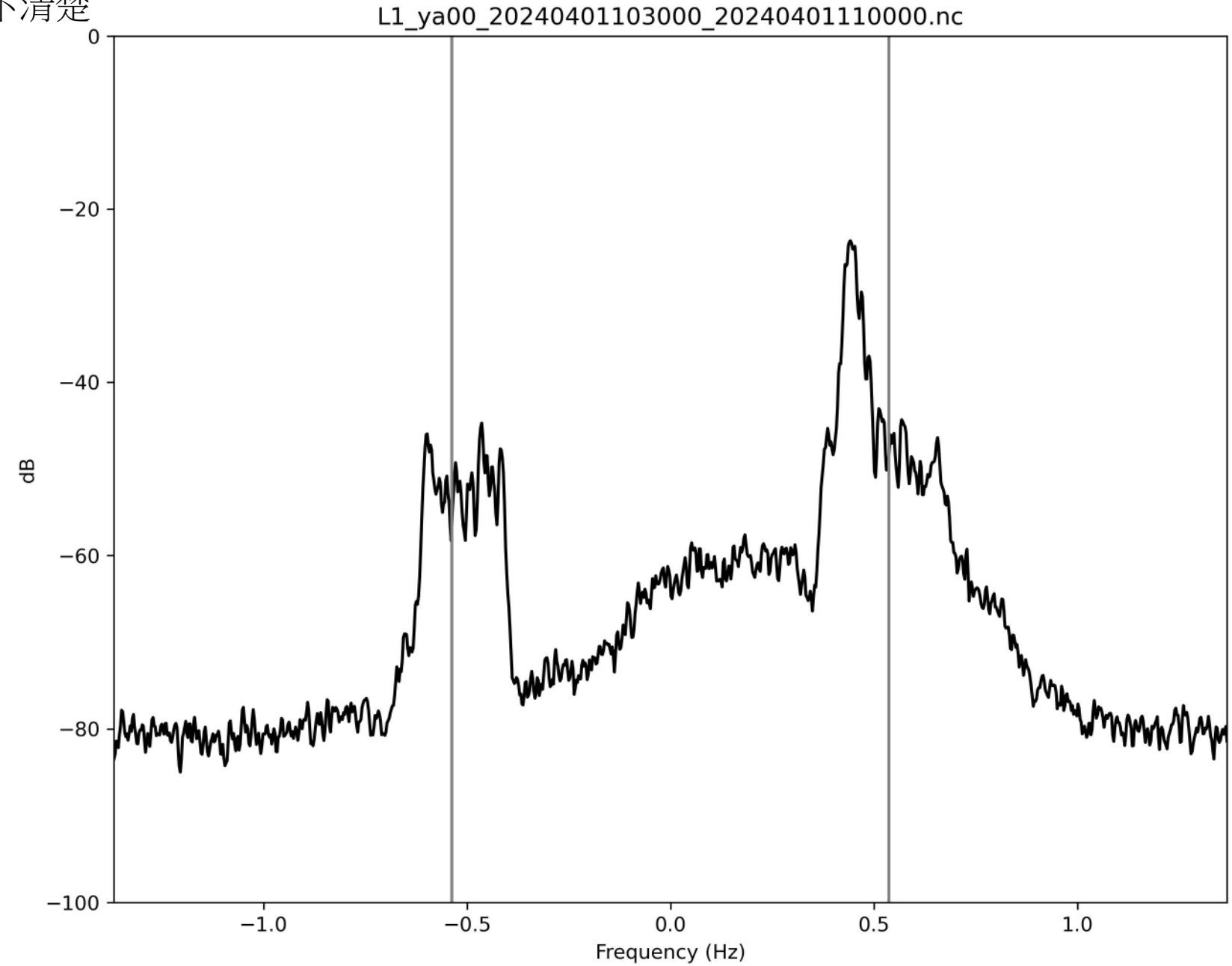
一階峰分界不清楚
(右邊)


L1_ya00_20250404083000_20250404090000.nc
0
−20
−40
−60
−80
−100
dB
−1.0
−0.5
0.0
0.5
1.0
Frequency (Hz)

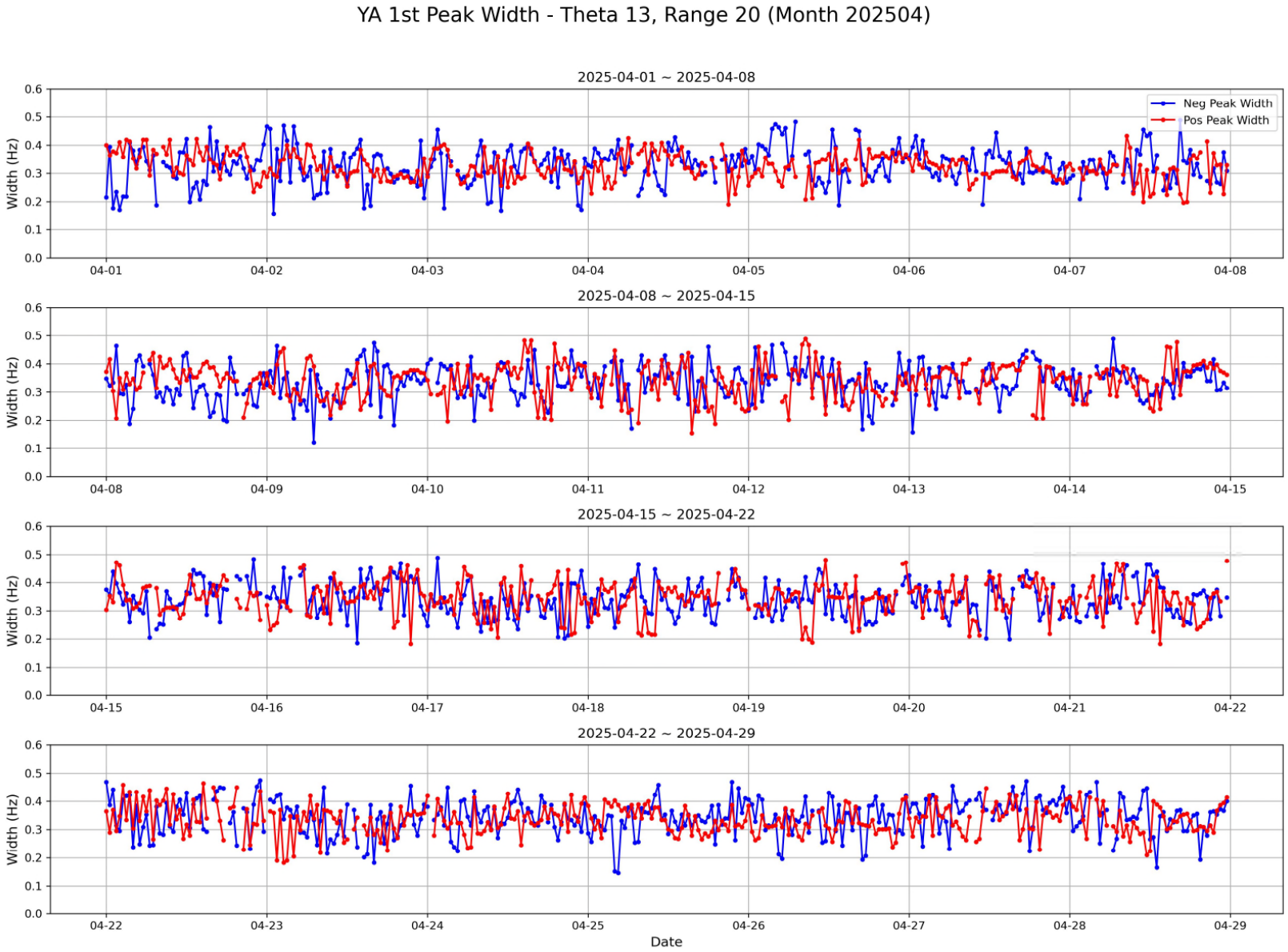
一階峰過寬


L1_ya00_20250524100000_20250524103000.nc
0
−20
−40
−60
−80
−100
dB
−1.0
−0.5
0.0
0.5
1.0
Frequency (Hz)

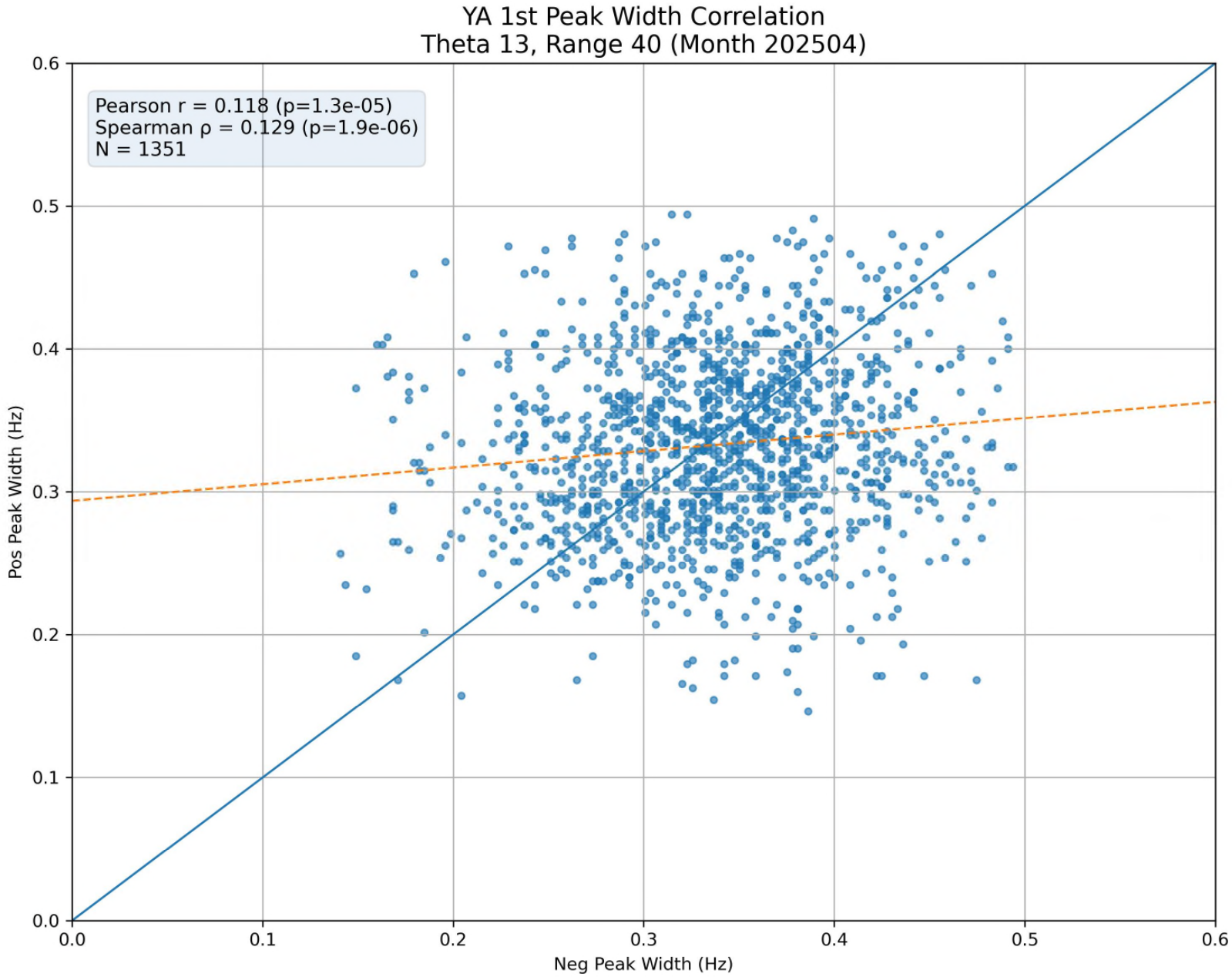
一階峰過寬且分界不清楚



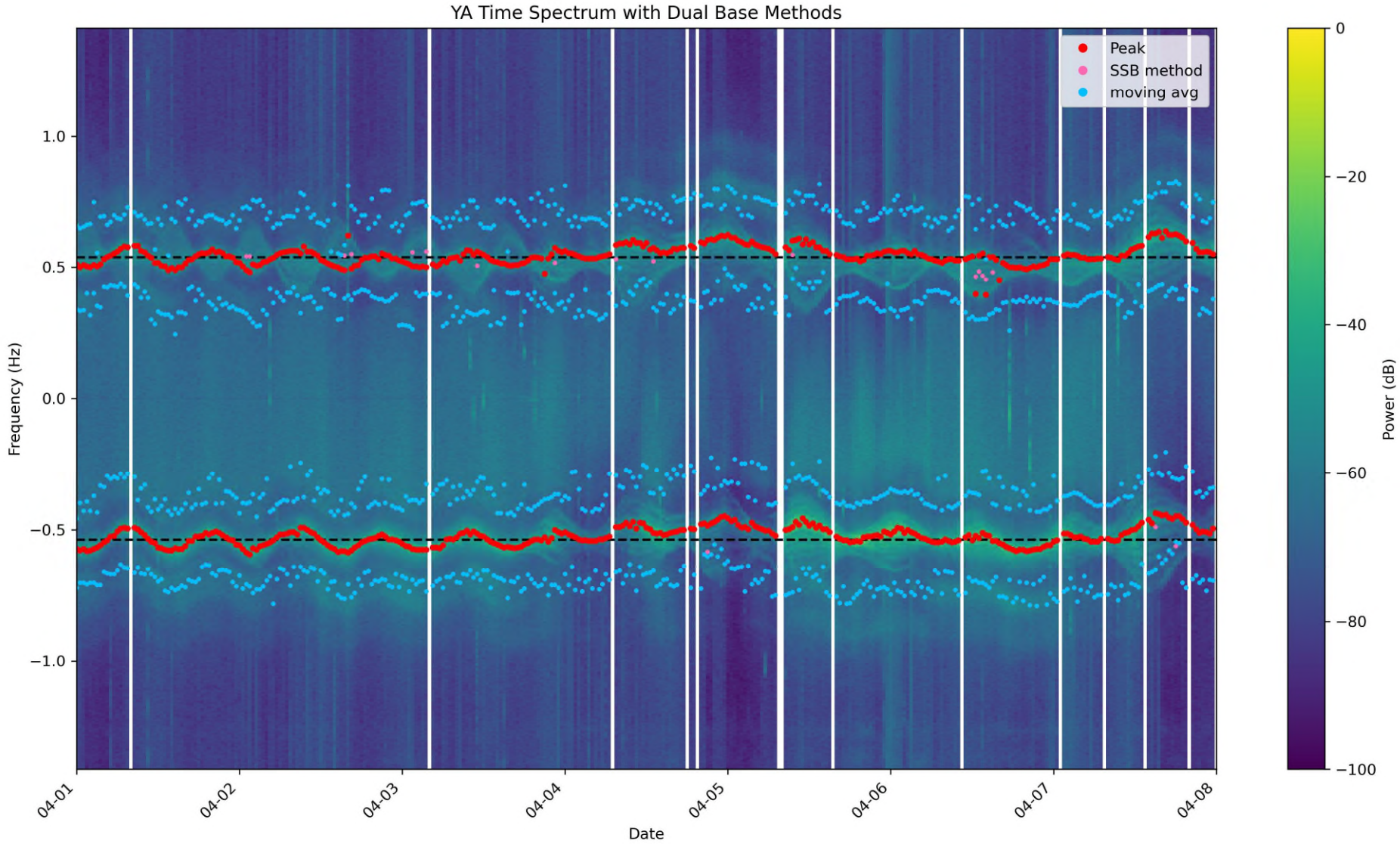
一階峰寬度時序列圖


YA 1st Peak Width - Theta 13, Range 20 (Month 202504)
2025-04-01 ~ 2025-04-08
2025-04-08 ~ 2025-04-15
2025-04-15 ~ 2025-04-22
2025-04-22 ~ 2025-04-29
Neg Peak Width
Pos Peak Width
Width (Hz)
Date

YA 2025/4的左右一階峰寬
相關程度
(固定距離角度)



品管前都普勒譜時序列圖



品管後都普勒譜時序列圖