Interference-sensitive Coastal SAR Altimetry Retracker for Measuring Significant Wave Height

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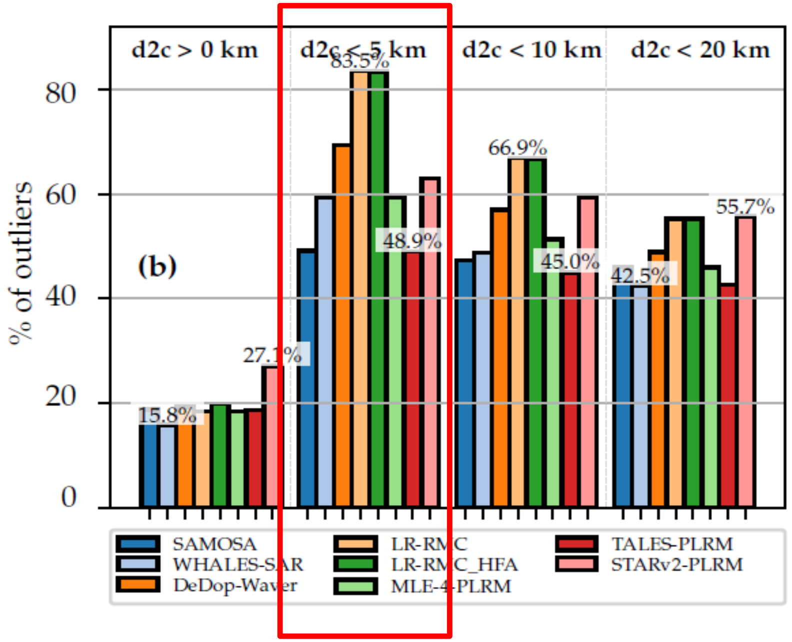
ESA Living Planet Symposium 2022 (LPS22)
Bonn, 24th of May 2022

Outline

1. Motivation
2. Novel Coastal SAR Altimetry Retracker: CORALv1
3. Validation
4. Conclusion

1. Motivation

- A lot of research about the open ocean performance of retracking with many evolutions coming for the Sentinel-6 PDAP processor (Virtual OSTST 2022 slides from Boy et al.)
- Altimeters‘ Round Robin assessment (Schlembach et al. 2020) within ESA SeaState CCI project
  - Performance was in general improved significantly by most of the retracker as compared to the Sentinel-3 baseline product
  - **BUT:** Number outliers is significantly increased in the coastal zone (dist2coast < 20 km): **up to 83.5%**



- We see a high potential in **increasing** the **quantity** (and the quality) in the **coastal zone**

*Schlembach et al. 2020

2. Novel Coastal SAR Altimetry Retracker: CORALv1

Objective

Estimation of SWH in the presence of strong spurious interference in the trailing edge that typically occurs in the coastal zone

→ **Maximising the quantity without sacrificing quality of records in the coastal zone**

CORALv1 - COastal Retracker for SAR ALtimetry version 1.0

- SAMOSA2-model based (SAMOSA DPM 2.5.2)
- Starts from L1B
- Based on SAMOSA+ (Dinardo et al. 2018)
- Features a three-step fitting process
- In open ocean: Falls back to standard SAMOSA-based retracker

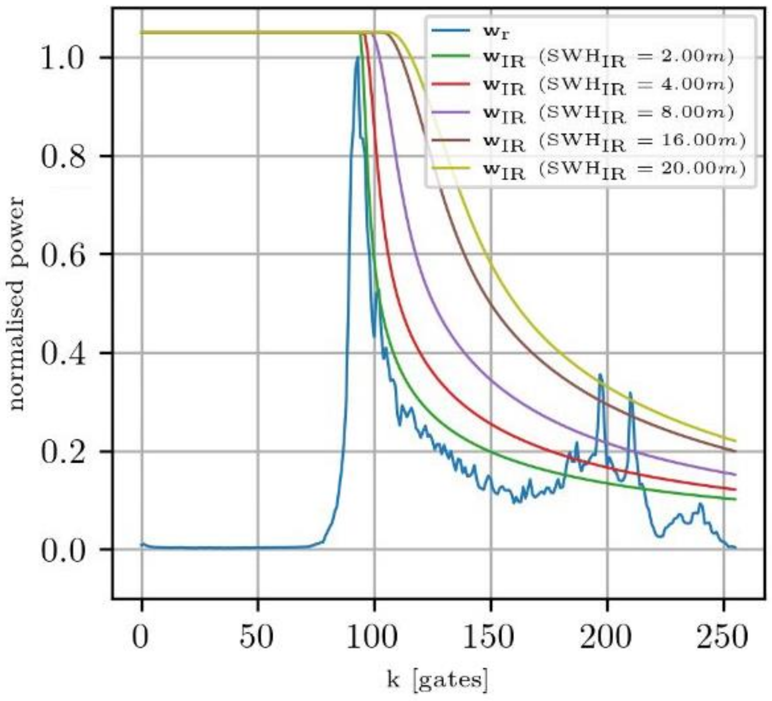
- Main novelty: Adaptive Interference Masking (AIM) scheme

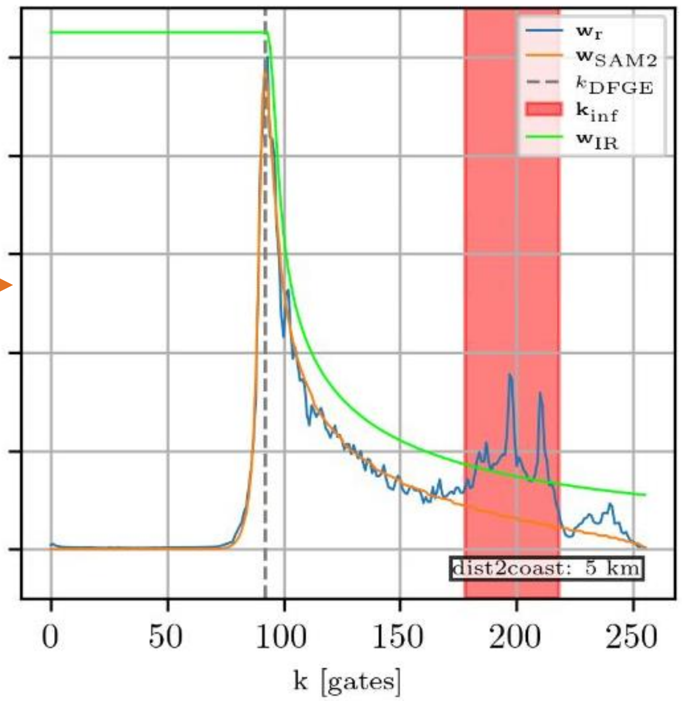
2. CORALv1: AIM

Adaptive Interference Masking (AIM)

→ senses and masks interference within the trailing edge

Generation of a single-look SAMOSA model $\mathbf{w}_{\mathrm{SAM2}}$ to produce the interference reference waveform $\mathbf{w}_{\mathrm{IR}}(\mathrm{SWH}_{\mathrm{IR}})$





detected interference gates

$$\mathbf{k}_{\mathrm{inf}} = \mathrm{True}(\mathbf{w}_{\mathrm{r}} > \mathbf{w}_{\mathrm{IR}})$$

→ AIM detects interference gates and excludes them from fitting procedure → **quality** of SWH estimate is improved.

2. CORALv1: AIM (cont‘d)

Quality flag definition by SAMOSA+

misfit calculation

$$\text{misfit} = 100 * \sqrt{\frac{1}{N}\sum_{i}^{N}(w_{r,i} - w_{\text{SAM2},i})^2}$$

Quality flag: True: bad, False: good

$$q = \text{misfit} > 4$$

→ Drawback: strongly pertubated waveforms are flagged **bad** even if correctly retracked

2. CORALv1: AIM (cont'd)

CORALv1 improves the quality flag by using the **selective misfit**
→ exclusion of interference gates $\mathbf{k}_{\text{inf}}$ from the misfit calculation

$$\text{misfit}_{\text{selective}} = 100 * \sqrt{\frac{1}{N}\sum_{i}^{N}\left(w_{r,i} - w_{\text{SAM2},i}\right)^2}$$

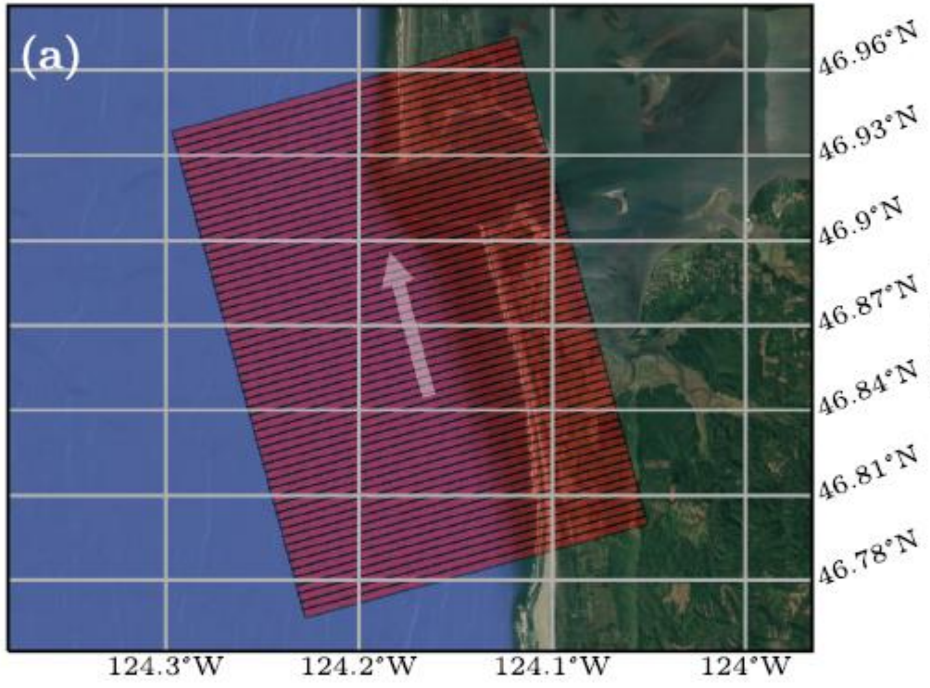
$$i \notin \mathbf{k}_{\text{inf}} = \text{True}(\mathbf{w}_{\text{r}} > \mathbf{w}_{\text{IR}})$$

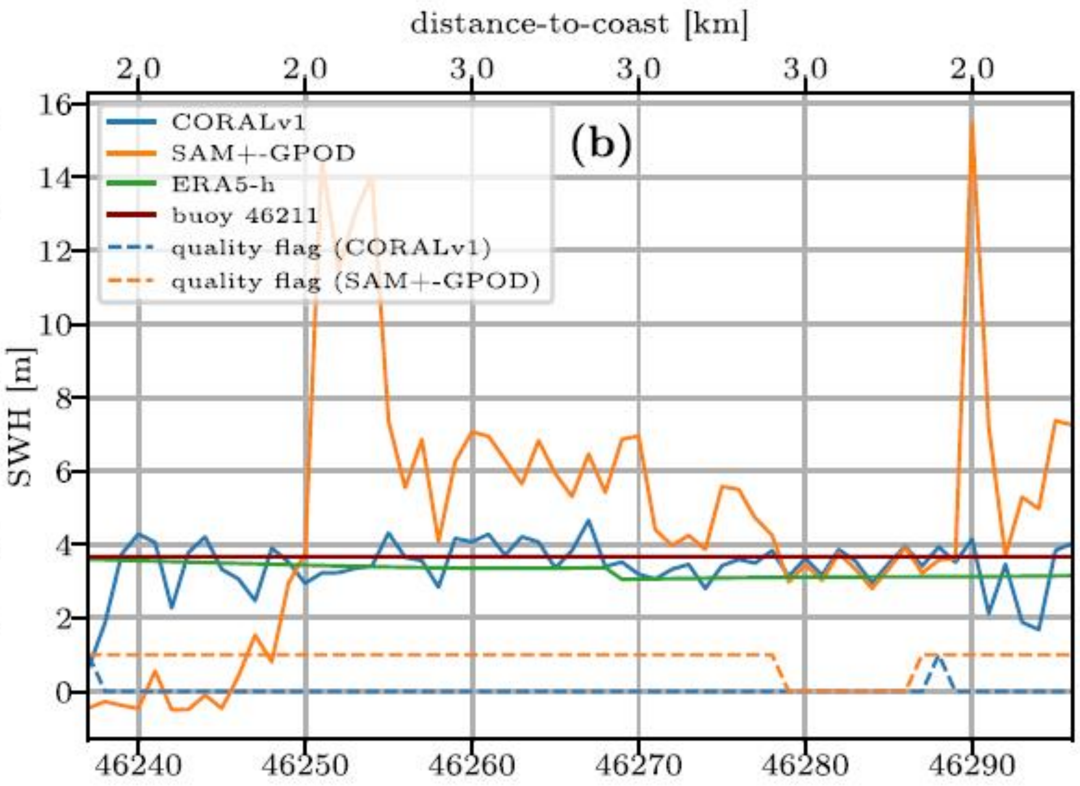
$$q_{\text{CORALv1}} = \text{misfit}_{\text{selective}} > 4$$

→ AIM better determines the goodness of the fit and recovers strongly interfered waveforms → **quantity** of records ↗

3. Validation: Coastal Case Study

Retracking waveforms with strong coastal interference by CORALv1 in comparison with SAMOSA+

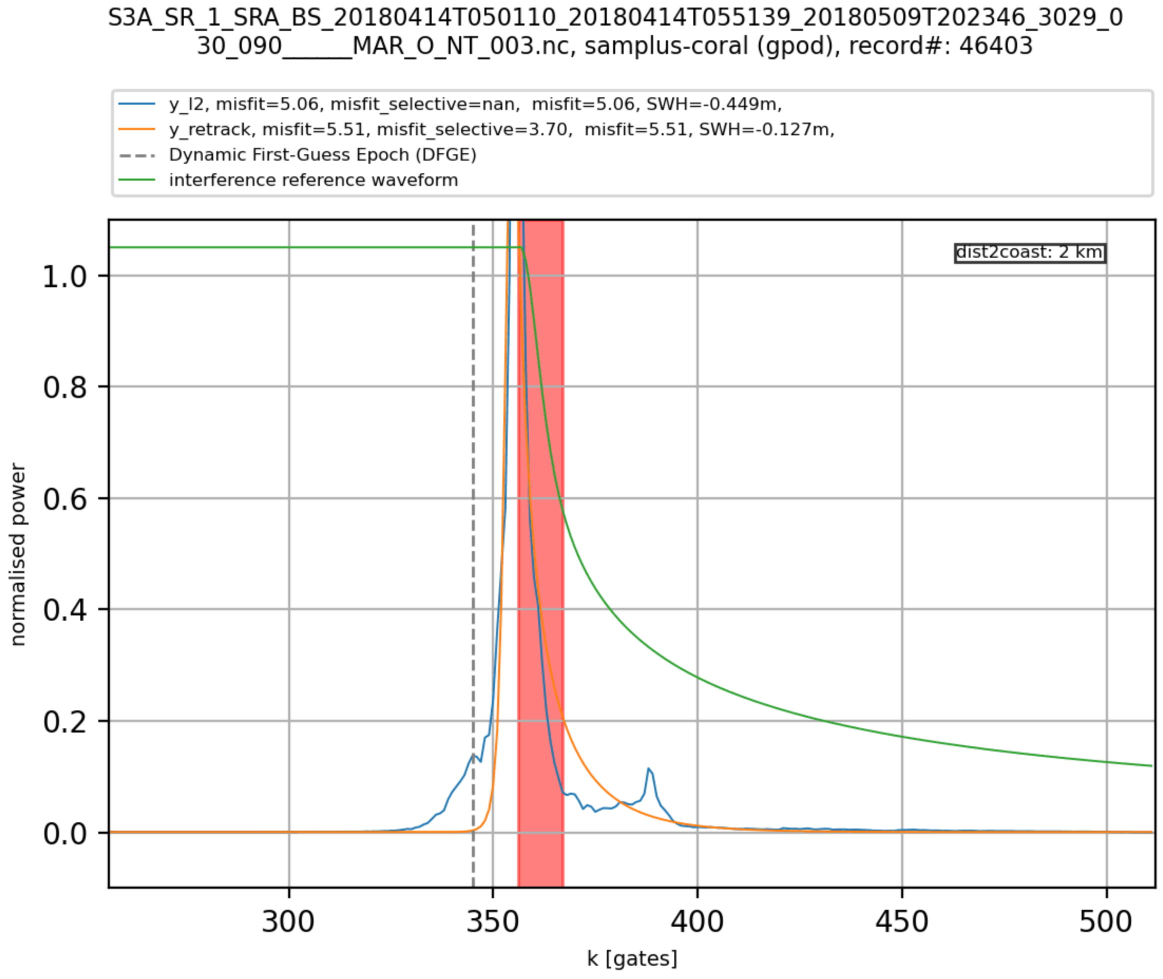


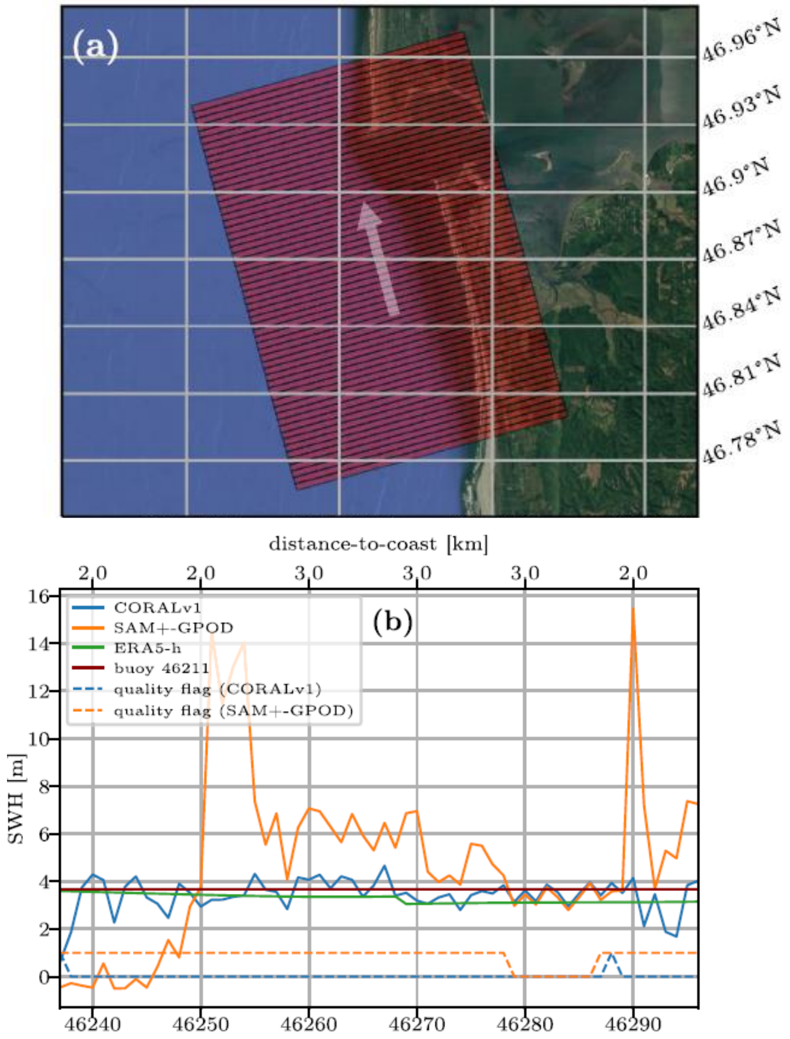


quality flag q

3. Validation: Coastal Case Study

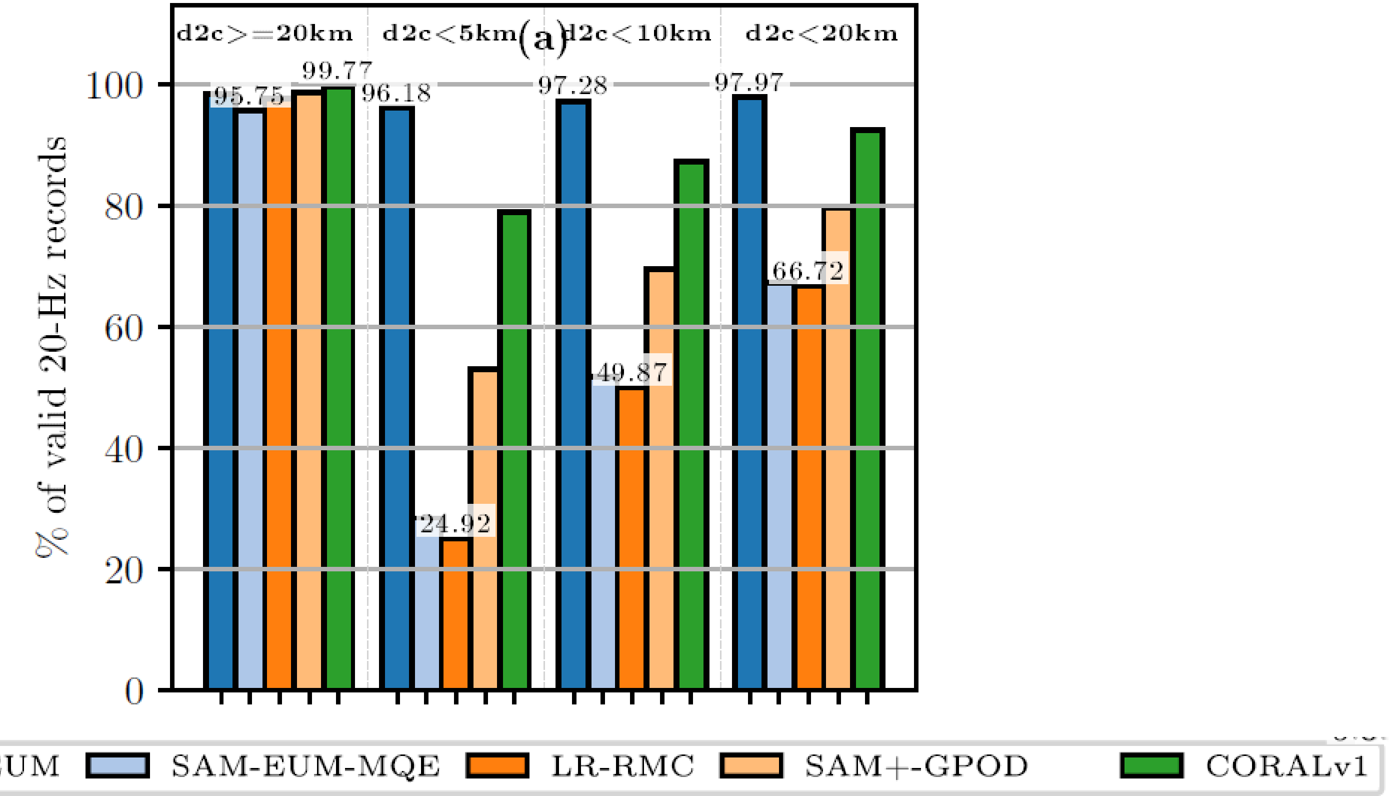
Retracking waveforms with strong coastal interference by CORALv1 in comparison with SAMOSA+





3. Validation: Number of Valid Records

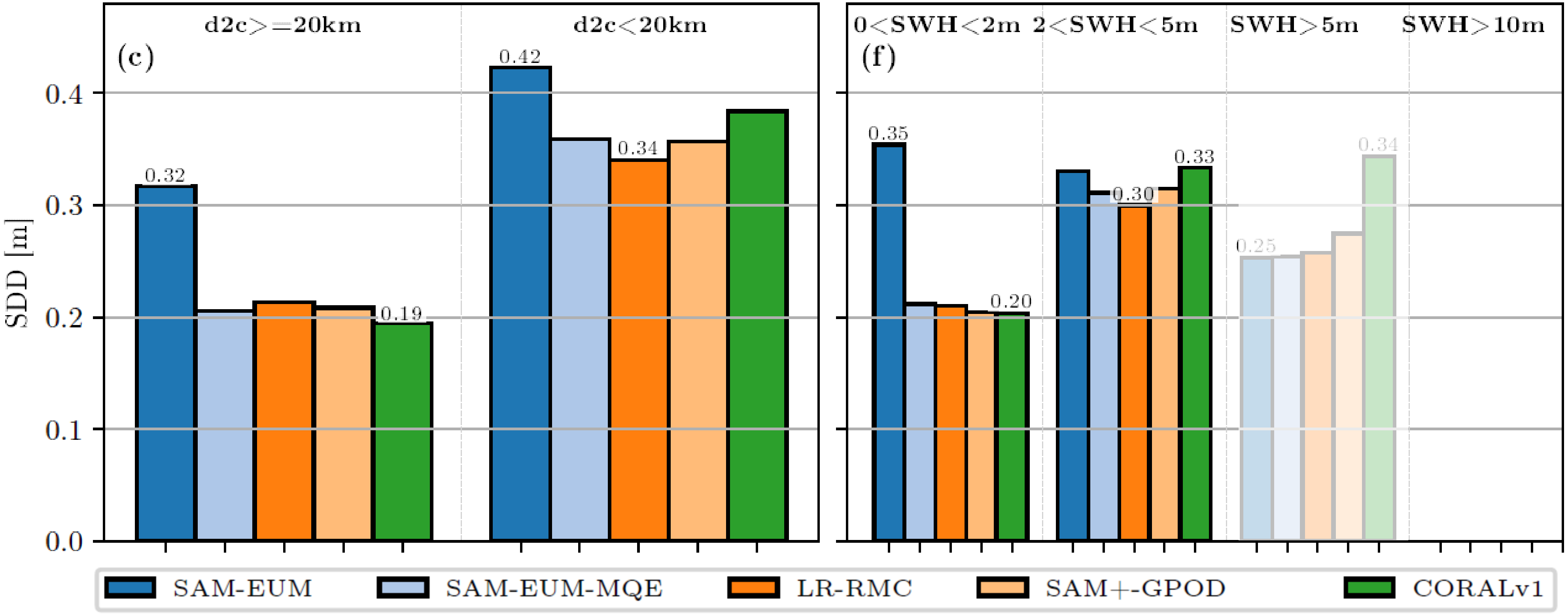
Valid record → quality flag = **good** (0)



→ CORALv1 shows an increased number of valid 20-Hz records of 25%, 17%, and 12% as compared to SAM+-GPOD.

3. Validation: Comparison with In-situ Data

Standard deviation of the differences (SDD)

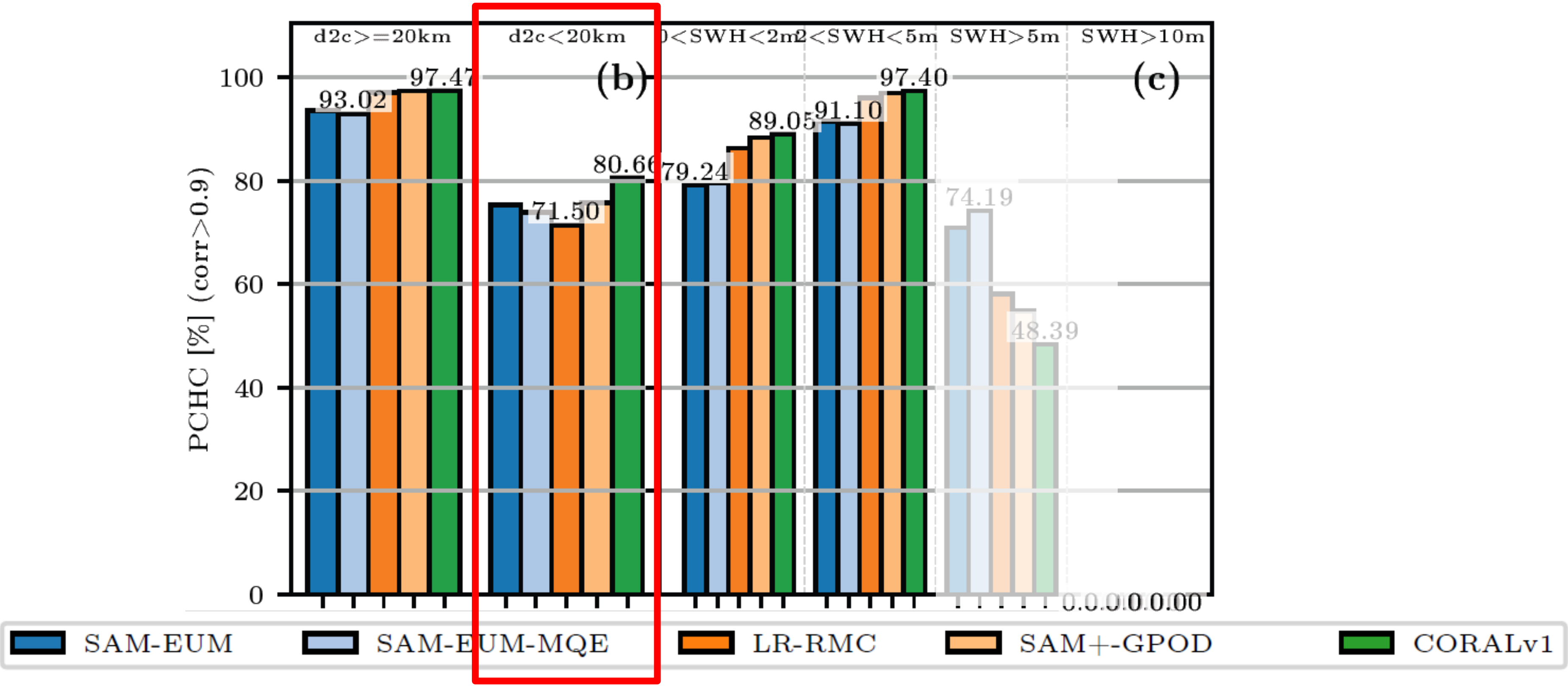


*170 buoys, 46 coastal buoys used

3. Validation: Comparison with In-situ Data

Percent of cycles for high correlation (PCHC): ratio between number of altimeter-buoy collocations with a high correlation (**0.9**) and number of all altimeter-buoy collocations

51 altimeter records collocated with 1 buoy records per cycle → correlation coefficient r → only take collocations with r > 0.9



*170 buoys, 46 coastal buoys used

4. Conclusion

- **CORALv1** has implemented a novel **Adaptive Interference Masking (AIM)** scheme that senses and masks interference in the coastal zone
- **CORALv1** significantly increases the number of valid 20-Hz records in the coastal zone by 25%, 17%, and 12% (5, 10, 20 km from the coast), without sacrificing quality

Published in Remote Sensing of Environment journal

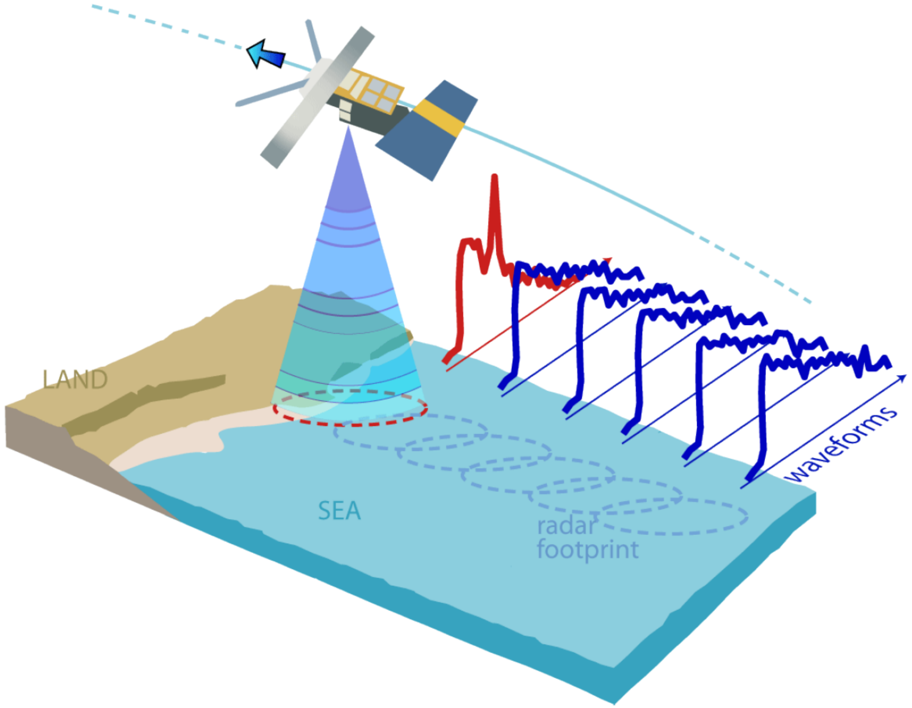
Schlembach et al. „Interference-Sensitive Coastal SAR Altimetry Retracking Strategy for Measuring Significant Wave Height“. *Remote Sensing of Environment,* 274, 112968. https://doi.org/10.1016/j.rse.2022.112968.

Thank you!

0. Satellite Altimetry

Principle

- An altimeter transmits and receives short radio-wave pulses, which are reflected from the ocean surface



round-trip time between altimeter’s antenna and ocean surface → **range/distance**

Power of reflected pulse → **wind speed**

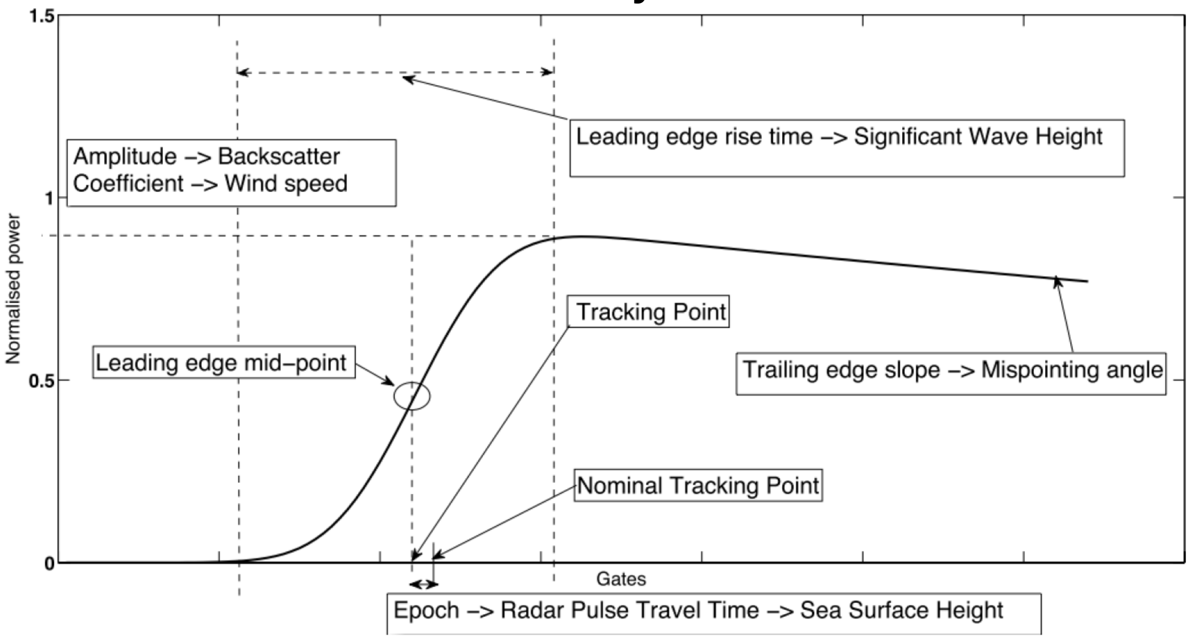
Steepness of the leading edge → **significant wave height**

0. Satellite Altimetry

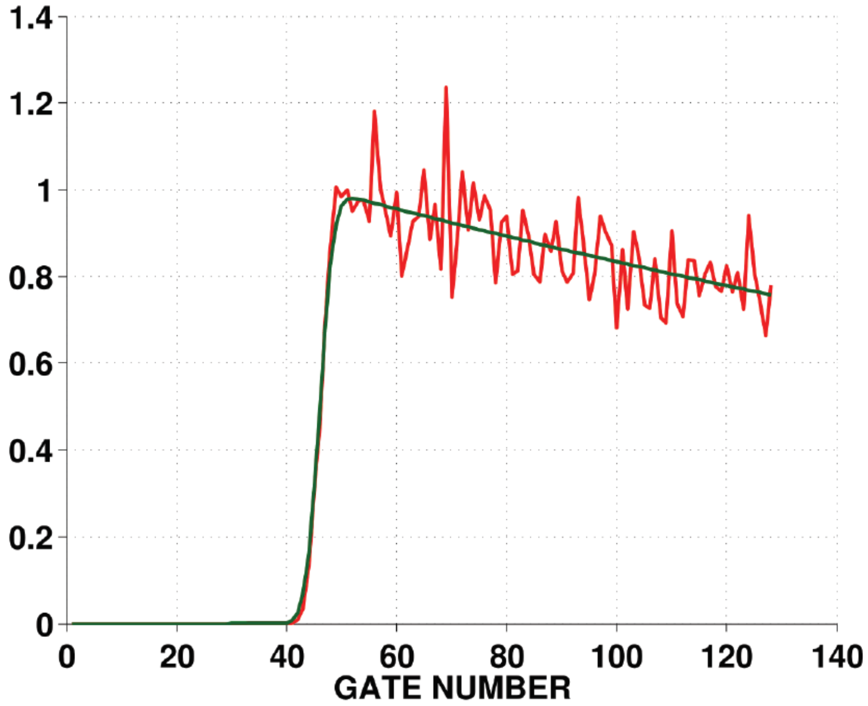
Retracking

- Process of fitting the received echo to an idealised model

Brown-hayne model



Retracking



➔ Extraction of geophysical parameters:

→ range, wind speed (σ_0), **significant wave height (SWH)**

(Estimated) Computational Complexity

L1B-to-L2 processing (=retracking)
12 h on 1 core @Intel(R) Xeon(R) W-2133 CPU @ 3.60GHz
2:15 h on 12 cores @Intel(R) Xeon(R) W-2133 CPU @ 3.60GHz

~35 min on 50 cores @Intel(R) Xeon(R) CPU E5-2699 v4 (x2) @ 2.20GHz

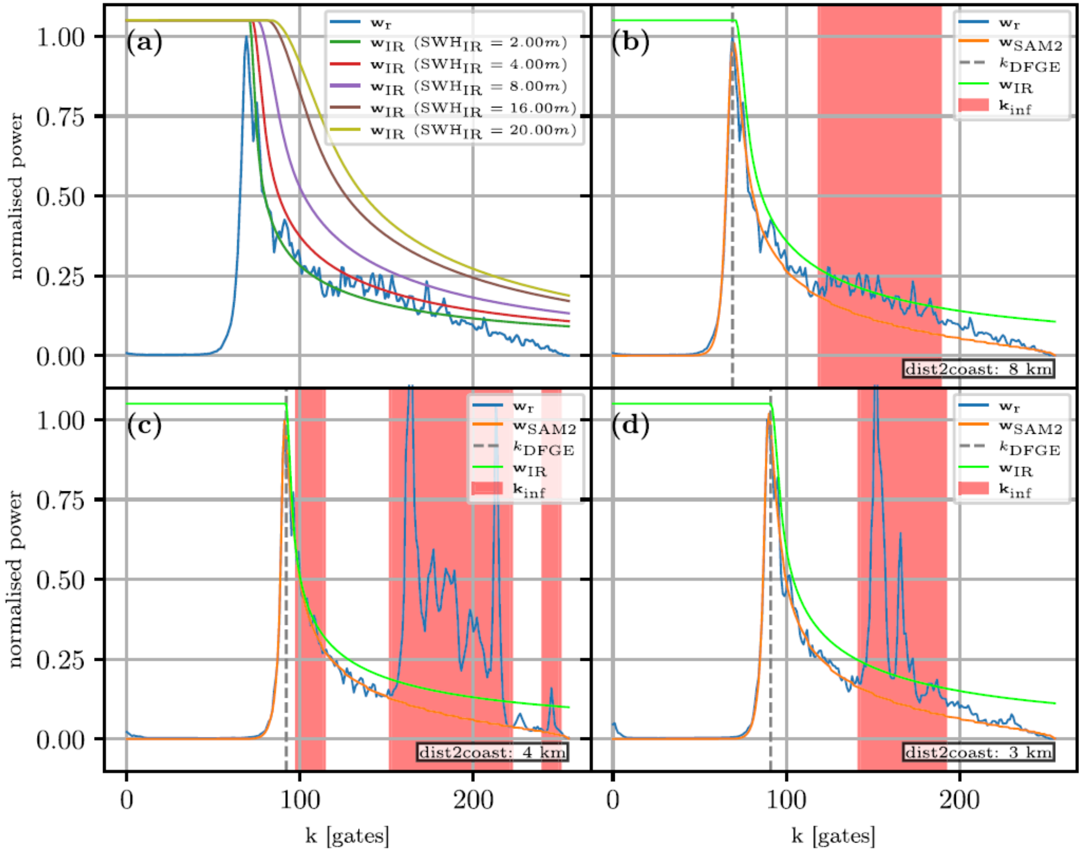
LRZ HPC cluster
512 netCDF files
~1.5 days on 896 cores (16 cluster nodes) @Intel Xeon E5-2690 v3 ("Haswell") @ 2.60GHz

CORALv1: AIM

Adaptive Interference Masking (AIM)

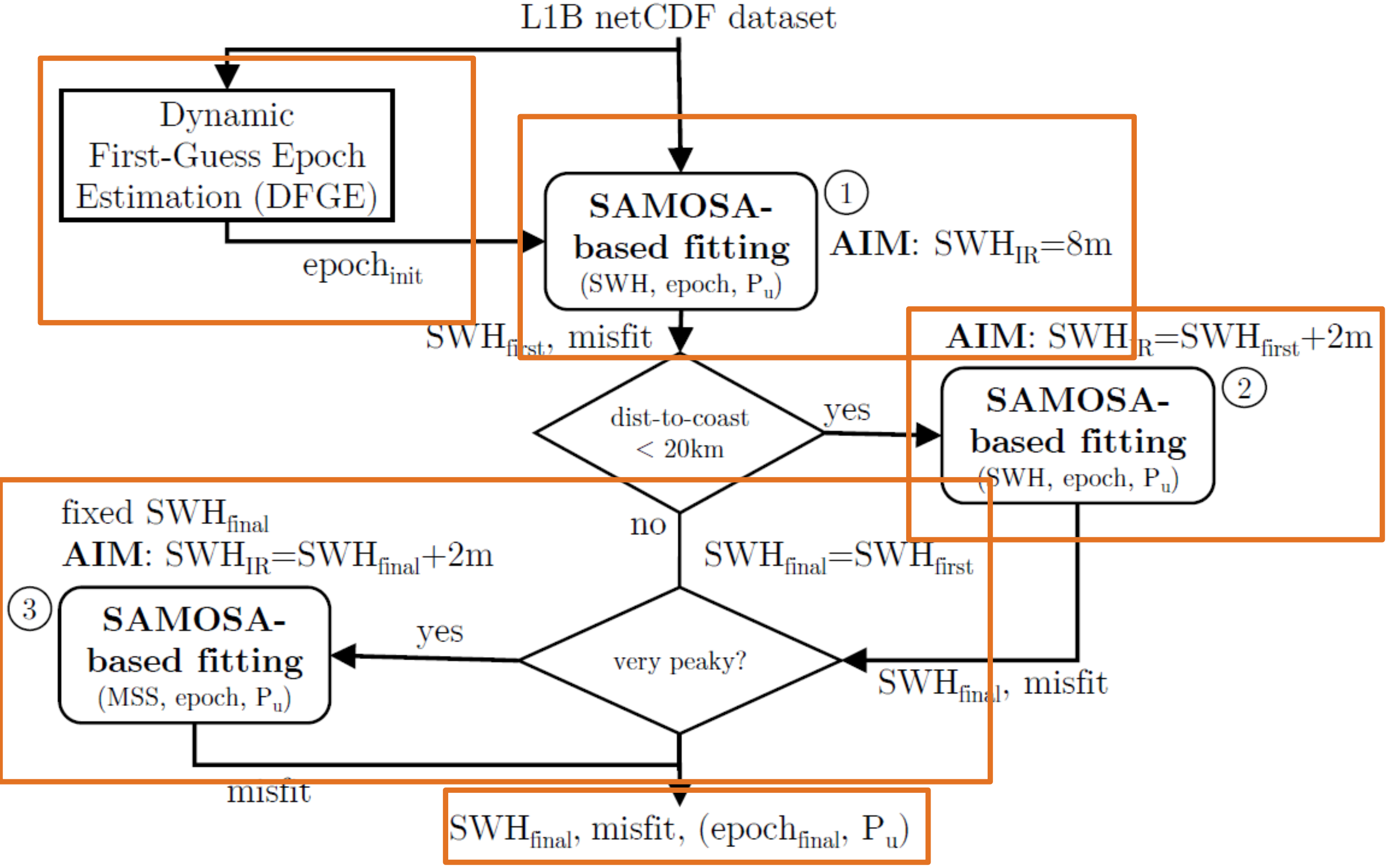
→ senses and masks interference within the trailing edge

Generation of a single-look SAMOSA model $\mathbf{w}_{\mathrm{SAM2}}$ to produce the interference reference waveform $\mathbf{w}_{\mathrm{IR}}(\mathrm{SWH}_{\mathrm{IR}})$



CORALv1: Retracking Strategy

- CORALv1‘ retracking strategy



a) run DFGE
b) SAMOSA-based fitting (1) → **SWH$_{first}$**
c) If dist-to-coast-<20: SAMOSA-based fitting (2) → **SWH$_{final}$**
d) If peaky waveform: SAMOSA-based fitting (3)
e) SWH$_{final}$, misfit, (epoch$_{final}$, P$_u$)

Validation

- Performed with retrackval framework from Altimeters‘ Round Robin assessment (Schlembach et al. 2020)
- Only minor changes to RR assessment
- Same L1B dataset as for RR:
  - 512 netCDF files, 30 pole-to-pole tracks, 17-18 cycles
  - 26th of March 2017 to the 30th of June 2018 (15 months)
  - From EUMETSAT CODA, baselines 002 and 003
- Validation data:
  - ERA5-based hindcast model (ERA5-h)
  - In-situ buoy data (170 buoys, 46 coastal buoys)
  - Reference L2 datasets:
    - SAM-EUM: original L2 with latest baseline 004 with original quality flag (defined by 3-sigma criterion)
    - SAM-EUM-MQE: original L2 with latest baseline 004 and redefined quality flag: $\mathrm{misfit\_eum} = \sqrt{100 * \sqrt{\mathrm{mqe}}}$
    - LR-RMC, dataset taken from Altimeter Round Robin
    - SAM+-GPOD, RR files processed by GPOD
- Types of analyses: Outliers, **Number of Valid Records**, Intrinsic noise, wave spectral variability, comparison against ERA5-h wave model, in-situ buoy data

Validation

- Performed with framework from Altimeters‘ Round Robin (RR) assessment (Schlembach et al. 2020)
- Reference L2 datasets:
  - SAM-EUM: original L2 with latest baseline 004 with original quality flag (defined by 3-sigma criterion)
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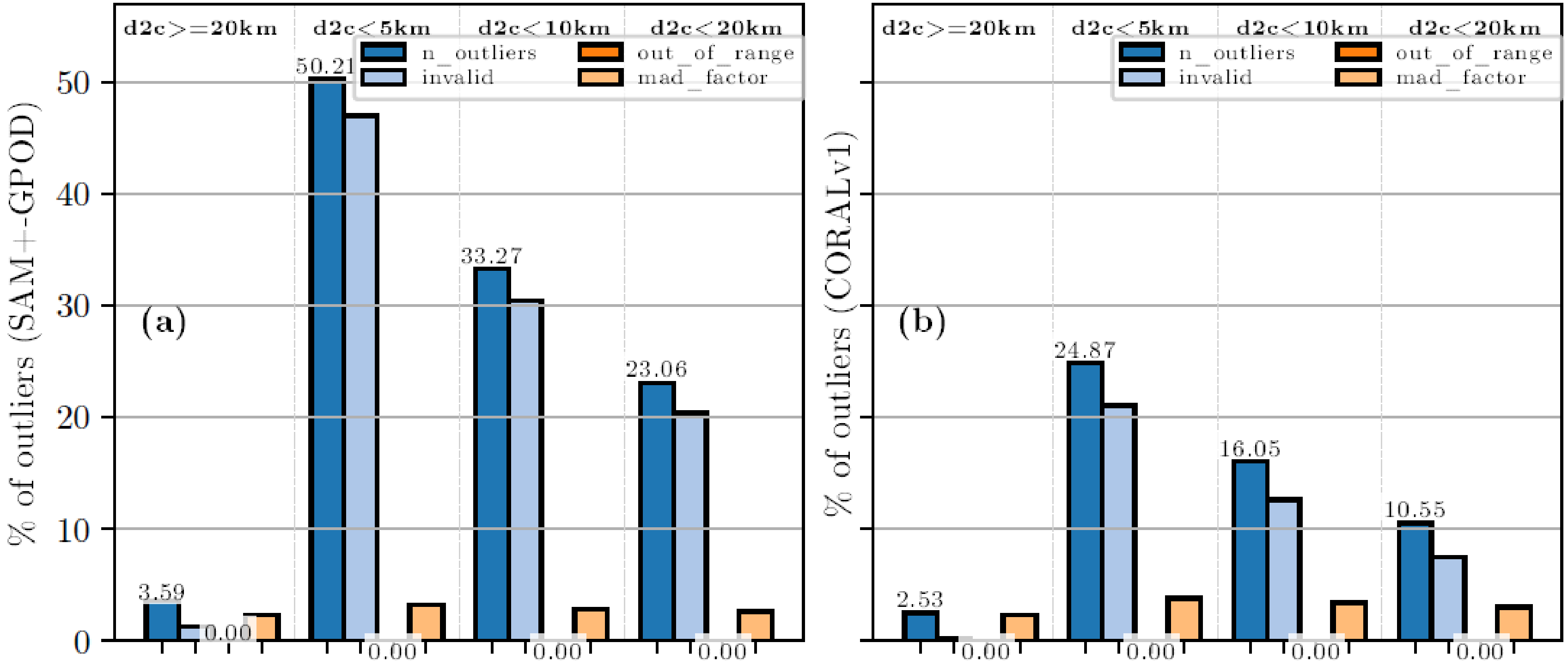
  - LR-RMC, dataset taken from Altimeter Round Robin
  - SAM+-GPOD, RR files processed by GPOD

Validation: Outliers

Distribution of the different types of outliers



Invalid: missing data or quality flag set ‚bad‘

Out_of_range: [-0.5, 25]m

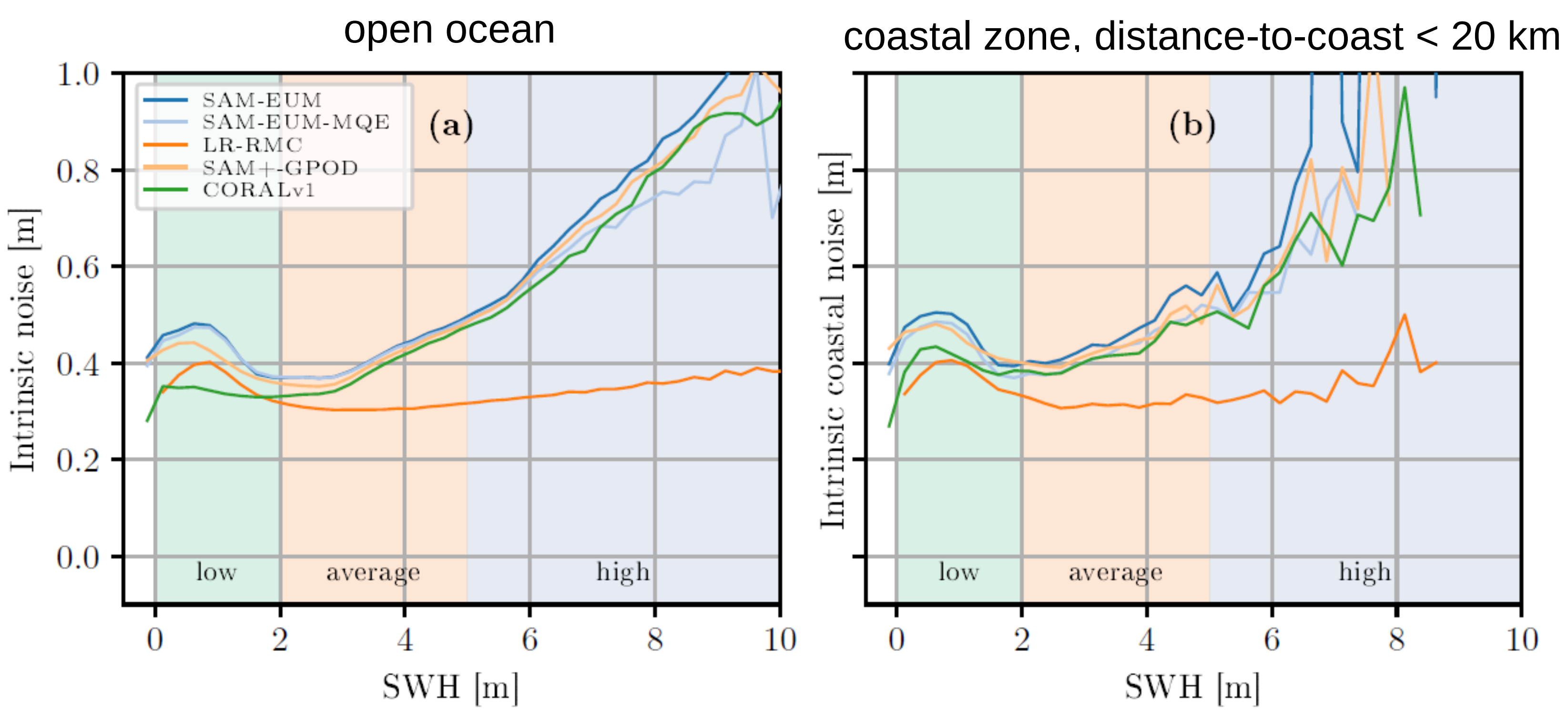
mad_factor:

$$|\mathrm{SWH}_i| - median_{20} > \pm 3 \cdot 1.4826 \cdot \mathrm{MAD}_{20}$$

Invalid outliers and thus the quality flag account for most of the outliers

Validation: Intrinsic Noise

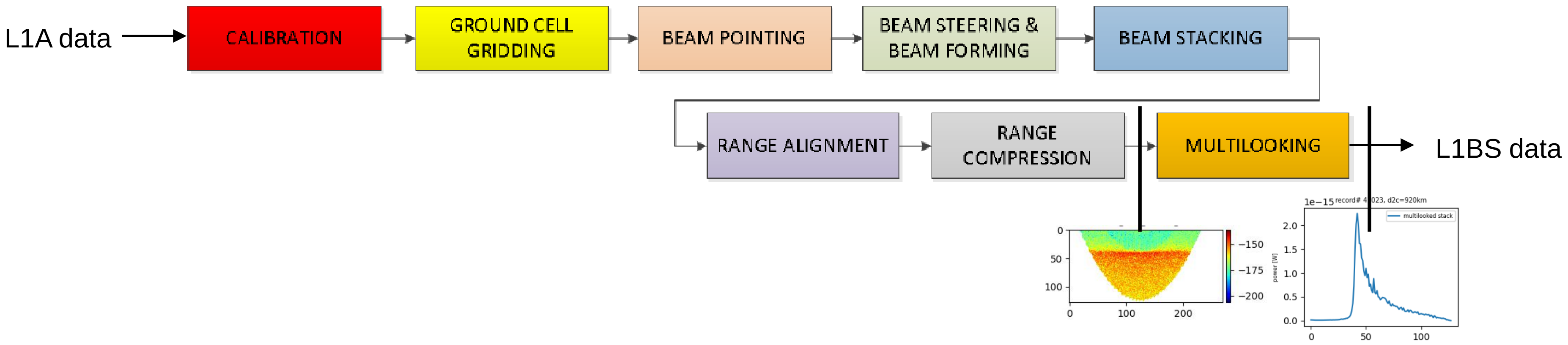
Defined as the standard deviation (STD) of 20-Hz data within a 1-Hz distance



→ No significant additional noise in coastal zone

SAR Altimetry Processing Levels

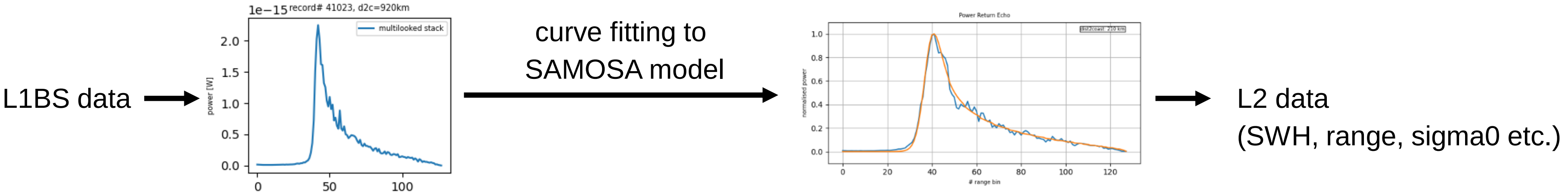
L1B processing (L1A -> L1B)



Different L1B products available

- EUMETSAT
- GPOD (‘official s3’ setting) → n_p=128, no Hamming window
- GPOD (‘coastal’ setting) → n_p=512, Hamming window
- DeDop framework → generation works, but large bias → buggy → needs rework

L2 processing (L1B/S -> L2)



→ Implemented retrackers: - SAM, SAM+, SAM++

→ Plus additional (optional) features that are **targeting coastal scenarios** (distorted multi-peak waveforms): **dynamic_fg_epoch**, **normalise_around_fg, leading_edge_detection, distortion_masking**, **new_qual_flag**

SAMOSA+ Algorithm

As in Dinardo2018, Dinardo2020

- Based on SAMOSA2 model (SAMOSA DPM 2.5.2)
- Dedicated L1B processing:
  - Oversampling (zero-padding) factor 2, double-extension of receiving window → 512-len waveform
  - Applied Hamming window to mitigate spurious signal originating from sidelobes
- Two extensions to L2 processing

1. Dynamic first-guess epoch: pointwise product of 20 adjacent waveforms to get an averaged initial epoch for fitting
2. Second retracking step: fix SWH from first step, retrack mean square slope, if one of the following conditions are met:

$$\mathrm{E} \cdot \mathrm{PP} < 0.68$$
$$\mathrm{E} \cdot \mathrm{PP} > 0.78$$
$$100 \cdot \mathrm{PP} > 4$$
$$\frac{\mathrm{E}}{\mathrm{mistfit}} < 8$$

$$E = -\sum_i^N |w_{r,i}|^2 log_2(|w_{r,i}|^2)$$
$$\mathrm{PP} = \frac{\max(\mathbf{w_r})}{\sum_i^N w_{r,i}}$$

CORALv1: TRR Fitting Parameters

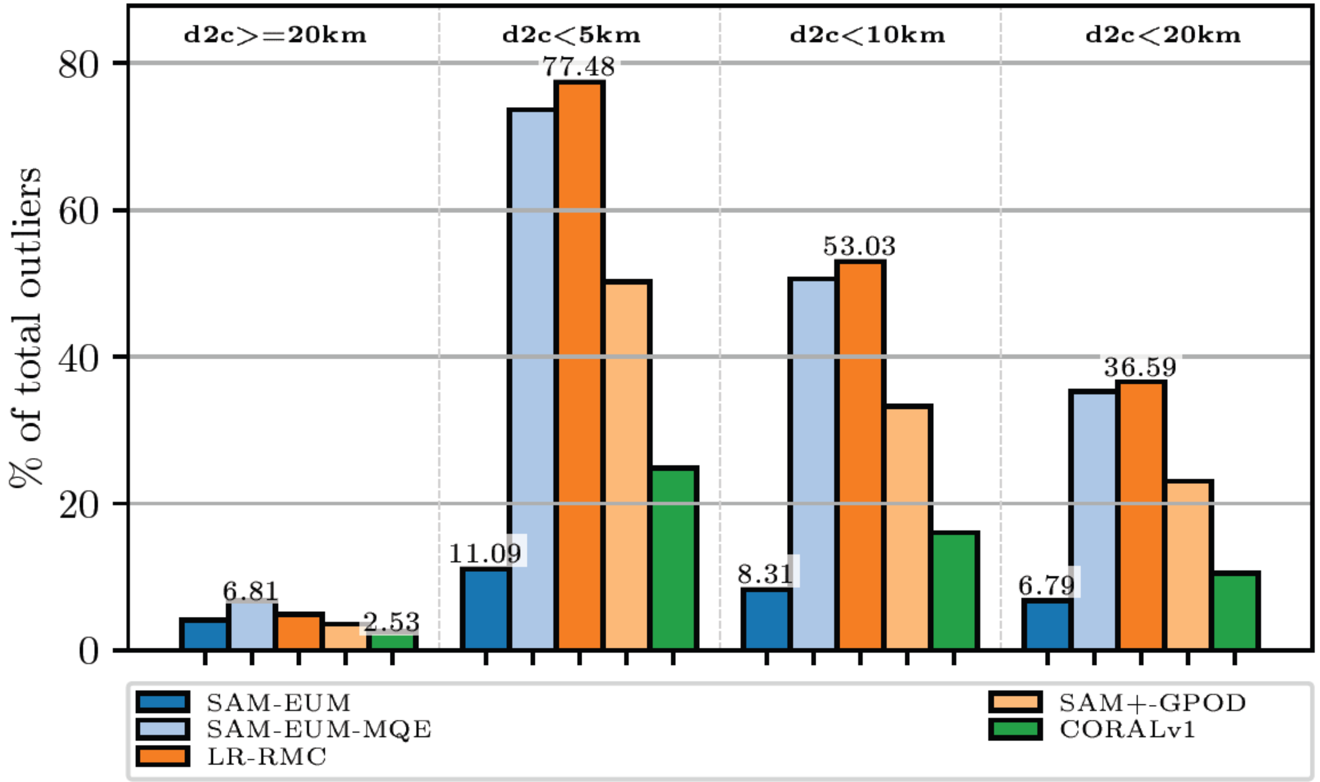
Chosen optimisation parameters for TRR algorithm

Optimisation parameter	**Value**
Init value: SWH	2.0 m
Boundary: SWH	$[-0.5, 20.0]$ m
Init value: epoch	estimated FG epoch
Boundary: epoch	$\pm 10\ k_{\mathrm{DFGE}}$
Init value: P_u	1.0
Boundary: P_u	$[0.2, 1.5]$
ftol/gtol/xtol	1e-5
Step size	1e-2

Table 2: Optimisation parameters used for TRR algorithm. ftol, gtol, and xtol are tolerances for terminating the fitting by the change of the cost function, the norm gradients, and the independent variables, respectively.

Validation: Outliers

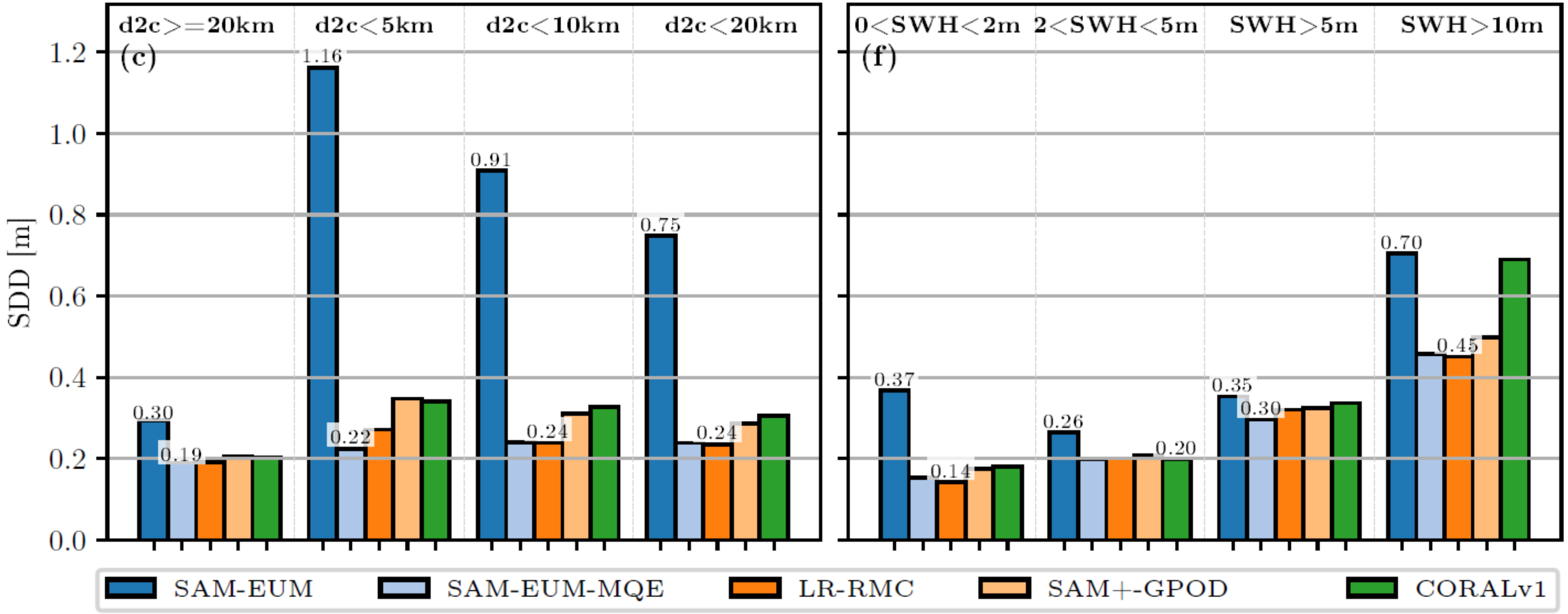
Total number of outliers



CORALv1 has significantly less outliers in the coastal zone.

Validation: Comparison with the ERA5-h Wave Model

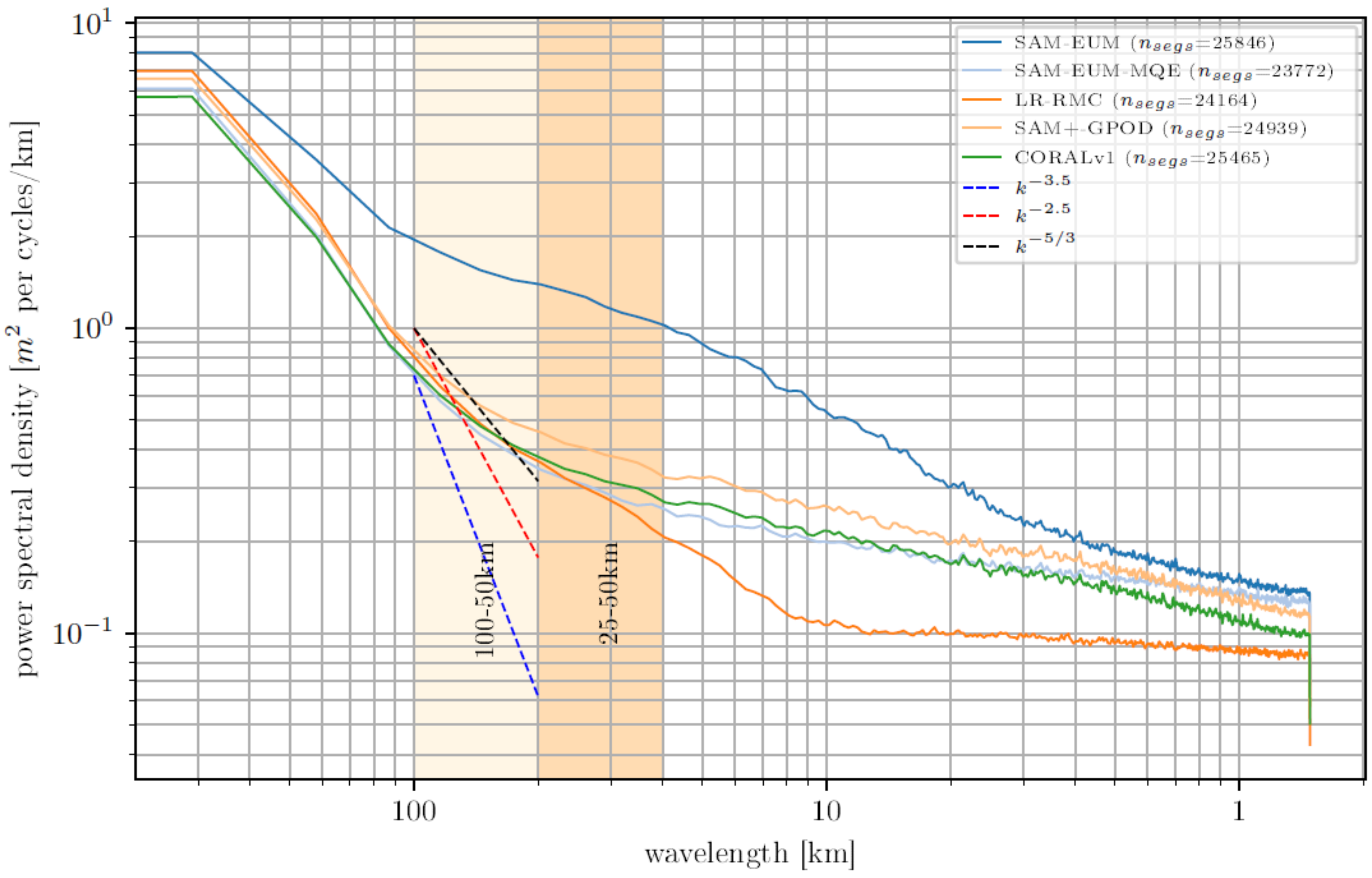
Standard deviation of the differences (SDD)



CORALv1 shows a comparable performance with regards to the ERA5-h wave model.

Validation: Power Spectral Density

Welch spectra (averaged 1024-pt Fourier spectra, 50% overlap, Hann windowed) → open ocean segments (gaps interpolated)



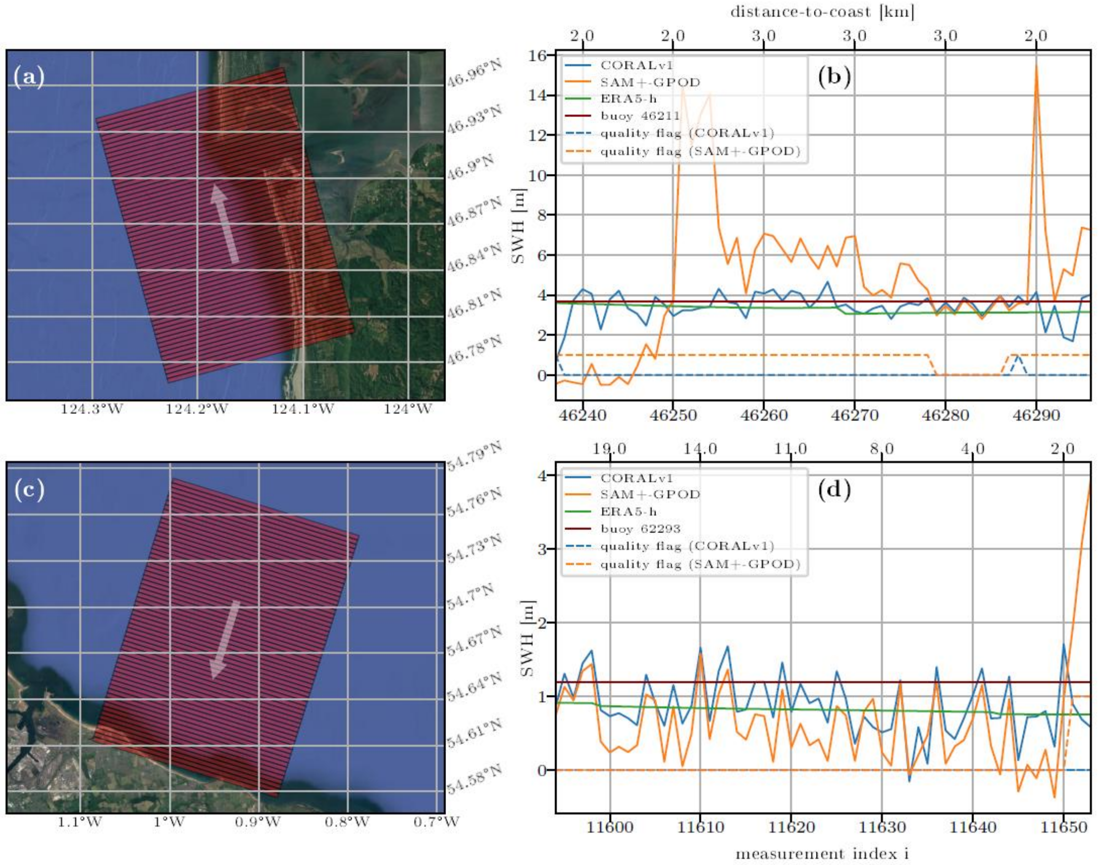
$k^{-5/3}$

Boas et al. 2020

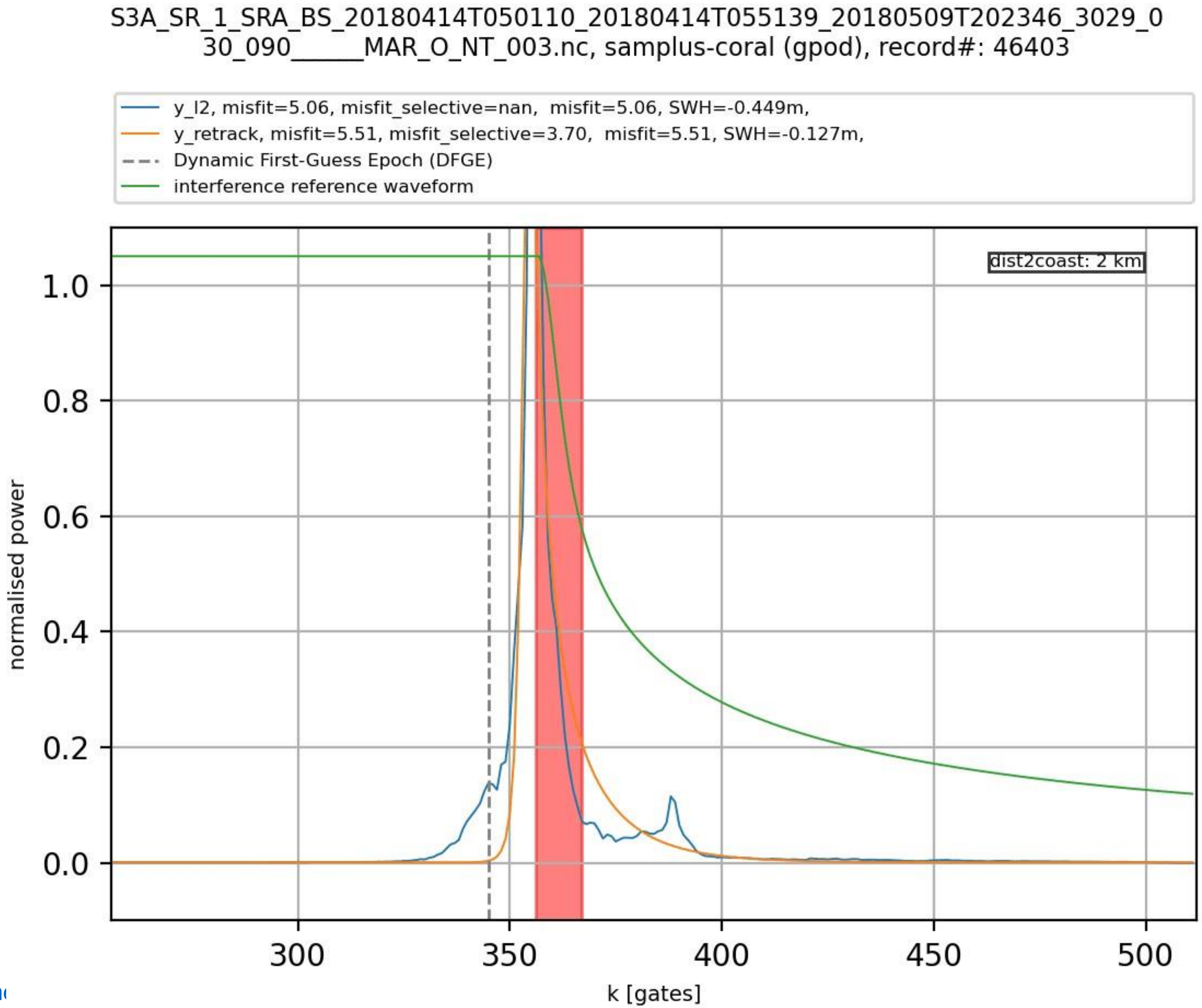
Dodet et al. 2020

Validation: Coastal Case Study

Two coastal case studies showing maps of effective footprints (14 km x 330 m)



CORALv1 shows a significant increase of valid, good quality SWH estimates when the effective footprint is land-intruded



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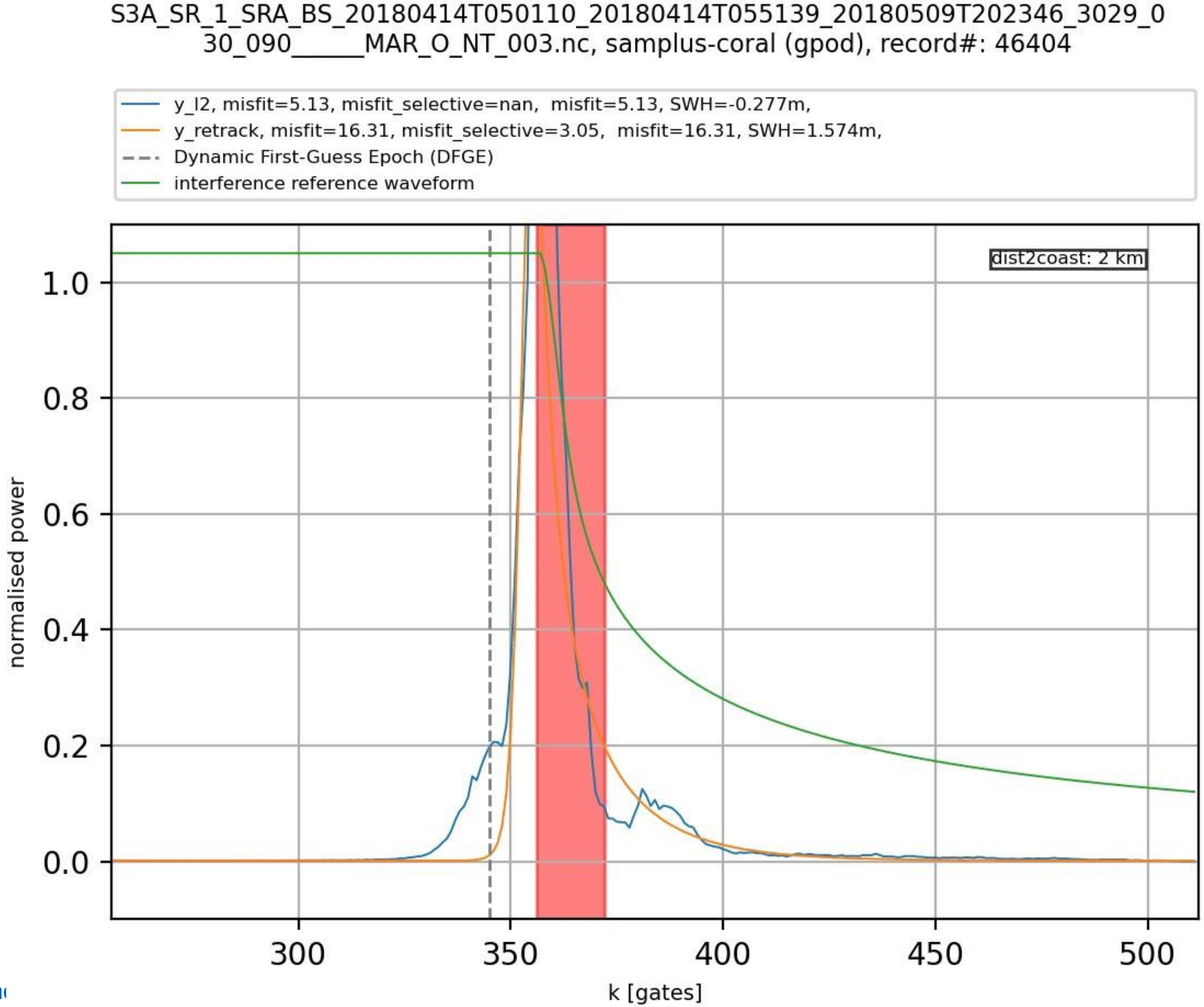
interference reference waveform
dist2coast: 2 km
normalised power
k [gates]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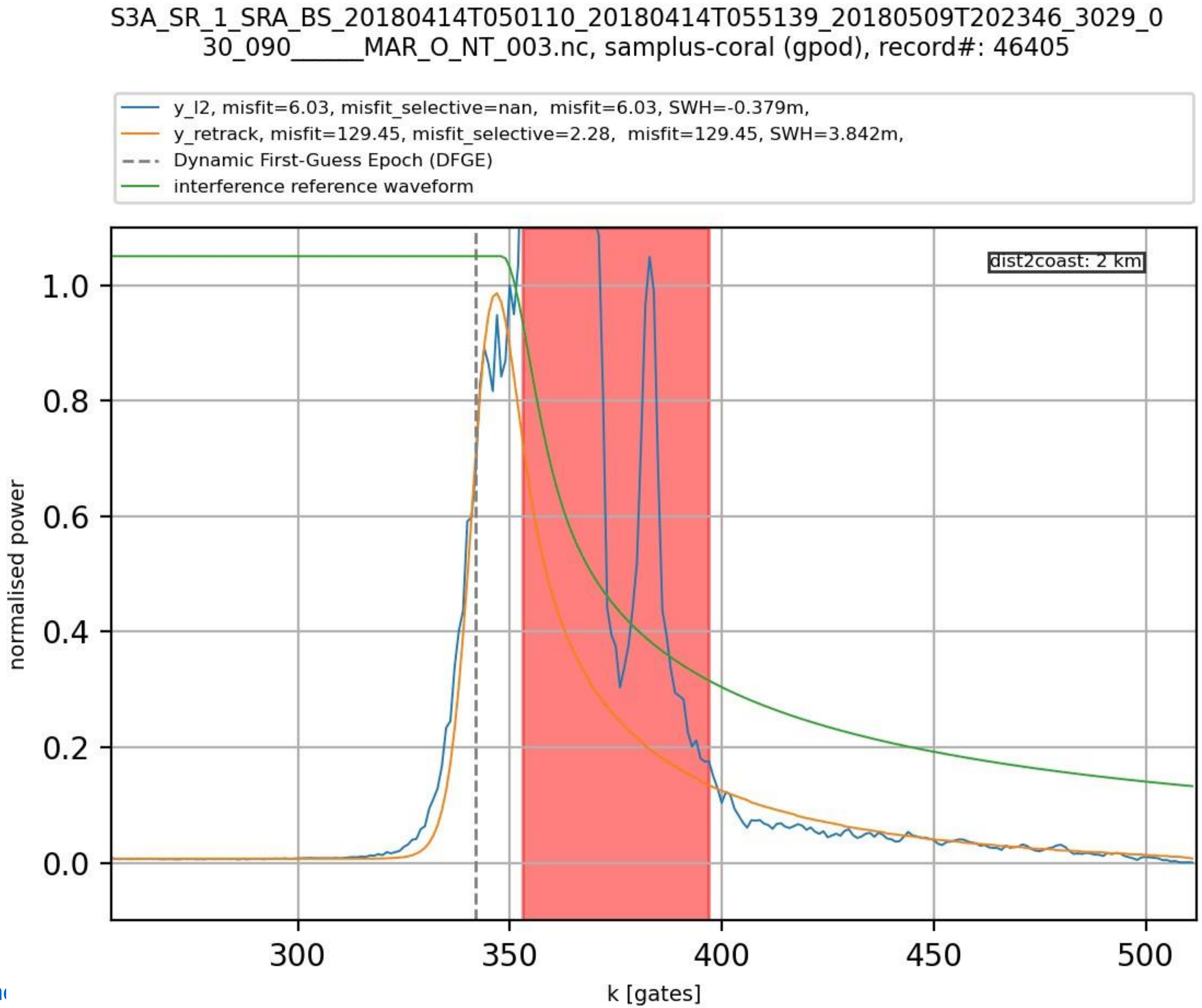
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]



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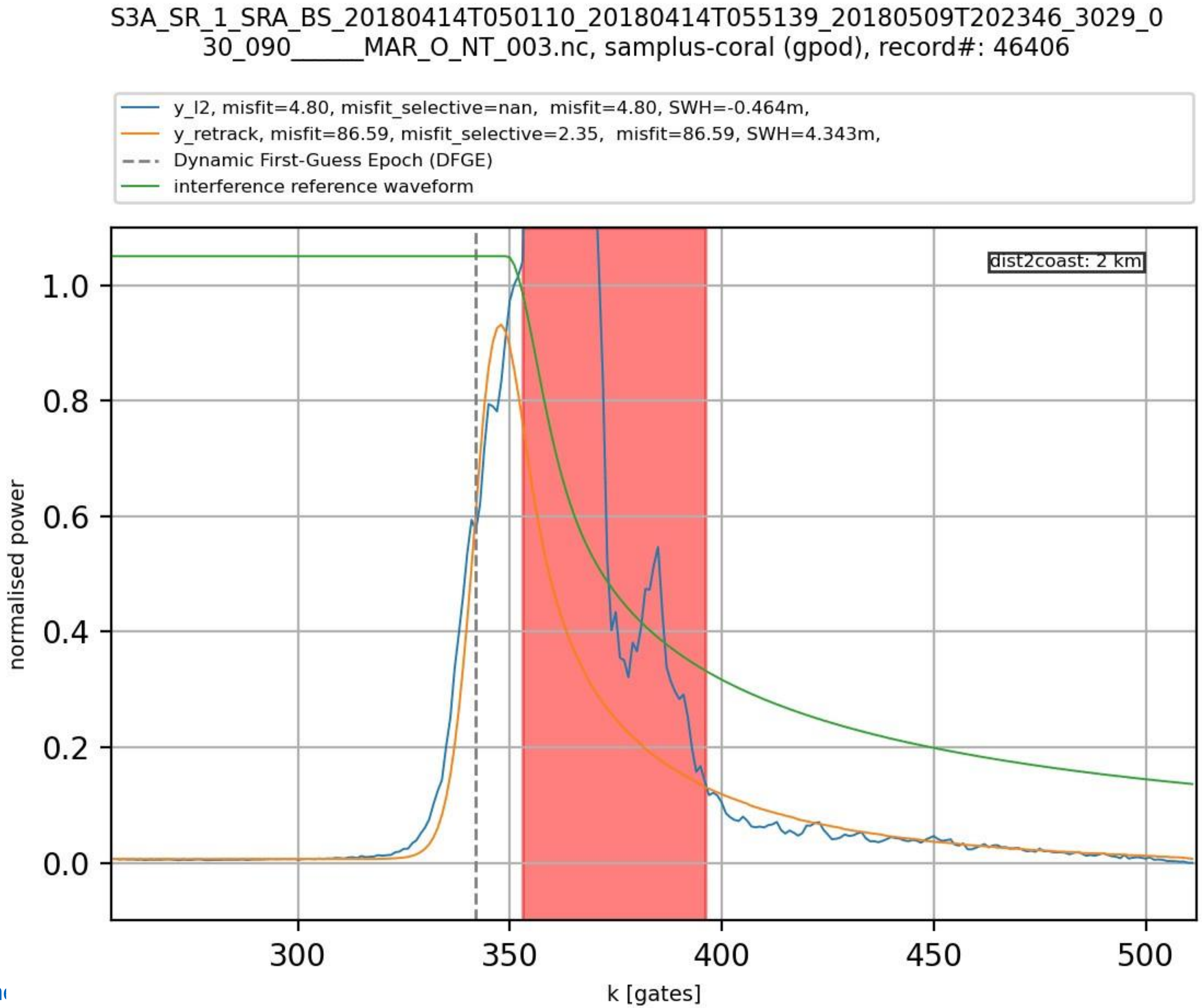
interference reference waveform
dist2coast: 2 km
normalised power
k [gates]



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Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
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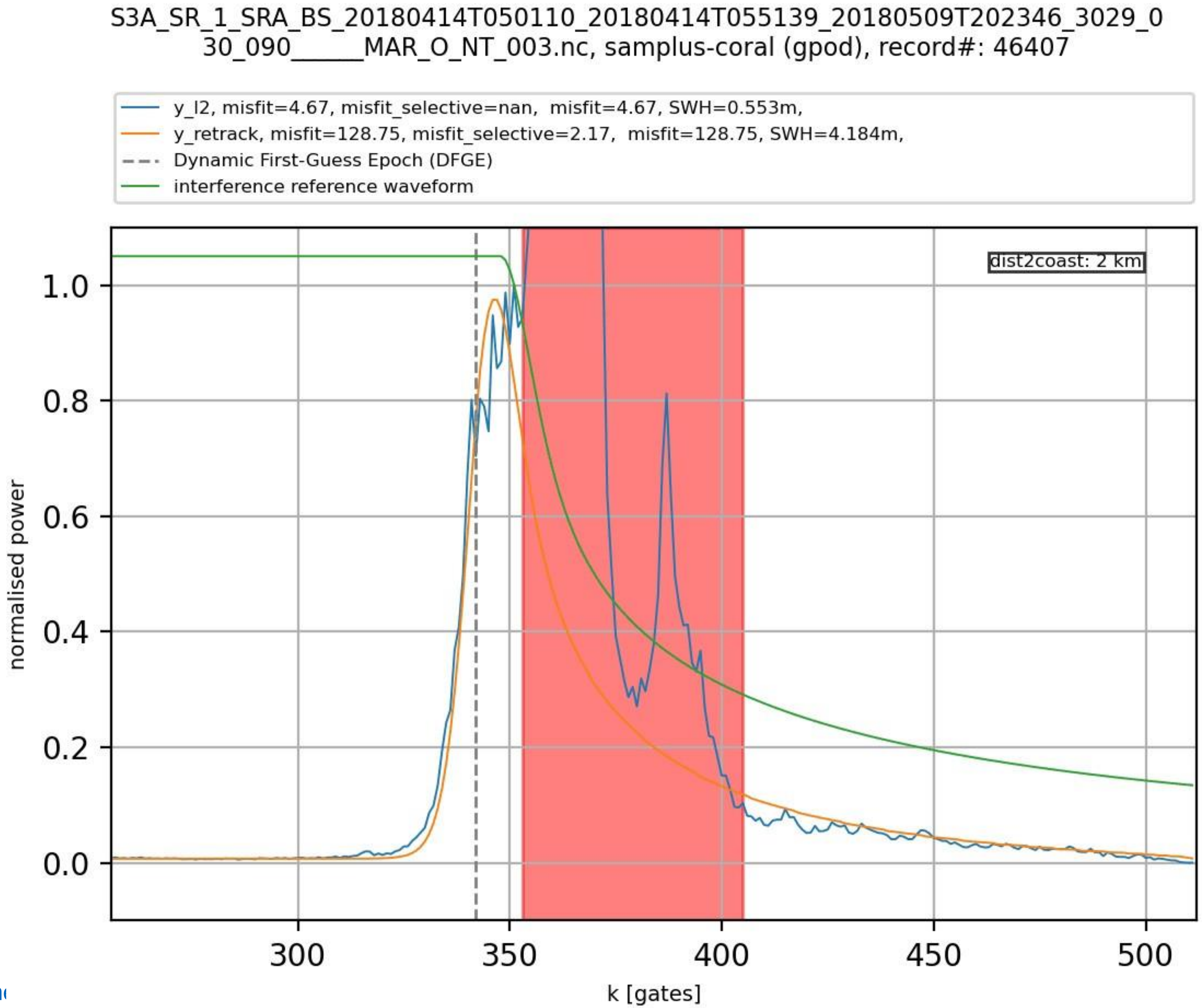
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]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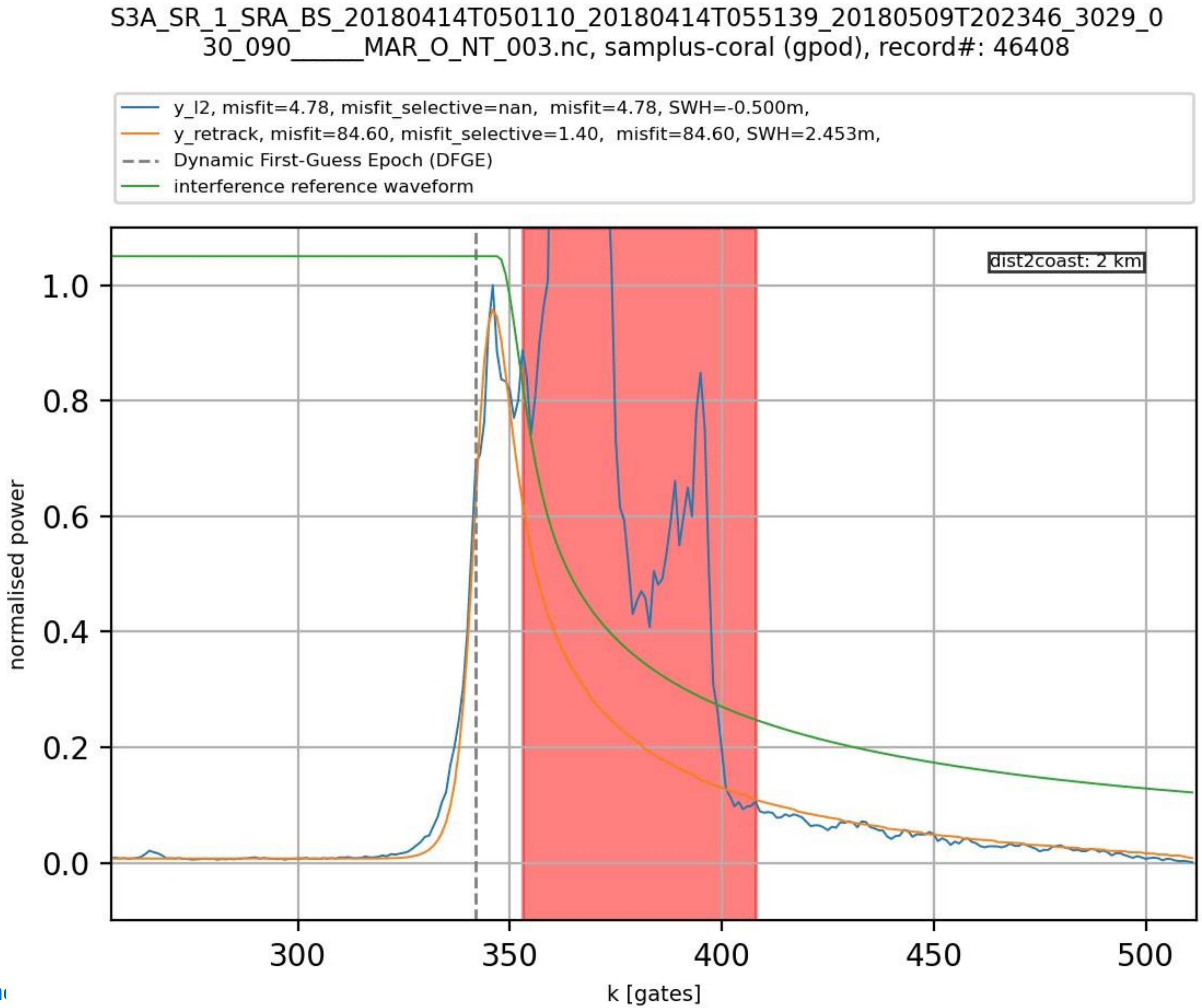
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]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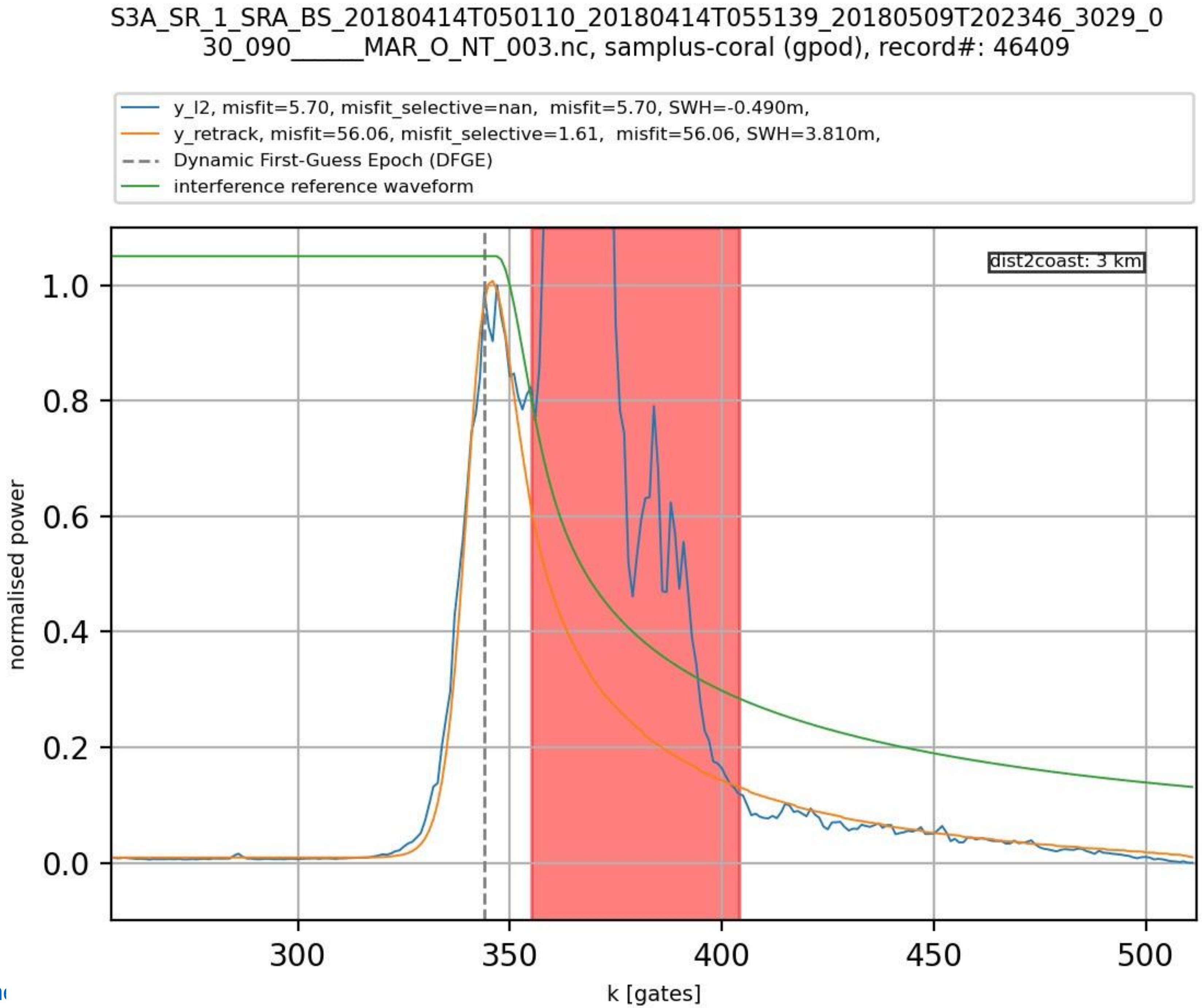
interference reference waveform
dist2coast: 2 km
normalised power
k [gates]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y_retrack, misfit=56.06, misfit_selective=1.61, misfit=56.06, SWH=3.810m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
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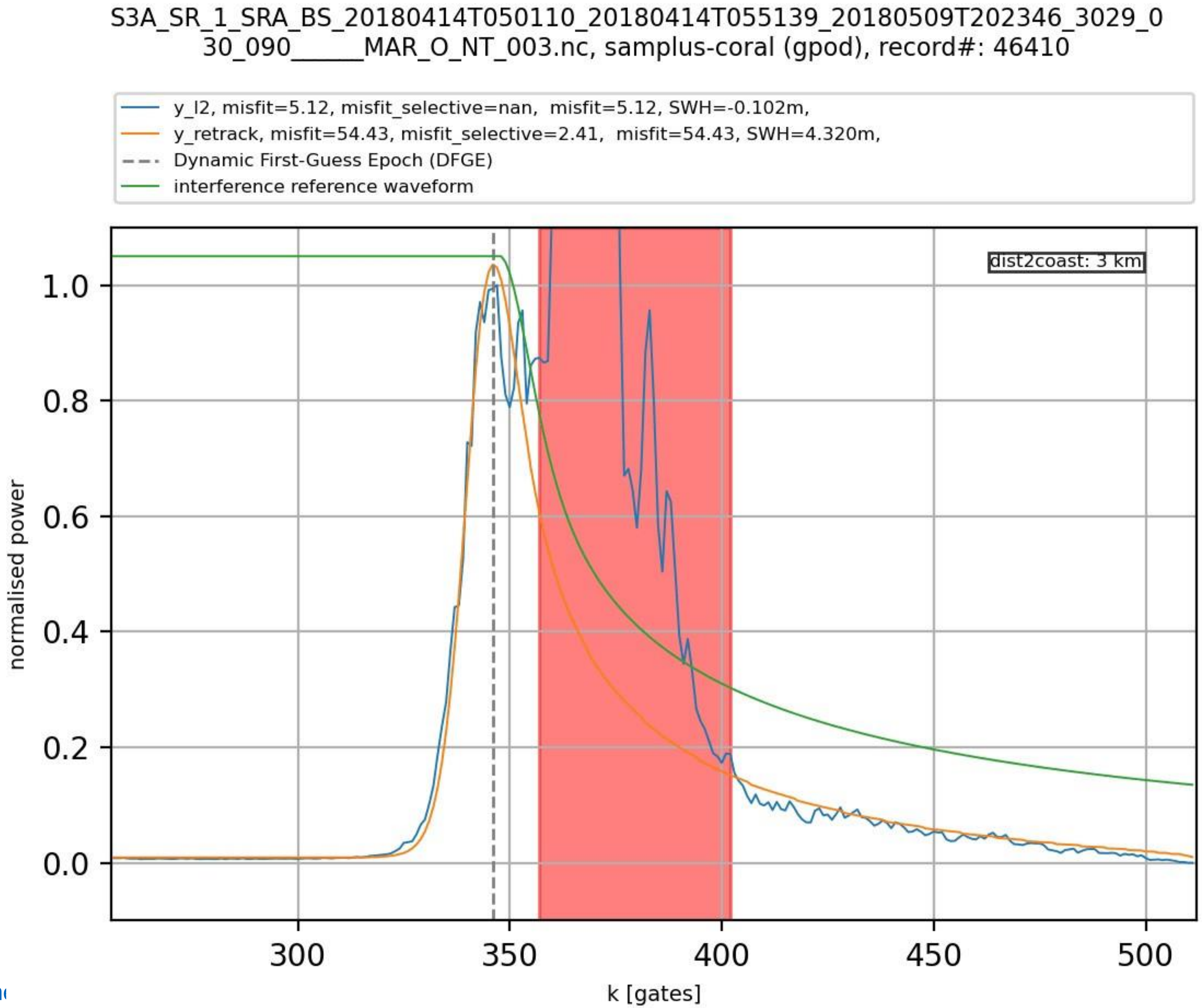
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]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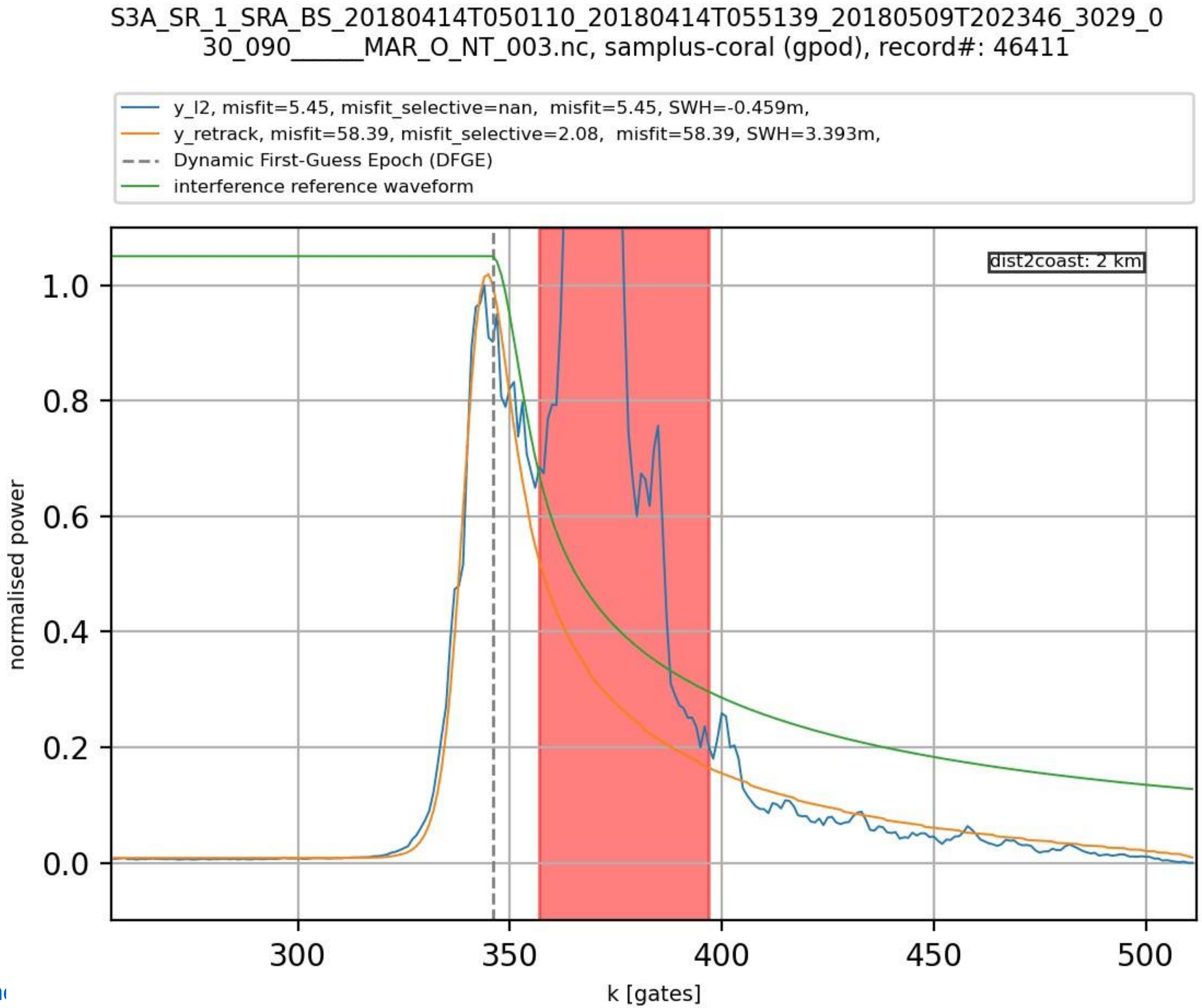
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46410
y_l2, misfit=5.12, misfit_selective=nan, misfit=5.12, SWH=-0.102m,
y_retrack, misfit=54.43, misfit_selective=2.41, misfit=54.43, SWH=4.320m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]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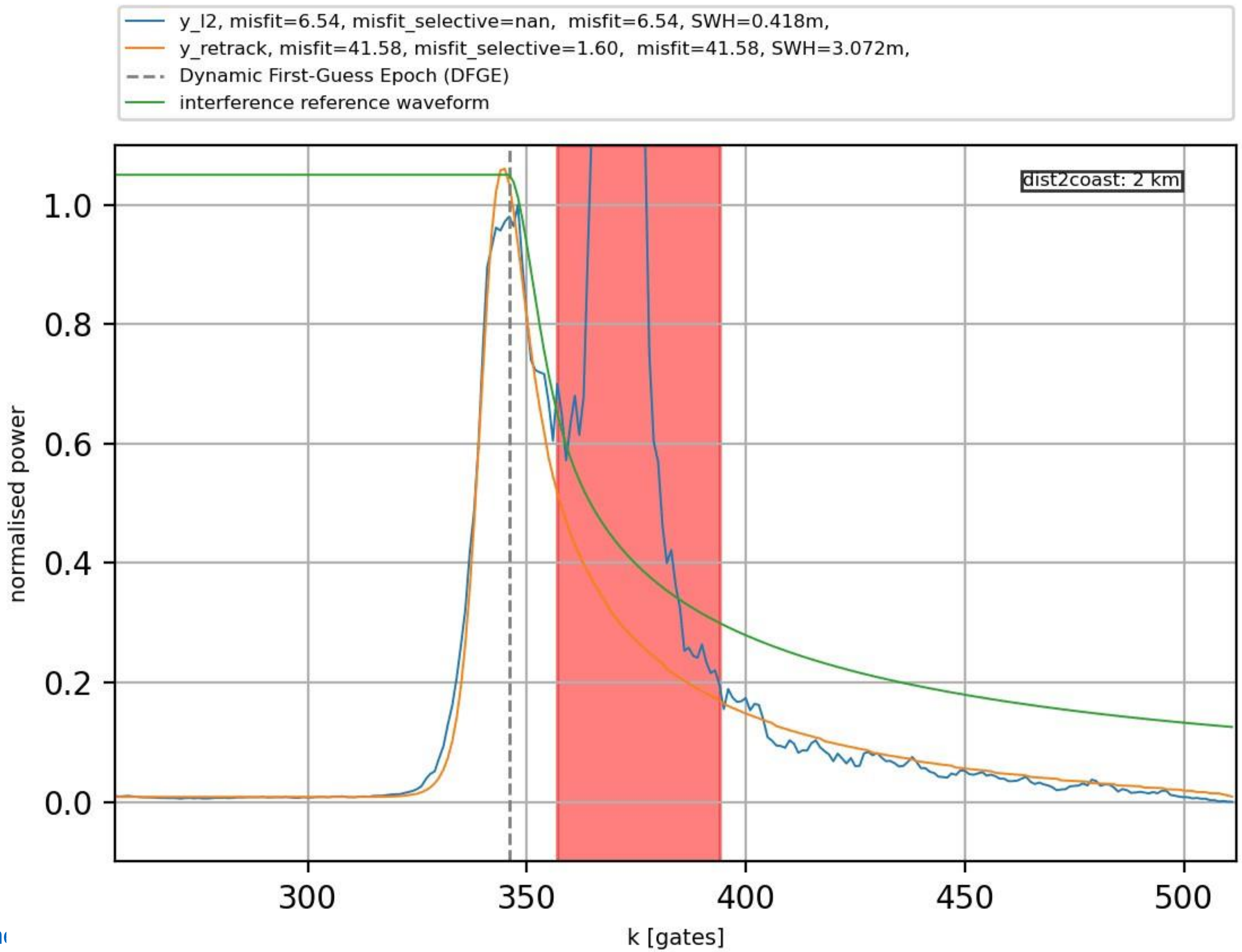
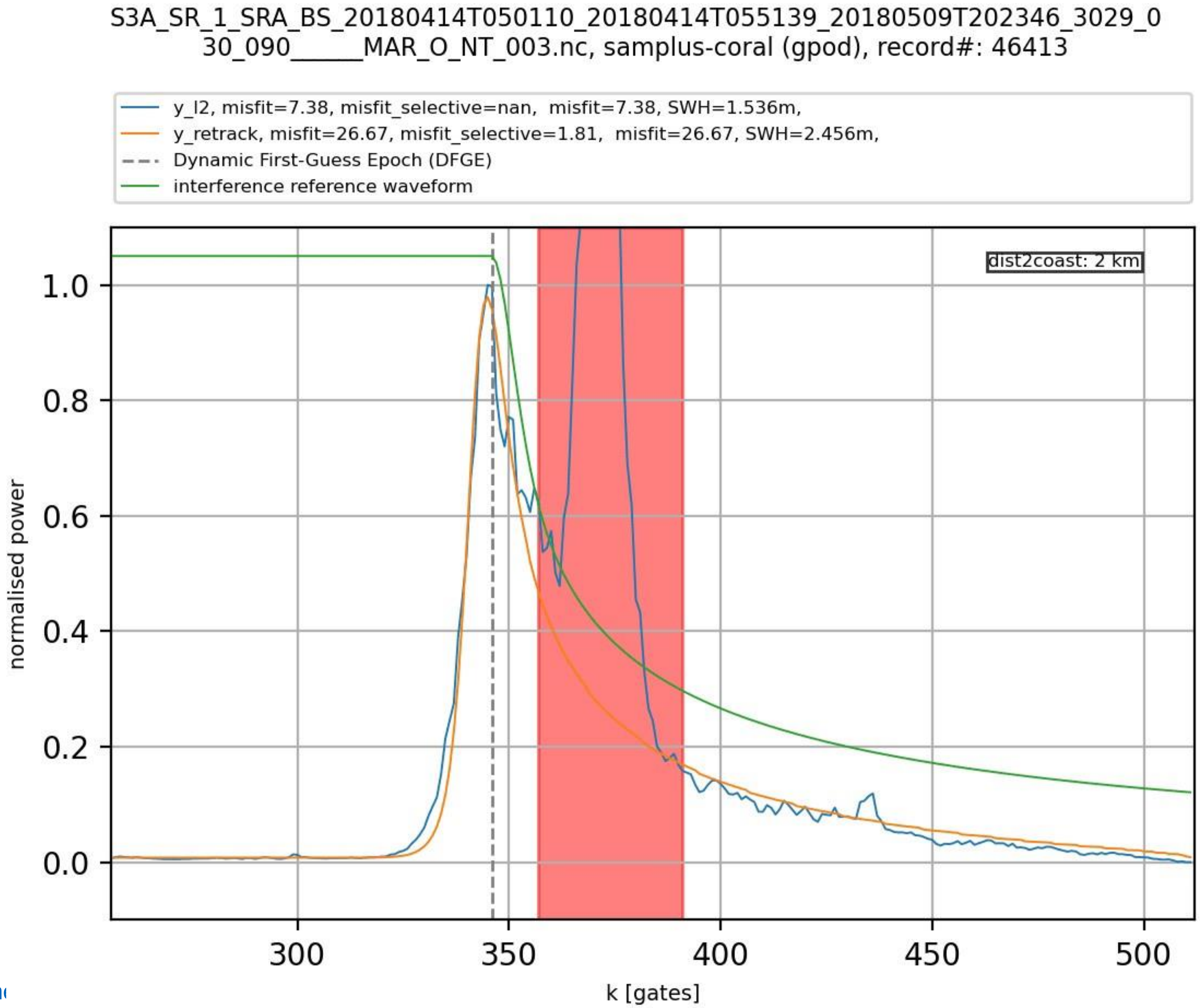
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46411
y_l2, misfit=5.45, misfit_selective=nan, misfit=5.45, SWH=-0.459m,
y_retrack, misfit=58.39, misfit_selective=2.08, misfit=58.39, SWH=3.393m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500

S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46412





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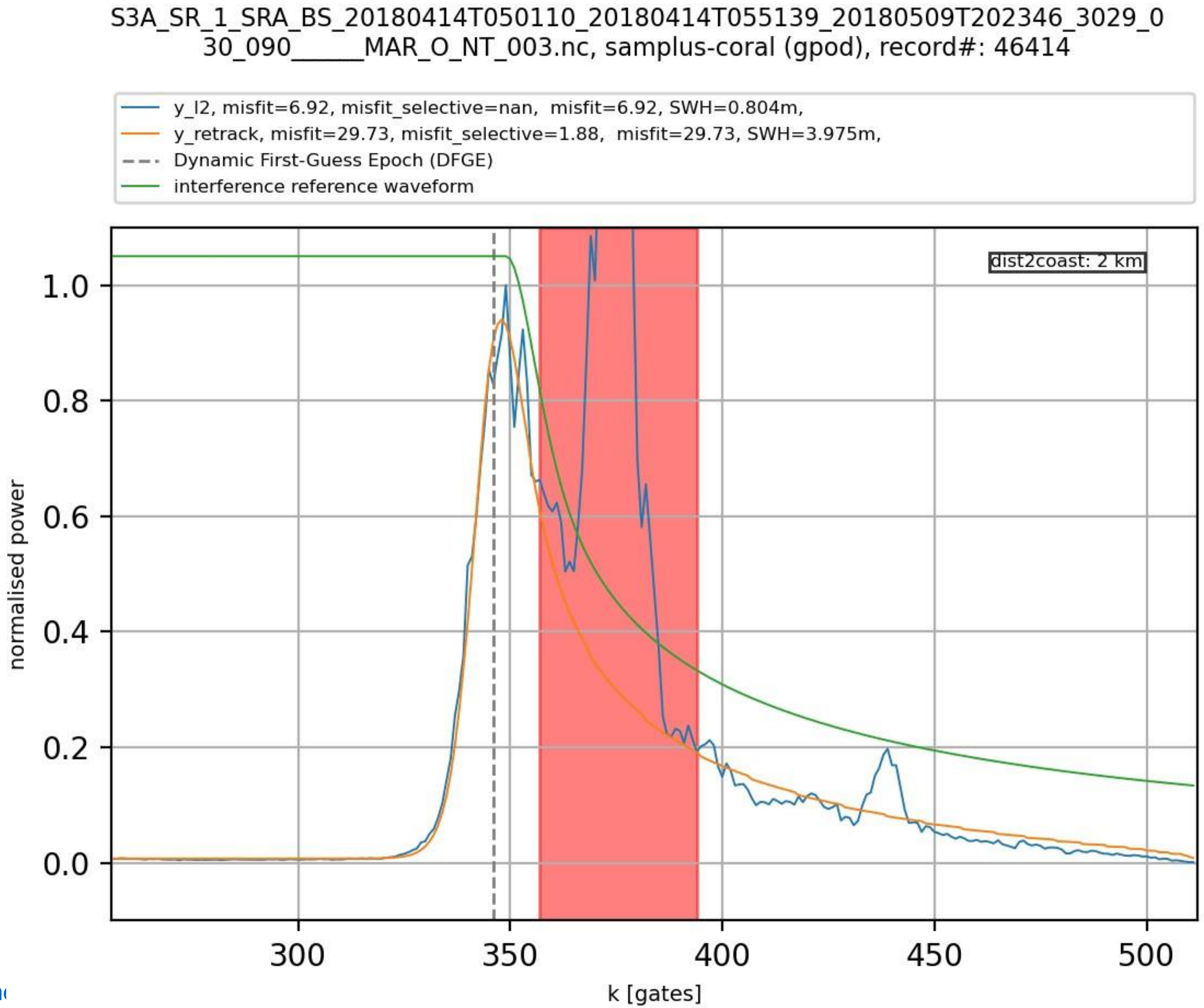
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46413
y_l2, misfit=7.38, misfit_selective=nan, misfit=7.38, SWH=1.536m,
y_retrack, misfit=26.67, misfit_selective=1.81, misfit=26.67, SWH=2.456m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]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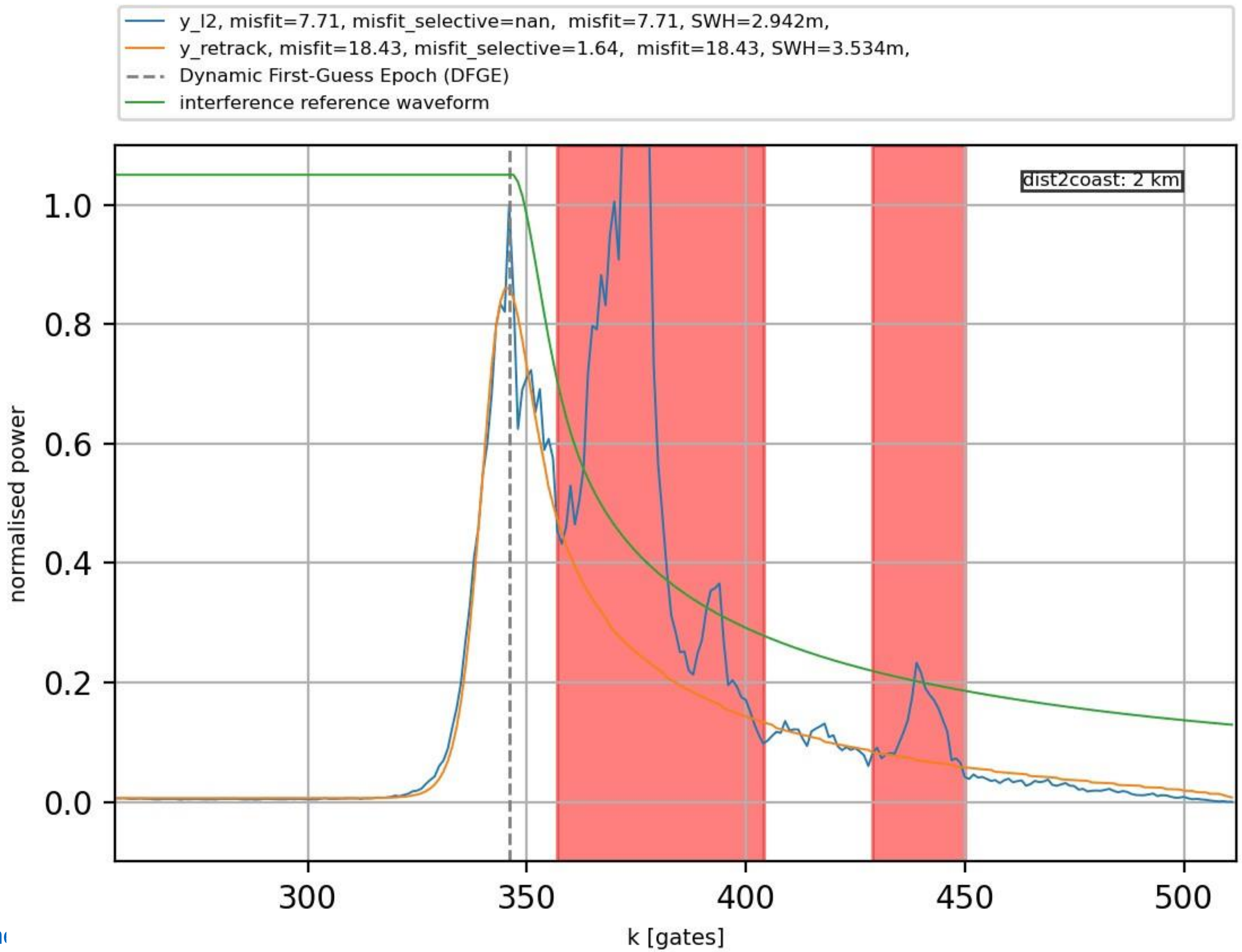
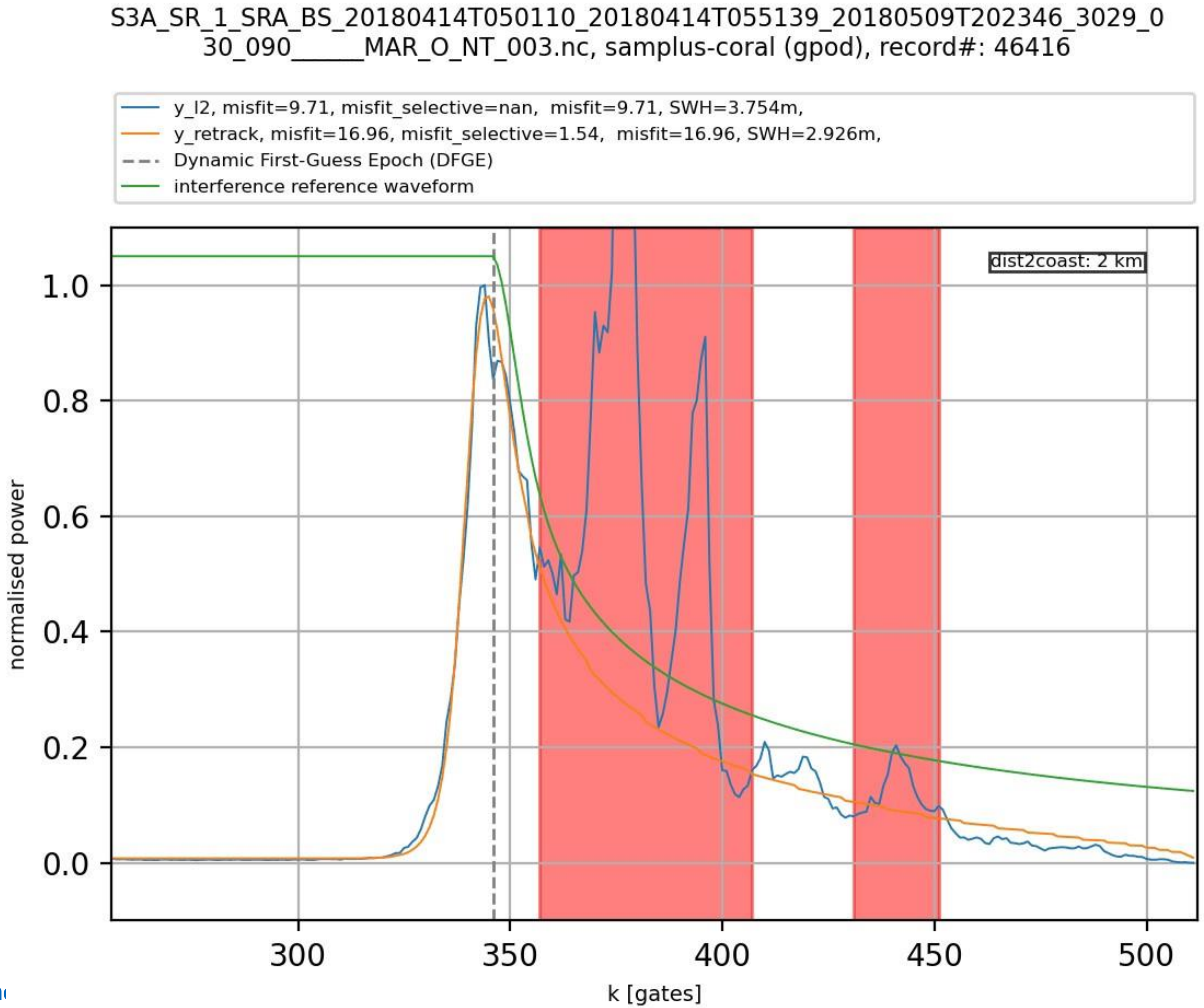
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46414
y_l2, misfit=6.92, misfit_selective=nan, misfit=6.92, SWH=0.804m,
y_retrack, misfit=29.73, misfit_selective=1.88, misfit=29.73, SWH=3.975m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500

S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_030_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46415

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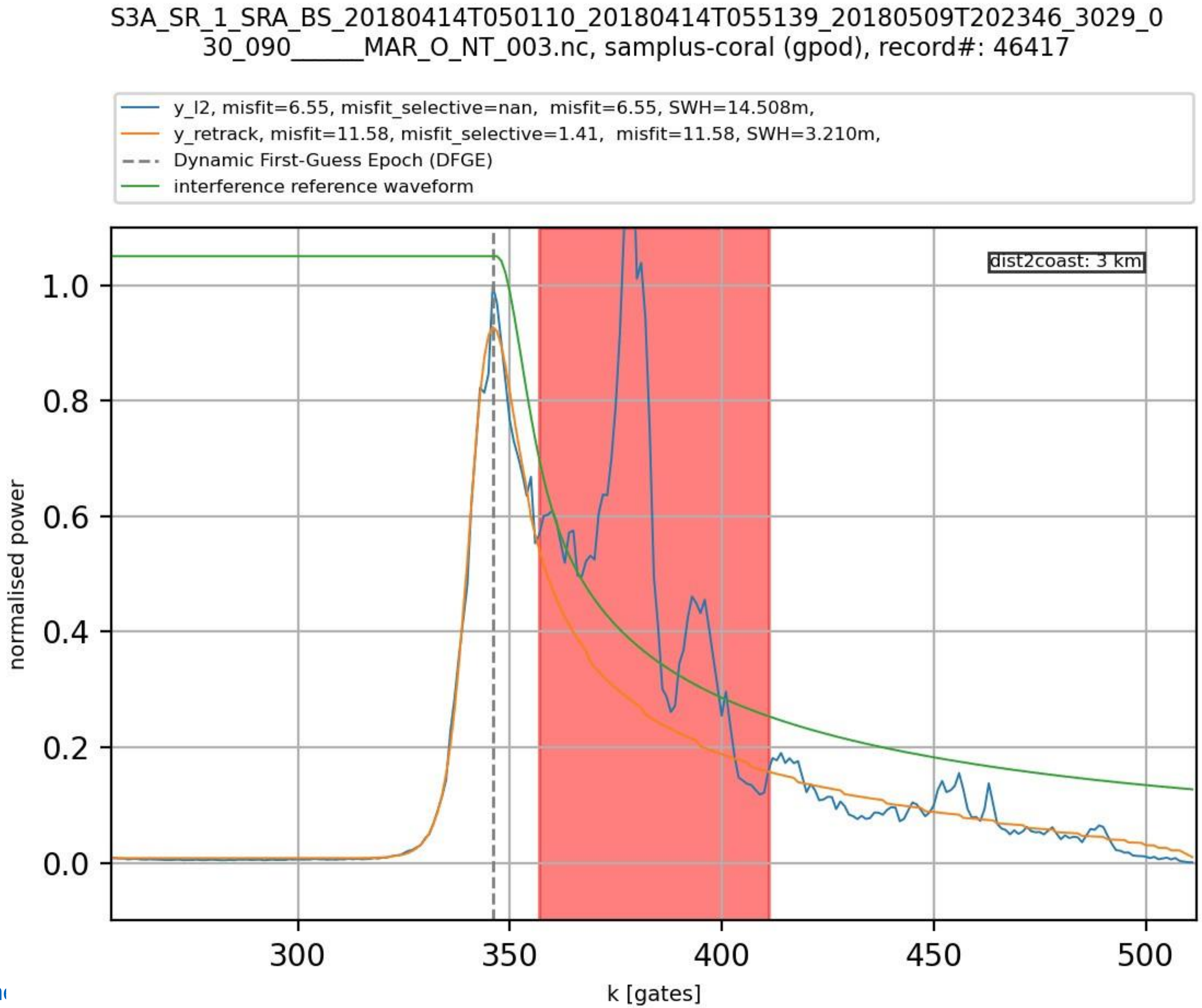
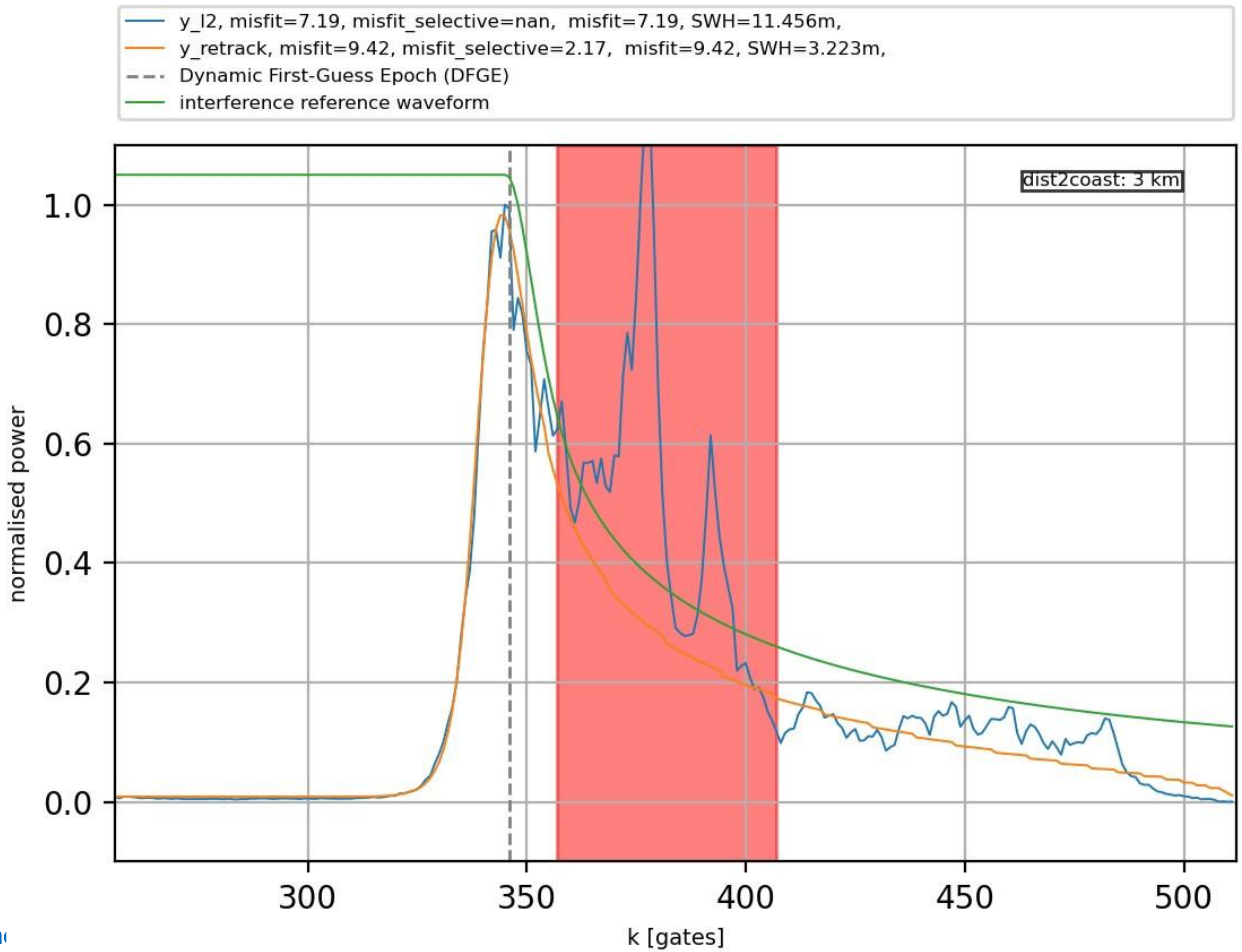
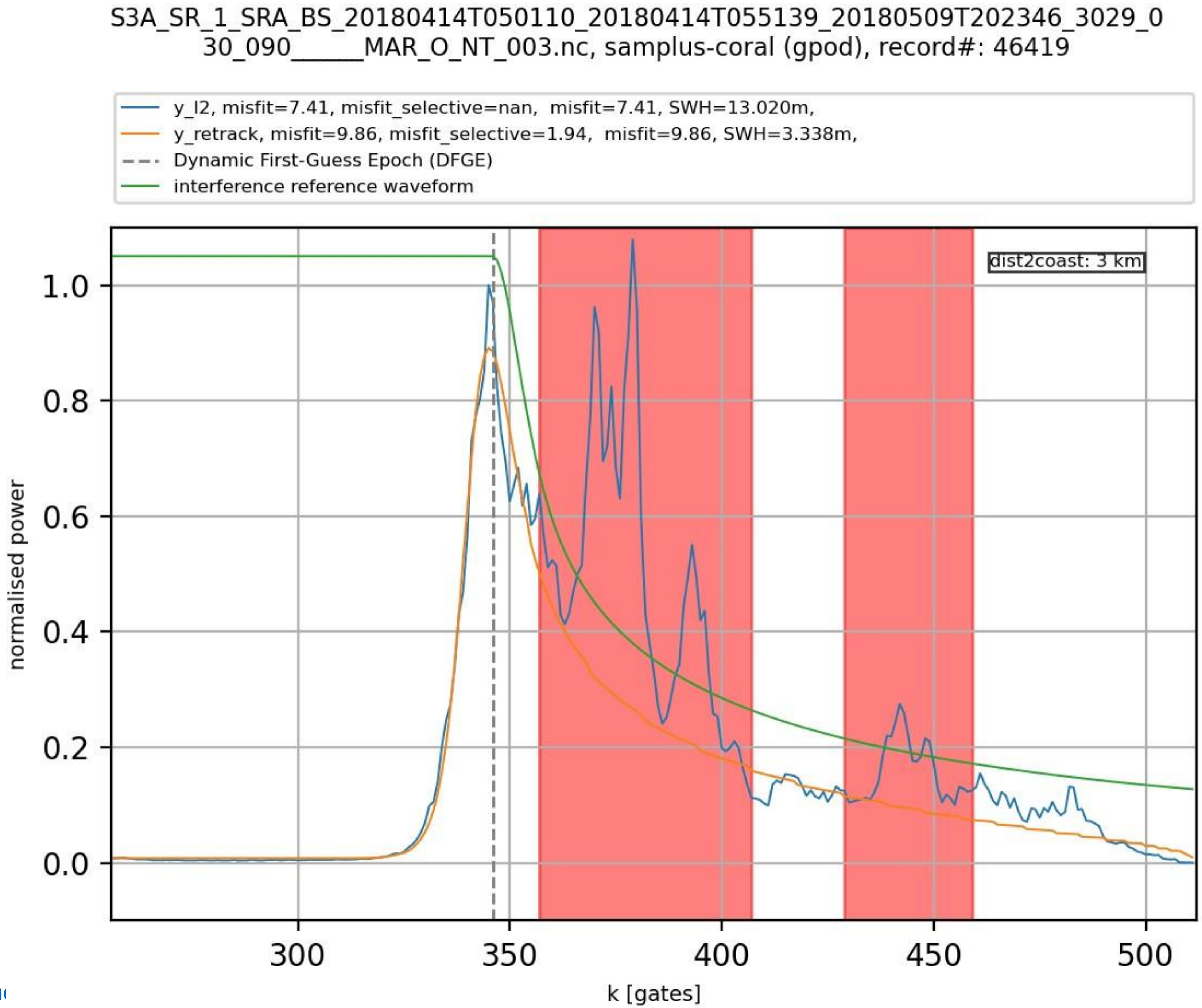
y_l2, misfit=9.71, misfit_selective=nan, misfit=9.71, SWH=3.754m,
y_retrack, misfit=16.96, misfit_selective=1.54, misfit=16.96, SWH=2.926m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]


S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46417
y_l2, misfit=6.55, misfit_selective=nan, misfit=6.55, SWH=14.508m,
y_retrack, misfit=11.58, misfit_selective=1.41, misfit=11.58, SWH=3.210m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]

S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_030_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46418

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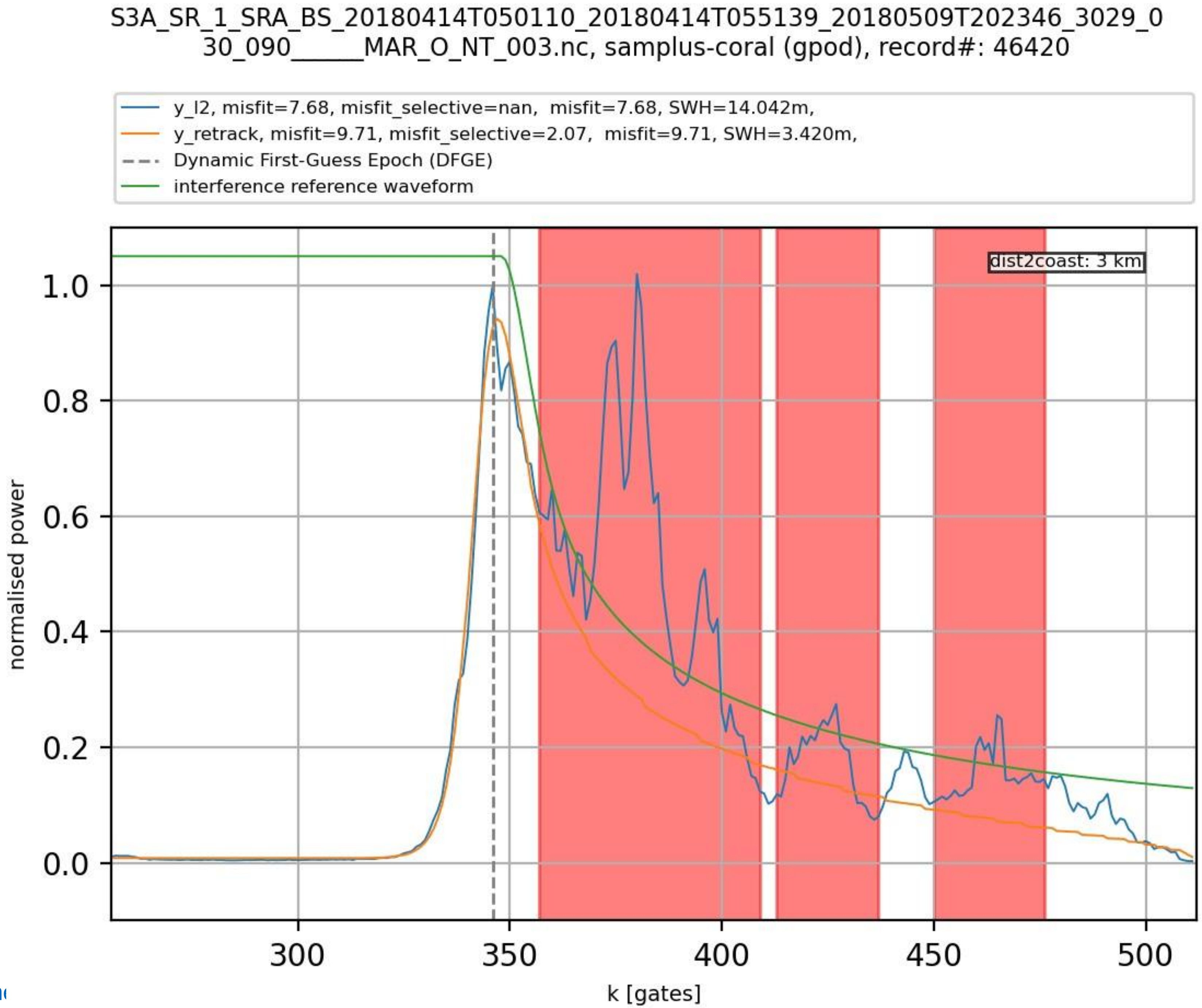
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46419
y_l2, misfit=7.41, misfit_selective=nan, misfit=7.41, SWH=13.020m,
y_retrack, misfit=9.86, misfit_selective=1.94, misfit=9.86, SWH=3.338m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]



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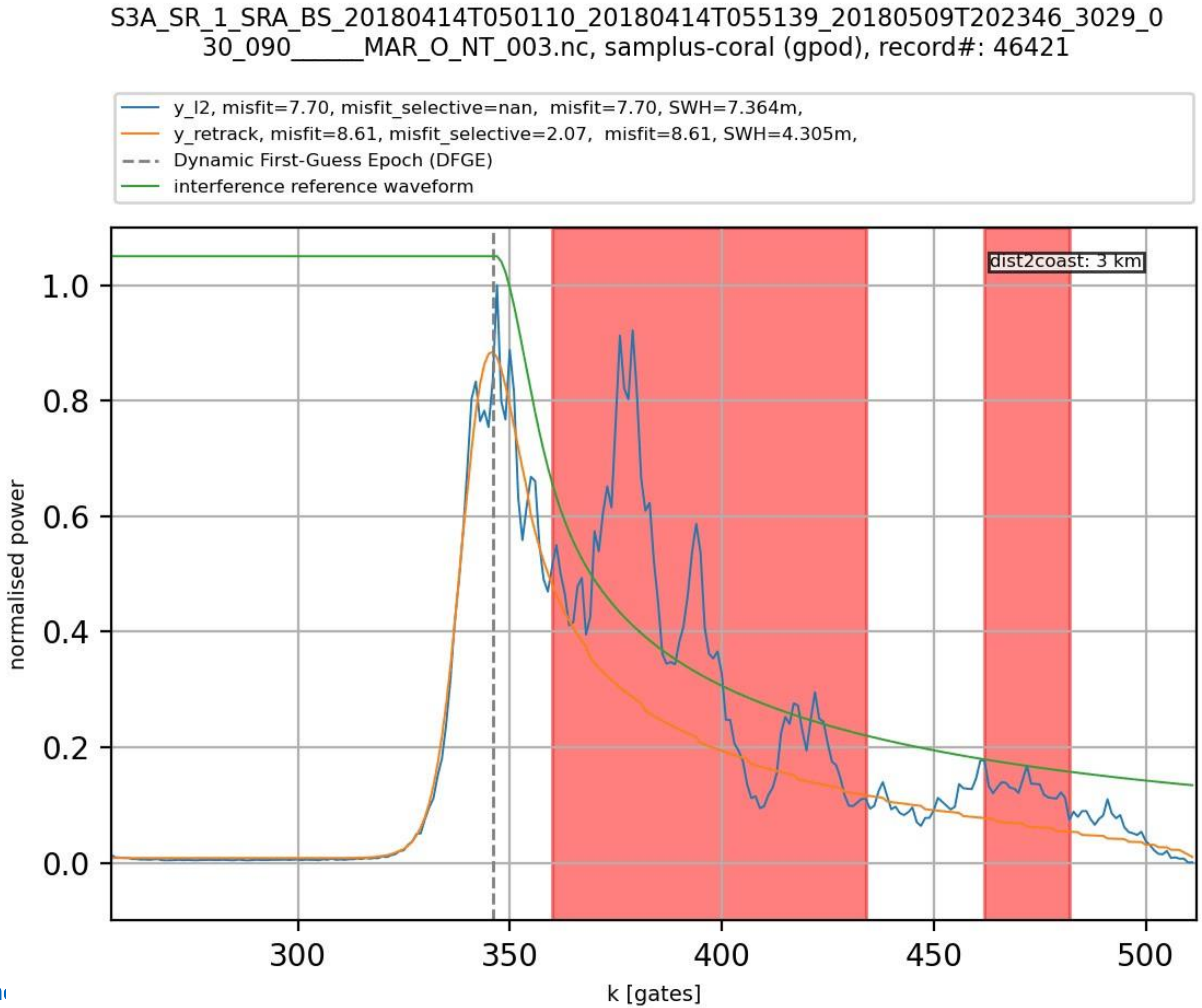
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46420
y_l2, misfit=7.68, misfit_selective=nan, misfit=7.68, SWH=14.042m,
y_retrack, misfit=9.71, misfit_selective=2.07, misfit=9.71, SWH=3.420m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]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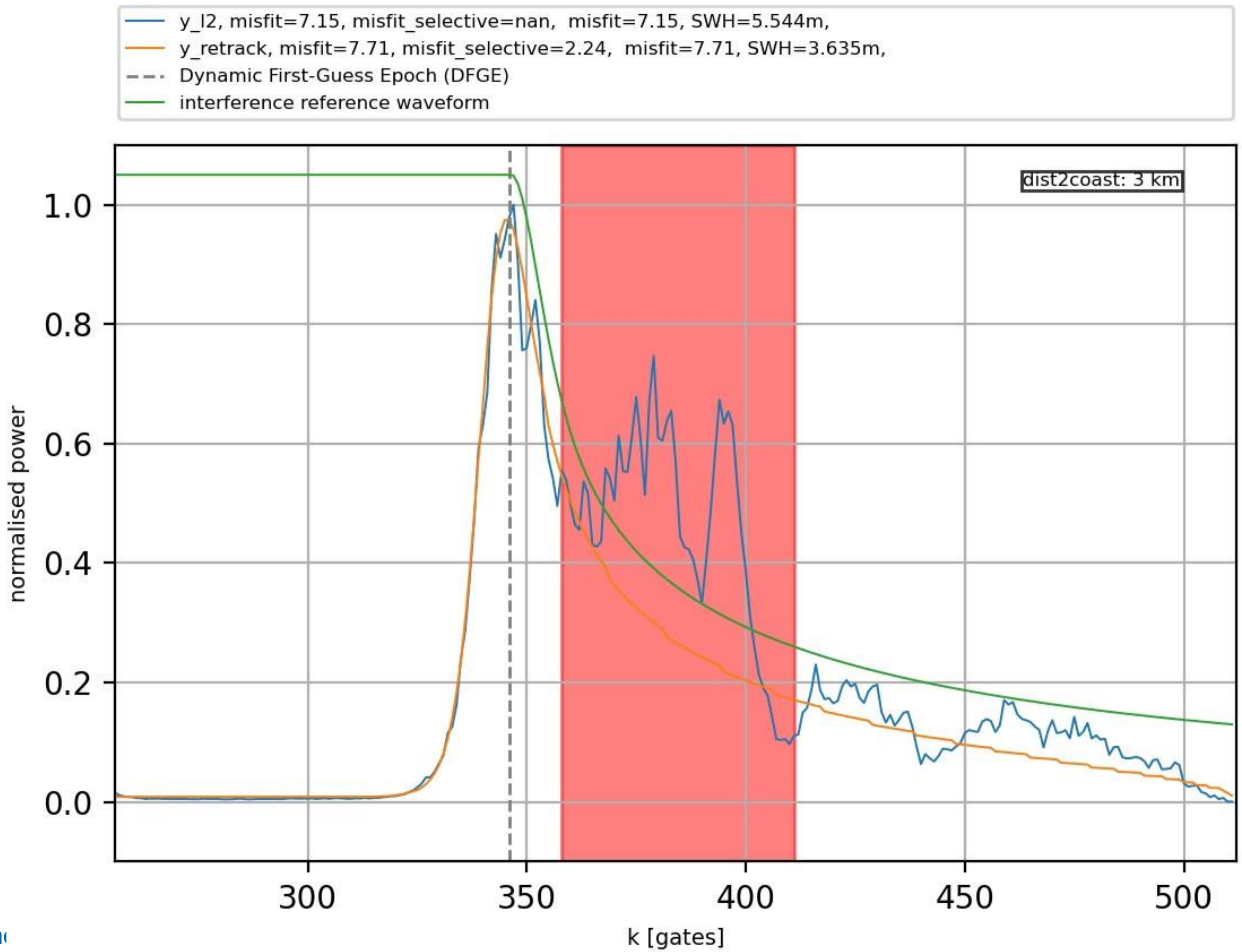
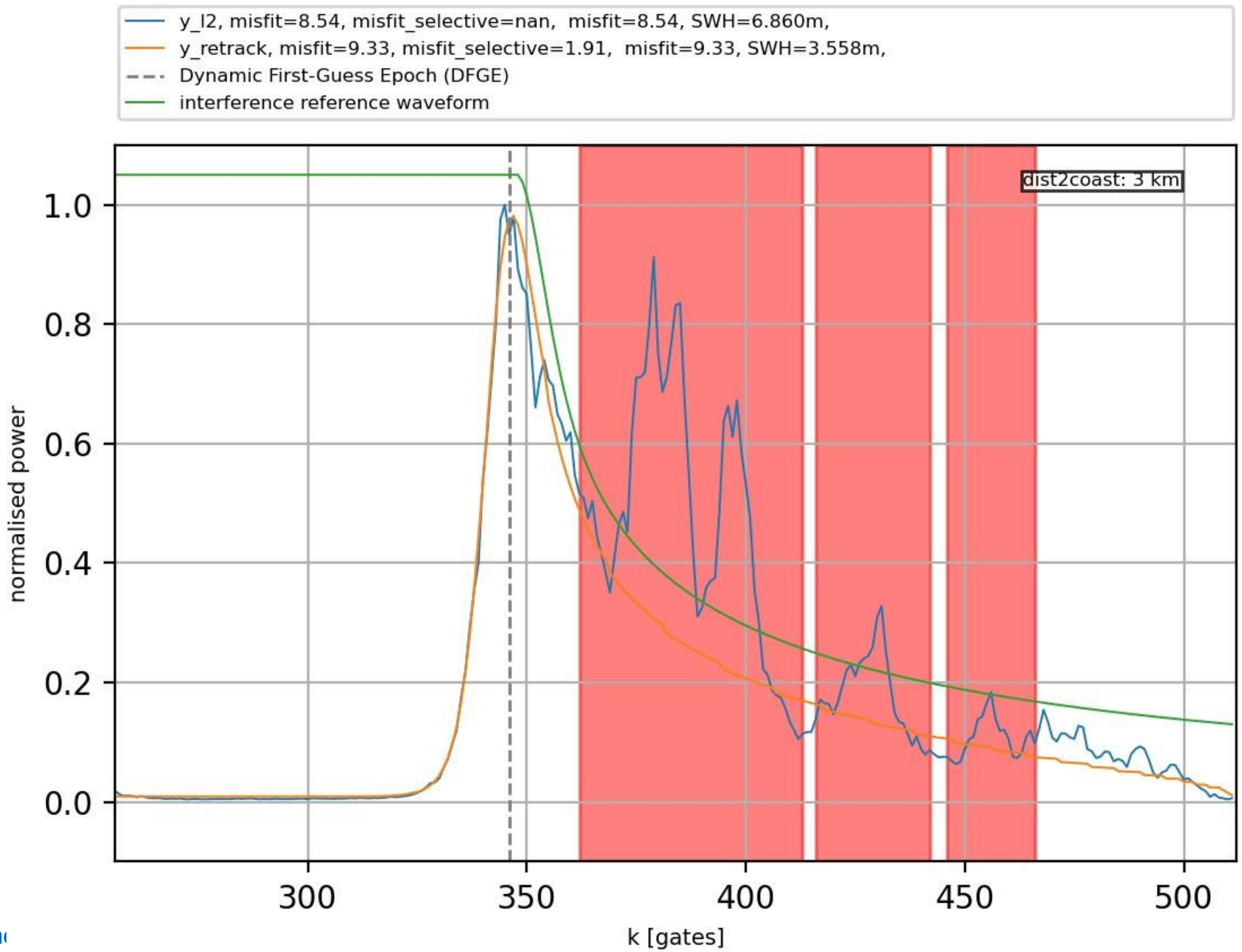
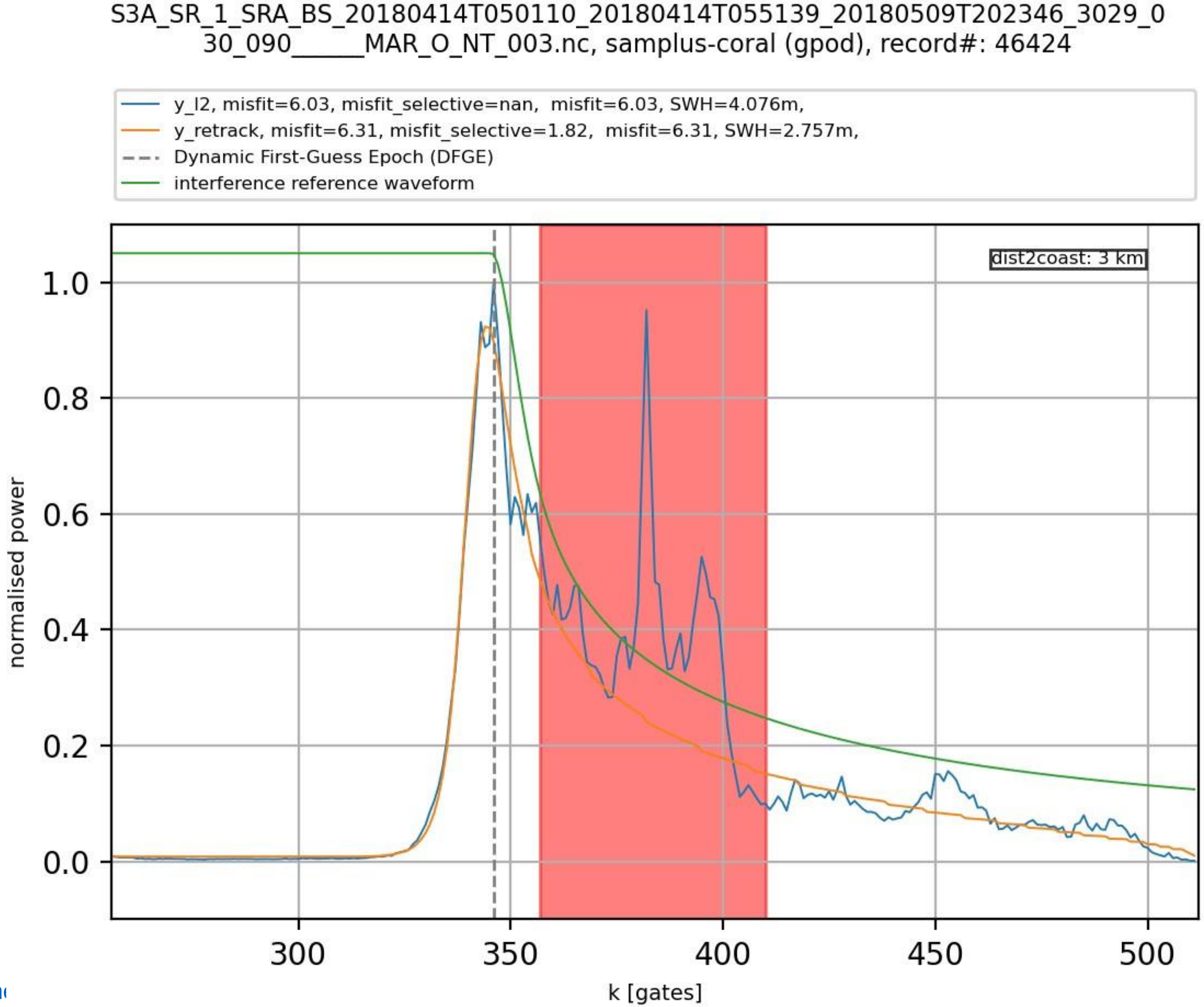
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46421
y_l2, misfit=7.70, misfit_selective=nan, misfit=7.70, SWH=7.364m,
y_retrack, misfit=8.61, misfit_selective=2.07, misfit=8.61, SWH=4.305m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]

S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_030_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46422



S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_030_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46423

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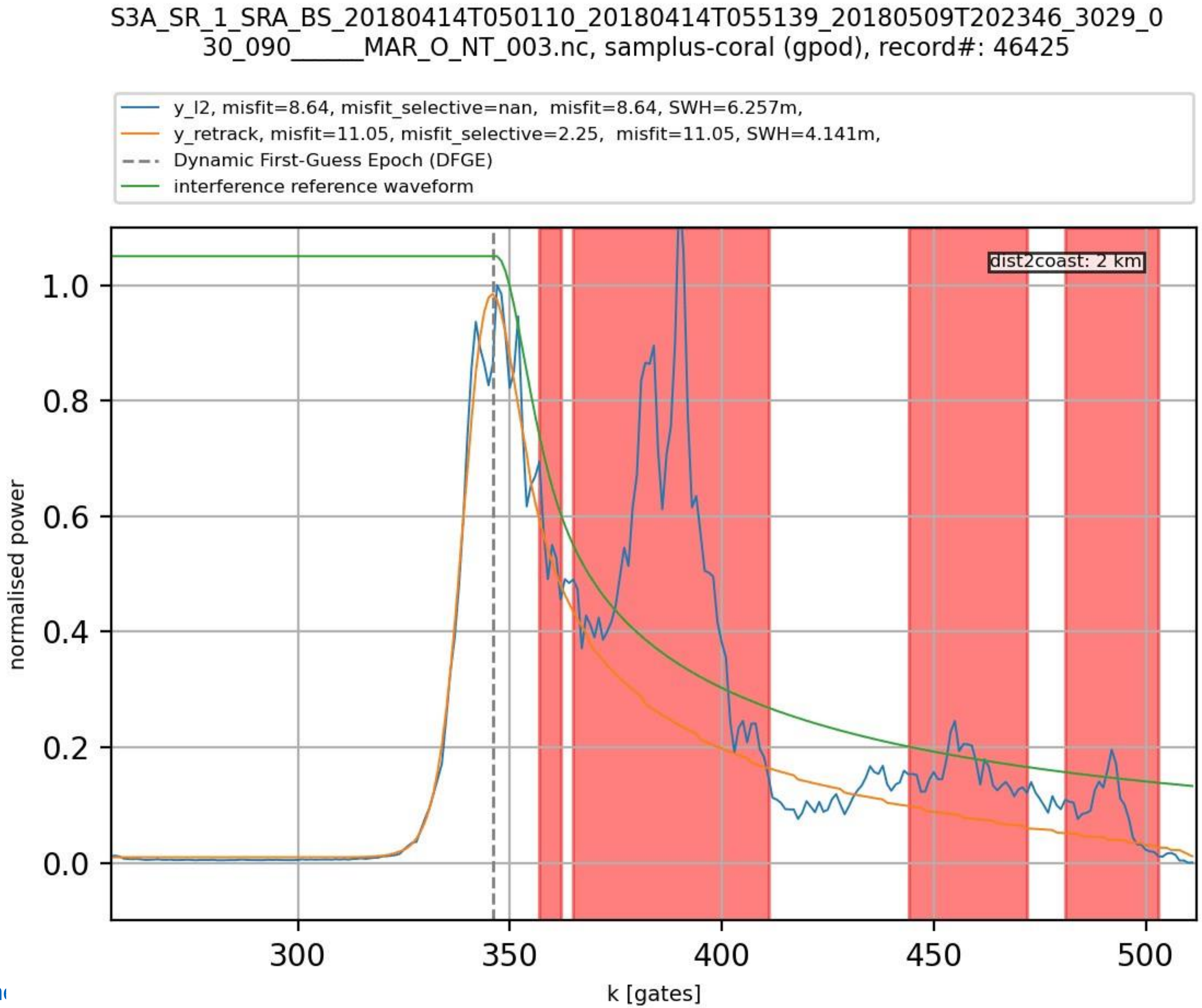
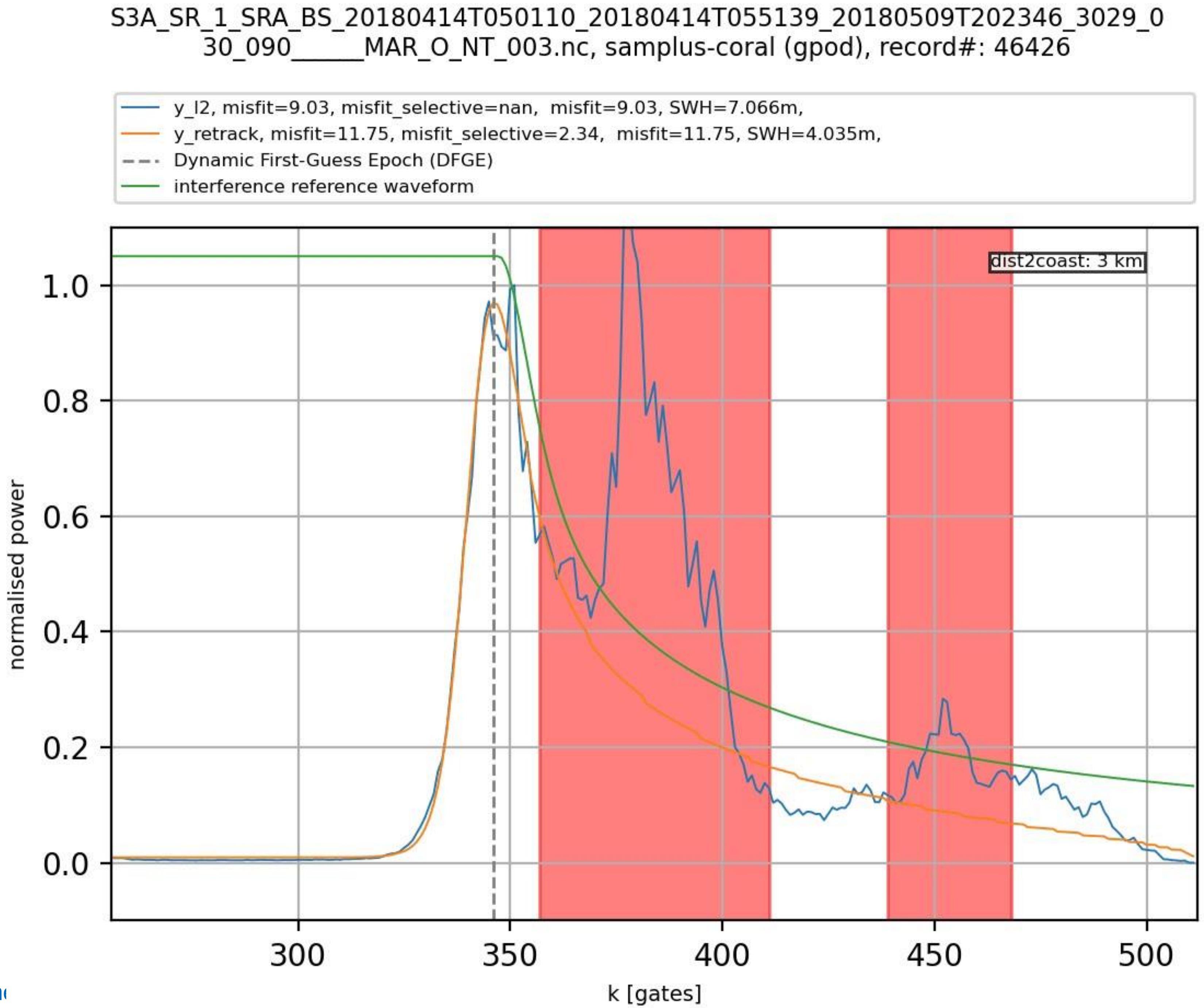
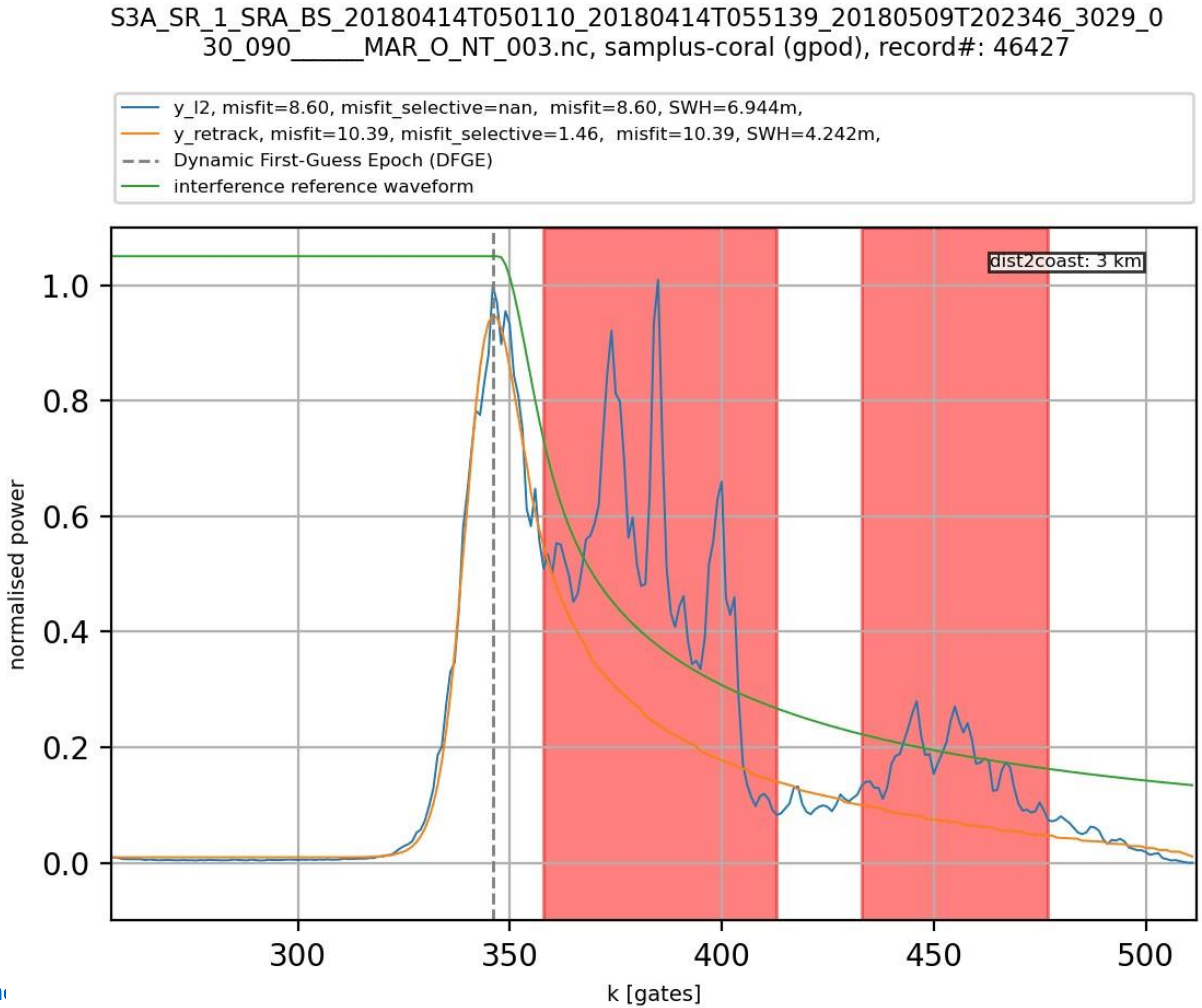
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46424
y_l2, misfit=6.03, misfit_selective=nan, misfit=6.03, SWH=4.076m,
y_retrack, misfit=6.31, misfit_selective=1.82, misfit=6.31, SWH=2.757m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]


S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46425
y_l2, misfit=8.64, misfit_selective=nan, misfit=8.64, SWH=6.257m,
y_retrack, misfit=11.05, misfit_selective=2.25, misfit=11.05, SWH=4.141m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500


S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46426
y_l2, misfit=9.03, misfit_selective=nan, misfit=9.03, SWH=7.066m,
y_retrack, misfit=11.75, misfit_selective=2.34, misfit=11.75, SWH=4.035m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500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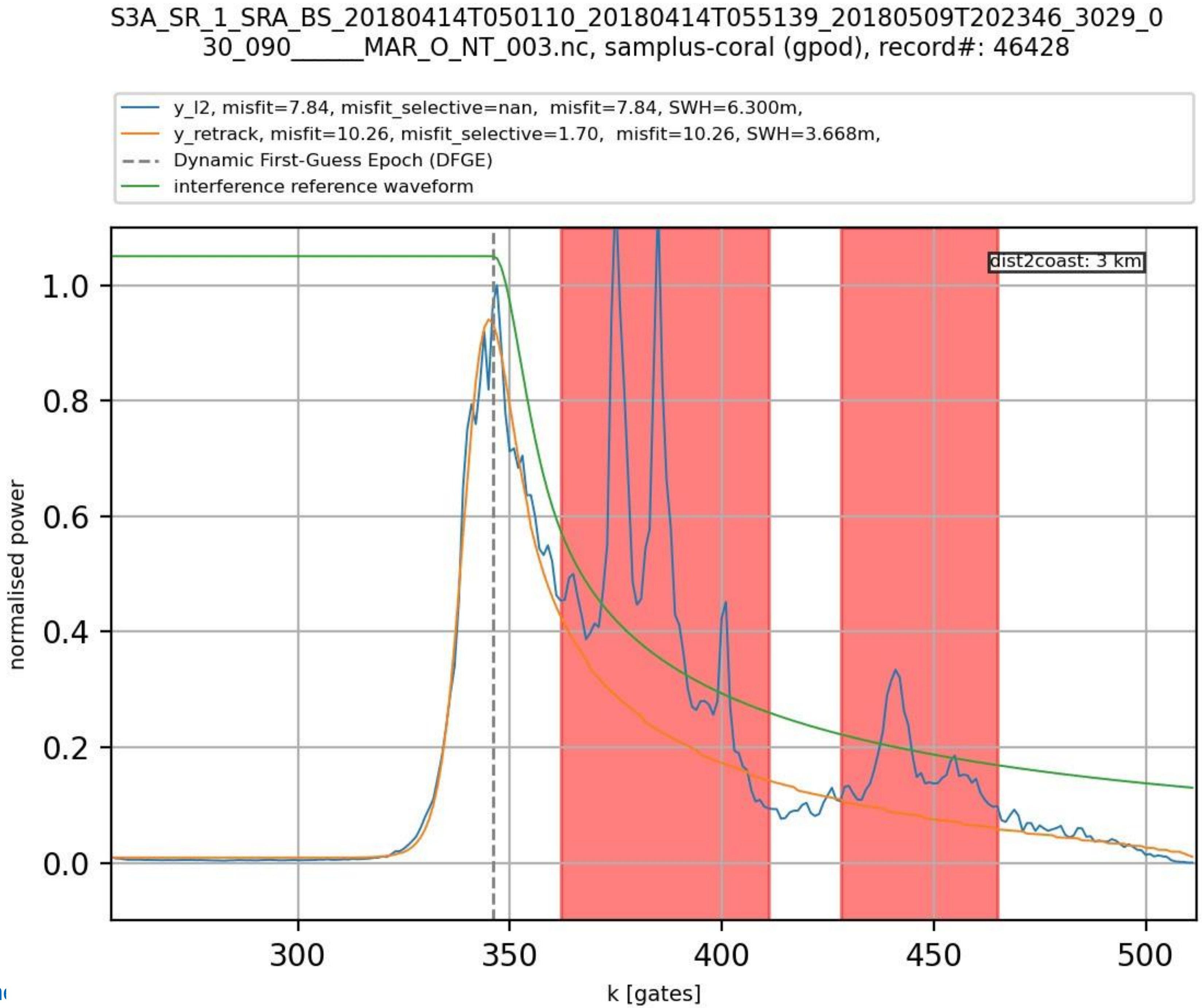
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46427
y_l2, misfit=8.60, misfit_selective=nan, misfit=8.60, SWH=6.944m,
y_retrack, misfit=10.39, misfit_selective=1.46, misfit=10.39, SWH=4.242m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500



S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
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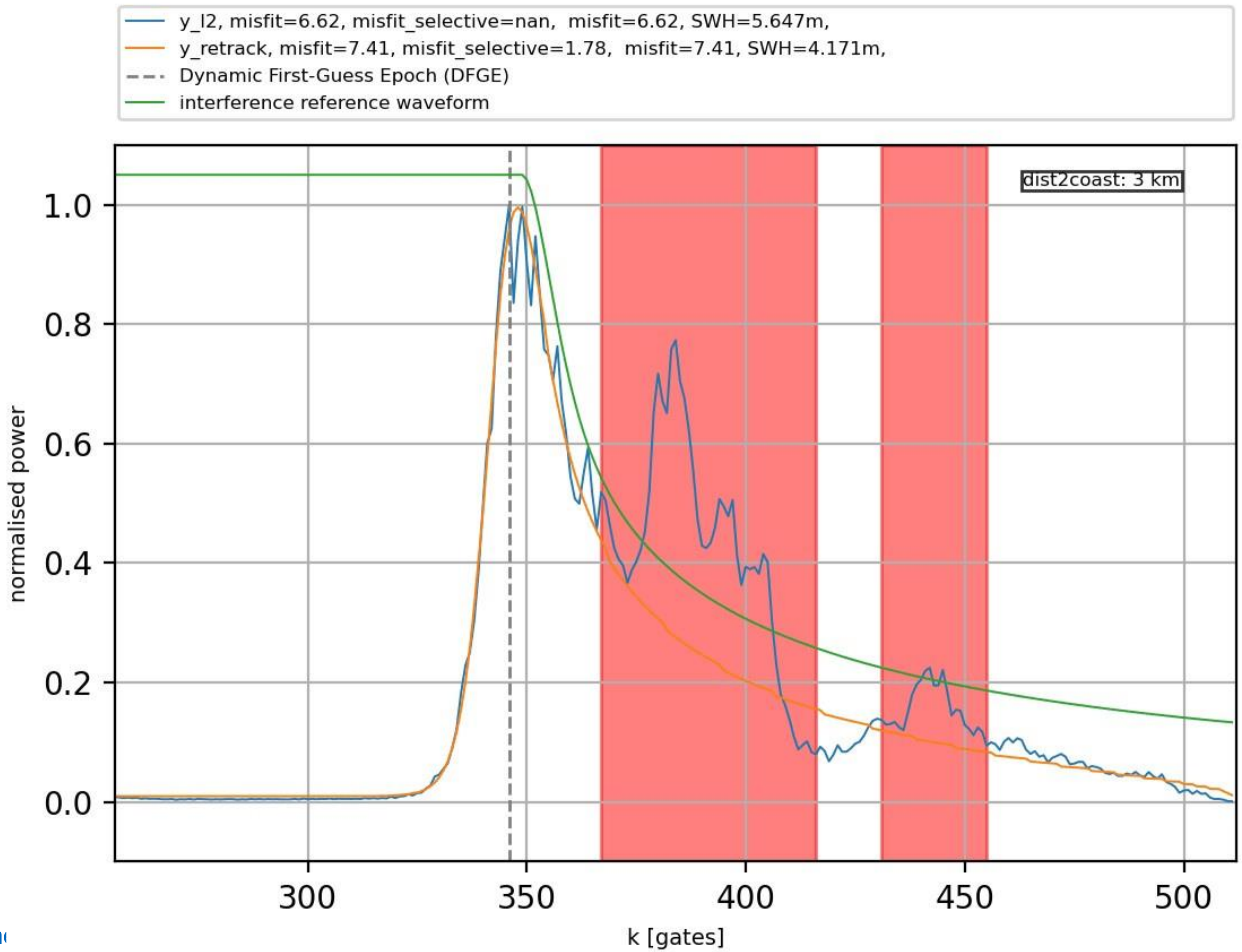
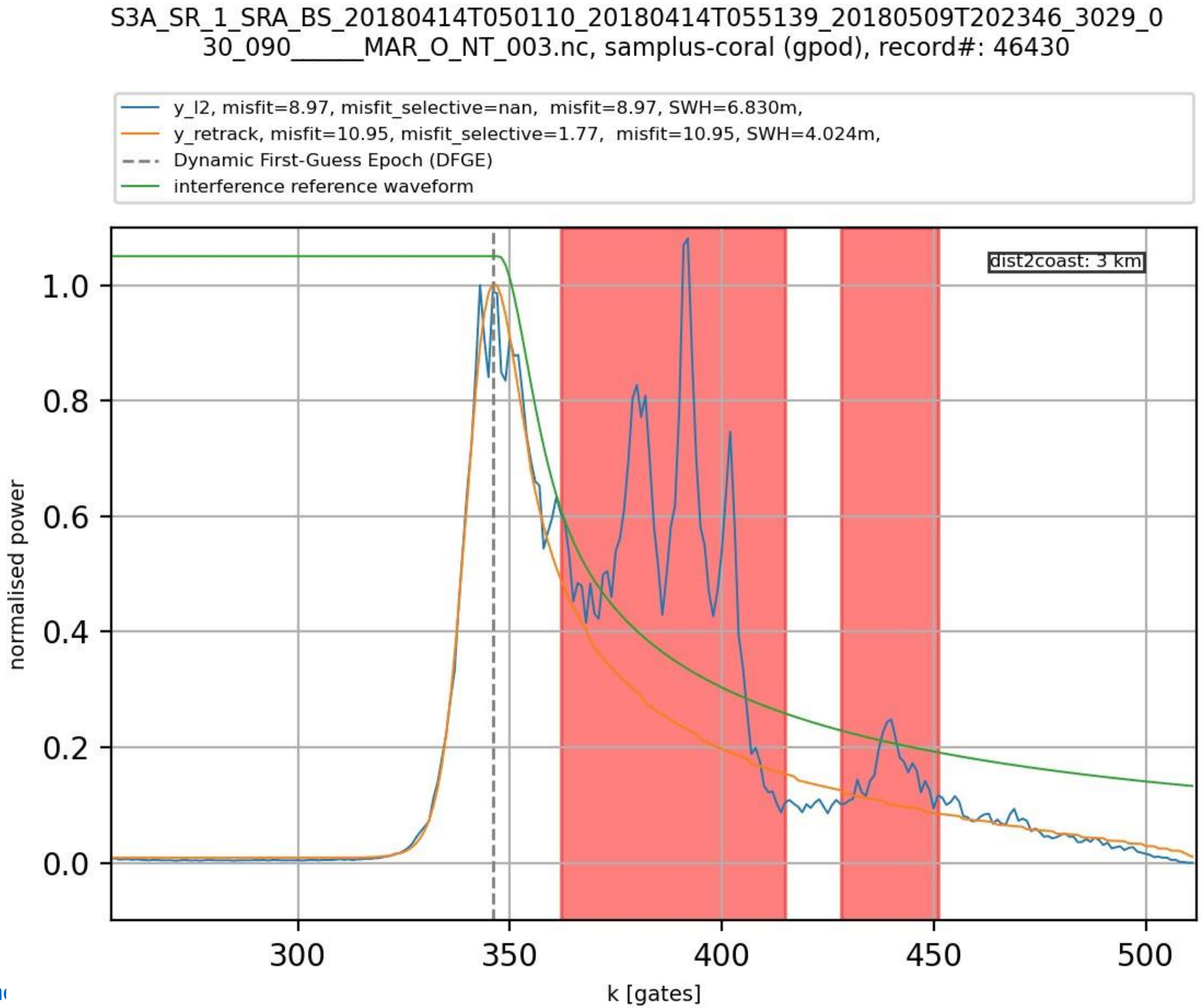
y_l2, misfit=7.84, misfit_selective=nan, misfit=7.84, SWH=6.300m,
y_retrack, misfit=10.26, misfit_selective=1.70, misfit=10.26, SWH=3.668m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500

S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_030_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46429

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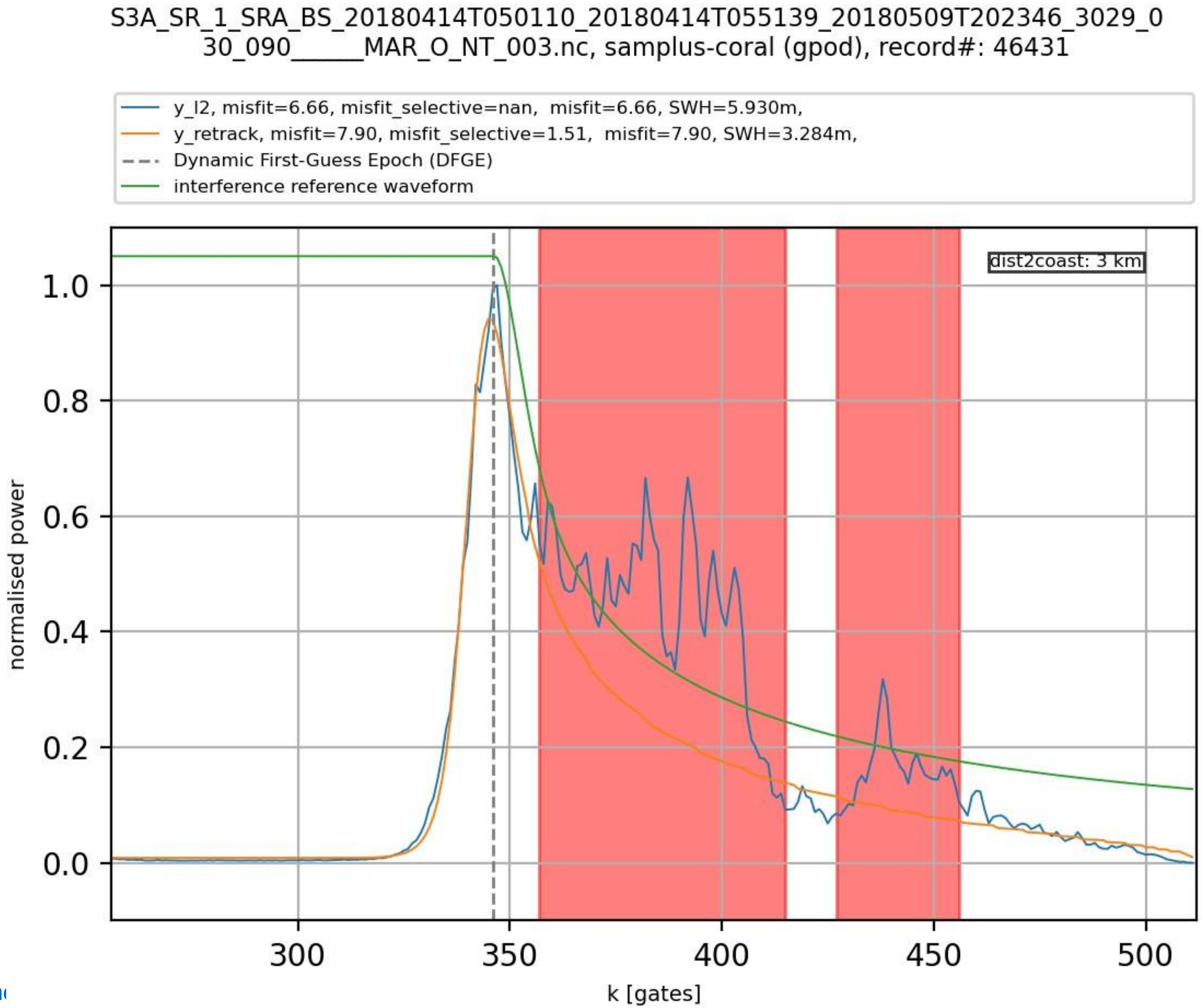
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46430
y_l2, misfit=8.97, misfit_selective=nan, misfit=8.97, SWH=6.830m,
y_retrack, misfit=10.95, misfit_selective=1.77, misfit=10.95, SWH=4.024m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500


S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
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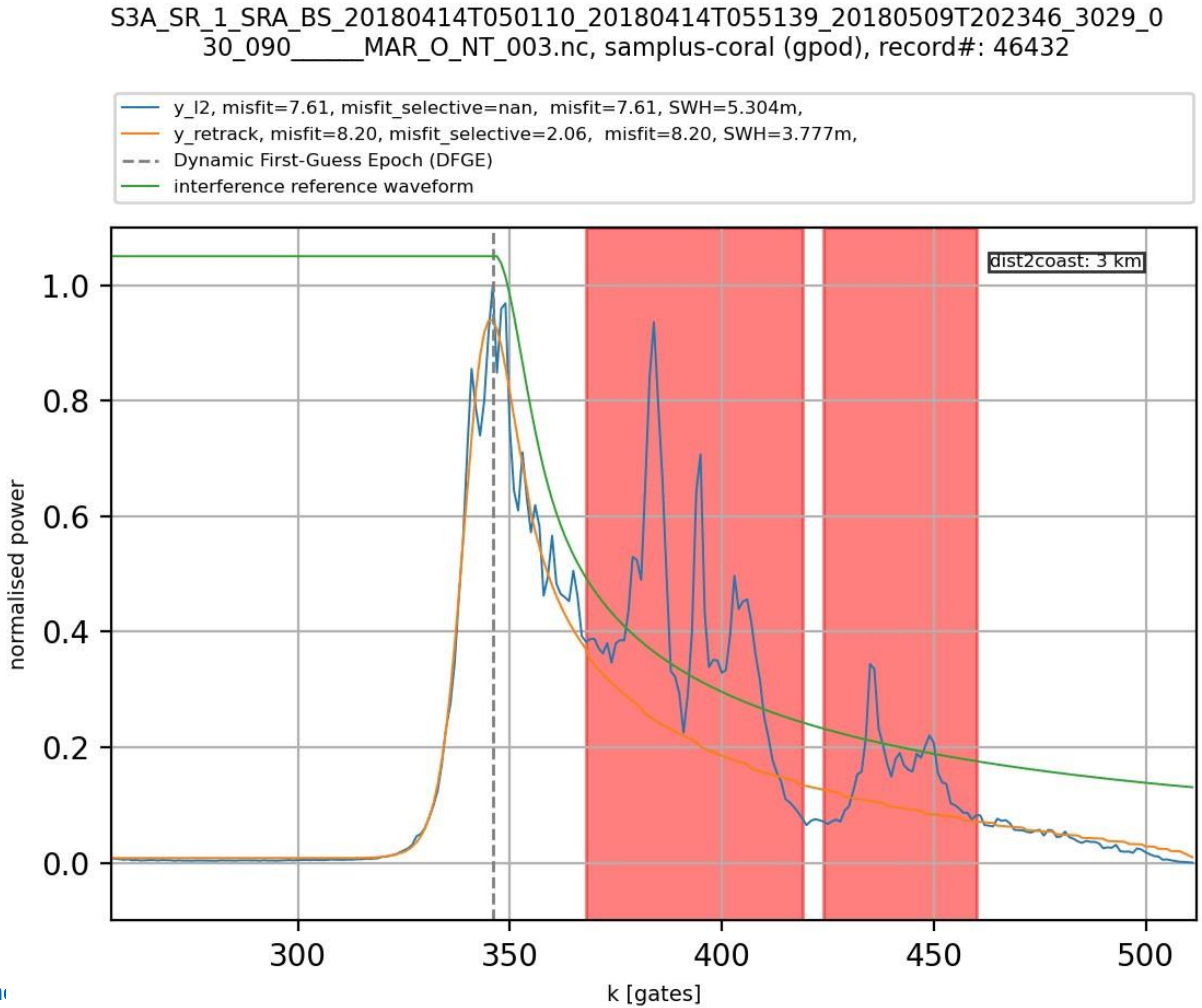
y_l2, misfit=6.66, misfit_selective=nan, misfit=6.66, SWH=5.930m,
y_retrack, misfit=7.90, misfit_selective=1.51, misfit=7.90, SWH=3.284m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500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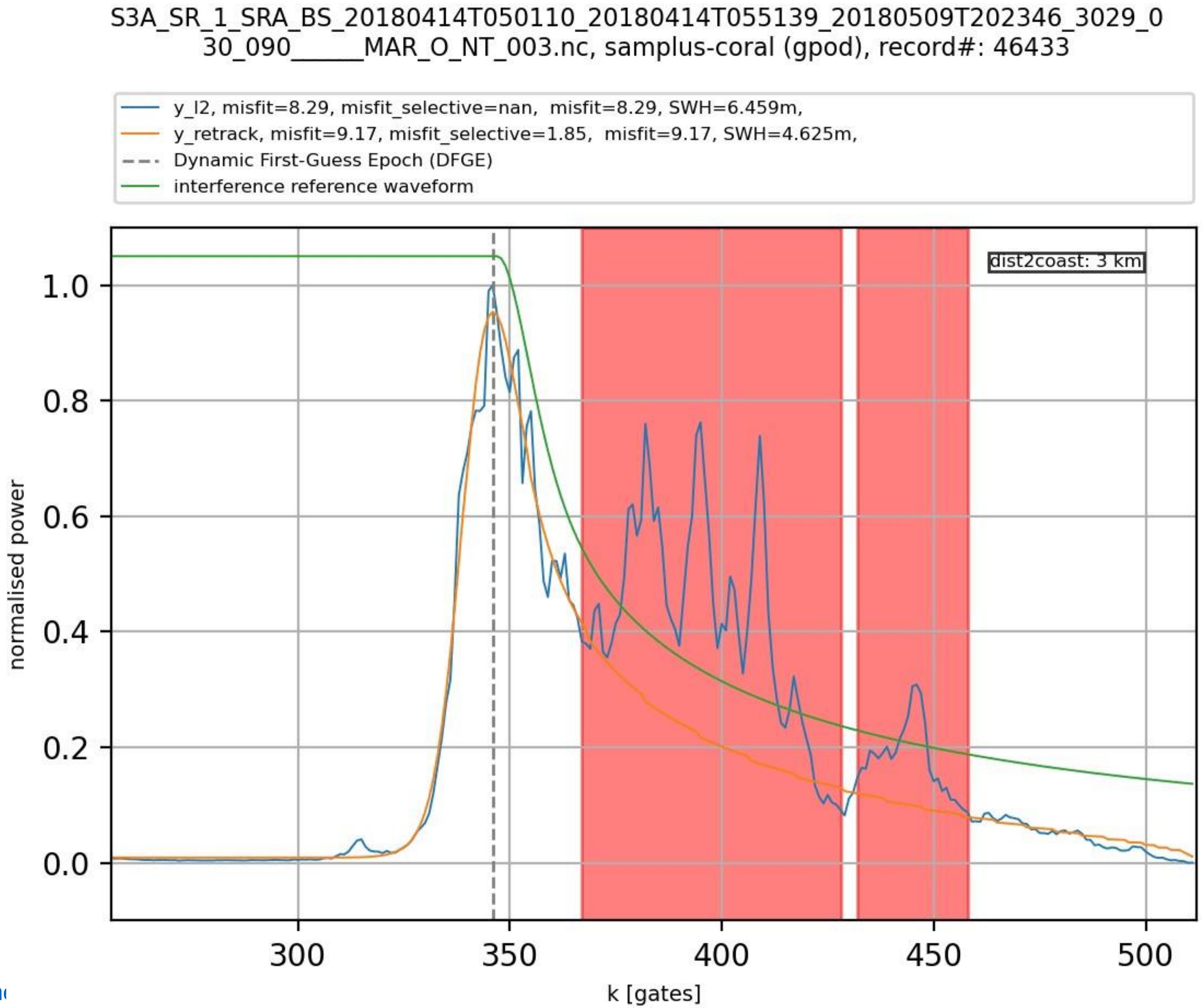
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46432
y_l2, misfit=7.61, misfit_selective=nan, misfit=7.61, SWH=5.304m,
y_retrack, misfit=8.20, misfit_selective=2.06, misfit=8.20, SWH=3.777m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]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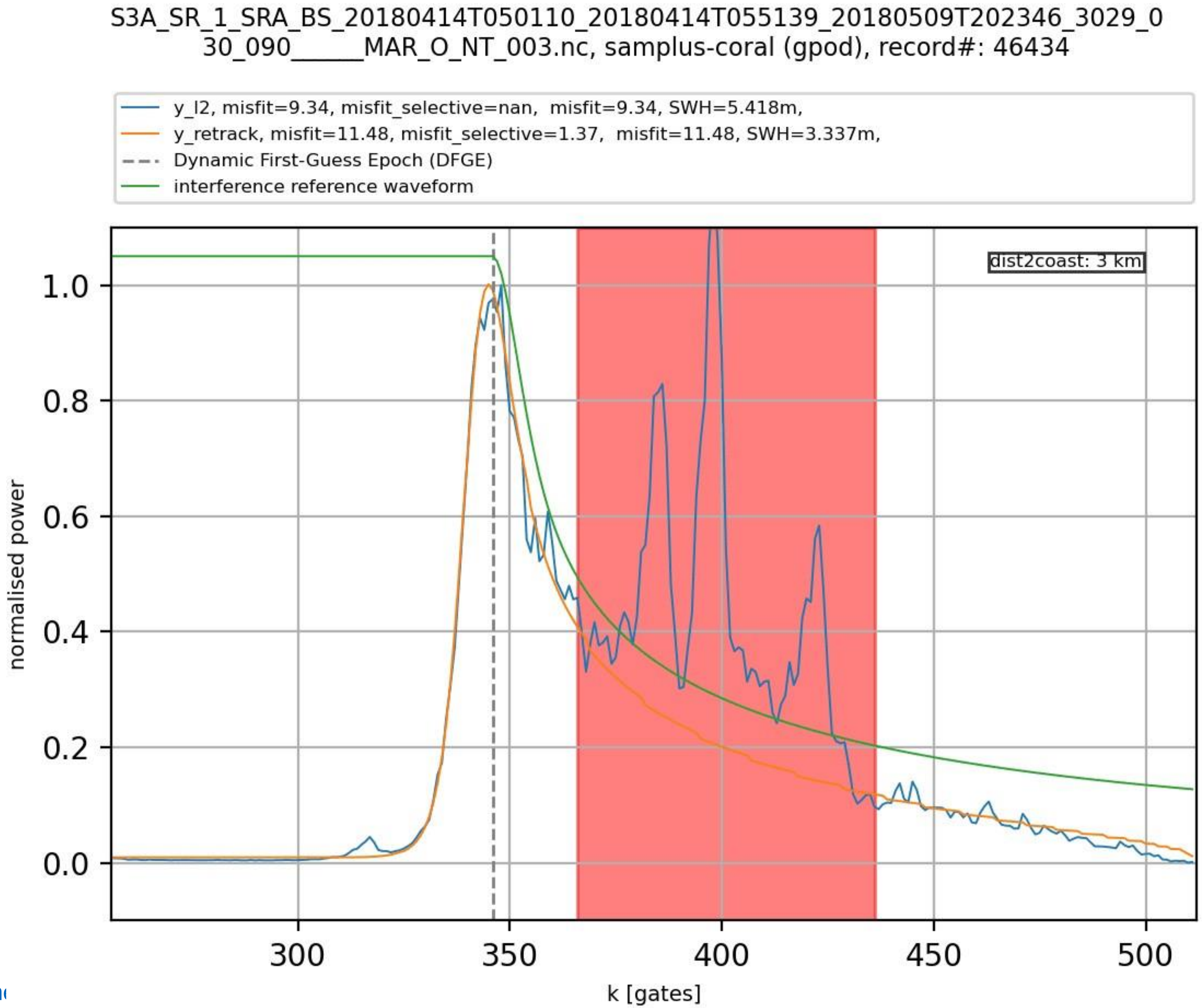
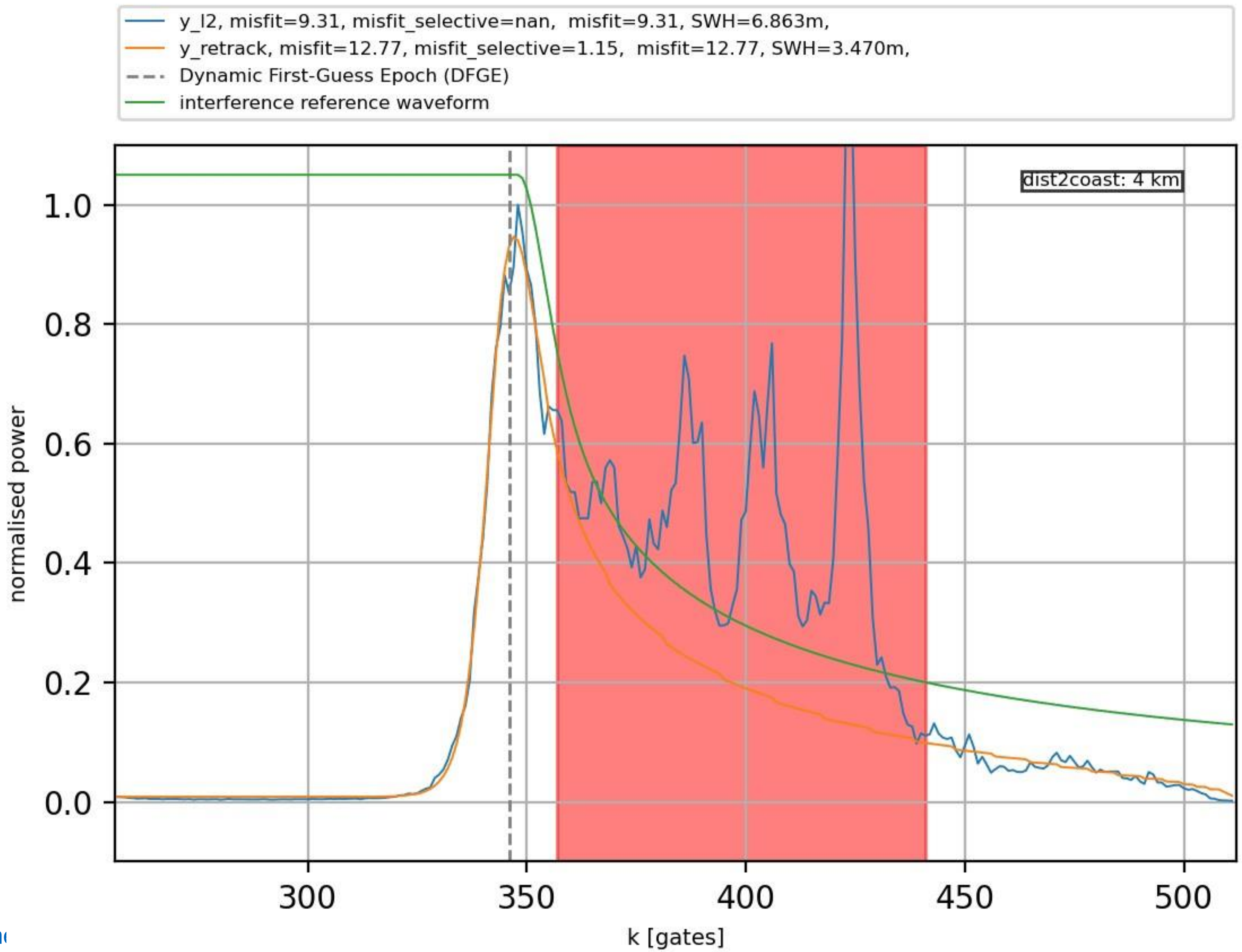
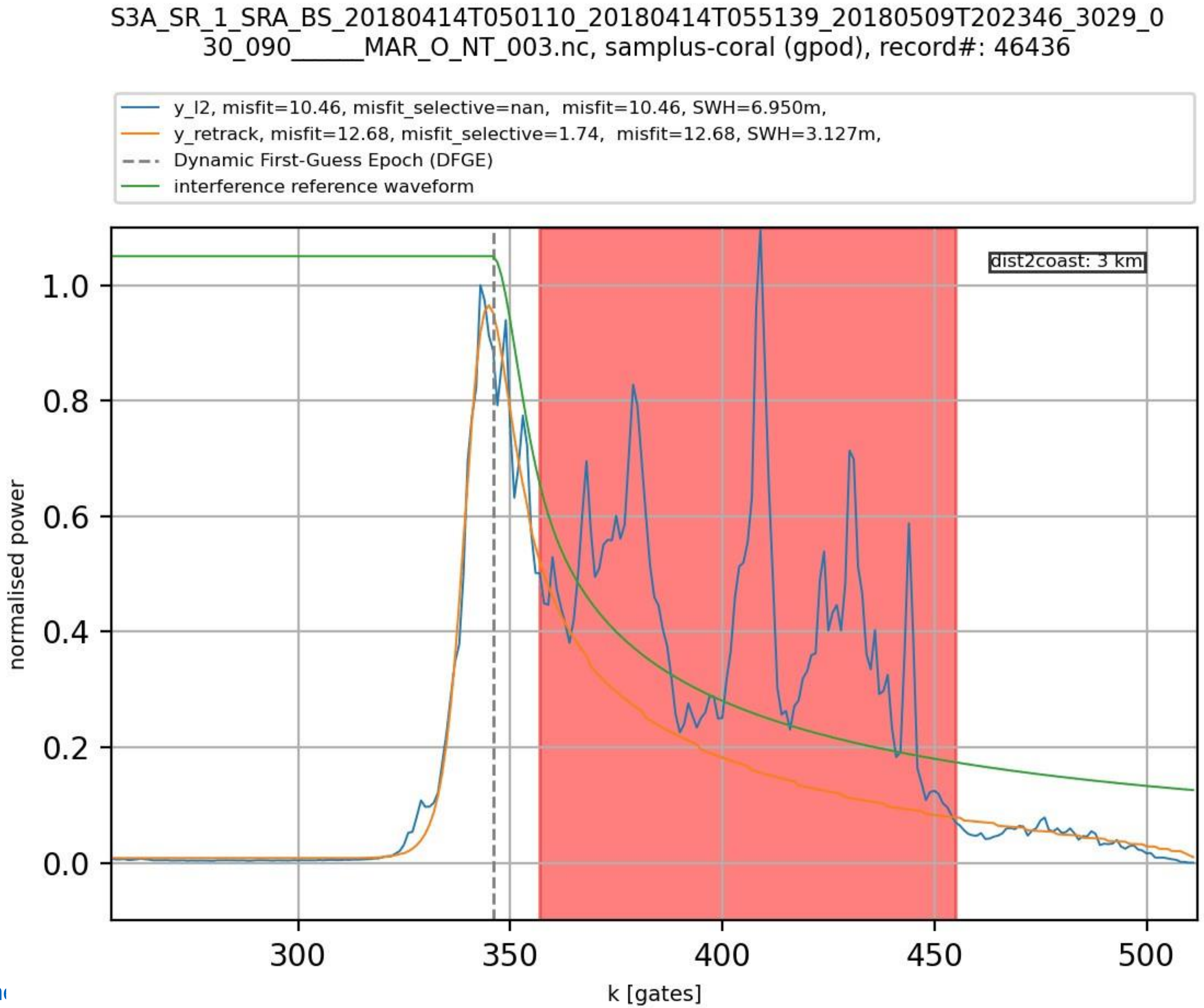
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46433
y_l2, misfit=8.29, misfit_selective=nan, misfit=8.29, SWH=6.459m,
y_retrack, misfit=9.17, misfit_selective=1.85, misfit=9.17, SWH=4.625m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]



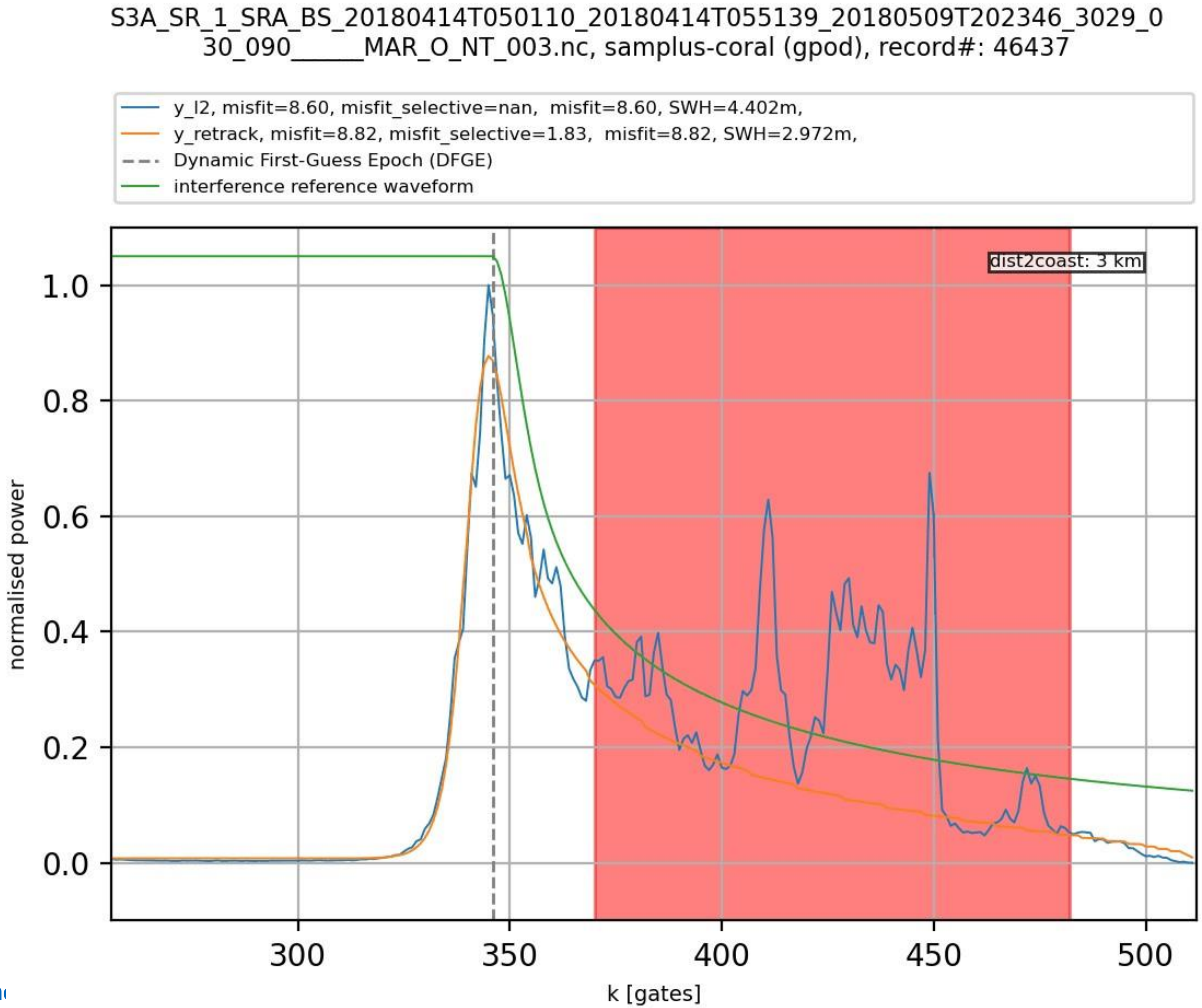
S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46434
y_l2, misfit=9.34, misfit_selective=nan, misfit=9.34, SWH=5.418m,
y_retrack, misfit=11.48, misfit_selective=1.37, misfit=11.48, SWH=3.337m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
k [gates]

S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_030_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46435





S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_030_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46436
y_l2, misfit=10.46, misfit_selective=nan, misfit=10.46, SWH=6.950m,
y_retrack, misfit=12.68, misfit_selective=1.74, misfit=12.68, SWH=3.127m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
k [gates]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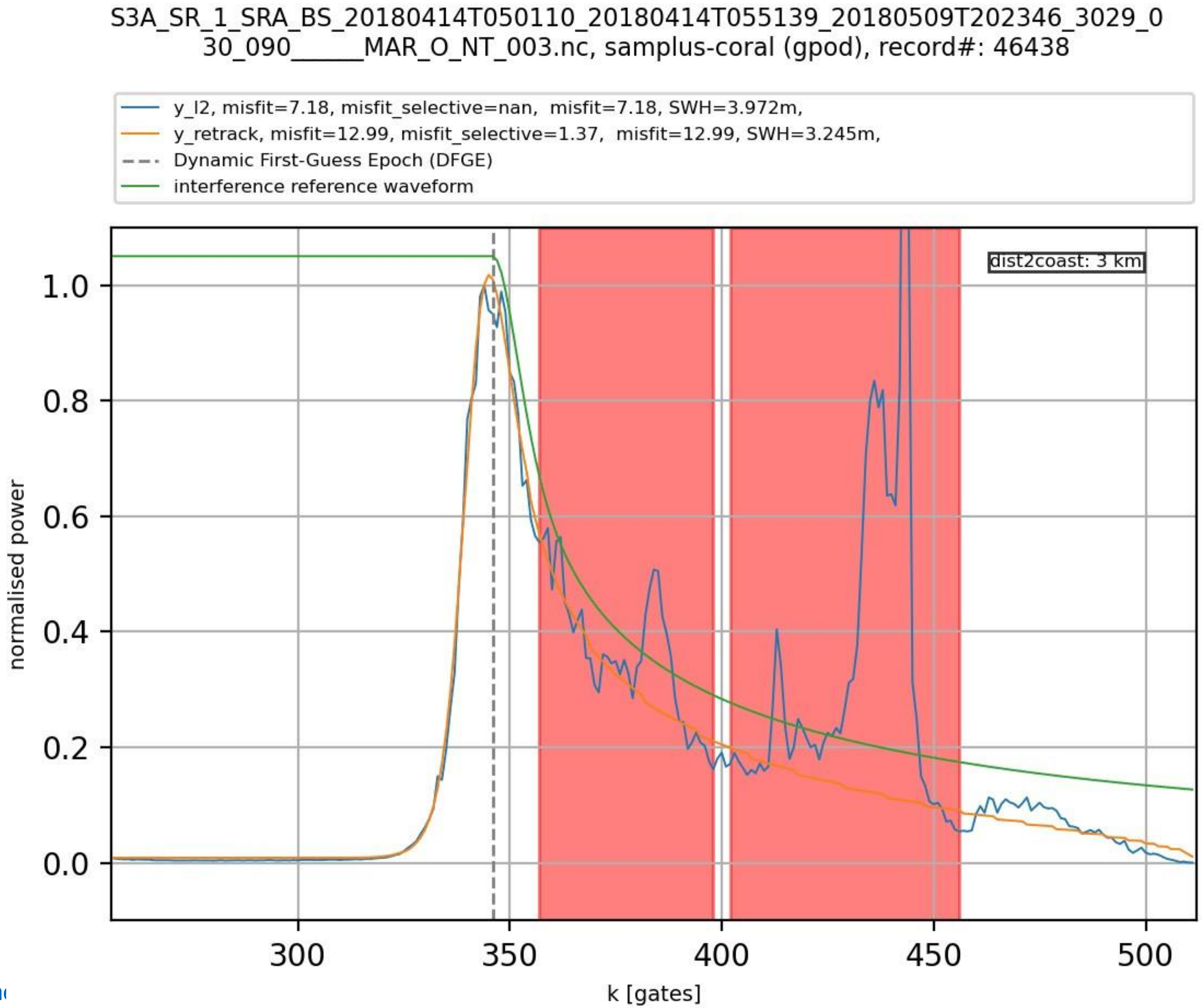
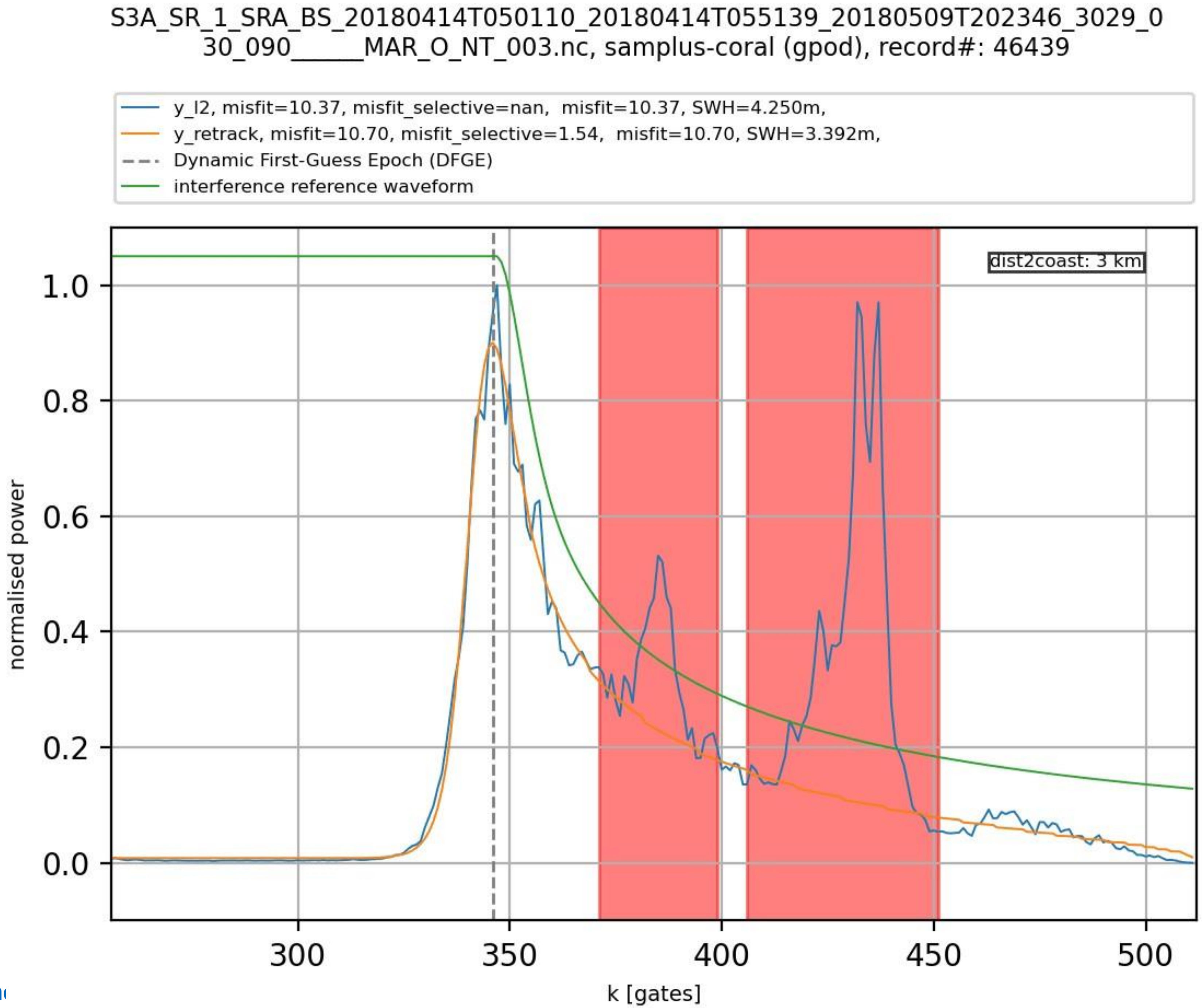
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46437
y_l2, misfit=8.60, misfit_selective=nan, misfit=8.60, SWH=4.402m,
y_retrack, misfit=8.82, misfit_selective=1.83, misfit=8.82, SWH=2.972m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]



S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_030_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46438
y_l2, misfit=7.18, misfit_selective=nan, misfit=7.18, SWH=3.972m,
y_retrack, misfit=12.99, misfit_selective=1.37, misfit=12.99, SWH=3.245m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
k [gates]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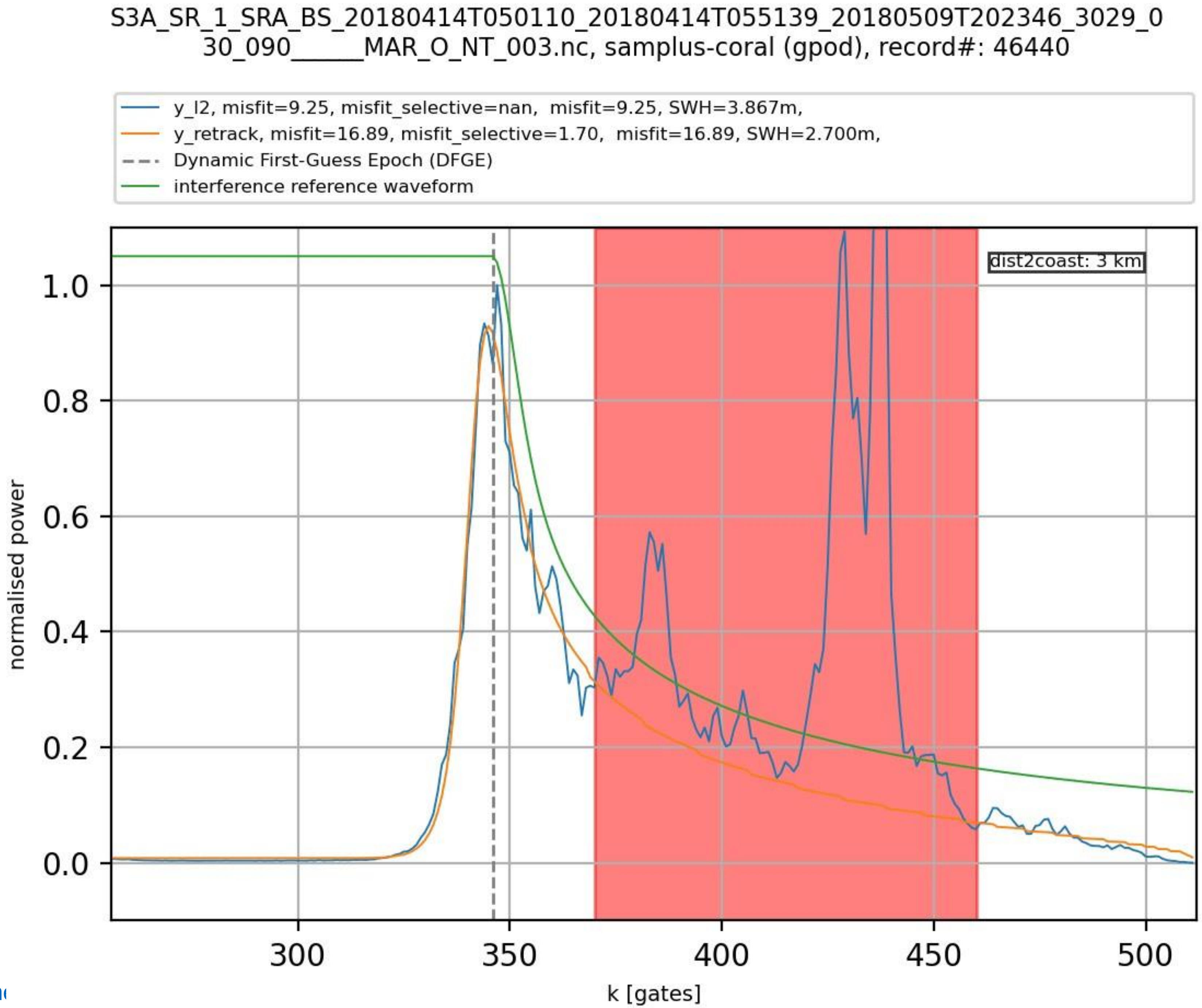
y_l2, misfit=10.37, misfit_selective=nan, misfit=10.37, SWH=4.250m,
y_retrack, misfit=10.70, misfit_selective=1.54, misfit=10.70, SWH=3.392m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]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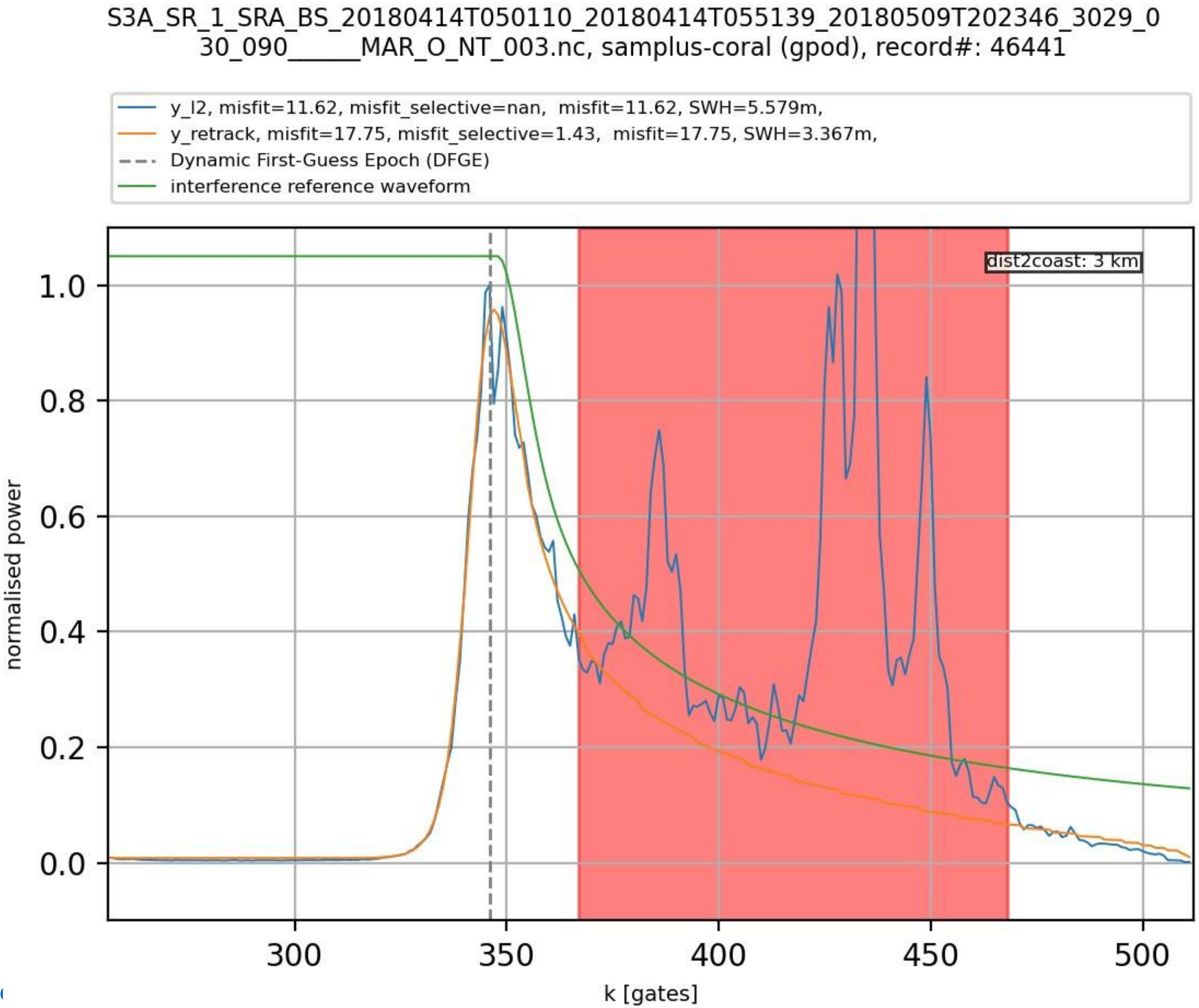
y_l2, misfit=9.25, misfit_selective=nan, misfit=9.25, SWH=3.867m,
y_retrack, misfit=16.89, misfit_selective=1.70, misfit=16.89, SWH=2.700m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500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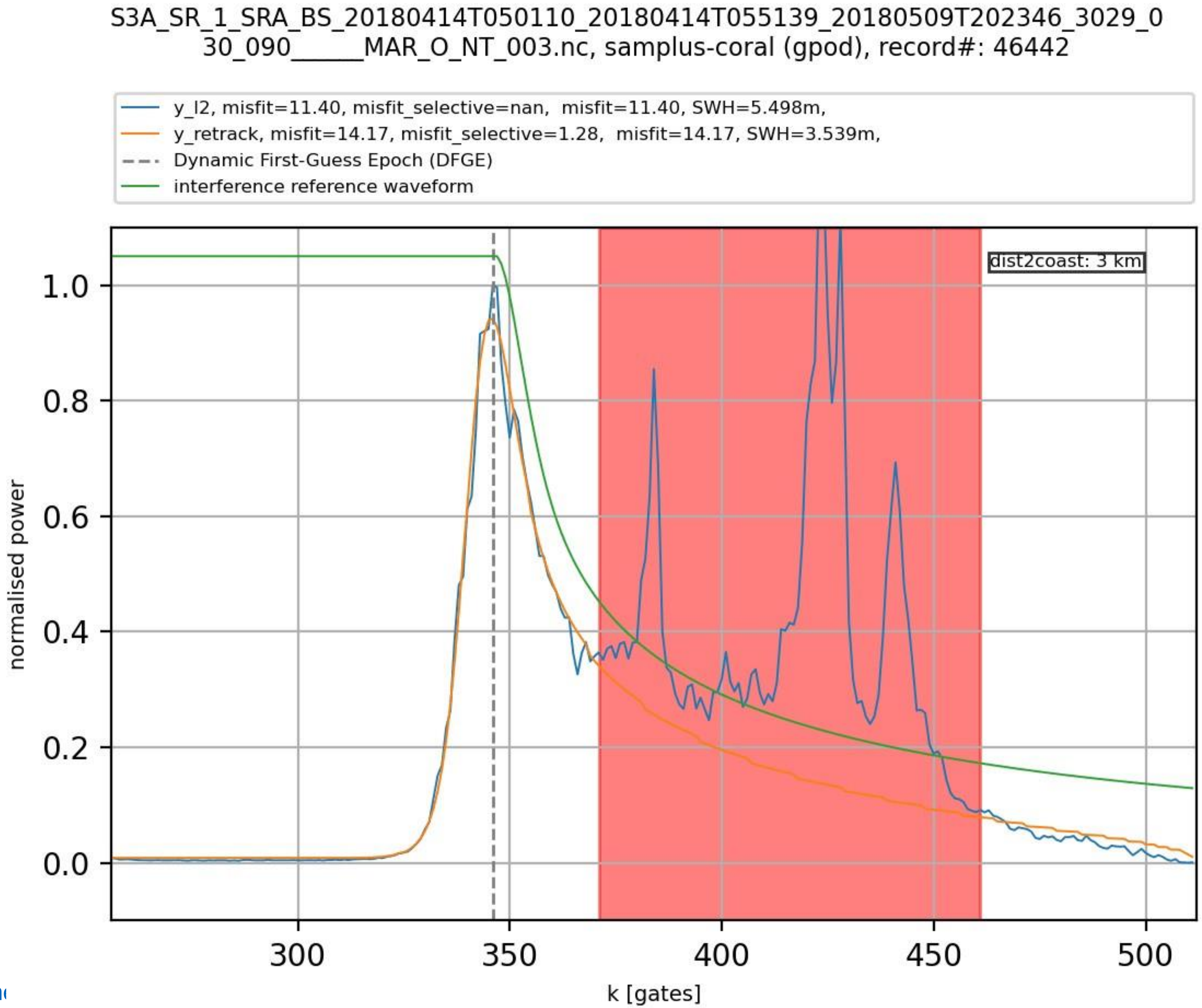
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46441
y_l2, misfit=11.62, misfit_selective=nan, misfit=11.62, SWH=5.579m,
y_retrack, misfit=17.75, misfit_selective=1.43, misfit=17.75, SWH=3.367m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]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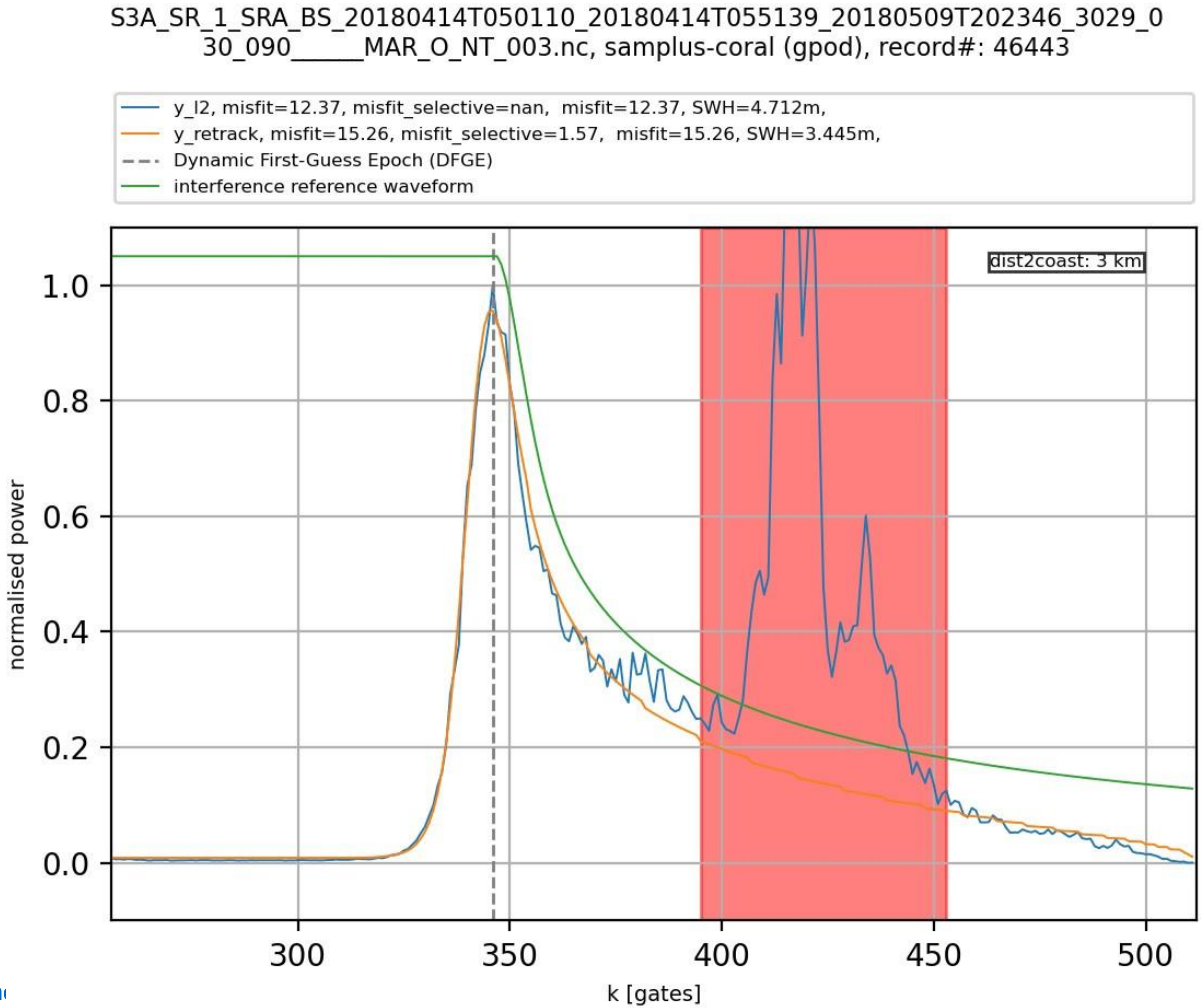
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46442
y_l2, misfit=11.40, misfit_selective=nan, misfit=11.40, SWH=5.498m,
y_retrack, misfit=14.17, misfit_selective=1.28, misfit=14.17, SWH=3.539m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]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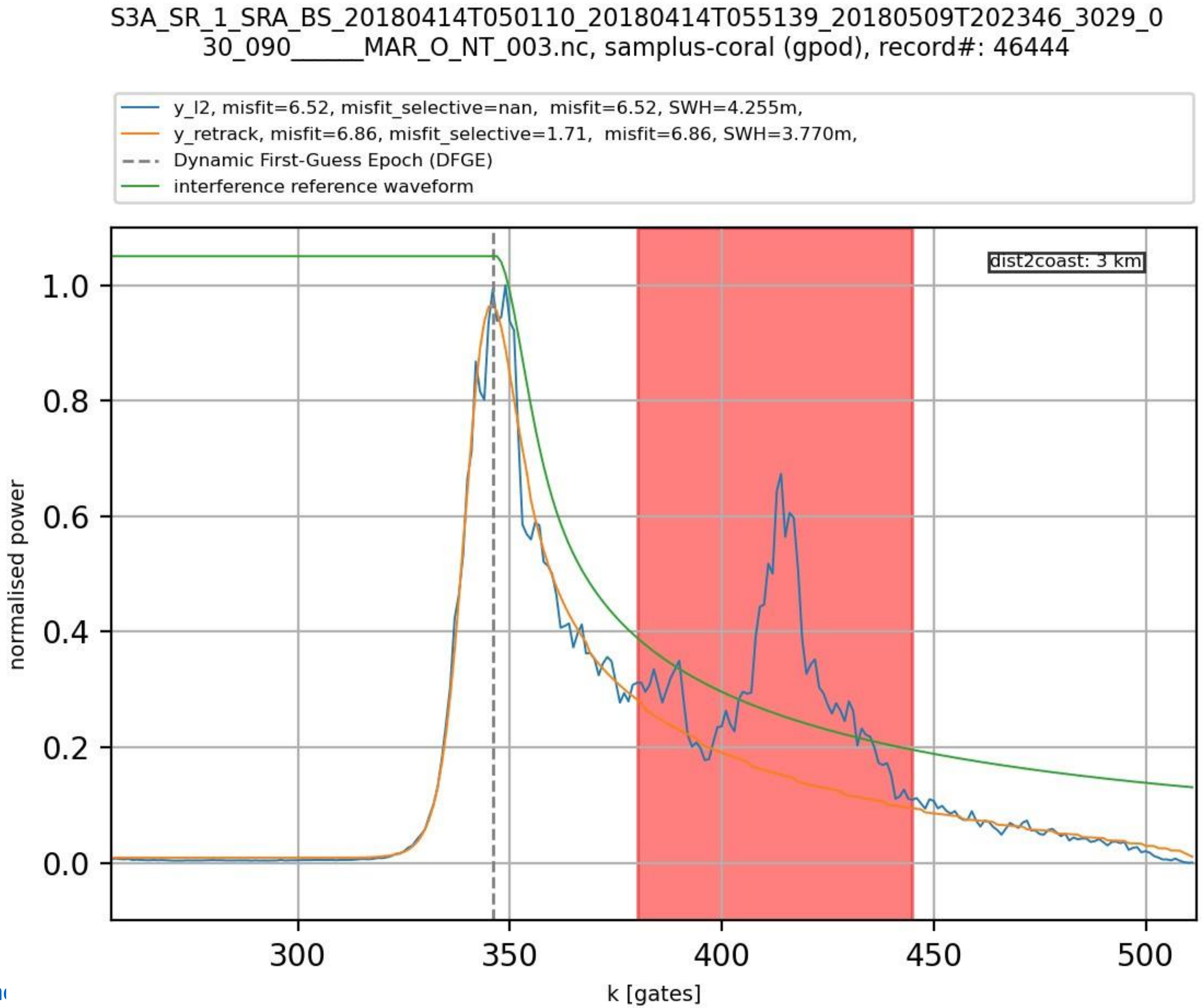
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46443
y_l2, misfit=12.37, misfit_selective=nan, misfit=12.37, SWH=4.712m,
y_retrack, misfit=15.26, misfit_selective=1.57, misfit=15.26, SWH=3.445m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]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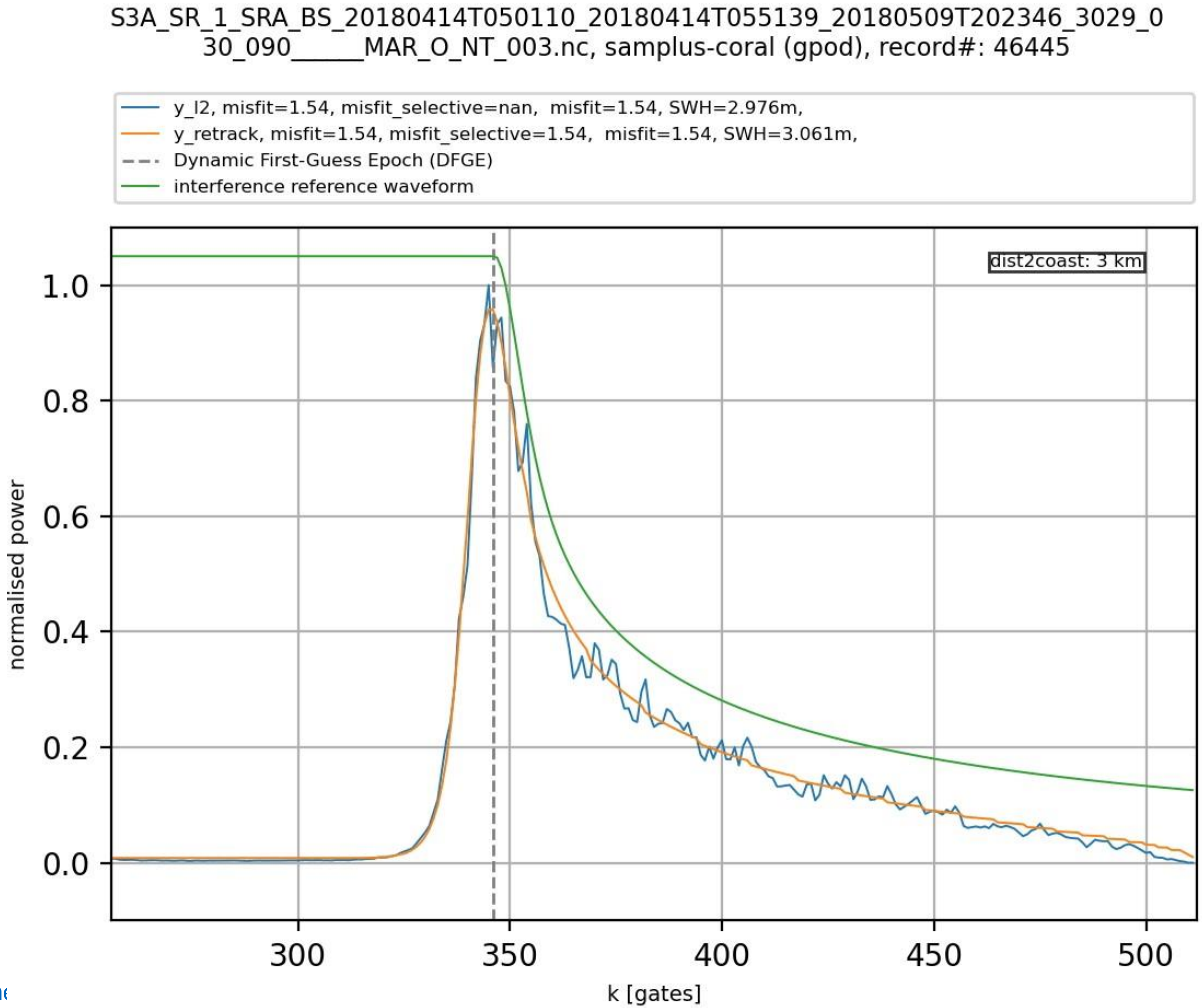
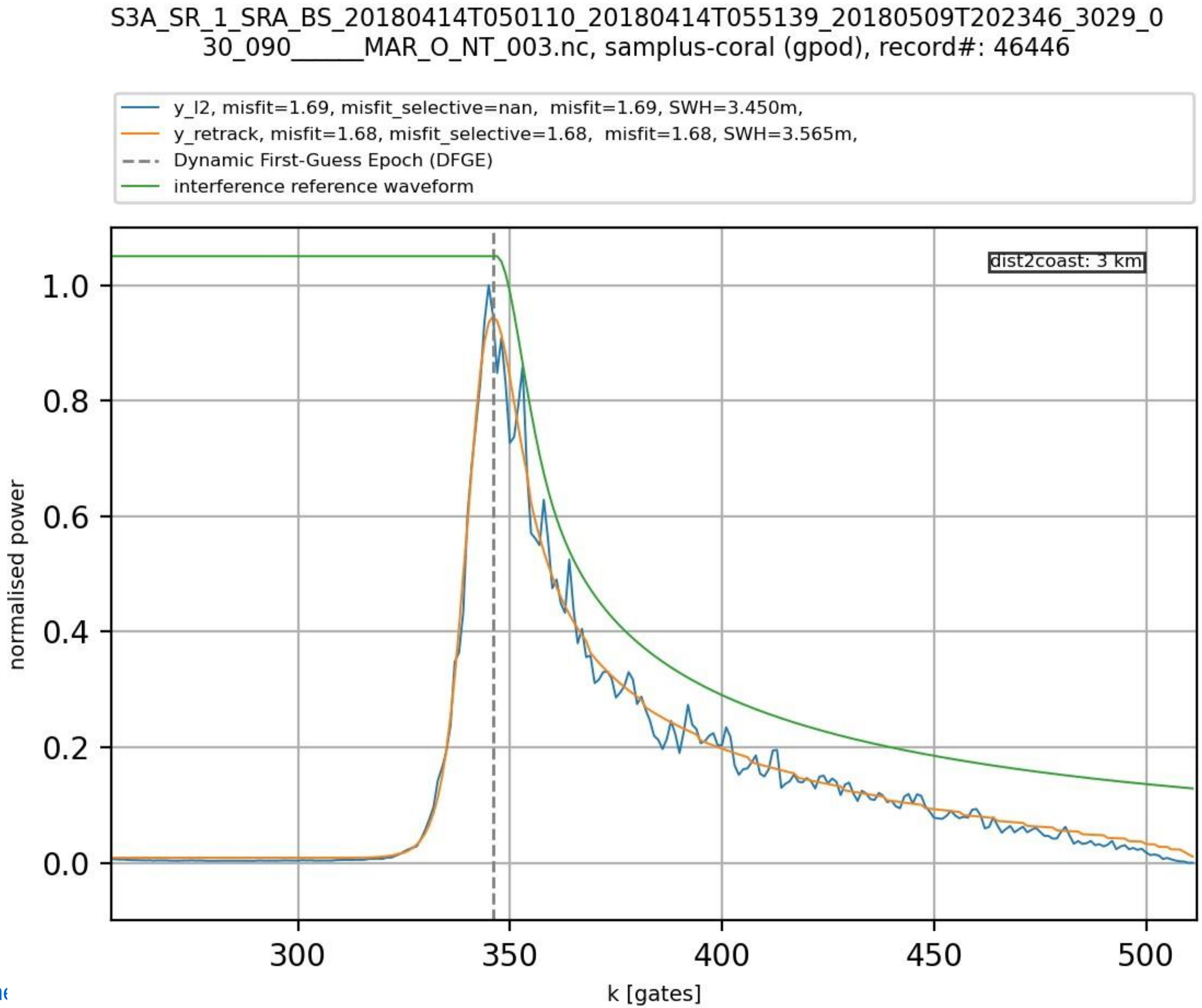
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46444
y_l2, misfit=6.52, misfit_selective=nan, misfit=6.52, SWH=4.255m,
y_retrack, misfit=6.86, misfit_selective=1.71, misfit=6.86, SWH=3.770m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]


S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46445
y_l2, misfit=1.54, misfit_selective=nan, misfit=1.54, SWH=2.976m,
y_retrack, misfit=1.54, misfit_selective=1.54, misfit=1.54, SWH=3.061m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500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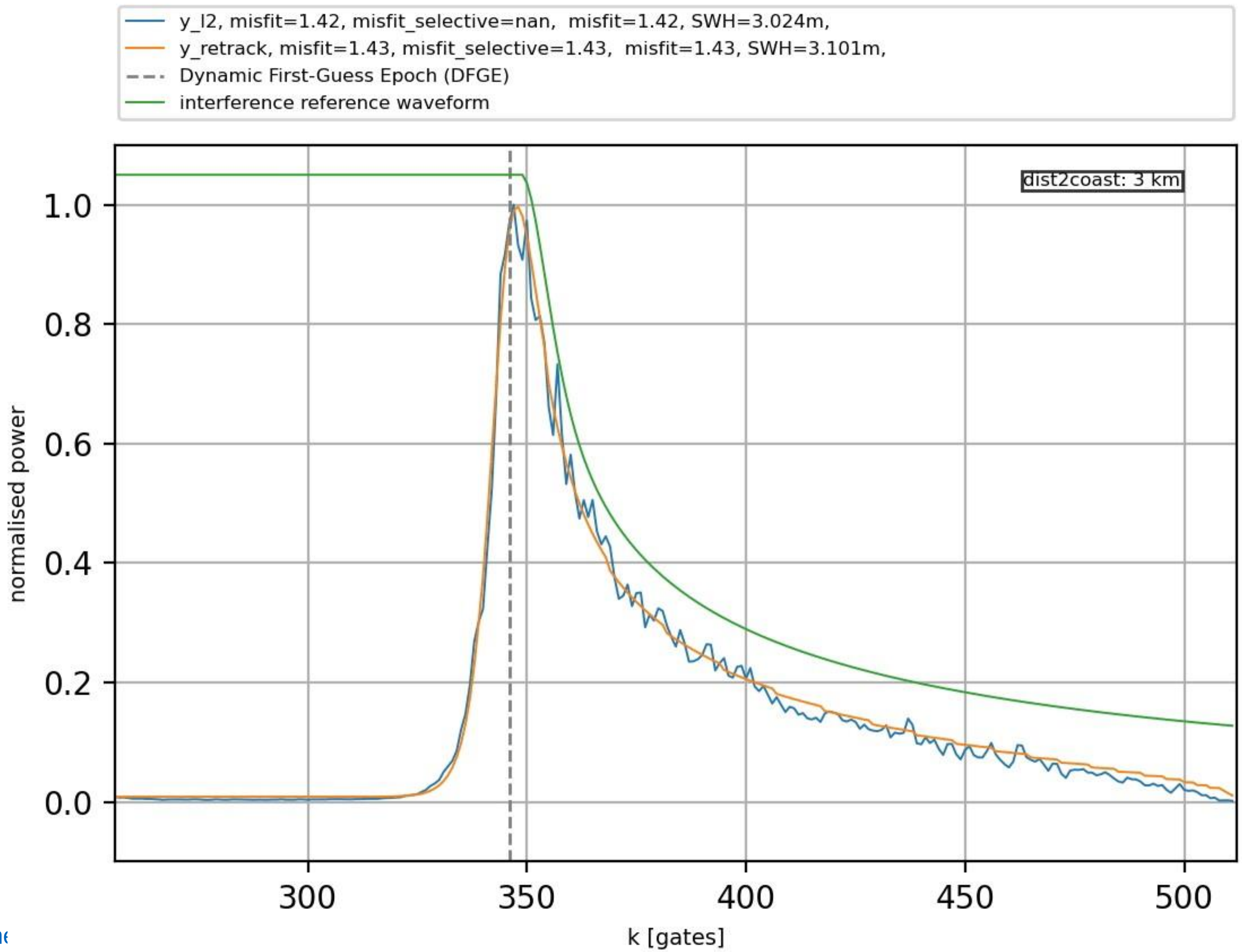
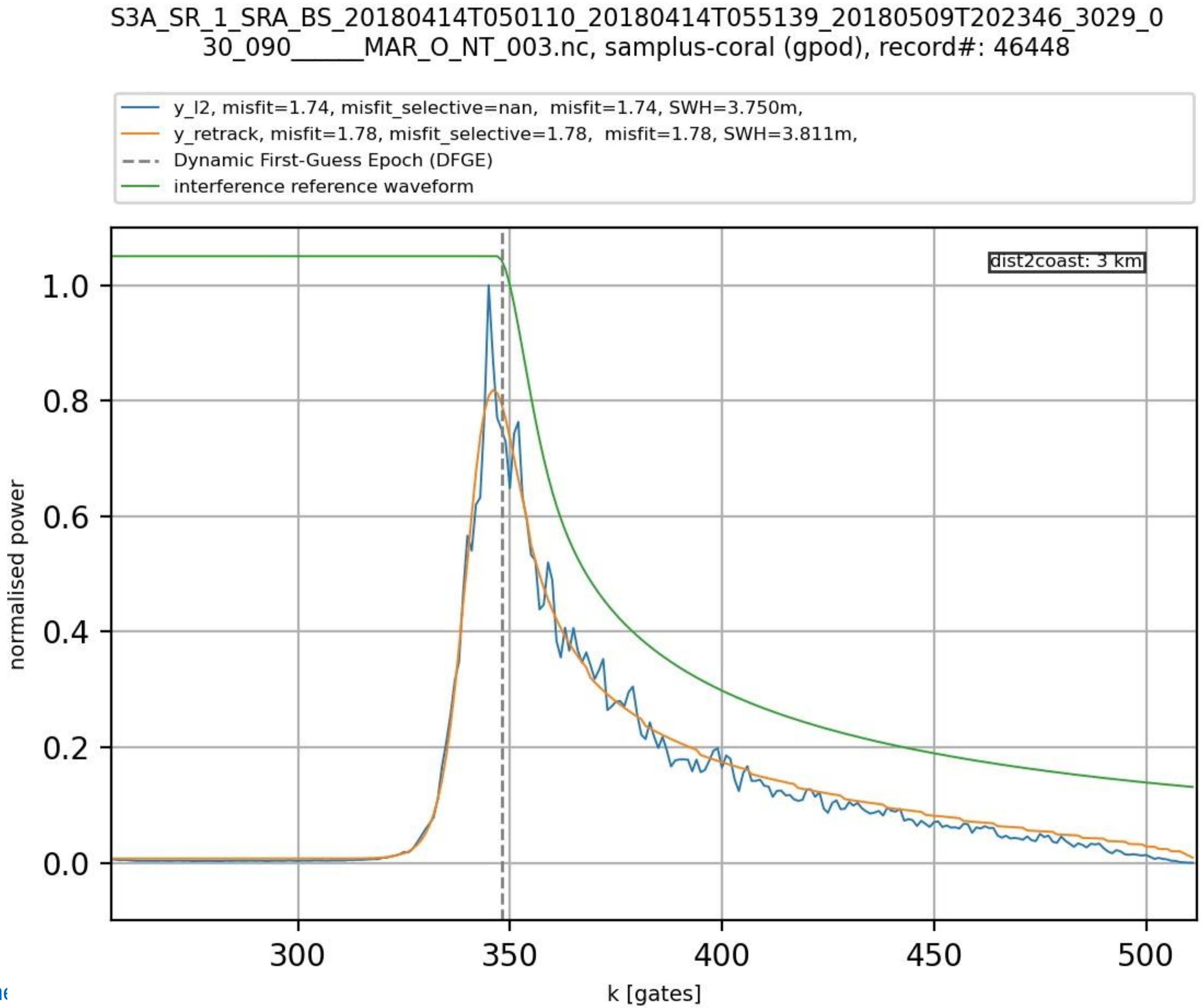
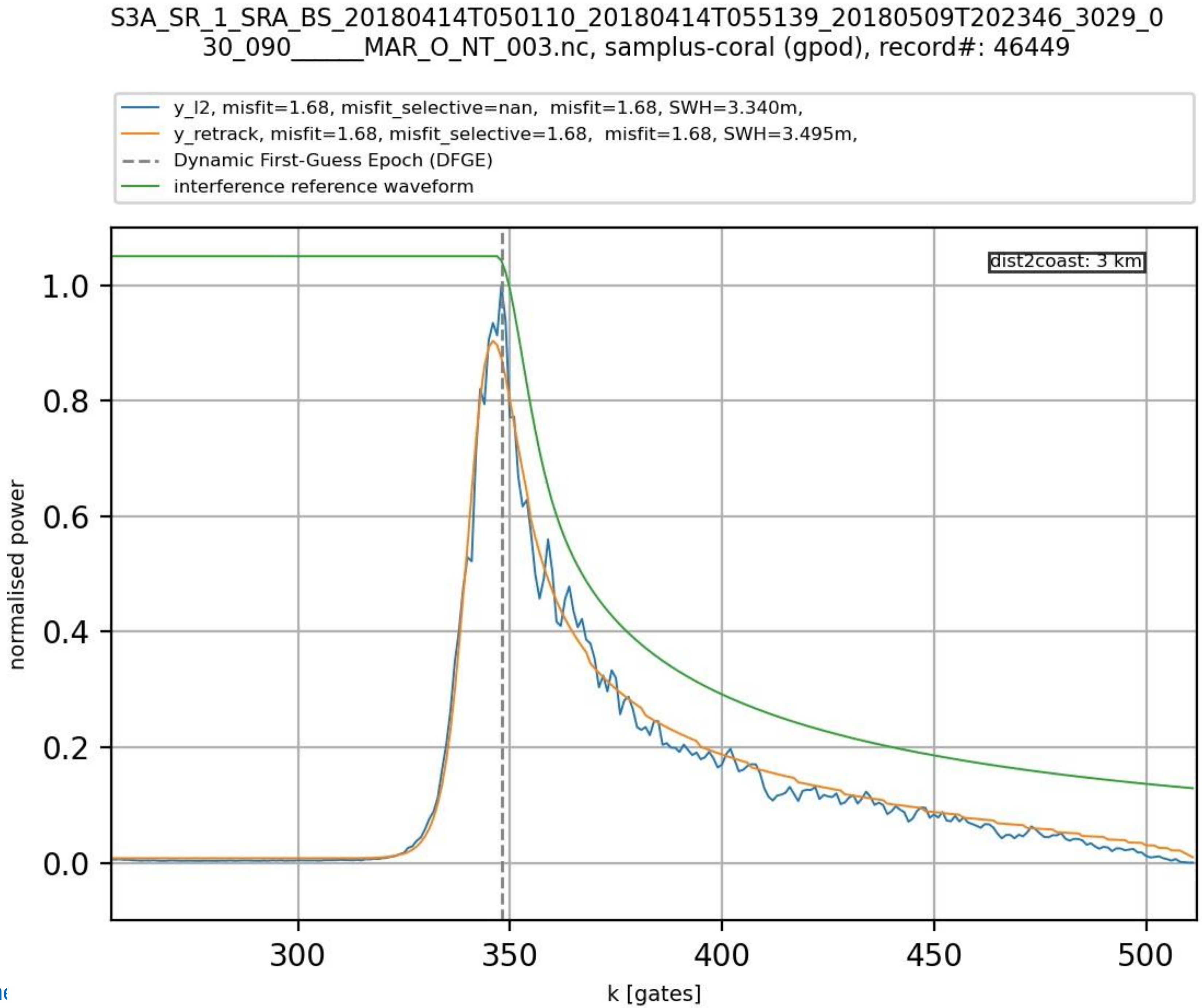
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46446
y_l2, misfit=1.69, misfit_selective=nan, misfit=1.69, SWH=3.450m,
y_retrack, misfit=1.68, misfit_selective=1.68, misfit=1.68, SWH=3.565m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500

S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_030_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46447




S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46448
y_l2, misfit=1.74, misfit_selective=nan, misfit=1.74, SWH=3.750m,
y_retrack, misfit=1.78, misfit_selective=1.78, misfit=1.78, SWH=3.811m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500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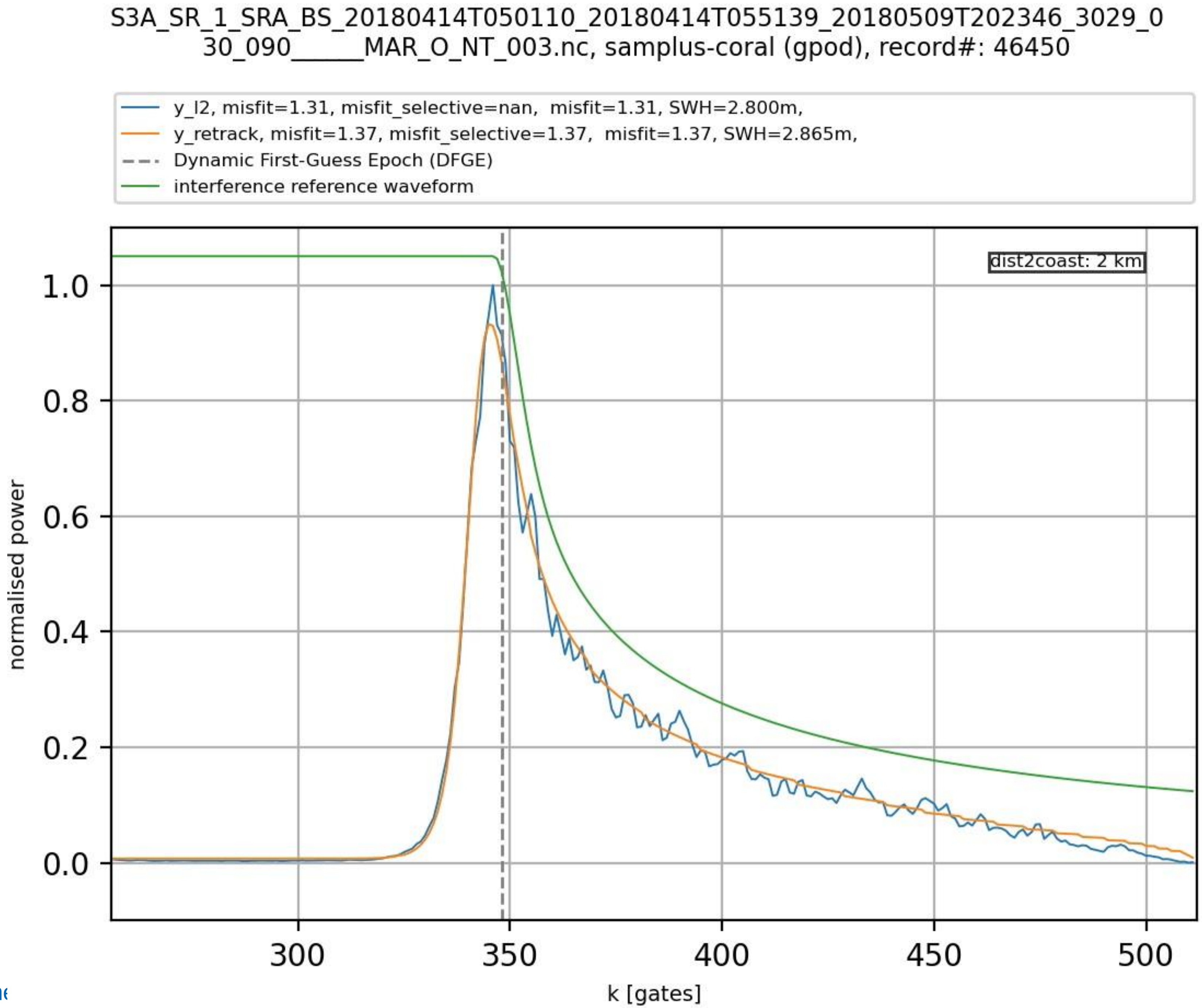
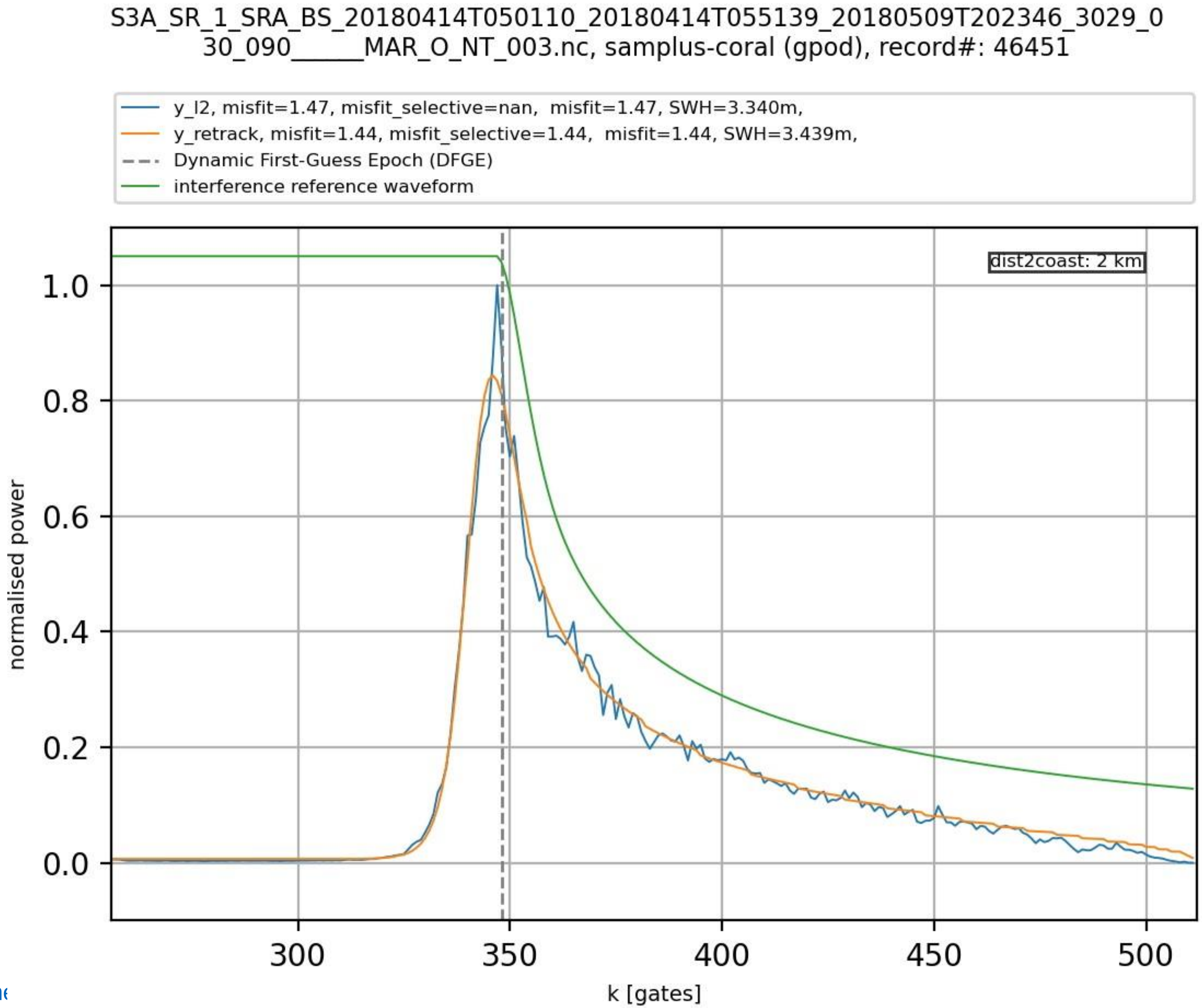
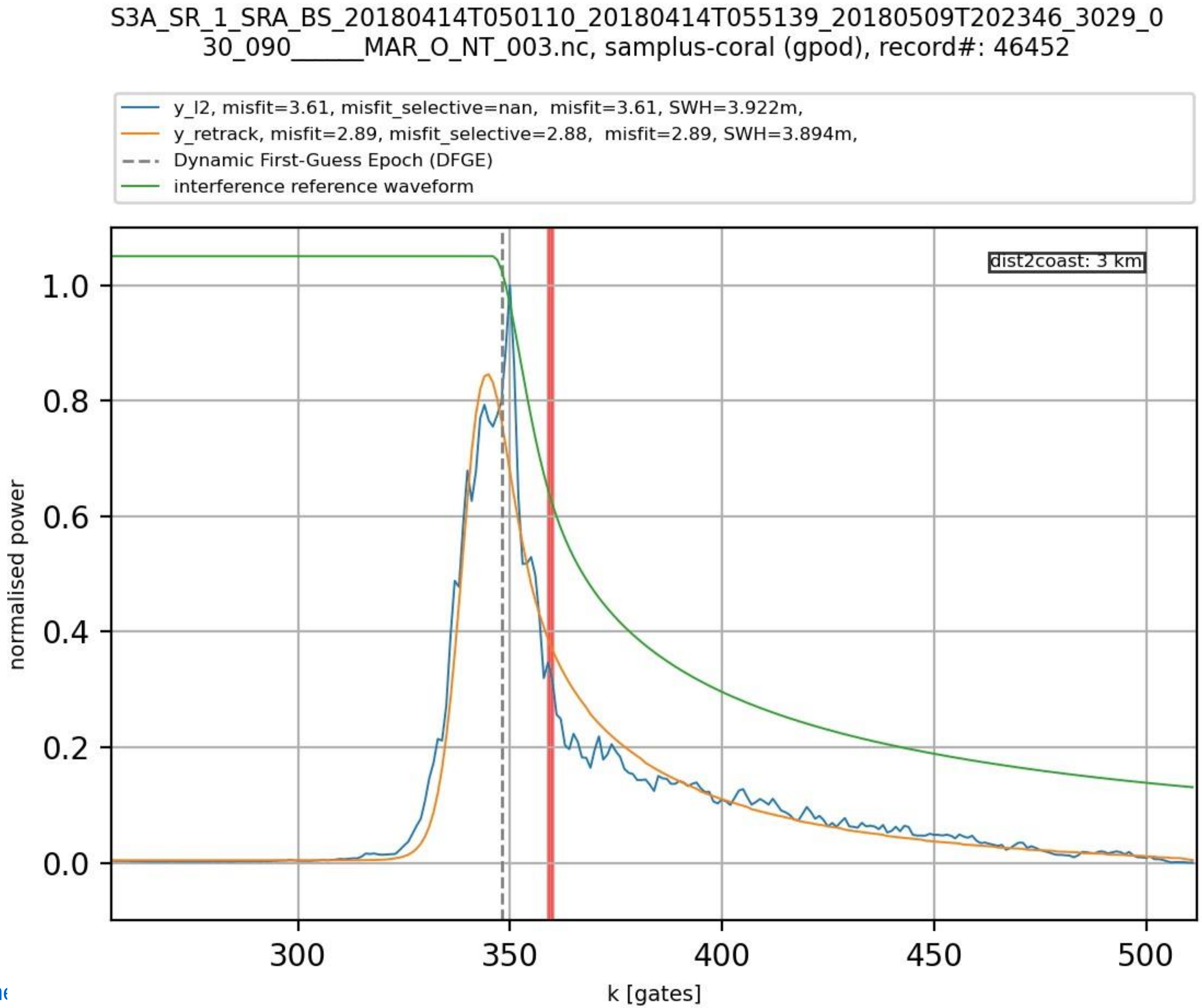
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46449
y_l2, misfit=1.68, misfit_selective=nan, misfit=1.68, SWH=3.340m,
y_retrack, misfit=1.68, misfit_selective=1.68, misfit=1.68, SWH=3.495m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]



S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46450
y_l2, misfit=1.31, misfit_selective=nan, misfit=1.31, SWH=2.800m,
y_retrack, misfit=1.37, misfit_selective=1.37, misfit=1.37, SWH=2.865m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]



S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46451
y_l2, misfit=1.47, misfit_selective=nan, misfit=1.47, SWH=3.340m,
y_retrack, misfit=1.44, misfit_selective=1.44, misfit=1.44, SWH=3.439m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500



S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
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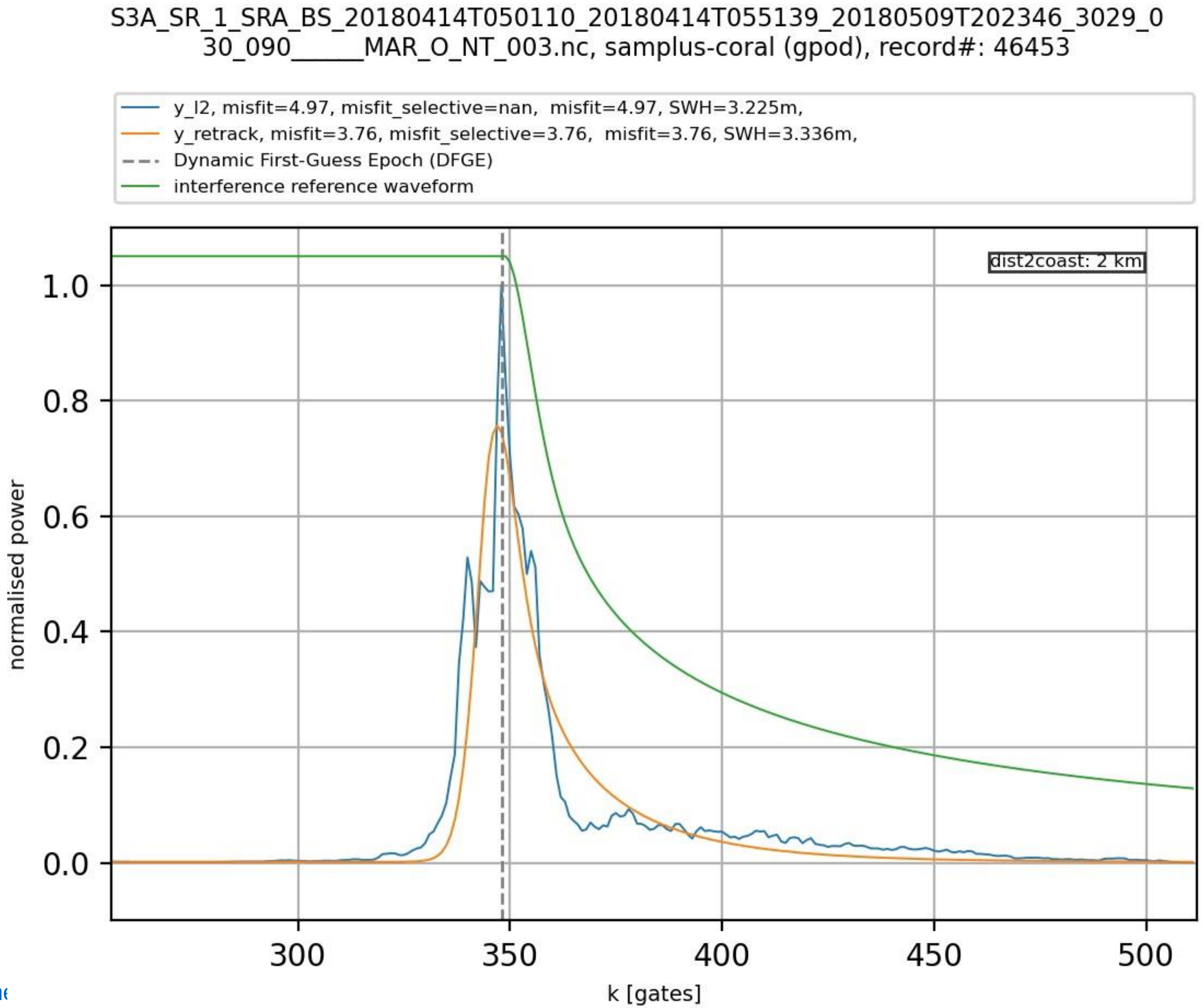
y_l2, misfit=3.61, misfit_selective=nan, misfit=3.61, SWH=3.922m,
y_retrack, misfit=2.89, misfit_selective=2.88, misfit=2.89, SWH=3.894m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 3 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]



S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
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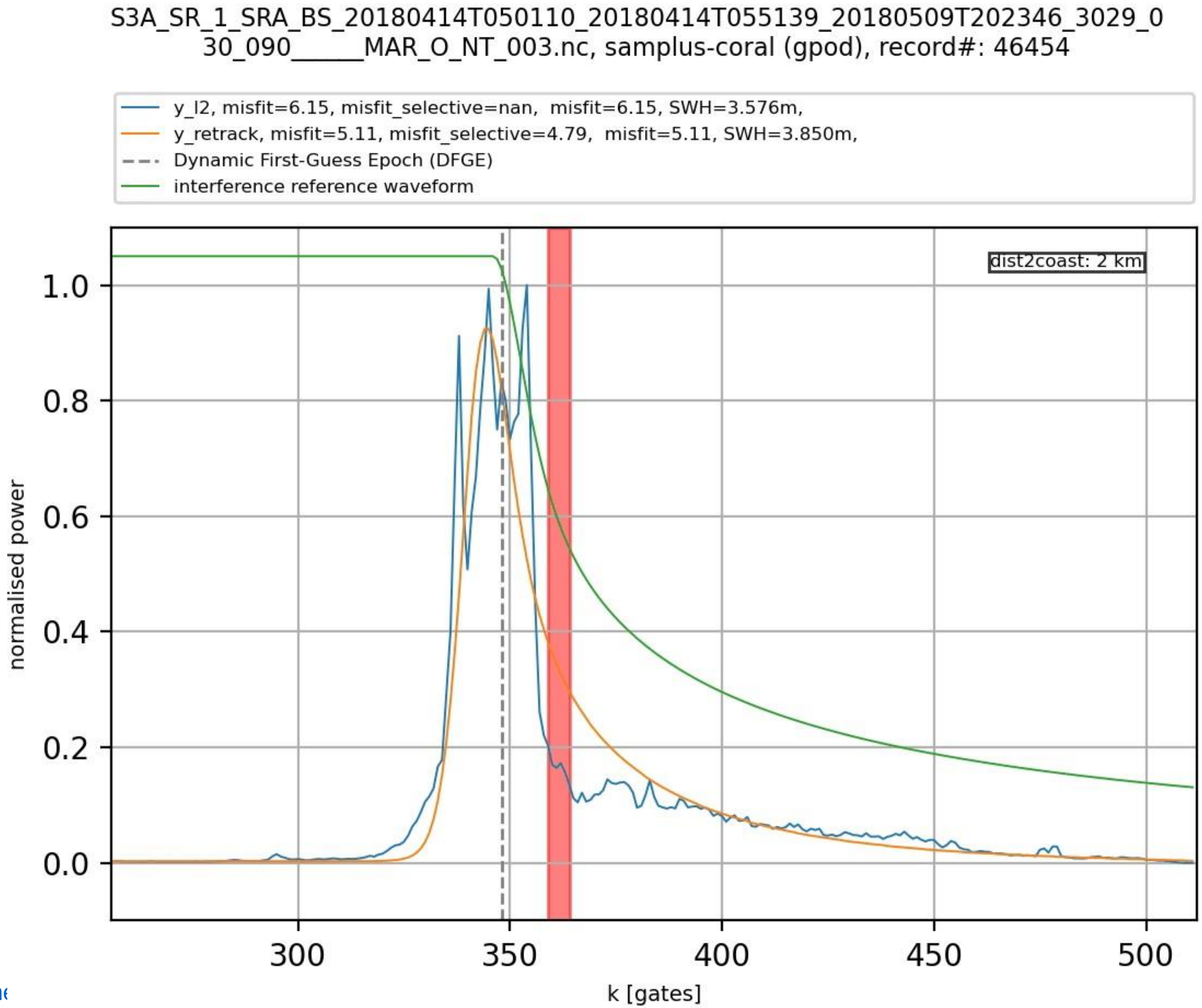
y_l2, misfit=4.97, misfit_selective=nan, misfit=4.97, SWH=3.225m,
y_retrack, misfit=3.76, misfit_selective=3.76, misfit=3.76, SWH=3.336m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]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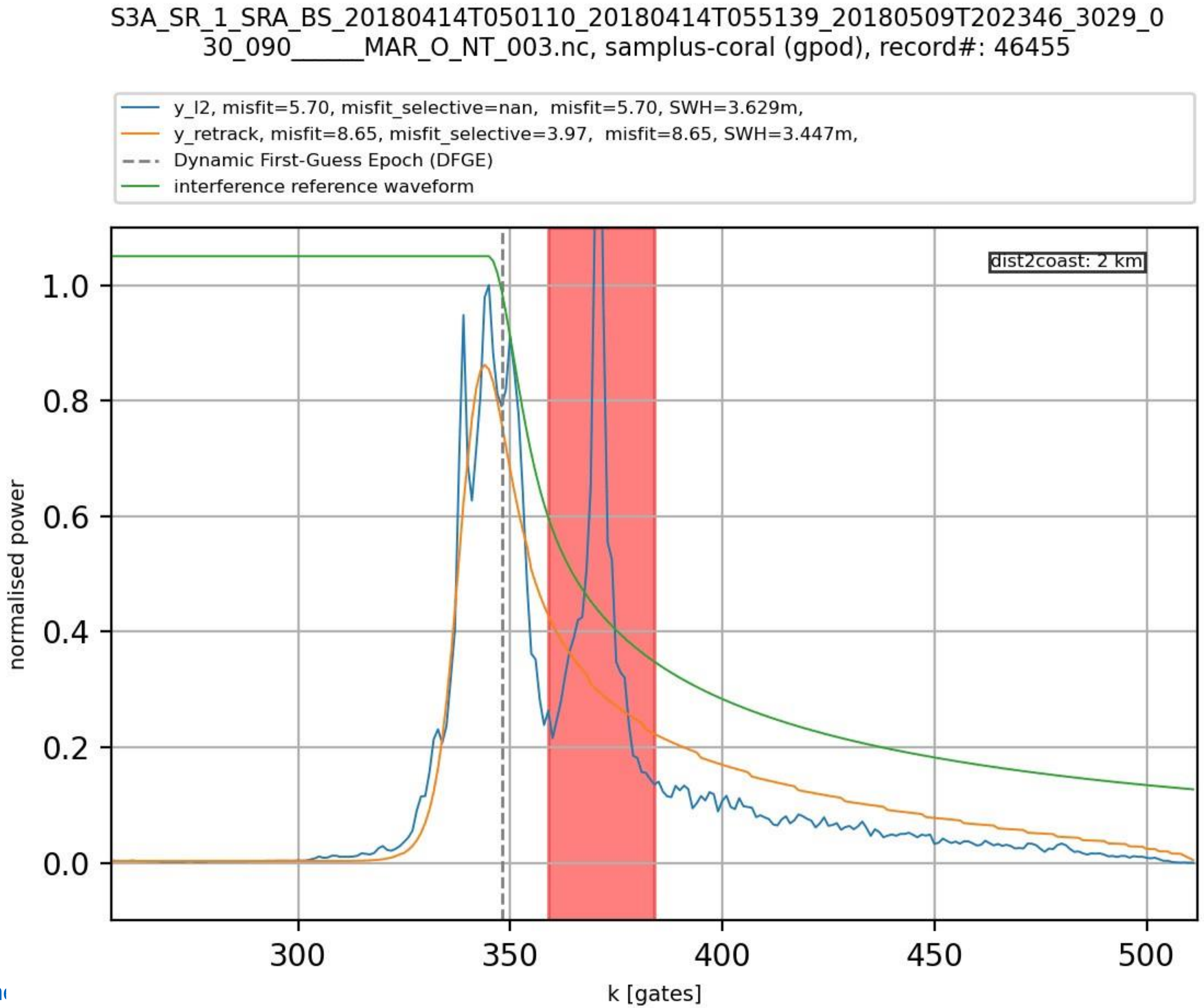
y_l2, misfit=6.15, misfit_selective=nan, misfit=6.15, SWH=3.576m,
y_retrack, misfit=5.11, misfit_selective=4.79, misfit=5.11, SWH=3.850m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]


S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
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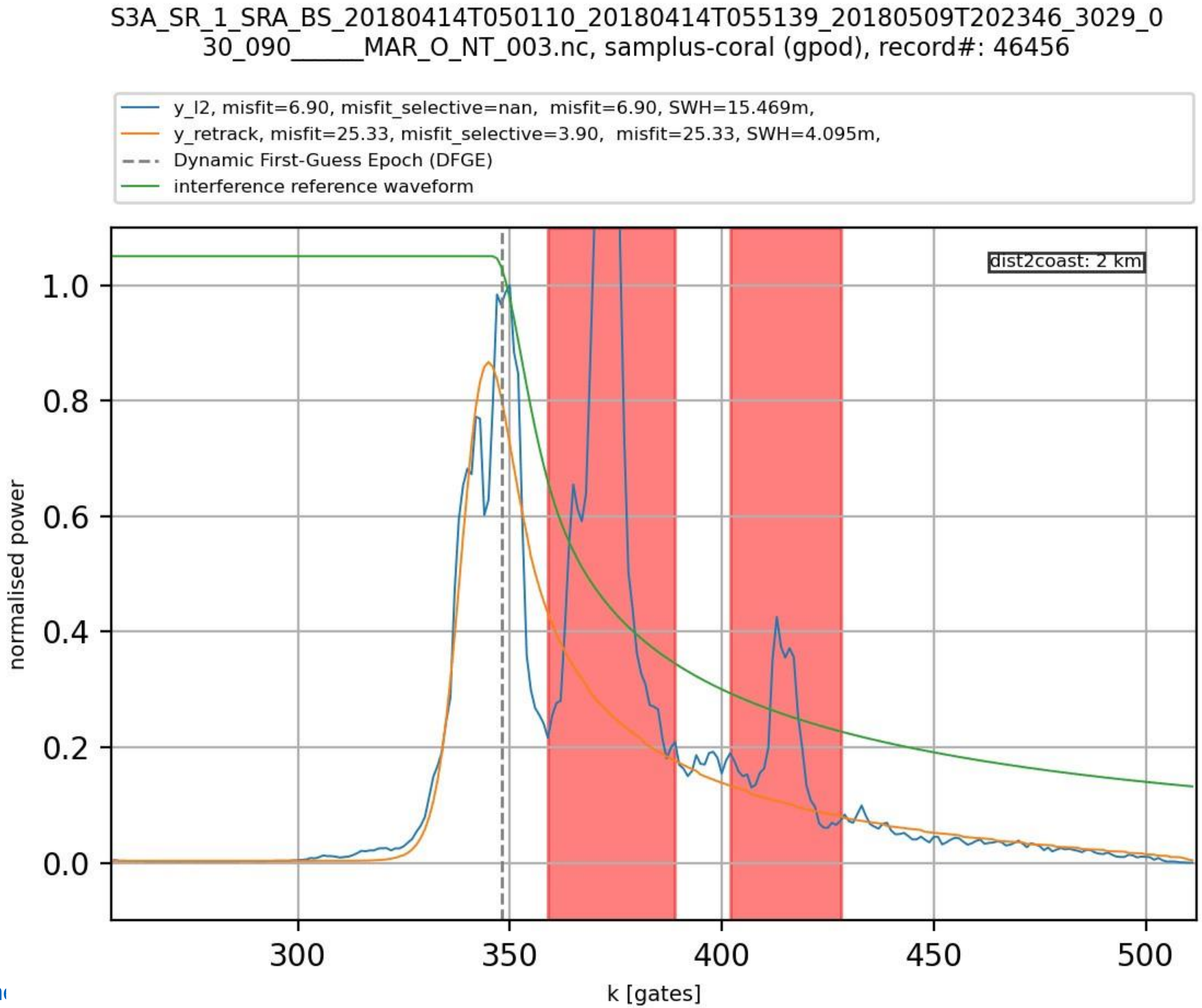
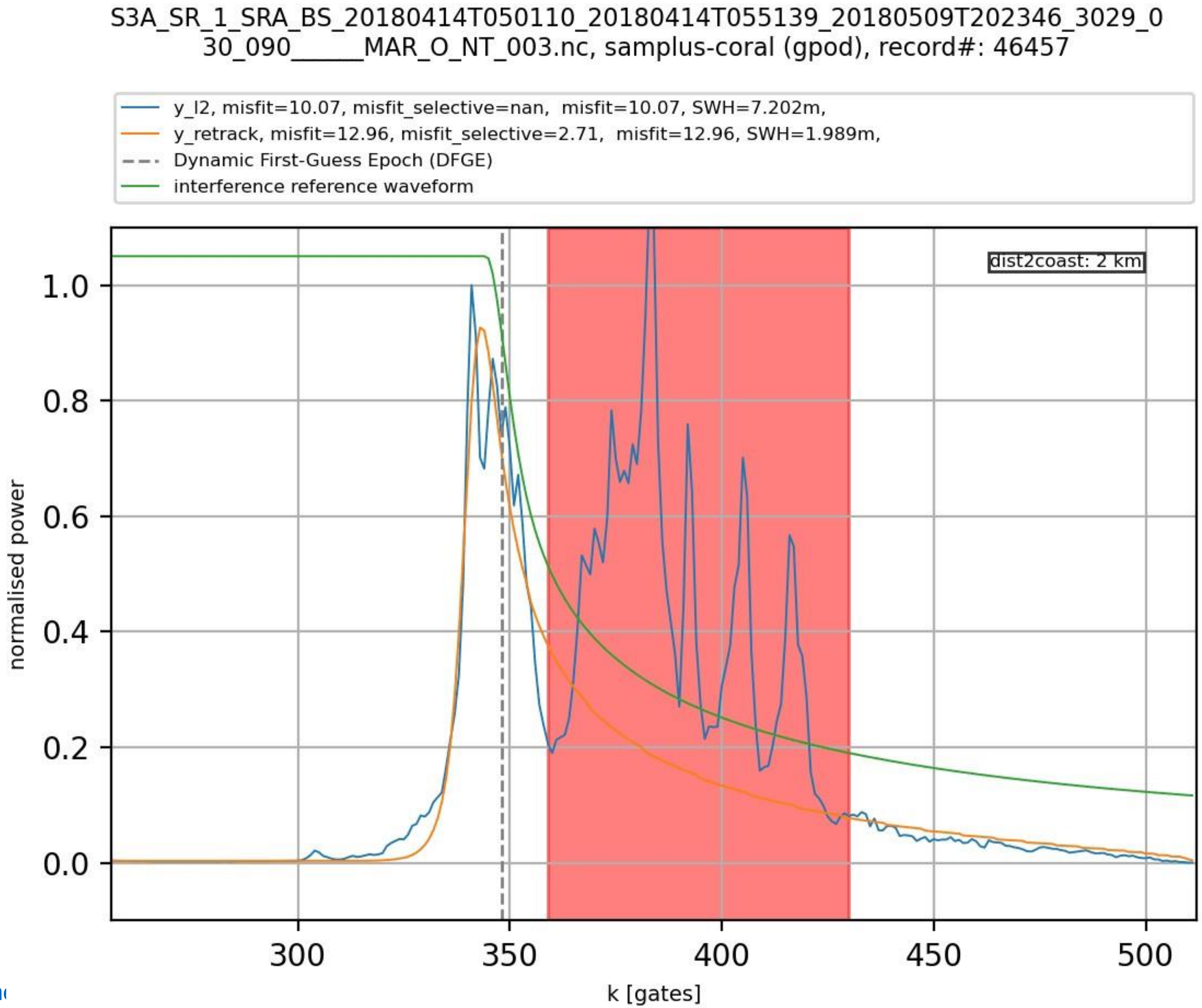
y_l2, misfit=5.70, misfit_selective=nan, misfit=5.70, SWH=3.629m,
y_retrack, misfit=8.65, misfit_selective=3.97, misfit=8.65, SWH=3.447m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]



S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46456
y_l2, misfit=6.90, misfit_selective=nan, misfit=6.90, SWH=15.469m,
y_retrack, misfit=25.33, misfit_selective=3.90, misfit=25.33, SWH=4.095m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
k [gates]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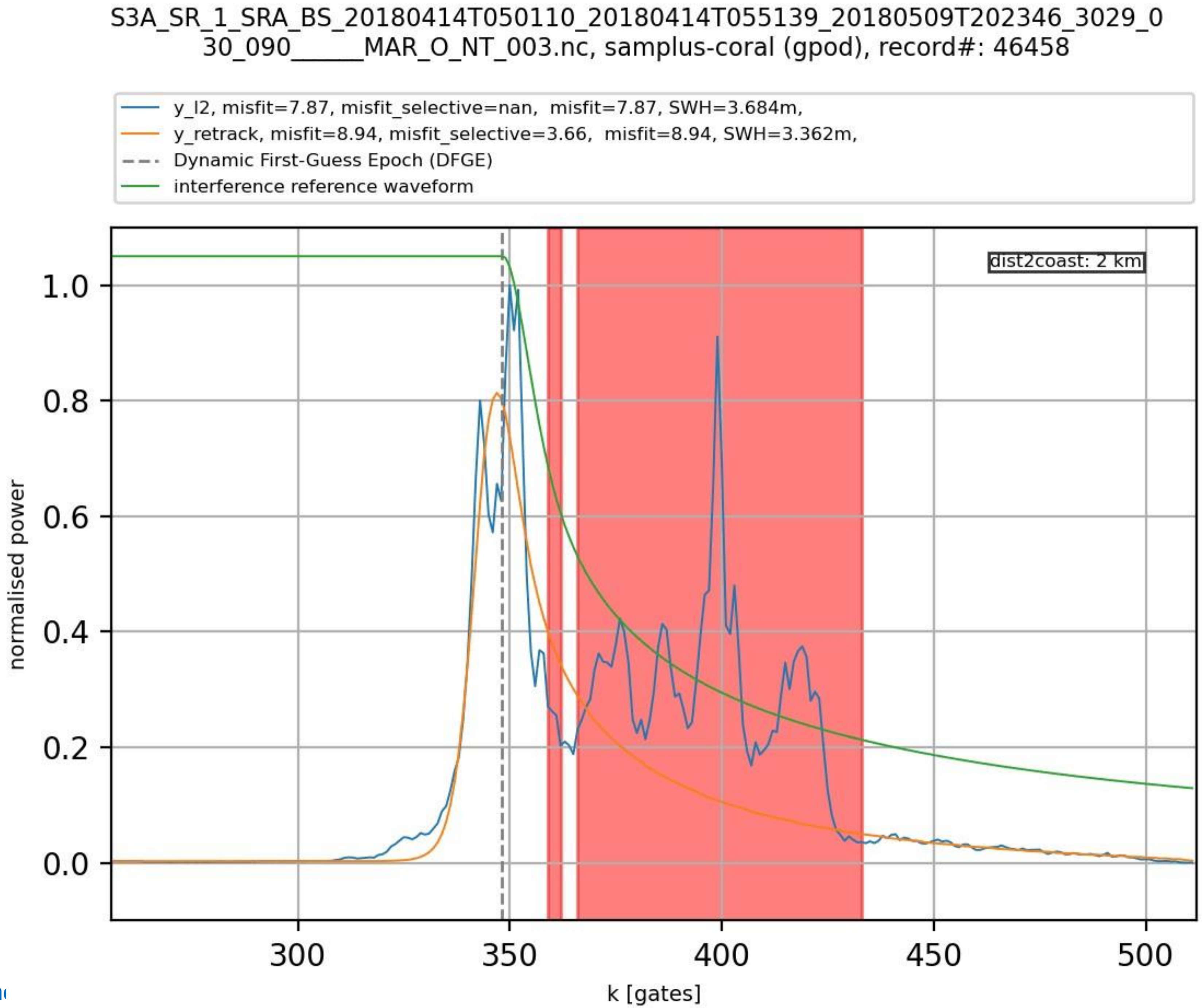
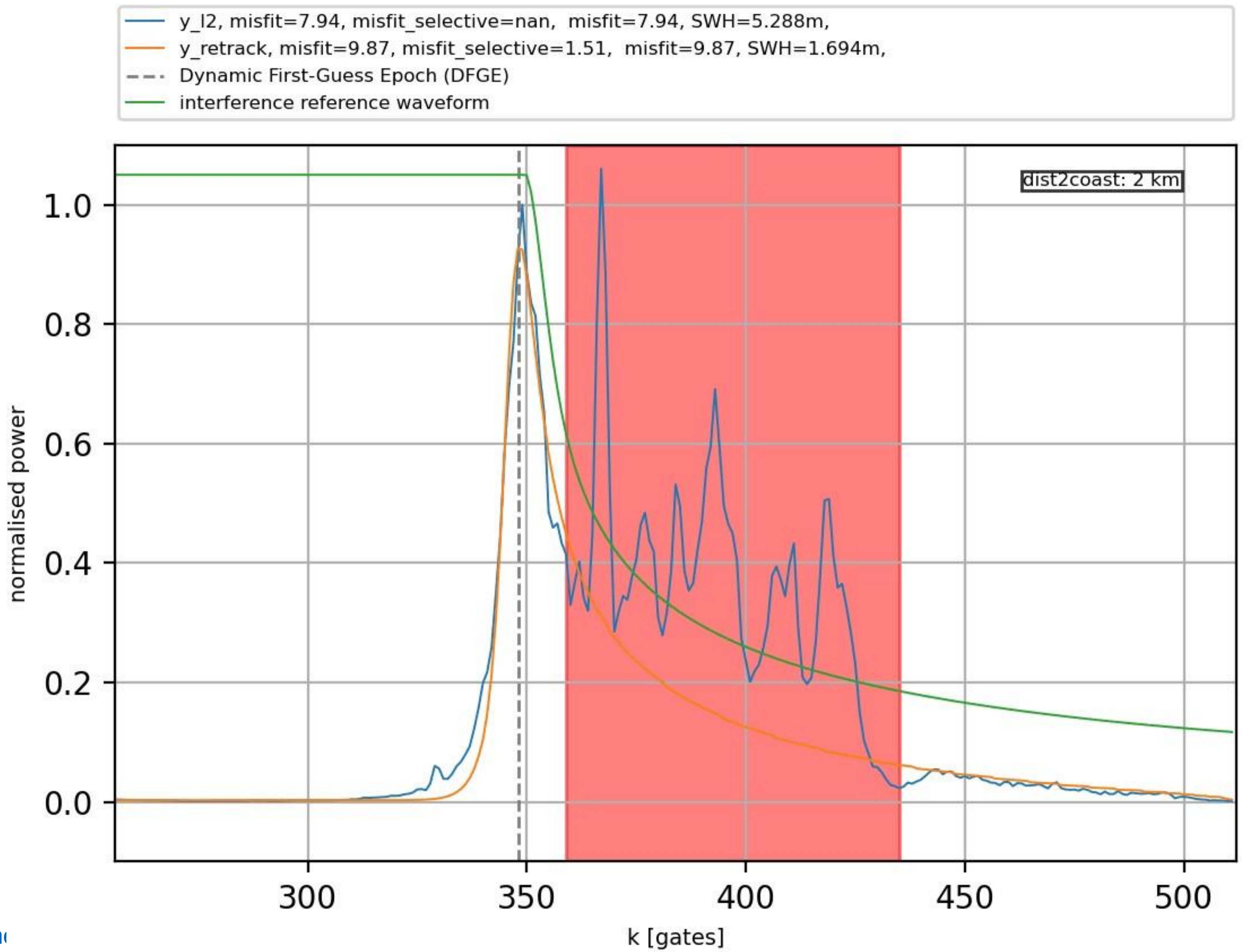
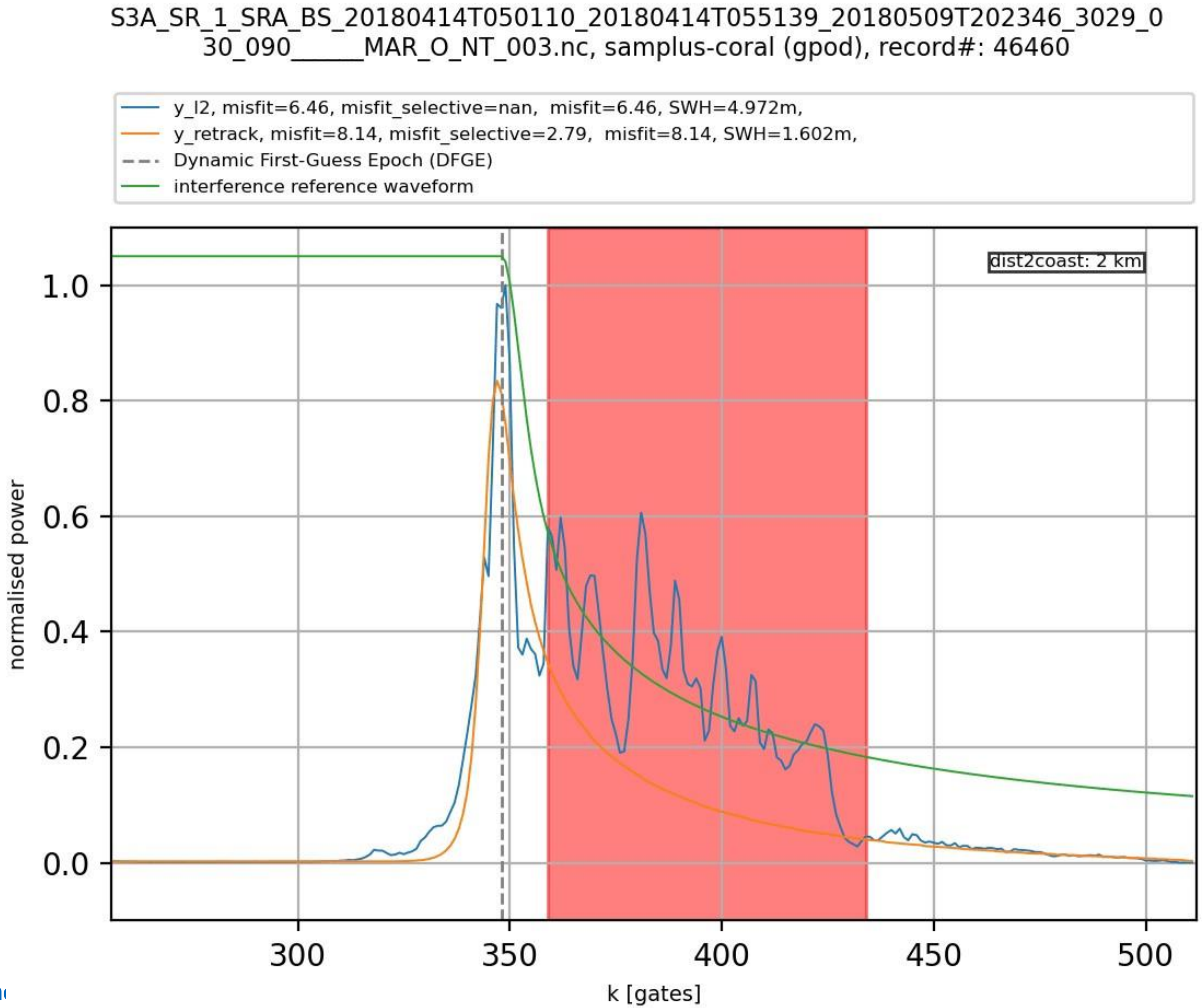
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46457
y_l2, misfit=10.07, misfit_selective=nan, misfit=10.07, SWH=7.202m,
y_retrack, misfit=12.96, misfit_selective=2.71, misfit=12.96, SWH=1.989m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]

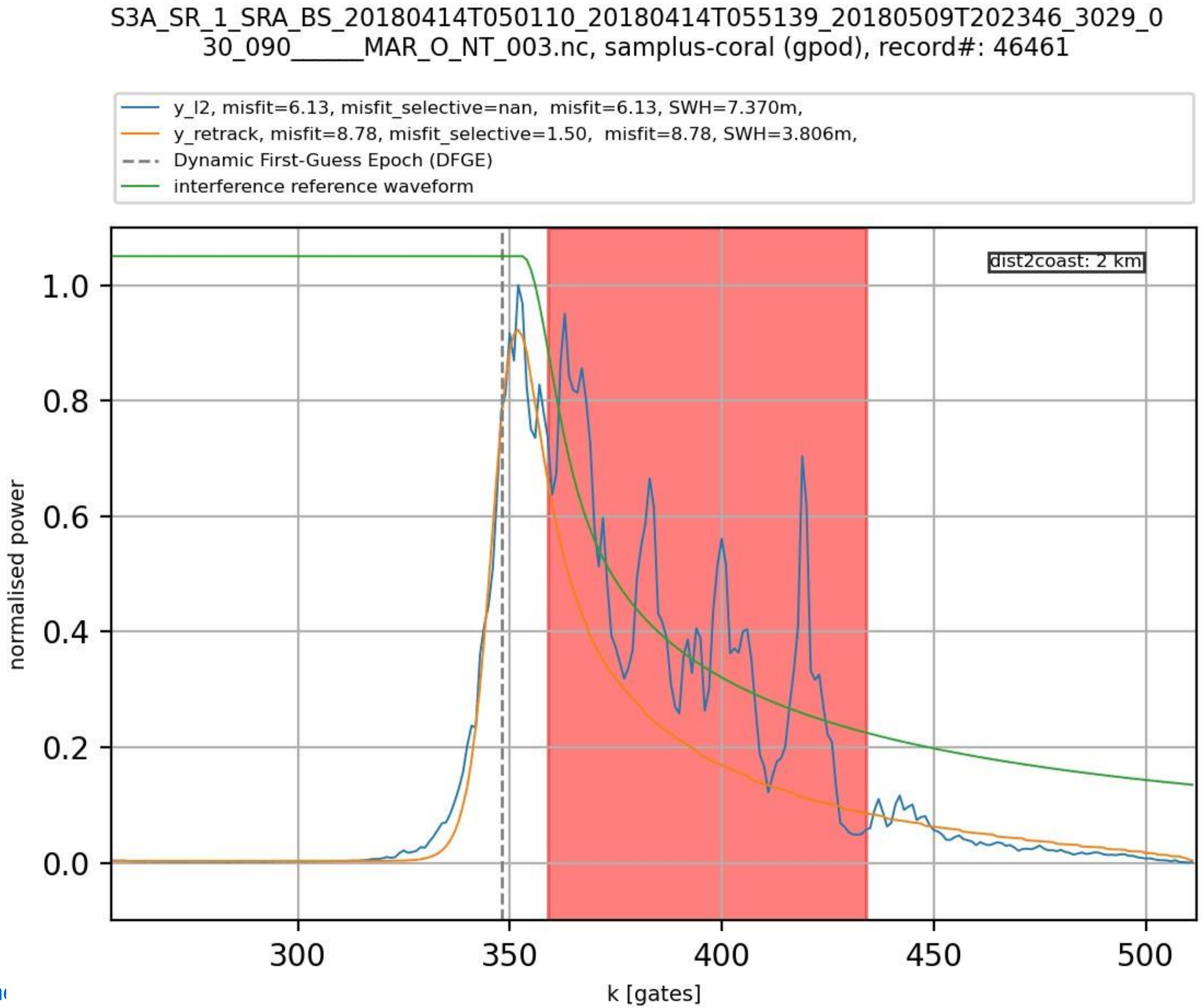


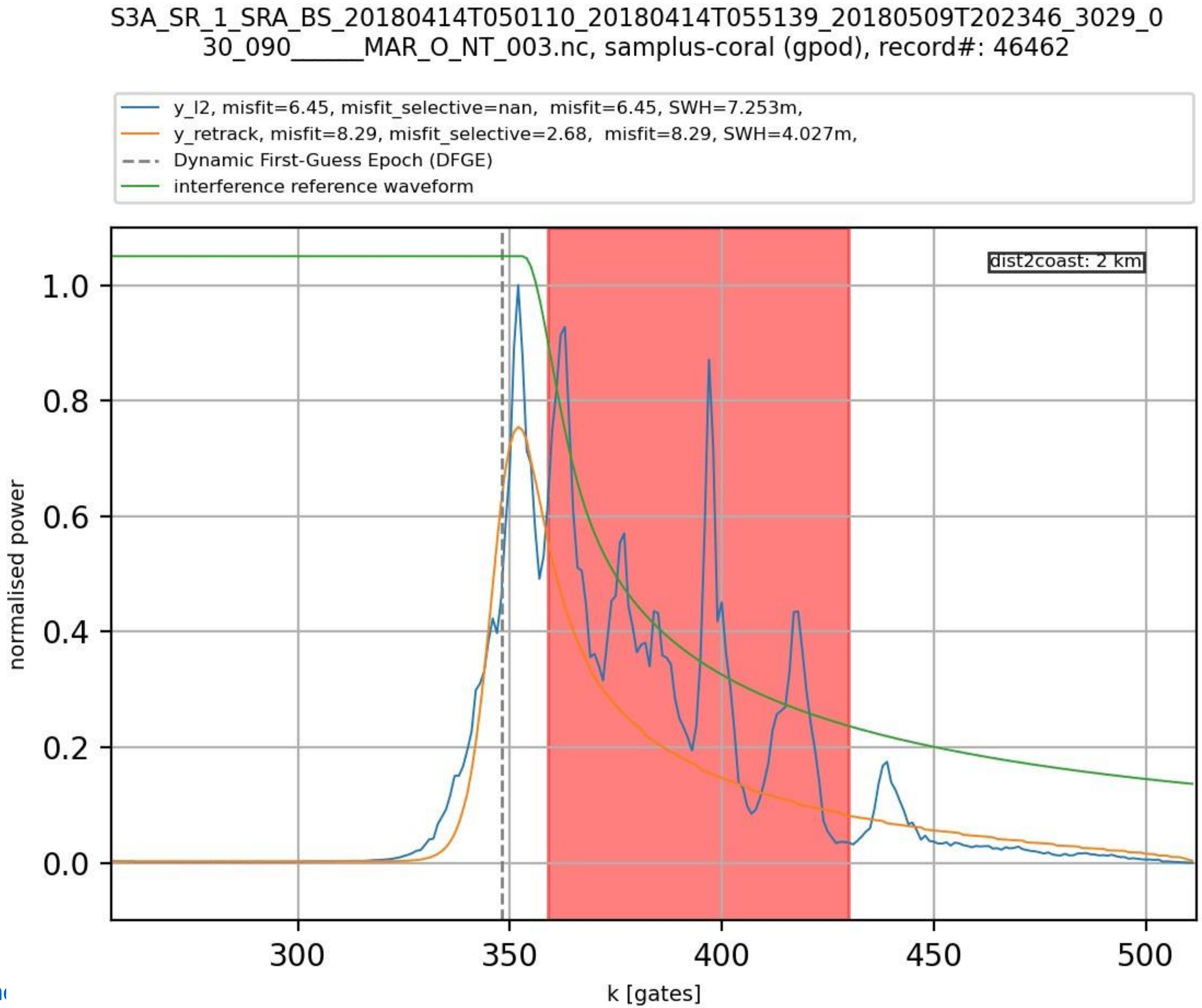
S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46458
y_l2, misfit=7.87, misfit_selective=nan, misfit=7.87, SWH=3.684m,
y_retrack, misfit=8.94, misfit_selective=3.66, misfit=8.94, SWH=3.362m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500

S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_030_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46459




S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46460
y_l2, misfit=6.46, misfit_selective=nan, misfit=6.46, SWH=4.972m,
y_retrack, misfit=8.14, misfit_selective=2.79, misfit=8.14, SWH=1.602m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500


S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46461
y_l2, misfit=6.13, misfit_selective=nan, misfit=6.13, SWH=7.370m,
y_retrack, misfit=8.78, misfit_selective=1.50, misfit=8.78, SWH=3.806m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
k [gates]
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500



S3A_SR_1_SRA_BS_20180414T050110_20180414T055139_20180509T202346_3029_0
30_090______MAR_O_NT_003.nc, samplus-coral (gpod), record#: 46462
y_l2, misfit=6.45, misfit_selective=nan, misfit=6.45, SWH=7.253m,
y_retrack, misfit=8.29, misfit_selective=2.68, misfit=8.29, SWH=4.027m,
Dynamic First-Guess Epoch (DFGE)
interference reference waveform
dist2coast: 2 km
normalised power
1.0
0.8
0.6
0.4
0.2
0.0
300
350
400
450
500
k [gates]