Sea Level CCI project

Phase II
1st annual review

Simultaneous retracking of multiple waveforms

WP2750-2770

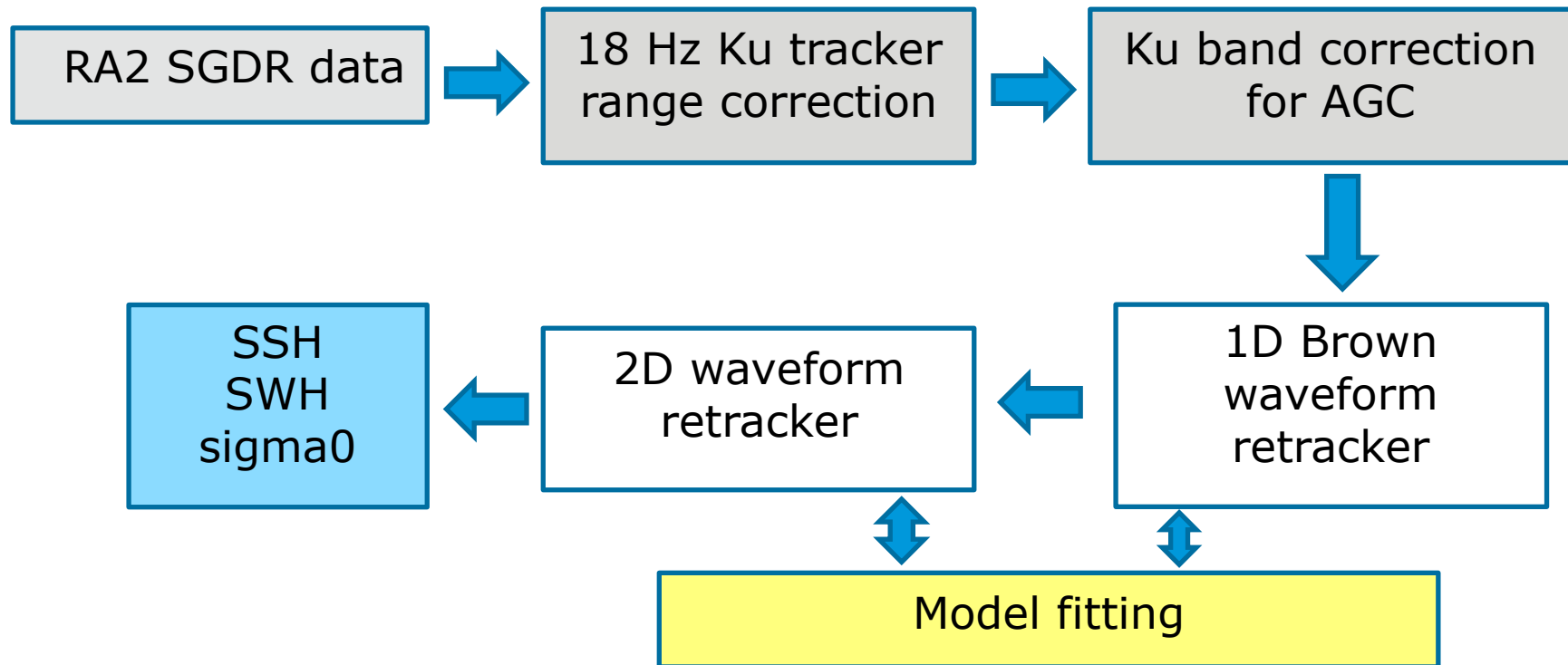**Andrey Kurekin, Graham Quartly**

2-D retracker

- the standard approach seeks to converge on a set of 3 or 4 parameters that minimises the r.m.s. error about a functional shape

- we consider, say, 21 waveforms together, with the parameters to be derived, being slowly varying functions of waveform no., j.

- we model the evolution of this parameter as a quadratic function:
f(j) = ai + bi(j-j0) + ci(j-j0)^2, where **j0** = 11

- the problem becomes one of estimating 9 values (**a1,a2,a3, b1,b2,b3, c1,c2,c3**) using 21 wavefoms

Features of 2D retracker

- More complex optimization task – 3-fold increase in the number of parameters, with a 21-fold increase in the data to be used

- The approach uses physical insight (the slowly-varying nature of the parameters of interest) to improve estimation properties

- It directly produces the key values of interest:
  - the smoothed values of the range parameter: **ai** terms
  - The spatial gradient (along-track slopes) used to infer geostrophic velocity: **bi** terms

The flow-chart of data processing in 2D retracker

```
┌──────────────────┐      ┌──────────────────┐      ┌──────────────────┐
│  RA2 SGDR data   │ ───► │  18 Hz Ku tracker│ ───► │ Ku band correction│
│                  │      │  range correction│      │     for AGC       │
└──────────────────┘      └──────────────────┘      └──────────────────┘
                                                              │
                                                              ▼
┌──────────────────┐      ┌──────────────────┐      ┌──────────────────┐
│      SSH         │ ◄─── │  2D waveform     │ ◄─── │   1D Brown       │
│      SWH         │      │   retracker      │      │   waveform       │
│     sigma0       │      │                  │      │   retracker      │
└──────────────────┘      └──────────────────┘      └──────────────────┘
                                   ▲                         ▲
                                   ▼                         ▼
                          ┌─────────────────────────────────────────┐
                          │            Model fitting                 │
                          └─────────────────────────────────────────┘
```

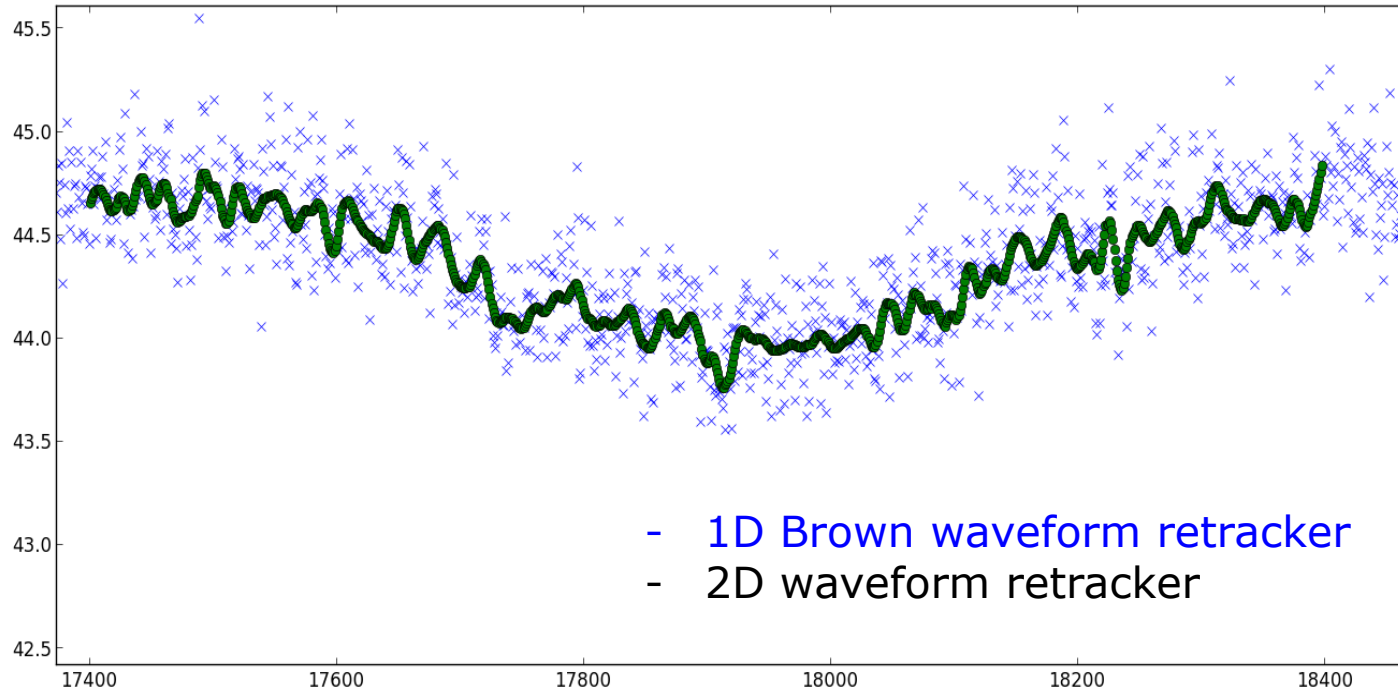## Fitting a model to measured waveforms

- cost function: the **sum of squares** of differences
- optimisation: the **Levenberg-Marquardt algorithm**
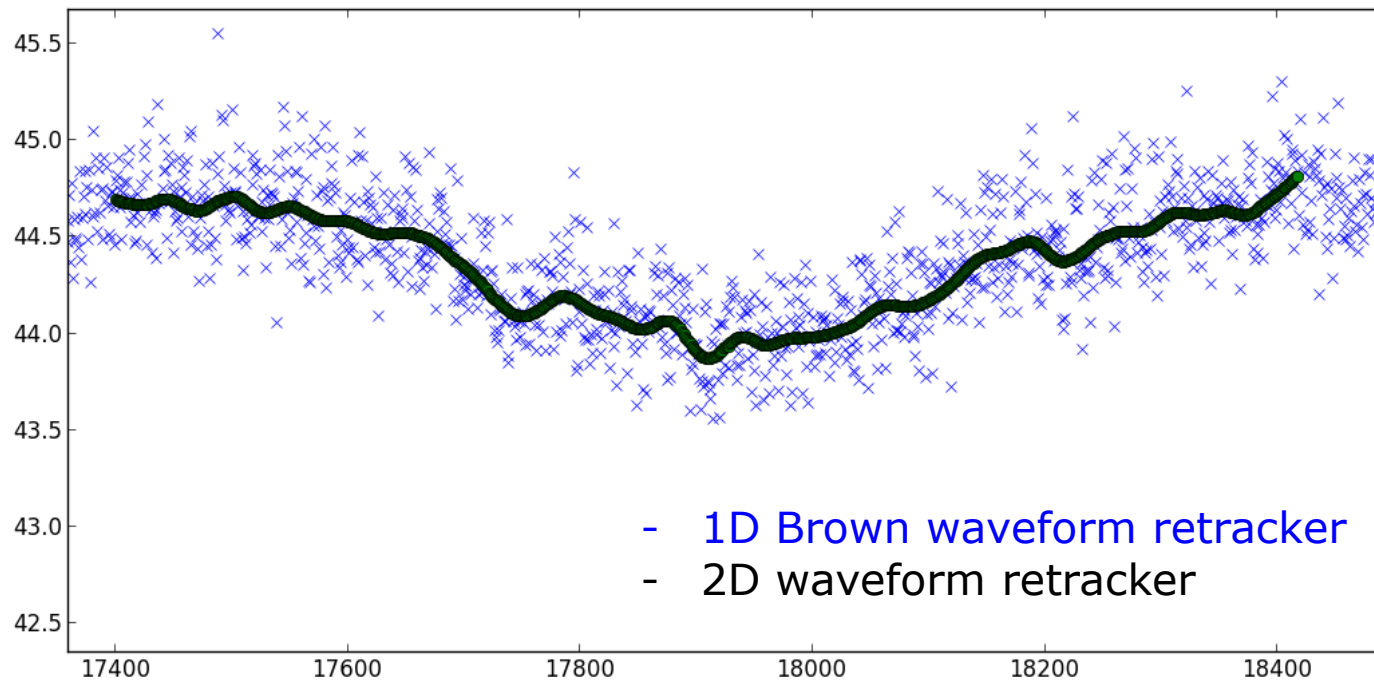
Waveform processing

2-D retracker output over open ocean surface

- - 1D Brown waveform retracker
- - 2D waveform retracker
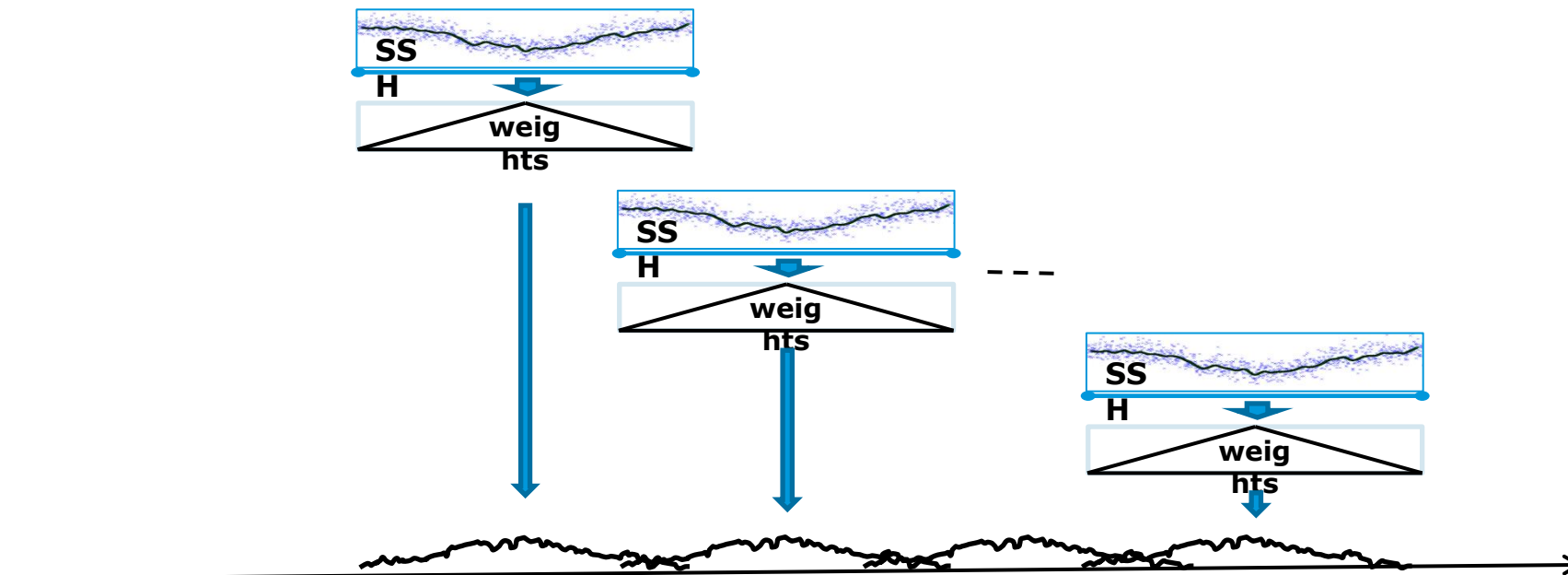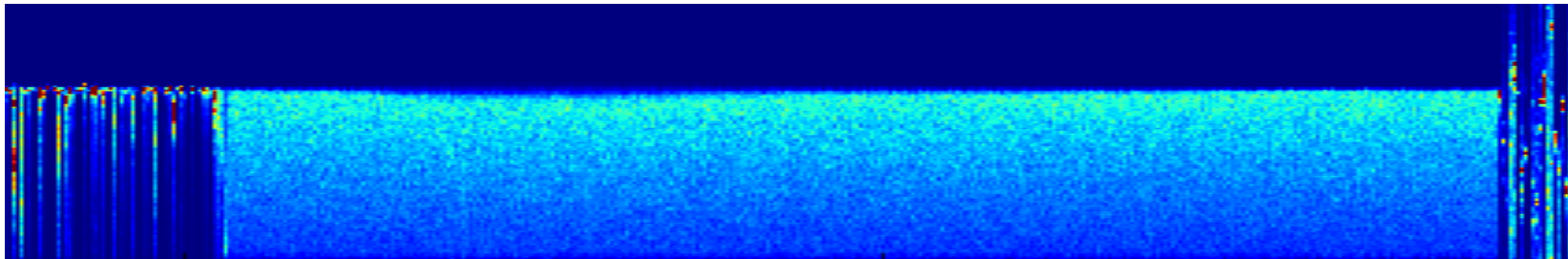
Window_size= 21 samples, step=11 samples

2-D retracker output over open ocean surface

- 1D Brown waveform retracker
- 2D waveform retracker

Window_size= 61 samples, step=33 samples

2-D retracker output over open ocean surface

- 1D Brown waveform retracker
- 2D waveform retracker
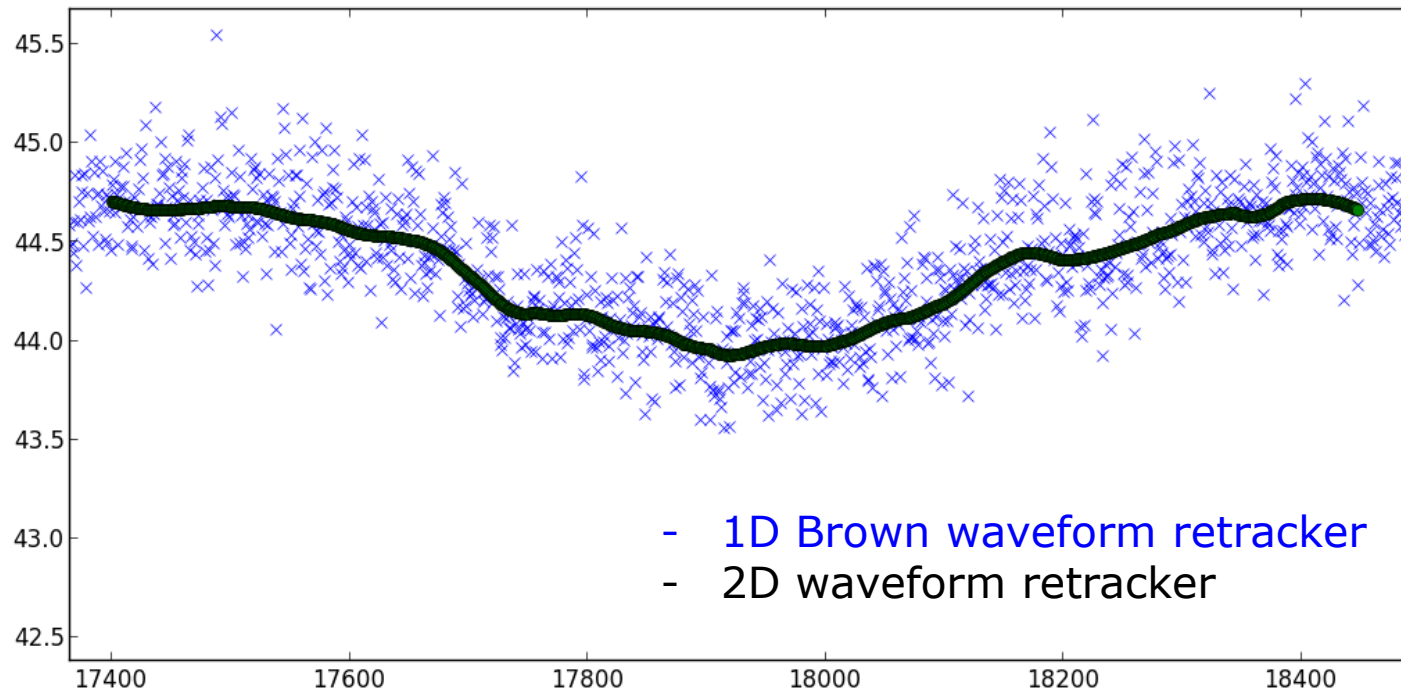
Window_size= 105 samples, step=63 samples

Conclusions and Future Work

- A new 2D retracker has been developed that appears to produce smoother estimates over the ocean. A quantitative comparison with the 1D Brown retracker will be done.

- ***Future work:***
    - looking at other measures of error, such as median absolute Deviation, and other optimisation techniques (Nelder-Mead Simplex and Broyden-Fletcher-Goldfarb-Shanno algorithms)
    - evaluate a strategy for number of waveforms to be processed and amount of overlap between consecutive groups
    - assess the problem of potential discontinuities between batches (applying the process on batches of 21 moving 1 waveform at a time)