Technical Achievements and Data from the COASTALT Project

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COASTALT

www.coastalt.eu

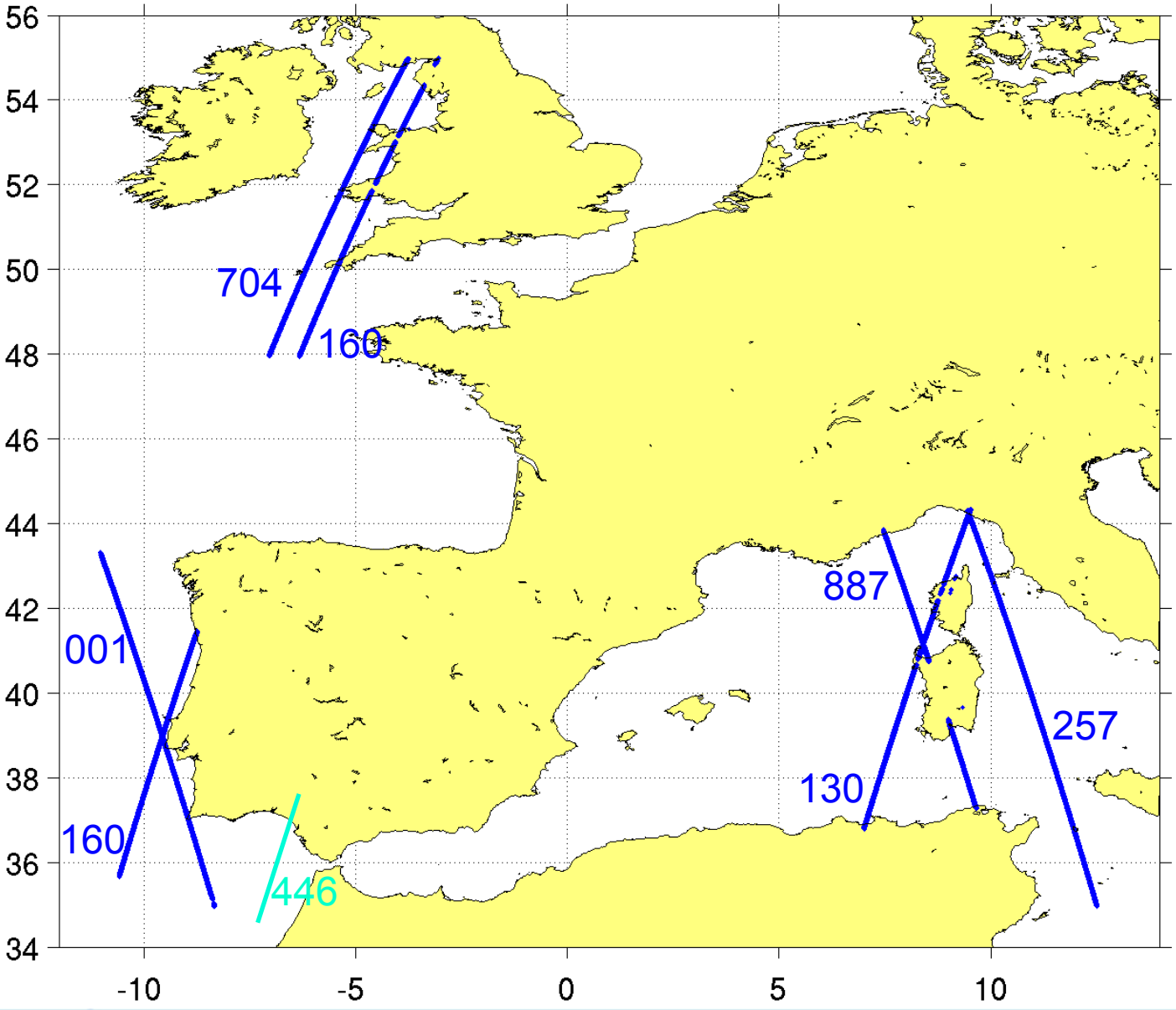
The COASTALT Team

- Phase 2 (2010-2011)
  - **NOC Southampton**: P. Cipollini (project manager), V. Byfield, P. Challenor, S. Gleason, C. Gommenginger, G. Quartly, H. Snaith, M. Tsimplis. L. J. West
  - **NOC Liverpool**: P. Woodworth, J. Wolf
  - **CNR Pisa**: S. Vignudelli, A. Scozzari
  - **Univ. Cadiz**: J Gomez-Enri
  - **Starlab Barcelona**: C. Martin-Puig, M. Caparrini, L. Moreno
  - **Univ. Porto**: J. Fernandes, L. Bastos, C. Lázaro, A. Nunes. N. Pires, M. Bos (CIIMAR), I. Araujo (CIIMAR)
  - **Univ. Lisbon**: S. Barbosa
- In Phase 1 (2008-09): Hidromod (H. Coelho)
- **ESA Support Team**: J. Benveniste (scientific officer), S. Dinardo, B. M. Lucas

COASTALT - objectives

- **definition, specification and prototyping** of a new pulse-limited radar altimetry coastal zone **product**.
- In COASTALT this has been done for a small number of track over **three study regions**:
  - NW Mediterranean (incl Corsica Channel)
  - West Britain
  - West Iberian Coast (and Gulf of Cadiz)
- This new product will hopefully be **the seed for future routine reprocessing** of coastal altimetry data by ESA
  - including the reprocessing **of whole ESA Radar Altimetry archive** (ERS-1, ERS-2, ENVISAT)
  - exploitation of **CryoSat** and **Sentinel**-3 over the coastal zone
  - the R&D is already moving on within the **eSurge Project**

COASTALT pilot tracks



A selection of COASTALT results

User requirements

- Joint PISTACH/COASTALT Survey in 2008
- **Modelling community** is an important user community
- **Wind and Waves** matter to a good share of the users in addition to SSH
- Some scope for **near-real-time** or even **real-time** delivery of coastal altimetry
- Need clear quality **flags** together with **all the separate corrections**
- Need good documentation → doing **NetCDF product specification** and **user handbook** (see later)

- results all available via COASTALT web www.coastalt.eu

Corrections: the way forward

- **Wet Tropospheric correction**:
  - **DLM (Dynamically Linked Model) approach**: Use models to extend radiometer observations → implemented in COASTALT processor
  - **GPD (GNSS-derived Path Delay)** - dry and wet tropo from GNSS (GPS/Galileo) measurements (Univ. Porto) → computed and available in COASTALT pilot data

→ Talk by J. Fernandes in session 7

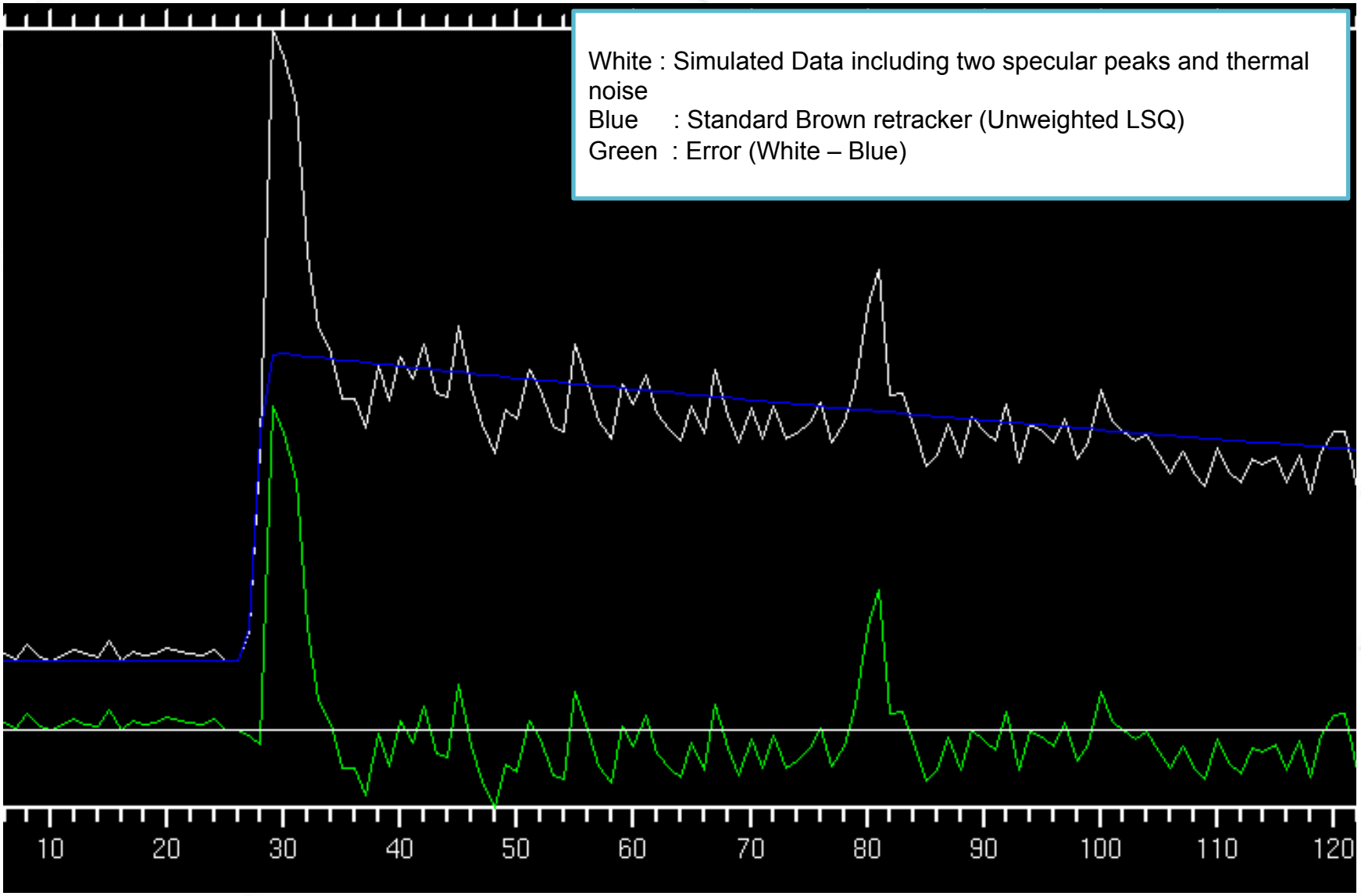
Fernandes et al., IEEE GRSL 2010

  - **GPD recommended by the ESA Sea Level CCI Consortium as Wet Tropospheric correction of choice in the coastal zone**
  - **GPD included in V2.0r3 COASTALT products**
- **Tides**
  - Investigated and used local models (UPorto/CIIMAR, WITM local tidal model for W Iberian shelf)

The COASTALT Processor

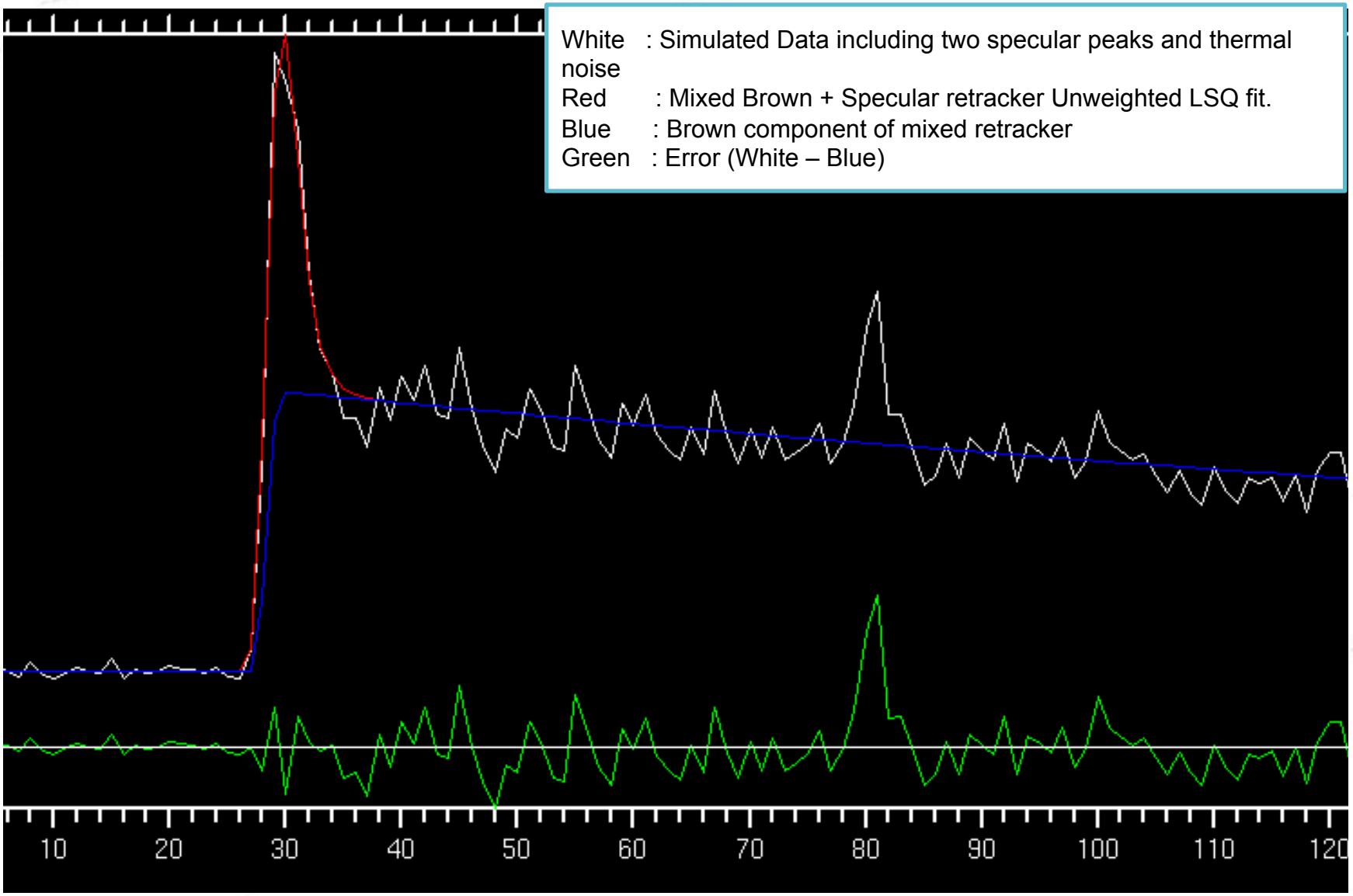
- Core deliverable and legacy of the Project
  - Flexible, user-configurable and modular software
- Baseline processor
  - Reads ENVISAT L2 SGDR files
  - Retracks all waveforms with different models
    - **Brown, Specular and Mixed,** plus innovative retrackers (see later)
  - Generates corrections at 18Hz
  - Generates **Coastal Geophysical Data Records (CGDRs)** output files in NetCDF
- User-defined Geophysical Corrections module ("addcorr")
  - Allows addition of any user-generated corrections
  - used to include GPD correction in CGDRs

Standard Brown Retracker



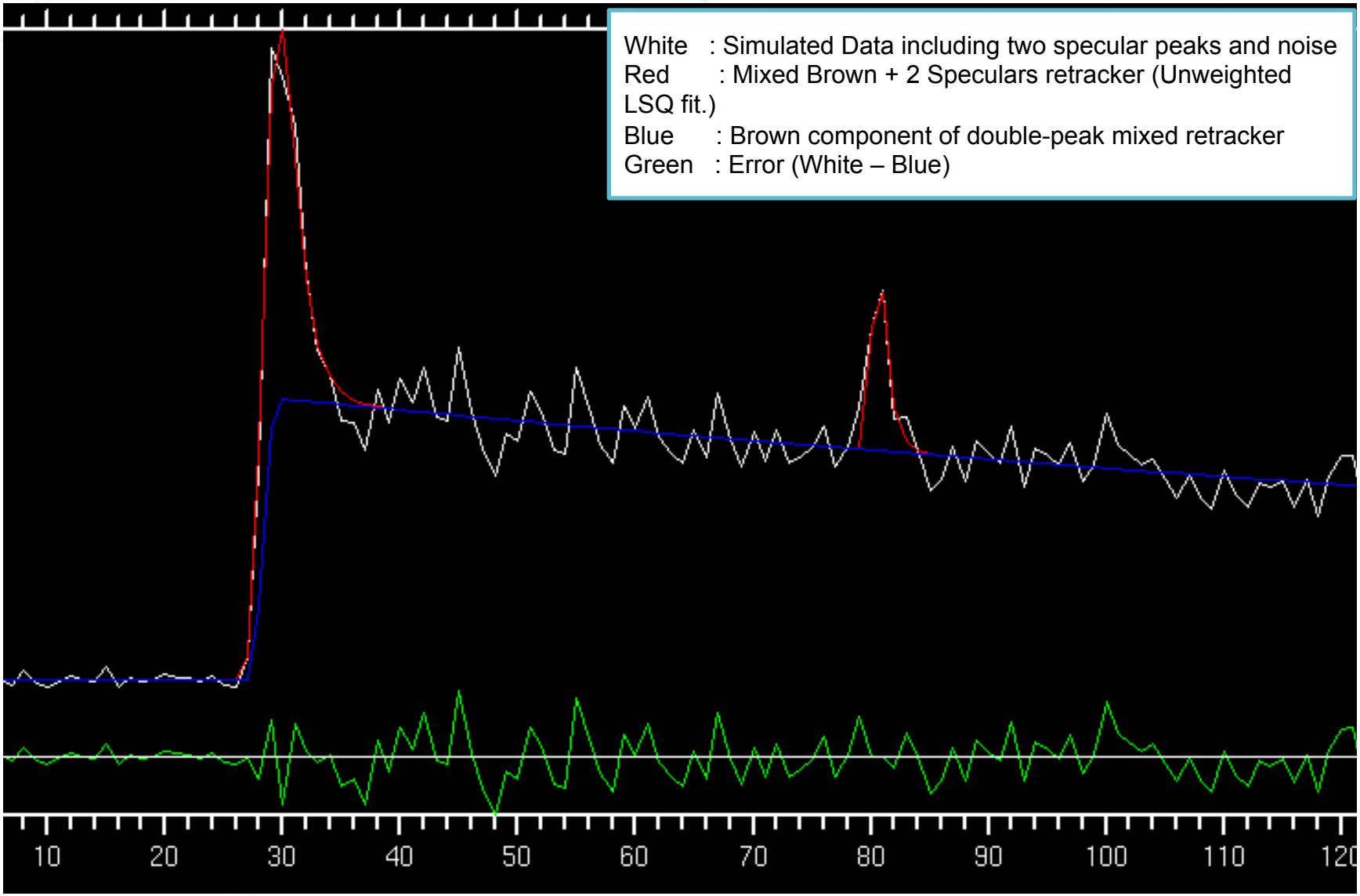
Brown range bin number: **27.66**

Brown + Specular Mixed Retracker



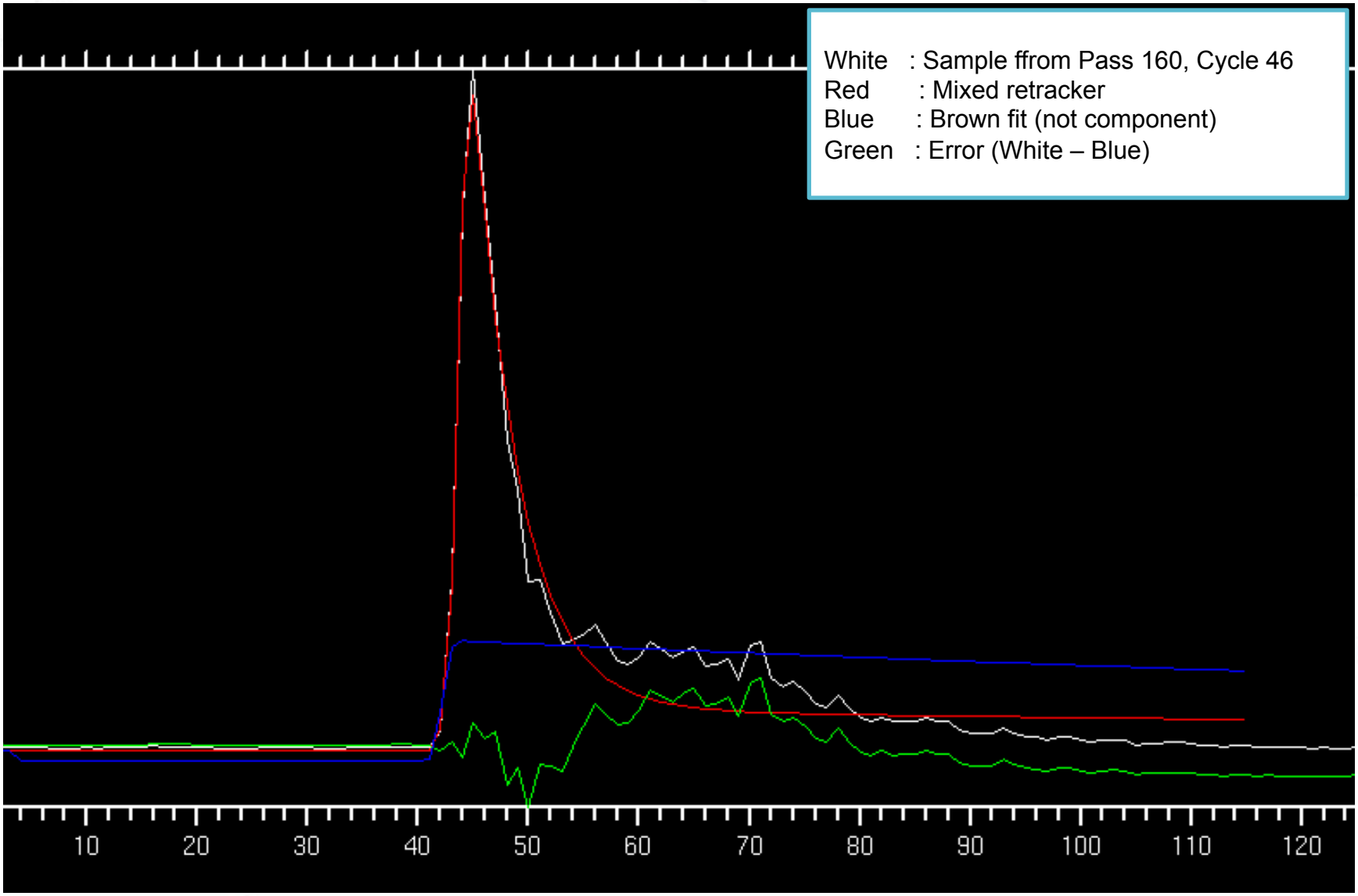
Brown range bin number: **28.36**

Brown + 2 Speculars Mixed Retracker



Brown range bin number: **28.35**

Mixed Retracker Pass 160 Cycle 46 Sample



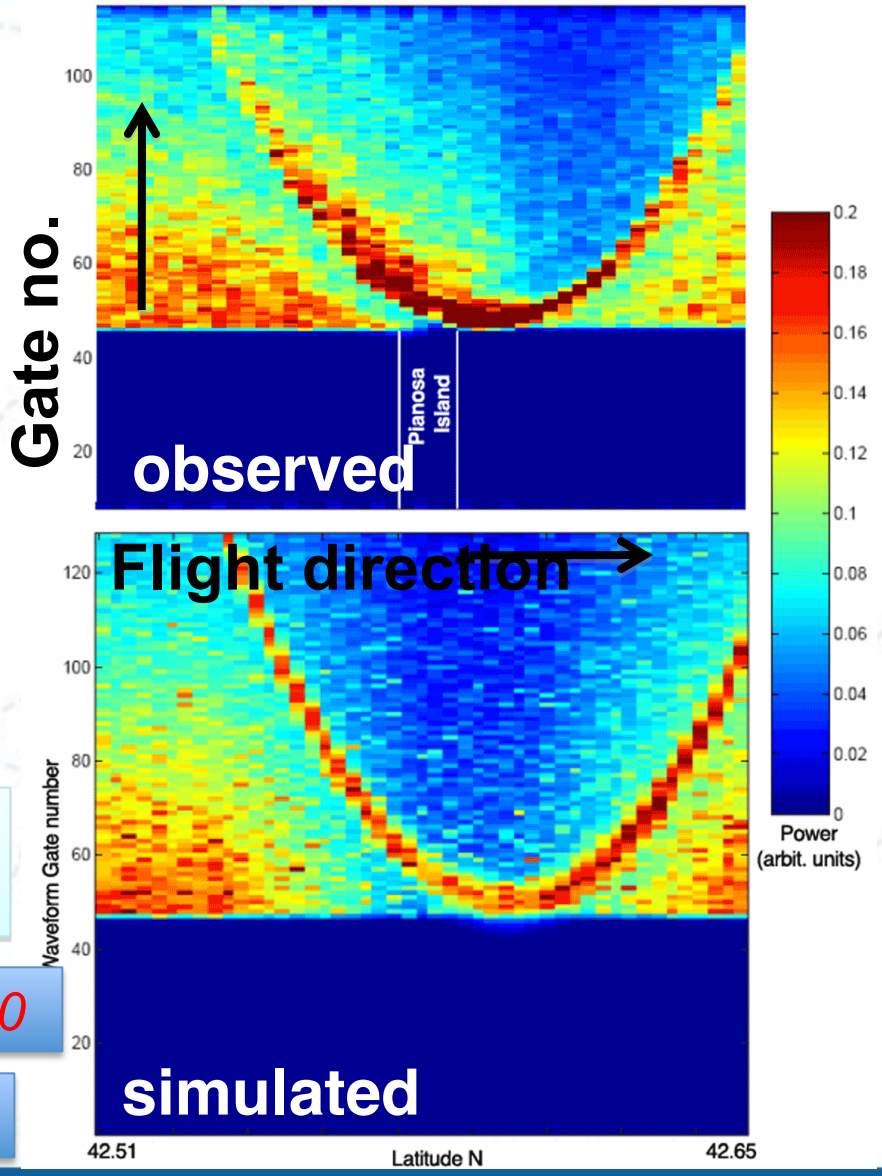
Retracking – crucial!

- The COASTALT processor is a useful tool for further research and development work on retracking techniques and corrections;
- We learnt that retracking in the coastal zone is hard work – needing a lot of effort for the optimization of the retrackers
  - specialized (mixed, specular) retrackers are noisy and need further improvements
  - work is continuing within follow-on projects, like **eSurge**

Retracking – Coastal waveforms

- Study of waveforms in coastal zone and island passes
- We observed **effects of land** and **effects of calm waters** in the coastal strip
  - Land normally gives 'dark' features (less signal)
  - Calm water cause quasi-specular reflections → bright features or **"bright targets"**
  - These features migrate in the waveform/gatenumber space following hyperbolae (a parabolic shape is usually a good approximation)
- Features are reproduced by a simple model of the land/ocean/calm waters response
  - The idea is that this should allow removal of the land/calm waters contamination prior to retracking

Example – Pianosa Island



In cycle 49, bright target due to wave sheltering in NW bay (Golfo della Botte)

J. Gómez-Enri et al., IEEE GRSL 2010

→ see also poster by Scozzari et al

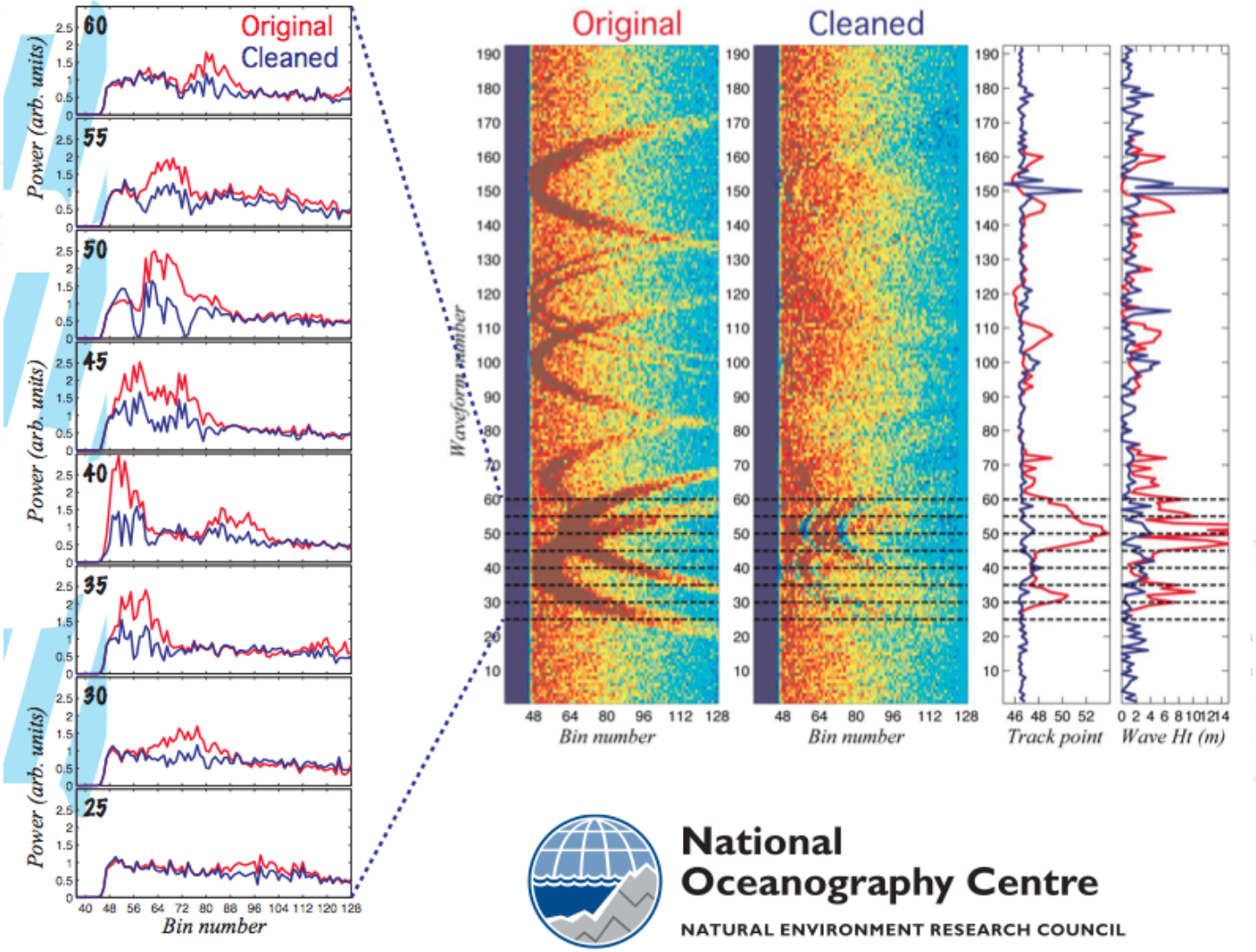
Innovative retrackers

- Innovative retrackers: retrack each waveform not in isolation but using info from adjacent ones
- Two different approaches
- The **hyperbolic retracker** to fit and remove bright/dark targets is an example → poster by Quartly
- Another example is the **Bayes Linear retracker**
  - Based on the application of Bayesian methods
  - The idea is to treat the posterior from one waveform as the prior for the next.

→ poster by Challenor

- Both these have been designed within COASTALT and prototyped

Hyperbolic retracker example



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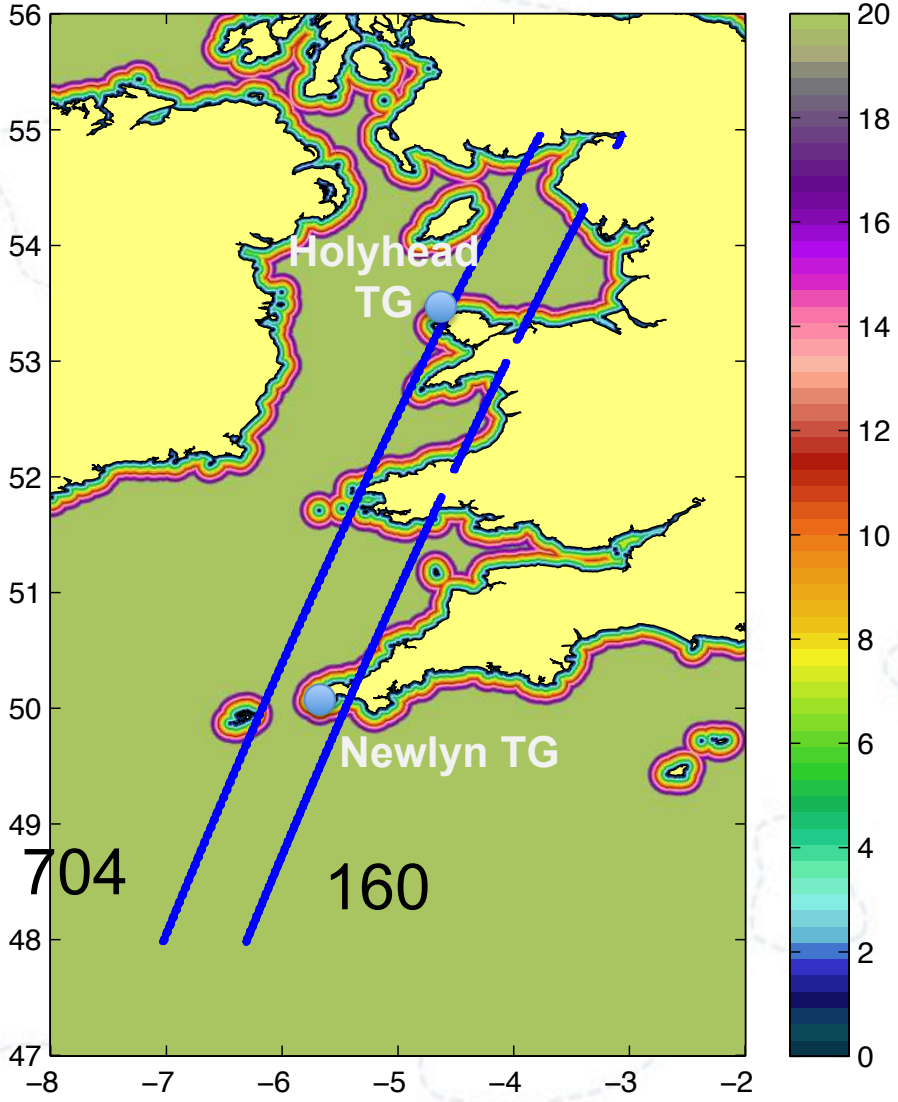
a look at the CGDRs

- The Coastal processor produces Coastal Geophysical Data Records – CGDRs – over pilot tracks
  - contains output of all retrackers (h, swh, sigma0) and full range of corrections
  - **v2.0r3 (latest) freely available from web site - www.coastalt.eu**
- Fully Documented:
  - Product Specification document
  - Product User handbook
- Validation so far has focused mainly on traditional (Brown) retrackers and GPD correction
- Example results
  - Alt heights w.r.t. Tide Gauges over west of Britain
  - Significant Wave Height over Gulf of Cadiz

→ talk by J. Gomez-Enri

West of Britain passes

Passes 160 and 704 and Distance from coastline (km)

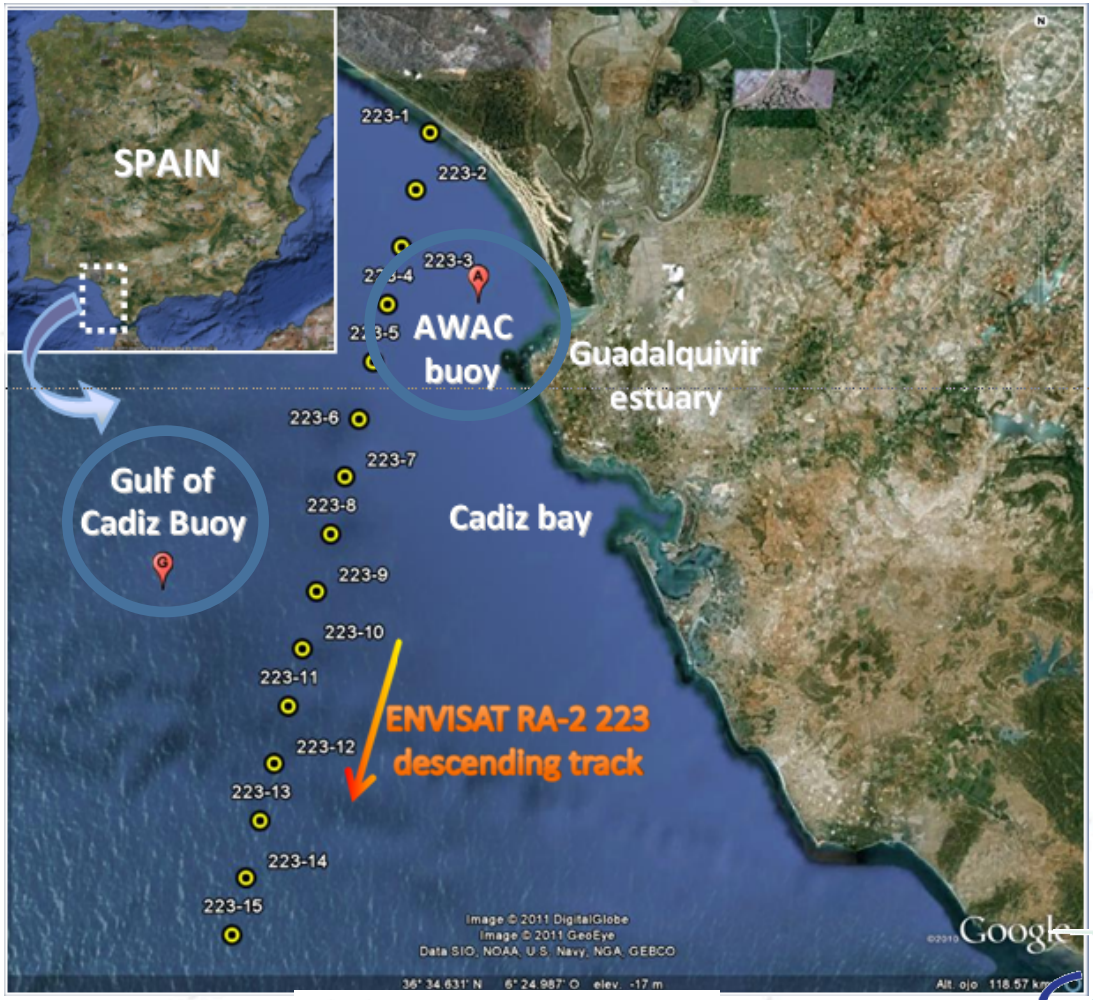


Comparisons to Tide Gauges

- Pass 160 compared to Newlyn and Pass 704 to Holyhead
- In this case only load tide correction (and no ocean tide or IB) correction applied to the altimetry
- Pass 160/Newlyn with Selection A has rms of **6.8 cm from 49 passes**
- Use of DORIS for iono reduces this to **3.7 cm**
- Use of DORIS + GPD for Wet tropo reduces **further to 3.2 cm**.

Validation of hi-rate SWH

STUDY AREA: THE GULF OF CADIZ



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Conclusions

- Significant international efforts underway to "*make satellite altimetry sailing closer to the coast*"
  - should have significant impact on numerous applications
- **ESA COASTALT: Flexible software processor, Innovation in corrections and retracking, well-documented NetCDF products (over a few example tracks), scientific output (papers)**
- **COASTALT has been an incubator of ideas, now developed in follow-on projects**
- **…and a catalyst of our Coastal Altimetry community!**

www.coastalt.eu