Coastal Altimetry for Storm Surge Forecasting in the eSurge Project

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Storm Surges

- amongst the deadliest natural phenomena
- need to **understand** & **model** → can prepare and mitigate impact
- potentially enormous societal benefits!!
  - especially to some of the world's poorest countries

Storm Surges and Earth Observation

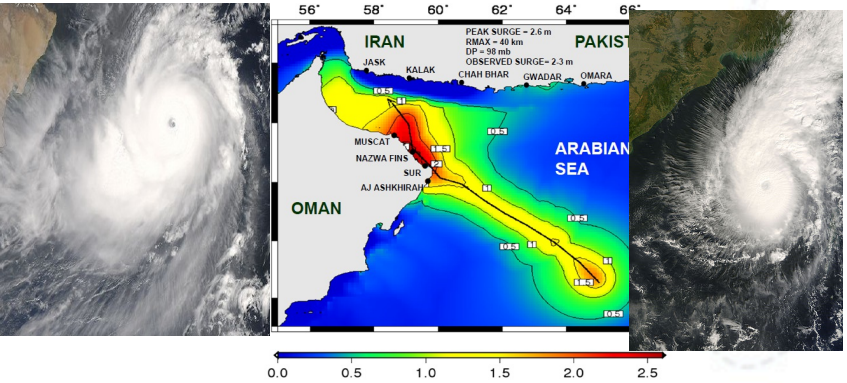
- Earth Observation data have a very important role to play
  - well beyond the simple ‘tracking’ of storms
  - winds, waves, sea level can aid the interpretation of the events, improve their modelling, and, when assimiliated, improve the forecasts!
- BUT uptake of EO data by users (Environment Agencies, tidal prediction centres, etc) has been slow (except for wind perhaps) and must be encouraged
  - we need demonstration studies to show the ‘added value’
  - we need to provide easy access to data

ESA and eSurge

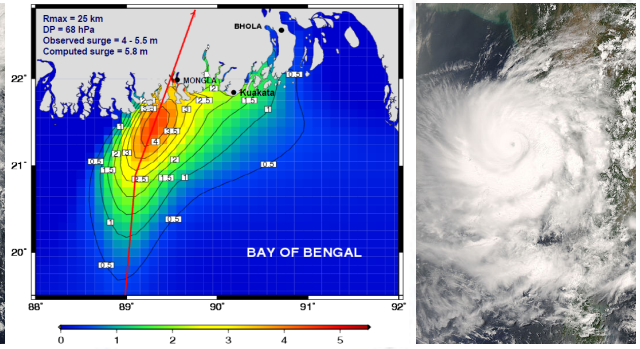
- ESA has recognized the above needs
- DUE (Data User Element) Project for 2011-2013: **eSurge**
  - DUE runs user-driven projects to transfer research to applications
- **eSurge Objectives:**
- *To contribute through Earth Observation to an **integrated approach to storm surge, wave, sea-level and flood forecasting** as part of a wider optimal strategy for building an improved forecast and warning capability for coastal inundation.*
- ***To increase the use of the advanced capabilities of ESA and other satellite data for Storm Surge applications***

The Storm Surge User Consultation Meeting, Venice, 2009

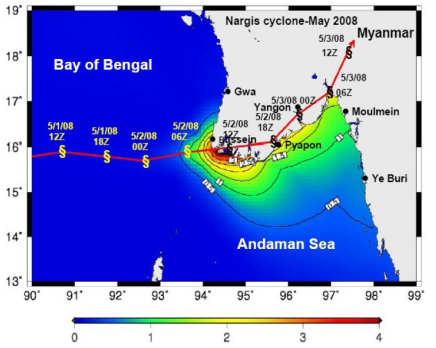
- The purpose of the User Consultation Meeting, supported by IOC and WMO, was to bring users and experts together to:
  - **define the detailed set of user requirements for the project, priority EO information, Services and Areas Of Interest.**
- A set of templates were used to collect feedback on what Users need from the Storm Surge project
- A number of **Champion Users** agreed to help guide the project, review the project outcomes and, advise ESA during the project



•Peak Surge Envelope
•Gonu 2007



•Peak Surge Envelope
•Sidr 2007

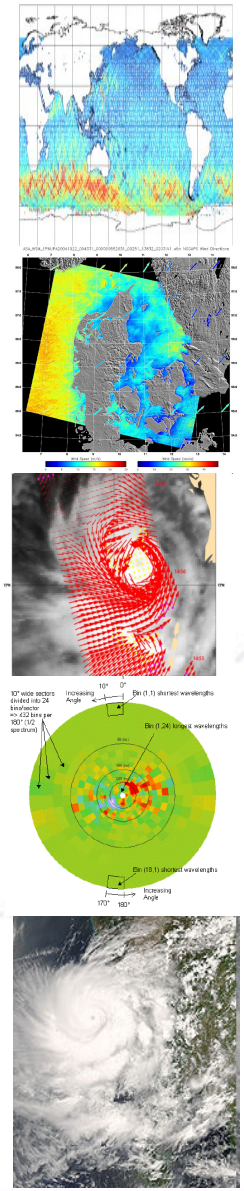


•Peak Surge Envelope
•Nargis 2008

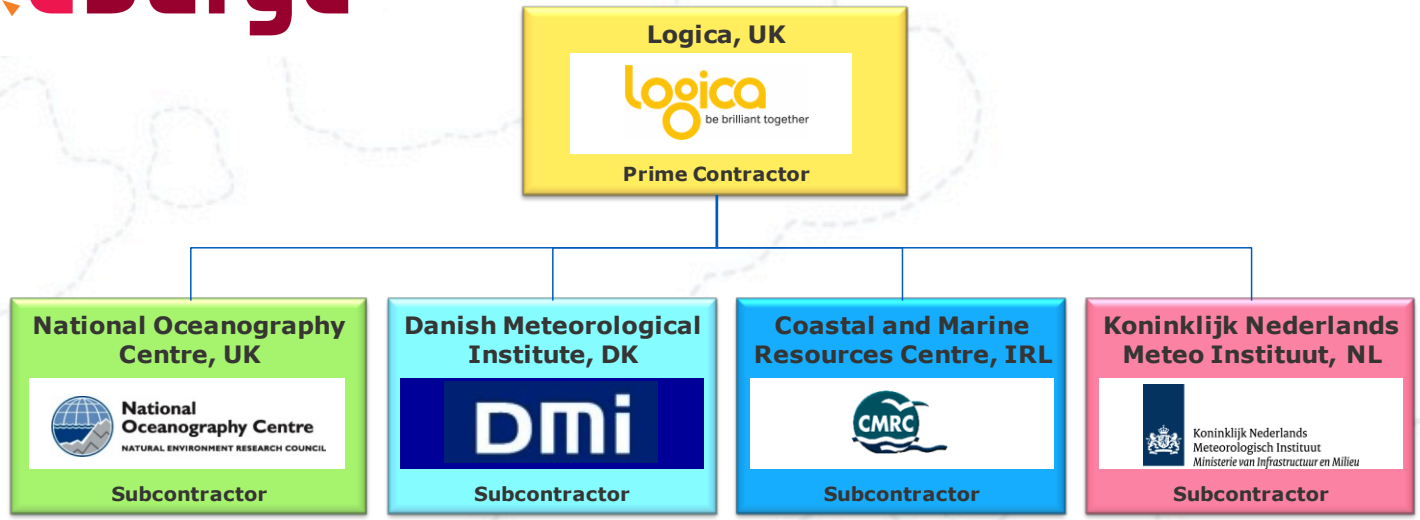
(Figures from S. K Dube)

Key User Requirements

- To develop, validate and provide dedicated **coastal altimeter products**.
- To develop, validate and, provide dedicated **coastal products derived from SAR, passive microwave and optical satellite products**.
- To provide and maintain an extensive **historical archive data products derived from satellite, in situ, model systems** and socio-economic data for the purpose of improved storm surge modelling and re-analysis.
- To provide a **near real time service of specific satellite products** in support of storm surge forecasting and warning services.
- To encourage and assist (training, documentation, tools, services) the storm surge community to **fully exploit the potential of satellite data for storm surge applications**.
- To **increase user uptake of coastal altimeter and other satellite data products by demonstrating their value in storm surge applications.**

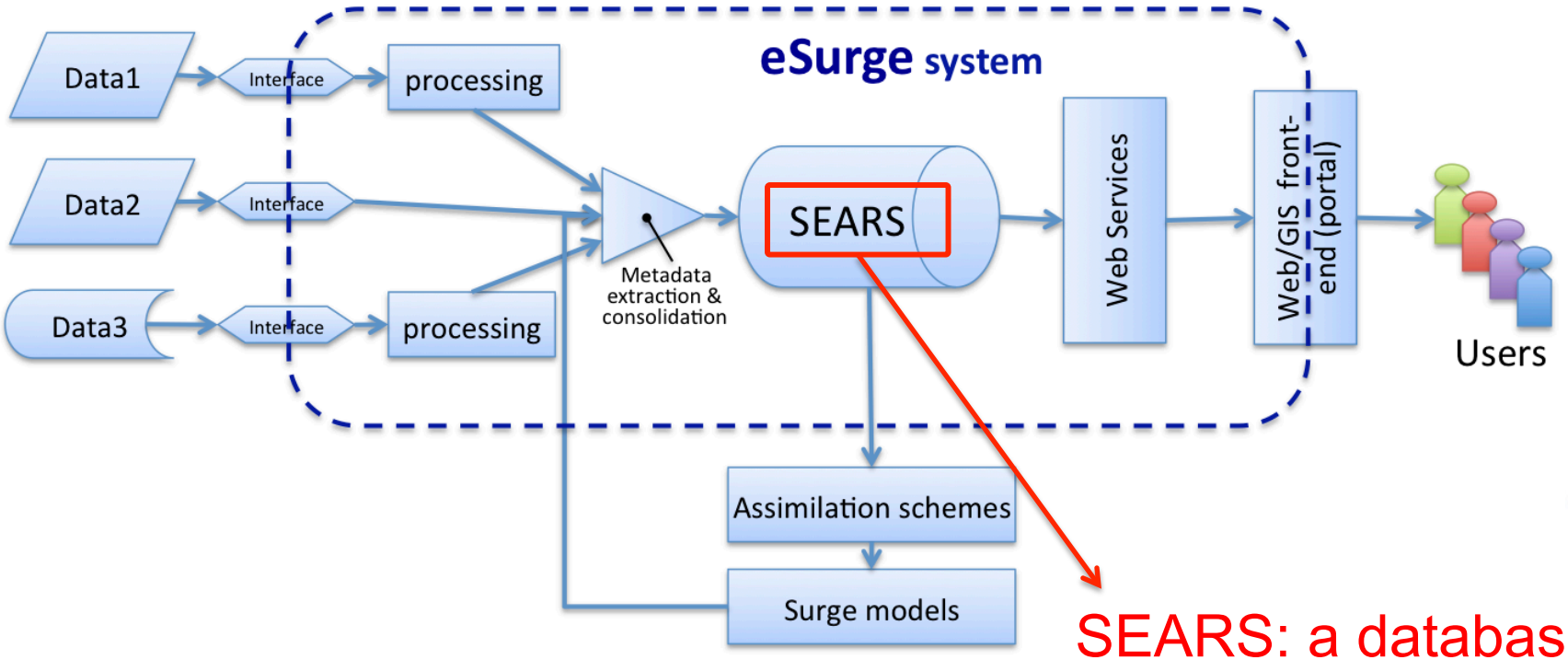


The eSurge consortium



- Then there is "**eSurge Venice**": a parallel project on surges in Northern Adriatic – key area for this kind of application - led by Italian CNR

The eSurge System

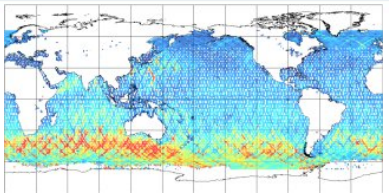
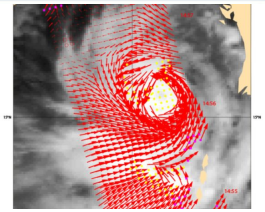
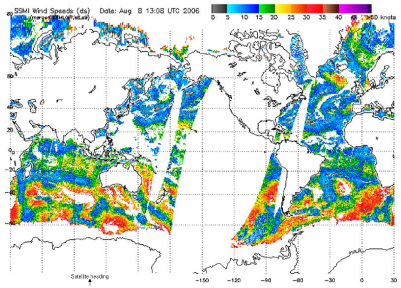
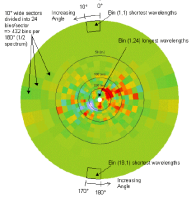


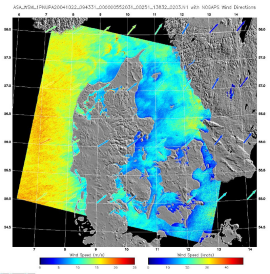
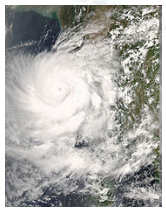
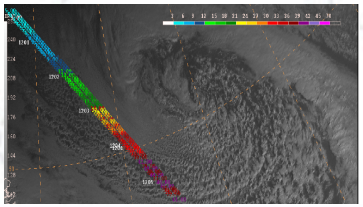
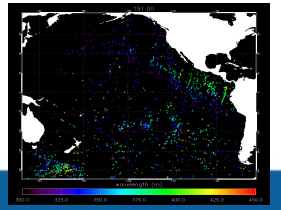
SEARS: a database of surge events

We aim to prove that by assimilating EO data our hindcasts improve!

Example eSurge Input Data

- Altimeter (ERS, Envisat, Geosat, TOPEX, JASON, CryoSat)
- Passive Microwave (SSM/I, AMSRE, TMI, WindSat)
- Scatterometer (ERS, QuickScat, ASCAT, NSCAT, OceanSat-2)
- SAR (ERS, ENVISAT, RADARSAT, COSMOSkyMed, TerraSAR-X, RISAT…)
- Optical/IR data (MERIS, MODIS, AATSR, AVHRR, geostationary satellites)
- NWP and NOP model outputs
- Storm Surge model output and forcing
- Flood maps
- In situ (Tide Gauges)

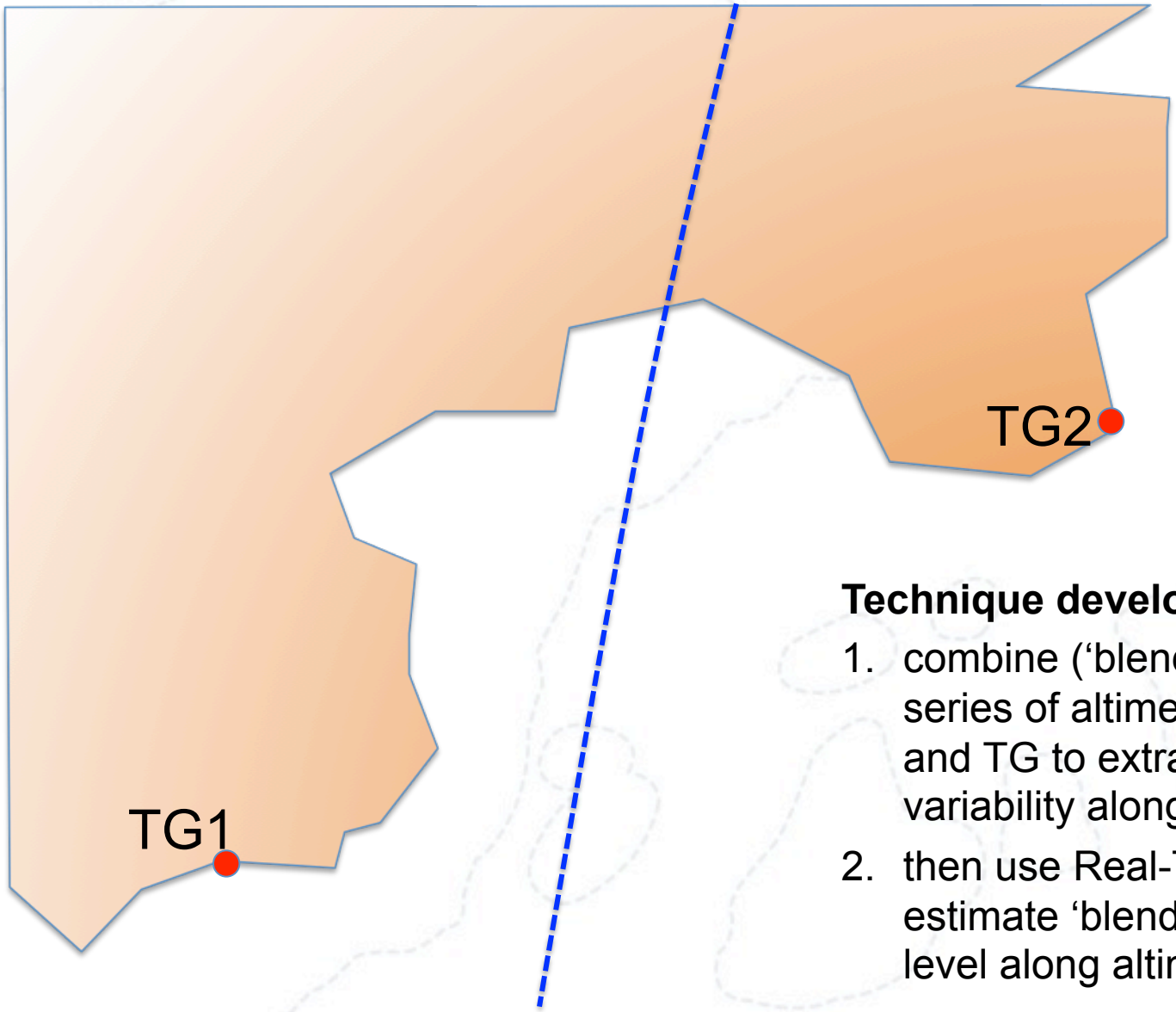





The role of coastal altimetry

- A very important component of eSurge will be the development, validation and provision of **dedicated coastal altimetry products**
- Coastal altimetry is important as it measures the **Total Water Level Envelope (TWLE)**
  - That's the level you get – inclusive of tide, HF atmospheric effects, wave setup, etc…
  - key quantity required by storm surge applications and services
- The wave field in the coastal strip is also relevant
  - helps development of more realistic wave models

- Of course there is a sampling issue – but altimetry is still useful, in combination with Tide Gauges, to ascertain the modes of variability of the coastal ocean – see next slide

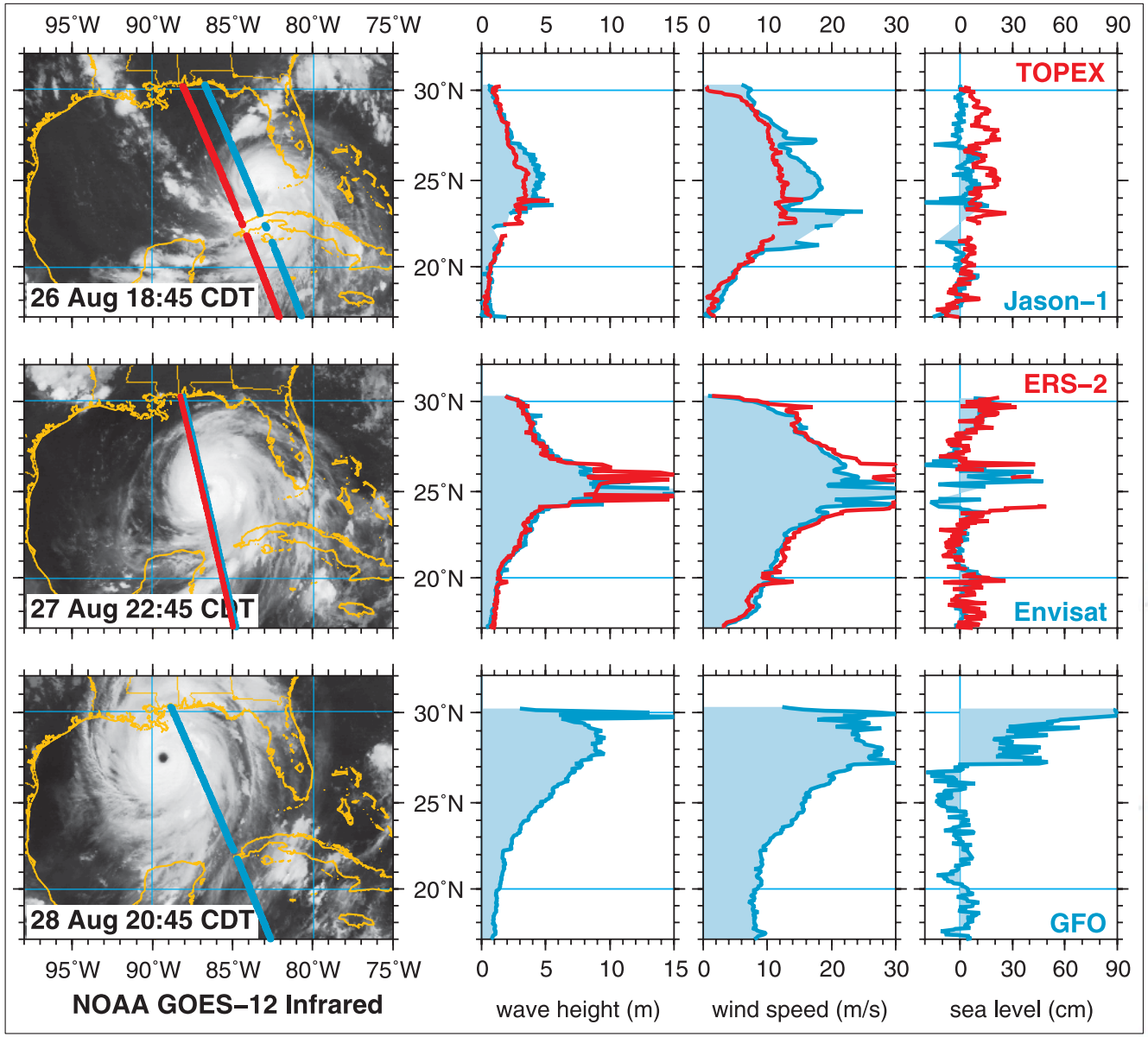
Blending Altimetry with Tide Gauges



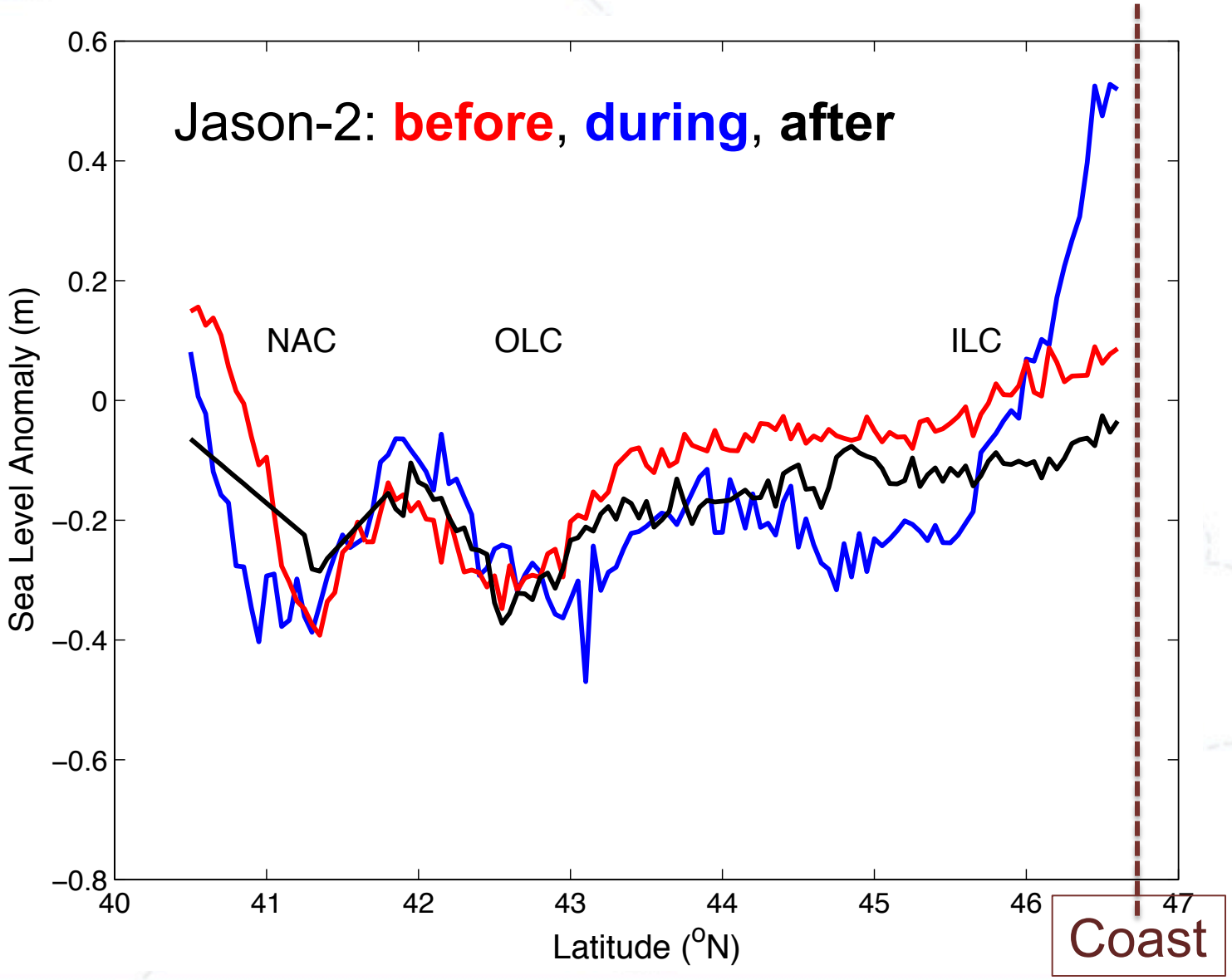
Technique developed by DMI

1. combine (‘blend’) long time series of altimeter(delayed) and TG to extract modes of variability along altimeter track
2. then use Real-Time TG data to estimate ‘blended’ Real-Time level along altimeter track

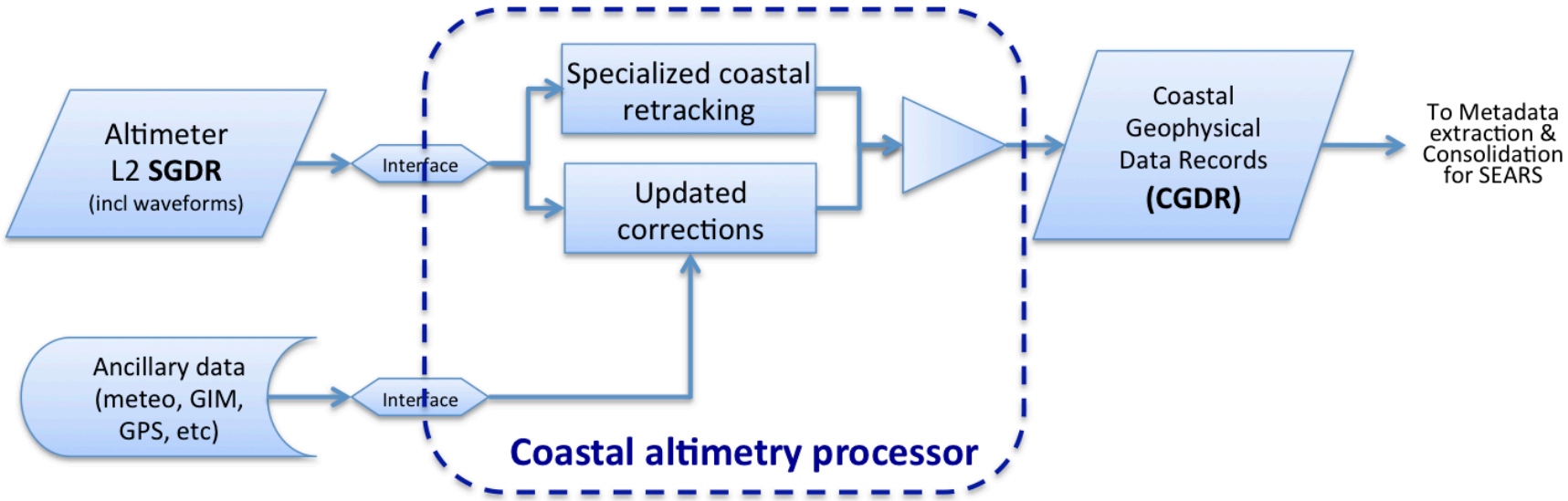
Scharroo et al 2005



Han 2011 – Hurricane Igor



The coastal altimetry processor for eSurge -1



The coastal altimetry processor for eSurge -2

- Evolution of the prototype COASTALT Envisat processor → Talk tomorrow
- Brown, Mixed, specular retrackers
- will be extended to ERS-1/ERS-2, Jason-1/2
- will work also on Cryosat-2 so we will plug in a SAR altimetry retracker (from the SAMOSA Project) → Talk by C. Gommenginger at OSTST

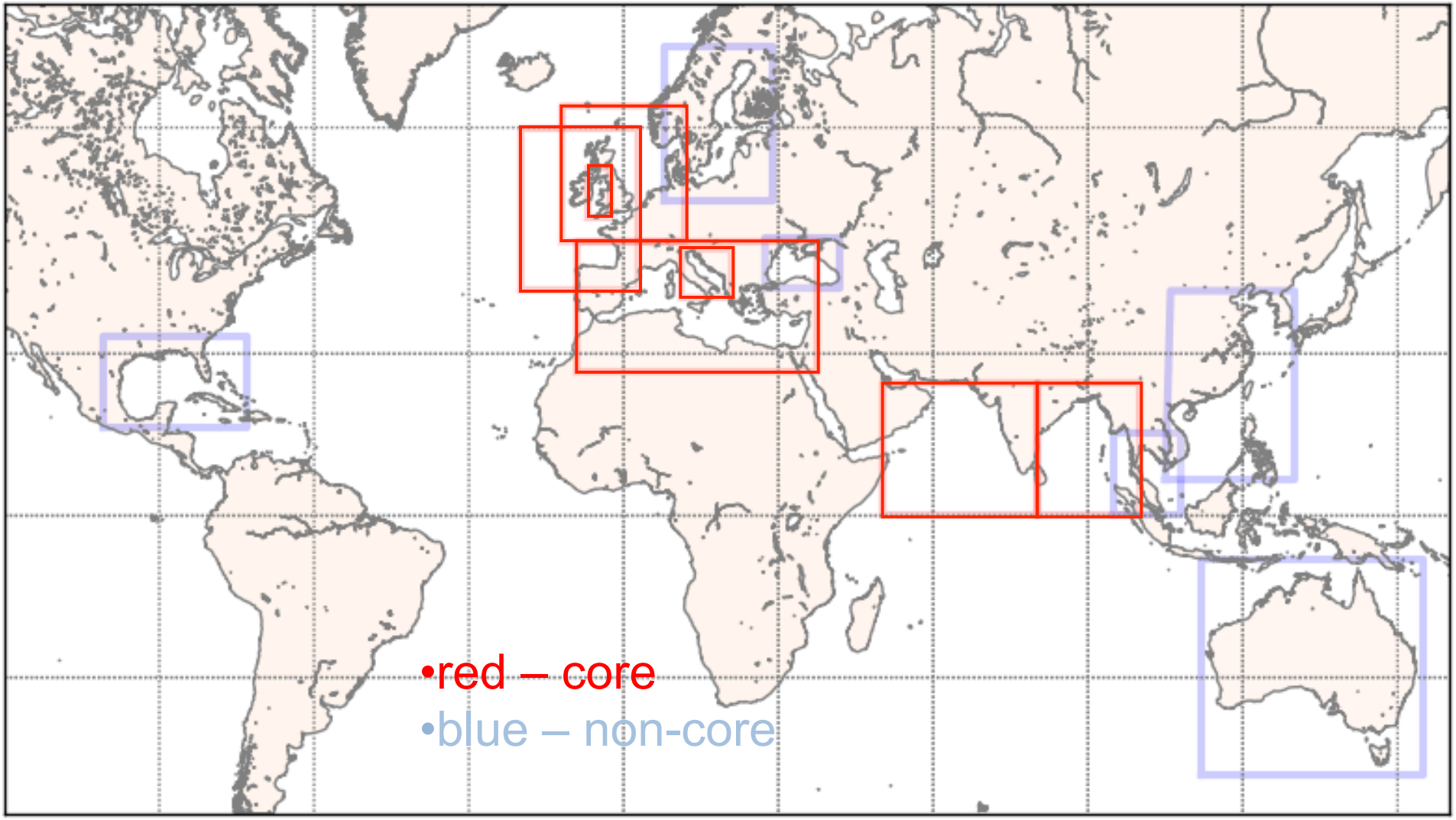
- … and all this expected to be up and running in early 2012!

…and we will venture in NRT territory!

- In a later phase of the project (mid-2012 onwards) the eSurge coastal altimetry processor will be extended to be able to ingest NRT raw altimetric waveforms
  - like FDMAR streams from ESA
- (we need ESA, NASA and CNES to make sure we have access to the NRT waveforms)
- this is part of the ‘eSurge-Live’ effort for the provision of NRT data to users during storm surge events

- **definitely uncharted waters for coastal altimetry!!!**

eSurge Areas of Interest



More can be added later depending on user request!

Summary

- eSurge: a timely initiative with a very ambitious aim:
  - *To support storm surge systems, their services, engineers and scientists by facilitating the widespread user uptake and application of advanced information products from ESA and other Earth Observation missions.*
- eSurge constitutes a golden opportunity for us coastal altimetrists:
  - processor extension to cope with all missions
  - make products pre-operational
  - exploit synergy of altimetry and other EO/in situ data, plus models
  - move to NRT
- In summary: **a great application of coastal altimetry**

eSurge website: **www.storm-surge.info**