Radar Altimeter Datasets for Coastal Applications

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Coastal Altimeter Workshop
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Altimeter Datasets

• Geophysical Data Records (GDRs)
  – Name GDR was inherited from the Seasat mission
  – Generally meant as *archival ocean product*
  – Provided on CD, DVD or FTP by the satellite mission project (NASA/PO.DAAC, CNES/AVISO, IFREMER, NOAA)

• Along-track Sea Level Anomaly Products
  – AVISO has produced on CDs (now FTP) *Sea Level Anomaly* data sets for TOPEX, ERS, Envisat and Jason-1
  – Attempt to provide easy access to altimeter data for ocean apps

• Gridded Datasets
  – Meso-scale and ocean-currents (research and commerce)

• On-line Altimeter Databases
  – RADS, ADS, CADS, ACCESS07
  – On-line web interface or off-line mirrored database
  – Continuously or regularly updated
Geophysical Data Records (GDRs)

- **Altimeter data and corrections**
  - Altimeter range, significant wave height, backscatter coefficient
  - 1-Hz (mean and standard deviation) and individual 10/20-Hz
  - Orbital altitude
  - Propagation delay corrections (dry, wet, iono)
  - Ocean interface corrections (sea state bias)
  - Geodetic corrections (tides, mean sea surface, inverse barometer)

- **Format**
  - Mission-specific, some awkward and ill-designed
  - Requires specialist knowledge to decipher
  - Often resistant to expansion (no/few spares)

- **Content and use**
  - Determined years prior to launch, reluctance to update
  - No consistency between missions
  - Aimed at ocean applications (but can be tweaked for coastal)
Along-track Sea Level Anomalies (SLA)

- **Examples**
  - AVISO/DUACS multi- and mono-mission SLA products

- **Altimeter data and corrections**
  - Only sea level anomalies (no corrections)
  - Interpolated to 1-Hz nodes
  - All corrections applied, no option to pick and choose

- **Format**
  - Small, easy to use, non-expert user with need for along-track data
  - FTP, NetCDF (therefore expandable)
  - Google Earth

- **Content and use**
  - Consistency between missions attempted
  - Updates made occasionally
  - Regional products for N-E Atlantic and Gulf of Mexico
  - Ocean variability, operational oceanography

CLS is working on a coastal product for Jason-2: PISTACH
Coastal Altimetry Workshop

Silver Spring 5-7 February 2008
PISTACH PRODUCTS

PISTACH, a CNES initiative: see presentation by Nicolas PICOT

Objectives:
• Definition of Level-2 altimetry products dedicated to coastal zones (and continental hydrology)
• implementation of a prototype (must be ready for Jason-2 launch) that integrates new algorithms
• generation of the products (I)GDR during 1 year, first products to be delivered in october 2008, before the OSTST.

Improvements (wrt Jason-2 regular products)
• Local models of tides, DAC, …
• Retracking (see slides of Pierre THIBAUT)
• Wet tropo (see slides of Estelle OBLIGIS and Franck MERCIER)
• SSB (see slides of Sylvie LABROUE)
PISTACH PRODUCTS

Format and structure:
• NetCDF, same as Jason-2 regular products
• probably 20Hz sampling instead of 1Hz
• New fields added to the product.
• → evolution of the regular products

Coverage
• Distance to shoreline < 200 km
• Distance to shoreline < 400 km
  and bathy > -5000m
• Continental shelves
• Specific basins (Med sea, Gulf of Mexico, …)

Dissemination
Via AVISO
Gridded Sea Level Anomalies (MSLA)

- **Examples**
  - AVISO/DUACS multi- and mono-mission MSLA products

- **Altimeter data and corrections**
  - Only sea level anomalies (no corrections)
  - Gridded to 1°x1° or 1/3°x1/3° resolution
  - All corrections applied, no option to pick and choose

- **Format**
  - Small, easy to use, particularly for those familiar with gridded data
  - FTP, NetCDF
  - Google Earth

- **Content and use**
  - Several missions combined
  - Updates made occasionally
  - Ocean variability, operational oceanography
On-line Databases

- RADS - Radar Altimeter Database System (Delft/NOAA)
- ADS - Altimeter Data System (GFZ Potsdam)
- CADS - Canadian Altimetry Database and Processing Centre (Univ. Calgary) - Under construction
- ACCESS07 - Web based altimeter service (NASA) - Proposed

• Altimeter data and corrections
  - Everything that’s on the GDR (current at 1-Hz)
  - More and up-to-date models (tides, propagation corrections)
  - Numerous bugs and anomalies fixed
  - Data calibrated

• Format
  - Proprietary expandable format (now being replaced by NetCDF)
  - FTP, rsync

• Content and use
  - All missions; Updates made regularly
  - Seeks widest possible use (oceanography, coastal, GSLR)
Web-Based Altimeter Service

ACCESS07 Proposal

Phil Callahan, PI
Brian Wilson, Rob Raskin

January 31, 2008
Web-Based Altimeter Service Overview

• Provide system to allow users to access and combine various parts of altimeter GDRs on demand.
  – Projects generate fundamental data record from telemetry with time, orbit, instrument information and basic corrections
  – Producers of other “components” of the altimeter record (see list next page) register products with Altimeter Service
    • Components can be data or data+operator(s)
    • Producers need to provide some documentation to guide use

• User interaction
  – Login (possible advanced functions: save profile, interests)
  – Select time period, region for product(s)
  – Select components
  – Select delivery method
  – Visualize selected results
Main Altimeter Data Components

- Location kernel: time, latitude, longitude
- Instrument measurements: fully corrected range, significant wave height (SWH), backscatter coefficient (sigma0)
- Instrument-based environmental corrections: radiometer wet troposphere, dual frequency ionosphere
- Flags, particularly on data quality and usability
- Parameters that are likely to be replaced by various investigators over time or for specific purposes from the baseline GDR:
  - Precision Orbit altitude (every frame, or approximately every second)
  - Elastic ocean tide
  - Mean Sea Surface or Geoid (reference surface)
  - Dry troposphere correction
  - Inverse barometer/barotropic correction
  - Electromagnetic/Sea State Bias correction
  - Pole Tide
- Detailed and ancillary data that are not needed for most investigations.
Some Usage Scenarios

- **Basic altimeter data records**: Project produces initial IGDR; all subsequent updates done with service – add POD, improved atmospheric models (observed replaces predict), any other improvements available on ~1 month time scale
- **Model improvements/updates**: Particularly revised orbits, improved tides, radiometer calibrations, barotropic corrections, geoid, mean sea surface
- **Regional/coastal products**: Local tide models, radiometer corrections (processed to remove land effects), local barotropic models
  - Special retracking could be linked to original points
- **Storm products**: Time/space subsetting, special tropo models
Implementation Issues

• Modularization of GDR processing
  – Remote callable; separation of processing and data
  – Bandwidth for distributing waveform data; specialize retracking

• Registration of Data Components
  – Generators need to cooperate by providing information to the central server, making data available routinely, continuously

• Registration of Models and Operators
  – Information as for data plus remote callable software
  – Where is processing done?

• Flagging – is there interaction among components that needs to be considered in generating flags?

• Documentation of data and models
  – Usage guidance, caveats
  – Error analysis
what we need from coastal altimeter data...

...and why we don’t get it at the moment
We Need

• All parameters (Height, SWH, wind speed)
• All corrections (instrumental, path delay, tides, geoid)
• Highest spatial resolution => 10/20Hz
• Precise geolocation
How will data be used

• Without assimilation?
  • Unlikely

• Gridded products?
  • Easy to assimilate
  • Can they capture variability?
  • High level pre-assimilated solutions

• Along track
Coastal specific processing

• Waveform tracking for SSH
  • effects of varying topography & geometry
  • stay locked on sea surface

• SWH
  • Change in wave spectra

• Wind Speed
  • change in distribution of scatterers
Corrections

• Instrumental  
  • In theory - the same!

• Tides  
  • High spatial & temporal frequency
  • Surges

• Geoid & Mean Sea Surface  
  • Short wavelengths significant
  • Cross-track separation ≈ along-track
Corrections

• Atmospheric
  • High spatial resolution changes
  • Interpolation of large grid not enough
  • Measured wet trop not yet “fixable”

• Ionospheric
  • Dual frequency -> retrack second waveform
  • Extrapolate to coast -> model may be better
Regional Plug-ins

• Corrections cannot be calculated globally
• Models for “global coast” do not exist
• Use regional plug-in data
  • Tides & high frequency responses
  • Geoid & MSS
  • Atmospheric (profiles & analysis)
RADS

- Probably closest in strategy
- Provides consistent database, including all corrections, in consistent format, for all altimeter missions
- Common meta file format (description of data, scale, offset, and constants)
- Along track ie highest spatial resolution
Advantages

• All parameters - not just Surface Height
• Geophysical corrections and reference frame common to all altimeters
• Selection of correction and quality control criteria at time of selection
  • Preferences controlled by user
• Ultra-flexible file augmentation
GDR data

• Higher level GDR data
  • widely available but don’t fit the bill
• 10/20Hz values only available for SSH (& sometimes SWH)
• No consistency across altimeters
Geosat GM mission

• Data available from NOAA
  • parameters from 4 different retracker results
  • All data and corrections at 10Hz
Web Services

• Make use of protocols to allow access to services.

• Similar to program function calls.

• Client accesses a web service using a recognised call

• web service returns the required information in standard manner
Why Bother?

• Allow access to data or services WITHOUT exposing the host system
  • e.g. allow access to data without needing full userid access

• Allows “simple” machine - machine access
  • eg - access data on remote sites from within matlab code
Example: download with real-time check
(for instance in an environmental crisis, when ‘latest model’ is essential)
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File-based architecture 1: precomputation of corrected params

- 1. SLAs (+ SWH, wind speed) are precomputed offline from raw data + corrections and stored

2. When user asks for data, the OPeNDAP server serves the precomputed SLAs

PROs: simple, no extra client required
CONs: allows only predefined correction schemes
**File-based architecture 2: computation at the user**

- The user runs a specialized client which gets raw data + corrections via the OPeNDAP server and computes the parameter.

**PROs:** trivial to setup on server side

**CONs:** needs separate, non-standard user clients for each application (they can be implemented with a range of software tools sitting on top of the standard OPeNDAP client)
File-based architecture 3: “on the fly” computation

- The request from the user to the OPeNDAP server prompts an interface server that retrieves the raw data and corrections and computes the parameter on the fly.

**PROs:** request is fully customizable  
**CONs:** interface server needs to be implemented and be able to interpret OPeNDAP request - CDAT is a possible candidate.
For Discussion

• What products do we need?
  – Data frequency: 1-Hz, 10/20-Hz, other?
  – Data corrections: Best available, Up-to-date?
  – Data sampling: Along-track, Gridded?
  – Data volume: Global, Regional?
  – Data format: GDR, NetCDF?
  – Data access: DVD, CD, FTP, Web?
  – Data latency: days, weeks, months?

• What service provides this now?