Radar Altimeter Datasets for Coastal Applications

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with contributions from

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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

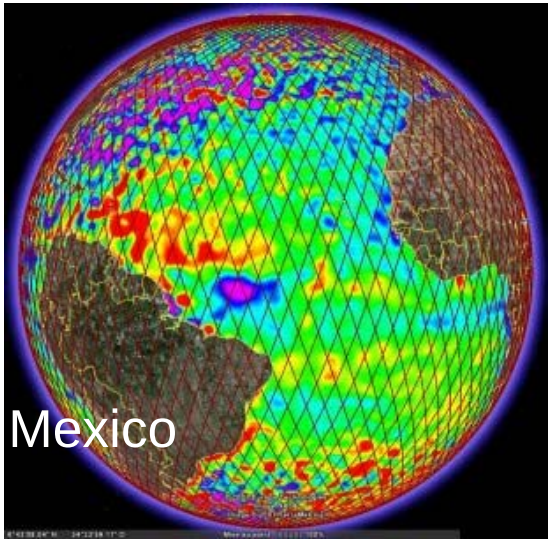
Geophysical Data Records (GDRs)

- 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**



Prototype
Innovant de
Système de
Traitement pour l'
Altimétrie
Côtière et l'
Hydrologie

Coastal Altimetry Workshop

Silver Spring 5-7 february 2008

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CENTRE NATIONAL D'ÉTUDES SPATIALES

CLS
COLLECTE LOCALISATION SATELLITES

LEGOS

IRD
HyBAm

Cemagref
TETIS

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)

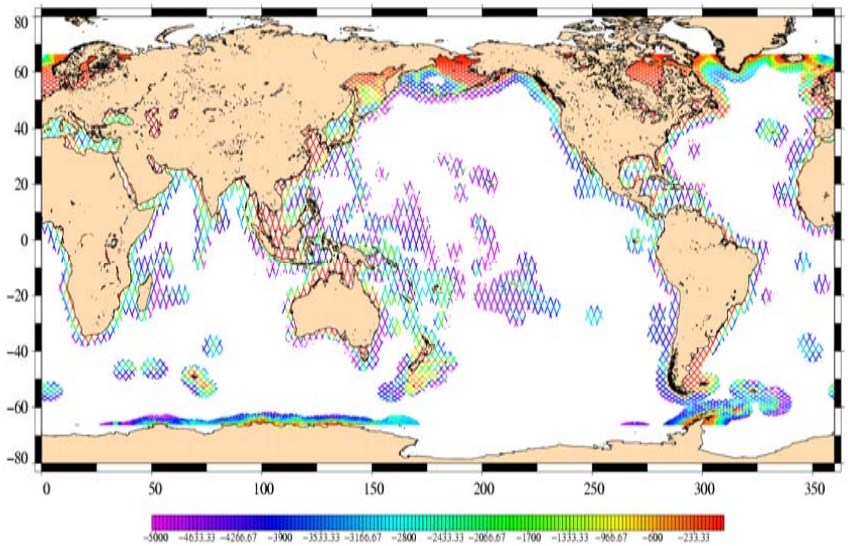
• Wet tropo (see slides of Estelle OBLIGIS and Franck MERCIER)

• 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

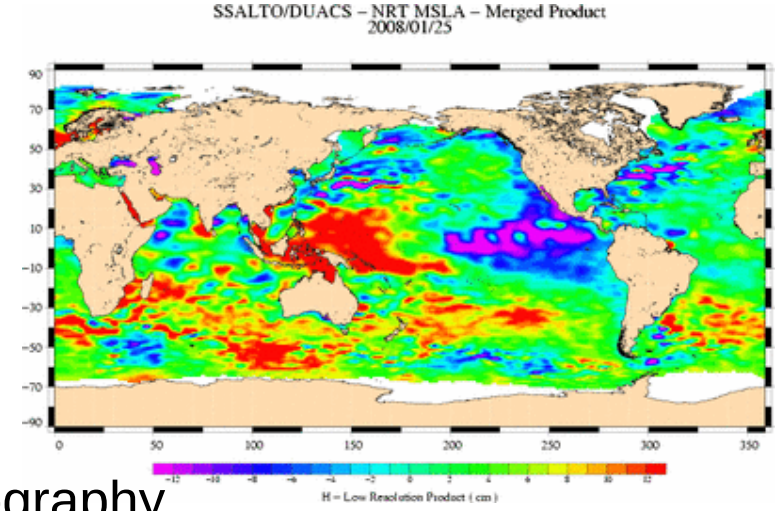
- Distance to shoreline < 200 km
- Distance to shoreline < 400 km
  and bathy > -5000m
- Continental shelves
- Specific basins (Med sea, Gulf of Mexico, …)

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 1ºx1º or 1/3ºx1/3º 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)

RADAR ALTIMETER DATABASE SYSTEM

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

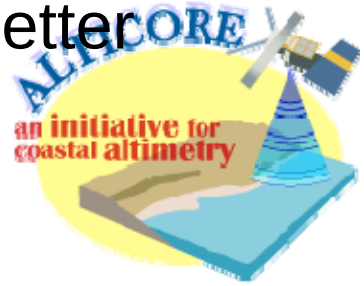
- Waveform tracking for SSH
  - effects of varying topography & geometry
  - stay locked on sea surface
- SWH
  - Change in wave spectra
- Wind Speed
  - change in distribution of scatterers

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 reponses
  - 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

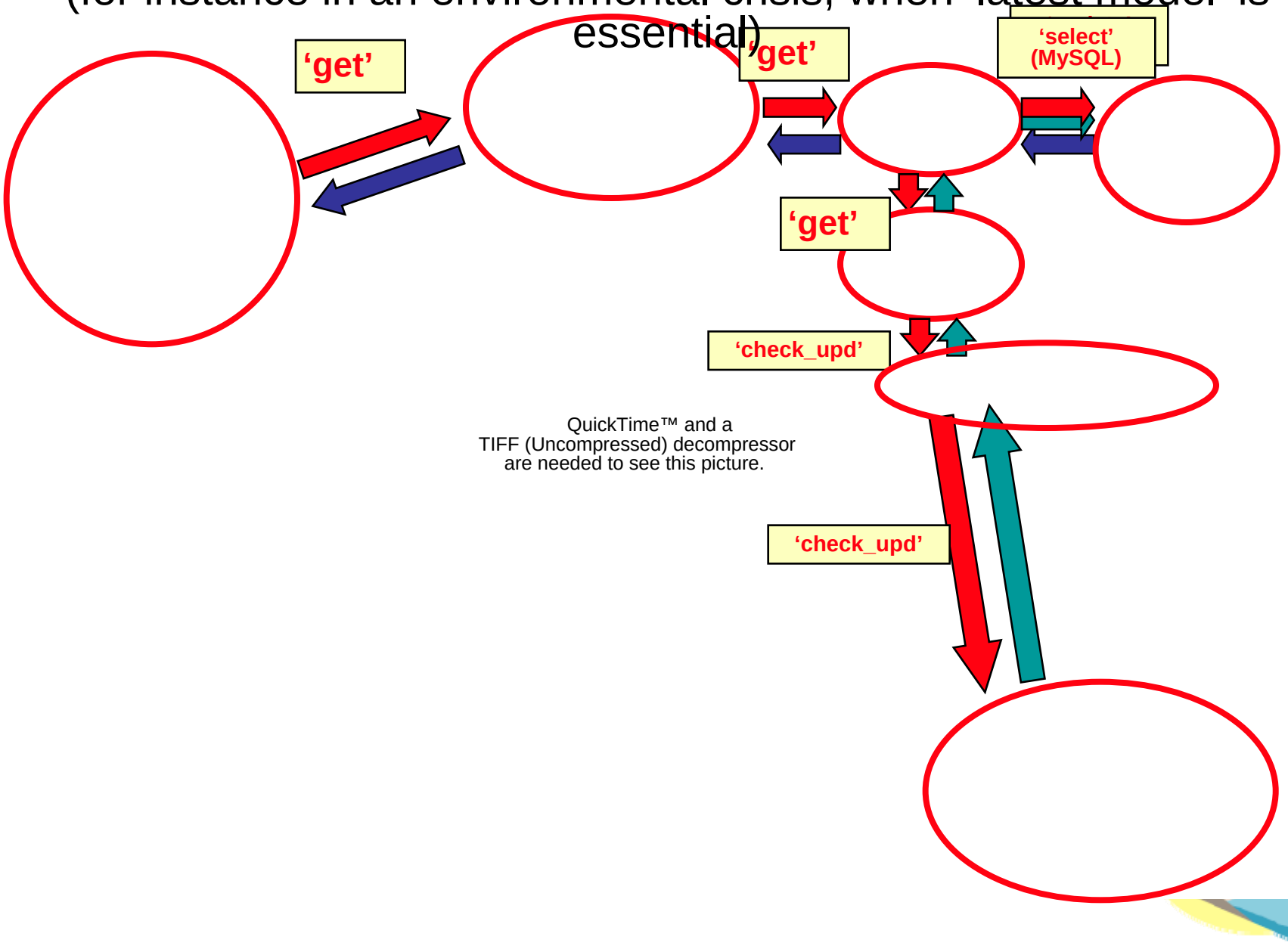
- Make use of protocols to allow access to services.
- Similar to program function calls.
- Client accesses a web service using a recognised call
- web service returns the required information in standard manner

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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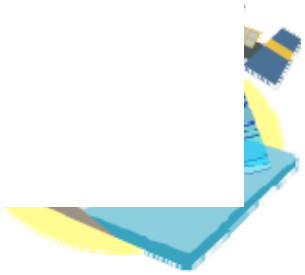
openDAP server

NetCDF Files

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

openDAP server

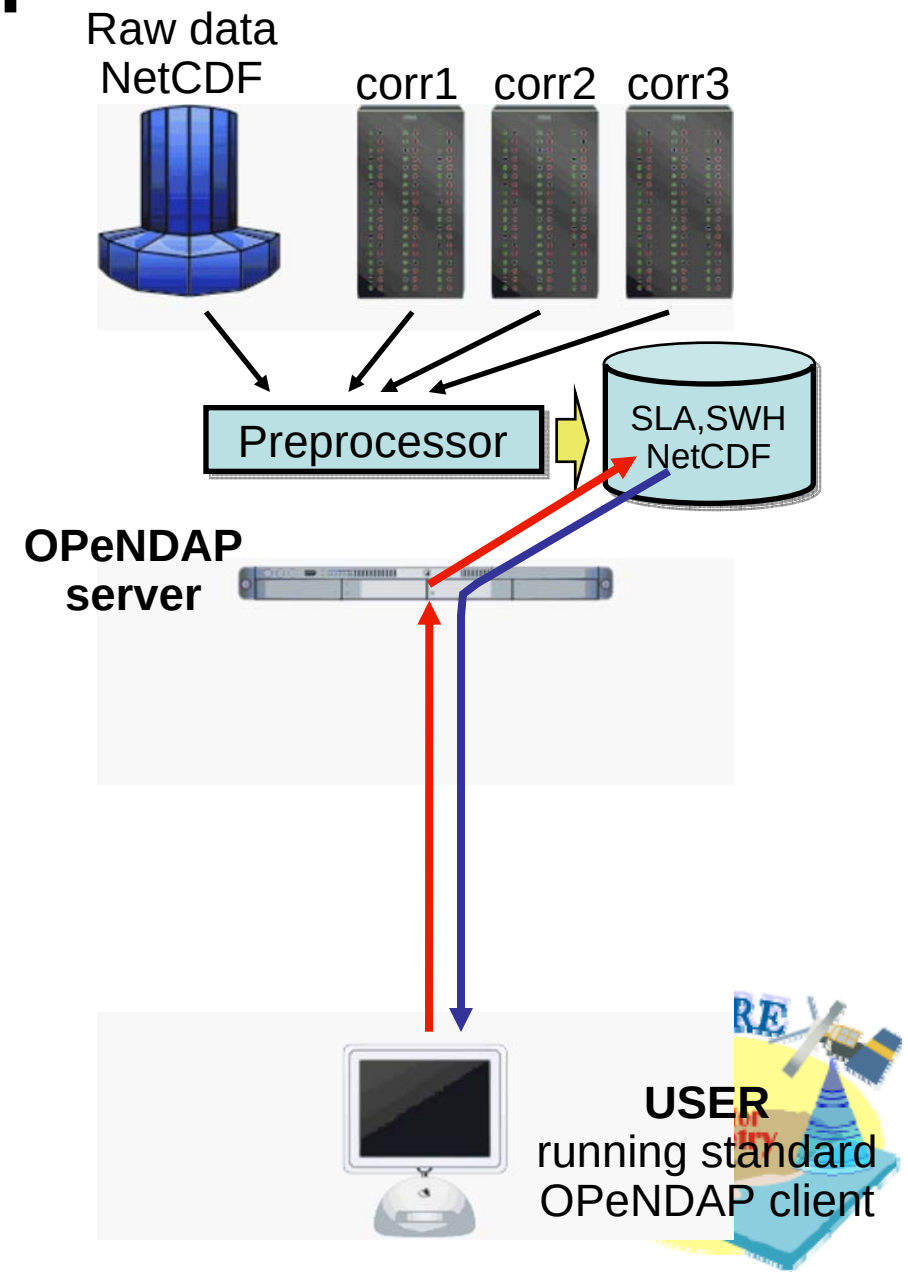
openDAP server



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

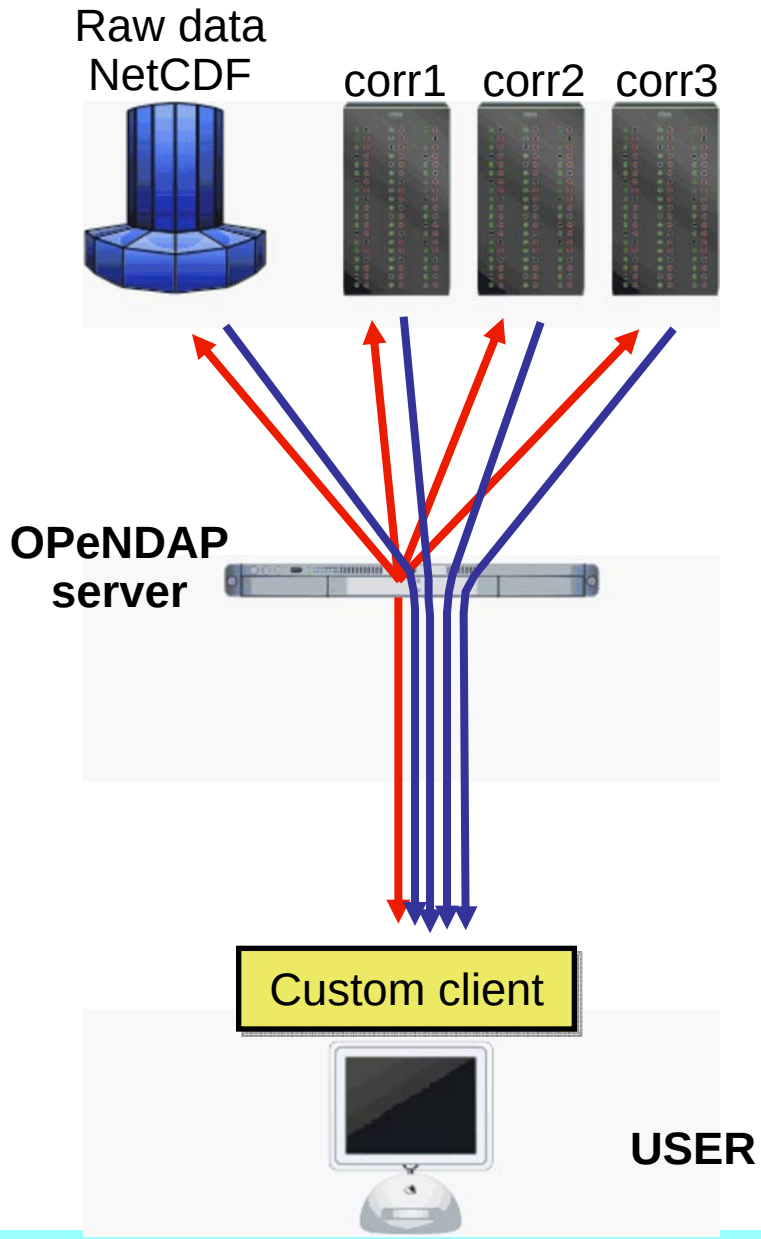


PROs: simple, no extra client required

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

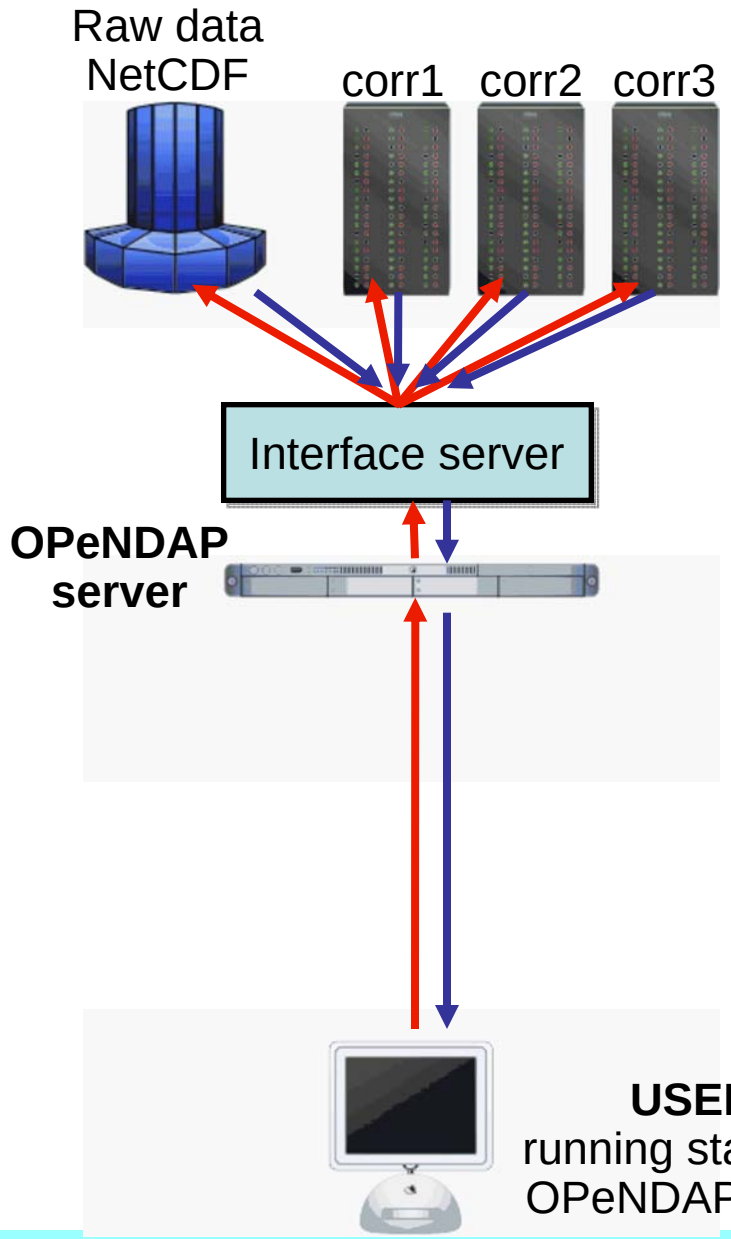


PROs: trivial to setup on server side

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?