coastcolour

Towards operational coastal ocean colour products – the Coastcolour approach

Carsten Brockmann

esa

Brockmann Consult

GKSS Forschungszentrum

PML Plymouth Marine Laboratory

MUMM

ADRINORD

Centro de Oceanografia University of Lisbon

MERIS has been designed as an instrument for coastal ocean colour measurements

CoastColour is ESAs initiative to bring coastal products from MERIS to the user community and to advance coastal ocean colour remote sensing

Objectives of CoastColour

- **MERIS FR data of challenging/important coastal zones** at a regional scale, processed with best possible algorithms for Level 1, with best possible regional algorithms for water leaving reflectances and IOPs, and demonstrating processing of regional higher level specific products; all products including **per pixel error/uncertainty estimates**;

- Internationally discussed **protocols for complex waters processing** including **algorithm performance assessment**;

- An **international comparison of processing algorithms for complex waters**, involving all relevant stakeholders and open to the scientific community;

- **Actively demonstrating and promoting MERIS capabilities for complex water** processing to the international ocean colour radiometry community, and increase of usage of MERIS within and outside Europe;

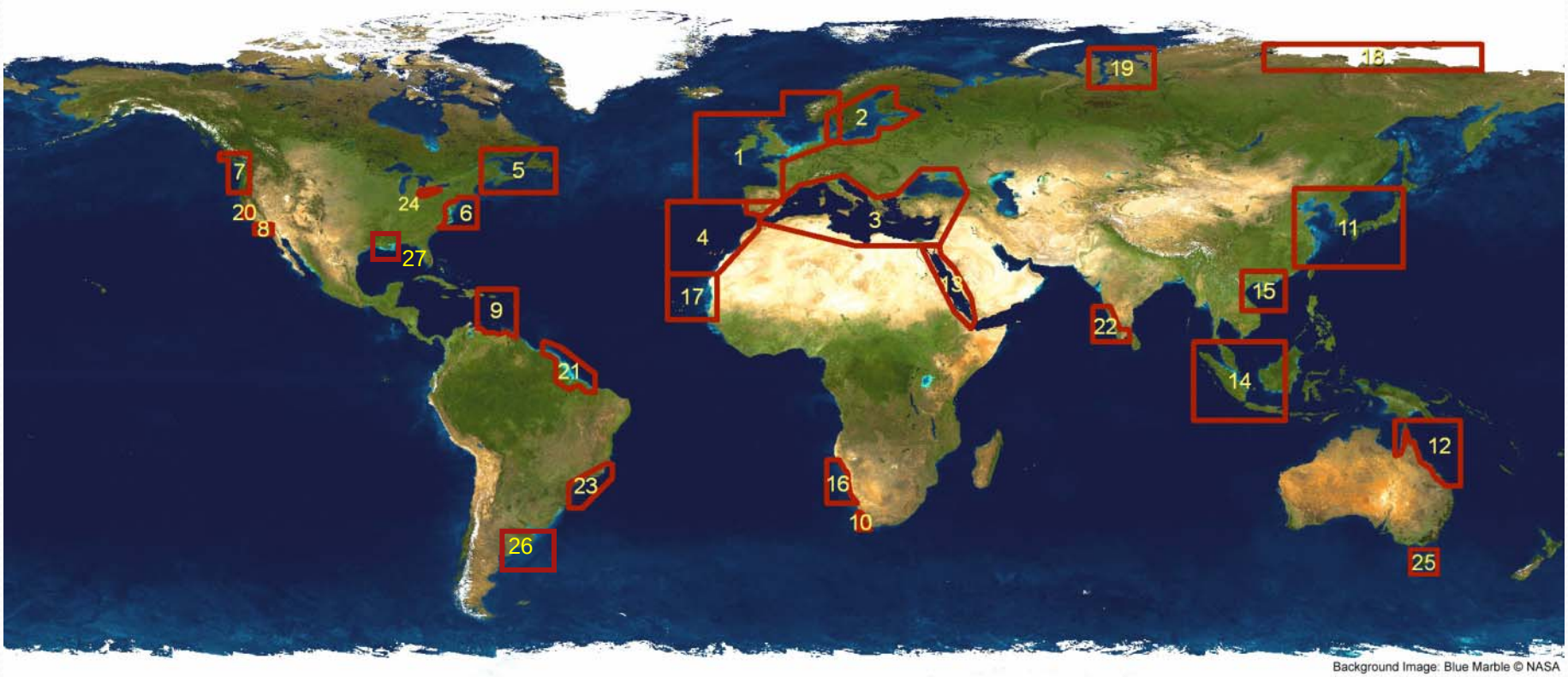
- **Preparation of the future exploitation of MERIS and Sentinel 3 products** for applications in complex waters and for climate change studies.

International CoastColour Team

- ESA
  - Simon Pinnock
- Core Team
  - Carsten Brockmann (BC, coordination, software and processing)
  - Roland Doerffer (GKSS, algorithm development)
  - Shubha Sathyendranath, Steve Groom (PML, International coordination, PP algorithms)
  - Kevin Ruddick (MUMM, Belgium , Round Robin)
  - Richard Santer (Adrinord, atmosphere characterisation)
  - Vanda Brotas (University Lisbon, in-situ data and quality management)
- Consultants
  - Mark Dowell, Zhongping Lee, Yu-Huan Ahn, Stewart Bernart, Thomas Schroeder/Arnold Dekker, Jim Gower, Bryan Franz
- Science Team
  - Mark Dowell, Gene Feldman, Paul DiGiacomo, Jürgen Fischer, Hubert Loisel, Kai Sorensen, Prakesh Chauhan, Trevor Platt, Steef Peters

Global Network of Users

Global Distribution of Sites



40 users, increasing, > 35.000 MERIS FRS Products

Products

- Standard products (for all sites)
  - Top Of Atmosphere radiances
  - Remote sensing reflectances
  - Classification
  - Inherent optical properties
  - Concentrations of Chlorophyll-a, Suspended Matter and CDOM
  - Water clarity (euphotic zone depth, Secchi disk depth)
  - Turbidity
  - Photosynth. Avail. Radiation
  - Aerosol optical depth
  - Chlorophyll-a FLH
- Experimental products (site specific)
  - Primary production
  - Phytoplankton carbon biomass
  - Phytoplankton functional types, abundance and particle size distribution
  - Distribution and abundance of cyanobacterial blooms
  - New products derived from MERIS fluorescence band; algal bloom monitoring using fluorescence band
- Uncertainties in each product, at each pixel

Regionalisation, Validation and Intercomparison

1. Regional Algorithm Calibration
   - Aerosols (from Aeronet and literature)
   - IOPs and IOP-to-concentration conversion
   - Concentration ranges
2. Validation
   - Marine reflectances (aeronet OC, user data)
   - Concentrations (match-ups, transects, L3 statistics)
3. Intercomparison
   - MERIS standard – MERIS Coastcolour – MODIS – SeaWiFS
   - Open Algorithm Round Robin
     - TOA and marine reflectances
     - Match-ups, in-situ & simulated data
     - Protocol online, Round Robin Data Package distribution in November

In-situ Database

- Global User Community
- 42 user organisations
  - 5 representing a large regional user group
  - 21 have already provided site specific in-situ data
- Users have different backgrounds and expertise
  - Datasets available and its quality differ accordingly
  - Monitoring responsibility
    - multiyear time series
    - bio-geo-chemical parameters
      - primarily chl-a
      - different methodologies
  - Research organisations
    - radiometric measurements
    - optical properties
    - bio-geo-chemical parameters
    - short time periods (cruises)

In-situ Data

SITE	in situ data	CAL	VAL	RR
Northern West Shelf	T, S, Chla, PP parameters, Turbidity (relation to TSM), TSM, Secchi, nutrients, water reflectance, dissolved oxygen , jellyfish abundance, pCO2, DIC, HPLC pigment data, IOP (apig, atot,bb), *	X	X	YES
Baltic Sea	T, S, Chl, Turbidity (relation to TSM), TSM, Secchi, IOPs , CDOM, phycocyanin and Chl fluorometers, CDOM data, reflectance measurements, cyanobacteria, *	X	X	YES
Mediterranean and Black Sea	Chl, SPM, radiometric measurements	X	X	YES
Morocco	Chl, PP		X	NO
Acadia	AOPs and IOPs, phytoplankton pigments, SPM and CDOM, PFTs, Particle Size distribution	X	X	YES
Chesapeake Bay	SeaBASS / NOMAD archives, US EPA WQMD (1984 to present) and other databases	X	X	YES
Oregon and Washington	Chl, IOPs and suspended sediments and CDOM	X	X	
Plumes and Blooms	T, S, Nutrients, Multispectral radiometry; AOPs, IOPs (including spectral Kd), phytoplankton pigments ,POC, DOC, Particle Size Distribution, Aerosol Optical thickness	X	X	GSM?
Puerto Rico	Chla, POC, TSM, IOPs, AOPs	X	X	?
Benguela	radiometry, pigment and aphy and ays data	X	X	YES
China, Korea, Japan	Chl , nLw, CDOM, and TSM, IOPs, cell counting in the redtides and euphotic depth data	X	X	YES
Great Barrier Reef	Chl , pigments, turbidity, TSM, IOPs, AOPs, secchi disk depth, 1% depth	X	X	YES
Red Sea	Chl, taxonomy and cell counts		x	
Indonesian Waters			X	
Beibu Bay			X	
Namibian Waters	Data available from different interdisciplinary research cruises		X	
Cape Verde			X	
Arctic	Water reflectances, concentrations of TSM, Chlorophyll, DOC, POC as well as basic hydrographic data.	X	X	

ESA Ocean Colour Climate Change Initiative

- "to realize the full potential of the long-term global ocean-colour archives that ESA together with its Member states have established over the last thirty years, as a significant and timely contribution to the ECV databases required by United Nations Framework Convention on Climate Change (UNFCCC)".

- Project lead by Shubha Sathyendranath (PML)

- Validation
  - relying on best available radiometry from SeaBASS, MERMAID, Aeronet-OC
  - error characterisation of the complete processing chain (QA4EO)
  - Round Robin

- Impact on climate models

Coastcolour User Consultation Workshop:

16.-17.11.2010, ESRIN, Italy

Thank you!

www.coastcolour.org

office@coastcolour.org

Backup slides

In-situ data overview

- Radiometric Quantities
- IOPs
- Bio-geo-chemical and bio-optical quantities
- anciallary data

Downwelled Irradiance	$E_d(z,l)$
Upwelled Radiance	$L_u(z,l)$
Water Surface Radiance in air	$L_{sfc}(l,q,f)$
Incident Irradiance in air	$E_s(l) = E_d(o+,l)$

Beam Attenuation Coefficient	$c(z,l)$
Absorption Coefficient	$a(z,l)$
Backscattering coefficient	$b_b(z,l)$
Scattering Coefficient	$b(z,l) = c(z,l) - a(z,l)$
Volume Scattering Function	$\beta(z,l,\Psi)$
Particle Absorption Coefficient	$a_p(z,l)$
Dissolved Material (CDOM) Absorption Coefficient	$a_g(z,l)$

Phytoplankton Pigment Composition (HPLC)
Chlorophyll a and Phaeopigments Conc. (Fluorometric method)
Fluorescence Intensity in situ profile F(z)
Phycobiliprotein Concentrations
Coccolith Concentrations
Phytoplankton groups abundance PFTs
Total Suspended Particulate Material SPM
Particle Size Distribution PSD
PI parameters for PP
Phytoplankton biomass convertion factors
Turbidity convertion factors

Latitude and Longitude
Date and Time (UTC)
Wave Height
Whitecap Conditions
Wind Speed, and Direction
Cloud Cover
Secchi Depth
Water Depth
Conductivity and Temperature over Depth (CTD)

Multi-Sensor RoundRobin

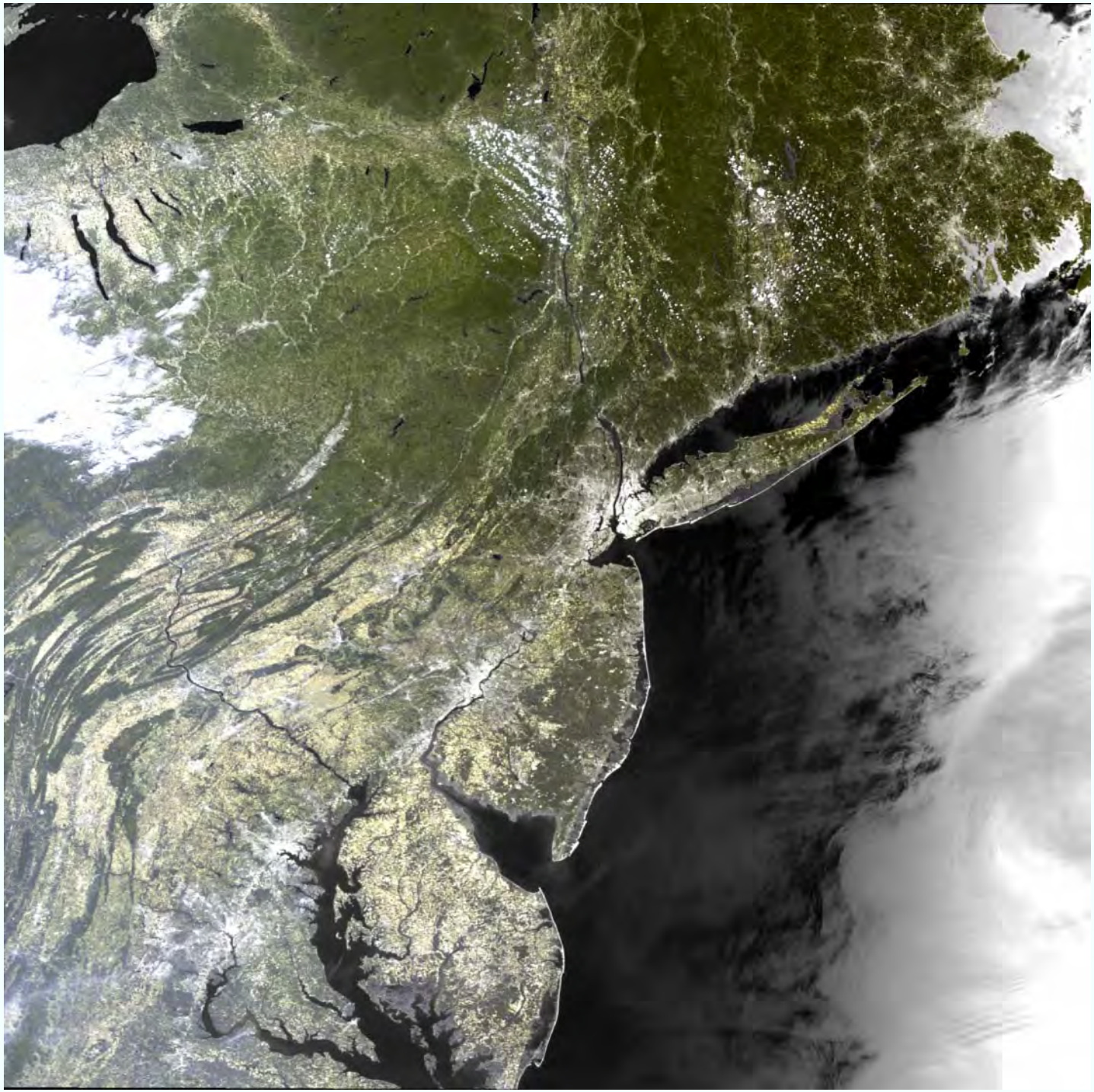
- Objectives
  - forum for improving the community's understanding of the performance of various algorithms
  - helping to select the optimal algorithm for a given region and application
- Round Robin Data Package
  - COASTCOLOUR Level 1P (TOA radiances)
  - L2 (water leaving radiance reflectances)
  - from MERIS measurements as well as simulated data
  - Protocol
- Participating scientists
  - run own algorithm
  - output IOPs and/or concentrations
- COASTCOLOUR team
  - compare participants results, COASTCOLOUR L2, standard MERIS L2, MODIS, SeaWiFS
- Benefit
  - co-author of Round Robin Final Report
  - co-author of submission to peer reviewed journal

MERIS Full Resolution Data Set of the Coastal Zones

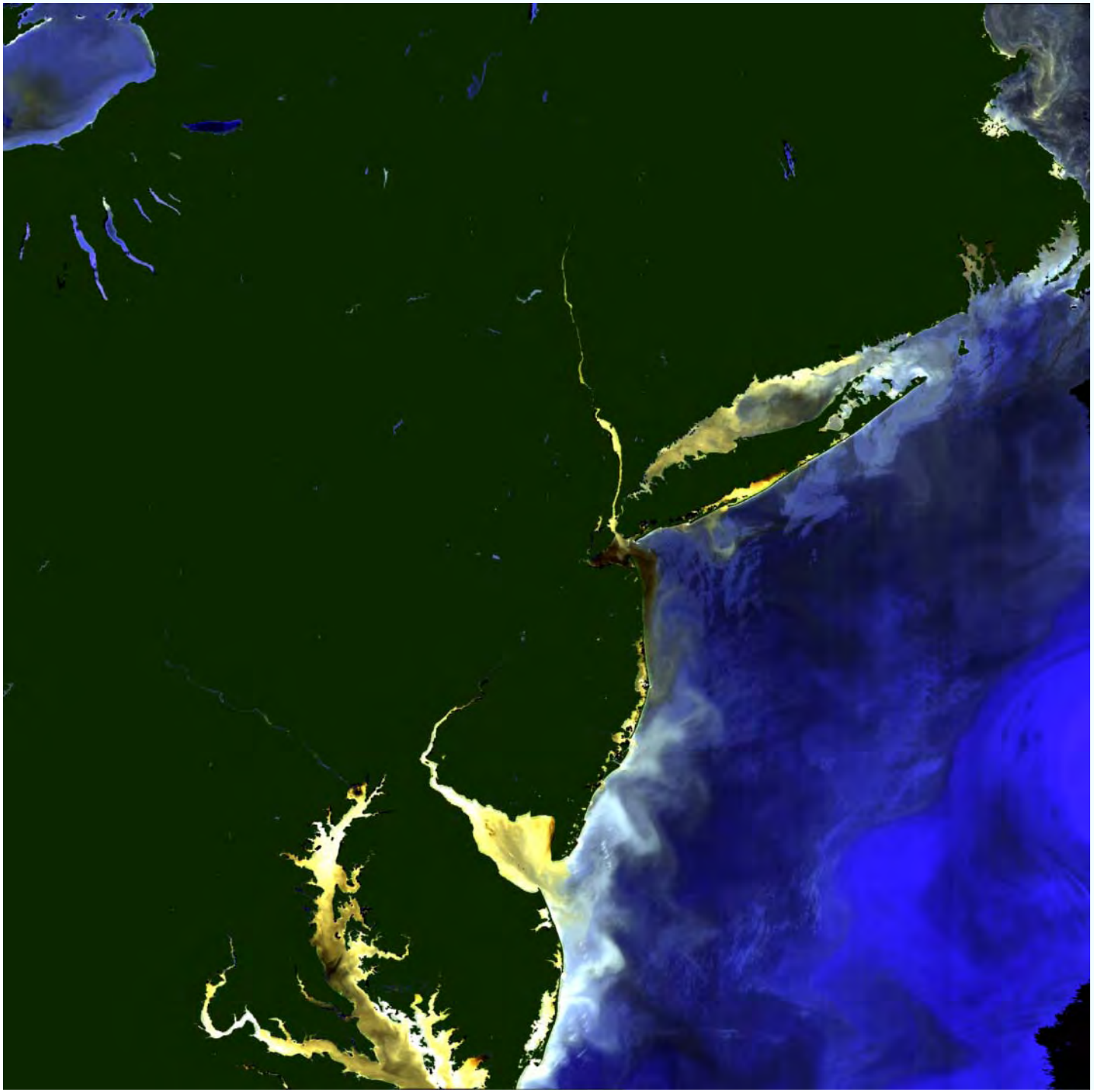
- These Products will be made available, open and free access
  - MERIS Full Resolution (300m) Full Swath (1200km)
    - Top of atmosphere
      - Standard Level 1b processing, but in netCDF format
      - **CoastColour Level 1P processing**
    - Water products
      - Standard Level 2 products, but in netCDF format
      - **CoastColour Level 2 products**
- Spatial coverage: all 27 Coastcolour sites
- Temporal coverage: 2005 – 2010; 2011 NRT service

MERIS FR
20080617

glint ratio > 10 !!

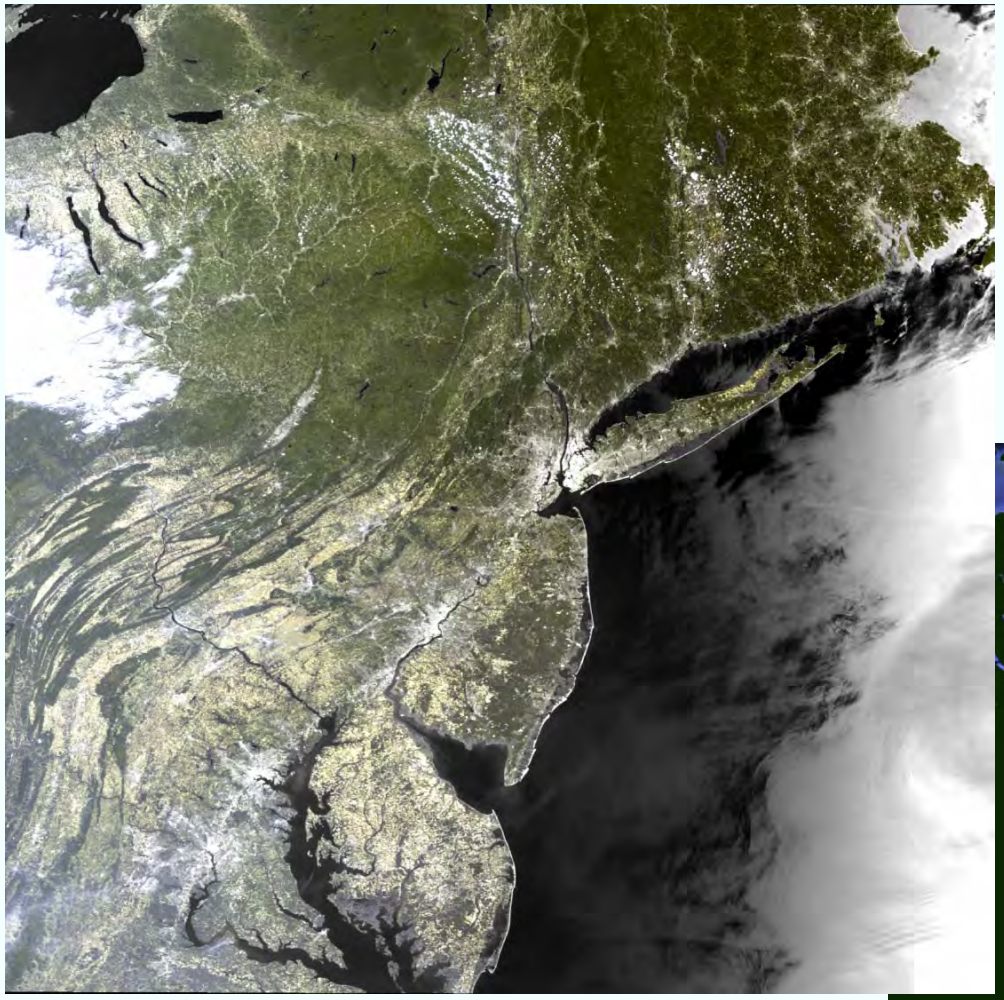


MERIS FR
20080617
RL_path
band 5

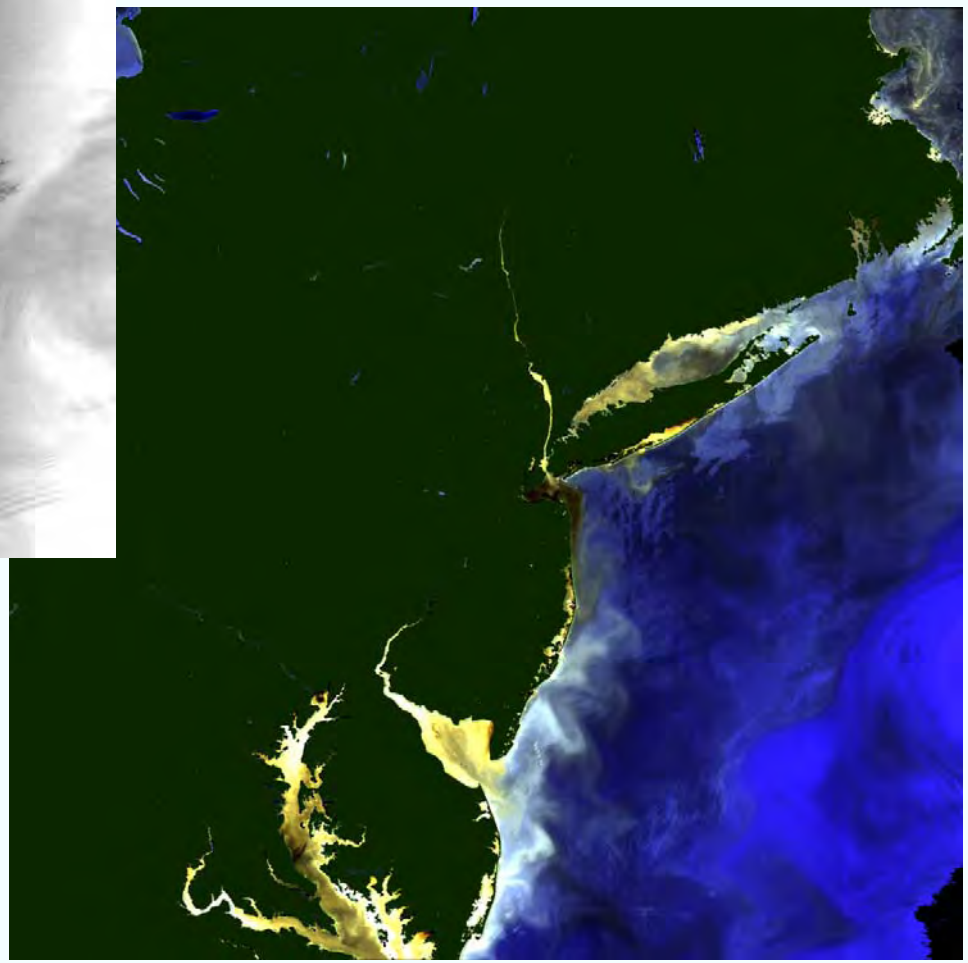


MERIS FR
20080617
RL_w RGB

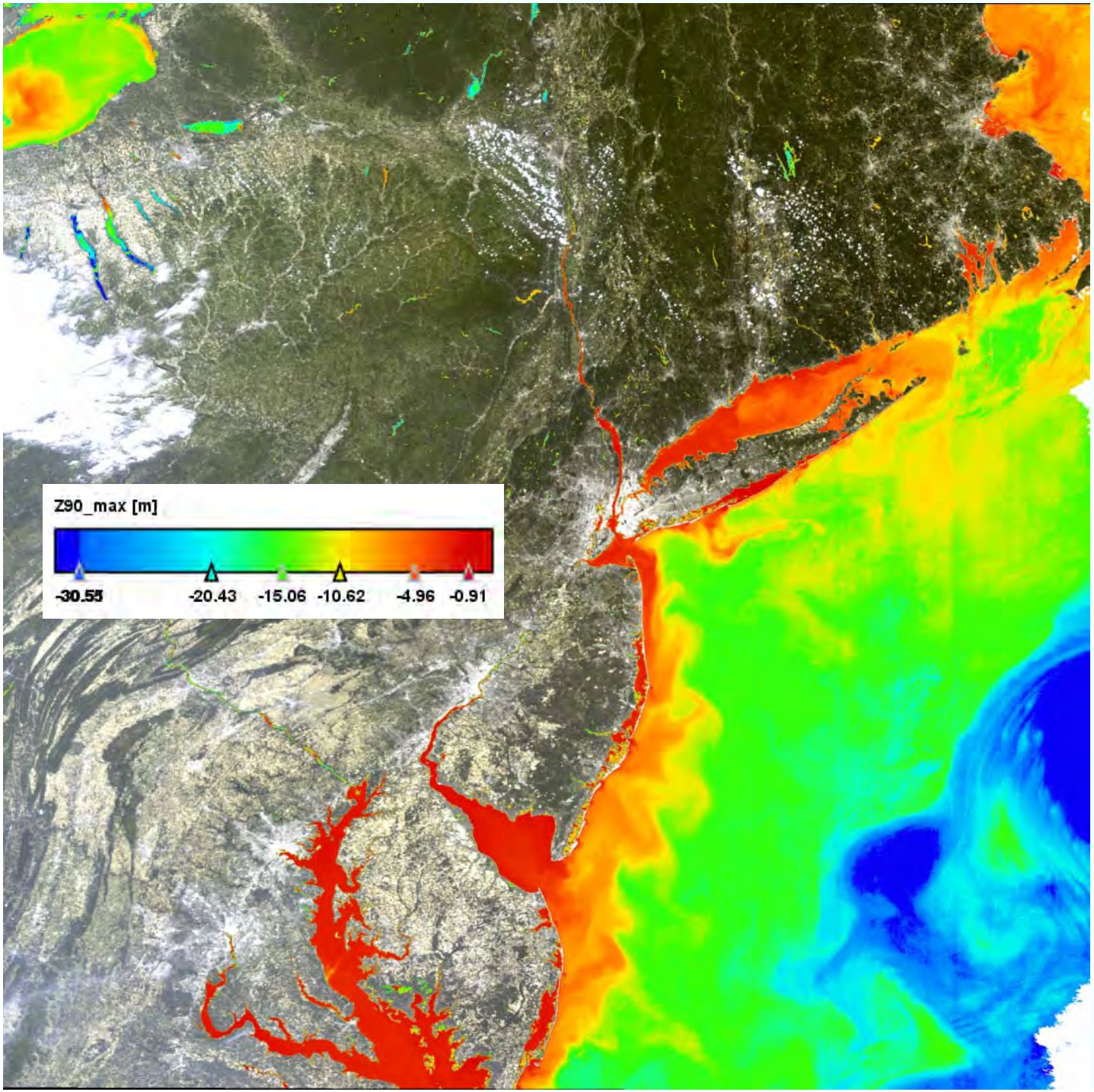
MERIS FR
20080617



← non-water signal

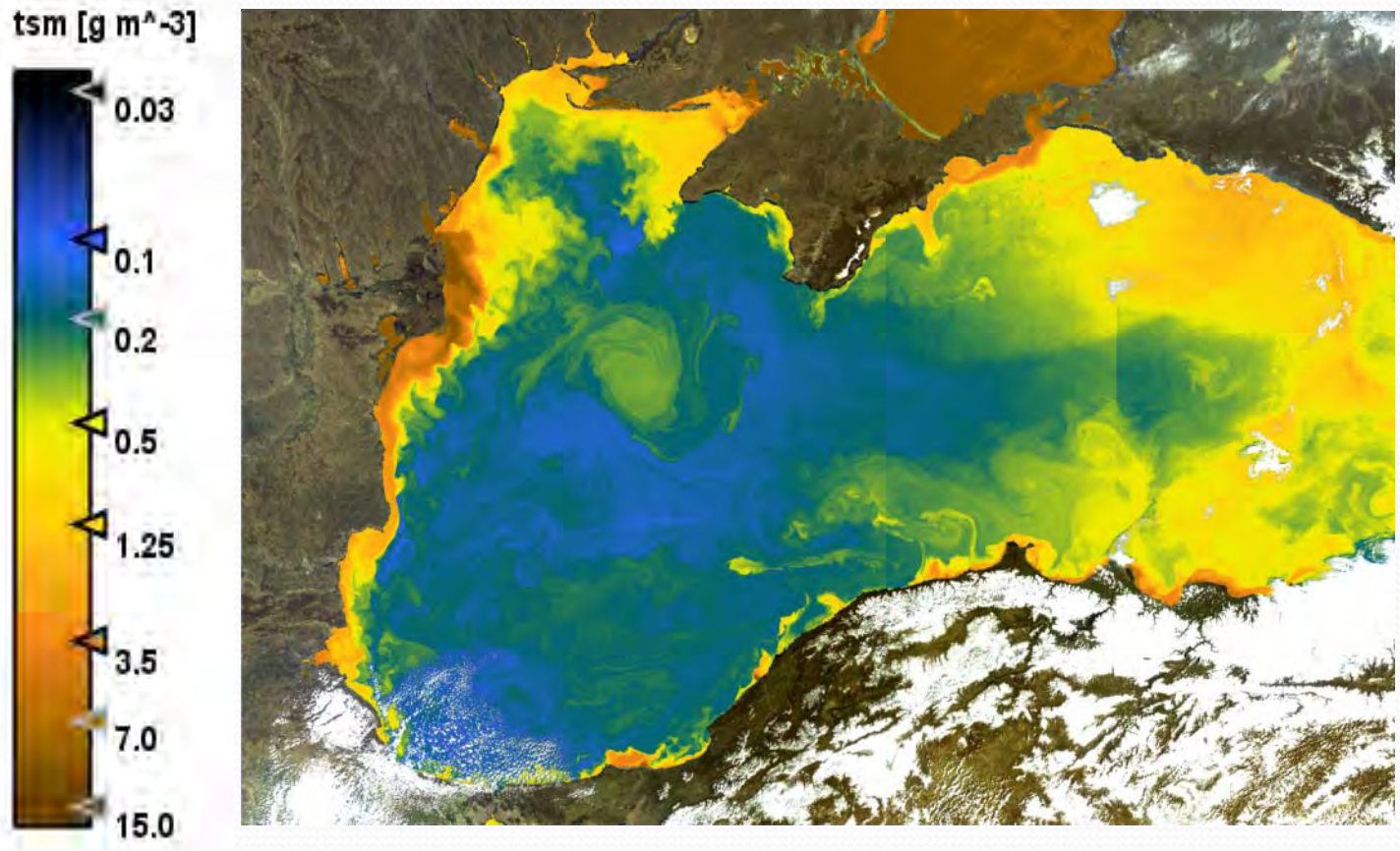


Water signal ➔



MERIS FR
20080617
z90_max

Product Example: TSM, Black Sea



Example: Product Uncertainty