Mapping estuarine turbidity using high and medium resolution time series imagery
GEO-Transfert

- **Mission:** to ensure that scientific and technological developments will be further developed and exploited into new products, processes, applications, materials or services ...
- **Remote sensing applications for decision making** - new developments towards operational products
- **Introduction of satellite data in coastal surveillance services**
Main issues in very turbid estuarine environments

- **Scientific issues**
  - Understanding MTZ dynamics (2D / 3D): high SPMs, low O2.
  - Hydro-sedimentary processes understanding and modeling

- **Conservation issues**
  - Natural heritage protection
  - Water quality (WFD)

- **Industrial and socio-economic issues**
  - Fisheries & aquaculture
  - Navigation & harbour activity

- **Management issues**
  - Waste water discharge
  - Nuclear power station cooling
MTZ monitoring

User needs
- Qualitative information (turbidity gradients)
- Quantitative measurement (SPM concentration, particle size determination)
- Operational measurement implementation
  - High frequency
  - Spatial coverage at the scale of the watershed
- Forecasting tools

Scientific questions
- Which sensor & which product to derive SPM?
- Product combination / fusion?
- Retrieval accuracy?

FOCUS: Gironde estuary, Garonne and Dordogne watersheds
Existing image products

Gironde: the widest estuary in western Europe

MTZ characteristics in the Gironde:
- several tens of km long;
- magnitude of movement: about 100 km

120 km

160 km

- Downstream section (2 to 12 km width): medium resolution imagery, MODIS HR wavebands
  - Level 1A
  - Level 2 SR (surface reflectance) - http://reverb.echo.nasa.gov/reverb

  Sentinel 3

- Upstream section (<100 m to 2 km): high resolution imagery
  - Landsat imagery
  - SPOT4 (Take5 experiment)
  - Rrs Products (TOSCA Landsat, Theia Pole - http://www.ptsc.fr/)

  Sentinel 2
RS product choice - Method

Space data sensitive to turbidity variability

- Data download (MODIS, SP, LANDSAT, Marel records)
- Image data processing
  - Level 1A → Rrs (Wang et al., 2009)
  - Reflectance to MES

MODIS:
SPM=12,996*exp((Rrs_859 ou SR_859/Rrs_645 ou SR_645)/0,189)
(Doxaran et al., 2009)

HR: New algorithms
R_{rs} = (L_{w}-ρ*L_{sky})/E_{d}
MES=f(G; R; NIR/G; NIR/R)

- Field data processing
  - NTU to MES
- Matchup constitutions and data comparison
MR product choice: L1A vs L2

**SPM maps**
- L1A - Rrs
  - Red
  - NIR
- L2 - SR
  - Red
  - NIR

**Reflectance sensitivity to turbidity changes**
Marel: measurements averaged over 30’
27 images over 1 year - 9 pixels in a box
- L1A – Rrs
HR product available

- L4, 5, 7 & SPOT4: a total of 12 matchup with the Marel station of Bordeaux

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HR product choice

- Waveband sensitivity to turbidity range

- Algorithms inversion for SPM assessment in Bordeaux
Space SPM accuracy

**MR**

Validation method approach robustness?

**HR**

- High resolution gives better estimates
- Adequate atmospheric corrections

Increase matchups nb
- Landsat 8
- S2
Sentinel-2 simulation

\[ y = 23,225e^{4.2766x} \]

\[ R^2 = 0.875 \]
Processing chain & available data for MTZ monitoring

- At minimum: monthly HR imagery
- Daily MODIS: 33% exploitable images
- 40% of exploitable images in summertime vs 27% in winter

RIVERCOLOR

- Download MODIS images for the specified MODIS tile
- Apply the preliminary created land mask
- Cloud and shadow detection and masking
- NIR and red reflectance ratio inversion into SPM
SPM time series production

Flood

Low water
Ongoing actions

- Field campaigns (AOPs, IOPs vs SPM, POC, chlorophyll, particle size)
- New OC products
- S2 SPM algorithm definition
- MAGEST station representativity
- MODIS / S3 validation
- MODIS SPM map analysis
  - Statistics
  - SiAM validation
- Model / space data complementarity analysis
Perspectives

- Particle size determination from space
- OC products in the estuarine plume
- Assimilation
- SWOT
- Fine clouds / shadow detection improvement over water surfaces (ex. morphology treatment)

- S2 algo validation
- S2 / S3 data fusion: operational SPM quantification from rivers to plumes
  - Watershed scale
- HIGHROC (K. Ruddick)
  - High frequency SPM quantification

- HYMOSED: application of RIVERCOLOR
  - Seine estuary
Thank you for your attention

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