

# Water Quality monitoring of Inland Waters using MERIS data

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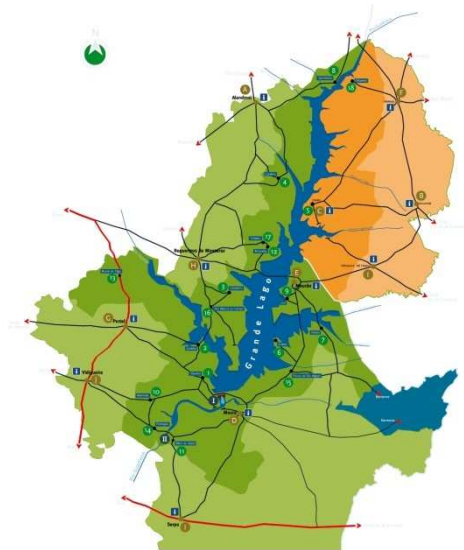


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# Alqueva Reservoir / Thau Lagoon

- Location: South-East Portugal
- Length: 83 km
- Surface: 250 Km<sup>2</sup>
- Maximum depth: 65 m
- Trophic state: eutrophic

- Location: South-East France
- Length: 15 km
- Surface: 75 Km<sup>2</sup>
- Maximum depth: 8 m



# Goals

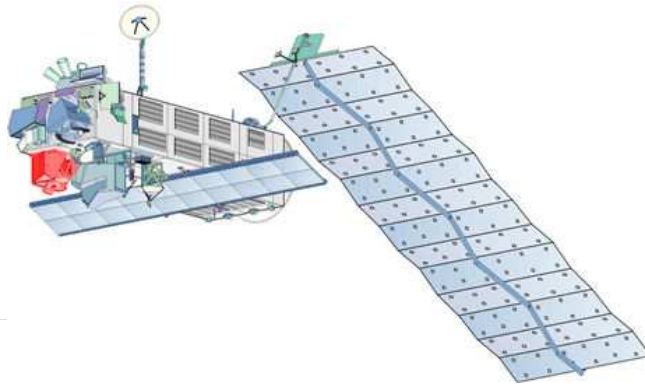
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- ❑ Atmospheric correction of satellite data
- ❑ Develop empirical algorithm for water turbidity
- ❑ In water measurements for extinction coefficient calculations

# Data

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**SATELLITE**



**ATMOSPHERIC**



**FIELD**



**LABORATORY**



# Satellite Data

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- ❑ **MERIS** (Medium Resolution Imaging Spectrometer) spectrometer aboard ENVISAT-1 satellite
- ❑ MERIS has around 300 m (full resolution) in 15 spectral bands (0.4 to 1.05  $\mu\text{m}$ )
- ❑ MERIS Level 1 products with TOA radiance
- ❑ Level 2 with surface reflectance

Alqueva  
Reservoir



Thau  
Lagoon





# Atmospheric Data

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- ❑ Spectrophotometer CIMEL CE-318-2 is installed on Évora Geophysics Centre Observatory.
- ❑ Determine aerosol optical depth (AOD), aerosol size distributions, water vapor concentration in the column.
- ❑ Operating since June 2003.
- ❑ Data available at AERONET (AErosol RObotic NETwork): <http://aeronet.gsfc.nasa.gov/>



# Laboratory Data

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- ❑ Laboratory data were provided by **EDIA** (Alqueva data) and **IFREMER** (Thau lagoon) through the water quality monitoring programs.
- ❑ The sampling points used were chosen taken into account the spatial resolution of spectrometer used (MERIS – around 300m).
- ❑ In situ and laboratory turbidity was used.

# Field data

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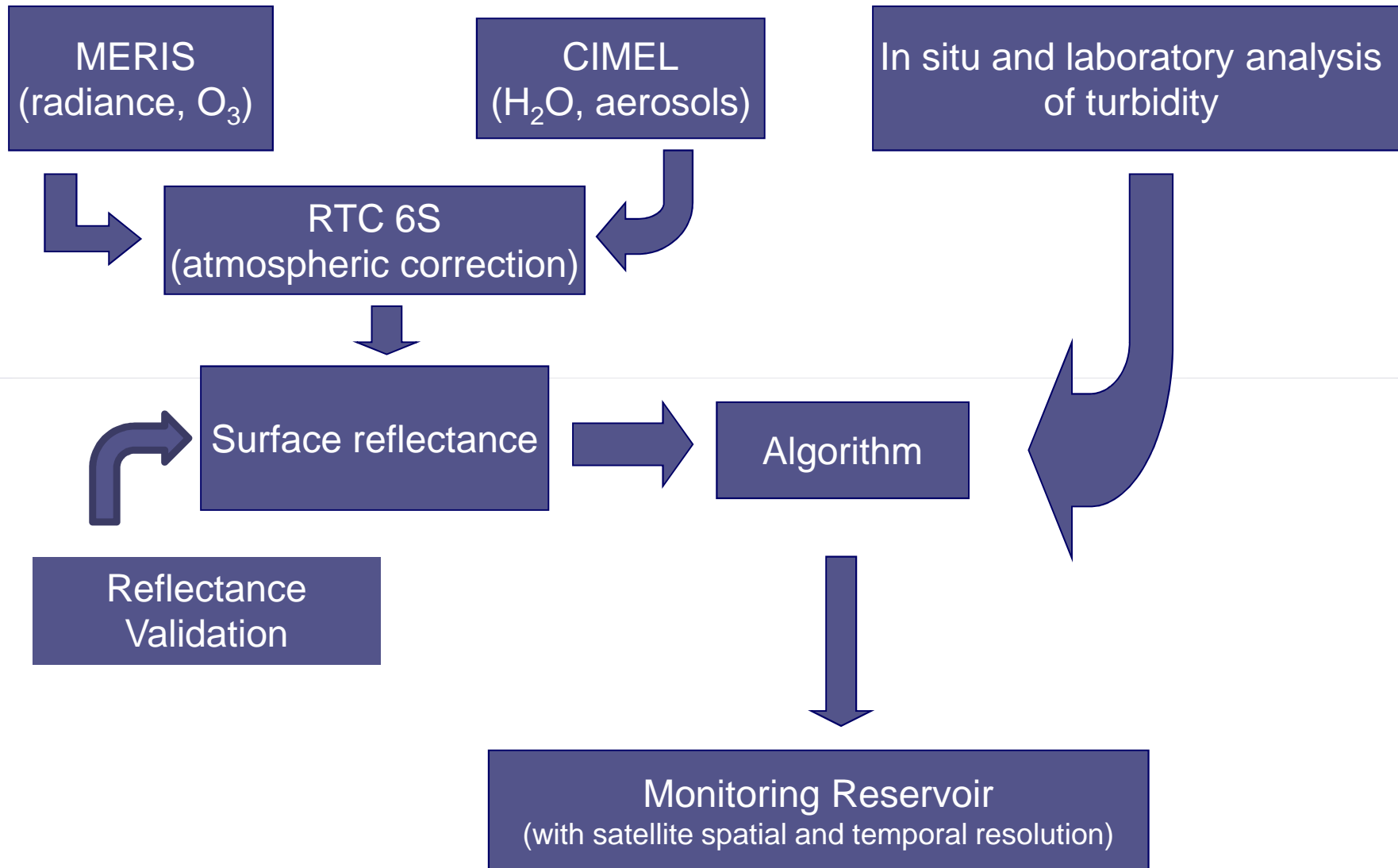
A Portable spectroradiometer from ASD - FieldSpec UV/VNIR was used to measure reflectance and radiance.

- ❑ 325 – 1075 nm range
- ❑ Absolute or relative measurements of light energy
- ❑ 3 nm spectral resolution at around 700 nm
- ❑ 1 – 25 degrees of view angle
- ❑ 17 ms to several minutes of integration time

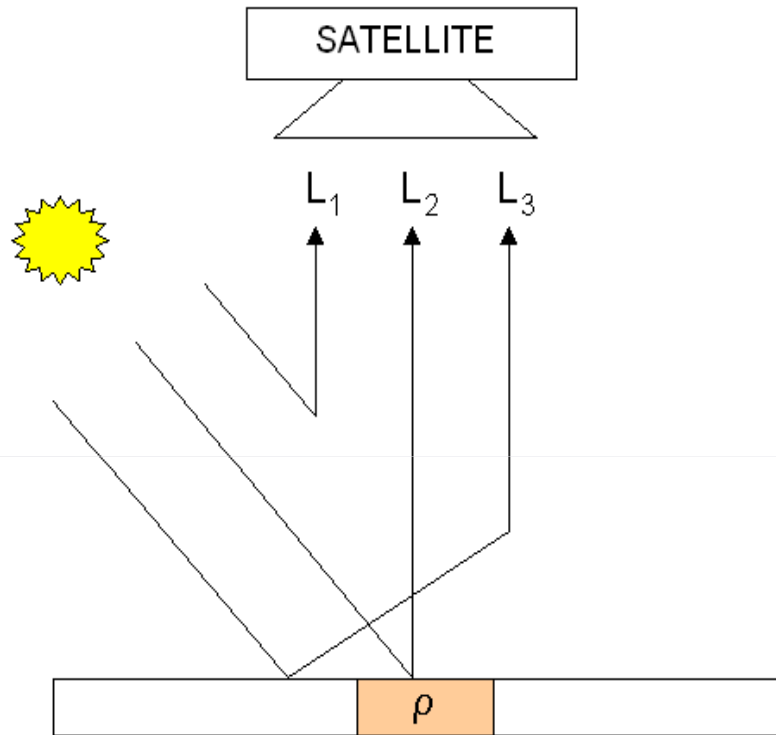




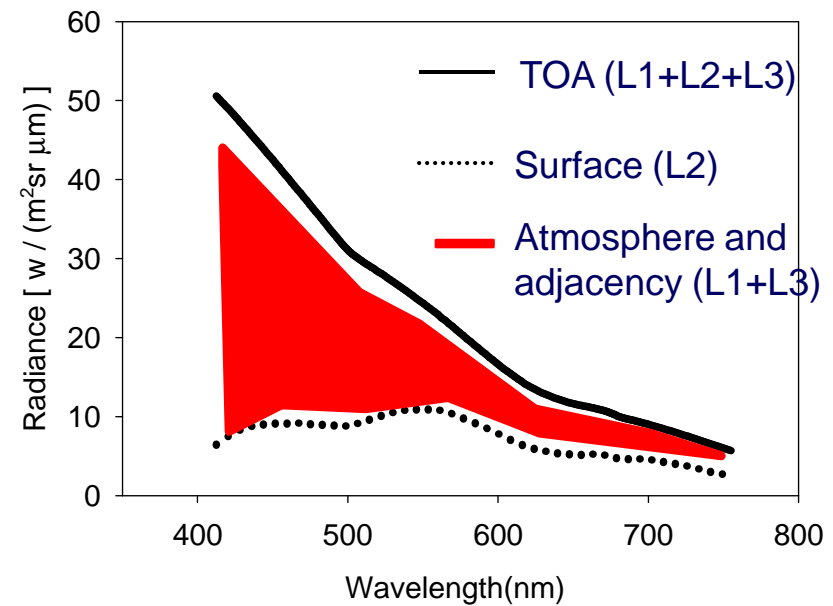
# Methodology



# Radiation Components



- L1 : Radiation scattered by the atmosphere
- L2 : Reflected radiation from the viewed pixel
- L3 : Radiation reflected by the neighborhood and scattered into the view direction (adjacency effect)

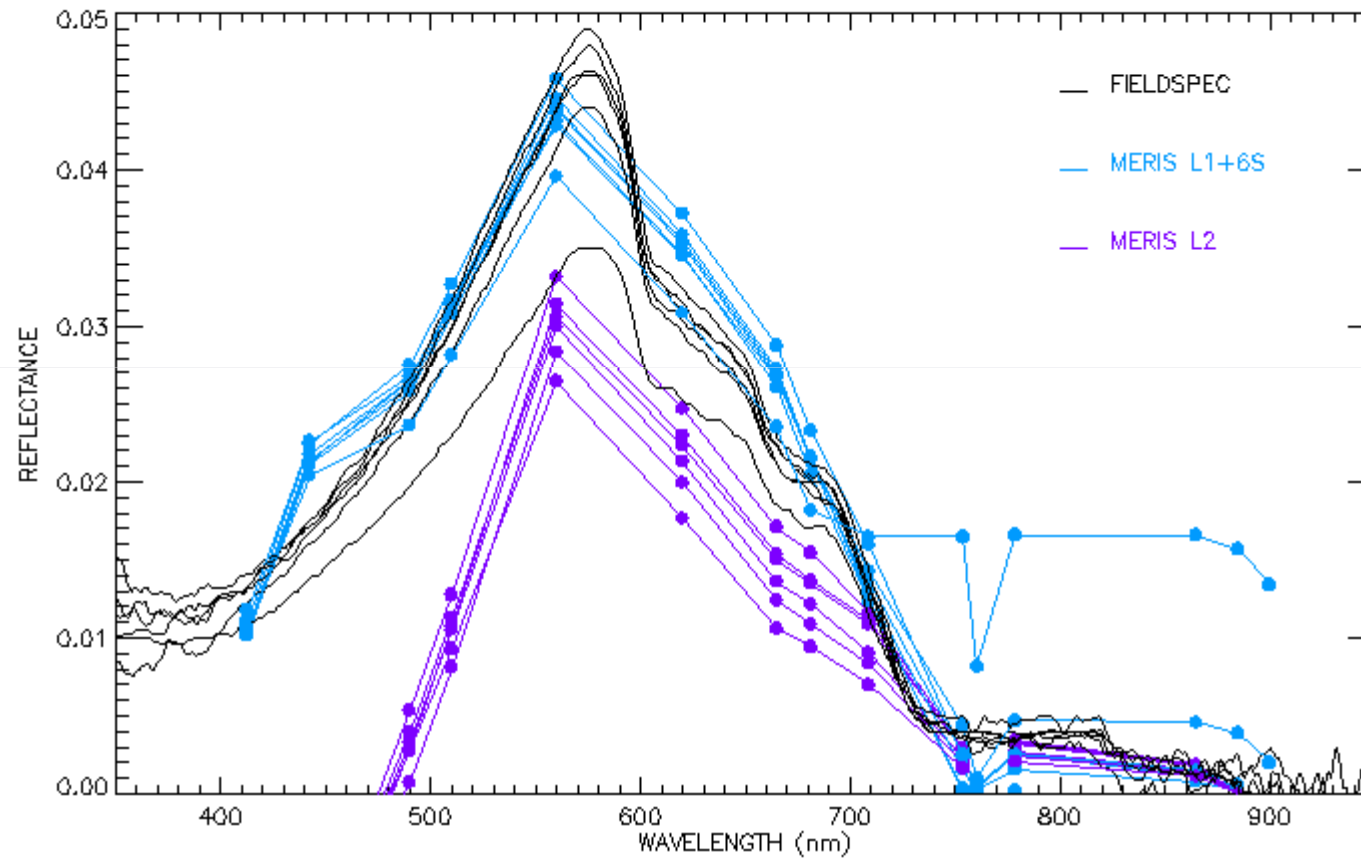


# Atmospheric Correction Validation

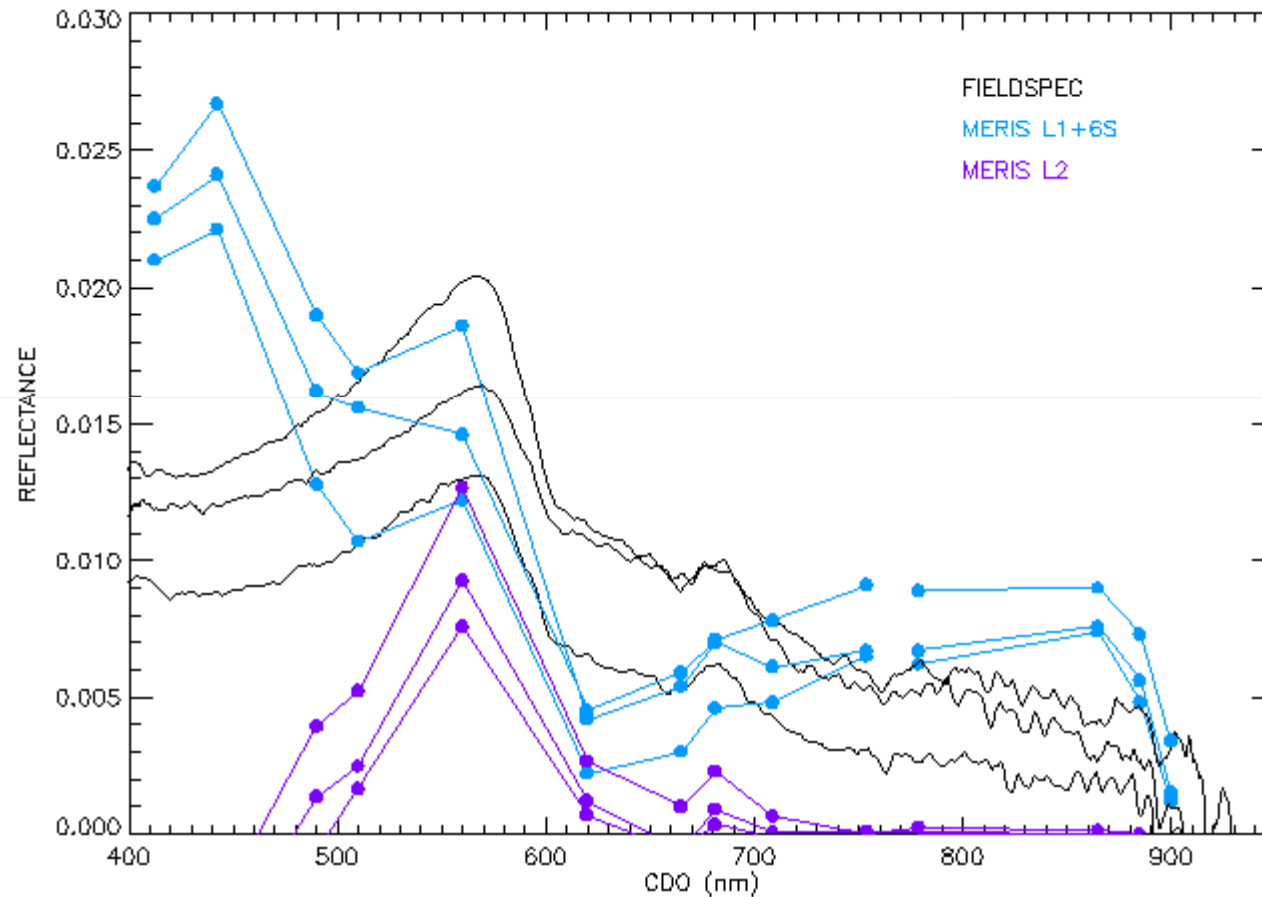
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□ Two field campaigns were conducted, in Alqueva reservoir and Thau lagoon, in order to obtain surface reflectance measurements, which are subsequently used to validate the satellite atmospherically corrected reflectance.

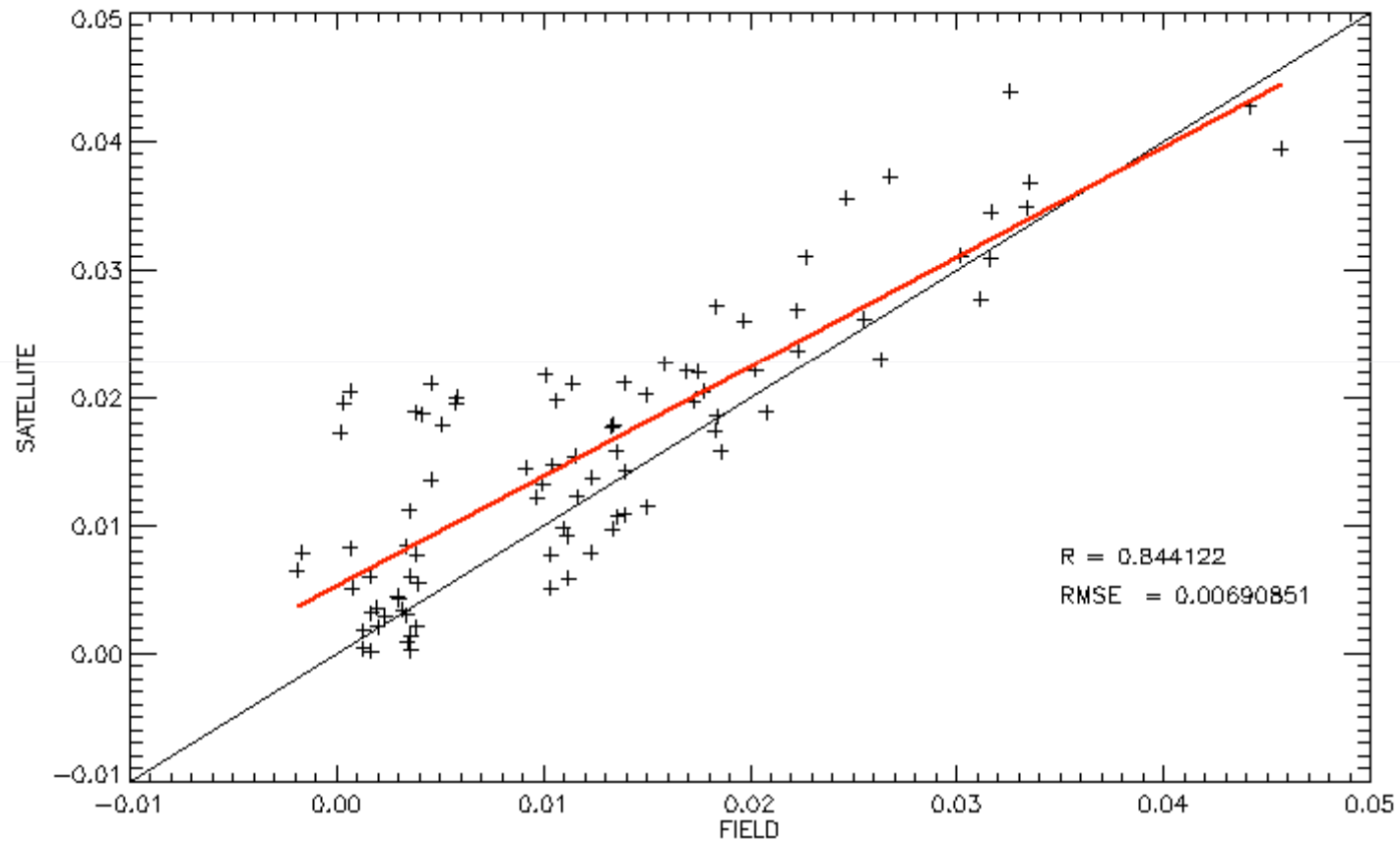
# Satellite and in situ (Alqueva Reservoir)



# Satellite and in situ (Thau Lagoon)



# Satellite validation (MERIS L1 6S)





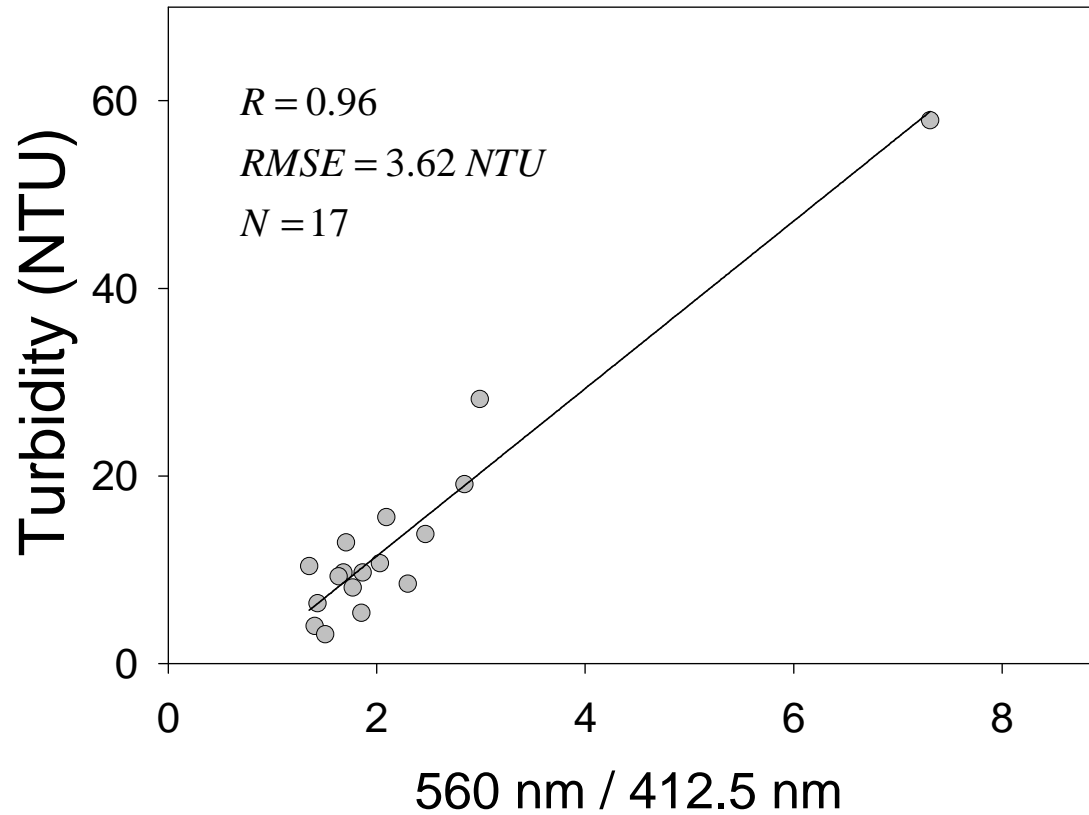
# Reflectance and turbidity

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- The surface spectral reflectance was related to water turbidity, and how?

Linking the surface reflectance of the closer pixel of sampling point to the water turbidity measurement.

# Turbidity algorithm

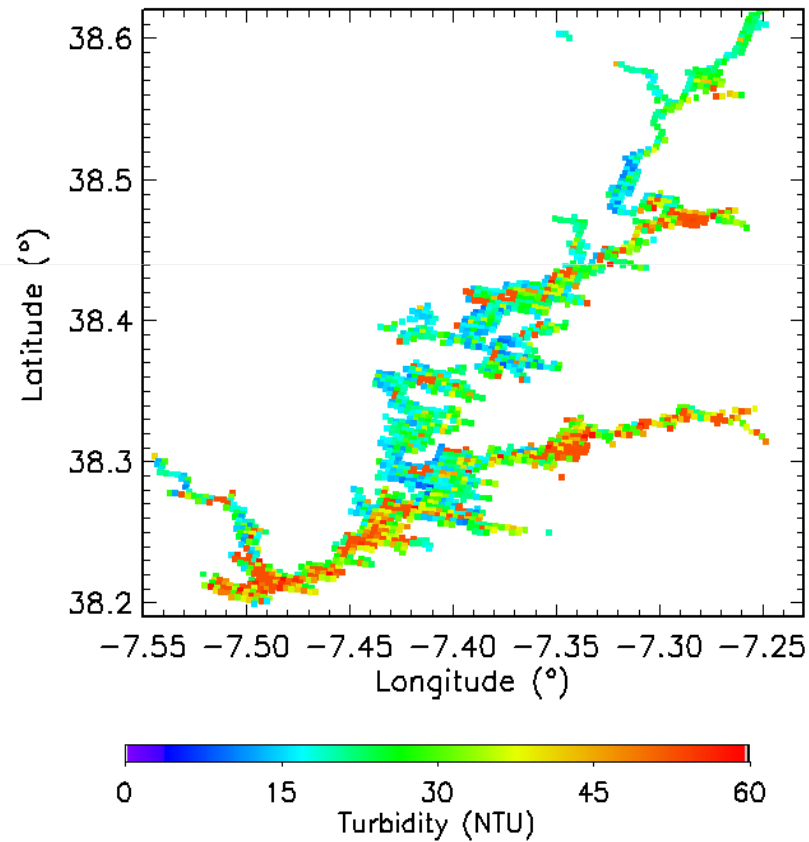


$$Turbidity[NTU] = 8.93 \times \left( \frac{B5}{B1} \right) - 6.39$$

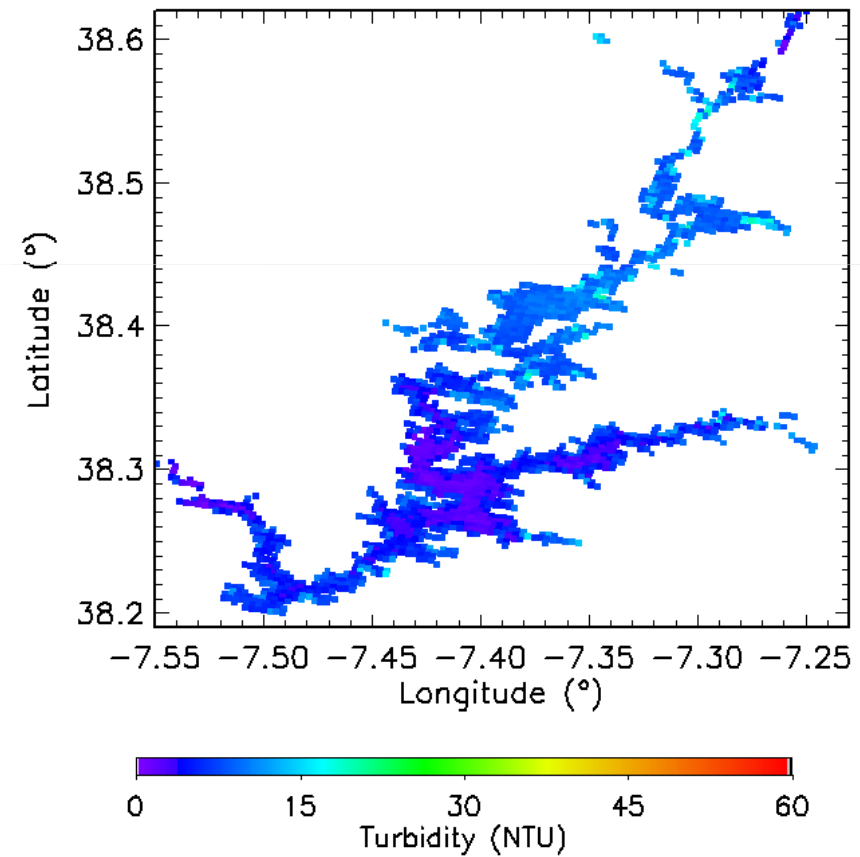


# Turbidity Maps

Just after – 11 February



Afterward – 15 March



# **In water radiance measurements**

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Recently an optical fiber was used to measure in-water radiance, at several levels, in order to calculate the extinction coefficient.

In general, light intensity declines exponentially with depth, as described by Beer-Lambert Law:

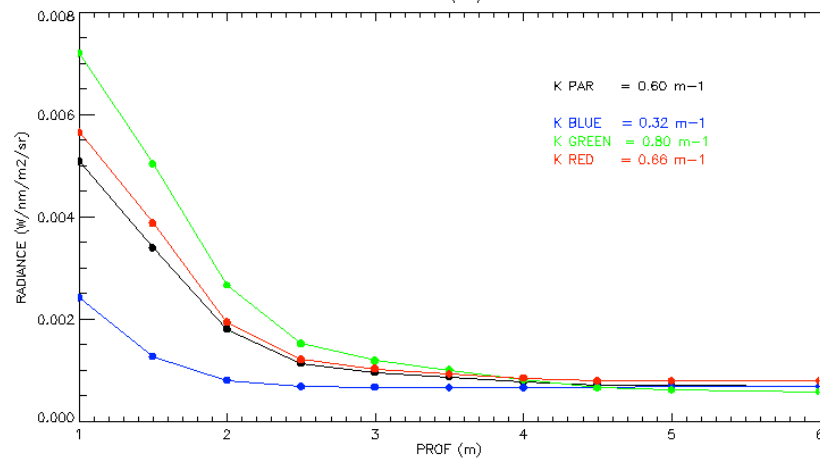
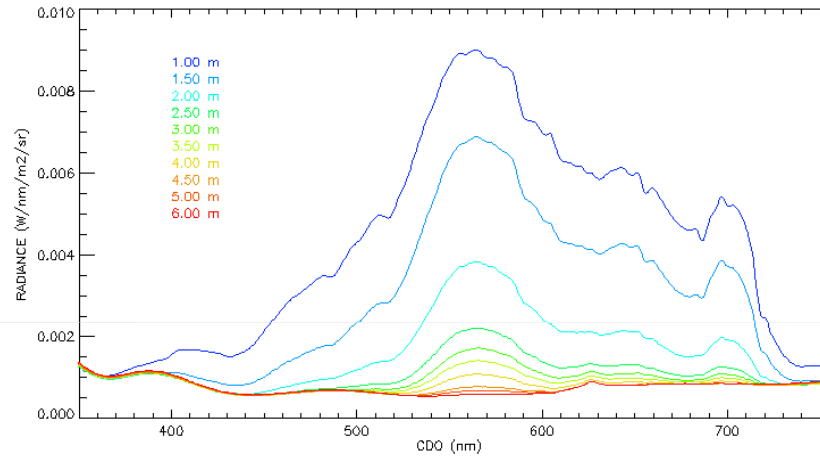
$$I_z = I_0 e^{-kz}$$

where  $I_z$  is the light intensity at a depth  $z$  below the surface,  $I_0$  is the immediate sub-surface light intensity,  $z$  is the depth and  $k$  is the rate of attenuation of downwelling radiation usually referred to as the extinction coefficient.

# Extinction Coefficient

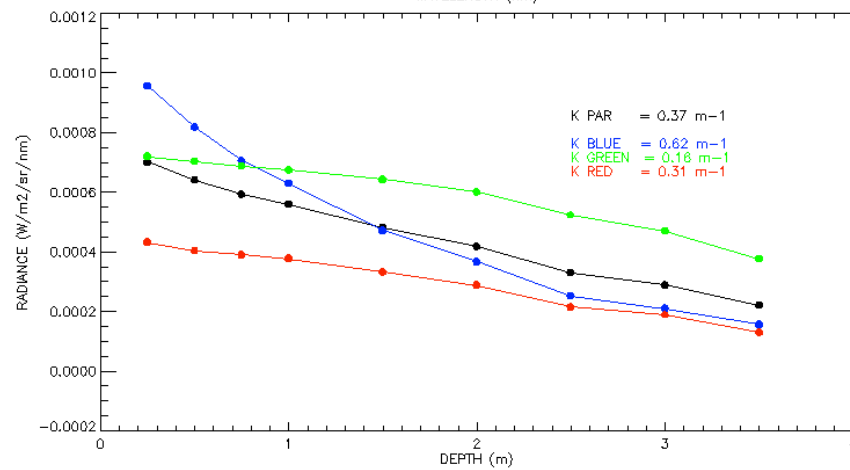
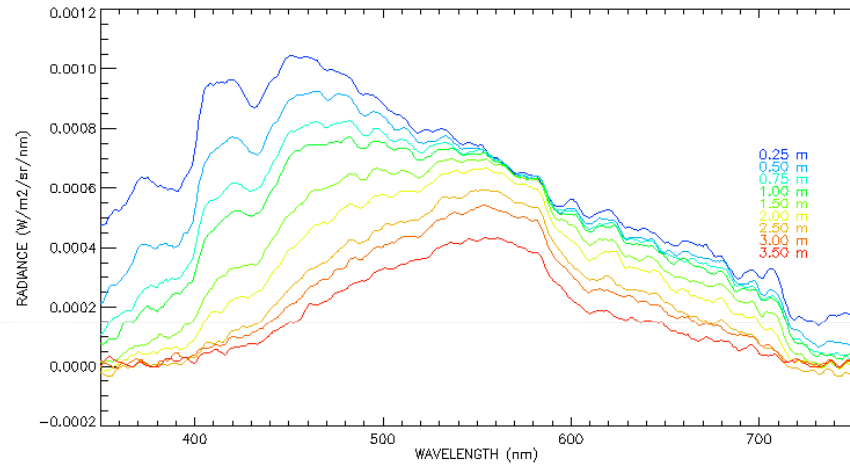
Alqueva Reservoir (19/08/2011)

Average Turbidity in column 15.01 NTU



Thau Lagoon (24/08/2011)

Turbidity at first meter 0.5 NTU





# SUMMARY

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- ❑ The results obtained by the field campaigns constitute promising results aiming at the validation of the atmospheric correction implemented.
- ❑ The algorithm developed to obtain water turbidity demonstrate the broad capabilities of MERIS sensor to monitor the water quality inland.
- ❑ In water radiance measurements allows the calculations of the water extinction coefficient of the water column.

# Future Work

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- ❑ Developing an algorithm to retrieve the light extinction coefficient.
- ❑ Explore the relationship between turbidity and light extinction coefficient.
- ❑ Apply the methodology to other reservoirs and lagoons.

# ACKNOWLEDGEMENTS

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- ❑ Laboratório da Água (CGE)
- ❑ EDIA
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THANK YOU !