Measurements of Lake-Atmosphere interactions at Alqueva reservoir

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ALEX2014 field campaign

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Four month study (June to September) with a Intensive Operational Period (IOP) of four days in July

- Meteorological and flux measurements
- Solar resource
- Water quality – Chemical and phytoplankton composition
- Solar atenuation inwater
- Air quality - Atmospheric, aerosols and gases composition
- Water vapour mapping through GPS network (IOP)
- Radiossondes with Meteorology and Atmospheric Electricity components (IOP)

ALEX2014 Goals

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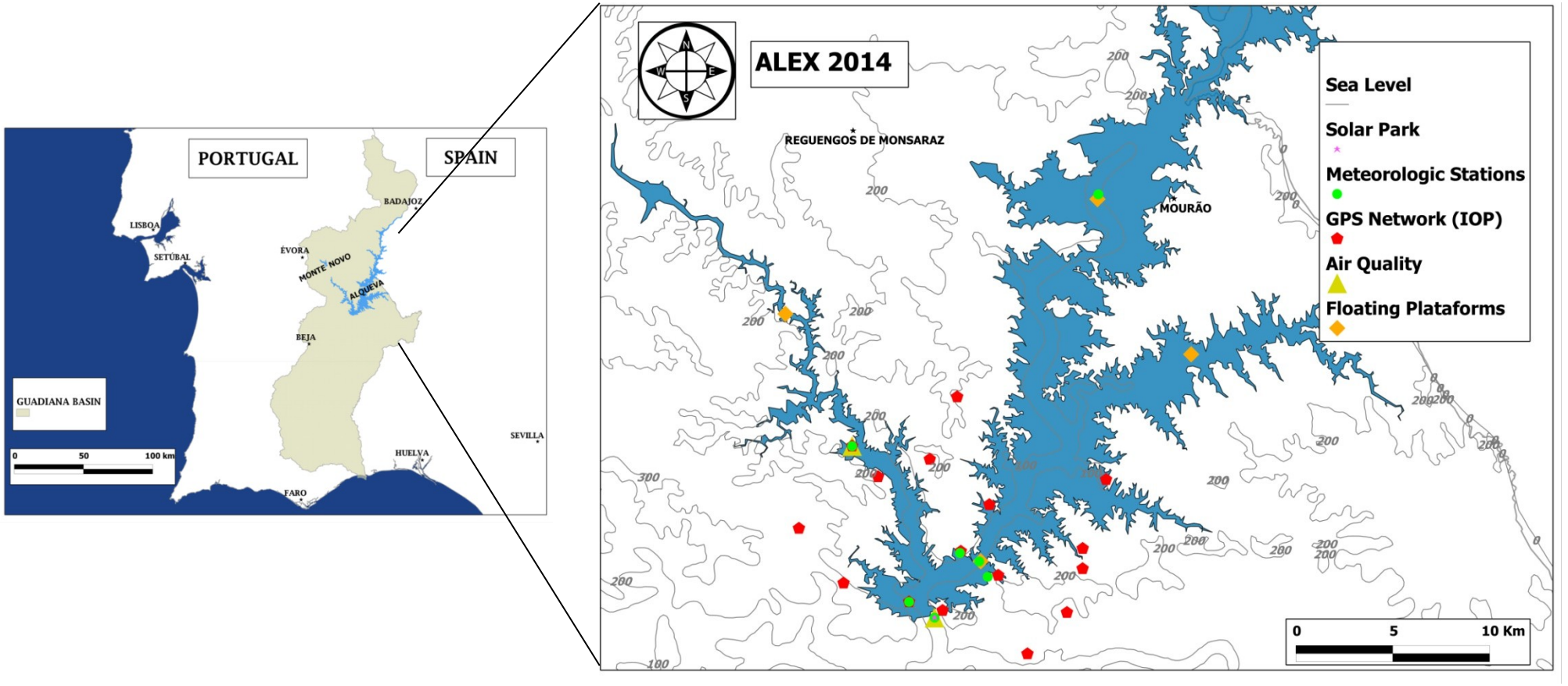
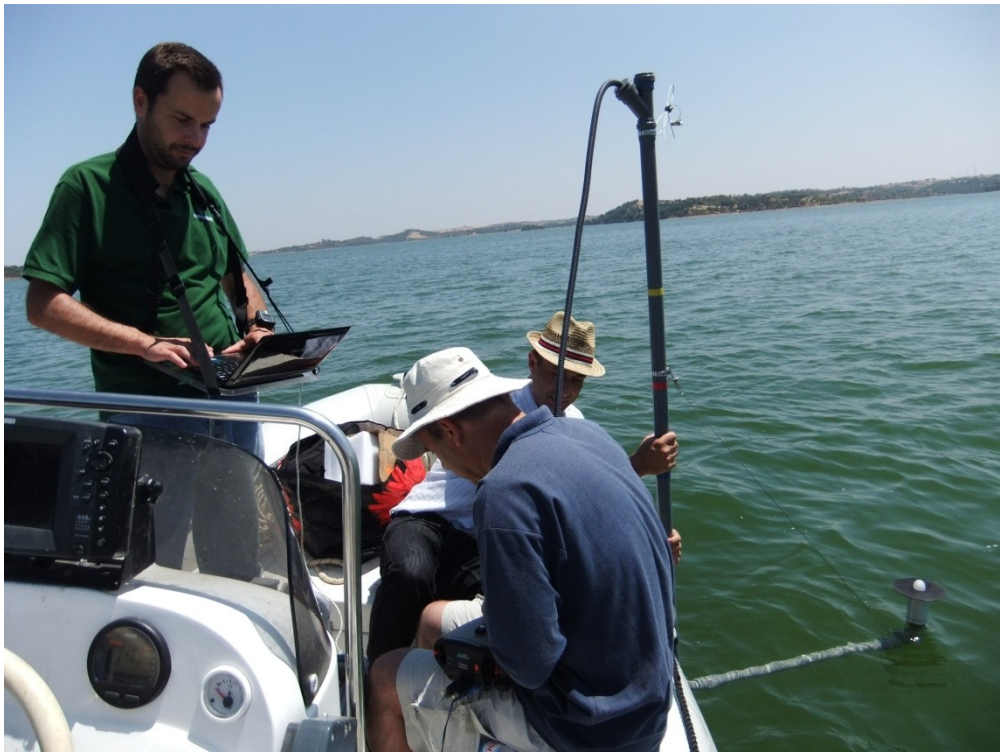
- Support the management of the reservoir
- Calibrate lake models - in particular the Flake (Mironov et al. 2010)
- Improve parametrization of lakes in numerical weather prediction
- Re-assess the effects of climate Alqueva in the region, continuing the previous work of Salgado (2006)
- Characterize the atmospheric boundary layer
- Develop and calibrate algorithms for satellite monitoring of water quality
- Characterize energy resources: solar (global and DNI) and wind
- Obtain CO_2 outgassing estimates

Alqueva Map



Surface area of 250 km^2
Gates were closed in 2002

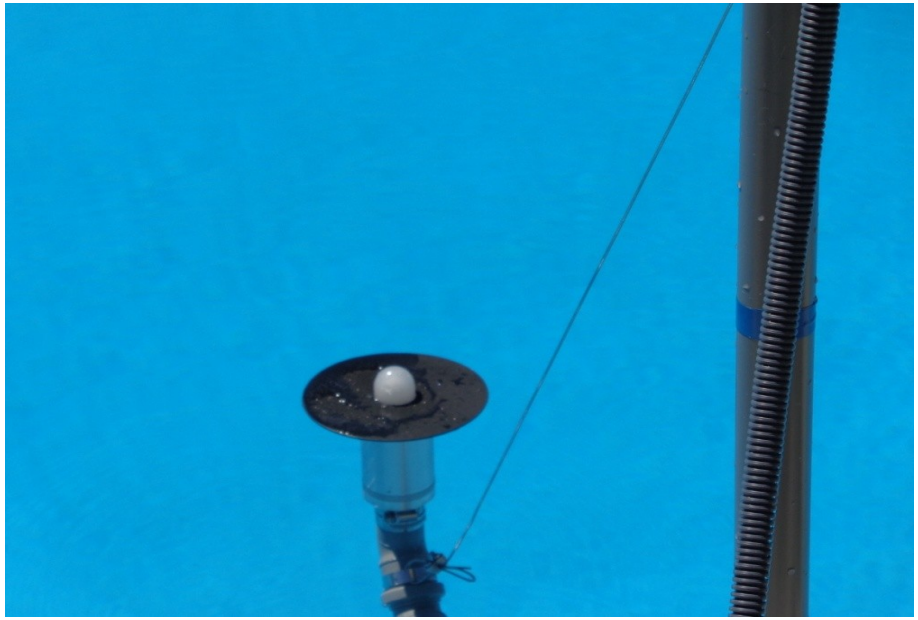
Underwater irradiance system



FieldSpec UV/VNIR da ASD coupled to an optical cable and a cosine receptor

- Wavelengths between 325 – 1075 nm
- Spectral resolution of 3 nm
- 180º of FOV
- Maximum depth of 3 m

Tests in a pool before ALEX2014



This is the dam !

Underwater irradiance profiles

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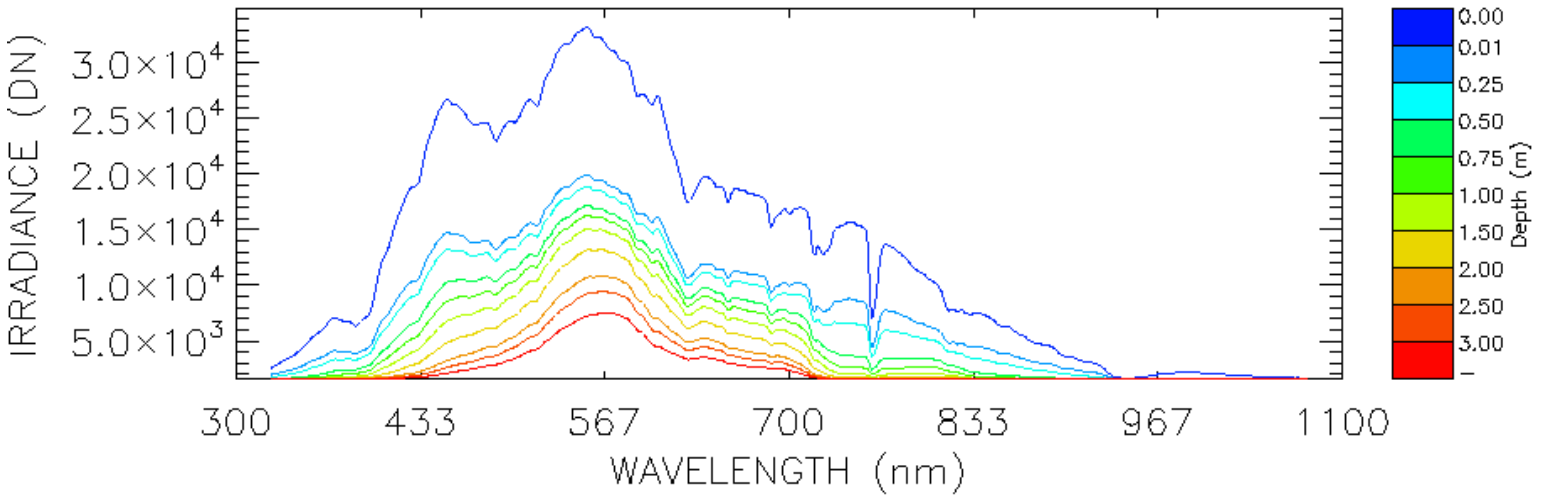
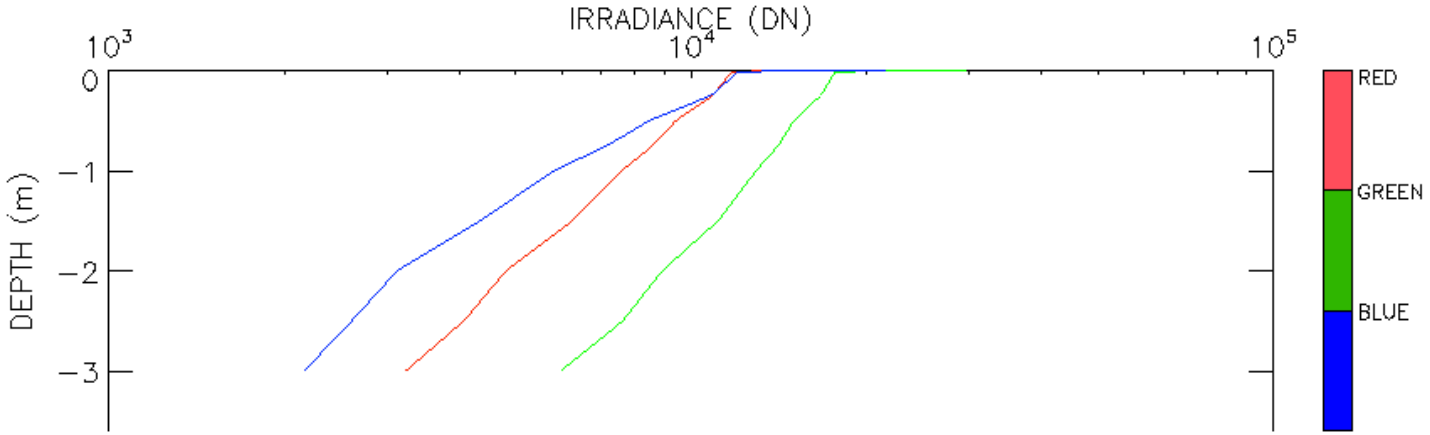




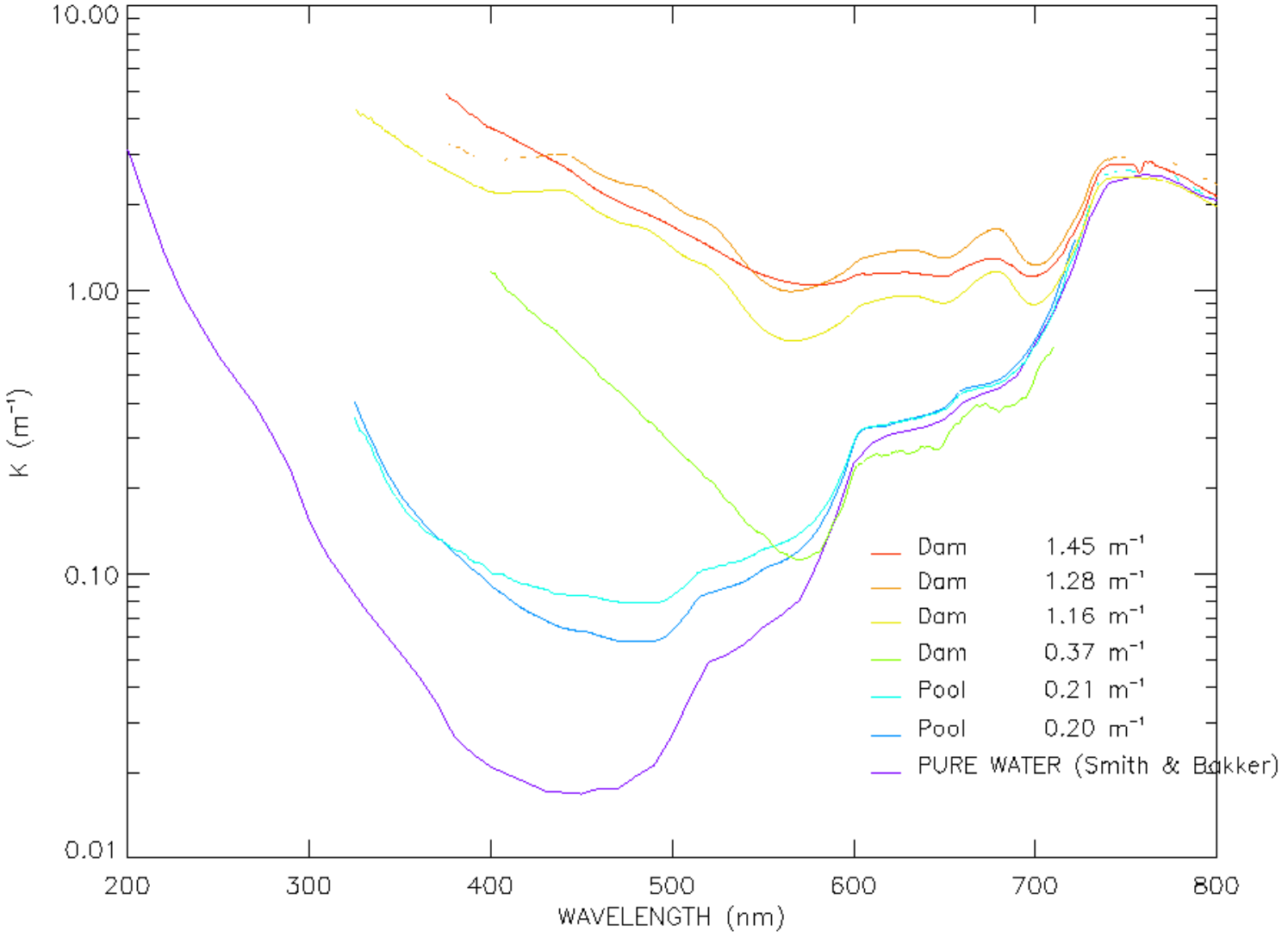
IOP 23 July
Clear Sky
Low wind

Profiles of the sum of irradiance between 400-500, 500-600 and 600-700 nm.

Attenuation Coefficient and PAR values

$$E(z,\theta,\phi,\lambda) = E(0,\theta,\phi,\lambda)\exp\left\{-\int_0^z K(z',\theta,\phi,\lambda)\,dz'\right\}$$

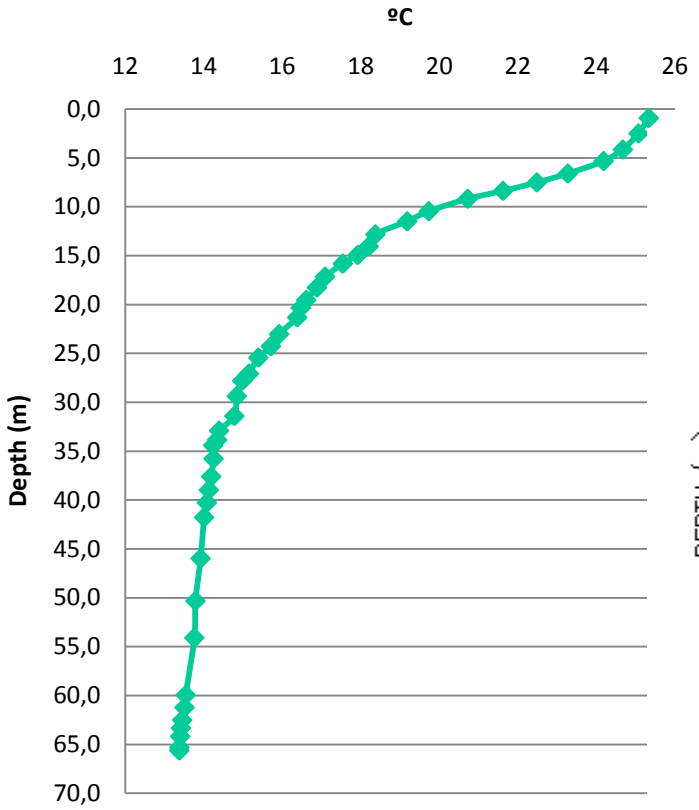
Preisendorfer, 1958



For pure and pool water the minimum of attenuation is between 400-500 nm and with increasing in turbidity (in dams) this minimum shifts to 500 to 600 nm. PAR values (400-700 nm) increases with turbidity (not shown here).

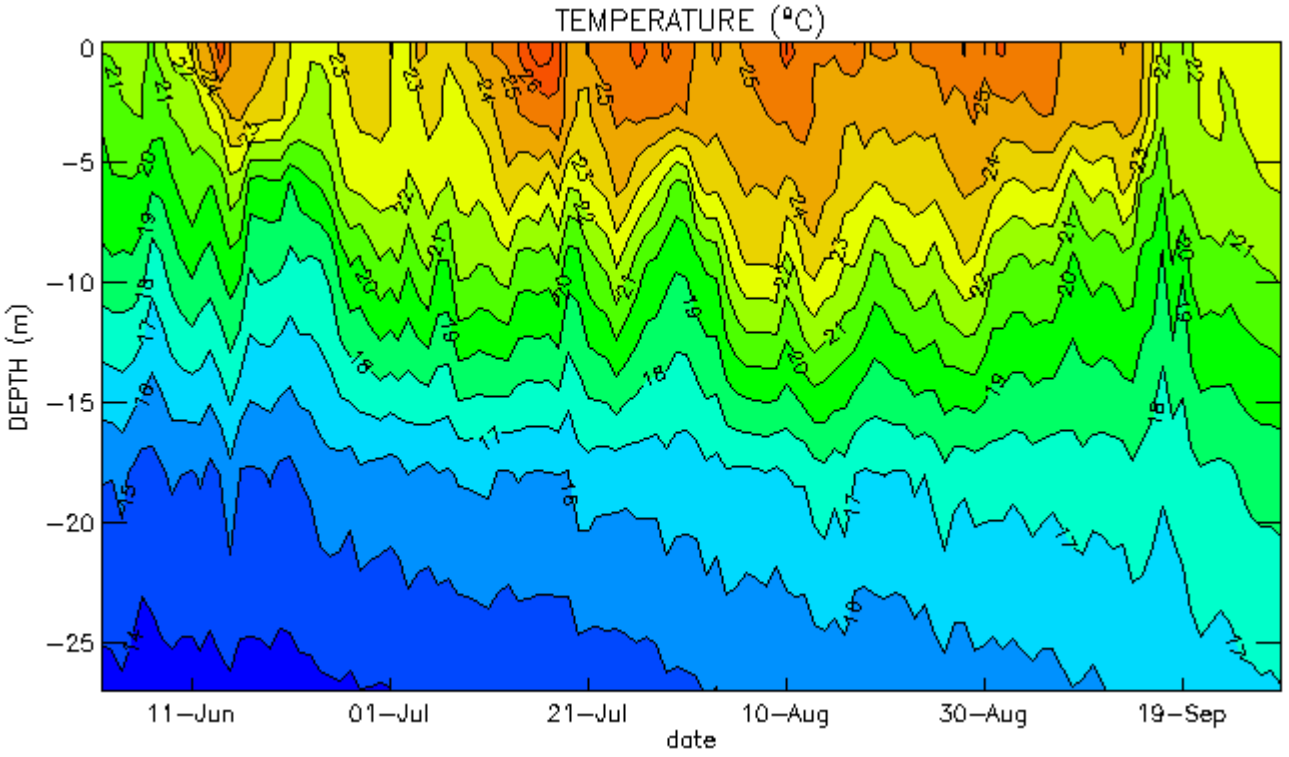
Inwater temperature

Ponctual temperature profiles up to bottom



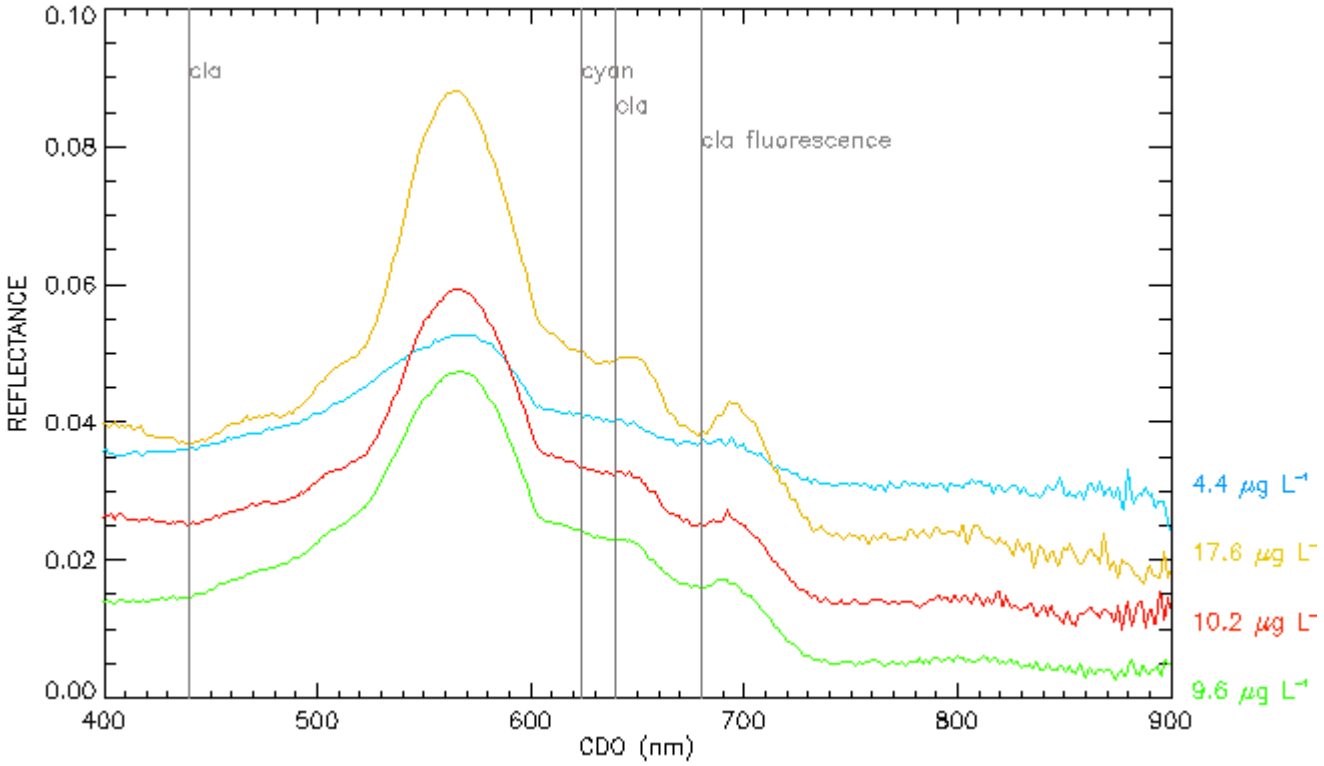
Thermocline between 5 and 15 meters. Also visible in the right graph.

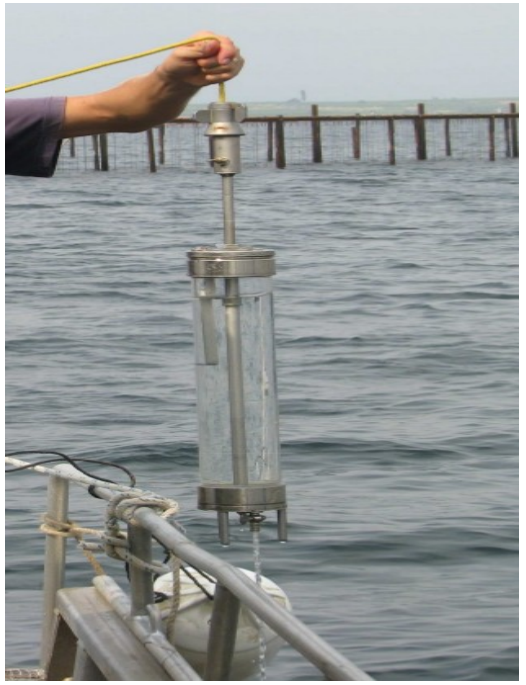
Continuous measurements up to 27 meters depth during the 4 months



It shows the diurnal warming in the first meters and progressive increase of temperature in deeper layers (below 10 meters)

Water Surface Reflectance

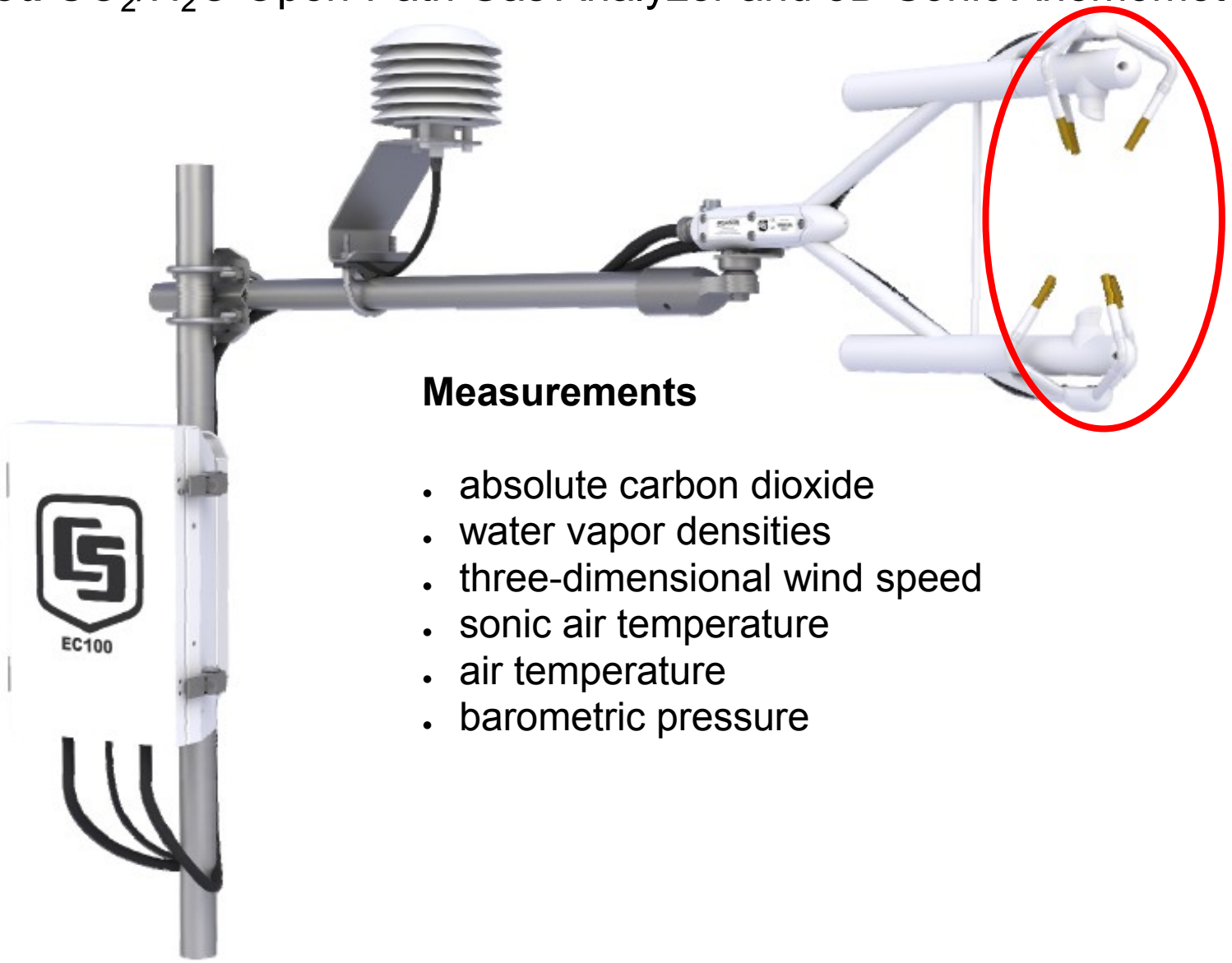




Chlorophyll a has special absorption bands that change the spectrum through his concentration allowing spectral remote sensing detection

Eddy covariance system

Integrated CO_2/H_2O Open-Path Gas Analyzer and 3D Sonic Anemometer



Measurements

- absolute carbon dioxide
- water vapor densities
- three-dimensional wind speed
- sonic air temperature
- air temperature
- barometric pressure

Eddy covariance In Alqueva platform

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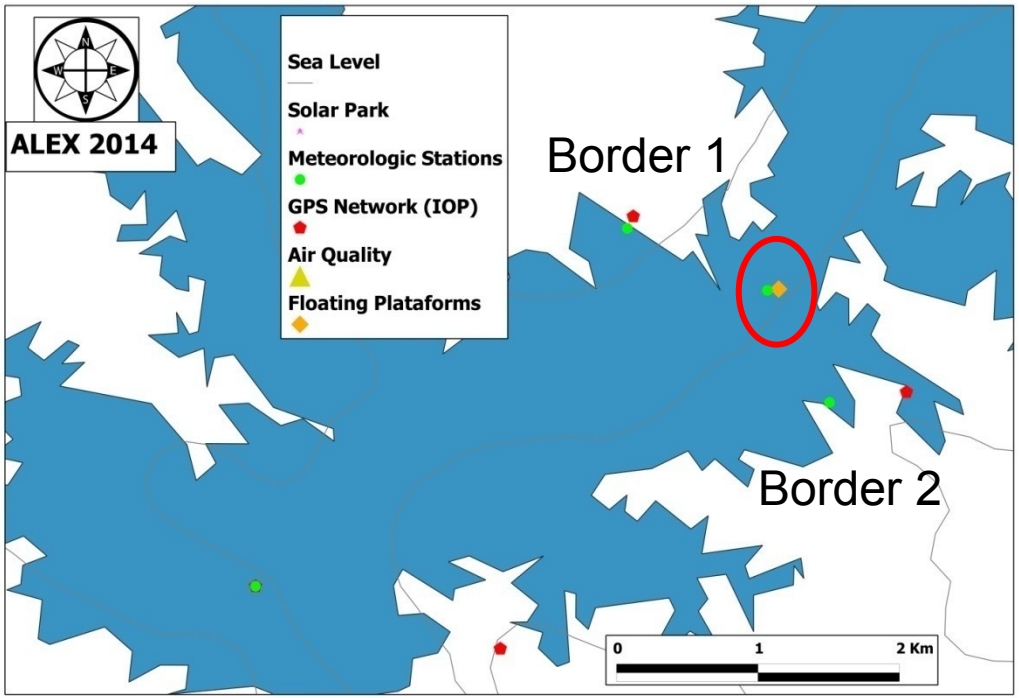
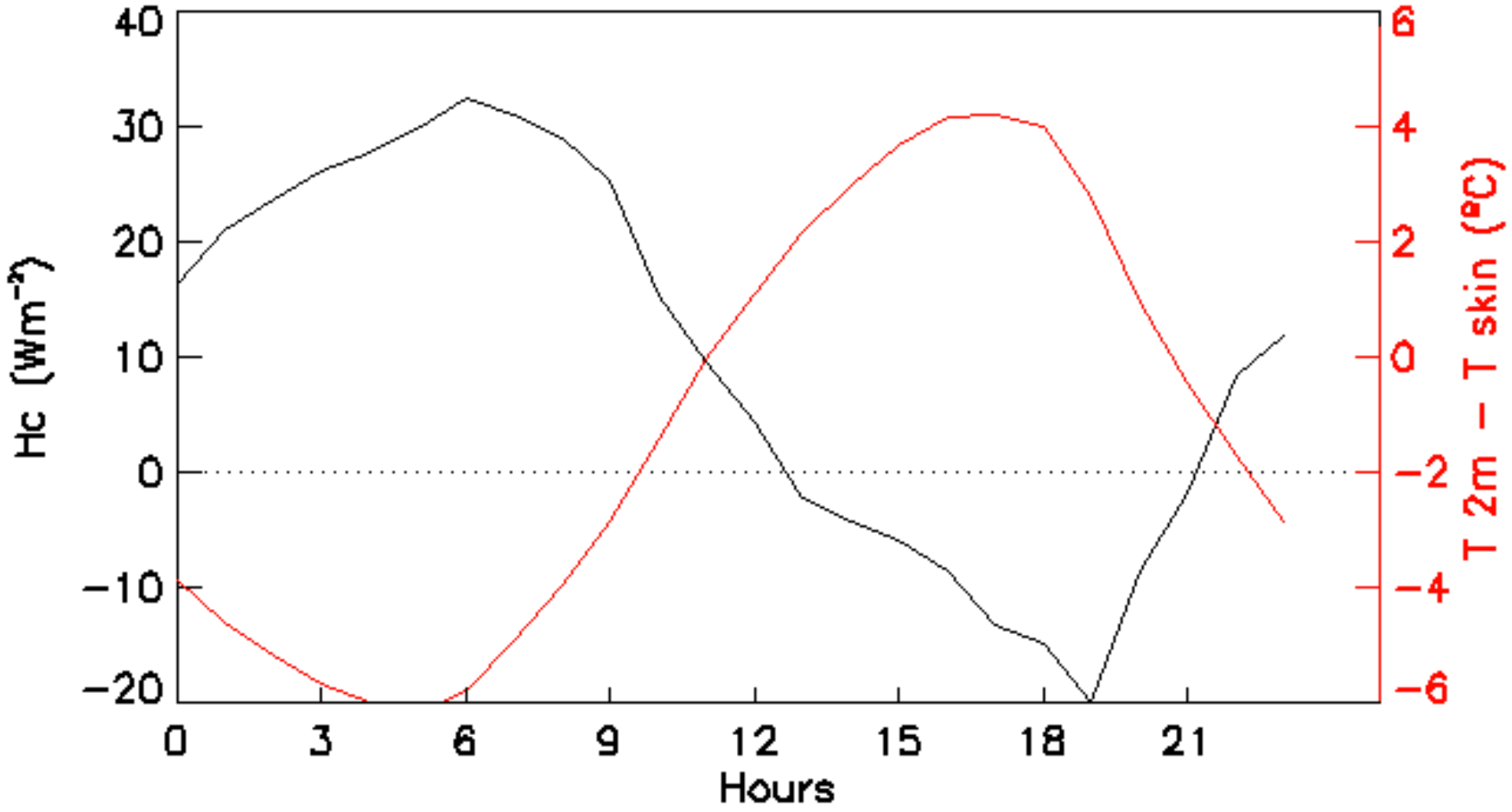
Frequency: 20 Hz
height: 2 m
Flux averages: 30 min
Orientation: NorthWest



Sensible heat flux (July)



When lake is hotter than the atmosphere flux is positive and vice versa

Latent heat flux (July)

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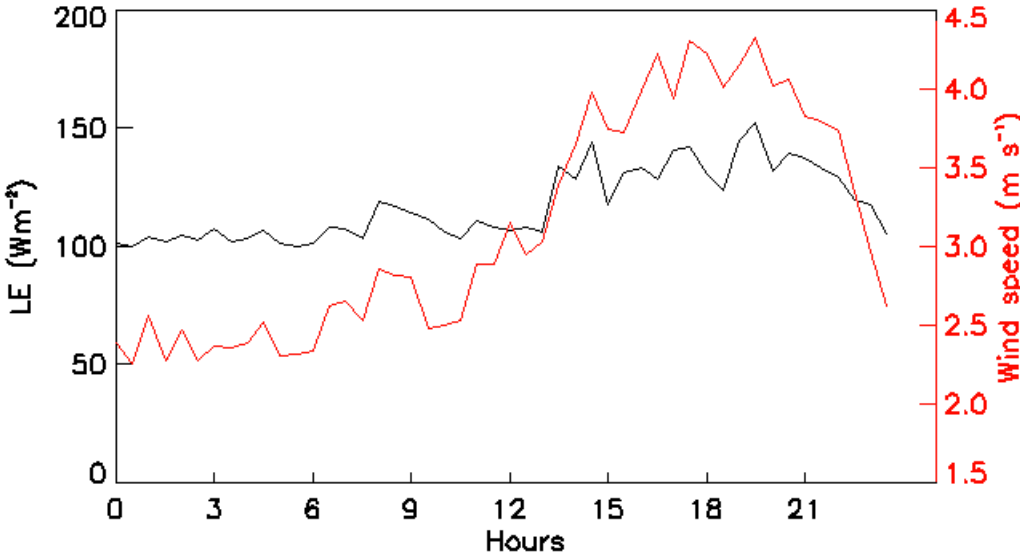
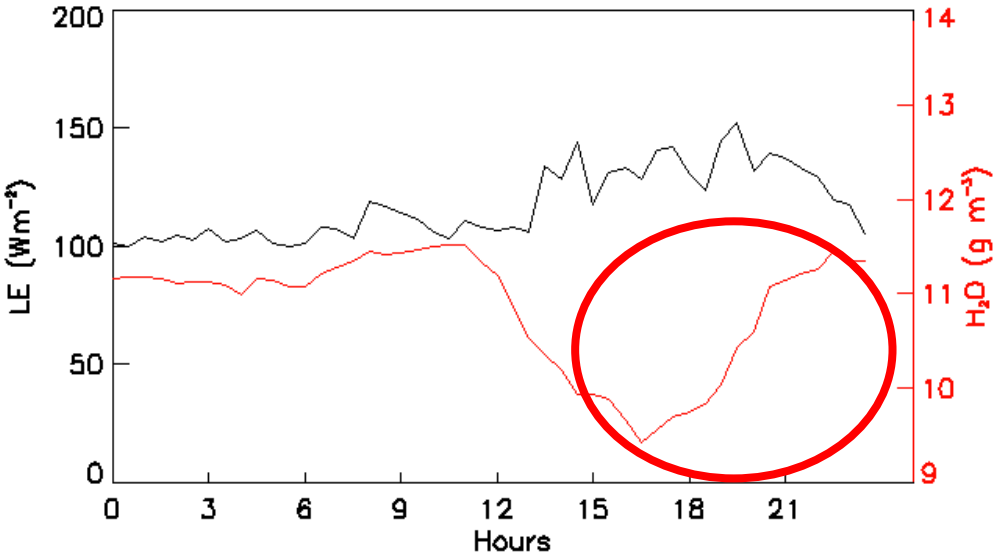
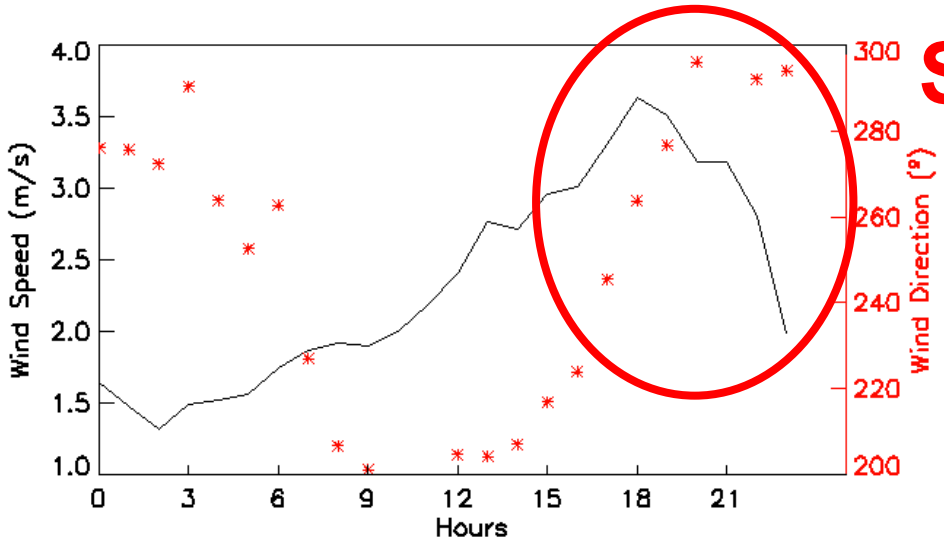
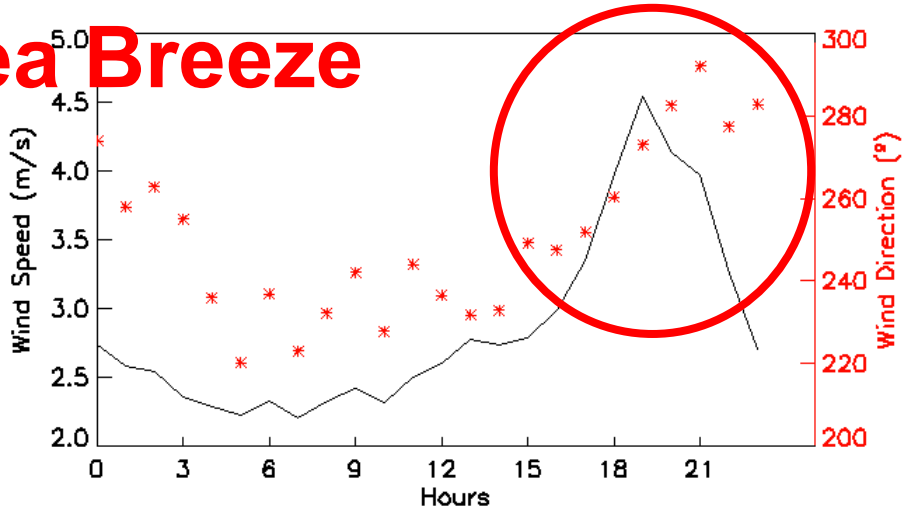
Floating Plataform







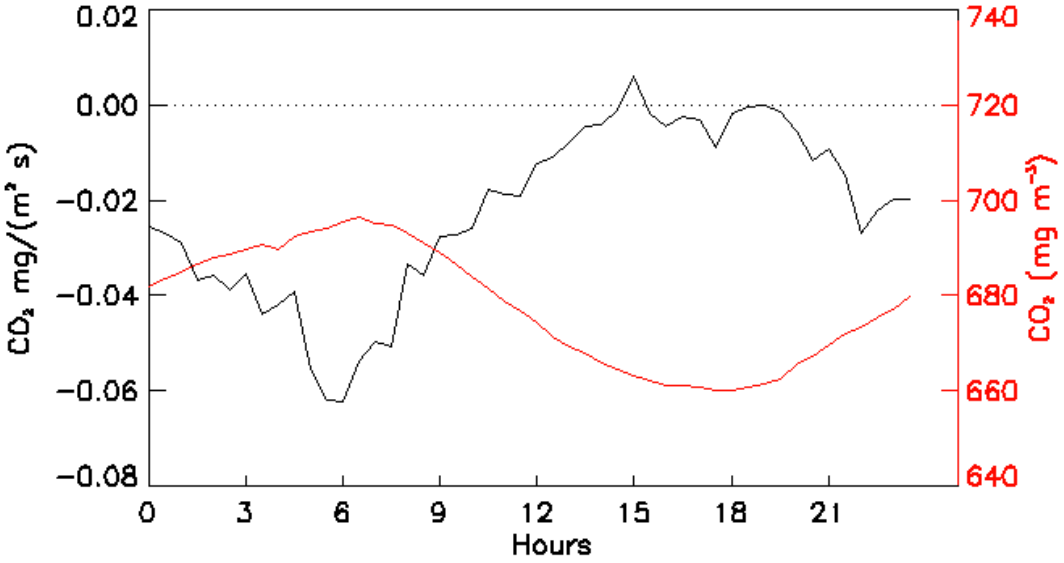
Sea Breeze



Border 1 wind

Border 2 wind

CO_2 flux

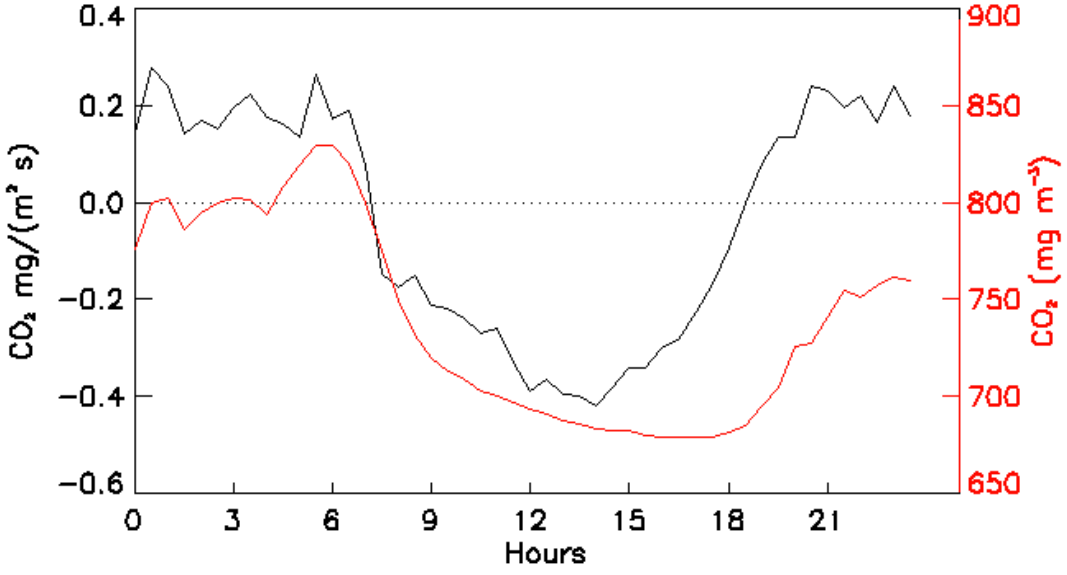


Over the reservoir (July)

When the CO2 concentration is higher (night and morning) the flux is much negative than for lower concentration (during afternoon) thus dam is absorbing more CO2 in this period.

Over grass (April)

During April the system was mounted inland to perform the tests. The local was covered with grass. The results show positive flux during night and negative during daytime. The flux is correlated with the concentration.



Radiossondes

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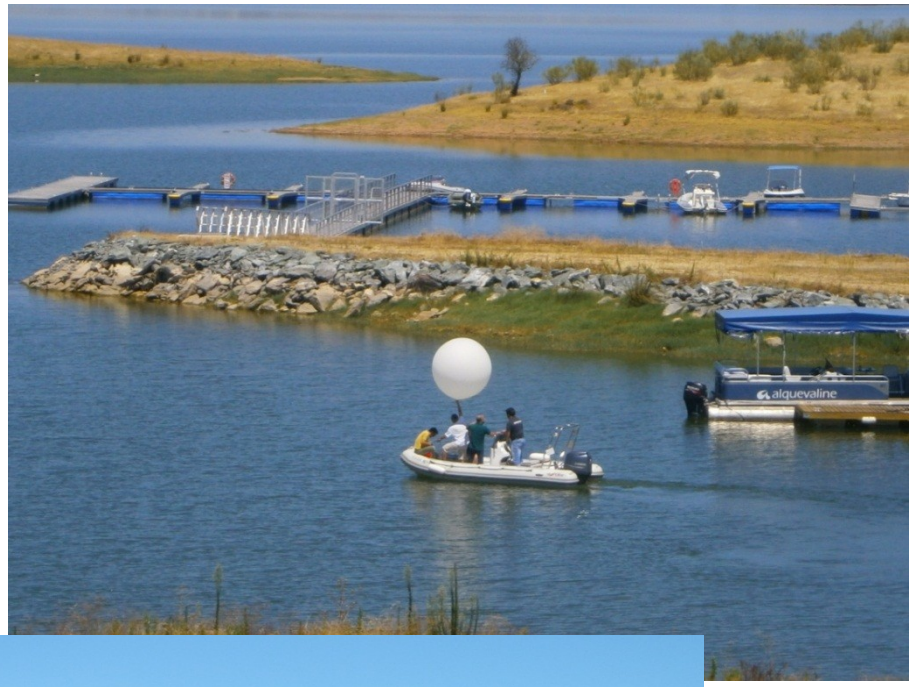
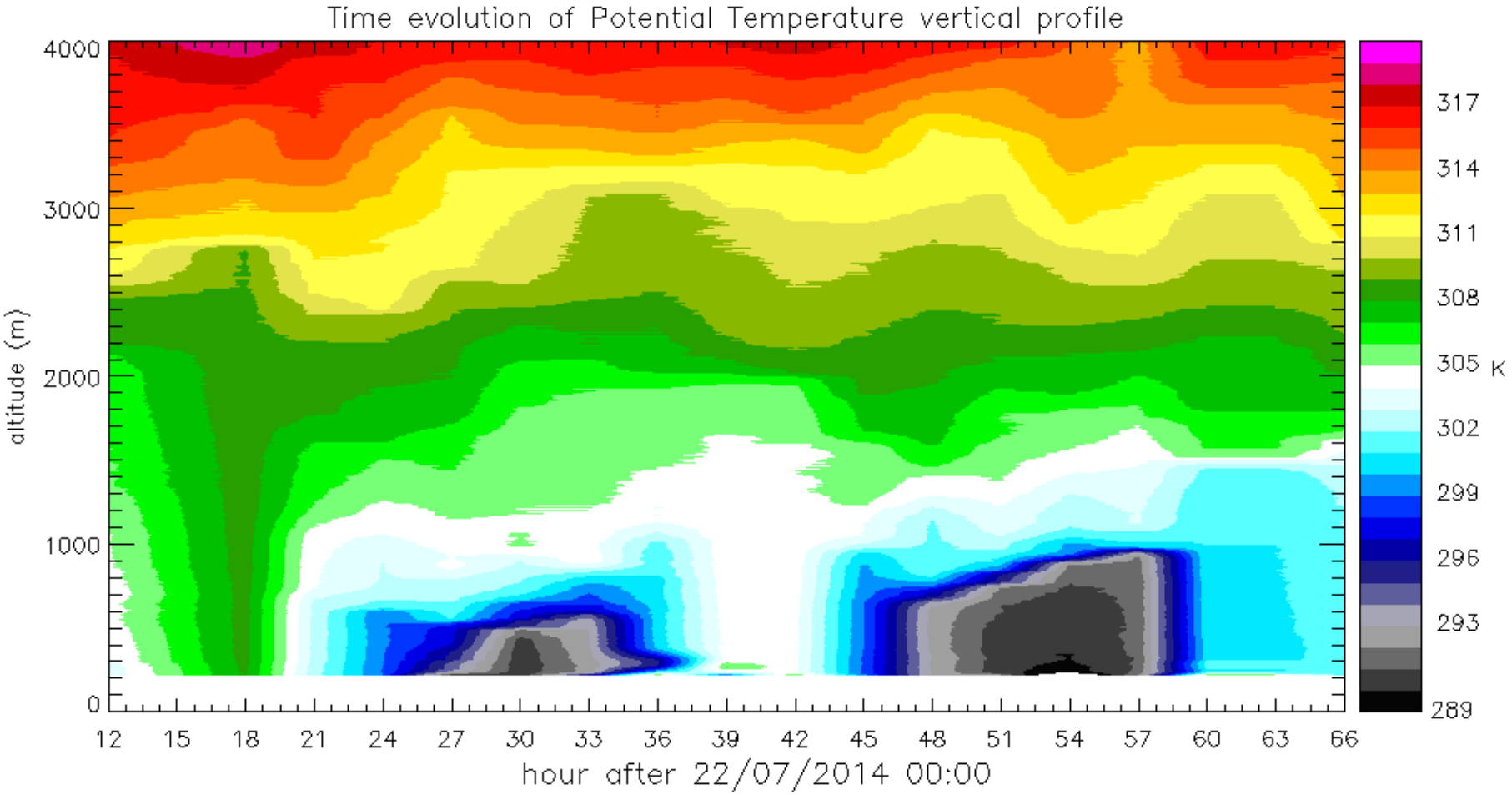
Profiles of Air temperature, Relative humidity,Wind speed and direction, atmospheric electricity

Every 3 hours during 3 days in July



IOP Atmospheric Radiossondes



Characterization of the vertical structure and synoptic conditions

- Anticyclonic conditions
- Boundary layer well developed (more than 2500m deep in 1st day)
- Instable surface layer in the region (over land) with high values of sensible heat flux
- Near surface temperatures greater than 35ºC (1st day)

Future work

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- Study the impact of the reservoir in the regions
- Estimate the energy and mass balance
- We are motivated to try the flux measurements in a smaller and eutrophic dam nearby next year
- Meso-NH and WRF simulations for the IOP

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Thank You !

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Articles

Potes, M., Costa, M. J., Silva, J. C. B., Silva, A. M., e Morais, M., 2011. Remote sensing of water quality parameters over Alqueva reservoir in the south of Portugal. Int. J. Remote Sens., 32:12, 3373-3388.

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