pCO2 wetland automatic analyzer

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Measuring pCO_2 and Dissolved Inorganic Carbonates in Brackish Lagoon

Wetland have a significant role in the global carbon budget, but spatial and temporal variation in lagoon-atmosphere CO_2 exchange is not well understood at the global level. As a result, many scientists are undertaking efforts to evaluate and characterize brackish water CO_2 fluxes. This document provides brief descriptions of D&D pCO_2 automatic systems.

When calculating CO_2 flux for a body of water, measurement of either the partial pressure (pCO_2) or total dissolved inorganic carbon (DIC) in the surface water is necessary. These measurements involve different steps

1) collecting a water sample and ancillary data like Temp, ORP and Conductibility,

2) equilibrating the partial pressures of CO_2 for a water sample and carrier gas in an enclosure for measurement of pCO_2;

3) stripping inorganic carbonates from the water sample with an acid for measurement of total DIC

4) measuring the CO_2 fraction in the gas sample (atmospheric)

5) calculating partial pressure of CO_2 or total dissolved inorganic carbon for the water sample.

System components and operation

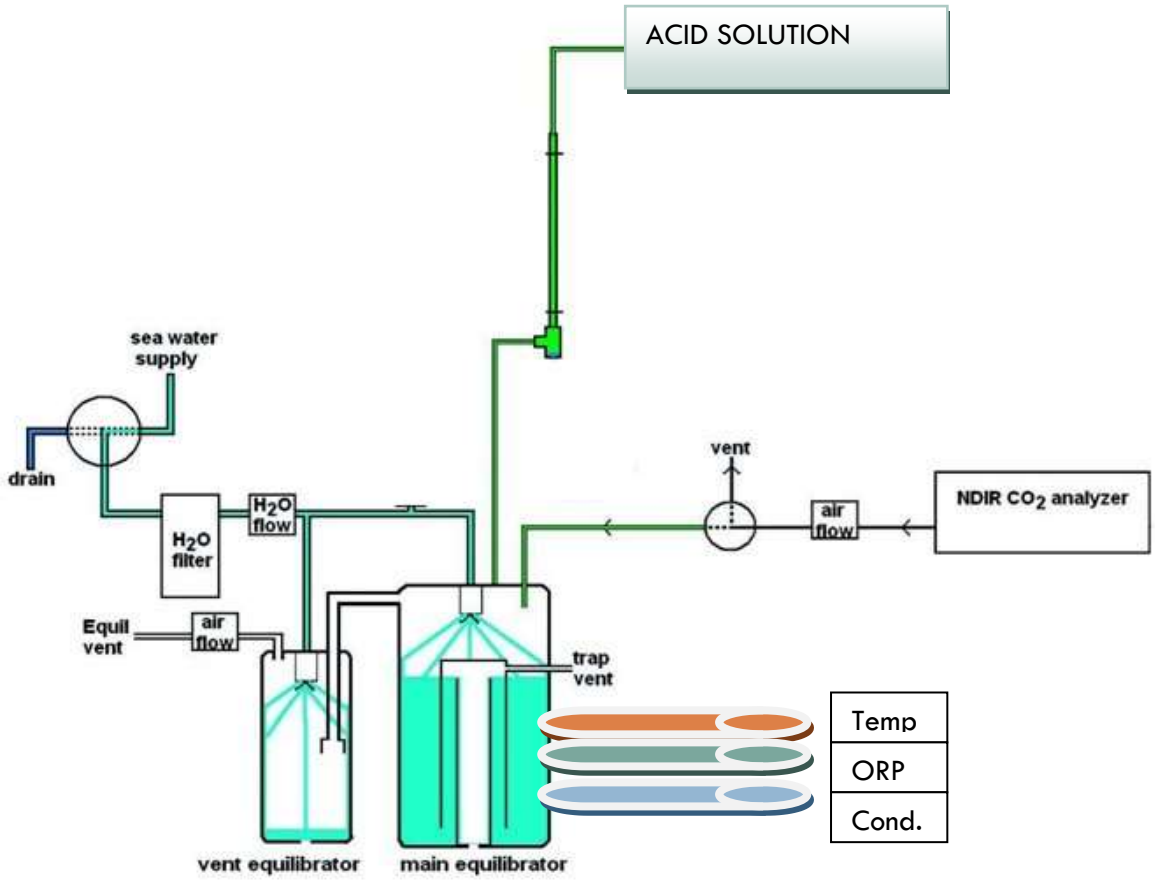
D&D pCO_2 automatic systems are comprised of sampling hardware, an analysis system, and a data logging/web site transmission system.

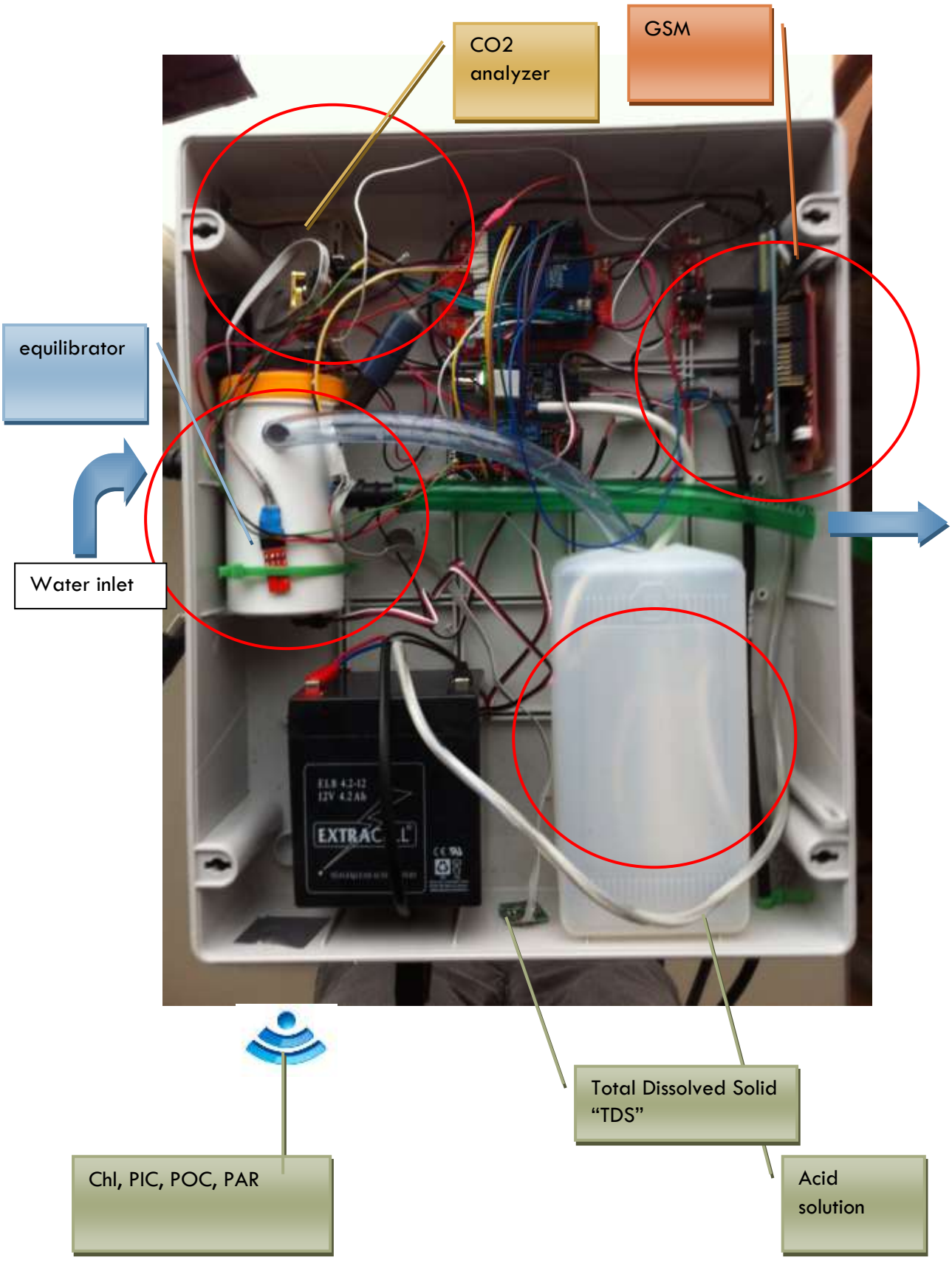
- The sampling hardware consists of:
- a seawater pump supply line, which may be mounted on a sampling platform up the lagoon water level
- a drain for disposing of sampled sea water

- a atmospheric air supply line
- data collection instrumentation to measure temperature, ORP and conductibility
- GPS position, time, depth of intake (tide) , and barometric pressure (opt)
- data collection instrumentation to check water chlorophyll , P.I.C. (Particulate Inorganic Carbon) , P.O.C. (Particulate Organic Carbon) and P.A.R. (Photosynthetic Active Radiation) .

The analysis system (Figure 1) includes:

- an equilibrator
- ancillary data collection instrumentation to measure temperature, ORP and conductibility
- an Infrared CO_2 Gas Analyzer (IRGA) and MIME led to analyze water Gross Primary Production
- plumbing and Arduino based circuitry
- an Arduino based GSM to send data to specific SERVER web site




CO2 analyzer
GSM
equilibrator
Water inlet
Total Dissolved Solid "TDS"
Chl, PIC, POC, PAR
Acid solution

The data collection system includes:

- a data logger or data logging recorded on mini SD card
- a RTC to record the time
- hardware to transfer data to shore using GSM communications technology

Measurement configuration

The D&D system use the stopped flow method : flow of the gas sample through the IRGA chamber is stopped momentarily during measurement. This may be useful when there is a need to limit the amount of standard gases used during calibration or when a limited volume of gas is available from the equilibrator.
The CO2 concentration is calculated by output millivolt values. Scientists who used this model were accustomed to calculating CO2 concentrations and corrections to account for IRGA temperature .

Sampling protocol

A typical run sequence will include measurement of ambient air samples, and equilibrator air samples coming from acid action to the brackish lagoon water .

The programmed sequence is :

1) Start the inlet air fun
2) CO2 and T°C test
3) Start the inlet water pump
4) Water CO2, T°C , ORP and conductibility test
5) Start the acid solution pump
6) Wait to strip CO2
7) CO2 and T°C test
8) CO2 sink calculation
9) Ultrasonic tidal measure
10) Memorization in microSD card
11) Data on line by GSM GPRS connection

Timing

A typical sequence is night and day photocell controlled . The system go on, one time, at day and night beginning. .

Additional considerations

The list below includes descriptions of some challenges that are encountered by scientists who operate with the D&D pCO_2 systems. It is not a comprehensive summary, but rather a description of some common challenges encountered when operating an D&D pCO_2 system.

- Difference in water inlet by pump due to the fouling . Pressure changes in the equilibrator.
- The accumulation and decomposition of organic matter in an equilibrator or any component of the system will result in a positive bias. Recommended solutions are clean the equilibrator unit
- Battery volts under 5V (normal is 12V) due to the photovoltaic panel dirty . Birds can dirty the panel and cause a decreased battery charge
- GSM card with no operation . Please check the line

Autonomous D&D pCO2 systems

The operation principals of pCO_2 monitoring systems use less power, and operate fully autonomously. This system use Arduino Based shield CO_2 Analyzer for gas analysis with a 20 W solar panel buffered by a 7 Amp/hr lead battery .

Dissolved Inorganic Carbon

CO_2 flux is total dissolved inorganic carbon (DIC). DIC refers to dissolved inorganic carbonates in an aqueous sample, including CO_2, H_2CO_3, HCO_3-, (note that H_2CO_3, HCO_3-, and CO_3^{-2} result from $CO_2 + H_2O \leftarrow H_2CO_3 \leftarrow H^+ + HCO_3 \leftarrow 2H^+ + CO_3^{-2}$). DIC requires measuring the total CO2 in a water or liquid mud sample coming by the inlet pump.

Water CO_2 sink index (*)

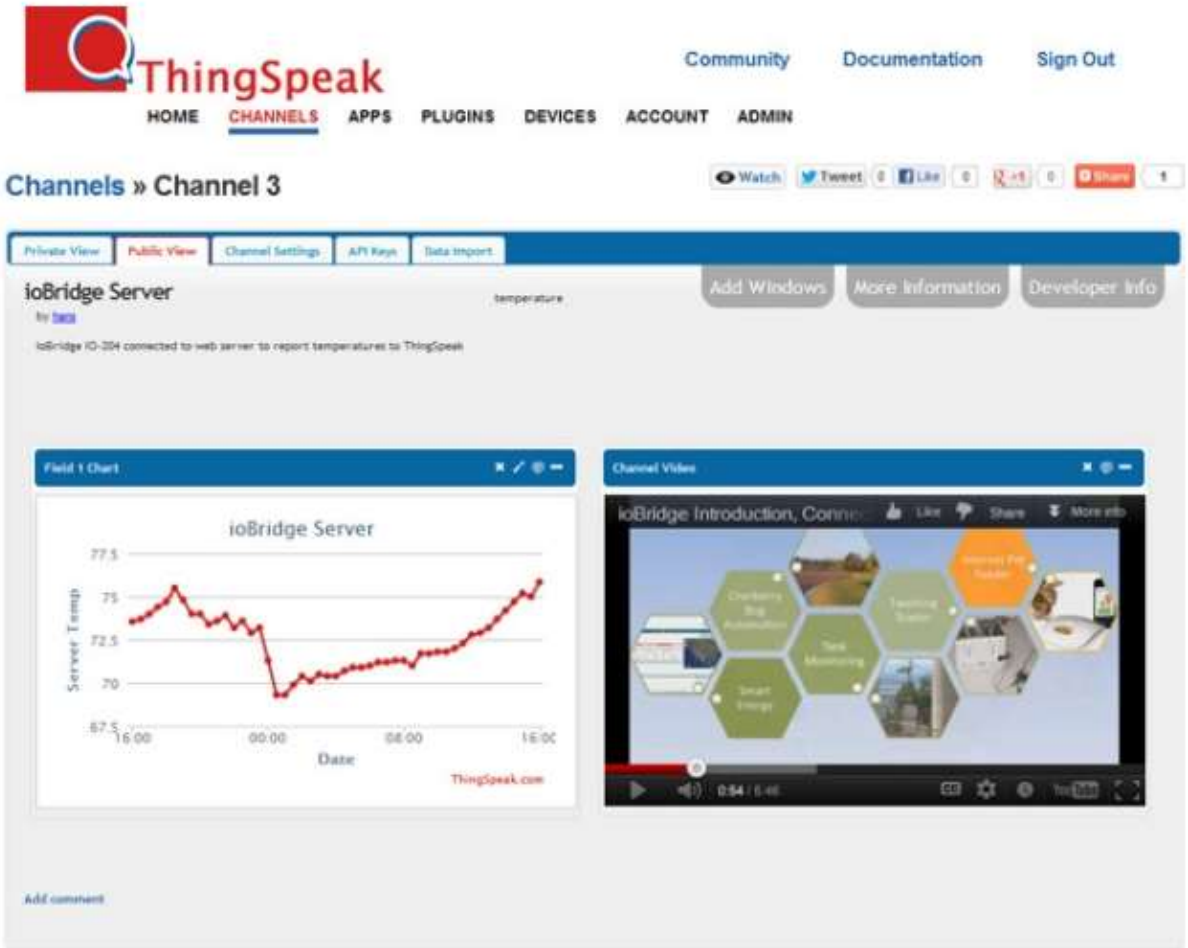
All the registered water parameter can define a carbon sink index (C.S.I.) . CSI can be used for a rapid check of the status of the area and help the inspector to release the Carbon sink certification.

I-CO2(*) = (($CO2_{out}$ -$CO2_{in}$)/100)+(P.I.C. *100)+(P.O.C./100)+(P.A.R./10)+ α Ch l/ tds))

$CO2_{out}$ is the atmospheric CO2 analyzed *outside* the area
$CO2_{in}$ is the atmospheric CO2 analyzed *by the analyzer*

ON LINE data logger by ThingSpeak

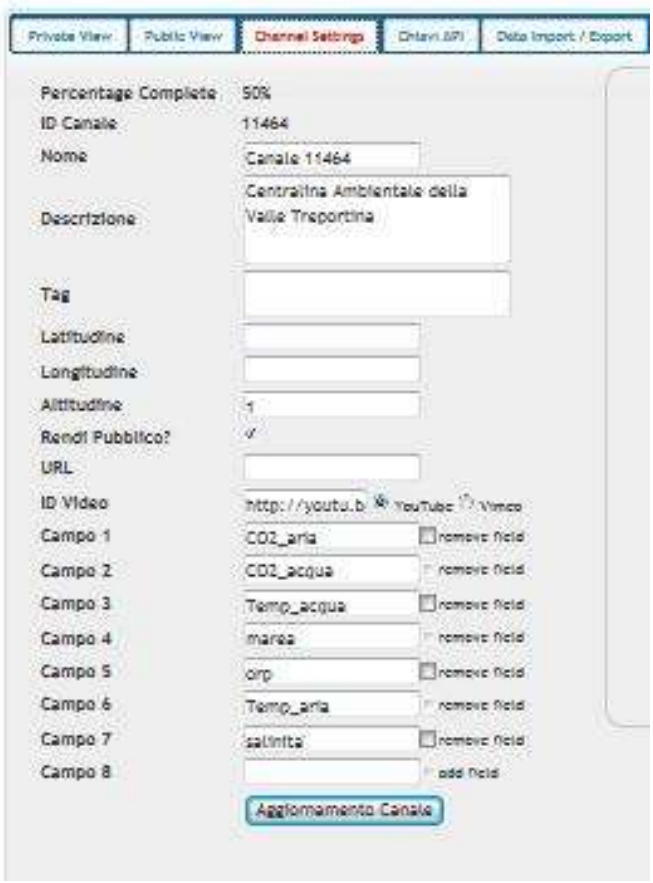
Regular URL: http://thingspeak.com
Channels are where application stores and retrieves data. Each channel has a Private View and a Public View. The Private View is only accessible by signing into your ThingSpeak.com user account. The Public View is what other viewers will see when they visit your ThingSpeak Channel. You can have different info on each view, customize the view with Plugins, and even disable the Public View.



Channel Views have the following features:

- Channel Watch
- Share via Social Networks

- Developer Info
- Ability to embed ThingSpeak Plugins
- Drag-and-drop Organization
- Tags
- Comments



Get a Channel Feed

Valid parameters for data:

results (integer) Number of entries to retrieve, 8000 max, default of 100 (optional)
days (integer) Days from now to include in feed (optional)
start (datetime) Start date in format YYYY-MM-DD%20HH:NN:SS (optional)
end (datetime) End date in format YYYY-MM-DD%20HH:NN:SS (optional)
offset (integer) Offset of your timezone without daylight savings time (optional)
status (true/false) Include status updates in feed by setting "status=true" (optional)
location (true/false) Include latitude, longitude, and elevation in feed by setting "location=true" (optional)
min (decimal) Minimum value to include in response (optional)

max (decimal) Maximum value to include in response (optional)
round (integer) Round to this many decimal places (optional)
timescale (integer or string) Get first value in this many minutes,
sum (integer or string) Get sum of this many minutes,
average (integer or string) Get average of this many minutes,
median (integer or string) Get median of this many minutes
callback (string) Function name to be used for JSONP cross-domain requests (optional)

Importer/Exporter

Using the ThingSpeak you are able to import and export data from a CSV file directly into or from a ThingSpeak Channel every where you are .

The format for the CSV should be the following:

datetime,field1,field2,field3,field4,field5,field6,field7,field8,latitude,longitude,elevation,status

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