

SOLAS SPAIN

compiled by Rafel Simó

Notes:

Reporting Period is January 2009 – December 2009

Information will be used for: reporting, fundraising, networking, strategic development & outreach

1. Scientific highlights

The Mediterranean sink for Atlantic anthropogenic CO₂

During 2009, regular sampling at the Spanish time series GIFT (Gibraltar Fixed Time Series) has been performed and the site was visited four times on board the Spanish RV Sarmiento de Gamboa, in April, June, September and November. The extensive monitoring program performed in the Strait has allowed the computation of the exchange of both anthropogenic and total CO₂ that occurs between the Mediterranean Sea and the North Atlantic, along with a carbon balance in the Mediterranean basin. Data gathered during the development of nine cruises conducted over a period of two years (2005-2007) in conjunction with continuous measurements of the transport of the Mediterranean outflowing water through the Strait of Gibraltar was used for the assessment (Huertas et al. 2009). According to the results, the Mediterranean acts as a sink for anthropogenic CO₂ from the Atlantic due to surface inflow of young, CO₂ anthropogenic-rich waters and deep outflow of older waters poorer in anthropogenic CO₂. The study was carried out as a collaboration among the ICMAN-CSIC (Cadiz), the University of Malaga, and the Institute National de Recherche Halieutique (INRH) of Morocco. In addition, rates of carbon fixation by phytoplankton were analysed in relation to the physical forcing and biological dynamics in the Strait, and the net contribution of primary production to the air-sea CO₂ exchange was also evaluated (Macías et al. 2009), with support from satellite imagery. Remote sensing was also applied to characterize the relationship between the physical and biological processes associated with the generation of internal waves in the Strait of Gibraltar and Alboran Sea (Vazquez et al. 2009). The export of carbon in the form of transparent exopolymer particles was also considered in the entire region. Results were presented at the 8th Carbon Dioxide Conference celebrated in Jena in September 2009 and at the SOLAS OSC held in Barcelona in November.

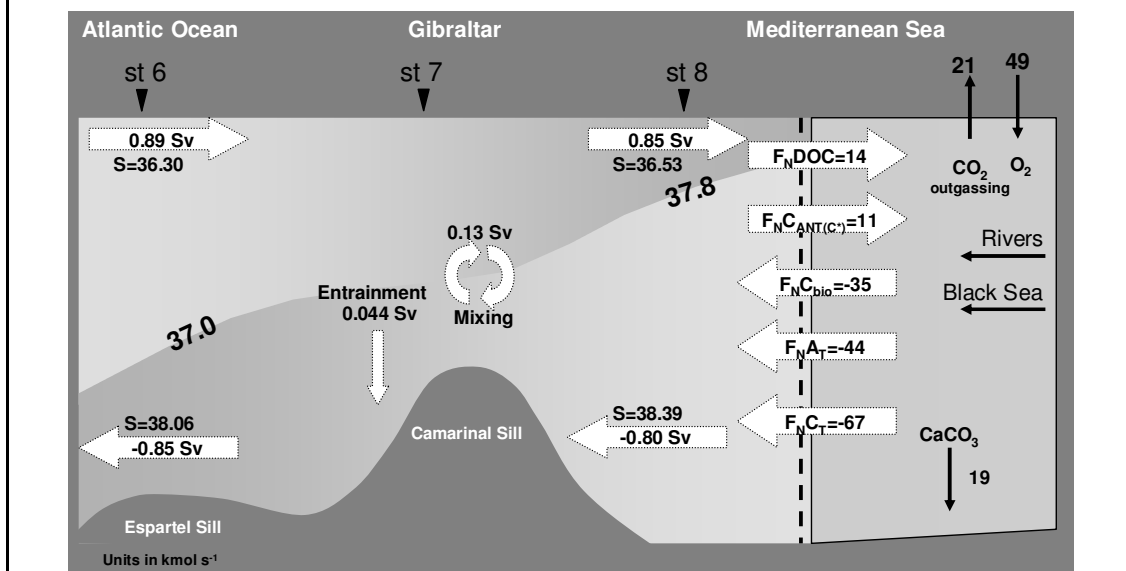


Diagram of a two-layer model of water mass exchange through the Strait of Gibraltar. Values of the net fluxes of alkalinity (F_{NA_T}), inorganic carbon (F_{NC_T}), dissolved organic carbon (F_{NDOC}), anthropogenic carbon ($F_{NC_{ANT(C^+)}}$) and inorganic carbon resulting from remineralization of organic matter ($F_{NC_{bio}}$) that take place between the Atlantic Ocean and the Mediterranean Sea are indicated on the dash line. Precipitation rate of $CaCO_3$ in the Mediterranean basin is also shown, along with air-sea transferences of O_2 and CO_2 . (From Huertas et al. 2009)

2. Main accomplishments (research projects, cruises, special events, workshops, outreach, capacity building, remote sensing used etc)

* SOLAS OPEN SCIENCE CONFERENCE. Barcelona 16-19 November 2009. The conference was organised by the SOLAS IPO and the SOLAS SSC, and I. Cacho (UBarcelona) and R. Simó (CSIC) acted as local organisers. Over 250 scientists from 6 continents attended the conference. A public lecture event was organised in collaboration with CosmoCaixa.

* Four PhD students (S. Flecha, ICMAN-CSIC, C. Galbán, IDAEA-CSIC, M. Huete, U Vigo, and S. Ruiz, IMEDEA-CSIC) received travel support from IGBP-Spain to attend the SOLAS Summer School 2009.

* The ATOS Project (part of IPY-Spain activities) team finished its activities in February 2009 with the second ATOS cruise to Antarctic waters (the first took them to the Arctic in 2007). Senior researchers involved were C.M. Duarte (project leader), J. Dachs (cruise chief scientist), M. Alcaraz, D. Planas, S. Agustí, A. Tovar, D. Vaqué, D. Gomis, M. Sala, E. Saiz, A. Calbet, J.M. Arrieta, S. Lacorte, R. Tauler, and R. Simó. The team successfully completed their objectives of sampling seawater, krill, iceberg ice, glacier ice, and aerosols. Currently ongoing analyses and data processing should provide insight on the role of ice melting in seawater biology and biogeochemistry, and the impacts of deposited atmospheric nutrients, metals and organic pollutants on the planktonic food web.

* P. Serret (U Vigo) participated in the research cruise ICON of the SOLAS-UK (15 April - 27 May 2009) with funding from the Spanish Ministry of Science and Innovation. The objective of this participation was the measurement of bacterial and plankton community respiration, and net community production.

* Extensive field studies aimed at assessing ocean carbon fluxes (SOLAS focus 3) are being conducted by ICMAN-CSIC (Cadiz) in the South-western Iberian Peninsula, including the Gulf of Cadiz, Strait of Gibraltar and Alboran Sea areas. Research has been funded by the EU through the Integrated Projects CARBOOCEAN (FP6-511176GOCE) and SESAME (GOCE2006-036949) (6th FP) and by the Spanish MICINN grants CTM2008-05680-C02/MAR and CTM2009-05835-E/MAR.

* The IIM-CSIC group (Vigo) has measured air-sea CO_2 fluxes during the CAIBEX project led by Eric Desmond Barton (IIM-CSIC) and also within the FAMOSO project led by Mikel Latasa (IEO Gijón). The main objectives of these projects are the study of shelf-ocean exchanges in the Canarias – Iberian Large Marine Ecosystem and the fate of the northwestern Mediterranean open sea spring bloom, respectively. Both projects have been funded from the Spanish Ministry of Science and Innovation.

* The ICMAN-CSIC (Cadiz) and IIM-CSIC (Vigo) groups have contributed to provide CO_2 data to CDIAC for timeseries and moorings and SOCAT databases.

* The ICMAN-CSIC group (Cadiz) has generated a data set representing the most complete oceanographic information available for the whole south Atlantic Iberian coast and one of the largest in the temperate Atlantic in terms of both spatial coverage and sampling frequency. The oceanographic and meteorological data can be checked in Prieto et al. (2009).

3. Top 10 publications in 2009 (Reports, articles, models, datasets, products, website etc)

Huertas IE, Rios AF, García-Lafuente J, Makaoui A, Rodríguez-Gálvez S, Sánchez A, Orbi A, Ruiz J, Perez FF (2009) Anthropogenic and natural CO₂ exchange through the Strait of Gibraltar. *Biogeosciences* 6: 647–662.

Padin XA, Navarro G, Gilcoto M, Ríos AF, Pérez FF (2009) Estimation of air-sea CO₂ fluxes in the Bay of Biscay based on empirical relationships and remotely sensed observations. *Journal of Marine Systems* 75:280-289.

Kirchman DL, Morán XAG, Ducklow H (2009) Microbial growth in the polar oceans - the impacts of climate change, *Nature Microbiology Reviews* 7: 451-459, DOI 10.1038/nrmicro2115.

Guadayol Ò, Peters F, Marrasé C, Gasol JM, Roldán C, Berdalet E, Massana R, Sabata A (2009) Episodic meteorological and nutrient-load events as drivers of coastal planktonic ecosystem dynamics: a time series analysis. *Marine Ecology Progress Series*. 381: 139-155. doi: 10.3354/meps07939.

Boxe CS, Saiz-Lopez A (2009) Influence of thin liquid films on polar ice chemistry: Implications for Earth and planetary science, *Polar Science* 3, 73-81.

Agustí S, Duarte CM, Llabrés M, Agawin NSR, Kennedy H (2009), Response of coastal Antarctic phytoplankton to solar radiation and ammonium manipulation: An in situ mesocosm experiment, *J. Geophys. Res.* 114, G01009, doi:10.1029/2008JG000753.

Hendriks IE, Duarte CM, and Álvarez M (2009) Vulnerability of marine biodiversity to ocean acidification: A meta-analysis, *Est Coast Shelf Sci* 86, 157-164

Simó R, Vila-Costa M, Alonso-Sáez L, Cardelús C, Guadayol Ò, Vázquez-Domínguez E, Gasol JM (2009). Annual series of DMSP contribution to S and C fluxes through phytoplankton and bacterioplankton in a NW Mediterranean coastal site. *Aquatic Microbial Ecology* 57: 43-55.

Alexander B, Hastings MG, Allman DJ, Dachs J, Thornton JA, Kunasek SA (2009) Quantifying atmospheric nitrate formation pathways based on a global model of the oxygen isotopic composition ($\Delta^{17}O$) of atmospheric nitrate, *Atmos. Chem. Phys.* 9, 5043-5056.

Mouriño-Carballido B (2009) Eddy-driven pulses of respiration in the Sargasso Sea. *Deep Sea Research Part I* 56, 1242-1250.

4. International interactions and collaborations

Collaboration among the research groups in plankton metabolism of C. Robinson (U East Anglia), V. Kitidis (Plymouth Marine Lab) and P. Serret (U Vigo) within the SOLAS-UK project ICON. Extension of such collaboration is intended via new proposals for funding.

The ICMAN-CSIC group participates in the European Consortiums involved in both CARBOOCEAN and SESAME. They lead the CARBOOCEAN Workpackage 13 in charge of generating databases, measurement systems and models able to quantify the carbon exchange through the Strait of Gibraltar. They are also part of the SESAME steering committee, also coordinating the Workpackage 5 focused on the development of ecosystem models to connect low and higher trophic levels. Within these two European initiatives, a closer collaboration in the context of SOLAS has been maintained with the group led by Dr. Alberto Borges at the Université de Liège and the INRH group. Furthermore, the group is in charge of coordinating the Spanish contribution to ICOS (Integrate Carbon Observing Systems) and attended the Central Facilities Conference for stakeholders held in Rome in November (16-18).

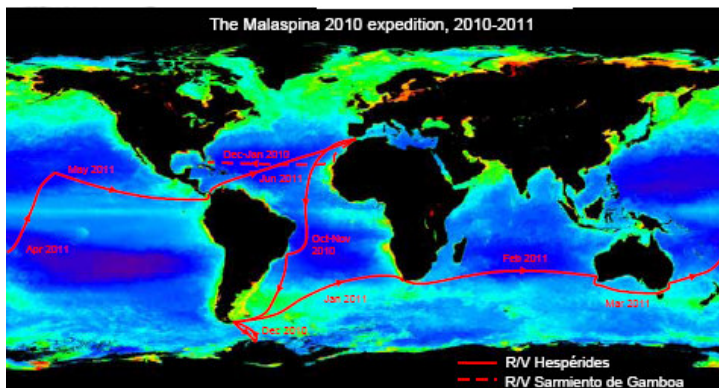
The IIM-CSIC has been involved in the SOCAT coastal region meeting (22–23 January, Norwick) and the SOCAT Atlantic meeting (25–26 June, Kiel). The group was designated IP for performing 2nd level quality control and data gridding of SOCAT dataset in the Iberian coast, Bay of Biscay and subpolar regions of the North Atlantic Ocean.

This has been the year of almost completion of the DMS-GO project, an initiative aimed to create a

new climatology of DMS concentrations and emission fluxes in the global oceans. This is a joint initiative of the SOLAS Integration Project, COST Action 735 and EUROCEANS. The core leading group is formed by A. Lana and R. Simó (ICM-CSIC, Barcelona), and T. Bell and P. Liss (UEA, Norwich).

5. Goals and plans for future activities

* A 9-month circumnavigation cruise, MALASPINA 2010, is planned with the aims to (1) provide a large-scale coherent inventory of physical, chemical, and biological measurements that may shed light on the footprints of global change on the open ocean ecosystems; (2) explore deep-sea microbial and genetic diversity across the world's oceans; (3) leave a collection of samples of organisms, DNA/RNA, and organic matter for the next generation of researchers; (4) build cooperative frameworks within the Spanish oceanographic community; (5) promote scientific vocations among Spanish youth, and train a new generation of young scientists with a global outlook to ocean ecosystems; (6) celebrate the 200th anniversaries of the birth of Charles Darwin (1809) and the death of Alessandro Malaspina (1810), who led the first Spanish scientific circumnavigation, and raise awareness on his expedition; and (7) inform society of all aspects above, with a dual emphasis on the impacts of global change on ocean ecosystems and the opportunities for exciting discoveries in the exploration of deep-sea biodiversity. The scientific activities include SOLAS-relevant measurements such as CO₂, biogenic trace gases (DMS and isoprene), and aerosols.



* The Climate and Halogen Reactivity tropical EXperiment (CHARLEX), led by Alfonso Saiz-López (CSIC, Toledo) will start in March 2010 in the Galapagos Islands. This field study aims at measuring halogen radicals, O₃, NO_x, ultrafine particles, etc, with a particular emphasis posed into the study of biogenic iodine emissions and their effects on the oxidative capacity of the atmosphere.

* The GIFT time series (conducted by ICMAN-CSIC, Cadiz and the IIM-CSIC, Vigo) has been included in the marine component of ICOS and has been considered as a choke point within a new proposal that has been submitted to the 7th FP for evaluation. The new project agglutinates most of the members of the CARBOOCEAN Consortium. At the national level, there is financial support to maintain the sampling and monitoring during 2010. Therefore, research activities concerning carbon fluxes in the Strait of Gibraltar and nearby basins will continue.

* The ongoing collaboration of P. Serret (U Vigo) with UK groups at the UEA and PML will carry on with joint participation in the forthcoming AMT and SAMS-ARCTIC cruises.

* 'Surface Mixing Modulation of the Exposure to solar Radiation' (SUMMER) is a Spanish project that pursues the study of the modulation effects that underwater solar radiation fields have on seawater biogeochemistry, with a particular emphasis on biogenic trace gases. PI: R. Simó (ICM-CSIC, Barcelona). Duration: 2009-2011.

* 'Primary and Secondary Marine Aerosols: origin, fluxes and role in biogeochemical cycles'



Annual Report for the year 2009:

(PRISMA) is a Spanish project that pursues the study of the emission of primary aerosols and secondary aerosol precursors from the surface ocean. PI: J. Dachs (IDAEA-CSIC, Barcelona). Duration: 2010-2012.

6. Other comments