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BioChem: A National Archive for Marine Biology and Chemistry Data

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Résumé

BioChem est une base nationale de données biologiques et chimiques sur le milieu marin qui a été développée pour rencontrer les besoins du Programme de Monitorage de la Zone Atlantique (PMZA) ainsi que pour fournir une infrastructure centrale permettant d'archiver les nombreux autres jeux de données semblables existant au Ministère des Pêches et des Océans (MPO). BioChem contient présentement une portion significative des données du PMZA ainsi que les données historiques de l'institut océanographique de Bedford. La migration des données de toutes les autres régions du MPO s'effectue présentement, et lorsque complétée, BioChem représentera une source d'informations marines inestimable et irremplaçable pour la recherche écosystémique au Canada.

History

The creation of a national DFO archive of marine biological and chemical data, a long-term goal of many dedicated individuals, is a reality. The database development began in 1997, when the DFO Climate Science Coordinating Committee recognized the importance of timely access to known-quality biological and chemical observations and subsequently allocated funds to develop a database model and implementation plan under the guidance of a national group. Following an initial meeting in Ottawa, where a framework for a national biological/chemical database was formulated, workshops were held in 1998 at the Bedford Institute of Oceanography (BIO) and Marine Environmental Data Service (MEDS) to finalize the initial design. This design was presented at the November 1998 meeting of the Atlantic Zone Monitoring Program (AZMP) and was adopted as the model for the zonal monitoring program. The original proposal for AZMP (Therriault et al. 1998) recognized the need to develop a database for archiving biological and chemical data, and AZMP became an enthusiastic supporter and contributor to the development.

The project received a major boost when the Ocean Sciences Division (OSD) and Marine Environmental Sciences Division (MESD) at the Bedford Institute of Oceanography decided that the database development in the Maritimes Region would be a priority as part of their Y2K preparedness. Subsequently, the DFO Investment Management Board recognized data as a capital asset and allocated substantial multi-year funding for this project.

During the next four years, the development of BioChem (Biology–Chemistry), as it came to be known, was led by the Maritimes Region through a partnership of data managers in MESD and OSD and database specialists of the Informatics group in the Maritimes Region. The development of the application was a major task; the migration of decades of biological and chemical data observations into the database has been an even greater challenge.

The most recent stage in the BioChem development has been the migration of the system to the Marine Environmental Data Service in 2003, where it will finally achieve its initial goal as a national resource accessible from all DFO regions.

Throughout BioChem's development, AZMP has played a major role in providing funding, scientific and technical guidance, and visibility as the project's major client. Without this endorsement, it would have been difficult to get the regional and national support for BioChem.

The Database

BioChem was originally designed to hold any type of marine scientific data. The main functional areas include plankton, discrete (water samples), continuous (profilers, flow-through systems), and environmental (meteorological) information. Provision is also made to accommodate large binary objects such as satellite images or video. The functional areas are built on a mission/event/measurement detail skeleton reflecting the sources of the information. From the outset, the database was designed as a de-centralized system to ensure that the regional experts responsible for data collection would also be responsible for data archive and quality control. The system would also be web-

Discrete Observation Classes / Classes d'observations ponctuelles

Heavy metals / Métaux lourds
Hydrocarbons / Hydrocarbones
Light / Lumière
Major ions / Ions majeurs
Nutrients / Sels nutritifs
Organic matter / Matière organique
Oxygen / Oxygène
Particulate matter / Matière particulaire
Physical Properties / Propriétés physiques
Pigments / Pigments
Primary production / Production primaire
Radionuclides / Radionucléides
Seawater chemistry / Chimie de l'eau de mer
Size of organisms / Taille des organismes
Stable Isotopes / Isotopes stables
Tracers / Traceurs

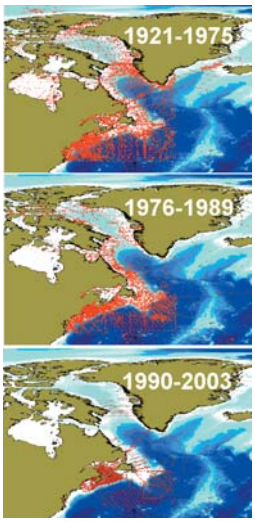

Fig. 1 Distributions of discrete observations in the BioChem database from 1921 to the present.

Répartition des observations ponctuelles dans BioChem de 1921 jusqu'à aujourd'hui.

Plankton Classes / Classes de plancton

Bacteria / Bactéries
Diatoms / Diatomées
Dinoflagellates / Dinoflagellés
Protozooplankton flagellates / Flagellés protozooplanctoniques
Protozooplankton ciliates / Ciliés protozooplanctoniques
Cnidaria / Cnidaires
Ctenophora / Cténophores
Mollusca / Mollusques
Ostracoda / Ostracodes
Copepoda / Copépodes
Amphipoda / Amphipodes
Euphausiacea / Euphausiacés
Decapoda / Décapodes
Chaetognatha / Chaetognates
Ichthyoplankton / Ichtyoplancton

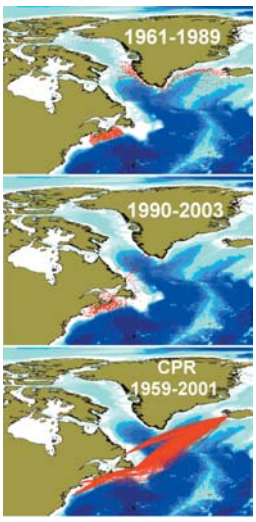

Fig. 2 Distribution of plankton observations in the BioChem database from 1961 to the present. The bottom panel shows observations from the Continuous Plankton Recorder (CPR) since 1959.

Répartition des observations sur le plancton dans BioChem de 1961 jusqu'à aujourd'hui. Le panneau du bas montre les observations provenant du CPR (Continuous Plankton Recorder) depuis 1959.

based to permit broad access. It delivers this capability by providing a centralized archive and web-based query application. Individual data managers have their own set of edit tables where they prepare observations for loading into the archive. A number of additional tools have been constructed to assist data managers in data entry, retrieval, and editing.

Data Holdings

The primary data source is scientific missions originating from DFO research institutions. These are augmented with observations from the MEDS and World Ocean Database (WOD) archives and continuous plankton recorder (CPR) data from the Sir Alister Hardy Foundation for Ocean Science (SAHFOS). The archive covers the Northwest Atlantic (35°-80°N and 40°-100°W) from 1921 to present. The current holdings consist of more than 1575 research missions and in excess of 2.2 million discrete observations from water samples and over 500,000 plankton measurements. The types of observations and their spatial and temporal distributions are summarized in Figures 1 and 2.

Example Applications

BioChem is a new tool to assist researchers in the detection, characterization, and prediction of ecosystem changes. Below we highlight two recent examples of analyses that used BioChem as a source of broad-scale chemical and biological observations.

1) Nitrate, silicate, and phosphate atlas for the Gulf of St. Lawrence (Brickman and Petrie 2003)

In this report, over 36,000 observations for each of nitrate, silicate, and phosphate for the Gulf of St. Lawrence were analyzed to create a nutrient atlas. Data were provided by the Bedford Institute

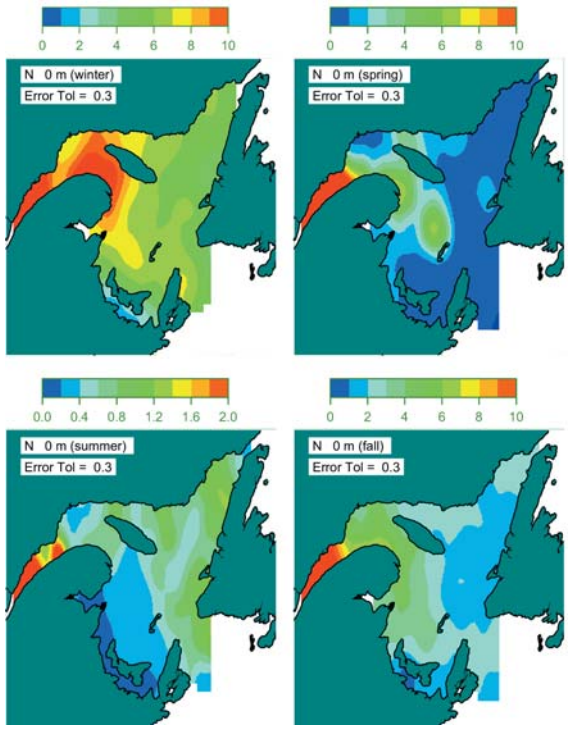

Fig. 3 Seasonal, optimally-estimated surface nitrate concentration (mmol m^{-3}) taken from Brickman and Petrie 2003. The analysis was based in part on nutrient data from the BioChem database.

Concentration saisonnière des estimés optimaux de nitrates en surface (mmol m^{-3}) (Figures tirées de Brickman et Petrie 2003). Cette analyse a été en grande partie réalisée à partir des données de sels nutritifs contenues dans la base de données BioChem.

and the Maurice Lamontagne Institute. Figure 3 shows the seasonal concentrations of surface nitrate throughout the Gulf. The atlas features similar presentations at several depths and statistical tables of monthly nutrient concentrations for smaller subareas of the Gulf. Products were produced with data derived for the most part from BioChem. The complete report can be found at <www.mar.dfo-mpo.gc.ca/science/ocean/coastal_hydrodynamics/download/gsl_atlas_CLR.pdf>.

2) Plankton Change in the Northwest Atlantic

In our second example, Sameoto (in preparation) examined Continuous Plankton Recorder (CPR) data collected between Iceland and New England from 1959 to 2001. The analysis indicates that the 1990s decade was one in which large changes in phytoplankton and zooplankton abundance occurred. Figure 4 illustrates the variability in the strength and timing of the spring bloom.

The Future

MEDS has assumed the lead in moving BioChem forward as a truly national archive. Several technical teams have been formed to resolve inter-regional issues and decide on standard practices. The BioChem database is now a reality, but there is still much work to do. Ensuring that all of the legacy data held throughout the department as well as data obtained from universities and other agencies are eventually housed in BioChem will take a major effort, as will educating new data providers to record the necessary support information at source. Data retrieval is only one aspect of BioChem; we must be able to produce products on demand that are syntheses of data held in the database. Finally, we must gain enough confidence in our quality control procedures so that we can move the BioChem system from the Intranet to the Internet, thereby making the data available to a much wider community. Based on our experience over more than a decade with the physical oceanographic databases, BioChem will make a significant contribution to ecosystem research in the oceans surrounding Canada.

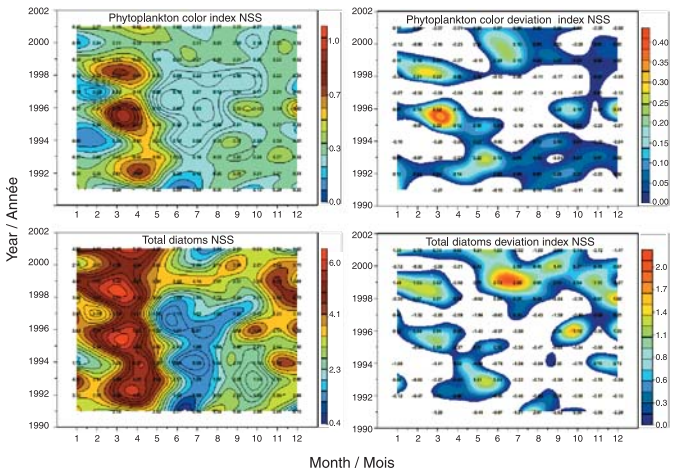

Fig. 4 Monthly abundance (left panels)and deviations (right panels)for the colour index (upper panels) and diatoms (lower panels)on the Scotian Shelf for the decade 1991 to 2001. The analysis was based on CPR data from the BioChem database. (Figures from D. Sameoto, BIO.)

Abondance mensuelle (panneaux de gauche) et deviations (panneaux de droite) de l'index de couleur (panneaux du haut) et du nombre de diatomées (panneaux du bas) sur le plateau Néo-Écossais pour la décade de 1991 à 2001. L'analyse est basée sur les données CPR provenant de la base de données BioChem. (Figures produites par D. Sameoto, BIO.)

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The Annual Cycle of Sea-Surface Temperature and Spatial Scales of Its Anomalies in Canadian Atlantic Waters

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Résumé

Afin d'évaluer la représentativité des mesures de température de surface de la mer (TSM) pour le Programme de Monitorage de la Zone Atlantique (PMZA), une analyse de la variabilité spatiale et temporelle de la TSM dans les eaux canadiennes atlantiques (40-52 ºN, 40-75º O) est présentée. Les données utilisées consistent en la TSM moyenne par semaine, obtenue du Jet Propulsion Laboratory, de 1981 à 2000 à une résolution de 18 km. Une attention spéciale est prêtée aux stations fixes du PMZA, qui sont situées dans la gyre d'Anticosti, le courant de Gaspé, le sud-ouest du golfe du Saint-Laurent (vallée de Shédiac), au large de St. John's (Station 27), au large de Halifax (Station 2) et à l'embouchure de la baie de Fundy (Prince 5). La moyenne, les harmoniques annuelles, semi-annuelles et tri-anuelles, ainsi que les anomalies de TSM, furent déterminées pour 9253 pixels. Les harmoniques contribuent à plus de 85 % de la variance des séries temporelles de TSM sur le plateau continental, et à plus de 95 % dans certaines parties du golfe du Saint-Laurent, du plateau Néo-Écossais et du golfe du Maine. Dans la région définie par la position moyenne ±1 écart type du front plateau–pente, les harmoniques contribuent de 30 % à 80 % de la variance. Les échelles spatiales furent évaluées en calculant les coefficients de corrélation mutuels entre une série de TSM à un pixel donné