An International Study of the Marine Biogeochemical Cycles of Trace Elements and their Isotopes

November 8, 2011

3rd GEOTRACES DATA-MODEL SYNERGY WORKSHOP

Universitat Autonoma de Barcelona, Spain, November 14-17, 2011

Planning Committee: C. Heinze, C. Jeandel, P. Lam, O. Marchal, B. Twining
(with the help of: B. Anderson, G. Henderson, P. Masque)

Local Organizers: P. Masque and E. Masferrer (GEOTRACES IPO)

GENERAL TEMPLATE

The 3rd GEOTRACES Data-Model Synergy Workshop will focus on ocean particles, with emphasis on their role in the biogeochemical cycle of trace elements & isotopes (TEIs). The exchange with particulate phases is recognized as an important process in the oceanic budget of a large number of substances present in trace amount in seawater, including that of key substances of GEOTRACES. Particles occur in variable amounts in different oceanic environments, such as the continental shelves and slopes, the bottom and intermediate nepheloid layers, and the particle-poor regions of the deep sea. Likewise, marine particles can occur with very distinct physical properties and chemical compositions. They are subject to a wide variety of processes, such as aggregation, disaggregation, precipitation, dissolution, sinking, and transport by currents. Moreover, the exchange of chemical constituents between the dissolved phase and particles can take different forms, including adsorption, desorption, (in)organic complexation, and biologically-mediated uptake and remineralization. In spite of the recognized importance of particles in the transport of trace elements in the ocean, various aspects of ocean particles remain poorly understood, such as the spatial variations in their concentration, chemical composition, and size distribution. This state of affairs implies that the current ability to constrain the representation of particles in models of ocean biogeochemistry is limited.

The goal of the workshop is to bring together analysts and modelers in an effort to answer to two specific questions:

1) What measurements of particles should GEOTRACES make?

2) How should models of ocean biogeochemistry represent particles?

The workshop will be held for a period of four days. The first three days will consist of three sessions:

1) Observing particles in the ocean: Methods, Results, & Lacunae

2) Role of particles in the cycle of trace elements & isotopes in the ocean

3) Transport & transformation of particles in the ocean

Session 1 will discuss (i) existing observational approaches to measure the concentration and size distribution of particles in the ocean; and (ii) the spatial variations in particle concentration and size distribution which these instruments have so far documented. This session will provide a review of current observational lacunae as well as instrumental possibilities. Session 2 will discuss the role of particles in the cycling of TEIs in the ocean, with emphasis on (i) the rates of biological uptake and release, (ii) the partitioning of trace elements between dissolved and particulate phases, (iii) the role of (in)organic complexation and ligands, (iv) the significance of colloidal material; and (v) the representation of metal-organic complexes in models of ocean biogeochemistry. This session will clarify the nature of subsequent studies on ocean particles, which would best benefit the study of TEIs in the ocean. Finally, session 3 will discuss the transport and transformation of particles in the ocean water column. Emphasis will be placed on (i) the lessons learned from sediment traps, (ii) the processes involved in the dynamics of particles, such as aggregation and disaggregation, (iii) the formation, maintenance, and descruction of nepheloid layers; and (iv) the sensitivity of TEIs to particles processes as vertical transport and remineralization in ocean biogeochemical models. Session 3 will thus identify which aspects of ocean particles should be given priority in future observational programs from the viewpoint of biogeochemical modeling.

Each session will start with keynotes by experts and will be followed by shorter talks. The keynotes will consist of reviews summarizing present observational knowledge and should culminate with a statement of emerging hypotheses. Each keynote should make an explicit distinction between what is known (or thought to be known) and what is unknown. The shorter talks following the keynotes will be topical studies illustrating some of the specific aspects discussed in the keynotes. The keynotes and the shorter talks will be followed by round-table discussions composed of both analysts and modelers. The goal of these discussions is to agree on a list of explicit hypotheses regarding the interaction of TEIs with particles in the ocean which have been formulated during the corresponding session. These hypotheses will provide the necessary context for the last day of the meeting

The last day of the workshop will be an essential component of the meeting, as it will rely on the material presented during sessions 1-3 to provide a set of specific recommendations regarding the nature of future studies that would further our understanding of ocean particles. Specifically, the expected outcome of the workshop is a statement of the nature of future research directions – observational, experimental, technological, and/or theoretical – which are the most likely to advance our understanding of ocean particles, both in the context of GEOTRACES and beyond. Although GEOTRACES is focused on TEIs, approximately 2/3 of the material to be covered at the workshop is equally relevant to the cycling of particulate biogenic phases as well, which is especially of interest to the ocean carbon community. The action items to be identified during the workshop will be posted on the GEOTRACES website and reported in a journal publication in order to provide higher visibility to the output of the workshop. We recognize that the tasks to be tackled during the last day of the workshop (see below) are difficult ones to address but they are of fundamental importance from the standpoint of future research on marine particles.

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NOV 14/SESSION 1: OBSERVING PARTICLES IN THE OCEAN: METHODS, RESULTS, AND LACUNAE

8:00 – 8:15: Pick up of badge and folder with meeting information

8:15 – 8:30: Welcome in the meeting room

8:30 – 10:15: Keynotes (30 min + 5 min for questions) – Chairman: O. Marchal

Sampling particles in the ocean: Go-Flo bottles versus in situ pumps (Robert Sherrell)

A global compilation of large-volume filtration data for the upper 1000 m (Phoebe Lam)

Measuring particle fluxes and sinking rates- how can polyacrylamide gel sediment traps help? (Ken Buesseler)

10:15 – 10:45: Coffee break

10:45 – 12:30: Keynotes (30 min + 5 min for questions) – Chairman: P. Lam

Quantitative optical assessment of particle concentrations during GEOTRACES global surveys and process studies (Jim Bishop)

Observing particles in situ using optical cameras (Lars Stemmann)

Optical proxies of biogeochemical variables in the ocean (Emmanuel Boss)

12:30 – 2:00: Lunch

2:00 – 3:00: Topical talks (12 min + 3 min for questions) – Chairman: C. Jeandel

Trace metals in suspended and rapidly sinking particles of the Brazil Basin and a 3D model for their distribution in the water column (W. Balzer)

Use of laser diffraction methods to obtain in-situ particle size distribution. Examples from the Meditteranean Sea and the Black Sea (A. Karageorgis)

Estimation of sinking particle fluxes from local measurements of particle size distribution, sinking velocities, and densities (A. McDonnell)

Monitoring the impact of ocean acidification through Th-230: where and when? (C. Heinze)

3:00 – 3:30: Coffee break

3:30 – 4:45: Topical talks (12 min + 3 min for questions) – Chairman: C. Heinze

Carbon export spatial variability: What scale to consider? (L. Guidi)

What can paired measurements of Th isotope activity and particle concentration tell us about particle cycling in the ocean? (O. Marchal)

Effects of particulate abundance on reversible exchange of dissolved Al in the Central North Pacific and Western Arctic Oceans (J. McAlister)

Particulate matter in the upper 1000 m of the water column from 62^{o}N to 5^{o}S, Eastern Atlantic Ocean from the A16N CLIVAR-Repeat hydrography cruise (J. Resing)

Chemical characteristics of Fe-rich nano- and colloid-size particles in the South Atlantic and Southern Ocean (A. Roychoudhury)

4:45 – 6:00: Round-table discussion

This discussion should focus namely on identifying the limits and potentialities of existing methods to sample and measure ocean particles. In particular, the discussion should explore how to best observe particles in the context of GEOTRACES sections given the impracticalities of sediment traps.

6:00 – 7:00: Posters

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NOV 15/SESSION 2: ROLE OF PARTICLES IN THE CYCLE OF TEIs IN THE OCEAN

8:30 – 10:15: Keynotes (30 min + 5 min for questions) – Chairman: R. Anderson

Role of plankton in the cycling of trace elements & isotopes (Ben Twining)

Partition coefficients of trace elements: from the ocean to the models (Matthieu Roy-Barman)

Role of complexation in metal partitioning between solution and particles (David Turner)

10:15 – 10:45: Coffee break

10:45 – 12:30: Keynotes (30 min + 5 min for questions) – Chairman: B. Twining

Biopolymers as carriers of natural (Th, Pa, Pb, Po, Be) radionuclides in aquatic systems (Peter Santschi)

Transparent exopolymer particles, DOM-POM transformations, and (ir)reversible svavenging: Merging the lessons from different research approaches (Walter Geibert)

Sensitivity of TEI cycles to metal-organic complexes in biogeochemistry models (Alessandro Tagliabue)

12:30 – 2:00: Lunch

2:00 – 3:00: Topical talks (12 min + 3 min for questions) – Chairman: C. Jeandel

Nd exchange between dissolved and particulate phases in the Lena River estuary and Laptev Sea (P. Andersson)

On the paleoceanographic potential of Nd isotopic composition (J. Rempfer)

Particles in hydrothermal plumes – Biotic or abiotic, regulators of hydrothermal fluxes or active sinks for global ocean TEI budgets? (C. German)

Modelling the distribution of RRE in the ocean: Sensitivity to scavenging processes and particle fluxes (S. Khatiwala)

3:00 – 3:30: Coffee break

3:30 – 4:30: Topical talks (12 min + 3 min for questions) – Chairman: P. Masqué

Modeling metal micronutrient concentrations and isotopes (S. John)

Is the free cupric ion concentration a master variable controlling the vertical distribution of copper in the water column (J. Moffett)

Al in a GCM compared with West Atlantic section cruises of GEOTRACES-Netherlands (M. van Hulten)

Net effect of dust particles on dissolved iron in seawater during DUNE (Y. Ye)

4:30 – 6:00: Round-table discussion

This discussion should focus namely on the nature of measurements on particles that are likely to best advance our understanding of the behavior of TEIs in the ocean.

6:00 – 7:00: Posters

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NOV 16/SESSION 3: TRANSPORT & TRANSFORMATION OF PARTICLES IN THE OCEAN

8:30 – 10:15: Keynotes (30 min + 5 min for questions) – Chairman: P. Lam

Lessons learned from sediment traps and other strategies about organic C fluxes - Challenges and questions for the TEI community (Richard Sanders)

Particle dynamics in the ocean (Adrian Burd)

Bottom and intermediate nepheloid layers (Michiel Rutgers van der Loeff)

10:15 – 10:45: Coffee break

10:45 – 12:30: Keynotes (30 min + 5 min for questions) – Chairman: O. Marchal

Sensitivity of biogeochemical models to particle export and recycling (Iris Kriest)

Sensitivity of biogeochemical models to the treatment of particle dynamics (Marion Gehlen)

Potential of inverse methods in studies of ocean biogeochemical cycles (Reiner Schlitzer)

12:30 – 2:00: Lunch

2:00 – 3:00: Topical talks (12 min + 3 min for questions) – Chairman: B. Twining

Particle dynamics and biogeochemical cycling over the NW Atlantic margin (T. Eglinton)

Mesozooplankton diel migration balances twilight zone carbon budgets (S. Giering)

Why coagulation theory is important for oceanic biogeochemistry? (G. Jackson)

Theoretical and experimental tracks that could improve the understanding of particle/dissolved exchange processes (C. Jeandel)

3:00 – 3:30: Coffee break

3:30 – 4:30: Topical talks (12 min + 3 min for questions) – Chairman: G. Henderson

Fertilizing the photic zone: Where do the bioactive trace elements come from? (W. Landing)

Particulate Fe, Al and Mn in the Pacific equatorial undercurrent and low latitude western boundary current sources (J. Murray)

The role of suspended matters on Fe horizontal transport from continental shelf to the ocean interior (N. Shigemitsu)

Associations and enhanced enrichments of some micronutrients, chalcophilic and redox-sensitive trace elements in time-series sinking particles from Alfonso Basin, SW Gulf of California (E. Choumiline)

4:30 – 6:00: Round-table discussion

This discussion should echo the discussion of day 1 by considering alternative strategies to sediment traps, given the insight sediment trap data have provided into the behavior of TEIs. The significance of nepheloid layers for the cycling of TEIs as suggested, e.g., by recent observations along part of the GEOTRACES North Atlantic section, should be discussed. The round-table should also address whether the application of inverse methods to infer rate constants of particle cycling from TEIs data should be encouraged or not in the context of GEOTRACES. Will it ever be possible, for example, to have sufficient data to reduce the error bars on estimates of aggregation and disaggregation rates? Finally, the discussion should address the need to consider, in biogeochemical models, various aspects of ocean particles, such aggregation/disaggregation, multiple size classes, variable settling velocities, ballasting effects, and the presence of bottom and intermediate nepheloid layers. Whether the description of particle scavenging in current models is adequate given current observations and experiments should be tackled. The nature of future observational and/or experimental studies that are likely to provide the most useful constraints on the treatment of particles in models should be clarified.

6:00 – 7:00: Posters

8:00: Group Dinner – Room Marti Franquès I (Hotel Campus).

NOV 17: PLENARY DISCUSSIONS TO PROVIDE RECOMMENDATIONS ABOUT FUTURE RESEARCH ON MARINE PARTICLES

- During the morning, two groups will be tasked with drafting a set of recommendations for GEOTRACES. One group (group 1) will focus on how to collect particle samples and how to measure aspects of particles. The other group (group 2) will focus on how to represent particles in biogeochemical models in order to simulate with reasonable accuracy the distribution of chemical constituents, of TEIs in particular. Both groups will aim to complete at least an outline of a set of recommendations. At the end of the morning, a brief overview will be given, in a plenary session, of the recommendations identified by both groups.

Chairman of group 1: **G. Henderson**

Chairman of group 2: **O. Marchal**

- During the afternoon, an initial plenary session will discuss the possibility of writing a scientific paper summarizing the state of the art of marine particle research. This paper would be a review of prior work on the subject and would end with a list of recommendations. Aspects to be discussed in the plenary session include, e.g., the overall structure of the paper, its length, the journal to which it should be submitted, and its authorship. The plenary session may then break again into two groups to focus on the specific observational and modeling aspects to be included in the paper.

Chairman of plenary session(s): **R. Anderson**

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NOV 14 – NOV 16: POSTERS DISPLAYED

Poster Number	Author/s	Title
1	Anagnostou Ch., Karageorgis, A. & Pagou, K.	Suspended particulate matter in a semienclosed marine area receiving significant riverine freshwater inputs - Nothern Thermaikos Gulf, NW Agean Sea
2	Anouk de Brauwere, François Fripiat, Damien Cardinal, Anne-Julie Cavagna, Luc André, Marc Elskens	Isotopic model of oceanic silicon cycling: the Kerguelen Plateau case study
3	Sylvia Christodoulaki, Georgios Petihakis, Maria Kanakidou, Nikolaos Mihalopoulos, Kostas Tsiaras, Georgios Trantafyllou	Assessing the importance of Atmospheric deposition on the eastern Mediterranean Sea biogeochmistry
4	Martin Frank, Patricia Grasse, Claudia Ehlert, Torben Stichel' and Lothar Stramma	Distribution of neodymium and silicon isotopes in Eastern Equatorial Pacific seawater
5	Sari L.C. Giering, Richard Sander, Eric Achterberg, Sebastian Steigenberger and Daniel J. Mayor	Iron recycling by mesozooplankton supports phytoplankton growth in the Irminger Basin
6	Jordan Landers, Samar Khatiwala, Bob Anderson, Steve Goldstein	Toward a better understanding of Nd isotopes in the North Pacific: observations and modeling of boundary exchange
7	Chris Marsay	Fe:C ratios of sinking particulate material in the upper mesopelagic: measurements from drifting sediment traps and in-situ pumps in the Irminger and Iceland Basins
8	Juan Carlos Miquel, Beat Gasser, Scott W. Fowler	Tracers of particle and plankton dynamics in the NW Mediterranean Sea
9	Peter L. Morton	Speciation of Suspended Particulate Matter in the Western North Pacific Ocean

Poster Number	Author/s	Title
10	Daniel C. Ohnemus, Phoebe J. Lam	Trace element composition of size-fractionated particles in the Mauritanian upwelling zone of the E. North Atlantic U.S. GEOTRACES section
11	Jennifer Riley, Richard Sanders, Alex Poulton, Eric Achterberg	Variations in particle size and density: implications for the ballast hypothesis
12	Andreas Schmittner	Using Isotopes to Reconstruct Glacial Ocean Nitrogen and Carbon Cycles
13	Konstantin Choumiline; Evgueni Shumilin, Ph.D.; Ana Patricia Rodríguez-Castañeda, Fernando Aguirre-Bahena, Ph.D.; Norman Silverberg, Ph.D.; Dmitry Sapozhnikov, Ph.D.	Role of episodic events on the settling particulate matter composition and element fluxes in Alfonso Basin
14	K. A. Smith, C. A. Stock, J. P. Dunne, and J. L. Sarmiento	Quantifying the role of bacterial extracellular enzymes in particle remineralization processes
15	Alessandro Tagliabue, Thato Mtshali, Olivier Aumont, Andrew R. Bowie, A. N. Roychoudhury, and Sebastiaan Swart	A global compilation of over 13,000 dissolved iron measurements: focus on distributions and processes in the Southern Ocean
16	M. Villa, F. de Soto, M. Salvador, F. Le Moigne, R. García-Tenorio, R. Sanders	Analysis of sinking particle speed through the water column using 210Po-210Pb concentration profiles
17	Angela Wagener, Stefano Bernasconi, Cassia Farias, Renato Carreira, Arthur Scofiel, Mario Soares	$\delta^{13}C$ and $\delta^{15}N$ in PM as Tools to Mapping Provenance of Organic Carbon in Eutrophic Coastal System
18	Y. Ye, A. Tagliabue, C. Völker, D. A. Wolf-Gladrow	Cycling of organic Fe-binding ligand in 3D biogeochemical model