

Fiche “ Valorisation des résultats des campagnes océanographiques en série”

(à envoyer par courriel à Commission.Flotte@ifremer.fr)

Nom de la série de campagnes: OISO

Programme : S.O. OISO

Navire : Marion-Dufresne

Dates de la campagne : 1998-2023

Engins lourds :

Zone : Océan Indien Sud et Océan Austral

Chef de projet : Metzl Nicolas

Chef de mission 1 : Metzl Nicolas

Chef de mission 2 : Claire Lo Monaco

Organisme : LOCEAN/IPSL CNRS/SU

Organisme : LOCEAN/IPSL CNRS/SU

Organisme : LOCEAN/IPSL SU/OSU Ecce-Terra

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Résultats majeurs obtenus

1 à 2 pages destinées à informer un large public sur les résultats obtenus par chaque campagne

- * Première campagne (OISO-1 Janvier-Février 1998) de mesures in-situ sur le système du CO₂ couplées à des observations satellitales de couleur de la mer (SeaWiFS lancé en Septembre 1997, Metzl, 2000).
- * Premières campagnes en hiver austral dans le secteur Sud Indien et Austral avec stations hydrologiques et mesures biogéochimiques: identification de couche de mélange profondes (> 500m en zone subantarctique) dans le secteur de formation des eaux de mode subantarctique (Metzl et al. 1999).
- * Première estimation directe de la variabilité saisonnière des flux de CO₂ à l'interface air-mer en zone australe (Metzl et al., 2004, 2006): les sources de CO₂ observées en hiver conduisent à réviser les précédentes estimations, notamment celles déduites des observations (climatologie, Takahashi et al, 2002) et des modèles océaniques. Ce résultat a été sélectionné dans le rapport annuel IGBP (Juin 2004) parmi 3 résultats majeurs de l'année 2003-2004.
- * Première identification de variabilité la interannuelle des flux air-mer de CO₂ à l'échelle régionale dans l'océan austral: implications sur les changements des sources et puits de CO₂ océaniques dans un contexte de réchauffement climatique (Jabaud-Jan et al., 2004).
- * Les données OISO récoltées en Janvier 2005, campagne couplée au programme KEOPS, ont permis d'évaluer l'intensité du puits de CO₂ dans le bloom fertilisé au Sud de Kerguelen (Blain et al., *Nature*, 2007, communiqué de presse CNRS)
- * Identification d'un accroissement de la pression partielle de CO₂ océanique (pCO₂) à toutes les latitudes (zone subtropicale, subantarctique et australe de l'océan Indien Sud). Cette augmentation, encore peu évaluée dans l'océan, est proche de celle observée dans l'atmosphère mais semble s'être accélérée depuis une décennie (Metzl, *DSR*, 2009, communiqué de presse CNRS).
- * Les données OISO ont permis de qualifier les modèles océaniques et couplés climat/carbone pour évaluer les processus responsables de la réduction du puits de CO₂ dans l'océan austral (Le Quéré et al., *Science*, 2007, communiqué de presse international; Lenton et al., *GRL*, 2009; Le Quéré et al., *Nature GeoScience*, 2009)
- * Les données OISO sont régulièrement intégrées dans des travaux de synthèse pour établir les climatologies de CO₂ et des flux air-mer associées (Takahashi et al., *DSR*, 2002, 2009) ainsi que dans l'évaluation des bilans de carbone planétaire (e.g. Global Carbon Project, Le Quéré et al, *Nature G.*, 2009, communiqué de presse CNRS).
- * Les analyses basées sur les données OISO ont été utilisées pour les rapports de synthèse internationaux (e.g. SCAR, ACCE, State of Climate) et européens (Carbo-Europe et Carboocean Assesment report).
- * Lors de la campagne OISO-4 (2000) des échantillons ont été récoltés pour l'analyse d'espèces marines parmi lesquelles deux nouvelles ont été découvertes, *Globoconella inflata* Type II et *Globigerina bulloides* Type IIf dans les eaux de surface subpolaires et polaires antarctiques (Morard, 2010).
- * Une synthèse des données OISO a été réalisée et informe pour la première fois des variations saisonnières à décennales du C13 dans l'Océan Indien Sud (Racapé et al., 2010; Thèse V. Racapé 2013).
- * Lors de la campagne OISO-11 (2004) des échantillons ont été récoltés pour l'analyse d'espèces marines, (coccolytophorides couplés aux mesures des concentrations de carbonates). Associées à d'autres observations, ces données ont permis de mieux connaître l'impact de l'acidification des océans sur les organismes marins (Beaufort et al, *Nature*, 2011 et communiqué de presse CNRS).
- * Les récentes observations (Janvier 2011), accompagnées des données historiques, ont permis d'évaluer depuis 1991, les variations décennales des flux air-mer de CO₂ dans la zone sub-antarctique au Nord de Kerguelen (Lourantou et Metzl, 2011, *GRL*, *Science Highlight in IMBER news*).
- * L'ensemble des données OISO de CO₂ de surface intégrées dans la base internationale SOCAT (Surface Ocean CO₂ ATlas, www.socat.info, Pfeil et al., 2013; Sabine et al., 2013; Bakker et al., 2014, 2016, 2017, 2018, 2019, 2020, 2021) sont également utilisées pour l'évaluation des flux de CO₂ air-mer à l'échelle globale et/ou régionale (Global Carbon Project, RECCAP, Wanninkhof et al. 2013; Lenton et al., 2013; Roedenbeck et al. 2013, 2014, 2015; Sarma et al., 2013; Tjiputra et al., 2014; Le

Quéré et al. 2015a,b, 2016, 2018; Landschutner et al. 2015, 2018, 2019; Friedlingstein et al., 2019, 2020, 2021, 2022a,b) et valider les modèles couplés climat/carbone (cadre GIEC/IPCC, CMIP). Les données OISO sont aussi intégrées dans le Global Ocean Acidification Observing Network (www.goa-on.org/) et les rapports State of Climate (2014 à 2021). Elles ont été le support pour l'évaluation du pH et son évolution dans l'océan global (Jiang et al., 2019) et sont maintenant intégrées dans le rapport annuel des Nations Unis (Sustainable Development Goals, SDG 14.3.1, 2020).

* L'analyse des données OISO avec les données historiques a permis de détecter l'accroissement du CO₂ dans les eaux de mode et intermédiaires et d'identifier qu'une partie de cet accroissement était directement associé au carbone d'origine anthropique, tandis qu'une autre était liée à des variations naturelles ou induites par le changement climatique (Lo Monaco et al. 2011, 2013)

* Associées à l'augmentation de CO₂, les données OISO révèlent aussi une diminution du pH (acidification) en surface et dans les eaux intermédiaires (Lo Monaco et al., 2017, ICDC10 ; SCAR Acidification report, in prep)

* Les données CO₂, O₂, nutritifs, et C13 de OISO récoltées sur la colonne d'eau sont intégrées dans les bases internationales CARINA, GLODAPII (Olsen et al 2016) et utilisées pour évaluer les inventaires de carbone anthropique dans l'océan et valider les modèles couplés climat/carbone (cadre GIEC/IPCC, CMIP, Eyring et al., 2016)

* Les données OISO (associées au projet KEOPS2), ont permis d'évaluer le cycle annuel du flux air-mer de CO₂ dans la zone fertilisée autour de Kerguelen (Lo Monaco et al., 2014).

* Associées au projet SoForCO₂, les données OISO ont apporté de nouvelles connaissances sur la distribution et variabilité des foraminifères planctoniques en surface et dans la colonne d'eau (Meilland et al., 2016a, 2016b, 2018).

* **De nombreux articles dans cette fiche valorisation OISO sont référencés dans les rapports IPCC 2013 (AR5-WG1) et IPCC 2019 (SROCC, 2019).**

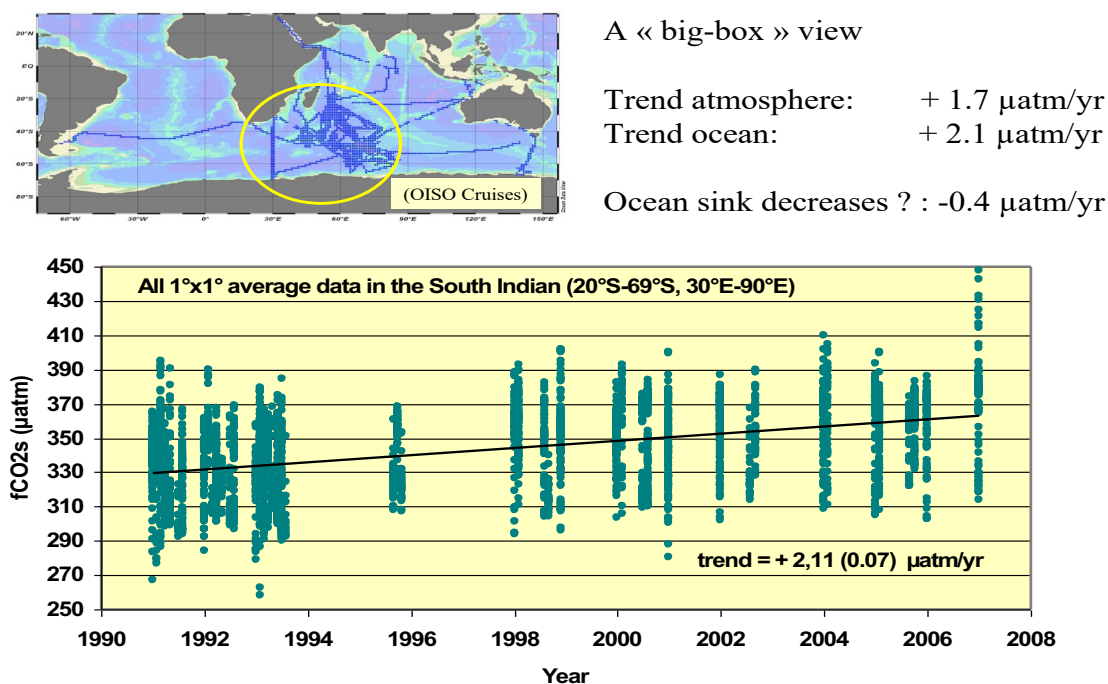


Figure 1 : La carte représente les trajets des campagnes réalisées à bord du Marion-Dufresne (IPEV/TAAF) depuis 1991. La figure témoigne de l'évolution du CO₂ océanique pour la zone sud-indienne. L'accroissement du CO₂ océanique est estimé à environ 2.1 µatm/an pour la période 1991-2007, tandis que le CO₂ atmosphérique augmentait en moyenne de 1.7 µatm/an durant la même période (Metzl, DSR, 2009). C'est la première fois, grâce au S.O. OISO, que sont obtenues des mesures directes du taux d'accroissement du CO₂ océanique dans l'hémisphère sud et hautes latitudes. La conséquence est une réduction du puits de CO₂ océanique dans cette région et sans doute sur l'ensemble de l'océan austral. Cette analyse suggère que l'augmentation de CO₂ océanique dans les eaux de l'océan indien sud est non seulement liée à l'invasion de CO₂ d'origine anthropique mais aussi à des changements climatiques dans les hautes latitudes. En effet, depuis une vingtaine d'années, l'augmentation des gaz à effet de serre et la réduction des concentrations d'ozone stratosphérique conduisent à des changements sur la répartition des transferts de chaleur et des pressions atmosphériques qui génèrent un renforcement des vitesses de vent dans les hautes latitudes sud. Cela induit des changements sur la circulation océanique (notamment le mélange verticale), et des apports plus importants de CO₂ en surface, depuis les couches profondes enrichies en CO₂ (Le Quéré et al, Science, 2007, 2008). C'est la première fois que le rôle des changements climatiques sur le cycle du CO₂ océanique dans l'hémisphère sud est ainsi révélé à partir d'observations in-situ. Outre l'intégration de ces résultats dans l'évaluation du bilan de carbone planétaire et son évolution depuis plusieurs décennies (travail réalisé au sein du Global Carbon Project; Le Quéré et al, Nature Geoscience, 2009; Takahashi et al., DSR, 2009), les observations OISO ont également permis de valider des simulations couplées climat/carbone prenant en compte la diminution de l'ozone stratosphérique (Lenton et al., GRL, 2009). Ces résultats annoncent aussi de nouvelles interrogations concernant l'évolution future du puits de CO₂ océanique en zone australe (Lenton et al., 2012) et ses conséquences sur le climat futur (rétroaction positive). A noter que les analyses sur les

variations du CO₂ océanique permettent également d'évaluer les changements chimiques et notamment quantifier et interpréter l'accélération de l'acidification des océans que nous observons depuis plusieurs années (Beaufort et al., *Nature*, 2011). Enfin, signalons l'intégration des données OISO dans les bases internationales SOCAT (Surface Ocean Carbon Atlas, www.socat.info, Bakker et al., 2012, 2014, 2016, 2017, 2018, 2019, 2020, 2021; Pfeil et al., 2013; Sabine et al., 2013), CARINA/GLODAP (Lo Monaco et al., 2010; Sabine et al. 2010), GLODAPv2 (Olsen et al., 2016) et leur utilisation dans les travaux de synthèse des bilans de carbone globaux et régionaux (e.g. Landschutzer et al, 2015; Le Quéré et al., 2015a,b, 2016, 2017, 2018; Lenton et al., 2013; Rödenbeck et al., 2013, 2014, 2015; Schuster et al., 2013; Sarma et al., 2013; Wanninkhof et al., 2013).

Une partie des travaux résumés ci-dessus ont fait l'objet de communiqués de presse publiés par le CNRS :

- L'océan moins efficace pour absorber le CO₂ émis par les activités humaines. *Comm. Presse*, CNRS, INSU, 13/2/09.
- Le trou d'ozone réduit l'absorption du CO₂ atmosphérique dans l'océan Austral, *Comm. Presse*, CNRS, INSU, 22/6/09.
- Toujours plus de CO₂ dans l'atmosphère en 2008. *Comm. Presse* INSU/CNRS, CEA, UVSQ, 18/11/2009.
- Les microalgues calcaires, témoins de l'acidification des océans. Communiqué presse CNRS, Aout 2011.
- Une base de données internationale pour mieux évaluer le puits de carbone océanique, *Comm. INSU*, 17 Mars 2012
- Le puits de carbone de l'océan Austral revivifié : Communiqué INSU/CNRS, 10/9/2015
- Actualisation de la base internationale SOCAT de CO₂ océanique : Communiqué INSU/CNRS, 18/9/2015
- Du nouveau sur le puits de carbone océanique grâce au projet SOCOM. Actualité INSU/CNRS, 22/12/2015
- Actualisation de la base internationale SOCAT de CO₂ océanique : Communiqué INSU/CNRS, 20/8/2016
- 24 millions d'observations de CO₂ océanique dans la base internationale SOCAT: *Comm. INSU/CNRS*, 06/06/2018
- Un bloom phytoplanctonique crée un fort puits de CO₂ océanique dans l'océan Indien. *Comm. INSU/CNRS* 23/03/2022

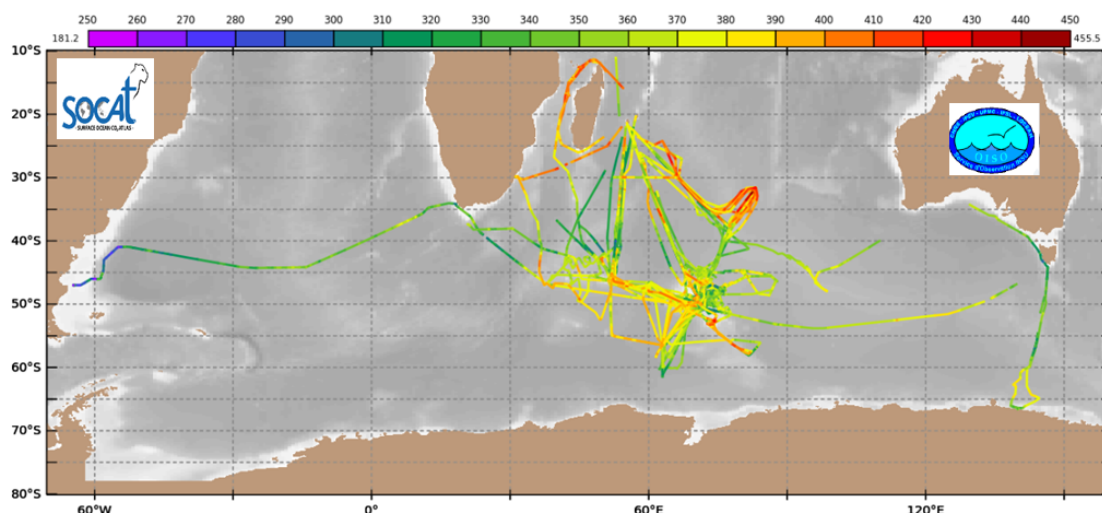


Figure 2 : Campagnes OISO (1998-2021) sur la base SOCAT, version 2022 (Bakker et al., 2022; www.socat.info)

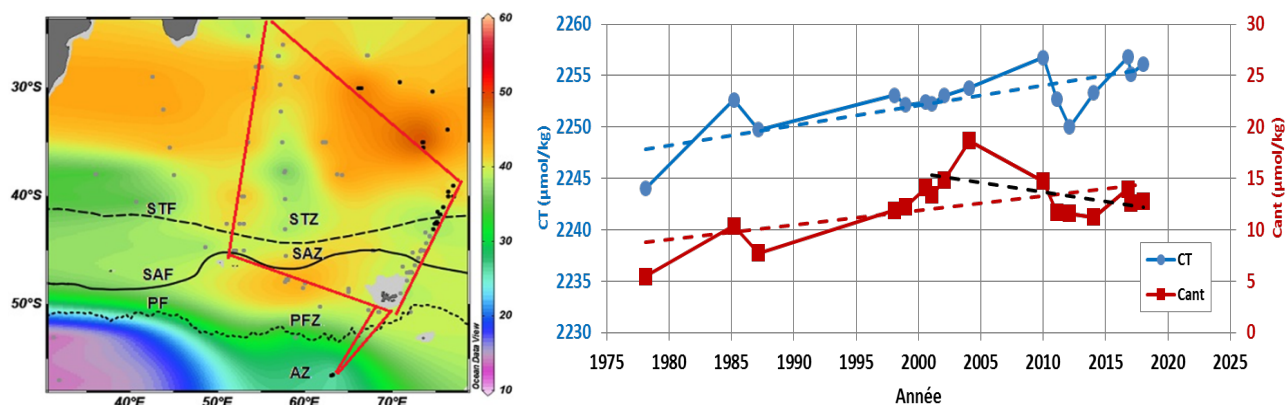


Figure 3 : CO₂ anthropique: A gauche : Concentration de carbone anthropique (μmol/kg) estimé à 300 m dans l'océan indien sud-ouest (données historiques et OISO 1998-2013, trajet rouge). A droite: Evolutions des concentrations de carbone total (CT, en bleu) et CO₂ anthrhopique (en rouge) observées dans les eaux antarctiques de fond à la station OISO-11 (56°S). D'après Mahieu et al., *Ocean Science*, 2020) et Actualité INSU/CNRS du 6/10/20.

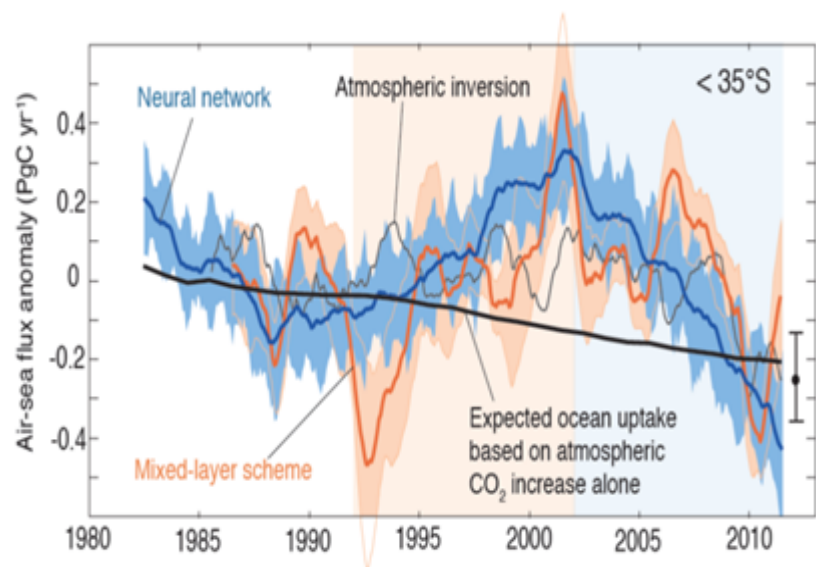


Figure 4 : Evolution du puits de carbone océanique dans l'océan austral (anomalies) estimée à partir d'un modèle inverse atmosphérique (courbe grisée), d'observations de pCO₂ extrapolées (courbes bleue et orange), comparé à l'évolution du puits de carbone sans changement de CO₂ océanique (courbe noire). La diminution du puits de CO₂ sur les années 90s conforte nos précédentes estimations (Le Quéré et al, 2007; Metzl, 2009). L'augmentation du puits de carbone depuis 2002 est un nouveau résultat (Landschutzer et al, *Science*, 2015) qui est pris en compte dans les bilans globaux du carbone (Le Quéré et al, 2015, 2016, 2018).

Tableau récapitulatif

		Nombre
1	Publications d'articles originaux dans des revues avec comité de lecture référencées SCI	609
2	Publications dans d'autres revues scientifiques	63
3	Publications sous forme de rapports scientifiques et/ou techniques	220
4	Articles dans des revues / journaux grand public	53
5	Publications de résumés de colloques	26 (+ > 30)
6	Communications dans des colloques internationaux Dont communications orales Dont posters	283 183 100
7	Communications dans des colloques nationaux Dont communications orales Dont posters	84 72 12
8	Nouvelles espèces (animales, végétales, microorganismes) découvertes et décrites	3
9	Rapports de contrats (Union européenne, FAO, Convention, Collectivités ...)	>100
10	Applications (essais thérapeutiques ou cliniques, AMM ...)	
11	Brevets	
12	Publications d'atlas (cartes, photos)	
13	Documents vidéo-films	5
14	Publications électroniques sur le réseau Internet : mots clés OISO CO2 Ocean	107 > 20000
15	DEA ou MASTER ayant utilisé les données de la campagne	54
16	Thèses ayant utilisé les données de la campagne	38
17	Validation des données en cours : ..X..	terminée : ..X..
18	Transmission au SISMER Non : ...X.	Oui : .X.
19	Transmission à d'autres banques de données Non :	Oui : .X.
20	Transmission à d'autres équipes Non :	Oui : ..X
21	Considérez-vous l'exploitation en cours : ..X..	terminée :

Fournir en annexe pour chacune des rubriques :

Rubriques 1 à 8 incluses : Une liste des publications et colloques avec les noms d'auteurs suivant la présentation en vigueur pour les revues scientifiques. A présenter selon la classification du tableau ci-dessus.

Rubriques 9 à 14 : Liste des références des rapports, des applications, des brevets, atlas ou documents vidéo

Rubriques 15 et 16 : Pour chaque étudiant Nom et Prénom, Laboratoire d'accueil. Sujet du DEA ou MASTER ou de la thèse, Date de soutenance

Rubriques 17 à 20 incluses : Le type des données validées et/ou transmises,
Les banques de données (SISMER, JGOFS, CDIAC ...) les équipes auxquelles elles ont été transmises.

Rubrique 21 : Si l'exploitation est toujours en cours, pouvez-vous donner un échéancier ?

1 Publications d'articles originaux dans des revues avec comité de lecture référencées SCI

1. Metzl, N., B.Tilbrook and A. Poisson, 1999. The annual fCO₂ cycle and the air-sea CO₂ flux in the sub-Antarctic Ocean. *Tellus*, 51B, 4, 849-861. <https://doi.org/10.1034/j.1600-0889.1999.t013-00008.x>
2. Guinet C., Dubroca L, Lea Ma, Goldsworthy S, Cherel Y., Duhamel G., Bonadonna F, Donnay Jp (2001). Spatial distribution of foraging in female Antarctic fur seals *Arctocephalus gazella* in relation to oceanographic variables: a scale-dependent approach using geographic information systems. *Marine Ecology Progress Series*, 219, 251-264. <https://doi.org/10.3354/meps219251>
3. Takahashi, T., S C. Sutherland, C. Sweeney, A.Poisson, N.Metzl, B.Tilbrook, N.Bates, R.Wanninkhof, R.A. Feely, C.Sabine and J.Olafsson and Y. Nojiri, 2002. Global Sea-Air CO₂ Flux Based on Climatological Surface Ocean pCO₂, and Seasonal Biological and Temperature Effect. *Deep Sea Res.* II, Vol 49, N 9-10, 1601-1622. [https://doi.org/10.1016/S0967-0645\(02\)00003-6](https://doi.org/10.1016/S0967-0645(02)00003-6)
4. Le Quere C. and N. Metzl, 2003. Natural processes regulating the oceanic uptake of CO₂. In “ *The Global Carbon Cycle : Integrating Humans, Climate, and the Natural World*”, (C.B.Field and M.R.Raupach eds.) SCOPE 62, Island Press, Washington, D.C. pp 243-255.
5. De Vargas, C., A. G. Saez, L.K. Medlin, H.R. Thierstein, 2003. Super-Species in the calcareous plankton. In "Coccolithophores From molecular processes to global impact." (H. Thierstein & J. Young, eds.), Springer-Verlag. 271-298.
6. Jabaud-Jan A, Metzl N, Brunet C, Poisson A, Schauer B (2004). Interannual variability of the carbon dioxide system in the southern Indian Ocean (20 degrees S-60 degrees S): The impact of a warm anomaly in austral summer 1998. *Global Biogeochemical Cycles*, 18(GB1042), 1-20. <https://doi.org/10.1029/2002GB002017>
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8. Mahadevan, A., M. Levy and L. Memery, 2004, Mesoscale variability of sea surface pCO₂: What does it respond to ? *Global Biogeochemical Cycles*. Vol. 18, No. 1, GB1017/10.1029/2003GB002102
9. Lo Monaco C., N. Metzl, A. Poisson, C. Brunet and B. Schauer, 2005. Anthropogenic CO₂ in the Southern Ocean : distribution and inventory at the Indo-Atlantic boundary (WOCE line I6), *Journal Geophys. Res.* 110, C06010, doi:10.1029/2004JC002643.
10. Lo Monaco C., C. Goyet, N. Metzl, A. Poisson and F. Touratier, 2005. Distribution and inventory of anthropogenic CO₂ in the Southern Ocean : comparison of three data-based methods. *Journal Geophys. Res.*, 110, C09S02, doi:10.1029/2004JC002571
11. Metzl N., 2005. Air-sea CO₂ Flux Variations in the Southern Ocean: New Observations, New Questions. *IGBP News Letters* N°61, 7-11.
12. Pasquer B, Laruelle G, Becquevort S, Schoemann V, Goosse H, Lancelot C (2005). Linking ocean biogeochemical cycles and ecosystem structure and function: results of the complex SWAMCO-4 model. *Journal Of Sea Research*, 53(1-2), 93-108. <https://doi.org/10.1016/j.seares.2004.07.001>
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14. Brévière, E., N.Metzl, A.Poisson and B.Tilbrook, 2006. Changes of oceanic CO₂ sink in the Eastern Indian sector of the Southern Ocean. *Tellus*, 58B, 438-446, 10.1111/j.1600-0889.2006.00220.x
15. Metzl, N., C.Brunet, Jabaud-Jan A, A.Poisson and B.Schauer, 2006. Summer and winter air-sea CO₂ fluxes in the Southern Ocean *Deep Sea Res I*, 53, 1548-1563, 10.1016/j.dsr.2006.07.006
16. Alvain, S., C. Moulin, Y. Dandonneau, H. Loisel, F.-M. Bréon, 2006. A species-dependent bio-optical model of case I waters for global ocean color processing. *Deep Sea Research Part I: Oceanographic Research Papers*, Volume 53, Issue 5, May 2006, Pages 917-925 doi:10.1016/j.dsr.2006.01.011
17. Hyrenbach KD, Veit RR, Weimerskirch H, Hunt GL. 2006. Seabird associations with mesoscale eddies: The subtropical Indian Ocean *Marine Ecology Progress Series*. 324: 271-279. DOI: 10.3354/meps324271
18. Hyrenbach, K.D., Veit, R.R., Weimerskirch, H., Metzl N., and Hunt, Jr., G.L., 2007. Community Structure Across a Large-scale Ocean Productivity Gradient: Marine Bird Assemblages of the southern Indian Ocean. *Deep-Sea Research I*, 54, 1129-1145, doi:10.1016/j.dsr.2007.05.002
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46. Boutin, J., 2007. VOS CO₂ measurements in the Indian and Southern Ocean. Surface Ocean CO₂ variability and vulnerabilities (SOCOVV) Workshop, 11-14 April 2007, Unesco, Paris, France.
47. Blain, S., 2007. What can we learn from natural iron sources ? *Ocean Iron Fertilization Symposium*, 26-27 Sept. 2007, WHOI, Mass, USA.
48. Metzl, N. and A. Lenton, 2007. Interannual to decadal variability of air-sea CO₂ fluxes in the Southern Ocean. Workshop WP5, CarboOcean, Dec 2, 2007, Bremen, Allemagne.
49. Lenton, A. and N. Metzl, 2007. Model/Observations comparisons: A focus on Interannual variability. Workshop WP5, CarboOcean, Dec 2, 2007, Bremen, Allemagne.

50. Lenton, A., L. Bopp, F. Codron, P. Cadule and N. Metzl, 2007. Present and Future Southern Ocean CO₂ buffering. Oral presentation, *Third CARBOOCEAN Science Meeting*, 3-7 Dec 2007, Bremen, Allemagne.
51. Le Quéré, C., T. Takahashi, C. Rödenbeck, E.T. Buitenhuis and S.C. Sutherland, 2008. Recent trends in the global oceanic CO₂ sink. Oral, plenary, *PICES Symposium on Climate Change Effects on the World's Oceans*, Gijon, Spain, 19-23 May 2008.
52. Lenton, A., L. Bopp, F. Codron, N. Metzl and P. Cadule, 2008. The combined effects of rising atmospheric CO₂ and declining stratospheric ozone on past and future Southern Ocean CO₂ uptake, *PICES Symposium on Climate Change Effects on the World's Oceans*, Gijon, Spain, 19-23 May 2008.
53. Lo Monaco C., A. Lenton, N. Metzl and K. B. Rodgers, 2008. Natural and anthropogenic carbon changes in mode waters of the south west Indian Ocean. *PICES Symposium on Climate Change Effects on the World's Oceans*, Gijon, Spain, 19-23 May 2008.
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55. Rodgers .K., J. Sarmiento, A. Gnanadesikan, R. Key, J. Dunne, R. Wanninkhof, O. Aumont, L. Bopp, A. Ishida, M. Ishii, C. Lo Monaco, E. Maier-Reimer, N. Metzl, F. Perez and Y. Yamanaka, 2008. Altimetry helps to explain patchy changes in repeat hydrography carbon measurements. *PICES Symposium on Climate Change Effects on the World's Oceans*, Gijon, Spain, 19-23 May 2008.
56. Lo Monaco C., et al., 2008. Repeated carbon observations in the South Indian Ocean: From a national observatory (CARAUS) to the European synthesis effort (CARBOOCEAN). *Asia-Pacific Workshop on Carbon Observations*, Tsukuba, Japan, 17-19 March 2008.
57. Borges A.V., B. Tilbrook, N. Metzl, A. Lenton and B. Delille, 2008. Inter-annual variability of the carbon dioxide oceanic sink south of Tasmania, *EGU*, Vienna, Austria. 13-18 Avril 2008, Abstract.
58. Le Quéré, C., C. Rödenbeck, E. T. Buitenhuis, T. J. Conway, R. Langenfelds, A. Gomez, C. Labuschagne, M. Ramonet, T. Nakazawa, N. Metzl, N. Gillett and M. Heimann, 2008. Saturation of the Southern ocean CO₂ sink due to recent climate change. *EGU*, Vienna, Austria. Abstract.
59. Metzl, N., The Indian Ocean region in SOCAT. Int. Workshop SOCAT-II, IOCCP, Unesco, 16-17 June 2008, Paris, France.
60. Metzl, N., The Southern Ocean in SOCAT. Int. Workshop SOCAT-II, IOCCP, Unesco, 16-17 June 2008, Paris, France.
61. Lo Monaco, C., and M. Alvarez. Southern Ocean Carbon Synthesis: Cross-over analysis in the South Indian Ocean. *Workshop CARINA*, Paris, France, 18-19 June 2008.
62. Beaufort, L., D. Ruiz-Pino, N. Metzl and C. Goyet, 2008. Calcification of coccolithophores in diverse chemical oceanic settings. *AGU*, San-Francisco, Dec 2008
63. Bakker et al., 2008. Southern ocean carbon uptake: achievements and future perspectives. Presented at IVth CARBOOCEAN conference, 8-12 Dec. 2008, Dourdan, France
64. Jamous, M., 2008. Carboshools activity at IPSL. Presented at IVth CARBOOCEAN conference, 8-12 Dec. 2008, Dourdan, France.
65. Lenton A., et al., 2008. Stratospheric ozone depletion reduces ocean carbon uptake and enhances ocean acidification. Presented at IVth CARBOOCEAN conference, 8-12 Dec. 2008, Dourdan, France
66. Lo Monaco C., A. Lenton and N. Metzl, 2008. Natural and Anthropogenic Carbon Changes in the Southern Indian Ocean. Presented at IVth CARBOOCEAN conference, 8-12 Dec. 2008, Dourdan, France
67. Metzl N. and A. Lenton, 2008. Decadal variability of the Southern Ocean CO₂ uptake: Regional and Circumpolar views. Presented at IVth CARBOOCEAN conference, WP5, 8-12 Dec. 2008, Dourdan, France
68. Metzl, N., 2008. Results of the last cruise (OISO-16, Jan 2008) and strategy for the future cruise (OISO-17, Jan 2009). Presented at IVth CARBOOCEAN conference, WP5, 8-12 Dec. 2008, Dourdan, France
69. Olsen, A., B. Pfeil, D. Bakker, M. Hood, N. Metzl, C. Sabine, A. Kozyr, 2008. SOCAT, the Surface Ocean CO₂ Atlas. Presented at IVth CARBOOCEAN conference, 8-12 Dec. 2008, Dourdan, France
70. Rodgers K., et al., 2008. Altimetry helps to explain patchy changes in hydrographic carbon measurements. Presented at IVth CARBOOCEAN conference, 8-12 Dec. 2008, Dourdan, France.
71. MORARD, R., QUILLEVERE, F., ESCARGUEL, G., UJIEE, Y., de GARIDEL-THORON, T., LECUYER, C., de VARGAS, C. 2008. Morphometric and stable isotope ($\delta^{13}C$, $\delta^{18}O$) analyses of planktonic foraminiferal cryptic species: new perspectives for paleoceanographic reconstructions. TMS Meeting, Tübingen, Allemagne
72. QUILLEVERE, F., MORARD, R., ESCARGUEL, G., LECUYER, C., de VARGAS, C. 2008. Morphometric and stable isotope ($\delta^{13}C$, $\delta^{18}O$) analyses of planktonic foraminiferal cryptic species: new perspectives for paleoceanographic reconstructions. GEOECOMAR Scientific Workshop, Bucarest, Roumanie
73. MORARD, R., QUILLEVERE, F., ESCARGUEL, G., UJIEE, Y., de GARIDEL-THORON, T., LECUYER, C., de VARGAS, C. 2008. Eco-morpho-genotypes in planktonic foraminifera: new perspectives for paleoceanographic reconstructions. Sarco-deal Meeting, Villefranche-sur-Mer, France

74. Metzl, N., A. Lenton, T. Takahashi and B. Tilbrook, 2009. Decadal variability of oceanic pCO₂ observed in the Southern Ocean: contrasting trends before and after 2000. Oral presentation, EGU, OS8, Vienna, Austria, 19-24 April 2009.
75. Álvarez, M. T. Tanhua, H. Brix, C. Lo Monaco and N. Metzl, 2009. Decadal biogeochemistry changes in the western Indian Ocean associated with Subantarctic Mode Water. Oral contribution, ISMS09, International Symposium in Marine Sciences, Vigo (Spain), 27-30 April 2009
76. C. Le Quéré et al., 2009. Recent trends in the global oceanic CO₂ sink. Oral, Royal Meteorological Society, Reading, UK, 29 May-2 June 2009
77. Alvarez, M., T. Tanhua, H. Brix, C. Lo Monaco, N. Metzl, 2009. Decadal biogeochemical changes in the western indian ocean associated with subantarctic mode water. Invited talk at *Symposium Decadal variations of the ocean's interior carbon cycle: synthesis and vulnerabilities*, Ascona, Switzerland, 13-17 July 2009
78. Lo Monaco, C., M. Álvarez, M. Vázquez-Rodríguez, and N. Metzl, 2009. Recent insights into the determination of anthropogenic CO₂. Oral presentation, *Symposium Decadal variations of the ocean's interior carbon cycle: synthesis and vulnerabilities*, Ascona, Switzerland, 13-17 July 2009
79. Metzl, N., 2009. Surface ocean and interior changes: toward a synthesis. Invited talk at *Symposium Decadal variations of the ocean's interior carbon cycle: synthesis and vulnerabilities*, Ascona, Switzerland, 13-17 July 2009
80. C. Le Quéré et al., 2009. Impact of climate change on the marine carbon cycle. Keynote, Joint Assembly of IAMAS/IAPSO/IACS. Montréal, Canada. 19-29 July 2009
81. Lenton, A., F. Codron, L. Bopp, A. Tagliabue and N. Metzl, 2009. The impact of ozone depletion and recovery on oceanic carbon uptake. Oral presented at International Carbon Dioxide Conference 8. Jena, Germany, Sep. 2009. Ext. Abstract
82. Le Quéré, C., M. R. Raupach, J. G. Canadell, G. Marland, L. Bopp, P. Ciais, T. J. Conway, S. Doney, R. Feely, C. B. Field, P. Friedlingstein, R. A. Houghton, N. Metzl, A. Mouchet, J. T. Randerson, S. W. Running, U. Schuster, T. Takahashi, N. Viovy, G. van der Werf, 2009. Recent trends in the global carbon cycle. Oral presented at International Carbon Dioxide Conference 8. Jena, Germany, Sep. 2009. Ext. Abst.
83. Lo Monaco C., N. Metzl, C. Pierre, V. Racapé, A. Lenton and M. Alvarez, 2009. Climate modulation of the Total Carbon increase observed in Southern Mode Waters. Oral presented at International Carbon Dioxide Conference 8. Jena, Germany, Sep. 2009. Ext. Abstract
84. Metzl N., B. Tilbrook, A. Lenton, T. Takahashi, D.C.E. Bakker, M. Ishii, C. Sabine, C. Sweeney, M. Hoppema, B. Pfeil. and A. Olsen, 2009. Decadal variations of the ocean carbon dioxide system observed in the Southern Ocean. Oral presented at International Carbon Dioxide Conference 8. Jena, Germany, Sep. 2009. Ext. Abstract
85. Watson, A., N. Metzl and U. Schuster, 2010. Monitoring and interpreting the ocean uptake of atmospheric CO₂. Greenhouse gases in the Earth system: setting the agenda to 2030, Royal Society, London, UK, Feb 22-23, 2010
86. Le Quere et al., 2010. Climate change and the carbon cycle. Oral, Canadian Meteorology and Oceanography annual meeting Ottawa, Canada, 31 May - 4 June 2010.
87. Metzl N., 2010. SOCAT versus LDEO and our ocean views of atmospheric inversions. Invited at SOCAT Southern and Indian Ocean SOCAT workshop. Hobart, TS, 16-18 June 2010.
88. Laurantou A. and N. Metzl, 2010. Progress in SOCAT, the Indian sector of Southern Ocean. Southern and Indian Ocean SOCAT workshop. Hobart, TS, 16-18 June 2010.
89. Laurantou A and N. Metzl, 2010. Islands effects. Southern and Indian Ocean SOCAT workshop. Hobart, TS, 16-18 June 2010.
90. Lenton A., N. Metzl, T. Takahashi, S. Sutherland, B. Tilbrook and M. Kuchinke, 2010. Controls on Southern Ocean surface CO₂ variability: Synthesis from LDEO v2009 data. SOCAT Southern and Indian Ocean SOCAT workshop. Hobart, TS, 16-18 June 2010
91. Metzl N. and C. Lo Monaco, 2010. Anthropogenic CO₂ distribution(s) in the Deep Southern Ocean. Invited, Deep Ocean Workshop: Observed and Model-Simulated Property Changes in the Deep Ocean of the Southern Hemisphere 21-23 June, 2010 Hobart, Australia.
92. Lenton A., L. Bopp, N. Metzl, R. Matear, A. Tagliabue and F. Cordon, 2010. The Future Evolution of the Southern Ocean and its Impact on Carbon Uptake. *Deep Ocean Workshop: Observed and Model-Simulated Property Changes in the Deep Ocean of the Southern Hemisphere 21-23 June, 2010 Hobart, Australia.*
93. Metzl, N., 2010. Carbon cycle and its perturbation by anthropic CO₂: role of the ocean, impacts on the marine life. Invited at Scientific Committee on Oceanic Research (SCOR) annual meeting, Toulouse, Sept 2010.
94. Morard, R., Quillévéré, F., Douady, C.J., Escarguel, G., de Garidel-Thoron, T., de Vargas, C., 2010. The allopatric distribution of *Globoconella inflata* cryptic species and its potential use for monitoring past movements of the Antarctic subpolar front. FORAMS 2010, International Symposium on Foraminifera, Bonn, Germany, abstract p. 144.

95. Quillévéré, F., Morard, R., de Vargas, C., Douady, C.J., Ujiie, Y., de Garidel-Thoron, T., Escarguel, G., 2010. *Truncorotalia truncatulinoides* and the value of direct morpho-genetic comparisons in planktonic foraminifera. FORAMS 2010, International Symposium on Foraminifera, Bonn, Germany, abstract p. 16
96. Metzl, N., A. Lenton and VVSS Sarma, 2010. CO₂ Sources (and Sinks ?) in the Indian Ocean. Invited at RECCAP/COCOS Workshop, 6-8 Oct., Viterbo, Italy.
98. Lenton A., D. Bakker, N. Metzl, C. Lo Monaco, M. Alvarez, K. Rodgers, C. Sweeney, B. McNeil, P. Monteiro, C. Sabine, B. Tilbrook et al., 2010. Southern Ocean. Invited at RECCAP/COCOS Workshop, 6-8 Oct., Viterbo, Italy
99. Pfeil B., Johannessen T., Watson A., Huertas E., Schuster U., Olsen A., Piera J., Körtzinger A., González-Dávila M., Santana-Casiano M., Metzl N., Boutin J., Rios A., Lefèvre N., Kelly-Gerrey B., de Baar H., Ólafsson J., Fransson A., Anderson L., Borges A., Skjelvan I., Heinze C., Dolman H., Rivier L., Paris J.-D. and Ciais P., 2011. Ocean flux and observing systems – the oceanic component of ICOS. Presented at The future of the 21st century ocean, Marine Sciences and European Research Infrastructures. International symposium, Brest-France, 28 June – 1 July 2011.
100. Fay, A. R. , G.A. McKinley, 2011. Attribution: What drives CO₂ sink trends? Invited at The ocean carbon cycle at a time of change: Synthesis and Vulnerabilities, A Joint SOLAS/IMBER/IOCCP international meeting, 14-16 Sept 2011, UNESCO, Paris, France.
101. Lo Monaco C., N.Metzl, A. Lenton, S. van Heuven, M. Vazquez et al., 2011. CO₂ changes in the Southern Ocean, Surface and Interior, What did we learn from observations ? Invited at *The ocean carbon cycle at a time of change: Synthesis and Vulnerabilities*, A Joint SOLAS/IMBER/IOCCP international meeting, 14-16 Sept 2011, UNESCO, Paris, France.
102. Lenton, A., N. Metzl, P. Monteiro et al., 2011. Overview of Carbon Changes in the Surface Ocean. Invited at *The ocean carbon cycle at a time of change: Synthesis and Vulnerabilities*, A Joint SOLAS/IMBER/IOCCP international meeting, 14-16 Sept 2011, UNESCO, Paris, France.
103. Pfeil, B., A. Olsen, D.C.E. Bakker, C. Sabine, N. Metzl, A. Kozyr et al., 2011. SOCAT: Surface Ocean CO₂ Atlas: Data treatment and adjustments. *The ocean carbon cycle at a time of change: Synthesis and Vulnerabilities*, A Joint SOLAS/IMBER/IOCCP international meeting, 14-16 Sept 2011, UNESCO, Paris, France.
104. Bakker, D., B. Pfeil, A. Olsen, C. Sabine, N. Metzl, S. Hankin, H. Koyuk, J. Malczyk, A. Kozyr, M. Telszewski and all SOCAT contributors, 2011. SOCAT: the official release. The ocean carbon cycle at a time of change: Synthesis and Vulnerabilities, A Joint SOLAS/IMBER/IOCCP international meeting, 14-16 Sept 2011, UNESCO, Paris, France.
105. Sarma, V., N. Metzl, C. Sabine, A. Lenton, M. Alvarez, C. Lo Monaco, P. Patra et al., 2011. Surface carbon fluxes and changes in ocean interior Carbon in the Indian Ocean. Invited at The ocean carbon cycle at a time of change: Synthesis and Vulnerabilities, A Joint SOLAS/IMBER/IOCCP international meeting, 14-16 Sept 2011, UNESCO, Paris, France.
106. Laurantou, A., and N. Metzl, 2011. Reduced decadal trend of carbon sink within a strong bloom area in the subantarctic zone. Oral presented at int. conference *Carbon in a Changing World*, 24-26 Oct, 2011. Rome, Italie.
107. Merlivat L., J. Boutin and D. Antoine, 2011. Remote estimates of marine primary productivity in the Southern Ocean from Carioca drifters and satellite based observations, WCRP Open Science conference, Denver, USA, Nov 2011.
108. Laurantou, A., and N. Metzl, 2011. Variability of CO₂ Fluxes in the NE Part of the Kerguelen Plateau at a Seasonal to Decadal Scale. Oral Presentation at *the ESA-SOLAS Conference: Earth Observation for Ocean-Atmosphere Interactions Science*, 29 Nov - 2 Dec 2011, Frascati, Italy.
109. Bakker, D., A. Olsen, B. Pfeil, N. Metzl, C. Sabine, S. Hankin, H. Koyuk, J. Malczyk, A. Kozyr, D. Pierrot, M. Telszewski, A. Borges, A. Chen, R. Feely, N. Lefevre, Y. Nojiri, V.V.S.S. Sarma, U. Schuster, B. Tilbrook, 2011. The Surface Ocean CO₂ Atlas (SOCAT). *ESA-SOLAS-EGU joint Conference: Earth Observation for Ocean-Atmosphere Interactions Science*, 29 Nov - 2 Dec 2011, Frascati, Italy.
110. Roy, T., Metzl, N., Lenton, A., Bopp, L. and C4M modellers, 2012. Using oceanic pCO₂ performance metrics to assess the dependency of future oceanic CO₂ uptake on model skill. Ocean Sciences Meeting 24-Feb 2012, Salt Lake City, USA. Abstract.
111. Roy, T., Metzl, N., Lenton, A., Bopp, L. and C4M modellers, 2012. An assessment of the drivers of regional oceanic pCO₂ seasonality in Earth System Models. Oral, *CARBOCHANGE 1st Annual Scientific Meeting*, Galway, Irlande. 7-9 Mar 2012.
112. Resplandy, L., J. Boutin and L. Merlivat, 2012. Seasonal and mesoscale variability of DIC in the Southern Ocean inferred from Carioca fCO₂. Oral, *CARBOCHANGE 1st Annual Scientific Meeting*, Galway, Irlande. 7-9 Mar 2012.
113. Legge O. et al., 2012. Surface Observing systems: overview and recent achievements. *CARBOCHANGE 1st Annual Scientific Meeting*, Galway, Irlande. 7-9 Mar 2012.
114. Laurantou A., Metzl N., 2012, Decadal evolution of carbon sink within a strong bloom area in the subantarctic zone. Oral, *European Geosciences Union, General Assembly*, April 2012, Vienna, Austria.

115. Lenton, A., B. Tilbrook and N. Metzl, 2012. Observed changes in ocean acidification in the Southern Ocean over the last two decades. *Third Symposium on The Ocean in a High-CO₂ World*, 24-27 Sept 2012, Monterey, CA, USA.
116. André, A., Quillévéré, F., Douady, C., Michel, E., de Garidel-Thoron, T., Weiner, A., Aurahs, R., Kucera, M., 2013. Pseudo-cryptic diversity in planktonic foraminifera: a rule with exceptions. *BioSyst.EU 2013*, Global systematics, Vienna, Austria, p. 16.
117. Dufour, C., L. Merlivat, J. Le Sommer, J. Boutin, D. Antoine, 2013. Interannual variability of primary production and air-sea CO₂ flux in the Atlantic and Indian sectors of the Southern Ocean. *EGU General Assembly 2013*, Apr 2013, Vienne, Austria. 15, pp.8634, 2013
118. Racapé, V., C. Lo Monaco, C. Pierre, N. Metzl, 2013. (talk) Coupling DIC/¹³C to estimate the anthropogenic carbon change in Irminger Basin and in Indian Ocean: new results. *CARBOCHANGE meeting*, 24-25-26 April 2013, Norwich – UK
119. Bakker, D.C.E. et al., 2013. An update to the Surface Ocean CO₂ Atlas (SOCAT version 2). 9th International Carbon Dioxide Conference, 3 to 7 June 2013, Beijing – China.
120. Lenton A., B. Tilbrook, R. Law, D. Bakker, S. C. Doney, N. Gruber, M. Hoppema, M. Ishii, N. S. Lovenduski, R. J. Matear, B. I. McNeil, N. Metzl, S. E. Mikaloff Fletcher, P. Monteiro, C. Rödenbeck, C. Sweeney, and T. Takahashi, 2013. Sea-air CO₂ fluxes in the Southern Ocean: 1990–2009. *ICDC9* June 2013, Benjing, China, Abstract
121. Lo Monaco, C., V. Racapé, N. Metzl, C. Pierre, A. Lenton, C. Brunet and A. Naamar, 2013. Evolution of anthropogenic CO₂, DIC and ¹³C_{DIC} in mode waters of the South Indian Ocean. *Workshop on Anthropogenic CO₂ in the Ocean Interior*, Beijing, China, June, 2.
122. Lo Monaco, C., N. Metzl, A. Lenton, C. Brunet, C. Pierre, V. Racapé, 2013. Anthropogenic and climate impacts on the total CO₂ increase observed in the South Indian Ocean. *9th International Carbon Dioxide Conference*, Beijing, China, June, 3-7, 2013.
123. Racapé, V., N. Metzl, C. Pierre, C. Lo Monaco and C. Brunet, 2013. (talk) Carbon 13, an additional constraint to reveal anthropogenic carbon uptake in the Southern Indian Ocean. *9th International Carbon Dioxide Conference*, 3 to 7 June 2013, Beijing – China.
124. Meilland J., Schiebel R., Howa H., 2013. The effect of planktic foraminifer biomass in biological carbon pump in the Southern Indian Ocean. *XIth SCAR (Scientific Committee of Antarctic Research) Biology Symposium*, Barcelona, Spain, 15-19 July 2013. Oral.
125. Olsen, A., D. Bakker, B. Pfeil, S. Hankin, K. Smith, C. Sabine, S. Alin, C. Cosca, B. Hales, S. Harasawa, S. Jones, A. Kozyr, N. Metzl, Y. Nojiri, K. O'Brien, U. Schuster, M. Telszewski, B. Tilbrook, C. Wada, N. Lefevre, J. Mathis, D. Pierrot, R. Wanninkhof, and all other SOCAT Contributors, 2013. SOCAT, A Global Data Product for Quantification of Air Sea Exchange of CO₂. *ESA-EGU-SOLAS international workshop "Air-sea Gas Flux Climatology; Progress and Future Prospects"* held at IFREMER in Brest, France from 24-27 Sept 2013
126. Rödenbeck, C., D. C. E. Bakker, N. Metzl, A. Olsen, C. Sabine, N. Cassar, R. F. Keeling, and M. Heimann, 2013. Atmosphere CO₂ flux variability estimated from SOCAT pCO₂ observations. *ESA-EGU-SOLAS international workshop "Air-sea Gas Flux Climatology; Progress and Future Prospects"* held at IFREMER in Brest, France from 24-27 Sept 2013.
127. Meilland J., Schiebel R., Lo Monaco C., Michel E., Howa H., 2014. New proxy of planktic foraminifer biomass based on test morphometry – Application to the reconstruction of the past biological carbon pump in the Southern Indian Ocean. *Int. Conf. CASE Project 5FP7-ITN - Bordeaux*, 4-6 February 2014.
128. Blain, S.; Quéguiner, B.; Team, K.; Team, O.; RESPONSE OF THE SOUTHERN OCEAN TO LARGE SCALE NATURAL IRON FERTILIZATION (KERGUELEN REGION) (Abstract ID: 15941), *ASLO Ocean Science Meeting*, 23-28/2/2014, Honolulu, Hawaii, USA
129. Gomez, R.; Lo Monaco, C.; Metzl, N.; Laurantou, A.; DECADAL CHANGE IN PH EVALUATED IN SUBANTARCTIC MODE WATER FROM OBSERVATIONS COLLECTED IN THE SOUTHERN INDIAN OCEAN (Abstract ID: 16268). *ASLO Ocean Science Meeting*, 23-28/2/2014, Honolulu, Hawaii, USA
130. Lo Monaco, C.; Metzl, N.; Lenton, A.; Racapé, V.; Gomez, R.; ANTHROPOGENIC AND CLIMATE IMPACTS ON THE TOTAL CO₂ INCREASE OBSERVED IN THE SOUTH INDIAN OCEAN (Abstract ID: 16470). *ASLO Ocean Science Meeting*, 23-28/2/2014, Honolulu, Hawaii, USA
131. Gruber, N., Clement, D., Tanhua, T., Ishii, M., Key, R. M., Rodgers, K., Feely, R. A., Sabine, C. L., Mathis, J. T., Wanninkhof, R., van Heuven, S., Hoppema, M., Perez, F. F., García-Ibañez, M., Lo Monaco, C., Murata, A., Lauvset, S. and Kozyr, A. (2014): The oceanic sink for anthropogenic CO₂ since the mid 1990s, *Ocean Sciences Meeting 2014*, Honolulu, Hawaii, U.S.A., 23- 28 February 2014
132. Gruber, N., Clement, D., Tanhua, T., Ishii, M., Key, R. M., Rodgers, K., Feely, R. A., Sabine, C. L., Mathis, J., Wanninkhof, R., Van Heuven, S., Hoppema, M., Pérez, F. F., García-Ibañez, M., Lo Monaco, C., Murata, A., Lauvset, S. and Kozyr, A., 2014. The oceanic sink for anthropogenic CO₂ since the mid-1990s, *CarboChange 3rd annual meeting*, Reykjavik, Iceland, 7-10 April 2014.
133. Boutin J. et al., 2014. Surface Observing system, Southern Ocean Data. *CarboChange 3rd annual meeting*, Reykjavik, Iceland, 7-10 April 2014.

134. Bellerby, R., C. Lo Monaco, N. Lovenduski, A. Lenton, K. Haruko, S. Trimbom, M. Hoppema, C. Sucking, M. Meredith and M. Sparrow, 2014. Southern Ocean ecosystems and ocean acidification. IMBER Open Science Conference, Bergen, Norway, 23-27 June 2014. (abstract)
135. Blain S. et al, 2014. Impact of large scale natural fertilization on carbon cycling in the Southern Ocean. IMBER Open Science Conference, Bergen, Norway, 23-27 June 2014. (abstract)
136. Lo Monaco, C., N. Metzl, A. Lenton, V. Racapé, C. Brunet, R. Gomez and C. Pierre, 2014. Anthropogenic and Climate Impacts on the Total CO₂ Increase Observed in the South Indian Ocean. IMBER Open Science Conference, Bergen, Norway, 23-27 June 2014. (abstract)
137. Racapé, V., Metzl, N., Pierre, C., Reverdin, G., Bopp, L., Tagliabue, A. and Roche, D., 2014. Spatiotemporal variability of $\delta^{13}\text{C}_{\text{DIC}}$ in surface ocean: Observations versus Models. IMBER Open Science Conference, Bergen, Norway, 23-27 June 2014. (abstract)
138. Rödenbeck, C., Bakker, D. C. E., Iida, Y., Jones, S., Landschutzer, P., Metzl, N., Nakaoka, S., Olsen, A., Park, G.-H., Sasse, T., Schuster, U., Valsala, V., Zeng, J., 2014. Data-based sea–air CO₂ flux estimation – The Surface Ocean pCO₂ Mapping intercomparison (SOCOM). IMBER Open Science Conference, Bergen, Norway, 23-27 June 2014. (abstract)
139. Bellerby, R. , Lo Monaco, C. , Lovenduski, N. , Lenton, A. , Haruko, K. , Trimbom, S. , Hoppema, M. , Suckling, C. and Meredith, M., 2014: Acidification of the Southern Ocean, XXIII SCAR Biennial Meetings - 2014 Open Science Conference, 25-28 August 2014. Auckland, New Zealand,
140. Bakker, D. C. E. and all international SOCAT, GLODAP2, SOCOM contributors, 2014. Global synthesis products enable quantification of the ocean carbon sink and ocean acidification: Global Data Analysis Project Version 2 (GLODAP2), Surface Ocean CO₂ Atlas (SOCAT), Surface Ocean pCO₂ Mapping Intercomparison (SOCOM). Challenger Conference for Marine Science, Plymouth, U.K., 8 -11 September 2014
141. Bakker D. et al, 2014. THE SURFACE OCEAN CO₂ ATLAS (SOCAT) ENABLES DETECTION OF CHANGES IN THE OCEAN CARBON SINK *1st ICOS International Conference on Greenhouse Gases and Biogeochemical Cycles* ICOS meeting, Bruxelles, 23-25 Sept 2014. Abstract.
142. Bakker, D.C.E. et al. 2015. The Surface Ocean CO₂ Atlas (SOCAT) enables detection of changes in the ocean carbon sink. *Carbochange final meeting*, 19-22 Jan 2015, Bergen, Norway.
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179. Leseurre, C., G Reverdin, C. Lo Monaco, C. Waelbroeck, N. Metzl, V. Racapé, C. Pierre, J. Demange, J. Fin, 2024. Investigation of the Suess Effect in the South-West and Southern Indian Ocean over the last two decades (1998-2021). 11th International Carbon Dioxide Conference (oral or poster ?).
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8 Nouvelles espèces découvertes et décrites:

Globoconella inflata Type I (Morard et al., 2011)
Globoconella inflata Type II (Morard et al., 2011)
Globigerina bulloides Type II (Morard et al., 2013)
 invalidated species : *Globigerinoides trilobus*, *Globigerinoides immaturus*, *Globigerinoides quadrilobatus* (André et al. 2013).

Rubriques 9 à 13 :

Liste des références des rapports, des applications, des brevets, atlas ou documents vidéo

9 Rapports

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Rubriques 17 à 20:

Le type des données validées et/ou transmises,

Les banques de données (SISMER, JGOFS, CDIAC ...) les équipes auxquelles elles ont été transmises.

17-19 Validation, transmission aux banques de données :

Les données OISO sont centralisées au LOCEAN/IPSL (<http://caraus.ipsl.jussieu.fr/>) et disponibles auprès des coordinateurs. Elles sont archivées progressivement en suivant l'actualité du post-traitement. Les données prioritaires du projet (CO₂), accompagnées d'un descriptif des méthodes de mesures, sont accessibles et régulièrement transmises aux bases internationales, CDIAC (Oak Ridge, USA, voir par exemple CDIAC news, Mai 2008, cdiac.ornl.gov), NCEI/OCADS (depuis 2017), SOCAT (www.socat.info; Pfeil et al., 2013, Sabine et al., 2013, Bakker et al., 2014; 2016; 2017; 2018; 2019), GLODAP/CARINA (version 1, Lo Monaco et al., 2010; Sabine et al., 2010; version 2, Olsen et al., 2016), CCHDO, la base du LDEO (Takahashi et al 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018), et intégrées aux bases des programmes européens CARBOOCEAN et CARBOCHANGE et internationale GOA-ON (Global Ocean Acidification Observing Network). Les données hydrologiques (bouteilles, CTD) sont transmises au SISMER et CORIOLIS. D'autres données associées (chl_a, isotopes C13, O18, etc...) ont été traitées et mises à disposition des demandeurs ou dans des bases dédiées (e.g. O18, <http://data.giss.nasa.gov/o18data/#NB>; C13 pour Atlas WOCE-Indian, <http://www.locean-ipsl.upmc.fr/OCEANS13C/>). Les données ADCP des campagnes OISO ont été transmises au SISMER et à la base internationale JasADCP (<http://ilikai.soest.hawaii.edu/sadcp/>). Les données bathymétriques sont archivées à l'IPEV et transmises auprès d'utilisateurs (géophysique, CEA). Les données des échantillons d'air (CO₂, d¹³CO₂ et dC¹⁸O₂, CH₄, CO) ont été intégrées dans la base de données du S.O. RAMCES et WMO. Signalons que des données sur les mammifères marins et les oiseaux recueillies durant les campagnes OISO sont disponibles sur la base Seamap. Les données relatives aux foraminifères sont intégrées sur la base : <http://pfr2.sb-roscoff.fr>. Associées aux données acoustiques, les données de profils CTD-O₂-Fluo OISO sont intégrées dans la base MESOPP (www.mesopp.eu/).

20 Transmission à d'autres équipes:

Depuis 1998, les données OISO ont été transmises à de nombreuses reprises dans la communauté. Par exemple, à la fin de la campagne OISO-3 (Décembre 98) nous avons transmis à bord le jeu de données au chef de mission d'ANTARES IV (M.Denis), campagne JGOFS/PROOF qui suivait OISO-3 dans le même secteur océanique (zones subtropicale et subantarctique indienne). Ces données, couplées aux données ANTARES, ont été utilisées avec profit lors de présentations à des colloques internationaux (Delille et al., 2000a,b,c). Des données OISO obtenues dans la région de Crozet ont été communiquées au CEA (programme HydroCro) ainsi qu'à R.Pollard (SOC/UK) et D.Bakker (UEA/UK) intéressés par la variabilité hydrologique et géochimique dans le secteur de Crozet (préparatoire à un projet de campagne UK dans ce secteur). Les données OISO-3, OISO-4, OISO-8, OISO-10, OISO-15 et OISO-20 traitées juste après les campagnes ont été transmises au LODYC/LOCEAN (L.Merlivat, J. Boutin) pour effectuer des comparaisons avec les enregistrements des bouées

Carioca larguées durant les mêmes campagnes. Toutes les données OISO acquises et analysées jusqu'à présent ont été mises à disposition à la communauté des expérimentateurs (S.Blain/COM, R.Morrow/LEGOS, C.Jeandel/LEGOS, X.Crosta/EPOC, A.Borges/UOC, T.Takahashi/LDEO, R. Wanninkhof/NOAA...) et modélisateurs (J.Orr/LSCE, O.Aumont/LOCEAN, C.Lequere/UEA, R.Matear/CSIRO, V.Garçon/LEGOS, C.Lancelot/ULB, A.Mahadevan/UNH, P.Wetzel/MPI, etc... ..) qui en ont fait la demande.

Lorsque les données sont dans des bases nationales et internationales à libre accès (e.g. SOCAT, www.socat.info, CDIAC, GLODAP, CARINA, LDEO, etc...), il est difficile d'établir une liste complète d'utilisateurs. Une liste est proposée ci-dessous, identifiant les laboratoires ayant effectivement utilisé des données OISO ou susceptibles d'en bénéficier ou d'en avoir bénéficié (thématiques biogéochimie et climat):

En France : LOCEAN (Maitre d'œuvre de OISO, Paris), LSCE (Gif), IUEM/LEMAR (Brest), LOV (Villefranche/Mer), LEGOS (Toulouse), LPO-IFREMER (Brest), MNHN (Paris), COM-MIO (Marseille), Météo-France (Toulouse), LGGE (Grenoble), CEBC (Chizé), CEA (Saclay), IMAGES (Perpignan), Station Biologique (Roscoff)...

Laboratoires et Instituts étrangers : NODC/NOAA (Silver Spring, USA), PMEL/NOAA (Seattle, USA), Princeton Univ (Princeton, USA), LDEO (Palisades, USA), University of California (Los Angeles, USA), SIO (San Diego, USA), NCAR (Boulder, USA), GSFC/NASA (Greenbelt, USA), CSIRO (Hobart, Aspendale Vic., Australie), NOC (Southampton, UK), UEA (Norwich, UK), BCCR (Bergen, Norvège), NIOZ (Texel, Pays-Bas), UOC (Univ Liège, Belgique), IFM (Kiel, All.), MPI (Lena, All.), MRI (Tsukuba, Japon), JAS-ADCP (Hawaii, USA), AWI (Bremerhaven, All.) etc...

Rubrique 21 :

Si l'exploitation est toujours en cours, pouvez-vous donner un échéancier ?

Le S.O. OISO étant un observatoire à long terme, il n'est pas possible, ou plutôt pas utile, de fournir un échéancier. Nous pouvons néanmoins indiquer que chaque campagne apporte son lot de nouveautés et de surprises, de sorte que des travaux spécifiques peuvent être menés dans l'année qui suit la campagne (e.g. OISO-1 et 2). Toutefois il faut admettre que l'intérêt prioritaire du projet visant à étudier la variabilité interannuelle à décennale du cycle du CO₂ océanique, il faut attendre plusieurs années d'observations avant de publier des résultats originaux (e.g. Jabaud-Jan et al, 2004 ; Takahashi et al., 2002, Metzl et al 2006, Le Quere et al, 2007 pour les observations 1998-2002; Metzl, 2009, Le Quéré et al. 2009 et Takahashi et al., 2009 pour les observations 1998-2007, Laurantou and Metzl, 2011; Lenton et al., 2012, 2013, Sarma et al., 2013, Roedenbeck et al., 2013, 2014, 2015, Landschutzer et al, 2015, pour les observations 1998-2011, Lo Monaco et al., 2014, Le Quéré et al 2015 pour les observations 1998-2013, Le Quere et al 2016 pour 2015, etc...). Avec la mise en place des bases de données internationales de CO₂ (SOCAT, CARINA/GLODAPII, CCHDO, GOA-ON...) on peut prévoir que les données OISO des campagnes 2020-2022 seront intégrées dans ces bases et atlas associés en 2021-2023. Celles de 2019 ont été intégrées à la base SOCAT-v2020 (Bakker et al 2020).