

An observation-based global monthly gridded sea surface pCO₂ product from 1982 onward and its monthly climatology.

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Method:

The observation-based pCO₂ fields were created using a 2-step neural network method extensively described and validated in Landschützer et al. 2013, 2014, 2016. The method first clusters the global ocean into biogeochemical provinces and in a second step reconstructs the non-linear relationship between CO₂ driver variables and observations from the 4th release of the Surface Ocean CO₂ Atlas (SOCAT, Bakker et al. 2016). This file contains the resulting monthly pCO₂ fields at 1°x1° resolution covering the global ocean with the exception of the Arctic Ocean and few marginal seas. The air-sea CO₂ fluxes are computed from the air-sea CO₂ partial pressure difference and a bulk gas transfer formulation following Landschützer et al. 2013, 2014, 2016. Furthermore, the monthly climatology is created from the monthly average of the period 1985-present.

Content:

File 1: spco2_MPI_SOM-FFN_CDIAC_v2018.nc

The netcdf file contains:

- lat: latitude in degrees north (89.5°S – 89.5°N with 1° resolution)
- lon: longitude in degrees east (179.5°W-179.5°E with 1° resolution)
- time: time in seconds since 2000-01-01-00:00 (monthly resolution)

- date: array containing year, month, day of month, hour minute, second
- spco2_raw: The raw 2-step neural network sea surface pCO₂ output in μatm
- fgco2_raw: The air-sea flux density, calculated from the raw sea surface pCO₂ in $\text{mol m}^{-2} \text{yr}^{-1}$
- spco2_smoothed: A smoothed product of the raw pCO₂, created by the spatial and temporal mean of each points neighboring pixels (the 3x3x3 pixel neighborhood domain) in μatm .
- fgco2_smoothed: A smoothed product of the raw air-sea CO₂ flux, created by the spatial and temporal mean of each points neighboring pixels (the 3x3x3 pixel neighborhood domain) in $\text{mol m}^{-2} \text{yr}^{-1}$.
- aco2: Atmospheric pCO₂ in μatm for the air-sea flux calculation, derived from the NOAAESRL marine boundary layer reference dry air mixing ratio of atmospheric CO₂ (<https://www.esrl.noaa.gov/gmd/ccgg/mbl/>) xCO₂ product and SST (Reynolds et al. 2002) as well as sea level pressure (Kalnay et al. 1996) following Dickson et al. 2007.
- dco2: Delta pCO₂ calculated from the CO₂ partial pressure difference between atmosphere and the raw surface ocean partial pressure.
- dco2_smoothed: Delta pCO₂ calculated from the CO₂ partial pressure difference between atmosphere and the smoothed surface ocean partial pressure.
- kw: The gas transfer velocity calculated from the ERA-interim wind product (Dee et al. 2011) as described in Landschützer et al. 2014 in m yr^{-1} .
- sol: The CO₂ solubility in $\text{mol m}^{-3} \mu\text{atm}^{-1}$ calculated from sea surface temperature (Reynolds et al. 1996) and Hadley centre EN4 sea surface salinity (Good et al. 2013) following Weiss 1974.
- ice: The percentage of sea ice from the Rayner et al. 2003 sea ice product.
- lsmask: The land-sea mask.

File 2: spco2_MPI_SOM-FFN_CDIAC_v2018_clim.nc

- lat: latitude in degrees north (89.5°S – 89.5°N with 1° resolution)
- lon: longitude in degrees east (179.5°W-179.5°E with 1° resolution)
- spco2_clim: Sea surface pCO₂ climatology in μatm
- fgco2_clim: Climatology of the air-sea flux density in $\text{mol m}^{-2} \text{yr}^{-1}$

Inquiries:

Inquiries should be sent to Peter Landschützer: peter.landschuetzer@mpimet.mpg.de. Other data formats (e.g. matlab) available upon request.

References:

Bakker, D. C. E., Pfeil, B., Landa, C. S., Metzl, N., O'Brien, K. M., Olsen, A., Smith, K., Cosca, C., Harasawa, S., Jones, S. D., Nakaoka, S., Nojiri, Y., Schuster, U., Steinhoff, T., Sweeney, C., Takahashi, T., Tilbrook, B., Wada, C., Wanninkhof, R., Alin, S. R., Balestrini, C. F., Barbero, L., Bates, N. R., Bianchi, A. A., Bonou, F., Boutin, J., Bozec, Y., Burger, E. F., Cai, W.-J., Castle, R. D., Chen, L., Chierici, M., Currie, K., Evans, W., Featherstone, C., Feely, R. A., Fransson, A., Goyet, C., Greenwood, N., Gregor, L., Hankin, S., Hardman-Mountford, N. J., Harlay, J., Hauck, J., Hoppema, M., Humphreys, M. P., Hunt, C. W., Huss, B., Ibáñez, J. S. P., Johannessen, T., Keeling, R., Kitidis, V., Körtzinger, A., Kozyr, A., Krasakopoulou, E., Kuwata, A., Landschützer, P., Lauvset, S. K., Lefèvre, N., Lo Monaco, C., Manke, A., Mathis, J. T., Merlivat, L., Millero, F. J., Monteiro, P. M. S., Munro, D. R., Murata, A., Newberger, T., Omar, A. M., Ono, T., Paterson, K., Pearce, D., Pierrot, D., Robbins, L. L., Saito, S., Salisbury, J., Schlitzer, R., Schneider, B., Schweitzer, R., Sieger, R.,

Skjelvan, I., Sullivan, K. F., Sutherland, S. C., Sutton, A. J., Tadokoro, K., Telszewski, M., Tuma, M., Van Heuven, S. M. A. C., Vandemark, D., Ward, B., Watson, A. J., Xu, S.: A multi-decade record of high quality fCO₂ data in version 3 of the Surface Ocean CO₂ Atlas (SOCAT). *Earth System Science Data* 8: 383-413. doi:10.5194/essd-8-383-2016, 2016

de Boyer Montegut, C., G. Madec, A. S. Fischer, A. Lazar, and D. Iudicone,: Mixed layer depth over the global ocean: An examination of profile data and a profile-based climatology, *J. Geophys. Res.*, 109, C12003, doi:10.1029/2004JC002378, 2004

Dee, D. P., Uppala, S. M., Simmons, A. J., Berrisford, P., Poli, P., Kobayashi, S., Andrae, U., Balmaseda, U. A., Balsamo, G. and Bauer, P.: The ERA-Interim reanalysis: Configuration and performance of the data assimilation system, *Quarterly Journal of the Royal Meteorological Society*, 137(656), 553-597, 2011

Dickson, A. G., Sabine, C. L., and Christian, J. R., eds.: *Guide to Best Practices for Ocean CO₂ Measurements*, PICES Special Publication, IOCCP Report No. 8, 2007.

Good, S. A., Martin, M. J. and Rayner, N. A.: EN4: quality controlled ocean temperature and salinity profiles and monthly objective analyses with uncertainty estimates, *Journal of Geophysical Research: Oceans*, 118, 6704-6716, 2013

Kalnay, E., Kanamitsu, M., Kistler, R., Collins, W., Deaven, D., Gandin, L., Iredell, M., Saha, S., White, G., Woollen, J., Zhu, Y., Leetmaa, A., Reynolds, R., Chelliah, M., Ebisuzaki, W., Higgins, W., Janowiak, J., Mo, K. C., Ropelewski, C., Wang, J., Jenne, R., and Joseph, D.: The NCEP/NCAR 40-year reanalysis project, *Bulletin of the American Meteorological Society*, 77, 437–470, 1996.

Landschützer, P., Gruber, N., Bakker, D. C. E.: Decadal variations and trends of the global ocean carbon sink, *Global Biogeochemical Cycles*, 30, doi:10.1002/2015GB005359, 2016

Landschützer, P., Gruber, N., Bakker, D. C. E., Schuster, U.: Recent variability of the global ocean carbon sink, *Global Biogeochemical Cycles*, 28, doi: 10.1002/2014GB004853, 2014.

Landschützer, P., Gruber, N., Bakker, D. C. E., Schuster, U., Nakaoka, S., Payne, M. R., Sasse, T., and Zeng, J.: A neural network-based estimate of the seasonal to inter-annual variability of the Atlantic Ocean carbon sink, *Biogeosciences*, 10, 7793-7815, doi:10.5194/bg-10-7793-2013, 2013.

Rayner, N. A., Parker, D. E., Horton, E. B., Folland, C. K., Alexander, L. V., Rowell, D. P., Kent, E. C., and Kaplan, A.: Global analyses of sea surface temperature, sea ice, and night marine air temperature since the late nineteenth century, *Journal of Geophysical Research*, 108, 4407, doi:10.1029/2002JD002670, 2003.

Reynolds, R. W., Rayner, N. A., Smith, T. M., Stokes, D. C., and Wang, W.: An improved in situ and satellite SST analysis for climate, *Journal of Climate*, 15, 1609–1625, 2002.

Weiss, R. F.: Carbon Dioxide in Water and Seawater: The Solubility of a Non-Ideal Gas, *Marine Chemistry*, 2, 203–215, 1974.