Joint workshop
SOCAT (Surface Ocean CO2 ATlas) Coastal Regional Group
&
COST Action 735 Working Group 3
IFM-GEOMAR, Kiel, Germany, 22/23 January 2009

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2. Aims of the workshop

The two primary aims of SOCAT are:

1. 2nd level quality controlled global surface ocean fCO2 data set
2. Gridded SOCAT product of monthly surface water fCO2 means, with no temporal or spatial interpolation (i.e. bin averages).

The SOCAT Coastal Regional Group decided to add the following secondary aims to the initiative:

3. Coastal climatology of fCO2
4. Coastal climatology of air-sea CO2 fluxes

During the workshop the SOCAT Coastal Regional Group discussed how to achieve these 4 targets along the following lines:

- Identification of areas of interest and of PIs in view of 2nd level quality control (QC)
- Achieving 2nd level QC (in particular handling high spatial and temporal variability of fCO2 in coastal waters)
- Gridding procedures (spatial extent of the coastal zone, grid resolution for binning the fCO2 data, interpolation)
- Collapsing data into a single virtual year taking into account the change in atmospheric CO2 and inter-annual variability
- Computation of air-sea CO2 fluxes (atmospheric CO2, gas transfer velocity parameterization and wind speed data source)

In parallel, several issues were raised that led to recommendations for the other SOCAT regional groups.

3. Summary of discussions

3.1 Identification of areas of interest and of PIs in view of 2nd level quality control (QC)

Refer to Figures 1A and 1B and Table 1

3.2 Achieving 2nd level QC (in particular handling spatial and temporal variability of fCO2)

The following steps to 2nd level QC the data were established:

A. look at metadata

B. look at the data

B.1 Look at “obvious” outliers (SSS, SST, pCO2 & position) for a given cruise taking into account the temporal and spatial resolution of the data (and ship speed)

B.3 Determine area of low spatial and short-term temporal variability based on fCO2, SST, and SSS data (autocorrelation analysis) to perform 2nd level QC.

B.3.1. Look for cross-overs (time and space interval to be determined by expert judgment).

B.4.1. Use property-property approach (fCO2vsSSS, fCO2vsSST) to compare cross-overed data-sets.

B.4. Statistics of each cruise regarding the variance on the monthly mean/median of all cruises in a given box.

B.5. Not mandatory other methods (expert specific tools) :

3.3 Gridding procedures (spatial extent of the coastal zone, grid resolution for binning the fCO2 data, interpolation)

- The spatial extent of the coastal zone is from the coast to an offshore boundary of 4° from major coast line.
- Two grid sizes were determined: 0.5°x0.5° or 1.0°x1.0° (depending on data availability (= temporal and spatial density) and expert judgment).
- Grids should include both the monthly mean and the monthly median of data.
- For the SOCAT Atlas grids (monthly/year), information on the number of original data points and the variance on mean or median need to be included.
- For the SOCAT Coastal Climatology grids, information on the number of months for which data is really available and variance need to be included.
- For each SOCAT Coastal Climatology grids, temporal interpolation will carried out to achieve yearly coverage based on expert judgement and knowledge on the seasonal variability of each specific area.
- For each SOCAT Coastal Climatology, no spatial interpolation will be attempted to fill gaps where data is unavailable.

3.4 Collapsing data into a single virtual year taking into account the change in atmospheric CO2 and inter-annual variability

- To achieve the Coastal Climatology, data should be collapsed to a single virtual year (2005), assuming that surface waters track atmospheric pCO2 increase, according to :
  $fCO_{2\ sea\ 2005} = fCO_{2\ sea\ year} + (xCO_{2\ air\ 2005} - xCO_{2\ air\ year})$
  where $fCO_{2\ sea\ 2005}$ is the fCO_2 collapsed to a virtual year (2005), $fCO_{2\ sea\ year}$ is the monthly average for a given grid cell and a given year, $xCO_{2\ air\ year}$ is the annual mean atmospheric xCO2 at Mauna Loa for the same given year, and $xCO_{2\ air\ 2005}$ is the annual mean atmospheric xCO2 at Mauna Loa for year 2005.
- For the purpose of producing the Atlas grids and the Climatology grids, data should be averaged regardless of climate oscillations that are know to induce inter-annual variability of surface fCO2 (ENSO, NAO, SAM, …).

3.5 Computation of air-sea CO2 fluxes (atmospheric CO2, gas transfer velocity parameterization and wind speed data source)

- It was decided to use 3 published gas transfer velocity parameterizations as a function of wind speed (Nightingale et al. 2000; Ho et al. 2006; Sweeney et al. 2007) and a fourth parameterization to be derived from available $SF^6/^3He$ data.
- It was decided to use the regression statistics on the fourth parameterization to provide uncertainties on the air-sea CO2 flux estimates.
- It was decided to use for atmospheric CO2, the "atmospheric CO2 rug" from Global View for year 2005 (if consensus is reached with other SOCAT regional groups)
- Advantages and caveats of several wind speed products (NCEP, ECMWF, COAS, Quickscat) were discussed, and no decision was reached regarding the best wind speed product to compute air-sea CO2 fluxes in coastal waters.

4. Recommendations for the other SOCAT regional croups

- Remove subjective names from flags:
  "Category A: A good cruise" should become "Category A"

"Category B: An acceptable cruise" should become "Category B"
"Category C: An acceptable cruise" should become "Category C"
"Category D: Un-documented data" should become "Category D"
"Category F: failure" should become "Category F"

- For the final SOCAT Atlas compilation, all regional groups must take care to avoid double-count with the "open ocean" regional group grids, since the Coastal domain is redefined with an offshore boundary of 4° from major coast line.
- Other Regional groups should discuss (and report) if the "atmospheric CO2 rug" from Global View is sufficient for the purposes of computing air-sea CO2 fluxes.
- Other Regional groups should discuss (and report) the choice of a wind speed product to compute air-sea CO2 fluxes.
- Other Regional groups should discuss (and report) how to achieve a climatology of wind speeds (period (years) of averaging and which wind speed product) or a climatology of k_{660} values.
- Schedule for future work of SOCAT activities is requested : dead-line for 2nd level QC ; dead-line for producing grids for Atlas.

5. Acknowledgements

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6. References

Ho D.T., C.S. Law, M.J. Smith, P. Schlosser, M. Harvey & P. Hill (2006) Measurements of air-sea gas exchange at high wind speeds in the Southern Ocean: Implications for global parameterizations, Geophysical Research Letters, VOL. 33, L16611, doi:10.1029/2006GL026817

Nightingale P. D., Liss P. S., and Schlosser P. 2000. Measurements of air-sea gas transfer during an open ocean algal bloom. Geophys. Res. Lett. 27, 2117-2120.

Sweeney, C., E. Gloor, A. R. Jacobson, R. M. Key, G. McKinley, J. L. Sarmiento, and R. Wanninkhof (2007), Constraining global air-sea gas exchange for CO2 with recent bomb 14C measurements, Global Biogeochem. Cycles, 21, GB2015, doi:10.1029/2006GB002784.

Figure 1A. PIs of the SOCAT Coastal Regional Group for performing 2nd Level QC and data gridding (excluding E.U. waters, refer to Fig. 1B) – refer to Table 1 for more details:

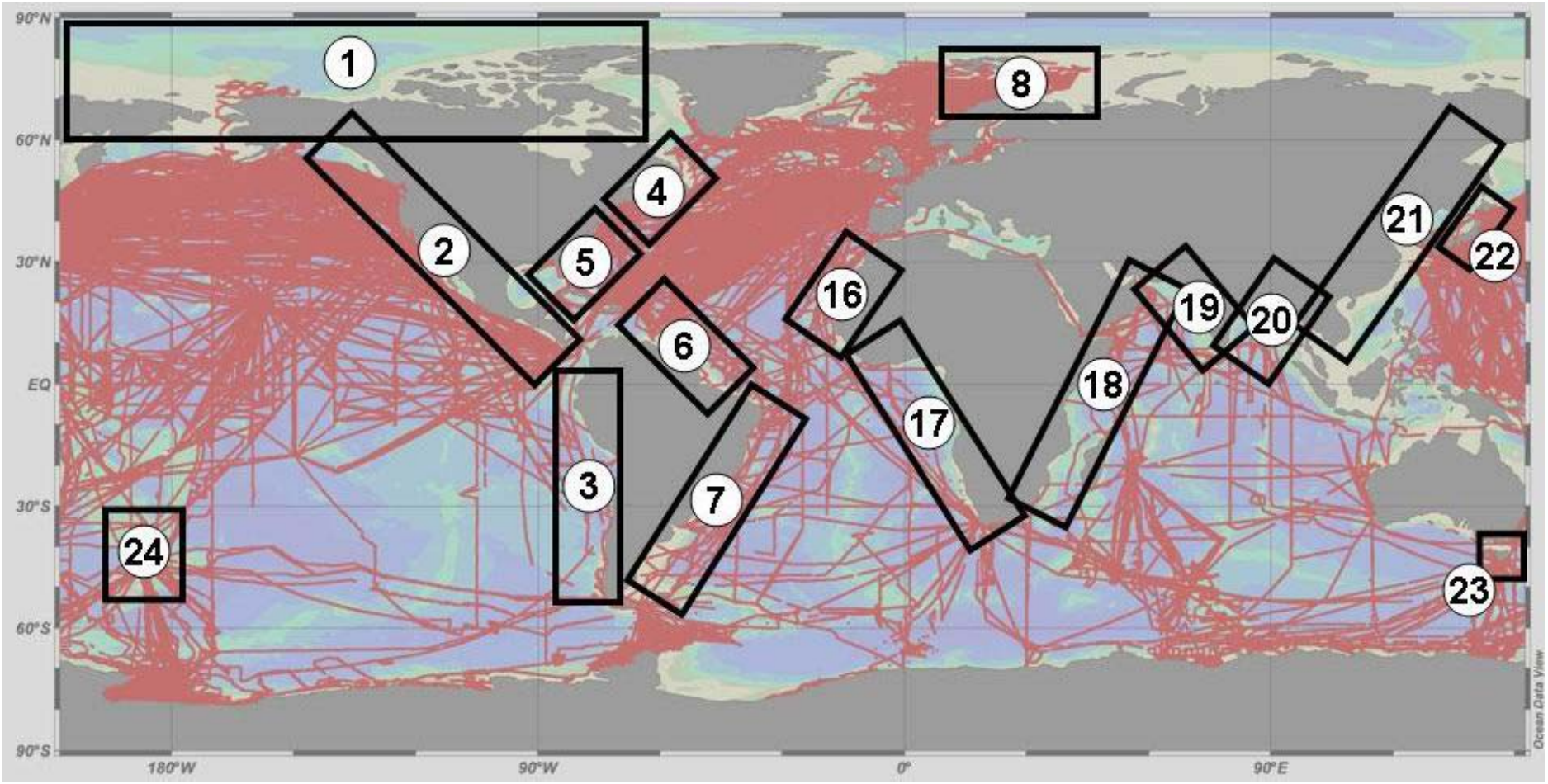

Figure 1B. PIs of the SOCAT Coastal Regional Group for performing 2nd Level QC and data gridding (focussing on E.U. waters) – refer to Table 1 for more details:

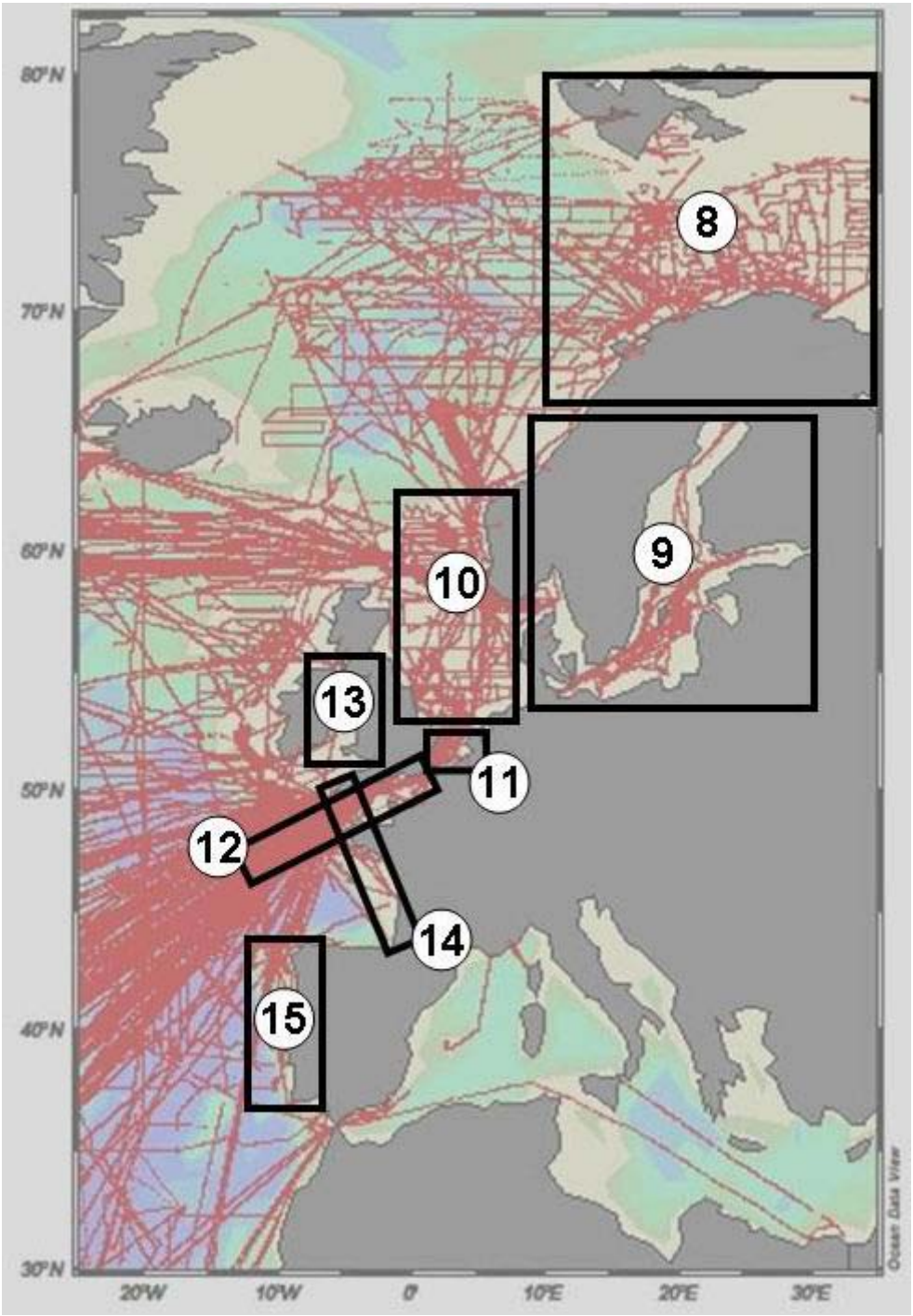

Table1. PIs of the SOCAT Coastal Regional Group for performing 2nd Level QC and data gridding:

ID N° (Fig.1)	Area	PIs
1	U.S. & Canadian Arctic	H. Thomas, N. Bates
2&3	U.S. & South American western coasts	F. Chavez, B. Hales, S. Alin
4	Northern U.S. East coast	J. Salisbury, H. Thomas
5	Southern U.S. East coast	W.J. Cai
6&7	South American East coast	S. Alin
8	European Nordic seas	A. Omar
9	Baltic Sea	B. Schneider
10	North Sea	A. Omar, H. Thomas
11	S.B. of the North Sea	A.V. Borges
12	English Channel & Celtic Sea	U. Shuster
13	Irish Sea	N. Hardman-Mountford
14	Bay of Biscay (French coast)	D. Hydes, A. Padin
15	Iberian coast	A. Padin
16&17	African West coast	M. Santana-Casiano, M. González-Dávila, P. Monteiro, F. Chavez, B. Hales, A. Körtzinger, T. Steinhoff
18, 19 & 20	Indian ocean coasts	V.V.S.S. Sarma
21	China Seas	M. Dai, A. Chen
22	Japan coastal	A.V. Borges (if no-one else)
23	Tasman shelf	A.V. Borges
24	New Zeeland coastal	A.V. Borges, K. Currie