New developments of pH and pCO2 systems for Ferrybox in Norwegian waters

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NIVA

Norwegian Ferrybox network

Core water sensors
- Inlet temperature
- Temperature
- Salinity
- Turbidity
- Oxygen

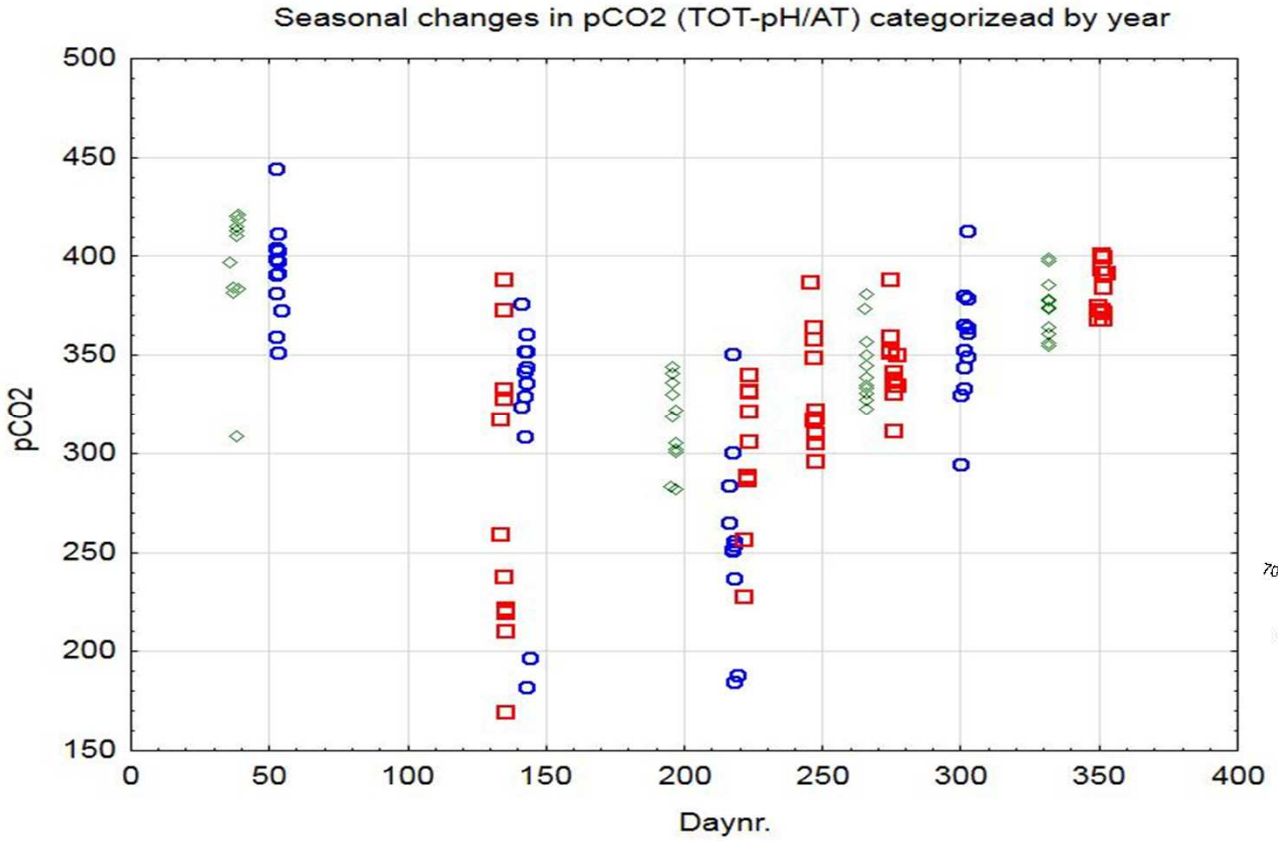
Biogeochemical
- Chl fluorescence
- PC Fluorescence
- CDOM Fluorescence
- **pH and pCO2**

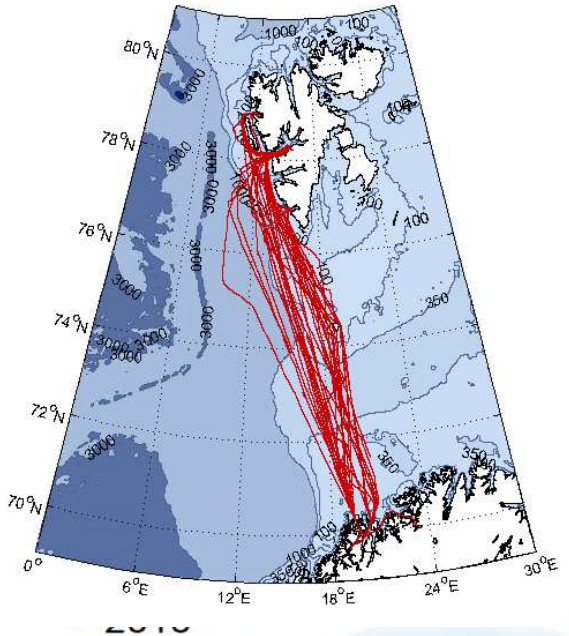
Water samples
- Chl-a
- TSM
- Turbidity
- CDOM
- Nutrients
- Algal pigment absorbtion
- Algae taxonomy

Deck sensors
- Uppwelling Radiance
- Down welling radiance
- Downwelling Irradiance
- Wind

Inter-annually variation in pCO_2 in the Arctic waters

From the national monitoring program in the Arctic



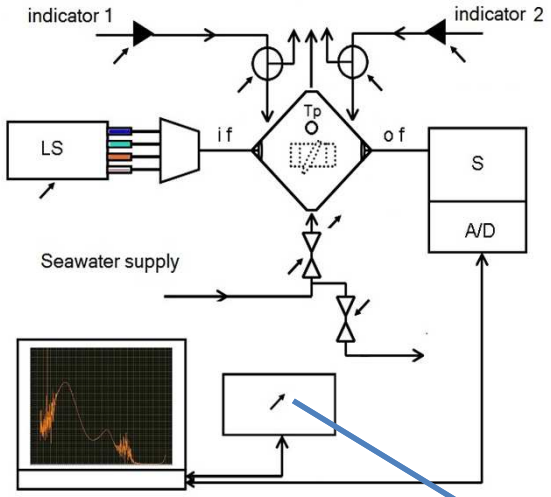


Based on water sampling and At, Ct, pH measurements

Ferrybox pCO2 and pH

- A new installation combining autonomous pCO_2 and spectrophotometric pH detection are installed in 2014
- pH is based on an effective set-up for high resolution absorbance detection of a suitable dye injections. Developed at NIVA.
- pCO2 using combined membrane technology and a new solid state detector. Developed at Franatech/NIVA.
- The two measurement systems will be coupled in a compact, reliable Ferrybox set-up requiring minimal maintenance, optimal calibration to performed the needed requirements.

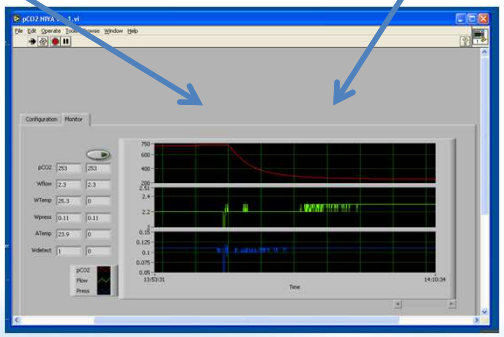
Combined approach pH and pCO2 into the Ferrybox



pH and carbonate

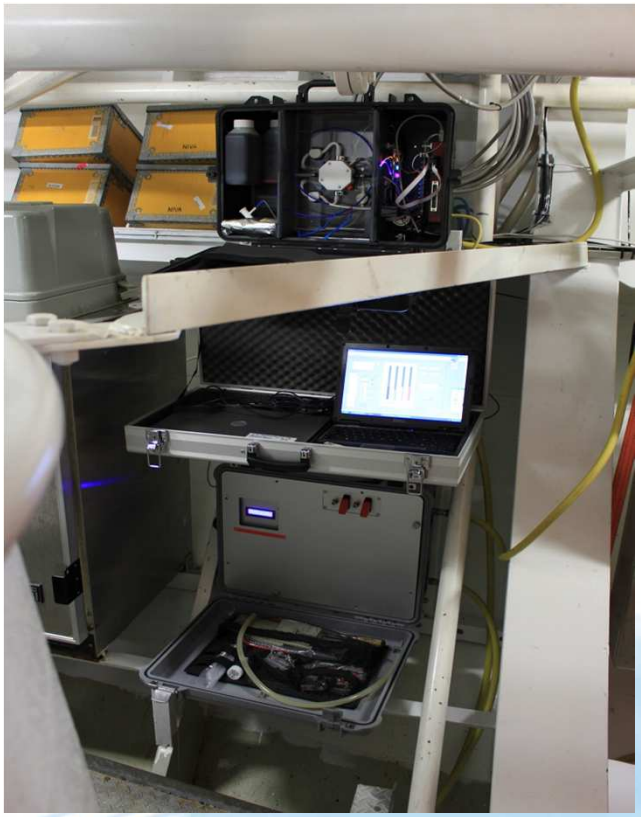
Physically implemented into the pCO2 will be tested!

pCO2



Combined in a common labview Software with data from the Ferrybox like SST, pressure e.g..

NIVA pH and NIVA/Franatech pCO2 in operation along the Norwegian coast



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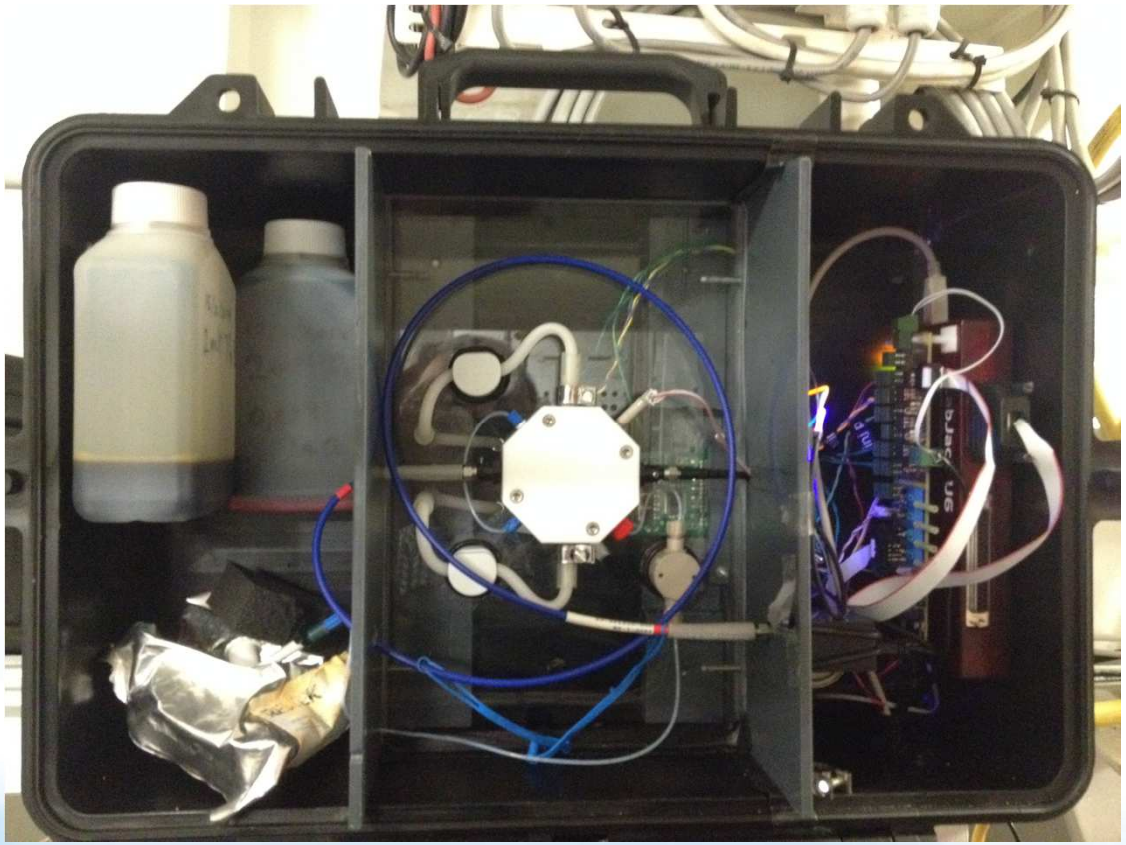
17.09.2014

NIVA pH system

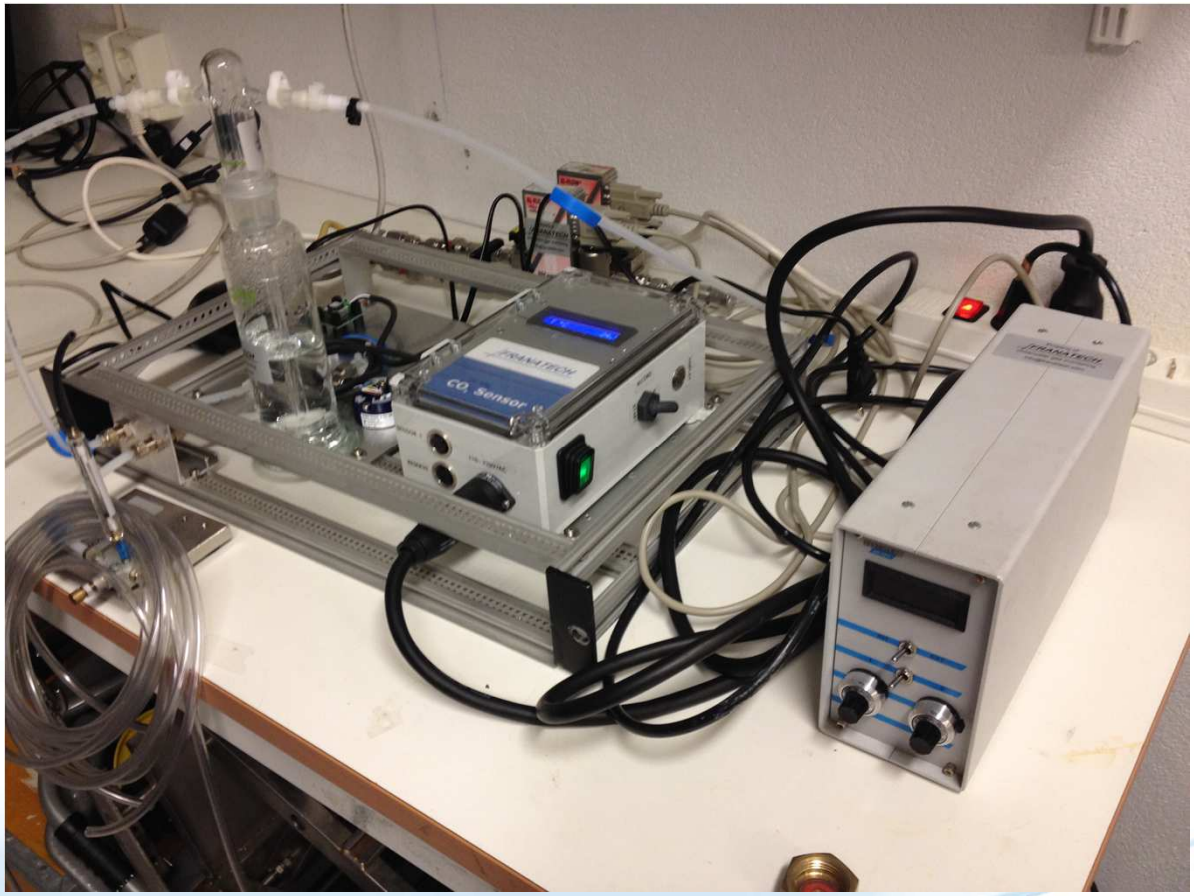


- Compack system
- Photometric
- Flow through system
- New cuvette design

Franatech/NIVA pCO2 system

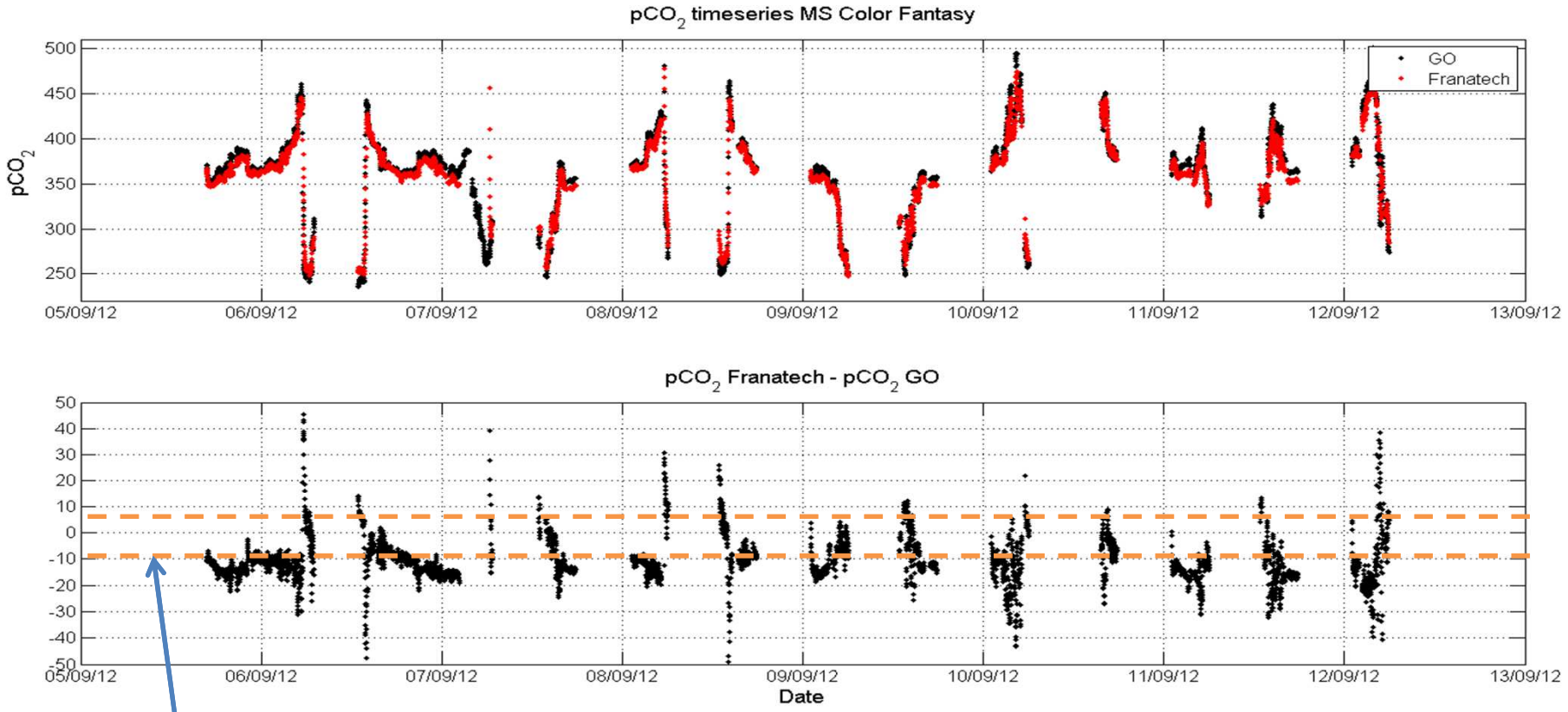
- Membrane system
- Calibration system onboard or own lab
- Easy connection for water
- High Temp. solid state detector

Two point calibration system using secondary standards with reference to NOAA gas



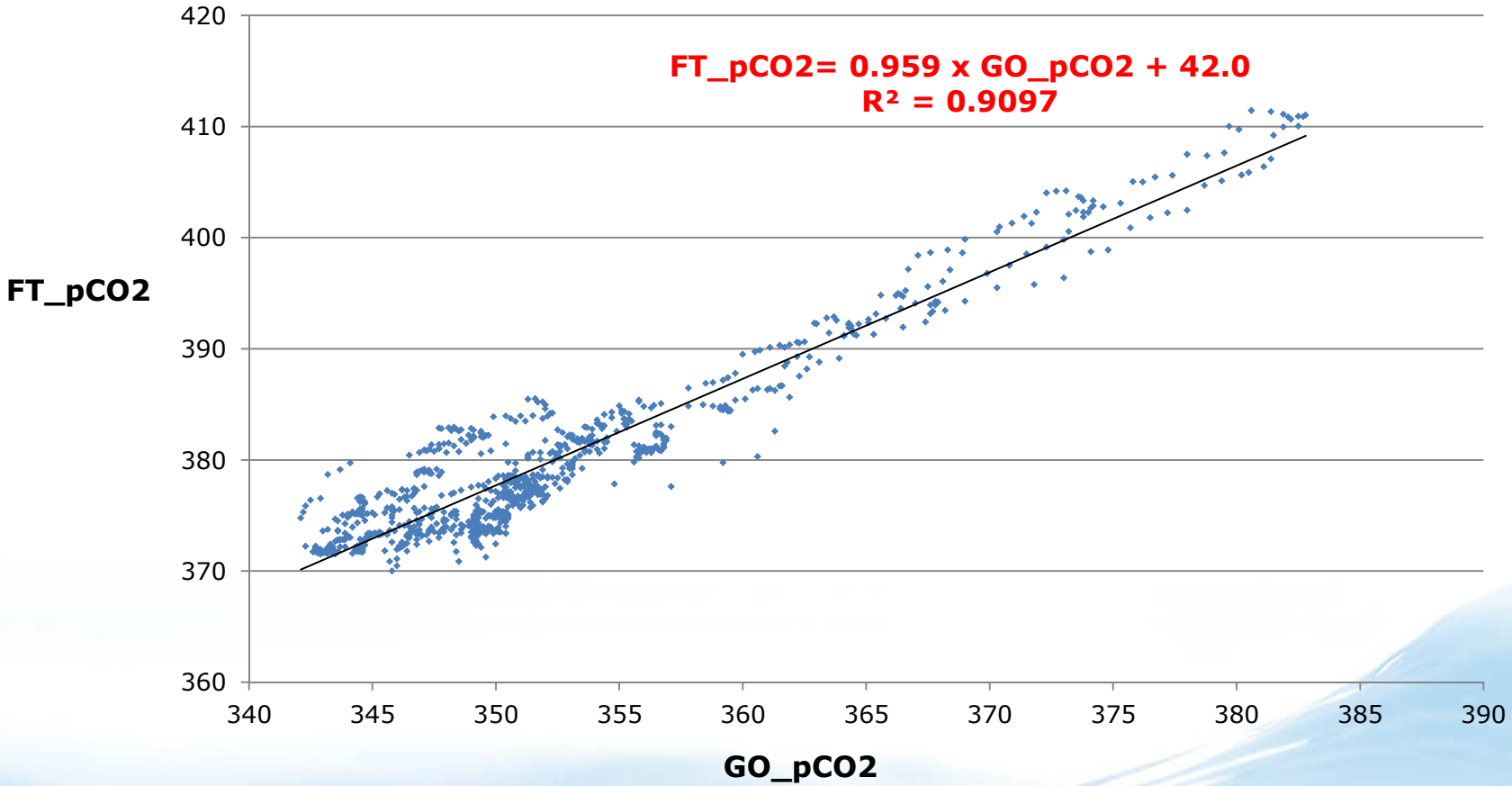
Field test comparing with the GO-systems (GEOMAR)

Field tests between GO_pCO2 and Franatech

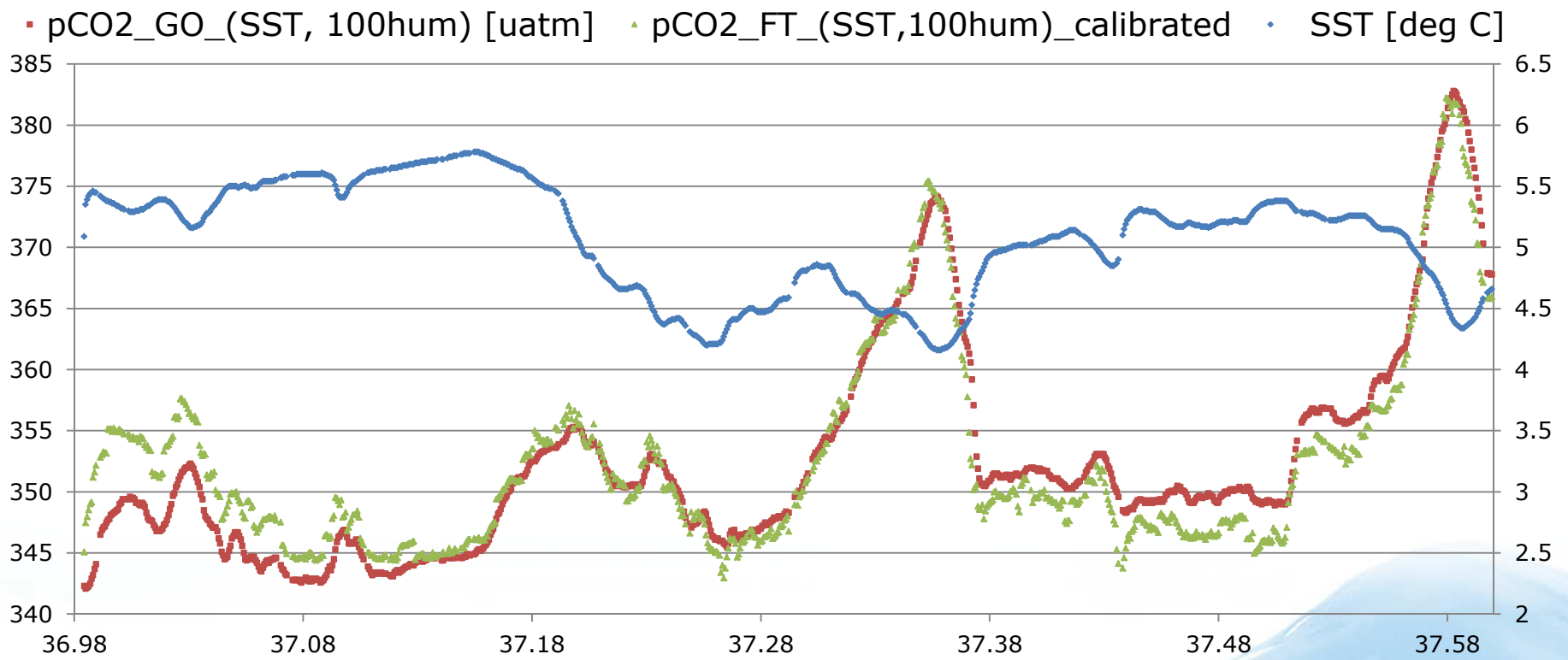


- +/- 2 % accuracy of the calibration gasses

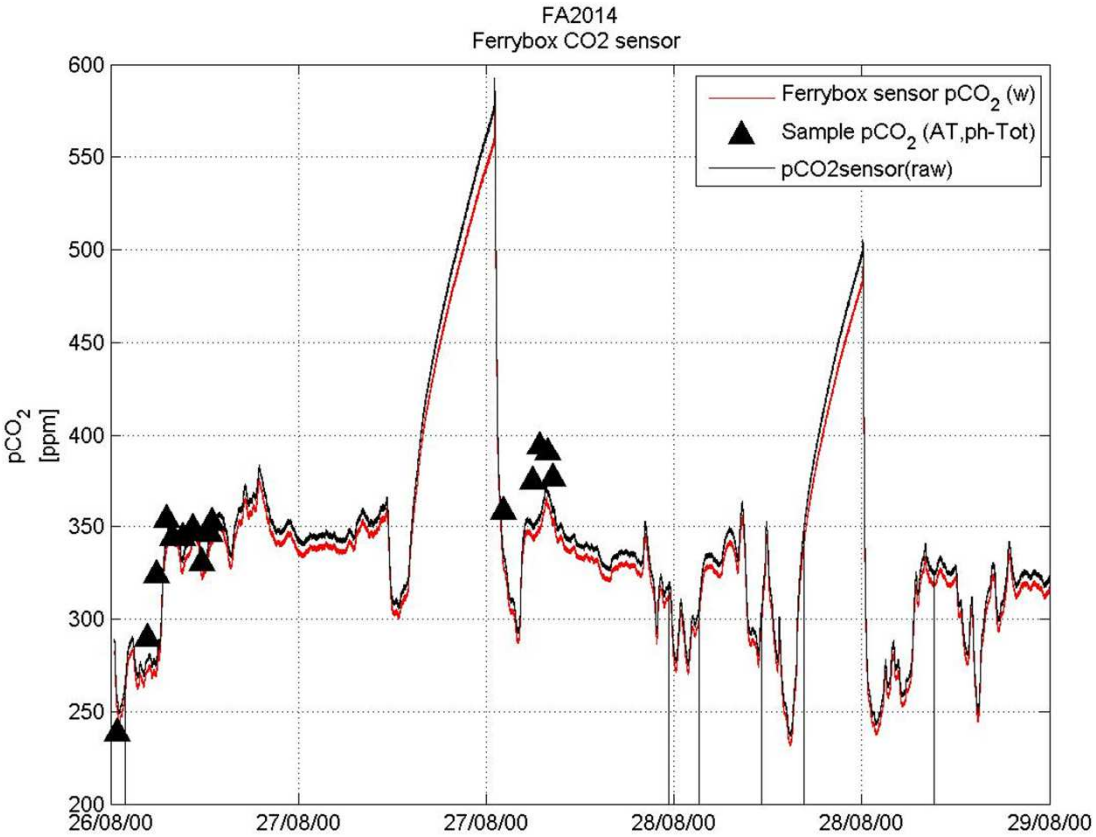
Comparisions of GO_ pCO2 and FT_pCO2 in a short term test (24 h)

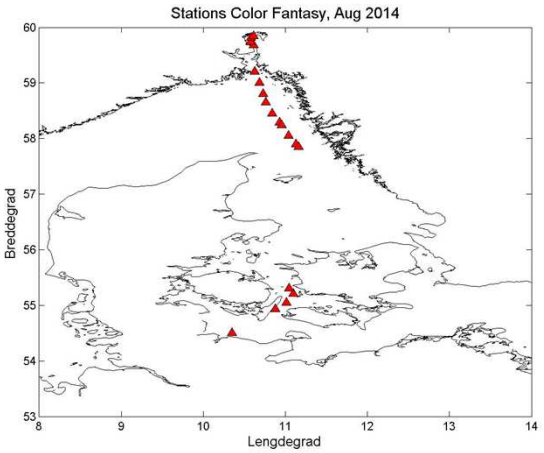


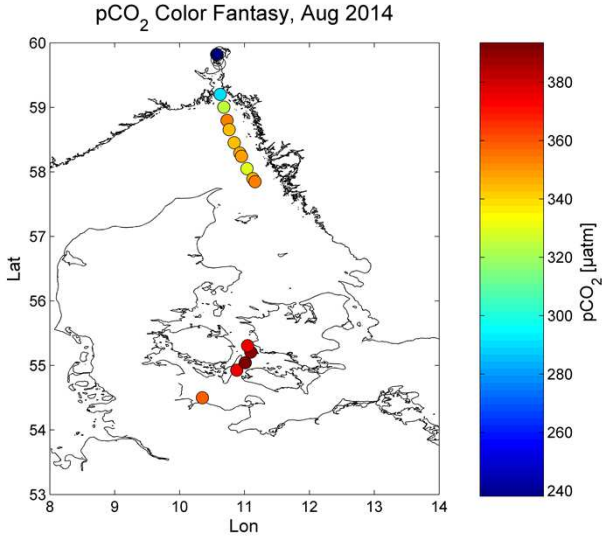
FT_pCO2 vs GO_pCO2 after applying a new calibration



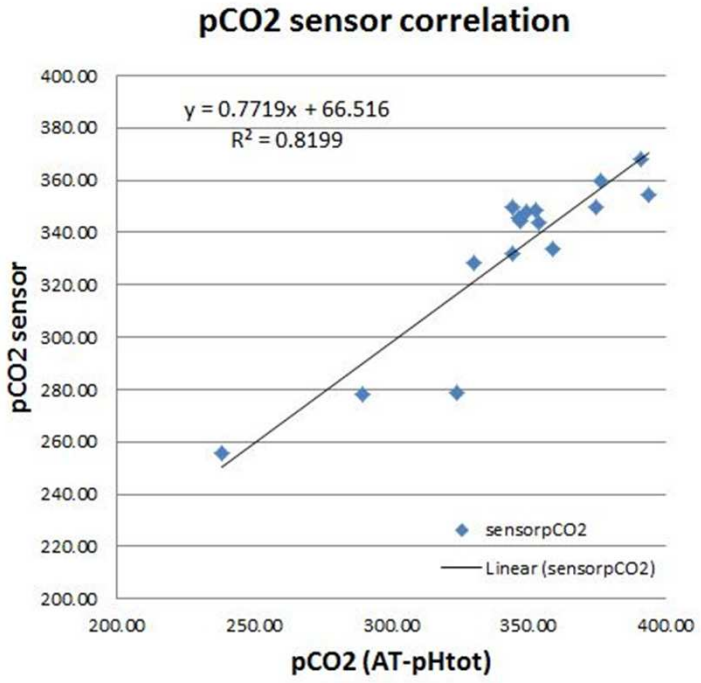
August 2014

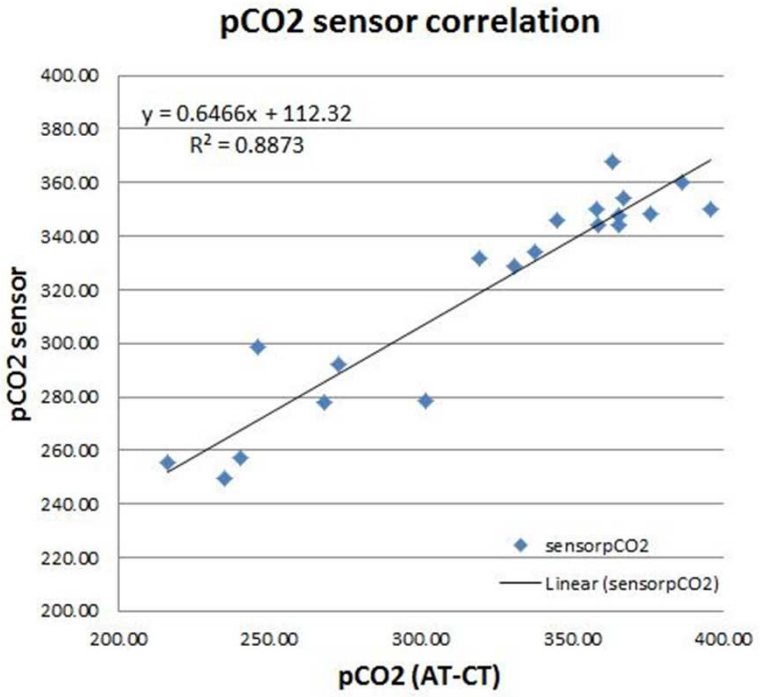

FA2014
Ferrybox CO2 sensor
Ferrybox sensor pCO2 (w)
Sample pCO2 (AT,ph-Tot)
pCO2sensor(raw)
pCO2 [ppm]
600
550
500
450
400
350
300
250
200
26/08/00
27/08/00
27/08/00
28/08/00
28/08/00
29/08/00


Stations Color Fantasy, Aug 2014
Breddegrad
Lengdegrad

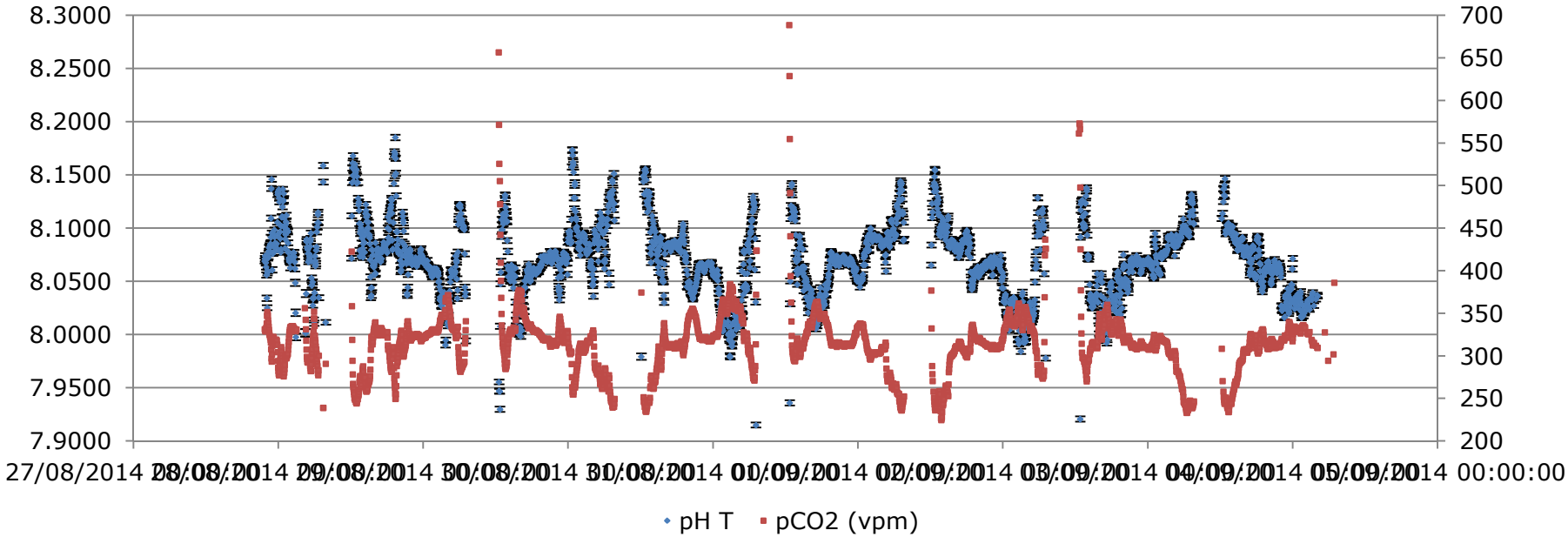

pCO2 Color Fantasy, Aug 2014
Lat
Lon
pCO2 [µatm]

Preliminary – August 2014

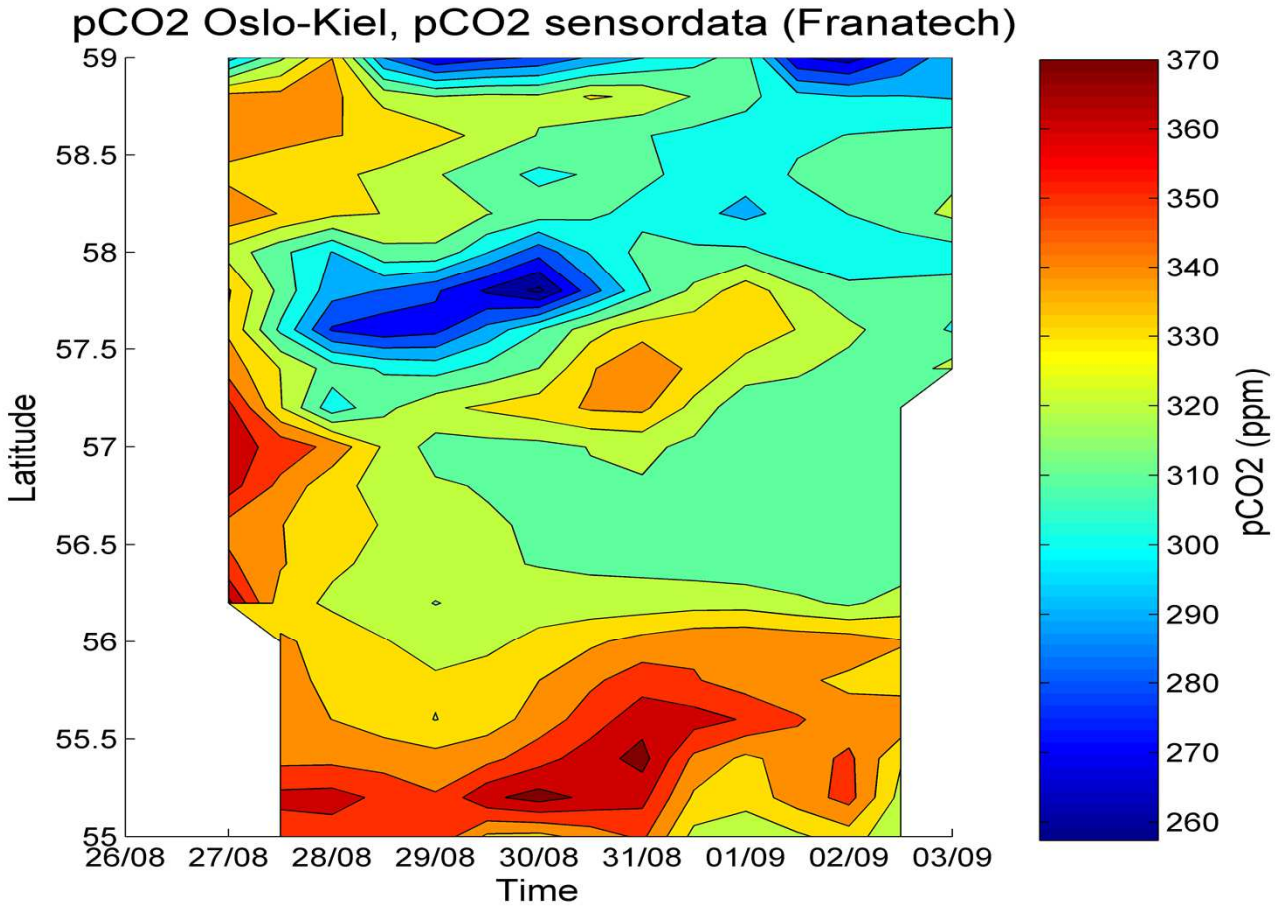




Kiel-Oslo – Aug. 2014
pH and pCO2



PCO2 one week variability



Summary sensors

- pH
  - Precision is 0.001 (95% rep. samples)
  - Accuracy is 0.0025 (95% CRM At/Ct)
  - Overall accuracy In situ measurements should be within 0.003 pH
- pCO2 (preliminary)
  - Calibration (wet gas) +/- 2vpm (TBC)
  - Precision is +/- 0.5-1 vpm (TBC)
  - Accuracy is +/- 3 - 6 vpm (TBC)

Future work

- Combine pH and pCO2 into one system
- Long term tests on three ship routes (seasons, years)
  - Kattegat/Skagerrak (low saline water, high Chl-a)
  - Coastal areas (Fjords, Rivers mouth)
  - Barents Sea (cold waters/Arctic)
- Long term technical experience
- Long term calibrations experience (NOAA-gas+)
- Establish the overall precision and accuracy
  - Comparison and implementation in the monitoring program
  - Hopefully implementation into the monitoring programs?
- Comparisons with other systems
  - GO-System,
  - Other membrane systems and other detectors
- Start on the spectrophotometric CO3-ions methods