

Détection en temps réel de la trichloramine dans l'air des piscines: caractérisation fine de l'exposition réelle

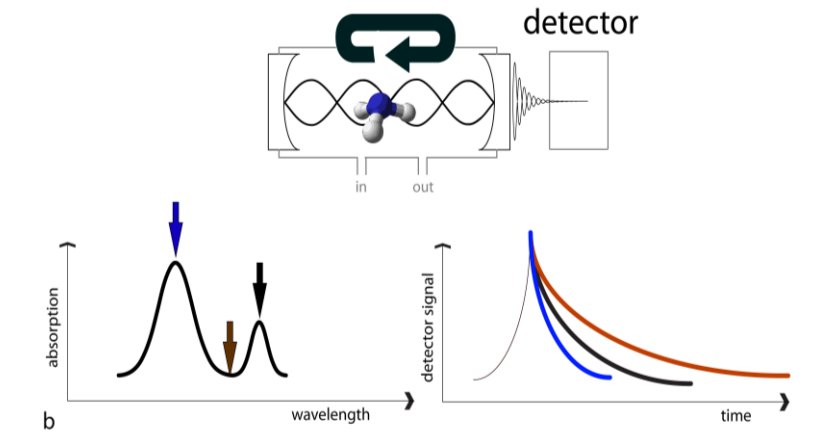
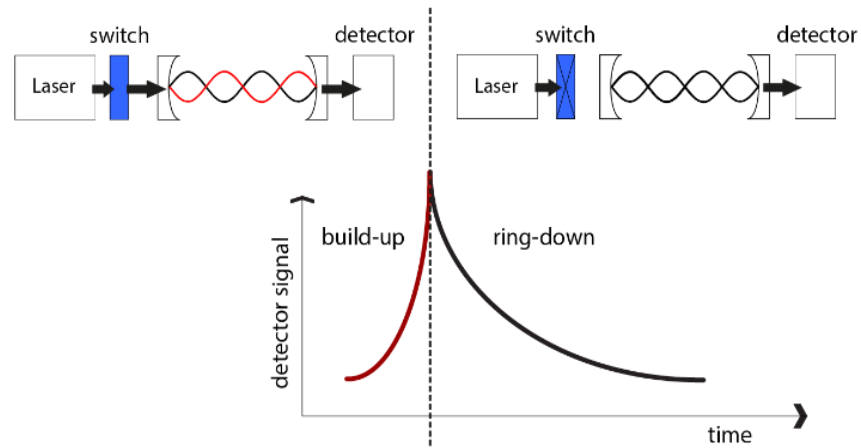
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¹ Service de Chimie Quantique et Photophysique, Université Libre de Bruxelles et
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² Laboratoire Vivaqua, Bruxelles, Belgique

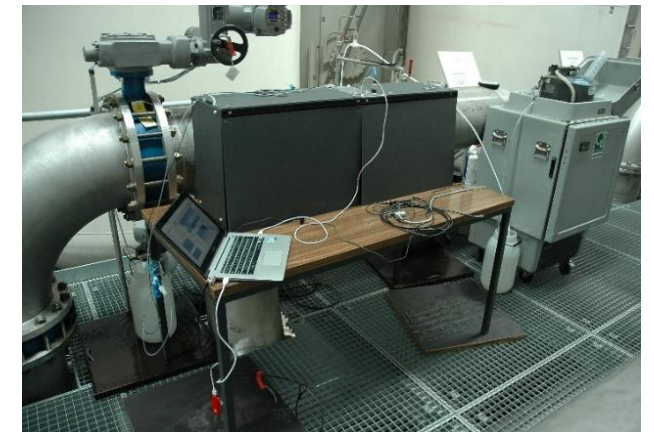
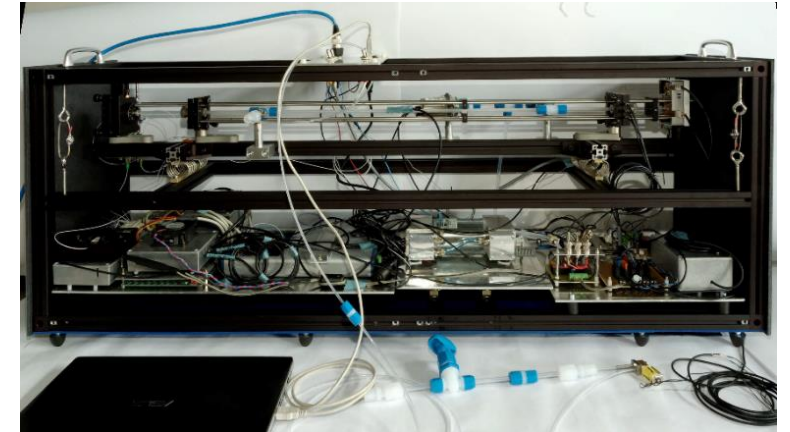
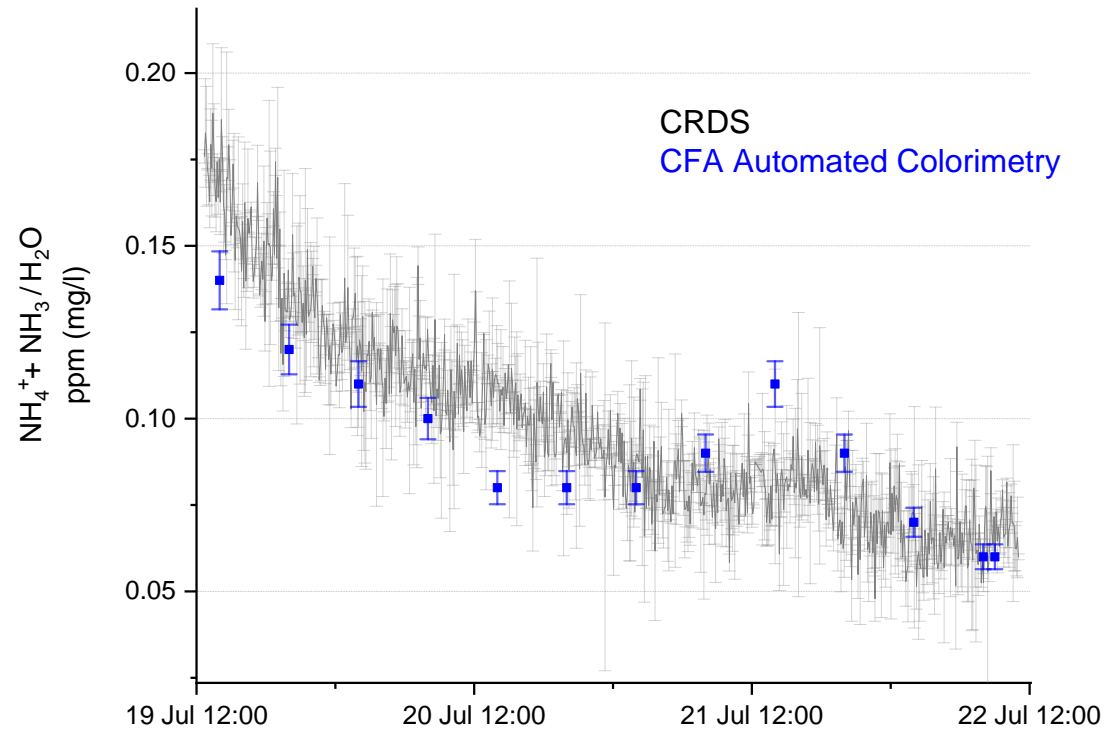


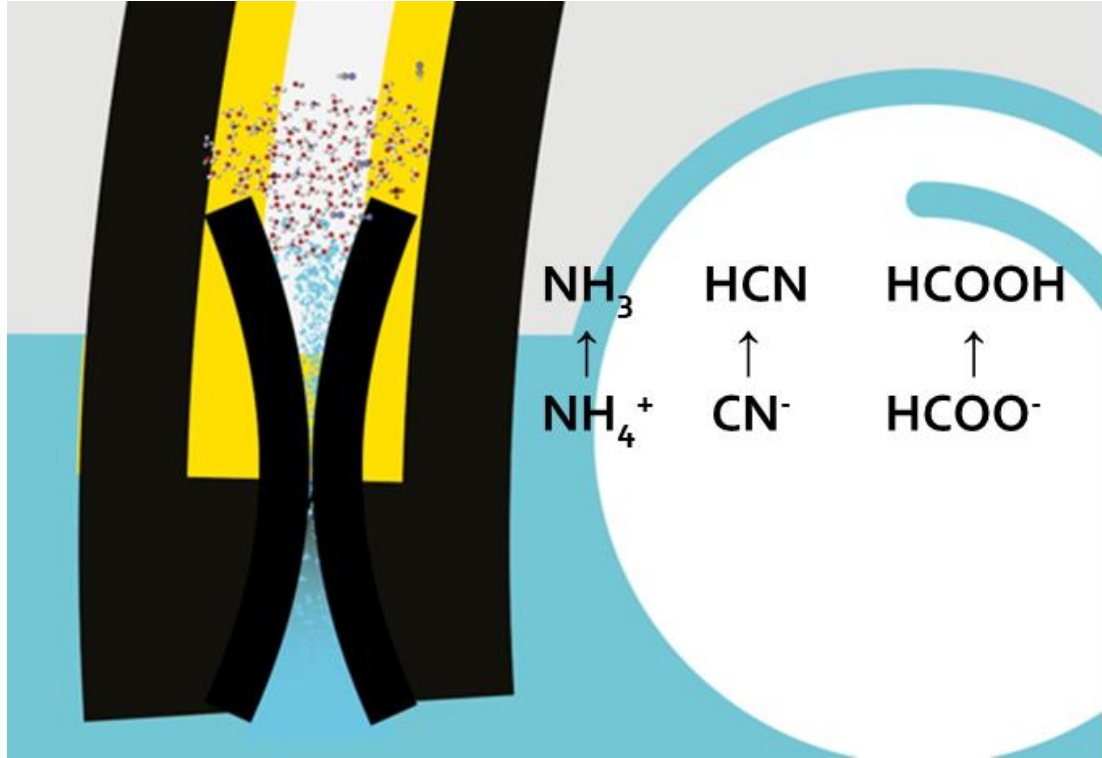
La technique CRDS



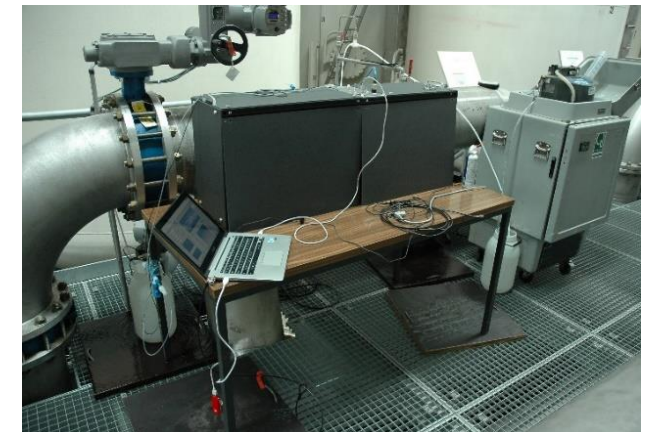
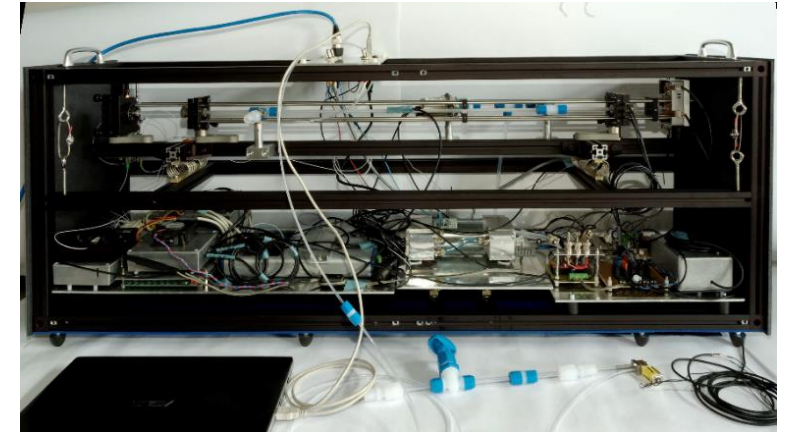
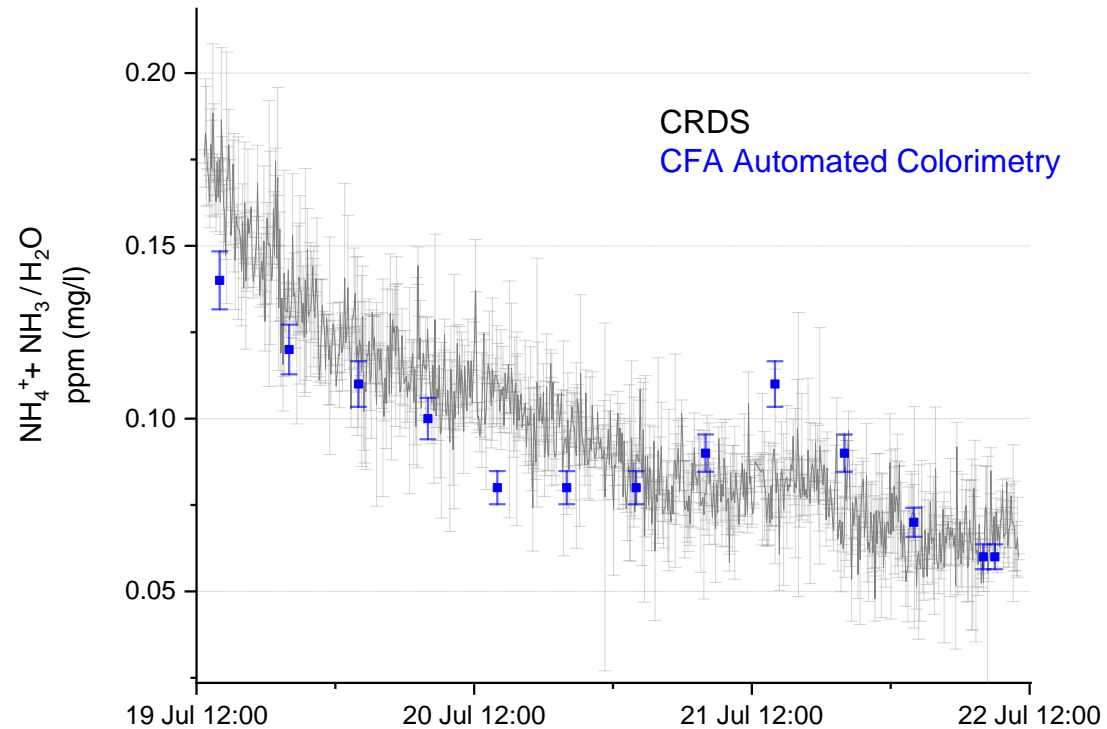
$$\alpha(\nu) = \left(\frac{1}{\tau(\nu)} - \frac{1}{\tau_0} \right) \frac{L}{c \cdot l}$$

Quantification de composés chimiques en phase aqueuse





Quantification de composés chimiques en phase aqueuse



Volatile DBPs

Compound	Typical Liquid-Phase Concentration (mg/L)	Henry's Law Constant (atm)	Equilibrium Gas-Phase Concentration (mg/m ³)	Reported Gas-Phase Concentration (mg/m ³)
HOCl	1.2	0.060	0.053	N.A.
Cl ₂	0.000012	767	0.0067	N.A.
NH ₂ Cl	0.30	0.45	0.10	N.A.
NHCl ₂	0.10	1.52	0.11	N.A.
NCl ₃	0.070	435	23	0.1-0.7
CHCl ₃	0.080	185	11	0.009-0.058
CHBr ₂ Cl	0.0040	57.3	0.17	0.002-0.003
CHBr ₃	0.0010	21.5	0.016	0.0008
CNCl	0.0030	108	0.24	N.A.*
CNCHCl ₂	0.00080	0.21	0.00013	N.A.
CH ₃ NCl ₂	0.020	154	2.3	0.016-0.07

From: Weng, S.C.; Weaver, W.A.; Afifi, M.Z.; Blatchley, T.N.; Cramer, J.; Chen, J.; Blatchley III, E.R. (2011) "Dynamics of Gas-phase Trichloramine (NCl₃) in Chlorinated, Indoor Swimming Pool Facilities," *Indoor Air*, **21**, 5, 391-399.

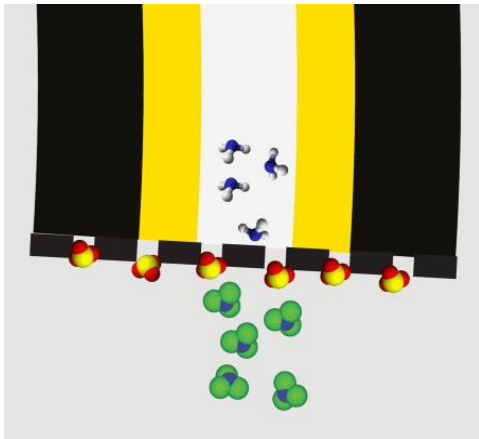
Concentration en phase liquide		Constante de Henry (volatilité - atm)	Concentration en phase gazeuse à l'équilibre		Concentrations observées		Concentration observées / équilibre
µg/l	Observée		mg/m ³	ppbv	mg/m ³	ppbv	
70	US ¹	NCl ₃ 435	23	4300	0.1-0.7	20 - 130	2-5%
25-100	Suisse ²		8-33	1500-6000	0.1-0.5	20 - 100	
10	Suède ³		3	600	0.1-0.2	20-40	

1 Weng, S.C.; Weaver, W.A.; Afifi, M.Z.; Blatchley, T.N.; Cramer, J.; Chen, J.; Blatchley III, E.R. (2011) "Dynamics of Gas-phase Trichloramine (NCl₃) in Chlorinated, Indoor Swimming Pool Facilities," Indoor Air, 21, 5, 391-399.

2 Thèse de Dr.Fabian Soltermann, Trichloramine in swimming pool water: analysis methods, factors influencing its fate and effects of UV treatment , DISS. ETH NO. 22497

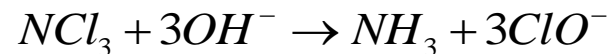
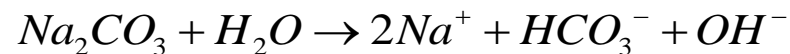
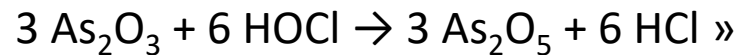
3 Notre mesure par OD-CRDS & stripage à l'air

Réduction de la trichloramine en ammoniac en ligne

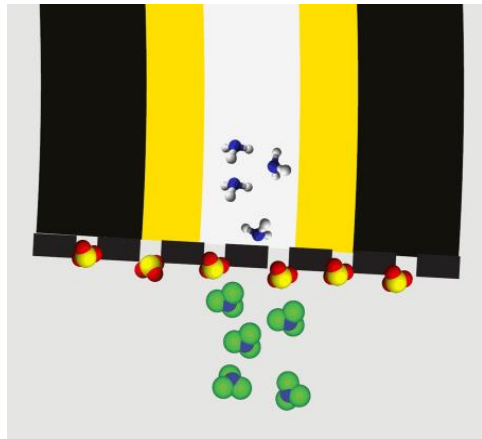


https://www.inrs.fr/publications/bdd/metropol/fiche.html?refINRS=METROPOL_104

« Les filtres imprégnés collectent la fraction de chloramines la plus volatile (trichlorure d'azote NCl_3) avec une efficacité proche des 100 %. Le principe est basé sur la décomposition à pH élevé, grâce au carbonate de sodium, du NCl_3 en ammoniac et hypochlorite. L'hypochlorite formé est ensuite réduit en chlorures par le trioxyde de diarsenic, selon les réactions:

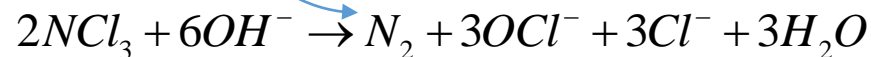
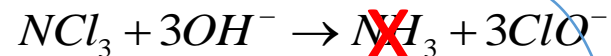
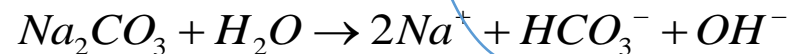


Réduction de la trichloramine en ammoniacque en ligne

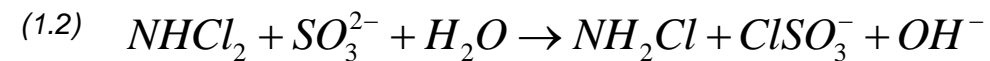
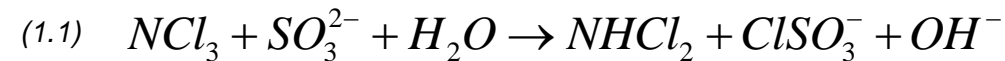
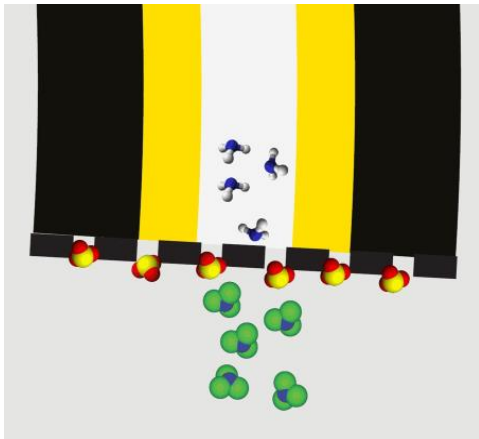


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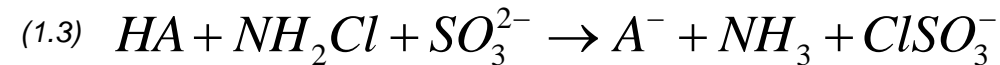
« Les filtres imprégnés collectent la fraction de chloramines la plus volatile (trichlorure d'azote NCl_3) avec une efficacité proche des 100 %. Le principe est basé sur la décomposition à pH élevé, grâce au carbonate de sodium, du NCl_3 en ammoniac et hypochlorite. L'hypochlorite formé est ensuite réduit en chlorures par le trioxyde de diarsenic, selon les réactions:



Réduction de la trichloramine en ammoniacque en ligne



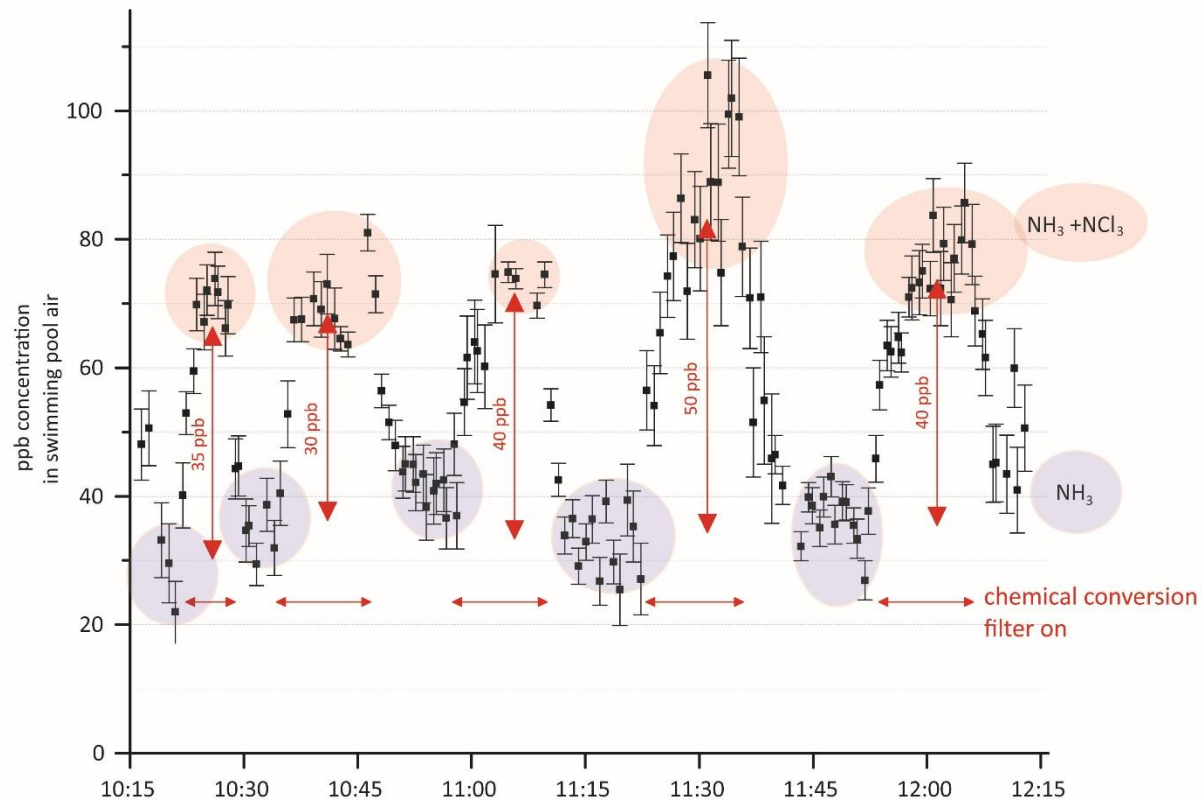
The monochloramine to ammonia reaction is general-acid (HA) assisted:



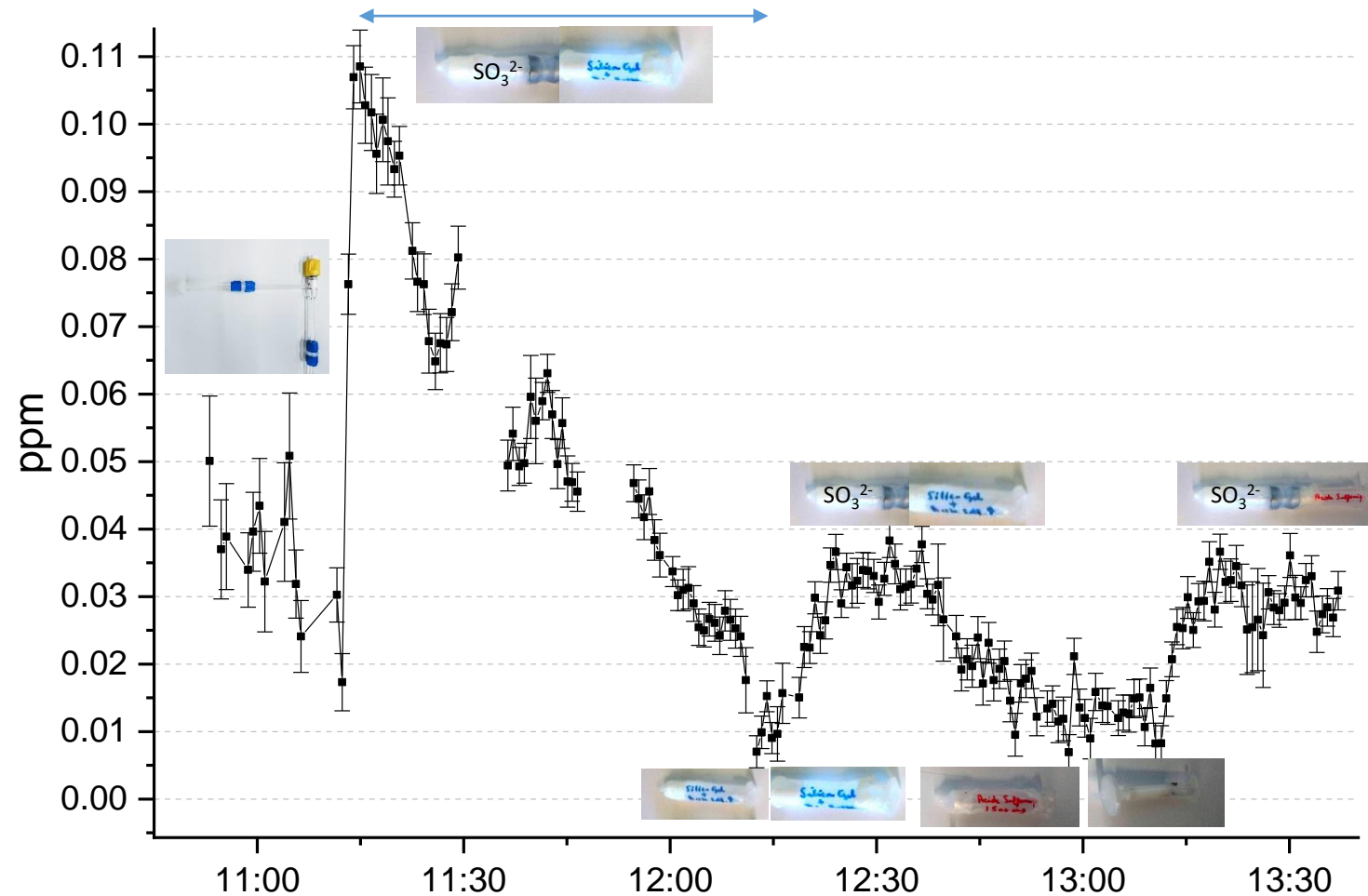
Experiments With Nitrogen Trichloride, C. T. Dowell, William C. Bray, *J. Am. Chem. Soc.*, 1917, 39 (5), pp 896-905, DOI: 10.1021/ja02250a005, Publication Date: May 1917

B. S. Yiin, D. W. Margerum, *Nonmetal redox kinetics: reactions of sulfite with dichloramines and trichloramine*, *Inorg. Chem.*, 1990, 29 (10), pp 1942–1948, DOI: 10.1021/ic00335a035

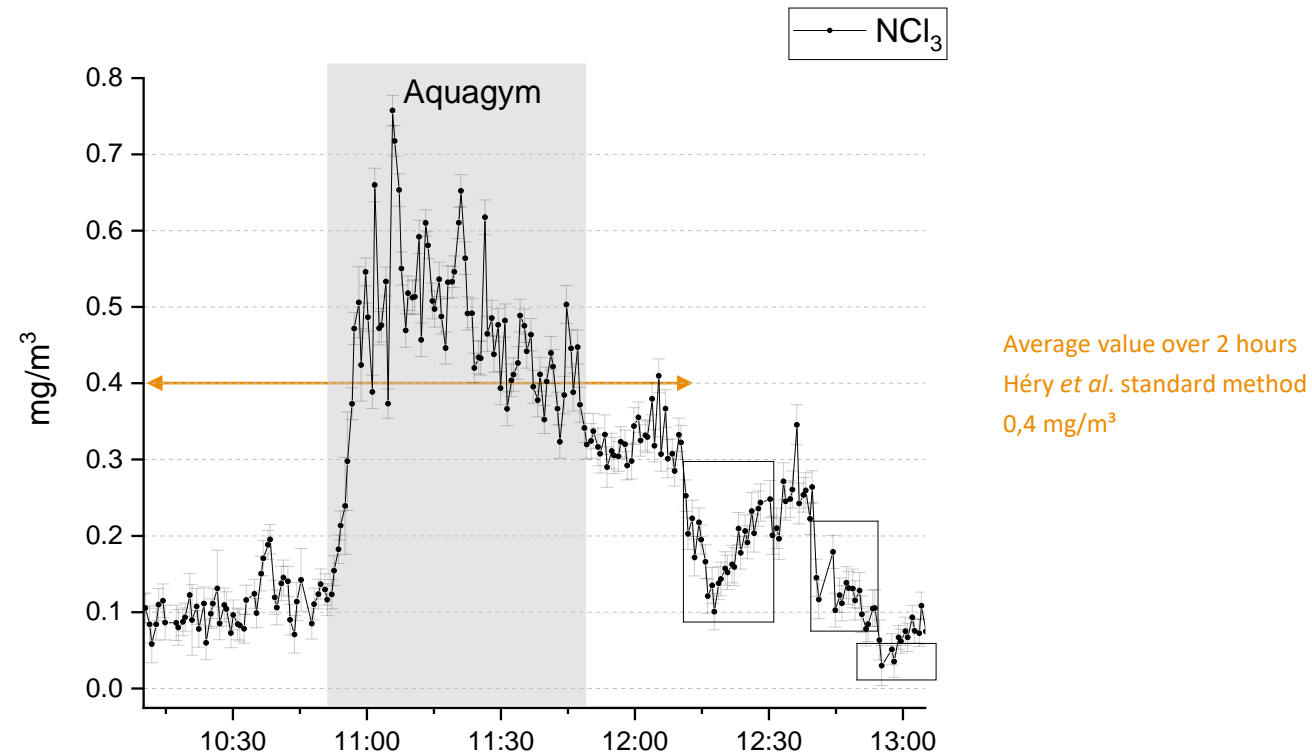
Résultats de campagnes de mesures Piscine communale 25m



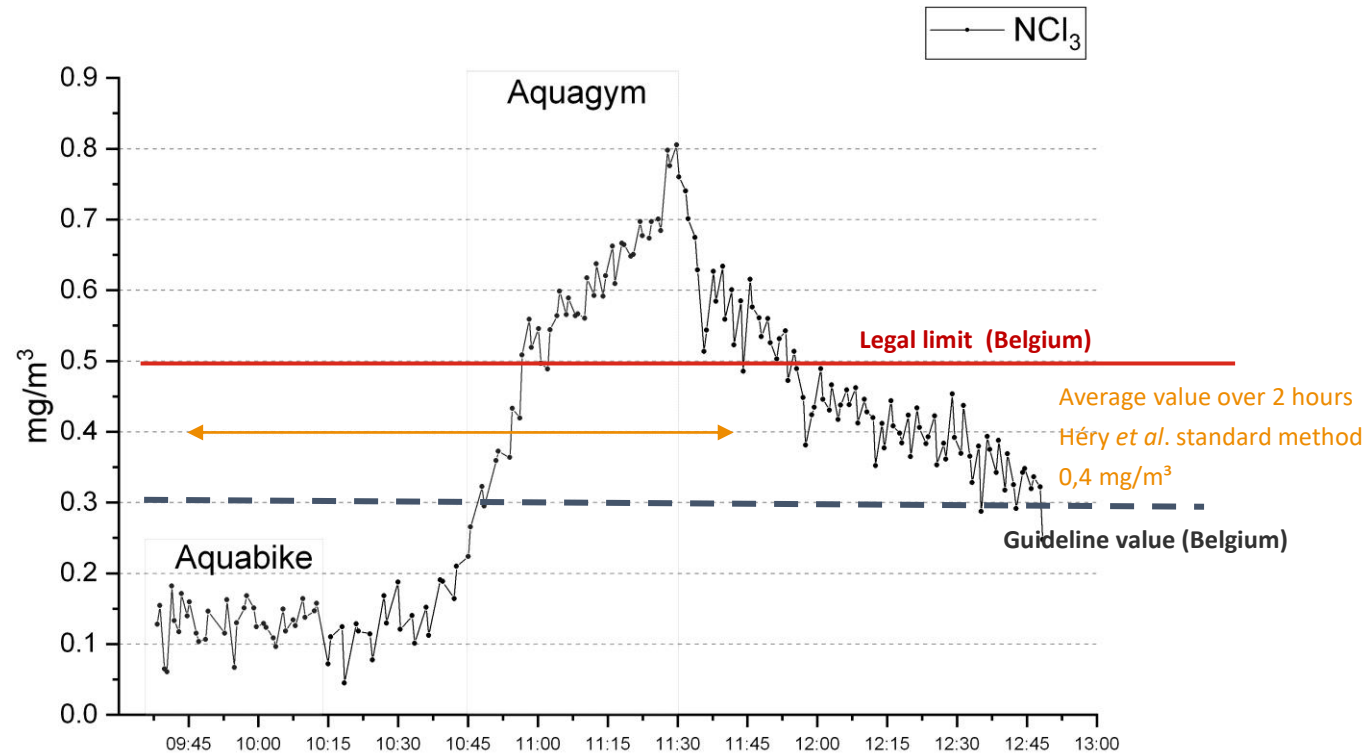
Résultats de campagnes de mesures Piscine communale 25m



Résultats de campagnes de mesures Piscine communale 25m



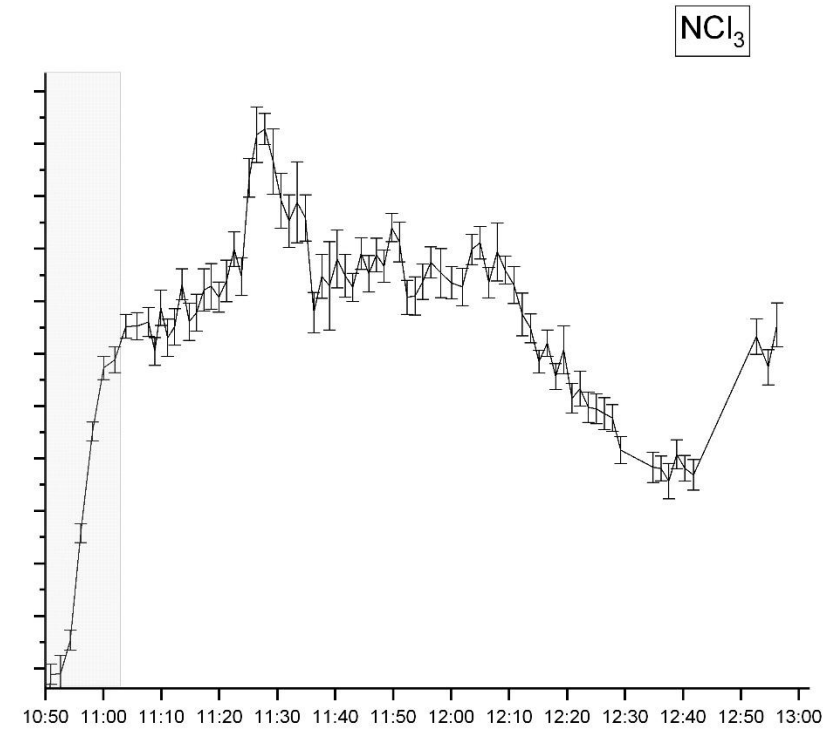
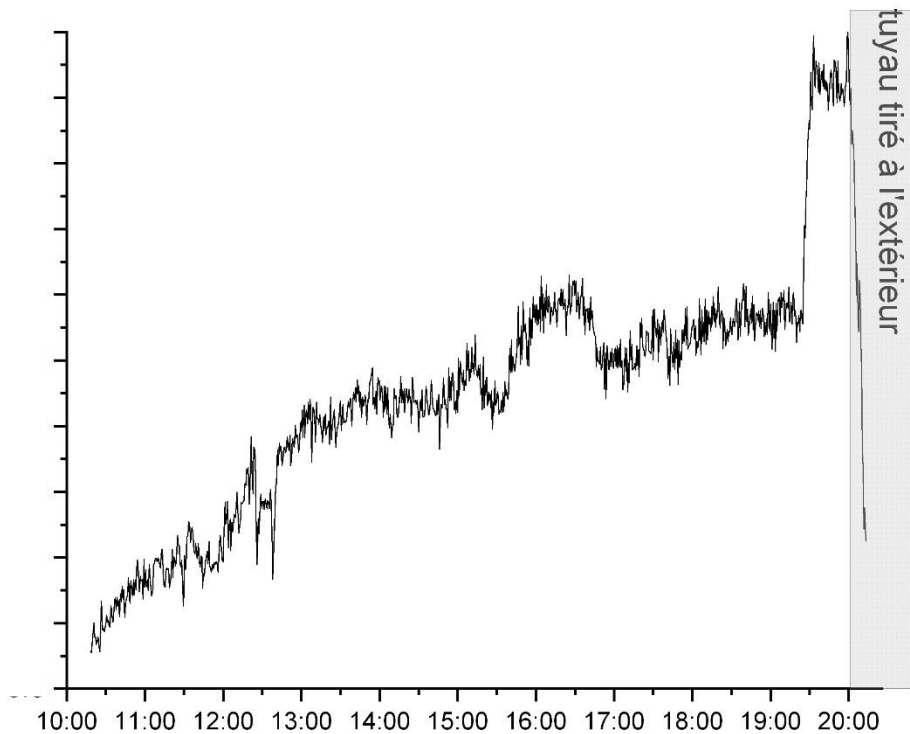
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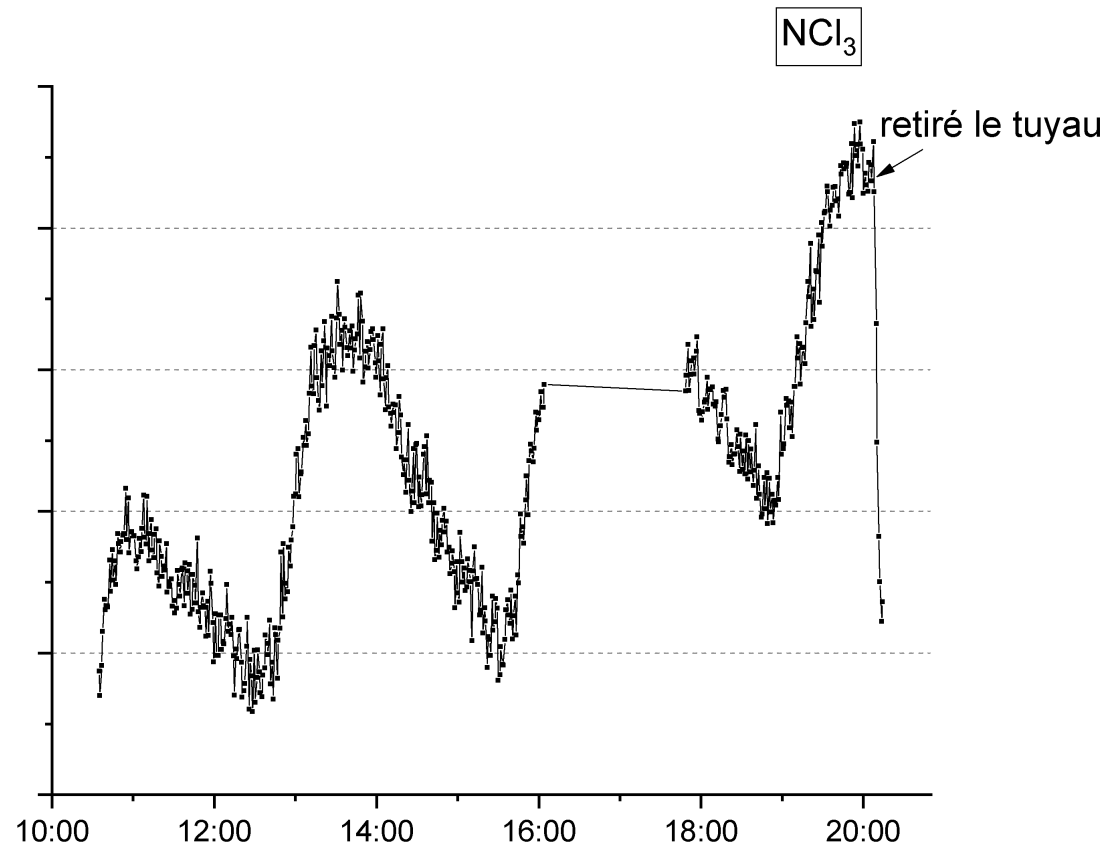
Résultats de campagnes de mesures Aquapark, point chaud



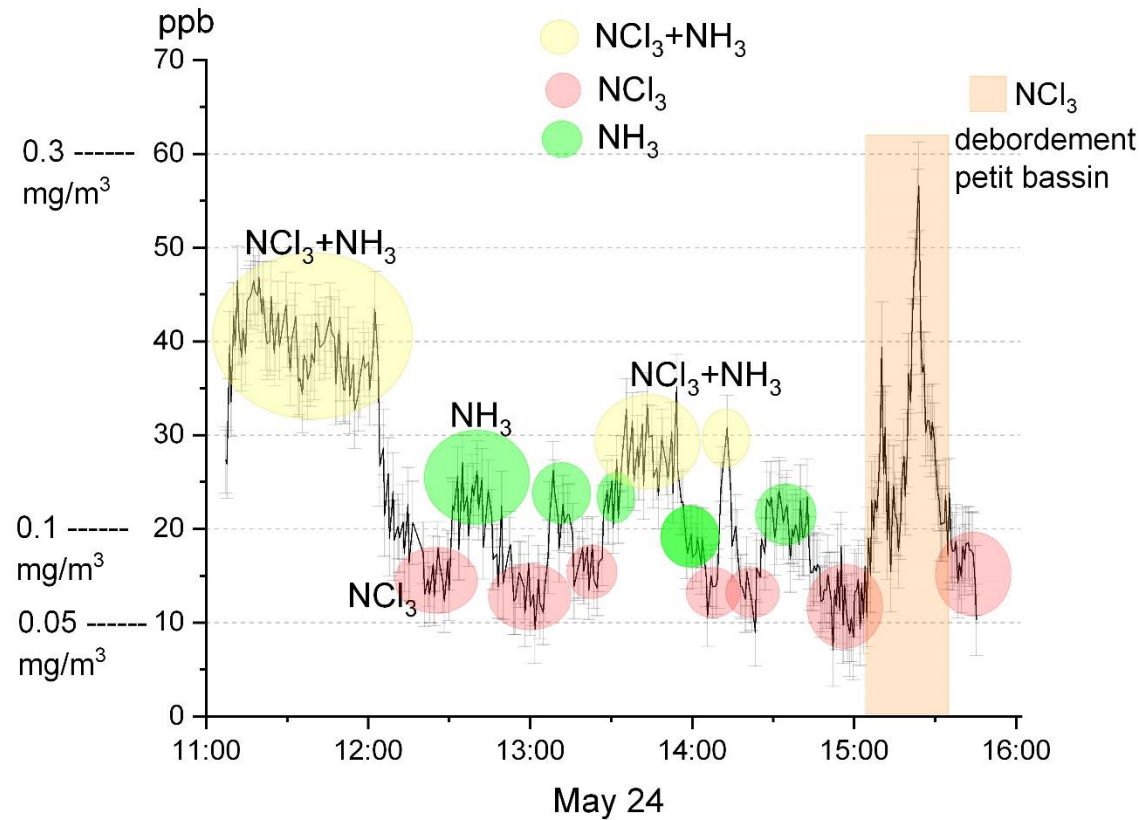
Résultats de campagnes de mesures Aquapark, point chaud



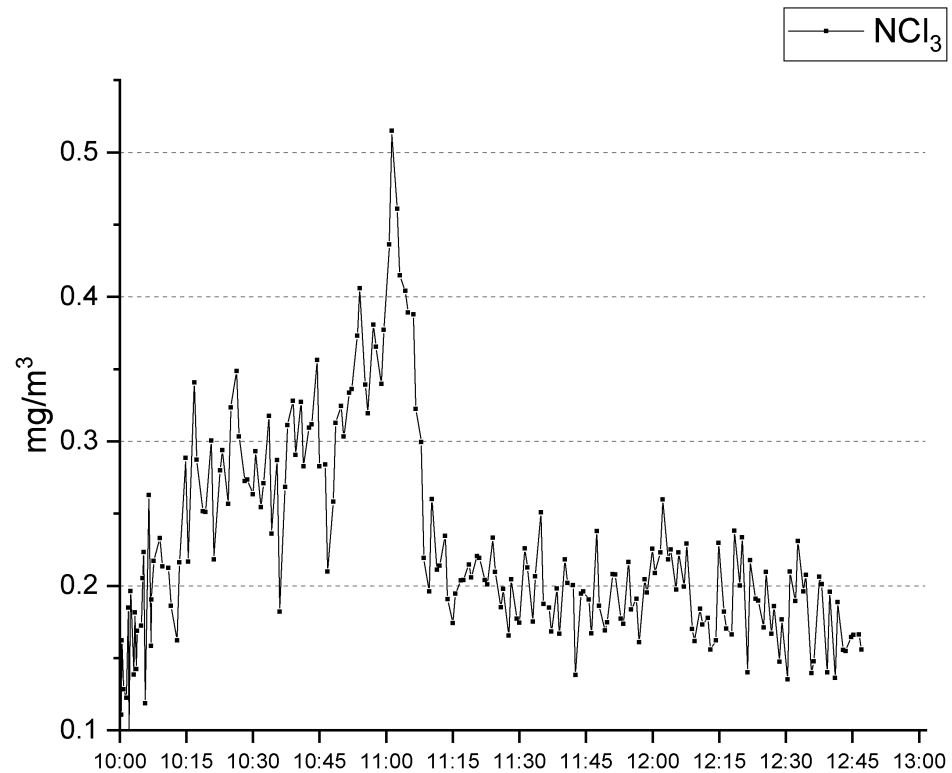
Résultats de campagnes de mesures Aquapark, gaine de reprise



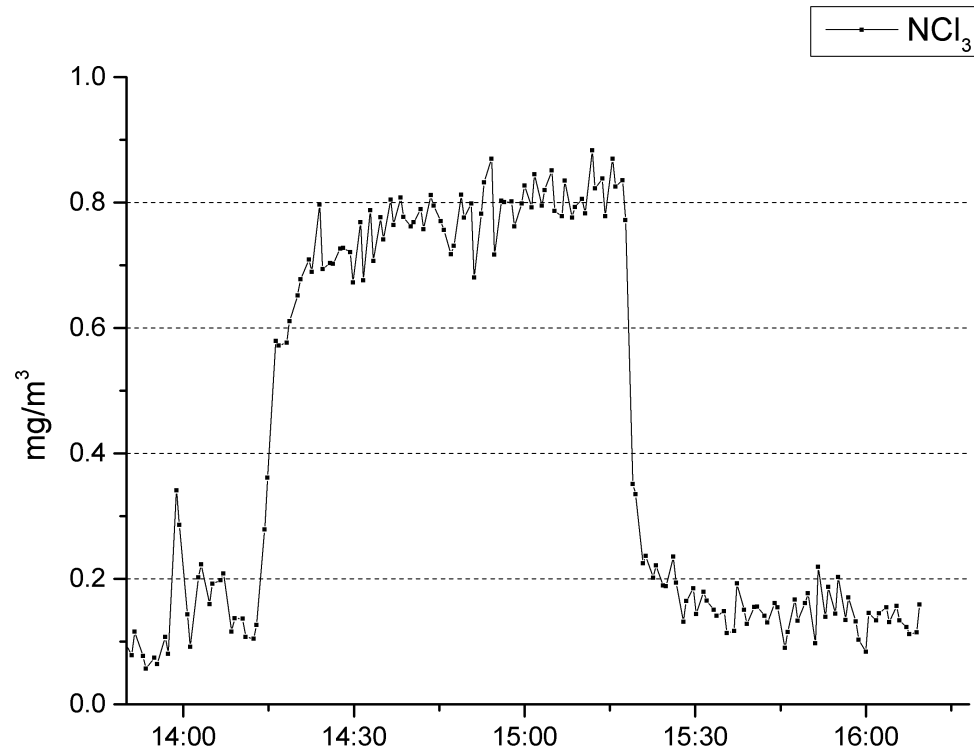
Résultats de campagnes de mesures Piscine communale, gaine de reprise



Résultats de campagnes de mesures Aquapark 2, point chaud



Résultats de campagnes de mesures Aquapark (SE), Air Stripper



Campagnes de mesures – Purdue (US)

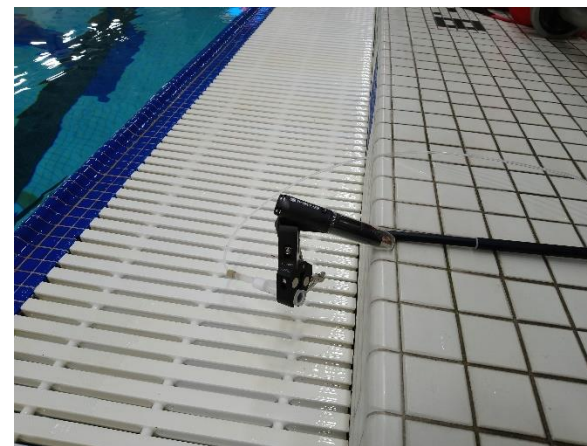
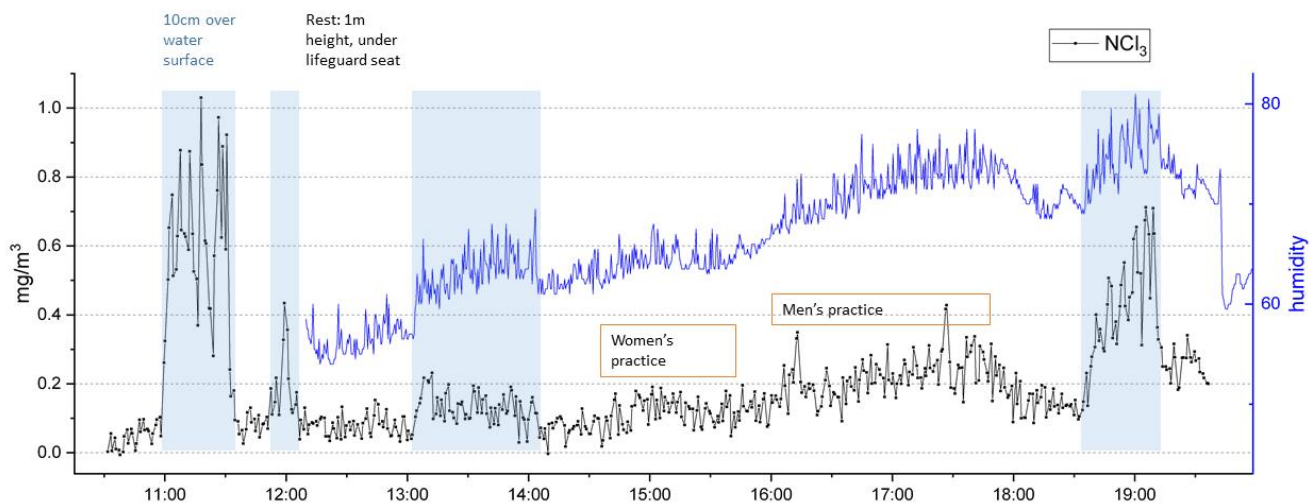
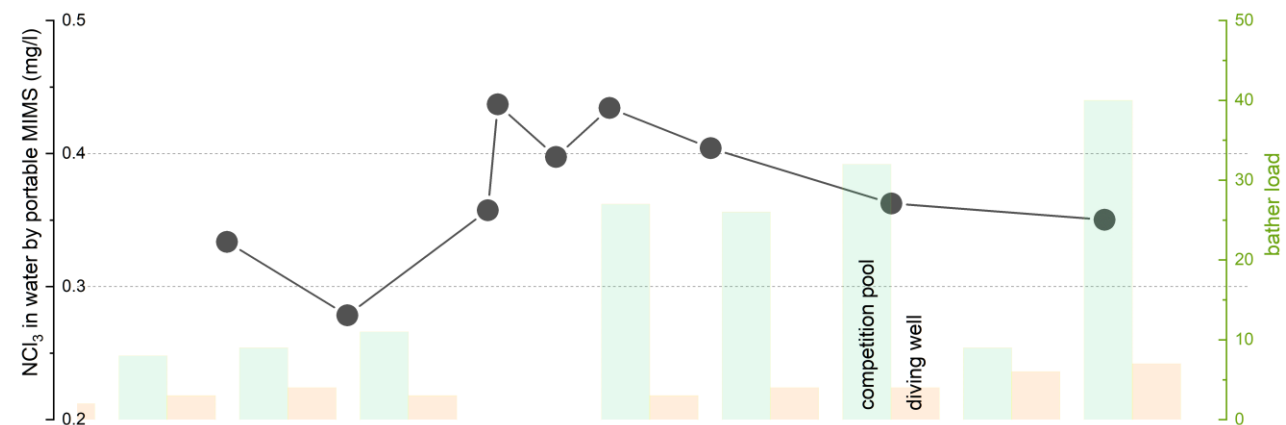


Collaboration avec:

Prof. Ernest R. Blatchley III, Lester T. Lee,

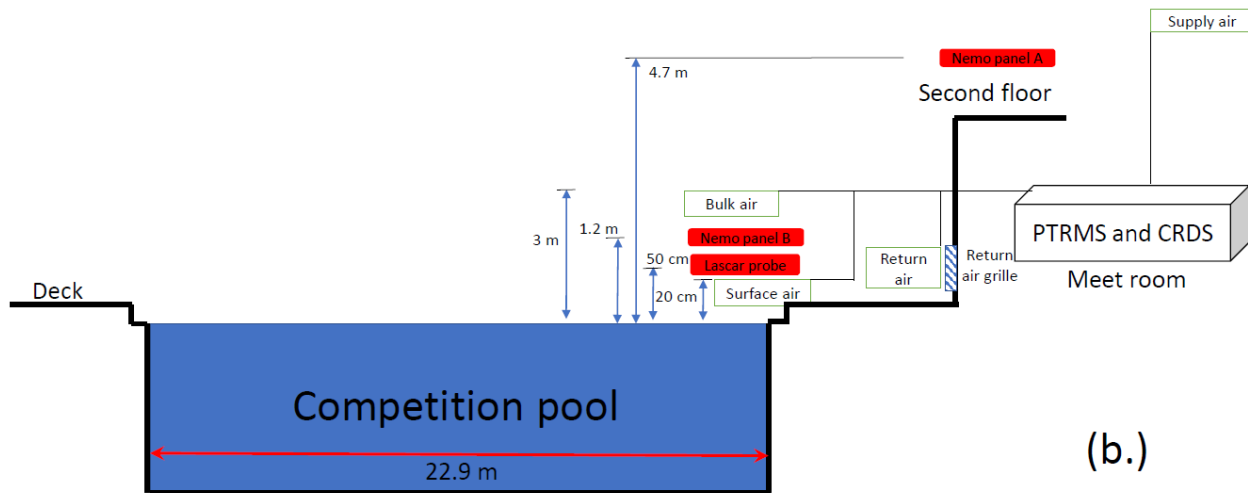
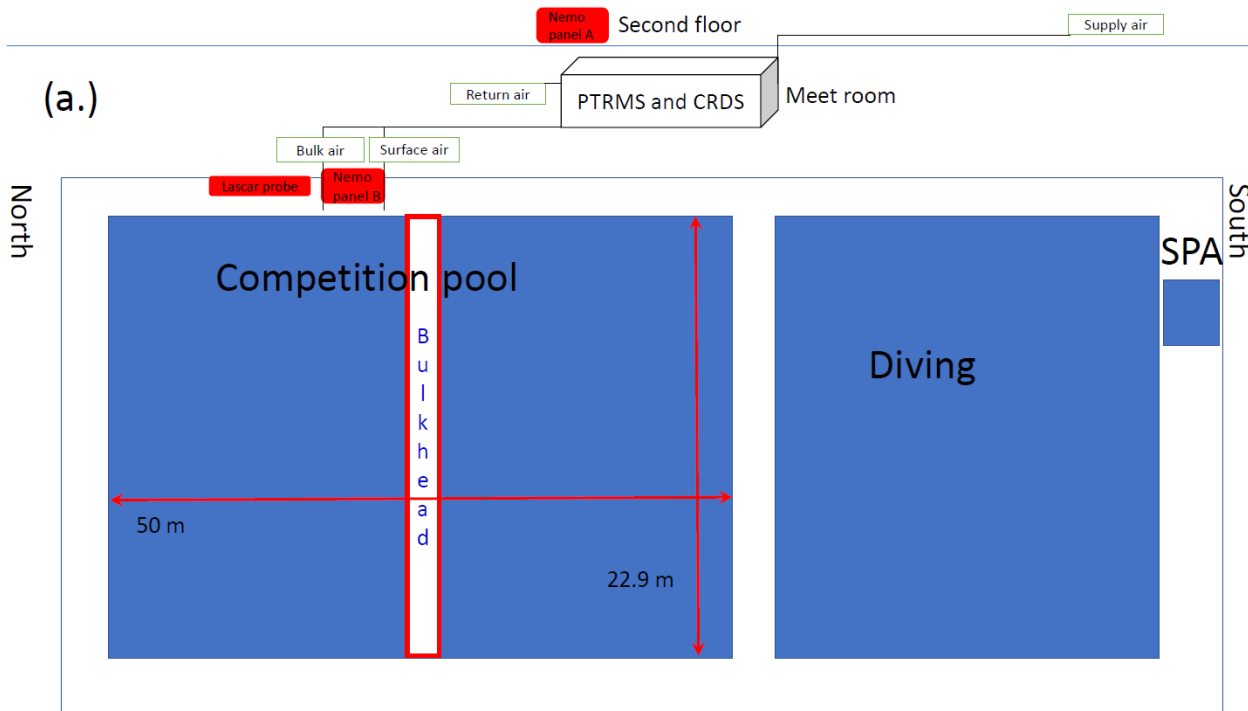
Lyles School of Civil Engineering, Purdue University, West Lafayette, Indiana, U.S.

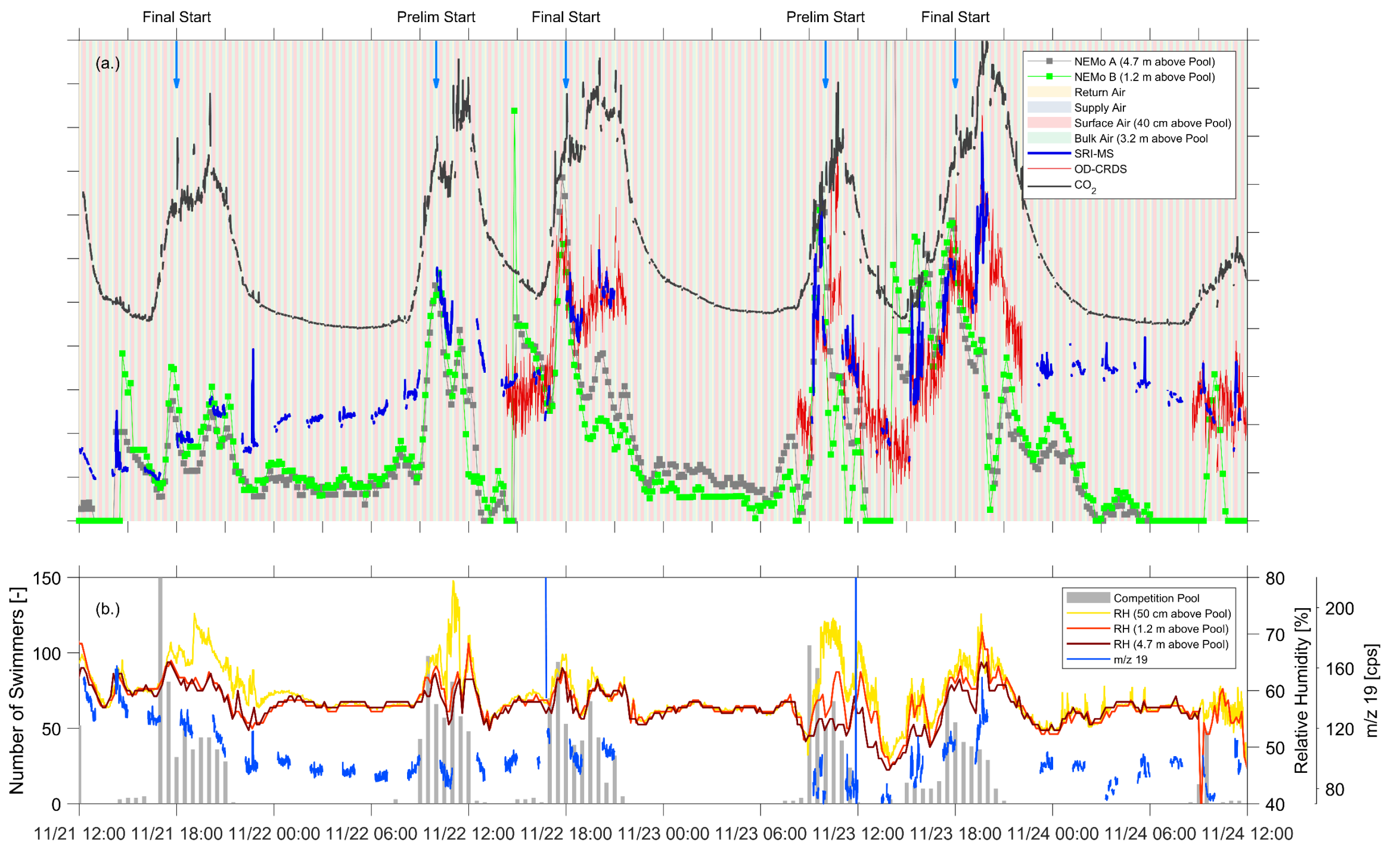
NCl_3 par MIMS (l'eau) & OD-CRDS (l'air)



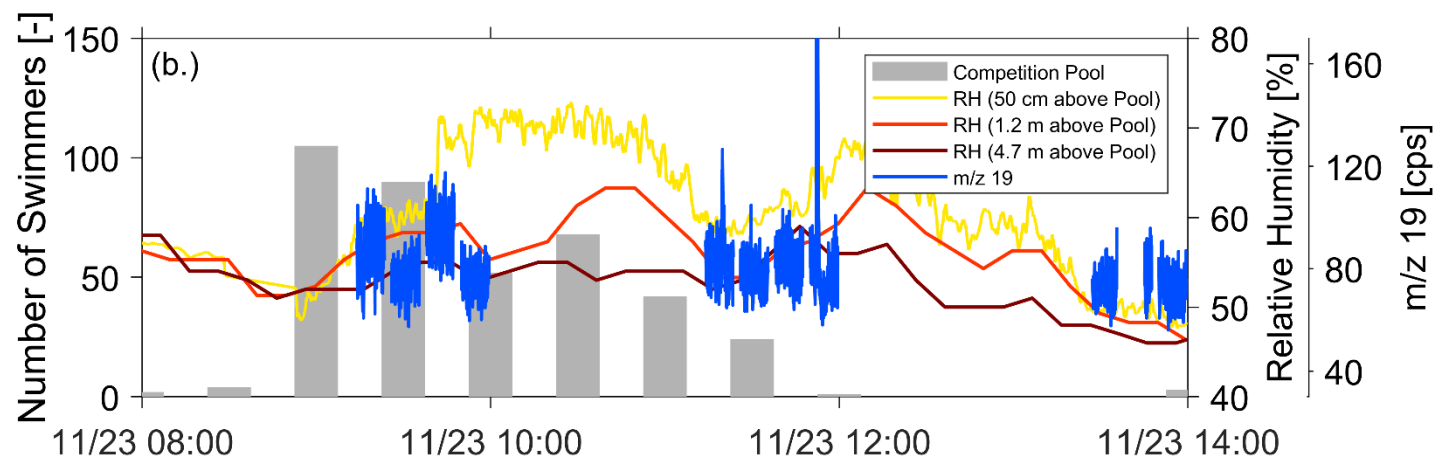
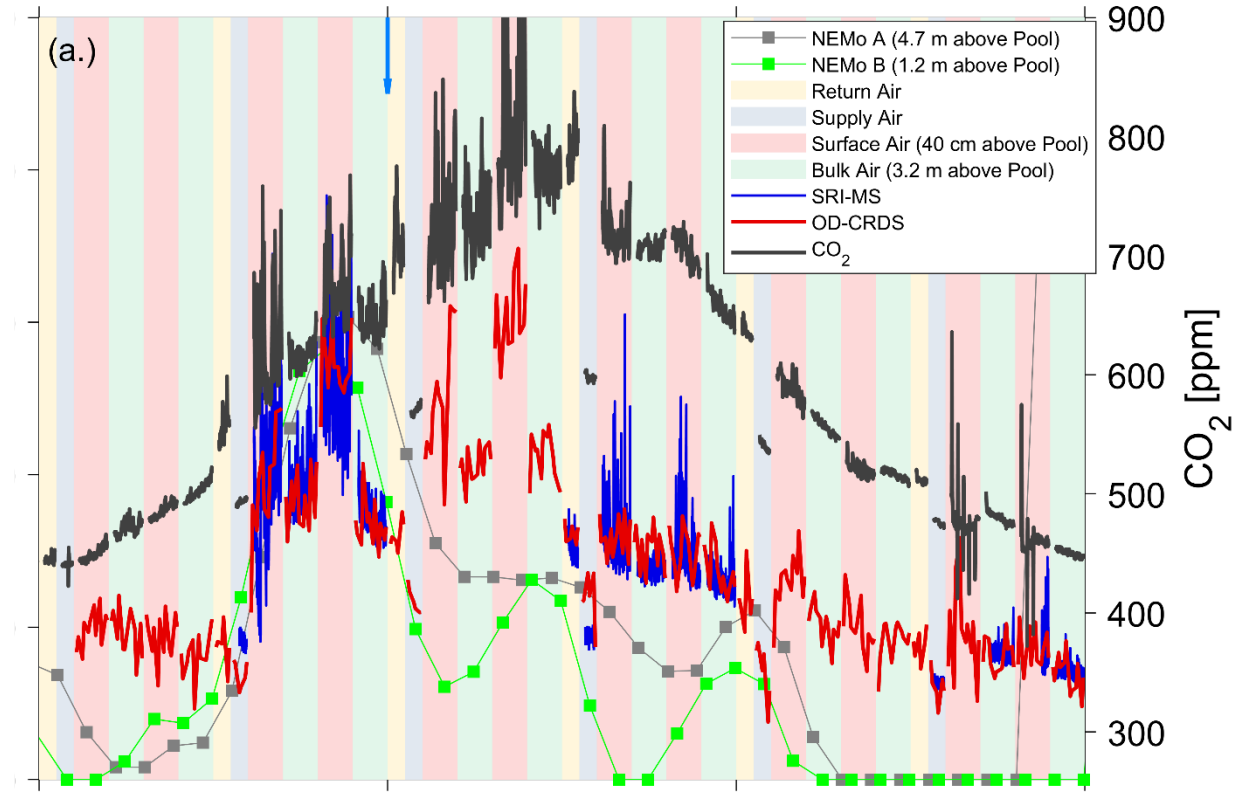


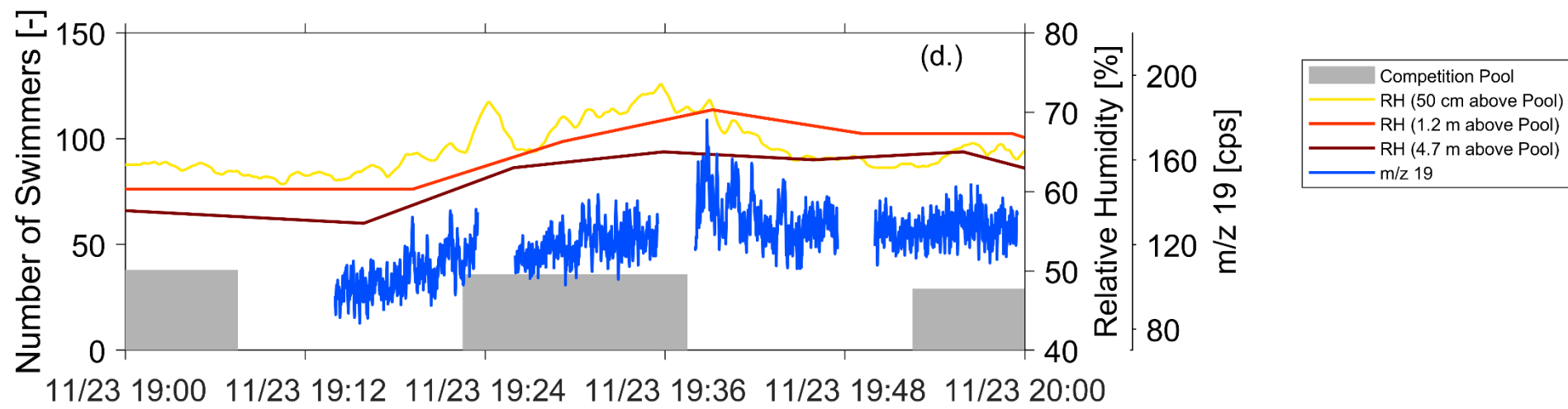
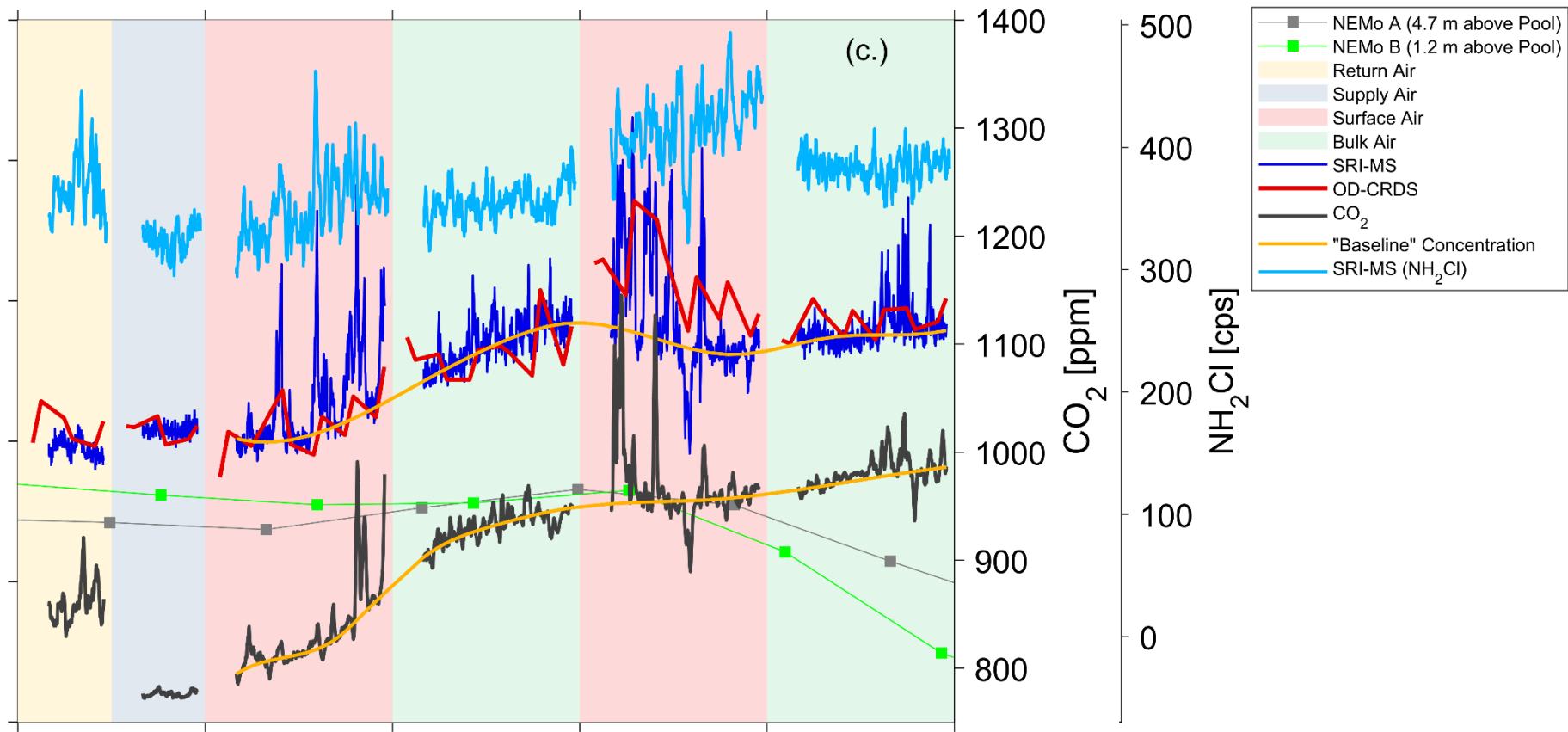
Wu, T., Foldes, T., Lee L., Wagner, D., Jiang, J., Tasoglou, A., Boor, B., Blatchley, E., Real Time Measurements of Gas-Phase Trichloramine (NCl_3) in an Indoor Aquatic Center. *Environmental Science & Technology*, soumis November 3, 2020.

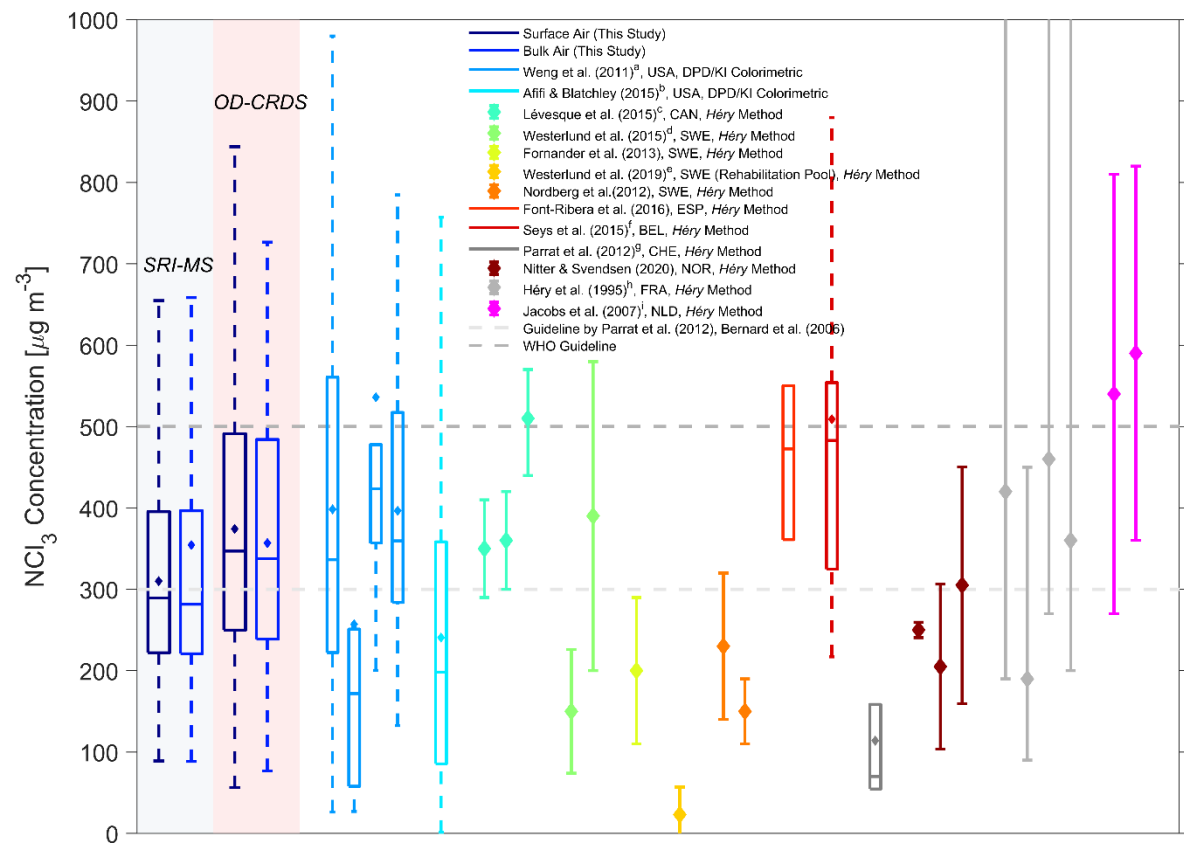
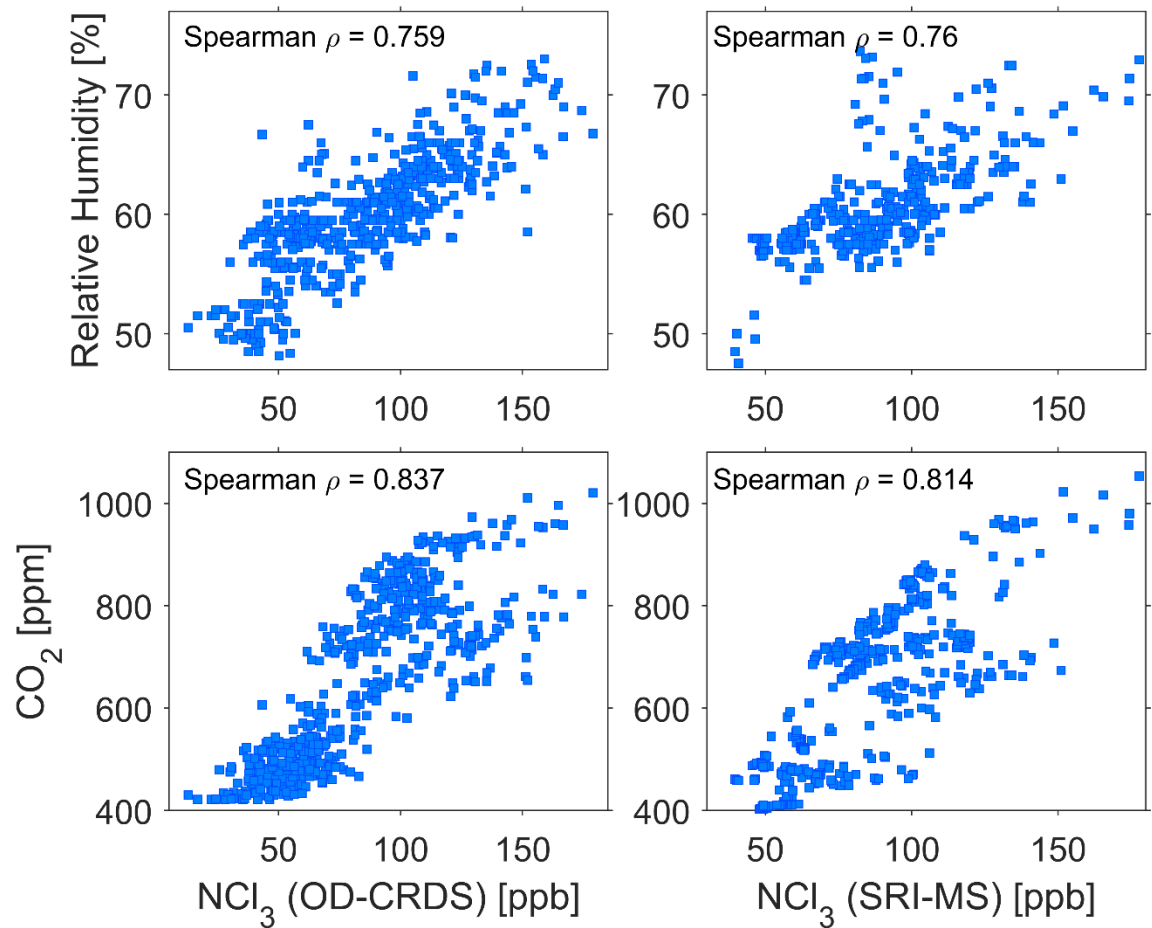


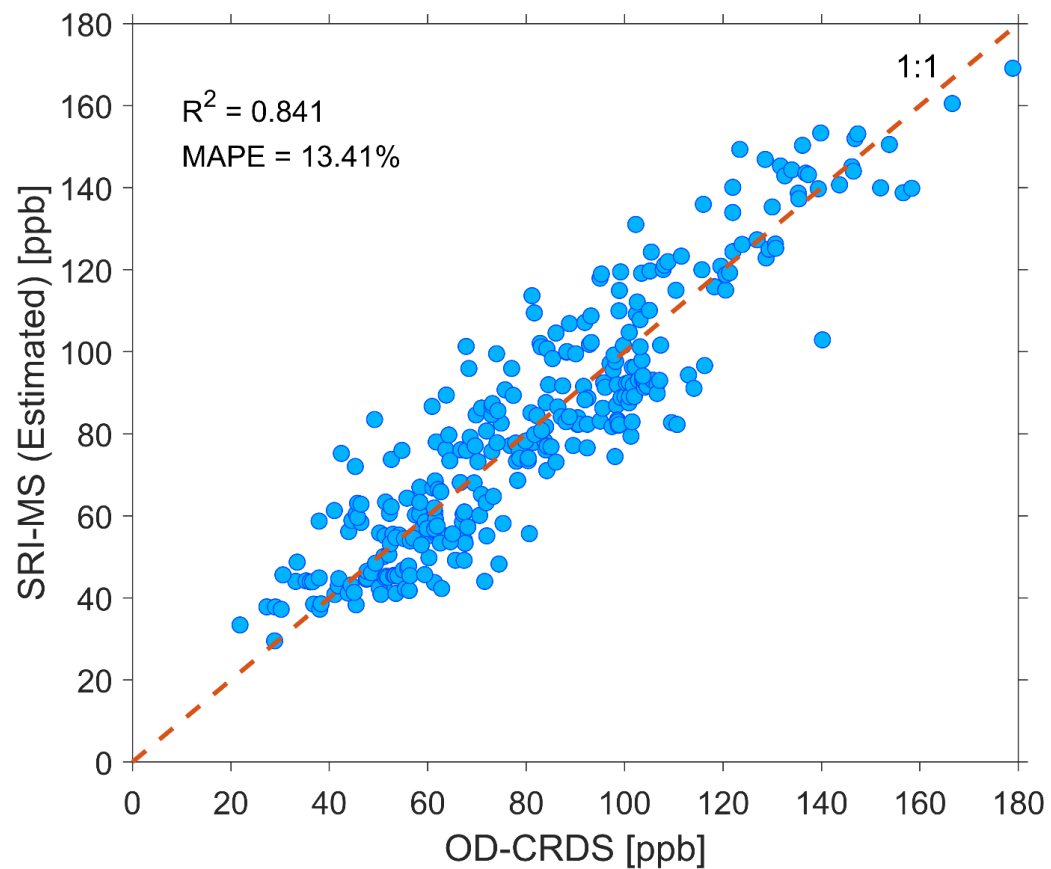


Prelim Start









Comparison of the estimated gas-phase NCl_3 concentration measured by the SRI-MS (assuming a default constant rate coefficient of $2 \times 10^9 \text{ cm}^3 \text{ s}^{-1}$; before applying the correction factors) and the concentration measured by the OD-CRDS (circular marker). The dashed line indicates where the ratio is equal to 1:1. The coefficient of determination (R^2) and mean absolute percentage error (MAPE) for the concentrations measured by two instruments are listed.

Merci pour votre attention!