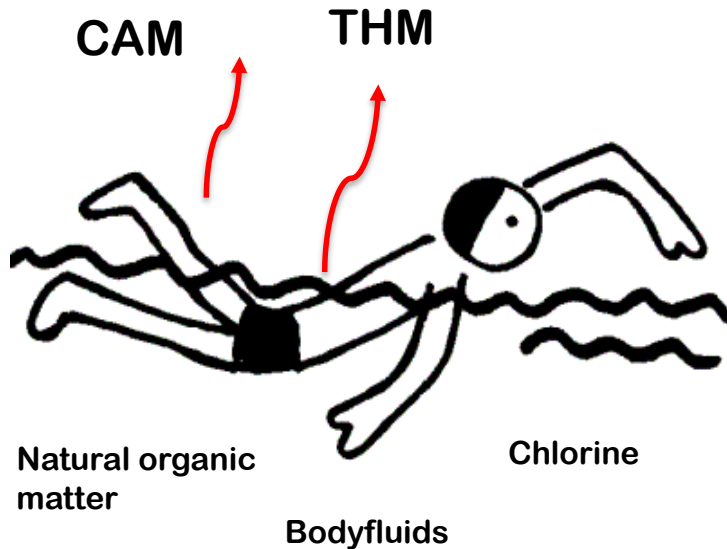

COMPARISON OF TRIHALOMETHANES IN THE AIR OF TWO INDOOR SWIMMING POOL FACILITIES USING DIFFERENT TYPE OF CHLORINATION AND DIFFERENT TYPES OF WATER

7th pool Conference 2017, May 4th

FORMATION OF DISINFECTION BY- PRODUCTS (DBPs)

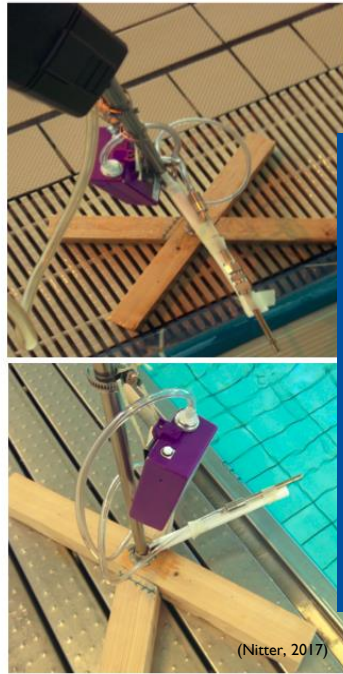


- More than 700 DBPs (Richardson et al, 2010)
- Trihalomethanes (THM)- of the most important groups
 - Chloroform- CHCl_3^*
 - Bromodichloromethane- BDCM^*
 - Dibromochloromethane- DBCM
 - Bromoform- CHBr_3
- Very to extremely volatile
- Easily penetrates the skin
- Exposure through dermal contact and inhalation

*Classified possible carcinogenetic to humans (2B) (IARC)

BACKGROUND

- Chloroform dominates freshwater pools
- Brominated THM dominates seawater pools
- Increased THM formation:
 - UV- lamps
 - Presence of brominated compounds
 - Seawater
- Brominated compounds:
 - Associated with NaOCl
 - More genotoxic and mutagenic
- Sample height from 0.25 m to 1.5 m
- Combined- and free chlorine are regulated → combined bromine is not (?)
- Some countries regulate level of THM in natatoriums (Sweden, Germany, Denmark, France, Austria, The Netherlands, Finland..)



AIM

1. Measure the concentration of THMs 0.05 m, 0.6 m and 1.5 m above the pool water surface
2. Compare the distribution of THMs from three freshwater pools and one seawater pool using different disinfection principles.

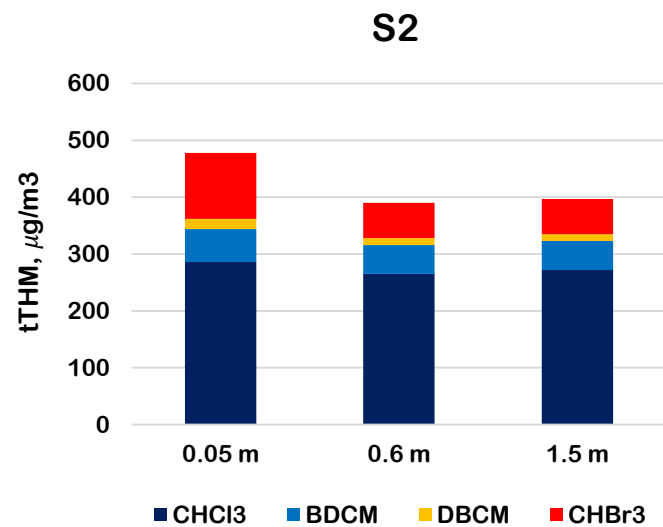
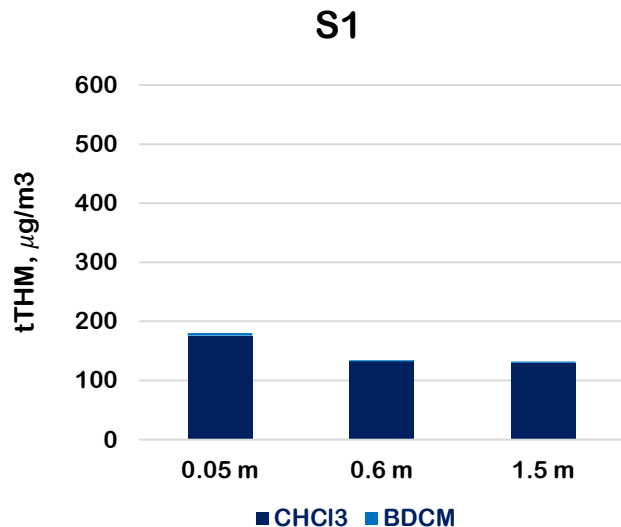
Facilities in the study

Facility	Pool	Water temperature (°C)	Disinfection	Water	Water volume (m ³)
S1	Sports spool, P1	27	Ca(OCl) ₂	Freshwater	600
	Therapy pool, P2	33	Ca(OCl) ₂ + UV	Freshwater	200
S2	Sports pool, P3	28	NaOCl+ UV	33 % seawater	2450
	Therapy pool, P4	34	NaOCl+ UV	Freshwater	210

METHOD

- **Sampling during morning swimming and baby swimming in the afternoon (therapy pool), public swimming in the evening (sports pool)**
- **Air samples;**
 - **0.05 m, 0.60 m and 1.5 m above water surface**
 - **through sorbent tubes containing Tenax TA; at 50 ml/min for 20 min**
- **Based on US EPA Method TO-17 and ISO 16017**
- **Free chlorine, combined chlorine, pH, air- and water temperature, number of occupants and relative humidity where registered**
- **THMs were determined by Unity thermal desorption coupled to a GC/MSD**

RESULT 1: THMs 0.05 m, 0.6 m and 1.5 m above the pool water surface



S1;

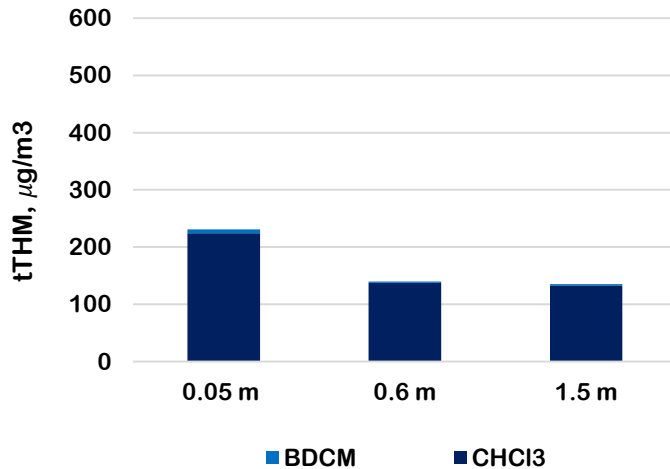
- 35 % more tTHM 0.05 m vs. 1.5 m
- 1 % more tTHM 0.6 m vs. 1.5 m
- 98 % of tTHM: CHCl₃

S2;

- 20 % more tTHM 0.05 m vs. 1.5 m
- 3 % more tTHM 1.5 m vs 0.6 m
- 59 % of tTHM: CHCl₃ (0.05 m)
- 87 % more CHBr₃ at 0.05 m vs 1.5 m

RESULT 2: Distribution of THMs; freshwater pool and seawater pool

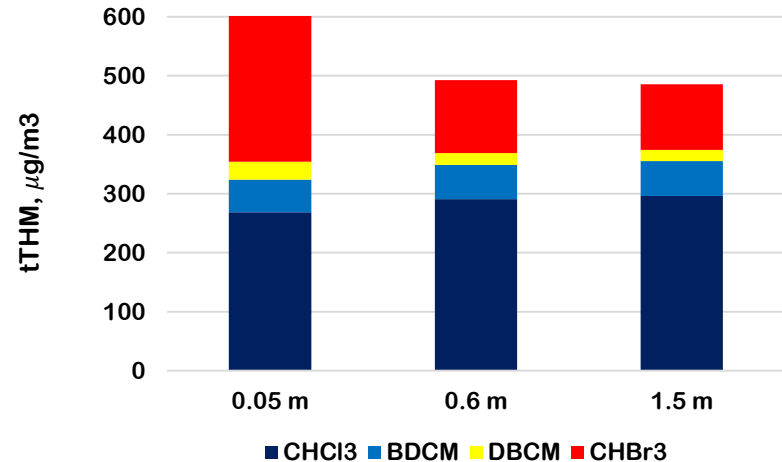
Sports pool, P1



S1;

- 70.5 % more tTHM 0.05 m vs. 1.5 m
- 3 % more tTHM 0.6 m vs 1.5 m
- 97 % of tTHM; CHCl₃ (0.05 m)

Sports pool, P3 (33 % seawater)



S2;

- 25 % more tTHM 0.05 m vs. 1.5 m
- 3 % more tTHM 0.6 m vs. 1.5 m
- 0.05 m: 42 % CHBr₃
- 1.5 m: 23 % CHBr₃

262 % more tTHM in S2 vs. S1 (0.05 m)

DISCUSSION

- **Both sports pools:**
 - **Higher concentrations in the morning**
 - **Night ventilation : Dehumidifaction only, no fresh air?**
- **When bromide is present: crucial to measure close to water surface**

DISCUSSION

	S1	S2
Air change per hours (ACH)	4	1
Visitors/year	130 000	360 000
Brominated THMs in therapy pool (freshwater)	2 %	25 %

- High concentration of THM in S2- Presents of bromide? ACH?
- Brominated compounds introduced by NaOCl
 - Contamination in NaOCl? storage time? storage temperature?
- When bromine is present; should combined bromine be measured?
- How to evaluate? Systemic dose calculations to compare with TDI-values?

THANKS FOR LISTENING 😊



Contact information; <http://www.ntnu.no/siat>