PFAS in environmental media at the Belgian coast

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Why measuring PFAS at the Belgian Coast?

I. Cousins 2019

Stockholm University

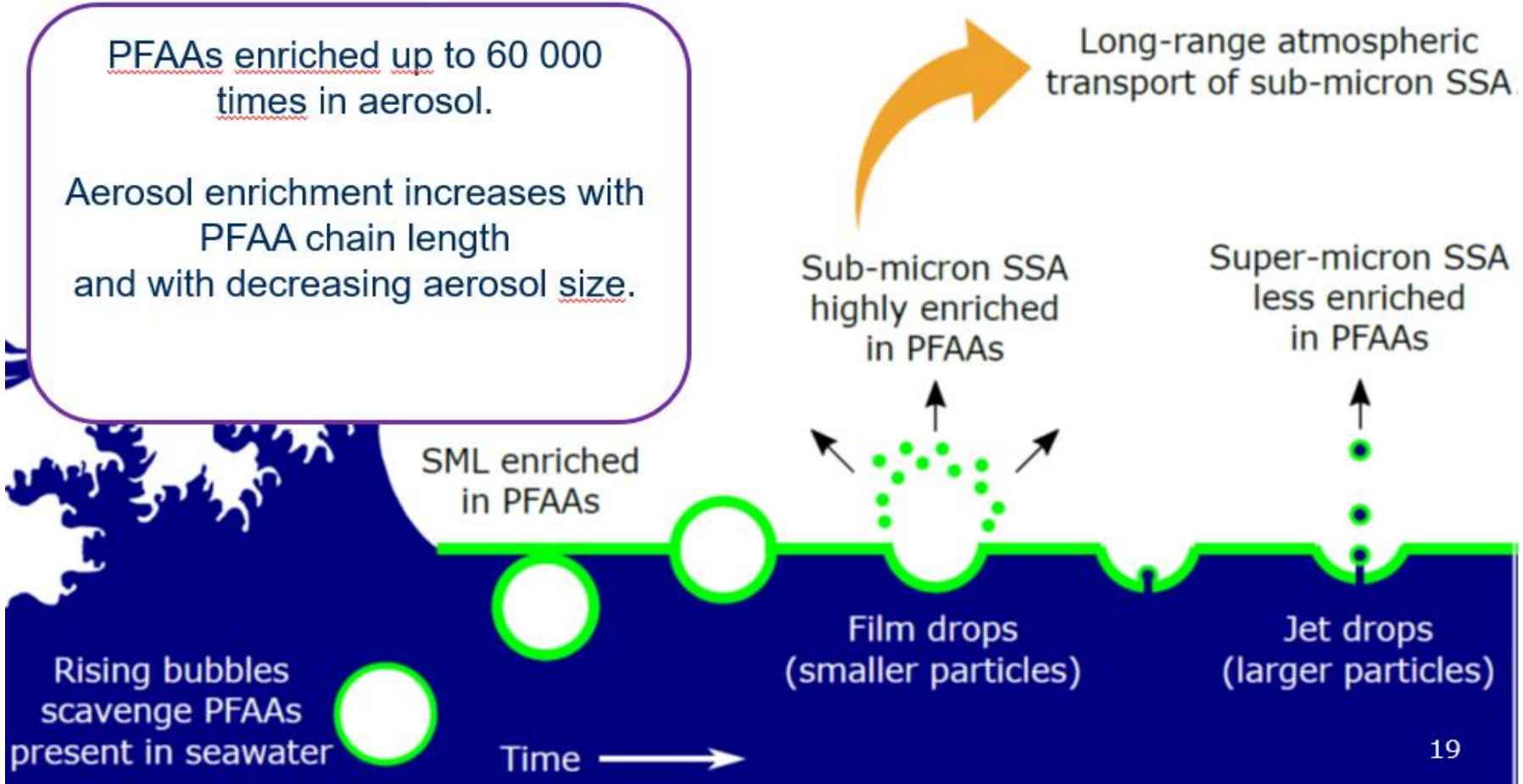
Potential sources of PFAAs to the atmosphere

Sea Spray aerosol

Lab study:

PFAAs enriched up to 60 000 times in aerosol.

Aerosol enrichment increases with PFAA chain length and with decreasing aerosol size.



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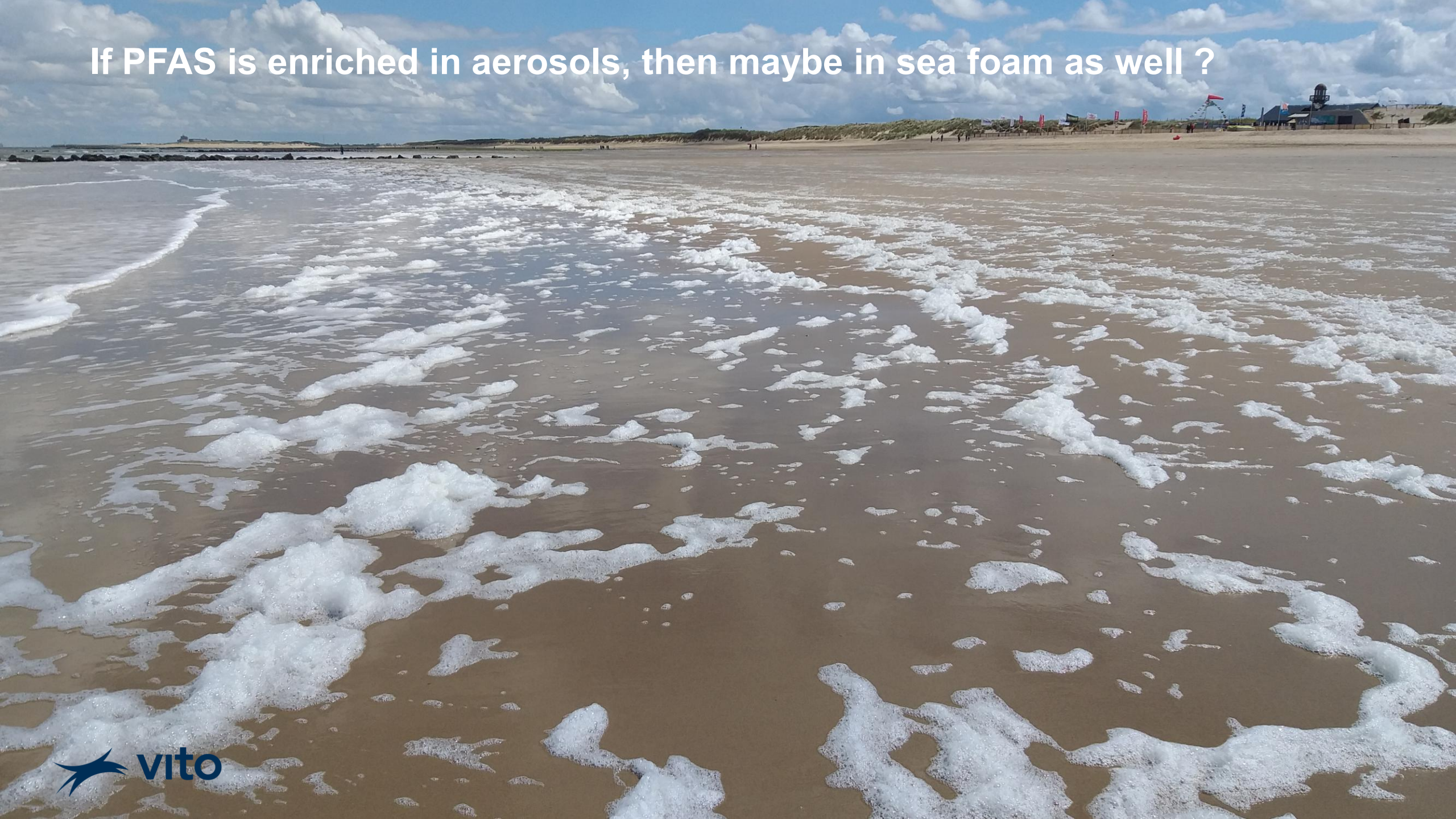
If PFAS is enriched in aerosols, then maybe in sea foam as well ?



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Results for PFAS in seafoam

First measuring campaigns 2021-2022 at eastern coast

Target analyses for 51 PFAS compounds (HRLC-MS/MS)

Sample	1	2	3	4	5	6	7
Total PFAS (µg/L)	25	15	8,7	73	129	2400	51
PFAS EFSA 4 (µg/L)	16	11	5,5	70	120	2200	47
PFAS EFSA 4 %	64 %	73 %	63 %	96 %	93%	92%	92%

Concentrations of PFAS in condensed seafoam samples : from 8,7 to 2400 **µg/**L

Sampling campaigns 2024 along Belgian coast

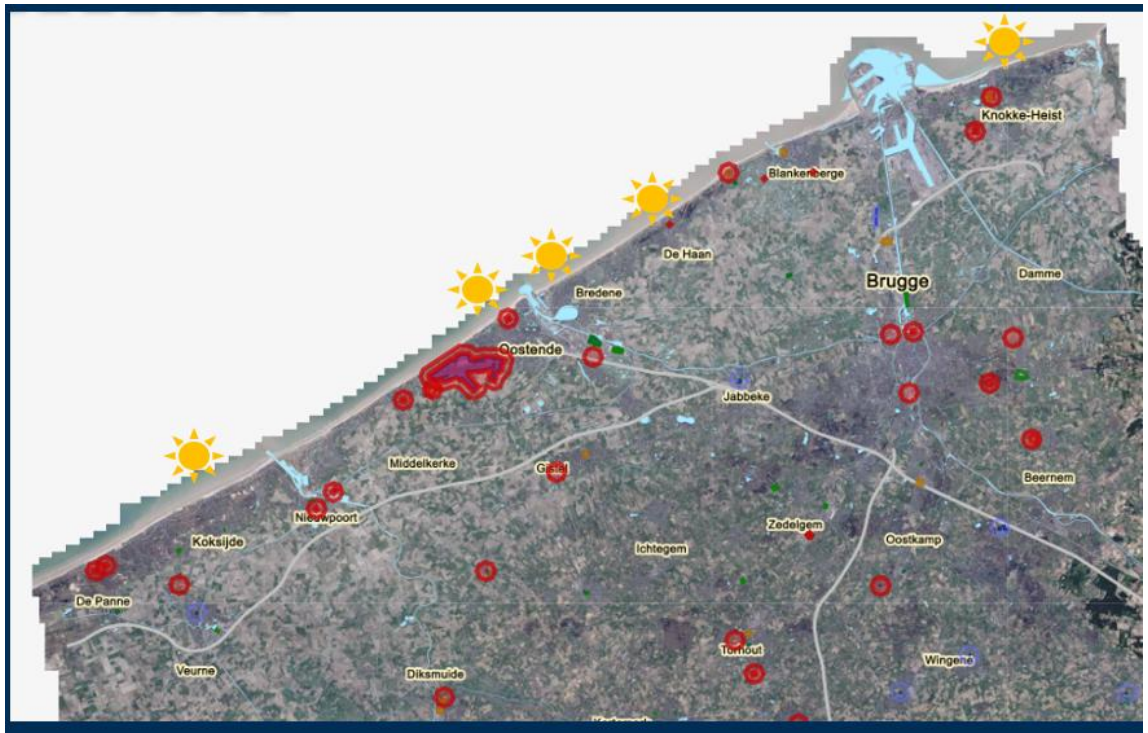
Locations: Knokke-Heist, De Haan, Bredene, Oostende, Koksijde

Sea foam: composite samples of trajectories of approx 500 meter

Seawater: depth 0 - 10 cm (ingestion when swimming)

3 time points for sea foam and sea water

Soil at 3 beach locations, one time point



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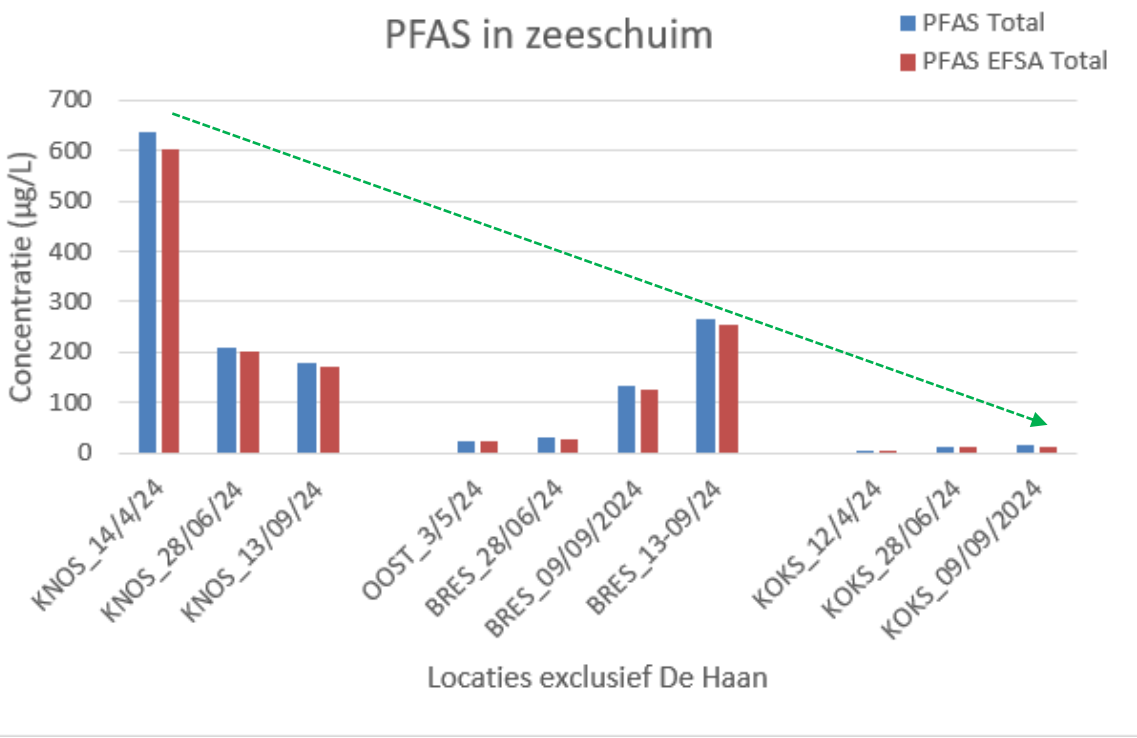
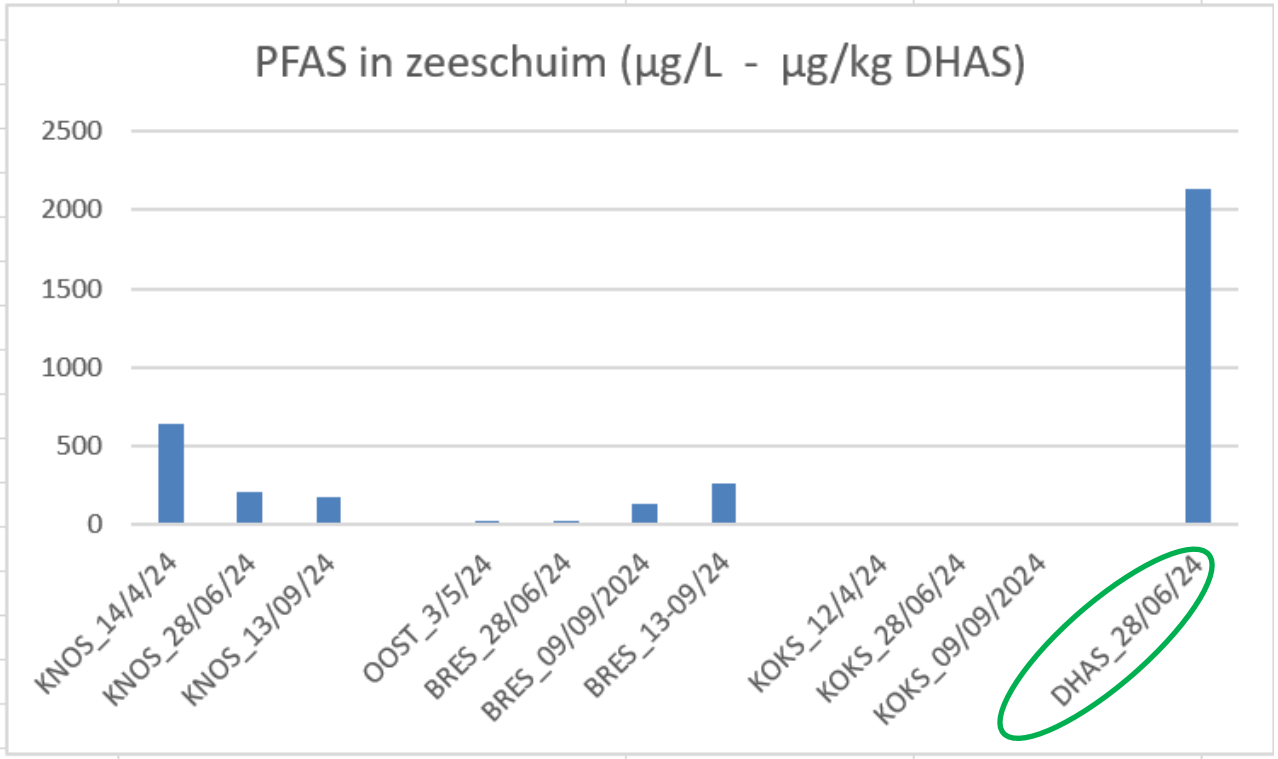
PFAS IN SEAFOAM TARGET ANALYSES 2024





Target PFAS predominantly 4 EFSA-PFAS
Gradiënt in concentrations from east (Knokke) to west (Koksijde)
PFAS concentrations variable in time

Seafoam sample at De Haan very high PFAS load (> 2000 µg/kg)

PFAS PROFILES IN SEA FOAM TARGET ANALYSES 2024

PFOS dominates everywhere

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PFOA (except for Koksijde)

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PFCA's (C9-C11) (Koksijde)

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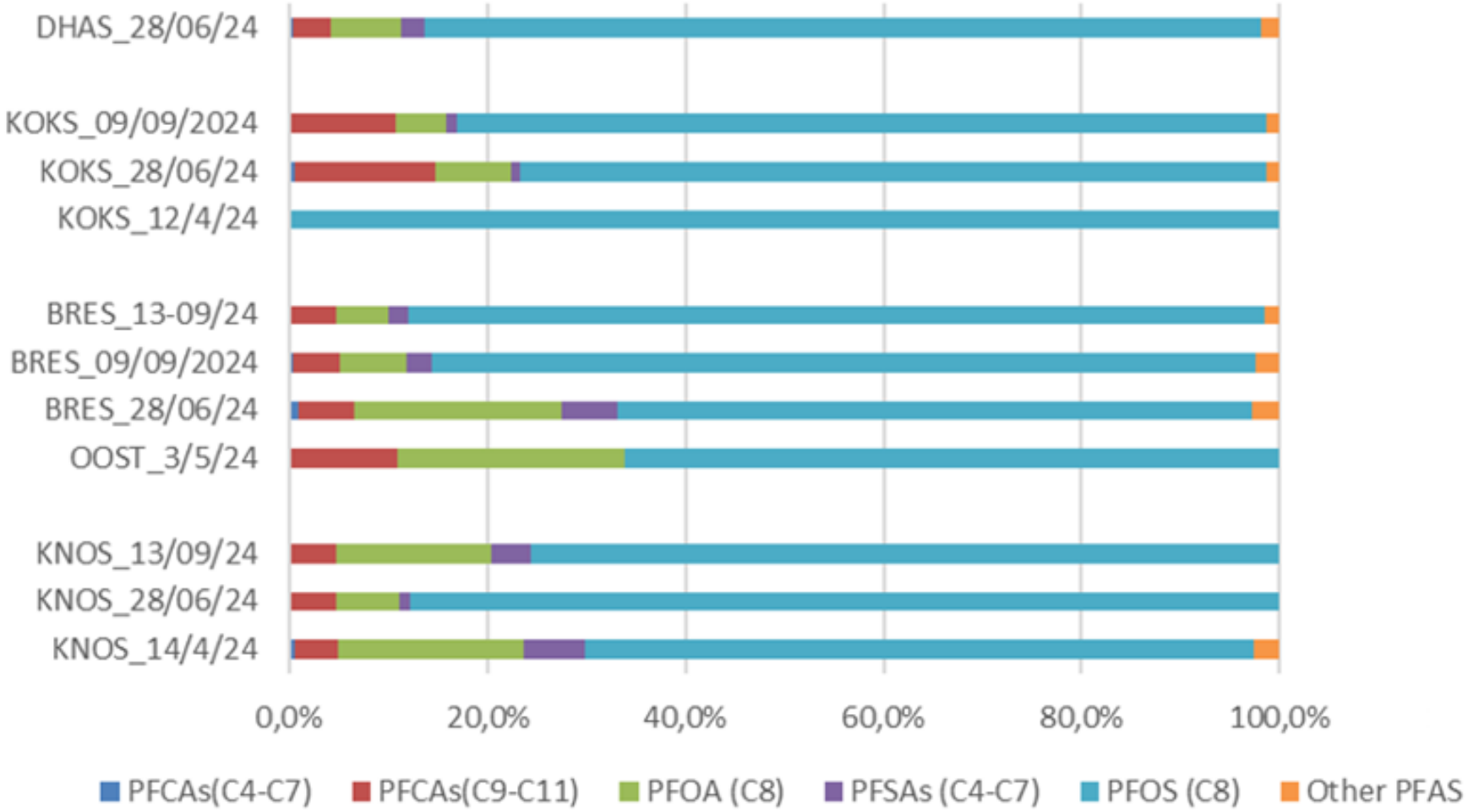
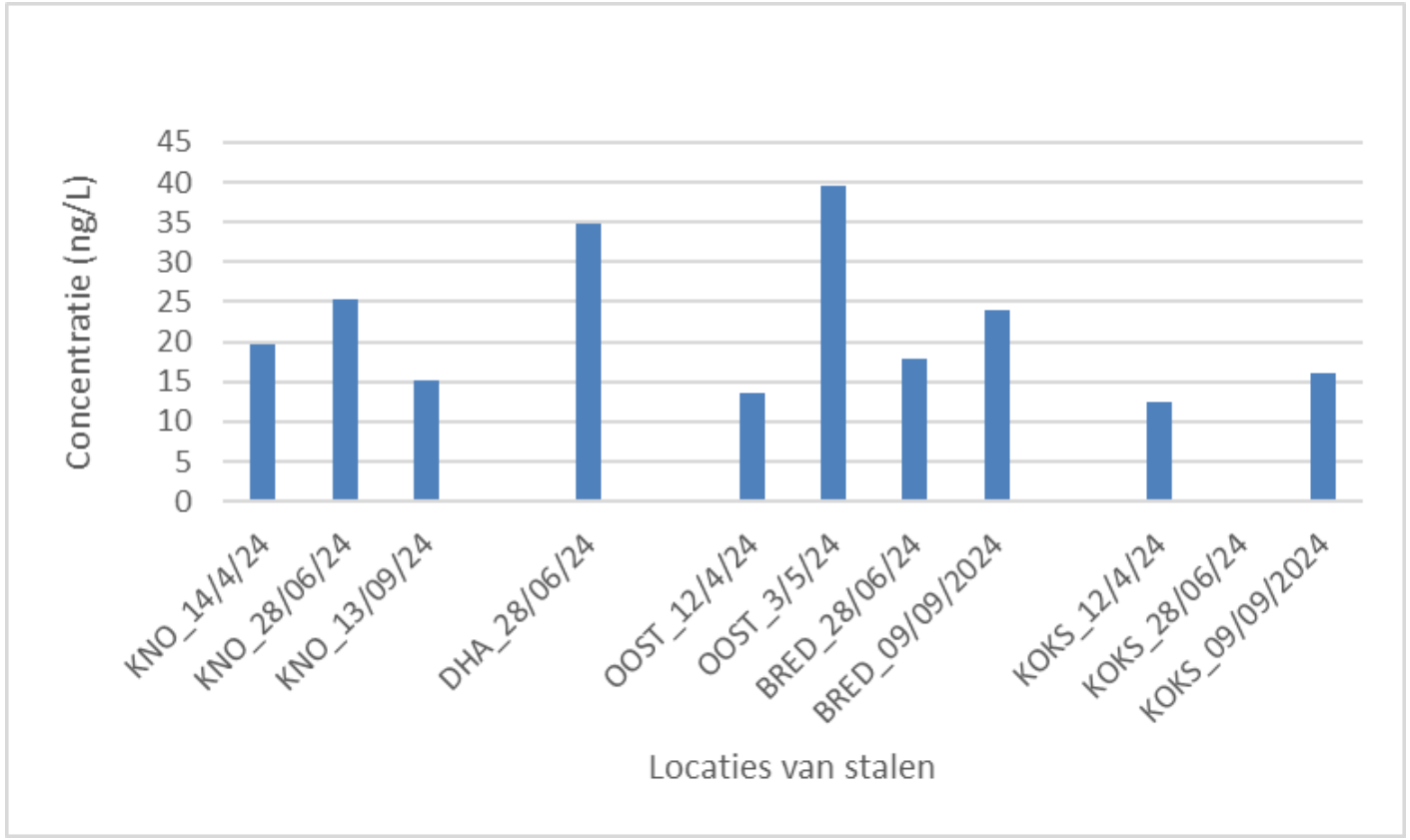
PFSA's (C4-C7)



SEAWATER - TARGET ANALYSES PFAS



Concentrations PFAS in shallow sea water (0-10 cm) much lower than in sea foam
→ very strong enrichment in foam
Concentrations comparable along the coast
EFSA-PFAS > 52% , except for Koskijde (PFOSA)

NON-TARGET ANALYSES PFAS IN SEAFOAM

C13-PFOA-equivalents

Samples	KNZS_14/4/24	KNZS_28/06/24	KNZS_13/09/24	DHAS_28/06/24	OSTS_1_3/5/24	BRES_28/06/24	BRES_09/09/24	BRES_13-09/24	KOKS_12/4/24	KOKS_28/06/24	KOKS_09/09/24	KNZW_28/06/24	BREW_28/06/24	DHAW_28/06/24	KOKW_28/06/24	blanc zipbag
Non-target analysis PFAS Classes - PFAS equivalents (other than target PFAS)	**Sea foam**											**Sea water**				**Blanc**
Ether substituded perfluoroalkyl carboxylic acids (PFECA)	3	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1
H-substituted perfluoro ether carboxylic acids	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
H-substituted perfluoroalkyl sulfonic acids	43	<1	7	<1	<1	<1	1	9	<1	<1	<1	<1	<1	<1	<1	<1
Perfluoroalkyl sulfinic acids (e.g.PFBSi)	3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Perfluoroalkyl sulfonamides (FASAs)	3	3	<1	1	2	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Unknown PFAS class (01-51)	*42*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*
Unknown PFAS class (05-55)	*6*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*
Unknown PFAS class (25-75)	*19*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*5*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*
Unknown PFAS class (40-90)	*11*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*
Unknown amine I	*7*	*1*	*<1*	*<1*	*<1*	*<1*	*<1*	*2*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*	*<1*
N-ethyl perfluoroalkyl sulfonamide (FASAs)	<1	<1	28	<1	<1	6	<1	<1	<1	22	<1	<1	<1	<1	<1	<1
H-substituted perfluoroalkyl sulfonates	<1	2	<1	3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Unsaturated perfluoro ether alkylsulfonic acids (e.g. PFEESA)	<1	8	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Perfluoroalkyl phosphonic acids (PFAPAs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	28	<1	<1	<1	<1	<1	<1
PFECHS	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
H-substituted perfluorocarboxylates	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
double bond-, diether-substituted perfluoroalkyl (linear) carboyxlic acids	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Perfluorosulfonic acids (PFSAs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Perfluoroalkyl N-heterocycles	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fluorotelomer sulfonic acids (x:2 FTS)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
sum of unknown classified PFAS equivalents	**138**	**15**	**35**	**4**	**2**	**7**	**1**	**16**	**<1**	**51**	**<1**	**<1**	**<1**	**<1**	**<1**	<1
sum of remaining unknown PFAS cpds (KMD filter CF2)	**790**	**217**	**239**	**311**	**160**	**277**	**78**	**207**	**46**	**806**	**26**	**1**	**18**	**22**	**2**	<1

Profiles of classified PFAS variable in time

Remaining unknown PFAS cpds (KMD Filter CF2) more important than classified PFAS

Highest # of sums of PFOA-equivalents for Knokke and Koksijde, while the latter had much lower target-PFAS

PFAS IN SOIL AT THE BEACH – KNOKKE, BREDENE, KOKSIJDE

TARGET ANALYSES PFAS IN SOIL

sample ID	Total PFAS	Total EFSA PFAS	PFOS	PFOA	6:2FTS	PFNA	PFDA
KN-BDU	3,5	3,3	3,1	0,13	<0.1	0,1	0,1
KN-BGB	0,6	<	<0.09	<0.08	0,6	<0.09	<0.08
KN-BST	0,3	0,1	0,13	<0.07	0,2	<0.08	<0.07
BRE-DU	0,9	0,8	0,8	<0.09	0,2	<0.09	<0.09
BRE-GB	0,6	<	<0.08	<0.07	0,6	<0.08	<0.07
BRE-ST	2,1	1,1	1,1	<0.09	1,0	<0.1	<0.09
KOK-DU	2,6	0,5	0,5	<0.1	2,1	<0.1	<0.09
KOK-ST-L	1,7	<	<0.09	<0.08	1,7	<0.08	<0.08
KOK-ST-H	1,2	<	<0.08	<0.07	1,2	<0.07	<0.07

Low concentrations PFAS in sandy soils (< 3,5 µg/kg)

Mainly PFOS at Knokke and Bredene, at Koksijde mainly 6:2-FTS

All samples collected after long period of exceptional rainfall (leaching?)

Soil samples collected in Knokke in 2022 : PFOS = 5 µg/kg as highest concentration

SEAFOAM AT DE HAAN – A SPECIAL CASE

only 1 sampling event June 2024 (not planned)

Locally clay enriched seafoam on the beach

Very high concentrations of PFAS (> 2000 µg/kg)

PFAS polluted soil at local scale and for short times ?

PFAS IN AMBIENT AIR AT THE BEACH

VITO MEASUREMENTS FOR VMM

Concentrations ΣPFAS in air suspended particles at beach
3 to 5 x higher than in Antwerp urban setting
15 to 24 x higher than rural background

	sum of Total Perfluoroalkyl substances (PFASs)	sum of total (T) EFSA PFAS
Zwevend stof (∑PFASs ng/m³)		
Knokke Zoute 2	0,219** (0,387)***	0,082 (0,105)
Duinbergen	0,136 (0,221)	0,035 (0,075)
Borgerhout*	*0,045 (0,065)*	*0,018 (0,034)*
Dessel****	*0,009 (0,057)*	*0,002 (0,025)*
EFSA norm		*0,44*
Kruiken (∑PFASs ng/m²/dag)		
Knokke Zoute	*80 (185)*	*61 (160)*
Duinbergen	*68 (165)*	*56 (144)*
Borgerhout	*27 (45)*	*2 (5)*
Dessel	*18 (44)*	*2 (30)*

** mean value of several campaigns; *** maximum value

https://www.vlaanderen.be/pfas-vervuiling/eindrapport-onderzoek-naar-pfas-in-omgevingslucht-in-vlaanderen

Questions?

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