THE SCIPPER PROJECT

Supplementary Materials of EGU23-2239

Ship-related ultrafine particles and SOA formation in a Mediterranean port city

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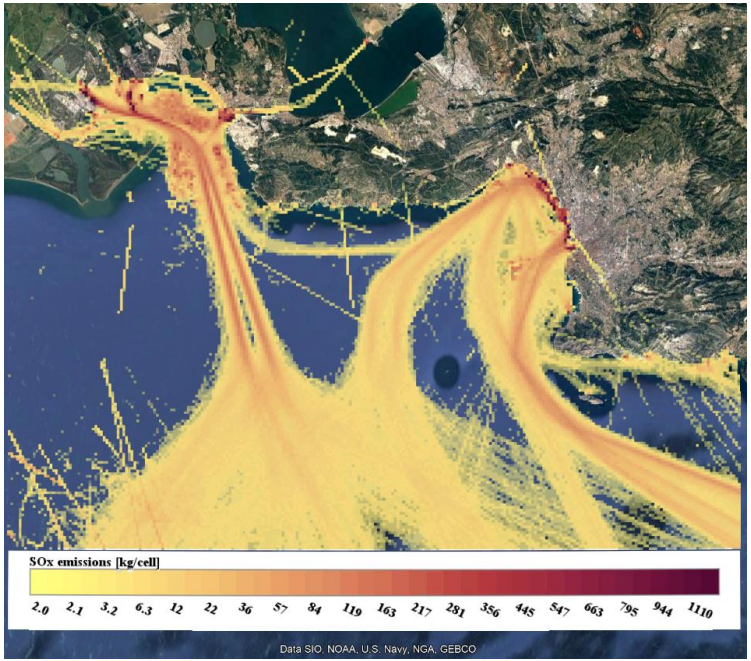
STEAM ship emissions Marseille

STEAM-3 ship emission of SO_x Marseille 2020



STEAM v3.5

Jalkanen et al., 2012;
Johansson et al., 2017

Marseille port inventory
Year 2020
Grid resolution: 250 m

AIS data from 2015 as baseline for ship positions

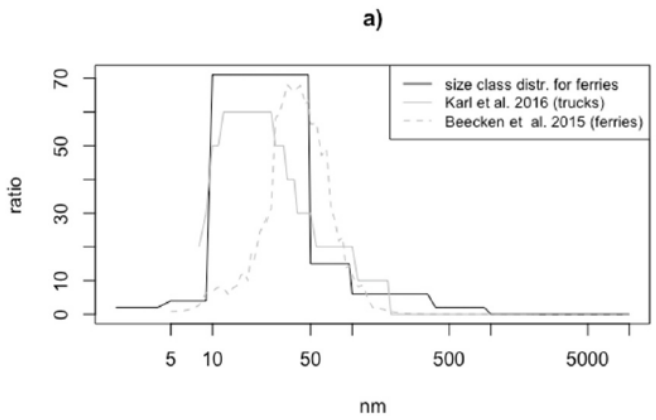
Map: FMI, Elisa Majamäki

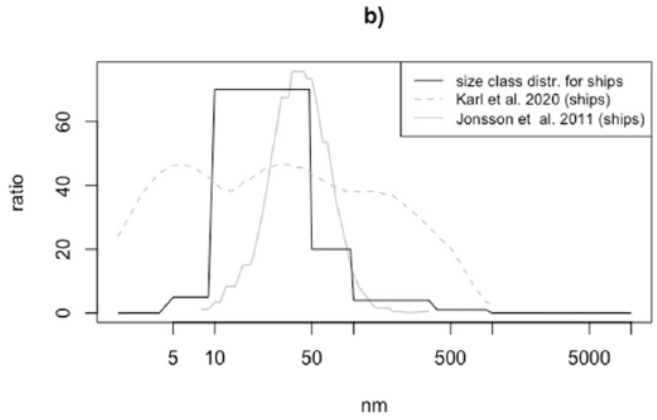
Split of VOC emissions from STEAM

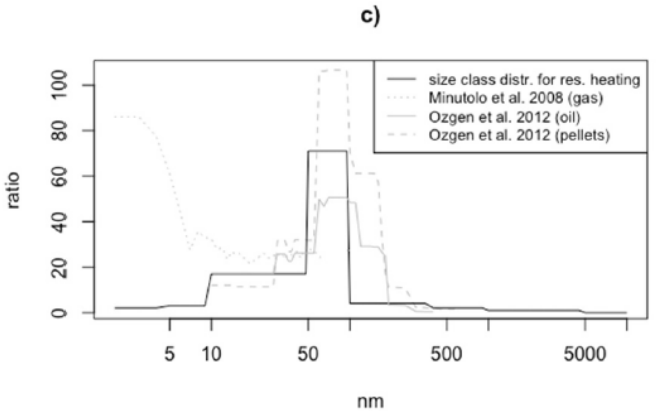
STEAM	PIOC	PSOC	XYL	MEK	HCHO	CH3CHO	C4H10	C3H6	C2
VOC A	0.914	0	0	0.011	0	0.021	0	0	0
VOC B	0	0.01	0.074	0	0.473	0.281	0.012	0.05	0.10
VOC C	0.433	0.421	0.146	0	0	0	0	0	0
VOC D	0	0.831	0.169	0	0	0	0	0	0

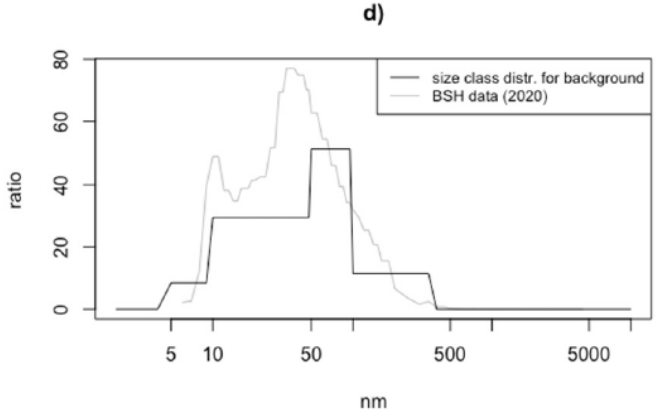
VOC groups A-D in STEAM-3 have a load dependency of emission factors based on Reichle et al., J. Air Waste Manag. Assoc., 2015; Agrawal et al., J. Geophys. Res., 2010; etc.

Emission size distributions





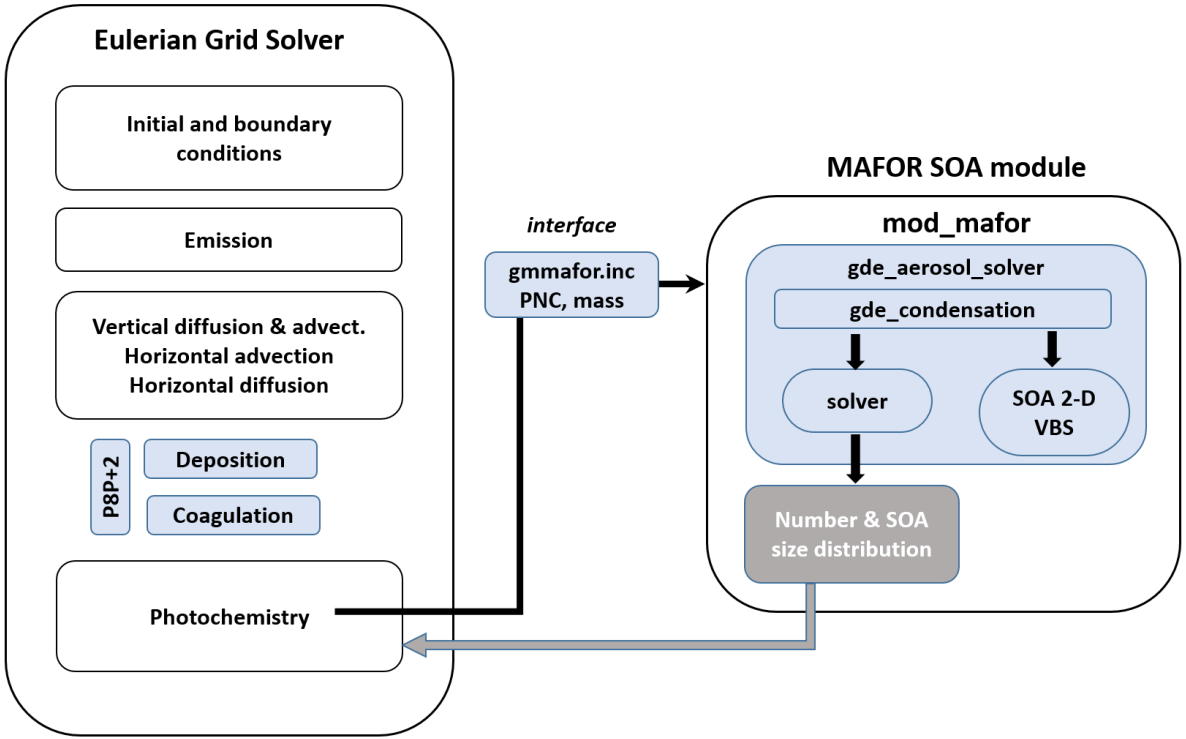




Particle number parameterization P8P+2

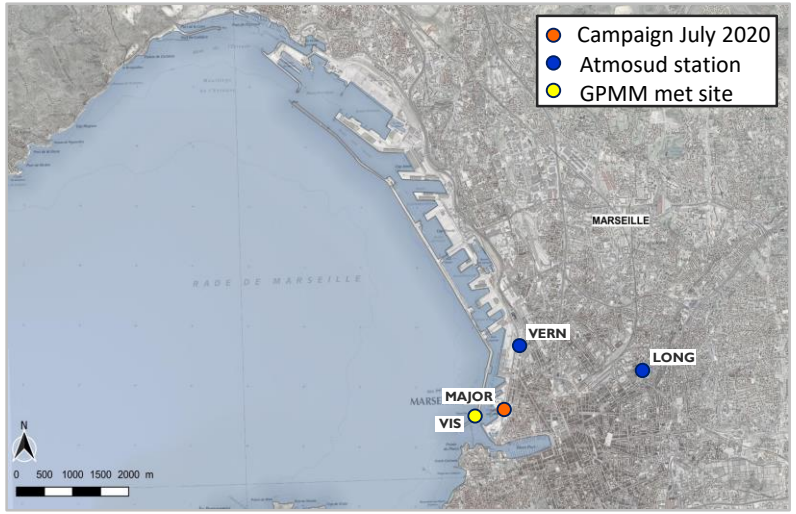
Size classes	Lower Dp (nm)	Upper Dp (nm)	Mean Dp (nm)	Band width (-)	V dep (cm/s)	K coag (cm^3/s)
PN1	1.5	4.0	2.0	1.3	1.000	6.30×10^{-9}
PN2	4.0	9.0	7.0	1.3	0.528	4.51×10^{-9}
PN3	9.0	21	17	1.5	0.355	9.76×10^{-9}
PN4	21	50	41	1.6	0.181	15.0×10^{-9}
PN5	50	120	98	1.6	0.068	5.40×10^{-9}
PN6	120	290	232	1.8	0.039	6.26×10^{-9}
PN7	290	670	551	1.8	0.031	4.27×10^{-9}
PN8	670	1000	850	1.8	0.023	2.28×10^{-9}
PN9	1000	2500	1500	2.0	0.110	0.87×10^{-9}
PN10	2500	10000	4000	2.0	0.200	0.80×10^{-9}

EPISODE-CityChem - SOA formation



Block structure of the Eulerian grid solver with P8P+2 and the MAFOR SOA module in EPISODE-CityChem

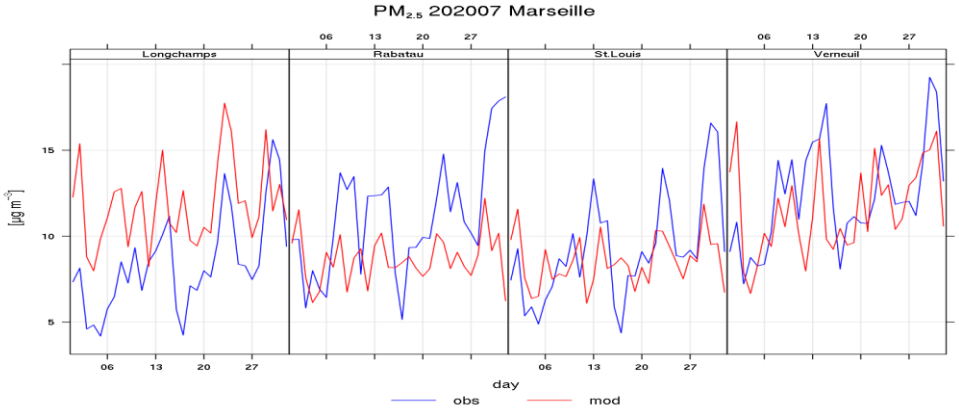
Comparison to AQ monitoring

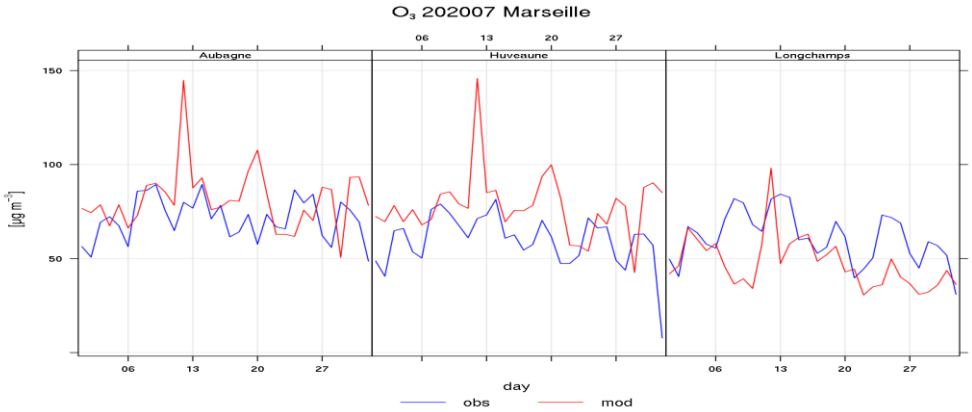


AQ Monitoring

Verneuil – urban traffic site

Longchamps –urban background



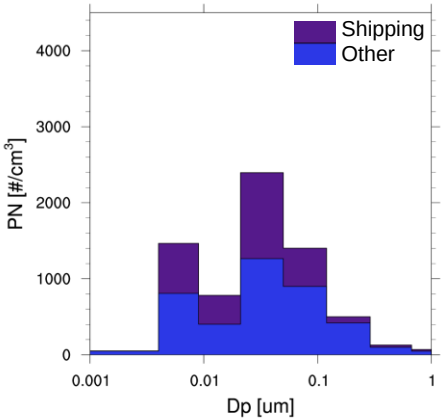


Evaluation of modeled PNSD

Particle Number Size Distribution (PNSD)

La Major – campaign port site
Longchamps –urban background

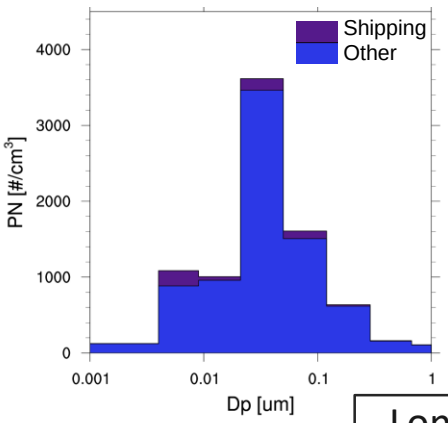
Observed PNSD at Longchamps from AtmoSud
Instrument: SMPS (TSI)

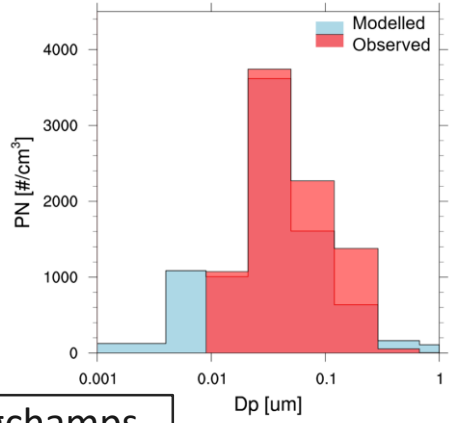


La Major

Size distribution from ships

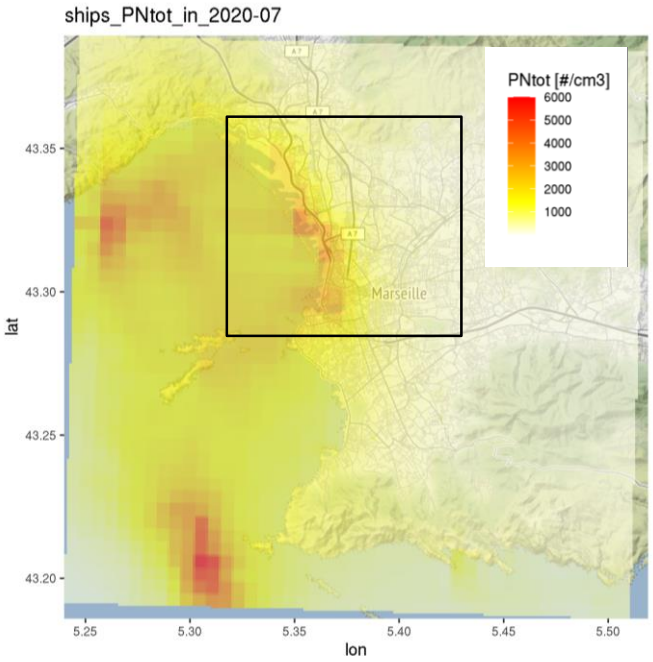
- Maximum at 21-50 nm
- Nucleation mode

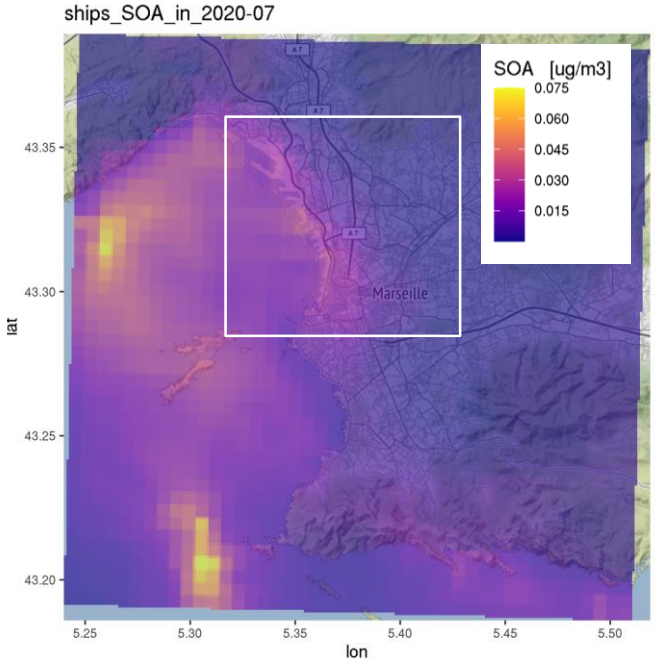




Longchamps

Absolute ship contribution to UFP and SOA



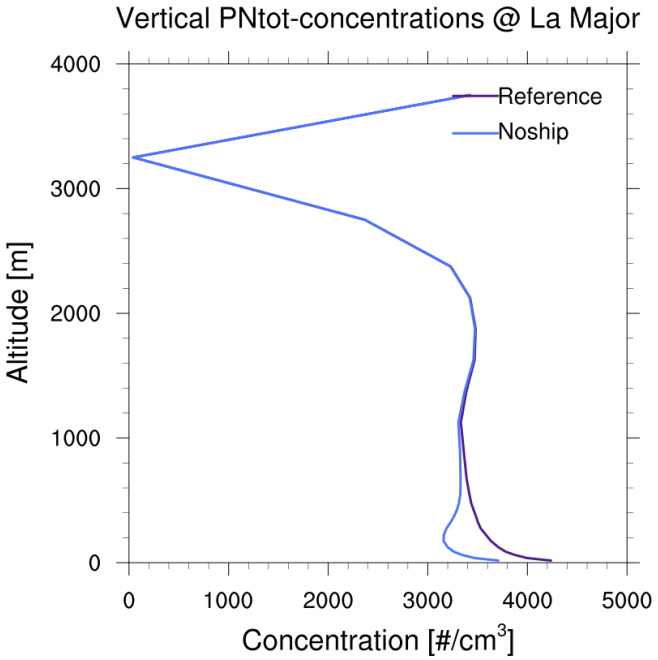


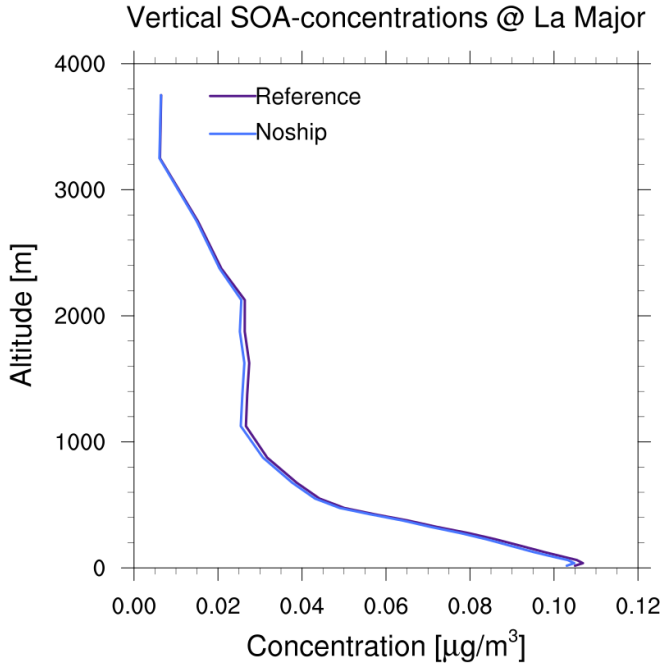
Potential ship impact

- Average July 2020
- Zero-out method ΔC(ship)

Average ship impact: 1100 #/cm^3 to UFP, 9.4 ng/m^3 to SOA (spatial mean of city box)

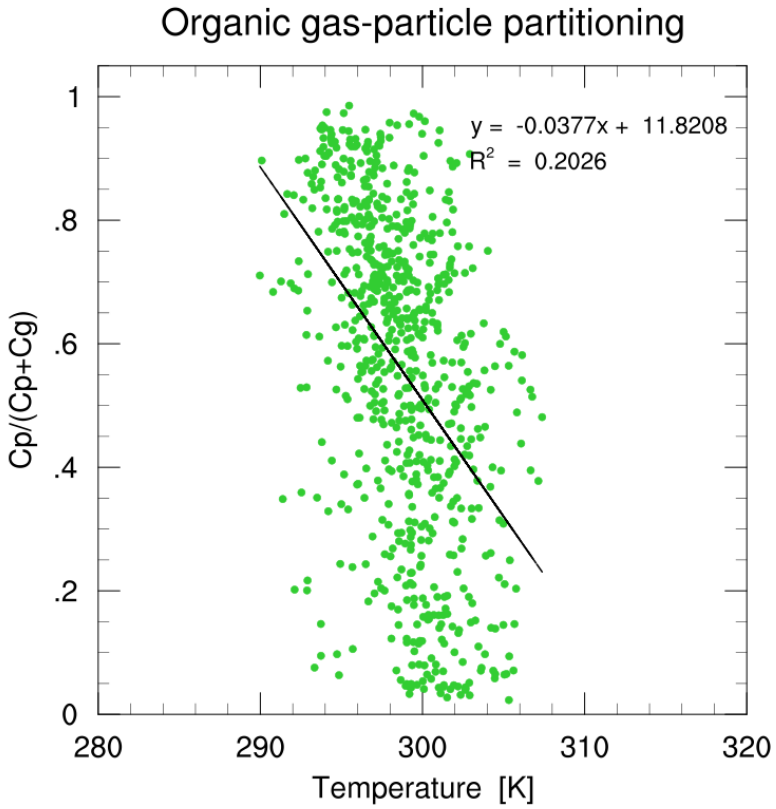
Vertical profile of modeled PN and SOA





La Major, Average 07/2020

Temperature dependence of modeled SOA



Temperature dependence of the modelled gas-particle partitioning of semi-volatile organics expressed as:

$$f_{in\_particles} = \frac{C_{soc,particle}}{C_{soc,gas} + C_{soc,particle}}$$

La Major, hourly model data 07/2020