



Monitoraggio della distribuzione di nanoparticelle ad alta risoluzione temporale in un sito portuale (Progetto Aernostrum)

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ARPAT

CRTQA- Centro Regionale Tutela Qualità dell'aria ARPA Toscana



Obiettivi del lavoro

- Prime misure ARPAT di nanoparticelle in Toscana
- Analisi dei dati al minuto combinando misure da strumentazioni diverse
 - Interpretazione dei dati in relazione alla sorgente porto
 - Caratterizzazione dei passaggi navali
 - Caratterizzazione delle soste



Progetto Aernostrum - Aria bene comune

E' un progetto Interreg Italia Francia, che si è svolto da maggio 2020 ad aprile 2023, con l'obiettivo generale di contribuire a preservare o migliorare la qualità dell'aria nelle aree prospicienti i porti dell'area di cooperazione favorendo al contempo la crescita sostenibile delle attività portuali

Nell'ambito del progetto, ARPAT si è dotata un contatore di nanoparticelle portatile **Nanoscan TSI 3910** adattato per il campionamento stand alone in esterno con un cabinet appositamente progettato



Nuova proposta di Direttiva

- **DEFINIZIONE:** ‘ultrafine particles’ (UFP) means particles with a diameter less than or equal to 10 nm, where UFP are measured as the particle number concentrations per cubic centimetre (cm³) for a size range with a lower limit of 10 nm and for a size range with no restriction on the upper limit;
- **PRESCRIZIONE MISURE:** Minimum number of sampling points for fixed measurements of ultrafine particles where high concentrations are likely to occur Ultrafine particles shall be monitored at selected locations in addition to other air pollutants. Sampling points to monitor ultrafine particles shall coincide, where appropriate, with sampling points for particulate matter or nitrogen dioxide referred to in Point A, and be sited in accordance with Section 3 of Annex VII. For this purpose, at least 1 sampling point per 5 million inhabitants shall be established at a location where high UFP concentrations are likely to occur. Member States that have fewer than 5 million inhabitants shall establish at least 1 sampling point for fixed measurements at a location where high UFP concentrations are likely to occur.
- **OBIETTIVO DELLE MISURE:** The objective of such measurements is to ensure that adequate information is available at locations where high concentrations of UFP occur that are mainly influenced by sources from air, water or road transport (**such as airports, ports, roads**), industrial sites or domestic heating. The information shall be appropriate to judge on enhanced levels of UFP concentrations from those sources.



Monitoraggi: quando, dove e come



dove



quando

Autunno	05/10/2021	15/10/2021
Inverno	11/01/2022	22/01/2022
Primavera	11-15/04/2022	20-24/04/2022
Estate	06/06/2022	17/06/2022

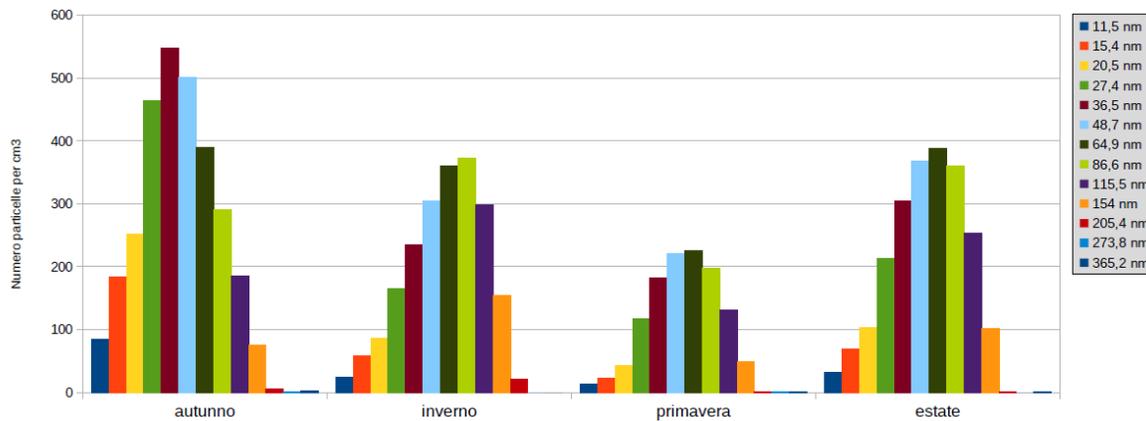
come





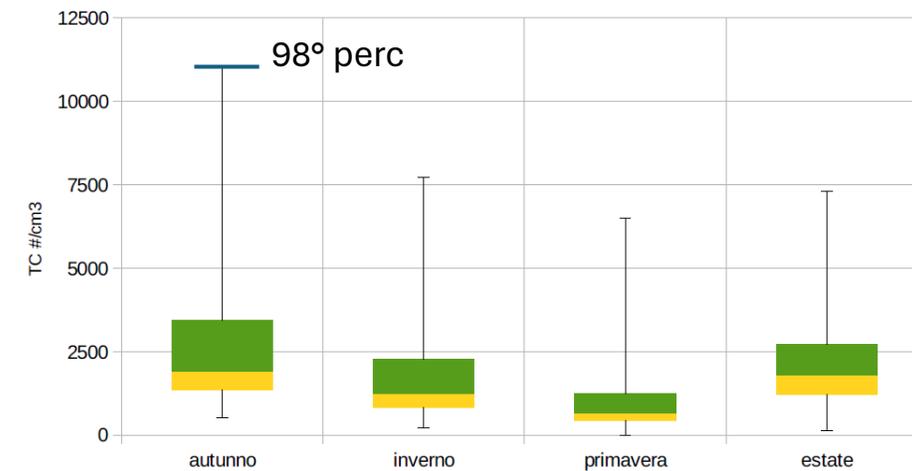
Sintesi dei risultati misura nanoparticelle per campagna (distribuzioni)

Distribuzione media per classe dimensionale e per campagna



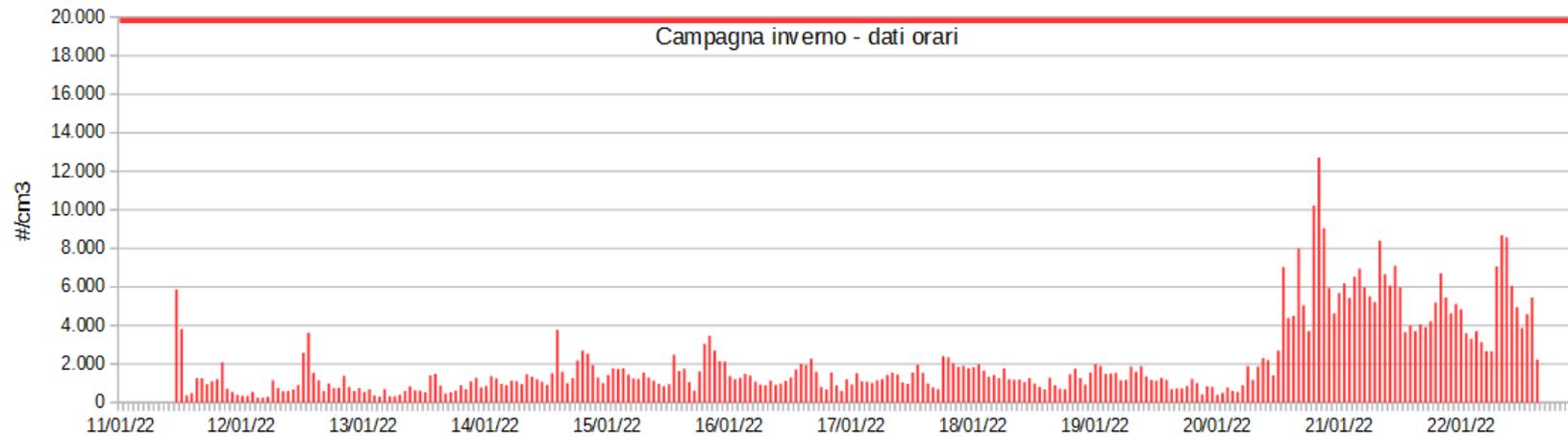
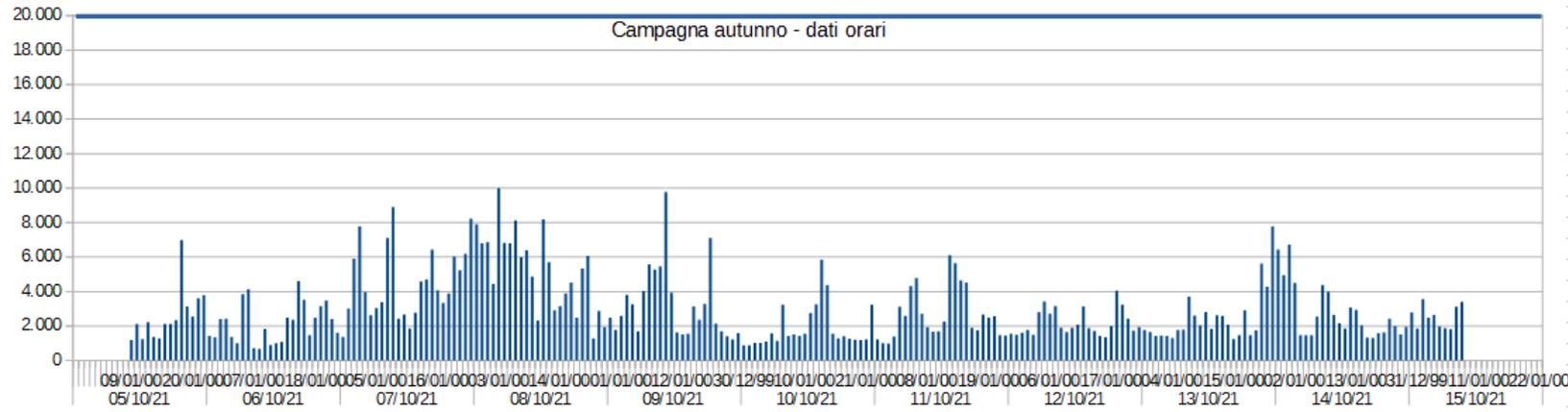
Conteggi totali distribuzione per campagna

Max 71.342 93.622 46.863 50.330



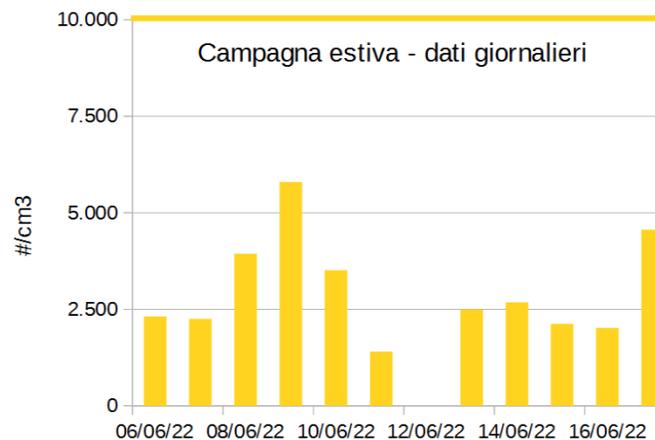
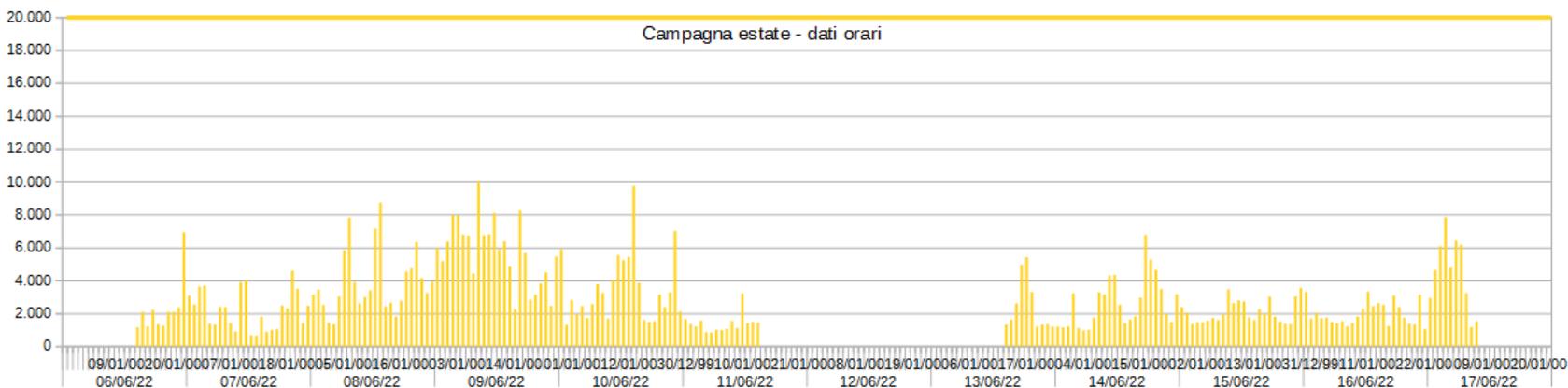
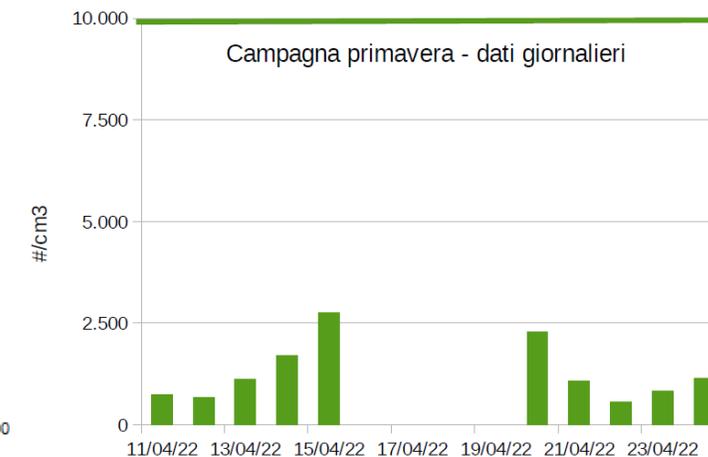
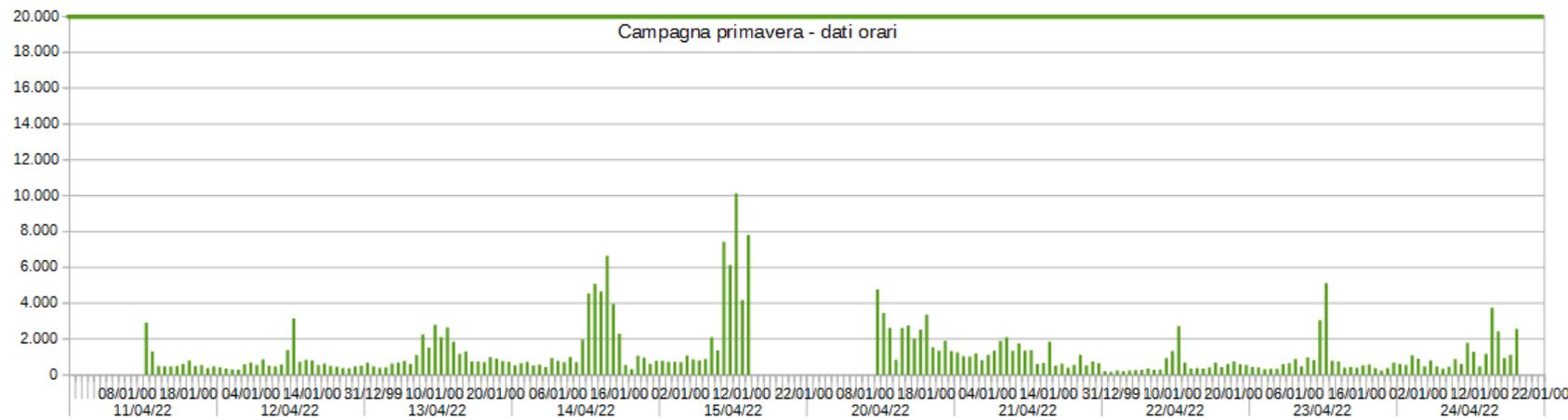


Valori orari e valori giornalieri conteggi totali nanoparticelle





Valori orari e valori giornalieri conteggi totali nanoparticelle



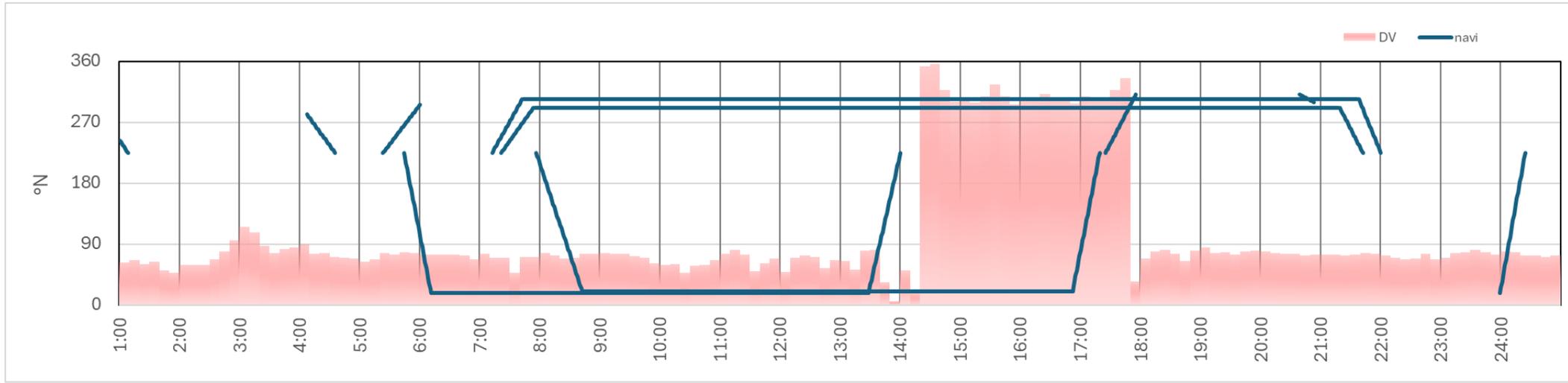


Analisi dati minuto

Per una analisi di maggior dettaglio si sono sfruttate le acquisizioni dati minuto combinando:

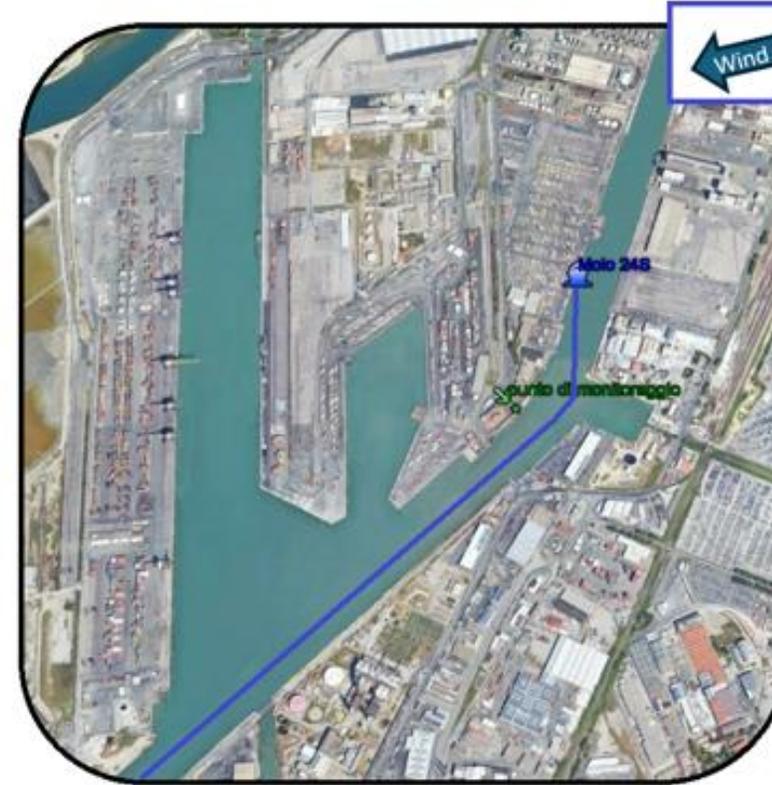
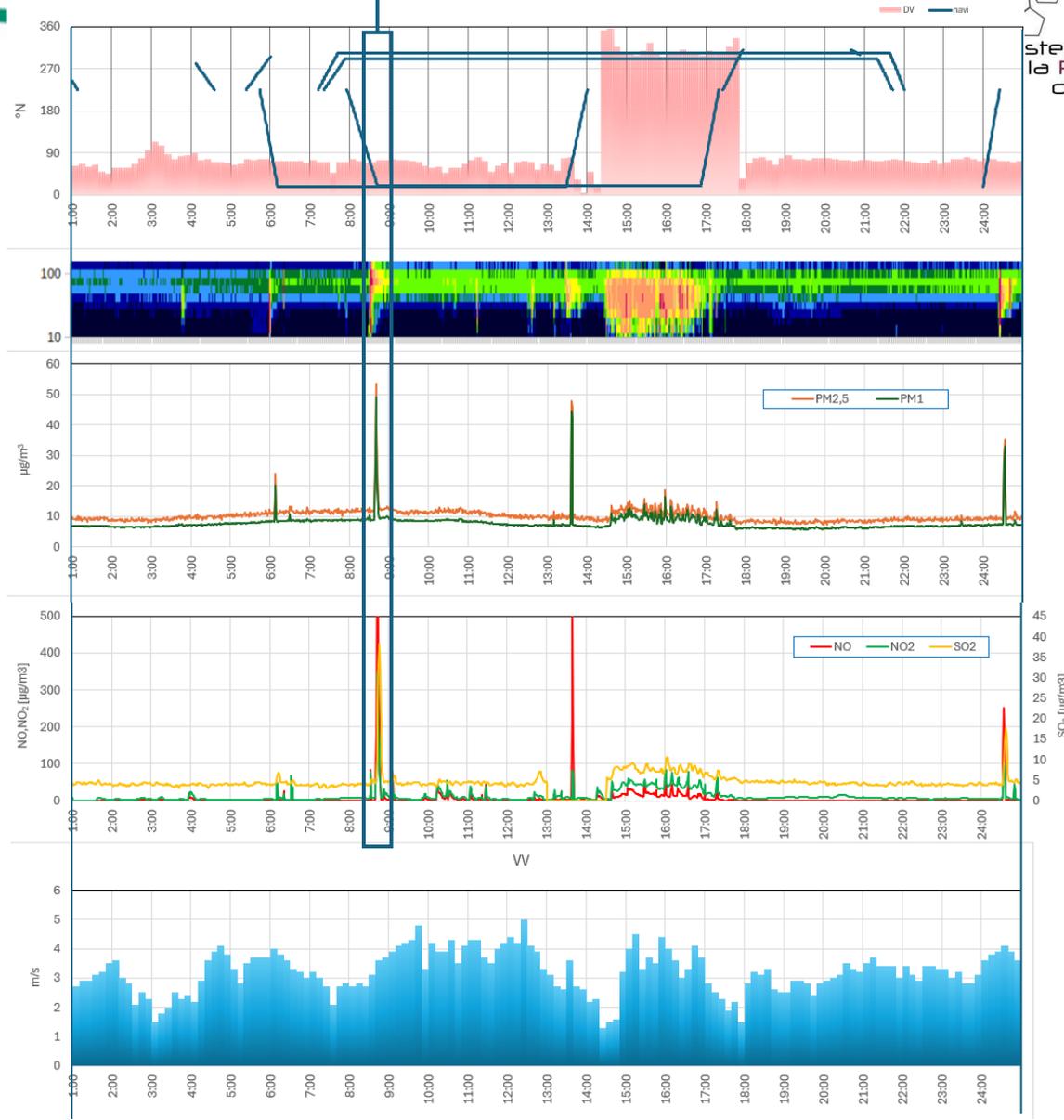
- I dati minuto di PM10/PM2.5 e PM1 misurati con OPC
- I dati minuto acquisiti con Nanoscan
- I dati DV e VV dalla stazione mareografica ISPRA acquisiti ogni 10 minuti
- I dati dei passaggi navali forniti come orario ingresso porto/orario attracco
- I dati minuto degli inquinanti gassosi acquisiti con mezzo mobile:
NO/NO₂/SO₂

problema allineamento temporale...





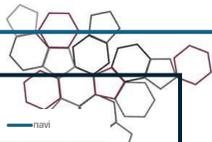
istema Nazionale
 la Protezione
 dell'Ambiente



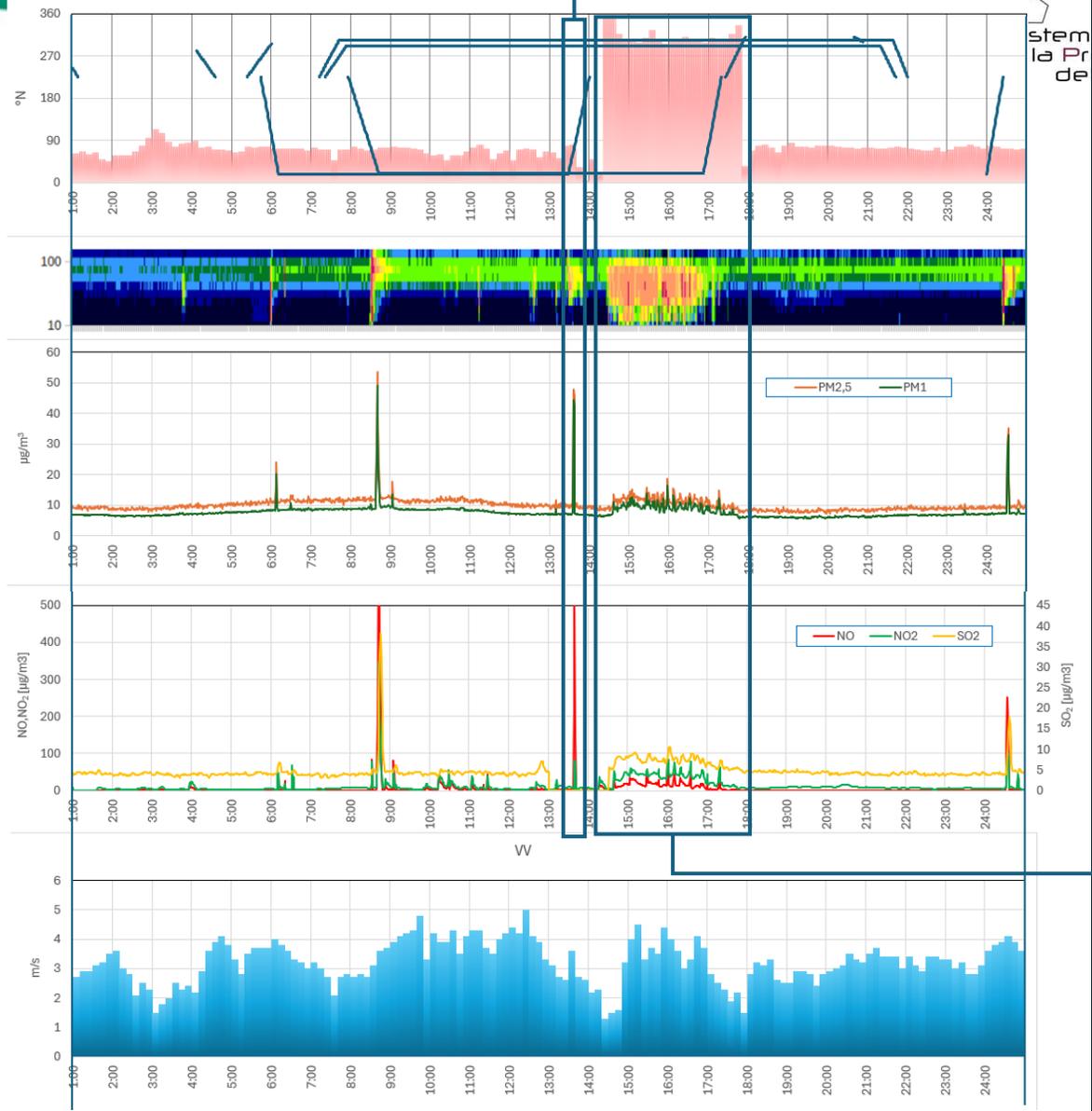
CARGO IN ARRIVO AL MOLO 24/S

TIPO NAVE	LUNGHEZZA	LARGHEZZA	TON. NETTO	ANNO COSTR.
Ro-Ro Cargo Ship	238	34	7.800	2021

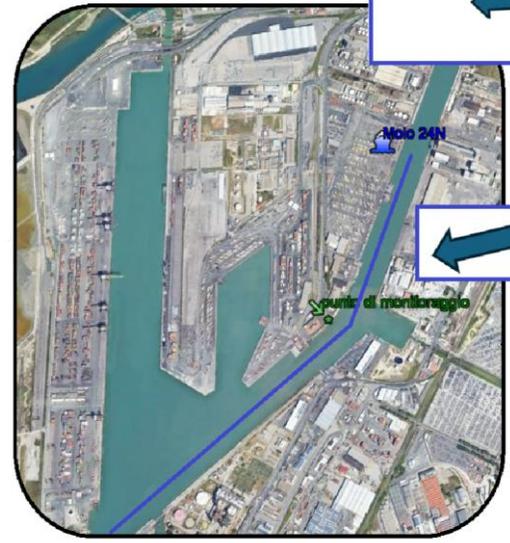
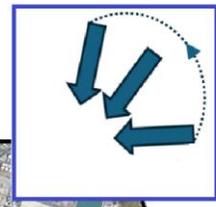




Sistema Nazionale
 per la Protezione
 dell'Ambiente



10/10/2023
 scana

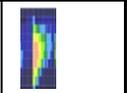
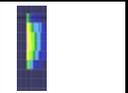
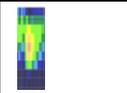
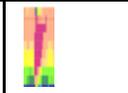
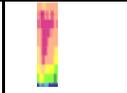
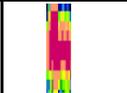
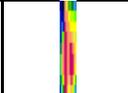
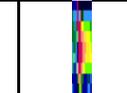
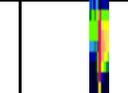
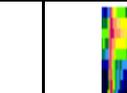
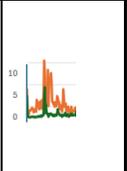
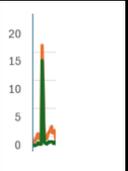
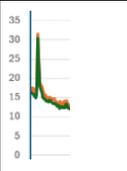
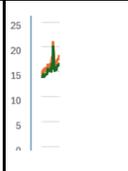
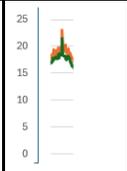
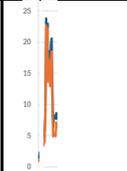
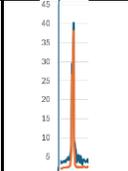
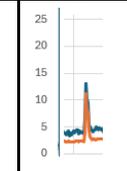
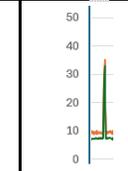
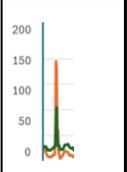
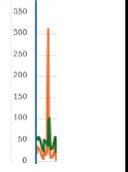
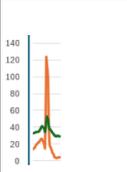
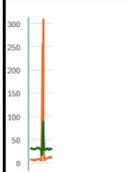
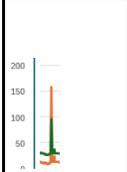
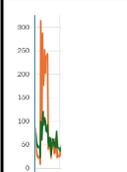
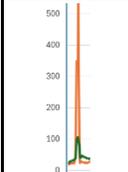
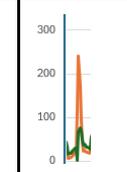
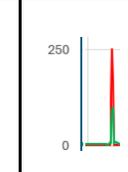
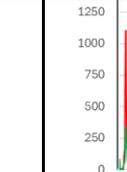
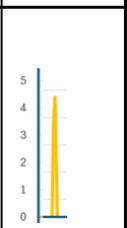
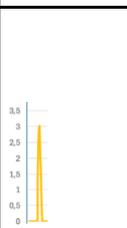
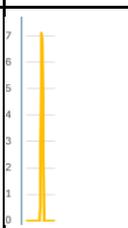
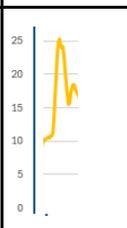
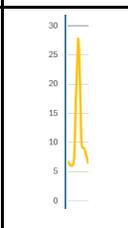
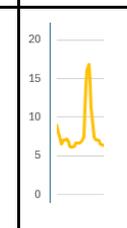
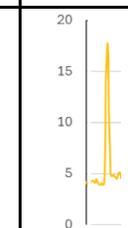
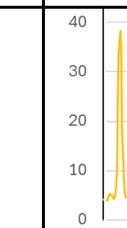
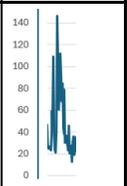
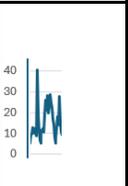
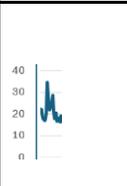
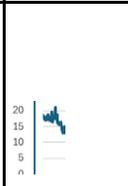
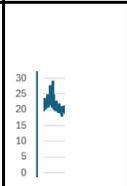
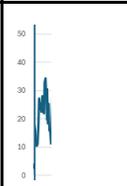
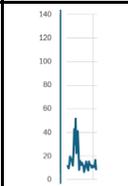
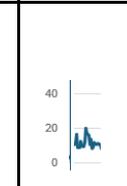
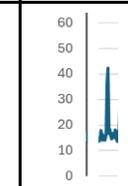
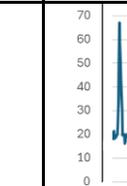


CARGO IN PARTENZA DAL 24/N



NAVI IN SOSTA AI MOLI 14/E - 14/D CON VENTO CHE GIRA A NORD-OVEST



Tipo mov	P	P	A	A	A	A	P	A	A	A
Giorno	13.01.2022	13.01.2022	15.01.2022	21.01.2022	21.01.2022	08.10.2021	08.10.2021	08.10.2021	10.10.2021	10.10.2021
Molo	24N	24N	24S	29/L	14/E	24/S	24/S	27	24/S	24/S
Ora	13:26	04:39	07:07	07:37	08:56	09:55	17:32	17:33	00:32	07:56
Cod. viaggio	213506	213500	213573	213743	213757	210251	210251	210267	210338	210313
IMO	9465552	9165310	9165310	9295311	9351505	9859545	9859545	9404376	9471068	9859569
Nave	Ro-Ro Cargo Ship	Ro-Ro Cargo Ship	Ro-Ro Cargo Ship	Chemical/Oil Products Tanker	Passenger/Ro-Ro Cargo Ship	Ro-Ro Cargo Ship	Ro-Ro Cargo Ship	Chemical/Oil Products Tanker	Ro-Ro Cargo Ship	Ro-Ro Cargo Ship
Anno costr.	2007	1998	1998	2005	2010	2021	2021	2009	2012	2021
Nanoparticelle										
PM2.5 /PM1 [µg/m3]										
NO/NO2 [µg/m3]										
SO2										
PM10										

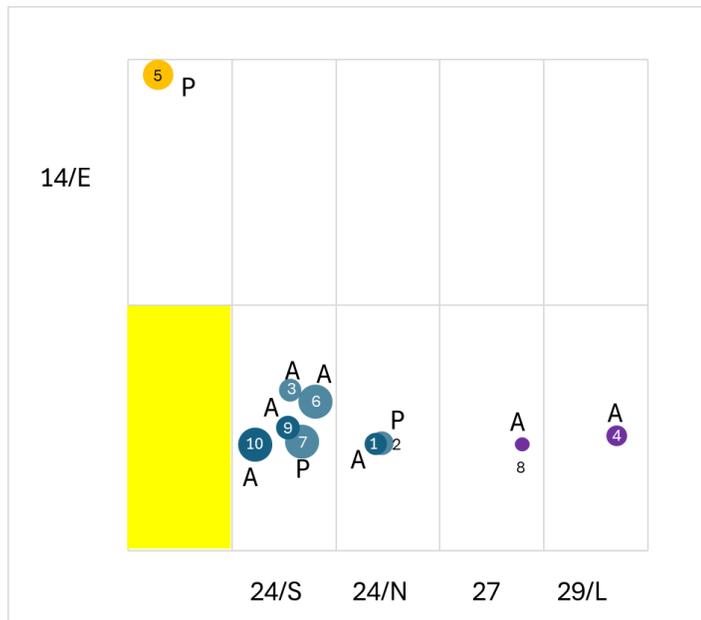
Durante il picco dovuto al passaggio di una nave in movimento:

- Aumenta il rapporto PM1/PM2.5
- Il rapporto NO/NO2 è sempre superiore a 1
- Si ha un picco corrispondente di SO2
- Il conteggio totale delle nanoparticelle aumenta rispetto alla media oraria in cui il picco avviene

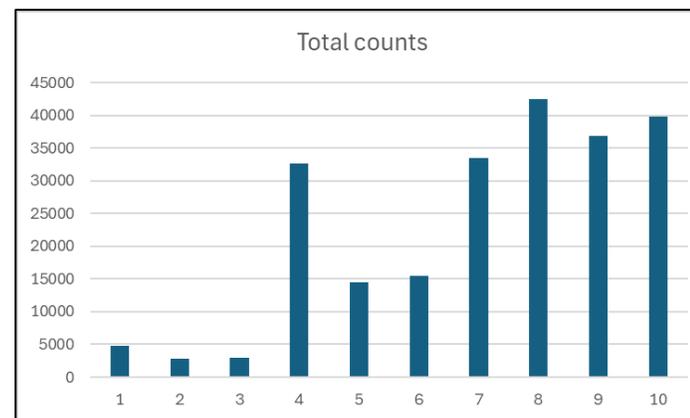
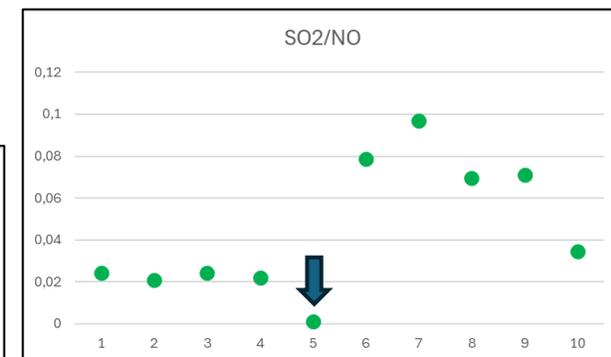
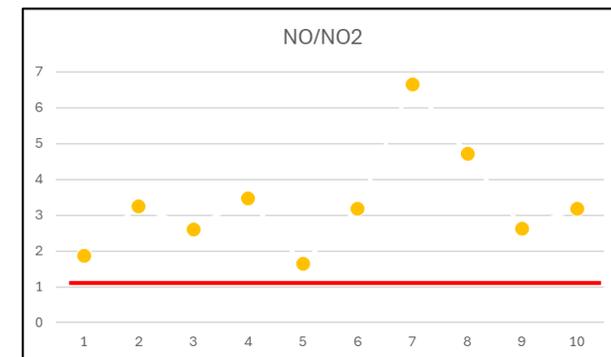
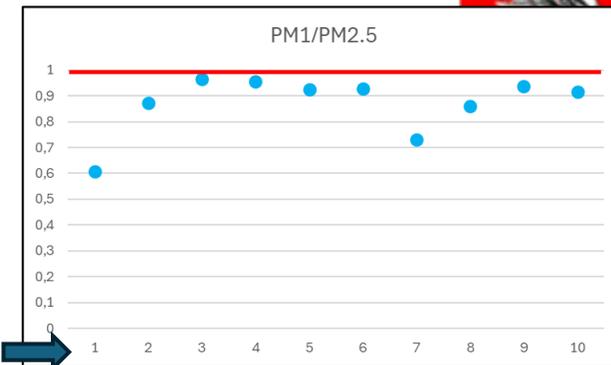
Questi picchi durano soltanto pochi minuti



Riepilogo passaggi navali



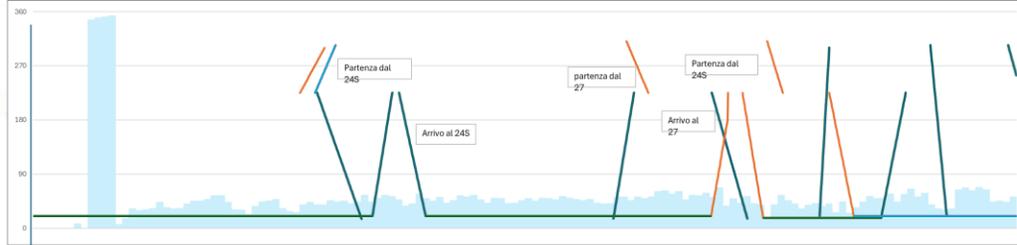
ID nave →



La maggior parte dei passaggi identificabili sono al molo 24/S, il più vicino al punto di monitoraggio

La grandezza della nave e l'anno di costruzione non producono effetti diversi ma quello che domina è la vicinanza delle ricadute

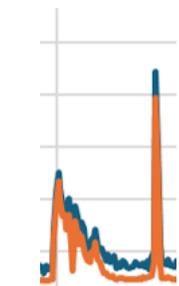
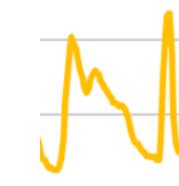
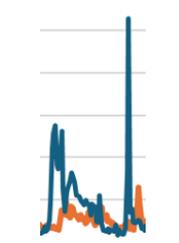
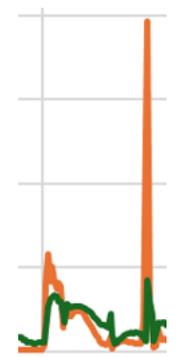
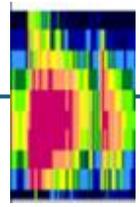
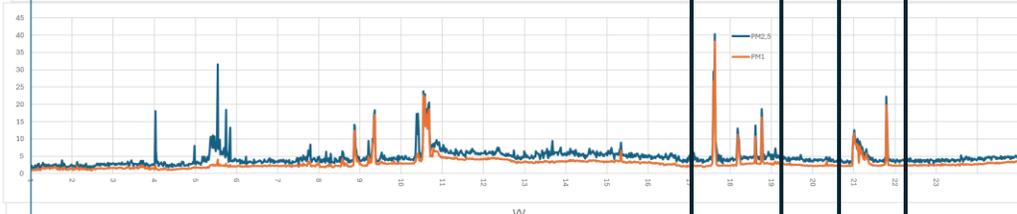
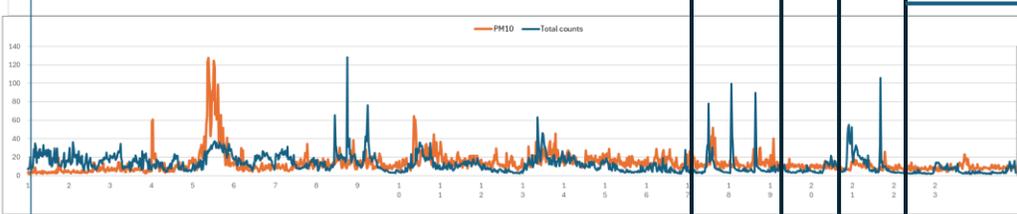
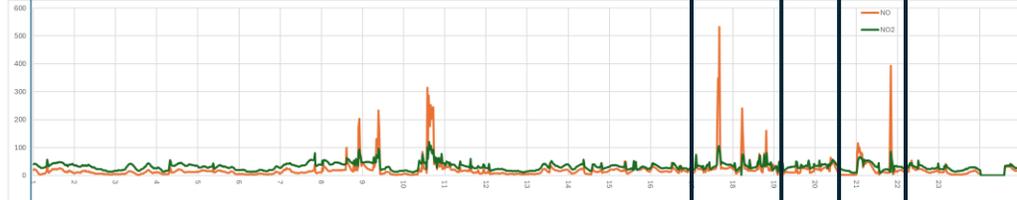
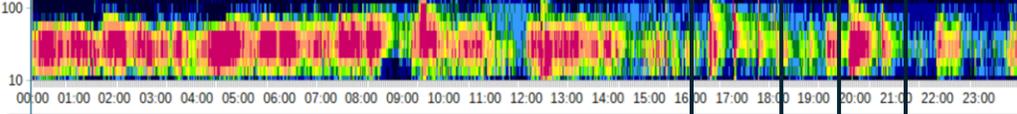
Le caratteristiche generalizzabili durante un passaggio navale sono rapporto PM1/PM2.5 e NO/NO2

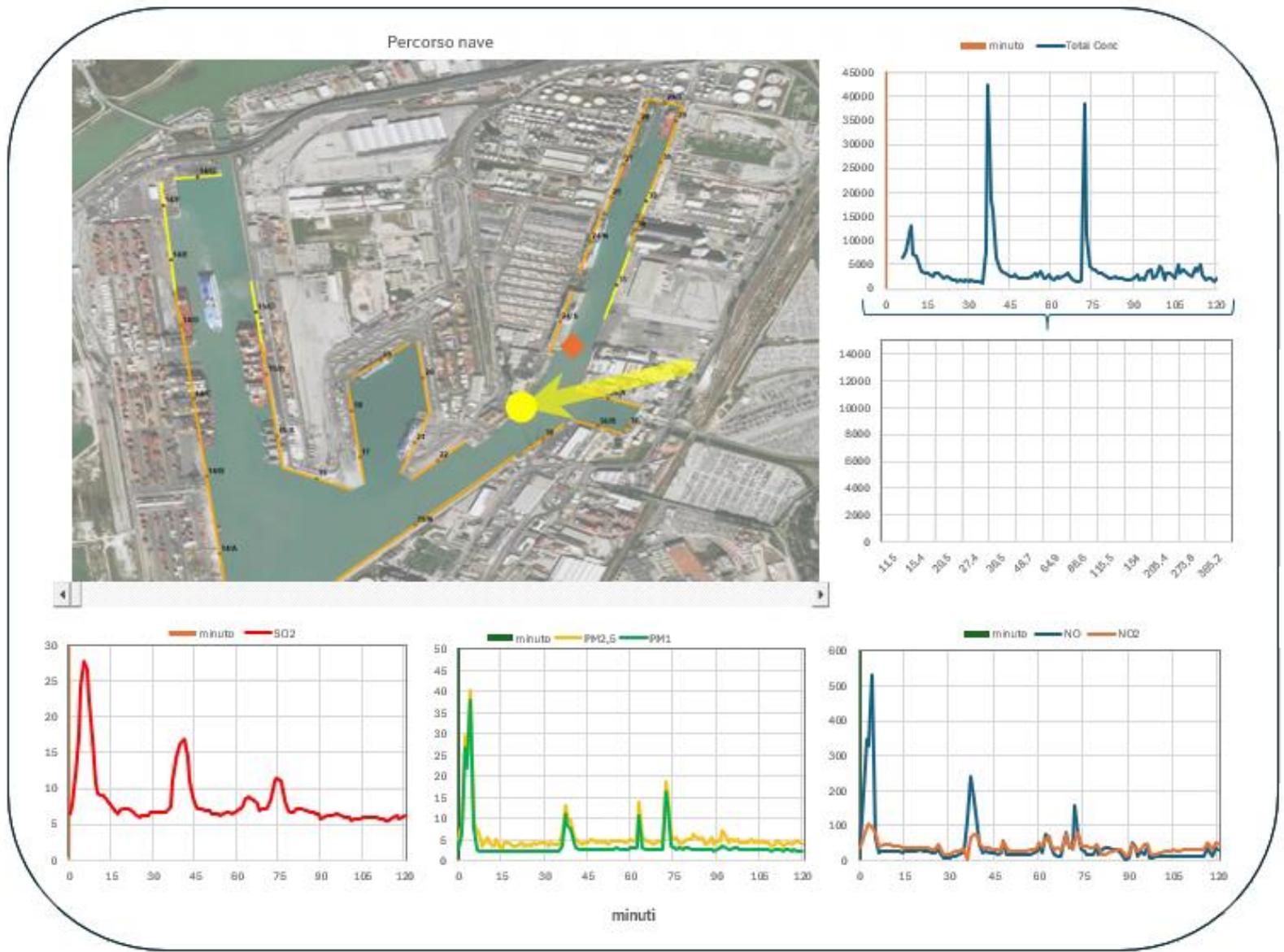
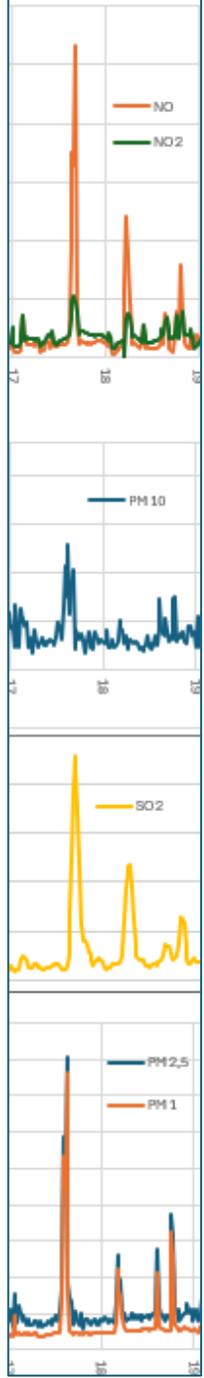
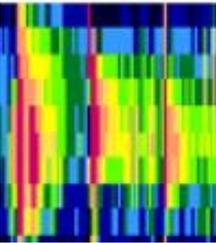
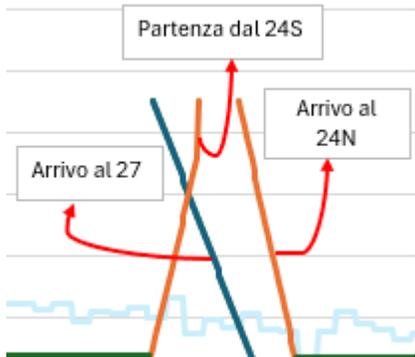


Regione Toscana



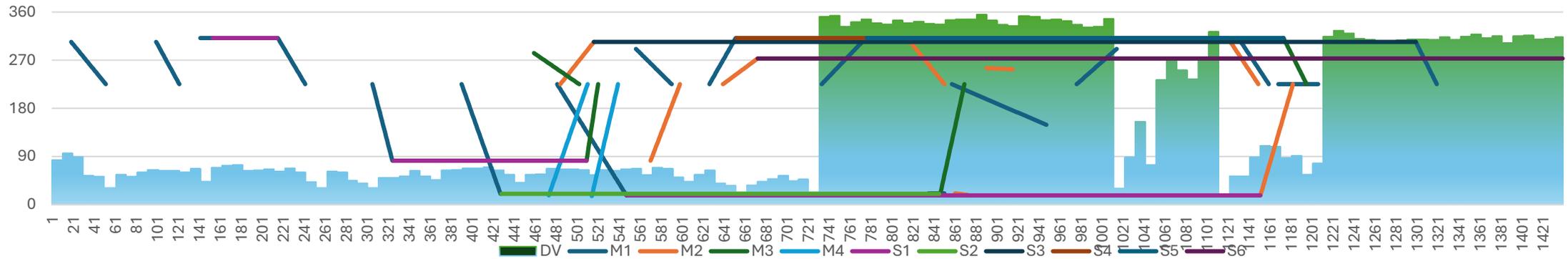
venerdì 8 ottobre







Per Valutare gli effetti delle navi in sosta le soste si prende ad esempio un giorno con numerosi cambiamenti nella direzione del vento **SABATO 15 GENNAIO**



Si tolgono i movimenti



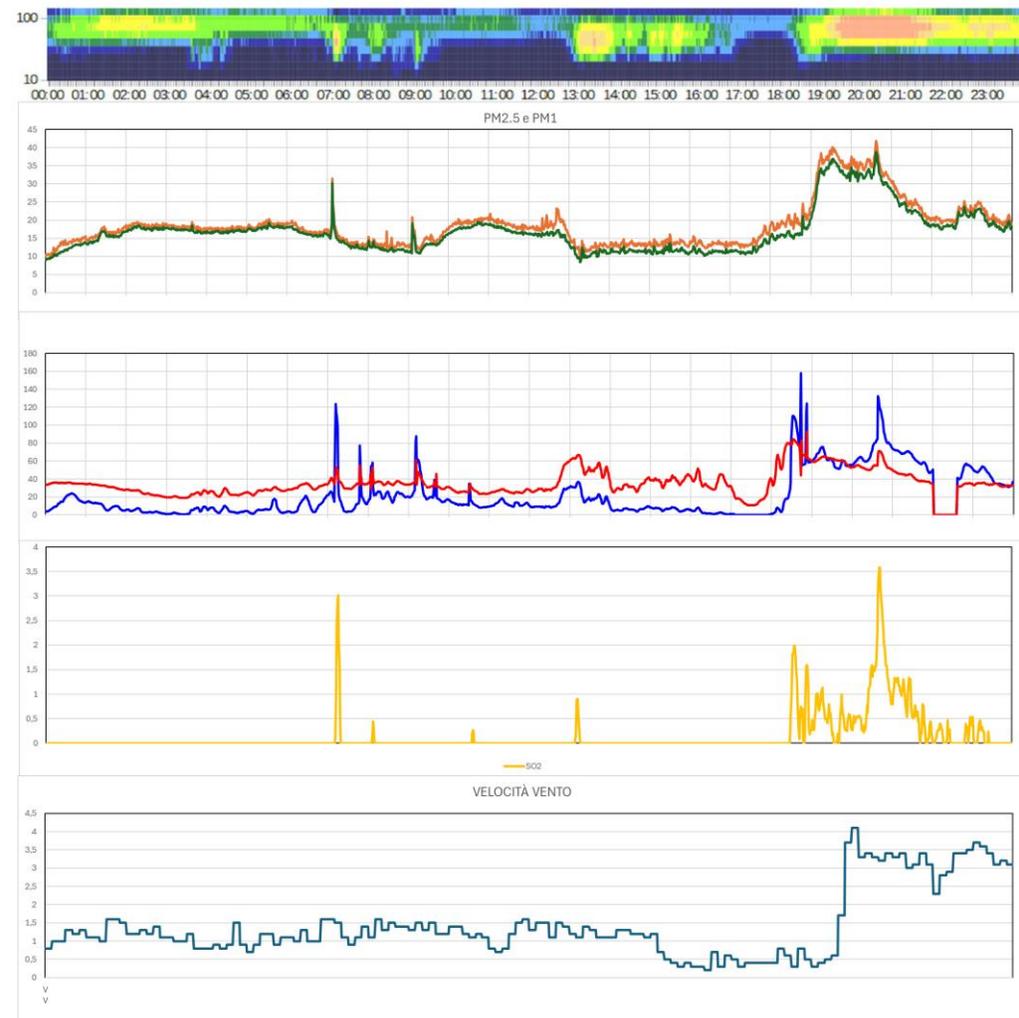
Si aggiungono le navi arrivate in giorni precedenti





15/01/2022

sabato 15 gennaio



Distribuzione nanoparticelle asimmetrica

Livelli di fondo di PM2.5 e PM1 molto dipendenti dal settore di vento

NO2 sempre maggiore di NO

SO2 in genere non presente, ma in alcuni casi sì



Varie navi in sosta, nessuna
 precisamente sopravento

Varie navi in sosta, molo 14F a tratti
 sopravento



domenica 16 gennaio

Distribuzione asimmetrica

Distribuzione più simmetrica



Conclusioni

- Abbinando i dati al minuto di strumentazioni diverse si ottiene contemporaneamente un consolidamento dei dati ad alta risoluzione temporale ed un quadro degli effetti del traffico marittimo
- I dati minuto consentono di identificare effetti che non risultano visibili nelle medie orarie e giornaliere
- I passaggi navali, quando hanno ricadute sul sito di monitoraggio hanno sui livelli degli inquinanti effetti importanti e di breve durata
- Le soste navali risultano avere un effetto sui livelli degli inquinanti sia nel caso in cui si verifichi una ricaduta diretta, sia contribuendo ai livelli di fondo con una composizione già parzialmente trasformata

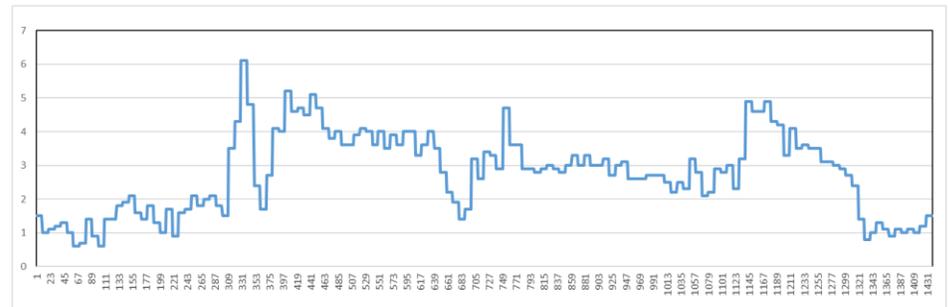
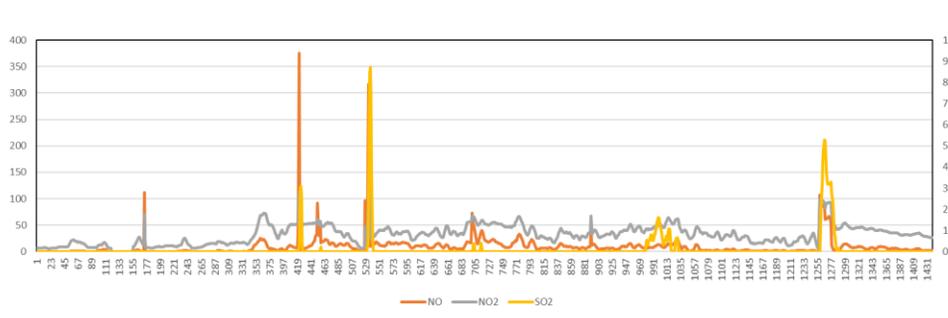
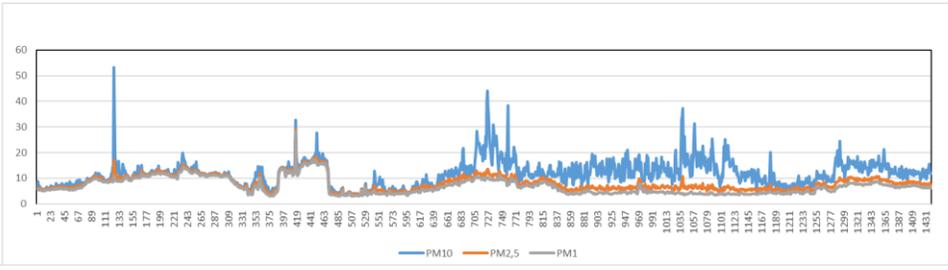
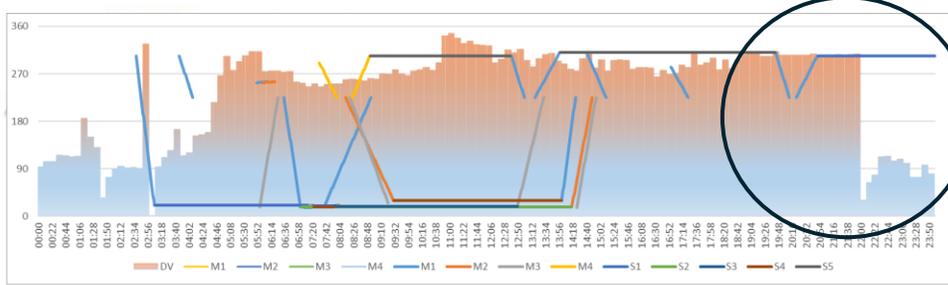


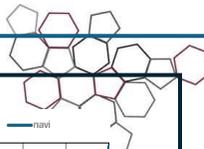
Regione Toscana



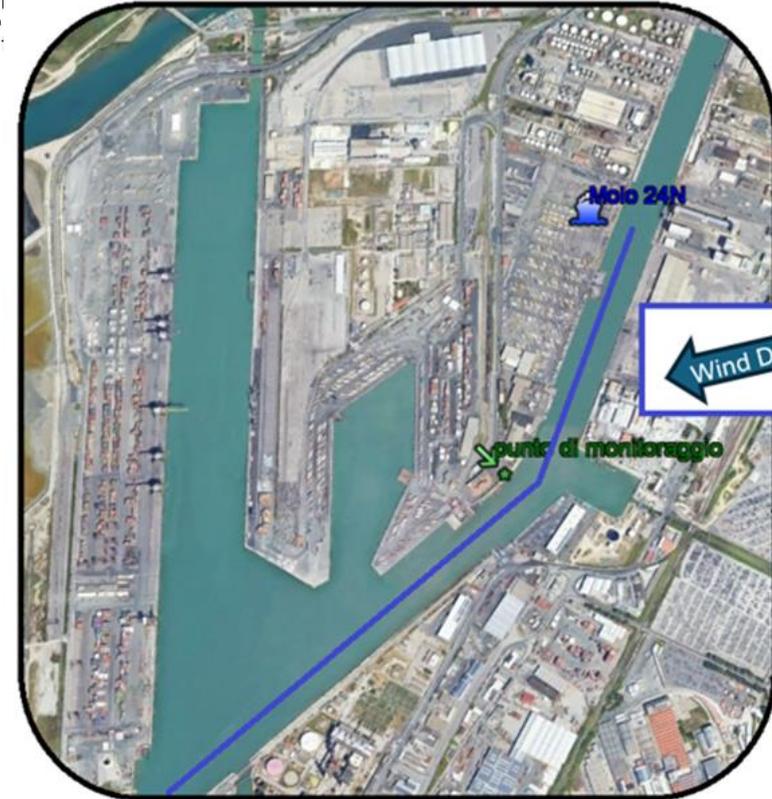
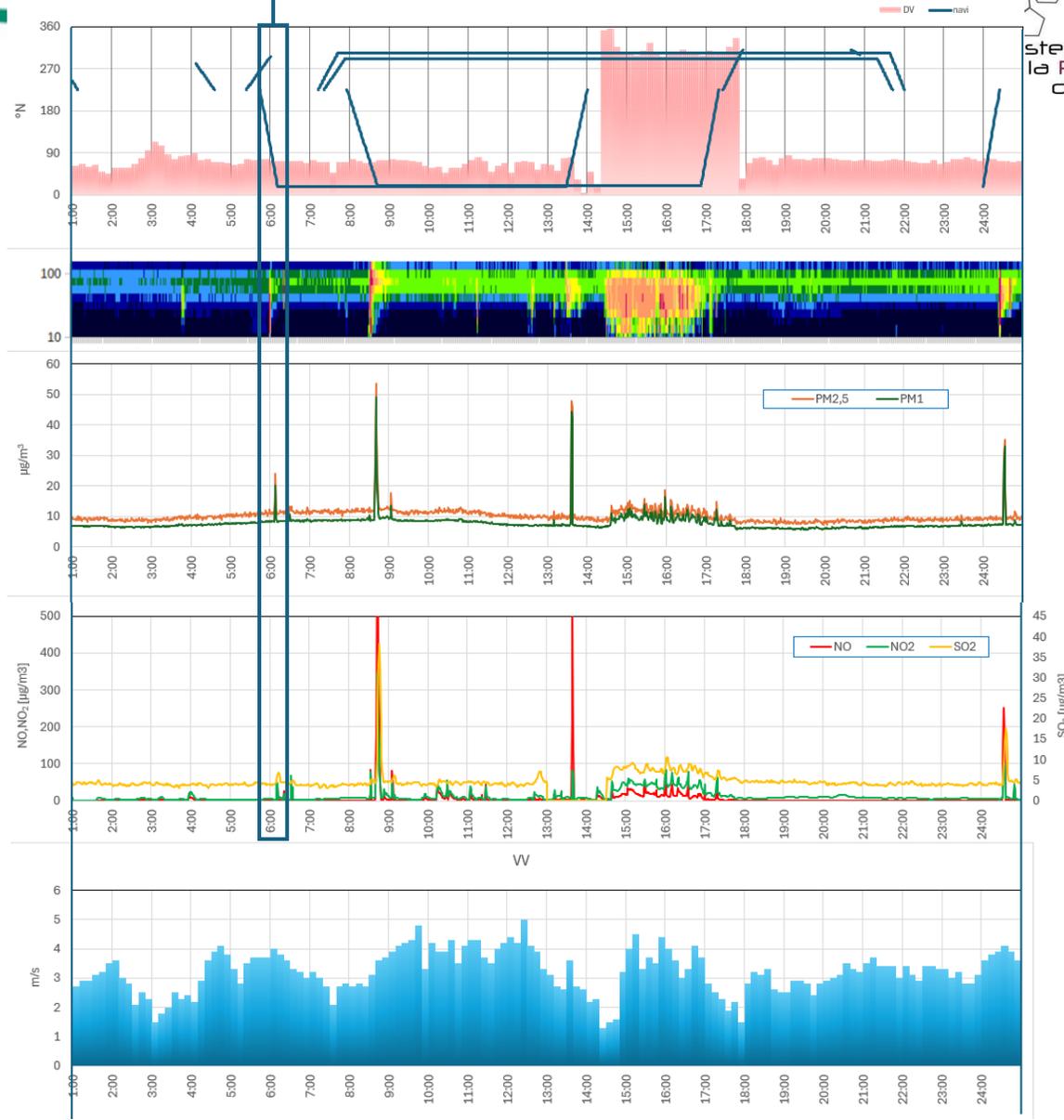
20.01.2022

Altro esempio di ricaduta, dei livelli che può raggiungere, e dell'effetto del vento che gira





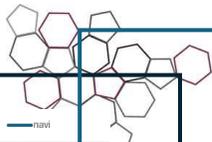
Sistema Nazionale
 per la Protezione
 dell'Ambiente



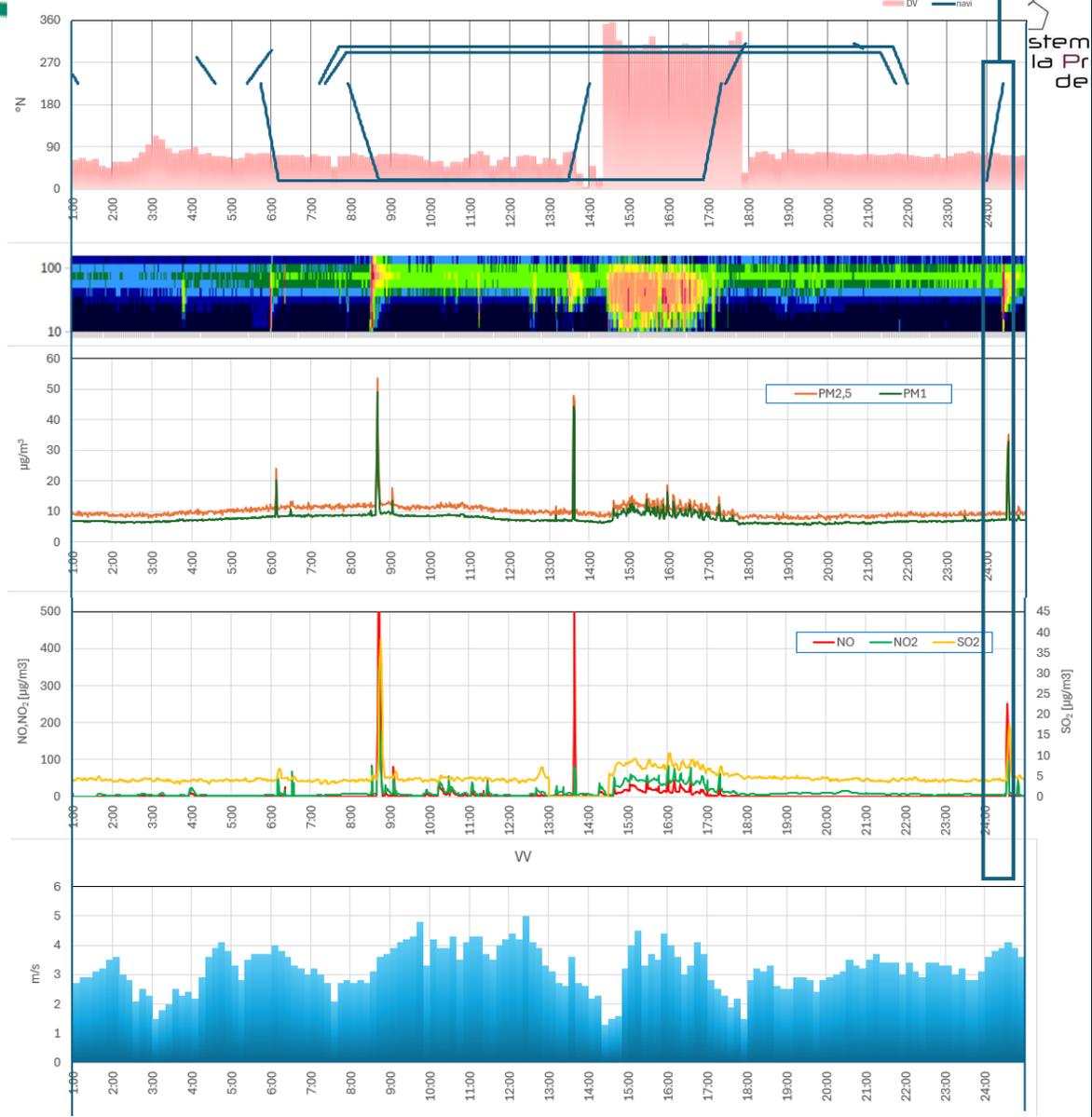
CARGO IN ARRIVO AL MOLO 24/N

TIPO NAVE	LUNGHEZZA	LARGHEZZA	TON. NETTO	ANNO COSTR.
Ro-Ro Cargo Ship	200	26,5	3.810	2012

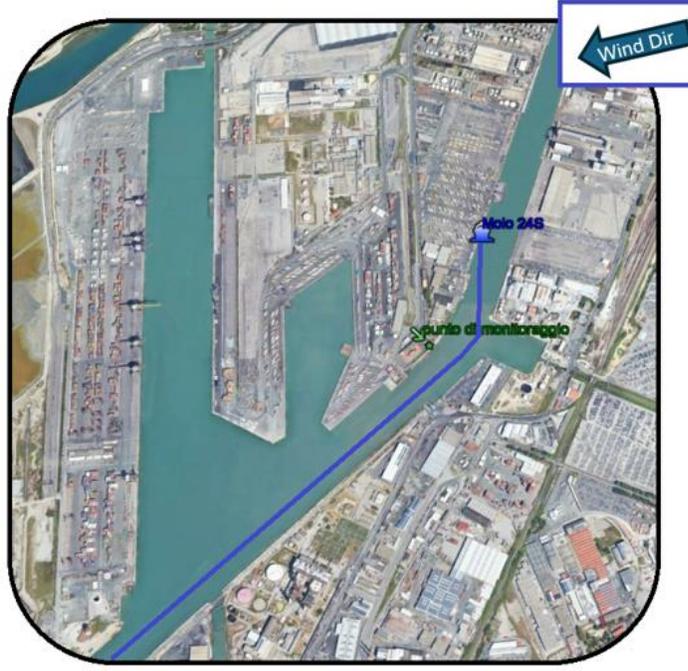




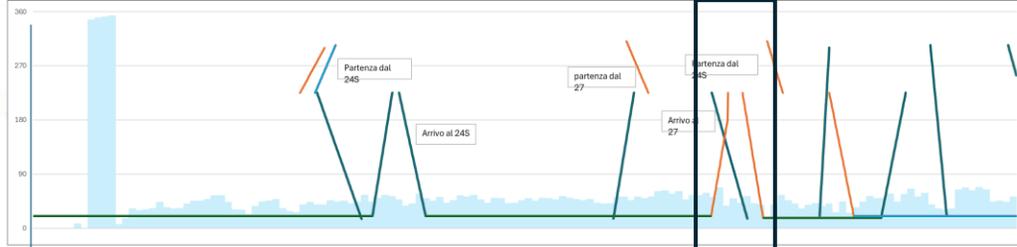
Sistema Nazionale
 per la Protezione
 dell'Ambiente



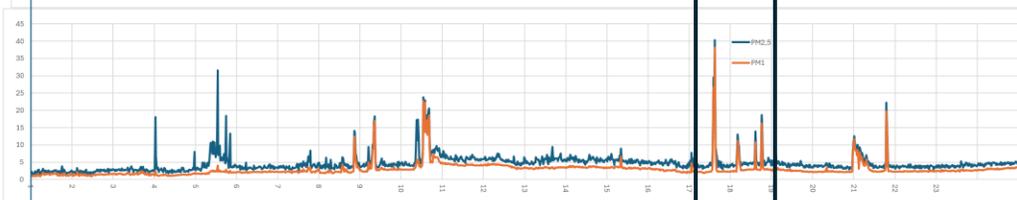
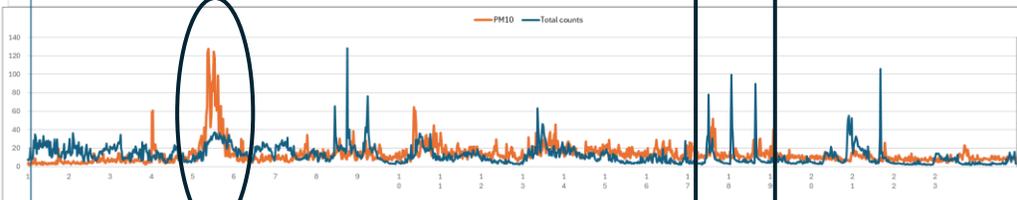
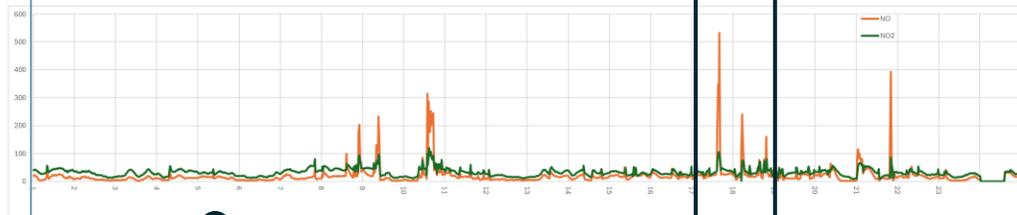
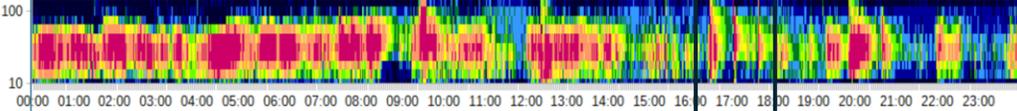
Regione Toscana



PARTENZA CARGO DA MOLO 24/S CON VENTO DA EST

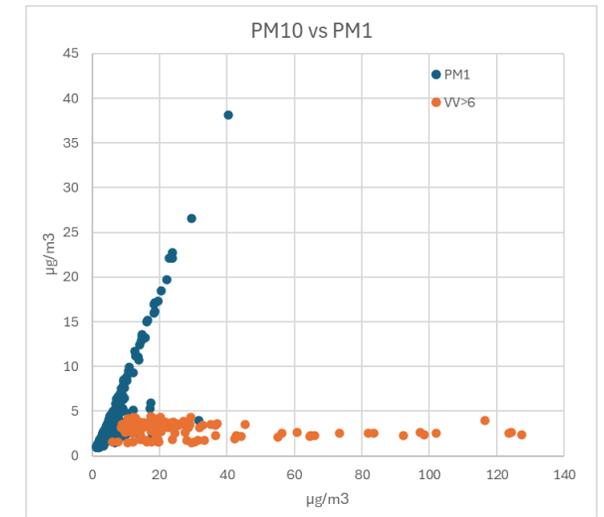


venerdì 8 ottobre



Giorno con vento forte di direzione uniforme nella giornata

Episodi di risollevarimento



Presenza di un numero contenuto di passaggi che ha permesso la corretta identificazione di vari picchi