Validation of marine plastic litter distribution models on the North-Western Mediterranean.

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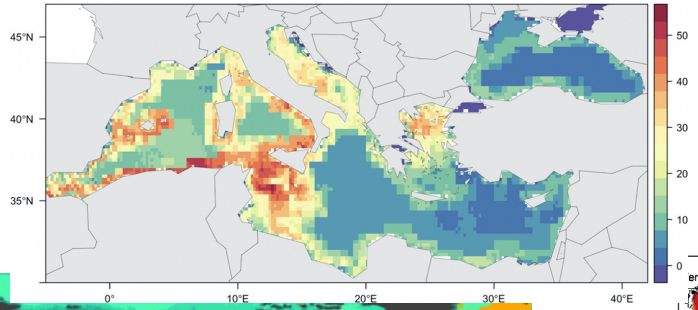
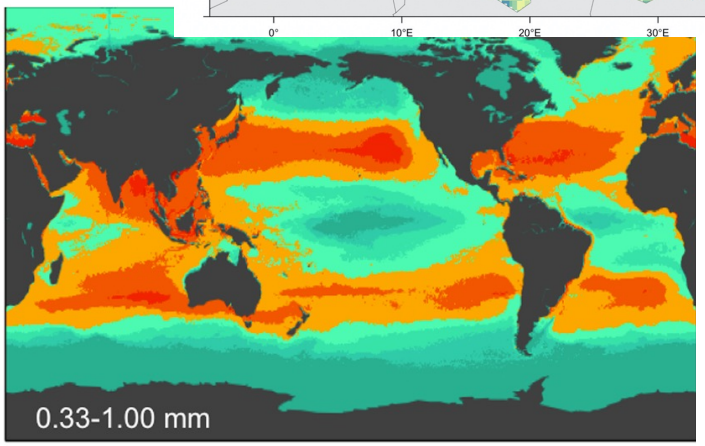
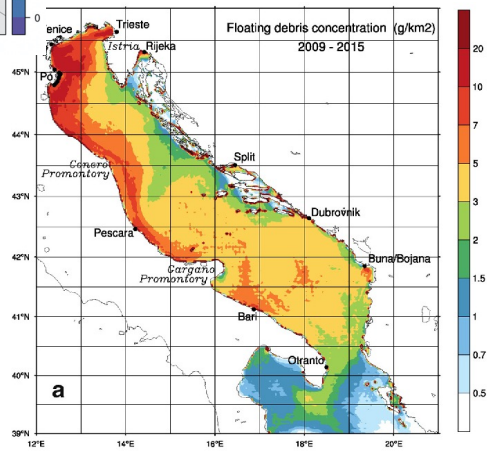
Motivation

Compa et al., 2019

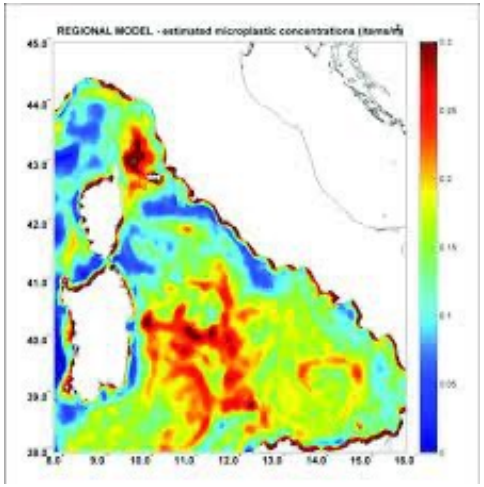




Eriksen et al., 2014



Liubarsteva et al., 2016

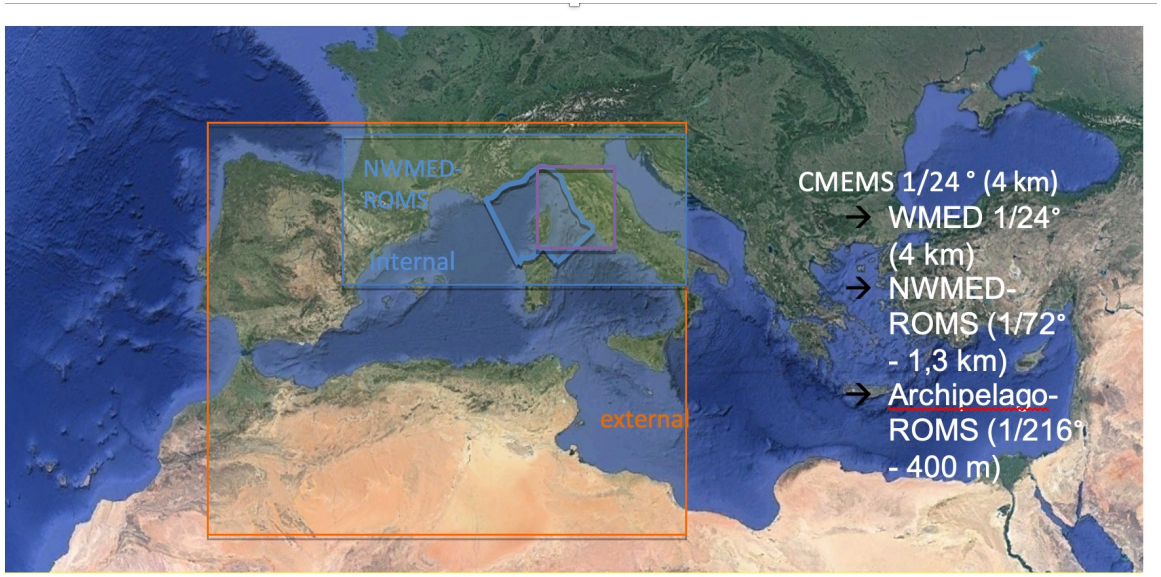


Fossi et al., 2017

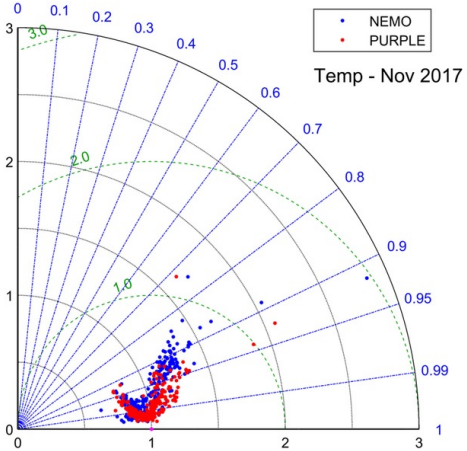
- In recent years, many numerical models have been proposed to describe the distribution of plastic debris in the global ocean, marginal seas, or regional areas; they are usually Lagrangian models forced by hydrodynamic conditions having different degrees of complexity, including pollutant sources or not, degradation effects, and different transport mechanisms.
- These models are rarely validated with observations, because: 1) model limitations with approximations difficult to verify, and 2) there are only a few observations, very sparse, unrepresentative of statistical variability, and difficult to use to validate models

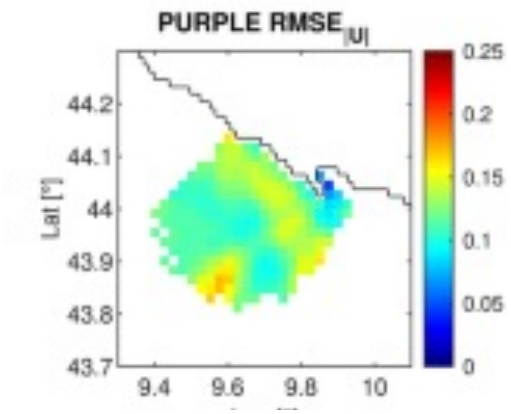
Models

- Lagrangian models forced by ocean circulation models
- difficulties to create LAMs (unknown initial ICs and boundary conditions BCs for marine litter distribution)
- sources of floating debris (rivers, coastal cities, ports, ship lanes…) only estimated



- hydrodynamic properties of floating objects poorly known
- Lagrangian models have some specific limitations → ie. approximation of floating passive particles; limitations in the number of virtual particles etc.

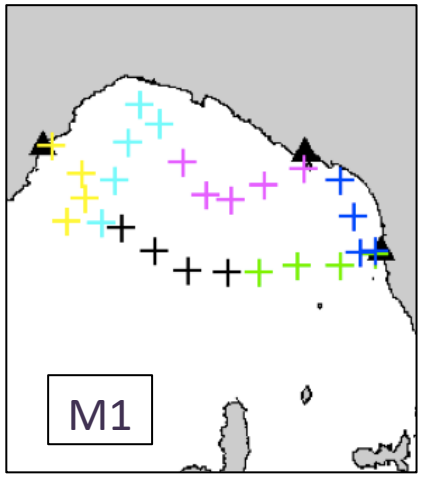




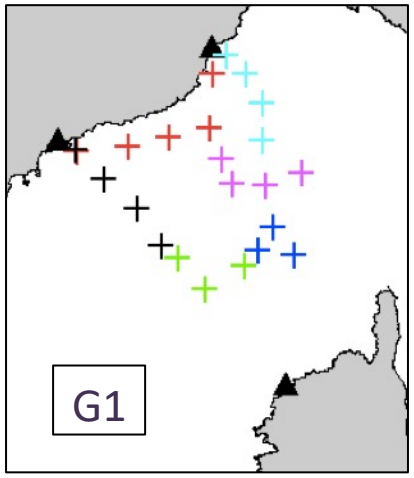
- Telescopic grid configuration (through ROMS native nesting)
- High resolution LAMs validated through CMEMS in-situ data (HF radar, CTD), Bendoni et al. 2022
- Homogeneous ICs (parcels) on a large model domain

Observations

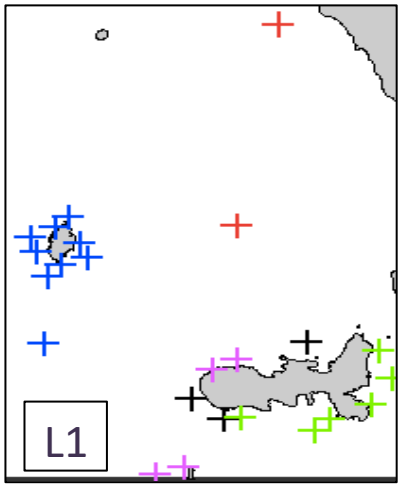
"Plastic Pelagos" campaigns May-September 2019



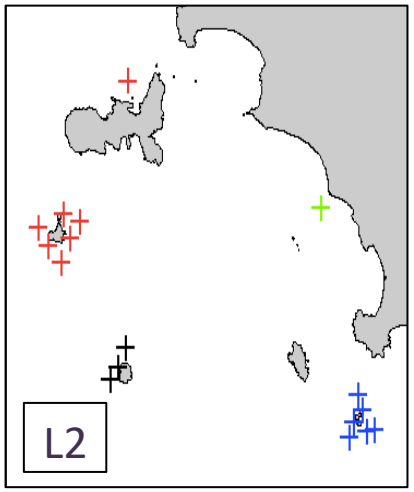
(30/05 – 05/06)



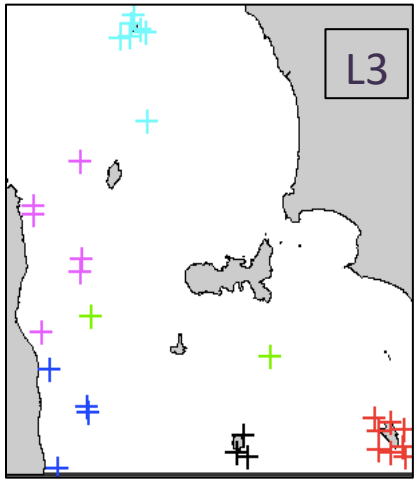
(16/06 – 21/06)



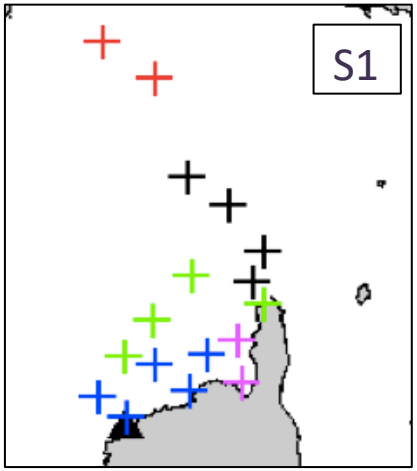
(08/07 – 12/07)



(13/07 – 17/07)



(18/07 – 23/07)

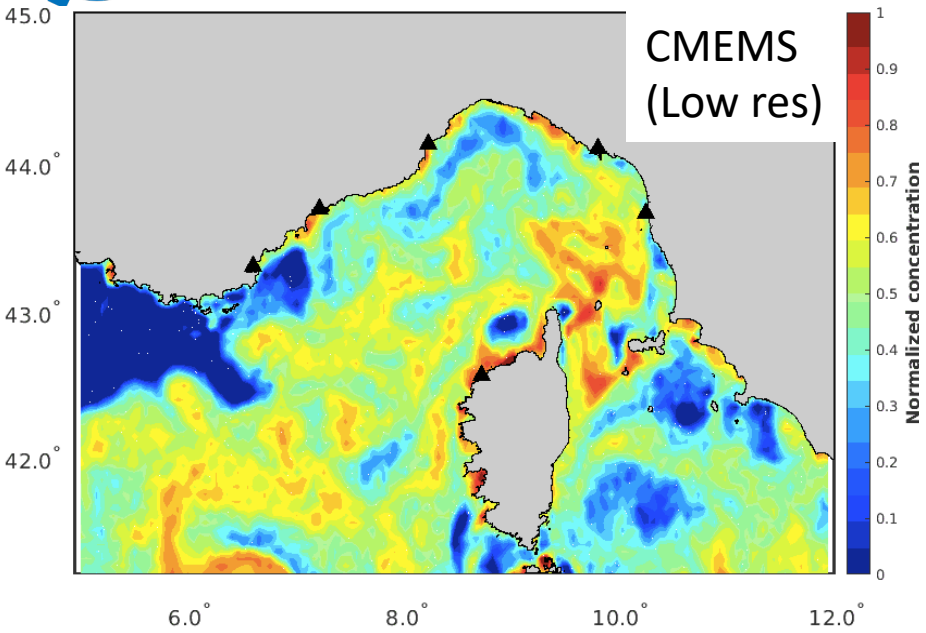


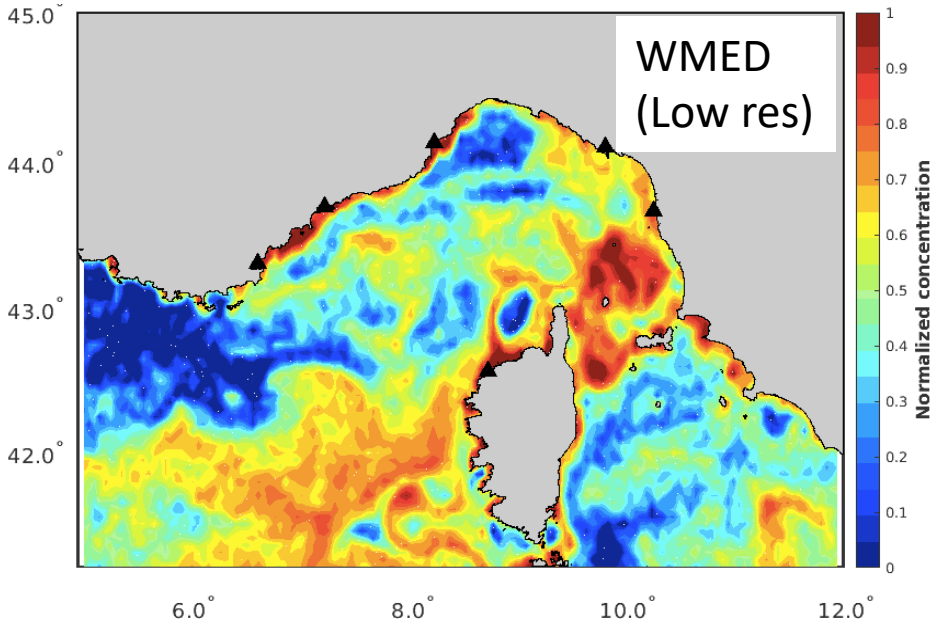
(14/09 – 18/09)

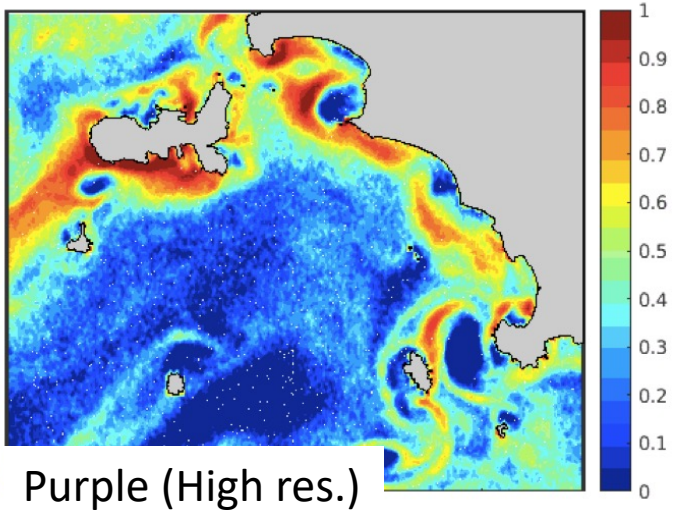
Sampling points (around 150 in the Pelagos SPAMI area) were first drawn based on model runs in previous years over the same period (hindcast) and then 'adjusted' to account for conditions predicted several days in advance (forecast).

Such large observation dataset comes from the Interreg MED Plastic Busters MPA project

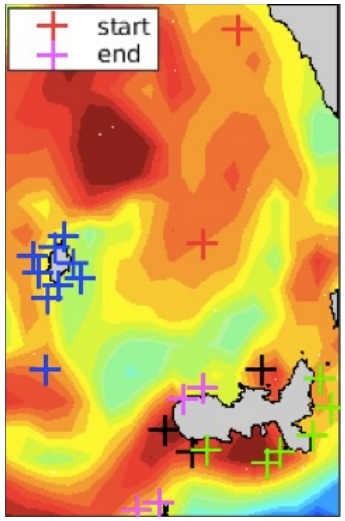
Hot & cold spots - variability



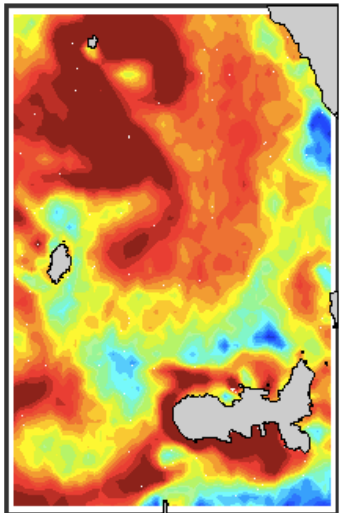




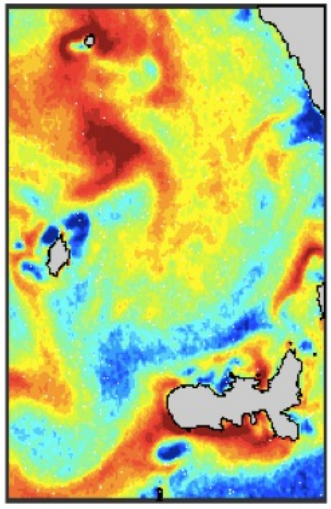
Purple (High res.)



zoom Low res

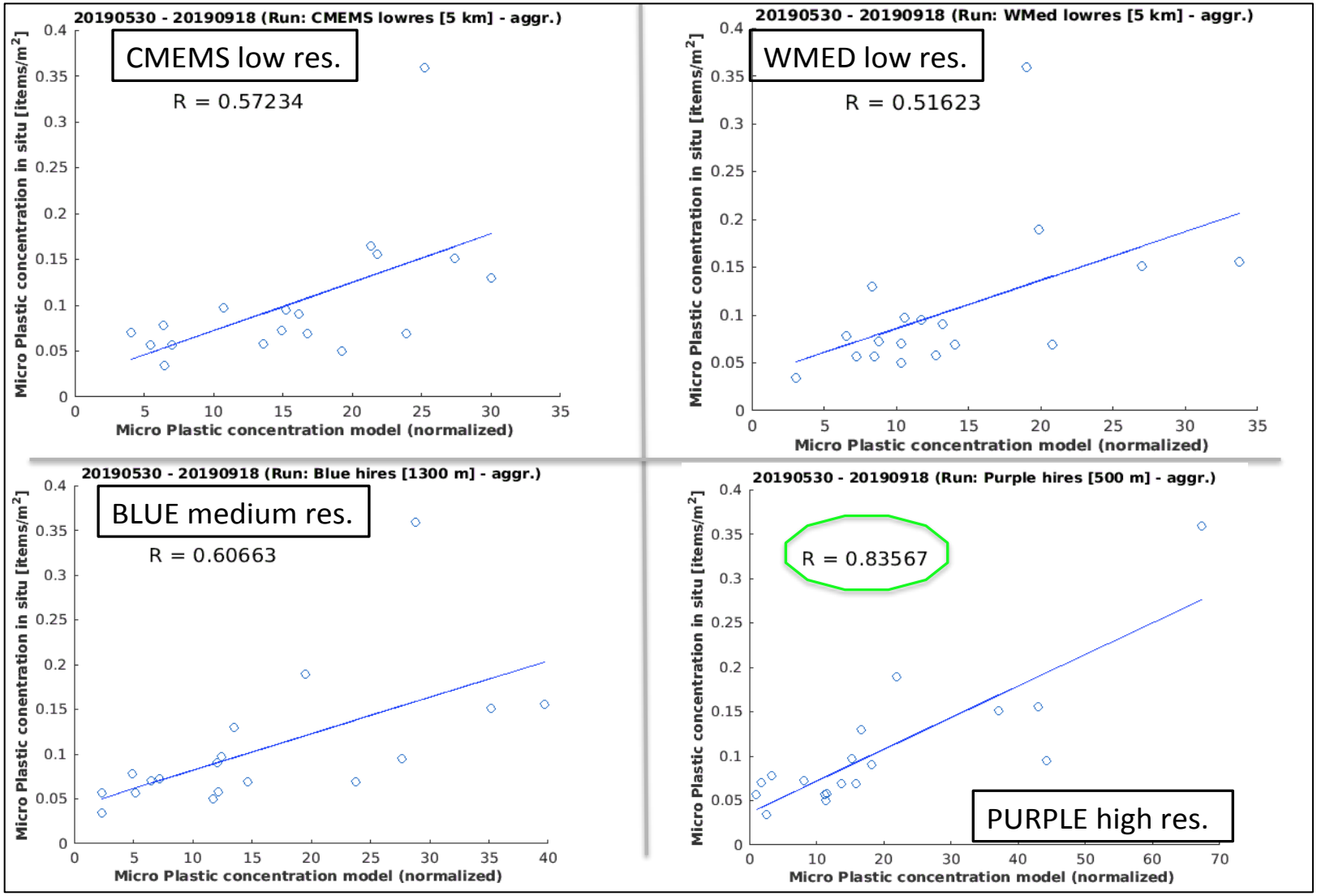


zoom Medium res

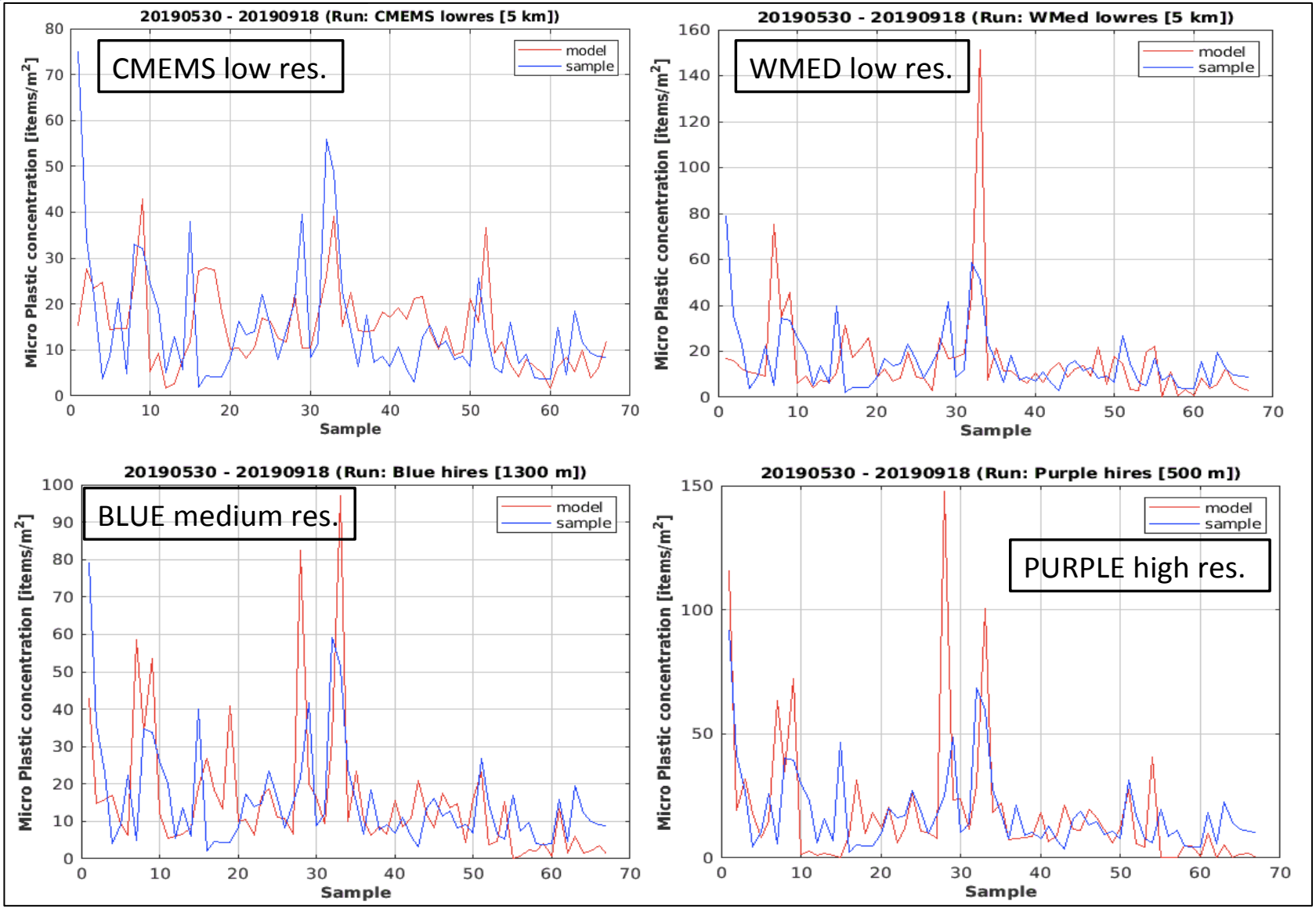


zoom High res

Observed PML concentrations vs models
Scatter plots



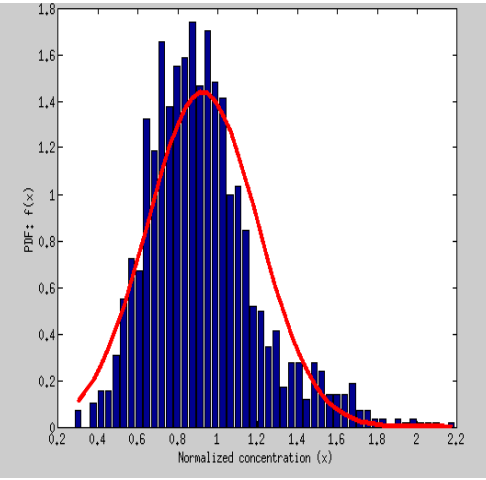
Observed PML concentrations vs models



Comments & Conclusions

- Results showed a significant correlation between models and observations. This correlation increases, in most cases, by using higher resolution models. In some cases, samplings made on coastal areas showed no correlation.
- There are two possible aspects to consider that may partly explain the mismatch between observations and models:

1) PML concentrations have an intrinsic variability especially in coastal areas as it can be estimated by comparing repeated observations in the same area or synthetic models at ultra-high resolution).



2) The HR model itself shows high variability and high/low concentrations at often mismatched locations.