Evaluation Of The Dispersion Of Marine Pollutants Associated With A River Discharge By Means Of Numerical Simulations And Satellite Analysis

Roberto Inghilesi (1), Arianna Orasi (1), Cinzia Pizzi (2), Francesco Bignami (2), Rosalia Santoleri (2), and Luisa Ottolenghi (3)

(1) Italian National Institute for Environmental Protection and Research, ISPRA Rome, Italy (e-mail roberto.inghilesi@isprambiente.it), (2) CNR-ISAC UOS Roma, Italy (e.mail cinzia.pizzi@artov.isac.cnr.it), (3) Universita' Roma 3, Roma (e-mai luisa.ottolenghi@libero.it)

Summer simulation: 2 July - 8 August 2010

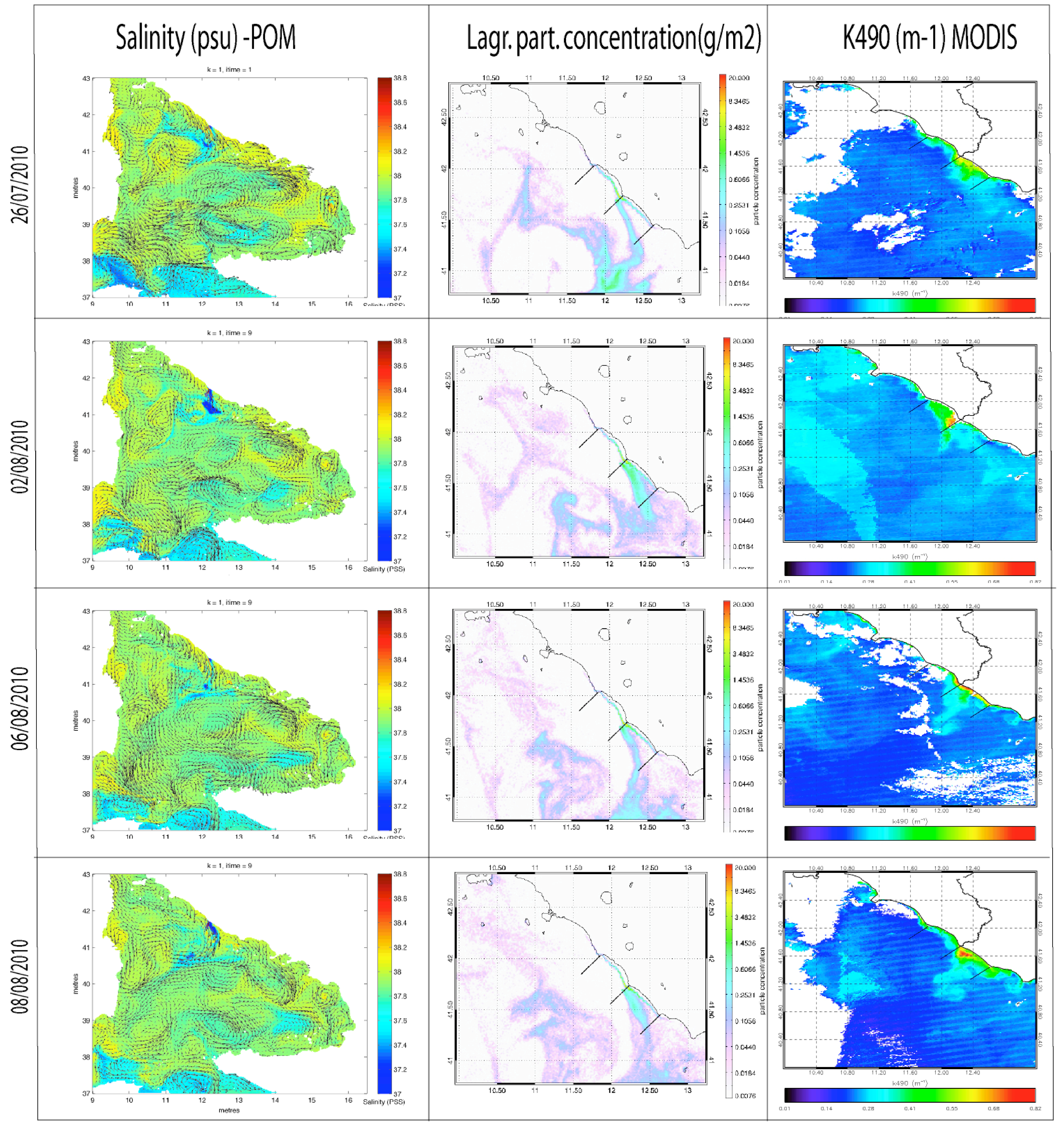

Figure 3: comparison between patterns of salinity, particles concentration and MODIS K490 on 26.08, 02/08, 06/08, 08/08 2010

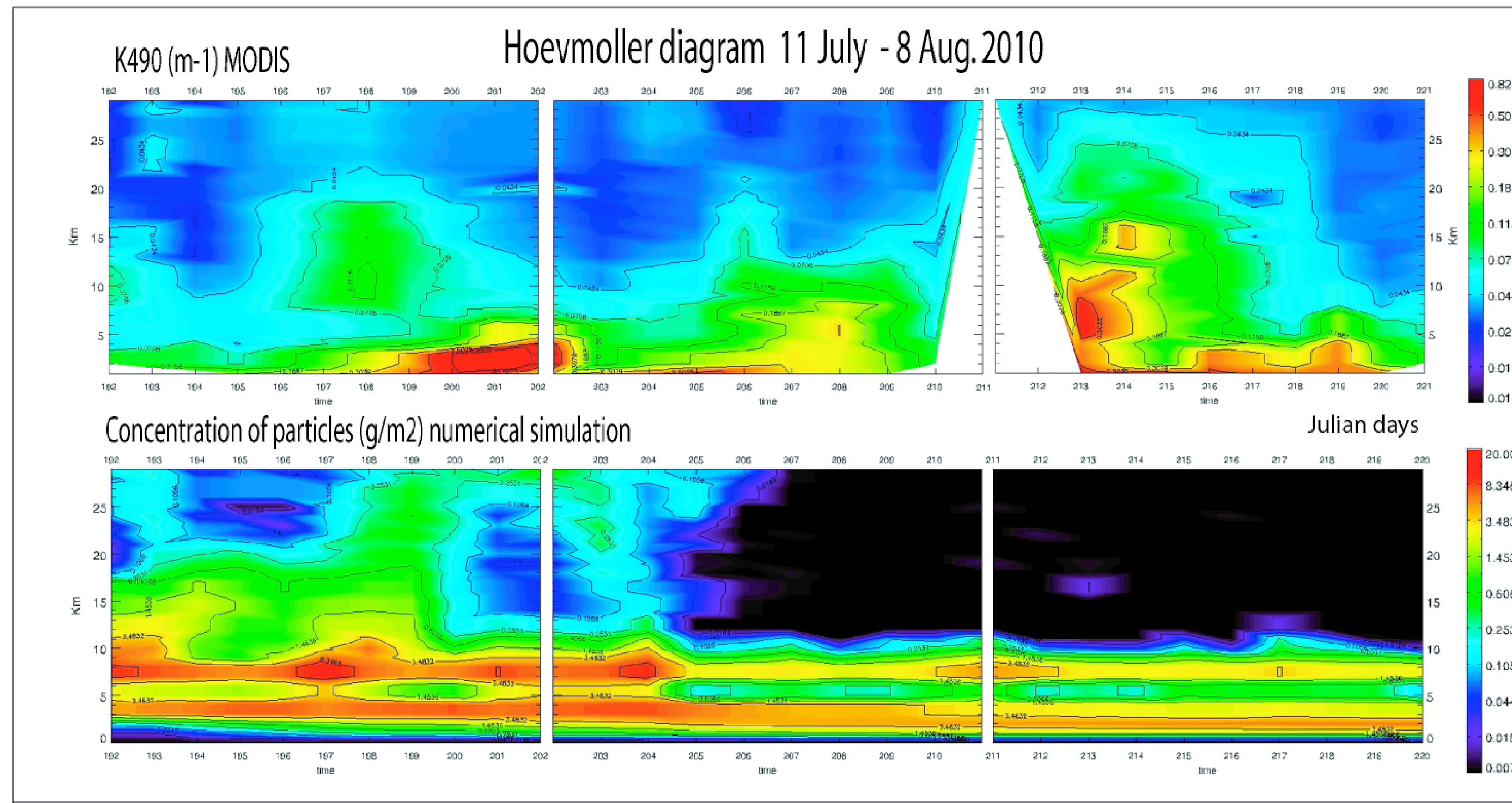

Figure 5: comparison between Hoevmoller diagrams of MODIS K490 (upper panel) and particles concentration (bottom panel) along the transect T in the period 11/7 - 8/8 2010

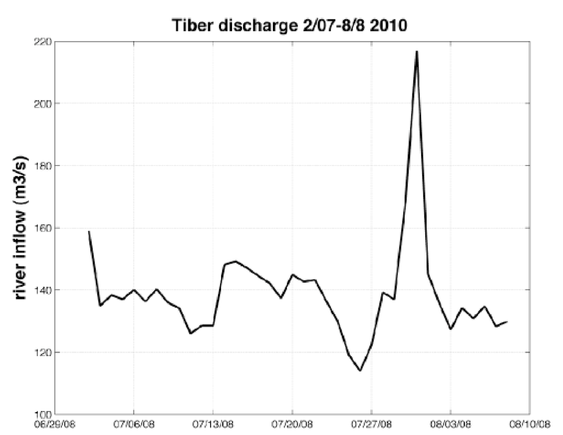

Figure 1: Tiber discharge 2/7-8/8 2010

Abstract (excerpt): The aim of the present work is the evaluation of the dispersion of passive pollutant associated with the Tiber discharge in the Tyrrhenian Sea using numerical marine circulation models, lagrangian dispersion models and satellite data analysis. Numerical results obtained in two key-studies are compared with the corresponding patterns and temporal evolution of the observed K490 diffuse light attenuation coefficient fields derived from MODIS data.

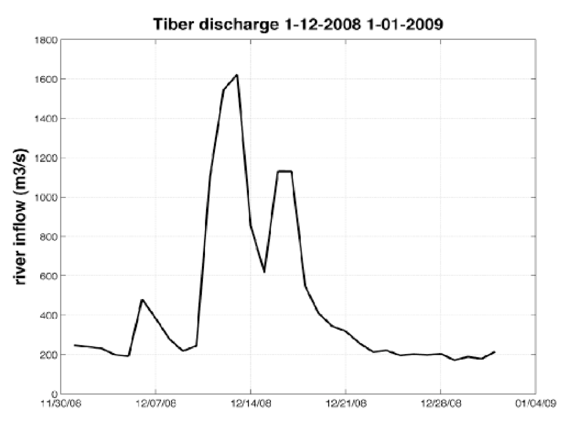

Figure 1: Tiber discharge 1/12/2008 -1/1/2009

The diffuse light attenuation coefficient at 490 nm (K490) fields at 1km resolution are obtained by processing the original NASA L0 490 nm radiance data with the standard SeaDAS software using the SeaWiFS algorithm (Mueller, 2000). K490 is a suitable tracer for riverine discharge and coastal water tracking (Bignami, 2007), being directly related to the quantity of suspended matter in seawater. Indeed, even though the numerical accuracy of the estimates in Case II (turbid coastal) waters is low, the very high values of this parameter allow for a very good distinction between coastal and open sea waters. In particular, it is seen that K490 is a good indicator for tracking riverine plumes both in summer and winter, so here it is used to evaluate the downshelf and across-shelf penetration of the buoyancy-driven coastal current under different meteorological and hydrological conditions. The numerical simulations of the Tyrrhenian Sea currents are made using the Princeton Ocean Model nested in the Mediterranean Ocean Forecasting System (Oddo, 2009) at the Sicily Channel, the Sardinia Channel and the Corsica Strait. MFS analysis have been provided by INGV in the framework of the project MyOcean. The model grid used has 375 x 300 nodes with 32 sigma vertical levels. The horizontal dimension of the grid cells is approximately 1.7 km. Initial and forcing conditions are provided by the MFS model, and, at the surface, the wind stress used is originated from the ISPRA Hydro-Marine and Meteorological System. The wind at 10 m has a resolution of 0.1/0.1 degrees and is available every 3 hours. Since the Tiber estuary is relatively small (200m) and shallow with respect to the dimension of the POM grid , local dynamical effects on the circulation and on the water density due to the river outflow are accounted for by considering the sub-grid river discharge as a buoyant jet-like feature in the POM (Oey, 1996). Due to the steep salinity gradients, the time step used is 1.0 s. A lagrangian particle dispersion model is applied on the eulerian POM velocity fields in order to reproduce the effects of the turbulent transport of passive tracers within the discharged riverine waters. The model used has been developed by V. Artale and G.M. Sannino (Garcıa Lafuente et al. , 2007). Particles are advected with a 3-D second-order Runge-Kutta scheme, the stochastic contribution is a simple Random-Walk process in which the turbulent diffusivity is provided by POM by means of the Mellor-Yamada scheme. The same number of particles is released at every time step, but they are weighted linearly with the value of the daily riverine discharge, so that particles released during episodes of significant inflow contributes more than others to the evaluation of the concentrations. In the present study the particles are not buoyant and non-decaying, i.e. they represent a conservative tracer neutrally dispersed by the flow. The lagrangian model is implemented on the same grid and with the same resolution as the POM, the time step is 300 s. The simulations are made during significant river discharge episodes in both winter and summer conditions, such as the December 2008 Tiber peak discharge event (Fig. 2) and the July-August 2010 event (Fig. 1). The emission from the source ranges from 33 kg/s for an average river discharge of 300 m3/s up to 130 kg/s during the peak of 1800 m3/s in the winter simulation. The comparison between the spatial patterns of salinity, particles concentration and K490 for 4 selected days during the simulations is shown in the upper part of the poster , in Fig. 3 is the Summer simulation, in Fig. 4 the Winter simulation.

Discussion : A comparison between the Hoevmoller diagram of K490 along a transect normal to the coast near the Tiber estuarine (transect T, Fig. 7) during all the period considered and the same representation of the lagrangian particles concentration is shown at the bottom of the poster for the Summer (Fig. 5 on the left) and Winter (Fig. 6 on the right) episodes. The comparison of spatial patterns shows a close resemblance in some periods, while the patterns seem decorrelated in others. The first days of July (Fig. 5, days 197-200) show a relatively particle-rich offshore plume, corresponding to relatively high values of k490, possibly indicating that the model well reproduced a true offshore migration of coastal waters. The same holds for an isolated offshore "blob" of non-zero particle concentration at the end of the month (day 213, at 18 km from the coast; Fig. 5 on the left), in correspondence of the summer peak of the Tiber discharge (Fig. 1). This correlation is much more apparent in the winter case (Fig. 6, on the right), for days 351-358, in which an offshore extension of the particles and k490 signals is coherent. This offshore migration of coastal waters is well correlated with the December high of the Tiber discharge (Dec. 9 – Dec 20, Fig. 2). The better correlation is thus probably due to the stronger riverine signal in wintertime, which enhances the signal of coastal water migration offshore . On the contrary, the particles concentration apparently is relatively too high at a greater distance from the shore with respect to the behaviour of the K490, such as in July, days 202-205 (Fig. 5). This is probably due to the fact that the lagrangian particles have null sedimentation velocity, while the k490 is strongly influenced by sediment loss during the offshore migration. Also, the fact that this discrepancy occurs in summer induces us to further investigate the nature of the summer coastal waters e.g., in terms of suspended matter, and to refine the model. Indeed, the next step in the simulation will be to improve the lagrangian model in order to simulate the turbulent dispersion as a Langevin process, and to consider sedimentation velocities and decaying times for the particles. Finally, simulations are planned in correspondence of past and future oceangraphic cruises during which the biogeochemical parameters have been or will be sampled both offshore and in the coastal zone, close to estuaries.

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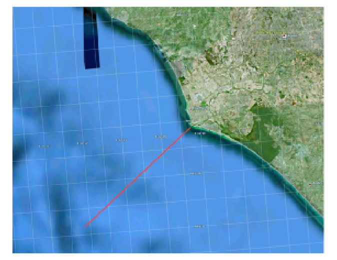

Figure 7: position of the transet T near the Tiber estuarine(in red)

Winter simulation: 01 December 2008 - 01 January 2009

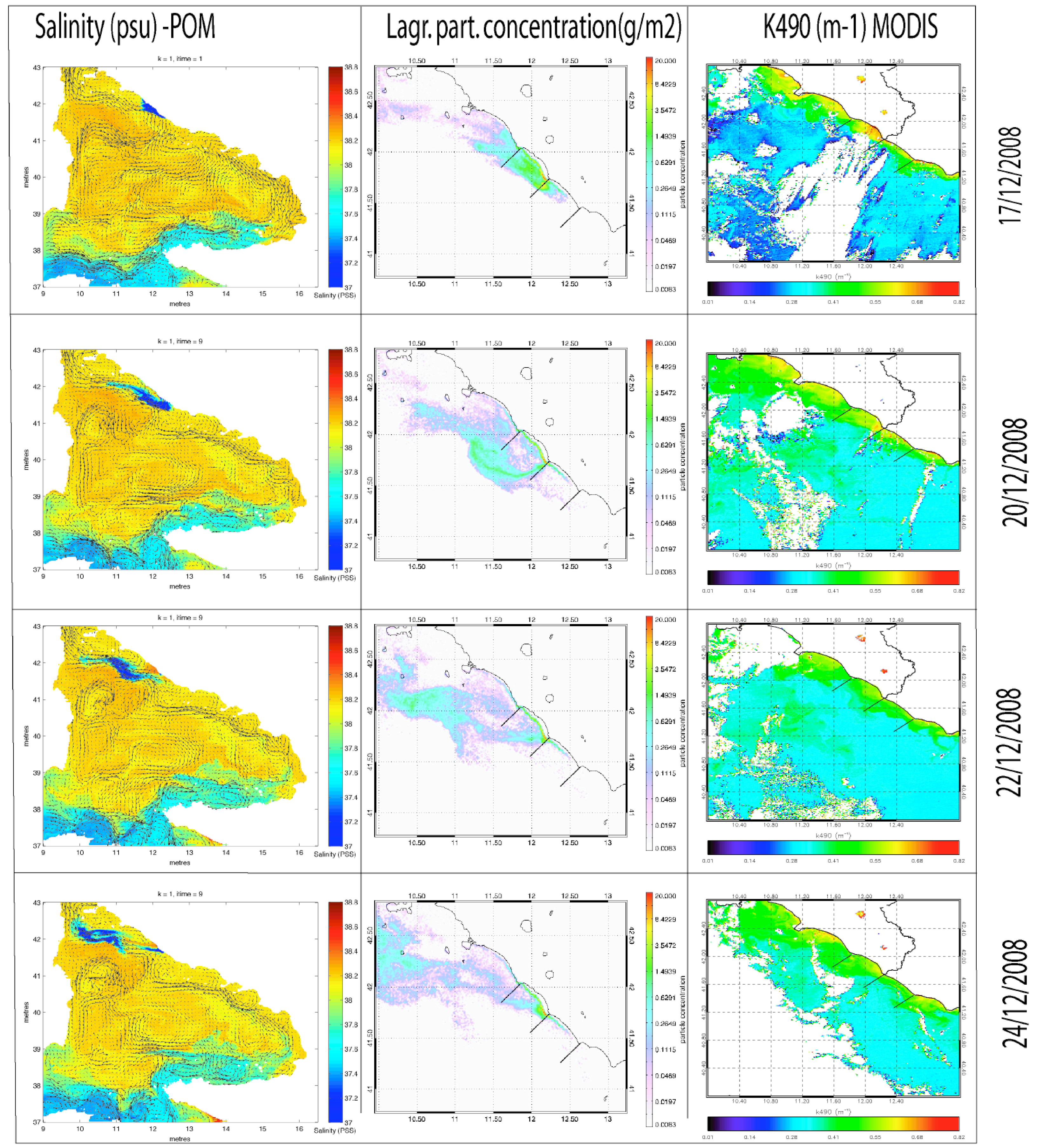

Figure 4: comparison between patterns of salinity, particles concentration and MODIS K490 on 17/12, 20/12, 22/12, 24/12 2008

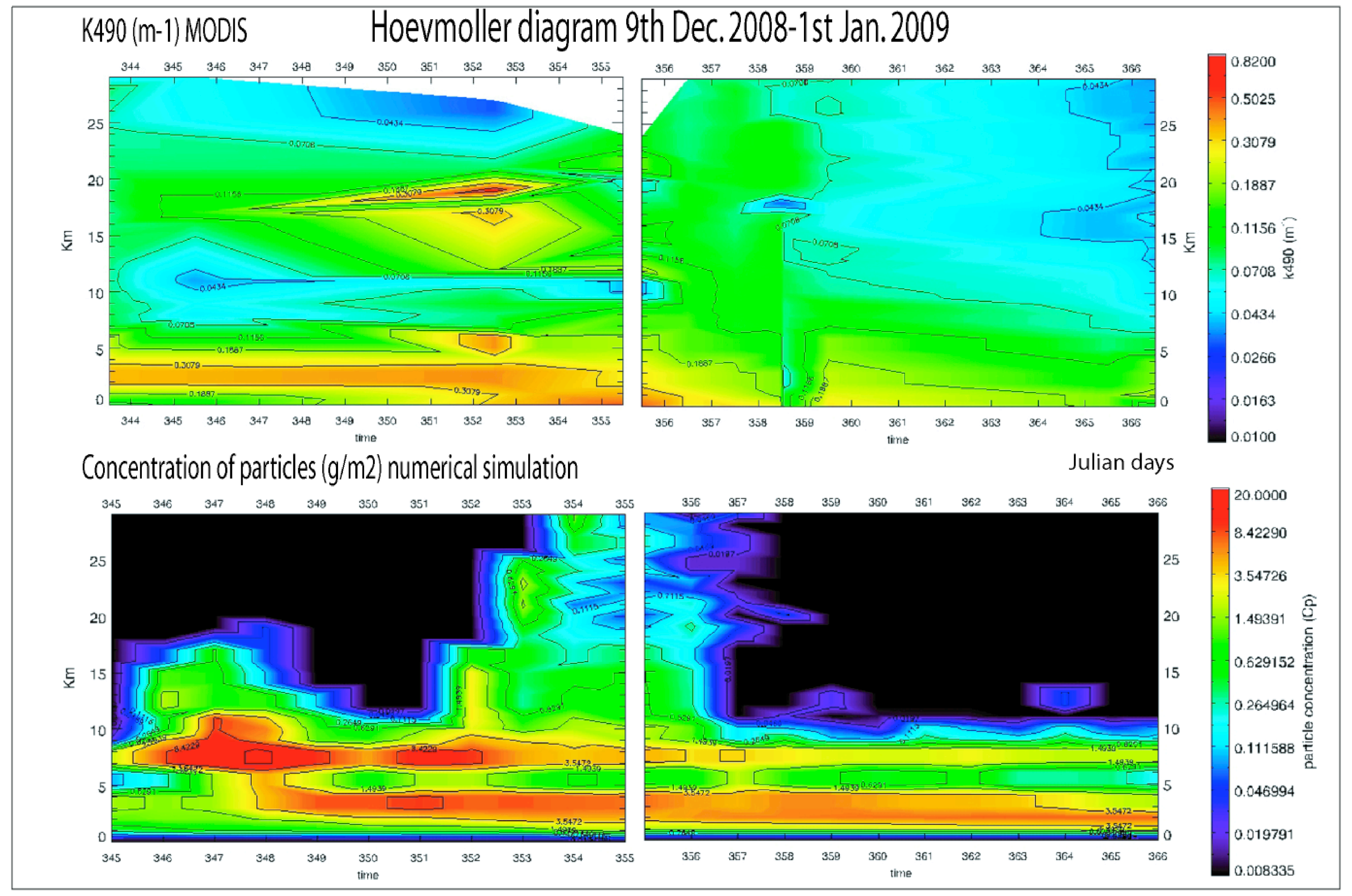

Figure 6: comparison between Hoevmoller diagrams of MODIS K490 (upper panel) and particles concentration (bottom panel) along the transect T in the period 09/12/2008 - 1/1/2009