TRANSMISSOMETRY AND LISST MEASUREMENTS DURING SESAME-IP CRUISE IN THE EASTERN MEDITERRANEAN (MARCH-APRIL 2008)

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Abstract
Light transmission, fluorescence, *in-situ* particle size, and particulate matter concentration were measured during March-April 2008 in 20 stations over the Eastern Mediterranean Sea, as part of the SESAME Project. We present a preliminary assessment of the similarities and differences of the Ionian, Levantine, north Aegean and south Aegean Seas, focusing on the properties of the suspended particles and their spatial distribution patterns.
Keywords: Eastern Mediterranean, Sampling Methods

Introduction
The use of transmissometers is well-known for the study of particle dynamics in the ocean for many decades [1, 2]. However, information regarding *in-situ* particle size spectra, mean grain size, and volume concentration of particles in suspension up to 3000 m depth, can be measured only recently with LISST-Deep (Laser In Situ Scattering and Transmissometry; Sequoia Scientific, Inc. [3]), the only commercially available instrument with such specifications. In the framework of SESAME Integrated Project (Southern European Seas: Assessing and Modelling Ecosystem Changes), a multidisciplinary oceanographic cruise took place in the Eastern Mediterranean, collecting data, among others, on light transmission, fluorescence, particulate matter concentration, and *in-situ* particle size distributions. The aim of this work is to contribute to a better understanding of particle dynamics in different sectors of the Eastern Mediterranean, i.e. the Ionian, Levantine, north Aegean, and south Aegean Seas, and to provide for the first time information on suspended particle size distributions.

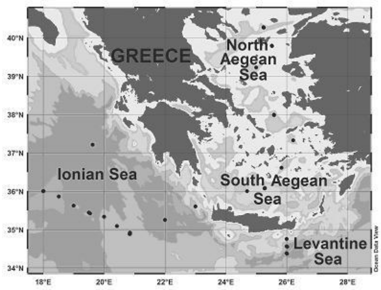

Fig. 1. Sampling stations location map.

Materials and Methods
During the cruise 20 stations were occupied on board the R/V Aegaeo (Fig. 1). Standard CTD measurements were obtained with a Sea-Bird Electronics 11*plus* CTD deck unit interfaced with a Sea-Bird Electronics 9*plus* unit attached to a General Oceanics rosette with 24 Niskin bottles. Light transmission (subsequently converted to beam attenuation coefficient *c*, in m^{-1}) was measured by two 25-cm path-length transmissometers emitting at 470 nm (Chelsea Alphatracka MKII) and 660 nm (Wetlabs C-Star), fluorescence by a fluorimeter (Chelsea Aquatracka III), and particle-size with the autonomous LISST-Deep. All sensors were attached to the lower part of the rosette frame and results refer to the downcasts [4]. The particulate matter concentration (PMC) was determined by on board water filtration of 1 to 10 litres of seawater passed through pre-weighed polycarbonate membrane filters with pore size 0.4 µm; filters were dried and re-weighed upon return to the laboratory (163 samples).

Results and Discussion
Ionian Sea: Beam *c* values vary from 0.384 to 0.503 m^{-1} (mean 0.401 m^{-1}) with noticeable higher values in the upper 150 m. The highest value is recorded near the surface of the westernmost station; however, there is a slight increasing trend towards the east. Fluorescence shows a very clear high concentration zone between 60 and 110 m depth, with maxima at 80 m. This pattern is consistent at all Ionian Sea stations. PMC range is 0.03-0.30 mg l^{-1} (mean 0.12 mg l^{-1}), with relatively higher values appearing at the upper 0-200 m (mean 0.16 mg l^{-1}), demonstrating the general scarcity of suspended particles in the Ionian Sea [5]. Median particle diameter D_{50} measured in 3 stations with LISST varied from 40 to 160 µm, but without any consistent pattern over depth. Records were generally noisy and with a lot of spikes, making the interpretation rather difficult, whereas the distribution of particle volume concentration (*VC*, in µl l^{-1}) looks more reasonable. *Levantine Sea*: Only 3 stations were occupied south of Crete. Beam *c* values vary from 0.406 to 0.521 m^{-1} (mean 0.422 m^{-1}) and they are observed clearly in the zone between the surface and 100 m depth. Fluorescence exhibits maxima around 80 m, with a decreasing trend offshore. PMC (0.06-0.43 mg l^{-1}) shows slightly higher values, similarly to beam *c*, because of the proximity of the stations to the land. D_{50} measured in 2 stations shows a similar behaviour as the previous. Summarizing, the general picture of the Ionian Sea and the Levantine Sea is fairly similar. *North Aegean Sea:* 4 stations occupied. Beam *c* values vary from 0.424 to 0.837 m^{-1} (mean 0.479 m^{-1}). In this area characteristic surface, intermediate, as well as bottom nepheloid layers are observed, demonstrating generally a more turbid environment. Fluorescence values show maxima at 50 m depth and an increasing trend from the north to the south. PMC range is 0.05-0.85 mg l^{-1} (mean 0.20 mg l^{-1}), with higher values appearing clearly at the upper 100 m. LISST measurements are characterized by high variability over depth (D_{50} 30-150 µm). *South Aegean Sea:* Beam *c* values vary from 0.409 to 0.578 m^{-1} (mean 0.444 m^{-1}), with pronounced surface nepheloid layers extending to 150 m depth. Fluorescence maxima appear between 50 and 100 m and decrease toward the open sea (southwards). PMC range is 0.04-0.63 mg l^{-1} (mean 0.22 mg l^{-1}). Similarly to the north Aegean, LISST measurements are not satisfactory.

Conclusions
The Ionian and the Levantine Sea are characterized by extremely particle-free waters throughout the water column, followed by the south Aegean Sea. The north Aegean Sea shows more turbid waters due to rivers inputs. Fluorescence maxima are pronounced but they are observed at different depths. Particle size measurements obtained with LISST are questionable, since they show high fluctuations over depth and also very high D_{50}, which is not expected at such depths. However, the presence of marine snow composed of large aggregates could provide an explanation for the large size classes. On the other hand, the high frequency variability in D_{50} is mostly due to the influence of noise on the measurements because the signal is very low. The main issue is that there are hardly any particles in the water; the volume concentrations from the LISST are well below 1 µl l^{-1} in most cases, and PMC data support this. So this is really pushing the technology to the extreme limits of what is measurable, in terms of light scattering. The overall behaviour of the instrument and its measurements needs careful re-evaluation. Most probably problems arise from the very low PMCs observed in the Eastern Mediterranean.

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