AFRICAN DUST DEPOSITION AND OCEAN COLOUR IN THE EASTERN MEDITERRANEAN

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Abstract

We study the impact of Saharan dust deposition on chlorophyll concentrations in the Mediterranean using ocean colour products and simulated dust deposition fluxes. Chlorophyll increases follow most dust deposition events but dust fertilization and wind-related effects cannot be disentangled.

Keywords: Surface water fertilization, Dust deposition, Chlorophyll, SeaWiFS, LMDz-INCA.

Introduction

African dust deposition significantly contributes to soluble phosphorus inputs to Mediterranean surface waters (1), where it is the limiting nutrient, and probably sustains the marine productivity *(2)*. This work aims at investigating this possible fertilization of low productive Mediterranean waters.

Data and method

SeaWiFS daily level-3 maps (~9 x 9 km^2) of chlorophyll concentration ([Chl]) were obtained from NASA (3) for 1998 2000. Only part of the basin is observed every day because of clouds and orbital characteristics.

The atmospheric dust cycle was simulated at a resolution of 1.84° x 2.25°with LMDz-INCA, a 3-D AGCM coupled with chemistry and aerosols *(4)*. We extracted daily integrated dry and wet dust deposition fluxes ($F = F_d + F_w$).

We averaged [Chl] within the model grid (~600 pixels/cell) and selected four grid cells across eastern Mediterranean: Southern Central (SC: 18°E, 33.06°N), Eastern Central (EC: 22.5°E, 34.90°N), South-western Levantine (SL: 24.75°E, 33.06°N), and Northern Levantine (NL: 29.25°E, 34.90°N). We rejected days with ≤25% of pixels per grid cell. This left 50-60% of days and we filled gaps using a 7-day moving average.

Results and discussion

Maximum (resp. minimum) surface [Chl] at a given site varies between 0.20 and 0.34 (0.04 and 0.06) mg m^3. The seasonal cycle shows a winter maximum of 0.20±0.05 mg m^3 in January-February, with another, occasionally absolute, maximum in March (Fig. 1). [Chl] drops down in spring and remains low (0.05-0.10 mg m^3) from May to September. From October, [Chl] slowly increases to its winter maximum.

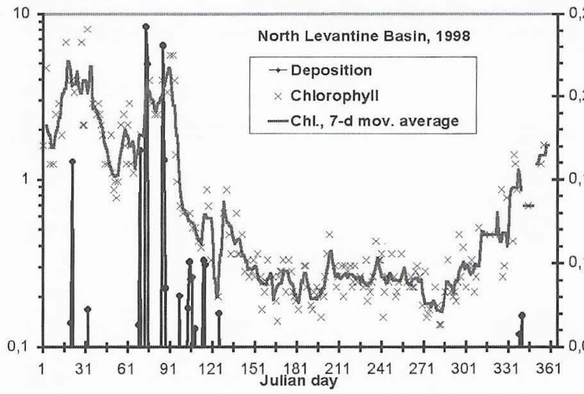

Fig. 1. Daily dust deposition, daily and 7d averaged chlorophyll at NL in 1998.

A dust outbreak generally causes high deposition at most sites. Overall range in F is 8.938.7 g m^2 yr^1, with a factor 2-3 of interannual variability at a given site, and no clear trend from one year or one site to the other. The fallout is controlled by a few wet deposition events (F_w/F>93%). Maximum F_w of 15.7 g m^2 yr^1 is simulated at SC and F_w>1 g m^2 d is reached up to 9 d yr^1. F_d exceeds 0.1 g m^2 yr^1 for only 910 d yr^1, with a maximum of 1.24 g m^2 yr^1 at SL. Most of highest deposition events and annual deposition occur during March-May. Summer fallout never exceeds 0.25 g m^2 d^1. The simulated seasonal cycle is consistent with observations *(5,6)*.

Laboratory experiments support an increase of 8 mg Chl m^2 (or 0.08 mg Chl m^3 in a surface mixed layer of 100 m) per g m^2 of dust deposition *(7)* with a lag time of ~48 hours (8). For a summer dust deposition of 0.1 g m^2 in a mixed layer of 20 m, the expected increase is 0.04 mg Chl m^3. Our data set shows in accordance 0.020.16 mg m^3 increases in [Chl] shortly following dust fallout, and thus supports a dust fertilization of Mediterranean waters.

However, we also find a good correspondence between high surface winds and [Chl] peaks, and dust events are generally associated with wind peaks (Fig. 2). Surface wind controls the mixing between surface waters and deeper ones, richer in nutrients. Observed [Chl] increases can thus be contributed by both dust deposition and wind. Coupled biogeochemical-circulation model and appropriate in situ measurements are necessary to unravel both effects.

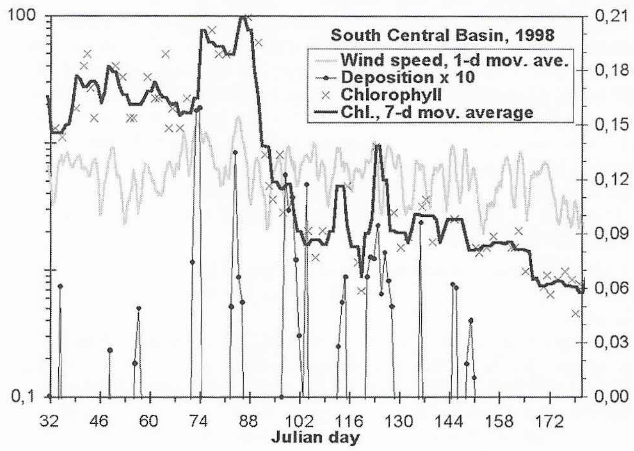

Fig. 2. Daily dust deposition, daily and 7d averaged chlorophyll, and wind speed at SC, between February 1 and June 30, 1998.

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