SEASONAL VARIABILITY OF THE NITROGEN CYCLE IN THE MEDITERRANEAN SEA

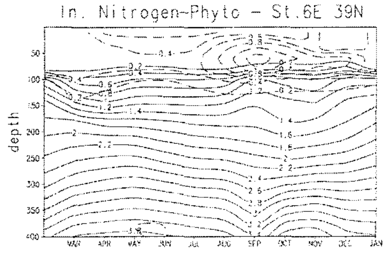
A. CRISE, G. CRISPI, E. MAURI and R. MOSETTI

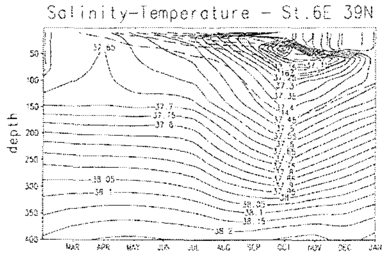
Osservatorio Geofisico Sperimentale, P.O. Box 2011, 34016 Trieste, Italy

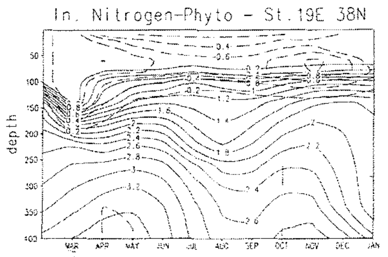
The role of upper ocean biochemical processes in determinig the basic trophic kinetics and distribution is deeply connected with the dynamical processes that determine the physical forcings active at the biological scales. The seasonal signal of the lower trophic level evolution in the Mediterranean Sea is reproduced by means of a trophodynamic model representing the aggregated nitrogen cycle in oligotrophic conditions. The total nitrogen, divided in inorganic nitrogen, phytoplankton and detritus, maintains the numerical conservativeness of the scheme described in CRISE *et al.* (1992), but includes exchanges at the Gibraltar Strait, because of the nitrogen and phytoplankton relaxation to climatological profiles in the transition zone between the Alboran Sea and the Atlantic Ocean all along the simulation.

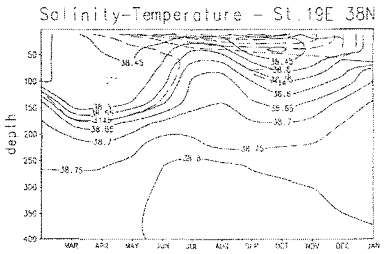
Limiting factors of the phytoplankton growth are the sea temperature, the irradiance and the available nutrient. The limiting factors are all considered to be depth dependent, and are respectively represented by the STEELE (1962), the EPPLEY (1972) and Michaelis-Menten uptake formulations. The hydrodinamical horizontal processes that affect the biogeochemical state variables are explicitely taken into account, as well as the vertical dynamics governed by advection- diffusion processes and the convective adjustments. For this purpose, the ecomodel is tightly coupled with the hydrodynamics simulation as developed in the frame of MERMAIDS project by PINARDI *et al.* (1993). This MOM based general circulation model has a 1/4 degree horizontal grid size and 31 vertical levels. The dynamical forcing terms used are the NMC winds, the COADS monthly mean clouds maps and the heat fluxes as in CASTELLARI *et al.* (1993). Even with a highly aggregated ecomodel, the seasonal cycle exibits a marked variability induced principally by the horizontal advective forcing. To study this effect on the ecomodel, the basic experiment considers the light as constant all over the basin varying only in time on an astronomical base. Two significant examples are shown to confirm the above statements. The differences in tracer concentration are all due to the internal dynamics, because the inorganic nitrogen and phytoplankton are initialized with the same climatological profiles in the whole Mediterranean. The hydrodynamical model is spinned up for eight years and the presented results were obtained in the second year of the ecological model run.

The inorganic nitrogen (full) and the phytoplankton (dashed) concentrations, all in micromoles Nitrogen per liter, are presented in two typical stations, the first in the Catalan-Algerian Basin and the second in the Ionian Sea. Salinity (full) and temperature (dashed) are also provi-ded in the same stations. In the Catalan-Algerian Basin station the seasonal variability slightly affects the inorganic nitrogen distibution below the euphotic zone, showing instead a stronger seasonal signal in the first hundred meters. After an initial period of mixing mainly due to convective adjustment, temperature and salinity exhibit the typical late spring-summer stratification, preventing the exchange of upper layer. The phytoplankon response to the higher irradiance and relatively abundant nitrates decreases in April showing a well shaped subsurface maximum in late summer. This second maximum is enhanced by the low salinity Modified Atlantic Water. In the Ionian Sea station the wind stirring creates an homogeneous phytoplankton maximum all along the water column even below the euphotic zone. The stratification is evident during the summer and early autumn and creates an isopycnal barrier with the surface layer. The anticyclonic regime of the northern Ionian is stronger in summer affecting progressively the inorganic nitrogen concentration below 150 meters. This effect is masked in the physical tracers and the intrusion of less salty water does not seem to influence the trophic dynamics. In winter, the progressive mixing of the upper layer creates again the homogeneous conditions typical of the beginnig of the cycle.









REFERENCES

CRISE A., CRISPI G. and MOSETTI R., 1992, Paralleliza-ion of a coupled hydrodynamical ecomodel, CNR/PFI, Technical report N. 1/135.

STEELE J.H., 1962, Environmental control of photosynthesis in the sea, *Limnol. Oceanogr.*, 7, 137-150.

EPPLEY R.W., 1972, Temperature and phytoplankton growth in the sea, *Fish. Bull.*, 70, 1063-1085.

PINARDI N., ROETHER W., MARSHALL J., LASKARATOS A., KRESTENITIS Y. and HAINES K., 1993, Mediterranean Eddy Resolving Modelling And InterDisciplinary Studies. Contract MAST 0039-C(A) Final Scientific and Management Report.

CASTELLARI S., PINARDI N. and LEAMAN K., 1993, A heat budget study for the Mediterranean Sea, submitted.