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# COASTAL UPWELLING OFF NORTHWEST AFRICA

## A three-dimensional numerical model

by

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## Abstract

An explicit three-dimensional numerical model of upwelling along the coast of Mauritania has been developed. The model consists of ten layers with increasing vertical resolution towards the surface and a variable horizontal grid step which enlarges with distance from the coast. Distinct from earlier versions realistic density distribution is now included.

The density is treated without any sources or sinks (no precipitation, evaporation, river discharges) and is purely advected by a transport equation. For the time scales under consideration (of the order of days) this seems to be justified.

The whole system is driven by wind and starts from the state of rest with horizontal homogeneous density layers. Numerical calculations are carried out to simulate 16 days. Within this period the velocities as well as the density variations achieves quasi-stationary results under constant wind forcing.

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Fig. 1 shows a density section drawn from observational data along 18°30' N in February 1977 (Mittelstaedt et al., 1980).
Fig. 2 shows the corresponding results of the numerical simulation.
The cross-circulation pattern as derived from measurements (Fig. 3) by Mittelstaedt et al. 1975 indicates an offshore Ekman transport at the surface, and a subsurface onshore compensatory flow, which intensifies just at the shelf break. The corresponding result of the model (Fig. 4) agrees well with this interpretation of direct measurements.

Minor, but realistic differences in the initial density stratification do not change the pattern of the system. Increased wind speed from northerly directions enhanced upwelling. Variation of the wind direction to easterly (strong offshore) winds leads to a distinct decrease of upwelling.

Calculations with realistic time-dependent wind fields yield encouraging results, compared to observed current and temperature measurements.

References

Meier-Fritsch, H., 1980: Ein numerisches Modell des Nordwest-Afrikanischen Auftriebs. Dissertation, 89 pp.

Mittelstaedt, E., D. Pillsbury and R.L. Smith, 1975: Flow Patterns in the Northwest African Upwelling Area. Dt. Hydrogr. Z. 28, 4, 146-167.

Mittelstaedt, E., G. Weichart, I. Hamann, H. Lüthje und H. Meier-Fritsch, 1980: Zur Hydrographie der Gewässer entlang der Küste von Mauretanien. Meereskundliche Beobachtungen und Ergebnisse. Deutsches Hydrographisches Institut, Hamburg, 286 pp.

Figures

Fig. 1: Density section carried out along 18°30' N during "Upwelling '77". (Mittelstaedt et al., 1980).

Fig. 2: Density section of the model; NNE-wind at day 16.

Fig. 3: Scheme of the cross-circulation according to measurements. (Mittelstaedt et al., 1975).

Fig. 4: Scheme of the cross-circulation according to the model. (Meier-Fritsch, 1980).

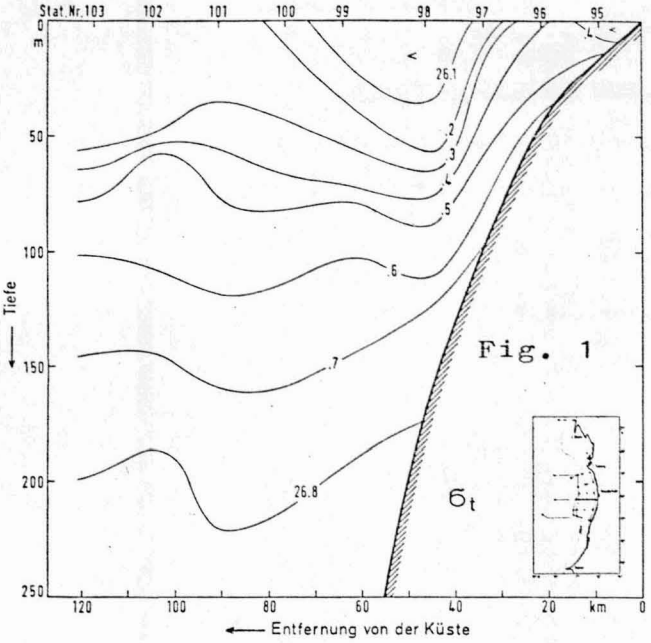


Fig. 1

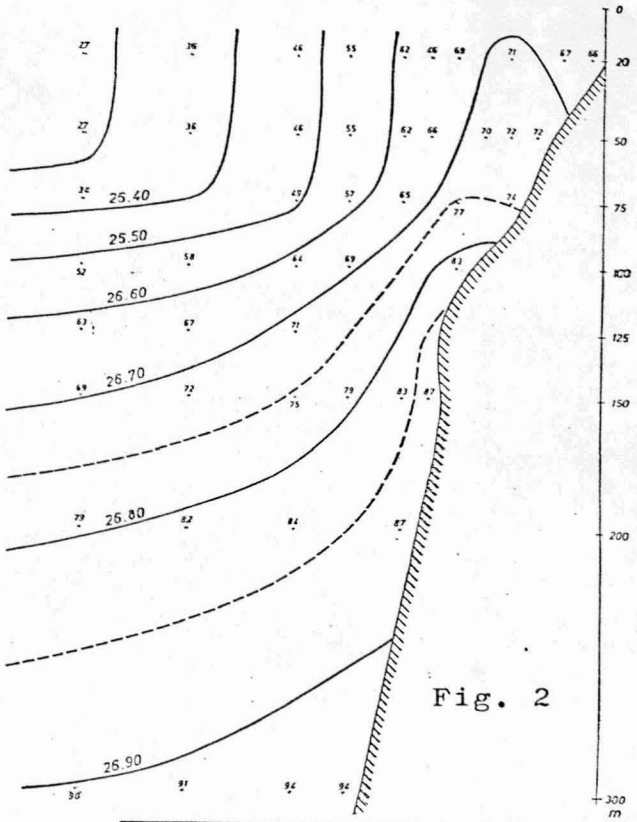


Fig. 2

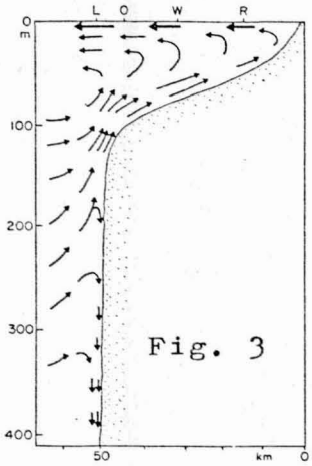


Fig. 3

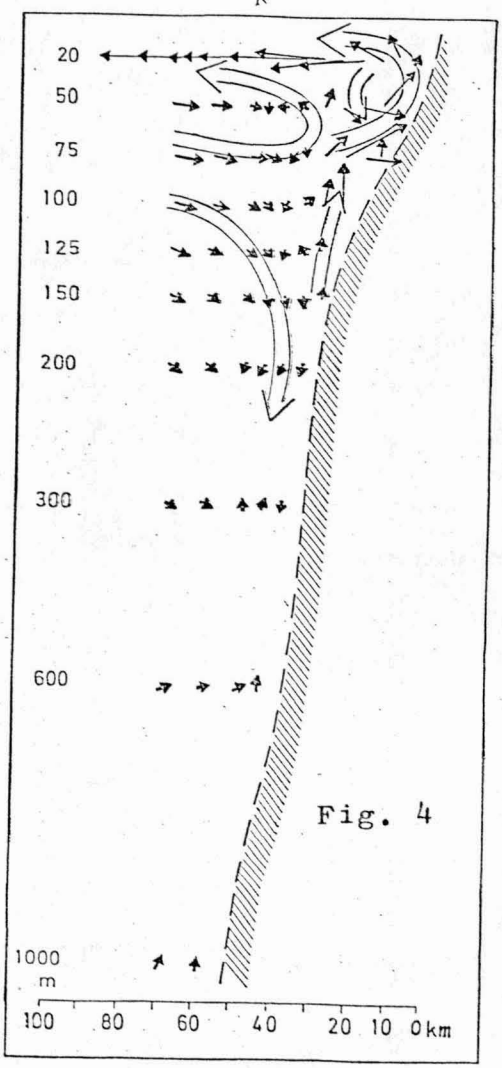


Fig. 4