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INTRODUCTION TO A COLLECTION OF PAPERS ON GATE OCEANOGRAPHY AND SURFACE LAYER METEOROLOGY

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A better understanding of tropical convection, being an essential part of the global atmospheric circulation, was considered crucial for an improvement of weather prediction and climate modelling, the fundamental goals of the Global Atmospheric Research Programme GARP. The first major international field experiment within this programme was therefore performed in the tropics: GATE (GARP Atlantic Tropical Experiment) 1974. The basic objectives for GATE were (a) to provide a means of estimating the effects of smaller tropical weather systems on synoptic scale circulations and (b) to facilitate the development of numerical modelling and prediction methods (ICSU, WMO, 1974 a, see Appendix).

At the same time the experiment provided a unique opportunity for investigating the response of the tropical ocean to atmospheric forcing on various scales. The resulting oceanographic sub-programme was presented by SCOR/ICSU (1973) and ICSU/WMO (1974b), the atmospheric boundary layer sub-programme by ICSU/WMO (1973) (see Appendix). The oceanographic observations on the smaller scales were mostly performed in the Intertropical Convergence Zone (ITCZ) while larger scale studies were concentrated on the equatorial region.

The two GATE supplements to Deep-Sea Research present results on the oceanic and atmospheric boundary layers in the region in or close to the ITCZ in the eastern Atlantic (Vol. I) and in the equatorial Atlantic (Vol. II). Most of the papers are based on lectures given at the SCOR/IAPSO/IAMAP "GATE Symposium on Oceanography and Surface Layer Meteorology", 16-20 May 1978, in Kiel. The manuscripts had to satisfy the requirements for Deep-Sea Research and went through the usual refereeing.

In order to provide some background material for the reader of the individual articles in this volume I, the basic objectives and the design of small- and mesoscale experiments will be summarized here.

The dominant scales of tropical weather systems determined the distribution of most research vessels in GATE:

Scale A: Easterly waves, $10^3 - 10^4$ km

Scale B: Cloud clusters, $10^2 - 10^3$ km

Scale C: Mesoscale, $10^1 - 10^2$ km

Scale D: Hot towers, $10^0 - 10^1$ km

The A-scale measurements covered the whole tropical Atlantic between 10°S and 20°N with a specific equatorial sub-programme (fig. 1). The B/C/D scale observations were centred at the expected position of the ITCZ half way between the equator and the Cape Verde Islands. The three-month duration of GATE included three observational phases, each three weeks long (fig. 2). The ships in each phase are presented in fig. 3 and table 1. The C-scale ship and buoy array nested in the B-scale array during phase III is plotted in fig. 4.

The atmospheric boundary layer studies at the ITCZ were supposed to describe low-level mass and moisture convergence and vertical fluxes of sensible heat, momentum and water vapor from the sea surface upwards. The area in the open Atlantic 1000 km south-west of the aircraft base at Dakar presented a satisfactory variety of disturbed and undisturbed conditions in the atmospheric boundary layer. The main emphasis in the meteorological programmes was put on identifying the above processes and on their parameterization for the modelling of the tropical convection.

Most of the oceanographic investigations at the ITCZ were designed to study the response of the upper ocean to atmospheric forcing. The site and the ship array proved less than ideal for the exploration of the oceanic boundary layer, since they lay in the swiftly flowing Equatorial Countercurrent, which swept water through the 100 km array in three days, with the advective term, rather than the vertical turbulent transport term, dominating the heat budget equation. Furthermore, significant patchiness existed in"mixed layer" salinity on a scale equivalent to less than one day's advection distance. Chances were therefore low of relating Eulerian time series of thermohaline profiles from individual fixed ships to one-dimensional models of the oceanic boundary layer. The main aim of the oceanographic programme was to identify the dominant processes that distribute energy and momentum in this part of the Atlantic. Specific phenomena studied were surface and internal waves, mixed layer changes, mean current and shear, and oceanic fronts at the shallow boundary layer existing in this area.

The standard meteorological observations on the GATE ships included measurements with tethered balloons at constant levels and vertical profiling systems, and surface flux measurements made either on board the ship or on a nearby buoy. The oceanographic observations were made on ships by conductivity -temperature-depth profiling devices, water samplers with reversing thermometers, mechanical or expendable bathythermographs and current profiling sondes. Moored buoy systems were used to obtain surface meteorological observations and upper ocean currents and temperature. These measurements on fixed position were supplemented by mobile ship observations with towed devices scanning the upper ocean and by additional special observations of individual research groups. A detailed summary of the field phase operations is presented in ICSU, WMO (1975) (see Appendix). Further details on some of the more specialized measurements can be found in several of the following articles.

We hope that by bringing together in these two volumes a large part of the papers that resulted from the GATE oceanographic and atmospheric boundary layer programmes we will be able to make the results more easily accessible for those who are interested in tropical processes and their role with respect to weather and climate modelling.

ACKNOWLEDGMENTS

We would like to use this opportunity to thank the numerous individuals and international and national institutions making this research programme and the publishing of these volumes possible. The symposium forming the basis of this publication was organized by the Scientific Committee on Oceanic Research (SCOR), the International Association for the Physical Sciences of the Ocean (IAPSO) and the International Association of Meteorology and Atmospheric Physics (IAMAP) in cooperation with the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the German Meteorological Society (DMG), with specific support by the Deutsche Forschungsgemeinschaft. We appreciated their assistence.

APPENDIX

Selected reports on GATE

ICSU = International Council of Scientific Unions
SCOR = Scientific Committee on Oceanic Research of ICSU
WMO = World Meteorological Organization, Geneva, Switzerland

SCOR, ICSU (1973). SCOR proposal for a GATE Oceanographic Program, pp. 49.

ICSU, WMO (1973). The boundary-layer sub-programme for the GARP Atlantic Tropical Experiment. GATE Report No. 5, pp. 128.

ICSU, WMO (1974a). The central programme for the GARP Atlantic Tropical Experiment. GATE Report No. 3, pp. 35.

ICSU, WMO (1974b). The oceanographic sub-programme for the GARP Atlantic Tropical Experiment. GATE Report No. 8, pp. 135.

ICSU, WMO (1975). Report on the field phase of the GARP Atlantic Tropical Experiment operations. GATE Report No. 15, pp. 148.

ICSU, WMO (1979). The GATE Bibliography, pp. 35.

ICSU, WMO (1979). Final report of SCOR Working Group 43 on Oceanography related to GATE, pp. 58.

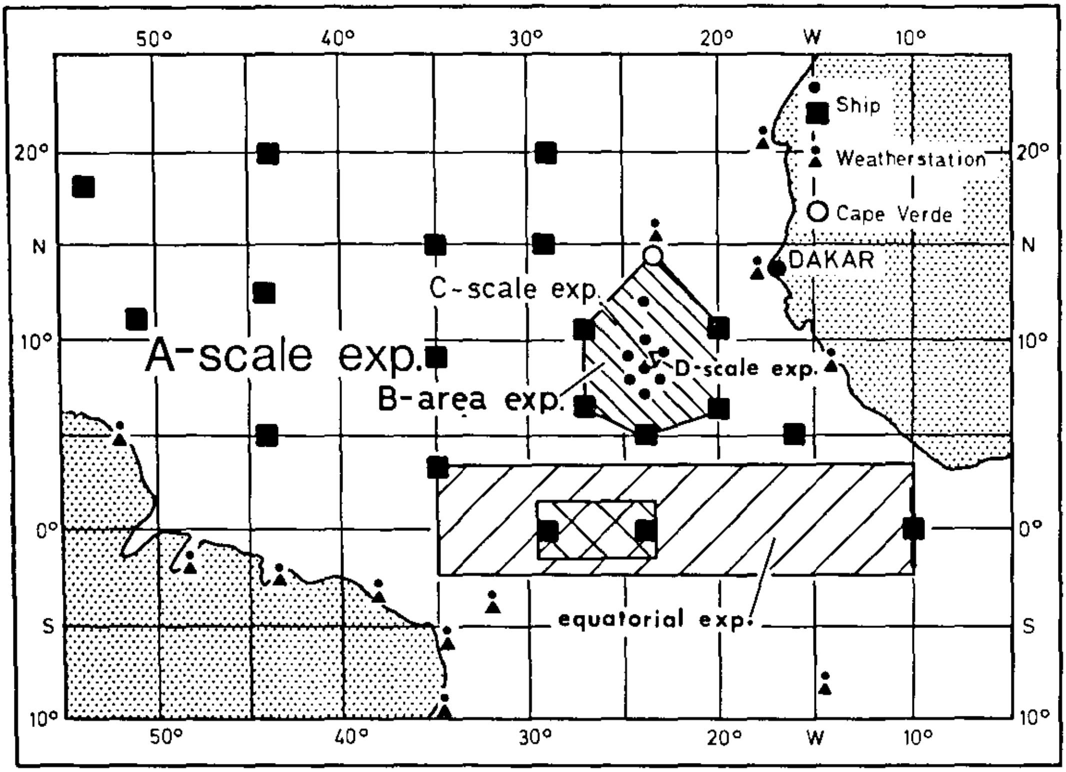

Fig. 1. Map indicating GATE observational areas in the tropical Atlantic, covering dominant scales A to D as defined in the text.

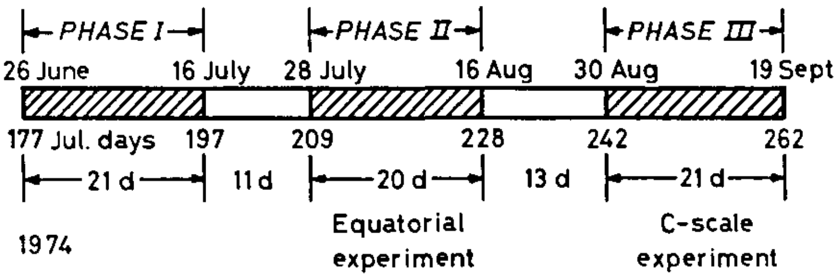

Fig. 2. GATE schedule. Specific experiments with intense oceanographic observations are indicated.

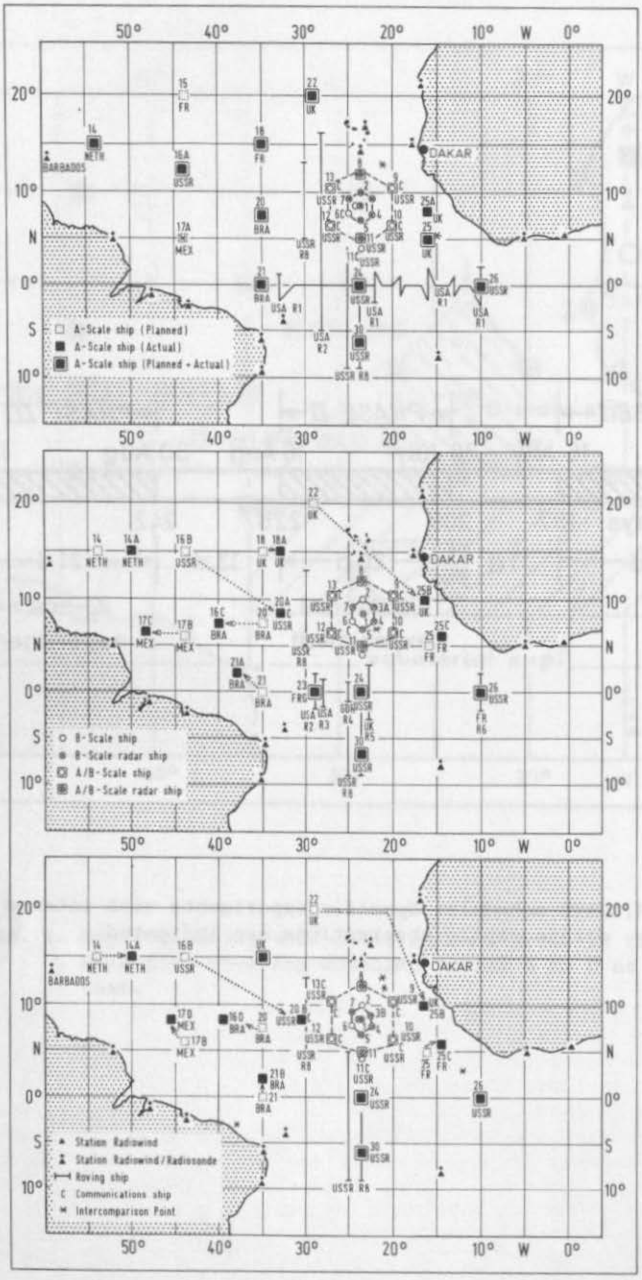

Fig. 3. Ship distribution during the three phases of GATE (see also Table 1).

TABLE 1 Positions of ships (see Fig. 3) during the three phases of GATE.

Position No. Phases			Ship	Position No. Phases			Ship
I	II	III		I	II	III	
		6	BIDASSOA	18			CHARCOT
1	1	4	OCEANOGRAPHER	20	16C	16D	SIRIUS
4	4	1	METEOR	21	21A	21B	AL. SALDANHA
1A	2	2	VANGUARD	22	25B	25B	ENDURER
2	1A	1A	PROF. VIZE		23		ANTON DOHRN
3A	3A	3C	QUADRA	24	24	24	ACAD. KURCHATOV
5	5	5	RESEARCHER	25	18A	18	CHARTERER
6	6	28	DALLAS		25C		LA PERLE
7	7	7	GILLISS		R6	25C	CAPRICORNE
8	8	8	ACAD. KOROLOV	26	26	26	PASSAT
9	9	9	PORYV			27	PLANET
10	10	10	ERNEST KRENKEL			29	HECLA
11	11	11	PROF. ZUBOV	30	30	30	LOMONOSOV
11C	11C	11C	MUSSON		R7	28A	H.J.W. FAY
12	12	12	OKEAN	R1	R1		ATLANTIS II
13	13	13	PRIBOY	R2	R2	R2	TRIDENT
14	14A	14A	ONVERSAAGD		R3	R3	COL. ISELIN
15			M. DUFRESNE		R4		A.V. HUMBOLDT
16A	20A	20B	VOLNA		R5	R5	DISCOVERY
17A	17C	17D	MATAMOROS	R8	R8	R8	S. DEZHNEV

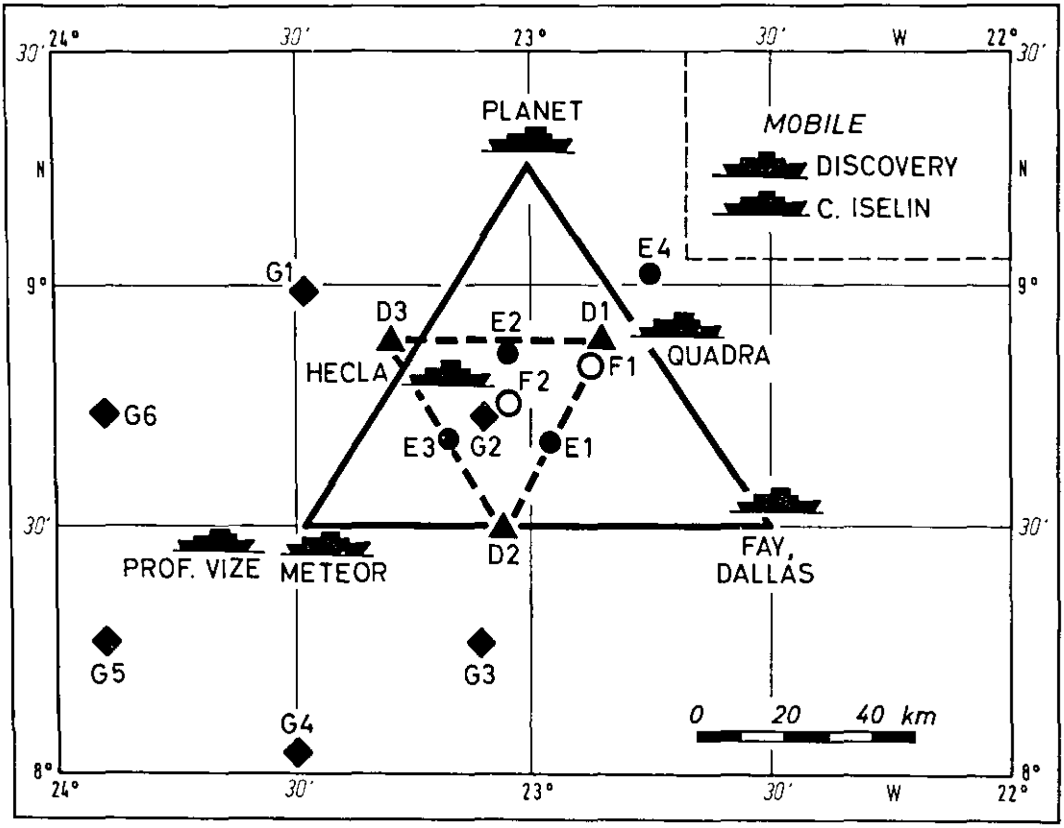

Fig. 4. C-scale ship and buoy array during phase III.