FIRST INTERNATIONAL CONFERENCE ON METEOROLGY AND AIR/SEA INTERACTION OF THE COASTAL ZONE

Sponsored by

Royal Netherlands Meteorological Institute

and

American Meteorological Society

May 10-14, 1982
The Hague, Netherlands

Cover: IJmuiden breakwater: NW Beaufort 8.

The manuscripts reproduced in this collection of preprints are unrefereed papers presented at the First International Conference on Meteorology and Air/Sea Interaction of the Coastal Zone; their appearance in this collection does not constitute formal publication.

AMERICAN METEOROLOGICAL SOCIETY
45 Beacon Street, Boston, Massachusetts 02108
U.S.A.

THE EXPERIMENT "KONTUR"

Hans Hinzpeter
Meteorologisches Institut
Universität Hamburg, FRG

1. INTRODUCTION

KonTur is the acronym for a field experiment in convection and turbulence. The convection part in this programme stands for studies of cumulus and deep convection, e.g. in form of cells, as well as studies of cloud streets and the organized motions of roll structures in the atmospheric boundary layer. The turbulence part comprises experimental studies not only in the surface, "Prandtl" layer (the lowest 30 m), but rather in the atmospheric boundary layer, "Ekman" layer, which is typically 500 m high above the sea in temperature zones.

Turbulence near the sea surface has long been studied in order to determine the turbulent fluxes of momentum, energy and mass between ocean and atmosphere. Due to the short time scales predominant in the surface layer, homogeneous, steady state theories are applicable, and experimental determinations of fluxes can reasonably well be parameterized. In the atmospheric boundary layer the time scale is much longer and the number of relevant or possibly relevant parameters is larger. Hence, theories for the atmospheric boundary layer are less well established, and experimental studies are missing, which provide at least some measurements of turbulent quantities above the sea surface layer as well as a reasonably complete set of relevant external parameters. Hence, models cannot be verified, and parameterization of fluxes through the atmospheric boundary layer remains uncertain.

Deep convection can be very effective in transporting heat and water vapour beyond the atmospheric boundary layer into higher layers of the atmosphere providing a mode of transportation outside the frontal systems of synoptic depressions. Again, convection depends on environmental conditions to a large extent. Hence it is difficult to describe and parameterize the convective fluxes. Also there is a reason to believe that convection and turbulence will interact or co-act. It is reasonable to assume that for cellular cloud structures or cloud streets turbulence in the atmospheric boundary layer provides an effective viscosity. Organized structures provided by convection in turn will structure the turbulence.

It may be noted that those processes, which KonTur is designed to measure, occur in a "mesoscale gap": traditionally, weather service networks have been designed to handle synoptic systems with scales of, say, 300 km and larger, while turbulence has been studied at single points at the sea surface or along a line from aircraft, with typical length scales of up to a few kilometers. Mesoscale systems with horizontal scales of several tens of kilometers and vertical extent of a few kilometers are difficult to access experimentally.

KonTur strategy is to provide different types of measurements simultaneously:

(i) a radiosonde network to provide the mean meteorological field, especially divergences and baroclinicity,

(ii) air-craft missions to study convection as well as turbulence, and

(iii) tethered balloon and surface equipment to provide vertical profiles of turbulent quantities throughout the atmospheric boundary layer.

The experiment is carried out in the area of the German Bight. It is hoped to collect a unique amount of information at sea, and it is, therefore, sensible that studies of land-sea transition and, for instance, the influence of coastal convergence on convection are planned in a coastal experiment, called PUKK, which is scheduled simultaneously with KonTur.

2. SCIENTIFIC PROGRAMMES

2.1. Convection

The role of convection in the transport of energy and mass is to be studied. Satellite pictures for example show organized or orderly cloud structures of different types: (i) cloud streets which are thought to be indicators of roll motions in the atmospheric boundary layer, and (ii) cellular structures which form closed or open cells. The latter may be formed by more isolated, deep cumulus convection. The amount of heat and water vapour carried by these convective systems is to be measured together with the parameters of the mean field in order to allow the verification or improvement of models of convective transports.

To this purpose, according to the prevailing cloud situation, different types of aircraft missions are flown, usually with two aircrafts, one above the other, to determine the fluxes inside and outside of the cloud. While the mean field is given by radiosonde network, the aircraft wind and navigation system is accurate enough to also check the large scale wind field. The flight legs will be oriented parallel and perpendicular to the dominant direction when organized line structures are visible. For more scattered structures, statistical sampling is to be applied.

The aircraft will also carry cloud physics equipment, and provision is made to determine radiational properties of scattered cloud fields. The aircraft missions will provide line averages of turbulent and mean quantities along the flight legs. From F.S. "Meteor", turbulence measuring tethered sondes will be flown at several levels between 250 m and 1000 m, providing time series of turbulent and mean quantities. As the cloud structures drift by, it will be possible to generate composite pictures of these structures.

2.2. Turbulence

Turbulence transports the fluxes exchanged between ocean and atmosphere across the atmospheric boundary layer and hands them over to either synoptic motion or convective transport. It is known that the turbulent transport is an important link in the energy and water vapour balance of the system earth-atmosphere. But due to a large number of relevant parameters, description of these processes, say by models, is difficult and needs empirical verification. It is the aim of this part of the experiment to provide a data set which is sufficiently comprehensive to test planetary boundary layer models. There is sufficient evidence from previous experiments or from order of magnitude calculations that nonstationarity and inhomogeneity must be considered. In the experiment, therefore, the advection is obtained from the radiosonde network which at the same time provides surface observations. large scale horizontal divergence will influence the height of the turbulent layer below the inversion. Divergences are obtained both from the aircraft flights and the fixed radiosonde/surface stations. The geostrophic wind is to be determined from the available surface network, supplemented by three buoys, so that the limited accuracy attainable from a simple station triangle is improved by redundant information. The thermal wind, which is known from the ageostrophic method to be important, can again be obtained both from aircraft and radiosonde stations. Turbulence is measured by F.S. "Meteor" with the aid of balloon-borne turbulence sondes as well as by the turbulence equipment of the aircraft.

2.3. Experimental network

The backbone of the experiment is a network of radiosonde stations:

R.V. "Meteor" at the experimental site of the Sonderforschungsbereich Meeresforschung Hamburg west of Sylt (55° 00'N, 7° 54'E),

R.V. "Gauss" (first phase) and R.V. "Poseidon" (second phase) about 50 km northwest of the experimental site (55° 15'N, 7° 05'E),

Research platform "Nordsee" (52° 42'N, 7° 10'E),

Lightvessel "Borkumriff" (53° 51'N, 7° 22'E),

Lightvessel "Elbe 1" (54° 00'N, 8° 07'E).

A scetch of the area is given in Fig. 1. The stations of the radiosonde network will also provide routine surface observations. In order to improve the surface data density, especially of pressure readings, three buoys will be deployed additionally.

The aircraft programme ist implemented by the C 130 of the Meteorological Research Flight Facility at Farnborough and the Falcon 20 of the Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt. The aircraft will fly coordinated patterns and therefore during daylight hours only. It is planned to have aircraft missions for either convective cloud structures or a clear, undisturbed boundary layer. Days with aircraft mission will be "intensive days" with up to twelve radiosondes per day, while on normal days four radiosondes are released.

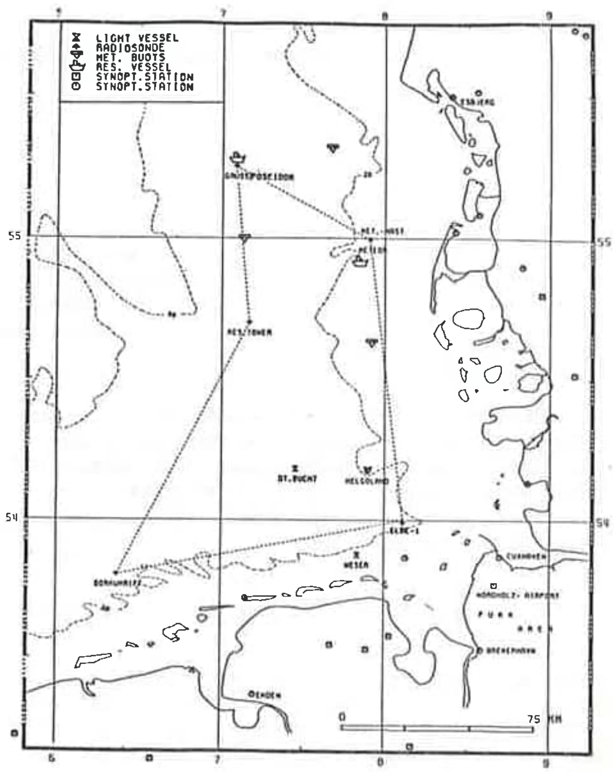

Figure 1: Schedule of radiosonde ascents

R.V. "Meteor" will fly a tethered balloon carrying turbulence sondes at four levels up to 1000 m to measure fluctuations of wind components, temperature and humidity, and additionally operate turbulence equipment between five and eight meters height on the "needles" of the experimental site.

The KonTur operations centre (KOC) will be established at the airport of Nordholz (near Cuxhaven). Nordholz will be the base for the aircraft during KonTur. The KOC provides overall control and coordination with the coastal experiment PUKK.

R.V. "Gauss" simultaneousl conducts an oceanographic programme.

2.4. Intercomparisons

A vital part for the integration of different measurement techniques from different platforms is a field intercomparison. It is planned that R.V. "Meteor" on the way to its station west of Sylt will pass by the other radiosonde stations and conduct intercomparison both of surface layer and radiosonde equipment. The two aircraft can intercompare in flight, e.g. on the way from or to the base. Frequent intercomparisons of aircraft with tether-sonde turbulence measurements are planned to be achieved by fly-bys of the aircraft near the tethered balloon of R.V. "Meteor" during the aircraft missions.