EUROMECH
European Mechanics Society

Newsletter 8
April 1997

President's Introduction

This is the first EUROMECH *Newsletter in a new format, under the Editorship of Dr John Finley. I welcome Dr Finley to the* EUROMECH *team and thank him for the work he is prepared to put in on behalf of* EUROMECH. *Readers will see, on p.2 that Dr Finley will be glad to receive comments on the format and content of the Newsletter. He will also be glad to receive contributions, in the form of brief articles, letters or announcements on topics in mechanics, for possible publication in future Newsletters.*

Readers will also see that in this issue we are publishing the first of a regular series of articles, by distinguished scientists, on important developments or major unsolved problems in mechanics. We are, further, publishing synopses of the reports on Colloquia submitted by Chairmen. Hitherto these had, after consideration by the Council, usually simply languished in the archives of the Secretary-General! Once the backlog of reports from 1995 and 1996 has been cleared, we shall publish reports from Colloquia in 1997 and onwards as they are received, to give an up-to-date picture to EUROMECH *members.*

A particularly important issue ***FOR ACTION NOW*** *by members of* EUROMECH *is that of the election in September 1997 of five new members of the* EUROMECH *Council. The Advisory Board (membership list on the internet at* http://www.euromech.maths.org.uk/) *will prepare a list of candidates on whom members will vote in June/July 1997, with papers issued with the next Newsletter No. 9 May/June. Suggestions for candidates can be made to any member of the Advisory Board. If you suggest a candidate, please make sure he/she is willing to serve on the Council for six years, and please supply a one-page curriculum vitae.*

Please do not simply suggest the most prominent scientists; such people are usually already very busy, and may not have the time needed. EUROMECH *has much to do, and the Council needs new blood, younger members and men and women with the ideas, energy, time and resources to really work for mechanics through* EUROMECH!

D.G.Crighton
President EUROMECH

EUROMECH Newsletter 8
Contents

The Newsletter

It is hoped to produce the Newsletter at more regular intervals, and in more substantial form. It will continue to carry the formal notices of the Society, but will also contain other material of potential general interest to members. From time to time we hope to have articles by members, generally about two to three pages in this format, or 900 – 1300 words. A suggestion is that members should comment on the unsolved problems which they would wish to see understood in their own lifetime. This issue carries a rather longer article by Sir James Lighthill. We will also carry short accounts of the Colloquia prepared from the Chairmen's reports (approximately 400 words). If chairmen do not wish to be misrepresented, it might be wise to provide a version of this length even if a lengthier report is submitted to the Council!

We will continue to give notice of meetings and conferences which are not arranged by EUROMECH, but will not copy the application forms. A short notice similar to that provided for Colloquia arranged by EUROMECH will include appropriate addresses, wherever possible e-mail.

This number has been prepared broadly to the format of previous Newsletters, apart from the significant reduction in size. Again, the type face is smaller. If this causes problems for members, please let me know. The Editor has also indulged certain of his individual preferences – words are not split at the end of lines, and the text is not justified, leading to a ragged right hand margin. If this is thought inelegant, again, let me know.

It would help if material for publication were to be sent both in hard copy and on disc, to save retyping. Graphics should always be in hard copy suitable for publication. Mac format is preferred, but DOS/Windows discs can be read, though often with loss of format and special symbols. This Newsletter has been prepared in Word 5 for Macintosh.

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NOTICES

EUROMECH CONFERENCES
(a reminder)

ESMC-3 *3rd. EUROMECH Solid Mechanics Conference:*
18 - 22 August 1997, Stockholm, Sweden.
Prof. B.Storåkers (Chairman) and Dr. P-L. Larsson (Secretary)
Department of Solid Mechanics, Royal Institute of Technology,
S-100 44 Stockholm, Sweden.
e-mail: 3esmc@halff.kth.se

EFMC-3 *3rd. EUROMECH Fluid Mechanics Conference:*
15 - 18 September 1997, Göttingen, Germany.
Prof. G.E.A.Meier (Chairman)
DLR Institut für Stömungsmechanik, Bunsenstraße 10,
D-37073 Göttingen, Germany.
e-mail: efmc97@msfdl.dnet.gwdg.de
http://msfm42.gwdg.de/efmc97/

OTHER CONFERENCES

September 22-26 1997. Aussois, France.
3rd International Conference on"Transfer Phenomena in Magnetohydrodynamic & Electroconducting Flows."
A.Alemany (Chairman), B.Collovati (Secretary), Ph.Marty (Scientific Secretary)
e-mail: beatrice.collovati@img.fr
http://www.legi.img.fr/mhd/pamir.html

October 6-11 1997. Bari, Italy.
9th. International Conference on"Waves and Stability in Continuous Media"
M.Maiellaro (Bari), S.Rionero (Napoli), Chairmen.
e-mail: arclab@sun.dm.uniba it

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Membership Fee for 1997 – Deadline 30/06/97

Please send your membership fee for 1997 to Prof. E-A. Müller, Treasurer of EUROMECH, Max-Planck-Institut für Strömungsforschung, Bunsenstr.10, D-37073 Göttingen, Germany.

Methods of payment:

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NOTICES

EUROMECH COLLOQUIUM 358
CHANGE OF DATE

"Mechanical behaviour of adhesive joints: analysis, testing and design"
Nevers, France

To avoid a clash with AUM, this meeting has been put back one day, the revised date being *4-6 September* 1997.

Prof. S. Aivazzadeh, Institut Supérieur de l'Automobile et des Transports.
49. rue Mademoiselle Bourgeois, BP 31, F-58027 Nevers, France.

EXTENDING THE FLUID MECHANICS OF AIR–SEA INTERACTION TO EVER HIGHER WIND SPEEDS

Sir James Lighthill, FRS. (University College London)

ABSTRACT
The past three decades of hard-won progress in understanding air-sea interaction have made a most valuable beginning. Yet the big challenges, of extension to still higher wind speeds (around 50m/s) relevant to the energetics of Tropical Cyclones, will need perhaps two more decades of dedicated observation and analysis.

1. An early campaign to promote air-sea interaction mechanics

In 1964, having devoted the first twenty-one years of my working life mainly to aerodynamics, culminating in five years as Director of the Royal Aircraft Establishment (Farnborough), I chose to branch out into new fields that would include not only biomechanics, but also ocean dynamics. Into this latter field I had been skilfully drawn by the late George Deacon who showed me the exciting work he directed at the then National Institute of Oceanography (Wormley) – one of the distinguished laboratories about to be placed under the control of Britain's new Natural Environment Research Council (NERC); of which, early in 1965, I became one of the fifteen founder members. Very soon, NERC appointed an Oceanography and Fisheries Research Committee and I accepted its chairmanship, with special responsibility for fostering research in both physical and biological aspects of ocean science; although here I write only about the physical aspects.

With fellow members of that committee, including Henry Charnock, I was conscious that air-sea interactions generate most ocean waves and currents and, reciprocally, are major influences on weather and climate. Yet, as an aerodynamic specialist moving into oceanography, I found far too much separation between the sciences of the atmosphere and the ocean. For example, meteorologists engaged in ever more refined studies of atmospheric motions seemed content to paramaterise, in only the simplest possible way, such key influences on those motions as transfers of water vapour, heat and momentum between the ocean and the atmosphere. Against this unpromising background for a programme of interaction studies that would need intimate involvement of meteorologists with physical oceanographers, a campaign to set up such a programme was nevertheless launched, with strong support from the Royal Society (of which I was then Physical Secretary).

The Royal Society project became known as JASIN (Joint Air-Sea Interaction Project) and, after a purely UK trial in 1970, was progressively expanded to involve five other countries from Western Europe, along with Russia, USA, Canada and Australia. by the summer of 1978 (5 July to 17 September) when the

main experiment was carried out[1] with the full co-operation of the (now convinced) meteorological community, seven UK ships co-operated with three German, two American, one Dutch and one Russian ship and with three aircraft (from UK, USA and Germany) in a 150km area of the Atlantic centred around 59°N, 12½°W that included 35 instrumented moorings. Several ships used tethered balloons – and released radiosonde balloons – for meteorological measurements, others specialised in ocean soundings; and observations from space by Seasat were calibrated from JASIN stress-vector data.

In summer westerlies over mid-latitude oceans, JASIN showed that about one-third of the radiative heat input to the sea was given up to the air (mainly as evaporative latent-heat flux); where, typically, a well-mixed boundary layer would underlie convective cloud cover. Ocean current distributions (barotropic and baroclinic, with thermocline depths around 30 to 40 m) were identified, along with spectra of internal waves – and with structures of fronts in both atmosphere and ocean. Above all, an international community of experts in the adjacent, and interacting, boundary layers in both media was created.

2. Continued expansion of the field

Since JASIN, many important new programmes of air-sea interaction have been initiated world-wide; meteorologists having, indeed, long abandoned former doubts about the importance of oceanography. In this they were influenced partly by being called on to use surface-wind forecasts to produce forecasts of the resulting ocean-wave distributions; such forecasts being needed, not only over continental-shelf areas that included oil and gas installations (and where, possibly, they might assist in evaluation of ocean waves as a renewable energy resource), but also over deep oceans where they contribute valuably to ship-routing computations. Then a greatly increased emphasis on long-range climate forecasting necessitated the use of global numerical models for ocean and atmosphere combined and call, of course, for rates of transfer at the ocean surface to be represented as accurately as possible. In this brief article I select for mention just two of the successful international programmes of recent years; one related to momentum transfer and one to transfer of heat and water vapour.

The group led by Klaus Hasselmann in Hamburg, Germany, had by 1988 developed a highly effective Wave Model (WAM) with the co-operation of scientists from five other countries of Western Europe (Netherlands, Italy, France, UK and Norway) and from USA, using results of extensive experiments on wave growth as well as field data on wind input to waves. The WAM model[2] integrates the transport equation for the two-dimensional ocean-wave spectrum, with **(i)** source functions specified from the wind's friction velocity and calibrated from uniform-wind experiments; with **(ii)** non-linear transfer from resonant wave-wave interactions paramaterised by Hasselmann's discrete-interaction approximation; and with **(iii)** dissipation (due to white-capping and turbulence) described in such a way that fully developed waves attain the

Membership of EUROMECH

The treasurer would like to make known more generally both how many members of EUROMECH there now are and the wide distribution, by no means confined to Europe. Forty-two countries are represented.

Membership: 1996

Albania	2	Ivory Coast	1
Austria	17	Japan	7
Azerbaijan	2	Lithuania	3
Belgium	8	Macedonia	3
Bulgaria	15	Mexico	1
Cameroun	1	The Netherlands	19
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China	6	Portugal	4
Croatia	6	Romania	33
Czech Republic	22	Russia	95
Denmark	5	Slovak Republic	4
Estonia	5	Slovenia	7
Finland	1	Spain	10
France	139	Sweden	24
Germany	131	Switzerland	8
Great Britain	87	Tunisia	1
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Iceland	1	United States of America	27
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Israel	16		
Italy	129	*Total:*	963

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EUROMECH Colloquium 341

Smart Structures and Materials

Chairmen: J.M. Crolet (Besancon), A.Preumont (Bruxelles)

The objective of EUROMECH 341, held on September 26th. – 28th., 1995 at Giens, was first to encourage the connection of the disciplines concerned in the development of this new sector of activity and then to summarize the advances in knowledge and technique for the concept of smart materials. Sixty-five participants were present at Giens to hear thirty-nine presentations from twelve countries, and all the main European teams working on this subject were represented.

The connection between disciplines concerned various aspects of mechanics, mathematics and to a lesser degree, automation. Many participants appreciated this range of subjects, but it seems desirable , in the future, to place more emphasis onautomation (activators), electronics and the science of materials.

Many significant theoretical results were been revealed, the major parts of which related to methods for stabilization of elastic, air-elastic and acoustic structures. New mathematical results on problems of stabilization showed that there are important advances in this subject by the European mathematical and mechanical communities. It seems that this aspect is rather better developed in Europe than in the USA. The description of experimental results and industrial applications made a really big impact. At the end of this Colloquium many participants thought that the smart materials concept had become a reality in Europe, since it had already given birth to the first industrial applications.

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observed Pierson-Moskowitz spectrum. Wave-packet propagation along great-circle paths (combined with dispersion and diffusion) is well described by the deep-water mode; while the extension to shallow water is based on data from the Joint North Sea Wave Project (JONSWAP). Good agreement between hindcast and observed waves was achieved even for hurricanes in the Gulf of Mexico, as well as for storms in the Atlantic and North Sea; while many further verifications come from Seasat data. The WAM model is now used satisfactorily for operational wave forecasting.

Besides this programme with modelling aims, another large programme entitled Humidity Exchange Over the Sea (HEXOS), pursued by five countries in Western Europe (Netherlands, Germany, France, UK and Denmark) with Canada and USA, has been directed primarily towards winning new data on transfer of water vapour and sensible heat – and secondarily to systematizing the results. After a pilot experiment in 1984, the HEXOS main experiment[3] took place near the Dutch coast from 6 October to 28 November 1986 with the use of **(i)** the Dutch research platform *Meetpost Noordwijk*, **(ii)** a tripod-based mast operated by Kiel University, and **(iii)** a British aircraft and research ship. Fluxes of each quantity were directly measured from its covariance with vertical velocity. because special interest attached to the water vapour transfer coefficient, the fact that for wind speeds up to 18m/s it took an essentially constant value 0.0011 (the same as the heat transfer coefficient) is viewed as a particularly important conclusion fro these researches.

3. Needs related to the thermodynamics of Tropical Cyclones

Tropical Cyclones (TC) are those huge cyclones (often called hurricanes or typhoons) in which the inward component of cyclonically spiral winds vanishes at the "eyewall": a circular wall of very dense convective cloud surrounding an essentially clear " eye of the storm". The eyewall is where water vapour transfer from the ocean to inwardly spiralling surface winds has raised their humidity to 100%; the thermodynamics of such saturated air allows it moreover to be lifted by buoyancy forces right up to the top (around 15 km altitude) of a not too stably stratified troposphere. A heat-engine analysis of the TC views it as following a Carnot cycle, with **(i)** surface winds gaining energy – mainly as evaporative latent heat – at approximately the sea surface temperature (around 300K); with **(ii)** the working phase as a nearly adiabatic process for rising saturated air subject to buoyancy forces in the eyewall; and with **(iii)** heat being lost at approximately the stratospheric temperature (around 200K). The mechanical energy gain (Carnot efficiency times energy input) is balanced by losses due to frictional dissipation at the sea surface.

This balance between latent-heat input and frictional dissipation indicates why TCs are tropical phenomena. For each unit mass of air, possible latent-heat input is proportional to the saturated water-vapour concentration (by mass) which is a steeply increasing function of temperature; yet dissipation rates in the atmospheric boundary layer depend little on temperature. Furthermore, to a first

approximation, turbulent (and radiative) heat transfer tends to equalise the temperature at which TC winds begin their rise in the eyewall with the sea-surface temperature (SST), suggesting a possible dominant influence for SST on TC formation and intensification. In strong support of this suggestion, Gray's comprehensive studies[4] of observed TC formation showed that SST is in every case at least 26°C.

Yet there are excellent reasons for seeking to go beyond such a "first approximation". I became aware of these as leader of a group of mechanics, geophysics and oceanography specialists representing the International Council of Scientific Unions (ICSU) in a joint programme of research[4] with the World Meteorological Organisation (WMO). The ICSU group secured, for our first joint meeting "Tropical Cyclone Disasters" (Beijing, October 1992), an exceptionally strong representation of oceanographers – including, from Russia, Dr. V.D.Pudov who had with colleagues taken part in courageous research-ship cruises through typhoons. In addition to quantifying heat losses from the ocean in a TC's wake, they had executed careful measurements in winds so intense that "a third fluid" – spray – is present between atmosphere and ocean; conditions under which they found wind temperatures significantly below SST.

Since that meeting, a collaboration of Australian meteorologists with Dr. Pudov yielded[5] an analytical interpretation of his data which suggests **(i)** that in typical TC winds the spray density is only about 1% above that of air, and yet, **(ii)** that the wind receives about 90% of its evaporative latent heat directly from spray droplets; while **(iii)** in this process, wind cooling is substantial in spite of heat transfer from the ocean surface. Yet it should be stressed that remarkable phenomena such as (ii) and (iii) arise only at speeds well above those for which the HEXOS group found (section 2) no measurable changes in evaporative regime.

If the above analysis is correct, then (i) suggests little effect of spray on momentum transfer – or on frictional dissipation – and thus supports the view (section 2) that WAM may be applicable even in hurricanes. By contrast, (iii) suggests that, whenever spray becomes even more intense, evaporative latent-heat input to rising air in the eyewall must fall still further below that which would be associated with air at the full sea-surface temperature. The two suggestions taken together imply that rises in TC intensity in response to increases in SST above 26° may be largely self-limiting – for a fuller explanation of this implication see the proceedings of another joint ICSU/WMO meeting which I chaired (Mexico, November 1993) on Global Climate Change and Tropical Cyclones[6].

4. Concluding remarks

The question to which this tentative answer was given remains, on the other hand, an extremely important one, and it must be confessed that the total amount of data available on air-sea interaction at extreme wind speeds is still far too small to permit the drawing of definitive conclusions on TC thermodynamics. That is why

from internal wave fields and stratified turbulence. These quite different dynamical regimes are often closely connected in actual flow problems, and a purpose of this colloquium was to better understand these connections. Participants were interested in fundamental aspects or in more specific applications, in engineering, geophysics and astrophysics. The colloquium was a rare opportunity to gather scientists with these different points of view, to compare approaches and results, and to stress general problems.

There is a full report of this meeting in *J.Fluid Mech.* **314** 349-371 (1996)

EUROMECH Colloquium 340

Statistical Properties of Turbulent Gaseous Flames

Chairmen: D. Roekaerts and Th.H. van der Meer, Delft, Nederland

EUROMECH colloquium 340 on "Statistical Properties of Turbulent Flames" took place at Delft University of Technology, from August 30th. to September 1st., 1995. The colloquium was organized in association with the ERCOFTAC Special Interest Group on "Aerodynamics of Stationary Combustion Chambers and Furnaces" and was supported financially by ERCOFTAC, by the J.M. Burgers Centre for Fluid Mechanics and by Shell Nederland BV. Participants came from 15 countries.

The objective of the colloquium was to compare measurements and predictions of statistical properties of turbulent gaseous flames. The main emphasis was on statistical properties as described by probability density function (PDF) methods. Other techniques for describing the interactions between turbulent mixing and combustion reactions were also discussed. About thirty-five papers were presented.

The presentations covered not only Monte Carlo PDF methods and assumed shape PDF methods, but also moment-closure methods andLES/DNS. The experimental contributions focused on laser diagnostic methods. Model development in the areas of premixed flames, micromixing and reduced kinetics was reported.

In the Colloquium participants were encouraged to contribute to lively, informal and penetrating discussions. We think that many of them have taken the opportunity to do so, and have developed new ideas that will show up in the literature soon.

In the framework of the ERCOFTAC Special Interest Group on Aerodynamics of Stationary Combustion Chambers and Furnaces the validation of models and computer programs by critical comparison with laser diagnostic experimental data will continue, to the benefit of both academic and industrial users.

passive scalar in connection with windtunnel data for wake flow over a two-dimensional hill, and the solution of the boundary layer equations with dust simulated by changes in the thermodynamic properties of the flow. A second order numerical model, appropriate to flow computation over terrain, was presented, capable of ranging from time-averaged flow descriptions to sub-grid averaging such as Large Eddy Simulations.

Turbulent boundary layer flow across a regular array of roughness elements was studied, both experimentally and by numerical models, which are suitable for application to situations of geophysical interest such as canopy flow. From the analysis it appears that the large shear produced at the roughness element height is the mechanism limiting the scale length of the eddies, a quite general mechanism which is everywhere present in shear-driven turbulence.

The last day of the meeting was devoted to a consideration of the needs of data bases and to presentations describing selected cases. These included the ERCOFTAC base for dispersion behind buildings, the RUSHIL and RUSVAL data sets for turbulence and dispersion in two-dimensional windtunnel flow and the TRACT database describing field measurements in the valleys of the Rhine and the upper Ticino.

The meeting was closed by a round table discussion concerning suggestions for future development of the data bases for improving our knowledge on the boundary-layer turbulence and dispersion in complex terrain and for model evaluation. The main points raised during the discussion concerned the need to account for the time variability intrinsic even in a time-averaged steady process (the task being to describe and model the concentration fluctuations, starting from simple conditions) and for the unsteadiness of the real world, where the concept of ensemble averaging, for instance, has in practical terms a quite different outcome from the laboratory case.

EUROMECH Colloquium 339

Internal Waves, Turbulence and Mixing in Stratified Flows

Chairmen: C. Staquet and J. Sommeria, Lyon, France

Euromech colloquium 339 was organized by C. Staquet in Lyon (France) from September 6th. to 9th., 1995. It involved seventy-six participants from fourteen countries. Papers were presented on various aspects of stably stratified flows: (1) internal waves, their generation mechanisms, propagation and reflection properties, their instabilities leading to breaking; (2) vortex structures in stably stratified fluids, which can be slow layerwise structures, or small intense vortices, appearing for instance in shear flow instabilities; (3) statistical properties of random wave fields or stratified turbulence; (4) mixing properties resulting

I eagerly proceeded, on being invited to use this article to identify the problem within fluid dynamics which I would most like to see solved during my lifetime, to single out "the mechanics of air-sea interaction at speeds of 40 to 60 m/s typical of Tropical Cyclones". Perhaps there may already be some hopes of promising new methods for moving towards this goal – whether from satellite sensors, from new types of instrumentation on oil and gas installations in TC-affected regions, or from new approaches to fluid-dynamical analysis. Happily all possible methods are due to be reviewed in detail at yet another WMO/ICSU meeting (Hainan, China, January 1998). Yet hopes of success in this latest stage of development of air-sea interaction mechanics might be better justified if a few readers of this EUROMECH Newsletter were to respond by bringing their great talents to bear on the problem.

References

1. H. Charnock and R.T.Pollard (eds.). Results of the Royal Society joint air-sea interaction project (JASIN), *Phil. Trans. Roy. Soc. A,* **308** 219–449, (1983).
2. The WAMDI Group. The WAM model – A third generation ocean wave prediction model, *J. Phys. Oceanogr.* **18** 1775–1810 (1988).
3. J. De Cosmo, K.B. Katseros, S.D. Smith, R.J. Anderson, W.A. Oost, K. Bumke and H. Chadwick. Air-sea exchange of water vapour and sensible heat: the HEXOS results. *J.Geophys. Res.* (to appear 1996).
4. J. Lighthill, Zheng Zhemin, G. Holland and K. Emanuel (eds.). *Tropical Cyclone Disasters,* Peking University Press (1993).
5. C.W. Fairall, J.D. Kepert and G.J. Holland. The effect of sea spray on surface energy transports over the ocean. *The global atmosphere and ocean system* **2** 121–142 (1994).
6. J. Lighthill, G. Holland, W. Gray, C. Landsea, G. Craig, J.Evans, Y. Kurihara and C. Guard. Global climate change and tropical cyclones. *Bull. Amer. Meteorol. Soc.* **75** 2147–2157 (1994).

Reminder

1997 Membership fee

See page 22

EUROMECH Colloquium 329

Methods for Nonlinear Stochastic Structural Dynamics

Chairman: G.I. Schueller, Innsbruck, Austria

The meeting, held March 13th.-17th., 1995 in Innsbruck/Igls, was concerned with problems of nonlinear stochastic structural dynamics and addressed theoretical developments and applications. Topics such as Stationarity, Non-Stationarity, Non-Gaussian Properties, Simulation, Stochastic Linearization, Parameter Uncertainties, Comparative Studies, Chaos, Stochastic Stability, Duffing Oscillators, Reliability, Waves in Random Media, System Identification, Wind and Hydraulic Problems, and Earthquake Problems were discussed. There were 42 presentations by authors from 12 European countries as well as from the United States and Japan.

One of the highlights of the meeting was a Panel Discussion on the main theme of the conference chaired by Professor Y.K. Lin, Director of the Center of Applied Stochastics Research at Florida Atlantic University, Boca Raton, USA. The Panel consisted of a number of renowned scholars and researchers, who presented their views and discussed them with the audience. The Panel Discussion in some ways summarized what was presented at the Colloquium. From this, three messages could be heard very distinctly:

1. Physical and Stochastic Modelling should be combined.
2. More realistic systems (MDOF-systems) as well as conditional stochastic fields, etc., should be treated so they can be used in practical applications.
3. Analytical methods should be combined with numerical methods. In this context known solutions should be used as so-called "building blocks".

These and other problems should be treated in the future.

It was decided to accept the offer by the Editor of the Journal of Nonlinear Mechanics, Professor P.D. Spanos, to publish a selection of the papers as a special volume, following that journal's requirements.

EUROMECH Colloquium 338

Atmospheric Turbulence and Dispersion in Complex Terrain

Chairman: F. Tampieri, Bologna, Italy

Turbulence and dispersion in the atmospheric boundary layer over complex terrain was the unifying theme of the EUROMECH colloquium 338 and of the ERCOFTAC Workshop "Data on Turbulence and Dispersion in Complex Atmospheric Flows", held in Bologna, Italy, on September 4.-7, 1995, with 44 participants; of these 10 were students from universities and research institutes.

The meeting opened with discussions of scalar dispersion in the atmosphere, with emphasis on the observation by P.C.Chatwin that as yet there is no satisfactory theory which will describe dispersion in real flows. The problem of finding a truncated Gram-Charlier expansion to fit given probability distributions was addressed, and compared with the use of two Gaussian probability distributions This approach showed that, accounting for some high-order moments only, a computed pdf could capture the correct decay. A number of authors showed how standard solutions of the convection-diffusion equation might be applied to flow over complex terrain, with emphasis on the importance of the removal processes in describing atmospheric pollution.

Windtunnel measurements of the turbulence structure for a variety of approach flows, supplemented by concentration measurements were presented and two new windtunnels designed for atmospheric simulation were described. A set of field measurements in the sea breeze region was presented.

Parameterization problems in numerical codes for boundary layer flow over topography were addressed by a number of authors. Discussion centred on the representation of roughness height and possible improvements on the mixing length concept.

Fundamental studies in fluid mechanics included results from a number of carefully conducted laboratory experiments on stratified flows around bodies, giving a visualization of the wake and the internal waves developing at the same time, in the lee of a sphere. An approximate analysis of the strongly stratified stable flow over hills, looking at the problem of matching the upper part of the fluid and the lower was presented. Some implications of these concepts for the evolution of a front impinging on a mountain barrier were also discussed.

Applications of analytical models of flow over terrain to various problems were shown by different authors, and the results compared with more complex numerical models. Problems addressed included the critical slope for separation, wind-produced fast-moving water waves and stable stratification effects on the form drag of two-dimensional hills. These studies should assist improvement of Numerical Weather Prediction. Problems associated with sub-grid paramaterisation included the definition of the area-average of the properties of a

EUROMECH Colloquium 337

Plastic Flow Instabilities at High Rates of Strain

Chairmen: C.Fressengeas, Metz, France; B.Dodd, Reading, UK

The colloquium was held at the University of Metz on July 10th.-13th., 1995. The colloquium venue was the 14th. century cloister "Cloître des Récollets" in downtown Metz. It focused on phenomena such as adiabatic shear banding and dynamic ductile fracture, and on their applications to penetration and perforation of plates, dynamic fragmentation of plates and shells, shaped charges, metal cutting, machining and metal forming at high velocities. Not only conventional metallic alloys have been covered, but also more "modern" materials, such as metal matrix composites. The contributions were allocated to six themes, each theme providing the basis for one of the six working sessions:

- Material behaviour
- Instabilities
- Adiabatic localization
- Experimental techniques and observations
- Forming processes

and - Shaped charge jets, penetration.

The basic theme of the colloquium (as stated in its title) was covered from various complementary points of view. Experiments and theoretical models (analytical and numerical) were reported. The microstructural as well as the macromechanical continuum aspects were reviewed. Fundamental as well as applied investigations were presented, although the fundamental ones were the more numerous. Due to that variety, it is believed that the Colloquium could be of interest for any expert working in the field; 40 scientists, many of them young, participated in the Colloquium.

The discussions brought to the attention of the participants the need for two offshoots of this colloquium, which could possibly be proposed to EUROMECH in the near future. One of these proposals could be concerned with terminal ballistics in multi-layered composite materials (DODD), the second one with explosive material elaboration and forming processes (PRUEMMER).

EUROMECH Colloquium 330

Laminar/Turbulent Transition of Boundary Layer Influenced by Free-Stream Disturbances

Chairman: P.Jonas, Prague, Czech Republic

The problem of the onset and development of laminar/turbulent transition in boundary layers under a free-stream with disturbances of various kinds has received wide interest in the fluid-dynamics communities engaged in fundamental and applied research. Most of the major European research groups participated in this Colloquium, held on April 10th.-13th., 1995 in Prague. Most of the participants stayed until April 14th. to attend the Workshop of ERCOFTAC SIG on Transition. The Colloquium was attended by 43 scientists, of which 5 were from Eastern Europe and 7 from the Czech Republic. Thirty contributions were presented by authors from 13 countries.

The main aim of the colloquium was to stimulate the exchange of ideas and results describing the physics of the phenomena, the mathematical aspects and experimental observations of transition in 2D and 3D-boundary layers.

The contributions can be grouped as follows, according to the methods used:

Analytical Studies (4 papers) based on the NS-equations, linear stability theory and the analogy between electromagnetic waves and waves in fluid flow.

Numerical Studies (8 papers) demonstrated a large range of approaches to the problem: e.g., large eddy simulation, linearized unsteady boundary layer equations, linearized NS-equations, parabolized stability equations, direct numerical simulation of NS-equations and the use of conditional averaging. The receptivity of boundary layers to disturbances of various kinds and intensities was studied.

Modelling of transitional boundary layers (6 papers) showed quite good computational prediction of some (but, as usual, not all) important boundary layer characteristics by means of various models including an algebraic model for the transition region, one-equation turbulence models (k-ε) and γ models, (k-*l*) or (k-ε) and RST models.

Experimental investigations of by-pass transition (16 papers) covered a wide range of boundary conditions, as well as of processes and phenomena. For example: boundary conditions: smooth flat plates, a curved turbine blade, a stagnation region on a cylindrical surface, a stratification of the fluid density near the surface, external disturbances coming from homogeneous grid-turbulence or from the wake of a body upstream of the boundary layer onset, disturbances generated by oscillating surfaces, etc.. Phenomena such as the flow stability, the internal structure of transitional boundary layers, the occurrence of turbulent spots, longitudinal streaks, bursts and other coherent motions were investigated.

Other topics were also explored: the effect of the dissipation length scale at a given turbulence intensity, the effect of the position and direction of an impinging wake on the boundary layer, and the changes in the heat transfer and in the temperature distribution originating in the by-pass transition route. The measurements were performed mainly by means of a hot-wire anemometer. Simultaneously, several interesting benefits were reported on the performance of hot film surface gauges in transition research.

Some presentations gave notice of preliminary results of recently-started investigations, and interesting new subjects have emerged from the discussions. It has to be stressed that computation, experiment and theory were well balanced in the contributions presented. The problem of by-pass transition is still a vivid one. This is why it might be helpful, after 3-4 years, to call the researchers investigating by-pass transition of boundary layers together again.

EUROMECH Colloquium 331

Flows with Phase Transition

Chairman: G.E.A. Meier, Göttingen, Germany

The colloquium "Flows with Phase Transition" had 43 contributions in total and was held on 13th.-17th. March 1995 in Göttingen. A detailed view of the different discussions is given in the "Book of Abstracts" (DLR-Mitteilung 94-11).

Many two-phase phenomena and their coupling to flow fields were discussed in the elaborate programme of the Colloquium. The first three sessions were devoted to nonequilibrium phase transition and dealt with nucleation phenomena, with droplet growth and gasdynamic applications. After a short session about vapour bubbles with two contributions, the following session was devoted to wave propagation in liquid-vapour mixtures. The 6th session dealt with droplets, sprays and reactive flows. The 7th session focused attention on modelling and dynamics of two-phase flows with some interesting contributions explaining experimental findings theoretically. The final session, on film condensation and evaporation, was mainly concerned with the inlfuence of walls on condensation and evaporation in flows. Theoretical, numerical and experimental contributions were in very good balance. All presentations had lively discussions.

The colloquium was a follow-up of the earlier colloquia 245 on "The Effect of Background Rotation on Fluid Motions" held at Cambridge in April 1989, and 288 on "Turbulent Flows Undergoing Distortion and Rotation" at Lyon in April 1992. The response with which this Colloquium was met made it necessary to reject more than 10 submitted abstracts in order to keep the it within the 3 days. 48 abstracts were accepted for presentation and grouped into 10 scientific sessions according to their subject area. The speakers were granted 20 minutes each for their presentation, except for 4 carefully selected keynote lecturers who were allotted 40 minutes. The particular sessions that were introduced by a keynote lecture were those on "Görtler Vortices" (J.M. Floryan, University of Western Ontario), "Swirling Flow" (S.V. Alekseenko, Institute of Thermophysics in Novosibirsk), "Coriolis Effects on Turbulence" (C. Cambon, Ecole Centrale de Lyon), and "Mixtures and Centrifugal Separation" (M. Ungarish, Technion).

The overall theme of the colloquium concerned flows substantially affected by body forces arising due to either streamline curvature or system rotation, i.e. centrifugal or Coriolis forces, or both. All flow regimes ranging from laminar via transitional to fully developed turbulence were considered, with emphasis on incompressible flow phenomena. Stability and transition studies, including the formation and stability of Görtler-like vortices, had been accomplished both experimentally and analytically (sessions 1 and 2). The influence of system rotation on homogeneous turbulence and turbulent shear flows was explored by means of spectral analysis (RDT, EDQNM) and numerical simulations (LES, DNS) in sessions 5 and 6, while engineering turbulence modelling was addressed in session 9. Swirling flows, arising frequently in industrial environments (Hydrocyclones, rotor-stator cavities, draft tubes), were addressed from a practical point of view in session 3 and in simpler geometrical configurations in session 4, while problems associated with centrifugal separation of mixtures were dealt with in session 8. Spin-up of fluid bodies from rest (session 7) has obvious relevance for centrifugal applications, and, moreover, represents a vehicle for fundamental investigations of vortex dynamics (both experimentally and numerically). Finally, some participants examined the combined influence of rotation or streamline curvature with another body force, notably that due to buoyancy (session 10).

The considerable interest in the theme of the colloquium, probably arising from its practical relevance in combination with the fascinating physical subtleties induced by centrifugal and Coriolis forces, suggests that another colloquium on the same theme can be held in 3 years' time.

An extended account is to be found in *Fluid Dynamics Research* **18** 53–64, 1996.

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of 3D DPIV were presented by scientists from Swiss Federal Institute of Technology, University of Warwick, Osaka Institute of Technology, DLR Germany and RWTH Germany. A brief presentation of the activities of a joint group for application of PIV to large wind tunnels (GARTEUR) was given by M. Stanislas (the GARTEUR Workshop and Meeting followed the Colloquium, June 8-9 1995).

The fourth session was introduced by a lecture from G. Carlomagno (University of Naples) on Infrared Thermography. It was followed by a short presentation session where 9 papers were presented: this session was particularly stimulating for comments and discussions. Papers from Exhibitors (see below) and three papers from the host institution (University of Rome) were included in this session. The final session was concerned with Liquid Crystals (LC) and Laser Induced Fluorescence (LIF): it was introduced by a lecture by J. Stasiek (City University of London). Four papers on LC were presented from Ruhr University Bochum, Centre for Mechanics in Warsaw, University of Surrey, and TU Freiberg. Three papers on LIF, from ONERA and CNRS in France, and from DLR in Germany concluded the Colloquium.

Authors were invited to submit a full length paper for a special issue of Applied Scientific Research by Kluwer Publishers before September 1 1995.

Some of the major industries and companies involved in Image Analysis hardware and software production were invited to exhibit their recent PIV products. The following companies decided to accept the invitation:

TSI GmbH, DANTEC Measurement Systems and QUANTA SYSTEM srl.

EUROMECH Colloquium 336

Flows dominated by centrifugal and Coriolis forces

Chairman: H.I. Andersson, Trondheim, Norway

The 336th Euromech colloquium, on flows dominated by centrifugal and Coriolis forces, was held in Trondheim from June 21st. to 23rd., 1995 with the author acting as chairman. An objective of the colloquium was to display the similarities and differences between flow phenomena induced by streamline curvature and system rotation. The forty-eight papers which were presented covered a wide range of flow problems with emphasis on geophysical as well as engineering applications. The purpose of this survey is to give an overview of the major topics addressed at the colloquium, anticipating that these reflect current trends in research on flows exposed to centrifugal and/or Coriolis forces.

EUROMECH Colloquium 332

Drag Reduction

Chairmen: P. Luchini, Naples, Italy; D.W. Bechert, Berlin, Germany

Following the eight European Drag Reduction Meetings held at Lausanne , London , Chatillon Lausanne, Teddington , Eindhoven , Berlin and Lausanne, a EUROMECH colloquium devoted to Drag Reduction and ERCOFTAC Workshop on Active Control for Turbulent Drag Reduction (Chairman K.S. Choi) was organized by the University of Naples Federico II in the village of Ravello, near Naples in Italy, from 19th. to 21st. April 1995. There were 50 participants.

The scope of the meeting encompassed a wide range of mechanisms and devices through which the structure of turbulence can be manipulated to the end of reducing the drag caused by internal or external turbulent flow, e.g. riblets, compliant walls, moving walls and the modification of the rheological properties of the fluid through chemical additives or particles. Three invited and 35 contributed papers were presented on the theoretical and experimental understanding of drag reduction phenomena, including in-flight experiments, as well as on ways of overcoming practical difficulties and on emerging new methods and combinations. Separation control and active versus passive techniques of drag reduction were also given space in both general lectures and contributed papers. The lively final discussion concentrated upon the basic similarities and differences of the physical mechanisms involved in different kinds of active and passive drag reduction and on the potentialities for future development.

EUROMECH Colloquium 333

Ground Freezing: Mathematical Models and Applications

Chairman: A. Fasano, Firenze, Italy

The Euromech colloquium 333 devoted to "Ground Freezing: Mathematical Models and Applications" was held in Montecatini Terme, near Florence, June 2nd.–4th., 1995. The organization of the colloquium was affected to some extent by the fact that the Organizer, Prof. Mario Primicerio, was elected Mayor of the City of Florence shortly before the conference and had to discontinue all his academic engagements. Professor. A. Fasano took over all organizational matters at very short notice.

Freezing of fluids in porous media is a phenomenon of great complexity and with relevant implications in civil engineering and environmental sciences, particularly because it is accompanied by a migration of the fluid towards the cold region.

The result is a sometimes intense heaving of the cold surface. The great attention devoted to this problem is certified by the fact that International Symposia on Ground Freezing (ISFG) are held every four years.

Freezing can occur basically in two ways: either by frost penetration, or by the formation of ice lenses. The physical mechanism responsible for the onset of the pressure gradient needed for the thermally induced flow (in the sense opposite to the one expected from buoyancy) is not well known, although there are various hypotheses.

The colloquium has been very useful in defining the state of the art in the delicate area of modelling, through a series of presentations of very high interest and quality. It has to be stressed that there are still contrasting views in the description and in the microscopic interpretation of this phenomenon. Nevertheless, it was pointed out that substantially different physical situations may indeed require different treatments, in order to emphasize some peculiar aspect (e.g. assuming the existence of a sharp interface between the phases is sometimes a more convenient approach than describing in detail the many coupled phenomena occurring in the so-called "frozen fringe" etc.). This stimulating colloquium will certainly influence future development in this research field.

EUROMECH Colloquium 334

Textile Composites and Textile Structures

Chairmen: P.Hamelin, Lyon, France and W.P.De Wilde, Brussel, Belgium

The aim of Euromech colloquium 334 "Textile Composites and Textile Structures", held on May 15th. – 17th., 1995 in Lyon, concerning the mechanical behaviour of composite materials and structures, has been achieved.

The first and second parts were dedicated to Textile Reinforcement. Here Textile Composite Characterization has shown that it is still necessary to develop experimental methods to analyse the mechanism and the interaction between fibres and matrix at different scales.

In addition, mixed methods, combining numerical calculations with strain or displacement analysis, seem to be particularly efficient to identify and evaluate the anisotropic stiffness and the failure criteria of complex composites such as braided composites, knitted composites or woven fabrics. It was noted that describing the textile reinforcement geometrical architecture is still a real difficulty which implies computer aided techniques. The description of the unit cell using a simplified method would be a real advance for homogenization and thus could minimize important computations using finite elements.

An interesting part concerns Dynamic and Impact Behaviour of Textile

Composites in which 2D or 3D reinforcement changes the wave propagation or the delamination failure modes. The dynamic experimental method can also be used for an anisotropic elastic characterization, and inverse methods can be successfully applied to experimental data.

The last part of the colloquium, on "Tensile Structures and Textile Application", was essentially dedicated to architectural projects using textile composites. An interesting contribution using large scale photogrammetry to determine the strain distribution on a three-dimensional textile structure allowed the validation of computational models. One of the main problems which limits the tensile structure design is still the exact definition of the pattern geometry and the form-finding software development which takes into account the rheological properties of textile composites and the exact boundary conditions.

EUROMECH Colloquium 335

Image Techniques and Analysis in Fluid Dynamics

Chairman: F.T.M. Nieuwstadt, Delft, The Netherlands

Scientific activities of the colloquium, held in Rome, took place on three days, June 5th.-7th. 1995, and were divided into five sessions:

1. Flow Visualization, Holography and Global Doppler
2. Particle Image Velocimetry I
3. Particle Image Velocimetry II
4. Short Presentations
5. Liquid Crystals and Laser Induced Fluorescence

Except for the first, each session was addressed by an expert in the field. About 30 papers were presented in all.

In the first session three papers concerned with flow visualization on a model airplane, on a stratified flow and on a convective flow came from leading groups in France and UK and from a Japanese University. One paper on Doppler Global Velocimetry was also given. In the second session, introduced by an overall lecture on the basic principles of Digital Particle Image Velocimetry (DPIV) by J. Westerweel (Delft), advanced applications of DPIV, especially to detect vortical structures in complex flow fields, were presented. Three of the major university groups in experimental fluid dynamics (TU Berlin, TU Delft and TU Denmark) and two other German teams (DLR Göttingen and Freie Universität Berlin) participated in the session.

The third session concerned the use of DPIV for study of fully three-dimensional (3D) fields. The subject was introduced by R.J. Adrian (University of Illinois) with an extensive and detailed overview of valuable recent results. Applications