International symposium on numerical weather forecasting Oslo, March 11–16, 1963

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An International Symposium on Numerical Weather Forecasting was held in Oslo, March 11 through 16, 1963, under sponsorship of the World Meteorological Organization and the International Union of Geodesy and Geophysics. Prior to this time there had been one similar international meeting, namely the International Symposium on Numerical Weather Prediction in Tokyo, November 7–13, 1960.[1] The eleven non-overlapping sessions of the Oslo Symposium, on five and one-half consecutive days, were convened in the spacious and attractive University Center on the new campus of the University of Oslo, located in Blindern in the western parts of Oslo, about 15 minutes from the city center. The University Center building is only a few minutes walking distance from The Norwegian Meteorological Institute, headquarters of the Norwegian weather service, whose Director Dr. Ragnar Fjørtoft was Chairman of the Program Committee for the Symposium.

Forty-two papers[2] were presented by scientists from twelve countries: Austria, Finland, France, Japan, Netherlands, Norway, Romania, Sweden, Union of Soviet Socialist Republics, United Kingdom, United States, and West Germany. To avoid overlap with the forthcoming international symposium on the dynamics of large-scale processes (to be held in Boulder during September 1963), the Program Committee aimed at restricting the Oslo symposium to "numerical problems connected with the numerical integrations of the hydrodynamical equations in general, and to specific problems of numerical and physical nature which appear when the integration techniques are applied to weather forecasting."

[1] Sponsored jointly by The Japan Meteorological Agency, The Science Council of Japan and The International Union of Geodesy and Geophysics.

[2] Some of these are found in the present, the previous or the following issues of Tellus.

More than half the papers presented were concerned with design, testing, or numerical-analysis aspects of dynamical-prediction models. Three papers (CORBY, KUIPERS, HAUG) dealt with the important problem of objective analysis. There were several papers on dynamical problems not concerned directly with prediction, of which two (by Charney–A. Eliassen and by Ooyama) revealed promising new lines of attack on the hurricane-development problem, with emphasis on the destabilizing role of the momentum boundary layer and on selective treatment or parameterization of cumulus-scale versus hurricane-scale convection. Holopainen showed that where a good aerological network exists, real wind data can be used to assess vertical turbulent stresses and the corresponding energy dissipation in the free atmosphere.

Arnason, Wiin-Nielsen and Edelmann discussed the baroclinic-stability problem for non-quasigeostrophic perturbations.

A few speakers (such as Duschkin, Gambo, Kindle, Pedersen) attacked the thorny problem of incorporating latent heat of water-vapor condensation (or evaporation) in dynamical-prediction models. Gambo also discussed the cyclogenetic role of sensible-heat transport from the sea surface, and gave examples of successful forecasts of wintertime cyclogenesis over the Sea of Japan. Pedersen reported good results in precipitation forecasts from a quasi-geostrophic model in which saturated-adiabatic conditions are postulated in the region of condensation.

General-circulation models based upon the momentum equations were discussed by Mintz and by Leith. (Similar work has been published by Smagorinsky.) There seems to be no doubt that such models can incorporate now the effects of continentality and of the annual insolation cycle. Moreover, it is possible to control truncation errors so effectively that integration can be extended (in steps much shorter than

one hour) over periods as long as several months or even years. A. Arakawa described an ingenious procedure for discretization of vorticity or momentum equations, in which the control of truncation errors is remarkable. (This procedure was used in the model discussed by Mintz.) Arakawa's scheme is based upon the idea of designing finite-difference approximations that conserve the discrete forms of certain quadratic integral invariants. It is well known from the work of Fjørtoft, Lorenz and others that this can be done in the spectral domain; Arakawa gives us now a means to achieve the same *gross* invariance in the function domain. It would be interesting to compare spectral analysis of inertial exchange in Arakawa's scheme with the corresponding exchange process under spectral integration. (Some aspects of the effect of discretization on inertial exchange were considered by Sundqvist.) Leith exhibited a fascinating moving picture of the cathode-ray-tube display of isometric analyses of his general-circulation calculations.

In connection with the general problem of truncation errors, the work of Holmström should be noted. This concerns the representation of *vertical* structure of the atmosphere by expansion in orthogonal functions determined empirically to minimize the residual "climatological" variance at each stage. (Similar work has been published by Obukhov and others.) It would be very useful to have Holmström's results applied explicitly to formulation of a dynamical-prediction model.

Analytical and numerical aspects of formulation of prediction equations were considered by several speakers. With a spectral, 28-parameter two-level model Lorenz investigated the consequences of small differences in initial states of two systems, by following each system as a point in an appropriate phase space. Some initial states are "stable" with respect to small initial differences within the noise level of meteorological data; some are not. In a simple, one-dimensional flow Platzman illustrated the breakdown of spectral integration when flow discontinuities develop.

In connection with formulation of "balanced" prediction systems, Green's-function methods were considered by several speakers (Dady, Nemchinov, Dobryschman). Dobryschman also discussed the "adjustment" (or "adaptation") problem with particular reference to the role of variation of the Coriolis parameter. A remarkable discovery was reported by Fjørtoft in connection with numerical solution of "balanced" equations of "mixed" type; that is, equations that are predominantly elliptic in character but are hyperbolic in some regions. This problem, well-known in numerical-prediction centers, has been side-stepped in most practical work to date by substituting synthetic data, where necessary, to render the equations completely elliptic so that conventional relaxation methods can be used. Fjørtoft has shown, by analysis of the operator spectrum, that conventional relaxation methods can in fact be used for mixed problems provided merely that the sign of the relaxation factor is alternated from one iteration step to the next. In this way the use of synthetic data, an unwholesome procedure at best, can be avoided. Hinkelmann considered the general problem of "filtering" the prediction equations and showed that "higher-order" filtering can be achieved by repeated application of certain operators.

Reports on the status of operational models at national numerical-prediction centers were made by Bengtsson (Sweden), Graystone (United Kingdom), Ito (Japan), Økland (Norway), Shuman (U. S. Weather Bureau), and Wolff (U. S. Navy). Ths use of Lagrangian or quasi-Lagrangian methods of integration is gaining ascendency in some circles, particularly in Norway, as evidenced in papers by Eliassen and collaborators, Fjørtoft, and Økland. Such methods are attractive because of their inherent simplicity, from a mathematical as well as physical point of view, and because in general they are stable from the standpoint of truncation error.

The Oslo Symposium served very effectively as a forum for dicussion of current research being carried out in many parts of the world. In a rapidly-evolving field, such international gatherings provide a means of communication that in many respects can be more effective than journal publication. (The Program Committee acted wisely, however, in advising participants to publish their contributions in the regular journals.) In the writer's view, the Symposium served also as a cogent reminder of the very important role being played by "small" countries in the development of numerical weather forecasting; that is, countries with limited resources in manpower and machine power.

This report can be completed only by congratulating the Norwegian hosts for excellent facilities and arrangements, and especially for the cheerful and informal friendliness that characterized the social side of the program. The latter was enlivened in a charming banquet speech given by Professor Erik Palmén, who reminded us with sly humor that our atmosphere is a part of the real world, and that we can still see it, feel it, and breathe it.