

**WMO/ICSU/IOC
WORLD CLIMATE
RESEARCH PROGRAMME**

**WMO
WEATHER PREDICTION
RESEARCH PROGRAMMES**

**CAS/JSC WORKING GROUP
ON NUMERICAL EXPERIMENTATION**

**RESEARCH ACTIVITIES
IN ATMOSPHERIC AND OCEANIC
MODELLING**

Edited by J. Côté

Report No. 35

**JULY 2005
WMO / TD - No. 1276**

© 2005, World Meteorological Organization

NOTE

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Editorial note: This report has been produced without editorial revision by the WMO secretariat. It is not an official WMO publication and its distribution in this form does not imply endorsement by the Organization of the ideas expressed.

From the Editor

There is considerable international activity in the development of numerical models for the purpose of climate simulation and for forecasting on various timescales. This publication is an attempt to foster an early interchange of information among workers in these areas. The material in the publication is the response to a "call for contributions" sent to approximately 650 scientists worldwide. Contributions obtained in response to this call are included if they are related to the CAS/JSC numerical experimentation programme, if they give new results, and if they are of suitable length and size. Reports that do not meet these criteria, have been previously published, or are purely theoretical may be rejected. Contributors do not routinely receive any correspondence concerning the contributions.

The most appropriate reports give results of new numerical experiments in the form of a succinct explanation accompanied by suitable tables and figures. The contributions are collected into subject groupings as appropriate. The range of subjects is expected to vary with time and depends on the submissions received. The large number of contributions from around the world indicates the wide scope of activities in numerical experimentation, and the valuable addition that this type of report makes to the refereed journals. Comments and suggestions for improvement to the publication are welcomed. To facilitate location of specific contributions, they are ordered alphabetically by author in the various subject areas. An overall index by author is also included.

The web-based publication is now well established and most contributions were submitted through the web site www.cmc.ec.gc.ca/rpn/wgne and a few still as an attachment to an e-mail message. Overall the electronic submissions are working well, thanks to Djamel Bouhemhem and Inès Ng Kam Chan, and make possible the production of this report on the web site. I would like to thank Yves Chartier who has been instrumental in setting it up. About 200 copies have also been printed in black and white and mailed directly from Montreal.



Jean Côté
Recherche en prévision numérique
Meteorological Service of Canada
2121, route Transcanadienne
Dorval, Québec H9P 1J3
Canada

ACTIVITIES OF THE CAS/JSC WORKING GROUP ON NUMERICAL EXPERIMENTATION (WGNE)

The JSC/CAS Working Group on Numerical Experimentation (WGNE) has the central responsibility in the WCRP for the development of the atmospheric component of climate models and, together with the Working Group on Coupled Modelling (WGCM), lies at the core of the climate modelling effort in WCRP. Close co-ordination is duly maintained between WGNE and WGCM. Furthermore, WGNE works in conjunction with the WCRP Global Energy and Water Cycle Experiment (GEWEX) in the development of atmospheric model parameterizations and, in this respect, WGNE sessions are held jointly with the "GEWEX Modelling and Prediction Panel". Liaison is also maintained with the SPARC "GRIPS" project (focussed on the intercomparison of model stratospheric simulations) and will be developed with the new SPARC initiative on stratospheric data assimilation.

WGNE additionally has an important role in support of the WMO Commission for Atmospheric Sciences (CAS) in reviewing the development of atmospheric models for use in weather prediction on all timescales. The close relationship between WGNE and operational (NWP) centres by virtue of the CAS connection underpins many aspects of WGNE work and provides a strong impetus for the refinement of the atmospheric component of climate models. WGNE sessions duly include reviews of progress at operational centres in topics such as data assimilation, numerics, physical parameterizations, ensemble predictions, seasonal prediction, forecasting tropical cyclone tracks, and the verification of precipitation forecasts. A particularly strong area of collaboration is in the planning and development of THORPEX: A Global Atmospheric Research Programme.

The following paragraphs review the main activities of WGNE in support of WCRP objectives, emphasising items arising at its twentieth session which was kindly hosted by the Met Office, Exeter, U.K., from 11 to 15 October 2004.

1. WGNE in the context of COPES

The Chair of the JSC made a brief presentation on "future directions of the WCRP including the Coordinated Observation and Prediction of the Earth System (COPES)". A COPES discussion document has been prepared and was being circulated widely for comments. It was emphasised that COPES is a strategy or framework and not a project, and work will be done through existing projects. As part of the structural changes necessitated by COPES, a WCRP Modelling Panel (WMP), and a WCRP Observations and Assimilation Panel (WOAP) have been set up, overseen by the JSC. The Chair of the WMP briefed WGNE about the aim and scope of this new Panel. To build on the strengths of existing projects, the WMP will involve the Chairs of all projects. To facilitate the coordination and interaction of WGNE and WGCM under the WMP, this would meet in conjunction with WGCM and WGNE in alternative years, starting with WGCM in 2005. It was also agreed that WGNE would in future have an explicit agenda item on the development of next generation atmospheric models.

Concern was expressed that the WOAP did not appear to have sufficient representation of data assimilation experts and it was agreed that this concern would be conveyed to the WOAP Chair.

The need for good metrics for climate-type models was discussed and WGNE noted that the WGCM is considering this and that PCMDI is already involved in developing metrics on applications. WGNE welcomed the idea of development of metrics in the spirit of the new 'unified' prediction systems and will also consider this at its next meeting.

2. Studies and comparisons of atmospheric model simulations

Model intercomparison exercises are a key element in meeting a basic WGNE objective of identifying errors in atmospheric models and reducing or eliminating them.

Atmospheric Model Intercomparison Project

The Atmospheric Model Intercomparison Project (AMIP), conducted by the Programme for Climate Model Diagnosis and Intercomparison (PCMDI) at the Lawrence Livermore National Laboratory, USA, with the support of the US Department of Energy has been an important and far-reaching WGNE-sponsored intercomparison. The second phase of AMIP (AMIP-II) is coming to a close and much of the data from these runs are available for a wide range of diagnostic sub-projects. Climatological comparisons are available for nearly every standard AMIP model output field. Overall, there have been progressive general improvements both in terms of the "median" model as well as for many of the individual models. The simulation of interannual variability and performance in specific geographical regions, as measured by global climatological statistics, also appear to be more realistic. Regular updates of the overall status of AMIP, model integrations, diagnostic subprojects are posted on the AMIP home page <http://www-pcmdi.llnl.gov/amip>.

WGNE expressed its gratitude to PCMDI for undertaking and successfully completing the AMIP projects and for creating a valuable infrastructure for processing model outputs at PCMDI and establishing efficient data formats etc for such exchanges of model simulations. WGNE recommended closure of AMIP2 in a time frame of six months. During this period PCMDI would announce the project's completion and update its status on AMIP homepage. It will also make available PCMDI diagnostics of all AMIP and CMIP runs. WGNE, WGCM, GMPP and PCMDI would discuss the future of AMIP beyond AMIP2.

"Transpose" AMIP

The goal of the Transpose AMIP is to obtain the benefits for climate model development and evaluation that have been realized in weather prediction by using climate models as weather forecasting tools, but without the huge costs of developing a complete NWP system. Initially the climate models are applied at their relatively low application resolutions and are not expected to make the best weather forecasts, however the approach will also encourage higher resolution studies. The method allows direct comparison of parameterized variables such as clouds and precipitation with observations from field programs such as ARM, early in the forecast while the model state is still near that of the real atmosphere. This is in contrast to the more traditional climate model statistical analysis based on the model simulated climate balance. In that approach the parameterizations see the erroneous climate model state rather than the true observed state.

Results were presented from the NCAR/PCMDI project, CAPT, the prototype version of "Transpose" AMIP developed for US modelling evaluation. These results demonstrate the viability and utility of this forecast approach for examining climate models and identifying avenues for improvement. It was agreed that WGNE would make a formal proposal to the international climate modelling community (including the AMIP mailing list) for an intercomparison Transpose AMIP.

Agua-Planet Experiments

WGNE has endorsed an intercomparison, the Aqua-Planet Experiment (APE), being led by staff from the University of Reading, NCAR and PCMDI. The details of the experiment and schedule are available at <http://www-pcmdi.llnl.gov/projects/amip/ape/index.html> and http://www.met.reading.ac.uk/~mike/APE/ape_home.html. The experiment is designed to provide a benchmark of current model behavior and to stimulate research to understand of differences arising from: (1) different models, (2) different subgrid-scale parameterization suites, (3) different dynamical cores, and (4) different methods of coupling. Sixteen groups have declared their intentions to participate. Some preliminary results were shown to WGNE which indicate a substantial spread in results with notably large variations in precipitation amounts. A Workshop will be held to discuss the results, summarize current model behaviour and produce a summary of research questions arising from the experiment.

Model-derived estimates of ocean-atmosphere fluxes

Evaluation and intercomparison of global surface flux products (over ocean and land) from the operational analyses of a number of the main NWP centres (the "SURFA" project) remains a high priority for WGNE. The atmospheric and coupled modelling communities and oceanographers have very strong interest in advancing SURFA, which could provide a good opportunity for progress in estimating and determining surface fluxes. Efforts are continuing through liaison with the newly-formed WCRP Working Group on Surface Fluxes (WGSF) to address the requirements of research, observations, analysis and modelling of surface fluxes within WCRP and closely-related programmes such as GODAE and GCOS. It was suggested that it was more convenient for NWP centres to provide data in real time. WGNE discussed the problems involved with adhering to data standards and noted that GODAE has been active in this area.

Regional Climate Modelling

The Chairman of the WGNE/WGCM RCM panel briefed WGNE about the joint WGNE/WGCM international Workshop, 'High-resolution climate modelling: Assessment, added value and applications' held in Lund, Sweden, 29 March to 2 April 2004. The Workshop focussed on the application of nested, limited-area models (LAM) for regional-scale climate simulations and climate-change projections. Among the recurring themes at the Workshop were the validation procedure and the identification of the added value beyond the simple increase in resolution. The relative merits and limitations of various approaches used for achieving high-resolution climate simulations (such as time slices of high-resolution GCM, variable-resolution GCM, LAM) and the ensuing climate-change impact analyses were also discussed. The Workshop was the forum for several proposals for collaborative endeavour which included: (i) an inter-comparison project of regional-scale climate-change projections for North America, NARCCAP, (ii) a "Transferability Working Group" (TWG), and (iii) a coordinated project exploiting the protocol of the "Big-Brother Experiment" (BBE). An electronic version of the Workshop proceedings is available from <http://www.natgeo.lu.se/Lars.barring/RCMworkshop/RCMhome.htm>.

WGNE also discussed results from SGMIP (Stretched Grid Model Intercomparison Project) noted that this was a very promising approach to higher resolution regional simulations. It will continue to monitor the developments in this area in its future sessions.

Stratospheric analyses and forecasts

Following a presentation by the SPARC Co-chair it was agreed to increase interactions between WGNE and SPARC including the establishment of agreed sets of model diagnostics. WGNE has already undertaken an intercomparison of stratospheric analyses and forecasts from a number of operational (NWP) models and a report is being prepared for publication.

SnowMIP2

A new Intercomparison of Forest Snow Process Models, (SnowMIP2) is being launched. The Working group commissioned by ICSI has drawn up a schedule of activities for the period 2004-2007. Three SnowMIP2 sites in Canada, Japan and Switzerland will be used, with simulations for forest and clearing at each site, simulations for two complete winters at each site, a pilot study with one model, and comparisons with ground and canopy snow loads. Both WGNE and GMPP endorsed the proposal.

3. Physical parameterizations in models

The GEWEX "modelling and prediction" thrust, with which WGNE works in close association, is devoting efforts to the refinement of atmospheric model parameterizations, notably those of cloud and radiation, land surface processes and soil moisture, and the atmospheric boundary layer. The discussion at the joint meeting of WGNE and GMPP, encompassing the

GEWEX Cloud System Study (GCSS), the Global Land-Atmosphere System Study (GLASS), the GEWEX Atmospheric Boundary Layer Study (GABLS), and the progress of CEOP is described in the report of the GEWEX Scientific Steering Group to the JSC.

Collaboration with WGNE in the related activities of land data assimilation, and reanalyses was discussed, and WGNE confirmed the value of the interaction with GMPP for parameterization work, particularly with GCSS. GMPP also considered that close interaction with AMIP is highly desirable. The analysis of the diurnal cycle in AMIP models will reinforce this. A special session on parameterizations is planned during the GEWEX SSG session in 2005.

A new GCSS Panel has been constituted, and a pan-GCSS meeting will be held in May 2005 in Athens. This will address clouds in the climate system, methodologies and metrics in assessing models, the fundamental role of precipitation in cloud systems, and advances in the representation of clouds in large-scale models. A joint WGNE/GCSS model intercomparison study of a Pacific cross section was proposed to evaluate physical parameterizations along the atmospheric cross section following the trade winds.

WGNE responded positively to this proposal and also suggested that there be a follow up exercise over continents. WGNE also proposed that participants for the study should include the AMIP community and that the proposal provides an excellent opportunity to bring together NWP and climate modellers.

The WGNE community provides comprehensive gridded output from global data assimilation systems for CEOP. Many modeling groups are utilizing CEOP data in research and development activities and this should lead to model intercomparisons during the CEOP period.

4. Re- analysis and data assimilation

Reanalysis projects

The ERA-40 reanalysis at ECMWF is complete and experimentation in preparation for the "interim reanalysis" has begun. This will run at least from 1989 onwards, with production beginning in 2005. The set of medium-range forecasts run twice daily from the ERA-40 reanalyses has been completed, and an "AMIP-style" simulation carried out for the ERA-40 period using the ERA-40 model and distributions of sea-surface temperature and sea ice. The ERA-40 publication series now comprises around 20 reports covering documentation of the data and of the data-assimilation system and its performance, and results from users of the ERA-40 data. The reports are available on-line for outside users (<http://www.ecmwf.int/publications/library/do/references/list/192>). A comprehensive atlas of the atmospheric general circulation as depicted by ERA-40 is being produced in collaboration with the Meteorology Department of the University of Reading.

The Japanese 25-year Reanalysis Project (JRA-25, 1979-2004) is now well in progress. Performance of JRA-25 is compared with other reanalyses in reference to precipitation data produced by CMAP. The JRA does not show the known problems of excessive tropical ocean precipitation seen in ERA-40. In general, precipitation in JRA-25 has much higher correlation with precipitation in CMAP than ERA-40 and NCEP reanalysis.

WGNE reiterated its strong support for the reanalysis efforts and the desirability of having a dedicated 'Reanalysis Centre' at a major NWP operational centre.

Earth System assimilation

WGNE took note of the new developments in the assimilation of parameters pertinent to the Earth System but not routinely analysed by current data assimilation systems. These include greenhouse gases, aerosols and reactive gases. Earth system science such as this will increasingly demand cross-project liaison within WCRP and CAS as discussed in the COPES context.

5. Numerical weather prediction topics

Model developments

WGNE noted the substantial improvements in the resolution of global (40 km or less) and deep convection permitting forecast models (5 km or less) in progress or planned in the next few years. WGNE also took note of recent results from dynamical core experiments indicating that resolutions of 150 km (T85) or better are necessary for accurate simulation of baroclinic wave development. This contrasts with typical climate model resolutions substantially poorer than this. There exists a dichotomy of opinion regarding the use and interpretation of gridlengths of several kms for forecasting. These resolutions will become affordable for GCM use in the coming years, and the prospect of climate simulations with grids of order one kilometre is an issue of international activity and debate, and WGNE will continue to monitor such developments.

Unified forecast systems

WGNE noted the plans for unified (coupled) forecast systems that will provide forecasts from days out to seasons, typically by progressively degrading the resolution with forecast range. Such developments will provide new opportunities for ensemble techniques, including initial perturbations, stochastic parametrizations and metrics, and bring even closer collaboration between the NWP and climate communities.

THORPEX: A Global Atmospheric Research Programme

WGNE devoted a session to THORPEX, with presentations on the general background and the Science Plan and its progress and plans. WGNE noted the direct relevance of THORPEX to its activities and interests, and was impressed by the progress of several components of its plans including the Implementation Plan itself. The commitment of the operational NWP community was very clear. WGNE considered however that it remained a major challenge to engage the academic community to a similar extent and encouraged the circulation of the draft science plan to suitable members of academia for comment and to stimulate interest. WGNE recognized that the proposed THORPEX sub-structure of a) predictability and dynamics, b) observing systems, c) data assimilation and observing strategies, and d) societal and economic impacts, neatly encompassed much of the interests of WGNE. It suggested that the Implementation Plan (TIP) should recognize the fundamental importance of model development (both of the dynamical cores and of the physical parametrizations), and should make clearer its contribution to this in collaboration with existing programmes. WGNE commended the GIFS concept for its vision, and noted that TIGGE plans are advancing rapidly, with the TIP including many of the research challenges that such an undertaking will entail. WGNE appreciated that the Science Plan stressed the linkages between weather and climate and the opportunities to engage this problem for the benefit of all longer time-scale modelling efforts. WGNE agreed to consider, in consultation with WGSIP, the possibilities of using seasonal forecast systems to study this issue. One possibility is to run seasonal timescale forecasts at several horizontal resolutions, including at as high as practicable, to investigate, inter alia, the resolution dependence of the atmospheric energy transports and their up- and down-scale characteristics. This would require diagnostics including suitable eddy statistics and spectra etc. Results from this should then guide the debate as to what forecast/simulation deficiencies are to be expected from the current use of relatively low resolutions. Ideally these experiments would be performed using several systems. At least one (and hopefully more) groups will be in a position to undertake such experimentation in the next year or so. The Chairs of WGNE and WGSIP will monitor this further.

Model Verification

There are a number of WGNE projects involved with the validation of deterministic forecasts. These include the compilation of the so-called WMO scores, verification of quantitative precipitation forecasts, validation of tropical cyclone tracks and verification of stratospheric analysis and forecasts. There has also been the recognition that with increasingly high resolution models, there is urgent need to move forward from the basic validation methods that have been used so far.

Verification is of considerable importance for both WGNE and WWRP and following the formation of the joint (WWRP/WGNE) Working Group on Verification (JWGV). It has held two meetings during the past year. The JWGV organized and held an International Workshop on Verification Methods, with sponsorship from the WWRP/SSC and WGNE, as well as the Meteorological Service of Canada (MSC). A number of important issues and new developments were discussed including the development of methods to verify high resolution spatial forecasts; verification methods for rare events; incorporation of scaling methods into verification processes; approaches to account for observational uncertainty in verification measures and analyses; development of methods that are customer dependent and appropriate for studies of forecast value; and verification of probability distribution functions. The workshop program and abstracts can be linked from http://www.bom.gov.au/bmrc/wefor/staff/eee/verif/verif_web_page.html; presentations will be posted there as well.

Following a request from the WGNE, the JWGV has prepared a set of recommendations for the verification and intercomparison of QPFs from operational NWP models. This first report focuses on deterministic forecasts; a future one will outline methods for probabilistic/ensemble forecasts. The JWGV verification web page and verification discussion group, continue to be an important focus, with the web page gradually being enhanced as new FAQs and other information pages are prepared. The JWGV is interested in collaborations with other WMO verification projects and groups. A new plan for the coming year is to prepare and make available "canonical" forecast and observation datasets that can be used to evaluate and compare the capabilities of different or new verification methodologies.

6. Workshops

In collaboration with other WMO Working Groups the following International Workshops have been held in 2004:

- The WGNE/WGCM Workshop, "High-resolution climate modelling: Assessment, Added value and Applications", Lund, March 29 - April 2
- The WGNE/WGSIP/WGCM Workshop on Ensemble Methods: From weather forecasting to climate change', Exeter, 18 – 21 October
- The WWRP/ WGNE Workshop on Verification, Montreal, 13-17 September

There will also be an Aqua-Planet intercomparison Workshop, Reading, UK, in April 20-22 2005.



(Martin Miller)
Chairman, WGNE

Table of Contents

1. Atmospheric data assimilation schemes, analysis and initialization, data impact studies, observing system experiments

Author	Paper Title	Country	Pages
H. Anlauf, W. Wergen, G. Paul	A Study of the Flow-Dependence of Background Error Covariances Based on the NMC Method	Germany	01-01
G. Balsamo, J.-F. Mahfouf, S. Bélair, G. Deblonde	A Prototype of the Canadian Land Data Assimilation System and its Application to Soil Moisture Analysis	Canada	01-03
N. Bormann, S.B. Healy, M. Matricardi	Assimilation of Infrared Limb Radiances from MIPAS in the ECMWF System	Europe	01-05
R. Danielson, M. Dowd, H. Ritchie, L. Fillion	High-Resolution Marine Wind Retrieval Using Synthetic Aperture Radar	Canada	01-07
R. Eresmaa	Forward Modelling of Ground Based GPS Slant Total Delay Observations	Finland	01-09
C. Gebhardt, T. Ochotta, D. Saupe, W. Wergen	Adaptive Thinning of Atmospheric Observations in Data Assimilation with Vector Quantization and Filtering Methods - the First Steps	Germany	01-11
E. Gérard, T. Montmerle, F. Rabier	Assimilation of New Sounder Data in the Operational System at Météo-France	France	01-13
J.-I. Ishida, K. Saito	Initialization Scheme for Water Substances in the Operational NHM	Japan	01-15
T. Kadowaki	A 4-Dimensional Variational Assimilation System for the JMA Global Spectrum Model	Japan	01-17
T. Kawabata, H. Seko, T. Kuroda, Y. Wakatsuki, Y. Honda, K. Tamiya, K. Aonashi, Y. Shoji, K. Saito, T. Tsuyuki	A Cloud Resolving 4DVAR Data Assimilation System Based on the JMA Non-Hydrostatic Model	Japan	01-19
M. Kazumori, K. Fukuda, H. Owada	Assimilation of ATOVS Level-1c Radiance Data at JMA	Japan	01-21
M. Kazumori, Y. Nakamura	MODIS Polar Winds Assimilation at JMA	Japan	01-23
M. Kunii, H. Seko	Assimilation of Radial Wind Measured By Doppler Radar to Typhoon HIGOS	Japan	01-25
S. Laroche, P. Gauthier, M. Tanguay, S. Pellerin, J. Morneau	Operational Implementation of 4D-Var at the Meteorological Service of Canada	Canada	01-27
L. Ma, N. Davidson, Y. Duan, J. Chan	Initialization with Rainfall Defined Diabatic Heating	China, Australia	01-29
P. Mukhopadhyay	Real Data Simulation of a Thunderstorm over Kolkata using RAMS	India	01-31

Table of Contents

Author	Paper Title	Country	Pages
A. Narui	Use of Temperature Data from Radio-Sonde Observations in Place of Geopotential Height in the JMA Global 3D-VAR	Japan	01-33
Y. Ohhashi, T. Imaizumi	Operational Use of QuikSCAT / SeaWinds Ocean Surface Wind Data in the Meso 4D-Var System	Japan	01-35
A. Rhodin, D. Pingel, O. Shmid, M. Tomassini, H. Anlauf, W. Wergen, M.E. Gorbunov, M.D. Tsyroulnikov, L. Kornblueh	A Global PSAS	Germany, Russia	01-37
K. Salonen	Towards The Use of Doppler Radar Radial Winds in NWP	Finland	01-39
H. Seko, T. Kawabata, T. Tsuyuki	Data Assimilation Experiments of Nerima Heavy Rainfall	Japan	01-41
K. Stephan, S. Klink, C. Schraff	Assimilation of Radar Data in the Mesoscale NWP-Model of DWD	Germany	01-43
M. Szyndel, J.-N. Thépaut, G. Kelly	Assimilation of SEVIRI Infrared Observations at ECMWF	Europe	01-45
T. Tauchi, Y. Takeuchi, Y. Sato	Use of AMSR-E Data in the JMA Operational Meso Analysis	Japan	01-47
D. Wang, X. Liang	Comparison of Two Tropical Cyclone Bogussing Schemes	China	01-49

2. Data sets, diagnostic and dynamical investigations, statistical post-processing , multi-year reanalyses and associated studies

Author	Paper Title	Country	Pages
V. Barras, I. Simmonds, D. Etheridge	Moisture Transport Across South Eastern Australia Using Stable Isotopes in Precipitation	Australia	02-01
B. Meneghini, I. Simmonds, I.N. Smith	Links Between the Southern Annular Mode and Australian Rainfall	Australia	02-03
A.E. Pokhil	On the Structure of the Eye Hurricane Isabel	Russia	02-05
R. Sakai, M. Yamaguchi	The WGNE Intercomparison of Tropical Cyclone Track Forecasts by Operational Global Models	Japan	02-07
T. Sakashita, M. Hirai	Verification of Quantitative Precipitation Forecasts over Japan from the Operational Numerical Weather Prediction Models (WGNE Precipitation Forecast Intercomparison Project)	Japan	02-09
I. Simmonds, A. Rafter, A. B. Watkins	Antarctic Sea Ice Variability and High-Latitude Fluxes	Australia	02-11

Table of Contents

Author	Paper Title	Country	Pages
A.A. Speranskaya, E.P. Anisimova, A.E. Pokhil	Eye of the Hurricane	Russia	02-13
Y. Yusupov	Tracking Tropical Cyclones with Low Level Potential Vorticity	Russia	02-15

3. Computational studies including new techniques, the effect of varying model resolution, parallel processing

Author	Paper Title	Country	Pages
M. Baldauf, J. Förstner, P. Prohl	Idealized Tests of the Very Short Range Forecast Model LMK	Germany	03-01
N. Bogoslovskii, M. Tolstykh	Study of Different Formulations for Continuity Equation in the SL-AV NWP Model	Russia	03-03
L. Bonaventura, L. Kornblueh, E. Roeckner, T. Heinze, D. Majewski, P. Ripodas	The ICON Dynamical Core Project: Modelling Strategies and Preliminary Results	Germany	03-05
D.S. Dukhovskoy, S. L. Morey, J.J. O'Brien	Topographic Rossby Waves in a Z-Level Ocean Model	USA	03-07
R.Y. Fadeev	The Reduced Grid for the Global Semi-Lagrangian Numerical Weather Prediction Model	Russia	03-09
S. Hagemann, K. Arpe, E. Roeckner	Influence of Different Vertical and Horizontal Model Resolutions on the Simulated Hydrological Cycle of the GCM ECHAM5	Germany	03-11
V. M. Krasnopolsky, M.S. Fox- Rabinovitz, D. V. Chalikov	Fast and Accurate Neural Network Emulation of the NCAR CAM-3 Short Wave Radiation Parameterization: Evaluation of Accuracy of Approximation and Computational Performance	USA	03-13
A. Mahidjiba, A. Qaddouri, J. Côté	Towards an Interactive Conserving Semi-Lagrangian Model for Chemistry and Climate	Canada	03-15
I.I. Mokhov	Analysis of Relative Dynamics of Different Cycles with the Use of Phase Portraits	Russia	03-17
V.P. Parkhomenko	Parallel Atmospheric General Circulation Model Code Analysis and Optimization	Russia	03-19
J. A. Pudykiewicz	Numerical Solution of the Reaction-Advection-Diffusion Equation on the Sphere	Canada	03-21
A. Qaddouri, L. Laayouni, J. Côté, M. Gander	Optimized Schwarz Methods with an Overset Grid System for the Shallow-Water Equations	Canada	03-23
H. Yoshimura, T. Matsumura	A Two-Time-Level Vertically-Conservative Semi- Lagrangian Semi-Implicit Double Fourier Series AGCM	Japan	03-25

Table of Contents

Author	Paper Title	Country	Pages
M. Zerroukat, N. Wood, A. Staniforth	Semi-Lagrangian Advection and Conservation	UK	03-27

4. Parameterization of important atmospheric and surface processes, effects of different parameterizations

Author	Paper Title	Country	Pages
M. Dubal, N. Wood, A. Staniforth	Analysis of the Numerics of Physics-Dynamics Coupling	UK	04-01
J. Ferreira, C. Marques, A. Rocha, P. Gonçalves	WRF Modelling System Experiments with Different Land-Surface Options	Portugal	04-03
J. Förstner, H.-J. Herzog, G. Vogel	Implementation of a 3D-Turbulence Parameterization for the Very Short Range Forecast Model LMK	Germany	04-05
J.-F. Geleyn, R. Fournier, G. Hello, N. Pristov	A New 'Bracketing' Technique for a Flexible and Economical Computation of Thermal Radiative Fluxes, Scattering Effects Included, on the Net Exchanged Rate (NER) Formalism	Czech Republic	04-07
A. Hashimoto, M. Murakami, C. Muroi, S. Kanada, Y. Wakazuki, K. Yasunaga, T. Kato, K. Kurihara, M. Yoshizaki	The Enhancement of Condensation in Melting Layer Simulated by Cloud Resolving Non-Hydrostatic Model	Japan	04-09
H. Kawai	Improvement of a Cloud Ice Fall Scheme in GCM	Japan	04-11
S. Kotlarski, D. Jacob	Development of a Subgrid Scale Parameterisation of Mountain Glaciers for use in Regional Climate Modelling	Germany	04-13
A. Lemonsu, S. Bélair, J. Mailhot	Inclusion of an Urban Canopy Parameterization in the Canadian Meteorological Models	Canada	04-15
D. Mironov, N. Schneider, B. Ritter, E. Heise	Implementation of a Lake Model FLake into the the Limited-Area NWP System LM of the German Weather Service: Preliminary Results	Germany	04-17
S. Murai, S. Yabu	Introduction of a New Radiation Scheme to the Operational Global NWP Model at JMA	Japan	04-19
A. Murata, M. Ueno	A Comparison of In-Cloud and Environmental Properties in Numerical Results Between Cloud-Resolving and Parameterized Simulations for a Tropical Cyclone Rainband	Japan	04-21
R. Nagasawa, H. Kitagawa	Improvement of Cloud Treatment in Radiation Process of the JMA Non-Hydrostatic Model	Japan	04-23
S. Niemelä, C. Fortelius	Applicability of Large-Scale Convection and Condensation Parameterization to meso- γ Scales	Finland	04-25
T. Reinhardt	A Prognostic Graupel Microphysics Scheme For High-Resolution NWP	Germany	04-27

Table of Contents

Author	Paper Title	Country	Pages
V. Shnaydman, G. Stenchikov	Effect of Turbulence on Atmospheric Chemistry	USA	04-29
M. Ueno, A. Murata, W. Mashiko	A Strong Dependency of Simulated TC Structure on Model Physics: Steering-Weight Perspective	Japan	04-31

5. Development of and studies with regional and smaller-scale atmospheric models, regional ensemble forecasting

Author	Paper Title	Country	Pages
L.V. Berkovich, K.G. Rubinstein, R.J. Ignatov, G.M. Kalugina, S.O. Krichak, M.V. Tsidulko, I.E. Zacharov	Adaptation of the PSU/NCAR MM5 for High-Resolution Weather Prediction over Russia	Russia	05-01
H. Eito, K. Aonashi, G. Liu, C. Muroi, S. Hayashi, T. Kato, M. Yoshizaki	Preliminary Comparison of AMSR-E Observation and Numerical Simulation with Cloud Resolving Model for Solid Precipitation in Winter During the Wakasa 2003	Japan	05-03
T. Haiden	NWP Research in Austria	Austria	05-05
T. Hosomi	Implementation of Targeted Moisture Diffusion for the JMA Regional Spectral Model (RSM)	Japan	05-07
J.-I. Ishida, S. Tanaka	Verification of Mesoscale Forecasts by the Newly Implemented JMA-NHM	Japan	05-09
T. Kato, K. Aranami	Prediction of Localized Heavy Rainfall Using a Cloud-Resolving Nonhydrostatic Model and its Problems	Japan	05-11
J. H.Y. Kwok, J. C.L. Chan	Tropical Cyclone Intensity Change in a Uniform Flow	China	05-13
H. Nakayama, K. Aranami	Development of a High-Resolution Meso-Scale Model at JMA	Japan	05-15
K. Saito, J.-I. Ishida	Implementation of the Targeted Moisture Diffusion to JMA-NHM	Japan	05-17
V.A. Shnaydman, L.V. Berkovich, Y.V. Tkacheva	Operational Forecast of the Meteorological and Turbulence Characteristics of the Boundary Layer	USA, Russia	05-19
R. Solomakhov	Correcting Prognostic GRIB Data Using Hi-Resolution 3D Lagrangian Model	Russia	05-21
J. Steppeler, H.W. Bitzer, Z. Janjic, U. Schättler, P. Prohl, U. Gjertsen, J. Parfinievicz, U. Damrath	A Z-Coordinate Version of the Non-Hydrostatic Model LM	Germany	05-23
Z. Vakula, L. Kalin, M. Tudor, S. Ivatek-Šahdan	Verification in Croatian Meteorological and Hydrological Service	Croatia	05-25

Table of Contents

Author	Paper Title	Country	Pages
M.L.M. Wong, J.C.L Chan	Tropical Cyclone Motion and Asymmetry due to Land-Sea Friction Contrast	China	05-27

6. Developments in global forecast models, case studies, predictability investigations, global ensemble, monthly and seasonal forecasting

Author	Paper Title	Country	Pages
M. Boisserie, T. LaRow, S.D. Coker, D.W. Shin	Comparison of Soil Moisture in the FSU Climate Model Coupled to a Land Model CLM2 to Soil Moisture from NCEP/DOE Reanalysis 2	USA	06-01
H.P. Frank, D. Majewski	40km/40 Layer Version of the Global Model GME of DWD	Germany	06-03
K. Katayama, H. Yoshimura, T. Matsumura	Operational Implementation of New Semi-Lagrangian Global NWP Model JMA	Japan	06-05
M. Roch, S. Bélair, A.-M. Leduc, P. Vaillancourt	Towards a High Resolution Global Model for Data Assimilation and Medium-Range Weather Forecasting in Canada	Canada	06-07
D.W. Shin, T.E. LaRow, S. Coker, J.J. O'Brien	The Role of the CLM2 in the Surface Air Temperature and Precipitation of the FSU Climate Model	USA	06-09
Y.L. Shmelkin	Evaluation of AVN NCAR Model Surface Temperature Data Errors in Cold Siberian Region Seasons	Russia	06-11

7. Global and regional climate models, sensitivity and impact experiments, response to external forcing

Author	Paper Title	Country	Pages
O.A. Alduchov, I.V. Chernykh	About Negative Correlations of Surface Temperature and Clouds Parameters for Antarctic Region	Russia	07-01
K. Bülow, D. Jacob, R. Podzun	Changes in Precipitation Intensity Under Climate Change Conditions Over Major Catchments in Europe	Germany	07-03
I.V. Chernykh, O.A. Alduchov, V.E. Lagun	About Climatic Changes of Clouds and Precipitation over Antarctic Peninsula	Russia	07-05
K.C. Chow, J.C.L. Chan	Time-Lagged Effects of Spring Tibetan Plateau Soil Moisture on the Monsoon over China in Early Summer	China	07-07
B. Dugas, A. Zadra, K. Winger	Current State of GEM Climate Simulation at RPN	Canada	07-09
S. Hagemann, D. Jacob	European Discharge Under Climate Change Conditions Simulated by a Multimodel Ensemble	Germany	07-11
T. Jung, T.N. Palmer, G.J. Shutts	Influence of a New Stochastic Physics Scheme on Weather Regimes in the North Pacific Region	UK	07-13

Table of Contents

Author	Paper Title	Country	Pages
A.A. Karpenko, I.I. Mokhov, P.A. Stott	Contribution of Natural and Anthropogenic Causes in Regions with Large Temperature Changes During XX Century	Russia	07-15
E. Keup-Thiel, T. Blome, D. Jacob	Climate Simulations of the Barents Sea Region	Germany	07-17
V.C. Khon, I.I. Mokhov, E. Roeckner, V.A. Semenov	Extreme Precipitation in Northern Eurasia from Observations and Model Simulations	Germany	07-19
V.C. Khon, I.I. Mokhov	Regional Changes of Arctic Sea Ice and Freshwater Balance Components from Model Simulations with Anthropogenic Forcing	Russia	07-21
S.O. Krichak, P. Alpert, M. Dayan	Simulation of the Surface Climatology over the Eastern Mediterranean Region Using the RegCM3 Model	Israel	07-23
P. Lorenz, D. Jacob	Influence of Regional Scale Information on the Global Circulation: A Two-Way Nesting Climate Simulation	Germany	07-25
P. Martineu	An Assessment of the PRECIS Regional Climate Modelling System - Simulations over North America using PRECIS	Canada	07-27
I.I. Mokhov	Spring-Summer Climate Extremes in Eurasian Midlatitudinal Regions	Russia	07-29
I.I. Mokhov, A.V. Chernokulsky, J.-L. Dufresne, H. Le Treut	Terrestrial Biosphere Response to Anthropogenic Changes in Growing Season in European Mid-Latitudinal Regions from Model Simulations	Russia, France	07-31
X. Shi, J.C.L. Chan, K.C. Chow, Y. Ding	Upstream Surface Heat Flux Effects on the South China Sea Summer Monsoon	China	07-33
K. Yasunaga, Y. Wakazuki, M. Yoshizaki, C. Muroi, K. Kurihara, A. Hashimoto, S. Kanada, T. Kato	The Changes in Precipitation Characteristics During the Baiu (Mei-yu) Season of the Global Warming Climate Simulated by a Cloud-Resolving Non-Hydrostatic Regional Model	Japan	07-35

8. Development of and advances in ocean modelling and data assimilation, sea-ice modelling, wave modelling

Author	Paper Title	Country	Pages
A.A. Deo, D.W. Ganer , P.S. Salvekar	Numerical Investigation of Ocean Mixed Layer in Response to Moving Cyclone of Different Eye Radii	India	08-01
S. L. Morey, M. A. Bourassa, D. Dukhovskoy, J.J. O'Brien	Modeling the Oceanic Response to Air-Sea Fluxes Associated with a Tropical Storm	USA	08-03
A. Samuelsen, J.J. O'Brien	Simulating the Effect of the Tehuantepec Jet on the Ecosystem in the Northeast Tropical Pacific	USA	08-05

Table of Contents

Author	Paper Title	Country	Pages
S. Shimokawa, H. Ozawa	Entropy Production of the Oceanic General Circulation	Japan	08-07
V. Shnaydman, J. Malensky	The Turbulence Characteristics of the Pollutant Diffusion in the Oceanic Boundary Layer	USA	08-09
A.A. Zelenko, Y.D. Resnyansky	Deep Convection Simulated by OGCM with Different Types of Atmospheric Forcing	Russia	08-11

9. Development of and studies with coupled ocean-atmosphere models

Author	Paper Title	Country	Pages
C. Girard, F. Roy, P. Pellerin, F. Saucier, H. Ritchie	A Unified Dynamical Model for Atmospheric and Oceanic Flows	Canada	09-01
B. Subrahmanyam, V.S.N. Murty, J. J. O'Brien	New Sea Surface Salinity Product in the Tropical Indian Ocean	USA	09-03
A. Wada	Numerical Experiments of Typhoon Bilis Using a Non-Hydrostatic Atmospheric Model Coupled with a Mixed-Layer Ocean Model	Japan	09-05

Index of Authors

A		Deo, A.A.	08-01	Hirai, M.	02-09
Alduchov, O.A.	07-01,	Ding, Y.	07-33	Honda, Y.	01-19
	07-05	Dowd, M.	01-07	Hosomi, T.	05-07
Alpert, P.	07-23	Duan, Y.	01-29		
Anisimova, E.P.	02-13	Dubal, M.	04-01	I	
Anlauf, H.	01-01,	Dufresne, J.-L.	07-31	Ignatov, R.J.	05-01
	01-37	Dugas, B.	07-09	Imaizumi, T.	01-35
Aonashi, K.	01-19,	Dukhovskoy, D.	08-03	Ishida, J.-I.	01-15,
	05-03	Dukhovskoy, D.S.	03-07		05-09, 05-17
Aranami, K.	05-11,				
	05-15	E		Ivatek-Šahdan, S.	05-25
Arpe, K.	03-11	Eito, H.	05-03		
		Eresmaa, R.	01-09	J	
		Etheridge, D.	02-01	Jacob, D.	04-13,
B					07-03, 07-11, 07-17, 07-25
Baldauf, M.	03-01			Janjic, Z.	05-23
Balsamo, G.	01-03	F		Jung, T.	07-13
Barras, V.	02-01	Fadeev, R.Y.	03-09		
Bélaïr, S.	01-03,	Ferreira, J.	04-03	K	
	04-15, 06-07	Fillion, L.	01-07	Kadowaki, T.	01-17
Berkovich, L.V.	05-01,	Förstner, J.	04-05	Kalin, L.	05-25
	05-19	Förstner, J.	03-01	Kalugina, G.M.	05-01
Bitzer, H.W.	05-23	Fortelius, C.	04-25	Kanada, S.	04-09,
Blome, T.	07-17	Fournier, R.	04-07		07-35
Bogoslovskii, N.	03-03	Fox-Rabinovitz, M.S.	03-13	Karpenko, A.A.	07-15
Boisserie, M.	06-01	Frank, H.P.	06-03	Katayama, K.	06-05
Bonaventura, L.	03-05	Fukuda, K.	01-21	Kato, T.	04-09,
Bormann, N.	01-05				05-03, 05-11, 07-35
Bourassa, M.A.	08-03	G		Kawabata, T.	01-19,
Bülow, K.	07-03	Gander, M.	03-23		01-41
		Ganer, D.W.	08-01	Kawai, H.	04-11
C		Gauthier, P.	01-27	Kazumori, M.	01-21
Chalikov, D. V.	03-13	Gebhardt, C.	01-11	Kazumori, M.	01-23
Chan, J.	01-29	Geleyn, J.-F.	04-07	Kelly, G.	01-45
Chan, J.C.L.	05-13,	Gérard, E.	01-13	Keup-Thiel, E.	07-17
	05-27, 07-07, 07-33	Girard, C.	09-01	Khon, V.C.	07-19,
Chernokulsky, A.V.	07-31	Gjertsen, U.	05-23		07-21
Chernykh, I.V.	07-01,	Gonçalves, P.	04-03	Kitagawa, H.	04-23
	07-05	Gorbunov, M.E.	01-37	Klink, S.	01-43
Chow, K.C.	07-07,			Kornblueh, L.	01-37,
	07-33	H			03-05
Cocke, S.D.	06-01	Hagemann, S.	03-11,	Kotlarski, S.	04-13
Cocke, S.	06-09		07-11	Krasnopolsky, V.M.	03-13
Côté, J.	03-15,	Haiden, T.	05-05	Krichak, S.O.	05-01,
	03-23	Hashimoto, A.	04-09		07-23
		Hashimoto, A.	07-35	Kunii, M.	01-25
D		Hayashi, S.	05-03	Kurihara, K.	04-09,
Damrath, U.	05-23	Healy, S.B.	01-05		07-35
Danielson, R.	01-07	Heinze, T.	03-05	Kuroda, T.	01-19
Davidson, N.	01-29	Heise, E.	04-17	Kwok, J.H.Y.	05-13
Dayan, M.	07-23	Hello, G.	04-07		
Deblonde, G.	01-03	Herzog, H.-J.	04-05		

Index of Authors

L					
Laayouni, L.	03-23				
Lagun, V.E.	07-05				
Laroche, S.	01-27				
LaRow, T.	06-01				
LaRow, T.E.	06-09				
Le Treut, H.	07-31				
Leduc, A.-M.	06-07				
Lemonsu, A.	04-15				
Liang, X.	01-49				
Liu, G.	05-03				
Lorenz, P.	07-25				
M					
Ma, L.	01-29				
Mahfouf, J.-F.	01-03				
Mahidjiba, A.	03-15				
Mailhot, J.	04-15				
Majewski, D.	03-05, 06-03				
Malensky, J.	08-09				
Marques, C.	04-03				
Martineu, P.	07-27				
Mashiko, W.	04-31				
Matricardi, M.	01-05				
Matsumura, T.	03-25, 06-05				
Meneghini, B.	02-03				
Mironov, D.	04-17				
Mokhov, I.I.	03-17, 07-15, 07-19, 07-21, 07-29, 07-31				
Montmerle, T.	01-13				
Morey, S.L.	03-07, 08-03				
Morneau, J.	01-27				
Mukhopadhyay, P.	01-31				
Murai, S.	04-19				
Murakami, M.	04-09				
Murata, A.	04-21, 04-31				
Muroi, C.	04-09, 05-03, 07-35				
Murty, V.S.N.	09-03				
N					
Nagasawa, R.	04-23				
Nakamura, Y.	01-23				
Nakayama, H.	05-15				
Narui, A.	01-33				
Niemelä, S.	04-25				
O					
O'Brien, J. J.	03-07, 06-09, 08-03, 08-05, 09-03				
Ochotta, T.	01-11				
Ohhashi, Y.	01-35				
Owada, H.	01-21				
Ozawa, H.	08-07				
P					
Palmer, T.N.	07-13				
Parfinievicz, J.	05-23				
Parkhomenko, V.P.	03-19				
Paul, G.	01-01				
Pellerin, P.	09-01				
Pellerin, S.	01-27				
Pingel, D.	01-37				
Podzun, R.	07-03				
Pokhil, A.E.	02-05, 02-13				
Pristov, N.	04-07				
Prohl, P.	03-01, 05-23				
Pudykiewicz, J. A.	03-21				
Q					
Qaddouri, A.	03-15, 03-23				
R					
Rabier, F.	01-13				
Rafter, A.	02-11				
Reinhardt, T.	04-27				
Resnyansky, Y.D.	08-11				
Rhodin, A.	01-37				
Ripodas, P.	03-05				
Ritchie, H.	01-07, 09-01				
Ritter, B.	04-17				
Roch, M.	06-07				
Rocha, A.	04-03				
Roeckner, E.	03-05, 03-11, 07-19				
Roy, F.	09-01				
Rubinstein, K.G.	05-01				
S					
Saito, K.	01-15, 01-19, 05-17				
Sakai, R.	02-07				
T					
Sakashita, T.	02-09				
Salonen, K.	01-39				
Salvekar, P.S.	08-01				
Samuelsen, A.	08-05				
Sato, Y.	01-47				
Saucier, F.	09-01				
Saupe, D.	01-11				
Schättler, U.	05-23				
Schneider, N.	04-17				
Schraff, C.	01-43				
Seko, H.	01-19, 01-25, 01-41				
Semenov, V.A.	07-19				
Shi, X.	07-33				
Shimokawa, S.	08-07				
Shin, D.W.	06-01, 06-09				
Shmelkin, Y.L.	06-11				
Shmid, O.	01-37				
Shnaydman, V.	04-29, 08-09				
Shnaydman, V.A.	05-19				
Shoji, Y.	01-19				
Shutts, G.J.	07-13				
Simmonds, I.	02-01, 02-03, 02-11				
Smith, I.N.	02-03				
Solomakhov, R.	05-21				
Speranskaya, A.A.	02-13				
Staniforth, A.	03-27, 04-01				
Stenchikov, G	04-29				
Stephan, K.	01-43				
Steppeler, J.	05-23				
Stott, P.A.	07-15				
Subrahmanyam, B.	09-03				
Szyndel, M.	01-45				
T					
Takeuchi, Y.	01-47				
Tamiya, K.	01-19				
Tanaka, S.	05-09				
Tanguay, M.	01-27				
Tauchi, T.	01-47				
Thépaut, J.-N.	01-45				
Tkacheva, Y.V.	05-19				
Tolstykh, M.	03-03				
Tomassini, M.	01-37				
Tsidulko, M.V.	05-01				
Tsuyuki, T.	01-19, 01-41				

Index of Authors

Tsyroulnikov, M.D.	01-37	Wada, A.	09-05	Yamaguchi, M.	02-07
Tudor, M.	05-25	Wakatsuki, Y.	01-19	Yasunaga, K.	04-09,
		Wakazuki, Y.	04-09,		07-35
			07-35	Yoshimura, H.	06-05,
U		Wang, D.	01-49		03-25
Ueno, M.	04-21,	Watkins, A. B.	02-11	Yoshizaki, M.	04-09,
	04-31	Wergen, W.	01-01,		05-03, 07-35
			01-11, 01-37	Yusupov, Y.	02-15
		Winger, K.	07-09		
V		Wong, M.L.M.	05-27	Z	
Vaillancourt, P.	06-07	Wood, N.	03-27,	Zacharov, I.E.	05-01
Vakula, Z.	05-25		04-01	Zadra, A.	07-09
Vogel, G.	04-05			Zelenko, A.A.	08-11
				Zerroukat, M.	03-27
		Y			
W		Yabu, S.	04-19		

