Summary of the Jehuda Neumann Memorial Symposium on Mesoscale Modeling and Climate History, 4–6 January 1995, Jerusalem, Israel

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1. Introduction

The research of the late Professor Jehuda Neumann unites mesoscale meteorology, climate history, weather modification, and air pollution, topics that seldom come together at any one conference.

In each of these disciplines, Neumann contributed significantly not only to Israel but also to the world. Many of the 50 contributions presented in the symposium are from people who have collaborated or discussed their work with him. In several cases, his research opened up new directions of study or understanding. Such was the case with his early cloud seeding experiments in Israel that continue to this day on a much extended scale: the mesoscale modeling of sea and land breezes was improved and virtually a whole new field was developed by his recent work on "great historical events that were influenced by weather and climate."

2. Tributes to Jehuda Neumann

Tributes to Jehuda Neumann were made in the opening session, chaired by J. Lomas and devoted to contributions from those most closely associated with him, which commenced with a contribution from M. Magidor, the dean of the Faculty of Sciences, Hebrew University. He recalled how Neumann was appointed the head of the Department of Meteorology at the Hebrew University during the 1950s and mentioned that Jehuda was the scientist who founded the "Pages in Mathematics" for high school students in Israel in the 1940s. He was followed by R. P. Pearce who read a tribute to Neumann from the president and Fellows of the Royal Meteorological Society; he then spoke briefly about mesoscale meteorological modeling research in the U.S. Army and Neumann's contribution in his more than 20 years as a member of the U.S. Army Panel on Mesoscale Meteorology. A welcome tribute on behalf of the American Meteorological Society was given by N. Surgi from the Tropical Prediction Center (TPC) (formerly the National Hurricane Center) and one from the Israel Meteorological Service by its director, Z. Alperson, and J. Lomas. A. Cohen, one of Neumann's early Ph.D. students, and P. Alpert, his last Ph.D. student, described their special relations with him. Alpert mentioned the central role Neumann played in all aspects of meteorological research in the young country of Israel since its foundation in 1948, in particular those related to the water shortage—Lake Kinneret's evaporation and cloud seeding experiments—and also air pollution and environmental issues.

3. Mesoscale modeling

Several papers were presented on mesoscale modeling spread over four sessions, chaired, respectively, by R. P. Pearce, T. N. Krishnamurti, Y. Mahrer, and R. V. Madala. In the first of these sessions, Madala, from the U.S. Naval Research Laboratory (NRL), described a nonhydrostatic, multigrid high-resolution mesoscale atmospheric prediction model developed by the navy for coastal circulations, now being further developed for the U.S. Army. Results presented show that mesoscale external forcing, like SST variations in space and time, can induce severe weather in a synoptically stable environment. Then, G. Gross of the University of Hannover presented

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results from a mesoscale model intercomparison performed by the U.S. Army involving the four mesoscale models FITNAH, HOTMAC, PSU/NCAR, and RAMS (see the appendix for definitions of acronyms). This was followed by A. Isakson from Ben-Gurion University, who suggested a simplified model for the annual rainfall distribution over Israel induced by large-scale moisture flux and local topography, and, finally, by H. Savijarvi from the University of Helsinki, who presented the mesoscale modeling project in the University of Helsinki. This latter model originated from the Alpert–Neumann model and was successfully applied to various atmospheric problems on both Earth and Mars.

The second session commenced with a paper by J. E. Simpson from the University of Cambridge, who reviewed the theories on the diurnal change in the sea-breeze direction with emphasis on Neumann's (1977) contribution concerning the role of the Coriolis force. He was followed by L. M. Druyan from the National Aeronautics and Space Administration/Goddard Institute of Space Sciences (NASA/GISS), who applied the GISS/GCM to African wave disturbances and their role in the rainfall variability of the Sahel region. Next, G. Schayes from the Université Catholiqué de Louvain compared two mesoscale models of complex sea-breeze situations in the Athens region. One is a vorticity mesoscale model, while the other was developed from the Alpert–Neumann 2D version, both being equally successful in predicting the sea breeze and its associated front.

Y. Mahrer from the Hebrew University of Jerusalem focused on microclimate and evaporation over Lake Kinneret using the RAMS mesoscale model, concluding that assuming a uniform evaporation rate over the whole lake may be quite misleading. Then, A. Anis from the Kinneret Limnological Laboratory, Israel, discussed some aspects of mixing and turbulence in the upper ocean. He used very high-resolution measurements to estimate vertical heat fluxes as well as turbulent kinetic energy dissipation rates within the oceanic boundary layer. Finally, K. D. Sashegyi from NRL discussed assimilation of Genesis of Atlantic Lows Experiment surface and upper-air data in the forecast model of the NRL, concluding that the inclusion of a 12-h period of assimilation prior to the running of a forecast led to a much improved forecast for the mesoscale coastal front.

The third session opened with a paper by T. N. Krishnamurti from The Florida State University, who illustrated how the inclusion of rainfall analyses based on OLR, SSM/I, and rain gauge observations in the physical initialization process led to much improved predictions of mesoscale rainfall distributions, the movement of typhoons, and ocean–atmosphere coupling. Next, K. D. Sashegyi described a method complementing the existing scheme of Harms et al. (1993) for using stratiform precipitation as input to a normal vertical mode initialization in order to add diabatic heating to the initial fields. Vertical motion fields are significantly improved using this method.

N. Surgi presented an encouraging review of tropical cyclone forecasting at the TPC with the Geophysical Fluid Dynamics Laboratory high-resolution model and was followed by A. I. Falkovich from NMC (recently renamed National Centers for Environmental Prediction), who discussed the evolution and motion of binary tropical cyclones as revealed by experiments with a coupled atmosphere–ocean movable nested grid model. The interaction with the ocean had a significant effect on the evolution, intensity, and tracks of the binary storms.

P. Alpert from Tel Aviv University, Israel, analyzed an intensive ALPEX lee cyclogenesis on 3–6 March 1982 by applying the factor separation method of Stein and Alpert (1993). Four processes were investigated—topography, latent heat release, and sensible and latent heat fluxes. It was shown how the mountainous convection—a synergistic contribution—is important at the second stage of cyclone deepening. The spread of the cyclones' centers in the model simulations is shown to be useful for the understanding of the effects of the various factors in the cyclone evolution. Finally, H. Gallee from the Université Catholique de Louvain, Belgium, described model simulations for the sudden cessation of katabatic winds in Adelie Land, Antarctica.

The fourth and final short session on mesoscale modeling was devoted to the second paper by H. Gallee, who presented simulations of boundary-layer fronts forced by katabatic airflow over the southwestern Ross Sea, Antarctica. Next, E. Gavze from the Israel Institute of Biological Research, Israel, suggested a linear regression estimator for physical vectors (i.e., winds) based on the Gauss–Markov theorem. Given the statistics of the wind field at the sites of measurement and prediction, this method shows a significant improvement over the $1/r^2$ interpolation.

The presentations at these four mesoscale modeling sessions reflected the considerable diversity of the applications of these models and highlighted the importance of actively pursuing their further development.

4. Climate

Nine papers were presented on this topic at a session chaired by A. Zangvil and L. Druyan. A. Cohen from the Hebrew University of Jerusalem opened by discussing a problem relating to the radiation balance—that of light scattering from a nonspherical

sliced target using the internal field of infinite cyclinders for each slice. Then E. H. Steinberger from the Hebrew University of Jerusalem used long-term total ozone records from five Southern Hemisphere stations to discuss the possible impact of the Antarctic vortex on the trend, seasonal, and latitudinal distribution of total ozone in the Southern Hemisphere.

Climate change in the Jordan Valley was discussed by S. Cohen from the Institute of Soils and Water, Israel. He suggested that significant changes in the region's water balance had taken place during the last 60 years. The diurnal temperature range decreased significantly primarily due to a decrease in maximum temperatures linked to a decrease in the global radiation. Last, H. Kutiel from the University of Haifa discussed the relationship between extreme rainfall conditions in Israel and pressure fields over Europe and the Mediterranean.

The opening contributor for the second part, A. Zangvil from Ben-Gurion University, Israel, suggested a 2D extension of the Budyko formula for local evaporation to precipitation. He showed that the correct extension to Budyko's formula requires a correction factor that depends on the atmospheric flow structure. Then J. Otterman from NASA/Goddard presented simulations for the effects of a vegetated desert fringe upon the atmospheric boundary layer. The effects of the plants are separated into the albedo reduction contribution and the direct heating effect by including a thin layer of black aerosols.

Data from 1875 onward were used by J. Lomas from the Israel Meteorological Service, Israel, to discuss the spatial and temporal rainfall patterns in Jerusalem. He was followed by M. Mandel, also from the Israel Meteorological Service, who evaluated the relation of evaporation over Israel to surface parameters by the use of the 3D RAMS model. Finally, T. Ben-Gai from Tel Aviv University, Israel, presented aircraft estimations for surface albedo in relation to climate change in southern Israel. Results show a large difference in surface albedo distribution between the cultivated areas in south Israel (0.19–0.24) and the adjacent arid regions (0.35). Land-use maps for the 1930s, 1960s, and 1990s are used to estimate corresponding changes in the surface albedo patterns. These climate studies contribute significantly to the important question of the role of vegetation in determining the regional climates of the semiarid subtropics.

5. Weather modification

A. Cohen chaired this session of five papers. Z. Levin from Tel Aviv University presented a new look at the microphysics of clouds and rain in Israel with implications for cloud seeding. Simulations suggest that seeding with ice nuclei is not an effective method for enhancing rain in Israel. In contrast, it would be much more effective to seed the clouds with large cloud condensation nuclei particles.

Applications of spatial analysis techniques for assessing the contribution of cloud seeding to the rainfall in Israel were reviewed by Y. Goldreich from Bar-Ilan University, Israel. Regression model methods were shown to help in distinguishing between the cloud seeding contribution and the rainfall enhancement of the urbanization. Then A. P. Khain from the Hebrew University of Jerusalem presented simulations of precipitation formation and distributions over the eastern Mediterranean coastal zone using a mixed-phase cloud ensemble model, and E. H. Steinberger from the Hebrew University of Jerusalem discussed the variations in the spatial distributions of rainfall in Israel during the last 30 years.

Finally, D. Rosenfeld, also from the Hebrew University of Jerusalem, suggested a new look at the Israeli-I cloud-seeding experiment. He has shown that the rainfall enhancement in Israel strongly depends on the absence of desert dust particles.

6. Air pollution

There were eight contributors to this session, each discussing a particular aspect of pollution of relevance to Israel. First, J. Padro from the Atmospheric Environmental Service, Canada, presented a dry deposition velocity model intercomparison for O_3, SO_2, and sulphates based on measurements. Two operational models were compared and differences between their performances were attributed to the representations of surface resistance. Next, U. Dayan from the Soreq Nuclear Research Center, Israel, presented an analysis of 3D ozone concentrations in the Los Angeles basin, providing insight into the formation of ozone in shallow atmospheric layers near the ground. Similiarities with Israel were suggested.

L. Berkofsky from Ben-Gurion University suggested a method for the inclusion in mesoscale models of the prediction of dust erosion by wind. Comparison of model results with available data was found to be very reasonable. Then J. Levitin from the Israel Meteorological Service, presented studies of atmospheric stability and the wind field in the atmospheric boundary layer in the Haifa Bay area using SODAR, suggesting classification of the SODAR echograms in a table.

Using two-way interactive nesting in the mesoscale RAMS model, G. Kallos from the University of Athens, Greece, presented some evidence for the transport of air pollutants from eastern Europe to the Mediterra-

nean region. He was followed by R. Avida from the Nuclear Research Center, Israel, who had developed a model for estimating source terms of chemicals from ruptured liquified gas containers, and L. Brenig from Brussels University, Belgium, who discussed various models and experiments for the understanding of basic problems in dust dynamics. Then, Y. Mamane from Technion, Israel, presented air pollution episodes and a receptor modeling study in the Czech Republic. The heavy use of lignite coal has resulted in SO_2 and annual average particulate matter levels of 130 and 145 $\mu g\ m^{-3}$, respectively.

The day ended with a panel discussion on climate and climate change with A. Cohen (chairperson), P. Kay, J. H. Joseph, Z. Levin, J. Lomas, and J. Otterman.

7. Climate history

This penultimate session, chaired by Z. Alperson, was devoted to four papers dealing with climate inferences drawn from historical records. P. A. Kay from the University of Waterloo, Canada, demonstrated how climatic inferences can be drawn from an early meteorological register from arctic Canada. Comparison of the 1821–22 and 1822–23 winters with the modern record for 1977–93 winters shows that they were similar. The conclusion is that the use of historical climatology records shows promising potential to add to our knowledge of arctic climatology and climate change. Next, M. Chernavskaya from the Institute of Geography, Moscow, presented an investigation of the weather conditions of 1695–96 in European Russia. Typical atmospheric circulations were deduced from the campaign journals of Czar Peter the Great 1695–1725 (in Russian). Chernavskaya was followed by N. Wolfson from the Meteo-Tech Company, Israel, who discussed weather-related events in two ancient crusader chronicles. The survey was based on the books of William of Tyre (dated 1185) and Fulcher of Charters (dated 1136).

Finally, M. Mandel from the Israel Meteorological Service, Israel, presented contemporary witness of extreme weather in Europe during the "Little Ice Age" according to Jewish sources. This included the Book of Zemach David from 1890 and the Köln Haggada.

In his excellent studies of the influence of climate on historical events, Jehuda Neumann also made extensive use of historical climate data and no doubt has stimulated considerable further interest in the examination of such records.

The symposium ended with a panel on the future of mesoscale meteorology, with the participation of P. Alpert (chairperson), G. Gross, T. N. Krishnamurti, R. V. Madala, Y. Mahrer, and R. P. Pearce.

Appendix: Acronyms

ALPEX	Alpine Experiment
FITNAH	Flow over Irregular Terrain with Natural and Anthropogenic Heat Sources
GALE	Genesis of Atlantic Lows Experiment
GCM	general circulation model
GFDL	Geophysical Fluid Dynamics Laboratory
GISS	Goddard Institute of Space Sciences
HOTMAC	Higher Order Turbulence Model for Atmospheric Circulations
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NRL	Naval Research Laboratory
OLR	outgoing longwave radiation
PSU	The Pennsylvania State University
SODAR	sound detection and ranging
SSM/I	Special Sensor Microwave/Imager
SST	sea surface temperature
TKE	turbulent kinetic energy
TPC	Tropical Prediction Center
RAMS	Regional Atmospheric Modeling System

References

Harms, D. E., R. V. Madala, S. Raman, and K. D. Sashegyi, 1993: Diabatic initialization tests using the Naval Research Laboratory limited area numerical weather prediction model. *Mon. Wea. Rev.*, **121,** 3184–3190.

Neumann, J., 1977: On the rotation rate of the direction of sea and land breezes. *J. Atmos. Sci.*, **34,** 1913–1917.

Stein, U., and P. Alpert, 1993: Factor separation in numerical simulations. *J. Atmos. Sci.*, **50,** 2107–2115.