

## IN MY OPINION . . .

by

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In my opinion the following publications represent my most important research. They are summarized below, in chronological order:

My doctoral dissertation (1926) »Über die Bewegung der Aussertropischen Zyklonen« presents the results of a synoptic study of the direction and speed of cyclone movement using the so-called Bergen school cyclone theory as a guideline. This theory was relatively new at that time. Although containing nothing essentially new, the results confirmed the school's opinion about the general nature of the extratropical cyclones.

The most important results from my oceanographic studies are included in papers Nos. 17, 19, 27 and 46. Some of the topics covered in these papers are current conditions in the northern parts of the Baltic Sea, current conditions caused by the wind as well as their effect on temperature and density stratification of the sea and the connection between wind stress and water level, mainly in quasi-stationary conditions. On the basis of this connection, *inter alia*, a quantitative expression for the connection between wind stress and wind speed was developed. This expression, with certain modifications, is still acknowledged within the field of oceanography.

Continuing in the field of general oceanography, papers Nos. 5 and 75 should be mentioned in particular. The first, published jointly with R.B. Montgomery, deals with a new equatorial counter current theory, based on the meridional variations of wind stress on the sea surface and the resulting gradient currents. The latter work concerned the antarctic circumpolar current and its connection with the meridional exchange of angular momentum.

In 1928 I began a long working association with J. Bjerknes of the Geophysical Institute of Bergen, mainly researching the three-dimensional structure of atmos-

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<sup>1)</sup> Professor Palmén wrote these reflections in 1977, to be used only after his death:

pheric disturbances. Studies were carried out by means of the serial release of balloons equipped with registering instruments. This type of research had been successfully started by Bjerknes earlier. These papers (Nos. 31, 34, 44, 47, 49 and 55), some of which were published jointly mainly with J. Bjerknes but also with L. Weickmann, P. Mildner of Germany and A. Nyberg of Sweden, gave an essentially new picture of the vertical structure of extratropical cyclones, which was not possible earlier because of inadequate aerological data. By about the end of this period radio techniques were beginning to develop.

In the autumn of 1939 I was appointed Director of the Institute of Marine Research. Because of the war and the administrative obligations connected with my new appointment, the period between 1939 and 1946 turned out to be an interim period, with limited scientific productivity. No results of any higher scientific value were achieved during this period and of the papers published, some are pure routine work, some the results of my research activities during the years just before the war.

A new active research period started in 1946 when I was invited by Professor C.G. Rossby to work as visiting professor at the University of Chicago. Here, apart from teaching activities, my most important duty was, as an associate research leader, to take part in a comprehensive research project concerning the general circulation of the atmosphere. From the scientific point of view, this turned out to be the most fruitful period of my life, especially since in 1948, having held a professorship in meteorology at the University of Helsinki for one year, I was appointed as a member of the Academy of Finland. This post offered me the greatest possible freedom totally to devote myself to research activities in those fields that primarily interested me. Over a longer period, 5–6 years altogether, I was able to work with senior and junior scientists at various institutions in America, principally at the University of Chicago and the University of California at Los Angeles. During this period, I also often visited the newly-founded meteorological institution at the University of Stockholm, which was first directed by Rossby and after his death in 1957, by Professor Bert Bolin. I had the privilege of working several well-known senior scientists in the U.S.A. and, apart from C.G. Rossby, I would like to mention in particular J. Bjerknes, who during the war had taken over a professorship at the University of California, Sverre Petterssen, Professor at the University of Chicago, and Herbert Riehl, first Professor in Chicago and later Professor at the University of Colorado in Fort Collins. Among the younger scientists, with whom I worked during those years, I would especially like to mention C.W. Newton, K.M. Nagler, M.A. Alaka, D. Bradbury and C.L. Jordan. Many other names could be included, but I have limited myself to those whose names appear in my list of references. From the Finnish scientists I worked

with during this time I must mention L.A. Vuorela, E. Holopainen and D. Söderman.

During this period which started in 1946, my research work covered, among other things, the dynamics and structure of extratropical cyclones, air currents in the upper west-wind zone, general atmospheric circulation especially in the lower latitudes, the exchange of angular momentum and heat in meridional direction and tropical cyclones. Of special importance was my contribution to the introduction of the concept of jet streams in meteorology (Nos. 39, 61, 63 and 65) and the distinction between the polar jet stream and the subtropical jet stream in each hemisphere (No. 73). One result of the jet stream research was the establishment of the rule that absolute vorticity has a lower limit, *i.e.* although no upper limit exists. Similarly the close connection between the polar jet stream and the polar front and between the subtropical jet stream and the Hadley circulation in the tropics was established. These studies were principally accomplished at the University of Chicago in cooperation with C.G. Rossby and some of my students and younger assistants there.

At the same time I carried out certain studies on the structure of the so-called high-level cyclone (Nos. 68 and 70). From this time on I have also paid specific attention to the problem of tropical hurricanes and their energy development. In the first paper concerning this problem (No. 62) I established the necessary, but certainly not sufficient conditions for the occurrence of tropical cyclones. These conditions, which are generally accepted, clarified why tropical hurricanes are restricted to certain oceanic regions and seasons. A more detailed discussion about the same problem is also included in paper No. 88. Energy development in tropical hurricanes is dealt with in detail in certain papers, some of which were published jointly with H. Riehl and C.L. Jordan (Nos. 85, 89 and 92). I consider these contributions to the theory of tropical cyclones to be some of my most original work, primarily because I was merely an amateur in this special field when I prepared my first contribution to the solution of the problem.

While working as a visiting professor at the University of California at Los Angeles during the years 1953–54, I came to study more closely the nature of the general circulation of the atmosphere in tropical and subtropical regions. In this connection, *inter alia*, average mass circulation was calculated for the Hadley circulation of the northern hemisphere in winter time when it is strongest (No. 86). Studies of tropical circulation later showed that my calculations concerning mass circulation, which were based on empirical material were right. A relatively detailed description of my views on tropical circulation is in the publication No. 112, which is the text of a lecture I gave when I was invited to a symposium in New Zealand in 1963. A complementary investigation of the same problem, in

cooperation with L.A. Vuorela is also included in No. 107.

During my last active years at the Academy of Finland, I also became interested in a hydrological problem, *i.e.* how evaporation from a certain limited area can be calculated by means of aerological observations. The method was used in particular for the Baltic Sea and it gave satisfactory results (Nos. 108 and 115). A comprehensive report on the usefulness of this method is also included in No. 119 – a summary which I gave at the request of the WMO in Geneva in 1967.

A great deal of my time in the 1960s was taken up with work on a monograph concerning various atmospheric circulation systems, requested by the Academic Press in New York (No. 122). In accomplishing this work, I was aided by my colleague and former student from the University of Chicago, Chester W. Newton, without whose help I would never been able to fulfil the task. The 603-page book was published in 1969 under the title »Atmospheric Circulation Systems». It gives a comprehensive description of various circulation processes in the atmosphere from the global time-mean circulation down to mesometeorological processes. The book was published in Russian in 1973.

If I may make my own judgement about the value of my contribution to research, I would like to stress the fact that my research activities span large areas of meteorology and oceanography. This possibly results in a certain superficiality in the treatment of many problems. Being very much aware of this myself, I only wish to point it out as a natural excuse for the weakness and lack of thoroughness that may occur in much of my research. I place most value on my contributions to the study of the structure and dynamics of extratropical cyclones, the introduction of the concept of jet streams within meteorology, my research concerning tropical circulation and the description of the energy balance of hurricanes and certain necessary conditions for their occurrence.

#### *Publications of Professor Erik Palmén*

1922

1. Untersuchungen über die Ayrton'sche Relation für den elektrischen Lichtbogen zwischen Metallelektroden (with H. Väyrynen). *Soc. Scient. Fenn. Comm. Phys.-Math. I*, **22**, 1–18.

1923

2. Zur Theorie der Zyklonenbahnen. *Soc. Scient. Fenn. Comm. Phys.-Math. II*, (3), 1–14.

1925

3. Beobachtungen von Strom und Wind an den Leuchtschiffen im Jahre 1932. *Merentutkimuslaitoksen Julkaisu/Havsforskningsinstitutets Skrift* **33**, 1–26.

1926

4. Über die Bewegung der aussertropischen Zyklonen. *Soc. Scient. Fenn. Comm. Phys.-Math.* **III**, (7), 1–102, app.
5. Über die Verteilung von Temperatur und Salzgehalt des Wassers im Finnischen Meerbusen bei stationärem Stromzustande. *Journ. du Cons. Intern. pour l'Exploration de la Mer*, **1** (3), 327–343.
6. Die thalassologische Terminfahrt im Jahr 1925. *Merentutk. Julk./Havsforskn. Inst. Skr.* **39**, 1–22, app.

1927

7. Die thalassologische Terminfahrt im Jahre 1926 (with R. Jurva), *Merentutk. Julk./Havsforskn. Inst. Skr.* **46**, 1–20, app.
8. Beobachtungen von Strom und Wind an den Leuchtschiffen in den Jahren 1924 und 1925. *Merentutk. Julk./Havsforskn. Inst. Skr.* **48**, 1–23.

1928

9. Zur Frage der Fortpflanzungsgeschwindigkeit der Zyklonen. *Meteor. Zeitschr.* **45**, 96–99.
10. Über die Horizontalströmungen in der Umgebung von beweglichen atmosphärischen Fronten. *Soc. Scient. Fenn. Comm. Phys.-Math.* **IV**, (20), 1–21.
11. Über die Natur der Luftdruckschwankungen in höheren Schichten. *Beitr. z. Phys. d. freien Atmosphäre*, **14**, 147–153.
12. Yleiskatsaus talven 1916–17 jääsuhteisiin/Översikt av isarna vintern 1916–17. *Merentutk. Julk./Havsforskn. Inst. Skr.* **50**, 1–41.

1929

13. Ein Fall der Regeneration einer sterbenden Zyklone. *Meteor. Zeitschr.* **46**, 66–69.
14. Über die Gleichgewichtsbedingungen beim dritten Sandström'schen Winter-typus. *Beitr. z. Phys. d. freien Atmosphäre*, **16**, 26–28.
15. Yleiskatsaus talven 1918–19 jääsuhteisiin/Översikt av isarna vintern 1918–19. *Merentutk. Julk./Havsforskn. Inst. Skr.* **57**, 1–35.
16. Beobachtungen von Strom und Wind an den Leuchtschiffen in den Jahren 1926 und 1927. *Merentutk. Julk./Havsforskn. Inst. Skr.* **59**, 1–22.

## 1930

17. Ein Beitrag zur Berechnung der Strömungen in einem begrenzten und geschichteten Meere. *Rapp. et Procès Verb. Cons. Intern. pour l'Exploration de la Mer*, **64**, 47–58.
18. Die vertikale Mächtigkeit der Kälteeinbrüche über Mitteleuropa. *Gerlands Beitr. z. Geophysik*, **26**, 63–78.
19. Untersuchungen über die die Strömungen in den Finnland umgebenden Meeren. *Soc. Scient. Fenn. Phys.-Math.* **V**(12), 1–94.
20. Nachtrag zum Aufsatz: Die vertikale Mächtigkeit der Kälteeinbrüche über Mitteleuropa. *Gerlands Beitr. z. Geophysik*, **28**, 235–237.
21. Strom- und Windbeobachtungen an den Feuerschiffen in den Jahren 1928 und 1929. *Merentutk. Julk./Havsforskn. Inst. Skr.* **73**, 1–58.

## 1931

22. Die Beziehung zwischen troposphärischen und stratosphärischen Temperatur- und Luftdruckschwankungen. (Über die Natur der sog. primären und sekundären Druckwellen). *Beitr. z. Phys. d. freien Atmosphäre*, **17**, 102–116.
23. Die Luftbewegung im Cirrusniveau über Zyklonen. *Meteor. Zeitschr.* **48**, 281–288.
24. Synoptisch-aerologische Untersuchung eines Kälteeinbruches. *Gerlands Beitr. z. Geophysik*, **32** (Köppen-Band I), 158–172.
25. Zur Bestimmung des Triftstromes aus Terminbeobachtungen. *Journ. du Cons. Intern. pour l'Exploration de la Mer*, **6**, 387–401.

## 1932

26. Versuch zur Analyse der dynamischen Druckschwankungen in der Atmosphäre (Beitrag zur Frage des »Sitzes« der Luftdruckschwankungen). *Beitr. z. Phys. d. freien Atmosphäre* (Bjerknes-Festschrift), **19**, 55–70.
27. Über die Einwirkung des Windes auf die Neigung der Meeresoberfläche. *Soc. Scient. Fenn. Comm. Phys.-Math.* **VI**, (14), 1–50.
28. Versuch zur Bestimmung des Tangentialdruckes des Windes auf die Meeresoberfläche mittels Wasserstandsbeobachtungen. *Ann. d. Hydrogr. und marit. Meteor.* **60**, 435–441.
29. Strom- und Windbeobachtungen an den Feuerschiffen in den Jahren 1930 und 1931. *Merentutk. Julk./Havsforskn. Inst. Skr.* **83**, 1–85.

## 1933

30. Aerologische Untersuchungen der atmosphärischen Störungen, mit besonderer Berücksichtigung der stratosphärischen Vorgänge. *Soc. Scient. Fenn. Comm. Phys.-Math.* **VII**, (6), 1–65.

31. Aerologische Analyse einer Zyklone (Ergänzung der Uccle-Serie vom 28. bis 30. März 1928) (with J. Bjerknes). *Beitr. z. Phys. d. freien Atmosphäre*, **21**, 53–62.

## 1934

32. Über die Temperaturverteilung in der Stratosphäre und ihren Einfluss auf die Dynamik des Wetters. *Meteor. Zeitschr.* **51**, 17–23.
33. Strom- und Windbeobachtungen an den Feuerschiffen in den Jahren 1932 und 1933. *Merentutk. Julk./Havsforskn. Inst. Skr.* **94**, 1–55.

## 1935

34. Registrierballonaufstiege in einer tiefen Zyklone. *Soc. Scient. Fenn. Comm. Phys.-Math.* **VIII**, (3), 1–32.
35. Den moderna cyklonteorien och stratosfären. Föredrag vid Finska Vetenskaps-Societetens sammanträde den 19 november 1934. *Soc. Scient. Fenn. Årsbo XIII B*, **2**, 1–17.
36. The thalassological summer cruise in 1934. *Merentutk. Julk./Havsforskn. Inst. Skr.* **98**, 1–17.

## 1936

37. Zur Frage der Temperatur-, Druck- und Windverhältnisse in den höheren Teiler einer okkludierten Zyklone. *Meteor. Zeitschr.* **53**, 17–22.
38. Strom- und Windbeobachtungen an den Feuerschiffen in den Jahren 1934 und 1935. *Merentutk. Julk./Havsforskn. Inst. Skr.* **106**, 1–57.
39. The thalassological cruise, Sept.-Oct. 1936 (with E. Laurila). *Merentutk. Julk./Havsforskn. Inst. Skr.* **110**, 1–14.
40. Über die von einem stationären Wind verursachte Wasserstauung. *V. Hydrologische Konferenz der Baltischen Staaten, Finnland, Juni 1936. Bericht 15 B* 1–17.
41. Försök med synoptisk aerologi. *Nordiska naturforskarmötet i Helsingfors*, 11–15 augusti 1936, 326–327.
42. De meteorologiska betingelserna för stratosfärflygning. *Terra* **48**, 60–71.

## 1937

43. En internationell cyklonundersökning. *Soc. Scient. Fenn., Årsbok XV B*, **7**, 1–24.
44. Investigations of selected European cyclones by means of serial ascents (with J. Bjerknes). *Geofysiske Publikasjoner* **12**, 1–62.

## 1938

45. Regular observations of temperature and salinity in the seas around Finland, July 1936–June 1937. *Merentutk. Julk./Havsforskn. Inst. Skr.* **120**, 1–43.
46. Über die Einwirkung eines Sturmes auf den hydrographischen Zustand im nördlichen Ostseegebiet (with E. Laurila). *Soc. Scient. Fenn. Comm. Phys.-Math.* **X**, (1), 1–53.
47. Aerologische Analyse einer Warmfrontfläche (with J. Bjerknes). *Beitr. z. Phys. d. Freien Atmosphäre*, **25**, 115–129.

## 1939

48. Strom- und Windbeobachtungen an den Feuerschiffen in den Jahren 1936 und 1937. *Merentutk. Julk./Havsforskn. Inst. Skr.* **121**, 1–57.
49. Synoptisch-aerologische Untersuchung der Wetterlage während der internationalen Tage vom 13. bis 18. Dezember 1937. *Veröffentl. d. Geophys. Inst. d. Universität Leipzig, Ser. II*, (With J. Bjerknes, P. Mildner, L. Weichmann). **12**, 1–107.

## 1940

50. Vedenkorkeusarvoja 1937 ja 1938/Vattenståndsvärden 1937 och 1938. *Merentutk. Julk./Havsforskn. Inst. Skr.* **130**, 1–92.
51. Contribution to the question of the equatorial counter current (with R.B. Montgomery). *J. Mar. Res.* **3**, 112–133.
52. Über die dreidimensionale Luftströmung in einer Zyklone und die Ozonverteilung. *Union Géodés. et Geophys. Internat., Septième Assemblée Générale, Washington, September 1939, Association de Météorologie, Procès-Verbaux II*, 75–77.

## 1941

53. Zur Frage des Windstaus in einem geschichteten Meer. *Soc. Scient. Fenn. Comm. Phys.-Math.* **XI**, (7), 1–11.
54. Zur Frage des thermischen Aufbaus der Fronten in der freien Atmosphäre (with I. Hela). *Soc. Scient. Fenn. Comm. Phys.-Math.* **XI**, (6), 1–23.

## 1942

55. Synoptisch-aerologische Bearbeitung der Internationalen Registrierballonaufsteige in Europa in der Zeit 17–19. Oktober 1935 (with A. Nyberg). *Geografiska Annaler*, **24**, 51–93.

1944

56. Wasserstandsregistrierungen in Hangö 1904–1920. *Merentutk. Julk./Havsforsk. Inst. Skr.* **133**, 1–41.
57. Havens vattenståndsvariationer och därmed sammanhängande problem. *Soc. Scient. Fenn. Årsbok XXII B*, **2**, 1–24.

1945

58. Vedenkorkeusarvoja 1939 ja 1940/Vattenståndsvärden 1939 och 1940. *Meren tutk. Julk./Havsforsk. Inst. Skr.* **136**, 1–80.

1947

59. On the general circulation of the atmosphere in middle latitudes (group research). *Bull. Amer. Meteor. Soc.*, **28**, 255–280.
60. Rolf Johan Witting. Minnestal vid Finska Vetenskaps-Societetens sammanträde den 16 September 1946. *Soc. Scient. Fenn., Årsbok XXV C*, **1**, 1–17.

1948

61. An analysis of the wind and temperature distribution in the free atmosphere over North America in a case of approximately westerly flow (with K.M. Nagler). *J. Meteor.*, **5**, 58–64.
62. On the formation and structure of tropical hurricanes. *Geophysica*, **3**, 26–38.
63. On the distribution of temperature and wind in the upper westerlies. *J. Meteor.* **5**, 20–27.
64. Structure of the tropical cyclone. *Bull. Amer. Meteor. Soc.*, **29**, 73–74.
65. A study of the mean wind and temperature distribution in the vicinity of the polar front in winter (with C.W. Newton). *J. Meteor.*, **5**, 220–226.
66. Discussion of problems concerning frontal analysis in the free atmosphere. *Soc. Scient. Fenn. Comm. Phys. Math.* **VIII**, (8), 1–47.

1949

67. Meridional circulations and the transfer of angular momentum in the atmosphere. *J. Meteor.*, **6**, 429–430.
68. The formation and structure of large-scale disturbances in the westerlies (with K.M. Nagler). *J. Meteor.*, **6**, 227–242.
69. Contribution to the theory of the general atmospheric circulation. *Soc. Scient. Fenn. Comm. Phys.-Math.*, **XV**, (4), 1–24.
70. Origin and structure of high level cyclones south of the maximum westerlies. *Tellus*, **1**, 22–31.

## 1950

71. Progress in research in synoptic meteorology. *Bull. Amer. Meteor. Soc.*, **31**, 237.

## 1951

72. On the three-dimensional motions in an outbreak of polar air (with C.W. Newton). *J. Meteor.*, **8**, 25–39.
73. The role of atmospheric disturbances in the general circulation. *Quart. J. r. Meteor. Soc.*, **77**, 337–354.
74. On the meridional transport of angular momentum due to large-scale atmospheric eddies and meridional circulations. *U. G. G. I. Proces. Verbaux des Seances de l'Association de Météorologie, Mem. et Disc., Brussels, August 1951*, 32–34.
75. Note on the dynamics of the Antarctic circumpolar current (with W.H. Munk). *Tellus*, **3**, 53–55.
76. The aerology of extratropical disturbances. *Compendium of Meteorology*, American Meteorological Society, 599–620.
77. Från den moderna meteorologins arbetsfelt. *Kertomus Suomen Akatemian toiminnasta vuonna 1950*. Esitelmä. 10–20.

## 1952

78. On the budget of angular momentum in the zone between equator and 30 N (with M.A. Alaka). *Tellus*, **4**, 324–331.

## 1953

79. On the vertical eddy flux of momentum in the trade-wind zone. *Indian Acad. of Sci. Proceed. Soc. A. Bangalore*, **37** (2), 189–194.
80. On the existence of a polar-front zone at the 500-mb level (with D. Bradbury). *Bull. Amer. Meteor. Soc.*, **34**, 56–62.

## 1954

81. On the relationship between meridional eddy transfer of angular momentum and meridional circulations in the earth's atmosphere. *Archiv für Meteor. Geophys. Biokl.* (A), **7**, 80–84.
82. The mean vertical meridional circulation in low latitudes of the northern hemisphere. *Sci. Proceed. of the Int. Ass. of Meteorol., Rome, Sept. 1954*. *Publication AIM 10/C*, 409–412.

83. Über die atmosphärischen Strahlströme. *Met. Abhandlungen Bd. II, Heft 3*.  
Inst. für Met. und Geoph. der Freien Univ. Berlin. Die Tagung der Dt.  
Meteorologischen Gesellschaft in Berlin vom 28. Sept. bis 4. Okt. 1953.  
S. 35–49.

## 1955

84. On the mean meridional drift of air in the frictional layer of the west-wind belts. *Quart. J. r. Meteor. Soc.*, **81**, 459–461.
85. Note on release of kinetic energy in tropical cyclones (with C.L. Jordan). *Tellus*, **7**, 186–188.
86. On the mean meridional circulation in low latitudes of the Northern Hemisphere in winter and the associated meridional and vertical flux of angular momentum. *Soc. Scien. Comm. Phys. Math.*, **XVII**, (8), 1–33.

## 1956

87. On the exchange of momentum between the atmosphere, the oceans, and the solid earth. *J. Mar. Res.*, **14**, 465–476.
88. Formation and development of tropical cyclones. *Tropical Cyclone Symposium, Brisbane, December 1956*. Proceedings, 213–231.

## 1957

89. Budget of angular momentum and energy in tropical cyclones (with H. Riehl). *J. Meteor.*, **14**, 150–159.
90. Oscar V. Johansson in memoriam. *Geophysica* **6**, 65–67.

## 1958

91. On the meridional circulation and release of kinetic energy in the tropics (with H. Riehl and L. Vuorela). *J. Meteor.*, **15**, 271–277.
92. Vertical circulation and release of kinetic energy during the development of hurricane Hazel into an extratropical storm. *Tellus*, **10**, 1–23.
93. On the dynamics of tropical hurricanes. *Final Report of the Caribbean Hurricane Seminar, Ciudad Trujillo, Dominican Republic, February 16–25, 1956*. 34–55.
94. Energy problems of the tropical hurricane. *Technical Conference on Hurricanes, Miami Beach, Florida, November 19–22, 1958*. Proceedings, Section C 11, 12 pp.
95. Tropiska Cykloner. *Soc. Scien. Fenn. Årsbok–Vuosisikirja XXXIV*, **B2**, 1–17.

## 1959

96. On the maintenance of kinetic energy in the atmosphere. *Rosby Memorial Volume*, Rockefeller Institute Press, New York. 212–224.
97. *Proceedings of the board of review and conference on research progress* (with other members). National Hurricane Research Project, Rep. No. 27, Washington, D.C.
98. Tropiska orkaner som ett termodynamiskt problem. *Arkhimedes* 2, 20–32.
99. Är det möjligt att inverka på vädret? *Soc. Scient. Fenn. Årsbok–Vuosikirja XXXVI*, B5, 1–15.

## 1960

100. On generation and frictional dissipation of kinetic energy in the atmosphere. *Soc. Scient. Fenn. Comm. Phys.-Math.* XXIV, (11), 1–15.
101. Jordens atmosfär. *Nordenskiöld-Samfundets tidsskrift.* 20, 3–18.
102. Geofysikaalisten tieteyden nykyisestä ja tulevasta asemasta Suomessa. *Akateeminen* No. 3, 12–13.

## 1961

103. On Conversion between potential and kinetic energy in the atmosphere. *Geofisica Pura e Applicata*, 49, 167–177.
104. Meteorologian kehityksestä 1900-luvulla. *Terra* 73, 110–122.

## 1962

105. Kvantitativ beräkning av nederbördsintensiteter med användning av kinematiska metoder. *Nordiska Meteorologmötet i Helsingfors 31.8.–2.9.1961.*
106. Divergence, vertical velocity and conversion between potential and kinetic energy in an extratropical disturbance (with Eero Holopainen). *Geophysica* 8, 89–113.

## 1963

107. On the mean meridional circulations in the northern hemisphere during the winter season (with L.A. Vuorela). *Quart. J. r. Meteor. Soc.*, 89, 131–138.
108. Computation of the evaporation over the Baltic Sea from the flux of water vapour in the atmosphere. *Publ. No. 62, Int. Association of Scientific Hydrology*, 244–252.
109. General Circulation of the Tropics. *World Meteorol. Org., TMS Doc.* 6.
110. Kinematic and thermal properties of a large-amplitude wave in the westerlies (with C.W. Newton). *Tellus*, 15, 99–119.
111. Kan vädret någonsin förutses fullt tillfredsställande? *Finsk Tidskrift.* 4–5, 184–194.

1964

112. General Circulation of the Tropics. *Proc. of the Symposium on Tropical Meteorology, Rotorua, New Zealand, 5–13 November 1963*, 1–30.

1965

113. On the interhemisphere mass circulation across the Equator. *Quart. J. r. Meteo Soc.*, **92**, 157–158.

1966

114. Computation of the evaporation from the Baltic Sea from the flux of water vapour in the atmosphere. (with D. Söderman). *Geophysica*, **8**, 261–279.
115. Die Zyklonen als Glieder des meridionalen und vertikalen Austausch und der Energieumwandlungen in der Atmosphäre. *Archiv für Meteorologie, Geophysik und Bioklimatologie, Supplementum 1*, 17–23.
116. On the mechanism of the vertical heat flux and generation of kinetic energy in the atmosphere. *Tellus*, **18**, 838–845.
117. Autobiography. *Modern Men of Science*. McGraw-Hill, New York. 364–365.

1967

118. Aerology of extratropical cyclones. *International Dictionary of Geophysics*. Pergamon Press, London, 1967 (1), 33–41.
119. Evaluation of atmospheric moisture transport for hydrological purposes. *Reports on WMO/IHD Projects*, No. 1. Geneva, 63 pp.
120. Role of the Tropics in the general circulation. *Bull. Amer. Met. Soc.* **48**, 627.
121. Maapallon ilmakehän lämpö- ja energiatalous uusimpien tutkimusten valossa. *Geofysiikan Päivät, 20.–21.6.1966, Oulu*, 8–24.

1969

122. Atmospheric circulation systems, their structure and physical interpretation (with C.W. Newton). *International Geophysics Series*, **13**, Academic Press, New York. 603 pp.

1972

123. En kritisk granskning av den synoptiska meteorologins utveckling under de senaste 50 åren. *Report No. 1*, Department of Meteorology, Univ. of Helsinki. 1–13.

1974

124. Vädervirvlarna. *Forskning och Framsteg*, Stockholm. (1), 34–41.
125. Atmospheric general circulation. *Encyclopedia of Environmental Science*, McGraw Hill, 41–46.

**Erik Herbert Palmén***Awards*

Symons Memorial Gold Medal (Roy. Meteor. Soc. 1957)  
Carl Gustaf Rossby Award (Amer. Met. Soc. 1960)  
Buys Ballot Medal (Koninkl. Nederlandse Akad. Wetens. 1964)  
Rossby Prize (Geof. Föreningen i Sverige 1966)  
Silver Medal (Geophysical Soc. in Finland 1968)  
IMO-Medal (World Meteor. Organization 1969)

*Membership honors*

Societas Scientiarum Fennica, Honorary Member  
Geographical Society in Finland, Honorary Member  
Geophysical Society in Finland, Honorary Member  
Geophysical Society in Sweden, Honorary Member  
American Meteorological Society, Honorary Member  
New York Academy of Sciences, Honorary Life Member  
Kungliga Vetenskaps-Societeten, Uppsala, Sweden, Foreign Member  
Norska Vetenskaps-Akademi, Oslo, Foreign Member  
Royal Meteorological Society, London, Foreign Member  
Deutsche Akademie der Naturforscher Leopoldina, Foreign Member  
Österreichische Akademie der Wissenschaften, Foreign Member