



HOKKAIDO UNIVERSITY

Title	Professor Seiichi Kanari and ocean turbulence measurement
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Description	"List of research work publications in English", "List of research work publications in Japanese", "List of other publications" あり
Citation	Journal of the Faculty of Science, Hokkaido University. Series 7, Geophysics, 11(2), 383-391
Issue Date	1998-03-30
Doc URL	https://hdl.handle.net/2115/8923
Type	other
File Information	11(2).pdf





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Professor Seiichi Kanari and Ocean Turbulence Measurement

Dr. Kanari was invited to the Department of Geophysics, Hokkaido University, as a professor of physical oceanography in 1980. He was expected to lead the newly founded physical oceanographic section. At that time, physical oceanography was a missing ring for the Department of Geophysics. It was like painting a new picture on a vacant canvas.

Among numerable possible fields in physical oceanography, he chose small scale turbulence in the ocean as the main theme of the section. Small scale turbulence plays important roles even in large scale phenomena in the ocean. In the basic equations describing the motion of sea water or evolution of temperature and salinity, there are so called mixing terms or diffusion terms. Usually, they are represented in Laplacian form, but it is just a parameterization. Moreover, in many cases, the coefficients are set to constant values, which no researcher believes true.

These approximations are used not because they are enough accurate to describe real mixing process. Researchers working on numerical models of large scale ocean circulation, know how much their results depend on these coefficients. Then, why do we use simple form of mixing with fixed coefficients? It is simply because we have very little knowledge about small scale turbulence and mixing process due to it. So, this problem has been a kind of taboo, among physical oceanographers.

But, if they are so important, why measurements of turbulence have not been made so much? Because they are very difficult to measure. The history of measurement of turbulence in the atmosphere, especially in its lower boundary layer, is much older. It is comparably easier to make a fixed point in the atmosphere by building a tower. It is possible to measure high frequency variation of air temperature, for example, using a very sensitive sensor. In the ocean, however, it is difficult to fix a sensor.

Recently, the circumstance surrounding physical oceanography changed substantially. Application of physical oceanography had been remaining much more indirect compared to meteorology. Numerical ocean models were not required to be so realistic. They were tools to solve complex and non-linear equations, rather than tools to simulate and examine real world. As climate changes become important issues, and important roles of ocean in climate changes are widely recognized, the situation changed completely. Now, ocean models are used as parts of climate prediction models, in which ability to simulate real ocean is strongly required.

Especially, demand for accurate simulation of sea surface temperature is increasing, as it plays a key role in air-sea interaction. For it, ocean surface mixed layer should be reproduced well. Many types of mixed layer model are tried recently. However, if the measurement of real ocean turbulence is missing, the development of mixed layer models are not expected.

Professor Kanari was among a few researchers who feel the needs and start to challenge this difficult task. After a few years of preparatory experiment, he began designing a new equipment. These devices are called by many names, like "micro structure profilers". Here in this article, I would like to call them "turbulence profilers". The profiler is designed to free fall slowly in the ocean, measuring tiny scale fluctuations of temperature, salinity and current shear. Data are recorded in IC memory in the profiler. After reaching a certain depth, it drops a weight and comes up to the sea surface to be recovered. To make the recovery easier, the profiler is tied to a thin fishing thread, which is winded by fishing reel to pull the profiler to a research vessel. When the profiler is descending, the thread is slacken so that it does not affect the free falling of the profiler.

The above description may not give you an impression that it requires very delicate design and careful handling. However, the sensors need to be very sensitive, but should be tough enough to be used in rough condition. The profiler should be free from any kind of noise, such as wave motion at the sea surface or vibration of ship engine. It is not easy to design a device fulfilling all these requirements.

Professor Kanari is not only a admirable scientist, but also is a superb electronic and mechanical engineer and an experienced ocean observation technician. Without any one of these elements, the profilers had not be finished and observations with them had not been successful. Different from the researchers in the other countries, who have technician working for them, he needed to be all of them by himself.

He used his profilers in many places. Among them, the observations in the Western Tropical Pacific need a special mention. The region is attracting attentions of many researchers as the key area for development of El Niño events, as unstable air-sea interactions are believed to start in this area. The area is also known as an ocean with very thick ocean surface mixed layer. Measurements of turbulence in the mixed layer are very important for the investigation of the air-sea interaction process, as sea surface temperature which is affected by behaviors of mixed layer, plays a key role in the air-sea interaction.

His profilers were used in several cruises in this region. Especially, in the TOGA COARE intense observation period (Nov. 1992 to Mar. 1993), in total more than hundred casts of observations are made at the fixed point at the equator, 165°E, from R/V Hakuho-maru and R/V Natsushima. In each cruise, observations cover 14 days and 9 days, respectively, with rate of 4 casts a day, for a few days 8 casts a day. These observations provide nice time series of turbulence distribution in the upper ocean including the mixed layer. The observed field of turbulence explained the evolution of the mixed layer consistently. It is shown that a mixed layer model can reproduce the evolution of the mixed layer better, when observed turbulence is used in the model.

It should be specifically mentioned that during this intense observation period, international inter-comparisons of this type of turbulence profilers were made twice between Japanese and American groups. These are the first international inter-comparisons of ocean turbulence profilers. These comparisons showed reasonable agreement between profilers. The meaning of these comparisons is not small. As there is no other practical mean of measuring ocean turbulence, there is no way to know whether these profilers measure real ocean turbulence. Along with the fact that these observations explain evolution of mixed layer, these inter-comparisons give strong impression that now oceanographers get a reliable tool to measure ocean turbulence.

Professor Kanari's challenge for better profilers did not stop there. He constructed a few more profilers, one of which can measure turbulence, T-S profiles, and current profiles simultaneously. It is expected to give us valuable information about ocean circulation, which should play important roles in climate changes with longer time scale, such as decadal oscillation or global warming.

Kensuke Takeuchi

List of Research Work Publications in English

1. On the Relations between the Distribution of Water Temperature Wind Stress-curl, Upwelling and Sinking. (with Y. Saito) *Journal of the Tokyo University of Fishery*, **46**(1960), 1-19.
2. Underwater Acoustic Telemetry for Oceanographical and Limnological Research (Part I). *The Bulletin of the Disaster Prevention Research Institute*, **15**(1966), 71-80.
3. Some Experiments on the Sedimentation in Estuaries with Density Stratification. *Special Contribution of Geophysical Institute, Kyoto University*, **6**(1966), 127-133.
4. Underwater Acoustic Telemetry for Oceanographical and Limnological Research (Part II). *The Bulletin of the Disaster Prevention Research Institute*, **15**(1966), 81-94.
5. Internal Waves in Lake Biwa (I) — The Responses of the Thermocline to the Wind Action —. *The Bulletin of Disaster Prevention Research Institute*, **19**(1970), 19-26.
6. Internal Waves in Lake Biwa (II) — Numerical Experiments with a Two Layer Model —. *The Bulletin of Disaster Prevention Research Institute*, **22**(1973), 69-96.
7. On the Study of Numerical Experiments of Two Layer Lake Biwa. *The Japanese Journal of Limnology*, **35**(1974), 1-17.
8. Large Scale Motions in Lake Biwa as an Information to Paleolimnology. *Proceedings of the Japan Academy*, **50**(1974), 628-633.
9. Some Results of Observation of the Long-Period Internal Seiches in Lake Biwa. *The Japanese Journal of Limnology*, **35**(1974), 136-147.
10. Study on the Currents in Lake Biwa (I) — Barotropic Circular Currents Induced by the Uniform Wind —. (with T. Imasato and H. Kunishi) *J. Oceanogr. Soc. Japan*, **31**(1975), 15-24.
11. An Estimation of the Deposition Rate of Lake Biwa during the Past 560, 000 Years. (with Y. Takenoya) *Paleolimnology of Lake Biwa and the Japanese Pleistocene*, **3**(1975), 235-240.
12. Factor Analysis with the Selected 21 Variable Quantities from the Core Sample of Lake Biwa. (with S. Horie) *Paleolimnology of Lake Biwa and the Japanese Pleistocene*, **3**(1975), 393-408.
13. The Long-Period Internal Waves in Lake Biwa. *Limnol. and Oceanogr.* **20**(1975), 544-553.
14. Buried Forest in Lake Yogo-ko and its Significance for the Study of Past

- Bio-environments. (with S. Horie and K. Nakao) Proceedings of the Japan Academy, **51**(1975), 669-674.
15. The Long-Period Internal Waves in Lake Biwa. Verh. Internat. Verein. Limnol., **19**(1975), 97-103.
 16. A Consolidation Model of Lake Sediments. Verh. Internat. Verein. Limnol., **20**(1978), 2658-2662.
 17. Limnological Studies of Tsugaru Twelve Lakes (Ju-niko). (with S. Horie et al.) Paleolimnology of Lake Biwa and the Japanese Pleistocene, **7**(1979), 379-384.
 18. Bashi Channel, Luzon Strait : A Hydraulic Model Experiment of the Tidal Current. (with T. Teramoto) J. Oceanogr. Soc. Japan, **37**(1981), 31-48.
 19. Hydraulic Model Experiments on Underwater Enforced-flow Structures for Applications to Artificial Shelters and Fish Farms. (with H. Matumoto and H. Myose) La mer, **19**(1981), 57-63.
 20. Vertical Eddy Diffusivity Coefficient in Stable Stratified Fluid at a Coastal Sea. (with M. Tsuji) La mer, **21**(1983), 84-88.
 21. The Paleoclimatological Constituents of Paleotemperature in Lake Biwa. (with N. Fuzi and S. Horie) Milancovitch and Climate, Part 1, eds. A. L. Berger et al., (1984), 405-414.
 22. Surface Mixed Layer Observation Using a Meteo-Oceanographic Spar Buoy, XTGP and SEMVP System. (with M. Koga) The Ocean Surface, eds. Toba and Mitsuyasu, D. Reidel Publishers Co., (1985), 559-564.
 23. Age-scaling for Upper-most Clayey Layer in the 1,400 m-core Sample from Lake Biwa — A Preliminary Study —. (with H. Taishi and A. Yamamoto) The Japanese Journal of Limnology, **47**(1986), 101-108.
 24. Vortex Generation by Multiple Source-Sink Forcing in a Rotating Tank. (with M. Koga) Journal of the Faculty of Science, Hokkaido Univ., Series VII (Geophysics), **8**(1987), 137-153.
 25. An Inference on the Process of Gas Outburst from Lake Nyos, Cameroon. Journal of Volcanology and Geothermal Research, **39**(1989), 135-149.
 26. Energy Dissipation Rate in the Mixed Layer in the Ocean South of Honshu. (with T. Kobayashi) Progress Report of WCRP Association (1990), 120-126.
 27. An Estimate of the Velocity and Stress in the Deep Ocean Bottom Boundary Layer. (with C. Kobayashi and T. Ishikawa) The Journal of the Faculty of Science, Hokkaido Univ., Series VII (Geophysics), **9**(1991), 1-16.
 28. Micro-Scale Profiler (MSP) for Measurement of Small-scale Turbulence in the Ocean. J. Oceanogr. Soc. Japan, **47**(1991), 17-25.
 29. Parameterization of Turbulent Mixing in the Western Equatorial Pacific

- Preliminary Observation —. (with C. Kobayashi and K. Takeuchi) *Journal of the Faculty of Science, Hokkaido Univ., Series VII (Geophysics)*, **9**(1992), 269-280.
30. Turbulent Structure in the Upper Layer of the Western Equatorial Pacific Ocean. (with C. Kobayashi and K. Takeuchi) *J. Oceanogr.*, **48**(1992), 117-127.
 31. Ocean Turbulence Observation in the Equatorial Surface Mixed Layer. (with C. Kobayashi et al.) Preliminary Report of the Hakuho-maru Cruise KH-92-5, Ocean Res. Inst., Univ. Tokyo, (1993), 63-68.
 32. Estimate of Turbulent Heat Flux and Heat Budget in the Upper Layer of the Western Equatorial Pacific Ocean. (with C. Kobayashi and H. Otobe) *J. Meteor. Soc. Japan*, **73**(1995), 597-609.
 33. Vertical Mixing near the Continental Shelf in the East China Sea and Intrusion of Shelf Water into the Kuroshio. (with K. Matsuno et al.) *Proceedings of JSPS-VCC Joint Seminar on Marine Science*, ed. by Mohd. Zaki Mohd. Said. Univ. Partanian Malaysia, (1996).
 34. Internal Wave Rolls Observed with the TSP, and their Contribution to Energy Transfer. (with Y. Kaya and S. Minobe) *Journal of the Faculty of Science Hokkaido Univ., VII (Geophysics)*, **10**(1997), 165-187.
 35. Small-scale Internal Waves and Turbulent Fluctuations near the Continental Shelf Break in the East China Sea. (with K. Matsuno et al.) *J. Oceanogr.*, **53**(1997), 259-269.

Book : Lake Biwa. Ed. S. Horie, Dr. W. Junk Publishers, Dordrecht, (1984), pp. 654.

List of Research Work Publications in Japanese

[論文]

1. 河口地形の海水遡上に及ぼす影響。(奥田と共著)京都大学防災研究所年報, **9** (1966), 501-512.
2. 河口締め切りにともなう塩分分布変化について(I)。(奥田と共著)京都大学防災研究所年報, **10-A**(1967), 505-512.
3. 児島湖締め切りの外界水底地形に及ぼす影響—Gorge Theoryの適応性について—。(奥田らと共著)木曾三川河口資源調査報告書, **4**(1967), 1613-1620.
4. びわ湖の内部波の研究(I)。京都大学防災研究所年報, **11-B**(1968), 179-189.
5. びわ湖の内部波の研究(II)—On the Instrumented Neutrally Buoyant Float—。京都大学防災研究所年報, **12-B**(1969), 669-680.
6. びわ湖の内部波の研究(III)—遠隔測定中立浮子による水の鉛直変位の測定について—。京都大学防災研究所年報, **13-A**(1970), 601-608.
7. 強風時の児島湖内における塩分分布。(奥田と共著)JIBP-PF 児島湖群集生産研究報告, **3**(1970), 62-67.
8. びわ湖の水の流動に関する数値実験的研究。(今里らと共著)京都大学防災研究所年報, **14-B**(1971), 451-464.
9. びわ湖底堆積物の古陸水学的研究。(堀江らと共著)京都大学防災研究所年報, **14-B**(1971), 745-762.
10. びわ湖における河口Deltaの発達過程について(I)。(中川らと共著)京都大学防災研究所年報, **15-B**(1972), 441-461.
11. 琵琶湖固定堆積物の粒度と圧密について。(山本らと共著)陸水学雑誌, **34** (1973), 63-74.
12. びわ湖における河口Deltaの発達過程について(II)。(中川らと共著)京都大学防災研究所年報, **16-B**(1973), 579-601.
13. びわ湖の内部波の研究(VI)—びわ湖の回転性内部波に関する近似解析解について—。(今里らと共著)京都大学防災研究所年報, **17-B**(1974), 249-258.
14. 湖沼水理観測のための流向・微流速計についてのノート。陸水学雑誌, **35** (1974), 183-184.
15. 海洋環境汚染に関連する地域別調査研究の現状と問題点—湖沼—。(小泉らと共著)日本海洋学会誌, 特集号(1975), 195-205.
16. 過去の湖底面における堆積速度の評価方法について。陸水学雑誌, **39**(1978), 55-60.
17. 静振の減衰振動と減衰係数・線形摩擦係数の評価について。(早瀬と共著)陸水学雑誌, **40**(1979), 102-109.
18. Three-fluid systemにおける内部波の対流不安定。北海道大学地球物理学研究報告, **41**(1982), 39-51.

19. 浅海用電磁式流速プロファイラー. 北海道大学地球物理学研究報告, **42**(1983), 215-228.
20. 噴火湾の潮汐の数値実験. (室伏らと共著) 北海道大学地球物理学研究報告, **42**(1983), 239-251.
21. フリーフォール型電磁式流速プロファイラーによる宗谷暖流の流速分布とフロント周辺の渦度構造について. (小賀らと共著) 北海道大学地球物理学研究報告, **44**(1984), 66-76.
22. Modified DKT による沿岸域表層混合層の数値実験. (小賀と共著) 北海道大学地球物理学研究報告, **46**(1985), 53-68.
23. 混合層ベースの内部波散逸. 北海道大学地球物理学研究報告, **48**(1987), 35-43.
24. 北海道余市市沿岸の近慣性内部波. (小賀らと共著) 北海道大学地球物理学研究報告, **49**(1987), 369-379.
25. ニオス湖ガス災害の原因と突発過程. 火山, **32**(1987), 43-55.
26. 沿岸域における季節水温躍層の周期的変動と微細水温分布の観測. (小賀と共著) 北海道大学地球物理学研究報告, **50**(1988), 15-32.
27. 流速・密度の鉛直プロファイル計測システム. (小賀らと共著) 北海道大学地球物理学研究報告, **50**(1988), 33-45.
28. 密度プロファイルに基づくエネルギー散逸率と渦拡散率の推定. 北海道大学地球物理学研究報告, **51**(1988), 47-54.
29. 本州南方域混合層の Diurnal Cycle と Trapping Depth. (小林と共著) 北海道大学地球物理学研究報告, **51**(1988), 55-61.
30. 海洋表層混合層の極微細乱流計測のためのマイクロ・ストラクチャー・プロファイラー (MSP). 気候変動国際協同研究計画 (WCRP), 第2回シンポジウム報告集, (1988), 55-59.
31. 一次元非定常線形境界層モデルによる深海底境界層の流速と海底摩擦の推定. (小林と共著) 北海道大学地球物理学研究報告, **52**(1989), 23-32.
32. 本州南方海域混合層のエネルギー散逸率の風および安定度依存性. (小林と共著) 気候変動国際協同研究計画 (WCRP), 第3回シンポジウム報告集, (1989), 181-184.
33. 一次元過程としての海洋表層乱流パラメータの評価に関する研究. (小林と共著) 気候変動国際協同研究計画 (WCRP), 第4回シンポジウム報告集, (1990), 167-174.
34. 海洋微細乱流観測のためのマルチ・プロファイラー. 北海道大学地球物理学研究報告, **54**(1990), 1-13.
35. 海洋混合層の乱流パラメータについて. (小林らと共著) 1991年度気候変動国際協同研究計画 (WCRP) シンポジウム, WCRP 協議会, (1991), 167-174.
36. 海洋表層混合層エネルギー散逸率のスケーリングについて. (小林らと共著) 北海道大学地球物理学研究報告, **56**(1992), 33-40.

37. 西太平洋赤道域における乱流拡散係数のパラメータリゼーション。(小林と共著) 日仏海洋学会誌, **31**(1993), 187-197.
38. 北太平洋の中層循環。(西野らと共著) 北海道大学地球物理学研究報告, **58**(1995), 1-19.
39. コードスキャン型曳航式水温観測チェーンシステムについて。(嘉屋らと共著) 北海道大学地球物理学研究報告, **59**(1996), 107-118.

[著 書]

1. 海洋の動態. 梶浦 欣二郎 編, 恒星社厚生閣, (1985), 531 pp.
2. 湖沼調査法. 半田 暢彦 編, 古今書院, (1987), 215 pp.

List of Other Publications

1. 内部波の研究。(奥田と共著)湖沼物理学の研究, 特別研究 I, 「湖沼; 貯水池における物質と熱の移動拡散の研究」成果報告書, (1970), 22-47.
2. びわ湖の内部波に関する研究. 水温の研究, **14**(1971), 2-16.
3. びわ湖の長周期内部波. 水温の研究, **17**(1974), 2-14.
4. 浅海用水温・水平流速の鉛直プロファイラーについて. 水温の研究, **23**(1980), 23-34.
5. 電磁式流速プロファイラーの落下・回転特性について. 海洋の動態構造に関する基礎的研究, 海洋計測研究会論文集 (1982), 23-25.
6. 琵琶湖湖底深層柱状資料におけるバルクデンシティの測定.(山本らと共著)自然環境変遷に関する琵琶湖深層掘削資料の解析—琵琶湖 1,400 m コア分析速報一, (1984), 16-21.
7. オホーツク海の潮汐。(鈴木と共著) 海洋科学, **18**(1986), 455-463.
8. 混合層ベースの内部波散逸. 本州南方海域の海洋混合層に関する総合的研究, 研究成果報告書, (1986), 110-112.
9. 表層係留系による混合層の観測実験. 本州南方海域の海洋混合層に関する総合的研究, 研究成果報告書, (1986), 179-187.
10. 海洋混合層における極微細乱流構造の観測. 海洋科学, **21**(1989), 393-398.
11. シンポジウム「鉛直混合と物質輸送」のまとめ。(福田らと共著) 沿岸海岸研究ノート, **31**(1993), 1-2.
12. MSP による海流乱流観測. 月刊海洋, **25**(1993), 467-475.
13. 東シナ海陸棚端付近における海底混合層と鉛直混合過程について. 月刊海洋, **26**(1994), 86-91.