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Geochemical Study of the Atmosphere
and Ocean in 1995 and 1996

by

Geochemical Research Department

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大気と海洋の地球化学的研究
(1995年及び1996年)

地球化学研究部



気 象 研 究 所

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序

気象研究所地球化学研究部では、気候変動・地球環境問題の解明・予測への貢献を大きな目標として研究の推進を図っている。これは地球環境に関連する近年の諸問題の多くが地球上での化学物質の循環に関連して発生しており、これらの物質循環のメカニズムの解明が現在最も重要な課題となっているからである。

地球温暖化・気候変動をもたらす大気微量気体の増加、降水の広域酸性化、重金属・放射能汚染の拡大などのように、人類活動の大幅な増大に伴う人為起源物質の環境への大量導入によって、地球環境は最近の数十年間にかつてないほど急激で広範囲な化学的变化を起こしており、これが社会経済的に重大な影響をもたらしつつある。この変化の現状を時・空間的に正確にかつ総合的に把握し、変化のメカニズムの解明と、結果の予測を行うことは、国内外の社会的要請に応えるとともに、学問的にもきわめて重要である。

このため、地球化学研究部では、大気・海洋・地殻中の化学物質の濃度や挙動解析のための新しい手法を開発し、それに基づいて、各環境における化学物質の特性の把握や、環境間の物質交換過程などを含む物質循環の素過程の解明の研究を推進している。

特に、「温室効果気体を含む大気微量成分の挙動とそれを支配する要因の研究」、「大気・海洋間の物質交換に係わる諸過程の研究」及び「海洋における生物地球化学的諸過程の研究」に重点を置き、これらの研究に関連して「海洋と大気の人放射核種の動態に関する研究」も精力的に推進してきた。

地球化学研究部で推進するこれらの研究成果は、気象庁における大気、海洋の気候変動観測・監視業務や環境気象業務の推進・改善等に役立てられているとともに、世界気候研究計画（WCRP）や地球圏－生物圏国際協同研究計画（IGBP）などの国際的に推進されている重要な地球環境問題の研究計画にも寄与するものである。

得られた研究成果は、行政的報告書の他に、関連する内外の様々な学会誌等に個別に投稿されて論文として発表されているが、1年間の成果をまとめて概観できる年報的な英文報告物がこれまで作成されていなかった。1995年と1996年の最近の研究成果の概要をひとつの印刷物にまとめることによって、この間に行った研究の成果を一望してその足跡を確認し、今後の研究活動に役立たせるとともに、英文印刷物として地球化学研究部の研究成果の概要を広く内外に示すことにより、研究の一層の推進に役立てることができるものと考えている。

平成11年1月

地球化学研究部長 伏見克彦

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地球化学研究部

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Geochemical Study of the Atmosphere and Ocean in 1995 and 1996

Foreword

Contribution to society and science through geochemical study by clarifying the earth's changing climate and environment is the most important objective of the Geochemical Research Department (GRD) of the Meteorological Research Institute (MRI). Most recent environmental problems have occurred in connection with chemical substance cycling, and science's most important task is to clarify the mechanism of substance cycling.

The earth's chemical environment has changed rapidly in the last decades, due to the massive introduction of anthropogenic substances caused by the abrupt expansion of human activities, such as increasing atmospheric trace gases leading to global warming and climate change, the wide-ranging expansion of acid rain, heavy metals, and radioactive substances. This change has brought serious effects on society and economics. It is also scientifically important to meet the needs of society to understand the change precisely and comprehensively, temporally and spatially, and to clarify mechanisms to predict consequences.

To meet these scientific and social needs, scientists in the GRD have promoted the development of new methods for analyzing chemical substances in the atmosphere, ocean, and earth's crust, and the study of geochemical cycle processes of substances in the environment and exchange processes between environments. Our recent studies focus on the behavior of atmospheric trace components including greenhouse gases, gas and particle air/sea exchange processes, biogeochemical processes in the ocean, and in connection with these geochemical studies, behavior of artificial radioactive nuclides in the ocean and atmosphere.

These studies are expected to be useful for promoting and improving Japan Meteorological Agency (JMA) business in the fields of climate and environmental observation and monitoring and to contribute to international scientific studies such as the World Climate Research Program (WCRP) and International Geosphere-Biosphere Program (IGBP).

Our results are submitted to and published in numerous scientific papers and administrative documents. Annual English-language summaries remain to be published yet, however. Such summaries would, I believe, be very useful in providing a bird's-eye view of our studies in 1995 and 1996, and to make known our scientific prospects.

Katsuhiko Fushimi
Director, GRD

VOYAGE STATISTICS

Shipboard observations in 1995

Cruise	Ship	Track/Sampling site	Substance
KH-90-2	R.V. <i>Hakuho Maru</i>	Tokyo (September 3, 1990) - Suva (Fiji) - Papeete (Tahiti) - Honolulu (October 25, 1990)	pCO ₂
KH-90-3	R.V. <i>Hakuho Maru</i>	Honolulu (October 31, 1990) - Rabaul (Papua New Guinea) - Guam - Tokyo (December 14, 1990)	pCO ₂
Ry-79-01	R.V. <i>Ryofu Maru</i>	137°E transect (January 1979)	¹³⁷ Cs
Ry-80-01	R.V. <i>Ryofu Maru</i>	137°E transect (January 1980)	¹³⁷ Cs
Ry-81-01	R.V. <i>Ryofu Maru</i>	137°E transect (Jan.-Feb. 1981)	¹³⁷ Cs
Ry-82-01	R.V. <i>Ryofu Maru</i>	137°E transect (January 1982)	¹³⁷ Cs
Ry-83-01	R.V. <i>Ryofu Maru</i>	137°E transect (January 1983)	¹³⁷ Cs
Ry-84-01	R.V. <i>Ryofu Maru</i>	137°E transect (Jan.-Feb. 1984)	¹³⁷ Cs
Ry-85-01	R.V. <i>Ryofu Maru</i>	137°E transect (January 1985)	¹³⁷ Cs
Ry-86-01	R.V. <i>Ryofu Maru</i>	137°E transect (January 1986)	¹³⁷ Cs
Ry-86-04	R.V. <i>Ryofu Maru</i>	31.5°N, 145.3°E (April 21, 1986)	¹³⁷ Cs
Ry-86-07	R.V. <i>Ryofu Maru</i>	34°N, 137°E (July 21, 1986)	¹³⁷ Cs
Ry-86-08	R.V. <i>Kofu Maru</i>	43°N, 138°E-45.3°N, 145°E (Aug. 1986)	^{134,137} Cs
Ry-86-09	R.V. <i>Ryofu Maru</i>	35.3°N, 141°E-38.5°N, 145.5°E (Sep. 1986)	^{134,137} Cs
Ry-87-01	R.V. <i>Ryofu Maru</i>	137°E transect (January 1987)	¹³⁷ Cs
NA-87-01	R.V. <i>Natsushima</i>	4°N, 180°E-6.2°N, 159.8°E (Feb. 1987)	^{134,137} Cs
Ch-87-03	R.V. <i>Chofu Maru</i>	27.8°N-130.7°E (March 1987)	^{134,137} Cs
Ry-87-04	R.V. <i>Ryofu Maru</i>	31.5°N, 145.7°E (April 1987)	^{134,137} Cs
Ko-87-08	R.V. <i>Kofu Maru</i>	41.5°N, 147°E-44.2°N, 141°E (Aug. 1987)	^{134,137} Cs
Ry-88-01	R.V. <i>Ryofu Maru</i>	137°E transect (January 1988)	¹³⁷ Cs
KH-93-4	R.V. <i>Hakuho Maru</i>	22.8°N, 158°W-45.2°N, 165.5°E (Oct.-Nov. 1993)	Protein

Shipboard observations in 1996

Cruise	Ship	Track/Sampling site	Substance
NA-8701	R.V. <i>Natsushima</i>	Western and central equatorial Pacific (WCEP) (January-February 1987)	pCO ₂ , CH ₄
NA-8901	R.V. <i>Natsushima</i>	WCEP (January-February 1989)	pCO ₂ , CH ₄
NA-9001	R.V. <i>Natsushima</i>	WCEP (January-February 1990)	pCO ₂ , CH ₄
NA-9101	R.V. <i>Natsushima</i>	WCEP (January-February 1991)	pCO ₂ , CH ₄
LIDAR	R.V. <i>Kaiyo</i>	WCEP (November-December 1992)	pCO ₂
LIDAR	R.V. <i>Kaiyo</i>	WCEP (January-February 1994)	pCO ₂
TOCS	R.V. <i>Kaiyo</i>	WCEP (November-December 1992)	pCO ₂
TOCS	R.V. <i>Kaiyo</i>	WCEP (November-December 1994)	pCO ₂
KH-90-2	R.V. <i>Hakuho</i>	WCEP (September-December 1990)	pCO ₂ , Protein, POC, PN, PCAA
KH-90-2	R.V. <i>Hakuho Maru</i>	Western, central North Pacific (WCNP) (September 1990)	Protein, POC, PN, PCAA
KH-90-3	R.V. <i>Hakuho Maru</i>	WCEP (September-December 1990)	pCO ₂
KH-91-3	R.V. <i>Hakuho Maru</i>	WCNP (May 1991)	Protein, POC, PN, PCAA
KH-93-4	R.V. <i>Hakuho Maru</i>	Western North and western equatorial Pacific (October- November 1993)	Protein
Ry-90-01	R.V. <i>Ryofu Maru</i>	137°E transect (January 1990)	Protein, POC, PN, PCAA
Ry-91-01	R.V. <i>Ryofu Maru</i>	137°E transect (January-February 1991)	pCO ₂
Ry-91-06	R.V. <i>Ryofu Maru</i>	137°E, 155°E transects (June-July 1991)	pCO ₂
Ry-92-01	R.V. <i>Ryofu Maru</i>	137°E transect (January-February 1992)	pCO ₂
Ry-92-06	R.V. <i>Ryofu Maru</i>	137°E, 155°E transects (June-July 1992)	pCO ₂
Ry-93-01	R.V. <i>Ryofu Maru</i>	137°E transect (January-February 1993)	pCO ₂
Ry-93-06	R.V. <i>Ryofu Maru</i>	137°E, 155°E transects (June-July 1993)	pCO ₂
Ry-87-01	R.V. <i>Ryofu Maru</i>	137°E transect (January-February 1987)	CH ₄
Ry-88-01	R.V. <i>Ryofu Maru</i>	137°E transect (January-February 1988)	CH ₄
Ry-89-01	R.V. <i>Ryofu Maru</i>	137°E transect (January-February 1989)	CH ₄
Ry-90-01	R.V. <i>Ryofu Maru</i>	137°E transect (January-February 1990)	CH ₄
Ry-91-01	R.V. <i>Ryofu Maru</i>	137°E transect (January-February 1991)	CH ₄
Ry-92-01	R.V. <i>Ryofu Maru</i>	137°E transect (January-February 1992)	CH ₄
Ry-93-01	R.V. <i>Ryofu Maru</i>	137°E transect (January-February 1993)	CH ₄
WOCE I	R.V. <i>Kaiyo</i>	Western equatorial Pacific (October 1992)	t, S, O ₂ , Nutrients
WOCE II	R.V. <i>Kaiyo</i>	Western equatorial Pacific (February 1994)	t, S, O ₂ , Nutrients
JKRJE	R.V. <i>Okean</i>	Japan Sea (March-April 1994)	t, S
JARE 34	I.B. <i>Fuji</i>	Indian and Southern Ocean (November 1992- March 1993)	Protein

Plane Observations From Cairns/Sydney, Australia, to Narita, Japan, Since April 1993

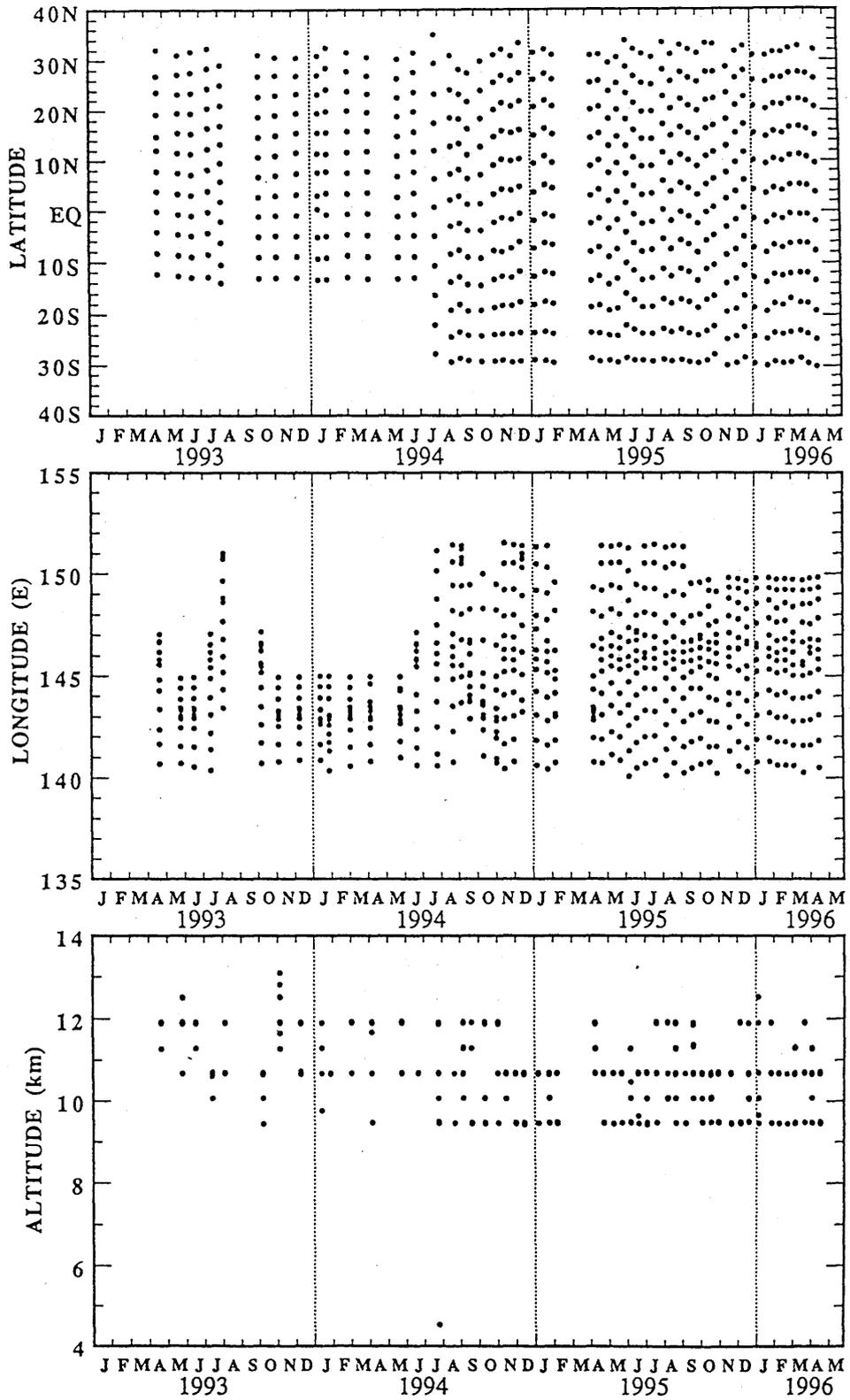
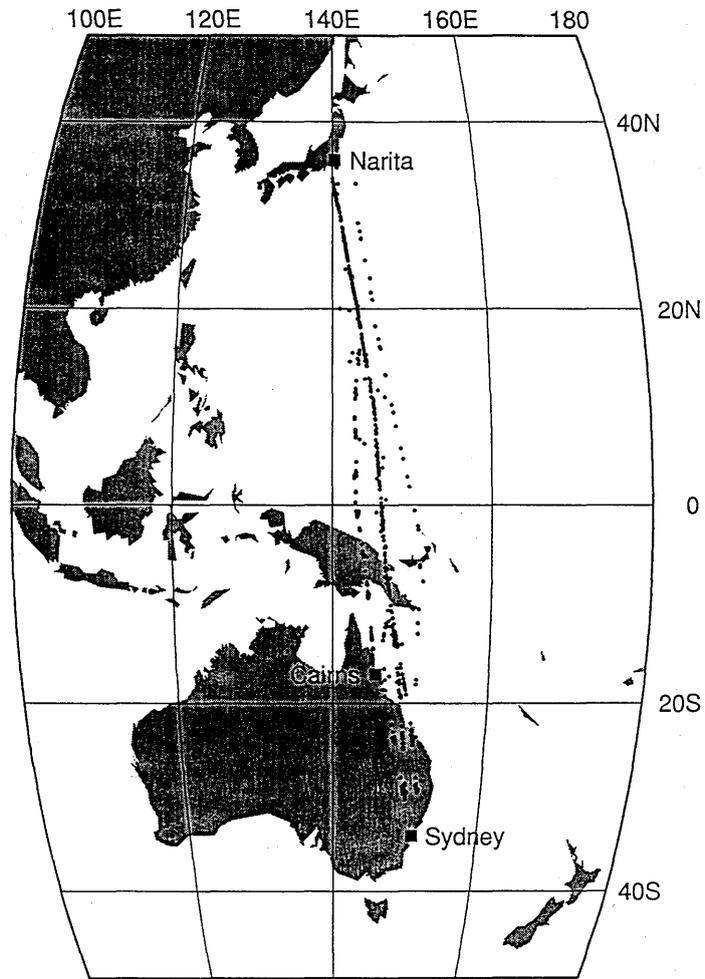


Fig. 1 Distributions of latitude(a), longitude(b) and altitude(c) of air samples collected from April 1993 to April 1996. (Matsueda *et al.*, 1997)



Sampling points (1993-1996)

Fig. 2 Sampling points of plane observations. (Matsueda *et al.*, 1997)

Radioactive fallout observations since 1958

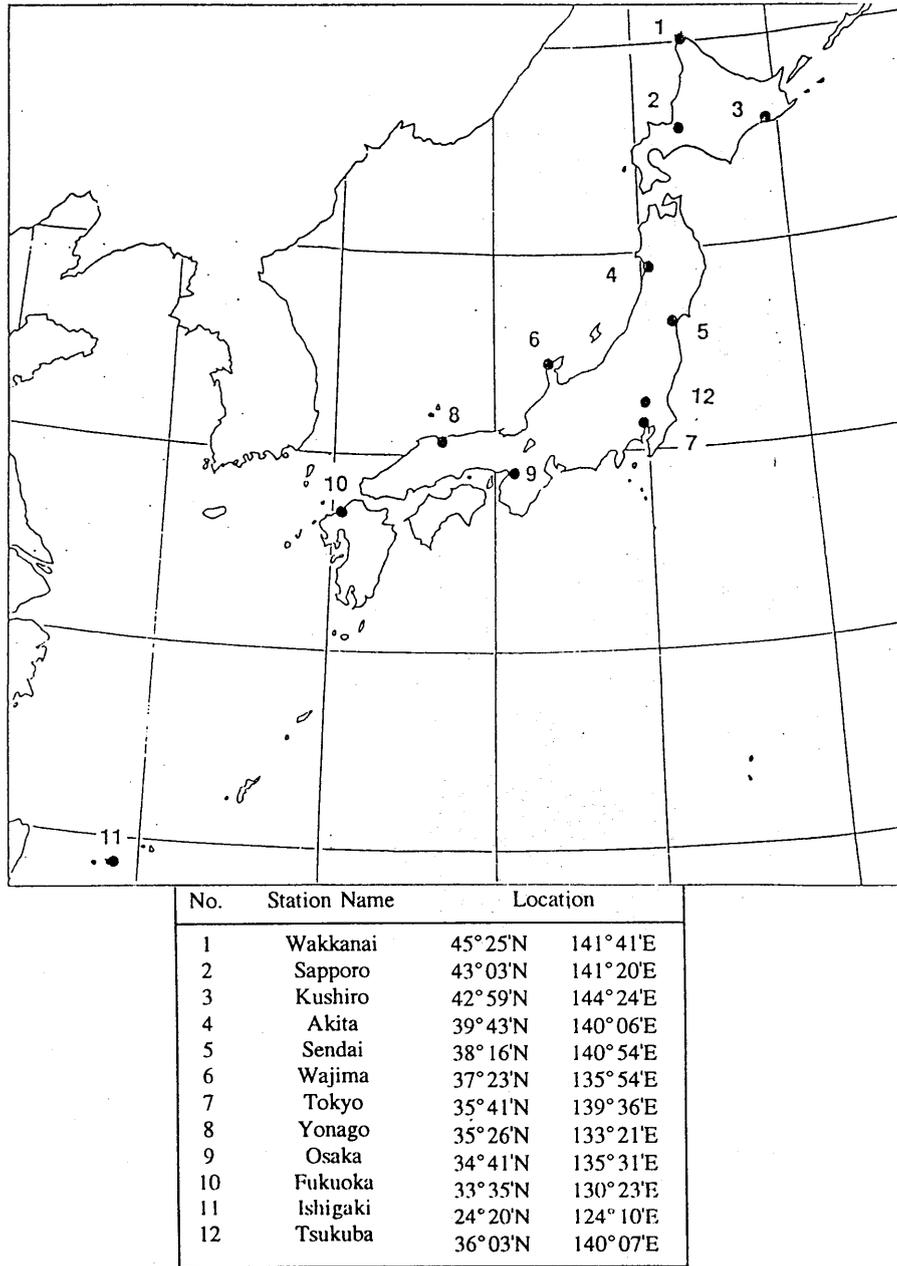


Fig. 3 Radioactive fallout sampling sites. (Hirose, 1995a)

INTERNATIONAL/NATIONAL PROGRAMS

Table 1 1995 International/National Programs

International Study Number	
WCRP/WOCE	
IGBP/JGOFS	1.1, 1.2, 1.3, 4.1, 4.2, 4.3
IGBP/IGAC	2.1, 5
National Study Number	
JASRE (Reallocation fund from the Science and Technology Agency of Japan)	3.1, 3.2, 3.3, 3.4, 4.3, 6
JASBEGGA (Reallocation fund from the Science and Technology Agency of Japan)	1.1, 1.2, 1.3
GASREPA (Grant-in-Aid from Ministry of Education, Science and Culture of Japan)	4.1, 4.2
MRI/JMA operating funds	1.1, 1.2, 1.3, 2.1, 4.1, 4.2, 5

Table 2 1996 International/National Programs

International Study Number	
WCRP/WOCE	3.1, III
IGBP/JGOFS	2.1, 2.2, 2.3, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, II
IGBP/IGAC	1.1, 1.2, 2.4
National Study Number	
JASRE (Reallocation fund from the Science and Technology Agency of Japan)	3.2, 4
JASBEGGA (Reallocation fund from the Science and Technology Agency of Japan)	2.1, 2.2, 2.3
GASREPA (Grant-in-Aid from Ministry of Education, Science and Culture of Japan)	5.1, 5.2, 5.3, 5.4, 5.5
UAOCA (Fund supported by the JAL Foundation)	1.1, 1.2
MRI/JMA operating funds	1.1, 1.2, 2.1, 2.3, 2.4, 3.1, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6