Intergovernmental Oceanographic Commission
Reports of Meetings of Experts and Equivalent Bodies

Joint CMM-IGOSS-IODE Sub-group on Ocean Satellites and Remote Sensing

First Session

Paris, 19-22 September 1994

UNESCO

In this Series, entitled

Reports of Meetings of Experts and Equivalent Bodies, which was initiated in 1984 and which is published in English only, unless otherwise specified, the reports of the following meetings have already been issued:

1. Third Meeting of the Central Editorial Board for the Geological/Geophysical Atlases of the Atlantic and Pacific Oceans
2. Fourth Meeting of the Central Editorial Board for the Geological/Geophysical Atlases of the Atlantic and Pacific Oceans
3. Fourth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño' *(Also printed in Spanish)*
4. First Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources
5. First Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
6. First Session of the Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
7. First Session of the Joint CCOP(SOPAC)-IOC Working Group on South Pacific Tectonics and Resources
8. First Session of the IODE Group of Experts on Marine Information Management
9. Tenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies in East Asian Tectonics and Resources
10. Sixth Session of the IOC-UNEP Group of Experts on Methods, Standards and Intercalibration
11. First Session of the IOC Consultative Group on Ocean Mapping *(Also printed in French and Spanish)*
12. Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ships-of-Opportunity Programmes
13. Second Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
14. Third Session of the Group of Experts on Format Development
15. Eleventh Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
16. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
17. Seventh Session of the IOC-UNEP Group of Experts on Methods, Standards and Intercalibration
18. Second Session of the IOC Group of Experts on Effects of Pollutants
19. Primera Reunión del Comité Editorial de la COI para la Carta Batimétrica Internacional del Mar Caribe y Parte del Océano Pacífico frente a Centroamérica *(Spanish only)*
20. Third Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
21. Twelfth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
22. Second Session of the IODE Group of Experts on Marine Information Management
23. First Session of the IOC Group of Experts on Marine Geology and Geophysics in the Western Pacific
24. Second Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources *(Also printed in French and Spanish)*
25. Third Session of the IOC Group of Experts on Effects of Pollutants
26. Eighth Session of the IOC-UNEP Group of Experts on Methods, Standards and Intercalibration
27. Eleventh Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans *(Also printed in French)*
28. Second Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources
29. First Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
30. First Session of the IOCARIBE Group of Experts on Recruitment in Tropical Coastal Demersal Communities *(Also printed in Spanish)*
31. Second IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
32. Thirteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asia Tectonics and Resources
33. Second Session of the IOC Task Team on the Global Sea-Level Observing System
34. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
35. Fourth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
36. First Consultative Meeting on RNODCs and Climate Data Services
37. Second Joint IOC-WMO Meeting of Experts on IGOSS-IODE Data Flow
38. Fourth Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
39. Fourth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
40. Fourteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
41. Third Session of the IOC Consultative Group on Ocean Mapping
42. Sixth Session of the Joint IOC-WMO-CCPS Working Group on the Investigations of 'El Niño' *(Also printed in Spanish)*
43. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
44. Third Session of the IOC-UN(OALOS) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
45. Ninth Session of the ICC-UNEP Group of Experts on Methods, Standards and Intercalibration
46. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
47. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
48. Twelfth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans
49. Fifteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
50. Third Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
51. First Session of the IOC Group of Experts on the Global Sea-Level Observing System
52. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean
53. First Session of the IOC Editorial Board for the International Chart of the Central Eastern Atlantic *(Also printed in French)*
54. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico *(Also printed in Spanish)*
55. Fifth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
56. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
57. First Meeting of the IOC *ad hoc* Group of Experts on Ocean Mapping in the WESTPAC Area
58. Fourth Session of the IOC Consultative Group on Ocean Mapping
59. Second Session of the IOC-WMO/IGOSS Group of Experts on Operations and Technical Applications
60. Second Session of the IOC Group of Experts on the Global Sea-Level Observing System
61. UNEP-IOC-WMO Meeting of Experts on Long-Term Global Monitoring System of Coastal and Near-Shore Phenomena Related to Climate Change
62. Third Session of the IOC-FAO Group of Experts on the Programme of Ocean Science in Relation to Living Resources
63. Second Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
64. Joint Meeting of the Group of Experts on Pollutants and the Group of Experts on Methods, Standards and Intercalibration
65. First Meeting of the Working Group on Oceanographic Co-operation in the ROPME Sea Area
66. Fifth Session of the Editorial Board for the International Bathymetric and its Geological/Geophysical Series
67. Thirteenth Session of the IOC-IHO Joint Guiding Committee for the General Bathymetric Chart of the Oceans *(Also printed in French)*
68. International Meeting of Scientific and Technical Experts on Climate Change and Oceans
69. UNEP-IOC-WMO-IUCN Meeting of Experts on a Long-Term Global Monitoring System
70. Fourth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
71. ROPME-IOC Meeting of the Steering Committee on Oceanographic Co-operation in the ROPME Sea Area
72. Seventh Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño' *(Spanish only)*
73. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico *(Also printed in Spanish)*
74. UNEP-IOC-ASPEI Global Task Team on the Implications of Climate Change on Coral Reefs
75. Third Session of the IODE Group of Experts on Marine Information Management
76. Fifth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
77. ROPME-IOC Meeting of the Steering Committee for the Integrated Project Plan for the Coastal and Marine Environment of the ROPME Sea Area
78. Third Session of the IOC Group of Experts on the Global Sea-level Observing System
79. Third Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
80. Fourteenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans
81. Fifth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes

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1. ORGANIZATION OF THE MEETING

1.1 OPENING OF THE MEETING

1 The First Session of the CMM-IGOSS-IODE Sub-group on Ocean Satellites and Remote Sensing (OSRS) was opened at 10.00 a.m. on Monday 19 September 1994 in the headquarters of the European Space Agency (ESA), Paris, by the Chairman of the group, Mr J. Sherman. The Chairman welcomed all members of the Sub-group, as well as observers to the session, and requested all participants to give a brief introduction to themselves, their background and work.

2 On behalf of the Secretary IOC, Dr G. Kullenberg, and the Secretary General of WMO, Prof. G.O.P. Obasi, the IOC Secretariat Representative, Mr J. Withrow, welcomed all participants to the meeting and to Paris. In so doing, Mr Withrow paid a special tribute to ESA, for their kind offer to host the meeting, for the excellent facilities provided, and for the special presentation on ERS-1 and 2, which was to be made during the session by Mr G. Duchossois, ERS-1/ERS-2 Mission Manager, of ESA.

1.2 ADOPTION OF THE AGENDA

3 The Sub-group reviewed its Provisional Agenda and agreed to adopt it as the agenda for the meeting. The Agenda is given in Annex I.

1.3 WORKING ARRANGEMENTS FOR THE MEETING

4 The Sub-group agreed on its hours of work and other arrangements necessary for the meeting. The list of documents for the session was introduced by the Secretariats.

5 The List of Participants in the meeting is given in Annex II.

2. FINALIZATION OF THE TERMS OF REFERENCE

6 The Sub-group recalled that it had been given only very generalized terms of reference by its parent bodies (WMO CMM; IOC-WMO IGOSS and IOC IODE), which had requested that these be finalized, together with the full membership of the group, by its Chairman, in consultation with the President of CMM, the Chairman of IGOSS and the Chairman of IODE. The Sub-group Chairman, Mr J. Sherman, had therefore prepared a draft set of terms of reference, based primarily on guidance from CMM and IGOSS. A second draft set had been prepared by the Secretariats, incorporating also requirements expressed by IODE. In view of certain substantive differences between these drafts, it had then been agreed that the finalization of the terms of reference, taking into account requirements expressed by the parent bodies, should be left to the first meeting of the Sub-group.

7 Consequently, the Sub-group reviewed the proposed drafts. It revised certain of the proposed terms, in the light of its perception of what was realistic and achievable with the expertise and time available. The final, agreed set of terms of reference for the Sub-group is given in Annex III to this report. The Sub-group also noted that it may wish to eventually propose certain additions to these to cover expected future work requirements, and it therefore requested the Chairman to consult with sub-group members on this matter prior to the next meetings of the parent bodies.

3. REPORT ON SATELLITE SYSTEMS AND CAPABILITIES

8 The Meeting agreed that the report of the Sub-group on Ocean Satellites and Remote Sensing will contain the revised terms of reference (see Annex III), the membership of the Sub-group and an overview. For the first report, the focus will be on those polar-orbiting satellites that can contribute to oceanography and marine meteorology, with numerous examples of their application.

9 The numerous sensors will be compared by generic class. More importantly, an analysis and assessment of these sensors to meet the requirements for oceanic and meteorological data, as defined by WMO and IOC working groups and affiliates, will be included. A preliminary analysis of satellite data requirements for climate and ocean services is given in Annex IV.

10 The Sub-group also decided to do an initial inventory and assessment of aircraft remote sensing applications relevant to the activities of the Sub-group. While the first synopsis of these aircraft would not be as complete, it was anticipated that it would expand as more aircraft programmes are identified.

11 Lastly, it was agreed that the report preparation would be accelerated from a proposed four-year cycle to about a twenty-month preparation time and would include polar-orbiting and geostationary satellites, surface-based systems and aircraft. The agreed table of contents for the report is given in Annex V. Specific assignments for preparation and/or compilation of sections of the report which remain to be drafted are given in Annex VI.

12 The Sub-group noted the importance of publishing by early 1995 a first edition of the report containing at least the chapters and sections relating to polar-orbiting satellites. This publication must be in loose-leaf format, to allow for the addition of the missing sections as they become available and for subsequent revisions. It therefore agreed that members should provide to the Chairman their comments and/or revisions to existing draft sections, as well as the drafts of the additional material required for the first edition as detailed in the workplan in Annex VI, by the end of October 1994 at the latest. The Chairman would then compile the full first edition and distribute it to the Sub-group members for final review and checking prior to publication by WMO-IOC in early 1995.

4. DATA MANAGEMENT

13 The Group recognized that in the past one of the greatest impediments to utilizing satellite-derived information in a wide variety of marine activities has been the difficulties encountered in gaining access to specific types of data. This has been particularly true in developing countries where, even if the modalities of access could be established, the high technology equipment required to receive and process it was often lacking.

14 Even in developed countries, however, problems of data are not unknown. Access may be limited to comparatively few principal investigators or a charge might be made which, in the absence of a firm demonstration that the data represented "good science", was often high enough to cause many investigators to hesitate.

15 Fortunately, in recent years there has been an increasing awareness that if remotely sensed data are going to justify the cost of the space programmes required to produce them, arrangements must be made for as wide a distribution as practicable.

16 Publications such as the 1993 CEOS Dossier, Volume B, Space Agency Ground Segments and Data Products, provide a comprehensive list of contact points for each of the space agencies. Distribution services which at first were overwhelmed by the volume of data are now much improved and data flows regularly from them. There may still be problems but access issues have been recognized and steps taken to solve them.

17 The Group decided to continue to follow the development of the space agency ground systems as well as surface based radar systems and if necessary make recommendations to its parent bodies if gaps developed between the data sources and users. It would continue to be sensitive to data access issues, especially in developing countries, and serve as a consulting body for technical aspects of data management related to remotely sensed marine data and information.

18 The Group recalled that it had requested Mr J. Guddal to prepare a section for the report on the assimilation of remotely sensed data into numerical models. To support this work, it requested all Group members to provide information on the topic to Mr Guddal according to the format given in Annex VII. It also suggested that some relevant information could be readily available in certain operational publications of IOC-WMO such as WMO manuals and guides, and the IGOSS Information Service Bulletin on Oceanographic Products.

5. WMO-IOC SATELLITE ACTIVITIES INCLUDING REGIONAL ACTIVITIES

WMO CBS Working Group on Satellites

19 The Sub-group reviewed the terms of reference and membership for the WMO Commission for Basic Systems Working Group on Satellites (CBSWGSAT), as well as the workplan and list of action items developed by the Working Group at its meeting in March 1994. It noted that the CBSWGSAT is primarily addressing operational meteorological satellites, the types of observation performed by these satellites, the application of the data to operational meteorology and global climate studies. As such, the Sub-group regarded its own activities as complementary to those of CBSWGSAT. At the same time, the Sub-group noted several items in the CBSWGSAT workplan which it supported and to which it felt it could usefully contribute, specifically:

(i) Radio frequency allocations for environmental satellites: the Sub-group reiterated the importance of maintaining existing allocations and of obtaining additional ones in the future; e.g. when salinity measurements become feasible. It therefore offered its wholehearted support for the work of CBSWGSAT, and of the WMO Secretariat, in this regard;

(ii) Codes and formats: the Sub-group noted the need to maintain codes and formats for both real-time and non-real-time exchange of ocean satellite data, and indicated its readiness to prepare detailed requirements for such codes, as necessary, for consideration by appropriate bodies;

(iii) Education and training: the Sub-group supported the approach adopted by CBSWGSAT with regard to the identification and development of certain of the WMO RMTCs, regionally distributed, to undertake specialized training in satellite data analysis and application. It noted the potential value of including modules relating to ocean satellite data in this training, and offered to contribute to the preparation of these modules if appropriate.

IOC Regional Activities and TEMA

20 The Sub-group reviewed the activities of the IOC with regard to Training, Education and Mutual Assistance in Marine Sciences (TEMA). The Group noted that the Programme plays a catalytic role to stimulate and co-ordinate specific activities related to capacity building of IOC Member States, with collaboration of the Commission's subsidiary bodies in ocean research, systematic observation and services, as well as marine pollution monitoring. This capacity building must be linked both to a commitment of government support and relevant regional programmes in order to achieve sustained results and benefit from the training. The Group again felt that these activities were complementary to its activities. Specifically it felt that:

(i) The UNESCO TREADMAR learning module programme in remote sensing of the marine environment could prove to be a very useful vehicle for providing training especially in developing countries.

(ii) Remote sensing training in the coastal zone would be of high interest to many countries.

(iii) There was a need to ensure that subjects addressed in training would constitute an ongoing activity. In this regard, it was important to ensure that if training was conducted with a particular data set, it was necessary to have on-going access to that data set.

Specialized training courses in ocean remote sensing

21 The Sub-group noted the increasing requirement within IOC and WMO to organize and conduct specialized training courses in ocean remote sensing. Such training courses are normally short-term (1-2 weeks), and therefore, of necessity, introductory in nature. At the same time, there is also a requirement for longer-term, more detailed training, but in general this will be satisfied by existing university-type diploma courses, or by the type of training facilities envisaged by the CBSWGSAT and noted under paragraph 18 above.

22 The Sub-group agreed that it could and should contribute to the short-term training requirements of IOC/WMO. It considered that training material/modules (lecture notes, computer packages, videos, transparencies, etc.) could be prepared based on either or both user applications (e.g. the GOOS modules) and sensor/variable type (e.g. altimeter wave heights). In this context, it drew up a matrix-type representation of the type of modules which might be prepared, which is given in Annex VIII.

23 The Sub-group next agreed that the first step was to identify specialists, covering as many of the official languages of IOC/WMO as possible, who could (and would be willing) to undertake the preparation of training material for selected modules in the matrix, and present this material to IOC-WMO training events as and when they are organized. It therefore requested group members to try to identify such experts for as many of the modules as possible, to obtain their informal agreement to be listed as IOC-WMO training instructors in their specific fields, and to notify the Secretariat of the names and contact addresses of these experts as soon as possible. The Secretariats would then proceed to seek formal agreement of the persons concerned, and would publish and maintain an official list of the experts, who would be approached to prepare and present their modules to specific training events as the needs arise.

24 For the longer-term, and as the availability and applications of ocean satellite data become more operational, the Sub-group noted the value of developing a more comprehensive strategy for education and training in this field. It therefore flagged this item for further consideration during the next intersessional period.

6. DEVELOPMENT OF A WORKPLAN

25 Based on discussions and agreements reached under other agenda items, the Sub-group drew up a detailed workplan for the remainder of the intersessional period. This workplan embraces specifically:

(i) finalization of the first edition of the report (deadline: January 1995);

(ii) finalization of the second edition of the report (deadline: mid-1996);

(iii) contributions to training requirements (deadline: mid-1995).

Details of this workplan are given in Annex VI.

7. CLOSURE OF THE MEETING

26 The Sub-group reviewed and approved the Summary Report of the meeting.

27 The Sub-group considered that it may be appropriate to convene the next (second) session of the group during the first half of 1996, in order to undertake a comprehensive review of the complete second edition of the report prior to publication as well as to address on-going issues such as training. It therefore requested its Chairman to discuss with the Secretariats and Sub-group members, at an appropriate time, the possibiities for such a meeting, as well as a suitable date and place.

28 Mr J. Withrow expressed his thanks to the participants for their participation and contribution to the meeting. He especially thanked the Chairman for his efforts in assembling the first draft of the report which proved invaluable in focusing the effort of the Group. The First Session of the CMM-IGOSS-IODE Sub-group on Ocean Satellites and Remote Sensing closed at 1 p.m. on Thursday 22 September 1994.

ANNEX I

AGENDA

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   - 1.2 ADOPTION OF THE AGENDA
   - 1.3 WORKING ARRANGEMENTS FOR THE MEETING
2. FINALIZATION OF THE TERMS OF REFERENCE
3. REPORT ON SATELLITE SYSTEMS AND CAPABILITIES
4. DATA MANAGEMENT
5. WMO-IOC SATELLITE ACTIVITIES INCLUDING REGIONAL ACTIVITIES
6. DEVELOPMENT OF A WORKPLAN
7. CLOSURE OF THE MEETING

ANNEX II

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ANNEX III

TERMS OF REFERENCE FOR THE CMM-IGOSS-IODE SUB-GROUP ON OCEAN SATELLITES AND REMOTE SENSING (OSRS)

The Terms of Reference of the CMM-IGOSS-IODE Sub-group on Ocean Satellites and Remote Sensing (OSRS) are:

(a) Prepare annually a report on the development of the main electro-magnetic remote-sensing programmes relevant to marine meteorology and oceanography;

(b) Analyze the requirements of marine meteorology and oceanography for data and information and prepare an assessment of current remote-sensing techniques to meet these requirements;

(c) Prepare recommendations to meteorological and oceanographic analysis centres relating to satellite data analysis and user requirements for such data;

(d) Monitor and report on the applications of ground-based HF and microwave radars and airborne remote sensing instrumentation to the provision of marine meteorological and oceanographic services;

(e) Co-operate and co-ordinate with other groups of WMO and IOC to ensure that a common policy is followed in the compilation and analysis of requirements for and use of ocean remote-sensing data and in interactions with relevant external bodies;

(f) Contribute to the development of training courses on the remote sensing of the marine environment (in both technical and managerial aspects) through appropriate WMO and IOC mechanisms.

ANNEX IV

Draft
Ocean Satellite Data Requirements[1]

Parameter	Regional/ Global	Horizontal Resolution	Frequency	Accuracy	Source	Application
Wind Vector	Global	200 km	12 hr	1 ms^{-1}/10°	GCOS	C
	Global	25 km	6 hr	2 kts/10°	WMO	S
	Regional	10 km	6 hr	3 kts/10°	WMO	S
SST	Global	100 km	5-10 days	0.2 K	GCOS	C
	Global	1 km	6 hr	0.1 K	WMO	S
	Regional	1 km	6 hr	0.1 K	WMO	S
Ocean Wave Spectra	Global	10 km	1 hr	10°/0.5s	WMO	S
Ocean Topography	Global	100 km	5 days	3 cm	GCOS	C
Ocean Color	Global	100 km	24 hr		GCOS	C
Sea Ice Cover	Regional	10 km	24 hr	2%	WMO	S
	Regional	100 km	24 hr	1-5%	GCOS	C
Sea Ice Thickness	Regional	25 km	12 hr	10%	WMO	S
	Regional	100 km	24 hr	10%	GCOS	C
Sea Ice Edge	Regional	10 km	24 hr	2%	WMO	S

Applications - GOOS Modules
(C) - Climate Module, (L) - Living Marine Resources Module, (Z) - Coastal Zone Module,
(H) - Health of the Ocean Module, (S) - Ocean Services Module

[1] Requirements are given for the Climate and Ocean Services Modules. Requirments for other modules will be added as they become available.

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy*	Source	Application
Wind Vector	Global	200 Km	12 hours	1 $ms^{-1}/10°$	GCOS	C
Assessement:						
Scatterometer	Yes	Yes	6-8 inst	$\approx$1.5 $ms^{-1}/15°$		
Altimeter	Yes	Yes	12-14 inst.	$\approx$2 ms^{-1}/no dir.		
Microwavė Rad.	Yes	Yes	4 inst.	$\approx$2 ms^{-1}/no dir.		

General Comments:

Altimeter - Global Sampling only; - 2 Altimeters require about 3-4 days for coverage
Scatterometer - One dual-sided scaterometer requires about 42 hours for 95% global coverage

*Best demonstrated for high wind speeds but not typical (most weather services also require σ_o)

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy*	Source	Application
Wind Vector	Global	25 Km	6 hours	2 kts/10°	WMO	S
Assessement:						
Scatterometer	Yes	Yes	6-8 inst	≈1.5 ms^{-1}/15°		
Altimeter	Yes	No	12-14 inst.	≈2 ms^{-1}/no dir.		
Microwave Rad.	Yes	No	4 inst.	≈2 ms^{-1}/no dir.		
				note: 2 kts ≈ 1 ms^{-1}		

General Comments:

Altimeter - Global Sampling only; - 2 Altimeters require about 3-4 days for coverage
Scatterometer - One dual-sided scaterometer requires about 42 hours for 95% global coverage

*Best demonstrated for high wind speeds but not typical (most weather services also require σ_o)

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy*	Source	Application
Wind Vector	Regional	10 Km	6 hours	3 kts/10°	WMO	S
Assessement:						
Scatterometer	Yes	No	6-8 inst	≈1.5 ms^{-1}/15°		
Altimeter	Yes	No	12-14 inst.	≈2 ms^{-1}/no dir.		
Microwave Rad.	Yes	No	4 inst.	≈2 ms^{-1}/no dir.		
				note: 3 kts ≈ 1.5 ms^{-1}		

General Comments:

Altimeter - Global Sampling only; - 2 Altimeters require about 3-4 days for coverage
Scatterometer - One dual-sided scaterometer requires about 42 hours for 95% global coverage

*Best demonstrated for high wind speeds but not typical (most weather services also require σ_o)

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy	Source	Application
SST	Global	100 Km	5-10 days	0.2 K	GCOS	C
Assessement:						
Infrared Rad. (IR)	Yes	Yes	Yes	0.5-1.0 K		
Microwave Rad.	Yes	Possible	Yes	≥2.0 K		

General Comments:

IR based on ATSR accuracies
Microwave has near all weather capability

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy	Source	Application
SST	Global	1 Km	6 hours	0.1 K	WMO	S
Assessement:						
Infrared Rad. (IR)	Yes	Close	Multiple Sats*	0.5-1.0 K		
Microwave Rad.	Yes	No	4-5 sats.	≥2.0 K		

General Comments:

IR based on ATSR accuracies with 500 Km swath. At 1 Km resolution there is no improvement by averaging
Microwave has near all weather capability

* Many Satellites - Major difference between AVHRR class and ATSR. AVHRR ≈ 1.6° K

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy	Source	Application
SST	Regional	1 Km	6 hours	0.1 K	WMO	S
Assessement:						
Infrared Rad. (IR)	Yes	Close	Multiple Sats*	0.5-1.0 K		
Microwave Rad.	Yes	No	4-5 sats.	≥2.0 K		

General Comments:

IR based on ATSR accuracies with 500 Km swath. At 1 Km resolution there is no improvement by averaging
Microwave has near all weather capability

* Many Satellites - Major difference between AVHRR class and ATSR. AVHRR ≈ 1.6° K

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy	Source	Application
Ocean Wave Spectra Assessement:	Global	10 Km	1 hour	10°/0.5 sec**	WMO	S
SAR (Wave Mode)	Global Sampling	Yes, but not continuous	Very difficult*	To be determined		
Altimeter (wave height only)	Global Sampling	10 Km along track	Very difficult*	1/2 meter		

General Comments:

*Numerous satellites required ≈ 100 present SAR-class sensors (or 100 altimeters)
**Requires wave model

Further background information required on this requirement.

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy*	Source	Application
Ocean Topography Assessement: Altimeter	Global Yes	100 Km Yes	5 days Yes, w/4-5 inst.	3 cm Yes**	GCOS	C

General Comments:

*Requires improved gravity field, very precise ephemeris, and improved tidal models.
** Can meet for short-arc analysis

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy*	Source	Application
Ocean Color Assessement: High Spectral Resolution Scanner	Global Yes	100 Km Yes	24 hours Yes, w/2 inst.		GCOS	C

General Comments:

*Specifications under development (chlorophyll, sestonic content, attenuation coefficient)

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy	Source	Application
Sea Ice Cover	Regional	10 Km	24 hours	2%	WMO	S
Assessement:						
SAR	Yes	Yes	Yes, w/3 SAR's*	Yes		
Microwave Rad.	Yes	Yes	Yes	≈10%		
Infrared Rad.	Yes	Yes	Yes	Yes (no clouds)		
Visible Rad.	Yes	Yes	Yes	Yes (no clouds)		
Altimeter	Yes	Yes	Yes			

General Comments:

*1 RADARSAT class SAR provides 3-day polar coverage in 400 Km swathwidth mode

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy	Source	Application
Sea Ice Cover	Regional	100 Km	24 hours	1-5%	GCOS	C
Assessement:						
SAR	Yes	Yes	Yes, w/3 SAR's*	Yes		
Microwave Rad.	Yes	Yes	Yes	≈10%		
Infrared Rad.	Yes	Yes	Yes	Yes (no clouds)		
Visible Rad.	Yes	Yes	Yes	Yes (no clouds)		
Altimeter	Yes	Yes	Yes			

General Comments:

*1 RADARSAT class SAR provides 3-day polar coverage in 400 Km swathwidth mode

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy	Source	Application
Sea Ice Thickness	Regional	25 Km	12 hours	10%	WMO	S
Assessement:						
SAR	Yes	Yes	Yes, w/3 SAR's*	Close		
Microwave Rad.	Yes	Close	Yes	Close		
Infrared Rad.	Yes	Yes	Yes	Close (no clouds)		
Visible Rad.	Yes	Yes	Yes	Close (no clouds)		
Altimeter	Yes	Yes	Yes			

General Comments:

*1 RADARSAT class SAR provides 3-day polar coverage in 400 Km swathwidth mode

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy**	Source	Application
Sea Ice Thickness	Regional	100 Km	24 hours	10%	GCOS	C
Assessement:						
SAR	Yes	Yes	Yes, w/3 SAR's*	Close		
Microwave Rad.	Yes	Yes	Yes	Close		
Infrared Rad.	Yes	Yes	Yes	Close (no clouds)		
Visible Rad.	Yes	Yes	Yes	Close (no clouds)		
Altimeter	Yes	Yes	Yes			

General Comments:

*1 RADARSAT class SAR provides 3-day polar coverage in 400 Km swathwidth mode
** All measurements are inferred from morphology. Not a direct measurement

Parameter/ Assessment	Regional/ Global	Horizontal Resolution	Temporal Resolution	Accuracy	Source	Application
Sea Ice Edge	Regional	10 Km	24 hours	2%	WMO	S
Assessement:						
SAR	Yes	Yes	Yes, w/3 SAR's*	Yes		
Microwave Rad.	Yes	Close	Yes	Close		
Infrared Rad.	Yes	Yes	Yes	Yes (no clouds)		
Visible Rad.	Yes	Yes	Yes	Yes (no clouds)		
Altimeter	Yes	Yes	Yes			

General Comments:

*1 RADARSAT class SAR provides 3-day polar coverage in 400 Km swathwidth mode

ANNEX V

TABLE OF CONTENTS FOR THE REPORT OF THE SUB-GROUP ON OCEAN SATELLITES AND REMOTE SENSING (OSRS)

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[1]Mal Heron, leader

[2]Serge Viktorov, leader

ANNEX VI

WORKPLAN FOR THE SUB-GROUP OF OCEAN SATELLITES AND REMOTE SENSING (OSRS)

Agenda Item	*Major Subject*	*Para*	*Actions Proposed*	*Responsibility*	*Due Dates*
3.	Report on Satellite Systems and Capabilities		Prepare draft section on Aircraft Sensors	Serge Viktorov (Russia) (Group Leader) Johannes Guddal (Norway) Marc Gillet (France) Evert Attema (Netherlands/ESA) Peter Dexter/Jack Sherman (Canada) Tom Allan (Germany/UK) Jack Sherman (US)	mid 1995
3.	Report on Satellite Systems and Capabilities		Prepare draft section on Data Assimilation	Johannes Guddal (Group Leader) John Withrow Jack Sherman	31 Oct 94 (?)
3.	Report on Satellite Systems and Capabilities		Prepare draft section on Calibration and Validation	M. Gillet/J.Poitevin (Altimeter) (Group Leaders) I. Nakanishi (Colour) E. Attema (Radar, Scatterometer)	mid 1995
3.	Report on Satellite Systems and Capabilities		Prepare draft section on Data Management	Tom Allan (Group Leader) John Withrow Serge Viktorov (Russia) K. Shida (Japan) J. Guddal (SSM/I)	mid 1995
3.	Report on Satellite Systems and Capabilities		Prepare draft section on Ground Based Radars	M. Heron (Group Leader) P. Dexter J. Guddal J. Poitevin	end 1995
3.	Report on Satellite Systems and Capabilities		Review Appendix A	OSRS (all)	Nov 1994
3.	Report on Satellite Systems and Capabilities		Complete Section on Topex/Poseidon	Tom Allan Joel Poitevin	31 Oct 94
3.	Report on Satellite Systems and Capabilities		Complete Section on ATSR	Evert Attema	31 Oct 94

Agenda Item	*Major Subject*	*Para*	*Actions Proposed*	*Responsibility*	*Due Dates*
3.	Report on Satellite Systems and Capabilities		Section on Synergetic Sensor Application	Tom Allan Serge Viktorov	31 Oct 94 completed
3.	Report on Satellite Systems and Capabilities		Prepare Section on El Nino	I. Nakanishi	31 Oct 94
3.	Report on Satellite Systems and Capabilities		Prepare material on Wave Spectra	J. Guddal	31 Oct 94
3.	Report on Satellite Systems and Capabilities		Capabilities of Polar Orbiting Satellites	Tom Allan	31 Oct 94
3.	Report on Satellite Systems and Capabilities		Finalize first edition of report	J.Sherman Secretariats	16 Jan 95
			Distribute Report	Secretariats	15 Feb 95
3.	Report on Satellite Systems and Capabilities		Prepare second edition	J. Sherman Secretariats	mid 1996
5.	WMO-IOC Satellite Activities including Regional Activities		Prepare list of lecturers for Training Courses	OSRS (all)	31 Dec 94
			Official contact with lecturers	Secretariats	1st trimester 1995
			Finalize list of lecturers	Secretariats	2nd trimester 1995
3.	Report on Satellite Systems and Capabilities		Geostationary Satellites	I. Nakanishi	mid 1995

ANNEX VII

FORMAT FOR INFORMATION PRESENTATION ON DATA ASSIMILATION

Centre	Meteorology	Oceanography	Method of Assimilation	Background fields	References
	Asssimilation of what RS data?	Assimilation of what RS data?	Met/OC consistency	QC	Contacts
(example) ECMWF	Forecasts Global SCAT Winds	Wave Forecasts Global ALT Waves	Dynamical 4D Consistency Wind/Waves Vertical Atm. Consistency	? ?	T. Hollingsworth
NOAA/NMC *etc.*					

ANNEX VIII

POTENTIAL TRAINING MODULES IN OCEAN SATELLITE REMOTE SENSING

OBSERVATION TYPE / APPLICATION	ROUGHNESS				SLOPE			COLOUR			TEMPERATURE	
	Waves	Wind	Slicks	Ships	Currents	Tides	Geoid	Chloro	Sediment	Man	Heat flux	Effluent
CLIMATE												
COASTAL												
HEALTH OF THE OCEAN POLLUTION												
OCEAN LIVING MARINE RESOURCES												
SERVICES												

Each element/module in this matrix should cover aspects such as data quality/resolution, data management, sampling, data processing and applications.

82. Second Meeting of the UNEP-IOC-ASPEI Global Task Team on the Implications of Climate Change on Coral Reefs
83. Seventh Session of the JSC Ocean Observing System Development Panel
84. Fourth Session of the IODE Group of Experts on Marine Information Management
85. Sixth Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and its Geological/Geophysical Series
86. Fourth Session of the Joint IOC-JGOFS Panel on Carbon Dioxide
87. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Pacific
88. Eighth Session of the JSC Ocean Observing System Development Panel
89. Ninth Session of the JSC Ocean Observing System Development Panel
90. Sixth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
91. First Session of the IOC-FAO Group of Experts on OSLR for the IOC/NCWIO Region
92. Fifth Session of the Joint IOC-JGOFS CO_2 Advisory Panel Meeting
93. Tenth Session of the JSC Ocean Observing System Development Panel (OOSDP)