Annex VI-4

Draft National Report on Ocean Remote Sensing in Russia

(Reviewed by the Second Meeting of NOWPAP WG4)

Introduction

Statement on State monitoring of environment (State ecological monitoring)
(Decision of Russian Federation Government from 31.03.2003 г. № 177)

- State monitoring of the Environment (ecological monitoring) is the integrated system of observation for the Environment state, for estimation and forecast of its changes under influence of natural and anthropogenic factors;
- Ecological monitoring includes monitoring of atmospheric air, land, forest, water objects, continental shelf of RF,…exceptional economical zone of RF, internal sea waters and territorial sea of RF;
- Organization and realization of the Ecological monitoring afford: Ministry of natural resources (coordinator), Federal Serves of RF on Hydrometeorology and Environment Monitoring, State Committee on Fishery and others…

Federal Program "World Ocean" (2003-2007)

1. Comprehensive investigation of oceanic processes, characteristics and resources of Far Eastern Russian seas.
2. Investigation of the state and operation of marine ecosystems of the Far Eastern seas and their productive possibilities.
3. Comprehensive study of the state and variability of the coastal zone of the Far Eastern seas

The main goal is to investigate dynamic phenomena and processes in Far Eastern seas and in the Northwestern Pacific on the basis of development and application of remote acoustic, optical and passive and active microwave techniques.

The project will allow studying the structure, composition and spatial distribution of meso- and submesoscale unhomogeneities, their temporal variability using remote techniques in the NOWPAP Region and Okhotsk seas including a shelf zone and transition zone between shallow and deep sea.

Systems of operational detection and forecast of transfer and degradation of oil spill adapted to Primorye and Sakhalin shelf will be created.

These investigations are currently central and have an additional support in connection of development of International projects in the Northwestern Pacific such as **NEAR-GOOS, COOP, NOWPAP/UNEP** and **ICZM**.

Participants: *Institutes of Far Eastern Branch of the Russian Academy of Sciences – FEB RAS (POI, IMTP, IACP, PIG, IMB), FIRHRI, Physics and Information Technology Institute of Far Eastern State University, Institute of Oceanology RAS (Moscow) , Pacific Scientific Research Fisheries Centre (TINRO-Centre).*

Table 1. Status of Remote Sensing utilization in marine environmental monitoring

Sensor	Satellite	Variables	Observing cycle	Intended use of data
SAR	ERS-2	Normalized radar cross-section (NRCS) σ°	35 days*)	Coastal and open sea monitoring, detection of oil spill, natural slicks, oceanic dynamic features, coastal circulation, river plumes, sea ice, near surface wind patterns

ASAR	Envisat	NRCS σ°	35 days*)	Coastal and open sea monitoring, detection of oil spill, natural slicks, oceanic dynamic features, coastal circulation, river plumes, sea ice, near surface wind patterns
MODIS MERIS	Terra, Aqua Envisat	Spectral brightness	14 orbits/ day 35 days*)	Fields of ocean colour (chl-a), detection of oceanic dynamic phenomena, sea ice, red tides, cloud patterns
AMSR-E	Aqua	Brightness temperatures at 6 frequencies (12 channels)	14 orbits/ day	Fields of SST, wind speed, precipitable water cloud liquid water content and precipitation in marine weather systems and sea ice
Scattero-meter	QuikSCAT	NRCS σ°	93% of daily coverage	Sea surface wind speed and direction Real-time QuikSCAT data are fully and openly available at <http://manati.wwb.noaa.gov/quikscat/>
Altimeter	Jason-1, Envisat, GFO, Topex/ Poseidon,	Along-track and high-resolution maps of sea level anomalies, along-track and maps of absolute dynamic topography	2 maps/ week	High resolution (1/3°x1/3° on a Mercator grid) maps of sea circulation, eddies' location and intensity Real or near-real time data at: http://www.jason.oceanobs.com/html/
AVHRR	NOAA series (12, 15, 17)	Spectral brightness and brightness temperatures	3-6 times/ day	Monitoring currents, frontal zones, eddies, upwelling, sea ice as well as the weather systems singly or in combination with other satellites/sensors. Submitting SST maps, recommendations for ship expeditions, etc.
MVISR	FY-1D	Spectral brightness (10 channels)	2-times/day	Monitoring currents, frontal zones, eddies, upwelling, sea ice as well as the weather systems singly or in combination with other satellites/sensors. Fields of ocean colour (chl-a), detection of oceanic dynamic phenomena
SeaWiFS	OrbView-2	Spectral brightness		Fields of ocean colour (chl-a), detection of oceanic dynamic phenomena

2. Case examples of RS application in marine environmental monitoring

At present Russia have no possibility to arrange RS monitoring of oil spills in the Far Eastern area since the available ground stations do not receive high-resolution satellite data provided, first of all, by a SAR. There are no agreements between Rosaviakosmos and the European Space Agency (ESA).

2.1. FEB RAS Centre for Regional Satellite Monitoring of Environment

http://www.iacp.dvo.ru http://www.satellite.dvo.ru/

(International registration GCMD - Satellite Monitoring Laboratory/Institute of Automation and Control Processes/Russian Academy of Sciences (SML/IACP/RAS).

The FEB RAS Centre for the Regional Satellite Monitoring of Environment is established at 1999 on the base of the *Satellite Monitoring Laboratory of the Institute of Automation and Control Processes, FEB RAS* with participation of the *V.I. Il'ichev Pacific Oceanological Institute, FEB RAS* and *TINRO-Centre.*

The main mission of the Centre is to conduct the *Regional Satellite Monitoring* of various nature objects and processes in the frames of scientific programs and applications of Institutes participated.

Objects of monitoring

- *at present:* Sea Surface Temperature (SST), frontal zones, eddies, currents, sea ice; typhoons, etc.
- *sight:* oil spill at the sea, floods, forest fires.

Applications of monitoring - *at present:*

- scientific investigations (physical oceanography and meteorology);
- information support of maritime cruises;
- productivity evaluation and forecast of fishing areas (with TINRO-Centre)

(Details will be given by A.I. Alexanin).

2.2. Oil spill monitoring – Research stage

The main instrument used for oil spill detection is a SAR installed on a board of the European Remote Sensing Satellites ERS-1 (archive data), ERS-2 and Envisat. Ground stations are absent in the Far Eastern Region of Russia, no agreements between the ESA and Russia to construct the stations in the nearest years. Thus only archive SAR images and also SAR images which should be ordered in advance (2 weeks and more) in the frames of three ongoing projects (2 project ESA-POI and one ESA - international team with POI participation) can be used to detect slicks on the sea surface, advance techniques of their analysis and to get statistical estimates of oil spill in the CEARAC area. Examples age given in the CEARAC web site on Remote Sensing of oil spill (http://cearac.poi.dvo.ru)

2.3 Sakhalin Scientific Research Fisheries Centre (SAKHNIRO-Centre)

http://www.SAKHNIRO.ru

This Center has a modern receiving station to get and analyze information on ocean color in the Okhotsk and the NOWPAP Region. The following Department/Laboratories/Groups participate in research:

- **Group of Network and Information Ensuring**
  http://www.sakhniro.ru/group_of_network_and_information_ensuring.html
- **Department of Applied Ecology**
  Laboratory of Analytical Researches
  Laboratory of Applied Ecology
  aboratory of Inland Bio resources
- **Laboratory of Coastal Researches**
  http://www.sakhniro.ru/laboratory_of_coastal_researches.html

2.4 Marine Oceanography and Marine Environment of the Far Eastern Region of Russia

http://www.pacificinfo.ru/en/

This POI specialized web-site in the FEB RAS Network is an independent regional segment for the National Unified System of Information on the World Ocean State "ESIMO". Information about the data bases maintained at the POI, in the region and over the world as well as about other resources accessible in the on/off-line mode and also information products on various aspects of oceanography, hydrometeorology and ecology are available on this site.

- National and International Regional Projects:

ESIMO, PICES, WESTPAC, NEAR-GOOS (Regional Data Bases), NOWPAP
Oceanographic Data Center, other Institutes and Projects

- Marine Research Institutes of Vladivostok
- RIHMI-WDC(B)
- FEB RAS Base Network
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Catalogues, Data Sets and Data Bases

- *List of Oceanographic Data held by POI*
- *Data Base of POI Oceanographic cruises Data*

- *Integrated Data Base of historical observations*
- *Satellite Data*
- *Geological and Geophysical Data*
- *NEAR-GOOS/POI Data Base*

Project Leader: Igor Rostov, POI FEB RAS rostov@pacificinfo.ru

3. Status of Research and Development on remote sensing technology for marine environment

3.1. Sensors and Satellites

The joint Russian-Ukrainian satellite, Sich-1M (sich is Ukrainian word denoting owl – a bird that can see at night), is planned for launch in November 2004. Its parameters are given in Table 2. The satellite is intended to acquire the information concurrently in visible, IR and microwave ranges. A set of scientific equipment installed on Sich-1M satellite board allows to solve a number of practical and research problems related to study of the World Ocean and the atmosphere, monitoring of hydrological and ice conditions, vegetation, soils, etc.

Table 2. Parameters of Sich-1M satellite

Mass	2223 kg
Orbital altitude	650/664 km
Orbital inclination	82.5 deg
Active lifetime	3 years

Oceanic studies will be carried out with several instruments: both high-resolution (24 m x 34 m) and low-resolution (1.7km x 2.8 km) visible and near-infrared scanning devices, a combined optical-microwave scanner (9 channels in the transparent *windows* between 6.9 and 89.0 GHz, four visible channels (0.37-0.78 μm) and three infrared channels (3.53-3.93, 10.4-11.5 and 11.5-12.6 μm) having the same swath width of 2000 km, as well as an X-band RAR and a scanning microwave radiometer with characteristics identical with Okean series satellites. Sensors' characteristics are given in Tables 3 and 4.

Table 3. Microwave sensors

Side-looking Radar (Real Aperture Radar - RAR)	Wavelength, cm	3
	Swath width (two modes), km	450, 700
	Resolution along (across) path, beginning/end of swath, km - swath width 450 km - swath width 700 km	 1.7/2.4 (1.3/0.7 1.7/2.8 (1.3/0.7)
Scanning Radiometer RM 0.8	Wavelength, cm	0.8
	Swath width, km	550
	Range of measured brightness temperatures, K	110-30 150-250
	Mean resolution in swath, km	25 x 25

Table 4. Visible, infrared and passive microwave sensors

MSD-E1 and MSD-E2 Optoelectronic Multiband Scanning Devices	Number of channels	3
	Spectral ranges, μm	0.5-0.6, 06.07, 0.8-0.9
	Coverage area width, km	800
	Swath width, km	48/48
	Resolution, m x m	23 x 34
MSD-L Low Resolution Multiband Scanning Device	Number of channels	4
	Spectral ranges, μm	0.52-1.03
	Swath width, km	2000
	Resolution, at the center/edge of line, km	1.5 (1.8)
MTVZA-OK Visible-Microwave Scanner	KM - 4BD (4 channels), μm	0.37-0.78
	KC-UK (1 channel), μm	3.55-3. 93
	KM -2UK (2 channels), μm	10.4-12.6
	Microwave radiometer (11 channels), range, GHz	6.9-183.3
	Swath width, km	2000
	Resolution, microwave radiometer, km x km KM–4BD, KC-UK, KM-2UK, km x km	From 112 x 260 to 8 x19 1.1 x 1.1

Satellite Meteor-3M # 2 will be launched in 2005. Observations of the ocean will be carried out with the usage of several sensors such as MTVZA-OK (see Table 4), MSD-E and MSD-M (Table 5), operating in visible, infrared and microwave ranges. Their characteristics are given in Tables

Table 5. Visible and near infrared sensors

MSD-E Optoelectronic Multiband Scanning Device	Spectral ranges, μm	0.5-0.6, 0.6-0.7, 0.8-0.9
	Coverage area width, km	800
	Swath width, km	76 (nadir) / 116(edge)
	Resolution, m x m	32 x 32
MSD-M Medium Resolution Multiband Scanning Device	Spectral ranges, μm	0.55-0.7, 0.7-0.9
	Swath width, km	2240
	Resolution, range / azimuth, m	544 / 142

Table 6. Scanning microwave sensor MIVZA

Microwave scanning radiometer for atmospheric integrating humidity sounding (MIVZA).	20 (V,H)	110	1700 (conic scanning)
	35 (V,H)	65	
	94 (H)	25	

Table 7. Microwave scanning radiometer MTVZA

Parameters	**MTVZA**								
Frequency, GHz	18.7	22.2	33	36.5	42	48	52-57	91.65	183.31
Amount of channels	2	1	2	2	2	2	5	2	3
Polarization	V,H	V	V,H	V,H	V,H	V,H	V	V,H	V
Resolution, km	75	68	45	41	36	32	30	18	12
Pixel size, km	32	32	32	32	32	32	64	16	64
Sensitivity in a pixel, K	0.25	0.25	0.35	0.38	0.45	0.45	0.3	0.5	0.4
Observation angle	51.3°								
Incidence angle	65°								
Swath width, km	2600								
Scanning	conical								
Scanning period, s	2.5								
Mass, kg	107								
Power consump., W	110								

3.2. Algorithm for geophysical parameters

ERS-1 and ERS-2 SAR and Envisat ASAR. ESA ESRIN program packet “Best” for format transformation and calibration of SAR data to compute σ° values. Original programs were also developed for format transformation as well as for transfer the ancillary information accompanying each SAR image in the Laboratory SAR data base.

SAR. CMOD-4 algorithm was used to estimate wind speed from σ° values when wind direction can be determined from orientation of the elongated features on a SAR image. No detailed comparison of SAR-derived wind speeds and *in situ* data (oceanic buoys, ship and coastal stations reports) was performed.

ADEOS-II AMSR and Aqua AMSR-E data. The measured brightness temperatures (TBs) represent the binary data in hdf format. They are transfer in text files for subsequent processing. Histogram technique was suggested and applied to correct calibration (brightness temperatures).

AMSR and AMSR-E. The developed global and regional algorithms (Mitnik L.M., Mitnik M.L. Retrieval of atmospheric and ocean surface parameters from ADEOS-II AMSR data: comparison of errors of global and regional algorithms. *Radio Sciences*. 2003. Vol. 38, No. 4, 8065, doi: 10.1029/2002RS002659) were applied to the measured TBs to retrieve SST, wind speed as well as the integrated atmospheric parameters such as precipitable water and total cloud liquid water content in the various synoptic situations such as cold air outbreaks, mesoscale convective eddies, extratropical and tropical cyclones.

3.3. Validation of geophysical parameters

Match up data sets were prepared by the JAXA and provided to PIs via ftp. They consist of massifs of collocated in space and close in time the AMSR/AMSR-E brightness temperatures TBs and

- SST and wind speed and direction values measured by oceanic buoys as well as
- radiosonde reports.

These data sets are used to estimate the retrieval errors, coefficients of regression equations and to correct (tune) the retrieval algorithms. Some problems in AMSR and AMSR-E data calibration were revealed. They were discussed at the ADEOS-II PI Workshop (1-3 March, Tokyo). Next meeting devoted to AMSR/AMSR-E data analysis will be on 8-10 December 2004. TBs are now reprocessed and can be used by PIs on the basis of "Announcement of EOIC online Service User Approval".

4. Introduction of latest findings

The Russian achievements in the field of marine environment remote sensing were presented (or will be presented) at several International Conferences and Symposia in 2004 (IGARSS'04, ESA Envisat and ERS Symposium, Sixth IOC/WESTPAC International Scientific Symposium, PICES (October, USA), PORSEC'04 (Chile, November-December), etc.

The Second Open Russian Conference "Current Problems of Remote Sensing of the Earth from Space" will be in Moscow on 16-18 November.
The latest finding will be summarized in December.

5. Strategies / Plans for RS related activities

I n accordance with Federal Space Program (2001-2005) Rosaviakosmos is responsible for making and launching of the following space apparatus: "Arkon", "Sich-1M", "Resurs-DK", "Resurs-01", "Meteor-3M" N2, "Electro", "Vulkan" and "Arkon-2". This family of satellites will allow to fulfill a national need for remote sensing information (http://www.rosaviakosmos.ru)

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Khrunichev State Research and Production Space Center (http://www.khrunichev.ru) plans to use a unified platform "Yacht" (Table 8) to make and launch the space apparatus *"Monitor-E, -N, -C, -O, -R3, -R23"* (Tables 9 and 10) for Earth's Remote Sensing

Table 8. Characteristics of a unified platform "Yacht"

Mass, kg	420

Power, kW	1…3
Orientation accuracy, deg	0.1
Stabilization accuracy, deg\sec	0.001
Expected operation duration, years	5…12

Table 9. Specification of space apparatus of "Monitor" system with radar

	"Monitor-R3"			**"Monitor-R23"**		
Range (wave-length), cm)	X (3,1)			L(23.5)		
Polarization	VV, HH			VV+VH, HH+HV		
Spatial resolution, m	3-5	20/40	100/200	5-10	20/40	100/200
Swath width, km	10…20	30…80/120…160	400	20 - 40	60…80/120…160	300
Cover width, km	450			300		

Table 10. Specification of Space apparatus of "Monitor" system with optic-electronic devices

	"Monitor-I" №1		**"Monitor-I" №2**		**"Monitor-C"**		**"Monitor-O"**	
Spectral ranges	0,51-0,85 0,45-0,52 0,54-0,59 0,63-0,68 0,79-0,90	0,54-0,59 0,63-0,68 0,79-0,90	3,55-3,95 10,4-11,5 11,5-12,6	0,54-0,59 0,63-0,68 0,79-0,90	(стерео-модуль) 0.51-0.85	0,54-0,59 0,63-0,68 0,79-0,90	0,51-0,85 0,45-0,52 0,54-0,59 0,63-0,68 0,79-0,90	0,54-0,59 0,63-0,68 0,79-0,90
Spatial resolution, m	3(П); 6(МЗ)	20/40	60	20/40	4-5	20/40	1(П); 2(МЗ)	20/40
Swath (cover) width, km	36 (700)	160 (890)	160 (890)	160 (890)	65 - 70 (65 - 70)	160 (890)	20 (690)	160 (890)

NPO Mashinostroenia plan to make and launch Kondor-E satellite with S-band SAR, VV and HH polarizations. Two swaths (left and right) with a width of 500 km. Spatial resolution from several meters to 100-150 m (scanSAR). http://www.npomash.ru/space/ru/space1.htm) Launching in 200??.

6. Challenges and Prospects

State the challenges and prospects in each member country regarding remote sensing of marine environment.

7. Suggested activities for the NOWPAP Region

The following topics are under consideration as subjects for suggested activities.

Joint Monitoring programs based on remote sensing data from the present and future satellites.

Analysis of the ERS-1/2, Envisat and ALOS Synthetic Aperture Radar, Envisat MERIS, NOAA AVHRR, ocean color, altimeter and scatterometer data collected over the NOWPAP Region to study the surface manifestations of oceanic phenomena (currents, eddies, fronts, internal waves, upwellings), river/sea mixing zones, oil spills, sea ice and mesoscale regulated structures in the surface wind field important for coastal zone management and monitoring. (Subarctic frontal zone in the NOWPAP Region, Korean Warm Current, Yangtze River mixing zone, coastal upwellings,…).

Analysis of the ADEOS-II AMSR, Aqua AMSR-E, NOAA AVHRR and other remote and ion situ data obtained over the Northwestern Pacific Ocean to retrieve the sea surface wind, sea surface temperature, total atmospheric water vapor content, total cloud liquid water content and rainfall rate in the weather systems with gale winds and heavy precipitation (polar lows, cold air outbreaks, tropical cyclones and other).

Training and education courses associated with data fusion, SAR application, in particular, for oil spill monitoring.

Conclusion

References

Will be added in December 2004 after The Second Open Russian Conference “Current Problems of Remote Sensing of the Earth from Space”