Use of image data of GMS and NOAA in Japan

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Abstract

In Japan meteorological satellite image data are used for operation in real time and for research in non-real time. Operational use is for disaster prevention, traffic safety, environment preservation, efficiency of commerce and various industries and convenience of people's lives. Serveral physical quantities like winds and cloud estimated by satellite images began to be used for initialization and validation of operational numerical weather prediction. Research use is mainly for accuracy raise of physical quantities estimated by satellite image data, and discovery and description of meteorological phenomena. If physical quantities are surface conditions like surface temperature, it is an important theme how to remove the influence of atmosphere and clouds. Image simulation study should be welcome for the Meteorological Satellite Center. The data serving activities by Tohoku and Tokyo Universities will make researches active.

Introduction

In Japan mainly GMS series and NOAA series are used for meteorological purposes in operation and research bases. A weather service company services GOES and METEOSAT images routinely. Some research magazines include papers using TOMS, ERB onboard NIMBUS, VTIR onboard MOS, PR in TRMM, INSAT images, SSM/I onboard DMSP, POLDER onboard ADEOS and ASTER onboard EOSAM1. But this study restricts the discussion within the use of GMS and NOAA data. Use of image data obtained by GMS and NOAA as well as vertical sounding data, TOVS of NOAA is discussed in the following.

Receiving stations

GMS distributes S-VISSR data to MDUSs and WEFAX to SDUSs. Numbers at least of MDUSs and SDUSs were estimated from reports by users to the Japan Meteorological Agency (JMA) who requested via electric companies making MDUS and SDUS. NOAA distributes HRPT and APT data to thein receiving stations. NOAA receiving systems are mainly made by NEC, NHE and JRC. Numbers at least of both HRPT and APT receiving stations were estimated from supplies by main equipment companies. A result is shown in Table 1. WEFAX use by schools is the largest. In addition, 53% of local public bodies is educational

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facilities, and also 17% of national government offices are research and educational facilities. This means that research and education shares 46% in use of satellite image by WEFAX. Also APT use by school is 40. And 64% by National government offices and 100% by Local public bodies are research or educataion. Therefore, 38% of APT use are research and educational.

Table.1 Classified satellite utilization stations as of April, 1995

No	Organs	S-VISSR	WEFAX	HRPT	APT
01	Weather observatories	1	32	1	1
02	Information media	2	6	0	0
03	National government offices	0	166	7	25
04	Local public bodies	0	147	0	9
05	Special corporations	0	25	0	2
06	Schools	4	229	4	40
07	Weather service companies	4	10	2	1
08	Public service companies	0	25	1	3
09	Electric power companies	0	19	0	0
10	Aviation companies	0	21	0	0
11	Industrial, trading companies	1	48	0	81
12	Personals	0	30	0	2
13	Ships *	0	1	4	5
14	Others	0	4	0	0
	Sum	12	763	19	169

* Use by ships appears few, but in fact seems to be included in industrial and trading companies. It is hard to compare GMS with NOAA recerving stations, because the ways of data collection are different.

Purpose of use

Uses of meteorological satellite data are classified into two manners: uses in operational services in real time and researches in non-real time. Operational use is weather service by JMA, weather service companies, information media, aviation companies and fishery organization. Purposes of weather service are for disaster prevention, traffic safety, environment preservation and efficiency of various industries, commerce and convenience of lives. Another use is for researches on meteorology, climatology, environmental problems, disaster prevention, education, receiving set and system development.

Operational use

1. Weather analysis and nowcast

Using S-VISSR, WEFAX, HRPT and/or APT data, weather analysis and nowcast are carried out not only by JMA, but also by national government offices like the Defense Agency (DA), the Maritime Safety Agency (MSA), weather service companies, information media, aviation companies and ships. Physical quantities obtained by satellite data are cloud tracked wind (by VISSR), sea surface temperature, vertical profile of temperature and humidity (by HRPT) and precipitation.

One feature of such physical quantities observed by satellite is homogeneously dense in the horizon, but is poorly dense in the vertical compared with conventional aerological and surface data. One of the most important analyses is a typhoon analysis including the location, movement and intensity. Use for initialization and validation of numerical weather prediction model is another utilization having future growth. In numerical weather prediction models, wind estimated by cloud movement

and humidity estimated by clouds are used to get the initial field and cloud distributions are used for the validation.

Most newspapers publish the latest infrared images of GMS around Japan in both the morning and evening editions. Most TV stations broadcast movies of GMS infrared images around Japan several times a day.

When aircraft are going to fly out of the GMS coverage area aviation companies will use GOES and/or METEOSAT images transmitted via communication satellites. Such operation is carried by Weather News IC., for example. When ships are going to sail out of the GMS coverage area the ships will use APT from NOAA satellites instead of WEFAX from GMS series.

2. Sea surface temperature

JMA analyzes and publishes 10 day-mean global sea surface temperature (SST) using conventional data measured by ships and buoys, referring one day- and 5 day-mean SST estimated by GMS data in the eastern Indian and western Pacific oceans, and an instant SST estimated by NOAA AVHRR around Japan. Marine observatories in JMA publish 10 day-mean SST regional maps analyzed by mixing ships, buoys and NOAA AVHRR SST.

A public service company makes an instantaneous SST estimated by NOAA AVHRR around Japan for fishery.

3. Sea ice

JMA and MSA produce sea ice distributions in the Sea of Okhotsk every 5 days using GMS, NOAA, LANDSAT and MOS satellite images, aircraft data and etc. We can discriminate sea ice from cloud because sea ices are stationary while clouds are mobile.

4. Total ozone amount

Decreasing trend of ozone over the earth is warned to occur due to freon gas increase in the upper atmosphere. So in order to monitor the ozone amount around Japan, the Meteorological Satellite Center (MSC) produces total ozone amount maps made by using NOAA TOVS data.

5. Volcanic ash detection plan by Volcanic Ash Advisory Center

The plan is to report the area of volcanic ash cloud using the analysis of GMS images and the results of numerical prediction model.

Research use

Uses for researches were studied from papers published in Journals of several academic societies interested in meteorological satellite data, and in Technical Note of MSC. The Journals are shown in Table 2. The period is during 1991 to 1995. Numbers of papers using GMS images are shown in Table 3 and those using NOAA images and TOVSs are shown in Table 4.

Table.2 Journals and the Societies used for statistics

"Journal"	〈Issue〉	Society
"Journal of the Meteorological Society of Japan"	〈Bimonthly〉	The Meteorological Society of Japan.
"Tenki (Weather)"	〈Monthly〉	The Meteorological Society of Japan.
"Umi to Sora (Sea and Sky)"	〈Quarterly〉	The Marine Meteorological Society of Japan.
"Journal of Oceanography"	〈Bimonthly〉	The Oceanographic Society of Japan.

"Umi no Kenkyu (Research of Ocean)"	〈Bimonthly〉	The Oceanographic Society of Japan.
"Sora to Umi (Sky and Sea)"	〈Annual〉	The Society of Airborne & Satellite Physical & Fishery Oceanography.
"Jurnal of the Remote Sensing Socciety of Japan"	〈Quarterly〉	The Remote Sensing Society of Japan.
"Technical Note"	〈Semiannual〉	Meteorological Satellite Center.

Common themes of researches using GMS and NOAA are estimations of surface conditions, estimations of physical quantities like aerosols, precipitation, precipitable water amount. Introductions of databases by Tohoku and Tokyo Universities will support researchers. (Also, Meteorological Business Support Center will provide GMS image data to not only private sides but universities.)

Themes of researches carried only by GMS data are estimations of cloud driven winds, initialization and validation of numerical weather prediction models. Descriptions and discoveries of meteorological phenomena are mainly performed using GMS images because they are stably provided every hour over the wide area covering the East Asia and West Pacific.

Themes of researches carried using only by NOAA data are estimations of total ozone amount. Researches about estimation of surface conditions by AVHRR are much more frequent than by GMS images because split window spectral bands are available in AVHRR but not in GMS-1 through -4 images. In order to investigate the surface condition, how to detect the atmospheric effect becomes the main theme. The on-orbit GMS-5 equipped with the split window and water vapor channels as well as the visible channel started the operation on June 21, 1995.

Table.3 Numbers of papers in Table 2 through 1991 to 1995 in which use GMS image data.

Theme	Number
a. Imager navigation	4
b. Detect of aerosols	
Dust cloud	1
Total aerosol	1
Volcanic Ash	2
c. Estimation of surface condition	
Solar radiation at the surface	3
d. Estimation of physical quantities	
Outgoing long wave radiation	1
Precipitation	2
Cloud driven wind	2
e. Relation between clouds and meteorological phenomena including discovering new meteorological phenomena	
Typhoon and tropical cyclone	5
Tropical convective system	17
Winter cyclones and convergence zone in Japan Sea	4
Cloud physics	1
Summer monsoon or Baiu front	6
Diurnal variation of Cb cluster	1
Warm front	1
Severe storm	1
Cyclone	1
Coupling development of extratropical cyclones	1
Meso-scale disturbance	1
Polar low	1

Shear line	1
f. Various forms of clouds	
Fog	1
Tapering cloud	1
g. Simulation of images	1
h. Initialization of numerical weather prediction	2
i. Validation of simulation	2
j. Satellite database	
Institute of Industrial Science, University of Tokyo	1
Meteorological Satellite Center	2
sum	67

Table.4　Numbers of papers in Table 2 through 1991 to 1995 in which use TOVS and AVHRR.

Theme	Number
(1) Estimation of physical quantities by TOVS	
Radiative forcing	1
Total ozone amount	2
(2) Use of AVHRR	
a. Geometoric correction	2
b. Detect of aerosolos	2
c. Estimation of surface conditions	
Atmospheric effect to estimate surface conditions	4
Cloud-detection algorithm	1
Sea surface temperature	10
Land surface temperature	2
Sea ice	1
Snow area detection	2
Fog area detection by APT	1
d. Estimation of physical quantities	
Precipitation	1
Precipitable water amount by split window	2
e. Japan Image Database	
The Center for Atomosphere and Oceanic Studies in the Tohoku University	6
Institute of Industrial Science, University of Tokyo	3
sum	40

Abberviation

ADEOS: ADvanced Earth Observing Satellite

APT: Automatic Picture Transmission

ASTER: Advanced Spaceborne Thermal Emission and Reflection Radiometer

AVHRR: Advanced Very High Resolution Radiometer

DMSP: Defense Force Meteorological Satellite Program

EOSAM: Earth Observation System AM

GOES: Geostationary Operational Environmental Satellite

GMS: Geostationary Meteorological Satellite

HRPT: High Resolution Picture Transmission

INSAT: Indian National Satellite

MDUS: Medium scale Data Acquisition Station

METEOSAT: Meteorological Satellite

MOS: Marine observation Satellite

POLDER: POLarization and Directionality of the

Earth's Reflectance
PR: Precipitation Radar
SDUS: Small scale Data Acquisition Station
SSM/I: Special Sensor Microwave/Imager
S-VISSR: Stretched Visible and Infrared Spin Scan Radiometer
TOVS: Tiros Operational Vertical Sounder
TRMM: Tropical Rainfall Measuring Mission
VTIR: Visible and Thermal Infrared Radiometer

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日本におけるＧＭＳとＮＯＡＡの画像データ利用

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日本では、気象衛星画像データは即時的な業務的利用と非即時的な研究的利用に供されている。業務的利用の目的は主に防災、交通安全、産業や商業の効率性向上、一般生活の利便性向上等が挙げられる。衛星画像より見積もられた風や湿度のような物理量が数値予報の初期値や検証値に使い始められた。研究的利用は主に衛星画像から推定される物理量の精度向上および気象学的現象の発見や記述である。もし、物理量が海面温度のような地球表面の性質ならば、大気や雲の影響をいかに取り除くかが重要なテーマとなる。画像シミュレイションの研究は衛星センターにとって歓迎すべきであろう。東北大や東大によるデータ画像の供給活動は研究を活発にするだろう。