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ACTIVITIES OF THE RSMC TOKYO - TYPHOON CENTER IN 2014

(Submitted by the RSMC Tokyo - Typhoon Center)

Action Proposed

The Committee is invited to review the activities of the RSMC Tokyo - Typhoon Center in 2014.

Activities of the RSMC Tokyo - Typhoon Center in 2014

1. Provision of RSMC Products

The RSMC Tokyo - Typhoon Center (hereinafter referred to as *the* Center) provides Typhoon Committee (TYC) Members with a range of products related to tropical cyclones in the western North Pacific and the South China Sea through the GTS and the AFTN. Table 1 shows the total number of products issued by the Center in 2014.

2. Track Forecasts

Operational track forecasts for 23 Tropical Cyclones (TCs) that reached Tropical Storm (TS) intensity or higher in 2014 were verified against the Center's analysis data. Figure 1 shows the time series of the annual mean position errors of 24-hour (from 1982), 48-hour (from 1989), 72-hour (from 1997), 96-hour and 120-hour (from 2009) forecasts. The errors of the year are 102 km (91 km in 2013), 176 km (149 km), 251 km (215 km), 358 km (336 km) and 466 km (480 km) for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively (Table 2). The mean hitting ratios of probability circles* for 24-, 48-, 72-, 96- and 120-hour forecasts are 78% (82% in 2013), 78% (82%), 75% (84%), 79% (81%) and 70% (75%), respectively (Table 3).

* Probability circle: a circular area within which a TC is expected to be located with a probability of 70% at each forecast time.

3. Intensity Forecasts

Table 4 gives the mean errors and root mean square errors (RMSEs) of 24-, 48- and 72-hour central pressure (Table 4a) and maximum sustained wind forecasts (Table 4b) for 23 TCs of 2014. The annual mean RMSEs for central pressure forecasts are 14.1 hPa (13.6hPa in 2013), 20.5 hPa (21.4 hPa) and 23.7 hPa (23.7 hPa) for 24-, 48- and 72-hour forecasts, respectively, while those of maximum wind speed forecasts for 24-, 48- and 72-hour forecasts are 6.0 m/s (6.4m/s in 2013), 8.7 m/s (9.4 m/s) and 10.3 m/s (10.4 m/s), respectively.

4. Tropical Cyclone Intensity Estimation Methods with Microwave Satellites

Two methods for TC intensity estimation using microwave satellites were developed by RSMC Tokyo for its operation: one is a method which estimates TC central pressure by using a regression equation which relates the maximum brightness temperature (TB) anomaly value from observations of Advanced Microwave Sounding Unit-A (AMSU-A) channel 6, 7 and 8 near TC center (within a radius of 200 km from the TC center) to TC central pressure. The other is an estimation method of maximum TC wind speeds with TC cluster analysis of parameterized Tropical Rainfall Measurement Mission (TRMM) Microwave Imager (TMI) brightness temperature distribution. Details on the method and verification results are described in the Technical Review No. 16.

5. Numerical Typhoon Prediction (NTP) website

Since October 2004, the Center has officially operated the Numerical Typhoon Prediction (NTP) website (https://tynwp-web.kishou.go.jp) in cooperation with eight NWP centers: BoM (Australia), MSC (Canada), CMA (China), ECMWF, DWD (Germany), KMA (Republic of Korea), UKMO (UK) and NCEP (US). The NTP website provides predictions of tropical cyclone tracks derived from models of the major NWP centers and TC related products in order to assist the NMHSs of TYC Members in their tropical cyclone forecasting and warning services. The website is available only to registered organizations including the NMHSs of TYC Members and participating NWP centers under the agreed conditions of use. Ten TYC Members other than Japan have access to the website as of the end of 2014. The main contents of this site are as follows:

1) Predictions of tropical cyclone tracks, in table and chart format, from nine major NWP centers including JMA. Ensemble mean predictions with any combination of those centers are also available.

2) NWP model products, in chart format, from the NWP centers

3) Results of satellite image analysis (EDA and Dvorak analysis)
4) Storm surge distribution maps, storm surge time series charts of points for TYC Members

Further enhancement of the website, including real-time provision of satellite microwave snapshot imageries and the TC intensity estimates with microwave satellites and Tropical Cyclone Heat Potential (TCHP) in the western North Pacific, is planned next year.

6. Regional storm surge watch scheme suitable for the TYC region

In response to the results of the survey in 2009, the Center has been providing distribution maps since 1 June 2011 and time-series charts of storm surges since 5 June 2012 on the NTP website. In 2014, RSMC Tokyo added 41 stations; USA (1) in June, the Philippines (10) in June and October, Viet Nam (20), Hong Kong China (5) and Republic of Korea (5) in September. The maximum storm surge value was added to horizontal storm surge maps for users' convenience since September 2014. All products can be found on the NTP website. There were requests from NWS (USA) for time-series storm surge forecasts at Kwajalein, Marshall Islands and in Wake Island located outside of the current forecasting region. It is, however, difficult to expand the forecasting region eastward due to limitation of the current computational resource. This request will be taken care of when the computer system is upgraded in a few years. TYC Members are encouraged to provide complete hourly tidal observation data for a few years at least for RSMC Tokyo to calculate astronomical tides at stations, and complete hourly tidal data during past storm surge events at the stations to verify storm surge forecasts for further improvements. In 2015, the Center plans to prepare for provision of storm surge multi-scenario forecasts to TYC Members. Also, the Center dispatched a storm surge expert to the Philippines to provide training for local staff members from 15 to 19 December 2014.

7. Contribution to the WMO North Western Pacific Tropical Cyclone Ensemble Forecast (NWP-TCEFP) Project

Tropical Cyclone Ensemble Forecast Information Home Page (NWP-TCEFP Home page) was launched by JMA in 2010 for the purpose of providing guidance of tropical cyclone forecasts in near real-time for TYC Members, using the TIGGE (THORPEX Interactive Grand Global Ensemble) Cyclone XML (CXML) data, under the joint project of World Weather Research Program (WWRP) and Tropical Cyclone Program (TCP), North Western Pacific Tropical Cyclone Ensemble Forecast Project (NWP-TCEFP). This web page provides deterministic and ensemble TC track forecasts, and strike probability maps based on ensemble TC track forecasts. The effectiveness of EPS for TC operational forecasts was confirmed by the questionnaire sent to TYC Members from WMO in December 2011 and 2012. To explore ways to provide those products in a more real-time basis responding to identified needs through the questionnaires, in 2014, the Center requested ECMWF, UKMO, and NWS to provide their ensemble NWP data on a real-time basis. The Center has found it difficult in short term to obtain ECMWF's ensemble NWP data on a real-time basis for this purpose. Instead, ECMWF ensemble track guidance available via GTS may be used under the condition of use of the NTP website. The Center is being under negotiation with UKMO and NWS.

Operational global medium-range ensemble forecasts of TC activity were systematically evaluated to further examine the skill of such forecasting and determine its potential for future operational use. The global ensembles used are ECMWF, JMA, NCEP and UKMO for the period from 2010 to 2013. It was found that operational global medium-range ensembles are capable of providing guidance on TC activity forecasts extending into the second week. Brier Skill Scores (BSS) for the western North Pacific, the Eastern and Central Pacific and the North Atlantic basins are higher than those for other basins, and ECMWF has the highest values in general. Meanwhile, BSS and reliability have been found to be sensitive to the choice of wind threshold values in the definition of model TCs. RSMC Tokyo plans to examine a multi-center grand ensemble (MCGE) for TC generation prediction in 2015 and report outcomes to the 48th TC session.

8. The Severe Weather Forecasting Demonstration Project (SWFDP) in South-east Asia

The Center has participated in a sub-regional project in Southeast Asia (SWFDP-SeA) as the Regional Center for Tropical Cyclone / Typhoon Forecasting Support to provide typhoon related products since 2013. It dispatched two experts as lecturers to Regional Training Workshop on Severe Weather Forecasting (GDPFS) and Warning Services (PWS) held in Metro Manila, the Philippines from 2 to 7 in June 2014. In addition, one storm surge expert of the Center gave a webinar (a lecture using a tele-communication tool) to the said workshop.

9. Tropical Cyclone Satellite Re-analysis

Responding to the discussions of the Seventh WMO International Workshop on Tropical Cyclones (IWTC-VII La Reunion, France, 15-20, November 2010), and the 2nd international IBTrACS Workshop (Honolulu, Hawaii, 11-13 April 2011) held in conjunction with the WMO sponsored International Workshop on Satellite Analysis of Tropical Cyclones (IWSATC) (Honolulu, Hawaii, 13-16 April 2011), the Center started tropical cyclone satellite re-analysis in 2012 for the period from 1981 to confirm and improve the quality of the Current Intensity (CI) number in the satellite TC analysis. Re-analysis over the period from 1987 to 1999 is being implemented to be completed by the end of 2015.

10. Development of regional radar network

The Development of Regional Radar Network is a project of the Working Group of Meteorology to develop a regional radar network in Southeast Asia. Toward this goal, as its first step, the Center has been providing technical assistance to the Thai Meteorological Department (TMD) for its development of the national radar network since 2011. In 2014, TMD worked on the application of the JMA's radar composite techniques to its nationwide radar network, as well as preliminary study on quantitative precipitation estimation (QPE) technique of its own. A follow-up technical meeting was held in Tokyo from 25 to 28 November 2014 with particular focus on provision of training on JMA's quality control techniques of radar data and essential techniques for QPE which can be applicable to TMD. In 2015, application of the JMA's quality control radar techniques and QPE source codes provided by JMA to the Thailand radar network are to be conducted by TMD with JMA's technical assistance. In addition, a follow-up technical meeting is also to be planned on receipt of a progress report by TMD.

11. Tropical cyclone advisories for SIGMET in graphical format

As indicated in the Manual of Aeronautical Meteorological Practice (Doc 8896), the information on TCs in a graphical format provided by TCAC Tokyo is shown in the JMA website (http://www.jma.go.jp/en/typh/). In addition, the Center is developing graphical TC advisories (TCAs) based on the techniques utilizing the cloud grid information for the analysis of existing CB areas according to MODEL TCG in Appendix 1 of ICAO Annex 3, and plans to start providing the graphical TCAs in 2015.

12. Himawari-8/9 – the next-generation geostationary meteorological satellites of JMA

JMA has operated a series of satellites at around 140 degrees east for more than 35 years since its launch of the first meteorological satellite in 1977. The currently operational MTSAT-2 is backed up by MTSAT-1R in stand-by orbit. The next-generation geostationary meteorological satellite of JMA, Himawari-8, was successfully launched on 7 October 2014. JMA conducted the in-orbit testing of the satellite on track, and provided the first image on 18 December 2014 shown as Figure 2. After the completion of all testing and checking of the satellite system including related ground facilities, the satellite is expected to start operation in mid-2015 as a replacement for MTSAT-2. Himawari-8, together with its backup and successor satellite Himawari-9, will observe the East Asia and Western Pacific regions for a period of 15 years. Himawari-8 is the world's first next-generation geostationary meteorological satellite, and features a new imager with 16 bands as opposed to the 5 bands of the current MTSAT series. Three of these are visible bands corresponding to red, green and blue to enable the creation of true-color composite images. Full-disk imagery will be obtained every 10 minutes, and rapid scanning at 2.5-minute intervals

will be conducted over several regions, one of which will be for targeted observation of tropical cyclones. The unit's horizontal resolution is also double that of the MTSAT series. These significant improvements will bring unprecedented levels of performance in monitoring for tropical cyclones.

Figure 3 shows a variety of methods to distribute/disseminate Himawari-8/9 imagery. JMA will distribute all imagery derived from the satellite via the HimawariCloud service for Members with broadband connection to the Internet. For Members with limited Internet access, in January 2015, JMA started a HimawariCast service by which primary sets of satellite imagery together with other meteorological data (e.g. SYNOP, NWP etc.) are disseminated via a communication satellite. The online imagery services for MTSAT (WIS Portal (GISC-Tokyo) and the JMA Data Dissemination System (JDDS)) will be continued for Himawari-8/9. Figure 4 shows the transition schedule to the new services (HimawariCloud and HimawariCast).

13. Post-Typhoon Haiyan Expert Missions to the Philippines and Viet Nam

The Post-Typhoon Haiyan expert mission to the Philippines was carried out by WMO, UN ESCAP, and TYC from 7 to 12 April 2014. The Center dispatched five experts to the mission to review the response of PAGASA to Haiyan, identify gaps and challenges, in particular, in TC analysis/forecasts and storm surge forecasts, and propose follow-up actions/projects. In addition, WMO subsequently organized the expert mission to Viet Nam, from 14 to 16 April 2014, in which four experts of the Center participated. The mission team reviewed the international and national emergency response to Haiyan in Viet Nam, and identified the requirements of the National Hydro-Meteorological Service of Viet Nam (NHMS) in support for emergency response and disaster risk reduction, and proposed recommendations including the follow-up actions based on the assessment of the international supports to NHMS. The mission reports are available at the WMO website (http://www.wmo.int/pages/prog/dra/).

14. Support operations by the Center for Typhoon Hagupit

In order to best prepare for the violent typhoon, Hagupit (T1422) by the TC Members, PAGASA in particular, the Centre implemented the following actions when Hagupit was expected to hit and seriously affect the Philippines: the Center 1) designated a contact point for Hagupit (24 hours accessible from PAGASA both by email and cellphone), 2) exchanged technical views on storm surge forecasts for Hagupit with PAGASA, and 3) implemented ten-minute-interval special satellite observation by MTSAT-1R (from 4 to 11 Dec. 2014) and made the imagery available to TC Members.

15. Publications

The Center published "Algorithm and validation of a tropical cyclone central pressure estimation method based on warm core intensity as observed using the Advanced Microwave Sounding Unit-A (AMSU-A) ", and "Development and Verification of a Tropical Cyclone Intensity Estimation Method Reflecting the Variety of TRMM/TMI Brightness Temperature Distribution" as its Technical Review No. 16 in March 2014, and Annual Report on the Activities of the RSMC Tokyo - Typhoon Center in 2013 in December 2014. They are available on the Center's website at http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.htm.

16. Training

Three forecasters from Lao P.D.R., Malaysia and the Philippines visited the Center from 23 July to 1 August 2014 to participate in the 14th TYC Attachment Training at RSMC Tokyo. The details of the training were posted at the JMA website (http://www.jma.go.jp/jma/en/photogallery/RSMC_training_201407.html).

17. Implementation Plans

Table 5 shows the implementation plans of the Center for the period from 2014 to 2018.

Table 1 Monthly and annual total numbers of products issued by the RSMC Tokyo - Typhoon Center in 2014

Product	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
IUCC10	38	17	41	68	3	26	231	144	197	137	73	109	1084
WTPQ20-25	55	27	41	81	3	32	261	145	223	142	80	118	1208
WTPQ30-35	13	7	10	20	1	6	63	36	54	36	19	30	295
WTPQ50-55	4	3	12	26	0	0	83	44	54	48	14	41	329
FXPQ20-25	54	26	40	80	2	28	257	142	218	140	78	116	1181
FKPQ30-35	27	13	20	40	1	14	129	71	109	70	39	58	591
AXPQ20	0	2	1	0	2	1	1	3	3	4	3	1	21

Notes:

IUCC10 RJTD	SAREP (BUFR format)
WTPQ20–25 RJTD	RSMC Tropical Cyclone Advisory
WTPQ30–35 RJTD	RSMC Prognostic Reasoning
WTPQ50–55 RJTD	RSMC Tropical Cyclone Advisory for five-day track forecast
FXPQ20–25 RJTD	RSMC Guidance for Forecast
FKPQ30–35 RJTD	Tropical Cyclone Advisory for SIGMET
AXPQ20 RJTD	RSMC Tropical Cyclone Best Track

Table 2 Mean position errors of track forecasts for the TCs in 2014

Tropical Cyclone			24-hour Forecast				48-hour Forecast				72-hour Forecast				96-hour Forecast				120-hour Forecast			
			Mean (km)	S.D. (km)	Num.	EO/EP (%)	Mean (km)	S.D. (km)	Num.	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)
TS	Lingling	(1401)	134	20	4	222	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Kajiki	(1402)	262	0	1	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Faxai	(1403)	119	47	17	52	142	50	13	23	137	36	9	12	162	67	5	14	191	0	1	-
TS	Peipah	(1404)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	Tapah	(1405)	149	54	8	97	303	102	4	48	-	-	0	-	-	-	0	-	-	-	0	-
TS	Mitag	(1406)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Hagibis	(1407)	62	16	3	53	349	0	1	51	688	0	1	-	-	-	0	-	-	-	0	-
TY	Neoguri	(1408)	100	60	25	35	184	121	20	29	230	119	16	22	303	112	12	20	358	119	8	23
TY	Rammasun	(1409)	118	63	26	74	180	102	22	44	198	114	18	28	286	135	14	25	213	99	10	13
TY	Matmo	(1410)	117	121	27	37	210	152	23	33	256	110	18	29	339	83	14	28	554	162	10	32
TY	Halong	(1411)	89	42	48	59	168	82	44	50	250	144	39	47	385	219	35	49	528	280	31	47
STS	Nakri	(1412)	129	98	15	33	200	169	11	31	189	98	6	20	346	5	2	45	-	-	0	-
TY	Genevieve	(1413)	118	34	16	29	223	49	12	22	201	79	8	13	149	99	4	4	-	-	0	-
STS	Fengshen	(1414)	78	46	11	45	102	62	6	17	258	23	2	24	-	-	0	-	-	-	0	-
TY	Kalmaegi	(1415)	86	56	17	45	182	86	13	37	372	93	9	42	492	107	5	32	794	0	1	-
TS	Fung-wong	(1416)	126	69	22	38	182	111	18	23	227	110	13	18	520	168	9	25	1077	260	5	54
STS	Kammuri	(1417)	148	56	19	45	302	140	15	43	553	277	11	50	971	355	7	56	1399	165	3	73
TY	Phanfone	(1418)	77	54	25	25	149	88	21	27	246	120	17	29	352	126	13	27	524	115	9	33
TY	Vongfong	(1419)	72	38	37	33	174	74	33	37	276	110	29	34	334	96	25	26	329	112	21	18
TY	Nuri	(1420)	76	36	23	49	122	54	19	30	263	133	14	31	521	113	10	37	891	141	6	38
TS	Sinlaku	(1421)	97	22	5	42	62	0	1	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Hagupit	(1422)	91	65	37	53	136	54	33	37	170	76	29	29	172	57	25	20	203	83	21	16
TS	Jangmi	(1423)	141	64	6	49	87	31	2	-	-	-	0	-	-	-	0	-	-	-	0	-
Annual Mean (Total)			102	66	392	43	176	106	311	34	251	151	239	30	358	220	180	30	466	315	126	30

Notes: S.D. means standard deviation of operational forecast errors.
Num. means numbers of forecasts.
EO/EP indicates the ratio of EO (mean position error of operational forecasts) to EP (mean position error of forecasts by the persistency forecast).

Table 3 Mean hitting ratios (%) and radii (km) of 70% probability circles issued for track forecasts for the TCs in 2014

Tropical Cyclone			24-hour Forecast			48-hour Forecast			72-hour Forecast			96-hour Forecast			120-hour Forecast		
			Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)
TS	Lingling	(1401)	75	4	157	-	0	-	-	0	-	-	0	-	-	0	-
TS	Kajiki	(1402)	0	1	139	-	0	-	-	0	-	-	0	-	-	0	-
TY	Faxai	(1403)	82	17	156	100	13	299	100	9	426	100	5	519	100	1	695
TS	Peipah	(1404)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
STS	Tapah	(1405)	50	8	130	0	4	204	-	0	-	-	0	-	-	0	-
TS	Mitag	(1406)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
TS	Hagibis	(1407)	100	3	179	0	1	296	0	1	407	-	0	-	-	0	-
TY	Neoguri	(1408)	84	25	149	85	20	281	88	16	422	100	12	540	100	8	695
TY	Rammasun	(1409)	69	26	137	77	22	247	89	18	368	93	14	519	100	10	695
TY	Matmo	(1410)	78	27	141	65	23	237	61	18	337	100	14	577	60	10	708
TY	Halong	(1411)	88	48	144	77	44	244	62	39	346	60	35	434	55	31	553
STS	Nakri	(1412)	60	15	141	64	11	237	83	6	395	100	2	482	-	0	-
TY	Genevieve	(1413)	75	16	140	75	12	245	100	8	370	100	4	551	-	0	-
STS	Fengshen	(1414)	82	11	163	100	6	333	100	2	463	-	0	-	-	0	-
TY	Kalmaegi	(1415)	82	17	137	69	13	246	67	9	368	80	5	519	0	1	695
TS	Fung-wong	(1416)	55	22	152	67	18	268	92	13	433	100	9	698	20	5	926
STS	Kammuri	(1417)	47	19	140	33	15	240	27	11	332	14	7	487	0	3	602
TY	Phanfone	(1418)	80	25	147	90	21	247	82	17	332	69	13	473	56	9	578
TY	Vongfong	(1419)	92	37	143	79	33	227	62	29	331	76	25	406	90	21	536
TY	Nuri	(1420)	100	23	160	100	19	304	86	14	407	40	10	519	0	6	695
TS	Sinlaku	(1421)	100	5	135	100	1	204	-	0	-	-	0	-	-	0	-
TY	Hagupit	(1422)	78	37	137	94	33	226	90	29	312	100	25	388	100	21	506
TS	Jangmi	(1423)	50	6	134	100	2	204	-	0	-	-	0	-	-	0	-
Annual Mean (Total)			78	392	144	78	311	251	75	239	360	79	180	479	70	126	602

Table 4 Root mean square errors and mean errors of central pressure (4a: left) and maximum sustained wind (4b: right) forecasts for the TCs in 2014

Tropical Cyclone			24-hour Forecast			48-hour Forecast			72-hour Forecast		
			Error (hPa)	RMSE (hPa)	Num.	Error (hPa)	RMSE (hPa)	Num.	Error (hPa)	RMSE (hPa)	Num.
TS	Lingling	(1401)	-1.5	1.7	4	-	-	0	-	-	0
TS	Kajiki	(1402)	-10.0	10.0	1	-	-	0	-	-	0
TY	Faxai	(1403)	-0.2	3.9	17	-0.1	4.4	13	-0.6	3.7	9
TS	Peipah	(1404)	-	-	0	-	-	0	-	-	0
STS	Tapah	(1405)	0.0	13.4	8	1.8	7.5	4	-	-	0
TS	Mitag	(1406)	-	-	0	-	-	0	-	-	0
TS	Hagibis	(1407)	-4.0	4.3	3	0.0	0.0	1	4.0	4.0	1
TY	Neoguri	(1408)	-6.6	17.8	25	-15.0	23.9	20	-15.9	19.7	16
TY	Rammasun	(1409)	5.0	11.2	26	8.6	14.2	22	12.2	19.9	18
TY	Matmo	(1410)	-5.0	11.5	27	-9.6	16.4	23	-17.1	23.9	18
TY	Halong	(1411)	-0.2	17.2	48	-1.0	20.0	44	0.6	20.0	39
STS	Nakri	(1412)	1.6	2.8	15	2.7	4.3	11	1.7	5.8	6
TY	Genevieve	(1413)	-8.5	19.5	16	-10.5	18.7	12	-12.0	15.1	8
STS	Fengshen	(1414)	-0.1	6.9	11	-7.5	8.4	6	-7.5	7.9	2
TY	Kalmaegi	(1415)	-1.1	6.7	17	-4.0	8.3	13	-7.7	15.8	9
TS	Fung-wong	(1416)	-3.1	4.2	22	-5.1	5.6	18	-14.3	15.4	13
STS	Kammuri	(1417)	0.8	4.0	19	-2.7	6.3	15	-7.7	8.4	11
TY	Phanfone	(1418)	1.8	11.8	25	4.0	15.5	21	3.5	15.6	17
TY	Vongfong	(1419)	-3.0	19.2	37	-1.4	26.0	33	4.1	25.1	29
TY	Nuri	(1420)	10.3	22.6	23	20.3	35.8	19	14.3	32.4	14
TS	Sinlaku	(1421)	2.0	3.9	5	-2.0	2.0	1	-	-	0
TY	Hagupit	(1422)	-2.1	17.0	37	-2.4	30.9	33	-7.0	41.1	29
TS	Jangmi	(1423)	-0.7	1.2	6	-2.0	2.0	2	-	-	0
Annual Mean (Total)			-0.7	14.1	392	-1.1	20.5	311	-2.4	23.7	239

Tropical Cyclone			24-hour Forecast			48-hour Forecast			72-hour Forecast		
			Error (m/s)	RMSE (m/s)	Num.	Error (m/s)	RMSE (m/s)	Num.	Error (m/s)	RMSE (m/s)	Num.
TS	Lingling	(1401)	-1.3	2.6	4	-	-	0	-	-	0
TS	Kajiki	(1402)	5.1	5.1	1	-	-	0	-	-	0
TY	Faxai	(1403)	0.0	3.1	17	-0.6	3.4	13	-0.9	3.1	9
TS	Peipah	(1404)	-	-	0	-	-	0	-	-	0
STS	Tapah	(1405)	1.0	7.3	8	0.0	4.1	4	-	-	0
TS	Mitag	(1406)	-	-	0	-	-	0	-	-	0
TS	Hagibis	(1407)	2.6	3.3	3	-7.7	7.7	1	-7.7	7.7	1
TY	Neoguri	(1408)	0.8	7.2	25	4.5	9.8	20	5.5	8.8	16
TY	Rammasun	(1409)	2.1	6.3	26	0.8	6.8	22	-1.0	8.3	18
TY	Matmo	(1410)	1.4	5.5	27	4.1	8.2	23	8.4	11.9	18
TY	Halong	(1411)	1.1	6.9	48	2.0	8.6	44	1.5	8.0	39
STS	Nakri	(1412)	-0.5	3.2	15	-1.9	4.2	11	0.0	3.0	6
TY	Genevieve	(1413)	5.6	7.6	16	8.4	9.2	12	11.3	11.9	8
STS	Fengshen	(1414)	0.0	3.6	11	3.9	4.3	6	3.9	4.1	2
TY	Kalmaegi	(1415)	0.2	3.4	17	1.4	3.8	13	3.7	8.0	9
TS	Fung-wong	(1416)	2.1	2.9	22	3.1	3.7	18	7.9	8.9	13
STS	Kammuri	(1417)	0.0	2.2	19	1.2	3.2	15	4.7	4.8	11
TY	Phanfone	(1418)	-0.8	4.8	25	-2.8	7.5	21	-2.3	7.2	17
TY	Vongfong	(1419)	0.8	7.1	37	0.3	8.5	33	-1.2	9.5	29
TY	Nuri	(1420)	-4.2	8.8	23	-8.0	14.2	19	-5.0	12.4	14
TS	Sinlaku	(1421)	-1.5	2.6	5	2.6	2.6	1	-	-	0
TY	Hagupit	(1422)	0.8	7.9	37	0.9	13.6	33	3.5	17.8	29
TS	Jangmi	(1423)	0.0	0.0	6	0.0	0.0	2	-	-	0
Annual Mean (Total)			0.6	6.0	392	1.0	8.7	311	2.1	10.3	239

Table 5 Implementation Plans of the RSMC Tokyo - Typhoon Center (2014 - 2018)

PRODUCT	2014	2015	2016	2017	2018	REMARKS
Satellite Observation						
MTSAT-2	———	———				Every 60 minutes (Full-disk) Every 30 minutes (Northern hemisphere)
Himawari-8		———	———	———	———	Every 10 minutes (Full-disk) Every 2.5 minutes (Target area)
Cloud motion wind (BUFR)	———	———	———	———	———	24 times/day
Analysis						
RSMC Tropical Cyclone Advisory	———	———	———	———	———	8 times/day
SAREP (for tropical cyclones, BUFR)	———	———	———	———	———	8 times/day Position of cloud sytem center, etc. 4 times/day Dvorak intensity
Numerical Typhoon Prediction Website satellite image analysis for tropical cyclones	———	———	———	———	———	4 times/day early stage Dvorak analysis & regular Dvorak analysis
Sea Surface Temperature	———	———	———	———	———	
Objective analysis pressure pattern, etc	———	———	———	———	———	
satellite Tropical Cyclone intensity	———	———	———	———	———	
Forecast						
RSMC Tropical Cyclone Advisory	———	———	———	———	———	4 times/day up to 120 hrs ahead 8 times/day up to 24 hrs ahead
RSMC Prognostic Reasoning	———	———	———	———	———	2 times/day
RSMC Guidance for Forecast	———	———	———	———	———	4 times/day up to 84 hrs ahead (GSM) 4 times/day up to 132 hrs ahead (TEPS)
NWP products pressure pattern, etc	———	———	———	———	———	
Numerical Typhoon Prediction Website tracks and prediction fields, etc	———	———	———	———	———	mostly updated 2 times/day 4 times/day up to 132 hrs ahead (TEPS)
Experimental CAP Tropical Cyclone Advisory	———	———	———	———	———	Time series charts at 41 stations have been provided anew since 2014
Others						
RSMC Tropical Cyclone Best Track	———	———	———	———	———	
Annual Report	———	———	———	———	———	Publication
Technical Review	·····	·····	·····	·····	·····	Publication (as necessary)
Tropical Cyclone Reanalysis	———	———	———	———	———	

SUPPORTING ACTIVITY	2014	2015	2016	2017	2018	REMARKS
Data archive	———	———	———	———	———	
Monitoring of data exchange	———	———	———	———	———	
Dissemination of products	———	———	———	———	———	Upgraded to WIS GISC Tokyo in 2011

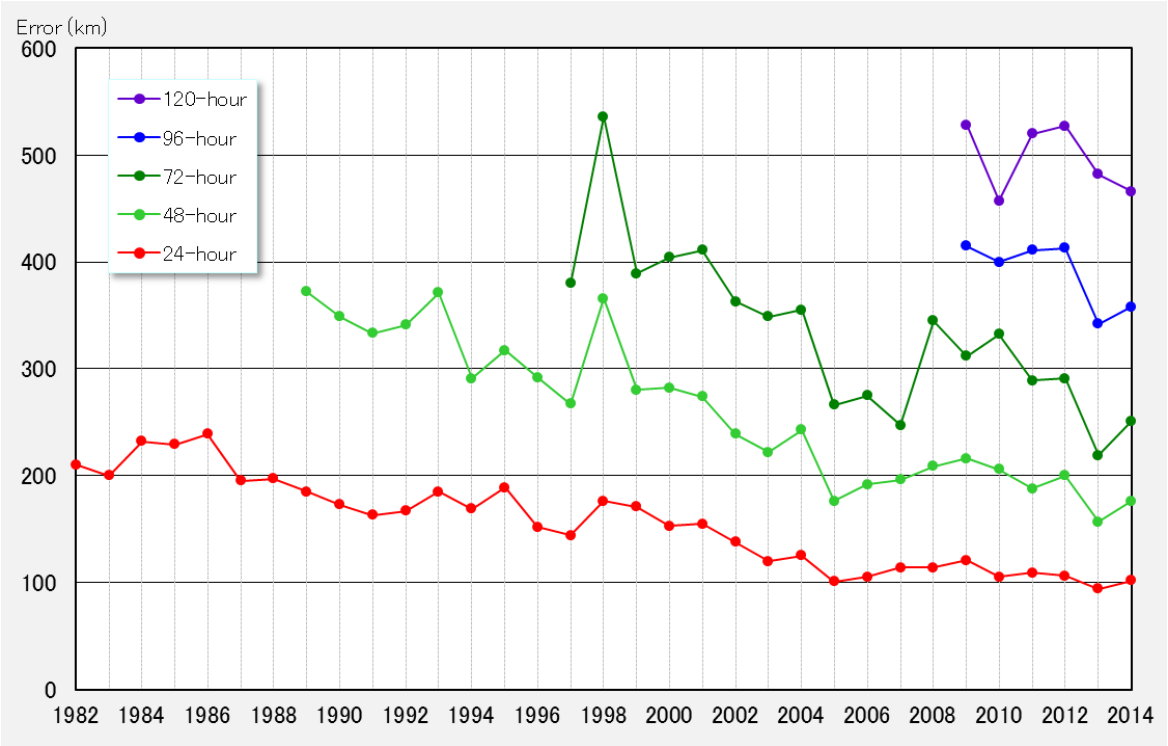

Figure 1 Annual mean position errors of track forecasts
Vertical axis: position error (km), Horizontal axis: year

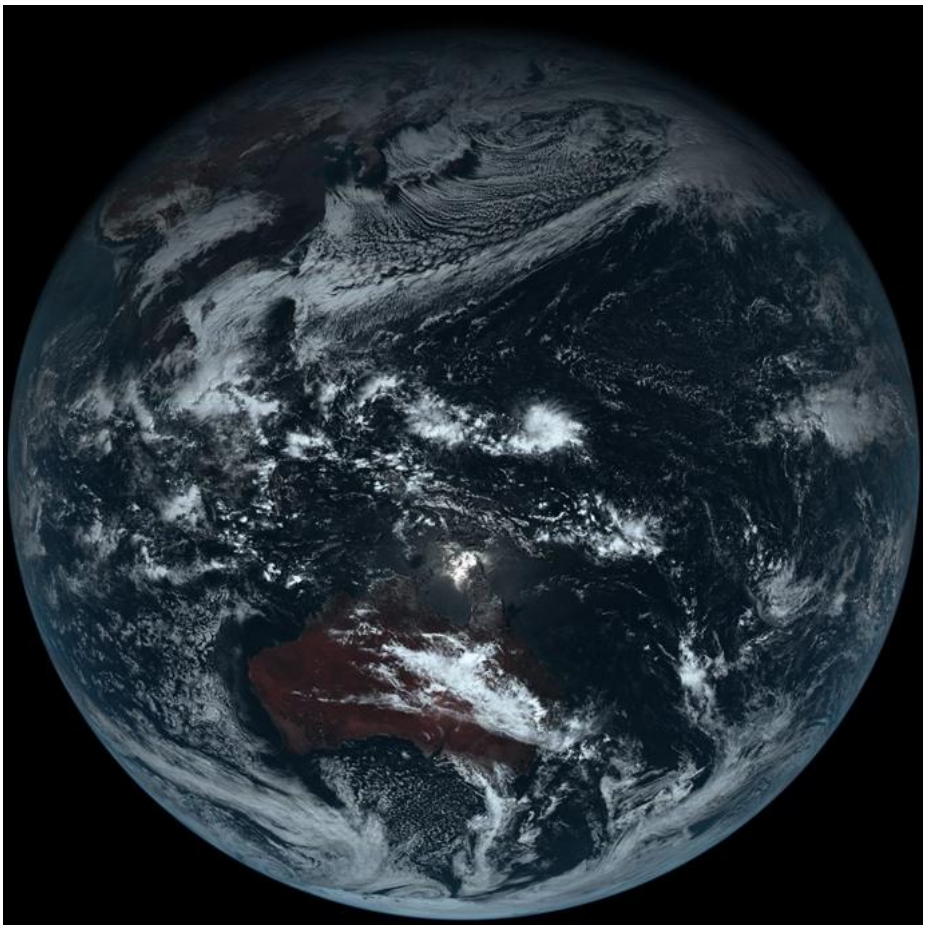

Figure 2: First image from Himawari-8 taken at 02:40 UTC on 18 December 2014

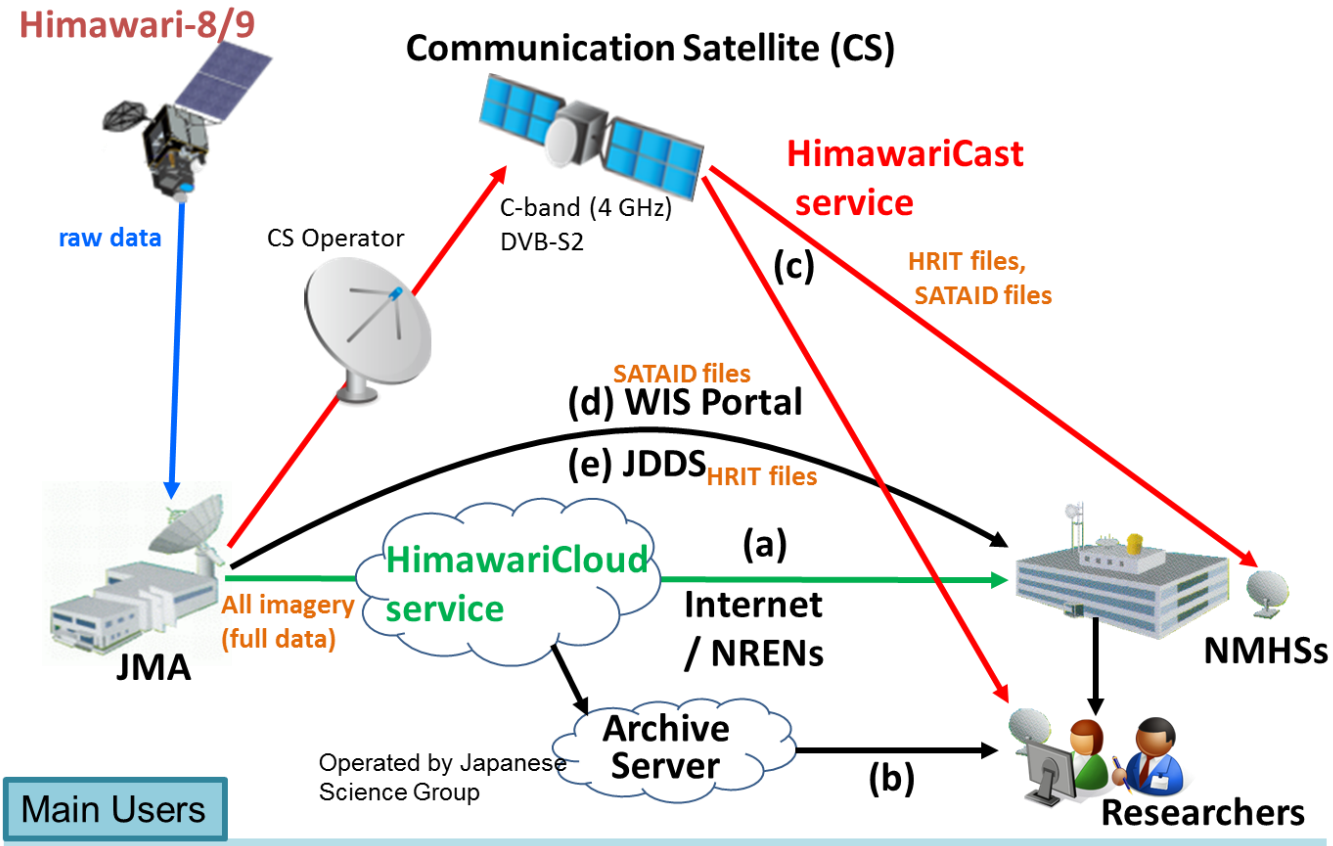

Figure 3: Himawari-8/9 data distribution/dissemination plan

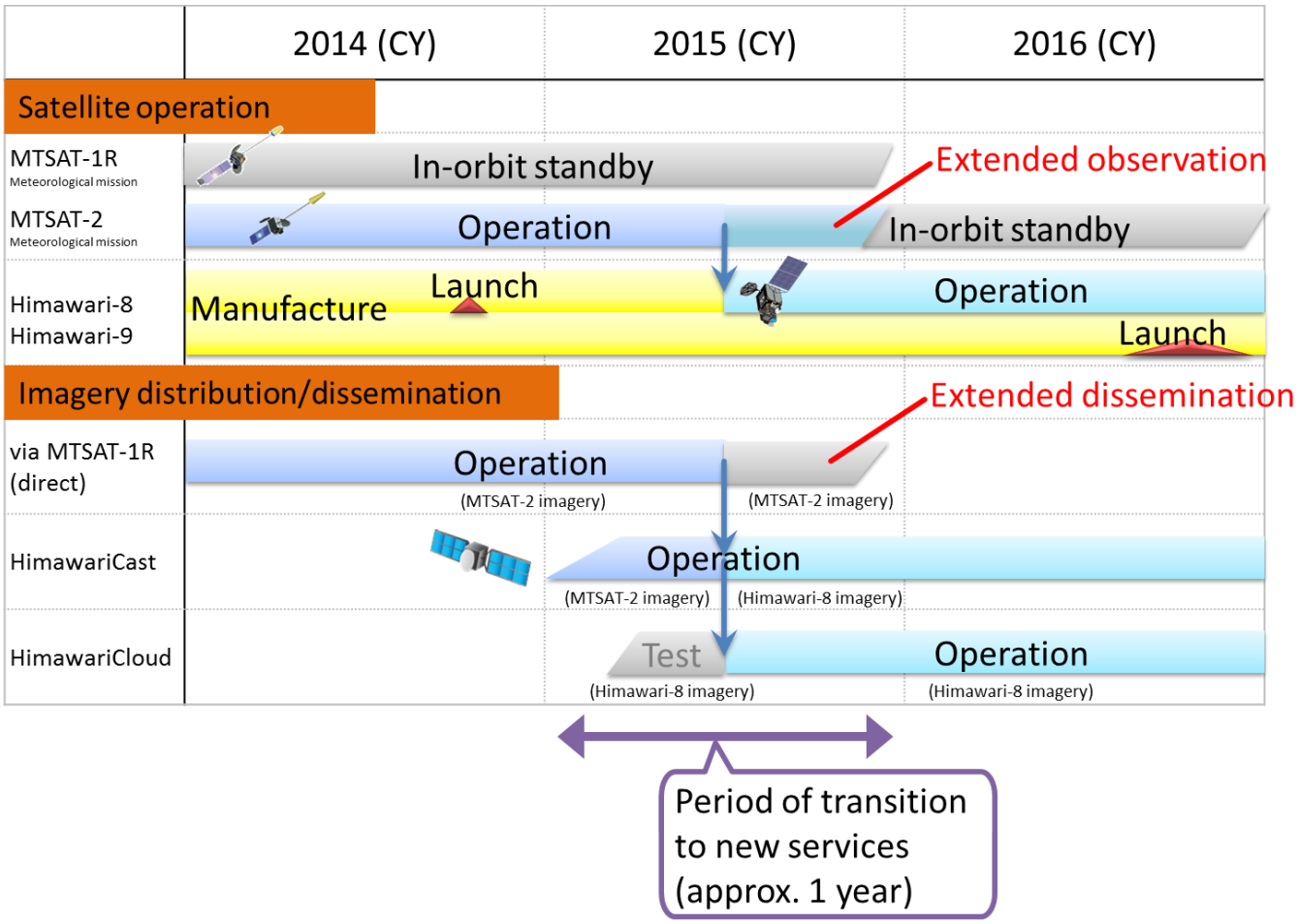

Figure 4: Transition schedule of Himawari-8/9 and their distribution/dissemination services