

## **The Geometric Accuracy Evaluation Results of RPC (Ver.1.1)**

### **1. Purpose**

This document describes the geometric accuracy evaluation results of RPC (Ver.1.1) produced by the ALOS-PRISM RPC generating software of JAXA-EORC/RESTEC. The updated points from Ver.1.0 [1] are all concerning about exterior orientation parameters as follows;

- The cubic polynomial model is applied for PRISM sensor alignment orbit cycle trend instead of the linear model.
- The offset errors of onboard STT parameter calibration (performed at Sep.5, 2006) are changed.
- The offset errors of onboard STT parameter calibration (performed at Mar.22, 2007) are compensated.
- The range of PRISM sensor alignment long term trend is changed.

### **2. Method**

Same as Ver.1.0 [1].

### **3. Data**

#### 1) PRISM Standard Product L1B1

18 triplet data sets which were observed from Jun.20, 2006 through May 8, 2007 are used for the evaluation. Those data sets are sampled from the calibration data sets of JAXA-EORC/RESTEC geometric Cal/Val activities. The differences of the data sampling strategy from Ver.1.0 are as follows;

- Excluding the Check Out phase scenes observed before May 15, 2006
- Add the low latitude area scenes (Thai, Antarctica, Australia) to confirm the whole alignment accuracies along the sensor alignment orbit cycle trend
- Add the scenes observed after Mar.22. 2007 to confirm the STT offset errors compensation.

#### 2) Geometric models

The CCD alignment data (interior orientation parameters) is version 2 (Feb.23, 2007 release) which has already applied to the JAXA-EOC Standard Product processing. The PRISM sensor alignment (exterior orientation parameters) is version 2 which was calibrated at JAXA-EORC/RESTEC (briefly explained at section 1). No orientation

processing with GCPs is performed.

### 3) GCP

Reference GCPs and its mensuration results are provided by JAXA-EORC/RESTEC Cal/Val activities.

## 4. Results

The number of GCPs and errors stats (Bias, SD = Standard Deviation, RMS) for “RPC for each image” and “RPC for full image” of forward, nadir, and backward images are described at Table 1~6 as RPC geometric accuracies evaluation results. The units of errors are converted to meters from pixels by using the default pixel spacing of 2.5m.

Table 1 The evaluation results of “RPC for each image” - forward

Scene			FWD					
Date	Site	No. of GCP	$\Delta P$			$\Delta L$		
			Bias[m]	SD[m]	RMS[m]	Bias[m]	SD[m]	RMS[m]
2006/06/20	Okazaki	42	4.809	1.614	5.073	-5.937	1.478	6.118
2006/06/21	Thun (Swiss)	73	3.297	1.273	3.534	-0.353	1.467	1.509
2006/07/29	Himeji	15	1.787	1.313	2.218	-3.138	1.436	3.451
2006/07/29	Tokushima	28	1.386	0.988	1.702	-1.232	1.592	2.013
2006/09/04	Chenmai (Thai)	24	-0.825	1.301	1.541	-14.502	1.172	14.549
2006/09/25	Kyoto	24	-3.921	1.073	4.065	-0.776	1.529	1.714
2006/10/31	Saitama	63	1.341	1.588	2.079	3.454	2.159	4.073
2006/11/08	Kyushu	86	1.402	1.823	2.300	-2.090	2.110	2.970
2006/11/26	Paris (France)	13	-0.611	1.379	1.508	-6.000	2.469	6.488
2007/01/01	Showa (Antarctica)	14	2.260	0.764	2.385	-18.103	1.200	18.143
2007/01/14	Tsukuba	129	11.633	1.513	11.731	-8.488	1.941	8.707
2007/02/18	Brisbane (Australia)	6	-9.239	1.939	9.440	4.186	2.902	5.093
2007/03/01	Tsukuba	56	-1.975	1.852	2.708	6.633	2.057	6.945
2007/03/09	Aso-U	13	-3.061	1.367	3.352	6.027	1.854	6.306
2007/03/23	Hamana	24	-3.995	1.577	4.295	-4.687	2.081	5.128
2007/03/30	Tsukuba-L	9	-2.161	0.609	2.245	-10.250	1.242	10.325
2007/05/03	Saitama	213	2.583	1.442	2.959	0.666	1.693	1.819
2007/05/08	Hamana-U	19	4.022	1.120	4.175	3.405	1.365	3.668
RMS			4.358	1.407	4.579	7.252	1.822	7.477

Table 2 The evaluation results of “RPC for full image” - forward

Scene			FWD					
Date	Site	No. of GCP	$\Delta P$			$\Delta L$		
			Bias[m]	SD[m]	RMS[m]	Bias[m]	SD[m]	RMS[m]
2006/06/20	Okazaki	42	4.832	1.592	5.087	-6.182	2.018	6.503
2006/06/21	Thun (Swiss)	73	3.336	1.247	3.562	-0.609	1.907	2.002
2006/07/29	Himeji	15	1.647	2.073	2.647	-2.066	2.120	2.960
2006/07/29	Tokushima	28	1.410	2.309	2.705	-0.956	2.328	2.517
2006/09/04	Chenmai (Thai)	24	-1.083	1.357	1.736	-14.151	1.124	14.195
2006/09/25	Kyoto	24	-4.184	0.957	4.292	-0.824	2.154	2.307
2006/10/31	Saitama	63	1.649	2.561	3.046	3.562	3.637	5.091
2006/11/08	Kyushu	86	1.046	2.707	2.902	-1.951	3.204	3.751
2006/11/26	Paris (France)	13	0.695	1.415	1.577	-2.978	2.642	3.982
2007/01/01	Showa (Antarctica)	14	1.838	0.763	1.990	-17.730	1.191	17.770
2007/01/14	Tsukuba	129	11.735	1.598	11.843	-8.717	2.468	9.059
2007/02/18	Brisbane (Australia)	6	-9.055	1.904	9.253	2.175	2.957	3.671
2007/03/01	Tsukuba	56	-1.843	2.530	3.130	7.373	2.852	7.905
2007/03/09	Aso-U	13	-2.962	1.410	3.281	5.247	1.970	5.605
2007/03/23	Hamana	24	-4.171	2.119	4.679	-4.075	2.166	4.615
2007/03/30	Tsukuba-L	9	-1.755	0.596	1.854	-12.392	1.531	12.486
2007/05/03	Saitama	213	2.809	2.923	4.054	0.404	2.882	2.910
2007/05/08	Hamana-U	19	3.874	2.098	4.405	3.199	2.431	4.018
RMS			4.351	1.905	4.750	7.179	2.398	7.569

Table 3 The evaluation results of “RPC for each image” - nadir

Scene			NDR					
Date	Site	No. of GCP	$\Delta P$			$\Delta L$		
			Bias[m]	SD[m]	RMS[m]	Bias[m]	SD[m]	RMS[m]
2006/06/20	Okazaki	42	4.738	1.421	4.946	5.211	1.299	5.370
2006/06/21	Thun (Swiss)	73	1.981	1.600	2.547	8.035	1.757	8.225
2006/07/29	Himeji	15	1.556	1.276	2.013	4.672	1.648	4.954
2006/07/29	Tokushima	28	2.537	1.262	2.833	6.369	1.787	6.615
2006/09/04	Chenmai (Thai)	24	0.162	1.795	1.802	-5.092	1.073	5.203
2006/09/25	Kyoto	24	-0.093	1.300	1.303	-1.907	1.747	2.587
2006/10/31	Saitama	63	2.087	1.887	2.814	-0.948	1.728	1.971
2006/11/08	Kyushu	86	3.241	2.159	3.895	-3.148	2.217	3.851
2006/11/26	Paris (France)	13	-4.098	1.201	4.271	7.271	2.012	7.545
2007/01/01	Showa (Antarctica)	14	3.342	0.737	3.423	-4.861	0.658	4.905
2007/01/14	Tsukuba	129	7.007	1.697	7.210	-12.188	1.661	12.301
2007/02/18	Brisbane (Australia)	6	-6.652	2.197	7.005	-9.960	2.617	10.298
2007/03/01	Tsukuba	56	-2.194	1.702	2.777	1.104	1.909	2.205
2007/03/09	Aso-U	13	-3.418	1.431	3.706	0.132	2.000	2.004
2007/03/23	Hamana	24	-1.166	1.589	1.971	-5.322	1.262	5.470
2007/03/30	Tsukuba-L	9	-1.484	0.731	1.654	0.894	1.568	1.805
2007/05/03	Saitama	213	4.455	1.663	4.755	2.966	1.668	3.403
2007/05/08	Hamana-U	19	2.890	1.313	3.174	1.809	0.945	2.041
RMS			3.494	1.548	3.821	5.583	1.704	5.838

Table 4 The evaluation results of “RPC for full image” - nadir

Scene			NDR					
Date	Site	No. of GCP	$\Delta P$			$\Delta L$		
			Bias[m]	SD[m]	RMS[m]	Bias[m]	SD[m]	RMS[m]
2006/06/20	Okazaki	42	4.835	1.465	5.052	4.964	1.625	5.224
2006/06/21	Thun (Swiss)	73	2.067	1.564	2.592	7.865	2.125	8.147
2006/07/29	Himeji	15	1.830	1.351	2.274	4.956	1.974	5.334
2006/07/29	Tokushima	28	2.745	1.470	3.114	6.374	1.920	6.657
2006/09/04	Chenmai (Thai)	24	0.010	1.850	1.850	-5.682	1.824	5.968
2006/09/25	Kyoto	24	-0.256	1.233	1.260	-2.498	2.144	3.292
2006/10/31	Saitama	63	2.325	1.951	3.035	-0.889	1.796	2.004
2006/11/08	Kyushu	86	3.374	2.288	4.076	-3.109	2.298	3.866
2006/11/26	Paris (France)	13	-3.283	1.202	3.496	7.141	2.067	7.434
2007/01/01	Showa (Antarctica)	14	2.834	0.737	2.928	-4.734	0.656	4.779
2007/01/14	Tsukuba	129	7.225	1.776	7.441	-12.131	1.670	12.245
2007/02/18	Brisbane (Australia)	6	-6.465	2.178	6.822	-10.410	2.628	10.737
2007/03/01	Tsukuba	56	-1.958	1.674	2.576	1.145	2.081	2.375
2007/03/09	Aso-U	13	-3.238	1.444	3.545	0.178	1.922	1.931
2007/03/23	Hamana	24	-1.048	1.336	1.697	-5.539	1.498	5.738
2007/03/30	Tsukuba-L	9	-1.067	0.739	1.297	0.782	1.691	1.863
2007/05/03	Saitama	213	4.631	1.704	4.935	2.947	1.855	3.482
2007/05/08	Hamana-U	19	2.983	1.424	3.306	1.586	1.165	1.967
RMS			3.457	1.574	3.798	5.644	1.878	5.948

Table 5 The evaluation results of “RPC for each image” - backward

Scene			BWD					
Date	Site	No. of GCP	$\Delta P$			$\Delta L$		
			Bias[m]	SD[m]	RMS[m]	Bias[m]	SD[m]	RMS[m]
2006/06/20	Okazaki	42	2.591	1.454	2.971	-8.336	1.197	8.421
2006/06/21	Thun (Swiss)	73	1.396	1.367	1.954	-0.101	2.233	2.235
2006/07/29	Himeji	15	4.603	1.434	4.822	-2.929	1.685	3.379
2006/07/29	Tokushima	28	4.414	1.100	4.549	-0.576	2.276	2.348
2006/09/04	Chenmai (Thai)	24	2.771	1.582	3.191	-18.104	1.543	18.170
2006/09/25	Kyoto	24	-1.922	1.149	2.240	2.614	1.526	3.027
2006/10/31	Saitama	63	-0.399	1.768	1.812	-5.856	2.465	6.354
2006/11/08	Kyushu	86	-2.866	1.720	3.343	-8.130	2.091	8.394
2006/11/26	Paris (France)	13	-6.834	1.184	6.935	12.054	2.910	12.400
2007/01/01	Showa (Antarctica)	14	7.640	1.170	7.729	-26.820	0.918	26.835
2007/01/14	Tsukuba	129	11.524	1.579	11.632	-18.611	2.096	18.729
2007/02/18	Brisbane (Australia)	6	0.771	2.230	2.359	0.735	2.755	2.851
2007/03/01	Tsukuba	56	3.976	1.752	4.345	4.516	2.221	5.033
2007/03/09	Aso-U	13	4.056	1.419	4.297	6.014	2.170	6.393
2007/03/23	Hamana	24	-1.657	1.425	2.185	-0.802	2.059	2.210
2007/03/30	Tsukuba-L	9	-2.755	1.282	3.039	-9.387	2.414	9.692
2007/05/03	Saitama	213	0.148	1.770	1.777	-1.638	1.815	2.444
2007/05/08	Hamana-U	19	-1.456	1.455	2.058	0.552	0.742	0.925
RMS			4.424	1.517	4.677	10.201	2.034	10.402

Table 6 The evaluation results of “RPC for full image” - backward

Scene			BWD					
Date	Site	No. of GCP	$\Delta P$			$\Delta L$		
			Bias[m]	SD[m]	RMS[m]	Bias[m]	SD[m]	RMS[m]
2006/06/20	Okazaki	42	2.620	1.404	2.972	-8.441	1.210	8.527
2006/06/21	Thun (Swiss)	73	1.525	1.421	2.085	-0.207	2.191	2.201
2006/07/29	Himeji	15	4.711	1.515	4.949	-2.565	2.038	3.277
2006/07/29	Tokushima	28	4.568	1.373	4.770	-0.516	2.009	2.074
2006/09/04	Chenmai (Thai)	24	2.900	1.603	3.313	-18.017	1.548	18.084
2006/09/25	Kyoto	24	-1.657	1.160	2.022	2.628	1.513	3.033
2006/10/31	Saitama	63	-0.111	1.769	1.772	-5.623	2.425	6.124
2006/11/08	Kyushu	86	-2.658	1.749	3.182	-7.975	2.093	8.245
2006/11/26	Paris (France)	13	-6.368	1.181	6.477	12.423	2.985	12.777
2007/01/01	Showa (Antarctica)	14	7.627	1.170	7.716	-26.104	0.930	26.121
2007/01/14	Tsukuba	129	11.538	1.597	11.649	-18.735	2.170	18.860
2007/02/18	Brisbane (Australia)	6	0.900	2.200	2.377	-0.103	2.776	2.778
2007/03/01	Tsukuba	56	4.313	1.815	4.679	4.845	2.279	5.354
2007/03/09	Aso-U	13	3.997	1.339	4.216	5.704	2.105	6.081
2007/03/23	Hamana	24	-1.481	1.425	2.055	-0.852	1.897	2.080
2007/03/30	Tsukuba-L	9	-2.592	1.316	2.906	-9.367	2.328	9.652
2007/05/03	Saitama	213	0.347	1.818	1.851	-1.572	1.808	2.396
2007/05/08	Hamana-U	19	-1.281	1.577	2.032	0.545	1.068	1.199
RMS			4.399	1.547	4.663	10.108	2.037	10.311

## 5. Summary

It is confirmed that the bias errors of RPC follow the fitting accuracy of PRISM alignment trend model calibrated by JAXA-EORC/RESTEC. Especially in low latitude (south hemisphere) part, the bias errors tend to be worse (max approx.27m in Antarctica backward  $\Delta L$ ) than other parts and this trend is same as the JAXA-EORC/RESTEC validation results. The fitting accuracy of PRISM sensor alignment orbit cycle trend is still not sufficient at the low latitude part. This is still one of the main subjects to be fixed in JAXA-EORC/RESTEC Cal/Val activities. In some case, the bias errors are wrong (e.g. approx. 19m in 2007/01/14 Tsukuba backward  $\Delta L$ ) though the latitude is not low (in Japanese site). The cause is under investigation. The accuracy differences between “RPC for full image” and “RPC for each image” are almost same as Ver.1.0. If the relative accuracy between CCD units has priority over the ease of data handling with small number of RPC files, the “RPC for each image” is recommended. If not, the “RPC for full image is recommended.

## References:

- [1] The Geometric Accuracy Evaluation Results of RPC (Ver.1.0): RESTEC, April 4, 2007.