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STUDY ON POTENTIAL FISHING ZONES (PFZ) INFORMATION BASED ON S-NPP VIIRS AND HIMAWARI-8 SATELLITES DATA

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Abstract. Sea surface temperature (SST) data from S-NPP VIIRS satellite has different spatial resolution with SST data from Himawari-8 satellite. In this study comparative analysis of potential fishing zones information from both satellites has been conducted. The analysis was conducted on three project areas (PA 7, PA 13, PA 19) as a representation Indonesian territorial waters. The data used were daily for both satellites with a period time from August 2016 to December 2016. The method used was Single Image Detection (SIED) to detect thermal fronts. Method of mass center point for determining potential fishing zones coordinate point from result thermal front detection. Furthermore, an analysis of overlapping was done to compare the coordinate point information from both satellites. Based on data analysis that had been done, the result showed that potential fishing zones coordinate points of Himawari-8 satellite was mostly far from potential fishing zones coordinate point of S-NPP VIIRS. The coordinate points whose positionswere close together or nearly same from both satellites was only about 20 %. Differences in potential fishing zones coordinate positions occur due to the effect of different spatial resolutions of both satellite data and the size of the front thermal events that had high variability. The ideal potential fishing zones coordinate points information was probably a combination of the potential fishing zones coordinate points of S-NPP VIIRS and Himawari-8 by making two adjacent coordinate points to be a single coordinate point. Field validation testing was required to prove the accuracy of the coordinate point.

Keywords*: Potential fishing zones, S-NPP VIIRS, Himawari-8, satellite, coordinate points.*

1 INTRODUCTION

Indonesia is a maritime country because nearly two–third of its territory consists of waters. The sea waters has a lot of abundant natural resources and must be managed and utilized for the prosperity of Indonesian community. One of the potential natural resources was the fish abundance in the sea waters of Indonesia. Potential resources have not been optimally utilized to fill the needs of the society. To optimize the utilization of these resources can be assisted by utilizing remote sensing technology (Zainuddin 2011). The vast area of sea waters can be monitored or observed with using remote sensing satellites. The results of spatial and temporal monitoring from satellites could be analyzed to provide important information of resource management in the marine and fisheries sectors. Satellite data which have been widely used for marine resources applications are SST, chlorophyll-a and salinity (Zainuddin *et al.* 2013).

Currently there are many remote sensing satellites that actively monitor marine waters based on various parameters (Mugo 2011). Among of them

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are Terra/Aqua MODIS (Moderate Resolution Imaging Spectro radiometer), S-NPP VIIRS (Suomi National Polar-orbiting Partnership Visible Infrared Imaging Radiometer Suite), and Himawari-8 (Ditri *et al.* 2018). The analysis results of each parameter can be applied in various sectors. From Terra/Aqua MODIS satellite, for example, the data has been widely used for applications in marine and fishery sector (Hamuna *et al.* 2015). One of the parameters of remote sensing satellites which is generally used for fishery is SST (Natteshan and Suresh 2016) data can be used to determine potential fishing zones (Cayula and Cornillon 1992).

The potential fishing zone or PFZ information service from Remote Sensing Applications Center-LAPAN uses SST data from Terra/Aqua MODIS and S-NPP VIIRS. The data processing system to produce daily PFZ information is automatic in the software called PFZ Auto Processing with SST input data from Terra/Aqua MODIS and S-NPP VIIRS. When the S-NPP VIIRS satellite is still relatively new, the Terra/Aqua satellites have been operated for a long time and in the short term will stop operating. To anticipate the satellite change, it is necessary to develop a system to replace the using of Terra/Aqua MODIS data. So that LAPAN could keep the services on PFZ daily information continuously. One of the most ideal satellites is the Himawari-8 satellite since it has a wide coverage and it can monitor all sea waters of Indonesia in one coverage. In addition, Himawari-8 satellite has a very high temporal resolution of 10 minutes. Therefore as a first step of the system development, a study was conducted using SST data of Himawari-8 satellite.

The previous studies on potential fishing zones have been conducted, such as the determination of PFZ coordinate points by calculating the mass center point of the polygon area of the front thermal detection (Hamzah *et al.* 2016). Another study suggested that the fishing zone can be determined from the thermal front gradient using 3-4 daily sea surface imagery (Nammalwar 2013). The thermal gradient of the front is the tilt of the vertically sea levels at territorial of waters. To improve and further develop the previous results, this research is conducted to review information about potential fishing zones in some areas or projects of marine areas in Indonesia and the surrounding areas. Before using SST data of Himawari-8 satellite to be operationally, a detailed scientific research was conducted by comparing the data with the other satellite data of the same parameter, although with different spatial resolution. Furthermore, Himawari-8 data should also be analyzed to determine the feasibility to be applied on sea waters of Indonesia.

2 MATERIALS AND METHODOLOGY

This research used SST data from S-NPP VIIRS and Himawari-8 satellites. Spatial resolution of SST data from S-NPP VIIRS is 750 meters and Himawari-8 is 2000 meters. The spatial resolution of SST data is different. Ideally to compare the data should be done downscaling to equate the temporal resolution but in this paper is not done because of time constraints. The temporal resolution of both data is daily. We used SST daily data from August 2016 until December 2016 (100 days). The Research area location is denoted by PA which is marked with square of red line those are PA 6, PA 13 and PA 19. Selection of those Project Areas (PA) as a representation study location of Indonesian sea waters for the northern and southern parts and the west-central-eastern part of Indonesia. Those area of interest are shown in Figure 2-1.

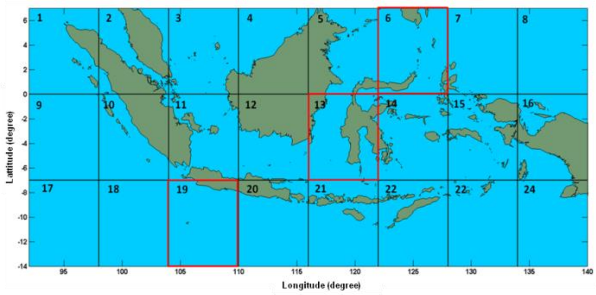

Figure 2-1: PA 6, PA 13 and PA 19 as research sites, see red boxes

The procedure in processing of SST data from S-NPP VIIRS and Himawari-8 to be PFZ daily information is used the flowchart in this research as shown in Figure 2-2.

Generally in determining potential fishing zones could be detecting from upwelling and front event based on satellite data (Simbolon and Tadjuddah 2008). In this study, Single Image Edge Detection (SIED) method is used to detect thermal front event from multi image with threshold value is 0.5 degree Celsius (Cayula and Cornillon 1995). The center method of polygon mass is used to determine the center point of the polygon area.

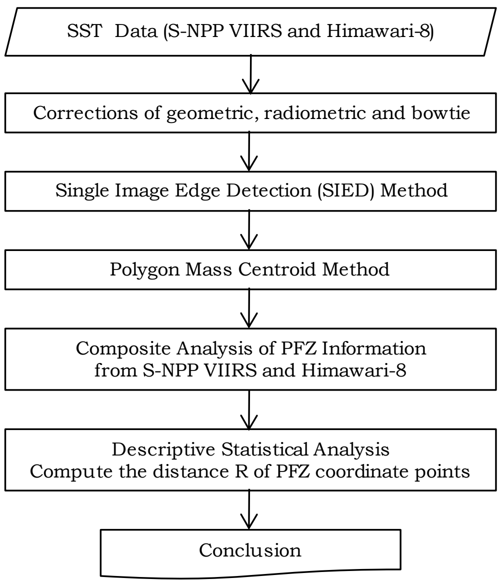

Figure 2-2: Flowchart of research

From the polygon area center point we obtained the PFZ coordinate point, consisting of longitude and latitude positions. Then the composite analysis is done to compare the position of PFZ coordinate points of S-NPP VIIRS and Himawari-8 satellites at the same time and date of recording data. The steps were done for PA 6, PA 13 and PA 19. The following descriptive statistical analysis was conducted by comparing the distance R between the coordinate points of S-NPP VIIRS and Himawari-8. Each PFZ coordinate point of S-NPP VIIRS has a coverage with radius 3.3 km from its center or diameter of coverage is 6.6 km (Marpaung *et al.* 2017). If two PFZ coordinate points to be combined has a diameter about 13.2 km. In this study, assumed if the distance R of the two coordinate points less than 10 km is called adjacent and if more than 10 km is far apart. In this research, PFZ coordinate points information from S-NPP VIIRS satellite is used as a reference to analyze PFZ coordinate points from Himawari-8 satellite.

3 RESULTS AND DISCUSSION

The results of data processing that have been obtained including the three studies area (PA 6, PA 13 and PA 19). The first results for the location study of PA 6 as a representation of sea waters areas in the north and east of Indonesia. Daily PFZ information in PA 6 is based on SST data from S-NPP VIIRS and Himawari-8 satellites that is shown in Figure 3-1. Data recording of 12 August 2016, 12.55 Indonesia Western Standard Time (IWST) for S-NPP VIIRS and at 13.00 Indonesia Western Standard Time (IWST) for Himawari-8. Difference of recording time data is 5 minutes. The red line is the result of the thermal detection of the front and the black points are the PFZ coordinates. The result is in Figure 3-1 descriptively indicates that the number of coordinate points based on S-NPP VIIRS satellite is 62 points and the Himawari-8 satellite has 65 points. There is no difference in the number of coordinate points but visually the spatial distribution of the coordinate points indicates the difference in coordinate position of the most coordinate points which is generated from the S-NPP VIIRS and Himawari-8 satellites. To find out the difference of coordinate point position, we analyzed the overlapping of the coordinate points derived from the both satellites.

To complete the analysis in comparing the daily PFZ information, PFZ coordinates of the S-NPP VIIRS and Himawari-8 satellites is made overlapping as shown in Figure 3-2.

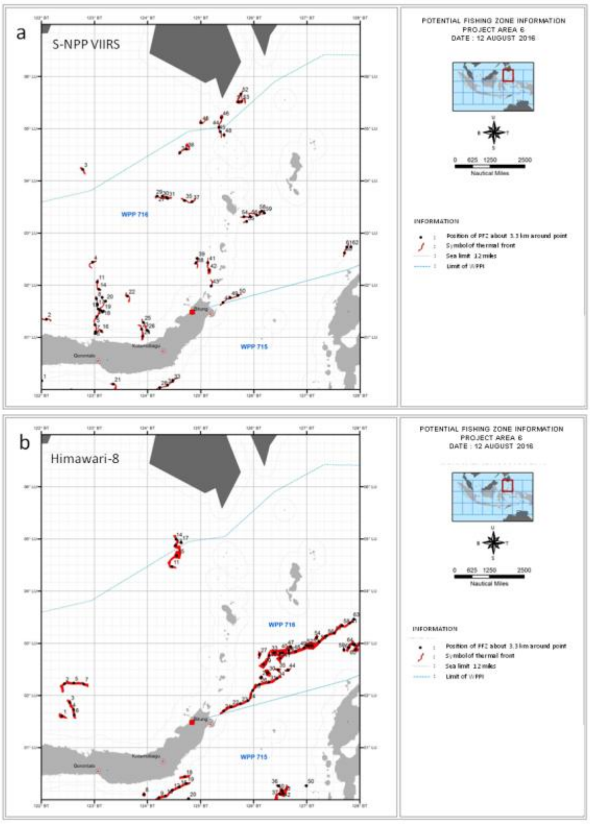

Figure 3-1: Daily of PFZ information on PA 6. (a) S-NPP VIIRS, and (b) Himawari-8

The blue star symbol is the PFZ coordinate point of the S-NPP VIIRS and the red plus symbol is the coordinate point of the Himawari-8 satellite. Basically, the position of the PFZ coordinate points of the two satellites are different. The result by computing of distance R between coordinate point of S-NPP VIIRS and Himawari-8, there are 9 PFZ coordinate points (about 15%) that it's positions are near each other with distance R less than or equal 10 km (Table 1 at attachments with blue font). Most of coordinate points (about 85%) are part with distance R greater than 10 km. In this study used as a reference is the PFZ coordinate point of the S-NPP VIIRS satellite. The utilization of SST data from S-NPP VIIRS satellites as representative has been validated and using operationally for PFZ daily information services in Indonesian territorial of waters. The result in Figure 3-2. is an example of comparison of PFZ daily coordinate points from S-NPP VIIRS and Himawari-8. Based on daily SST data processing from August 2016 to December 2016 at PA 6 (100 days with 2155 coordinate points), the position of the adjacent PFZ coordinate points is approximately 20% (431 coordinate points).

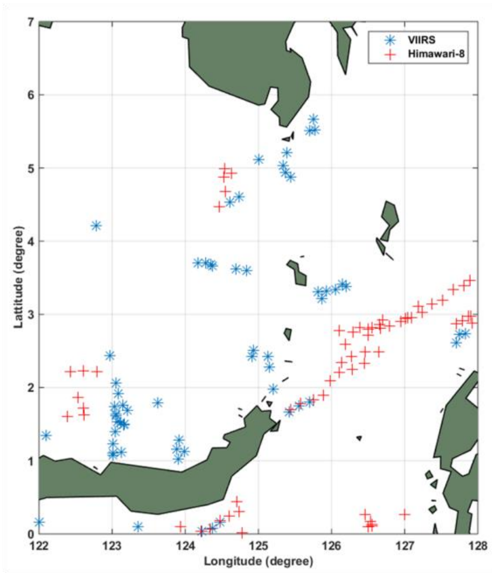

Figure 3-2: PFZ coordinate points of S-NPP VIIRS and Himawari-8 on PA 6 at 12 August 2016

The second result for region of interest is PA 13 as a representation of areas in the southern and central parts of Indonesia waters, which is the daily PFZ information at 17 October 2016 as shown in Figure 3-3. The data acquisition time is 12.57 IWST (S-NPP

VIIRS) and at 13.00 IWST (Himawari-8). Section (a) is the PFZ coordinate points information based on the SST data of the S-NPP VIIRS satellite, which consists of 54 points. Section (b) PFZ coordinate point information from Himawari-8 consists of 55 points. The number of coordinate points from both satellites are almost the same. Spatial distribution of PFZ coordinate points vary and it shows that there are several points are close but many points are far apart. It was expected that the coordinate position of points derived from Himawari-8 are closely to the points derived from S-NPP VIIRS. However, it is not a matter that the points are far apart since we aimed to select the best points fitted to PFZ. The position of the coordinate points from Himawari-8 are far apart from S-NPP VIIRS points, it will be a challenge to prove the accuracy of coordinate points to indicate the PFZ location.

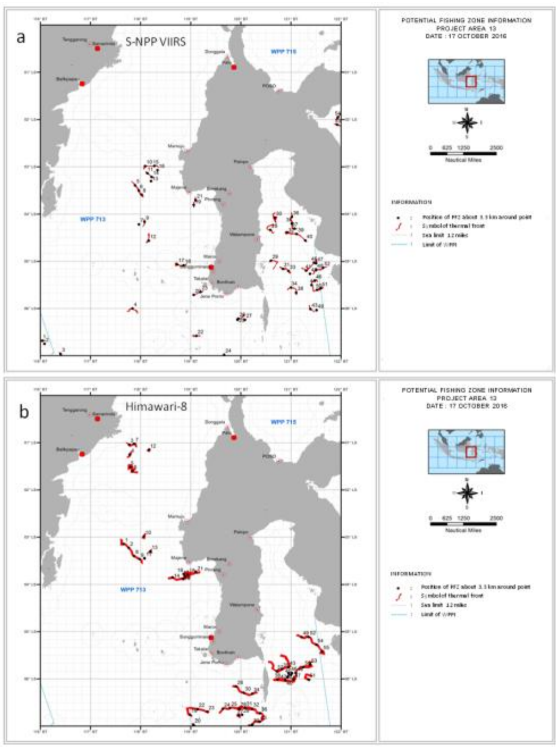

Figure 3-3: Daily PFZ information on PA 13 (a) S-NPP VIIRS, and (b) Himawari-8

The result of overlapping PFZ daily coordinate point information according to Figure 3-3 is shown in Figure 3-4. The result by computing distance R that there are 12 PFZ coordinates points (Table 2 in attachment with blue font) of S-NPP VIIRS and Himawari-8 is adjacent (about 22%) with R less than or equal 10 km. Most of the positions are scattered in PA 13 with a distance R greater than 10 km (about 78%). The result in Figure 3-4 is an example of comparison of PFZ daily coordinate points from S-NPP VIIRS and Himawari-8 at PA 13. The result of daily data processing from August 2016 to December 2016 (100 days), there are PFZ coordinate points 2340 resulted. The number of coordinate points with distance R adjacent is 585 coordinate points (about 25%). The position of the PFZ coordinate points of Himawari-8 which is far from the coordinate points of the S-NPP VIIRS requires the field trials of information. Further test can be conducted through representative field surveys in sea waters of Indonesia.

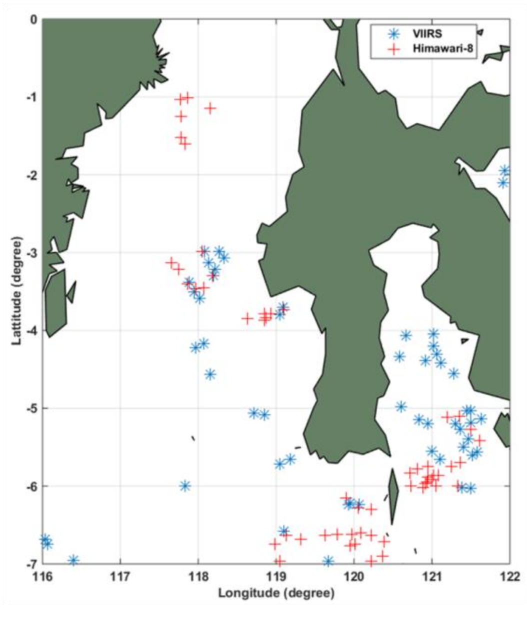

Figure 3-4: PFZ coordinate points of S-NPP VIIRS(*) and Himawari-8 (+) on PA 13 at 17 October 2016

The third results for the study location is PA 19, sea waters which represents the southern and western parts of Indonesia, the daily PFZ information at 29 December 2016 is shown in Figure 3-5. The data recording time is 13.25 for S-NPP VIIRS and at

13.00 IWST for Himawari-8. Based on the SST data of S-NPP VIIRS there are 46 PFZ coordinate points is shown in part (a) and from the SST data Himawari-8 there are 22 point coordinates PFZ is shown in part (b). The number of coordinate points from both satellites have a significant difference. This indicates the possibility of a dominant thermal front is small so could be detected by S-NPP VIIRS but could not be detected by Himawari-8.

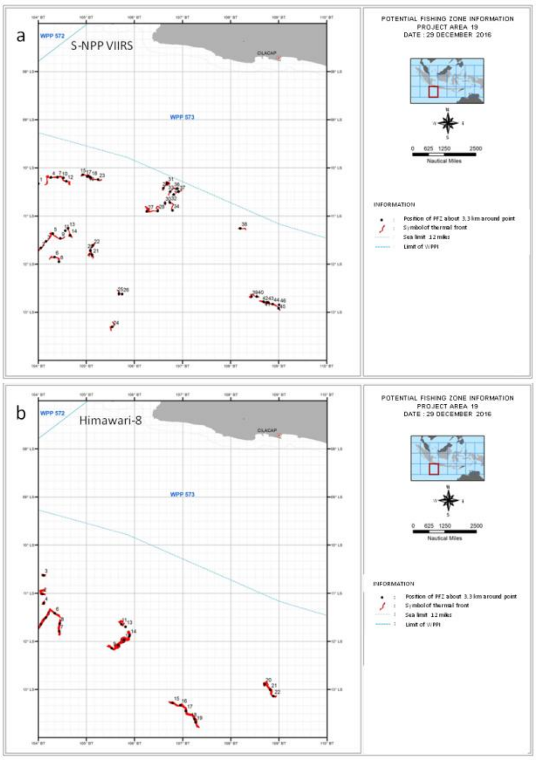

Figure 3-5: Daily PFZ information on PA 19 (a) S-NPP VIIRS, and (b) Himawari-8

This condition is possibly due to the influence of the large circulation and dynamics of the Indian Ocean. Spatial distribution indicates that the position of the coordinate point is generally different, only a small portion which is almost the same or close.

Based on the information of daily PFZ coordinate point in Figure 3-5, we generated the overlapping of PFZ coordinate points as shown in Figure 3-6. The result by computing distance R, there are 5 coordinate points (about 11%) are adjacent between S-NPP VIIRS and Himawari-8 (Table 3.1 in attachments with blue font). The result in Figure 3-6 is an example of comparison of PFZ daily coordinate points from S-NPP VIIRS and Himawari-8. Daily PFZ data processing results for PA 19 from August 2016 to December 2016 (100 days), there are PFZ coordinate points 2220 resulted. The number of coordinate points with distance R less than 10 km or adjacent is 333 coordinate points (about 15%). The S-NPP VIIRS satellite is more precise than Himawari-8 in ability to detecting thermal front events. Whereas Himawari-8 satellite can detect the thermal event front with a wider coverage. These results illustrate that the process of thermal fronts has various size. In general, SST in the southern ocean waters have a high variability (Fitrianah *et al.* 2016).

Table 3-1: Number of PFZ coordinate points in PA 6, PA 13, PA 19

No	PA	Number of PFZ points	Adjacent points number	Adjacent points percentage
1	6	2155	431	20%
2	13	2340	585	25%
3	19	2220	333	15%

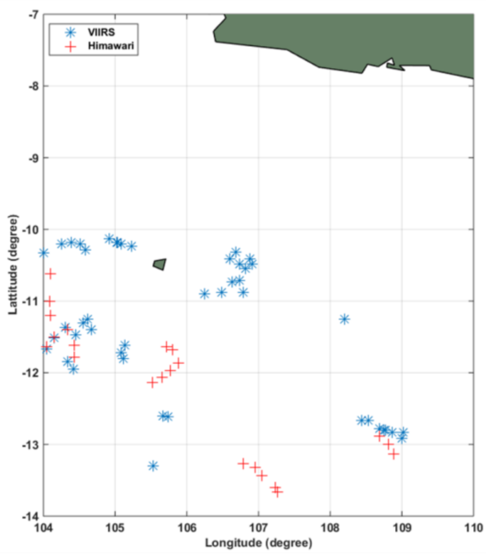

Figure 3-6: Overlapping the PFZ coordinate points of S-NPP VIIRS and Himawari-8 on PA 19 at 29 December 2016

Overall, the result of data analysis from August 2016 to December 2016 from S-NPP VIIRS and Himawari-8 satellites shown in Table 3-1.

Average of coordinate points with distance R from both satellites are adjacent is 20%. Most of the PFZ coordinate points from both satellites with distance R greater than 10 km is about 80%. The coordinate point of Himawari-8 which is remote from the coordinate point position of S-NPP VIIRS is necessary to test field validation to prove its accuracy. The possibility of significant difference results due to the effect of different spatial data resolution of both satellites (750 m and 2000 m). Based on the dynamics that is occurred at sea level, the thermal front has varying sizes, ranging from small to large sizes. The S-NPP VIIRS satellite is more precise in detecting thermal front events because of its higher spatial resolution. At the same time Himawari-8 satellite can detect thermal front events with larger spatial size according to lower spatial resolution. If the validation test results indicate that the PFZ coordinate point of Himawari-8 which is remote from the coordinate point of S-NPP VIIRS is accurate, thus the information of PFZ coordinate point daily is the coordinate point of S-NPP VIIRS which is combined with the coordinate point of Himawari-8. The adjacent of coordinate point is made as one PFZ coordinate point. The differences of data recording time for both satellites influent to amount and position of PFZ coordinate points.

4 CONCLUSION

Total of PFZ coordinate points with distance R adjacent or R less than 10 km, percentage is 20% (1349 points). Most of the coordinate point positions of the two satellites are far apart with distance R greater than 10 km, percentage is 80% (5366 points). For that its required field validation to prove the accuracy of the PFZ coordinate points from Himawari-8. Differences in PFZ coordinate positions occurred due to the effect of different spatial resolutions of both satellites data and the size of thermal front events that have high variability.

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ATTACHMENTS

Table 1: Values the PFZ coordinate points of S-NPP VIIRS and Himawari-8, R^2 and R on PA 13 at 12 August 2016

SNPP VIIRS		Himawari-8		R^2 (°)	R (°)	R (km)
Longitude (°)	Lattitude (°)	Longitude (°)	Lattitude (°)			
122,0056	0,1619	122,3889	1,6008	2,22	1,49	148,91
122,0925	1,3428	122,4342	2,2194	0,89	0,94	94,09
122,7786	4,2161	122,5314	1,8614	5,61	2,37	236,77
122,9644	2,4364	122,6036	1,7236	0,64	0,80	79,89
123,0094	1,2350	122,6072	2,2322	1,16	1,08	107,53
123,0106	1,0706	122,6186	1,6219	0,46	0,68	67,65
123,0147	1,1011	122,7975	2,2153	1,29	1,14	113,51
123,0336	1,7364	123,9331	0,0997	3,49	1,87	186,75
123,0450	1,3944	124,5286	4,8717	14,29	3,78	378,05
123,0508	1,6375	124,5414	4,9919	13,47	3,67	367,07
123,0517	2,0578	124,6011	0,2417	5,70	2,39	238,73
123,0528	1,6172	124,6339	4,9294	13,47	3,67	367,02
123,0689	1,5364	124,7022	0,4381	3,87	1,97	196,83
123,0797	1,9186	124,7328	0,3025	5,34	2,31	231,18
123,1119	1,5186	124,7736	0,0144	5,02	2,24	224,14
123,1247	1,1192	125,7500	1,8378	7,41	2,72	272,19
123,1425	1,7611	125,8914	1,8958	7,57	2,75	275,22
123,1514	1,4892	125,9844	2,0919	8,39	2,90	289,65
123,1658	1,4994	126,1100	2,2058	9,17	3,03	302,77
123,2086	1,6897	126,1111	2,7783	9,61	3,10	309,99
123,3519	0,0997	126,1397	2,3428	12,80	3,58	357,81
123,6211	1,7872	126,1864	2,5908	7,23	2,69	268,82
123,8864	1,1531	126,2675	2,4292	7,30	2,70	270,15
123,9042	1,0194	126,2875	2,2528	7,20	2,68	268,35
123,9189	1,2828	126,2953	2,7625	7,84	2,80	279,94
123,9925	1,1306	126,3908	2,8200	8,61	2,93	293,36
124,1781	3,7031	126,4442	2,3267	7,03	2,65	265,14
124,2289	0,0325	124,2172	0,0344	0,00	**0,01**	1,18
124,2775	3,7033	126,4597	2,4897	6,23	2,50	249,70
124,3517	3,6769	126,4619	0,2636	16,10	4,01	401,30
124,3739	3,6603	126,4958	0,1014	17,17	4,14	414,35
124,3742	0,0783	124,3394	0,0678	0,00	**0,04**	3,63
124,4725	0,1628	124,4711	0,1800	0,00	**0,02**	1,73
124,6058	4,5381	124,5211	4,5239	0,01	**0,09**	8,59
124,6950	3,6197	126,5017	2,8025	3,93	1,98	198,29
124,7322	4,6558	124,6508	4,6764	0,01	**0,08**	8,39
124,8347	3,5967	126,5036	2,7111	3,57	1,89	188,93
124,9131	2,4292	126,5317	0,1717	7,72	2,78	277,78
124,9325	2,5097	126,5492	2,8164	2,71	1,65	164,55
125,0092	5,1117	126,5525	0,1103	27,40	5,23	523,41
125,1322	2,4272	126,5528	0,1258	7,31	2,70	270,45
125,1550	2,2803	126,6442	2,4844	2,26	1,50	150,31
125,1981	1,9833	126,6603	2,8569	2,90	1,70	170,33
125,3411	5,0269	126,6644	2,8067	6,68	2,58	258,47
125,3664	4,9403	126,6947	2,9275	5,82	2,41	241,16
125,3889	5,2069	126,7889	2,8414	7,56	2,75	274,88
125,4194	1,6636	125,4381	1,7000	0,00	**0,04**	4,09
125,4378	4,8781	126,9494	2,9078	6,17	2,48	248,34
125,5544	1,7544	125,5794	1,7781	0,00	**0,03**	3,44
125,7000	1,8006	125,7500	1,8378	0,00	**0,06**	6,23
125,7058	5,5139	127,0072	2,9489	8,27	2,88	287,63
125,7544	5,6642	127,0381	2,9511	9,01	3,00	300,14
125,7706	5,5225	127,0942	2,9558	8,34	2,89	288,79
125,8136	3,3092	127,1839	3,1097	1,92	1,38	138,47
125,8625	3,2186	127,2386	3,0275	1,93	1,39	138,93
125,9300	3,3150	127,3722	3,1378	2,11	1,45	145,31
126,0544	3,3378	127,5211	3,1947	2,17	1,47	147,36
126,1464	3,4142	127,6661	3,3372	2,32	1,52	152,17
126,1950	3,3781	127,8139	3,3864	2,62	1,62	161,89
127,7044	2,6128	127,7892	2,9122	0,10	0,31	31,12
127,7517	2,7300	127,7322	2,8147	0,01	**0,09**	8,69
127,8272	2,7322	127,8689	2,9156	0,04	0,19	18,80
		127,8906	3,4600			
		127,9053	2,9769			
		127,9247	2,8789			

R is the distance of PFZ coordinate point between S-NPP VIIRS and Himawari-8

R^2 is quadratic of distance

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Table 2: Values the PFZ coordinate points of S-NPP VIIRS and Himawari-8, R^2 and R on PA 13 at 17 October 2016

SNPP VIIRS		Himawari-8		R^2 (°)	R (°)	R (km)
Longitude (°)	Lattitude (°)	Longitude (°)	Lattitude (°)			
116,0333	(6,6833)	117,6500	(3,1333)	15,22	3,90	390,08
116,0667	(6,7500)	117,7500	(3,2167)	15,32	3,91	391,38
116,4000	(6,9500)	117,7667	(1,0333)	36,87	6,07	607,25
117,8333	(6,0000)	117,7833	(1,2500)	22,57	4,75	475,03
117,8833	(3,3833)	117,8667	(3,4000)	0,00	0,02	2,36
117,9500	(3,5000)	117,9667	(3,4667)	0,00	0,04	3,73
117,9667	(4,2167)	117,8667	(1,0167)	10,25	3,20	320,16
118,0167	(3,5833)	117,7833	(1,5167)	4,33	2,08	207,98
118,0667	(4,1667)	117,8333	(1,6000)	6,64	2,58	257,73
118,0833	(2,9833)	118,0500	(2,9833)	0,00	0,03	3,33
118,1333	(3,1333)	118,0667	(3,4500)	0,10	0,32	32,36
118,1500	(4,5667)	118,1500	(1,1500)	11,67	3,42	341,67
118,2000	(3,3000)	118,1833	(3,3000)	0,00	0,02	1,67
118,2167	(3,2167)	118,6333	(3,8500)	0,57	0,76	75,81
118,2667	(2,9833)	118,8500	(3,8667)	1,12	1,06	105,86
118,3333	(3,0667)	118,8500	(3,7833)	0,78	0,88	88,35
118,7167	(5,0667)	118,8667	(3,8333)	1,54	1,24	124,24
118,8500	(5,0833)	118,9833	(6,7500)	2,80	1,67	167,20
118,9905	(3,8000)	118,9333	(3,7903)	0,00	0,06	5,80
119,0500	(5,7167)	119,0500	(6,9667)	1,56	1,25	125,00
119,0833	(3,7000)	119,1000	(3,7333)	0,00	0,04	3,73
119,1000	(6,5833)	119,1333	(6,6333)	0,00	0,06	6,01
119,1833	(5,6500)	119,3167	(6,6833)	1,09	1,04	104,19
119,6667	(6,9667)	119,6333	(6,6333)	0,11	0,33	33,50
119,9333	(6,2333)	119,7833	(6,6167)	0,17	0,41	41,16
119,9500	(6,2167)	119,9000	(6,1500)	0,01	0,08	8,33
120,0667	(6,2333)	120,0500	(6,2833)	0,00	0,05	5,27
120,5833	(4,3333)	119,9667	(6,6167)	5,59	2,37	236,51
120,6000	(4,9833)	120,0167	(6,7500)	3,46	1,86	186,05
120,6667	(4,0667)	119,9500	(6,7667)	7,80	2,79	279,35
120,8333	(5,1500)	120,0833	(6,6000)	2,67	1,63	163,25
120,9167	(4,3833)	120,2167	(6,6333)	5,55	2,36	235,64
120,9500	(5,2000)	120,2167	(6,9667)	3,66	1,91	191,28
121,0000	(5,5500)	120,2167	(6,3000)	1,18	1,08	108,45
121,0167	(4,2000)	120,3667	(6,9000)	7,71	2,78	277,71
121,0167	(4,0500)	120,3833	(6,7167)	7,51	2,74	274,08
121,0667	(4,3000)	120,7167	(5,8333)	2,47	1,57	157,28
121,1000	(5,6500)	120,7333	(6,0000)	0,26	0,51	50,69
121,1167	(4,4167)	120,8167	(5,7833)	1,96	1,40	139,92
121,2833	(4,5500)	120,8833	(6,0167)	2,31	1,52	152,02
121,3000	(5,2000)	121,3500	(5,1500)	0,00	0,07	7,07
121,3667	(5,2667)	120,9333	(5,9500)	0,65	0,81	80,91
121,3833	(6,0167)	121,3333	(6,0000)	0,00	0,05	5,27
121,4000	(5,5000)	120,9500	(5,7500)	0,27	0,51	51,48
121,4500	(5,0333)	120,9500	(5,8833)	0,97	0,99	98,62
121,4667	(5,4000)	121,0000	(5,9167)	0,48	0,70	69,62
121,5000	(5,0333)	121,0167	(5,8667)	0,93	0,96	96,34
121,5000	(5,1833)	121,5000	(5,2667)	0,01	0,08	8,33
121,5000	(6,0333)	121,0500	(6,0000)	0,20	0,45	45,12
121,5167	(5,6000)	121,0833	(5,8667)	0,26	0,51	50,88
121,5833	(5,5667)	121,2000	(5,1167)	0,35	0,59	59,11
121,6333	(5,1333)	121,2500	(5,7500)	0,53	0,73	72,61
121,9167	(2,1000)	120,9167	(5,9667)	15,95	3,99	399,39
121,9333	(1,9500)	121,3667	(5,7000)	14,38	3,79	379,26
		121,6167	(5,4167)			

R is the distance of PFZ coordinate point between S-NPP VIIRS and Himawari-8

R^2 is quadratic of distance

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Table 3: Values the PFZ coordinate points of S-NPP VIIRS and Himawari-8, R^2, R on PA 19 at 29 December 2016

SNPP VIIRS		Himawari-8		R^2 (°)	R (°)	R (km)
Longitude (°)	Lattitude (°)	Longitude (°)	Lattitude (°)			
104,0000	(10,3333)	104,0833	-11,0000	0,45	0,67	67,19
104,0500	(11,6667)	104,0500	-11,6333	0,00	0,03	3,33
104,1500	(11,5167)	104,1500	-11,5000	0,00	0,02	1,67
104,2500	(10,2000)	104,1000	-10,6167	0,20	0,44	44,28
104,3000	(11,3667)	104,3333	-11,4000	0,00	0,05	4,71
104,3533	(11,8100)	104,4333	-11,8053	0,01	0,08	8,01
104,3833	(10,1833)	104,1000	-11,2000	1,11	1,06	105,54
104,4167	(11,9500)	104,4333	-11,6167	0,11	0,33	33,37
104,4500	(11,4667)	105,5167	-12,1333	1,58	1,26	125,79
104,5167	(10,2000)	105,6500	-12,0667	4,77	2,18	218,38
104,5500	(11,3000)	105,7167	-11,6333	1,47	1,21	121,34
104,5833	(10,2833)	105,7667	-11,9667	4,23	2,06	205,76
104,6167	(11,2500)	105,8000	-11,6833	1,59	1,26	126,02
104,6667	(11,4000)	105,8833	-11,8667	1,70	1,30	130,31
104,9167	(10,1333)	106,7833	-13,2667	13,30	3,65	364,72
105,0167	(10,1833)	106,9500	-13,3167	13,56	3,68	368,18
105,0333	(10,1833)	107,0500	-13,4333	14,63	3,82	382,48
105,0833	(10,2000)	107,2333	-13,6000	16,18	4,02	402,27
105,0833	(11,7167)	107,2667	-13,6667	8,57	2,93	292,74
108,6833	(12,7833)	108,6833	-12,8833	0,01	0,10	10,00
105,1167	(11,8000)	108,8167	-13,0000	15,13	3,89	388,97
105,1333	(11,6167)	108,8833	-13,1333	16,36	4,05	404,51
105,2333	(10,2333)					
105,5333	(13,3000)					
105,6667	(12,6000)					
105,7333	(12,6167)					
106,2500	(10,9000)					
106,4833	(10,8833)					
106,6000	(10,4167)					
106,6333	(10,7333)					
106,6833	(10,3167)					
106,7333	(10,7167)					
106,7333	(10,4833)					
106,7833	(10,8833)					
106,8167	(10,5500)					
106,8833	(10,4167)					
106,9167	(10,4833)					
108,2000	(11,2500)					
108,4333	(12,6667)					
108,5333	(12,6667)					
105,0833	(11,7167)					
108,7500	(12,8000)					
108,7667	(12,8000)					
108,8667	(12,8333)					
109,0000	(12,9167)					
109,0167	(12,8333)					

R is the distance of PFZ coordinate point between S-NPP VIIRS and Himawari-8

R^2 is quadratic of distance