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INTERNATIONAL SYMPOSIUM ON REMOTE SENSING 2012
INTERNATIONAL CONFERENCE ON SPACE, AERONAUTICAL AND NAVIGATION ELECTRONICS

SONGDO CONVENSIA, INCHEON, KOREA

10~12 OCTOBER 2012

Organized by

- Korean Society of Remote Sensing Korea (KSRS)
- Chinese (Taipei) Society of Photogrammetry and Remote Sensing (CSPRS)
- Remote Sensing Society of Japan (RSSJ)
- Technical Committee on Space, Aeronautical and Navigation Electronics of IEICE
- Standing Committee of Environmental Monitoring from Space of East Asia (EMSEA)

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- Ministry of Environment
- Korean Federation of Science and Technology Societies
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In association with

- 28th Fall Symposium of KSRS
- 4th Workshop on Environmental Geospatial Information
- 21th Annual Workshop of EMSEA

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ISRS 2012 ICSANE
International Symposium on Remote Sensing

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The Korean Society of Remote Sensing
East Building #313
College of Life Science, Korea University,
Anam-dong, Seongbuk-gu, Seoul 136-713, Korea
Tel. +82-70-7558-0380, Fax. +82-2-3290-3470
E-mail ksrs@ksrs.or.kr
www.ksrs.or.kr

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Chair Person : Prof. Woo-Kyun Lee

Chair, Organizing Committee of ISRS2012
Executive Director, Korean Society of Remote Sensing

Wednesday, 10th October 9:20 ~ 9:35 - Room E (1F)

Welcome Messages

Welcome to ISRS 2012 ICSANE

***Prof.* Kyu-Sung Lee**
President, Korean Society of Remote Sensing

***Dr.* Shigeru Ozeki**
Chair, SANE Committee of IEICE

***Prof.* Liang-Chien Chen**
President, Chinese (Taipei) Society of Photogrammetry and Remote Sensing

***Prof.* Yasushi Yamaguchi**
President, Remote Sensing Society of Japan

Congratulatory Messages

***Prof.* Hajime Fukushima**
Co-Chair of EMSEA, Japen

***Prof.* Yuei-An Liou**
Co-Chair of EMSEA, Taiwan

***Prof.* Choen Kim**
Co-Chair of EMSEA, Korea

Plenary Session 1

Wednesday, 10th October 9:35 ~ 10:35 - Room E (F1 Floor)

Remote Sensing Applications to the Polar Regions

Yeadong Kim

Korea Polar Research Institute

Importance of monitoring in the polar regions has been increasing with the emerging concern for the global environmental change. It becomes extremely clear that coupling of ocean, atmosphere, cryosphere and biological processes should be considered and both Arctic and Antarctic need to be studied as entire systems for understanding the change. For instance the effects of global warming are greatly amplified and enhanced at high northern latitudes and stratospheric ozone depletion is clearly observed over the Antarctic during the austral springtime. The effect of surface temperature increase in the Arctic includes carbon release from thawing permafrost, a reduction in sea ice extent, ocean/atmospheric heat and gas (CO2, methane, ozone, etc.) exchange, surface albedo, coastal erosion and changes of the surface runoff that might effect the Arctic Ocean salinity and circulation. When considering Antarctica changes in global atmospheric circulation might alter both the mass balance of the ice sheet and the distribution of the highly seasonal sea ice concentration. The delicate marine ecosystem in the Southern Ocean is affected by local warming and by ultraviolet radiation from ozone depletion.

The growing awareness for the global change comes when we have the capability of acquire global view from satellites. Since most of the land and ocean in high latitudes are remote, inhospitable and spacious the space borne remote sensing is essential to study the regions. For many earth observing satellites missions are designed primarily for the study of tropical to mid latitudes. However these satellites rotate along near polar orbits we may recover data for polar research. By extracting data from polar orbiting satellites large geographic area can be covered for longer time scales in the polar regions.

Satellites with radio altimeter measuring ice sheet topography and ocean surface, Synthetic Aperture Radar(SAR) providing high resolution all weather image of ocean, land and ice surface and GRCAE measuring slight mass variation provide very promising data to detect and predict the mass balance with improving accuracy. More recently laser altimeter and InSAR data provide a high spatial resolution and accurate pictures of ice dynamic.

Despite of satellite data availability in the polar regions and advance of remote sensing technique we still do not have enough data in term of quantity and quality to provide prediction for the mass balance and sea ice characteristics. It is required that more data coverage in high latitudes with high resolution device such as SAR and LIDAR to improve our ability to predict effects of future climate changes. At the same time in situ measurement is necessary to increase accuracy of the satellite data even logistic challenges of the field work limit detailed experiment in the polar environment.

Surface Movements during the 2011 Great Tohoku-Oki Earthquake Detected ALOS/PALSAR

Manabu Hashimoto[1], Yo Fukushima[1], and Youichiro Takada[2]

[1] Disaster Prevention Research Institute, Kyoto University
[2] Kamitakara Observatory, Disaster Prevention Research Institute, Kyoto University

The Tohoku earthquake of March 11, 2011 caused a remarkably large deformation over Honshu, Japan. By analyzing ALOS/PALSAR data, we detected up to 5 m of eastward shift at the tip of the Oshika peninsula, and ~1 m subsidence along the Pacific coast. These deformations were caused by huge reverse slip on the plate interface near the trench axis. PALSAR also revealed deformations due to induced activities of local earthquakes of magnitude 6 or larger, volcanic unrests, and potential landslides. Furthermore, changes in intensity and coherence show good coincidence with areas of tsunami inundation and liquefaction.

Plenary Session 2

Wednesday, 10th October 10:50 ~ 12:10 - Room E (F1 Floor)

GEMS(Geostationary Environment Monitoring Spectrometer) onboard the GeoKOMPSAT to Monitor Air Quality and short-term climate change forcer in high Temporal and Spatial Resolution over Asia-Pacific Region

Jhoon Kim[1], Hanlim Lee[1], Rokjin J. Park[2], Seung Hoon Lee[3], Dai Ho Ko[3], Chang Keun Song[4],
Youdeog Hong[4], Sukjo Lee[4]; H.W. Seo[5], Jung Hun Woo[6], Young Joon Kim[7], Chul Han Song[7],
Jae Hwan Kim[8], Kwang Mog Lee[9], Jung-Moon Yoo[10], Seon Ki Park[10], Yong Sang Choi[10],
Myeongjae Jeong[11], Kelly Chance[12], Mijin Kim[1], Sangseo Park[1], Sang Soon Yong[4]

[1] Yonsei University, Seoul, Korea; [2] Seoul National University, Seoul, Korea; [3] KARI, Daejon, Korea;
[4] National Institute of Environment Research(NIER), Inchon, Korea;
[5] Ministry of Environment(ME), Gwacheon, Korea; [6] Konkuk University, Seoul, Korea;
[7] GIST, Gwangju, Korea; [8] Pusan National University, Pusan, Korea;
[9] Kyungpook National University, Daegu, Korea; [10] Ewha Womans University, Seoul, Korea;
[11] Gangreung Wonju National university; [12] Harvard Smithonian Center for Astrophysics

A scanning UV-Visible Spectrometer, GEMS (Geostationary Environment Spectrometer) is planned to be launched in 2018 onboard a geostationary satellite, GeoKOMPSAT(Geostationary Korea Multi-Purpose SATellite by KARI(Korea Aerospace Research Institute), together with AMI(Advanced Meteorological Imager) and GOCI-2 (Geostationary Ocean Color Imager). The main objective of the mission is to provide measurements of O_3, NO_2, SO2, HCHO and aerosol in high temporal and spatial resolution. The spectral coverage of GEMS is 300-500 nm with 0.6 nm resolution, and the spatial coverage is 5 S - 45 N and 75 E - 145 E with 7 km × 8 km resolution at Seoul, Korea. SNR is 720 and 1500 at 320 and 450 nm, respectively. Data retrieval algorithm are under the development by using DOAS(different optical absorption spectroscopy) and optimal estimation technique. Additional products are cloud height by using rotational Raman scattering and O_2-O_2 absorption, cloud fraction, aerosol optical depth, aerosol index, the height of aerosol layer by using O_2-O_2 absorption, and Lambertian equivalent surface reflectance.

Synchronous measurements of air pollutants and short-term climate forcer together with the meteorological variables and ocean color information are expected to contribute to better scientific understanding on the distribution and transboundary transportation of air pollution, and on interactions between meteorology and air chemistry in the Asia-Pacific region. This mission is expected to improve the accuracy of air quality forecasting and reduce current discrepancy between the model and observation. Optional IR payload to measure CO_2, CH_4 and CO are under the discussion with foreign collaborative partners. Furthermore, the constellation of the GeoKOMPSAT with Senteniel-4 by ESA and GEOCAPE by NASA in 2017- 2020 time frame can result in great synergistic outcomes including enhancing significantly our understanding in globalization of tropospheric pollution.

Initial Checkout Result of GCOM-W1(Shizuku)

Matsuaki KATO, Marehito KASAHARA, Toshitaka SASAKI, Norimasa ITO, Masaaki MOKUNO and Keizo NAKAGAWA
Space Applications Mission Directorate, Japan Aerospace Exploration Agency

GCOM-W1:Global Change Observation Mission 1st-Water, "SHIZUKU", was launched by HII-A Launch Vehicle No.21 on 17 May 2012 (UT) from the Tanegashima Space Center, and moved to the regular observation operation on 10 August 2012 (UT) after the initial checkout had been completed. This is the report of GCOM-W1 on-orbit checkout result.

Successful Launching of KOMPSAT-3 by H2-A Rocket

Hae-Jin CHOI
KOMPSAT-3 Program Manager, Korea Aerospace Research Institute

KOMPSAT-3 is an earth observation satellite which is operating at the altitude of 685km sun-synchronous orbit and has a sub-meter class EO camera. It was launched successfully with GCOM-W by the H2-A rocket on May 18th 2012 at Tanegashima Space Center. It was the first cooperation between Korea & Japan in the field of space business. KARI and MHI/JAXA have had many technical interface meetings and safety reviews for 2 years. The experience of KOMPSAT-3 launch operation will be shared, and the lessons & learned will be discussed. KOMPSAT-3 is providing 0.7m high-resolution optical images which are more precise than those from KOMPSAT-2. The images will be demonstrated as well.

The Next-Generation Infrared Space Astronomy Mission SPICA

Takao NAKAGAWA, Hideo MATSUHARA, Yasuhiro KAWAKATSU, and SPICA Team
Institute of Space and Astronautical Science, Japan Aeorspace Exploration Agency

We present the overview and the current status of SPICA (Space Infrared Telescope for Cosmology and Astrophysics), which is a mission optimized for mid- and far-infrared astronomy with a cryogenically cooled 3.2 m telescope. SPICA has high spatial resolution and unprecedented sensitivity in the mid- and far-infrared, which will enable us to address a number of key problems in present-day astronomy, ranging from the star-formation history of the universe to the formation of planets. To reduce the mass of the whole mission, SPICA will be launched at ambient temperature and cooled down on orbit by mechanical coolers on board with an efficient radiative cooling system, a combination of which allows us to have a 3-m class cooled (6 K) telescope in space with moderate total weight (3.7t). SPICA is proposed as a Japanese-led mission together with extensive international collaboration. ESA's contribution to SPICA has been studied under the framework of the ESA Cosmic Vision. The consortium led by SRON is in charge of a key focal plane instrument SAFARI (SPICA Far-Infrared Instrument). Korea and Taiwan are also important partners for SPICA. US participation to SPICA is under discussion. The SPICA project is now in the "risk mitigation phase". The target launch year of SPICA is 2022.

Closing Ceremony

Chair Person : Dr. Woo-Kyun Lee

Chair, Organizing Committee of ISRS2012
Executive Director, Korean Society of Remote Sensing

Friday, 12th October 12:30 ~ 13:00 - Room E (1F)

ISRS 2012 ICSANE Student Session Award

***Dr.* Chan-Su Yang**

Chair, Technical Committee of the ISRS 2012 ICSANE

***Dr.* Korehiro Maeda**

Chair, Technical Committee of the ISRS 2012 ICSANE

Closing of a Meeting

***Prof.* Kyu-Sung Lee**

General Co-Chair of ISRS 2012 ICSANE
President, Korean Society of Remote Sensing

***Dr.* Shigeru Ozeki**

General Co-Chair of ISRS 2012 ICSANE
Chair of SANE Committee of IEICE

Poster Session 1

Lounge

(12:10 ~ 14:00)

Room A

WA1 **ICSANE-A (Small Satellite)**

Chair: TBD

Room B

WB1 **Student Session (Data & Image Processing)**

Chair: WATARU TAKEUCHI, CHUNG–RU HO

Room C

WC1 **Student Session (SAR & LiDAR Application)**

Chair: FUAN TSAI, KOJI KAJIWARA

Room D

WD1 **Workshop on Environmental Geo-spatial Information (Environmental Information and Application)**

Chair: WOO–KYUN LEE

16:00-16:30 Coffee Break

Room A

WA2 **ICSANE-B (RADAR)**

Chair: TBD

16:40-17:00 **Coffee Break**

Room B

WB2 **Land Remote Sensing 1**

Chair: Duk–Jin Kim, Takuro Masuda

16:40-17:00 **Coffee Break**

Room C

WC2 **IIRC Special Session on Hyperspectral Sensing**

Chair: Kyu-Sung Lee

16:40-17:00 **Coffee Break**

Room D

WD2 **Workshop on Environmental Geo-spatial Information (Climate Change Impact and Adaptation)**

Chair: Doo-Ahn Kwak

Room A

WA3 **ICSANE-C (Navigation)**

Chair: TBD

Room B

WB3 **Microwave Remote Sensing**

Chair: Tsutomu Yamanokuchi, Hyung−Sup Jung

Room C

WC3 GOCI Special Session

Chair: Yu–Hwan Ahn

Room A

TA1 ICSANE-D (SAR 1)

Chair: Kazuo Ouchi

10:20-10:40 Coffee Break

Room B

TB1 — Student Session (KOMPSAT & Land Remote Sensing)

Chair: Hoonyol Lee, No–Wook Park

10:20-10:40 Coffee Break

Room D

TD1 — Student Session (Ocean Remote Sensing)

Chair: Naoto Ebuchi, Kyeong–ae Park

10:20-10:40 Coffee Break

Room A

TA2 — ICSANE-E (SAR 2)

Chair: TBD

Room B

TB2 — Atmospheric Remote Sensing

Chair: LUNG–CHIH TSAI, MASANORI NISHIO

Room D

TD2 **Ocean Application**

Chair: Hajime Fukushima, Ming–An Lee

10:20-10:40 **Coffee Break**

Poster Session 2

Lounge

(12:10 ~ 14:00)

Room A

TA3 ICSANE-F (System Components 1)

Chair: Shigeru Ozeki

Room B

TB3 Digital Photogrammetry & image processing 1

Chair: Liang–Chien Chen, Tae–Jung Kim

Room D

TD3 — KOMPSAT Special Session

Chair: Dong–Han Lee

Room A

TA4 — ICSANE-G (System Components 2)

Chair: Dr. Atsushi Tomiki: JAXA

16:40-17:00 Coffee Break

Room B

TB4 **Photogrammetry & image processing 2**

Chair: Sang–Hoon Lee, Im Pyeong Lee

16:40-17:00 **Coffee Break**

Room D

TD4 **DubaiSAT Special Session 1**

Chair: Moon–Gyu Kim

16:40-17:00 **Coffee Break**

Room A

TA5 **ICSANE-H (Communication Technology)**

Chair: Fujinobu Takahashi

Room B

TB5 **Land Remote Sensing 2**

Chair: Yasushi Yamaguchi, Sung–Dong Park

Room D

TD5 **DubaiSAT Special Session 2**

Chair: Moon–Gyu Kim

Room A

FA1 **ICSANE-I (Remote Sensing)**

Chair: TBD

10:20-10:40 Coffee Break

Room B

FB1 **GIS/RS Application 1**

Chair: Chi–Farn Chen, Naoto Ebuchi

10:20-10:40 **Coffee Break**

Room D

FD1 **Special Session on Planetary Remote Sensing 1**

Chair: Kyeong Ja Kim, Takao Kobayashi

Room A

FA2 **ICSANE-J (Science Mission)**

Chair: Akitsugu Nadai

12:00-12:30 Coffee Break

Room B

FB2 **GIS/RS Application 2**

Chair: Sayaka Yoshikawa, Peter T.Y. Shih

12:00-12:30 Coffee Break

Room D

FD2 — Special Session on Planetary Remote Sensing 2

Chair: Nobuyuki Hasebe, J. Alexis Rodriguez

ICSANE

Environmental Geospatial Information

THRESHOLD-VARIATION ANALYSIS OF MOD14 ALGORITHM MODEL USING MODIS DATASETS OVER TROPICAL AREA IN INDONESIA

[1,2] Bowo E. Cahyono, [2] Peter Fearns, [2,3] Brendon McAtee

[1] Department of Physics, Jember University-Indonesia (Jl. Kalimantan 25 East Java – Indonesia 68125, email: bowo_ec@yahoo.com); [2]Department of Imaging and Applied Physics- Curtin University-Australia (Kent Street, Bentley, WA 6102, email: P.Fearns@exchange.curtin.edu.au); [3]Satellite Remote Sensing Services- Western Australian Land Information Authority (Landgate) –Australia (65 Brockway Road, Floreat WA 6014, email: brendon.mcatee@landgate.wa.gov.au).

ABSTRACT: The Moderate Resolution Imaging Spectroradiometer (MODIS) which is equipped with thermal bands for measuring the temperature of the earth's surface has been widely utilized in fire detection activities. Of the fire detection algorithms developed for MODIS the most commonly applied algorithm principle is the contextual algorithm. Such global algorithms for fire detection can be customized for local or regional areas to improve the accuracy of fire detection. For this reason there has been substantial research performed to apply and assess how accurate the global algorithm results are in certain local or regional areas. In principle, fire pixels detection is base on dichotomizing assessed imagery pixels values using certain threshold value. Determining the best threshold value leads to optimal detection results and minimum errors. This paper analyses the impact of variation of T_4 and ΔT threshold values on outputs from the MOD14 algorithm using MODIS data within different seasons in Indonesia. Analysis is conducted by analysis of the sensitivity of detected Fire Hotspots (FHS) to changes of T_4 and ΔT and also through statistical calculations. The results show that the sensitivity of the MODIS FHS algorithm is different between dry and wet seasons which indicates the need for different threshold values to be applied to optimise fire detection using MODIS within dry and wet seasons.

KEY WORDS: MODIS, contextual-algorithm, threshold, seasons, tropical-area.

1. INTRODUCTION

1.1. Background

Fire plays a significant role within most terrestrial vegetation alteration and land cover change. During biomass burning gases and particulate matter are released into the atmosphere and contribute to atmospheric chemical reactions and physical processes. Biomass burning with the release of gases and aerosols potentially makes a significant contribution to climate change. Also, the change in the balance of an ecosystem due to the impact of burning biomes can affect the resilience of the ecosystem to adapt to climate change. Hence monitoring fire occurrence is significant in managing the impact of climate change. Scientists and policy decision makers in many countries are directing resources to the study of the effect of forest burning on the environment.

Indonesia government agencies which monitor fire using different satellite-based fire detection algorithms include the ASEAN Specialised Meteorological Centre (ASMC) in Forestry Ministry and Indofire in National Institute of Aeronautics and Space (LAPAN). Because agencies apply different methods in different locations and times based on their governmental roles, they often report different results in a number of detected Fire Hotspots (FHS). Validation activities are therefore important to estimate the correct number of FHS.

Fire detection activities are performed not only in Indonesia but also in many areas of the world. NASA's science teams extensive research on fire detection issues has led to the development of an algorithm called 'MOD14 algorithm' which is applied globally but gives differing results on a regional basis. Researchers around the world continue to assess the accuracy of MOD14-based FHS detection method in their own areas to evaluate errors of omission and commission.

The most reliable data to validate results of recognised FHS from satellites is ground truth data. The Forestry Ministry as the authorised Indonesian government agency has this task. It collects fire data from local forestry agency (BKSDA) and also performs its own field validation. Ground data collection requires considerable effort in terms of funding, facilities, manpower, and time. Hence ground data are limited and in order to have confidence in FHS detection results other validation methods are required. As an example, LAPAN validates FHS detection using a combination of ground data and high resolution satellite imagery such as Système Pour l'Observation de la Terre (SPOT) imagery for which they run their own satellite receiver in Pare-Pare Sulawesi.

The LAPAN approach did not provide a definite estimate of FHS detection accuracy reportedly due to some environmental factors. Here, haze and cloud were reported as a key factor influencing the accuracy of fire detection (Vetrita, Haryani, and Komaruddin, 2012).

Additionally, another environmental factor such as precipitation was reported as one other factor which obscured fire occurrence detection in the Brazilian Amazon region (Schroeder, Csiszar, and Morisette, 2008). Precipitation in Indonesia varies considerably between dry season and wet season. A high level of precipitation is commonly encountered in the wet season and there is typically little rain in dry season.

To account for environmental influences the statistical analysis of suitable temperature threshold values within the fire detection algorithm is another approach which has been used to investigate the accuracy of FHS detection. Liew et.al. (2006) proposed method to retrieve the optimal thresholds for fire detection from a statistical point of view. This paper studies the impacts of applying various thresholds in the MOD14 algorithm using MODIS datasets over Indonesia by considering the sensitivity of FHS detection in the dry and wet seasons.

1.2. Fire detection principle

Most satellite-based or airborne remote sensing instruments are designed to measure a combination of surface and atmospheric signals in the visible and near infra red spectrum. To gain better result in fire and burned scars monitoring from a fire detection perspective, the MODIS instrument aboard the Terra and Aqua satellites were designed to have improved satellite-based FHS detection capabilities by the addition of more channels in the thermal band compared its predecessor instruments, NOAA-AVHRR (National Oceanic and Atmospheric Administration - Advanced Very High Resolution Radiometer).

In satellite remote sensing especially for passive remote sensing sensors, fire existence can be detected by thermal infra red sensors because most of the fires emit radiation in this range (3 – 12 μm) so satellite-base sensors for fire detection purposes are focus on this wavelength range.

Each channel of the satellite-based sensor has different sensitivity to land surface thermal properties. The radiated energy of fires can be derived from a combination of several channels. Kaufman, Kleidman, and King (1998) found in their simulation that the best channel to derive fire radiated energy is the 3,9 μm channel because the relationship of the fire radiated energy and the apparent temperature is least sensitive to the mixture of temperature in the fires. They prove that the greatest contrast images between the fire pixel and the surrounding pixels is shown from the 3,9 μm channel.

Accordingly, the most commonly used wavelength bands for fire detection are 4 μm and 11 μm. The 4 μm channel is highly sensitive to the radiated energy emitted from fire, so it has a key role in remote sensing of fire. Brightness temperature calculated from this channel is notated as T_4. Additionally the 11 μm channel on is not as sensitive as the 4 μm channel but it is less influenced by surface reflection. Thus fire detection algorithms consider differences in sensed radiation from both channels.

1.3. Contextual Algorithm

Giglio, et.al (2003) performed fire detection using a contextual algorithm that exploits the strong emission of mid-infrared radiation from fires. The algorithm examines each pixel of the MODIS swath, and ultimately assigns to each one of the following classes: missing data, cloud, water, non-fire, fire, or unknown. The algorithm uses brightness temperatures derived from the MODIS 4 μm and 11 μm channels, denoted by T_4 and T_{11}, respectively.

2. RESEARCH METHODS

The first step in contextual algorithm is a screening test. All examined pixels which cannot pass this test have no chance to go into next steps and they are automatically classified as non fire pixels. The focusing of this research is on the screening step due to its very significant role in the fire detection algorithm. All pixels are examined where their value sit above the determined threshold value of T_4 and $\Delta T = T_4 - T_{11}$.

This paper analyses FHS detection in respect to the variation of the T_4 and ΔT threshold values in the MOD14 algorithm using MODIS datasets over Indonesia. Curves of detected FHS numbers are constructed as the various values of T_4 and ΔT. Threshold values are changed in order to investigate the sensitivity of MODIS FHS detection in the dry and wet seasons over Indonesia.

This investigation has been conducted by partitioning MODIS data into two groups. The first group is MODIS data acquired within the dry season (Aug – Sep 2009) and the second group is datasets from the wet season (Feb 2010). The performance of the MOD14 FHS algorithm is evaluated for each group using graphs of FHS sensitivity and a T-test statistical analysis.

3. RESULTS AND DISCUSSIONS

This paper is concerned only with T_4 and ΔT parameters as they are used on both day and night time MODIS datasets. Iterating the various values of T_4 and ΔT threshold produce the graphs shown in Figure 1 and Figure 2.

Considering the shape of the curves in both figures it is clear that FHS detection is more sensitive to the change in T_4 threshold values rather than ΔT changes. This is used as a basis for further analysis into whether there is significant seasonal influence on the sensitivity of the fire detection algorithm over Indonesia.

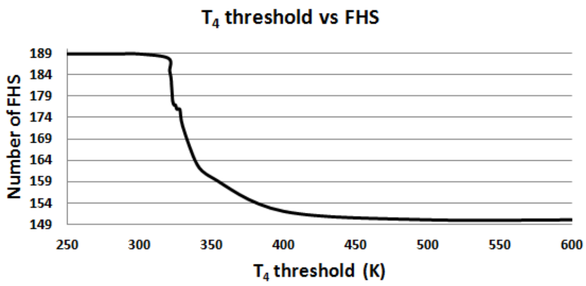

Figure 1. Plot of T_4 threshold values (K) and detected FHS number

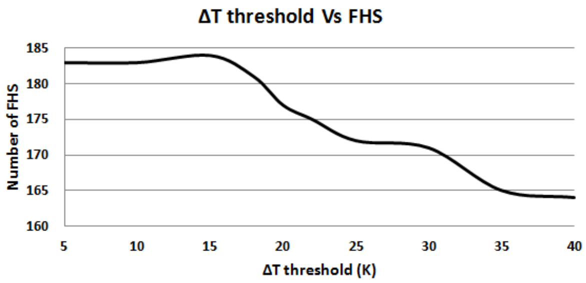

Figure 2. Plot of ΔT threshold values (K) and detected FHS number

Indonesia has only two seasons - the. dry season and the wet season. In the dry season precipitation is very low and most vegetation suffers from drought and is prone to be burning. Naturally, the dry season has a higher average temperature than the wet season.

Investigation of seasonal impacts to fire detection has been conducted by changing threshold values then recompiling the MOD14 algorithm. By normalising the detected number of FHS in dry and wet season separately as percentages, a variation of the T_4 threshold values results in different sensitivity curves as shown in Figure 3 and Figure 4.

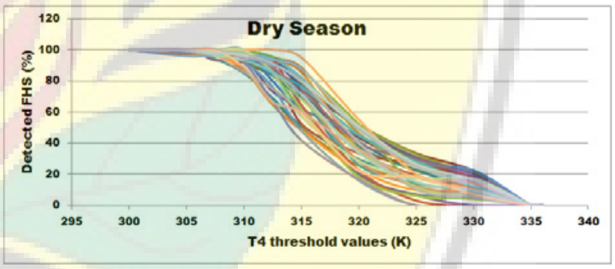

Figure 3. Dry season plot of T_4 threshold values (K) and relative detected FHS (%)

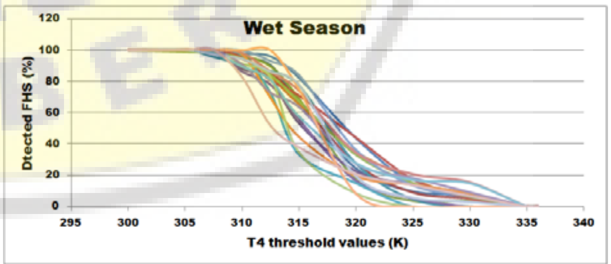

Figure 4. Wet season plot of T_4 threshold values (K) and relative detected FHS (%)

The difference in the curves between the dry season and wet season data is clearly seen by calculating average number of fires detected in each season. The average values from the curves in Figure 3 and Figure 4 is shown in Figure 5.

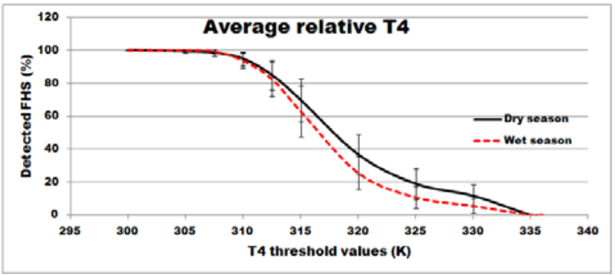

Figure 5. Plot of T4 threshold values (K) and average of relative detected FHS (%)

Figure 5 shows that the MOD14 algorithm displays different sensitivity when it is applied to dry season data compare to wet season data. It indicates that to obtain a certain level of FHS detection sensitivity a higher T_4 threshold value is required in the dry season compare to the wet season.

To confirm the claim above, a statistical analysis was performed to the dry and wet season data groups. The analysis of T-test is mostly used to assess the means differences between two groups (Moore and McCabe, 2003). The T-test is applied to the FHS data from Figure 5 and the results are shown in Table 1.

Table 1. Results of T-test analysis

	Mean	Std. Deviation	Significance (2-tailed)
Dry season	55.8391	42.57335	.001
Wet season	52.7209	44.27578	.003

The results of the T-test analysis show that the dry season data has a statistically significant higher mean value than the wet season data. It indicates that for a given threshold of T_4, the MOD14 algorithm possesses higher sensitivity for dry season datasets compared to the other season. The 2-tailed significance values from the T-test analysis from both seasons sit under 0.05 (Table 1) which confirms that both datasets display significantly different means of the population (Pallant, 2011). We can interpret this as meaning that there is a change in the sensitivity of the MOD14 algorithm to choice of T_4 threshold between the dry and wet seasons and that the accuracy of FHS detection is also significantly different between dry and wet season as a result. Accordingly we find that in the wet season a lower T_4 threshold value is required to gain the same accuracy in FHS detection as dry season. This is a logical finding because increased rain in the wet season leads to decreasing environmental temperature and the temperature of fires are also lower as a result.

4. CONCLUSSIONS

The screening test is the first step of the contextual fire detection algorithm for MODIS and has two significant parameters namely T_4 and ΔT, of which T_4 affects the accuracy of FHS detection significantly more than ΔT. The MOD14 algorithm shows different sensitivity to the choice of T_4 threshold between dry and wet season in Indonesia based on the characteristics of the curves of detected FHS. Statistical analysis indicates that the dry season fire detection algorithm requires a higher T_4 threshold value compared to the wet season in order to provide results at the same level of accuracy. We believe this to be due to the lower environmental temperature characteristic of the wet season which exhibits significantly higher rainfall.

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