Team KOREA

Korea Aerospace Research Institute (KARI)

2022

Oct 2022

Hello girls,

I have been very happy to organize the first edition of SHE SPACE KOREA this year and to welcome you all to our first-year program. The beginning of She Space Korea goes back to July 2019, when Prof. Shimrit Maman visited Korea as lecturer in the KARI International Space Training Program. She introduced the SHE-SPACE initiative in Israel and suggested us to join. I was very interested but it seemed to be a “mission impossible” with high school students in Korea because you are very busy to prepare for the college entrance exam and an out-of-school program is something, only very motivated students would consider.

With great efforts of KARI colleagues, Ms. Soyoung Chung, Mr. Jeong-Won Lee, and Ms. Seok-Hee Lim, SHE SPACE KOREA was able to be set up as an official education program funded by the Ministry of Science and ICT. Also, we received great support by Dr. Yeji Choi and Dr. Eunbin Kim from SI Analytics (private company specialized in AI for earth observation), who joined us cheerfully. After all these preparations, we were delighted to have you participate in the program.

Due to the far distance between two schools and different school schedule, we couldn’t have in-person meeting all together but mixed programs with common orientation as well as lectures on-line and individual team research projects off-line. Fortunately, we could have a Korea-Israel camp this year. I realized that you were all pleased to have the opportunity to make new friends and communicate with each other. Something which should be normal for young people but was limited for the last two and half years due to the global COVID-19 pandemic.

I sincerely hope you had a great experience and keep fond memories of our SHE SPACE program. Wishing you all the best in your future endeavors.

Best regards,

Dr. (Catharina) Hyun-Ok Kim

Team Leaders

(Catharina) Hyun-Ok Kim

Hi, my christian name is Catharina. I majored in geo-information and remote sensing focusing on urban ecology and environmental planning and received Ph.D. degree in engineering from Berlin University of Technology (TU Berlin), Germany in 2007. After finishing postdoctoral work at TU Berlin I joined the Korea Aerospace Research Institute (KARI) in 2010. I worked as Program Board member of the Group on Earth Observation (GEO) in 2016 and have been participating as executive secretariat member in the International Charter on Space and Major Disasters since 2014. My current main research project is to develop the earth observation application system using constellation of small satellites in the scope of South Korea's national space program. I'm also motivated to extend the role of women scientists in the society, so that I act as a board member of KARI's women advisory committee and as a board member of the Association of the Korea Woman Scientists and Engineers (KWSE).

Yeji Choi

My name is Yeji Choi and I am a research scientist at AI research center in SI Analytics. My research interests are weather and climate observations from space. I graduated from Yonsei University in Seoul, Korea and majored in atmospheric science. I was glad to be a tutor for this project and I really enjoyed teaching remote sensing to Daejeon Science High School students. It was a great opportunity for me to meet the next generation who will lead the future of Korean science. They were great students and I hope this project helped them expand their knowledge of climate change and satellite observations.

Eunbin Kim

Hi, I am Eunbin Kim, and I am a research scientist at SI Anylytics. I majored in astronomy and currently doing a research in climate change using carbon observation satellite data. While doing research, I thought it would be good to share this knowledge and experience. Finally, I was so happy to be able to participate in Shespace and share the climate change issues with women. I believe that what you learned and experinced in this project will be a good foundation for bringing awareness of climate change and improving the condition of our planet for the future generation.

Staff

Soyoung Chung

Hi, my name is Soyoung. I am a senior researcher at KARI. I have academic background in Space Engineering and Science & Technology Policy. At KARI, I have been working as a specialist in space policy and research strategy. I am a member of KARI's Space Education Committee and International Cooperation Committee. I am also a member of KARI Women's Association. As an advocate of international cooperation and women's participation in the space sector, I became a fan of She Space. Being part of the team this year was both exciting and rewarding.

(Sonya) SeokHee Lim

Hi, everyone. I am Sonya SeokHee Lim, a principal researcher from KARI. I have studied in Chemical Eng. at Inha University and graduated from Moscow State Technical University named after Bauman in Liquid Rocket Engine Faculty. I have made the Launch Vehicle such as Naro and Nuri which was successfully launched this year. And I am interested in not only rocket but also the beyond it. I have over than 20 years of teaching Space technology including space launch and space ecosystem and sharing my experience. I am a member of Space Education Committee in KARI and a secretory of KARI Women's Association. I love to meet the next generation who has passion and do their best to find their ability in space sector. So I joined the She Space International 2022 in Korea as a facilitator and could find why I should keep making space transportations well as a provider in space ecosystem for my future customer!. It was great honor for me to participate in SheSpace program, to think many kinds of diverse issues to solve in my life and to meet the shining future potential colleagues in advanced.

Jeong Won Lee

Hi, I am a principal administrator at KARI Academy. I am also the project manager for She Space Korea. I studied Business management at Chungbuk National University and received Masters in Intellectual Property Law at Pai-Chai University. I joined KARI in 1996 and devoted the last ten years of my career in space education and outreach for students and general public. From 2013 to 2019, I operated Space Science Museum at NARO Space Center as a manager and developed many space education and outreach programs for the students.

Participant Girls

From Goyang Global High School

Hi, I'm Yoonseo Jeong. I am from Goyang Global High School and this is my senior year. I love sports climbing and math, I also like to explore places I've never been before near my town. I'm most interested in agriculture and the climate crisis that I want to have a job related to it some day. I joined the SheSpace program since I wanted to know more about the use of earth observation satellites. I also wanted to expand my knowledge to new areas. I'm really grateful that I have been a part of SheSpace and learned a lot from it.

My name is Nankyung Yun. I am 19 years old and I attend Goyang Global High School. I was always interested in lots of things. So, I don't know what I want to be in the future as an adult, however, I always dreamed about helping or giving happiness to others with the work I will do. Because of that, I am now trying lots of things to find the best path for me. I like listening to music, reading books, crafting and taking photos·videos and editing them. I joined She Space because my most considerable interest now is doing things with data. I wanted to learn how to manage various data. Also, as the satellite is an excellent data-gathering method, I wanted to learn about satellites and how the gathered data is used.

Hello, my name is Yuna Lee. I am 17 years old and I attend Goyang Global High School. Joining SheSpace, I learned a lot and expanded my horizons. When I am older, I want to be CTO, Chief Technical Officer, and SheSpace was the opportunity to learn about the space technology and the space industry. I love playing sports, especially dodgeball and badminton. I also finished second in the school badminton tournament. In my free time, I draw pictures. These days, I usually draw on my iPad, but I also like to draw on paper with watercolor.

My name is Seohee Lim, and I attend Goyang Global High School in Korea. I like geography and I'm interested in the urban environment where we live. Taking a spatial data analysis class at school, I found out that satellite imagery information is helpful for managing urban problems. I participated in She Space project to get experience of satellite imagery analysis. I was able to some spend quality time with members of She Space. And taking this opportunity I could think about data collection and utilization using satellite. I want to thank all of the She Space members.

My name is Jaeyun Jung. I'm 18 years old, and I attend Goyang Global High School. Until now, I've had various dreams such as being a writer, announcer, and lawyer. But I realized that I'm interested in international issues the most and I do want to interact with people around the world. So now my dream is to be a diplomat. I hope to spend my life on the world stage not trapped in my community. However, it was hard to figure out how to start. Even I wondered if I really wanted to be a diplomat, sometimes. In this confusion, She-Space activities became an opportunity to be hopeful about my future. The world I faced through She-Space was wider than I thought before, and what I have to do and what I can do was infinite. Now I want to be a 'space' diplomat who makes cooperation with other countries in space development for Korea. All people I met during the She-Space and everything I experienced there are precious to me, and I dare say it was the best experience I've ever had in my life.

My name is Jiwoo Kim. I am 19 years old in Korean age and attending Goyang Global High School. I've had many different experiences and am still trying to do it. Through those processes, I am learning about my aptitude. I like reading books, I enjoy playing group sports and sportsmanship a little more, and I love science very much. And it's always been my dream to work in a space or sea job. Thus, the title "She Space" was fascinating to me. She Space activities provided me with more information about what I would do if I achieved my dream and an opportunity to get to know them. I set my goal more clearly with the help of She Space.

My name is Chaeyun Lee and I attend Goyang Global High school. I like to read books and want to be a teacher. The SheSpace program was a series of surprises for me. I never thought I could handle satellite images with an interest in aerospace. Also, I never expected I will visit the space center or make friends from Israel. As I did new challenges that I didn't think I could do, I was able to improve myself day by day. Using this experience as a good stepping stone, I want to continue my interest in space!

Hi my name is Heo Hyun. I know, it’s a very hard name to pronounce but it comes from my mother’s name and it actually means black, which I find it quite unique and original. Anyway, I’m very passionate person who is interested in music, science, along with other things. One of the things I enjoy doing is playing violin in orchestra because I really enjoy the harmony we can bring. The reason I participated in SheSpace is because I liked the idea of people from different countries working together, using space technologies, to solve the problems in the Earth. The collective work from students all over world about space, was the opportunity I wouldn’t miss for the world.

Research Project #1:

Analysis of Forest Fire Damage Areas in Gangwon-do

by Jiwoo Kim, Yuna Lee, Cheyun Lee, Seohee Im, Yunseo Jeong, Jaeyun Jeong, Hyun Heo
Goyang Global High School

Motivation

Today, the frequency of wildfires is rapidly increasing, globally. Korea is no exception, and in March of this year, massive wildfires broke out in Uljin and Gangwon. It took 9 days to extinguish the wildfires and they spread to the surrounding areas, causing great damage. Statistically, of course, the biggest cause of wildfires is the arson of the mountain climber, but the impact of climate change can never be overlooked, given the frequency of fire occurrence and the rate of spread. Therefore, our team became interested in the wildfire-affected areas, and we wanted to derive meaningful results through satellite image analysis of before-and-after the wildfires, mainly in the Gangwon Province area. The theme of the project is "Analysis of Forest Fire - Affected Areas Centered on the Gangwon Province Region."

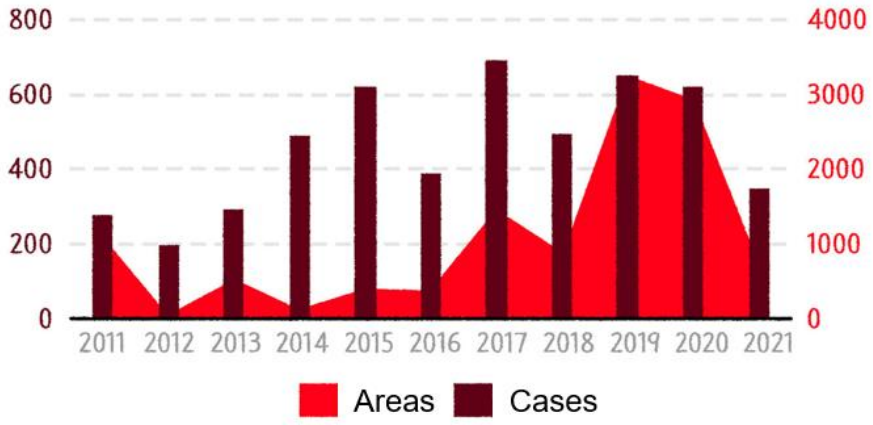


Figure 1. Forest fires in Korea

Satellite Data Utilization Process

We wanted to find out the changes before and after the wildfires occurred in 2019, in the Gangwon Province Region through satellite image information. To this, we synthesized multi-band images from the Sentinel-2 satellite images on April 3, the version before the wildfires and the KOMPSAT-3 satellite images from April 5, the version after the wildfires. A colored-satellite image that combines several bands visualizes a combination of reflective values that vary depending on the constituent material or state that makes up the indicator, so that the state or characteristics of the ground can be known. As a result, the satellite image on April 5 showed a marked increase in the areas that appeared dark due to low vegetation, compared to the satellite image on April 3. Since April 3 and 5 are just two days apart, this short-term vegetation area decline can only be explained by wildfires.

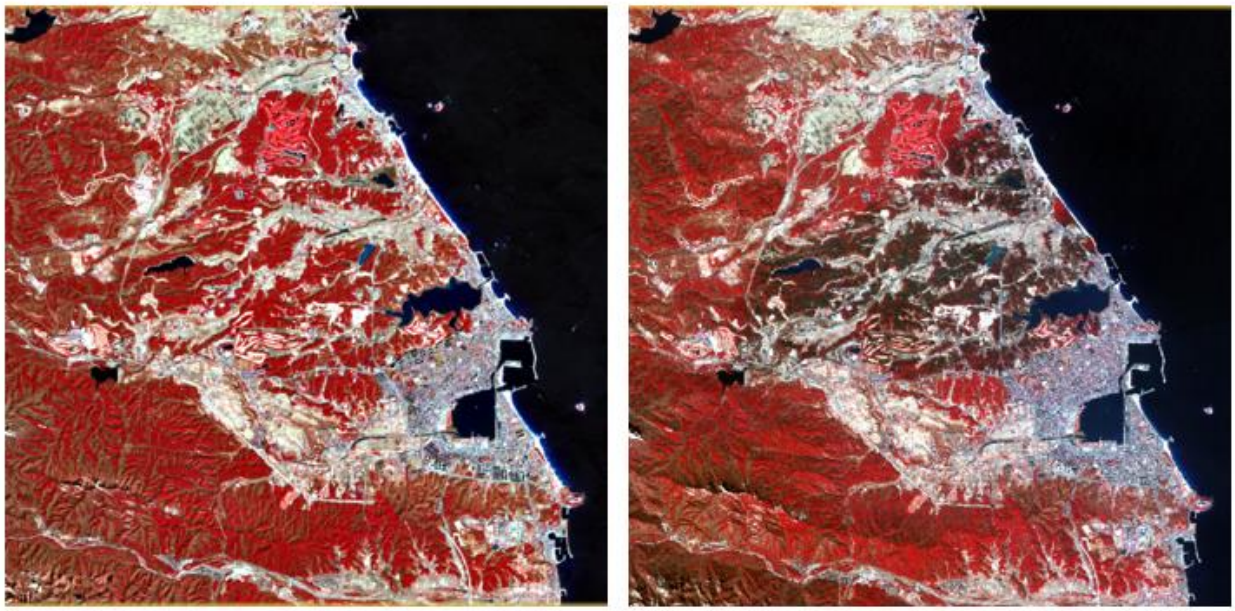


Figure 2. Satellite data used in the study: Sentinel-2 Satellite Image acquired on Apr.3 (left) & KOMPSAT-3 Satellite Image acquired on Apr.5 (right)

Image Analysis Using SNAP

We learned the NDVI and how to use the SNAP program. NDVI means Normalized Difference Vegetation Index. It measures the state of plant health based on how the plant reflects light at certain frequancies. This index defines values from -1 to 1. The closer to 1, the healthier the plant

is. Select the NDVI processor in 'thematic land processing'. After that, select Band 4 in the Red source band, and Band 8 in the NIR source band. The part seems red on the images could be interpreted as vegetation.

Now, in order to find areas with numerically high levels of damage, we intended to find the difference in Normalised Difference Vegetation Index (NDVI) between the two satellite imagery images on April 3 and April 5. However, since the spatial resolutions of the two satellite images were not the same, we began to work on unifying them, preferentially. Using the 'GEOMETRIC RESAMPLING' function, we unified the pixel resolution to 3 M.

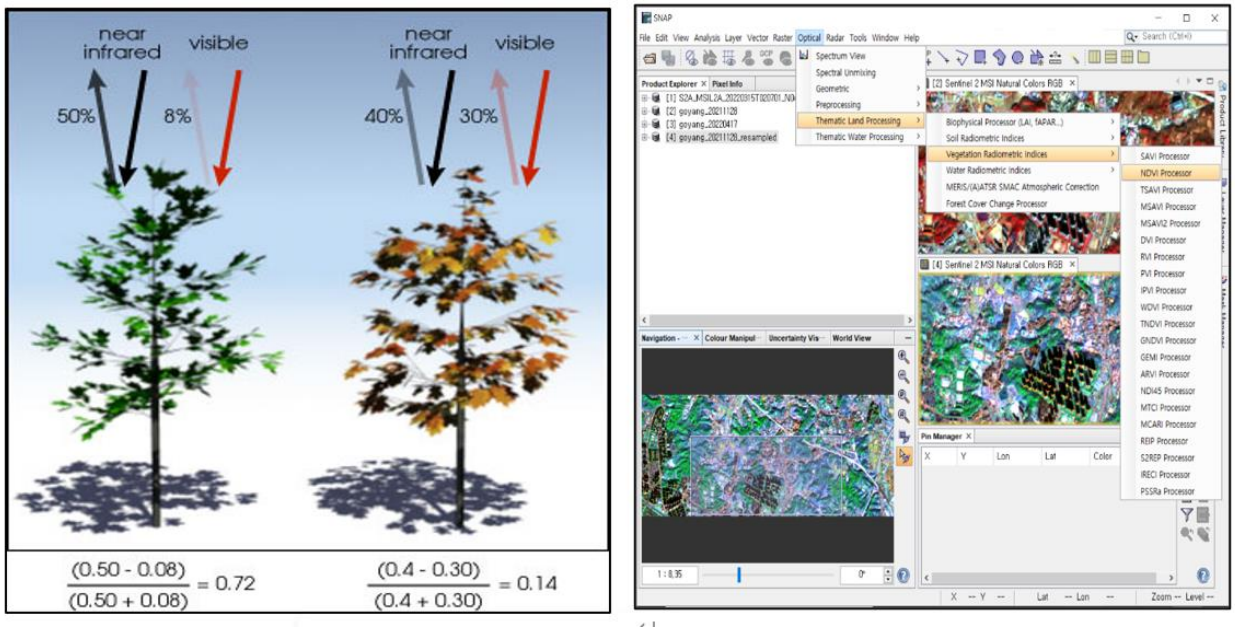


Figure 3. Calculation of NDVI using SNAP

Vegetation Index gap

After figuring each vegetation index of two satellite images, we analyzed the vegetation index gap of those. It was calculated by subtracting the pre-forestry photos with lower vegetation index from the post-forestry photos with a higher index. The bigger the gap is, the more white they were displayed on the map (see Figure 4, left). This means the white part is the most damaged area. Adjusting the difference value slightly and displaying the gap through mask manager, where the

difference value was between 0.51 and 1 was found that the forest fire damage was the most serious (see Figure 4, right).

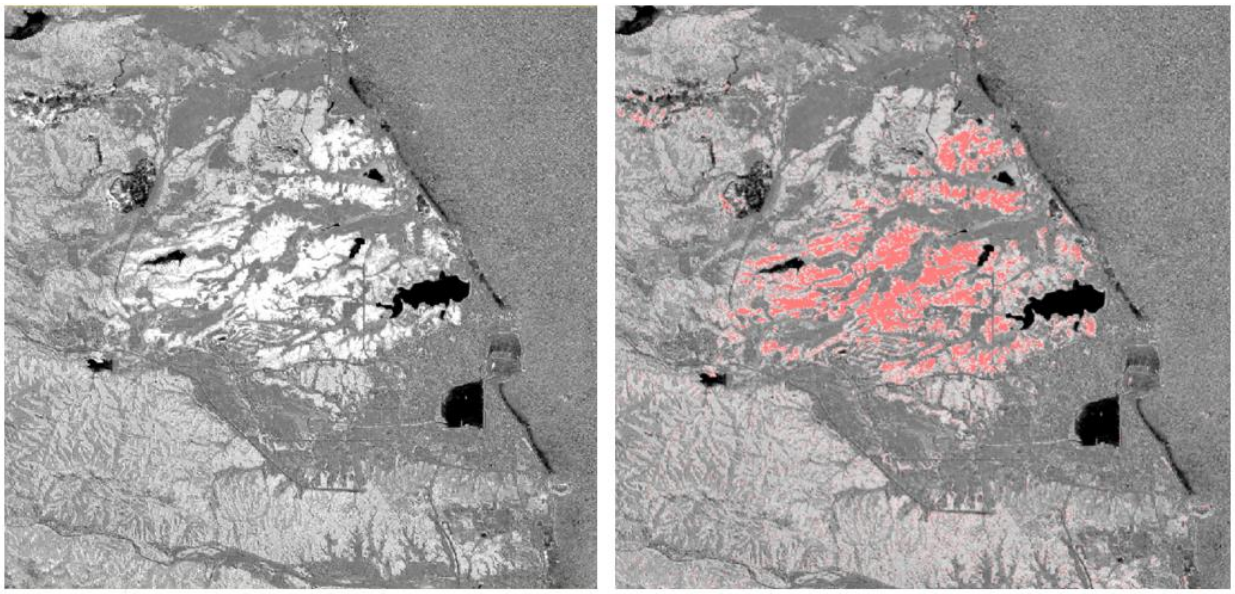


Figure 4. NDVI difference map (left) and extraction of burned area (right)

Data Analysis Results

Since the data on April 3, 2019 and the data on April 5, 2019 were compared, it is very reasonable to explain the cause of the sharp difference between the two points by the Gangwon-do forest fire that occurred from April 4 to 6, 2019. The high vegetation index in the April 3 data fell sharply on April 5, and the difference was more than 0.51. Through this, it can be seen that the environment was rapidly destroyed within a short period of time due to forest fires.

Final Thoughts

During this program, we were more than honored to be a part of this project. As we enter the final year of high school, we have been struggling a lot between finishing high school, and entering college. But because of this SHE SPACE project, we were able to be united toward a single goal. Although our career paths vary, we had a common interest in one field, and that is International Studies. And that's how we were able to meet in this school called 'Global High School'. We are

people who pursue knowledge about the international world, and that naturally included the international society united for the outer space. In fact, it was also a big challenge for us to participate in this program. Our school is very unique and it's different from international schools. Unlike other high schools, our school is focused on specific fields that are related to understanding and having a better view of the world. The classes we take include international politics, microeconomics and macroeconomics, environmental studies, regional studies, Geographic Information System a.k.a. GIS, and comparative culture. Concentrated on liberal arts and social sciences, this curriculum was able to give us a broad view of the world, but at the same time, it limited in our knowledge related to natural science and engineering. The reason I brought up this story is because this program was able to break us free from the limit of scientific knowledge. And the limitation was not just knowledge of space or satellites, but the convergence between disciplines. Connecting space with our lives, we realized that science and technology and the culture of society were eventually linked together to construct this diversified and complex society that we live in.

On the main page of Harvard University, you can find this sentence written with a cosmic background image, "An accessible world is a better world for everyone." That's why we, the students of Goyang Global High school, dream of a world where aerospace is accessible to everyone and where not only students but all people do not hesitate to dream and express their unlimited creativity. Therefore, we would like to say that we were more than glad to be part of this amazing project and we also want to give thanks to all the teams who participated in the SHE SPACE INTERNATIONAL. Through this activity, we made a lot of unforgettable memories that will always be a part of us and that will give strength to us in the future. We couldn't be happier sharing this experience with you.

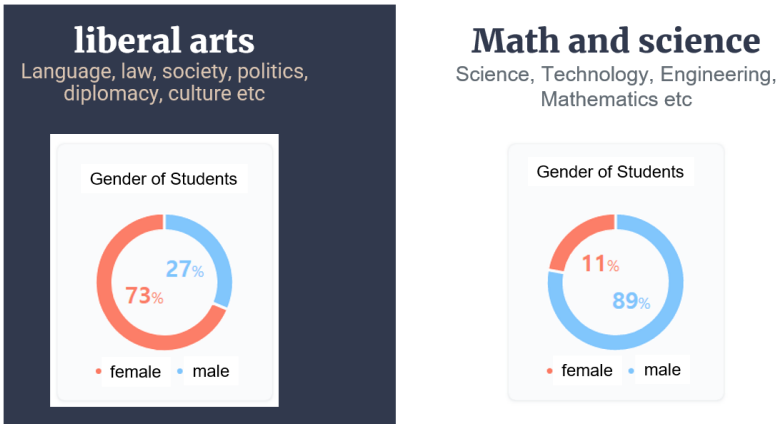
My personal thought at the end of the project

by Chaeyun Lee, Goyang Global High School

Will I be able to learn and use satellite images? This sentence is what we thought when I applied for the SHE SPACE project. Due to the lack of confidence in science, I had no choice but to worry about whether I could adapt well to clubs dealing with aerospace and satellites. But when I finished

the project, I found it not as difficult as I expected to handle satellite images, and I couldn't get one question out of my head. Why did I not have confidence in science?

In order to solve my question, it is necessary to take a deep look at the cultural, social, and educational structures of Korea. First, Goyang International High School, where our team is attending, focuses on humanities and social sciences. The so-called liberal arts. The most distinctive feature is that the proportion of women among students exceeds 70%. In Korea, it can be clearly seen from the opposite of how certain studies correlate with women. On the one hand, if there is our school, on the other side, there is a science high school called 'Science Department', which mainly teaches natural science and science technology. The situation here is more serious. Daejeon Science High School, which carried out the project together, has nearly 89 percent of men. It is said that all 8 girls from Daejeon Science High School who participated in the project are second-year girls.



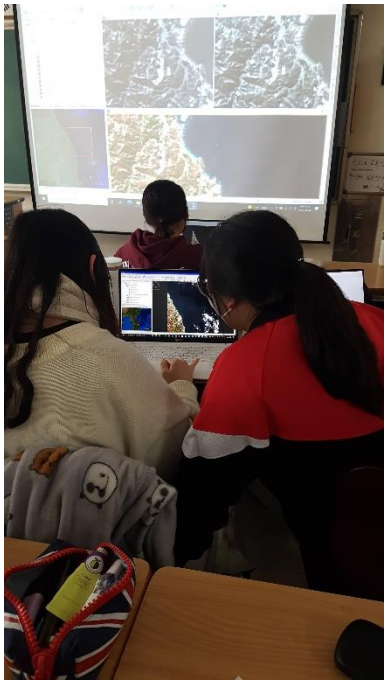
Comparison of gender ratio in Goyang Global High School(left) and Daejeon Science High School(right)

I don't want to say that women are better at liberal arts and men are better at science. I just want to pinch the social structure where certain genders are concentrated in a specific subject. According to the 2018 OECD Programme for International Student Assessment (PISA), there was no difference in math and science grades according to gender in Korea. Nevertheless, Korean society still recommends liberal arts to countless female students. They will naturally lose confidence in natural science and technology, learning about humanities and social sciences.

This vicious cycle is so natural that it has a discriminatory structure in our society without our noticing it. Johann Galtung says structural force is tantamount to inequality in social structure. The

SheSpace project was born because it could no longer condone this structural force. We were able to participate in the project and reject the structural force we were given and learn about what we wanted to learn. This was only a step toward a truly just and fair society.

All the Hard Work…



Research Project #2:

Analysis of Climate Change: Rainy season (2020, 2021)

by Hyunseo Son, Seoyoon Lee, Jiyoon Jeong, and Hayoung Chung

Daejeon Science High School

Motivation

Climate change can affect rainfall intensity and frequency. When the ocean temperature increases, more amounts of water evaporate into the air, and it can produce more precipitation. In addition to this, global warming also affects large-scale atmospheric circulation, and as a result of wind changes, the subtropic is expanded with the changes in rainfall trends. The latest IPCC reports that the surface temperature has risen due to global warming with high confidence. However, the change in precipitation due to global warming is difficult to detect. Therefore, it is necessary to understand the pattern of precipitation change and analyze its relationship with global warming through continuous global precipitation monitoring. Satellite observation is an effective tool to monitor the Earth's atmospheric state continuously. This study analyzes rainfall products from Korea's second geostationary satellite, GEO-KOMPSAT-2 (GK2A). Since Korea experienced an abnormal rainy season in 2020, we conducted a comparative analysis of the rainfall patterns from satellite observation in 2020 and 2021.

Research Results

The rainy season, Changma, is caused by precipitation along a persistent stationary front. It usually starts in late spring and ends in early summer when the subtropical ridge becomes strong enough to push the seasonal rain front north. However rainy season in 2020 started in late June and lasted mid-August, causing 45 deaths from flooding and about 8000 victims. It happens because the southern system (related to the Northwestern Pacific subtropical High) provided the moisture for Korean Changma, and the northern one created northerly (southward) winds, which held the moisture in place over the Korean Peninsula, creating more persistent rain. Compared to 2020,

Changma in 2021 recorded the third shortest rainy season. It started in Early July and lasted about 15 days.

Table 1 The period of rainy season

Year	Rainy Season	Period (day)
2018	6/26 ~ 7/11	16
2019	6/26~7/29	34
2020	6/24 ~ 8/16	54
2021	7/3 ~ 7/19	17
common year	6/24 ~ 7/24	32

To compare precipitation patterns during two rainy seasons in 2020 and 2021, we downloaded the GK2A satellite data from the National Meteorological Satellite Center. The GK2A is a geostationary meteorological satellite launched on December 5, 2018, and has 16 channels from Visible to Infrared. The National Meteorological Satellite Center provides 52 types of weather products retrieved from GK2A. They are divided into 23 primary products: surface temperature, sea surface temperature, rainfall rate, and ozone amount. And 29 additional products include forest fire detection, current, and aerosol particle size.

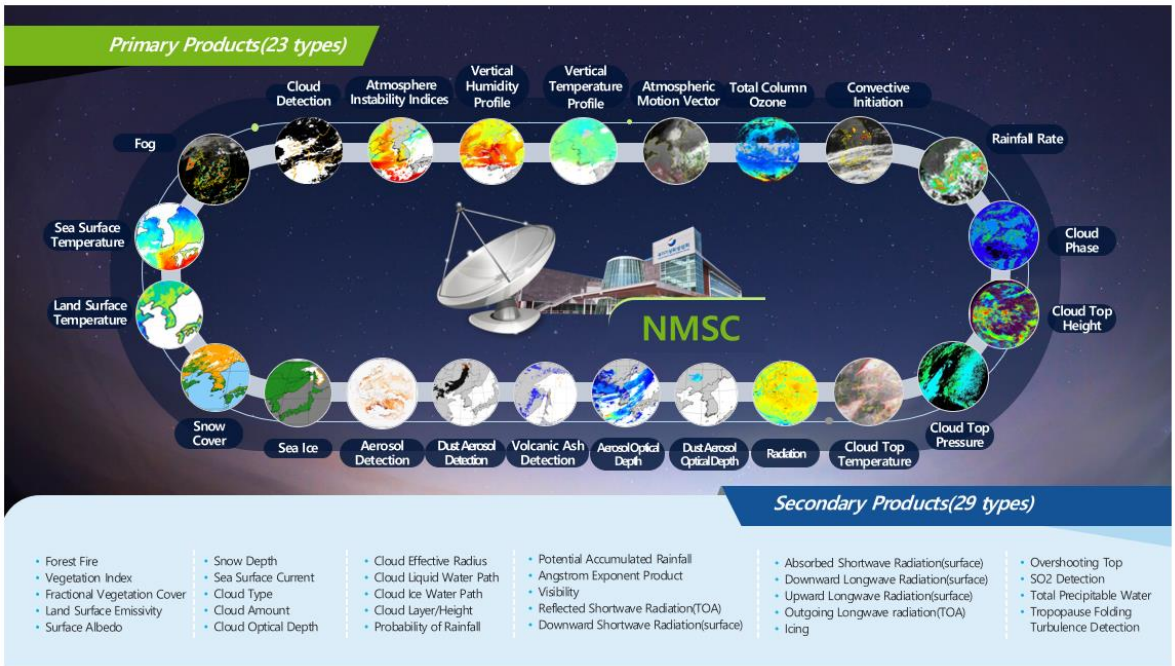


그림 1 The primary products of GK2A

We used Python programming to visualize and analyze the data. The rainfall products from GK2A represent in figure 2 and 3. The figure shows the feature of the rain front in 2020 and 2021.

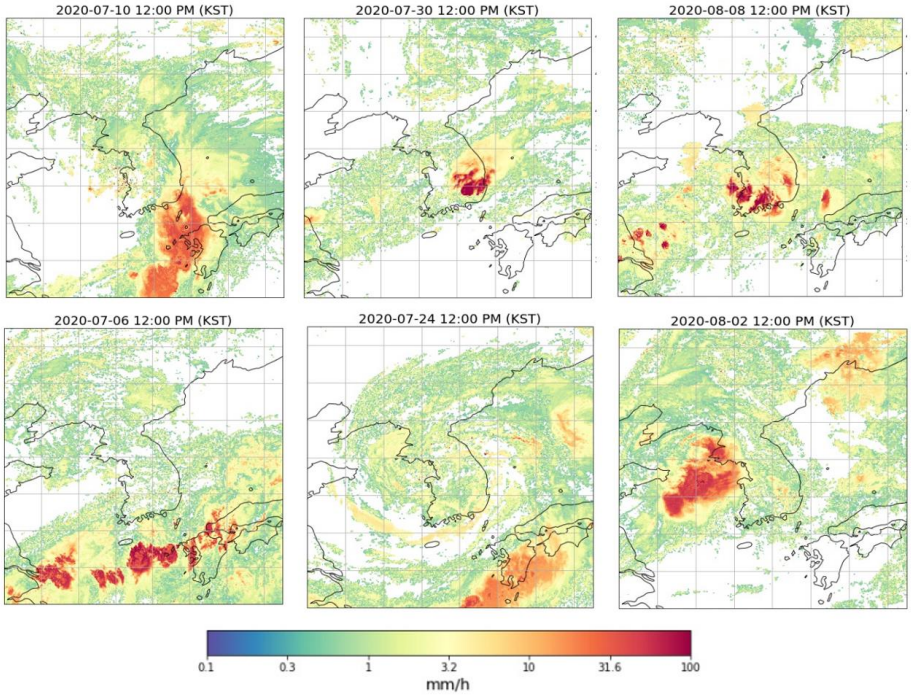


그림 2 Rainfall map in the 2020 rainy season

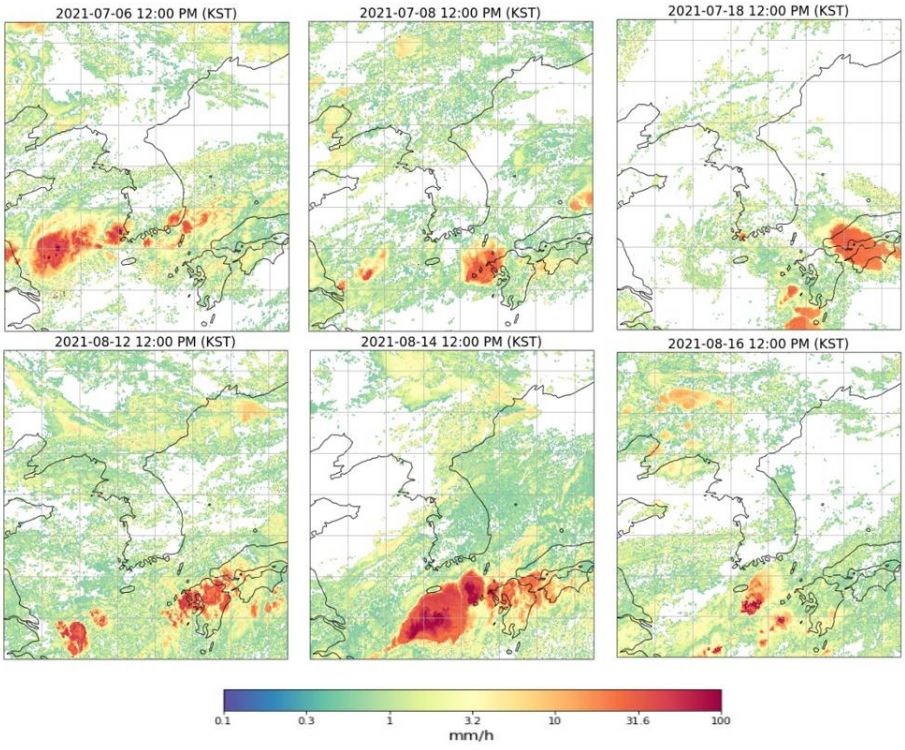
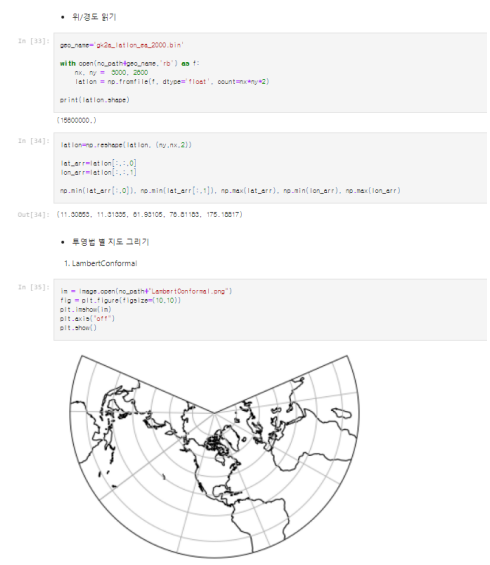


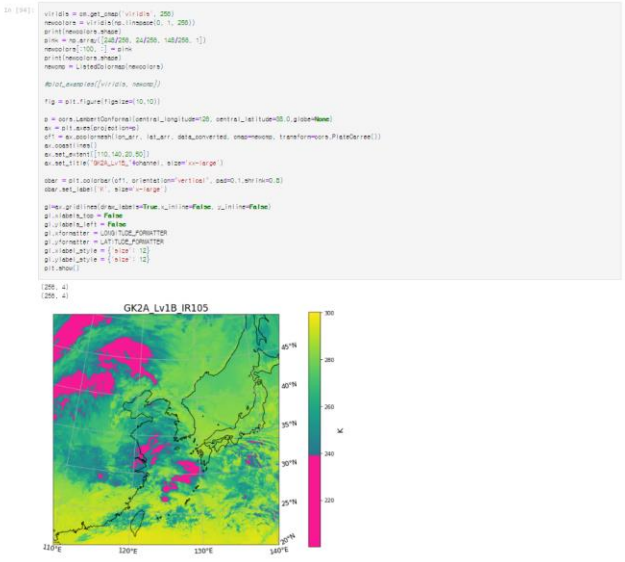
그림 3 Rainfall map in the 2021 rainy season

With this project to analyze the rainfall patterns from satellite data, we were able to learn the following:

- How to get the rainfall information from satellite observations.
  - Geostationary satellite provides continuous monitoring images that are valuable for analyzing the impact of climate change on the precipitation system.
- Various satellite products characterized by each channel.
  - The satellite uses various wavelengths that provide physically meaningful observation values for analyzing weather and climate patterns.
- Python programming to visualize the satellite data.
  - Satellite data differs from the image files (png, jpg, …). Therefore, to read satellite products, specific programming is needed. Python is an open-source tool to read satellite data effectively.

All the Hard Work…





Research Project #3:

Analysis of Heat Wave Change in Korea

by Hyun Jeong, Yong, Seo Yoon, Jeong, Seo Eun, Kang, Hee Jin, Ahn

Daejeon Science High School

Motivation

As global climate change is becoming more severe, this year, especially, the heat wave caused significant damage. In the summer of 2022, the UK recorded 40 degrees Celsius for the first time since weather observations began. Also, hundreds of people have died in southwestern Europe, including Portugal and Spain. This heat wave eventually led to a forest fire, which intensified the damage. This heat wave was also observed in India and Pakistan from March to May, setting the highest temperature recorded in April. We conducted this study to analyze how these phenomena are changing in Korea, where we currently live, and to recognize and inform the seriousness of climate change through heat waves.

Introduction

A heat wave is a period of excessively hot weather. Although definitions vary, heat waves are usually measured in relation to the general climate of the area and the normal temperature of the season. According to the Korea Meteorological Administration, when a day with a daily maximum temperature of 33°C or higher is expected to last for more than two days, it is considered a heat wave and an advisory is issued in Korea.

Therefore, the number of heatwave days in Korea was investigated with this definition on the Korea Meteorological Administration website. When the data were collected and graphed, it was confirmed that the number of heatwave days in Korea increased over time [Figure 1]. The unusually long heat wave was caused by high atmospheric pressure from Tibet and a North Pacific anticyclone. Also, we found that the number of heatwave days increases, and the average heatwave

temperature also increases every year [Figure 2]. Thus, we tried to find out the increase of heatwave in Korea using the data of meteorological satellite GEO-KOMSAT-2A (GK2A).

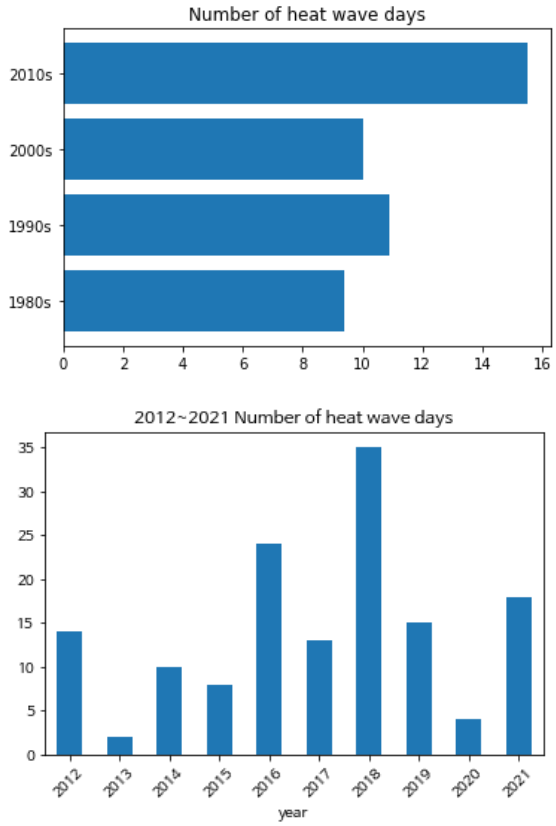


Figure 1. Heatwave days in each year

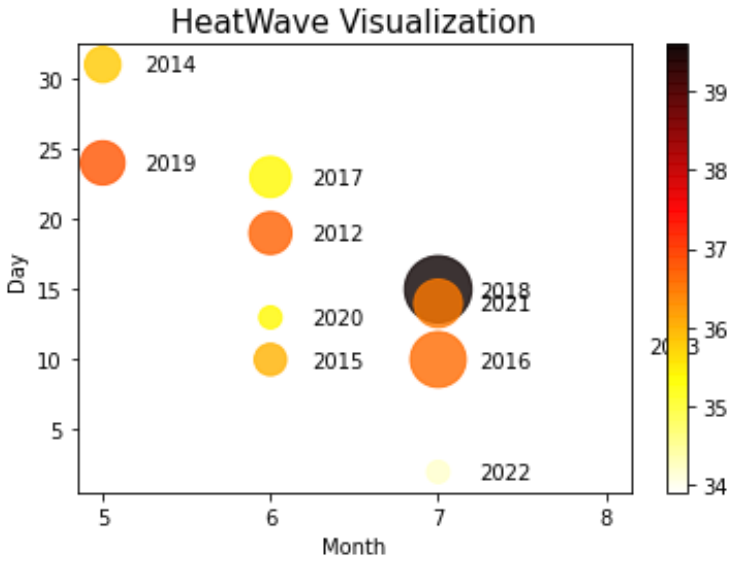


Figure 2. Heatwave days and heatwave average temperature in each year

Satellite data collecting

The GK-2A launched on December 5, 2018 is available for diverse observations owing to its 16 channels from previous 5 channels. In total, 52 types of meteorological products are made based on this. GK-2A is available for observing the entire sectors in 10-minute interval and this makes speedier monitoring of severe weather phenomena for reducing meteorological disaster. In addition, high performance meteorological sensor (AMI) provides more precise observation. Korean developed space environment monitor strengthened our capabilities of space weather observation.

We used AMI and collected the data which is observed at 2p.m. However, if we could not find proper data because of heavy clouds at the time, we used different time images in that case. We finally collected the highest temperature days as heatwaves in each year from 2019 to 2021.

Analysis & Results

During the SheSpace program, we learned how to use Python to collect satellite data and visualize scientific data [Figures 3 and 4]. In Figure 3, we find that the surface temperature of the heat wave is much higher than that of a typical day. Also, through data investigation, we found that the sea surface temperature during the heat wave is higher than usual.

In conclusion, we summarize what we learned through the study. Firstly, the number of heat wave days is increasing, and the ocean surface temperature is rising. According to our analysis, the heat wave is getting harsher. Second, we realize that meteorological satellite research is needed to understand climate change trends in the long term. Lastly is the effect of a heatwave. Through the survey of the articles, we realized that at least one person had died yearly. Forty-eight people dead from heat-related illnesses in 2018, the hottest year. The heatwave is a threat to the ecosystem. Looking at these results, we have been thinking a lot about what actions we should take to reduce the impact of climate change on humans. We will start with one step to reduce the use of plastics to prevent climate change.

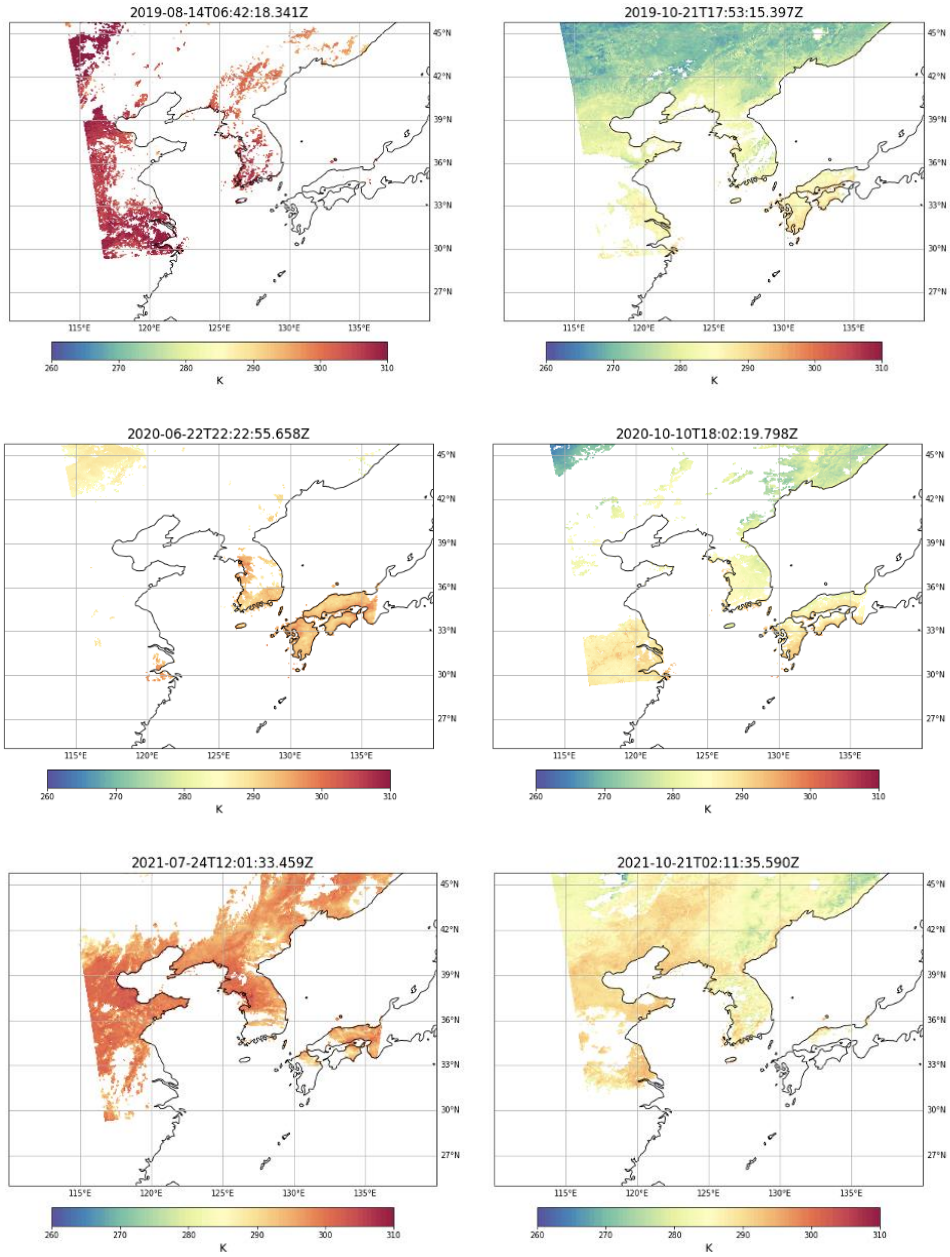


Figure 3. Comparison of surface temperatures for heatwave and normal day

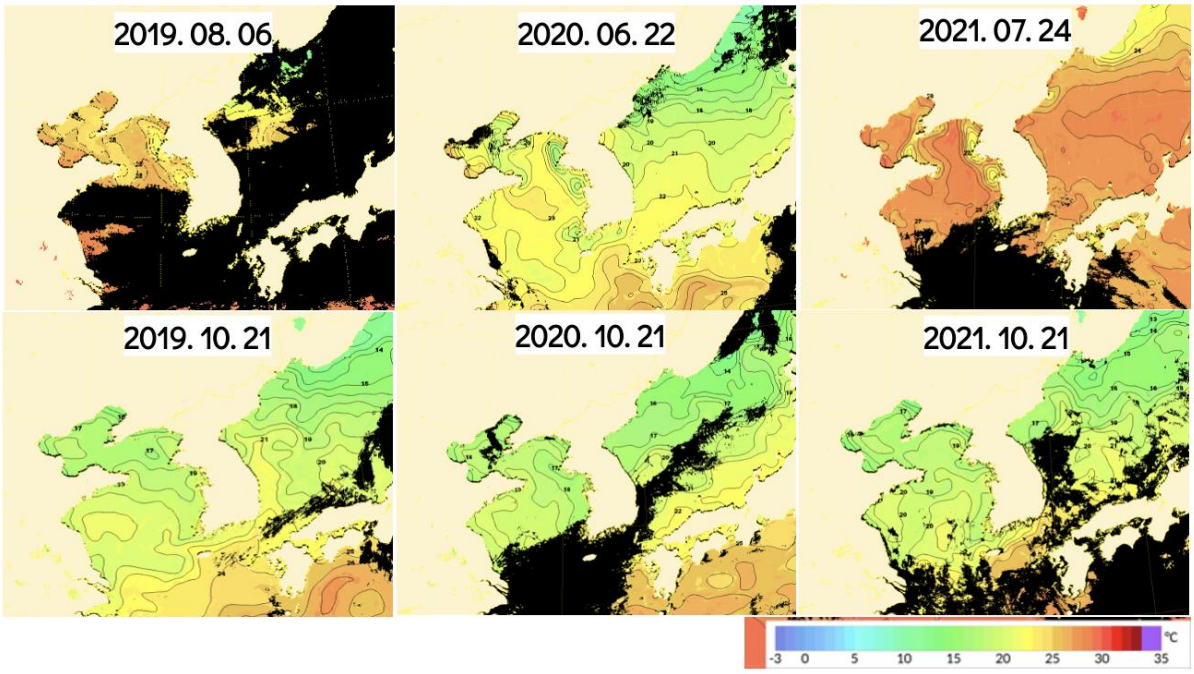


Figure 4. Comparison of ocean surface temperatures for heatwave and normal day

All the Hard Work…