Using *Convective Stratiform Technique* (CST) method to estimate rainfall (case study in Bali, December 14th 2016)

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**Abstract.** Accurate and realtime data in wide spatial space at this time is still a problem because of the unavailability of observation of rainfall in each region. Weather satellites have a very wide range of observations and can be used to determine rainfall variability with better resolution compared with a limited direct observation. Utilization of Himawari-8 satellite data in estimating rainfall using Convective Stratiform Technique (CST) method. The CST method is performed by separating convective and stratiform cloud components using infrared channel satellite data. Cloud components are classified by slope because the physical and dynamic growth processes are very different. This research was conducted in Bali area on December 14, 2016 by verifying the result of CST process with rainfall data from Ngurah Rai Meteorology Station Bali. It is found that CST method result had simililar value with data observation in Ngurah Rai meteorological station, so it assumed that CST method can be used for rainfall estimation in Bali region.

**Key words:** rainfall, CST, satellite, Himawari-8

1. **Introduction**

Indonesia is the largest archipelagic country in the world extending from the geographical latitude of 7° 20' N - 14° LS and 92° - 141° E with about 70% water area and 30% land area. Tropical rainfall in Indonesia is very important to be studied, other than as a source of life of high rainfall can be a source of flood natural disasters. Indonesia's rainfall plays an important role in the process of determining global weather and climate conditions because two-thirds of the total global rainfall occurs in the tropics (Tjasyono, 2013). One of the causes of high rainfall in the tropics is the year-round solar warming that results in the evaporation rate in Indonesia and the presence of convergence areas that have high cloud growth potential.

Geographically, Bali is located at 9° 0' - 7° 50' S and 114° 0' - 116° 0' E. Bali is included in tropical climates influenced by the Asian Monsoon and the Australian monsoon that led to Bali experienced two seasons of the dry and rainy season. The Asian monsoon brings wet air masses to Indonesia including Bali, causing the rainy season in Bali to occur around the period of November to March with the highest average rainfall in December and January. Ngurah Rai Meteorology Station Bali recorded the amount of rainfall on December 14, 2016 that occurred in was 78.8 mm/day. The rain events can be categorized as high intensity rainfall.
Rainfall data report in weather information are carried out at every Meteorological Station in Indonesia. However, the availability of rainfall data is still limited because rainfall observations are not conducted in every region and rainwater damage can also be hampered in weather data reports. Rainfall estimation is one way in handling the problem so that used of satellite weather data that can reach all areas even areas that do not have observation stations and rain gauges. This weather satellite data can be obtained up to date and is not charged, but its utilization is still very limited among the public (Suwarsono et al, 2009; Endarwin, 2014). Utilization of Himawari-8 satellite data in estimating rainfall is done using Convective Stratiform Technique (CST) method. The CST method is applied by separating convective and stratiform cloud components using infrared channel satellite data. Cloud components are classified based on slope because the physical and dynamic growth of air movement and precipitation between the two components is very different (Goldenberg et al, 1990). This research was conducted to find out the comparison of rainfall estimation result with CST method in Bali area on December 14, 2016 by utilizing infrared channel data of Himawari-8 satellite image and verify result from CST method with rainfall data from Ngurah Rai Meteorological Station, Bali.

2. Data and Method
The location of the research was conducted at Ngurah Rai Meteorological Station with coordinates station 08 ° 44'46" S and 115 ° 09'57" E representing Bali area on December 14, 2016. The method used is Convective Stratiform Technique (CST) method by using data as follows:

2.1. Himawari-8 Satellite Data
Satellite data in the form of PGM (Portable Gray Map) obtained from http://weather.is.kochi-u.ac.jp/sat/GAME and calibration data (CAL) obtained from http://weather.is.kochi-u.ac.jp/sat/CAL is used for estimation of rainfall. In addition, satellite data taken from the Meteorological Climatological and Geophysical Agency in the form of infrared channels are also used to verify the results from satellite data PGM and CAL.
2.2. Observation Data
Weather observation data from Ngurah Rai Meteorological Station on December 14, 2016 to verify the results of rainfall estimation from the CST method.
The data processing in this study are as follows:
- Converting the Himawari-8 infrared satellite data in the .pgm and .dat file extensions to obtain the cloud top temperature.
- Set the coordinates of the research area at Ngurah Rai Meteorological Station with the coordinates of stations 08 ° 44'46" S and 115 ° 09'57" E.
- Calculate the slope parameter (S). For data resolution 5.5 km x 5.5 km.
- Separation of convective and stratiform nuclei.
- Estimating hourly rainfall.
- Evaluation of the results of rainfall estimation with rainfall observation data from Ngurah Rai Meteorological Station.
- Application of spatial rainfall estimation for samples of heavy rain events per 3 hours and daily. The estimation results in the plot using Python programming and compared with rainfall observation data from Ngurah Rai Meteorological Station.

3. Results and Discussion
3.1. CST Method

![Figure 2. Rainfall Estimation in Bali using CST Method (06.00-09.00 UTC)](image)

Through the utilization of CST method to estimate rainfall can be done. In this research, rainfall estimation is done for Bali area when there is moderate rain phenomenon on 14 December 2016. In accordance with the availability of weather satellite data, the estimation can be determined for at least one hour at a time. Furthermore, the accumulation of the hourly estimation results can be determined also can be applied for longer period rainfall, as well as daily to monthly rainfall estimation. In the
Convective Stratiform Technique (CST) method there is a separation to determine whether the rain to be estimated is from a stratiform or convective cloud type. In a grid of estimation, it is assumed that the convective cloud type is a region of high cloud cover or a towering cloud, whereas the stratiform cloud type is a stratiform cloud cover area or a cloud that grows horizontally. In this case, the stratiform type of rainfall values tends to be smaller than the convective.

The estimation results on the CST method shows the rainfall forecast on Bali area on December 14, 2016 at 06.00 UTC, almost evenly distributed throughout Bali Island. At 06.00 UTC, shows a contour with a value of rainfall estimation that is not too significant for heavy rain category. This is due to the separation that occurs is an estimate of stratiform clouds. While at 06.00 UTC and 07.00 UTC, there is a contour of rainfall estimation with a range of values ranging from 25 - 35 mm, these indicate in some areas of Bali there is a convective cloud that caused precipitation (rainfall). This estimation is based on the separation of convective clouds that show that clouds are dominant in the area of Bali. This result is assumed that in the morning in the Bali region is not too dominant by the growth of convective clouds but stratiform clouds that have a uniform cloud contour with small slopes. At 08.00 UTC, the convective contours are visible in the middle and most of the island, and this also indicates high precipitation with values ranging from 25 to 40 mm. And at 09.00 UTC, the visible cloud is a stratiform cloud, where most of the contours are evenly distributed, with estimation values ranging from 5 - 15 mm.

3.2. Satellite imagery

![Image of satellite imagery](figure3.png)

**Figure 3.** Himawari-8 Satellite Imagery in Bali (06.00-09.00 UTC)

The verification of rainfall estimation by using Himawari-8 satellite imagery data in Bali on 06.00 UTC - 09.00 UTC. In the results of the image of Himawari-8 satellite at 06.00 UTC shows the...
presence of thick cloud contours in the southern region of Bali Island which indicates that in the region occurs precipitation (rainfall) is quite high. While at 07.00 UTC, the thick cloud contours that occur in the southern region of Bali island growing and expanding to some parts of the central island of Bali. At 08.00 UTC and 09.00 UTC, the thick clouds of the contour move westward so that the rainfall is reduced.

3.3. Meteorological Station Observation

Figure 4. Total Rainfall in Bali on December 14, 2016

Ngurah Rai Meteorological Station observation data is used to verify the CST method rainfall estimation. The rainfall at 12.00 UTC measured about 20.4 mm, this indicates that in the preceding hour precipitation (rainfall) is quite high. This result corresponds to the accumulated estimation of precipitation on Convective Stratiform Technique (CST) method which shows rainfall values ranging from 15 to 20 mm per hour. While at other important hours such as at 18.00 UTC and 21.00 UTC shows rainfall that occurred in Bali region ranged from 30-40 mm.

Based on the data above, it can be seen that the results shown from the CST model almost approaching the value of the observation data. It proves that the CST model can be applied in estimating rainfall in areas that have not yet observed rainfall such as Bali region. The CST model can be used to improve gathering meteorological information of observers.

4. Conclusions

Based on the analysis of the application of rainfall estimation by CST method on December 14, 2016 at Ngurah Rai Meteorological Station that representing Bali region, can be concluded that CST method can be applied to make rainfall estimation in Bali area. It corresponds to rainfall observation data from the Ngurah Rai Meteorological Station. The CST method is quite consistent in estimating rainfall per hour. The good quality of these estimation shows that the method is suitable for year-round use in the monsoon-dominated Bali area, which can be used to monitor near-real time rainfall.
5. References

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