Prediction of Snow Blizzard

Chiranjeevi Rahul Krishna Saride
Vardhaman College of Engineering
Hyderabad, India

Kishor Kumar Reddy C
Vardhaman College of Engineering
Hyderabad, India

H Venkateswara Reddy
Vardhaman College of Engineering
Hyderabad, India

Abstract—

An environmental calamity is something that inflicts adverse effects on biodiversity, economy and human health. In order to diminish such adverse effects proper methodologies are to be brought into action to forecast them in before in hand. The present research presents an alternative in predicting a Snow blizzard in advance by taking into account the results obtained from processing of satellite images. By using the satellite images the noise levels can be reduced and higher accuracy of the results can be obtained compared to radar images. Taking into consideration of the historical values, the results obtained can be compared and a more accurate prediction can be made that would help us in reducing huge losses both life and property. Till date, none of the methods put forward were up to the mark and provided inaccurate predictions, and the drawbacks of which are eliminated in this research providing with more accurate predictions. Obstacles like noise and attenuations deteriorate the quality of image hence segmentation by K-mean clustering should be done on Snow blizzard images after which coif wavelet transformations are applied on the image in order to obtain square root balance sparsity norm threshold value, which helps to find the wavelength ranges to formulate accurate predictions of Snow blizzards. The proposed technique capitulate an average accuracy of 92.1% in the prediction of a Snow-Blizzard.

Keywords - Clustering, Haar wavelet transform, Image processing, Remote sensing, Satellite imagery, Snow blizzard

I.INTRODUCTION

Originally, the term blizzard came from the German word 'blitz' meaning lightning. A blizzard is a rigorous snowstorm characterized by burly constant winds of at least 35 mph and lasting for a prolonged period of time i.e., typically three hours or more. A severe blizzard has winds over 45 mph, near zero visibility, and temperatures of -12 °C or lower. A ground blizzard is a weather state where snow is not declining but loose snow on the ground is lifted and blown by sturdy winds. Officially, the National Weather Service defined blizzard as a severe snowstorm characterized by strong winds causing blowing snow that result in low visibilities. The difference between a blizzard and a snowstorm depends on the strength of the wind but not on the amount of snow.

The Earth's Hydrological cycle consists of a significant component in the form of snow, which is also considered as an important factor in the balancing of global and regional energies. Melt onset, snow water equivalent and snow extent are some of the parameters for hydrological models which are used in wide range in flood controlling, forecasting the climate and managing the irrigation. The same basic mechanism associated with rainfall generation also applies to snowfall production, i.e. rapid air ascent as a result of horizontal convergence within surface low pressure cells, orthographic uplift induced by the presence of hills, convective instability, and frontal uplift. Low temperatures throughout the atmosphere are a prerequisite for rainfall. The most critical condition which favors the development of snow occurs in the lower atmosphere. For the snowflakes to be observed, the freezing point of the temperature must be reached, and then the snowflakes are observed which sometimes intensifies as a Snow-Blizzard. The varied behavior that occurs every moment in the climate is a very tedious task to forecast. The snow conditions are varied in case of blizzards and other snow disasters that depend on the parameters of atmosphere and the precipitation forms.

Blizzards in Australia frequently occur in the Snowy Mountains of New South Wales and Victoria. In the United States, the most affected places with blizzards are Great Plains, the Great Lakes states, the northeastern states along the coast, and the Pacific Northwest. The Great Blizzard of 1888 is one of the worst blizzards in U.S. history. It dropped 40-50 inches of snow and killed 400 people, mostly in New York. Record breaking snowfall covered New York City on February 11-12, 2006, stood as biggest in the city's history. Measurements taken in Central Park showed that 26.9 inches had accumulated by the storm's end. The snow fell for 16 hours, and meteorologists classified the storm as a nor'easter with winds about 20-30 mph. Dumping more than 20 inches of snow in Central Park, the blizzard of January 7-8, 1996, marked the second biggest snowstorm in New York City history. With winds gusting to more than 50 miles an hour, the powerful nor'easter caused widespread power outages, scores of fatalities and $1 billion in damages from Washington, D.C. to Boston.

Though snow is said to be one of the significant component of the earth's hydrological water resource it can also be a natural disaster at times. Snowstorms are said to be ten times worst than rain as it causes much societal and economical damages. These damages occurs when the strong air from the high latitudes of the northern regions meets the warm air, resulting in a strong snowfall in that region, which can cause a greatest impact on the agriculture community causing severe crop damages. Even a minor storm with comparatively minute sized snowflakes can have an overwhelming effect, which can collapse roofs of the commercial and domestic buildings and can cause landscaping. An accurate estimation to recognize snow will probably cause progressively less loss to a countries economy. It is a huge requirement to identify these unexpected disasters to a greater extent in advance. More recently, detection of snow was carried on by using SAR polarimetry technique [2], but this is limited to a particular region rather than a total snowfall area at large. Further this model captures and measures only wet snow region, leaving the dry snow region as transparent media. Another detection method like SRM model depends on hydrological year data and glacier data. The first depends on the changing temperature taken in advance and only for a particular period, but as the climate changes in fraction of minutes then this prediction would be complicated. The second depends on the accumulation and compaction of snow on mountain or near the poles. Further radar based snow measurement techniques are also used to observe the snow event availability. Apparently, the amount of radar based data is less, due to which the prediction is limited to the available data. On observations, the signals through radar based data are weak due to which they face strong echoes and attenuation issues. This motivates the present research to utilize satellite images, which are high in quality and can be an efficient and effective source for the prediction purpose. This research is a new development in the remote sensing area for the detection of snow using satellite imagery.

The snow blizzard identification methodology developed in this paper comprises of four stages. In the first stage, the satellite image is segmented in order to differentiate various textures like water body, forests, grass, asphalt, barren lands, concrete and clouds etc. The segmentation is based on k-means clustering technique in order to extract the snow blizzard features from the original image. In the second stage, haar wavelet transform is adopted to acquire square root balance sparsity norm threshold values for the feature extracted image. In the third stage, the obtained threshold value is multiplied by wavelength factor to compute a wavelength range of the required image and this range should lie in between 380nm-750nm. On experimenting for a set of satellite images, a range of wavelengths are to be noted and any wavelength of the feature extracted image lying in between 550nm - 600nm is detected to be a snow blizzard image. This research enlightens an effective procedure for the identification of snow blizzard from the cloud satellite images by estimating an appropriate threshold values.

The rest of the paper is organized as follows: Section II gives a glance to all the recent research carried on for the prediction of Snow blizzard. Section III depicts the formation of Snow blizzard. Section IV describes experimentation methodology. Section V illustrates the experimental results. Section VI gives a conclusion and finally Section VII ends up with the future work.

II.RECENT RESEARCH

Research is a continuous phenomenon which involves the identification of a problem in any field and adopting the existing technologies or models or invention of new models and techniques for solving the problem. In this paper, a model is proposed for the detection of Snow blizzard in clouds. Cirrus clouds cover about 30% of the earth's surface and are responsible for major physical and chemical processes of the atmosphere. The global radiation balance, global warming and other effects such as green house effect are affected significantly due to change in cirrus clouds. Ice particles in cirrus clouds can form by the homogenous ice nucleation from liquid aerosols or by heterogeneous ice nucleation on solid ice nuclei. But, the peculiar and fast evolution in the weather conditions would also make research to face a tough task of predicting Snow blizzard.

Larry Vardiman explained the mechanisms of crystal growth by considering a hexagonal symmetry model of an ice crystal [5]. Norihiko Fukuta and Tsuneya Takahashi explained the growth of atmospheric ice crystals [6]. They used diffusion growth theory with Maxwellian surface condition to describe the behaviors of intermediate ice growth. C.D. Westbrook and A.J. Illing worth focused their research on thin single - layer mixed - phase clouds [7]. Ashok. N. Srivastava and Julienne stroeve proposed detection of snow, ice and clouds from satellite images using kernel methods for retrieving surface parameters from optical and thermal imagery [8]. Cathey J. Kessinger and Edward A. Brandes compared different Snow blizzard detection algorithms such as NEXRAD Algorithms, NSSL Algorithms, etc. [9]. Kais J. Al-Jumily and Robert B. Charlton and Robert G. Humphires proposed a model for identification of Rain and Snow blizzard with circular polarization Radar [10]. Debin Su, Jianli Ma, Qiang Zhang and Daren Lu studied the snow blizzard identification with dual polarization Radar [12]. Jakob Zschischler, Miguel D. Machecha, Stefan Harmeling stated a model for unsupervised clustering of geophysical data [13]. LIU Guihua, Yu Xing, JIA Ling and DAI Jin used image retrieval of a strong Snow Storm which contains multiple spectral images [14].

The previous research in the prediction of Snow blizzard was done only by using radar signals [15], [16]. For the first time, the present research has opted satellite images for the prediction of Snow blizzards which is a blend of image processing and data mining.

III.FORMATION OF SNOW BLIZZARD

Snow starts to form in the clouds which contain temperatures that are below the freezing level. As clouds are the source of rainfall when these clods keeps freezing and gradually as it melts with the environmental changes they reach the ground in the form of Snow [17]. Saturated air in the atmosphere condenses when it reaches some high altitude. In other words, the moisture turns into a liquid from a gas. As soon as the saturated air cools, the moisture condenses out like the moisture that is usually developed on the outer surface of an ice-water container. Due to the nature of the water molecule, the ice will develop into hexagonal crystals [18]. When we observer a snowflake, it is likely that we can observe a bunch of 6 sided ice crystals joined together. When a snowflake gets big enough in a cloud then gravitational force tries to attract the snowflake due to which it gets showered the surface. The snowflake will continue to integrate, i.e. gets bigger as it joins with other falling crystals. This occurs due to the attachment property between the snowflakes that quickly join with other snowflakes forming bigger one [19].

The size of the snowflakes mainly depends on the changes in the Temperature. The biggest snowflakes are formed when the temperature is near freezing point. The snowflakes are very small when compared to the bigger ones when the temperature is well below the freezing point and these do not stick together as well [20].

Most precipitation that reaches the ground actually begins as snow high in the atmosphere. These snowflakes develop somewhere above the freezing level where the air temperature is less than 32oF, and begin to fall toward the earth as snow, shown in figure 1.

If the ground temperature is above 32oF, the freezing level must be located somewhere above the ground. The falling snow passes through the freezing level into the warmer air, where it melts and changes to rain before reaching the ground. When the air temperature at the ground is less than 32oF, the precipitation begins falling as snow from the clouds.

Since it is falling into the cold air, the snow does not melt as it ascent towards the ground and remains as a perfect snow fall [21]. This is why cold air is important for the formation of snow.

Sometimes, a very thin layer of warm air is found near the surface and the temperature may be several degrees above freezing point [22]. However, since the layer of warm air is so shallow, the snow reaches the ground in tact before it has a chance to melt and become rain. This is how snow falls with the change in the surface temperature, shown in figure 1.

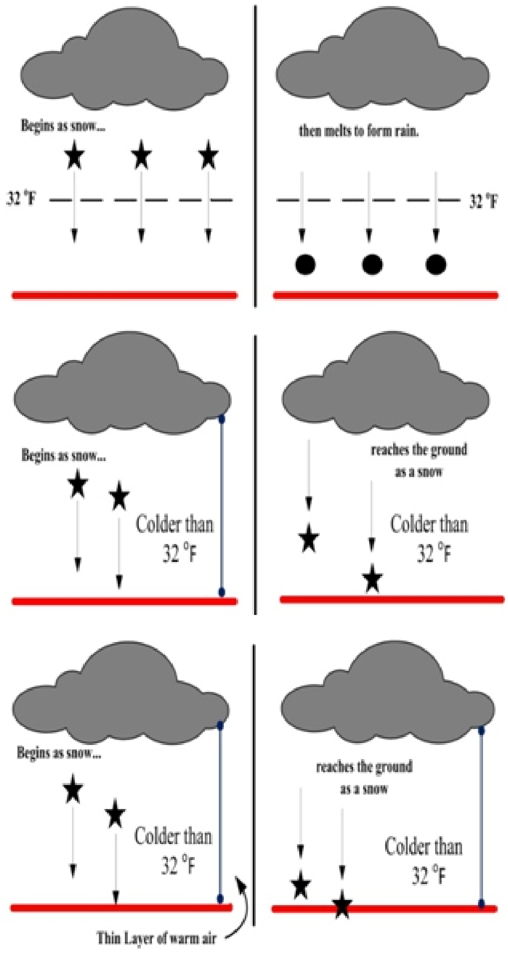

Fig. 1. Formation of Snow blizzard

IV.EXPERIMENTATION METHODOLOGY

Examining the satellite images and real time processing them is the objective, in order to predict whether Snow blizzard occurs or not. The overall process for the prediction of Snow blizzard in the present research is shown in figure 2. The inputs for the experimentation are satellite imagery of clouds with noise or without noise. The satellite images obtained may contain the noise which is ought to be removed. There are different types of noise in satellite images such as striping noise, speckle noise, blurs and so on. These major noises are followed by minor obstructions such as illumination variations, occlusions, and scale variations, deformation of objects and so on. When the satellite image containing such types of noise is analyzed, the value obtained may deviate from original value. Hence, the image must be denoised.

The original image may contain various textures such as water bodies, forests, grass, asphalt, barren lands, concrete and clouds. These textures are to be separated to obtain the image of interest as the other textures does not affect Snow blizzard prediction. Clustering is a popular strategy of segmentation of data into several regions based on similarity measures using Euclidean distance. These segmentations are based on wavelength as similarity measure. These segmented regions are used to generate a wavelength range based on the pixel values for different textures. The various pixel values of different textures used for this segmentation are shown in Table 1.

The area of interest i.e. the cloud texture from the satellite image is obtained by segmenting into various clusters based on the pixel value. The required cloud texture is found to be lying in between pixel values of 0 and 255.

The one of the clustering technique, k-means clustering is adopted for segmenting the image in this paper. According to this technique, it segments the data such that the object in a cluster contains relatively similar data are grouped into different clusters. In order to predict the occurrence of Snow blizzard at higher range K-means algorithm based on Euclidean distance metric is used here to segment the satellite image. Here based on color factor segmentation is done since it can be varied on the basis of color wavelength. The input satellite images after experimented yields to have a maximum of six to seven colors, therefore the number of clusters k is taken as 7.

Fig. 2. Real time detection procedure of snow blizzard

TABLE 1. Pixel Values of various textures

Textures	Pixel values
Water Body	0-20
Forests	21-33
Grass	34-81
Asphalt	82-140
Barren Lands	141-199
Concrete	200-224
Clouds	225-255

Clustering was carried out using MATLAB a image processing tool box that consists of image processing tool box and can provide different wavelet transformations with a comprehensive environment for data analysis, visualization and algorithm development. The segmentation process is applied for the image shown in Figure 3 and the resulted clusters generated are shown in Figure 4. By applying wavelet transformations the feature extracted cluster image shown in Figure 5, is selected to analyze. The Haar wavelet transform is chosen here as it is an efficient technique, where decomposition is applied to the image in rows and columns by transforming from data space to wavelet space in frequency domain .As we are considering Satellite image which is a RGB image, haar wavelet transforms can automatically invert a RGB image into gray scale image and further denoise the image, and present it in one dimension. In order to predict the occurrence of Snow blizzard we have to estimate certain range of values from the feature extracted image. As the cloud image taken is in the form of visible (VIS) infrared, the wavelength will be in the visible spectrum range that would lie between 400 nm - 700 nm.

Now a value for square root balance-sparsity norm threshold has to be estimated by applying Haar wavelet transform. From the Table 3, it can be observed that, whenever a Snow blizzard is present in the feature extracted image in frequency domain square root balance-sparsity norm threshold value varies between 12 and 13. Soft threshold was chosen to find the value for square root balance-sparsity norm, because this procedure does not cause non-continuants at

$$c(k) = \pm .$$

Fig. 3. Original input satellite image

The soft threshold expression is shown in equation (1).

$$\bar{c}_S(k) = \begin{cases} sign\, c(k)(c(k) - t), & c(k) \geq t \\ 0, & c(k) < t \end{cases} \quad (1)$$

For the determination of threshold values, equation (2) is used.

$$t = \sqrt{\frac{2s^2 \log(n)}{n}} \quad (2)$$

The equation (3) is used to calculate the variance.

$$s^2 = \frac{\sum (c(k_i) - \bar{c}(k))^2}{n-1} \quad (3)$$

Fixed threshold value is calculated by using equation (4).

$$t_k = \int_0^{255} \left(\frac{d\Delta}{dl} \sqrt{\frac{2s^2 \log n}{n}} \right) d \quad (4)$$

The prime objective of the research is to find the results that are as accurate as possible. Ideally, the proposed algorithm aims for 100% sensitivity and 100% specificity.

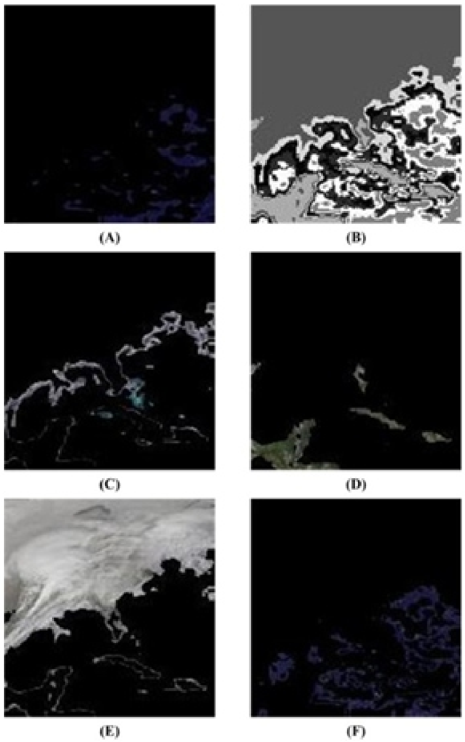

**Fig. 4. Images segmented as separate objects. (A) Cluster 1.
(B) Cluster 2. (C) Cluster 3. (D) Cluster 4. (E) Cluster 5. (F) Cluster 6.**

Fig. 5 Desired cluster image

The true positive (TP) specifies the positive tuples that were correctly labeled. The true negative (TN) specifies the negative tuples that were correctly labeled. The false positive (FP) specifies the negative tuples that are incorrectly labeled. The false negative (FN) specifies the positive tuples that are incorrectly labeled. The true positive rate, also called sensitivity, measures the rate of the accurately recognized positives. On the other hand, specificity quantifies the capability of correctly detecting negatives. The mathematical formulations of the two statistical measures are provided in equations 5 and 6. Using the defined measures, two other scores can be defined: the false positive rate (1 - specificity) and the false negative rate (1 - sensitivity).

$$Sensitivity = \frac{TP}{TP + FN} \quad (5)$$

$$Specificity = \frac{TN}{FP + TN} \quad (6)$$

Accuracy is related to the rate of correct results with respect to the whole domain basing on this factor the accuracy of this research are computed. Precision is the percentage of the accurately identified positives with respect to all positive results. The definitions are confirmed by the equations 7 and 8. In case of these measures, higher percentage refers to higher performances of the assessed segmentation algorithm and lower error rate percentage refers to more accuracy. The notations used in the research are given in Table 2.

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \quad (7)$$

$$Precision = \frac{TP}{TP + FP} \quad (8)$$

TABLE 2. Symbols and notations used for wavelength factor estimation

Symbol	Notation
$\bar{c}_s(k)$	Soft threshold value
$c(k_i)$	Wavelength of i^{th} Pixel
τ	Square root balance-sparsity norm threshold
σ^2	Variance of wavelength
n	Number of pixels
$\bar{c}(k)$	Mean wavelength
τ_k	Fixed threshold value
Δ	Correction factor
$\frac{d\Delta}{d\lambda}$	Wavelength factor
TP	True positive
TN	True negative
FP	False positive
FN	False negative

V.EXPERIMENTAL RESULTS

Snow Blizzard is one of the biggest and most brutal forms of a natural disaster, forecasting which can prevent lot of damage. Many researchers have put forward many theories which have turned to be inaccurate due to the lack of proper analysis and study of various parameters that involve in the formation of aSnow Blizzard. Mining of data from satellite images is even more challenging and cumbersome task since it involves processing of not one but hundreds of satellite images in order to extract the required results. The satellite images are obtained from Indian meteorological department and are used to analyze in order to identify the Snow Blizzard. The extraction of factors

TABLE 3. Values for variance, square root balance-sparsity norm threshold, wavelength factor and the wavelength

Image number	Standard deviation (σ)	Square root balance sparsity norm threshold (τ)	Wavelength factor $\left(\frac{d\Delta}{d\lambda}\right)$	Wavelength $(\lambda) = \tau * \frac{d\Delta}{d\lambda}$	Historically established result
image 56.jpg	2.94	12.05	38.75nm	559.12nm	Snow Blizzard
image 57.jpg	3.31	12.21	34.37nm	566.54nm	Snow Blizzard
image 58.jpg	2.97	12.52	38.29nm	580.92nm	Snow Blizzard
image 59.jpg	3.77	12.22	30.16nm	567.00nm	Snow Blizzard
image 60.jpg	3.30	12.61	34.50nm	585.10nm	Snow Blizzard
image 61.jpg	3.29	12.28	34.54nm	569.79nm	Snow Blizzard
image 62.jpg	3.71	12.86	30.67nm	596.70nm	Snow Blizzard
image 63.jpg	2.03	12.80	56.12nm	593.92nm	Snow Blizzard
image 64.jpg	2.11	12.31	53.84nm	571.18nm	Snow Blizzard
image 65.jpg	2.28	12.93	49.84nm	599.95nm	Snow Blizzard
image 66.jpg	2.29	12.06	49.62nm	559.58nm	Snow Blizzard
image 67.jpg	2.24	12.20	50.77nm	566.08nm	Snow Blizzard
image 68.jpg	2.31	12.27	49.25nm	569.32nm	Snow Blizzard
image 69.jpg	2.70	12.31	42.19nm	571.18nm	Snow Blizzard
image 70.jpg	2.49	12.36	45.61nm	573.50nm	Snow Blizzard

TABLE 4. Detection of snow blizzard

Image number	Standard deviation (σ)	Square root balance sparsity norm threshold (τ)	Wavelength factor $\left(\frac{d\Delta}{d\lambda}\right)$	Wavelength $(\lambda) = \tau * \frac{d\Delta}{d\lambda}$	Experimentally obtained result	Historically established result	Prediction
Image 1.jpg	2.62	12.18	46.65nm	565.15nm	Snow Blizzard	Snow Blizzard	TRUE
Image 2.jpg	2.44	12.65	42.94nm	586.96nm	Snow Blizzard	Snow Blizzard	TRUE
Image 3.jpg	2.65	12.67	43.15nm	587.88nm	Snow Blizzard	Snow Blizzard	TRUE
Image 4.jpg	2.64	12.06	42.94nm	559.58nm	Snow Blizzard	Snow Blizzard	TRUE
Image 5.jpg	2.65	12.57	47.25nm	583.24nm	Snow Blizzard	Snow Blizzard	TRUE
Image 6.jpg	2.41	12.16	50.63nm	564.22nm	Snow Blizzard	Snow Blizzard	TRUE
Image 7.jpg	2.25	12.66	47.25nm	587.42nm	Snow Blizzard	Snow Blizzard	TRUE
Image 8.jpg	2.41	12.68	45.41nm	588.35nm	Snow Blizzard	Snow Blizzard	TRUE
Image 9.jpg	2.50	12.63	47.43nm	586.03nm	Snow Blizzard	Snow Blizzard	TRUE
Image 10.jpg	2.52	12.53	45.17nm	600.80nm	Snow Blizzard	Non-Snow Blizzard	FALSE
Image 11.jpg	2.53	12.42	44.94nm	581.39nm	Snow Blizzard	Snow Blizzard	TRUE
Image 12.jpg	2.41	12.64	47.11nm	576.28nm	Snow Blizzard	Snow Blizzard	TRUE
Image 13.jpg	2.03	12.72	56.12nm	586.49nm	Snow Blizzard	Snow Blizzard	TRUE
Image 14.jpg	2.40	12.78	47.31nm	590.20nm	Snow Blizzard	Snow Blizzard	TRUE
Image 15.jpg	2.44	12.48	46.56nm	592.99nm	Snow Blizzard	Snow Blizzard	TRUE
Image 16.jpg	2.36	12.15	48.23nm	579.07nm	Snow Blizzard	Snow Blizzard	TRUE
Image 17.jpg	2.56	12.13	44.45nm	563.76nm	Snow Blizzard	Snow Blizzard	TRUE
Image 18.jpg	2.40	12.06	47.45nm	562.83nm	Snow Blizzard	Snow Blizzard	TRUE
Image 19.jpg	2.30	12.30	49.36nm	559.58nm	Snow Blizzard	Snow Blizzard	TRUE
Image 20.jpg	2.25	12.91	50.59nm	570.72nm	Snow Blizzard	Snow Blizzard	TRUE
Image 21.jpg	2.14	12.75	53.16nm	599.02nm	Snow Blizzard	Snow Blizzard	TRUE
Image 22.jpg	2.24	12.80	50.65nm	591.60nm	Snow Blizzard	Snow Blizzard	TRUE
Image 23.jpg	2.65	12.34	50.77nm	593.92nm	Snow Blizzard	Snow Blizzard	TRUE
Image 24.jpg	2.03	12.02	42.92nm	589.50nm	Snow Blizzard	Snow Blizzard	TRUE
Image 25.jpg	2.38	12.75	56.12nm	572.57nm	Snow Blizzard	Snow Blizzard	TRUE
Image 26.jpg	2.41	12.71	47.83nm	557.72nm	Snow Blizzard	Snow Blizzard	TRUE
Image 27.jpg	2.47	12.48	47.17nm	591.60nm	Snow Blizzard	Snow Blizzard	TRUE
Image 28.jpg	2.37	12.14	46.09nm	589.74nm	Snow Blizzard	Snow Blizzard	TRUE
Image 29.jpg	2.30	12.39	48.07nm	579.07nm	Snow Blizzard	Snow Blizzard	TRUE
Image 30.jpg	2.24	12.67	49.53nm	563.29nm	Snow Blizzard	Snow Blizzard	TRUE
Image 31.jpg	2.35	12.77	48.35nm	574.89nm	Snow Blizzard	Snow Blizzard	TRUE
Image 32.jpg	2.62	12.18	47.31nm	591.80nm	Snow Blizzard	Snow Blizzard	TRUE
Image 33.jpg	2.44	12.65	50.81nm	600.49nm	Snow Blizzard	Non-Snow Blizzard	FALSE
Image 34.jpg	2.65	12.67	48.35nm	587.88nm	Snow Blizzard	Snow Blizzard	TRUE
Image 35.jpg	2.64	12.06	49.04nm	592.52nm	Snow Blizzard	Snow Blizzard	TRUE
Image 36.jpg	2.64	13.01	44.55nm	603.66nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 37.jpg	2.62	13.14	43.80nm	609.69nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 38.jpg	2.45	13.26	44.55nm	615.26nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 39.jpg	2.51	13.01	43.12nm	603.66nm	Non-Snow Blizzard	Snow Blizzard	FALSE
Image 40.jpg	2.54	13.15	43.45nm	610.16nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 41.jpg	2.39	13.26	46.35nm	615.26nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 42.jpg	2.38	13.23	45.39nm	613.87nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 43.jpg	3.25	13.18	44.82nm	611.55nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 44.jpg	3.20	13.97	47.49nm	648.20nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 45.jpg	2.81	13.83	47.77nm	641.71nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 46.jpg	2.63	13.94	35.00nm	646.81nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 47.jpg	3.15	13.99	35.53nm	649.13nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 48.jpg	2.79	13.04	40.53nm	612.05nm	Non-Snow Blizzard	Snow Blizzard	FALSE
Image 49.jpg	2.84	13.76	43.22nm	638.46nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 50.jpg	2.75	13.95	36.06nm	647.28nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 51.jpg	2.84	13.18	40.80nm	611.55nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 52.jpg	2.84	13.29	40.09nm	616.65nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 53.jpg	2.64	13.99	41.35nm	649.13nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 54.jpg	2.62	13.24	40.07nm	614.33nm	Non-Snow Blizzard	Non-Snow Blizzard	TRUE
Image 55.jpg	2.45	13.10	40.09nm	610.66nm	Non-Snow Blizzard	Snow Blizzard	FALSE

which mainly affect the formation of Snow Blizzard are acknowledged and studied. Images contain primary lower attributes such as texture, pixel values and intensity. In this study, pixel values are considered as the main factor that is to be extracted from the satellite images. Using pixel values, wavelength is calculated and this wavelength is used for the detection of Snow Blizzard. In our study, the satellite images obtained from Canada, Europe and U.S meteorological departments, are analyzed to identify the presence of snow within the clouds.

On analysis of these satellite images using MATLAB R2011a, a square root balance sparsity norm threshold value is computed and established to be in between an optimal range of 12-13. As satellite image is a visible spectrum, its wavelength value always lies in the range of 400nm-700nm. Based on these criteria, the wavelength range for the feature extracted images is tested and on observation of these results, a range of 550nm-600nm is established for the clouds containing snow. If the input image lies within the established range then the particular clouded area is said to shower with snow.

The preliminary results presented in Table 4 shows that the wavelength of the Snow blizzard image is in the range of 550nm-600nm. Consider Snow blizzard image image23.jpg, its calculated wavelength is 593.92nm, thus lies in the established range. The predicted experimental result is Snow blizzard which is same as historical result. Also consider another Snow blizzard image image39.jpg, its calculated wavelength is 603.66nm which does not lie in the range established for Snow blizzard and the experimental result is no-Snow blizzard, contradicting with the historical result making the prediction to be wrong.

Similarly, let us consider a non - Snow blizzard image from Table 4. The image55.jpg calculated wavelength is 610.66nm which does not lie in the range and hence, the experimental result is no-Snow blizzard which coincides with historical result. Hence, the prediction is true. Now consider image48.jpg, a no-Snow blizzard image, its calculated wavelength is 612.05nm which lies in the range and found to be Snow blizzard image. But, the obtained experimental result contradicts with the historical result. Hence, the prediction is found to be wrong.

In the present research, 35 samples of core cloud images with Snow blizzard, 33 images are found to be predicting correctly, yielding an accuracy of 94.2% and 20 non Snow blizzard images are tested for the presence of Snow blizzard and 18 images are predicting their natural characteristic i.e., non Snow blizzard, yielding an accuracy of 90%. The mean accuracy for an image to predict the natural phenomenon is 92.1%.

The main goal of the research is to find the results that are as accurate as possible. Ideally, the proposed algorithm aims for 100% sensitivity, 100% specificity, 100% accuracy and 100% precision. From Table 4, the performance measures such as sensitivity, specificity, accuracy and precision are calculated using TP, TN, FP and FN for which the numbers of true positives are 28, true negatives are 26,

false positives are 2 and false negatives are 9 and the calculated values are shown in Table 5.

As the accuracy obtained from the present research is more than previous model, the proposed model proves to be more promising.

VI.CONCLUSION

This paper proposes an alternate and more accurate method of predicting a Snow Blizzard by choosing Square root balance- sparsity norm threshold and spectral characteristics of cloud in the visible and infrared spectrum to differentiate between snow blizzard and non-blizzard clouds from the satellite images. The methodology employed here surpasses previous approaches where radar images were processed. Therefore more accurate prediction of Snow Blizzards can be made by exploiting K-Mean clustering algorithm and coif wavelet transformations. The risk of getting deviating and inaccurate results due to presence of noise in radar images can be eliminated by utilization of satellite images for forecasting of Snow Blizzards.

TABLE 5. Performance measures for snow

Performance measure	Percentage (%)
Sensitivity	75.67
Specificity	92.8
Accuracy	83.07
Precision	93.33

VII.FUTURE ENHANCEMENTS

Additional parameters like dimension of the cloud, thermal velocity, temperature at the stratospheres and surface temperature effecting the precipitation of the cloud in the atmosphere can be considered which would be emphasized in our future work.

REFERENCES

[1]Ashok N. Srivastava and Julienne Stroeve, " Onboard Detection of Snow, Ice, Clouds and Other Geophysical Processes Using Kernel Methods," ICML 2003 Workshop on Machine Technologies for Autonomous Space Sciences.

[2]G. Singh, Y. Yamaguchi, S. E. Park and G. Venkataraman, "Identification of Snow Using SAR Polarimetry Techniques," International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XXXVIII, Part 8, Kyoto Japan 2010, pp.146-149.

[3]Albert Rango and Jaroslav Martinec, "Predictions for Snow cover, Glaciers and Runoff in a Changing Climate," HydroPredict 2008, pp.277-280.

[4]A. E. Walker and B. E. Goodison, "Discrimination of a wet snow cover using passive microwave satellite data," International Glaciological Society, Annals of Glacialogy 17 1993.

[5]Pascal Sirguey, Yves Arnaud and Muhammad M. Khan, "Improved Resolution for the Detection of Snow with MODIS Using Wavelet Fusion," IEEE, 2007, pp.3975-3977.

[6]Hyeungu Choi and Robert Bindschadler, " Cloud Detection in Landsat imagery of ice sheets using shadow matching technique and automatic normalize difference snow index threshold value decision," Elsevier, Remote Sensing Environment, March 2004.

[7]Naoya Maeda, Shun'ichi Kobayashi, Kaoru Izumi", Shigekazu KOUNO and Michihiro AMENOMORI, "Prediction of precipitation by Aneural network method,"Journal of Natural Disaster Science, 2001, pp.23-33.

[8]Fan Ke and Tian BaoQiang, "Prediction of Wintertime Heavy Snow Activity in Northeast China,"Atmospheric Science, 2012.

[9]B. B. Fitzharris and B. P. McAlevey, "Remote Sensing of Seasonal Snow Cover in the Mountains of New-zeland using Satellite Imagery","Geocarto International 1999, pp.35-44.

[10]Jeremie Bossu, Nicolas Hautiere and Jean-Philippe Tarel, "Rain or Snow Detection in Image Sequences Through use of a Histogram of Orientation of Streaks," Springer, 2011.

[11]Bruce J. McGurk and David L. Azuma, "Correlation and Prediction of Snow water Equivalent from Snow Sensors," USDA Forest Science Research Paper, 1992.

[12] J. M. Krijger, I. Aben and H. Schrijver, "Distinction Between Clouds and Ice/Snow cover Surfaces in the idenification of Cloud-Free observations using SCIAMACHY PMDs," Atmospheric Chemistry and Physics, 2005, pp.2729-2738.

[13] Julienne C. Stroeve and Anne W. Nolin,"New Methods to Infer Snow Albedo from the MISR Instrument with Apllications to the Greenland Ice Sheet," IEEE Geoscience and Remote Sensing, 2002, pp.1616-1625.

[14]Xiaolan Xu, Ding Liang, Konstantionos M. Andreadis and Dennis P. Lettenmaier,"Active Remote Sensing of Snow using NMM3D/DMRT and Comparision with CLPX II Airborne Data," IEEE Applied Earth Observations and Remote Sensing, 2010, pp.689-697.

[15]Jintang Lin and Xuezhi Feng, "Comparision of Snow Indexes in Estimating Snow Cover Fraction in a Mountainous Area in Nortwestern China," IEEE Geoscience and Remote Sensing Letters, 2012, pp.725-729.

[16]Terje Tjelta and David Bacon, "Prdicting Combined Rain and Wet Snow Attenuation on Terrestrial Links," IEEE Antennas and Propagation, 2010, pp.1677-1682.

[17]Jianjun Guo and Leung Tsang, "Mapping the Spatial Distribution and Time evaluation of Snow Water Equivalent with Passive MicroWave Measurements,"IEEE Geoscience and Remote Sensing, 2003, pp.612-621.

[18]F. Riche and M. Schneebeli, "Thermal Conductivity of Snow Measured by three independent Methods and Anisotropy considerations," The Cryosphere, 2013, pp.217-227.

[19]Noel Dacruz Evora and Dominique Tapsoba, "Combining Artificial Neural Network Models, Geostatistics, and Passive Microwave Data for Snow water Equivalent Retrieval and Mapping," IEEE Geoscience and Remote Sensing, 2008, pp.1925-1939.

[20]Richard L. Armstrong and Mary Jo Brodzik, "Northern Hemisphere Snow Extent Derived from Microwave and Optical Satellite Data," pp.1-7.

[21]Manjeeth Singh and V. D. Mishra, "Remote Sensing GIS based Statistical Modeling for Prediction of Natural Hazards," International Journal of Engineering Research and Technology, 2012.

[22]Hossein Zeinivand and Florimond De Smett, "Simulation of Snow Cover Area by a Physical based Model," World Academy of Science, Engineering and Technology, 2009.