ANALYTICAL RESULTS OF THE COMPUTER-PROCESS CALCULATING THE SNOWPACK WITH REMOTE-SENSED INFORMATION IN XINJIANG

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ABSTRACT:

The present paper have discused the results of calculating by using digital image processing system.We have used computers to carry out a great number of experimental explorations in processing the information from the remote-sense satellite images to calculate the snowpack in a part of XinJiang and toexplore the relation of the annual snowpack and natural calamity in the area, and the high mountain-snowpack and seasonal temperature, the relations of the snowpack and native water resource, finally,to determine the law of snowpack distribution in the area.

KEY WORDS: Landsat, Image Processing, remote sensing application,. Image Analysis, Snowpack, Xinjiang.

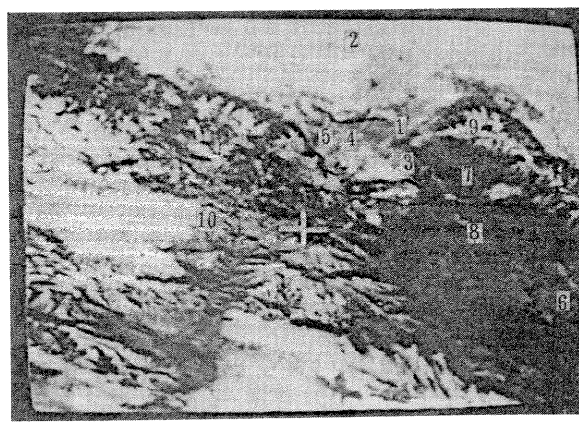
1. INTRODUCTION

A simply realizable and real economic way for calculating the amount of accumulated snow about certain area is to process the plentiful information in satellite images by computers. Nowaday,we receive contiously image material about earth surface from satellite,these material have made already more advantages as large surface covered,accuracy in time and less expense. More than four years, we have made a great deal of exprimantal investigation on digital image processing system, and carried out a relative complete method for calculating the amount of accumulated snow in XinJiang with remote-sense information by computer.

Before using the digital image system processing the satellite image material to calculate the amount of accumulated snow,we used to completely several steps as following:

a). Make a precise geometric correction on satellite image material.Reference[4]; b).To realize the automatic ranging and make-window of the bonudary of exploring region in the digital image processing system , we must make the window expand and decrease according to the size of the images.Reference[5];c). In accordance with the real situation we may divide the exploring region into some local image information blocks with their own characteristics, conveniently . Reference[5]. d).Automatically discriminat and determine the gray scale of the accumulated snow and other characterics of earth in the image, particularly filtering process the image covering with the cloud.Reference[3];e).Determine the coefficients in calculation for the correction of errors of distortions and the basic ratio of surface.

In the experimental stage, we use the image material recieved by XinJiang earth station, these material come from American 3rd generation service weather satellite TIROS--N/NOAA/AVHRR and Feng yun No1. NOAA weather satellite with its AVHRR (advanced very high resolution meter)has five channels,including:visible, infrared,heat-infrared three channels. We may obtain the material of image data, snow surface scanning rate, snow surface temperture,etc. It may have more good effects for the image material with higher resolution. But there is not that those of facility in XinJiang China to receieve that remote-sense information.Our material from weather satellite have limitation:mainly without microwave exploring data for calculating the depth of snow disectly;and may estimate at large area for its low resolution.



Fig(1) The satellite image of U.R .

Our analyses and processhave taken the research object with the region about Urumqi XinJiang .(U.R.). Fig(1) show the satellite image of U.R. at Oct.1987. The land satellite image show the topography of U.R. in the middle section of TianShan Mountain, with altitude between 500M-5445M.Its topographic,geomorphic situation have its typical representivities. It had located just on the cross of the east-to-middle section of TianShan Mt. and the south-to-north zone of XinJiang.The two climates of the south and north side of TianShan effect this region alternatively, and the seasonal wind effect the snow seriously. ZhunGer Basin on the north side of the mountain and there are hinterland river:Urumqi River[3],Toutun River[4] Sautun River[5],flowing from south to north.And Baiyang River[8] at DaBanCheng flowing toward east into Tulufan Basin. The capital of X.J.Autonomous Region has its city of Urumqi[1] on the altitude of 918M. Bogeda Mountain[9] with white cap(5445M)in the east, and in the south west there is Tianger Mountain [10] (5289M), although without long distance between each other,these two mountains have different characteristics of the distribution of snow pack. In U.R.there are several observatories for meteorology and hydrology, and the plenty data material had accumulated for many years which be convenient for real exploriation.That is the reason to make the selection to calculate the accumulated snow of U.R.as an example. If the calculating method is resolved for the local area snowpack processing, than it may be extend to analyse and calculate the snowpack about the whole region of X.J.

This paper may use the computer processed image as an example, base on the collective analysis of the data from the observatories to estimate the variation of accumulated snow in the period of snowpack on the exploring region for one year. Mainly,to discuss the statistical method with its principle and results analysis,working on the information of accumulated snow which taken from the remote-sense image material. The problem of the error correction exist in the whole process,particularly,to calculating the snowpack of larger region the elimination of error is most important.The method of error elemination in

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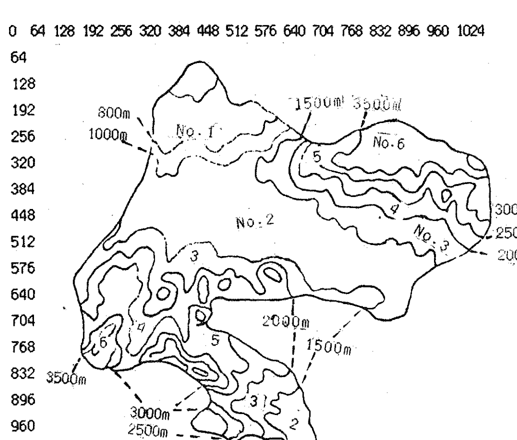
the whole process may discuss in other paper, here may touch a little at concerning paragraph.

2.ANALYSIS AND CALCULATING METHOD

2.1 Analysis of the Presentation Snowpack

To determine the depth of the snowpack in various place is the key problem of the calculation of the accumulated snow on certain area. It may show only the depth less than 36cm by the light reflection varying with the depth of snow, and it may be shown by the grey scale of infrared image with nice quality.Obviously,this measurement cannot realize the exploriation of snow depth in X.J.China, for the depth more than 36cm at most region of mountain in X.J . when winter. These places are very complicated in geomorph and topograph,high mountain with steep slope , and the snow more concentrate to the gorge and canyon.The distribution of snow be different for the slope tendencies, direction of the slope surface and adjacent basins;and it be effected by temperature of the local environment extra ordinarily.Most of these area cannot set an observatory. So at certain region the quantity of accumulated snow must be the result infered by the computer with the synthesis of various measuring and processing data.

Now we discuss the inference of snowpack with the situation of U.R. The position of U.R. is in the middle section of Tianshan with the range of longitude E86°38′～E88°58′ and latitude N43°15′～N44°15′,the area of 11440 km^2. Almost the whole region snowpack are variable in the period from the middle of November until the middle of Mar. next year, about four to five months. There is not severe hot weather in the short summer but the seasonal temperature difference is large.The atmosphere is dry for four seasons by the gigantic flow air. Almost all of the snowfall become seasonal snowpack, the snowfall in winter accumulated to next year when the temperature rise about 0°C be melted. The upper limit is the snowline and the lower limit of the seasonal snowpack vary with seasons and the situation on the south or north of the mountain. The permanent snowline swing about 3700M, it varied with average temperature and atmospheric environment change for times every year.Fig(1) &(2) shown most part



Fig(2) Marginal coordinate and contour line map of U.R.

of U.R. are below 3700M, its snowpack is in seasonal distribution.During the winter the atmosphere of U.R. mainly be controlled by the counter cyclone from Siberia and Mongolia, and in the summer air flow from Arctic Ocean and the West wind cycling flow enlarge its effection.By the alternate effection of this two seasonal flows the distribution of the snowfall in U.R.be more on the north than the south side of Bogeda and Tianger; and the snowfall be 25--35% of the total precipitation one year (local area may reach 40% or more).The snowfall make very different amount in November for years, the snow fall down and melt repeatedly, and without regulation; this period the snowpack is unstable.The snowpack stay in a storing period about middle Nov.to middle Feb.next year this period all region is covered by snow except the bushy area with low reflection and Dabancheng Region with its never snowpacking area in the midst of wind In this circumstance to search the rule of snowpack variation by processing and analyzing the image may gain unsuccesful result.The middle Feb to the beginning of May every year the accumulated snow on high mountain may be melted regularly with the atmosphere and surface tempreature of earth to change variously This period there is a effective method for search the rule of snowpack variation, that is to use the image information of snowpack calculating the covering rate in continous time;and taking about several years(at least three years)snow covering rate variation and the data material from land observatories, then using the correlation between the covering rate and the melting process of maximum snowpack decrease to permanent snowpack for solving this rule. Before process we have to certify the maximum and minimum (permanent) snowpack in this region for year and the time interval for variation from maximum to minimum snowpack. Also, the air flow, temperature,geograplic enviroment and the wind speed of that place with in that time all be considered.

2.2 Method of Analyzing the Snowpack Material

We had analyzed and processed some parts of the continuous satellite image material of the period Jun. 1989 to Mar.1992. We concluded the results and the analylitic and processed method as following: Divide U.R.into six zones for the altitudes as: below 1000M (zone No.1), 1000--1500M (No.2), 1500--2000M (No.3), 2000--3000M(No.4),3000--3700M(No.5) and above 3700 M (No. 6), and processing the image material of zones in digital image process system , Fig [2] and refer [5].We may take any zone independently for analysis, it is very useful for analyzing the distribution characteristics of accumulated snow. It has denoted the high way from Urumqi to Dabancheng cutting the geographic section of U.R. ;the left side is the south-west slope of Bogeda Mountain , the right side is north slope of Tianger Mountain.The parts of U.R. on the north slo pe of Bogeda and Tianger including Urumqi city almost are cultivated land with altitude below 1000M, about 1000--1500M the more low grass pasture and the less cultivated land,with in 1500--2500M altitude are conifierous band,and above 2500--3000M are bare rock band. The parts of U.R. on the south slope of Bogeda and Tianger with altitude 1000--1600M are sandy land,only less portions with water there are low grass pasture and little cultivated land, but little accumulated snow in winter; above 1600--2500M are bare rock band.

In accordance of above statement we may take image blocks with characteristics of geographic and snow pack distritution for calculating .First we calculated the area of snow and ice for each image block. Then take the real measeuring depth of snow on standard base points located at every image block to calculate the average snow depth . And calculate with this by computer for the local snowpack in each image block.At last sum up for total amount of accumulated snow. Here the real measuring data on standard base points and the material of snow and ice be utilized in later statement and calculation be offered by main observatories of U.R. far hydrology and metorology.Table(1) shown the geographic situation, average maximum temperature for several years, maximum depth of snowpack and the quantity of evaporation of Urumqi city, Xiaoquze,Dabancheng and Daxiguo meteorological observatories and the hydrological observatory at YinXungQiao within U.R.for the following statement.On this table all real measuring data on land surface are taken from formal announcements.

2.3 Approximate Calculation of Snow Pack

2.3.1 Snowpack in zone No.1 As shown in Fig(2), zone No.1 of U.R.(include City)situate on the north-

station	altitude	snowh depth	T℃		evaportion quantity(ml)		slope position
	m	cm	H	L	max	min	
U.qi city	918	19	2.5	-27.0	4.2	0.0	north slope
Daxigou	2100	29.0	4.8	-34.2	4.0	0.1	north slope
Dabancheng	1225	2.0	12.9	-25.2	9.8	0.3	south slpoe
Xiaoquze	1722	36.0	9.4	-29.3	3.2	0.1	north slope
Yinxunqiao	1920	46.0	-3.1	-29.5	-	-	north slope
Baluntai	1751	21.0	-2.2	-22.3	-	-	south slope

Table(1) Data from 4 main observatories in U.R.(offered by corresponding stations and the snow depths are maximum.)

west slope of Bogeda, with plain outlook and slight slant from south to north. In winter the depth of snow for everywhere almost be a same qantity, and the Ssnow pack may be

$$D_I(t)=A_I(t)*D_I(t) \qquad (2\text{-}1)$$

here $D_I(t)$ is the average depth of snow at several real measuring points of this zone with in same time, and with the unit m. $A_I(t)$ is the area of snow and ice of this zone for same time , may be defined by following equation

$$A_I=[\sum_{x=n}^{N}\sum_{y=m}^{M}\beta_{x,y}+0.5\sum_{x=i}^{I}\sum_{y=j}^{J}\rho_{x,y})\eta_I K_I \qquad (2\text{-}2)$$

eq.(2-2) for calculating the total area of snow distribution or other scenes. In above eq. :

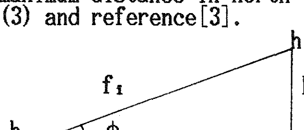
$$\beta_{x,y}=\begin{cases}1;\ \text{When } G>e \text{ in snowpack zone.}\\ 0;\ \text{other.}\end{cases}$$

$$\rho_{x,y}=\begin{cases}1;\text{When } G>e \text{ on the margin of snow pack zone.}\\ 0;\ \text{other.}\end{cases} \qquad (2\text{-}3)$$

The second term in eq.(2-2) right side is the sum of points which statistical snowpack or scenes margin varying at coloume position. The first term is the sum of all image elements encircle by the margin but except the second term.
K_I is area coefficient , the ratio of R_I the real geographic area of the measuring zone to L_I the total number of the image elements in window of the measuring zone. If in zone NO.1 the number of total elements in the window is L_1 equal to 1704 , real area R_1 is the valus of 936.6 KM^2,then,

$$K_1=R_1/L_1=936.6KM^2/1704=0.5496478KM^2$$

η_I is the corrective coefficient of error,determinted by factors as the shape of snow pack zone, geomorphic characteristics , proportional scale of this zone and the margin, etc . Altitude blow 1000m make $\eta_1=\sqrt{h_1^2+d_1^2}/d_1$,here h_1 is the altitude difference and d_1 is the maximum distance in north south direction. Refer Fig(3) and reference[3].
In the condition eq. (2-3) G is the gray scale, e is the limitation of gray for snow and other scenes in this zone.



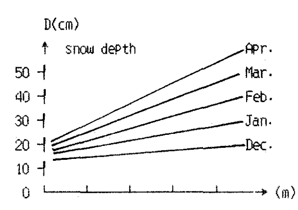
Fig(3) Slope relation

2.3.2 Snowpack in zone NO.2 As shown in fig(2), zone NO.2 of U.R mainly on the south slope east part of Bogeda,with mounds terrace sloped down from north to south gradually,and include the famous 30 Li windy zone of Dabancheng;recent years little snow pack. Consider the accuracy of total quantity of snow pack may calculate with eg.s(2-1) and (2-2);for it may be treated as gravel plain,and snow depth D_I approximat unify.But the correcting coefficients of error have using $\eta_2=\sqrt{h_2^2+d_2^2}/d_2$, here η_2 is altitude difference and d_2 is the maximum distance with in north south direction. The area coefficient K_2 be detemined by following:

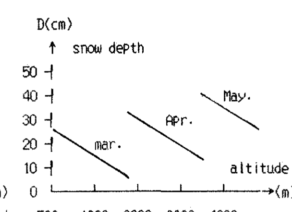
$$K_2=R_2/L_2=3545.72\ KM^2/L_2$$

here L_2 is the total number of image elements in zone NO.2.

2.3.3 snowpack in zone NO.3 As know in Fig (2), in regard the variation per year of the snow pack in zone NO.3, for the calculation we must know the snow depth distribution on the high mountain with altitude above 1500m. Here we make analysis on the rule of the variation of snow depth within zone NO.3 in the storing snowfall period. Fig(4) shows the snow depth distributed with altitudes for a month on north slopes of Bogeda and Tianger.In the accumulating period snow depth increase with altitude, linear slope increase with time. A respective analysis on south slopes is made also. The results shown for every month the snow depth be an increasing founction of altitude,the winter snowpack of mountain slopes with its depth distribution may be presented by an inreasing function of altitude,averagely.



Fig(4) The distribution of maximum snow depth in accumulating period on north slopes of U.R. for years average .



Fig(5) the distribution of maximum snow depth in melting period on north slopes of U.R. For years average.

After accumulating period the snow depth of melting period is shown as Fig(5).This time interval the distribution of snow depth also has a linear relation with altitude as same in accumulating period . Zone NO 1 has its accumulating period till middle March, and followed by melting period. From middle March to the beginning of May, lowerpart of slope the snow be melted with the temperature rise ,and accumulated on higher parts ,the linear slop increasing rapidly. At the altitude about 3700M,the snow depth distribution have a approximeate linear slope for all the time in snow fall and melting period , that is the melted quantity independent of altitude.This seem contrary with the higher place the lower temperature and less melted quantity. Consider the surface heat equilibrium,the input and output heat depend on temperature include the latent term and the appear term . According to results of observation the appear term be positive,the latent term be negative ,and the sum of these two less than the equilibrated value of radiation .So in the melteing period for melted quantity the sun radiation is essential as comparing with temperature . The surface of snowpack receive radiation quantity independent with altitude ,the melted quantity in melting period are also independent to altitude and may be a constant.These results are obtaind by collecting and arranging real observed data from representative observatories in U.R.Refrence[1] By this analysis , we may obtain the characteristics of the snow pack distribution of mauntain slopes of

U.R. On the time interval from beginning accumalate snow time t_1 until the end time t_2, a place with altitude h_1 has accumlated snow depth $\Sigma D(h_1)$ having a proportionl relation with $\Sigma D(h_\circ)$ the accumulated snow depth at altitude $h_\circ$, and may be shown as following :

$$\sum_{t}^{t_1} D(h_1) = \alpha(h) \sum_{t}^{t_1} D(h_\circ) \quad) \quad (2\text{-}4)$$

$$t_1 \leqslant t < t_2, \quad t < t_1 \leqslant t_2$$

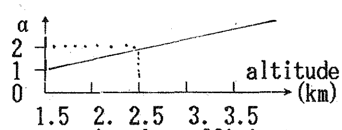
heve t is the time starting calculatiug, t_1 is the evding time. at shows a place with altitude h_1 and a basic paint with altitude $h_\circ$ both accumulated snow depth ase in proportional selation with same time starting is calculate.also eq(2-4)may show the slope $\alpha(h)$ increaseing with the altitude rise, and Fig(6) shows $\alpha(h)$ and h_1 oppearing a linear function relation, that is

$$\alpha(h) = \alpha(h_1) \cdot h + \alpha_\circ(h_\circ)$$

Here $\alpha(h)$ is called snow pack proportional coefficient . If we let $h_1 = h_0$ the basic point has proportional coefficient $\alpha_\circ(h_\circ) = 1$, $h = h_1 - h_0$, then,

$$\alpha(h) = \alpha(h_1)(h_1 - h_\circ) + 1 \qquad (2\text{-}5)$$

For the reason of that the distcibution of snow depth with linear sela-



Fig(6) snow pock proportioual coefficients α ralated to altitude h_1 on north slope of U.R.

tion to altitude, as shown in Fig (5), so the basic point may be selected at any where on the slope,only consider easily to observe and to take data.

By these sesults , if we have known on measure point with $h_\circ$ its accumulated snow depth and temperature T, then may calculate the snow depth of any altitude point.If in eq (2-4) a certain altitude h_1 point and $h_\circ$ point there are real measuring data,then may determine $\alpha(h)$ .By the known $\alpha(h)$ from eq.(2-5) may calculate $\alpha(h_1)$. For example, on south slope at points with altitude 1750m and 2750m calculating $\alpha(h_1)$ are equal to 1.08 and 1.20 respectively. And for the north slope points with altitude 1900m and 2500m calculating $\alpha(h_1)$ are 1.40 and 1.60 respectively. Then we use the caleulated $\alpha(h_1)$ and snow depth of basic point may calculating snow depth of any altitude for checking up the accuracy of above calculation , examine it by real measured data, if bacsic point located at Hejing (1100M), the $\Sigma D(h_\circ)$ is 18.0 cm , $\alpha(h_1$ # is 1.14 , and calculate the depth of Daxiguo(2100M) observatory is 20.6cm,the real measured value is 22.4cm the error is abaout 8%.If the basic point is located at Urumqi city (918m) with its $\Sigma D(h_\circ)$ 35.0cm, $\alpha(h_1)$ 1.41, then calcute the depth of Tianchi Observatory (1924M) is 49.35CM,real measured value is 55.0cm the error is 10.27%.Previqus calculating method caleulated its value and the real measured value there are errors between them almost less than 10%. This accuracy is available for actual calculatiog on large area.From calculated result may know altitude 1500--2500M the average srow pack depth D_J:

$$D_J = [D(h_r) + D(h_\circ)]/2$$
$$= [\alpha(h) D(h_\circ) + D(h_\circ)]/2$$

In the digital image processing system with eq(2-2) calculate the snowpack distribution area,then by the following equation calculating the quantity of snow pack, on the corresponding altitude Zone with in the accumulating period:

$$S_3 = A_3 W_3 [\alpha(h) D(h_\circ) + D(h_\circ)]/2$$
$$= A_3 W_3 \{D(h_\circ)[\alpha(h)+1]\}/2$$

For eq(2-5) more over:

$$S_3 = A_3 W_3 \{D(h_\circ)[\alpha(h_1)(h_1 - h_\circ) + 2]\}/2$$
$$= A_3 W_3 D(h_\circ)[\alpha(h_1)(h_1 - h_\circ)/2 + 1] \qquad (2\text{-}6)$$

On account of the difference between snow depth of south and north slopes in middle part of Tian shan, calculating individuly for south and north slope on above 1500M , then:

$$S_{31} = A_{31} W_{31} D_1(h_\circ)[\alpha_1(h_{11})(h_{11} - h_{\circ 1})/2 + 1]$$
$$S_{32} = A_{32} W_{32} D_2(h_\circ)[\alpha_2(h_{12})(h_{12} - h_{02})/2 + 1] \qquad (2\text{-}7)$$

In previons eq.s,$D(h_O)$ is snow depth on basic point, unit in M , A_3 is the area of snow pack of the zone No. 3 with in that period , may be calculated by eq.(2-2) but the correcting coefficient of error $\eta_3 = (h_1 - h_\circ) / \sin\phi = d_3 / \cos\phi$, as shown in Fig(3). d_3 may be obtained on image by mouse or in real calculation. The area coefficient k_3 may be determined by following eq:

$$K_3 = R_3 / L_3 = 2542.2126 KM^2 / L_3$$

In this eq. L_3 is the total number of image elements in zone No.3

<u>2.3.4 Snowpack in zone No.4 and No.5</u> For the same may as in zone No.3 we may get the eq.s of zone No.4 and No.5 repectively:

$$S_{41} = A_{41} W_{41} D_1(h_\circ)[\alpha_1(h_{11})(h_{11} - h_{\circ 1})/2 + 1]$$
$$S_{42} = A_{42} W_{42} D_2(h_\circ)[\alpha_2(h_{12})(h_{12} - h_{\circ 2})/2 + 1] \qquad (2\text{-}8)$$

and

$$S_{51} = A_{51} W_{51} D_1(h_\circ)[\alpha_1(h_{11})(h_{11} - h_{\circ 1})/2 + 1]$$
$$S_{52} = A_{52} W_{52} D_2(h_\circ)[\alpha_2(h_{12})(h_{12} - h_{\circ 2})/2 + 1] \qquad (2\text{-}9)$$

In these equations $D(h_\circ)$ is the snow depth of basic point,wrile in M,A_4 and A_5 are areas of snow pack of zone No.4 and No.5 respectively may be calculated by eq.(2-2) but the correcting coefficient of error $\eta_4 = (h_1 - h_0) / \sin\phi = d_4 / \cos\phi$, $\eta_5 = (h_1 - h_\circ)/\sin\phi = d_5 / \cos\phi$, as shown in Fig(3).The area coefficient K_4 may be determined by following eq:

$$K_4 = R_4 / L_4 = 2614.113 KM^2 / L_4$$

In this eq. L_4 is the total number of image elements in zone No.4. The area coefficient k_5 may be determined by following eq:

$$K_5 = R_5 / L_5 = 721.5 KM^2 / L_5$$

In this eq. L_5 is the total number of image elements in zone No.5.

In gereral , with in the altitude 1500~3700M, may divid the exploring region with different altitudes into n blocks, x=1,2,....n,and south and north slope denot by 1,2.Then the total quantity of snowpack within this region is equal to the snow of individul quantities. And may be calculated by following eq:

$$S_{xy} = \sum_{x=1}^{n} \sum_{y=1}^{2} A W_{xy} D_y(h_\circ)[\alpha_y(h_{iy})(h_{iy} - h_{\circ y})/2 + 1] \qquad (2\text{-}10)$$

Obviously, the more blocks divided, the sufficiently line dividing margins of blocks, This sum may have delicate valve.But cause the calculating complicated and large,The calculating interval and proccedure of process also be enlarged. Particularly, the measurements of basic point may be difficult, generally the real measuring on snow depth of basic point have take average value of points at a same contour line.

<u>2.3.5 Snowpack in zone No.6</u> As shown in Fig(2), above 3700M, near the top of montain the snow depth reversely decrease by hight for both south and north slopes of U.R,and previous distributing rule of snow depth is impracticable,reference [1].There are several reasons to cause this condition.This area take a little propotion of the total moutain area. The snow pack on this zone almost be the permanent snow pack,

may be melted in the interval from June to the begining of September, so make little effect with the spring flood every year, but more effect with the flow of four seasons rivers. The snow and ice quantity in this zone may be estimated according to average wind speed for year, quantity of snow and ice last year, average temperatuce per year, and gereral snow depth of U.R. The estimate eq. is :

$$S_6 = A_6 W_6 D_6 + S_7 \qquad (2\text{-}11)$$

Here the area A_6 calculated by eq. (2-2) and $\eta_6 = 1+21*10^{-7}$ determined by the average slope of this zone, area coefficient k_6 may be determine by following eq:

$$K_6 = R_6 / L_6 = 1084.8 KM^2 / L_6$$

In this eq. L_6 is the total number of image elements in zone No. 6. D_6 is determined by the accunmlated snow and depth from beginning snowfall to the measuring time. S_7 is the quantity of permanent snow and ice last year. This calculation all are based on total quantity as $61.9\times10^8 M^3$ arounced by the goverment in 1987, and estimate year by year. Finaly, in whole region the snow ice quantity of U.R. may be calculated:

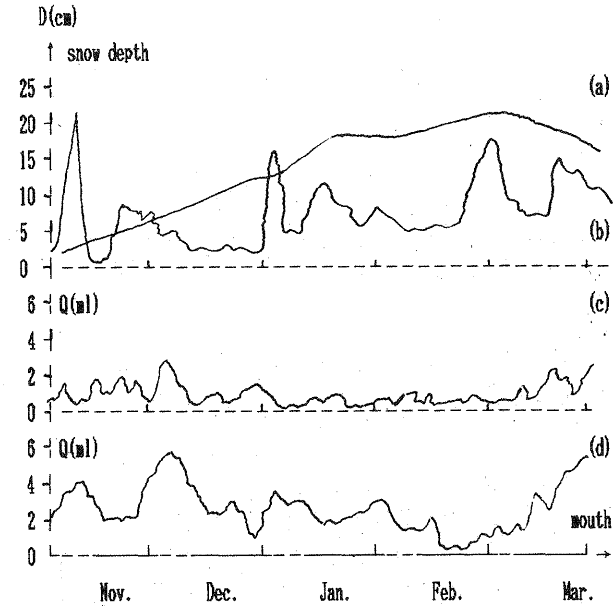
$$S = S_1 + S_2 + S_{31} + S_{32} + S_{41} + S_{42} + S_{51} + S_{52} + S_6 \qquad (2\text{-}12)$$

With processing the revnote-sense images of Aug.1990, we have the minimum snowpack this year as $3154.4 kM^3$, the maximum snowpack is $50.32*10^8 M^3$ for March 1991. Because of the average temperatize for 1990 is 6.5°C, it is highter than that of recent years , it is a rare dry year.And coincide with the condition of the retreated glacier , this tendency start at 1970 and retreated year by year ,for all glaciers in U.R .

3. CONCLUSION

Generally,about previous statement,all processes are compild for real programe with PASCAL language , and realized on WT--2 digital image process system , may analyses and estimate rapidly for snowpack information from any remote-sense image material with continuous or discontinuous in time.It is very suitable to use for measuring,analyzing and statistics on satellite image with in terms of areas and quantity of snowpack . The results from analyzing the processing satellite image be collated with real measured material,may give a satisfaction.As the base of synthesis and analysis, the collatting material include average maximum snowpack for several years on observatories with different altitude. The acquisitive material come from six metorological observatories (series limitation 1950-1980),4 hydrological observatories(series limitation 1960-1980 individual stations are short) and 4 main stations of U.R.(series limitation Nov.(beginning) 1990-March (end) 1992) . Also refered part material of Tianshan snow pack station of Acdemy of Science XingJiang China .

The variety of snow pack are complicate,diffrent for years, effected by environment,with the large temperature difference per a day,and the severe effection of air flow, in winter and spring the temperature unstable.For example,in Fig(1),the stations of Urumqi city and Dabancheng with a distance only 80km, and Dabancheng higher than the city about 200m,their snow pack be very differant. refer to Fig(7) (a) and (b),the temperature in city is slight higher and the time of variaty be a little fore . But in city their snow pack,the region nange YanHu to Dabancheng,their are little snow pack all year, mainly caused by the wind speed much larger . Refer Table(2) , there is effection of blown snow, and evaporing quantity per day much larger than that of city [Refernce Fig(7) (c) and (d)].And other regions,generally,above 1700m, the distribution of snow pack are stable.May use the sliding average value with in ten days of average



Fig(7) The variation of years snowpack depth and avaporing quantity
[(a) and (c) shown the Urumqi city,(b) and (d) shown the Dabancheng]

mouth	Nov	Dec	Jan	Feb	Mar	Apr
Urumqi city (918m)	1.8	1.2	1.2	1.5	2.3	3.3
Dabancheng (1225)	4.1	3.8	3.7	3.6	4.3	4.5
Tian shan station(3500	3.1	2.8	2.8	2.6	3.3	3.5

Table(2) Average wind speed in winter for several years unit: $M.sec^{-1}$

temperature per month to estimate the melting process can corresponding about temperature variety. It have to show, in satellite images, near top the snow pack decreased in U.R, and on bare rock there is not snowpack.It because the average wind speed per month much larger than that of mountain foot, and effected by blown snow for more complicated in the distribution of snow pack. Consequently, high mountain snow pack decreased, the snow be flown down into valleys and heaped to gorges and canyons, thus the snow pack estimation of snow pack and error elimination be more complicated.

For without the satellite image material of before middle of 1989, here we processed parts of satellite images of the interval Jan. 1989 to March 1992. So some result can not be concluded,particularly in the band above 2500m and the midest of wind at 1000-1500 m. Although have calculated approximatly the storing quantity, but can not collate by previous data with continous material, so only concluded later for more investigation.

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