Targeted Emissivity in Determining Land Surface Temperature

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ES 6973
Image Processing/Advanced Remote Sensing

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Purpose

To create a program that will create Land Surface Temperature (LST) determinations more accurately based on utilization of targeted emissivity values vice a single emissivity.
Emissivity

Ratio between radiant flux exiting real-world selective radiating body and a blackbody at the same temperature.

Sooo…

<table>
<thead>
<tr>
<th>Material</th>
<th>Emissivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>0.018</td>
</tr>
<tr>
<td>Green Needle Forest</td>
<td>0.991</td>
</tr>
<tr>
<td>Water</td>
<td>0.986</td>
</tr>
<tr>
<td>Green Grass Savanna</td>
<td>0.991</td>
</tr>
<tr>
<td>Roofing Paper</td>
<td>0.910</td>
</tr>
<tr>
<td>Arid Bare Soil</td>
<td>0.972</td>
</tr>
</tbody>
</table>
Land Surface Temperature

- Radiance:
  \[ L = 0.0370588 \times \text{High Gain Band 6} + 3.2 \]

- Brightness Temperature:
  \[ TB = \frac{1282.71}{(\varepsilon((666.09/L)+1))} \]

- Land Surface Temperature:
  \[ RT = \frac{TB}{1+(0.0007991666\times TB)\times \varepsilon(0.988)} \]
Radiance Formula

\[ \text{Radiance} = 0.0370588 \times \text{High Gain Band 6} + 3.2 \]

Predetermined Constants
Brightness Temperature Formula

Brightness Temperature = \frac{1282.71}{\varepsilon \left( \frac{666.09}{L} \right) + 1}
Land Surface Temperature

\[
\text{Land Surface Temperature} = \frac{\text{Brightness Temperature}}{1 + (0.0007991666 \times \text{Brightness Temperature}) \times \varepsilon(E)}
\]
Data

- NASA LANDSAT ETM+ Image
- Subset of Path 25, Row 38
- Projection: UTM, Zone 15N
- Datum: WGS 84
- Pixel Size: 30 Meters
Another View
Data

Classification: ROIs

- Green Needle Forest
Data

Classification: ROIs

- Green Grass Savanna
Data Classification: ROIs

- Arid Bare Soil
Data

Classification: ROIs

- Cloud
Data

Classification: ROIs

- Water
Data

Parallelepiped Classification

- Single Value
- 3.00 Maximum Standard Deviation from Mean

Water (Color: Yellow)

Clouds (Color: Thistle)
Data

More Parallelepiped Results

Green Needle Forest (Color: Bright Green)
Arid Bare Soil (Color: Red)
Green Grass Savanna (Color: Sea Green)
Classification Accuracy Assessment

- Confusion Matrix
- Overall Accuracy: 98.2574%
- Kappa Coefficient: 0.9863
Method

IDL Code

```idl
pro ems
B6=READ_TIFF('C:\ES6973\MyWork\band6.tif', CHANNELS=[0,1], geotiff=GTMODELTYPEGEOKEY)
; read Band6 to B6, and channel 0 is the low gain, channel 1 is the high gain
C=READ_TIFF('C:\ES6973\MyWork\classify.tif', CHANNELS=[0], geotiff=GTMODELTYPEGEOKEY)
; read classification image to C.
B6h=TRANSPOSE(B6(1,:,:))
; assign the high gain (channel 1) of Band6 to B6h
L=TRANSPOSE(0.0370588*B6h+3.2)
; calculate radiance
TB=TRANSPOSE(1282.71/(alog((666.09/L)+1)))
; calculate brightness temperature

arrdim=size(c, /dimensions)
; get the dimensions of the ETM
cols = 3768
rows = 4062
; c2 = bytarr(cols,rows)
for j = 0, cols-1 do begin
  for i = 0, rows-1 do begin
    if (c[j,i] EQ 1) then begin
      c[j,i] = 0.991
    endif else if (c[j,i] EQ 2) then begin
      c[j,i] = 0.986
    endif else if (c[j,i] EQ 4) then begin
      c[j,i] = 0.972
    endif else if (c[j,i] EQ 5) then begin
      c[j,i] = 0.991
    endif else begin
      c[j,i] = 0.0
    endelse
  endfor
endfor

RT=TRANSPOSE(TB/(1+(0.0007991666*TB)*alog(c)))
; supposing the same emissivity of 0.988
WRITE_TIFF('realT.tif', RT, geotiff=GTMODELTYPEGEOKEY, /FLOAT)
; write the temperature to an image called TM.tif
```
Method

IDL Code

pro ems

B6=READ_TIFF('C:\ES6973\MyWork\band6.tif', CHANNELS=[0,1], geotiff=GTMODELTYPEGEOKEY)
;read Band6 to B6, and channel 0 is the low gain, channel 1 is the high gain

c=READ_TIFF('C:\ES6973\MyWork\classify.tif', CHANNELS=[0], geotiff=GTMODELTYPEGEOKEY)
;read classification image to c,
B6h=temporary(B6(1,*,*)) ;assign the high gain (channel 1) of Band6 to B6h
L=temporary(0.0370588*B6h+3.2) ;calculate radiance
TB=temporary(1282.71/(alog((666.09/L)+1))) ;calculate brightness temperature
IDL Code

arrdim = size(c, /dimensions) ; get the dimensions of the ETM
cols = 3768
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Method

IDL Code

```
endfor
endfor

RT=temporary(TB/(1+(0.0007991666*TB)*alog(c))))
; supposing the same emissivity of 0.988
; supposing the same emissivity of 0.988
WRITE_TIFF,'realT.tif', RT,
geotiff=GTMODELTYPEPEGEOKKEY, /FLOAT
; write the temperature to an image called TMt.tif
```
Method

Emissivity Image
Conclusion

- Right Approach
  - Procedure Correct
- Unable to get single image with different classes
  - Due to IDL coding?
Comparison

[Two computer screens showing image comparisons]
Questions?