

1 **File S1: Code for re-projection and extraction of sub-datasets for remote sensing**
2 **images in batches, and calculating the monthly maximum ground temperature.**
3
4 The supporting information is organized in three sections. In the first section the code
5 for re-project remote sensing images in batches is provided. In the second section the
6 code for extracting sub-dataset of remote sensing images in batches is provided. And
7 the code needs to run with MRT (MODIS Reprojection Tool) software. In the third
8 section the code for extracting the maximum ground temperature per month from the
9 daily land surface temperature of the MOD11A1 data is provided.

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11 **Section 1. The code for re-project remote sensing images in batches.**

12 rem set the MRTDATADIR environmental var to the MRT data directory.
13 # define the path to MRTDATADIR
14 set MRTDATADIR=D:\MRT\bin\data
15 # re-projection using saved parameter file
16 for %%i in (*.hdf) do D:\MRT\bin\resample -p my.prm -i %%i -o %%iout.tif
17 # keep bat run window for error reminder
18 pause

19

20 **Section 2. The code for extraction of sub-datasets for remote sensing images in**
21 **batches.**

22 # define the path to MRTDATADIR

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23 set MRTDATADIR=c:\Modis\data
24 # put the file name of all data within a month in a TXT file
25 set /a DAY=start data
26 set /a DEADLINE=end data
27 :start
28 if %DAY% leq %DEADLINE% (goto ORDER) else exit
29 :ORDER
30 dir *%DAY%.*.hdf/a/b/s > MOSAICINPUT.TXT
31 # extract the LST_Day_1km band sub-dataset from HDF dataset
32 c:/Modis/bin/mrtmosaic.exe -i MOSAICINPUT.TXT -s "1 0 0 0 0 0 0 0 0 0 0 0" -o
33 MOSAIC_TMP_%DAY%.hdf
34 # copy the extracted data to the built R folder and delete the original daily data
35 copy MOSAIC_TMP_%DAY%.hdf  R& del MOSAIC_TMP_%DAY%.hdf
36 del *%DAY%.*.hdf
37 # extract the data of the next phase
38 set /a DAY= %DAY% + 1
39 goto start
40
41 Section 3. The code for calculating the maximum ground temperature per month
42 (the example for August 2009).
43 # install the necessary package
44 install.packages("sp")

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45 install.packages("raster")
46 install.packages("rgdal")
47 # load the necessary package
48 library(sp)
49 library(raster)
50 # path for the daily land surface temperature of the MOD11A1 data
51 path<- "E://2009/8"
52 # extracting the maximum ground temperature per month
53 fileNames<-dir(path)
54 filePath<-sapply(fileNames,function(x) {paste(path,x,sep="/")})
55 b<-array(1:43650,dim=c(194,225, length(filePath)))
56 for(n in 1: length(filePath)) {
57   R<-raster(filePath[n])
58   a <- as(extent(338000,546000,3750000,3930000), 'SpatialPolygons')
59   crs(a) <- crs(R)
60   A <- crop(R,a)
61   for (i in 1:nrow(b)){
62     for (j in 1:ncol(b)) {
63       t<-getValuesBlock(A,row=i,nrow=1,col=j,ncol=1)
64       T<-0.02*t-273.15
65       b[i,j,n]<-T
66     }
}

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67      }
68      }
69      B<-matrix(1:43650,nrow=194,ncol=225)
70      for (I in 1:nrow(B)){
71          for (J in 1:ncol(B)) {
72              B[I,J]<-max(b[I,J,])
73          }
74      }
75      # outputting monthly maximum ground temperature data in CSV format
76      write.csv(B,file = "E://R/200908.csv")
77      # outputting monthly maximum ground temperature data in TIF format
78      re<-raster(xmn= 337630.3,xmx= 546121,ymn= 3749957,ymx=
79      3929722,ncols=225,nrows=194)
80      for(N in 1: nrow(re)) {
81          for(M in 1:ncol(re)) {
82              re[N,M]<-B[N,M]
83              if(re[N,M]==-273.15) {
84                  re[N,M]<-NA
85              }
86          }
87      }
88      writeRaster(re,filename="E://R/200908.tif",overwrite=TRUE)

```

```
89 # outputting monthly maximum ground temperature data in JPEG format  
90 cols <- rev(heat.colors(50))  
91 setwd("E:/R")  
92 jpeg(file="200908.jpeg")  
93 plot(re,col=cols)  
94 dev.off()  
95
```

96 **File S2: R code for calculating normalized spectral entropy of the study region**

97

98 The supporting information is organized in two sections. In the first section the code
99 for the procedure “sim.Hsn” is provided. In the second section the code for calculating
100 the Normalized Spectral Entropy (H_{sn}) based on the monthly maximum ground
101 temperature and the predefined “sim.hsn” function is provided.

102

103 **Section 1. The “sim.hsn” procedure**

```
104   # load the necessary package  
105   library(TSA)  
106   # define “sim.hsn” function  
107   sim.hsn <-function(tseries, mw=3, bootreplicates=9999, demean=TRUE,  
108   detrend=TRUE,conf = 0.95, plot.hist = TRUE)  
109   {  
110   # check the package dependence and parameters  
111   check = suppressPackageStartupMessages(require(TSA))  
112   if (check != TRUE) stop("Please install the package TSA from CRAN")  
113   mw = as.integer(mw)  
114   if ((mw <=0) ||(mw > 6)) stop("Please check the mw parameter, wrong data type or  
115   value. Do not use windows bigger then 6.")  
116   bootreplicates= as.integer(bootreplicates)  
117   if (bootreplicates <= 0) stop("Please check the number of replicates.")
```

```

118 if (demean %in% c(TRUE,FALSE)==FALSE) stop("Please check the value of
119 demean.Must be TRUE or FALSE")
120 if (detrend %in% c(TRUE,FALSE)==FALSE) stop("Please check the value of
121 detrend.Must be TRUE or FALSE")
122 conf = as.numeric(conf)
123 if ((conf <=0) || (conf >= 1)) stop("Please check the conf parameter, wrong data
124 type or value. Must be within zero and one.")
125 if (plot.hist %in% c(TRUE,FALSE)==FALSE) stop("Please check the value of
126 plot.hist. Must be TRUE or FALSE")
127 # calculate the power spectrum for the different frequencies
128 periodog = spec(tseries, kernel=kernel('daniell', m=(mw-1)), log='no', plot=FALSE,
129 demean=demean, detrend=detrend)
130 periodog = periodog$spec
131 kermw = seq(from = -mw, to = mw, by = 1)
132 lengths = length(periodog)
133 # build main resampling matrix
134 MC = array(sample(kermw, (bootreplicates * (lengthts - 2* mw-2)),prob=rep(1,
135 (mw*2 +1)), replace=TRUE), dim=c(bootreplicates,(lengthts - 2*mw-2)))
136 for (i in 1:mw) {
137   if (i == 1) Ms = sample(seq(from = 0, to = mw, by=1),
138 bootreplicates,prob=rep(1, (mw + i)), replace=TRUE)

```

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139   Ms = cbind(Ms, sample(seq(from = (-i), to = mw, by=1),
140 bootreplicates,prob=rep(1, (mw +i+1)), replace=TRUE))
141 }
142 for (i in 1:mw) {
143   if (i == 1) Md = sample(seq(from = -mw, to = mw, by=1),
144 bootreplicates,prob=rep(1, (2*mw + 1)), replace=TRUE)
145   Md = cbind(Md, sample(seq(from = -mw, to = (mw-i), by=1),
146 bootreplicates,prob=rep(1, (2*mw +1 -i)), replace=TRUE))
147 }
148 MC = cbind(Ms, MC, Md)
149 MC = MC + t(array(rep(seq(1:lengthts), bootreplicates), dim=c(lengthts,
150 bootreplicates)))
151 # calculate the value of Hsn for the provided time series
152 N = length(periodog)
153 periodog[periodog == 0] <- 1e-07
154 periodogn = periodog/sum(periodog)
155 Hsn = -sum(periodogn * log(periodogn)) / log(N)
156 for (i in 1:bootreplicates){
157   nperiodog = periodog[MC[i, ]]
158   nperiodog[nperiodog == 0] <- 1e-07
159   nperiodogn = nperiodog/sum(nperiodog)
160   Hsn = rbind(Hsn, -sum(nperiodogn * log(nperiodogn)) / log(N))

```

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161      }
162      Hsn = as.vector(Hsn)
163      # output the results
164      cum.distr = ecdf(Hsn)
165      pvalue= cum.distr(Hsn[1])
166      cat("\n The value of Hsn is: ")
167      cat(as.numeric(Hsn[1]), "\n")
168      cat("\n The p-value is: ")
169      cat(pvalue, "\n")
170      th0 = Hsn[1]
171      th = Hsn
172      n <- length(periodog) #observations in rows
173      N <- 1:n
174      alpha <- (1 + c(-conf, conf))/2
175      zalpha <- qnorm(alpha)
176      z0 <- qnorm(sum(th < th0) / length(th))
177      th.jack <- numeric(n)
178      for (i in 1:n) {
179          serie2 = periodog[-i]
180          serie2[serie2 == 0] <- 1e-07
181          serien = serie2/sum(serie2)
182          th.jack[i] = -sum(serien * log(serien)) / log(n-1)

```

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183     }
184 
185     L <- mean(th.jack) - th.jack
186 
187     a <- sum(L^3)/(6 * sum(L^2)^1.5)
188 
189     adj.alpha <- pnorm(z0 + (z0+zalpha)/(1-a*(z0+zalpha)))
190 
191     limits <- quantile(th, adj.alpha, type=6)
192 
193     Ris = list("est"=th0, pvalue = pvalue, "BCa"=limits, bootstrap = Hsn)
194 
195     class(Ris) = "Hsn"
196 
197     cat("\n The BCa confidence limits are: ")
198 
199     cat(as.numeric(limits), "\n")
200 
201     cat("\n The p-values are: ")
202 
203     cat(adj.alpha, "\n")
204 
205     # plot results
206 
207     if (plot.hist == TRUE) {
208 
209         hist(Hsn, xlab="Hsn", main = "Bootstrap distribution of Hsn")
210 
211         abline(v=limits,col="red")
212 
213         abline(v=Hsn[1], col="blue")
214 
215     }
216 
217     return(Ris)}
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```

205  fileNames <-list.files(path,full.names = TRUE)

206  b<-array(1:43650,dim=c(194,225, length(fileNames)))

207  R<-matrix(1:43650,nrow=194,ncol=225)

208  for(n in 1: length(fileNames)) {

209  D<-read.csv(fileNames[n])

210  for (i in 1:194){

211      for (j in 1:225) {

212          b[i,j,n]<-D[i,j+1]

213      }

214      }

215  }

216  # call “sim.hsn” function

217  hsn<-array(1:43650,dim=c(194,225))

218  date<-c(1: length(fileNames))

219  for (I in 1:nrow(b)){

220      for (J in 1:ncol(b)) {

221          for(n in 1:length(fileNames)) {

222              date[n]<-b[I,J,n]

223          }

224  pippo = sim.hsn(date, bootreplicates=5000)

225  hsn[I,J]<-pippo$est

226      }

```

```

227     }
228 # output the resulted Hsn and Hsn map
229 write.csv(hsn,"E://Hsn.csv")
230 re<-raster(xmn= 337630.3,xmx= 546121,ymn= 3749957,ymx=
231 3929722,ncols=225,nrows=194)
232 for(N in 1:nrow(re)) {
233   for(M in 1:ncol(re)) {
234     re[N,M]<-hsn[N,M]
235     if(re[N,M]==1) {
236       re[N,M]<-NA
237     }
238   }
239 }
240 writeRaster(re,filename="E://Hsn.tif",overwrite=TRUE)
241 cols <- rev(heat.colors(50))
242 setwd("E:// ")
243 jpeg(file="Hsn.jpeg")
244 plot(re,col=cols)
245 dev.off()
246 # output the resulted Hsn and Hsn map for the study region
247 R<-raster("E://Hsn.tif")
248 a <- as(extent(338000,546000,3750000,3930000), 'SpatialPolygons')

```

```

249 crs(a) <- crs(R)
250 A <- crop(R,a)
251 x<- nrow(A)
252 y<- ncol(A)
253 for (i in 1:x){
254   for (j in 1:y) {
255     t<-getValuesBlock(A,row=i,nrow=1,col=j,ncol=1)
256     b[i,j]<-t
257   }
258 }
259 write.csv(b,file = "E://Hsn2.csv")
260 re<-raster(xmn= 337630.3,xmx= 546121,ymn= 3749957,ymx=
261 3929722,ncols=y,nrows=x)
262 for(N in 1:nrow(re)) {
263   for(M in 1:ncol(re)) {
264     re[N,M]<-hsn[N,M]
265   }
266 }
267 }
268 writeRaster(re,filename="E://Hsn2.tif",overwrite=TRUE)
269 cols <- rev(heat.colors(50))
270 setwd("E:// ")

```

```
271 jpeg(file="Hsn2.jpeg")
```

```
272 plot(re,col=cols)
```

```
273 dev.off().
```

```
274
```

Table S1. ANOVA of Hs_n of different roads and the area outside the road buffer with respect to land cover and elevation.

	Land covers	Source of difference	Sum of Squares	df	Mean Square	F	P-value	F crit
The Hs_n of road buffer and outside the buffer	High coverage grassland	Between Groups	0.068	1	0.068	5.724	0.017	3.846
		Within Groups	25.222	2132	0.012			
		Total	25.290	2133				
	Medium coverage grassland	Between Groups	0.200	1	0.200	23.144	<0.001	3.842
		Within Groups	137.264	15876	0.009			
		Total	137.464	15877				
	Low coverage grassland	Between Groups	0.090	1	0.090	9.622	0.002	3.842
		Within Groups	139.736	14895	0.009			
		Total	139.826	14896				
	Shrubbery	Between Groups	0.000	1	0.000	0.047	0.829	3.861
		Within Groups	2.477	484	0.005			
		Total	2.478	485				
	Unused land	Between Groups	0.004	1	0.004	0.213	0.644	3.844
		Within Groups	64.734	3178	0.020			
		Total	64.739	3179				
The Hs_n of different roads buffer and outside the buffer	High coverage grassland	Between Groups	0.193	3	0.064	5.457	0.001	2.609
		Within Groups	25.097	2130	0.012			
		Total	25.290	2133				
	Medium coverage grassland	Between Groups	1.189	4	0.297	34.626	<0.001	2.372
		Within Groups	136.275	15873	0.009			
		Total	137.464	15877				
	Low coverage grassland	Between Groups	1.388	4	0.347	37.330	<0.001	2.373
		Within Groups	138.438	14892	0.009			

The H_{sn} of road buffer and outside the buffer	Shrubbery	Total	139.826	14896				
		Between Groups	0.025	4	0.006	1.209	0.306	2.390
		Within Groups	2.453	481	0.005			
		Total	2.478	485				
	Unused land	Between Groups	0.483	4	0.121	5.969	<0.001	2.375
		Within Groups	64.286	3179	0.020			
		Total	64.768	3183				
	3700-3900m	Between Groups	0.000	1	0.000	1.766	0.187	3.924
		Within Groups	0.025	114	0.000			
		Total	0.025	115				
	3900-4100m	Between Groups	0.013	1	0.013	0.768	0.381	3.851
		Within Groups	17.053	994	0.017			
		Total	17.066	995				
	4100-4300m	Between Groups	0.064	1	0.064	9.367	0.002	3.842
		Within Groups	86.726	12704	0.007			
		Total	86.790	12705				
	4300-4500m	Between Groups	0.043	1	0.043	8.004	0.005	3.842
		Within Groups	90.820	16742	0.005			
		Total	90.864	16743				
	4500-4700m	Between Groups	0.221	1	0.221	17.510	<0.001	3.842
		Within Groups	134.824	10690	0.013			
		Total	135.045	10691				
	4700-4900m	Between Groups	0.017	1	0.017	0.801	0.371	3.844
		Within Groups	91.671	4200	0.022			
		Total	91.688	4201				

	4900-5100m	Between Groups	0.092	1	0.092	3.199	0.074	3.854
		Within Groups	21.789	758	0.029			
		Total	21.881	759				
The H_{S_n} of different roads buffer and outside the buffer	3700-3900m	Between Groups	0.001	3	0.000	0.880	0.454	2.686
		Within Groups	0.025	112	0.000			
		Total	0.025	115				
	3900-4100m	Between Groups	0.103	4	0.026	1.499	0.200	2.381
		Within Groups	16.964	991	0.017			
		Total	17.066	995				
	4100-4300m	Between Groups	1.517	4	0.379	56.474	<0.001	2.373
		Within Groups	85.273	12701	0.007			
		Total	86.790	12705				
	4300-4500m	Between Groups	0.261	4	0.065	12.033	<0.001	2.372
		Within Groups	90.603	16739	0.005			
		Total	90.864	16743				
	4500-4700m	Between Groups	0.333	4	0.083	6.608	<0.001	2.606
		Within Groups	134.712	10687	0.013			
		Total	135.045	10691				
	4700-4900m	Between Groups	0.294	3	0.098	4.501	0.004	2.607
		Within Groups	91.394	4198	0.022			
		Total	91.688	4201				
	4900-5100m	Between Groups	0.178	2	0.089	3.106	0.045	3.008
		Within Groups	21.702	757	0.029			
		Total	21.881	759				

276 Difference is significant at the 0.05 level.