satin: a R package for extracting and visualizing satellite data for oceanographic applications

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Satellites, sensors

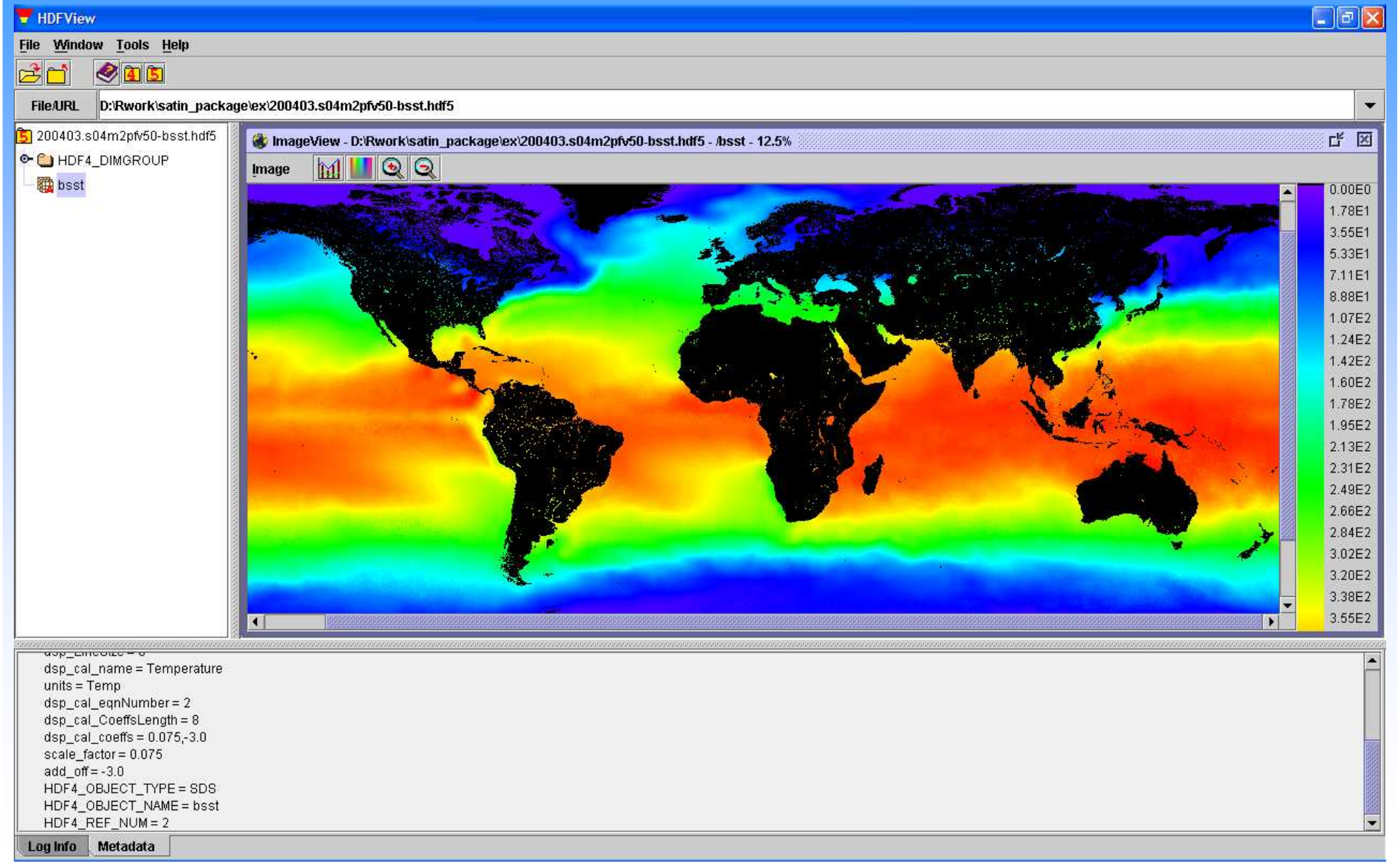
http://aspera.jpl.nasa.gov/download/pub/sea_surface_temperature/avhrr/pathfinder/data_v5

http://oceancolor.gsfc.nasa.gov/cgi/l3

ftp://podaac.jpl.nasa.gov/pub/ocean_wind/quikscat/L3/data/

Images: NASA

Hierarchical Data Format (hdf) files



Converting hdf version 4 files to v.5

```
`hdf4to5` <-
function(nom.hdf4, path2exe=NULL)
{
   nom.hdf5 <- paste(nom.hdf4, "5", sep="")
   if (is.null(path2exe))
     path2exe="D:/Rwork/AVHRR/h4h5-1.2-windows/bin/"
   h4h5cmd <- paste(path2exe, "h4toh5.exe", sep="")
   shell(paste(h4h5cmd, nom.hdf4, nom.hdf5, sep=" "))
}
```

From the HDFGroup:
http://www.hdfgroup.org/

```
> hdf4to5("200805.s04m3pfrt-bsst.hdf" )
```

satin functions

Functions for reading and displaying satellite data for oceanographic applications with R

Help pages for package 'satin' version 0.01

dbsst	SST sample data - Pathfinder sensor (AVHRR)
dchla	Chlorophyll sample data - Aqua Modis sensor
dmap	Map of northwest Mexico from GSHHS
dwind	Ocean wind sample data - Quikscat sensor
genColorArrows	Assigning colors to wind speed arrows
genColorPal	Generating color palettes for satellite data
get_DateString	Getting date or averaging period from an HDF file name
get_nomSST	Internal function
isotherms	Obtaining isotherms from SST data
quiverc	Easy maps of wind speed data
satinPlot	Easy maps of satellite data
simplifySat	Summarizing satellite data by quadrants
xtAVHRR	Extracting SST from AVHRR data in hdf format
xtModis	Extracting SST or Chl-a from Aqua Modis data in hdf format
xtQuikscat	Extracting ocean wind vectors from Quikscat data in hdf format
xtSensor	Extracting satellite data from several HDF files at once

Sample data

Palette functions

"Internal" functions

Mapping functions

Extraction functions

Internal functions

get_DateString( )
get_nomSST( )

```
> for (i in 1:length(fnames)) {
+     av.perio <- get_DateString( fnames[i] )
+     print(av.perio)
+  }
```

```
> fnames <- c(
"2007.s04y3pfrt-bsst.hdf",
 "200001.s04m3pfv50-bsst-16b.hdf",
"2000001-2000008.s0483pfv50-bsst-16b.hdf",
"2000001-2000005.s0453pfv50-bsst-16b.hdf",
"2007005.s04d3pfrt-bsst.hdf",
"2009031-2009035.s0453pfrt-sst.hdf",
"A20071822007212.L3m_MO_SST_4.hdf5",
"A20081222008152.L3m_MO_CHLO_4.hdf5",
"QS_XWGRD3_2008366.20090021524.hdf5",
"200901.s04w3pfrt-bsst.hdf“
)
```

```
[1] "2007"
[1] "Jan 2000"
[1] "1 - 8 Jan 2000"
[1] "1 - 5 Jan 2000"
[1] "5 Jan 2007"
[1] "31 Jan - 4 Feb 2009"
[1] "1 - 31 Jul 2007"
[1] "1 - 31 May 2008"
[1] "31 Dec 2008"
[1] "Week 1 2009"
```

extraction functions

Extracting SST from AVHRR data in hdf format

Description

Sea Surface Temperature data for a user defined area is extracted from Pathfinder hdf v5 files

Usage

```
xtAVHRR(nom.hdf5, lats, lons)
```

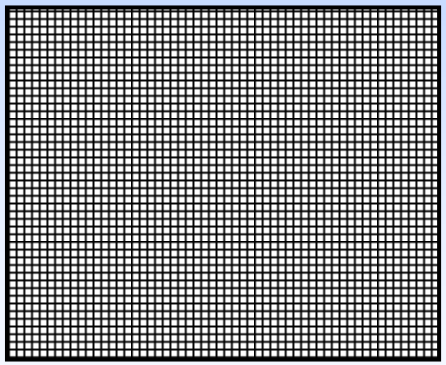
Arguments

`nom.hdf5`	name of the hdf file
`lats`	a vector with minimum and maximum latitude
`lons`	a vector with minimum and maximum longitude

```
> exo1 <- xtAVHRR( "2008121.s04d3pfrt-bsst.hdf5",
                   lats = c(22, 33), lons = c(-117, -106)  )
```

Structure of returned object

```
> class(exo1)
[1] "list"

> names(exo1)
[1] "longitude"   "latitude"   "sst"   "period"

> exo1$longitude[1:5]
[1] -116.96   -116.91   -116.87   -116.83   -116.78

> exo1$latitude[1:5]
[1] 22.03    22.08   22.12   22.17   22.21

> exo1$sst[1:5, 1:5]
         [,1]     [,2]     [,3]     [,4]     [,5]
[1,] 20.175   20.175   20.175   20.250   20.250
[2,] 20.175   20.175   20.175   20.175   20.175
[3,] 20.025   20.100   20.100   20.100   20.100
[4,] 20.025   20.025   20.025   20.025   20.100
[5,] 20.025   20.025   20.025   20.025   20.025
```



```
> exo1$period
[1] "30 Apr 2008"
```

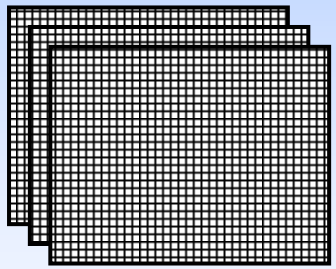
extraction functions

The extraction for aqua Modis is the same

```
exo2 <- xtModis("A20081212008128.L3m_8D_CHLO_4.hdf5",
                lats = c(22, 33), lons = c(-117, -106) )
```

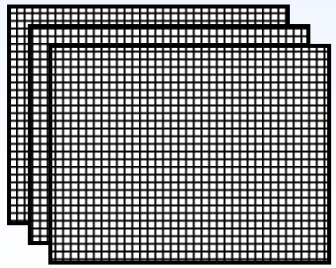
And also the structure of the returned object

```
>  class(exo2)
[1] "list“

>  names(exo2)
[1] "longitude"   "latitude"   “param"   "period"
```



Idem for QuikSCAT:

```
exo3 <- xtQuikscat("QS_XWGRD3_2008121.20081230017.hdf5",
                   lats=c(22, 33), lons=c(-117, -106) )
```

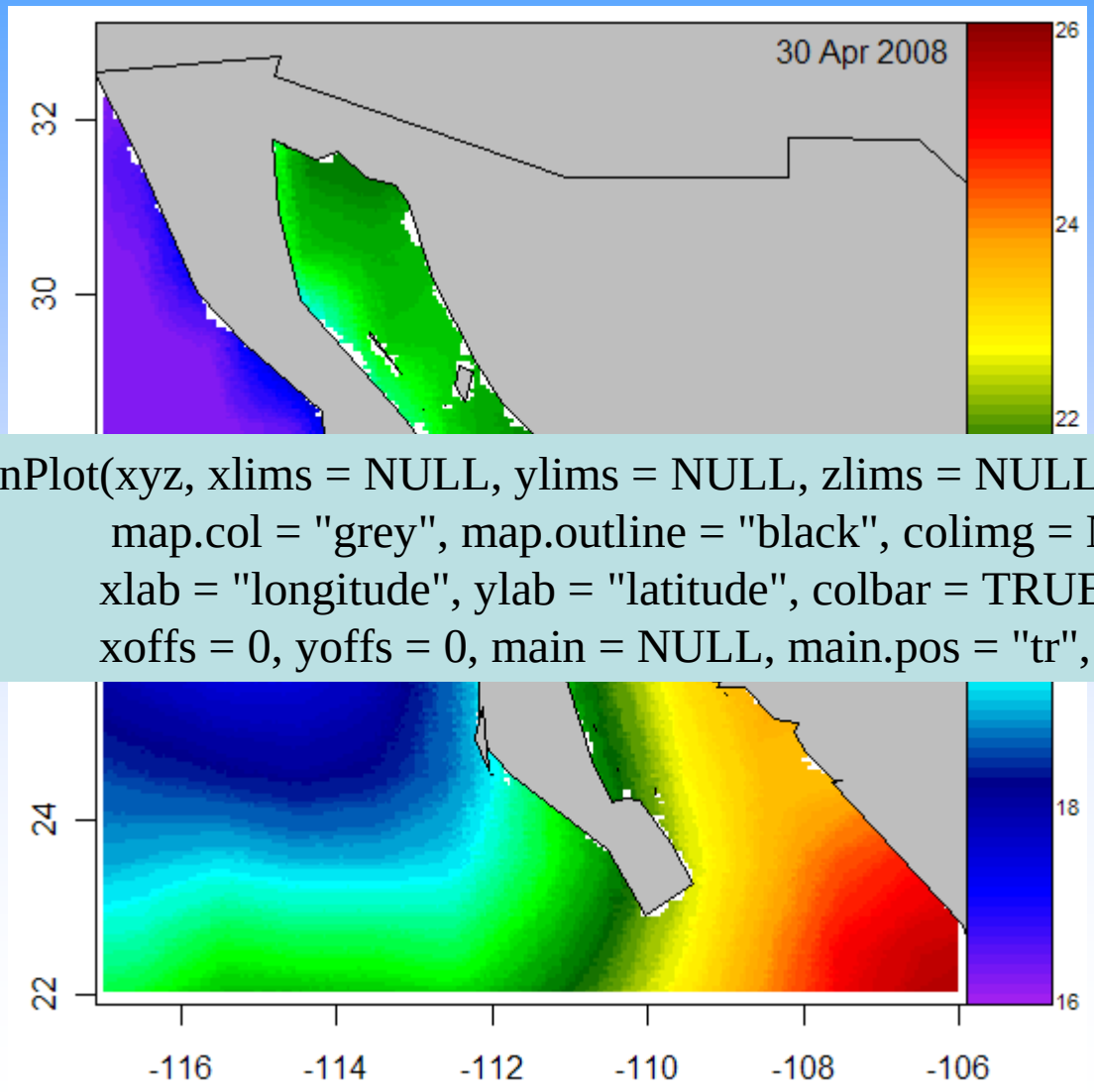


But its structure differs a little:

```
>  names(exo3)
[1] "longitude"   "latitude"   "ucomp"   "vcomp"   "period"
```

mapping functions (SST, Sea Surface Temperature, ℃)

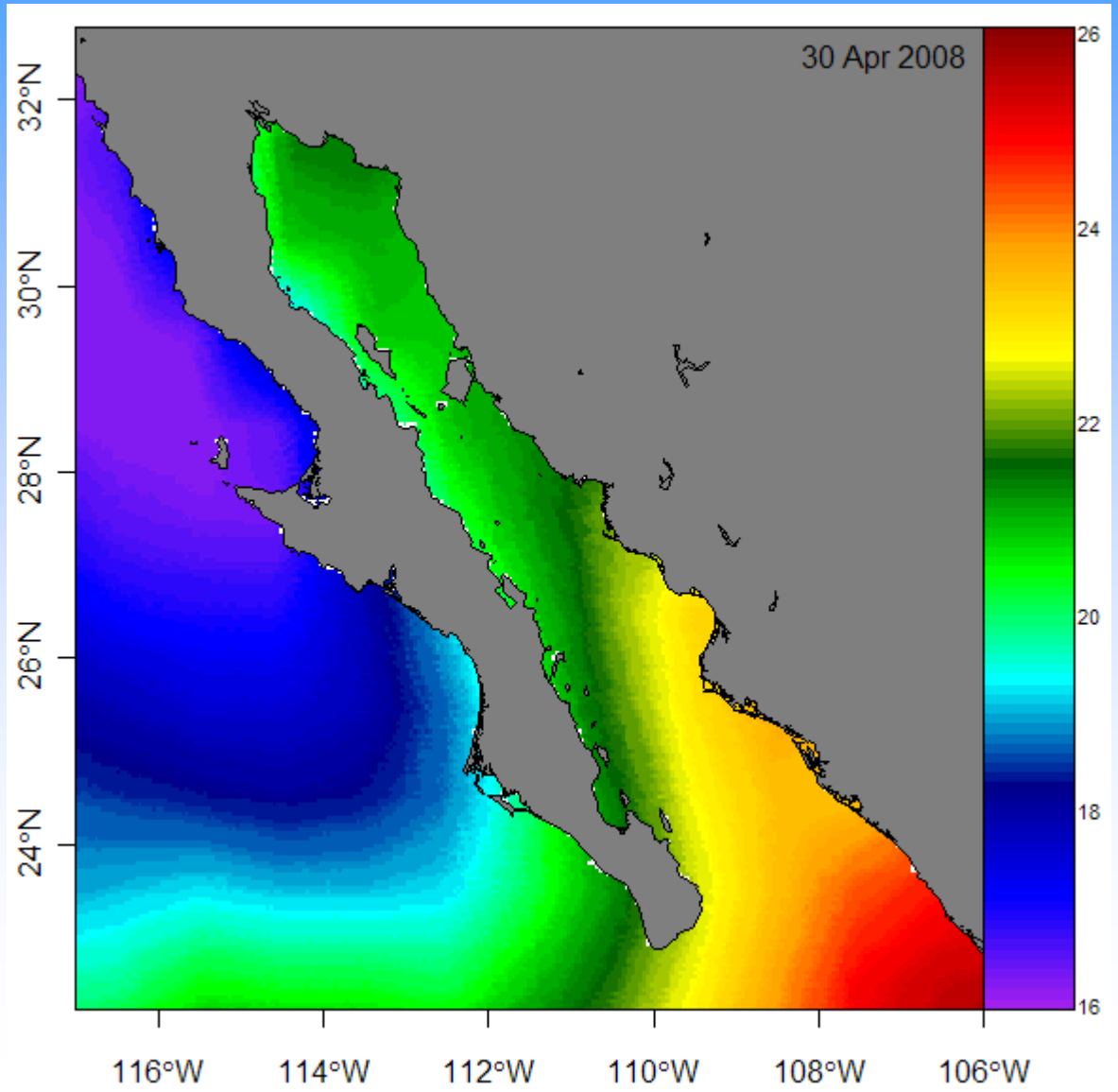
> satinPlot(exo1)



satinPlot(xyz, xlims = NULL, ylims = NULL, zlims = NULL, map = NULL,
map.col = "grey", map.outline = "black", colimg = NULL,
xlab = "longitude", ylab = "latitude", colbar = TRUE, colbar.pos = "r",
xoffs = 0, yoffs = 0, main = NULL, main.pos = "tr", ...)

mapping functions (SST, Sea Surface Temperature, ℃)

> satinPlot(exo1, map = nwmexico, map.col = "grey50", map.outline = "black", yoffs =1.2)



Map was obtained from:

“Global Self-consistent Hierarchical High-resolution Shoreline Database” (GSHHS)

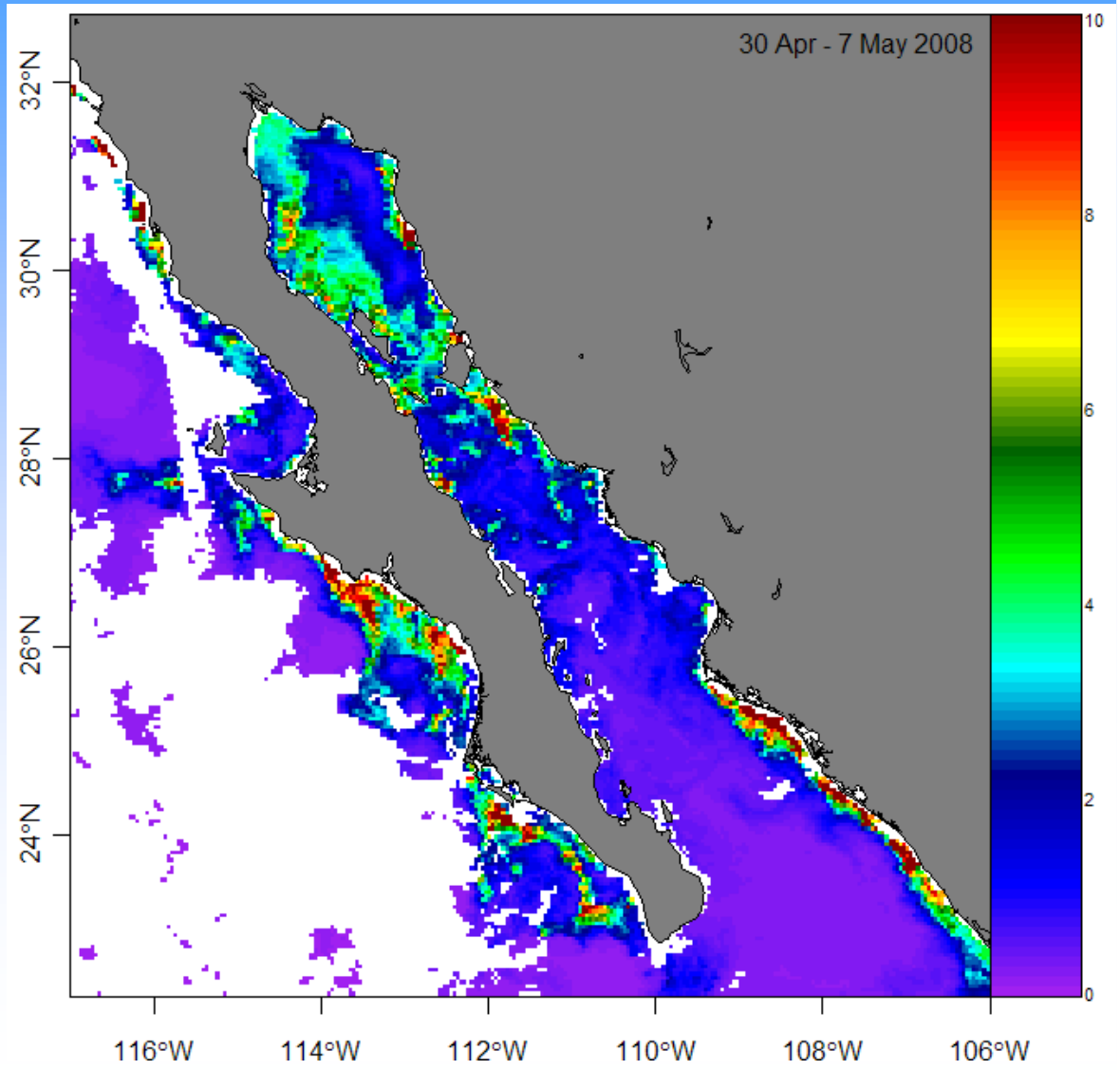
with function:

Rgshhs(maptools)

mapping functions (Chlorophyll a concentration, mg·m^{-3})

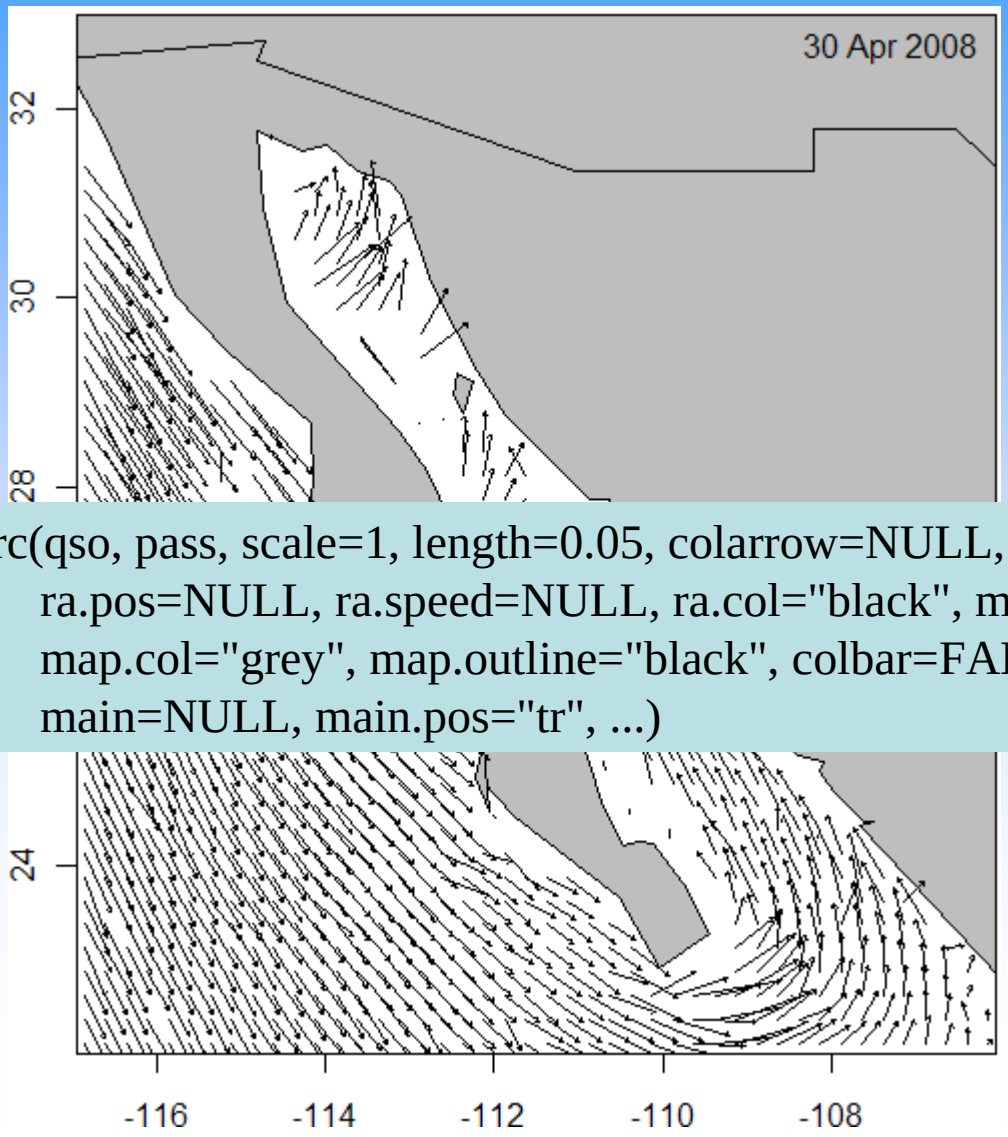
```
> cb <- genColorPal(0, 10, 0.1)
```

```
> satinPlot(exo2, zlim=c(0, 10),
  map = nwmexico,
  map.col = "grey50",
  map.outline = "black",
  colimg = cb, yoffs =1.2)
```



mapping functions (Ocean wind speed, $m \cdot s^{-1}$)

> quiverc(exo3, pass="mean")

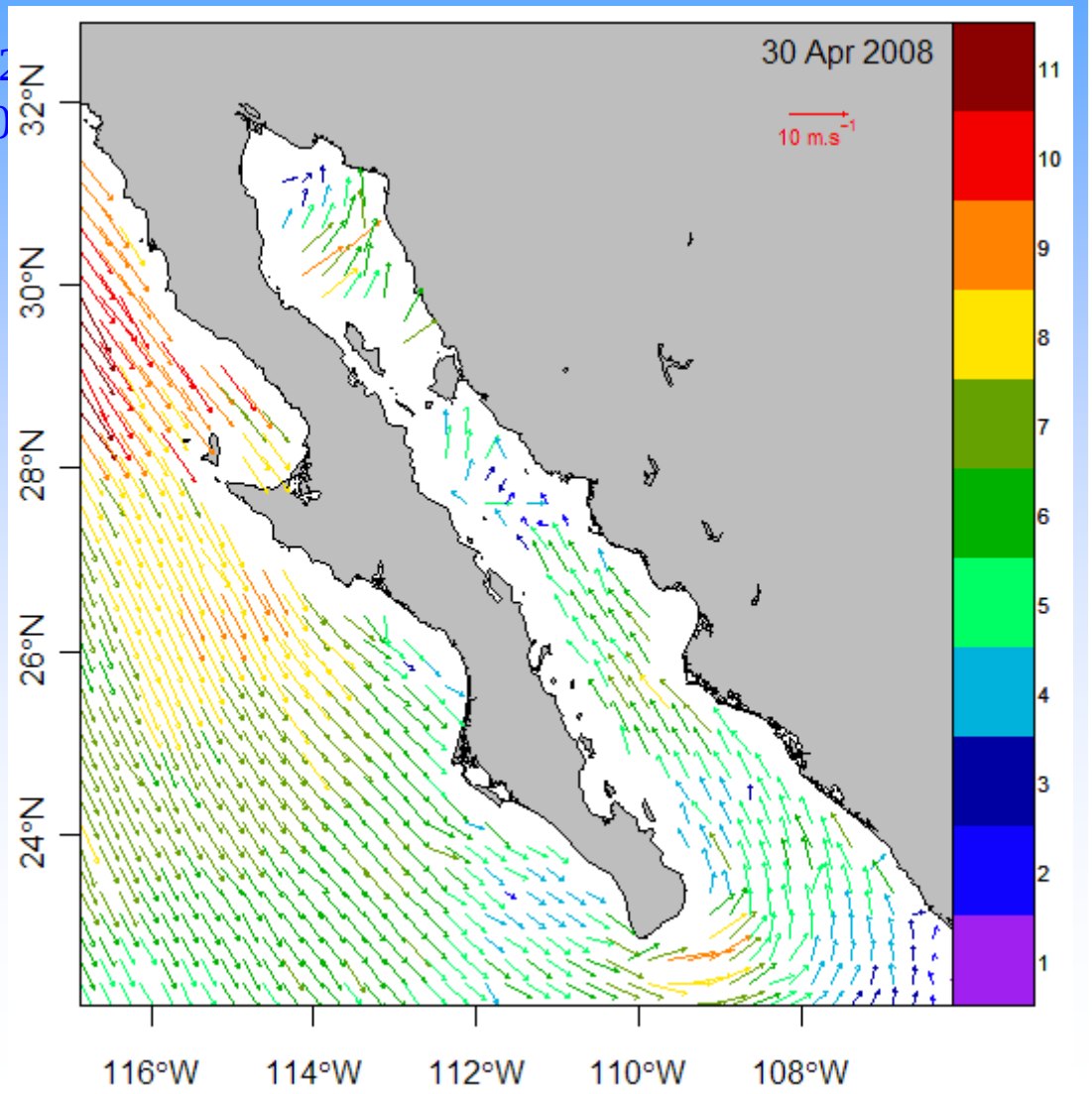


quiverc(qso, pass, scale=1, length=0.05, colarrow=NULL, add2map=FALSE,
ra.pos=NULL, ra.speed=NULL, ra.col="black", map=NULL,
map.col="grey", map.outline="black", colbar=FALSE, colbar.pos="r",
main=NULL, main.pos="tr", ...)

mapping functions (Ocean wind speed, m·s^{-1})

```
> cb2 <- genColorPal(0, 11, 1)
> colarr <- genColorArrows(exo3, pass="mean", cb2)
$pal
 [1] "#A020F0" "#0F03FD" "#0000A2"
 [6] "#00B100" "#65A100" "#FFE400"
[11] "#8B0000"

$breaks
 [1]  0  1  2  3  4  5  6  7  8  9 10 11
```

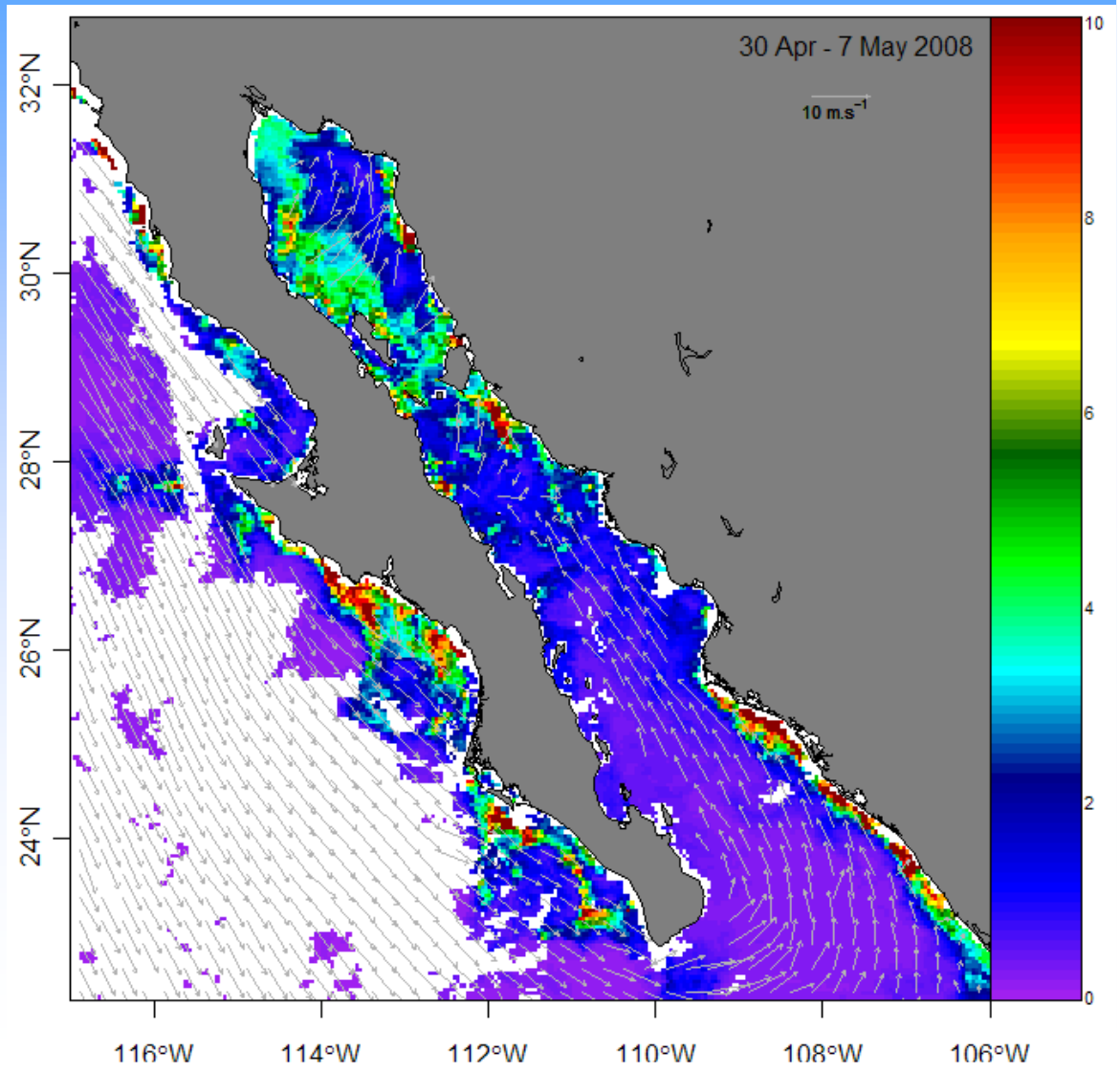
```
> quivers(exo3, pass = "mean",
    scale = 0.7, colarrow = colarr,
    add2map = FALSE,  ra.pos =
    c(-108, 30), ra.speed = 10,
    ra.col = "red", map = nwmexico,
    map.col = "grey", map.outline =
    "black", colbar = TRUE,
    colbar.pos = "r")
```



mapping functions (overlaying wind vectors)

> satinPlot(exo2, zlim=c(0, 20), map = nwmexico, map.col = "grey50", …)

```
> quiverc(exo3, pass="mean",
      scale=0.7, colarrow="grey80",
      add2map=TRUE,
      ra.pos=c(-108, 32),
      ra.speed=10, main="")
```

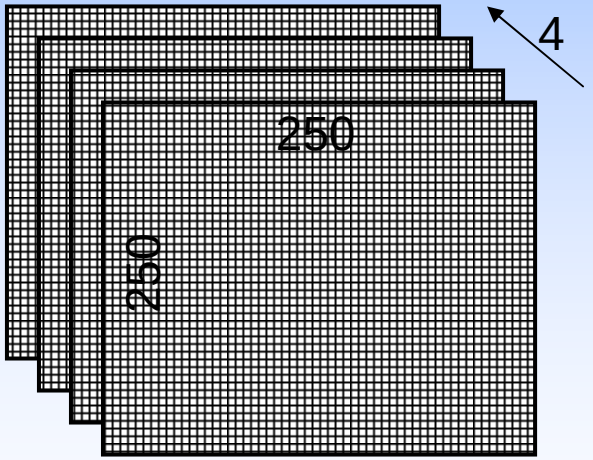


Processing several files at once

```
exo4 <- xtSensor(hdf5.files, lats = c(22, 33), lons = c(-117, -106),
                 sensor = "avhrr")
```

```
> names(exo4)
[1] "longitude"   "latitude"   "param"   "period"
```

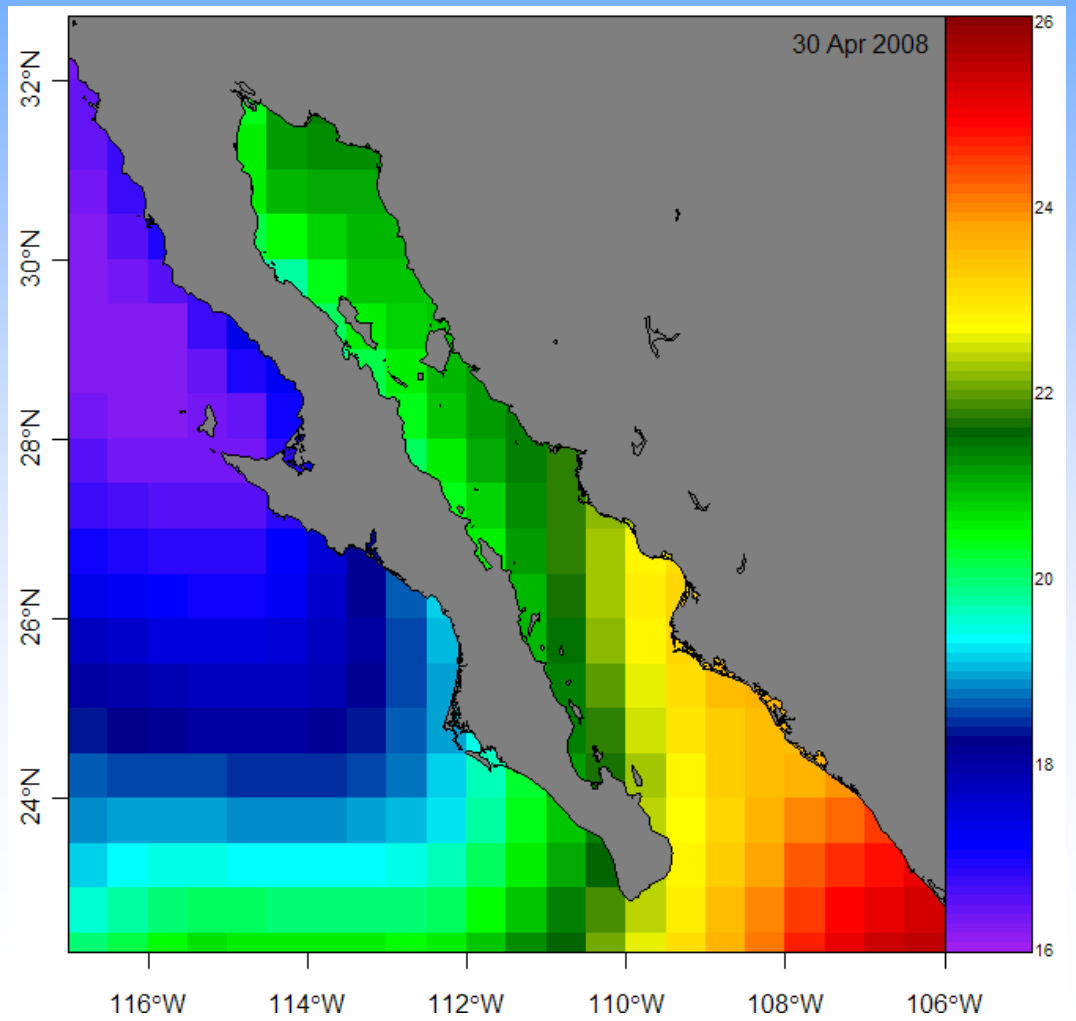
```
> class(exo4$param)
[1] "array"

> dim(exo4$param)
[1] 250 250   4
```




```
> exo4$period
[1] "30 Apr 2008"   "1 May 2008"   "2 May 2008"   "3 May 2008"
```

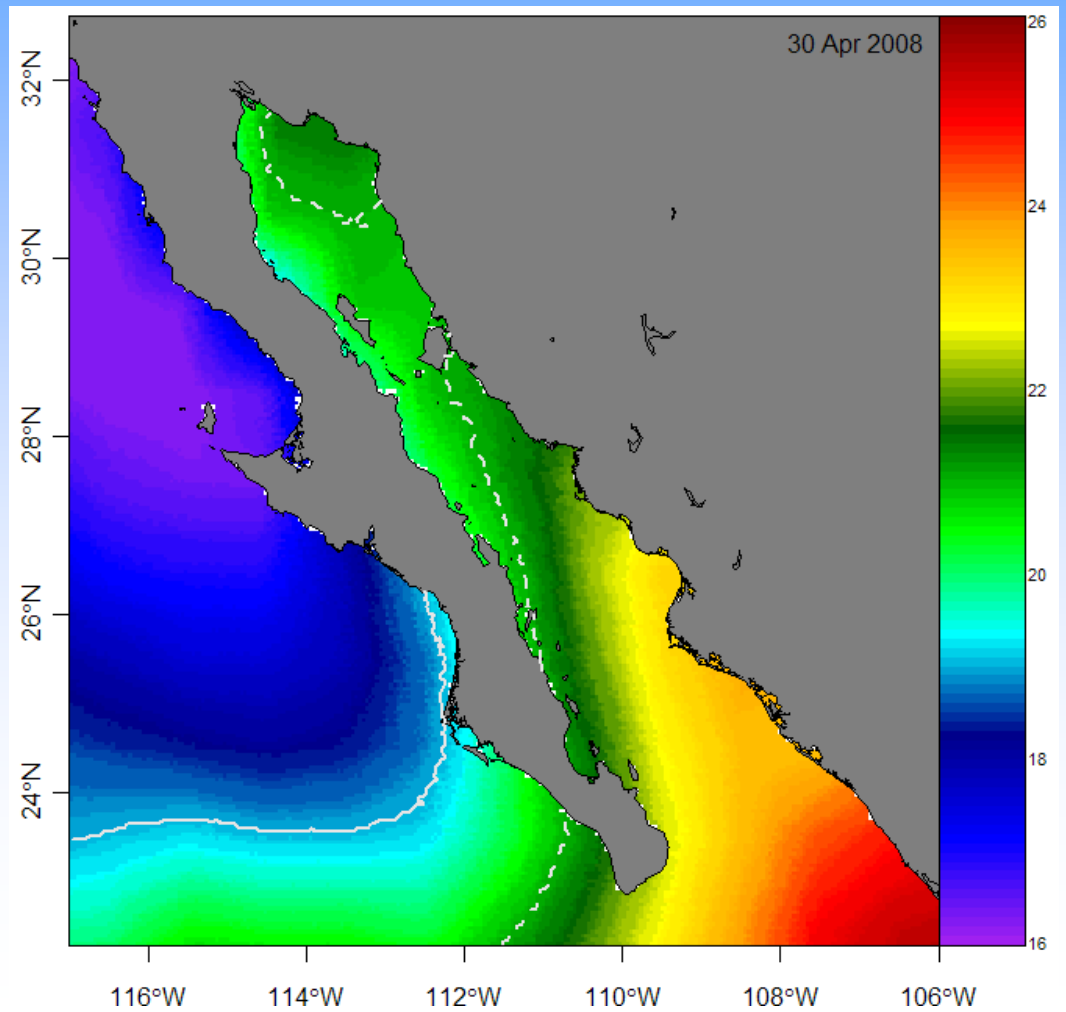
Summarize data by quadrants

```
> exo1.s <- simplifySat(exo1, extent=0.5, FUN=mean)

> satinPlot(exo1.s, map = nwmexico, map.col = "grey50", map.outline = "black",
            colimg = NULL, colbar = TRUE, colbar.pos = "r", xoffs = 0, yoffs =1.2)
```



Obtaining isotherms

```
> isot <- isotherms(exo1, tlevels=c(19, 21))

> satinPlot(exo1, map = nwmexico, map.col = "grey50“)
> addLines(isot$PolySet, col="grey90", lwd=2, lty=c(1, 2) )
```



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Nicholas J. Lewin-Koh and Roger Bivand, contributions by Edzer J. Pebesma, Eric Archer, Adrian Baddeley, Hans-Jörg Bibiko, Stéphane Dray, David Forrest, Patrick Giraudoux, Duncan Golicher, Virgilio Gómez Rubio, Patrick Hausmann, Thomas Jagger, Sebastian P. Luque, Don MacQueen, Andrew Niccolai and Tom Short (2009). **maptools**: Tools for reading and handling spatial objects. R package version 0.7-23. http://CRAN.R-project.org/package=maptools

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