Subject: spherical harmonics
Posted by Klaus Gottschaldt on Fri, 13 Oct 2000 07:00:00 GMT
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Hallo!

I want to analyze data on a sphere, representing them by spherical harmonic coefficients.
This is somehow like a Fourier transform, but based on Legendre polynoms, which are
defined on the surface of a sphere.
Unlike wavelets, this transform is global.
My data are given in the form [longitude, latitude, data_value], where longitude, latitude
and data_value are vectors of the same length.
Data points are randomly scattered over the sphere with a resolution of approx. 100km
on the Earth's surface.

Does somebody know, how to do this transform with idl?

Klaus

Subject: Re: spherical harmonics
Posted by Kenneth P. Bowman on Thu, 16 Jun 2011 13:42:45 GMT
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In article
<e6e92b27-4152-413e-945a-7f57232e3b55@p13g2000yqh.googlegroups.com>,
 parama mukherjee <parama2all@gmail.com> wrote:

> Hi,
> Does anybody know how to compute spherical harmonic transforms in IDL.
> Other than doing FFT followed by legendre transform?
> I have tried looking for it without much success so any help would be
> appreciated.
> Thanks,
> -Parama

Have you looked at SPHER_HARM? I haven't used it and don't know anything about its efficiency. It looks like it only computes the values of the spherical harmonics, but that is an essential step in computing the transform.

There are a number of technical issues with spherical harmonic transforms that you might need to be aware of. For example, global atmospheric models generally use a non-regular Gaussian

grid in the meridional direction to improve the efficiency and accuracy of the Legendre transforms.

NCAR provides a very mature and complete SH transform library called SPHEREPACK.

http://www.cisl.ucar.edu/css/software/spherepack/

It is a collection of Fortran programs, but could probably be compiled and called from IDL. It will handle both Gaussian and regular grids.

Ken Bowman

Subject: Re: spherical harmonics
Posted by parama mukherjee on Thu, 16 Jun 2011 16:03:37 GMT
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Hi,
I downloaded the Spherepack application but meanwhile also chanced upon the following code (I am posting only parts of it) in IDL that claims to do spherical harmonic transforms. I did not want to use a fortran/C code as I need to do transforms at every time step of my calculation and thought going to and fro between IDL and Fortran may not be very efficient. So if I can get this to work it will be really helpful. The problem with the code right now is I cannot follow what it means by collocation points, or the cp parameter that it lists as one of its input. I post below the parts where it mentions about collocation points :

```
;  spherical_transform.pro - This routine performs a spherical
harmonic
;                         transform on a 2-D array.
;
;  usage:  B = spherical_transform(A,cp,lmax=lmax,period=period)
;       where B(lmax,lmax) = transformed array ordered (l,m)
;             A(n_phi,n_theta) = array to be transformed ordered
(phi,theta)
;             cp = cosine of theta collocation points for theta grid
;             lmax = maximum l in expansion (default is (2*n_theta-1)/
3)
;             period = periodicity factor in phi

;  This routine performs a spherical harmonic transformation on a 2-D
;  (N_phi,N_theta) array.  Currently all the work is done in idl, but
future
;  versions may want to call C or Fortran routines for efficiency
```

reasons.
; The input parameters include the array A and the colocation points
for the
; grid (cos(theta)), which is of length N_theta, along with an
optional
; specification of lmax.

; preliminaries
costheta=double(cp)
 ---------- ----------
Now I was thinking maybe cp is an array of cos(theta) values for all
theta 0 - 180 but the costheta = double(cp) is unclear to me.
Please advice.
Thanks,
-Parama

Subject: Re: spherical harmonics
Posted by Kenneth P. Bowman on Thu, 16 Jun 2011 17:58:35 GMT
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In article
<15555635-f0d5-41cc-9550-65c5ca2600b3@n11g2000yqf.googlegroups.com>,
 parama mukherjee <parama2all@gmail.com> wrote:

> Hi,
> I downloaded the Spherepack application but meanwhile also chanced
> upon the following code (I am posting only parts of it) in IDL that
> claims to do spherical harmonic transforms. I did not want to use a
> fortran/C code as I need to do transforms at every time step of my
> calculation and thought going to and fro between IDL and Fortran may
> not be very efficient.

Note the comment in the code snippet you provided: "Currently all
work is done in idl, but future version may want to call C or Fortran
routines for efficiency reasons."

SH transforms (like the FFTs they include) are complex. You have to
weight the benefits of having a well-tested and highly-efficient
implementation in Fortran against the difficulty of linking an
external library.

You might want to start with Ronn Kling's book on calling C and
C++ from IDL.

> The problem with the code right now is I cannot follow what
> it means by collocation points.

Collocation points are the points at which the functions are
evaluated.

See, for example

http://en.wikipedia.org/wiki/Collocation_method

Ken Bowman

Subject: Re: spherical harmonics
Posted by parama mukherjee on Thu, 16 Jun 2011 20:50:38 GMT
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Thanks for the word of advice.
I am trying to work it out with Spherepack, alongside, I also want to
work with this code so maybe I can even go on and compare both results
at some point.
I cannot apply the concept of collocation points in wikipedia to this
case. I have a data set with data at every longitude and latitude grid
point, thats my input array. Now the output array will be of order
lmax,lmax with coefficients for various l's and m's. So where does
collocation point come into picture? and what does cosine(theta) have
to do with it? I tried using cp as an array with cos(theta(values for
theta : 90 : -90 but getting NaN answers.
-Parama

Subject: Re: spherical harmonics
Posted by parama mukherjee on Thu, 16 Jun 2011 21:07:59 GMT
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Hi,
Thanks for the piece of advice. So I downloaded the Sphere pack
application but at the same time would want to see this code work too.
Maybe can do a comparison later on.
Going by the definition in wikipedia for collocation point, I cannot
place it in the scheme of things here. Like my input array has data
points in a latitude-longitude grid and the ourput would be
coefficients for various l and m so what are collocation points and
what has cos(theta) to do with it. I tried cos(theta) : theta from -90
to 90 but does not work.
Could you please reflect on this?
Thanks,
-Parama
