Analysis Methods in Atmospheric and Oceanic Science

AOSC 652

Fourier Analysis in IDL

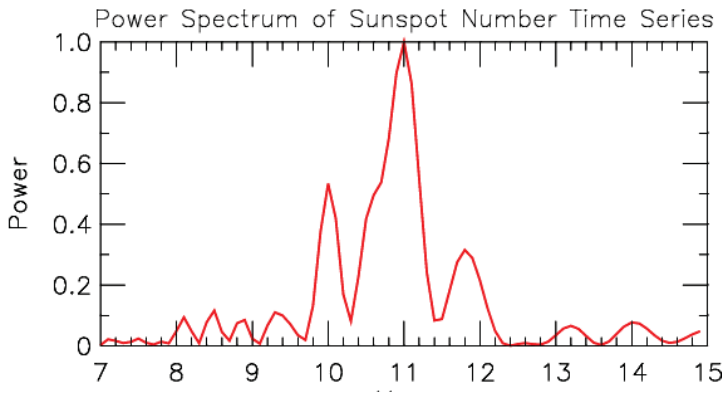
Week 9, Day 2

26 Oct 2016

AOSC 652: Analysis Methods in AOSC

Fourier Series and Spectral Analysis

Using program fourier_analysis.f (from Monday), find the Power Spectrum of the time series in file **sunspot_number_monthly.dat**, for time periods from **7 to 15 years** every **0.1 years** and ***display the results*** :



Let's see how we can do this example in IDL

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Fast Fourier Transform in IDL

Please copy the file ~tcanty/AOSC652/WEEK_09/sunspot.pro

```
read_file,'sunspot_number_monthly.dat',v1,h1

year=v1(0,*)
month=v1(1,*)
year_frac=v1(2,*)
sunspot_number=v1(3,*)

n=n_elements(year_frac)
```

n_elements returns the number of elements in the array

```
Determine the frequency of the FFT output
x1=findgen(n)
k=[lindgen(n2 + 1), reverse(-1+lindgen(n/2 – 1)))]
k1=k*(12./n)
Fs=12.
```

This is the number of data samples per unit of time

```
f=x1*Fs/n
t=1/f

g=fft(sunspot_number)
pow=abs(g)^2
pow_norm=pow/max(pow(2:n/2.))
```

The rest is just plotting!!!!!

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Fast Fourier Transform in IDL

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```
read_file,'sunspot_number_monthly.dat',v1,h1

year=v1(0,*)
month=v1(1,*)
year_frac=v1(2,*)
sunspot_number=v1(3,*)
```

Can try to improve fft frequency by “zero padding” but care must taken!!!

```
n=n_elements(2.*year_frac)
```

n_elements returns the number of elements in the array

```
Determine the frequency of the FFT output
x1=findgen(2.*n)
Fs=12.
```

This is the number of data samples per unit of time

```
f=x1*Fs/(2.*n)
t=1/f

sunspot_number1=lindgen(2.*n)
sunspot_number1(*)=0
sunspot_number1(0:n-1)=sunspot_number

g=fft(sunspot_number1)
```

What to do with irregularly spaced data?

Or… what is the sampling frequency of the observations are infrequent?

One way to fix this is to interpolate the data to regularly spaced time intervals.

Assume your sporadic data begins at year_begin=521 and ends at year_end=1972

1) Create a new time array

time_new=521+indgen(year_end-year_begin+1)

2) Interpolate to the new time array

data_new=interpolate(data,time,time_new)

3) Let's try something….
Change your time array so it begins and ends outside of the actual time range
Repeat step 2)

Inverse FFT

You can take your transformed FFT output and change it from frequency space back to time space.

g=fft(sunspot_number)
h=fft(g, /inverse)

Why would you want to do this?