HW3

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1 Niño 3.4 index

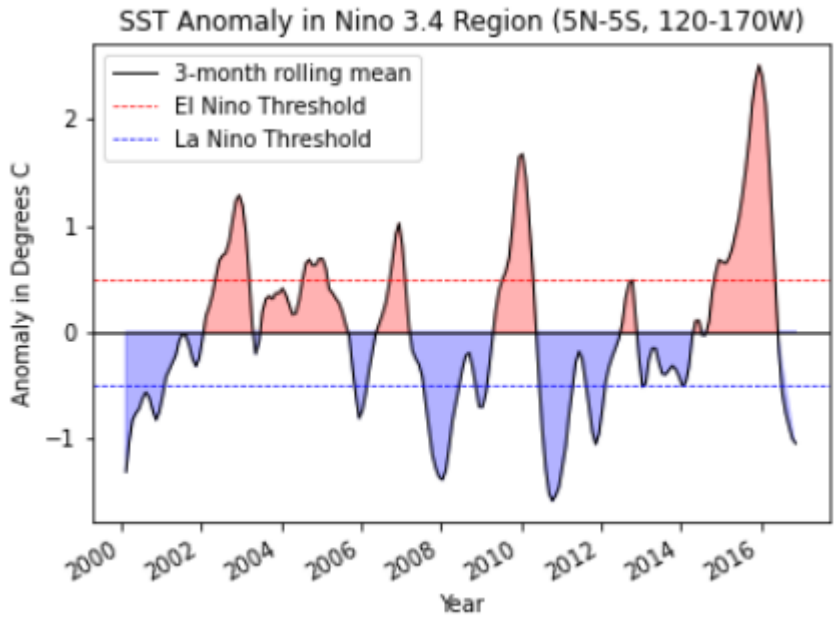
Data: NOAA_NCDC_ERSST_v3b_SST.nc

1.1 [5 points] Compute monthly climatology for SST from Niño 3.4 region, and subtract climatology from SST time series to obtain anomalies.

```
# Group data by month
group_data = ds.sst.sel(time=slice('2000','2020'),lat=slice(-5, 5), lon=slice(-170, -120)).groupby('time.month')#每个月group
group_data

# Apply mean to grouped data, and then compute the anomaly
sst_anom = group_data - group_data.mean(dim='time')#减去平均值得到每个月的异常值
sst_anom
```

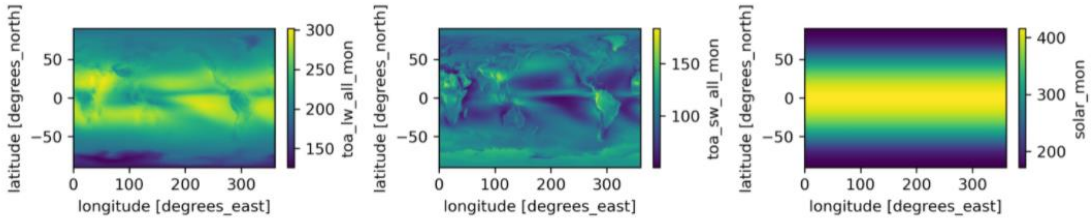
1.2 [5 points] Visualize the computed Niño 3.4.

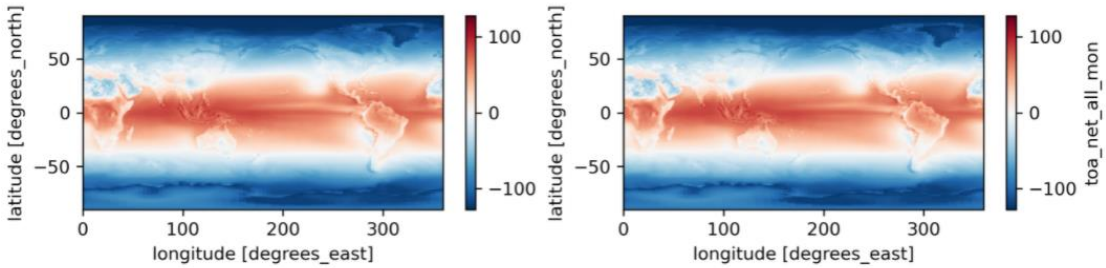


2 Earth's energy budget

Data: CERES_EBAF-TOA_200003-201701.nc

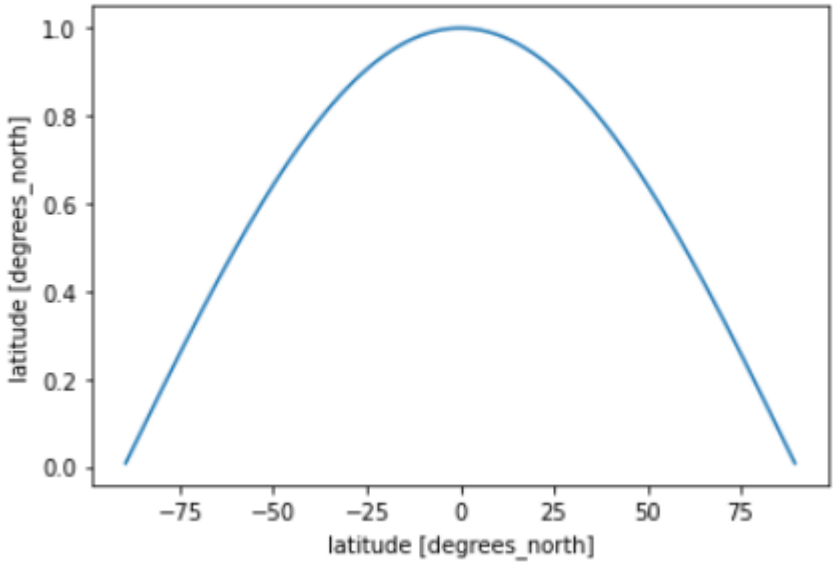
2.1 [5 points] Make a 2D plot of the time-mean TOA longwave, shortwave, and solar radiation for all-sky conditions. Add up the three variables above and verify (visually) that they are equivalent to the TOA net flux.





2.2 [10 points] Calculate and verify that the TOA incoming solar, outgoing longwave, and outgoing shortwave approximately match up with the cartoon above.
[Hint: Consider calculating the area of each grid]

```
[<matplotlib.lines.Line2D at 0x20d971a3280>]
```



```
print('TOA incoming solar:')
ds.solar_mon.weighted(weights).mean()
```

```
TOA incoming solar:
xarray.DataArray 'solar_mon'
array(340.28326598)
► Coordinates: (0)
► Attributes: (0)
```

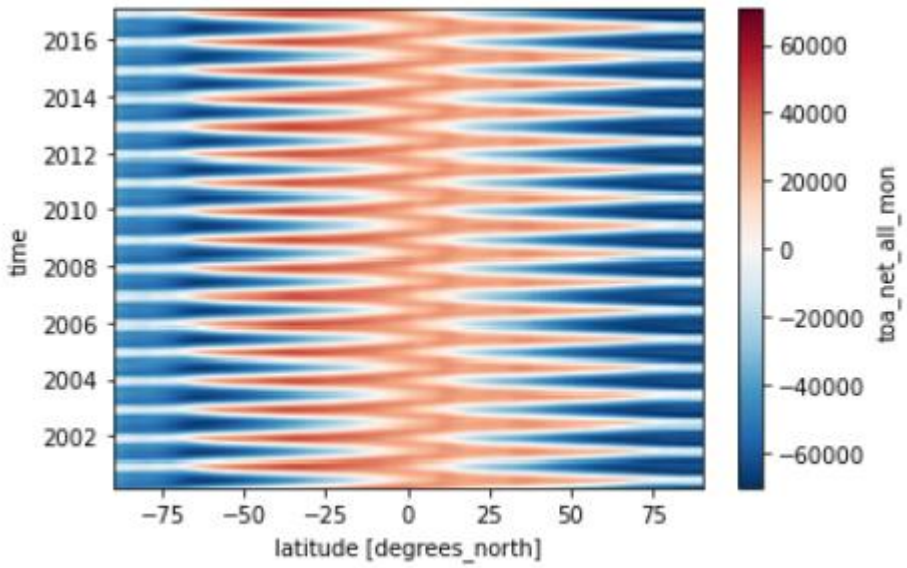
```
print('outgoing longwave:')
ds.toa_lw_all_mon.weighted(weights).mean()
```

```
outgoing longwave:
xarray.DataArray 'toa_lw_all_mon'
array(240.26693375)
► Coordinates: (0)
► Attributes: (0)
```

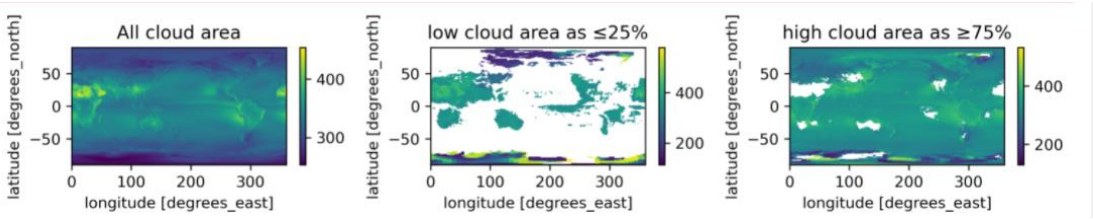
```
print('outgoing shortwave:')
ds.toa_sw_all_mon.weighted(weights).mean()
```

```
outgoing shortwave:
xarray.DataArray 'toa_sw_all_mon'
array(99.13805277)
► Coordinates: (0)
► Attributes: (0)
```

2.3 [5 points] Calculate and plot the total amount of net radiation in each 1-degree latitude band. Label with correct units.



2.4 [5 points] Calculate and plot composites of time-mean outgoing shortwave and longwave radiation for low and high cloud area regions. Here we define low cloud area as ≤25% and high cloud area as ≥75%. Your results should be 2D maps.



2.5 [5 points] Calculate the global mean values of shortwave and longwave radiation, composited in high and low cloud regions. What is the overall effect of clouds on shortwave and longwave radiation

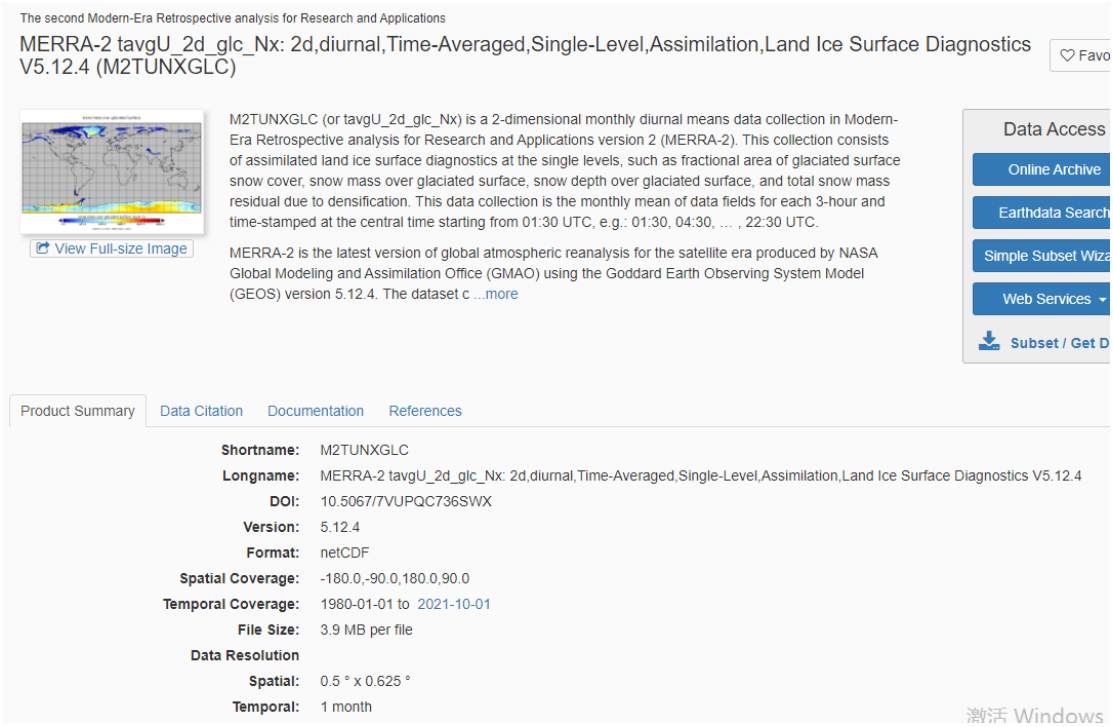
```
toa_lw_all_mon_lt25=ds.where(ds.cldarea_total_daynight_mon<25).toa_lw_all_mon.mean()
print(toa_lw_all_mon_lt25)
toa_sw_all_mon_lt25=ds.where(ds.cldarea_total_daynight_mon<25).toa_sw_all_mon.mean()
print(toa_sw_all_mon_lt25)

toa_lw_all_mon_gt75=ds.where(ds.cldarea_total_daynight_mon>75).toa_lw_all_mon.mean()
print(toa_lw_all_mon_gt75)
toa_sw_all_mon_gt75=ds.where(ds.cldarea_total_daynight_mon>75).toa_sw_all_mon.mean()
print(toa_sw_all_mon_gt75)
```

```
<xarray.DataArray 'toa_lw_all_mon' ()>
array(247.33109, dtype=float32)
<xarray.DataArray 'toa_sw_all_mon' ()>
array(97.11116, dtype=float32)
<xarray.DataArray 'toa_lw_all_mon' ()>
array(215.39049, dtype=float32)
<xarray.DataArray 'toa_sw_all_mon' ()>
array(111.765945, dtype=float32)
```

3 Explore a netCDF dataset

Data: MERRA2_combined.nc



- **Data processing**

```
ds = xr.open_mfdataset('data/MERRA2*.nc4',combine = 'by_coords', concat_dim="time")#https://
ds.to_netcdf('MERRA2_combined.nc')
```

```
ds
```

xarray.Dataset

► Dimensions: (**time**: 864, **lat**: 361, **lon**: 576)

▼ Coordinates:

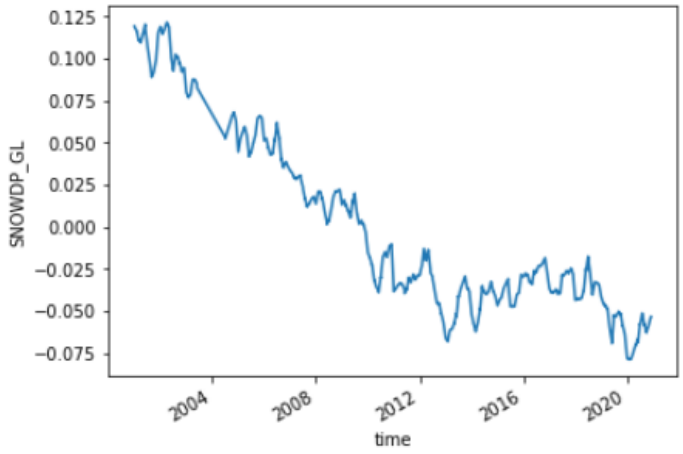
lat	(lat)	float64	-90.0 -89.5 -89.0 ... 89.5 90.0
lon	(lon)	float64	-180.0 -179.4 ... 178.8 179.4
time	(time)	datetime64[ns]	2001-01-01T01:30:00 ... 2010-12-...

▼ Data variables:

WESNSC	(time, lat, lon)	float32	dask.array<chunksize=(8, 361, 576), meta=np.n...
RUNOFF	(time, lat, lon)	float32	dask.array<chunksize=(8, 361, 576), meta=np.n...
SNOMAS_GL	(time, lat, lon)	float32	dask.array<chunksize=(8, 361, 576), meta=np.n...
WESNEXT	(time, lat, lon)	float32	dask.array<chunksize=(8, 361, 576), meta=np.n...
SNOWDP_GL	(time, lat, lon)	float32	dask.array<chunksize=(8, 361, 576), meta=np.n...
ASNOW_GL	(time, lat, lon)	float32	dask.array<chunksize=(8, 361, 576), meta=np.n...
SNICEALB	(time, lat, lon)	float32	dask.array<chunksize=(8, 361, 576), meta=np.n...

► Attributes: (32)

3.1 [5 points] Plot a time series of a certain variable with monthly seasonal cycle removed.



3.2 [5 points] Make at least 5 different plots using the dataset.