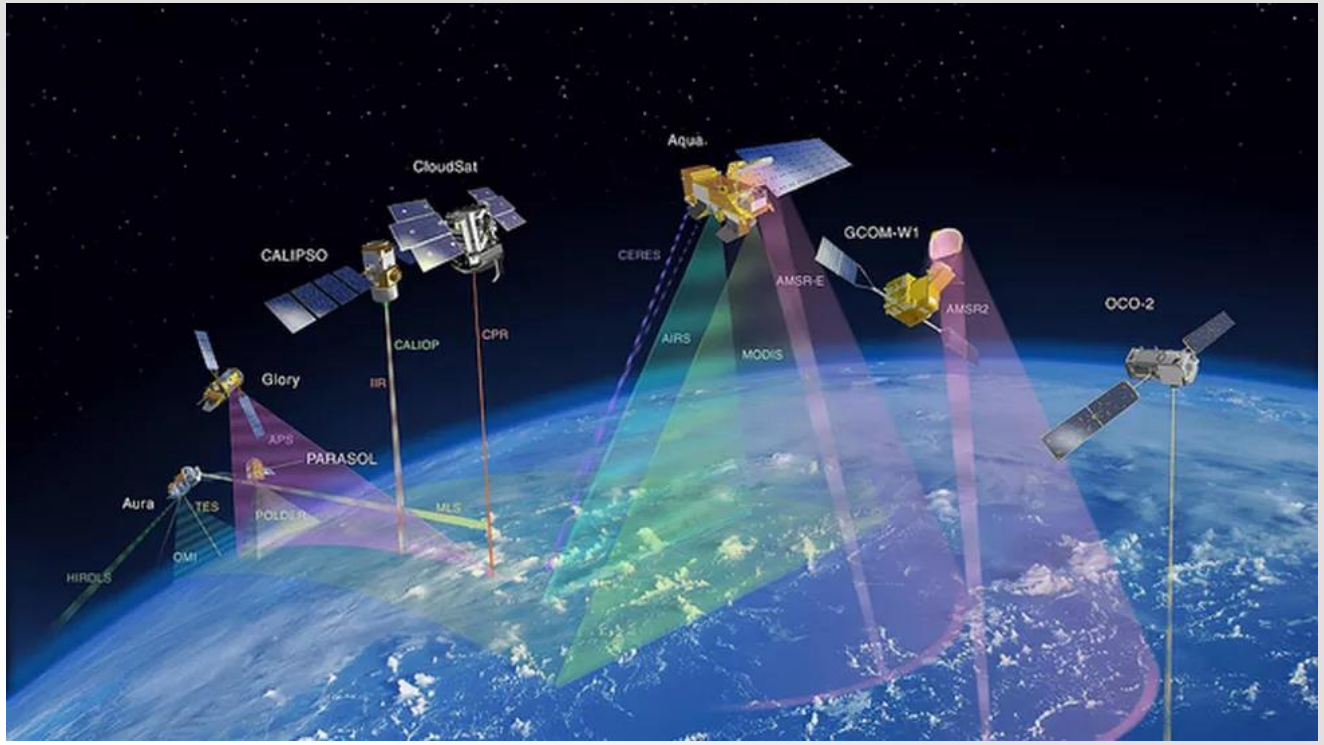
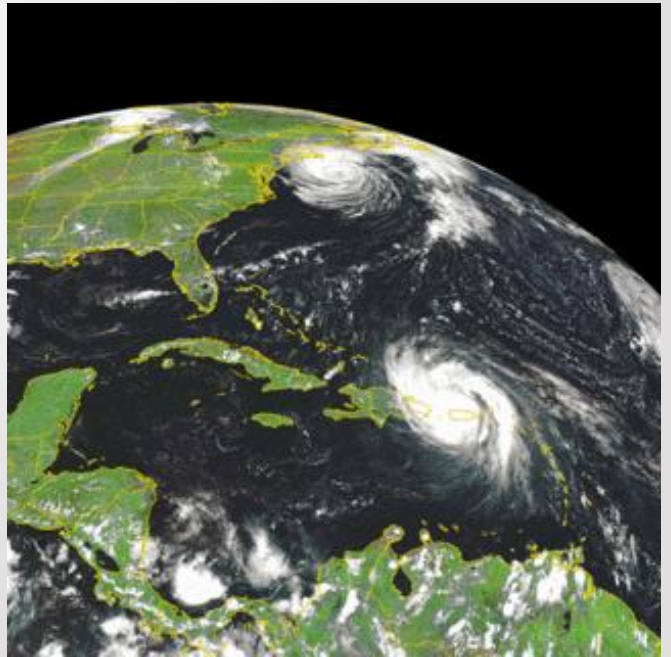
CloudSat Cloud Product

Peng-Jen Chen
大氣環境研究室

CloudSat Satellite Product

- CloudSat:
  - **A-train** (Afternoon Train) satellite
  - Launch at 28 April 2006
  - 705 km above the Earth
  - Cross the equator at local time 1:30 pm and 1:30 am
- Due to battery malfunction
  - After 2011 only day-time have observation
- Exit the A-Train on 2018/2/22
  - Move to lower orbit (688 km) call C-train
  - CALIPSO join C-train from A-train on 2018/09/20

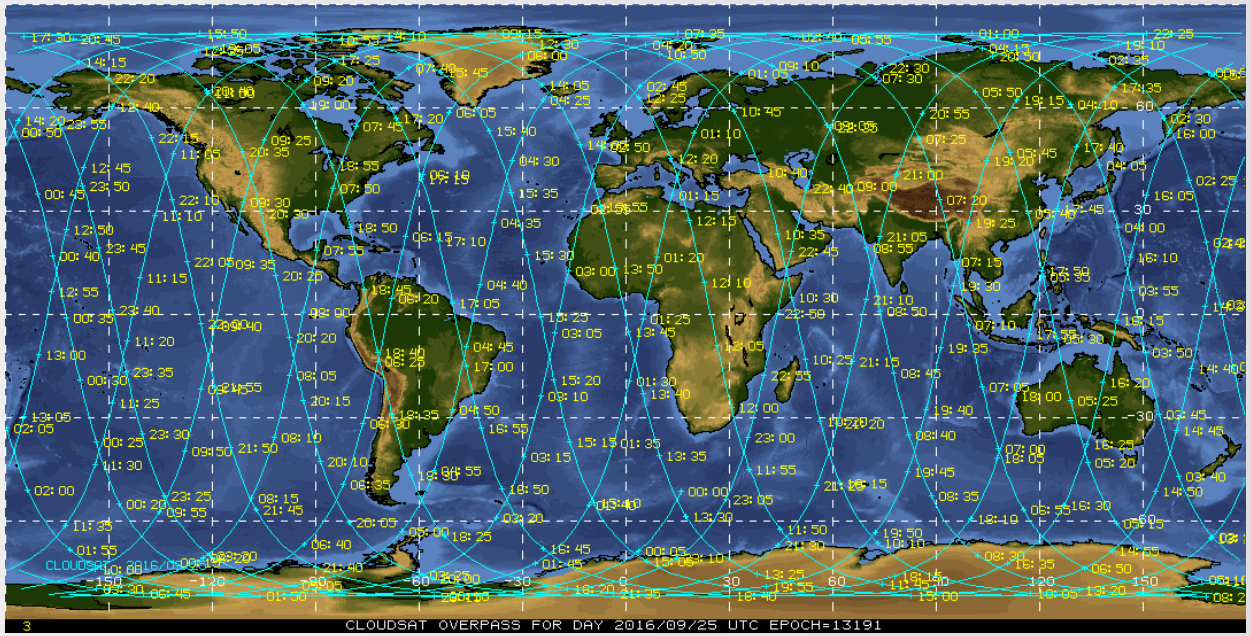


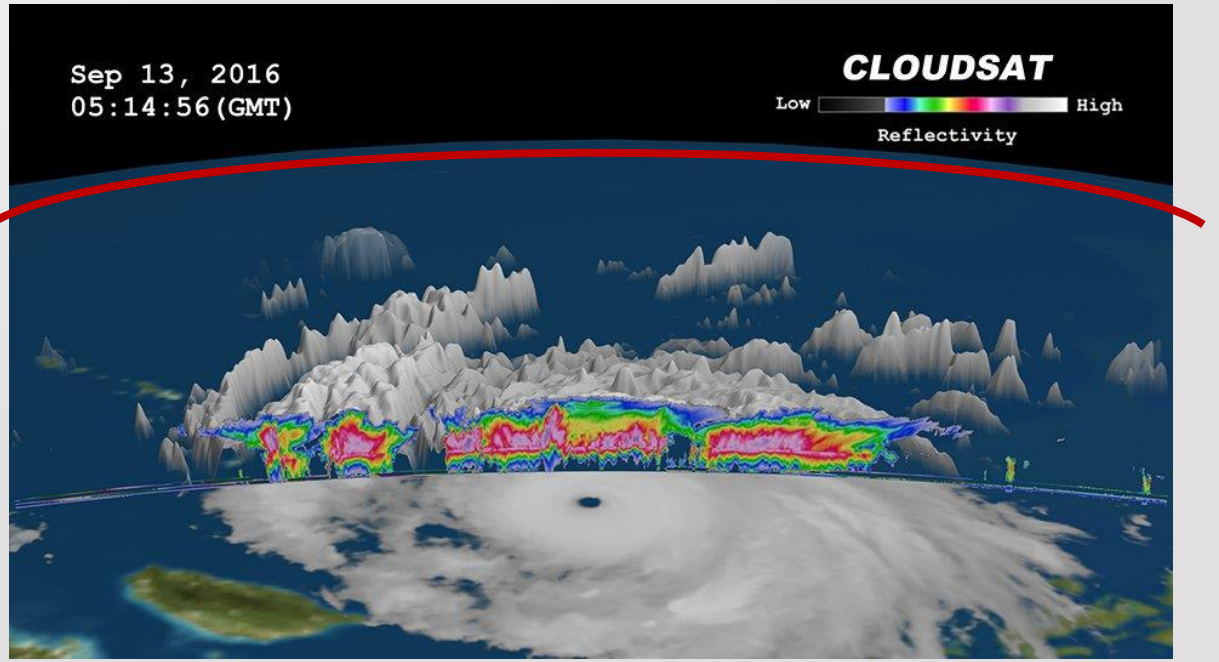


https://www.nasa.gov/feature/langley/sister-satellites-briefly-separated-working-together-again

CloudSat Satellite Product

- CloudSat: Polar-orbiting satellite
  - ➢Launch at 28 April 2006
  - ➢**Vertical resolution:** 240m
  - ➢**Horizontal resolution:** 1.1km
- ➢Provide high resolution vertical profile cross the atmosphere
- Weakness:
  - ➢narrow observation domain
  - ➢Temporal resolution is limited to derive diurnal cycle
    (13:30 LT and 01:30 LT)





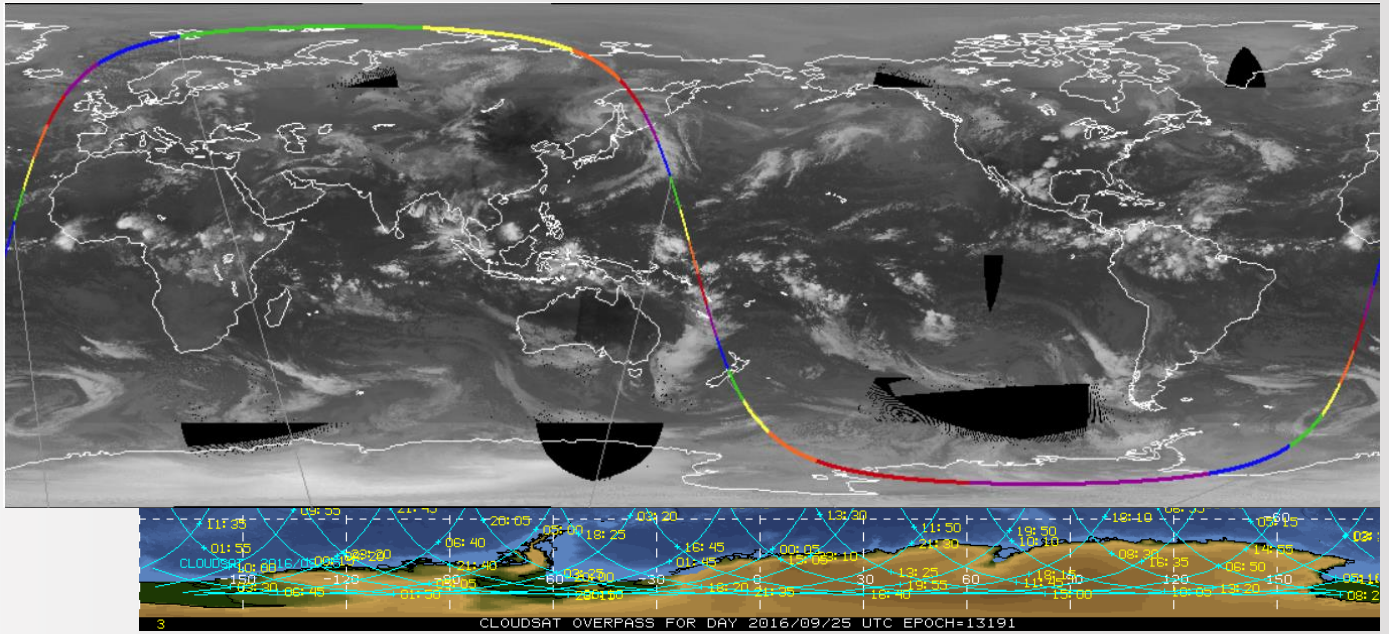
- ➢Cloud Profiling Radar (CPR)
- ➢CPR : more sensitive to larger hydrometeors
- ➢Product : HDF format

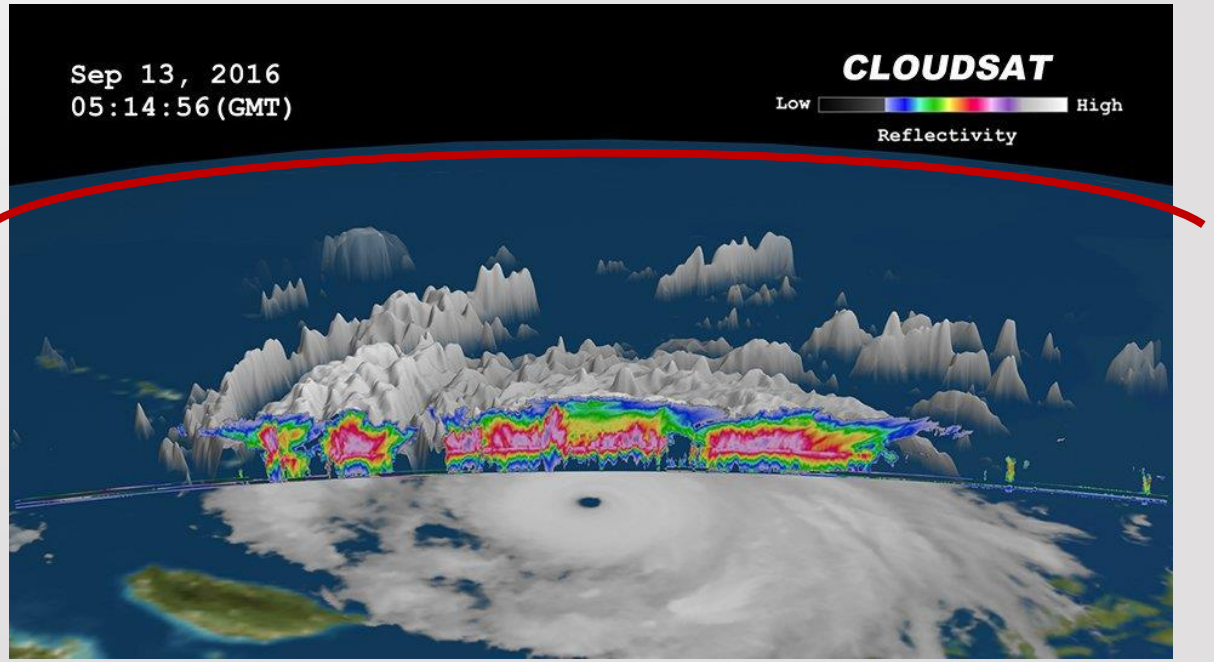
CloudSat Satellite Product

- CloudSat: Polar-orbiting satellite
  - ➢Launch at 28 April 2006
  - ➢**Vertical resolution:** 240m
  - ➢**Horizontal resolution:** 1.1km

➢Provide high resolution vertical profile cross the atmosphere

- Weakness:
  - ➢narrow observation domain
  - ➢Temporal resolution is limited to derive diurnal cycle
    (13:30 LT and 01:30 LT)





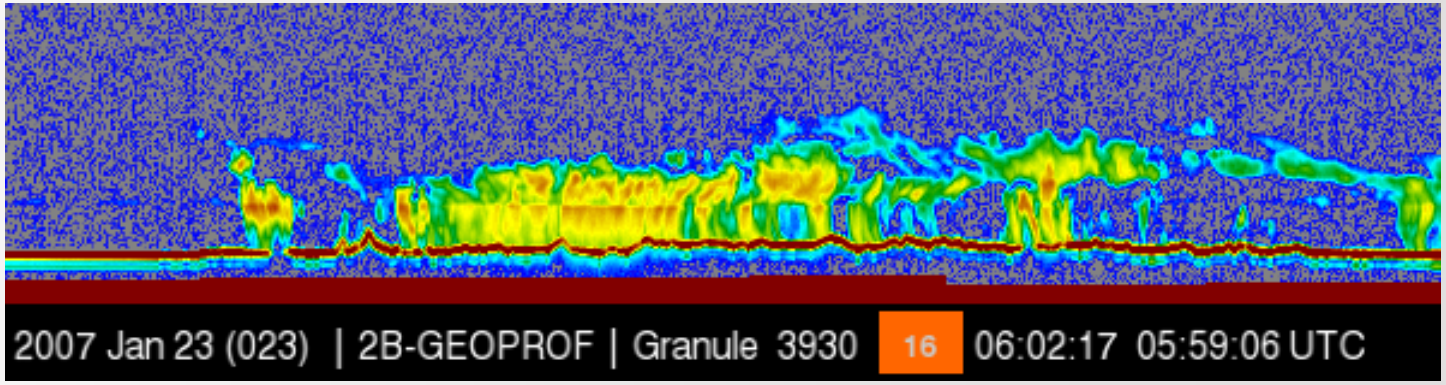
➢Cloud Profiling Radar (CPR)

➢CPR : more sensitive to larger hydrometeors

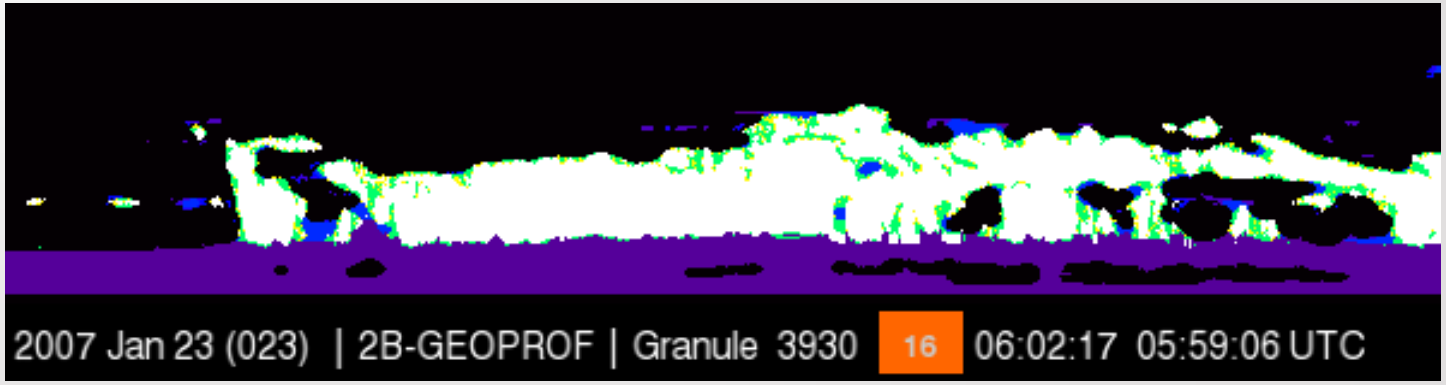
➢Product : HDF format

CloudSat Satellite Product

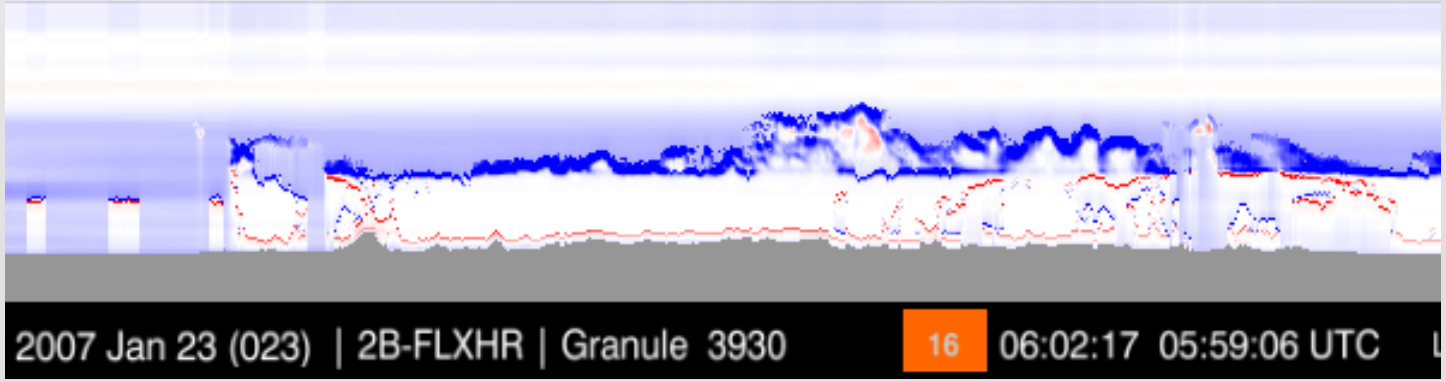
- Radar_Reflectivity



- Cloud_mask



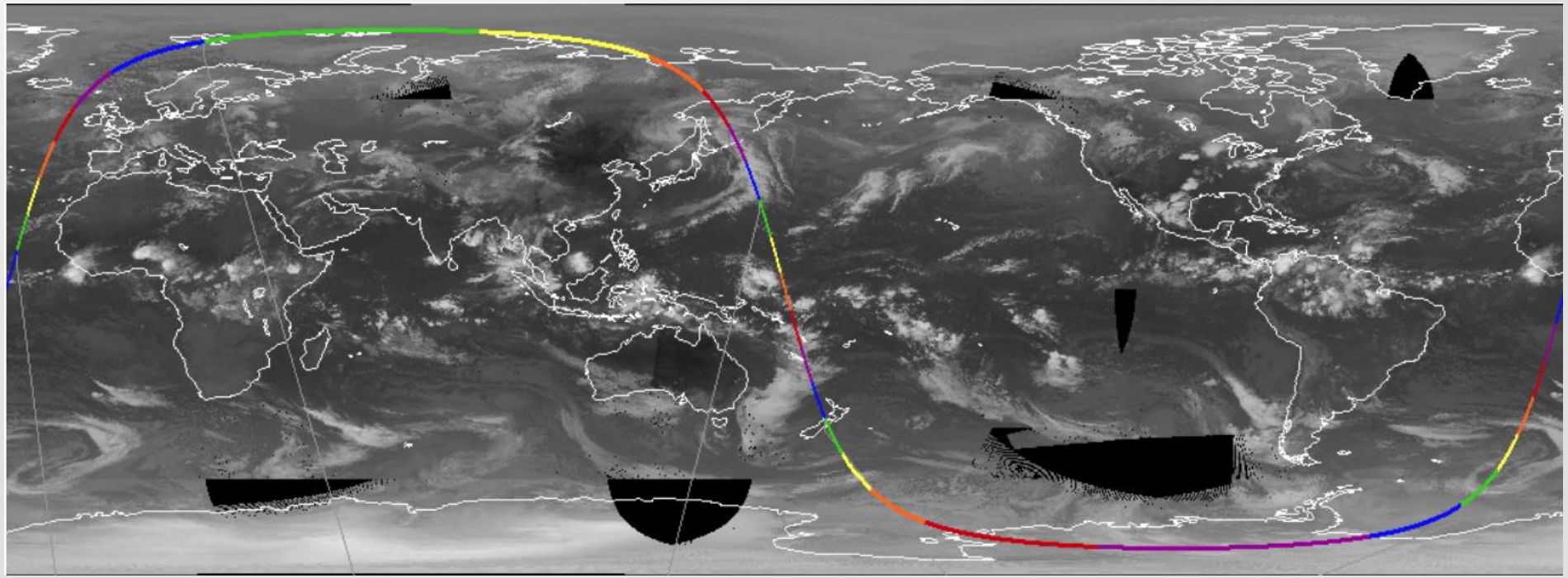
- Radiative Heating Rate



CloudSat Satellite Product

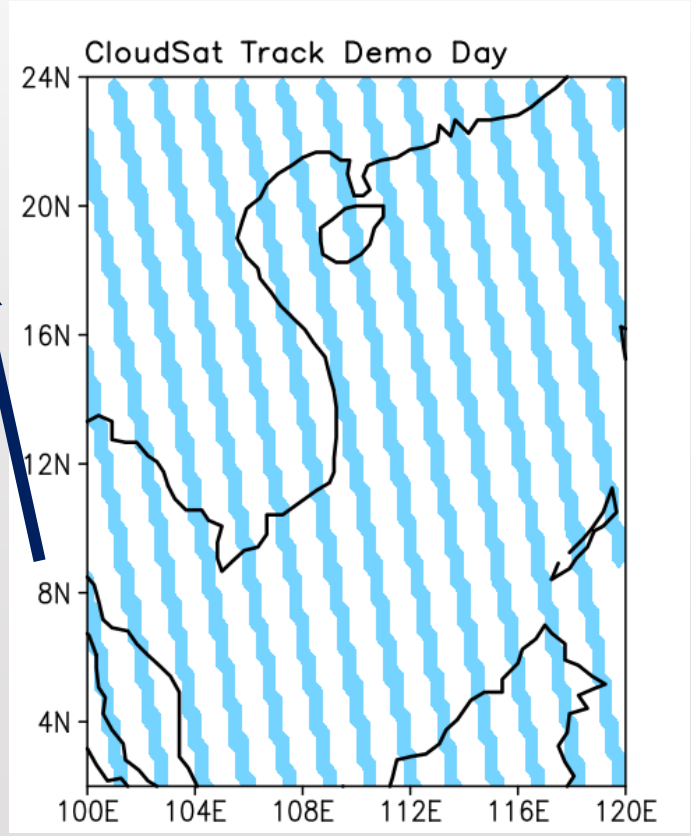
- Level 2 CloudSat Product
- One orbit <--> one hdf file
- Non-gridded data
- Temporal and spatial resolution is limited

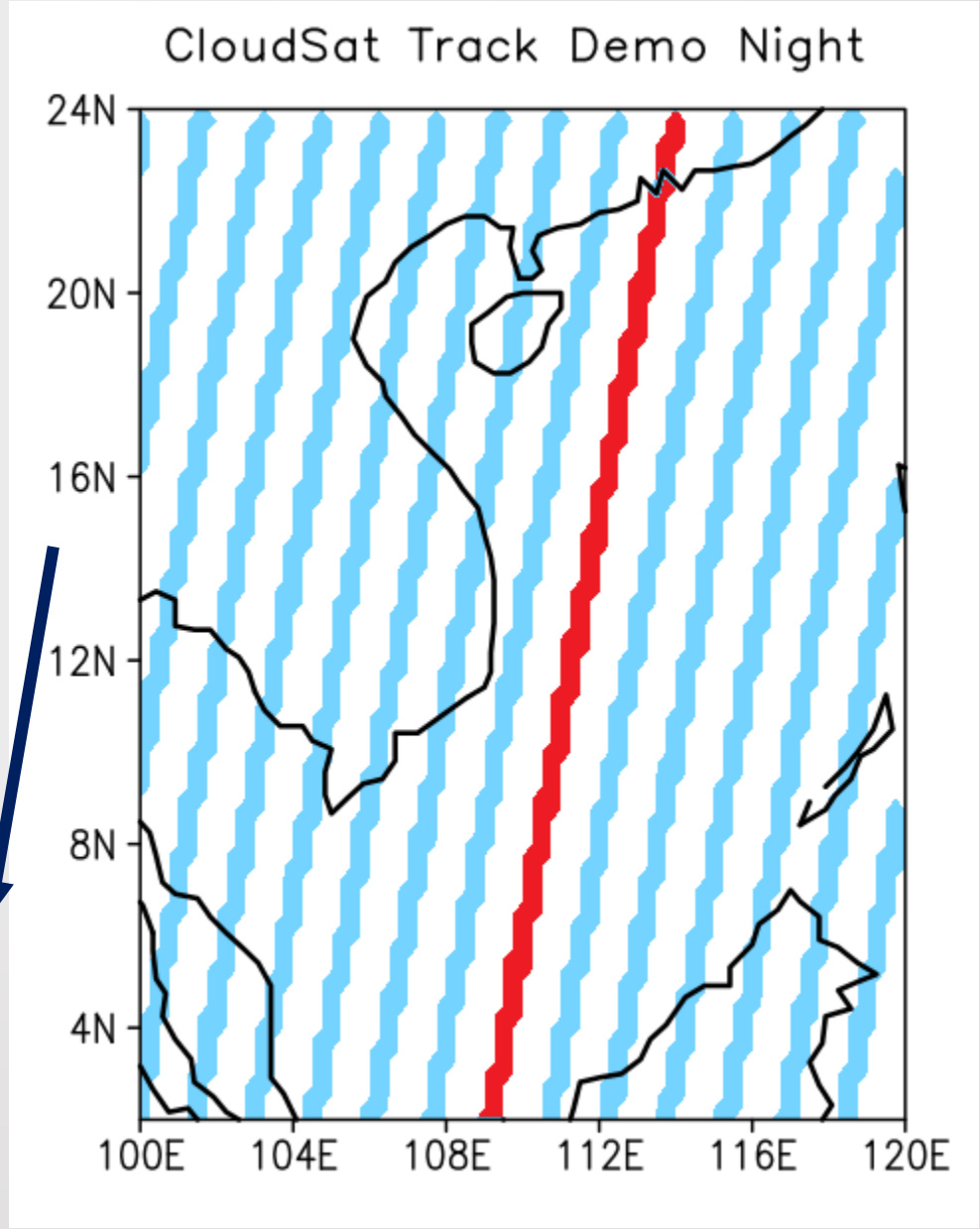
2B-FLXHR
2B-GEOPROF
2B-CLDCLASS
⋮



CloudSat Satellite Product

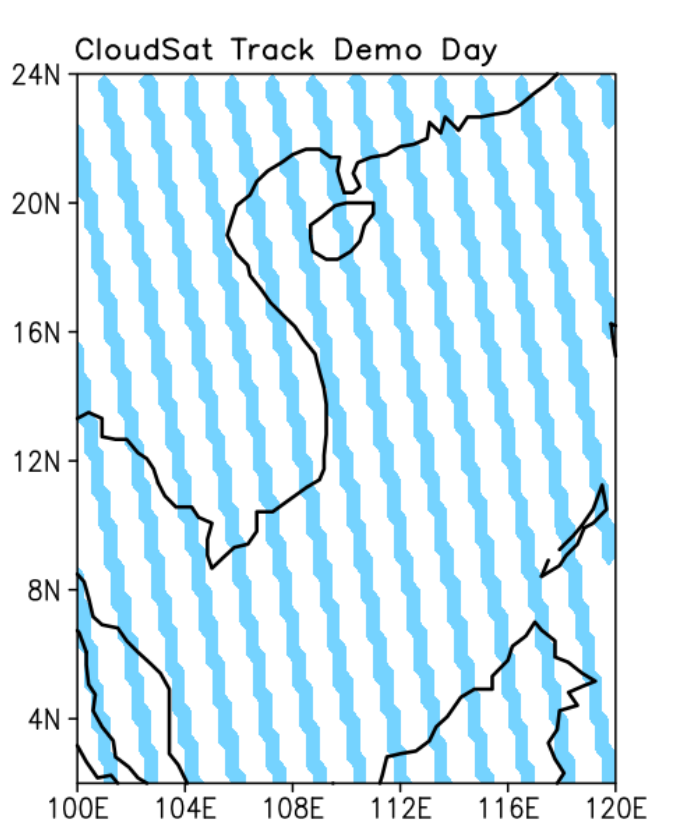
- Level 2 CloudSat Product
- Temporal and spatial resolution is limited
- Non-gridded data

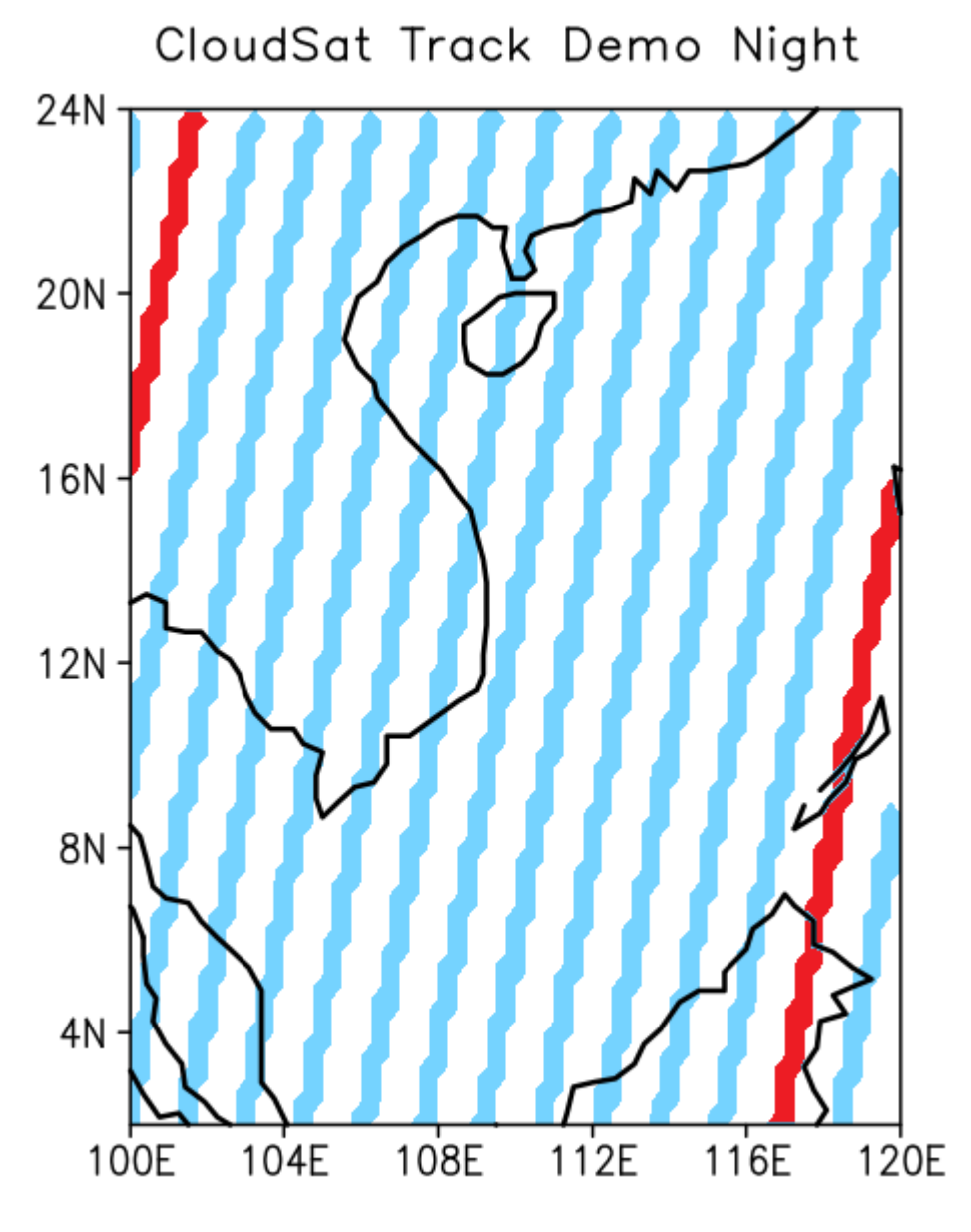




CloudSat Satellite Product

- Level 2 CloudSat Product
- Temporal and spatial resolution is limited
- Non-gridded data





Information from file name

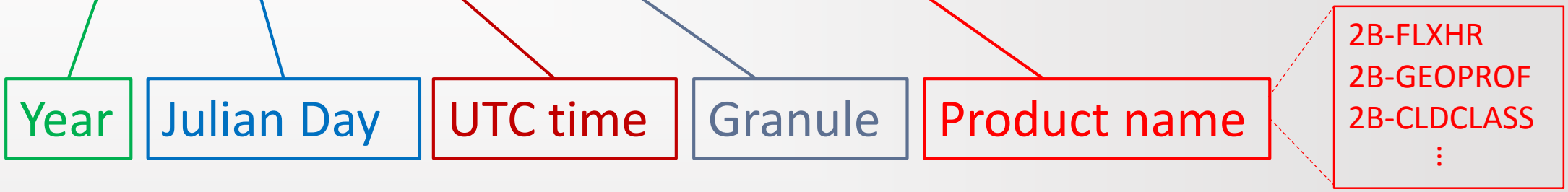
- Example :

2013128195751_37394_CS_2B-GEOPROF_GRANULE_P_R04_E06.hdf

Information from file name

- Example :

2013128195751_37394_CS_2B-GEOPROF_GRANULE_P_R04_E06.hdf



2013128195751_37394_CS_2B-GEOPROF_GRANULE_P_R04_E06.hdf

- 2B-GEOPROF
- Year: 2013
- Julian day: 128 ⟶ 5/8
- UTC time: start at 19:57:51
- Granule: 37394

- **File path:** dadm1/obs/CloudSat/hdf-GEOPROF/

Hdf file introduction

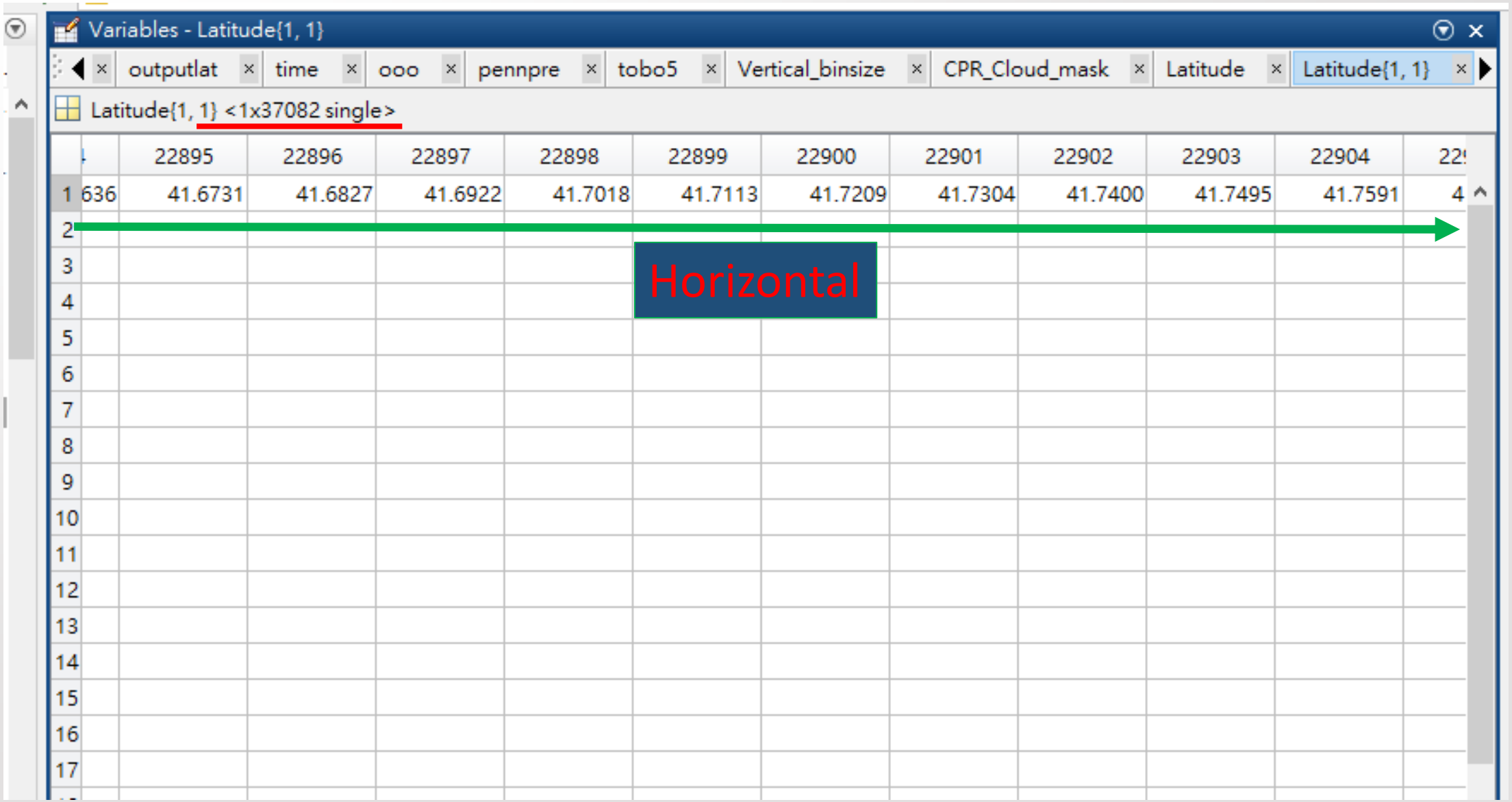
CPR_Cloud_mask <37082x125 int8>

Vertical

	4	95	96	97	98		101	102	103	104
343	0	0	0	8	0	10	10	5	5	5	5
344	0	0	0	0	0	10	10	5	5	5	5
345	0	0	0	0	10	10	10	5	5	5	5
346	0	0	0	10	10	10	20	5	5	5	5
347	0	0	30	10	20	20	20	5	5	5	5
348	20	20	20	20	20	40	40	20	5	5	5
349	40	20	20	20	40	40	40	40	20	5	5
350	40	40	40	40	40	40	40	40	20	5	5
351	40	40	40	40	40	40	40	40	40	5	5
352	40	40	40	40	40	40	40	40	40	5	5
353	40	40	40	40	40	40	40	40	40	5	5
354	40	40	40	40	40	40	40	40	40	5	5
355	40	40	40	40	40	40	40	40	40	5	5
356	40	40	40	40	40	40	40	40	40	5	5
357	40	40	40	40	40	40	40	40	20	5	5
			40	40	40	40	40	40	20	5	5
			40	40	40	40	40	40	20	5	5

Horizontal

Hdf file introduction



Hdf file introduction

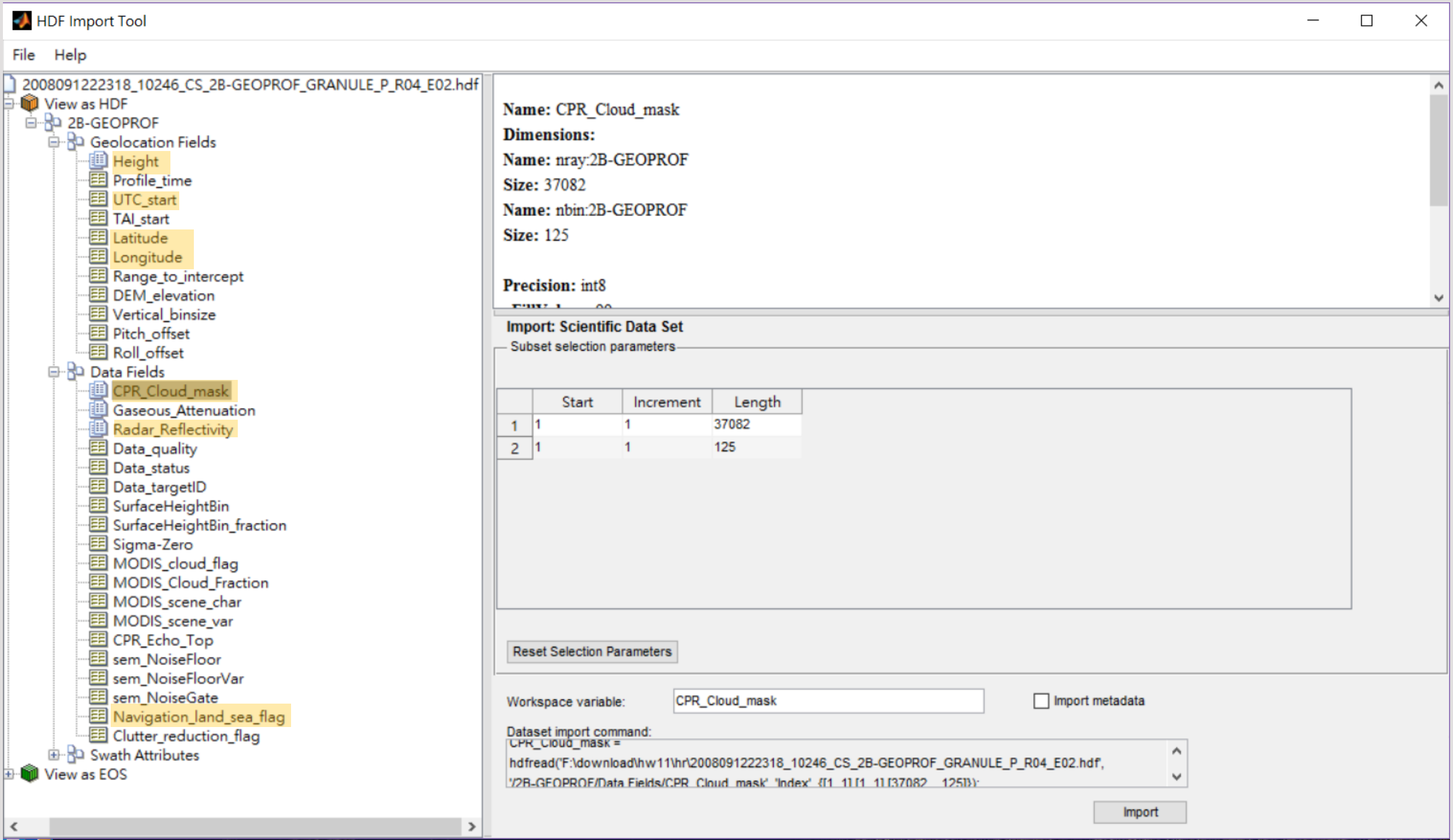
Height

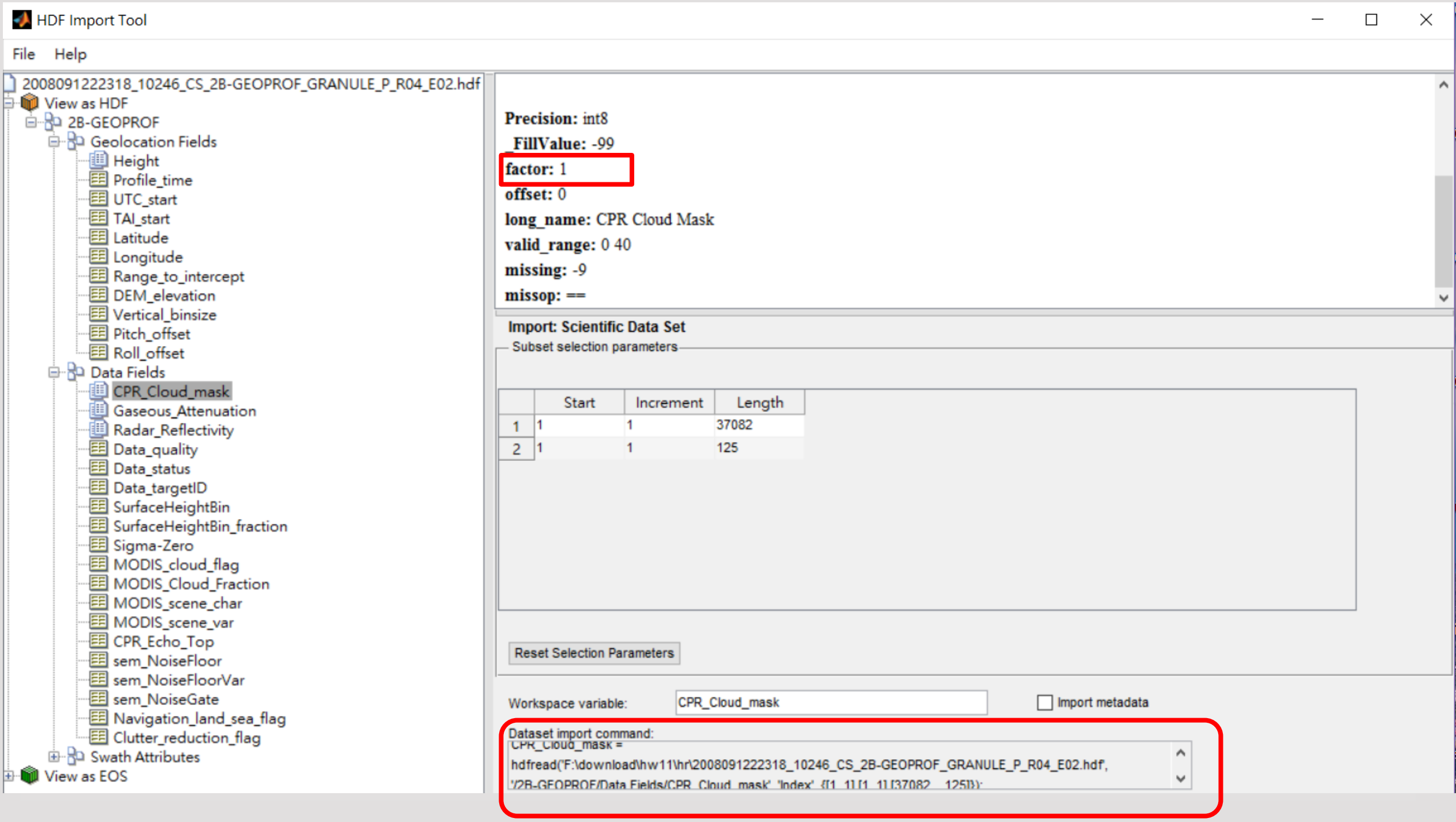
20841x125 int16

Vertical

Horizontal

	1	2	3	4	5	6	7	8	9	10	11	12
1	25005	24765	24526	24286	24046	23806	23566	23326	23087	22847	22607	22367
2	25008	24768	24528	24288	24048	23809	23569	23329	23089	22849	22609	22370
3	25010	24770	24530	24291	24051	23811	23571	23331	23091	22852	22612	22372
4	25013	24773	24533	24293	24053	23813	23574	23334	23094	22854	22614	22374
5	25015	24775	24535	24296	24056	23816	23576	23336	23096	22857	22617	22377
6	25017	24778	24538	24298	24058	23818	23578	23339	23099	22859	22619	22379
7	25020	24780	24540	24300	24061	23821	23581	23341	23101	22861	22622	22382
8	25022	24782	24543	24303	24063	23823	23583	23344	23104	22864	22624	22384
9	25025	24785	24545	24305	24065	23826	23586	23346	23106	22866	22626	22387
10	25027	24787	24548	24308	24068	23828	23588	23348	23109	22869	22629	22389
11	25030	24790	24550	24310	24070	23831	23591	23351	23111	22871	22631	22392
12	25032	24792	24552	24313	24073	23833	23593	23353	23113	22874	22634	22394
13	25035	24795	24555	24315	24075	23835	23596	23356	23116	22876	22636	22396
14	25037	24797	24557	24318	24078	23838	23598	23358	23118	22879	22639	22399
15	25039	24800	24560	24320	24080	23840	23600	23361	23121	22881	22641	22401
16	25042	24802	24562	24322	24083	23843	23603	23363	23123	22883	22644	22404
			24565	24325	24085	23845	23605	23365	23126	22886	22646	22406
			24567	24327	24087	23848	23608	23368	23128	22888	22648	22409
			24569	24330	24090	23850	23610	23370	23130	22891	22651	22411
20	25052	24812	24572	24332	24092	23852	23613	23373	23133	22893	22653	22413


HDF Import Tool
File
Help
2008091222318_10246_CS_2B-GEOPROF_GRANULE_P_R04_E02.hdf
View as HDF
2B-GEOPROF
Geolocation Fields
Height
Profile_time
UTC_start
TAI_start
Latitude
Longitude
Range_to_intercept
DEM_elevation
Vertical_binsize
Pitch_offset
Roll_offset
Data Fields
CPR_Cloud_mask
Gaseous_Attenuation
Radar_Reflectivity
Data_quality
Data_status
Data_targetID
SurfaceHeightBin
SurfaceHeightBin_fraction
Sigma-Zero
MODIS_cloud_flag
MODIS_Cloud_Fraction
MODIS_scene_char
MODIS_scene_var
CPR_Echo_Top
sem_NoiseFloor
sem_NoiseFloorVar
sem_NoiseGate
Navigation_land_sea_flag
Clutter_reduction_flag
Swath Attributes
View as EOS
Name: CPR_Cloud_mask
Dimensions:
Name: nray:2B-GEOPROF
Size: 37082
Name: nbin:2B-GEOPROF
Size: 125
Precision: int8
Import: Scientific Data Set
Subset selection parameters
Start
Increment
Length
1
1
1
37082
2
1
1
125
Reset Selection Parameters
Workspace variable:
CPR_Cloud_mask
Import metadata
Dataset import command:
CPR_Cloud_mask =
hdfread('F:\download\hw11\hr\2008091222318_10246_CS_2B-GEOPROF_GRANULE_P_R04_E02.hdf',
'/2B-GEOPROF/Data Fields/CPR_Cloud_mask', 'Index', {[1 1] [1 1] [37082 125]});
Import


HDF Import Tool
File
Help
2008091222318_10246_CS_2B-GEOPROF_GRANULE_P_R04_E02.hdf
View as HDF
2B-GEOPROF
Geolocation Fields
Height
Profile_time
UTC_start
TAI_start
Latitude
Longitude
Range_to_intercept
DEM_elevation
Vertical_binsize
Pitch_offset
Roll_offset
Data Fields
CPR_Cloud_mask
Gaseous_Attenuation
Radar_Reflectivity
Data_quality
Data_status
Data_targetID
SurfaceHeightBin
SurfaceHeightBin_fraction
Sigma-Zero
MODIS_cloud_flag
MODIS_Cloud_Fraction
MODIS_scene_char
MODIS_scene_var
CPR_Echo_Top
sem_NoiseFloor
sem_NoiseFloorVar
sem_NoiseGate
Navigation_land_sea_flag
Clutter_reduction_flag
Swath Attributes
View as EOS
Precision: int8
_FillValue: -99
factor: 1
offset: 0
long_name: CPR Cloud Mask
valid_range: 0 40
missing: -9
missop: ==
Import: Scientific Data Set
Subset selection parameters
Start
Increment
Length
1 1 1 37082
2 1 1 125
Reset Selection Parameters
Workspace variable:
CPR_Cloud_mask
Import metadata
Dataset import command:
CPR_Cloud_mask =
hdfread('F:\download\hw11\hr\2008091222318_10246_CS_2B-GEOPROF_GRANULE_P_R04_E02.hdf',
'/2B-GEOPROF/Data Fields/CPR_Cloud_mask', 'Index', {[1 1] [1 1] [37082 125]});

Hdf file introduction

2019_summer_tutorial/cloudsat_2019_demo/cprtransfer_ver2019.m

Editor - /work2/C.jerryjerry9/2019_summer_tutorial/cloudsat_2019_demo/cprtransfer_ver2019.m

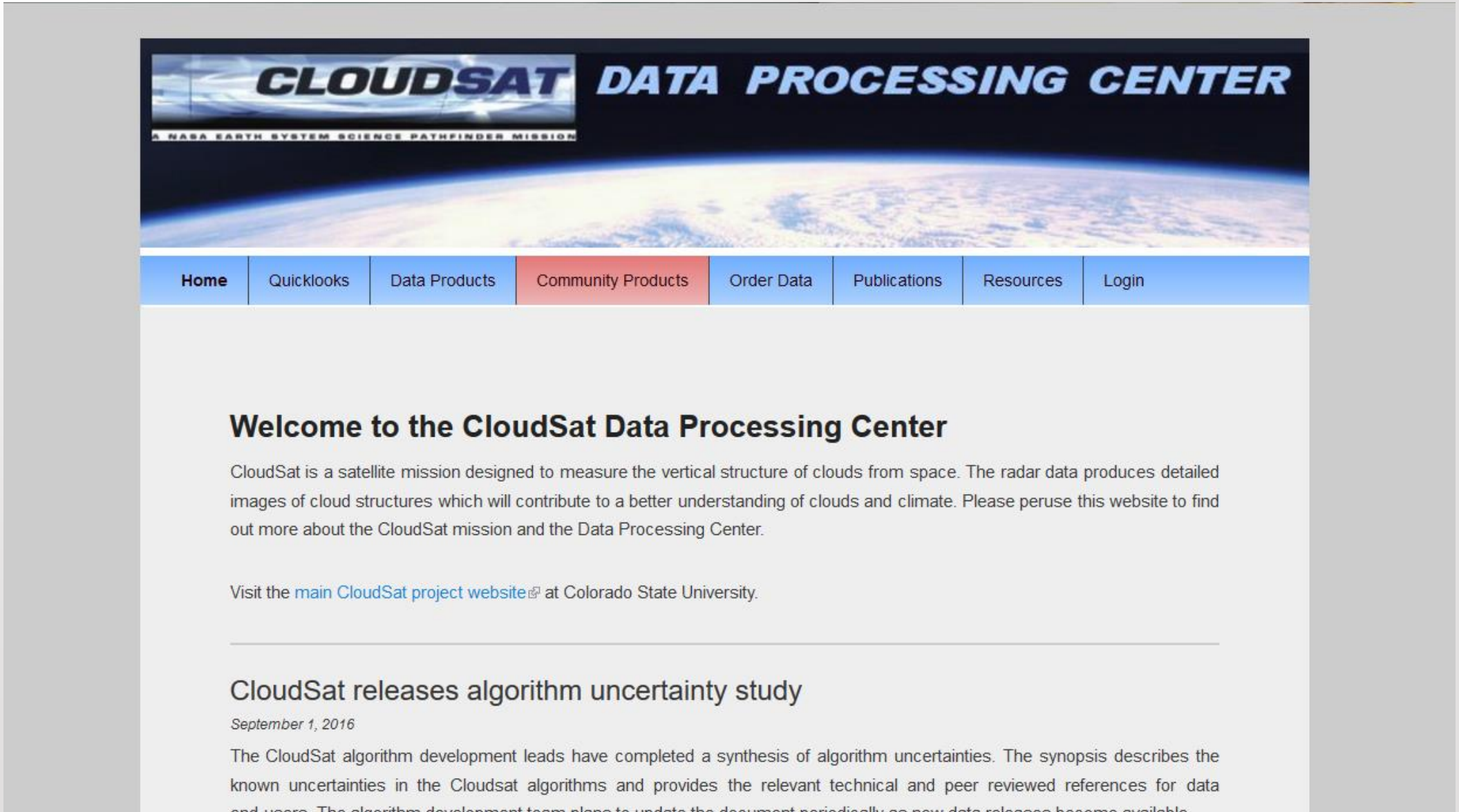
+25 | q1output.m | q2cal.m | q2_domain_ave.m | q1_domain_output.m | cprtransfer_ver2018.m | cprtransfer_ver2019.m

```
1   %%%%%%% For 2B-GEOPROF hdf file %%%%%%%
2   %%% notice that the vertical resolution of 2B-GEOPROF is 240m
3   %%% Height information is in the variable: Height.
4   %%% Cloudsat after 2012 only work during day time
5
6   %%% time period input
7   stratday=301;%julian date : https://landweb.modaps.eosdis.nasa.gov/browse/calendar.html
8   endday=365;
9   %%% latitude(-90~90) & longitude(-180~180) range
10  startlat=15; %small one
11  endlat=30; %large one
12  startlon=115;
13  endlon=130;
14  yearrange=[2009:1:2009];
15
16  [a,yearnumber]=size(yearrange);
17  for ppp=1:yearnumber;
18  selectyear=num2str(yearrange(1,ppp));
19  yearfile=strcat('/dadm1/obs/CloudSat/hdf-GEOPROF/',selectyear,'/*.hdf');
20  yearfolder=strcat('/dadm1/obs/CloudSat/hdf-GEOPROF/',selectyear,'/');
21  readfile = dir(yearfile);%change with the file path
22  [t,tt]=size(readfile);
23
24  for w=1:t;
25
26  %%%% creat the hdf files location path %%%%
27  filename1=readfile(w).name;
28  filename=strcat(yearfolder,filename1);
29  file={filename};%this variable should be the actual file path
30  %%%%
```

END

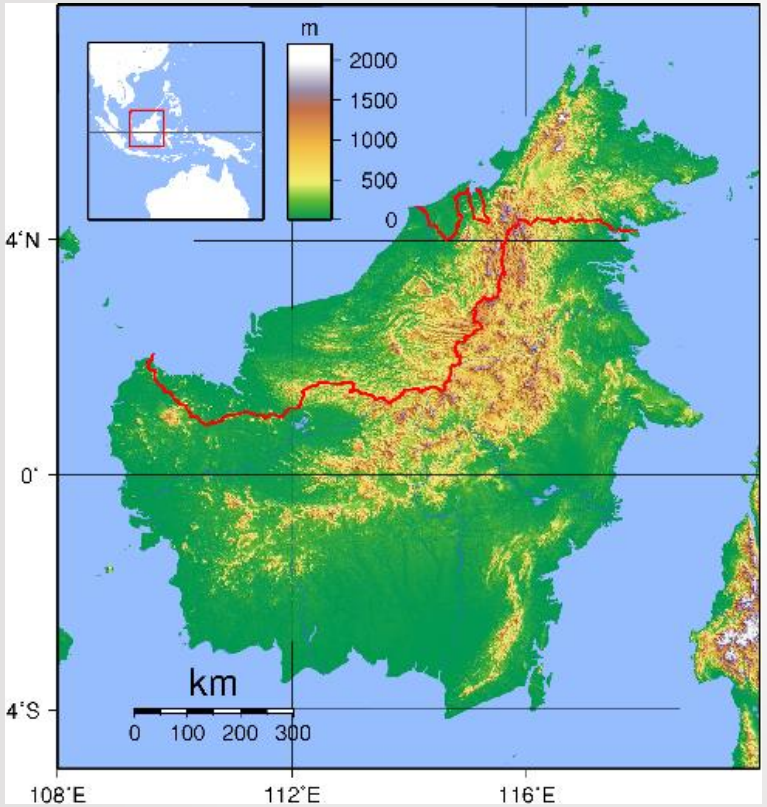
website

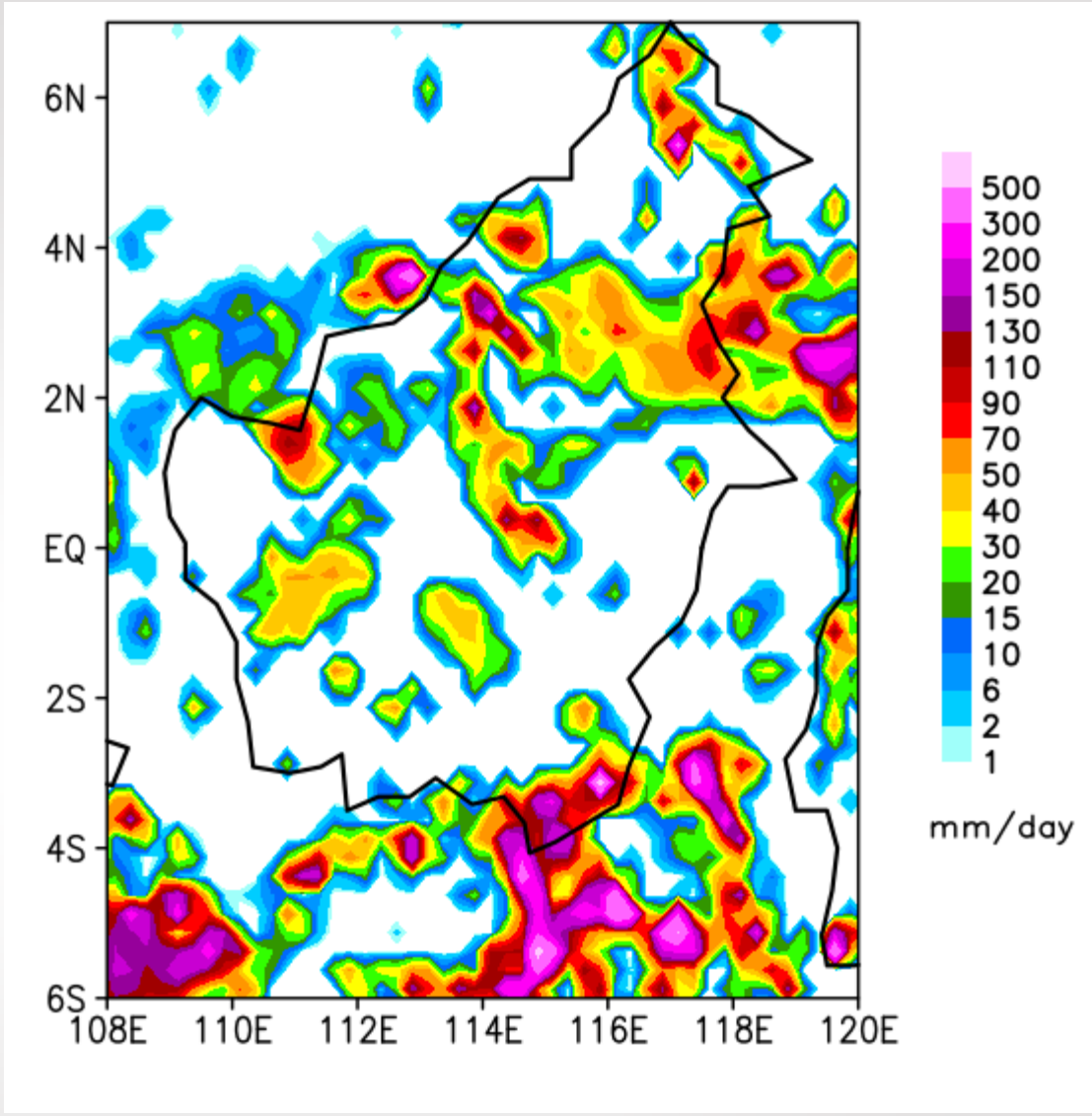
- http://www.cloudsat.cira.colostate.edu/



CloudSat sampling

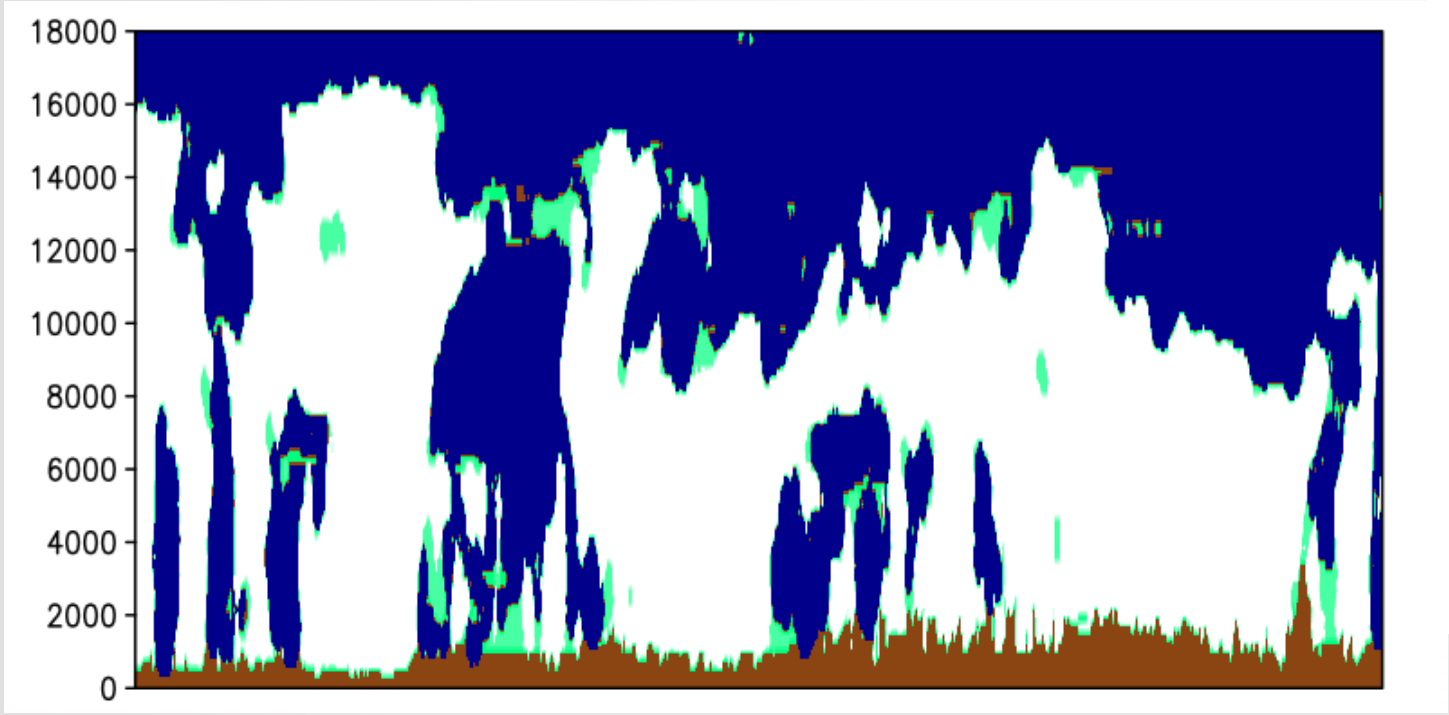
- TRMM : 1400LT
- 2007/1/23

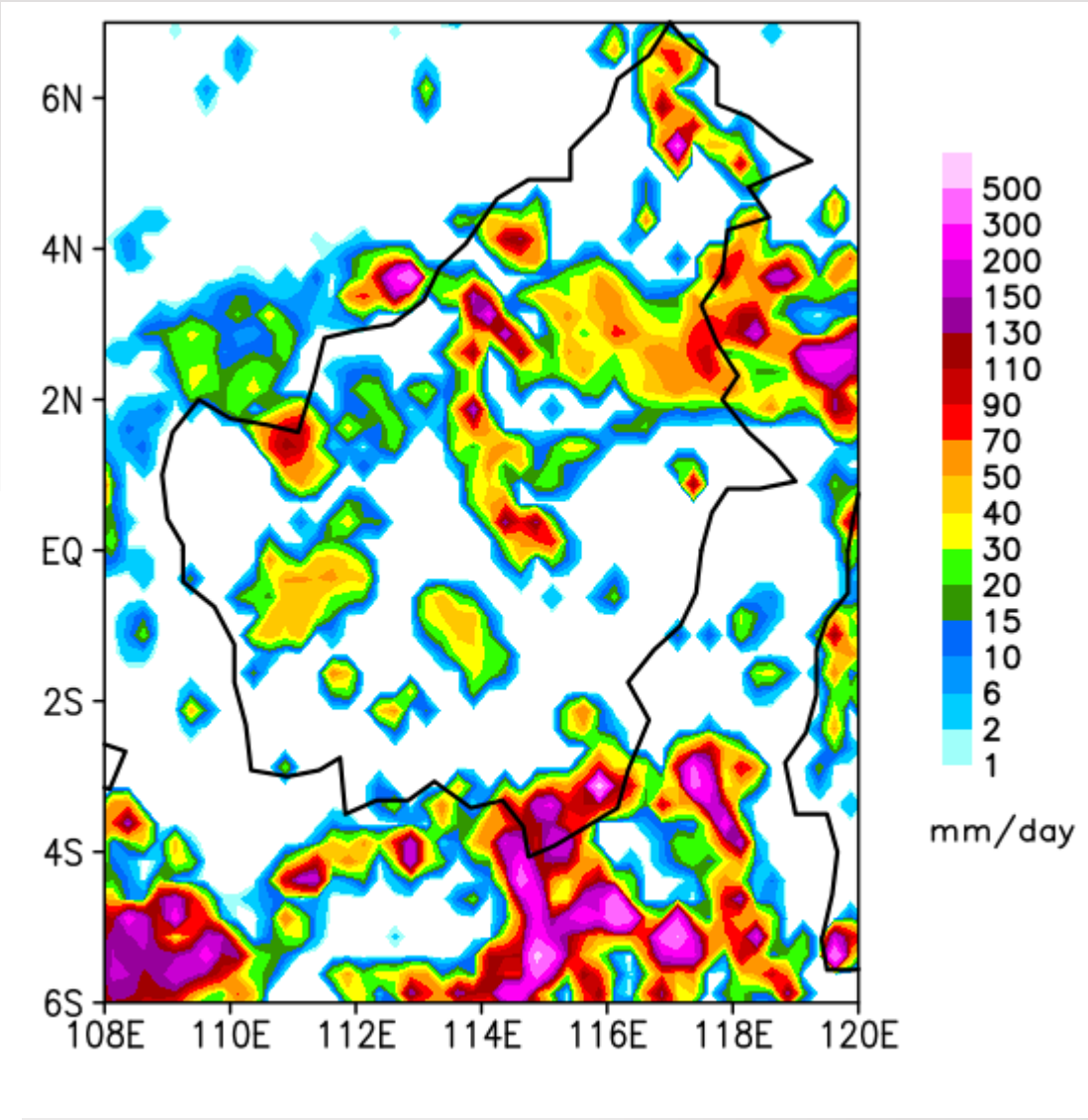




CloudSat sampling

- TRMM : 1400LT
- 2007/1/23
- CloudSat : ~14:00LT



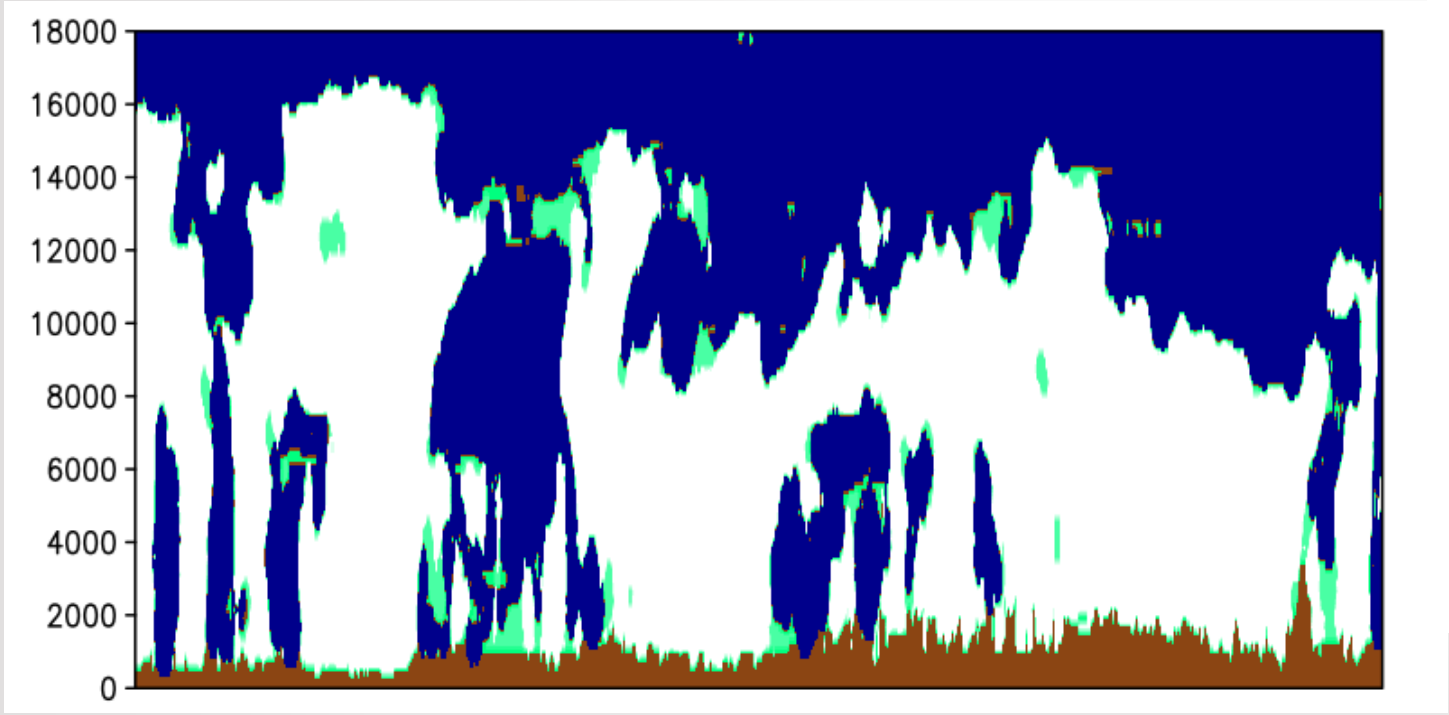


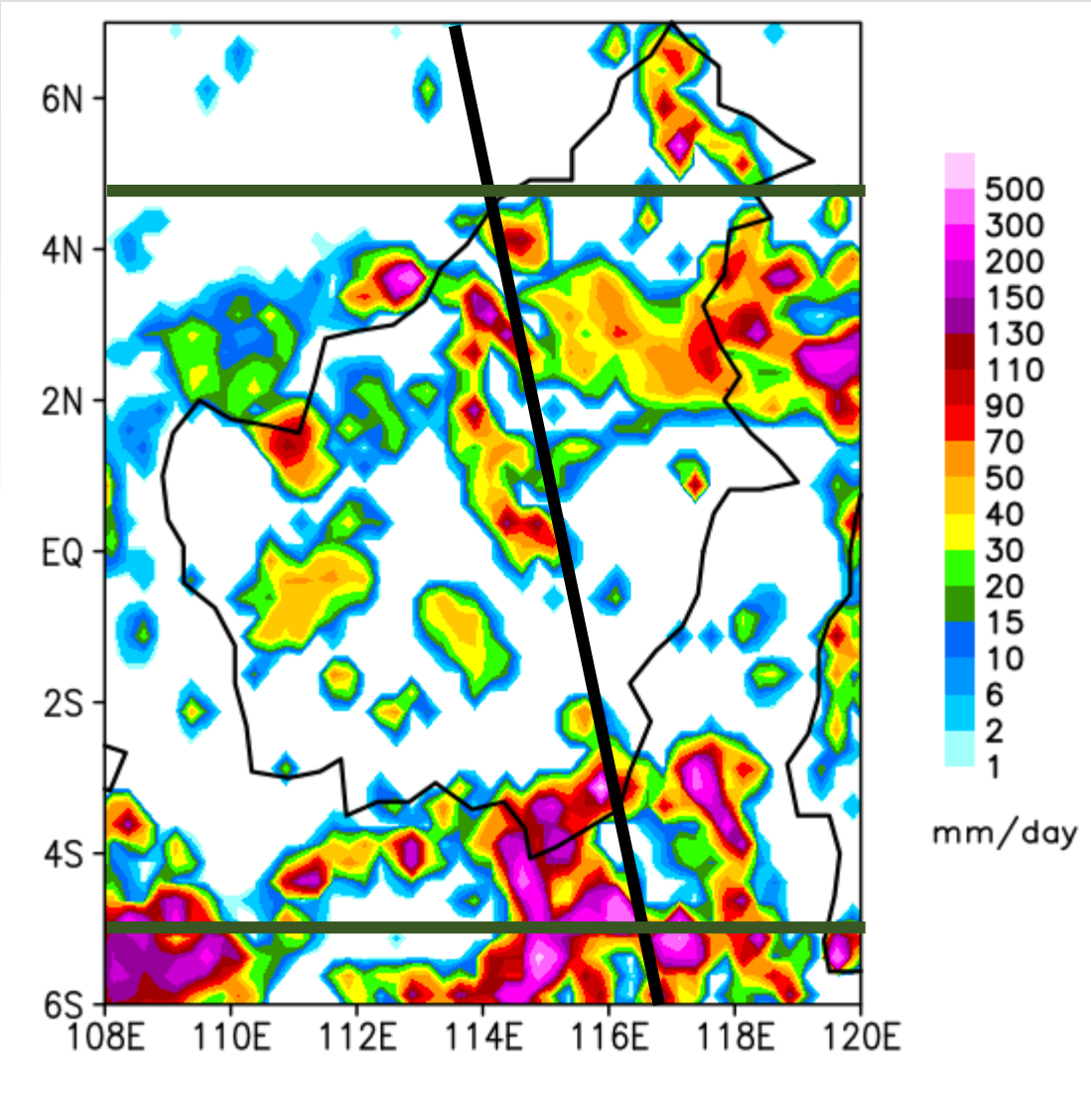
Lat -5
Lon 116.8

Lat 4.6
Lon 114.8

CloudSat sampling

- TRMM : 1400LT
- 2007/1/23
- CloudSat : ~14:00LT



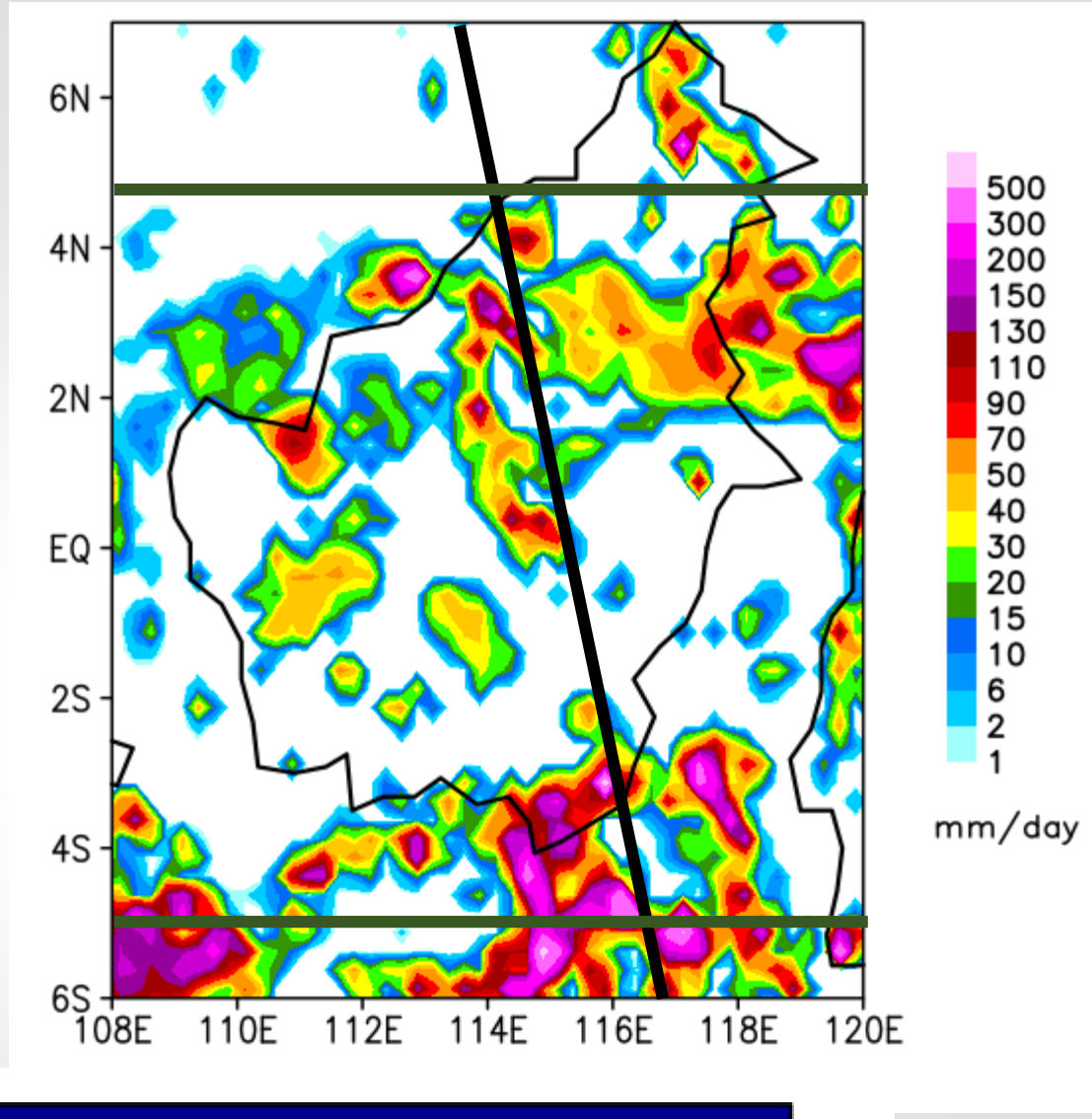


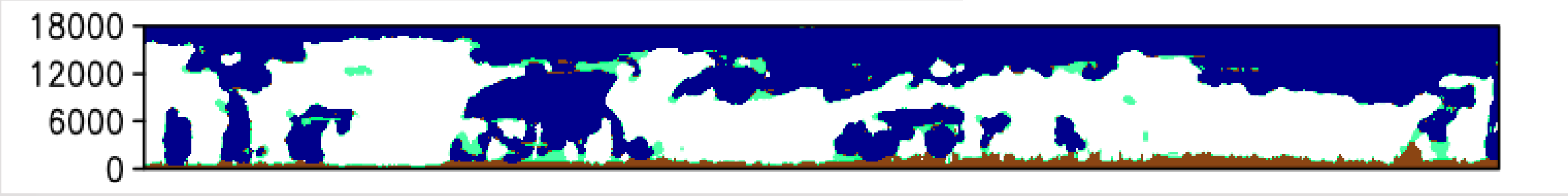
Lat -5
Lon 116.8

Lat 4.6
Lon 114.8

CloudSat sampling

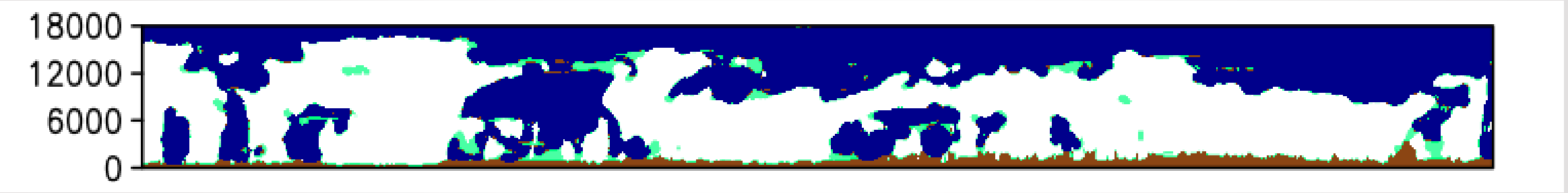
- TRMM : 1400LT
- 2007/1/23
- CloudSat : ~14:00LT

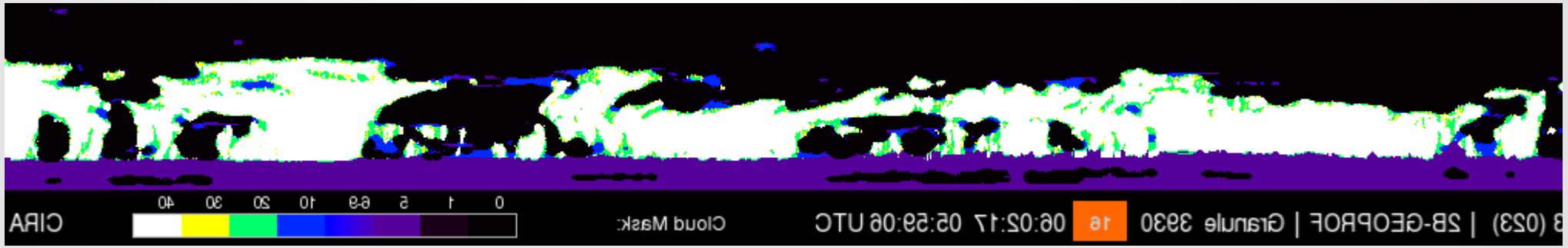




CloudSat sampling

- TRMM : 1400LT
- 2007/1/23
- CloudSat : ~14:00LT





Cloud product processing

Copy “coldsugrge.mat”

mkdir folder

day-5
day-4
day-3
day-2

day4
day5

cprtransfer_ver2018_crossyear.m

CPR_2012005_30262_day.nc
⋮

Varibles in .nc :
locationinfo
height
CPRCloudmask
Landseamask

125 * xxxx

Find your own cloud

Example : ppt 10~12

nctodatforcpr_forenv.m

Merge all cases in same folder to one .dat file

Example:
cpr_day-5_cloud_2786.dat
day-5_2786.ctl

Cloud product processing

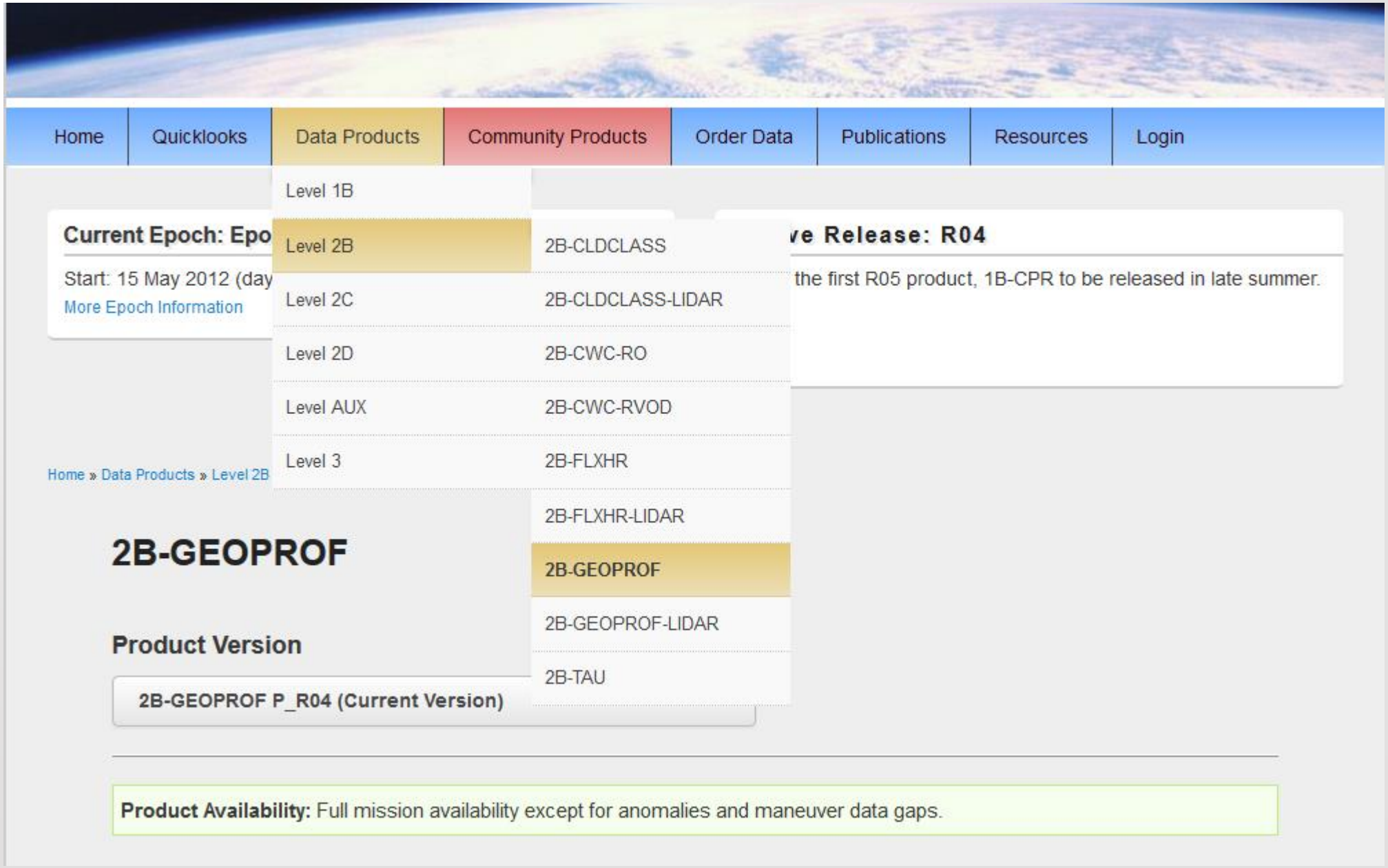
```
%%%%%%% For 2B-GEOPROF hdf file %%%%%%%
%%% notice that the vertical resolution of 2B-GEO
%%% Height information is in the variable: Height
%%% Cloudsat after 2012 only work during day time
%julian date : https://landweb.modaps.eosdis.nasa
%%% time period input
yearrange=coldsurgejulian;

%%% latitude(-90~90) & longitude(-180~180) range
startlat=-5; %small one
endlat=30; %large one
startlon=100;
endlon=140;


[casenumber,useless]=size(yearrange);
for ppp=1:19;%casenumber;
```

- time information in hdf is UTC time.
- If the pressure information is needed, check the "ECMWF-AUX" product.
- No observation at nighttime after 2011/04/17
- 2011's observation only have 1430 cases (other years : over 4000)

Useful website



Useful website

-