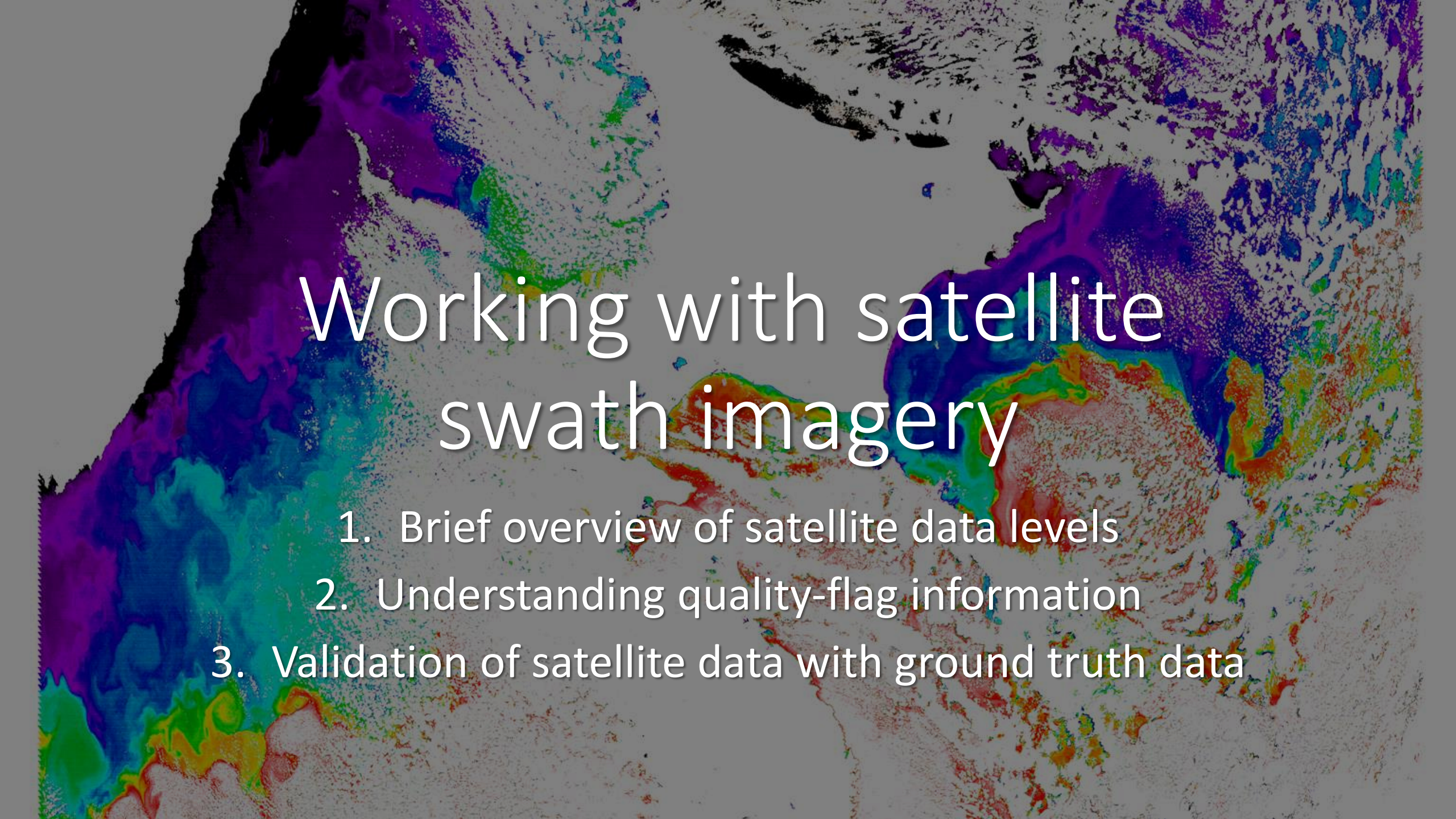


Working with satellite swath imagery

1. Brief overview of satellite data levels
2. Understanding quality-flag information
3. Validation of satellite data with ground truth data

Brief Overview of Satellite Data Levels

- **Level 0: Uncalibrated science data** (engineering units) **in a raw format**.
- **Level-1A: Uncalibrated science data in an archive format** (are Level 0 with ancillary information including radiometric and geometric calibration coefficients and georeferencing parameters appended)
- **Level-1B: Calibrated, geolocated science data** (instrument/radiometric calibrations applied)
- **Level-2: Derived geophysical science products** at the same resolution as the source Level-1 data. These variables can be ocean color, SST, etc., and are obtainable from JAXA, NASA, ESA, etc.
- **Level-3: Derived geophysical science products, temporally/spatially composited.** Level-3 data are downloadable from Marine Environmental Watch of NOWPAP (regional), JAXA (global), NASA (global), etc.
- **Level-4: model output or results from analyses of lower-level data** (e.g., Primary Productivity, CHL from YOC algorithm, etc.)

Brief Overview of Satellite Data Levels (L2: Level-2)

L2: Advantages

- Unmapped data at native satellite swath coordinate system (spatial resolution and geometries)
- Includes in a single file many geophysical parameters
- Satellite-to-in situ validation exercises are performed with L2 data products

L2: Disadvantages

- Unmapped images (geometrically distorted) and cannot be compared with other images
- **Data must be quality screened to remove low-quality data prior to use**
- Files with large data volume
- Require more technical expertise to work with

Understanding quality-flag information

NASA L2

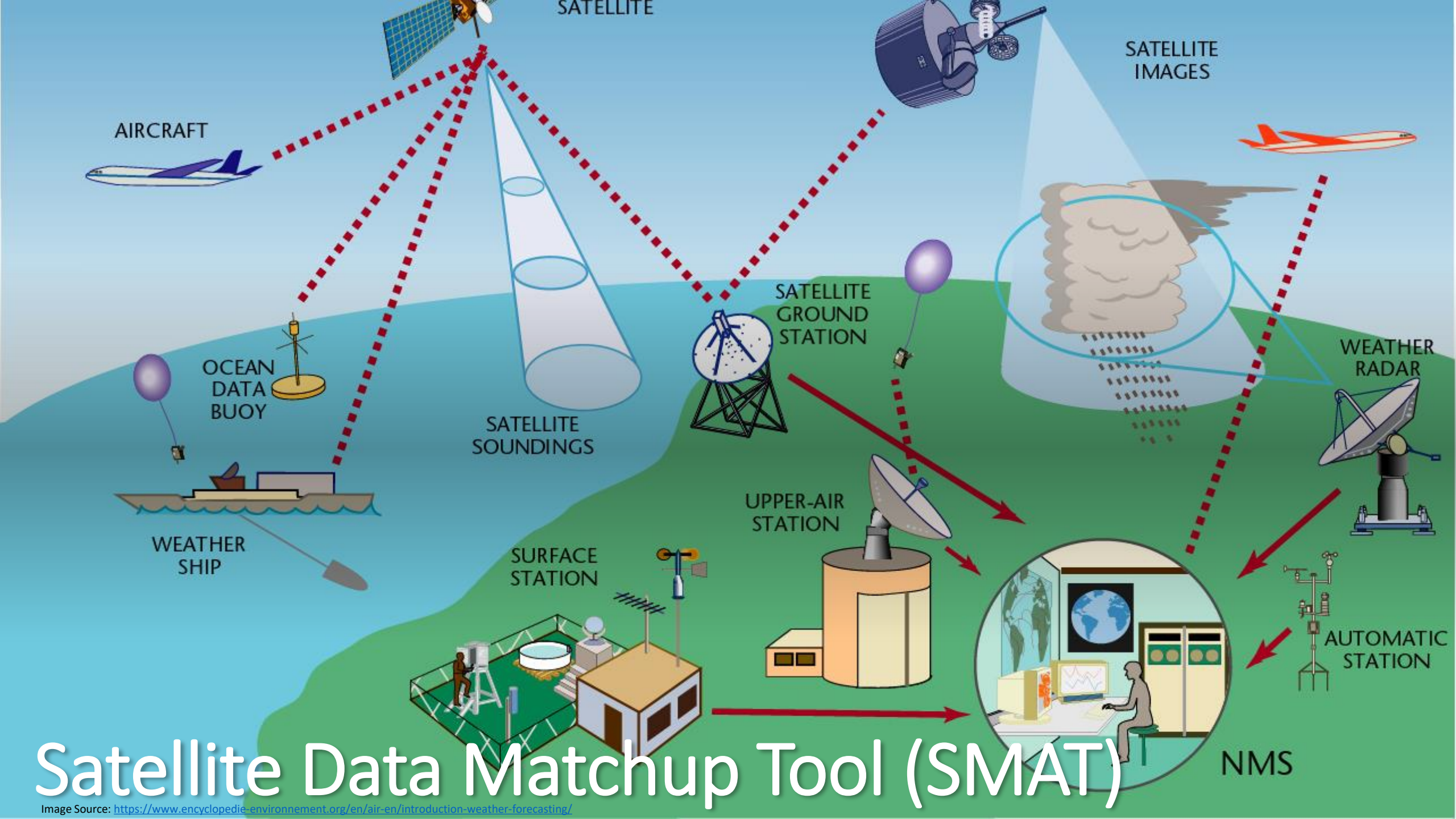
Use Level 2 Flags

Bit	Name	Bit	Name
00	☑ ATMFAIL	16	☐ NAVWARN
01	☑ LAND	17	☐ ABSAER
02	☐ PRODWARN	18	☐ SPARE
03	☐ HIGLINT	19	☐ MAXAERITER
04	☐ HILT	20	☐ MODGLINT
05	☐ HISATZEN	21	☐ CHLWARN
06	☐ COASTZ	22	☐ ATMWARN
07	☐ SPARE	23	☐ SPARE
08	☐ STRAYLIGHT	24	☐ SEAICE
09	☑ CLDICE	25	☑ NAVFAIL
10	☐ COCCOLITH	26	☐ FILTER
11	☐ TURBIDW	27	☐ SPARE
12	☐ HISOLZEN	28	☐ BOWTIEDEL
13	☐ SPARE	29	☐ HIPOL
14	☐ LOWLW	30	☐ PRODFAIL
15	☑ CHLFAIL	31	☐ SPARE

JAXA L2 SGLI

Use Level 2 Flags

Bit	Name
00	☐ DATAMISS
01	☑ LAND
02	☑ ATMFAIL
03	☑ CLDICE
04	☐ CLDAFFCTD
05	☐ STRAYLIGHT
06	☐ HIGLINT
07	☐ MODGLINT
08	☐ HISOLZ
09	☐ HITAUA
10	☐ NEGNLW
11	☐ TURBIDW
12	☐ SHALLOW
13	☐ ITERFAILCDOM
14	☐ CHLWARN
15	☐ SPARE



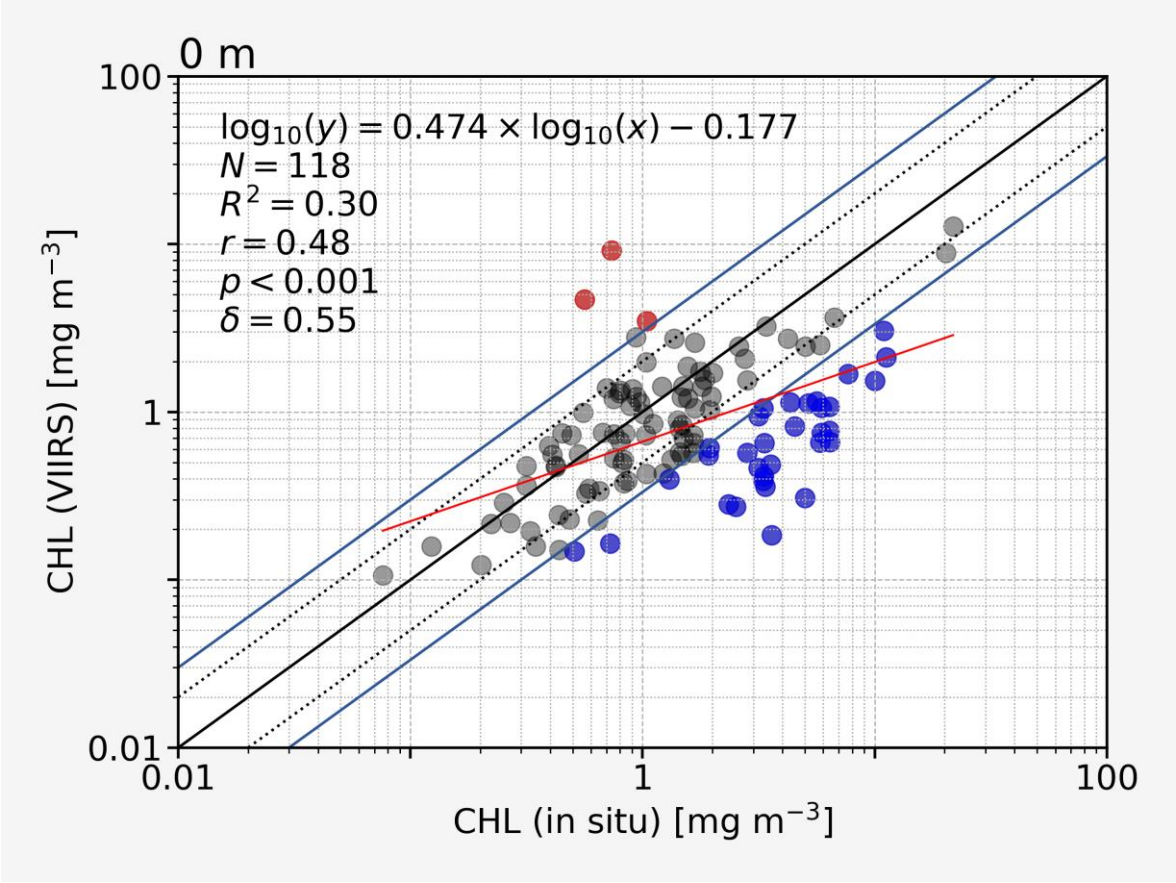
Satellite Data Matchup Tool (SMAT)

Image Source: https://www.encyclopedie-environnement.org/en/air-en/introduction-weather-forecasting/

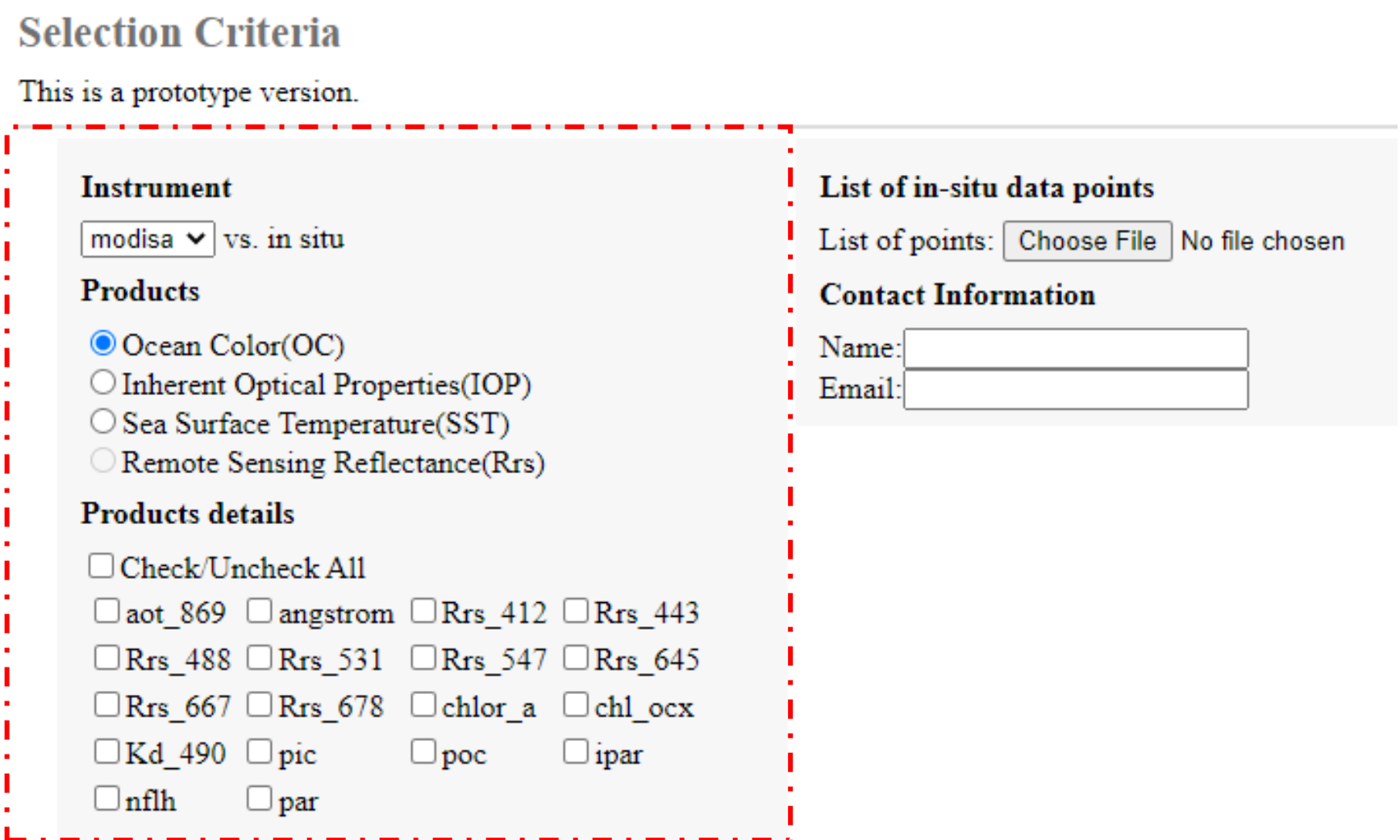
SMAT: Satellite Data Matchup Tool

Online Matchup Tool
(https://ocean.nowpap3.go.jp/smat/)

- **Purpose**
  - Matchup of satellite and in-situ observations
- **Composed of two parts**
  1. **Selection Criteria**
  2. **Validation Criteria**



SMAT: (1) Selection Criteria



1. Instrument

(list of supported satellite)

↓

2. Data Type

(OC, IOP, Rrs, SST)

↓

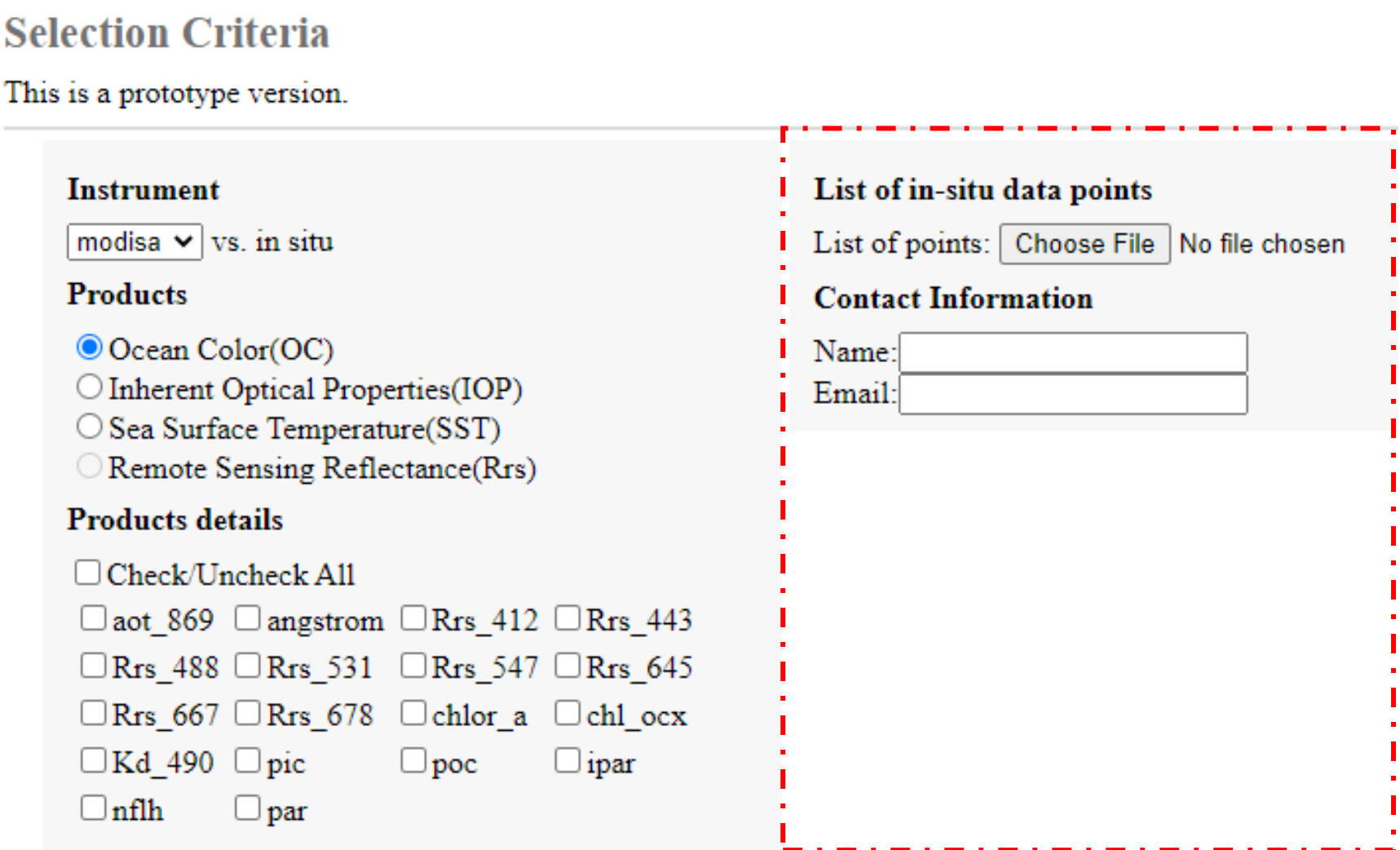
2.1 Products

(list of products per data type)

↓

Check all/Select a few

SMAT: (1) Selection Criteria



In-situ data

(upload a .csv file with a list of field observation points)

Sample .csv file

Header

Should have at least:

- **lon, lat, date, time, chl**

Time (UTC)

SMAT: (1) Selection Criteria

Selection Criteria

This is a prototype version.

Instrument

modisa vs. in situ

Products

- (•) Ocean Color(OC)
- ( ) Inherent Optical Properties(IOP)
- ( ) Sea Surface Temperature(SST)
- ( ) Remote Sensing Reflectance(Rrs)

Products details

- [ ] Check/Uncheck All
- [ ] aot_869 [ ] angstrom [ ] Rrs_412 [ ] Rrs_443
- [ ] Rrs_488 [ ] Rrs_531 [ ] Rrs_547 [ ] Rrs_645
- [ ] Rrs_667 [ ] Rrs_678 [ ] chlor_a [ ] chl_ocx
- [ ] Kd_490 [ ] pic [ ] poc [ ] ipar
- [ ] nflh [ ] par

List of in-situ data points

List of points: Choose File No file chosen

Contact Information

Name:

Email:

Contact

(notifications are sent to provided email with link of matchup data download)

SMAT: (2) Validation Criteria

Validation Criteria

Specify the values

Pixel Window Size

5 Pixels

Min Valid Pixels

50 %

Max Time Difference

3 hours

SST Quality Level

1

Use Level 2 Flags

Bit	Name	Bit	Name
00	☑ ATMFAIL	16	☐ NAVWARN
01	☑ LAND	17	☐ ABSAER
02	☐ PRODWARN	18	☐ SPARE
03	☐ HIGLINT	19	☐ MAXAERITER
04	☐ HILT	20	☐ MODGLINT
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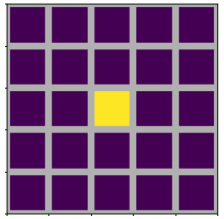
06	☐ COASTZ	22	☐ ATMWARN
07	☐ SPARE	23	☐ SPARE
08	☐ STRAYLIGHT	24	☐ SEAICE
09	☑ CLDICE	25	☑ NAVFAIL
10	☐ COCCOLITH	26	☐ FILTER
11	☐ TURBIDW	27	☐ SPARE
12	☐ HISOLZEN	28	☐ BOWTIEDEL
13	☐ SPARE	29	☐ HIPOL
14	☐ LOWLW	30	☐ PRODFAIL
15	☑ CHLFAIL	31	☐ SPARE

Click "Apply" button to run the system

Submit

No Data!!

Pixel Window Size



data search window

yellow → in-situ point centre

Min Valid Pixels

(5x5=25, 50% = 13)

Max Time Difference

(in-situ—satellite time difference)

SST Quality Level

(quality number 0: best, 4: worst)

SMAT: (2) Validation Criteria

Validation Criteria

Specify the values

Pixel Window Size

5 Pixels

Min Valid Pixels

50 %

Max Time Difference

3 hours

SST Quality Level

1

Use Level 2 Flags

Bit	Name	Bit	Name
00	☑ ATMFAIL	16	☐ NAVWARN
01	☑ LAND	17	☐ ABSAER
02	☐ PRODWARN	18	☐ SPARE
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13	☐ SPARE	29	☐ HIPOL
14	☐ LOWLW	30	☐ PRODFAIL
15	☑ CHLFAIL	31	☐ SPARE

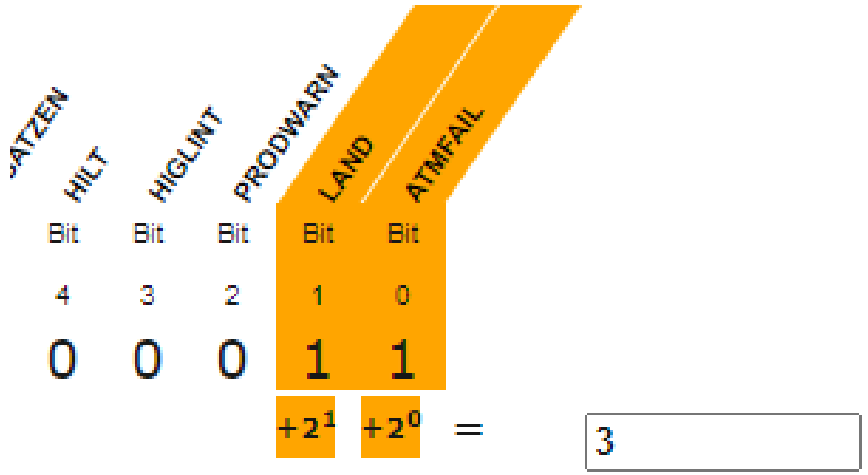
Click "Apply" button to run the system

Submit

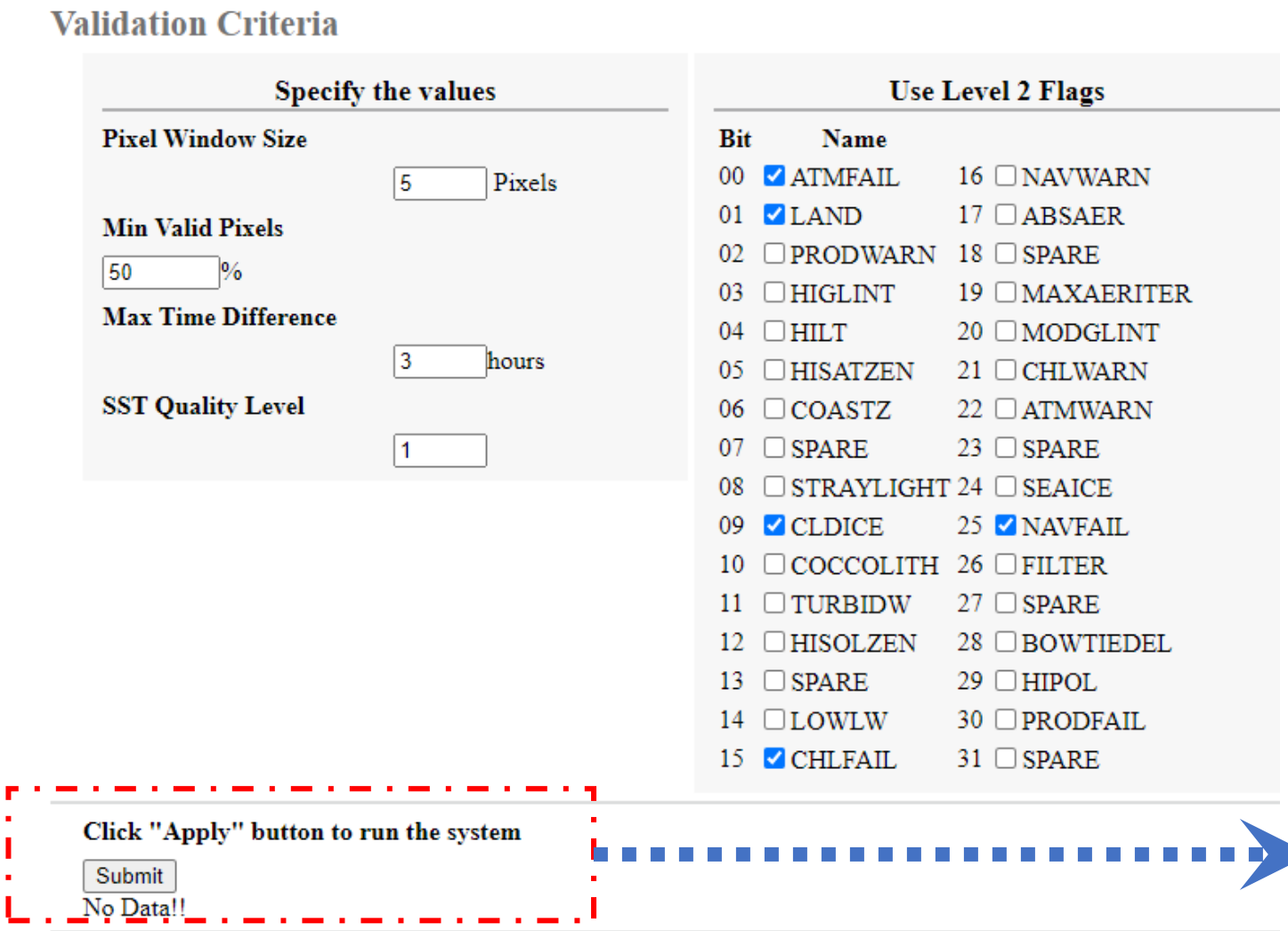
No Data!!

Level-2 Flags

16 or 32bits: Data Type dependent



SMAT: (2) Validation Criteria



Submit

(Submit request for processing)

SMAT: Results

```
:BeginHeader
Using satellite data from MODIS/AQUA
Match-up generation datetime: 2021-12-01T14:32:06
Investigator: ermaure
Contact: maure@npec.or.jp
Missing: -999
Delimiter: comma
Header rows: 14
VALIDATION CRITERIA applied to this match-up
-Box size of satellite extract: 5 x 5 = 25 pixels
-Minimum percent valid satellite pixels: 25.0
-Maximum time difference between satellite and in situ: 3 h
-Level-2 flags considered for data screening: ATMFAIL+LAND+CLDICE+CHLFAIL+NAVFAIL
:EndHeader
cruise,Year,Month,Day,Hour,Minute,Second,Lat,Lon,id,etopo2,chl,Datetime,Filename,Variable [Units
bats173,2003,2,22,17,6,0,32.1844,-64.4933,462.0,3013.0,0.382,2003-02-22T17:06:00,A2003053173000.
```

- GEE: https://code.earthengine.google.com/84446da594ddebc41fab3e50da212311

- Jupyter: https://github.com/npec/5th-NOWPAP-Training-Course-on-Remote-Sensing-Data-Analysis/blob/main/02.Working-with-swath-imagery/1.2.2.UnderstandingLevel-2Flags.ipynb