Overview of SeaDAS 8.4.1 for the Processing, Analysis, and Visualization of Optical Remote Sensing Data for Water Quality Monitoring

Amita Mehta (NASA-UMBC-GESTAR II)
Guest Speaker: Daniel Knowles

February 13, 2024

About ARSET

About ARSET

- **ARSET provides accessible, relevant, and cost-free training on remote sensing satellites, sensors, methods, and tools.**

- Trainings include a variety of applications of satellite data and are tailored to audiences with a variety of experience levels.

AGRICULTURE

CLIMATE & RESILIENCE

DISASTERS

ECOLOGICAL CONSERVATION

HEALTH & AIR QUALITY

WATER RESOURCES

NASA EARTH SCIENCE APPLIED SCIENCES CAPACITY BUILDING

About ARSET Trainings

- Online or in-person
- Live and instructor-led or asynchronous and self-paced
- Cost-free
- Bilingual and multilingual options
- Only use open-source software and data
- Accommodate differing levels of expertise

- Visit the ARSET website to learn more.

Overview of SeaDAS 8.4.1

What is SeaDAS?

Sea, earth and atmosphere Data Analysis System

- NASA Software for the processing, visualization, and analysis of Earth science data
- Developed by NASA's Ocean Biology Processing Group (OBPG)
- OB.DAAC (Ocean Biology Distributed Active Archive Center) is a NASA EOSDIS DAAC

https://seadas.gsfc.nasa.gov

https://oceancolor.gsfc.nasa.gov

https://www.earthdata.nasa.gov/eosdis/daacs/obdaac

- EOSDIS – Earth Observing System Data and Information System

SeaDAS Supported Missions

AVHRR	OLI Landsat 8
CZCS	OLI Landsat 9
ETM+ Landsat7	OSMI
GOCI	SeaWiFS
HawkEye	TM Landsat 5
HICO	VIIRS Suomi NPP
MERIS	VIIRS NOAA20
MODIS Aqua	VIIRS NOAA21
MODIS Terra	
MOS	Polarimeters:
MSI Sentinel 2A	HARP2 PACE*
MSI Sentinel 2B	MISR
OCI PACE**	SPEXone PACE*
OCM1	Airborne Sensors:
OCM2	AVIRIS
OCTS	PRISM
OLCI Sentinel 3A	
OLCI Sentinel 3B	

** Limited Support*
** Planned (Limited Support)*
*** Planned Full Support*

From Daniel Knowles (OB.DAAC)

What is SeaDAS Used for?

- SeaDAS software is important for satellite image processing for deriving water quality parameters such as chlorophyll concentration, water surface temperature.
- SeaDAS not only allows calculations of remote sensing reflectances for multiple optical sensors, but it also offers image analysis and visualization options and allows comparison with *in situ* water quality measurements.

Why SeaDAS 8.4.1?

- The current version of SeaDAS 8.4.1 has evolved with data processing capability for additional sensors such as Sentinel-3 OLCI, Sentinel-2 MSI, and upcoming sensor: PACE OCI.
- The earlier version of SeaDAS science data processing could only be used on the Mac operating system (macOS) and Unix/Linux operating system. The current version can also be used on the Windows system.

OLCI: Ocean and Land Color Instrument
PACE: Plankton, Aerosol, Cloud, and Ocean Ecosystem

MSI: Multi Spectral Image
OCI: Ocean Color Instrument

Training Learning Objectives

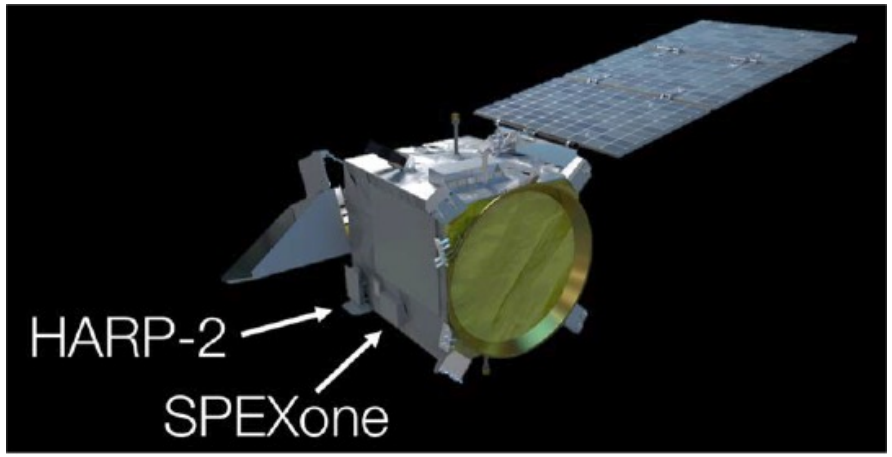
By the end of this training, participants will be able to:

- Identify expanded sensor data processing capability of the latest version of SeaDAS 8.4.1 for sensors such as OLCI and MSI.
- Use key SeaDAS tools to analyze and visualize a water quality parameter, such as chlorophyll-a concentration, from Sentinel-3 OLCI for a given water body.
- Improve awareness of the plans for incorporating future PACE data processing into SeaDAS.

Plankton, Aerosol, Cloud, and Ocean Ecosystem (PACE)

PACE is NASA's next great investment in hyperspectral earth imagery and multi-angle polarimetry.

  - Launch Date: No sooner than **February 6, 2024**
  - 3-year design life; 10-year propellant
- **Hyperspectral Imager: Ocean Color Instrument (OCI)**
  - Spectral Resolution: UV to SWIR (340-890 nm every 2.5 nm, with 940, 1038, 1250, 1378, 1615, 2130, & 2250 nm)
  - Temporal Resolution: 2 days
  - Spatial Resolution: 1-km^2 at nadir
- **Two Multi-Angle Polarimeters**
  - **HARP-2**: Wide swath, hyper-angular, 4 bands across the VIS & NIR
  - **SPEXone**: Narrow swath, hyperspectral (UVNIR), 5 viewing angles



Prerequisites

- Fundamentals of Remote Sensing
- Monitoring Coastal and Estuarine Water Quality using Remote Sensing and In Situ Data

Training Outline

- SeaDAS User Software: General Image Analysis Tools
- SeaDAS Science Processing Software: OCSSW
- SeaDAS Reference Workflows
- SeaDAS for PACE Data Analysis and Visualization
- Demonstration of SeaDAS Workflow Case Study: OLCI Level-2 and Level-3 Data Processing

Homework

Opens February 13 – Due February 29 – Posted on Training Webpage

A certificate of completion will be awarded to those who attend this live session and complete the homework assignment(s) before the given due date.

Trainers

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ARSET Instructor
NASA–UMBC–GESTAR II

Daniel Knowles Jr.
Software Developer
NASA Ocean Biology Distributed Active Archive Center

Contributors

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SeaDAS Application Lead

Bing Yang
Software Developer
NASA Ocean Biology Distributed Active Archive Center/SAIC

How to Ask Questions

- Please put your questions in the Questions box and we will address them at the end of the webinar.
- Feel free to enter your questions as we go. We will try to get to all the questions during the Q&A session after the webinar.
- The remainder of the questions will be answered in the Q&A document, which will be posted to the training website about a week after the training.

Useful Definitions

https://oceancolor.gsfc.nasa.gov/

OC: Ocean Color

Ocean Color is the apparent hue, shade, or tone of water that results from the interactions of sunlight with the microscopic composition of the water column and water itself. Typical relevant water constituents include phytoplankton, mineral particles, and dissolved organic matter.

IOPS: Inherent Optical Properties

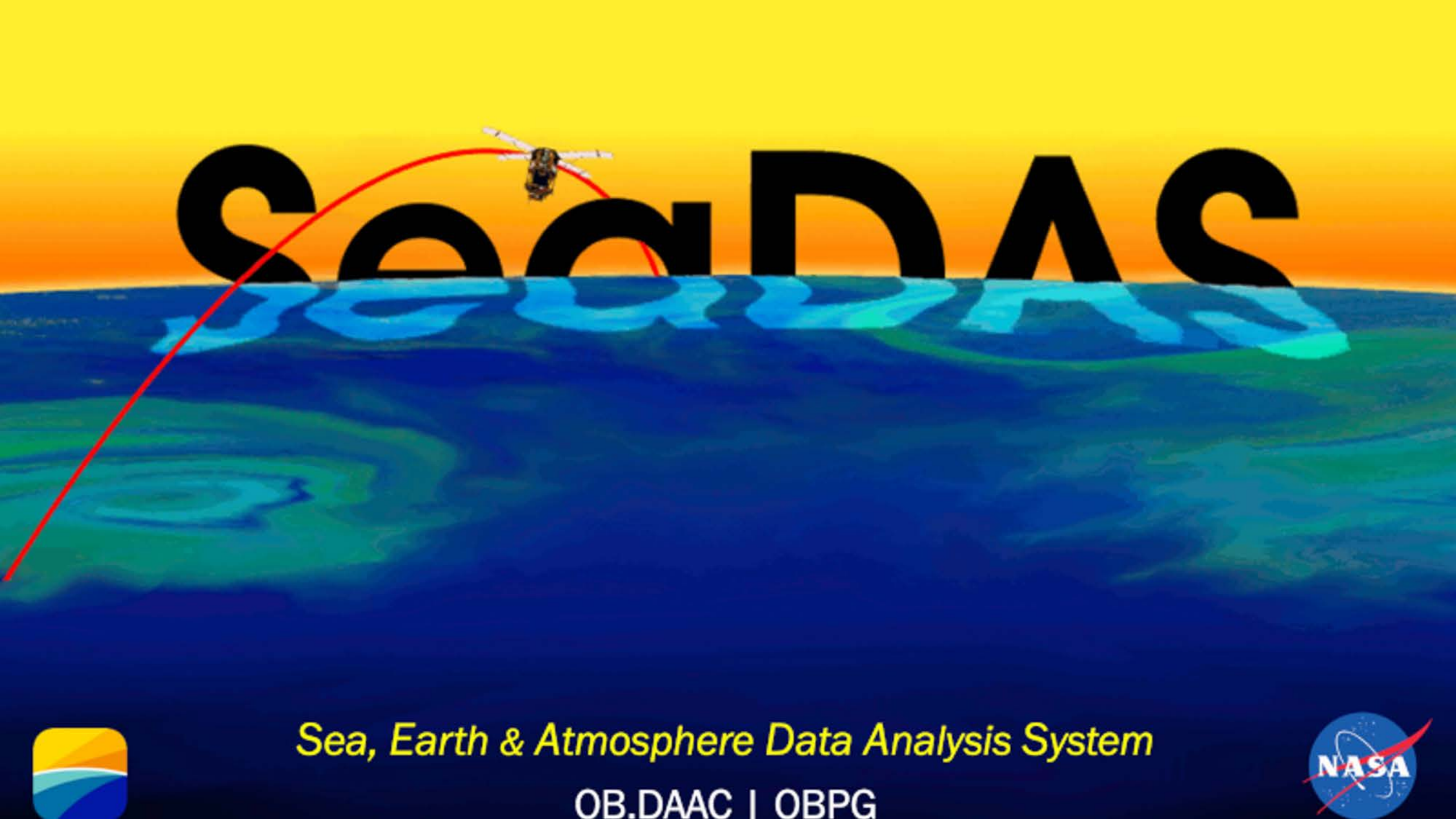
Describe the fundamental optical properties of the ocean (total absorption and backscattering coefficients), from which a host of bio-optical and bio-geochemical properties can be derived.

Rrs_λ: Remote Sensing Reflectance

Surface spectral remote-sensing reflectances observed by the satellite instrument after atmospheric correction.

$Rhos_\lambda$: Surface Reflectance

Surface spectral reflectances observed by the satellite instrument after Rayleigh correction.


SeaDAS
Sea, Earth & Atmosphere Data Analysis System
OB.DAAC | OBPG
NASA

SeaDAS Historical Perspective

- **1987** – "System Concept for Wide Field-of-View Observation of Ocean Phenomena from Space"
  - Specifications report outlines SeaWiFS as an improved ocean color sensor
    - Nimbus-7 Coastal Zone Color Scanner (CZCS) had ceased operating (Oct 1978 – June 1986)
      - Early 1990s SeaDAS Vision:
        - » Provide user community with tools to work with the satellite data
          - Visualization & Analysis of distributed NASA products: levels 1, 2, and 3
          - Processing: Identically reproduce all standard NASA products: levels 1, 2, and 3
        - » Continually evolve to keep up with technology

SeaDAS Historical Perspective (Continued)

- **1994** July – SeaDAS Beta Release
  - SeaDAS (SeaWiFS Data Analysis System)

- **1997** Sep – SeaDAS Release (Version 3.0B3): Supports SeaWiFS Operations
- **2012** – SeaDAS Integrates BEAM GUI Interface Software
- **2021** – SeaDAS Integrates SNAP GUI Interface Software
- **2023** – Supports 24 Missions (Version 8.3.0)
  - SeaDAS (**S**ea, **e**arth and **a**tmosphere **D**ata **A**nalysis **S**ystem)

SeaDAS User Software

General Image Analysis Tools

SeaDAS User Software: General Image Analysis Tools

Satellite

Receiving Station
Data Provider

Level-0 Files*
Level-1A Files*
Level-1B Files*

OB.DAAC

ODPS

SeaDAS

Level-0 Files*
Level-1A Files*
Level-1B Files*

Geo Files*

Level-2 Files*

Level-3 Binned Files

Level-3 Mapped Files

Ancillary Files

Ancillary Files

Ancillary Sources

SeaDAS Science
Processing Tools

Geo Files*

Level-1B Files*

Level-2 Files*

Level-3 Binned Files

Level-3 Mapped Files

SeaDAS
General Image
Analysis Tools

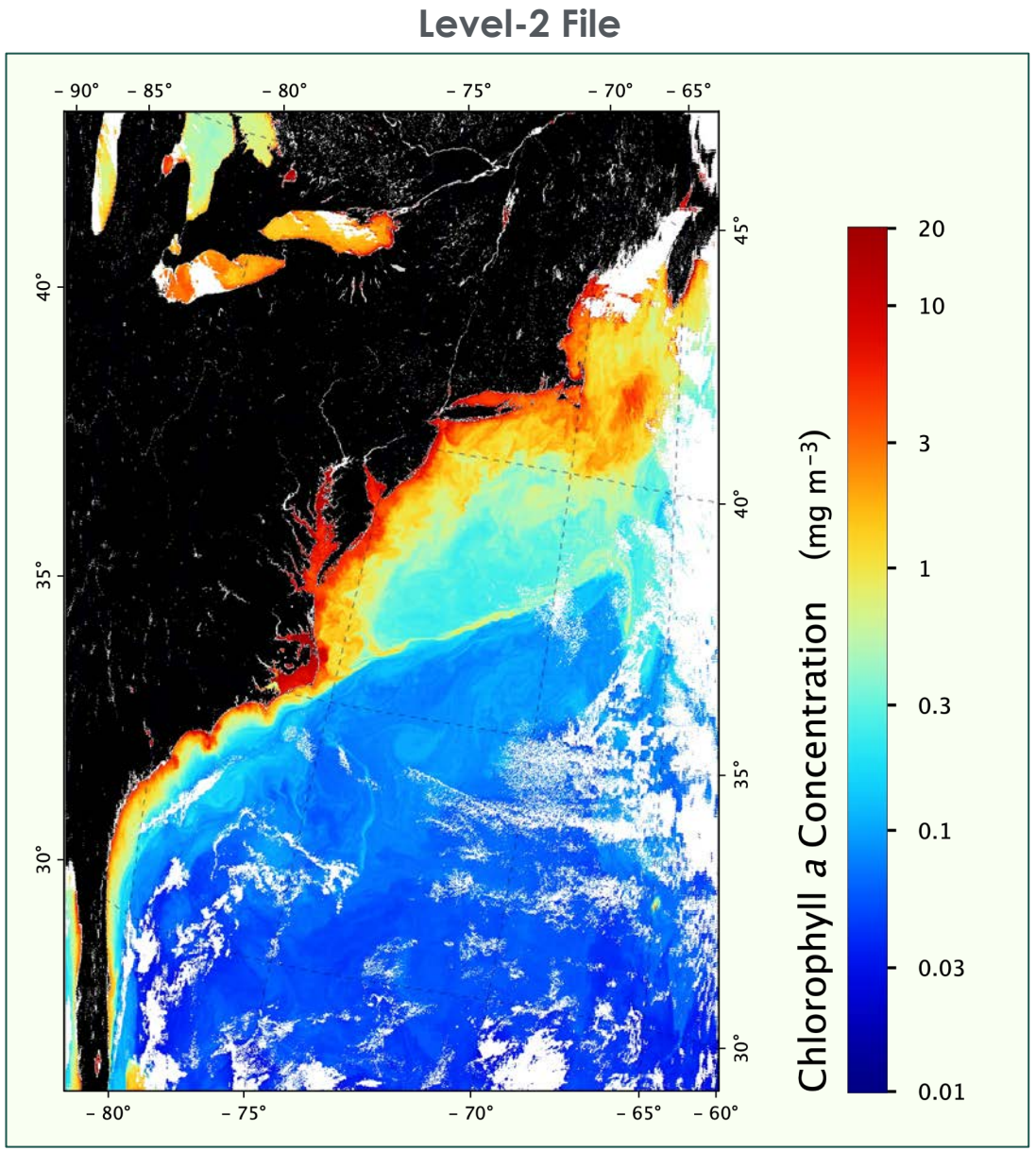
- Imagery
- Masking
- Mapping
- Aggregation
- Algorithms
- Analysis
- Statistics

User

SeaDAS

* Mission Dependent

SeaDAS User Software: General Image Analysis Tools



SeaDAS General Image Analysis Tools

- Imagery
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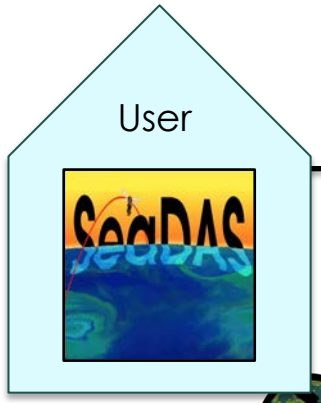
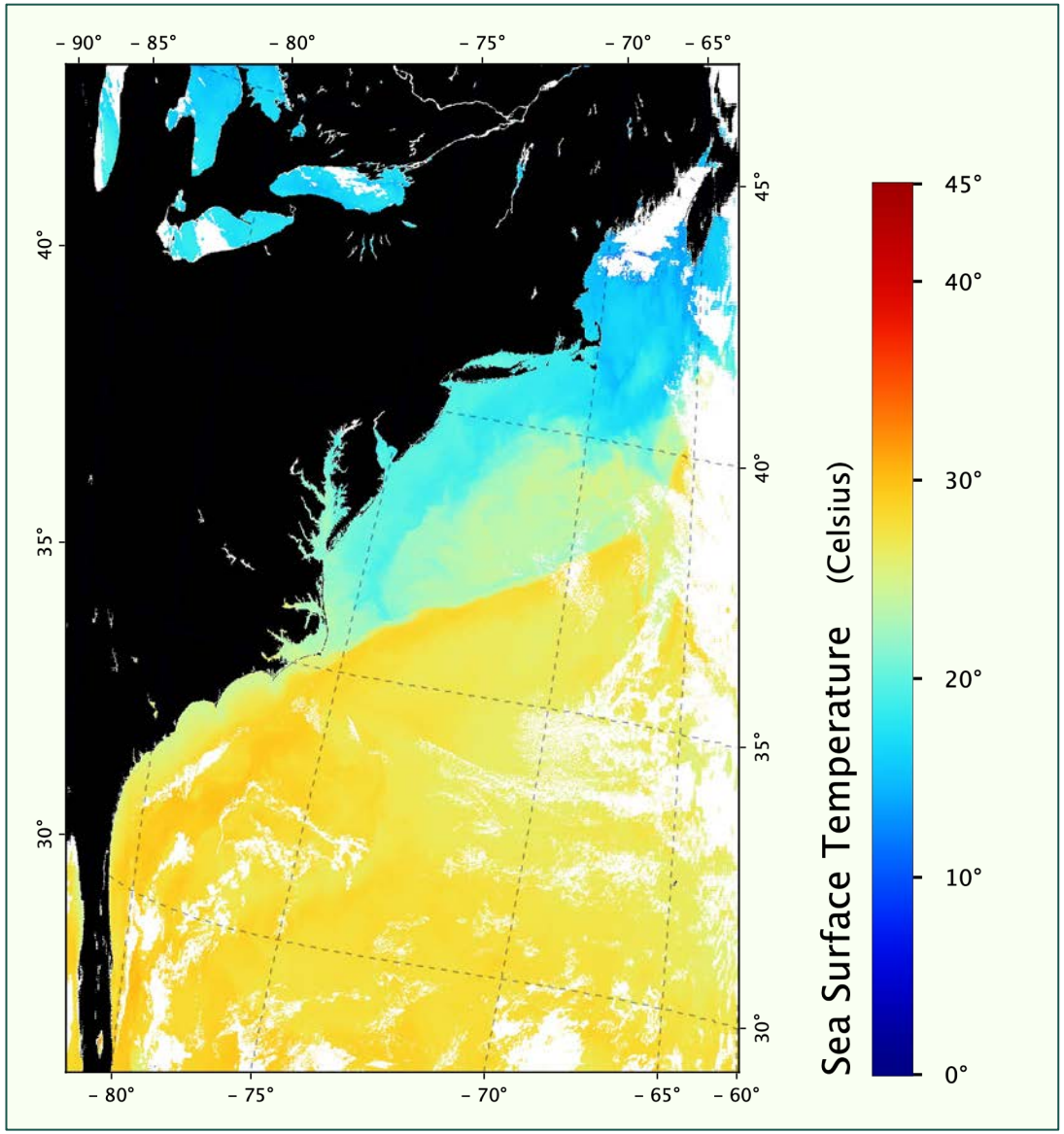


SeaDAS User Software: General Image Analysis Tools

Level-2 File



SeaDAS General Image Analysis Tools

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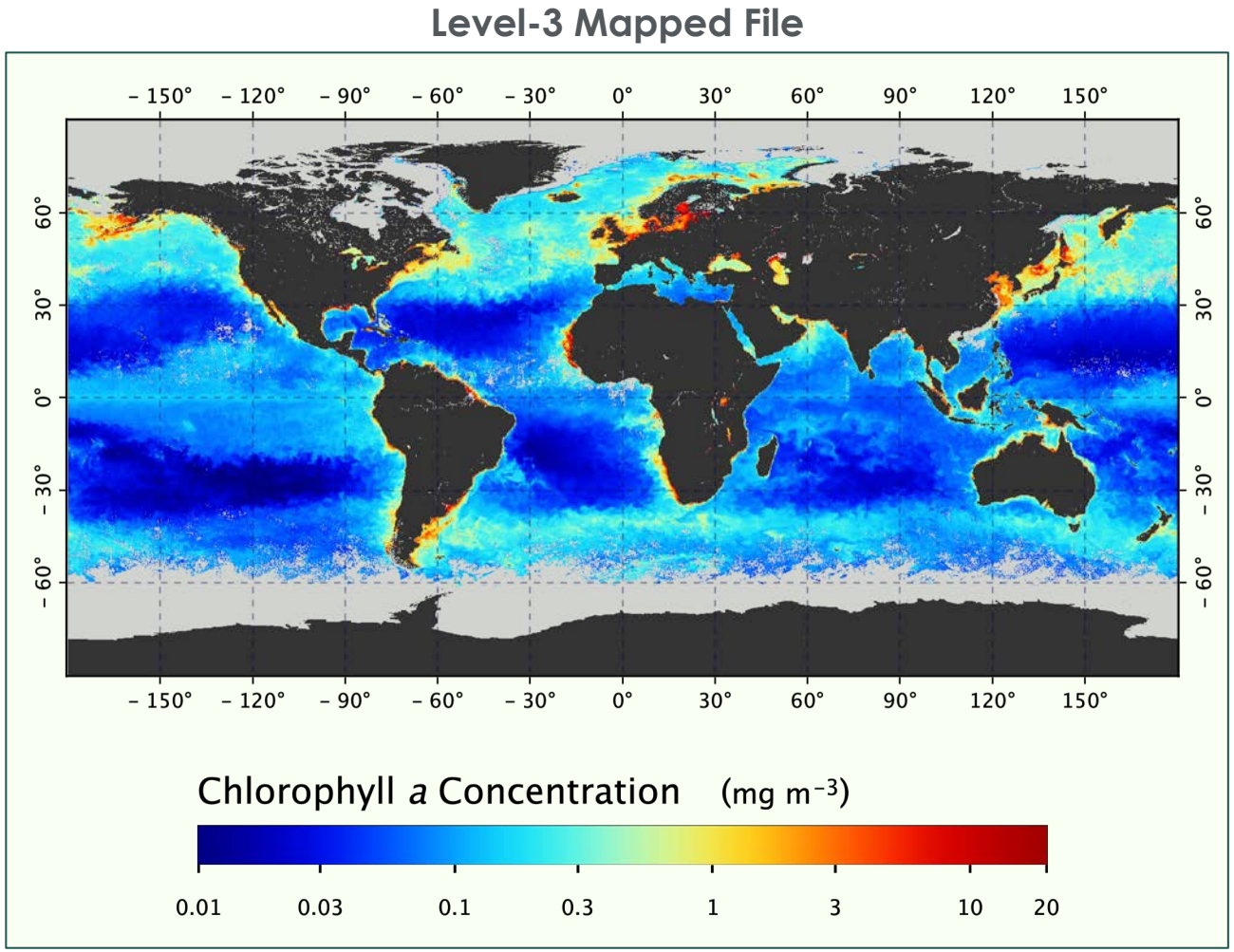
User

SeaDAS User Software: General Image Analysis Tools



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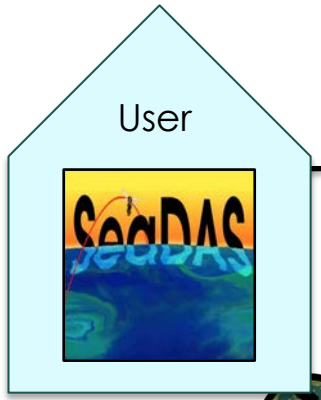
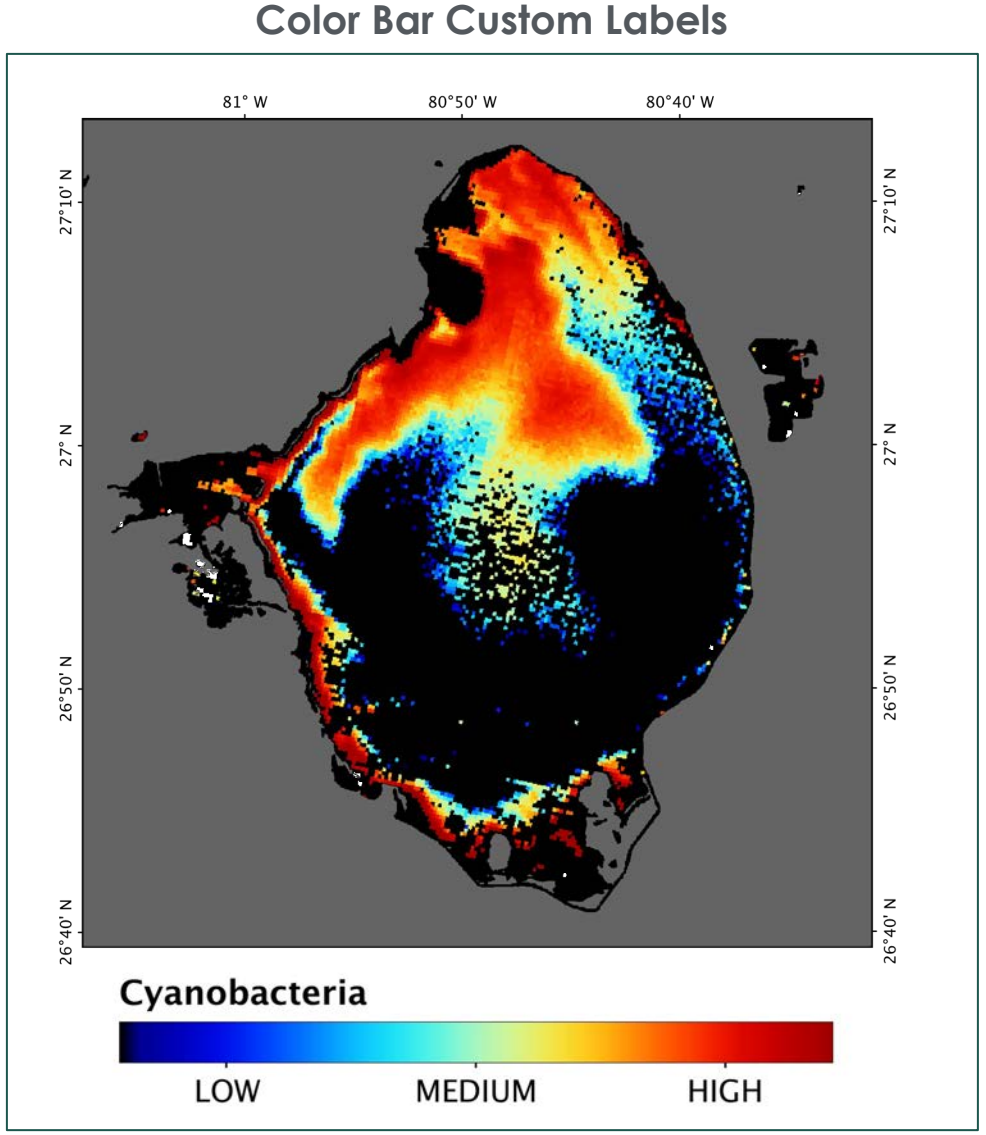


SeaDAS User Software: General Image Analysis Tools



SeaDAS General Image Analysis Tools

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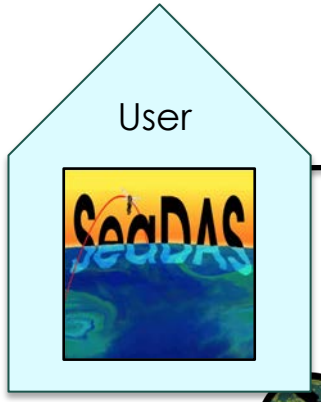
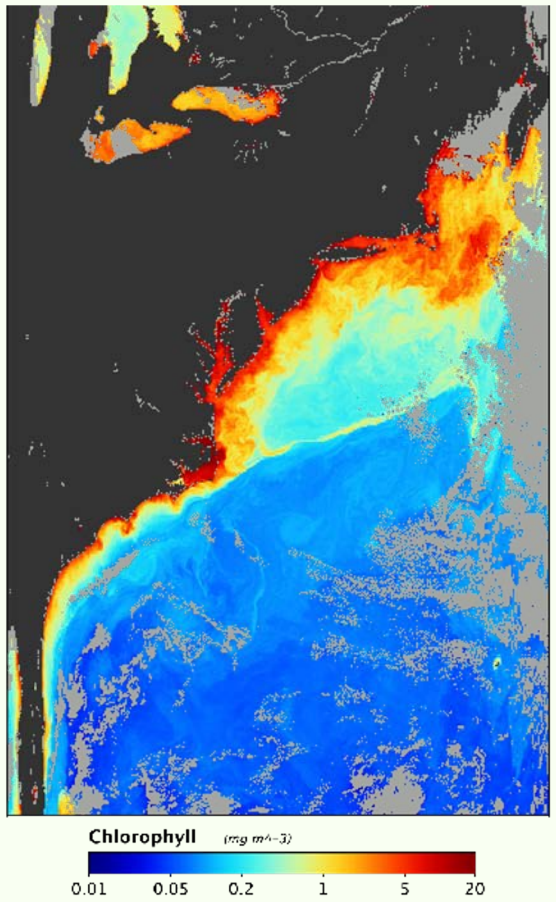


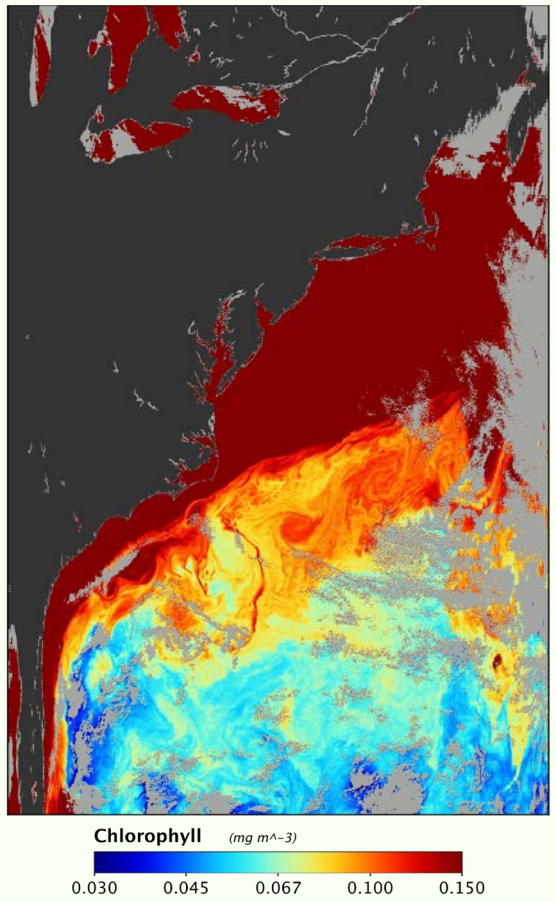
Lake Okeechobee: June 22, 2011
Source Data: MERIS M2011173153504

SeaDAS User Software: General Image Analysis Tools

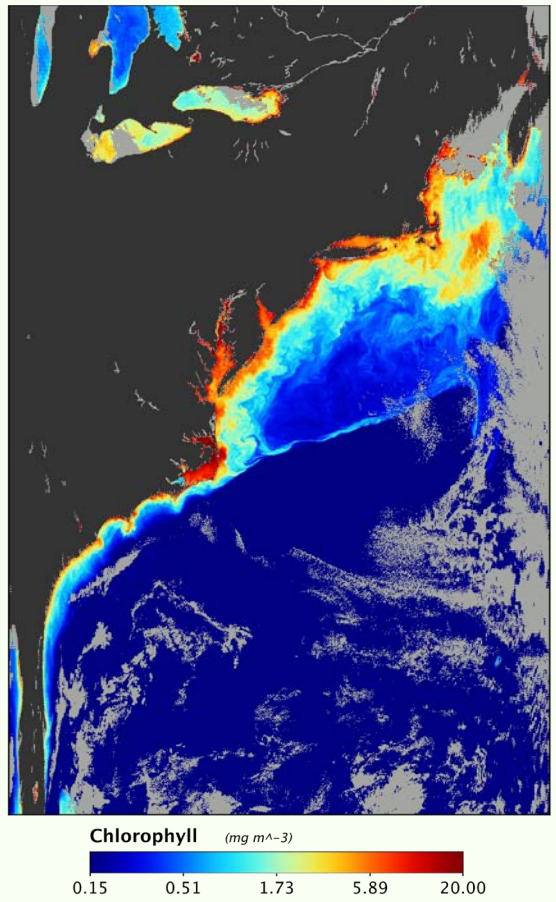
Color Palette Range Settings



Default



Low (Oligotrophic)



High (Eutrophic)

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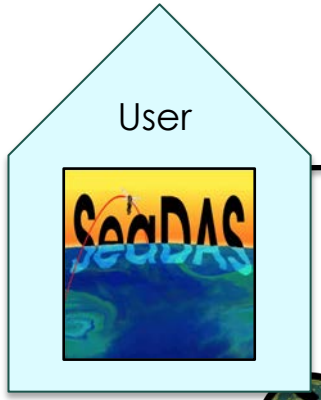
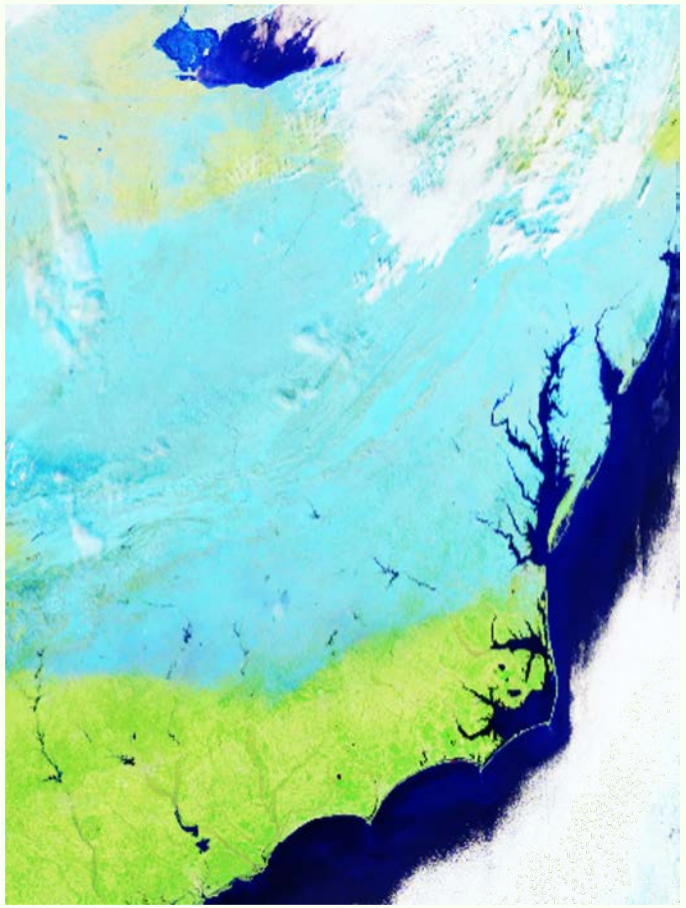


SeaDAS User Software: General Image Analysis Tools

Band Combinations RGB Imagery

Pseudo True Color
R=645, G=555, B=469



Distinguish Ice, Snow, Clouds
R=2130, G=1240, B=469

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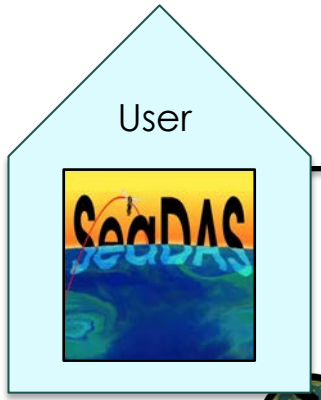
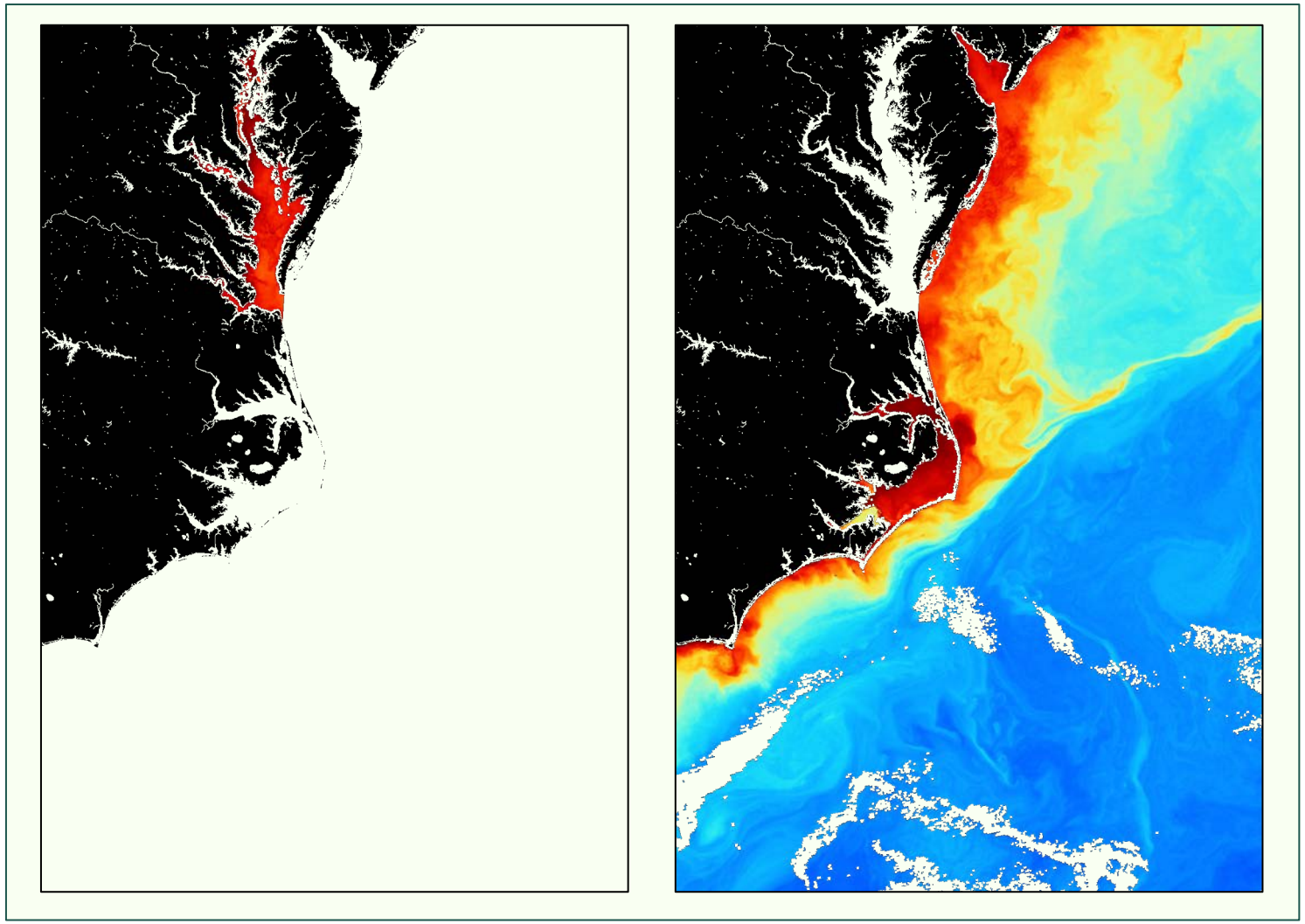


SeaDAS User Software: General Image Analysis Tools

Masking Regional Areas of Interest



SeaDAS General Image Analysis Tools

- Imagery
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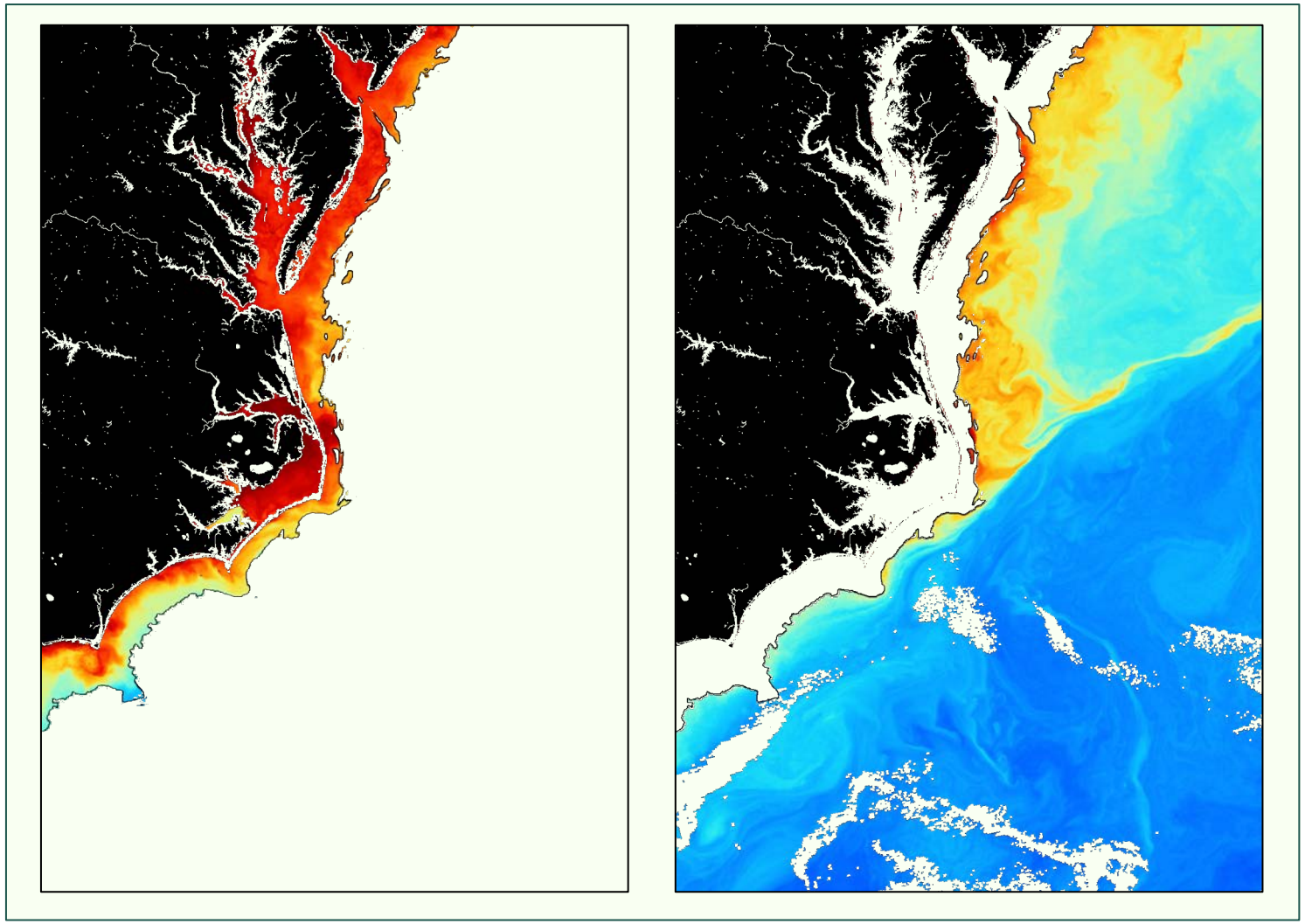
User

SeaDAS User Software: General Image Analysis Tools

Masking Water Depth (Bathymetry)



SeaDAS General Image Analysis Tools

- Imagery
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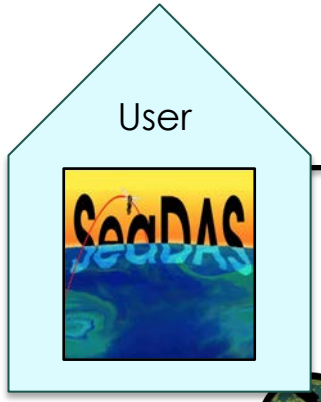
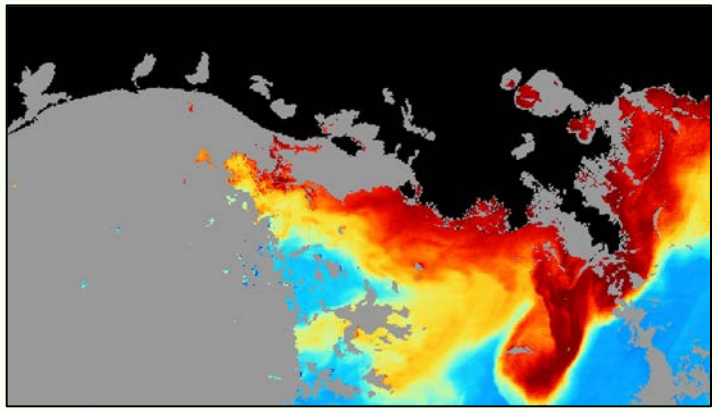


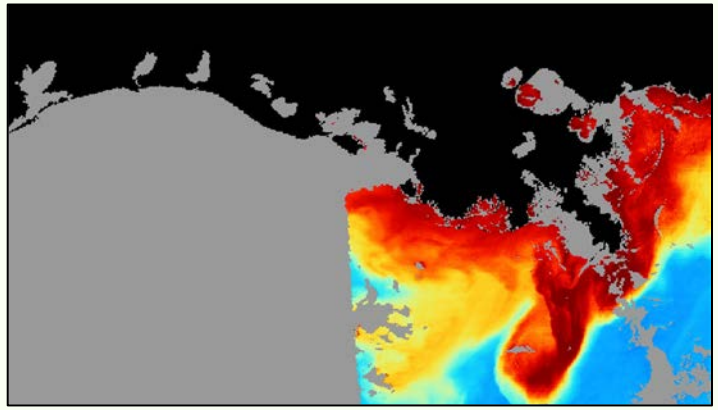
SeaDAS User Software: General Image Analysis Tools

Masking with Flagged Data

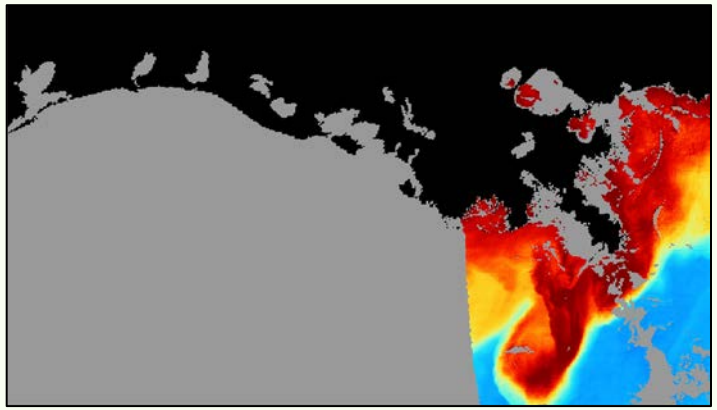
True Color RGB



Chlorophyll (No Glint Masking)



Chlorophyll (HIGLINT)



Chlorophyll (HIGLINT, MODGLINT)

SeaDAS General Image Analysis Tools

- Imagery
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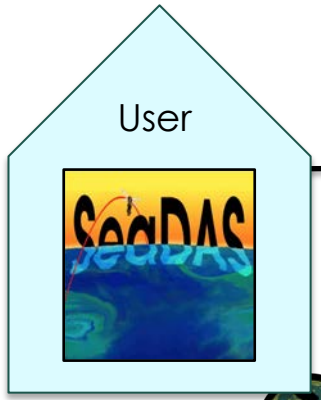
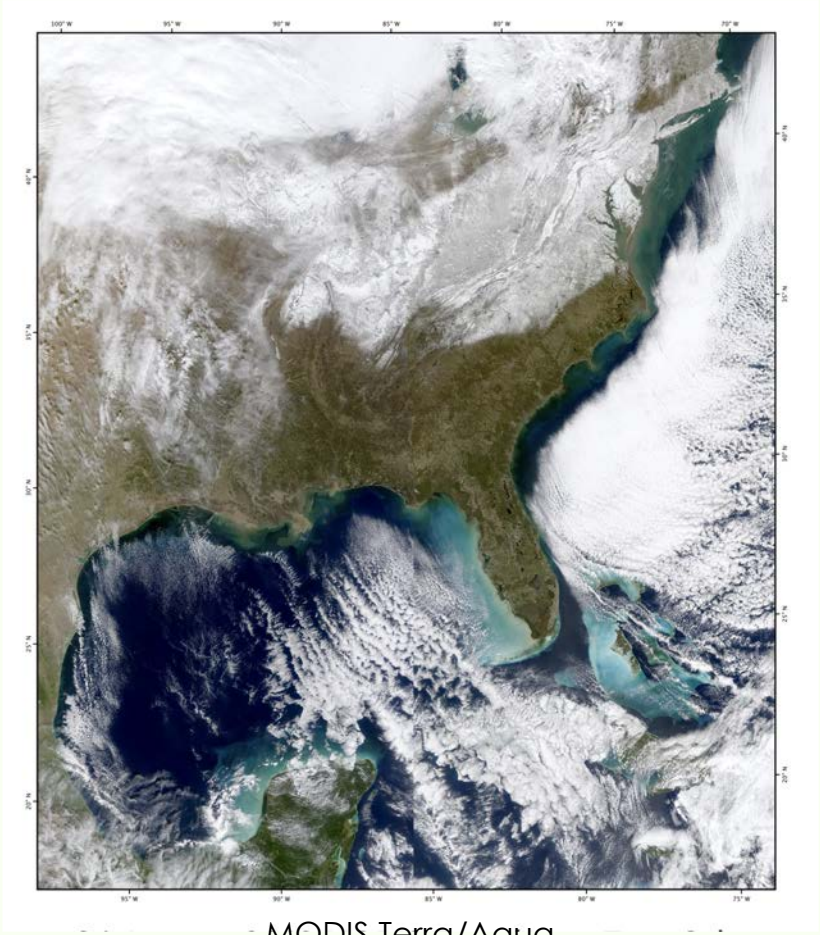


SeaDAS User Software: General Image Analysis Tools

Image Aggregation

MODIS Terra
(Two Level-2 Files)

MODIS Aqua
(Two Level-2 Files)



MODIS Terra/Aqua
(Four-File Aggregation) 24 January 2016

SeaDAS General Image Analysis Tools

- Imagery
- Masking
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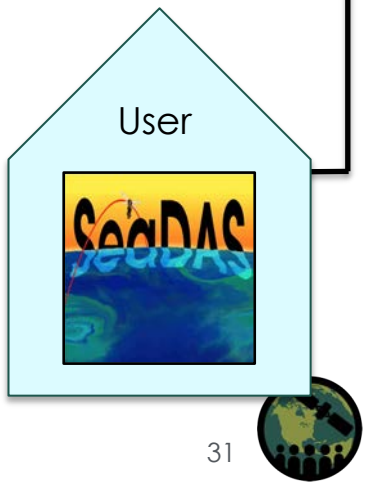
- Analysis
- Statistics



SeaDAS User Software: General Image Analysis Tools

Custom Math Expression Bands

Target product:

[2] AQUA_MODIS.20101010T180501.L2.OC.nc

Name: Kd_490_calculated

Description: Diffuse attenuation coefficient at 490 nm, KD2 algorithm

Unit: m^-1

Spectral wavelength: 490.0

☐ Virtual (save expression only, don't store data)

☑ Replace NaN and infinity results by NaN

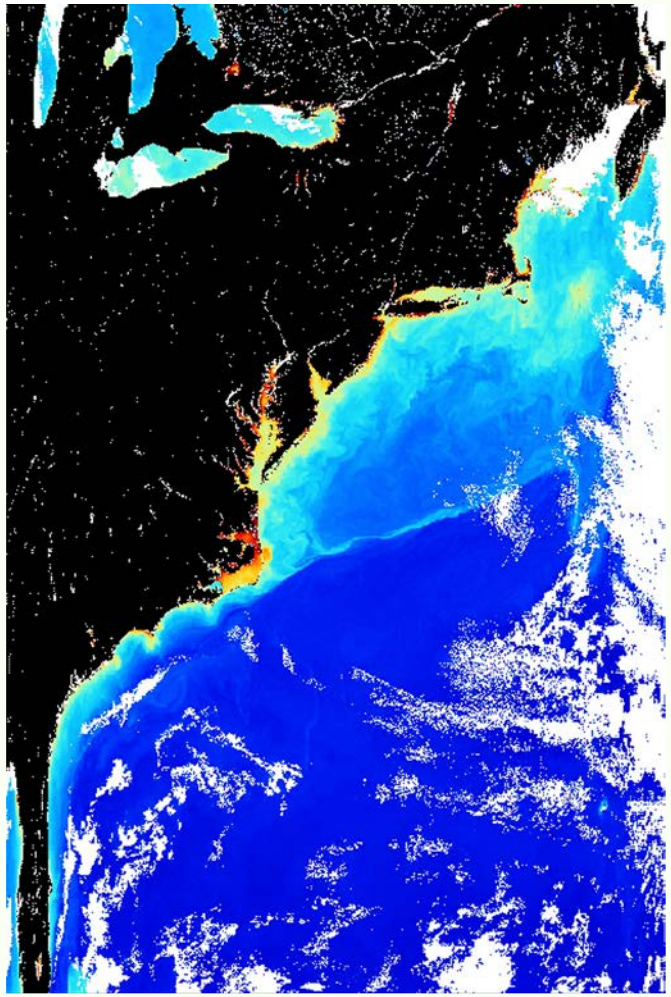
☐ Generate associated uncertainty band

Band maths expression:

```
exp10( -0.8813
-2.0584 * pow(log10(Rrs_488/ Rrs_547),1)
+ 2.5878 * pow(log10(Rrs_488/ Rrs_547),2)
-3.4885 * pow(log10(Rrs_488/ Rrs_547),3)
-1.5061 * pow(log10(Rrs_488/ Rrs_547),4)) + 0.0166
```

Load... Save... Edit Expression...

OK Cancel Help



SeaDAS General Image Analysis Tools

- Imagery
- Masking
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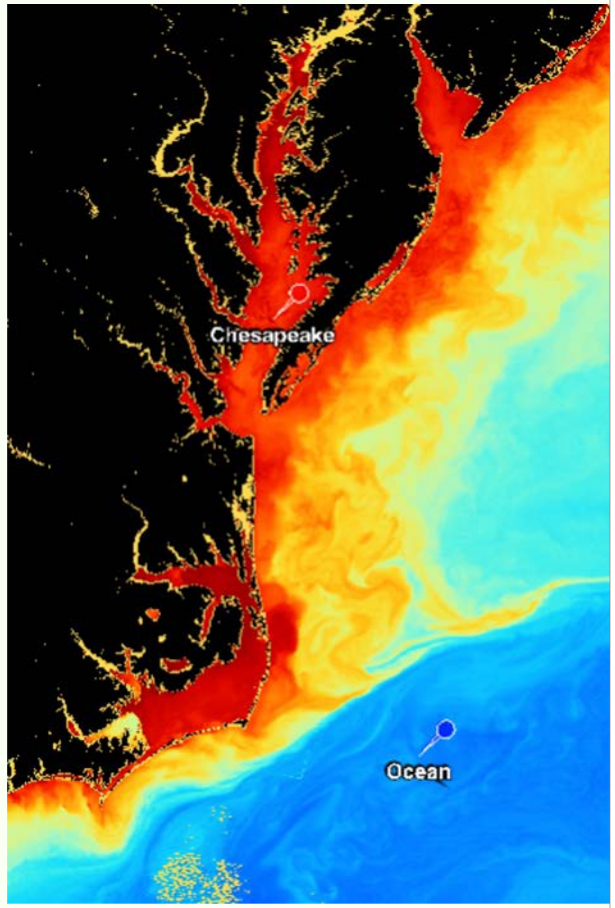
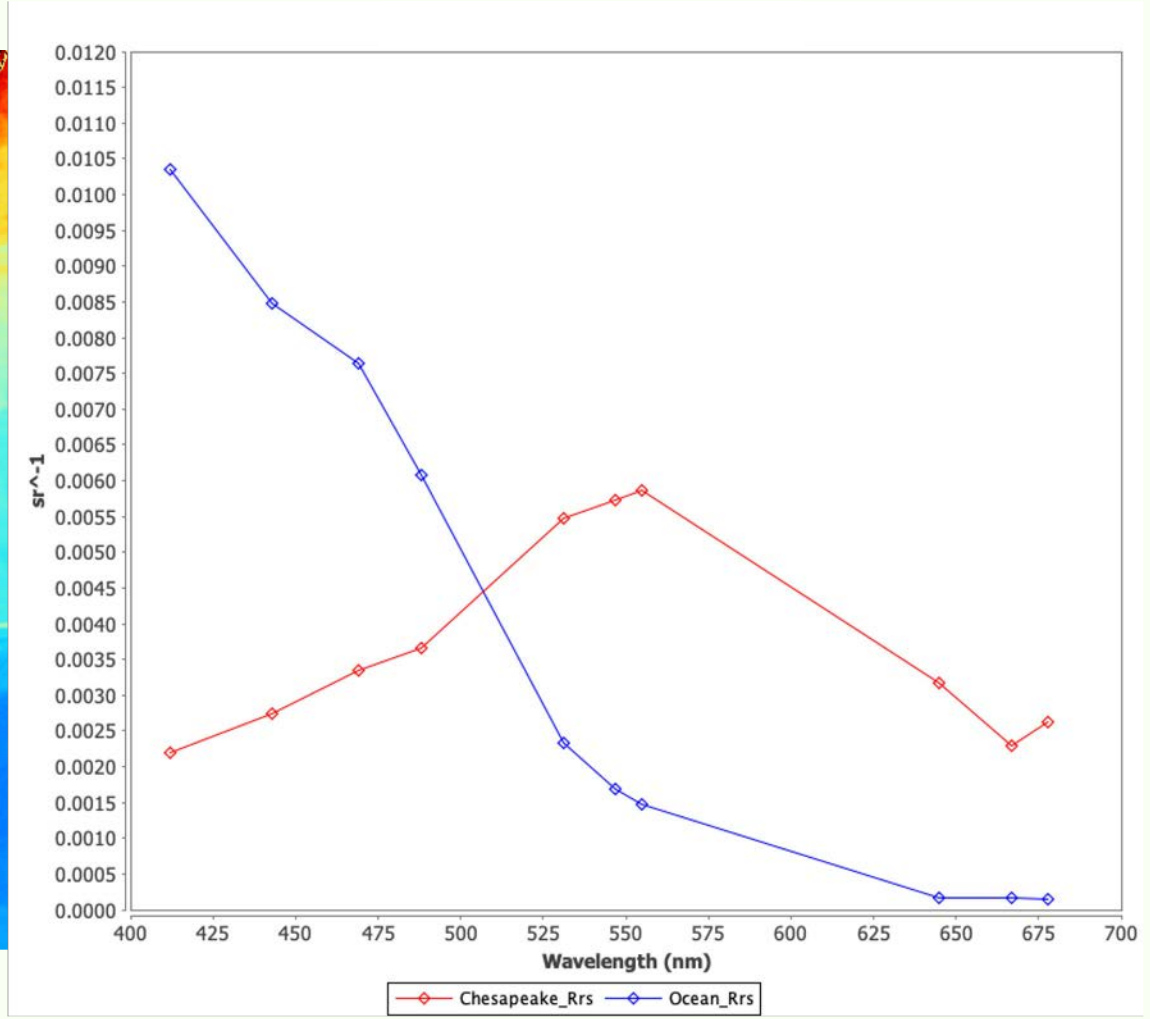
- Statistics

User

SeaDAS User Software: General Image Analysis Tools

Spectral Plots





SeaDAS General Image Analysis Tools

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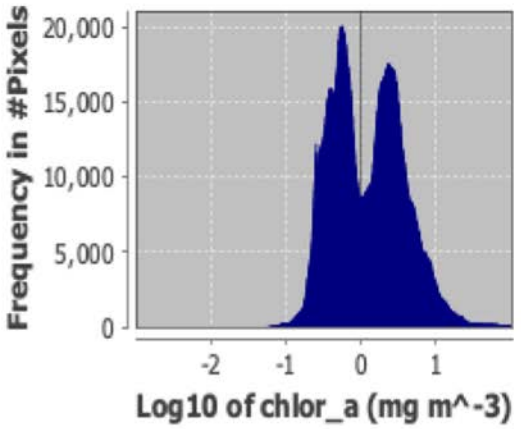
User

SeaDAS User Software: General Image Analysis Tools

Level-2 File

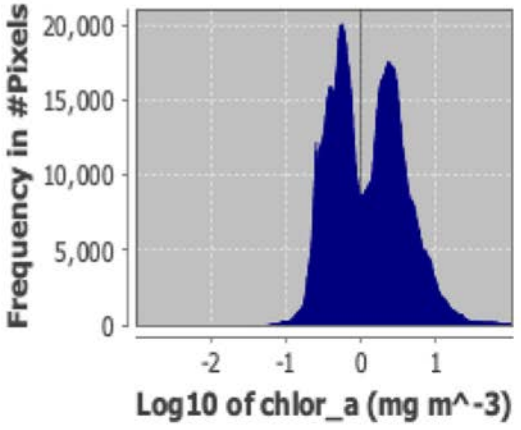
chlor_a

Regional_Pixels	10411140
Valid_Pixels	4200379
Fraction_Valid	0.4035
Mean	2.3743
Standard_Deviation	4.6472
Variance	21.5963
Coefficient_of_Variation	1.9573
80%Threshold(Log)	3.1259
90%Threshold(Log)	5.0116
95%Threshold(Log)	7.5853



chlor_a (regional_mask=Water)

Regional_Pixels	6521335
Valid_Pixels	4200379
Fraction_Valid	0.6441
Mean	2.3743
Standard_Deviation	4.6472
Variance	21.5963
Coefficient_of_Variation	1.9573
80%Threshold(Log)	3.1259
90%Threshold(Log)	5.0116
95%Threshold(Log)	7.5853



SeaDAS General Image Analysis Tools

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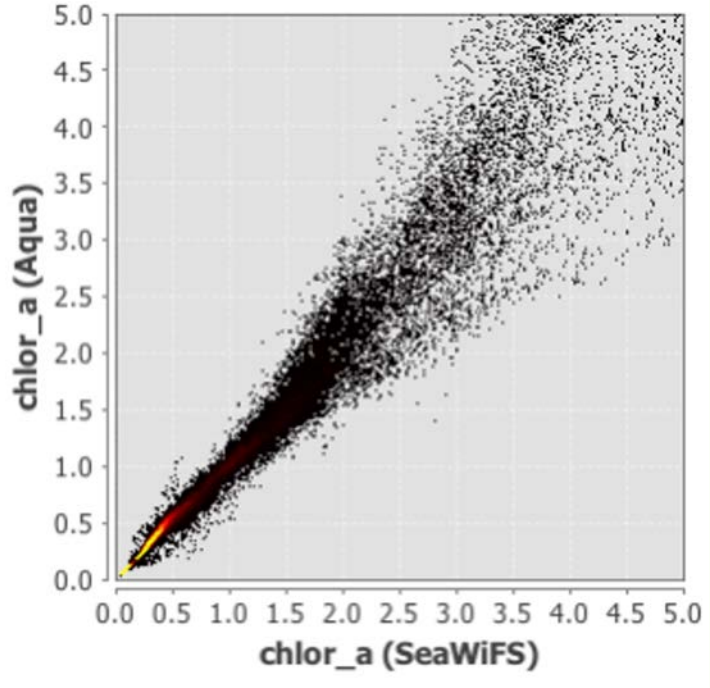
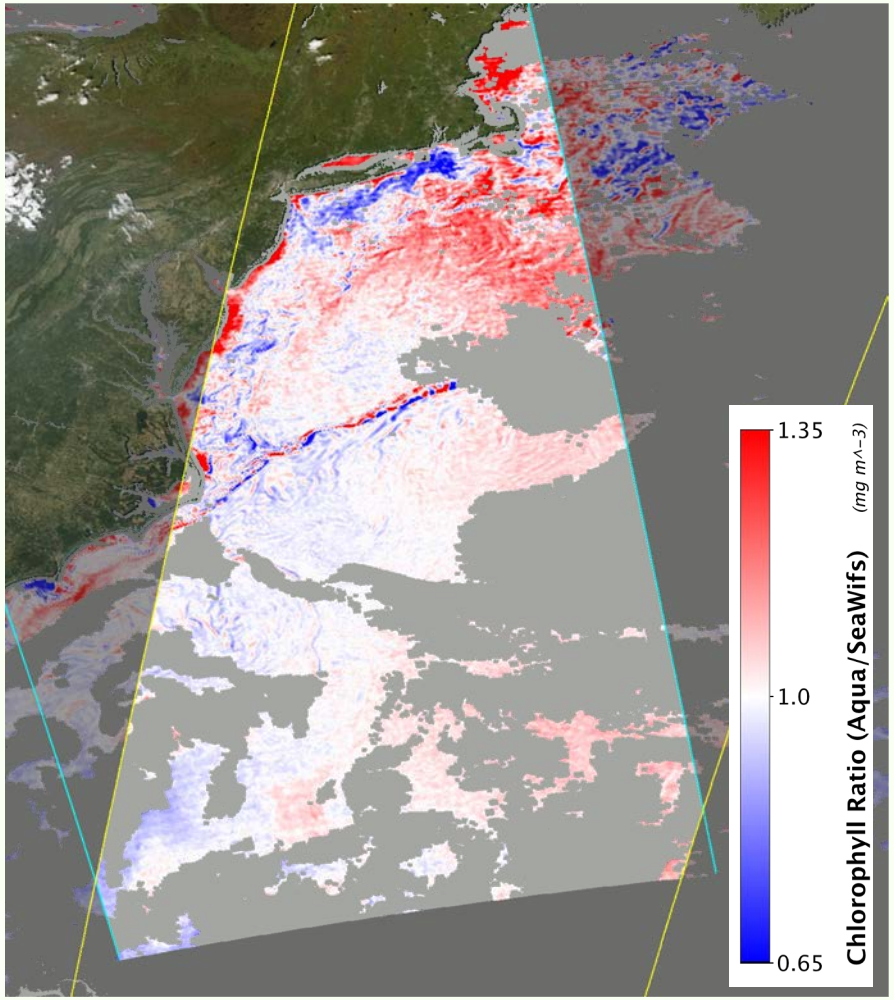
User

SeaDAS User Software: General Image Analysis Tools

Data Comparison



MODIS Aqua chlor_a / SeaWiFS chlor_a
40-Degree Sensor Zenith Restriction



MODIS Aqua: Oct 10, 2010, 18:05 UTC
SeaWiFS: Oct 10, 2010, 19:11 UTC

SeaDAS General Image Analysis Tools

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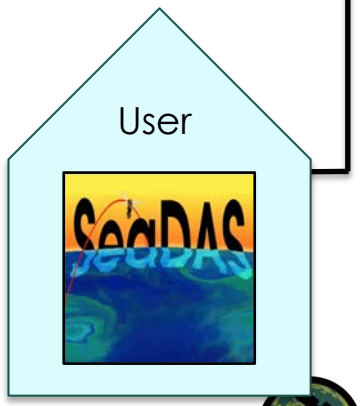
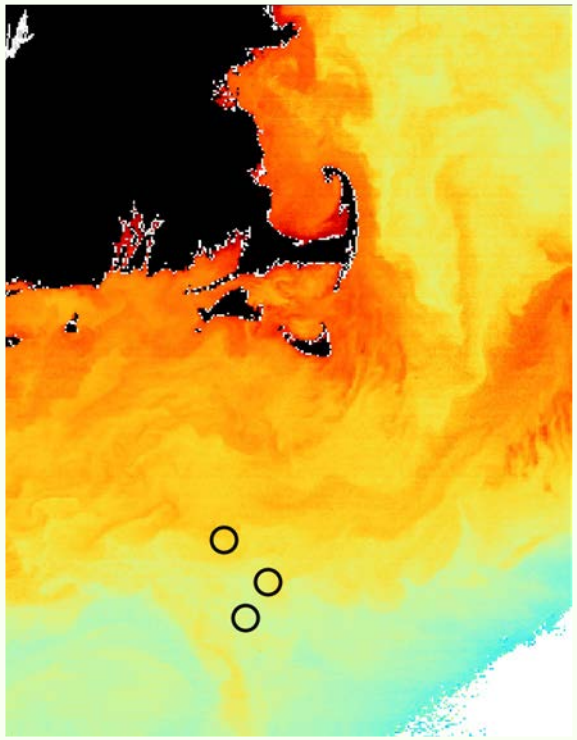
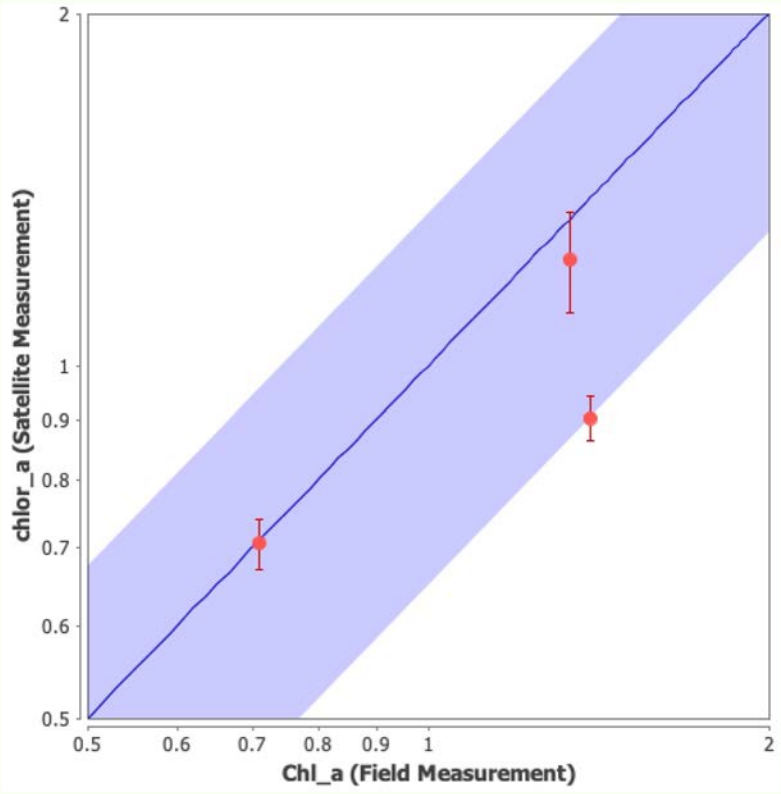


SeaDAS User Software: SeaBASS File Integration

MODIS/Field Measurement (SeaBASS) Comparison

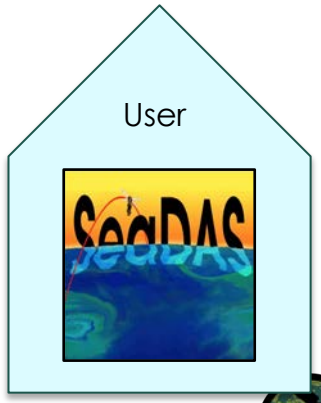




latitude	longitude	chlor_a_mean	chlor_a_sigma	Chl_a_ref
40.35293	-70.38024	1.2306663	0.1228122	1.334
40.022915	-70.1517...	0.7050959	0.03447295	0.709
40.20138	-70.05719	0.9026586	0.0399214...	1.39

SeaBASS Files

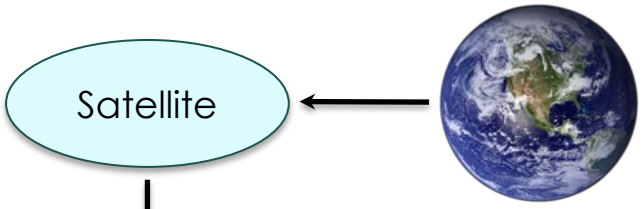
- Comparison Plots
- Location Overlays
- Matchup Extraction



SeaDAS User Software

Science Processing Software OCSSW

SeaDAS-OCSSW OB.DAAC: Data Downlink and Acquisition



Satellite

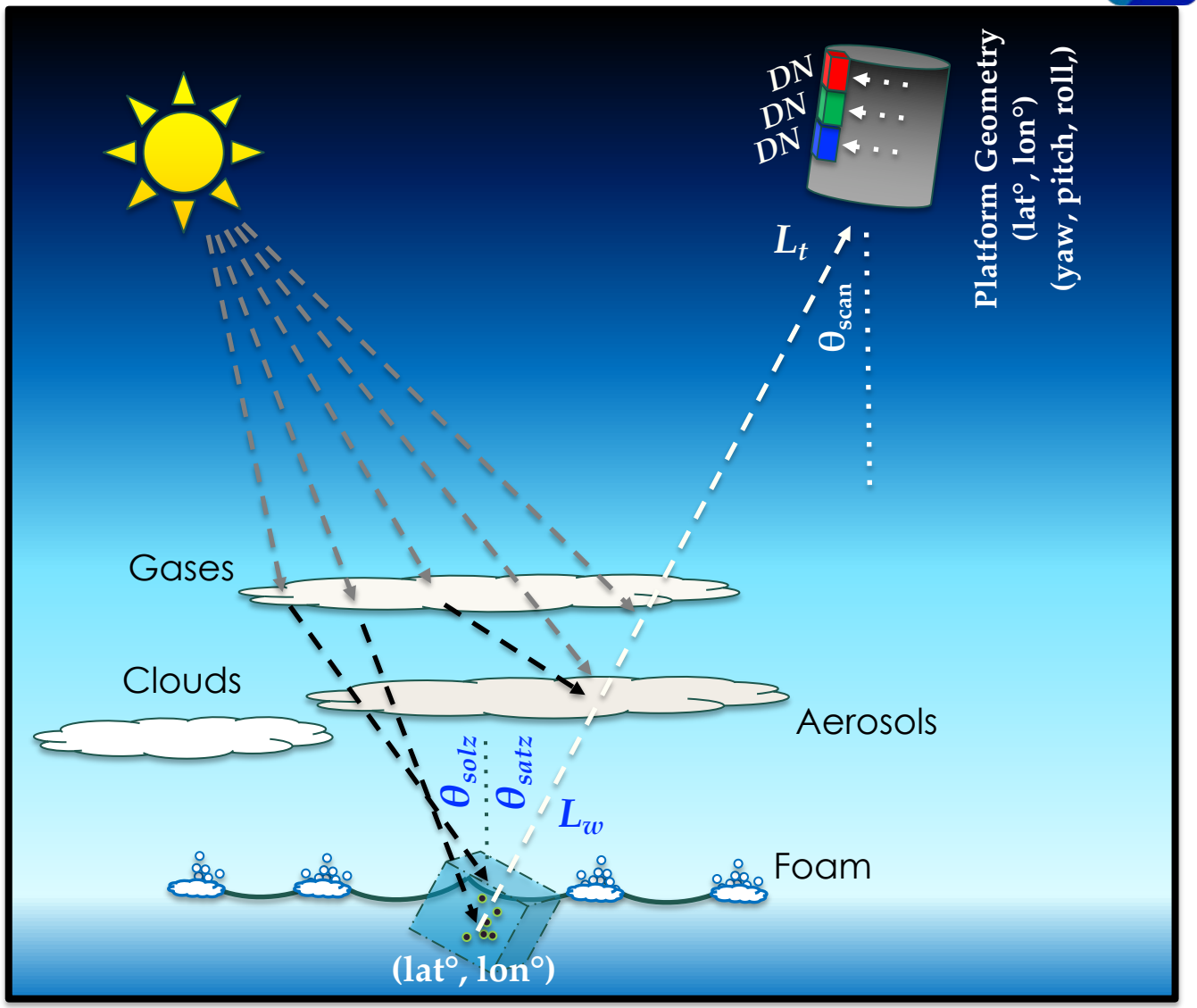
Receiving Station
Data Provider

Level-0 Files*
Level-1A Files*
Level-1B Files*

OB.DAAC

ODPS
(Ocean
Data
Processing
System)

* Mission Dependent



SeaDAS-OCSSW OB.DAAC: Software Data Flow and Tools

Satellite

Receiving Station
Data Provider

Level-0 Files*
Level-1A Files*
Level-1B Files*

OB.DAAC

ODPS

SeaDAS

Level-0 Files*
Level-1A Files*
Level-1B Files*

Geo Files*

Level-2 Files*

Level-3 Binned Files

Level-3 Mapped Files

Ancillary Files

Ancillary Files

Ancillary Sources

SeaDAS Science
Processing Tools

Geo Files*

Level-1B Files*

Level-2 Files*

Level-3 Binned Files

Level-3 Mapped Files

SeaDAS
General Image
Analysis Tools

- Imagery
- Masking
- Mapping
- Aggregation
- Algorithms
- Analysis
- Statistics

ESA SNAP
Processing Tools

User

SeaDAS

SeaBASS Files

* Mission Dependent

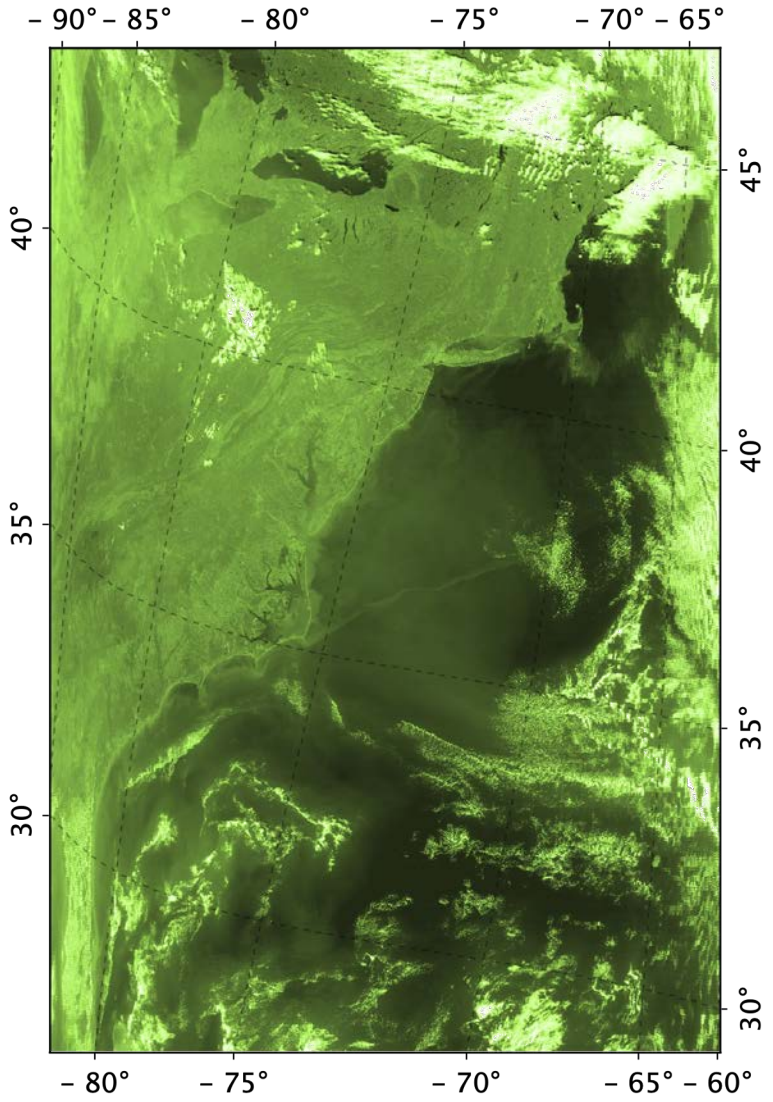
SeaDAS-OCSSW OB.DAAC: Level-2 Files

Level-2 File: Key Points

- Native Resolution
  - Each pixel gridded same as corresponding L1A and L1B files
  - Each pixel contains time and location
  - Adjacent pixels may or may not be geographically adjacent
  - MODIS has some 500m and 250m bands*
- Contains derived geophysical variables
  - OC, IOP, SST Suites
- Contains level-2 flags
- Instrument Calibration has been applied
- Atmospheric correction has been applied
- Vicarious Calibration has been applied
- Ancillary data has been applied
- File format is mission independent

User Options

- Many additional geophysical, ancillary, and geometric products
- Atmospheric correction and processing options
- Users can set many of the flag thresholds
- MODIS has some 500m and 250m bands

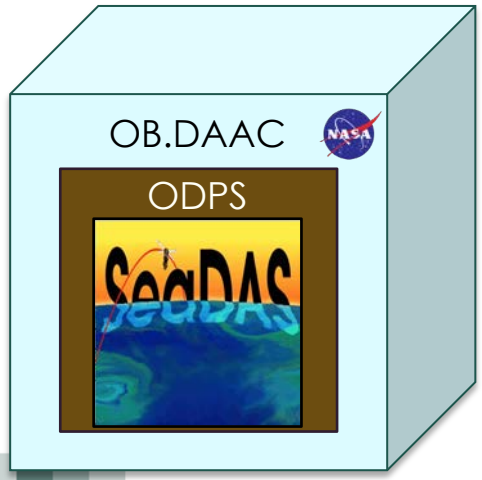


Level-2 File

SeaDAS-OCSSW OB.DAAC: Level-2 Files

Level-2 Files

- Geophysical Products
  - OC
  - IOP
  - SST
- Flags
- Native Pixels (Location, Time)
- Atmospheric Correction
- Vicarious Calibration
- Terrain Correction



OB.DAAC Level-2 Data:
Geophysical Products: OC Suite

Rrs	Remote Sensing Reflectance
chlor_a	Chlorophyll Concentration
Kd_490	Diffuse Attenuation Coefficient
pic	Particulate Inorganic Carbon
poc	Particulate Organic Carbon
aot	Aerosol Optical Thickness
par	Photosynthetically Available Radiation
ipar	Instantaneous Photosynthetically Available Radiation
nflh	Normalized Fluorescence Line Height
angstrom	Aerosol Angstrom Exponent

Product (Rrs) for each applicable visible band of the satellite sensor

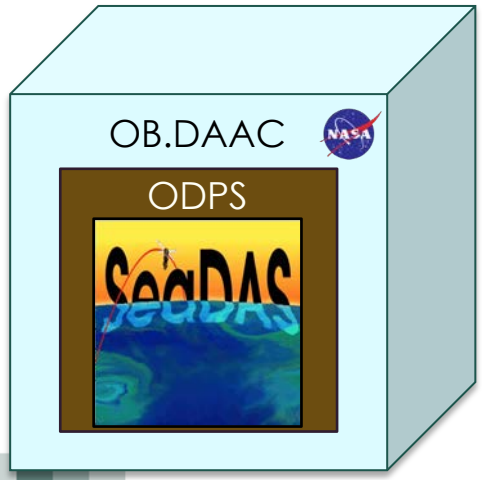
"par" is currently estimated as above the surface, new algorithm will be developed for below the surface.

Algorithms available at:
https://oceancolor.gsfc.nasa.gov/resources/atbd

SeaDAS-OCSSW OB.DAAC: Level-2 Files

Level-2 Files

- Geophysical Products
  - OC
  - IOP
  - SST
- Flags
- Native Pixels (Location, Time)
- Atmospheric Correction
- Vicarious Calibration
- Terrain Correction



OB.DAAC Level-2 Data:
Geophysical Products: IOP Suite

a	Total Absorption
bb	Total Backscattering
aph	Absorption due to Phytoplankton
aph_unc	Uncertainty (aph)
adg	Absorption due to gelbstoff and detrital matter
adg_s	Spectral Parameter (adg)
adg_unc	Uncertainty (adg)
bbp	Particulate Backscattering
bbp_s	Spectral Parameter (bbp)
bbp_unc	Uncertainty (bbp)
rrsdiff	Fractional Mean Rrs Difference

Products (a, bb) for each applicable visible band of the satellite sensor

SeaDAS-OCSSW OB.DAAC: Level-2 Files

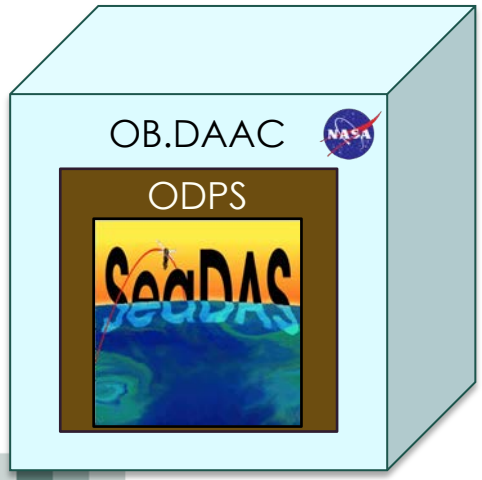
Level-2 Files

Geophysical Products
- OC
- IOP
- SST

Flags
Native Pixels (Location, Time)
Atmospheric Correction
Vicarious Calibration
Terrain Correction

OB.DAAC Level-2 Data:
Geophysical Products: SST Suite

sst	Sea Surface Temperature
sstref	Sea Surface Temperature Reference
qual_sst	Quality Levels (sst)
bias_sst	Bias (sst)
stdv_sst	Standard Deviation (sst)



Missions: Level-2 SST Data in OB.DAAC

MODIS Aqua
MODIS Terra
VIIRS Suomi NPP
VIIRS NOAA20
VIIRS NOAA21*

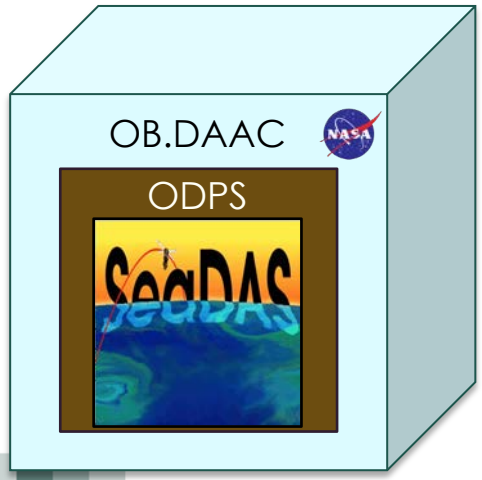
* In production, will be available soon

SST (Day and Night: 11 and 12 microns)
MODIS: SST4 (Nighttime: 3.9, 11, 12 microns)
VIIRS: SST3 (Nighttime: 3.7, 11, 12 microns)

SeaDAS-OCSSW OB.DAAC: Level-2 Files

Level-2 Files

Geophysical Products
Flags
Native Pixels (Location, Time)
Atmospheric Correction
Vicarious Calibration
Terrain Correction



OB.DAAC Level-2 Data:
Flags

CLDICE	Cloud/Ice Determined
COCCOLITH	Coccolithophores Detected
FILTER	Insufficient Data for Smoothing Filter
HIGLINT	High Glint Determined
HILT	High (or Saturating) TOA Radiance
HIPOL	High Degree of Polarization Determined
LOWLW	Low Lw @ 555nm (Possible Cloud Shadow)
MODGLINT	Moderate Glint Determined
SEAICE	Sea Ice Determined
STRAYLIGHT	Straylight Determined
TURBIDW	Turbid Water Determined
COASTZ	Shallow Water (<30m)
HISATZEN	Large Satellite Zenith Angle
HISOLZEN	High Solar Zenith Angle
LAND	Land

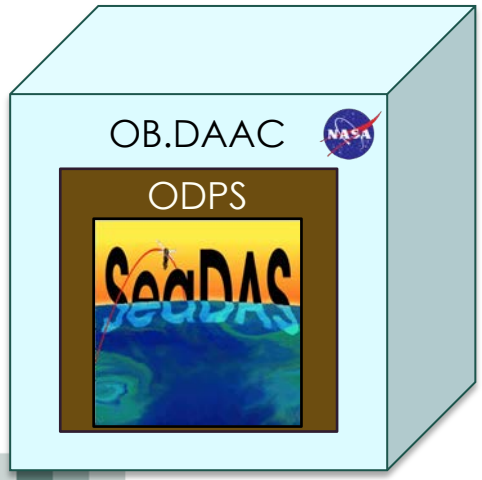
SeaDAS-OCSSW OB.DAAC: Level-2 Files

Level-2 Files

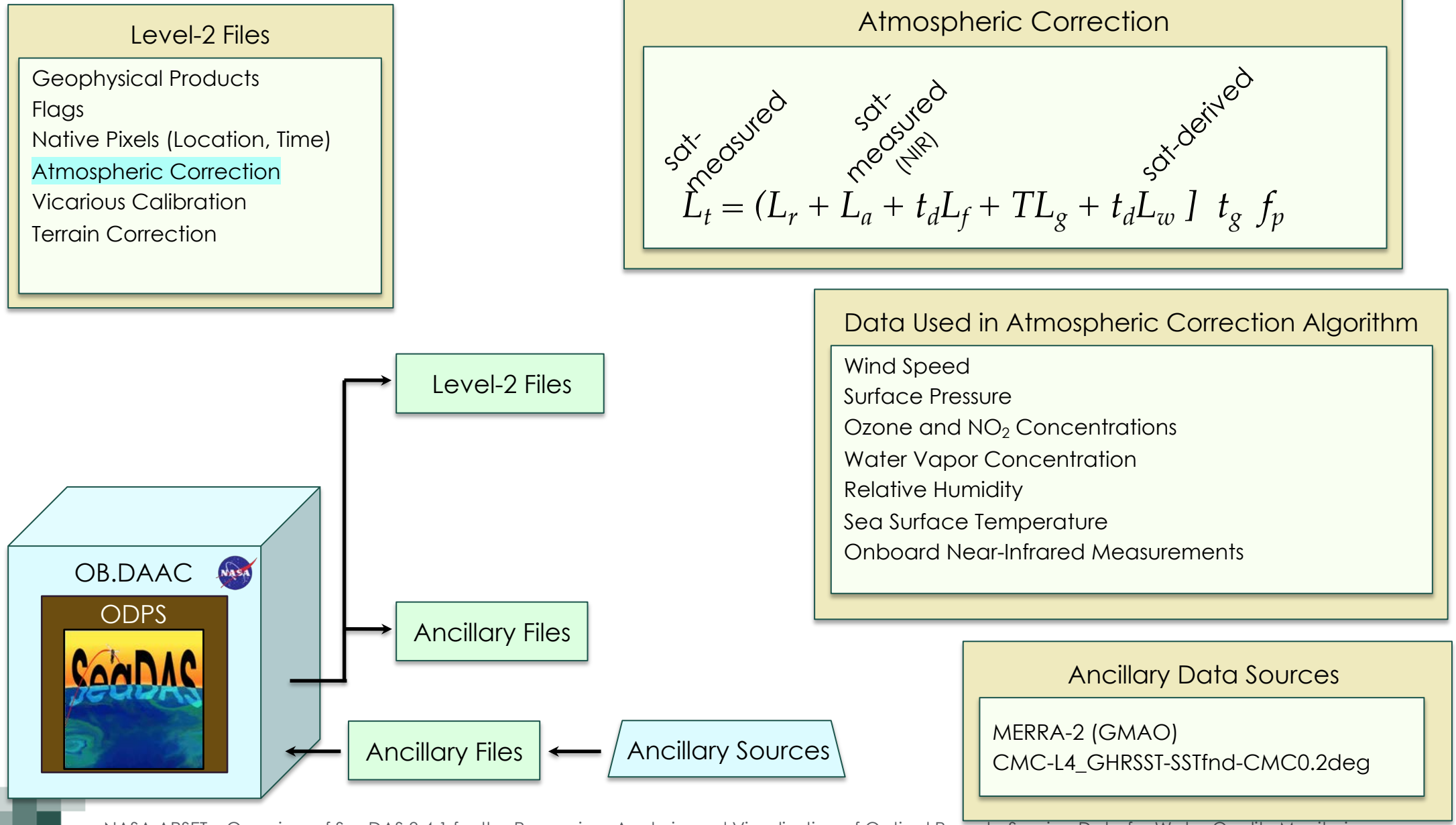
- Geophysical Products
- Flags
- Native Pixels
- Atmospheric Correction
- Vicarious Calibration
- Terrain Correction

OB.DAAC Level-2 Data: Native Pixels

- Same pixel gridding as L1A and L1B files
- Each pixel contains time and location
  - No assumed mapping projection
- Adjacent pixels are based on instrument data and not scene location
  - Adjacent pixel may not be geographically adjacent
  - Bow-tie effect



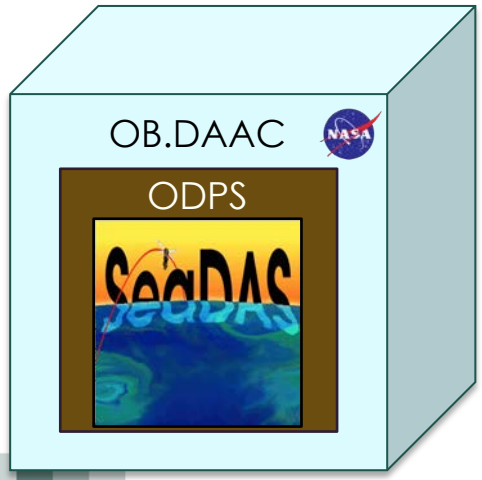
SeaDAS-OCSSW OB.DAAC: Level-2 Files



SeaDAS-OCSSW OB.DAAC: Level-2 Files

Level-2 Files

Geophysical Products
Flags
Native Pixels (Location, Time)
Atmospheric Correction
Vicarious Calibration
Terrain Correction



Vicarious Calibration Methodology

- Apply inverted atmospheric correction

$$L_t \text{ (vicarious derived)} = f\left(L_w \text{ (vicarious measured)} \right)$$

- Determine vicarious gain correction coefficient

$$g_i = \frac{L_t \text{ (vicarious derived)}}{L_t \text{ (satellite measured)}}$$

- Average vicarious gain correction coefficient

$$g = \frac{1}{n}\sum_{i=1}^{n} g_i$$

- Apply to satellite measurement

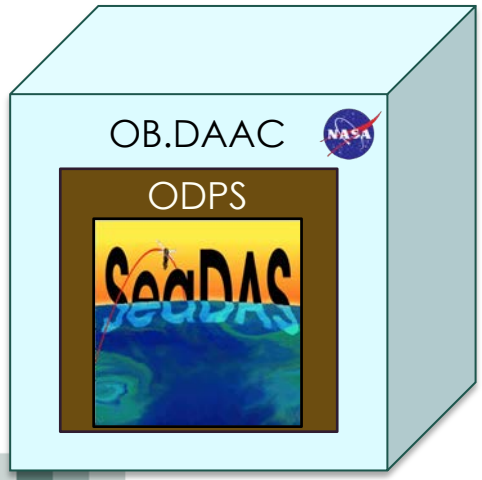
$$gL_t = (L_r + L_a + t_d L_f + TL_g + t_d L_w \,] \,.\, t_g \,.\, f_p$$

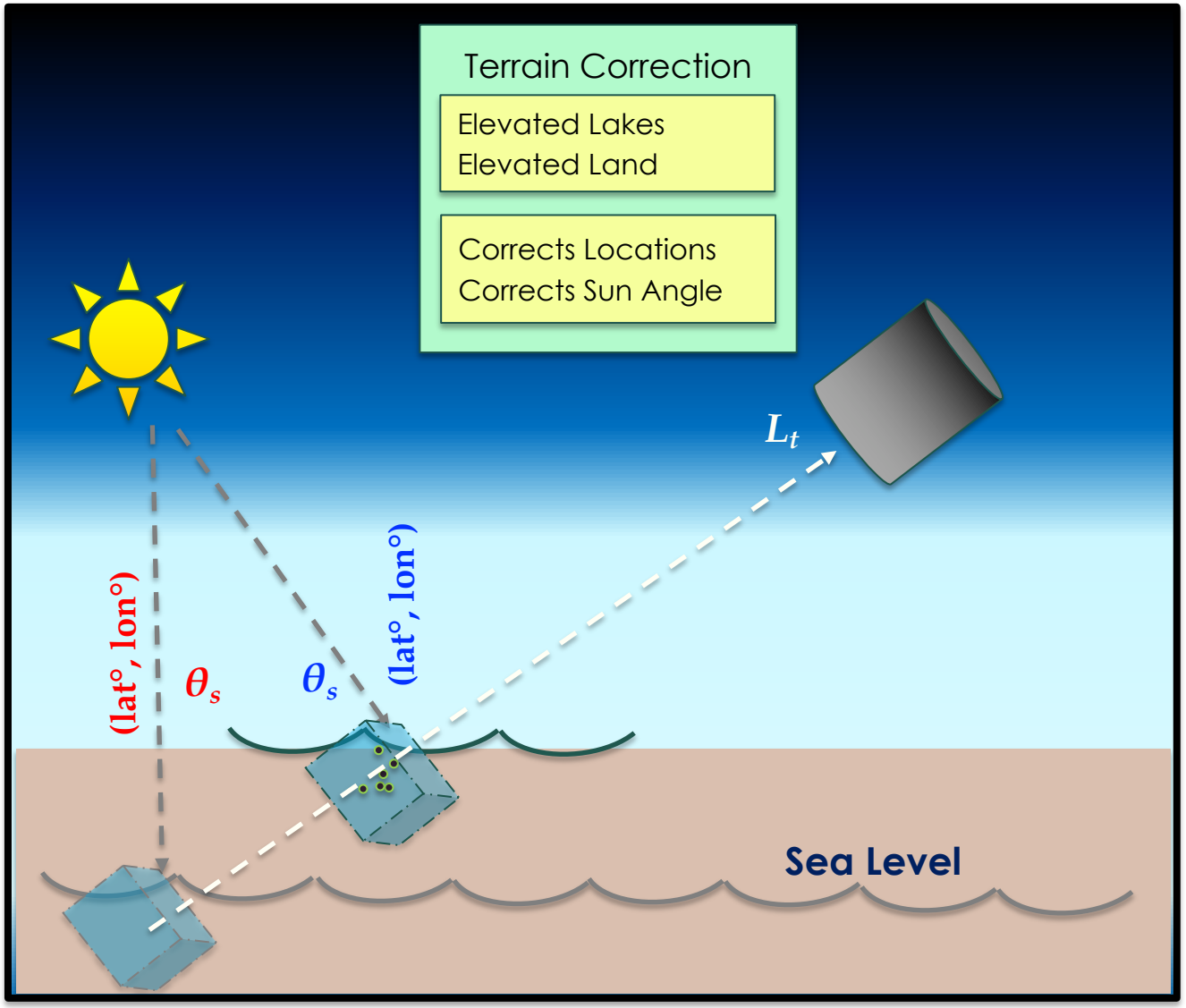
(sat-measured, sat-measured, sat-derived)

SeaDAS-OCSSW OB.DAAC: Level-2 Files

Level-2 Files

- Geophysical Products
- Flags
- Native Pixels (Location, Time)
- Atmospheric Correction
- Vicarious Calibration
- Terrain Correction





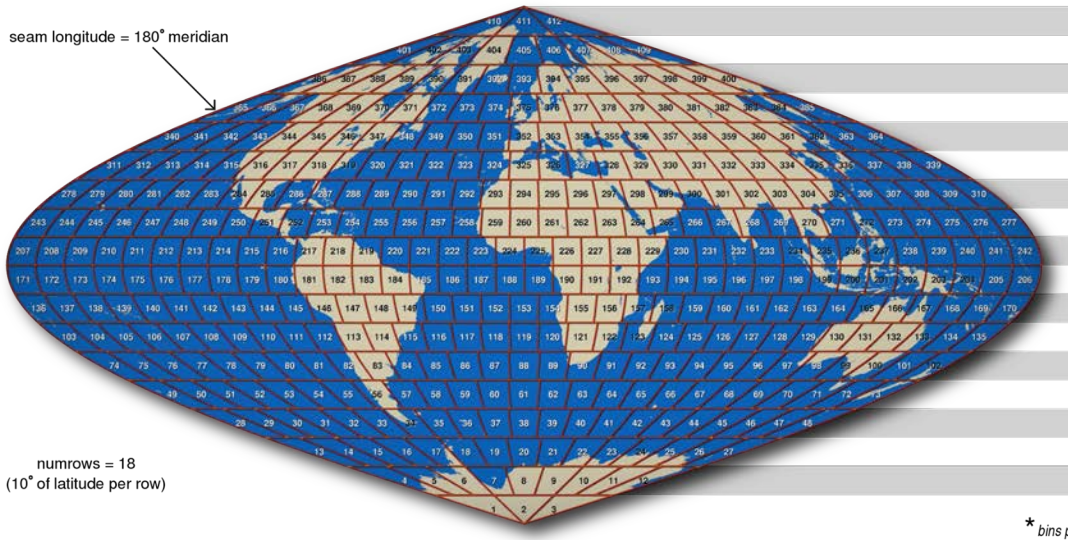
SeaDAS-OCSSW OB.DAAC: Level-3 Binned Files

Level-3 Binned Data: Key Points

- Accumulated data from L2 products
- Equal surface area bins
  - Projection: Integerized Sinusoidal
- Applies level-2 flags (suite specific)
  - Each "valid" level-2 pixel goes in a single level-3 bin
- Bin Contents:
  - Product Value (Mean)
  - Count
  - Standard Deviation, Sum, Sum Squared, Weight
- Bin Resolutions (OB.DAAC):
  - 4.64 km (Lat Span=1/24°, Rows=4320)
- Time Resolutions (OB.DAAC):
  - Day, 8 Day, Month, Seasonal, Annual, Mission
- Global Files (OB.DAAC)
- Handles "Bow-Tie" Pixels

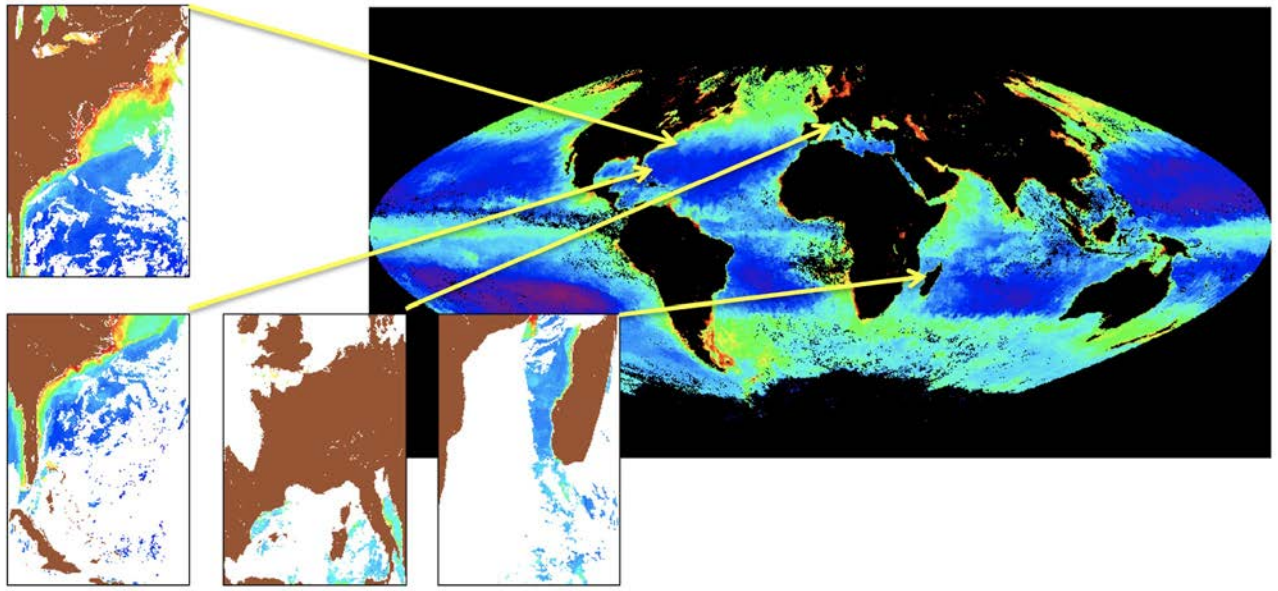
User Options

- Many Bin Resolutions
- Any Time Resolution



row	central latitude	bins per row *
17	85	3
16	75	9
15	65	15
14	55	21
13	45	25
12	35	29
11	25	33
10	15	35
9	5	36
8	-5	36
7	-15	35
6	-25	33
5	-35	29
4	-45	25
3	-55	21
2	-65	15
1	-75	9
0	-85	3

* *bins per row = 2 x numrows x cos(central latitude) rounded to the nearest integer*



SeaDAS-OCSSW OB.DAAC: Level-3 Binned Files

Level-3 Bin Spatial Resolutions

Angular Span (Latitude)	Rows	Bin Resolution	Short Name
1°	180	111.32 km	1D
1/2°	360	55.66 km	HD
1/3°	535	37.45 km	36
1/4°	720	27.83 km	QD
1/6°	1080	18.55 km	18
1/12°	2160	9.28 km	9
1/24°	4320	4.64 km	4
1/48°	8640	2.32 km	2
1/96°	17280	1.16 km	1
1/192°	34560	580 m	H
1/384°	69120	290 m	Q
1/1920°	345600	58 m	HH

* Bin height displayed is average and approximate based on a spherical Earth having a radius of 6378.145 kilometers
** Short name is subject to change in the future

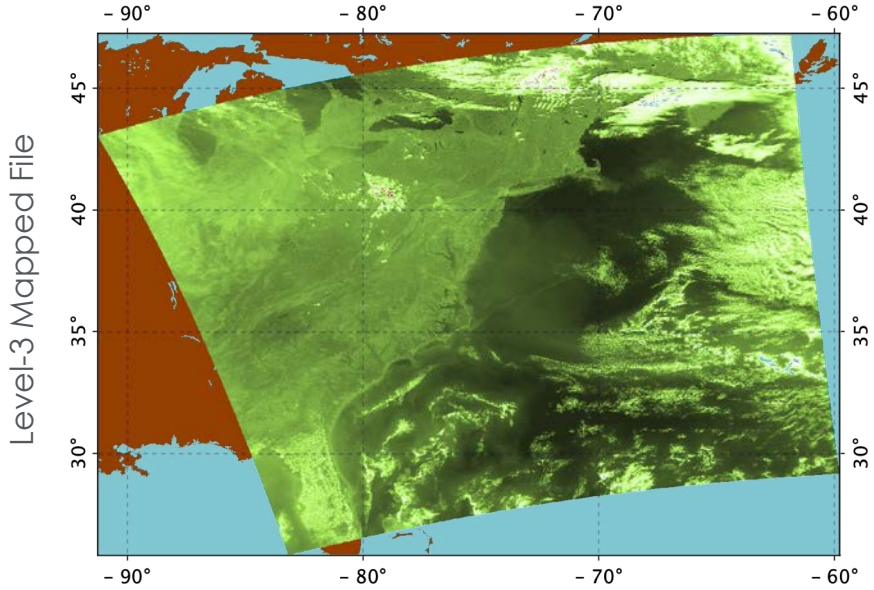
SeaDAS-OCSSW OB.DAAC: Level-3 Mapped Files

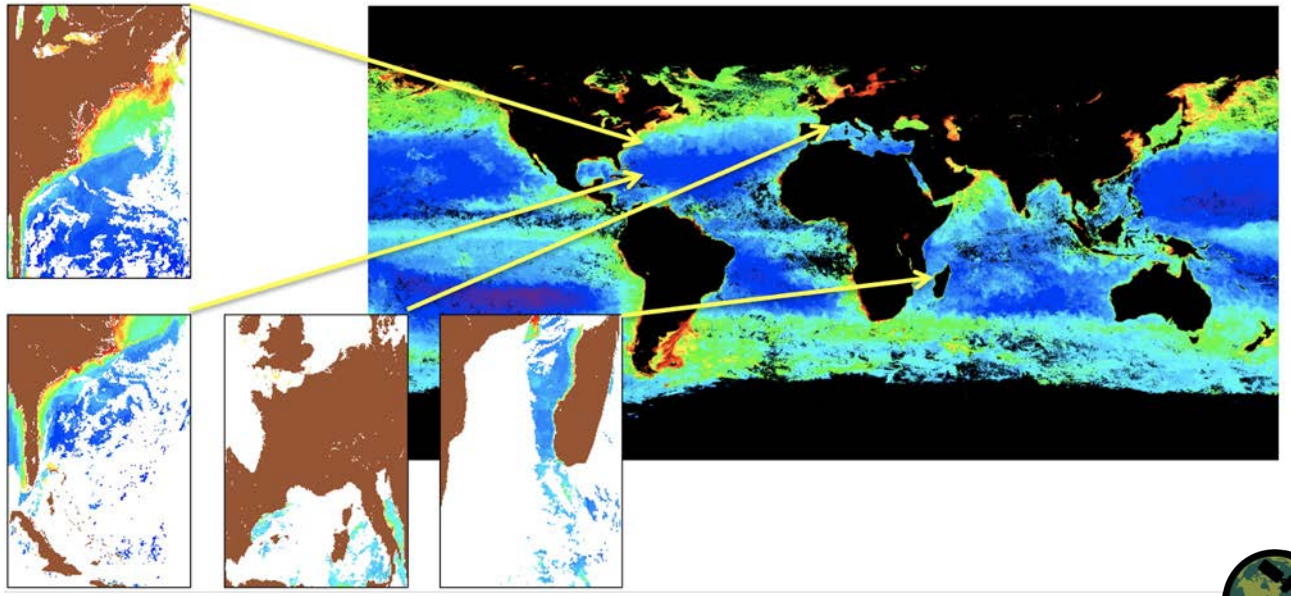
Level-3 Mapped Data: Key Points

- Not equal surface area pixels (OB.DAAC)
  - Projection: SMI (Plate Carrée)
- Interpolation: Nearest Neighbor (OB.DAAC)
  - Each mapped pixel populated by up to one bin
  - A single bin can go into multiple mapped pixels
- Pixel Contents:
  - Product Value
- Spatial Resolutions (OB.DAAC):
  - 4.64 km
  - 9.28 km
- Time Resolutions (OB.DAAC):
  - Day, 8 Day, Month, Seasonal, Annual, Mission
- Global Files (OB.DAAC)

User Options

- Any Spatial Resolution
- Many Mappings (including raw bin dump)





SeaDAS-OCSSW: OB.DAAC vs. User Generated Files

OB.DAAC

Level-2

- Limited geophysical products available
- No ancillary and geometric products
- Default flag thresholds
- Only 1 resolution

Level-3 Binned

- Only 4km resolution available
- Limited time resolutions available
- Already processed and available

Level-3 Mapped

- 4km and 9km resolution available
- SMI Mapping

User Generated

Level-2

- Many geophysical products available
- Many ancillary and geometric products
- Flag thresholds
- Resolution choices (MODIS only)

Level-3 Binned

- Many resolutions available
- Any time resolution available
- Could involve substantial runtime and resources

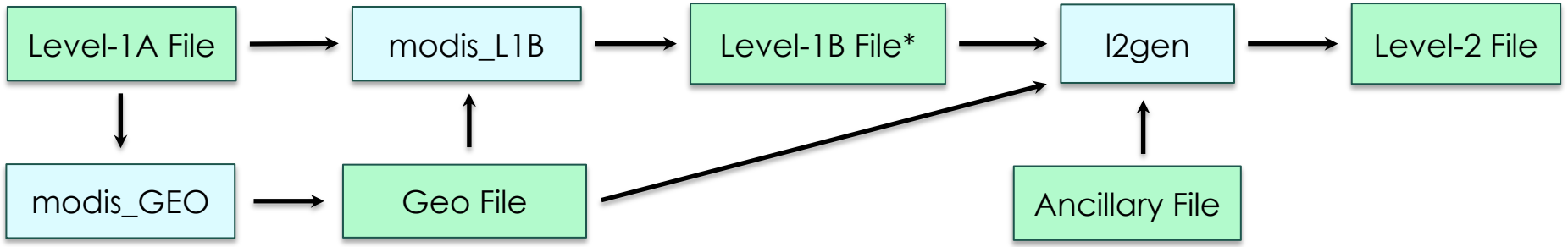
Level-3 Mapped

- Any spatial resolution available
- Many mappings, raw bin dump

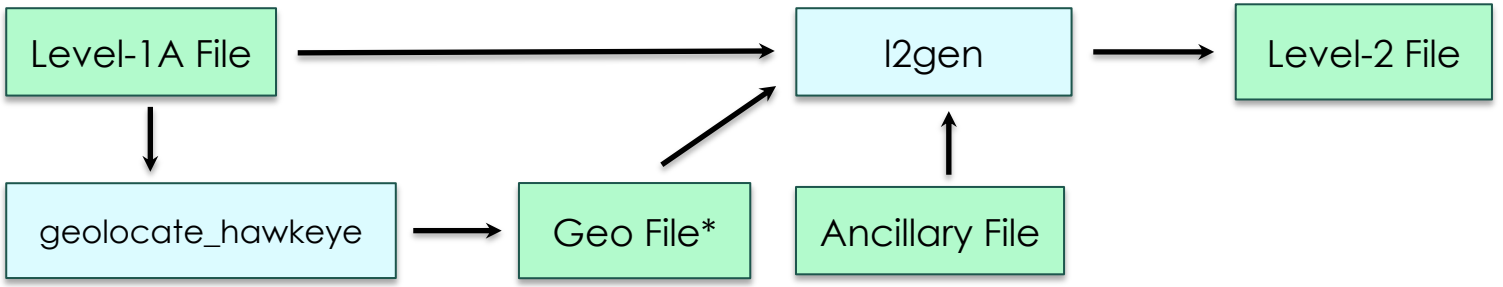
SeaDAS Reference Workflows

Creating Level-2 Files: Processing Workflows

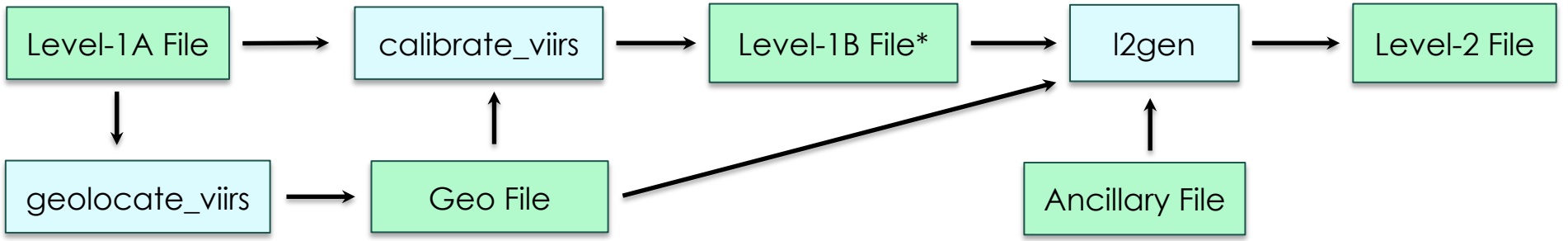
- **MODIS**



- **HawkEye**

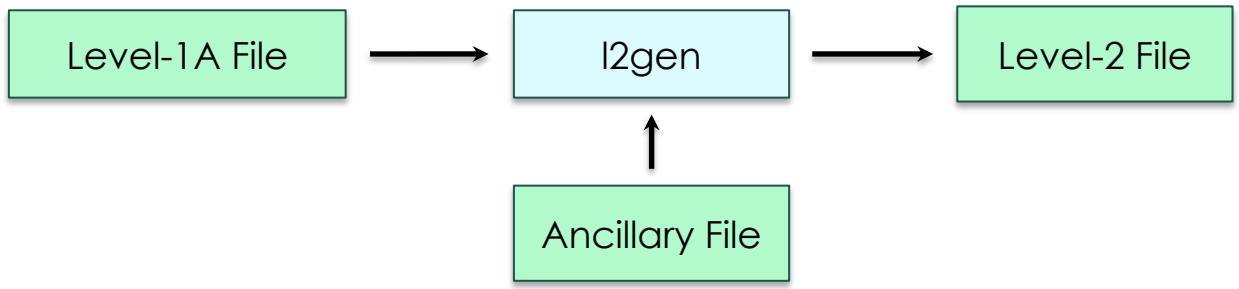


- **VIIRS**

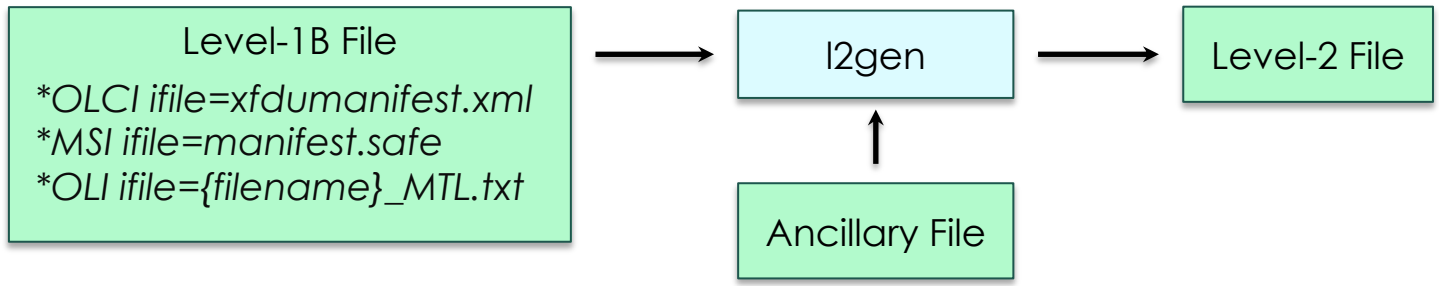


Creating Level-2 Files: Processing Workflows

- SeaWiFS
- CZCS



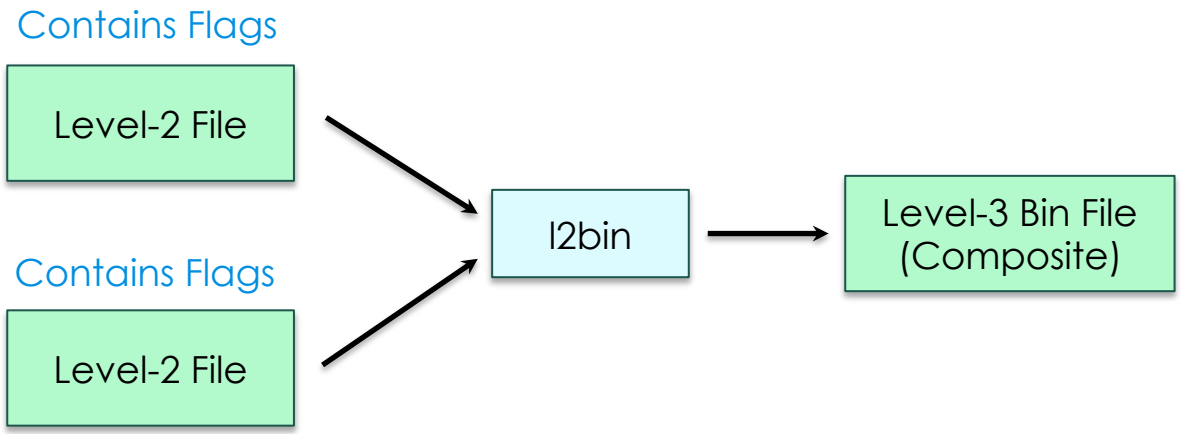
- OLCI
- MSI
- OLI
- GOCI
- HICO
- MERIS



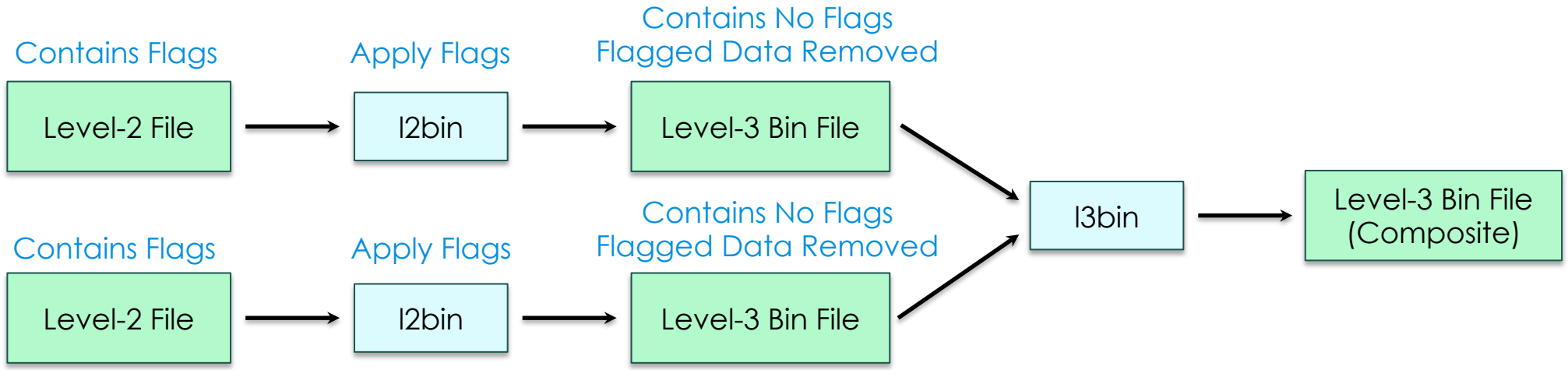
* Input files contained in directory with Level-1B file

L3 Binning Workflows (Temporal: l2bin, l3bin)

- Combining Files with l2bin

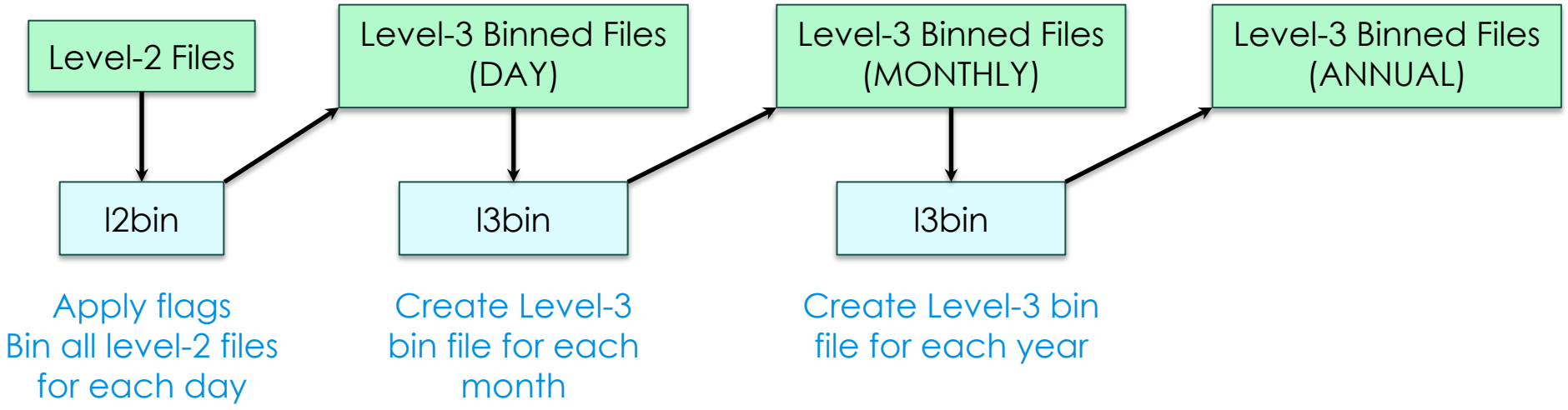


- Combining Files Later with l3bin



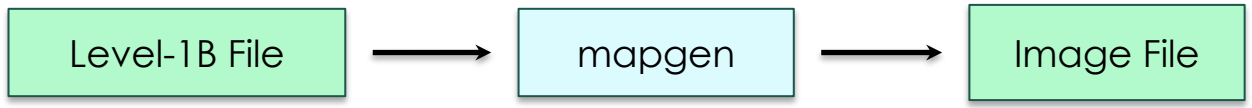
L3 Binning Workflows (Temporal: l2bin, l3bin)

- Avoid Impacts due to Uneven Temporal Distribution of Data



Creating RGB and Product Images: Processing Workflows (mapgen)

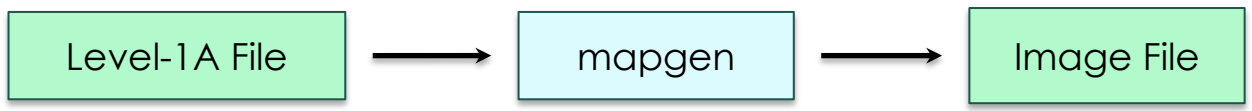
- Flow A:



OLCI
MSI
OLI
GOCI
HICO
MERIS

***ifile=xfdumanifest.xml*
***ifile=manifest.safe*
***ifile={filename}_MTL.txt*

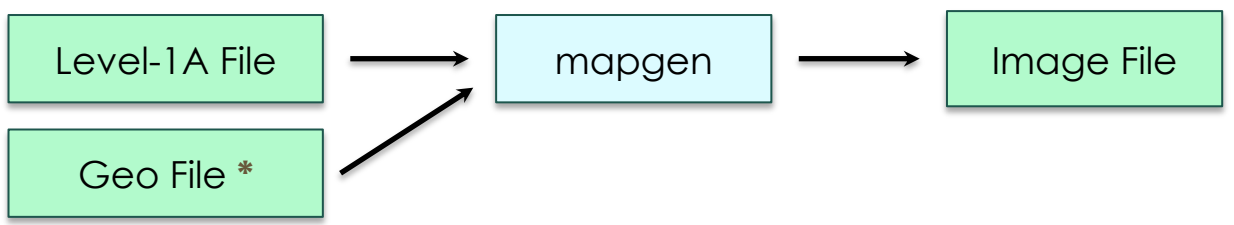
- Flow B:



SeaWiFS
CZCS.

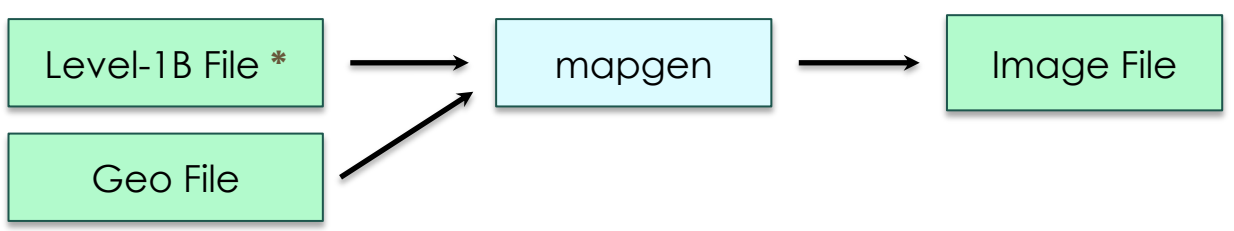
***ifile=xfdumanifest.xml*

- Flow C:



HAWKEYE *

- Flow D:



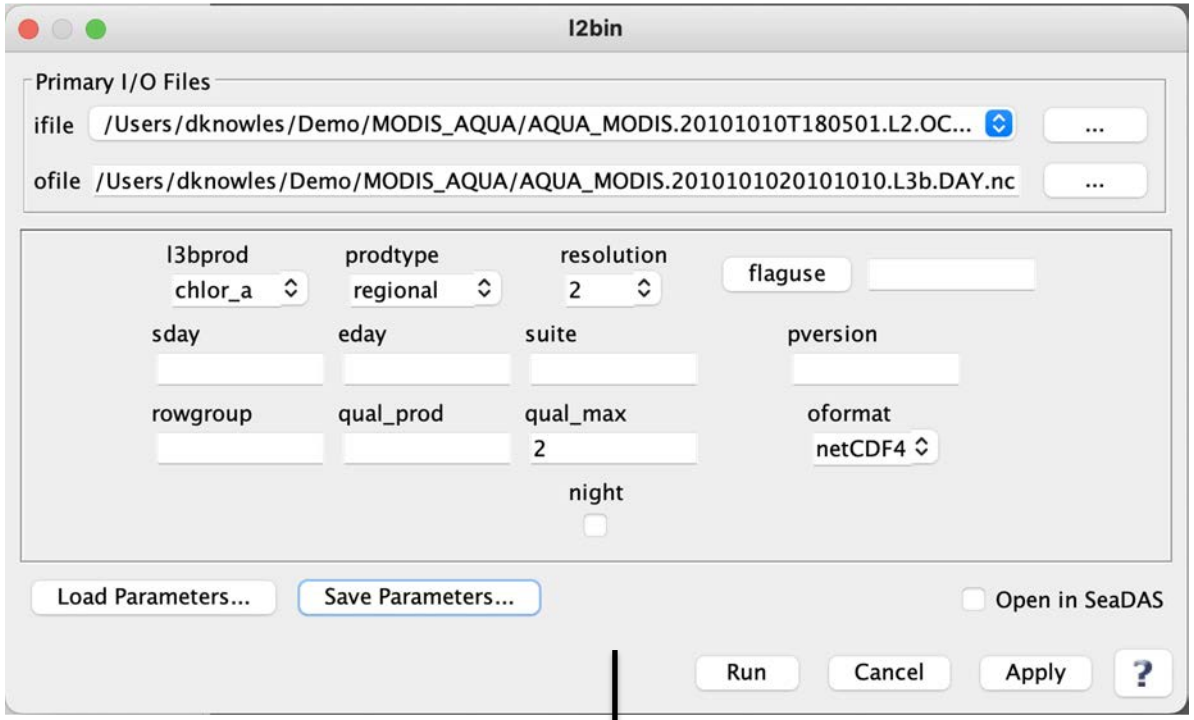
MODIS *
VIIRS*

* Level-1B file (MODIS) and Geo file (HawkEye) not available at NASA OB.DAAC

** Input file contained with Level-1B file directory

SeaDAS Science Processors (Run l2bin from GUI or User Terminal)

L2bin GUI



JAVA API or User Terminal

l2bin par=parfile.par

Level-2 File

L2bin
Executable File

Level-3 Bin File

parfile.par*

```
ifile=/Users/dknowles/Demo/AQUA_MODIS.20101010T180501.L2.OC.nc
ofile=/Users/dknowles/Demo/AQUA_MODIS.2010101020101010.L3b.DAY.nc
l3bprod=chlor_a
prodtype=regional
resolution=2
```

*not exact name of file

Demonstration
SeaDAS Workflow for Sentinel-3 OLCI

SeaDAS Workflow: OLCI

Source Files:

S3A_OLCI_EFRNT.20230106T161140.L2.OC.nc

S3A_OLCI_EFRNT.20230106T161440.L2.OC.nc

S3A_OLCI_EFRNT.20230106T161740.L2.OC.nc

S3B_OLCI_EFRNT.20230106T153231.L2.OC.nc

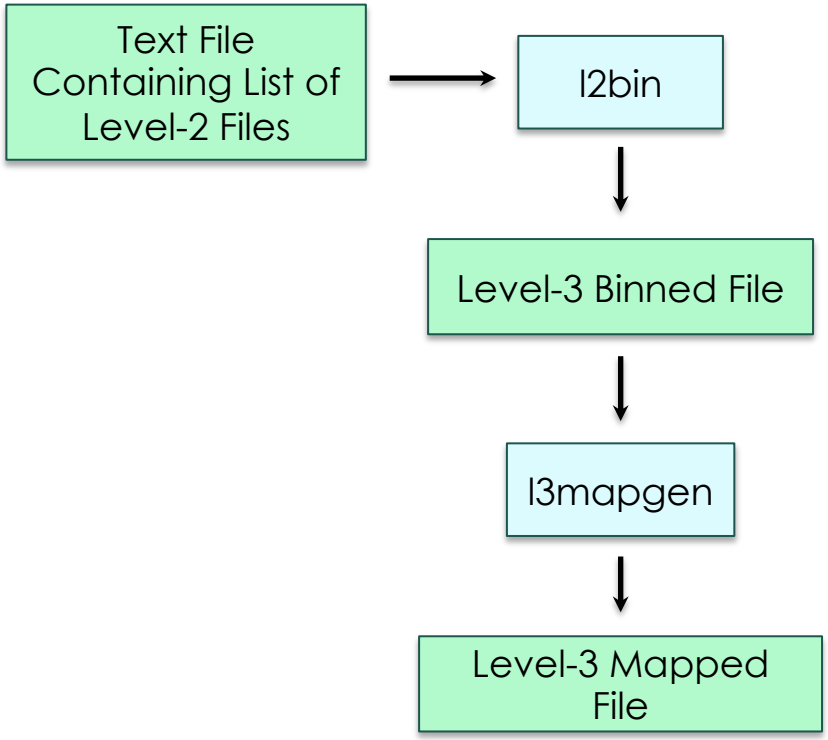
S3B_OLCI_EFRNT.20230106T153531.L2.OC.nc

S3B_OLCI_EFRNT.20230106T153831.L2.OC.nc

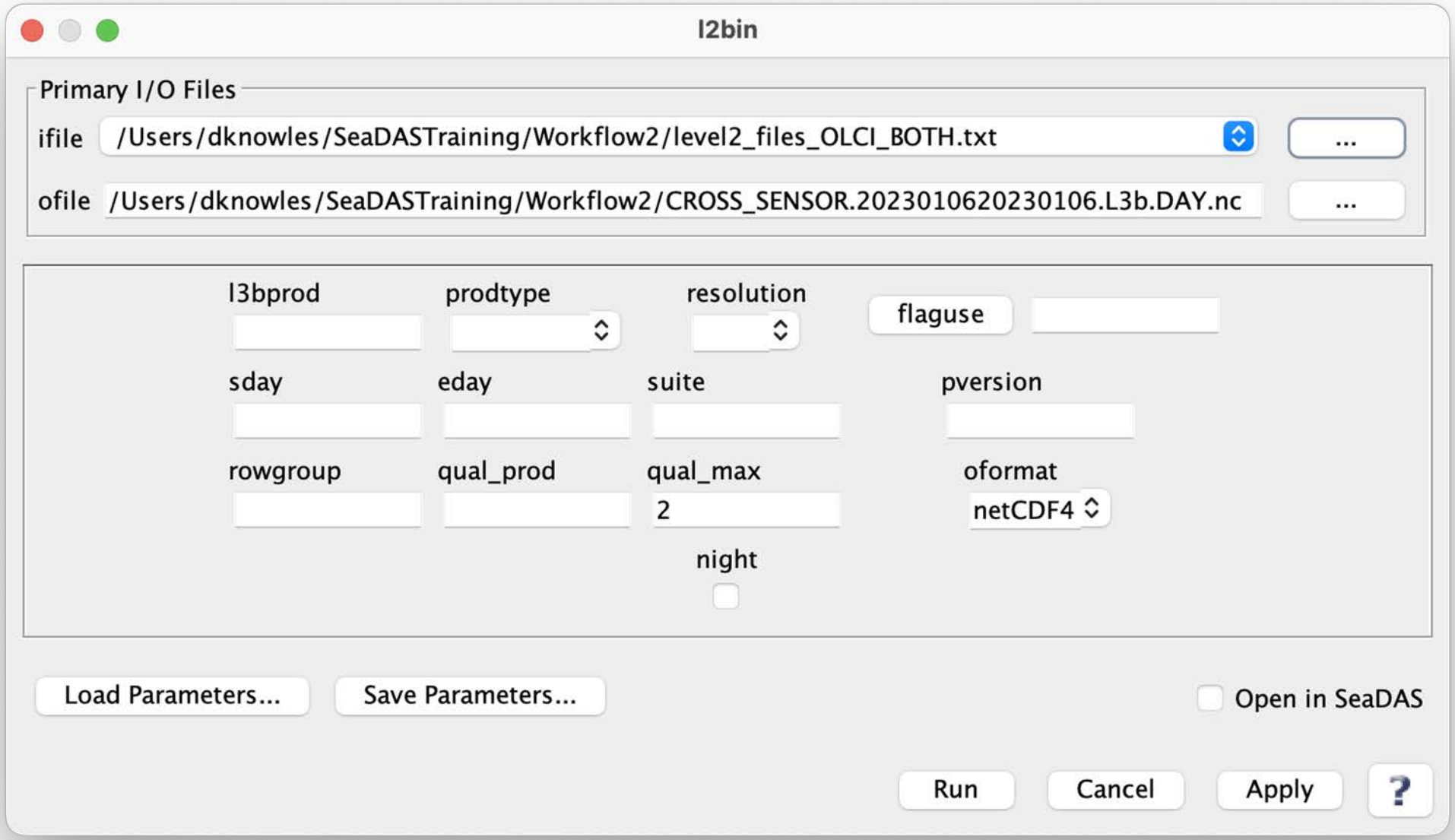
Workflow: Overview (Text File to Serve as "ifile" to l2bin)

File: level2_files_OLCI_BOTH.txt

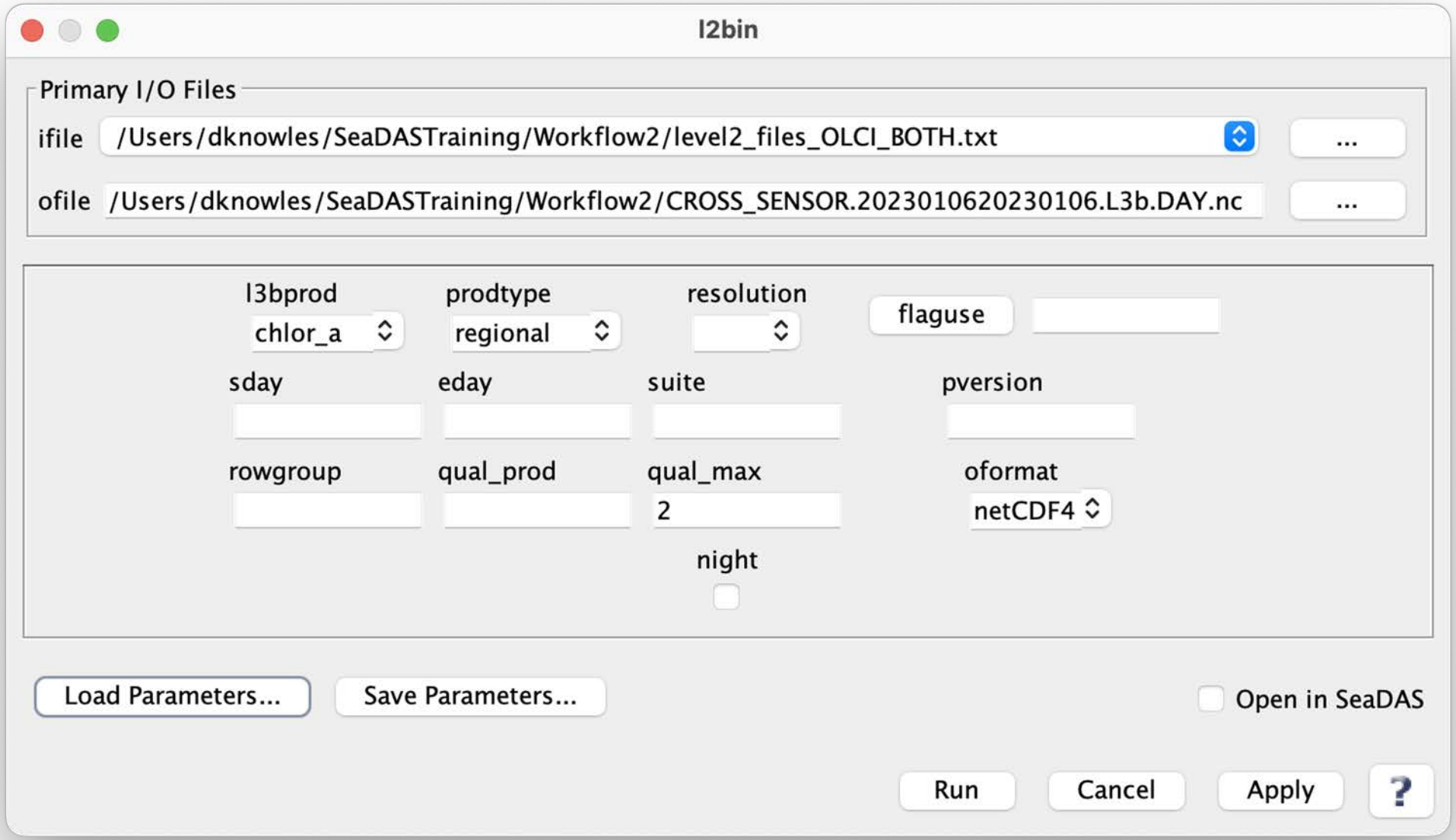
```
S3A_OLCI_EFRNT.20230106T161140.L2.OC.nc
S3A_OLCI_EFRNT.20230106T161440.L2.OC.nc
S3A_OLCI_EFRNT.20230106T161740.L2.OC.nc
S3B_OLCI_EFRNT.20230106T153231.L2.OC.nc
S3B_OLCI_EFRNT.20230106T153531.L2.OC.nc
S3B_OLCI_EFRNT.20230106T153831.L2.OC.nc
```



Workflow: Create L2 Binned File (Select"ifile")

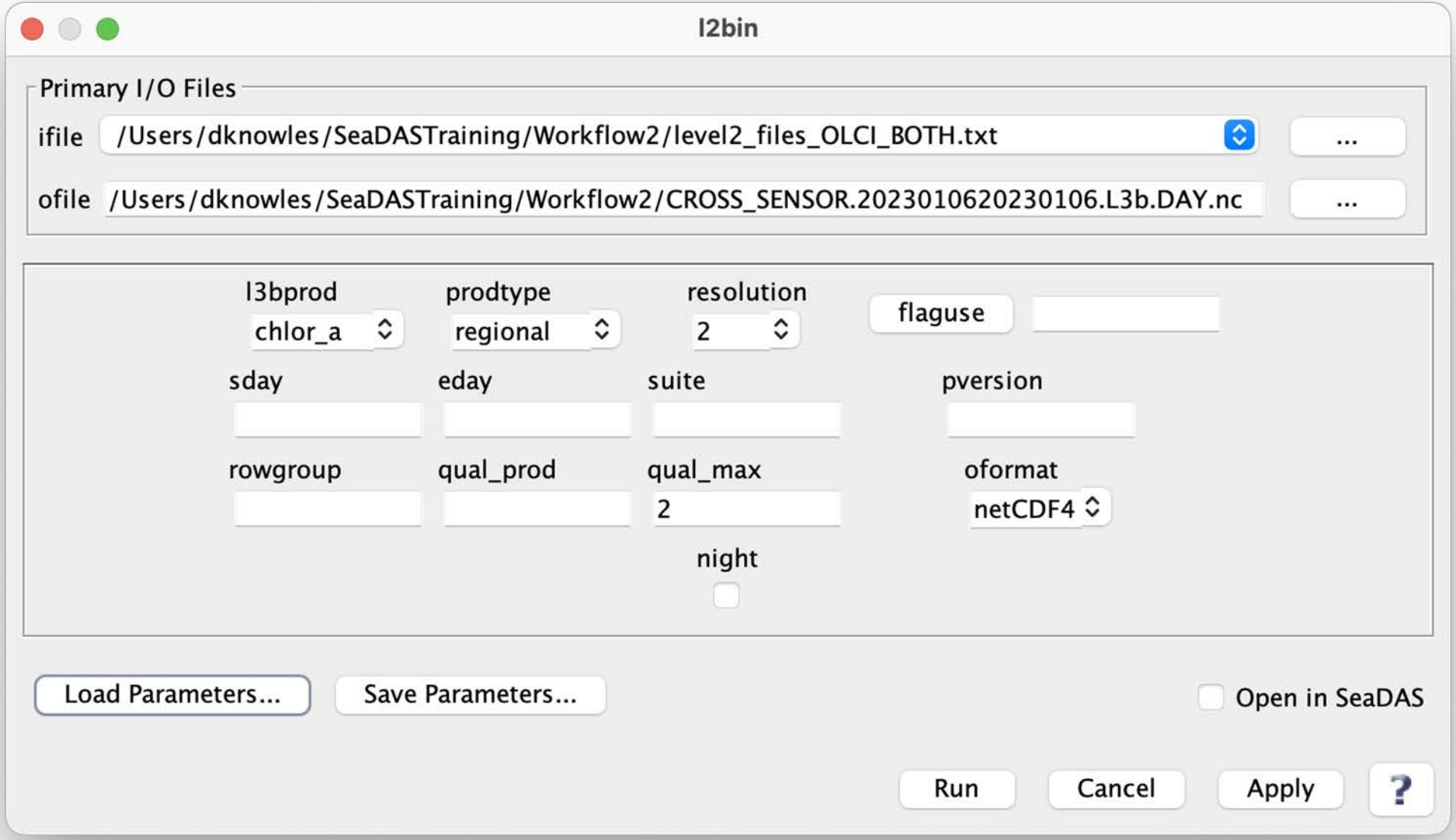


Workflow: Create L2 Binned File (Specify"l3bprod" and "prodtype")

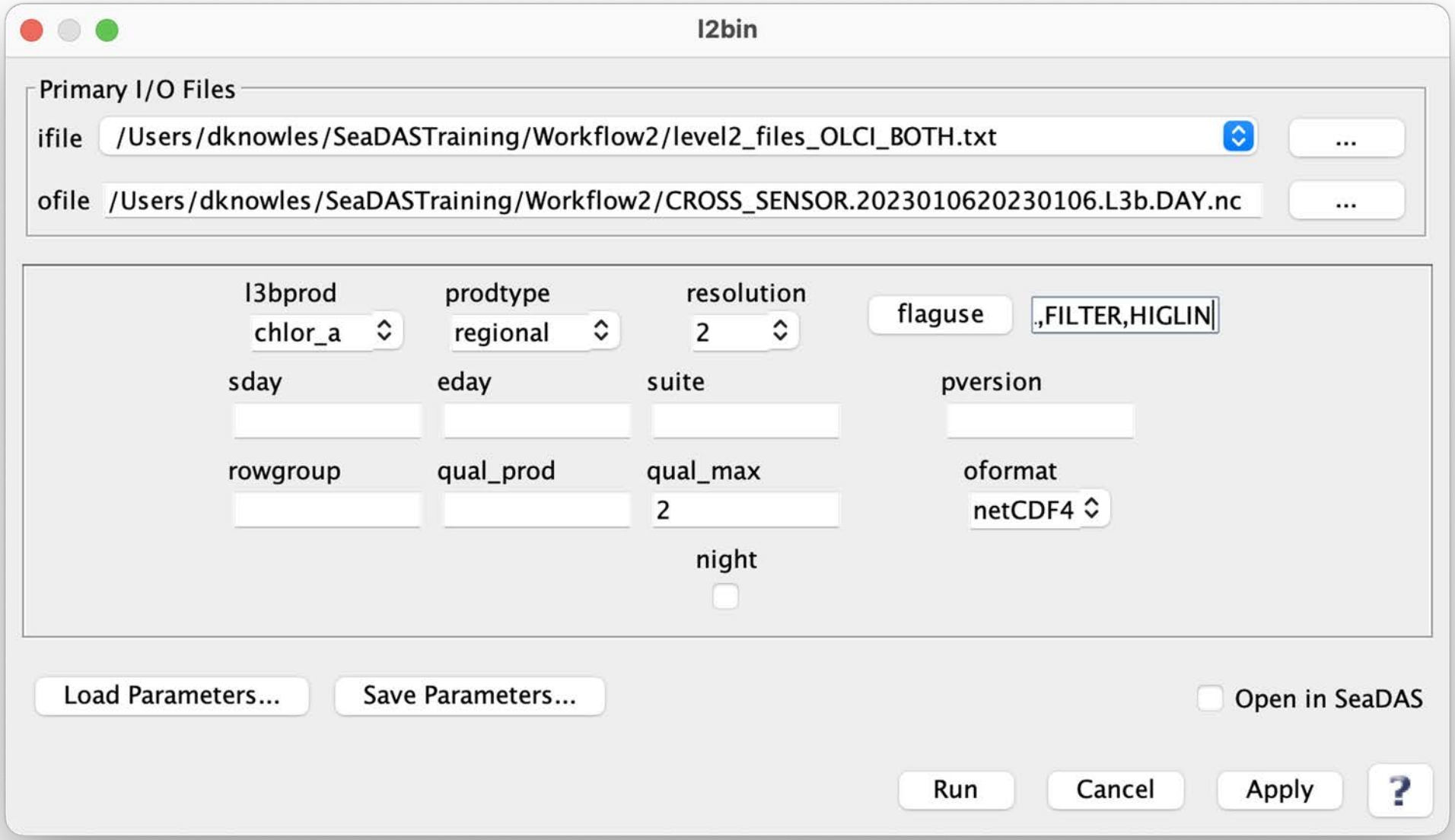


Workflow: Create L2 Binned File (Specify "resolution=2")

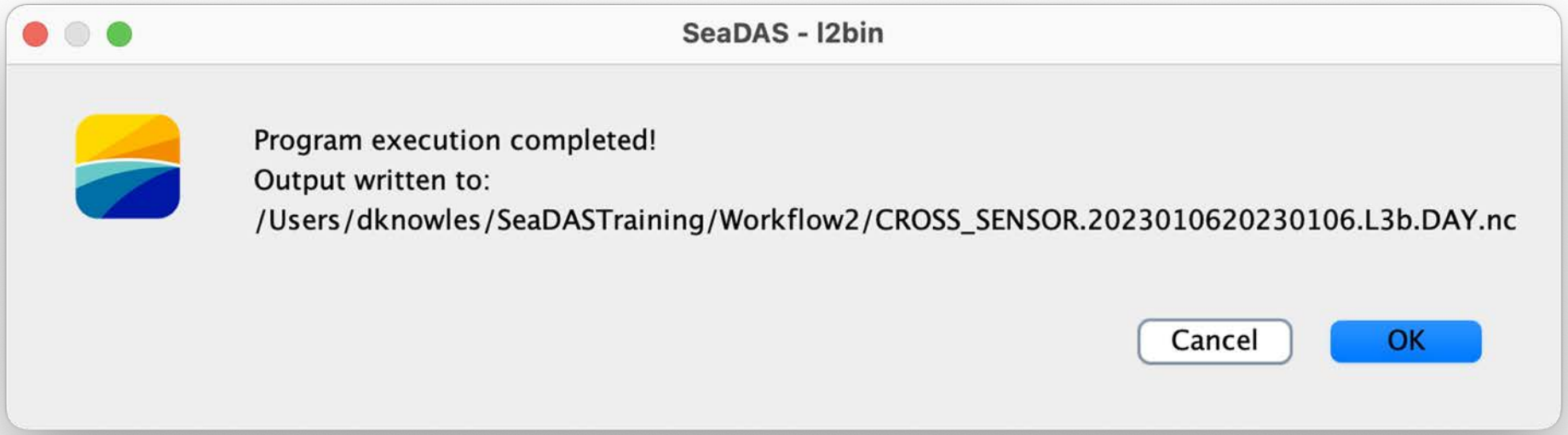
– Multiscene file could be big



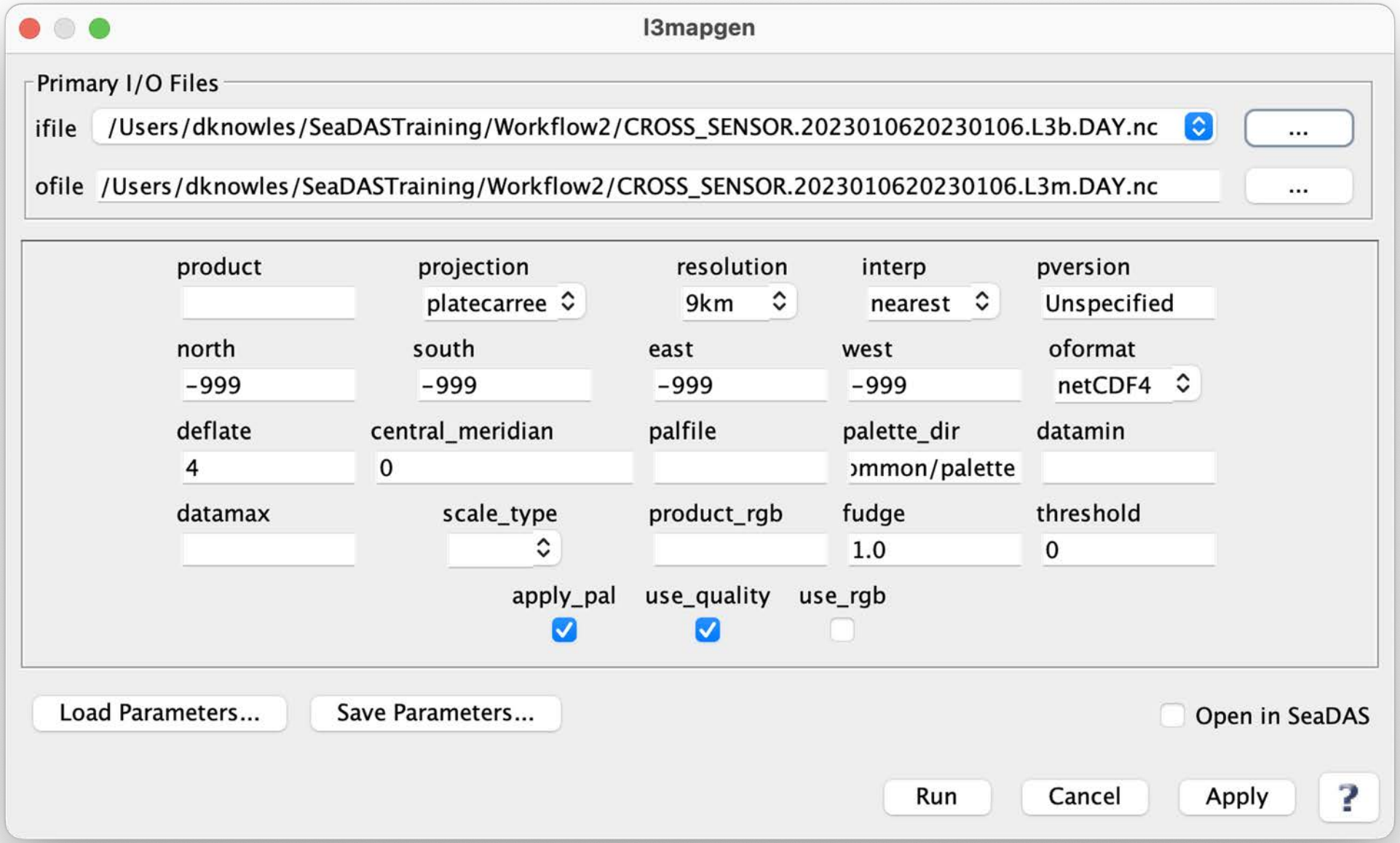
Workflow: Create L2 Binned File (Specify "flaguse" and click "Run")



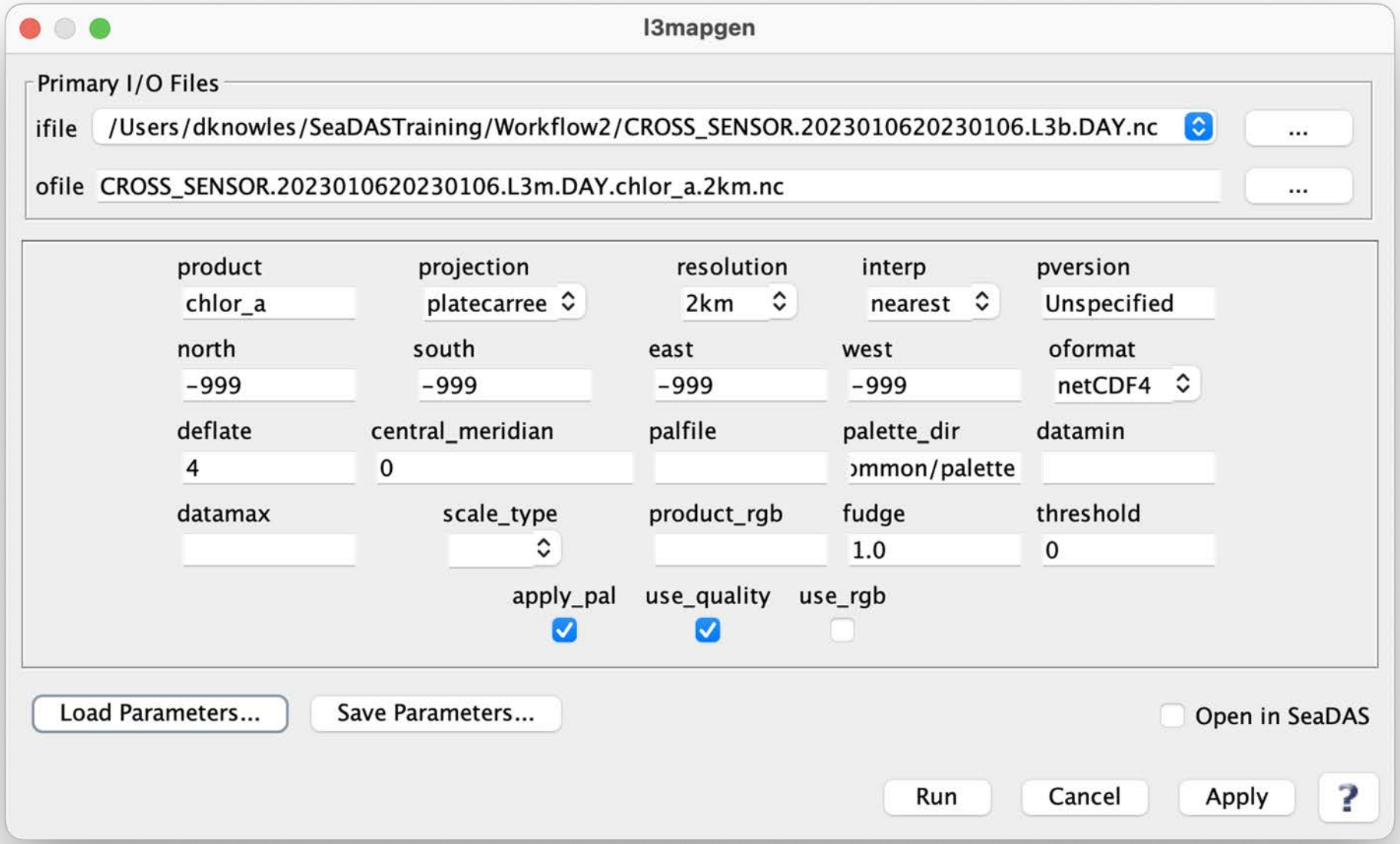
Workflow: Create L2 Binned File (Results Message)



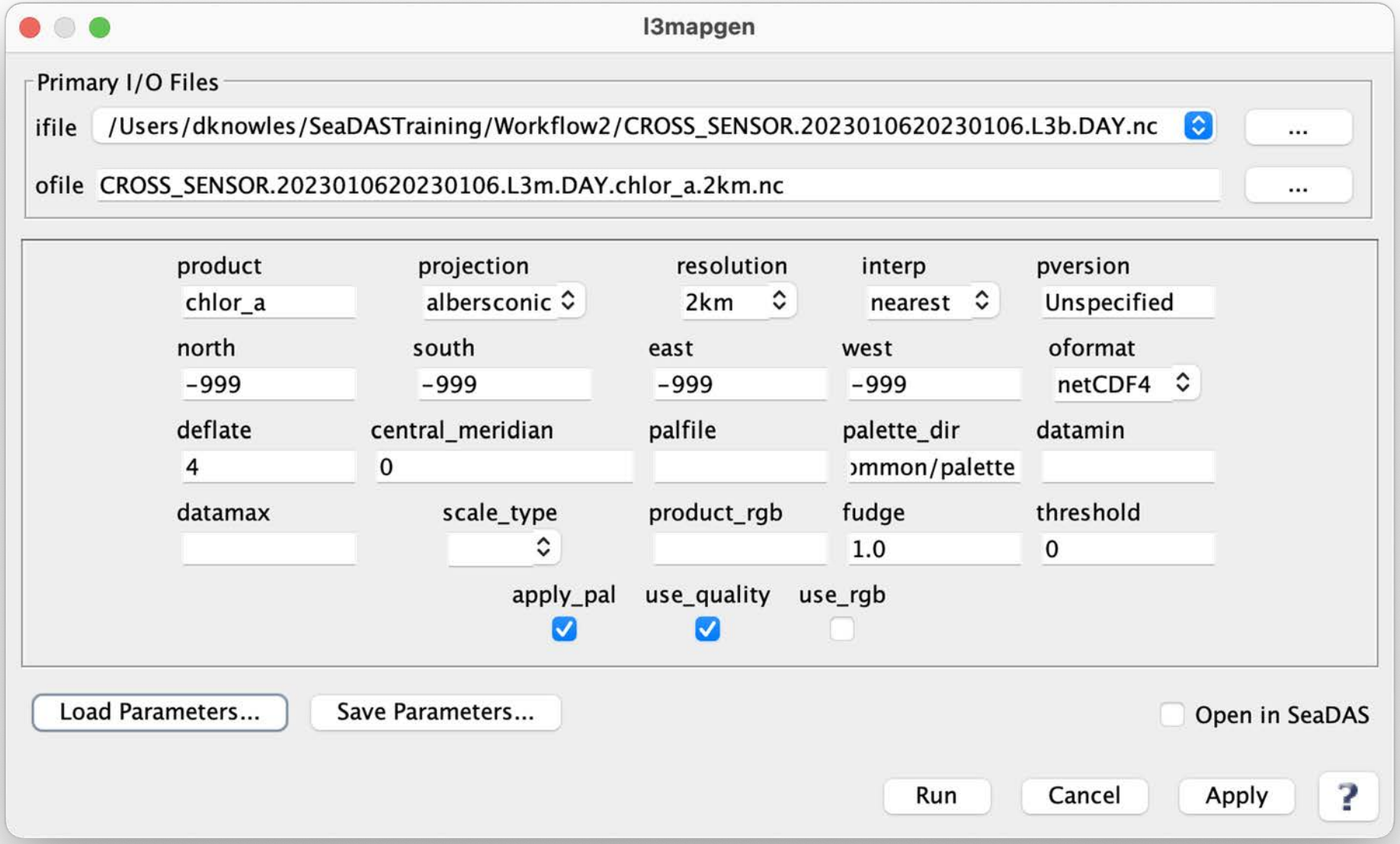
Workflow: Create L3 Mapped File (Select "ifile")



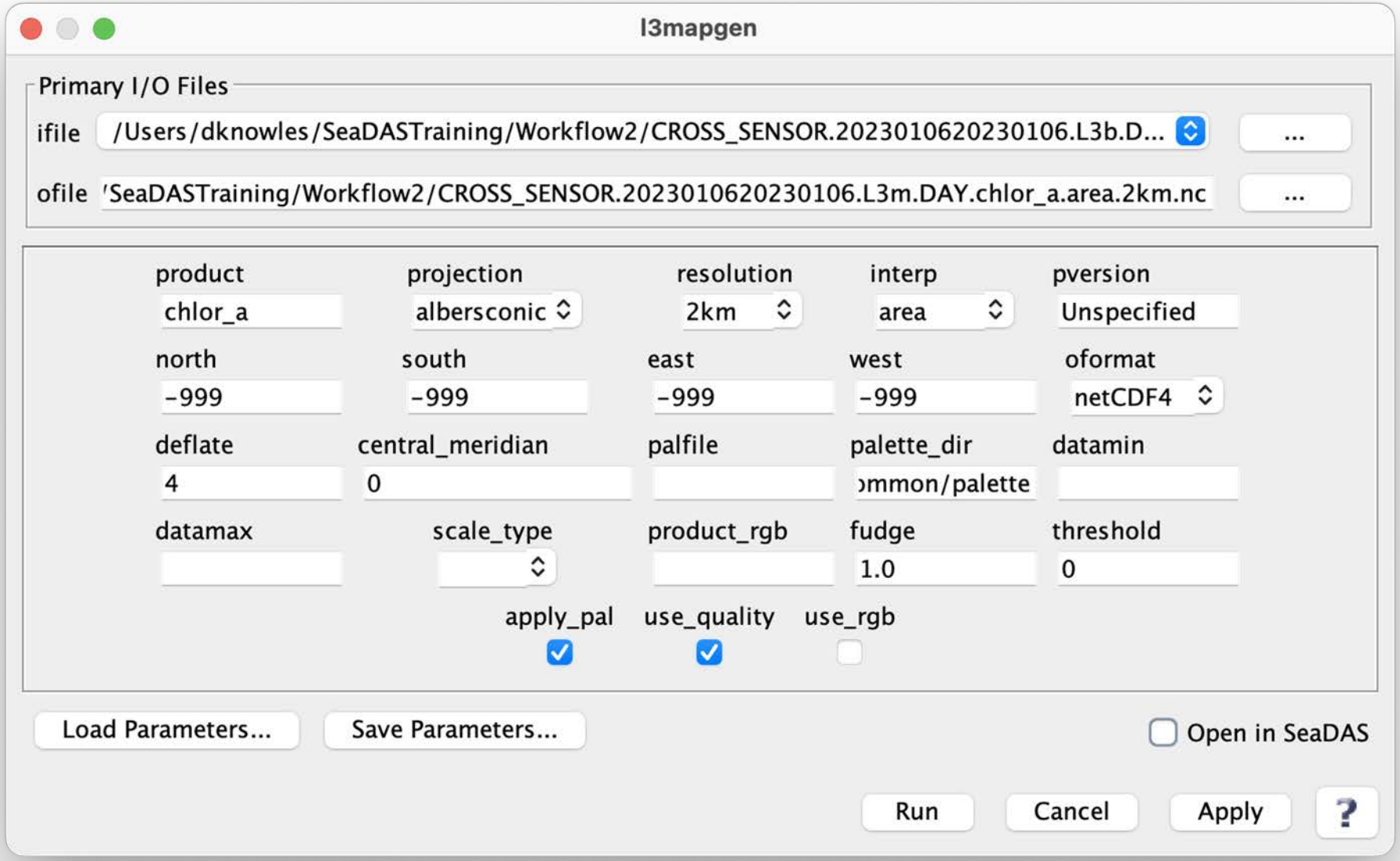
Workflow: Create L3 Mapped File (Specify "product=chlor_a" and "resolution=2km")



Workflow: Create L3 Mapped File (… or perhaps select "projection=albersconic" for statistics)

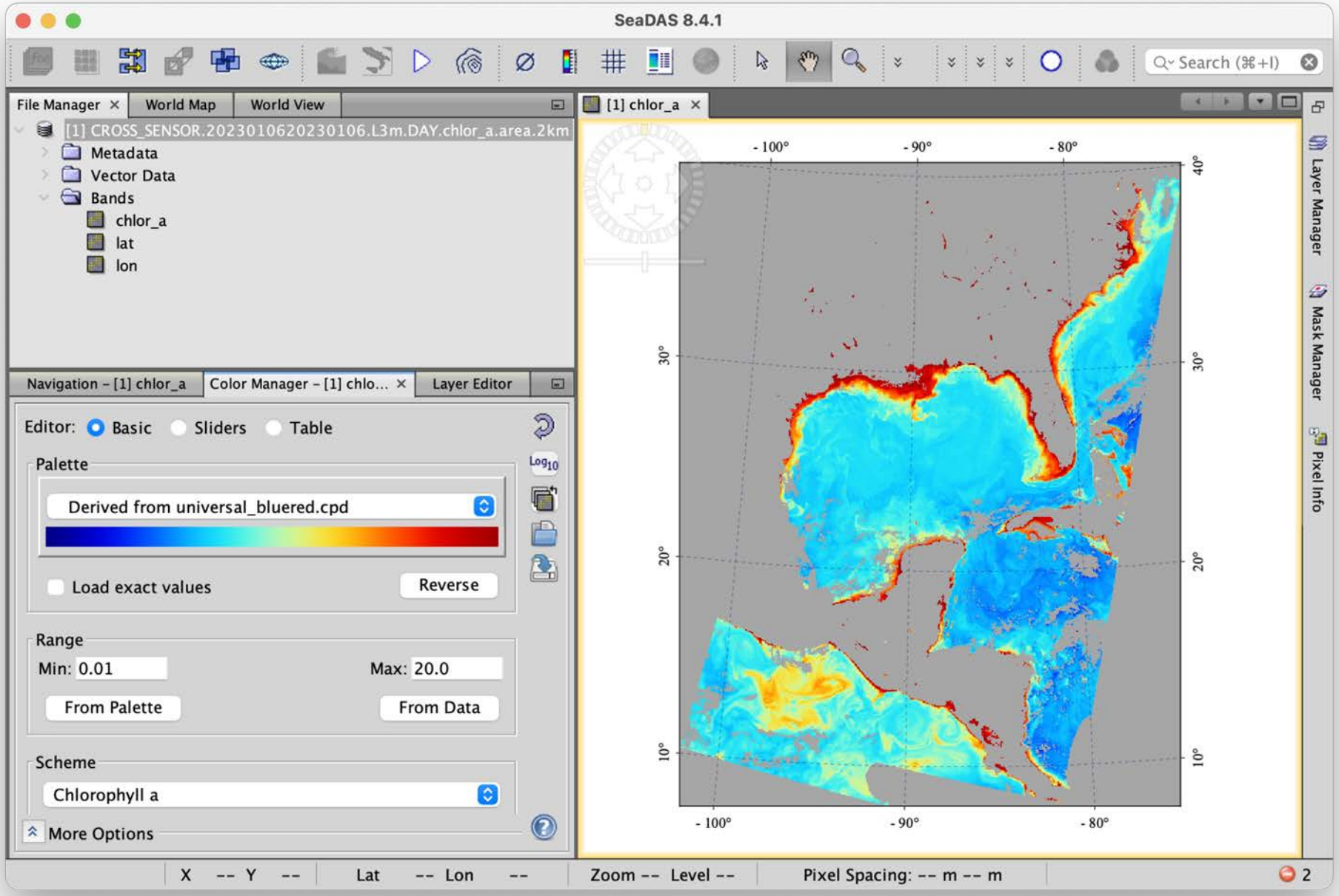


Workflow: Create L3 Mapped File (Select "interp=area" and click "Run")

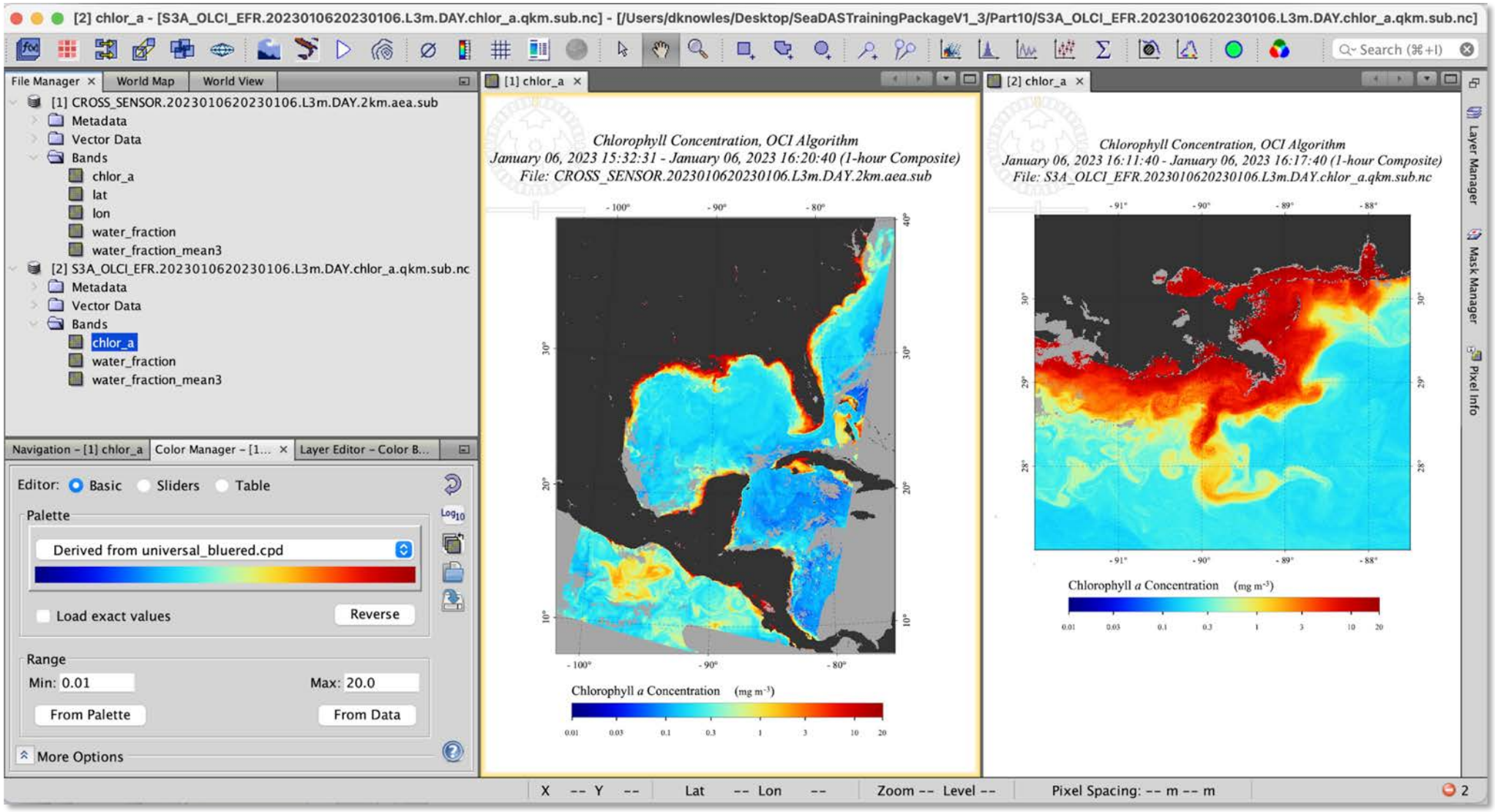


Workflow: Create L3 Mapped File (Results Message)

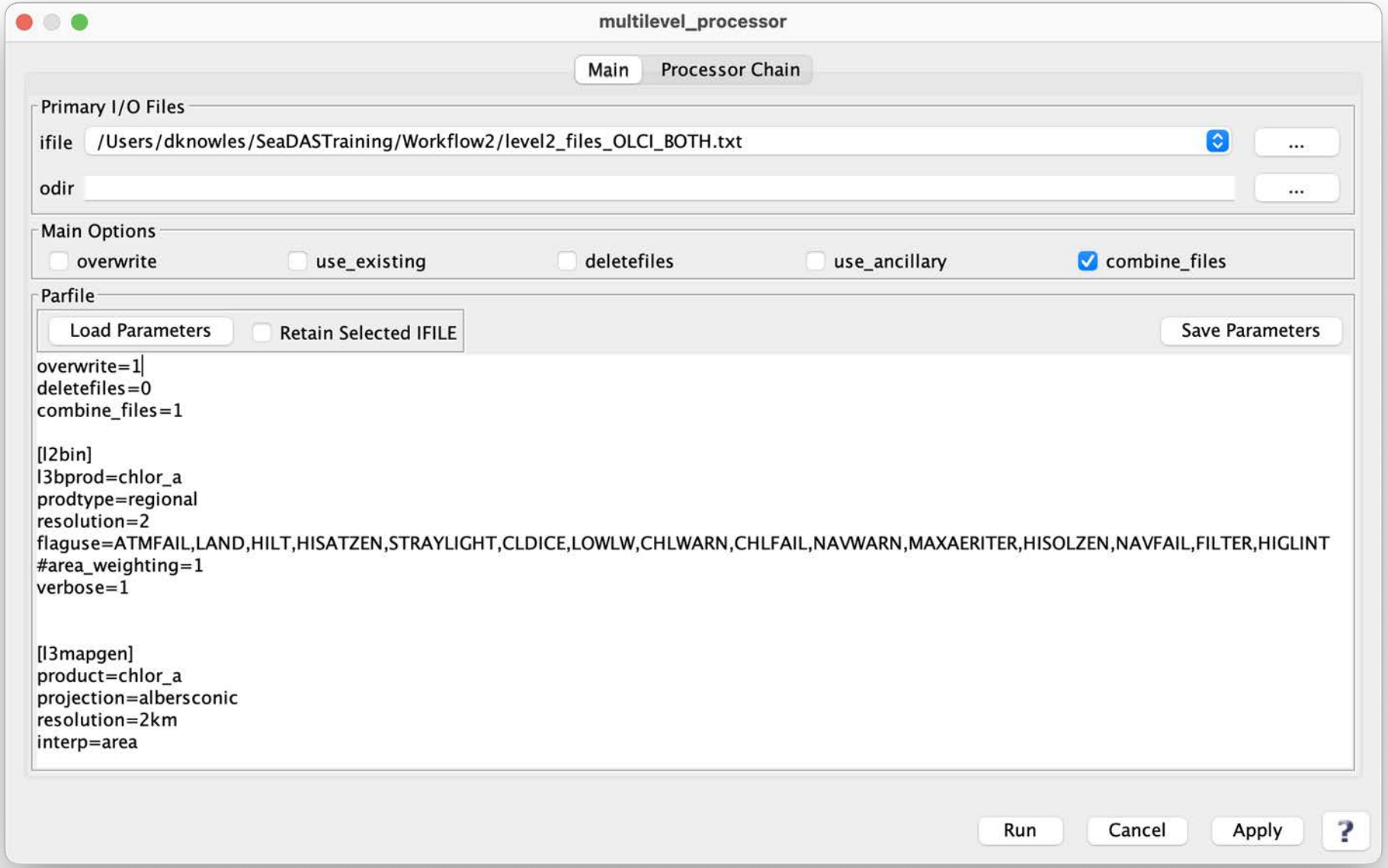
Workflow: View L3 Mapped File



Workflow: View L3 Mapped File (Right-Side Image Processed at 250 m)



Workflow: multilevel_processor

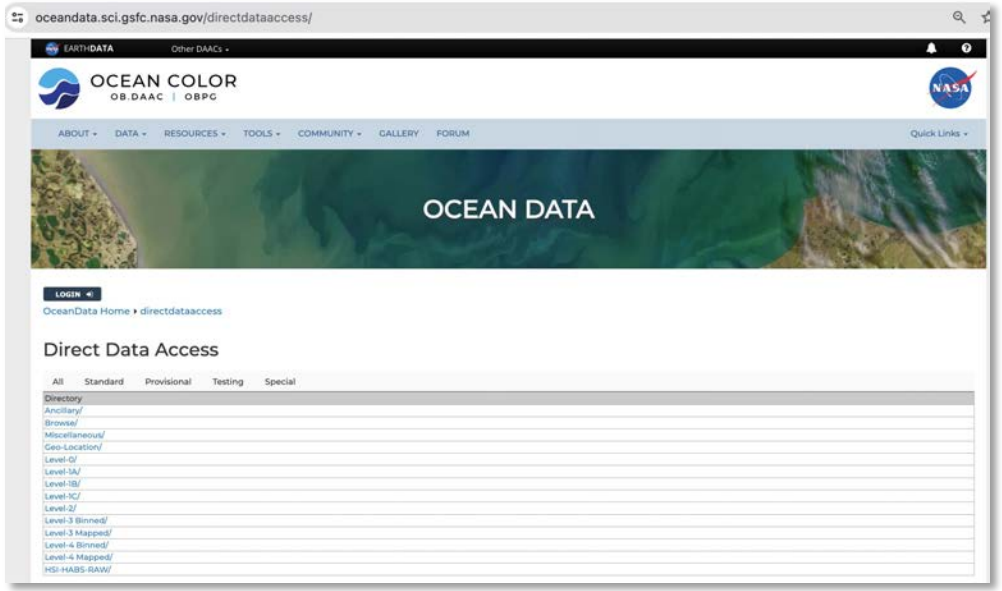


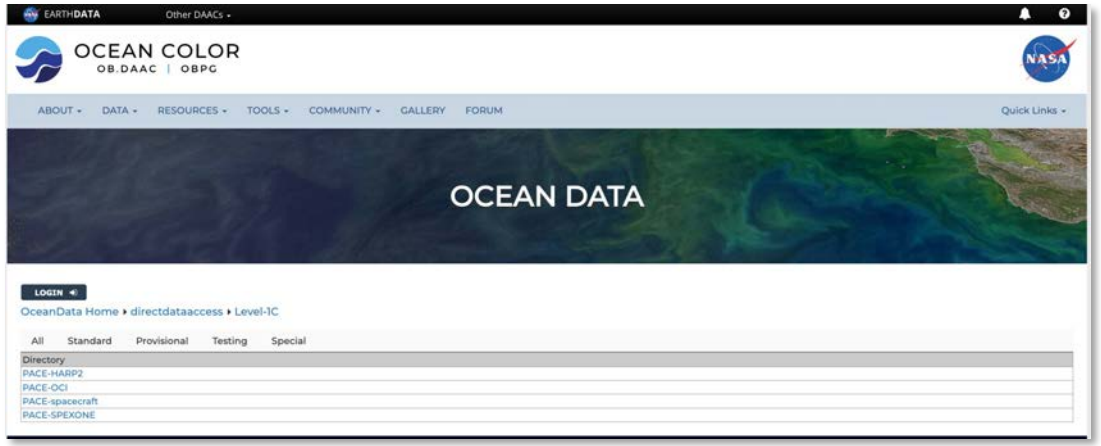
SeaDAS for PACE Data Analysis and Visualization

PACE Data Access

- Pace data will be available from the following link after April 2024
- Currently simulated data are available.

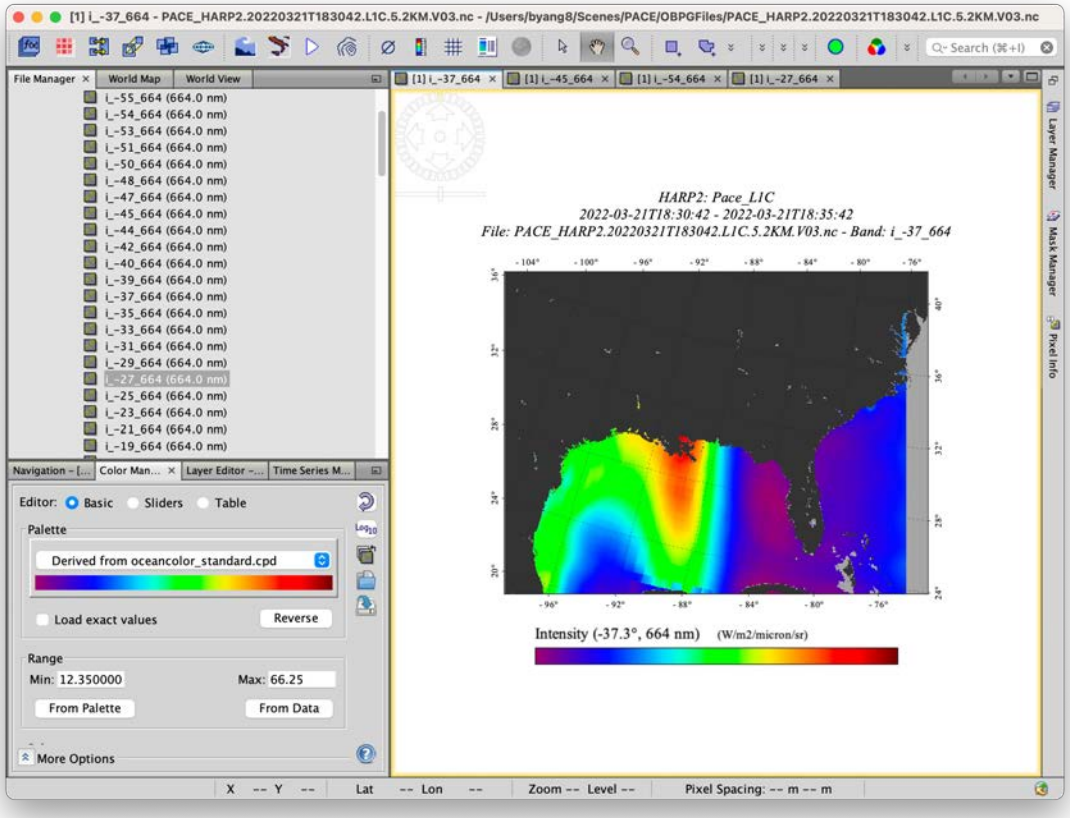
  https://oceandata.sci.gsfc.nasa.gov/directdataaccess/



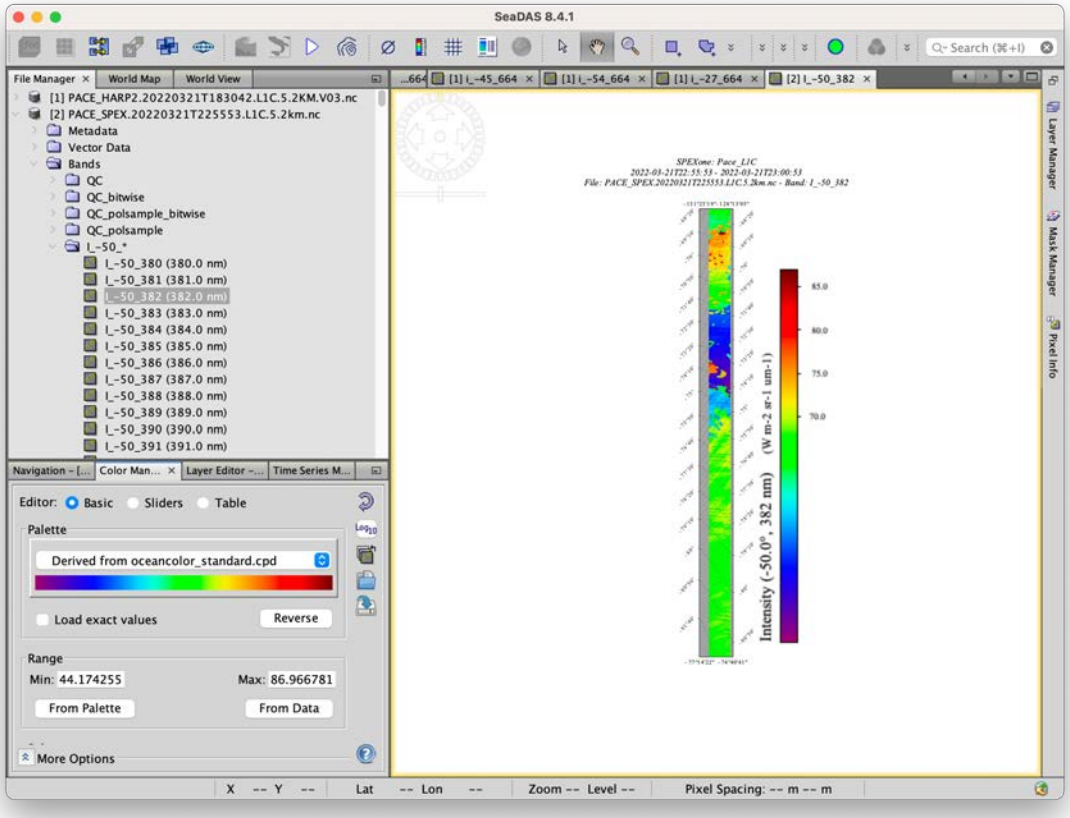


Level 1C Data Images

HARP-2

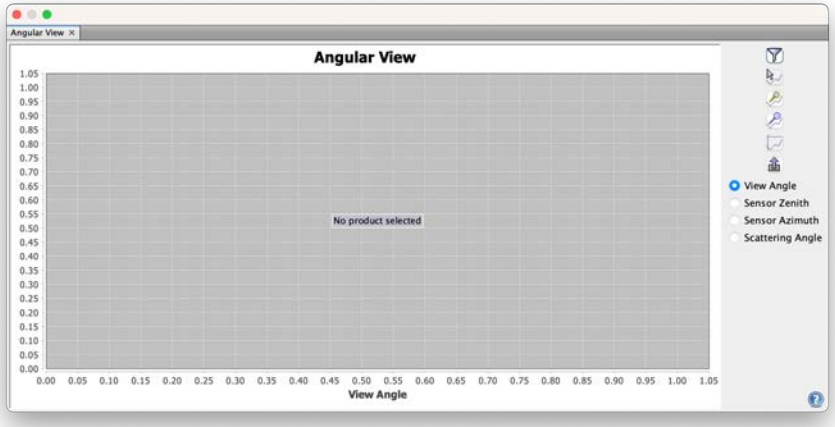


SPEXone

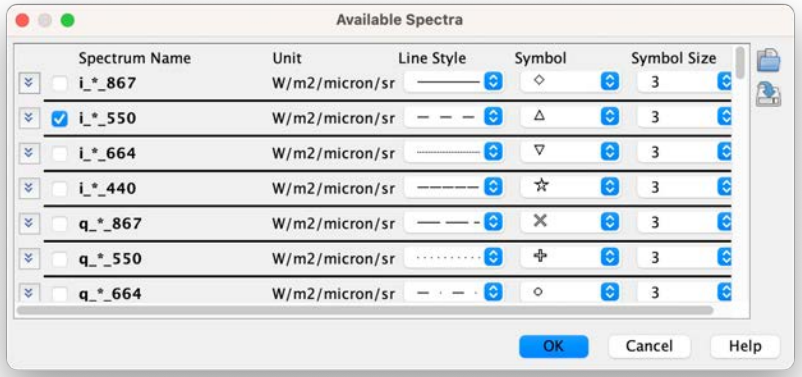


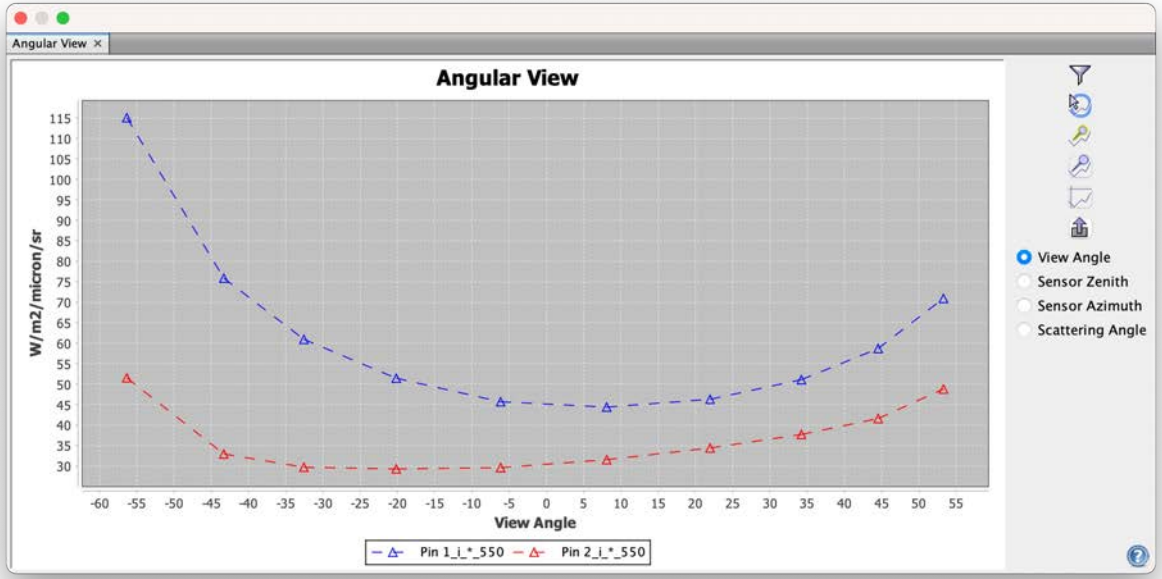
SeaDAS New Feature: HARP-2 Angular View of I Stokes Vector

HARP-2 Angular View GUI



Angular View Chooser



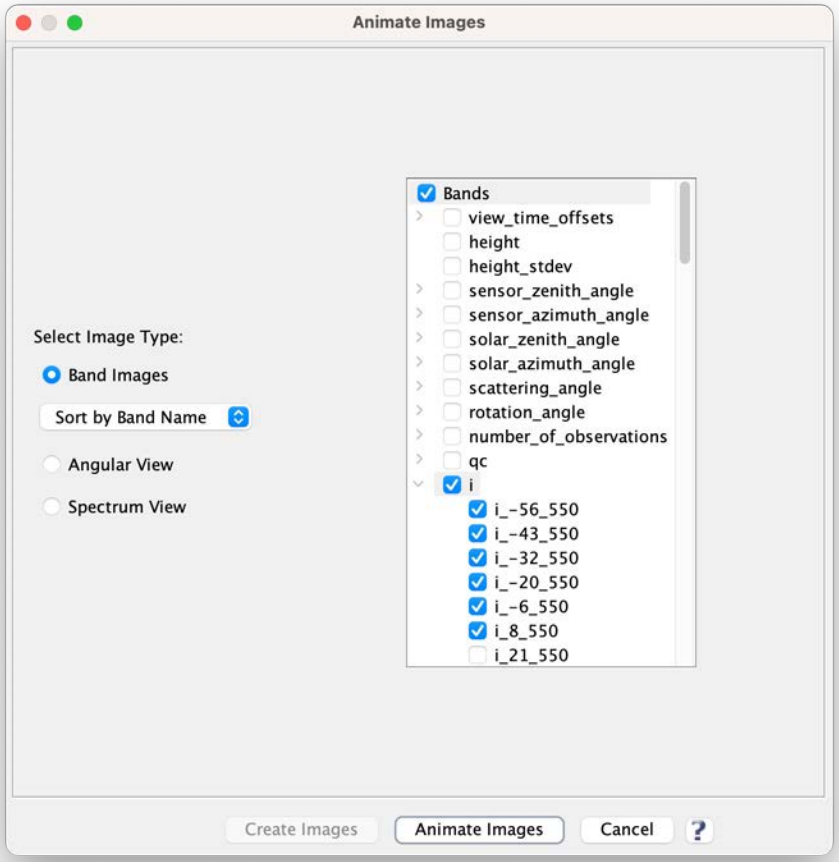


SeaDAS New Feature: Animation

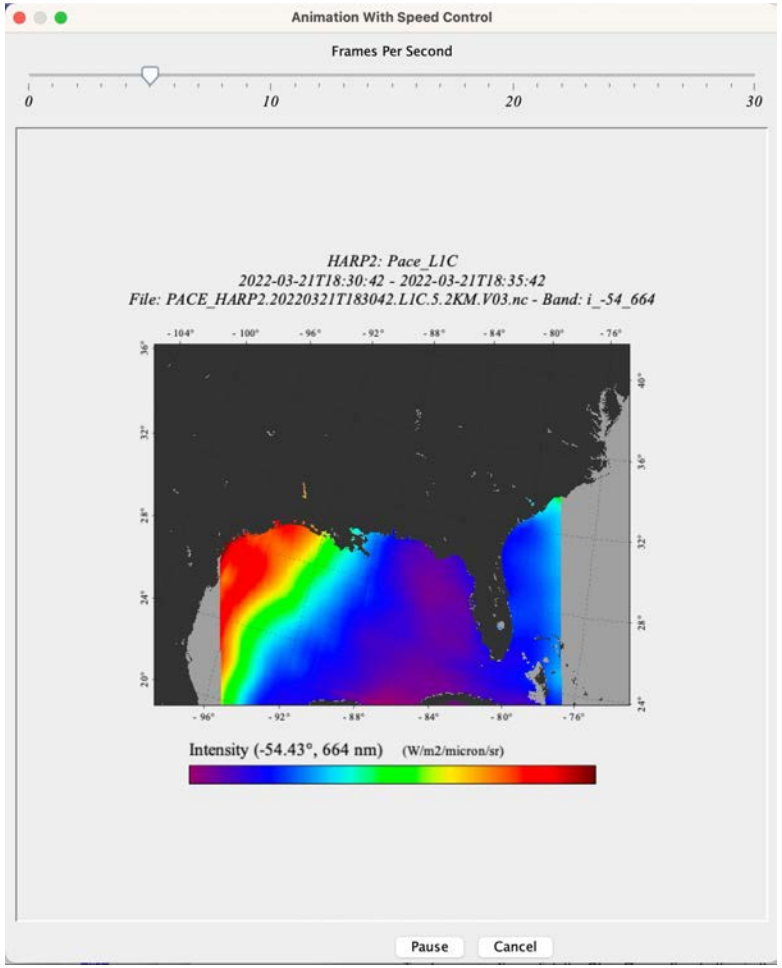
SeaDAS GUI Allows:

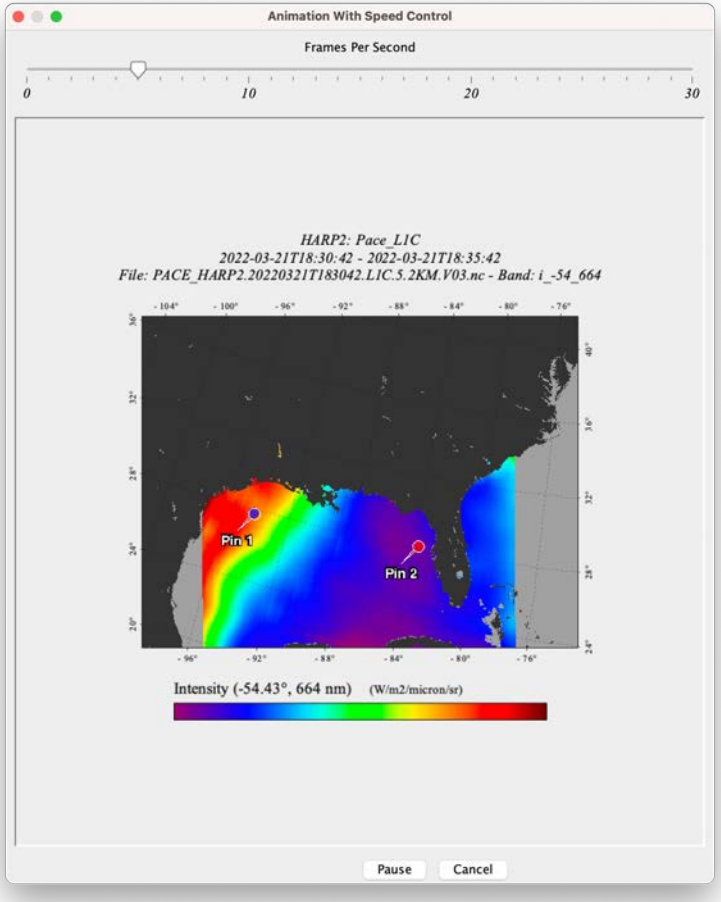
- Animation of band images
- Animation of angular view or spectral view at a location(s)
- Animation speed control

Animation GUI



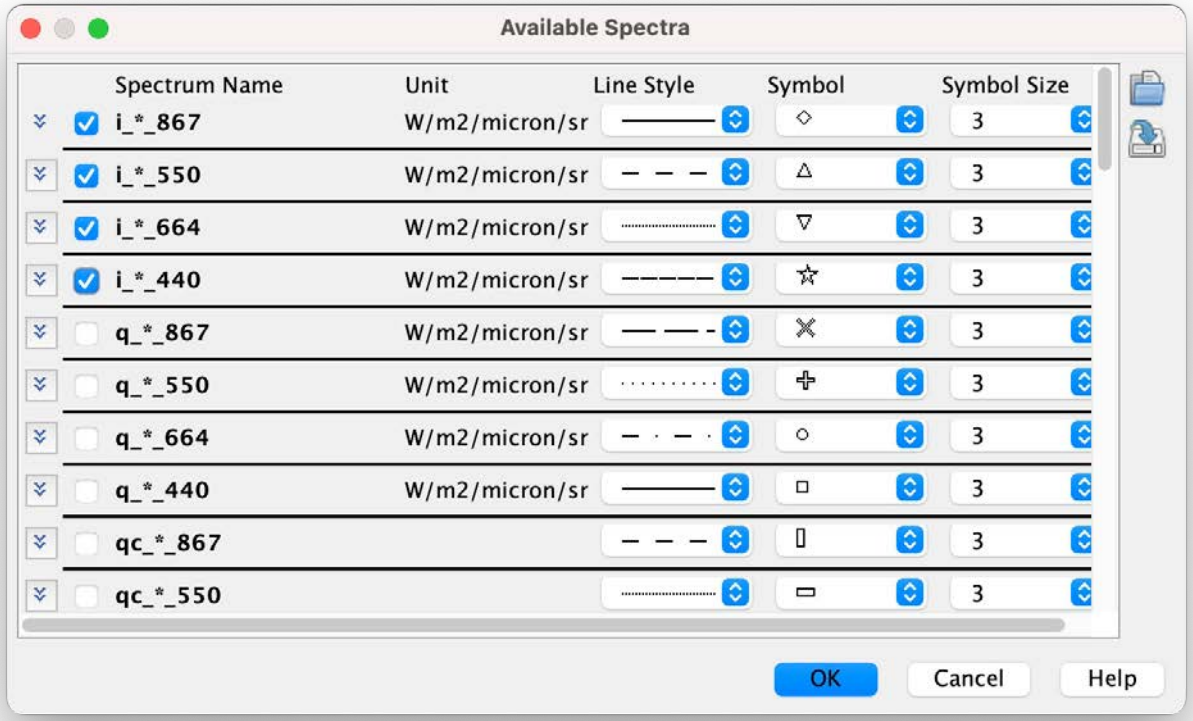
SeaDAS: HARP-2 Band Image Animation

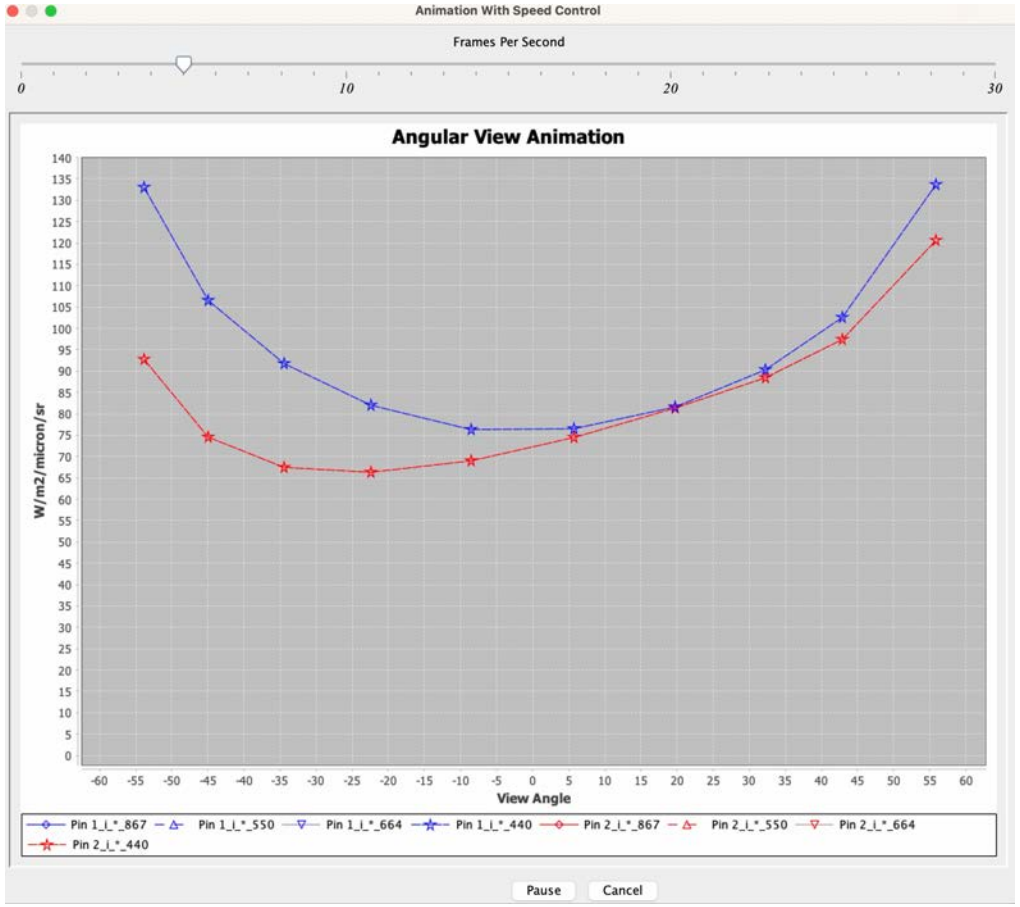




Selected Locations with pin-1 and pin-2

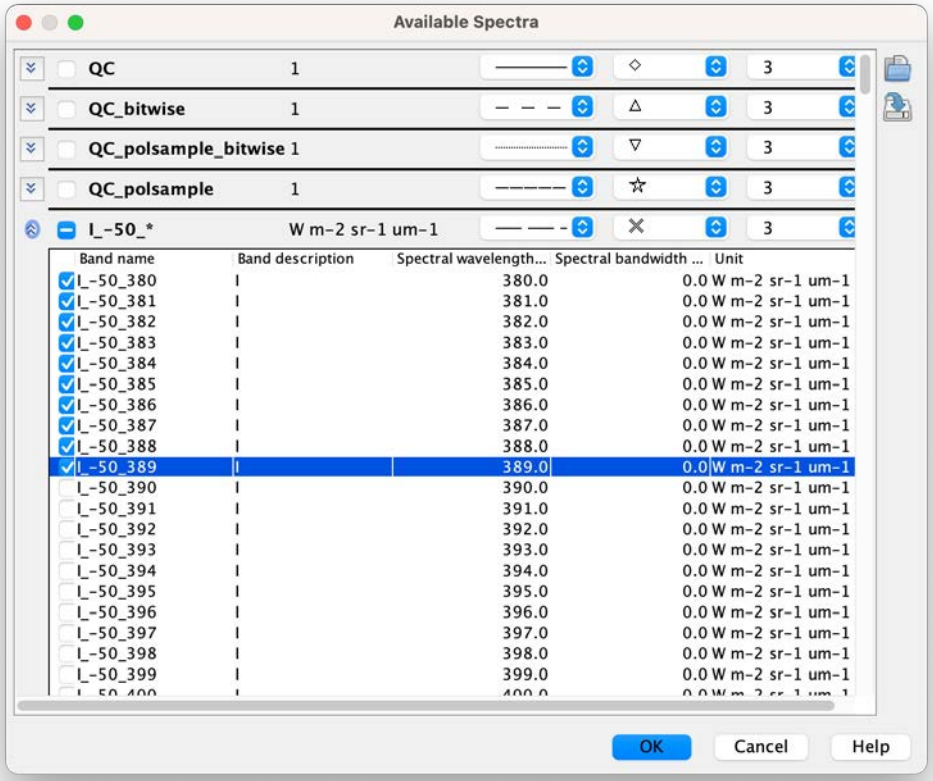
HARP-2 Angular View Animations

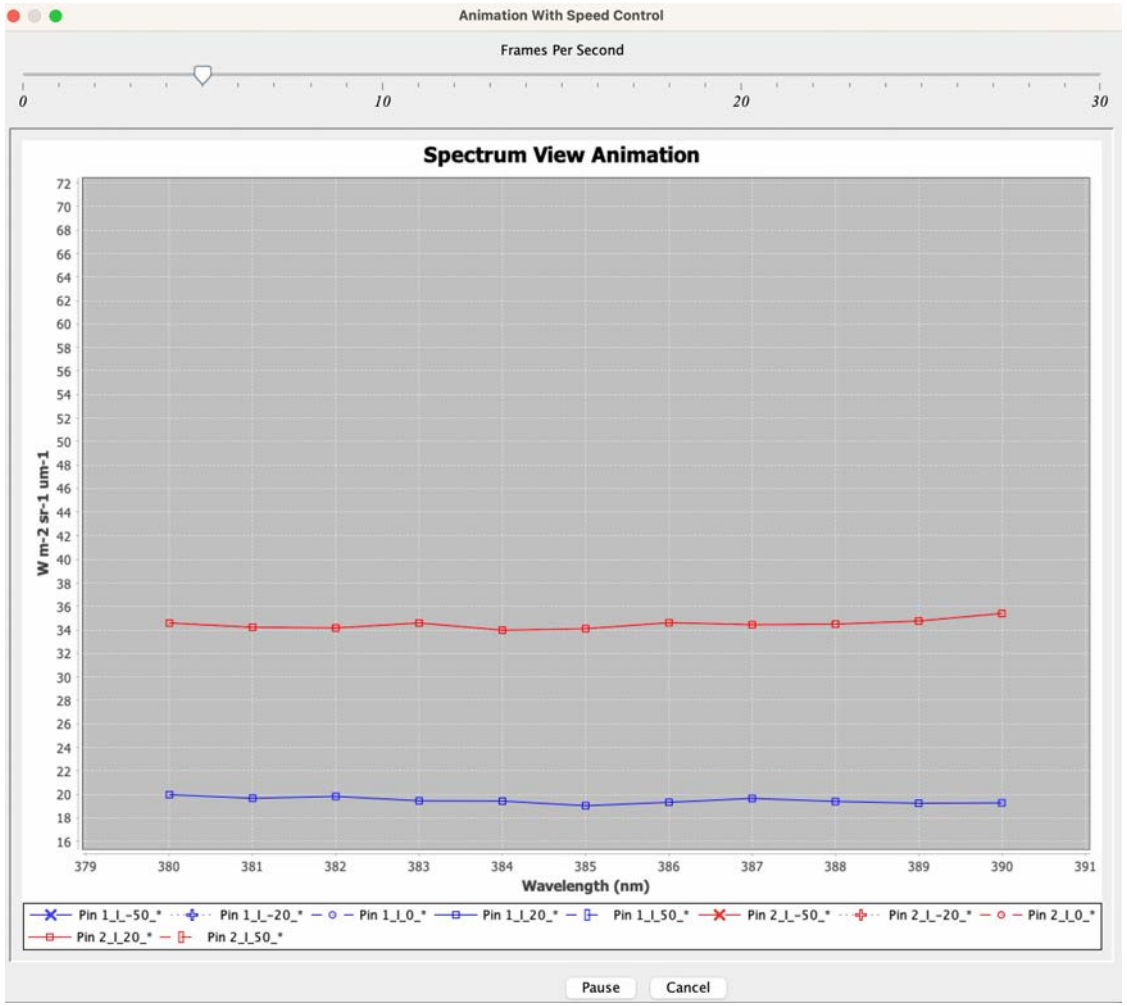




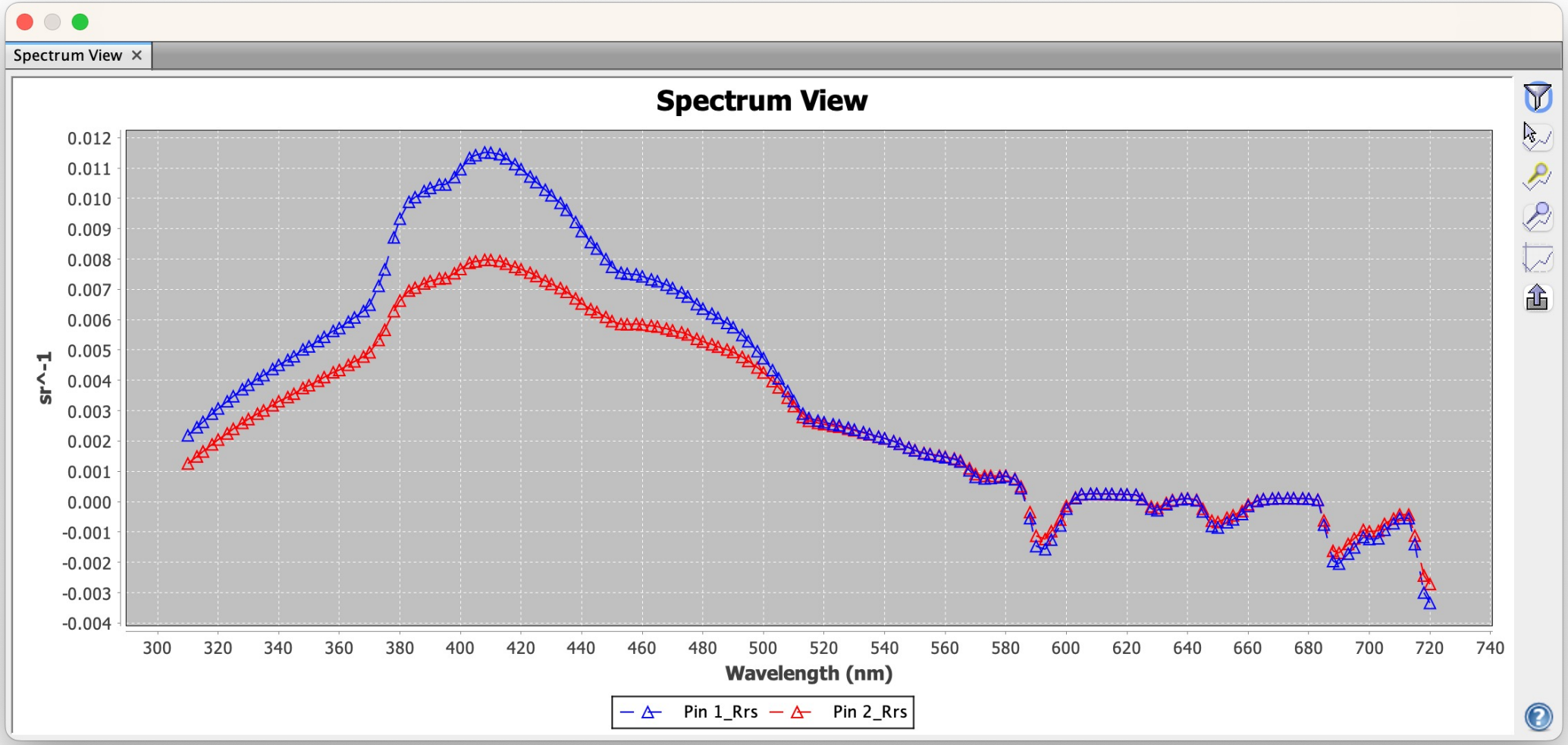
SPEXone Spectral View Animations

GUI for Choosing Bands





PACE OCI Remote Sensing Reflectance Spectra



Summary

Summary

In the training today, we:

- Identified sensor data processing capability and workflow for: OLCI, MODIS, VIIRS, OLI, and MSI
- Demoed Sentinel-3 OLCI data processing and analysis for the Chesapeake Bay:
  - True-color image display
  - Level-2 and Level-3 Data: binning and mapping, adding quality flags, statistical and band math analysis
  - OCSSW Tool
  - Analyzed and visualized chlorophyll-a concentration, and remote sensing reflectances
- Previewed plans for incorporating PACE data

Homework and Certificates

- **Homework:**
  - One homework assignment
  - Opens on 02/13/2014
  - Access from the training webpage
  - Answers must be submitted via Google Forms
  - **Due by 02/29/2024**

- **Certificate of Completion:**
  - Attend all three live webinars (attendance is recorded automatically)
  - Complete the homework assignment by the deadline
  - You will receive a certificate via email approximately two months after completion of the course.

Acknowledgement

OB.DAAC SeaDAS Team

Aynur Abdurazik – SeaDAS Lead Developer

Donald Shea – SeaDAS Processors Lead Developer

Daniel Knowles – SeaDAS Developer, SeaDAS Instruction

Bing Yang – SeaDAS Developer, SeaDAS Processors Developer

Sean Bailey – DAAC Manager

Alicia Scott – Deputy DAAC Manager

Guoqing Wang – DAAC Scientist

OBPG (NASA's Ocean Biology Processing Group) – Many Scientists and Algorithm Developers

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- ARSET Website
- Follow us on Twitter!
  - @NASAARSET
- ARSET YouTube

Visit our Sister Programs:

- DEVELOP
- SERVIR

Resources

- NASA Ocean Biology Distributed Active Archive Center (OB.DAAC)
- Official NASA/OB.DAAC Data Analysis Software SeaDAS
- NASA Ocean Color
- NASA Ocean Ecology: Missions and Projects
- NASA Earth Data Forum
- NASA PACE


APPLIED REMOTE SENSING TRAINING PROGRAM
TRAIN - EMPOWER - ADVANCE

Thank You!

Miscellaneous Reference Notes

SeaDAS Reference Notes: Adding Custom User Band Lookup Schemes

Edit the following 2 files in the directory ~/.seadas8/auxata/color_schemes/
Note: setting up color scheme lookup for NDVI (next release will be a default)

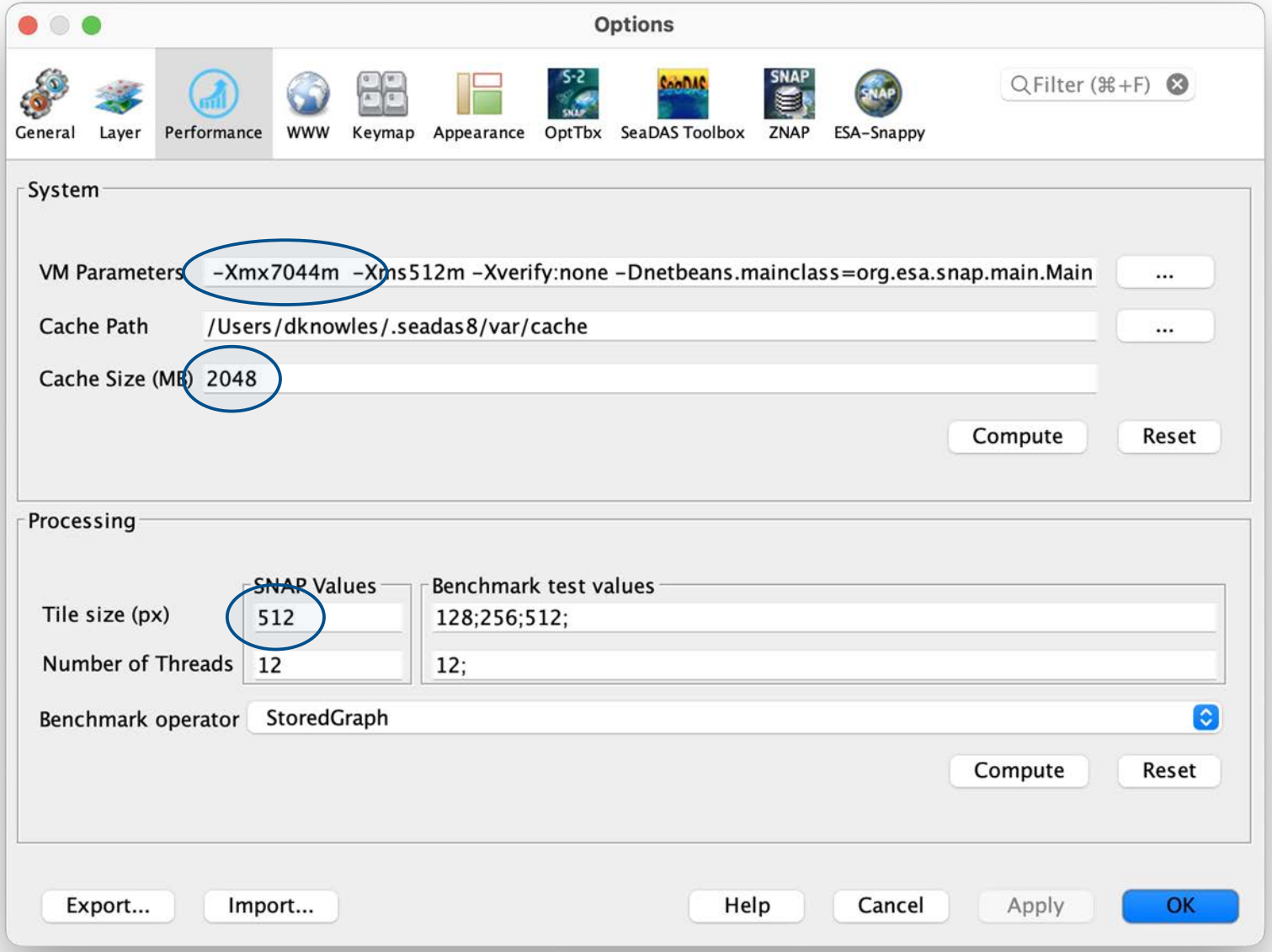
~/.seadas8/auxdata/color_schemes/color_palette_schemes_user.xml

```
# Add the following line somewhere between the lines <schemeList> and </schemeList>

<Scheme name="ndvi">
        <VERBOSE_NAME/>
        <MIN>-0.05</MIN>
        <MAX>0.915200</MAX>
        <LOG_SCALE>false</LOG_SCALE>
        <STANDARD_FILENAME>oceancolor_ndvi.cpd</STANDARD_FILENAME>
        <UNIVERSAL_FILENAME>oceancolor_ndvi.cpd</UNIVERSAL_FILENAME>
        <COLORBAR_TITLE></COLORBAR_TITLE>
        <COLORBAR_LABELS></COLORBAR_LABELS>
        <DESCRIPTION>Normalized Difference Vegetation Index</DESCRIPTION>
</Scheme>
```

~/.seadas8/auxata/color_schemes/color_palette_scheme_lookup_user.xml

```
# Add the following line somewhere between the lines <colorSchemeLut> and </colorSchemeLut>

<KEY REGEX="^ndvi($|_.+)">
        <SCHEME_ID>ndvi</SCHEME_ID>
        <DESCRIPTION/>
</KEY>
```

SeaDAS Reference Notes: Boosting Performance (Virtual Memory Issues)



SeaDAS Reference Notes: Boosting Performance (Virtual Memory Issues)

Most of these get overridden in the System Performance GUI
(with the exception of snap.dataio.reader.tileWidth and snap.dataio.reader.tileWidth).

${SEADAS_HOME}/etc/snap.properties

```
# Boost the virtual memory (by factors of gigabyte - adding in increments of 1024)

default_options="--branding snap --locale en_GB  -J-Xverify:none -J-Xms512M -J-Xmx7044M -J-
Dnetbeans.mainclass=org.esa.snap.main.Main -J-Dsun.java2d.noddraw=true -J-
Dsun.awt.nopixfmt=true -J-Dsun.java2d.dpiaware=false"
```

${SEADAS_HOME}/etc/seadas.conf

```
# Consider modify these lines

# Tile cache size [Mb]
snap.jai.tileCacheSize=2048
# Default tile size in pixels
snap.jai.defaultTileSize=512

# Reader tile size in pixels
snap.dataio.reader.tileWidth=512
snap.dataio.reader.tileHeight=512
```

Note:
snap.dataio.reader.tileWidth and snap.dataio.reader.tileWidth could be temporarily optimized to a particular file shape.

SeaDAS-OCSSW OB.DAAC: True Color Wavelengths

True Color Wavelengths

Mission	R	G	B
GOCI_COMS	660	555	490/412*
$OCSSWROOT/share/goci/msl12_sensor_info.dat			
HawkEye_SE1**	670	556	488
$OCSSWROOT/share/hawkeye/msl12_sensor_info.dat			
MERIS	665	560	490/413*
$OCSSWROOT/share/meris/msl12_sensor_info.dat			
MODIS_AQUA	645	555	469
$OCSSWROOT/share/modis/aqua/msl12_sensor_info.dat			
MODIS_TERRA	645	555	469
$OCSSWROOT/share/modis/terra/msl12_sensor_info.dat			
OLCI_S3A	665	560	490/412*
$OCSSWROOT/share/olci/s3a/msl12_sensor_info.dat			
OLCI_S3B	665	560	490/412*
$OCSSWROOT/share/olci/s3b/msl12_sensor_info.dat			
OLI_LANDSAT8	655	561	482
$OCSSWROOT/share/oli/msl12_sensor_info.dat			
OLI_LANDSAT9	655	561	482
$OCSSWROOT/share/oli/msl12_sensor_info.dat			
SeaWiFS_SEASTAR	670	555	490/412*
$OCSSWROOT/share/seawifs/msl12_sensor_info.dat			
VIIRS NOAA20**	667	556	489
$OCSSWROOT/share/viirs/j1/msl12_sensor_info.dat			
VIIRS NOAA21**	667	556	489
$OCSSWROOT/share/viirs/j2/msl12_sensor_info.dat			
VIIRS Suomi NPP	671	551	486
$OCSSWROOT/share/viirs/np/msl12_sensor_info.dat			

* SFREFL/TC Mapping

** rgb profile configuration file not yet added to SeaDAS (~/.seadas8/auxdata/rgb_profiles)

SeaDAS: OB.DAAC User Software

SeaDAS Support and Help

Earth Data Forum:
This is where you go to ask questions
https://forum.earthdata.nasa.gov/app.php/tag/SeaDAS

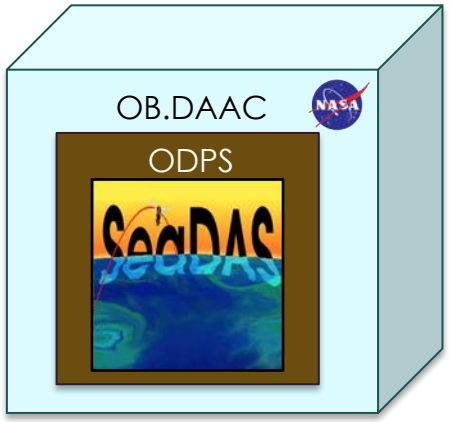
OB.DAAC Website:
This is where you get the Ocean Biology data and SeaDAS
https://www.earthdata.nasa.gov/eosdis/daacs/obdaac

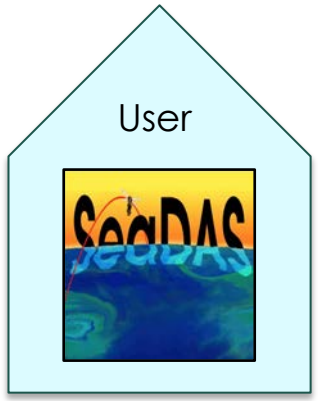
Ocean Color Website:
A direct link to OBPG web site*
https://oceancolor.gsfc.nasa.gov

SeaDAS Website:
A direct link to the SeaDAS web site*
https://seadas.gsfc.nasa.gov

YouTube:
More SeaDAS tutorials planned
https://www.youtube.com/@NASAOceanColor

* Website URL subject to change in future



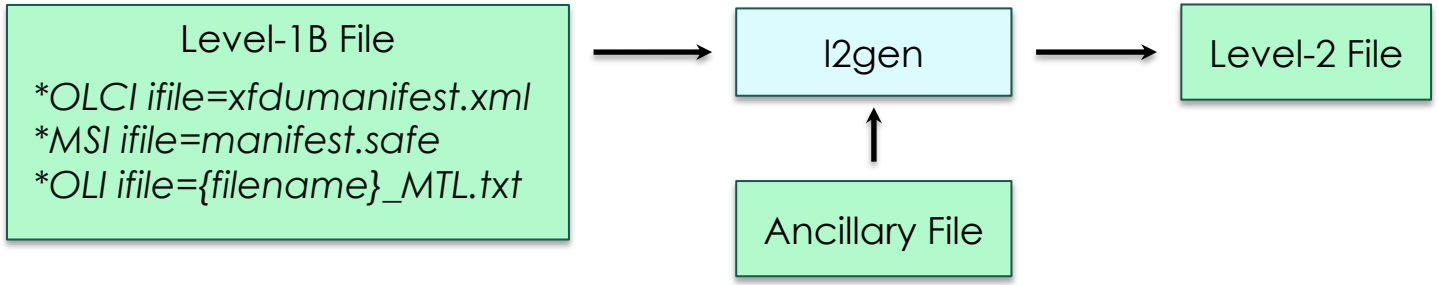


SeaDAS Workflow: OLCIS3B

Source File:

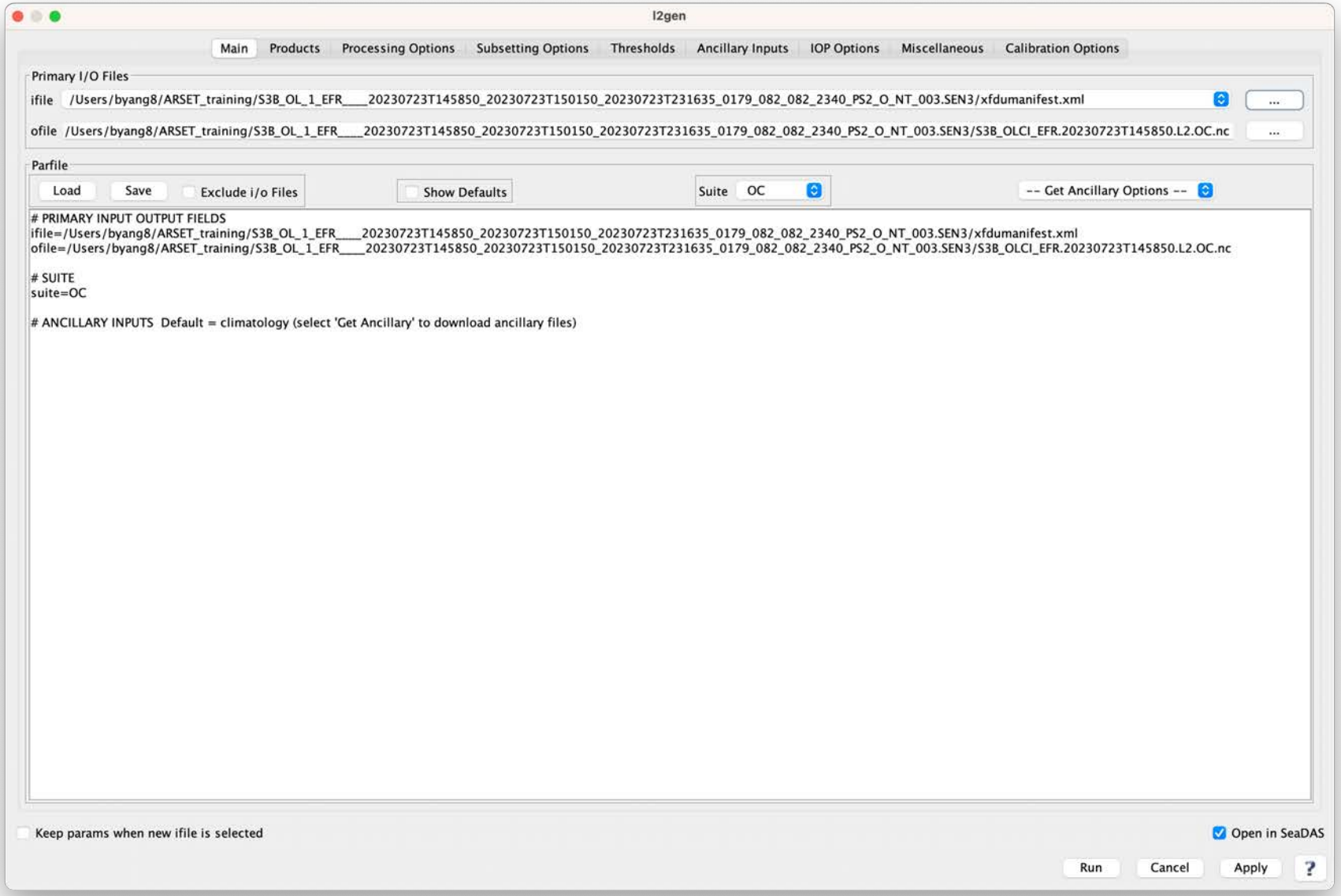
S3B_OL_1_EFR____20230723T145850_20230723T150150_20230723T231635_0179_082_082_2340_PS2_O_NT_003.SEN3/xfdumanifest.xml

SeaDAS Demo: Workflow 1

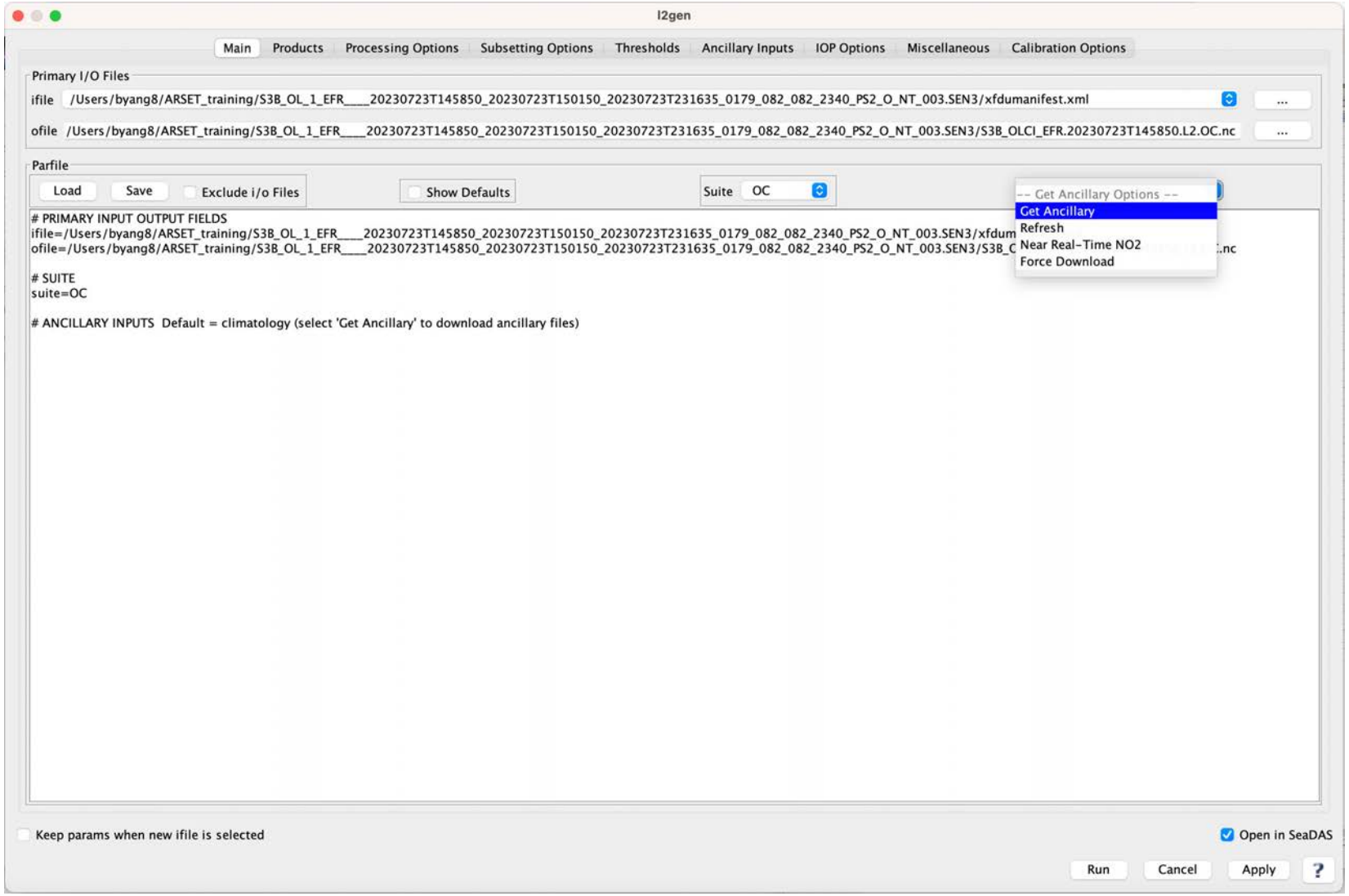


* Input files contained in directory with Level-1B file

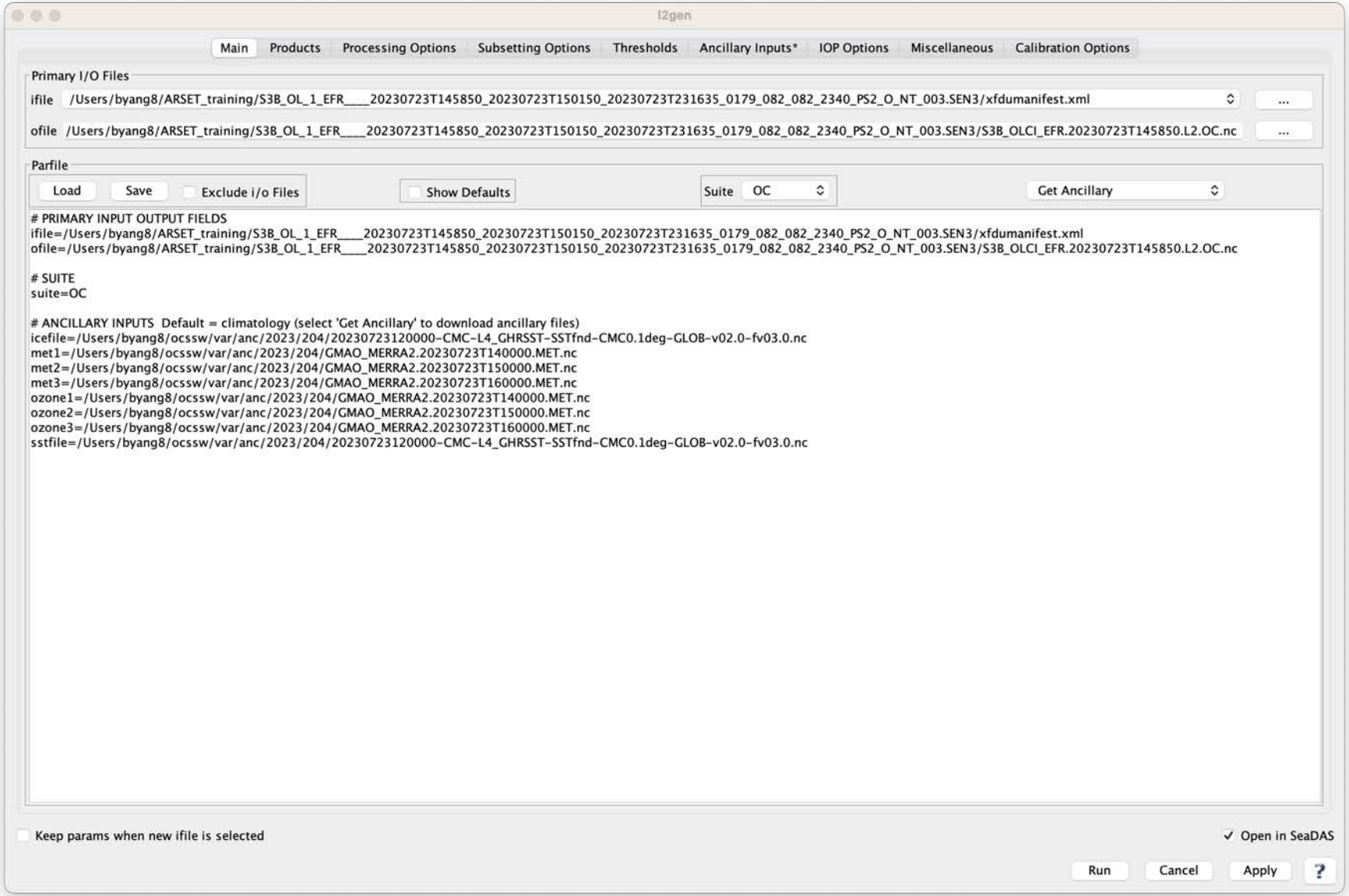
Workflow 1: Create OLCI S3B L2 File (Select "ifile")



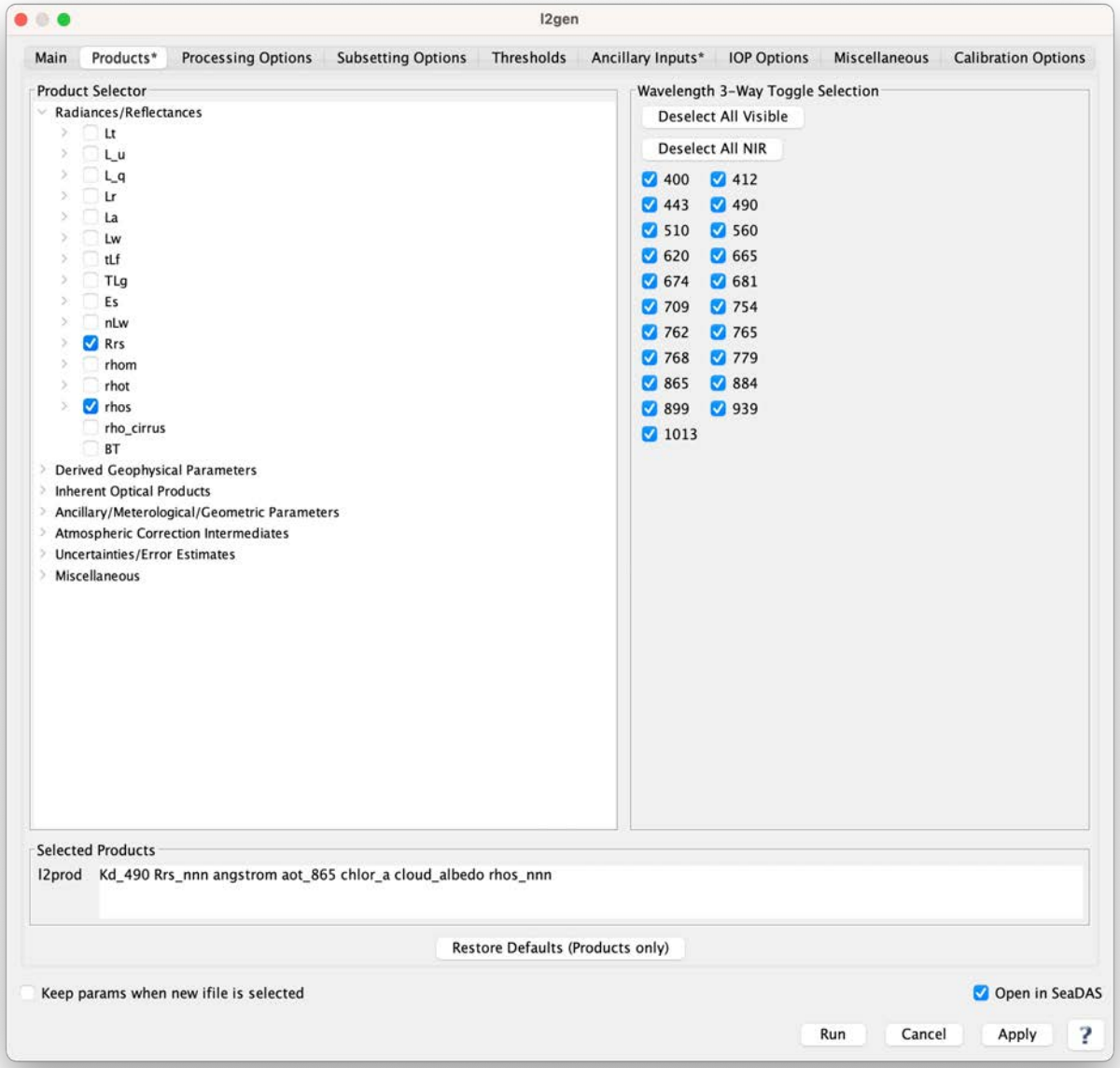
Workflow 1: Create OLCI S3B L2 File (Select "Get Ancillary")



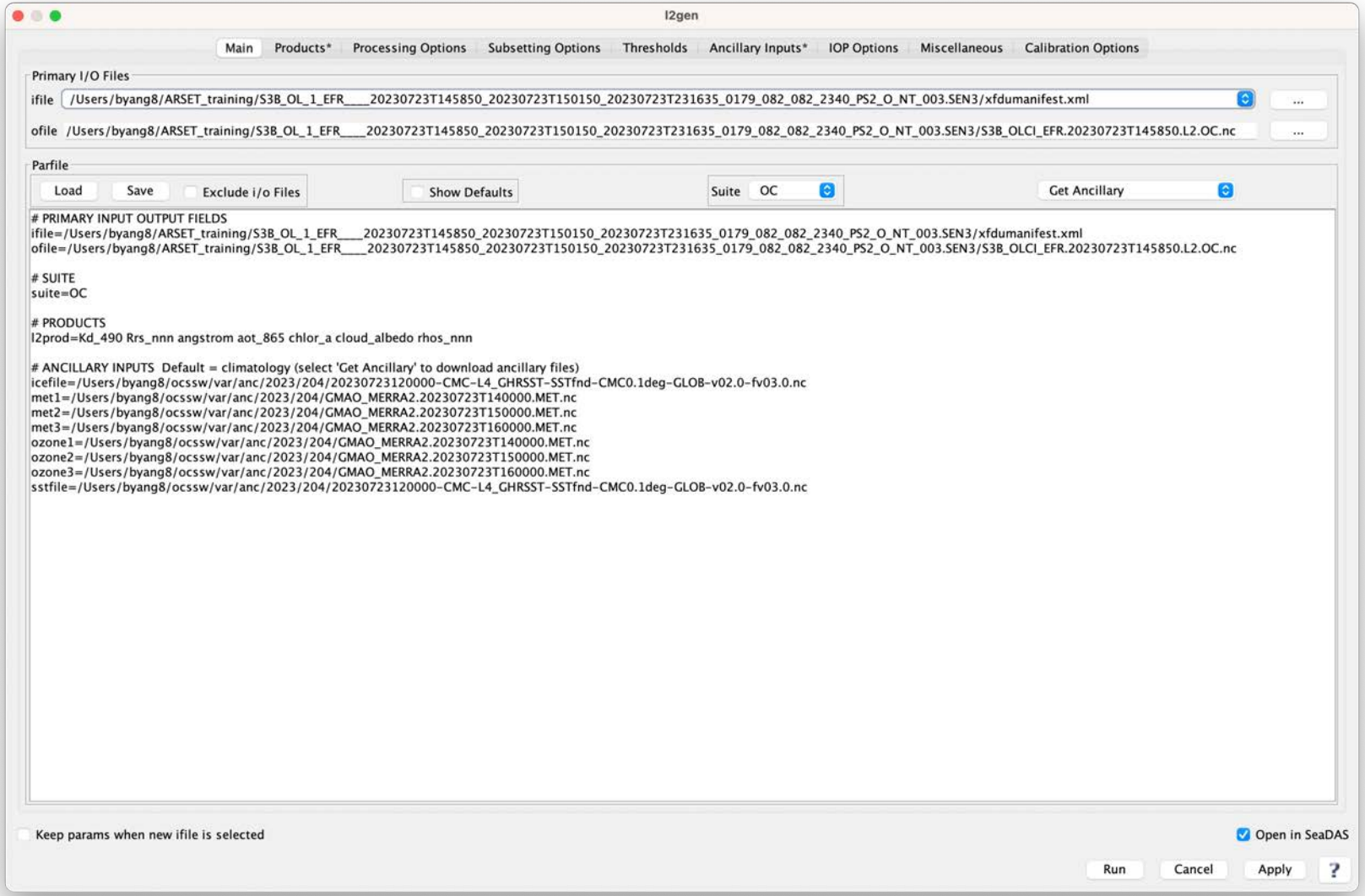
Workflow 1: Create OLCI S3B L2 File (Ancillary files have been loaded)



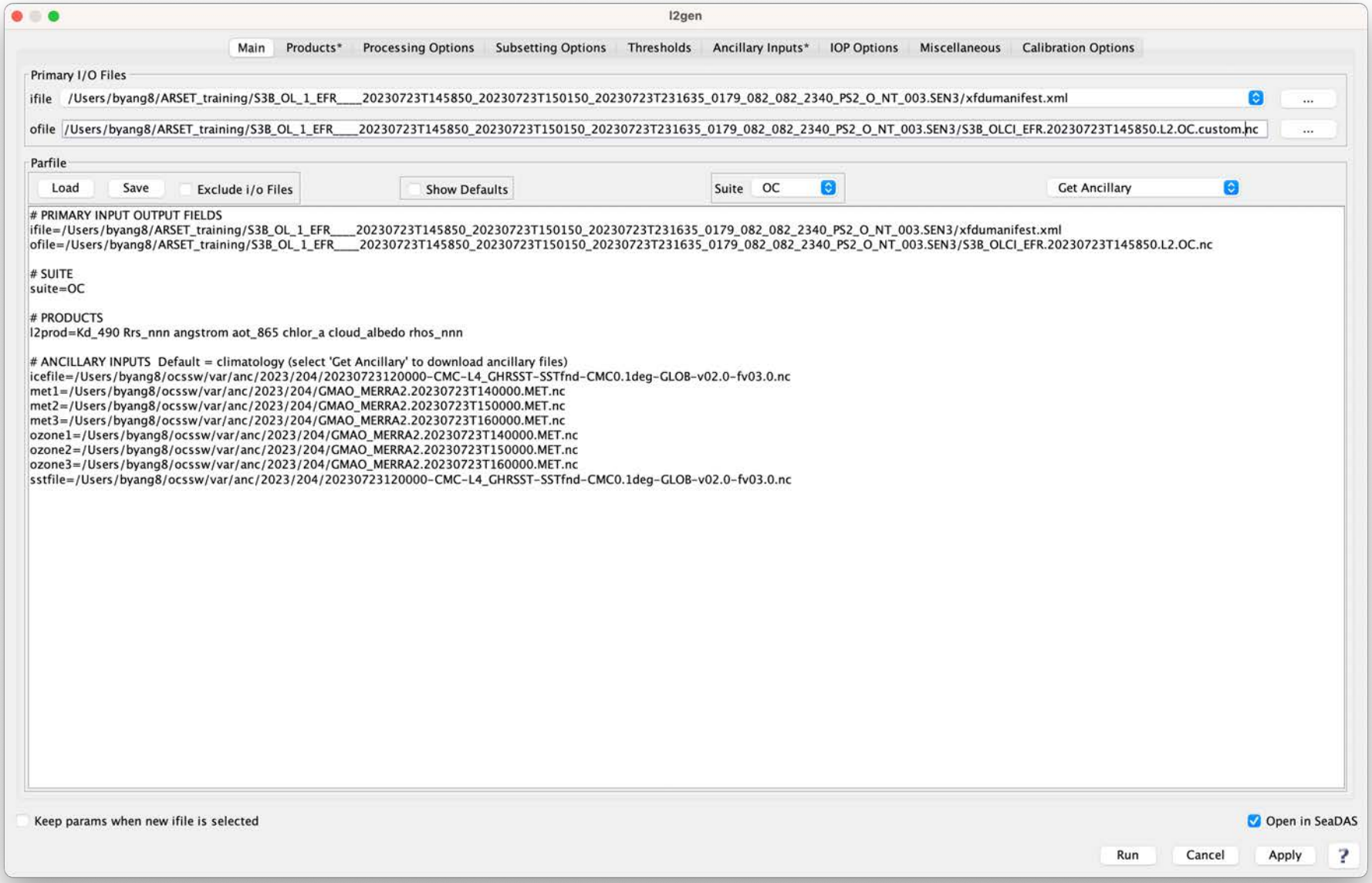
Workflow 1: Create OLCI S3B L2 File (Select some more products)



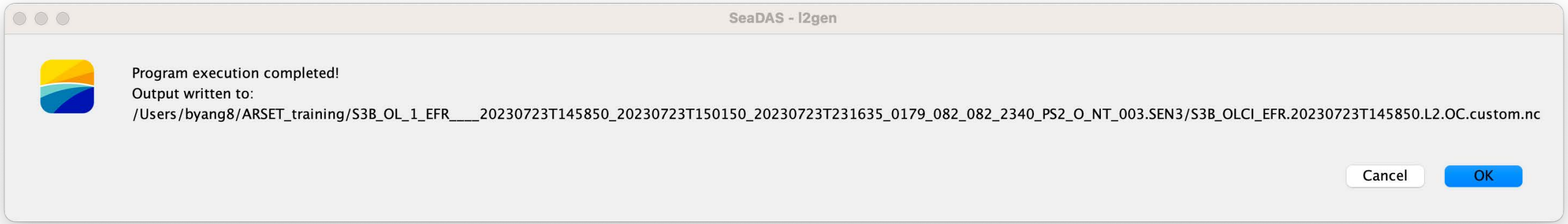
Workflow 1: Create OLCI S3B L2 File (Parameter "l2prod" has been updated)



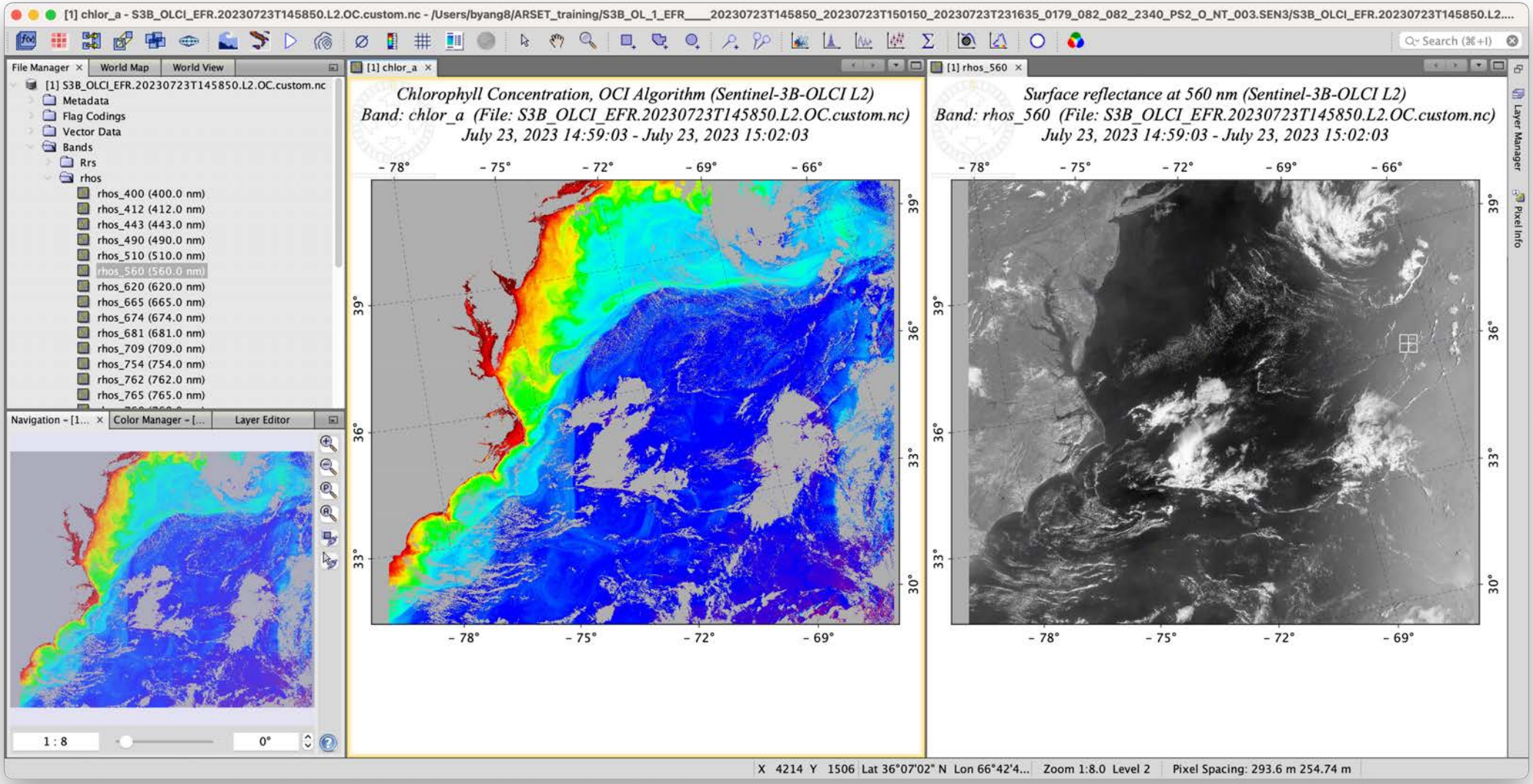
Workflow 1: Create OLCI S3B L2 File (Rename "ofile" and click "Run")



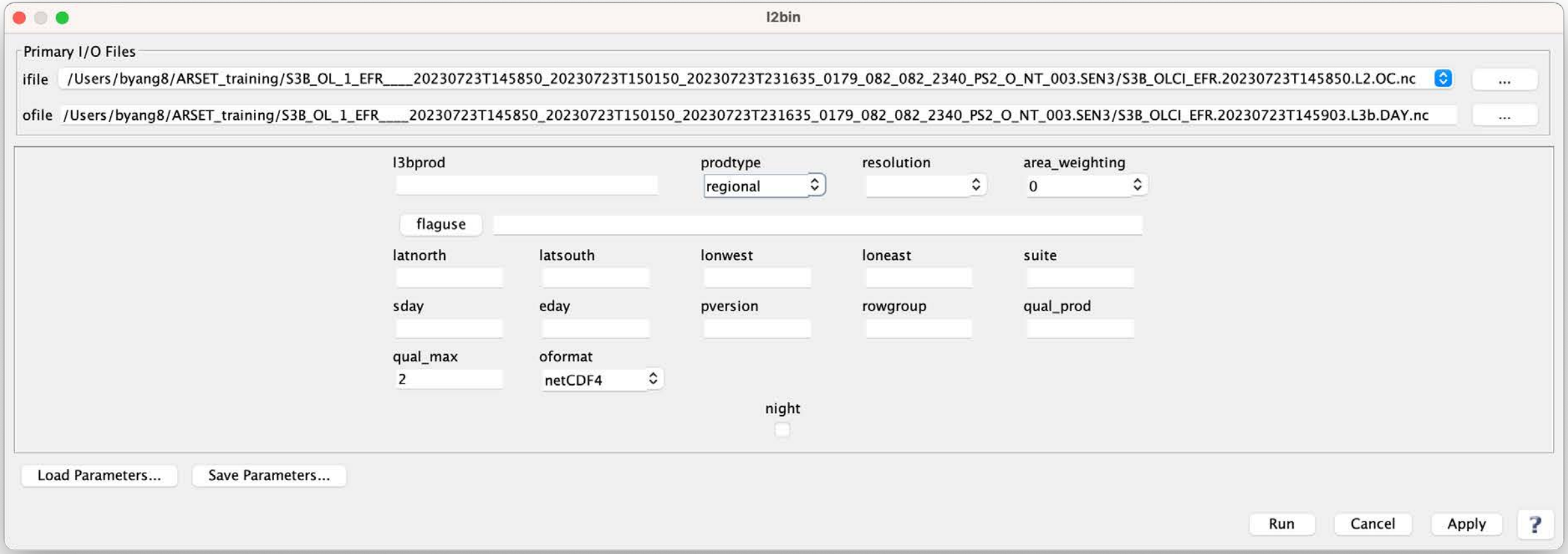
Workflow 1: Create OLCI S3B L2 File (Results Message)



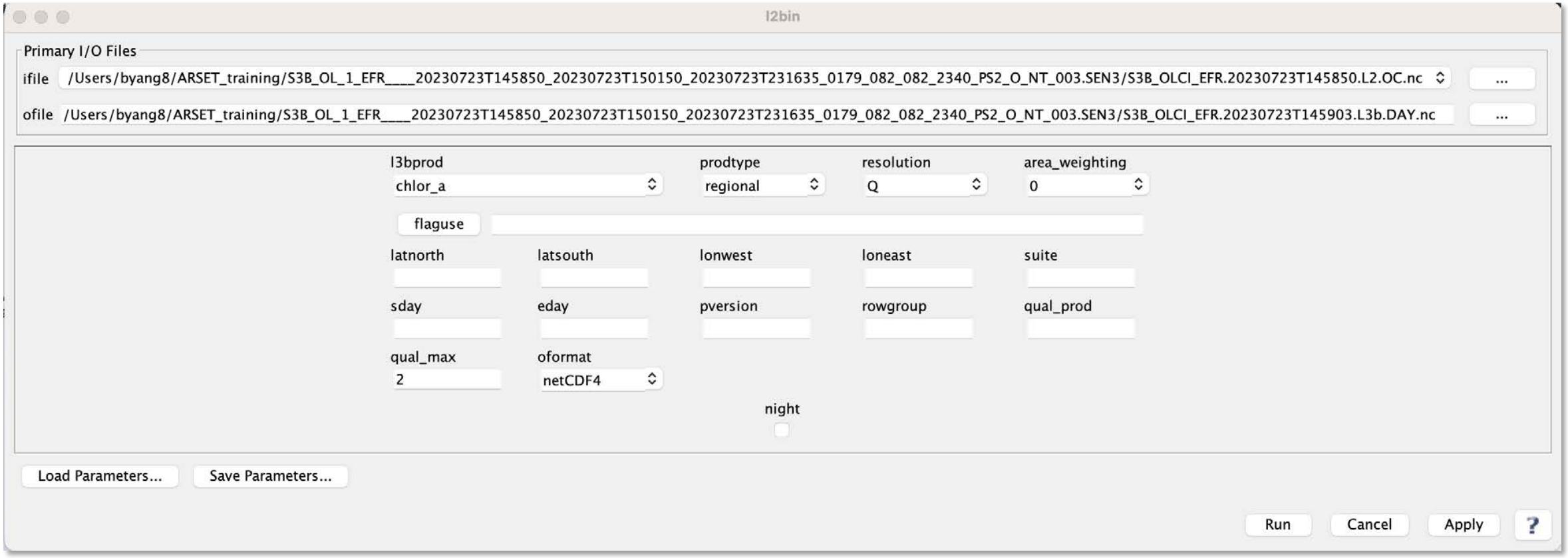
Workflow 1: View the Created OLCI S3B L2 File



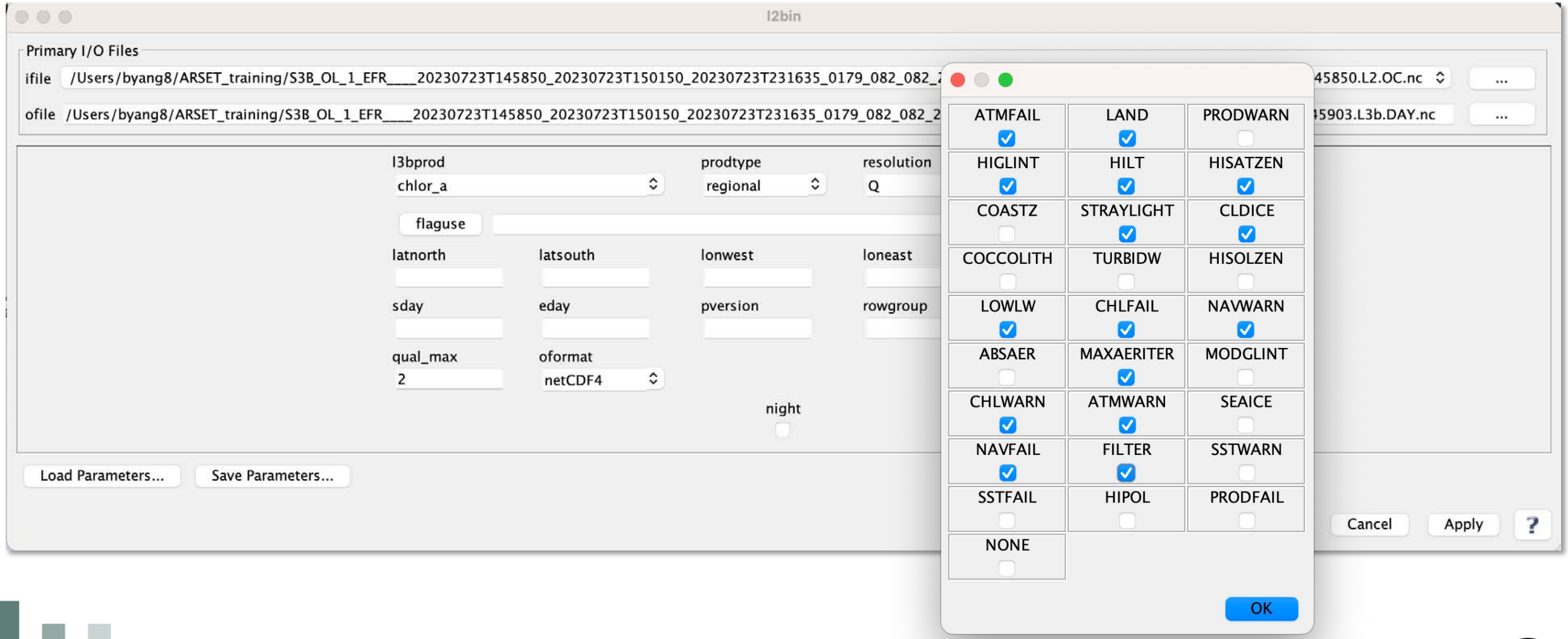
Workflow 1: Create L3 Binned File (Select "ifile")



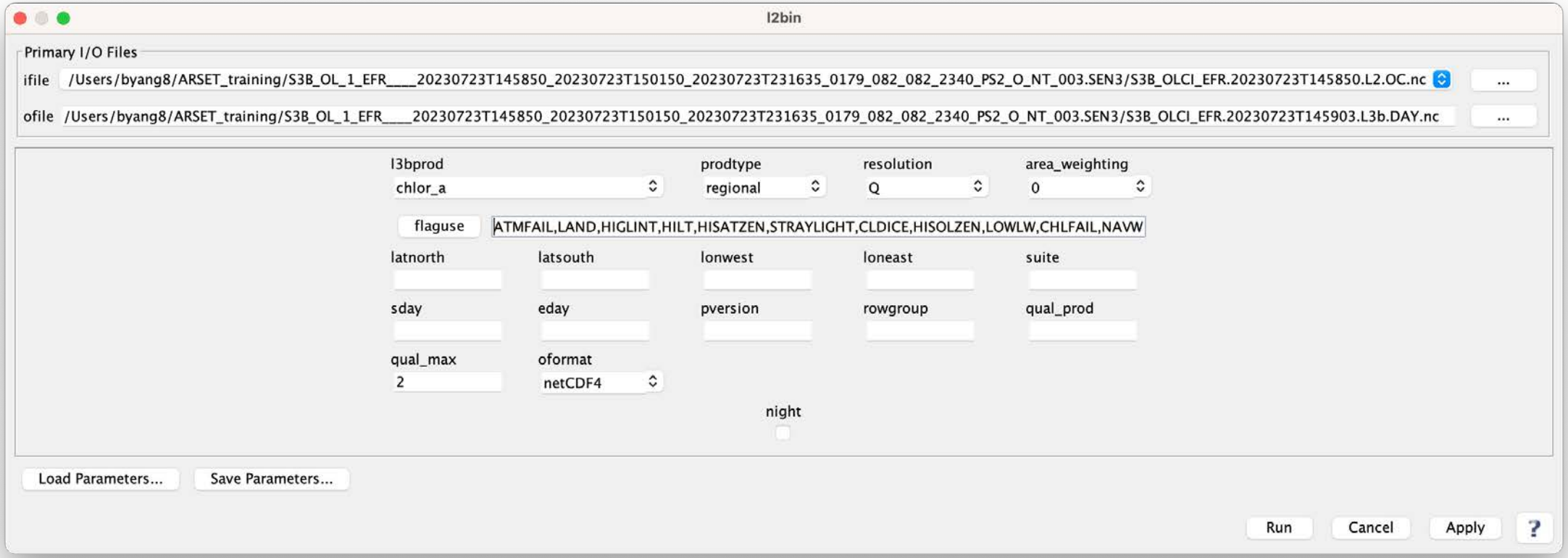
Workflow 1: Create L3 Binned File (Select "l3bprod", "prodtype", and "resolution")



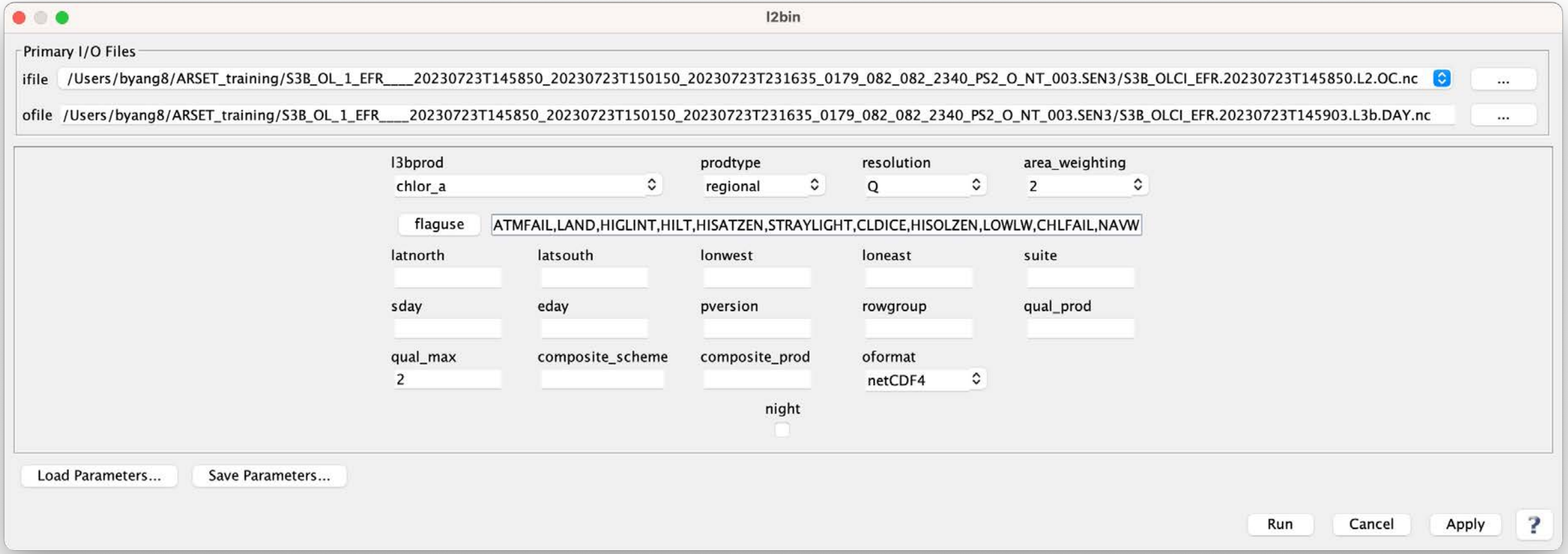
Workflow 1: Create L3 Binned File (Click "flaguse" and specify any desired flags)



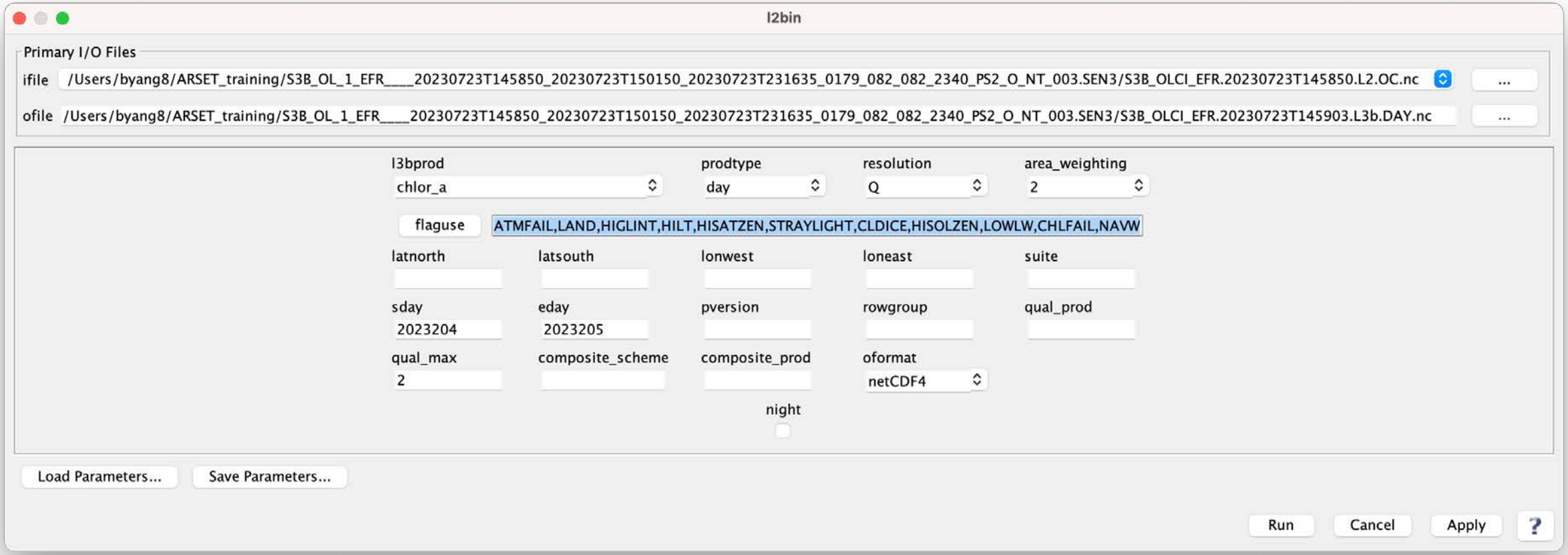
Workflow 1: Create L3 Binned File ("flaguse" has been updated)



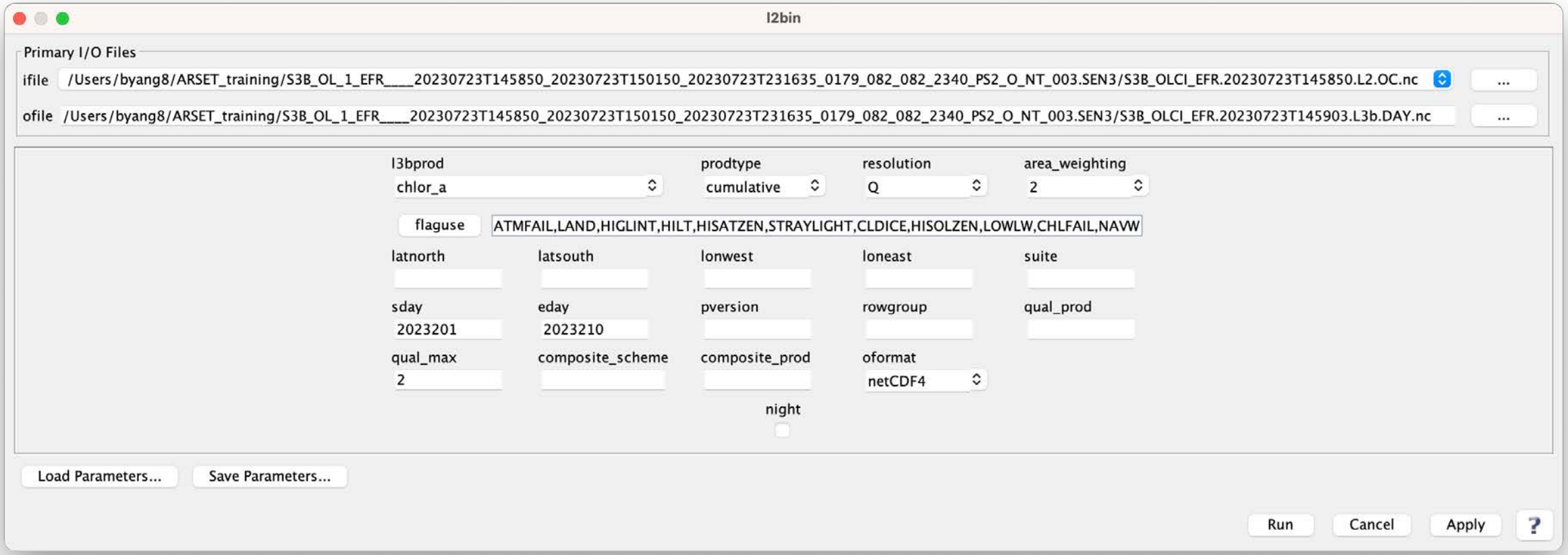
Workflow 1: Create L3 Binned File (…or select area_weighting)



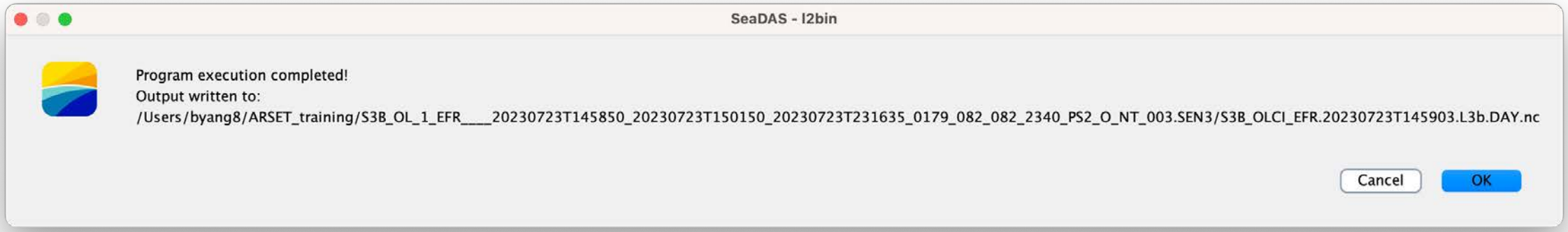
Workflow 1: Create L3 Binned File (…or select "day" temporal range)



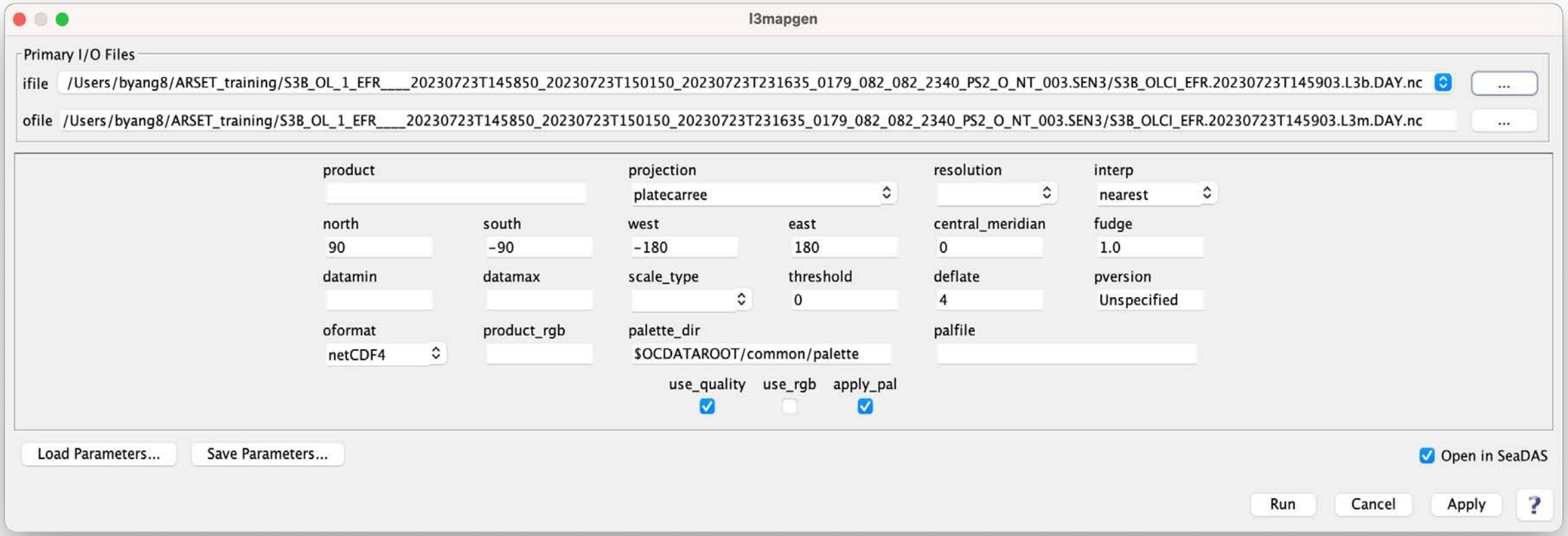
Workflow 1: Create L3 Binned File (…or select custom temporal range and click "Run")



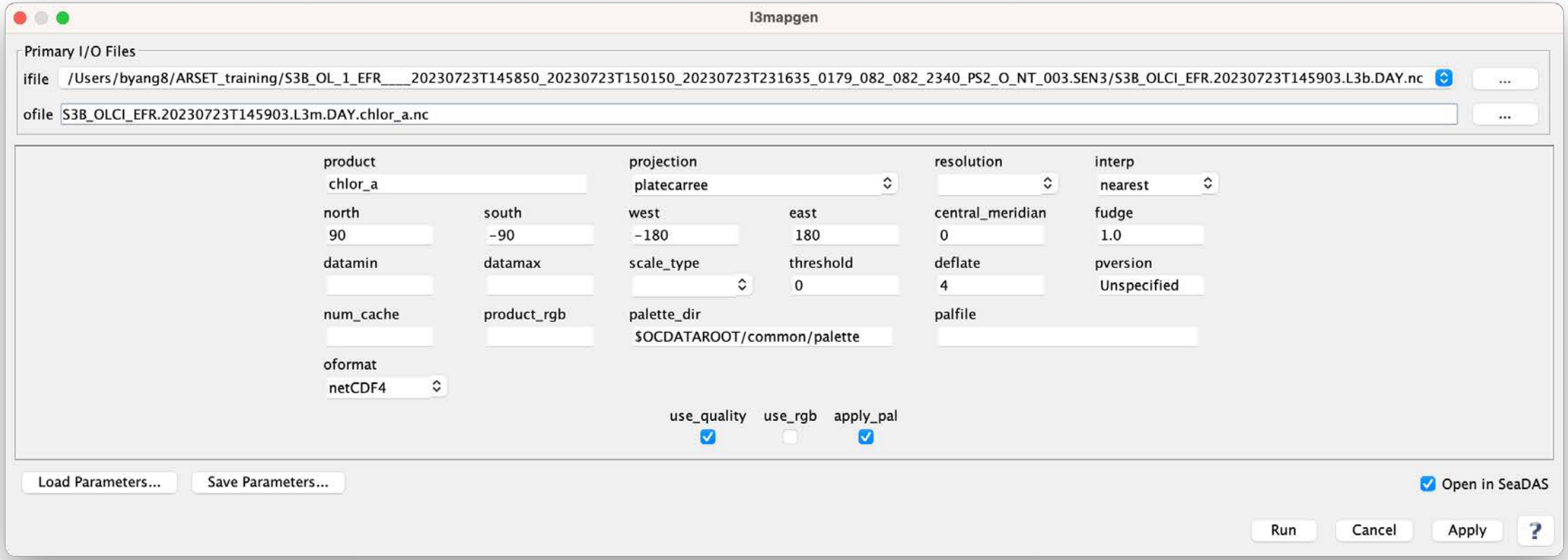
Workflow 1: Create L3 Binned File (Results Message)



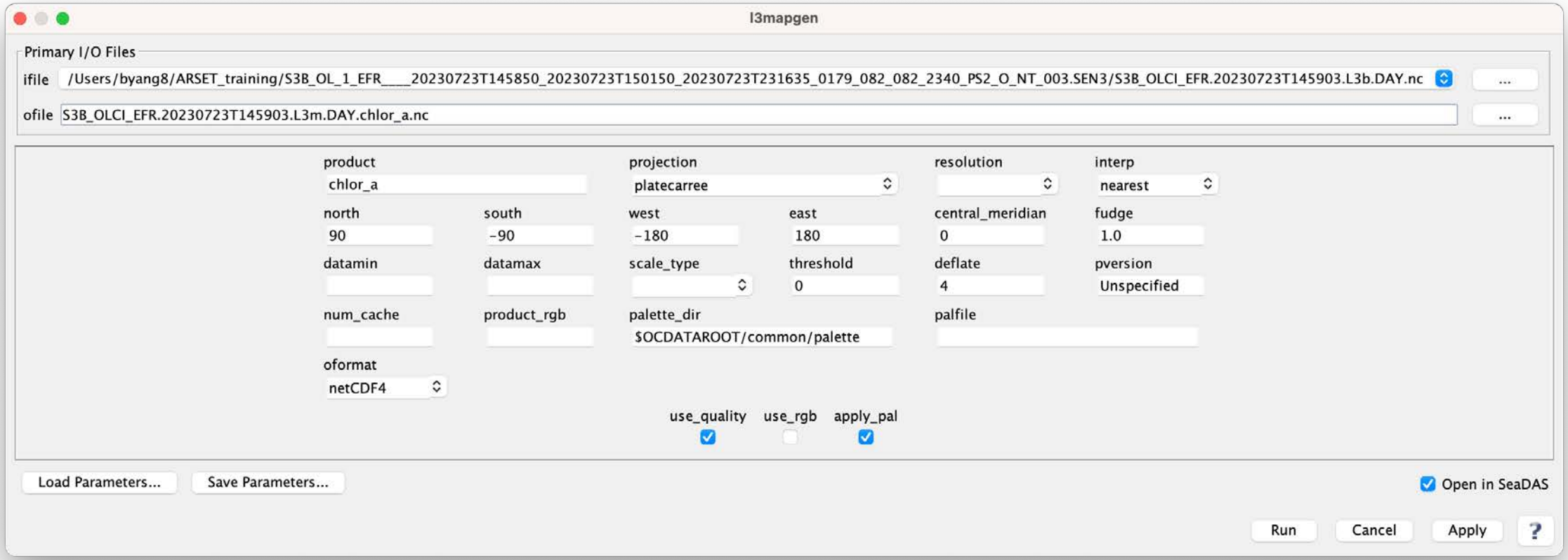
Workflow 1: Create L3 Mapped File (Select "ifile")



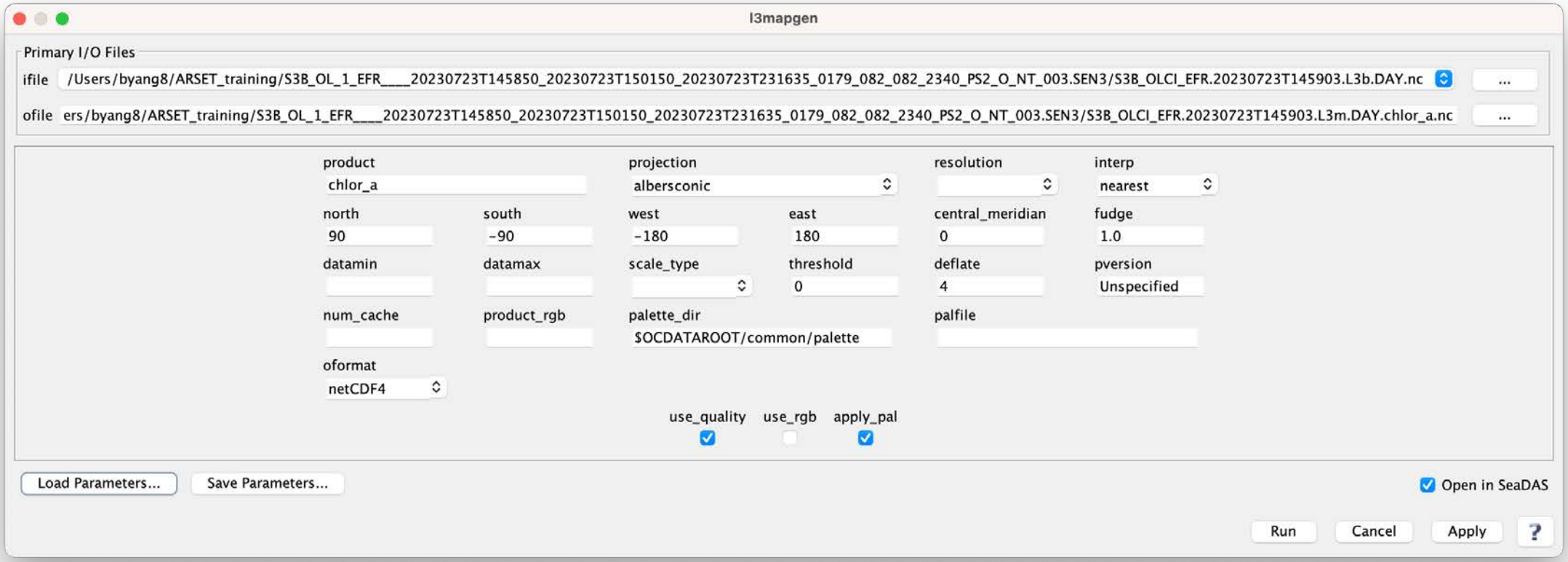
Workflow 1: Create L3 Mapped File (Specify "chlor_a" product – or it can be a product list)



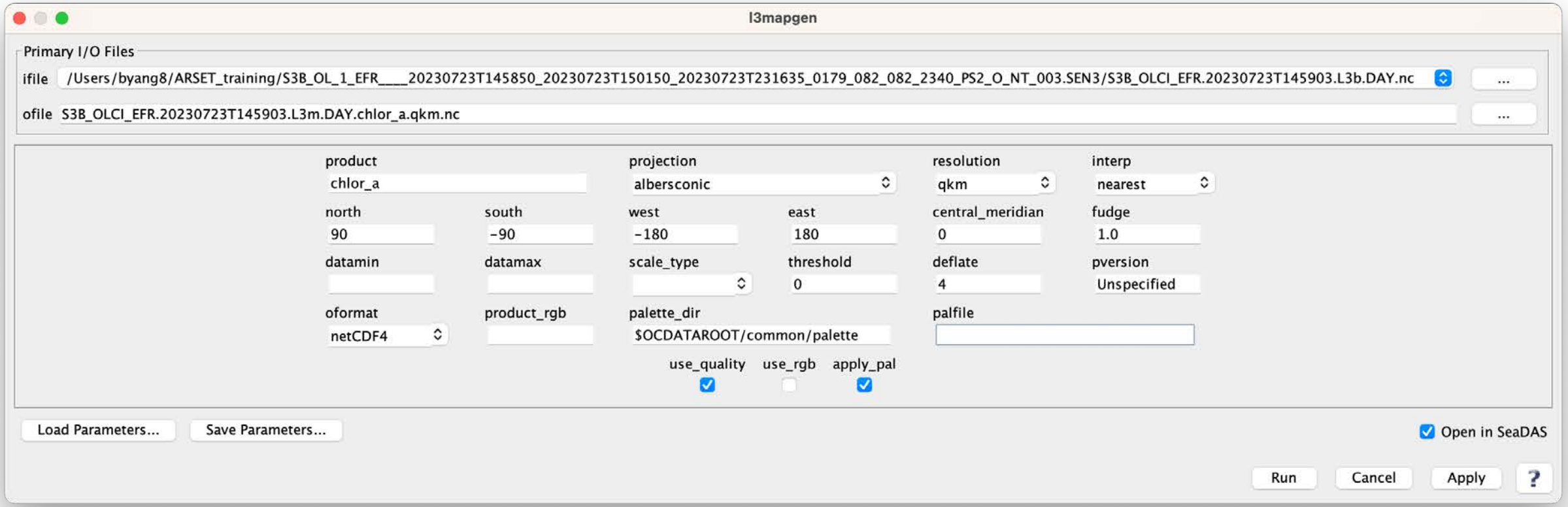
Workflow 1: Create L3 Mapped File (Specify Projection – "platecarree" is common for visualization)



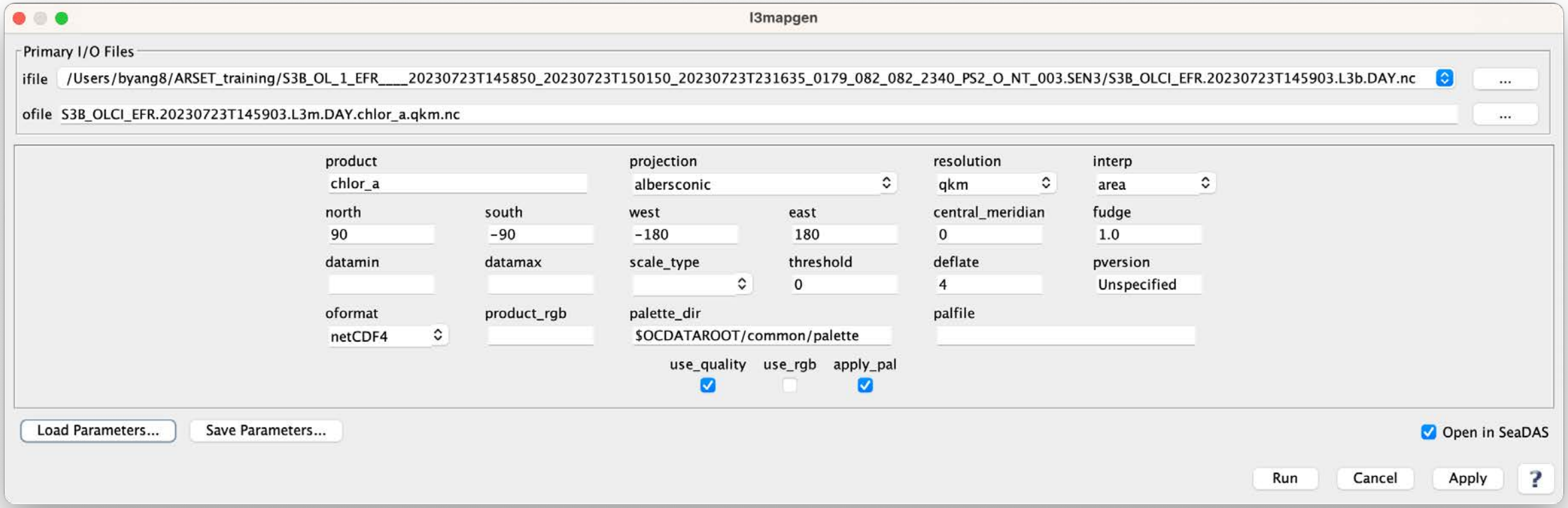
Workflow 1: Create L3 Mapped File (Specify Projection – or perhaps "albersconic" for statistics)



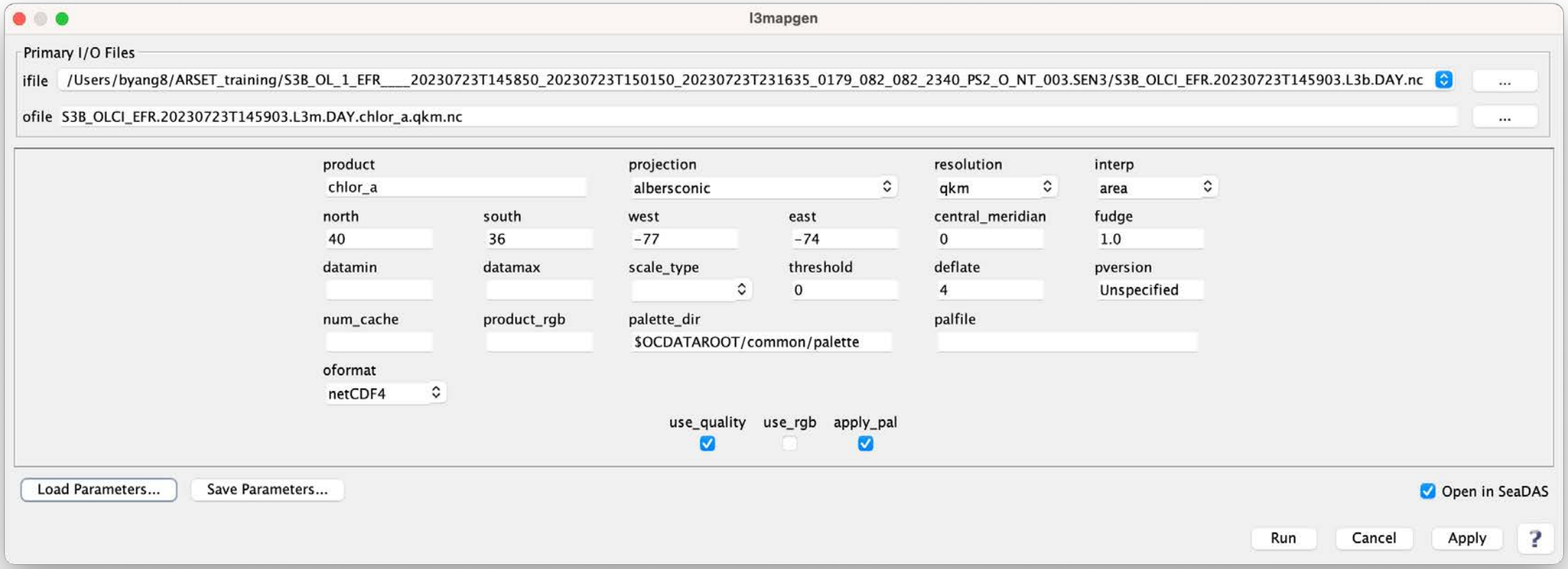
Workflow 1: Create L3 Mapped File (Specific Resolution – Perhaps comparable with bin resolution)



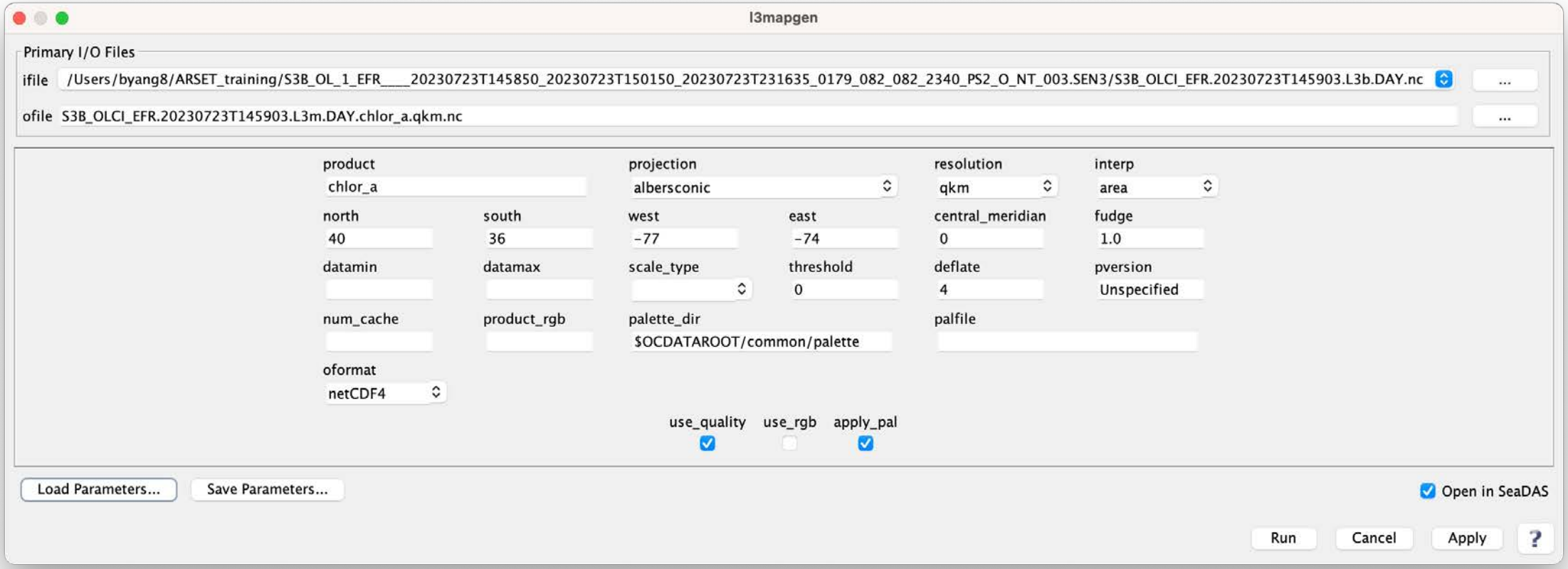
Workflow 1: Create L3 Mapped File (Select interp="area" to help counteract some missing bins)



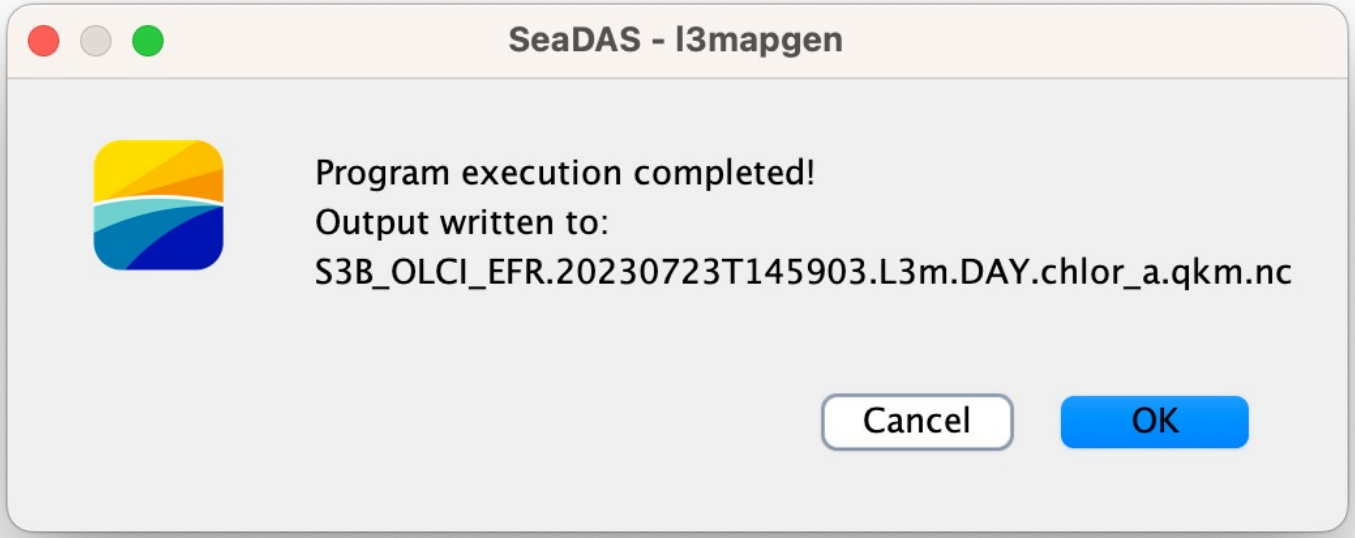
Workflow 1: Create L3 Mapped File (Select Desired Region – Otherwise scene has default boundaries)



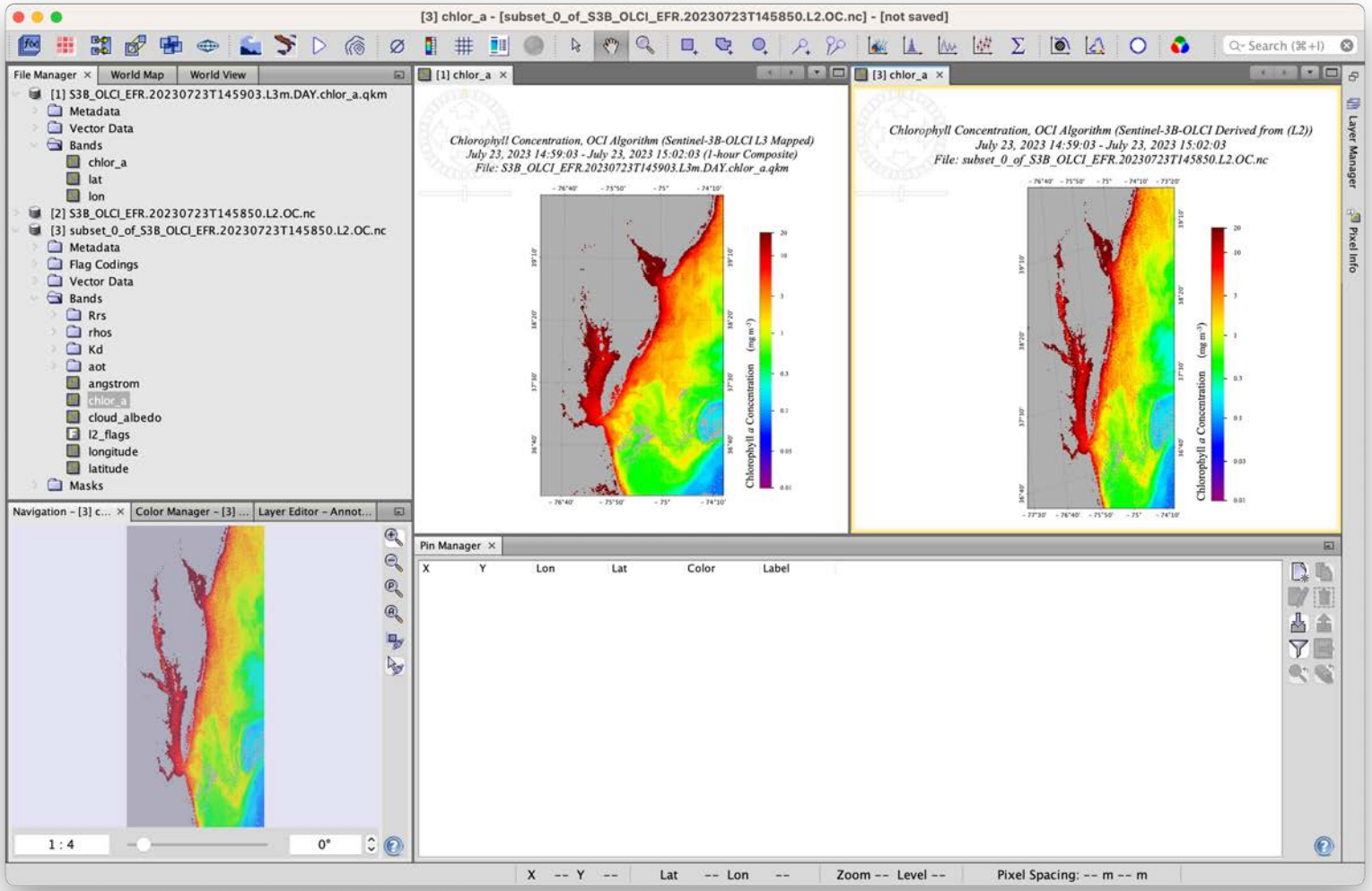
Workflow 1: Create L3 Mapped File (Click "Run")



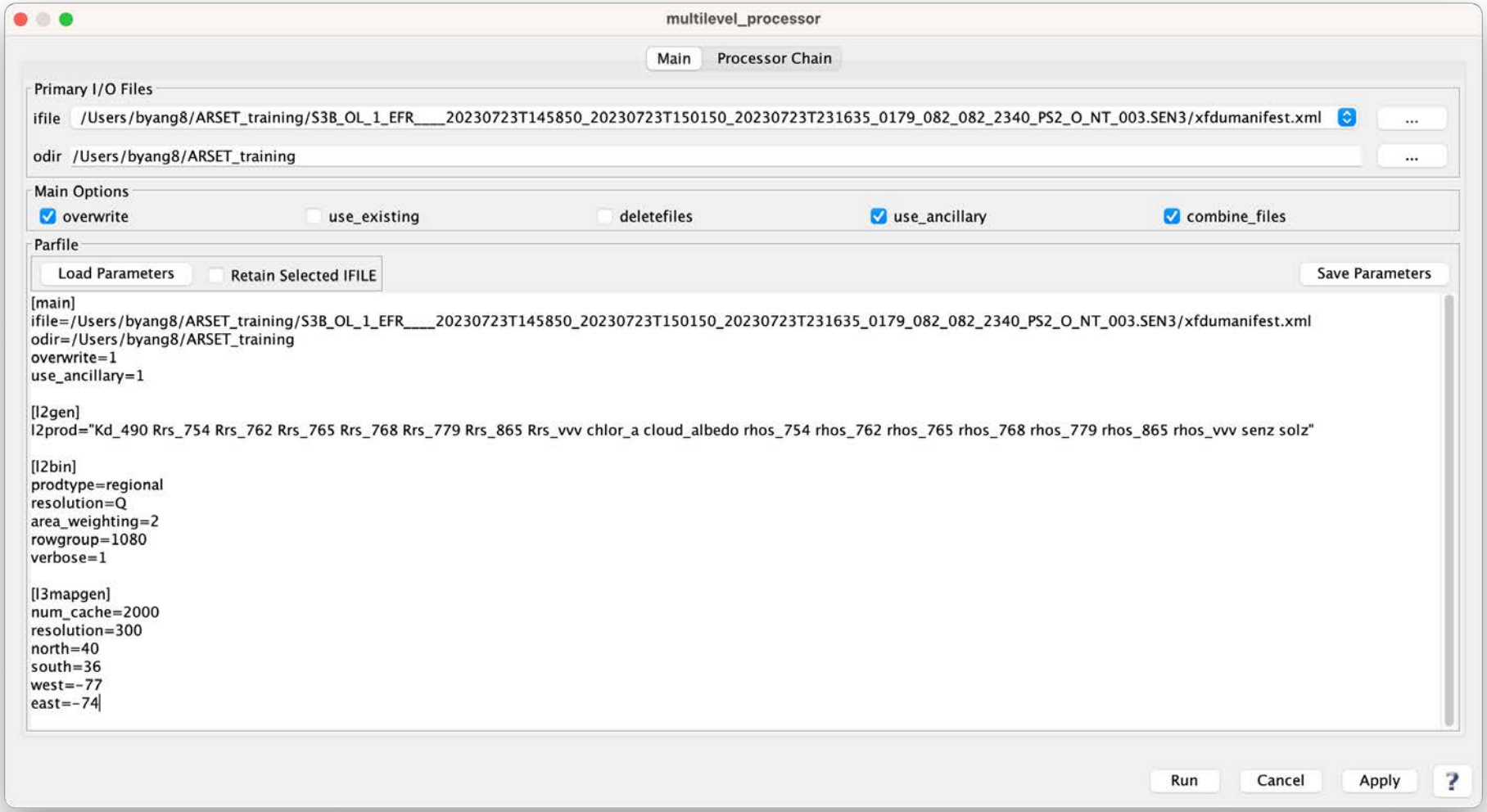
Workflow 1: Create L3 Mapped File (Results Message)



Workflow 1: View L3 Mapped File alongside L2 File



Workflow 1: multilevel_processor (smi – platecarree)



Workflow 1: View L3 Mapped File