

Ocean color satellite data processing lab ...

Data discovery & acquisition

Satellites 101

- Options
- Processing flow (levels)

Hands-on data processing

- GUI and command line
- Sensitivity studies (e.g., inversion model parameterization)

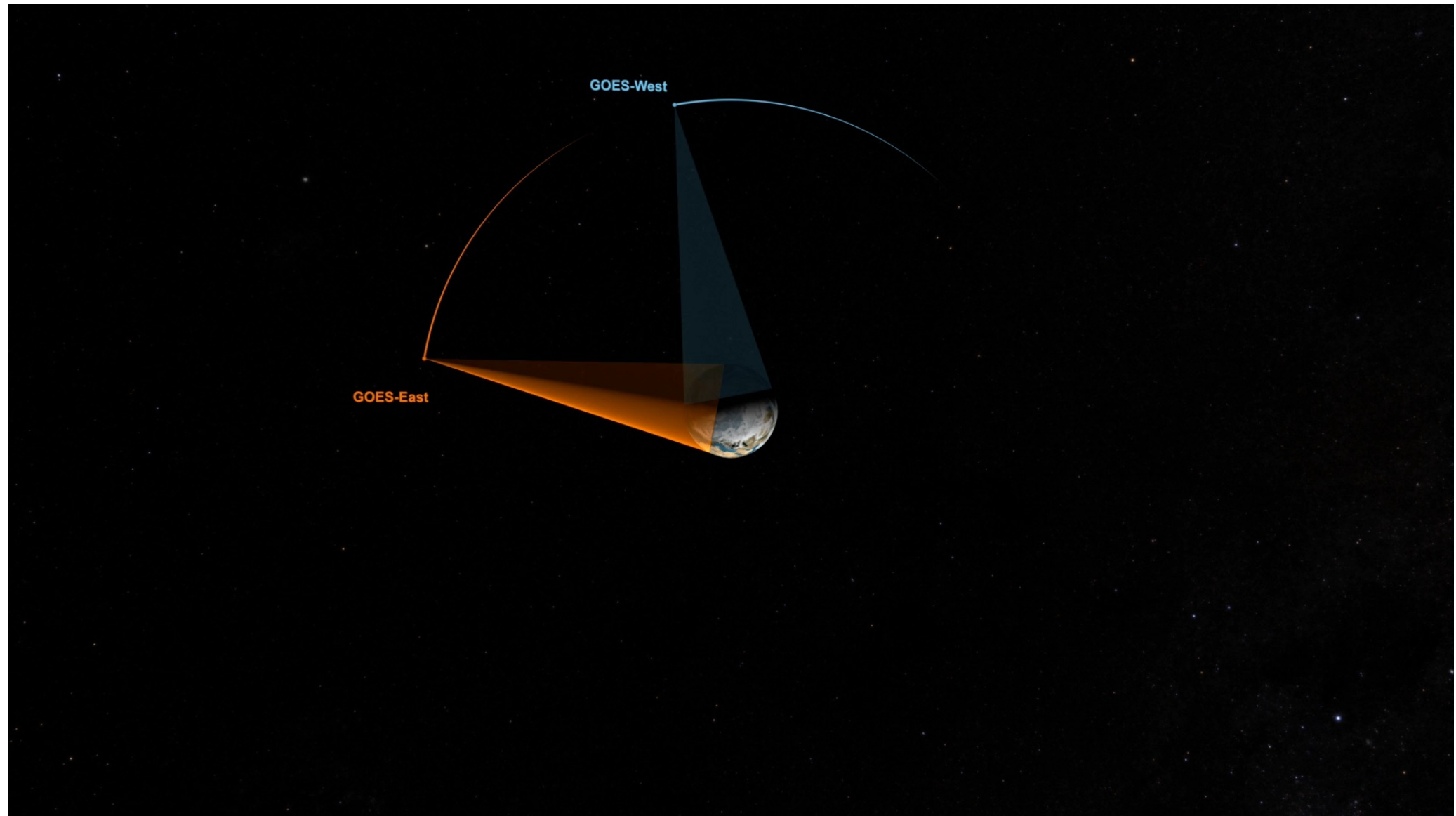
Medium res, high res

Anything you want to discuss

GEO (geostationary) vs. LEO (polar, low earth orbit)

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35,786 km altitude ↓



GEO (geostationary) vs. LEO (polar, low earth orbit)

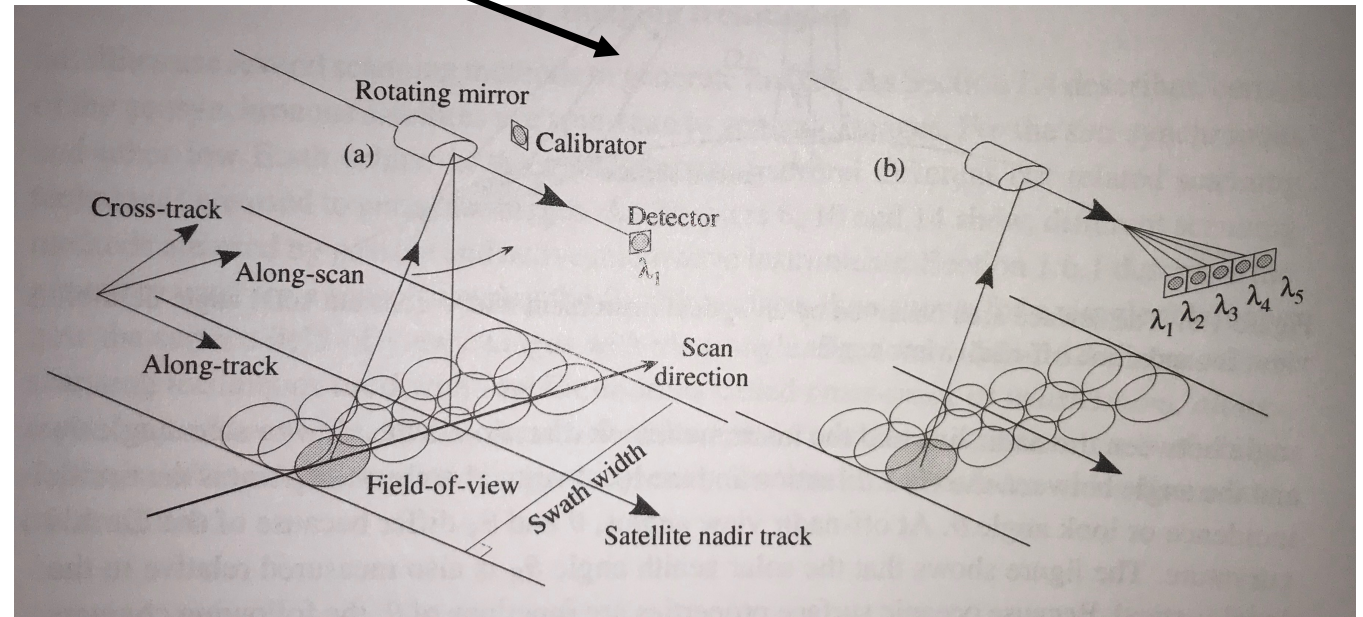
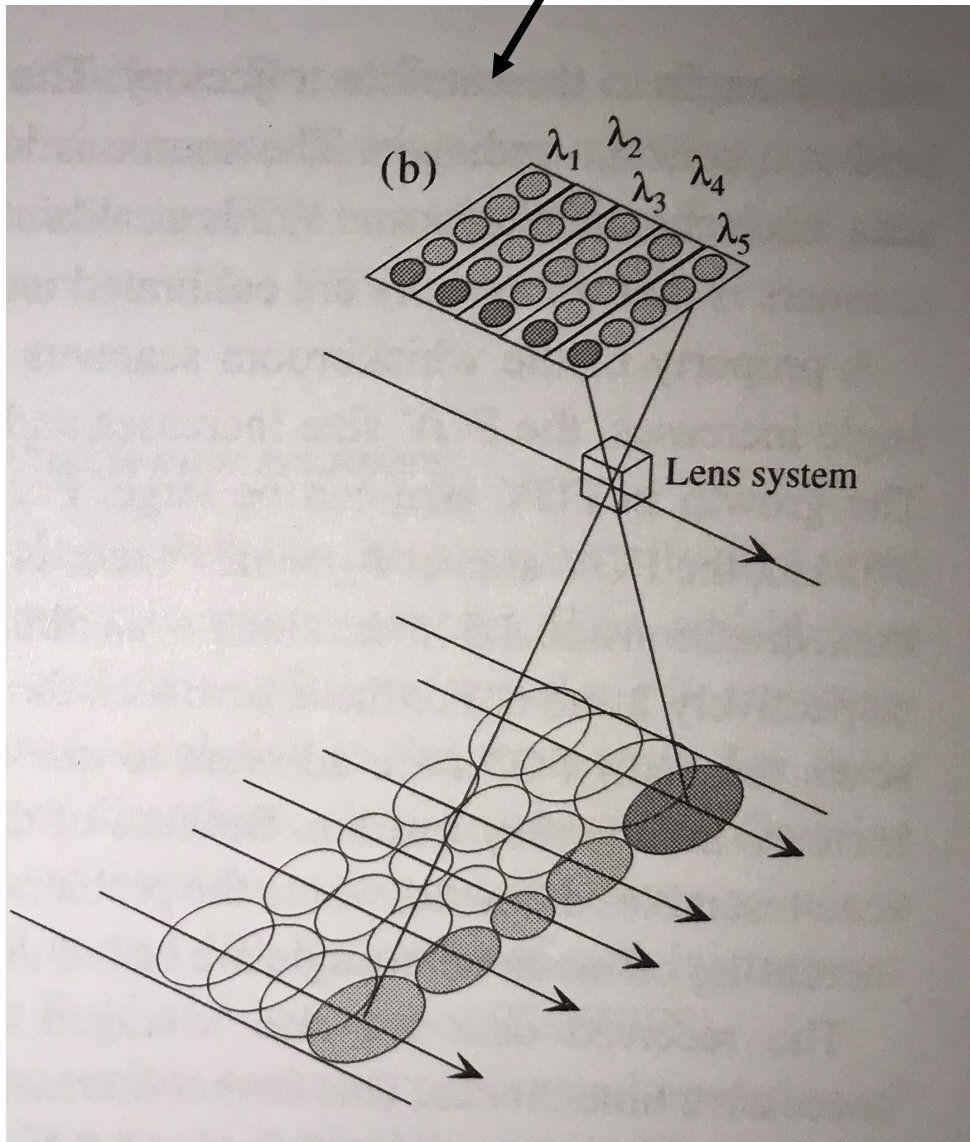
35,786 km altitude



400-700 km altitude

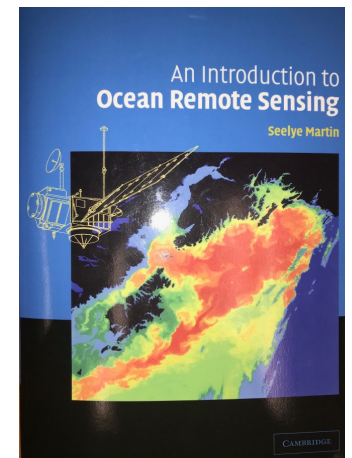


pushbroom vs. whiskbroom (scanner)

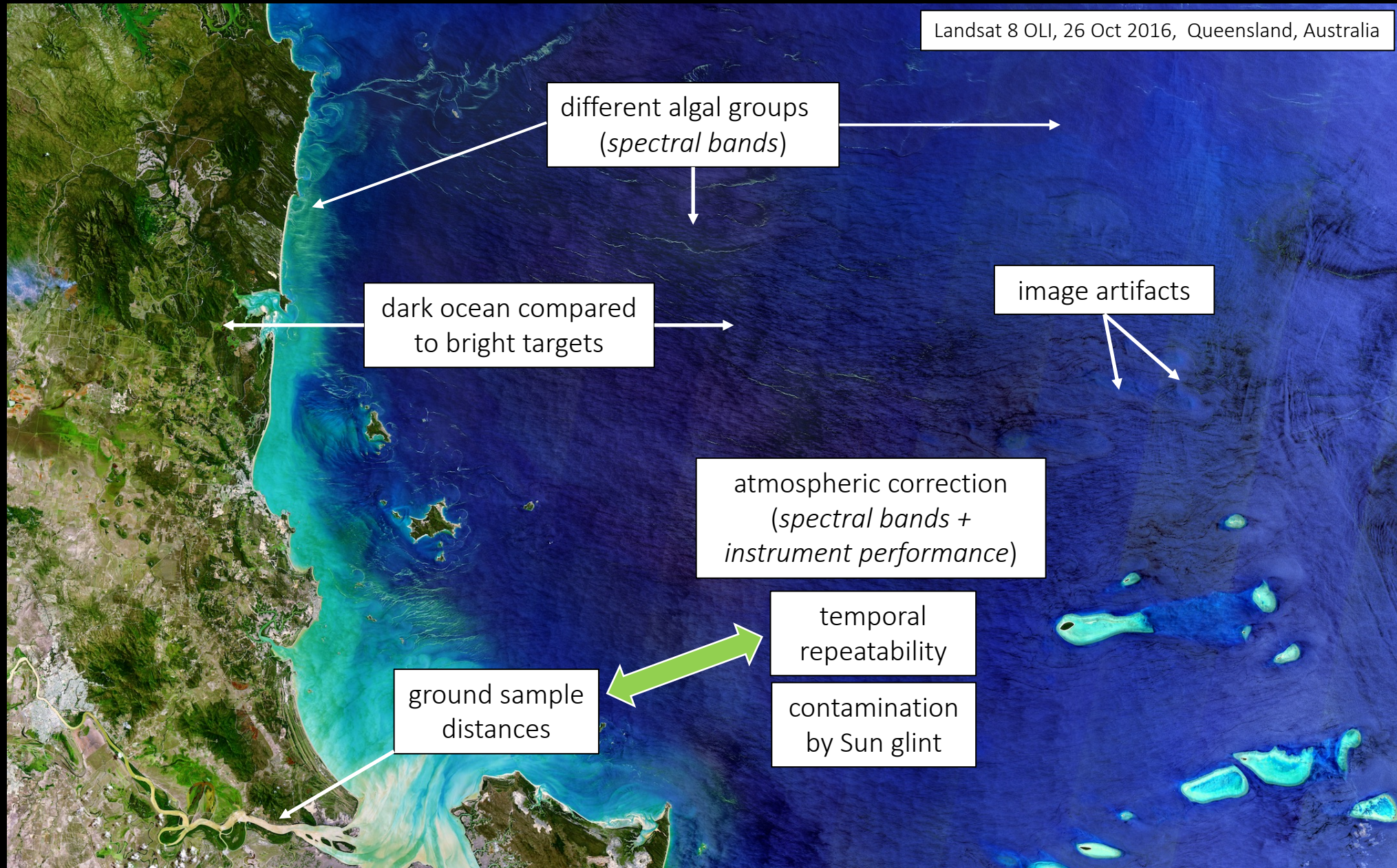


HICO
Landsat 8 OLI
MERIS
OLCI

SeaWiFS
MODIS
VIIRS
PACE OCI



different instruments & missions offer different capabilities



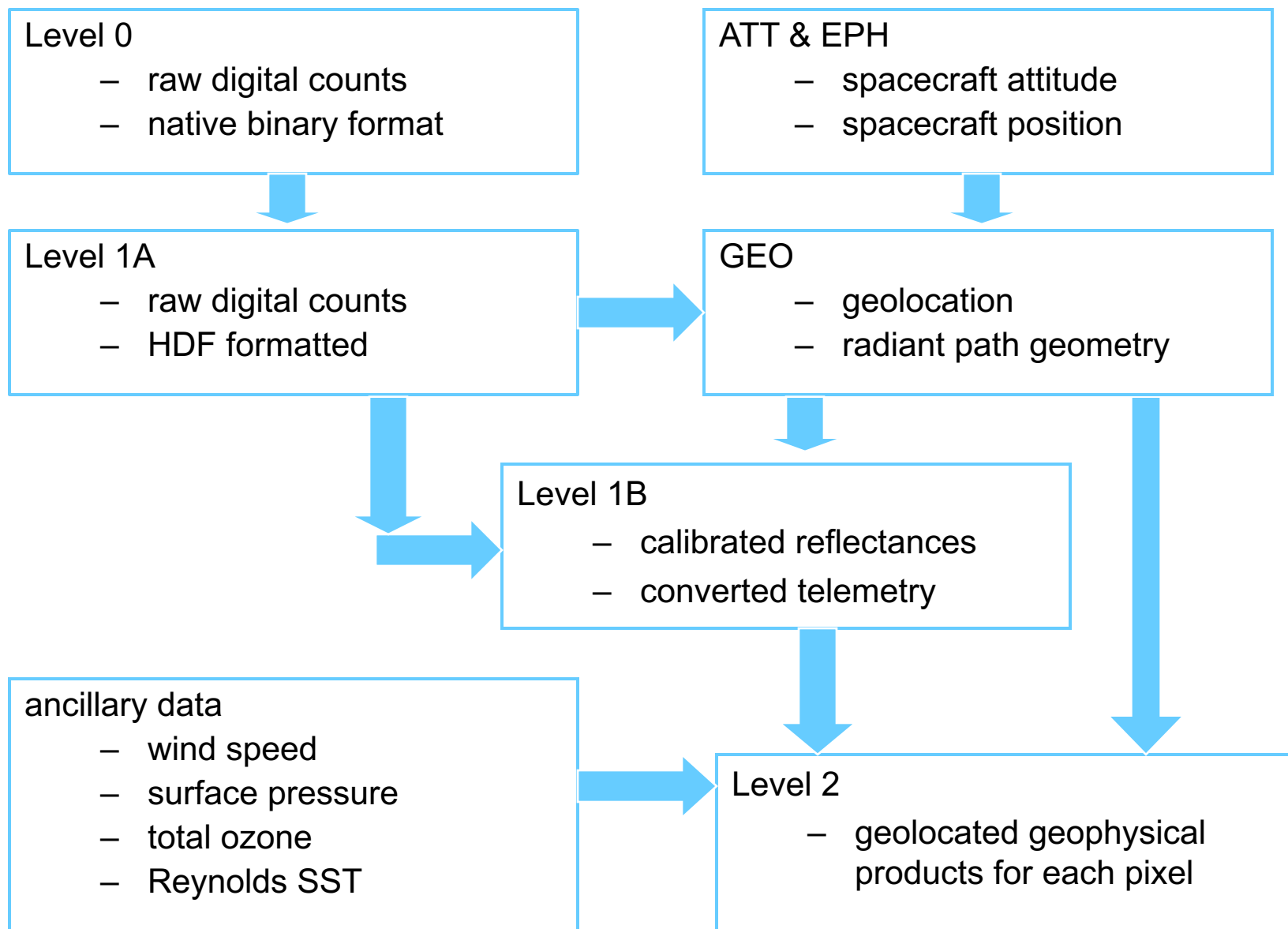
current & future missions – it's a consumer's market



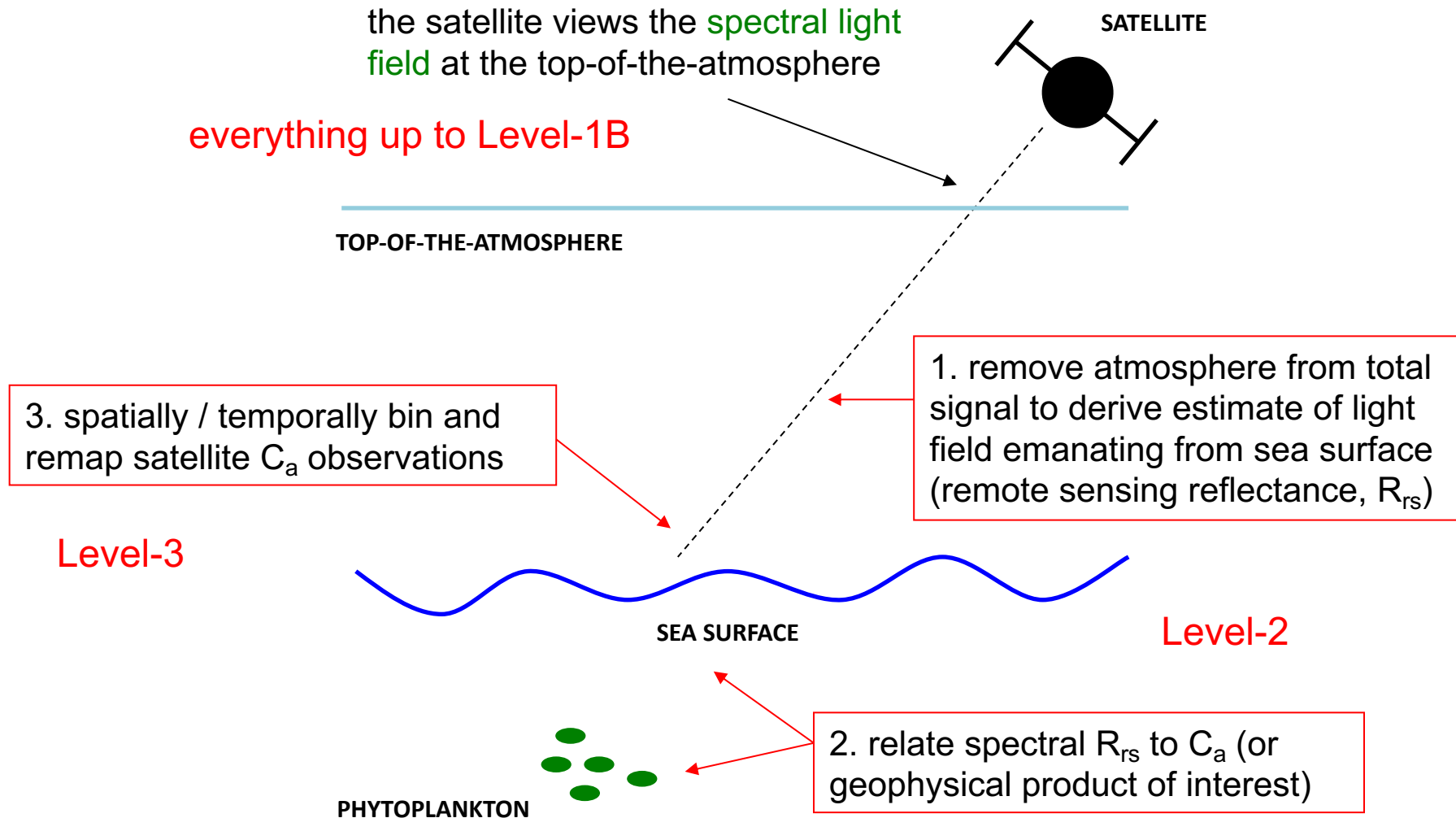
SENSOR / DATA LINK	AGENCY	SATELLITE	LAUNCH DATE	SWATH (KM)	SPATIAL RESOLUTION (M)	BANDS	SPECTRAL COVERAGE (NM)	SPECTRAL RESPONSE FUNCTION	EQUATORIAL CROSSING TIME
COCTS CZI	NSOAS/CAST (China)	HY-1D	11 June 2020	3000 950	1100 50	10 4	402 - 12,500 433 - 885		13:30
COCTS CZI	NSOAS/CAST (China)	HY-1C	7 September 2018	3000 950	1100 50	10 4	402 - 12,500 433 - 885		10:30
GOCHI-Geostationary	KARI/KIOST (South Korea)	GeoKompsat-2B	18 February 2020	2500 x 2500	250	13	380 - 900	SRF-link	10 times/day
MODIS-Aqua	NASA (USA)	Aqua (EOS-PM1)	4 May 2002	2330	250/500/1000	36	405-14,385	SRF-link	13:30
MODIS-Terra	NASA (USA)	Terra (EOS-AM1)	18 Dec 1999	2330	250/500/1000	36	405-14,385	SRF-link	10:30
MSI	ESA	Sentinel-2A	23 June 2015	290	10/20/60	13	442-2202	SRF-link	10:30
MSI	ESA	Sentinel-2B	7 March 2017	290	10/20/60	13	442-2186	SRF-link	10:30
OCM-2	ISRO (India)	Oceansat-2 (India)	23 Sept 2009	1420	360/4000	8	400 - 900		12:00
OLCI	ESA/ EUMETSAT	Sentinel 3A	16 Feb 2016	1270	300/1200	21	400 - 1020	SRF-link	10:00
OLCI	ESA/ EUMETSAT	Sentinel 3B	25 April 2018	1270	300/1200	21	400 - 1020	SRF-link	10:00
SGLI	JAXA (Japan)	GCOM-C	23 Dec 2017	1150 - 1400	250/1000	19	375 - 12,500	SRF-link	10:30
VIIRS	NOAA (USA)	Suomi NPP	28 Oct 2011	3000	375 / 750	22	402 - 11,800	SRF-link	13:30
VIIRS	NOAA/NASA (USA)	JPSS-1/NOAA-20	18 Nov 2017	3000	370 / 740	22	402 - 11,800	SRF-link	13:30

SATELLITE	AGENCY	SENSOR / DATA LINK	LAUNCH DATE	SWATH (KM)	SPATIAL RESOLUTION (M)	# OF BANDS	SPECTRAL COVERAGE (NM)	ORBIT
HY-1E/F (China)	CNSA (China)	CZI	2021	2900 1000	1100 250	10 4	402 - 12,500 433 - 885	Polar
EnMAP	DLR (Germany)	HSI	2021-2022	30	30	242	420 - 2450	Polar
OCEANSAT-3	ISRO (India)	OCM-3	end-2021	1400	360 / 1	13	400 - 1,010	Polar
SABIA-MAR	CONAE	Multi-spectral Optical Camera	2023	200/2200	200/1100	16	380 - 11,800	Polar
PACE	NASA	OCI	2023	2000	1000	Hyperspec (5 nm, 350-890nm + 7 bands NIR-SWIR)	350-2250 nm	Polar
		SPEXone		100	2500	Hyperspec (2 nm)	385-770 nm	
		HARP-2		1550	3000	4 bands	440-870 nm	
GISAT-1	ISRO (India)	MX-VNIR HyS-VNIR HyS-SWIR	12 August 2021	470 160 190	42 320 191	6 158 256	450-875 375-1000 900-2500	Geostationary (35.786 km) at 93.5°E
SBG	NASA	*Hyper-VSWIR *TIR-Imager	2026	-185 -600	30 60-100	>200 -8	380-2500	Polar
GLIMR	NASA	*VNIR-imager *WFOV-sensor	>2023	TBD	300 133	141	340-1040	Geostationary -Cont.US coasts, Amazon, Caribbean

MODIS data levels & flow



satellite ocean color

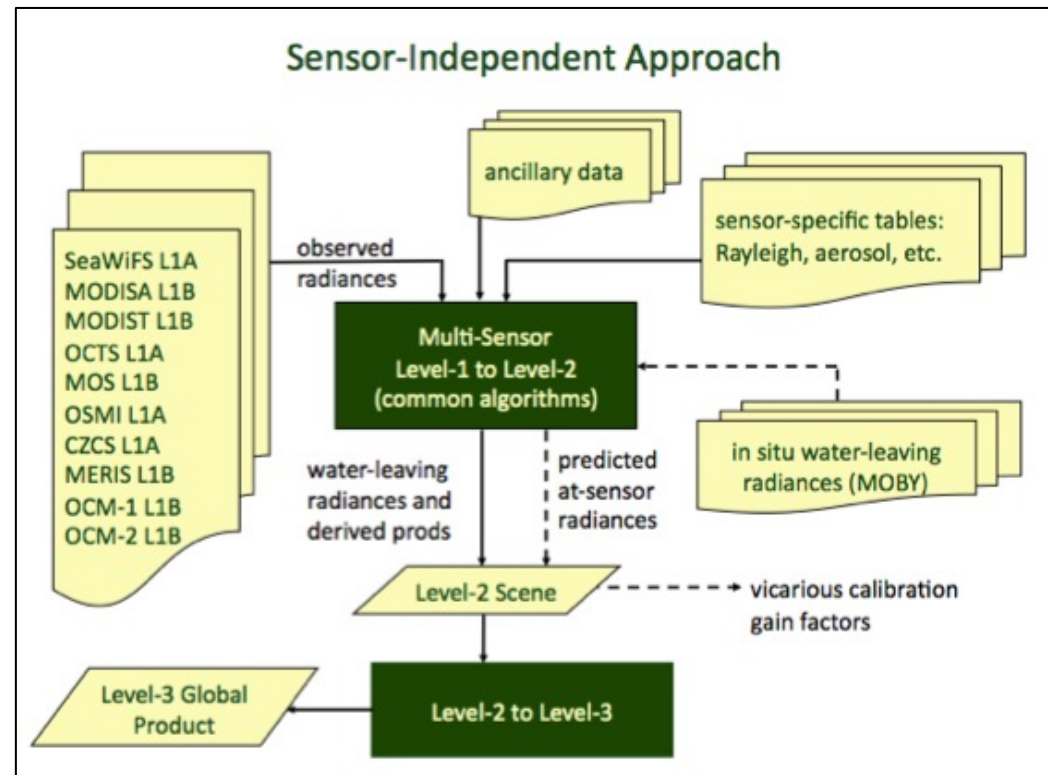


Level-2 processing (I2gen)

common software for Level-2 processing of MODIS, SeaWiFS, MERIS, & other sensors in a consistent manner

supports a multitude of product algorithms and processing methodologies

- standard products
- evaluation products
- user defined products
- run-time selection



Level-2 processing (I2gen)

as data is processed by I2gen from Level 1 to Level 2, checks are made for different **defined conditions**

when certain tests and conditions are met for a given pixel, **a flag is set** for that pixel for that condition

a total of **31 flags** can be set for each pixel

these I2gen processing flags are stored in the Level 2 data file as the "**I2_flags**" product

the storage method sets bits to 0 or 1 in 32-bit integers that correspond to each pixel

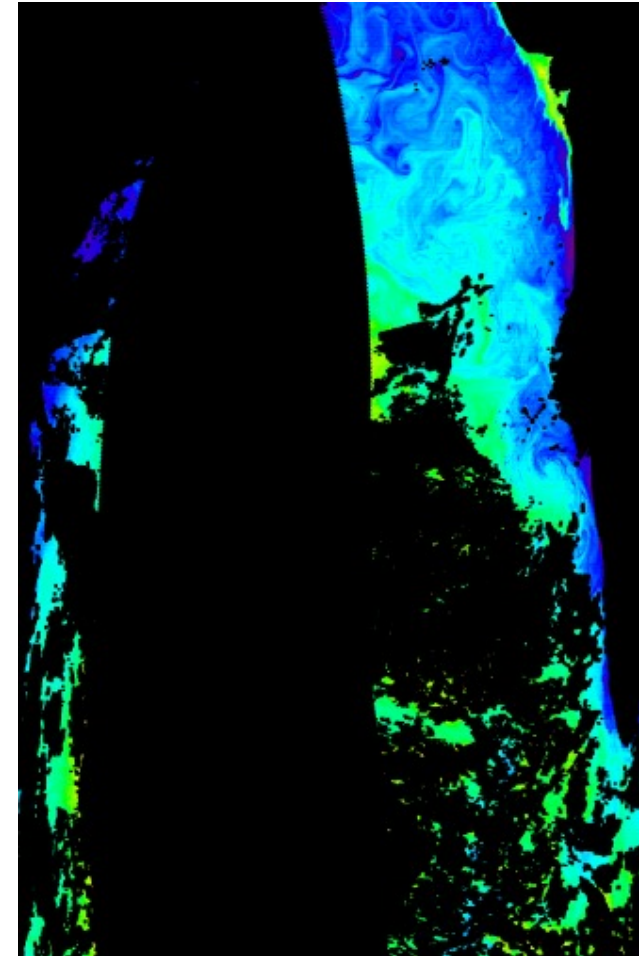
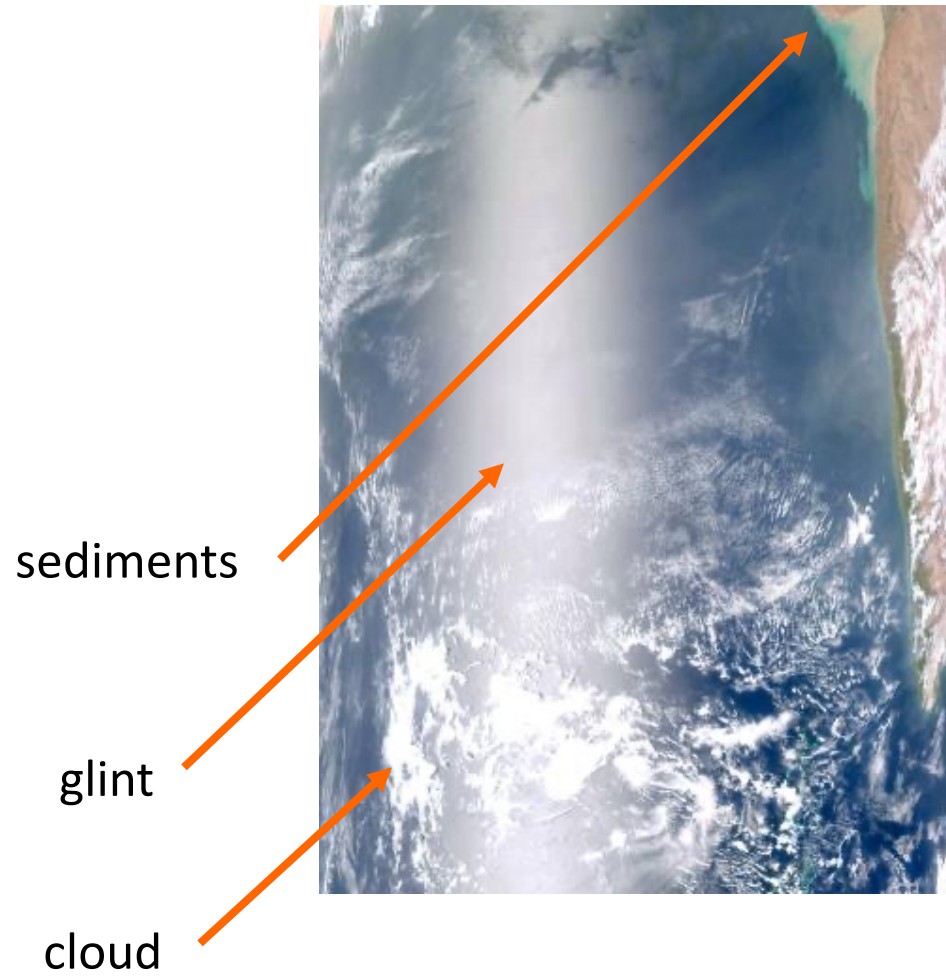
Level-2 processing flags

Bit	Name	Short Description	L2 Mask Default	L3 Mask Default
00	ATMFAIL	Atmospheric correction failure		ON
01	LAND	Pixel is over land	ON	ON
02	PRODWARN	One or more product algorithms generated a warning		
03	HIGLINT	Sunglint: reflectance exceeds threshold		ON
04	HILT	Observed radiance very high or saturated	ON	ON
05	HISATZEN	Sensor view zenith angle exceeds threshold		ON
06	COASTZ	Pixel is in shallow water		
07	spare			
08	STRAYLIGHT	Probable stray light contamination	ON	ON
09	CLDICE	Probable cloud or ice contamination	ON	ON
10	COCCOLITH	Coccolithophores detected		ON
11	TURBIDW	Turbid water detected		
12	HISOLZEN	Solar zenith exceeds threshold		ON
13	spare			
14	LOWLW	Very low water-leaving radiance		ON
15	CHLFAIL	Chlorophyll algorithm failure		ON
16	NAVWARN	Navigation quality is suspect		ON
17	ABSAER	Absorbing Aerosols determined (disabled?)		ON
18	spare			
19	MAXAERITER	Maximum iterations reached for NIR iteration		ON
20	MODGLINT	Moderate sun glint contamination		
21	CHLWARN	Chlorophyll out-of-bounds		
22	ATMWARN	Atmospheric correction is suspect		ON
23	spare			
24	SEAICE	Probable sea ice contamination		
25	NAVFAIL	Navigation failure		ON
26	FILTER	Pixel rejected by user-defined filter OR Insufficient data for smoothing filter ?		
27	spare	(used only for SST)		
28	spare	(used only for SST)		
29	HIPOL	High degree of polarization determined		
30	PRODFAIL	Failure in any product		
31	spare			

Level-2 flags & masks

RGB Image

nLw (443)



add masking for straylight

MODIS Level-3 processing

Level 2

- geolocated geophysical products for each pixel



Level 3 binned

- geophysical products averaged spatially and/or temporally
- sinusoidally distributed, equal area bins



Level 3 mapped

- images created by mapping and scaling binned products
- user-friendly, cylindrical equiangular projection

Bin resolution 4.6 x 4.6 km²

Mapped resolution

- 0.042-deg
- 0.084-deg

Composite Periods

- Daily
- 8-day
- Monthly
- Seasonal
- Yearly
- Mission

Level-3 terminology

projection - any process which transforms a spatially organized data set from one coordinate system to another

mapping - process of transforming a data set from an arbitrary spatial organization to a uniform (rectangular, row-by-column) organization, by processes of projection & resampling

binning - process of projecting & aggregating data from an arbitrary spatial & temporal organization to a uniform spatial scale over a defined time range

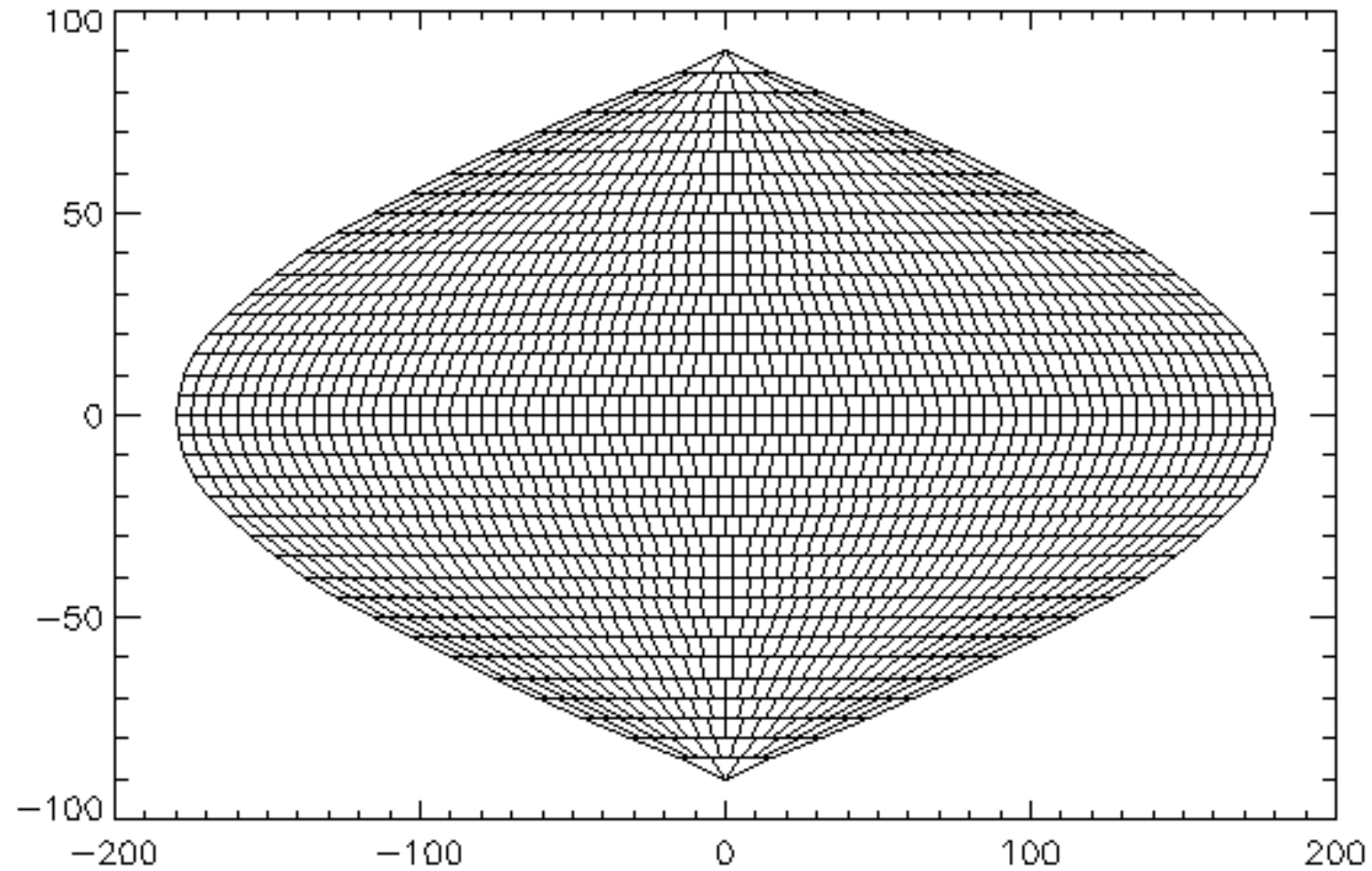
ocean color projections

equal-area - sinusoidal with equally space rows & number of bins per row proportional to sine of latitude

equal-angle - rectangular (Platte Carre) with rows and columns equally spaced in latitude and longitude

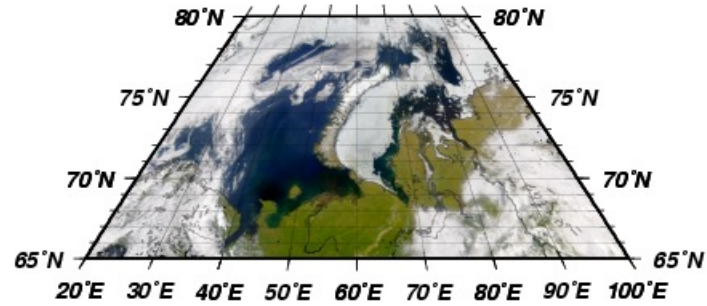
equal-area & -angle projections are equivalent at the equator

sinusoidal equal area projection



Level-3 binned vs. mapped

bin file grid



Sinusoidal

map file grid

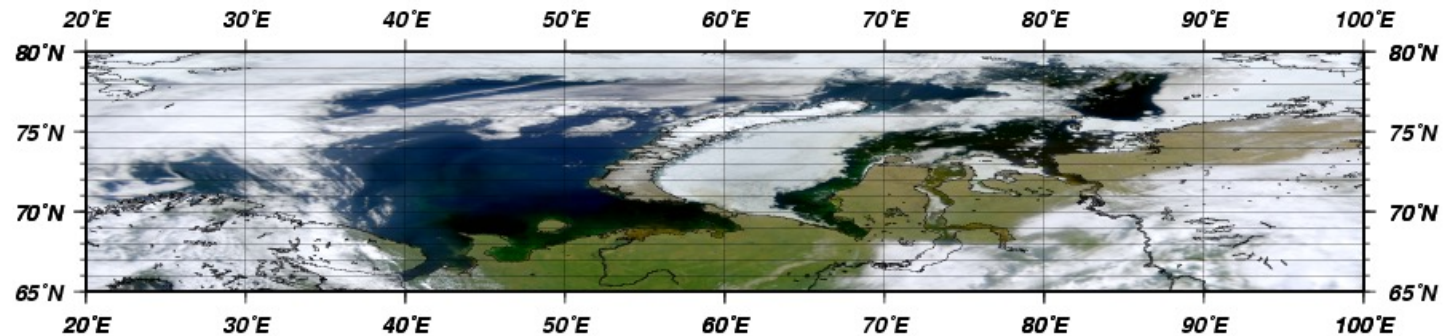
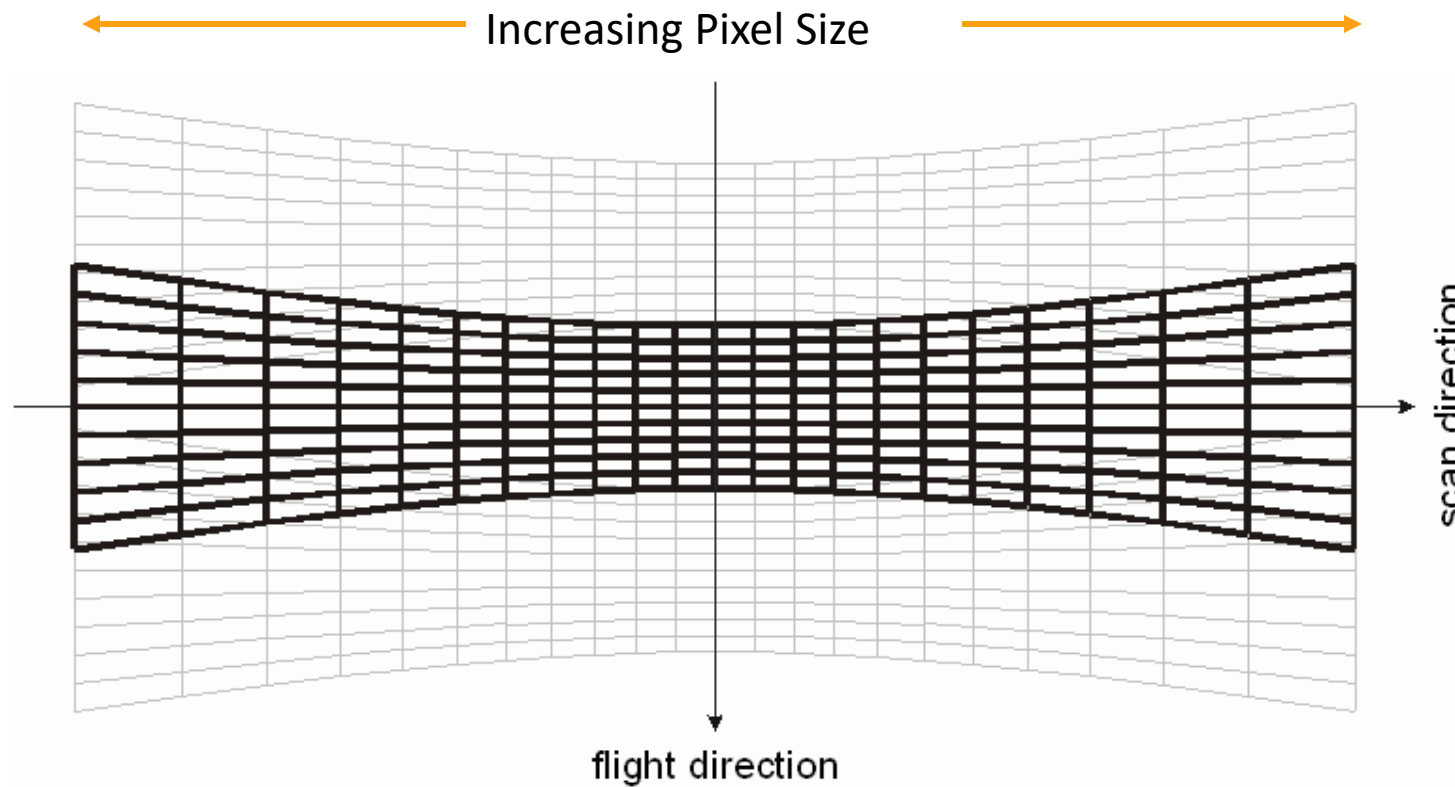
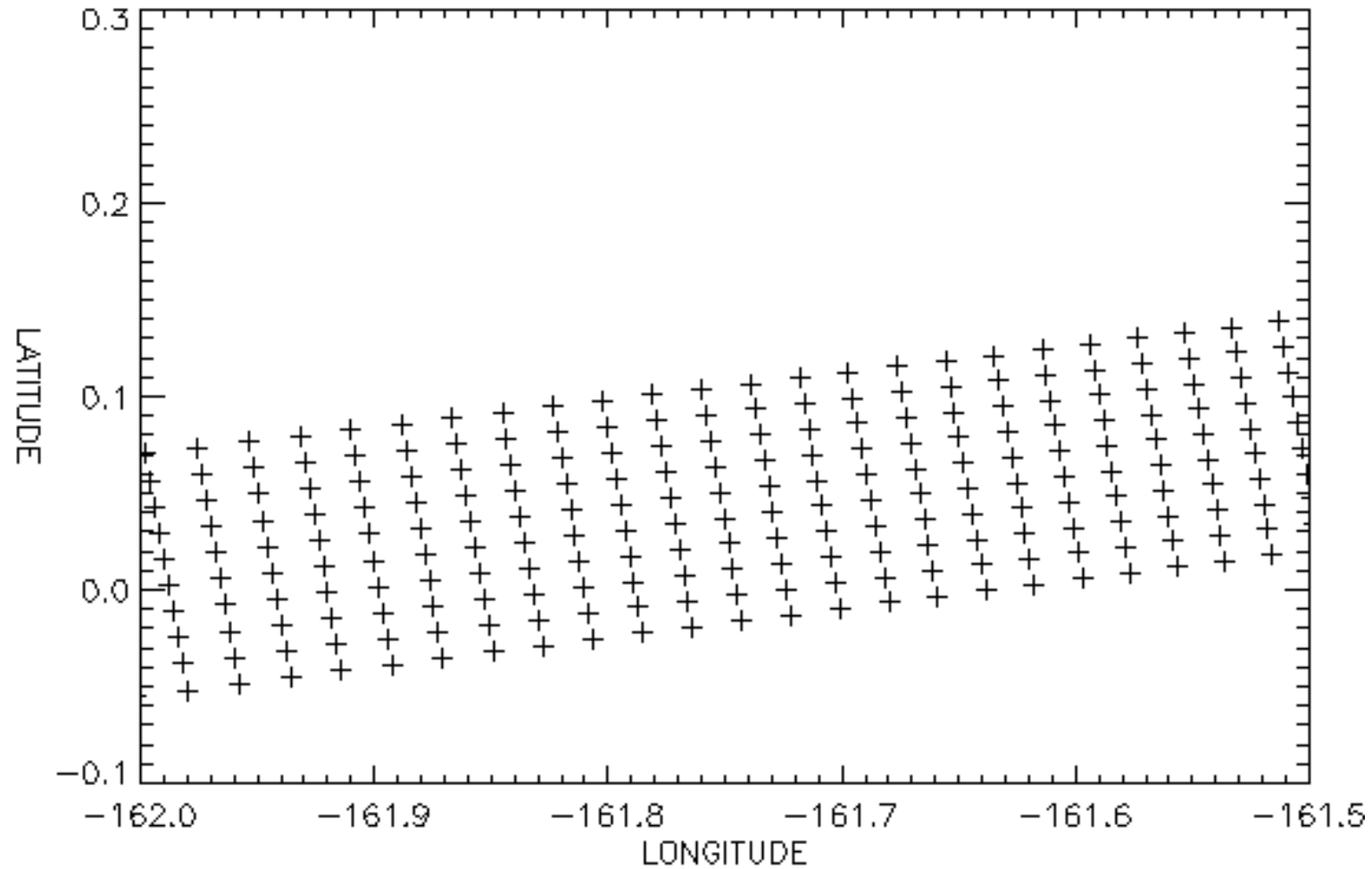


Plate Carrée

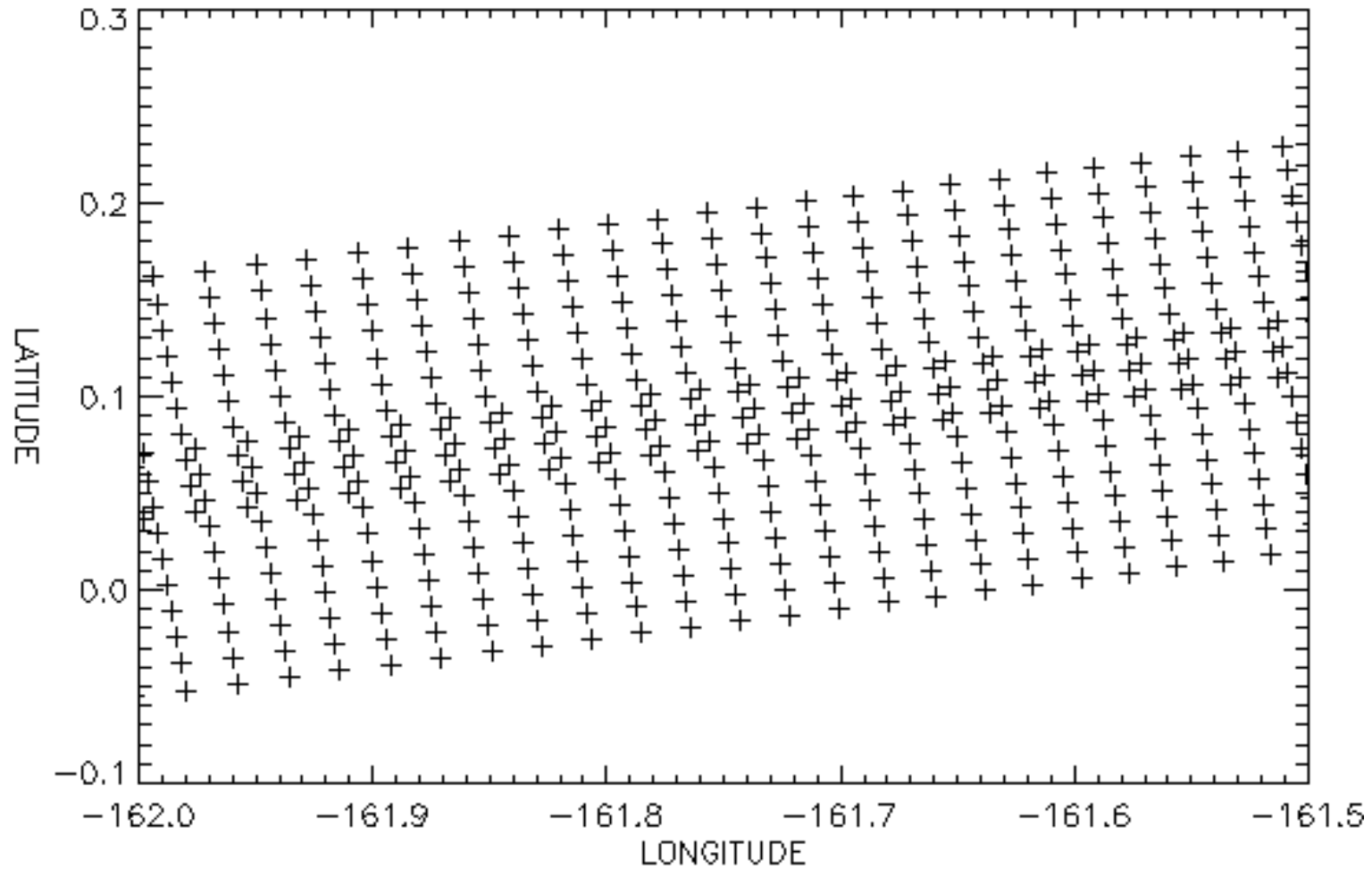
MODIS "bow-tie" effect



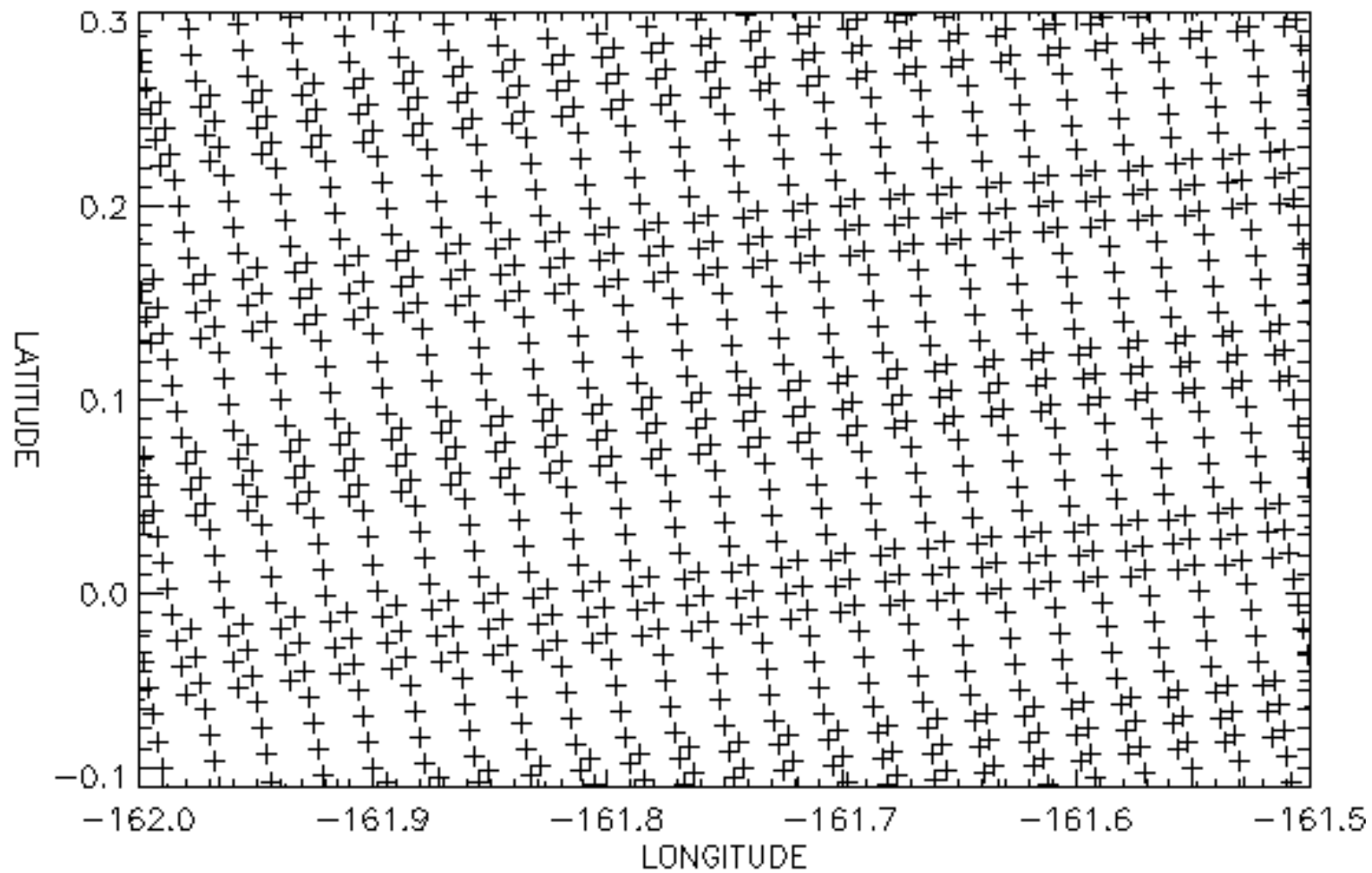
one MODIS scan at ~45 degrees scan angle



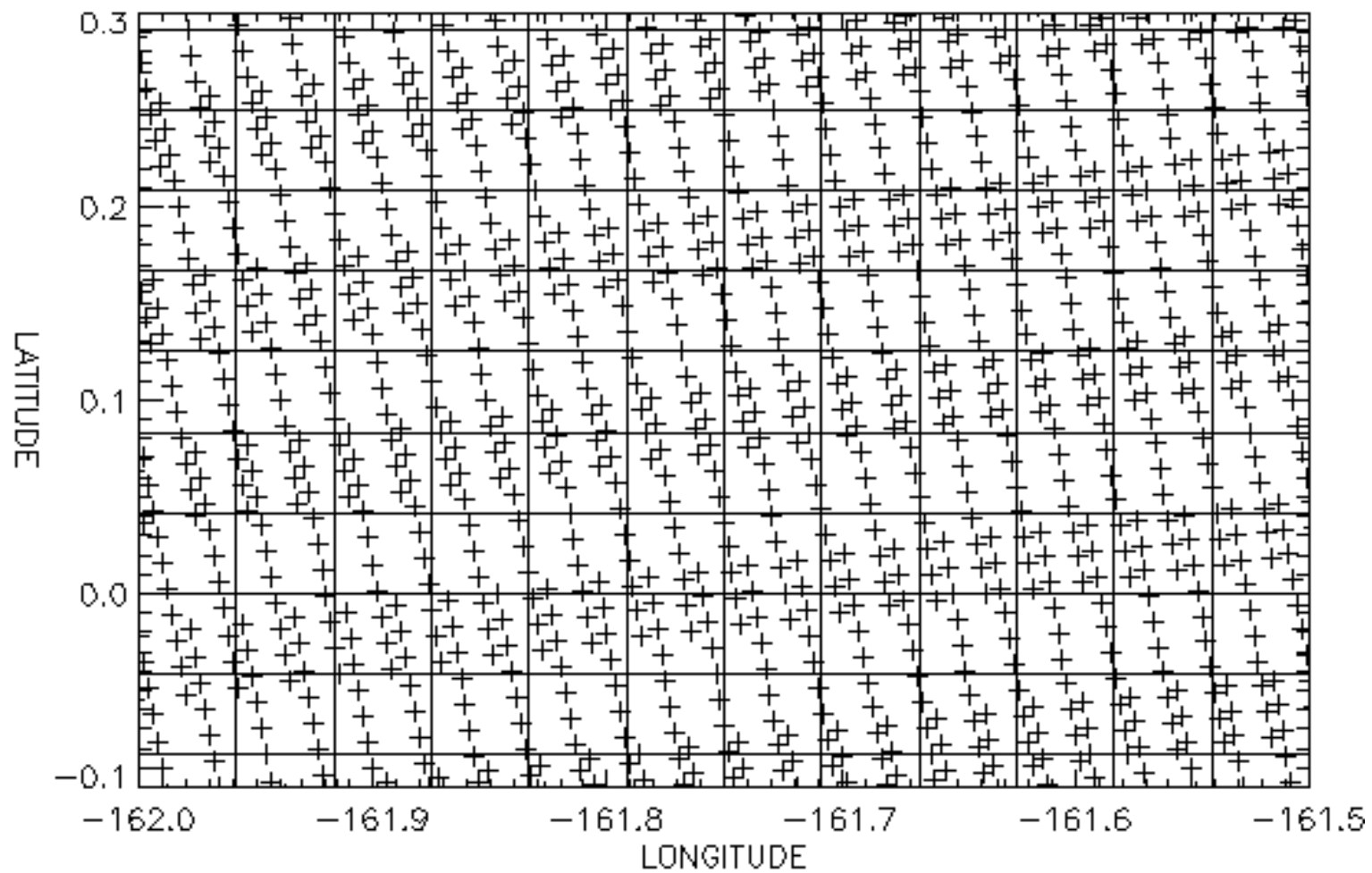
two MODIS scans showing overlap of pixels



multiple MODIS scans showing pixel overlap



bin boundaries overlaid on pixel locations



ocean coverage over time for binned files

