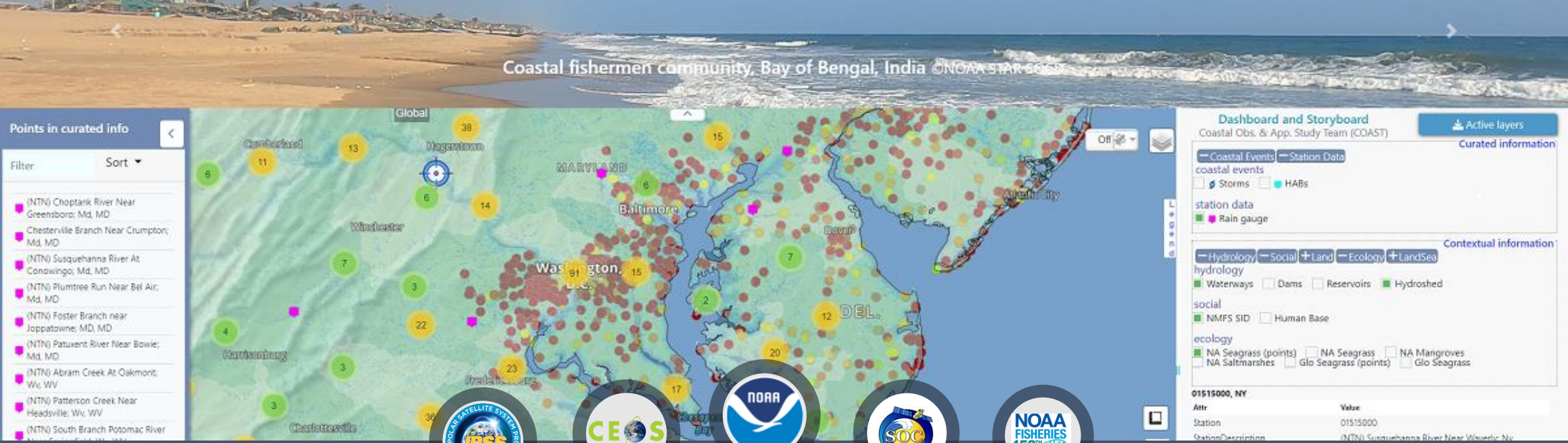


CEOS COAST

A web-based coastal application prototype in development

https://www.star.nesdis.noaa.gov/socd/coast/ (work in progress)

NOAA SOCD, NOAA Fisheries, CEOS

Prasanjit Dash, Paul DiGiacomo, Nicole Bartlett, Guangming Zheng, Nikolay Nezlin, Rachel Lazzaro, Sean Helfrich, Merrie Neely

CEOS COAST Project co-leads: NOAA (Paul DiGiacomo), ISRO

Scope and Vision

CEOS
Committee on Earth Observation Satellites

CEOS COAST
Coastal Observations Applications Services and Tools

Co-design co-develop relevant diagnostics and tool
https://ceos.org/ourwork/ad-hoc-teams/ceos-coast/
(contact Paul D and/or Merrie B for further details)

Vision
Contribute to coastal safety and restoration by addressing challenges and risks in the coastal zones

Goal
Direct efforts toward providing new and improved scientific and technical capabilities and building capacity for a more robust, end-to-end value chain:

Data → Information → (actionable) Knowledge

Preamble to the CEOS COAST knowledge hub: The OceanView

The COAST application is inspired by a previously released generalized geospatial viewer, namely, The OceanView.

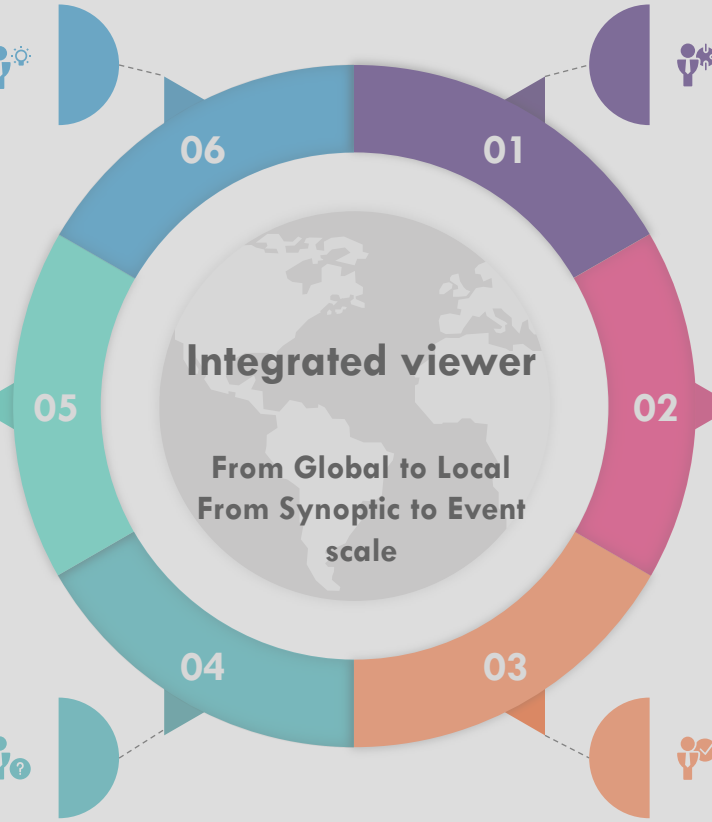
Presentation (1hr) https://www.star.nesdis.noaa.gov/star/PastSeminars.php (2021)

https://www.star.nesdis.noaa.gov/star/documents/seminardocs/2021/20210802_Dash.pdf

https://www.star.nesdis.noaa.gov/star/documents/seminardocs/2021/20210802_Dash.mp4

OceanView = a web-application *toward* integrated viz of remote sensing & *in situ* data, model, and ocean, coastal & inland water events

Released v1.0
May 2021



Events

Hurricane tracks; SAR hurricane images; Oil-spill event

In plan:
Polar ice-event visual
MHW, HABs, Ships/Saildrones

Satellite

SST: 12 Chl-a: 6 SSHA: 1
Salinity: 2 Wind: 7 True Color: 1
D/N Band: 1 Atm: 2 (Precip., AOD)
(more in plan)

Aircraft

Operation Icebridge DMS
- Navigation included
- Images (in near-future plan)

Model

GFS 10m wind

In plan: RTOFS surface parameters

Potential Spinoff (varied data)

Reusability was a key consideration in the design
AquaWatch, GEO Blue Planet, CEOS
COAST related knowledgebase

In situ data (match-ups and as is)

Derived

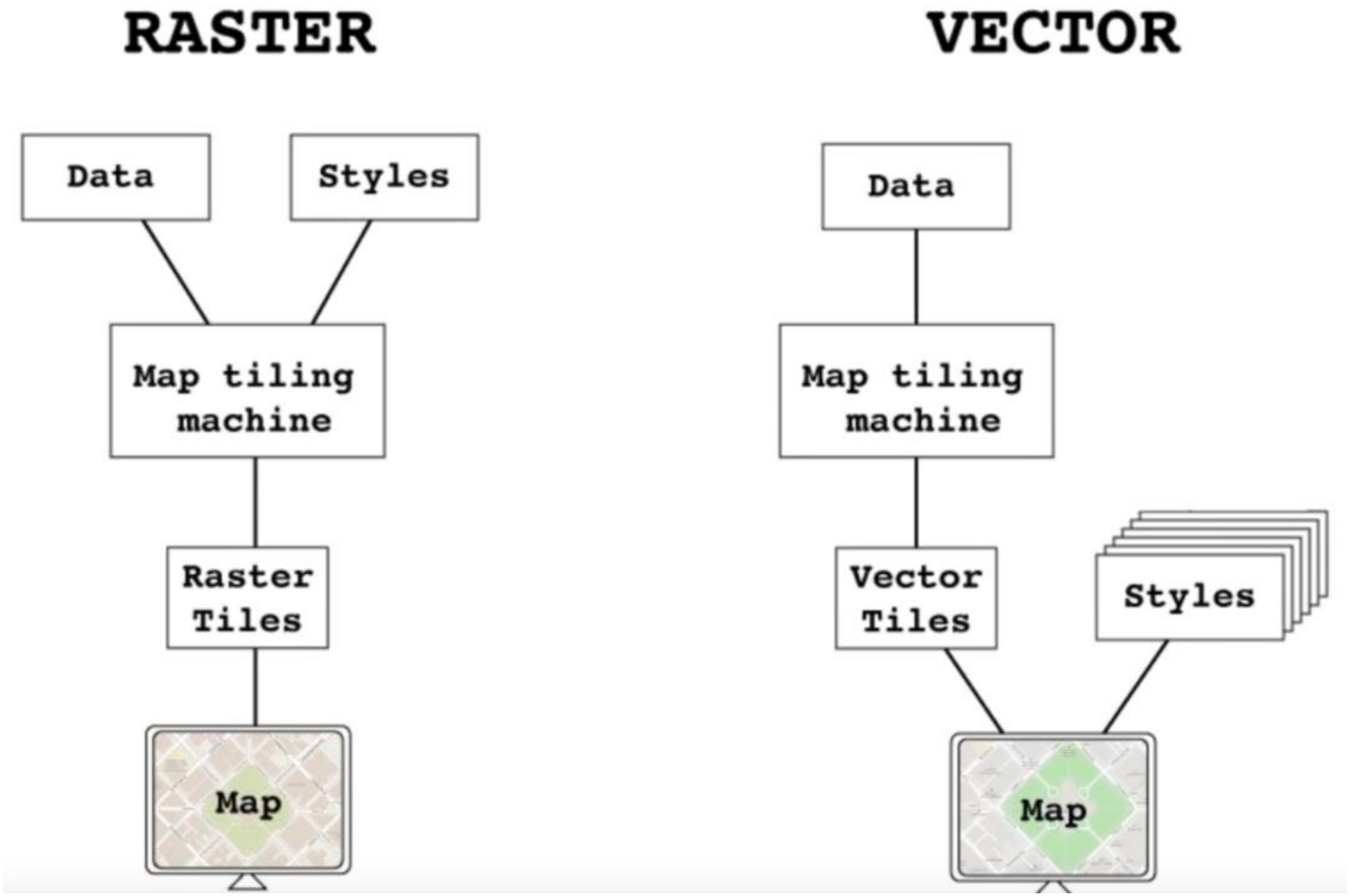
Available from other sources:
RADS geostrophic current
Derived in OV:
Thermal fronts from L4 SST (exp)
In plan: 3
FCC/TCC, Flooding, Biological L4 fronts

- The COAST KH and OceanView have a shared origin.
- However, they diverge, and the COAST application will focus on coastal studies
  - ✓ In addition to **satellite products**, will showcase **curated information** about events and other **contextual information**
  - ✓ Expands on the technology stack using newer formats and protocols
  - ✓ Improved presentation using story maps and dashboard
  - ✓ Mobile-friendly (not just responsive grid but build menu differently)

Modern web mapping tech

OceanView	• Projections: EPSG 3413, 4326, 3031 • Raster: WMTS raster tiles in MRF (ref. OV presentation for WMTS vs WMS etc) • Vector: GeoJSON (unsuitable/unresponsive for large datasets) • Data-processing: Python, GDAL; Screen display: Leaflet JS
CEOS COAST	All of the above + • Vector tiling (Google protocol buffer format; MVT encoder/decoder) for millions of records • OGR/Fiona for vector handling + • Provision to effectively display high-res, non-routine images through story maps

Tech continued… Vectortile



Binary encoded, ***gridded squares*** in Google protobuf containing layers & attributes just as a shapefile or GeoJSON but faster… Its a watershed moment for the *client-side enthusiasts* of geospatial information. Google/OSM moving to VT.

Enough of technology, switch gears …

Coastal infographics

FACTORS AFFECTING COASTAL ECOSYSTEMS

CLIMATOLOGICAL
- Extreme events (Hurricanes)
- Sea-level rise
- SST rise
- Ocean current pattern changes
- Acidification

LOCAL
- Runoff
- Pollutant dumping
- …

ECOSYSTEMS OVERVIEW

Temperate
-Rocky shores, Kelp/Algae

Tropical
- Coral Reef, Seagrass, Mangrove
Polar eco

HUMAN

Social science data

Land use land cover

Recreation

FAUNA

Detail for specific ecosystems.

Fish, Snails, Turtles, Lionfish…

FLORA

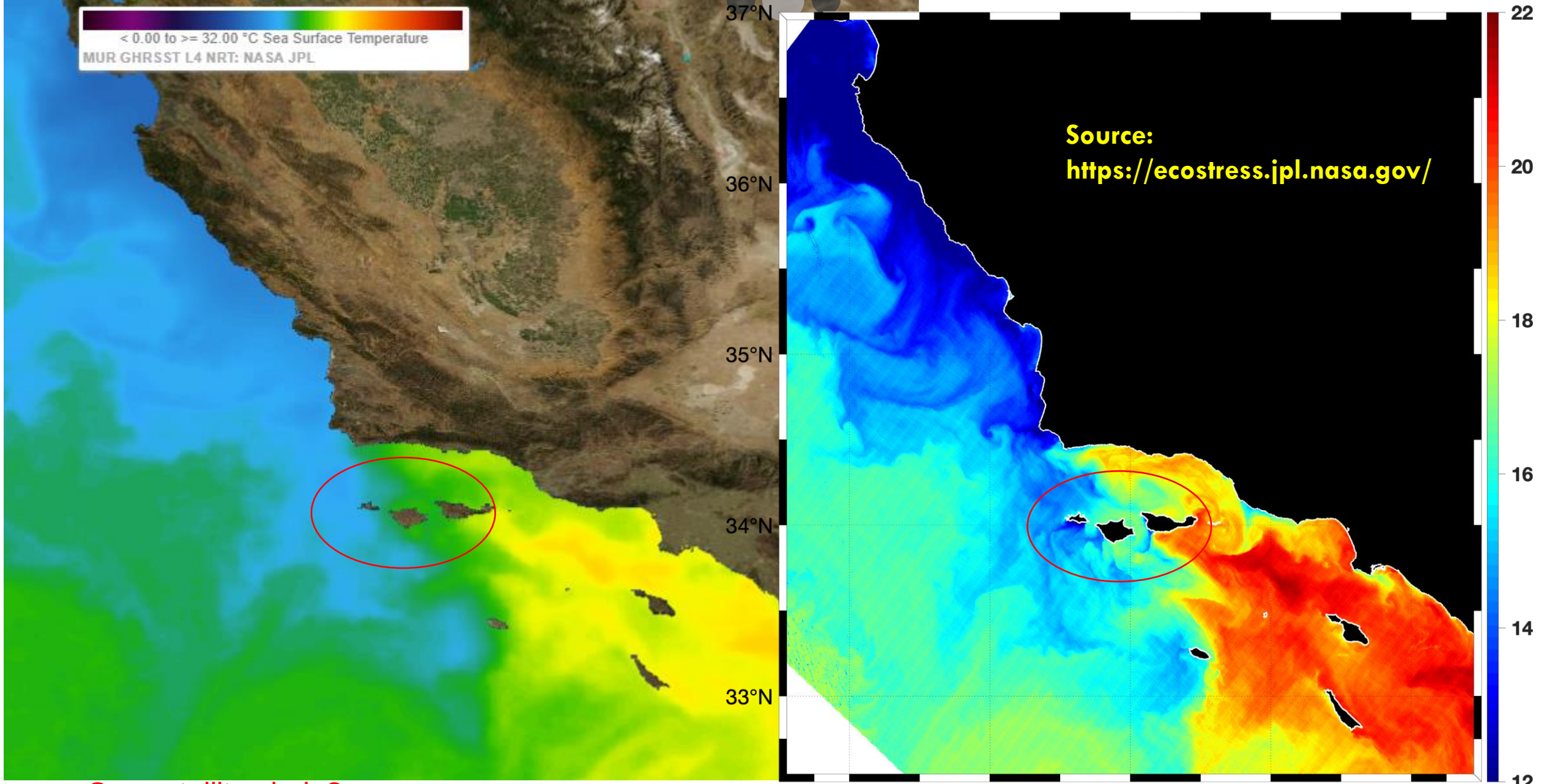
Detail for specific ecosystems.

Can they be identified from satellites?

WATER QUALITY INDICATORS

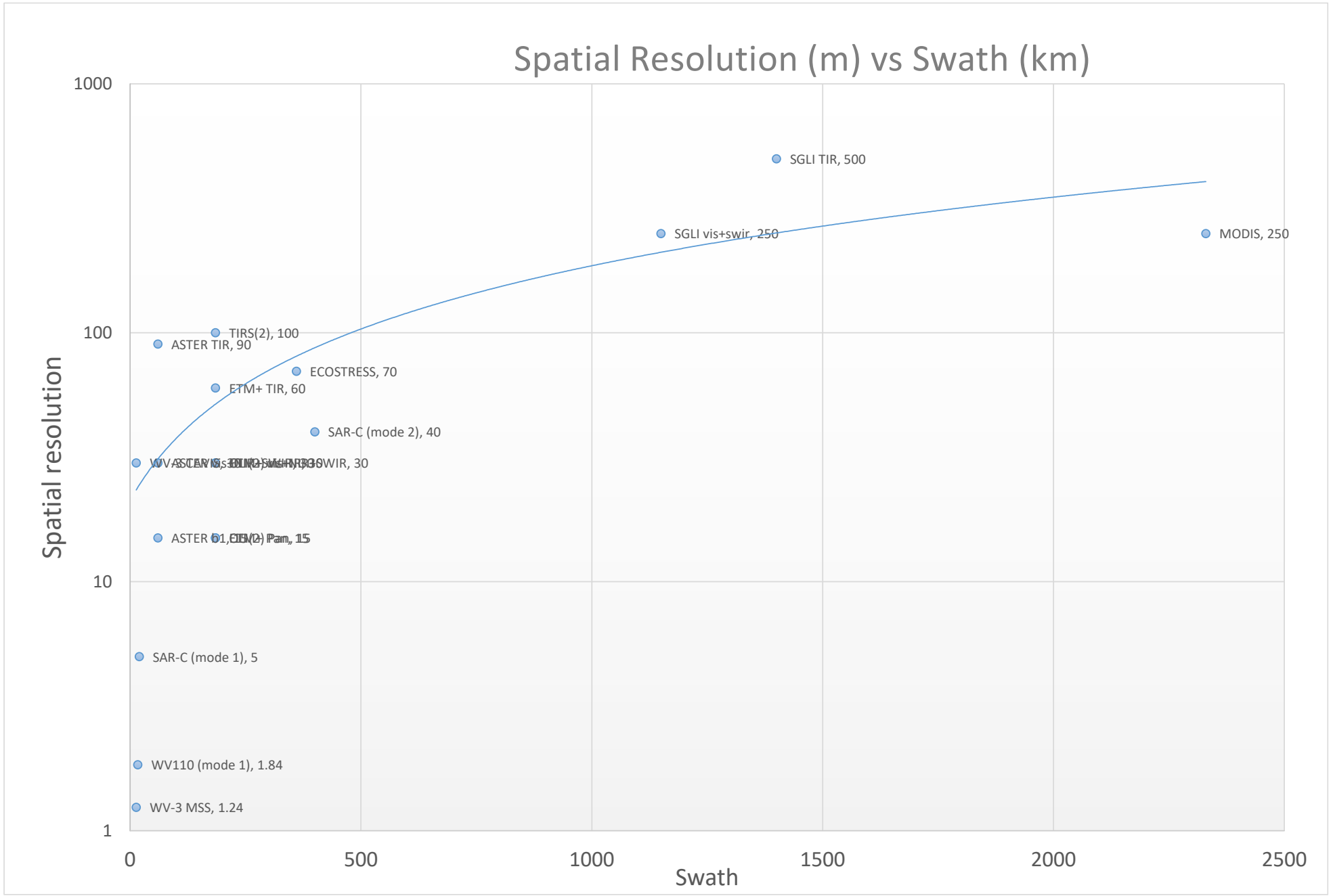
Chl-a (Phytoplankton)
Colored Dissolved Org. Matter (CDOM)
TSS/TSM
SST
Salinity
Fluorescence line height
Derived prod: Nutrient/Hypoxyia

Can satellites help?



Can satellites help?

Need High-res, multi-sensor records



Use of HR data is gaining momentum, but the variation in radiometric and geometric quality compared to traditional platforms (i.e., Landsat, MODIS, etc.) means the images are not always 'analysis ready' upon download. Need additional steps.

Components

Physical environment

- Sea state (SST, SSH, Salinity, Winds …)
- Flooding/Inundation
- Geomorphology - shoreline change/bathymetry, coastlines
- Hydrology - hydrobasins (global), waterways, dams, reservoirs
- Land cover/land use, DEM

Biological/Ecological/habitat

- Water quality parameters/indicators - blooms/biomass via chl-a, turbidity/sediments
- Habitat maps/assessments – seagrass, mangroves, salt-marshes
- Stressors - ship traffic/detection
- Oil spill/slicks - vessel discharge

Social data and indicators

- Social vulnerability indicators, Human-base, Population, flood mortality and economic impacts

Events-scale, seasonal/annual static assessments, climatologies/anomalies

- Story maps for weather events including regular analytics and true/false color images/animations

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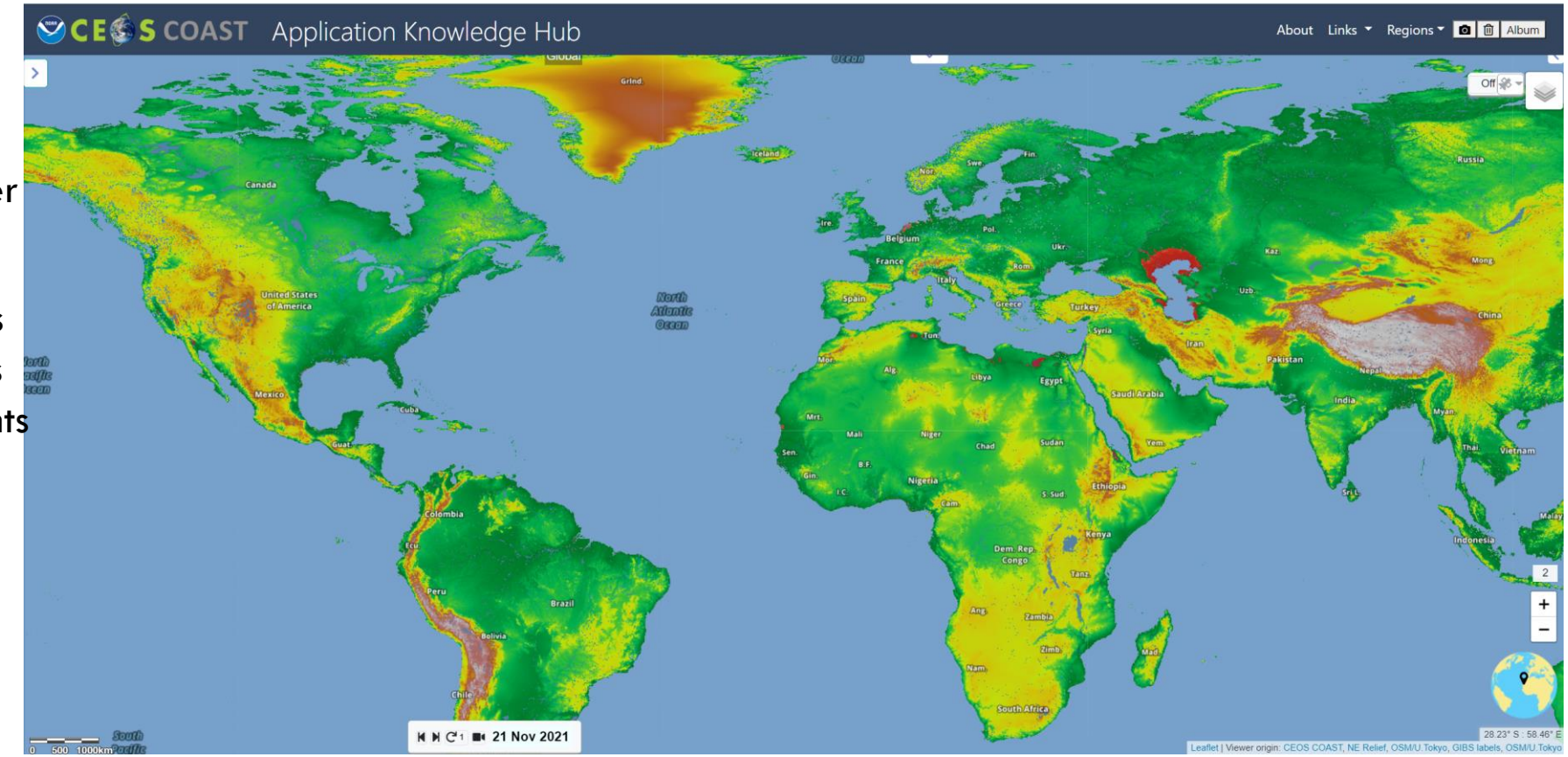
Data handling challenges: example raster, MERGE DEM

- Univ of Tokyo
- widely referred
- 90m grid res; 2m or better vertical accuracy
- Retains negative values as low as 1000 mts (perhaps Antarctica rift) and 400 mts (Dead sea)

Challenges:

- The data is prepared as 5x5 deg tiles (6000 pixel x 6000 pixel)
- In total **2300 files (>80 Gb)** that needs to be merged/stitched and tiled at multiple zoom levels

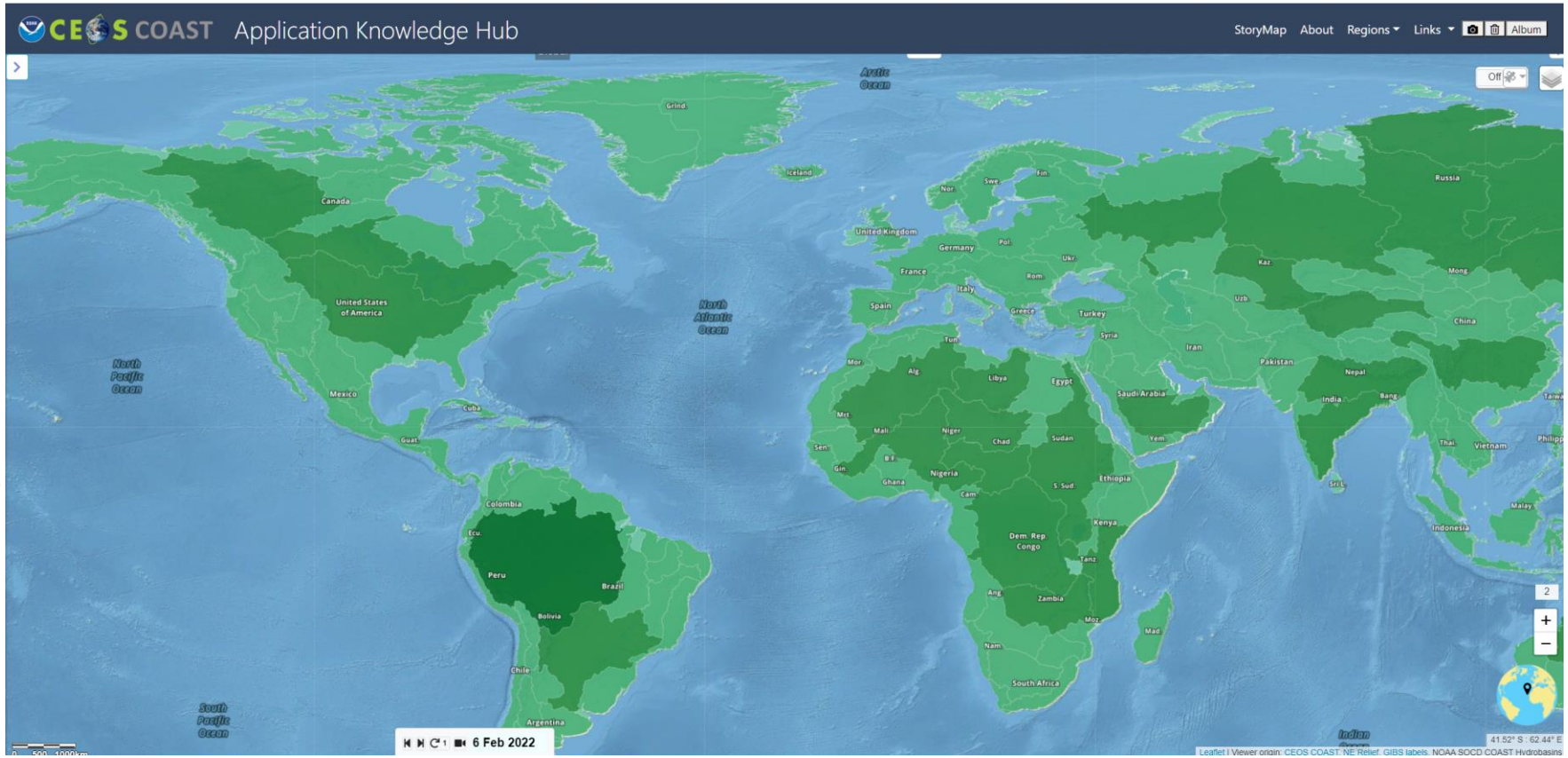


Data handling challenges: example vector, HYDROBASINS

- Hydrosheds.org
- widely referred

Challenges:

- Separately for 9 Regions
- At 12 zoom (Pfatstetter) levels, natively
- In total **108 shapefiles (>8 Gb)** that needs to be merged and vector-tiled at individual zoom levels
- Even server-side app will throttle. So, VT.



Cf. existing visualizations

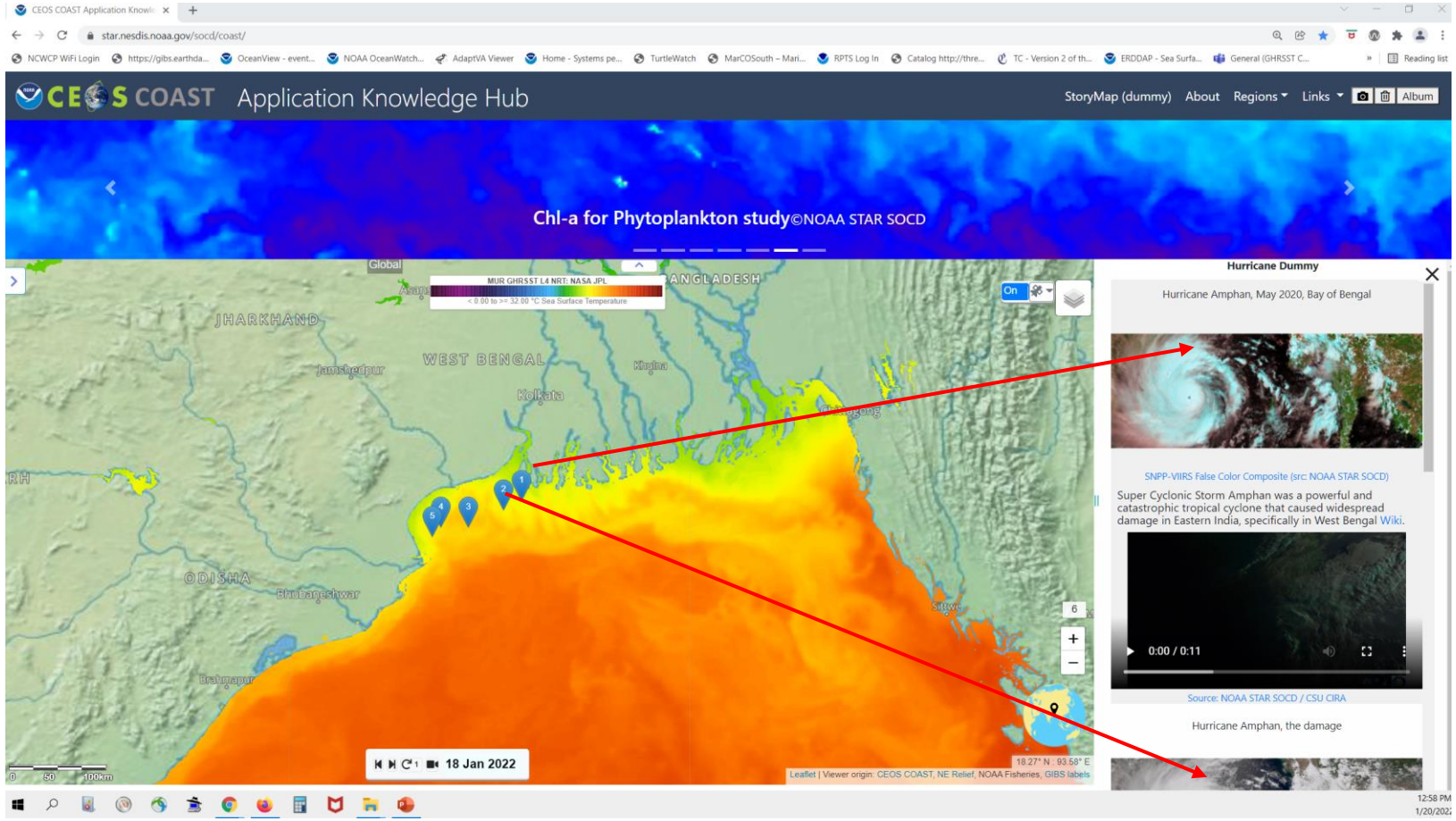
GEE: https://developers.google.com/earth-engine/datasets/catalog/WWF_HydroSHEDS_v1_Basins_hybas_7

ESRI: https://www.arcgis.com/home/item.html?id=8f6356f23e05444894190c361705a802

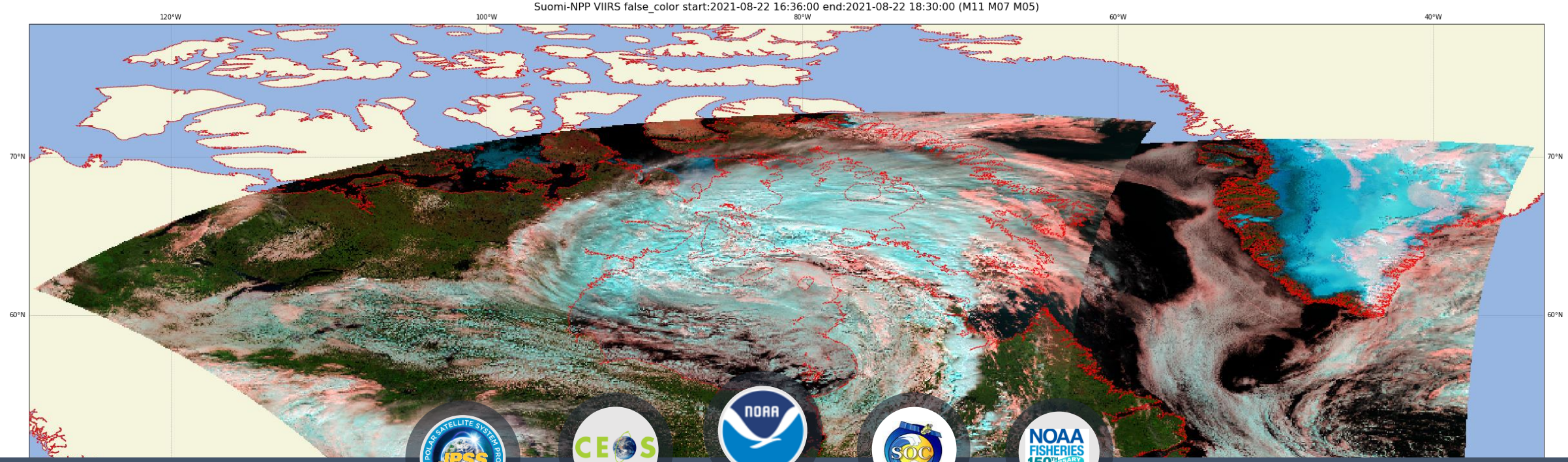
NASA: https://appliedsciences.nasa.gov/sites/default/files/HydroSHEDS%20Tutorial.pdf

Storymap concept

- For a given event, **a story map provides a pointwise guided tour**, with a scrolling narrative to display collated information (text, images/CC, audio, animation etc.)
- The points along the trajectory of an event are displayed on the map-panel and are linked to relevant description in the story board. These are inter-linked and mutually callable.
- The primary advantage is that a suitable "narrative" can be added to each story that is understandable to the educated non-experts in the field along with quick facts for reference.
- Another advantage is, the data that are not routinely displayed as raster tiles (due to unavailability or operational challenges) can also be shown for use-cases, e.g., high-resolution images from SAR, S2, Landsat(s), Ecostress, Trishna (2025), Planet etc.



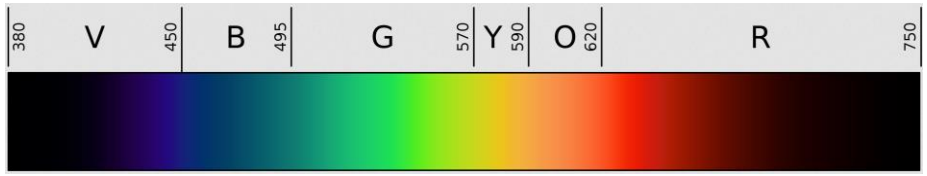
Demo: https://www.star.nesdis.noaa.gov/socd/coast/
(password protected till beta)


Suomi-NPP VIIRS false_color start:2021-08-22 16:36:00 end:2021-08-22 18:30:00 (M11 M07 M05)
120°W
100°W
80°W
60°W
40°W
70°N
60°N

THANK YOU

Backup:

Basics of true/false color composites



Color	Wavelength (μm)	Frequency (Thz)	Photon energy (eV)
Violet	0.380–0.450	670–790	2.75–3.26
Blue	0.450–0.485	620–670	2.56–2.75
Cyan	0.485–0.500	600–620	2.48–2.56
Green	0.500–0.565	530–600	2.19–2.48
Yellow	0.565–0.590	510–530	2.10–2.19
Orange	0.590–0.625	480–510	1.98–2.10
Red	0.625–0.700	400–480	1.65–1.98

Electromagnetic spectrum

VIIRS M and DNB bands (750m nadir res)

#	Band	C. W(μm)	Width(μm)	Type
0	M1	0.412	0.402-0.422	Violet
1	M2	0.445	0.436-0.454	Indigo
2	M3	0.488	0.478-0.488	Blue
3	M4	0.555	0.545-0.565	Green
4	M5	0.672	0.662-0.682	Red
5	M6	0.746	0.739-0.754	NIR
6	M7	0.865	0.846-0.885	NIR
7	M8	1.240	1.230-1.250	SWIR
8	M9	1.378	1.371-1.386	SWIR
9	M10	1.61	1.58-1.64	SWIR
10	M11	2.25	2.23-2.28	SWIR
11	M12	3.70	3.61-3.79	MWIR
12	M13	4.05	3.97-4.13	MWIR
13	M14	8.55	8.4-8.7	LWIR
14	M15	10.763	10.26-11.26	LWIR
15	M16	12.013	11.54-12.49	LWIR

VIIRS I Bands (375m nadir res)

#	Band	C. W(μm)	Width(μm)	Type
0	I1	0.64	0.6-0.68	Vis (Red)
1	I2	0.865	0.85-0.88	NIR
2	I3	1.61	1.58-1.64	SWIR
3	I4	3.74	3.55-3.93	MWIR
4	I5	11.45	10.5-12.4	LWIR

+ DN 0.7 micron band (VIS+NIR)

VIIRS spectrum

Backup:

Recipe for true/false color composites
(correct for molecular scattering as needed)

1. True Color Composite (as a pair of human-eye would see)

Color gun	VIIRS Band	CW(μm)	Band
R	**M5**	0.672	Vis (Red)
G	**M4**	0.555	Vis (Green)
B	**M3**	0.488	Vis (Blue)

2. False Color Composite (Bands Vis, SWIR, SWIR)

Color gun	VIIRS Band	CW(μm)	Band
R	**M3**	0.488	Blue
G	**M10**	1.61	SWIR
B	**M11**	2.25	SWIR

Vegetation=Green
Ice or snow=Red
Liquid water on the ground=Black or dark red
Liquid water clouds=White
Ice clouds=Peach
Desert=Light blue-green

3. False Color Composite (Bands SWIR, NIR, Vis)

Color gun	VIIRS Band	CW(μm)	Band
R	**M11**	2.250	SWIR
G	**M07**	0.865	NIR
B	**M05**	0.672	Vis

Vegetation=Green
Water=Black or dark blue
Desert/Naturally bare soil=Sandy pink
Burn scar=Red to reddish-brown, depending on the nature of pre-fire vegetation and burn severity

4. Natural (but false) Color Composite SWIR, NIR, Vis for a realistic view

CG	VIIRS Band	CW(μm)	Type		CG	VIIRS Band	CW(μm)	Type
R	I3	1.610	SWIR		R	M10 or M11	1.610 or 2.225	SWIR
G	I2	0.865	NIR		G	M07	0.865	NIR
B	I1	0.640	Vis		B	M05	0.672	Vis

Natural-looking images of earth surface
Flooding extent (CIRA)