Earth Information System (EIS) Monthly Highlights

October 2022

Project objectives

EIS integrates NASA's existing Earth science observations and modeling capabilities to produce new actionable science. EIS work is currently organized around four multi-disciplinary thematic areas.

- Demonstrate innovative and integrative science and applications enabled by emerging cyberinfrastructure for cloud computing and collaborative development
- Improve transparency and accessibility of data and methods in support of NASA's Transition to Open Science

Setting the agenda in research

Comment

KAZI SALAHUDDIN KAZI/NURPHOTO VIA GETTY

Flooding of coastal regions in Bangladesh has increased soil salinity and killed off plants and trees.

Avert Bangladesh's looming water crisis through open science and better data

Augusto Getirana, Nishan Kumar Biswas, Asad Sarwar Qureshi, Adnan Rajib, Sujay Kumar, Mujibur Rahman & Robin Kumar Biswas

Intensive irrigation and climate change are depleting groundwater reserves in this fast-developing nation. To improve its water security, researchers need more information on water use, quality, flows and forecasts.

Bangladesh is home to a network of hundreds of rivers and the world's largest river delta, the Ganges Delta. Historically, the nation has been water rich. But that is changing owing to declining rainfall, more-intensive irrigation and heavier use of water upstream. Contamination from arsenic and sewage is also on the rise.

To feed our future planet, it is crucial that water is used more sustainably in agricultural regions such as Bangladesh. Other agricultural hotspots face similar water stresses, including the Western and Central United States, northern India and Brazil[1,2], where falling water tables punish farmers and grab headlines.

Bangladesh has taken some steps to address the problem. In 2018, its Ministry of Planning published the Bangladesh Delta Plan 2100 (BDP; see go.nature.com/3s26anc). This outlines a long-term strategy for the country's sustainable and resilient socio-economic development in a changing climate. Water security is a key part of this plan. Although the BDP rightly identifies the main issues facing the nation's water, it is vague on effective actions. These will require heavy investments and more supporting research.

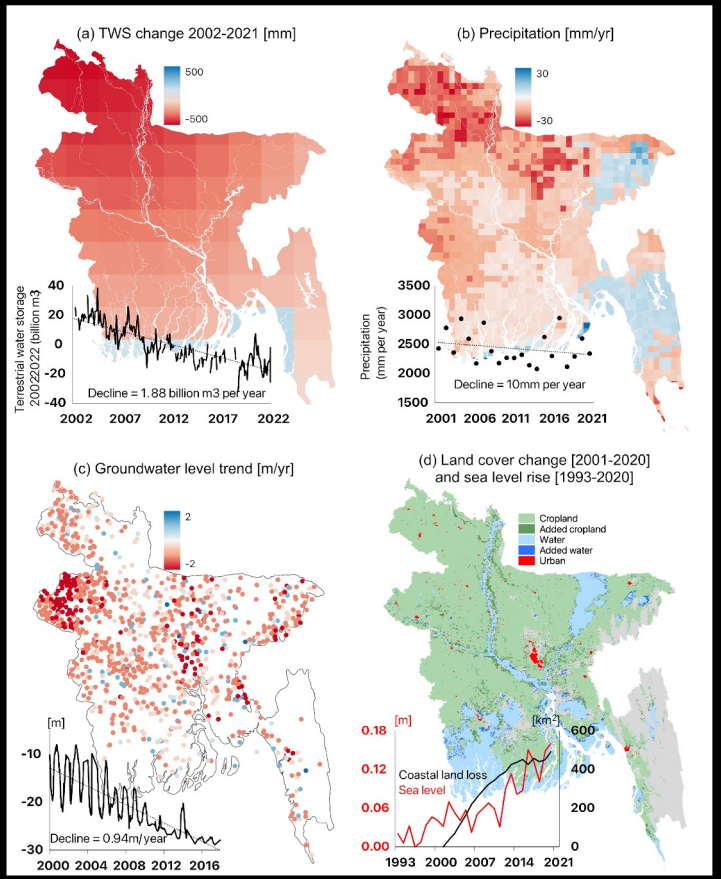
Open science initiatives such as EIS highlighted as a significant need for solving looming water resource issues

"New open-science initiatives, particularly NASA's Earth Information System, launched in 2021, can help by supporting the development of customized data-analysis and modelling tools."

Getirana et al. (2022) Nature. DOI: 10.1038/d41586-022-03373-5

EIS synthesis reveals the looming water crisis in Bangladesh

- The demands of a growing population of Bangladesh have driven intensified agricultural practices putting significant strain on available water resources.
- GRACE data shows that 37.5 billion m^3 of terrestrial water storage have been lost across the country since 2002, mainly from groundwater depletion.
- GPM data shows that rainfall rates in Bangladesh have fallen by 10 mm/year.
- Radar altimetry data shows that sea levels have been rising at a rate of ~5 mm/year; this, combined with land subsidence and other issues, has led to the loss of 490km^2 of coastal land since 2001, according to MODIS data.

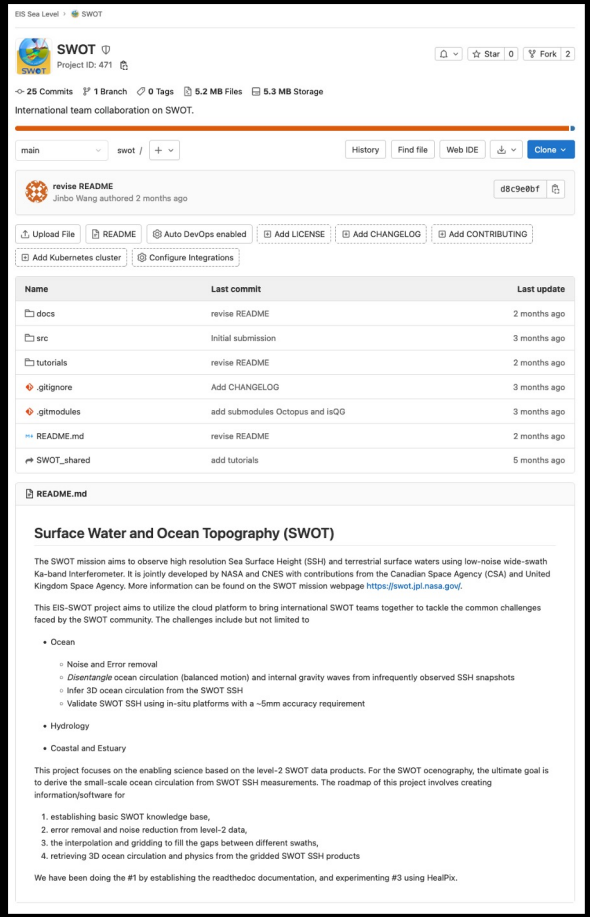


Getirana et al. (2022) Nature. DOI: 10.1038/d41586-022-03373-5

EIS enables analysis on the cloud for future missions

EIS is building foundational tools, creating a knowledge base, and developing capacity within the research community around cloud computing that will be critical for enabling analysis on the cloud for future missions such as SWOT. Specific capabilities include:

- Creating knowledge base for SWOT via platforms such as GitHub
- Developing fundamental tools by creating a collection of core analytical tools to bridge data archive and science/applications
- Building a SWOT community using cloud platform, identifying roadblocks, and documenting best practices
- Enhancing teamwork and cross-team collaborations (e.g., SWOT AdAC, SWOT ocean team leads, CNES/French SWOT collaborators)

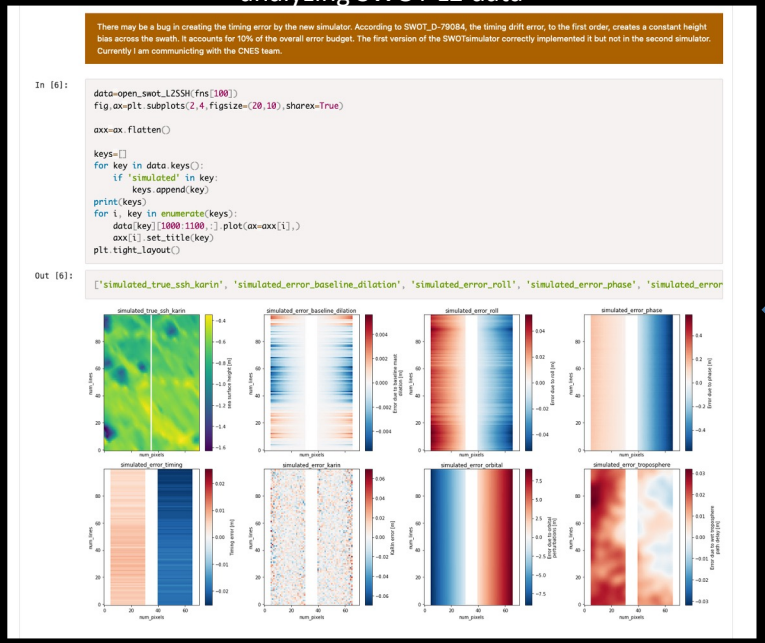


See more at: *https://git.mysmce.com/eis-sealevel/swot/*

Enabling SWOT analysis on the cloud

Creating SWOT knowledge base. The goal is to distill mission ATBDs for community consumption, with interactive notebook tutorials that can access and process simulated SWOT data products (already available).

Interactive notebook tutorial for understanding and analyzing SWOT L2 data



There may be a bug in creating the timing error by the new simulator. According to SWOT_D-79084, the timing drift error, to the first order, creates a constant height bias across the swath. It accounts for 10% of the overall error budget. The first version of the SWOTsimulator correctly implemented it but not in the second simulator. Currently I am communicting with the CNES team.

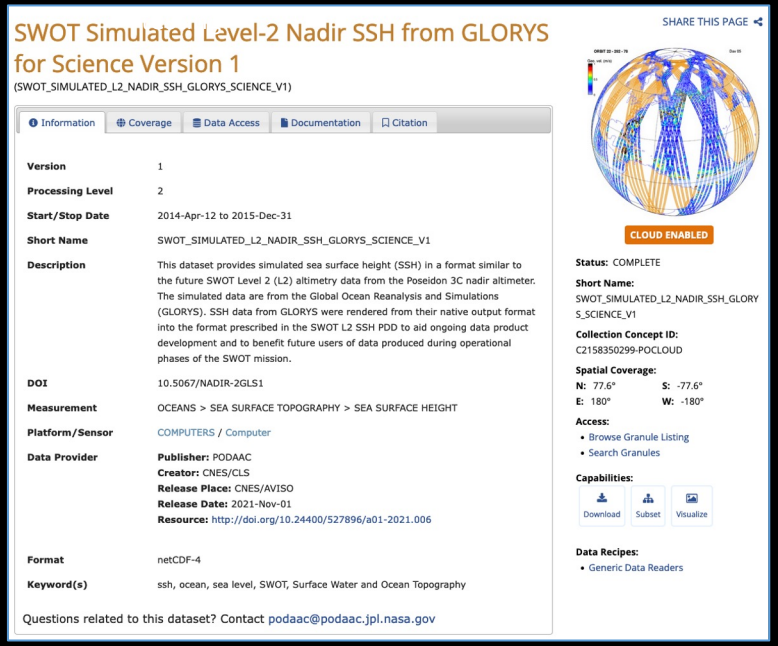
In [6]:

```
data=open_swot_L2SSH(fns[100])
fig,ax=plt.subplots(2,4,figsize=(20,10),sharex=True)

axx=ax.flatten()

keys=[]
for key in data.keys():
    if 'simulated' in key:
        keys.append(key)
print(keys)
for i, key in enumerate(keys):
    data[key][1000:1100,:].plot(ax=axx[i],)
    axx[i].set_title(key)
plt.tight_layout()
```

Out [6]:

```
['simulated_true_ssh_karin', 'simulated_error_baseline_dilation', 'simulated_error_roll', 'simulated_error_phase', 'simulated_error
```


Synthetic SWOT L2 SSH products for



SWOT Simulated Level-2 Nadir SSH from GLORYS for Science Version 1

(SWOT_SIMULATED_L2_NADIR_SSH_GLORYS_SCIENCE_V1)

SHARE THIS PAGE

Information | Coverage | Data Access | Documentation | Citation

Version	1
Processing Level	2
Start/Stop Date	2014-Apr-12 to 2015-Dec-31
Short Name	SWOT_SIMULATED_L2_NADIR_SSH_GLORYS_SCIENCE_V1
Description	This dataset provides simulated sea surface height (SSH) in a format similar to the future SWOT Level 2 (L2) altimetry data from the Poseidon 3C nadir altimeter. The simulated data are from the Global Ocean Reanalysis and Simulations (GLORYS). SSH data from GLORYS were rendered from their native output format into the format prescribed in the SWOT L2 SSH PDD to aid ongoing data product development and to benefit future users of data produced during operational phases of the SWOT mission.
DOI	10.5067/NADIR-2GLS1
Measurement	OCEANS > SEA SURFACE TOPOGRAPHY > SEA SURFACE HEIGHT
Platform/Sensor	COMPUTERS / Computer
Data Provider	**Publisher:** PODAAC **Creator:** CNES/CLS **Release Place:** CNES/AVISO **Release Date:** 2021-Nov-01 **Resource:** http://doi.org/10.24400/527896/a01-2021.006
Format	netCDF-4
Keyword(s)	ssh, ocean, sea level, SWOT, Surface Water and Ocean Topography

Questions related to this dataset? Contact podaac@podaac.jpl.nasa.gov

CLOUD ENABLED

Status: COMPLETE

Short Name: SWOT_SIMULATED_L2_NADIR_SSH_GLORYS_SCIENCE_V1

Collection Concept ID: C2158350299-POCLOUD

Spatial Coverage:
N: 77.6° S: -77.6°
E: 180° W: -180°

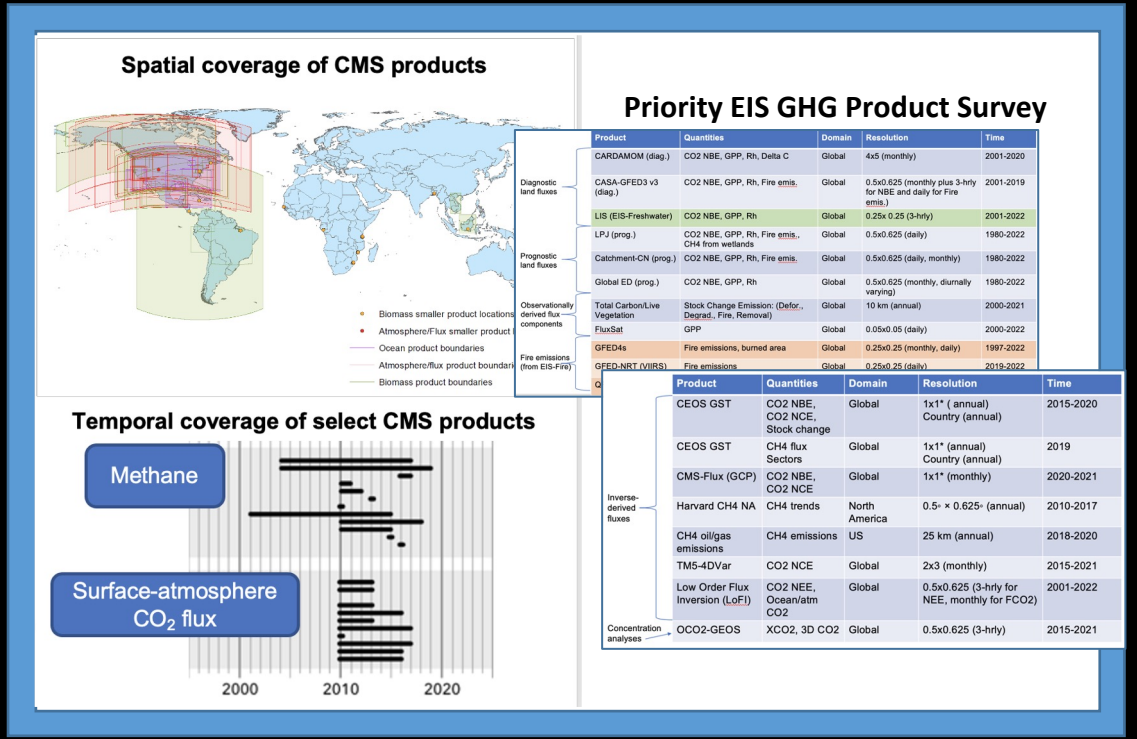
Access:
- Browse Granule Listing
- Search Granules

Capabilities: Download | Subset | Visualize

Data Recipes:
- Generic Data Readers

Mining NASA's rich catalog of GHG Products

- Through programs like NASA's Carbon Monitoring System and Science Team for the OCO Missions, NASA has supported the development of dozens of high-quality datasets that characterize emissions and concentrations of greenhouse gases.
- EIS focuses on integrating these multiple satellite-based products to provide a comprehensive assessment of GHGs during the past several decades and to improve delivery of information on recent changes.



Product	Quantities	Domain	Resolution	Time
CARDAMOM (diag.)	CO2 NBE, GPP, Rh, Delta C	Global	4x5 (monthly)	2001-2020
CASA-GFED3 v3 (diag.)	CO2 NBE, GPP, Rh, Fire emis.	Global	0.5x0.625 (monthly plus 3-hrly for NBE and daily for Fire emis.)	2001-2019
LIS (EIS-Freshwater)	CO2 NBE, GPP, Rh	Global	0.25x 0.25 (3-hrly)	2001-2022
LPJ (prog.)	CO2 NBE, GPP, Rh, Fire emis., CH4 from wetlands	Global	0.5x0.625 (daily)	1980-2022
Catchment-CN (prog.)	CO2 NBE, GPP, Rh, Fire emis.	Global	0.5x0.625 (daily, monthly)	1980-2022
Global ED (prog.)	CO2 NBE, GPP, Rh	Global	0.5x0.625 (monthly, diurnally varying)	1980-2022
Total Carbon/Live Vegetation	Stock Change Emission: (Defor., Degrad., Fire, Removal)	Global	10 km (annual)	2000-2021
FluxSat	GPP	Global	0.05x0.05 (daily)	2000-2022
GFED4s	Fire emissions, burned area	Global	0.25x0.25 (monthly, daily)	1997-2022
GFED-NRT (VIIRS)	Fire emissions	Global	0.25x0.25 (daily)	2019-2022

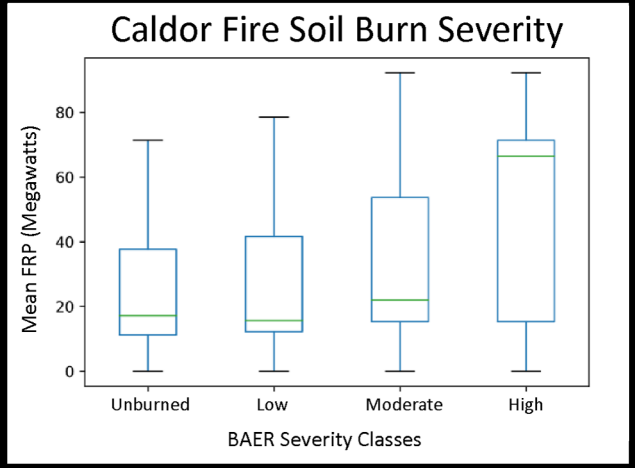
Product	Quantities	Domain	Resolution	Time
CEOS GST	CO2 NBE, CO2 NCE, Stock change	Global	1x1° (annual) Country (annual)	2015-2020
CEOS GST	CH4 flux Sectors	Global	1x1° (annual) Country (annual)	2019
CMS-Flux (GCP)	CO2 NBE, CO2 NCE	Global	1x1° (monthly)	2020-2021
Harvard CH4 NA	CH4 trends	North America	0.5° × 0.625° (annual)	2010-2017
CH4 oil/gas emissions	CH4 emissions	US	25 km (annual)	2018-2020
TM5-4DVar	CO2 NCE	Global	2x3 (monthly)	2015-2021
Low Order Flux Inversion (LoFI)	CO2 NEE, Ocean/atm CO2	Global	0.5x0.625 (3-hrly for NEE, monthly for FCO2)	2001-2022
OCO2-GEOS	XCO2, 3D CO2	Global	0.5x0.625 (3-hrly)	2015-2021

Figure adapted from Hurtt et al., Env. Res. Lett., 2022. doi: 10.1088/1748-9326/ac7407

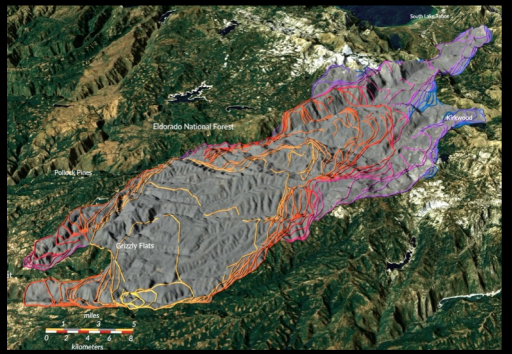
Post-fire impact assessments from EIS

- EIS analyses quantify a strong relationship between sub-daily fire intensity (measured as fire radiative power, FRP) and soil burn severity for the Caldor Fire, CA, 2021. Higher burn severity conditions in steep terrain are typically associated with higher likelihood of post-fire debris flow initiation.

- Stakeholder engagements include new academic collaborations at the University of Arizona and USGS; partnerships for helping streamline emergency response with USFS and FEMA.



The relationship between sub-daily Fire Radiative Power (FRP) and soil burn severity data (Burned Area Emergency Response, BAER).



EIS on the Road:

Geological Society of America (GSA), NASA Land Cover Land Use Change (LCLUC), NASA Carbon Monitoring System (CMS), ICESat-2 Science Team Meeting, OCO-2 Science Team Meeting, NASA Applied Sciences Program, World Water Week, Digital Twin Workshop.