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Survey of Remote Sensing Applications for Ecology and Biodiversity Conservation

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RGGS 2020

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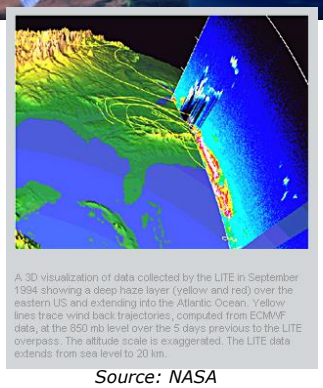
Air Quality



Source: NASA

- Stratospheric Ozone O_3
- Nitrogen Dioxide NO_2 (precursor to surface ozone)
- Sulfur dioxide (SO_2) and ammonia (NH_3)
- Formaldehyde (HCHO) a proxy for many volatile organic compounds
- Particulate matter (PM) via precursors(NO_2, SO_2 and NH_3) and aerosol optical thickness

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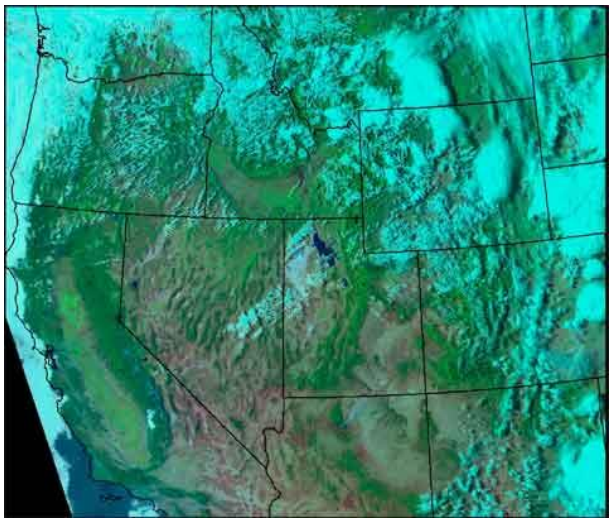
Weather and Climate Data

- Rainfall and temperature data over large areas
- Long-term climatological summaries
- Temperature measured (more or less) directly and rainfall is modeled
- Rainfall and temperature RS measurements compliment ground measurements
- Monitor ice loss at and near the poles
- Cloud cover and type
- Snow depth and water equivalent



source: U.S. Forest Service

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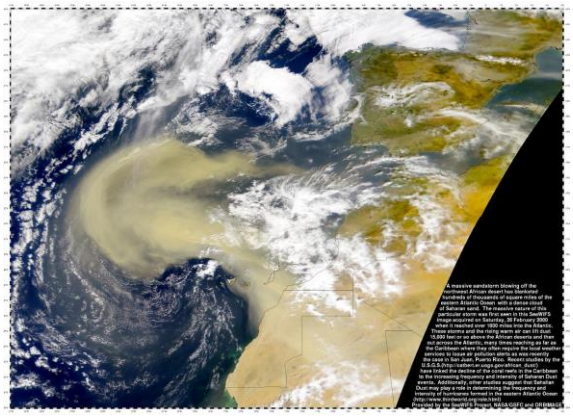
Weather Monitoring

http://www1.ncdc.noaa.gov/pub/data/images/hurr-katrina-20050828-n18rgb.jpg

Hurricane Katrina

Source: http://seawifs.gsfc.nasa.gov/SEAWIFS/IMAGES/Africa/S2000057133341.L1A_HDUN_CAN.SaharanDust Storm.small.jpg



African Dust storm

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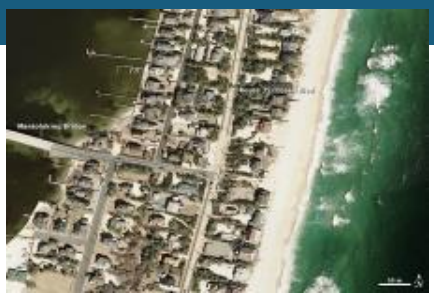
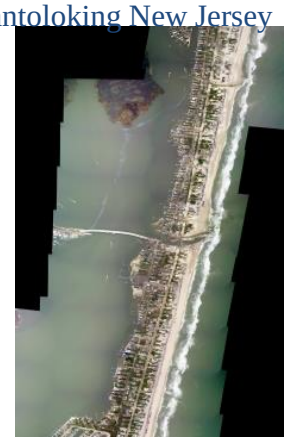
- Weather after-effects

Hurricane Sandy, Monday 29 October 2012



Mantoloking New Jersey



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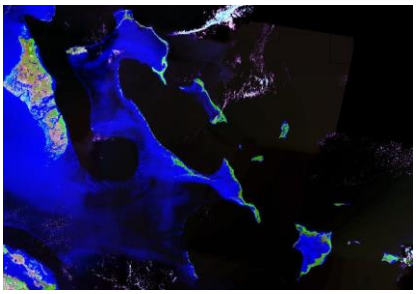
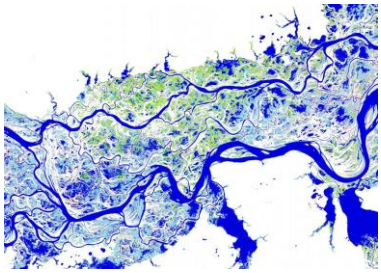
Aquatic Ecosystems





Source: Global Surface Water Explorer

- Ocean wind and currents
- Flooding
- Water quality
- Water body extent
- River flow rates
- Wetlands mapping
- Water surface elevation and depth
- Ocean color
- Coral reef mapping
- Benthic habitat
- Oil spill monitoring

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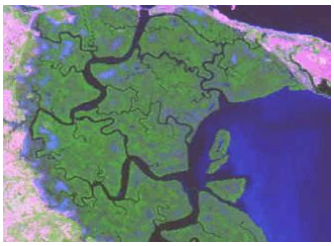
Surface Water and Wetlands



Source: NASA

- Mapping wetland extent and plant species
- Global surface water spatial and temporal distribution
- Global river classification
- Suspended sediments and turbidity
- Water temperature
- Aquatic vegetation
- Hydrologic modeling to calculate watershed geometry and predict flow
- Predict and monitor flooding

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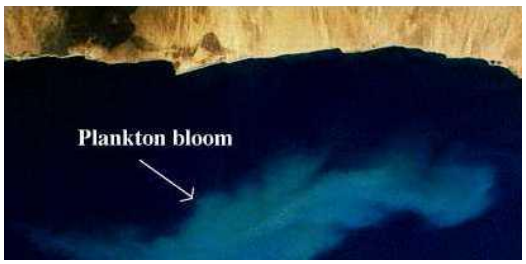
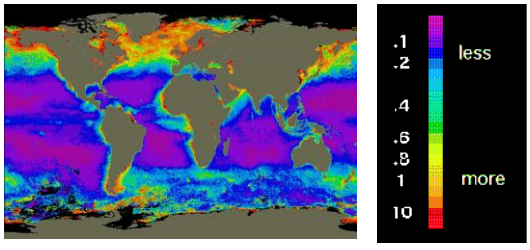
Monitoring Ocean Color



Source: NASA



Source: NASA

- Surges in phytoplankton appear as sudden bright blooms in satellite images
- In contrast, relatively low fluorescence indicates a healthy area and appears darker
- Primary productivity can be measured by determining the amount of light absorbed by phytoplankton chlorophyll
- Sensors detect variations in the intensity of reflected light, called ocean color, at the ocean surface
- Specific bands detect chlorophyll absorption

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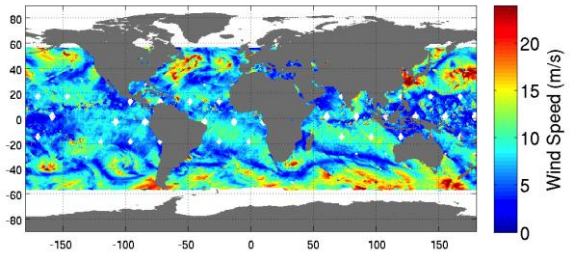
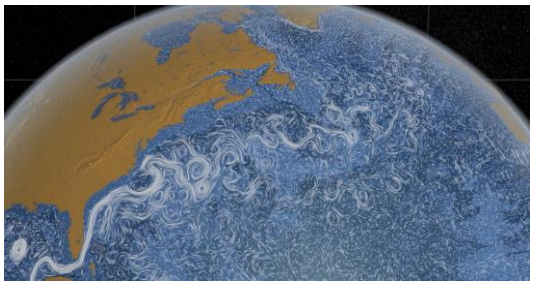
Other Marine Monitoring



Source: NASA



Source: NASA

- Sea surface temperature
- Coral reef mapping and monitoring
- Benthic monitoring
- Sea ice movement, mass monitoring
- Salinity
- Surface roughness
- Sea surface height, topography
- Ocean currents and circulation
- Wind speed and direction
- Modeling for carbon fluxes
- Shipping and fishing activities

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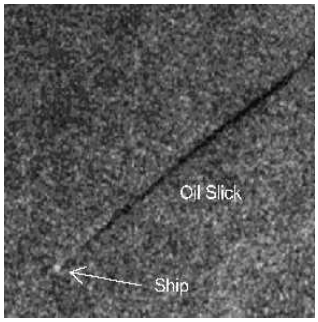
Pollution and illegal fishing

© Greenpeace



- Oil spill detection, mapping and monitoring
- Illegal fishing
- Marine pollution (plastics) mapping and monitoring

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Terrestrial ecosystems

Source: NOAA

Source: Harri Eliasson

- Population
- Fire mapping and modeling
- Forestry
- Landscapes
- Vegetation phenology and health
- Ecosystem processes and services
- Ground water and soil moisture
- Topography

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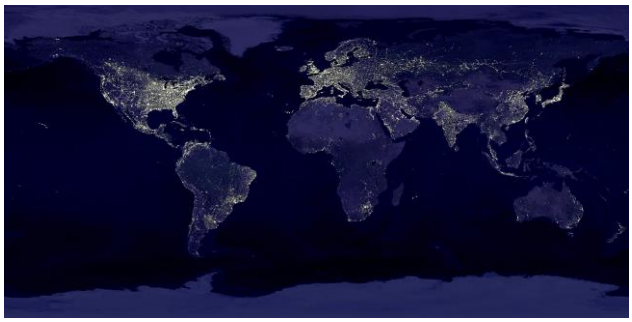
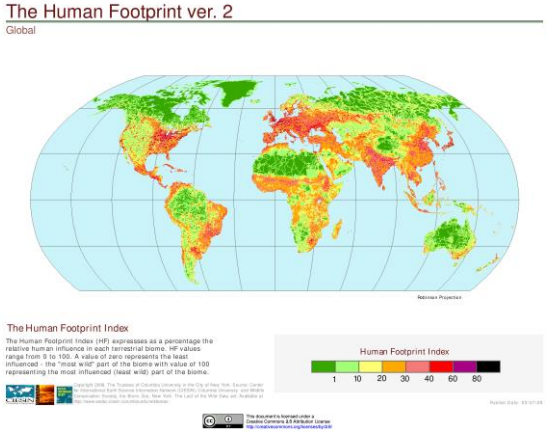
Population distributions and human footprint



Nighttime lights

Source: NASA GSFC and NOAA NGDC

http://antwrp.gsfc.nasa.gov/apod/image/0011/earthlights2_dmsp_big.jpg



Source: NASA SEDAC

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Fire Mapping and Prediction

Source: U.S. Forest Service

Source: U.S. Forest Service

During Fire Goals:

- Detection
- Behavior
- Monitoring
- Prediction

Post-Fire Goals:

- Assessment
- Burn severity
- Mapping
- Rehabilitation

Fire behavior dependent on:

- Fuel
- Weather
- Topographic Factors

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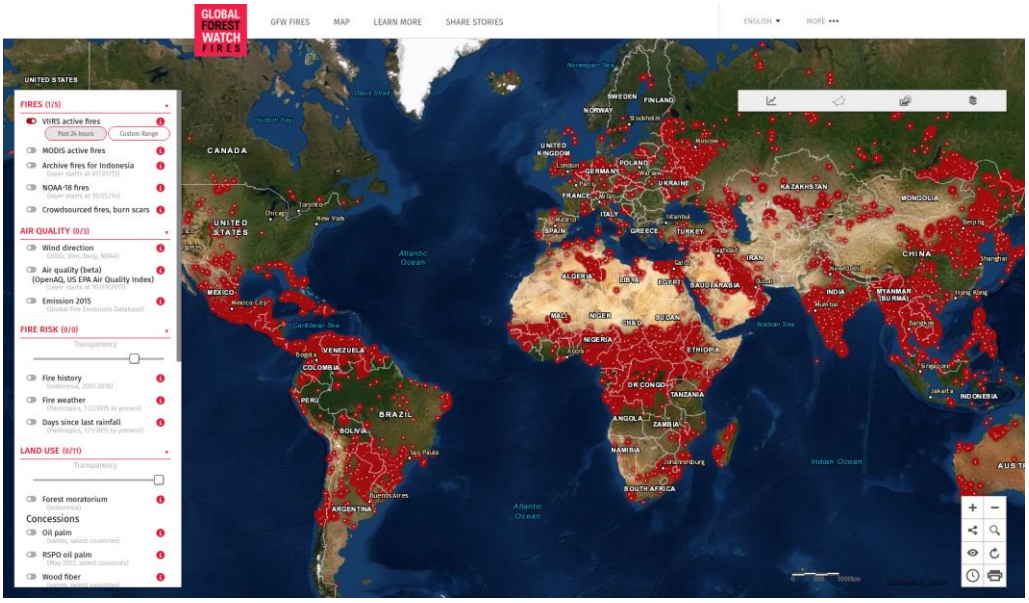
Fire Monitoring



Source: Global Forest Watch

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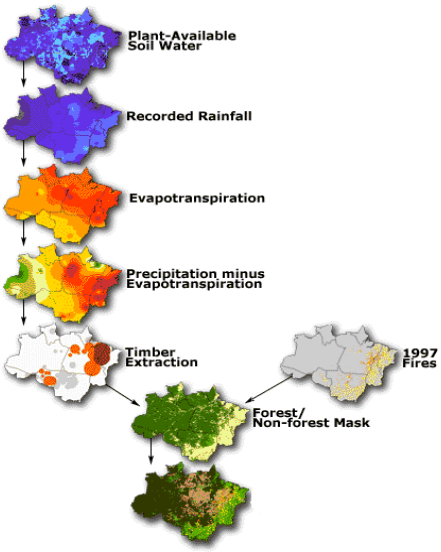
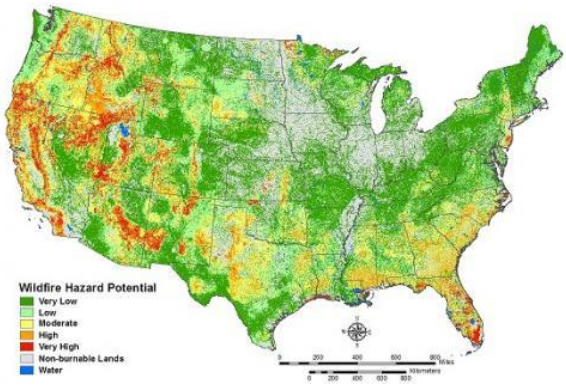
Predicting Fire Risk



Source: http://www.ipam.org.br/fogo/ppt-peten.htm



Source: USDA

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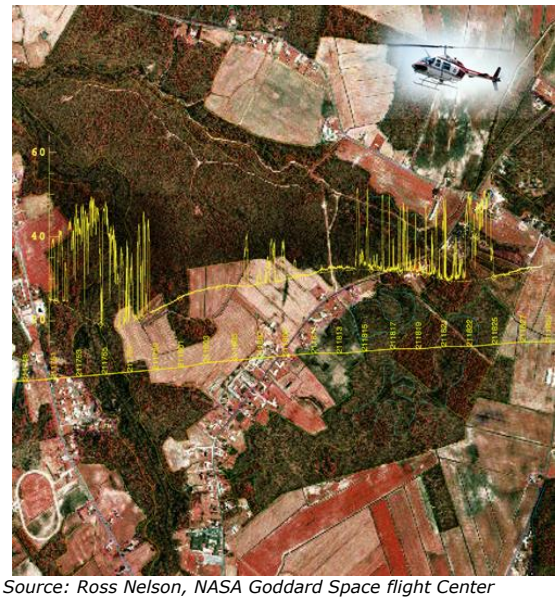
Forestry



Source: Ross Nelson, NASA Goddard Space flight Center

- Tree height
- Volume
- Stand density
- Biomass
- Leaf area index
- Structure
- Forest Health

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Landscapes

Source: University of Idaho

Land Use Land Cover and Change

- Repeated inventories of land cover and land use and land cover over space and time
- Classification vs percent cover: discrete vs continuous
- Monitoring degradation
- Simulation of processes (land conversion and use) taking place on the ground
- Soil composition

Landscape ecology

- Spatial patterns of landscapes can be observed and documented to model landscape metrics and indicators.

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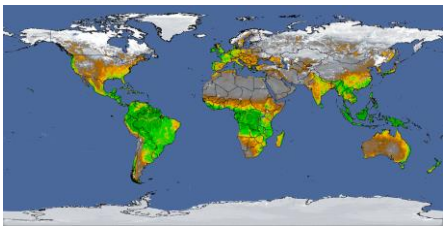
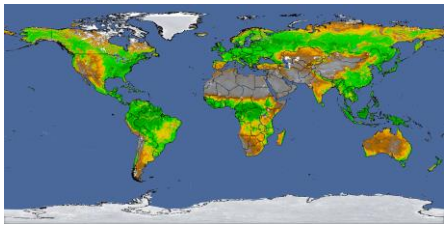
Vegetation phenology and health





Source: NASA

- Use vegetation indices to measure "greenness" over space and time
- Can be used to monitor vegetation events e.g., green-up and senescence
- Used in agriculture and monitoring vegetation disease outbreaks
- Estimate net primary productivity

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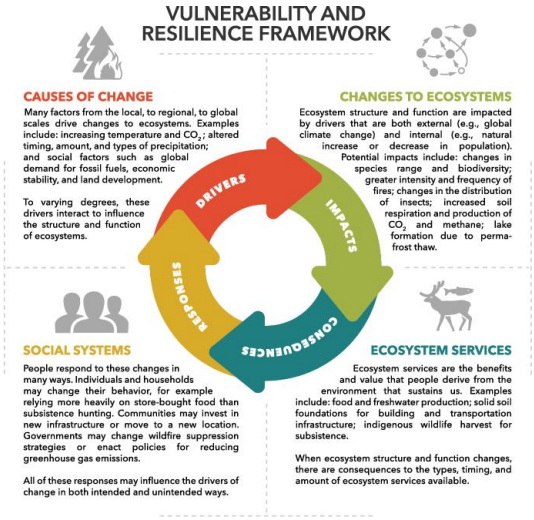
Ecosystem processes and services



Source: NASA Arctic – Boreal Vulnerability Experiment

- Use many data layers to model processes and services
- Area of active research
- Software and image products

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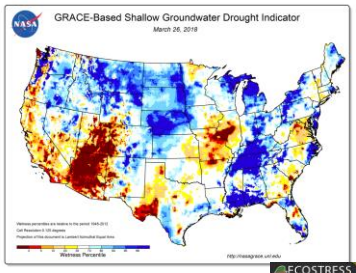
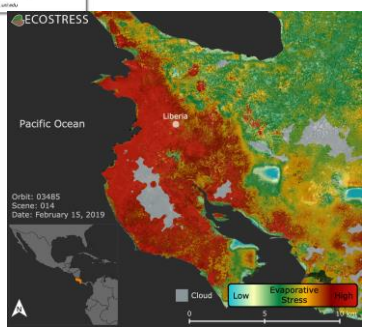
Ground water and soil moisture





Source: NASA

- Gravity measurements for groundwater and its movement
- ECOSTRESS new NASA mission to monitor plant temperature to monitor evaporative stress to detect stress
- Microwave radar for soil moisture
- Most soil moisture products very coarse resolution

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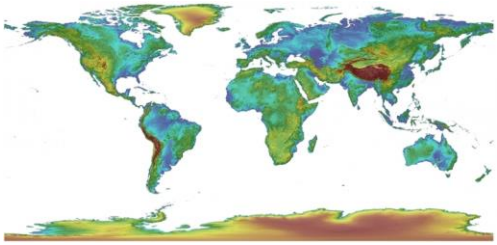
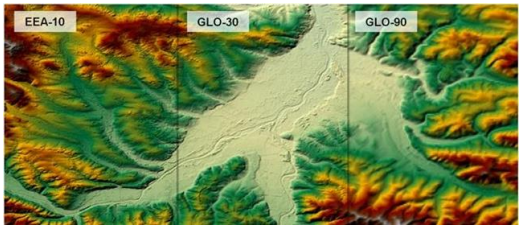
Topography



Source: USGS



Source: ESA - Copernicus

- Created using optical aerial and satellite imagery, radar and lidar
- Surface (DSM) vs elevation (DEM)
- Many different products available
- Software available for creating your own

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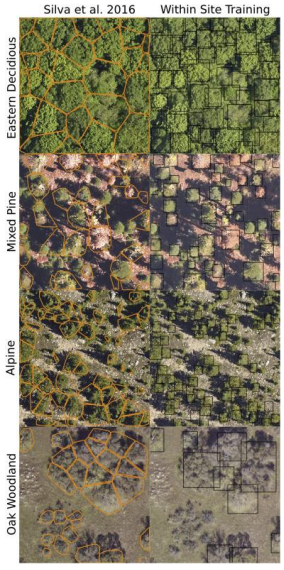
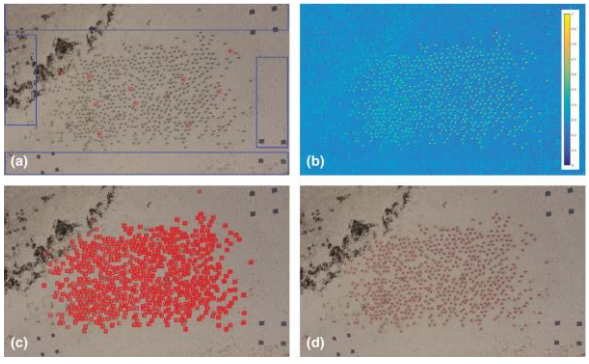
Feature extraction



Source: Ben Weinstein



Source: Jarrod Hodgson

- Nests
- Individual animals
- Trees and shrubs
- Vernal pools
- Counting objects

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Other types of remote sensing

Source: Open Acoustic Devices

Source: RESOLVE, TrailGuard AI

- Camera traps
- Animal movement
- Weather radar for bird and insect monitoring
- Acoustic monitoring
- Sonar

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Limitations of Remote Sensing

- Cost and licensing of satellite images, software and equipment
- Cloud cover
- Data product errors
- Satellite spatial and temporal coverage
- Many derived products have coarse spatial resolution
- Large data storage needs
- Limited (and disappearing) historical data

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Final thoughts

- Many opportunities available to learn about remote sensing applications and products
- So many data sets and data portals – often best to ask a colleague with prior experience for sources
- Pay attention to dataset production methods and metadata
- Uncertainty is important
- Online platforms such as Google Earth Engine are powerful tools for processing remotely sensed imagery
- Derived products are often reprocessed using new methods

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