2020 Satellite Needs Working Group (SNWG) Agency Survey: Aggregate Information

SNWG Background

The SNWG partners with federal civilian agencies to identify high-priority sustained and unmet needs for satellite Earth observations. Starting in 2016, the SNWG has conducted a biennial survey to formally document and communicate satellite Earth-observing needs to NASA and other spaced-based Earth observation providers NOAA and USGS. The Satellite Needs Survey obtains information about key agency objectives that require the application of satellite Earth observations, as well as specific measurement requirements.

Use of the 2020 SNWG Survey Aggregate Information Report

The 2020 Satellite Needs Survey featured 123 responses from 23 agencies. Each response represents an agency's satellite data need. This report presents aggregate statistics about agency measurement requirements as well as a subset of other quantifiable aspects of agency needs. Agency-identifying information, including specific needs, cannot be released publicly and is not included in this report. In interpreting these statistics, please note the following caveats:

- The Satellite Needs Survey is a voluntary reporting in which each agency's leadership chooses whether to participate and which, if any, satellite needs to submit
- The survey responses represent only a subset of the full satellite Earth observation needs of the federal civilian agencies, and the subset and derived statistics cannot be assumed to be unbiased

This report is intended to give readers information about the types of satellite data that agencies request in order to support their needs, including:

- The geophysical feature, parameter, or phenomenon the agency needs to observe
- Technical specifications of data that could support their work, including resolution, coverage, latency, and other data characteristics
- Processing aspects of data use, including data discovery, access methods, and formats

Take-Home Messages

Across five survey cycles, there is a steady increase in the need for continuous, routinely collected, high-quality, free data.

Specific findings from 2020:

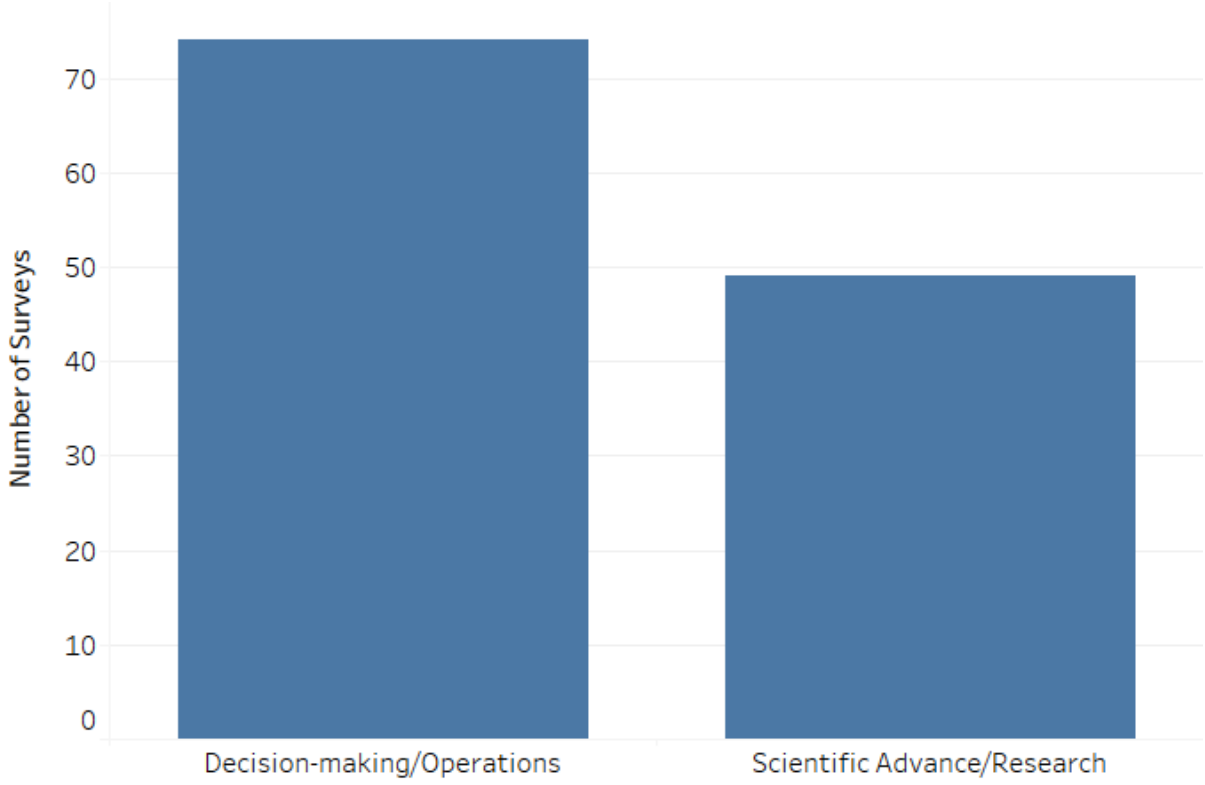
- The number of survey responses increased by approximately 50% compared with the 2016 and 2018 cycles.
- The observables most frequently requested by agencies were those pertaining to the atmosphere, biosphere, land surface, and terrestrial hydrosphere.

    - Atmospheric observation needs frequently encompass multiple related variables, e.g. atmospheric composition needs request multiple specific chemical species.
    - Biosphere needs often request variables related to ecosystem functions, aquatic ecosystems, and canopy characteristics.
- Although the number of scientific research-related surveys doubled from 2018 to 2020, decision-making and operational requirements still constituted the majority of needs.
- Geographic coverage was identified as the most critical attribute to agencies, followed closely by spatial resolution, with a clear trend toward higher resolution requests.
- Daily data and latency of three hours or less were requested in 40% of survey responses, with some agencies also requiring sub-hourly latency.
- Data handling (including data volume and transformation) represented the biggest factor limiting agencies' use of satellite data.
- Over half of survey responses indicated interest in commercial satellite products, with a continued increase in demand for high-resolution optical data, followed by commercial SAR and atmospheric composition data.
- Direct download was the most preferred data access method, although over 70% of responses ranked cloud-based processing or cloud-based access in their top three preferred access mechanisms.

Aggregate Statistics

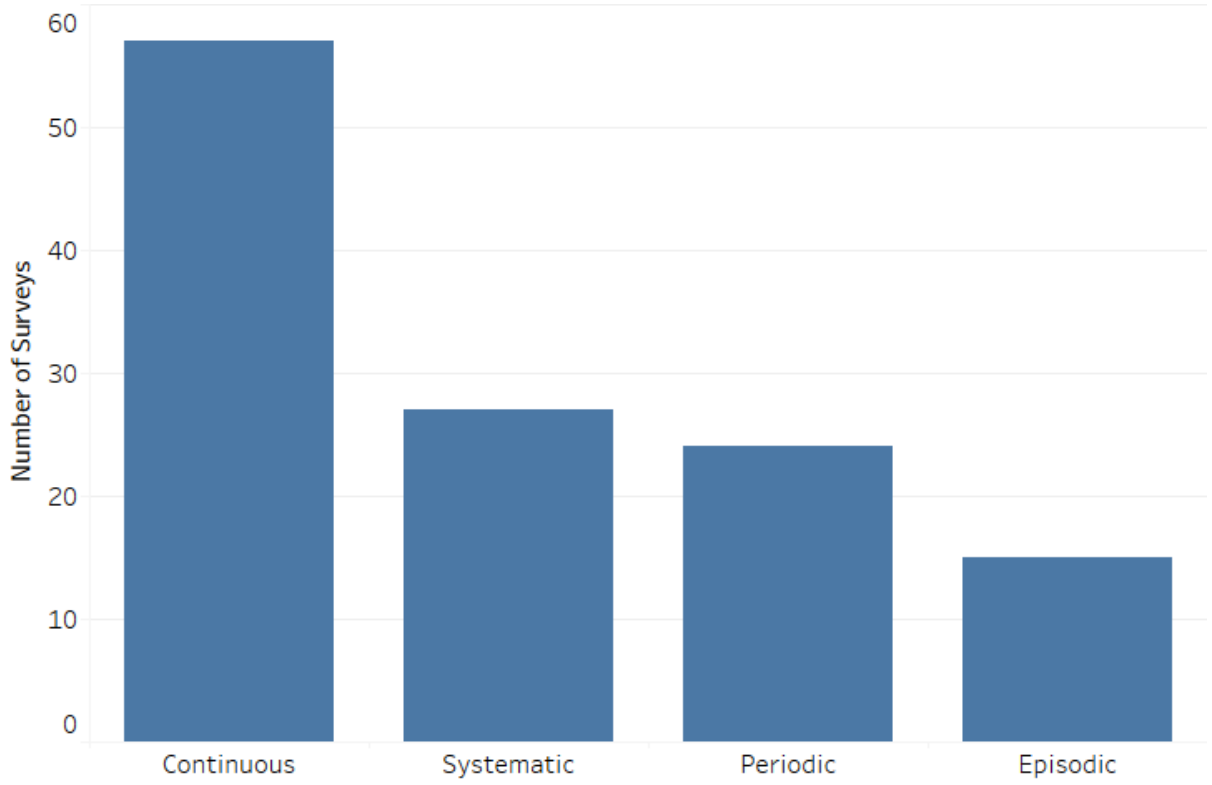
Context for Satellite Measurement or Data Product Need

Which of these descriptions best fits the nature of the need? (1)



Option	**# of Surveys (%)**
Decision-making/Operations	74 (60%)
Scientific Advance/Research	49 (40%)

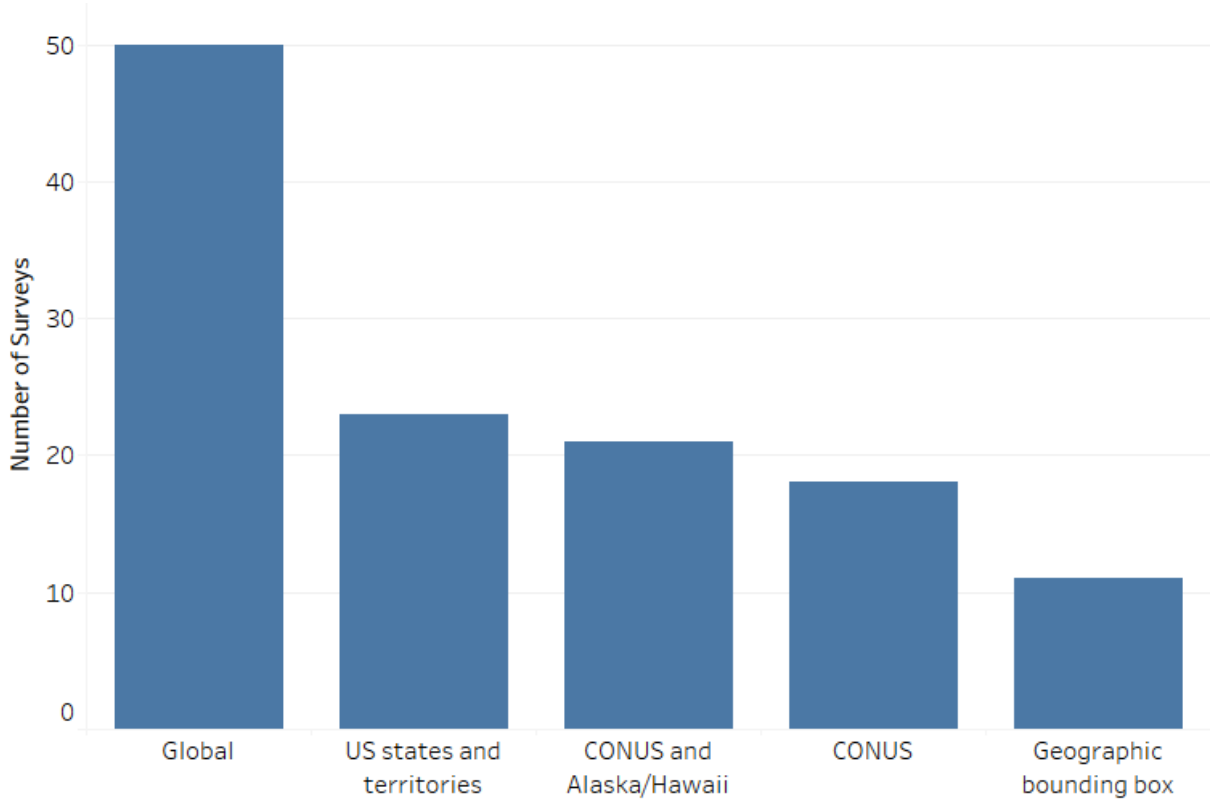
Which of these descriptions best fits the nature of the need? (2)



Option	**# of Surveys (%)**
Continuous	57 (46%)
Systematic (Examples: time-series to detect landslide motion, volcanic unrest, land-use change, or ecosystem disturbance)	27 (22%)
Periodic (Examples: crop health during the growing season or reservoir levels after spring snow melt)	24 (20%)
Episodic (Examples: imagery during forest fires or volcanic eruptions)	15 (12%)

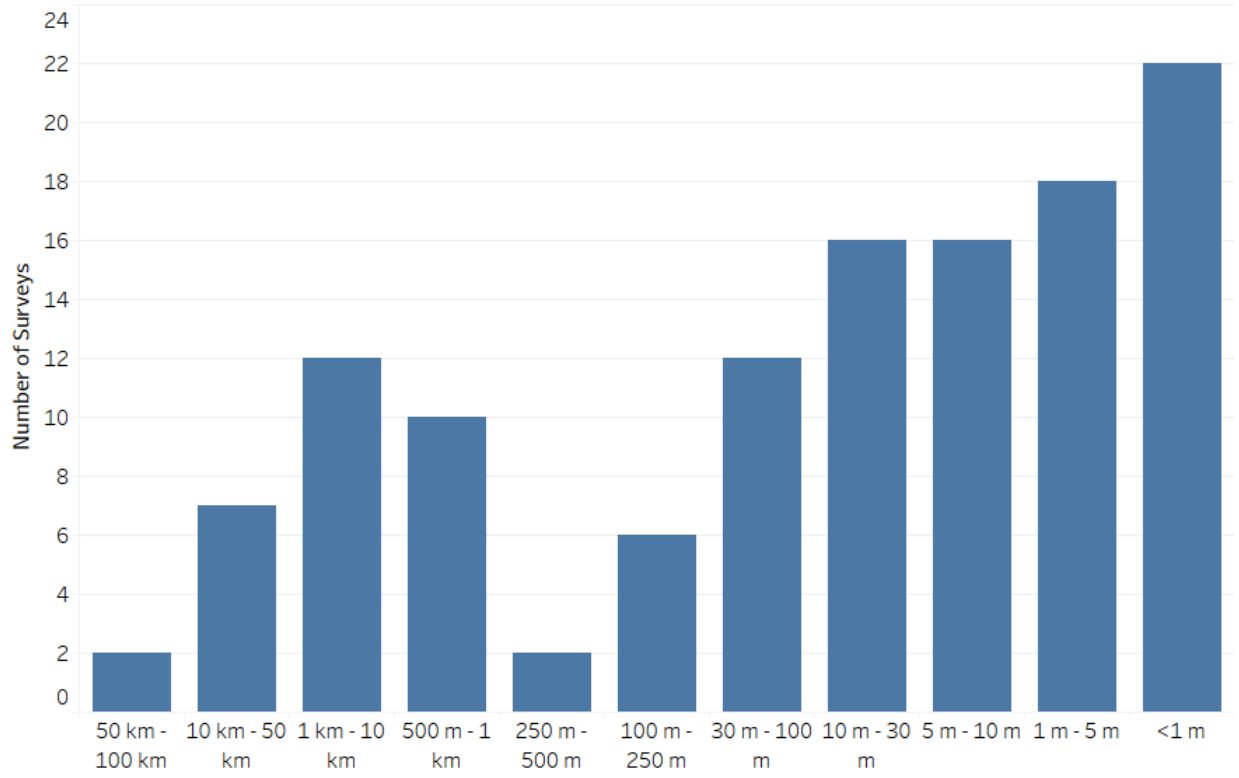
Specific Satellite Measurement or Product Need

What is the optimal geographic coverage to meet your satellite measurement or product need?



Option	**# of Surveys (%)**
Global	50 (41%)
US states and territories	23 (19%)
CONUS and Alaska/Hawaii	21 (17%)
CONUS	18 (15%)
Geographic bounding box	11 (9%)

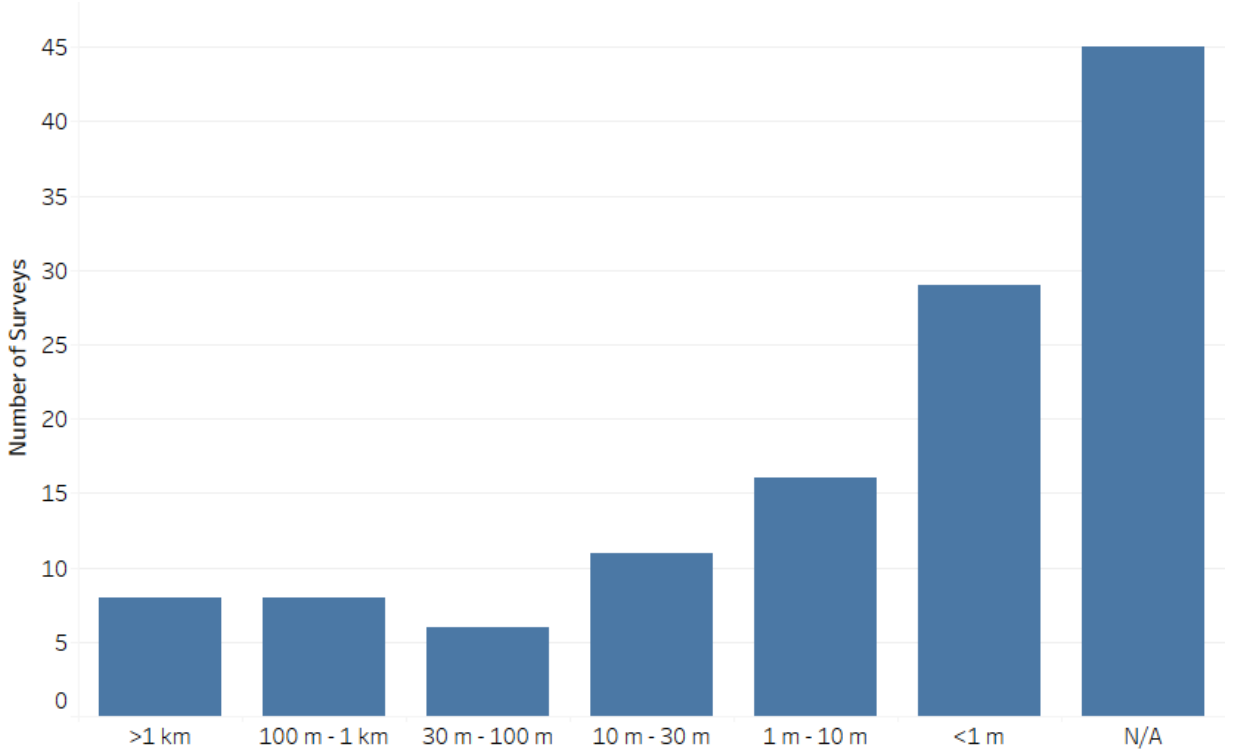
What is the optimal horizontal spatial resolution to meet your need?



Option	# of Surveys (%)
>1000 km (>10 degrees)	0 (0%)
500 km - 1000 km (5-10 degrees)	0 (0%)
250 km - 500 km (2.5-5.0 degrees)	0 (0%)
100 km - 250 km (1.0-2.5 degrees)	0 (0%)
50 km - 100 km (0.5-1.0 degrees)	2 (2%)
10 km - 50 km (0.09-0.5 degrees)	7 (6%)
1 km - 10 km (0.01-0.09 degrees)	12 (10%)
500 m - 1 km	10 (8%)
250 m - 500 m	2 (2%)
100 m - 250 m	6 (5%)
30 m - 100 m	12 (10%)
10 m - 30 m	16 (13%)

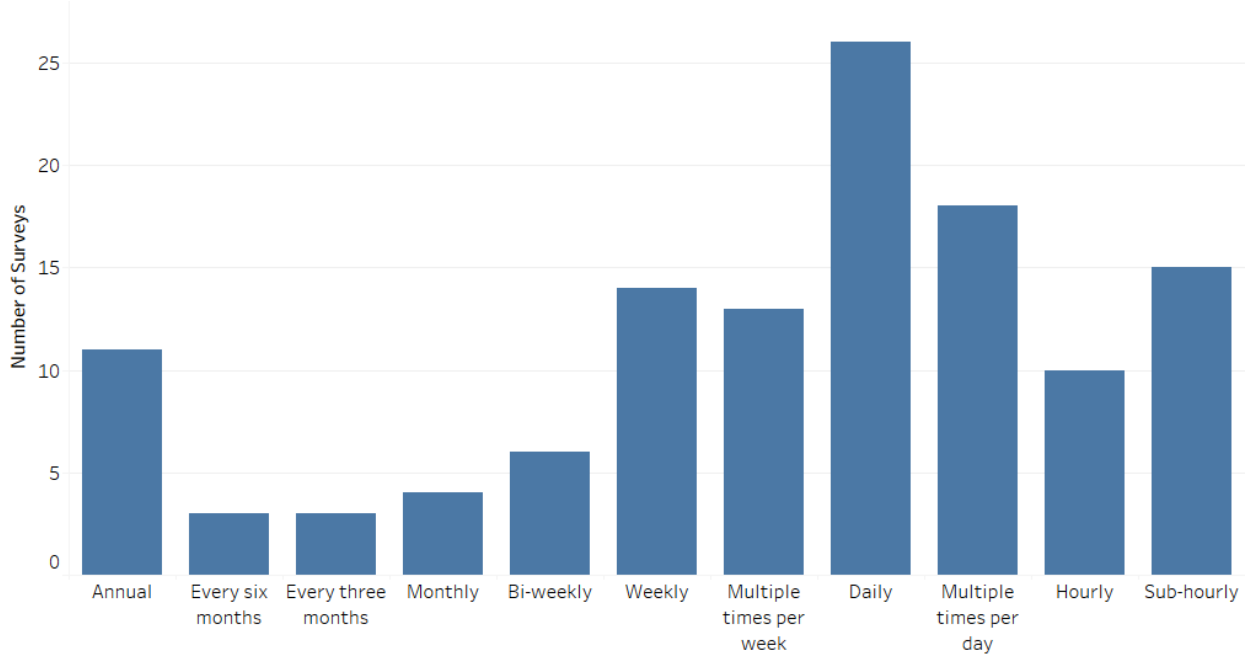
5 m - 10 m	16 (13%)
1 m - 5 m	18 (15%)
<1 m	22 (18%)

What is the optimal vertical spatial resolution to meet your need?



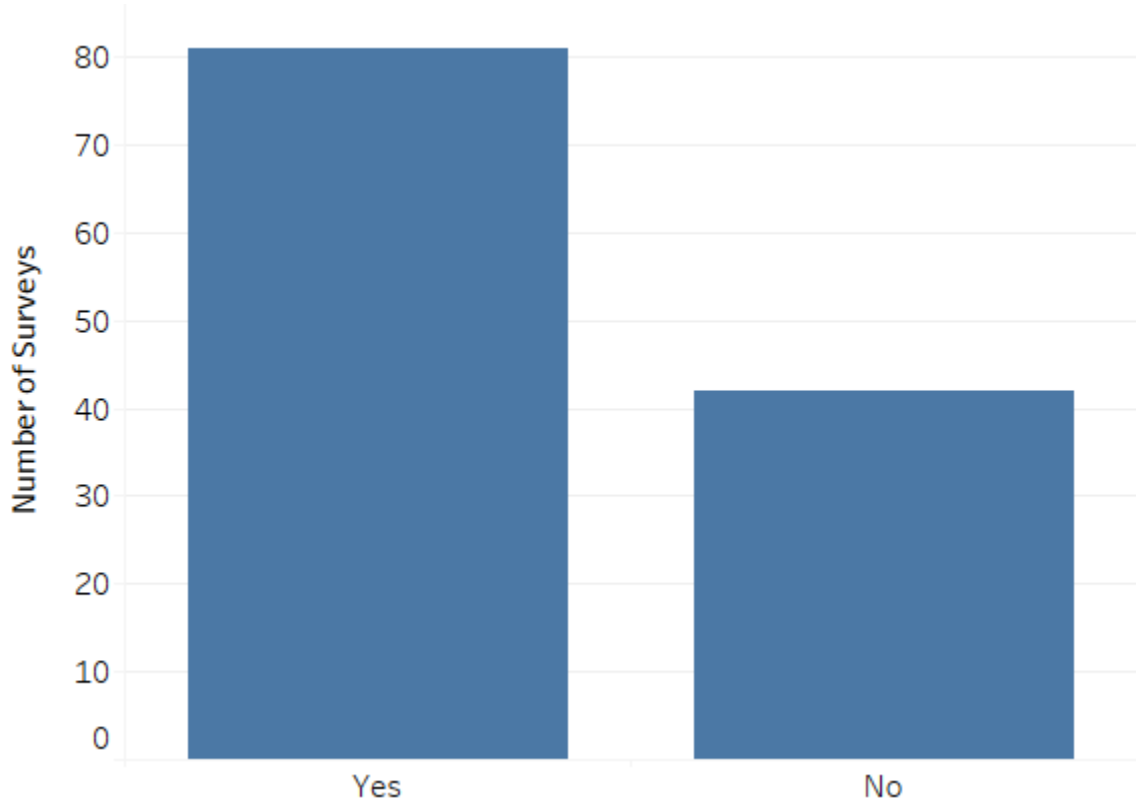
Option	**# of Surveys (%)**
>1 km	8 (7%)
100 m - 1 km	8 (7%)
30 m - 100 m	6 (5%)
10 m - 30 m	11 (9%)
1 m - 10 m	16 (13%)
<1 m	29 (24%)
N/A	45 (37%)

What is the optimal measurement or data product temporal frequency?



Option	**# of Surveys (%)**
Annual	11 (9%)
Every six months	3 (2%)
Every three months	3 (2%)
Monthly	4 (3%)
Bi-weekly	6 (5%)
Weekly	14 (11%)
Multiple times per week	13 (11%)
Daily	26 (21%)
Multiple times per day	18 (15%)
Hourly	10 (8%)
Sub-hourly	15 (12%)

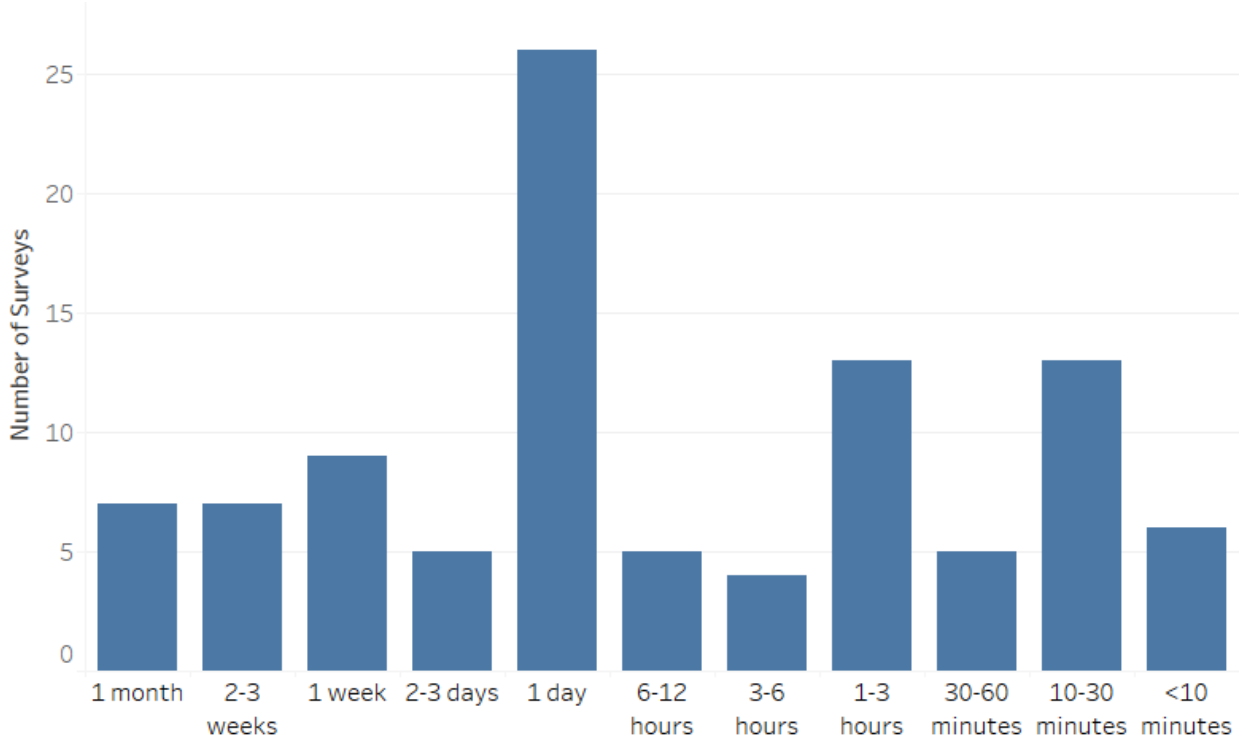
Is data latency a critical attribute for these needs?



Option	# of Surveys (%)
Yes	81 (66%)
No	42 (34%)

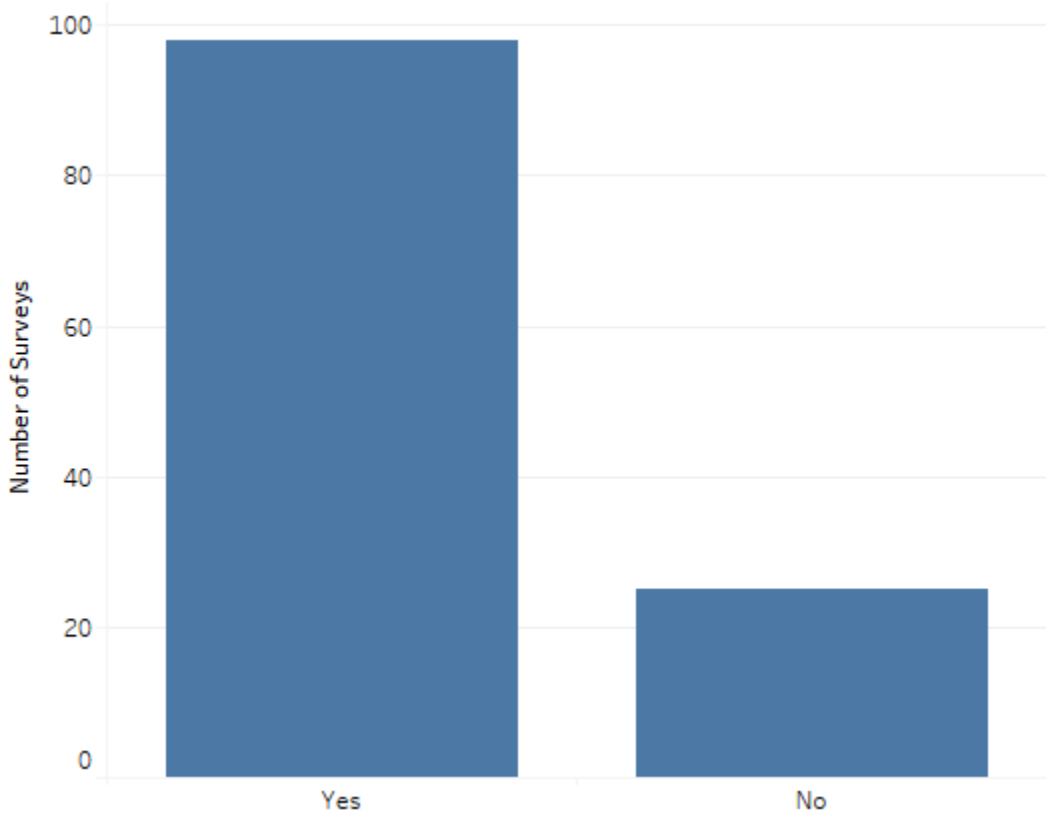
What is the optimal data latency to meet your measurement or product need?

For the 100 surveys (81%) that indicated a critical data latency need:



Option	# of Responses (% of those responding)
1 month	7 (7%)
2-3 weeks	7 (7%)
1 week	9 (9%)
2-3 days	5 (5%)
1 day	26 (26%)
6-12 hours	5 (5%)
3-6 hours	4 (4%)
1-3 hours	13 (13%)
30-60 minutes	5 (5%)
10-30 minutes	13 (13%)
<10 minutes	6 (6%)

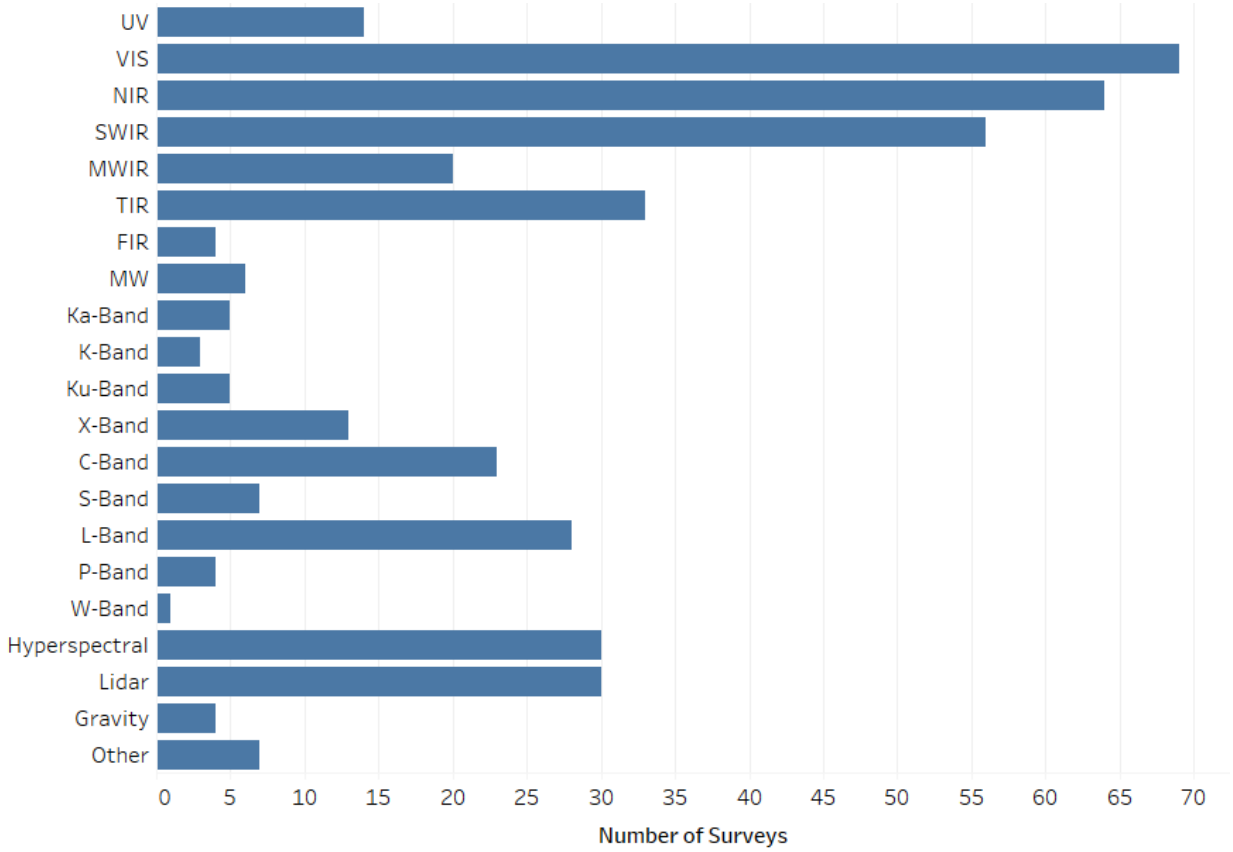
Is spectral resolution or are specific spectral bands critical attributes in meeting your need?



Option	# of Surveys (%)
Yes	98 (80%)
No	25 (20%)

What spectral resolution or spectral bands would best meet your need? (select all that apply)

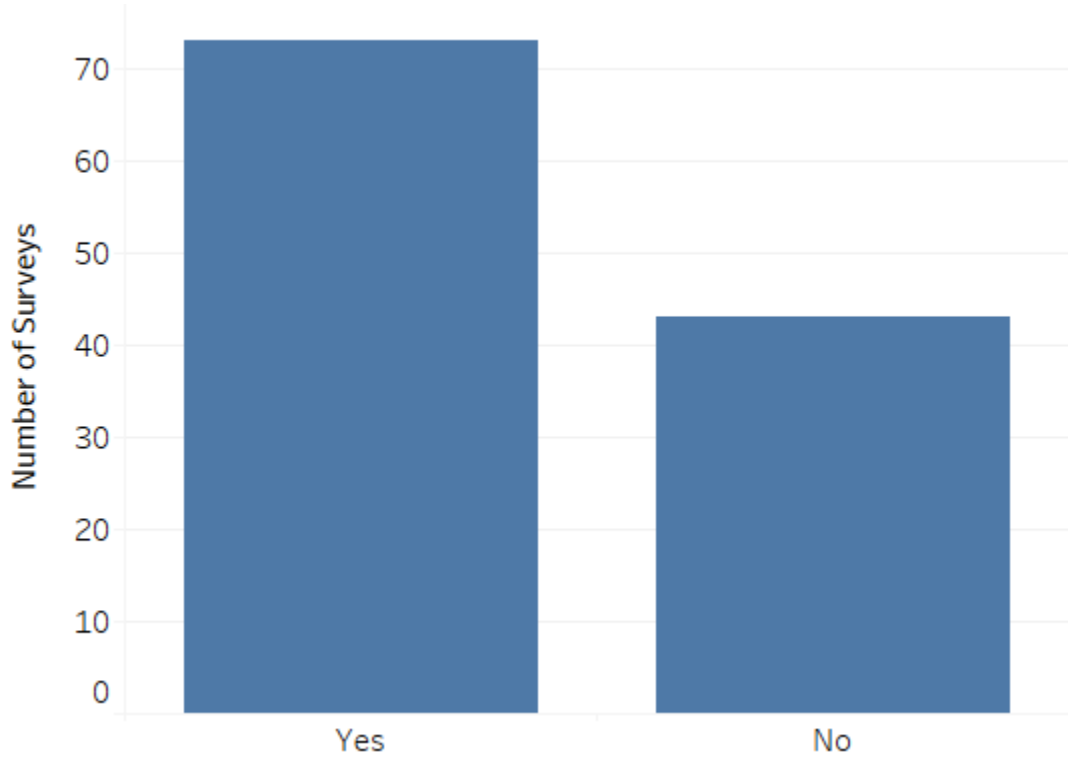
For the 98 surveys (80%) that indicated a critical spectral band need:



Option	# of Surveys (% of those responding)
UV (~0.01 µm - ~0.40 µm)	14 (14%)
VIS (~0.40 µm - ~0.75 µm)	69 (70%)
NIR (~0.75 µm - ~1.3 µm)	64 (65%)
SWIR (~1.3 µm - ~3.0 µm)	56 (57%)
MWIR (~3.0 mµ - ~6.0 µm)	20 (20%)
TIR (~6.0 mµ - ~15.0 µm)	33 (34%)
FIR (~15.0 µm - ~0.1 cm)	4 (4%)
MW (~1.0 cm - ~100 cm)	6 (6%)
Ka-Band (26.5 - 40 GHz)	5 (5%)

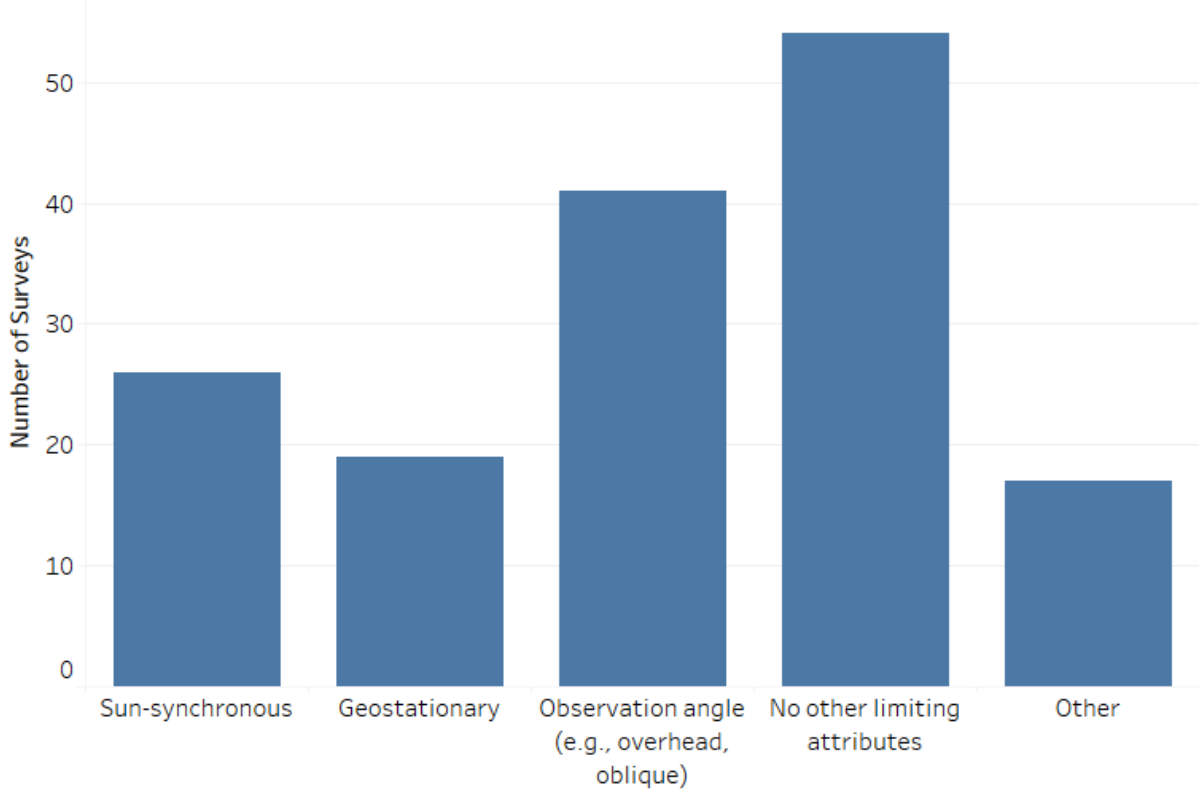
K-Band (18 - 26.5 GHz)	3 (3%)
Ku-Band (12.5 - 18 GHz)	5 (5%)
X-Band (12.5 - 8 GHz)	13 (13%)
C-Band (8 - 4 GHz)	23 (23%)
S-Band (4 - 2 GHz)	7 (7%)
L-Band (2 - 1 GHz)	28 (29%)
P-Band (0.999 - 0.2998 GHz)	4 (4%)
W-Band (94 GHz)	1 (1%)
Hyperspectral	30 (31%)
Lidar	30 (31%)
Gravity	4 (4%)
Other	7 (7%)

Is measurement uncertainty a critical attribute in meeting your need?



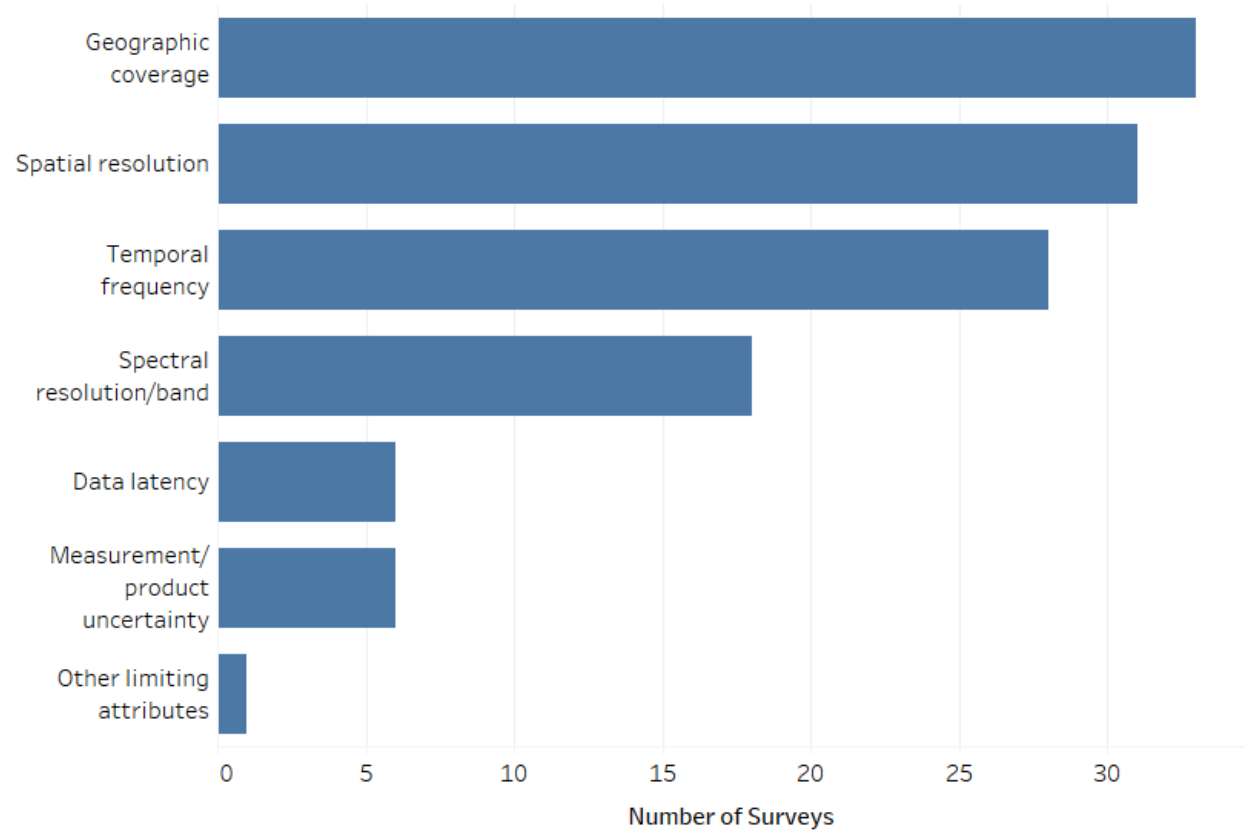
Option	# of Surveys (%)
Yes	83 (67%)
No	40 (33%)

Are there other limiting attributes such as the following? (select all that apply)



Option	**# of Surveys**
Sun-synchronous	26 (21%)
Geostationary	19 (15%)
Observation angle (e.g., overhead, oblique)	41 (33%)
No other limiting attributes	54 (44%)
Other	17 (14%)

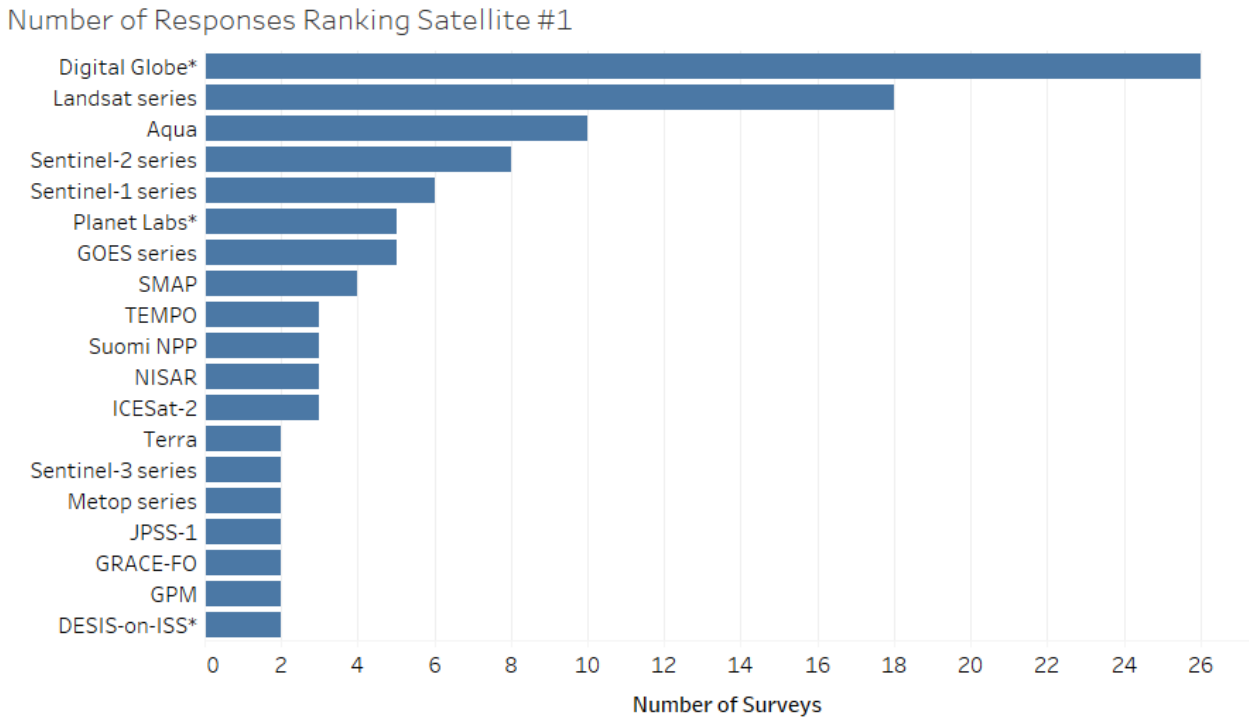
Rank how critical each of the above attributes is for meeting your need, with 1 = most important.

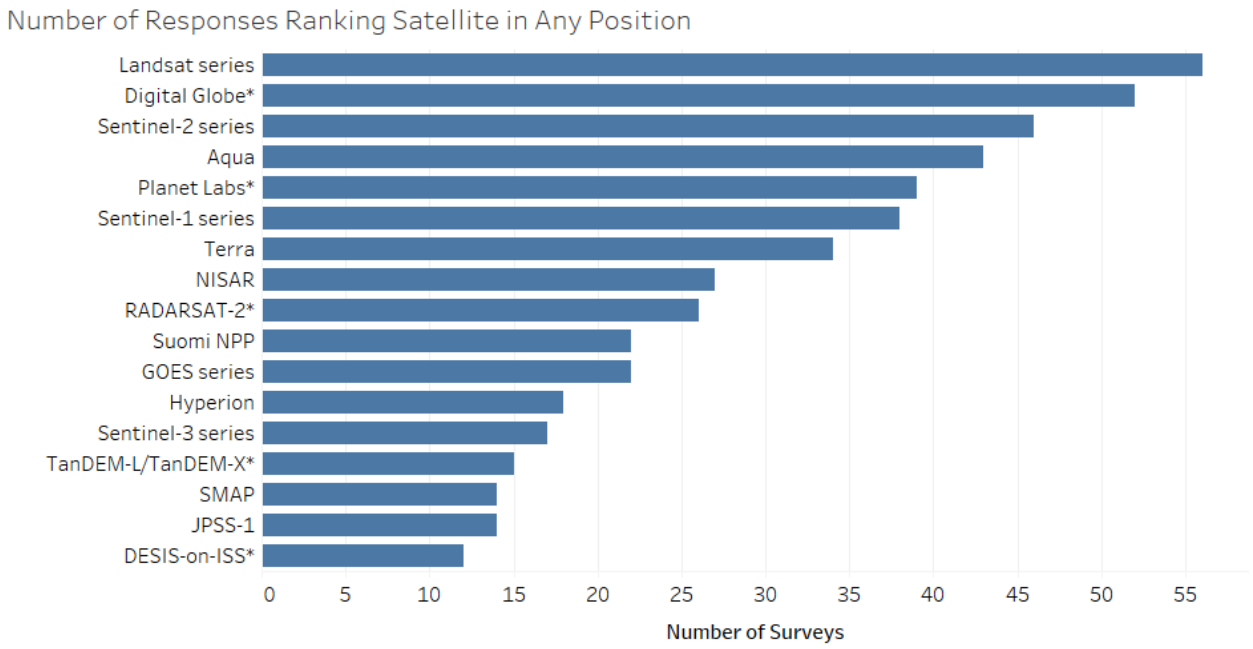


Option	# of Surveys Ranking #1 (%)	# of Surveys Ranking #2 (%)
Geographic coverage	33 (27%)	12 (10%)
Spatial resolution	31 (25%)	40 (33%)
Temporal frequency	28 (23%)	34 (28%)
Spectral resolution/band	18 (15%)	15 (12%)
Data latency	6 (5%)	11 (9%)
Measurement/product uncertainty	6 (5%)	9 (7%)
Other limiting attributes	1 (1%)	2 (2%)

If you know which satellite mission or sensor is currently or could be used to satisfy your needs, please rank in order of priority, with 1 = most important.

Note: responses marked with an asterisk signify that the mission or sensor is commercial





Option	# of Surveys Ranking #1 (%)	# of Surveys Ranking Overall (%)

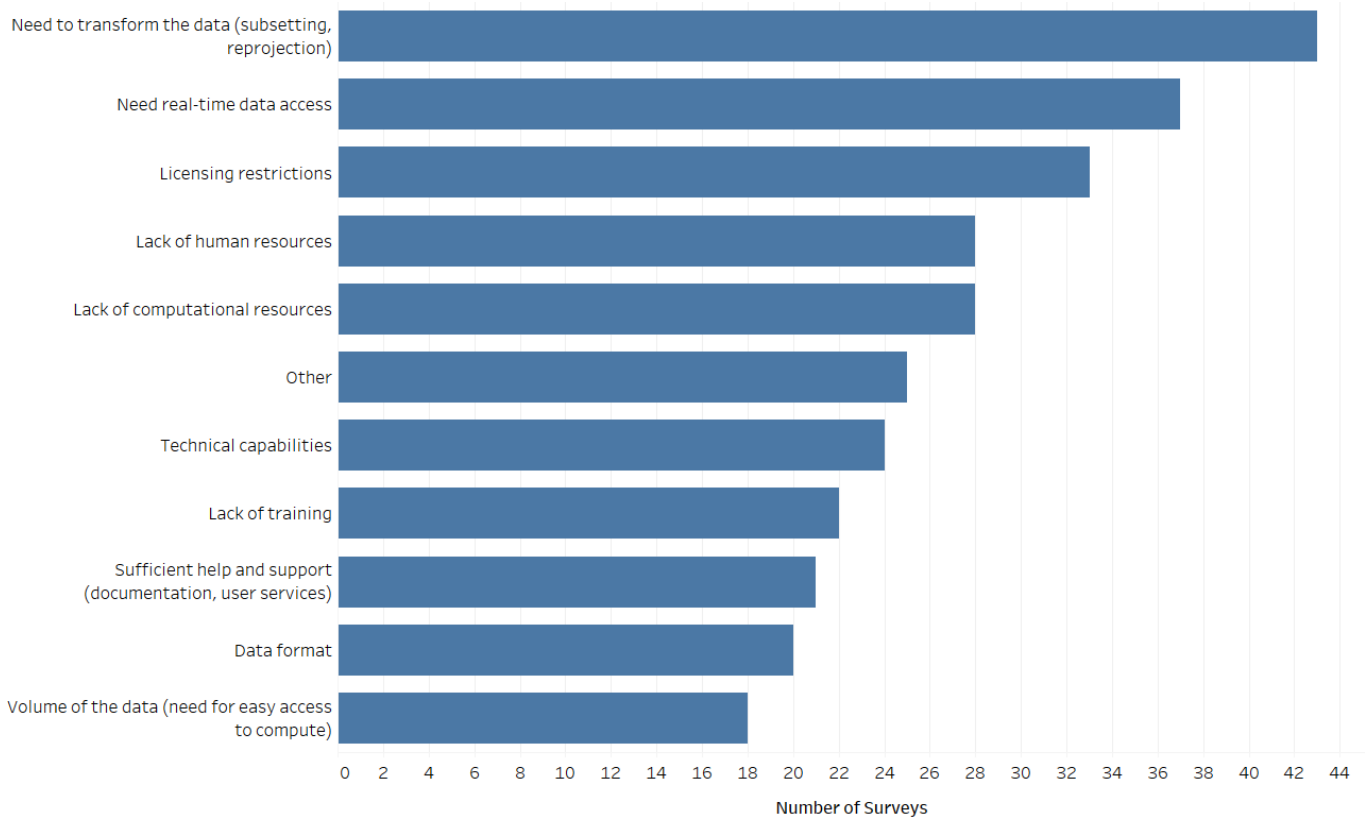
ADM-Aeolus	1 (1%)	2 (2%)
ALOS-2	0 (0%)	0 (0%)
Aqua (AIRS, AMSR-E, AMSU-A, CERES, HSB, MODIS)	10 (8%)	43 (35%)
Aura (HiRDLS, MLS, OMI, TES)	0 (0%)	6 (5%)
CALIPSO	0 (0%)	5 (4%)
CloudSat	1 (1%)	4 (3%)
COSMIC-1/COSMIC-2	1 (1%)	2 (2%)
CryoSat-2	0 (0%)	1 (1%)
CYGNSS	0 (0%)	3 (2%)
Deimos-1	0 (0%)	4 (3%)
DESIS-on-ISS	2 (2%)	12 (10%)
Digital Globe (Worldview-1/Worldview-2/Worldview-3/Worldview-4, GeoEye, QuickBird)	26 (21%)	52 (42%)
DMC UK-2 (decommissioned)	0 (0%)	2 (2%)
DMSP F-14/F-15/F-16/F-17/F-18	0 (0%)	3 (2%)
DSCOVR	0 (0%)	0 (0%)
EarthCARE	1 (1%)	3 (2%)
ECOSTRESS-on-ISS	0 (0%)	10 (8%)
GCOM-C/GCOM-W	0 (0%)	4 (3%)
GEDI-on-ISS	0 (0%)	6 (5%)
GeoCarb	0 (0%)	1 (1%)
GOES-16/GOES-17 (ABI, GLM)	5 (4%)	22 (18%)
GOSAT/GOSAT-2	1 (1%)	2 (2%)
GPM	2 (2%)	6 (5%)
GRACE-FO	2 (2%)	5 (4%)
Himawari-8/Himawari-9	0 (0%)	6 (5%)
Hyperion	0 (0%)	18 (15%)
ICESat-2	3 (2%)	6 (5%)
Jason-3	0 (0%)	3 (2%)
JPSS-1	2 (2%)	14 (11%)

LAGEOS-1/LAGEOS-2	0 (0%)	0 (0%)
Landsat 7/Landsat 8/Landsat 9	18 (15%)	56 (46%)
LIS-on-ISS	0 (0%)	2 (2%)
Meteosat-8/Meteosat-9/Meteosat-10/Meteosat-11	0 (0%)	7 (6%)
Metop-A/Metop-B/Metop-C	2 (2%)	10 (8%)
NISAR	3 (2%)	27 (22%)
NOAA-18/NOAA-19	0 (0%)	7 (6%)
OCO-2	1 (1%)	4 (3%)
Odin	0 (0%)	0 (0%)
OSTM (Jason-2)	1 (1%)	2 (2%)
PACE	0 (0%)	3 (2%)
Planet Labs [PlanetScope (Dove), RapidEye, SkySat]	5 (4%)	39 (32%)
PROBA/PROBA-V	0 (0%)	1 (1%)
RADARSAT-2	0 (0%)	26 (21%)
RCM-1/RCM-2/RCM-3	0 (0%)	3 (2%)
RESOURCESAT-2	0 (0%)	6 (5%)
SAGE-III-on-ISS	0 (0%)	0 (0%)
SAOCOM 1A/SAOCOM 1B	0 (0%)	1 (1%)
SARAL	0 (0%)	2 (2%)
SCISAT-1	0 (0%)	0 (0%)
Sentinel-1 A/Sentinel-1 B	6 (5%)	38 (31%)
Sentinel-2 A/Sentinel-2 B	8 (7%)	46 (37%)
Sentinel-3 A/Sentinel-3 B	2 (2%)	17 (14%)
Sentinel-5 precursor	0 (0%)	7 (6%)
Sentinel-6 A	1 (1%)	5 (4%)
SMAP	4 (3%)	14 (11%)
SMOS	1 (1%)	6 (5%)
SORCE	0 (0%)	0 (0%)
Spire	0 (0%)	1 (1%)
Suomi NPP	3 (2%)	22 (18%)
Swarm	0 (0%)	0 (0%)

TanDEM-L/TanDEM-X	0 (0%)	15 (12%)
TDS-1	0 (0%)	0 (0%)
TEMPO	3 (2%)	7 (6%)
Terra (ASTER, CERES, MISR, MODIS, MOPITT)	2 (2%)	34 (28%)
TSIS-1-on-ISS	0 (0%)	0 (0%)
Other	6 (5%)	26 (21%)

Processing for Satellite Measurement or Product Need

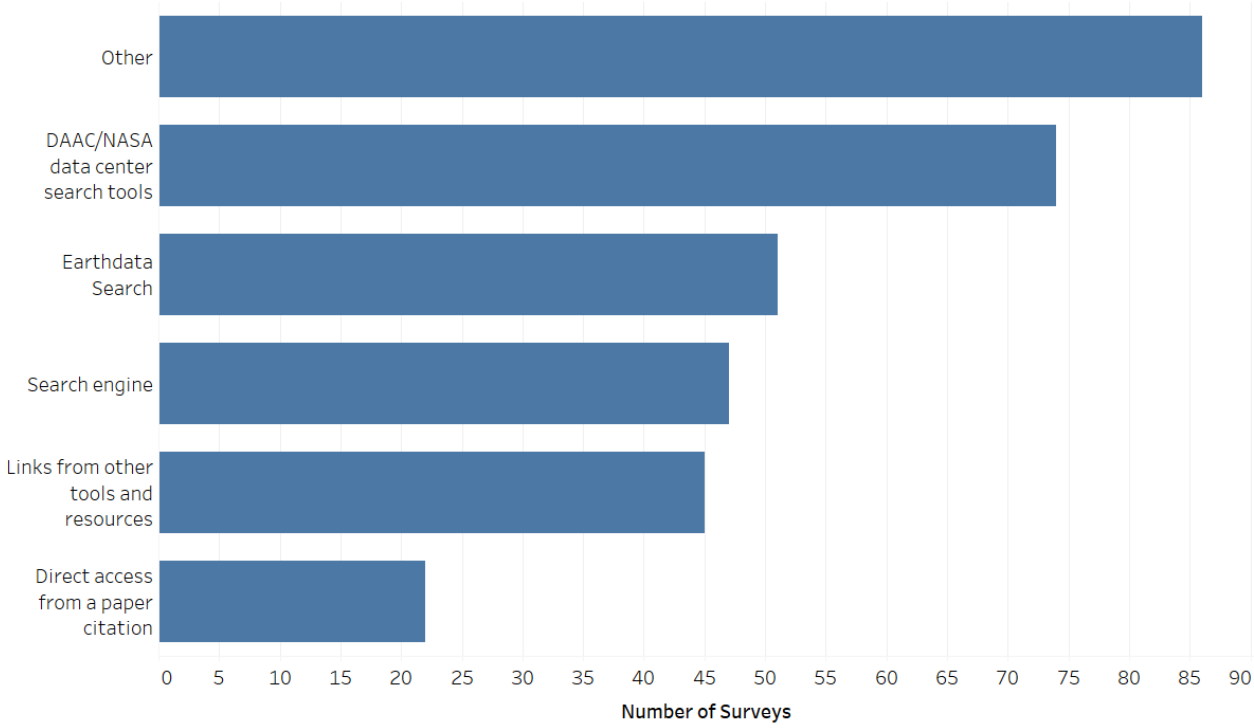
What factors limit your ability to use satellite data? (select all that apply)



Option	**# of Surveys (%)**
Need to transform the data (subsetting, reprojection)	43 (35%)
Need real-time data access	37 (30%)
Licensing restrictions	33 (27%)
Lack of human resources	28 (23%)
Lack of computational resources	28 (23%)
Other	25 (20%)
Technical capabilities	24 (20%)
Lack of training	22 (18%)
Sufficient help and support (documentation, user services)	21 (17%)

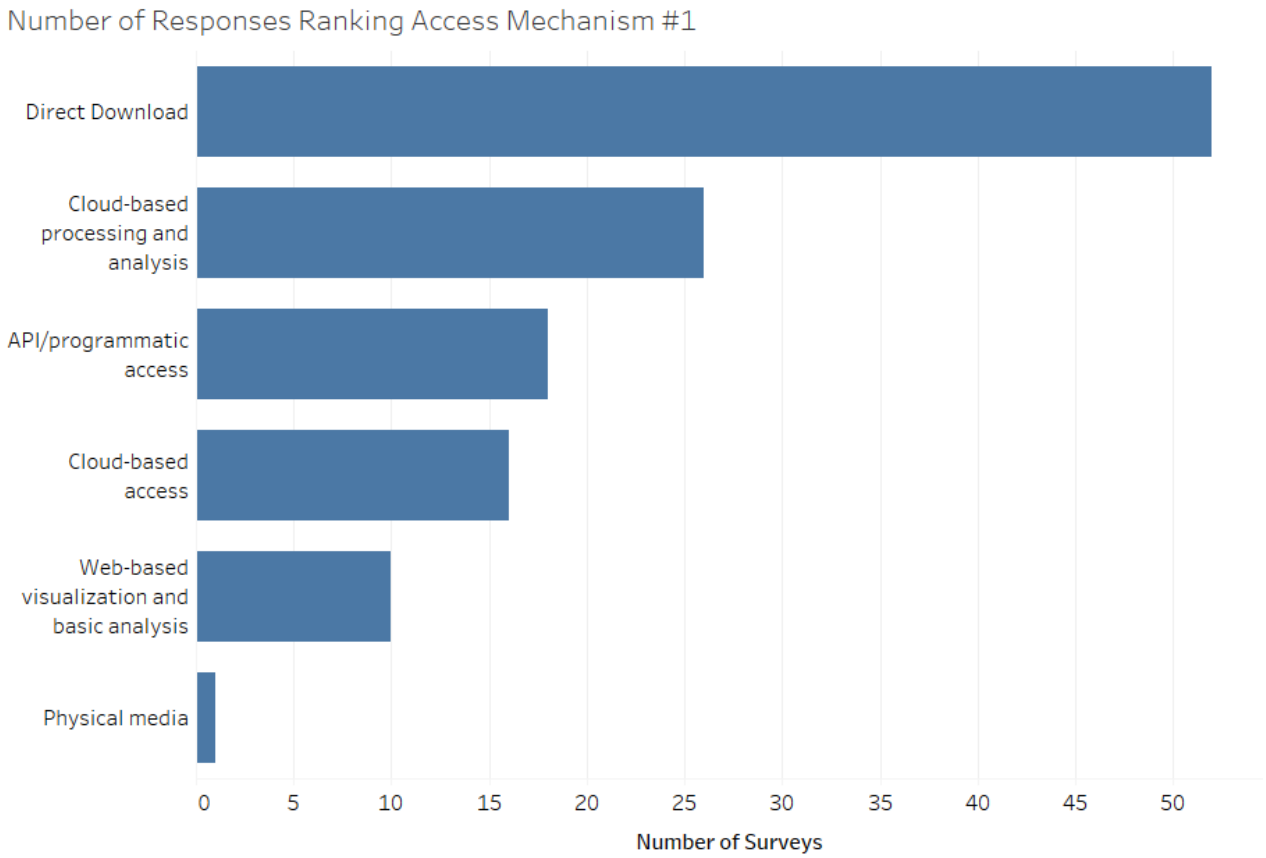
Data format	20 (16%)
Volume of the data (need for easy access to compute)	18 (15%)

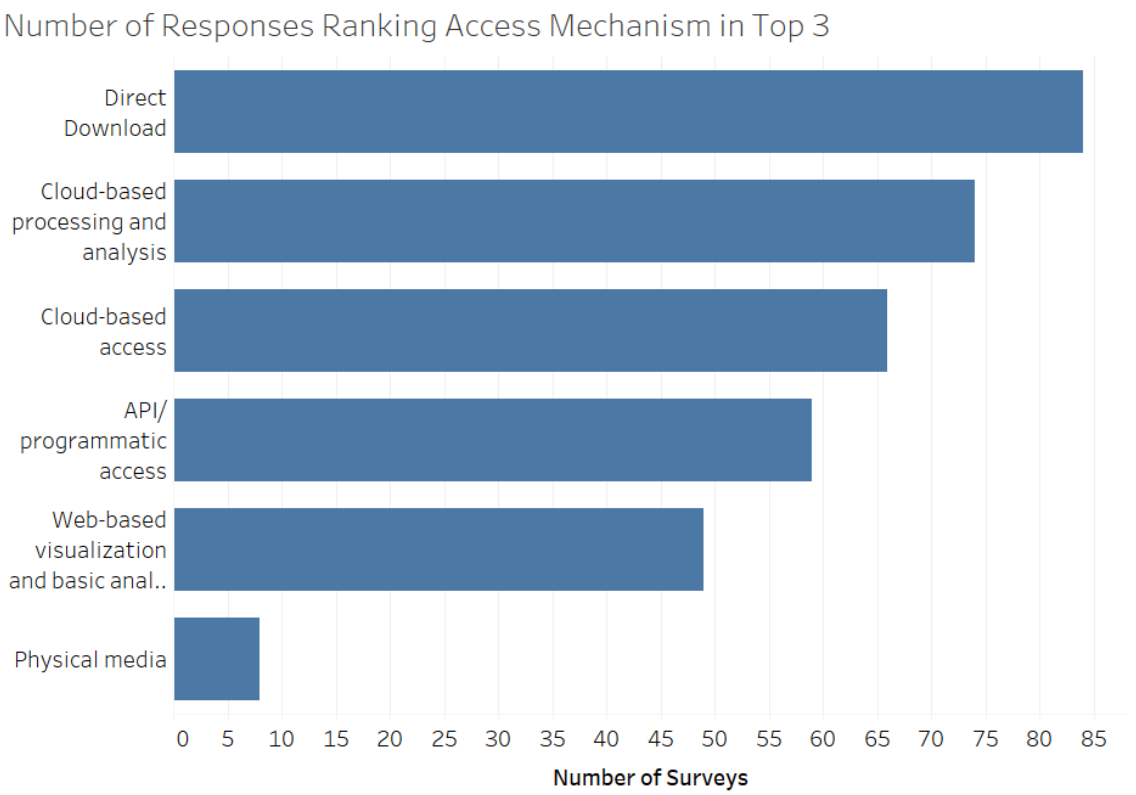
Which data discovery tools have you used to find satellite datasets? (select all that apply)



Option	**# of Surveys (%)**
Other	86 (70%)
DAAC/NASA data center search tools	74 (60%)
Earthdata Search	51 (41%)
Search Engine	47 (38%)
Links from other tools and resources	45 (37%)
Direct access from a paper citation	22 (18%)

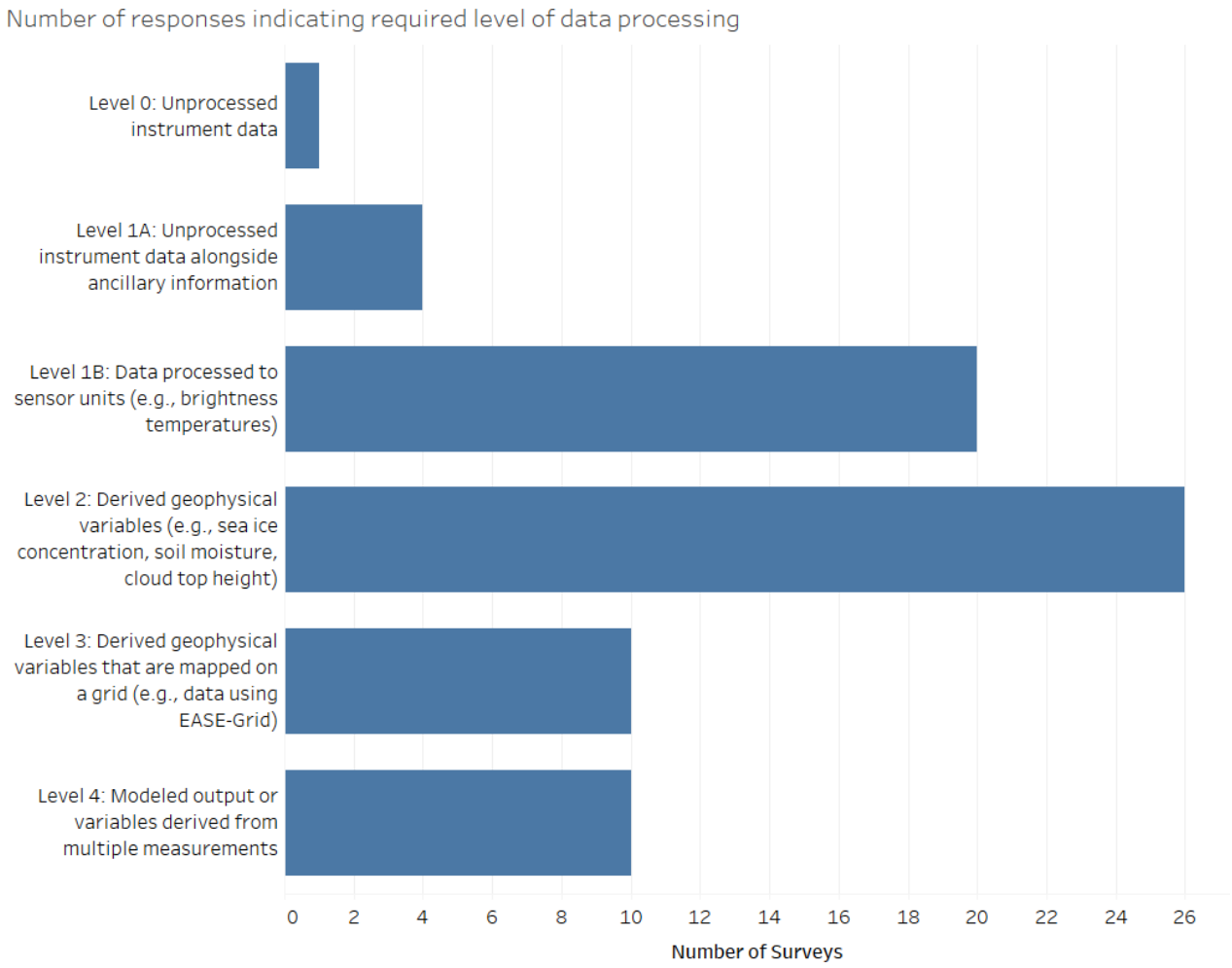
Rank the following access mechanisms in order of preference, with 1 = most preferred.

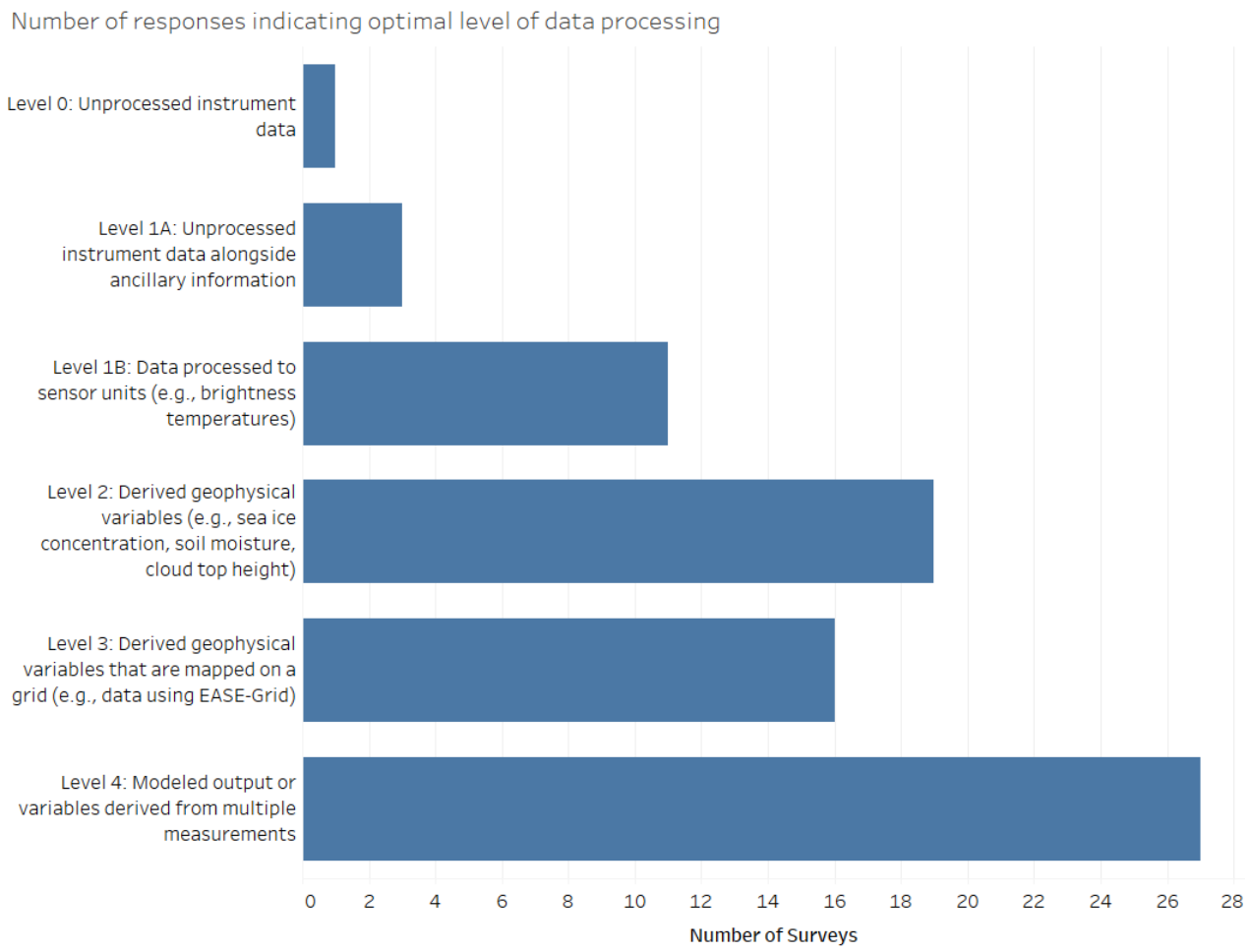




Option	# of Surveys Ranking #1 (%)	# of Surveys Ranked Top 3 (%)
Direct Download (FTP, HTTPS)	52 (42%)	84 (68%)
Cloud-based processing and analysis	26 (21%)	74 (60%)
API/programmatic access	18 (15%)	59 (48%)
Cloud-based access (i.e., no download)	16 (13%)	66 (54%)
Web-based visualization and basic analysis	10 (8%)	49 (40%)
Physical media	1 (1%)	8 (7%)

What would be the required and optimal levels of data processing for your agency to exploit the satellite measurements or products requested? (A full description of data processing levels is available at: https://www.earthdata.nasa.gov/learn/earth-observation-data-basics/data-processing-levels)

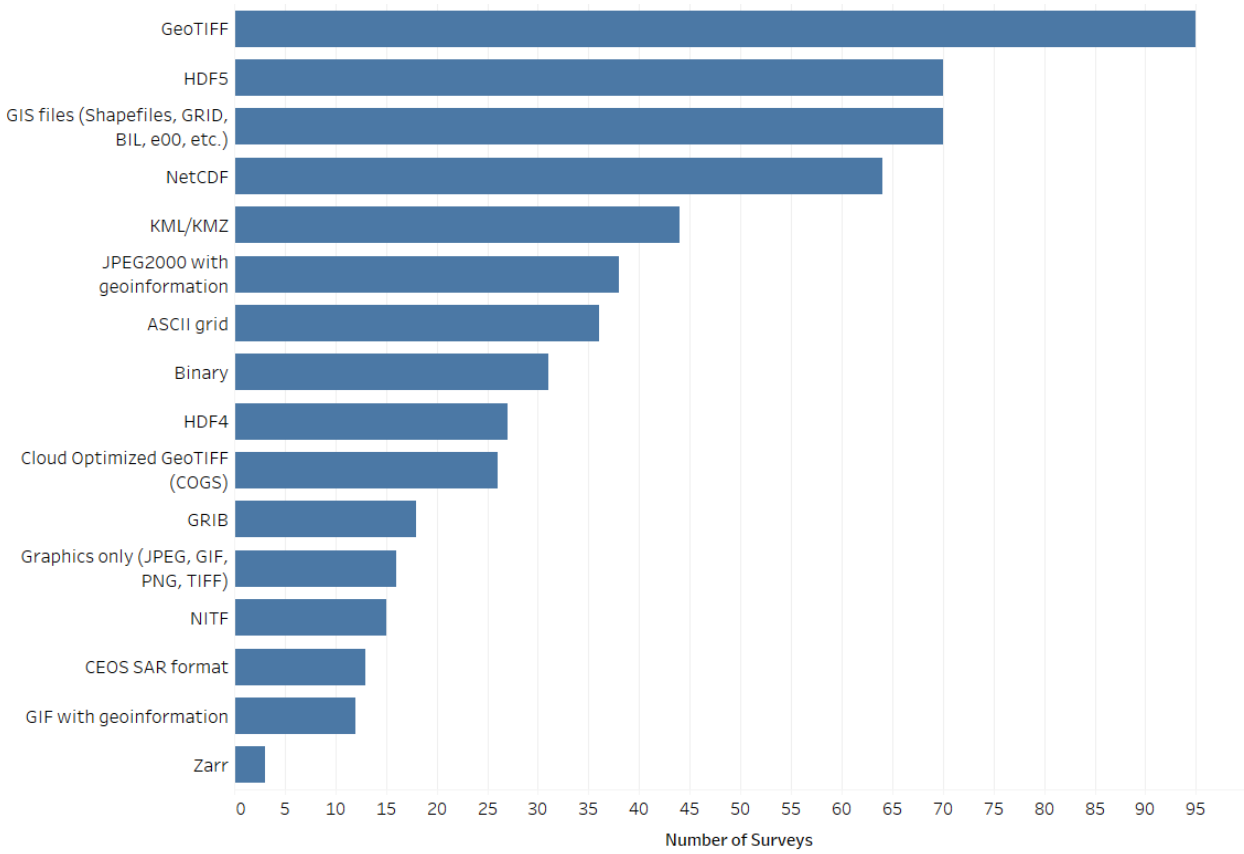




Option	**# of Surveys Selecting "Required" (%)**	**# of Surveys Selecting "Optimal" (%)**
Level 0: Unprocessed instrument data	1 (1%)	1 (1%)
Level 1A: Unprocessed instrument data alongside ancillary information	4 (3%)	3 (2%)
Level 1B: Data processed to sensor units (e.g., brightness temperatures)	20 (16%)	11 (9%)
Level 2: Derived geophysical variables (e.g., sea ice concentration, soil moisture, cloud top height)	26 (21%)	19 (15%)
Level 3: Derived geophysical variables that are mapped on a grid (e.g., data using EASE-Grid)	10 (8%)	16 (13%)
Level 4: Modeled output or variables	10 (8%)	27 (22%)

derived from multiple measurements		

Rank your top 5 of the following data formats in order of preference. If you are able to make use of fewer than 5 formats, only rank those that you can use. (1 = most preferred)



Option	**# of Surveys (%)**
GeoTIFF	95 (77%)
HDF5	70 (57%)
GIS files (Shapefiles, GRID, BIL, e00, etc.)	70 (57%)
NetCDF	64 (52%)
KML/KMZ	44 (36%)
JPEG2000 with geoinformation	38 (31%)
ASCII grid	36 (29%)
Binary	31 (25%)
HDF4	27 (22%)
Cloud Optimized GeoTIFF (COGS)	26 (21%)

GRIB	18 (15%)
Graphics only (JPEG, GIF, PNG, TIFF)	16 (13%)
NITF	15 (12%)
CEOS SAR format	13 (11%)
GIF with geoinformation	12 (10%)
Zarr	3 (2%)

Aggregate Geophysical Observables

What feature or quantity do you need to observe? (E.g., evapotranspiration, aerosol optical depth, land surface deformation)

Agencies provided free-form text responses to this survey question. From these, individual geophysical observables were extracted and, where possible, mapped to the Global Change Master Directory (GCMD) keywords, described by NASA as "a hierarchical set of controlled Earth Science vocabularies that help ensure Earth science data, services, and variables are described in a consistent and comprehensive manner." The table below shows the number of instances where a mapped observable falls under the first three levels of the GCMD Earth Science hierarchy, along with a list of the fourth level keywords with mapped instances. Note that keywords with no mapped instances are excluded, and that three extracted observables could not be mapped to a GCMD keyword.

GCMD Keyword Hierarchy	**# of Instances (%)**
Earth Science	**503 (100%)**
Earth Science > Agriculture	**13 (3%)**
Earth Science > Agriculture > Agricultural Plant Science	11 (2%)
Earth Science > Agriculture > Forest Science	1 (0%)
Earth Science > Agriculture > Soils	1 (0%)
Earth Science > Atmosphere	**126 (25%)**
Earth Science > Atmosphere > Aerosols	20 (4%)
Earth Science > Atmosphere > Air Quality	6 (1%)
Earth Science > Atmosphere > Altitude	1 (0%)

Earth Science > Atmosphere > Atmosphere/Surface Interactions	2 (0%)
Earth Science > Atmosphere > Atmospheric Chemistry	35 (7%)
Earth Science > Atmosphere > Atmospheric Pressure	1 (0%)
Earth Science > Atmosphere > Atmospheric Radiation	1 (0%)
Earth Science > Atmosphere > Atmospheric Temperature	8 (2%)
Earth Science > Atmosphere > Atmospheric Water Vapor	17 (3%)
Earth Science > Atmosphere > Atmospheric Winds	3 (1%)
Earth Science > Atmosphere > Clouds	14 (3%)
Earth Science > Atmosphere > Planetary Boundary Layer	2 (0%)
Earth Science > Atmosphere > Precipitation	9 (2%)
Earth Science > Atmosphere > Weather Events	2 (0%)
Earth Science > Biological Classification	**1 (0%)**
Earth Science > Biological Classification > Bacteria/Archaea	1 (0%)
Earth Science > Biosphere	**111 (22%)**
Earth Science > Biosphere > Ecological Dynamics	24 (5%)
Earth Science > Biosphere > Ecosystems	16 (3%)
Earth Science > Biosphere > Vegetation	71 (14%)
Earth Science > Climate Indicators	**4 (1%)**
Earth Science > Climate Indicators > Atmospheric/Ocean Indicators	1 (0%)
Earth Science > Climate Indicators > Biospheric Indicators	1 (0%)
Earth Science > Climate Indicators > Carbon Flux	1 (0%)
Earth Science > Climate Indicators > Cryospheric Indicators	1 (0%)
Earth Science > Cryosphere	**2 (0%)**
Earth Science > Cryosphere > Sea Ice	1 (0%)
Earth Science > Cryosphere > Snow/Ice	1 (0%)
Earth Science > Human Dimensions	**45 (9%)**

Earth Science > Human Dimensions > Boundaries	1 (0%)
Earth Science > Human Dimensions > Habitat Conversion/Fragmentation	6 (1%)
Earth Science > Human Dimensions > Infrastructure	9 (2%)
Earth Science > Human Dimensions > Natural Hazards	28 (6%)
Earth Science > Human Dimensions > Social Behavior	1 (0%)
Earth Science > Land Surface	**93 (18%)**
Earth Science > Land Surface > Erosion/Sedimentation	3 (1%)
Earth Science > Land Surface > Geomorphic Landforms/Processes	5 (1%)
Earth Science > Land Surface > Land Use/Land Cover	26 (5%)
Earth Science > Land Surface > Soils	21 (4%)
Earth Science > Land Surface > Surface Radiative Properties	13 (3%)
Earth Science > Land Surface > Surface Thermal Properties	11 (2%)
Earth Science > Land Surface > Topography	12 (2%)
Earth Science > Oceans	**34 (7%)**
Earth Science > Oceans > Bathymetry/Seafloor Topography	2 (0%)
Earth Science > Oceans > Ocean Optics	2 (0%)
Earth Science > Oceans > Ocean Temperature	2 (0%)
Earth Science > Oceans > Ocean Waves	1 (0%)
Earth Science > Oceans > Ocean Winds	4 (1%)
Earth Science > Oceans > Salinity/Density	2 (0%)
Earth Science > Oceans > Sea Ice	19 (4%)
Earth Science > Oceans > Water Quality	2 (0%)
Earth Science > Solid Earth	**20 (4%)**
Earth Science > Solid Earth > Gravity/Gravitational Field	1 (0%)
Earth Science > Solid Earth > Rocks/Minerals/Crystals	1 (0%)
Earth Science > Solid Earth > Tectonics	18 (4%)

Earth Science > Spectral/Engineering	**6 (1%)**
Earth Science > Spectral/Engineering > Hyperspectral Imagery	1 (0%)
Earth Science > Spectral/Engineering > Infrared Wavelengths	2 (0%)
Earth Science > Spectral/Engineering > Multispectral Imagery	1 (0%)
Earth Science > Spectral/Engineering > Radar	1 (0%)
Earth Science > Spectral/Engineering > Radio Wave	1 (0%)
Earth Science > Terrestrial Hydrosphere	**48 (10%)**
Earth Science > Terrestrial Hydrosphere > Glaciers/Ice Sheets	1 (0%)
Earth Science > Terrestrial Hydrosphere > Ground Water	3 (1%)
Earth Science > Terrestrial Hydrosphere > Snow/Ice	14 (3%)
Earth Science > Terrestrial Hydrosphere > Surface Water	24 (5%)
Earth Science > Terrestrial Hydrosphere > Terrestrial Hydrosphere Change	3 (1%)
Earth Science > Terrestrial Hydrosphere > Water Quality/Water Chemistry	3 (1%)
Earth Science Services	**1 (0%)**
Earth Science Services > Hazards Management	**1 (0%)**
Earth Science Services > Hazards Management > Disaster Response	1 (0%)