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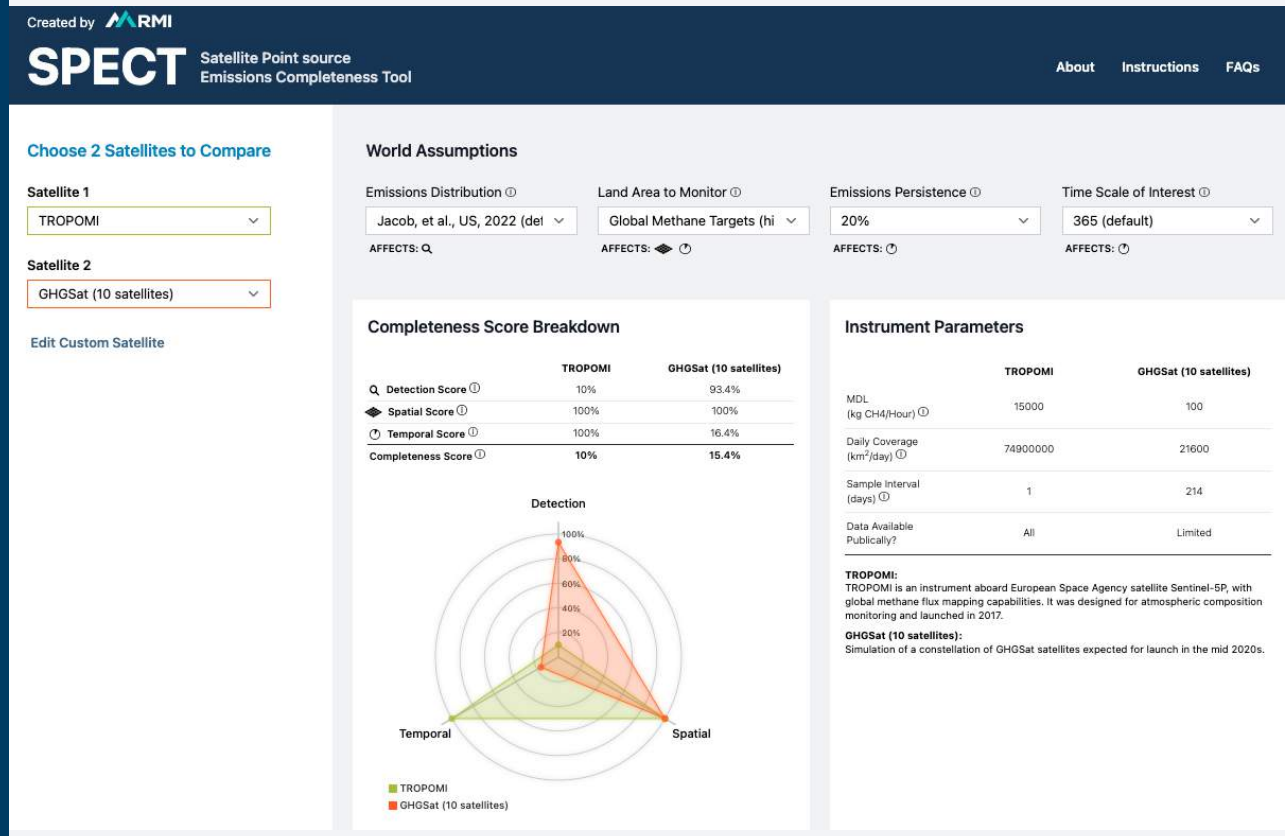
A Guide to Using SPECT: The Satellite Point Source Emissions Completeness Tool

Climate Intelligence Program, 2023

What Is SPECT?

SPECT, the Satellite Point source Emissions Completeness Tool, is an interactive educational tool designed to aid in understanding global methane emissions detection.

Users can compare the capabilities of satellite systems to detect large planet-warming methane emissions from multiple industries like oil and gas, waste, and agriculture.

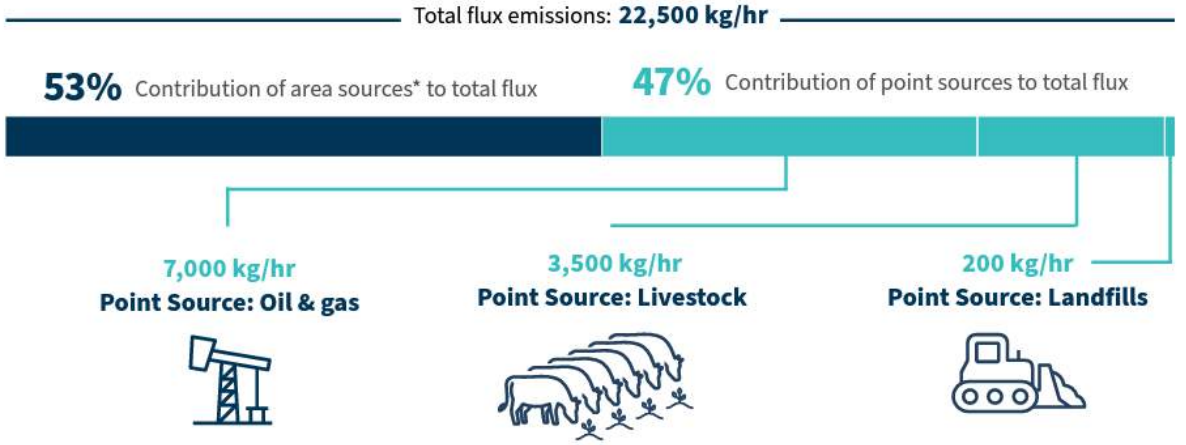


What Is *Completeness?*

SPECT examines different methane-sensing satellites and compares them according to a metric called *completeness*.

Completeness refers to the portion of emissions detectable from a population of methane super-emitters — these are large point sources emitting methane at a rate greater than 25 kg/hr.

Example point source methane emissions contributions to a regional total



*Area sources are emissions sources that cannot be attributed to a single location. These include thousands of small sources that individually fall below the point source threshold (10 kg/hr), but collectively accumulate to a large total. They also include diffuse sources such as enteric fermentation, wetlands, wildfires, and other natural sources.

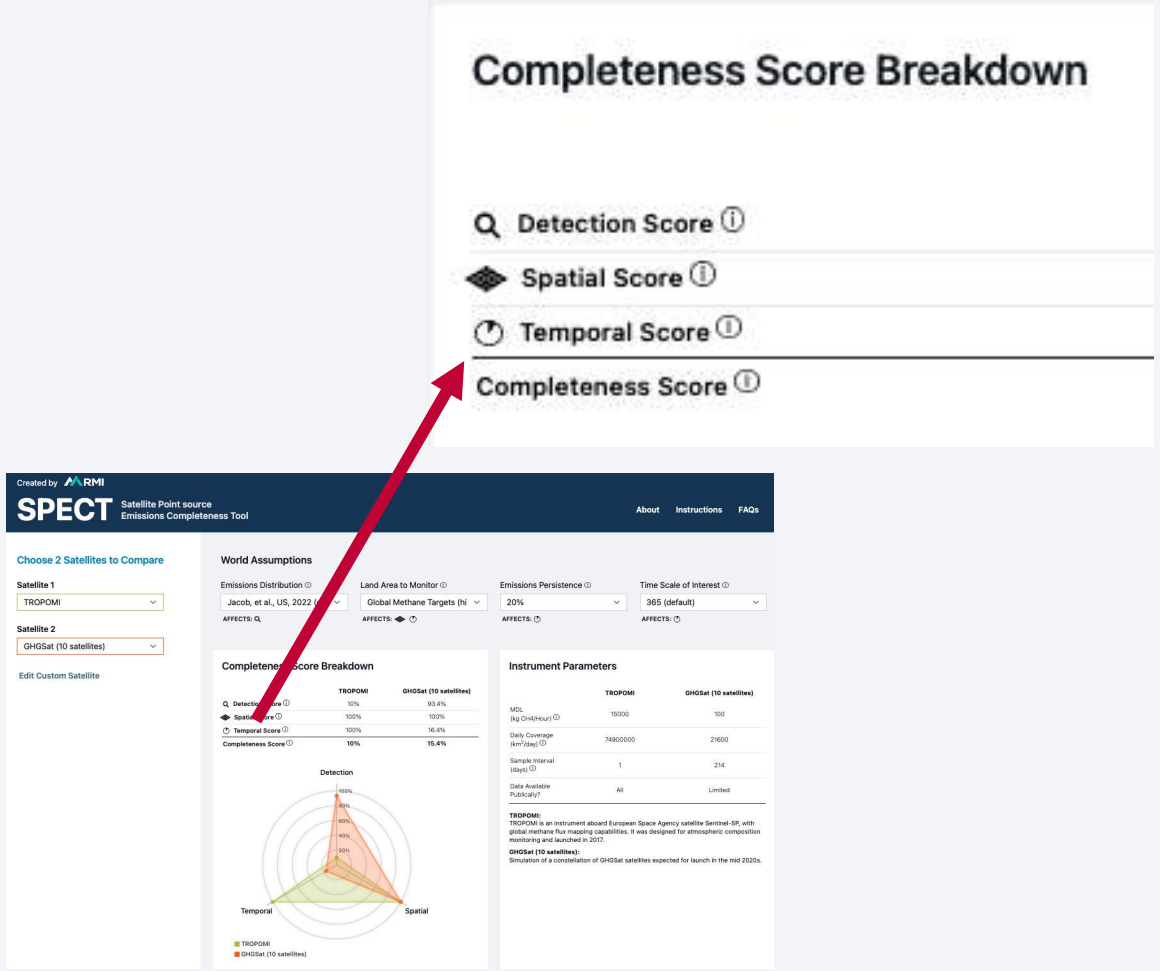
Source: Cusworth, et al., 2022

Completeness Score Breakdown

In the Completeness Score Breakdown box, you can see that completeness is calculated as the product of three sub scores:

- Detection score
- Spatial score
- Temporal score

Hover over the information icon to see a short definition of each.



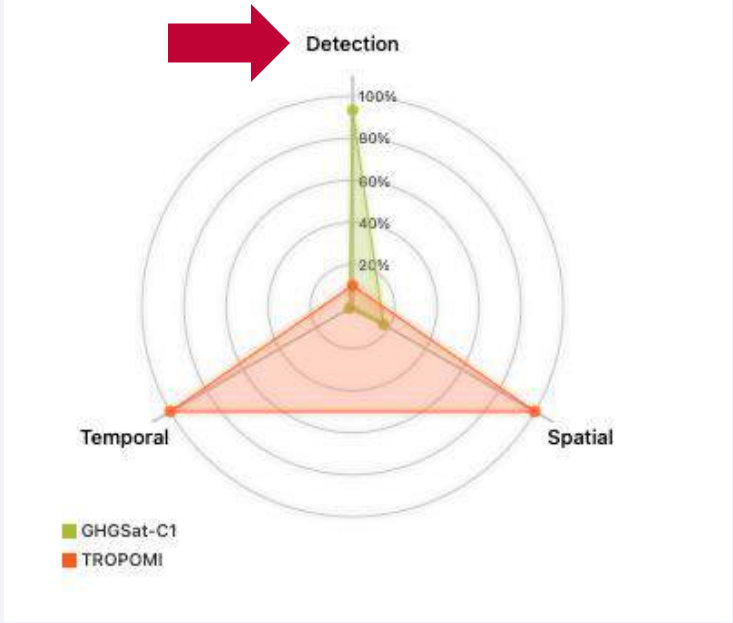
Detection Score

The Detection score refers to the percentage of point sources detectable by a satellite instrument. This is dependent on the satellite's sensitivity, also called its Minimum Detection Limit (MDL).

A high Detection score indicates that a satellite can detect a higher percentage of point sources — both small and large plumes of methane — within a given emissions distribution. A low detection score indicates that a satellite can only spot larger bursts.

Completeness Score Breakdown

	GHGSat-C1	TROPOMI
Detection Score ⓘ	93.4%	10%
Spatial Score ⓘ	17%	100%
Temporal Score ⓘ	1.8%	100%
Completeness Score ⓘ	**0.3%**	**10%**



Spatial Score

The Spatial score illustrates the geographic area observed by the satellite each day, and what percentage of a specified land area the satellite can observe in a defined time period of interest (i.e., a day, month, or year).

Completeness Score Breakdown

	GHGSat-C1	TROPOMI
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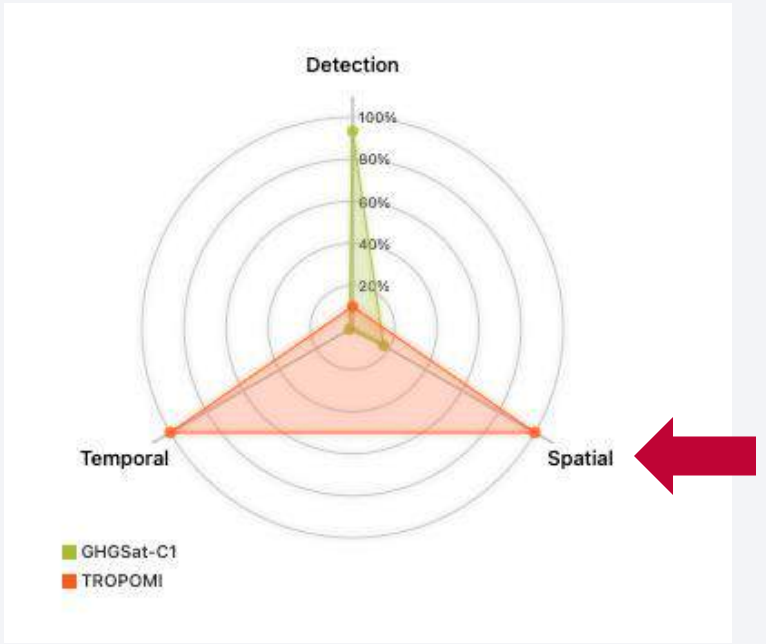

Temporal Score

The Temporal score refers to the probability that an emissions source is detected. It is primarily affected by two things:

1. The persistence of the emissions source — how often a particular source is emitting methane.
2. The sample frequency — how often a satellite successfully completes an observation of a given area.

Completeness Score Breakdown

	GHGSat-C1	TROPOMI
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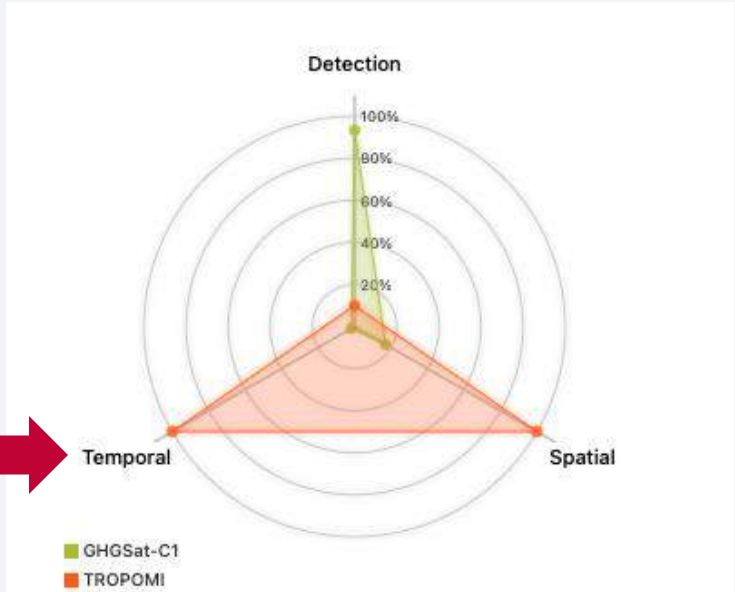
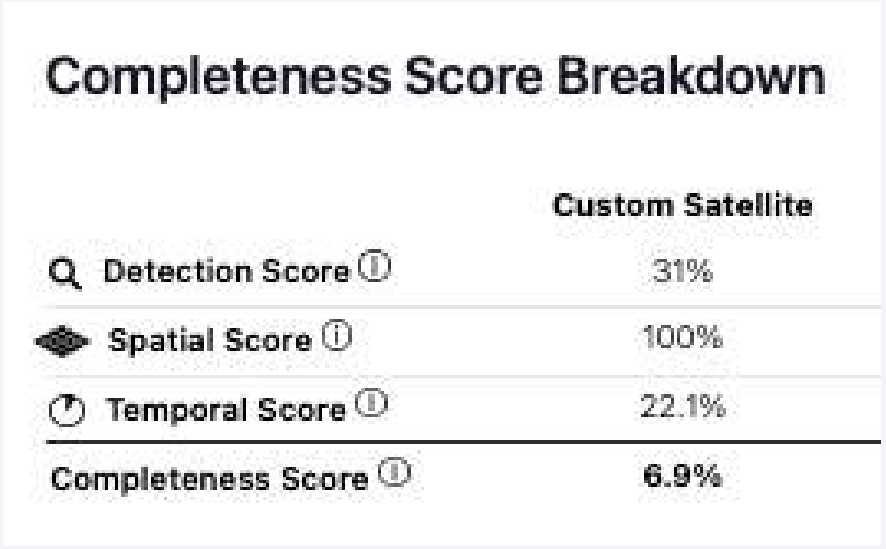


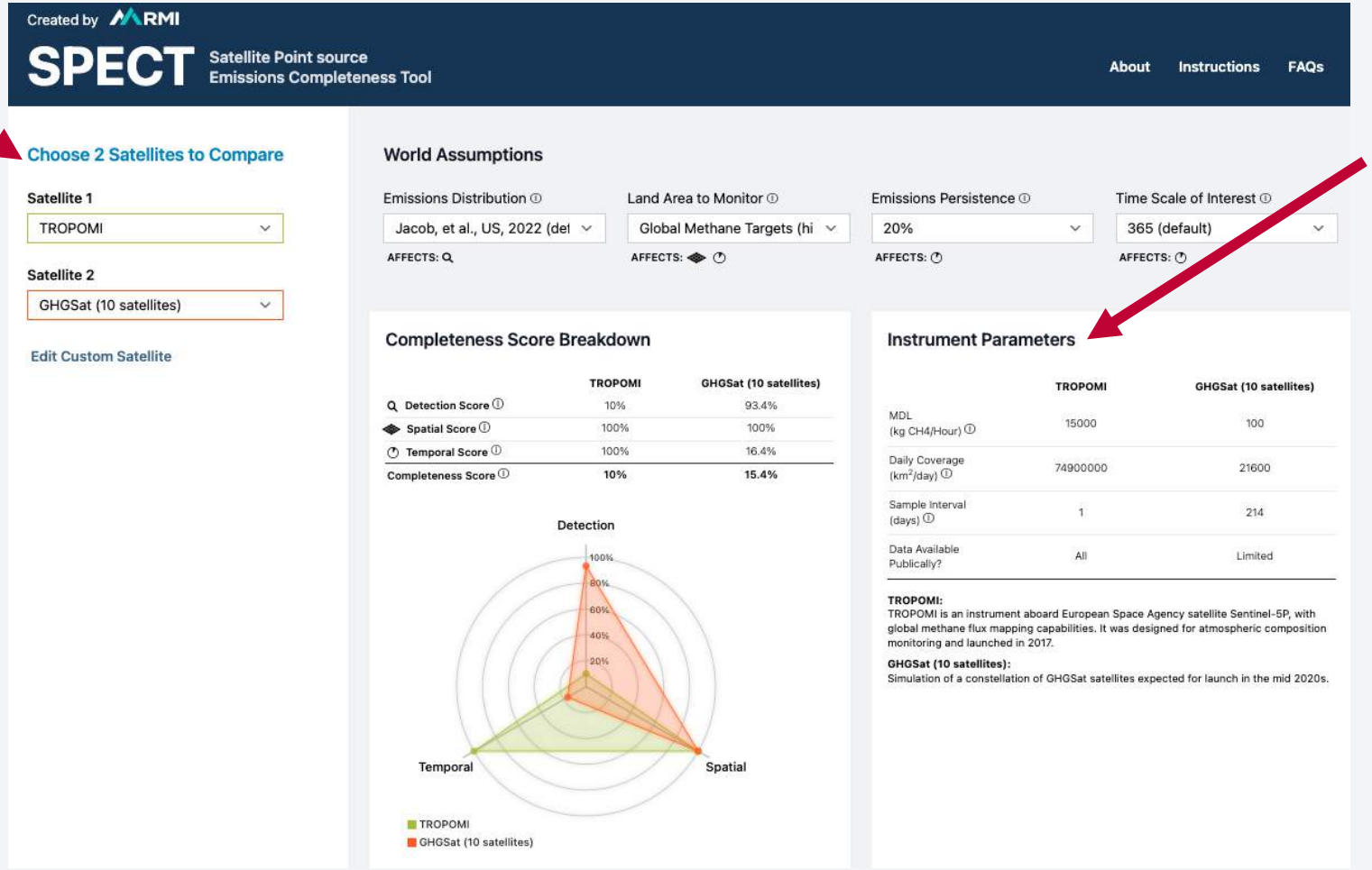
Calculating “Completeness”

Multiply the Detection score, Spatial score, and Temporal score together and you get your overall Completeness score!



Comparison Page

On the Main Comparison page, you'll notice a drop-down menu on the left that allows users to select two satellites to compare.



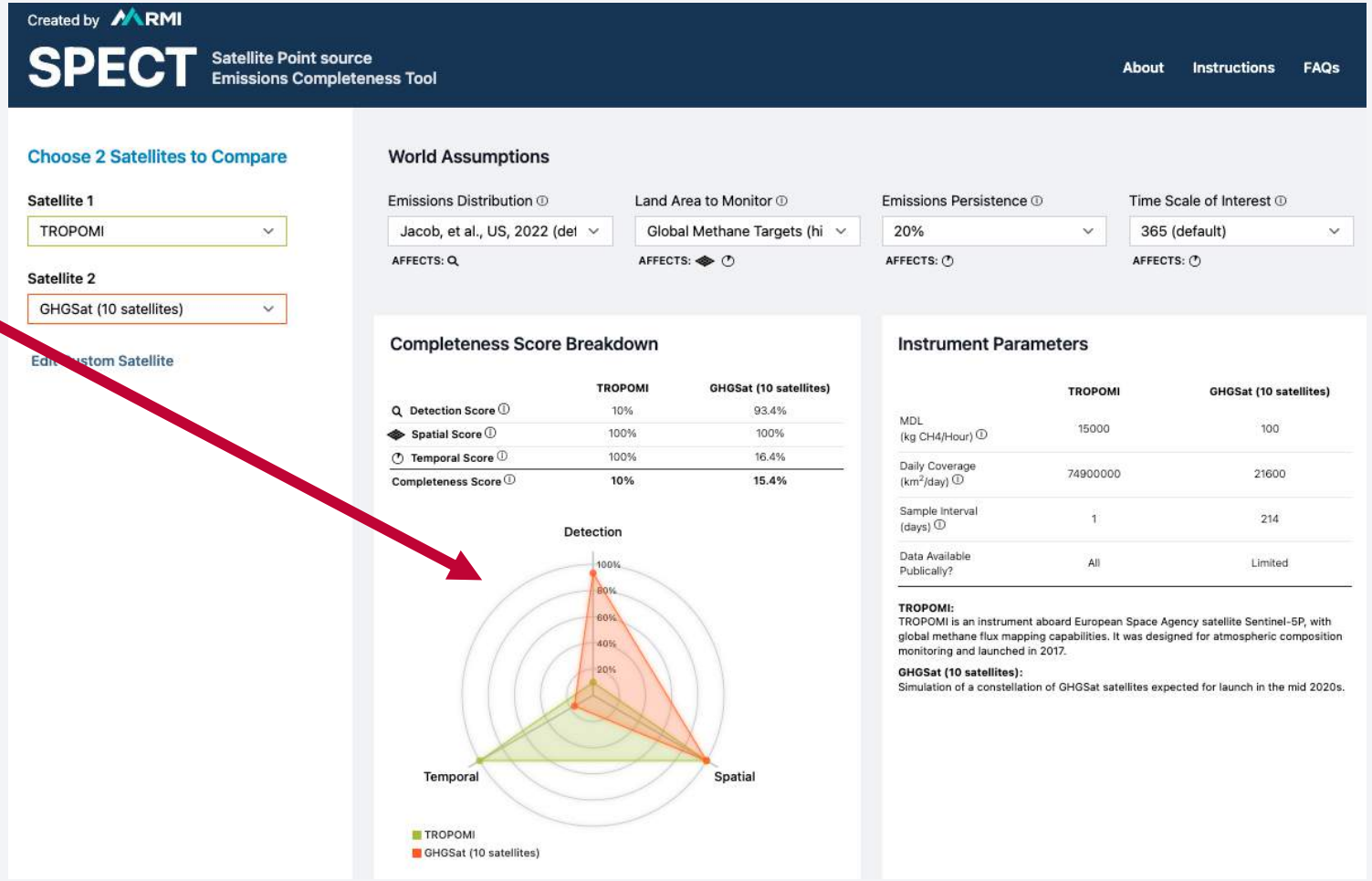
Once a satellite is selected, its pre-set Instrument Parameters populate in a box on the right side.

This includes the satellite's daily coverage, revisit time, and Minimum Detection Limit, or MDL. There's also a short description of each selected satellite technology.

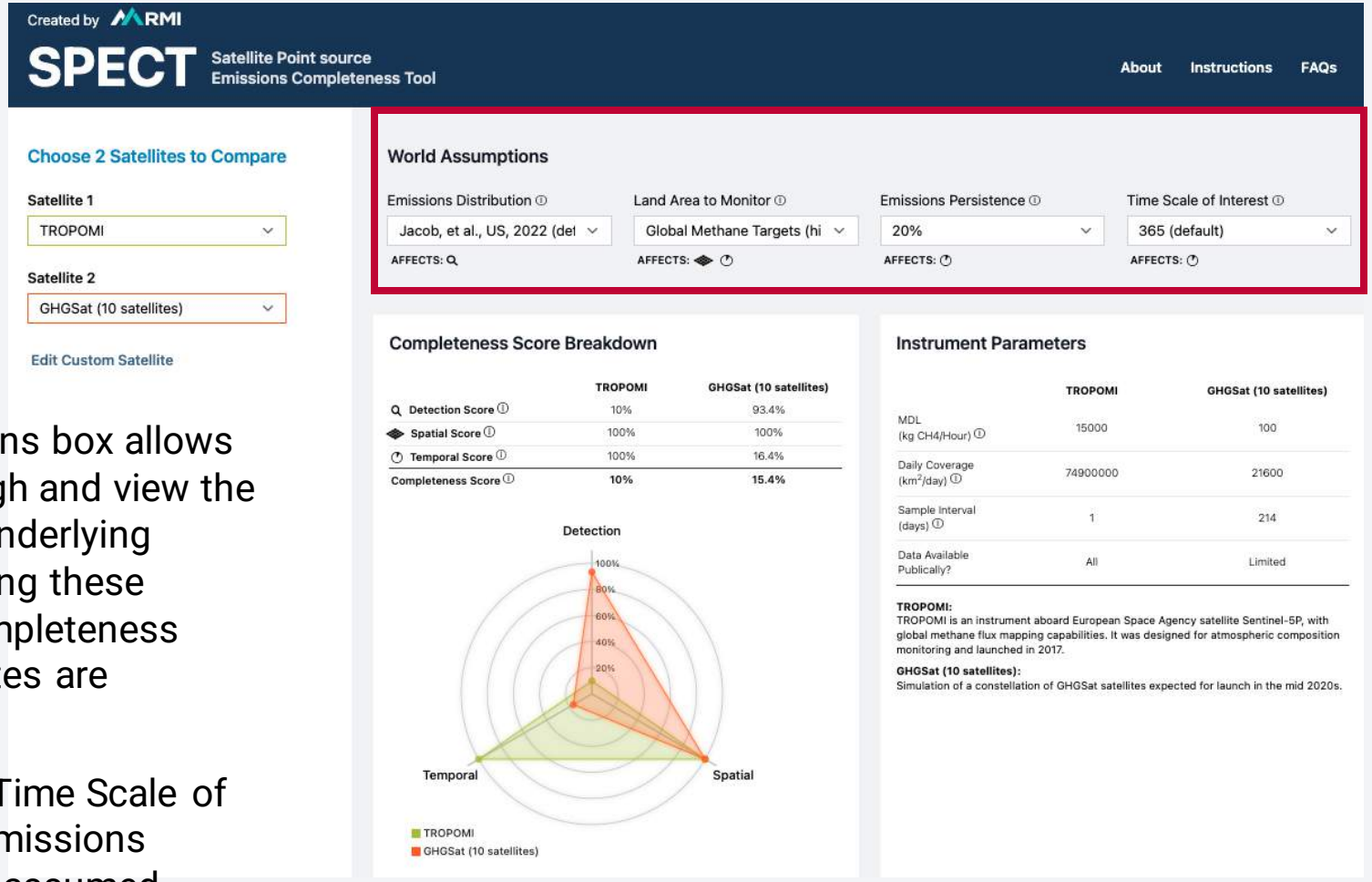
Comparison Page: Radar Chart

The radar chart in the middle of the page automatically calculates the sub scores and the overall Completeness score for each satellite.

If a satellite scores high in a given sub-score, that vertex of the radar chart will be stretched out near the edge of the circle. Lower scores stay closer to the middle.



Comparison Page: World Assumptions

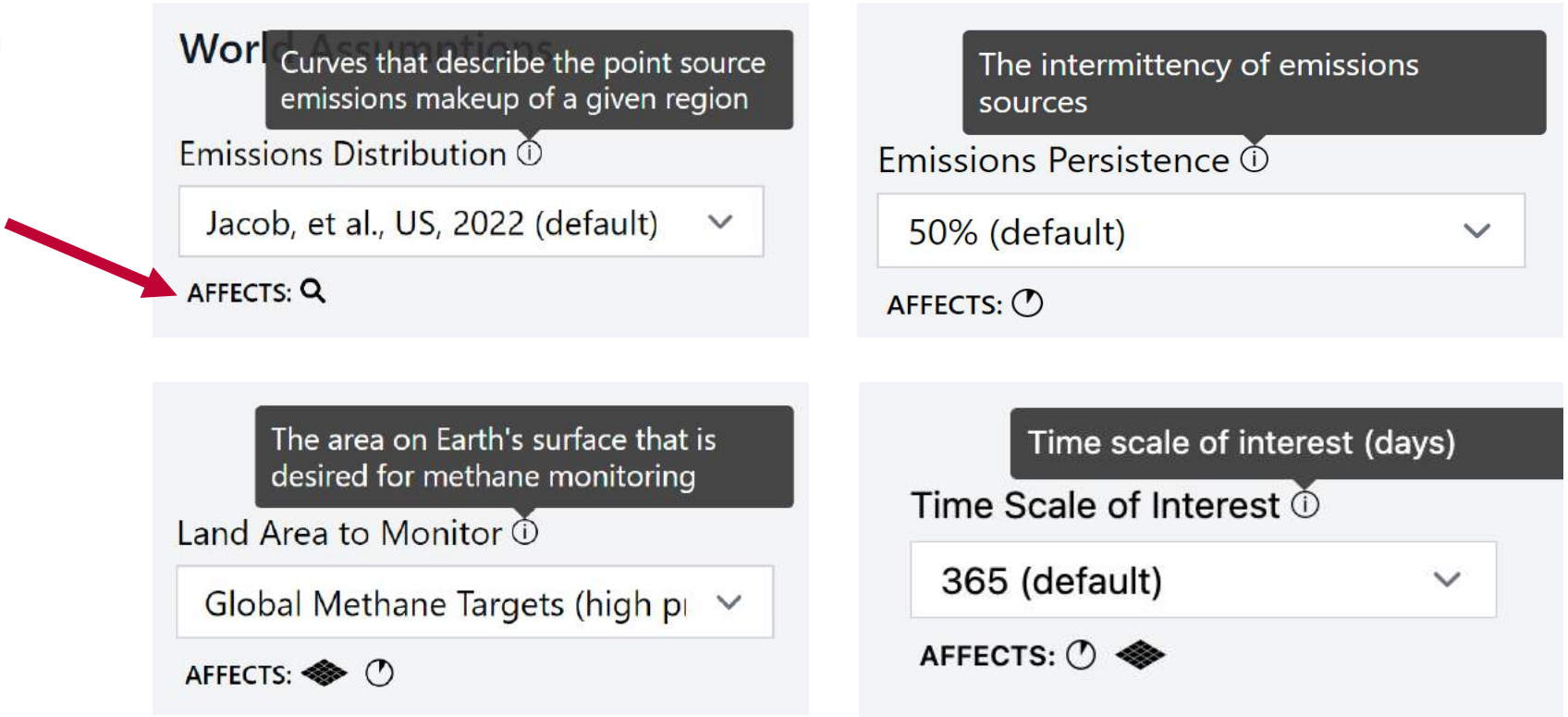


The World Assumptions box allows users to toggle through and view the effects of changing underlying conditions. By changing these assumptions, the Completeness scores for ALL satellites are affected.

Users can adjust the Time Scale of Interest, Land Area, Emissions Distributions, and the assumed Persistence of Emissions.

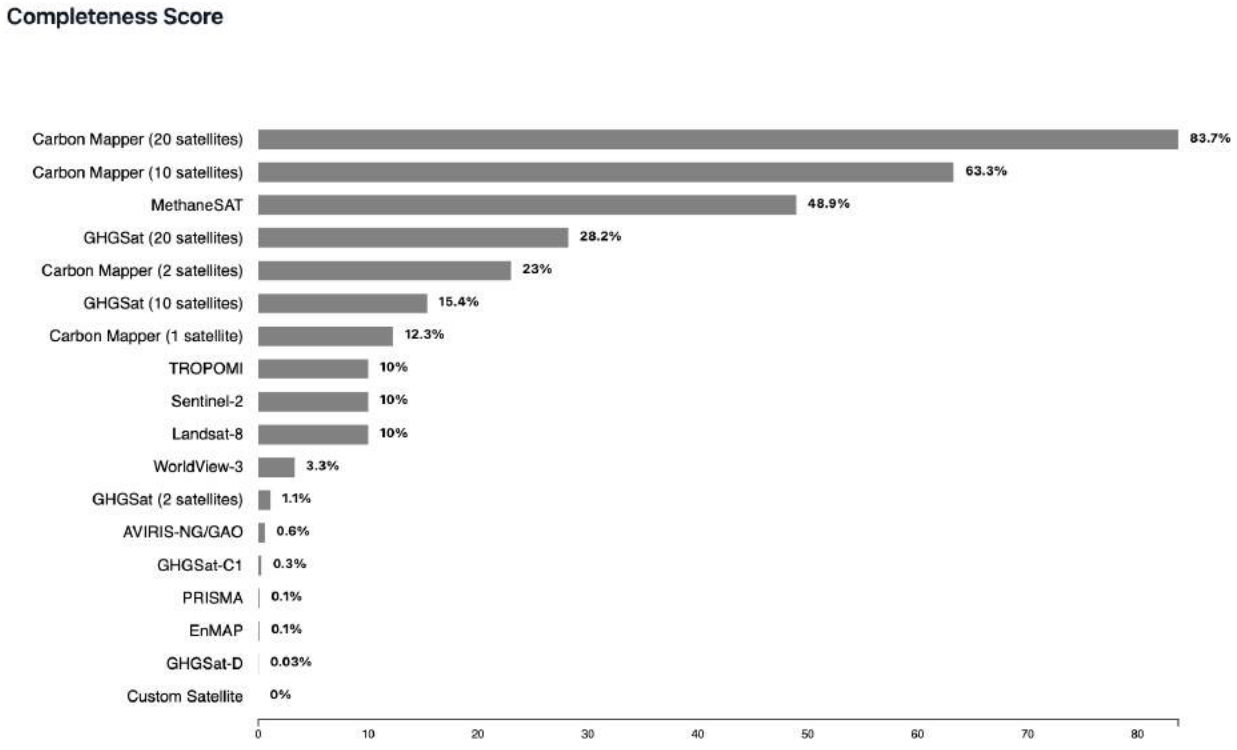
Comparison Page: World Assumptions

The icons below each assumption indicate what sub-scores are affected. The timer means that by changing this assumption, temporal scores will be affected. Similarly, the diamond represents an impact on spatial sub-scores, and the magnifying glass represents changes to the detection sub-score



Comparison Page: Bar Chart

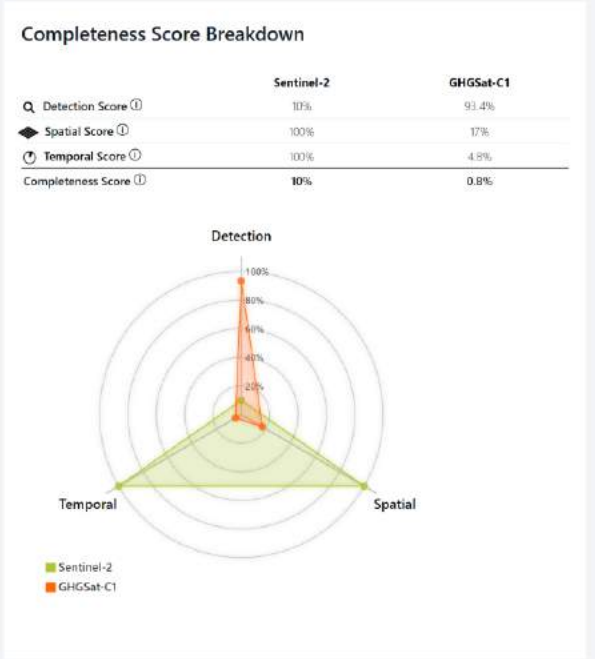
By scrolling down on the Main Comparison page, users can view a bar chart that compares completeness across all the pre-entered satellite systems based on the pre-set Instrument Parameters and the specified World Assumptions.

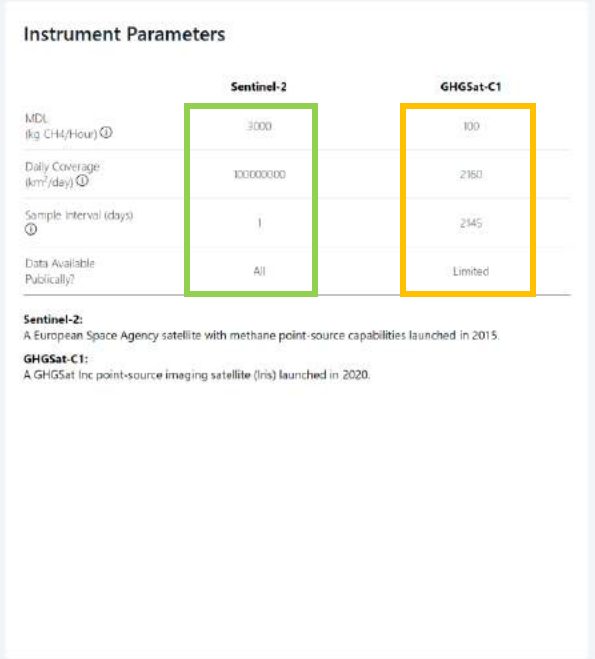


SPECT Tips and Context

Tradeoffs are an inherent part of satellite system design. For example, some satellites, often referred to as *targeting satellites*, are designed to target small areas with high accuracy and resolution. These satellites are useful for detecting small emissions over a limited geographic area.

Other satellites, sometimes called *global scanners*, have bigger daily coverage, scanning the whole earth in a few days or less. These satellites tend to have relatively lower resolution and are not as effective for detecting small emissions sources.





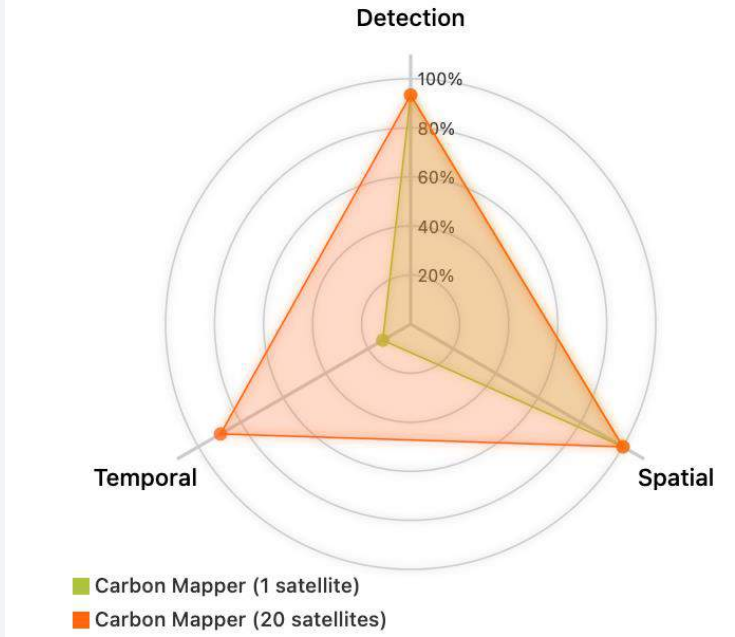
SPECT Tips and Context

When it comes to global methane point source detection, it is important to balance sufficient sensitivity, spatial coverage, and revisit times.

This is one reason that some organizations are launching constellations of satellites that comprise 10 or more identical satellites. You'll notice that these constellations tend to score high in overall completeness, as they are able to combine low detection thresholds with high spatial coverage and frequent revisits.

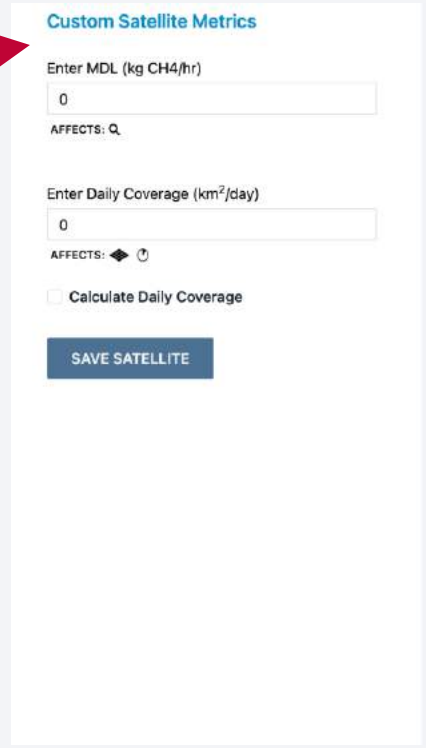
Completeness Score Breakdown

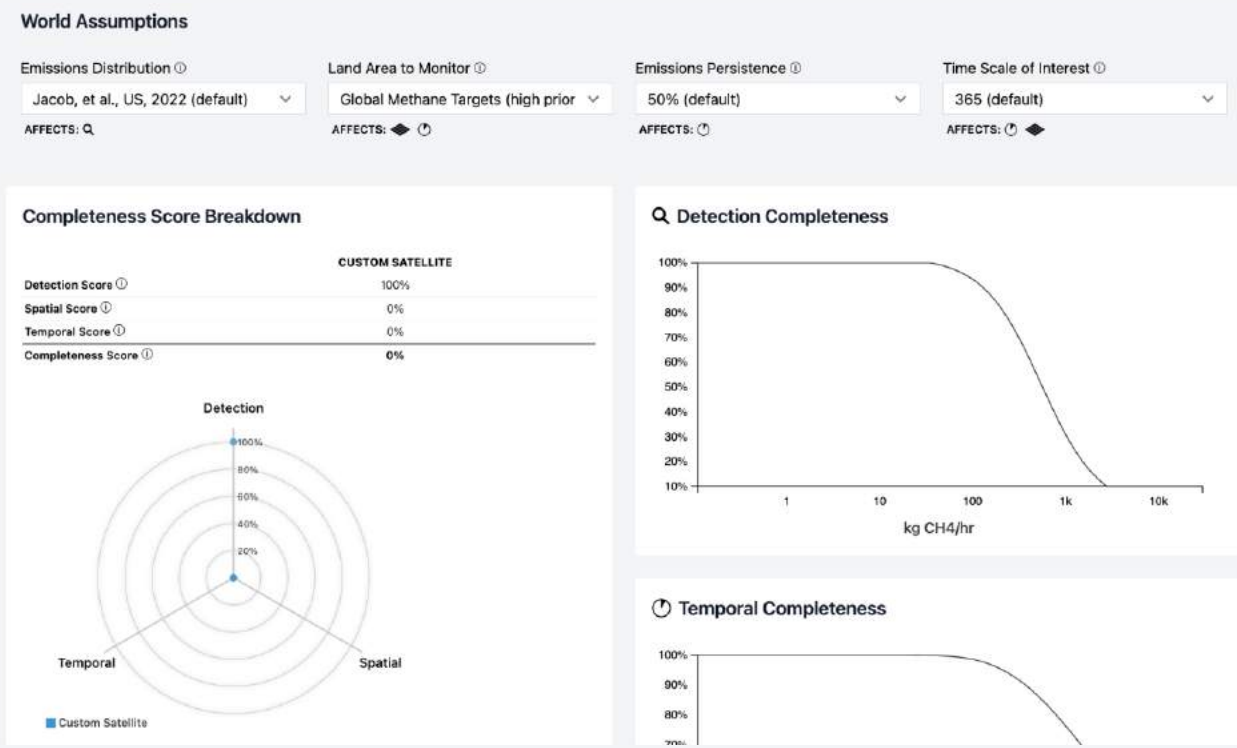
	Carbon Mapper (1 satellite)	Carbon Mapper (20 satellites)
Detection Score ⓘ	93.4%	93.4%
Spatial Score ⓘ	100%	100%
Temporal Score ⓘ	13.1%	89.6%
Completeness Score ⓘ	**12.3%**	**83.7%**



Custom Satellite Tab

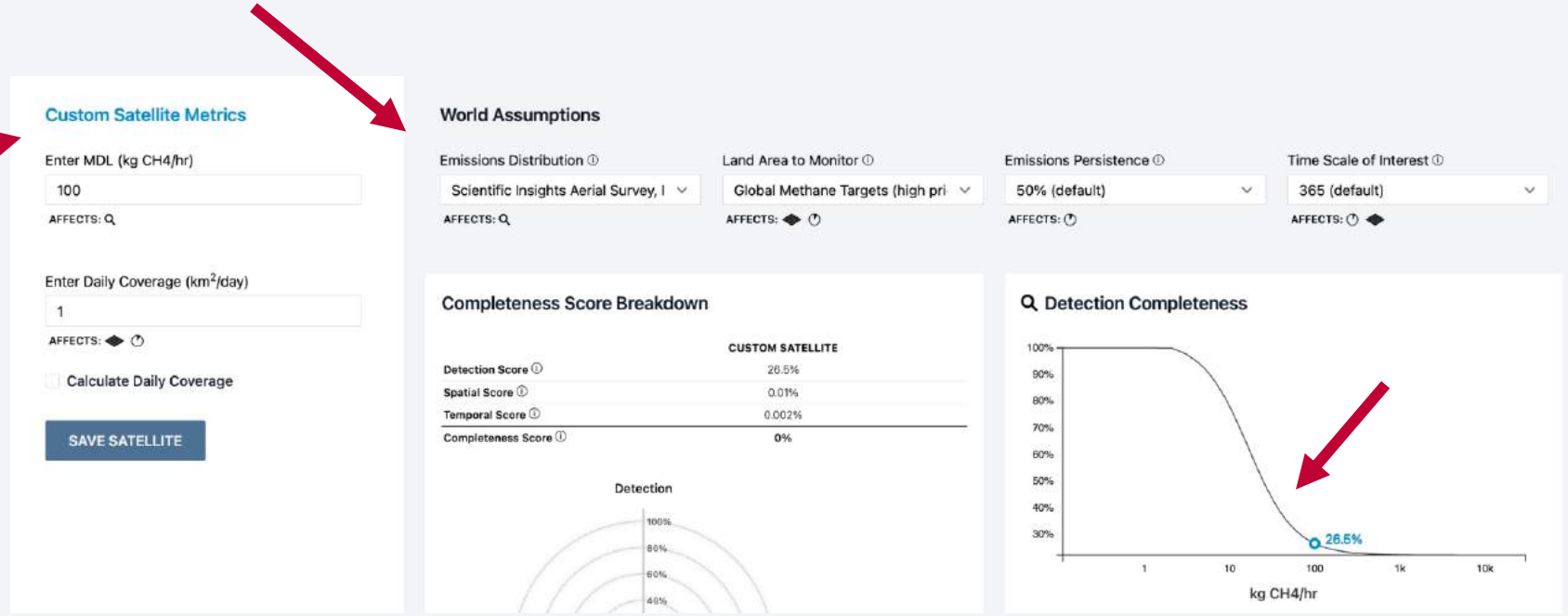
On this tab, users can enter their own instrument parameters for a real-life or imaginary satellite. This is a great way to explore how adjusting different parameters can affect overall Completeness and Completeness sub-scores.





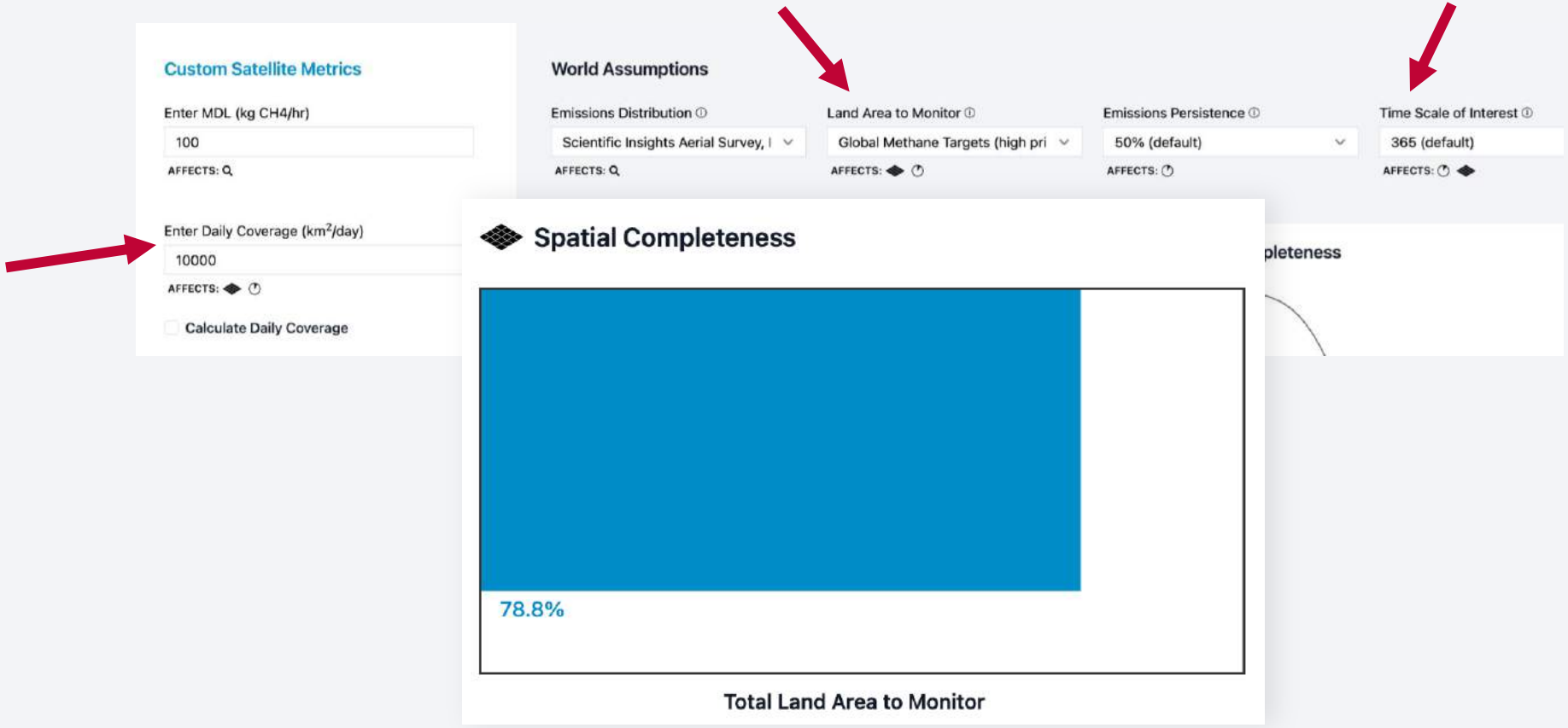
Custom Satellite Tab: Detection Completeness

For example, users can enter a satellite Minimum Detection Limit and toggle the Emissions Distribution assumption to see how these inputs combine to form the Detection Completeness sub-score.



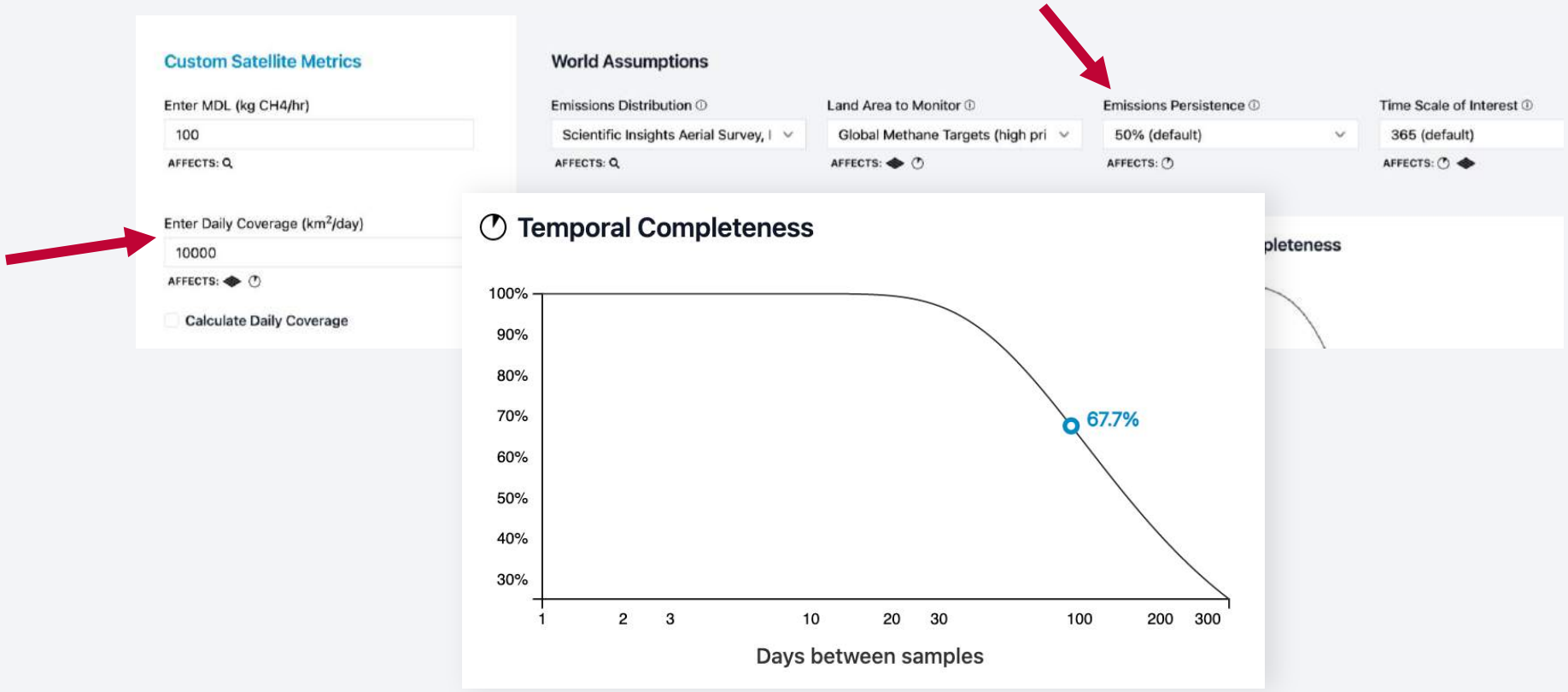
Custom Satellite Tab: Spatial Completeness

By entering a Daily Coverage, selecting a Land Area and Time Scale, and scrolling down, users see how these inputs combine to form the Spatial Completeness sub-score.



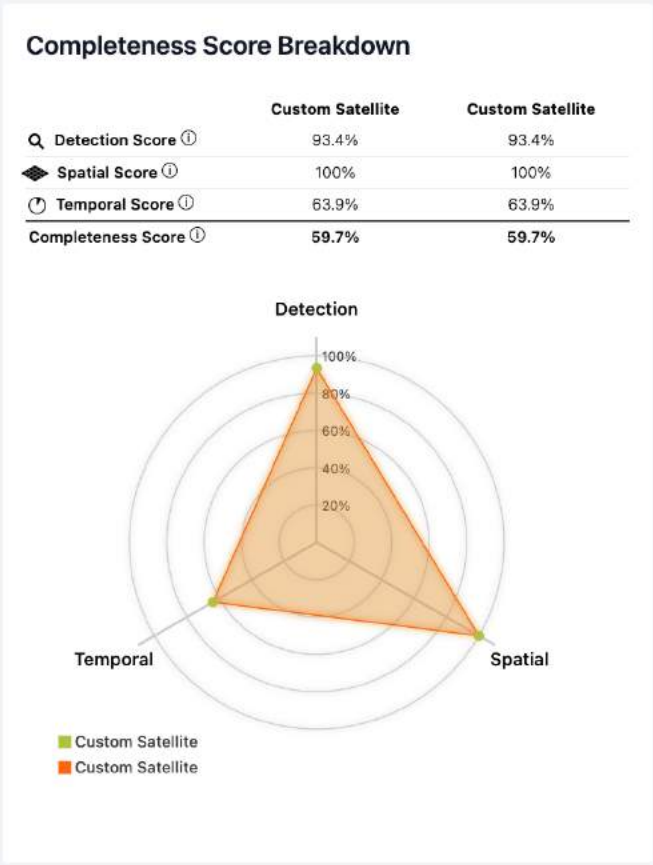
Custom Satellite Tab: Temporal Completeness

By entering a Daily Coverage, selecting an Emissions Persistence and scrolling down, users see how these inputs combine to form the Temporal Completeness sub-score.



Custom Satellite Tab

After saving your entry, the Custom Satellite will appear in the drop downs on the main tab. Note that the custom satellites are evaluated against the same world assumptions as the other satellites.



Learn More

For more information, check out the FAQ and About tabs.

You can also learn more by reading RMI's accompanying report, *Intel from Above: Spotting Methane Super-Emitters with Satellites*.

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Thank You!

We welcome questions, feedback, and comments.

Please reach out to us at climateintelligence@rmi.org.