INVEST
CONSERVATION

Quantifying Nature Based Carbon Removals in Real-time via Flux Towers

Unlocking Market Opportunities for Conservation

HYPHEN

Quantifying Real-Time Greenhouse Gas Removals in Tropical forests

Verified Real-Time Carbon Removal

-Scientific atmospheric measures using flux towers, replace manual and infrequent assessments, and provide independent & transparent measures.

End-to-end Transparent Data trail

-From raw data, processing & verification to integration with issuance and settlement-*fully traceable all the way*.

Enable Payment for Ecosystem Services

-Of the carbon removals and life-sustaining global climate services that standing natural tropical forests provide-*every day*.

Background: Carbon markets & Measurable Impact

To limit further global temperature, as outlined in the Paris Agreement, GHG emissions need to be cut by 50% by 2030 and reach net zero by 2050 [1]. This will entail both avoiding and reducing emissions, especially of Carbon CO_2 and methane CH_4. Inadequate emissions reduction action to date means that achieving net zero will also require removing GHGs from the atmosphere, increasing the importance of carbon capture and storage (CCS) [2]. Large-scale deployment of technical CCS solutions currently under development are costly and will take decades [3].

Nature-based carbon removal solutions are consequently receiving widespread attention, as evidenced by a large and growing number of nature-based preservation and restoration initiatives. Terrestrial ecosystems absorb in the order of 440 billion metric tons of CO_2 (tCO2) annually [4]. A productive forest can absorb over 11 tCO_2 per hectare per year [5]. Increasing the amount of CO_2 and other GHGs retained by the terrestrial biosphere by even a few percentage points would make a significant contribution towards achieving net zero.

Tropical forests have an outsized impact both on climate change and biodiversity yet have been overlooked in historical carbon funding. They support around 2/3 of life on earth despite covering less than 10% of the surface [6]. The principal reason for species extinction today is tropical deforestation, caused by human activity. If the current rate of tropical tree cover loss persists, achieving the Paris Agreement's goal of limiting warming to 2°C will be nearly impossible[7]. Tropical forests are natural climate regulators by sequestering carbon and maintaining water cycles, preventing droughts and fires. Mature forests sequester more carbon than most young forests.

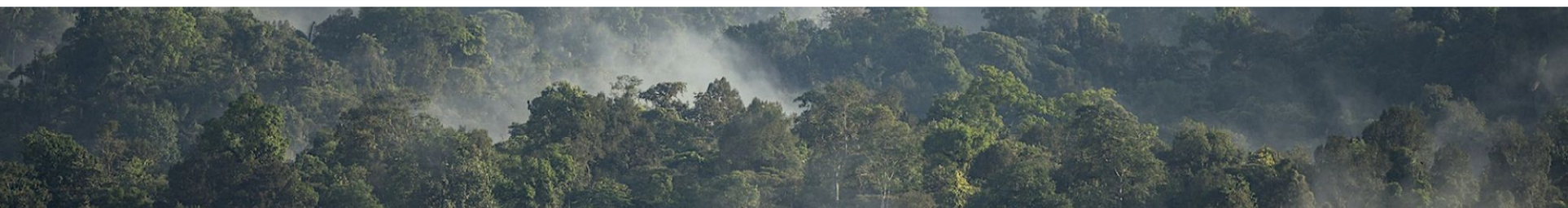
Conserving forests is 7-10 times more cost effective than reforestation which is resource intensive and cannot replace the unique ecosystem of natural standing forests [8].

Yet, traditional carbon markets have largely ignored the **Conservation of Key Biodiversity Areas** focusing instead on reforestation, afforestation and costly engineered solutions. Afforestation has focused on degraded areas where fast-growing monoculture plantations can demonstrate a 100% uplift—while failing to value the ecosystem services provided by mature conserved forests. Historical methodologies, focused on reforestation have limited the flow of carbon finance to the conservation of tropical forests, despite their outsized importance for both climate change and biodiversity.

Carbon markets should be an important mechanism for funding the goal of limiting the global temperature increase. However, uncertainty and lack of trust against a background of controversies have highlighted uncertainties with respect to the quality of nature-based credits. Traditional activity-based approaches to measuring carbon are slow, infrequent and lacking the necessary transparency and scientific verification of actual removals, instead they have relied on hypothetical scenarios predicated on assumptions about tree growth, future harvesting, and estimated sequestrations.

With measured and verified real carbon removals, credits will become a source of funding for tropical forest conservation.

Read more in Hyphen Research paper -Building Trust in Carbon Markets through atmospheric based gas monitoring and verification, March 2024 and InvestConservation's overview of Tropical forest impact.



What is the solution?
High-Impact Project & Verifiable Removals

Combining high-quality projects with scientifically verified, atmospheric-based measurement, ensuring that every carbon credit and emissions claim is based on accurate, measured impact—not estimates, enables payments for the carbon removal services provided by tropical forests.
This mobilizes funding where it has the greatest impact on both carbon sequestration and biodiversity.

InvestConservation's High-Integrity Projects

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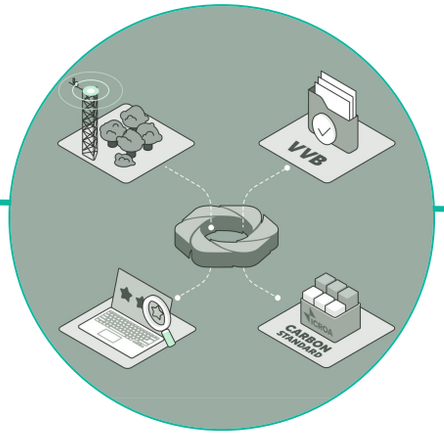
InvestConservation provides & manages high-integrity conservation projects in tropical forest that safeguard threatened biodiversity, ensuring project efficiency and quality by maximizing on-the-ground conservation and community benefits, overseeing carbon and biodiversity measurement & reporting, and delivery of registered removal credits.

Verified Real-time Carbon Removals via Hyphen



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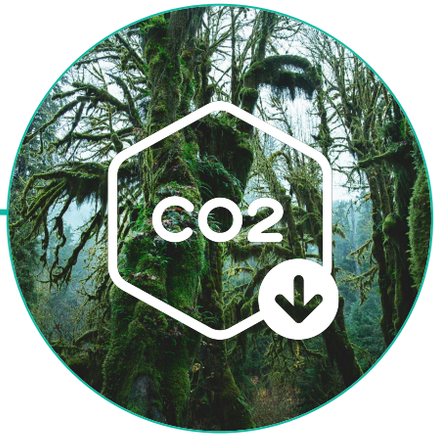
Hyphen's flux towers and dMRV solution is deployed to scientifically measure real-time greenhouse gas fluxes. These verified measurements quantify the project's net removals and integrate directly with carbon crediting methodologies, standards, and Validation and Verification Bodies (VVB) - establishing a fully transparent monitoring value chain.

Issuance of High Quality Carbon Removal Credits



Standards & Registries

The dynamic integration with recognized carbon standards and registries **facilitate rapid, efficient issuance of high-quality carbon credits.**

Unlocking the verified nature-based carbon removals credits to fund conservation of tropical forests.

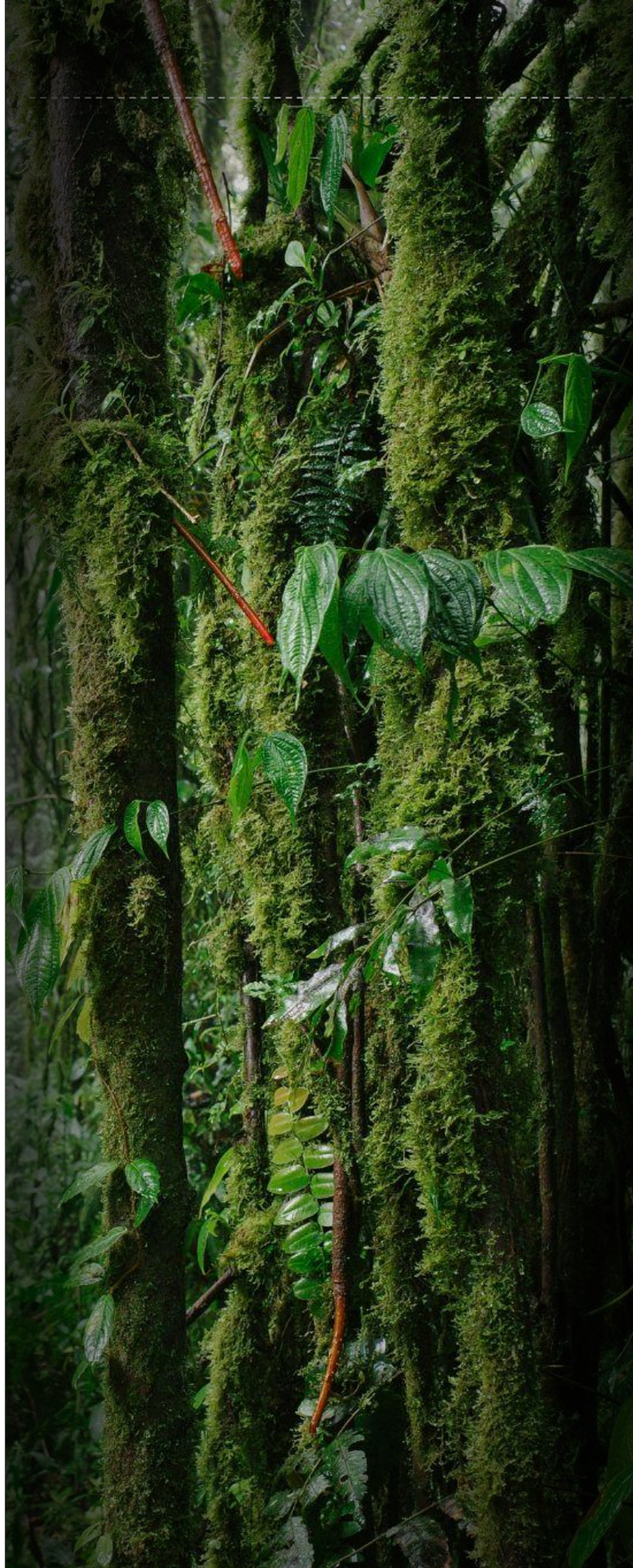
Flux & Forest: Unlocking Market Opportunities for Conservation.

Forests are highly dynamic and diverse entities whose capacity to both absorb and emit GHGs is a function not only of tree growth but also of soil-atmosphere exchange and decomposition of litter.

Forests' GHG absorption capacity changes as they mature; new forests could emit GHGs for their first 10-15 years before canopy closure [9-10] and a forest's net GHG balance can vary from source to sink depending on the season. Droughts and wildfires can turn forest sinks into sources. Forests and grassland GHG fluxes are also sensitive to management practices and to human-induced stresses, such as logging and deforestation.

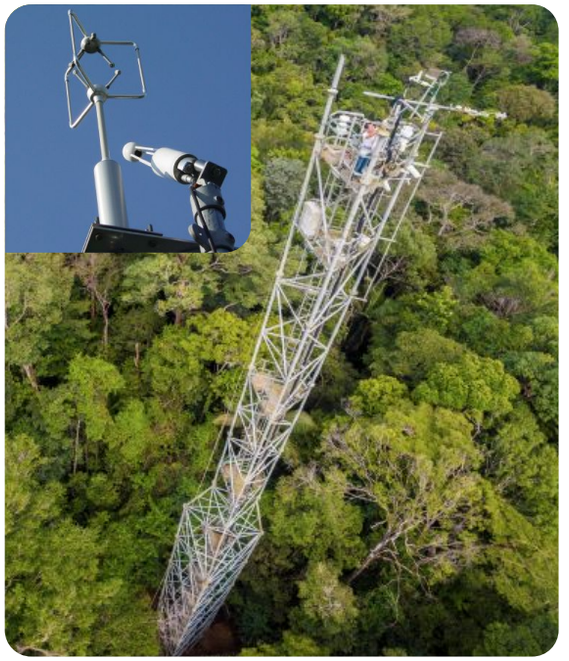
Atmospheric-based monitoring accommodates nature-based fluxes' dynamic nature and provides a net flux associated with all of these processes. By measuring "carbon in and carbon out", atmospheric-based monitoring provides a direct measurement of actual fluxes, making it a more direct means of assessing emissions and removals than proxy estimates obtained from monitoring land use and land use change.

Carbon (CO_2) and Methane (CH_4) are two key GHGs to monitor. The global warming potential of CH_4 is 30x that CO_2 ; the considerable CH_4 removal potential of forests is vastly under-appreciated in today's carbon markets. This makes CH_4 flux monitoring a valuable investment for nature-based projects involving woody surfaces (i.e. trees) of heights greater than 1.5-2 meters.



Hyphen solves digital MRV challenges by providing real-time quantification of greenhouse gas (GHG) removals

*Hyphen is a Swiss company delivering an **end-to-end atmospheric-based MRV (aMRV)** solution with a seamless integration of hardware and software, including:*



Eddy Covariance Flux Towers

The Towers are 1.5x the height of the forest canopy.
The systems are **solar-powered and designed to operate off-grid** and create a minimal physical footprint.
The towers are fitted with eddy covariance atmospheric and soil analyzers, and meteorological instruments. **The installation** in a standard deployment takes 2–10 weeks from mobilization.

aMRV Software

Hyphen's proprietary aMRV platform automates the processing of flux data and integrates it with remote sensing and site-specific variables. This enables real-time, project-wide quantification of GHG removals, reductions, and emissions. The dashboard transforms complex GHG and land data into clear, actionable insights.

The solution directly integrates to carbon registers.

Key Benefits:

- **Direct Measurement, Not Proxies.**
- **Uncertainty Quantified.**
- **Scientific Integrity at the Core.**

How it Works:

Flux Towers

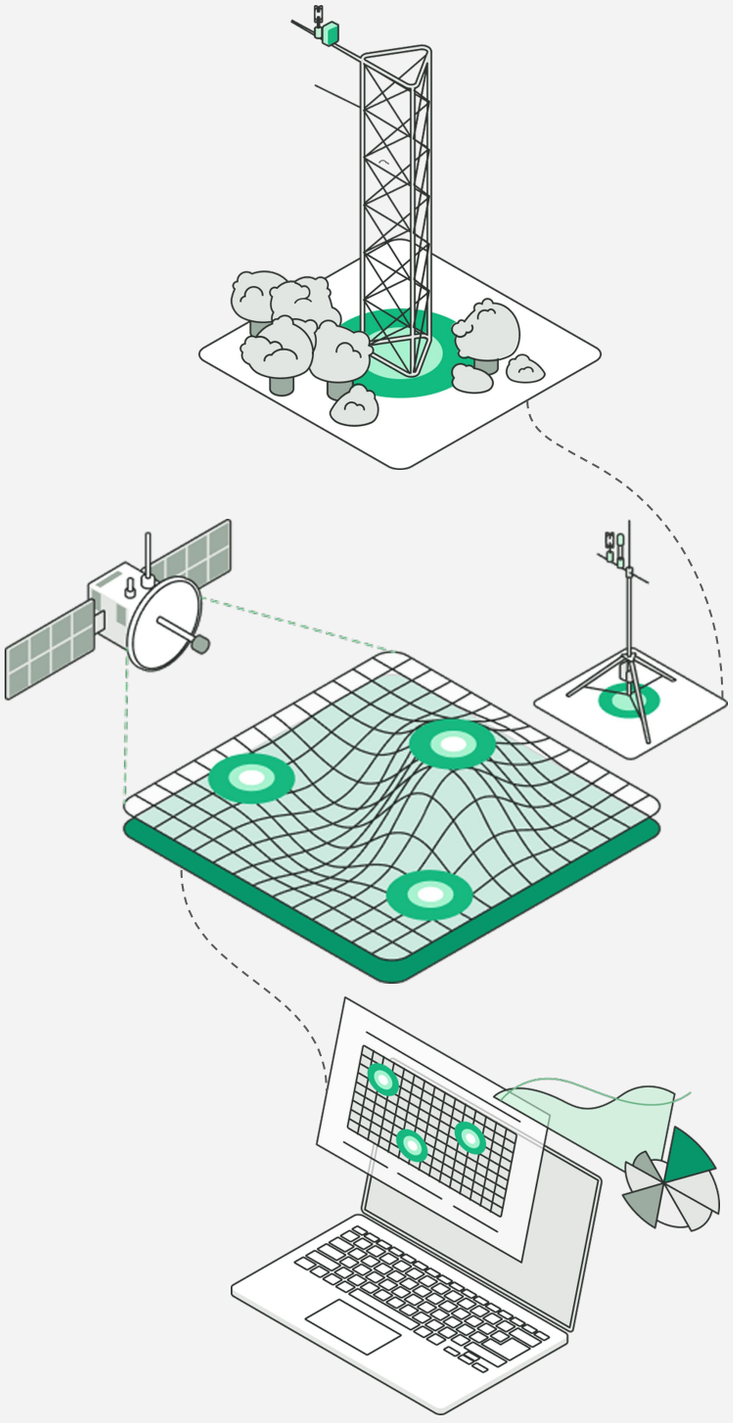
Flux towers are equipped with LI-COR's eddy covariance and soil flux chamber instrumentation. Each tower continuously measures CO_2, CH_4, N2O (atmosphere & soil flux) and other environmental variables with 10-20Hz resolution.

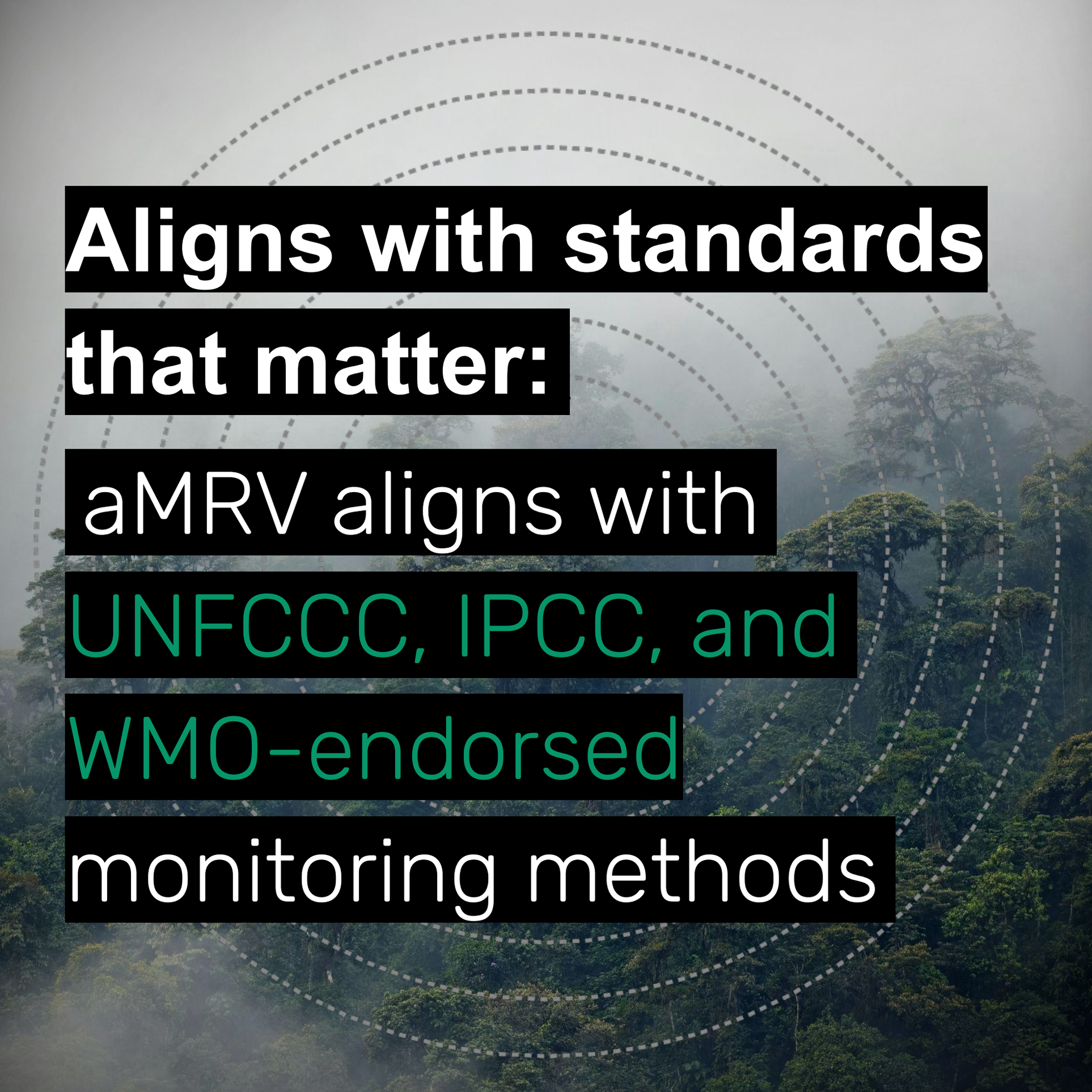
MRV Software

Automated data processing of high-resolution GHG flux data in real-time, 24/7. Flux data is then combined with remote sensing data for a comprehensive quantification of GHG removals and reductions for an entire project area net ecosystem exchange.

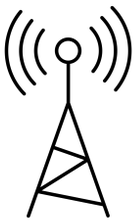
MRV Software & Analytics

A customized dashboard shows real-time analytics and provides valuable insights for mitigation outcomes.




Aligns with standards that matter:
aMRV aligns with UNFCCC, IPCC, and WMO-endorsed monitoring methods

Atmospheric-based GHG monitoring methods: scientifically & intergovernmentally approved



Atmospheric-based GHG monitoring draws on over 60 years of scientific research, infrastructure development, operations and data.

Routine atmospheric GHG monitoring within the science world dates back to the late **1950s,** with the first site at Mauna Loa in Hawaii.

Since it has been implemented across 126 sites as part of the **WMO Global Atmosphere Watch (GAW) program.** It is coordinated by the US National Oceanic and Atmospheric Administration (NOAA), the Integrated Carbon Observation System (ICOS) and Advanced Global Atmospheric Gases Experiment (AGAGE) network hosted by the **Massachusetts Institute of Technology (MIT).**

Atmospheric-based GHG monitoring methods have been internationally recognized through three separate intergovernmental processes:

The IPCC endorses atmospheric-based monitoring methods for quality assurance of national GHG inventories.

The UNFCCC Subsidiary Body on Scientific and Technological Advice recognizes and encourages the use of the atmospheric-based WMO Integrated Global Greenhouse Gas Information System (IG3IS).

WMO-The World Meteorological Congress itself, as an intergovernmental organization, oversees the GAW program, through which many of the existing atmospheric based GHG monitoring techniques have been developed.

ipcc

WMO

Carbon Markets & Flux Measures

Setting a New Global Benchmark for GHG Quantification

SOCIALCARBON Foundation's SCD0003 — Module for Eddy Covariance-Based Continuous Quantification of Greenhouse Gas Fluxes sets a new global standard for how GHG removals and reductions are measured, verified, and valued in carbon markets.

By leveraging on-site eddy covariance flux towers, SCD0003 enables continuous, real-time, and high-precision quantification of greenhouse gas fluxes, that directly correlate to carbon credits.

The result is an unprecedented level of scientific accuracy, transparency, and accountability — delivering a trusted foundation for high-quality carbon credits.

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Definitions

Atmospheric-based GHG monitoring Uses observations from surface-, aircraft-, and space-based instruments in combination with analysis and modeling of atmospheric processes to transform measurements of atmospheric GHG concentrations into GHG fluxes (see below) for specific spatial areas and time periods.

GHG fluxes The exchange of GHGs between the earth's surface and the atmosphere. Positive fluxes indicate increasing emissions into the atmosphere (sources) and negative fluxes indicate removal of GHGs from the atmosphere (sinks).

Digital Measurement, Reporting and Verification (dMRV) The use of artificial intelligence, machine learning, satellite imagery, blockchain, smart contract, smart sensors, the internet of things (IoT), cloud computing and drones in MRV systems to fully or partially automate data collection, recording and processing for data validation, reporting, and verification.

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InvestConservation®
is a mission driven company specialized in providing & managing high-quality projects that safeguard threatened biodiversity in tropical forests.

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