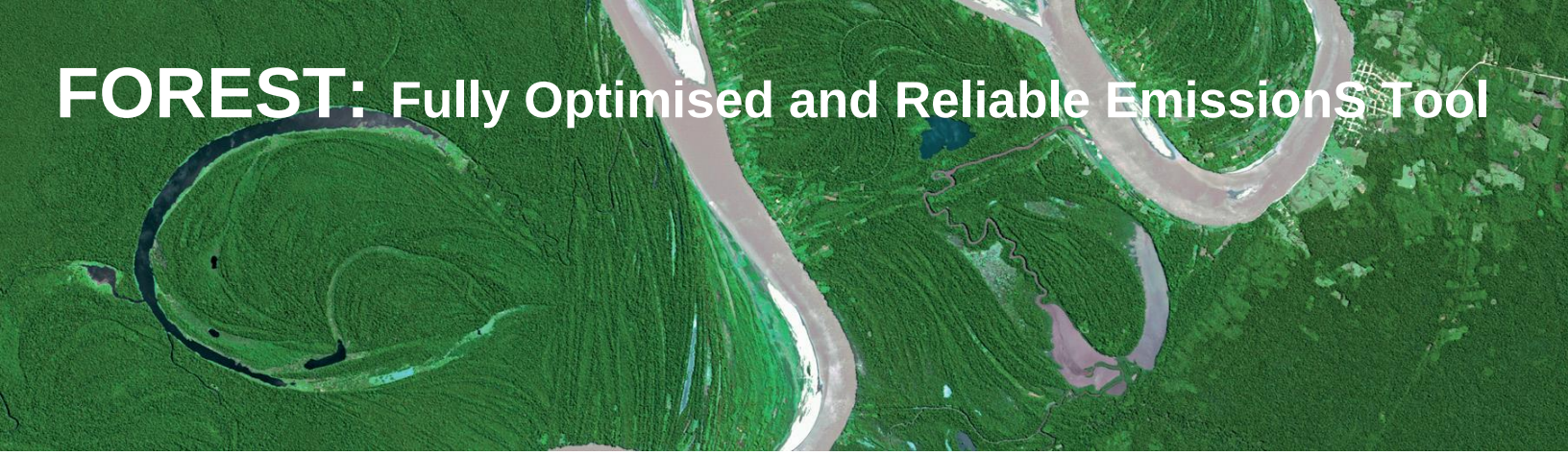
FOREST: Fully Optimised and Reliable EmissionS Tool



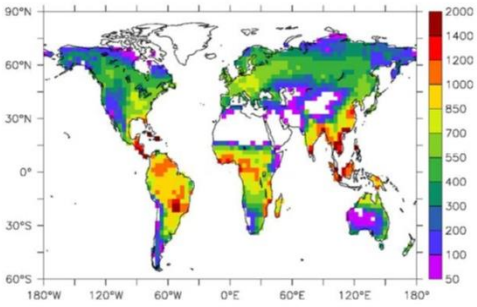
The concept

FOREST project funded by the EIT-KIC (http://www.climate-kic.org) aims to respond to the growing demand of forest carbon stakeholders for trusted, fully integrated and cost effective Measuring Reporting Verification (MRV) service components, enabling forest monitoring projects and initiatives to achieve carbon goals, *i.e.* emission reduction and/or stock enhancement.

It brings building blocks for such services including the observations from space, the local in-situ ground measurements to calibrate and validate these observations, the forest maps and the theoretical model needed to estimate and manage the carbon sequestred in forested areas; as well as quality metrics for each product to promote end-user confidence in the fidelity of the services being provided.

The FOREST project has brought together the expertise of Airbus Defence and Space, AMAP, I4CE, NPL, ONFI and UVSQ-LSCE to provide cost effective capacities and answer the need of a wide range of users from fields as diverse as forestry management, environmental impact assessment within industries such as mining and oil companies, conservation management and performance based payments to remunerate REDD+ efforts (including carbon credits).

Airbus DS satellites constellation – SPOT, Pléiades, TerraSAR, TanDEM-X, DMC



Biomass production based on a simulation of the ORCHIDEE model (gC m^{-2} yr^{-1})

FOREST rationale

- Provision of Earth Observation data (optical and radar) from calibrated multi-mission time-series for deriving primary products required in the assessment of forest cover and change, i.e. deforestation and degradation
- Determining land cover, forest types, forest structure and changes thereof at a maximum spatial resolution of 0.04 ha over local (100 km²) and regional areas (>20 000 km²) based on these EO data and innovative processing chains.
- Developing the ORCHIDEE carbon flux model already recognized by the scientific community towards its operational implementation in national and regional REDD+ MRV systems.
- Quality Assurance (QA), calibration and validation strategies for each step supported by existing ground based in situ measurements or products accuracy assessment already established through robust metrological practices providing an uncertainty for the overall services.

Market Focus

After long political and technical negociations that took more than seven years on a global mechanism for **Reducing Emissions from Deforestation and Degradation and enhancement of carbon stocks (REDD+)** this issue has gained strong momentum and it is expected to be included in the 2015 Paris Climate Change agreement for the post 2020. There is clear consensus on the need of solid Monitoring, Reporting and Verification (MRV) systems and national forest carbon accounting schemes to back up the countries efforts to reduce tropical deforestation and forest degradation.

FOREST aims to respond to the increasing demand of this type of services required for REDD+ and other forestry monitoring related activities.

AIRBUS DEFENCE & SPACE · NPL National Physical Laboratory · I4CE INSTITUTE FOR CLIMATE ECONOMICS · FOREST · LSCE · ONF International · AMAP

FOREST services

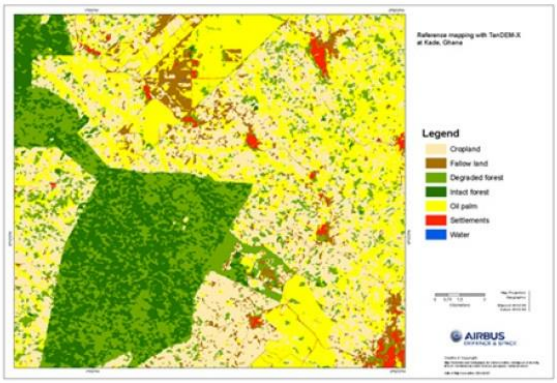
➢ Quality assurance service

The Quality Assurance (QA) framework and methodology developed within FOREST will provide a means for assessing the quality of data and products being delivered as part of any MRV service through the provision of provenance and traceablity information (inputs → processing methods →output → validation). QA will be integrated into the FOREST services to provide end users and customers with independently verified data they can trust and use confidently in their applications.

➢ Forest Maps

Baseline Land Use/Land Cover (LULC) mapping at regional scale is a key product required for forest mapping in the context of carbon accounting to support the implementation of REDD+ and national GHG inventories but also for sustainable forest management and environmental protection. Furthermore technical guidance for REDD+MRV recommends the stratification of forest cover to support efficient field surveys and carbon accounting.

The Baseline maps (or Historical maps) provide a binary classification of the territory into Forest and Non Forest, at pivot dates. From pivot dates onwards they identify changes (deforestation or forest regeneration) which have occurred since the previous date. The objective of the Benchmark Forest map is to provide a reference land use state at the initiation of national or local REDD+ projects.



Land use/ cover & forest classification with TanDEM-X – Ghana, Kade.

Integrated service

Better identification of degradation

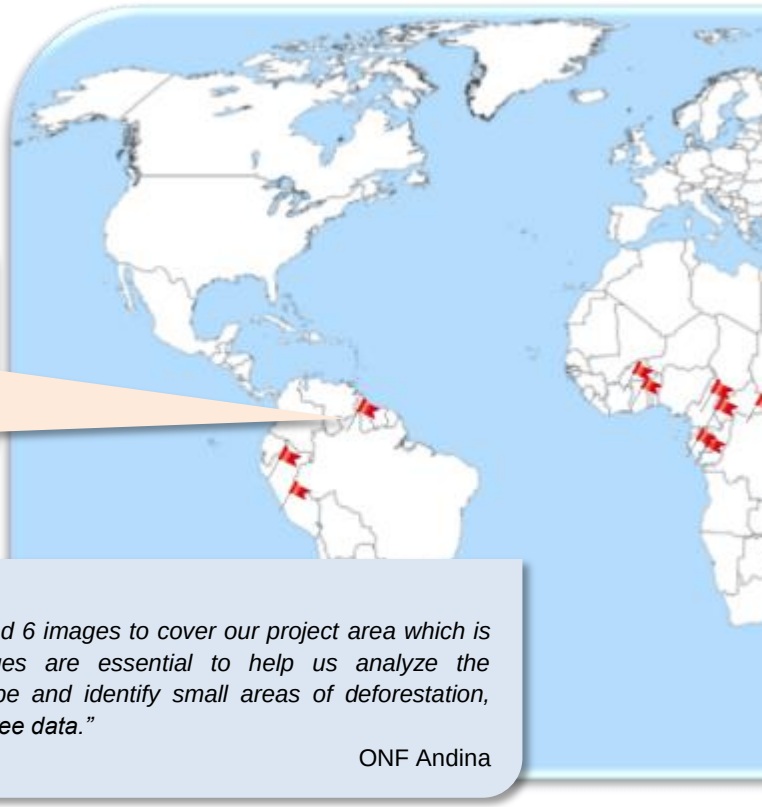
Reduction of uncertainty

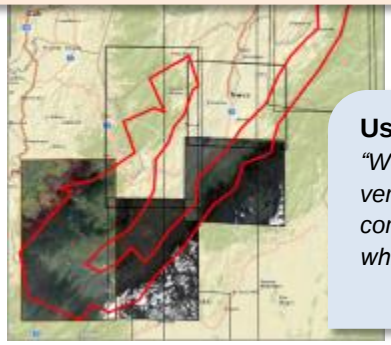
➢ Change mapping & Analysis

Identifiying the beginning of an illegal activity before the damage get too big, detecting signs of deforestation and degradation on a REDD+ project or analyzing forest harvesting practices in connection with forest certification requirements is now possible with rapid acquisition accessible with Very High Resolution (VHR) images such as Pléiades or SPOT6/7 data.

Project examples

Detection of small of deforestation in 2014 in Huila Colombia for the Colombian Ministry of the Environment and Sustainable Development using satellite imagery (SPOT4, 5 & 6). The service included change mapping and capacity building to end users.





SPOT6 cloud free data – Huila, Colombia

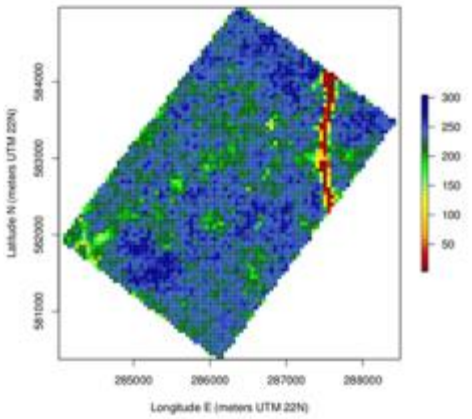
User Testimony

"We purchased SPOT 5 and 6 images to cover our project area which is very cloudy. These images are essential to help us analyze the complexity of the landscape and identify small areas of deforestation, which is not possible with free data."

ONF Andina

➢ Carbon emissions maps

Based on climate data, census data and Earth Observations data as well as derived parameters (e.g. forest structure, biophysical), **Carbon emission maps** are able to estimate the forest carbon stocks and forest carbon changes at local and regional scales. Scenarios of forest management over a 30-year time horizon are proposed (deforestation, degradation, and enhancement).

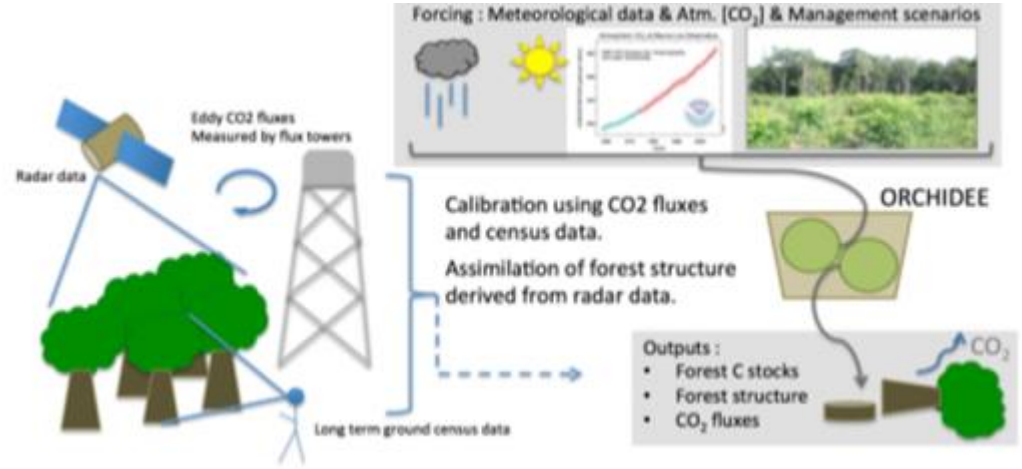


Above-ground biomass with assimilated height (MgC/ha) – Paracou, French Guyana

Improve field trips

Attractiveness for donors/investors

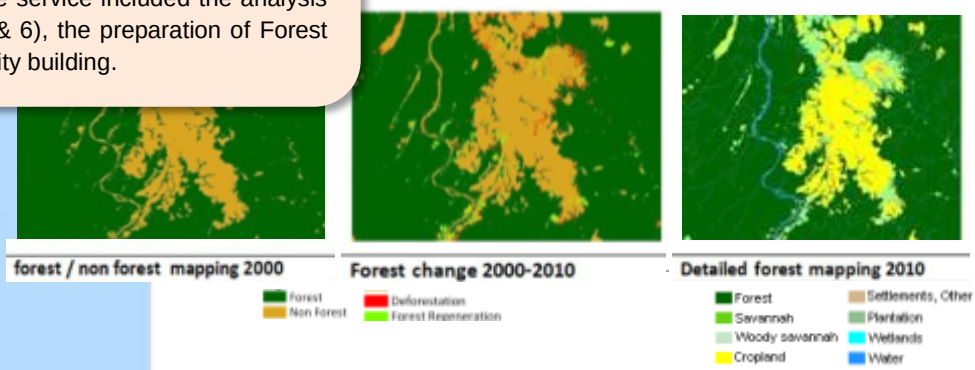
Cost-effective



Project examples

The "Observatoire Spatial des Forêts Tropicales" initiative financed by the French Development Agency through a partnership with Airbus Defence and Space, ONFI & IGNFI (2011-2015, Congo Basin). The service included the analysis of satellite imagery (SPOT4,5 & 6), the preparation of Forest maps (600.000km2) and capacity building.

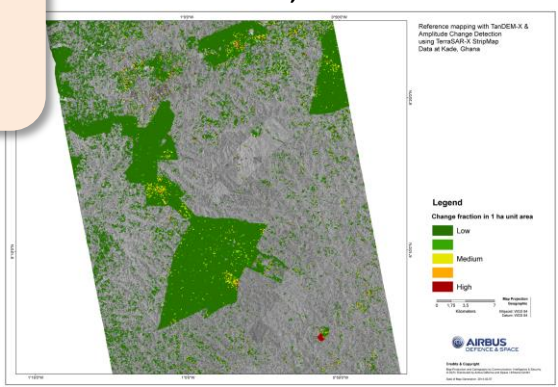
Historical base map (2000) and change map (2000-2010) and Benchmark map (2010) – Central Africa Republic, Congo Basin



Project examples

Supporting Ghana in forest monitoring with remote sensing technology. Service included images+, benchmark maps, change mapping & analysis and capacity building in radar remote sensing and carbon stock change monitoring

Reference Mapping with TanDEM-X & Ampletude Change detection using TerraSAR-X – Kade, Ghana



User Testimony

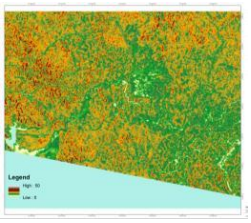
"The significance of this project for national MRV development effort is enormous. Therefore CERSGIS views this project as highly successful and expects further cooperation with Infoterra GmbH [..] in Ghana and possibly the West African sub-region"

Centre for Remote Sensing and Geographic Information Services (CERSGIS), Ghana.

FOREST products

Forest Structure

The product includes measurements that are key to sustainably manage, exploit, preserve and enhance forest resources. Forest structure parameters such as Forest canopy height or biomass information from VHR optical data or radar data are used to feed carbon emission models for REDD+ MRV.



Forest height map of Mabounie, Gabon

3D tree and forest structure and dynamics, leaf distribution, phenology and spectrometry are necessary for calibration and sensitivity studies.

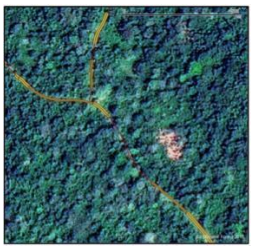
Forest Maps

The synergy of SPOT and TanDEM-X data enables us to deliver more accurate mapping of the 6 land use categories (mandatory for GHG reporting) compared to conventional mapping based on high resolution optical sensors alone, with MMU< 0.5 ha and compliant with national standards. . More detailed forest typology mapping is also available, which may be of interest for applications in forest management, conservation and impact studies.

Benchmark forest map, Cameroun

Forest base mapping

We use high or very high resolution satellite images (Pléiades, SPOT 6, TerraSAR-X, TanDEM-X) to identify and interpret forest disturbances smaller than 0.1 ha anywhere in the world in near real time.



Cameroun – SPOT 6 2012 – width tracks extraction

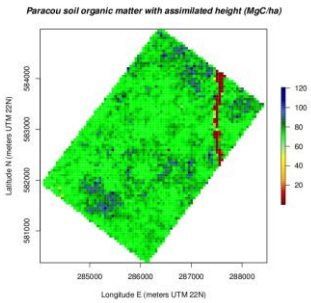
Forest Degradation

Besides deforestation addressed in the LULUCF mapping significant forest destruction is caused by forest degradation. Even small scale logging operations (e.g. selective logging) can lead to a persistent decline in forest goods and thus be a precursor to forest degradation. Using TerraSAR-X data or VHR optical data, FOREST innovative method provides degradation maps with MMU of 0.5 ha.

Change indicator layer produced from TerraSAR-X StripMap (3m) in Cameroon

Forest Carbon stocks

FOREST provides spatial estimates of the five carbon pools required for Tiers 3 REDD+ projects (above-ground biomass, below-ground biomass, dead wood, litter, soil organic matter). The ORCHIDEE model coupled with the canopy light penetration module (CAN) provides carbon stocks for these carbon pools.



Paracou soil organic matter with assimilated height (MgC/ha)

Forest Carbon changes

Changes in various carbon pools between a reference date and a later one are provided in a gridded format, including changes in above and belowground forest biomass, soil carbon, as well as their uncertainties. We use the ORCHIDEE-CAN model, using forest structural information from Pléiades or TanDEM-X and land cover data to run at different dates and differences are then computed between these dates.

FOREST partners

AIRBUS DEFENCE & SPACE

Based on an exclusive access to Pléiades, SPOT, TerraSAR-X and TanDEM-X (radar and optical satellites), **Airbus Defence and Space** spans the entire geo-information value chain and provides decision makers with IPCC compliant LULUCF maps and forest maps & analysis allowing for an optimized management, better risk anticipation and more comprehensive reporting (safeguards) of forest monitoring and carbon projects.

I4CE INSTITUTE FOR CLIMATE ECONOMICS

I4CE provides independent expertise on economic issues related to climate change policies. Its objective is to help public and private decision makers understand, anticipate and facilitate the implementation of the economic and financial instruments for managing the transition to a low-carbon economy and fostering adaptation to changes in the global climate.

LSCE

UVSQ-LSCE is a laboratory which is a joint research unit of the University of Versailles Saint-Quentin (UVSQ), the French National Centre of Scientific Research (CNRS), the Atomic Energy Commission (CEA). It is a part of the Institute Pierre Simon Laplace (IPSL), which federates several laboratories involved in climate and environment studies. It develops and applies models to investigate a range of biogeochemistry, biogeography, and climate related questions. Among them the ORCHIDEE model estimates carbon, water and energy fluxes across multiple spatial scales.

AMAP

AMAP is a joint laboratory co-operated by the University of Montpellier II, along with four French research agencies including CIRAD, CNRS, INRA and IRD. AMAP focuses on plants and vegetation, and specifically develops research at the interface between applied mathematics and informatics and plant and vegetation sciences.

NPL National Physical Laboratory

The **National Physical Laboratory (NPL)** is the UK's national measurement institute. The Centre for Carbon Measurement is its low carbon and climate science arm, undertaking projects regarding GHG measurements and other measurements that are required to take us towards a low carbon economy.

ONF International

ONF International is an unquestioned player in climate change mitigation in the forestry sector, it provides technical and methodological support to projects and countries involved in the REDD+ mechanism. The strength of ONFI is the ability to act as a link between political and institutional challenges, markets and financial reasonning, and the reality of implementation in the field.

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