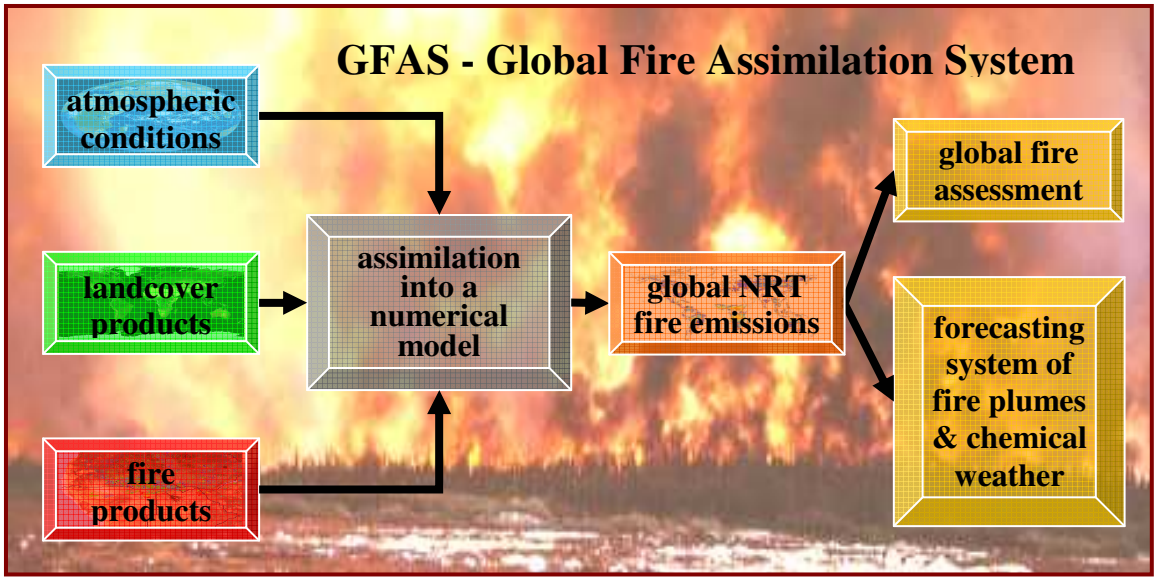
**Expression of Interest for Listing of a European Project on a Global Fire Assimilation System**

## 1. Objective

Vegetation fire emissions are among the most important contributors to the global budget of various gases and aerosols, and they affect regional air quality, weather, and climate. Accurate assessment of the emissions from fires is needed over extended time periods for negotiations of international emission control regulations (e.g. Kyoto, CLRTAP). Near-real-time information is required for the forecasting and warning of fire-related pollution episodes. An increasing number of different satellite data provides information on various fire properties. However, there are still large uncertainties about the quantification of fires and their severity. Inconsistencies exist between different satellite data products, and there are only few data available in near-real-time. An integrated effort to synthesize the available information is needed in order to generate an operational system for accurate global fire emissions monitoring.

A Global Fire Assimilation System (GFAS) should be constructed from the best available satellite products. These data have to be integrated into a state-of-the-art numerical model. Data assimilation into numerical models provides the most efficient and consistent method for integrating a large variety of observational data in near-real-time. This is demonstrated by operational systems for numerical weather prediction. The GFAS must have a flexible structure to allow for continuous improvements when new parameterisations or more detailed information (e.g. higher temporal or spatial resolution) becomes available. The GFAS should produce emission estimates with sufficient accuracy and adequate resolution in space and time for use in regional air quality models. The development and operation of such a system must also include extensive validation efforts. An integrated research project provides an excellent opportunity and the necessary resources to gather a strong consortium of experts in all relevant fields in order to *generate the first European operational global fire assimilation system*. Such a system would add enormous value to the objectives of the Integrated Global Observation Strategy (IGOS) and the Global Climate Observing System's Implementation Plan (GCOS IP). GCOS IP has been endorsed by the UNFCCC and is to form part of the climate change societal benefit areas of the Global Earth Observation System of Systems (GEOSS) plan. The proposed configuration of the GFAS is shown the figure below.



## 2. Methodology for Estimation of Fire Emissions

The quantification of fire emissions is based on the assessment of the amount and type of burnt biomass, the location and duration of the fire, the injection height, and the emission factors for particular species. Many of these parameters – or at least their variability - can be estimated from satellite observations. The generation of information on individual fires or of gridded fire emission fields in the required spatial and temporal resolution from satellite data involves *s*ophisticated retrieval algorithms. These infer fire properties from raw radiance observations from satellite und must include screening of clouds and knowledge of land surface parameters. The latter can either be obtained from climatological vegetation maps, remote sensing, or vegetation modelling. The GFAS will profit from a closer link to observations of the vegetation cover and to numerical vegetation modelling within GEOLAND.

The combination of detailed information on the spatial distribution of fires from polar orbiting systems must be combined with detailed temporal information from geostationary platforms to determine the diurnal variation of the burning activity. The GFAS will make use of satellite products that provide near-real-time data, like active fire products that are based on the thermal signal during burning. Reanalysis of extended periods can also incorporate information from additional satellite products that are available with a time lag, e.g. burnt area products. At present, only two systems provide near-real-time analysis and forecast of air pollution due to fire emissions. The RAMS model at INPE/CPTEC assimilates the WF_ABBA product from the GOES satellites. It monitors CO and aerosol from severe fire events over the Americas. The NRL/NAAPS aerosol model within the FLAMBÉ programme additionally assimilates the MODIS active fire product to provide global forecasts of aerosol emissions from fires.

Recently, new algorithms have been developed that directly quantify the fire radiative power (FRP) from space. In several field experiments, FRP has been shown to relate directly to the rate of fuel consumption, which is proportional to fire emissions. The FRP method thus has the potential to significantly reduce the uncertainty of fire emission estimates, because it does not depend on specific knowledge of the fuel load and burning efficiency. EUMETSAT will operationally generate FRP products from SEVIRI in the near future. While this method requires further validation and testing, the GFAS would benefit from further developments of global operational FRP products.

Emission factors for trace gas and aerosol components are hitherto based on measurements in the field and in the laboratory, complemented with model studies. More comprehensive and reliable field data characterizing types (e.g. peat fires) and quantities of fuel consumed are needed. Differences between flaming vs. smouldering combustion in typical and extreme fire situations should be investigated. Recent studies indicate that emission factors can significantly change during the burning season, and this necessitates the development of new parameterisations for the GFAS. Another important parameter which has until now been mostly neglected in modelling is the fire plume height. The injection height of fire emissions is, however, decisive for their dispersal and residence time. Information on the fire energy together with the atmospheric conditions and possibly additional satellite observations of plume heights from MISR or CALIPSO will yield more realistic injection heights in the GFAS.

## 3. Strategy

An integrated European research effort is required to generate an operational system for accurate global fire emissions. It should involve space agencies, satellite retrieval experts, and biosphere and atmosphere modellers from different research institutes and operational centres. A large integrating project would ensure a successful construction of the GFAS through intensive collaboration of experts ensuring long-term continuity. The GFAS will build on strong heritage from ongoing or recent European Integrated Projects (IP). Initial efforts to build a non-operational version of the GFAS will already be started within the atmospheric IP GEMS. The ongoing land surface IP GEOLAND will provide access to high-quality information on the land surface (e.g., vegetation cover, soil moisture, temperature). Parallel targeted research and development activities by the European, US and Asian communities will be pursued, and close collaboration with existing international efforts will be established (e.g. GCOS, GEOSS, GOFC/GOLD-FIRE, TF-HTAP). A close link to potential users of the fire emissions assessment and the forecast system will be established, e.g., via the land and atmosphere monitoring in GMES.

The project will require significant efforts in the following research areas:

1. Assessment of regional-scale performance of existing satellite fire products and improvement of fire data retrievals
2. Development of an assimilation system using multiple fire observations, a vegetation model and adaptation of land surface data sets
3. Development of new parameterisations for emission factors and injection heights
4. Development of a model infrastructure for the GFAS addressing specifically the needs for near-real-time operational use
5. Validation of the GFAS
6. Development of fire data products for end users

For an initial cost estimate, we assume that each of these activities will require the involvement of 5-8 scientists throughout project duration of 4 years. The total required budget would be about 12 M€.

## 4. Authors

The ideas presented in this document result from the EU Specific Support Action HALO and a special session on fire emissions during the first General Assembly of the EU Integrated Project Global and regional Earth-system (Atmosphere) Monitoring using Satellite and in-situ data (GEMS) in Reading, UK, February 2006.

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