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THE DEVELOPMENT OF A FIRE RADIATIVE ENERGY PRODUCT

This document presents a fire product, namely the Fire Radiative Energy (FRE) product, that will be developed at EUMETSAT in 2006. The product will be based on MSG/SEVIRI observations and is targeted to support to the global change research community, atmospheric pollution tracking, air quality forecasting and the assessment of carbon emissions.

This paper has been written in response to Action 31.18.

EUM-WP-17 EUMETSAT Activities on Fire Monitoring

1. INTRODUCTION

This document presents a Fire Radiative Energy (FRE) product which will be developed at EUMETSAT in 2006. This product will be based on MSG/SEVIRI observations and is targeted to support to the global change research community, atmospheric pollution tracking, air quality forecasting and the assessment of carbon emissions. A justification for the choice of this product is given in this document.

2. POTENTIAL FIRE PRODUCTS

Fire is a combustion process, which transforms the fuel (vegetation) and releases energy, resulting in gases and particles emissions, and burned areas. Those fire consequences impact on a wide range of areas, including: atmosphere chemistry, Earth radiation budget, biogeochemical cycles, health, economy, ecology, biodiversity, etc.

The majority of vegetation fires are human-caused. In many vegetation types of the world, the application of fire in agriculture, pastoralism and the occurrence of natural wildfires (natural fire regimes) are established (sustainable) elements in traditional land-use systems, natural ecosystem processes and biogeochemical cycles. Excessive application of fire associated with rapid demographic and land-use changes in some regions, as well as climate variability, such as El Niño, contribute to the severity of fire impacts, and the projected demographic and climate change scenarios suggest that this situation will become more critical during the next decades This led, in the last 1990's, to an increased interest in fire issues by the local, regional and global communities.

Remote sensing can provide relevant information on fire activity. From an observational capability point of view, the decreasing order of feasibility to retrieve quantities that can provide information on the fire impact, and that can be attributed to the fire, is:

1. Fire energy (probably directly detectable);
2. Burned area (probably detectable by temporal change);
3. Emitted particles (in theory detectable, but difficult);
4. Emitted gas (probably not feasible).

3. USERS' NEEDS VERSUS SEVIRI POTENTIAL

SEVIRI includes at least the main spectral channels that are commonly used to retrieve fire information from remote sensing data. Its main added value compared to existing sensors is its 15 minute repeat cycle, and the potential for a near-real time operational products.

In summary the appropriateness of a SEVIRI potential fire product to the user's needs is as follows:

- Fire management community in Europe: Useful and complementary→ SEVIRI's spatial resolution limits the interest for real-time operational fire information such as

active fire and fuel moisture content Therefore SEVIRI observations are complementary to existing information systems in place, but likely not essential (e.g., early detection of night time fires, documentation of fire activity).

- Fire management community in Africa: Useful and complementary→ The need for operational information in Africa is commonly constrained by the limited means to act upon the received information, and therefore mostly limited to large fire events with international community interventions, and some limited local monitoring (e.g., South Africa). However, SEVIRI (similarly to other instruments) offers the potential to document fire activity (primarily active fire) to describe seasonal activity and trends, allowing, for example, to develop and monitor fire management policies.
- Global change community: Useful and important→ there is a clear demand to better understand global change and to satisfy international protocols such as Kyoto. Since biomass burning has a strong impact on the vegetation, ecosystem and atmosphere chemistry, it has also a strong impact on global change. In particular there is a need to improve the documentation of the biomass burning contribution to gas and particles emissions. SEVERI provides an appropriate spatial resolution to provide relevant information to most continental and global models, as well as the capability to provide information on fire released energy, which should substantially contribute to such improvement.

The EUMESAT FRE product will thus initially focus on providing information in support to the Global Change Community and air quality forecasting. In this context, FRE appears to be an appropriated product. It is also noted that this product is complementary to the active fire monitoring performed by other entities. The feasibility of a FRE product has been demonstrated by Wooster (2002).

4. FIRE RADIATIVE ENERGY

The key variable used to assess the effects of a biomass burning event, or series of events, is the amount of fuel burned [1], generally derived using an equation of the form:

$$M = A \times B \times C \qquad (1)$$

where M is the amount of dry biomass combusted (kg/m^2), A is the burnt area (m^2), B is the biomass density (kg/m^2) and C is the combustion factor (i.e. the fraction of the available fuel actually consumed, unitless). Estimation of burned area has received much attention and useable satellite-derived products available at the continental scale are now becoming available. However, the related remote sensing estimates of biomass density and combustion efficiency are not foreseen in the near term, leading to large uncertainties in parameterisation of (1). Due to these limitations an alternative, independent approach to estimating *M* was considered by [2, 3] for use with the MODIS Airborne Simulator, and later the MODIS spaceborne instrument, based on analysis of the fires whilst they are still actively burning. Essentially, it was hypothesised that the amount of radiant energy liberated per unit time during a burn (the so-called Fire Radiative Power) should relate to the rate at which the fuel is being consumed. [4, 5] developed the approach further, indicating that temporal integration of this Fire Radiative Power (FRP) measure over the lifetime of the burn provides a measure of the total Fire Radiative Energy (FRE), which should be proportional to the fuel mass combusted. Observations from a geostationary platform would provide the temporally detailed record necessary to undertake this temporal integration, and the measurement of FRE represents an alternative, physically-based variable capable of being used to provide an

independent estimate of parameter *M* in equation (1), assuming that the amount of radiated energy released per kg of fuel mass burned (the so-called radiative heat yield of the fuel) is known.

5. CONCLUSION

An FRE algorithm will be prototyped at EUMETSAT in 2006 in support to the Global Change scientific community. The operational dissemination of this product is not expected to take place before 2007. An update on the status of development of the FRE product could be provided at the next CGMS meeting.

6. References

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