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A mission concept for a dedicated Fire Monitoring Constellation of small satellites based on the BIRD heritage

G. Ruecker (1), E. Lorenz (2), A.A. Hoffmann (3), D. Oertel (2), and J. Tiemann (1)

(1) ZEBRIS GbR, Lipowskystr. 26, 81373 Munich, Germany (gruecker@zebris.com, +49-189378939), (2) Deutsches Zentrum für Luft- und Raumfahrt e.V., Rutherfordstr. 2, 12481 Berlin, Germany (eckehard.lorenz@dlr.de), (3) Consultant, Uhlandstr. 15, 74889 Sinsheim, Germany (aahoffmann@email.de)

Due to its spatial resolution and sensor characteristics, the experimental small satellite BIRD (Bispectral InfraRed Detection, active from 2001 through 2003) was superior to any past or current spaceborne instrument in its capacity to detect and characterize fires. Here we present the results of a concept study by the German Aerospace Center (DLR) for a follow-up, dedicated Fire Monitoring Constellation (FMC) consisting of four BIRD-type satellites with improved infrared detectors and sensors. Main objective of the proposed mission is the quantitative analysis of fire related emissions and fire behaviour with the focus on the observation of fires during their active phases. The approach of deriving estimates of biomass combustion - and subsequently emissions - from a burning fire's radiative energy release has been developed relatively recently, and is now used semi-operationally for global air pollution and greenhouse gas emission estimation in the EU-sponsored Global Monitoring of Environment and Security (GMES) atmosphere service. However, existing and currently planned remote sensing missions only marginally meet the requirements for such a system. Based on a comparison of historical BIRD data with near coincident observations from the currently leading polar orbiting fire monitoring instrument, MODIS, we estimate that the amount of fire radiative energy - and thus biomass burned - not detected by MODIS due to its coarser spatial resolution is in the order of 20% and thus not negligible. Many of these fires are smouldering fires - such as peat fires - which release a greater share of methane and carbon monoxide per mass unit burned when compared to flaming fires. However, existing spaceborne systems are not accurate enough to measure fire temperature and distinguish between flaming and smouldering fires to account for these differences. To do so, a spatial resolution in the order of 250m and an additional SWIR channel is needed. A dedicated FMC should therefore provide information on small and smouldering fires and on combustion regime. It should also provide information on fires in low latitudes (with frequent and low intensity fires) and on fire line intensity of those fires requiring a managed response. Such a constellation would consist of three to four BIRD-type satellites with an enhanced optical system, and a wider swath (about 650 km) as well as a higher spatial resolution (about 250 m) than BIRD, and feature a fire-adapted SWIR 2 band (at 2.3 μm) to allow for improved characterization of fires, also useful for burned area mapping and vegetation indexes. Two FMC (FMC-1/2) satellites would fly in a mid-to late sun-synchronous afternoon orbit (at 3:30 pm to 4 pm) providing near daily coverage of selected areas of interest. One satellite (FMC-3) with approximately the same characteristics shall cover the lower latitudes between 35 deg N and S in an inclined orbit. Optionally one satellite (FMC-4) should fly in a mid-morning orbit (10:00 am), supplementing the European Sentinel-3. The proposed system would provide ample synergies with existing and planned missions and support international conventions such as UN framework convention on climate change.