Fire Radiative Energy Estimation from Sparse Satellite Observations and its Relationship With Fire Emissions, Biomass Burned and Fire Severity, in China

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In Dragon-2 we developed techniques and algorithms able to estimate the Fire Radiative Power, FRP. This magnitude is an instantaneous estimation of the power release by fire (unit: watts). Since the main fire effects, CO/CO_2 emissions, biomass burning and severity are produced by the total amount of released power, it is necessary to integrate the FRP over the fire duration to get the Fire Radiative Energy, FRE, (unit: J). A continuous sampling of the fires is impossible due to the lack of observations enough to know the fire evolution during all the burning time.

Recent research indicates that satellite FRP retrievals over fires follow a power law distribution. That gives us the possibility to estimate the FRE from satellite sparse observations: if the distribution law of FRE is known, then doing some observations, and knowing the fire duration, it is possible the temporal integration of FRP and getting the FRE.

It has been shown that FRE is linearly related to the total biomass burned. This approach will give the opportunity to map biomass burned from space without the need for fuel load and combustion completeness information, which are difficult to define.

The fire emissions are also related to the FRE. Probably it will be possible to establish any type of relationship between both magnitudes: FRE and CO/CO_2 emissions.

The burnt severity is linked to the previous vegetation amount and the biomass burned. A severity index could be defined based on the FRE, the previous vegetation amount, defined by means of any vegetation index such as NDVI or other, and the post fire NDVI or similar.

To carry out this project, images from different satellites will be needed, in order to have some observations of the same fire. The parameters defining the active fire properties are retrieved from mid and far infrared remotely sensed data. So, all satellites having such thermal bands will be suitable for our purposes. We can mention: AATSR, on board ENVISAT; AVHRR on board METOP-1 and NOAA; VIRR on board Feng Yun-3; MODIS on board TERRA and AQUA;VIIRS on NPP and perhaps some others.

利用卫星观测数据进行中国火灾辐射能量估测及　　火灾排放、生物燃烧量和火烈度等关系研究

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在"龙计划"二期中，我们开发了能够对火灾辐射率（FRP）进行估测的新技术和算法。火灾辐射率是对火灾释放功率的瞬时估测（单位：瓦特）。由于火灾排放的一氧化碳/二氧化碳、生物燃烧量和火烈度等主要影响因子都是由释放的总辐射率产生的，因此对整个火灾燃烧期间的辐射率值进行积分而获得火灾辐射能量（单位：焦耳）是非常必要的。在火灾燃烧的全过程中，由于缺少足够的观测次数来获得燃烧期间火灾的全部演变情况，导致了不可能对整个火灾过程进行连续的取样观测。

近期的研究成果表明：通过卫星估算的火灾辐射功率（FRP）遵从幂律分布，这使得通过不连续的卫星观测数据进行火灾辐射能量估计成为可能。如果知道了火灾辐射能量的分布规律，再进行一些观测，并且知道火灾的持续时间，就可以对一段时间的火灾辐射功率进行积分，从而得到火灾辐射能量。

已经证明火灾辐射能量与总生物量燃烧呈线性相关。这就使利用火灾辐射能量进行生物量燃烧制图变为可能，而不需要知道可燃物载量和燃烧完整性这些难以估测的信息。

火灾排放也与火灾辐射能量相关。这样可以建立火灾辐射能量和一氧化碳、二氧化碳排放量的估测关系。

燃烧程度是与火前的植被总量和燃烧的生物量相关。燃烧程度指数可以基于火灾辐射能量和火前的植被总量进行定义。火前的植被总量可以用如NDVI或其他，以及过火后的NDVI或相似的植被指数来进行定义。

为完成这个项目，将需要不同的卫星影像对同一场火灾进行观测。定义的上述着火参数是通过中波和远红外遥感数据反演得到。因此，所有包含这些热红外波段的传感器数据都适合用于研究，例如：ENVISAT的AATSR传感器，METOP-1和NOAA的AVHRR传感器，FY-3的VIRR传感器，TERRA和AQUA的MODIS传感器，NPP的VIIRS传感器以及一些别的传感器数据。