VII Simposio de Doctorandos de la UAH en Investigación con Tecnologías de la Información Geográfica (SITIG-UAH)

Development, testing and implementation of a forecasting system for forest-fire smoke

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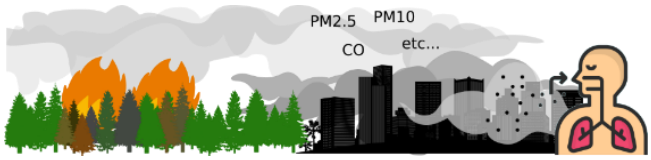

Forest fires close to populated areas tend to lead to very high exposures to air-pollution, often resulting in unhealthy cities. In order to mitigate these effects wildfire smoke forecasting has been implemented in some countries, usually alongside daily air-quality forecasts. The provided information can be employed by stakeholders and the public to e.g. reduce outdoor activities or postpone events at critical moments. However, many challenges are still interfering with the quality of such forecasts. This thesis is addressing those challenges, searching for more efficient ways of modelling the underlying phenomena of wildfires, emitted smoke and its dispersion in the atmosphere. An improved forecasting system was developed and its capabilities assessed through case studies and comparisons with measurements.

The forecast system is composed of a set of three models. Firstly, the fire progression is estimated based on the meteorology, the ignition point, and the topography. Next a local-scale wildfire-smoke dispersion model, DISPERFIRE, uses the results from the previous model to estimate the emissions of several air-pollutants and their dispersion in the air. Finally, a regional scale model, CHIMERE, calculates the dispersion of the smoke at regional scale, considering the emissions from the local dispersion model.

Satellite data was used in two different ways during the development of the forecast system. As an input for one of the models, providing information about burned areas later used for emission estimation in the CHIMERE model, and in the validation of concentration results of the models.

The APIFLAME satellite emissions model for CHIMERE

APIFLAME is a biomass burning emissions model that is coupled to CHIMERE. The estimates are based on pre-processed satellite imagery in the form of the MODIS burned scars product (MCD64A1), which uses thermal anomalies from active fires and changes in reflectance due to the charring of the vegetation to detect burned regions. For each fire and associated vegetation type, the amount of consumed fuel is calculated, and the corresponding emissions of trace gases and aerosols are derived using a list of emission factors. APIFLAME was used for testing the regional part of the system without having to rely on DISPERFIRE.

Validation of Model Concentrations with Satellite Data

Satellite instruments like TROPOMI and CrIS are able to provide the total column of trace gases or their volume mixing ratios. This information can also be calculated from the simulation results of both the local- and the regional-scale simulations. Some gases like carbon monoxide are present in high concentrations during a wildfire and can be seen in these instruments. By comparing the satellite data with the simulation results it will be possible to evaluate the accuracy of the models.