Remote Sensing Technology Institute

Institute of Space Sensor Technology and Planetary Exploration

HTE temperature and gas profile retrieval from combined IR imaging and spectrometer measurements

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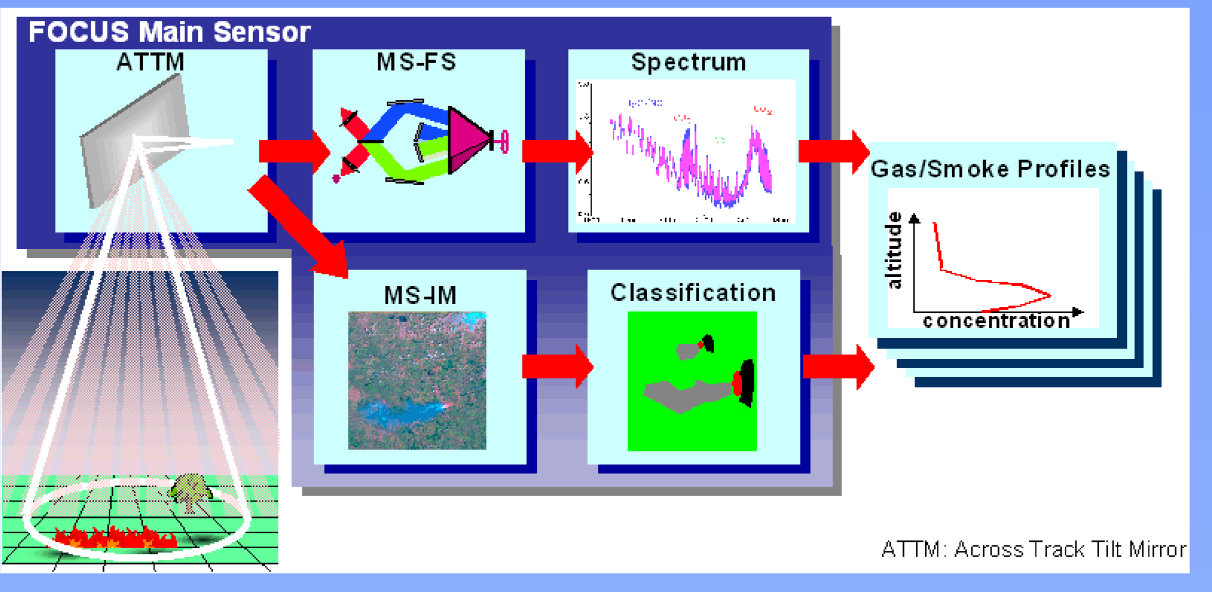
Introduction

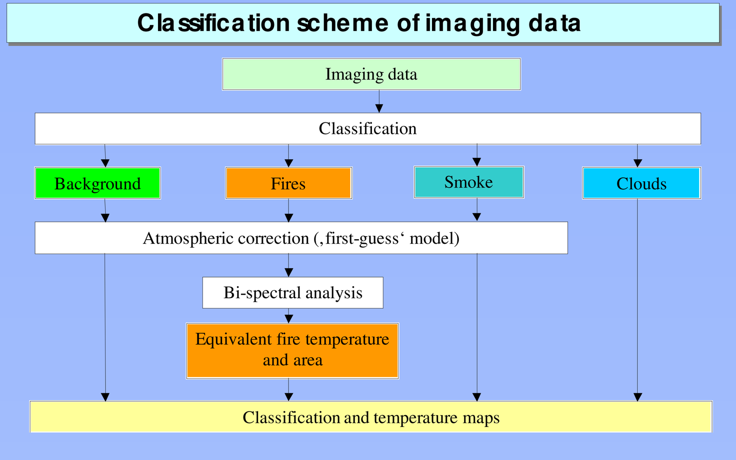
Fourier Transform Spectrometers (FTS) with a high spectral resolution principally allow the retrieval of height resolved profiles of temperature and trace gas concentrations. However, they need a comparatively large field of view to gain enough energy to yield a sufficient signal to noise ratio. In case of fire scenes, this results in the contribution of different surface types and fire zones to the measured spectrum. If the area fraction and surface temperature of these contributing surfaces is known from measurements of an imaging sensor with a high spatial resolution operating in the visible and IR spectral ranges, the temperature and gas profiles can be retrieved separately.

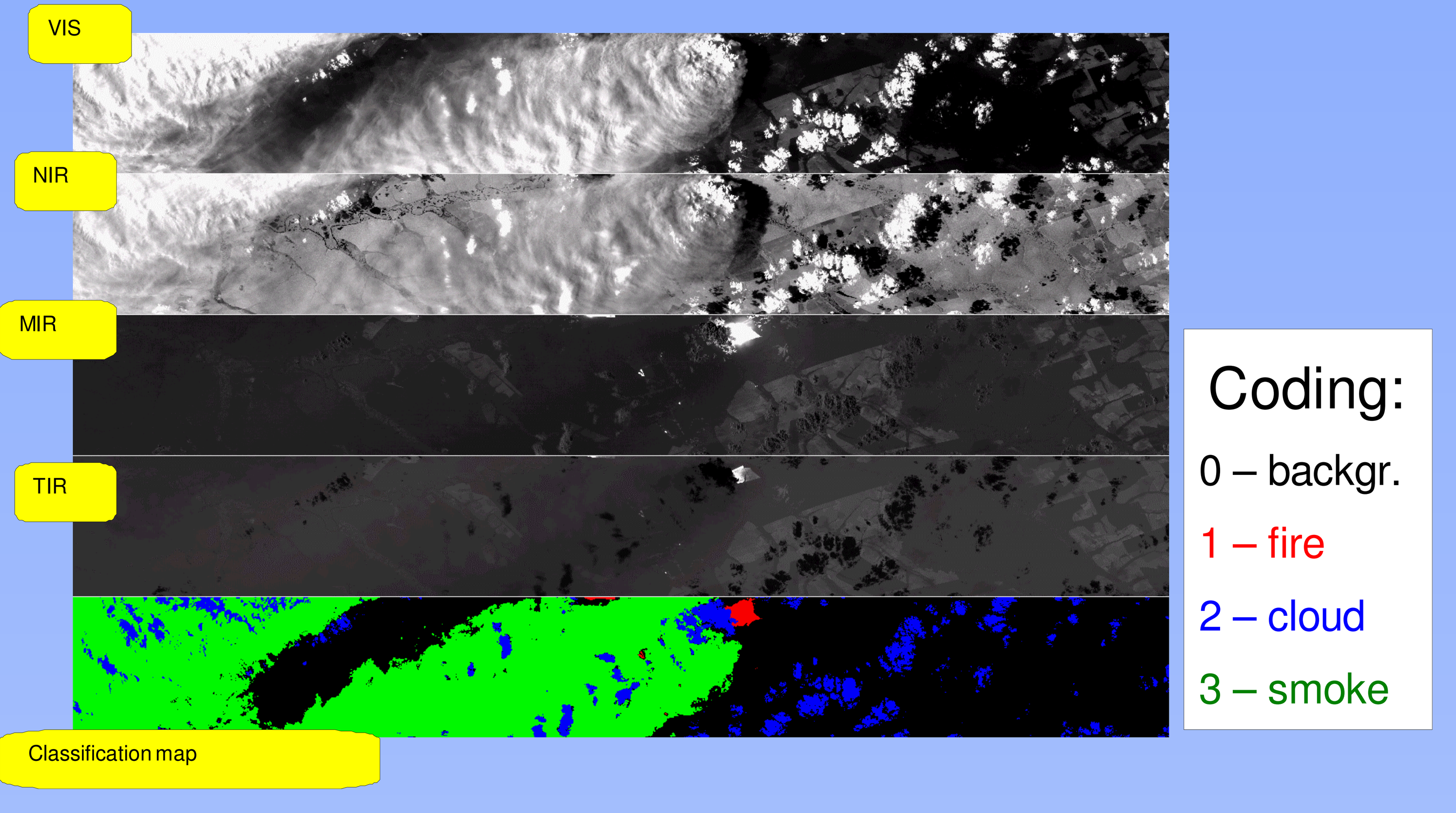


Surface temperature and classification

Imaging data is used to retrieve:

- area fractions of fires, smoke, clouds and background in FTS footprints,
- at-ground temperature of these components (for fires - in the sub-pixel domain - *Dozier, 1981*).





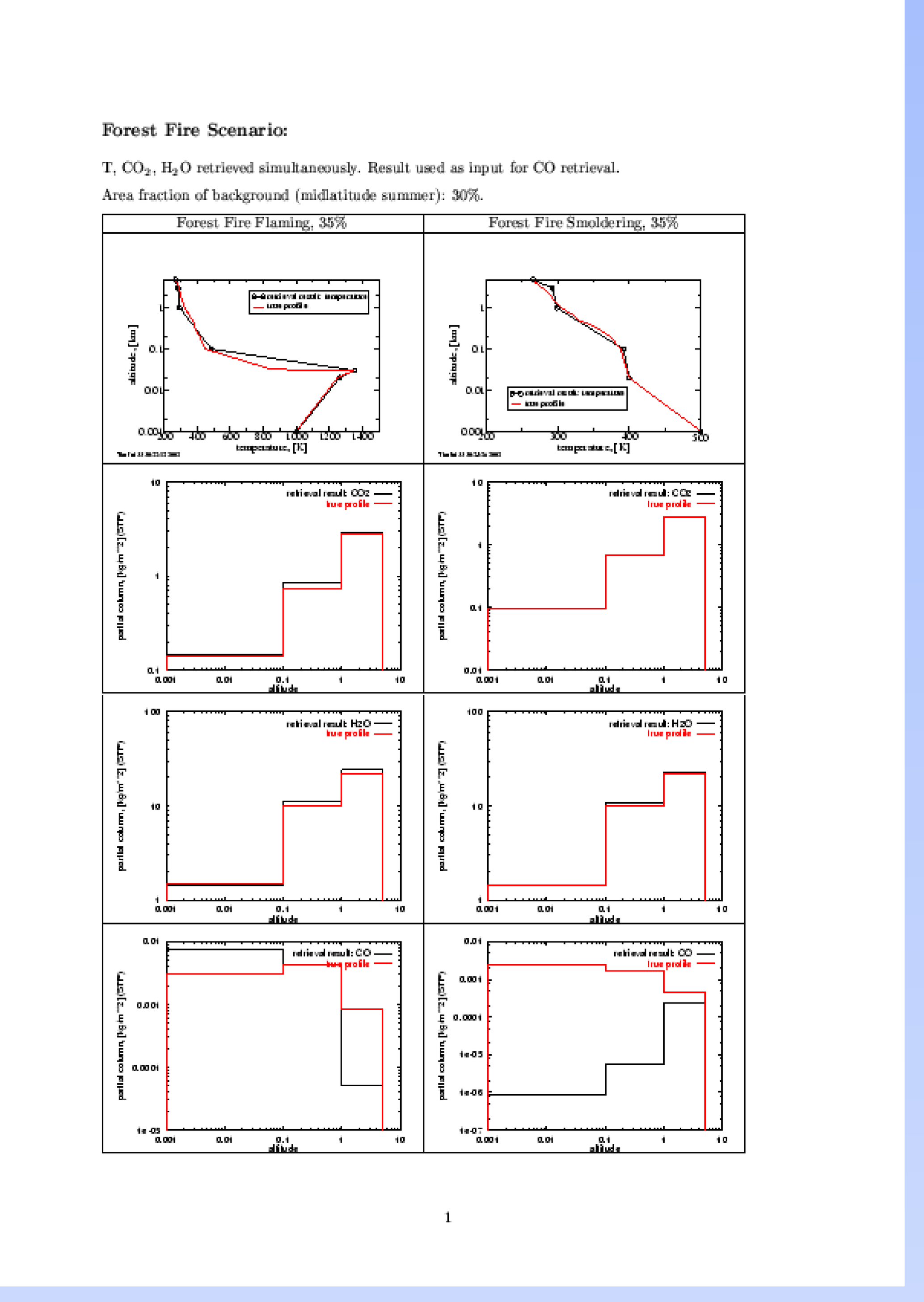
Temperature and gas profile retrieval

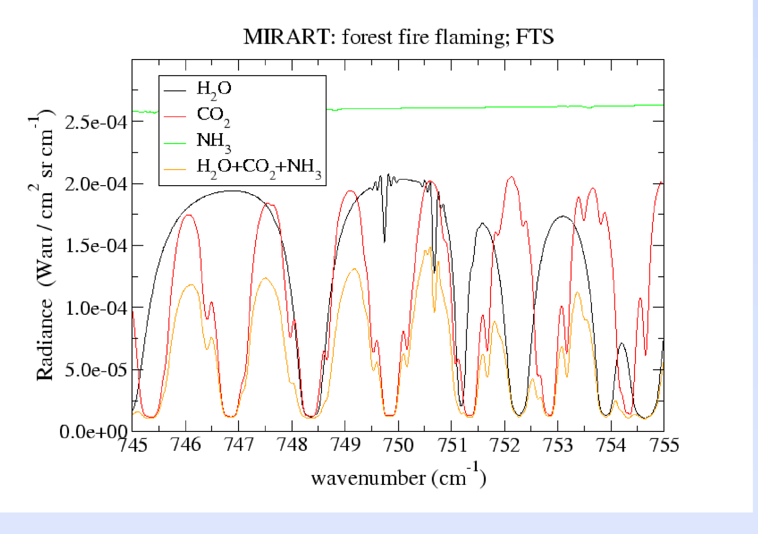
The retrieval of atmospheric parameters as temperature and trace gas profiles from spectrometric measurements is based on a comparison of a measured and a calculated spectrum, the latter resulting from a radiative transfer model (line by line model MIRART (Schreier et al., 2001) with Hitran/Hitemp data base) with assumed temperature and gas concentration profiles. The difference between measured and calculated spectrum is minimized iteratively with help of an optimization procedure ("trust region method" with Gauss/Newton and Quasi Newton method) by adjusting appropriately the temperature and gas profiles used in the calculation.

In case of a fire scenario, we have to perform radiative transfer calculations for several homogeneous scenes, as flaming fire, smoldering fire, background, and smoke over background, each with the surface temperature derived from the IR imager, and add the resulting spectra, weighted by their fraction of total area, which we also get from the IR imager analysis.

One of the first results of our new retrieval code PyReS, for a synthetic measurement, is shown here. We use a Forest Fire scenario, derived from a number of published measurements) with area fractions of 35% flaming, 35% smoldering, and 30% background, and surface temperatures of 1000 K, 500 K, and 300 K respectively. The background (Midlatitude Summer) parameters are not retrieved (are assumed to be known) in this case.

Temperature, CO_2 and H_2O are retrieved simultaneously in the spectral region 745 – 755 cm^{-1}, and CO is retrieved afterwards, using these results, in the region 2167.5 – 2171 cm^{-1}.





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References:

Dozier J. (1981): *A method for satellite identification of surface temperature fields of subpixel resolution*, Remote Sens. Environm., Vol. 11, 221-229.

Schreier, F. and B. Schimpf (2001): *A New Efficient Line-By-Line Code for High Resolution Atmospheric Radiation Computations incl. Derivatives,* in IRS 2000: Current Problems in Atmospheric Radiation, A. Deepak Publishing, 381 – 384

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