Suraface emissivity characterization from modern hyperspectral infrared observations

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New generation meteorological satellites carry infrared sensors able to sense the earth emission spectrum at very high spectral resolution. High spectral resolution infrared sensors on operational meteorological polar orbiters include the Infraed Atmospheric Sounding Interferometer (IASI) on the European Meteorological Operational Satellite (METOP) launched in October 2006 and the Cross Track Infrared Sounder (CrIS) on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) preparatory project (NPP) satellite. High spectral resolution radiance data are also available for instruments that are part of a National Aeronautics and Space Administration (NASA) research mission, i.e. the Atmospheric Infrared Sounder (AIRS) on the second Earth Observing System (EOS) polar orbiting platform, EOS-Aqua (launched in April 2002), and the Tropospheric Emission Spectrometer (TES) on the AURA satellite (launched in 2004). All these sensors are characterized by a wide band spectral coverage (3.7 to 15.5 μm) and a spectral sampling rate in the range 0.25 to 2 cm^{-1}. The high spectral-resolution of new advanced infrared sensors should provide temperature and constituent profiles at a higher accuracy and with more vertical resolution than the existing filter wheel radiometers. However, the full exploitation of these new sensors requires more accurate radiative transfer calculations, and, in general, new data processing algorithms, which, in turns, need to be validated.

In particular, these new sensors should also allow us to estimate surface parameters, such as emissivity with unprecedented accuracy and reliability.

Surface emissivity is one of the most critical parameters when dealing with the use and interpretation of high spectral resolution observations in the infrared. The spectral signature of the surface becomes relevant in the range with higher transmittance and, therefore, an incorrect model for the surface emissivity could sensitively bias, e.g., the retrieval of geophysical parameters in the lower part of the atmosphere, such as surface temperature and lower level moisture.

In this work, while reviewing the characteristics of modern sensors and the related mathematical tools (both forward and inverse methodology), we illustrate a technique which can be validly applied to characterize the surface emissivity. Examples will be shown by using observations from the NAST-I instrument (NAST-I is the NPOESS Aircraft Sounder Testbed Interferometer) recorded during the EAQUATE (European

Aqua Thermodynamic experiment) campaign which took place in Italy in September 2004. Emissivity will be derived for an area covered by a forest. For this kind of vegetation (plant canopy), the surface emissivity is typically modeled with that of a black-body (emissivity equal to 1 and no dependence on the field of view angle). Our results show that this is, indeed, not the case and the above straightforward model can produce highly biased retrieval for temperature and water vapor.

The presentation will include:. 1) an account of the modern infared sensors; 2) the description and discussion of the forward/inverse methodology; 3) the fitting technique used for the surface emissivity, including comparison of the results with laboratory measurements and the use of the estimated emissivity to input the physical inverse scheme, for the retrieval of temperature and water vapor profiles.