HYPXIM HYPERSPECTRAL SENSOR: FROM SCIENCE AND SOCIETAL APPLICATIONS TO AT-SENSOR RADIANCE SPECIFICATIONS

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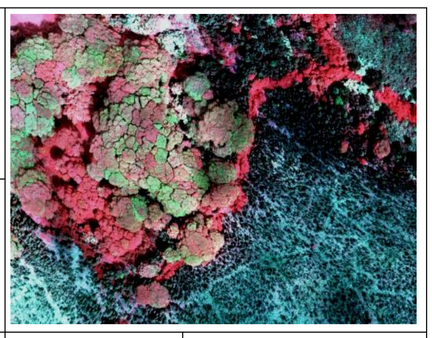
With the support of Astrium and Thales Alenia Space, CNES has conducted pre-phase A studies for a new high resolution hyperspectral satellite mission based on technical requirements provided by a group of national experts in hyperspectral imagery. This poster gives an overview of the scientific mission objectives, how they have been translated into at-sensor radiances specifications: L2 is the reference radiance, used to build the instrument requirements. In particular, L2 is associated to Signal-to-Noise requirements, while L1 and L3 are respectively associated to minimum and maximum radiances. The ground reflectance values associated to these radiances will also be shown, taking into account the orbital characteristics chosen for this challenging hyperspectral mission.

HYPXIM scientific mission objectives

Requirements for HYPXIM mission *δλ = Spectral resolution* *GSD = Ground Sampling Distance* *SNR = Signal-to-Noise ratio*

Vegetation

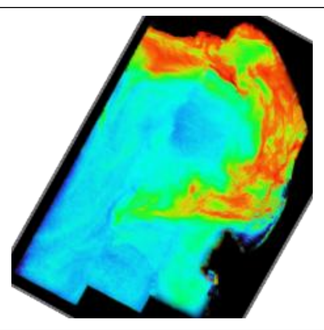


Biodiversity
Water leaf contents
Biochemistry spectroscopy

δλ (nm)	GSD (m)	Swath (km)	Revisit Period	SNR
≤ 10	≤ 10	Variable	Critical during growing season	> 500:1

63 spectra from Broom »s Barn site (vegetation, bare soil) → extraction of min, mean, max spectra
Institut de Physique du Globe de Paris (IPGP)

Coastal ecosystems

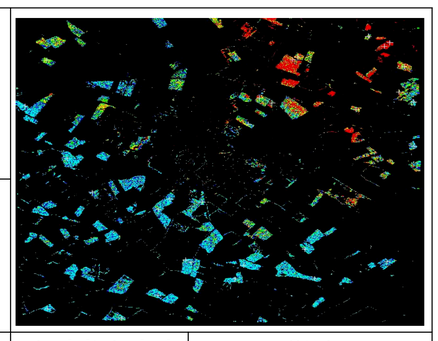


Biometry, red tide, blooming
Bathymetry, sedimentology
Effluents, water quality
Intertidal cartography

δλ (nm)	GSD (m)	Swath (km)	Revisit Period	SNR
≤ 10	≤ 10	Variable	Critical for inter tidal monitoring	> 400:1

9 spectra from 0.4 to 1 µm: coastal waters (non-turbid and turbid), estuary waters and soil (sandy, soils, mudflats, …)
University of Bordeaux

Geosciences

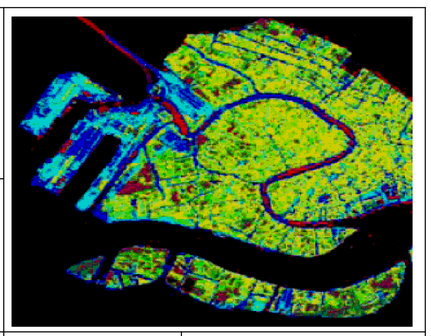


Mineralogy
Cartography
Soils degradation
Environmental Risks

δλ (nm)	GSD (m)	Swath (km)	Revisit Period	SNR
≤ 10	10	Variable	Non critical (except crisis)	>> 100:1 SWIR

Basalt spectrum (min), AVIRIS image containing cuprite (mean), clear image over Israël (max)
University of Nantes

Urban areas

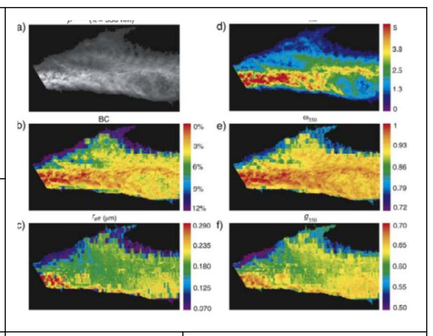


Materials and their variability
Non pure pixels
Hidden pixels
Shadow effects

δλ (nm)	GSD (m)	Swath (km)	Revisit Period	SNR
≤ 10	5 -10	20 – 50	Critical during crisis	> 250:1 VNIR > 100:1 SWIR

Spectrum of asphalt concrete (min), mean spectrum from the Capitoul campaign except water and vegetation (mean), granite / brick (max)
ONERA

Atmosphere

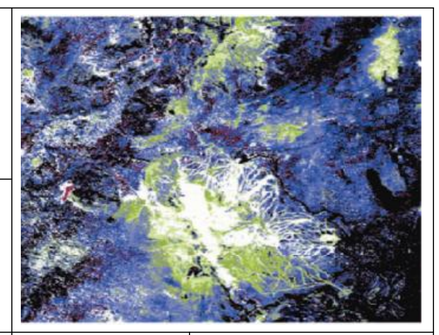


Black Carbon maps
Gases
Aerosols
Air pollution

δλ (nm)	GSD (m)	Swath (km)	Revisit Period	SNR
≤ 10	20	10 – 50	Variable	> 250:1 VNIR > 150:1 SWIR

HYPERION images from World Trade Center (clear smoke) and from Eyjafjöll volcano (black smoke) → extraction of min, mean and max spectra
CEA

Cryosphere



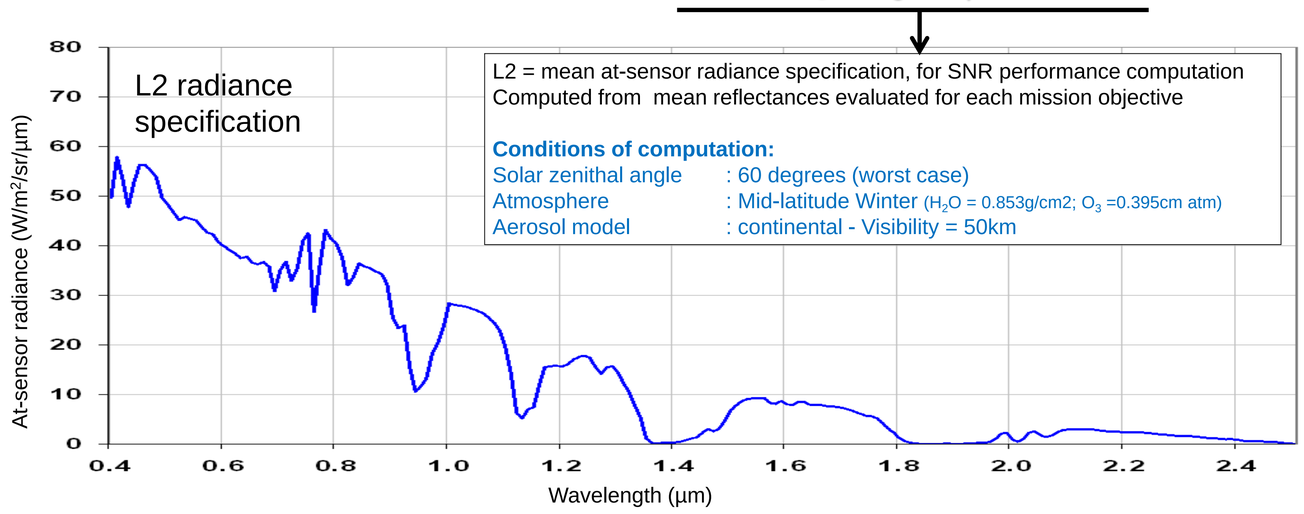
Cleanness of the snow
Radiative budget
Hydrology
Climate change

δλ (nm)	GSD (m)	Swath (km)	Revisit Period	SNR
≤ 10	≤ 10	Variable	Critical / melting	Below saturation VNIR > 150:1 SWIR

Verification of at-sensor radiances w.r.t. max radiance specifications (L3)

At-sensor radiances

Vegetation Coastlines Geosciences Urban areas Atmosphere Cryosphere + Defence



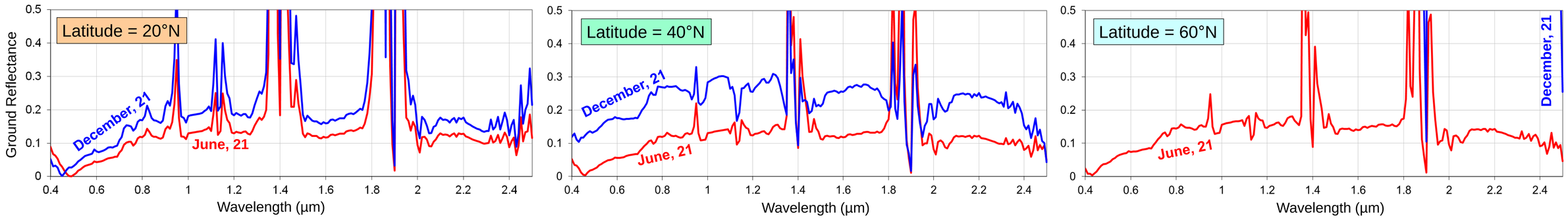
Mission & orbit parameters

Altitude	660 km
Local Time of Descending Node	10h30
Payload	Korsch telescope Φ430 mm Dedicated panchromatic channel, prism-based spectrometer Detector VNIR-SWIR 2000 x 360 pixels (to be developed)
Resolution / Swath	8 m / 16 km
Spectral bandwidth / resolution	400 – 2500 nm / 10 nm
Payload budget	Mass <150 kg, Power (imaging) <350 W
Satellite	1-ton range
Revisit period	With +/-20 deg across-track imaging : 15 days With +/-40 deg across-track imaging : 3 days
Imaging capacity	200 square images per day
Ground-to-space link	X-band link at 270 Mbps (with ground or mobile stations)
Launcher compatibility	Soyuz, Vega
Expected launch date / lifetime	2018 / 10 years (incl. end-of-life operations)

Ground reflectances

Taking into account the altitude and local time of the satellite, the at-sensor radiances specifications are converted into observable ground reflectances, according to the Sun zenithal angle associated to the date and latitude of the observed scene.

Ground reflectances corresponding to L2 at-sensor radiances, and sensitivity to the latitude of the observed scene and to the date of observation



References
X. Briottet *et al.* : « HYPXIM : a new hyperspectral sensor combining science/defence applications », Proc. 3rd Workshop on Hyperspectral Image and Signal Processing : Evolution in Remote Sensing, Lisbon, Portugal, 2011
S. Michel *et al.* : « HYPXIM : a hyperspectral satellite definefd for science, security and defence users », Proc. 3rd Workshop on Hyperspectral Image and Signal Processing : Evolution in Remote Sensing, Lisbon, Portugal, 2011.

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