Advances in remote sensing of cultivated landscapes at LISAH

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Abstract: In order to propose new and sustainable methods for cultivated areas managment, the French INRA-IRD-Supagro laboratory for the study of Soil-Agrosystem-Hydrosystem Interactions (LISAH) develops tools for modelling fluxes (water, soils, solutes) based on a fine characterisation and observation of the landscape mosaics and of its dynamic (field limits, networks, structures, vegetation, agricultural practices, topography, etc.). Such observations require to develop innovative acquisition and processing methods. This poster presents somes of these methods concerning different scales and techniques.

I. Digital Mapping of Soil properties

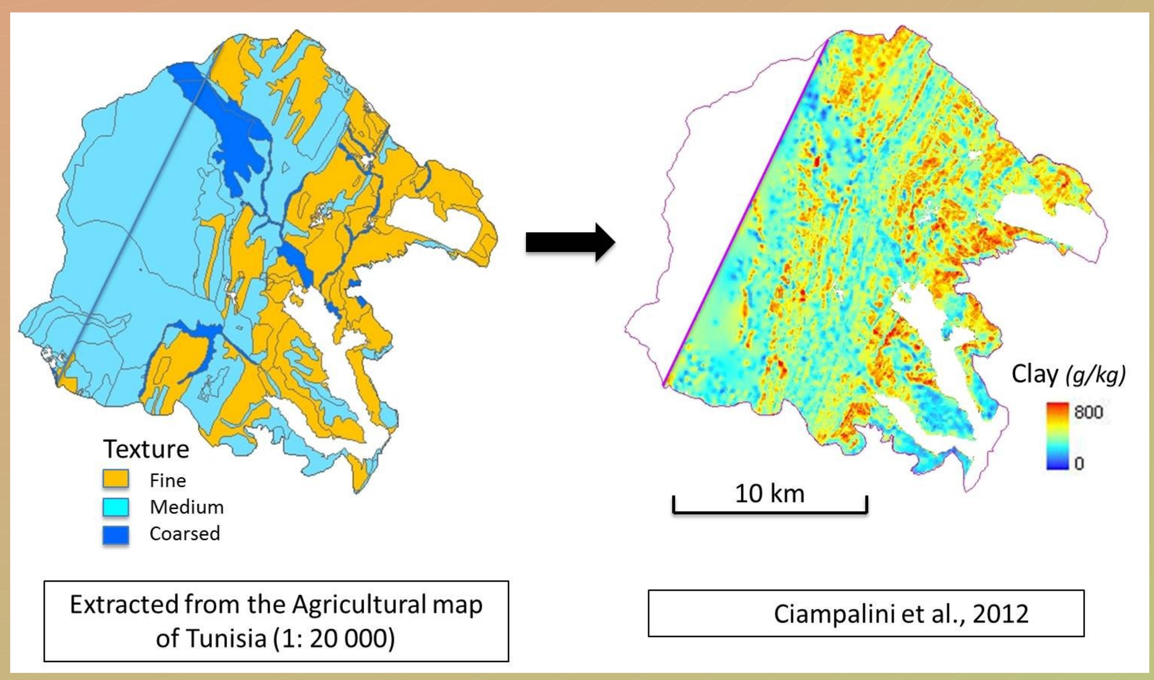
Objective:

Mapping of soil properties over the Lebna catchment (250km²), from the surface to the sub-surface

Approach in 3 steps:

1[st]: Vis-NIR hyperspectral imaging data were used to map key topsoil properties over bare soils of Lebna catchment using multivariate models *(Gomez et al., 2012)*.

2[nd]: These topsoil properties estimations were used as covariates in geostatistic methods to produce entire topsoil properties maps over Lebna catchment (see illustration).



3[th]: Topsoil properties estimations were used in pedotransfert functions to map sub-surface soil properties *(Lagacherie et al., 2013)*.

Results: Vis-NIR hyperspectral imaging data and Digital Soil Mapping methods can be used to map key soil properties, used by soil surveyors to describe soil types, related to soil erosion processes…

References : Gomez, C., Lagacherie, P., & Bacha, S. (2012). Using Vis-NIR hyperspectral data to map topsoil properties over bare soils in the Cap-Bon Region, Tunisia. In B. Minasny, B. Malone, & A. B. McBratney (Eds.), Digital Soil Assessment and Beyond (pp. 387–392).
Ciampalini, R., Lagacherie, P., Monestiez, P., Walker, E., & Gomez, C. (2012). Co-kriging of soil properties with Vis-NIR hyperspectral covariates in the Cap Bon region (Tunisia). In B. Minasny, B. Malone, & A. B. McBratney (Eds.) Digital Soil Assessments and Beyond (pp. 393–398).
Lagacherie, P., Sneep, A.-R., Gomez, C., Bacha, S., Coulouma, G., Hamrouni, M. H., & Mekki, I. (2013). Combining Vis–NIR hyperspectral imagery and legacy measured soil profiles to map subsurface soil properties in a Mediterranean area (Cap-Bon, Tunisia). Geoderma, 209–210(0), 168–176. doi:http://dx.doi.org/10.1016/j.geoderma.2013.06.005

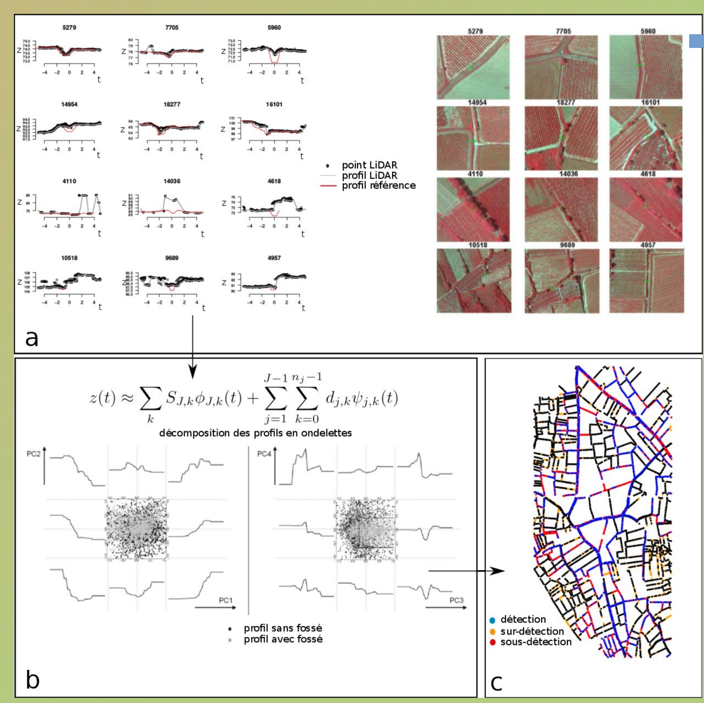
II. Landscape structures mapping

Objective:

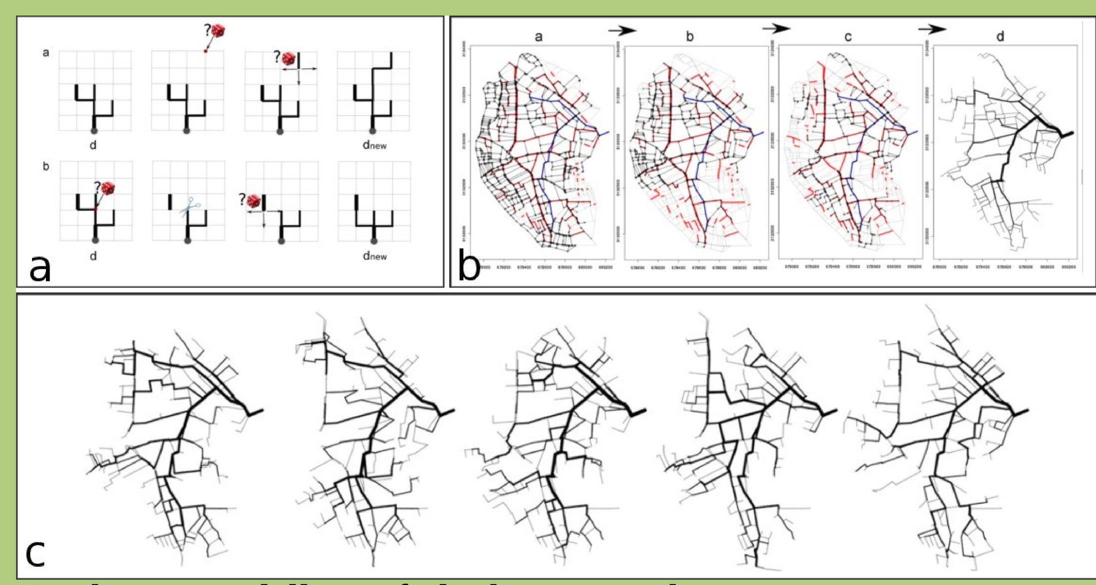
Mapping landscapes structures which have an impact on hydrological fluxes

Approach :

- LiDAR DEM analysis to detect topographic discontinuities
- DEM-driven stochastic modelling to interpolate the detected lines and remove false detections



a. 12 LiDAR profiles with ground truth and aerial views
b. principle of Haar wavelet decomposition and classification
c. result



Stochastic modelling of ditches network
a. network correction approaches : reconstruction and cut
b. application of the reconstruction
c. five equiprobable reconstructed networks

References : Bailly, J.; Lagacherie, P.; Millier, C.; Puech, C. & Kosuth, P. (2008), '*Agrarian landscapes linear features detection from LiDAR: application to artificial drainage networks*', International Journal of Remote Sensing 29(12), 3489-3508.
Bailly, J.; Levavasseur, F. & Lagacherie, P. (2011), '*A stochastic algorithm to reconstruct artificial drainage networks from incomplete remote sensing delineations*', International Journal of Applied Earth Observation and Geoinformation 13, 853--862.

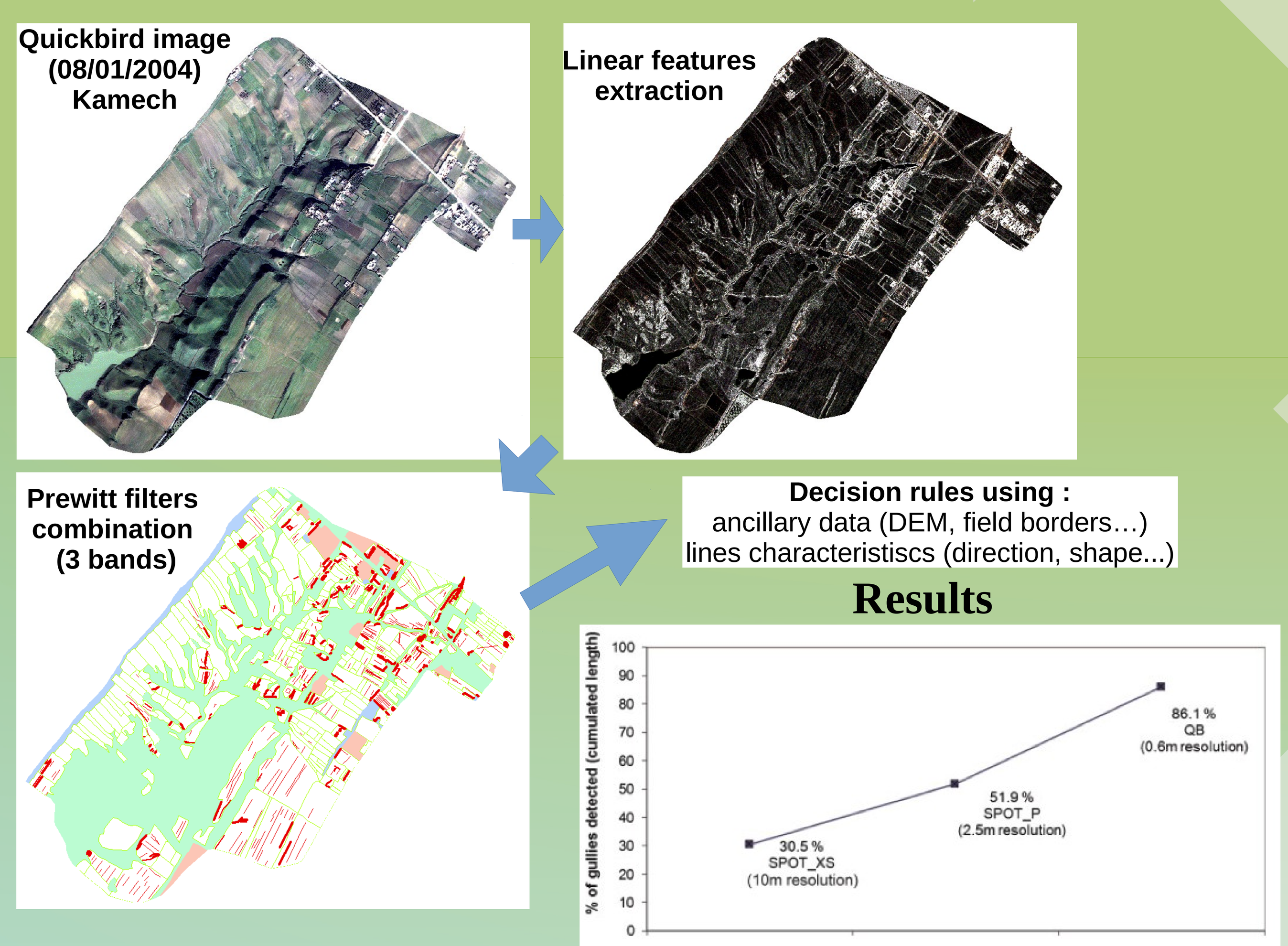
III. Gullies detection with THRS imagery

Objective:

Exhaustive mapping of gullies for hydrological modelling

Approach :

- Contour detection from THRS satellite imagery
- Filter combination and decision rules with ancillary data



Reference : Desprats J.F., Raclot D., Rousseau M., Cerdan O., Garcin M., Le Bissonnais Y., Ben Slimane A.,Fouche J., Monfort-Climent D. (2013). *Mapping linear erosion features using high and very high resolution satellite imagery. Land Degradation & Development*, 24: 22-32. doi: 10.1002/ldr.1094.

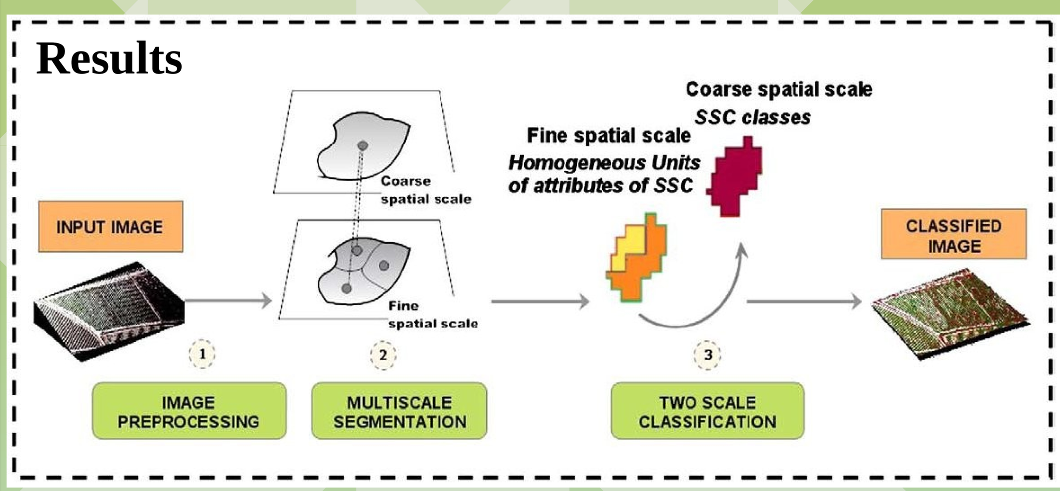
IV. Soil Crust Mapping

Objective: Monitoring of soil crust dynamics at the crop scale

Approach :

- Lightweight platform (UAV) ; ultra high resolution
- Mapping of soil surface characteristics

Results



Reference : C. Corbane, D. Raclot, F. Jacob, J. Albergel, P. Andrieux, Remote sensing of soil surface characteristics from a multiscale classification approach, CATENA, Volume 75, Issue 3, 15 November 2008, Pages 308-318, ISSN 0341-8162, http://dx.doi.org/10.1016/j.catena.2008.07.009.

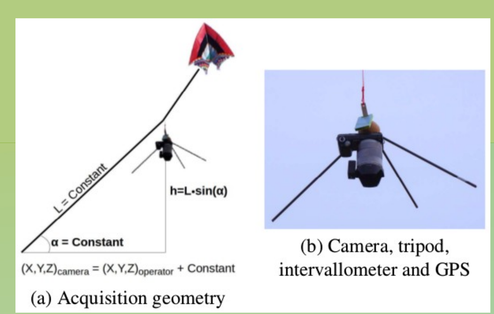
V. 3D modelling by photogrammetry and Structure-from-Motion (SfM)

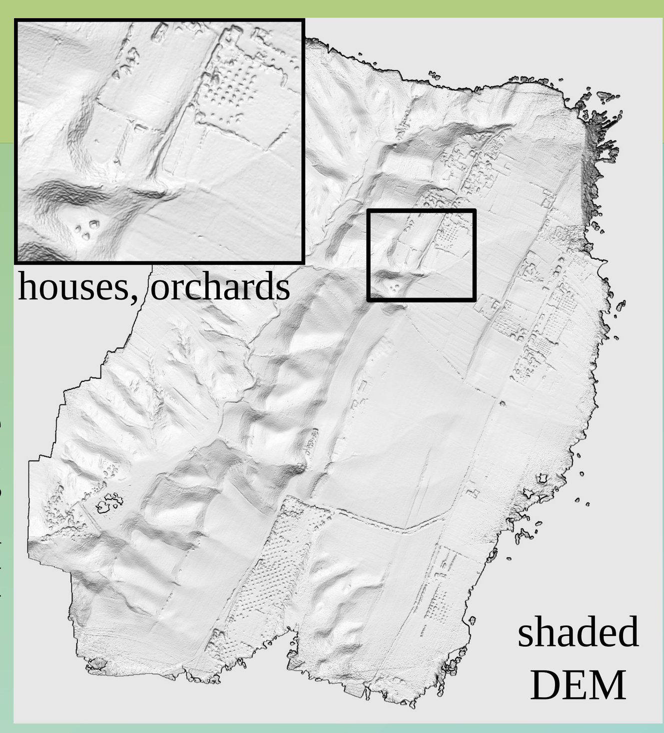
Objectives:

Attaining a decimeter to centimeter scale description of landscape features at the watershed scale

Approach :

- Lightweight image acquisition : light platforms (kite) and consumer grade cameras
- High image redundancy and SfM approaches for processing

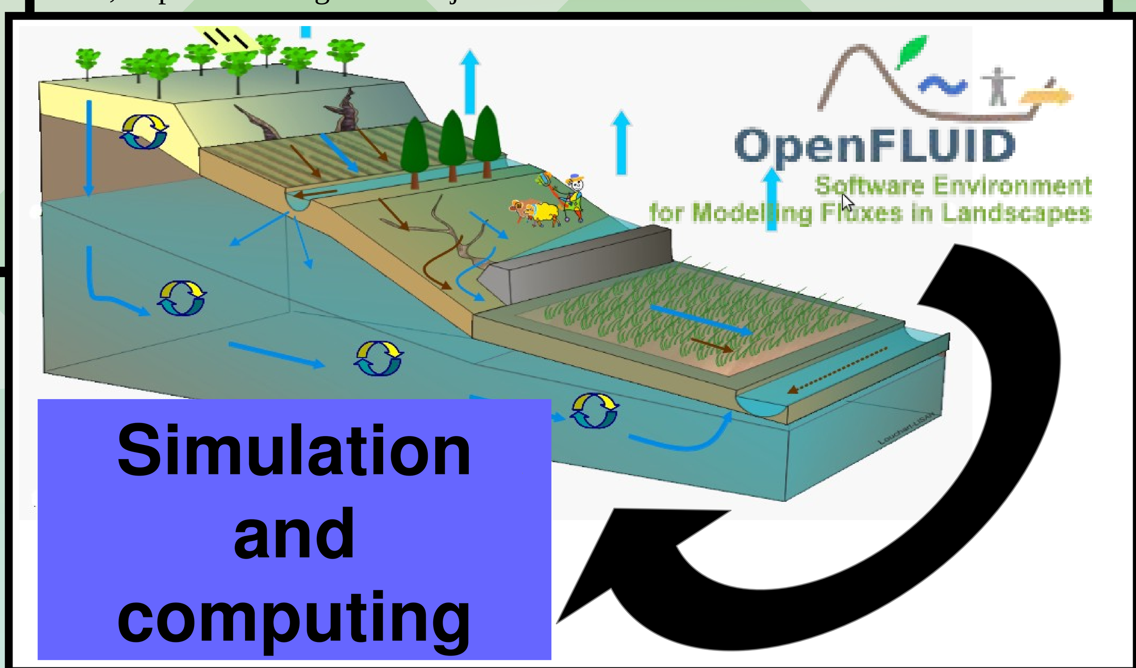




Results:

Operationnal method of image acquisition and 3D processing which allows to obtain decimetric to centimetric DEM on areas up to several km²

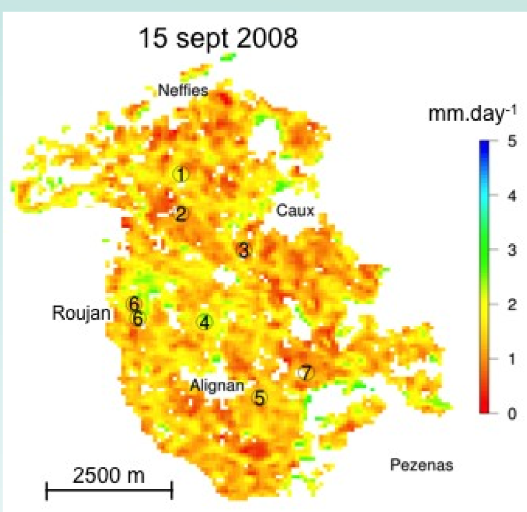
Reference : Feurer, D.; El Maaoui, M. A.; Planchon, O.; Boussema, M. R. & Pierrot-Deseilligny, M. *Kite-Borne photogrammetry for decimetric 3D mapping of several square kilometers areas* Proceedings of IEEE 2015 International Geoscience and Remote Sensing Symposium (IGARSS'15), 2015



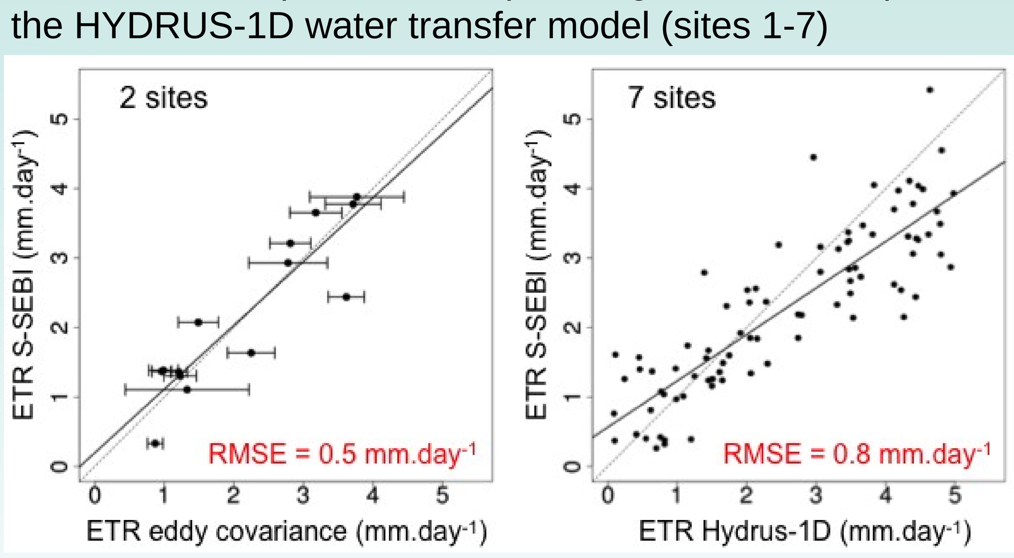
VI. Mapping evapotranspiration of vineyards

Objective: Mapping of vineyard daily evapotranspiration (ETR) over the Peyne catchment (65 km2)

Approach : 12 ETR maps produced from visible-NIR and thermal IR images (ASTER instrument, 90 m resolution) using two water stress indices : WDI (Moran et al., 1994) and S-SEBI (Roerink et al., 2000)



Validation at the plot scale against eddy covariance ETR measurements (sites 6 and 7) and against ETR outputs of the HYDRUS-1D water transfer model (sites 1-7)



Results:

Visible-NIR and thermal images allow for ETR mapping at the regional scale. ETR maps can be useful for assessing the available water content of soils

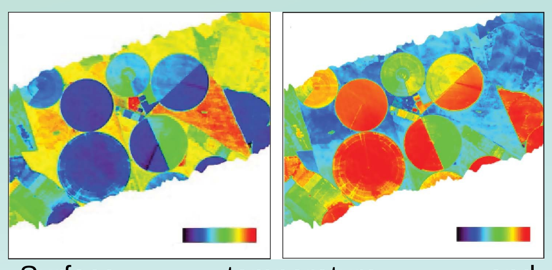
Reference : Galleguillos, M., Jacob, F., Prévot, L., Lagacherie, P. and French, A., *Comparing two simplified models for inferring daily evapotranspiration from ASTER over a Mediterranean vineyard watershed*. Remote Sensing of Environment, 2015, 6 (115), 1326-1340

VII. Mistigri mission design

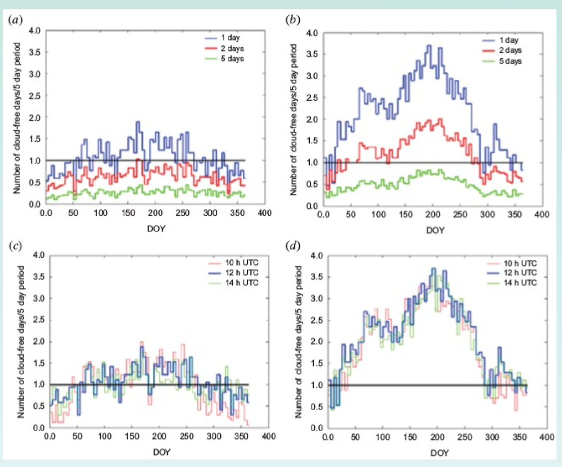
Objective: Design of a high spatial and temporal resolution thermal satellite

Approach :

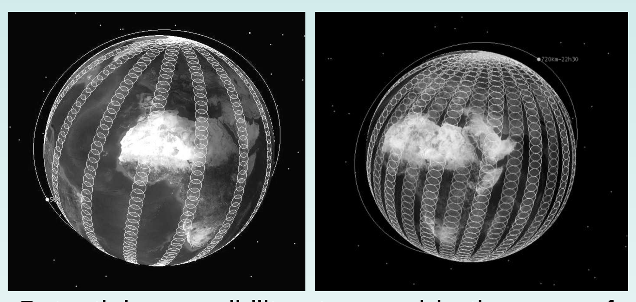
Image simulation (radiative transfer modelling, airborne campaigns)



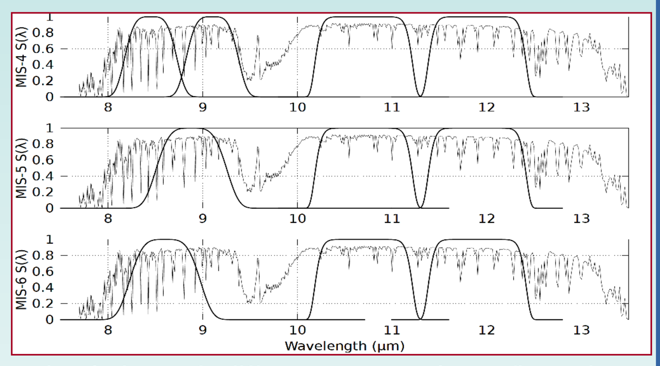
Surface temperature and evapotranspiration retrieved from airborne hyperspectral scanner



Impact of the revisit time (1, 2, 5 days) on the availability of data (a:Rennes, b: Avignon). Impact of acquisition time (10, 12, and 14 h UTC) for Rennes (c) and Avignon (d)



Potential accessibility at ground in the case of (a) 1 satellite at 561 km or (b) 2 at 720 km



Simulation of different spectral configurations with 4 or 3 bands and different positions in the thermal infrared spectrum

Results: Having worked on the spectral sampling (bands, bands resolutions) the LISAH team proposed a spectral configuration allowing for a 1K accuracy in temperature estimation

Reference : Lagouarde, J.-P.; Bach, M.; Sobrino, J. A.; Boulet, G.; Briottet, X.; Cherchali, S.; Coudert, B.; Dadou, I.; Dedieu, G.; Gamet, P.; Hagolle, O.; Jacob, F.; Nerry, F.; Olioso, A.; Ottlé, C.; louis Roujean, J. & Fargant, G. *The MISTIGRI thermal infrared project: scientific objectives and mission specifications*. International Journal of Remote Sensing, 2013, 34, 3437-3466

Poster coordinated by Denis Feurer with the contributions of Gomez C., Bailly J.-S., Coulouma G., Lagacherie P., Jacob F., Prevot L. and Raclot D.
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