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Land biophysical products derived from space data: overview and performance

Nadine Gobron

Science and Technology for Applied Remote Sensing (STARS) group

Global Vegetation Monitoring (GVM) unit

In collaboration with:

B. Pinty, M.M. Verstraete, J.-L. Widlowski & A. Belward

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Land Remote Sensing Products

- Modern Remote Sensing (RS) algorithms are physically-based & designed to retrieve **biophysical surface parameters** such as surface albedo, FAPAR (fraction of absorbed photosynthetically active radiation), LAI, vegetation structure etc …
- Physically-based algorithms can be prototyped for a variety of instruments.
- These physical quantities can be:
  - ✓ used for both delivered long time series of products or merged together for larger spatial samples.
  - ✓ measured independently from RS data, and
  - → compared against other sources of information (e.g., field in-situ measurements and simulations).

FAPAR
fraction of absorbed photosynthetically active radiation

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The Fraction of Absorbed Photosynthetically Active Radiation is an indicator of the state and productivity of vegetation and has been recognized as a fundamental surface parameter for environmental studies by international organizations (GCOS, 2003).

This quantity represents the fraction of the solar energy which is absorbed by vegetation and therefore plays the role of a battery during the plant photosynthetic process.

Monitoring land surfaces variable from remote sensing data in time provides important information on the productivity of the vegetation.

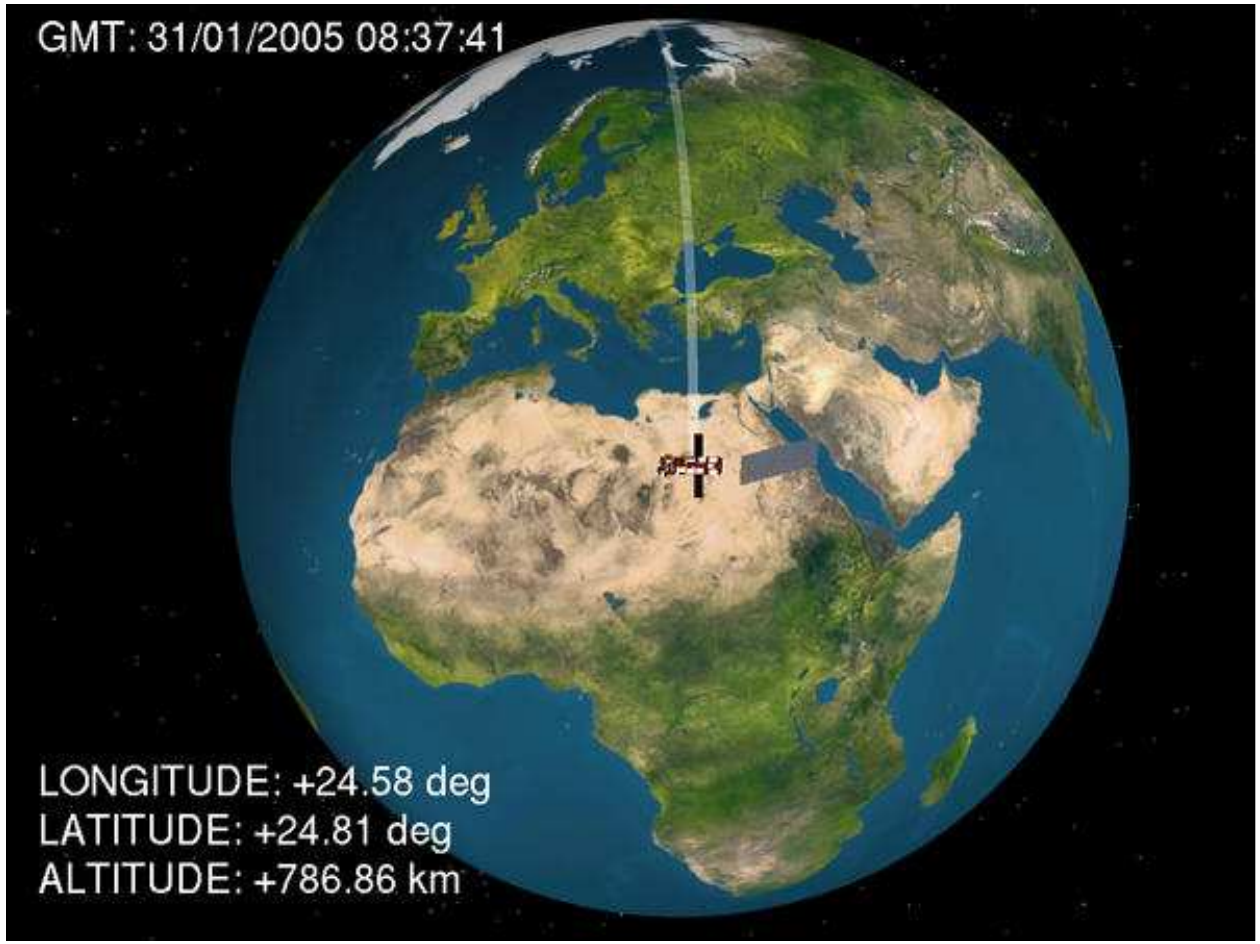
to estimate the effectiveness of atmospheric carbon dioxide assimilation by plants,

to monitor agricultural crops, or

to assess the state and evolution of forests, etc …

Remote Sensing Products

Satellite



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Remote Sensing Products

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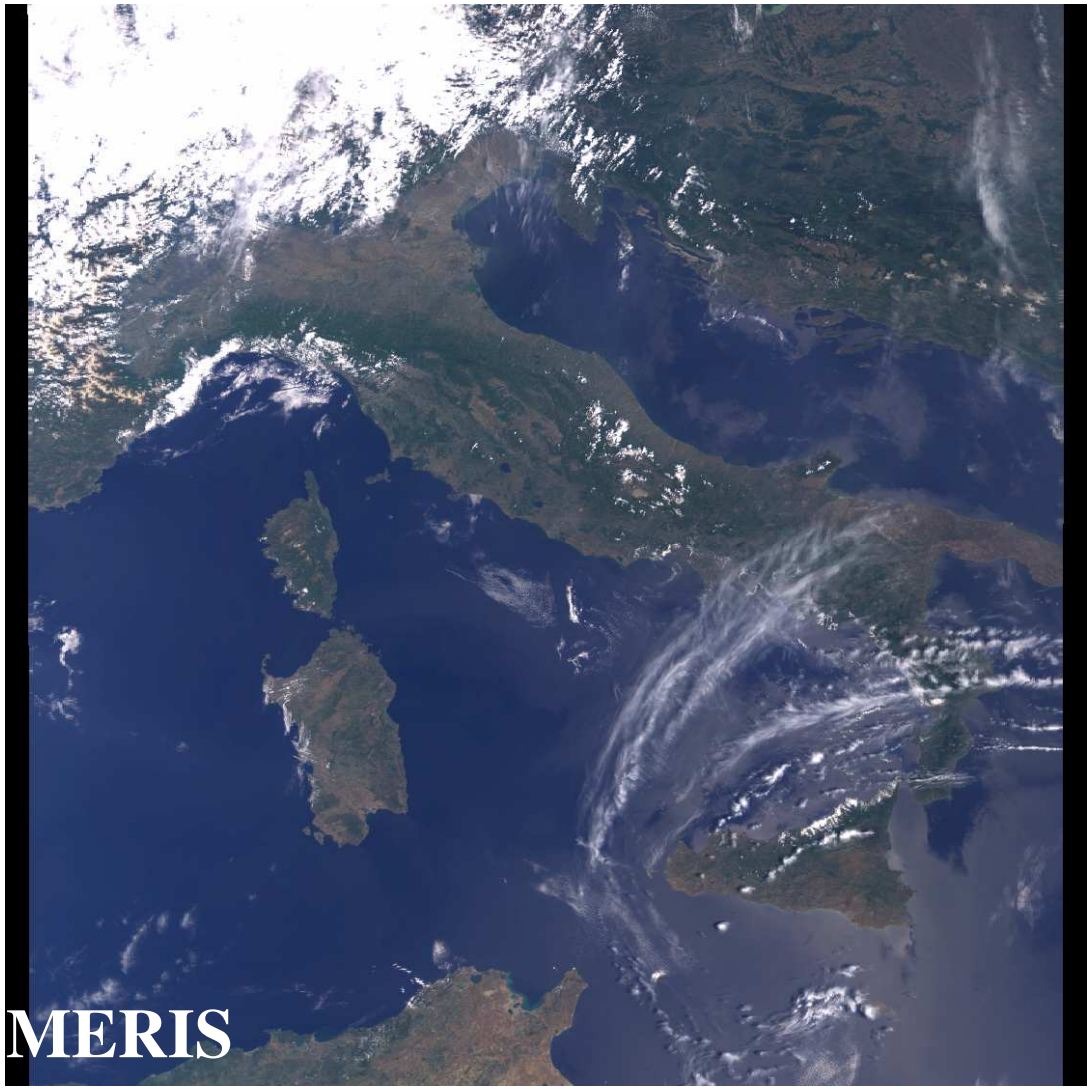
Satellite DATA

FAPAR Algorithm
Based on physics



Govaerts, Y. et. al. (1999) 'Designing Optimal Spectral Indices: A Feasibility and Proof of Concept Study', *International Journal of Remote Sensing*, **20**, 1853-1873.

Gobron, N. et. al. (1999) 'The MERIS Global Vegetation Index (MGVI): Description and Preliminary Application', *International Journal of Remote Sensing*, **20**, 1917-1927.

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FAPAR product

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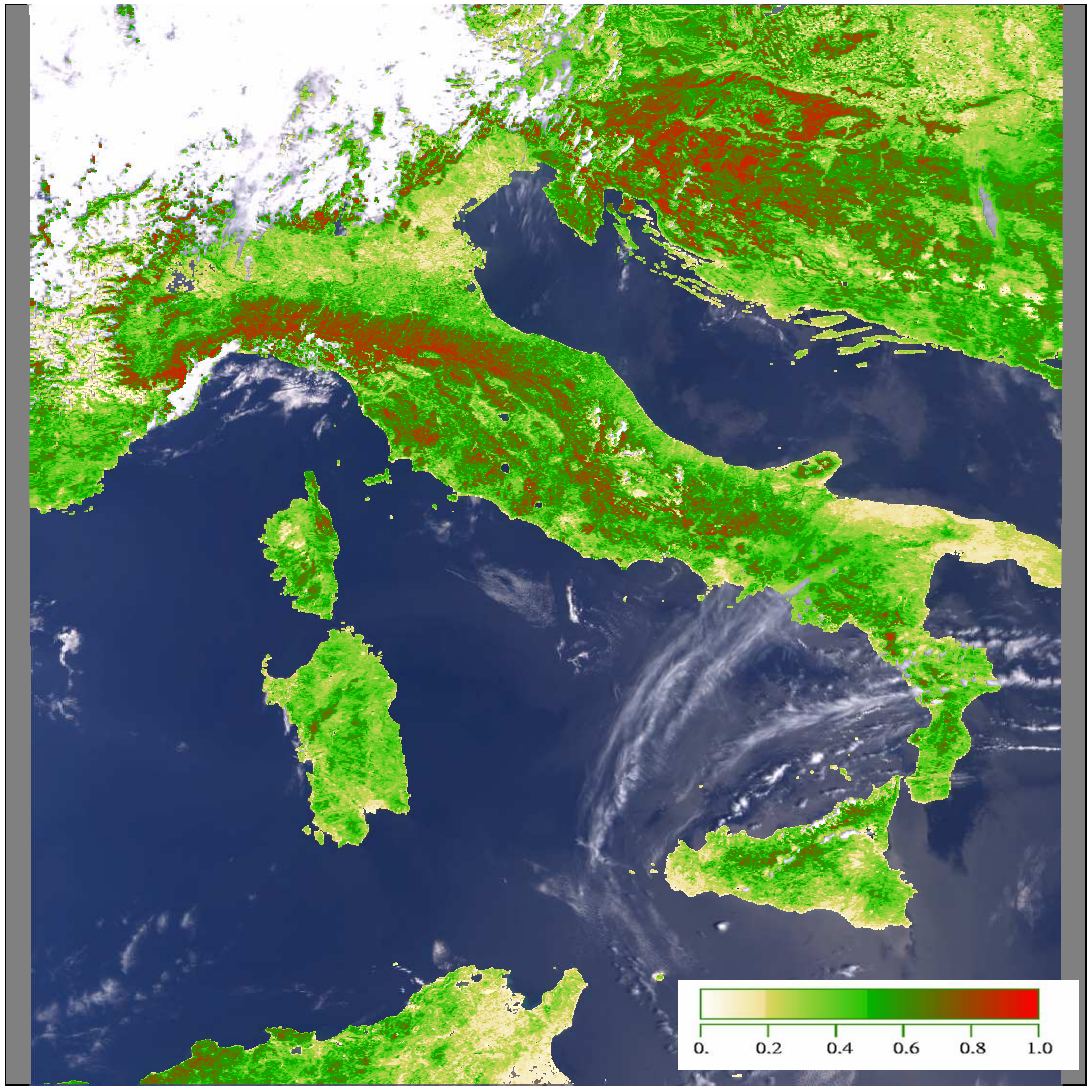
Satellite DATA

FAPAR Algorithm Based on physics

FAPAR fraction of absorbed photosynthetically active radiation



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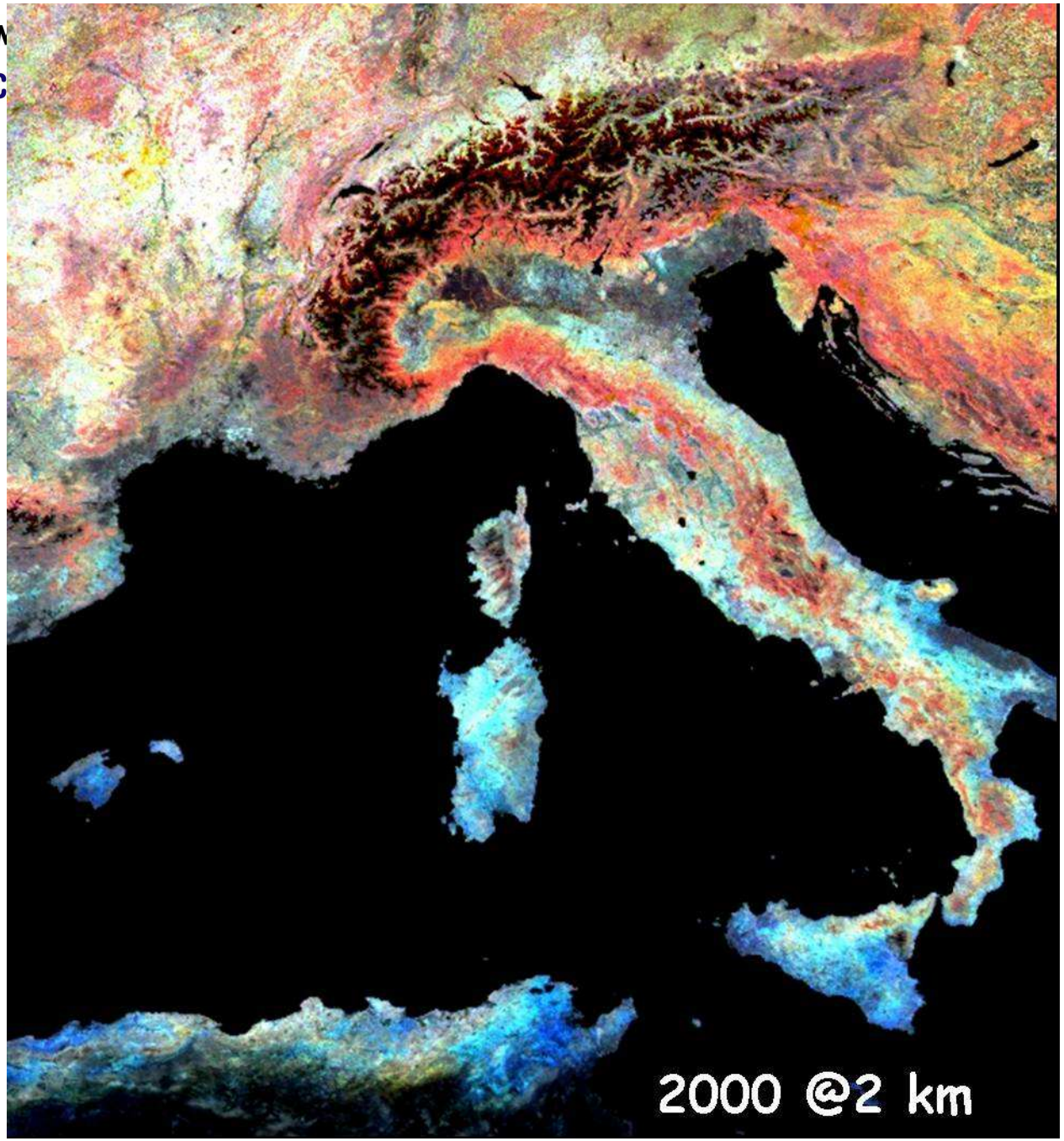
May

April

March



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15 - 16 March 2005

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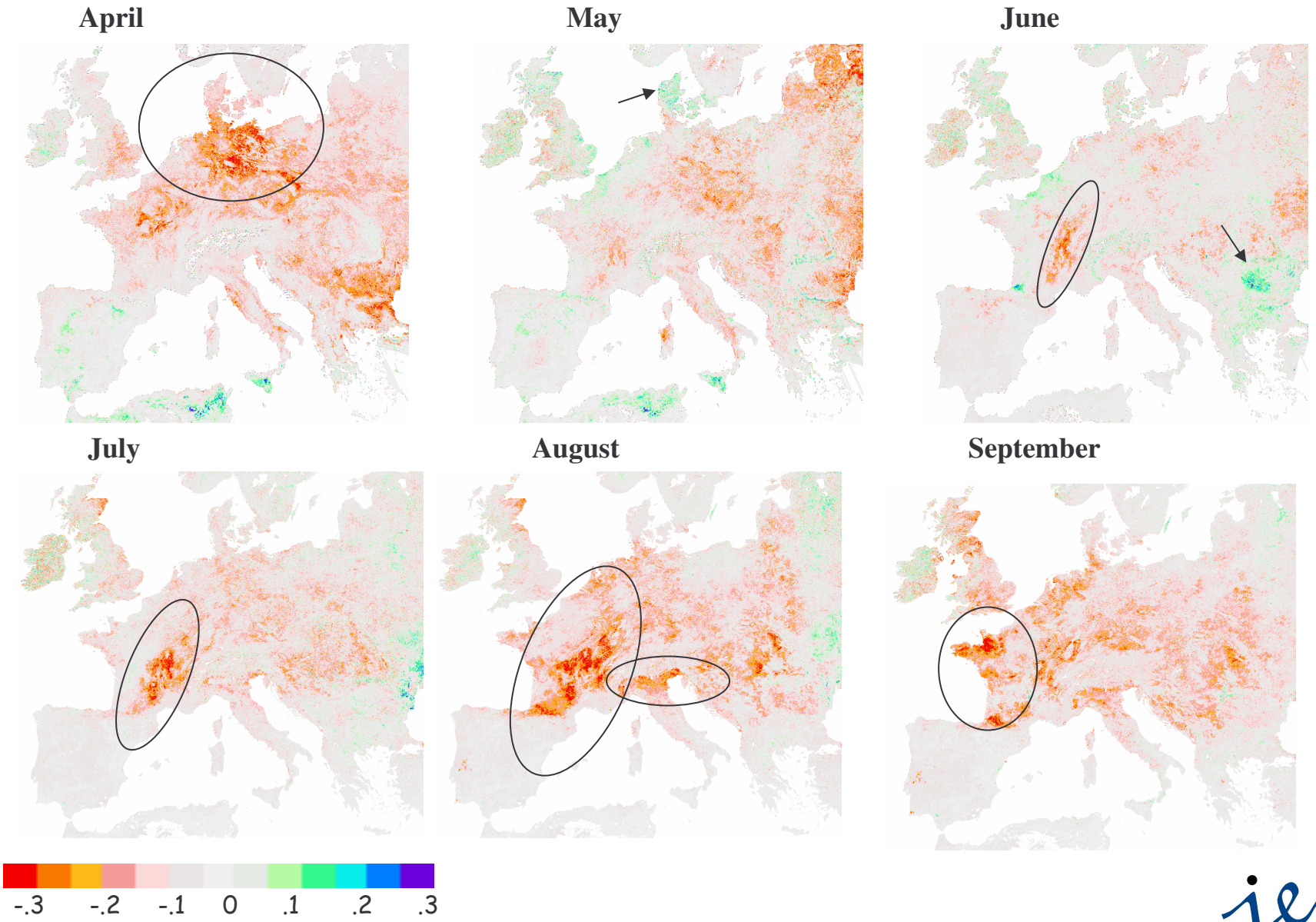
Satellite Derived FAPAR Anomalies – Europe
Anomalies 2003 - Base period 1998 - 2002



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Gobron, N., B. Pinty , F. Mélin, M. Taberner , M. M. Verstraete, A. Belward , T. Lavergne and J.-L. Widlowski (2005) 'The state of vegetation in Europe following the 2003 drought', *International Journal of Remote Sensing Letters*, in press.

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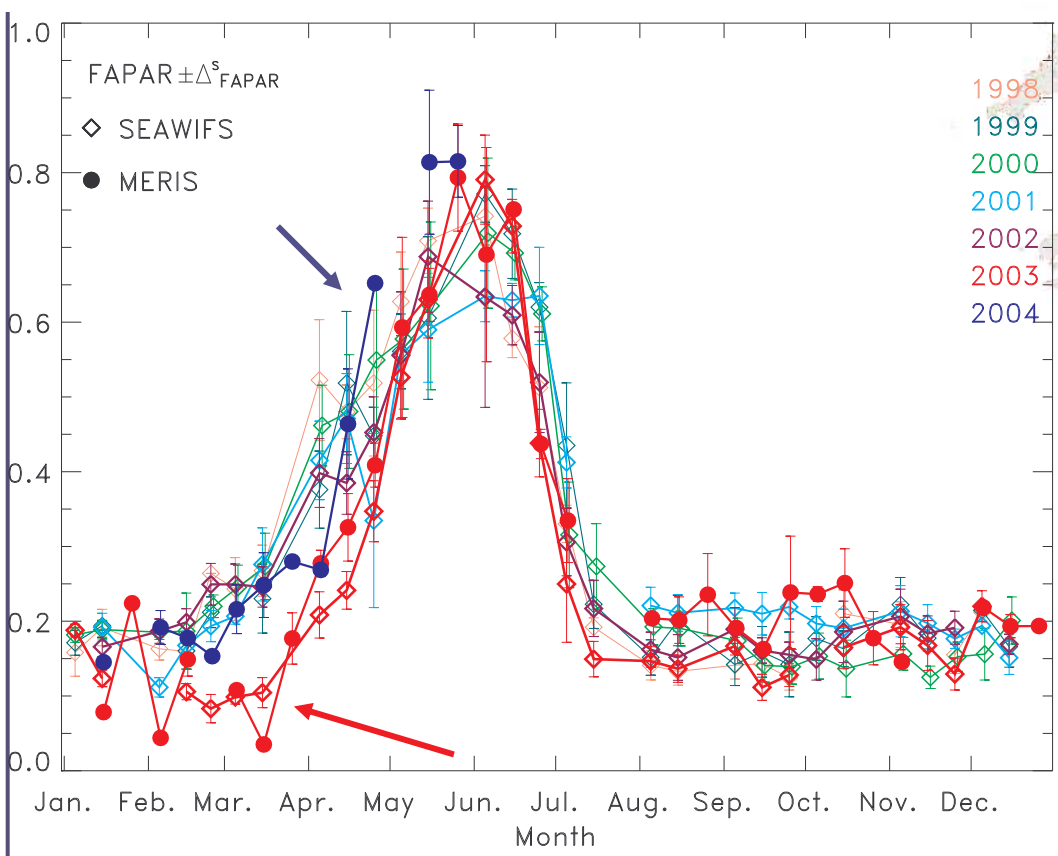
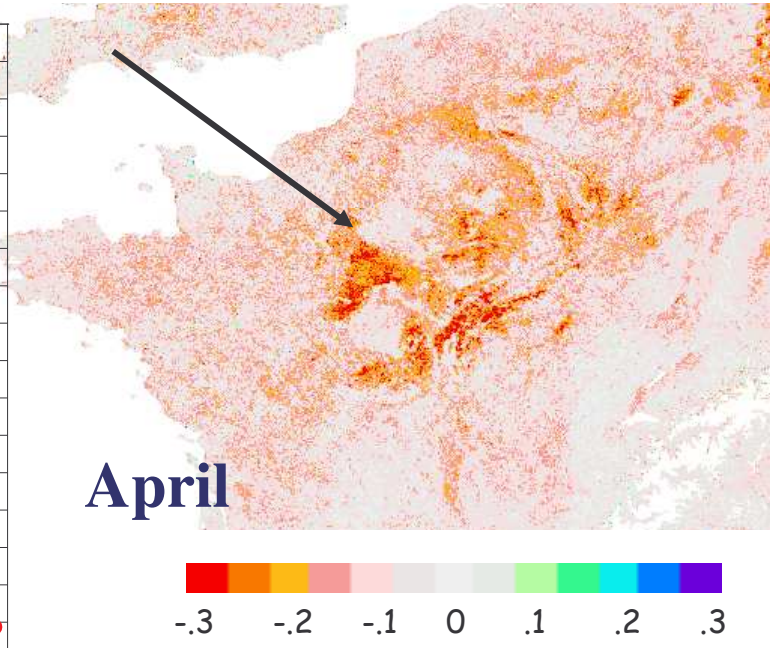
Wheat - Chartres (48° 20' N;2° 0' E)





The seasonal evolutions of FAPAR during the period 1998 to 2003 (estimated from SeaWiFs data), as well as that for 2003 and 2004 (derived from MERIS data), for an area close to Chartres (France)

The impact of the 2003 drought on the vegetation is clearly noticeable as early as March in this under-irrigated area

MERIS values indicate that the situation is back to normal in 2004 at this location.

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Gobron, N., B. Pinty , F. Mélin, M. Taberner , M. M. Verstraete, A. Belward , T. Lavergne and J.-L. Widlowski (2005) 'The state of vegetation in Europe following the 2003 drought', *International Journal of Remote Sensing Letters*, in press.

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Rice - Pavia (45° 17' N; 8° 23'W)

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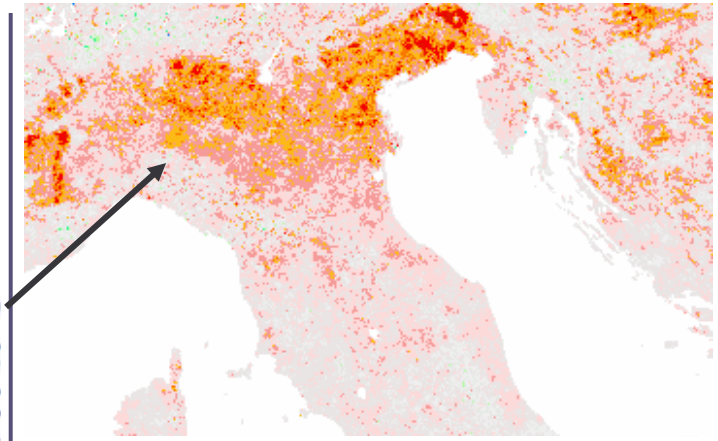
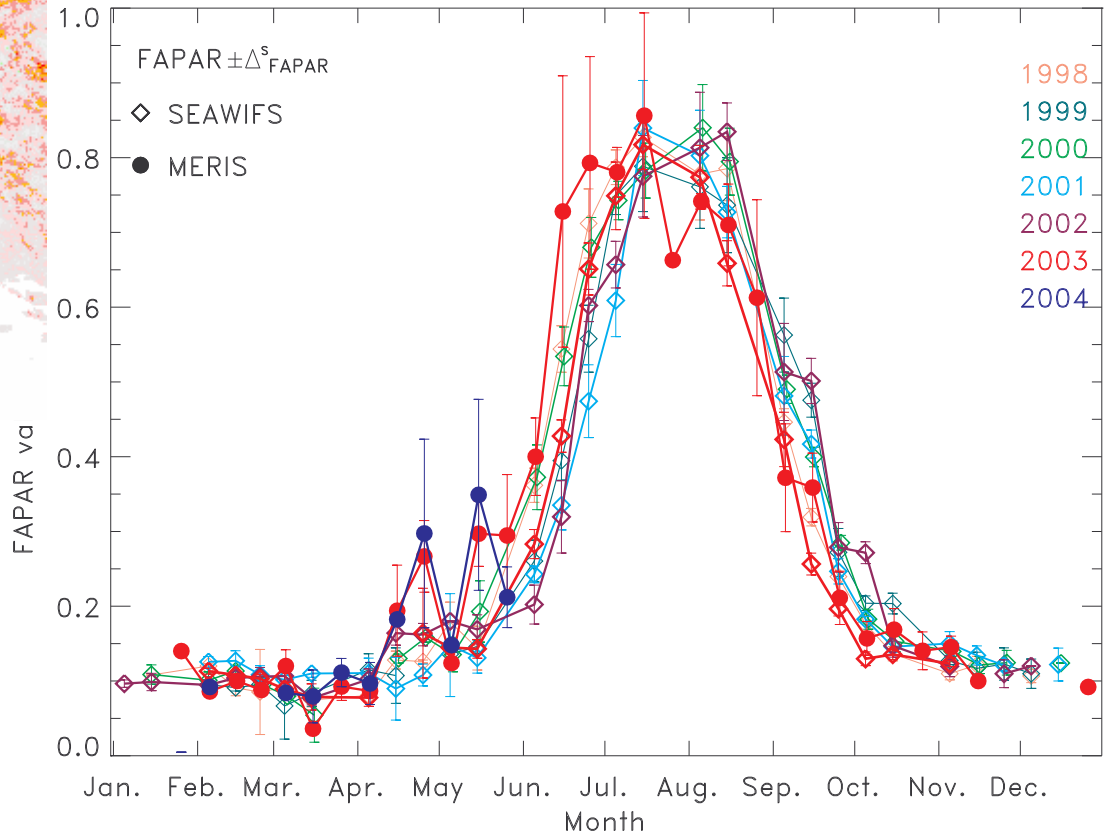


August



We have the same 6 (almost indistinguishable) annual vegetation cycles.

This rice-growing area was regularly irrigated throughout the period and was unaffected by the drought.

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Gobron, N., B. Pinty , F. Mélin, M. Taberner , M. M. Verstraete, A. Belward , T. Lavergne and J.-L. Widlowski (2005) 'The state of vegetation in Europe following the 2003 drought', *International Journal of Remote Sensing Letters*, in press.

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Scrub -Plan de la Tour (43° 21'N;6° 35'E)

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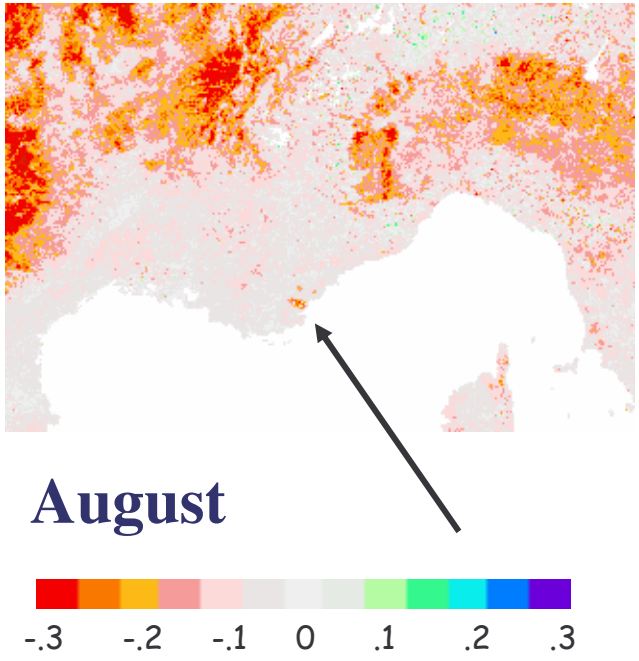

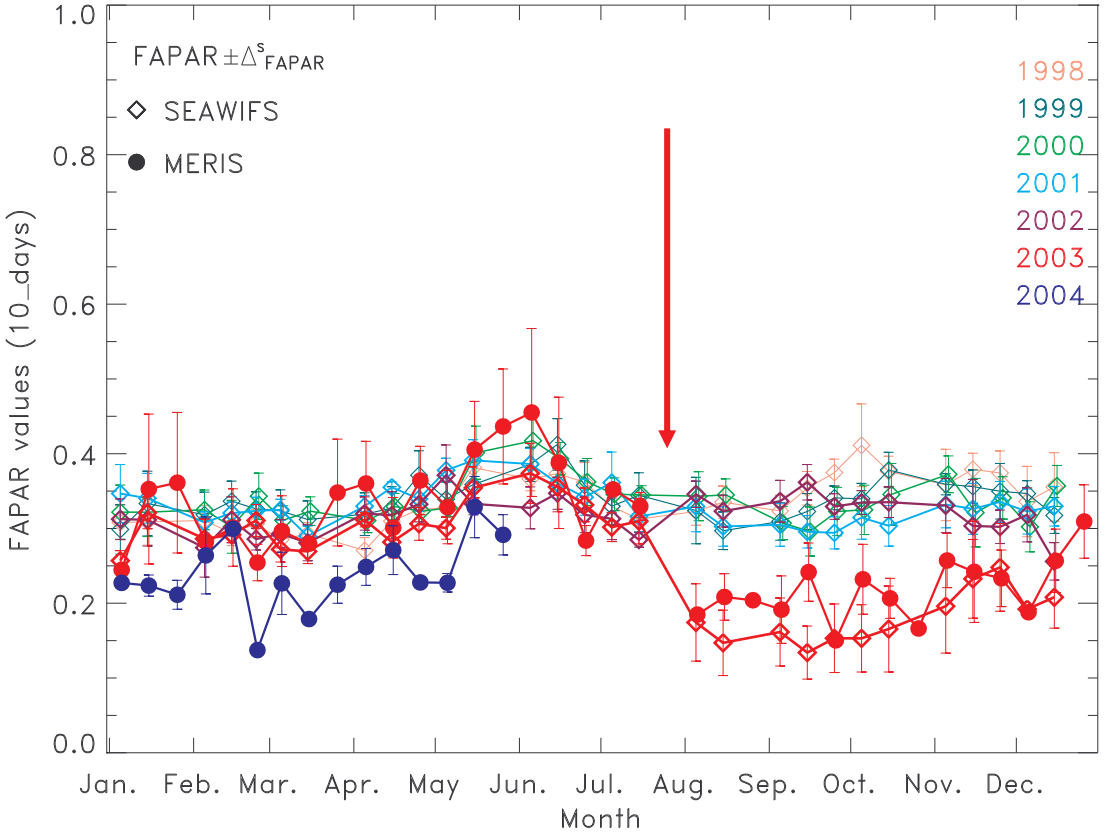

The most extreme illustration of the 2003 drought impact: Plan de La Tour (France) experienced intense fires in August 2003. The FAPAR values suddenly decline after the summer fire events and keep relatively low values, by comparison to those obtained for the period 1998-2002, until the end of 2003.

The 2004 spring FAPAR estimations suggest that the vegetation has not recovered from the 2003 fire stress.

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Gobron, N., B. Pinty , F. Mélin, M. Taberner , M. M. Verstraete, A. Belward , T. Lavergne and J.-L. Widlowski (2005) 'The state of vegetation in Europe following the 2003 drought', *International Journal of Remote Sensing Letters*, in press.

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Site code	NAME	Land Use /Land Cover	Latitude	Longitutde
FR-Hes	Hesse	Beech/Forest	48° 40' N	07° 04' E
IT-Roc1	Roccarespampani	Oak /Forest	42° 24' N	11° 55' E
DK-Sor	Soroe	Beech/Forest	55° 29' N	11° 38' E
ES-ESa2	El Saler-Sueca (Valencia)	Crop	39º 20' N	00º 19' W
NL-Loo	Loobos	Scots Pine/Forest	52° 10' N	05° 44' E
BE-Bra	Braschaat	Pinus Sylvestris+ *Quercus robur* Forest	51° 18' N	04° 31' E
IE-Car1	Carlow	Arable Grassland	52° 51' N	06° 54' W
Hu-Bug	Bugapuszta	Grasslands	46° 48' N	18° 54' E
CH-Oen	Oensingen	Grassland Arable	47° 17' N	7° 44' E

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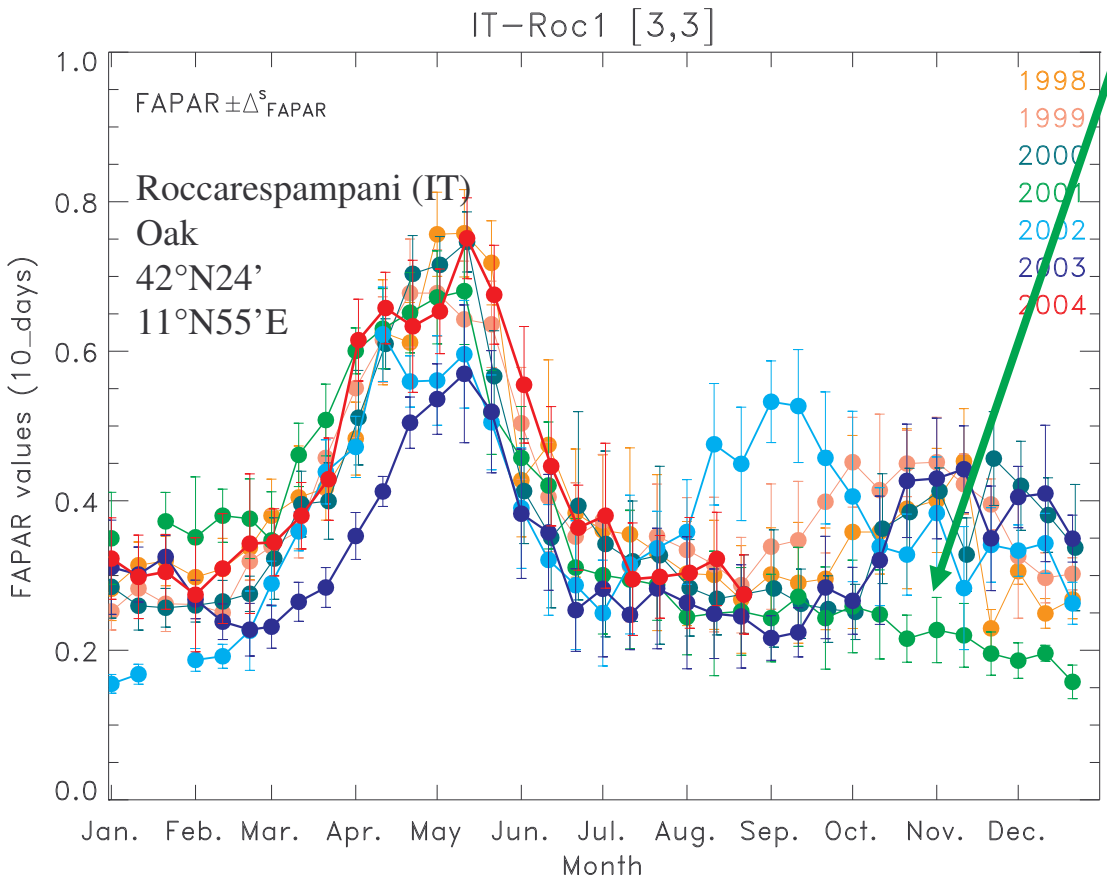
Oak /Forest

Management of forest



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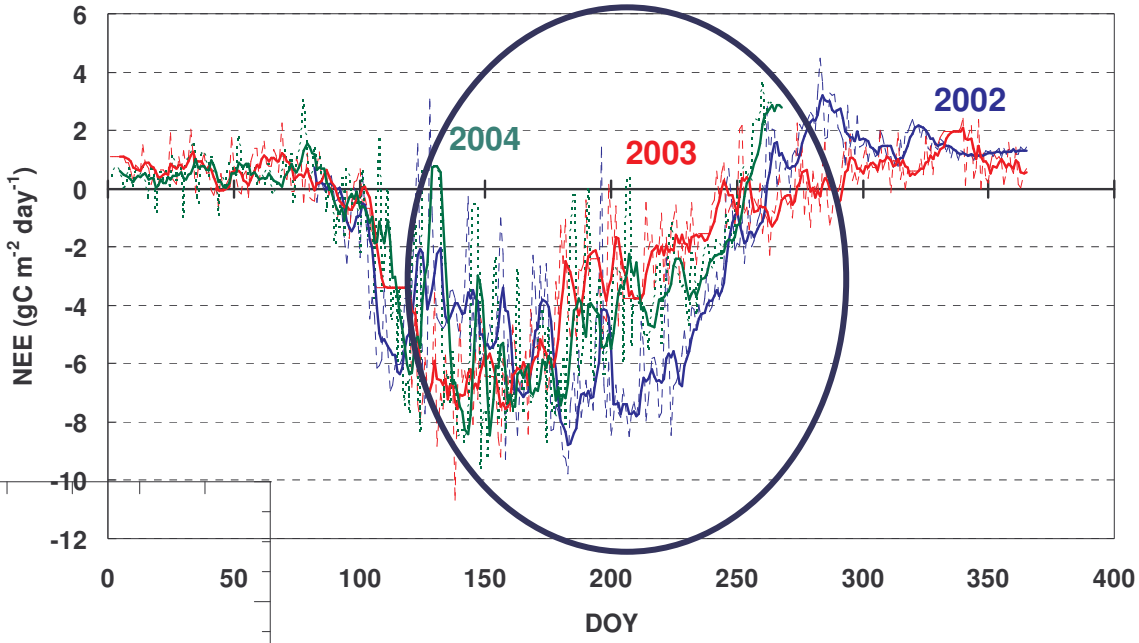
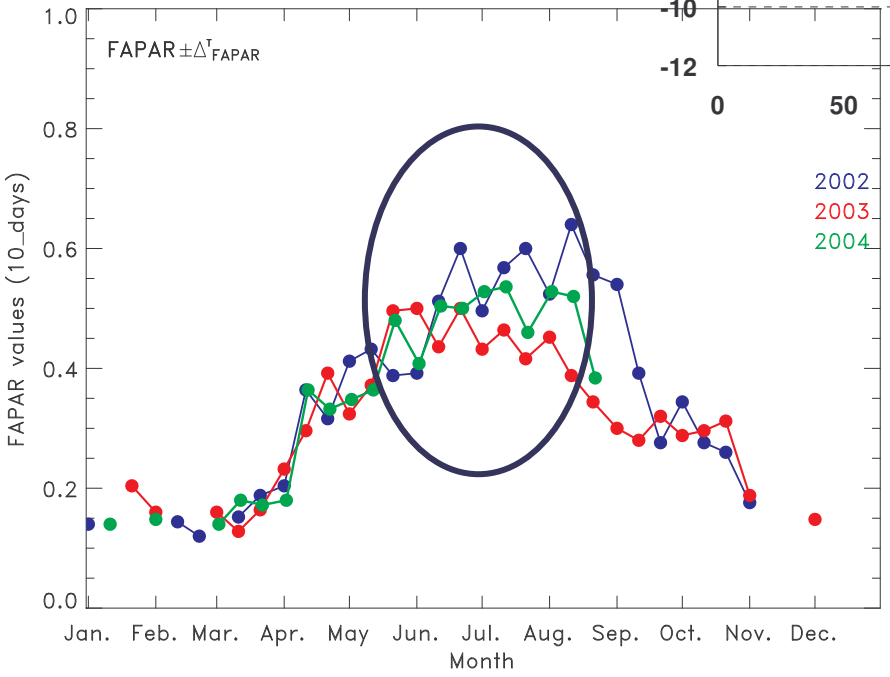
Space FAPAR versus field NEE

Local Site: Poplar (Ticino)

In collaboration with the IES/Climate Change Unit





The observed in situ NEE increase (from -8 to -2) in 2003 implies a diminished production of biomass, hence a reduced uptake of CO_2 by vegetation.

The FAPAR decrease in 2003 corresponds to a smaller photosynthetic activity by vegetation compared to a normal year.

NEE = Net Ecosystem Exchange ≈ Actual Amount of C taken by biosphere

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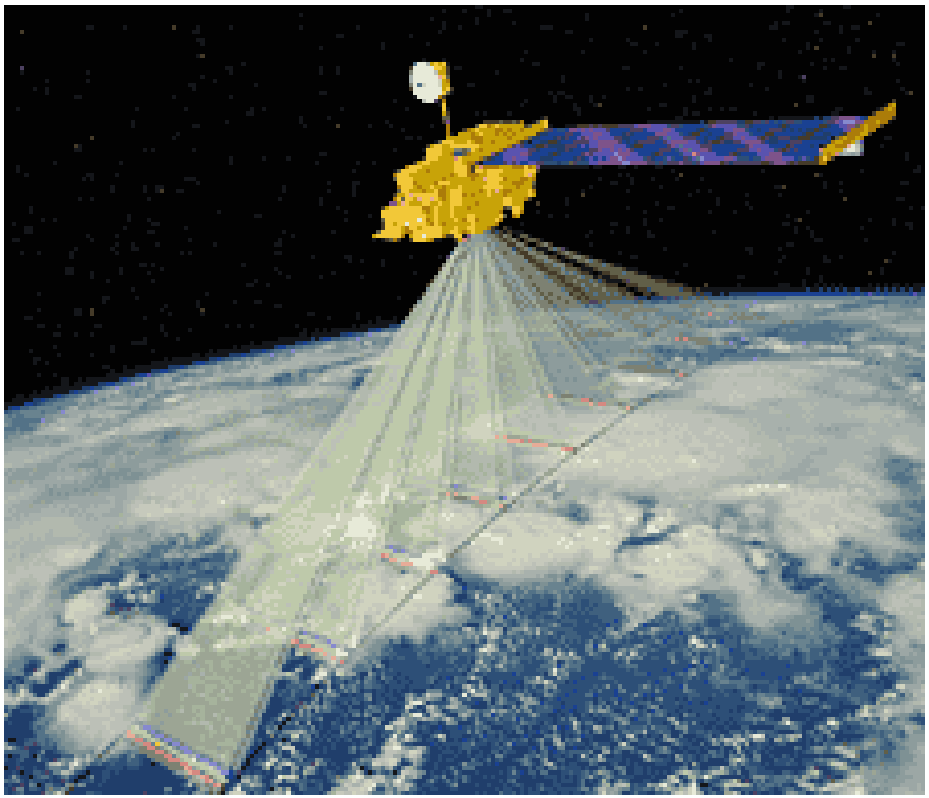
Multi-angle Imaging SpectroRadiometer (MISR) on board Terra

9 cameras at ±70.5, ±60, ±45.6, ±26.1, 0°



Each camera at blue, green, red, and near infrared bands

Spatial resolutions of 275 m &1.1 km

http://www-misr.jpl.nasa.gov/mission/minst.html

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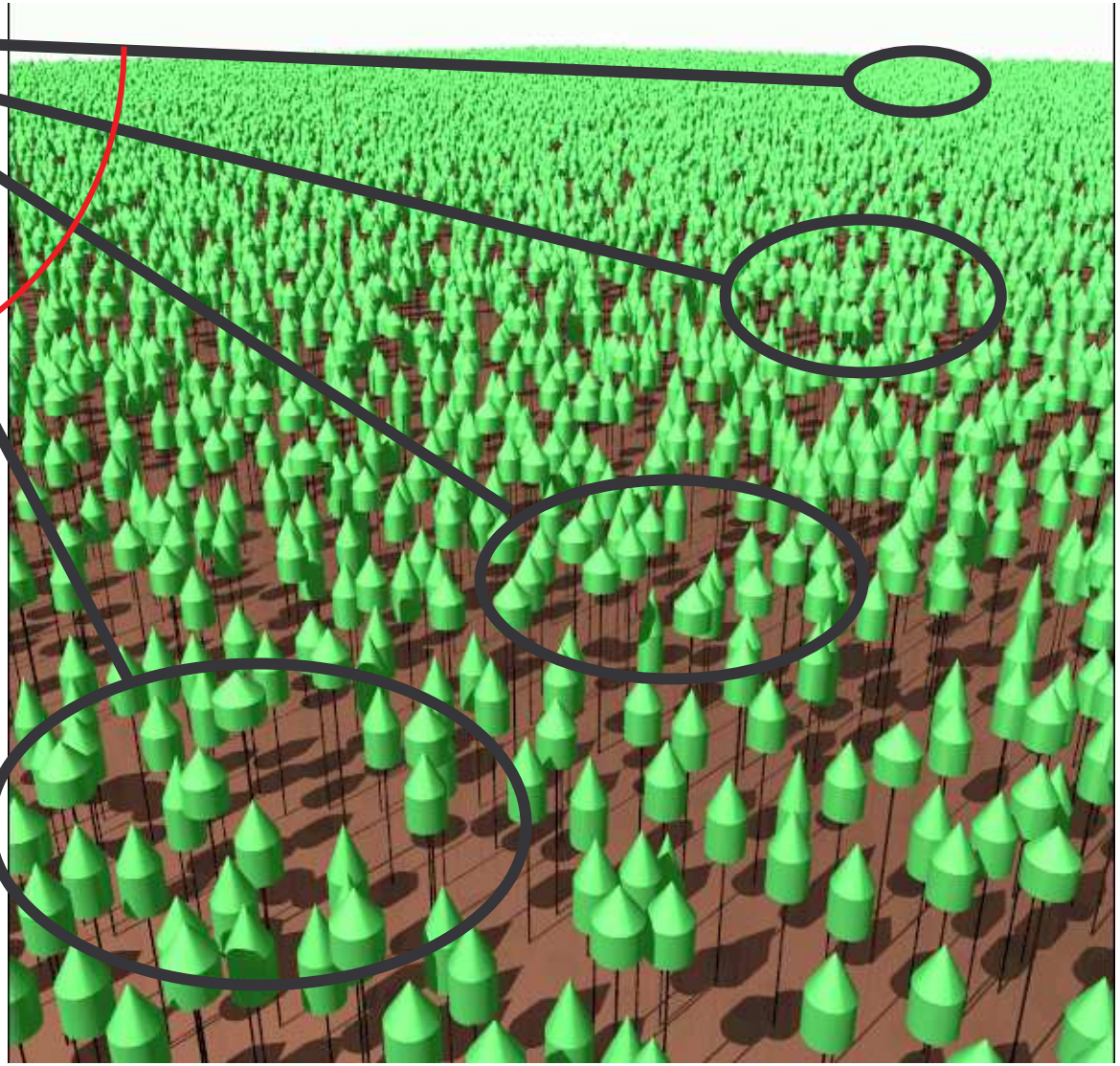
Multi-angle views for surface structure



Angular signature provides information about the **presence of gaps** in the canopy

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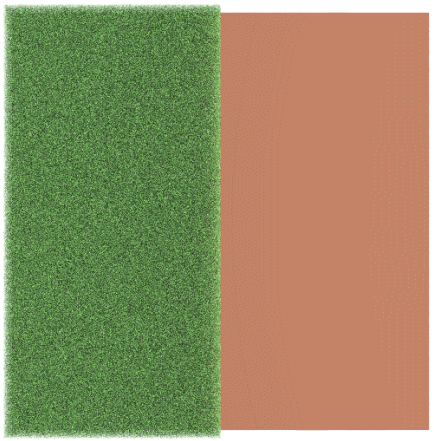
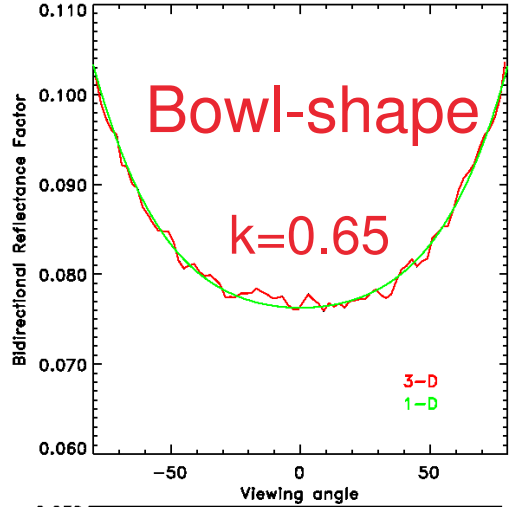
Angular signatures in the red region

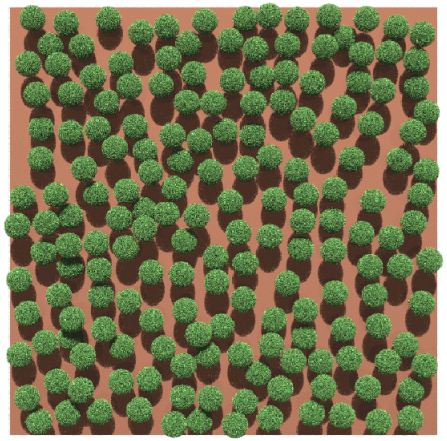
1-D

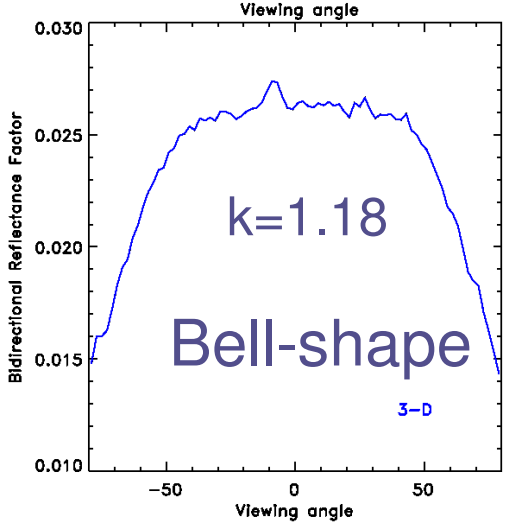




Weak structure effects

3-D





Strong structure effects

Presence of gaps

Pinty, B., J.-L. Widlowski, N. Gobron, M. M. Verstraete and D. J. Diner (2002) 'Uniqueness of Multiangular Measurements Part 1: An Indicator of Subpixel Surface Heterogeneity from MISR', *IEEE Transactions on Geoscience and Remote Sensing*, MISR Special Issue, **40, 1560-1573.**

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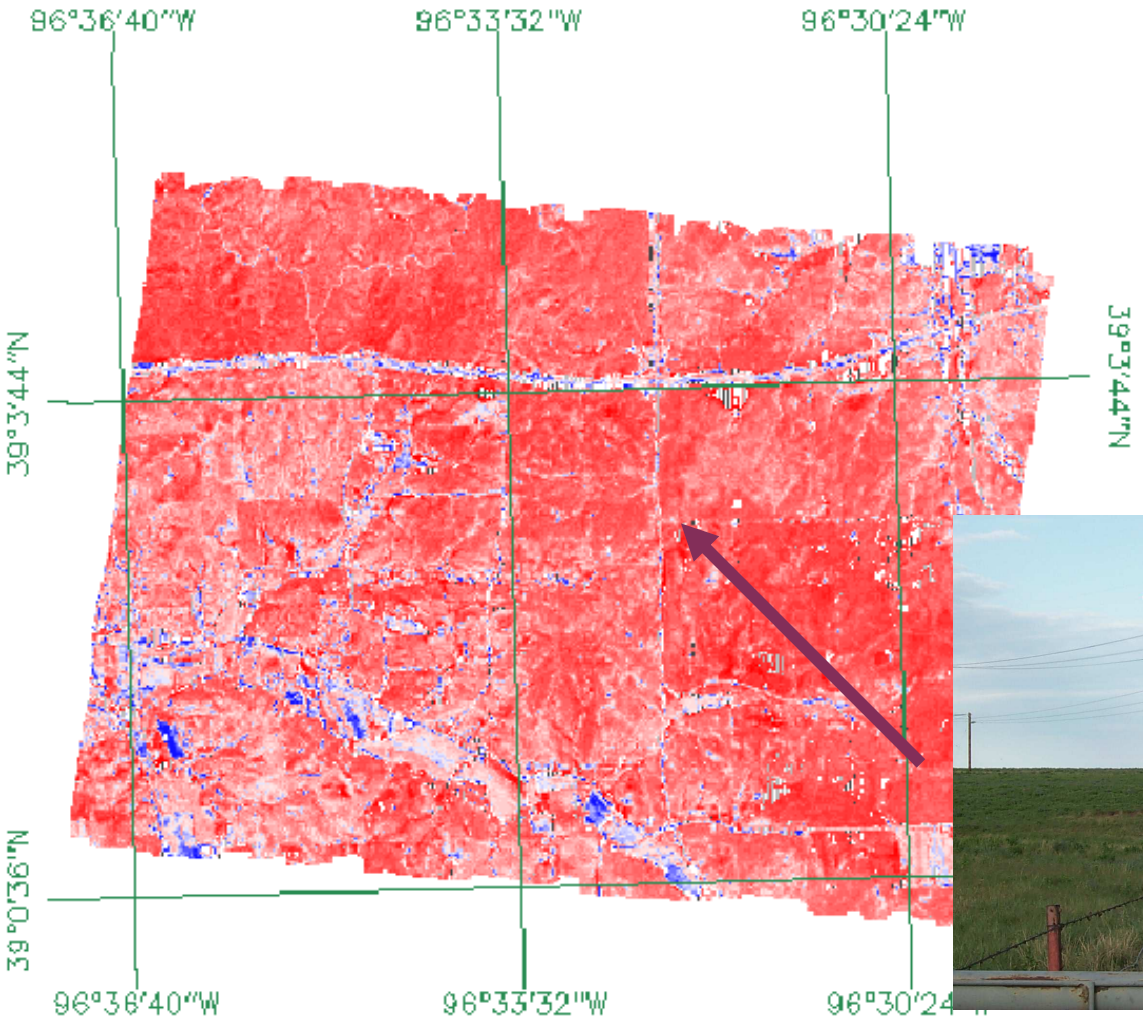
K from AirMISR over the Konza Prairie



Bowl-shape

Fields separated by a fence

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Pinty, B., J.-L. Widlowski, N. Gobron, M. M. Verstraete and D. J. Diner (2002) 'Uniqueness of Multiangular Measurements Part 1: An Indicator of Subpixel Surface Heterogeneity from MISR', *IEEE Transactions on Geoscience and Remote Sensing*, MISR Special Issue, **40, 1560-1573.**

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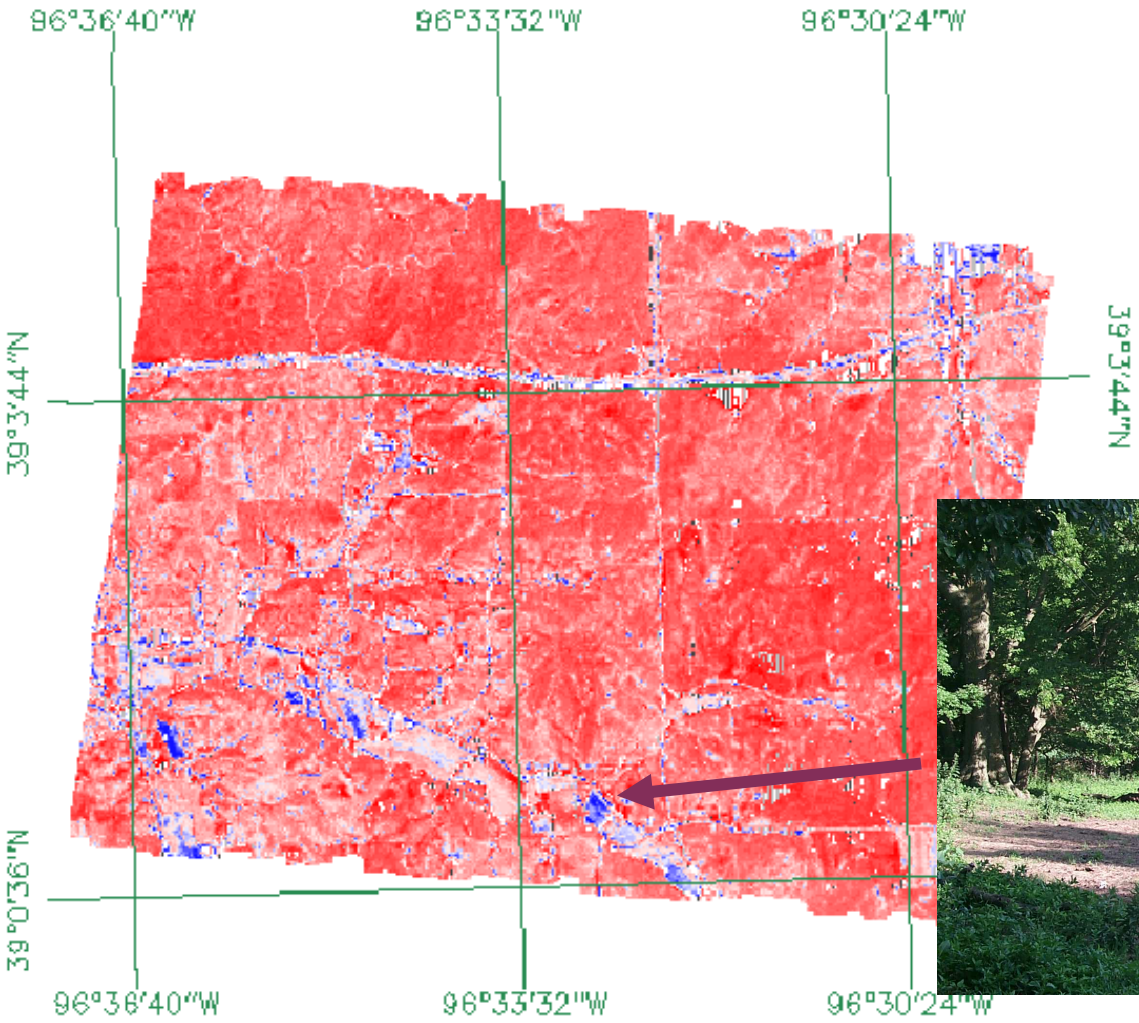

Bell-shape

Bare soil clearing in a wooded area (used by cattle)

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Pinty, B., J.-L. Widlowski, N. Gobron, M. M. Verstraete and D. J. Diner (2002) 'Uniqueness of Multiangular Measurements Part 1: An Indicator of Subpixel Surface Heterogeneity from MISR', *IEEE Transactions on Geoscience and Remote Sensing*, MISR Special Issue, **40, 1560-1573.**

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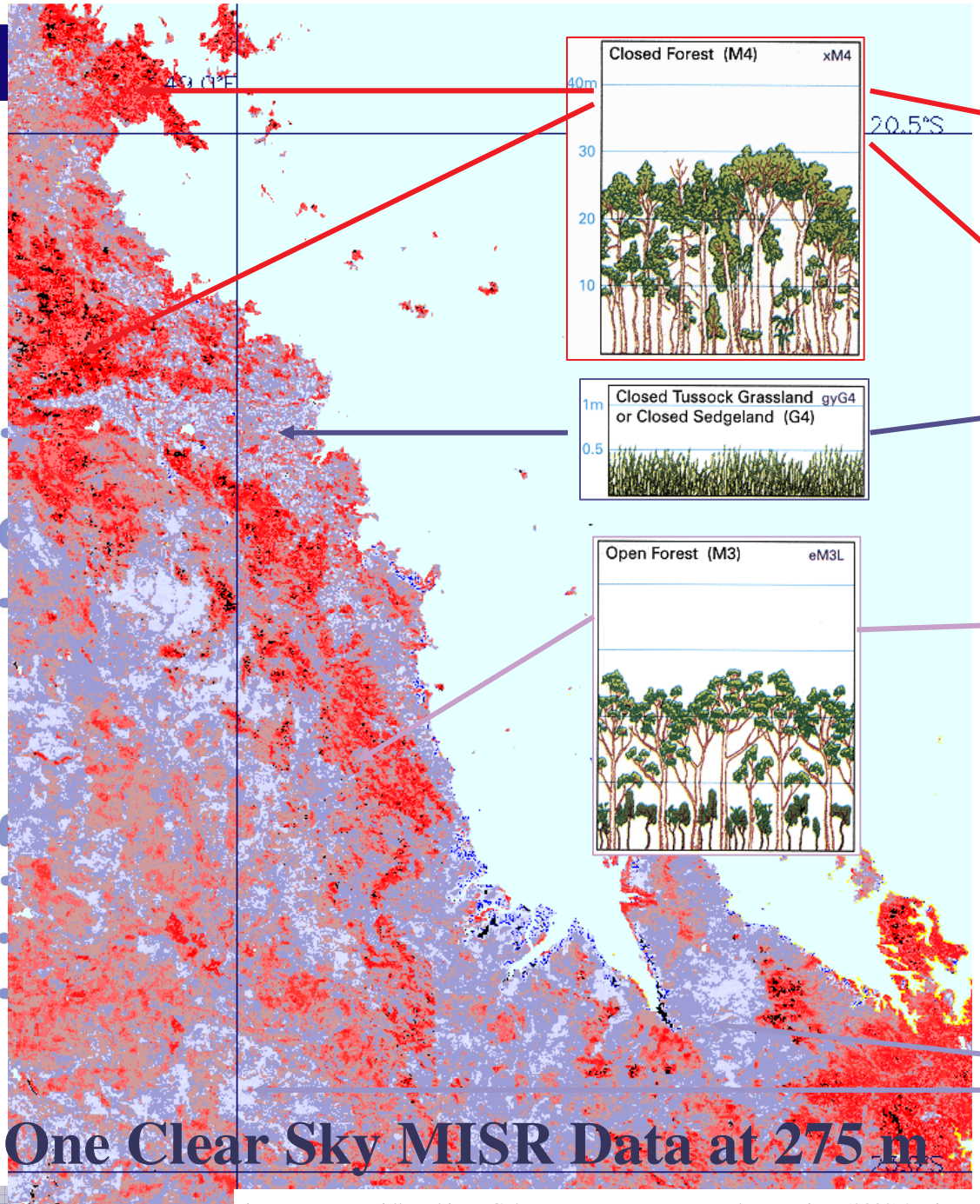


Australian Surveying & Land Information Group

Map of structural forms

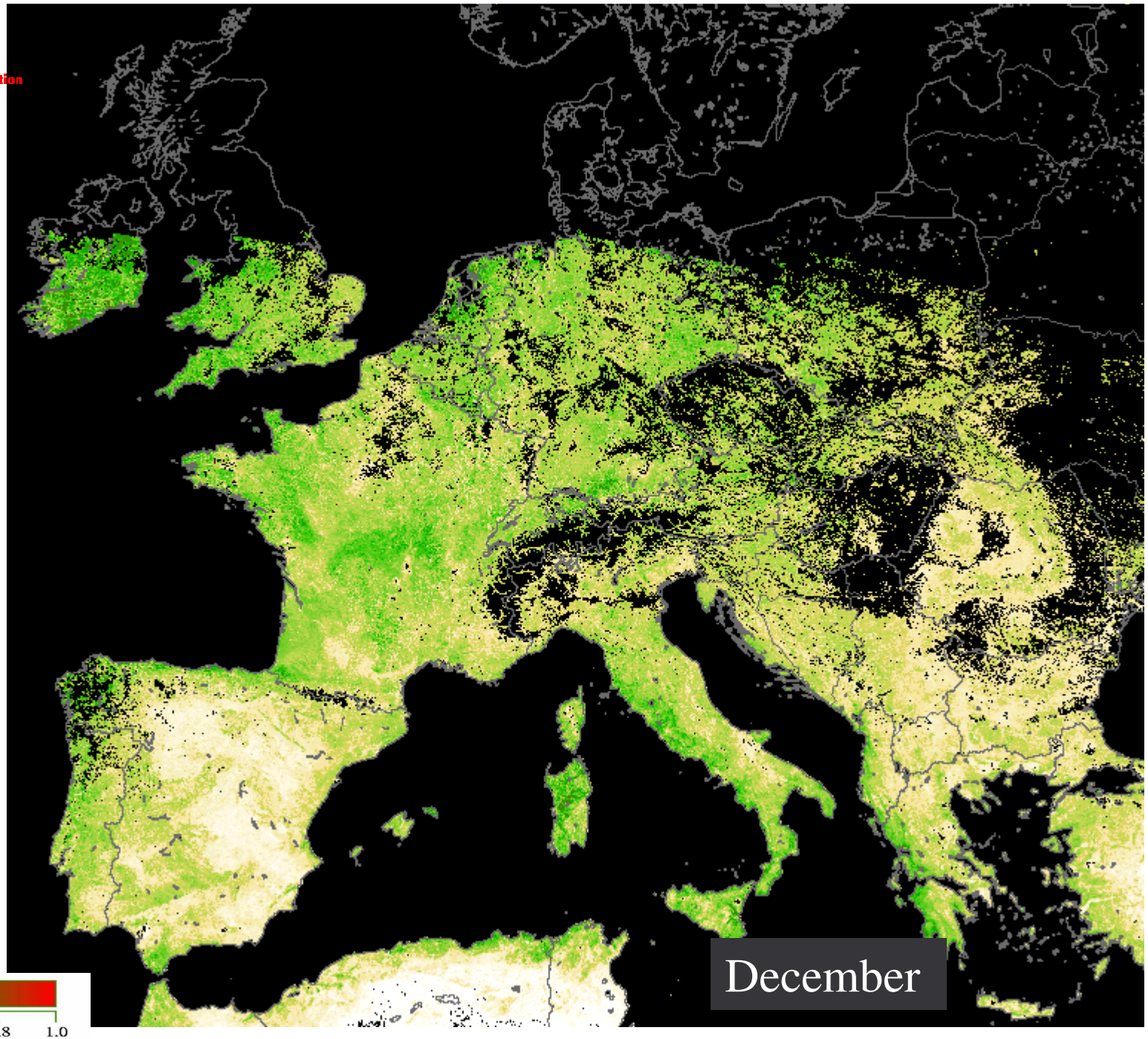
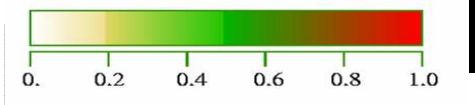
One Clear Sky MISR Data at 275 m

Pinty, B., J.-L. Widlowski, N. Gobron, M. M. Verstraete and D. J. Diner (2002) 'Uniqueness of Multiangular Mea of Subpixel Surface Heterogeneity from MISR', *IEEE Transactions on Geoscience and Remote Sensing*, MISR Special Issue, 40, 156

Conclusion & perspectives

✓ **FAPAR time series and associated products over Europe are available for ecosystem accounting system.**

✓ **Vegetation Structure from optical RS could be soon available.**

✓ **R&D for developing new methodology to link the RS products to ecosystem functioning.**

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