EGU – BG2.5
2 May 2014

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Cross-validation of satellite products over France through their integration into a land surface model

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Context

- Long (more than 30 years) time series of satellite-derived land products over land are now available
  - Essential Climate Variable (ECV) products such as LAI, FAPAR, surface albedo, and soil moisture.
  - Produced by ESA, EUMETSAT, Copernicus
- Integration into land surface models
  - Validation of ECV products
  - Model verification
  - Reanalysis of land variables and fluxes

Objectives

- Consolidate the LDAS (Land Data Assimilation System) developed in the FP7 geoland2 project over France
  - Joint assimilation of vegetation variables and soil moisture observations
  - Interoperable with operational real-time applications
    - Weather forecast, Hydrology, Atmospheric inversions
- Monitor the quality of satellite-derived terrestrial ECVs
  - Key to the development of future climate services
  - Quality control the terrestrial products of the Copernicus Global Land service
    - Statistics on the assimilated observations
    - Soil moisture, LAI, FAPAR, surface albedo, surface temperature

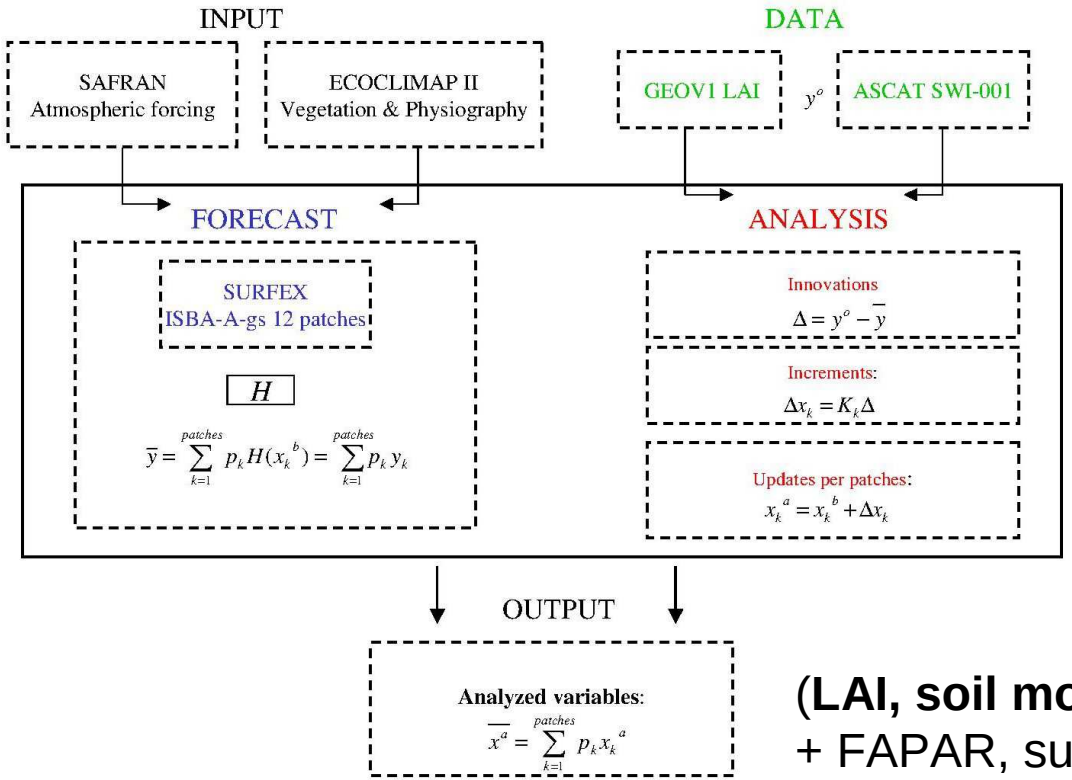
SURFEX / ISBA-A-gs

- SURFEX modelling platform:
  - Shared by many meteorological services in Europe and North Africa
  - Used in CNRM-ARPEGE climate model (IPCC simulations)
  - Version 8 will be open-source (end 2014)

- ISBA-A-gs land surface model (within SURFEX)
  - Photosynthesis-driven phenology
    - No growing degree-days
    - All the atmospheric variables impact phenology (including atmospheric CO_2)
    - Interannual variability of LAImax is modelled
    - LAI is flexible and can be analyzed at a given time
    - FAPAR is modelled
  - Surface soil moisture is modelled

LDAS-France

FIG. 1 – Joint assimilation of LAI and surface soil moisture (8km x 8km)



H observation operator

K Kalman gain

(**LAI, soil moisture,**
+ FAPAR, surface albedo,
surface temperature)

Barbu et al. 2014, HESS

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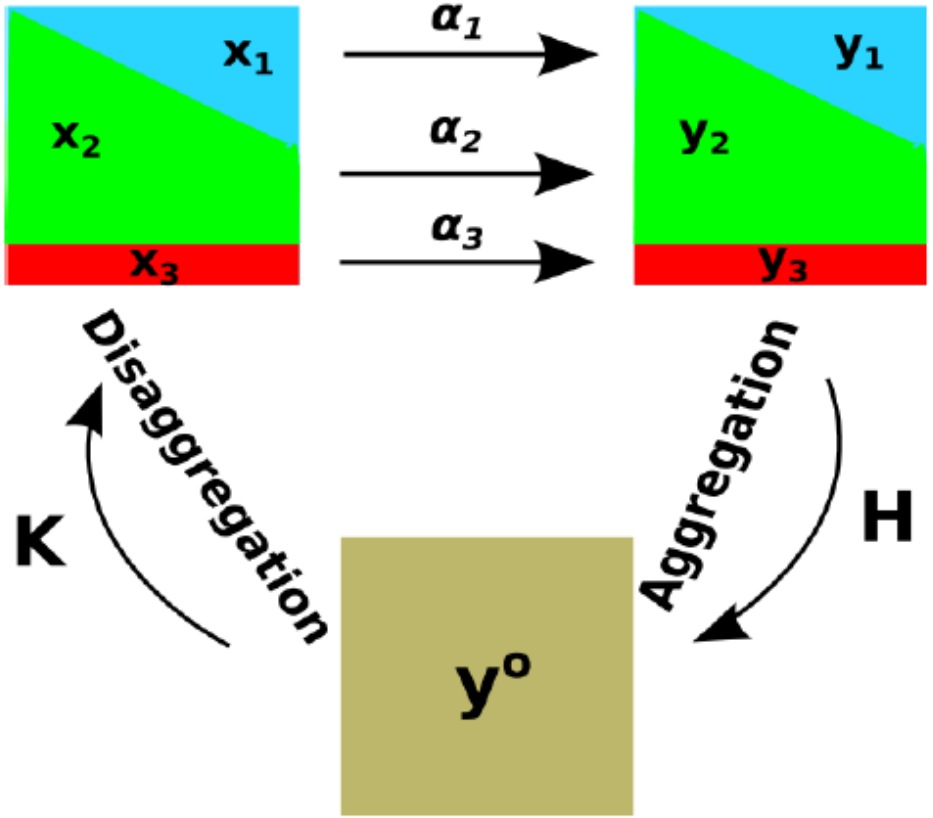
LDAS-France

FIG. 2a – Accounting for sub-grid heterogeneity (8km x 8km)



FORECAST

ANALYSIS

Barbu et al. 2014, HESS

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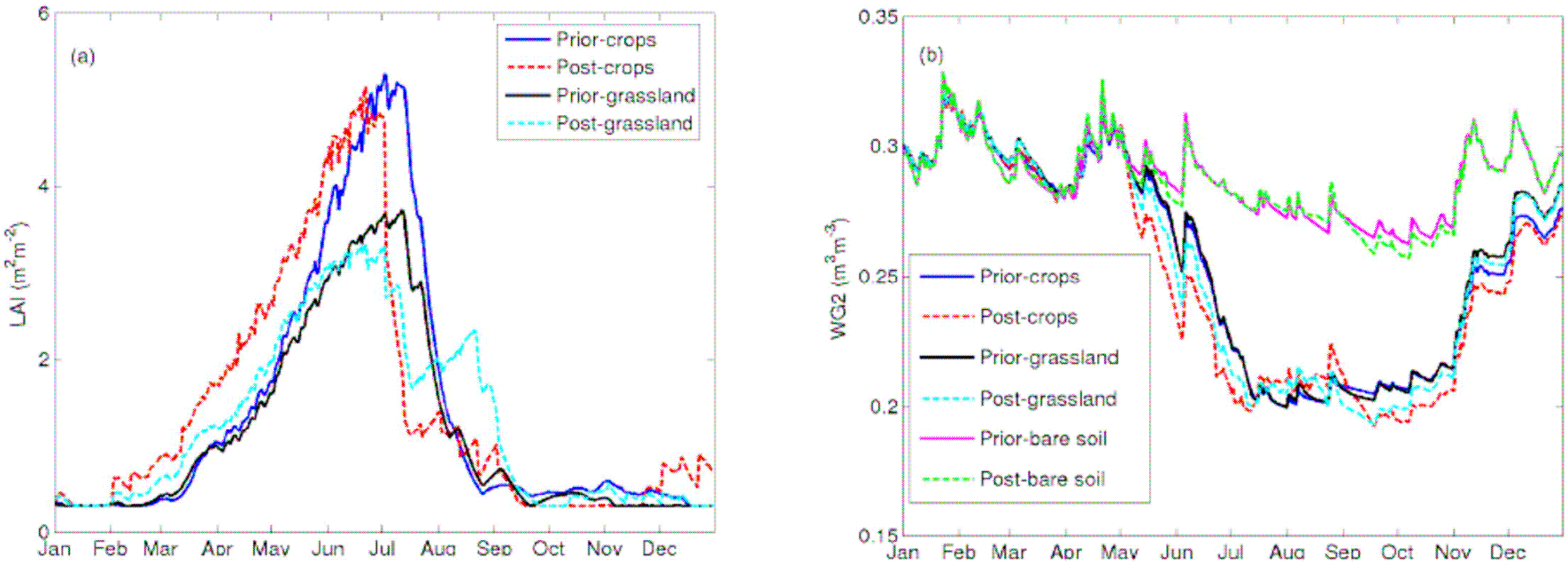
FIG. 2b – Accounting for sub-grid heterogeneity (8km x 8km)

One grid-cell near Toulouse:



Barbu et al. 2014, HESS

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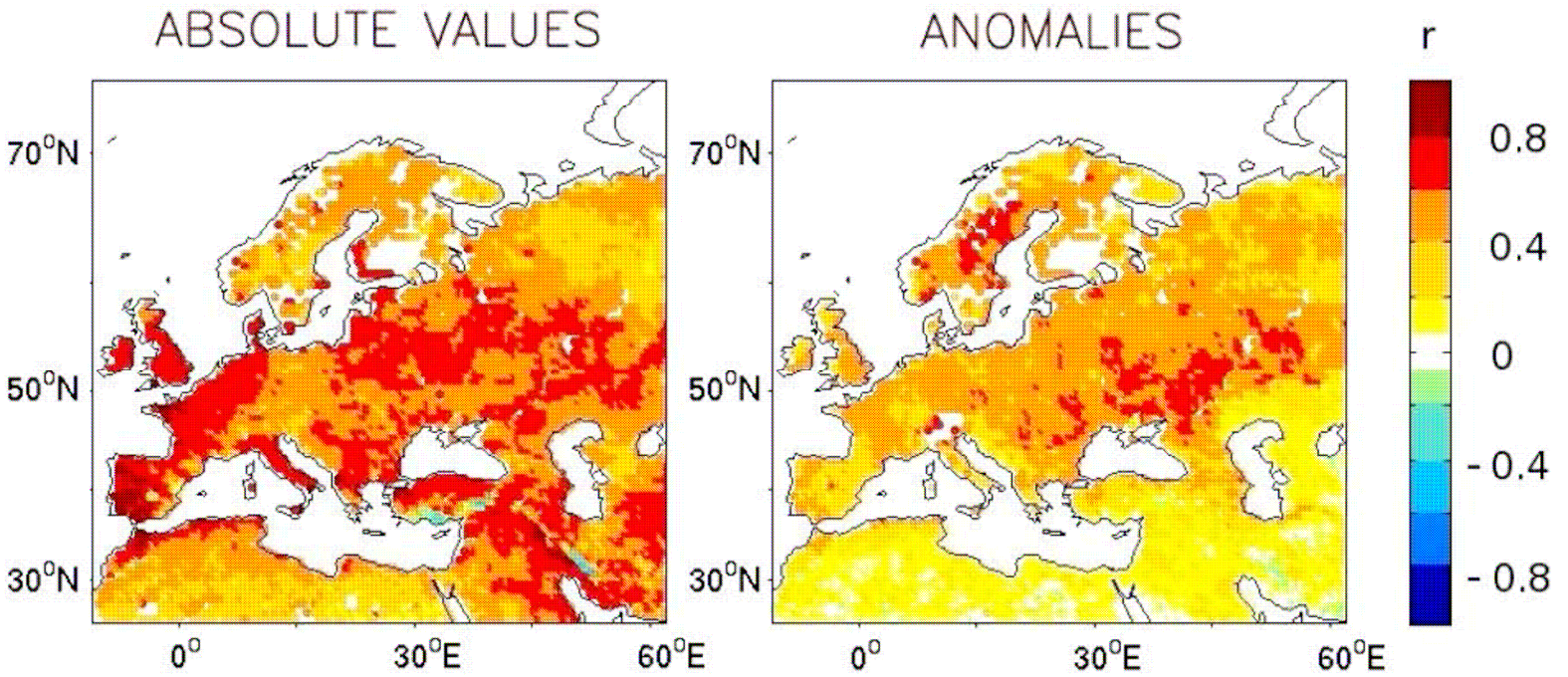
Model / satellite product consistency check

FIG. 3 – Surface soil moisture (ESA-CCI microwave-derived product)

Correlations (1991-2008 day-to-day variability)



Szczypta et al. 2014, GMD

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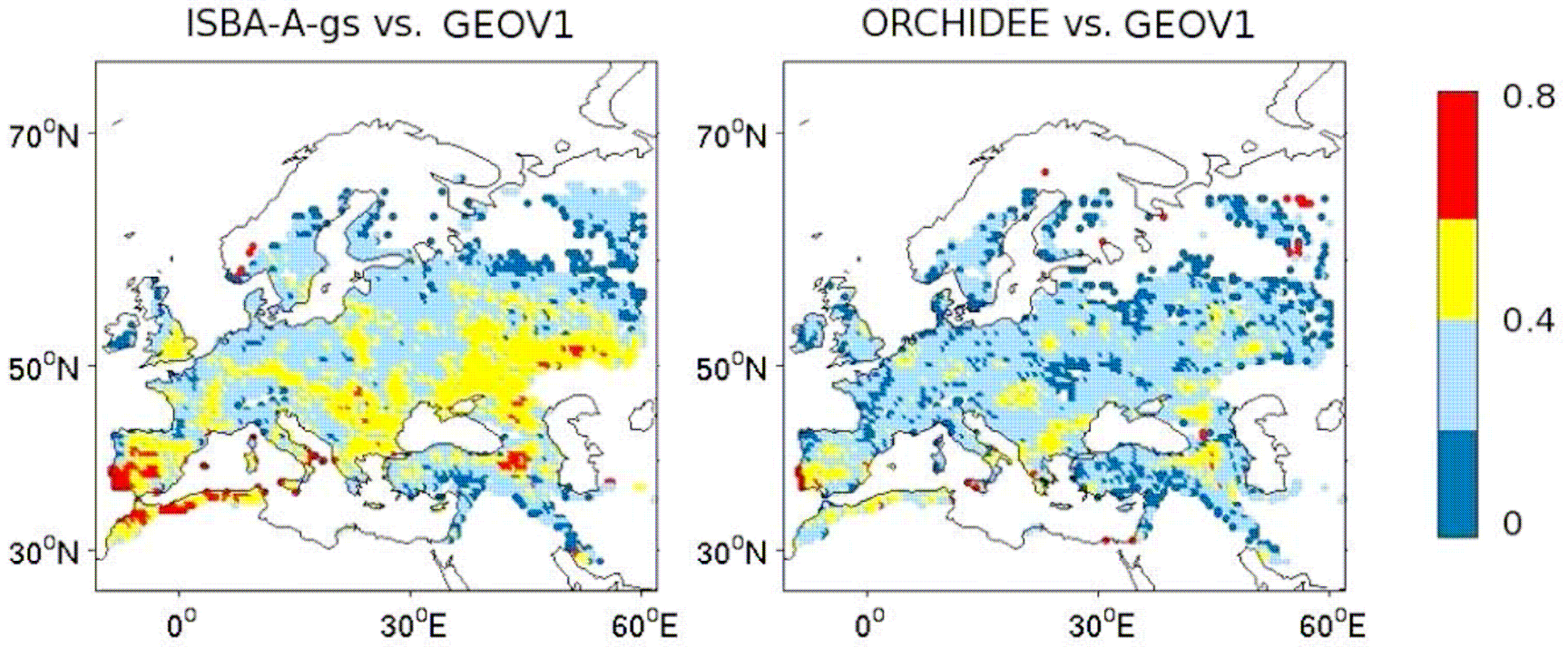
Model / satellite product consistency check

FIG. 4 – Leaf Area Index (GEOV1 Copernicus Global Land product)

Correlations (1991-2008 10-daily interannual variability)



Szczypta et al. 2014, GMD

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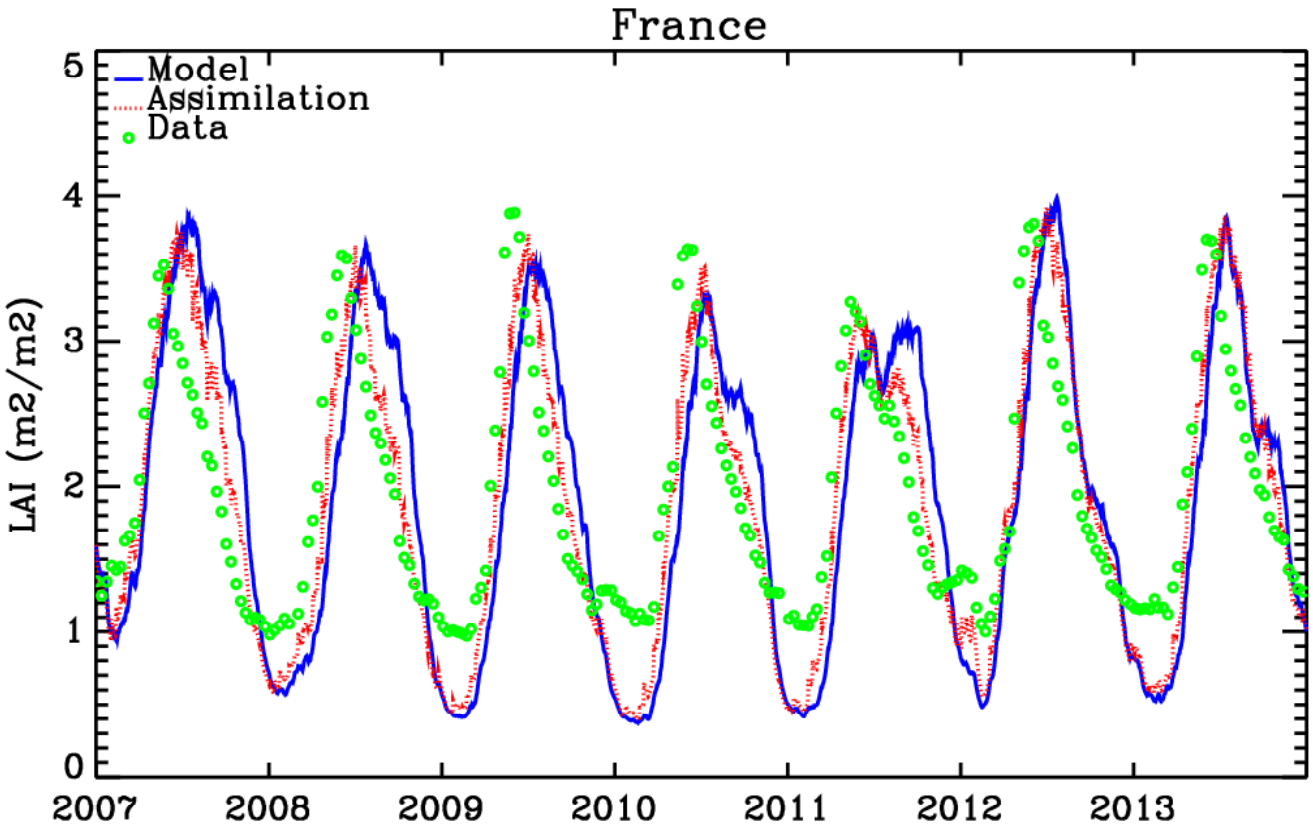
Assimilation results

FIG. 5 – LAI analysis (mean value for France)



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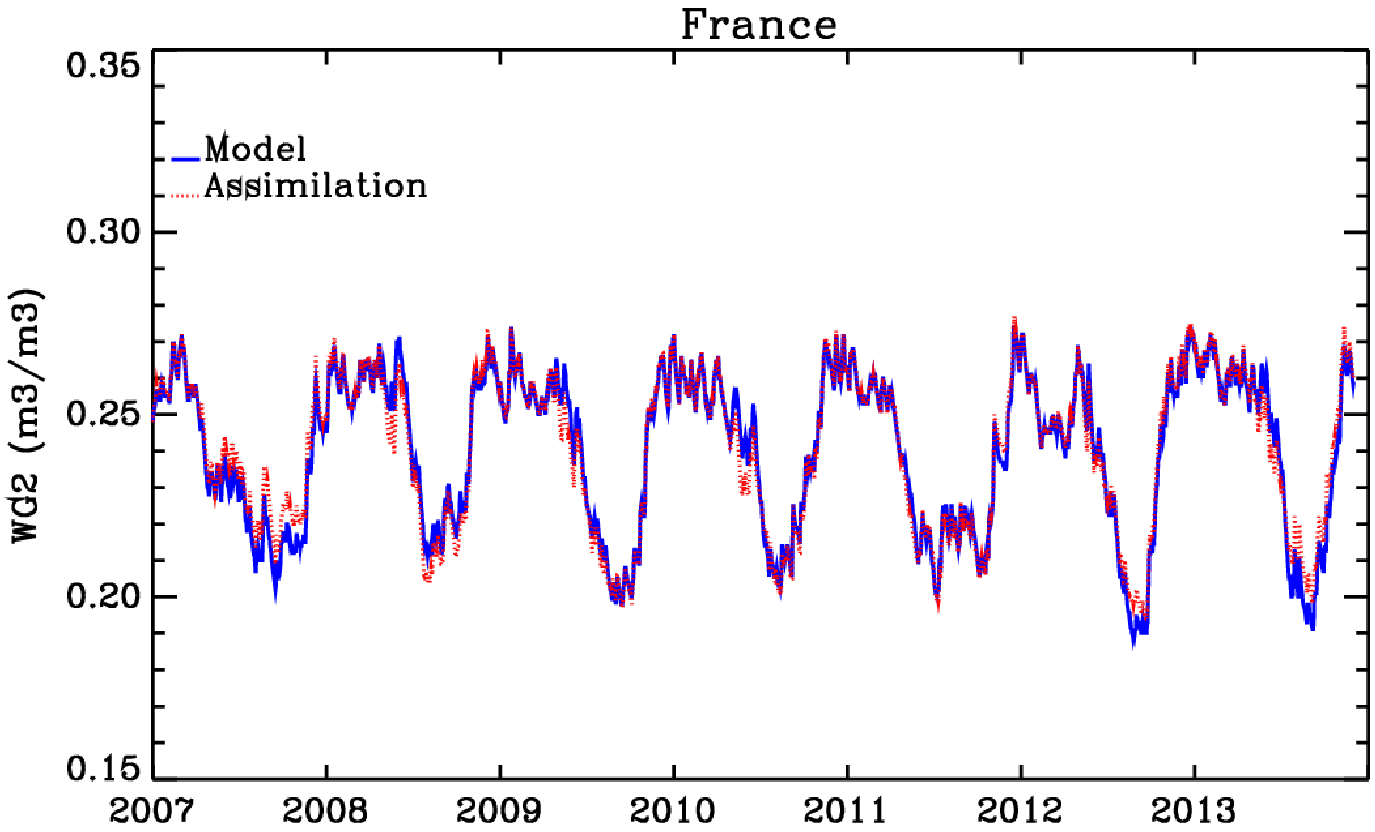
Assimilation results

FIG. 6 – Root-zone soil moisture analysis (mean value for France)



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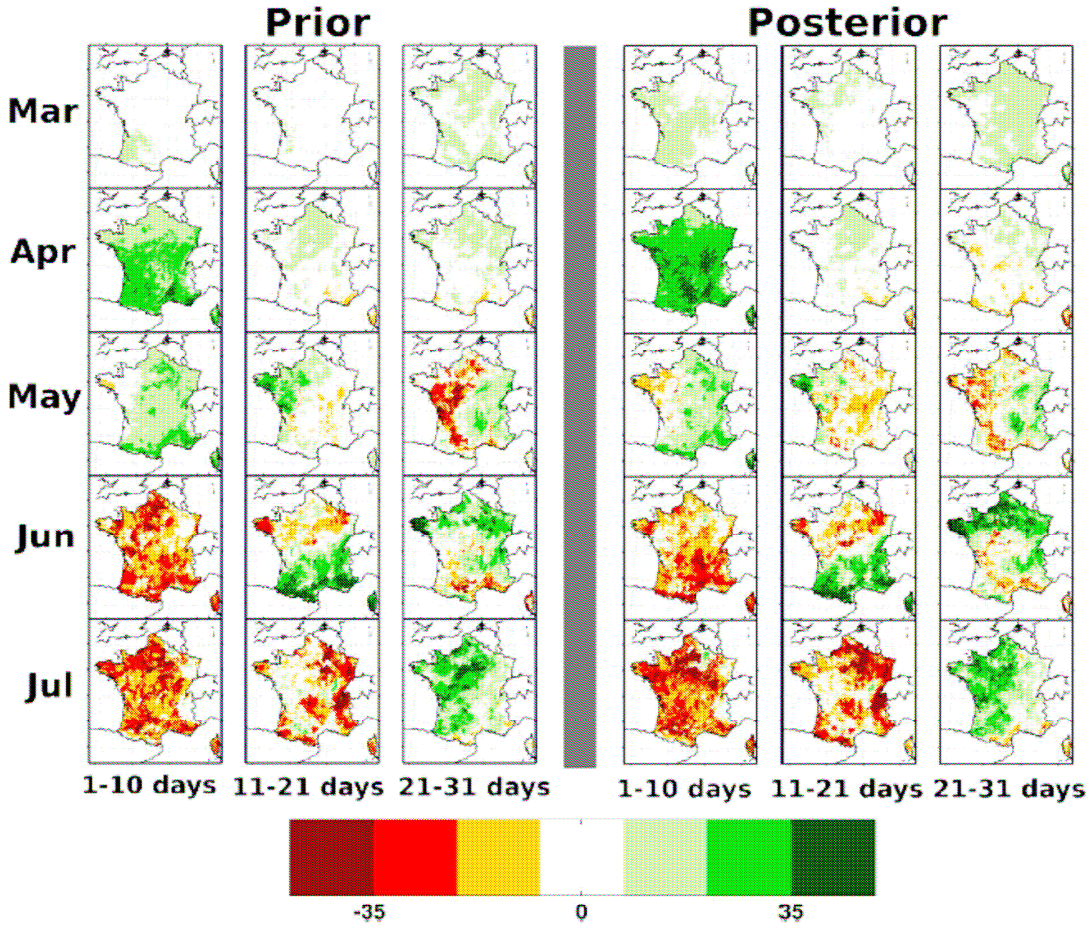
Assimilation results

FIG. 7 – 10-daily GPP change rate in 2011 (extreme spring drought)



$$\mathrm{g\,CO_2\,m^{-2} \times 10\,days^{-1}}$$

Barbu et al. 2014, HESS

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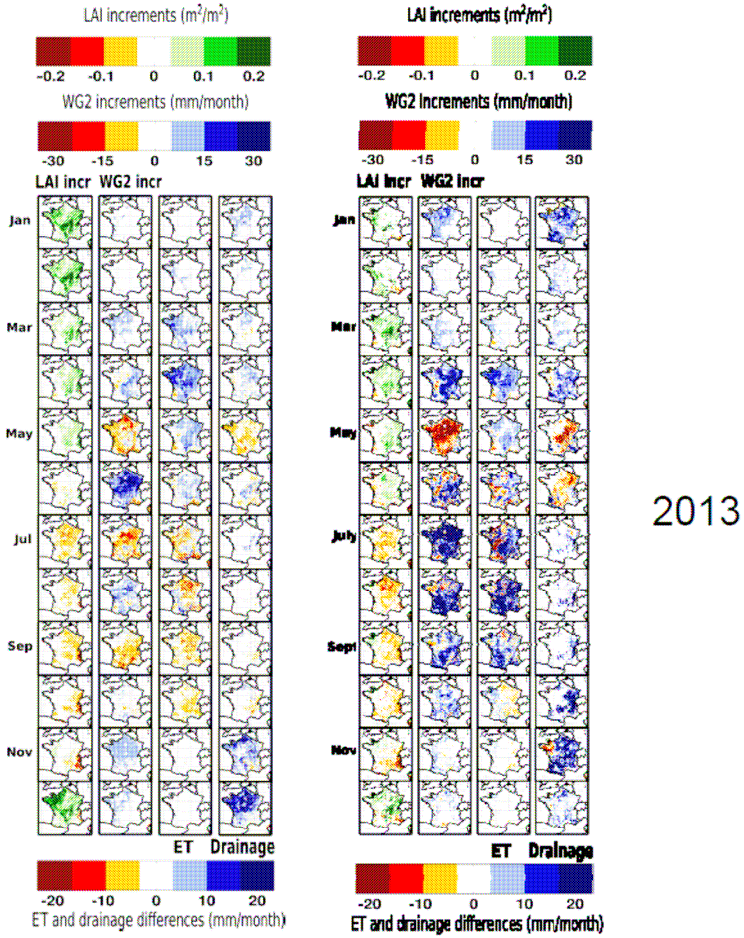
Assimilation results

FIG. 8a – Increments



2008 - 2012

2013

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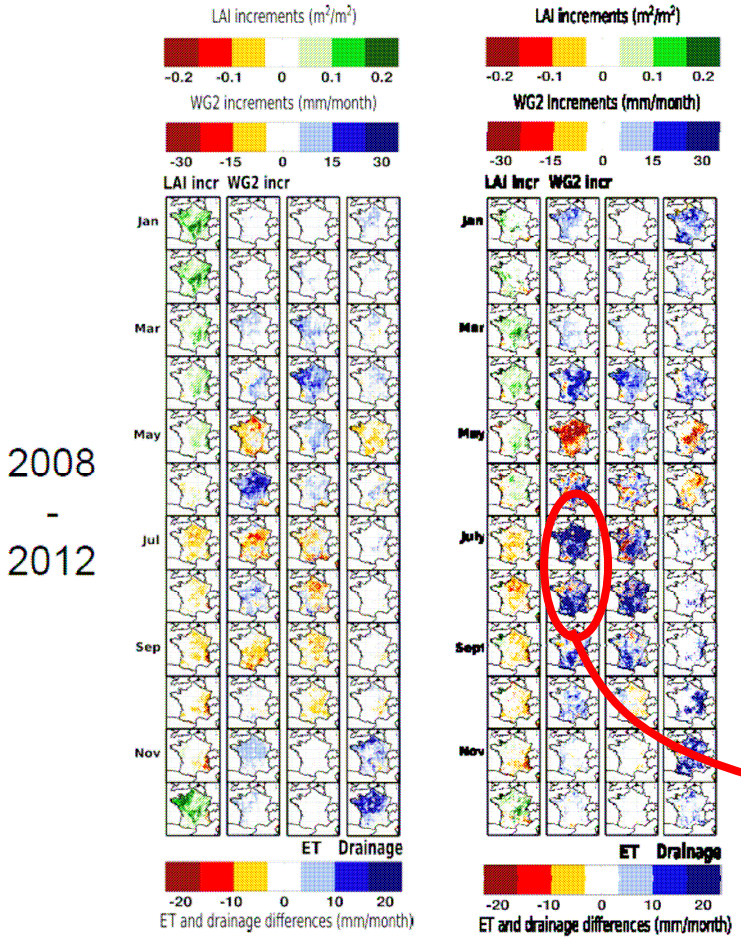
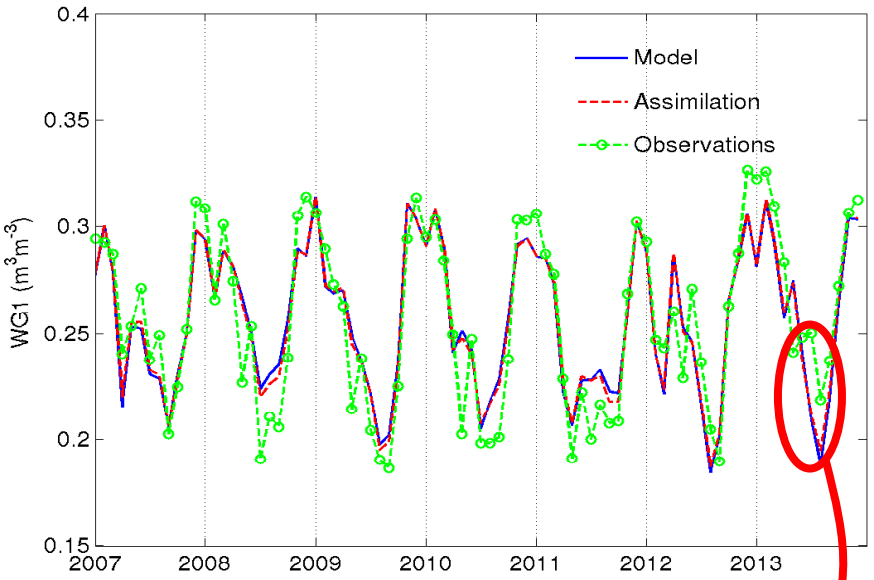
Assimilation results

FIG. 8b – Increments





Too high SSM observations ?

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Conclusions

- **LDAS-France** is operational
  - Cross-cutting validation reports are generated every 6 months for the Copernicus Global Land service
  - Possible application for land reanalyses and drought monitoring

- Ongoing activities
  - Test the assimilation of FAPAR
  - Multi-layer soil hydrology
  - From EKF to EnKF
  - Link to hydrology (NRT in situ river discharge observations)
  - Go global (**LDAS-Monde**)

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Acknowledgements

The EUMETSAT Network of Satellite Application Facilities

H SAF
Support to Operational Hydrology and Water Management

Imagine

geoland2

opernicus
The European Earth Observation Programme

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Thank you for your attention !

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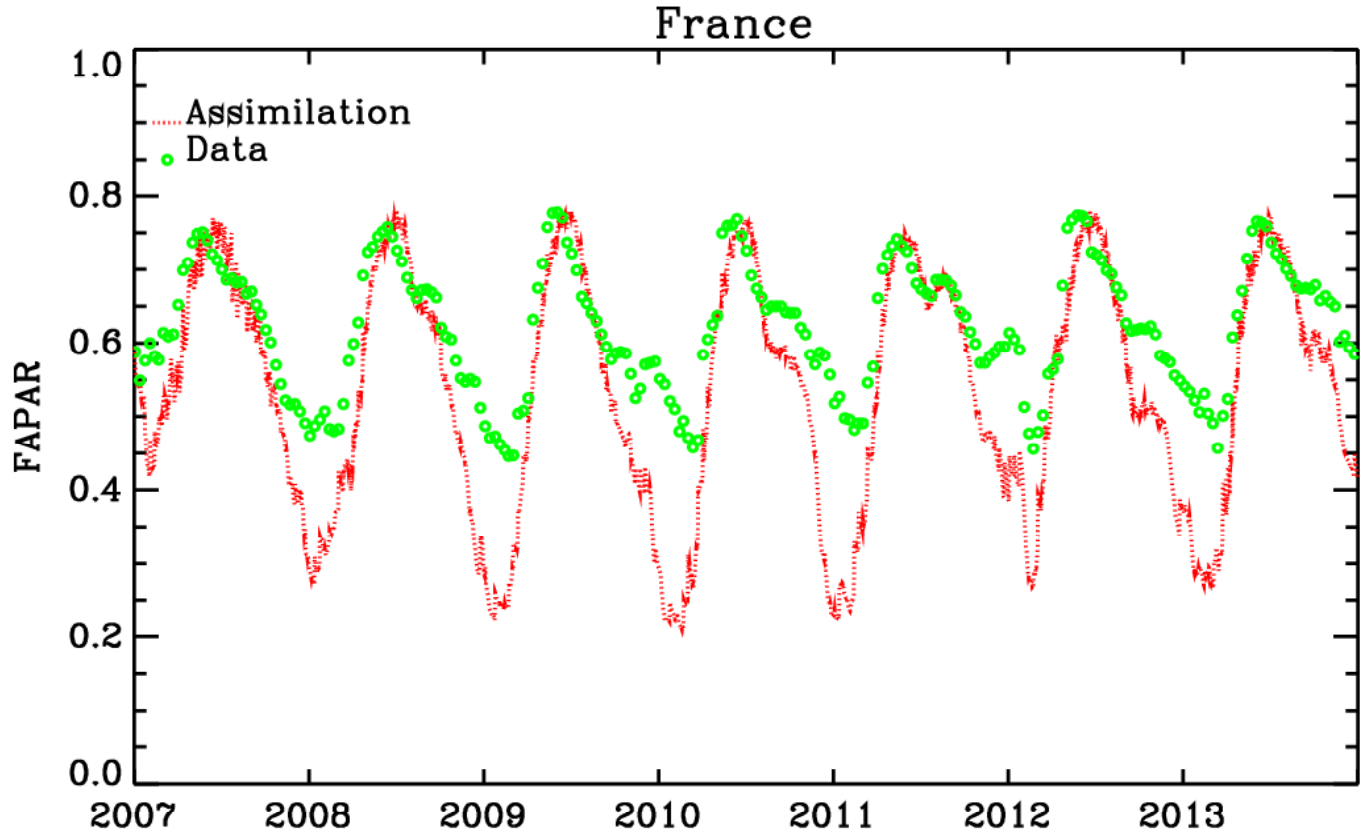
Side result: FAPAR

- **Underestimation at wintertime (in relation to grassland LAI ?)**



Side result: Surface Albedo

- **Simulations are driven by snow and LAI of crops**