Use of TIR-MSG data to validate land surface processes modelisation of the AMMA-Niger supersite

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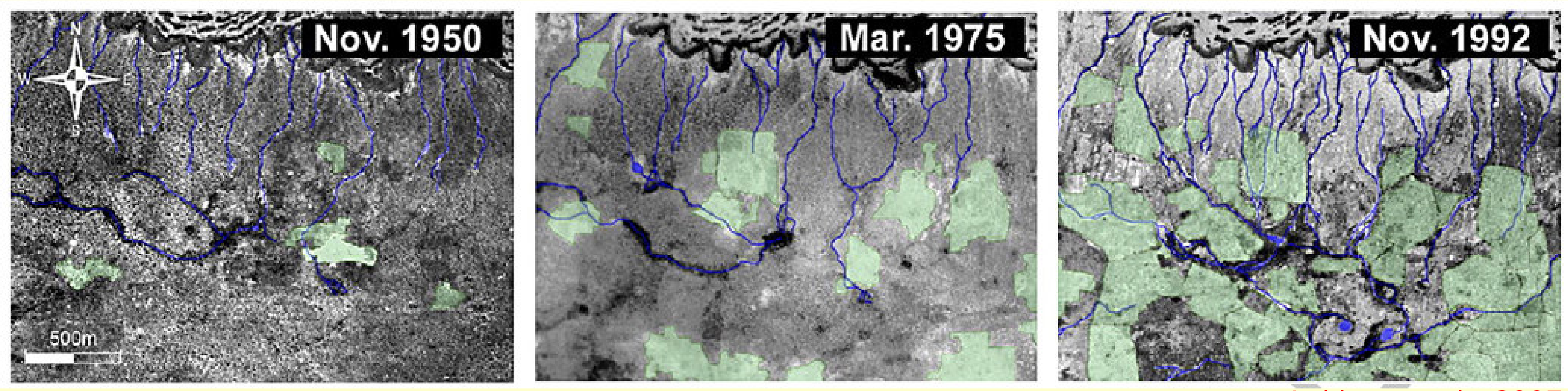
Context :

- Importance of land surface processes on surface hydrology
- Vegetation changes during the last 50 years
- Consequences on hydric and energetic budgets ?
- Predictions for near future ?



Leblanc et al., 2007

✓Increase of cultivated surfaces
✓Decrease of natural savannah
✓Increase of drainage network

• Need to develop models to understand land surface interactions and able to predict near future changes

•Need to validate these models with data representative of the modelling scale (RS)

Methodology :

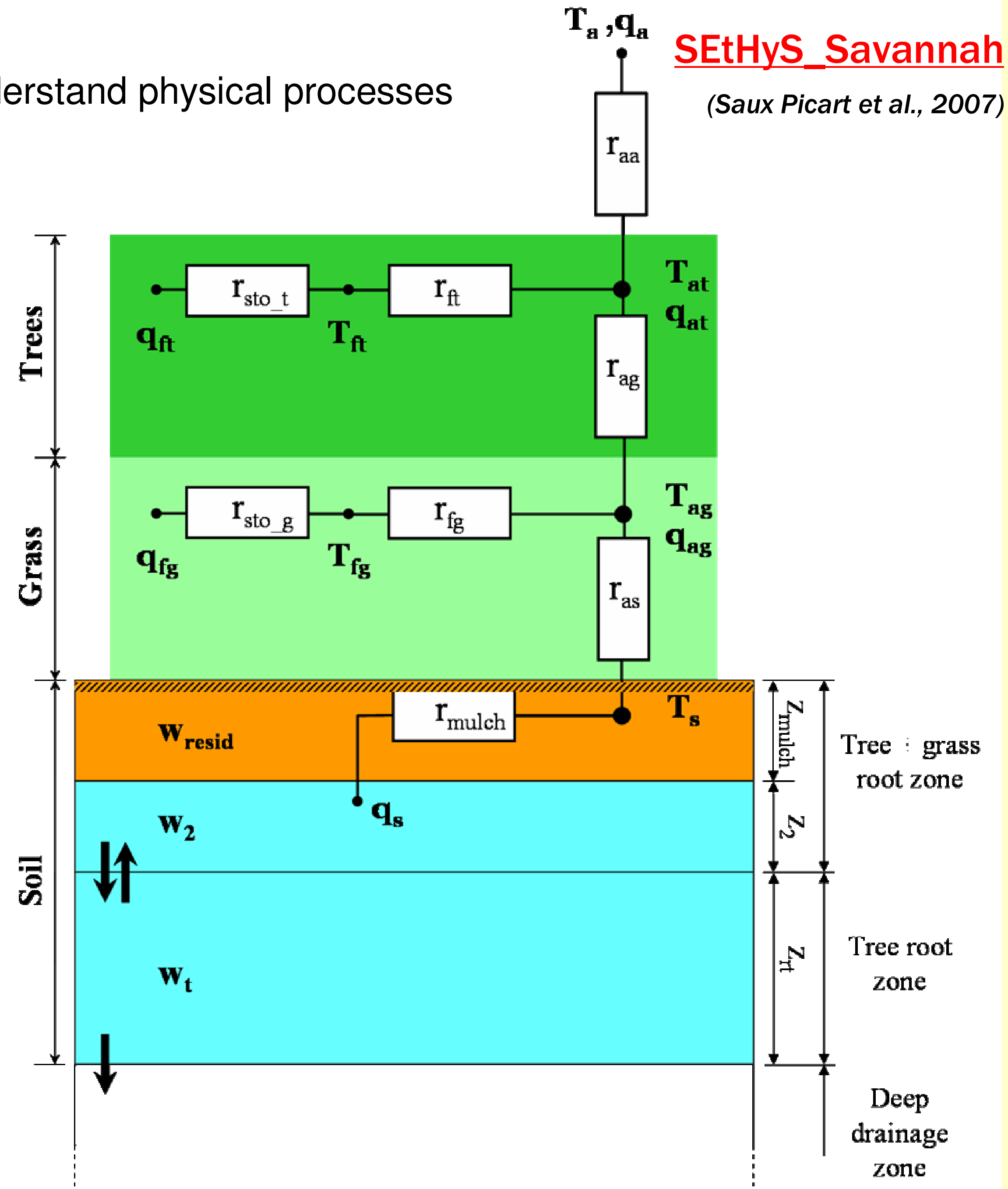
- Use of a land surface model to understand physical processes
- Validation at different scales
- Perform sensitivity studies

SEtHyS_Savannah

(Saux Picart et al., 2007)

- 3 sources : soil + 2 vegetation layers
- Dry mulch soil layer
- Horton infiltration excess runoff (Decharme and Douville, 2006)
- Saturation runoff

3 energy budgets
Radiative transfer models
Stomatal resistance (Ball, 1988 and Collatz, 92,93)
Soil resistance related to mulch thickness



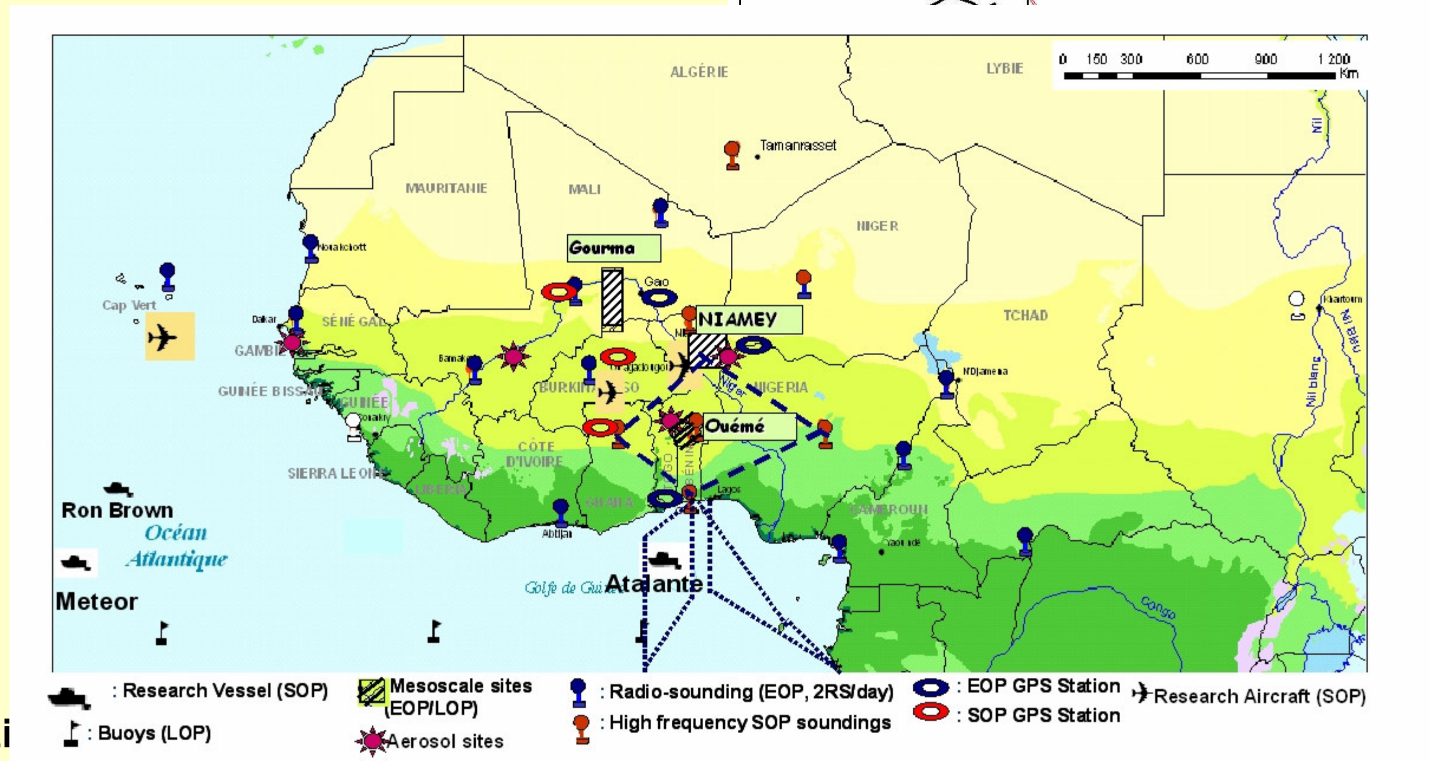
Input data :

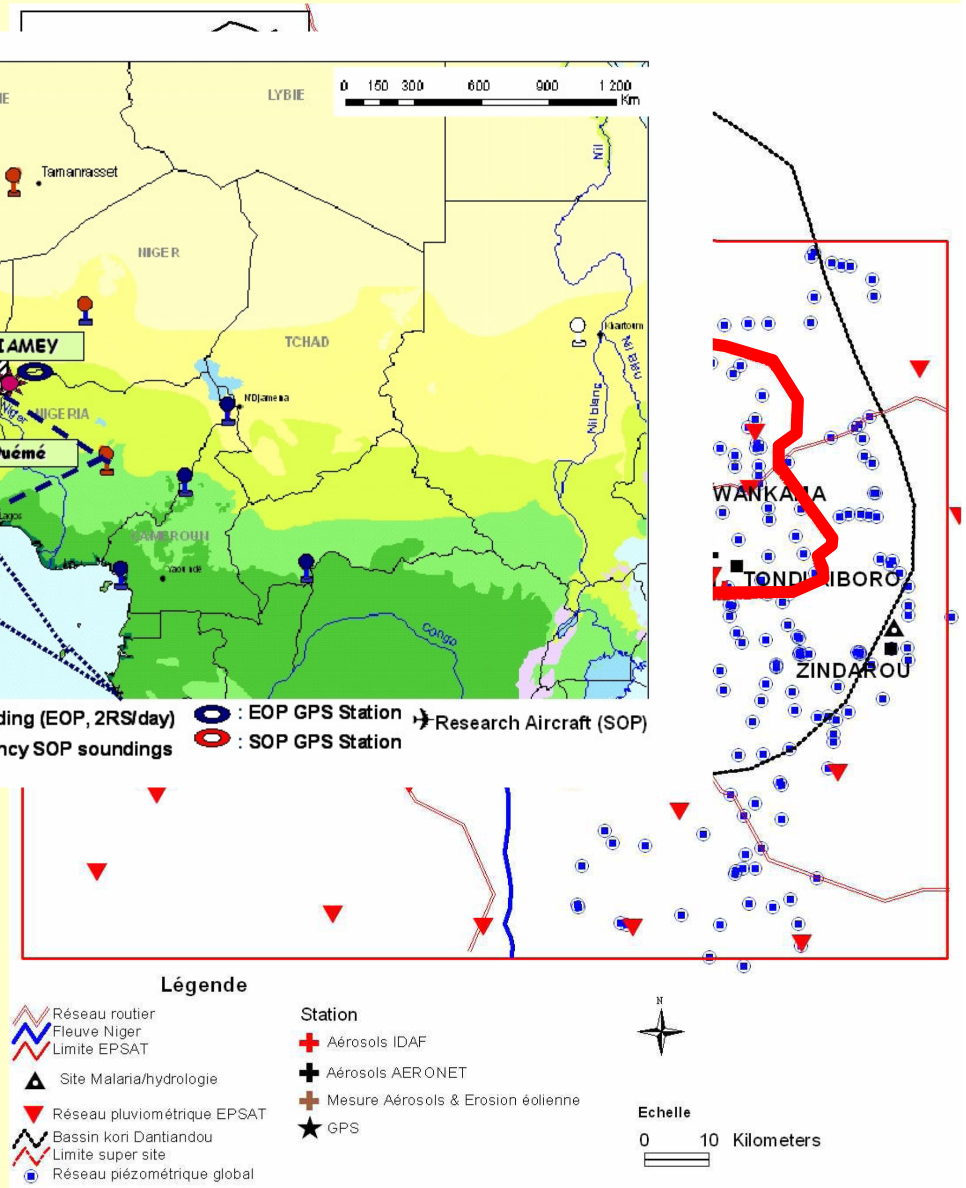
- Atmospheric forcing
- Vegetation and soil parameters (17)

Output data :

- Soil and vegetation temperatures
- Surface fluxes
- Soil moisture in 2 layers
- Surface reflectances and radiances

AMMA/Niger super site





Situati

Area : ~1700 km²

Data available :

2 flux stations (millet and fallow)

Precipitation network

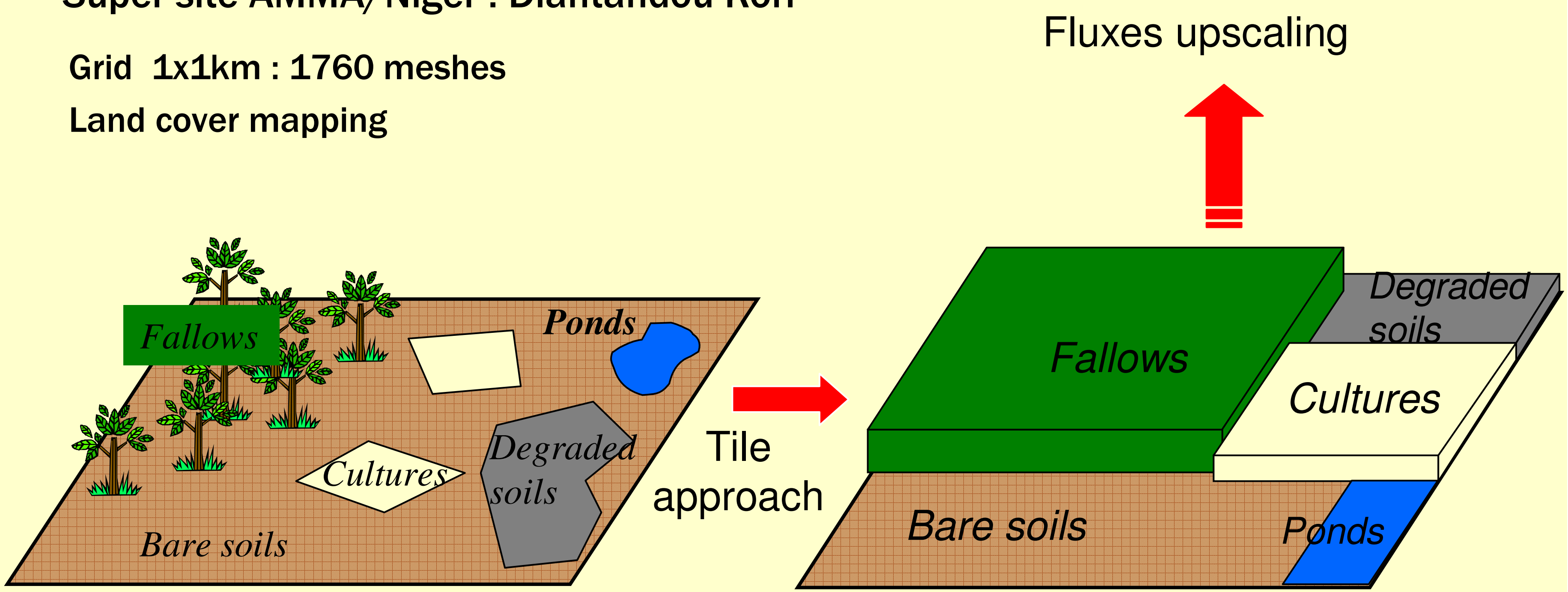
Satellite data

Model spatialisation

Super-site AMMA/Niger : Diantandou Kori

Grid 1x1km : 1760 meshes

Land cover mapping



Atmospheric forcing : flux station , homogeneous over the Kori

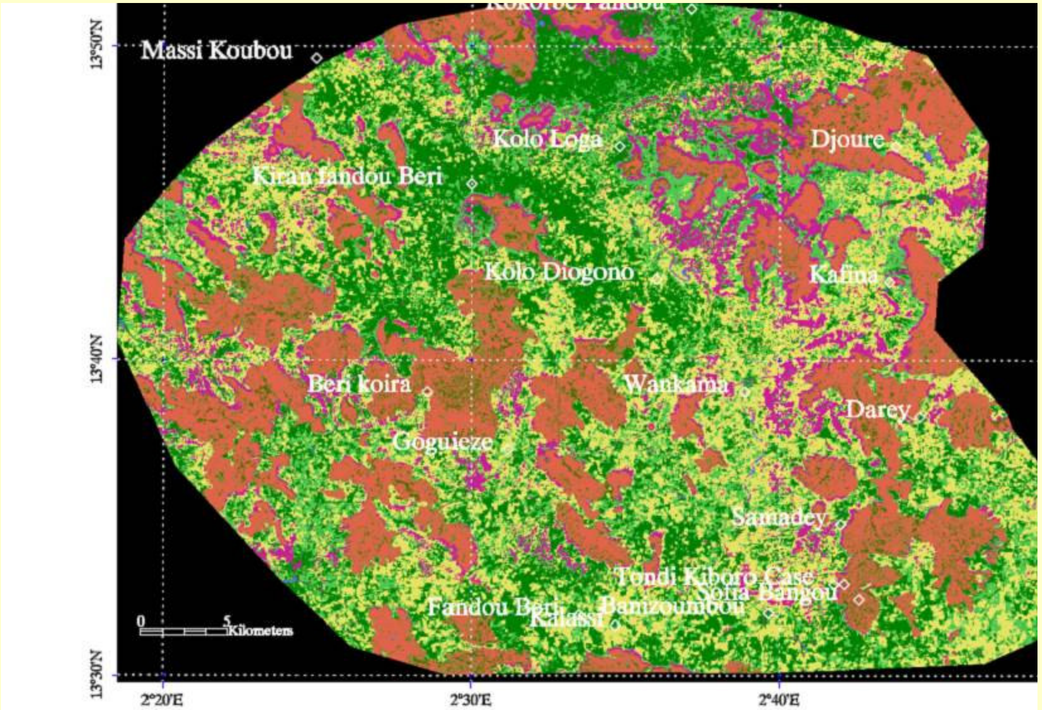
Rainfall : EPSAT network (~20 on the super site)

→ nearest neighbourhood interpolation (Thiessen)

Parameters : 2 varying according to land cover (soil albedo (larger values in valleys //MODIS), saturation hydraulic conductivity (lower values on degraded slopes //ground truth measurements)

Validation : local : fluxes stations (millet and fallow)

regional : surface temperature (MSG) , surface soil moisture (ENVISAT/ASAR)

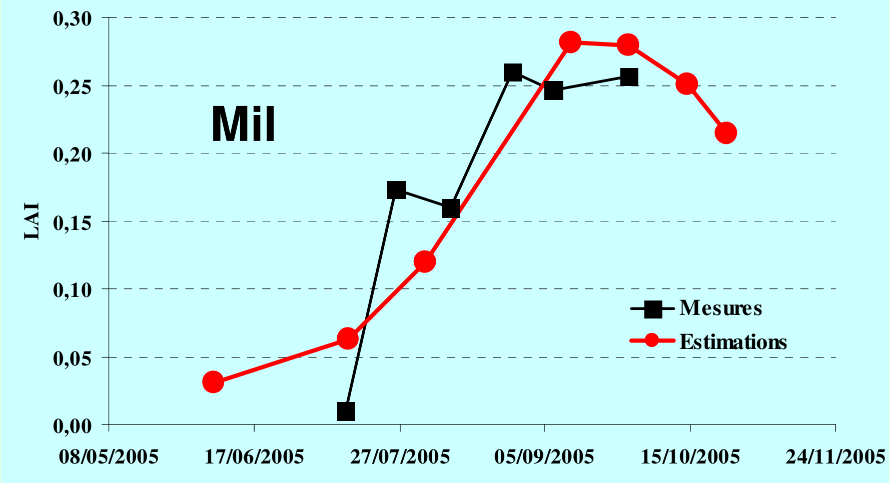


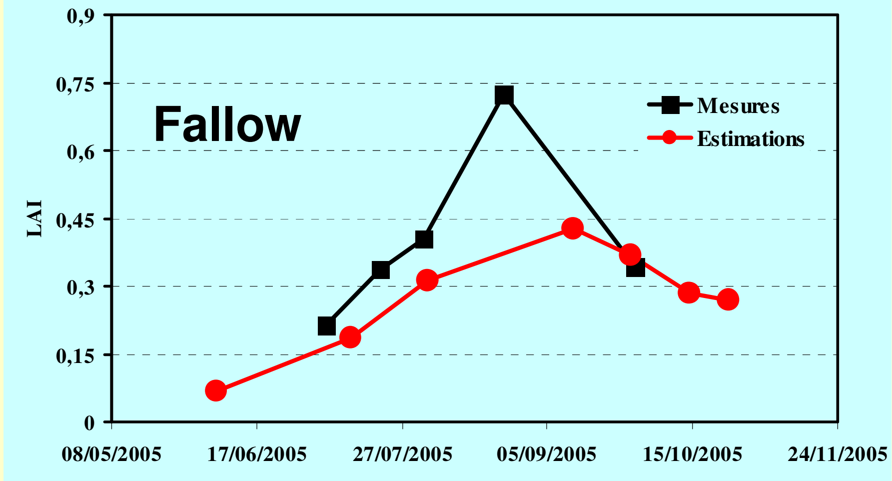
Diantandou Kori

SPOT image at 20m in 2005

- Unclassified
- Plateau, bare soil
- Plateau, clear vegetation
- Plateau, dense vegetation
- Degraded hill slope
- Millet or Crops
- Young fallows
- Old fallows
- Water bodies

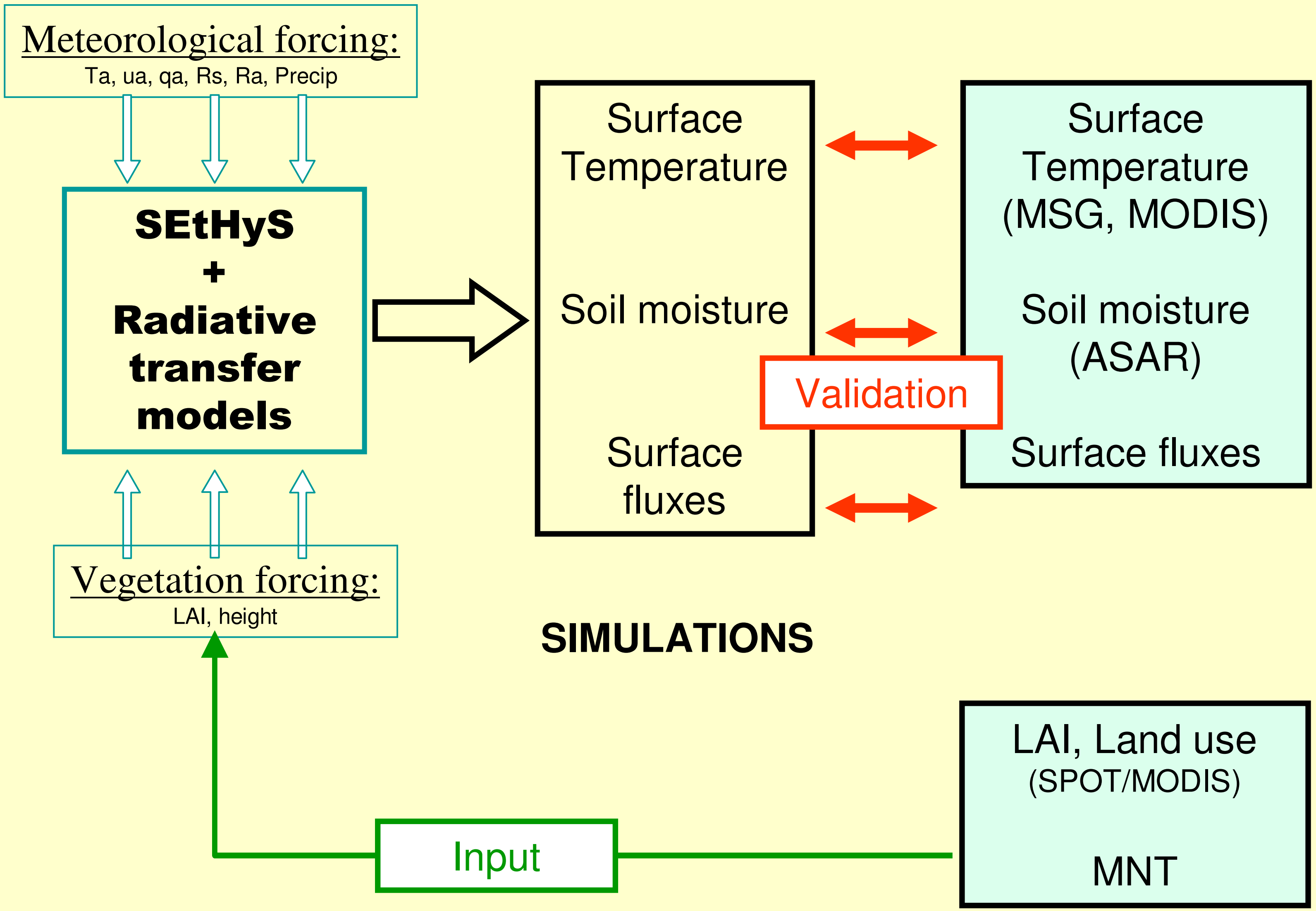
Estimated LAI from 7 SPOT images (Neural network; Baret et al., 2007)





Larger values on fallows than on cultures (different from HAPEX-Sahel)

Validation at regional scale



TIR satellite data used

SEVIRI/MSG : LAND SAF LST product

Spatial resolution : 3x3 km at nadir

Temporal resolution : 1 image/15 minutes

Period : 13 july 2005 to 31 december 2005

from http://postel.mediasfrance.org

MODIS/Aqua et Terra : NASA LST product

Spatial resolution : 1x1 km

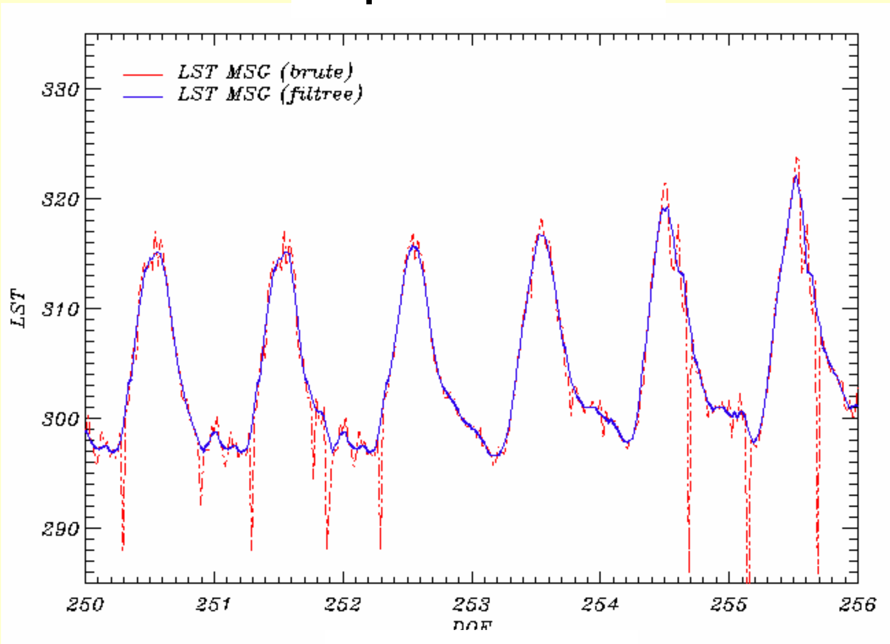
Temporal resolution : 4 images/day (~1h, 10h, 13h et 22h)

from http://edcimswww.cr.usgs.gov

First steps : evaluate the uncertainties on the satellite products intercomparison

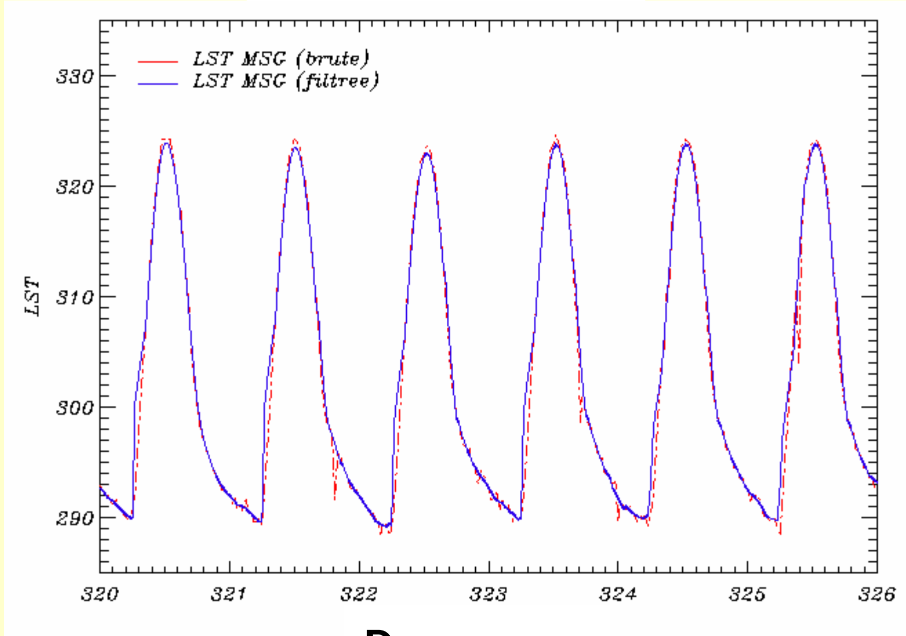
Clouds filtering

September 7-13



Rainy season

November 16-22



Dry season

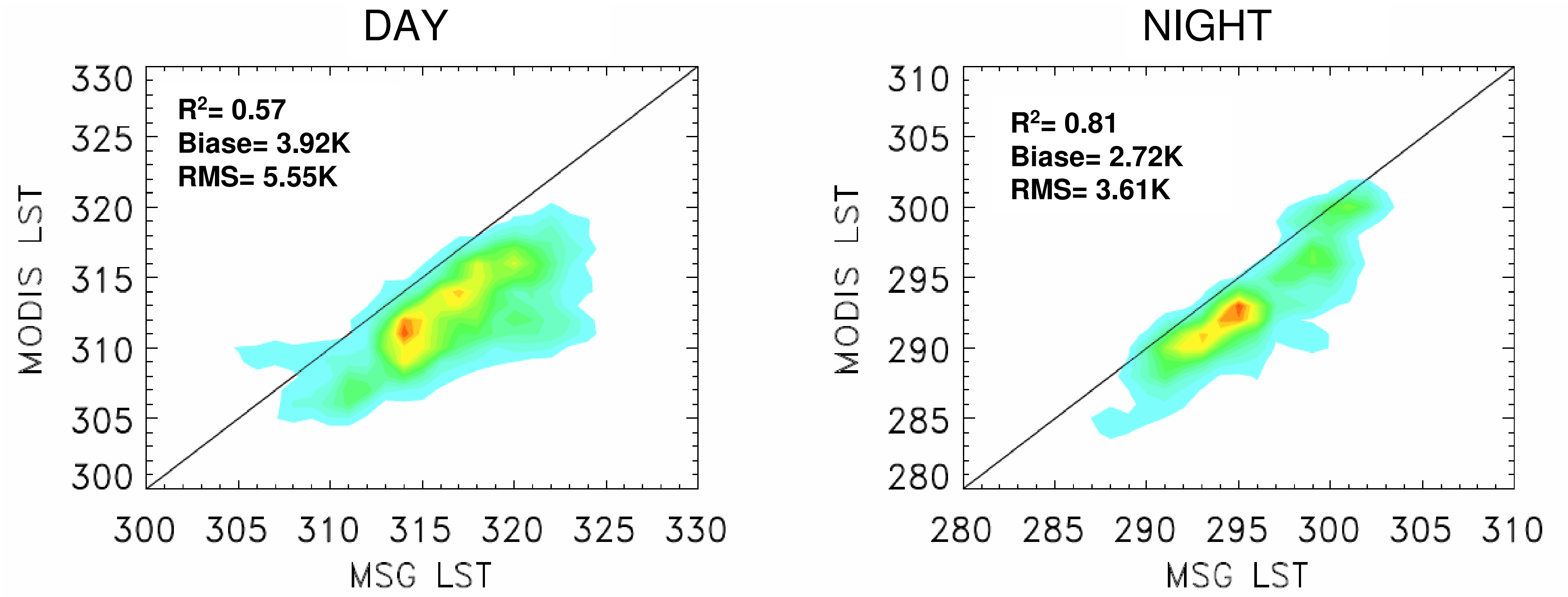
Cloudy pixels remains on MSG dataset :

Application of a cloud filter in two steps :

- Elimination of suspect data with a threshold test using a prior smoothing filter (based on wavelet transform)
- Filling the gaps with another smoothing interpolation

LST products intercomparison

Comparison at MSG pixel scale over the AMMA-Niger supersite



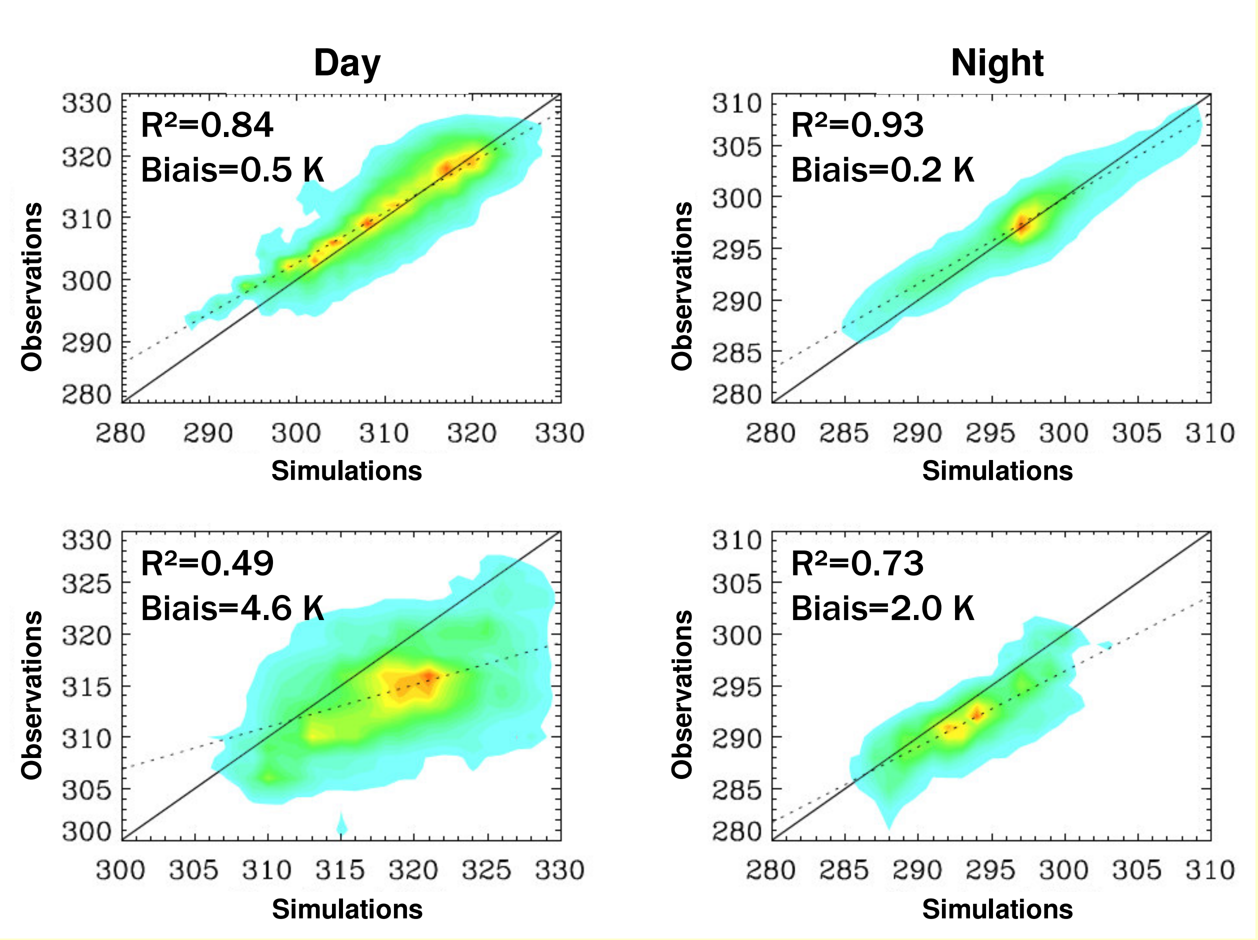
LST-MSG product presents larger values, lower biases and RMSE at night :

Reasons of these discrepancies :

- **different emissivity maps**
- **MODIS cloud masking problems ?**
- **instrument calibration ?**
- **viewing angles effects (15° for MSG, up to 65° for MODIS) ?**

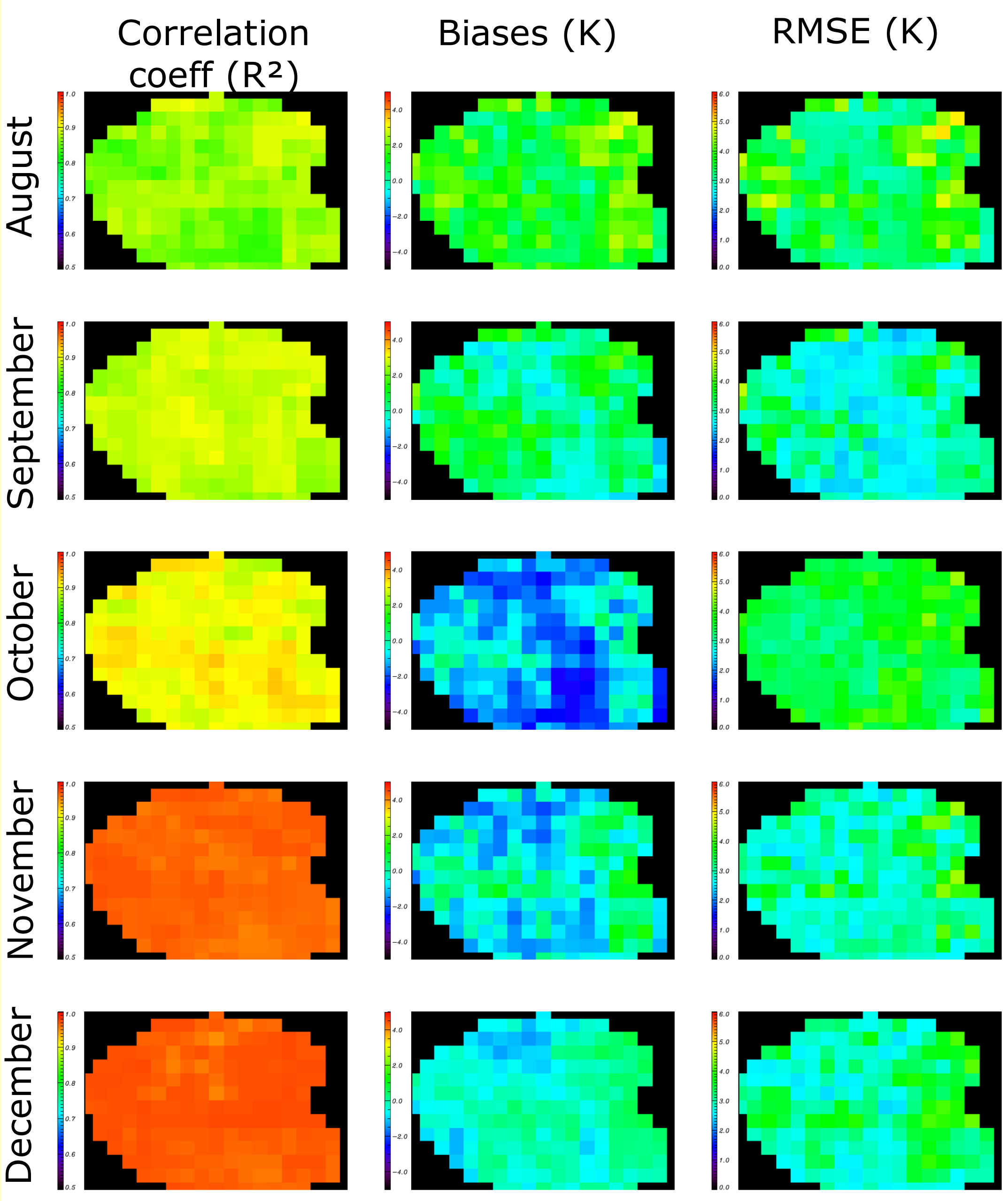
Model validation

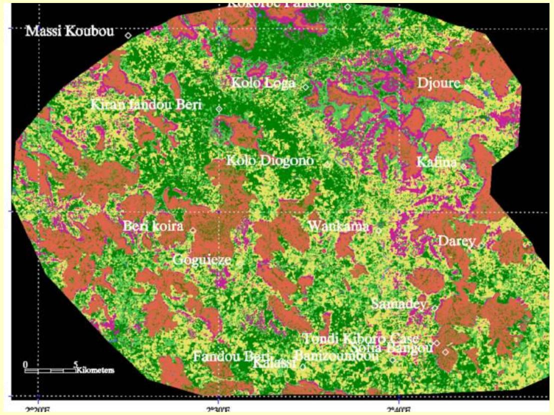
Comparison of LST simulated/ MSG LST product



Good correlation and lower biases with MSG products compared to MODIS

Spatial and temporal validation of surface temperatures





Good agreement with MSG LST (R^2 varies from 0.7 to 0.85)

Larger correlation during dry season (pb of residual clouds in wet season)

Larger biases over plateaus (less than 2K, due to non representativity of atmospheric forcing)

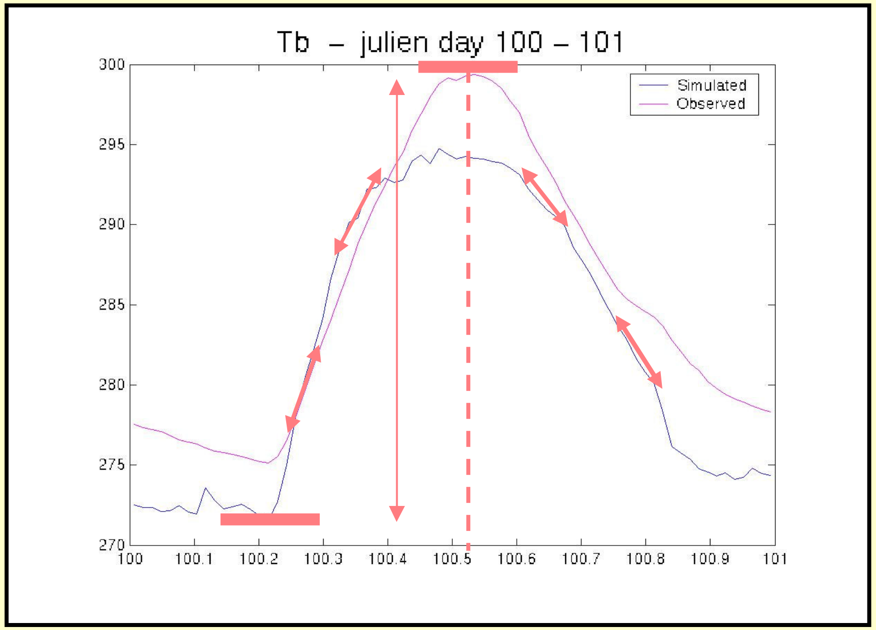
RMSE can reach 5K locally, larger values over plateaus,

LST products permitted to diagnose parameterizations or input data problems.

Further steps : model calibration/assimilation

- Two approaches :
  - Downscaling MSG data to endmember scale and calibration using sub-pixels temperature (Kallel et al., 2008)
    - Inversion of subgrid temperatures using the assumption of the linear mixing model, with constraints (a priori temperature provided by the SVAT model + spatial and temporal hypothesis)
  - Calibration of model sub-grid parameters with upscaled variables (Coudert et al., 2008 + poster)
    - Optimization of diurnal cycle surface temperature features (temporal gradients, amplitude, phase…) ,

→ limit the impact of model and observation biases



Conclusions

- Contribution of TIR data for LSM validation and calibration
- High temporal resolution provide new measurements interesting for model calibration/assimilation
- Work is needed for developing methods to downscale TIR data for regional studies and/or assimilate in LSM
- Need to evaluate products uncertainties to assess observations errors

Thanks for your attention !