CONTRIBUTION OF METOP ASCAT DATA FOR LAND SURFACE PARAMETERS MONITORING OVER THE SAHEL

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AMMA - African Monsoon Multidisciplinary Analyses
GOALS

- Surface processes modeling
- Better understanding of the West African Monsoon and its interactions with global environment
- Impact of climatic variability on surface processes
- Role of continental surfaces on climate
- Radar sensors to assess:
  - Vegetation biomass
  - Net Primary Productivity (NPP) ➔ Carbon budget
- Soil moisture in relation with:
  - evaporative fluxes
  - moisture deeper layer
- To assess the seasonal and inter-annual variations of these 2 key surface parameters over the Sahel from spaceborne radars sensors: scatterometers.
The SAHEL

Alternation of a long dry season (October - June) and a short rainy season (June – September)

Vegetation closely linked to the rainfall regime
Sahelian Pastoral Area

herbaceous steppe (annual grass):
• herbaceous layer (0-50%)
• shrub layer (0-20%)
• trees (1-5%)
Strong interannual variability

1984 1985 1986
1987 1988 1989
1990 1991 1999
Radar signal temporal evolution over a Sahelian region
(ERS scatterometer – Rharous site)

- Signal stability during the ERS mission
- Annual cycle linked to the alternation rainy/dry season
- Inter-annual variability

Incidence angle: 45°
Study area: GOURMA (MALI)

Pastoral areas

- Rharous
- Gossi
- Hombori
- Seno
ERS scatterometer
Temporal evolution of $\sigma^0(45^\circ)$ : 4 sites

- Signal inter-annual variability ➔ southward
- Signal level during dry season ➝ southward
Modeling study

Calibration with *in situ* biomass measurements

- Sahelian vegetation growth model (STEP)
- Daily meteorological data
- Soil parameters

Daily surface parameters:
- Biomass
- Soil moisture

Radiative Transfer model (Karam, 1992)
- Soil roughness
- Vegetation parameters

Simulated backscattering coefficient $\sigma^0(t)$

- Daily surface parameters:
  - Biomass
  - Soil moisture

- Soil roughness
- Vegetation parameters

- Daily meteorological data
- Soil parameters
Simulation and ERS scatterometer observations

Rharous (16.5°N)

Gossi (16.0°N)

Hombori (15.3°N)

Seno (14.6°N)

Overall good concordance

Incidence angle: 45°
**SURFACE PARAMETER ESTIMATION**

- **METEOSAT**
  - Rainfall estimation

- **Sahelian vegetation growth model (STEP)**

- **Daily surface parameters:**
  - Biomass
  - Soil moisture

- **Radiative Transfer model (Karam, 1992)**

- **σ^0(t) simulations**

- **OPTIMISATION**

- **Observations:** Satellite measurements (σ^0)
Inversion method: Biomass production map at a regional scale

Biomass production map: 2000

rainfall estimation: METEOSAT

Biomass + soil moisture: ERS WSC + METEOSAT

Validated over 4 pastoral sites (Gourma and Seno regions)

Absolute errors:
~ 200 kg Dry Matter (DM) / ha

Relative error: 17 %
Spatialisation to the Sahel

Maximum herbaceous mass, year 1999 (0 – 3.5 t DM/ha)

- Overall good agreement between both sensors
- Detection of low biomass values
- Wrong values over swampy areas
Spatialisation to the Sahel - Validation sites

**Agro-Pastoral Area:**
Fakara (NIGER)

**Pastoral Areas:**
Ferlo (SENEGAL)  Gourma (MALI)

⇒ In situ measurement (rainfall, biomass) available
TEMPORAL EVOLUTION of ERS SCATTEROMETER RESPONSE
(Sahelian sites)

Gourma Rharous (Mali)

Ferlo (Senegal)
COMPARISON BETWEEN ERS SCATTEROMETER RESPONSE AND SIMULATIONS

FERLO (SENEGAL)

Good overall concordance

⇒ Reliability of spatialisation of surface parameters estimation over the Sahel
QUIKSCAT (Ku band) TEMPORAL SIGNATURES

- Atmospheric perturbation hampering interpretation

+ : $\sigma^0$ measured (L2A)
* : $\sigma^0$ atmospheric attenuation corrected (L2A)
X : BYU products
(Brigham Young University)
Long time series provided with METOP - ASCAT measurements

FERLO (SENEGAL)

*: ERS scatterometer
*: METOP - ASCAT
Long time series provided with ASCAT mission

FERLO (SENEGAL)

ASCAT acquisition: Higher temporal frequency

*: ERS scatterometer  
*: METOP - ASCAT
ASCAT DATA - Comparison between 25 km and 50 km spatial resolution products

FERLO (SENEGAL)

\[ \Delta \sigma^0 < 0.2 \text{ dB} \]

⇒ 25 km products for land surfaces monitoring
CONCLUSIONS

- The method is relevant for a spatialisation over the whole Sahel
- The method requires Meteosat data and ASCAT data for the surfaces
- C band leads to better results than Ku band
- ASCAT data warranty the follow on of ERS data
- ASCAT data dispersion is lower
- ASCAT data with a better temporal resolution
- 25 km products are relevant