

What is the influence of surface properties on wind erosion in semi-arid regions?

A modelling case study during AMMA

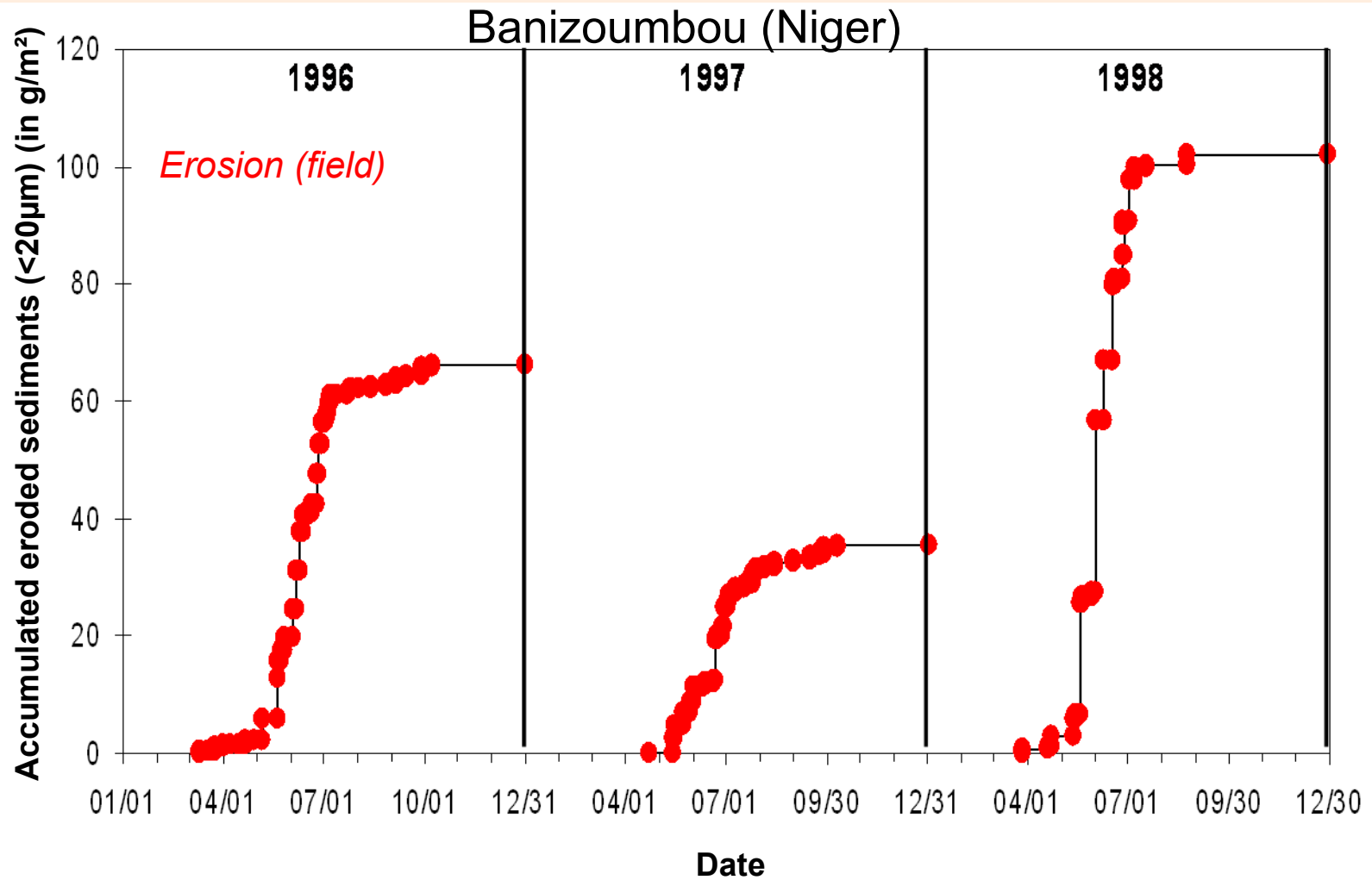
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2-6 July 2012

Outline

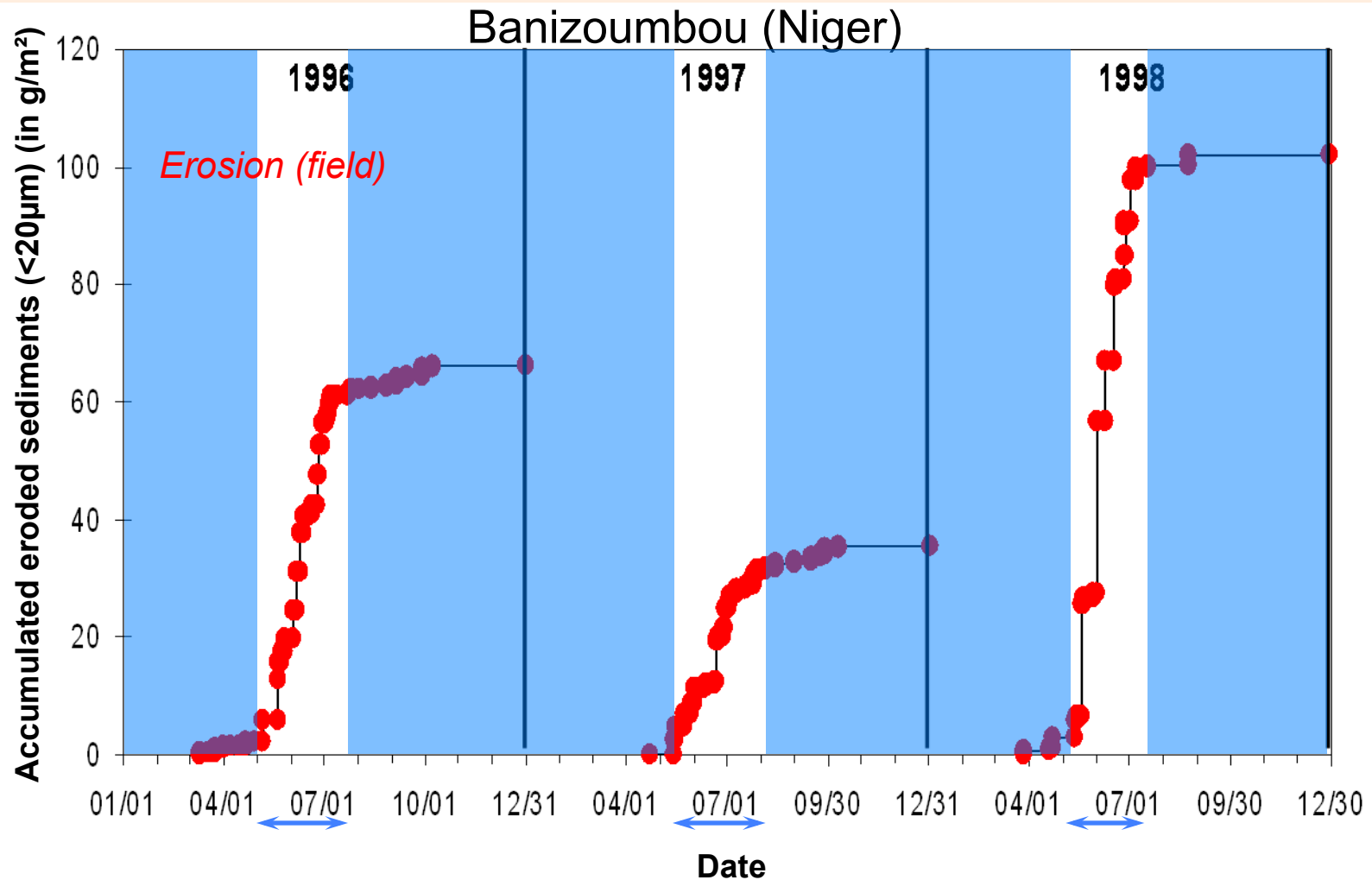
- Scientific context
- Problem
- Description of the numerical experiment
 - Numerical tool
 - Sensitivity tests
- Results
- Conclusions

Scientific context



Rajot (2001)

Scientific context

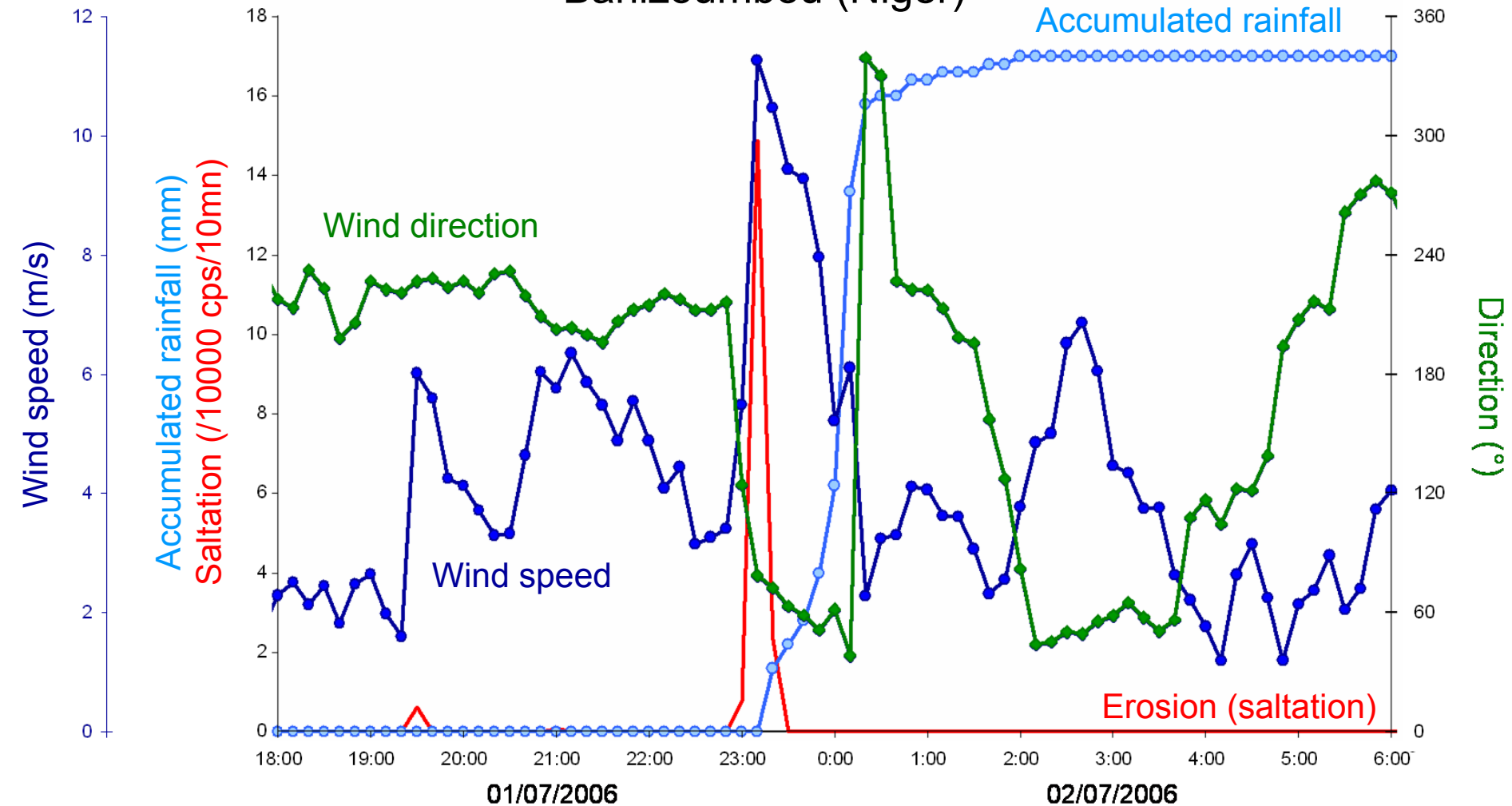


Rajot (2001)

Wind erosion systematically occurs at the beginning of the rainy season

Scientific context

Banizoumbou (Niger)



Wind erosion in the Sahel is associated to Mesoscale Convective Systems (MCS)

Problem



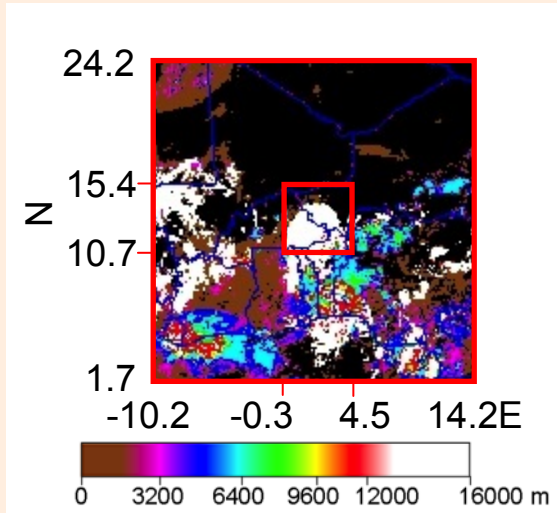
High surface wind speed
= dust emission

Rainfall = dust washout

=> What is the impact of these systems on the mass balance of dust emitted in this area?

Numerical experiment

1. Simulated domain



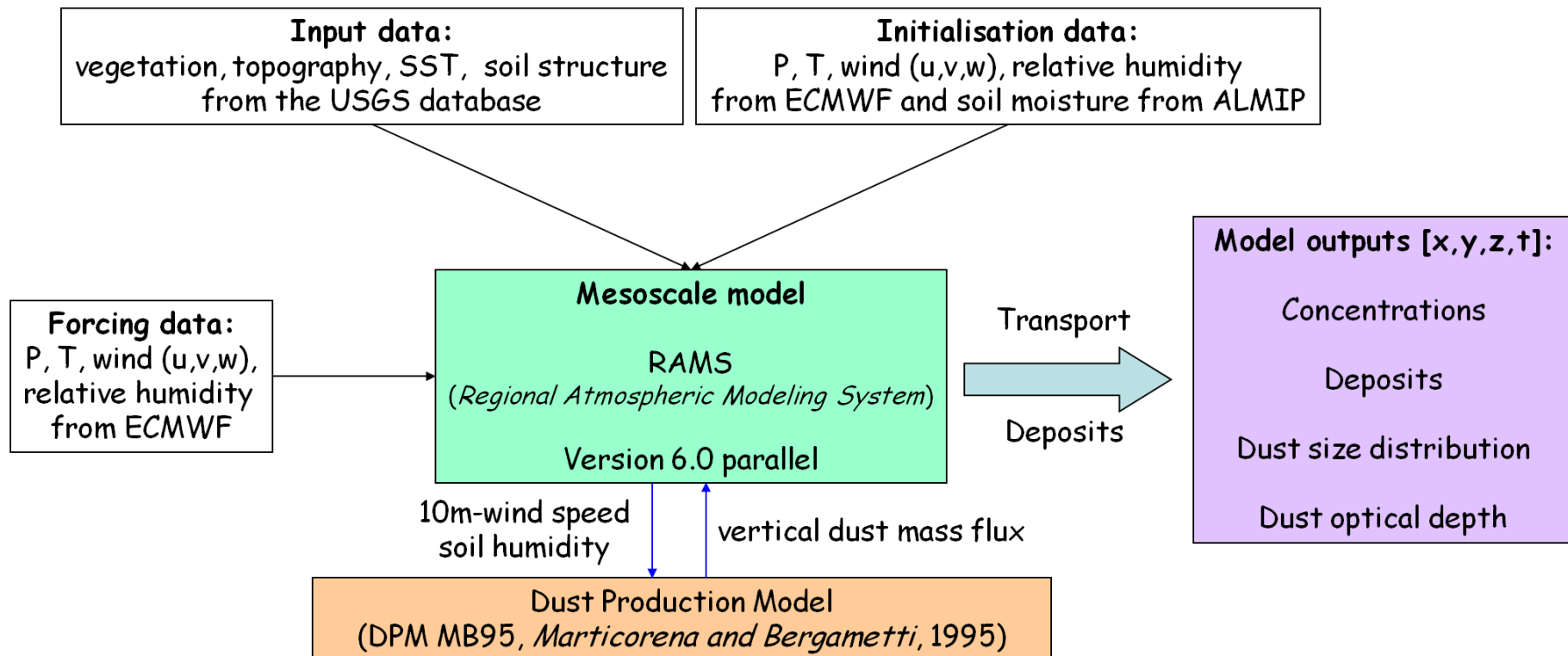
- 2 nested grids in 2-way nesting centred on Niamey (13°N; 2°E)
- Grid 1 features:
 - $n_x = n_y = 101$; $\Delta x = \Delta y = 25$ km
- Grid 2 features:
 - $n_x = n_y = 102$; $\Delta x = \Delta y = 5$ km
- For the 2 grids: $n_z = 50$ levels from the ground to 22 km agl, with 20 levels in the planetary boundary layer

2. Simulated period

The simulated period begins on 29 June 2006 on 00UTC, lasts 6 days and ends on 5 July 2006 on 00UTC

Numerical tool

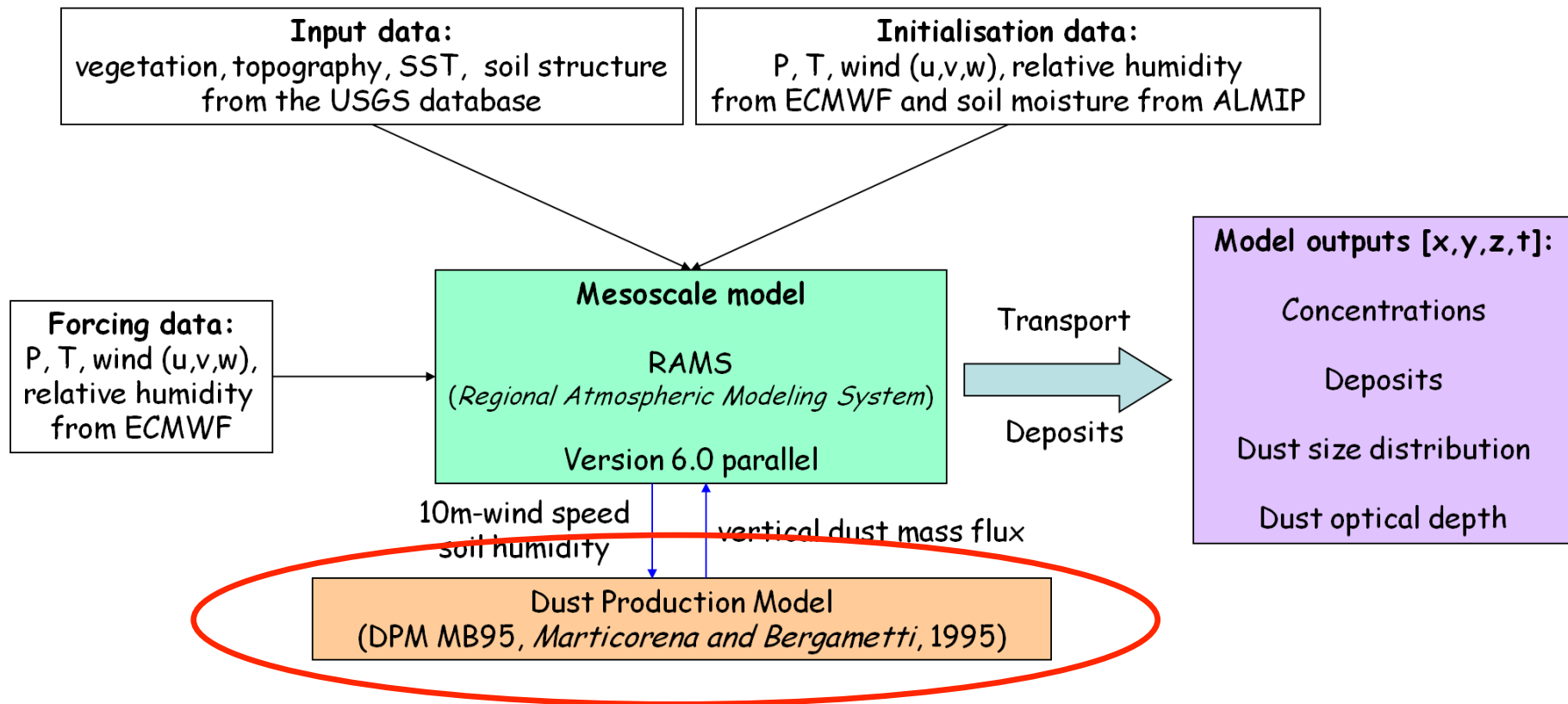
Regional Atmospheric Modeling System (**RAMS**, *Cotton et al. [2003]*) coupled online with the Dust Production Model (**DPM**, *Marticorena and Bergametti [1995]*, *Laurent et al. [2008]*)



Remark: no initialisation of the dust concentration field

Numerical tool

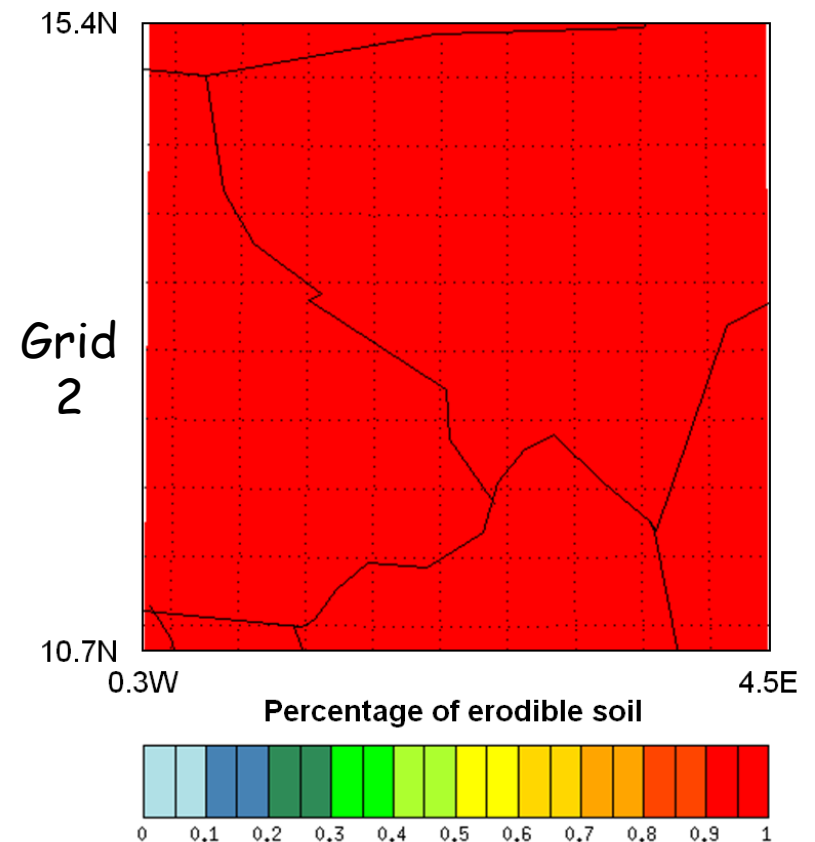
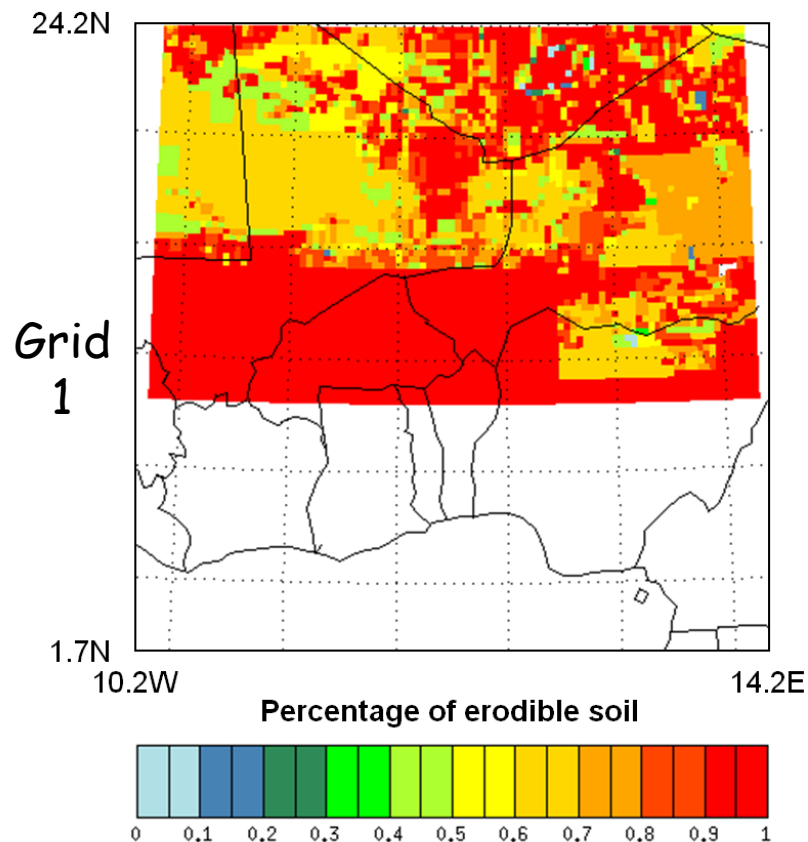
Regional Atmospheric Modeling System (**RAMS**, *Cotton et al. [2003]*) coupled online with the Dust Production Model (**DPM**, *Marticorena and Bergametti [1995]*, *Laurent et al. [2008]*)



PROBLEM: no data on the surface properties below 16°N

Sensitivity tests

Case n° 1: the whole Sahel is erodible

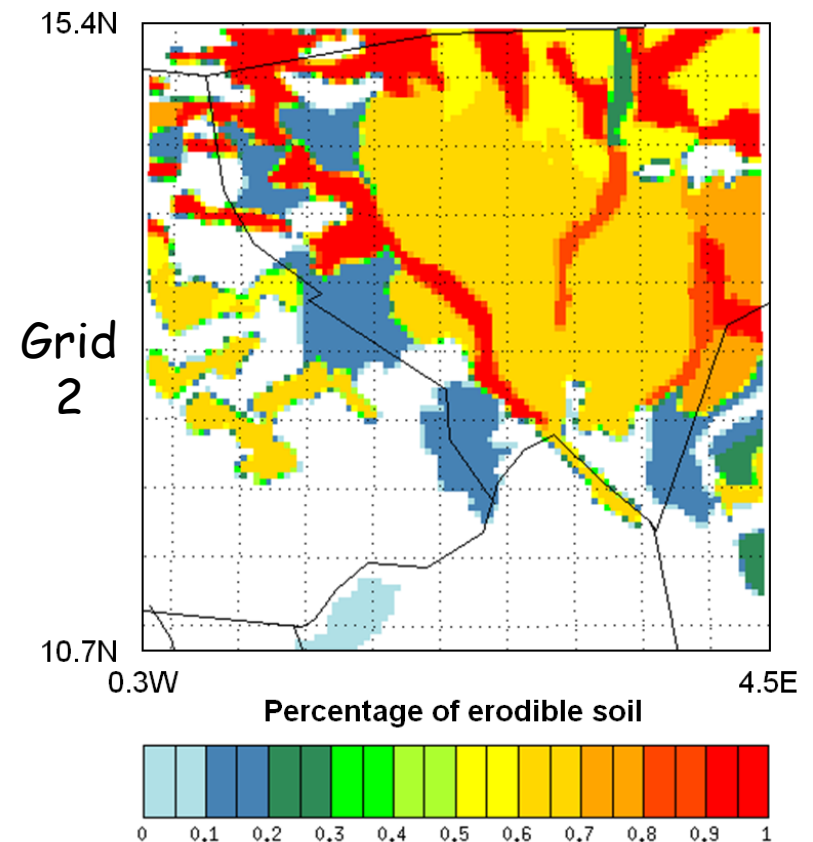
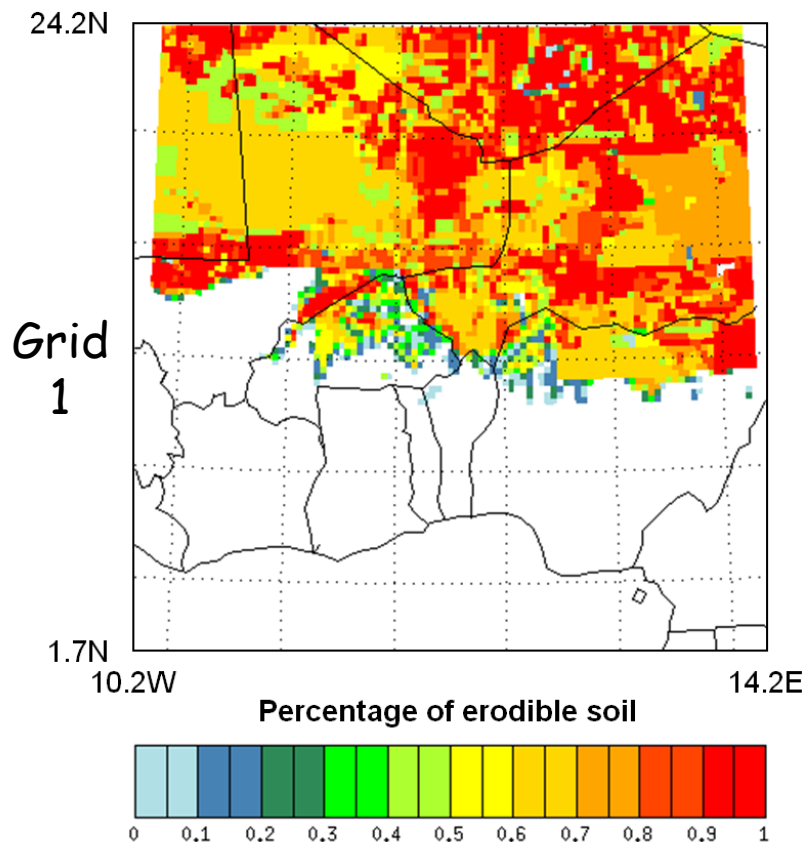


Sensitivity tests

Case n° 2: only sandy soils in the Sahel are erodible



Use of the **Harmonized World Soil Database (HWSD)**

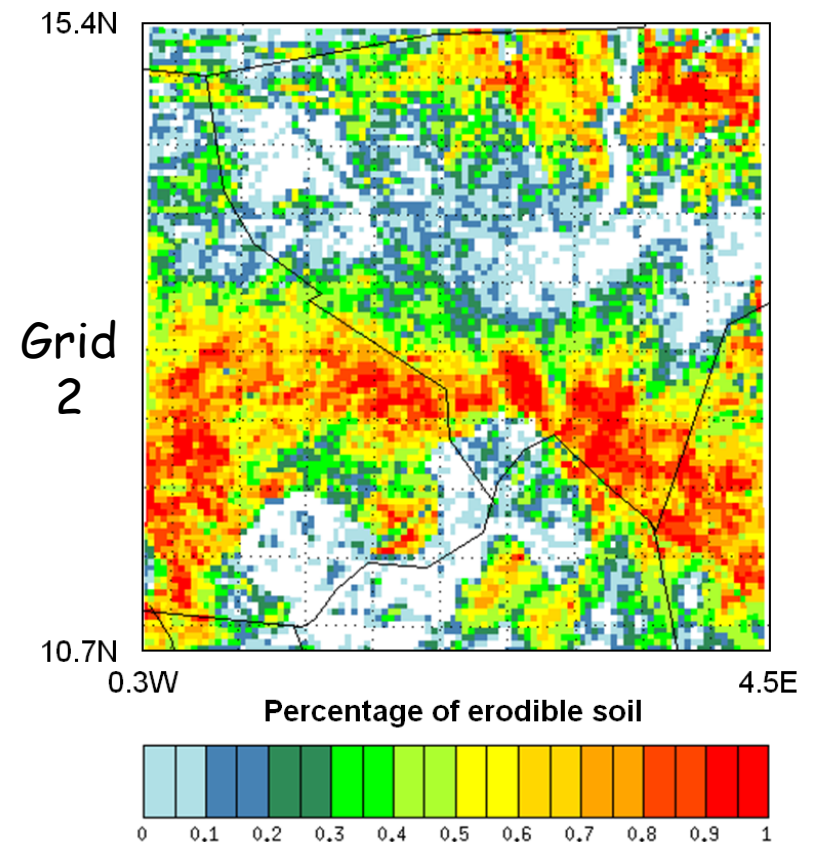
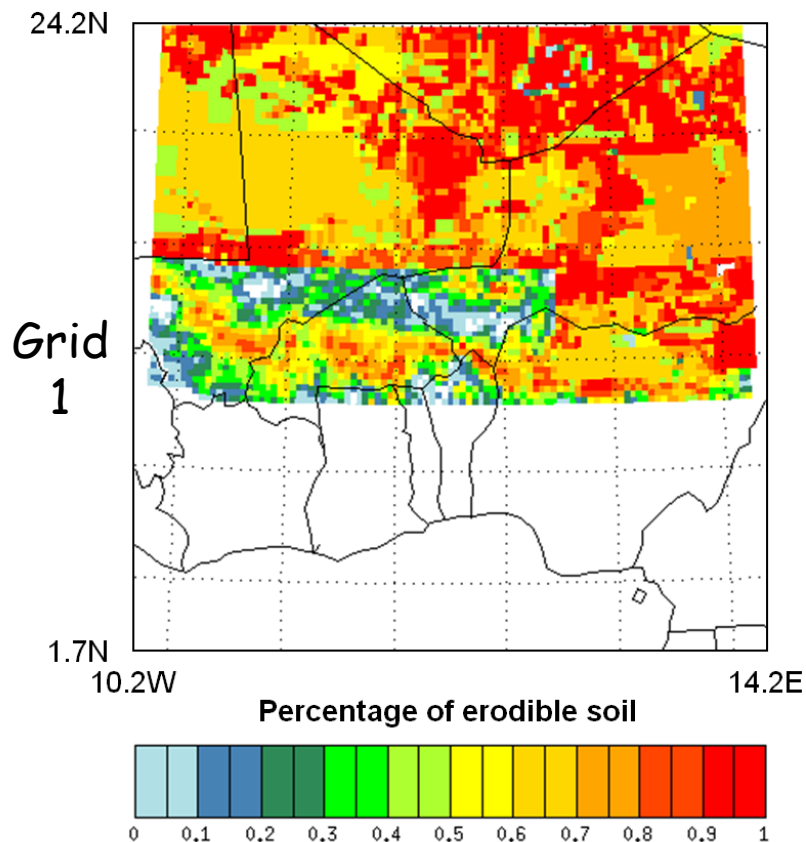


Sensitivity tests

Case n° 3: only bare surfaces (natural and agricultural)
in the Sahel are erodible



Use of the **Globcover** database

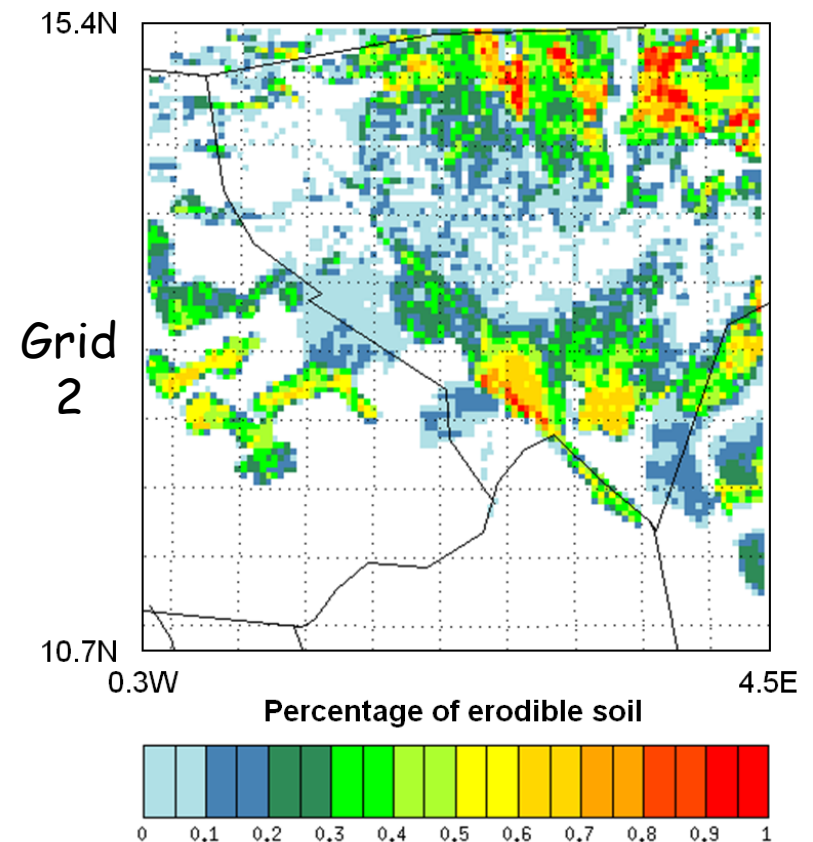
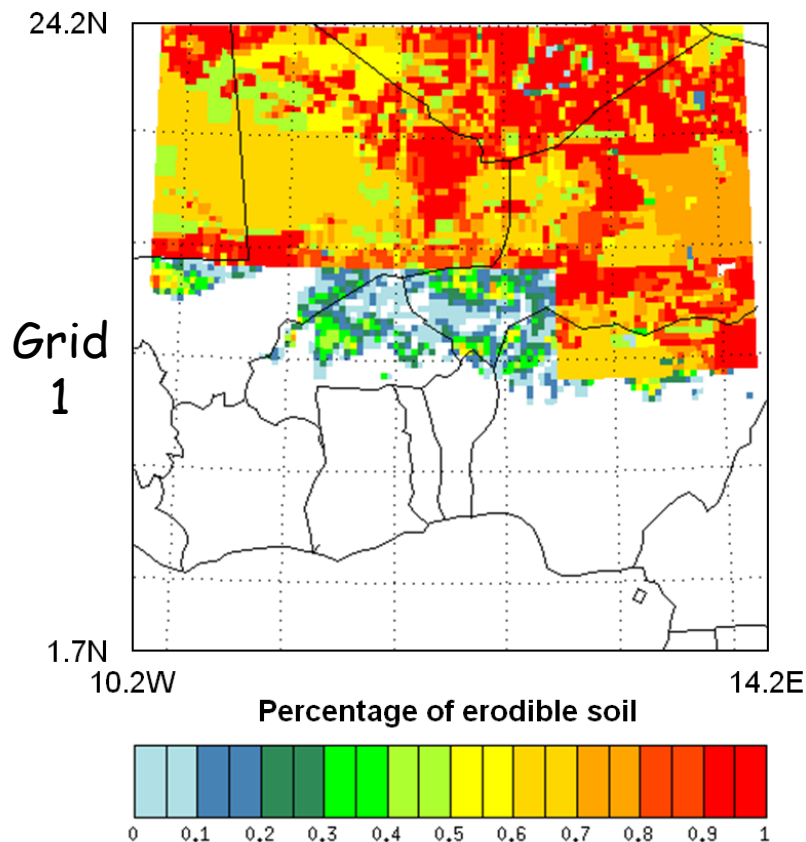


Sensitivity tests

Case n° 4: only sandy bare surfaces (natural and agricultural) in the Sahel are erodible

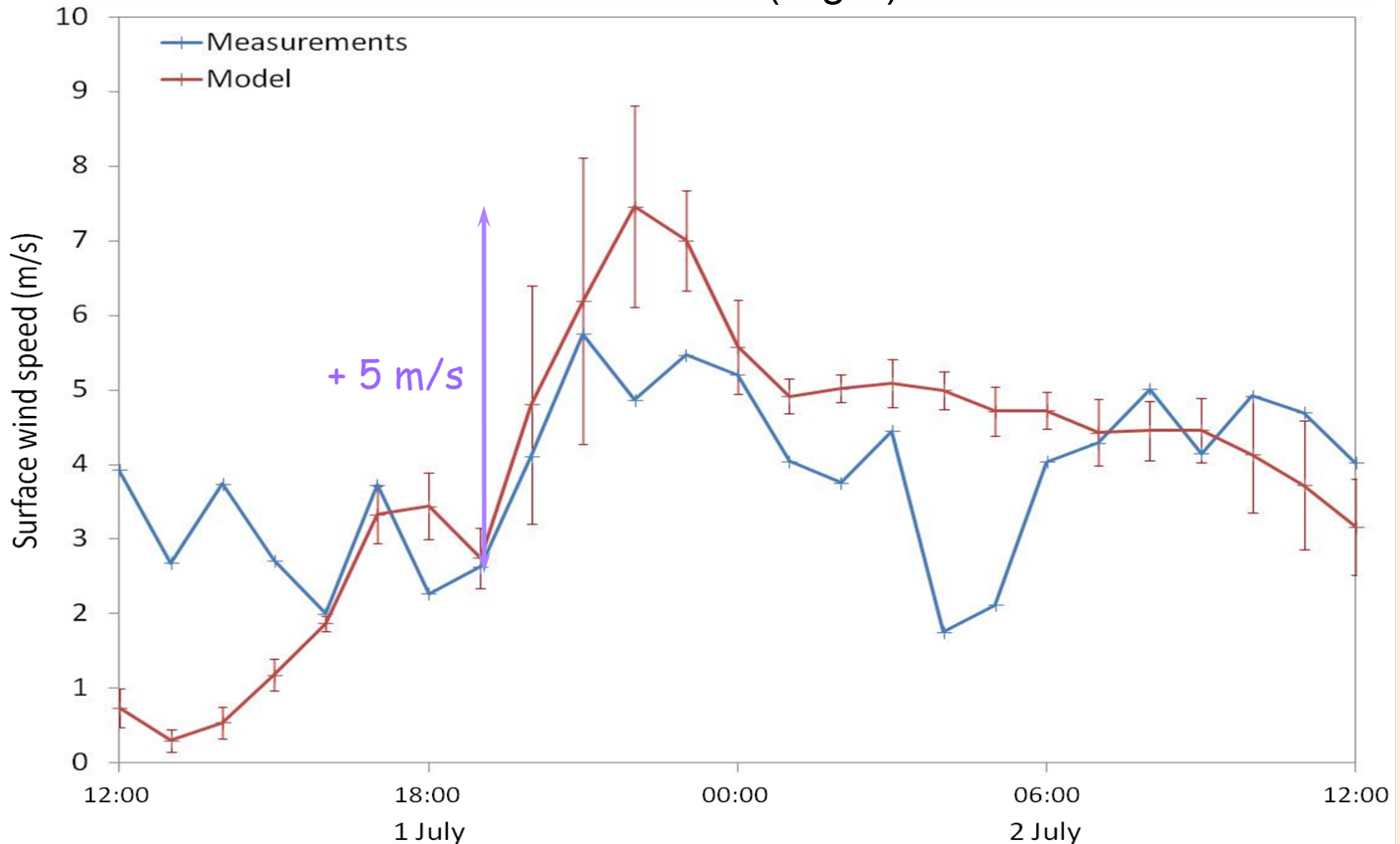


Use of the HWSD + Globcover databases



Results: meteo validation

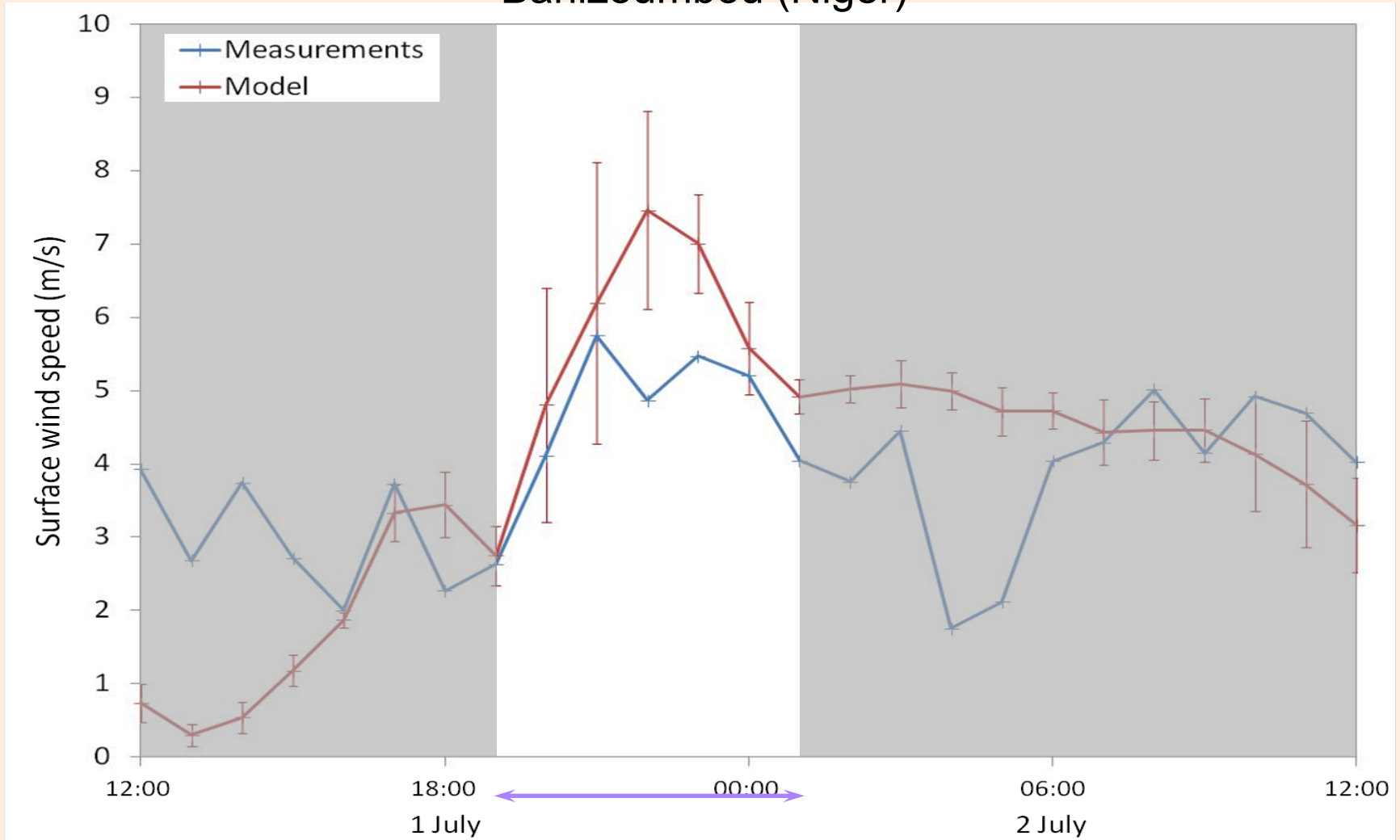
Banizoumbou (Niger)



The intensity of the event is fairly well reproduced

Results: meteo validation

Banizoumbou (Niger)

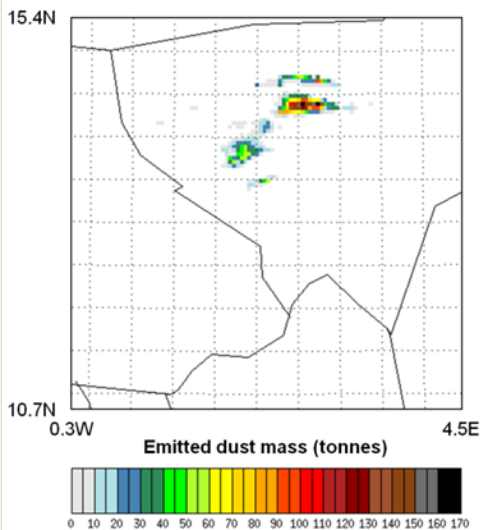


The duration of the event is satisfactorily reproduced

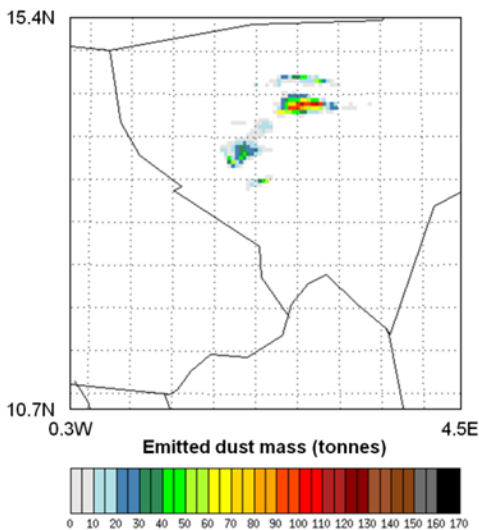
Results: impact on dust emissions

On Grid 2 - from 01/07/2006 18UTC to 02/07/2006 06UTC

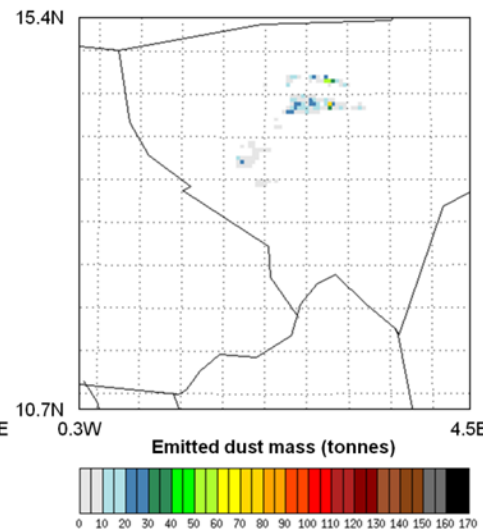
Case 1
Ideal



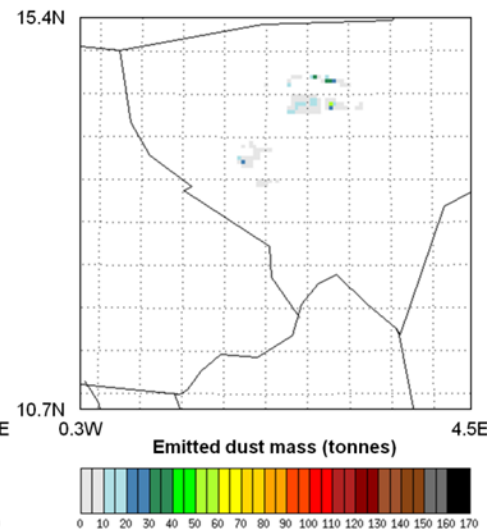
Case 2
With HWSD



Case 3
With Globcover



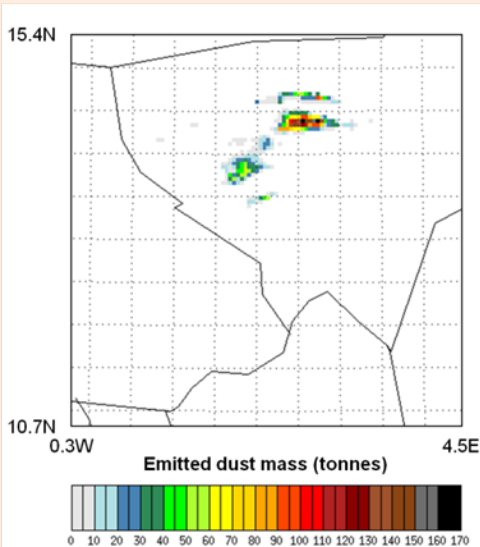
Case 4
With HWSD
& Globcover



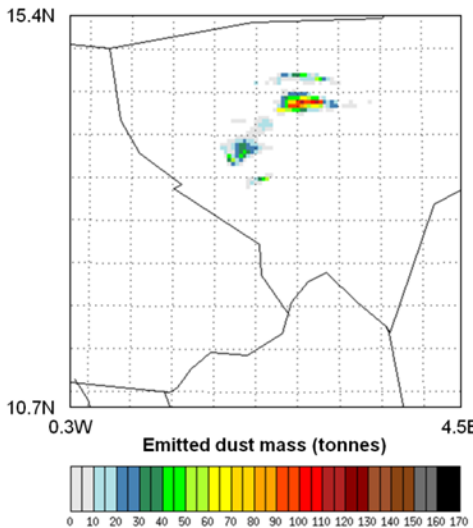
Results: impact on dust emissions

On Grid 2 - from 01/07/2006 18UTC to 02/07/2006 06UTC

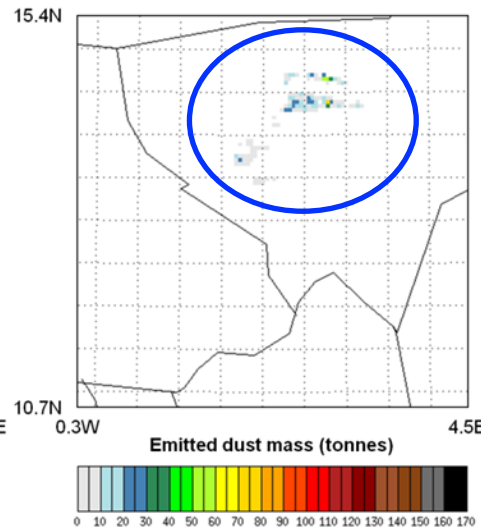
Case 1
Ideal



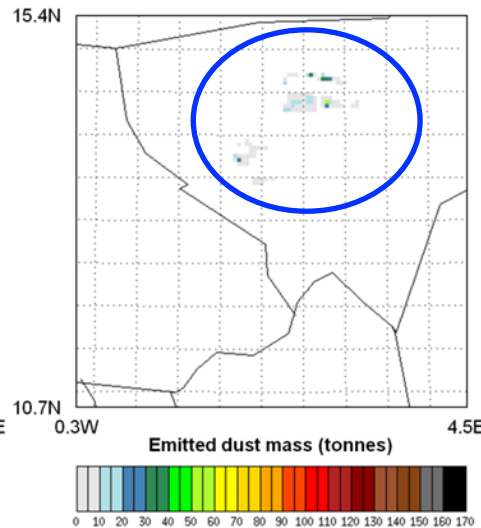
Case 2
With HWSD



Case 3
With Globcover



Case 4
With HWSD
& Globcover



Drastic decrease of the emitted dust mass
when vegetation is accounted for

Results: impact on dust mass balance

On Grid 2 - from 01/07/2006 18UTC to 02/07/2006 06UTC

	Case n°1	Case n°2	Case n°3	Case n°4
Emitted dust mass (Mg)	8.85×10^3	6.25×10^3	2.08×10^3	1.46×10^3
Dry deposit (Mg)	2.21×10^3	1.58×10^3	0.48×10^3	0.35×10^3
Wet deposit (Mg)	5.74×10^3	4.45×10^3	2.09×10^3	3.51×10^3
Dust mass balance (Mg)	0.90×10^3	0.22×10^3	-0.49×10^3	-1.94×10^3

Results: impact on dust mass balance

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	Case n°1	Case n°2	Case n°3	Case n°4
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Dust mass balance (Mg)	0.90×10^3	0.22×10^3	-0.49×10^3	-1.94×10^3

Drastic decrease of the emitted dust mass (up to 6 times less) when vegetation is accounted for

Results: impact on dust mass balance

On Grid 2 - from 01/07/2006 18UTC to 02/07/2006 06UTC

	Case n°1	Case n°2	Case n°3	Case n°4
Emitted dust mass (Mg)	8.85×10^3	6.25×10^3	2.08×10^3	1.46×10^3
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Dust mass balance (Mg)	0.90×10^3	0.22×10^3	-0.49×10^3	-1.94×10^3

Drastic decrease of the deposited dust mass as well when vegetation is accounted for

Results: impact on dust mass balance

On Grid 2 - from 01/07/2006 18UTC to 02/07/2006 06UTC

	Case n°1	Case n°2	Case n°3	Case n°4
Emitted dust mass (Mg)	8.85×10^3	6.25×10^3	2.08×10^3	1.46×10^3
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Balance > 0

(Emissions > Deposition)

Balance < 0

(Emissions < Deposition)

Conclusions

Dust mass balance is very dependent on surface characteristics

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⇒ Need to carefully account for Sahelian surface features to study dust emission in this region

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Dust mass balance is very dependent on surface characteristics

⇒ Need to carefully account for Sahelian surface features to study dust emission in this region

In particular, a special attention must be paid to land use description



Thank you