



Soil Moisture – Rainfall Feedbacks in the Sahel

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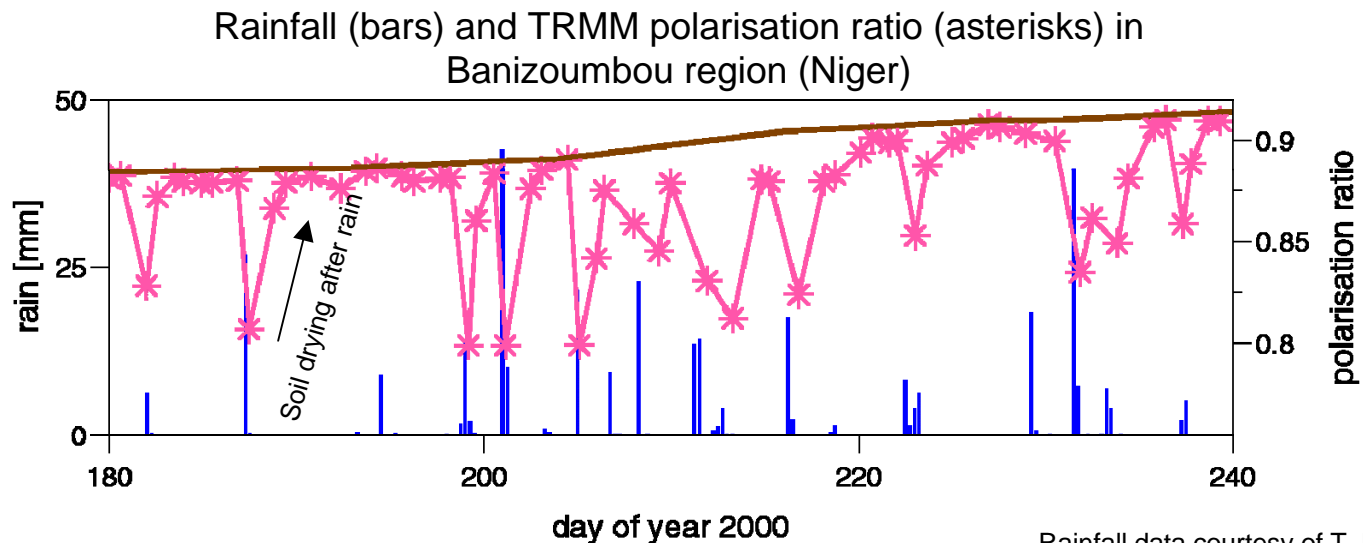
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Motivation

- Atmospheric models suggest soil moisture important control on rainfall in Sahel
- Large uncertainty in models (Koster et al 2004)
- Observations valuable
 - How does the coupled land-atmosphere system really function?
 - How do feedbacks depend on space and time scales?
- Lack of direct observations at appropriate spatial scale, but satellite data provides useful proxy

Satellite data in the Sahel

- Sparse vegetation: surface moisture important control on fluxes of sensible and latent heat
- Several possibilities for identifying variability in surface soil moisture from satellite
- Use passive microwave (10.65 GHz) from TRMM Microwave Imager to infer wet soil (high evaporation) after recent rain

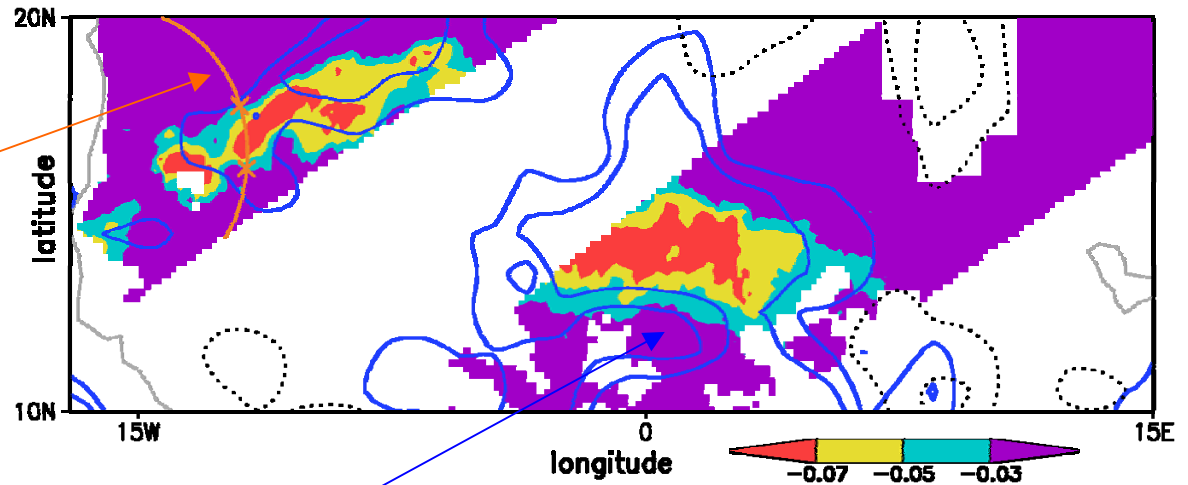


Rainfall data courtesy of T. Lebel

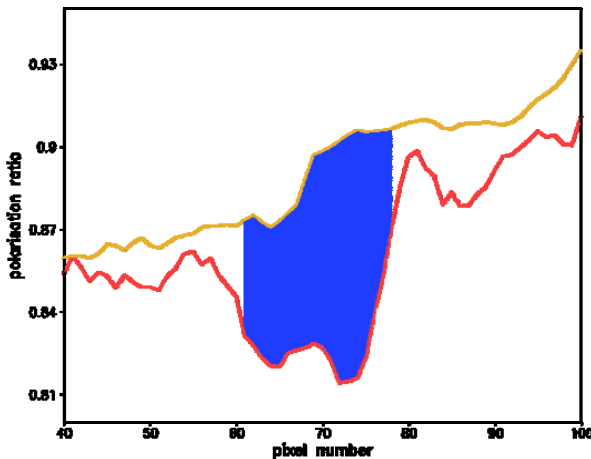
Locating wet areas

Data from 2 orbits on 3 Aug 2000

Can define wet strip of length X along scan line



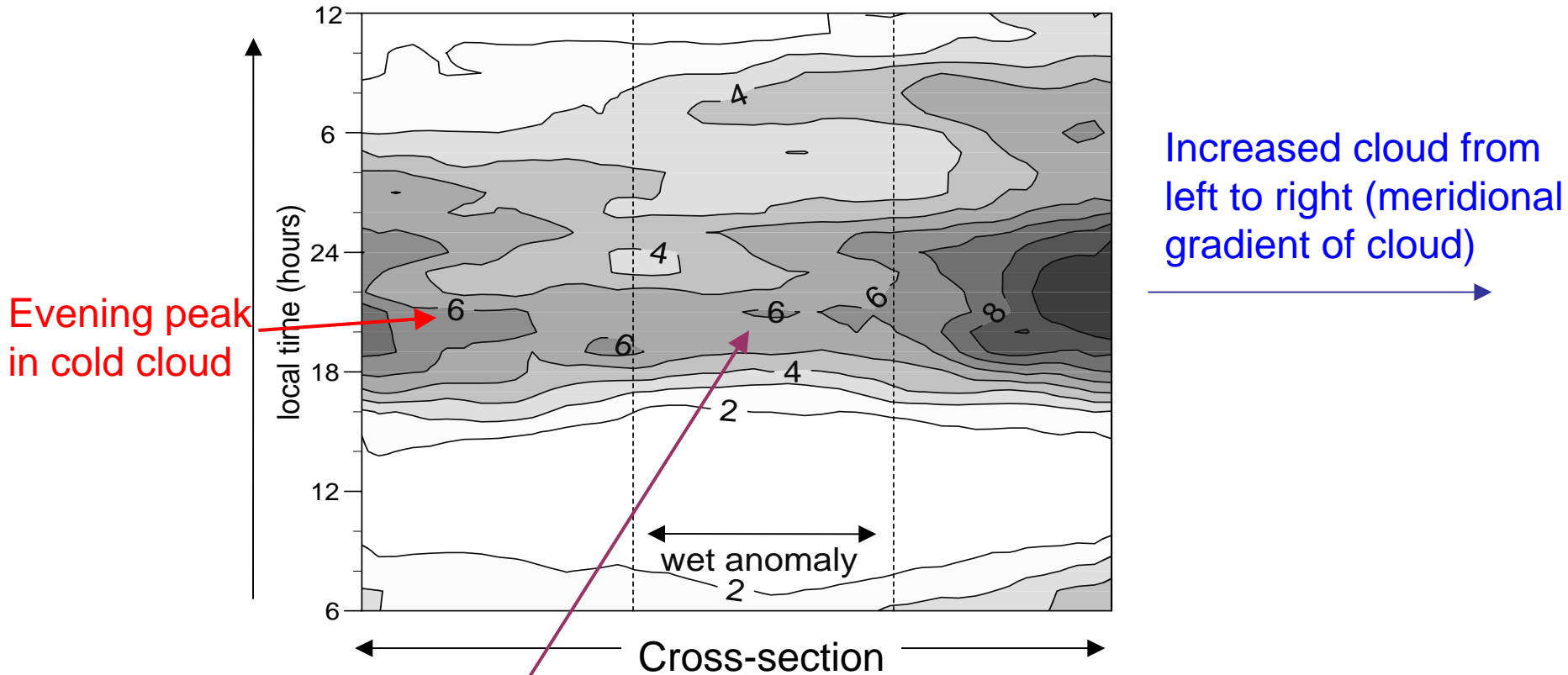
Mean cold cloud cover (pixels < - 40 degC) in previous 12 hours (Meteosat)



Identify 1559 wet strips from 2000 wet season
Study *subsequent* evolution of cold cloud
- differences due to soil moisture variations along section

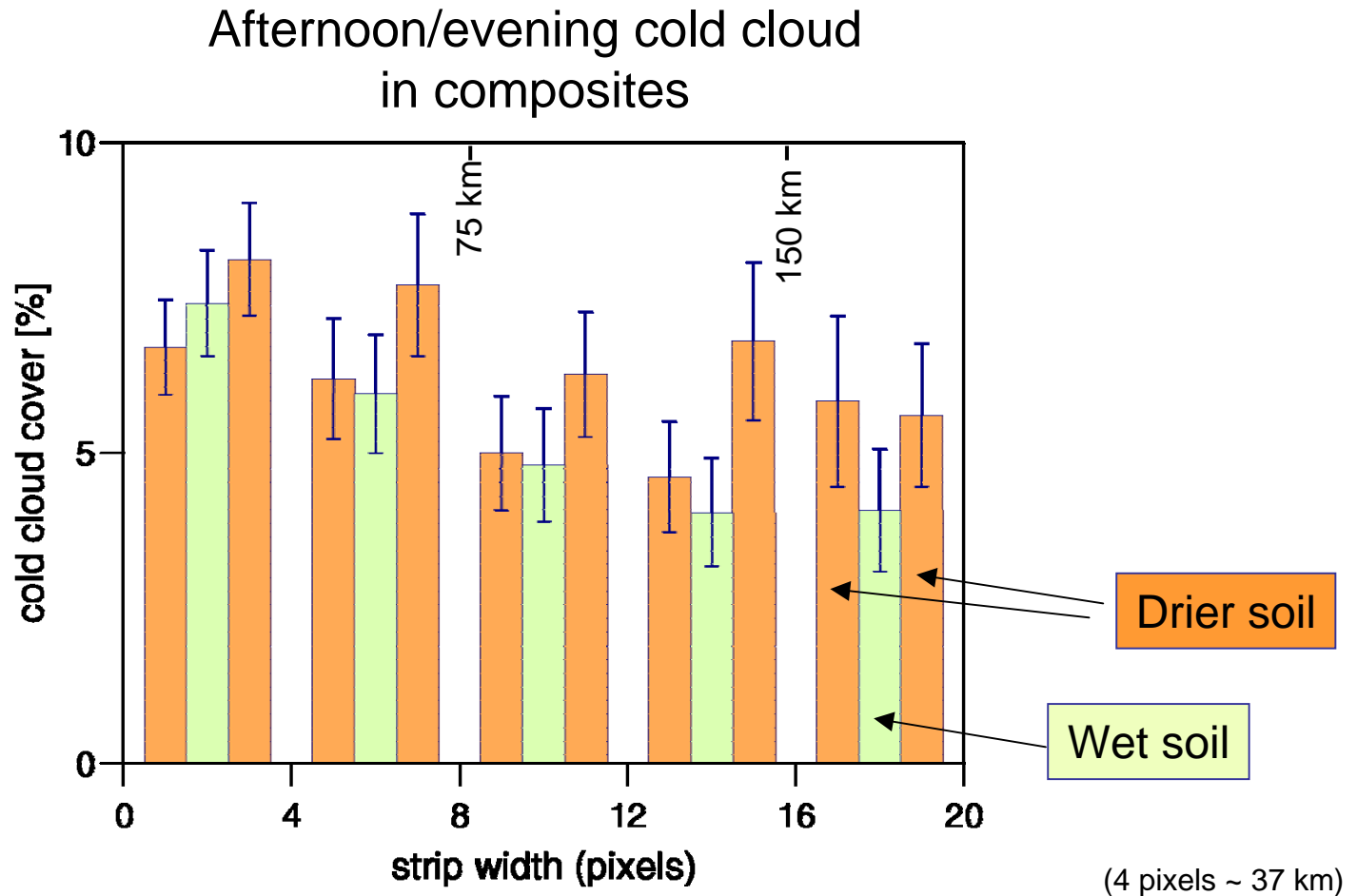
Impact of soil moisture on subsequent convection

Cold cloud cover [%] in composite
(739 cases)



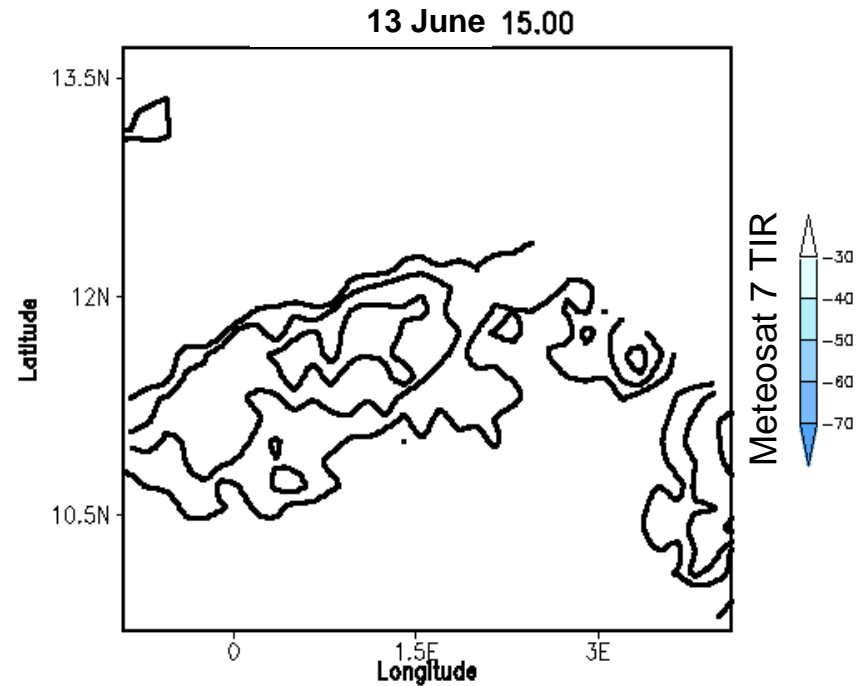
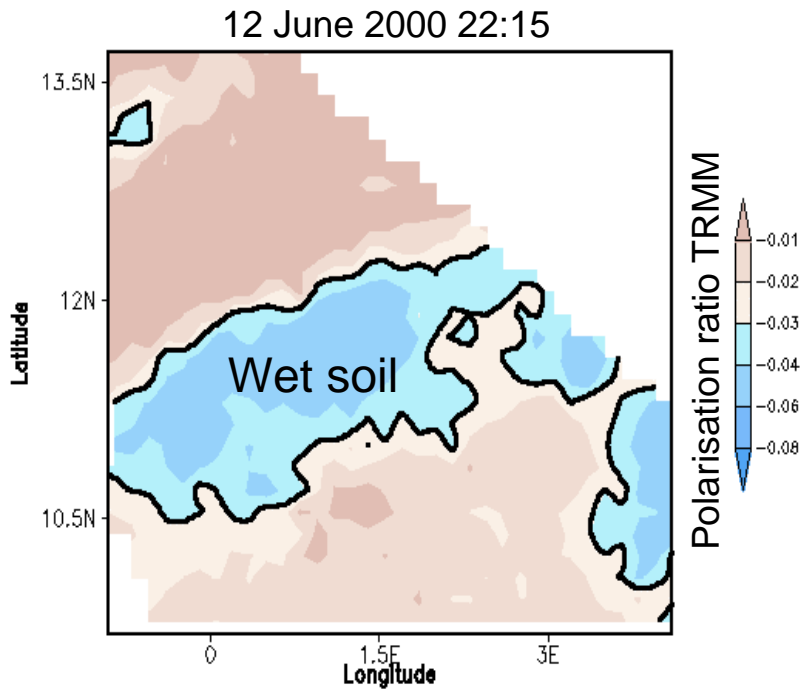
Reduced cloud in vicinity of wet soil
Biggest effect afternoon and early evening
33% reduction in cold cloud!

Sensitivity to length scale of wet strip



All but smallest strips (< 37km) exhibit reduced cloud over wet soil

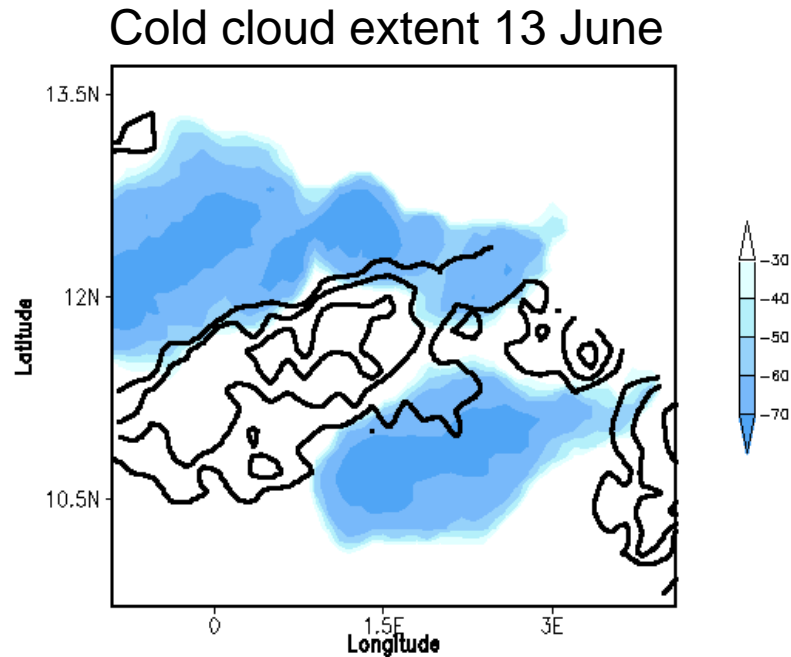
An individual case



In this single case, extent of convective system influenced by soil moisture

Storms appears to “avoid” wet patch

Results from 108 cases



Taylor and Ellis, submitted GRL

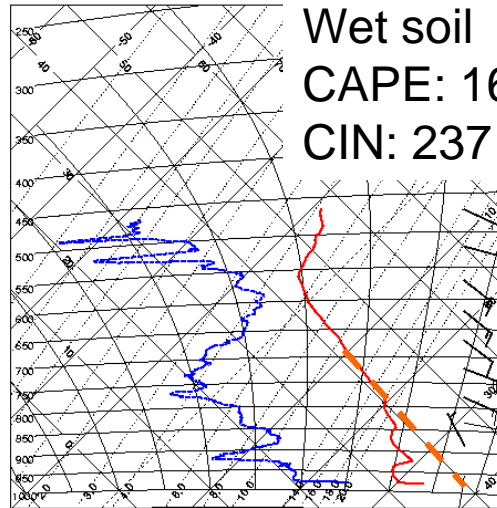
- Initiation over wet soil strongly suppressed (2% cases)
- Over 50% cases similar to example shown
- Even clearer signal for small (<200 km) cloud systems
- Suggests a negative soil moisture – precipitation feedback

Mechanisms?

- Thermodynamic arguments can be used to support positive or negative feedback (e.g. Findell and Eltahir)
- Satellite analysis suggests CIN may be more important in early stages of storm life cycle
- Possible dynamical (“sea-breeze”) effect?

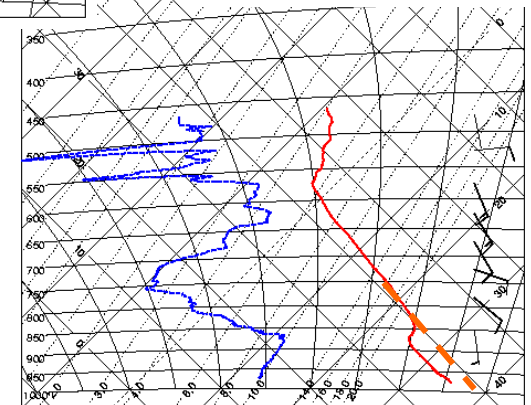
Dropsonde profiles JET2000 ~100 km apart
10:30 28/8/00

A780/e/D20000828_103059.1
lon = 2.3 lat = 16.0

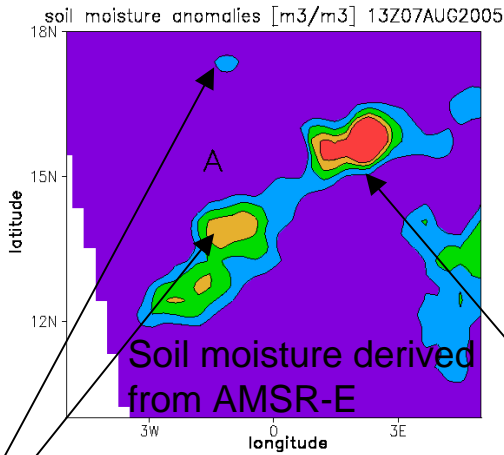


20000828_1
lon = 17.0

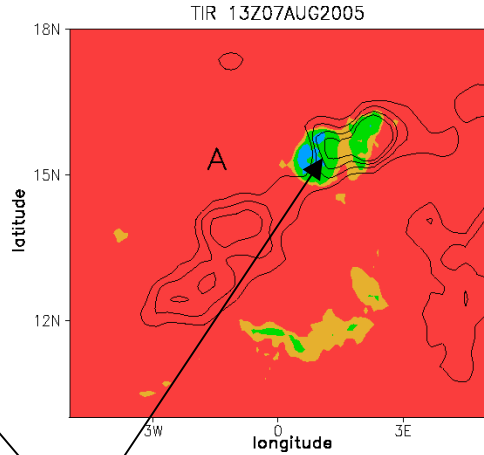
Dry soil
CAPE: -57 J/kg
CIN: 169 J/kg



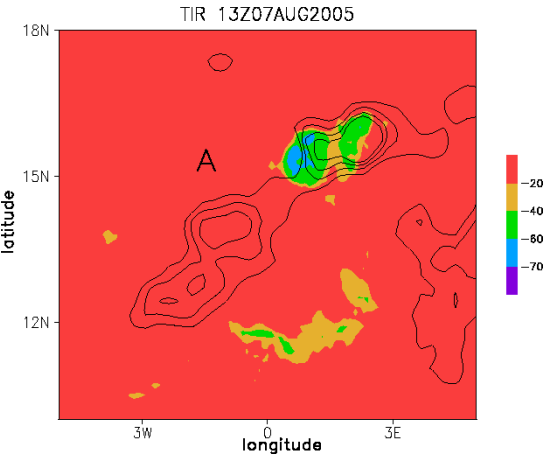
Different year, different satellite, same behaviour!



Storms previous night



Approaching storm 13Z



66 mm at Agoufou (cf 401mm annual mean)

To understand impact of feedback on seasonal time scale, important to analyse events