Impact of land surface properties on convection in a 40 day convection-permitting simulation over West Africa

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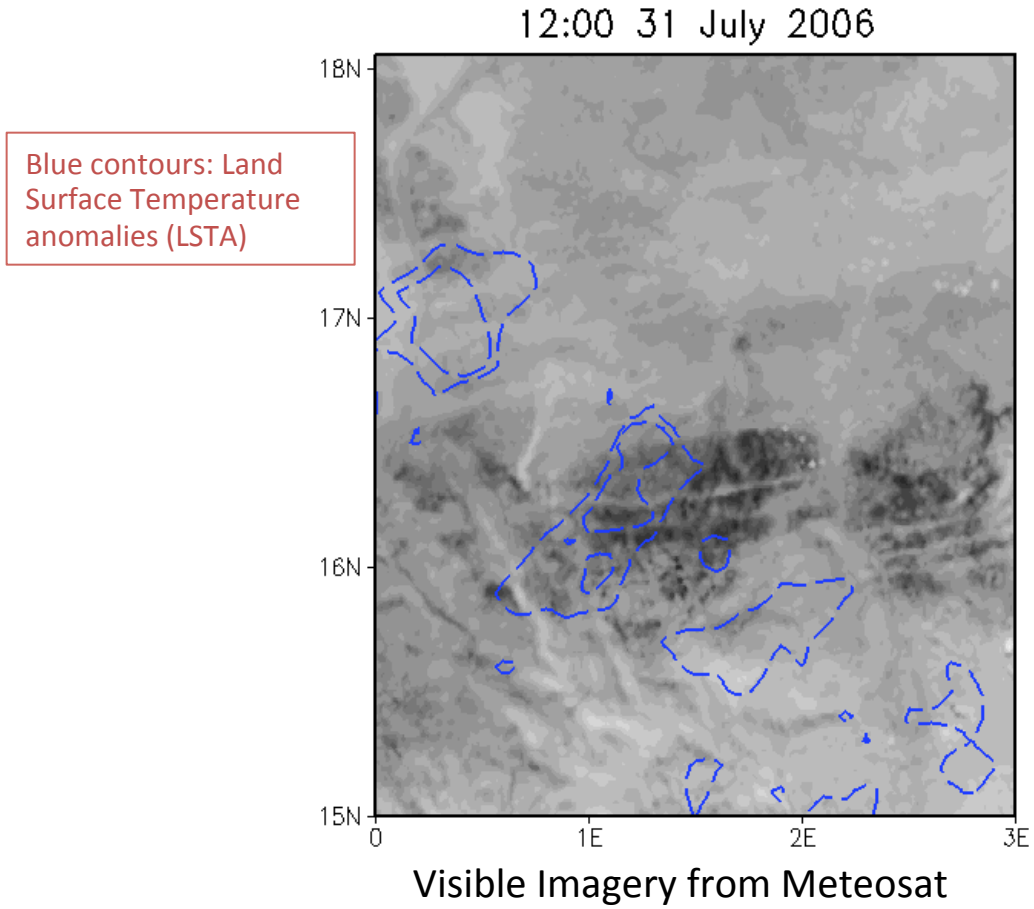
Soil moisture and MCS initiation

Number of AMMA case studies highlighted soil moisture-induced circulations as important factor in MCS initiation in models (e.g. Gantner and Kalthoff 2010, Gaertner et al 2010, Kluepfel et al 2011)

How important are gradients for climatology of MCS?



Visible Imagery from Meteosat

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Taylor et al, QJRMS 2010

How important is this feedback process for climatology?

nature geoscience
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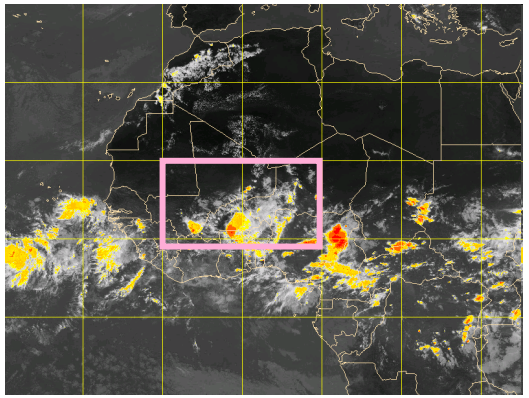
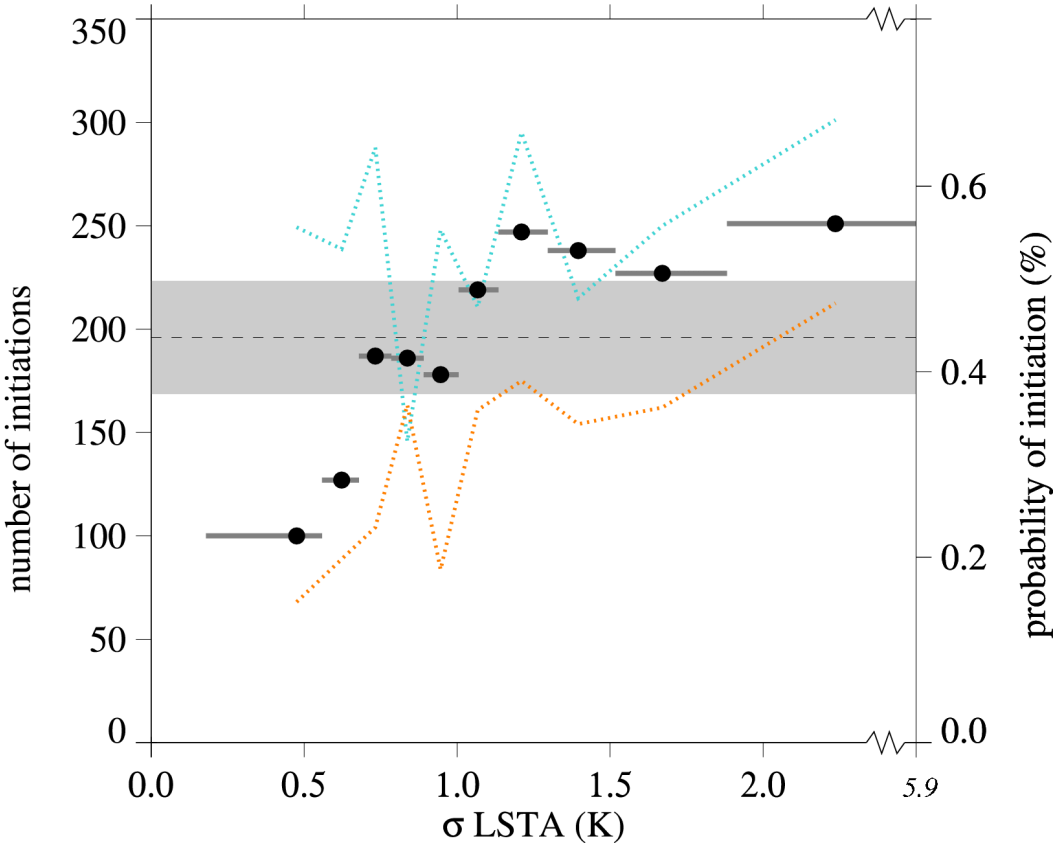
Frequency of Sahelian storm initiation enhanced over mesoscale soil-moisture patterns

Christopher M. Taylor[1]*, Amanda Gounou[2], Françoise Guichard[2], Phil P. Harris[1], Richard J. Ellis[1], Fleur Couvreux[2] and Martin De Kauwe[3]



- Tracked convective cloud systems with Meteosat data, over 3000 MCS, 2006-10
- Looked at Land Surface Temperature data to map soil moisture (~3km resolution) relative to initiation

1. Initiations more likely over variable surface



Proxy for soil moisture variability

All atmospheric conditions

LFC<200hPa above surface (favourable atmospheric conditions for storm)

LFC>300hPa above surface (marginal atmospheric conditions)

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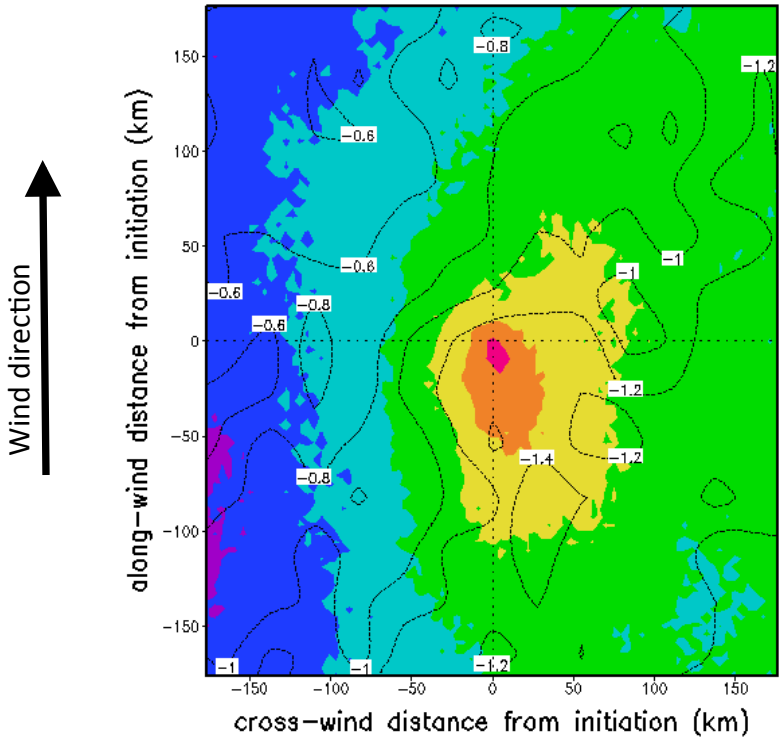
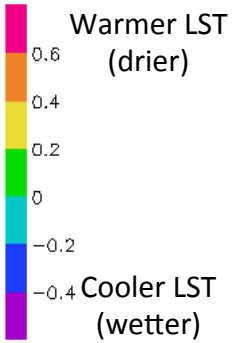
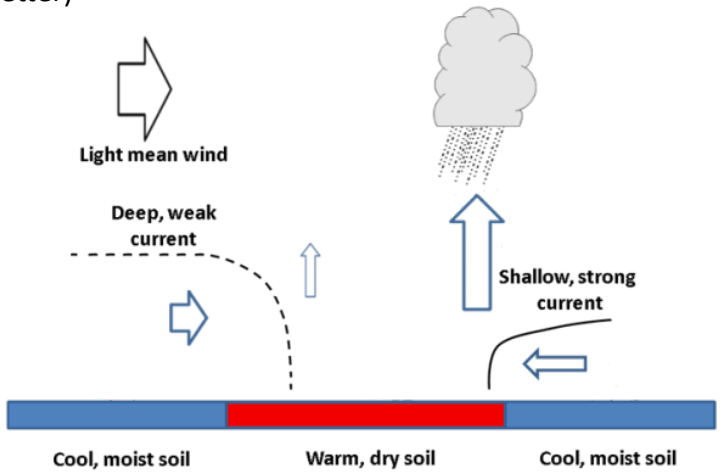
Taylor et al Nature Geoscience 2011

2. MCS initiation favoured over drier soils





Preference for initiation over locally drier surface close to (~10 km) LSTA gradient downwind



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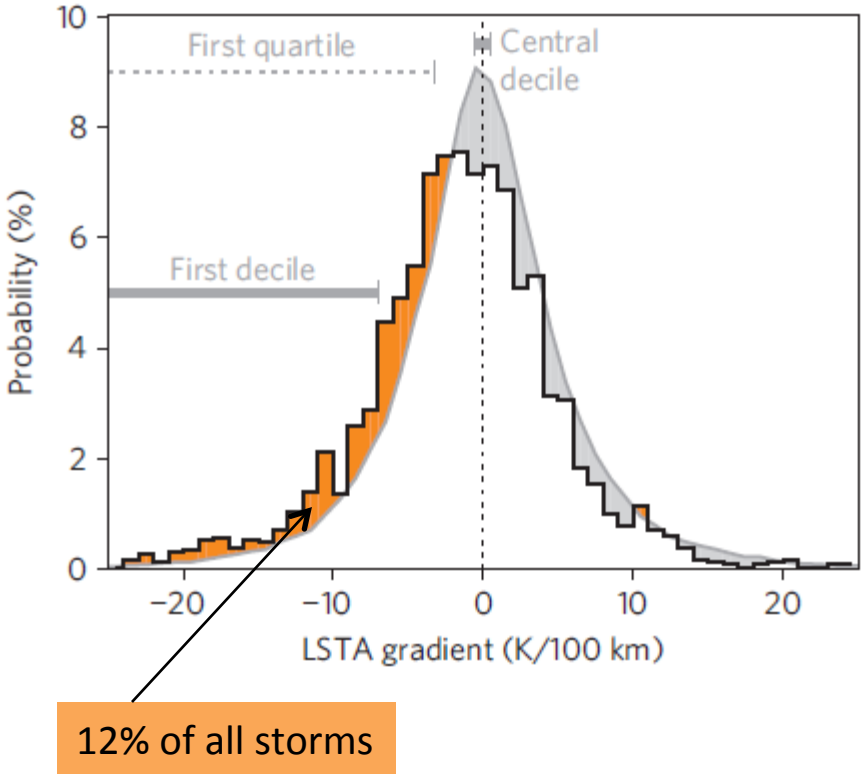
3. Significant impact on MCS climatology



Effect important for ~1 in 8 storm initiations

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Taylor et al Nature Geoscience 2011

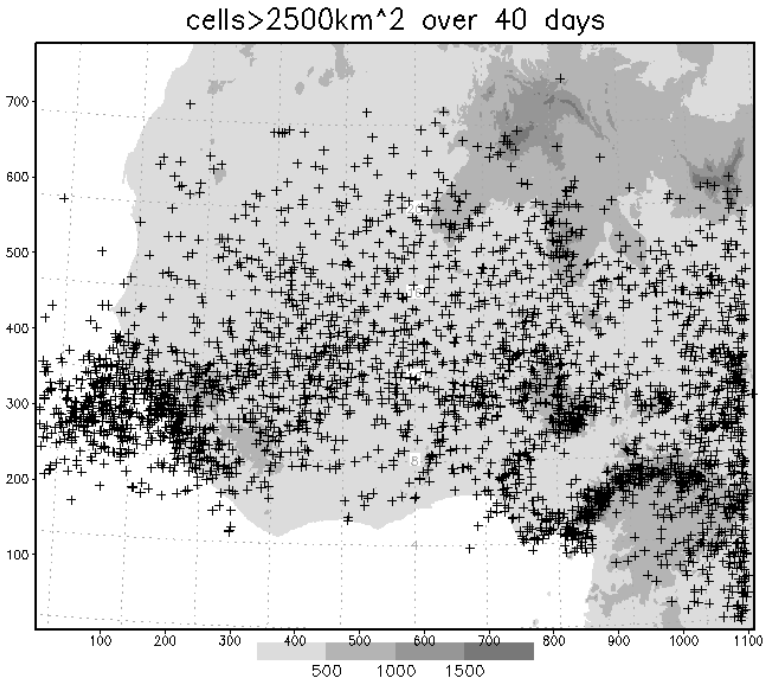
What about models? Cascade simulation

- Reading/Leeds/Met Office/UEA work: Unified Model seasonal simulations of high resolution large-domain. Focus on scale interactions

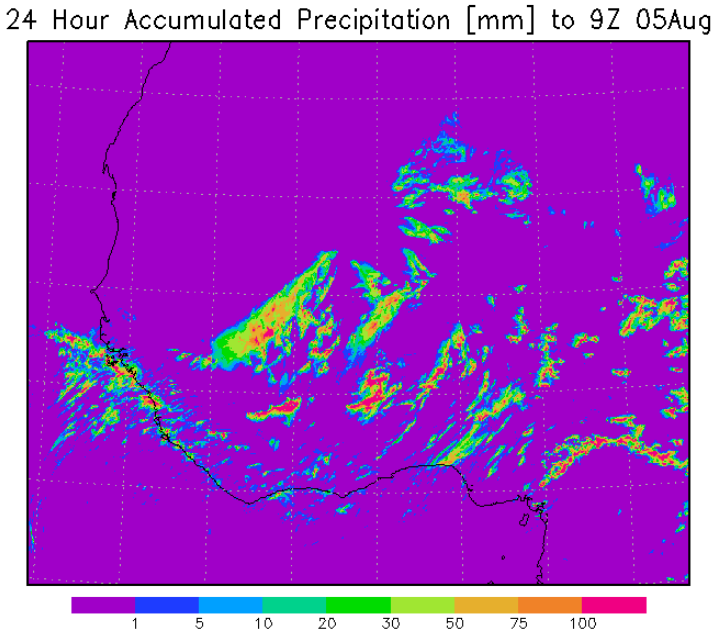
- African domain, 4 km resolution, 40 day run

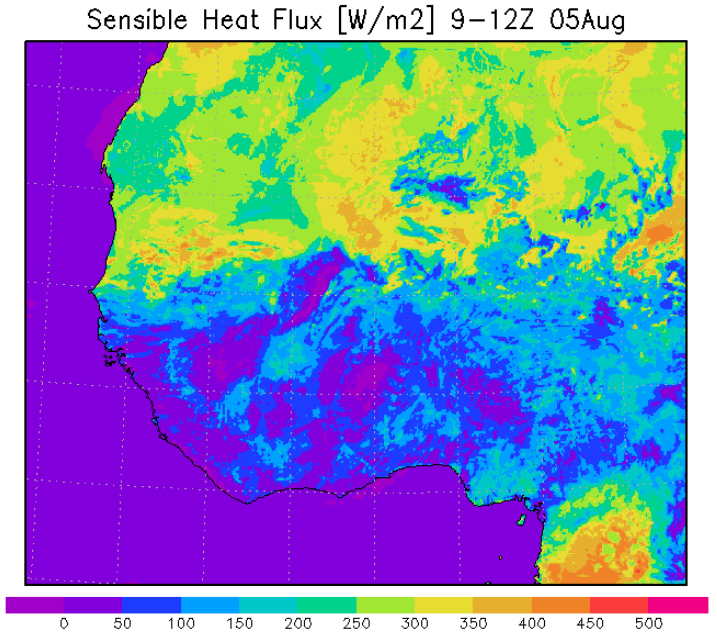
- Good depiction of diurnal cycle and growth of MCS (Pearson et al JGR 2010)

- Goal current study: relationships between surface and convective initiation in model to compare with observed climatology (Taylor et al 2011)



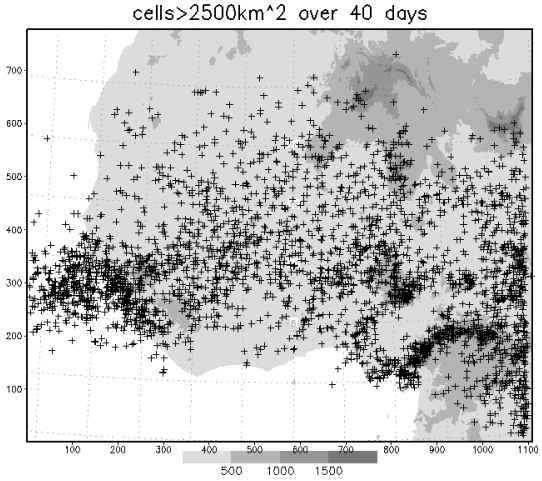
Precipitation and sensible heat flux





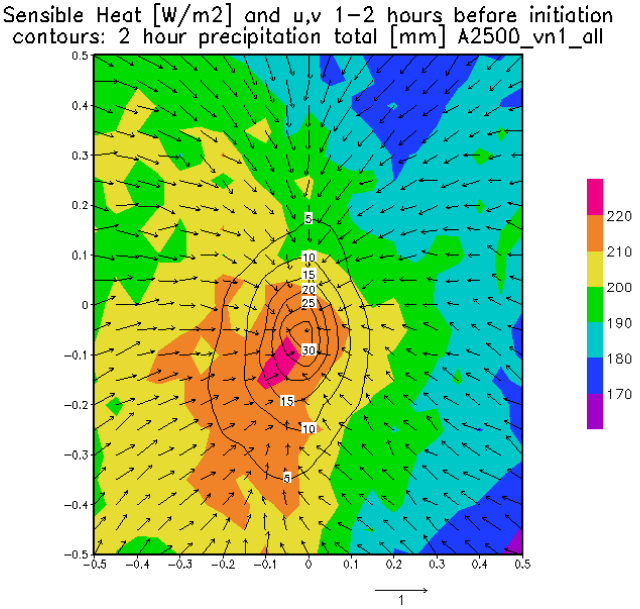
Large gradients in SH for day or 2 after rain in northern half of domain
Are gradients important for initiation in model?

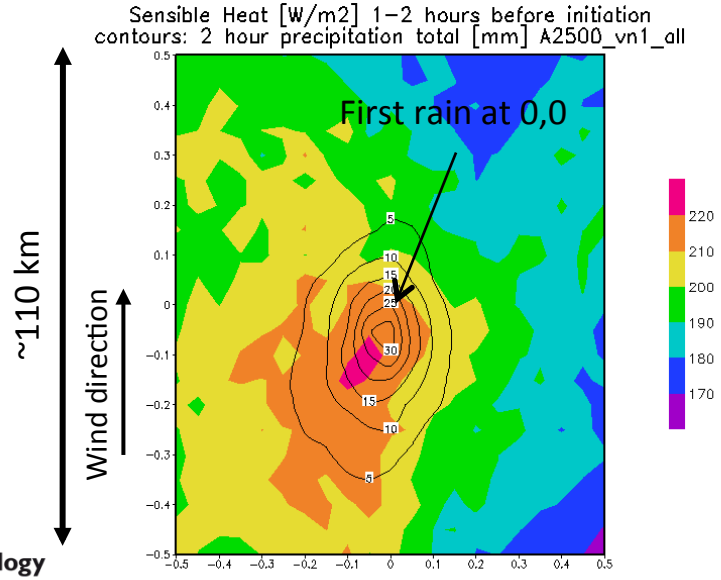
Composite initiation

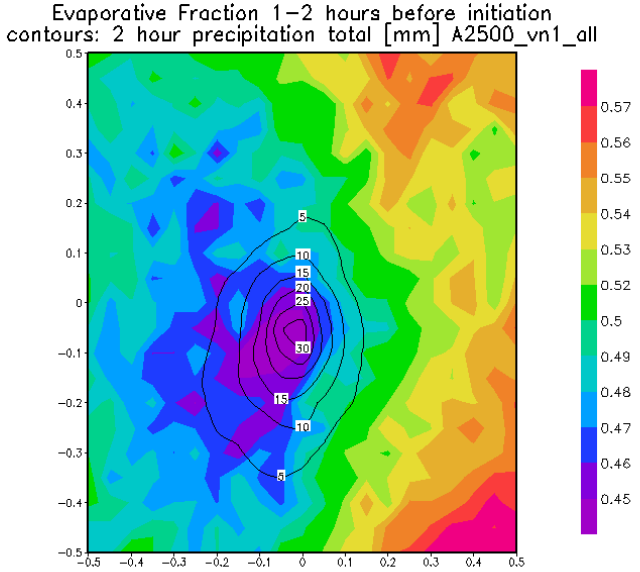


Composite rapidly developing cells>2500km2 tracked back to first rain, 10-21Z.

Excluding ocean and mountains => 533 cases







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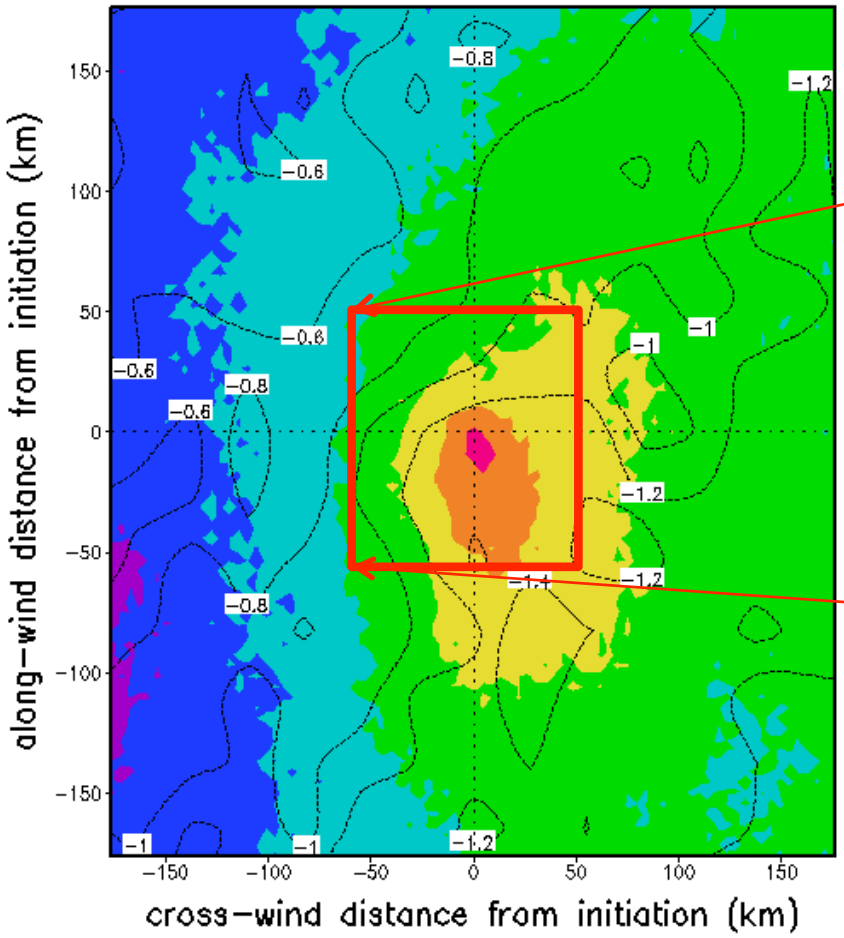
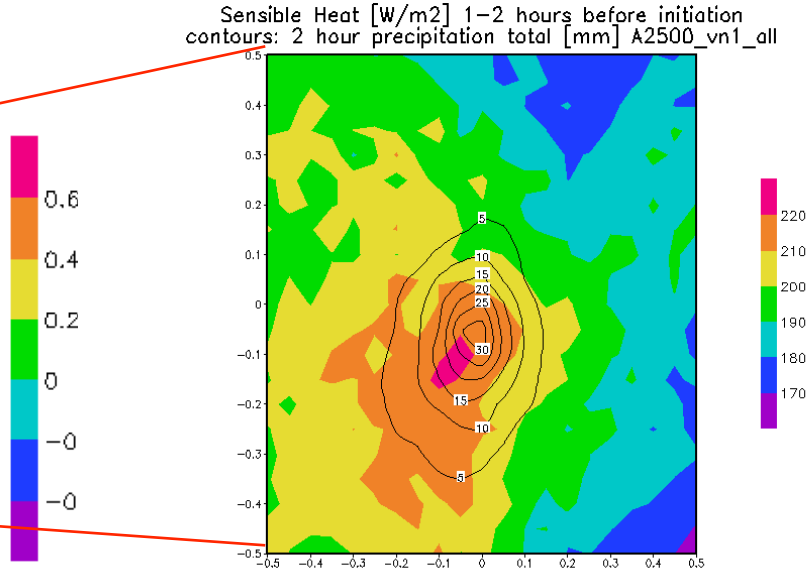
First comparison: obs v model

Obs: shading LST anomalies [K]

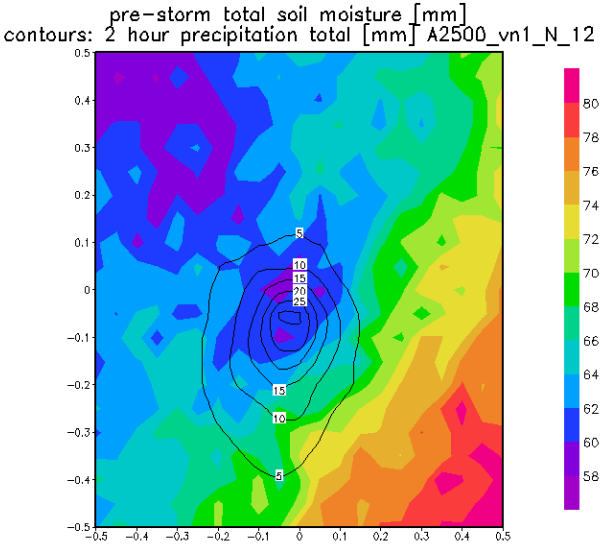


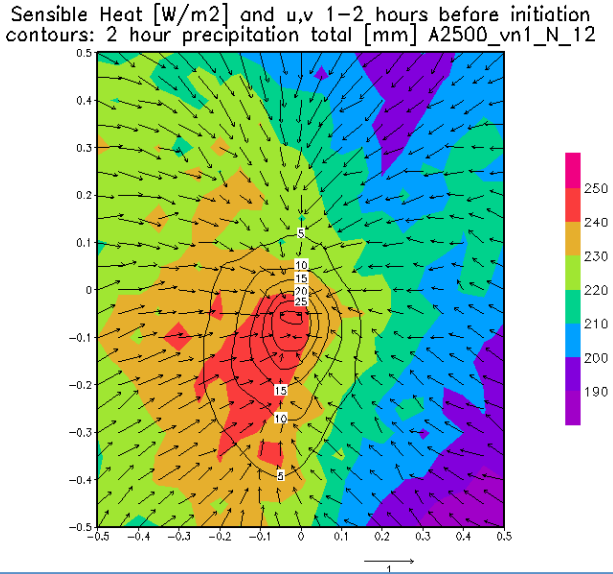


Not comparing like-with-like but…

- initiation over higher LST (or SH)
- aligned (ish) with background wind
- similar geometry and spatial scales

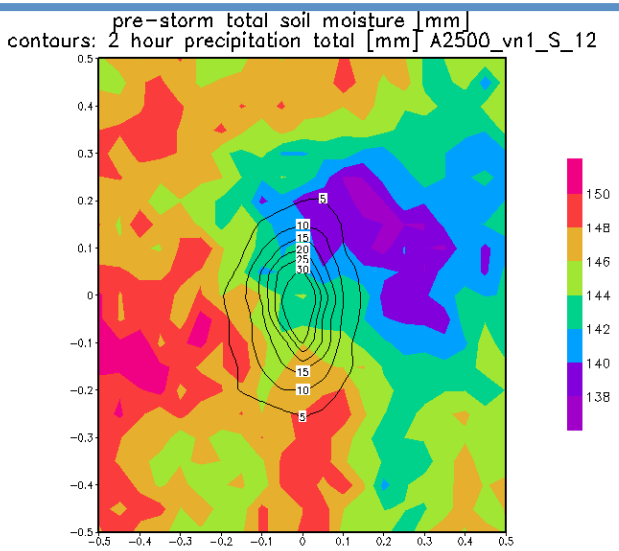
Different behaviour over sparse/dense vegetation

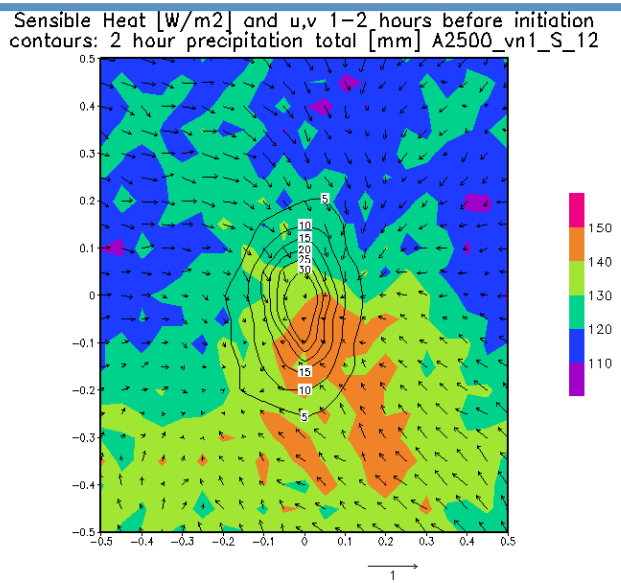




North of 12N
(372 cases)

South of 12N
(151 cases)





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Next steps in analysis

Pre-initiation dynamics and thermodynamics:

- density currents, gravity waves (Birch et al in revision)
- analyse CIN/CAPE (Garcia-Carreras, 2011)

Impact of convective parameterisation on initiation signal

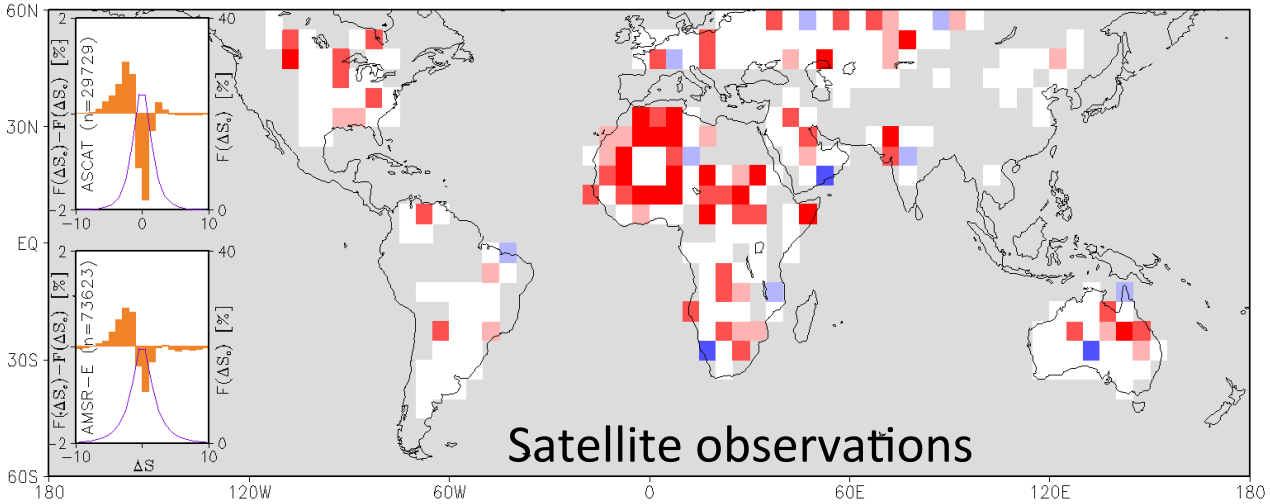
- pair of 12km simulations (cf Hohenegger et al J Clim 2009)

Importance of fixed (veg, topo, water bodies) vs transient sm features

Land impacts on propagation of mature systems

Sahel in global context

Shading: relative strength of soil moisture influence on precipitation



Afternoon rain more frequent over drier soil

Afternoon rain more frequent over wetter soil

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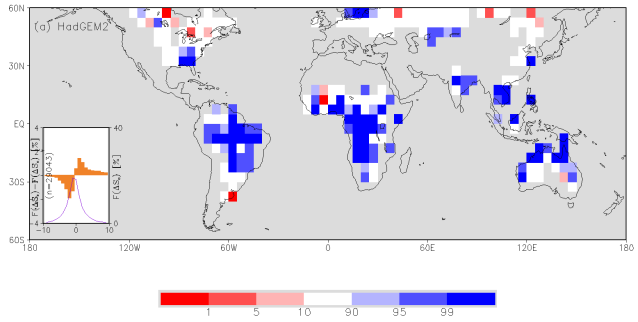
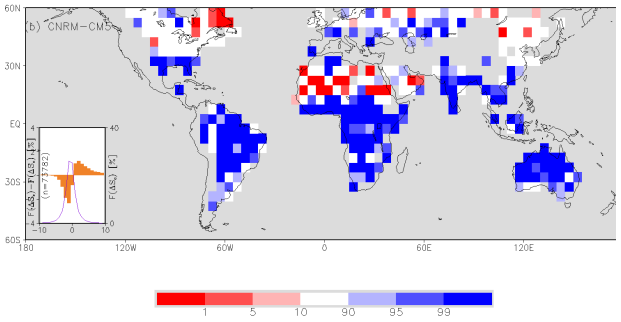
Taylor, de Jeu, Guichard, Harris, Dorigo, in press

Soil water –precipitation feedbacks in global models

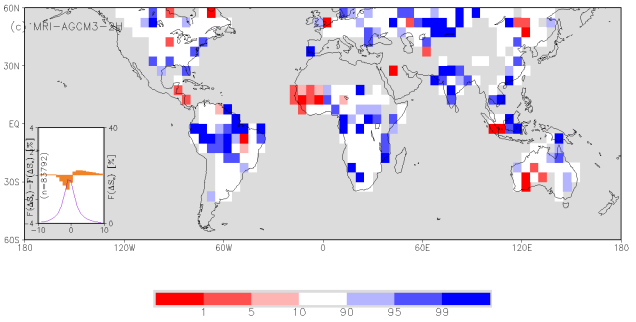
Shading: relative strength of soil moisture influence on precipitation



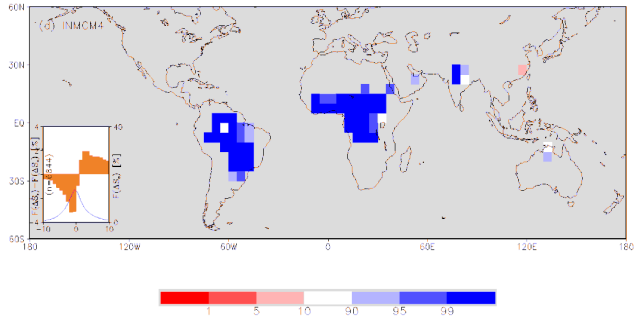
HadGEM2 (CMIP5)



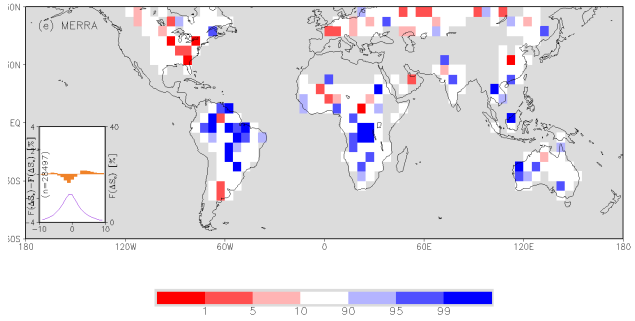
CNRM (CMIP5)



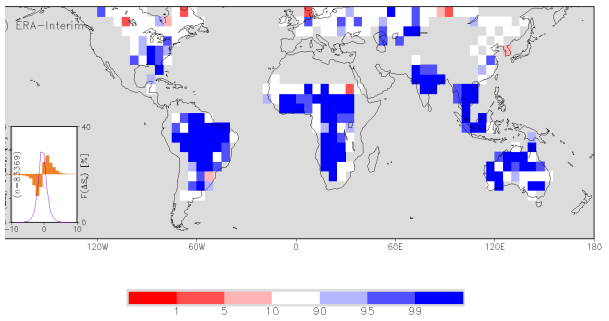
MRI (CMIP5)



INM (CMIP5)



MERRA reanalysis



ERA-Interim reanalysis

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Taylor, de Jeu, Guichard, Harris, Dorigo, in press