WAM dynamics for chemists

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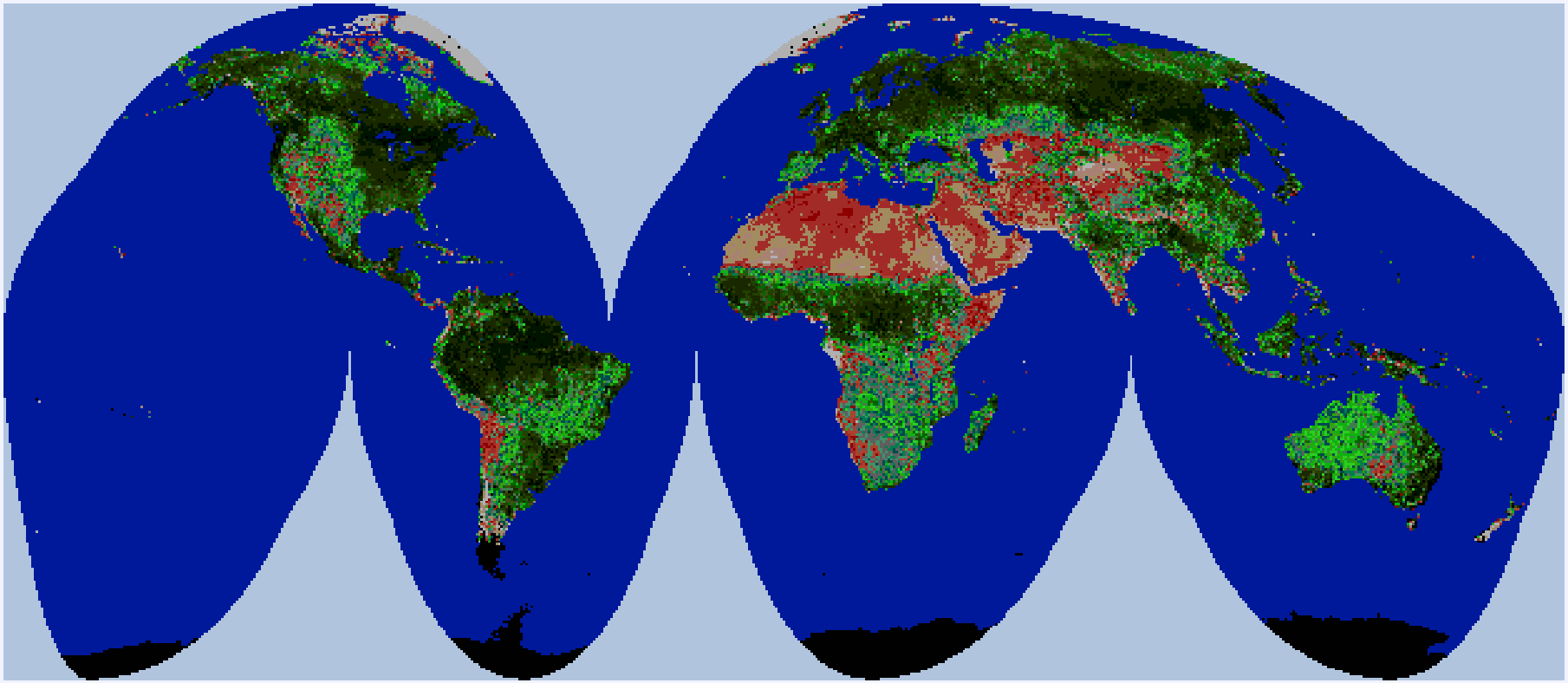
21 September 2005



NDVI 20-30 August 2000 (NASA-DAAC)

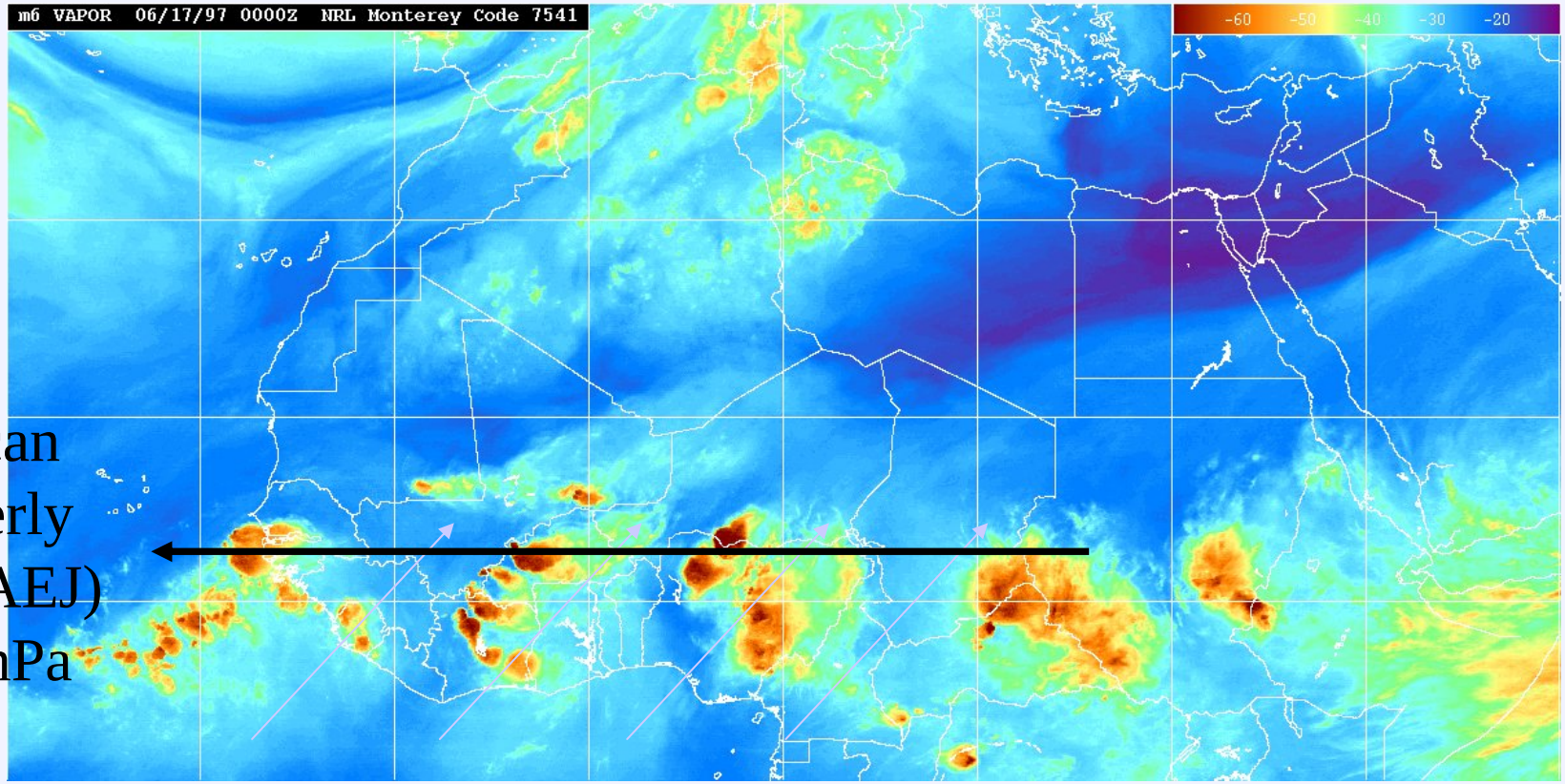
18 N

8 N

R Niger, 13.5 N

Cu Congestus

Moist convection in the south, dry convection in the north (the Sahara): a ‘natural laboratory’ for tropical continental convection.

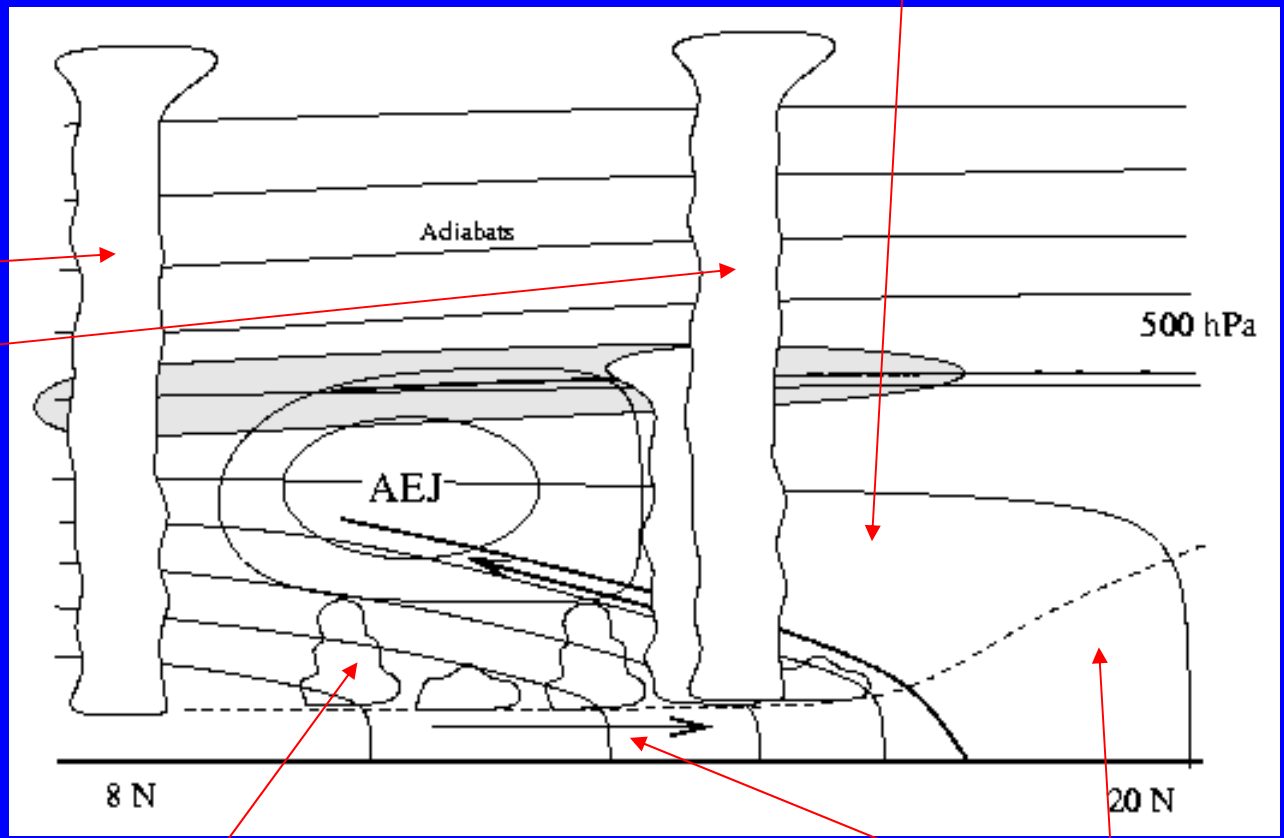


Water vapour 17/6/97

Summary of WAM structure (from JET2000 dropsondes; Parker *et al* QJRMS 2005a):

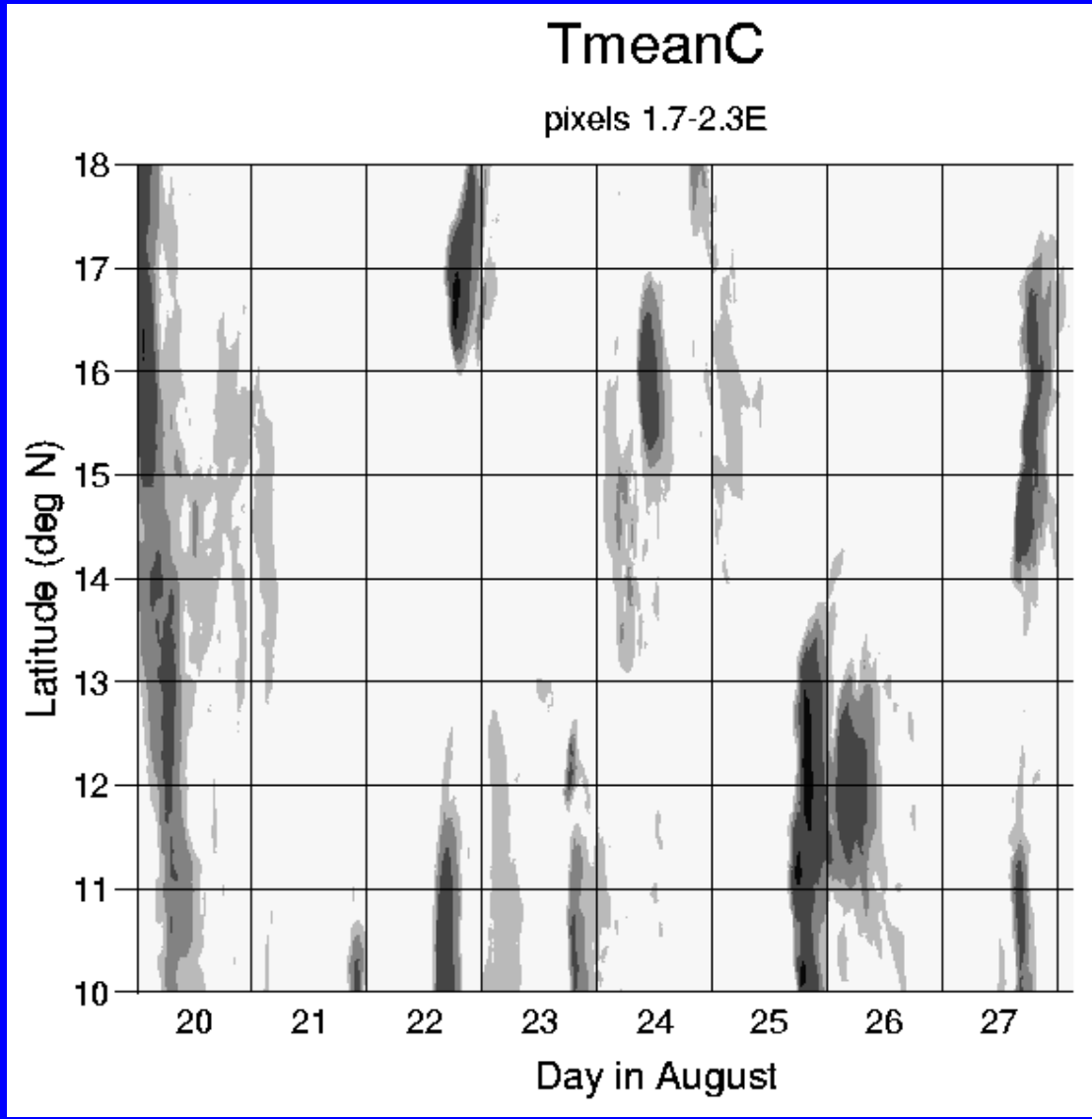
Saharan Air Layer (SAL; a.k.a. Harmattan Layer)

Deep convection



Shallow cumulus and congestus

Mixed layer

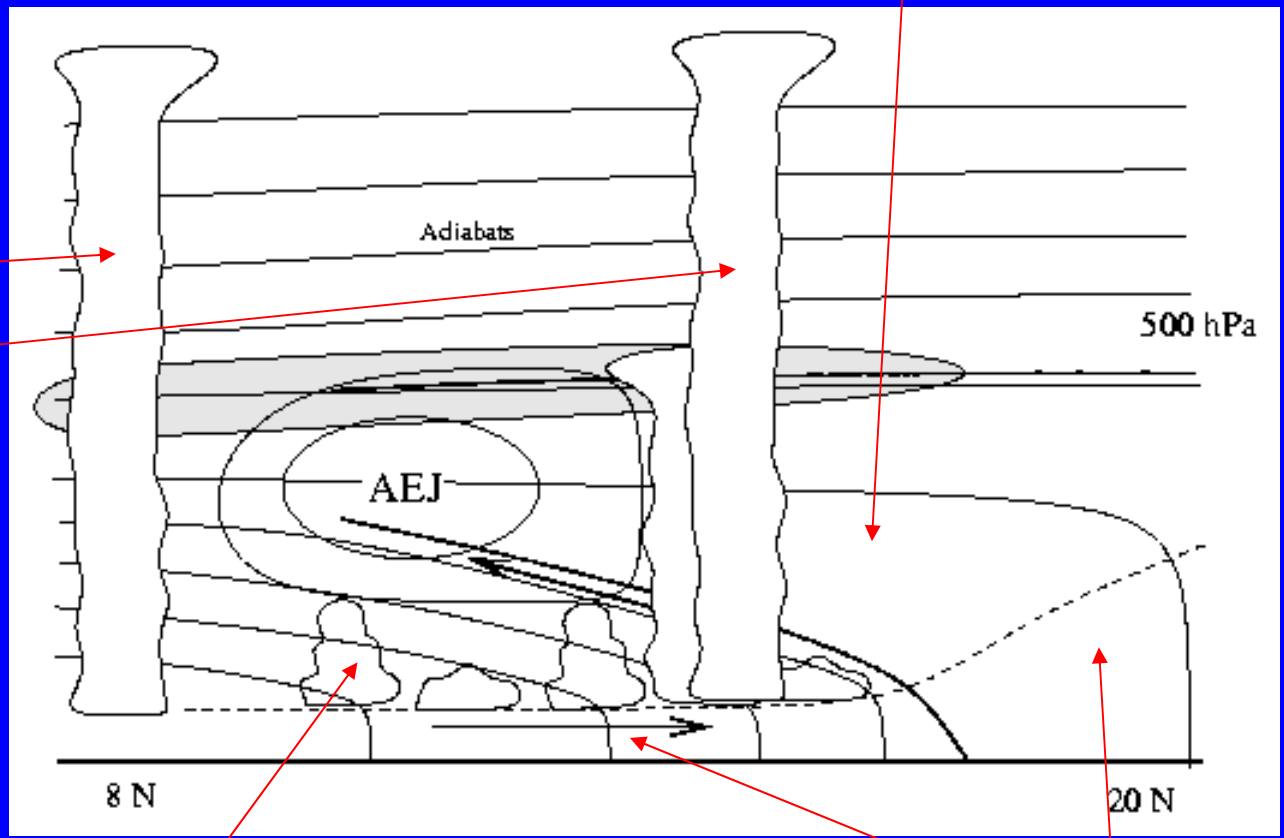

TmeanC
pixels 1.7-2.3E
Latitude (deg N)
18
17
16
15
14
13
12
11
10
20
21
22
23
24
25
26
27
Day in August


Warm rain

Summary of WAM structure (from JET2000 dropsondes; Parker *et al* QJRMS 2005a):

Saharan Air Layer (SAL; a.k.a. Harmattan Layer)

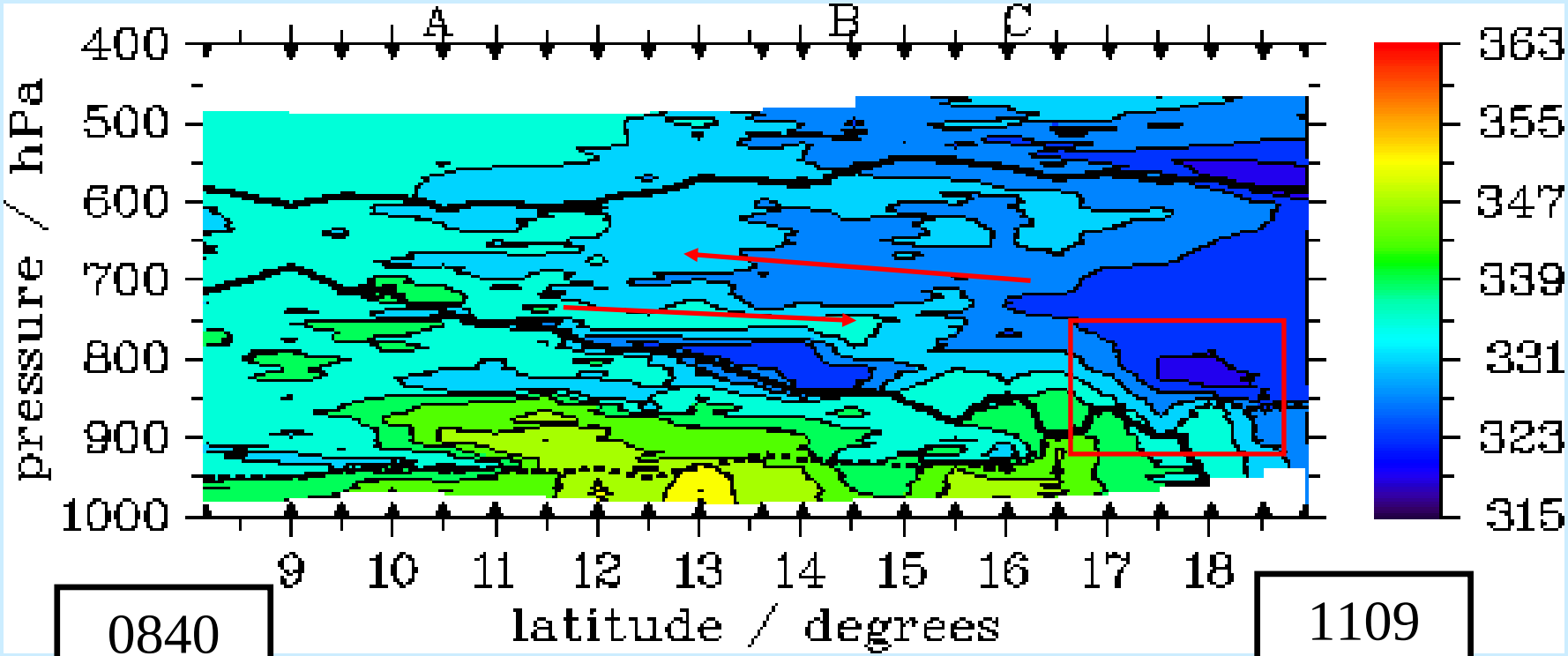
Deep convection



Shallow cumulus and congestus

Mixed layer

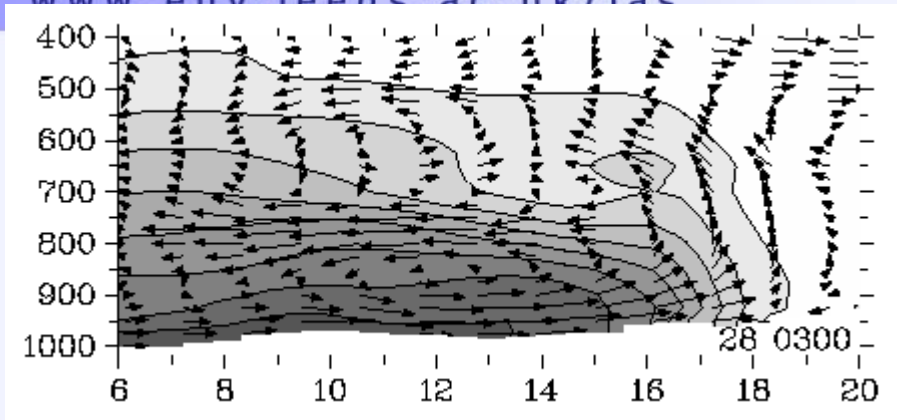
JET2000 dropsonde data

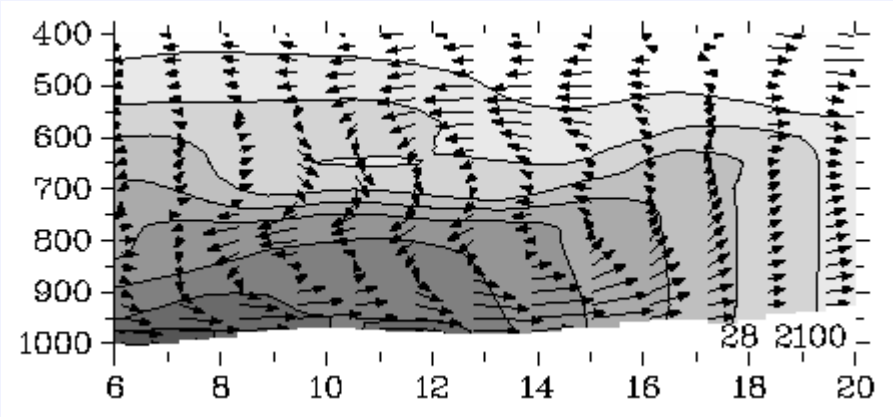


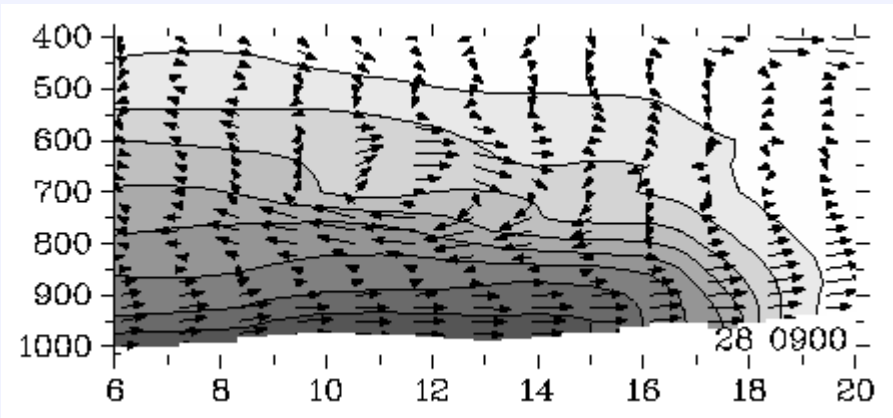
0840 UTC

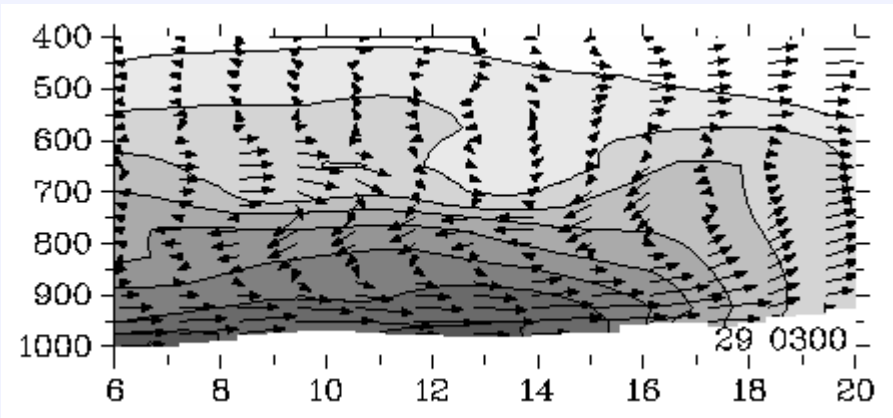
1109 UTC

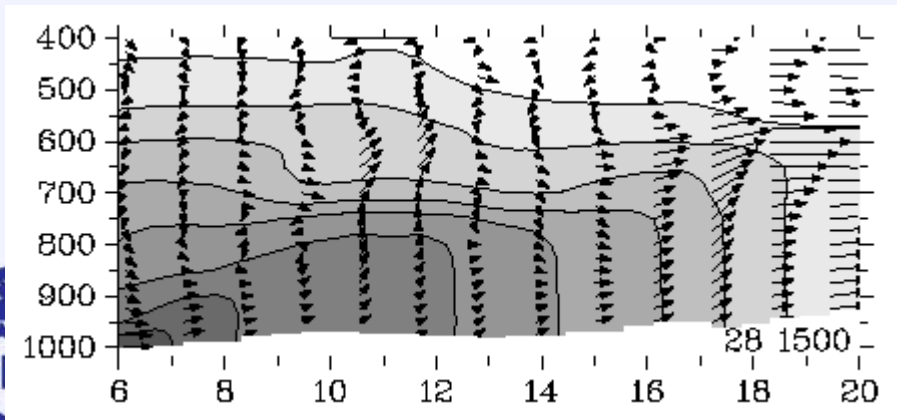
We can use biogenic chemical tracers to attach timescales to the mixing and transport ('chemical clocks') …









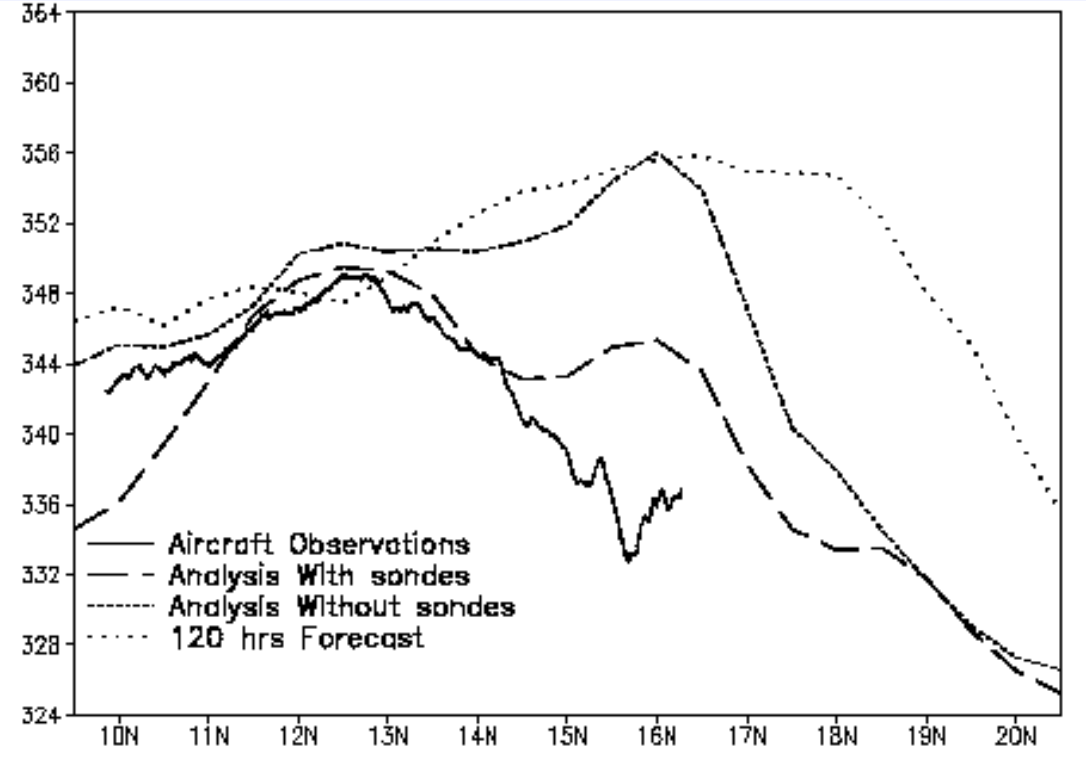


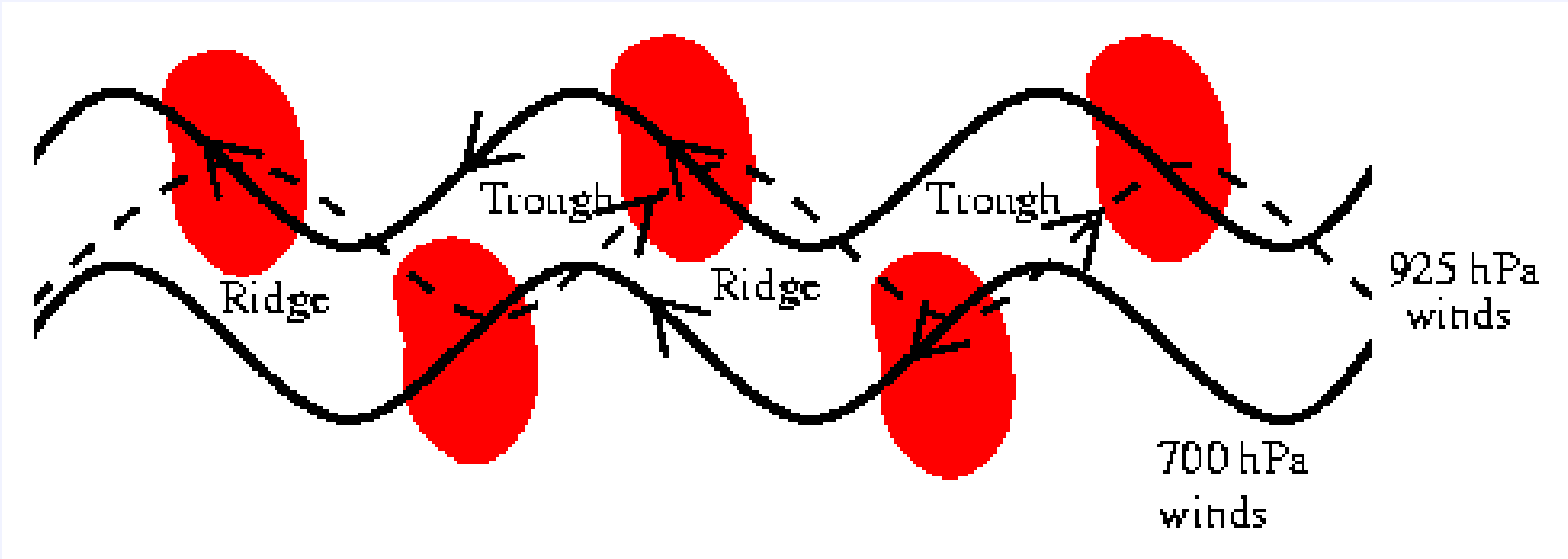
The monsoon flow is active at night and in the morning (Parker *et al* QJRMS 2005b).

2. Synoptic control. African Easterly waves and convection: Current understanding

- Convective initiation is dominated by the diurnal cycle of heating over hills (e.g. Hodges and Thorncroft 1997)
- Southern zone: convection maximised in the northerlies and trough of an AEW
- Northern Sahel: convection maximised in the southerlies

θ_e distribution (JET2000)

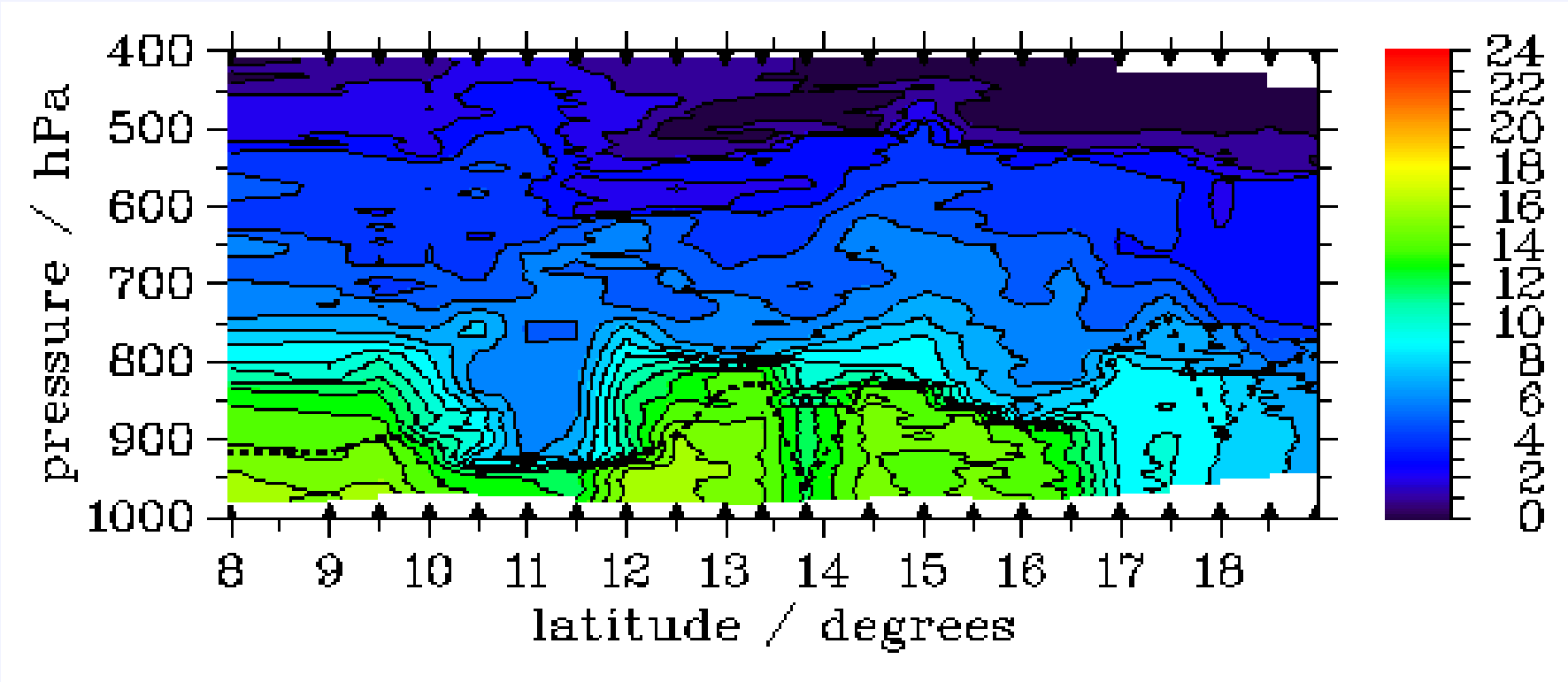




(see also Rosalind Cornforth PhD thesis, U. Reading, 2005 – also Nick Hall WP2.1)

The wake of an MCS

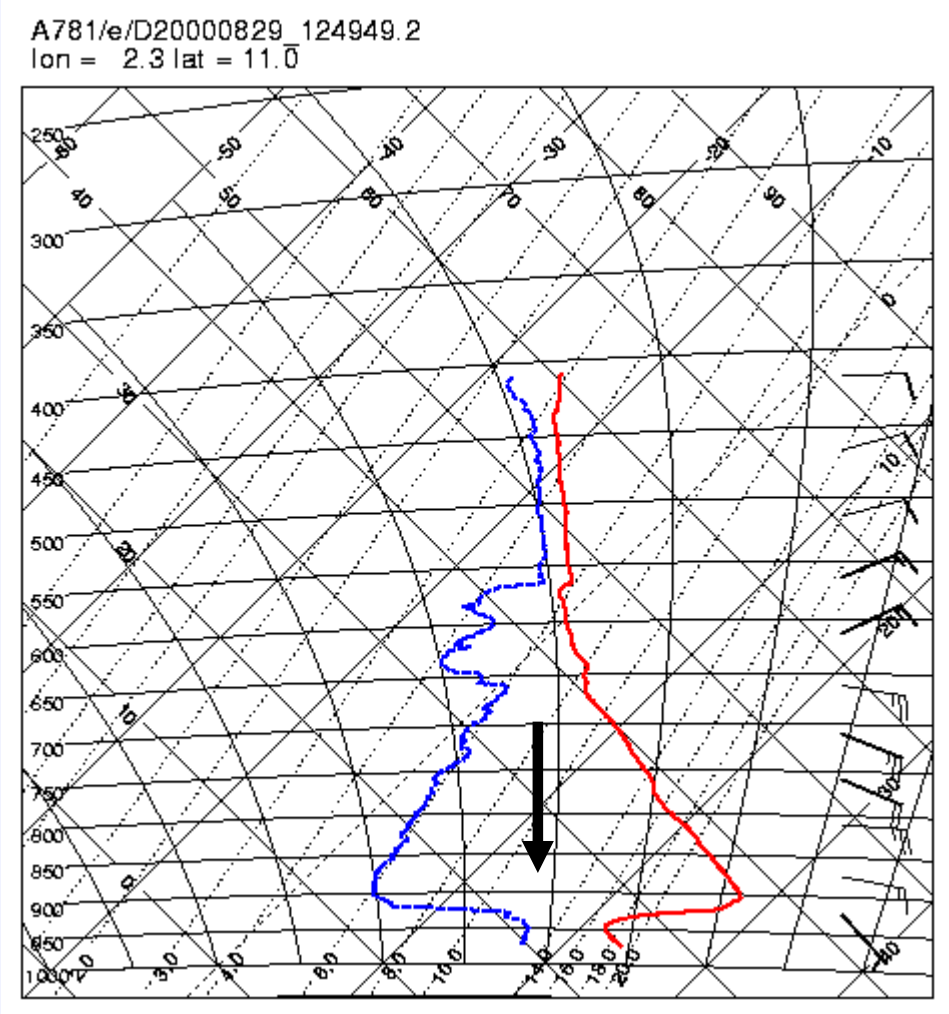
⇓



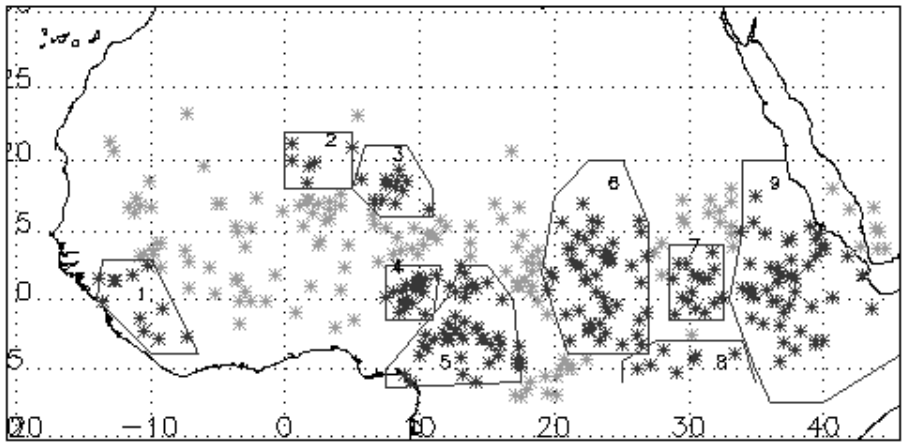
Mixing ratio, the following afternoon (29/8/00)

‘Onion’ profile

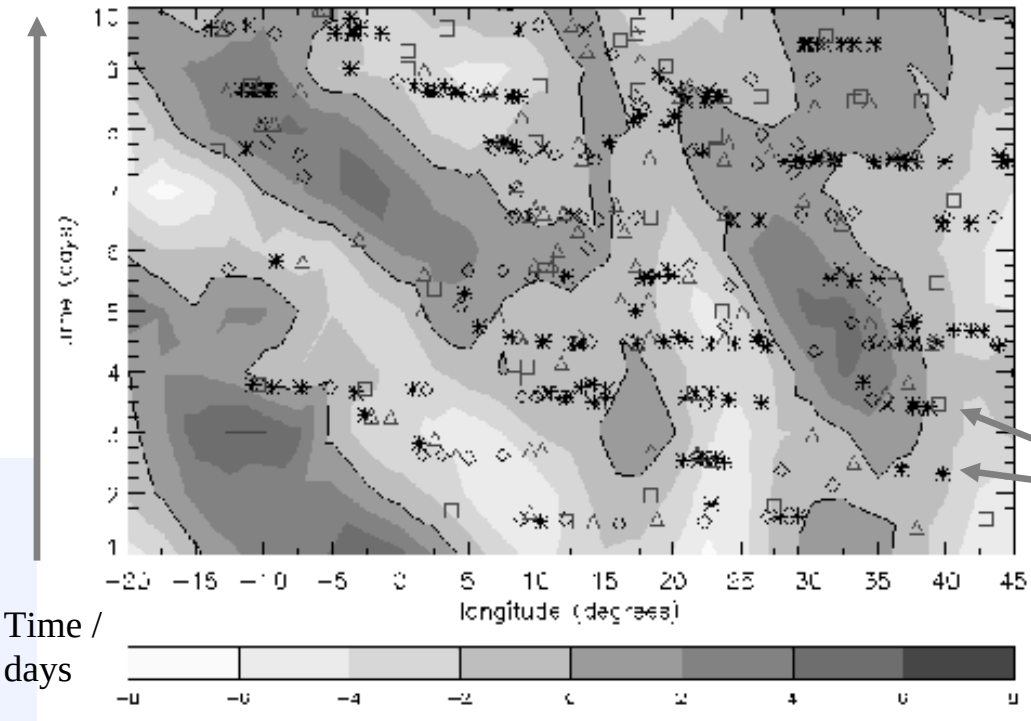
1249 UTC



Statistics of storm initiation, 1-10 August 1997 (Mariane Diop)



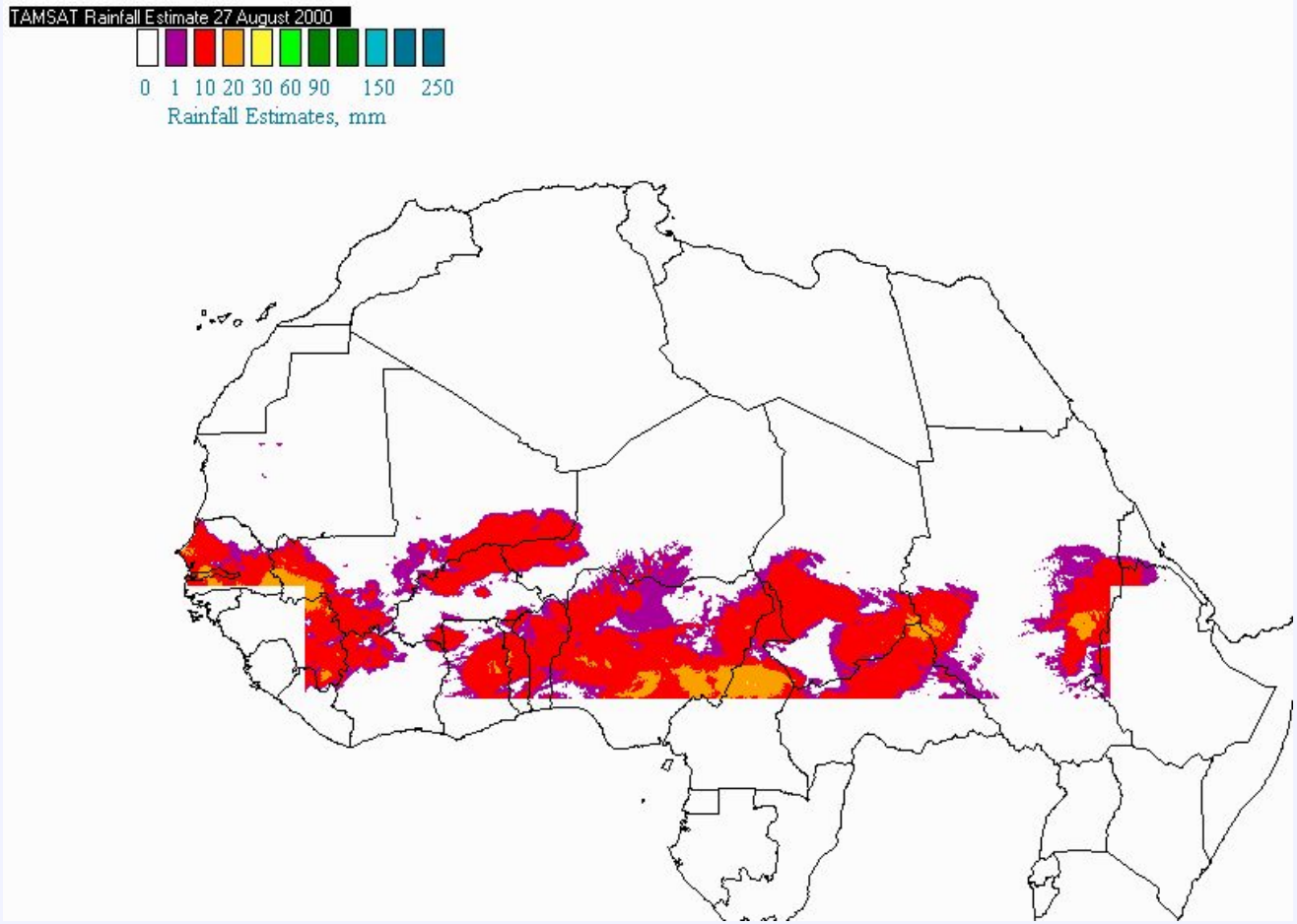
All initiations.



Longitude of initiations, and associated meridional wind (5 – 20^{o}N; shaded / ms^{-1}).

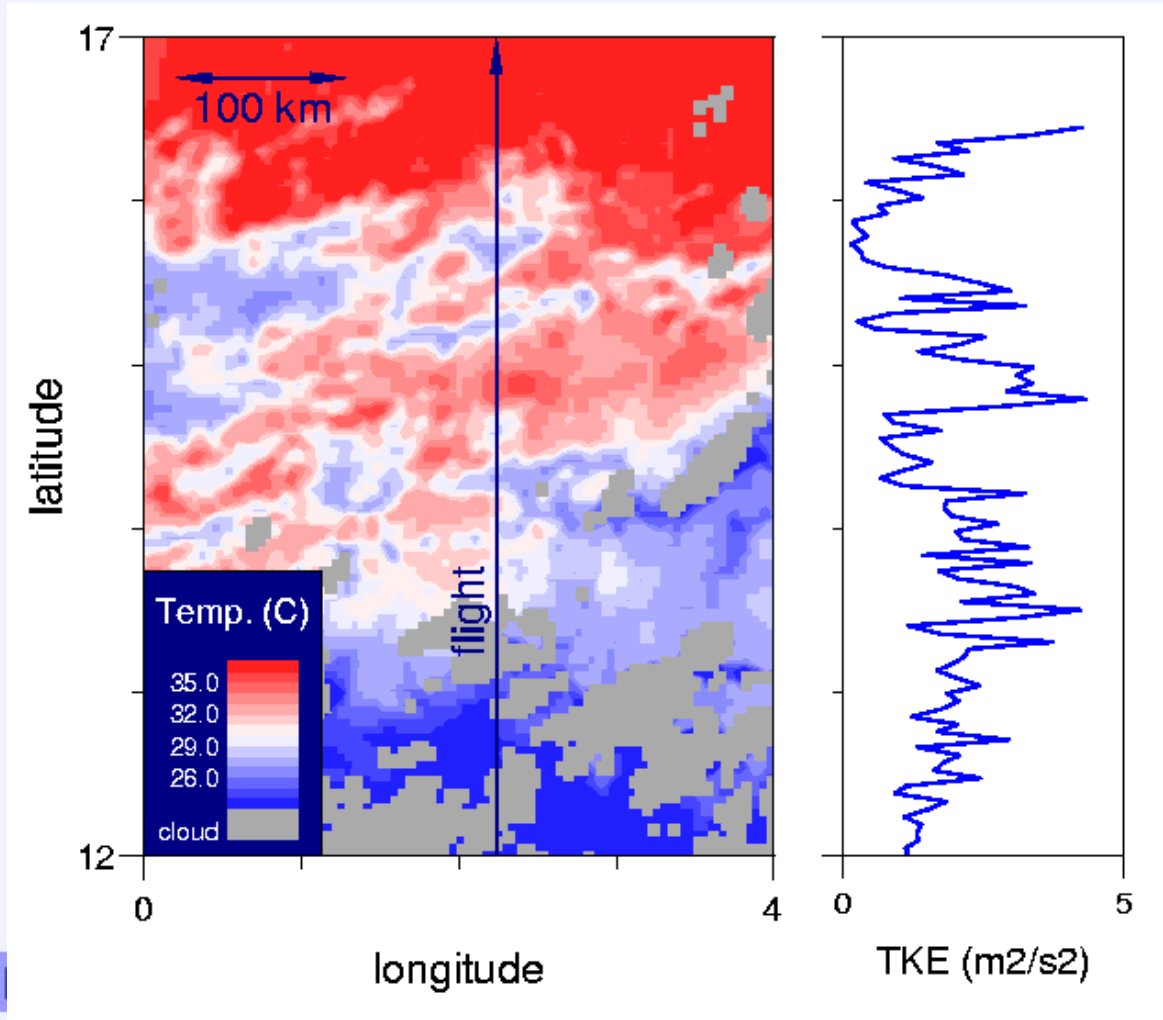
Note diurnal cycle.

3. Soil moisture effects – a case from JET2000



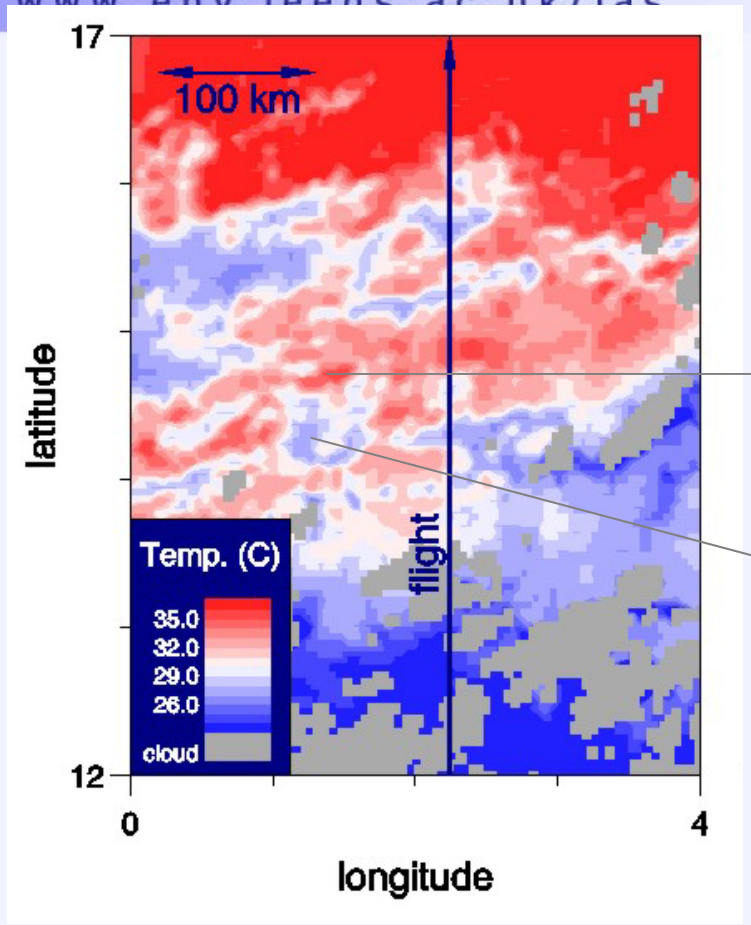
TAMSAT estimated rainfall; 27 August 2000

Surface temperature (Chris Taylor, CEH)

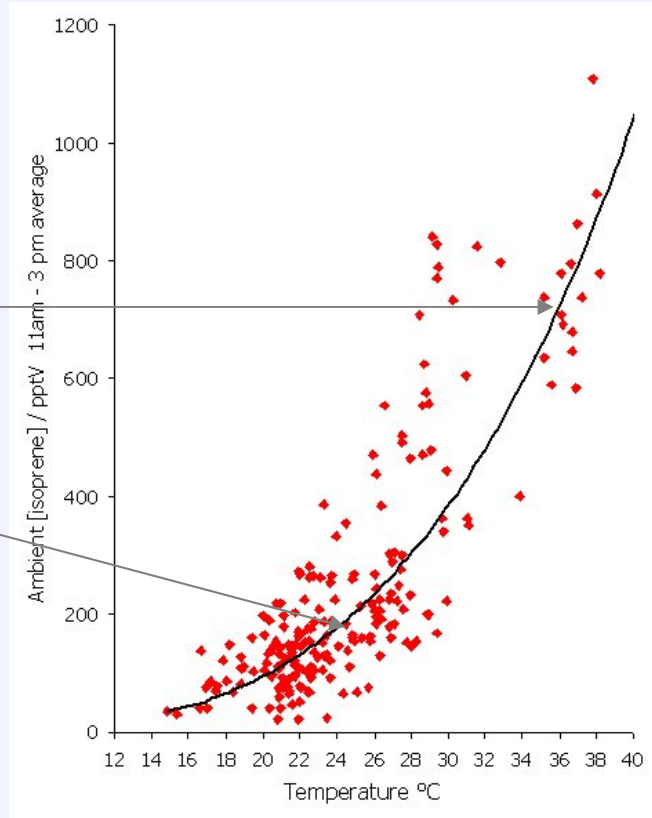


west African monsoon dynamics

- By day, the boundary layer 'maps' onto soil moisture
- By night, airflow responds to pressure gradients
- The next day …



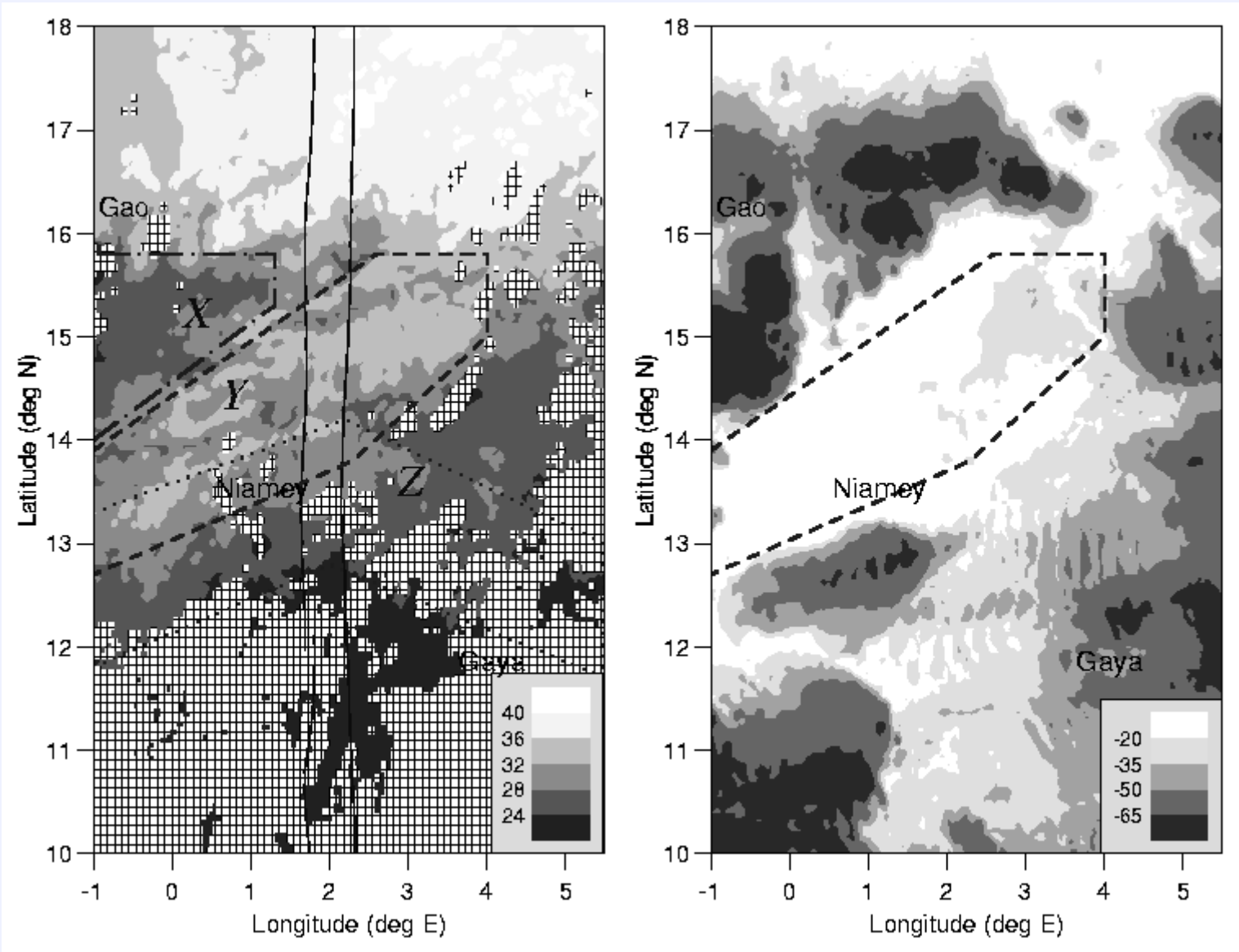
Isoprene against temperature



(Ally Lewis, York)

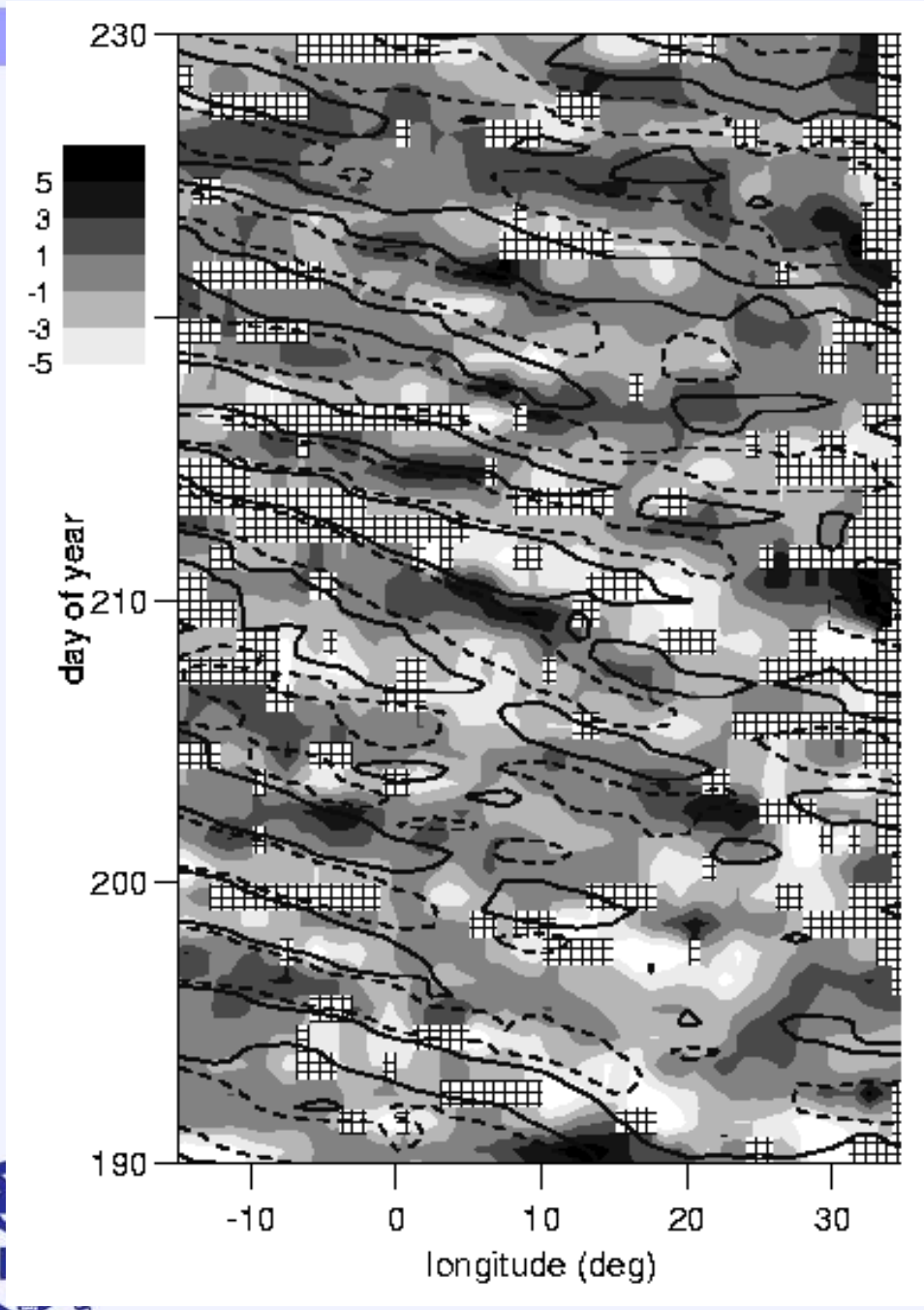
- West Africa may account for peak global biogenic emissions
- Isoprene emissions are the largest source of reactive carbon in the atmosphere

Taylor *et al*, QJRMS, 2003



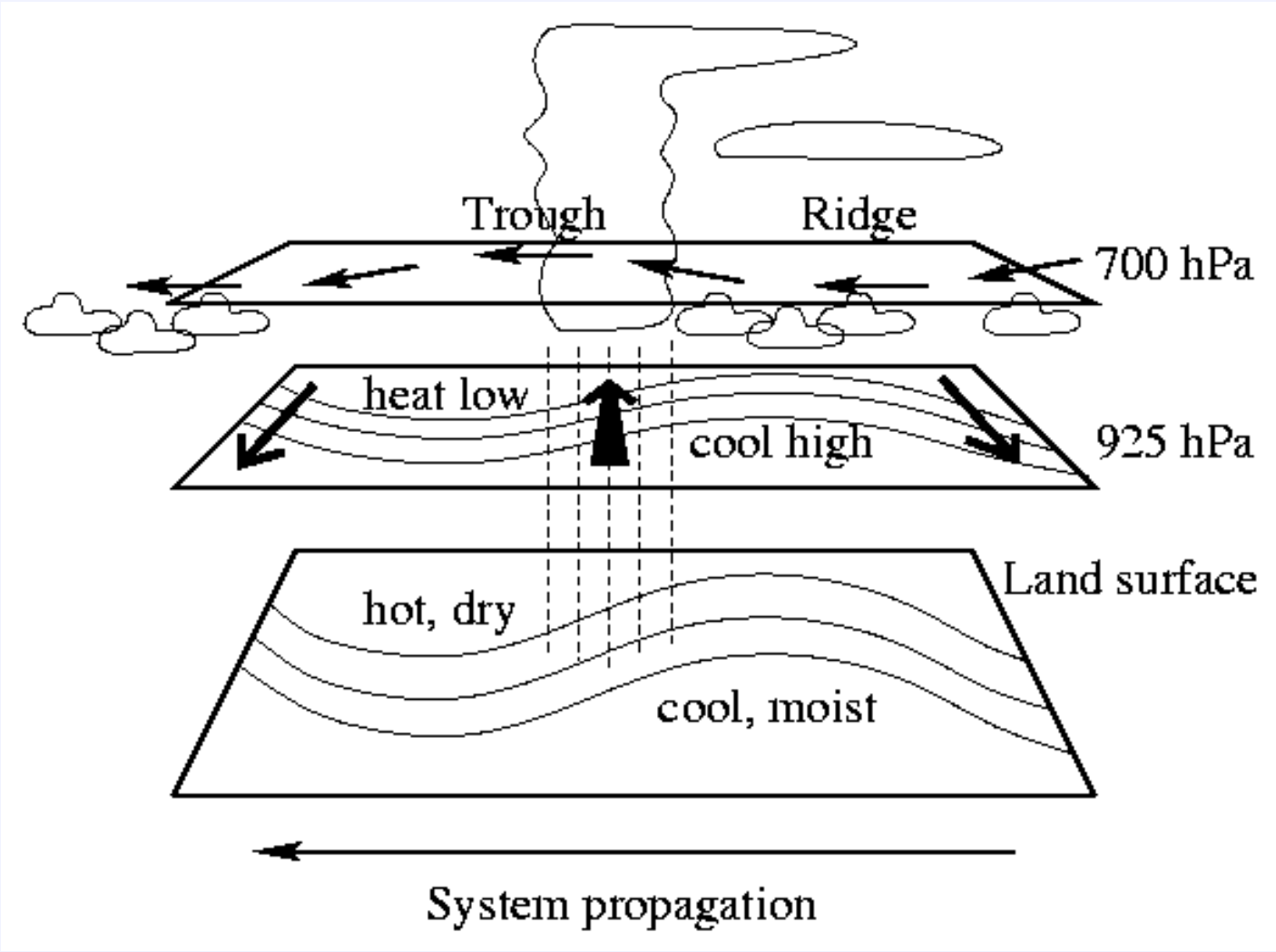
Surface temperature 28 Aug

Min. cold cloud temperature 28-29 August



Cloud-screened METEOSAT surface temperature estimate (shaded); 700 hPa v-wind (contoured).

Taylor *et al*, QJRMS, 2005


Trough
Ridge
700 hPa
heat low
cool high
925 hPa
Land surface
hot, dry
cool, moist
System propagation

Storm maintenance and propagation

- Dry mid-level air (e.g. SAL – strong downdraughts
- Heavy rainfall (relation to CCN / IN?)
- Shear (e.g. AEJ)

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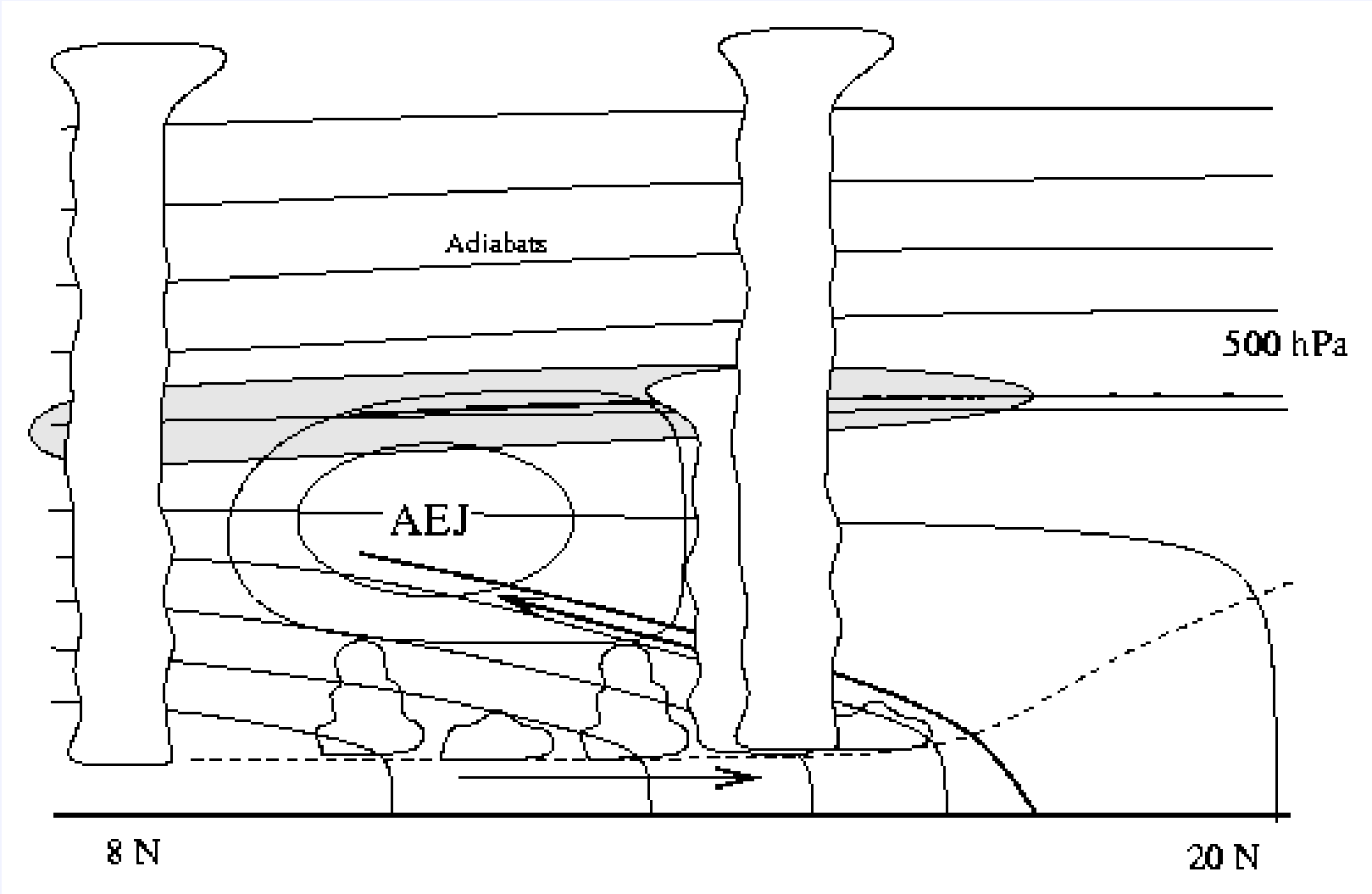
Adiabats
500 hPa
AEJ
8 N
20 N

WP2.1.1 objectives

- Large-scale control of rainfall
  - Upper-level features
  - Dry intrusions from north
  - SAL intrusion
  - Continental-scale boundary layer
- Heat low dynamics
  - regional and synoptic (northern AEWs)
  - Dust-radiative impacts

WP2.1.2 objectives

- Dynamics of AEWs
  - Forcing by (dry and moist) convection
  - Downstream lifecycle
- Role of SAL (radiative-convective-dynamical)
- Case studies in ground-based data and analyses

WP2.1.3 objectives

- Convective systems (synoptic forcing?)
  - Triggering, growth, decay, propagation, diurnal cycle
- Influence of land surface (topography / moisture) on convective fields (including *congestus*)
- Role of synoptic environment
  - SAL, monsoon layer, shear, upper levels
- Aerosol-microphysics-lightning