

High Impact Weather in Arid and Semi-arid Regions: The Case of Dust Storms



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Introduction

- What is a dust storm ?

An ensemble of particles of dust or sand energetically lifted to great heights by a strong and turbulent wind

[reducing visibilities to less than 1,000 meters]



A dust storm in the form of dust wall observed at Niamey (Sahel) at the beginning of the rainy season on 05/07/2010 at 15h15 LT

Introduction



- Impacts of dust storms

- Socio-economic

- ✦ Health (Meningitis, Respiratory and Pulmonary Problems physical damage to the epithelial cells lining the nose and throat, etc.)
 - ✦ Transport (aviation, road)

Introduction

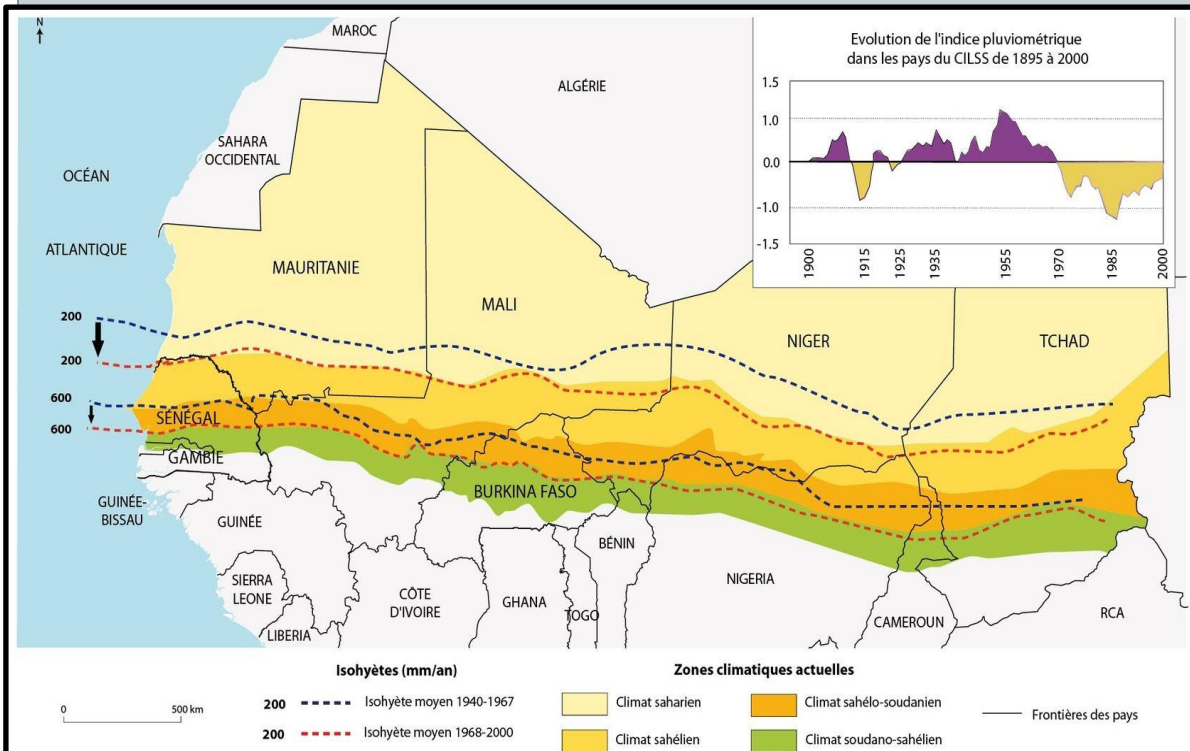


- Impacts of dust storms

- *Climate & Environmental*

- ✦ Sahara & Sahel are the main source of desert dust worldwide (Prospero et al., 2002).
- ✦ Dust a major atmospheric pollutant:
 - 400 to 700 megatons of aerosols produced by the Sahara and the Sahel per year (Bach, 1976).
 - Estimated to 1,900 megatons worldwide of which 240 Mt for long-range transport related particles (D'Almeida, 1986).
- ✦ *Impact on radiation budget*
- ✦ *Interaction with clouds*

Meteorological Processes Responsible for Dust/Sand Storms

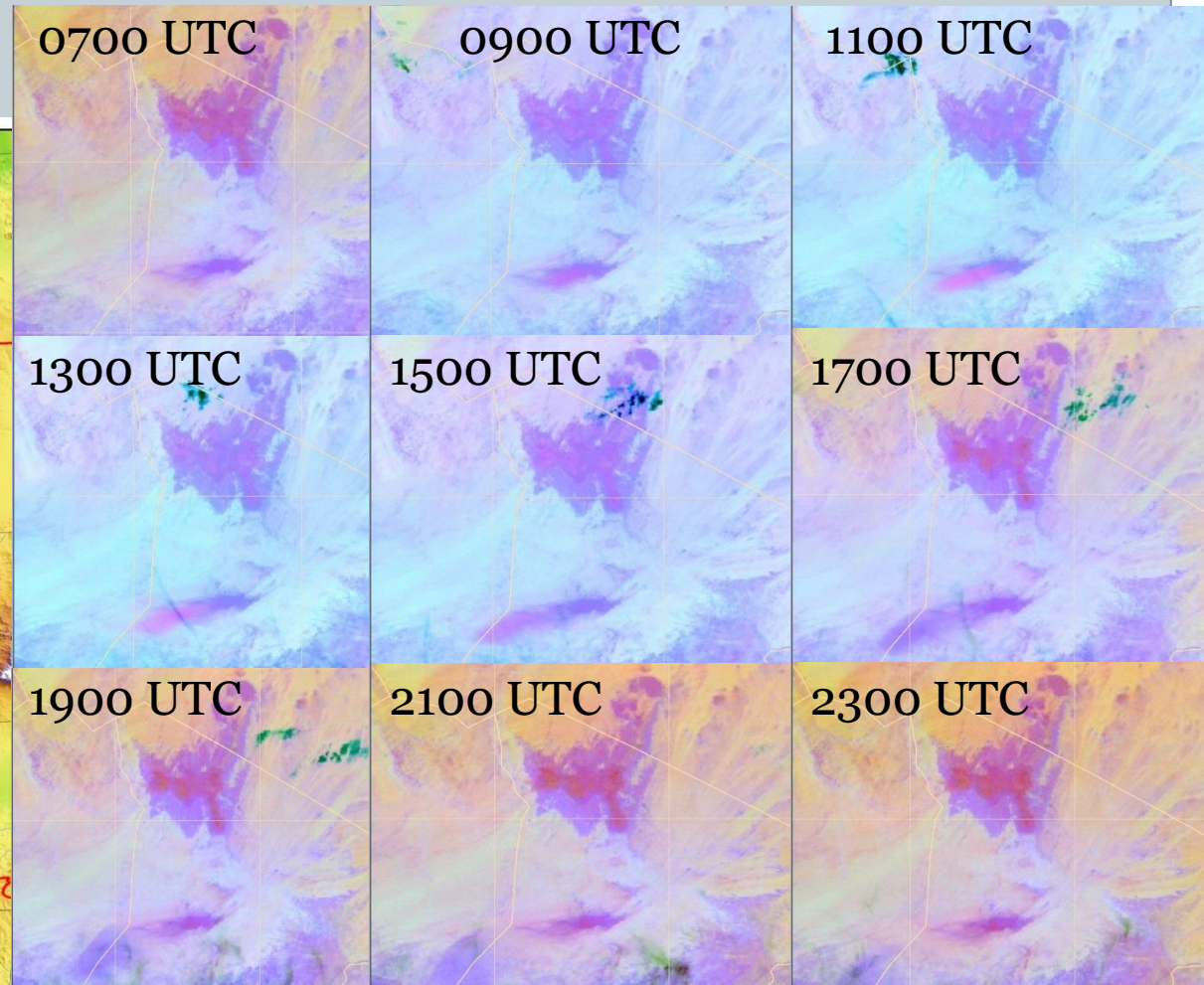
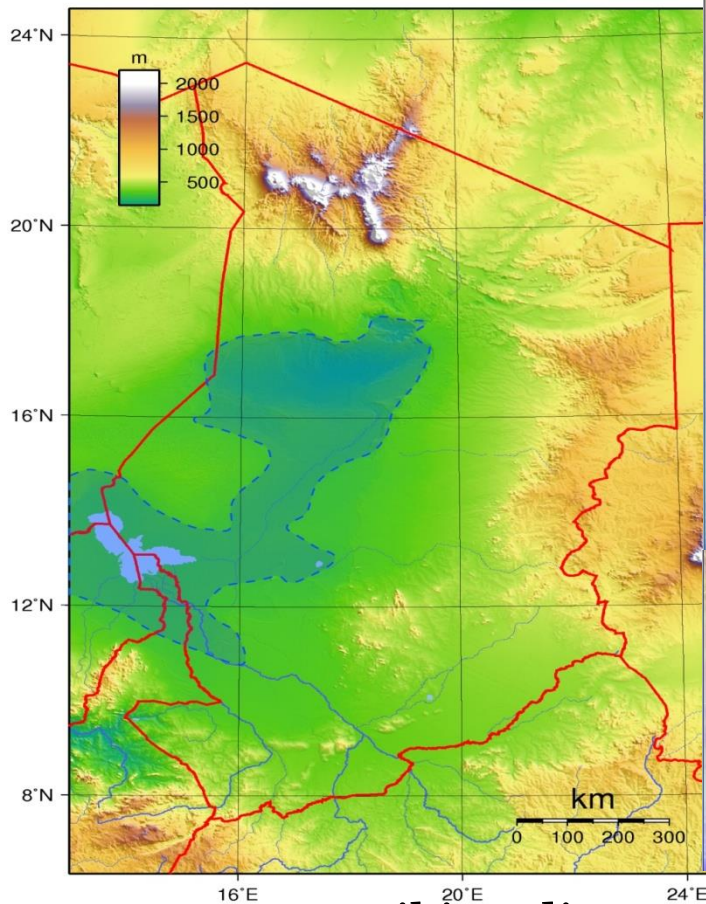


Evolution of RR indices in CILSS Countries from 1895 to 2000
 Source : Centre Régional Agrhymet (CRA), CSAO/OCDE (2005)

Meteorological Processes Responsible for Dust/Sand Storms: Local Scale Processes

❖ LLJ

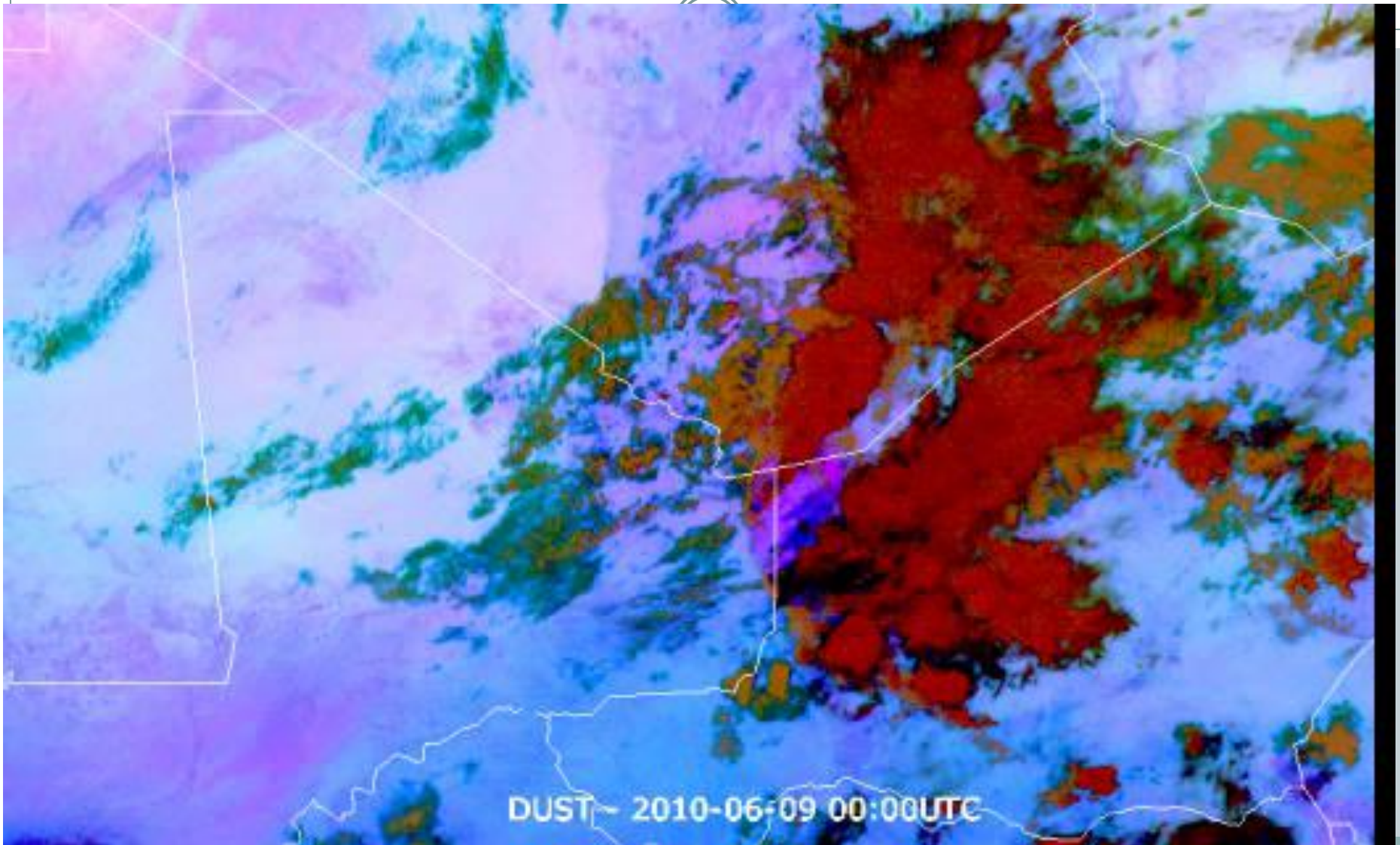
❖ Katabatic Winds



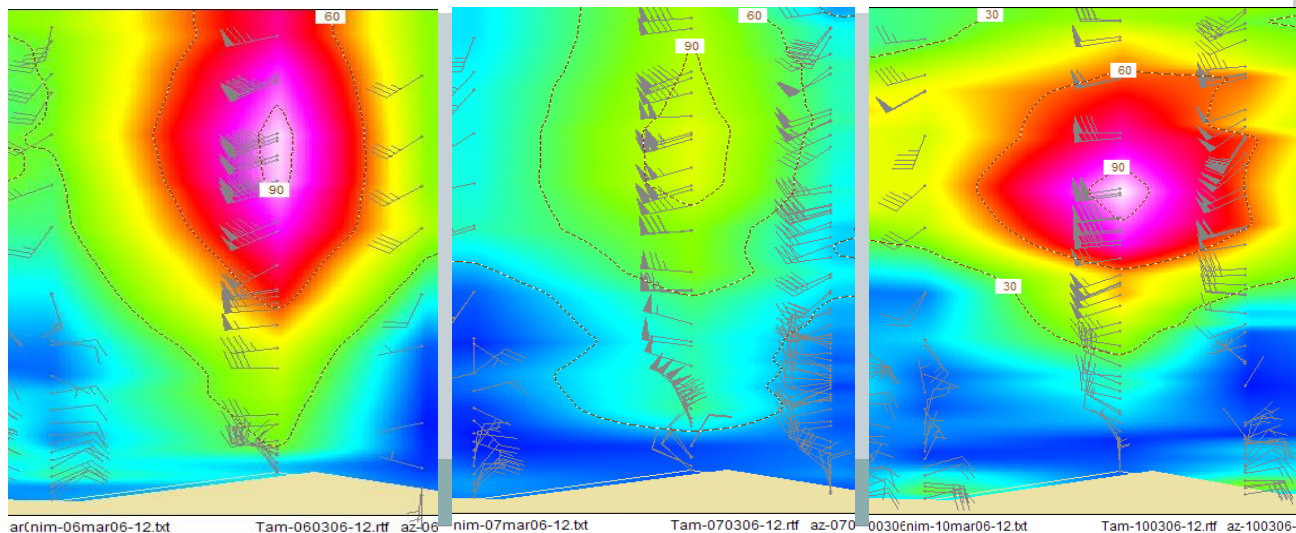
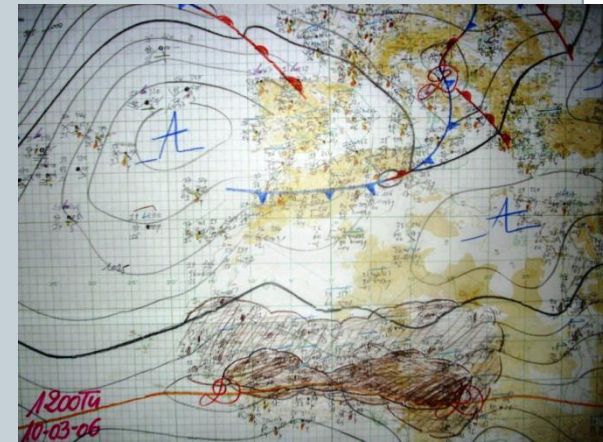
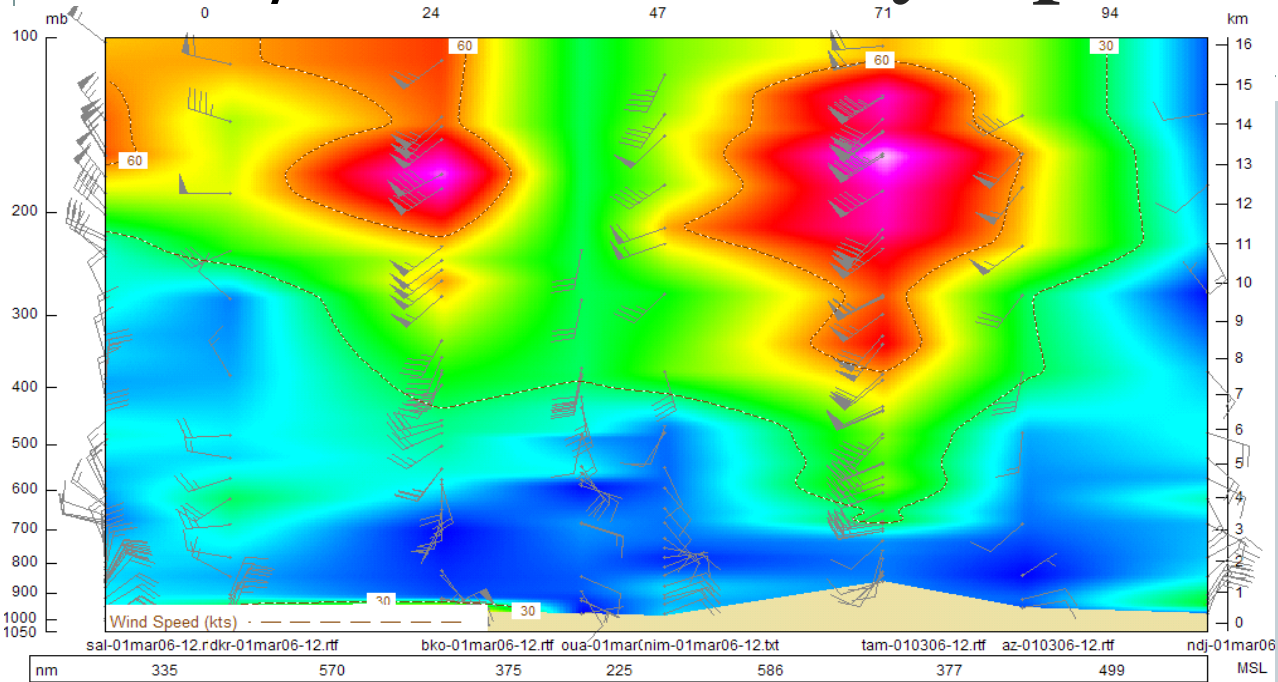
Source: wikimedia

Dust RGB, 25-12-2013 2013

Meteorological Processes Responsible for Dust/Sand Storms: Mesoscale Processes

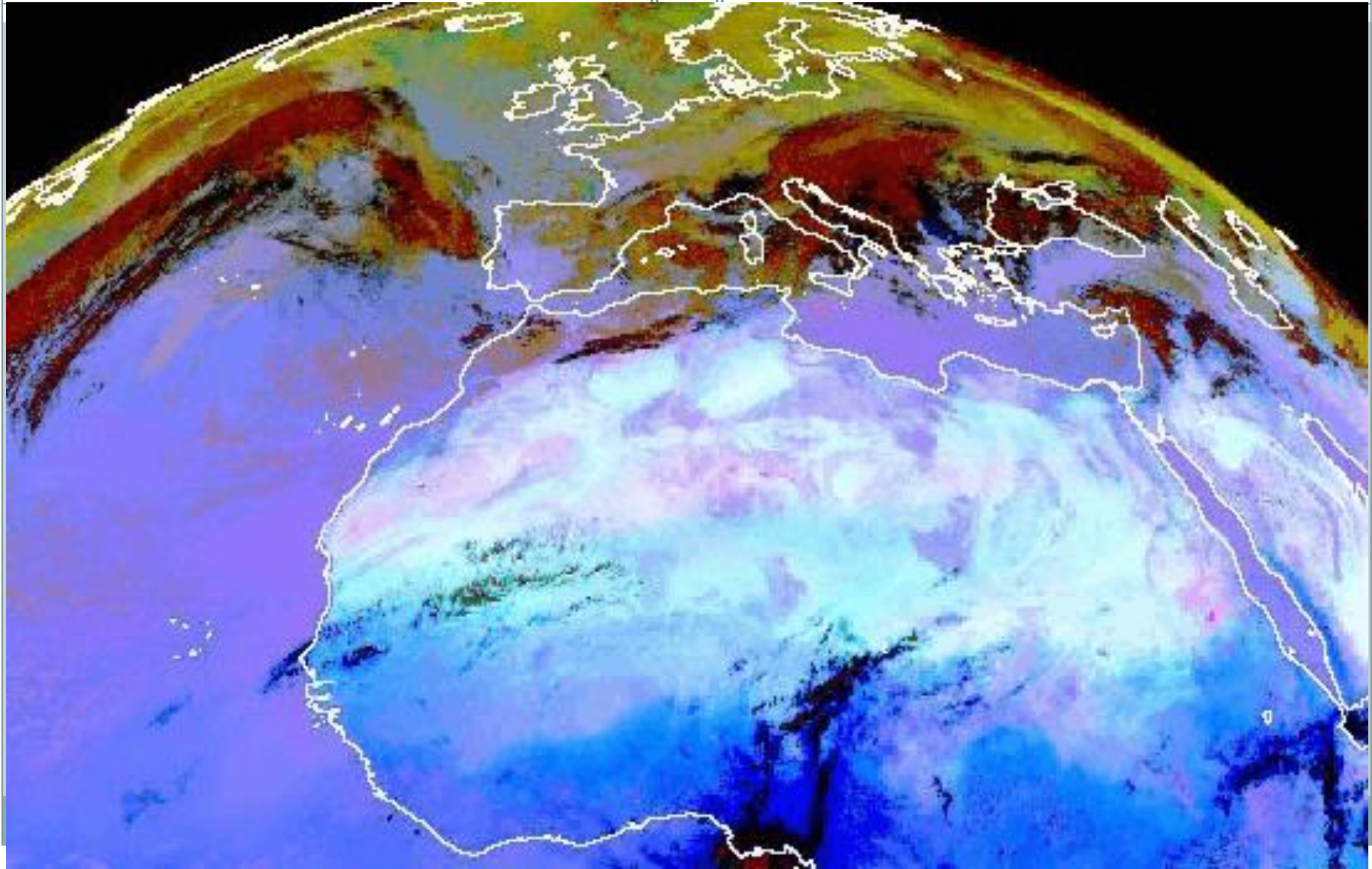


Meteorological Processes Responsible for Dust/Sand Storms: Synoptic Scale Processes

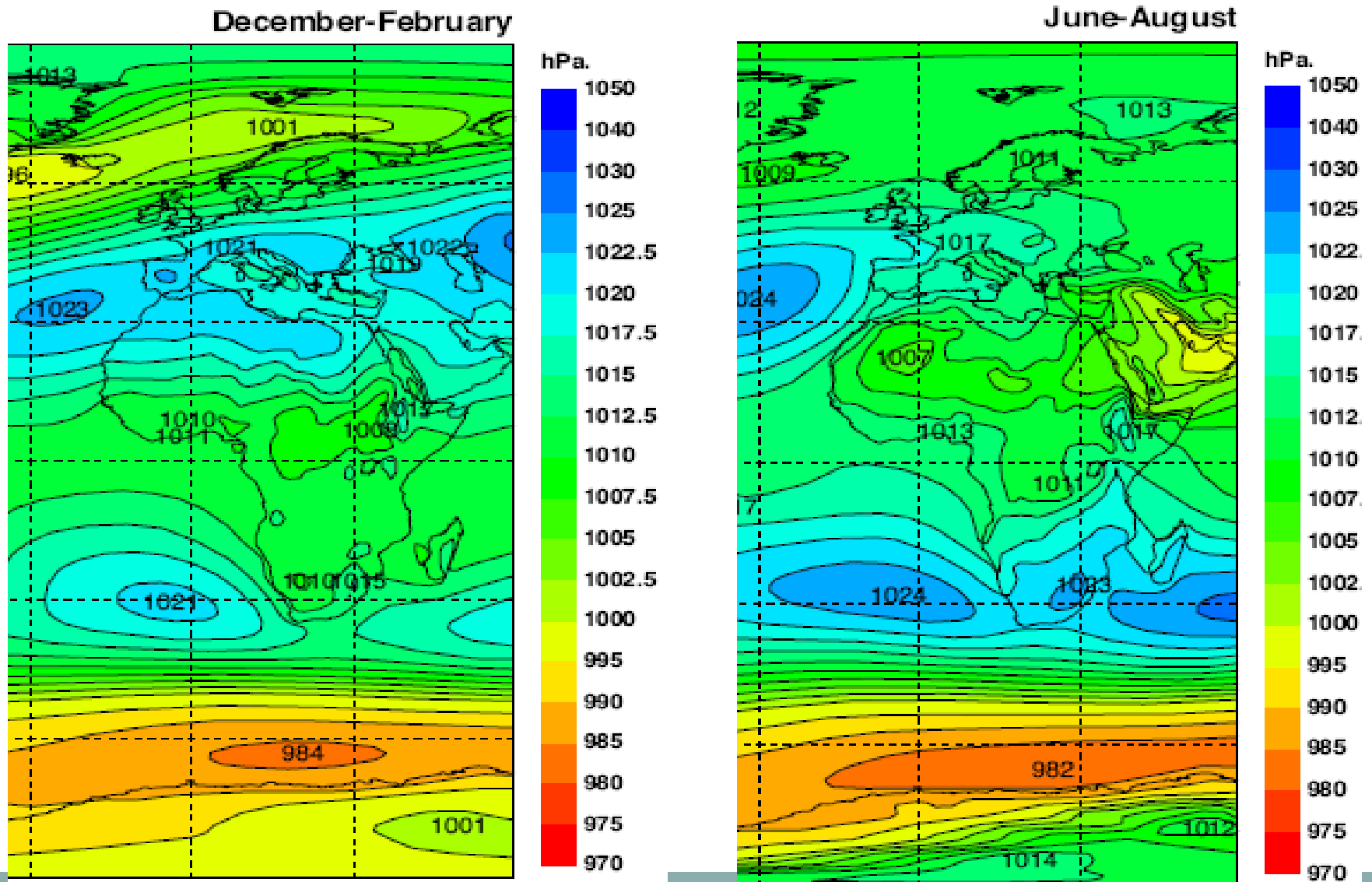


Dust RGB Loop :

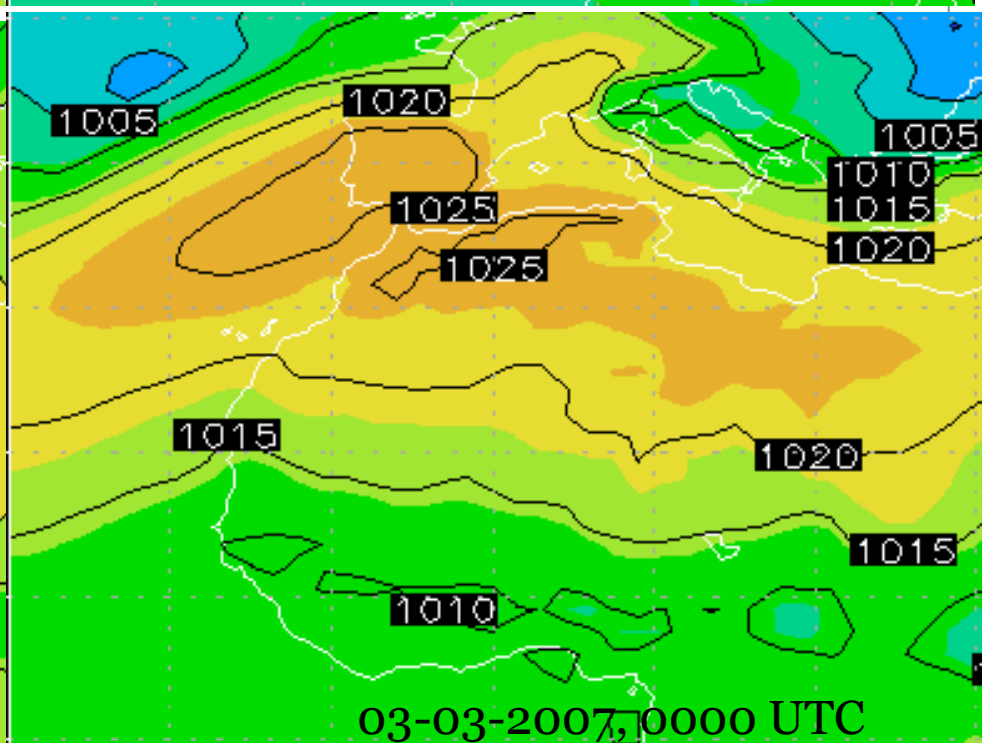
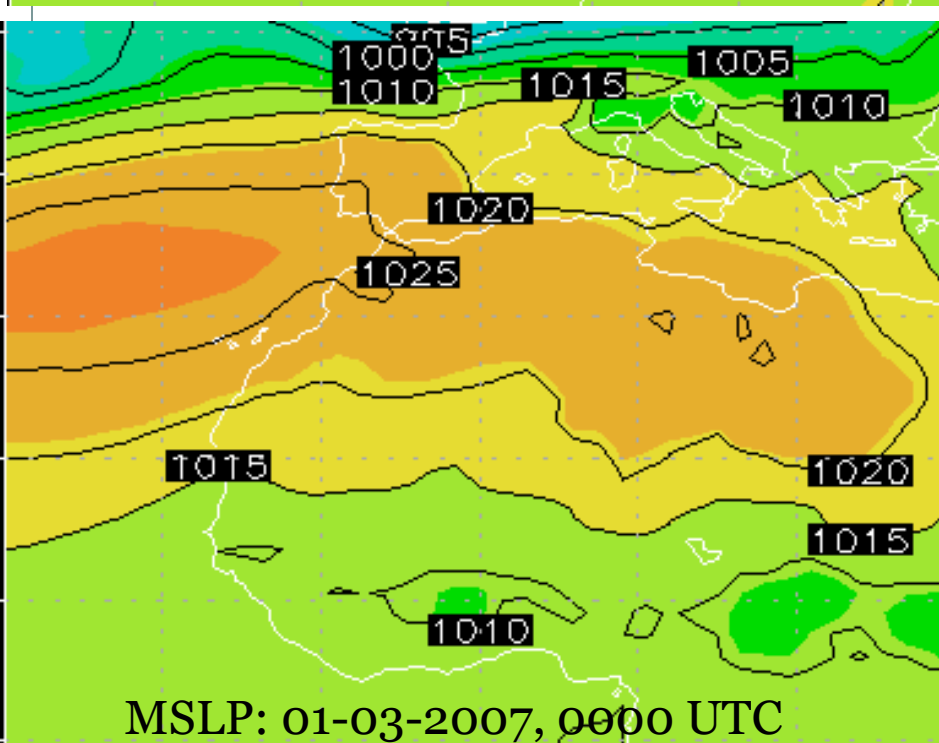
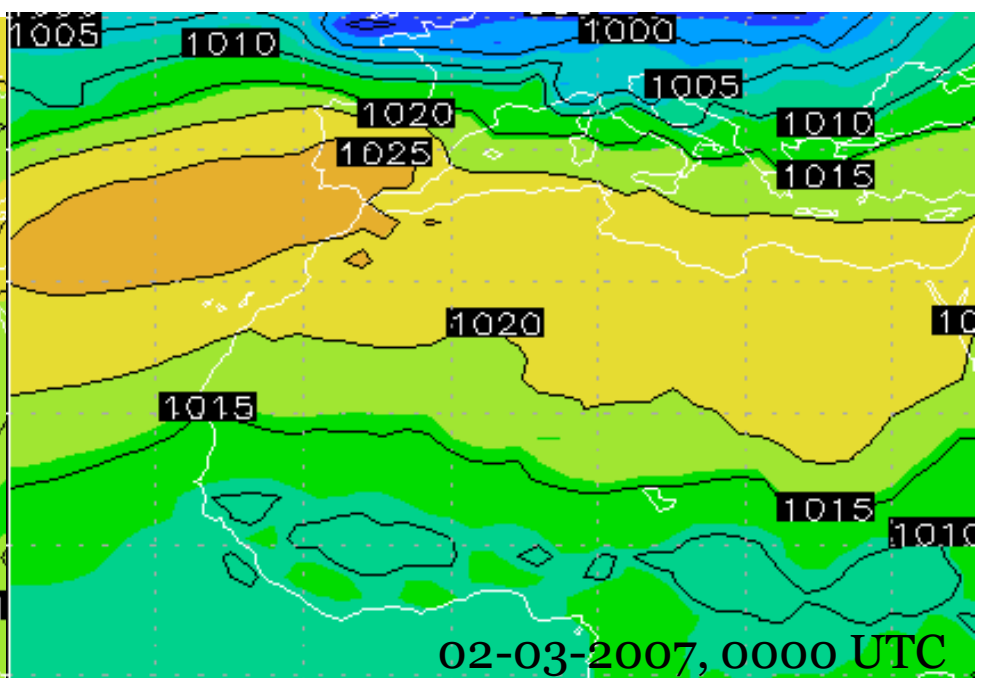
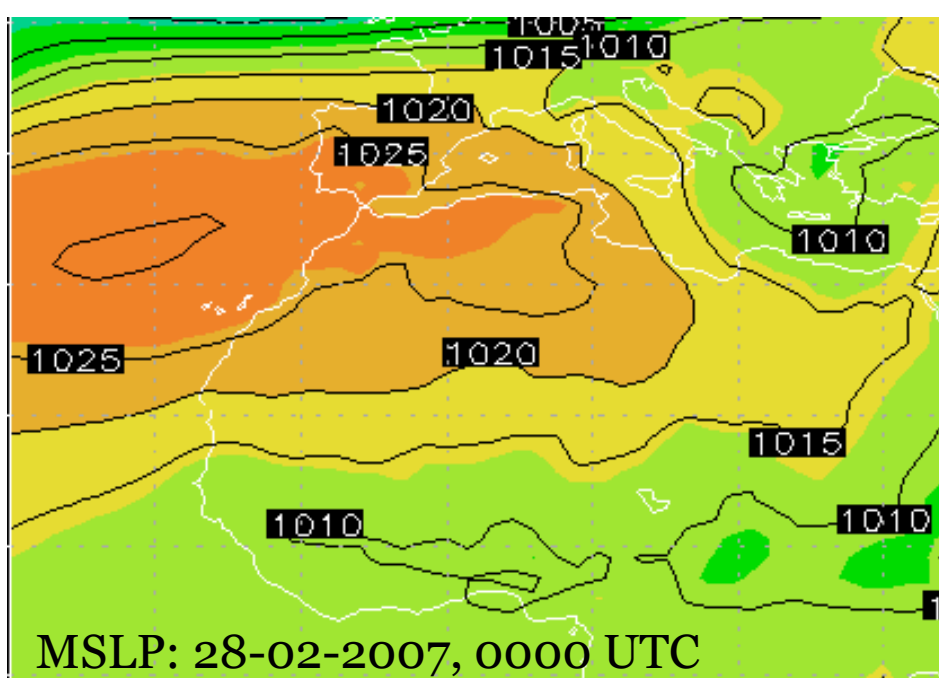
From 5 Mar 2006 @1200 UTC to 8 Mar 2006 @ 1400 UTC

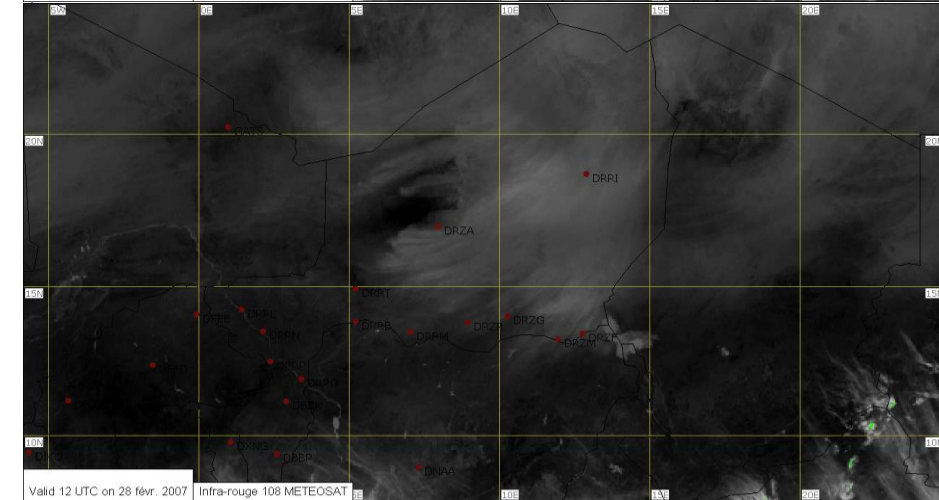
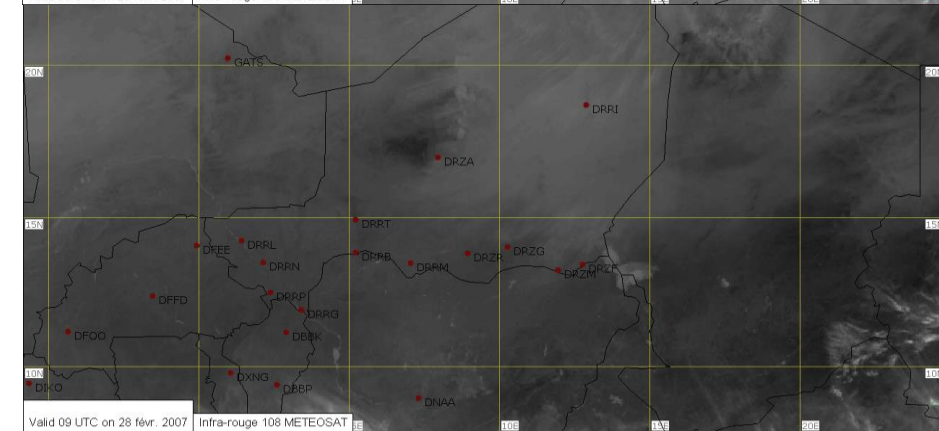
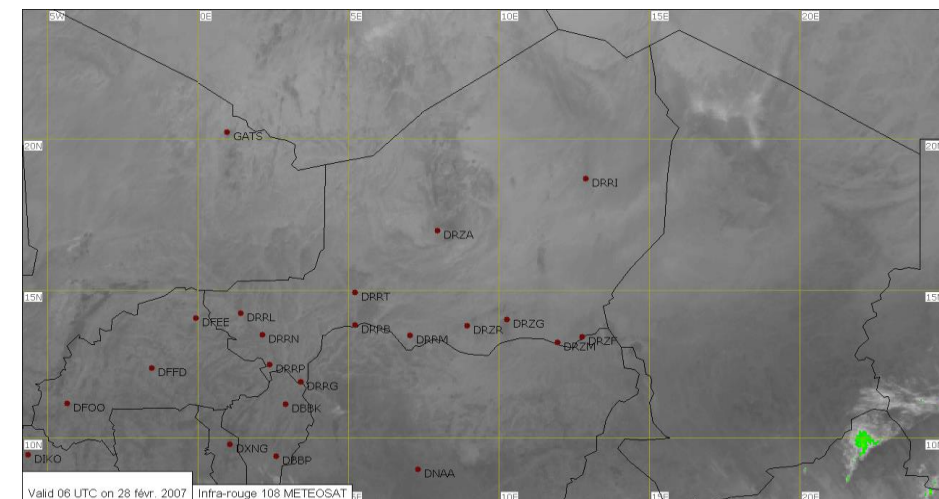


Meteorological Processes Responsible for Dust/Sand Storms: Synoptic Scale Processes

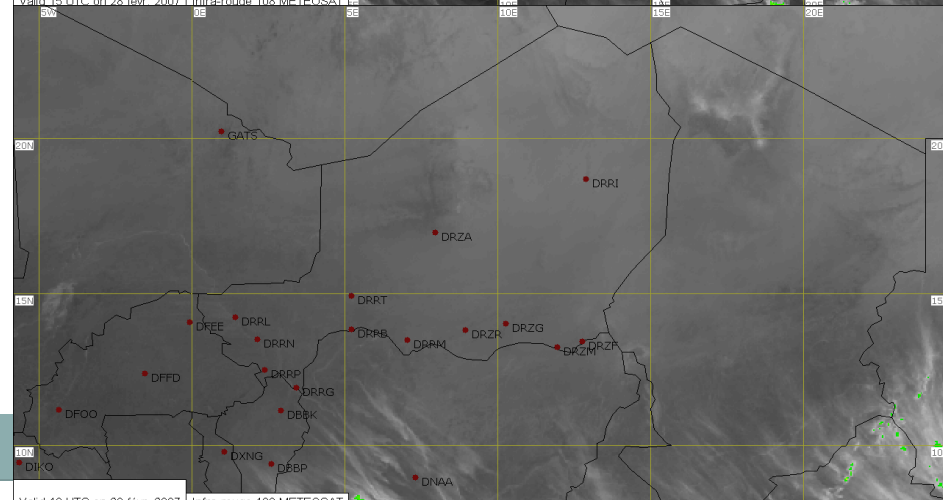
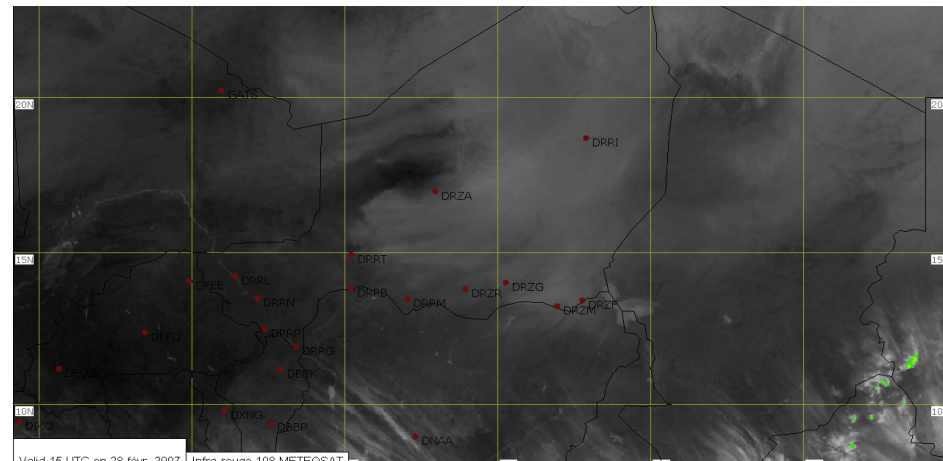


Long Term Seasonal MSLP, ERA40 Reanalysis (1952-2002)

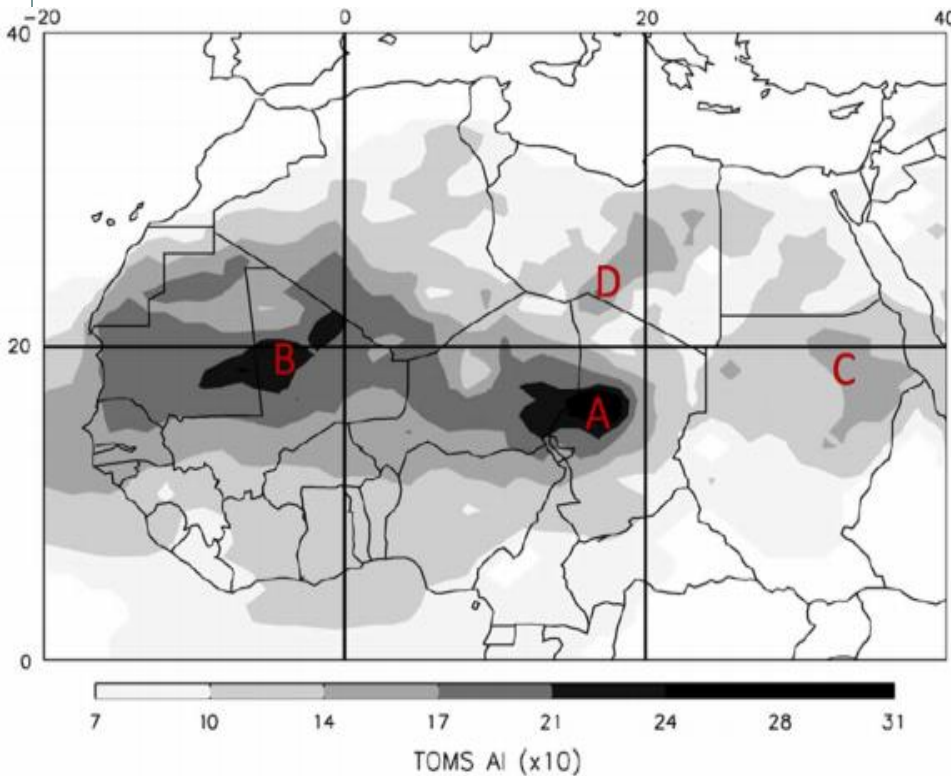




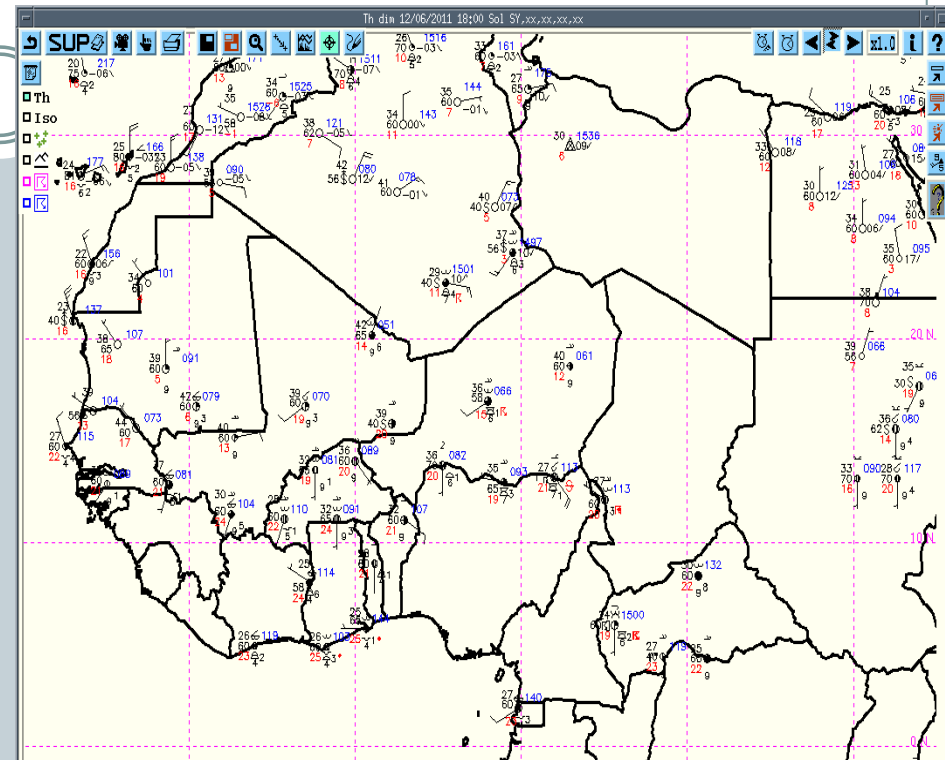
METAR DRZA 280700Z **00000KT CAVOK** 18/Mo8
 Q1016 =
 METAR DRZA 280900Z **10017KT 8000** NSC 27/Mo8
 Q1017=
 METAR DRZA 281200Z **10019KT 4000** BLSA NSC
 28/Mo6 Q1017=
 METAR DRZA 281500Z **08016KT 6000** NSC 29/Mo1
 Q1015=
 METAR DRZA 281800Z **10019KT 1600** BLSA NSC
 26/Mo6 Q1015=



Challenges in Dust Storm Forecasting



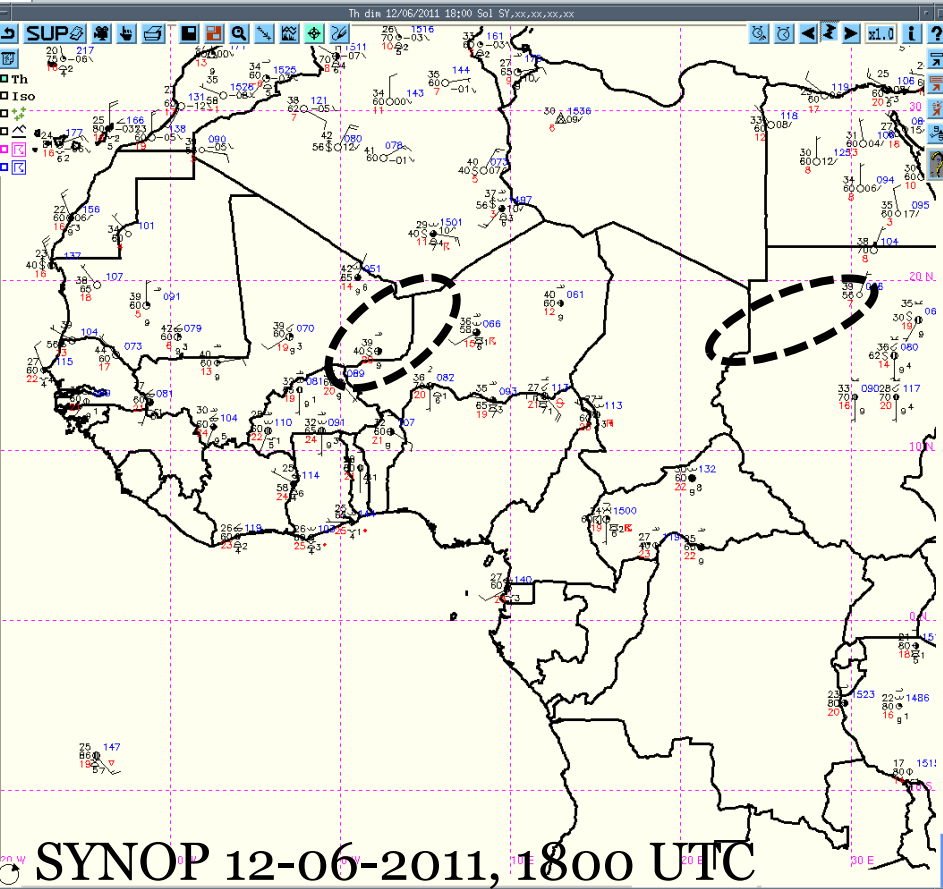
Main dust source regions (d'après Engelstaedter et al., (2006))



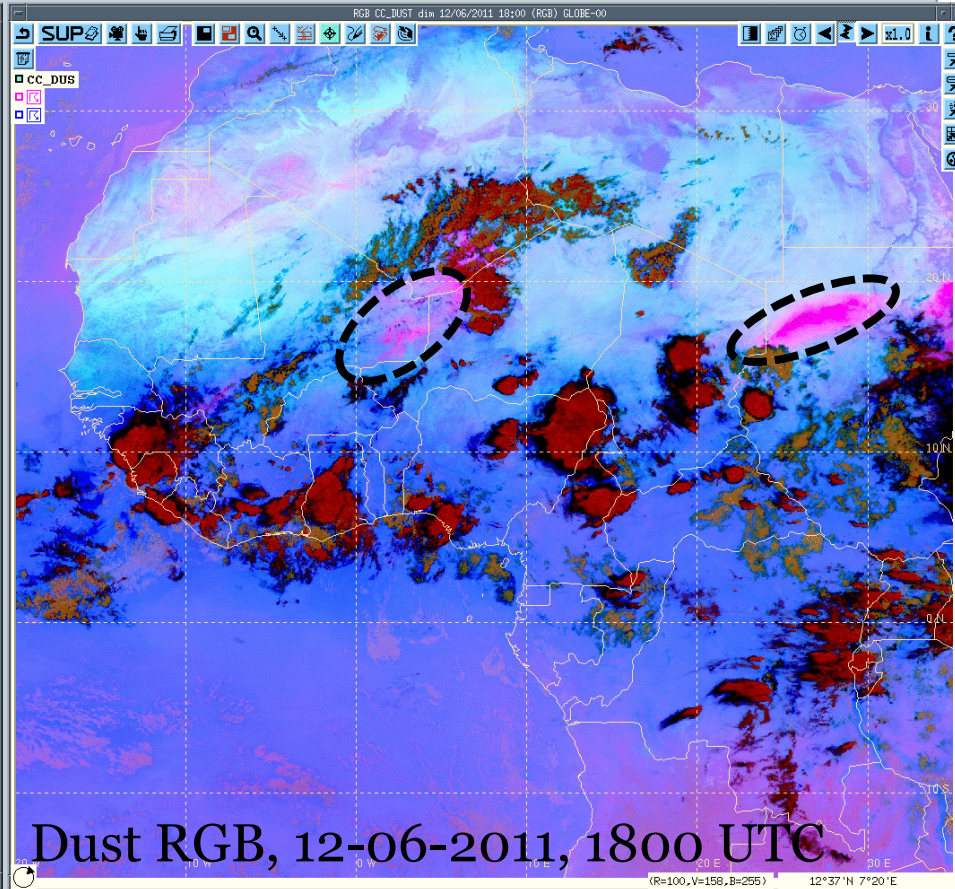
SYNOP 12-06-2011, 1800 UTC

- ❑ Paucity/lack of in-situ observations particularly over the Sahara;
- ❑ Inferring visibility thresholds from satellite imagery for aviation and road transport

Satellite Imagery in Monitoring & Forecasting Dust



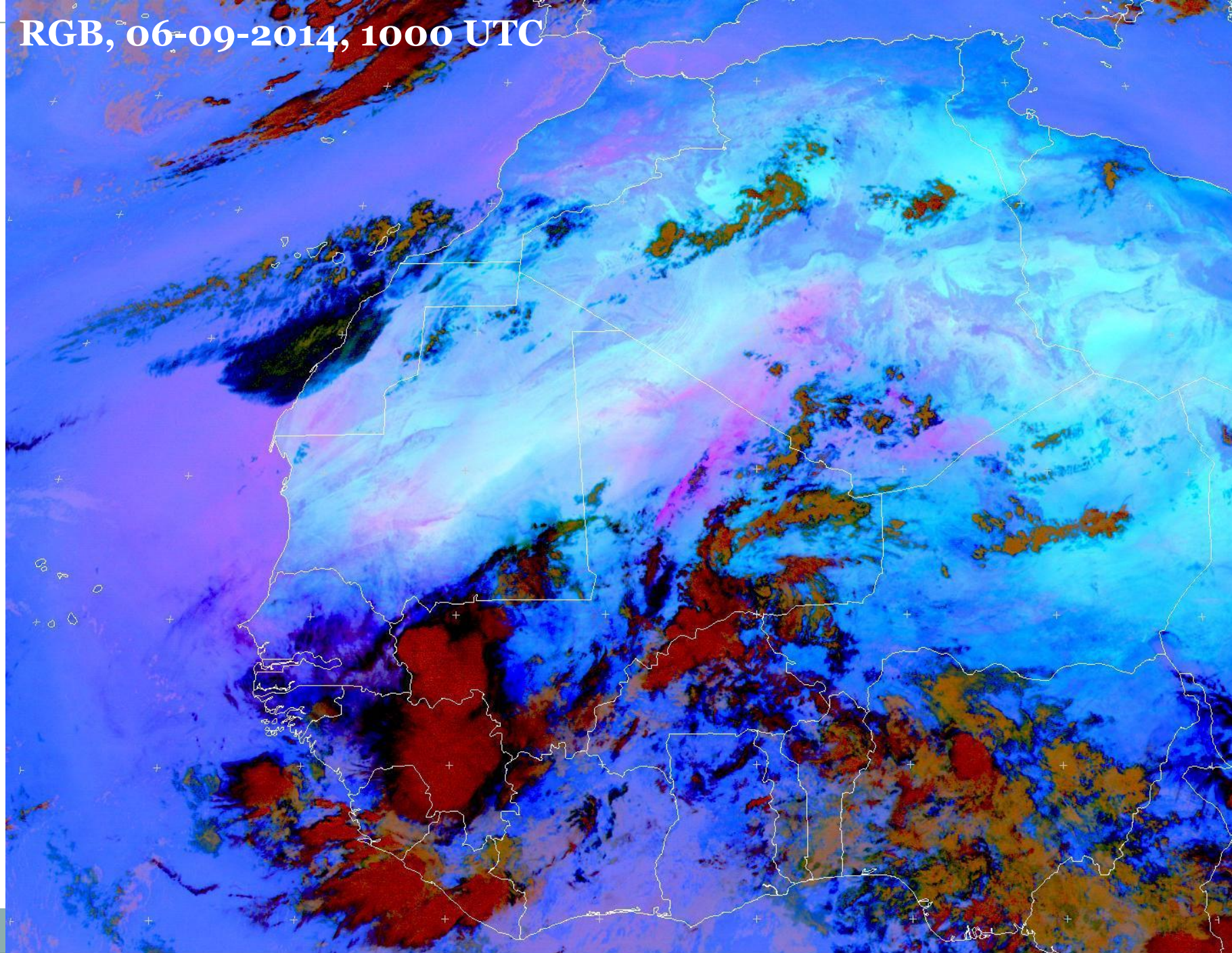
SYNOP 12-06-2011, 1800 UTC



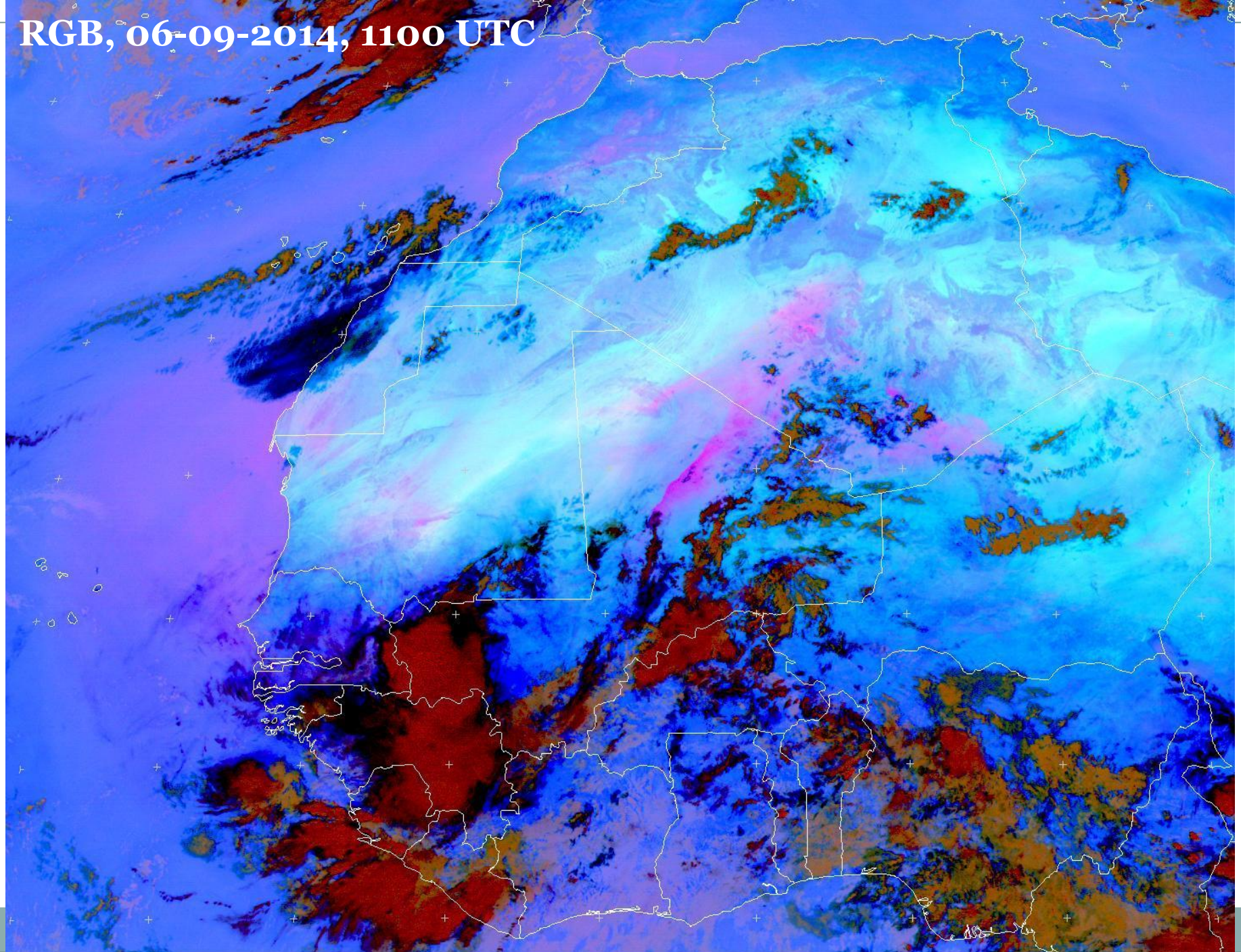
Dust RGB, 12-06-2011, 1800 UTC

(R=100, V=158, B=255) 12°37'N 7°20'E

RGB, 06-09-2014, 1000 UTC

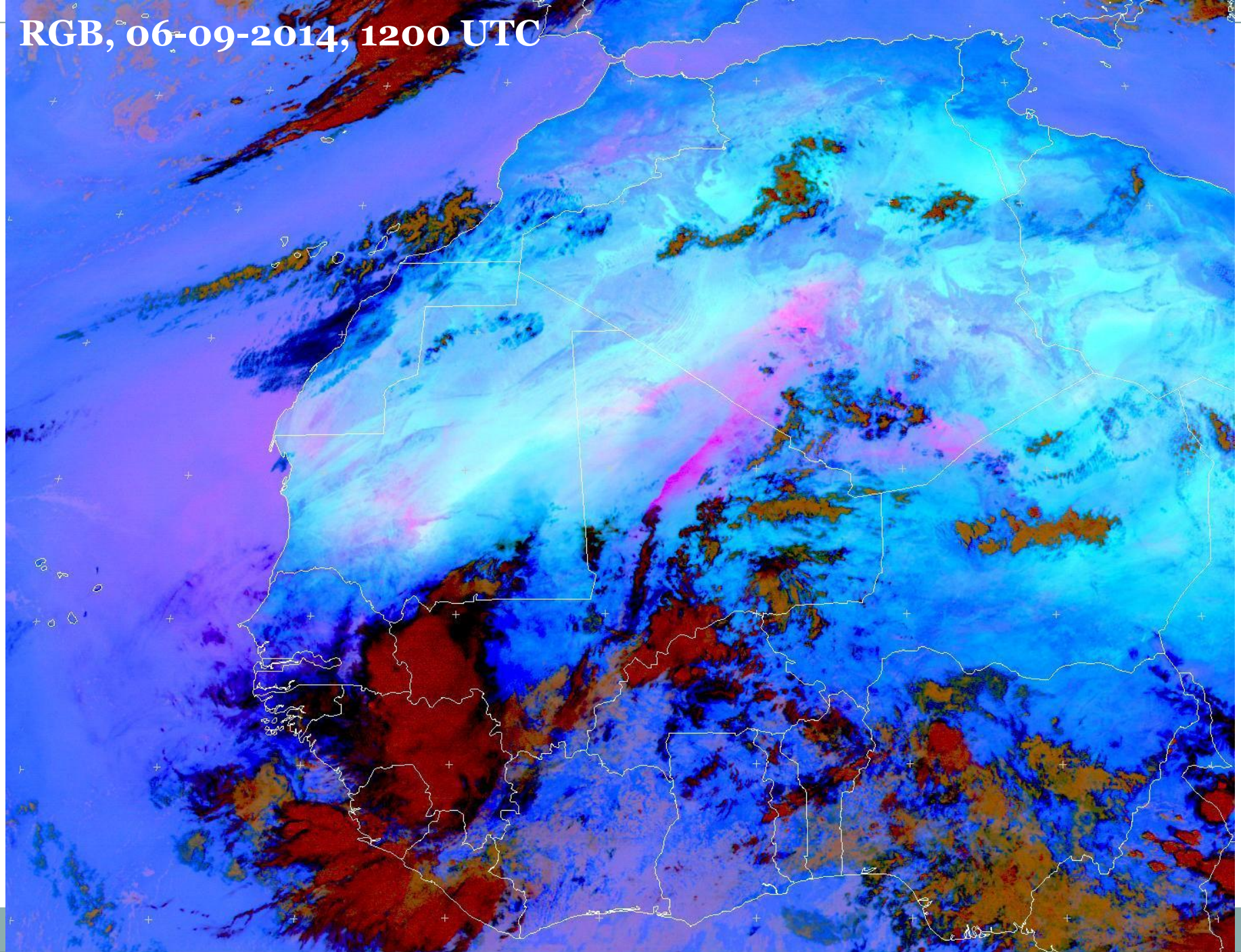


RGB, 06-09-2014, 1100 UTC

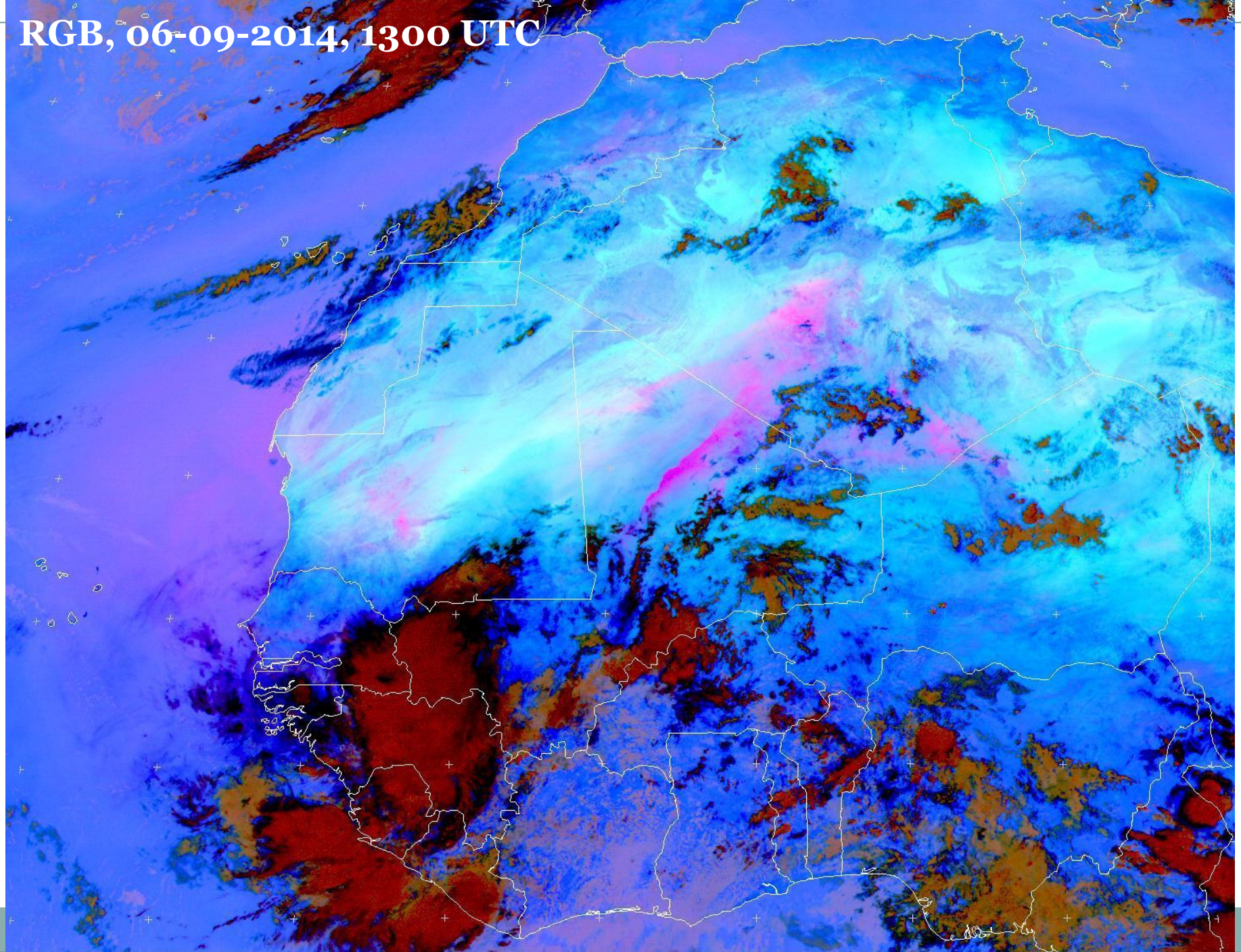


MET10 RGB-Dust 2014-09-06 11:00 UTC

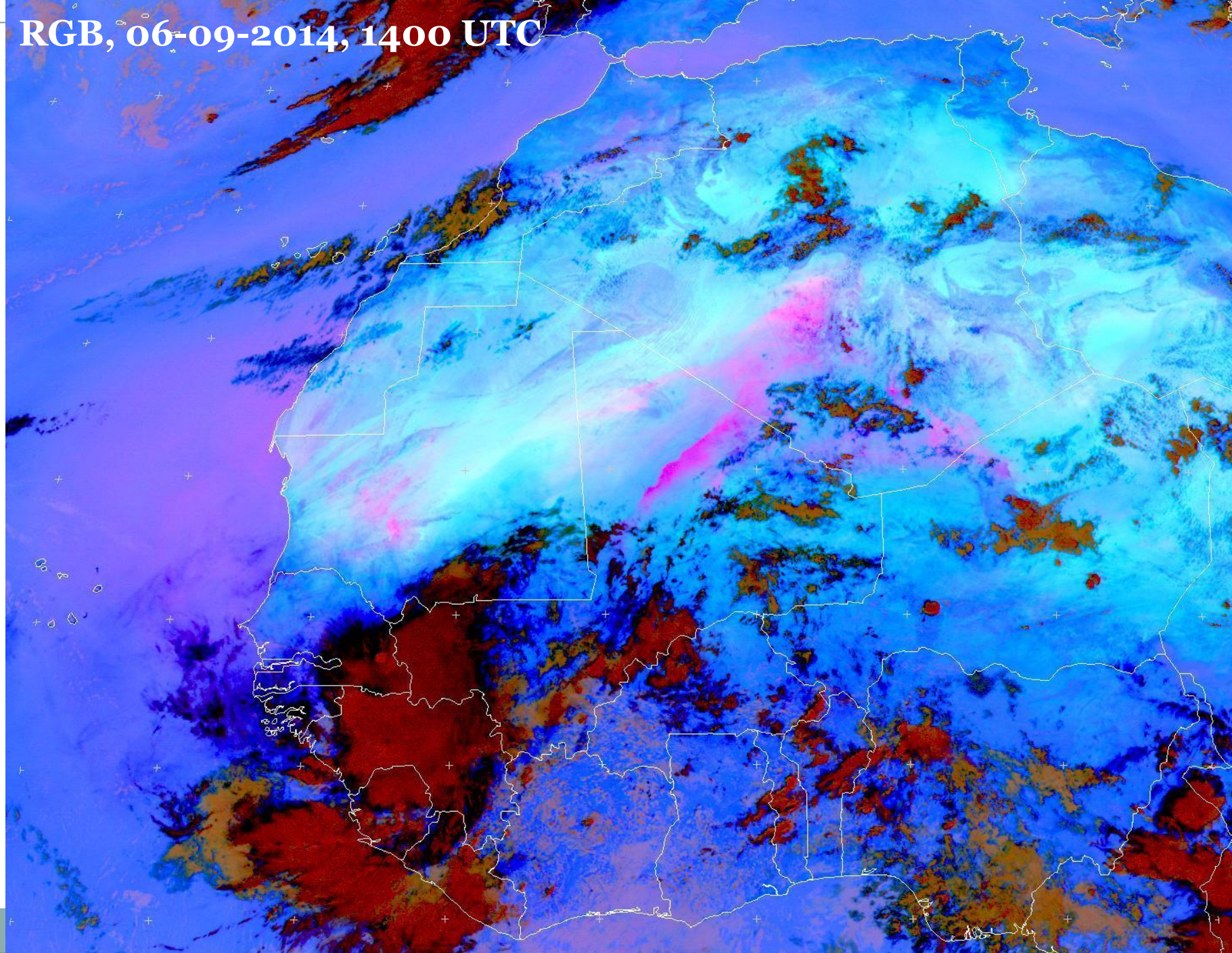
RGB, 06-09-2014, 1200 UTC



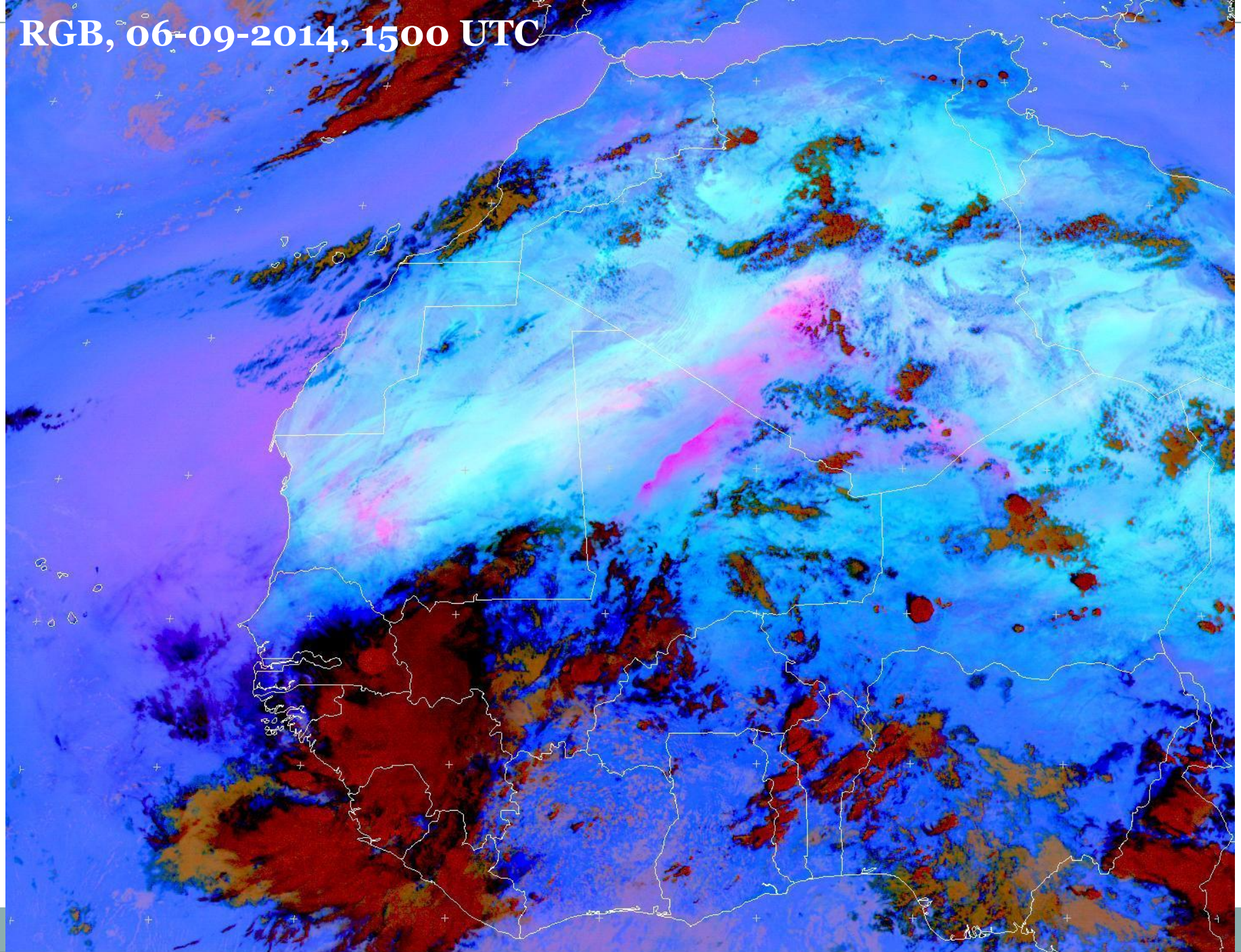
RGB, 06-09-2014, 1300 UTC



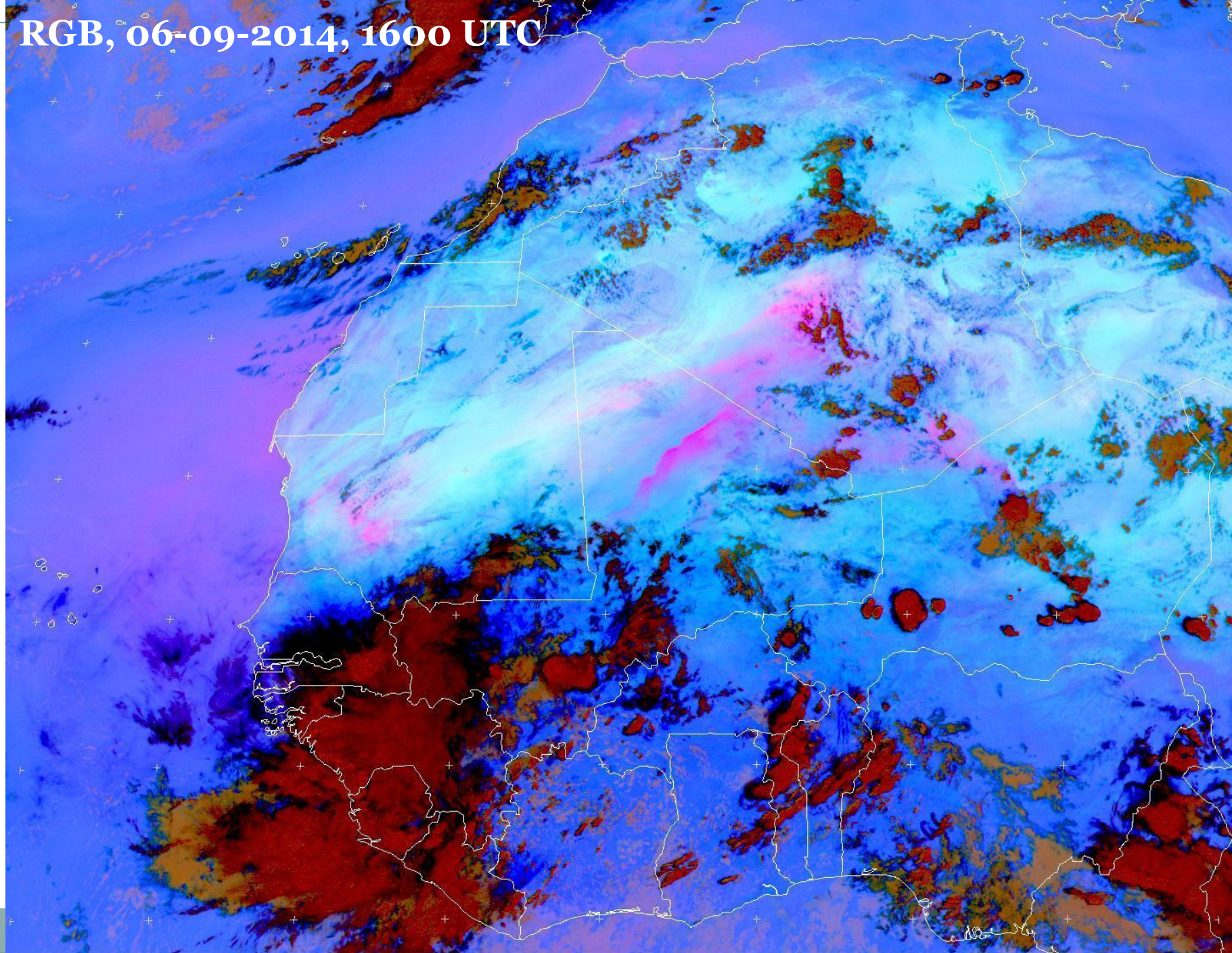
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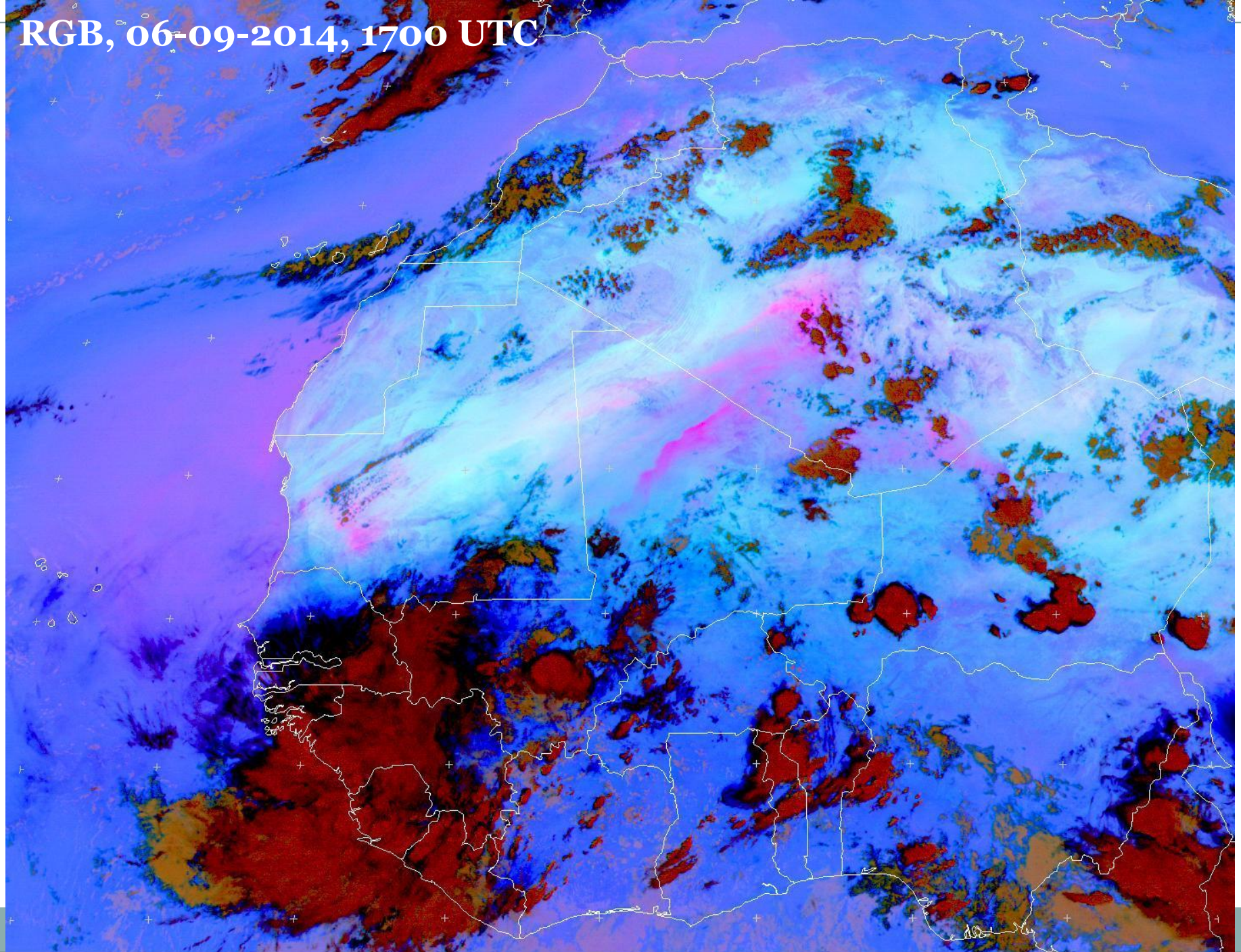
RGB, 06-09-2014, 1500 UTC



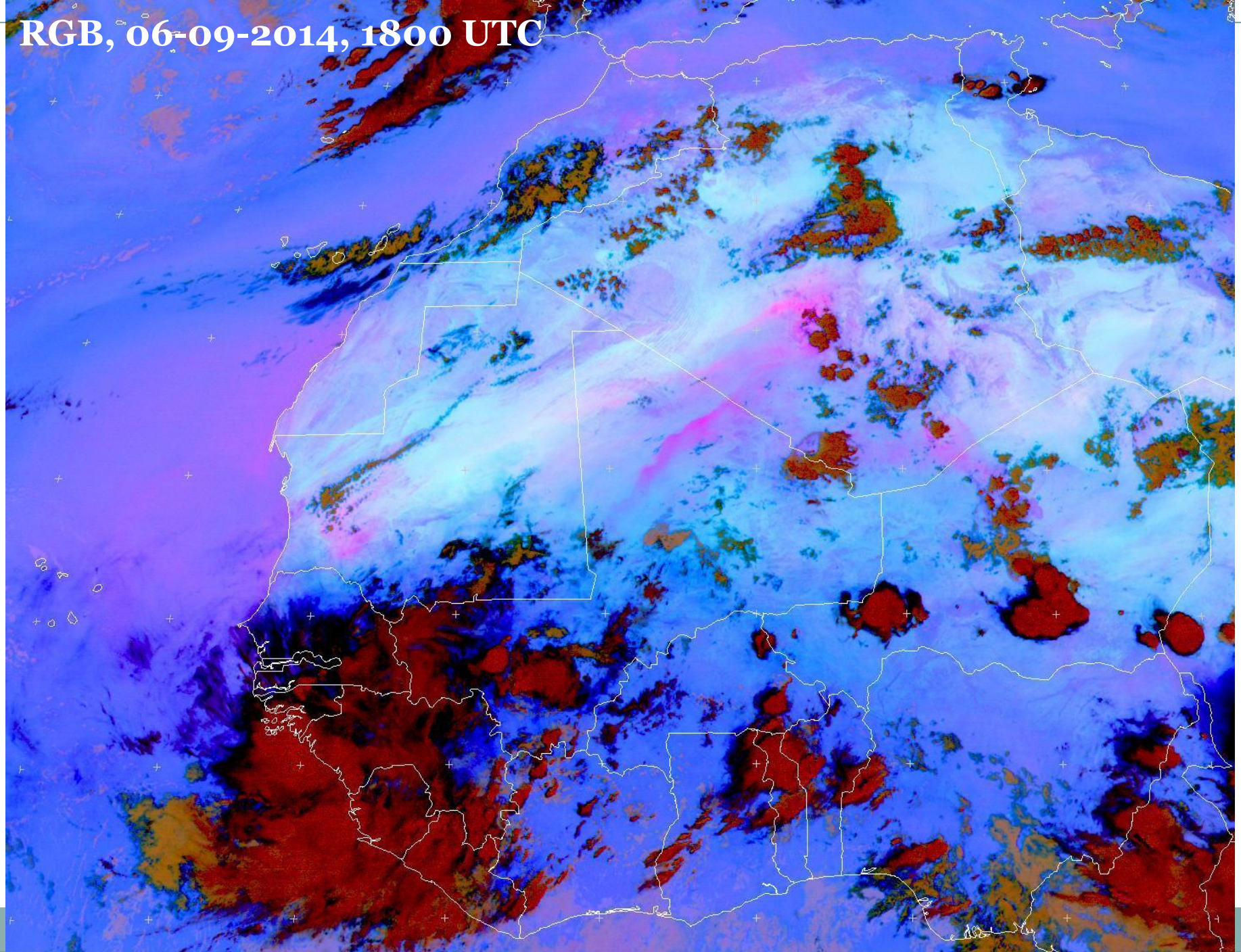
RGB, 06-09-2014, 1600 UTC



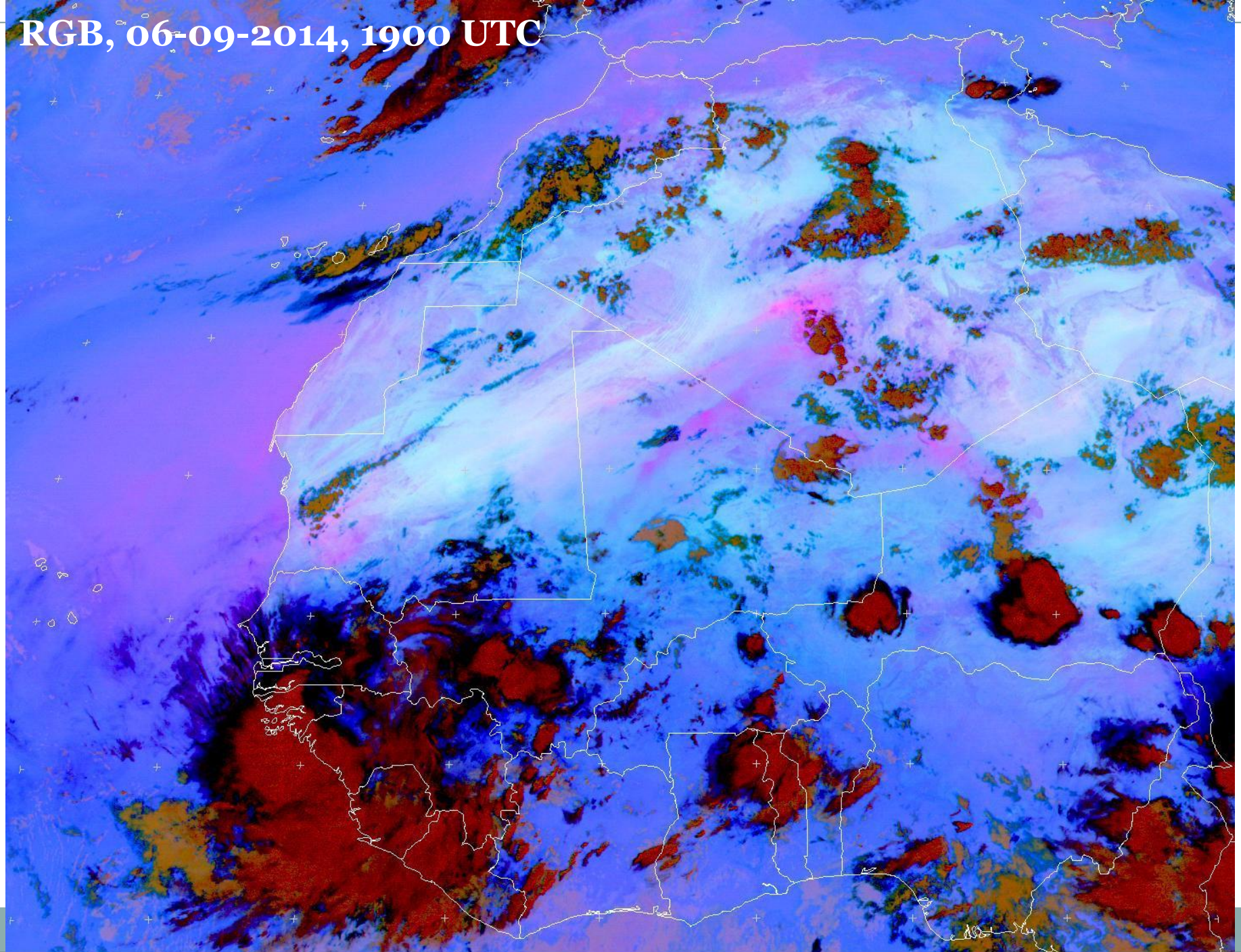
RGB, 06-09-2014, 1700 UTC



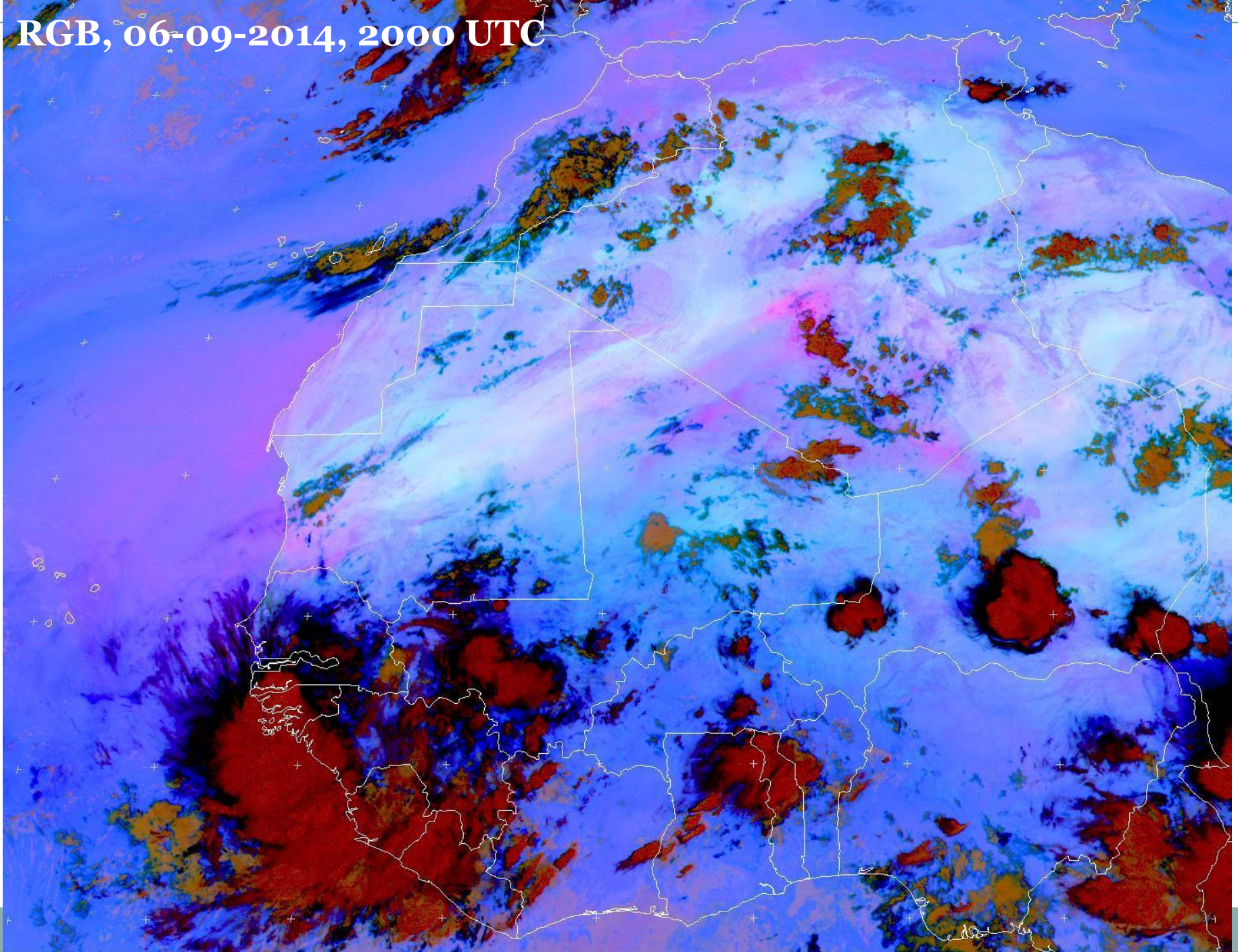
RGB, 06-09-2014, 1800 UTC



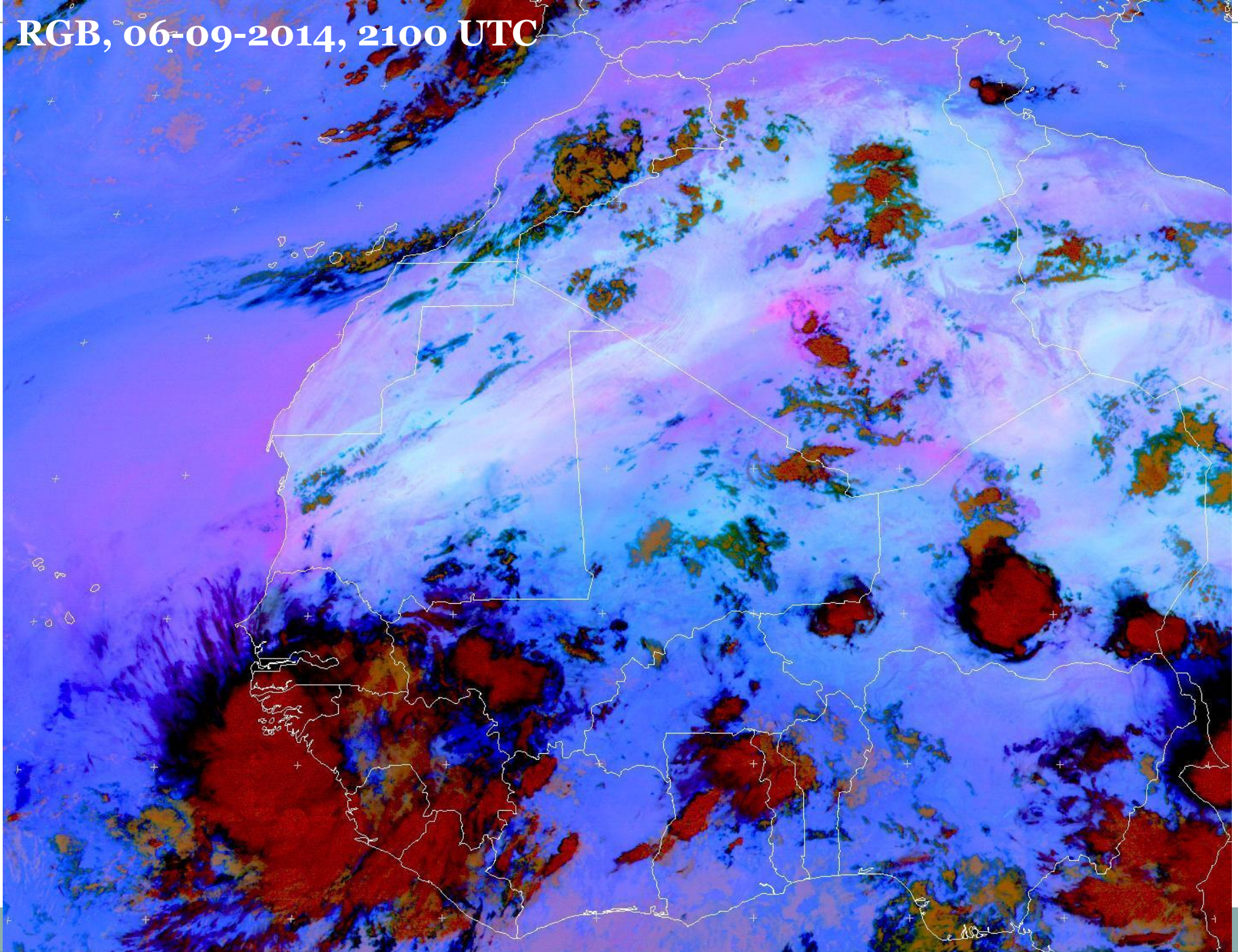
RGB, 06-09-2014, 1900 UTC



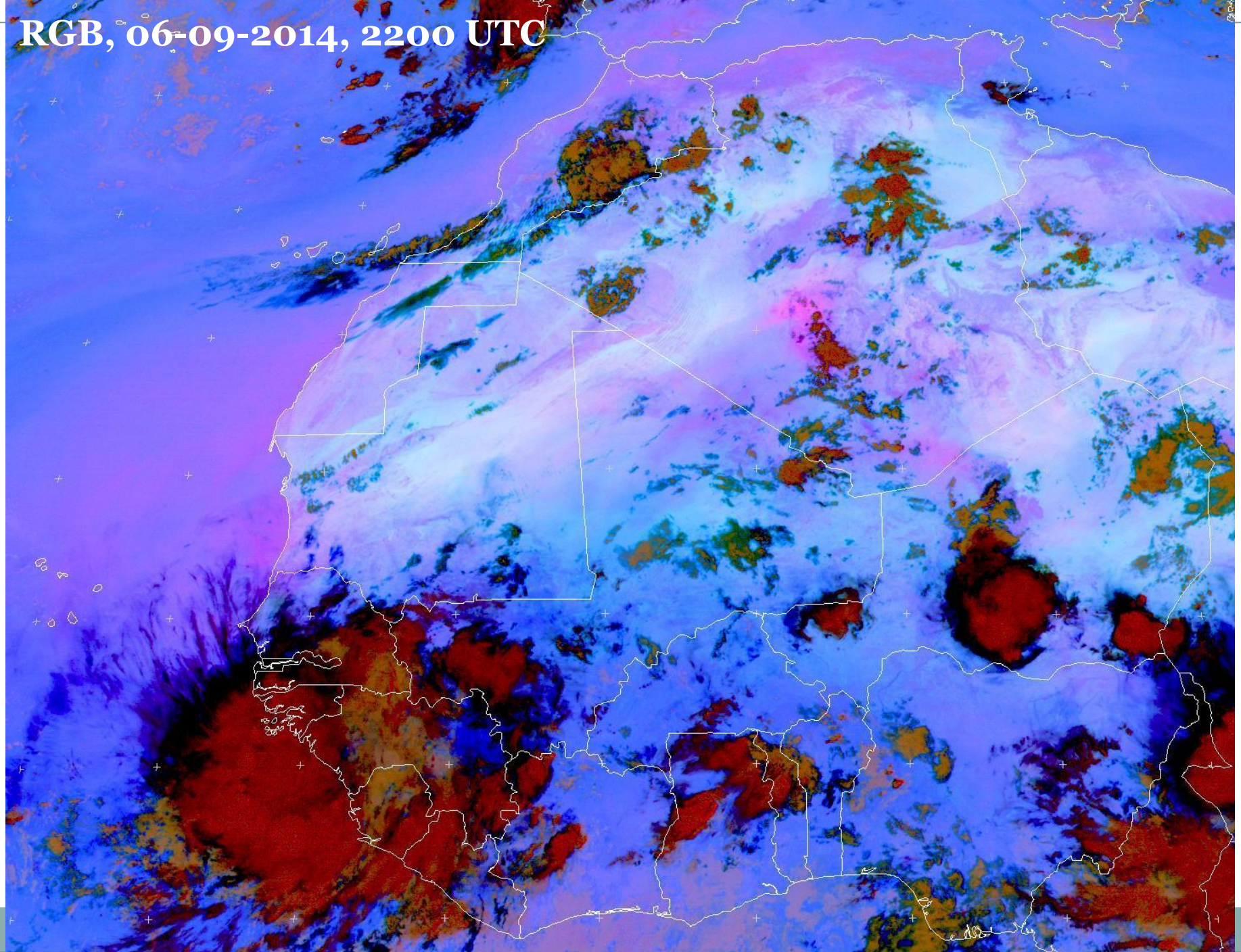
RGB, 06-09-2014, 2000 UTC



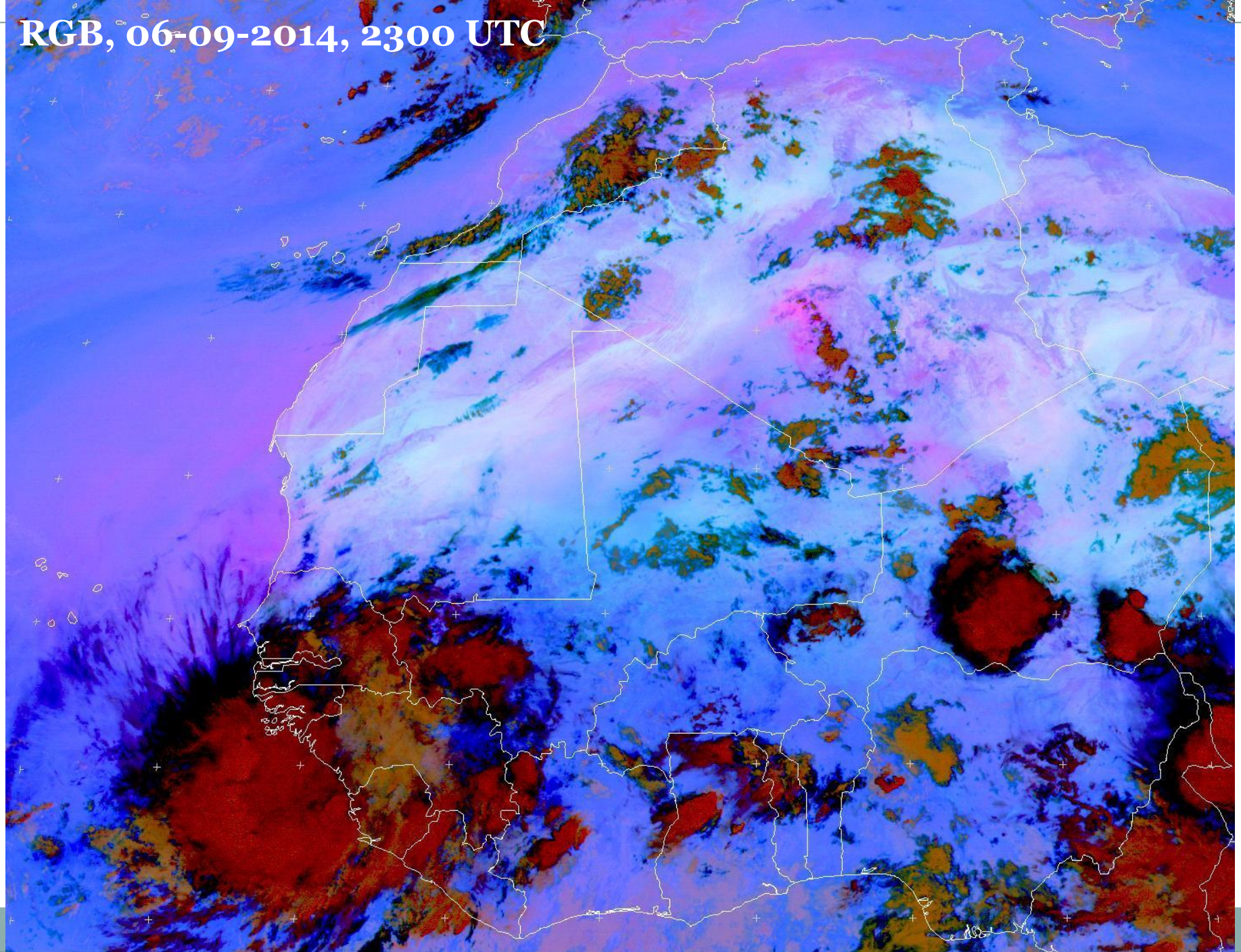
RGB, 06-09-2014, 2100 UTC



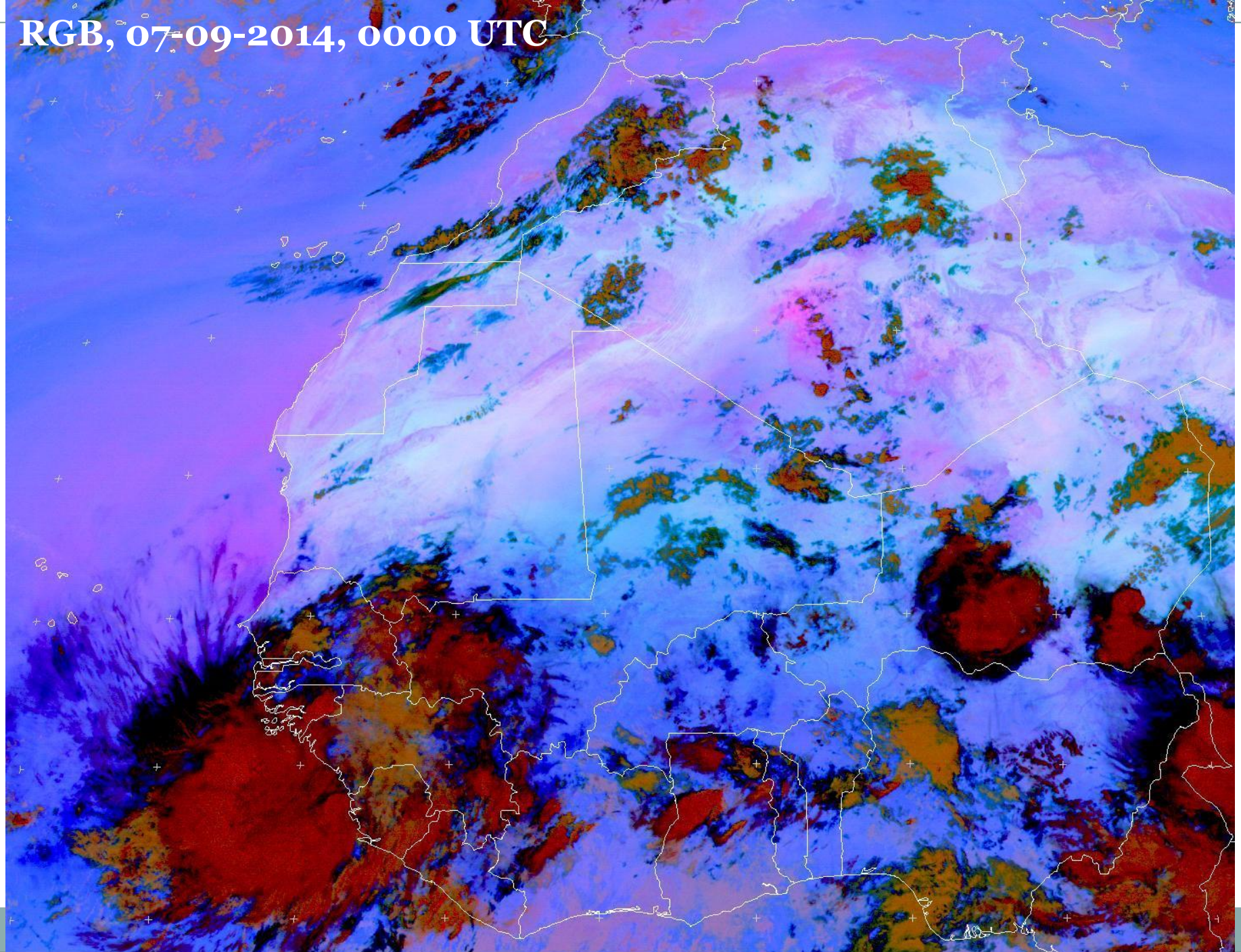
RGB, 06-09-2014, 2200 UTC



RGB, 06-09-2014, 2300 UTC



RGB, 07-09-2014, 0000 UTC



MET10 RGB-Dust 2014-09-07 00:00 UTC

Thank You