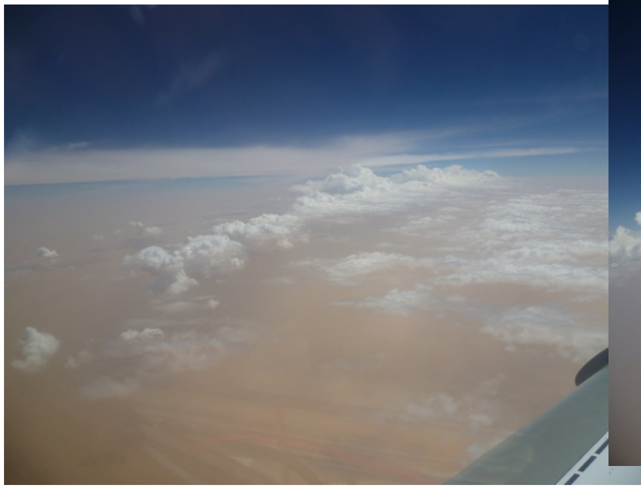
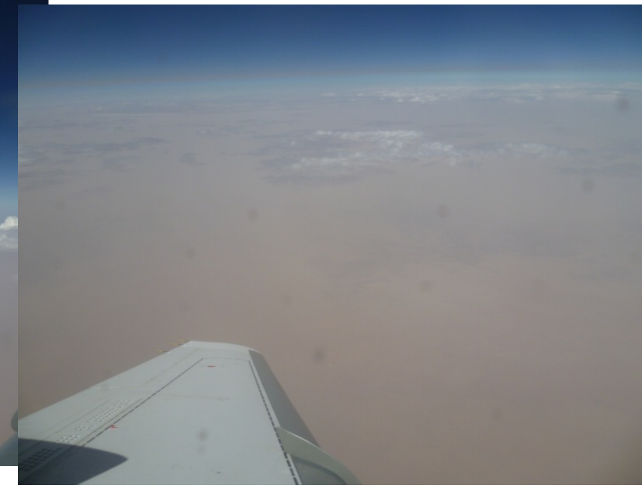




The evolution of the Saharan Boundary layer thermodynamics and composition in connection with intra-seasonal pulsations of the West African Heat Low

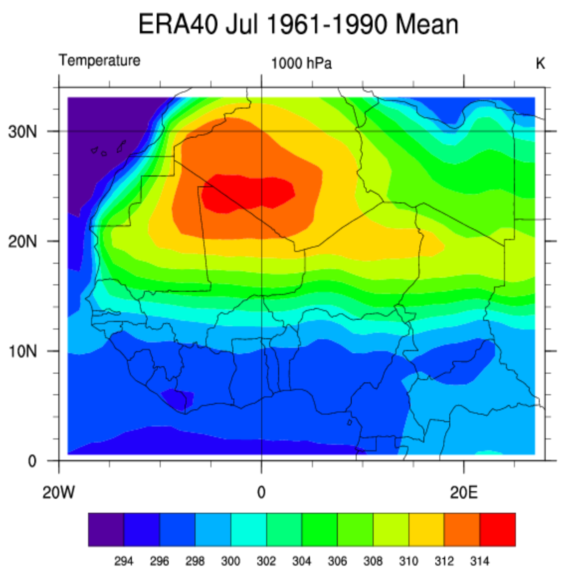
C. Flamant, C. Lavaysse, J. P. Chaboureau, S. Engelstaedter, C. Kocha, J.-P. Lafore, J. Marsham, J. Mc Quaid, M. Mokhtari, D. Parker, R. Roehrig, K. Schepanski, M. Todd, P. Tulet and R. Washington

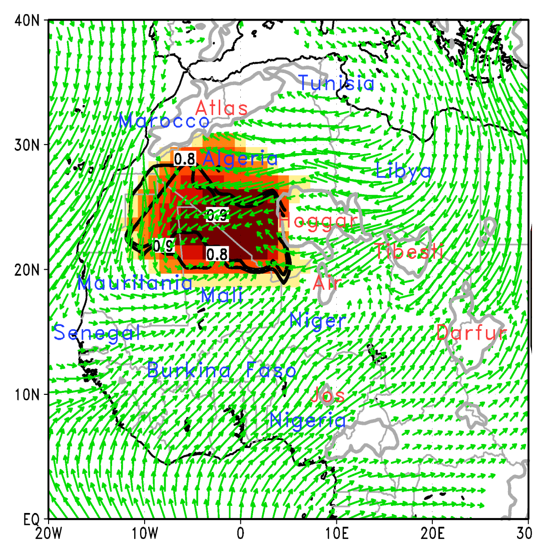
FENNEC was initiated by French, UK and German researchers, in collaborations with African Meteorological Institutes (Algeria, Mali, Mauritania, Morocco, Senegal).

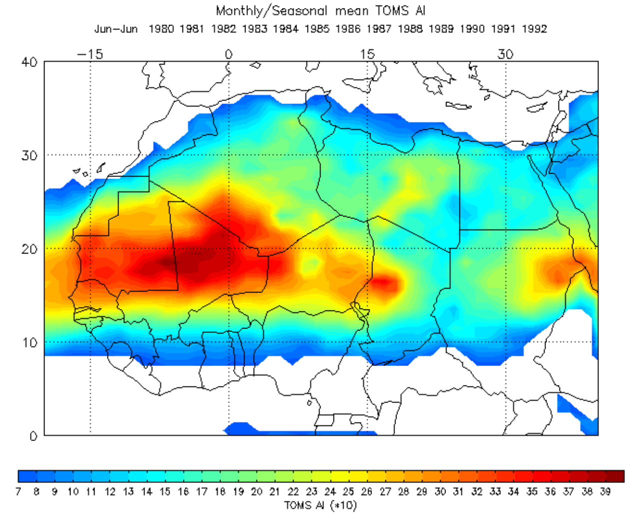
FENNEC Rationale

The Saharan climate system is the locus of numerous extremes within the general circulation during the Boreal summer:

- Intense surface heating produces the deepest boundary layers on Earth,
- Development of the Saharan Heat Low (SHL) which plays a pivotal role in the West African Monsoon system,
- Largest loads of dust aerosols.



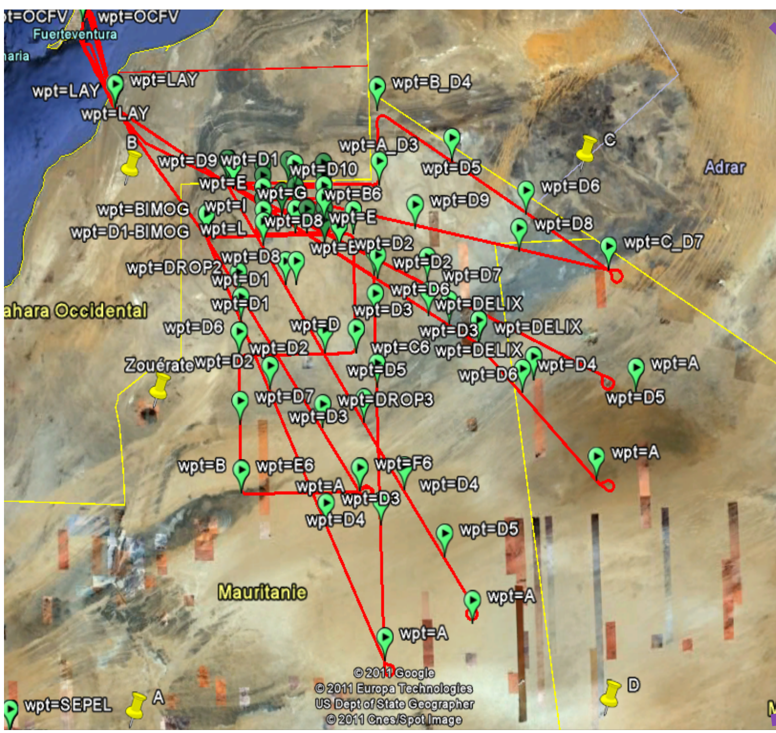


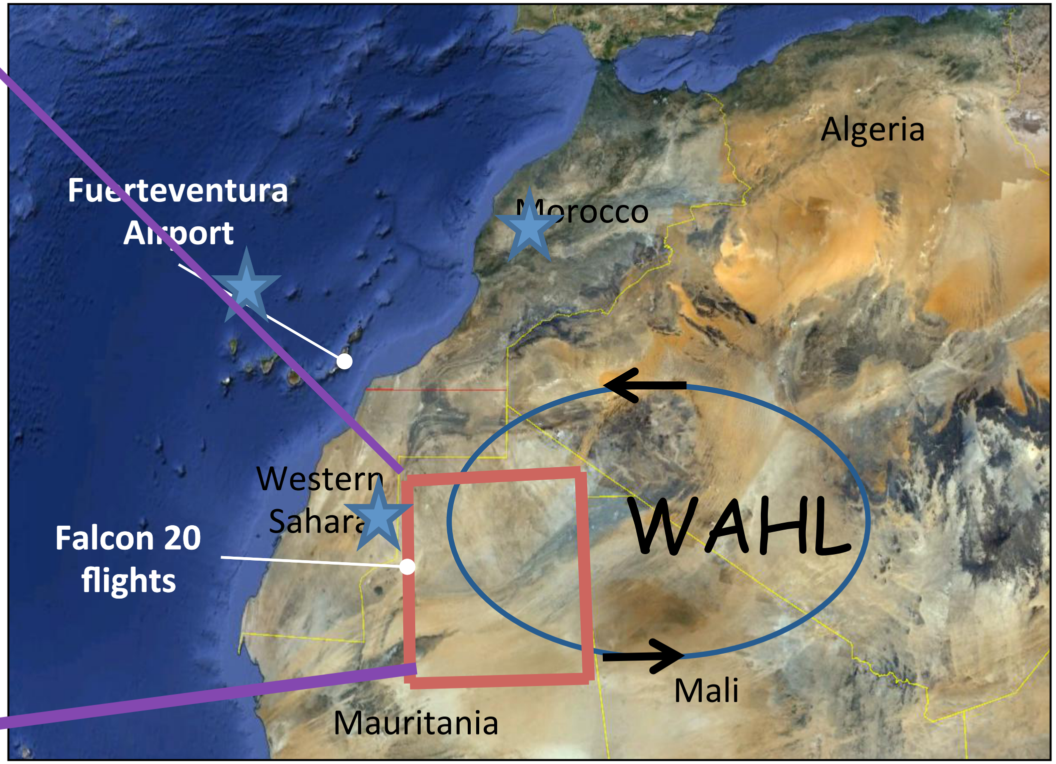


Objectives

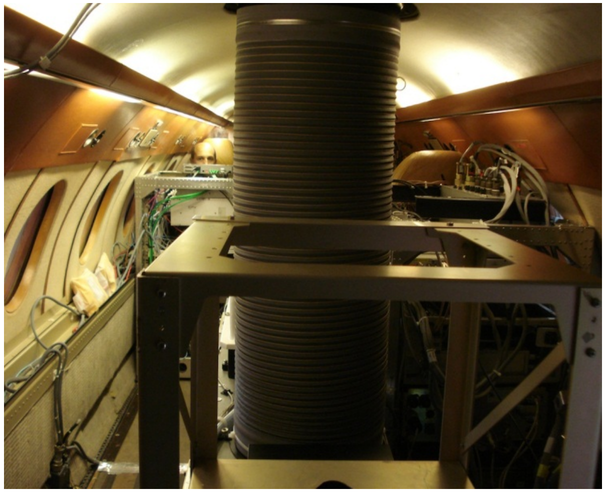
Characterize the dynamics, thermodynamics and particle composition of the Saharan atmospheric boundary layer (SABL) at the mesoscale during an east-west shift of the WAHL, using:

1. Airborne operations (SAFIRE Falcon 20 & FAAM Bae 146) over northern Mali and northern Mauritania,
2. High resolution dust forecasts from three models (AROME, Meso-NH and ALADIN) ➔ Chaboureau et al. (this session)
3. *Sunphotometers & AWS*





Airborne lidar onboard the SAFIRE Falcon



LNG LIDAR (left) on board of the SAFIRE FALCON 20

The Falcon 20 performed eighteen flights from the Island of Fuerteventura (Canary Islands), fourteen of which were made over the central Sahara, for a total of 65h.

The Falcon 20 was equipped with the HRS backscatter lidar LNG allowing the measurement of atmospheric reflectivity at three wavelengths (355, 532 and 1064 nm) to analyze the structure and radiative characteristics of desert dust plumes.

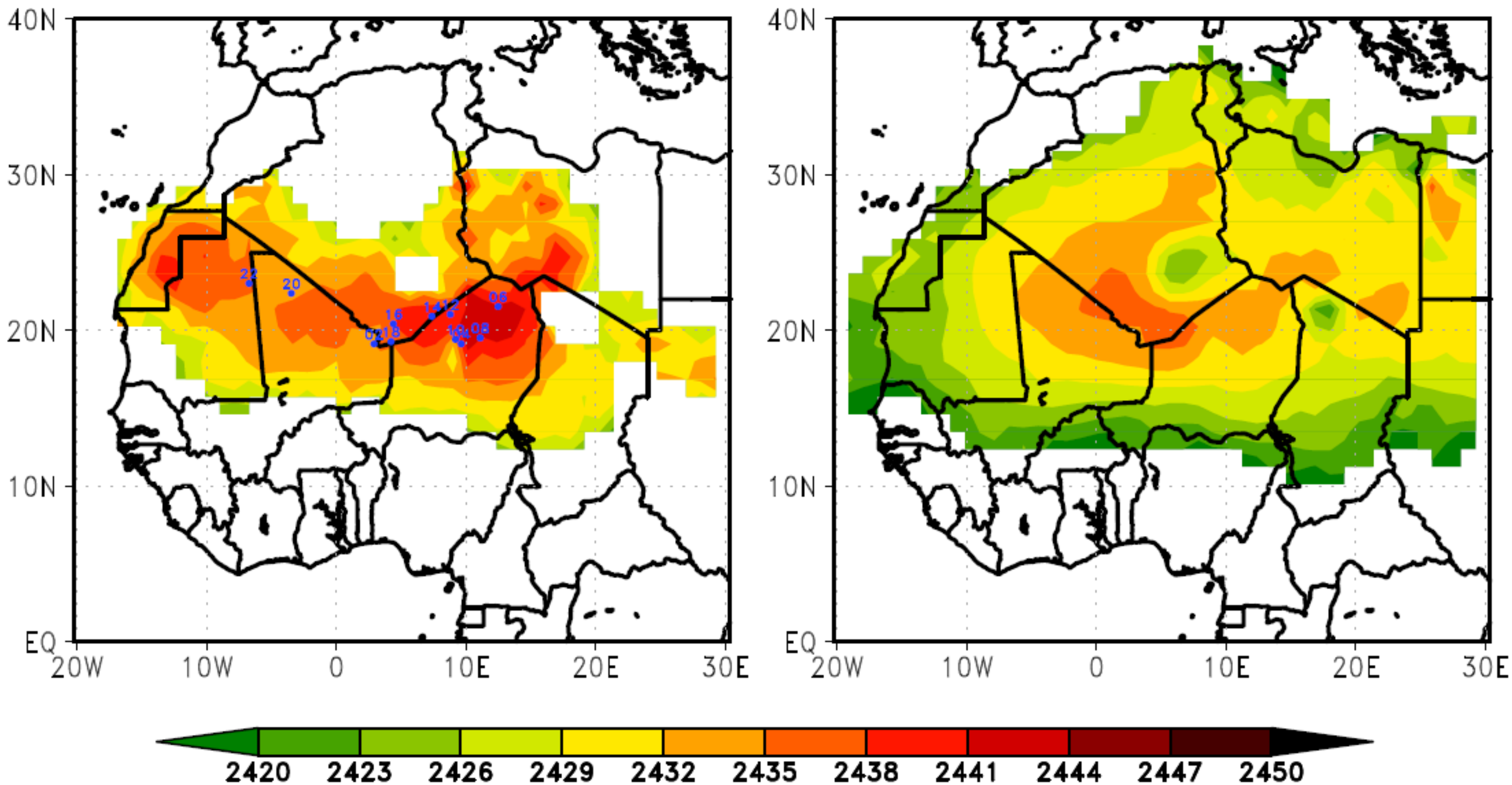
➔ vertical resolution: 6 m   horizontal resolution: 2 km

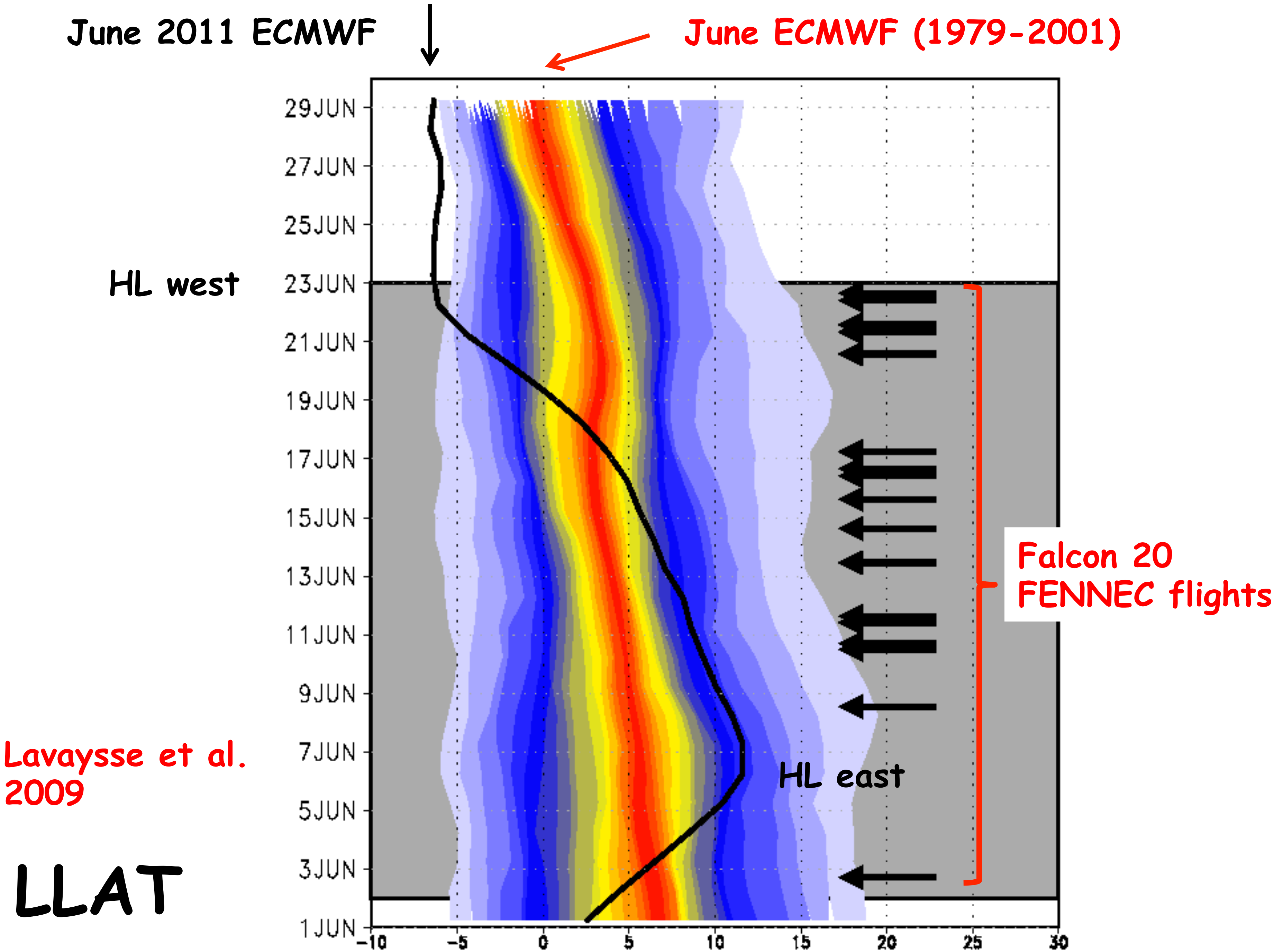
The Falcon 20 was also equipped with a **dropsondes** launching device, radiometers (broad-band up- and down-looking pyranometers and pyrgeometers), the radiometer CLIMAT as well as in situ PTU and wind sensors.

West Africa Heat Low detection

Low Level Atmospheric Thickness (LLAT) ➔ Lavaysse et al (2009)
Column thickness between 925 hPa and 700 hPa

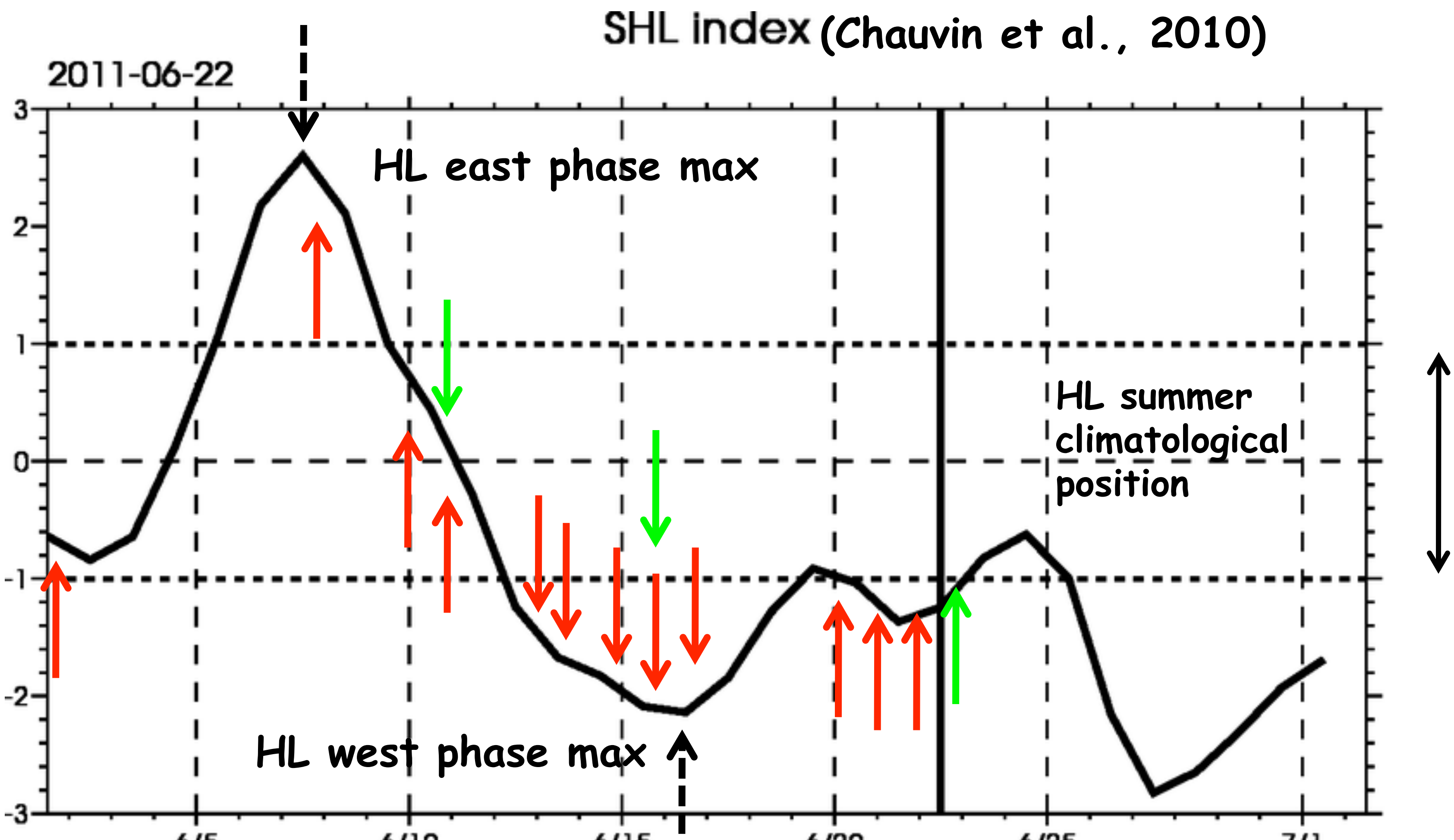
June 2011 ECMWF | **June ECMWF (1979-2001)**





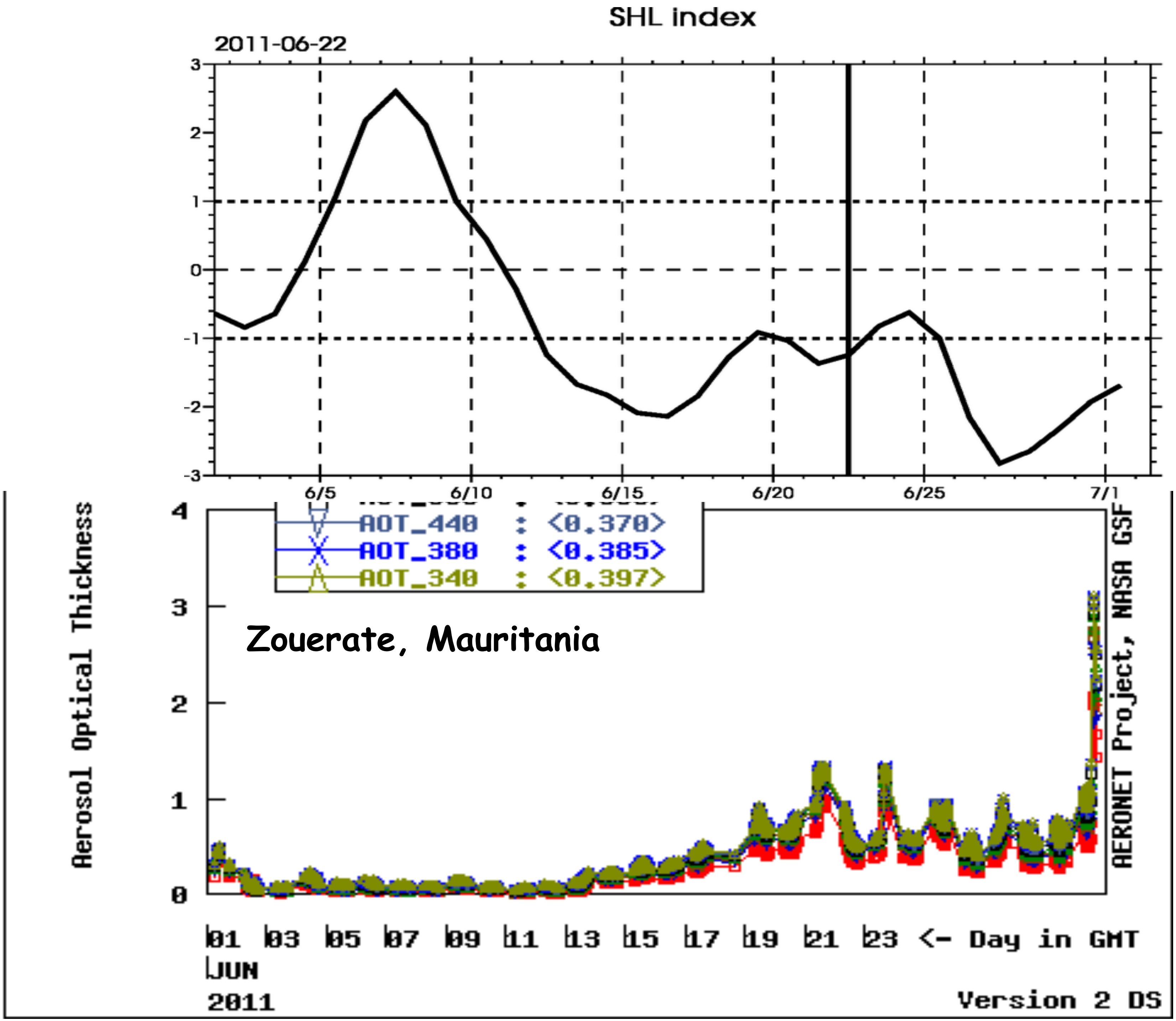
June 2011 ECMWF
June ECMWF (1979-2001)
HL west
HL east
Falcon 20
FENNEC flights
Lavaysse et al. 2009
LLAT
29JUN
27JUN
25JUN
23JUN
21JUN
19JUN
17JUN
15JUN
13JUN
11JUN
9JUN
7JUN
5JUN
3JUN
1JUN
-10
-5
0
5
10
15
20
25
30

Roehrig et al. talk yesterday

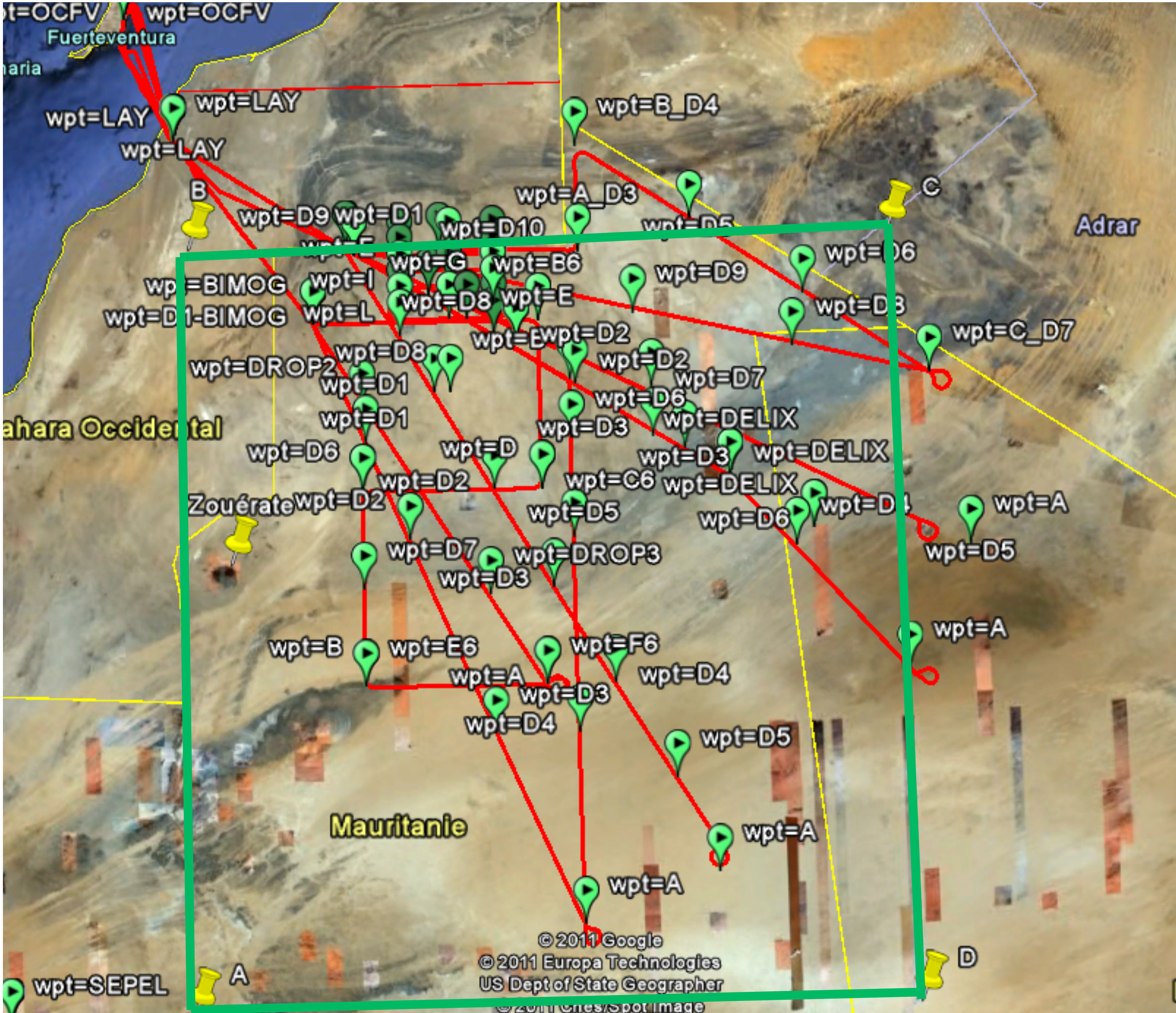


Fennec flights

Rain4dust flights



SHL index
2011-06-22
3
2
1
0
-1
-2
-3
6/5
6/10
6/15
6/20
6/25
7/1
AOT_440 : <0.370>
AOT_380 : <0.385>
AOT_340 : <0.397>
Zouerate, Mauritania
Aerosol Optical Thickness
4
3
2
1
0
01 03 05 07 09 11 13 15 17 19 21 23 <- Day in GMT
JUN
2011
AERONET Project, NASA GSF
Version 2 DS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Adrar
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wpt=G
wpt=B6
wpt=D9
wpt=BIMOG
wpt=I
wpt=E
wpt=D1-BIMOG
wpt=L
wpt=D8
wpt=D8
wpt=C_D7
wpt=D2
wpt=D8
wpt=D2
wpt=DROP2
wpt=D1
wpt=D7
wpt=D6
wpt=D1
wpt=DELIX
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Sahara Occidental
wpt=D6
wpt=D
wpt=D3
wpt=DELIX
wpt=D2
wpt=C6
wpt=DELIX
Zouérate
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wpt=A
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wpt=A
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wpt=A
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wpt=D4
wpt=D5
Mauritanie
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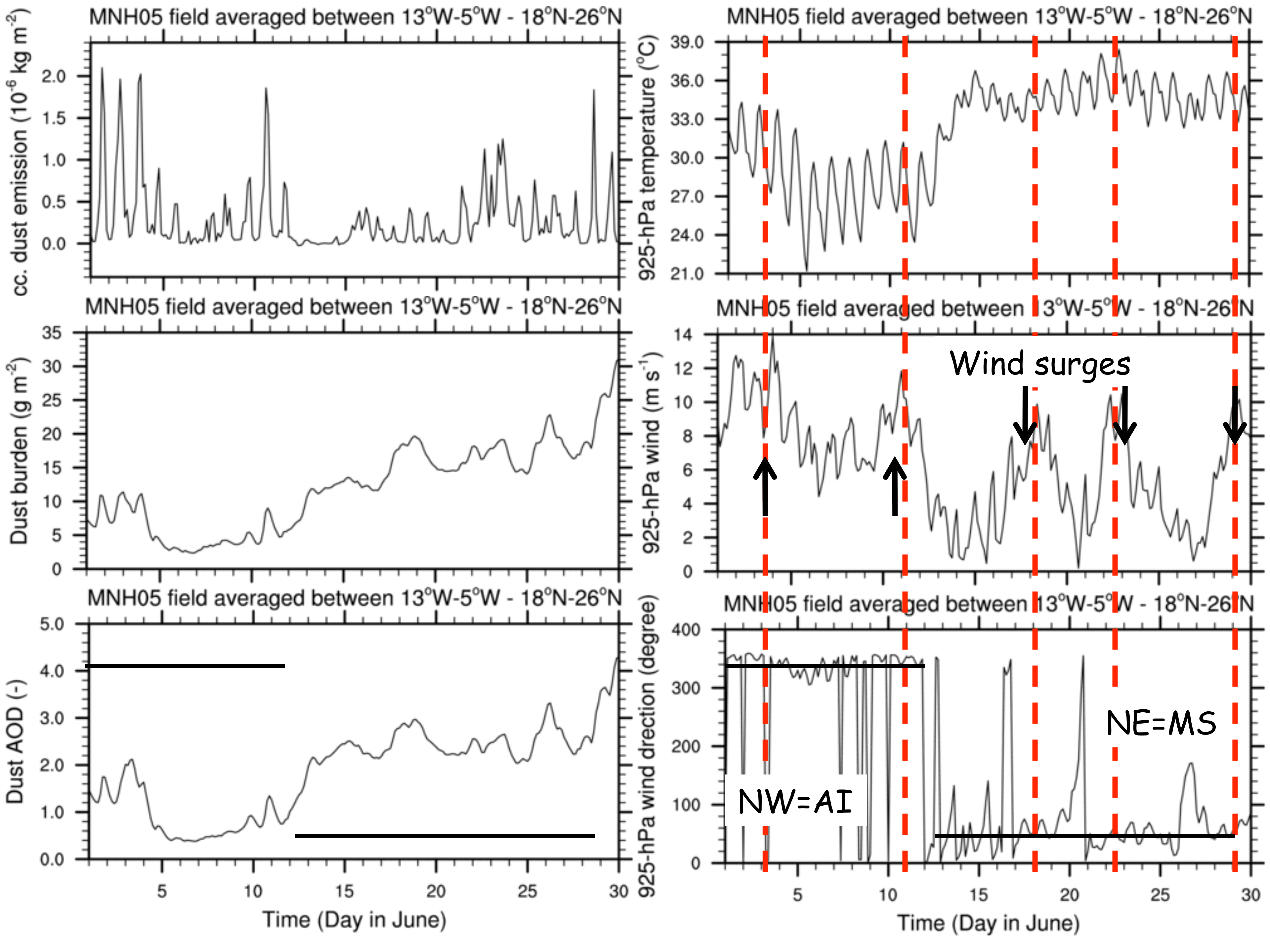
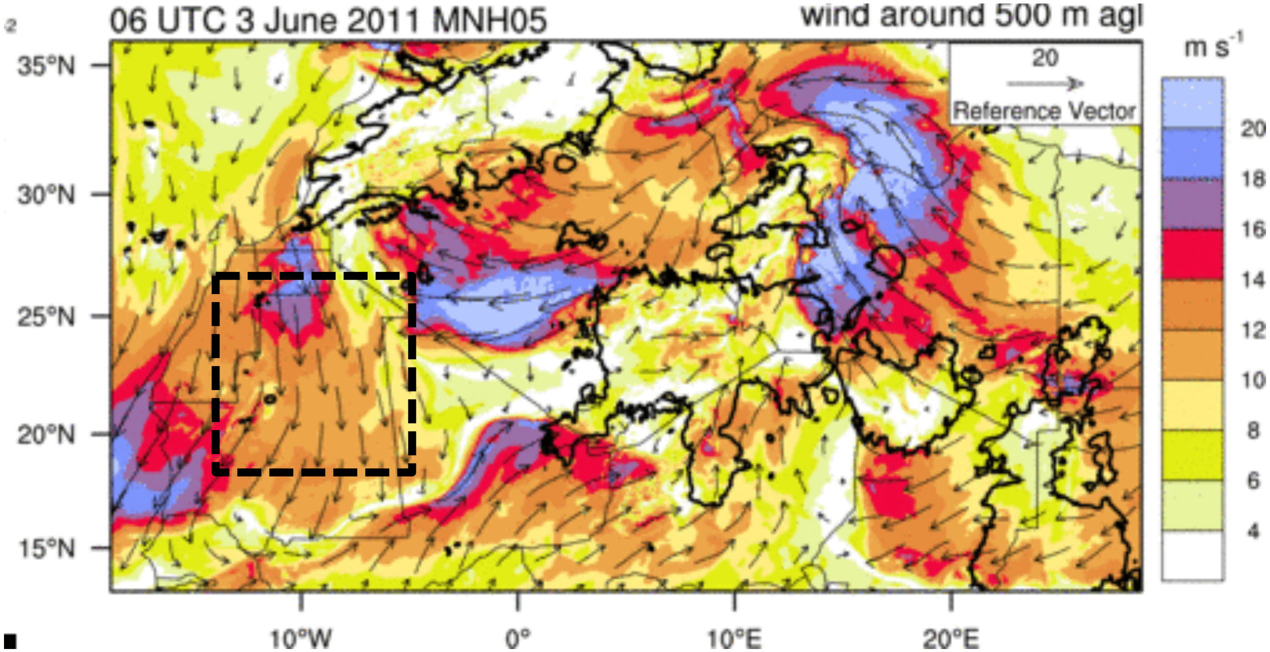
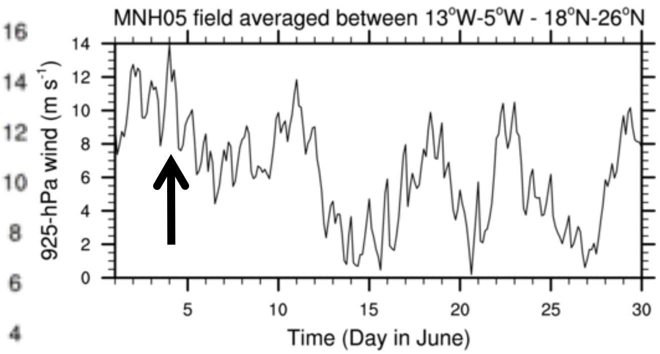


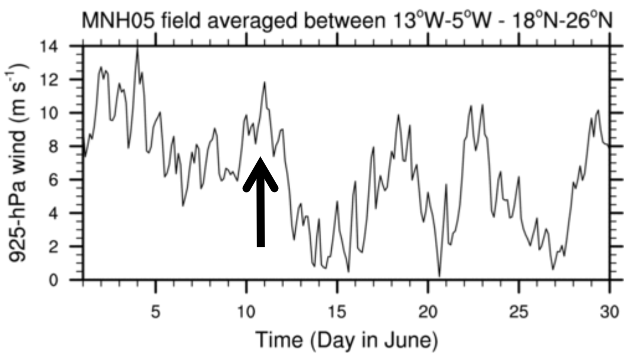
MNH05 field averaged between 13°W-5°W - 18°N-26°N
cc. dust emission (10⁻⁶ kg m⁻²)
925-hPa temperature (°C)
Dust burden (g m⁻²)
925-hPa wind (m s⁻¹)
Wind surges
Dust AOD (-)
925-hPa wind drection (degree)
NE=MS
NW=AI
Time (Day in June)

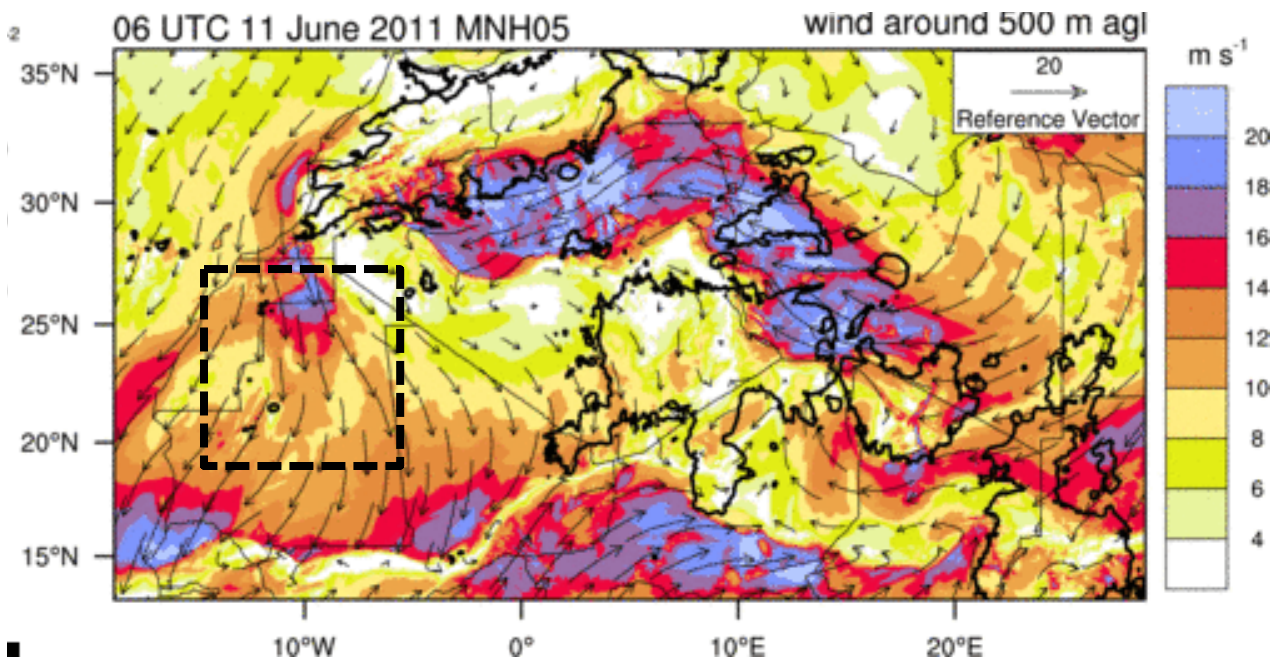
NW wind surges associated with the Atlantic Inflow

→ ~12 June



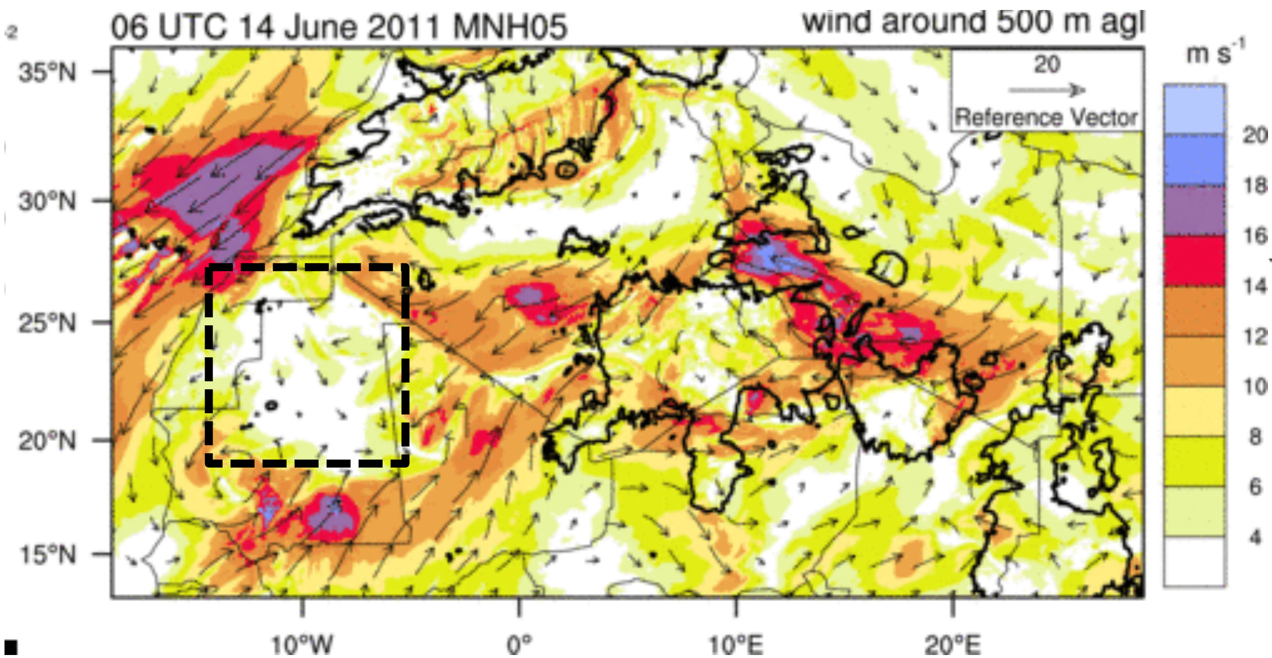


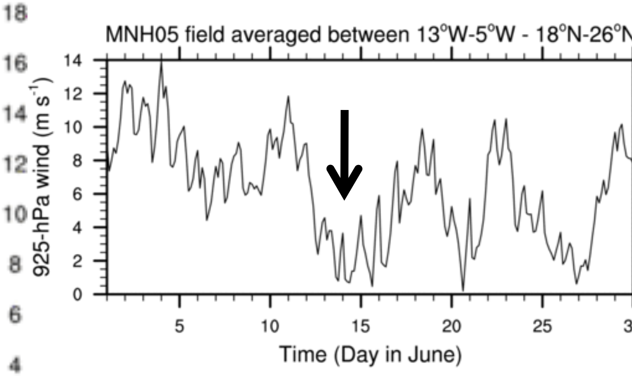


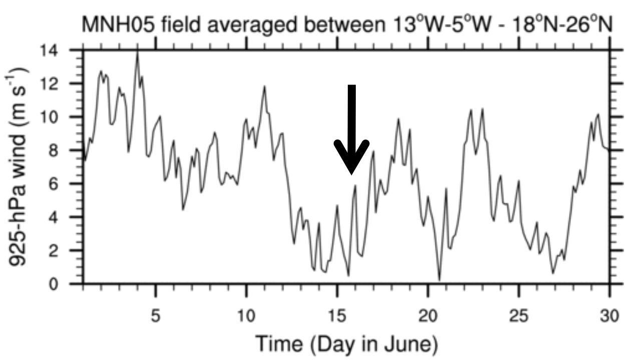


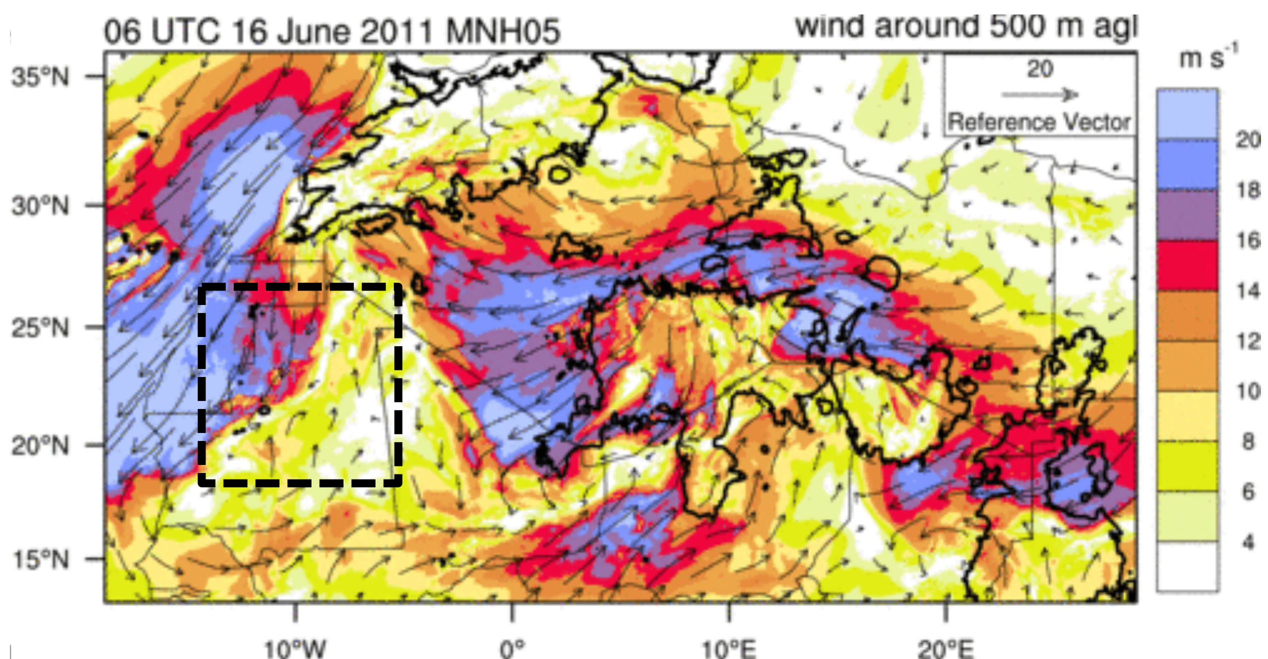
Intermediate phase

→ 13-16 June



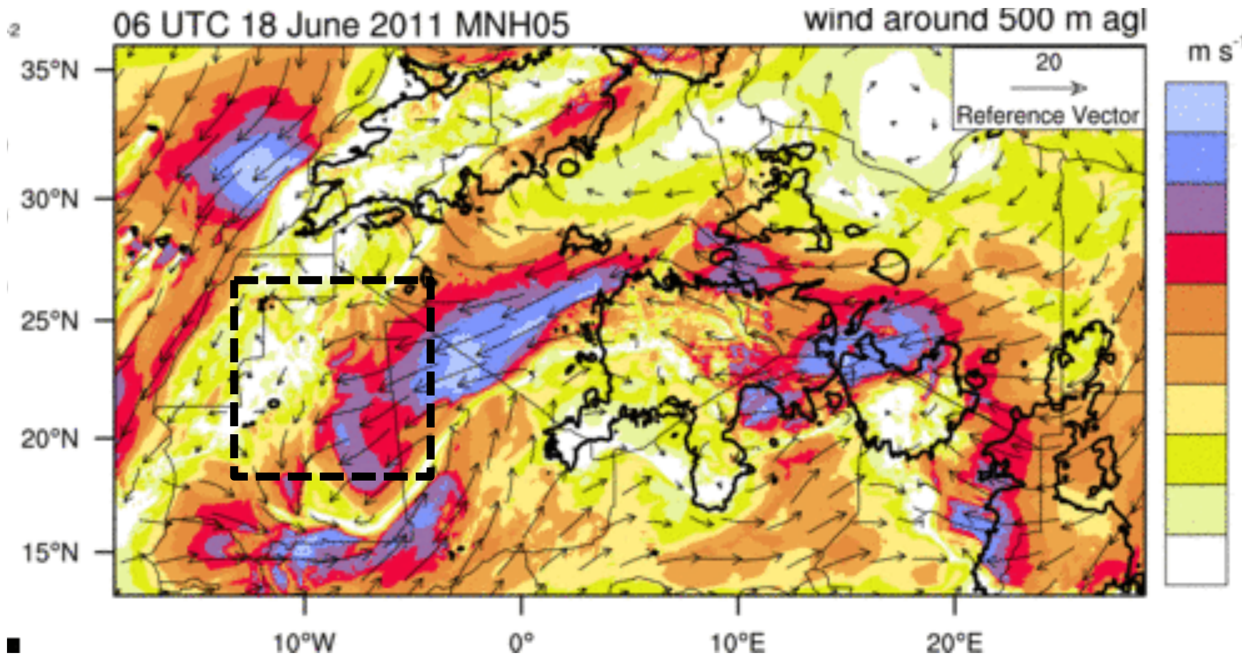


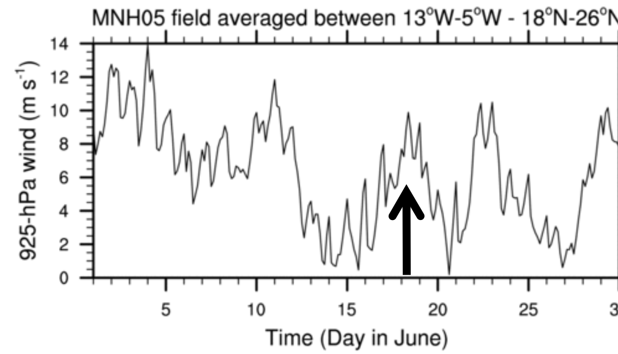


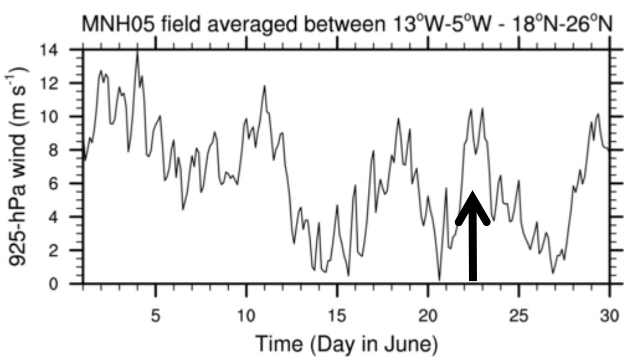


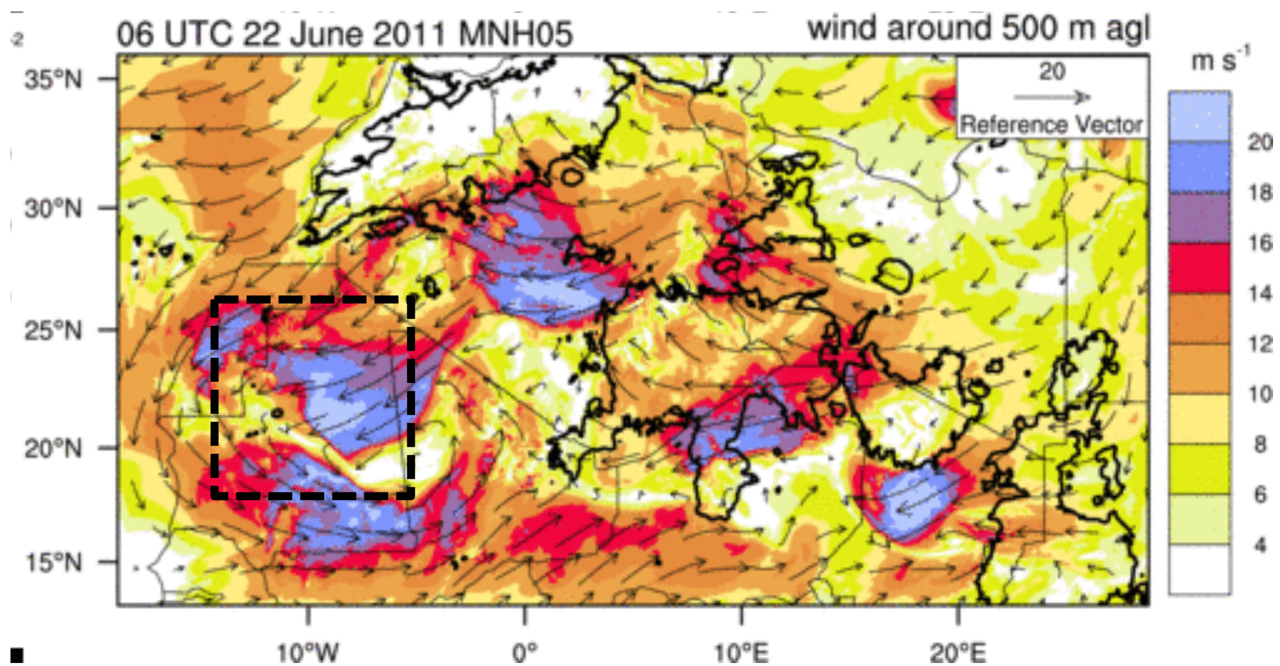
NE wind surges associated with Mediterranean cold surges

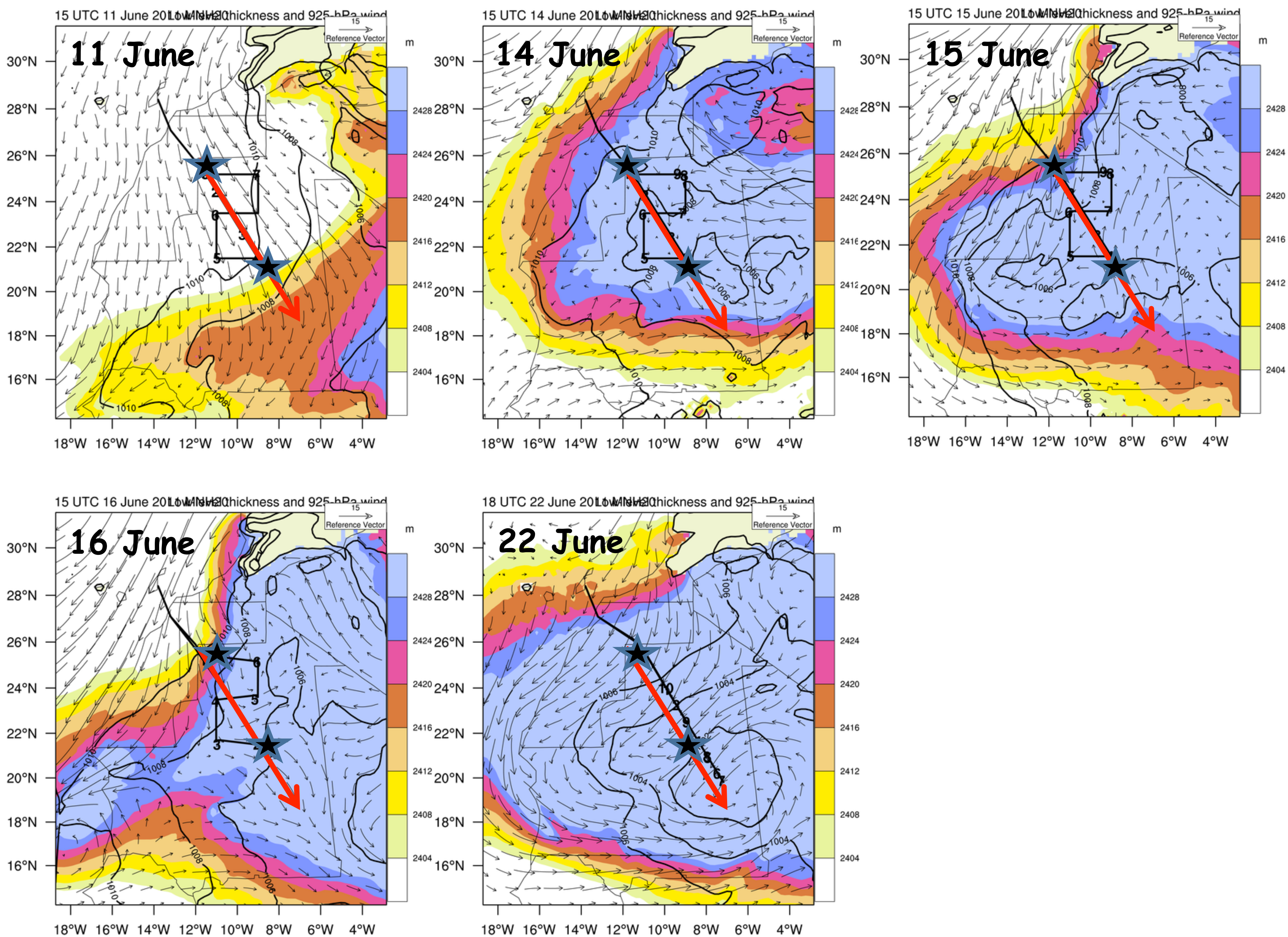
→ 17-22 June

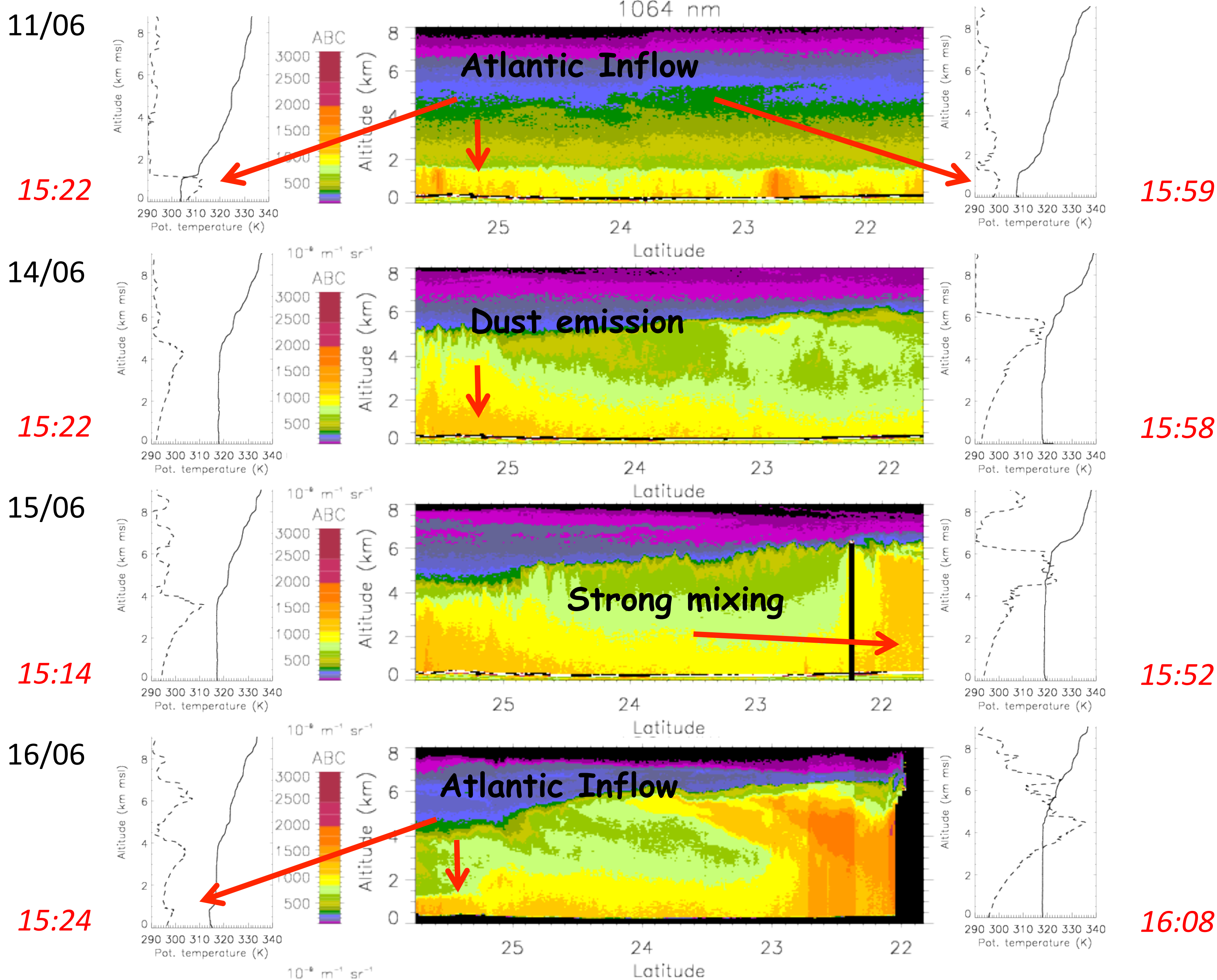




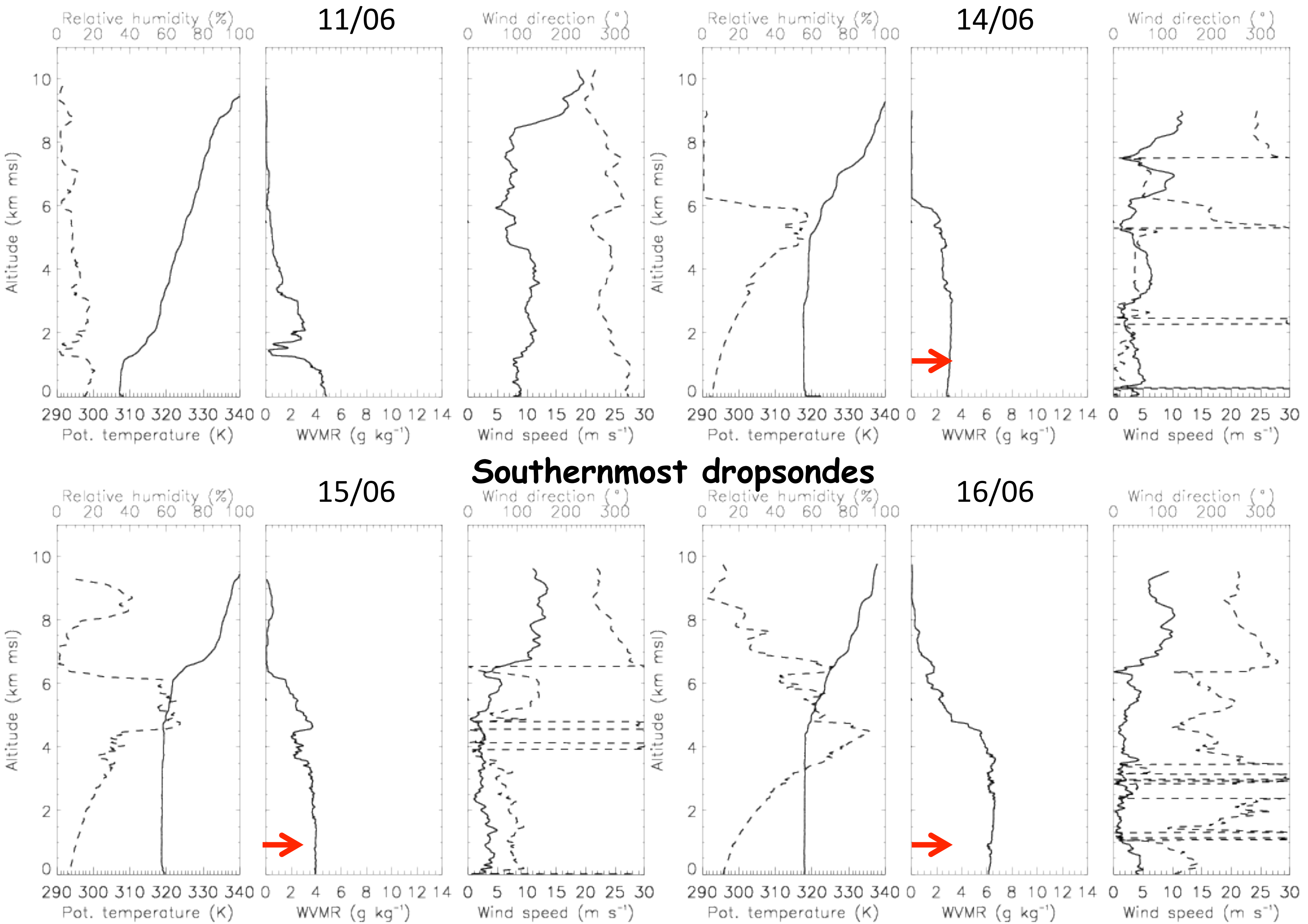





11 June
14 June
15 June
16 June
22 June
Reference Vector
m
2428
2424
2420
2416
2412
2408
2404
30°N
28°N
26°N
24°N
22°N
20°N
18°N
16°N
18°W
16°W
14°W
12°W
10°W
8°W
6°W
4°W



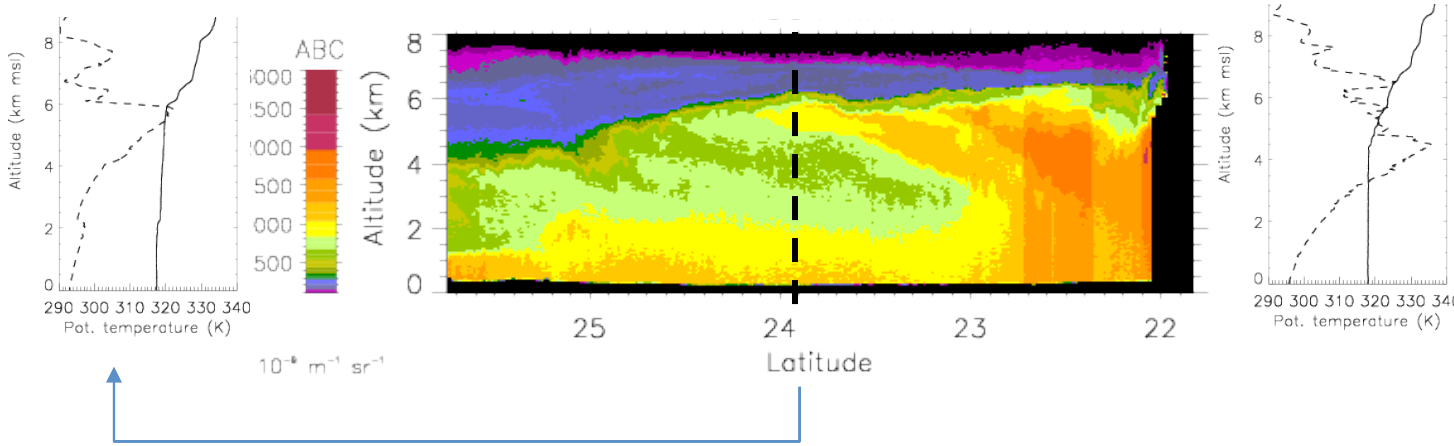
11/06
15:22
15:59
1064 nm
Atlantic Inflow
14/06
15:22
15:58
Dust emission
15/06
15:14
15:52
Strong mixing
16/06
15:24
16:08
Atlantic Inflow
Altitude (km msl)
Pot. temperature (K)
ABC
10^{-6} m^{-1} sr^{-1}
Altitude (km)
Latitude



Increasing moisture and decreasing temperature

16/06

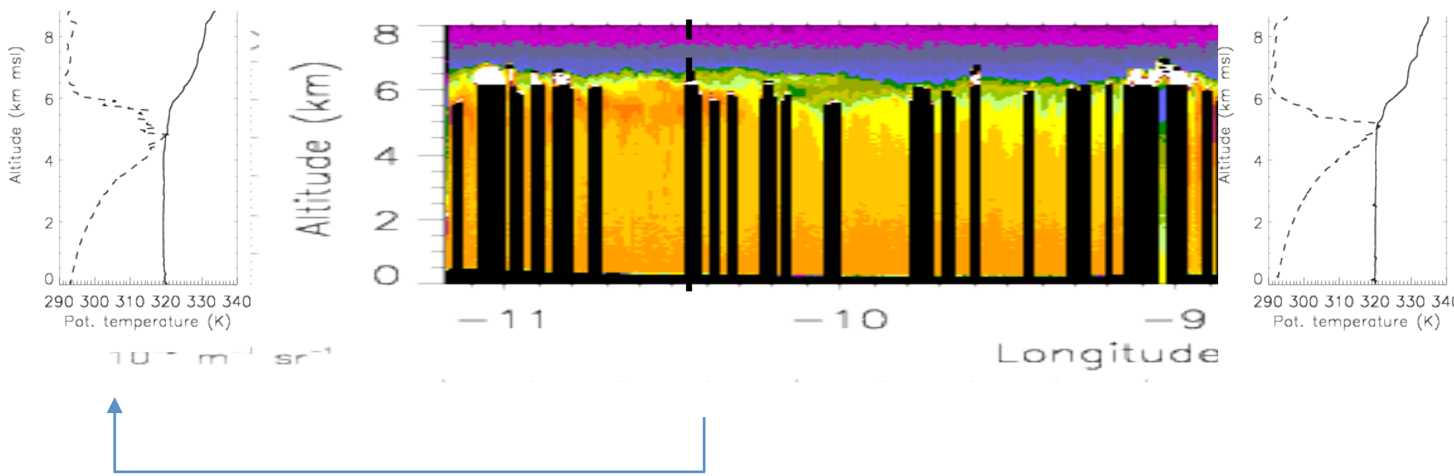
16:42
#4



16:08

22/06

16:21



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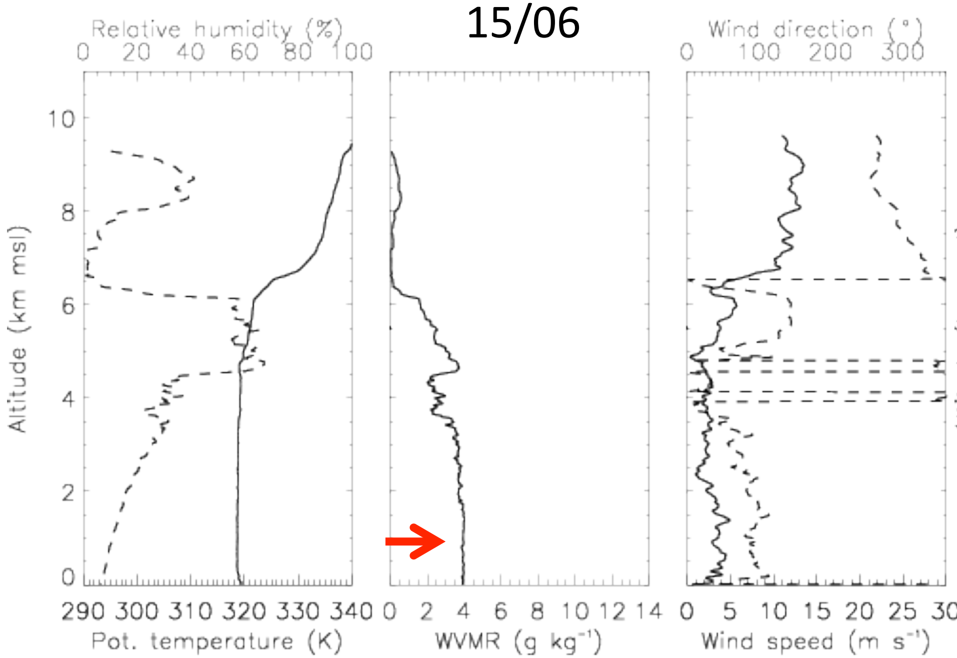
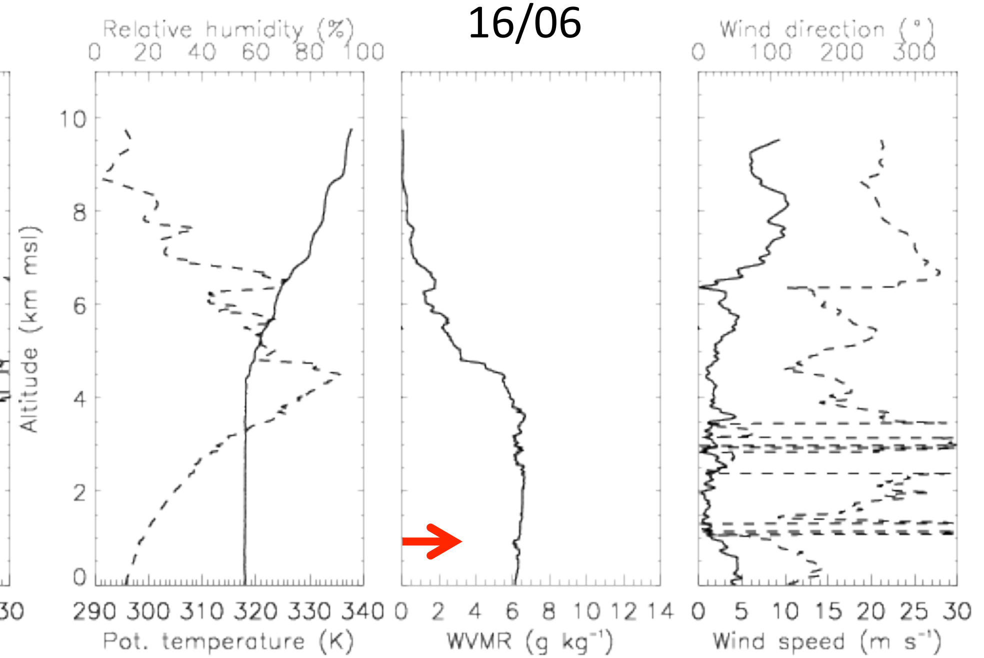
15/06

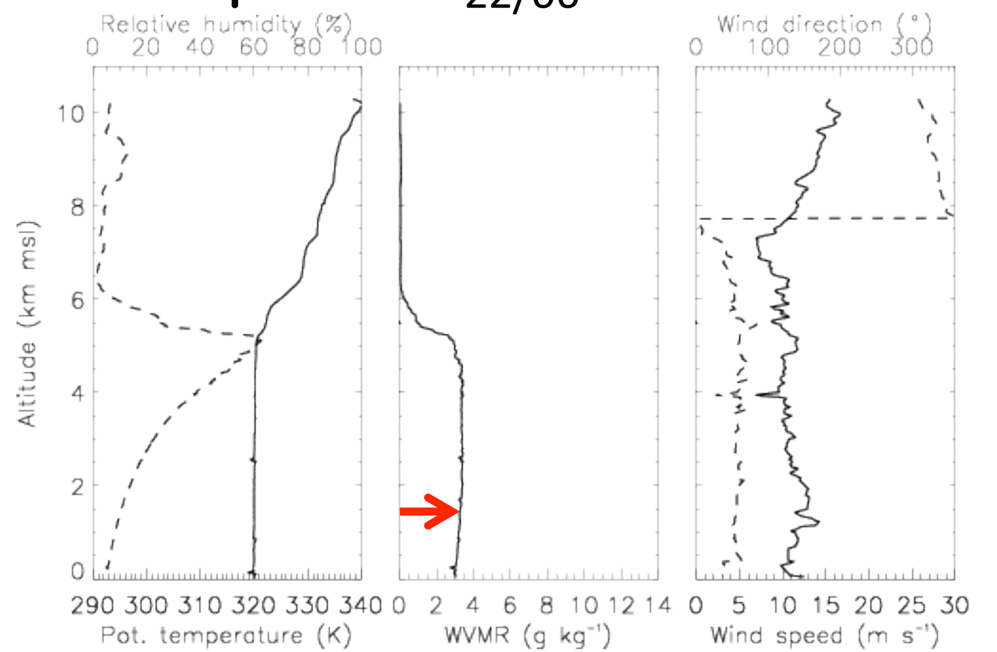


16/06

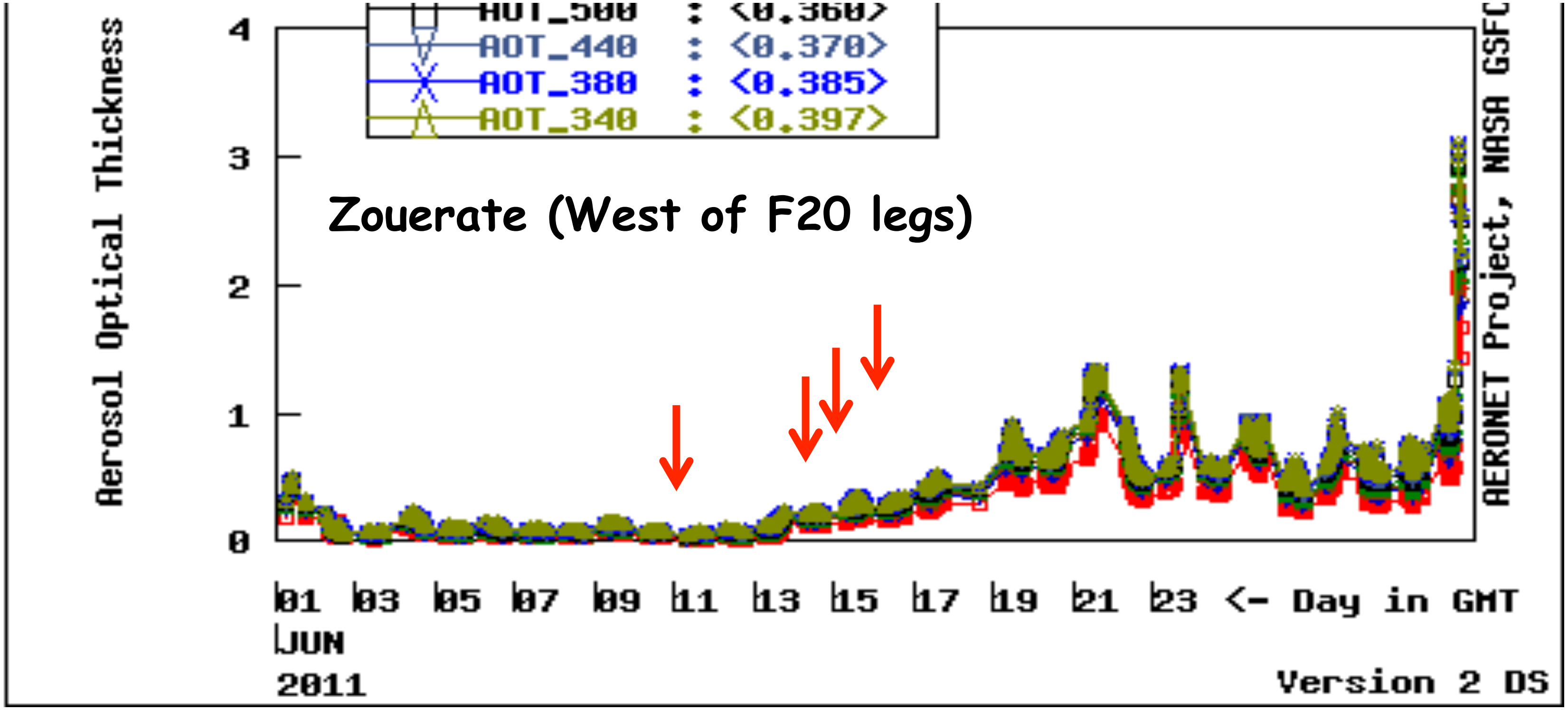


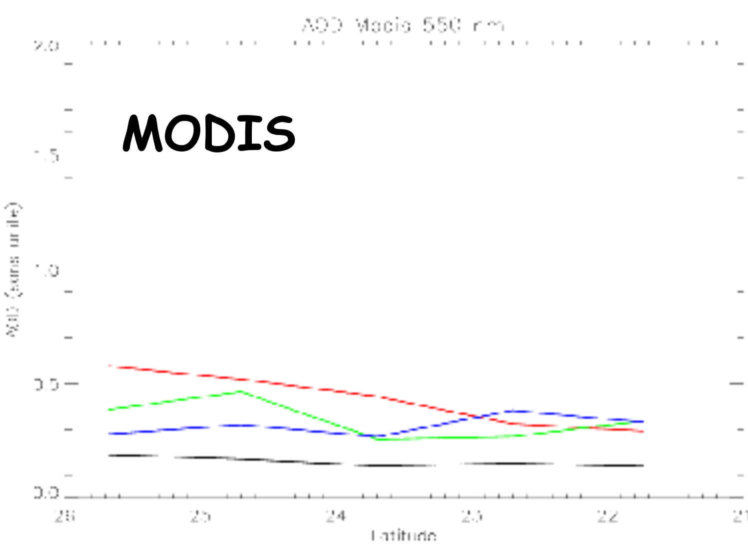
Southernmost dropsondes

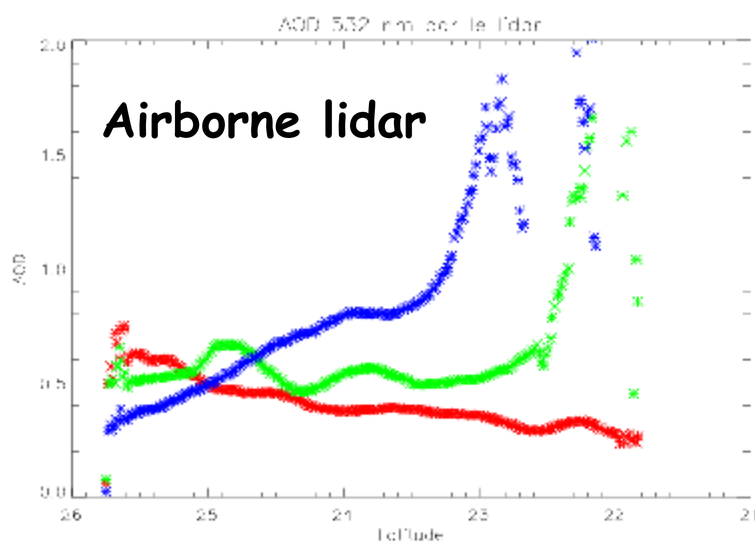
22/06



Strong heating and drying once WAHL is in its western phase







11 juin
14 juin
15 juin
16 juin

Conclusions

There is an evolution of the dynamics, thermodynamics and particle composition of the Saharan atmospheric boundary layer (SABL) at the mesoscale during an east-west shift of the WAHL:

1. Steady moistening in the SABL until the WAHL is in its « western phase », then drying is observed [inverse trend for temperature]

2. Steady increase of the dust load over our « flight domain » during the HLE to HLW transition (significant W-E gradient)
   ➔ Mediterranean surges

3. Deepening of the SABL to the southeast of the leg ➔ depening of the SABL to the northwest once the WAHL is in its "western phase"

Perspectives

1. Include BAE 146 flights for June 2011

2. Compare with high resolution dust forecasts from three models (AROME, Meso-NH and ALADIN)

3. Conduct similar analyses for June 2012 (for comparison with June 2011)