Improved extraction of low-level atmospheric motion vectors over West-Africa from MSG images

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Plan

- **Specific adaptation for low-level wind extraction.**
- **Cloud classification-based height assignment of AMVs and issues.**
- **CALIPSO-lidar-based height assignment .**

Object of this study

- **Main goal : extract and validate (low-level) atmospheric motion vectors over West-Africa in the frame of the AMMA campaign (African monsoon).**

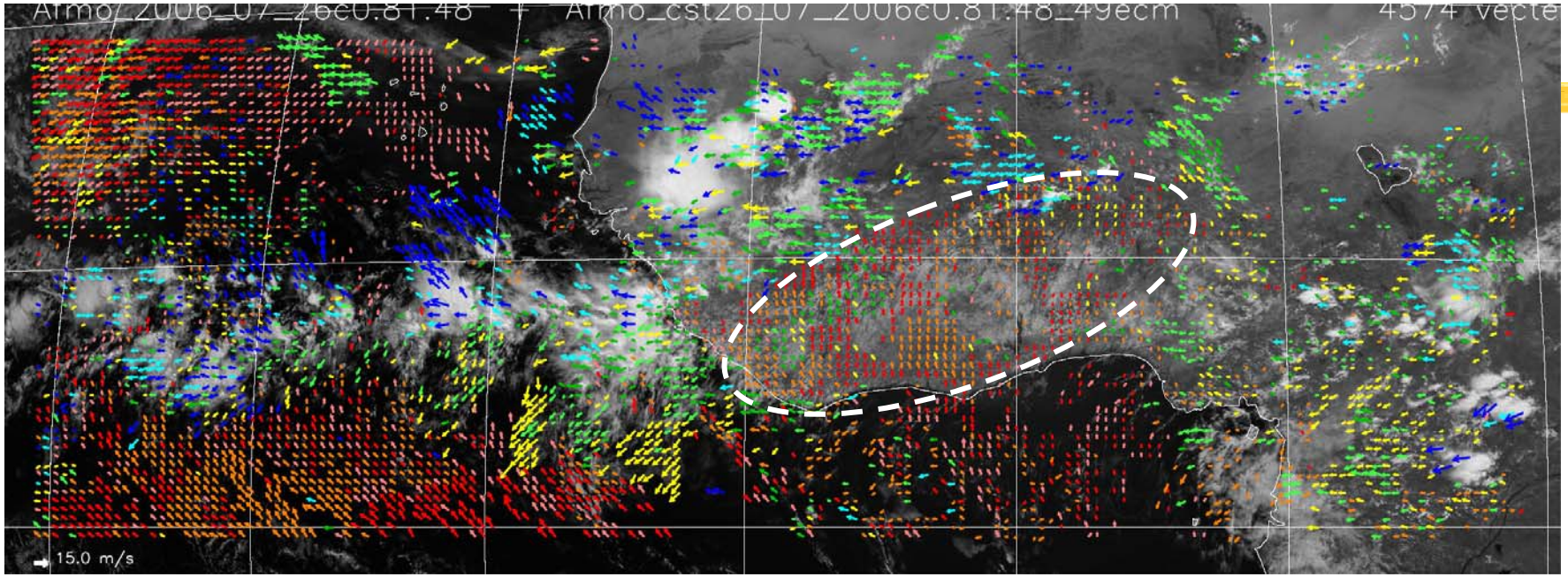
- **Reasons :**
  - **Poor forecasts over West-Africa.**
  - **Low-level winds not taken into account.**

- **Possible validation with CALIPSO-lidar data.**

LMD AMV calculation method

- **AMV calculation :**
  - **Based on the minimisation of the Euclidean distance.**
- **Quality tests :**
  - **Suppression of too large and too small vectors.**
  - **Temporal consistency test.**
  - **Spatial consistency test.**
- **Use of the Nowcasting-SAF cloud classification**
  - **Related parameter : cloud top pressure.**

Choice of MSG channel



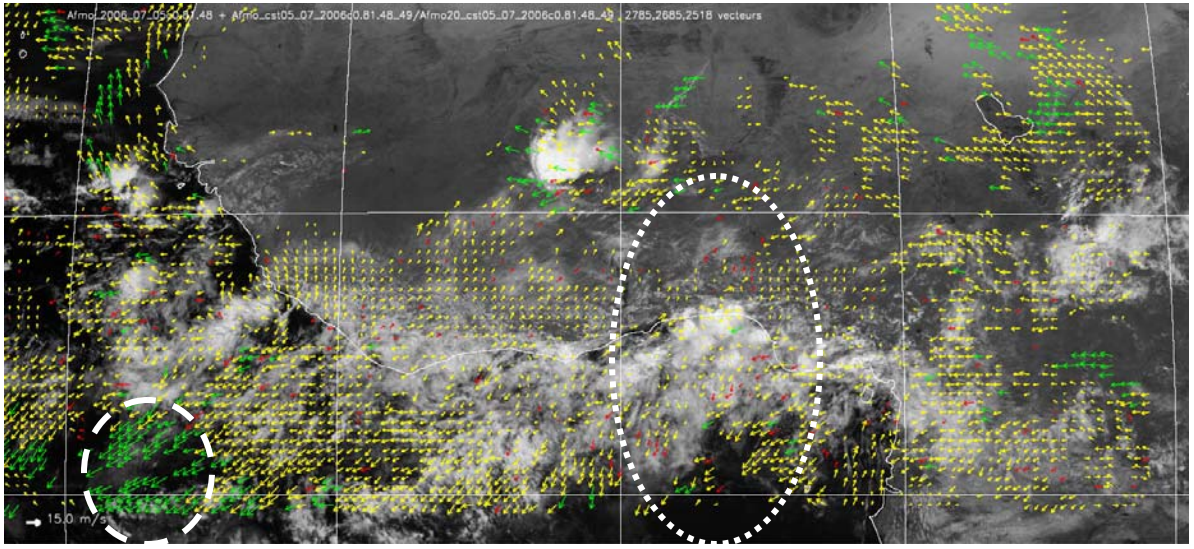
Best-fit level with ECMWF analyses : 1000, 925, 850, 700, 500, 400, 300, 250, 200 hPa

- **VIS 0.8 : best for low-level winds over West-Africa (daytime), especially over land - - - - - .**
- **HRV : better resolution, but no coverage over West-Africa (sliding window after 2006).**

1) Influence of the maximal displacement (D_{maxth})

- **Comparison of VIS 0.8 AMV fields :**
  - **Target window : 12 pixels**
  - **Standard search window : 28 pixels ==> D_{maxth} = 8 pixels = 96 km/h (green+yellow).**
  - **Reduced search window : 20 pixels ==> D_{maxth} = 4 pixels = 48 km/h (red + yellow)**

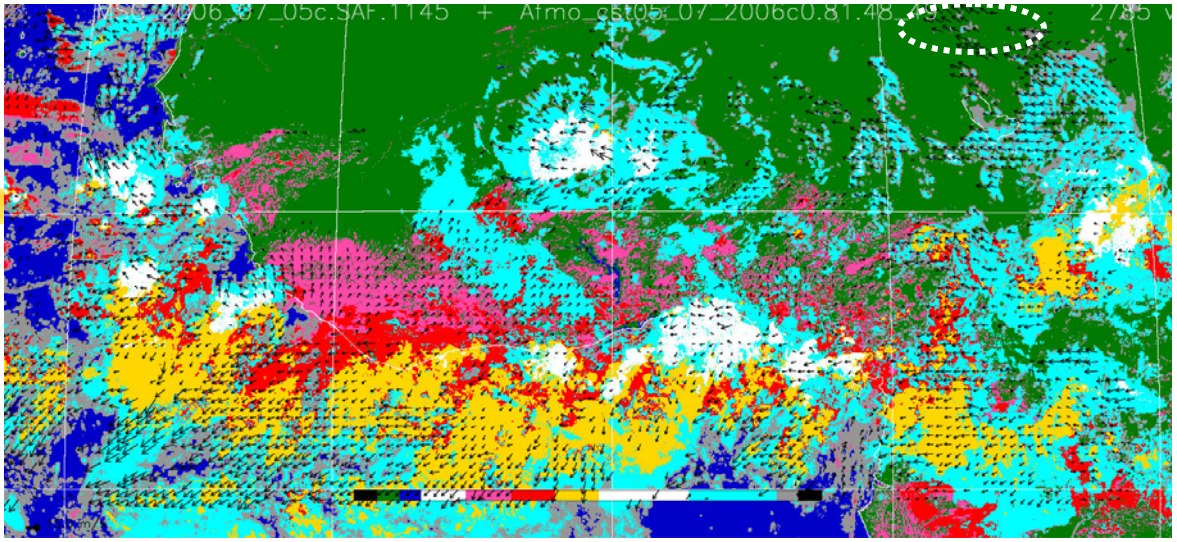
- **Reduced maximal displacement : better tracking of low-level clouds :**
  - **Monsoon winds (slow). ---> tracking of small cumulus clouds. . . . . .**
  - **But no extraction of strong winds. - - - - -**



2) Cloud classification-based height assignment of AMVs

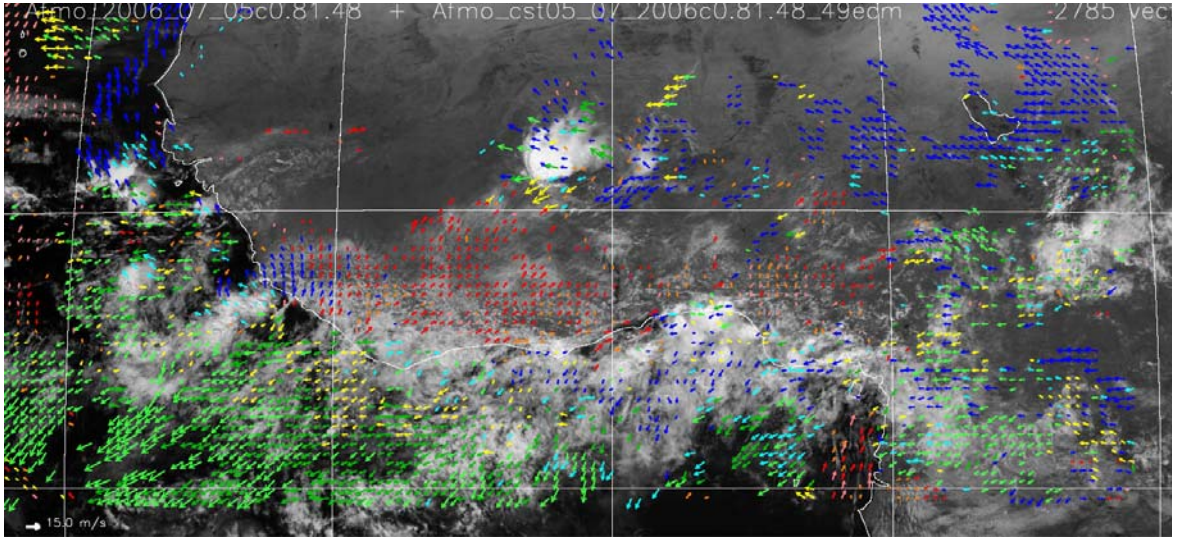
- **Comparison of pressures:**
  - **Best-fit pressure level with ECMWF analysed winds**
  - **Averaged classification-derived pressure of pixels from dominant cloud class in target window.**
  - **(Other possible pressures : coldest or warmest cloud of the cloud class, etc…)**

No cloud-classification related pressure



***Green** : land ; grey : partial coverage*

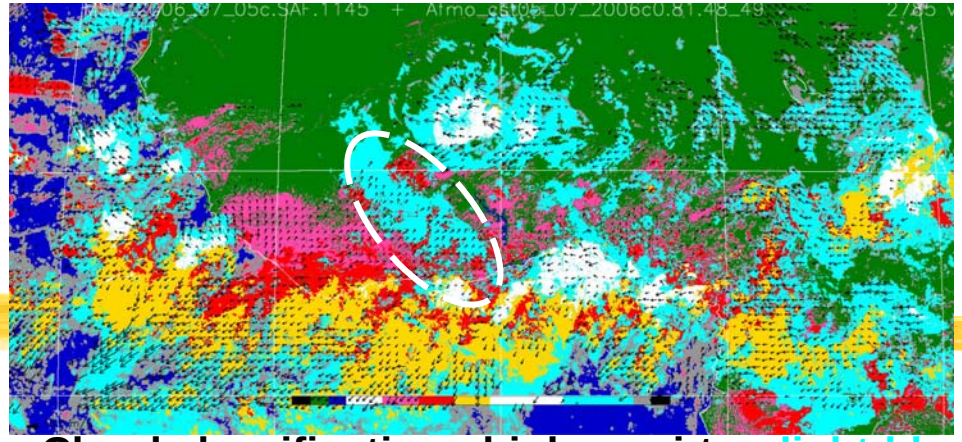
- **Situation (5-July-2006) :**
  - **Low (pink and red)**
  - **Medium (yellow) (important coverage)**
  - **High opaque (white) and semi transparent (light-blue)**
- **No cloud areas : Mainly over land (Sahara) - - - -**
- **No pressure for some partial coverage pixels**



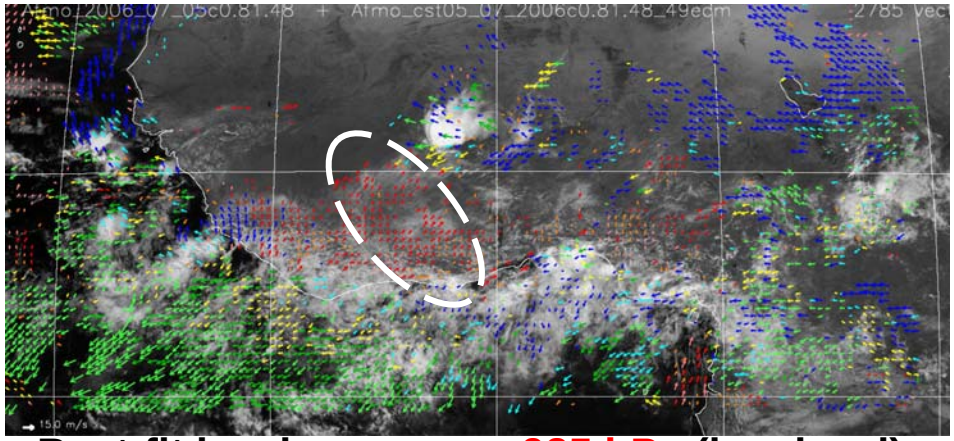
Best-fit level : 1000, 925, 850, 700, 500, 400, 300, 250, 200 hPa

Important difference between best-fit and classification-related pressure

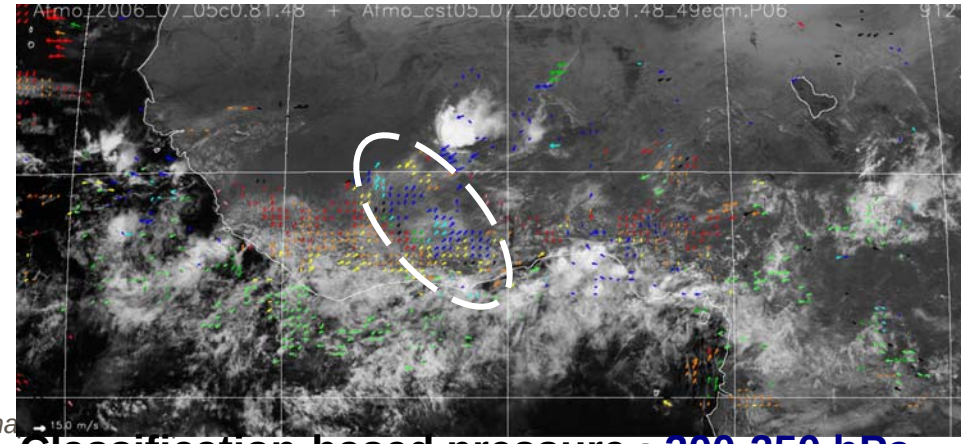
- **Classification-based pressure levels :**
  - **Vectors filtered with best-fit level pressure.**
  - **Only low-level vectors (after filtering) retained and coloured.**
- **Interpretation :**
  - **Low-level clouds overflown by high-level cirrus**
  - **Low-level clouds give motion, high-clouds dominate classification.**



Cloud classification : high-semi-tr. : light-blue



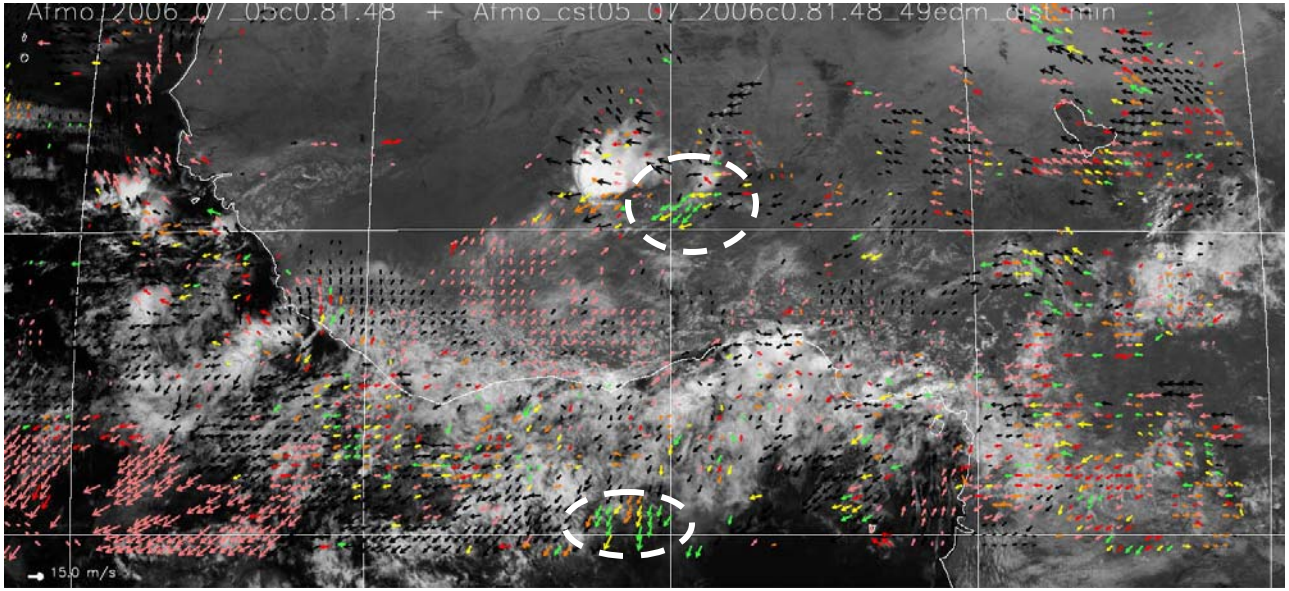
Best-fit level pressure : 925 hPa (low-level)



Classification-based pressure : 200-250 hPa

Bad determination of best-fit level

- **Study of the difference $\Delta V = | V_{sat} - V_{ecmwf}(P)|$ function**
- **Best-fit for minimal ΔV**
- **On limited areas : 2 close minima of ΔV function - - - -**
- **Risk of incorrect determination of best-fit level :**
  - **if $R_{\Delta V} = \Delta V(_{Pbest\text{-}fit\ level}) / \Delta V(P_{\ level\ of\ 2nd\ minima})$ close to 1**



Black : 1 minimum

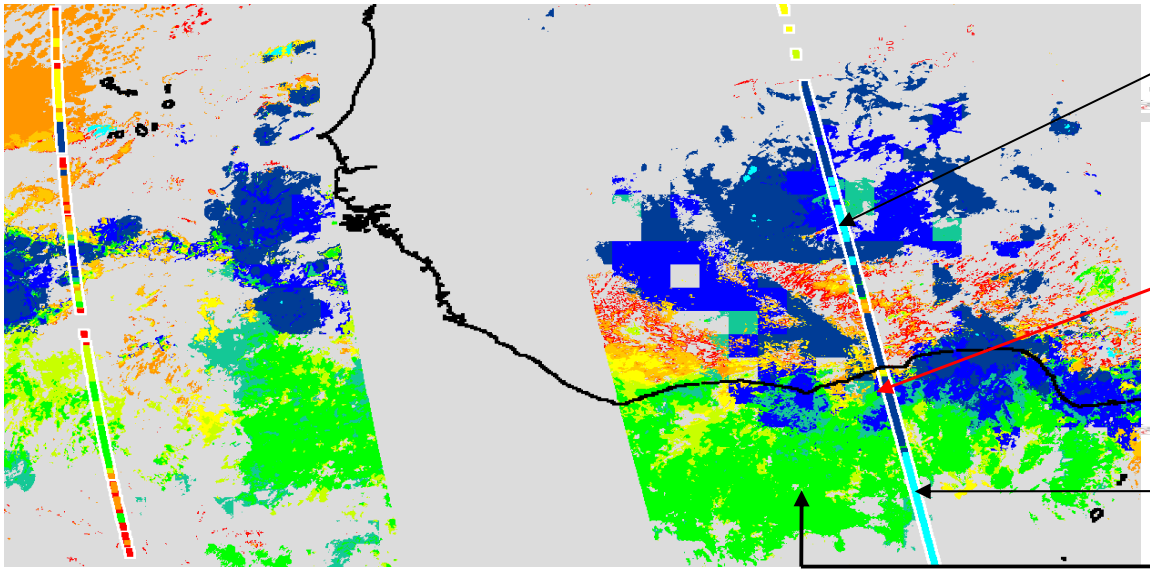
$R_{\Delta V}$:

0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.

3) CALIOP lidar height vs. classification-based height

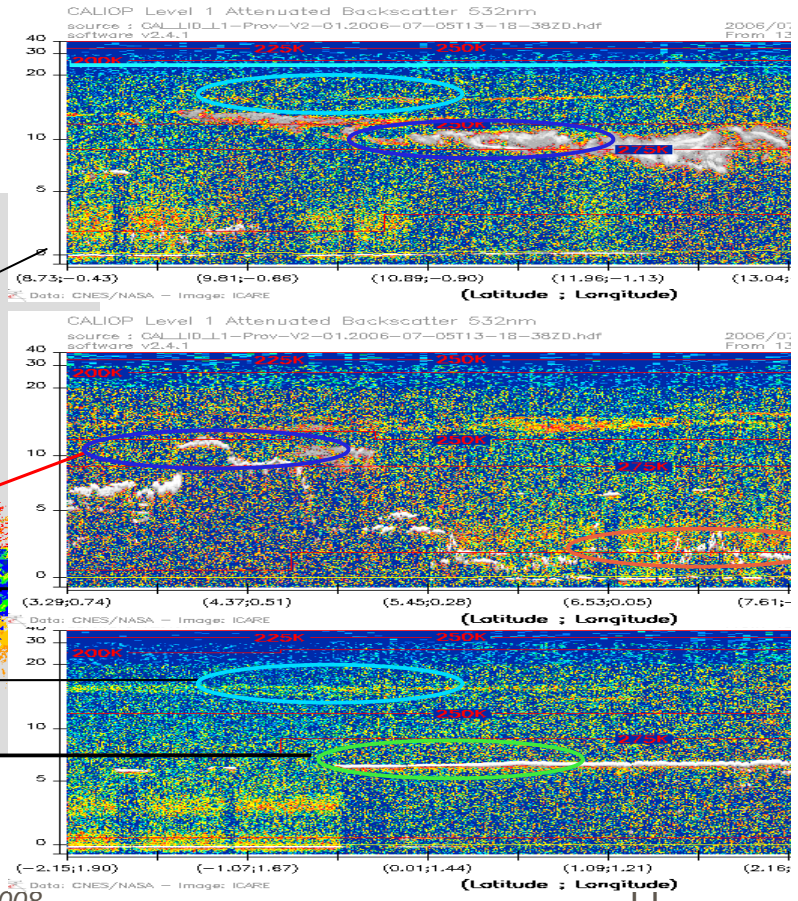
- **Multiple layers observed in the presence of thin clouds (cirrus) at higher level than indicated by cloud classification.**

SOUTH to NORTH →



SAF classification-based pressure image

0 100 200 300 400 500 600 700 800 900hPa



Lidar data provided by J. Pelon

Conclusions

- **VIS : better adapted for low-level wind extraction than other channels.**
- **Use of smaller search window : small increase of the number of low-level winds**
- **Limits of cloud classification :**
  - **No clouds or no pressure related to fractional pixel coverage by clouds in some areas with observed motion. (Possible presence of very thin cirrus.)**
  - **Measured motion (AMV) not corresponding to expected motion associated to cloud classification. (Low-level motion vs. high-level cloud according to classification.)**
- **Risk of bad determination of best-fit level in case of 2 close minimal vector differences over limited areas.**

Prospects

- **Extend comparisons over long period (July 2006, summer 2006) :**
  - Cloud classification-based pressure vs. best-fit level of analysed winds
  - Lidar heights vs. classification-based heights.
  - Comparisons of AMVs with other data from the AMMA campaign (radiosondes, dropsondes, …)

- **Produce a reliable AMV product over the tropics (West-Africa)**
  - Comparisons or use of SAF HRV wind product ?