AMV Height Assignment with Meteosat-9: Current Status and Future Developments

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EUMETSAT

Organisation of this presentation

- Algorithm changes
- Best-fit analysis:
  - To study impact of algorithm changes,
  - To highlight some ‘features’
- Future developments

What has happened since 2006 ?

- February 2007: major algorithm changes
- 11 April 2007: Meteosat-9 became prime satellite
- March 2008: minor algorithm changes
- Ongoing: new image radiance definition

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Algorithm Changes (February 2007)

- Scenes analysis: dynamic clustering instead of ‘layering’
- AMV location moved to position with maximum local standard deviation (radiance)
- CO_2 height assignment methods: improved handling of forecast temperature inversions
- Use Semi-Transparency Correction (STC) methods for narrow selection of AMVs
- Do not apply Cloud Base Height Assignment if this places the AMV higher in the atmosphere
- Do not apply Inversion Height Correction if this places the AMV higher in the atmosphere
- Various smaller changes

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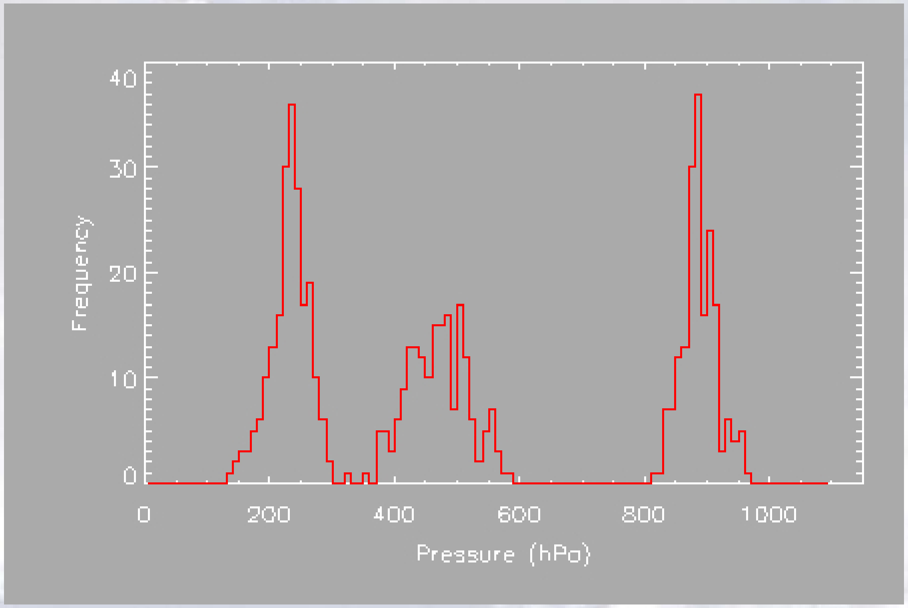
Scenes Analysis

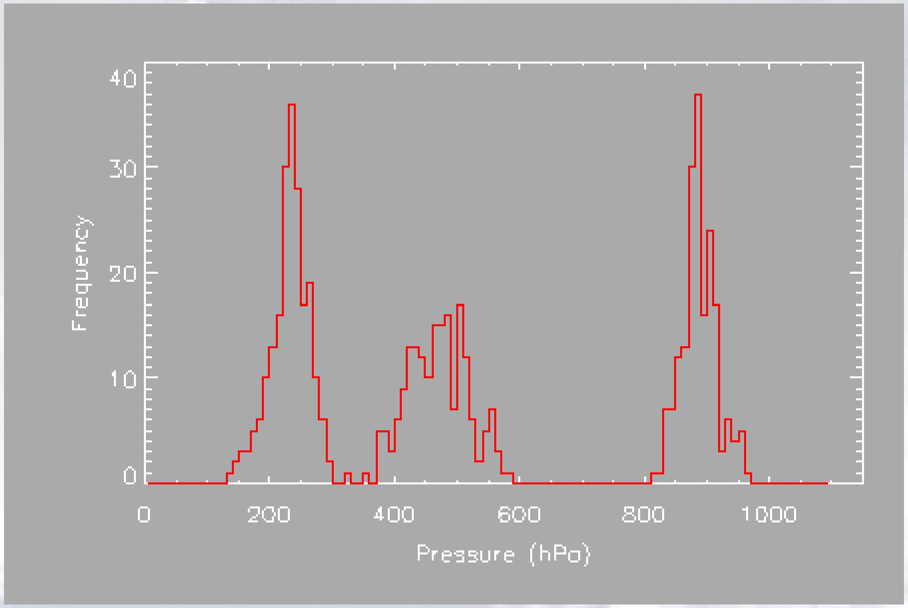
- Consider 24 x 24 target area
- Select cloudy pixels
- Use cloud top height of each pixel (provided by CLA product)



Scenes Analysis

Old method:

- Layering
- Fixed boundaries at 100, 300, 500, 700, 900 hPa



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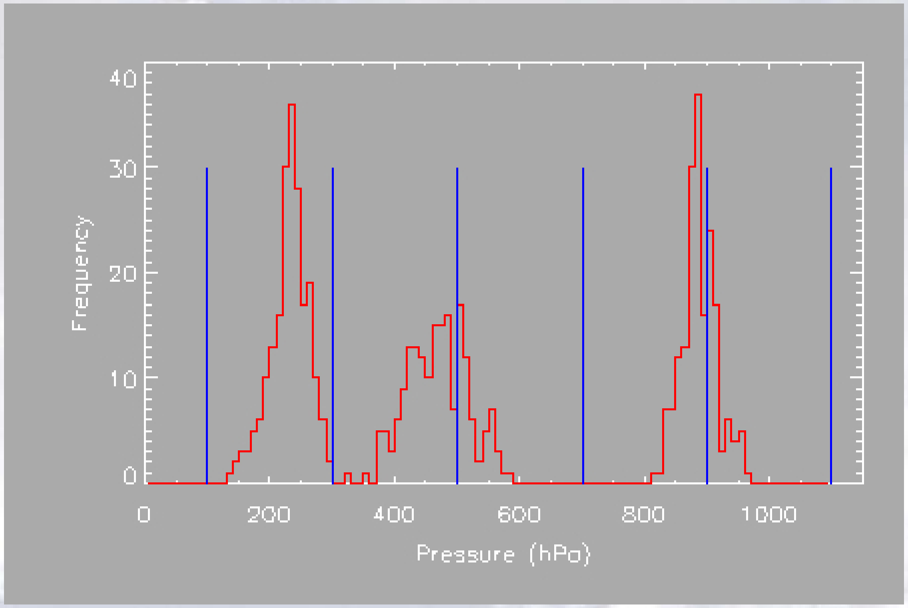
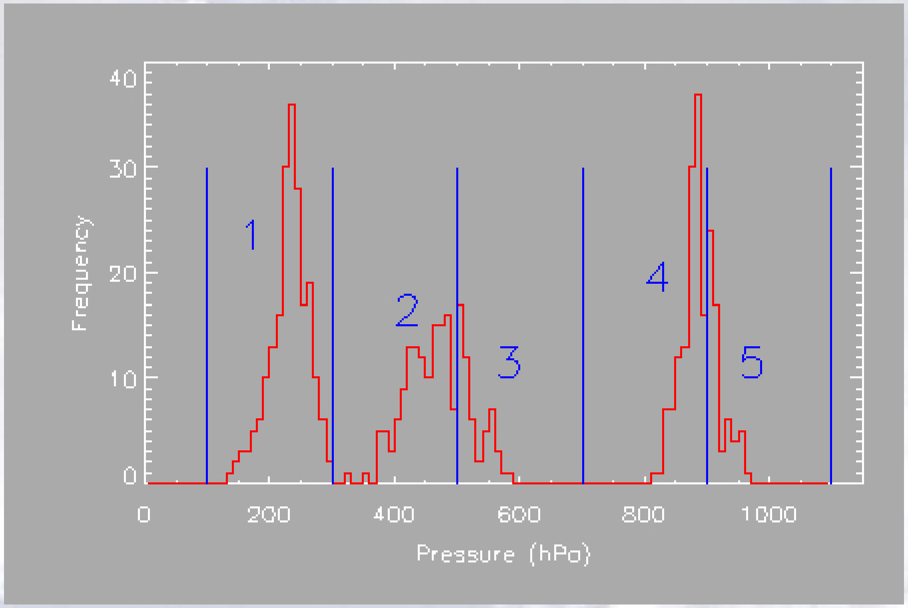


Scenes Analysis

Old method:

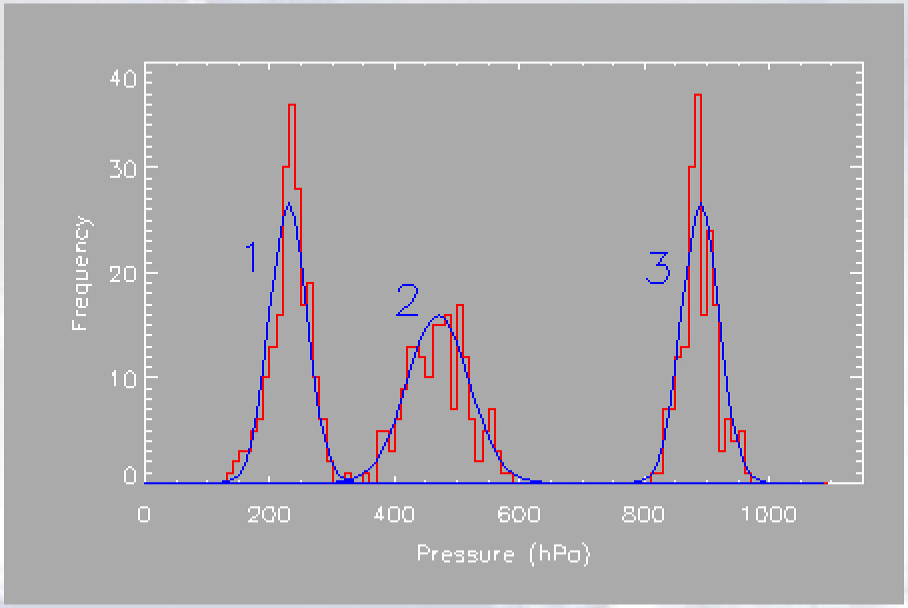
- Layering
- Fixed boundaries at 100, 300, 500, 700, 900 hPa
- A well-defined cloud scene is sometimes split into 2 separate scenes



Scenes Analysis

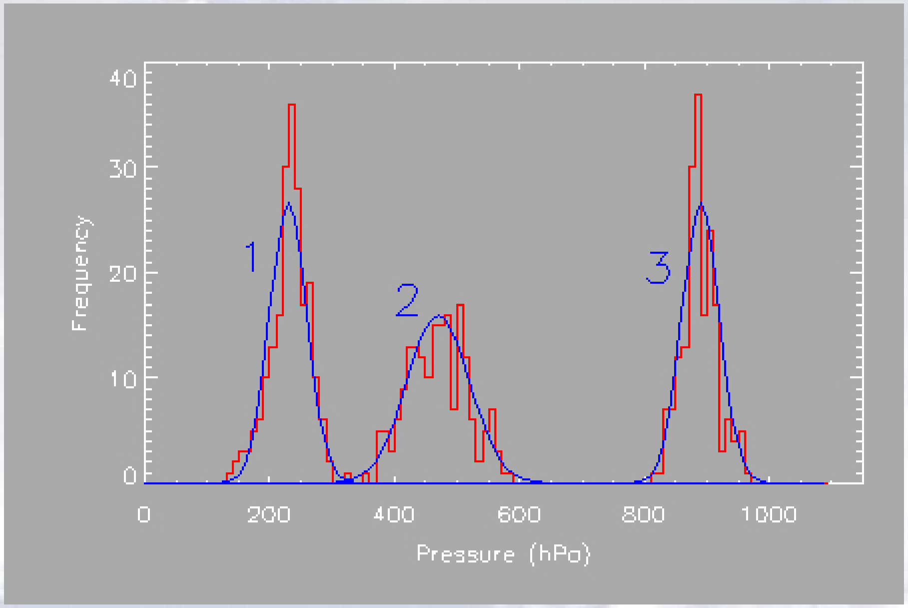
New method:

- Dynamic clustering
- Applies histogram analysis
- Fits Gaussian curve to each well-defined pixel cluster
- If multiple low-level scenes: merge



Height Assignment

- Select scene with coldest EBBT
- Apply all supported H/A methods:
  - EBBT,
  - CO_2-12.0 & CO_2-10.8
  - STC methods
- Select most appropriate method:
  1) CO_2-12.0
  2) EBBT
  3) STC



Impact of these changes

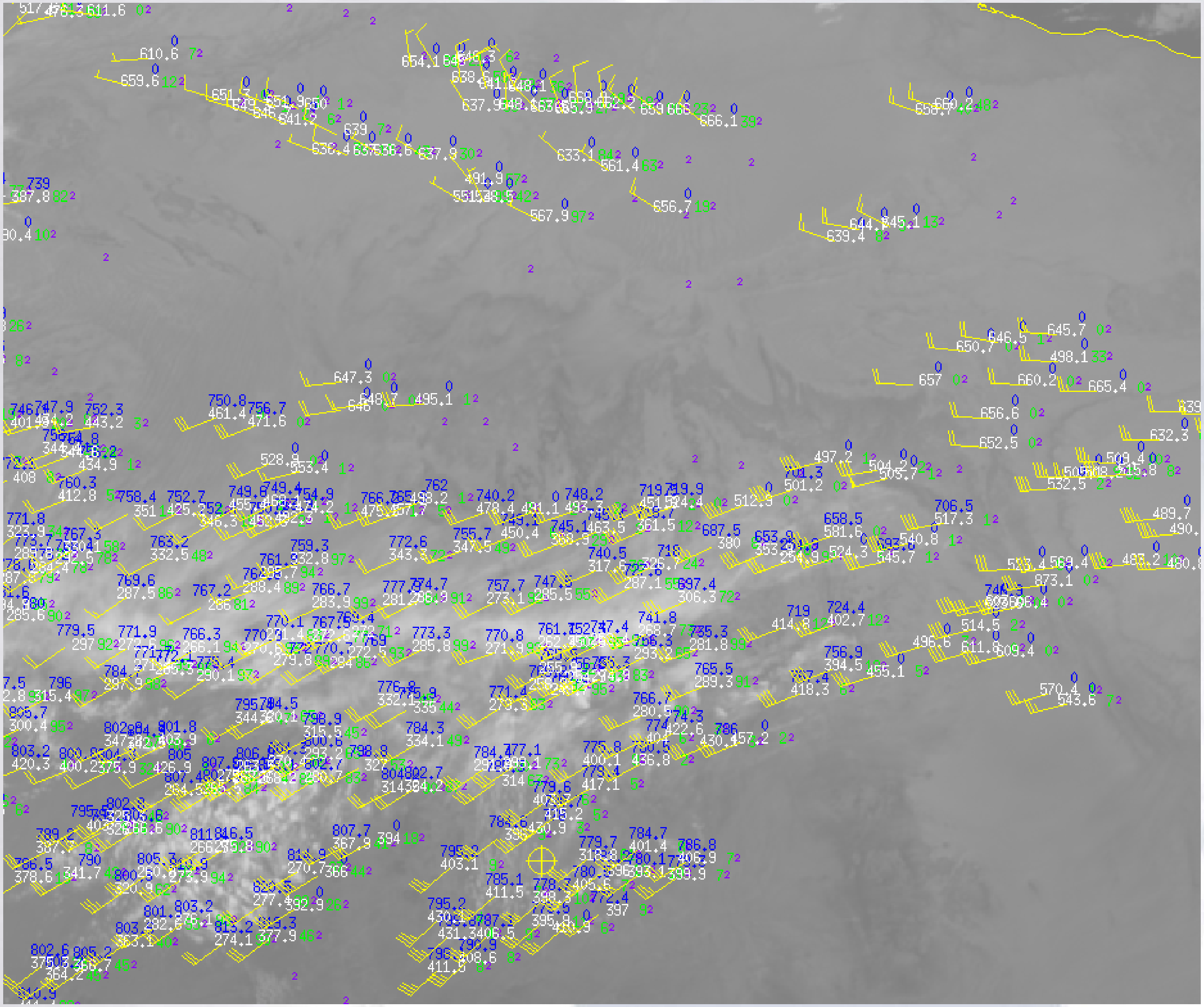
According to ECMWF:

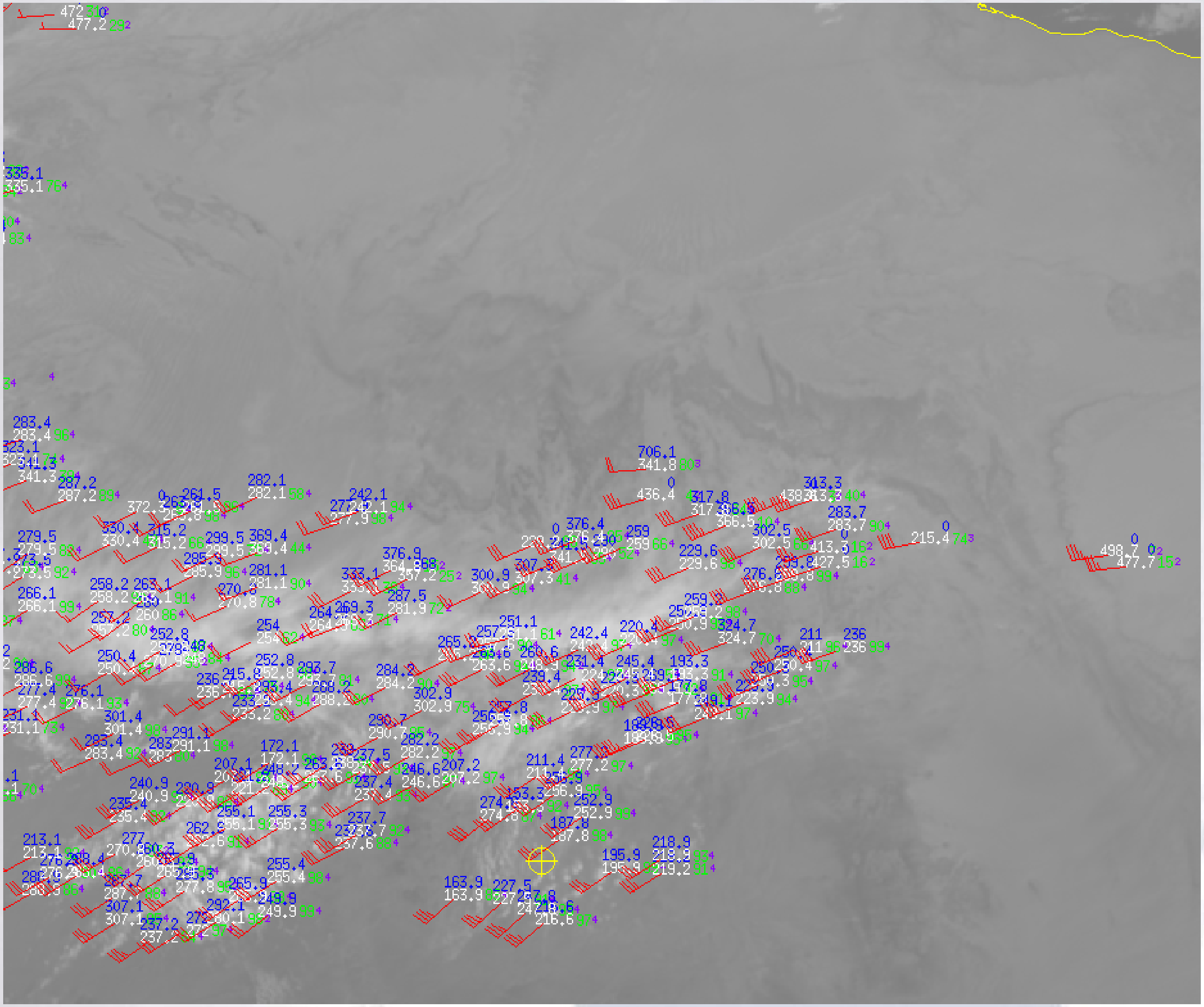
- Overall neutral impact
- More low-level winds assimilated
- Better statistics for medium-level winds

Impact of these changes

Internal validation:

One can do a visual inspection . . .





Impact of these changes

Internal validation:

Or one can do a statistical analysis . . .

Impact of these changes

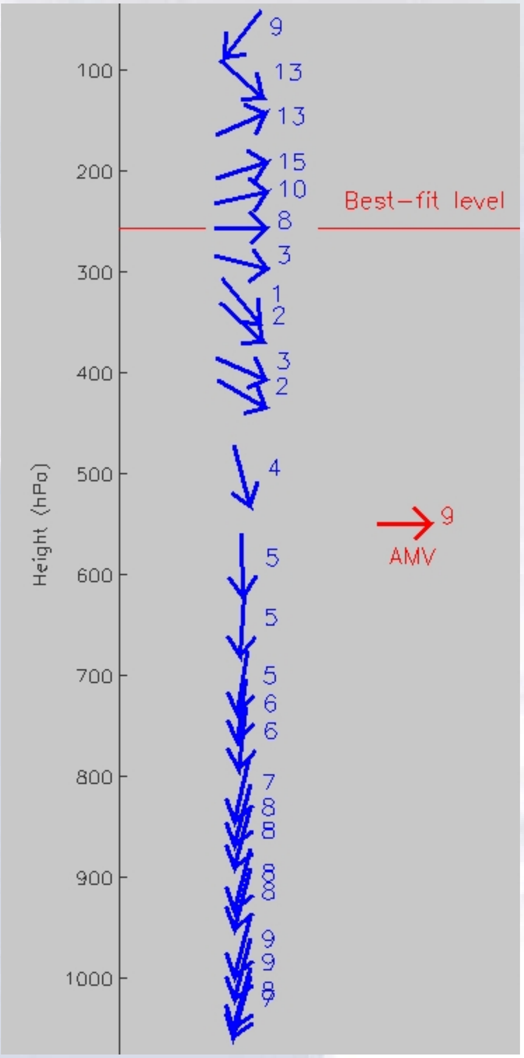
Internal validation:

Or one can do a statistical analysis . . .

Best-fit analysis, comparing AMVs with ECMWF forecast data

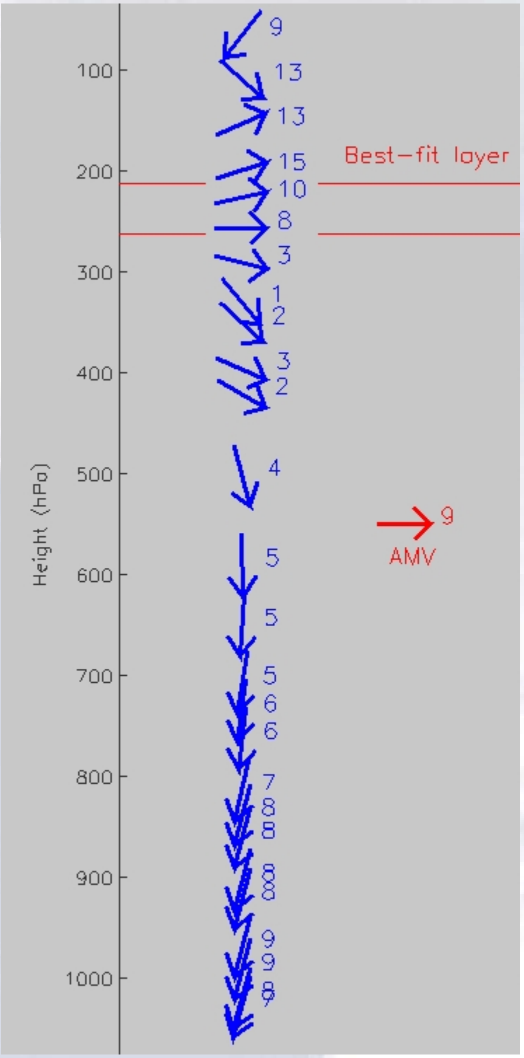
What is ‘best-fit’ ?

- Compare each AMV to forecast profile data at the same location.
- Identify the level at which the profile speed and direction match the AMV most accurately.
- Use forecast consistency.
- If this is a well-defined level, then accept it as a so-called ‘best-fit’ level.
- Some considerations:
  - Apply AMV quality threshold,
  - Is there a good match at all ? ‘best-fit’ does not necessarily mean ‘good fit’.



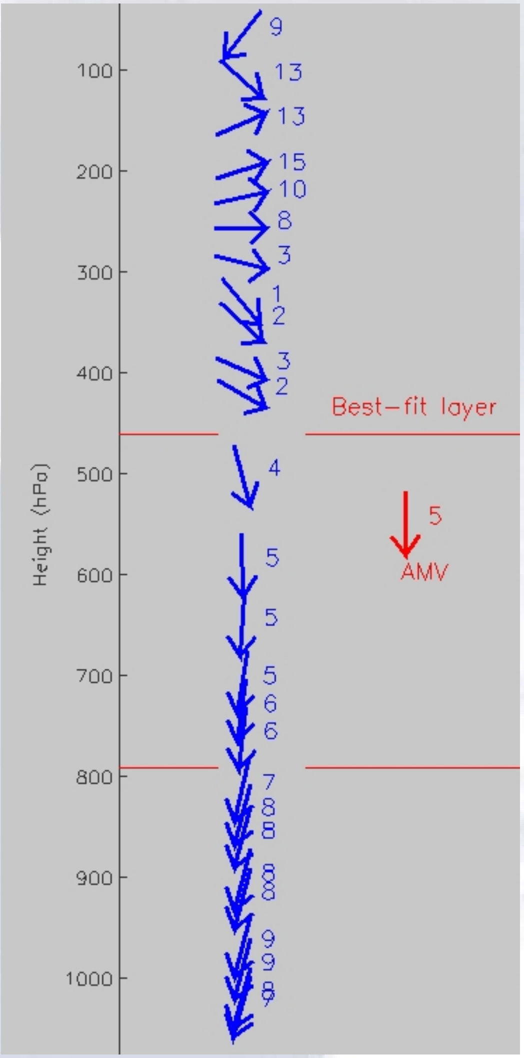
But what is a ‘well defined level’ ?

- So we have identified a ‘best-fit’ level, but is it actually useful?
- That will only be the case when it is clearly distinct from all other levels.
- Let’s introduce the concept of ‘best-fit’ layer.
- A shallow ‘best-fit’ layer implies a well defined ‘best-fit’ level.



But what is a ‘well defined level’ ?

- If the ‘best-fit’ layer is very broad, then reject the collocation.
- A ‘best-fit’ layer being shallow is not sufficient; there should not be any secondary ‘best-fit’ levels.



The ‘best-fit’ algorithm

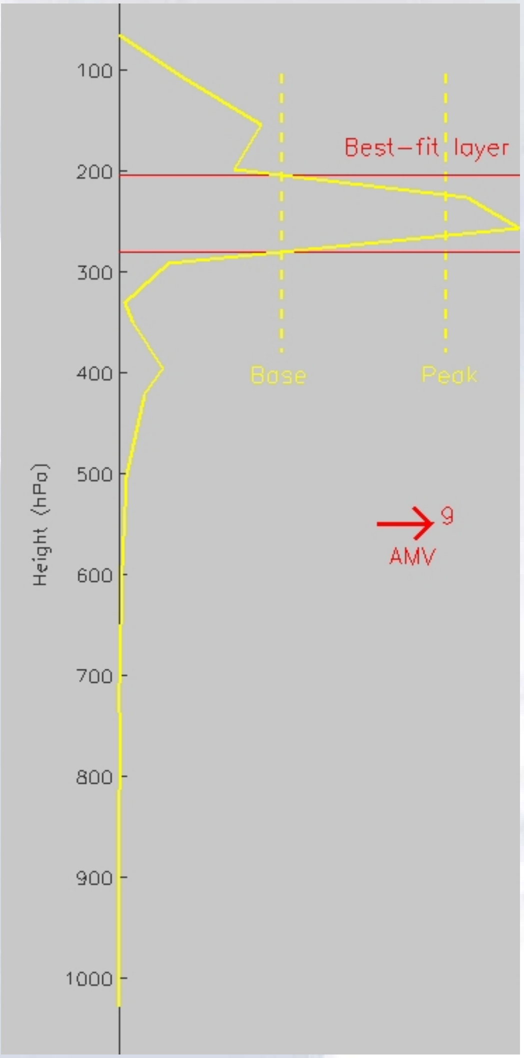
- Apply the same algorithm as we use to derive the AMV forecast consistency
(S ≡ AMV, F ≡ forecast wind vector):

$$Consistency = 1 - \left(\tanh\left(\frac{\left|\vec{S} - \vec{F}\right|}{MAX(0.2 \cdot \left|\vec{S} + \vec{F}\right|, 0.01) + 1} \right) \right)^2$$

- Values are in the range [0, 1],
- Value ~0: very poor consistency,
- Value ~1: very good consistency.

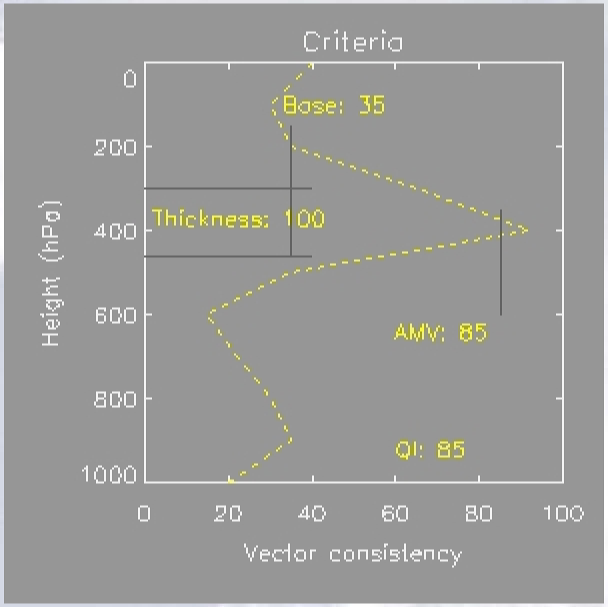
'Best-fit' layer

- Search for 'best-fit' layer = identification of pronounced peak in consistency profile.
- Maximum consistency must exceed C_{peak},
- Consistency at base of peak must be lower than C_{base}.
- C_{peak} defines existence of suitable peak,
- C_{base} defines layer thickness.



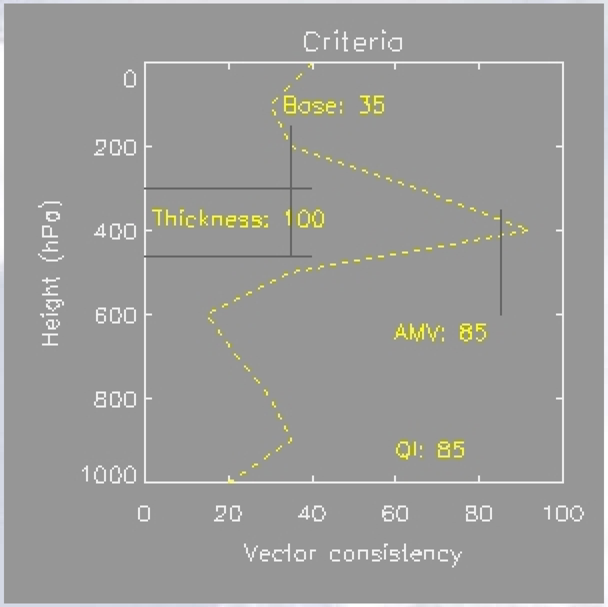
Our 'best-fit' analysis

- Forecast profiles (+12 hours forecast).
- Intermediate AMV products.
- Very strict conditions:
  - QI at least 0.85,
  - 'best-fit' layer thickness of 110 hPa at most,
  - F/C consistency criteria:
    - Peak value at least 0.85,
    - Base value of 0.35.



Best-fit statistics

- February 2007
- November 2007
- Two aims:
  - Current performance of height assignment methods,
  - Performance improvement after algorithm changes.

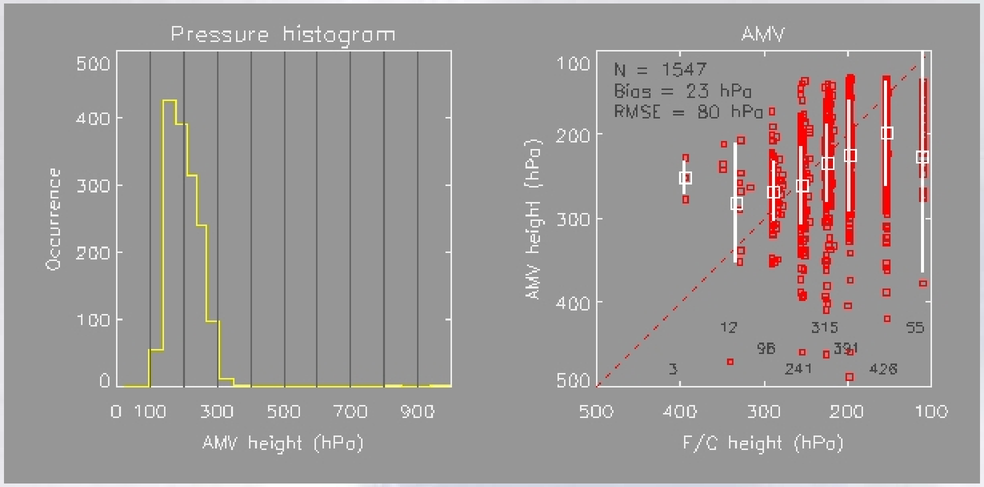


Height Assignment Methods

- EBBT
- 2 CO_2 methods:
  - CO_2 - 12.0 (prime method)
  - CO_2 - 10.8
- 4 Semi-Transparency Correction (STC) methods:
  - STC - 6.2
  - STC - 7.3
  - IR / WV - 6.2
  - IR / WV - 7.3

‘Best-fit’ cases (IR-10.8, global)

February 2007



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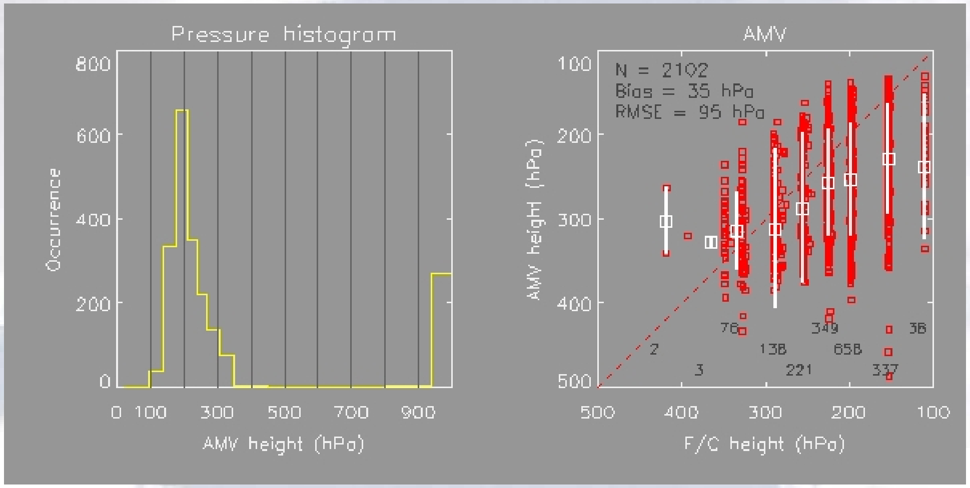

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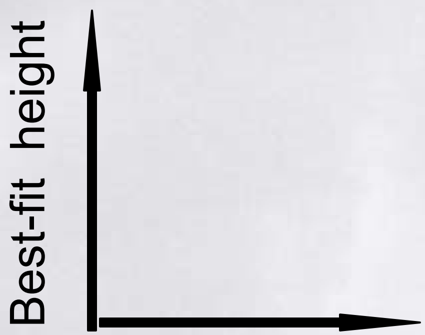

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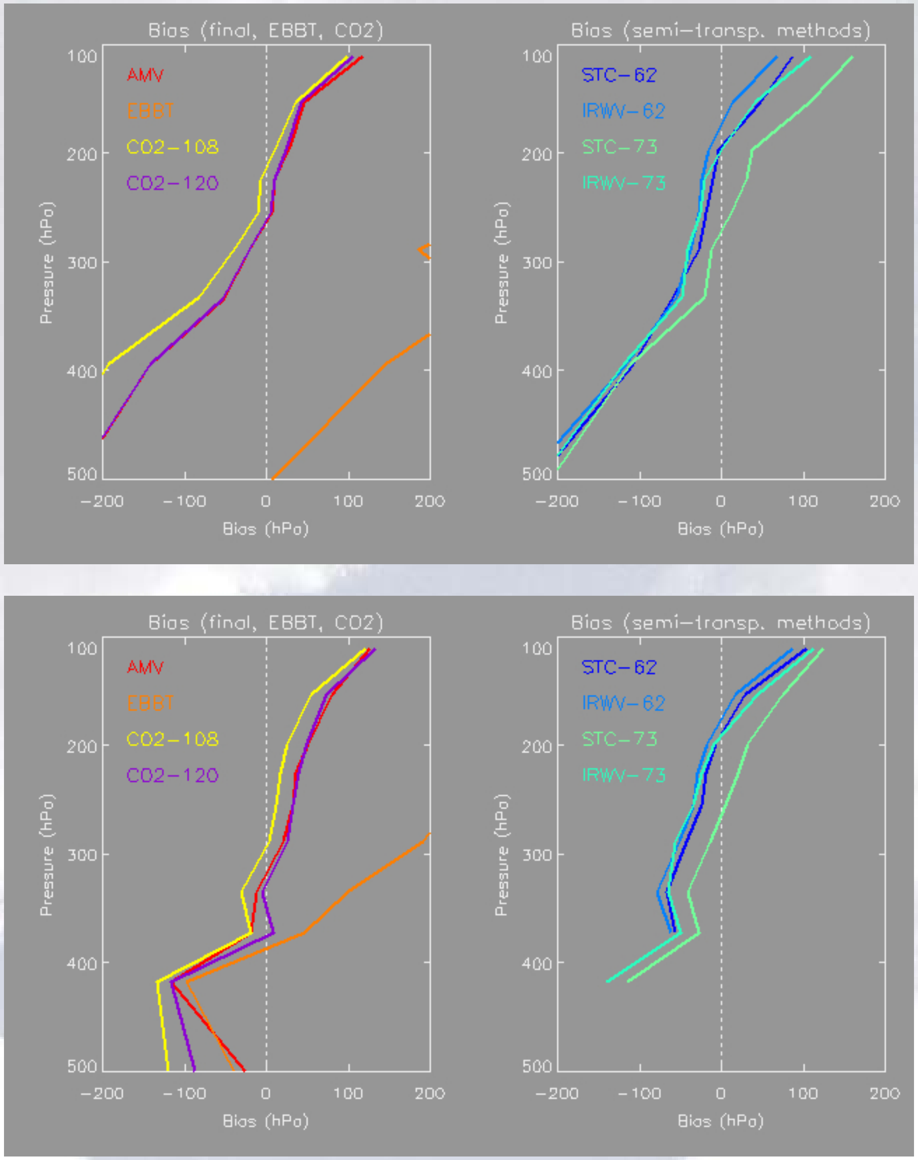

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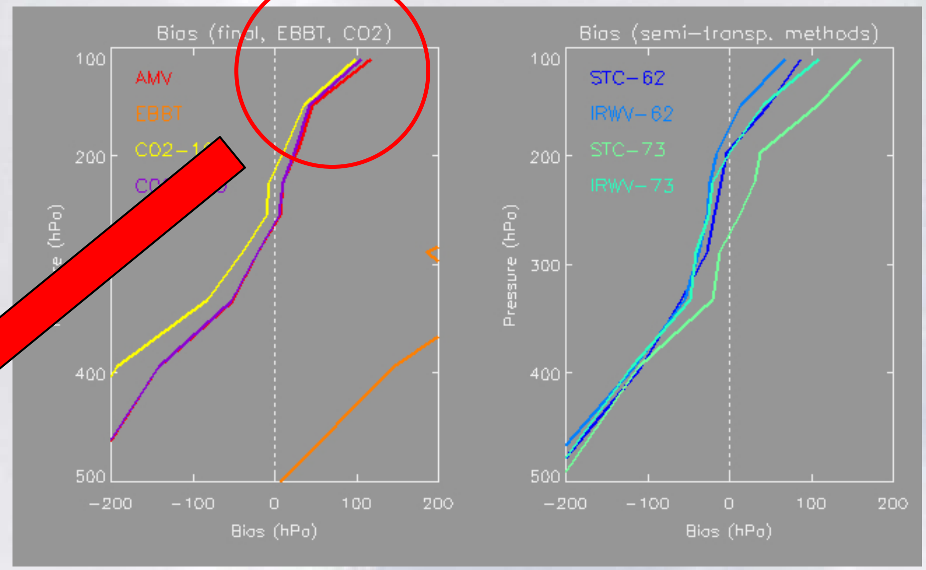
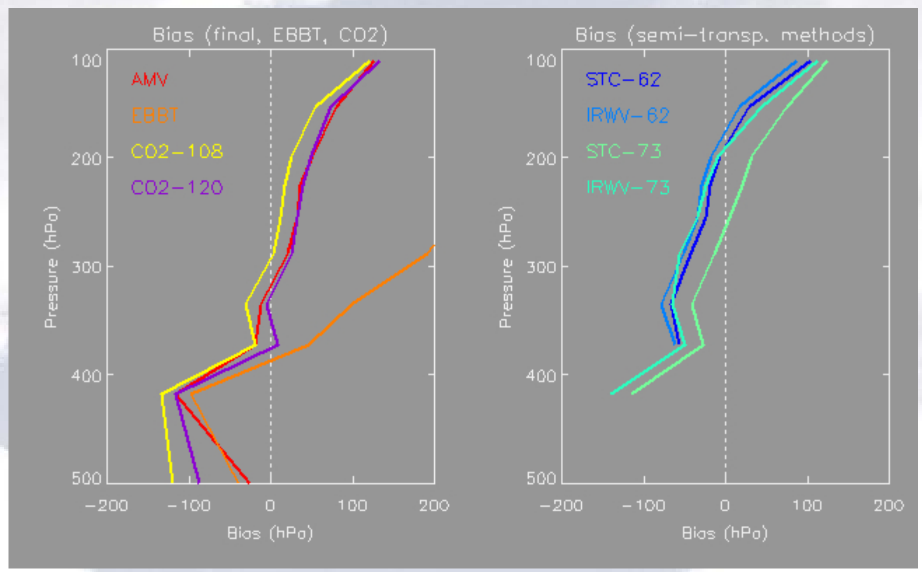


Implies H/A ceiling of 200 hPa:

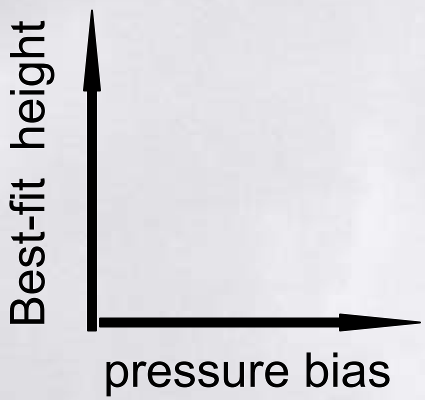
Tropopause problem ?

November 2007



‘Best-fit’ cases (WV-6.2, global)

February 2007



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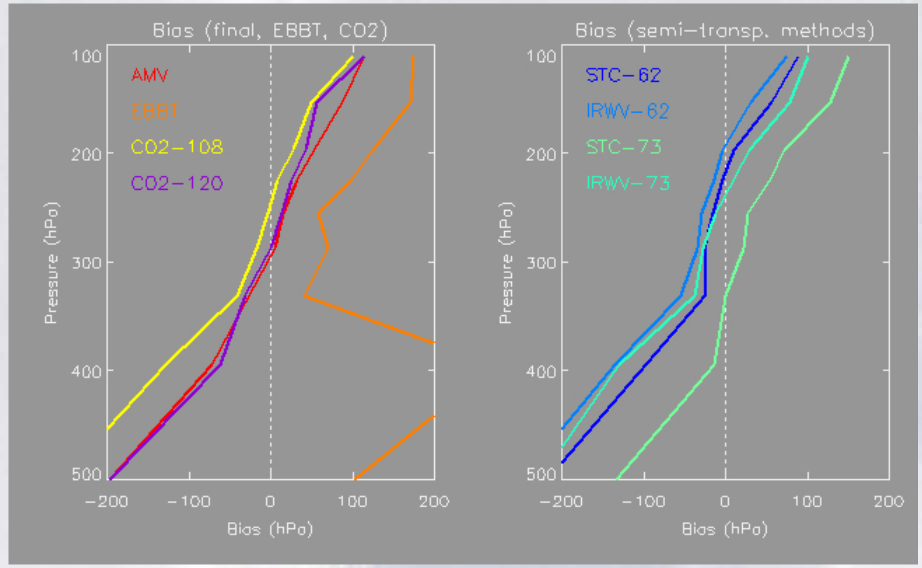
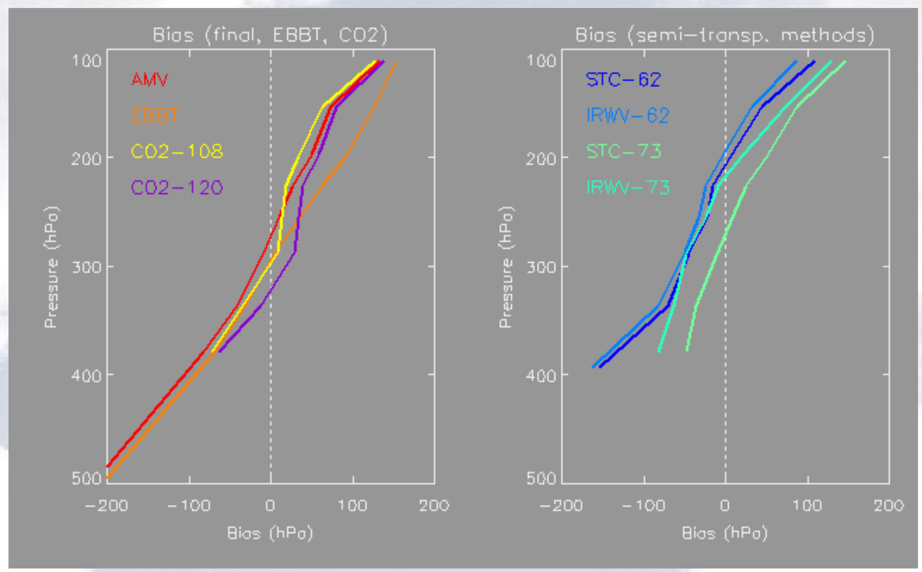
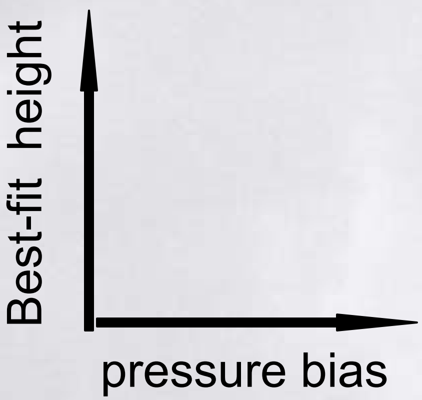
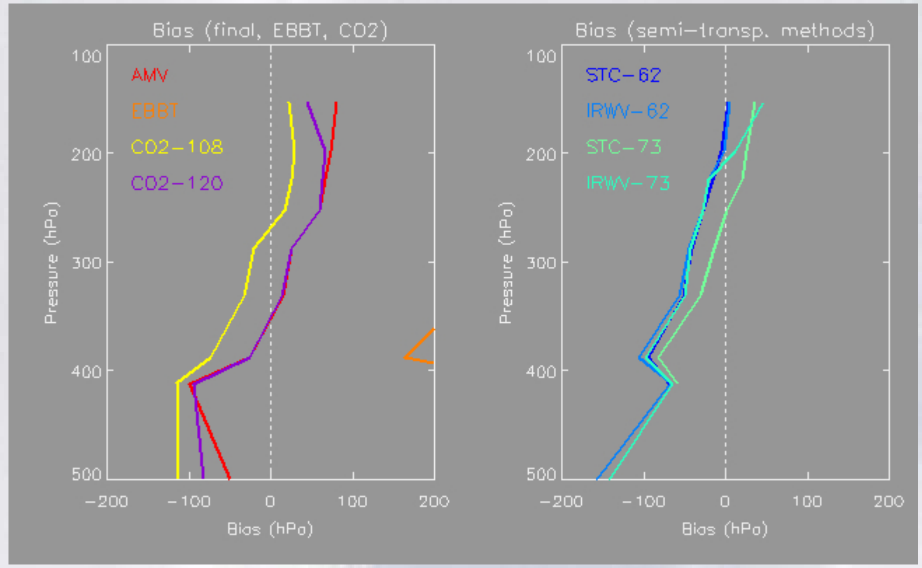




‘Best-fit’ cases (IR-10.8, Sahara, noon)

February 2007





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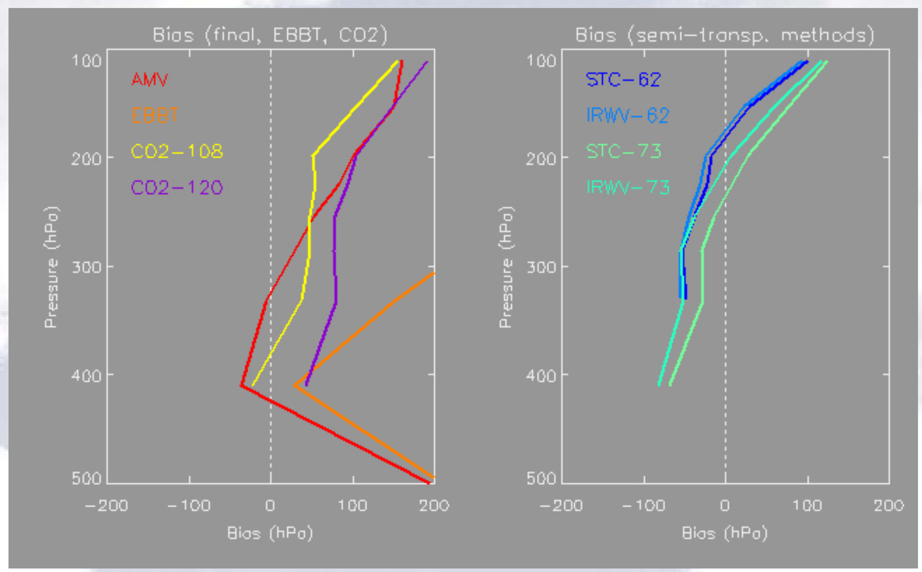

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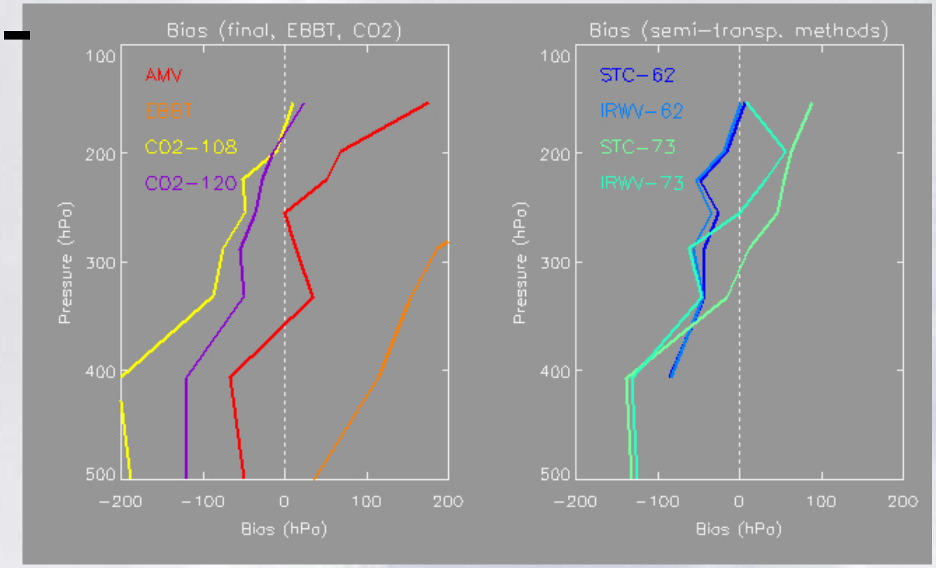

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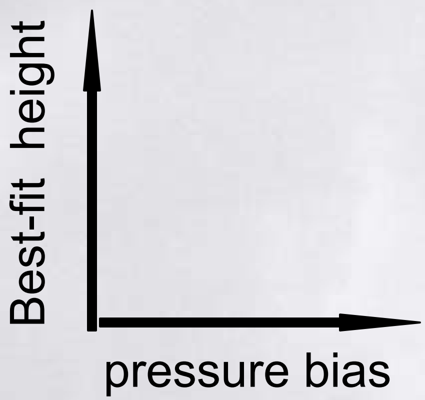

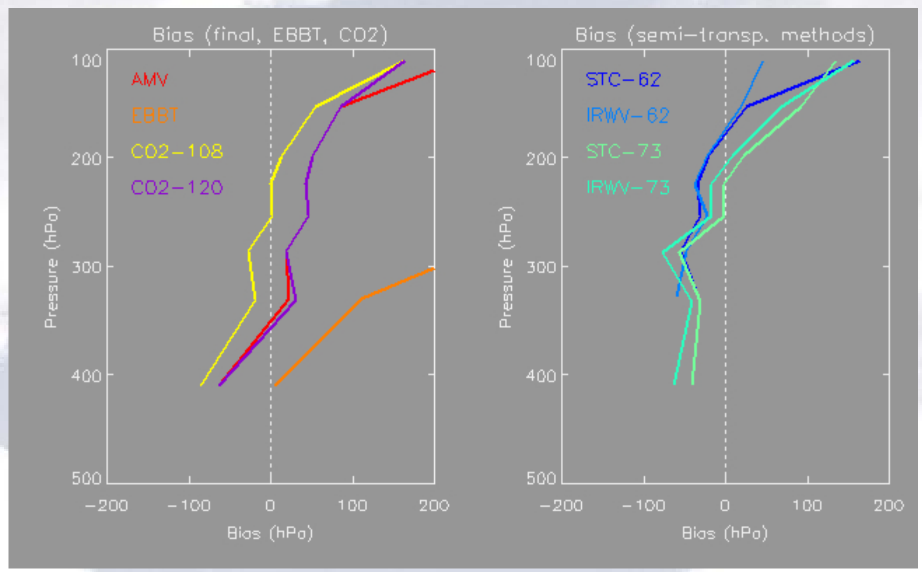

November 2007

Summary of collocation results

- General:
  - Average bias of + 50 hPa (200 - 350 hPa layer),
  - Strong positive bias above 150 hPa, probably related to problems with tropopause handling,
  - CO_2-10.8 performs better than CO_2-12.0,
  - STC methods show negative bias below 300 hPa.
- New algorithms:
  - Big improvement of CO_2 heights below 350 hPa (from large, negative bias to weak, negative bias),
  - Not so big improvement of STC heights below 350 hPa (from very large, negative bias to large, negative bias),
  - Sahara still problematic.

Interpretation of collocation results

Suggestions:

- Keep on trying to improve CLA cloud-top heights.
- Alternative method: consider pixels that contribute most to the peak in the cross-correlation surface (Ryo Oyama, Régis Borde).

What is next ?

- Test alternative pixel selection:
  - Pixels that contribute most to the peak in the cross-correlation surface
- Investigate handling of tropopause
- Introduce height QI, based on inter-comparison of individual methods
- Expand AMV collocations:
  - For all individual methods,
  - Radiosonde & forecast data.

Thanks !