Improvement and calibration of clouds in models 12/04/2021
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Impacts of a change in deep convection scheme on the ARPEGE data assimilation system.

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Analysis comparison

- We compare analysis produced by two **ARPEGE 4D-Var**:
  - Operationnal ARPEGE, Cy43 written : x_a
  - Same ARPEGE model with another deep convection scheme Tiedtke Bechtold written : x_a'
- Let's consider the quantity : $MS(D_a)$

$$E[(x_a - x_a')^2] = E[(\underbrace{x_a - x_{true}}_{e_a} + \underbrace{x_{true} - x_a'}_{-e_a'})^2]$$

$$E[(x_a - x_a')^2] = E[e_a^2] + E[e_a'^2] - 2E[e_a e_a']$$

Assumptions:
- The analysis standard deviation of both model is the same : σ_a
- Unbiased analysis errors

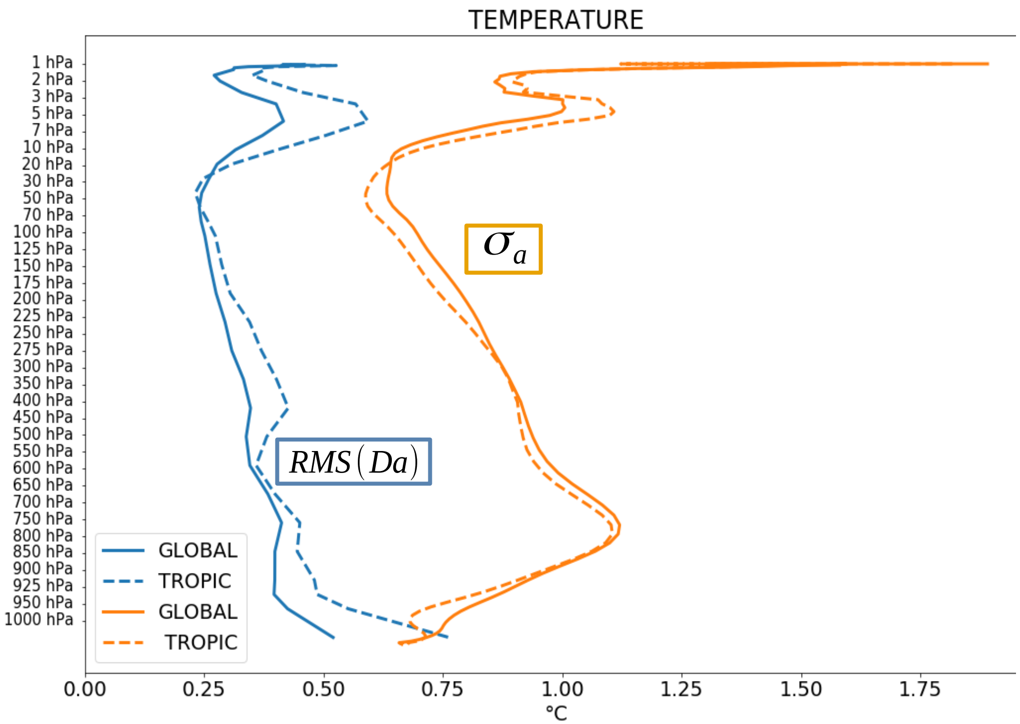
⋮

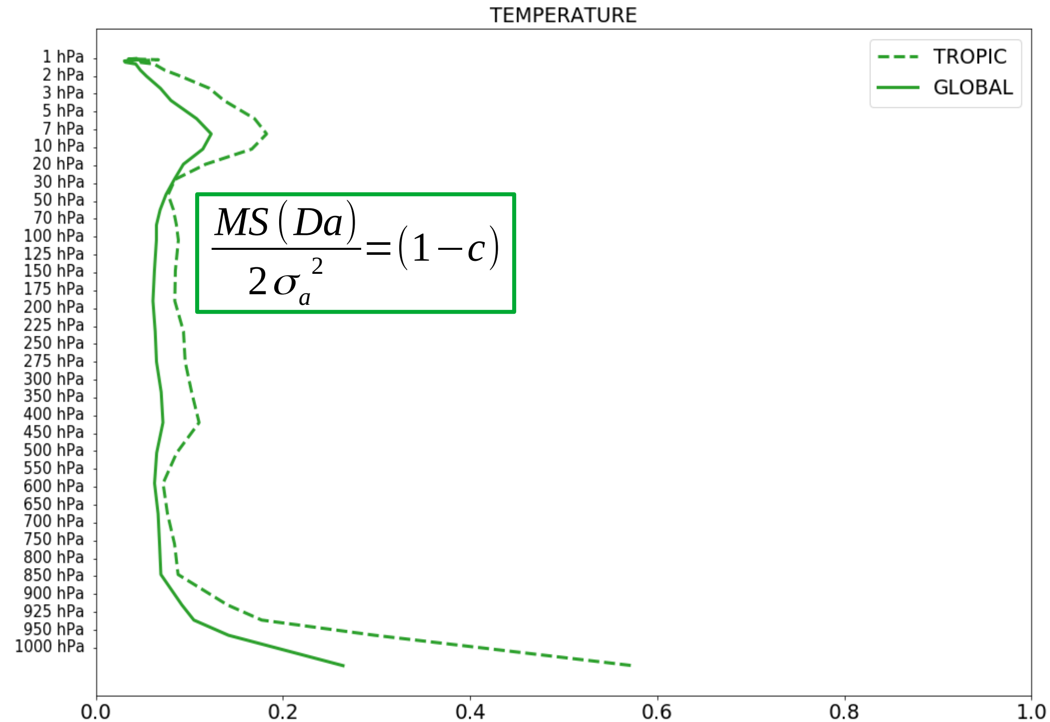
$$\boxed{MS(D_a) = 2\sigma_a^2(1-c)}$$

c being the correlation between the analysis errors e_a and e_a'

- The quantity $(1-c)$ will increase as we introduce more decorrelation between the two models analysis errors. It is also the ratio of the variances of the analysis error due to deep convection change over the variance of the analysis error itself.

Comparison of the analysis temperature





- The standard deviation σ_a is computed from the ARPEGE ensemble data assimilation (EDA)
- The variance of analysis error in temperature is between **10 and 20 % of the total analysis error** variance. It is even larger in the tropic and in the boundary layer
- From Berre 2019 we know that the **model error is the main contributor to analysis error**, here we show that the **deep convection scheme play a large role** in this contribution
- Furthermore, other studies have shown that **initial conditions of the model play a big role on medium range forecast performances** (Magnusson 2019)
- Thus, the deep convection scheme impact is double as it changes the way forecast are performed as well as the inital conditions