CONVECTIVE PARAMETERIZATION OF ENSEMBLE WEIGHTED APPROACH FOR THE REGIONAL MODEL BRAMS

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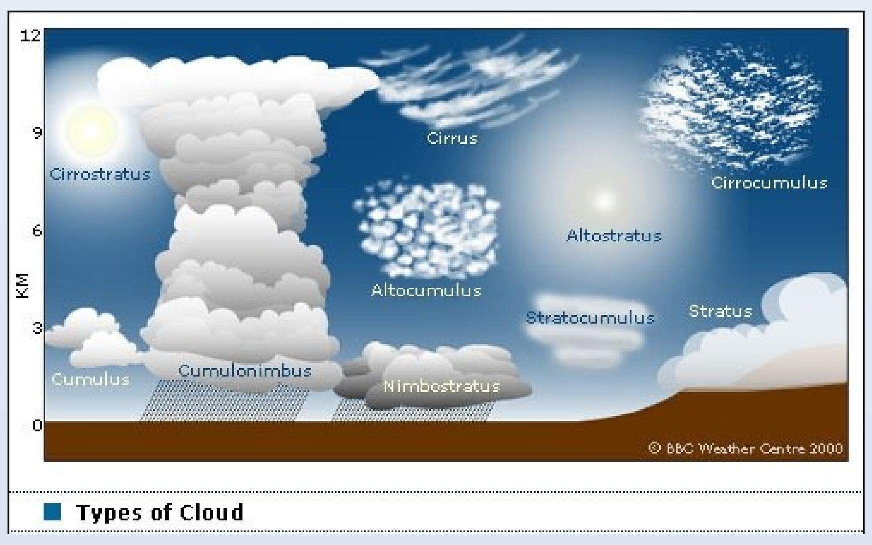
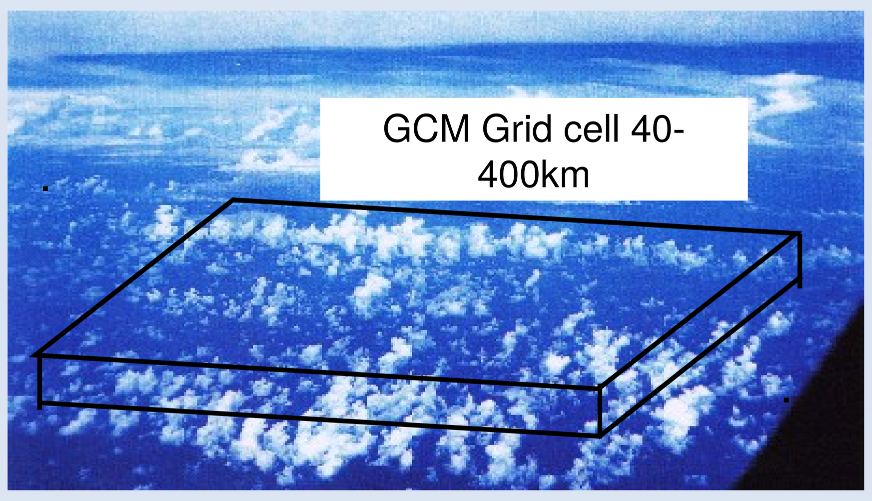
***RESUMO:** No presente trabalho, a metodologia de problema inverso de estimação de parâmetros é aplicada ao modelo BRAMS. O problema inverso é resolvido pelo método de otimização Firefly (FA) e o modelo direto é dado pelas simulações de precipitação utilizando diferentes parametrizações de convecção do modelo. O objetivo é determinar numericamente os pesos de cada parametrização para ponderar o conjunto de parametrizações convectivas. Como resultado, é obtido o campo de chuva reconstruído a partir da combinação entre as simulações e os campos de pesos. Os resultados indicaram um campo de precipitação reconstruído mais próxima das observações.*

***ABSTRACT:** In this study, the methodology of inverse problem of parameter estimation is applied using the regional model BRAMS. The inverse problem is solved by the Firefly (FA) optimization method and the direct model is given by the simulations of precipitation expressed by different cumulus parameterizations of the model. The goal is to determine numerically the weights of each parameterization to weight the ensemble of cumulus parameterizations. The results showed a retrieved precipitation field closest to the observations.*

INTRODUCTION

Why is so difficult represent clouds in the numerical models?





FIREFLY METHOD

Pseudo code

begin
Objective function f(x), x=(x_1,..., x_d)^T
Generate initial population of fireflies x_i(i=1, 2,..., n)
Light intensity I_i at x_i is determined by f(x_i)
Define light absorption coefficient γ
while (t < MaxGeneration)(Number of iterations)
for i = 1 : n all n fireflies
for j = 1 : d loop over all d dimensions
if (I_j > I_i), Move firefly i towards j: end if
Attractiveness varies with distance r via exp[- γr]
evaluate new solutions and update light intensity
end for j
end for i
Rank the fireflies and find the current best
end while
Postprocess results and visualization
end
Adapted of Yang (2008)

$$I(x) \propto f(x) \;\Rightarrow\; I_r = \frac{I_{fonte}}{r^2}$$

Movement of the firefly i toward firefly j (brightest)

$$x_i = x_i + \underbrace{\frac{\beta_0}{1+r^2\gamma}(x_j - x_i)}_{\text{atraction}} + \underbrace{\alpha\left(rand - \frac{1}{2}\right)}_{\text{randomness}}$$

γ =O(1) => determines the convergence velocity

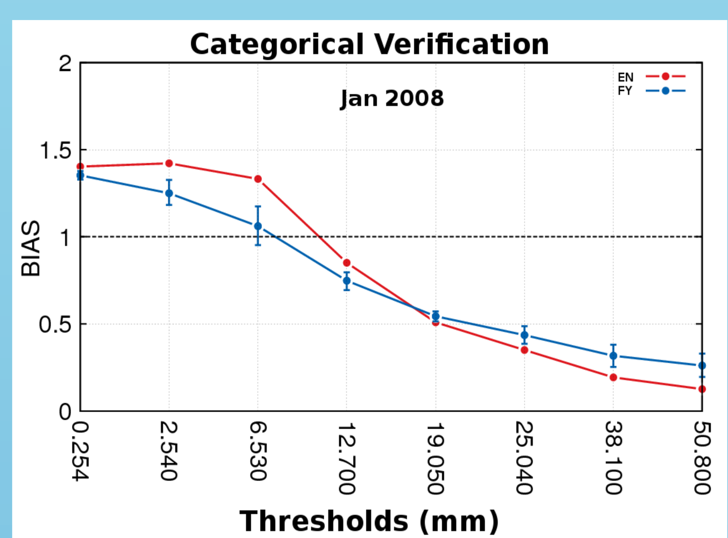
To an environment light absorption coefficient fix γ

$$I = I_0 e^{-r\gamma} \;\Rightarrow\; I = I_0 e^{-r^2\gamma} \;\Rightarrow\; I_r = \frac{I_{fonte}}{1+r^2\gamma}$$

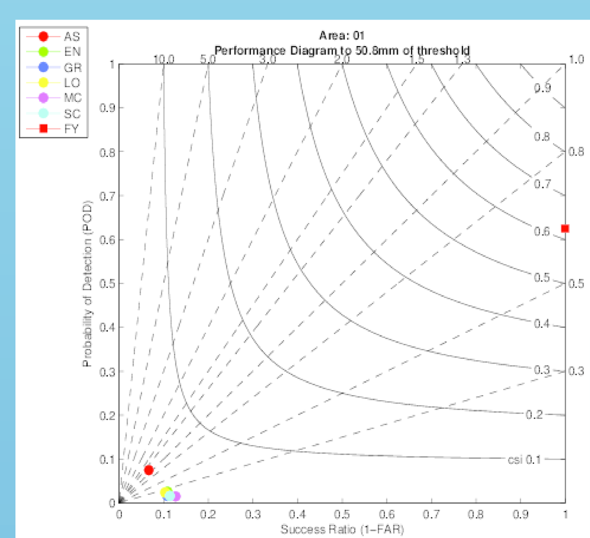
RESULTS

Experimental tests with the FA algorithm parameter

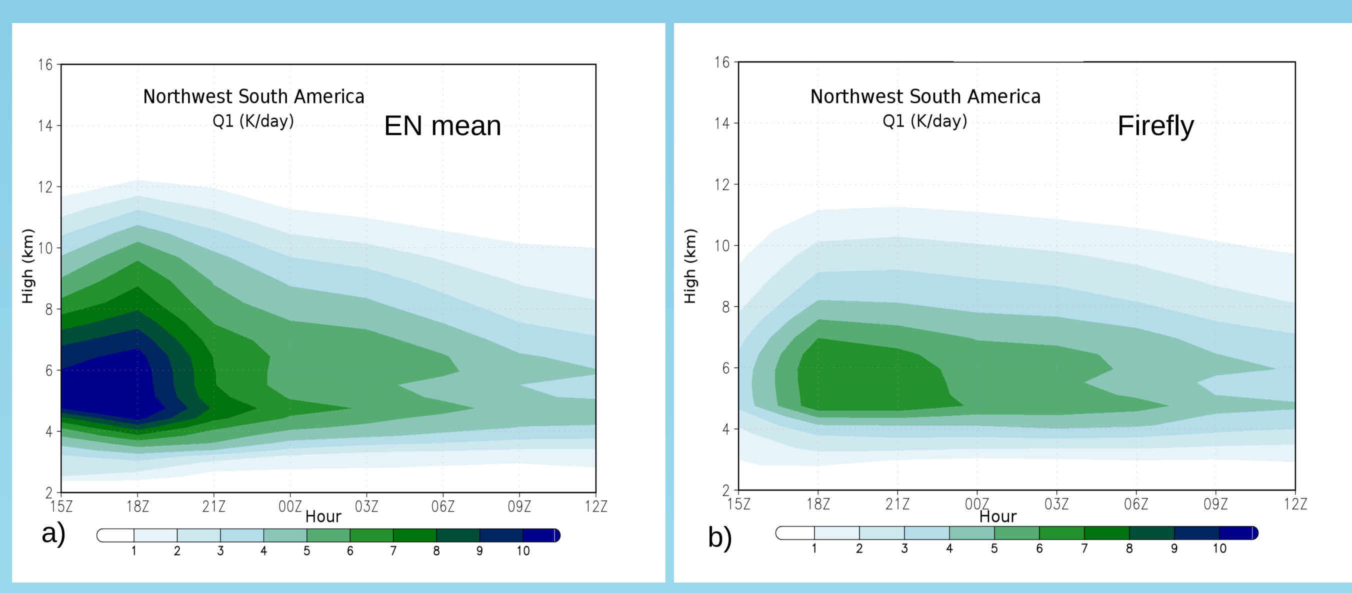
Parameter	Initial Value	Final Value	Increment
α	0.01	0.1	0.01
β	0.1	1.0	0.1
γ	1.0	10.	1.0
n	5	5	5
G	10	100	10



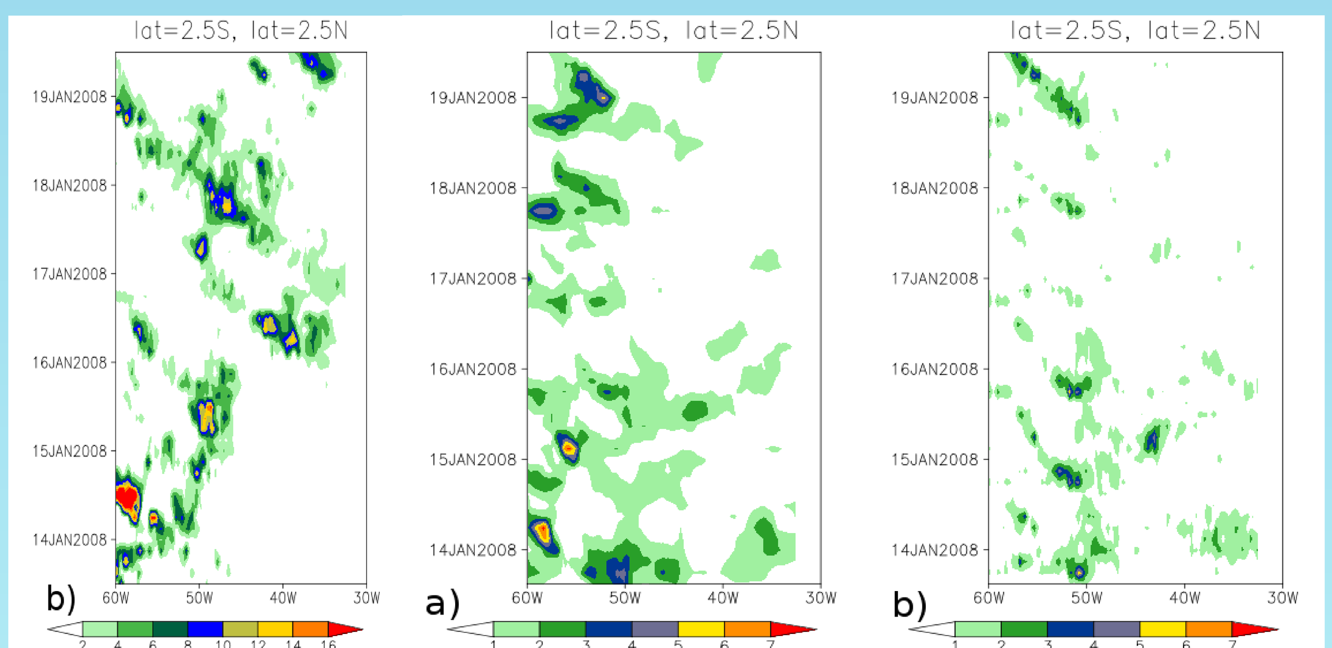
Categorical verification: Mean bias score versus precipitation thresholds (0.254, 2.54, 6.53, 12.7, 19.05, 25.4, 38.1, 50.8 mm) for South America for a set of 30 forecasts of 24-h accumulated precipitation for 120h in advance for (A) January 2008. Blue line represents simulations using FY weight method and red line the original EN. Blue bars indicate significance test from the bootstrap method (Hamill, 1999).



Categorical verification: Performance Diagram to threshold 50.8 mm for South America, for January 2008. AS, EN, GR, LO, MC, SC and FY represent the original ensemble, Grell, Low-level Omega, moisture convergence, Kain-Fritsch and Firefly closures.



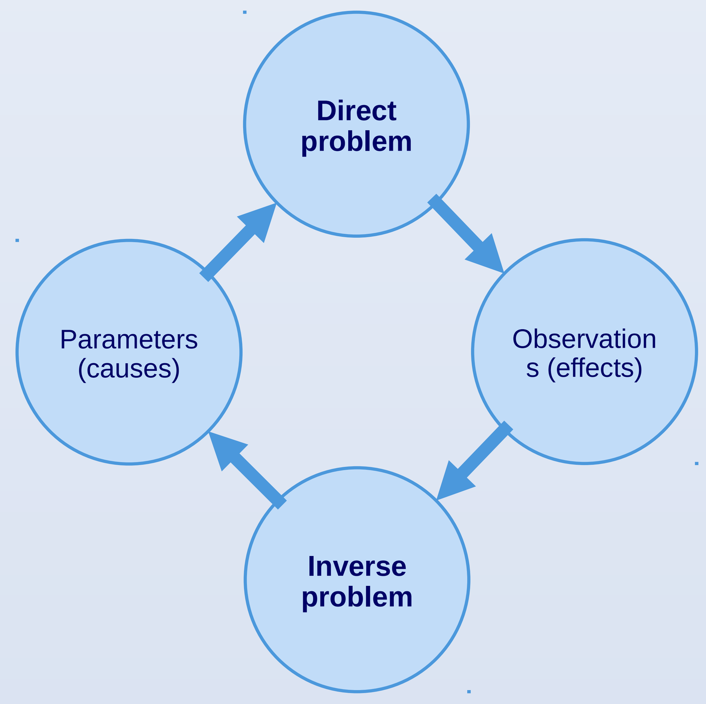
Diurnal cycle: Mean diurnal cycle of Q1 for January 2008 over northwest South America: a) ensemble mean and b) Firefly



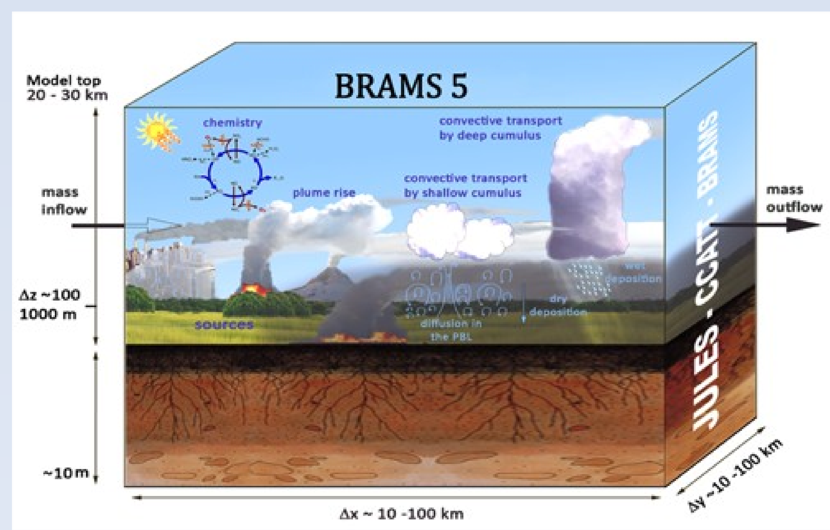
Diurnal cycle: Hovmöller diagram of accumulated precipitation each 3h from 13 January 12:00 to 19 January 12:00 2008 mean over 10°S and 2,5°N

METHODOLOGY

Weights estimation
Inverse Problems



The model BRAMS



$$P_S = w_{AS}P_{AS} + w_{GR}P_{GR} + w_{KF}P_{KF} + w_{MC}P_{MC} + w_{LO}P_{LO}$$

$$J(\overrightarrow{W}^T) = \min \left\| P_M^{w_i} - P_S \right\|_2^2 \quad \text{where} \quad P_M = \sum_i^5 w_i P_i$$

Closures used:

- **Grell (GR)**
- **Arakawa & Schubert (AS)**
- **Kain e Fritsch (KF)**
- **Moisture convergence (MC)**
- **Low-level omega (LO)**

Numerical experiment: simulation of the diurnal cycle; 30-days of 24h forecasts January 2008

Iterations (MaxGeneration)= 1000
Nº fireflies (n) = 20

B_0= 1
α = 0,2
γ = 1

CONCLUSION

Results showed high sensitivity of model BRAMS to Firefly algorithm method, with impacts over diurnal cycle of precipitation, heatig profiles and improvement of the skill of BRAMS

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