



MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO  
**INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS**

# ***Current developments in the INPE/CPTEC modeling system***

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**Thanks to: Carlos Bastarz, Paulo Kubota, Silvio N. Figueroa,  
Enver Ramirez**

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Pan-WCRP Modelling Groups Meeting  
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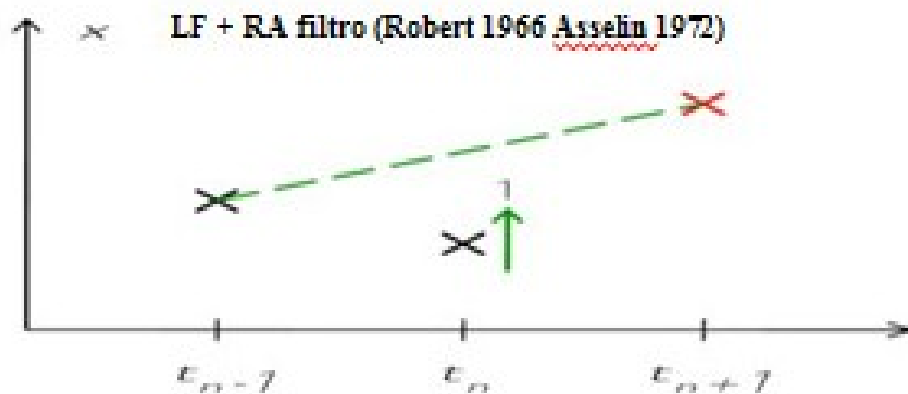
# BAM-Model Development Report

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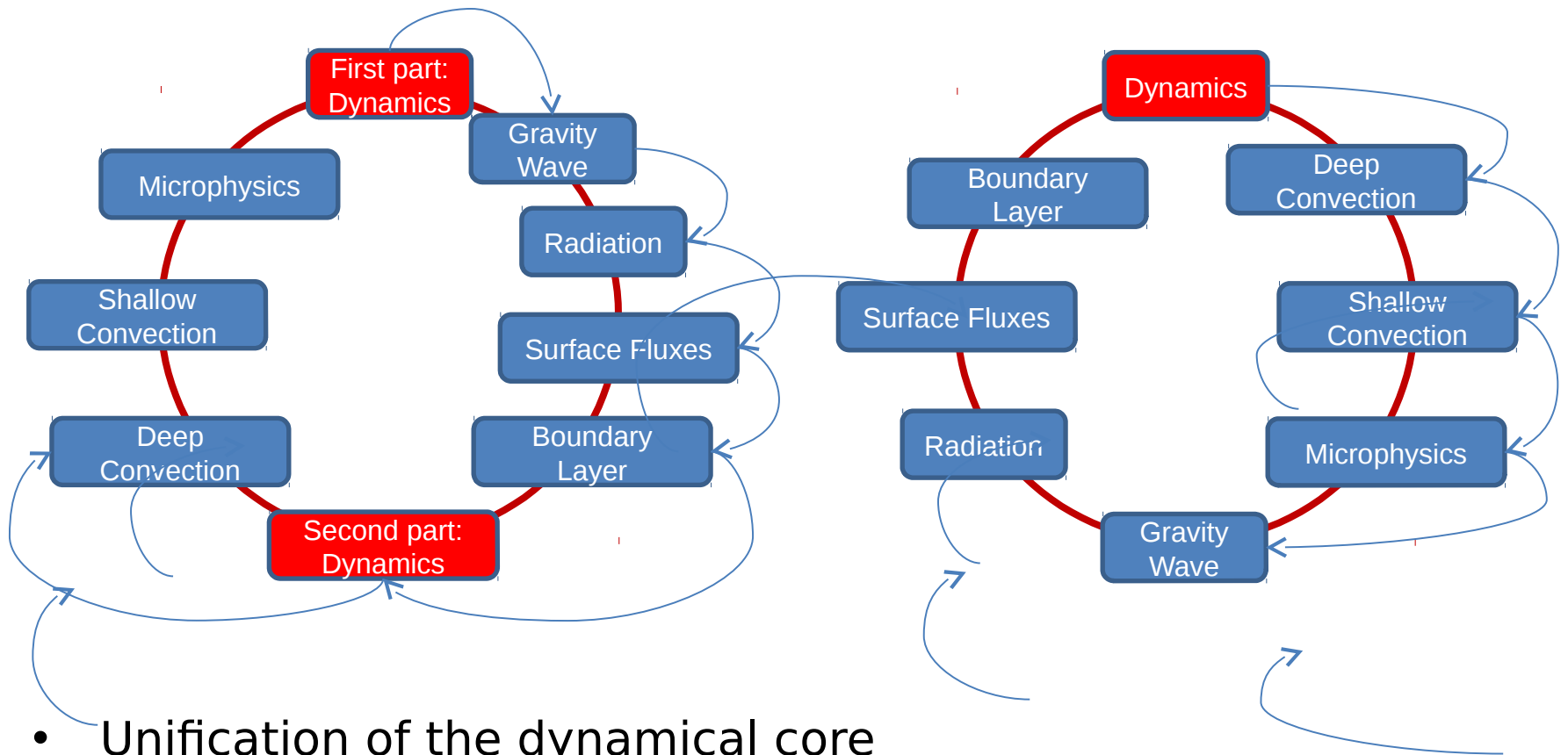
## The Brazilian Atmospheric Model (BAM, Figueroa et al., 2016)

- CPTEC's general circulation model;
- Spectral model with global domain;
- Horizontal movement is given in terms of vorticity and divergence;
- Normal model initialization;
- Pure  $\sigma$  vertical coordinate (hybrid is under testing);
- Model physics is parameterized.
- GSI atmospheric analysis, spectral coefficient of  $\ln(ps)$ ,  $T_v$ ,  $D$ ,  $\zeta$ ,  $q$

The asselin filter was implemented in all prognostic variables of the IBIS surface model.

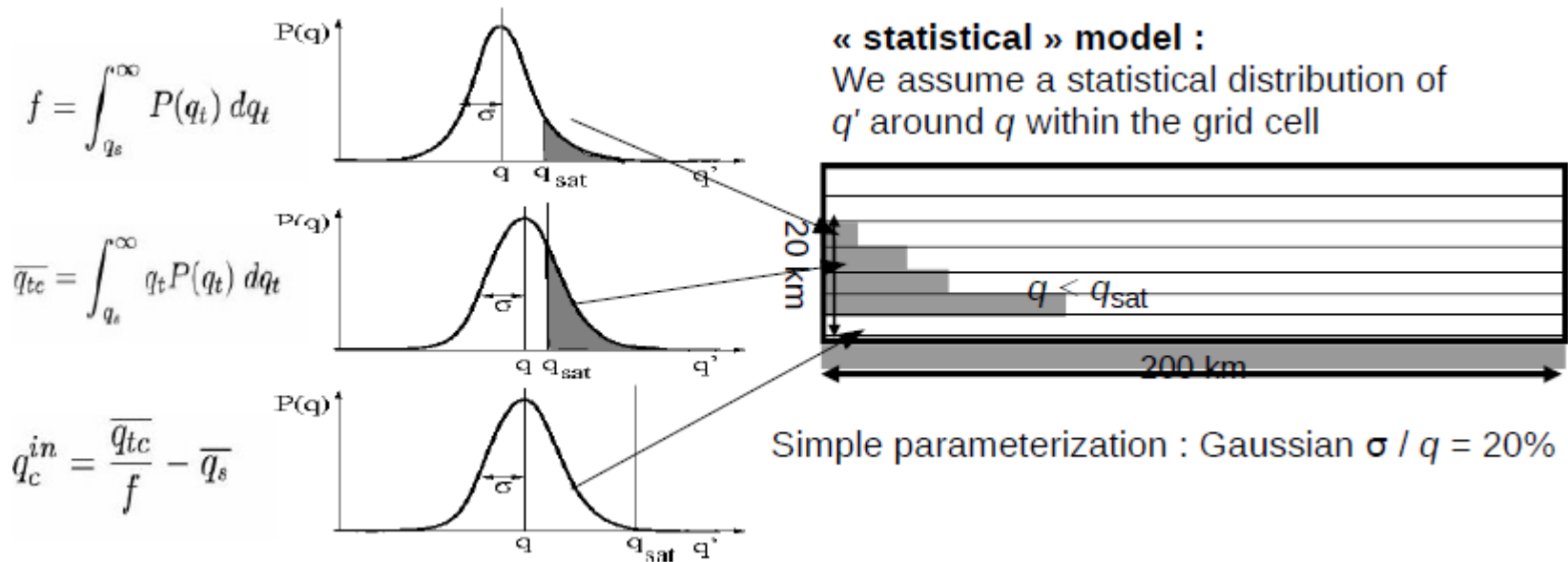


This filter has helped to reduce spurious noise in prognostic variables.



- Unification of the dynamical core
- Reduce the amount of spectral transform
- Improves computational efficiency → 20km 11-day weather forecast in 2 hours

# Statistical cloud schemes (Jam & al., BLM, 2012 )



This cloud scheme improved the simulation of cloudiness and interaction with the radiation fluxes.

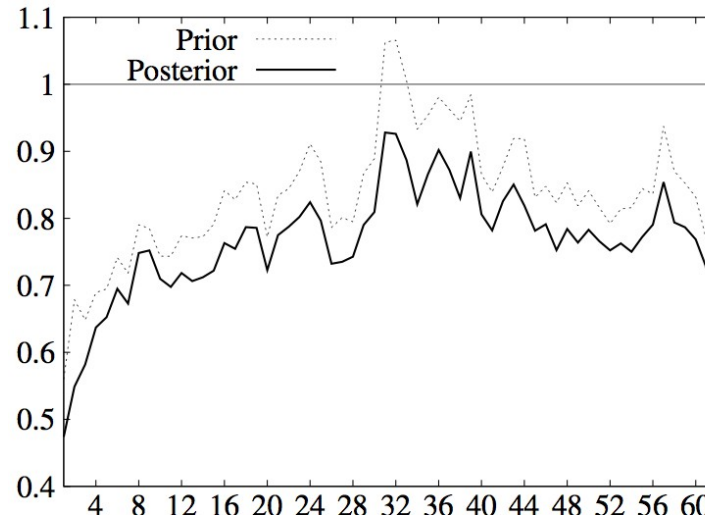
# **GSI based hybrid 3DVar data assimilation for the CPTEC-INPE BAM global model**

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With contributions from: Dirceu Herdies, Ricardo Todling  
(GMAO/NASA), João Gerd Zell de Mattos, Luiz Fernando  
Sapucci, Luis Gustavo Gonçalves, Bruna Silveira, Fábio Diniz  
and many others from CPTEC/INPE

## Results: Ensemble Innovation Statistics

$$IC = \frac{\sigma(\mathbf{y}^o - \mathbf{H}\mathbf{x}_k^b)}{\sqrt{S + R}}$$

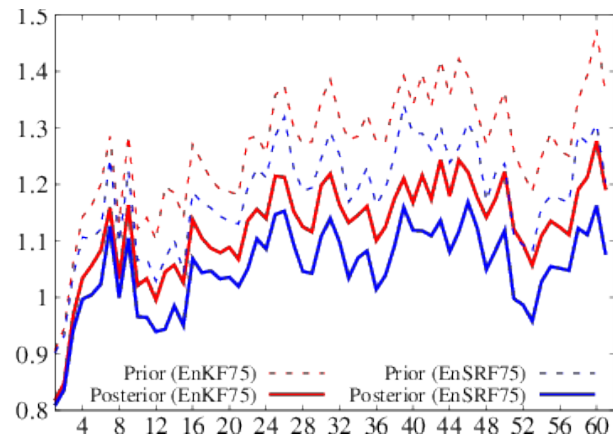


- Ensemble evaluation looking at the reduction of the error of the priors to posteriors, due to the observation innovation;
- Values must converge to 1 (unit);
- Greater values may indicate deficiencies in the ensemble spread.

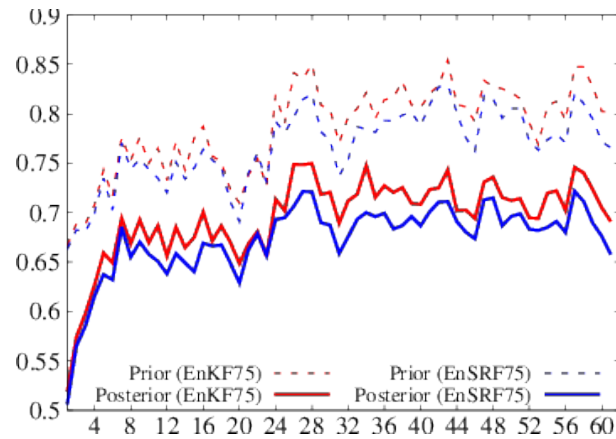


# Results (Innov. Statistics)

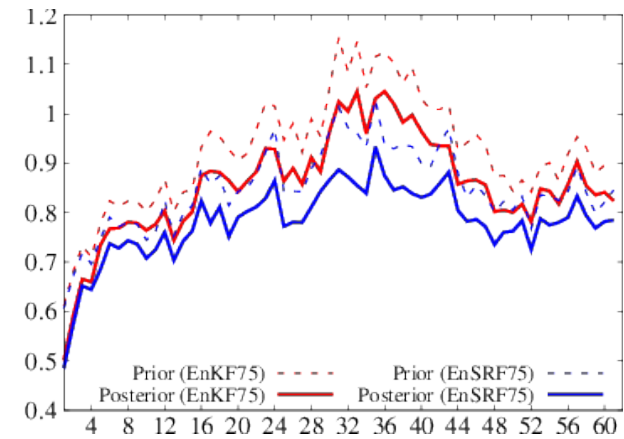
a) uv (NH)



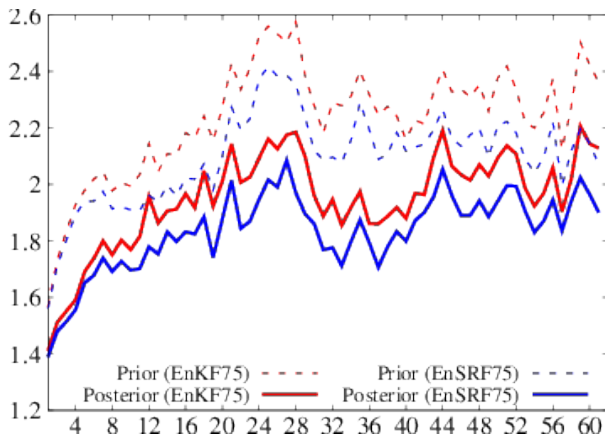
b) uv (TR)



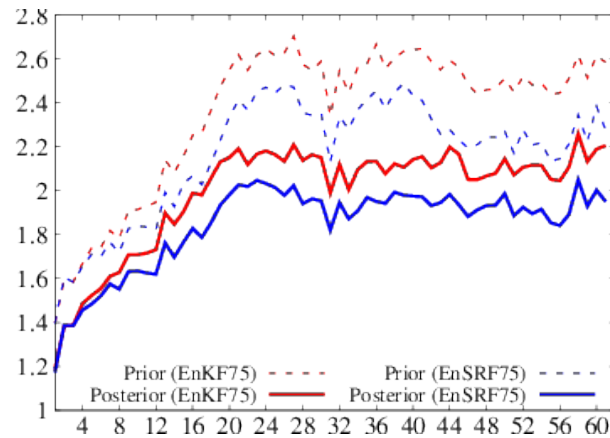
c) uv (SH)



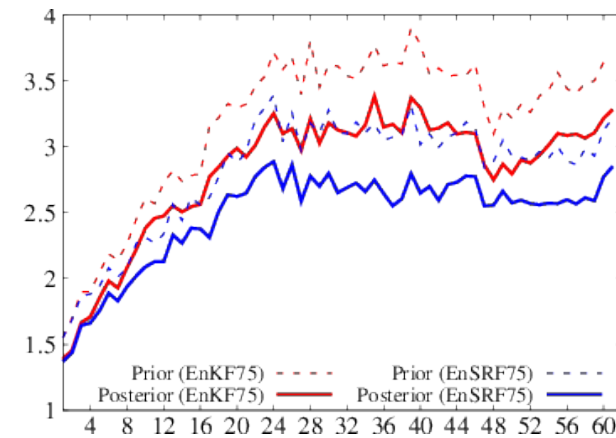
d) T (NH)



e) T (TR)

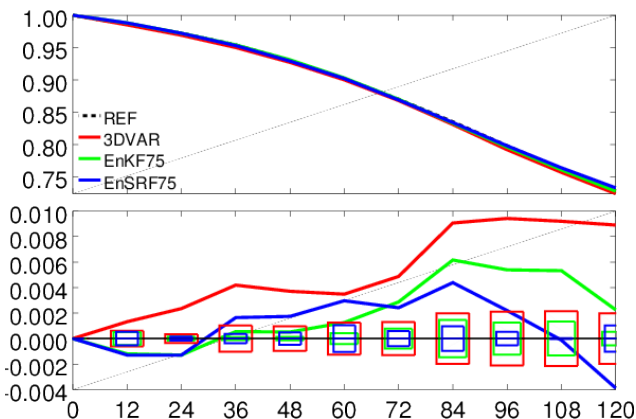


f) T (SH)

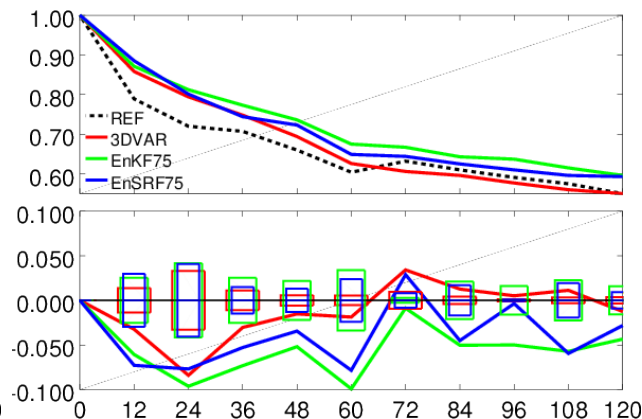


# Results (Anomaly Correlations)

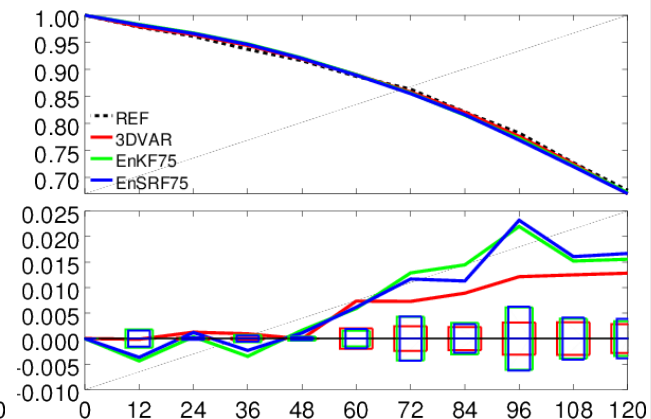
a) psnm (NH)



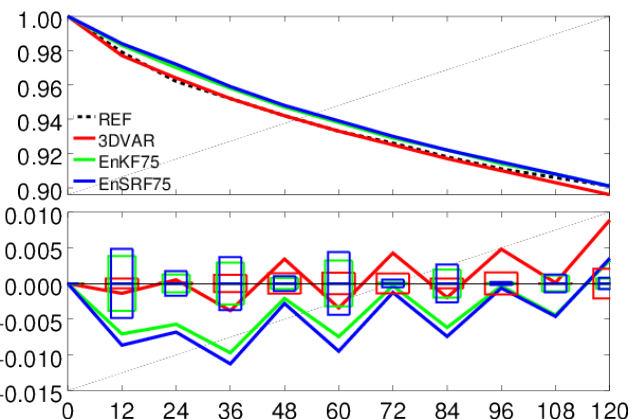
b) psnm (TR)



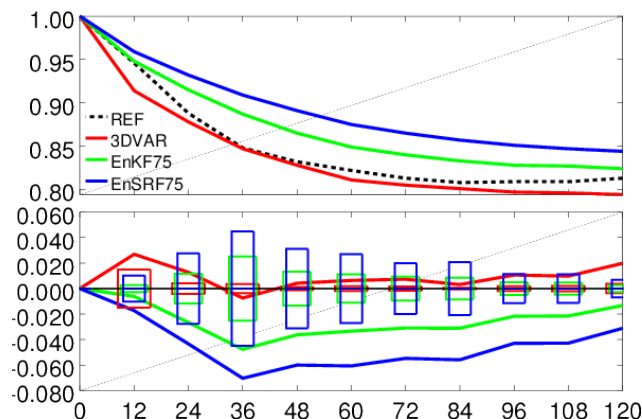
c) psnm (SH)



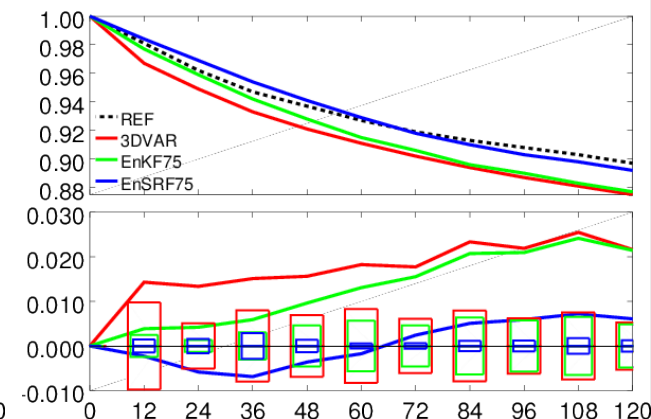
d) q925 (NH)



e) q925 (TR)

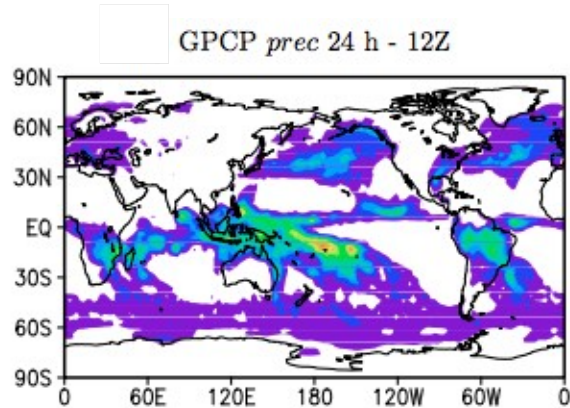


f) q925 (SH)

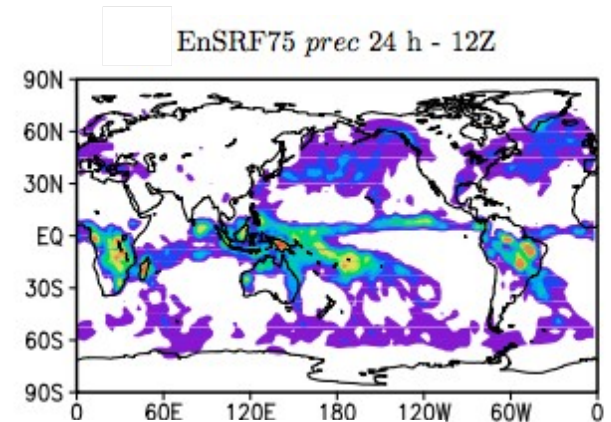
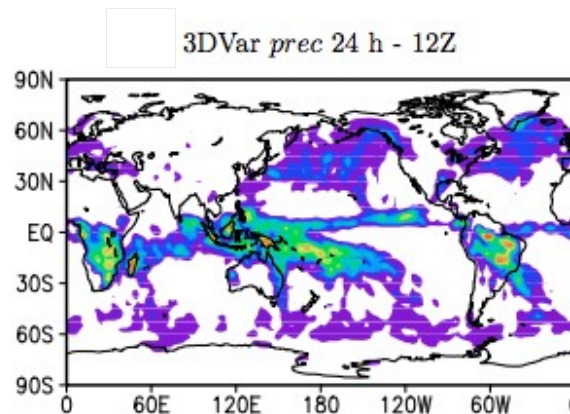
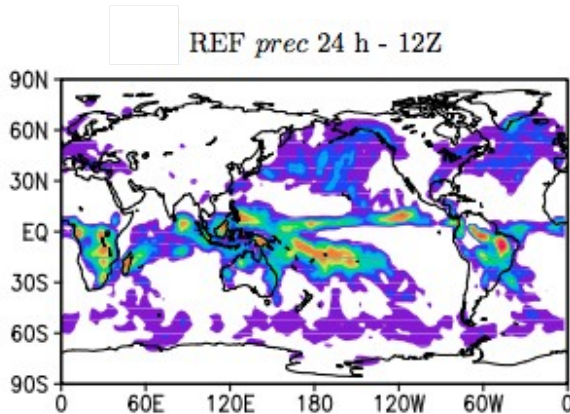


# Results (Precip. Verification)

## Precip. 24 hour forecast (monthly mean)



Precip. forecasts from the hybrid analysis show that the average patterns of the large and convective scale are relatively well represented, in comparison with the observed (GPCP), the BAM model with the NCEP anl, and also the BAM model with pure 3DVar analysis.



# BAM 1D

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With contributions from Silvio Nilo Figueroa

## BAM 1D / CAM 1D

Model developments with BAM 1D are being compared against CAM 1D (SCAM)

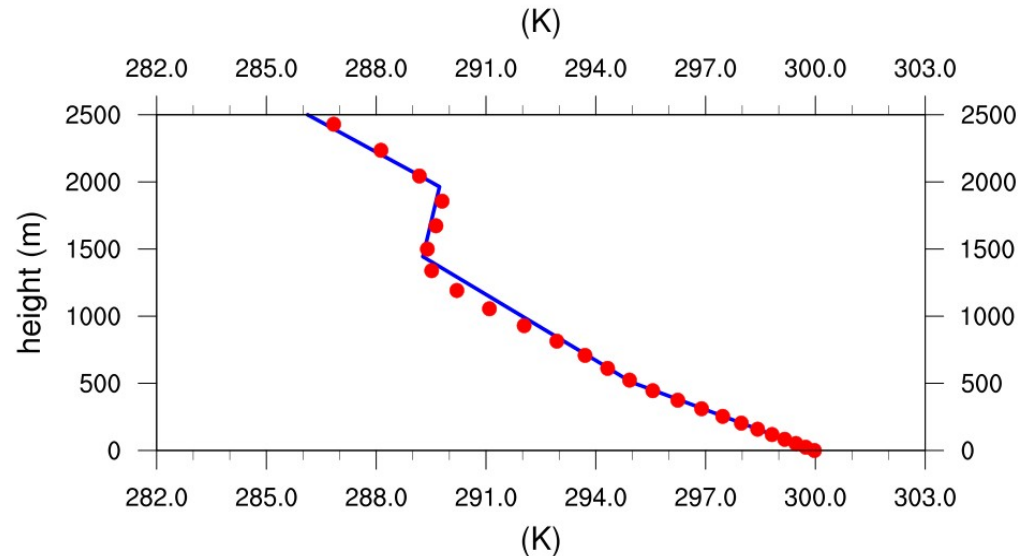
Previous comparisons were with Cloud Resolving Models, which were unfair

Intensive field experiments are being used:  
Ex., BOMEX, TOGA, TWP-ICE, etc.

# BOMEX:

Obs data x  
BAM 1D 64  
levs new

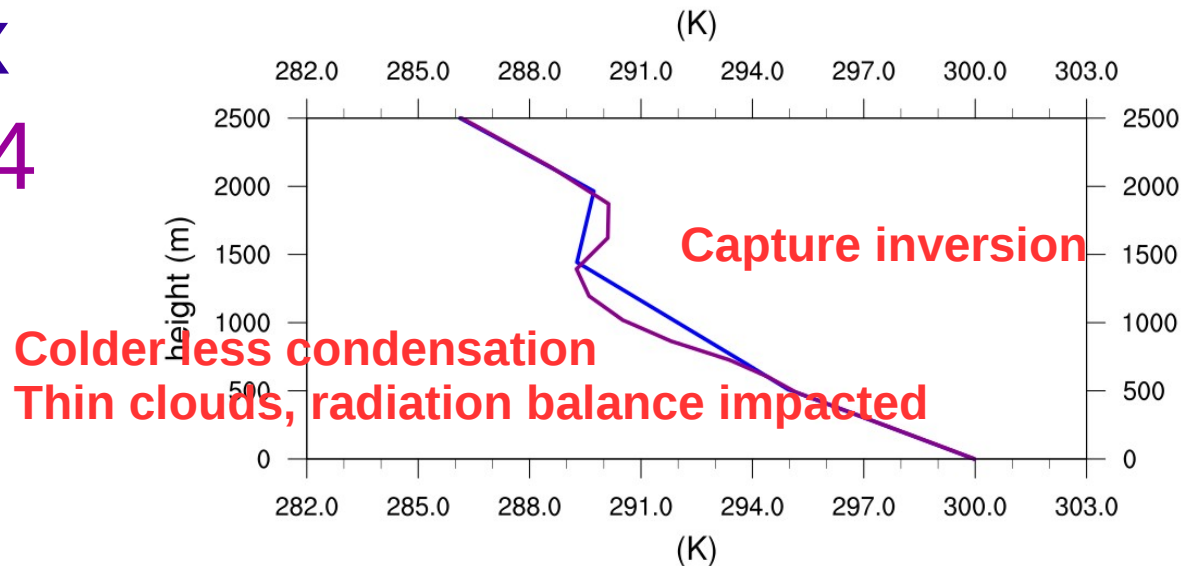
BOMEX\_interp 64 (t0) vs BOMEX obs data



# BOMEX:

Obs data x  
BAM 1D 64  
levs old

bam-1d 64 CI (t0) vs BOMEX obs data



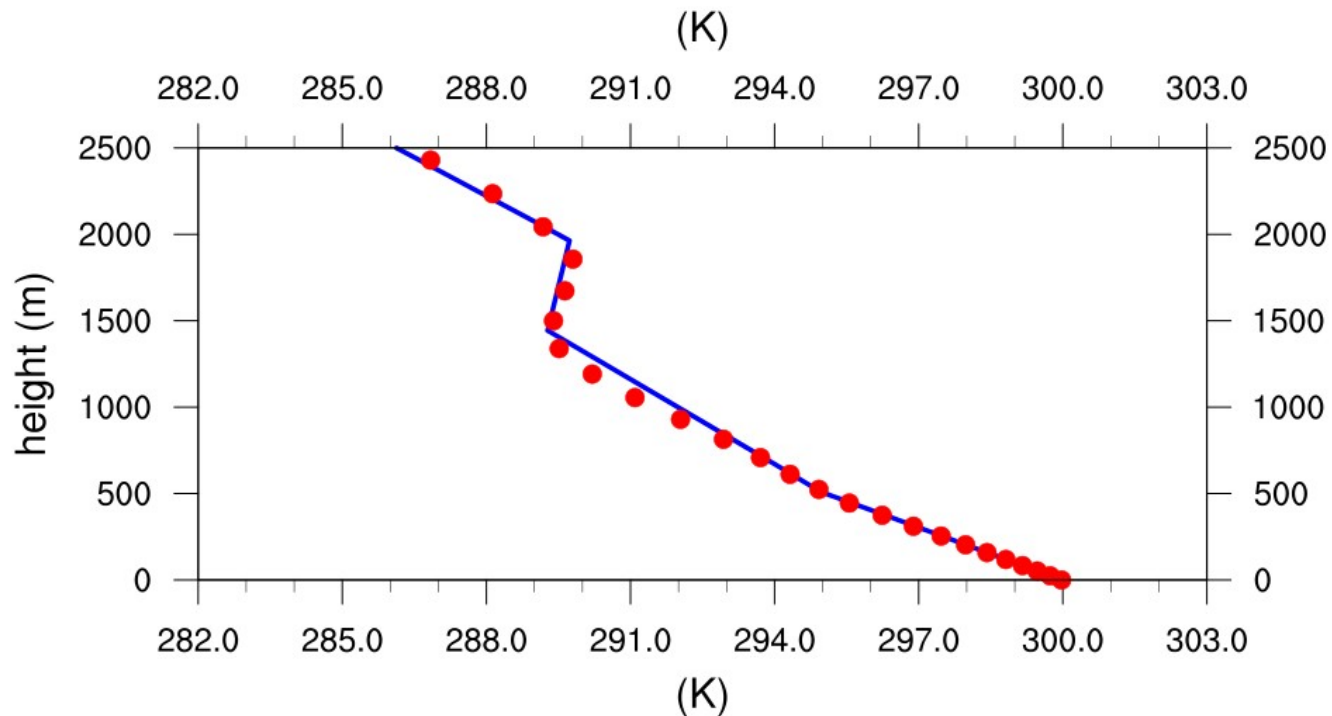
## BAM 1D / SCAM

Improvements in the vertical interpolation scheme from quadratic to cubic, has improved model results

Now BAM 1D approaches CAM 1D

# BOMEX: Obs data x BAM 1D 64 levs

BOMEX\_interp 64 (t0) vs BOMEX obs data





# BOMEX: Obs data x CAM 1D 80 levs

BOMEX scam SPARK 80 (t0) vs BOMEX obs data

