



NCAR

# **Short Term forecasts along the GCSS Pacific Cross-section: Evaluating new Parameterizations in the Community Atmospheric Model**

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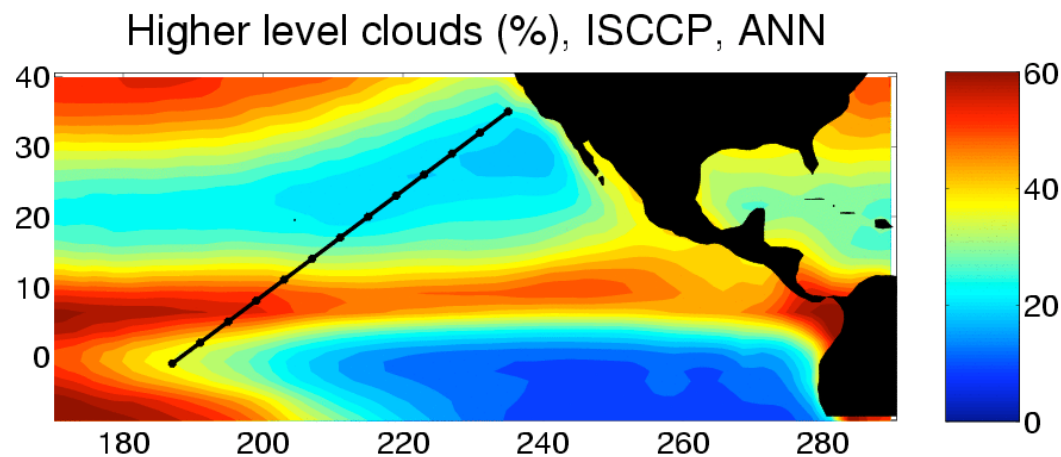
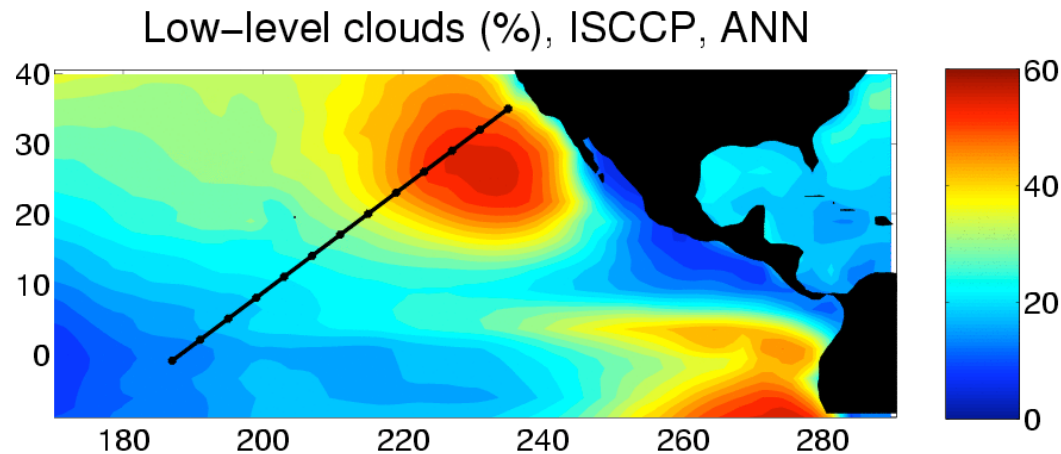
# Outline

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- The Community Atmospheric Model (CAM) and new candidate parameterizations
- Methodology of the forecasts
- Evaluation of the forecasts against observations
- Conclusions

# The Pacific Cross-section

- Pacific Cross-section: several cloud regimes  
stratocumulus, shallow cumulus, deep convection...



# Towards CAM4: a suite of new parameterizations

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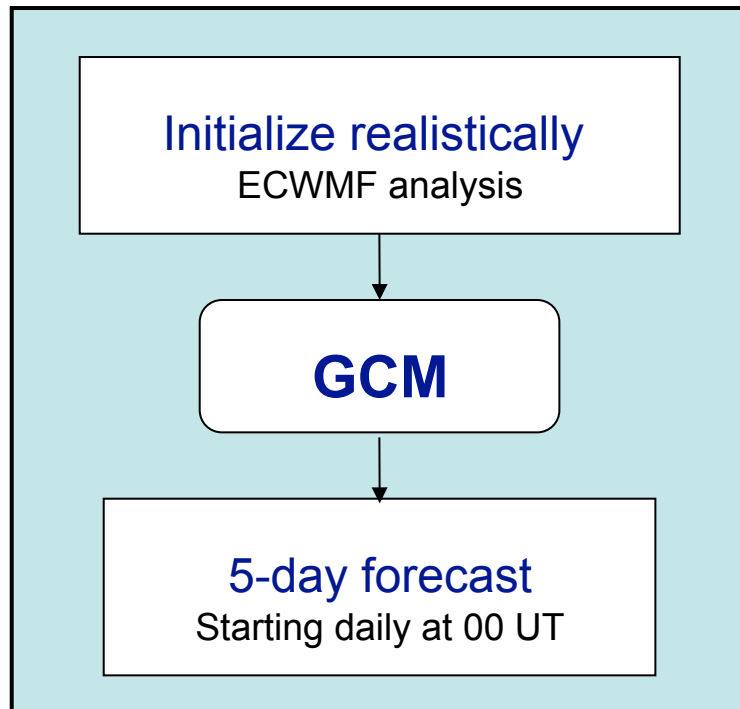
Towards CAM4 (Oct 2008)



<b>Control: CAM3 (2004)</b>	<ul style="list-style-type: none"><li>- Deep convection: Zhang-McFarlane (1995)</li><li>- Microphysics: Rasch and Kristjansson (1998)</li><li>- Boundary layer: Holtslag-Boville (1993)</li><li>- Shallow convection: Hack (1993)</li></ul>
<b>Deep convection</b> Neale	<ul style="list-style-type: none"><li>- parcels are diluted by environment air</li></ul>
<b>Microphysics</b> Morrison and Gettelman	<ul style="list-style-type: none"><li>- 2-moment scheme: prognostics variable for cloud mass and number concentration (liquid + ice)</li><li>- explicit representation of mixed phase</li></ul>
<b>PBL and shallow convection</b> Bretherton and Park	<ul style="list-style-type: none"><li>- Turbulence scheme includes explicit entrainment at the top of the PBL</li><li>- Shallow convection: cloud-base mass flux based on surface TKE and convection inhibition near cloud base</li></ul>

# Methodology for the forecasts

## Forecast



## Evaluation

AIRS, ISCCP, TRMM, SSMI, CloudSat  
ECWMF analyzes

- **Strategy**

If the atmosphere is initialized realistically, the error comes from the parameterizations deficiencies.

- **Advantages**

Look at process level

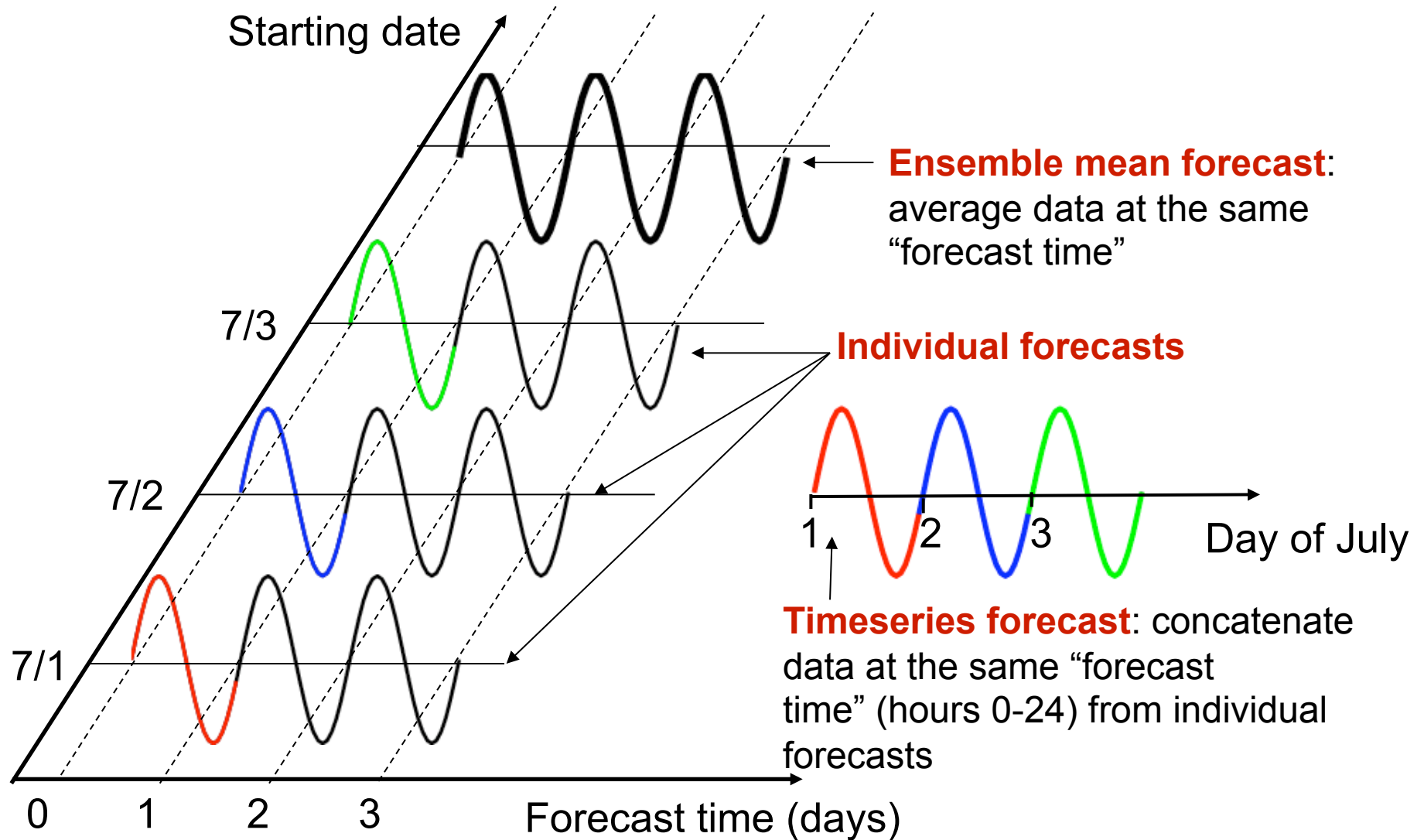
Deterministic  statistical

Full feedback  SCM

- **Limitations**

Accuracy of the atmospheric state ?

# Ensemble mean forecast and timeseries forecast

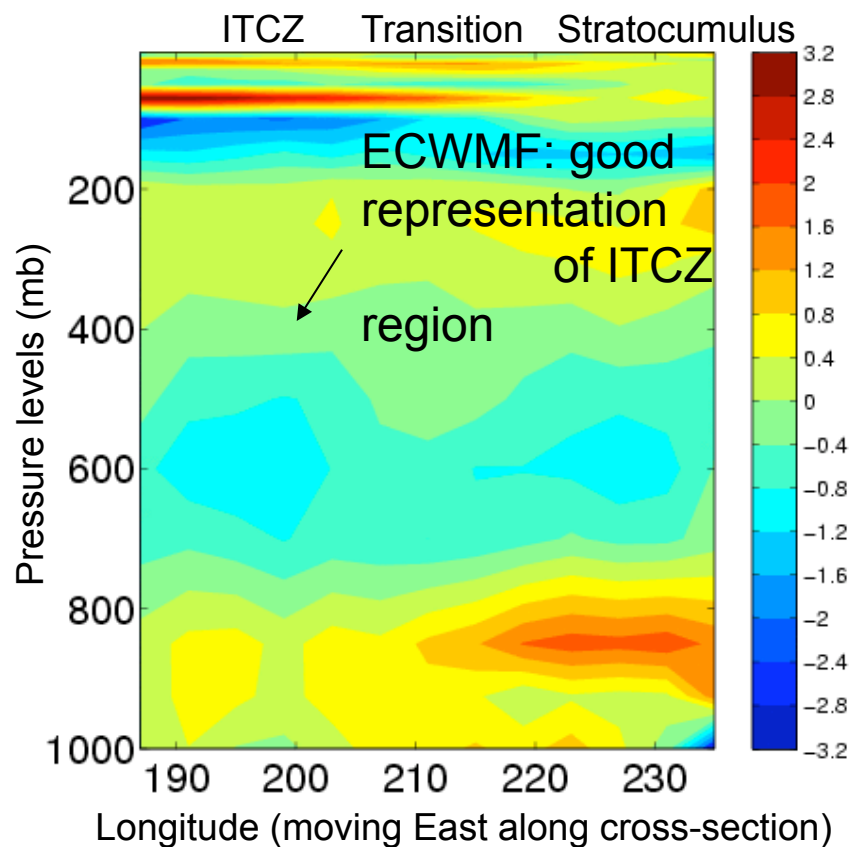


# Accuracy of the initialization: ECMWF versus AIRS

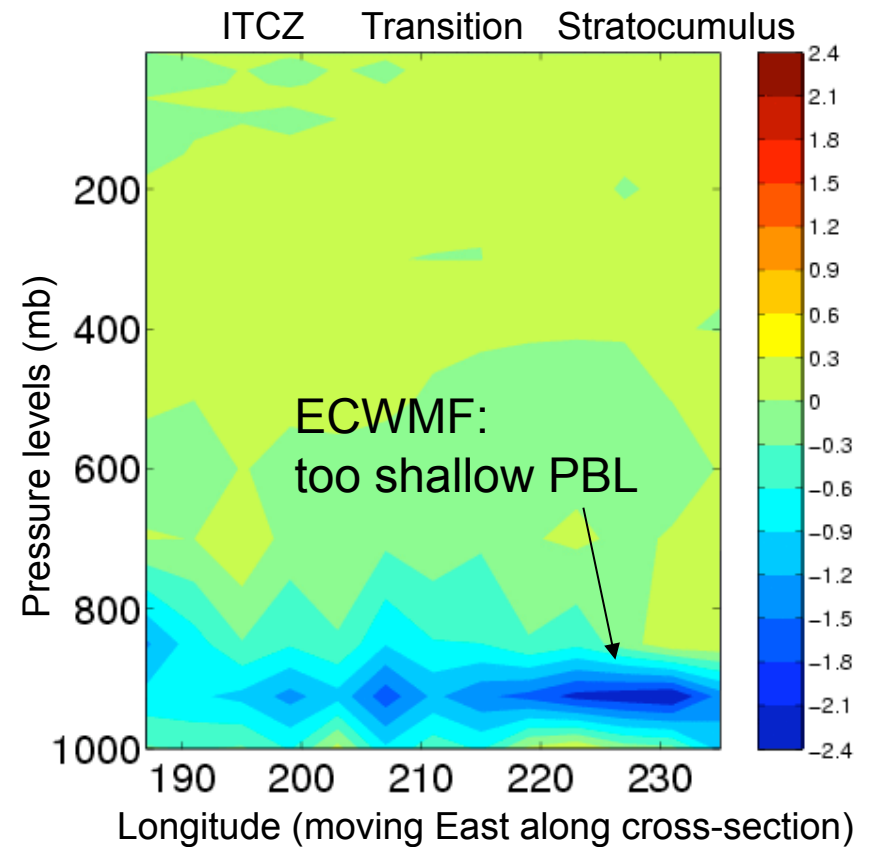
- AIRS** Accuracy of the daily global profiles
- temperature: 1 K per 1 km layer
  - moisture: 20-60% per 2 km layer

**ECWMF analysis**  
IFS cycle 26r3

**Temperature error, July 2003**

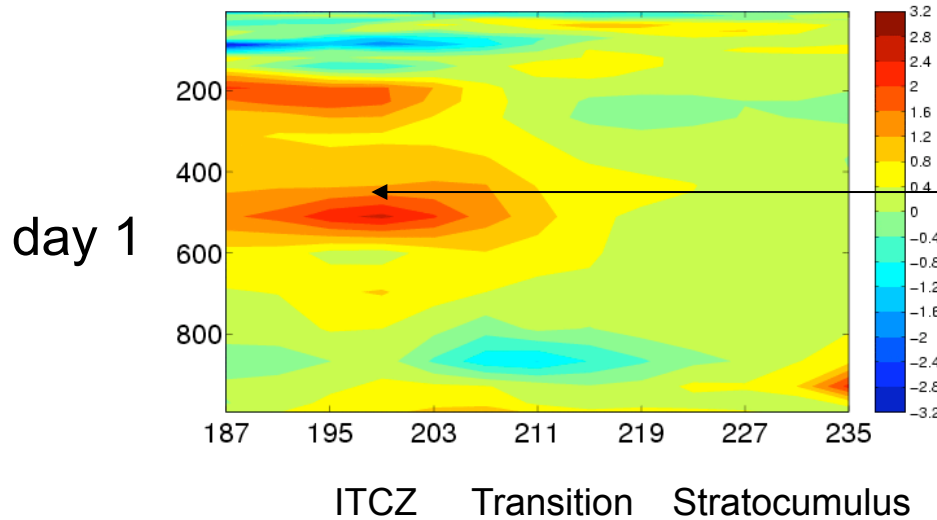


**Moisture error, July 2003**

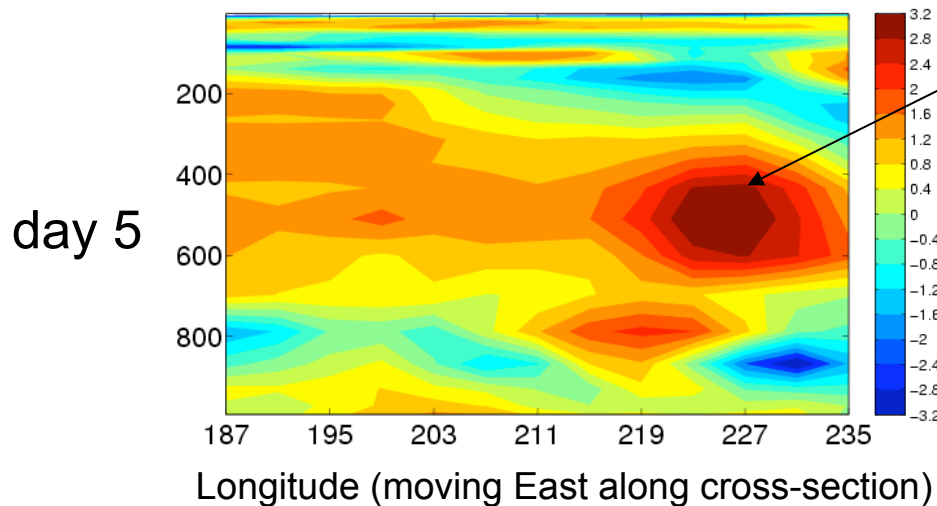


# Ensemble mean forecast: T error at day 1 and day 5

Control: T error, July 2003



where deep convection is active, error is set within 1 day



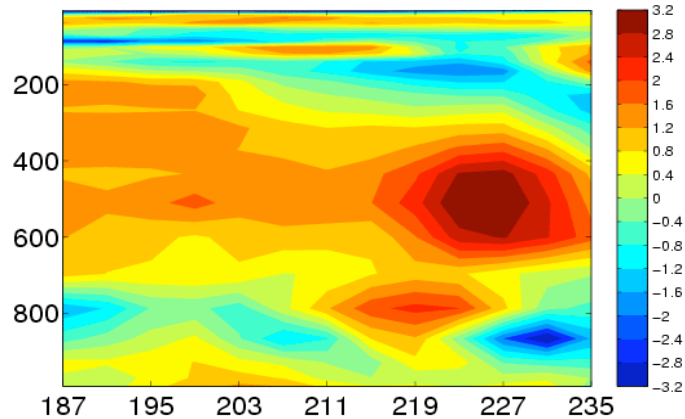
Error built slower towards the stratocumulus region

5-day errors are comparable to the mean climate errors.

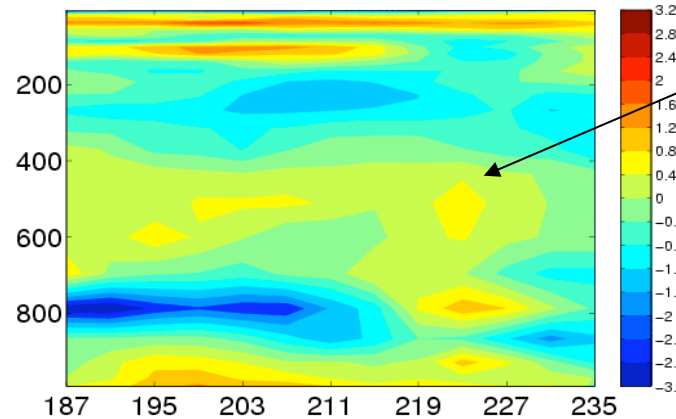


# Sensitivity to the new schemes: T error at day 5

Control

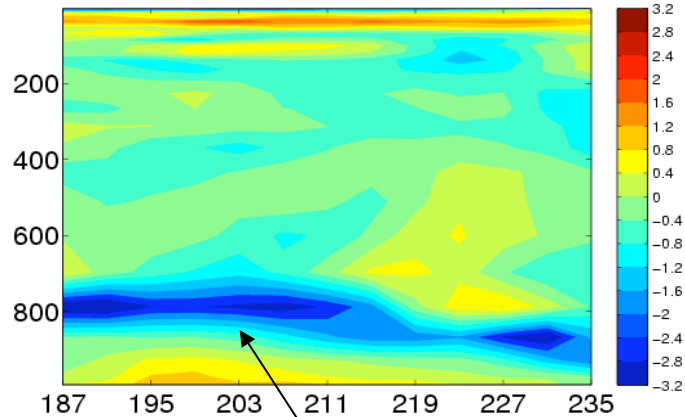


+ new deep convection



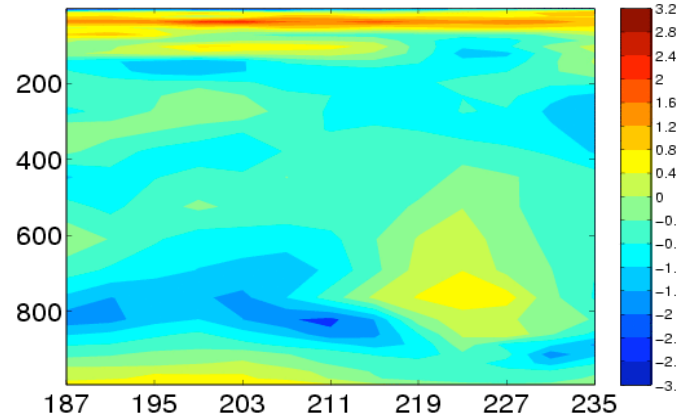
Change in the error structure even where the deep convection is **not active**

+ new microphysics



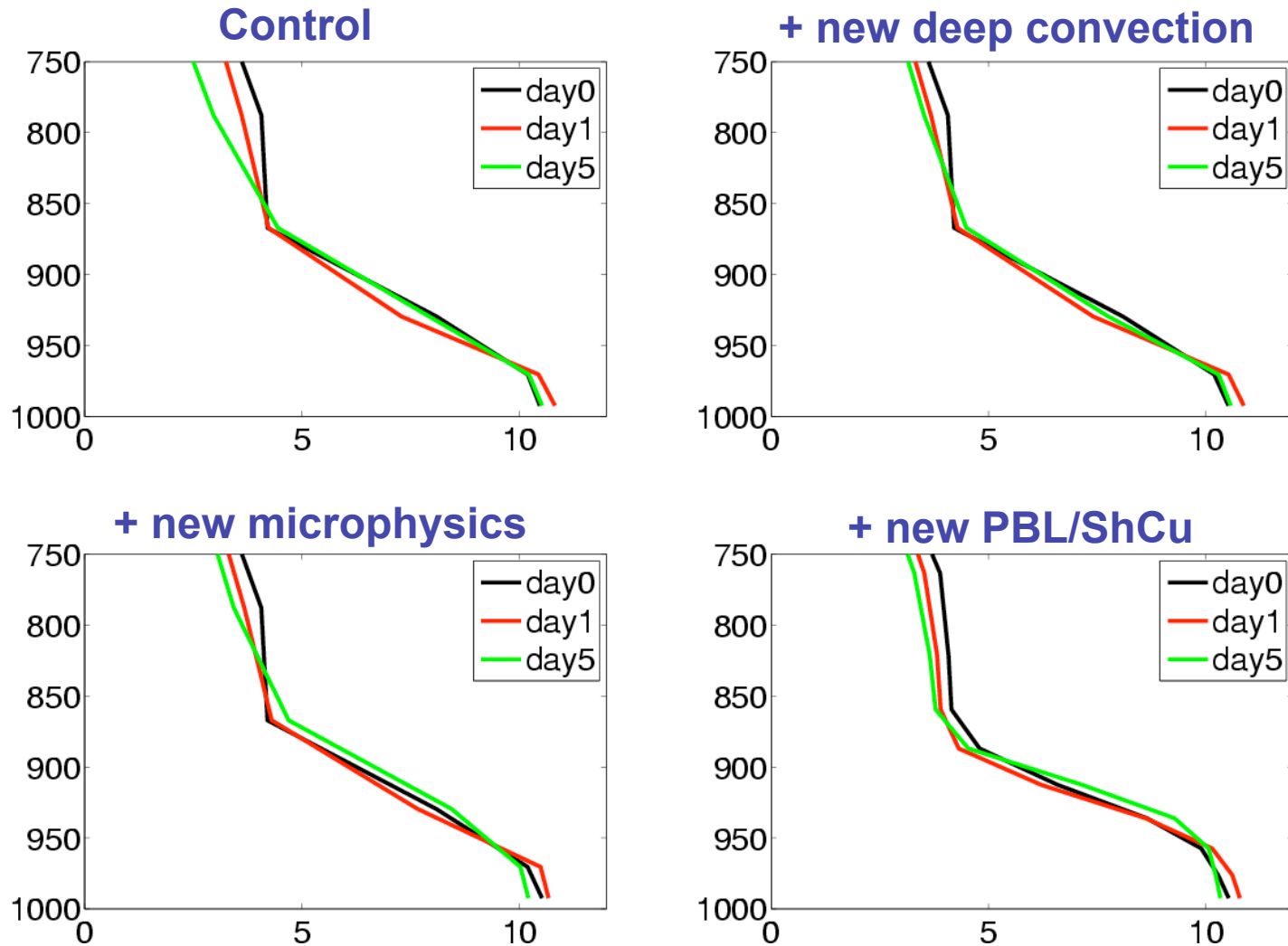
Cooling is related to shallow convection

+ new PBL/ShCu



**Conclusion:**  
**New schemes:**  
**reduce T error**

# Moisture and ability to maintain the PBL height

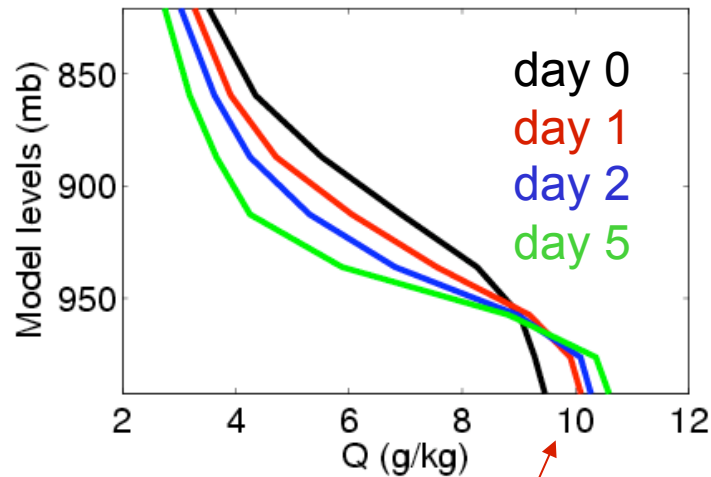


Stratocumulus: PBL too shallow but maintained in 5-day forecast

# Moisture and PBL for stratocumulus, JJA 1998

## Specific humidity

Control



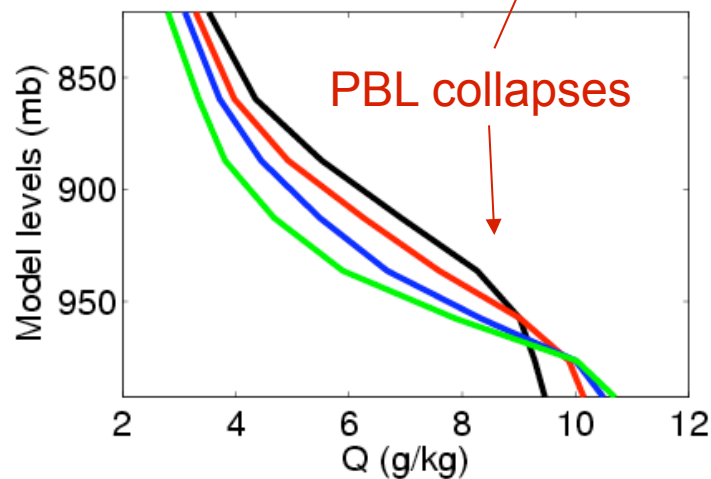
Earlier results for JJA 1998

☒ collapse of the PBL compared to ECWMF.

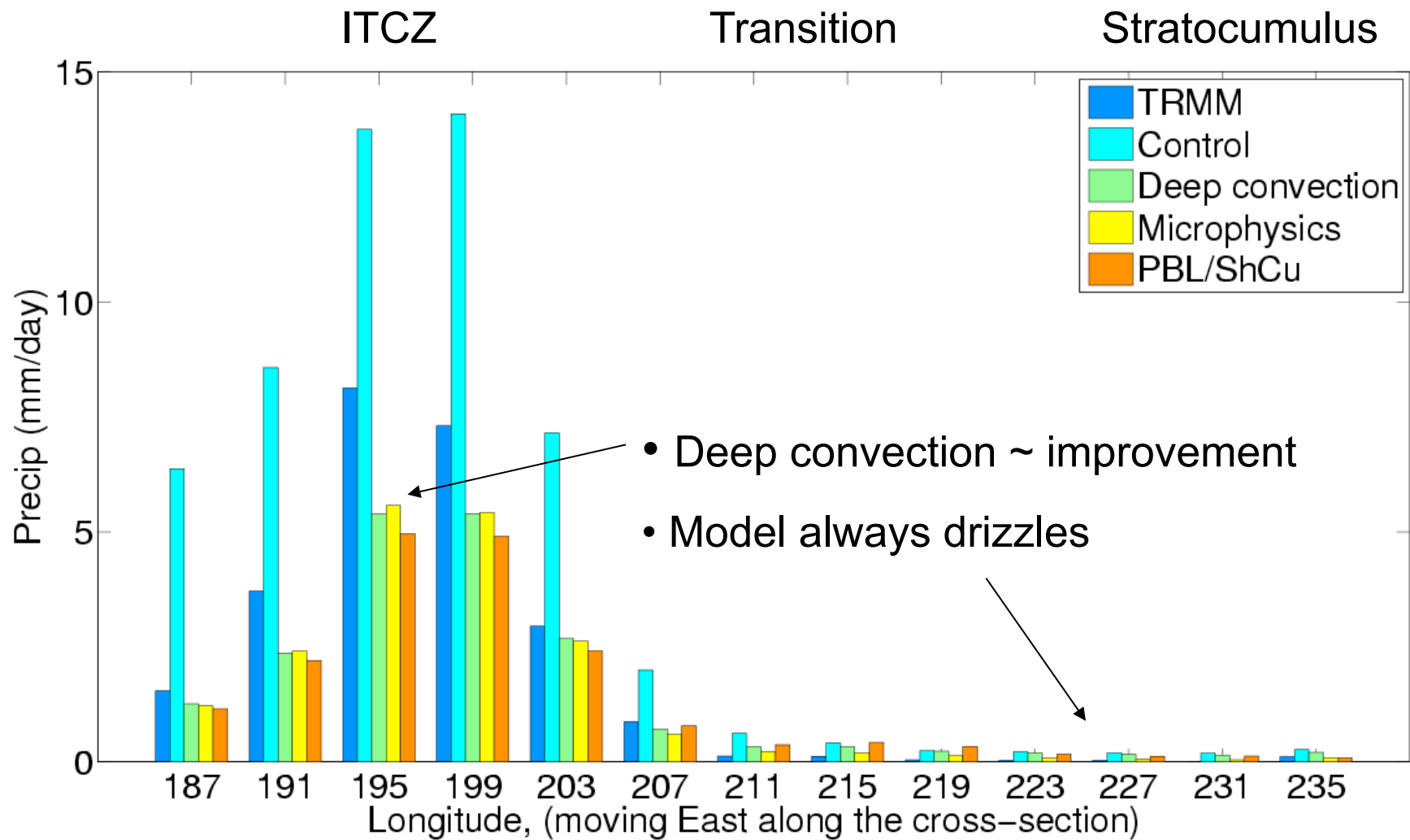
But:

- different dynamical core
- different initialization
- different year

+ new  
PBL/ShCu

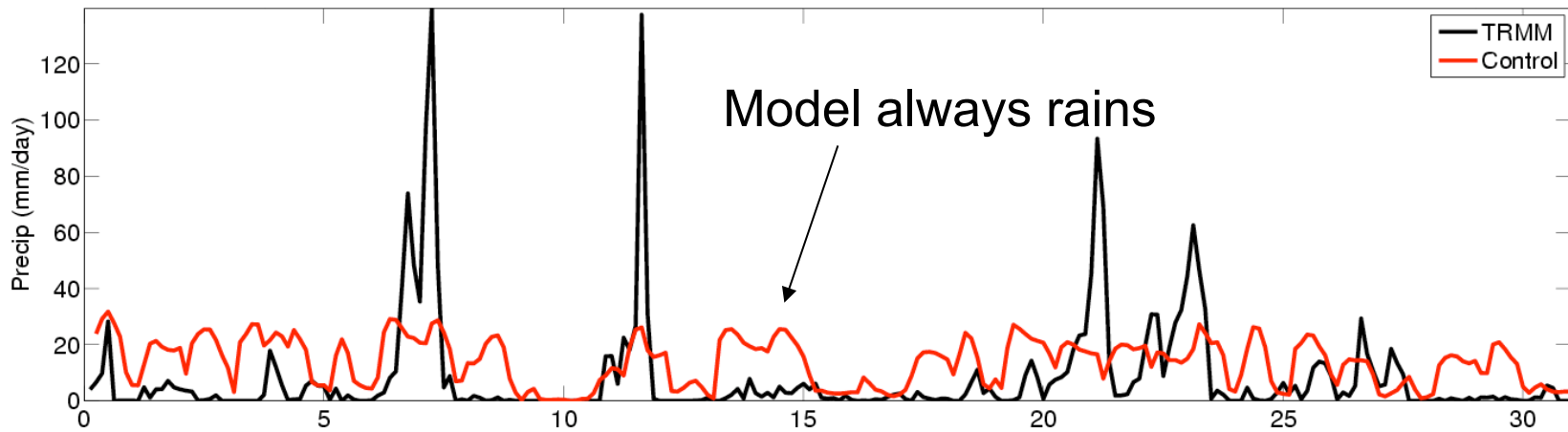


# Precipitation along cross-section, July 2003

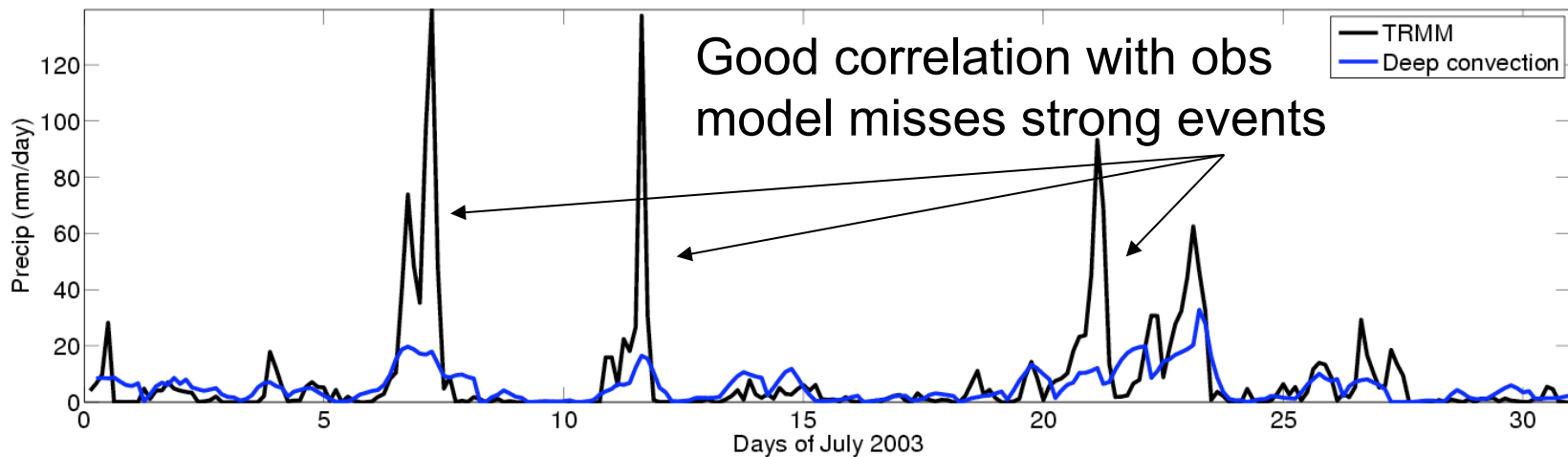


# Timeseries of precipitation at the ITCZ

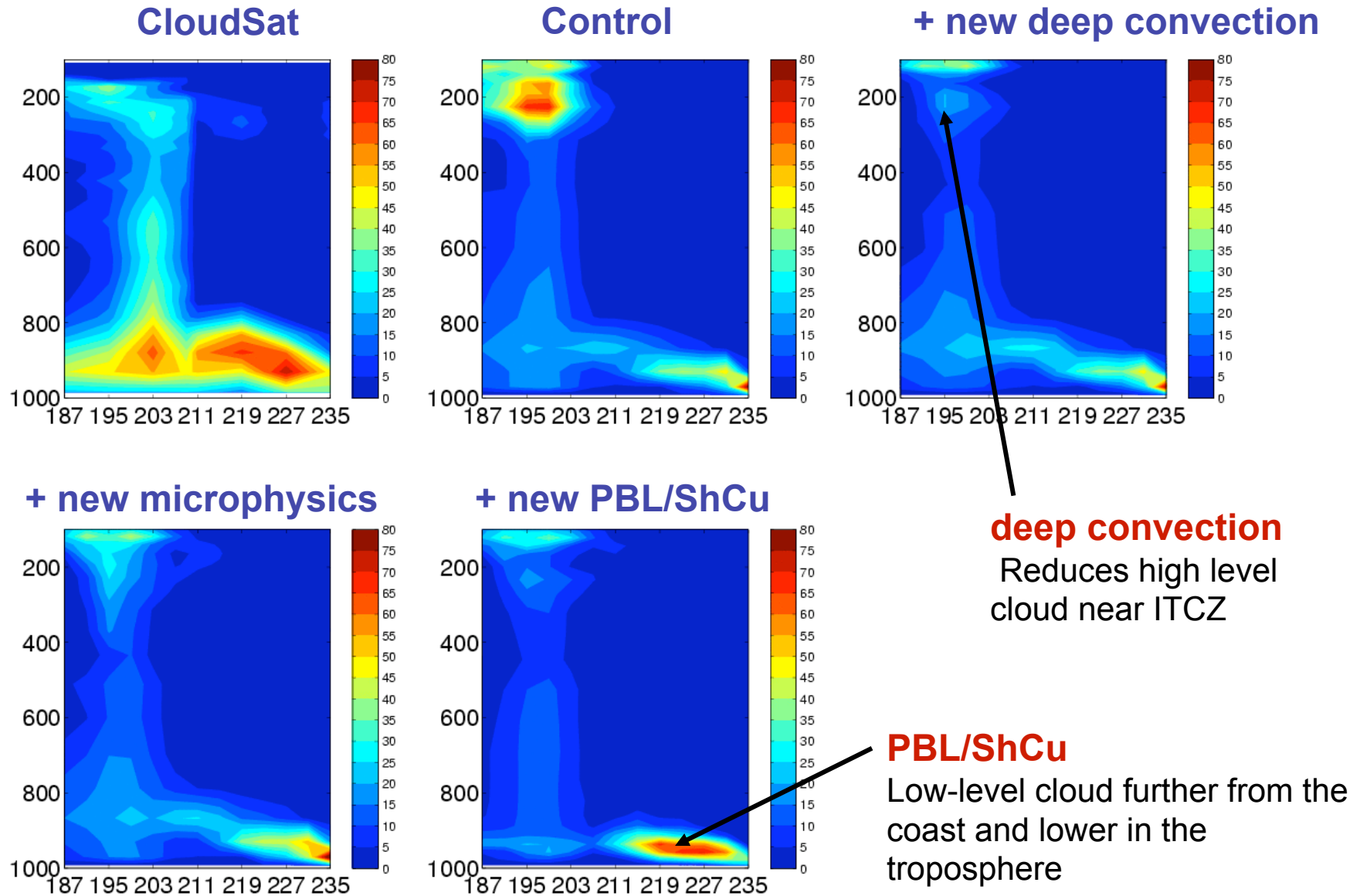
## Control



## New deep convection scheme



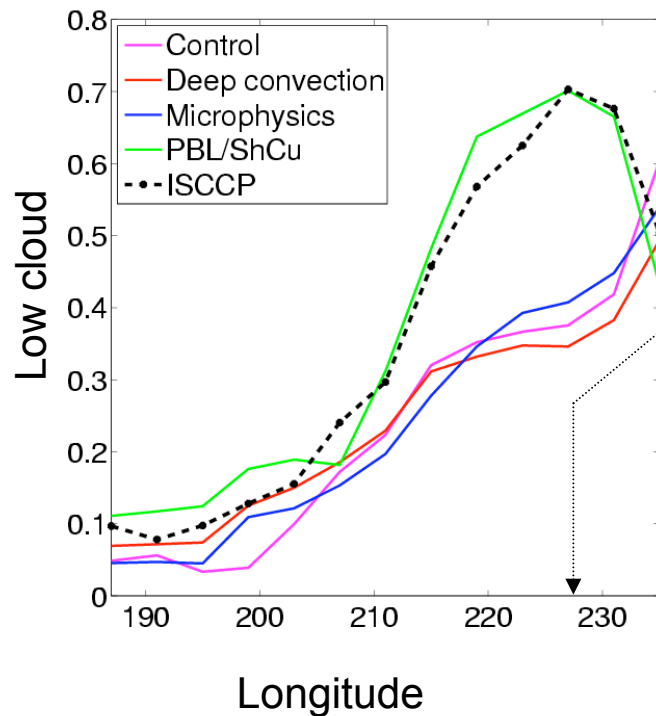
# Cloud fraction averaged over day 1



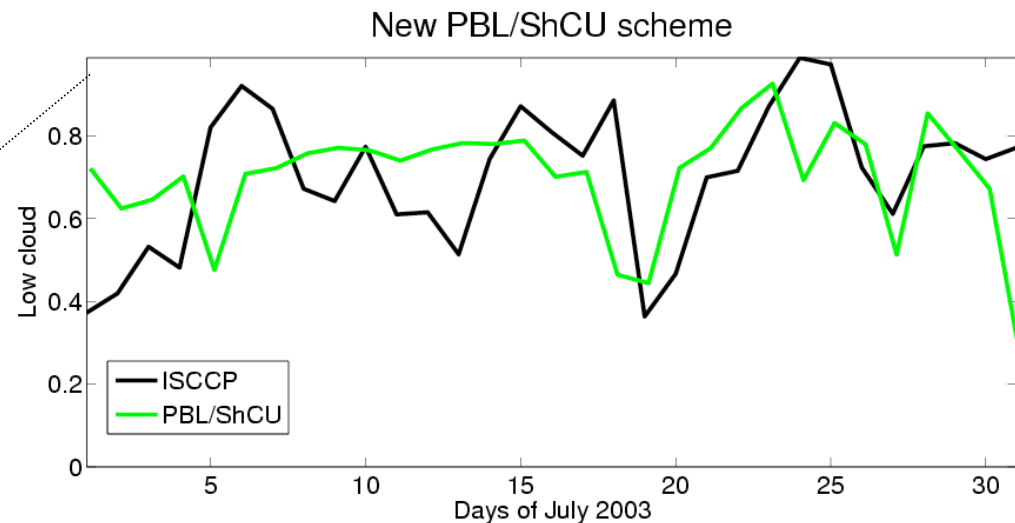
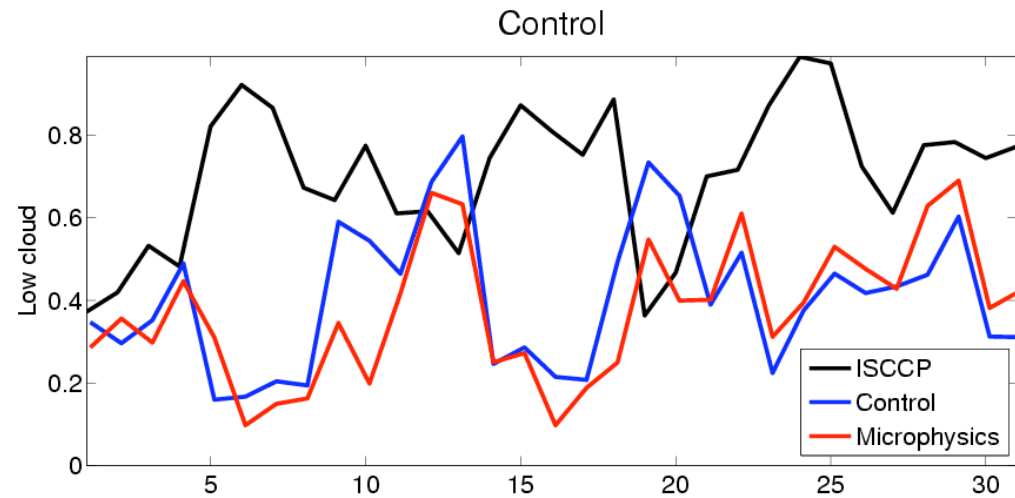
# Low-level cloud as seen by ISCCP

Major improvement of the low-level clouds with the new **PBL/ShCU** scheme

## Ensemble mean forecast



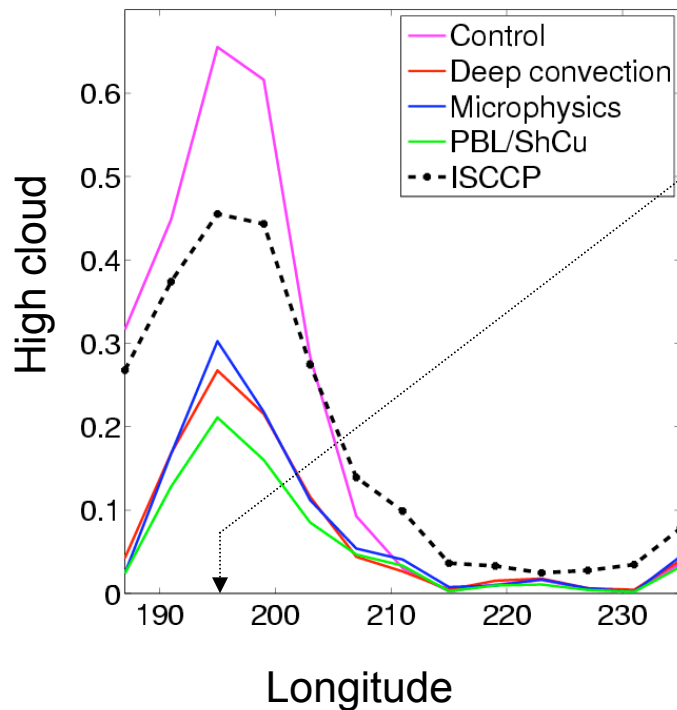
## Forecast timeseries (0-24h average)



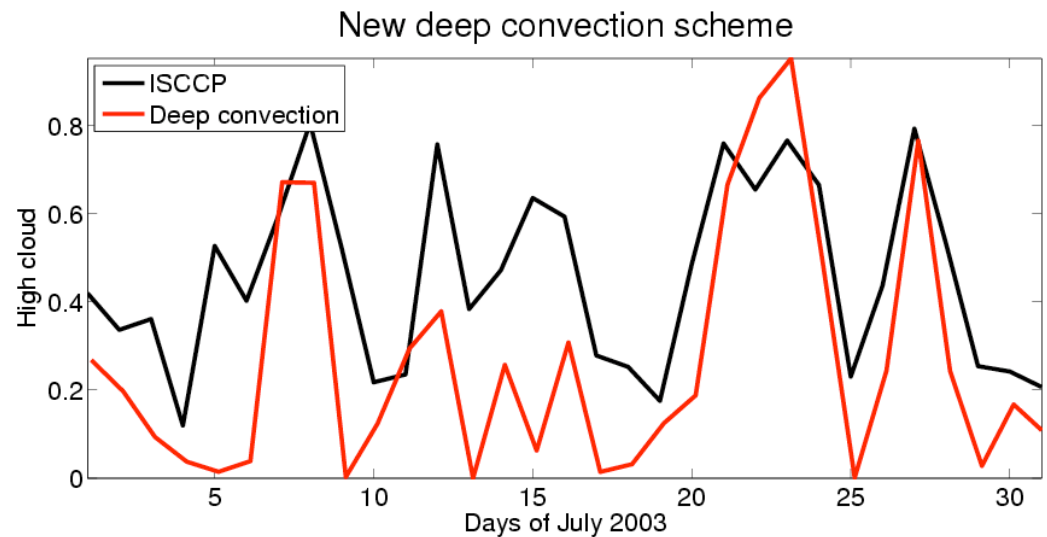
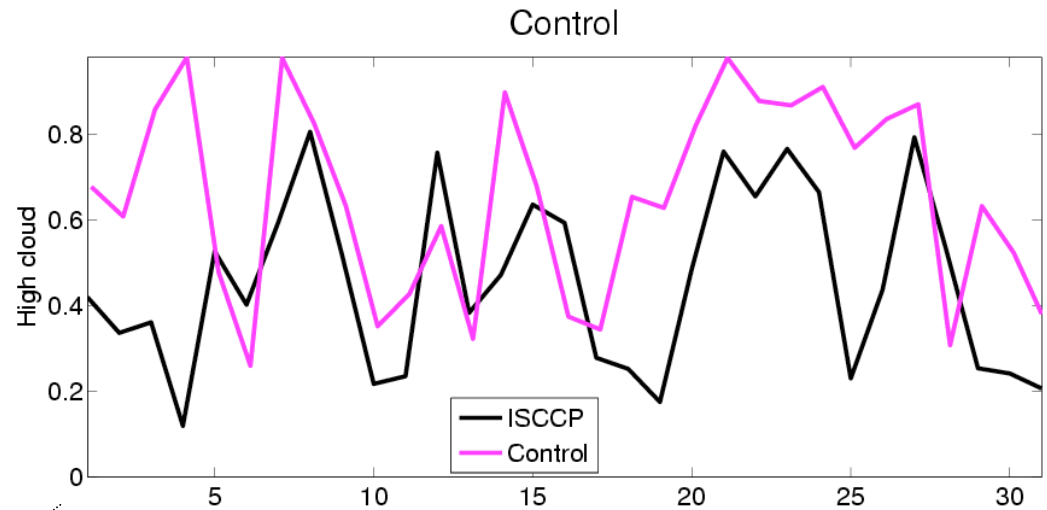
# High-level cloud as seen by ISCCP

High level cloud is largely reduced by the new convective scheme

## Ensemble mean forecast



## Forecast timeseries (0-24h average)





# Conclusion

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- CAM forecasts allows for **diagnosing parameterization errors** in the different cloud regimes.
- Climate bias appears **very quickly**
  - where deep convection is active, error is set within 1 day
  - 5-day errors are comparable to the mean climate errors.
- Sensitivity to candidate parameterizations
  - New **deep convection**: dramatic improvement of the **precipitation** in the ITCZ region but **high-level cloud** fraction too low compared to ISCCP.
  - New **microphysics**: **little change** along the cross-section. Slightly reduce drizzle in stratocumulus regions
  - New **PBL/ShCu**: dramatic improvement of the **low-level clouds** when compared to ISCCP.

## Outstanding issues and future work

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- Quality of the analysis in the stratocumulus region.
- Behavior of the PBL in the stratocumulus region for 1998 versus 2003 (impact of the dynamical core and of the initial condition)