



NCAR

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

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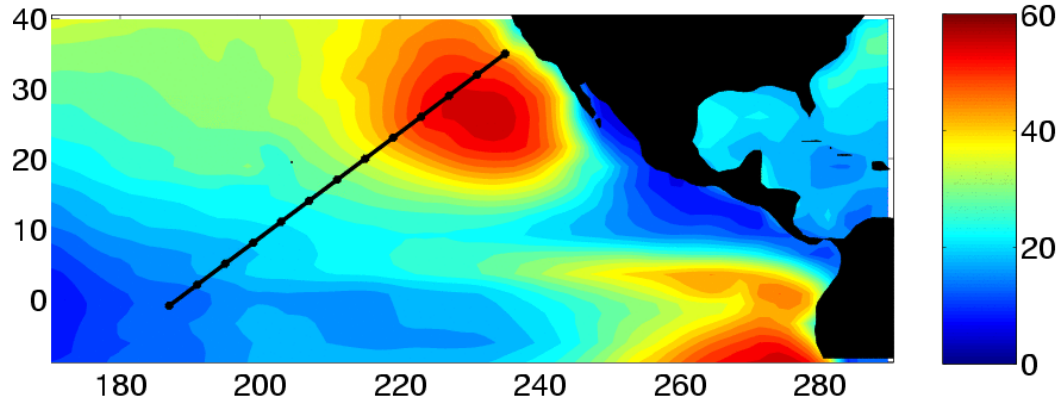
Outline

- The Pacific cross-section
- New candidate parameterizations for CAM4
- Methodology of the forecasts
- Evaluation of the forecasts against observations
- Conclusions

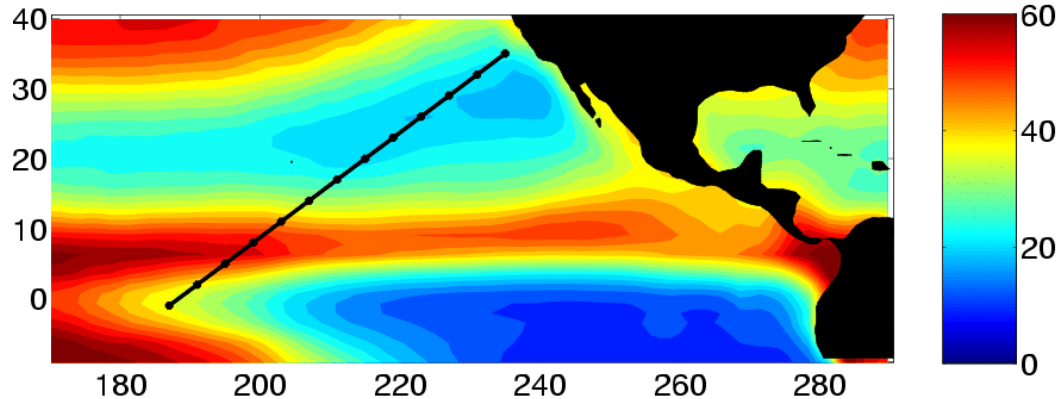
The Pacific Cross-section

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

Low-level clouds (%), ISCCP, ANN



Higher level clouds (%), ISCCP, ANN



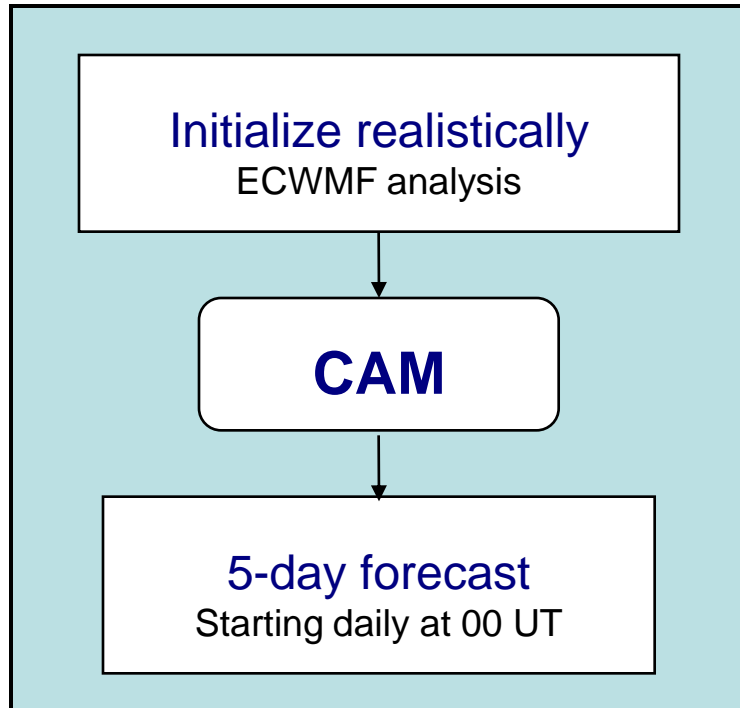
Towards CAM4: a suite of new parameterizations

Towards CAM4 (Oct 2008)

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

Methodology for the forecasts

Forecast



- **Strategy**

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

- **Advantages**

- Evaluate the simulation of moist processes against observations taken on a particular day and location
- Evaluate the nature of moist processes parameterization errors before longer-time scale feedbacks develop.

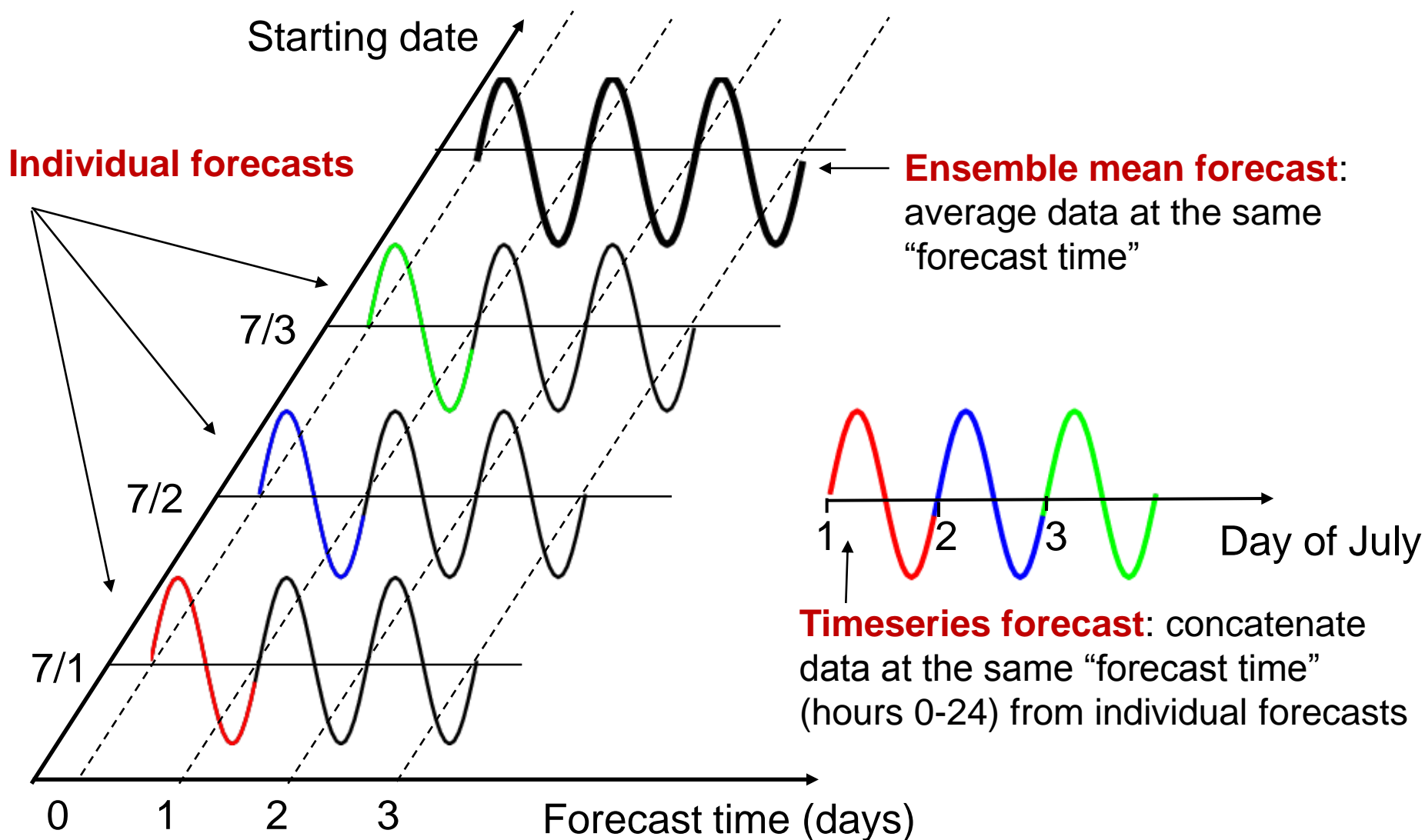
Evaluation

AIRS, ISCCP, TRMM, SSMI, CloudSat
ECWMF analyzes

- **Limitations**

Accuracy of the atmospheric state ?

Ensemble mean forecast and timeseries forecast

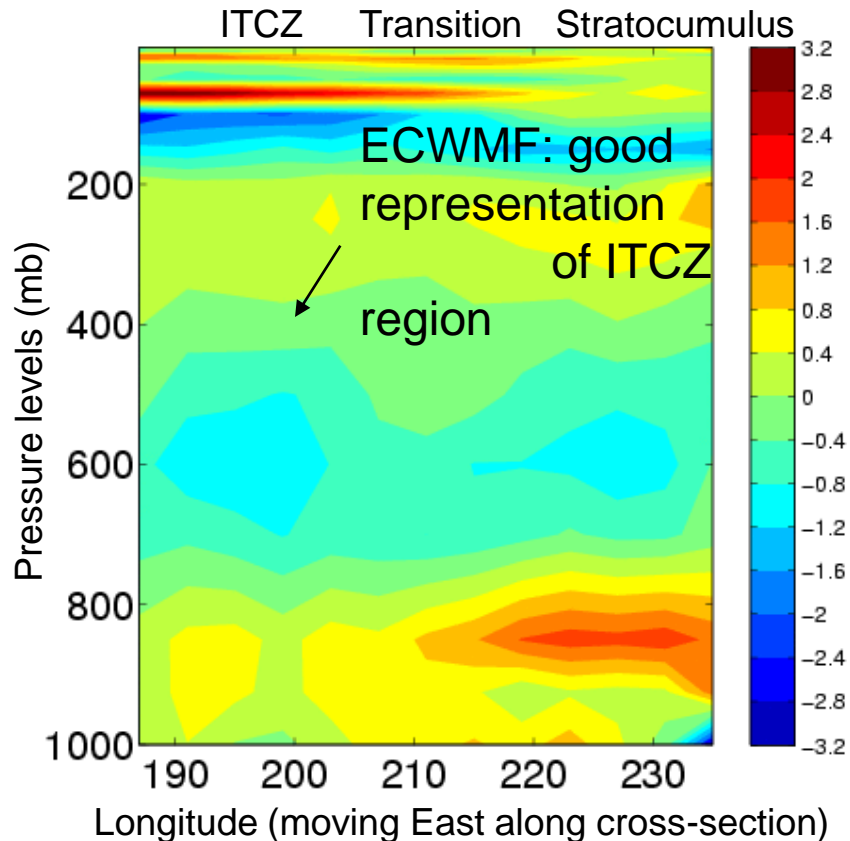


Accuracy of the initialization: ECMWF versus AIRS

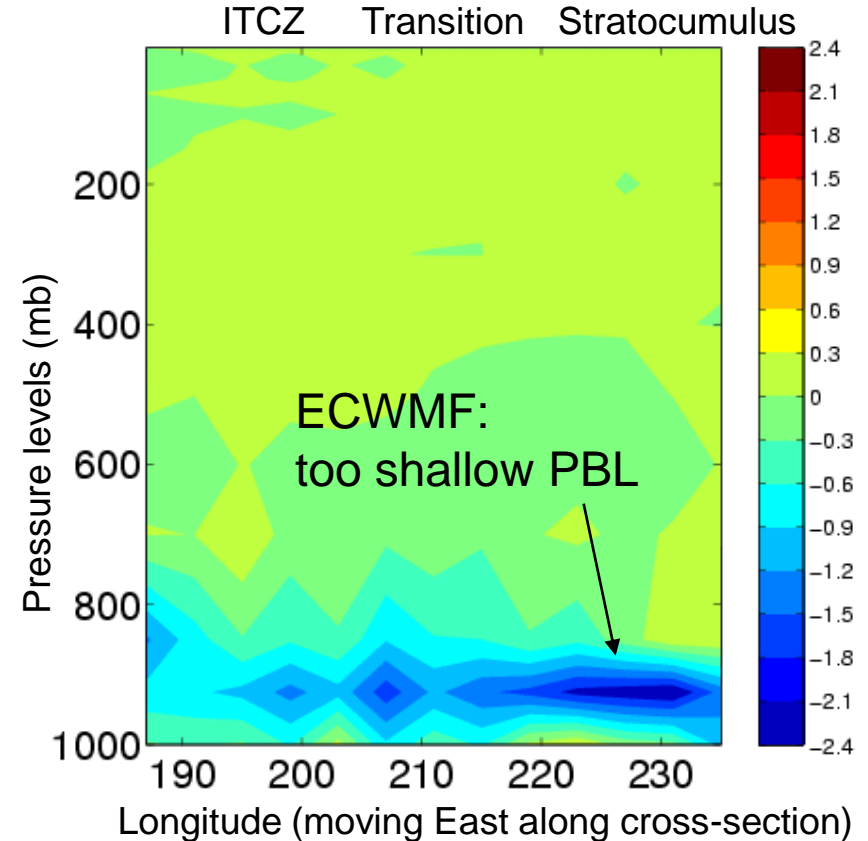
- AIRS** Accuracy of the daily global profiles
- temperature: 1 K per 1 km layer
 - moisture: 20-60% per 2 km layer

ECWMF analysis
IFS cycle 26r3

Temperature error, July 2003

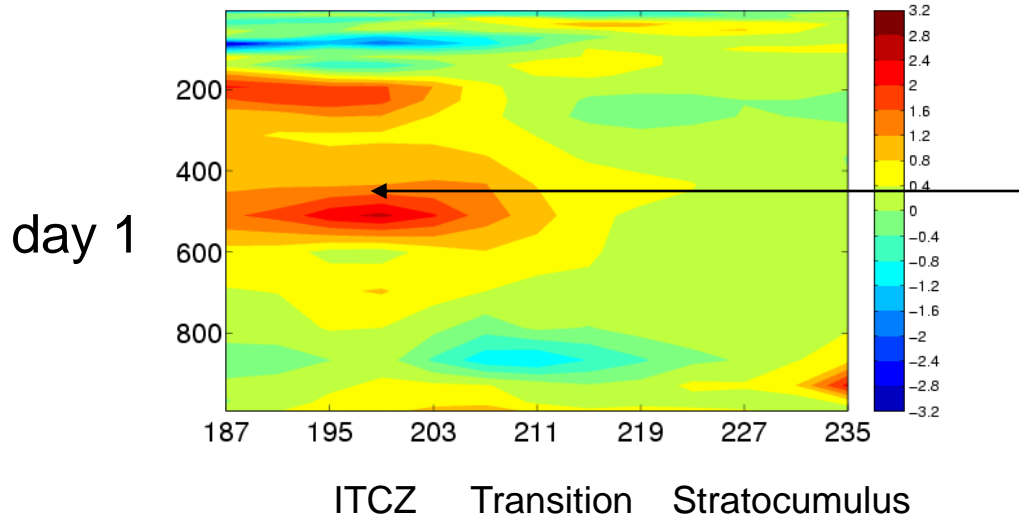


Moisture error, July 2003

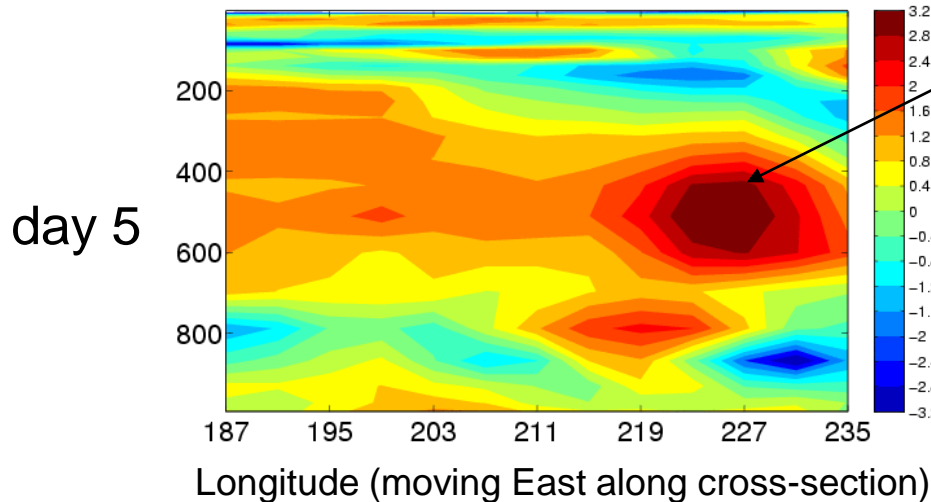


Ensemble mean forecast: T error at day 1 and day 5

Control: T error, July 2003



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

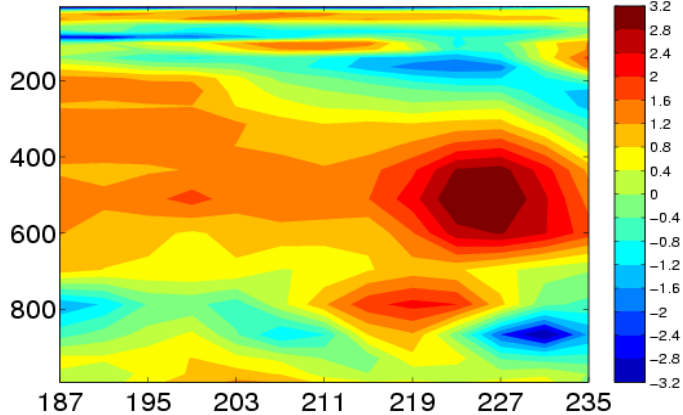


Error built slower towards the
stratocumulus region

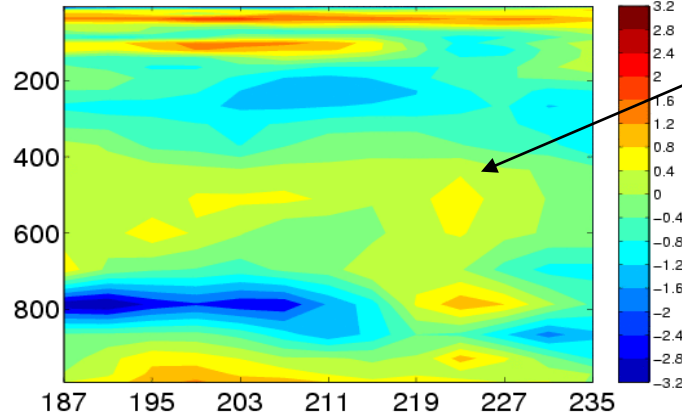
5-day errors are comparable
to the mean climate errors.

Sensitivity to the new schemes: T error at day 5

1. Control

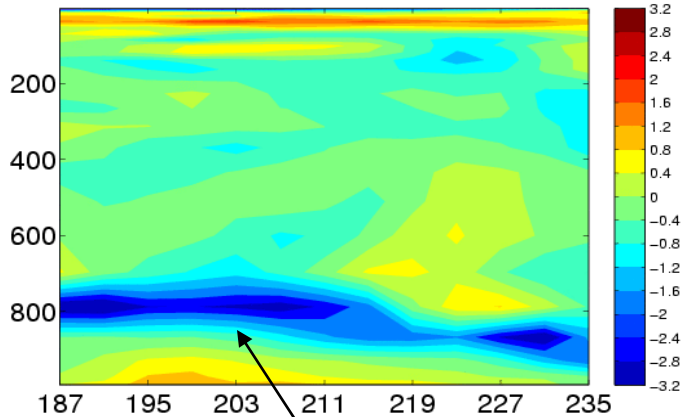


2. deep convection (dilute)



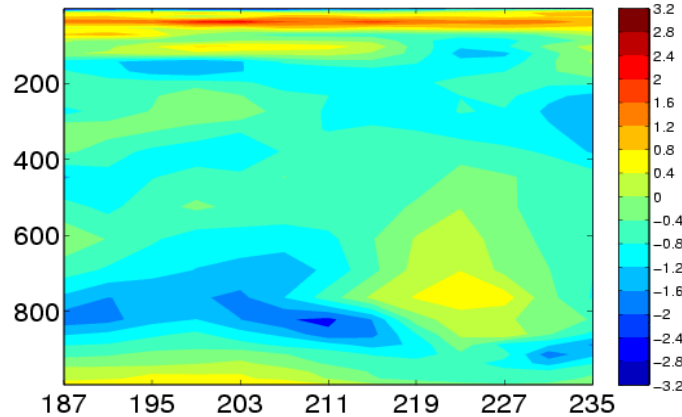
Change in the error structure even where the deep convection is **not active**

3. Microphysics (MG)



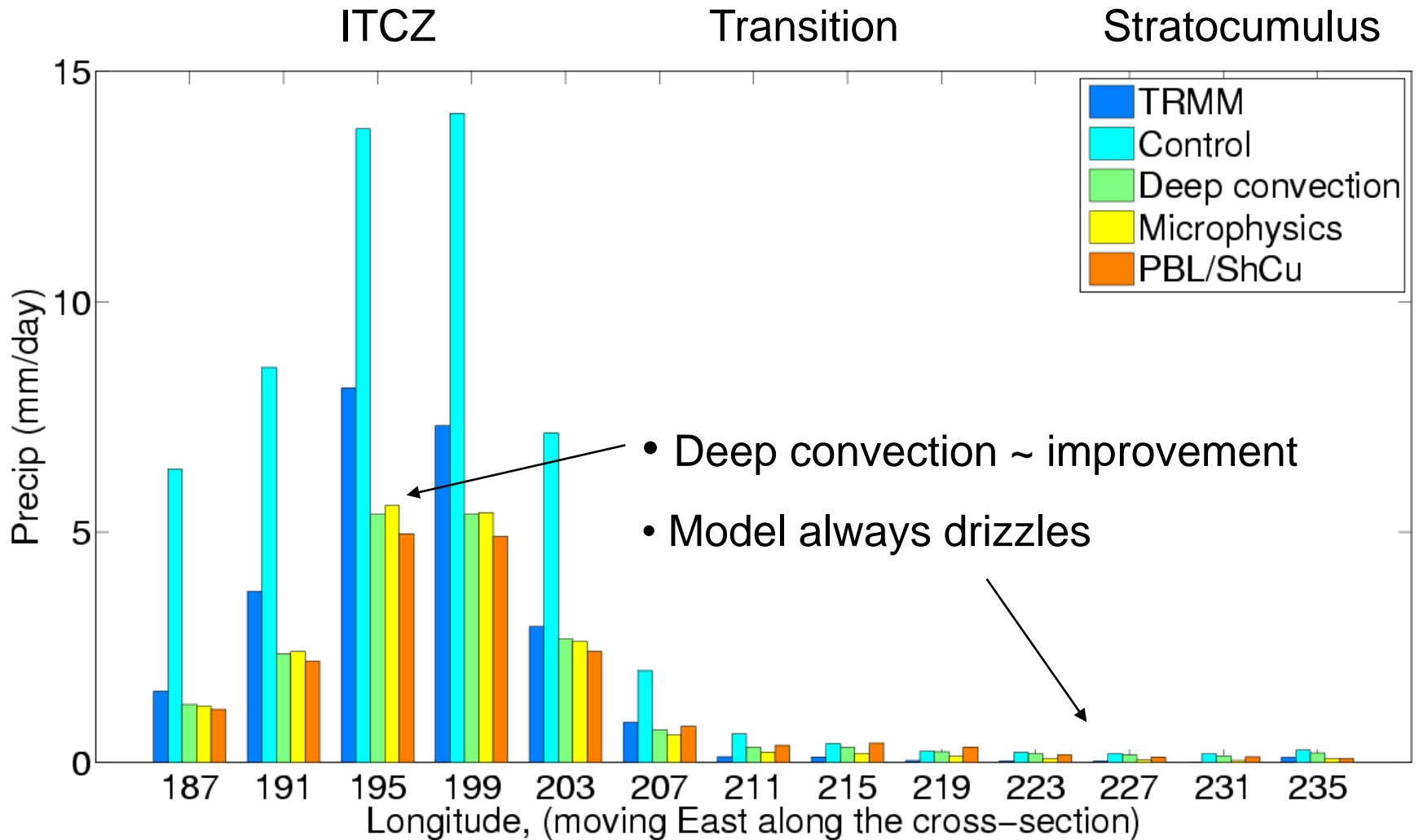
Cooling is related to shallow convection

4. PBL/ShCu (UW)



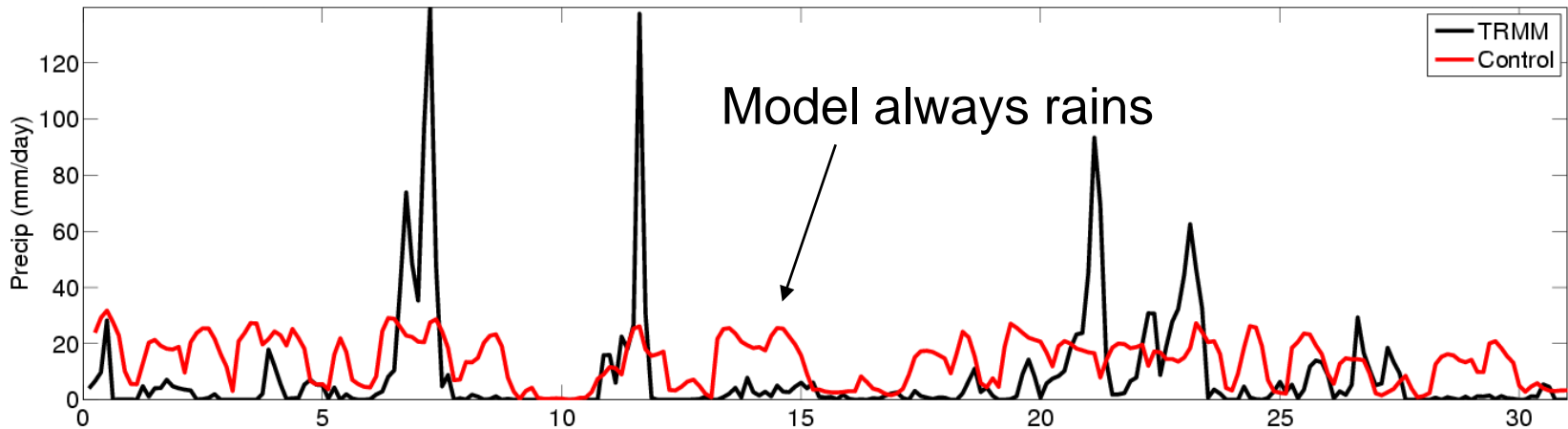
Conclusion:
New schemes:
reduce T error

Precipitation along cross-section, July 2003

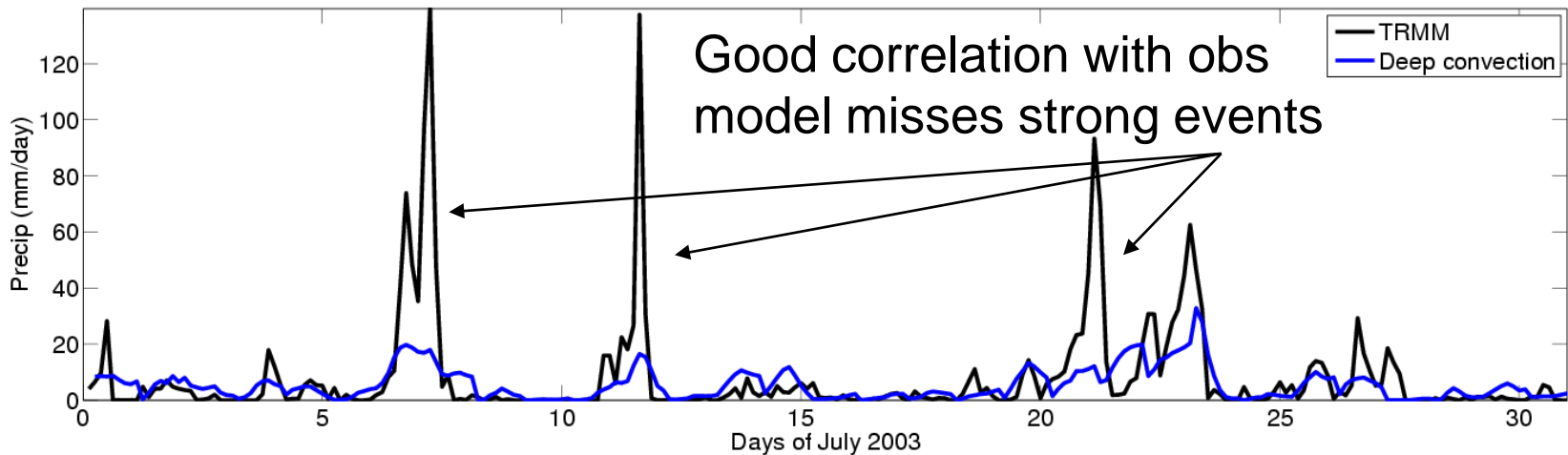


Timeseries of precipitation at the ITCZ

Control

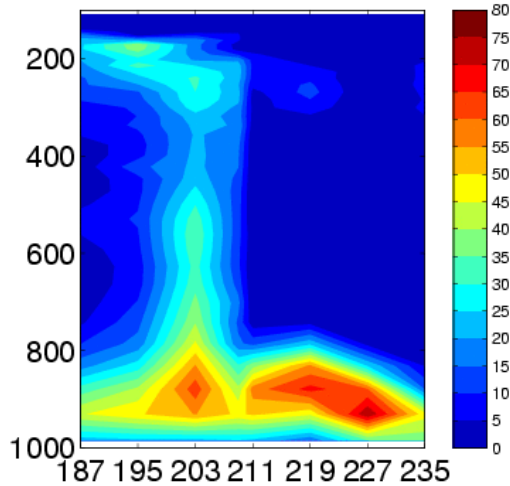


Deep convection (dilute)

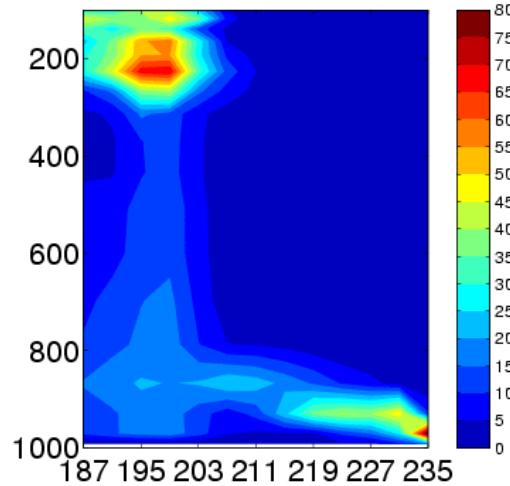


Cloud fraction averaged over day 1

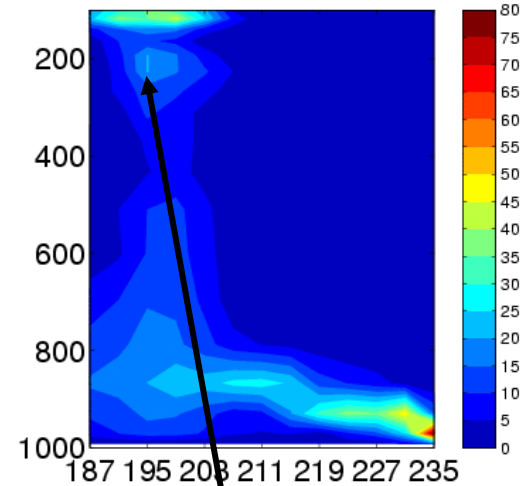
CloudSat



1. Control



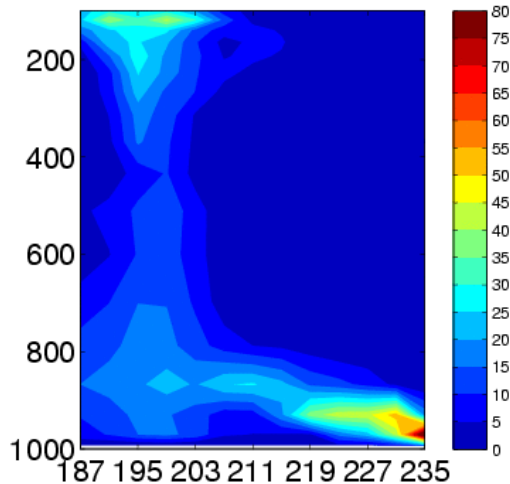
2. deep convection (dilute)



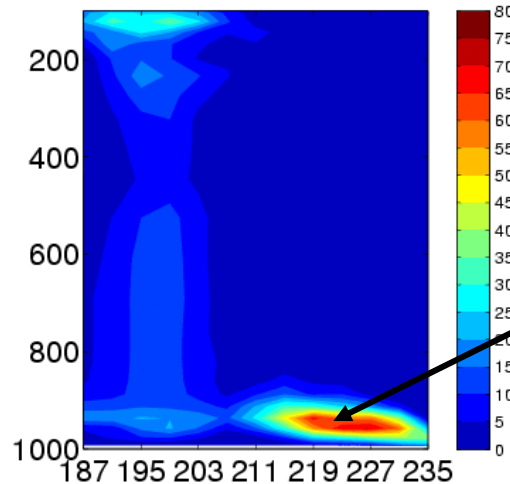
deep convection

Reduces high level cloud near ITCZ

3. Microphysics (MG)



4. PBL/ShCu (UW)



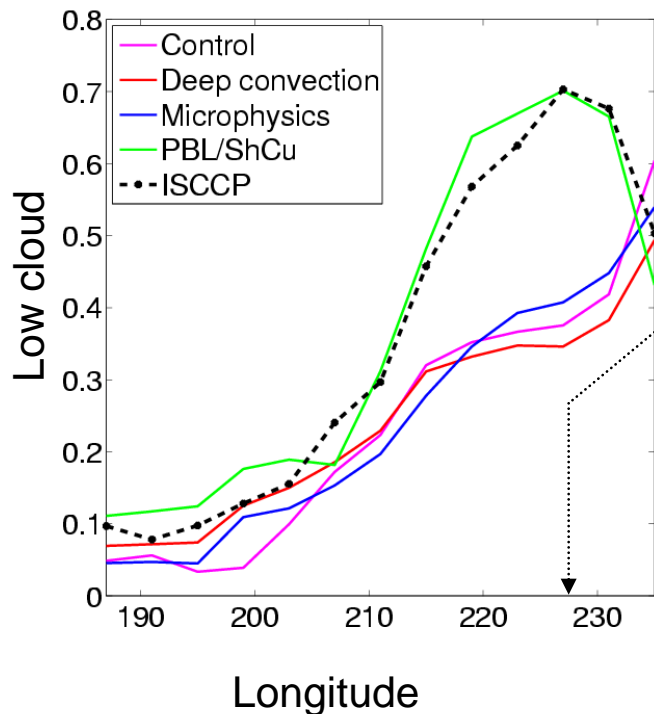
PBL/ShCu

Low-level cloud further from the coast and lower in the troposphere

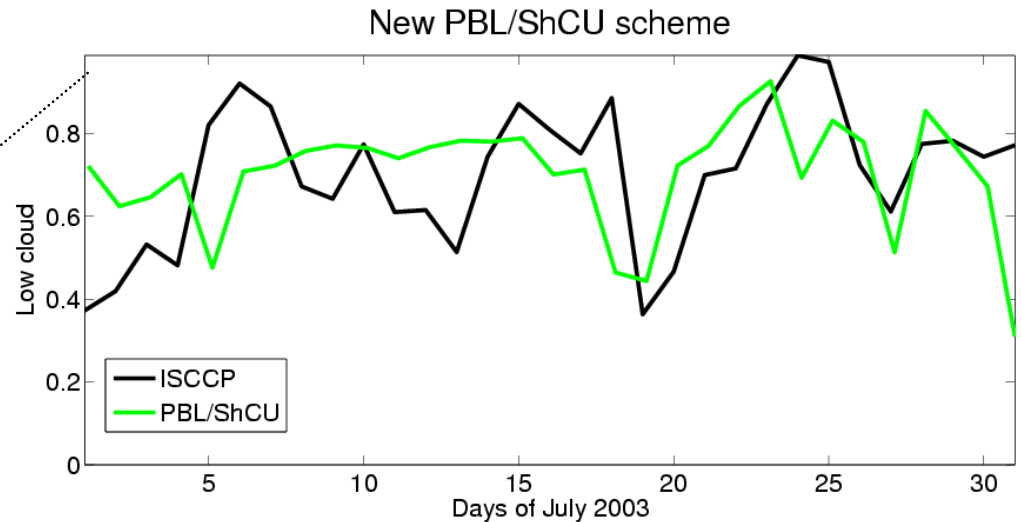
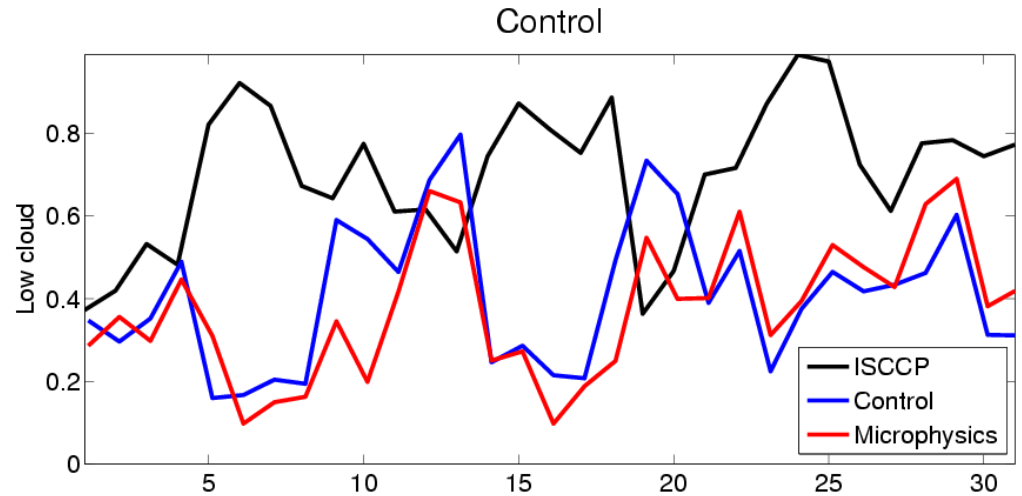
Low-level cloud as seen by ISCCP

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

Ensemble mean forecast



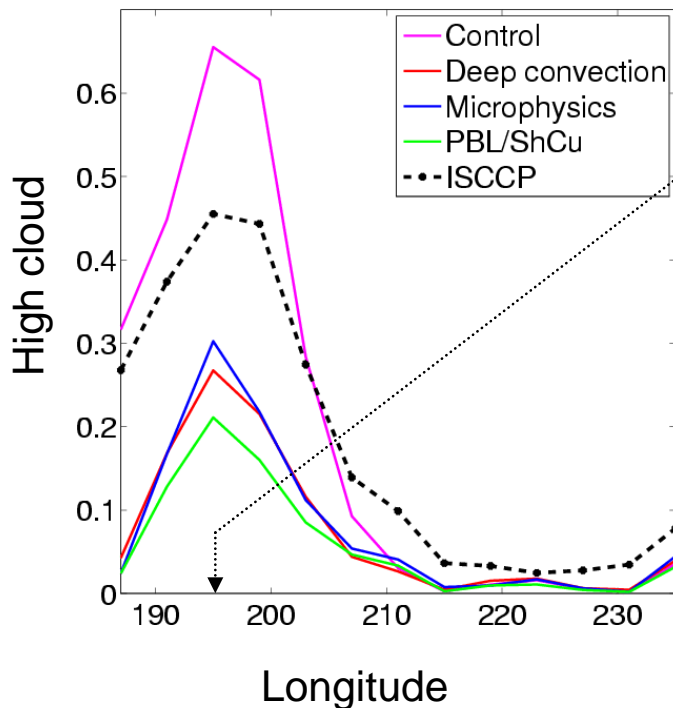
Forecast timeseries (0-24h average)



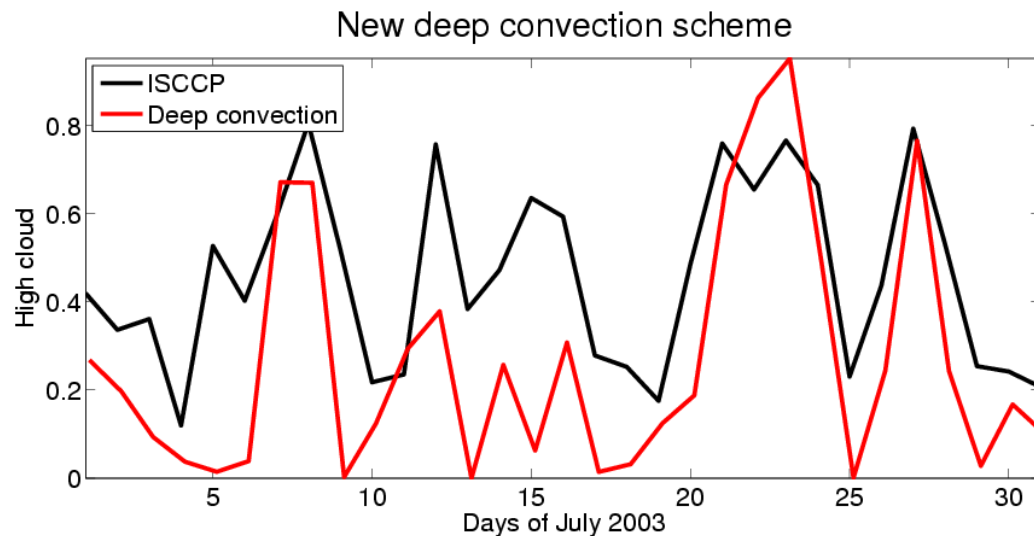
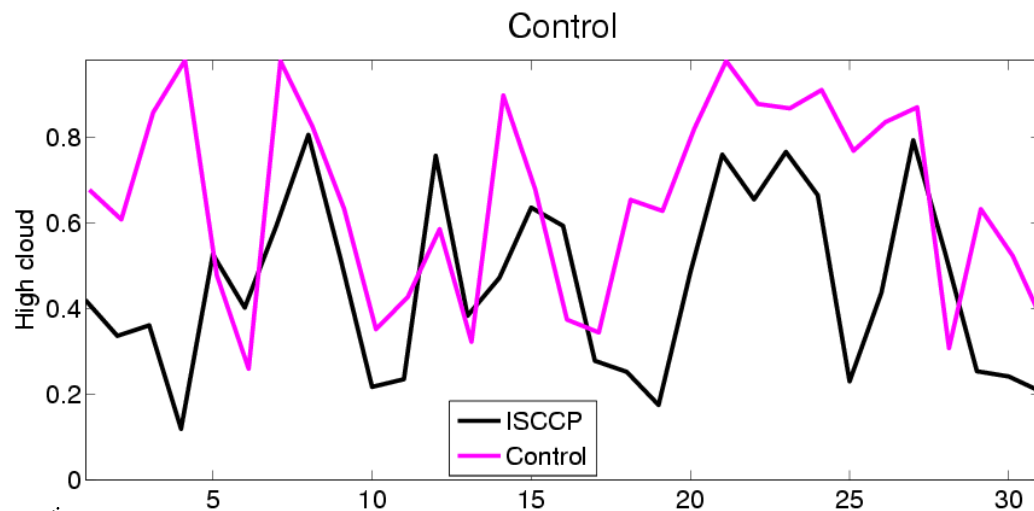
High-level cloud as seen by ISCCP

High level cloud is largely reduced by the new convective scheme

Ensemble mean forecast



Forecast timeseries (0-24h average)



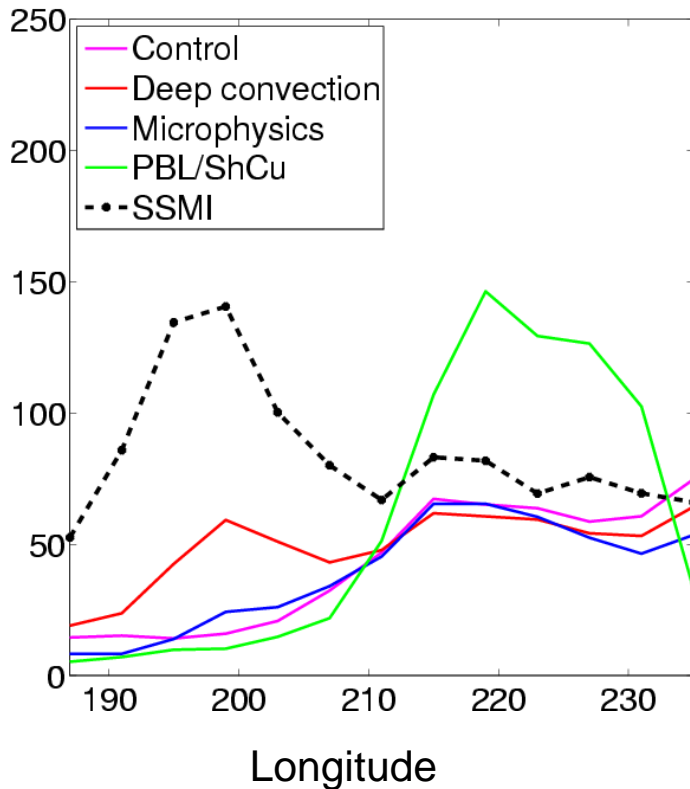
Conclusion

- 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
 - Deep convection (dilute):**
 - reduces **temperature** bias
 - dramatic improvement of the **precipitation** in the ITCZ region
 - **high-level cloud** fraction too low compared to ISCCP.
 - Microphysics (MG):**
 - **little change** along the cross-section.
 - PBL/ShCu (UW):**
 - improvement of the **low-level clouds** when compared to ISCCP.

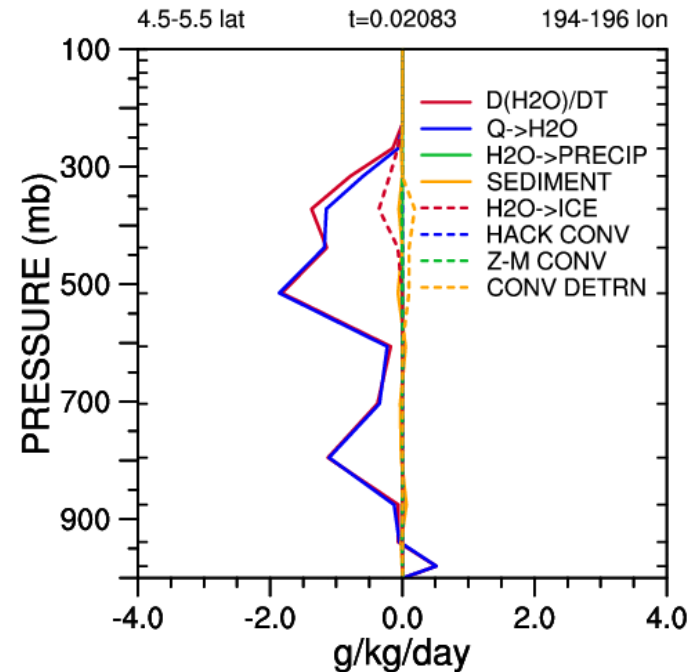
Extra slides

Liquid water path versus SSM/I

Ensemble mean forecast (day1)

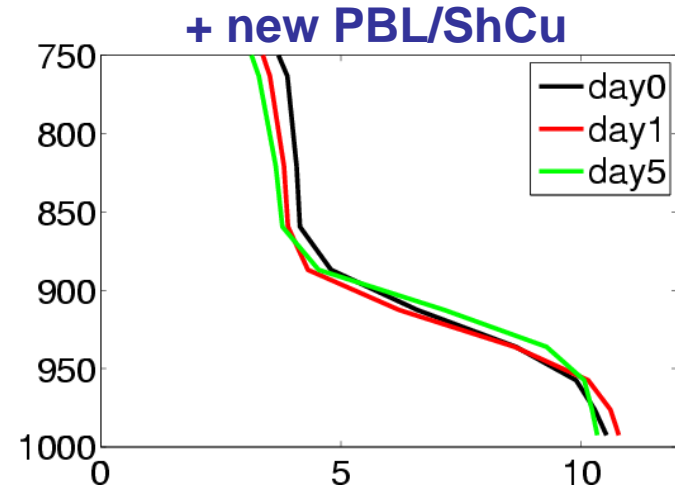
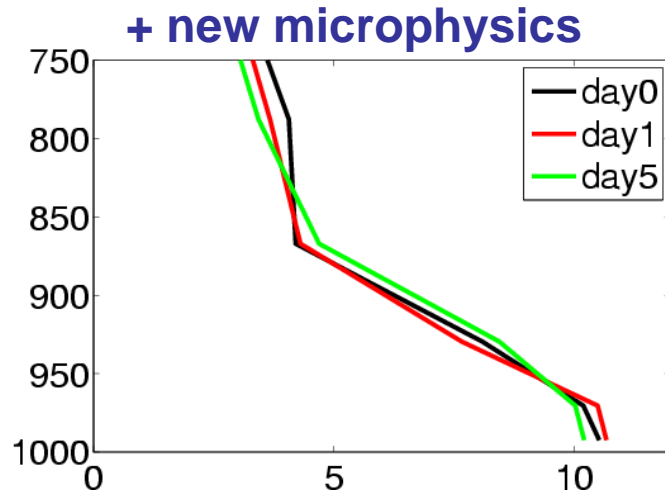
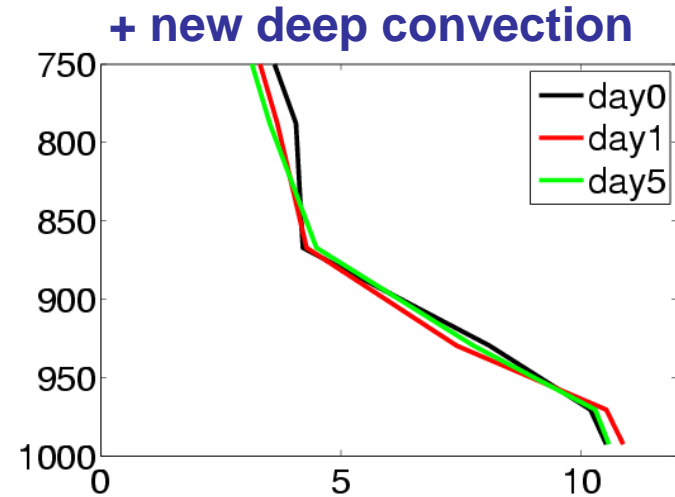
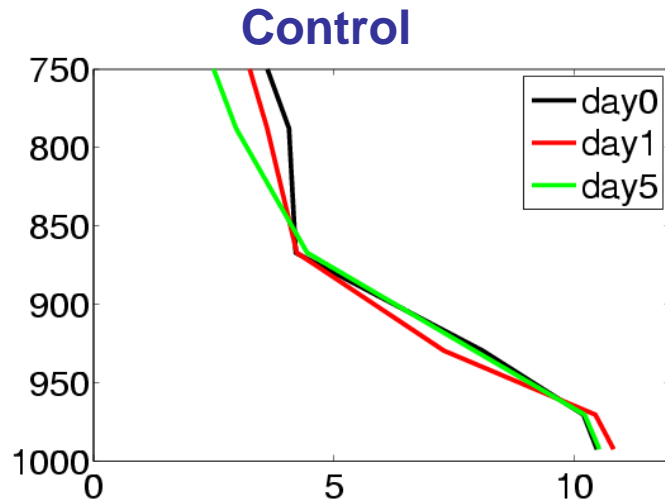


Cloud water budget



- Cloud water is **dumped out** at the first timestep and slowly rebuilt within 5 days
- New microphysics: cloud water is **too low** near ITCZ.
- New PBL/ShCu: values **too large** in the transition and stratocumulus regions

Moisture and ability to maintain the PBL height

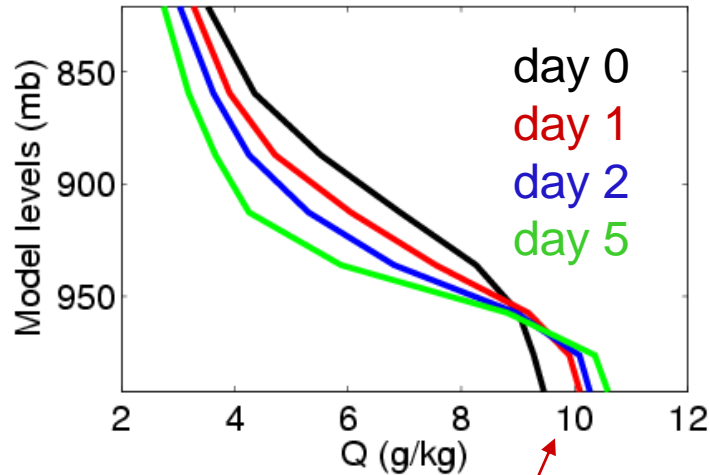


Stratocumulus: PBL too shallow but maintained in 5-day forecast

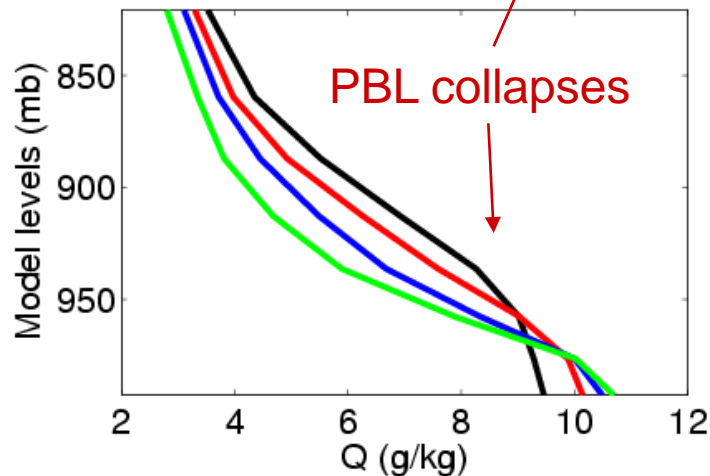
Moisture and PBL for stratocumulus, JJA 1998

Specific humidity

Control



+ new
PBL/ShCu



Earlier results for JJA 1998

⇒ collapse of the PBL
compared to ECWMF.

But:

- different dynamical core
- different initialization
- different year

Outstanding issues and future work

- 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)

Accuracy of the initialization: ECMWF versus AIRS

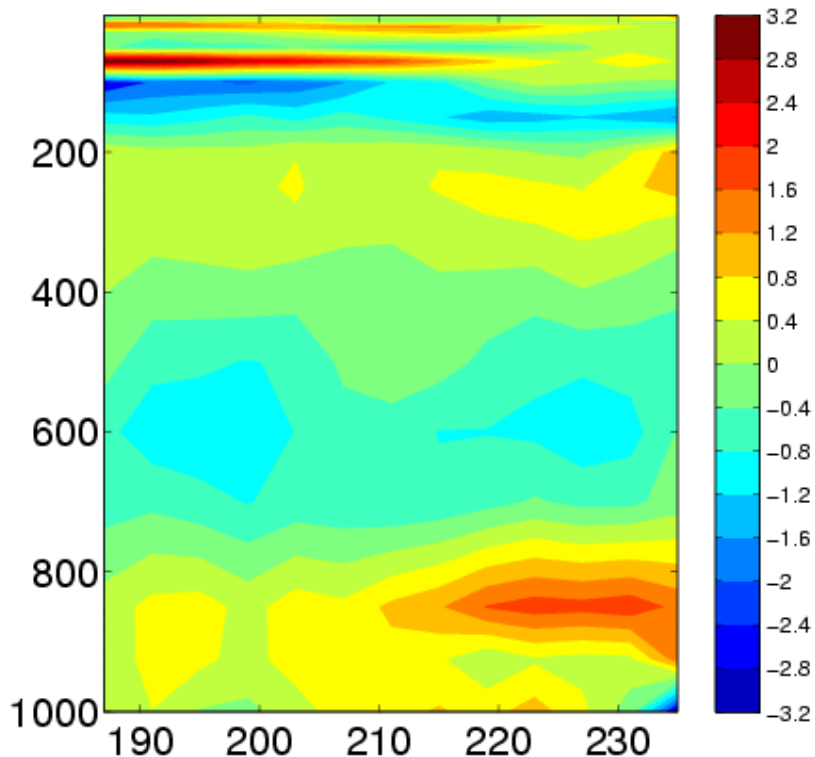
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- temperature: 1 K per 1 km layer
- moisture: 20-60% per 2 km layer

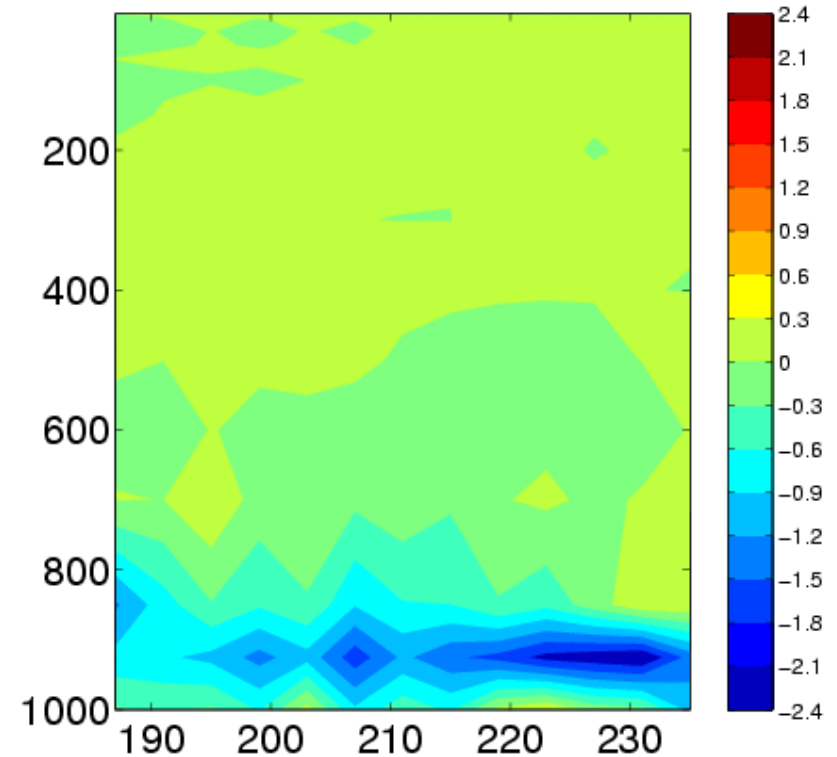
ECWMF analysis

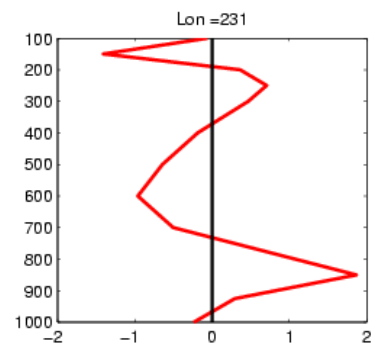
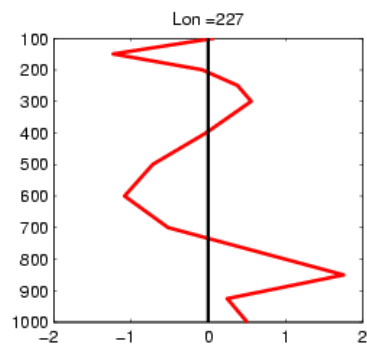
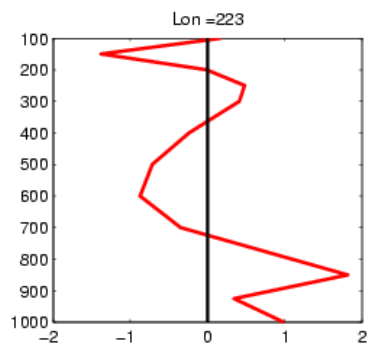
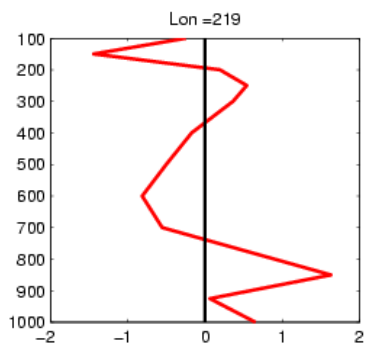
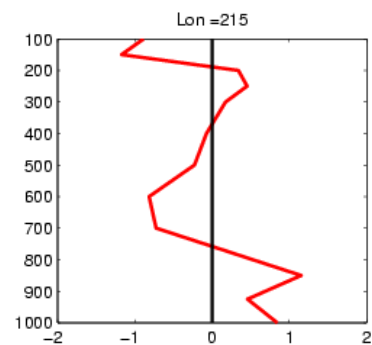
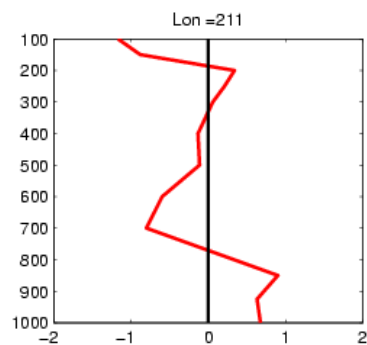
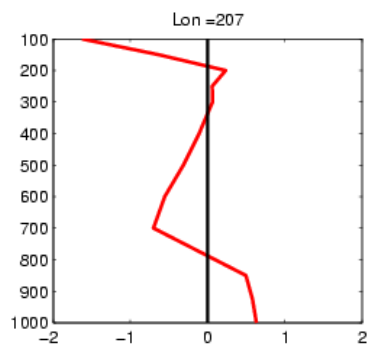
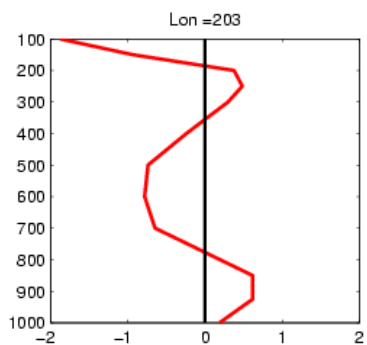
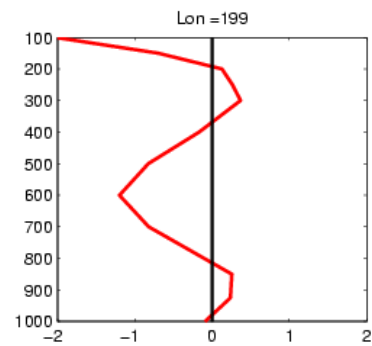
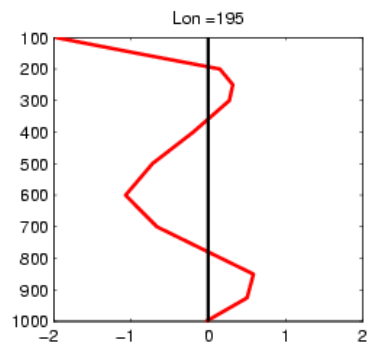
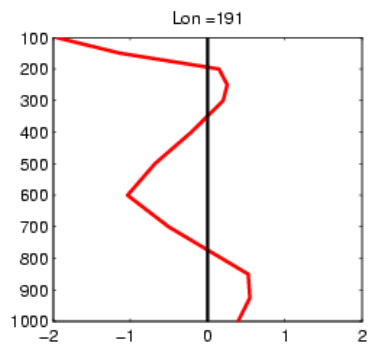
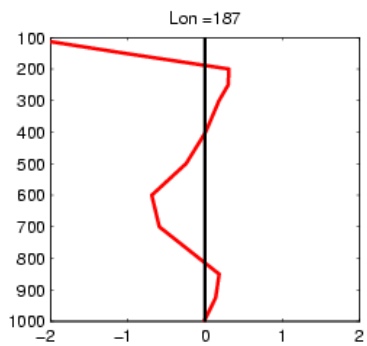
IFS cycle 26r3

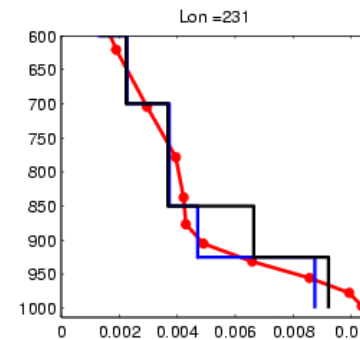
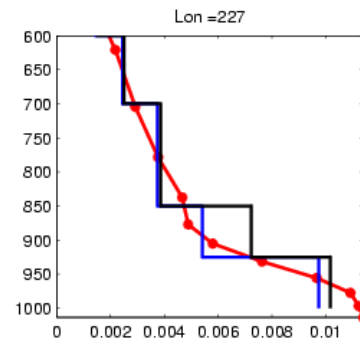
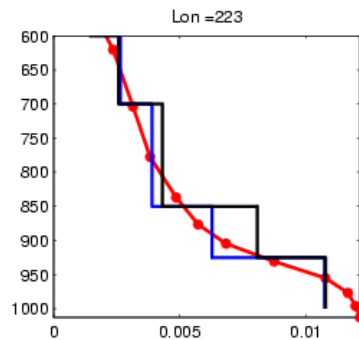
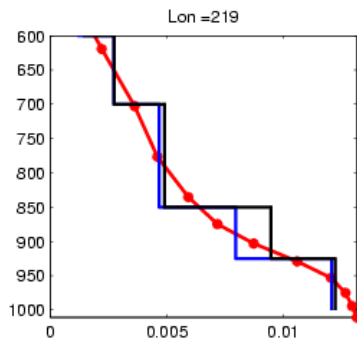
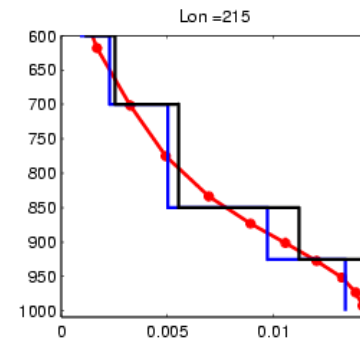
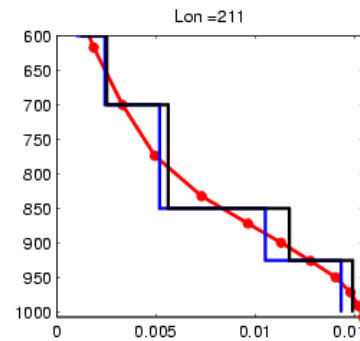
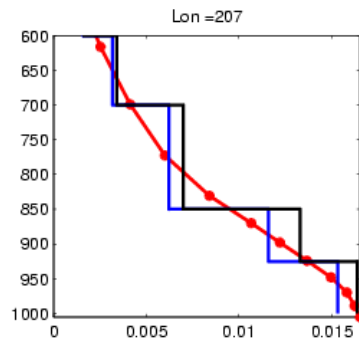
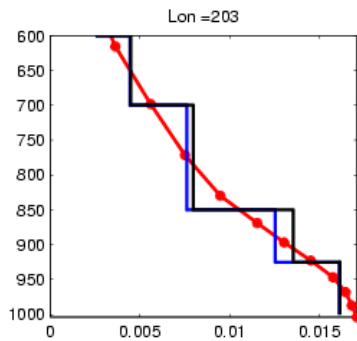
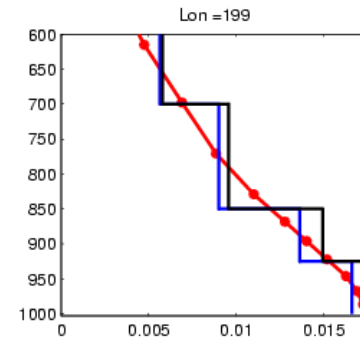
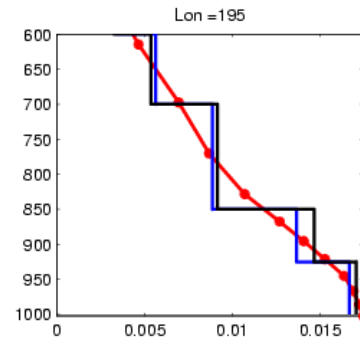
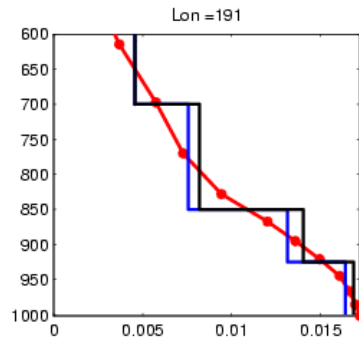
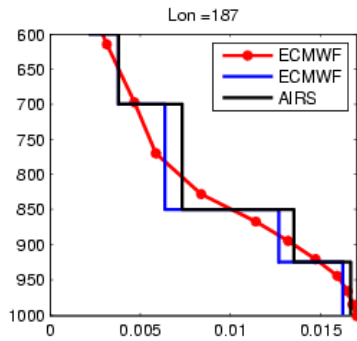
Temperature error, July 2003

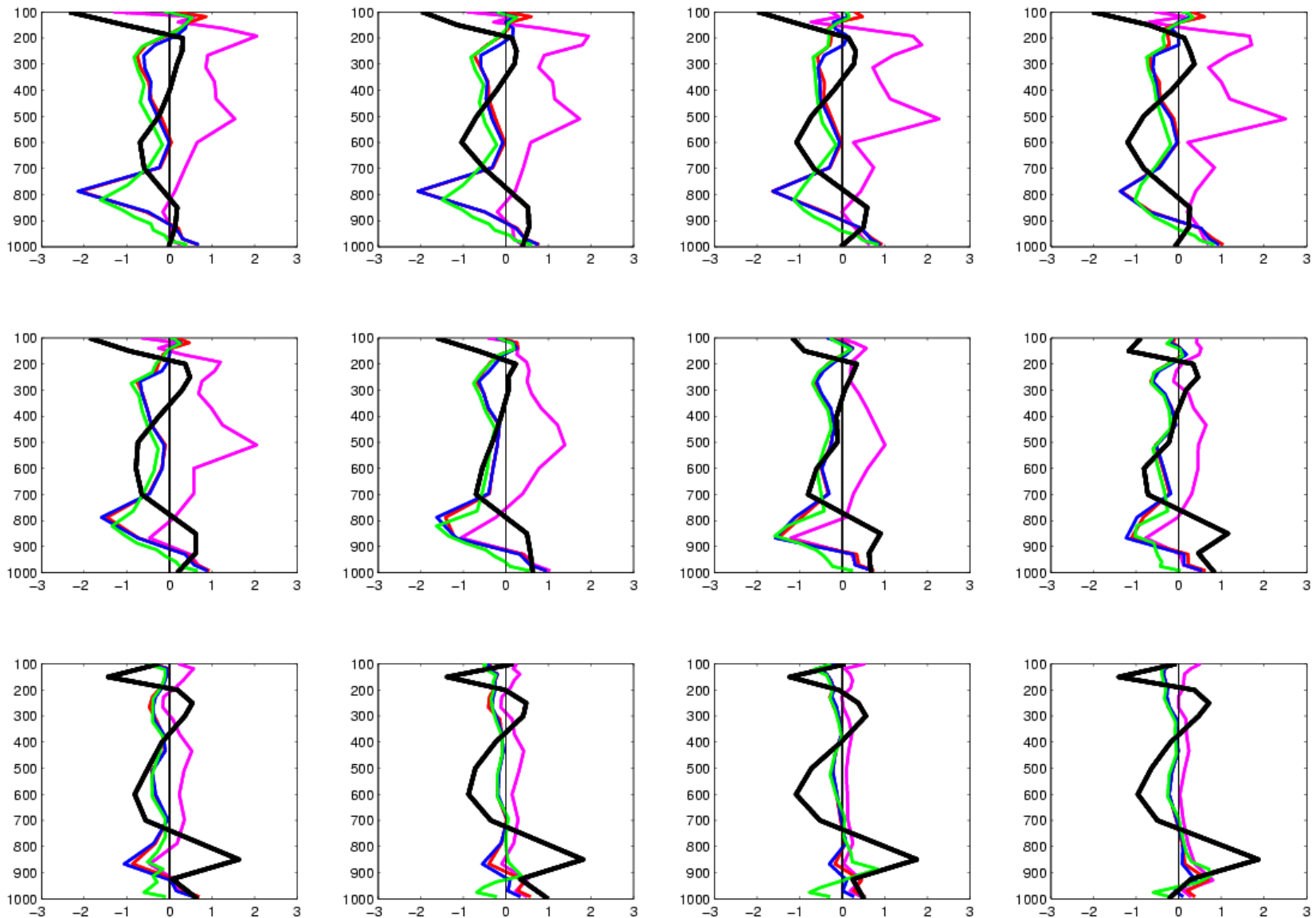


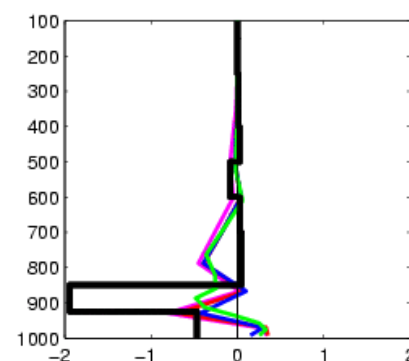
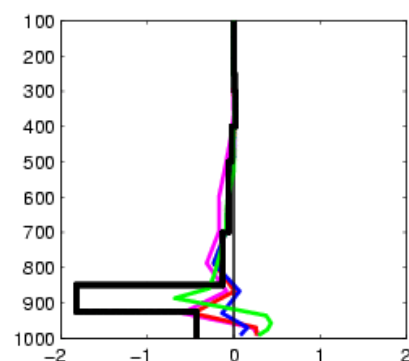
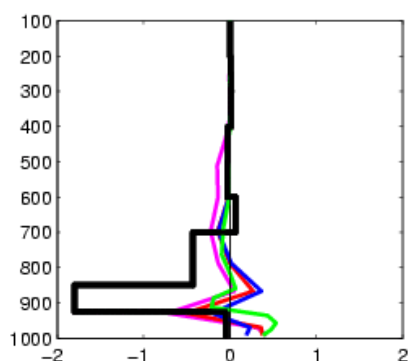
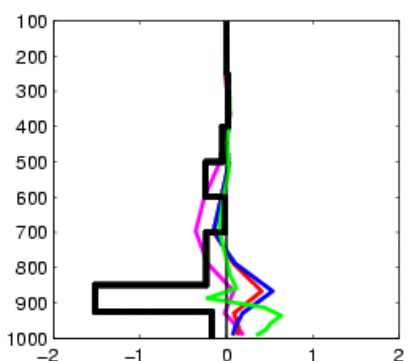
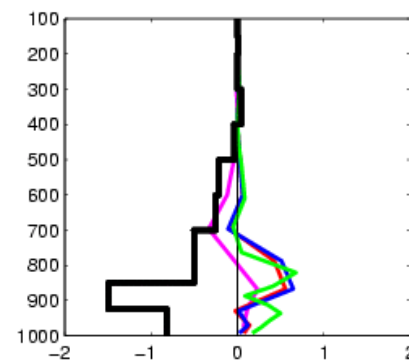
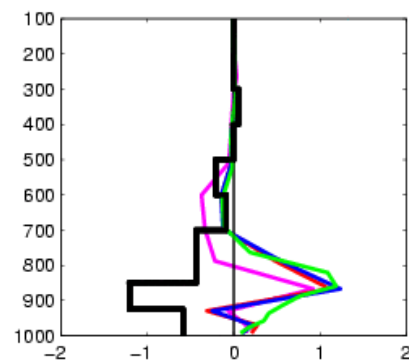
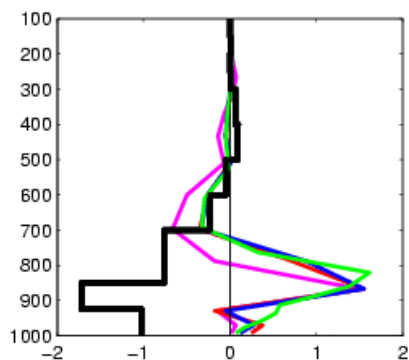
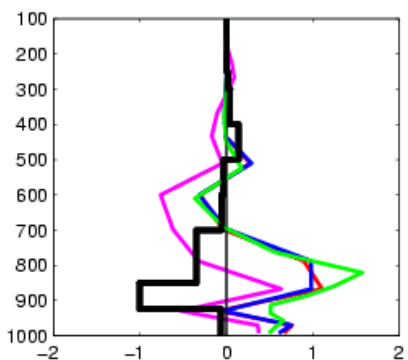
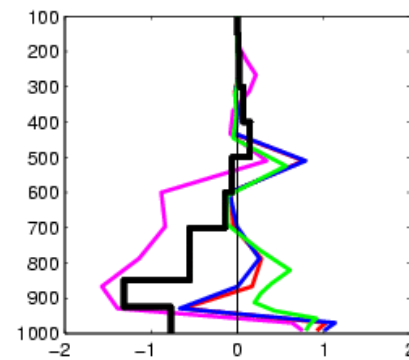
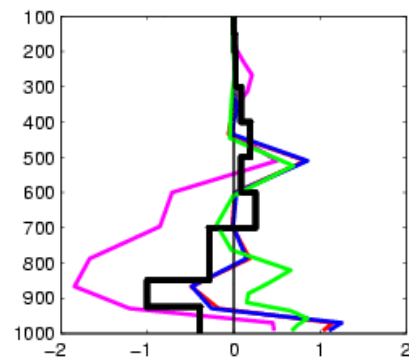
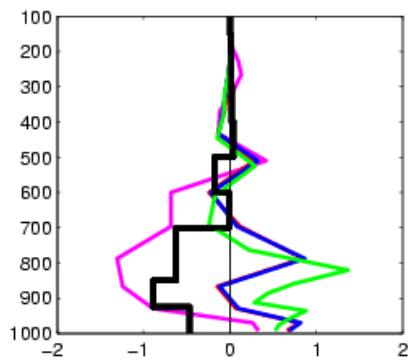
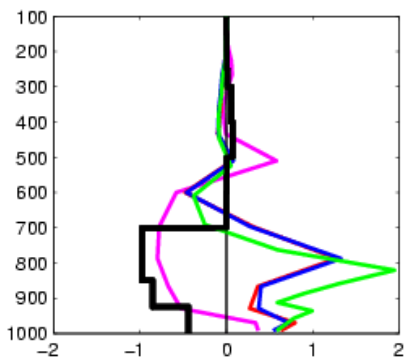
Moisture relative error, July 2003





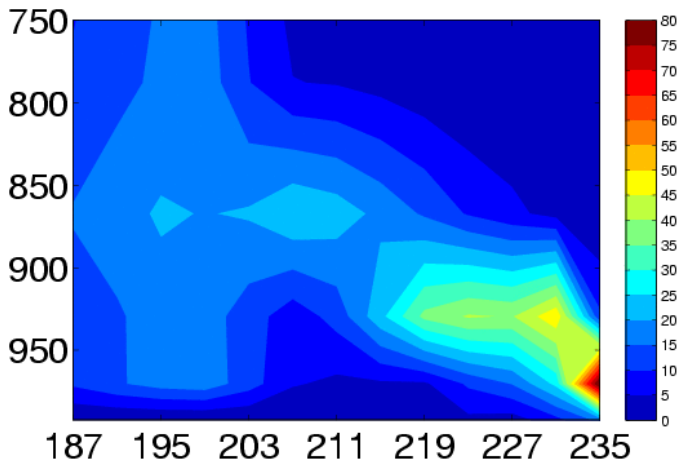




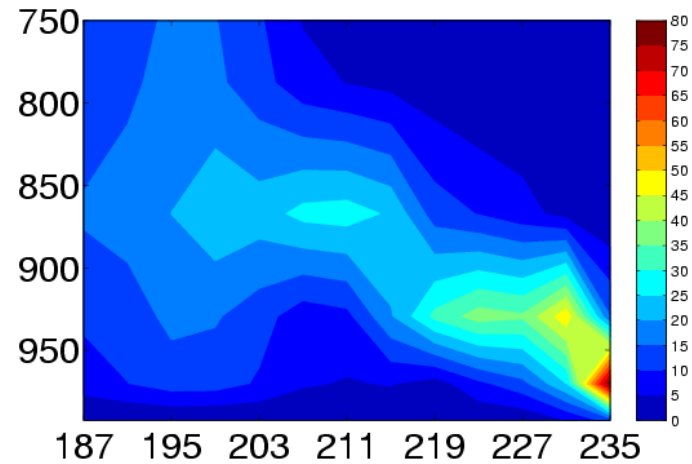


Cloud fraction averaged over day 1

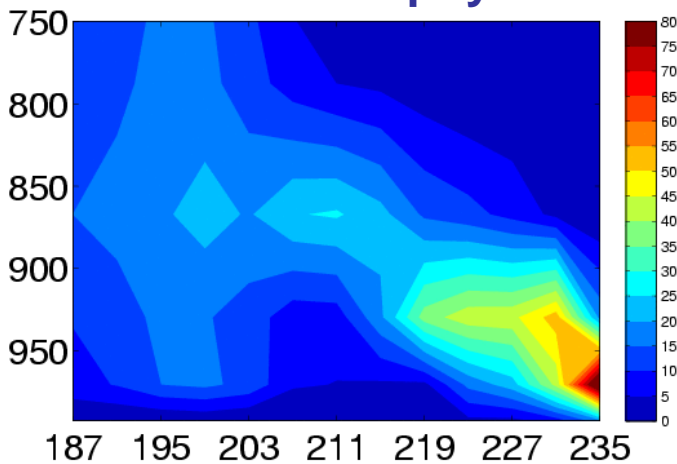
Control



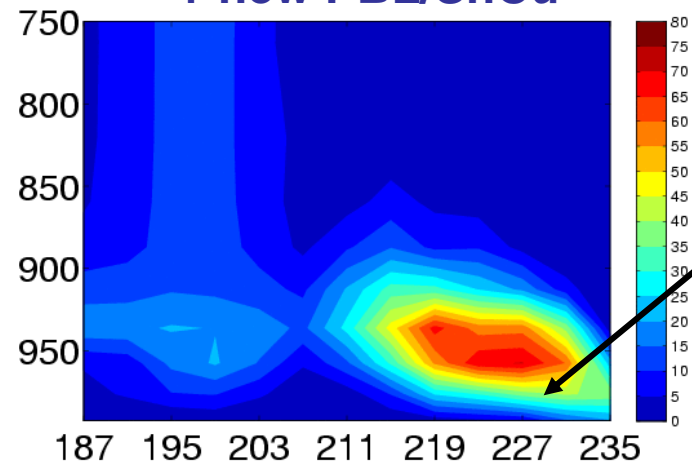
+ new deep convection



+ new microphysics



+ new PBL/ShCu



PBL/ShCu
Low-level cloud in
stratocumulus and
cumulus regions

LWP

