Improved representation of clouds in the atmospheric component LMDZ6A of the IPSL Earth system model IPSL-CM6A

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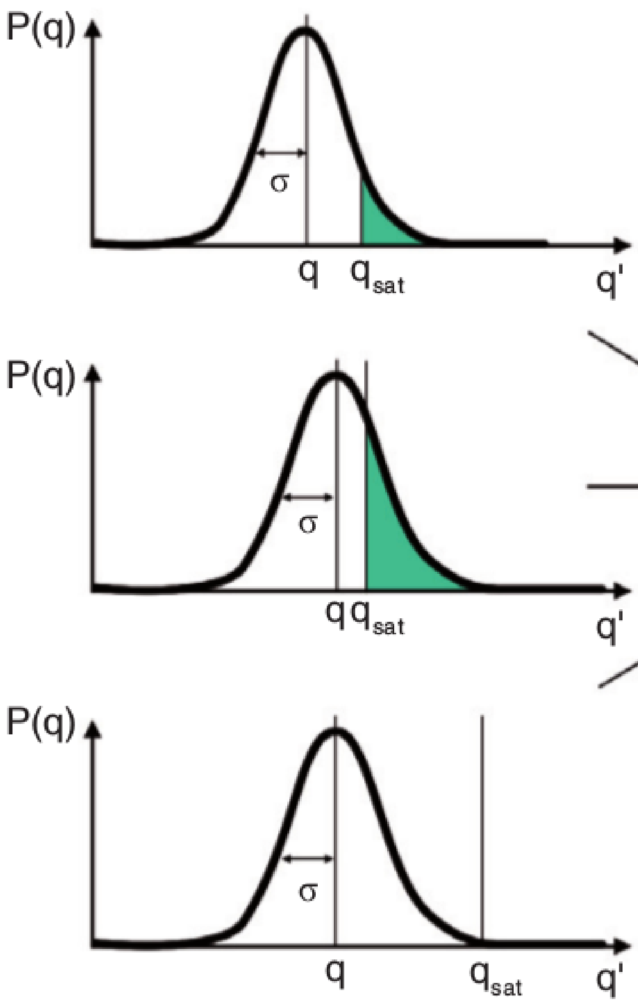
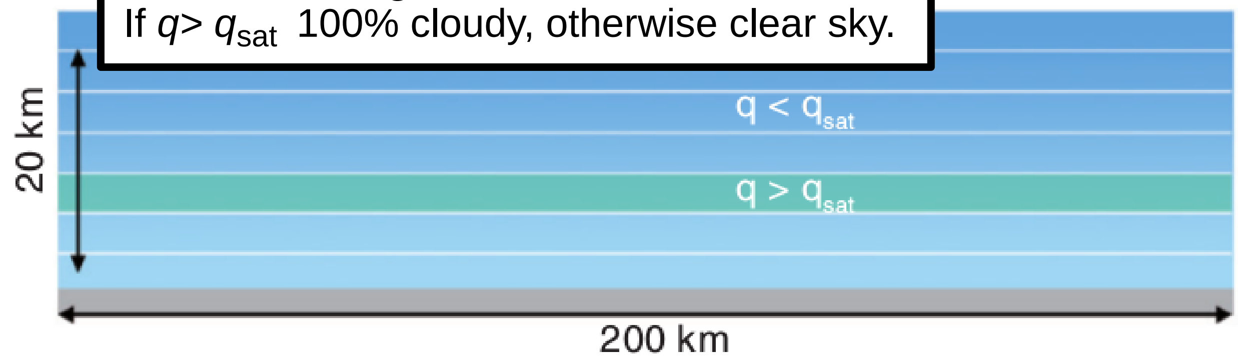
Picture by Oleg Artemyev taken from the ISS

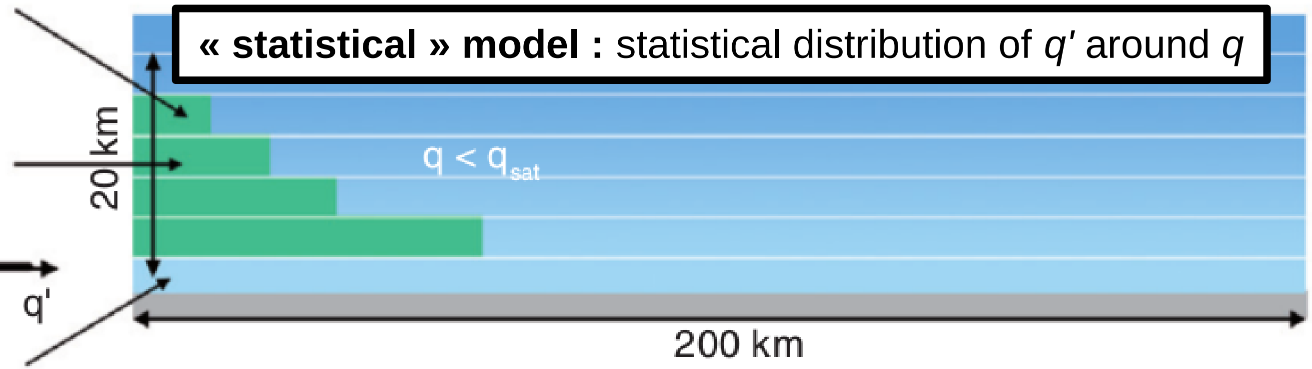
Schéma statistique de nuages

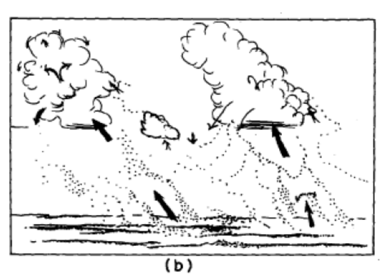
« all or nothing » model :
If $q > q_{sat}$ 100% cloudy, otherwise clear sky.

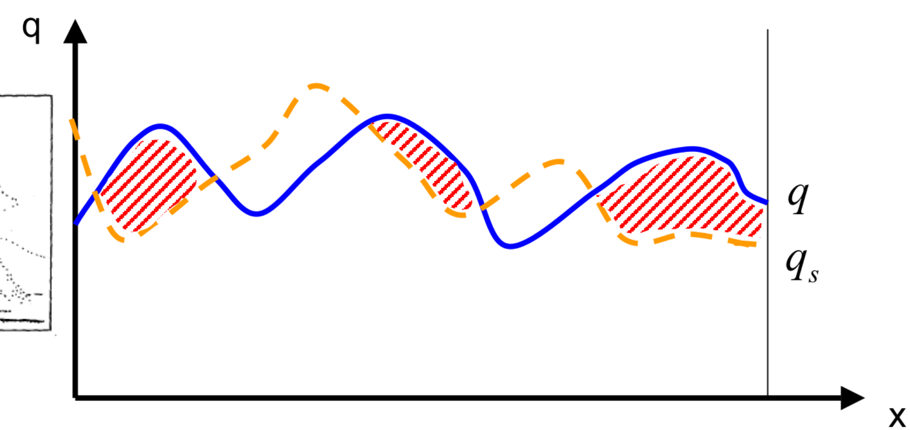




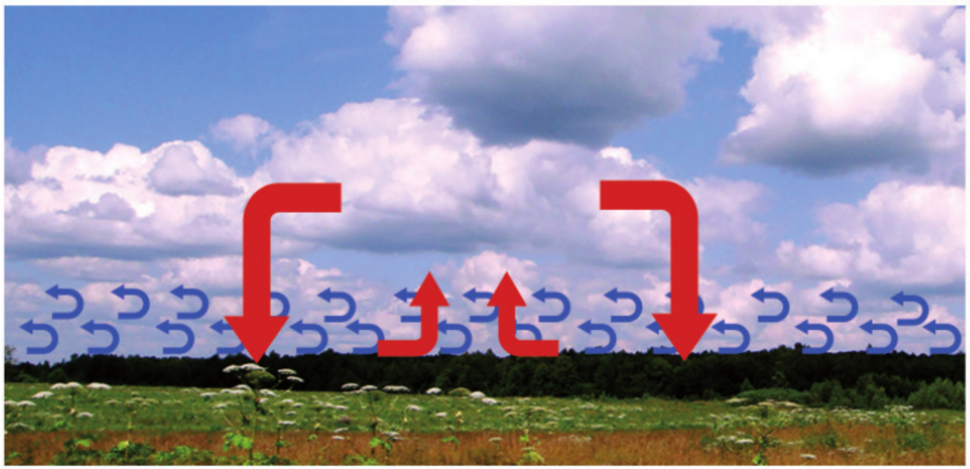
« statistical » model : statistical distribution of *q'* around *q*

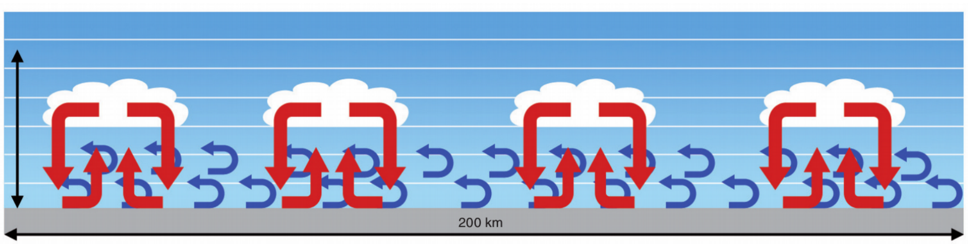


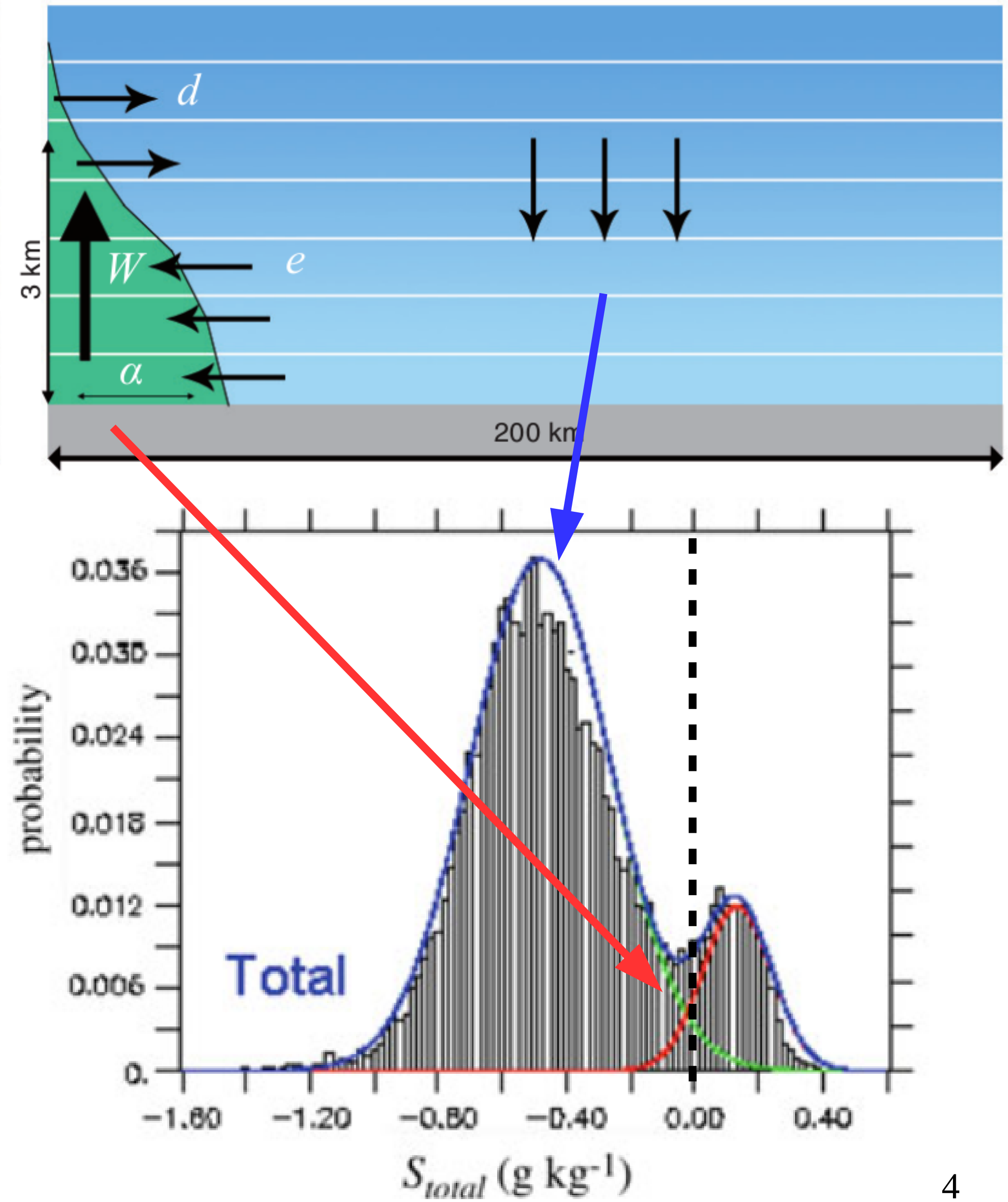




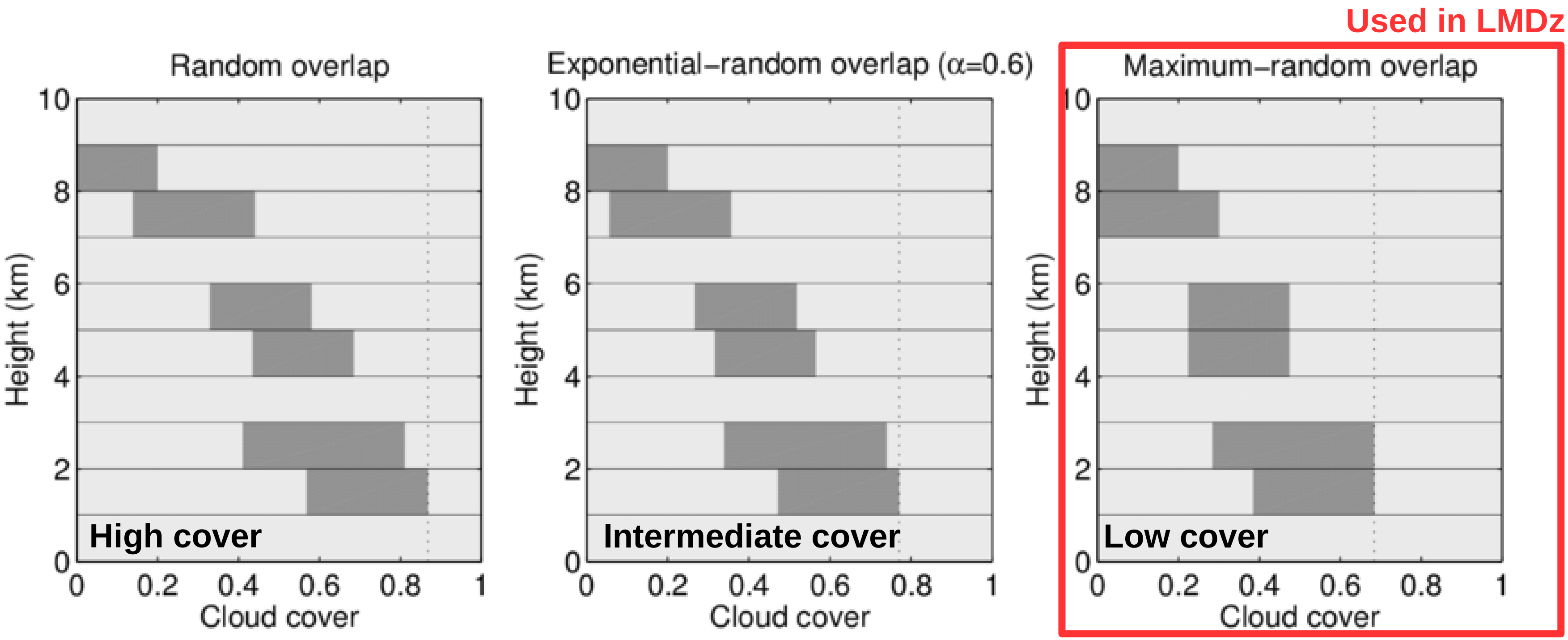
Shallow cumulus convection





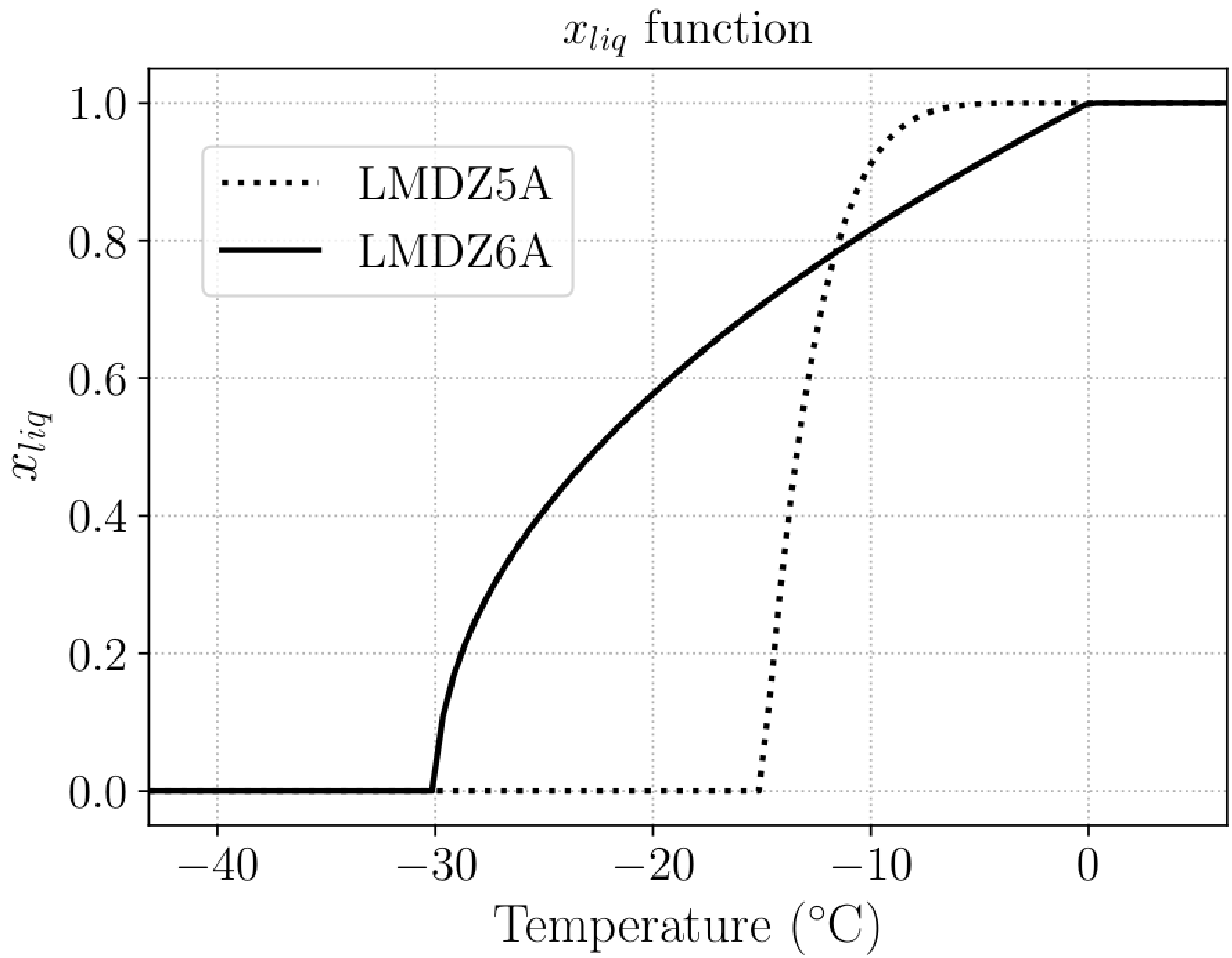


Hypothèses de recouvrement



[Radiation parameterization and clouds, Hogan, 2009]

Phase des nuages

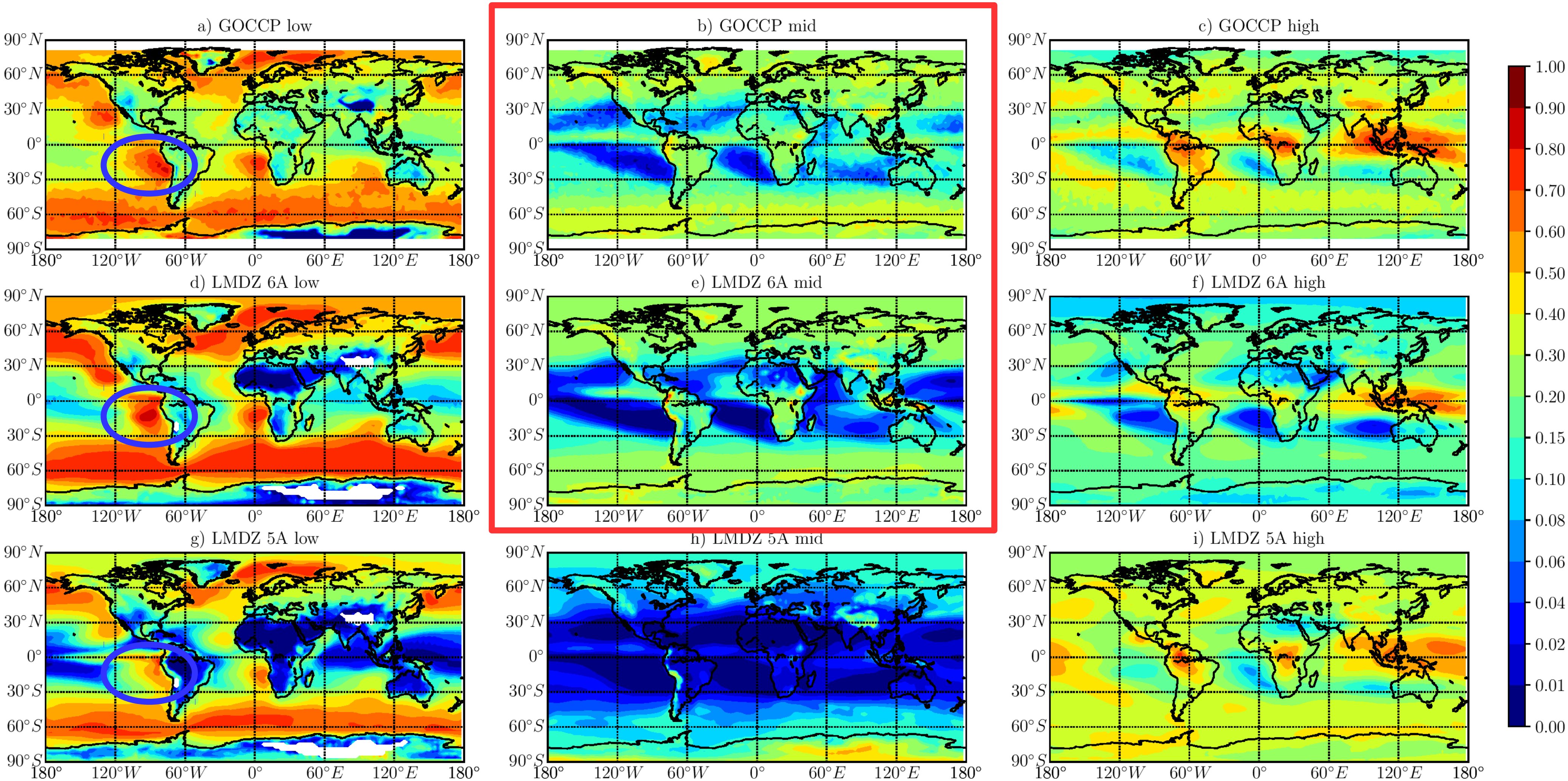


Tout ce que vous avez toujours voulu savoir sur les nuages dans LMDZ

(sans jamais oser le demander)

Procedure / Subsection	Input variables	Other outputs
	$\circlearrowleft$ Updated variables	
2.1. Evaporation	$\theta\ q_v\ q_l\ q_i$	
	$\circlearrowleft$ $\theta\ q_t\ (q_l = q_i = 0)$	
2.2. Local turbulent mixing	$\theta\ q_t$	
	$\circlearrowleft$ $\theta\ q_t$	
2.3. Deep convection	$\theta\ q_t\ ALE\ ALP$	$q_c^{in,cv}$ $P_{l,i}^{cv}\ d\theta_{dw}^{cv}\ dq_{t,dw}^{cv}$
	$\circlearrowleft$ $\theta\ q_t$	
2.4. Deep convection PDF	$q_t\ q_c^{in,cv}$	α_c^{cv}
2.5. Cold pools (wakes)	$\theta\ q_t\ d\theta_{dw}^{cv}\ dq_{t,dw}^{cv}$	$ALE^{wk}\ ALP^{wk}\ \theta_{env}^{wk}\ q_{t,env}^{wk}$
	$\circlearrowleft$ $\theta\ q_t$	
2.6. Shallow convection	$\theta_{env}^{wk}\ q_{t,env}^{wk}$	$(s_{th}\ \sigma_{th}\ s_{env}\ \sigma_{env})^{th}\ ALE^{th}\ ALP^{th}$
	$\circlearrowleft$ $\theta\ q_t$	
2.7. Large-scale condensation	$\theta\ q_t\ (s_{th}\ \sigma_{th}\ s_{env}\ \sigma_{env})^{th}$	$q_c^{in,lsc}\ \alpha_c^{lsc}$ $P_{l,i}^{lsc}$
	$\circlearrowleft$ $\theta\ q_v\ q_l\ q_i$	
2.8. Radiative transfer	$q_c^{in,lsc}\ \alpha_c^{lsc}\ q_c^{in,cv}\ \alpha_c^{cv}$	
	$\circlearrowleft$ θ	

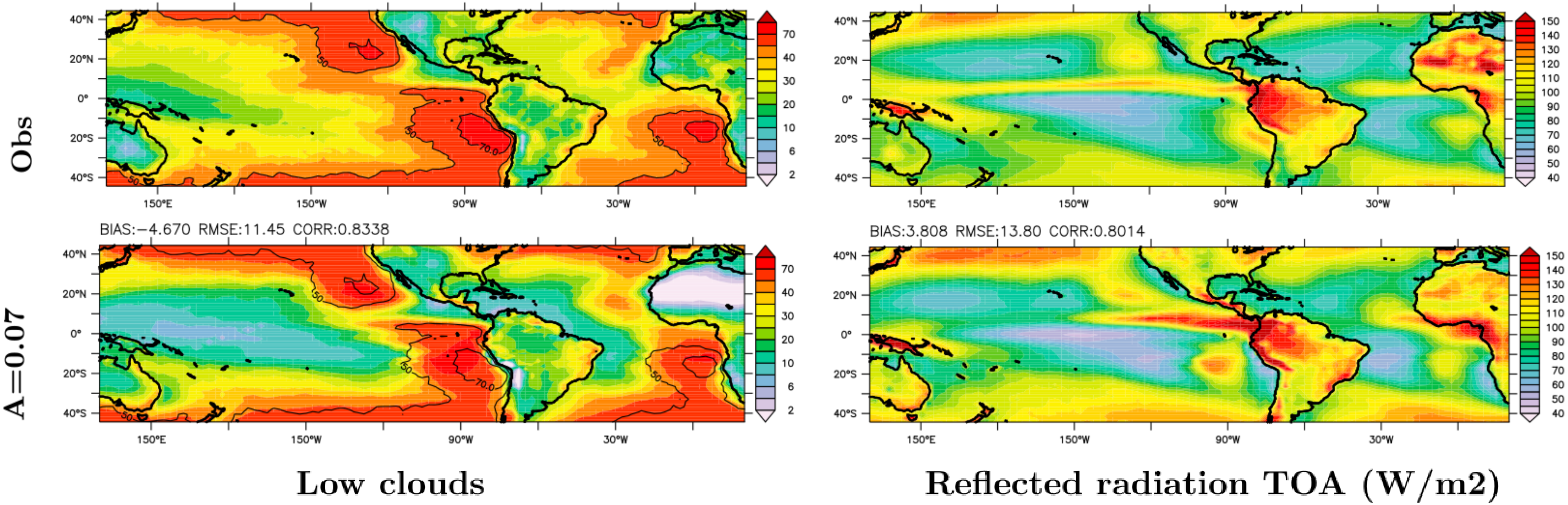
Couverture nuageuse



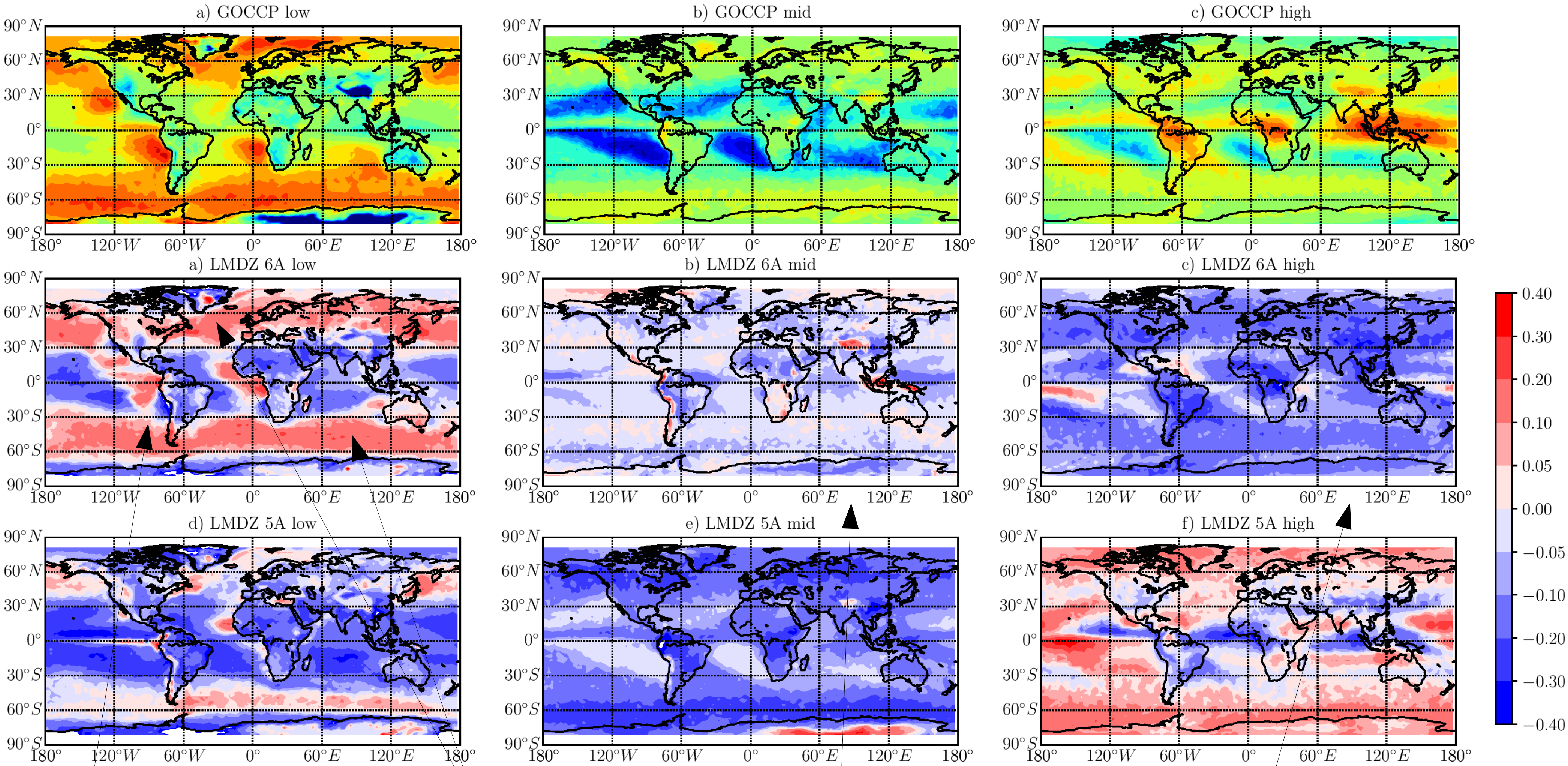
low-level clouds (p > 680 hPa, z < ~3 km),
mid-level clouds (680 hPa > p > 440 hPa, i.e. 3 < z < 6.5 km),
high-level clouds (p < 440 hPa, z > ~6.5 km)

Unified Parameterization of Convective Boundary Layer Transport and Clouds With the Thermal Plume Model

Frédéric Hourdin[1], Arnaud Jam[1], Catherine Rio[2], Fleur Couvreux[2], Irina Sandu[3], Marie-Pierre Lefebvre[2], Florent Brient[2], and Abderrahmane Idelkadi[1]



Biais couverture nuageuse



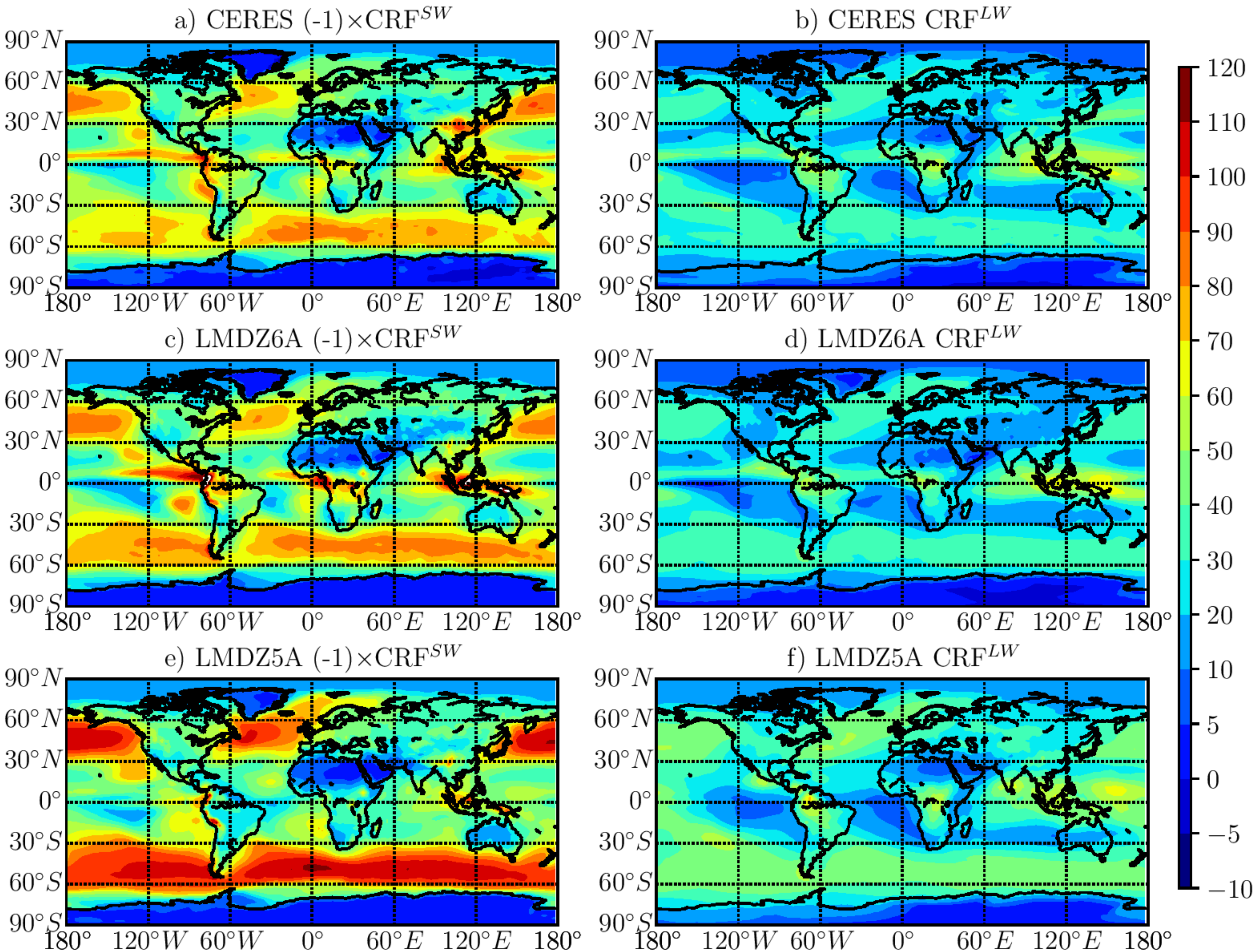
Décalage vers l’ouest

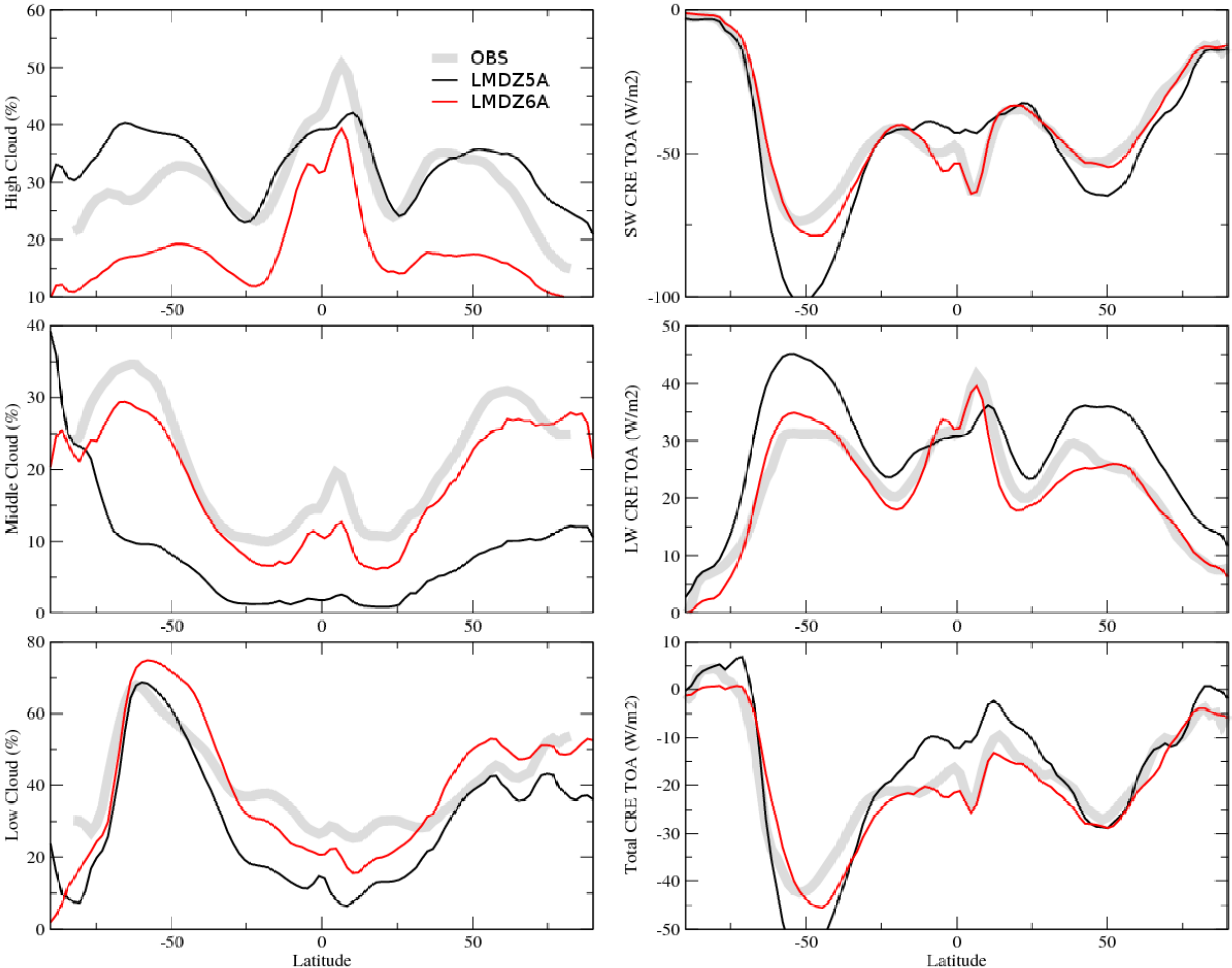
Biais + forts sur océan austral et arctique

Peu de biais

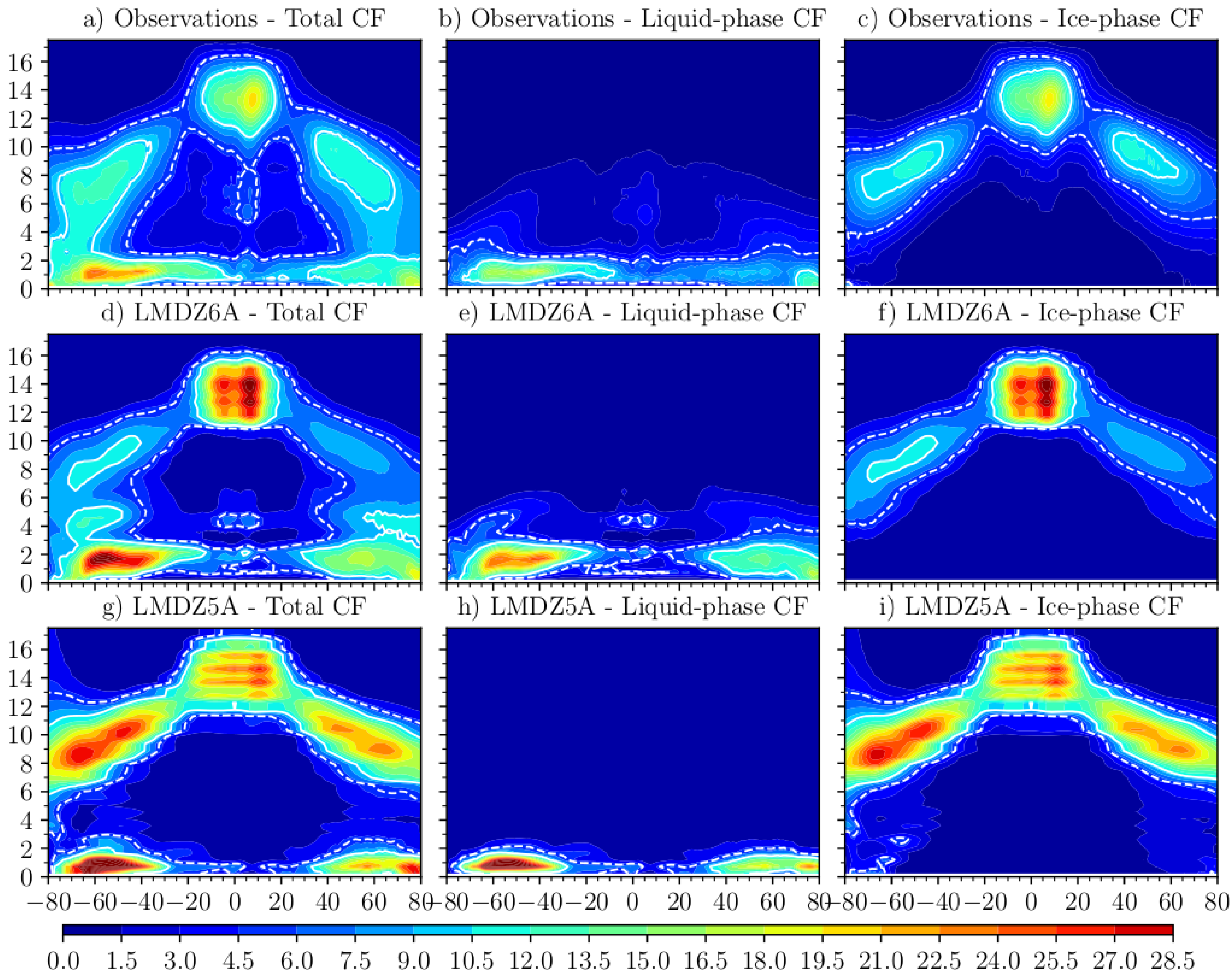
Biais partout mais bonne distribution

Cloud radiative effect



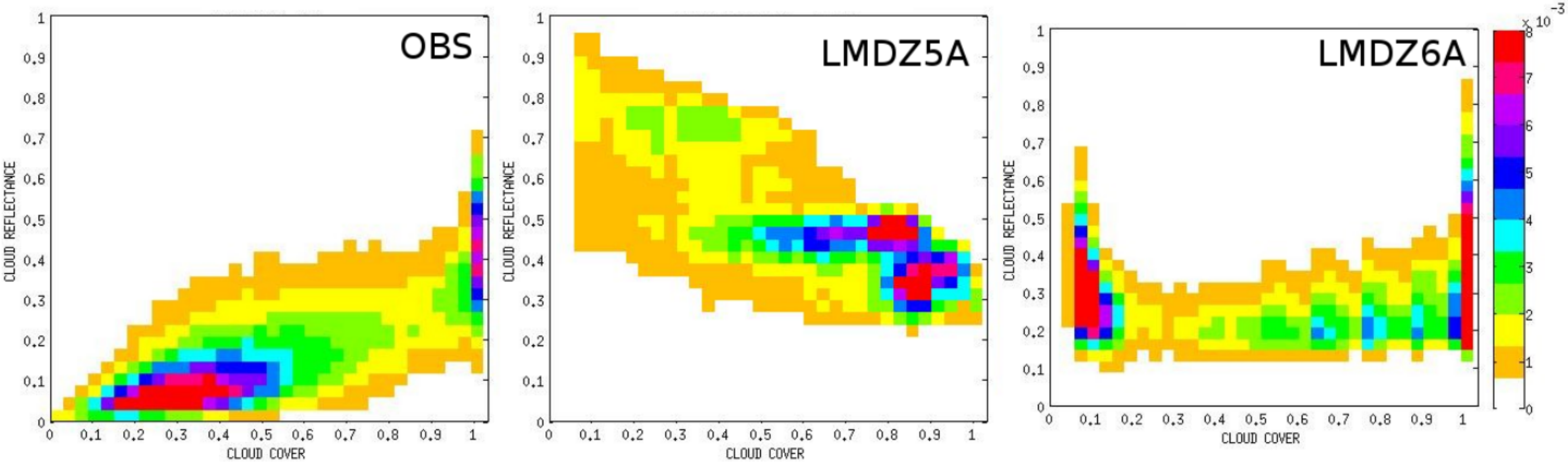


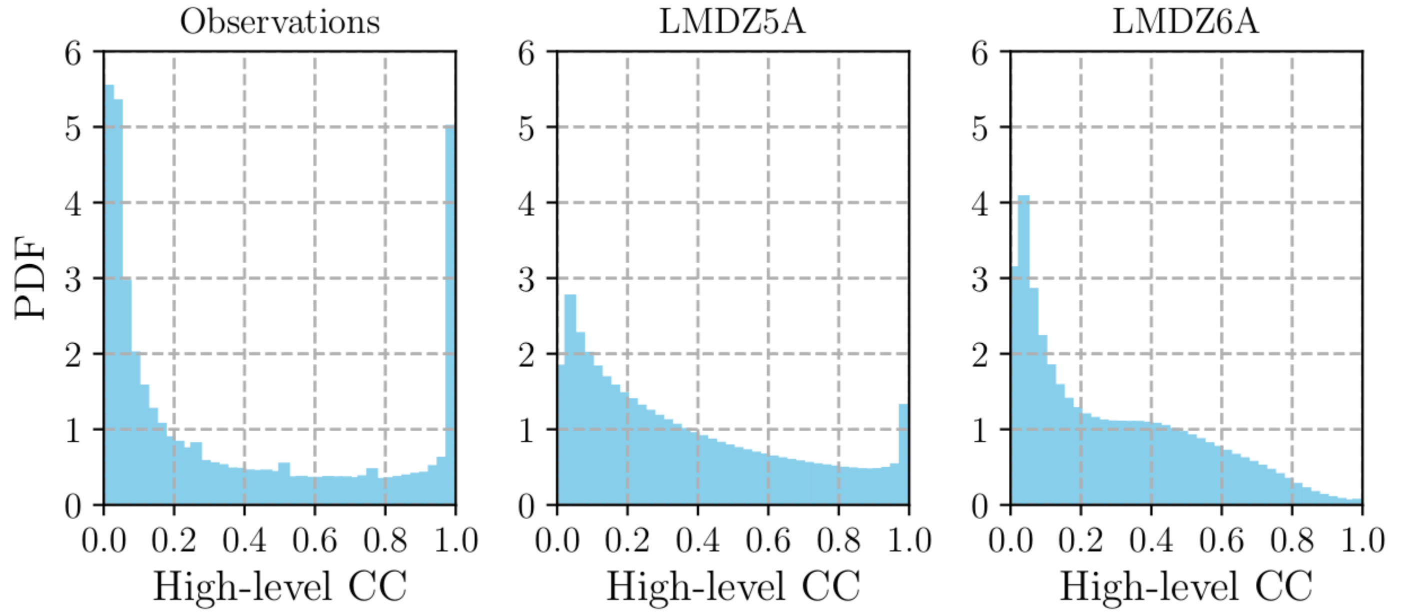
OBS
LMDZ5A
LMDZ6A
High Cloud (%)
Middle Cloud (%)
Low Cloud (%)
SW CRE TOA (W/m2)
LW CRE TOA (W/m2)
Total CRE TOA (W/m2)
Latitude
Latitude



a) Observations - Total CF
b) Observations - Liquid-phase CF
c) Observations - Ice-phase CF
d) LMDZ6A - Total CF
e) LMDZ6A - Liquid-phase CF
f) LMDZ6A - Ice-phase CF
g) LMDZ5A - Total CF
h) LMDZ5A - Liquid-phase CF
i) LMDZ5A - Ice-phase CF
0 2 4 6 8 10 12 14 16
−80 −60 −40 −20 0 20 40 60 80
0.0 1.5 3.0 4.5 6.0 7.5 9.0 10.5 12.0 13.5 15.0 16.5 18.0 19.5 21.0 22.5 24.0 25.5 27.0 28.5

Diagnostique Reflectance / Cover



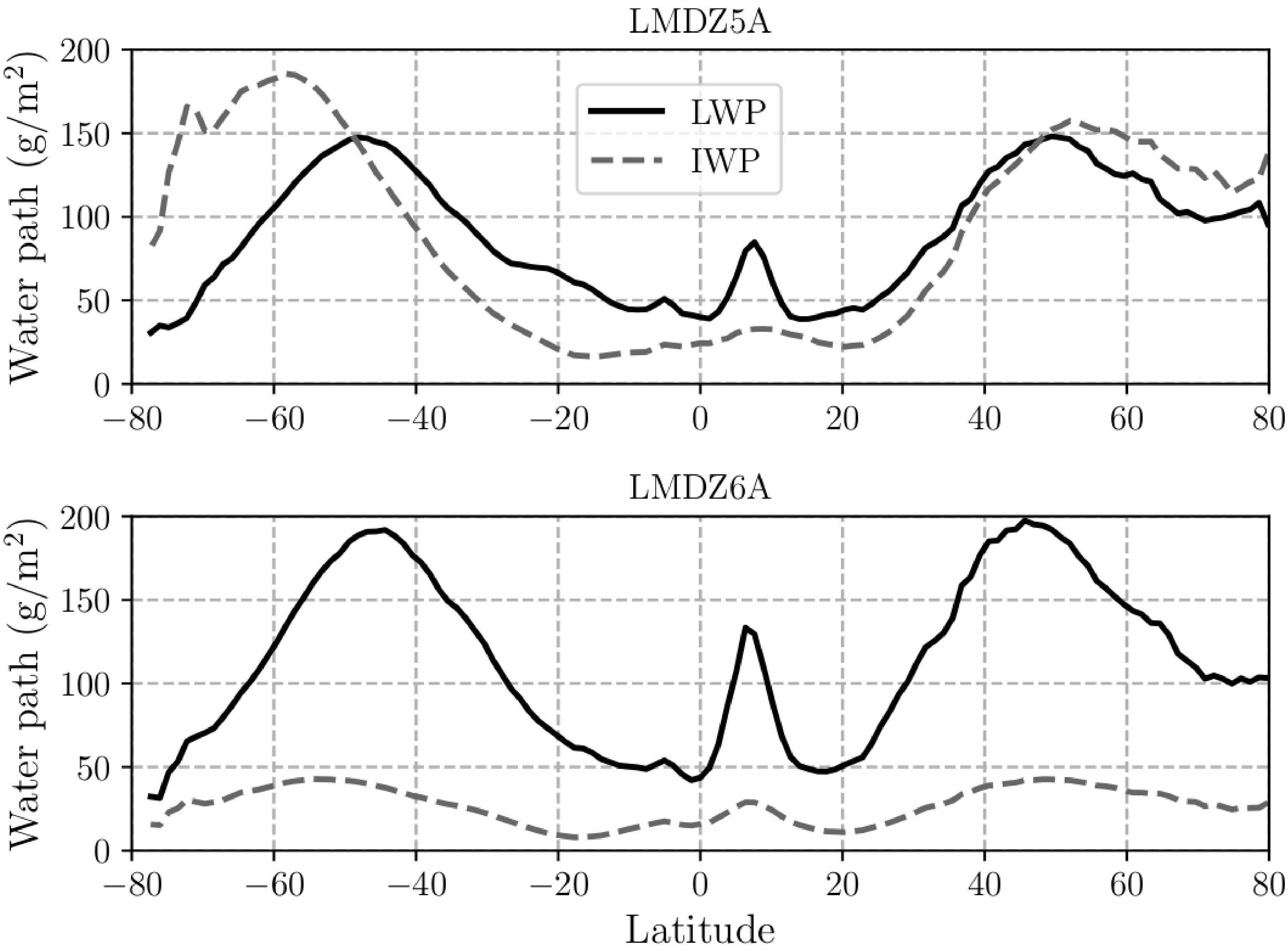


Que sera LMDZ7 ?

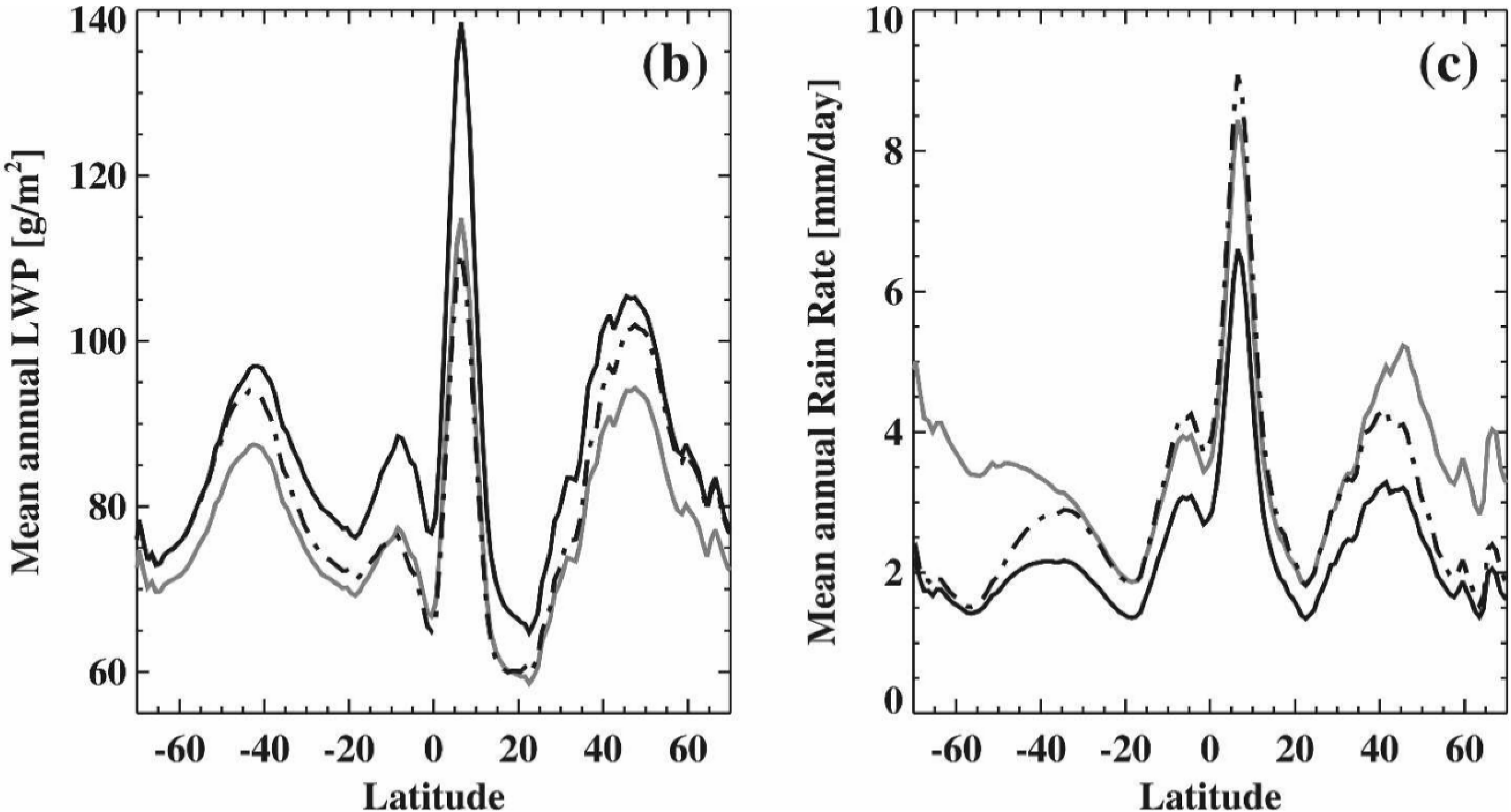
- Hypothèses de recouvrement, hétérogénéités sous-mailles
- PDF pour la grande échelle et « ratqs »
- Extension du « splitting »
- Représentation sous-maille de la phase mixte et microphysique froide
- Amélioration des précipitations liquides et solides
- Diagnostiques supplémentaires (par exemple LWP/IWP)

Backup slides

Liquid water path et ice water path



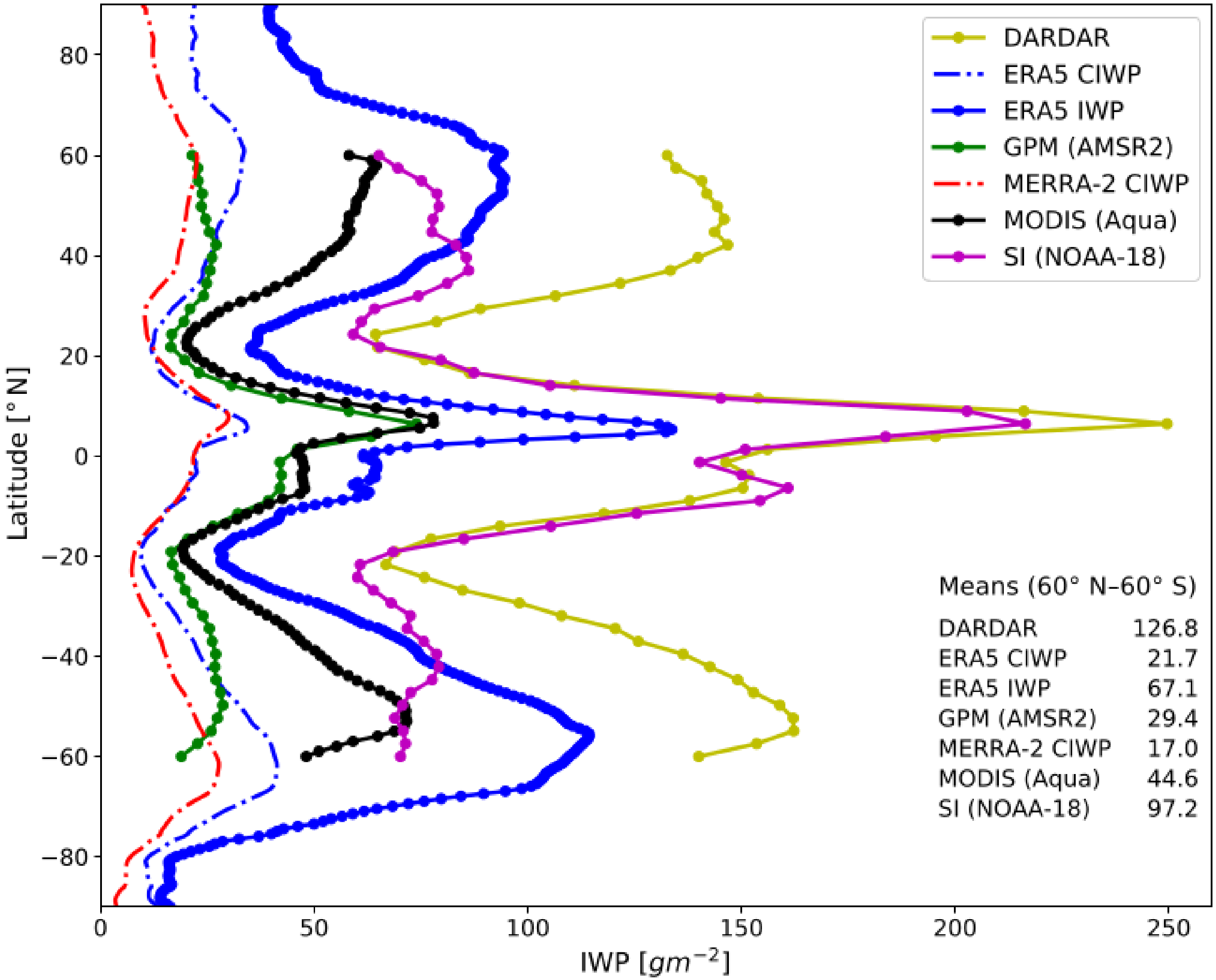
Odell_2008



text for details. (b) Zonal mean LWP from standard RSS algorithm as well as the two alternative assumptions; (c) as in (b) but for the zonal mean rain rate.

Figure 3. Zonal means of IWP, centred on A-Train daytime observations. 2015 is used for all data sets except for SI (2013). ERA5 zonal means are presented for both non-precipitating cloud ice (CIWP) and total ice (CIWP + SIWP = IWP) for a better comparison with MERRA-2 and the observations, respectively. The observational data sets are cut off at 60° latitude to mitigate relative sampling biases, with near-global mean values displayed.

duncan_2011



lwcon / iwcon

OK c’est confirmé, il y a + d’eau liquide sur la colonne et moins de gouttelettes dans les nuages bas