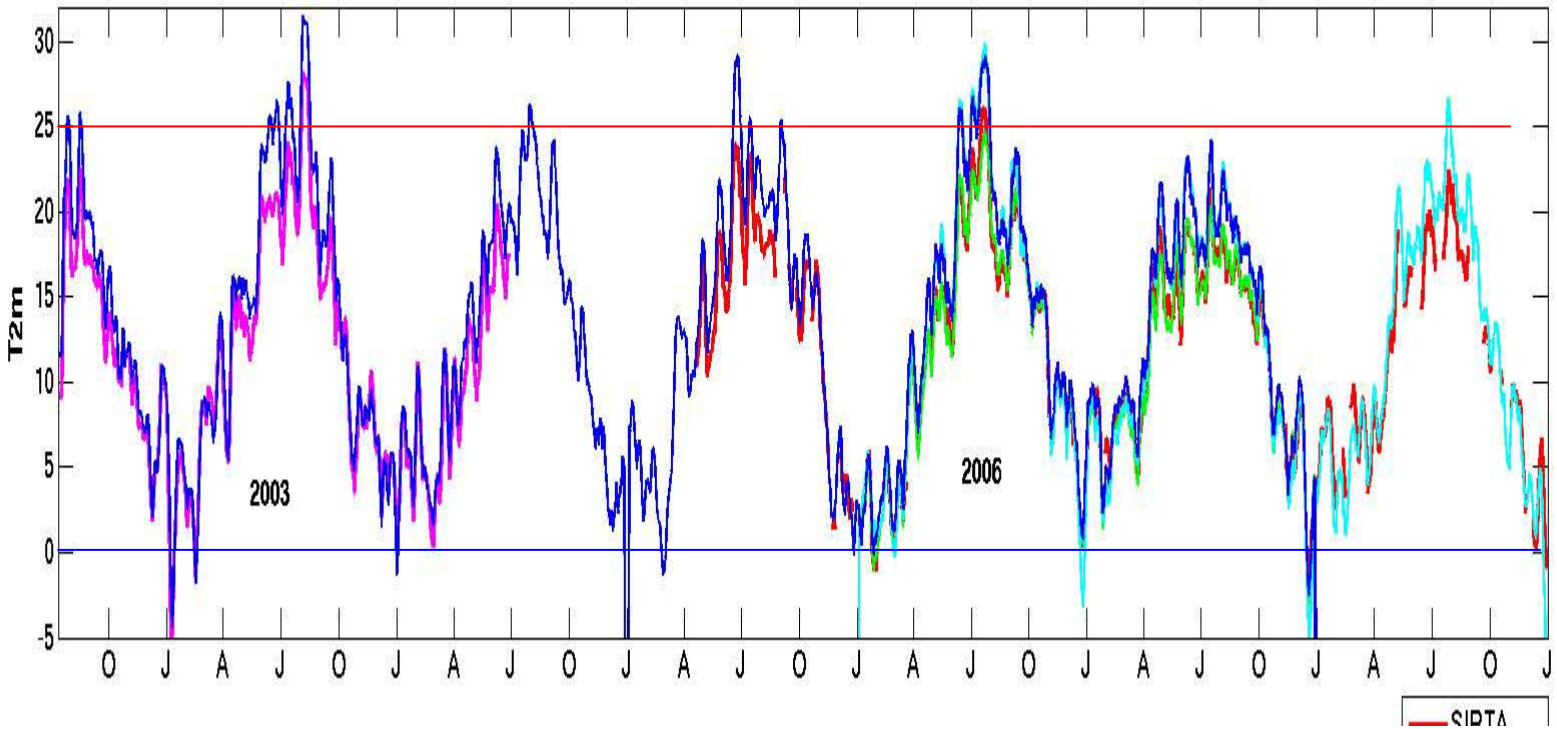
Evaluation of climate model with site data

F. Chéruy,
J.C. Dupont, F. Hourdin, M. Haeffelin,
A. Campoy



SIRTA Atmospheric Observatory

A French national experimental site dedicated to observation, research and education

Contribution to EUCLIPSE: The SIRTA Climate Testbed Dataset

M. Chiriaco, J-C Dupont, M. Haeffelin, L. Klenov

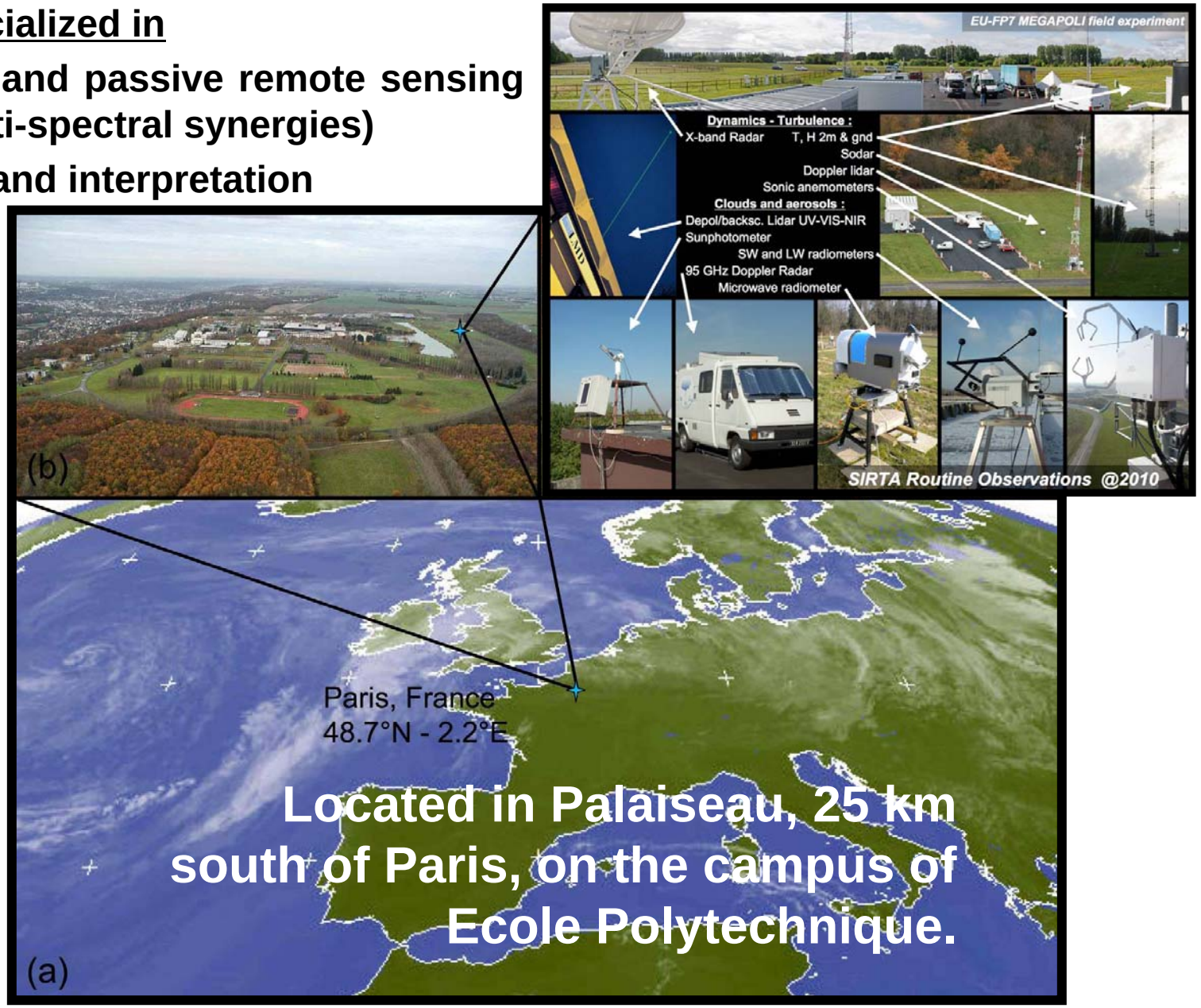
Institut Pierre Simon Laplace

SIRTA Observatory

➔ **SIRTA is specialized in**

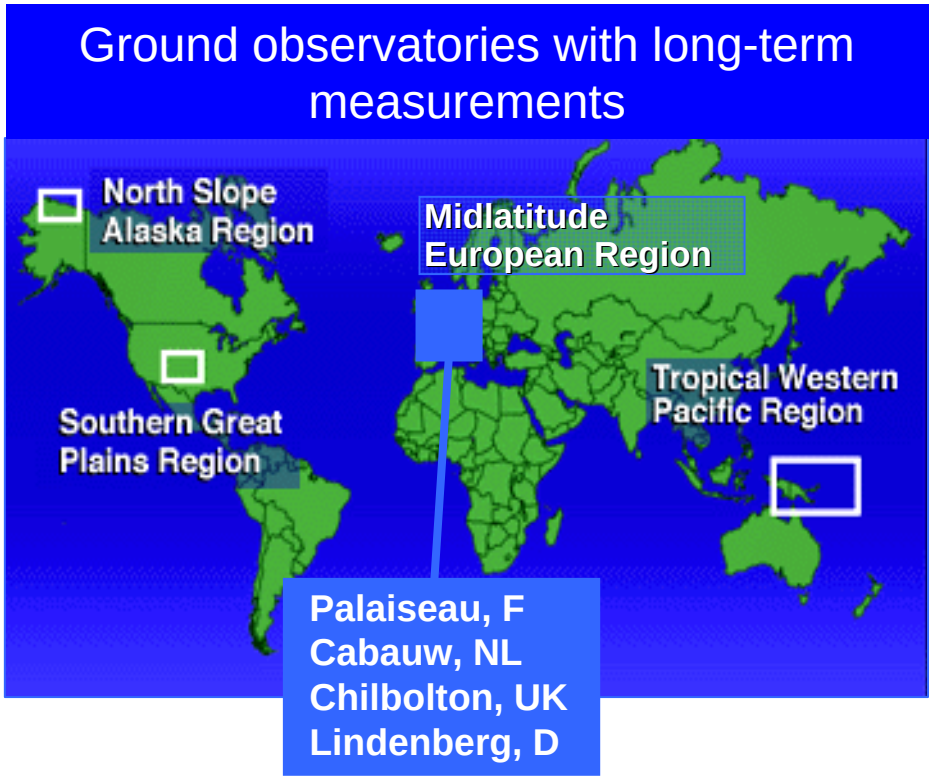
✓ **in-situ, active and passive remote sensing techniques (multi-spectral synergies)**

✓ **data analysis and interpretation**



Motivation for SIRTA Climate Testbed Dataset

Initial objectives observe the decanal variability of atmospheric properties, in order to better understand atmospheric processes and climate feedbacks



- ➢Synergy between different sensors is under-used
- ➢Statistical analysis is laborious
- ➢Large heterogeneity concerning: temporal resolution, level of quality control, formats, documentations…
- ➢Hard to use for scientists that are non-specialists of measurements

- Same approach as for the « ***ARM Climate Modeling Best Estimate Data*** » :

→Decanal synthesis of about 10 atmospheric parameters
→One entire netcdf file
→Homogeneous data hourly averaged
→Quality control ++

➔ Synthesis of observations is necessary

SCTD variables

Variable	*Instrument*	*Period*	*Network*	*Current status*
CLOUDS *Cld. fraction/Altitude*	ALS450 lidar(1)	2008-//		**Done**
	LNA Lidar(2)	2002-//		
	TSI440 sky-imager(3)	2008-//		
	Rad. flux analysis(4)	2003-//	BSRN	
	MSG(5)	2000-//	Meteosat	Fall-2010
AEROSOLS *Optical thickness*	Sun-photometer	2002-//	AERONET	**Done**
BOUNDARY LAYER - *Altitude*	LNA Lidar	2008-//		**In progress**
SURFACE WEATHER *In-Atmos./In-Ground measurement* *Precipitation*	In-situ	2005-// SIRTA 2000-// Paris area(6)	Météo-France	**In progress** Mid-2010
WATER VAPOR *Integrated water vapor* *+ liquid water content*	GPS	2007-// SIRTA	RPG-IGN	**In progress**
		2000-// Paris area(7)		Beg-2011
	Sun-photometer	2002-//	AERONET	**Done**
	µ-wave radiometer	2006-//		End-2010
RADIATIVE fluxes *SW/LW Down.* *SW/LW Up.*	Pyrano., pyrhelio., Pyrgeo.	2003-// SIRTA	BSRN	**In progress**
		2000-// Paris area(6)	Météo-France	Mid-2010
	Pyrano., Pyrgeo.	2007-//		**In progress**
TURBULENT heat fluxes Sensible and latent	3D Sonic anemometer	2005-//		Beg-2011
THERMODYNAMIC PROFILES Temp., humid., press., wind speed and dir.	Radiosonde	2000-//	Météo-France	End-2010
LIDAR Attenuated backscatter	ALS450 lidar(1) LNA Lidar(2)	2008-// 2002-//		**In progress**
RADAR Reflectivity	BASTA radar	2009-//	CloudNet	Beg-2011

(1) automatic mode
(2) semi-automatic mode during several hours during the day depending on weather conditions (the lidars do not operate when rain is present).
(3) calculation of cloud fraction distinguishing thin and opaque clouds if necessary, (4) calculation of cloud fraction based on retrievals by Long et al. (2006).
(5) zoom on SIRTA site inside a box of 4x4 km, (6) surface Meteo-France stations located 150km around SIRTA site
(7) surface IGN stations located 150km around SIRTA site

Contribution to EUCLIPSE

ALGORITHM issues and actions: CFMIP diagnostic 2-D fields

Surface weather parameters: available

Radiative fluxes:

- available BSRN for surface;

- KNMI to extract MISR and GERB data over SIRTA and Cabauw

Total cloud fraction (Total cloud area):

- Cloud Fraction Best Estimate combining cloud imaging, radiative flux analysis and Lidar

- IPSL extracts MSG Nowcasting SAF cloud fraction and cloud type at 15min and 5km resolution over Europe

Water vapor path:

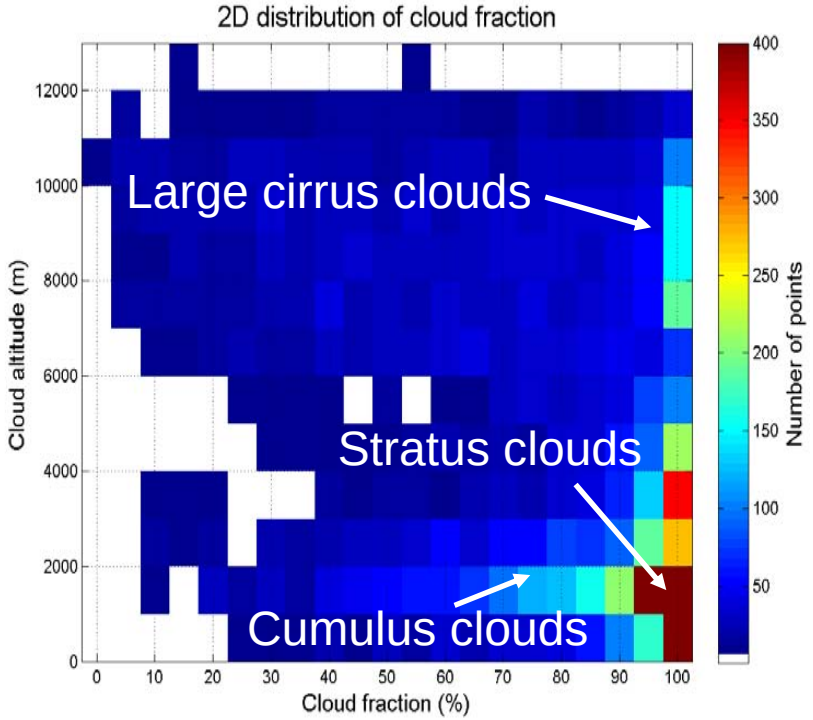
- Composite: from GPS + RS + MWR

- Currently under study at IPSL

Surface fluxes: under study using closure of surface heat balance

Contribution to EUCLIPSE

ALGORITHM issues and actions: CFMIP diagnostic 2-D fields

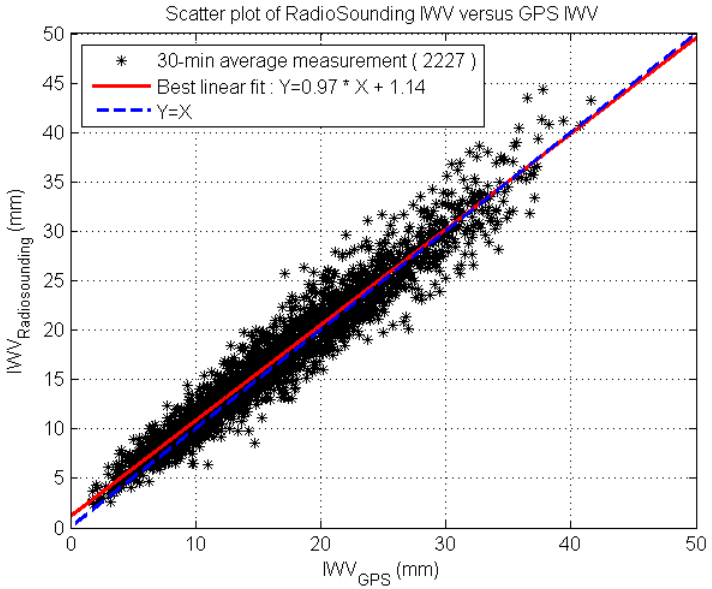


Cloud fraction best estimate yields area cloud fraction + cloud based altitude (Lidar)

Problem: Cloud cover is highly dependent on instrument used (instrument sensitivity, profiling or not, …)

Water vapor path can be retrieved from many different instruments

Problem: which one is the reference GPS, RS, MWR? Depends on community. Inter-comparisons in progress.



Contribution to EUCLIPSE

ALGORITHM issues and actions: CFMIP diagnostic 3-D fields (vertical profiles)

Weather parameters: PTUV available from radiosondes

3-D cloud fraction:

- CloudNet algorithm using Lidar, Radar, Microwave Radiometer implemented for Cabauw and SIRTA (but radar measurements discontinuous at SIRTA)

Lidar and Radar observables:

-IPSL to introduce ground-based lidar and radar simulators in CMIP-5 models

- IPSL to transfer STRAT Lidar algorithm to KNMI

Other parameters not currently planned:

- Radiative flux profiles

- Liquid and ice water profiles

Contribution to EUCLIPSE

DATABASE issues and actions:

****Regional variability:** Representation of spatial variability inside model grid box area

- Retain the site value measurements (SIRTA, Cabauw)
- Add uncertainty bars from regional measurements (e.g. Meteo-France stations around SIRTA)

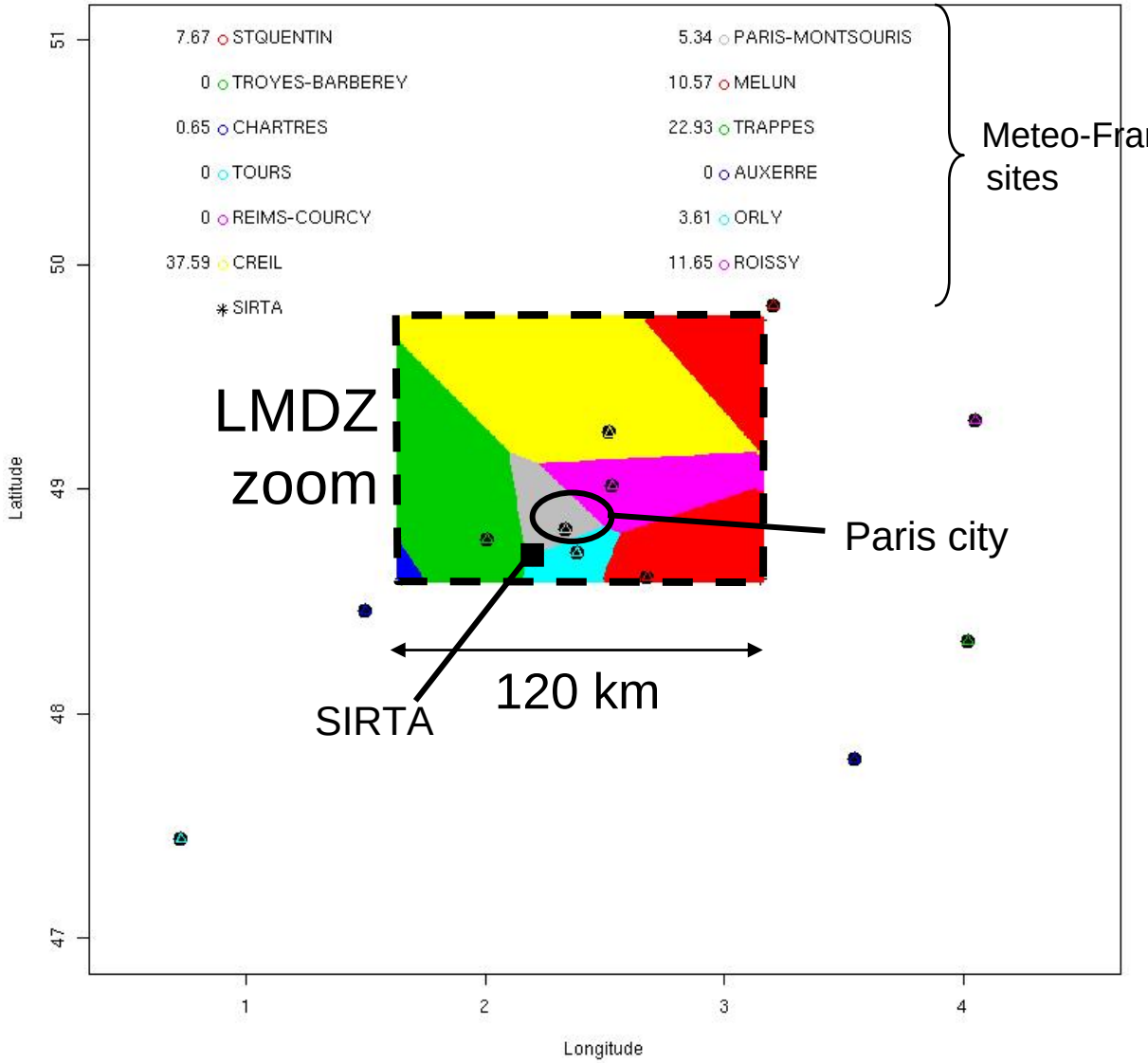
****Temporal resolution:**

- Model = instantaneous every 30 min or 1hr.
- Observations: average all measurements over 1 hr

****File Format:**

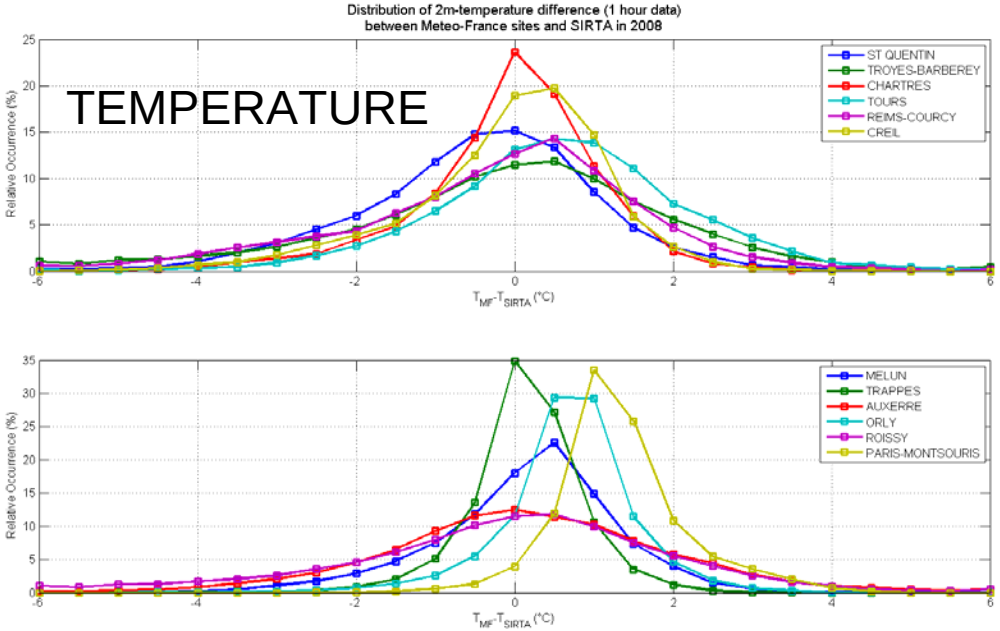
- Use NetCDF format
- Variable names: use both ARM CMBE and CMIP-5
- Naming convention: use CF compliant (climate and forecast conventions)

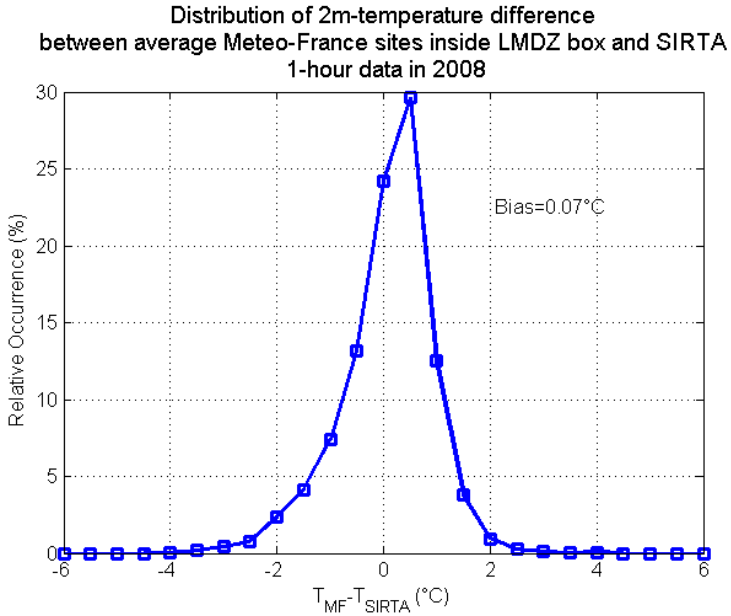
DATABASE issues and actions: *representativity of SIRTA at regional scale*

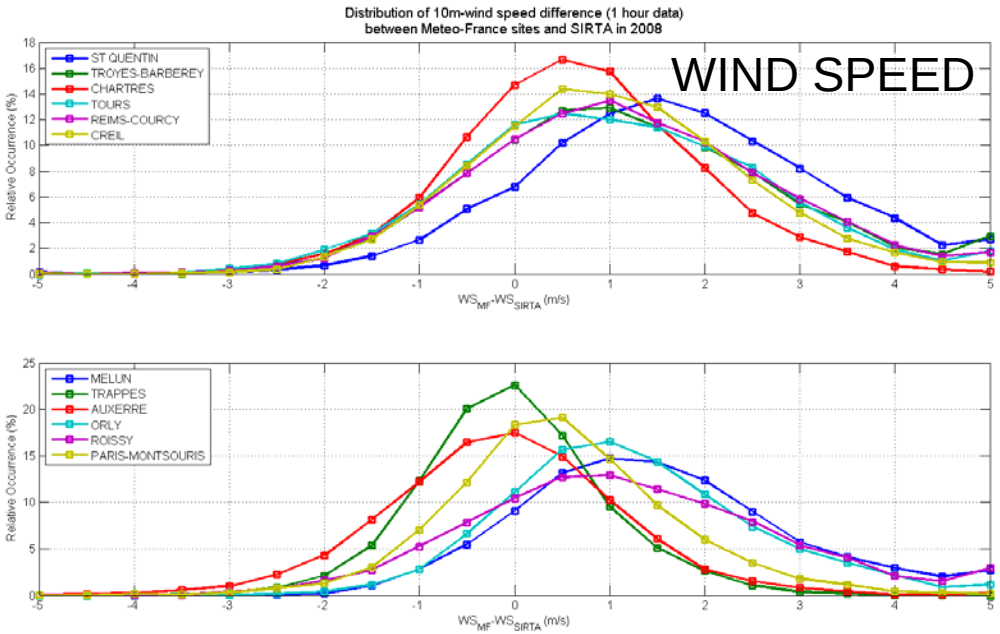


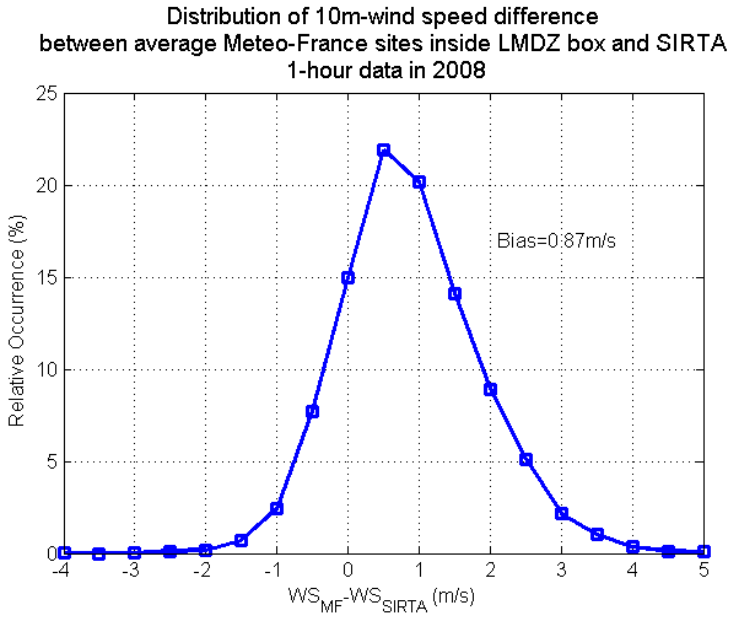
Dephy
A. Campoy

DATABASE issues and actions: *representativity of SIRTA at regional scale*









Conclusions

Joint action for IPSL/KNMI: first develop a focused dataset (a few parameters) geared towards CMIP-5 by the end of 2010

EUCLIPSE is a good opportunity:

- For application of SIRTA Climate Testbed Dataset

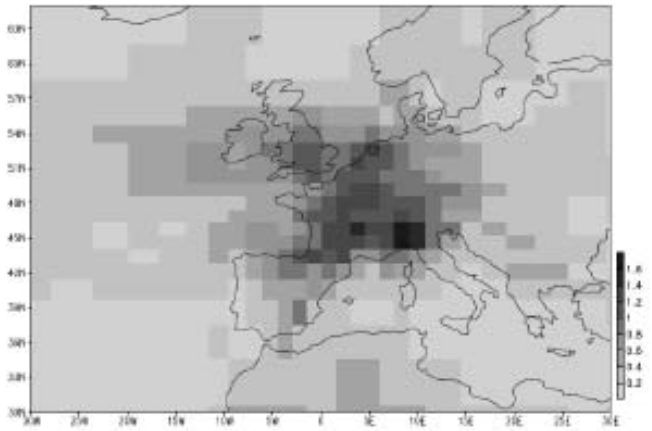
- For collaboration between KNMI and IPSL (KPT, LMDZ, Cabauw, SIRTA)

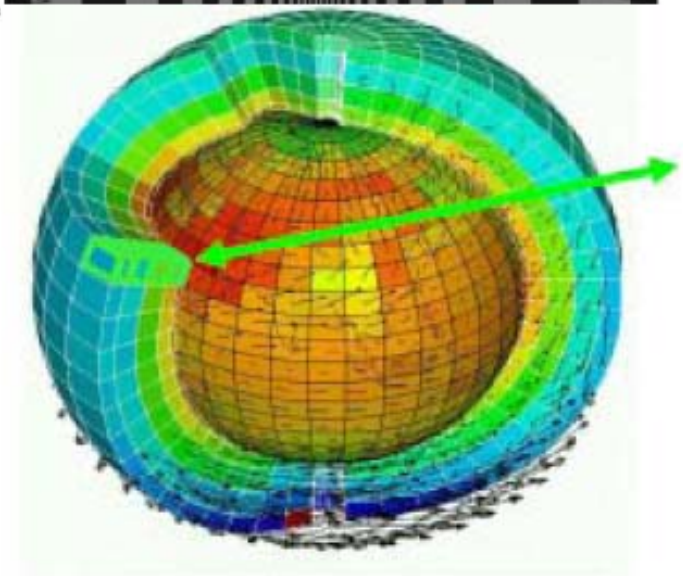
LMDZ Physical parameterization evolution

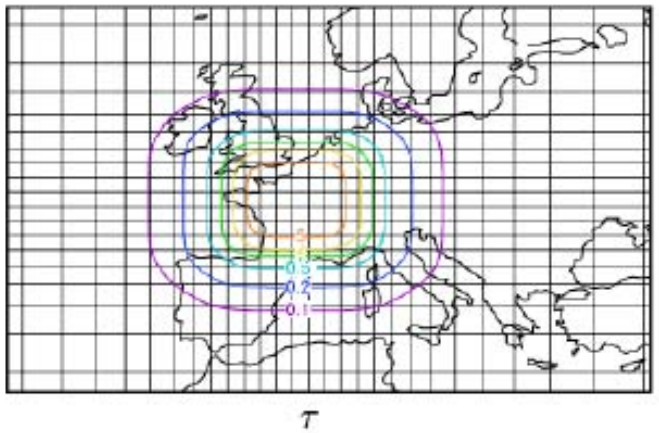
	LMD	IPCC/AR4	Nouvelle physique IPCC/AR5?	
Atmosphere	Couche limite	Diffusion turbulente + Contre gradient (Louis/Laval)	Diffusion turbulente (Mellor et Yamada) + Schéma en flux de masse couche limite convective (modèle du thermique)	Rio and hourdin, 2006
Atmosphere	Convection	Schéma en flux de masse d'Emanuel. Fermeture CAPE	Schéma d'Emanuel modifié. Fermeture ALE/ALP Couplé au modèle du thermique. + poches froides	Grandpeix and Lafore 2010 Grandpeix, Lafore,Cheruy 2010
Continental surfaces	Surface	Modèle Sechiba à 2 couches	Modèle Sechiba à 11 couches (Patricia de Rosnay)	

+ new cloud scheme A. JAM

LMDZ nudged and zoomed over SIRTA



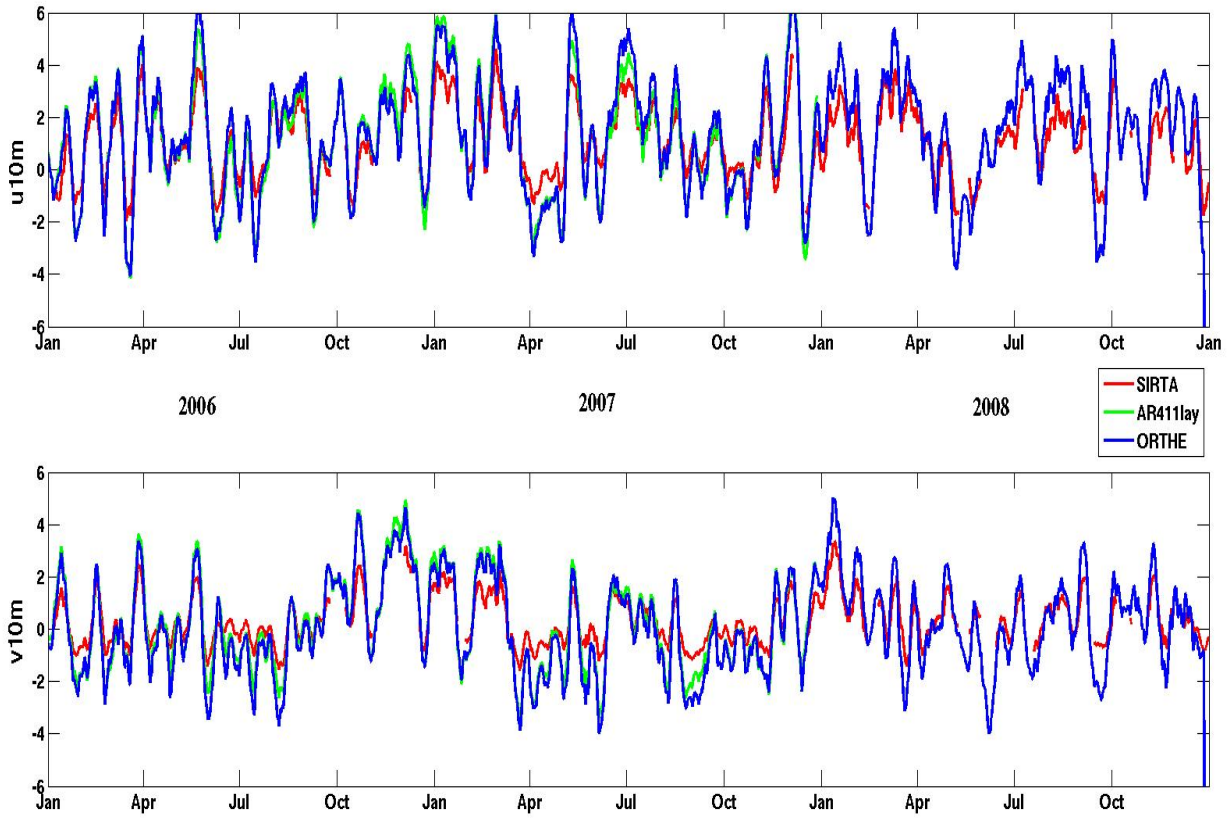




$$\frac{\partial X}{\partial t} = F(X) + \frac{X^a - X}{\tau}$$

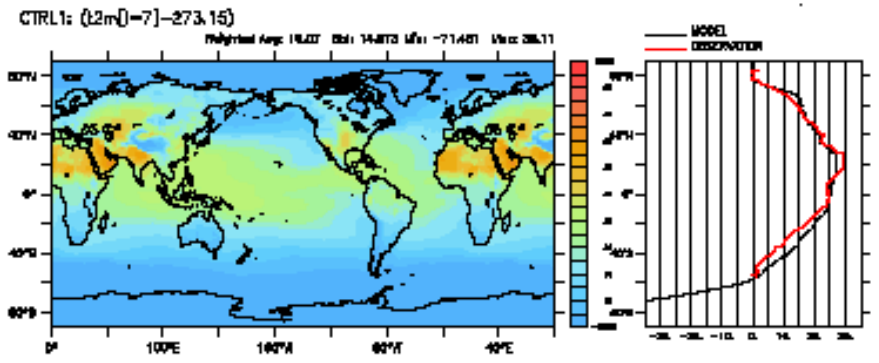
Coindreau et al., 2006
Assessment of physical parameterizations using a global climate model with strechable grid and nudging.

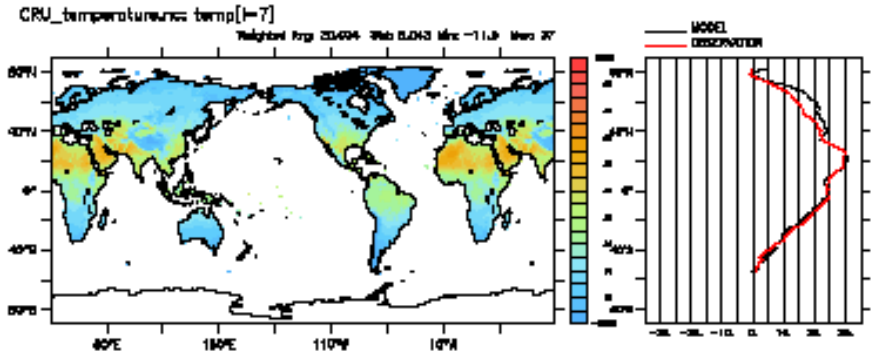
The nudging allows consistency with the local meteorology

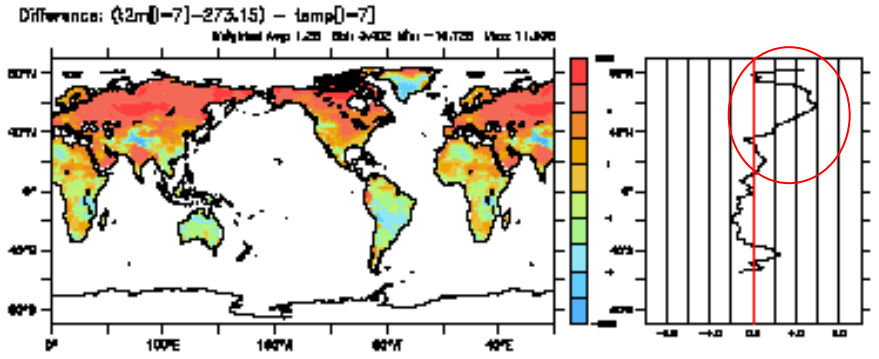


Over-estimation of extrema:
Roughness length at SIRTA probably higher than model

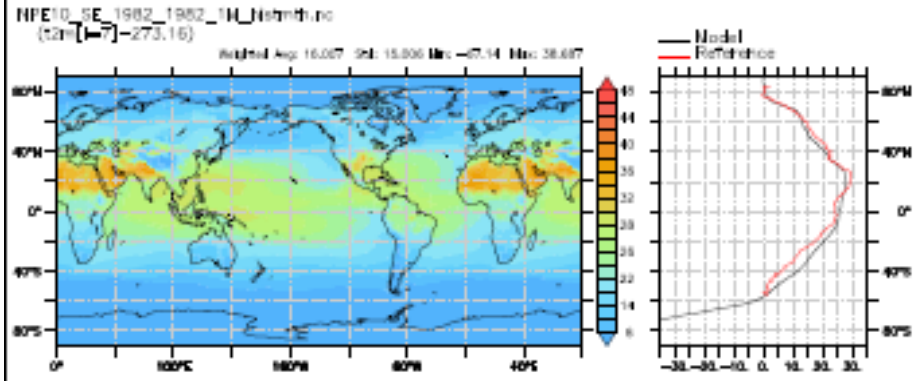
T2m (C): LMDZ4, CRU, (LMDZ4 – CRU)

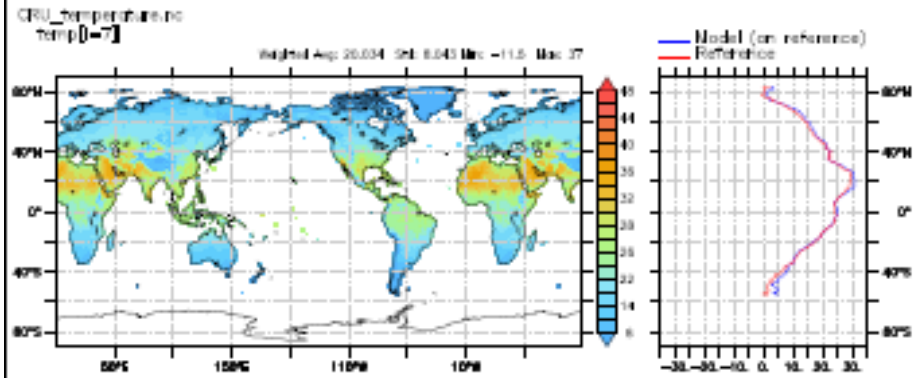


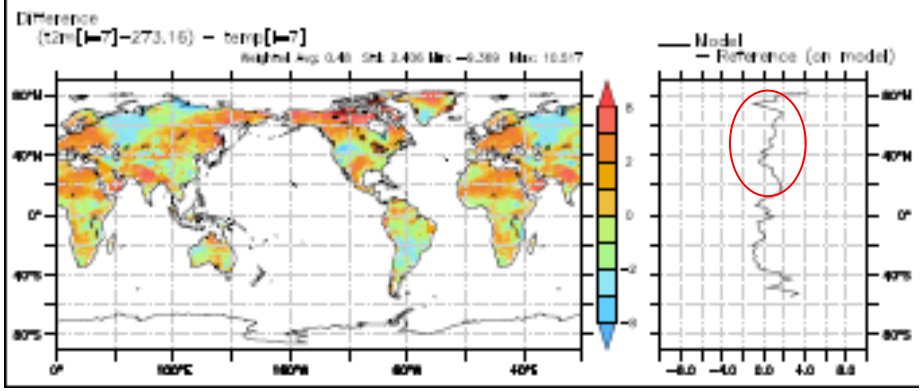


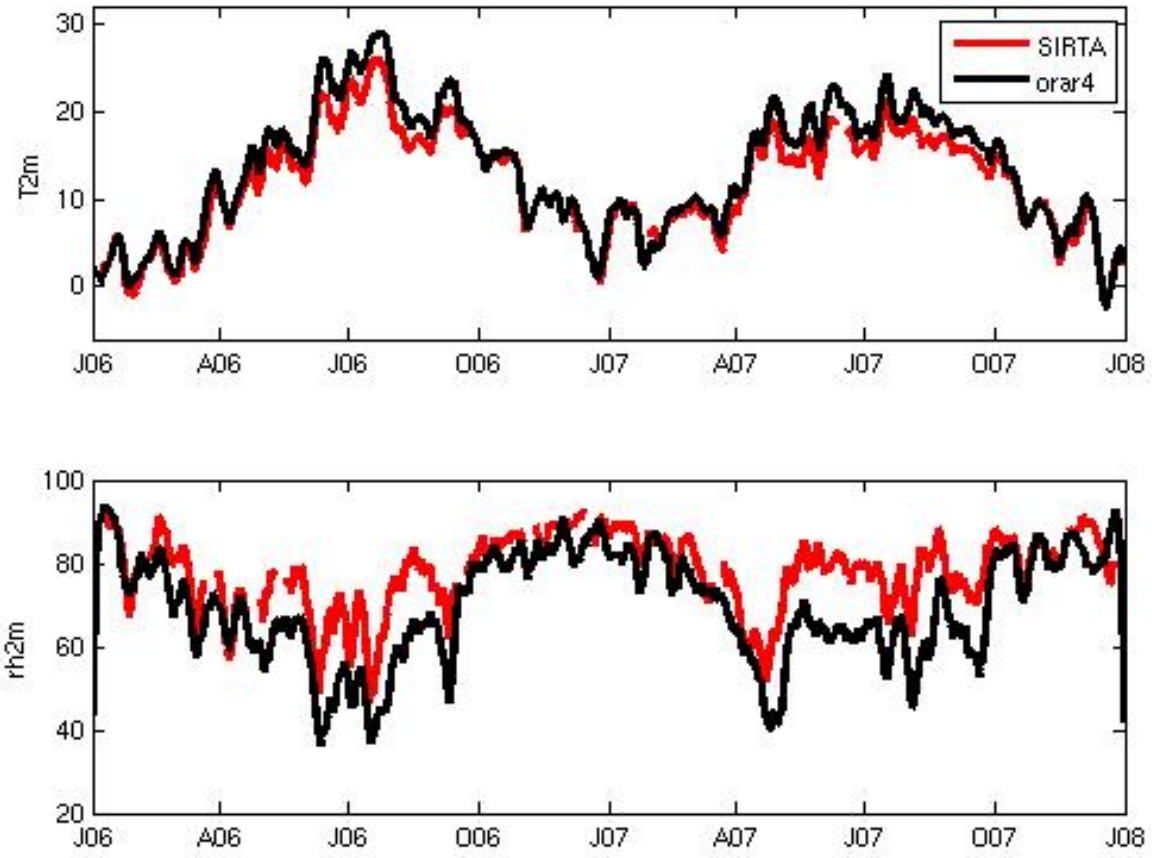


T2m (C): LMDZ4, CRU








SIRTA
orar4
T2m
30
20
10
0
J06
A06
J06
O06
J07
A07
J07
O07
J08
rh2m
100
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J06
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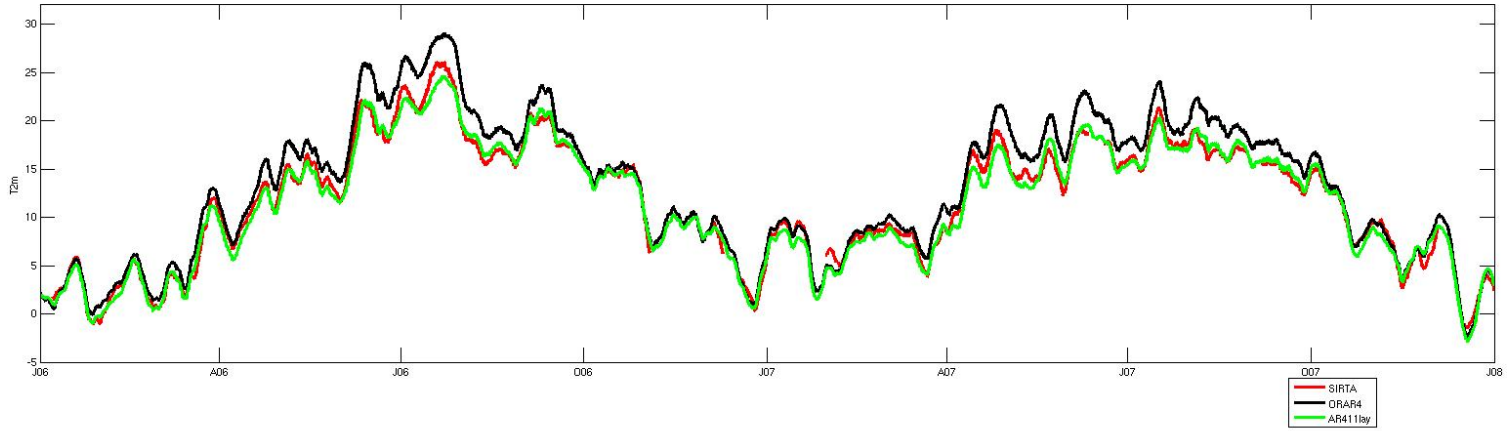
A07
J07
O07
J08


T2m
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SIRTA
ORAR4
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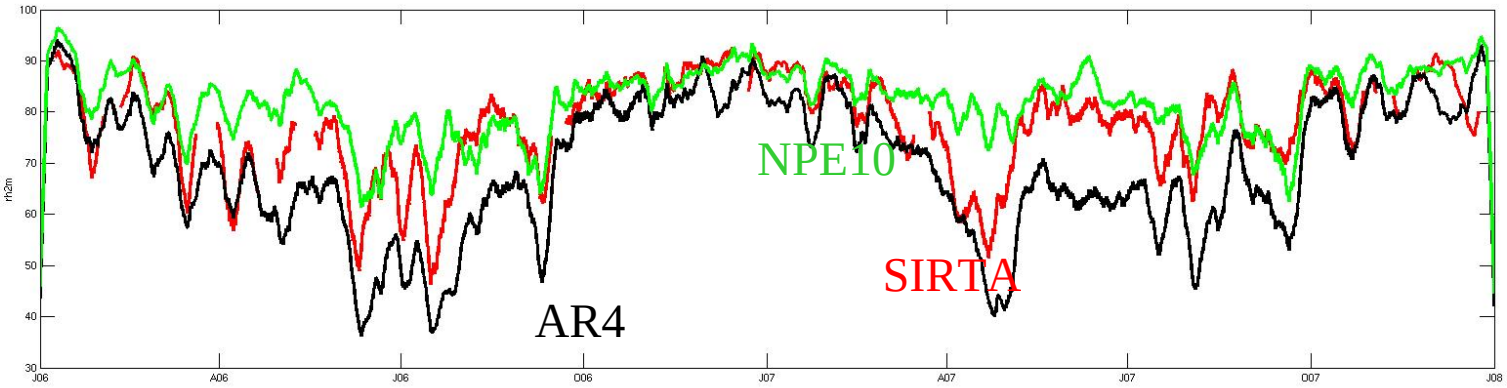
rh2m
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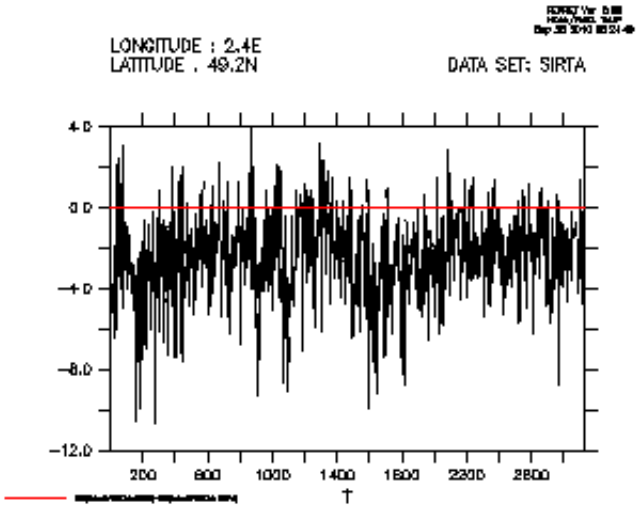
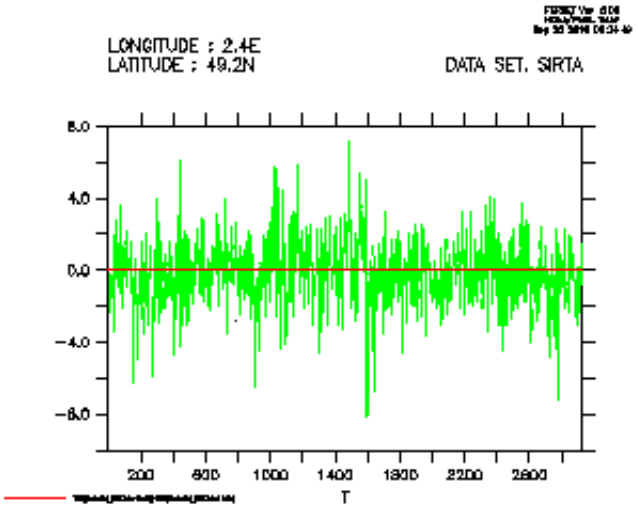
SIRTA
AR4

2007

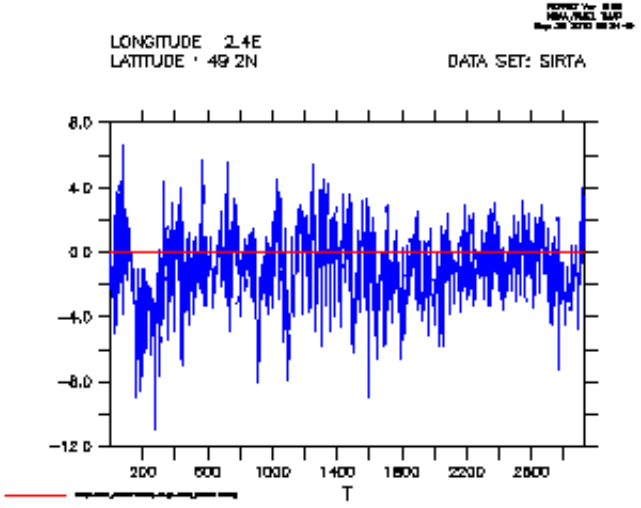
2008



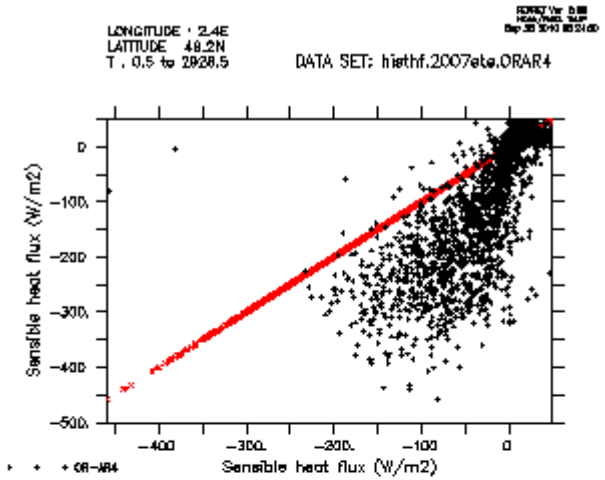
'ORAR4'



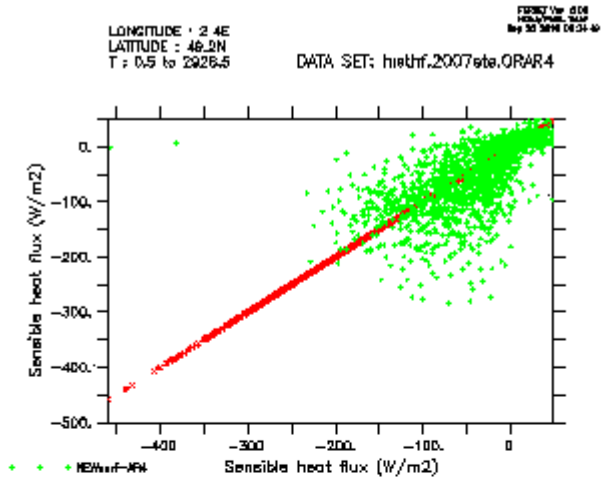
'newsurf−AR4'



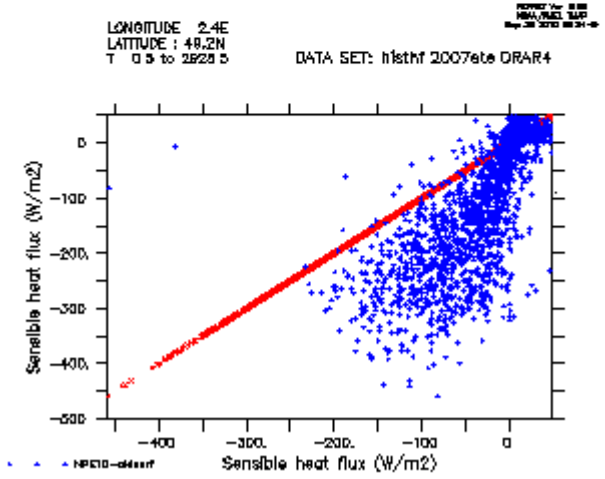
'NEWPHY−oldsurf'



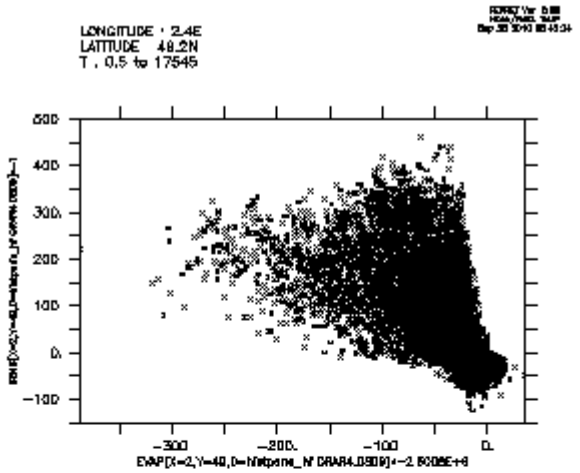
'SIRTA vs LMDZ'



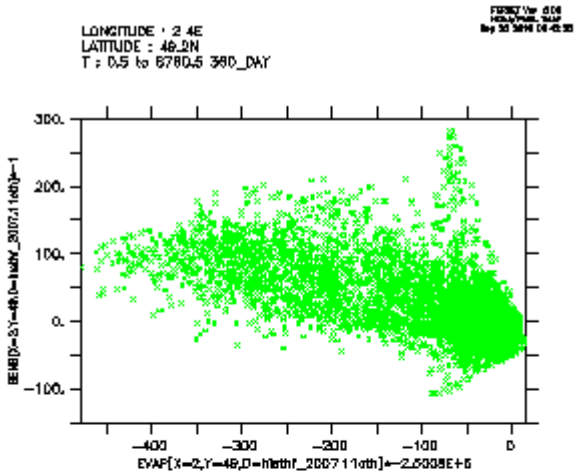
'SIRTA vs LMDZ'



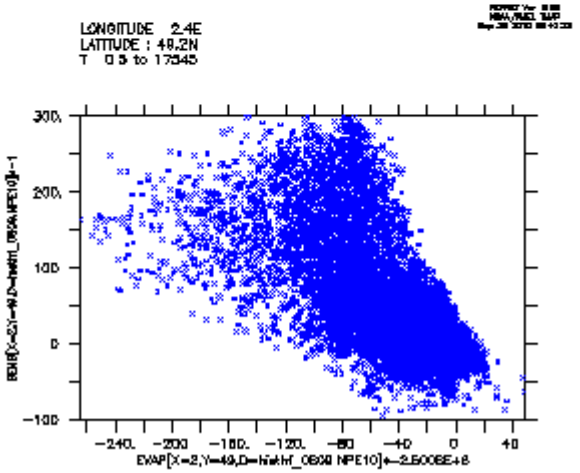
'SIRTA vs LMDZ'



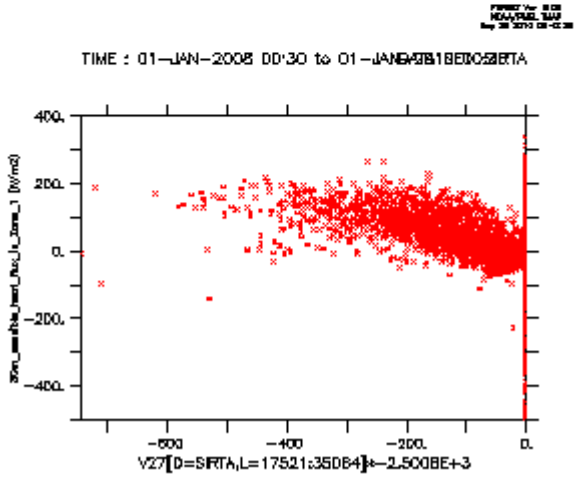
OR−AR4 sens/lat



newsurf−AR4 sens/lat



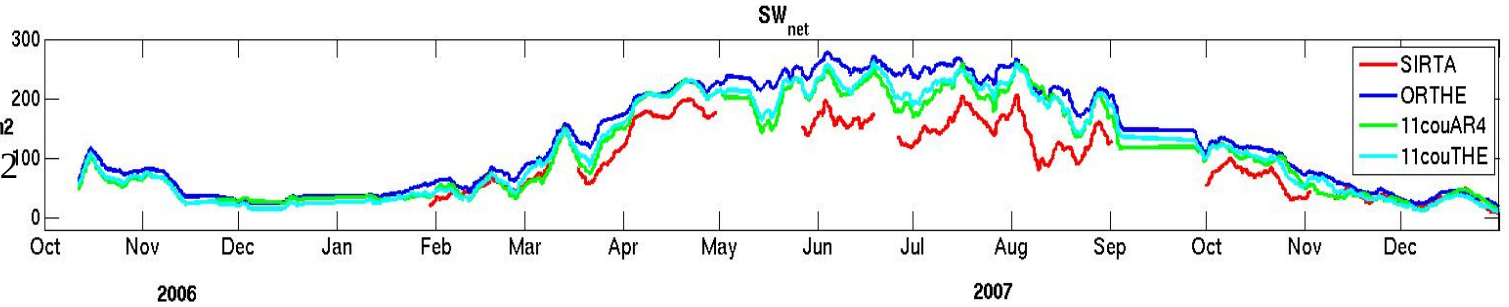
NPE10 sens/lat



SIRTA LAt/sens V2

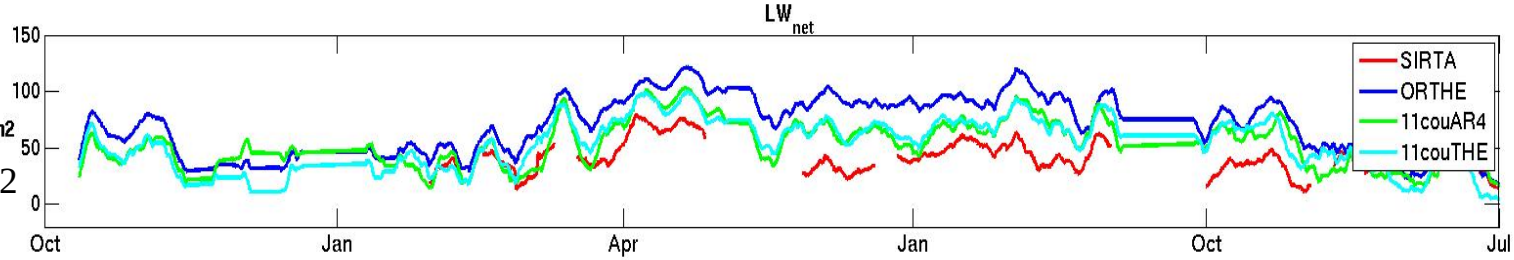
SW W/m2

50 to 100 W/m2



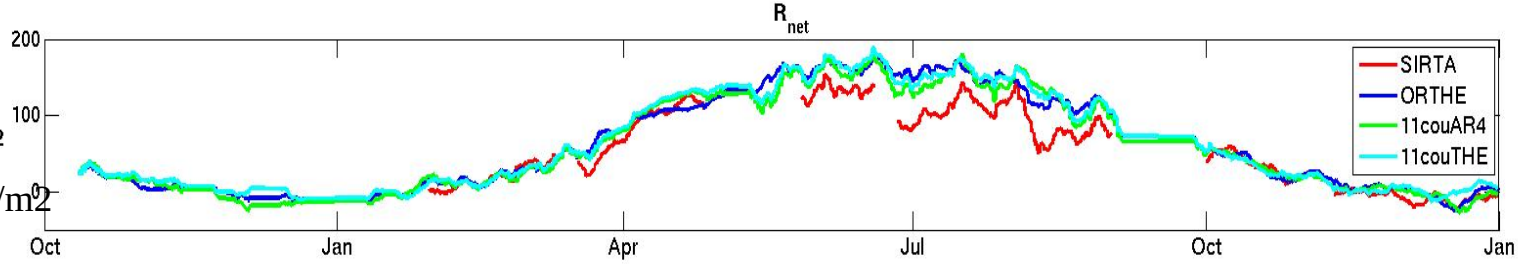
LW W/m2

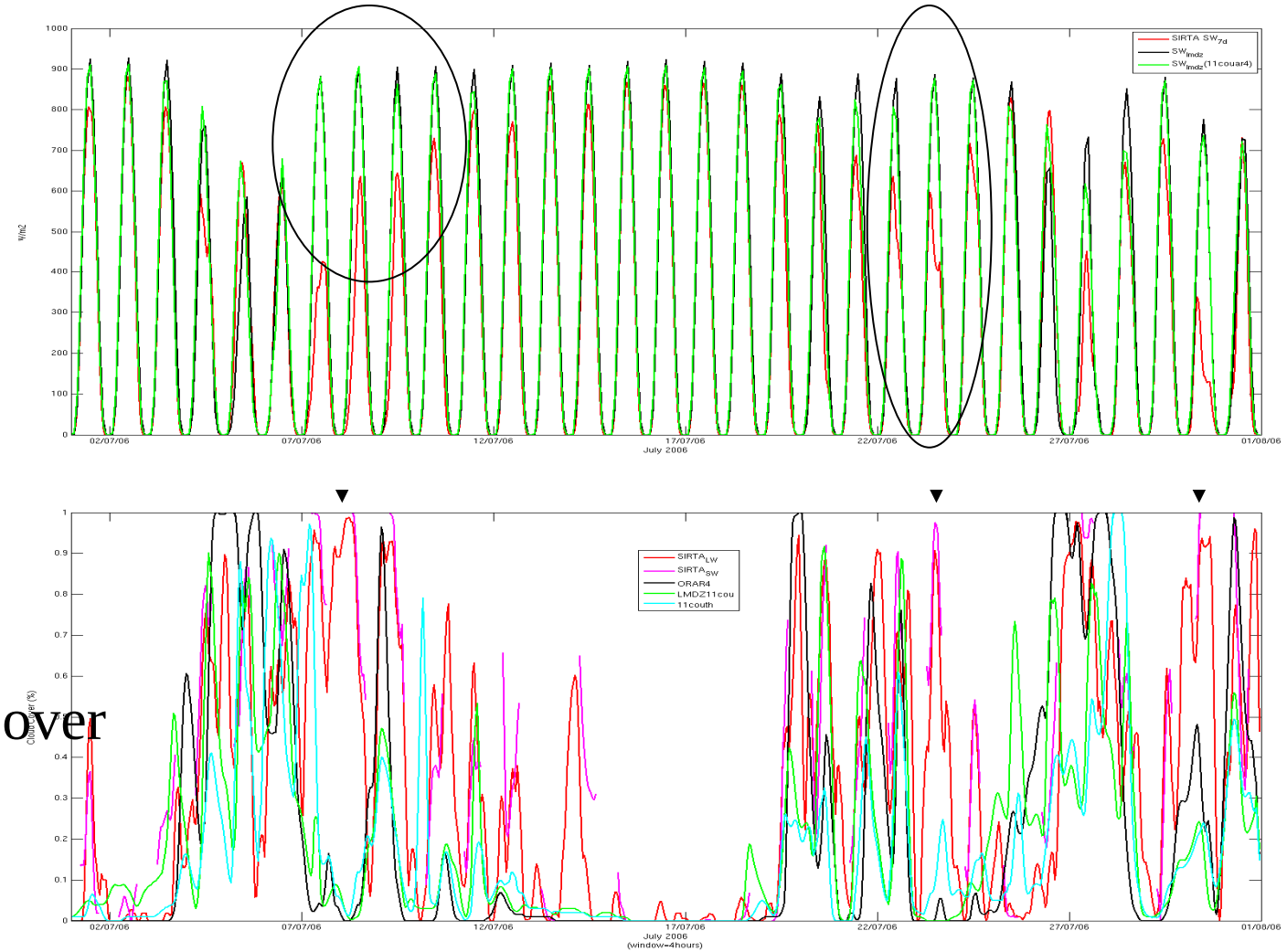
20 to 50 W/m2



NET W/m2

20 to 70 W/m2



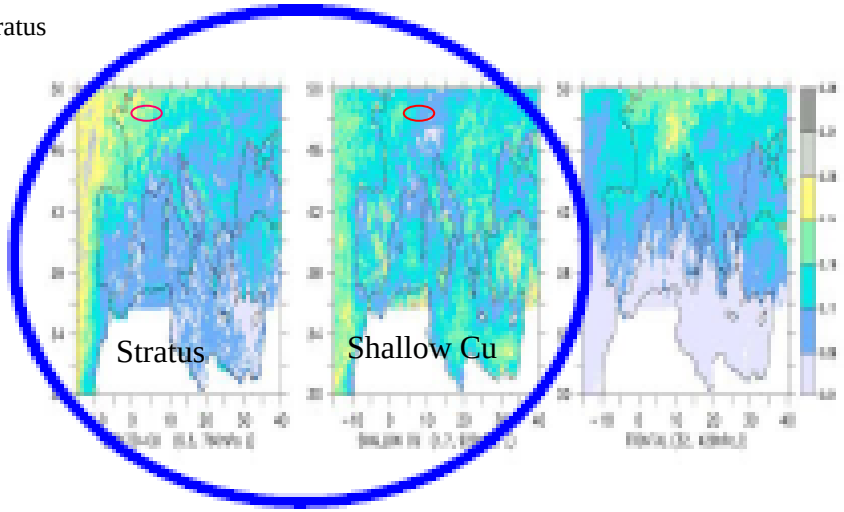


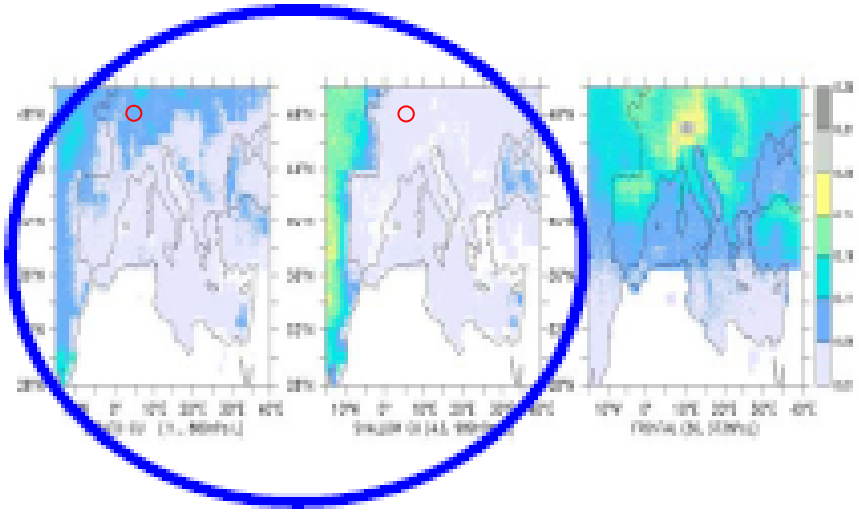
Cld Cover

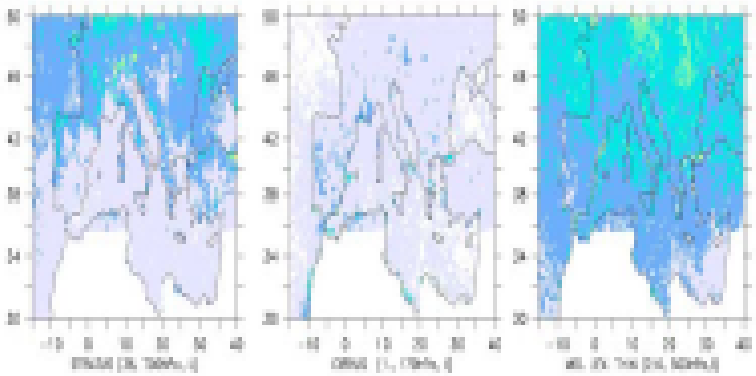
July 2007

Cluster analysis of clouds properties over the southern European mediterranean area in observations and in a model

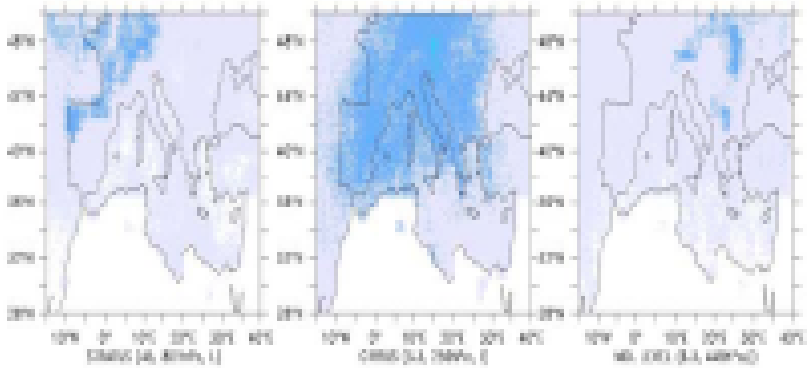
stratus





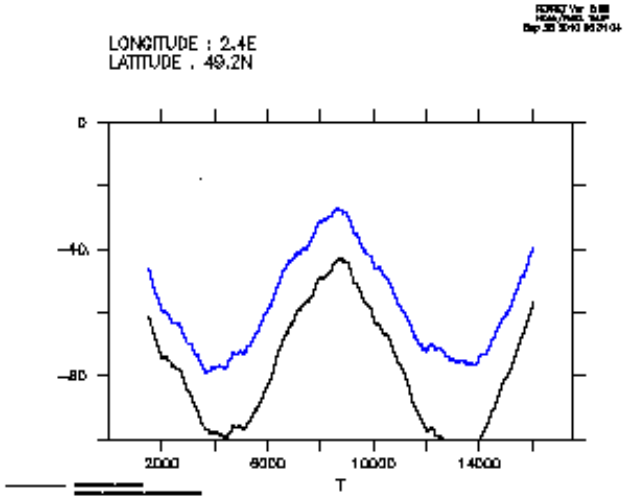


ISCCP-DX

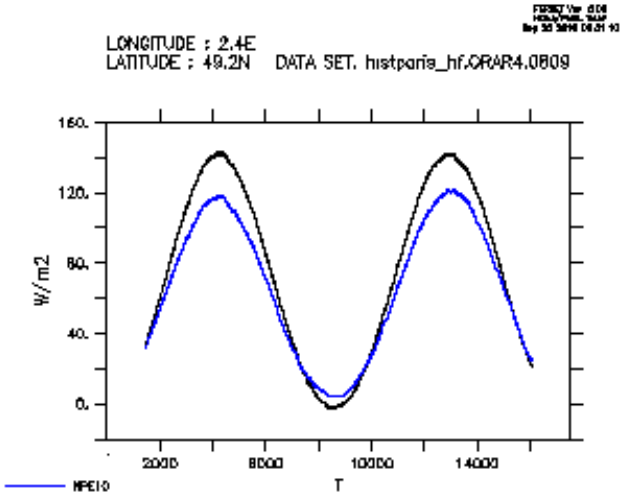


LMDZ (zoomed,nudged)

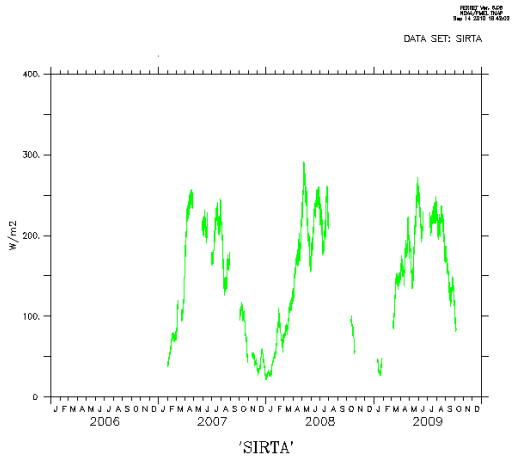
Cherry and Aires, MWR 2009



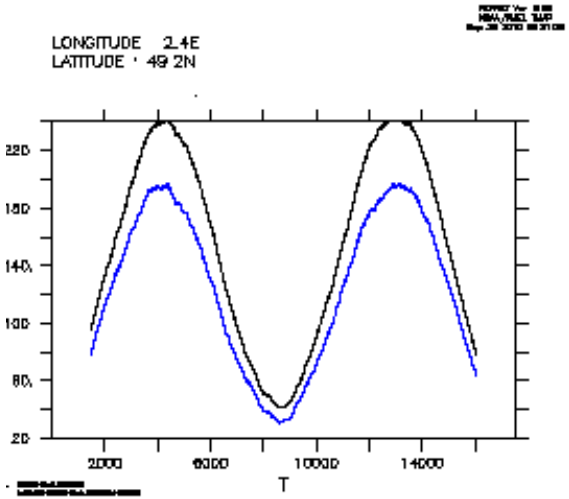
LWSFCNET



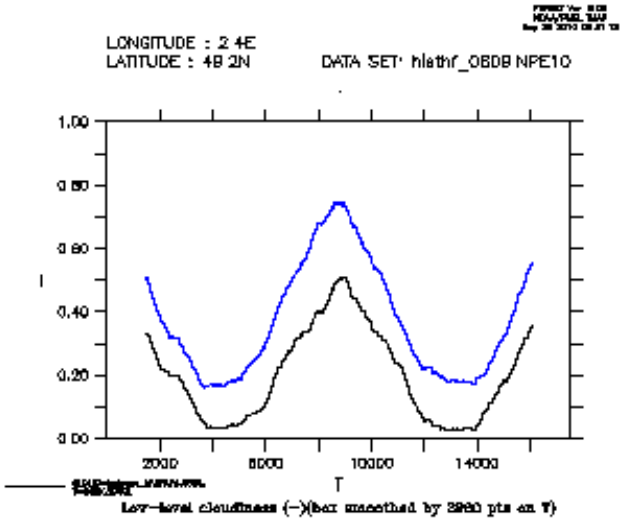
ORAR4 NET



'SIRTA'



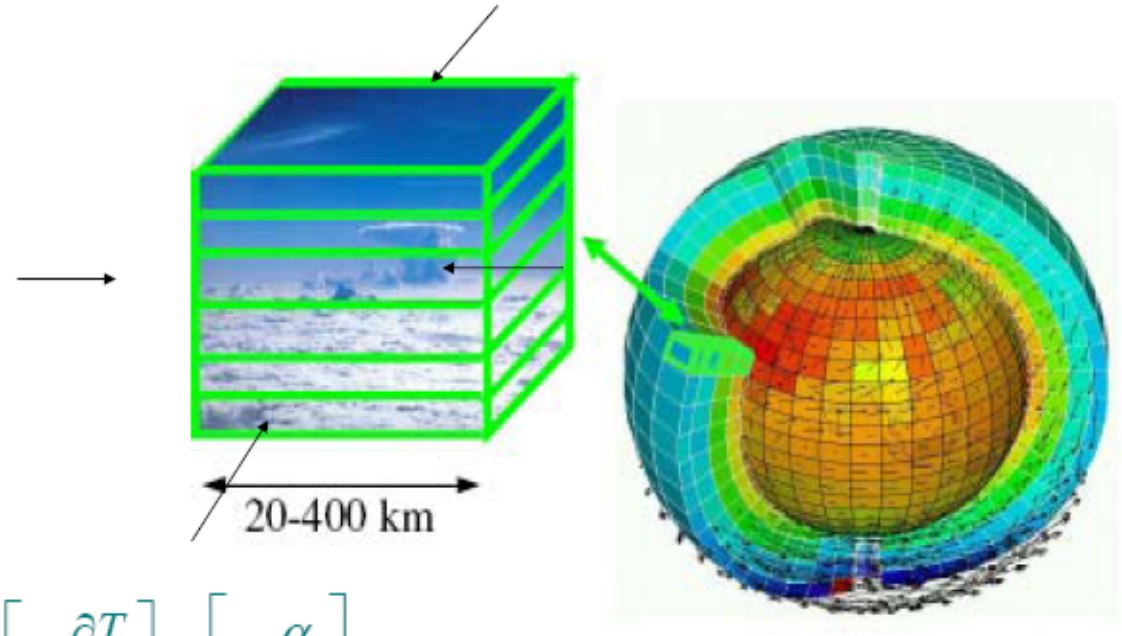
SWSFCnet NPE10



- At first order the soil model controls the warm biais observed over mid-lat in summer
- Still biais in the Radiation, linked with CC AR4.
- New physics increases the CC and reduces the net radiation at the surface.
- NEW-physics/new-surface scheme simulation soon available
- The surface scheme-BL coupling is essential to analyse the bias
- The nudged and zoomed simulations over the SIRTA allowed to analyse and correct the biais.
- The continental surface/atmosphere coupling is accounted for as in the GCM

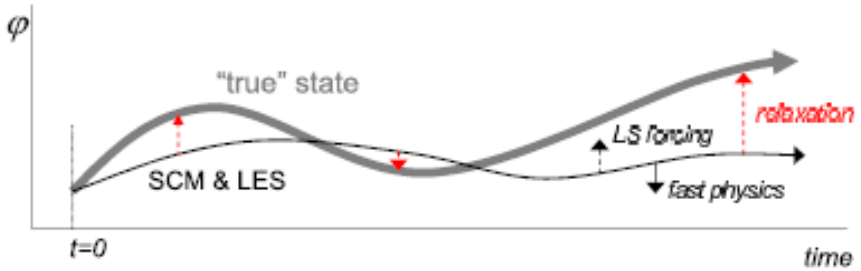
Other evaluation method: SCM forced with analyses

LMDZ-SCM and the KPT



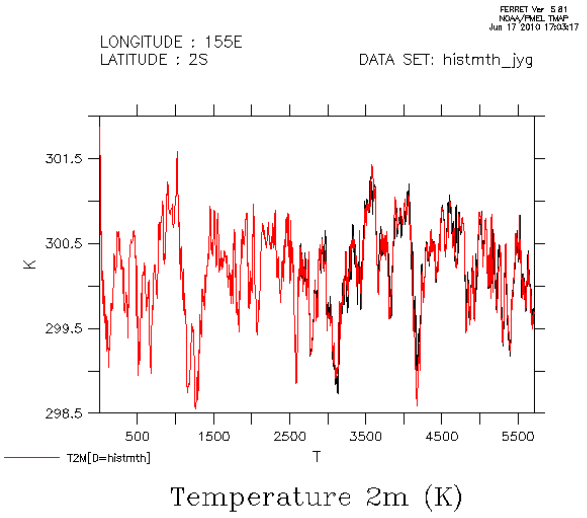
$$\frac{\partial T}{\partial t}+\left[\vec{V}_H\cdot\vec{\nabla}T\right]+\left[\omega\frac{\partial T}{\partial p}\right]=\left[\omega\frac{\alpha}{c_p}\right]+P_T$$

$$\frac{\partial q}{\partial t}+\left[\vec{V}_H\cdot\nabla q\right]+\left[\omega\frac{\partial q}{\partial p}\right]=P_q$$

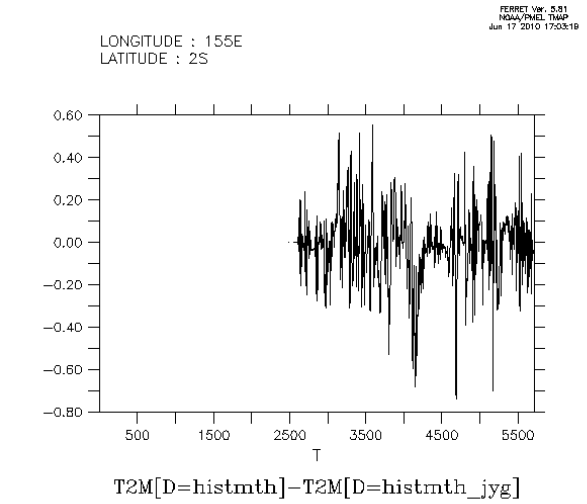


Neggers et al. 2010

Some funny things with 1D

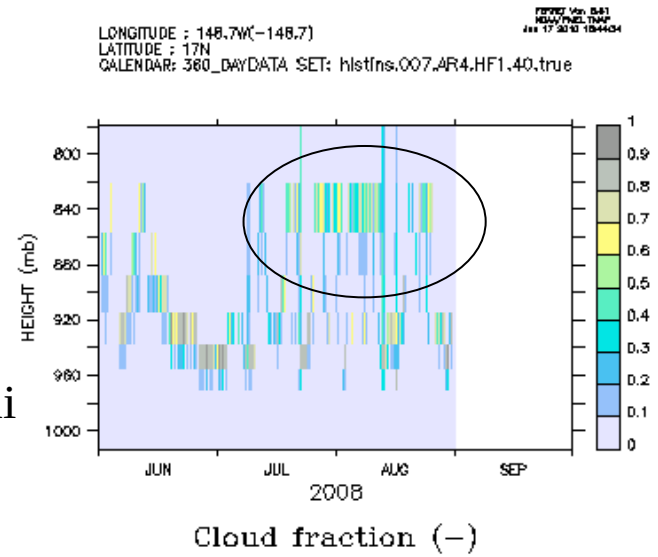


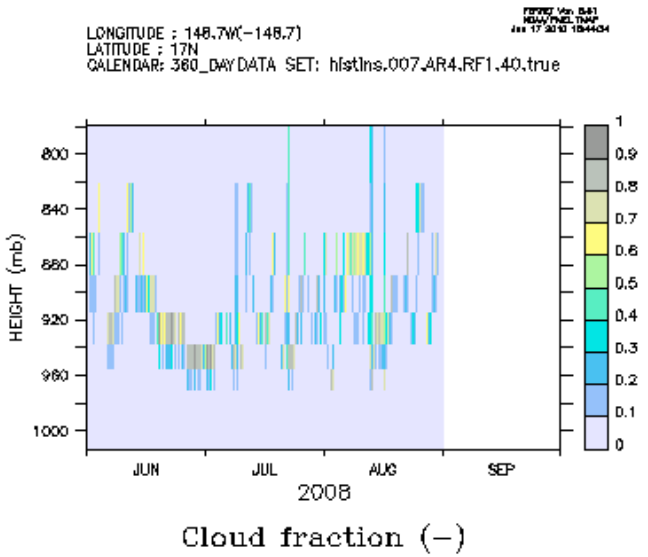
TOGA case,



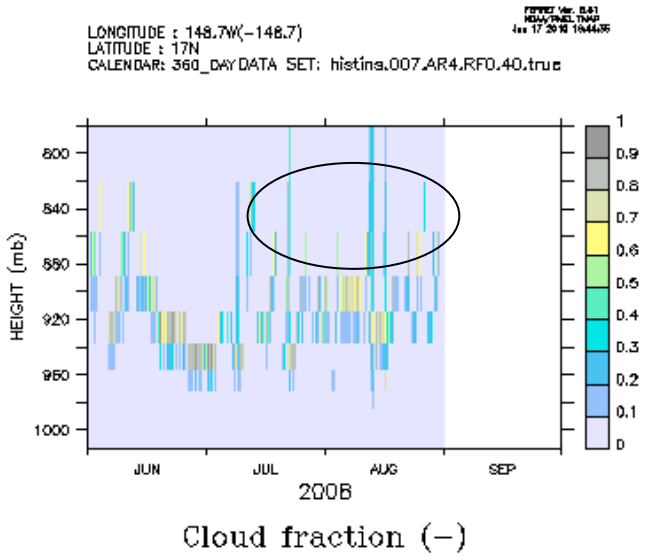
SCM forced with GCM large scale (vertical advection and radiation part. coupled or not)

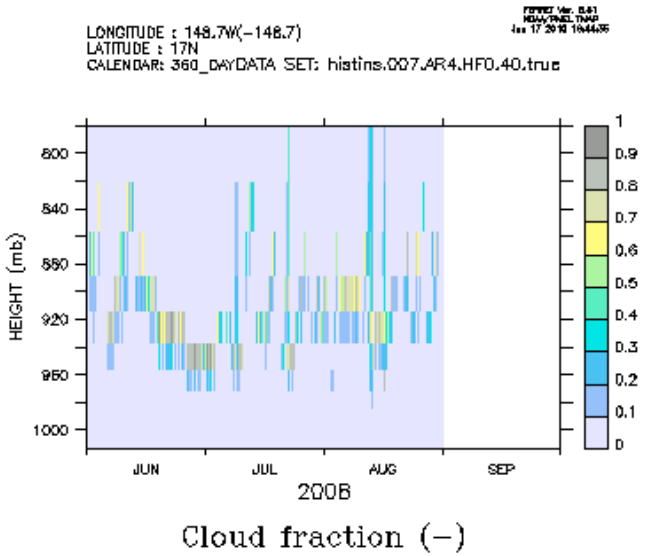
Small cumuli GPCI





A.Catarino





- For short time period (30 days) no problem identified.

LMDZ1D and KPT, 3days long simulations

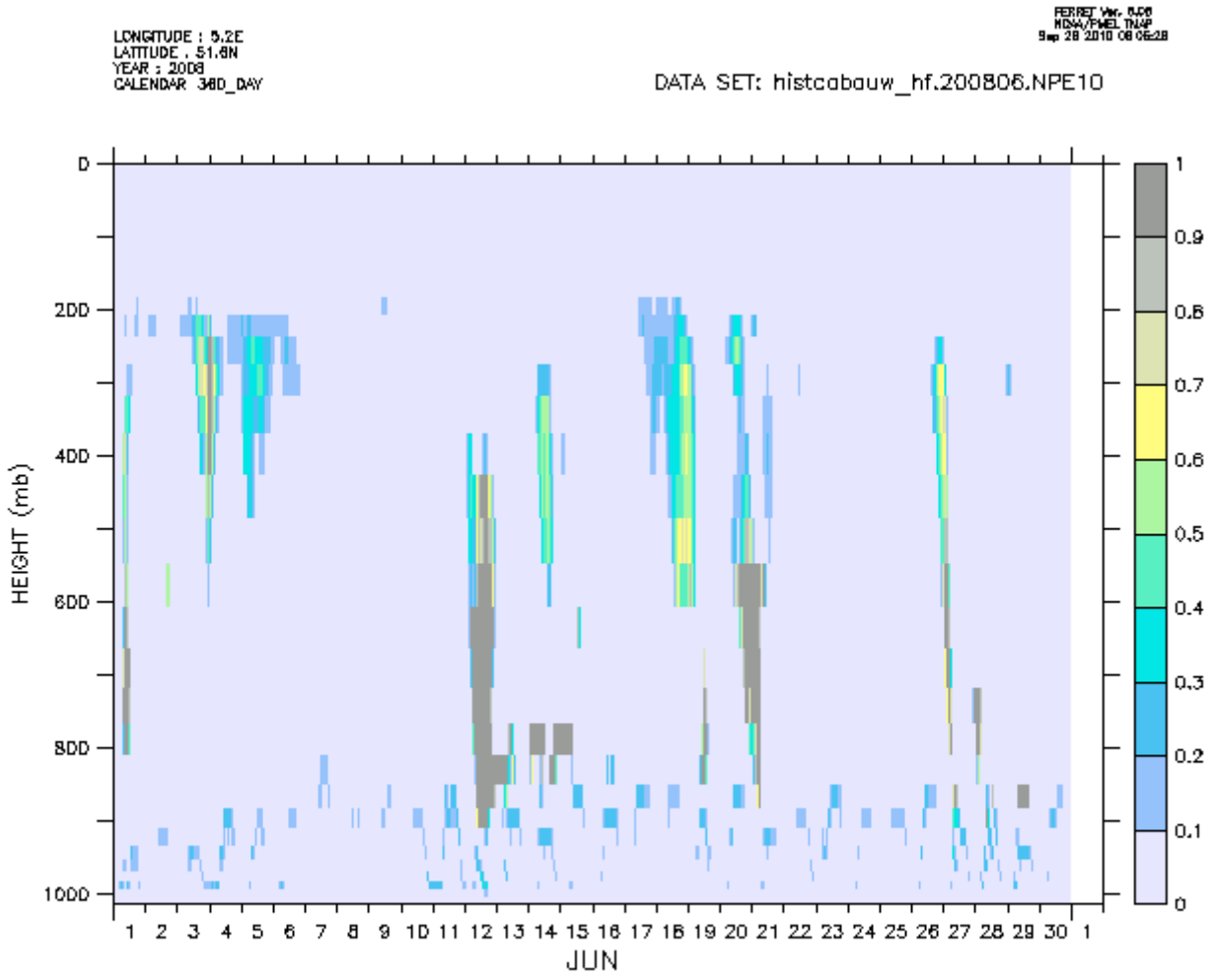
From RACMO

- Advective tendencies (as from the KPT doc.)
- Initial conditions :(T,q,u,v,Ts, Tsoil)
- Boundary conditions:

Forced with turbulent fluxes (H and L)

LMDZ + thermal soil model

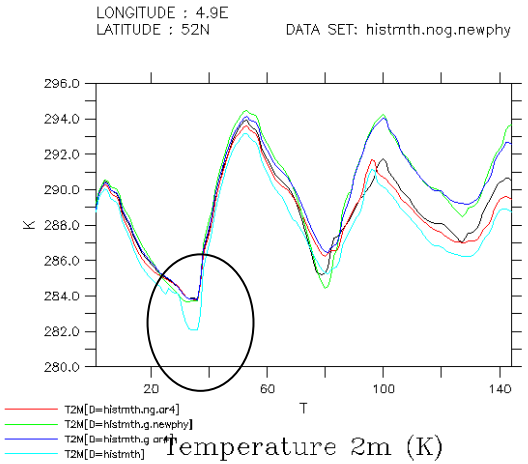
From the 3D-zoomed and nudged



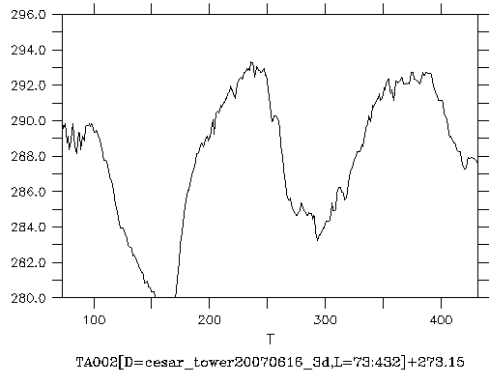
'NPE10−CABAUW'

16/06/2008

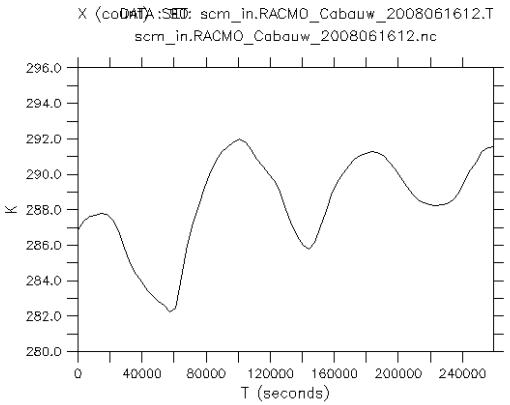
1D



Temperature 2m (K)

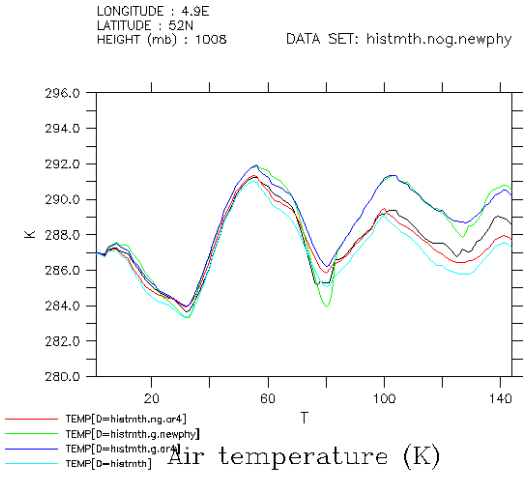


Cesar 2m



Temperature (K)

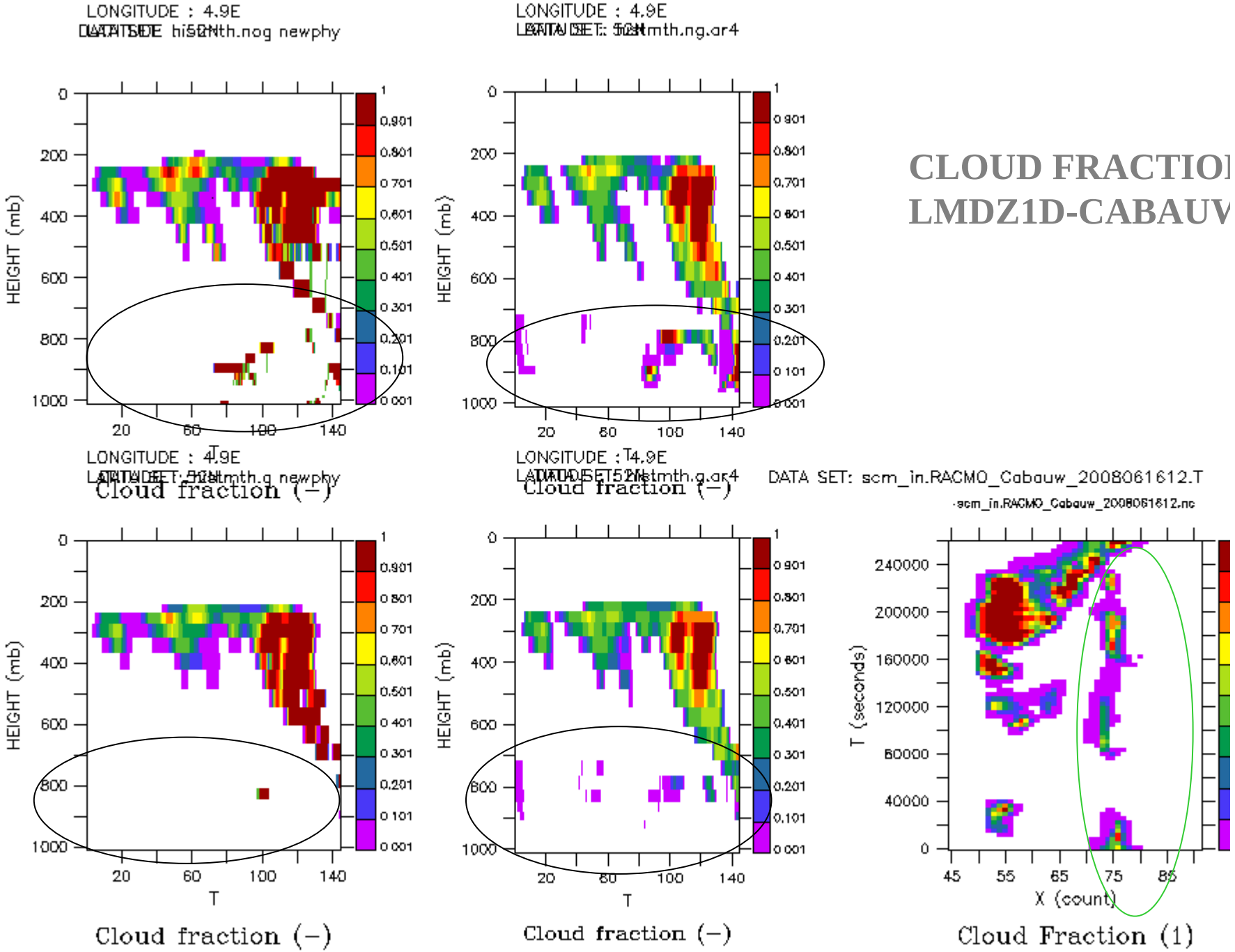
RACMO

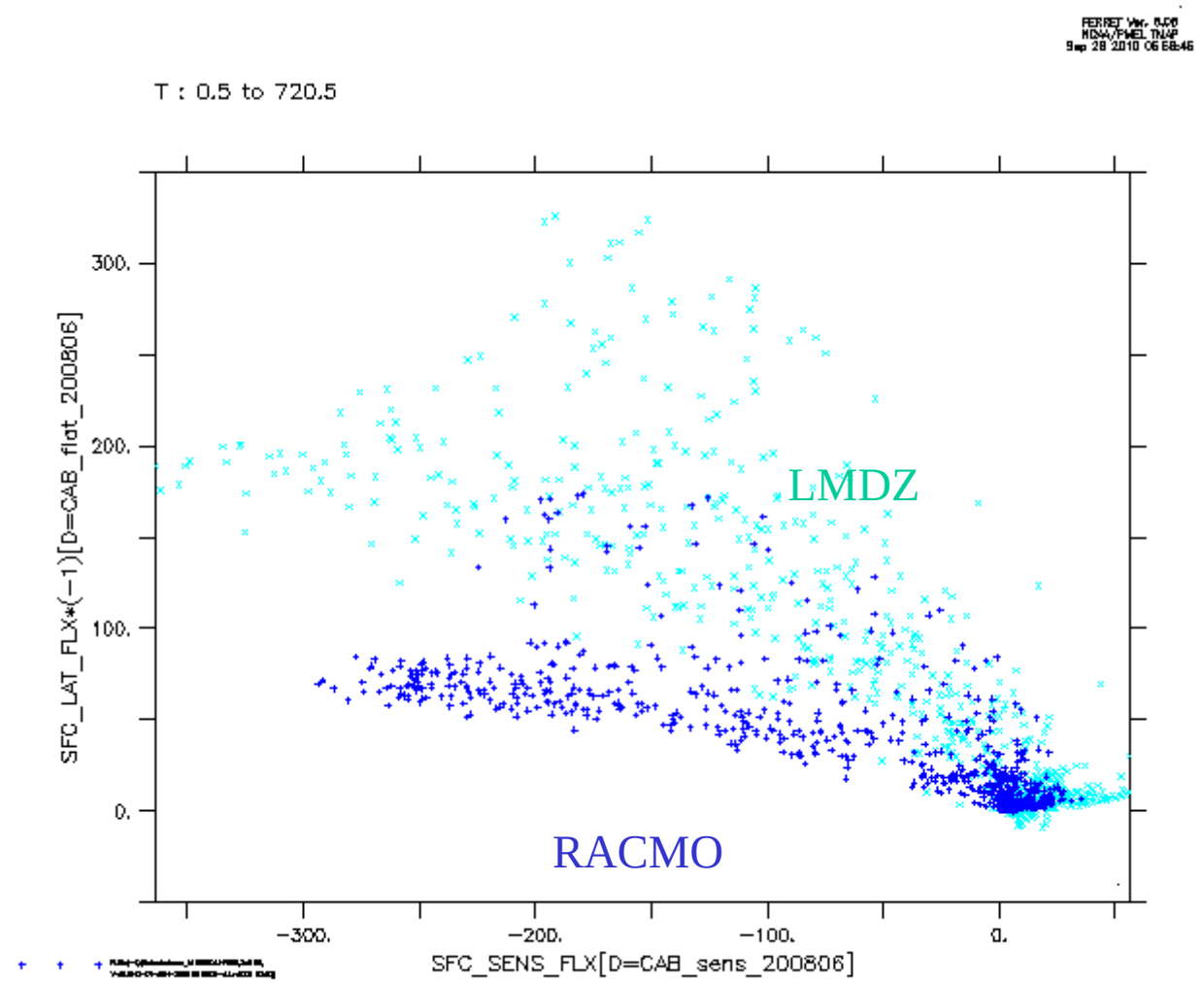


Air temperature (K)

1D

CLOUD FRACTIO
LMDZ1D-CABAUV




T : 0.5 to 720.5
SFC_LAT_FLX*(-1)[D=CAB_flat_200806]
300.
200.
100.
0.
-300.
-200.
-100.
0.
SFC_SENS_FLX[D=CAB_sens_200806]
LMDZ
RACMO

Very preliminary

- Analyze/improve the soil interaction account with the 1D. Include LMDZ surface model in the 1D, what about humidity initialisation…
- Verify the LS forcing
- Initial conditions
- Compare with the LS forcing from LMDZ-GCM

Next

- 1D over SIRTA (thanks Roel for the forcings) Availability of Cabauw obs (netcdf file?)
- Compare RACMO and LMDZ, LS forcings
- Quasi-real time version of LMDZ over SIRTA (Nudged with NCEP analysis+3day forcast: proxy for transpose AMIP?)
- New-surf + new-physics runs

invonvenients

- Certains couplage presents dans le modele de climat sont coupes: sol-atmosphere; physique-dynamique
- Peut necessiter un rappel vers les analyses qui peut biaiser l'interpretation des differences

- Excercices d íntercomparaison de modeles plus difficiles (zoom)
- Plus lourd que le 1D

Avantages des 2 methodes

- Plusieurs modeles peuvent etre testes dans le meme cadre
- Tres economique et rapide
- Economique par rapport 3D
- Tous les couplages du modele de climate sont presents

La suite

- Reactivation LMDZ semi-operationnel SIRTA (suivi au jour le jour)
- Mise en place 1D
- Le projet DEPHY

confrontation autres modeles, autres sites: Cabauw, ARM

Euclipse (FP7), CFMIP

- Representativite spatiale du SIRTA