Synthesis of ground-based atmospheric measurements from 3 European observatories

Their utility for climate model evaluation in the framework of EUCLIPSE

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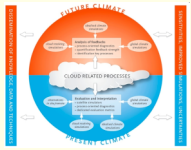
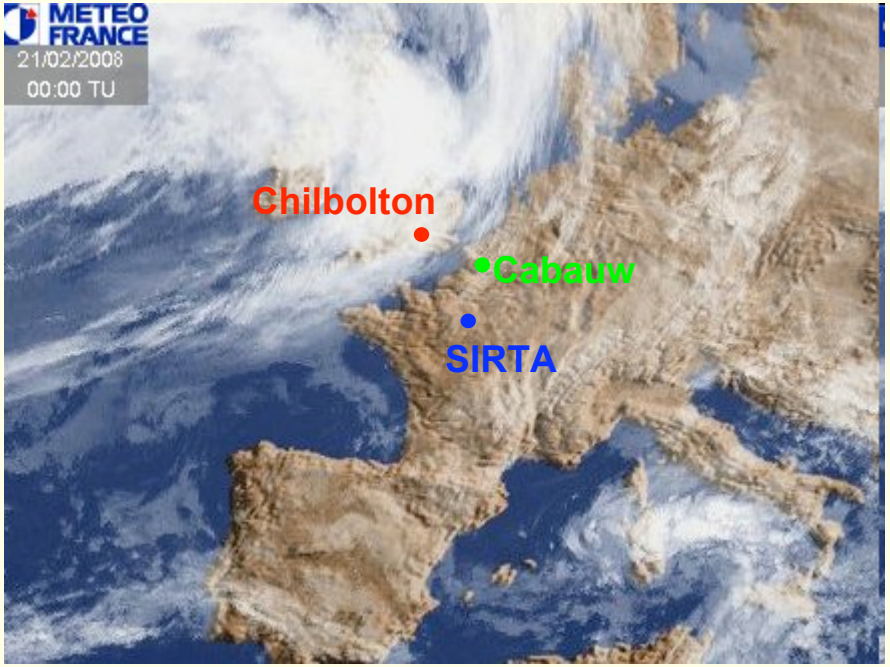
(1) LATMOS, (2) IPSL, (3) KNMI, (4) Uni. of Reading/FMI, (5) LMD



Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

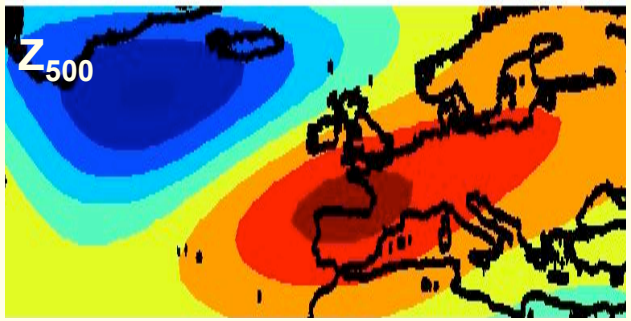
The ground-based observatories



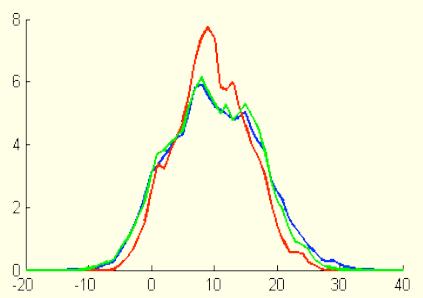
- In Situ measurements
- Active remote-sensing
- Passive remote-sensing
- Multi-spectral synergy
- Data analysis & interpretation
- Long-term

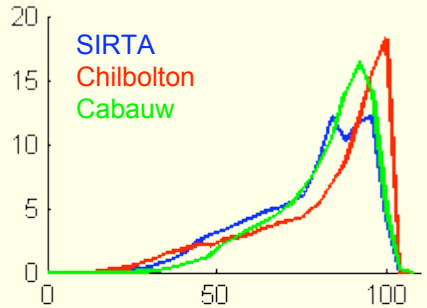
➔3 **CLOUDNET** Sites:

Same large-scale dynamics influence



Different local environments





Motivations

Initial objectives

(1) Observe the **decadal variability** of atmospheric properties, to better understand the atmospheric processes and the cloud feedback

(2) Use an atmospheric column completely resolved to **evaluate climate models** and their ability to simulate clouds

BUT

- Multi-sensor synergy is under-used
- Statistical analysis is complicated
- Large heterogeneity concerning: spatial resolution, level of quality control, formats, documentation…
- Difficult to use for scientists who are not specialist of measurements

→ Synthesis of observations is necessary:

One single **netCDF** file
Homogeneous data hourly averaged
Quality Control ++

→ Same approach as the "*ARM Climate Modeling Best Estimate Data*":

(1) **SCTD file** = SIRTA *climate testbed dataset* – all possible variables retrieved at SIRTA, from 2002 to 2010

(2) **3 EUCLIPSE files** = SIRTA/ Cabauw/ Chilbolton – CFMIP variables, from Jan 2008 to Apr. 2010

Methodology

STEP 1 *N sources: different possible temporal resolutions (1 to 5 min)*	Derive **1-hour averages** – *several statistics* calculation of temporal variability (STD from 1 hour averaged) Quality control 1
STEP 2a *N1 sources: 1-hour resolution*	Apply **harmonized retrieval algorithms** Quality control 2a, flag production
STEP 2b *N2 sources: 1-hour resolution*	Calculate **spatial variability** from meteorological stations Quality control 2b, flag production
STEP 3 *N sources: 1-hour resolution*	**Produce NetCDF files**: metadata, definition of the attributes, use 2 nomenclatures (CFMIP and ARM), …

File 1	***File 2***	***File 3***	***File 4***
SCTD 2002 – 2010 *SIRTA climate testbed file* *Same approach as ARM CMBE*	EUCLIPSE – SIRTA Jan 2008 – Apr. 2010	EUCLIPSE – Cabauw Jan 2008 – Apr. 2010	EUCLIPSE – Chilbolton Jan 2008 – Apr. 2010

Each step has required important preparatory work

Content of datafiles

Variables recommended by CFMIP (Jan. 2008 – Apr. 2010)

State variables: tas, tasmin, tasmax, psl, ps, uas, vas, sfcWind

Humidity variables: hurs, huss, Pr

Heat fluxes: hfls, hfss

Ground radiative fluxes: rlds, rlus, rsds, rsus, rsdscs, rsuscs, rldscs

TOA radiative fluxes: rsdt, rsut, rlut, rlutcs, rsutcs

Water vapor: prw, wv

Cloud water: CF, clwvi

Additional variables – only in SCTD file (2002-2010)

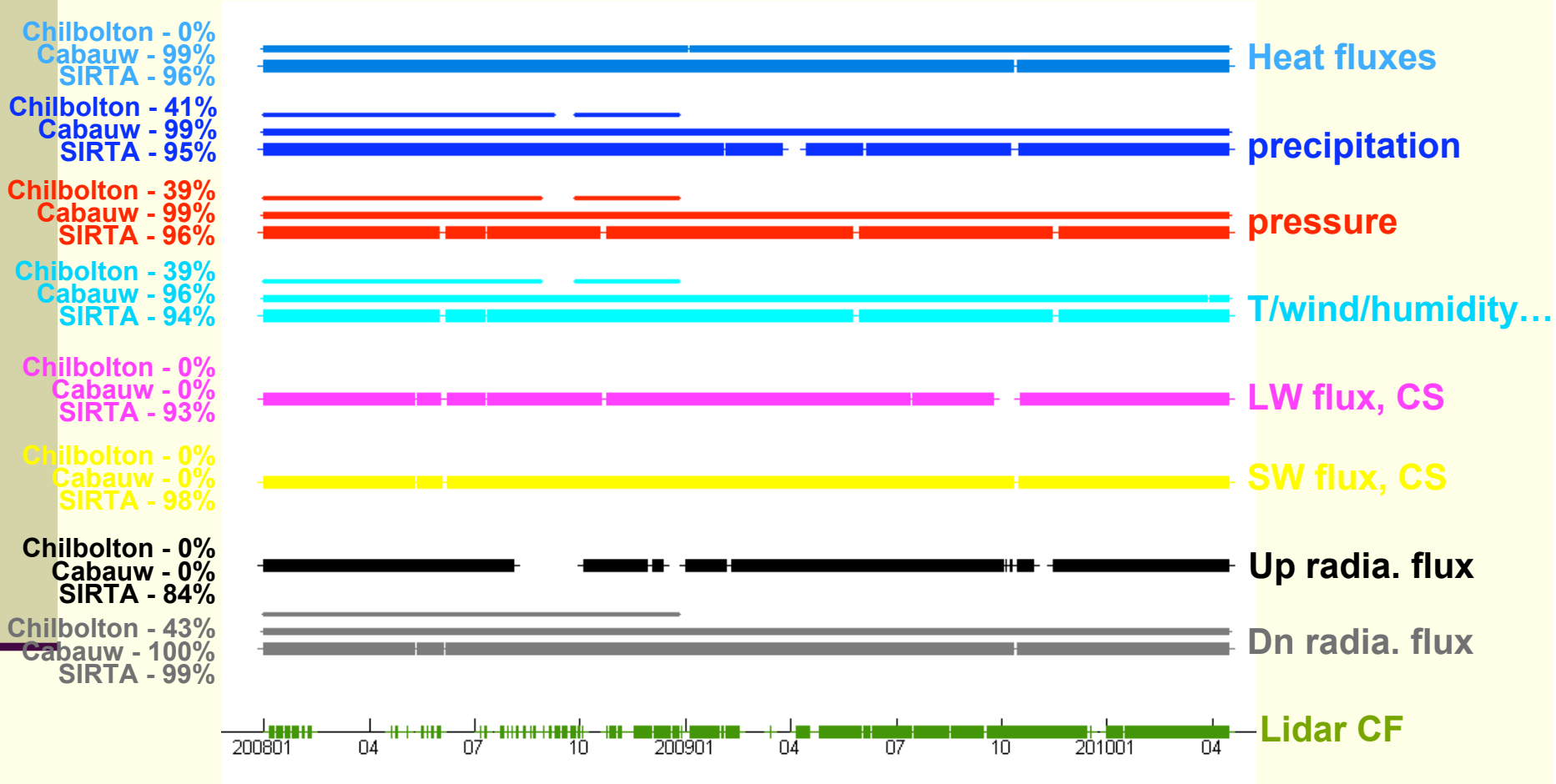
Lidar backscatter profiles

Different definitions of CF

In ground temperatures and moistures

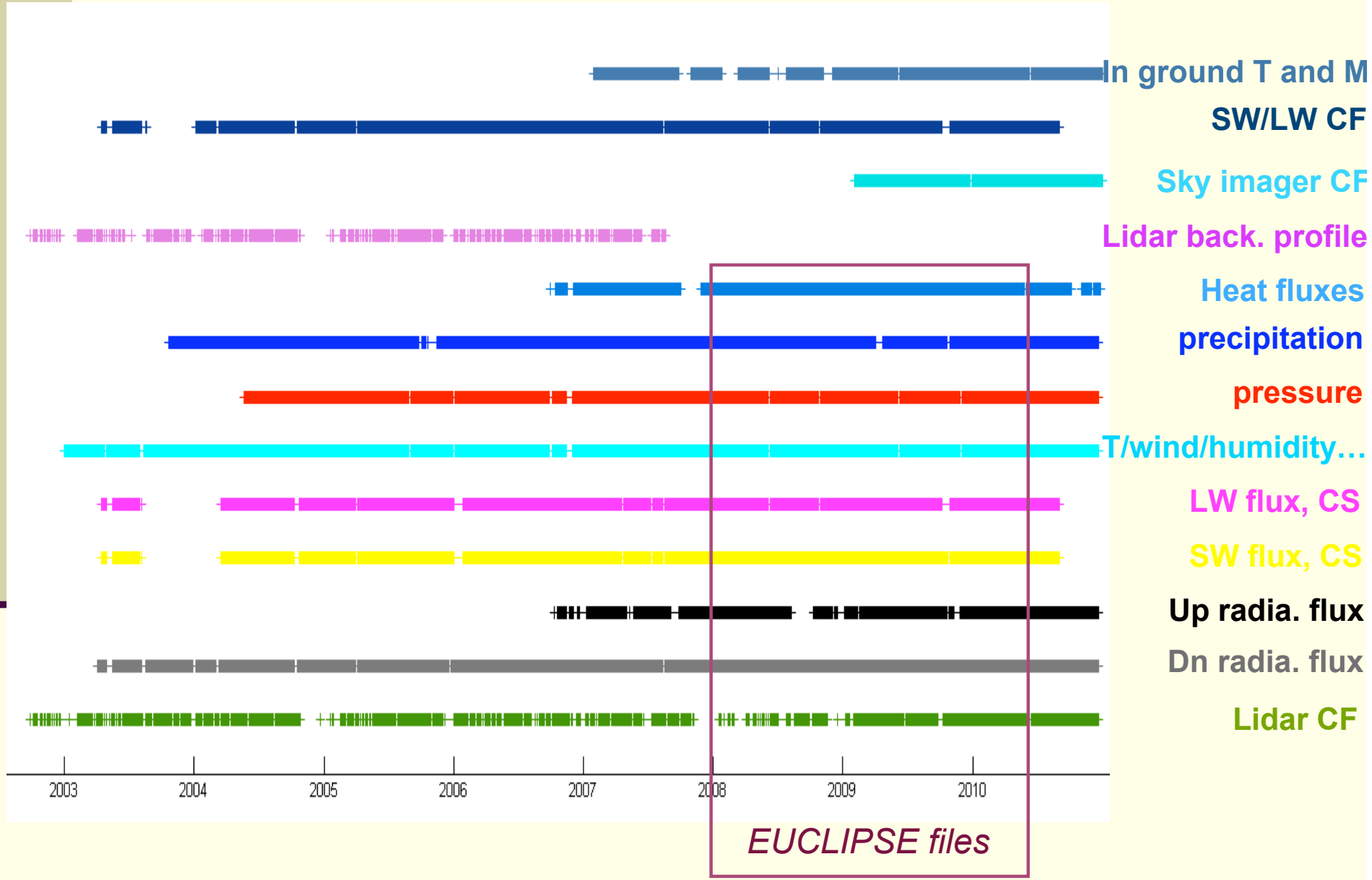
- For each variable: an **instrument uncertainty**, a **quality flag**, a standard deviation from **temporal variability**, + a standard deviation from **spatial variability** for the state variables
- Two different nomenclature: **CFMIP** and **ARM-CMBE**

Content of EUCLIPSE files – *current*



Not yet for the 3 sites : TOA radiative fluxes, condensed water content, water vapor

Contents of SCTD file – *current*



Spatial representativity of a site – ex. of SIRTA (1)

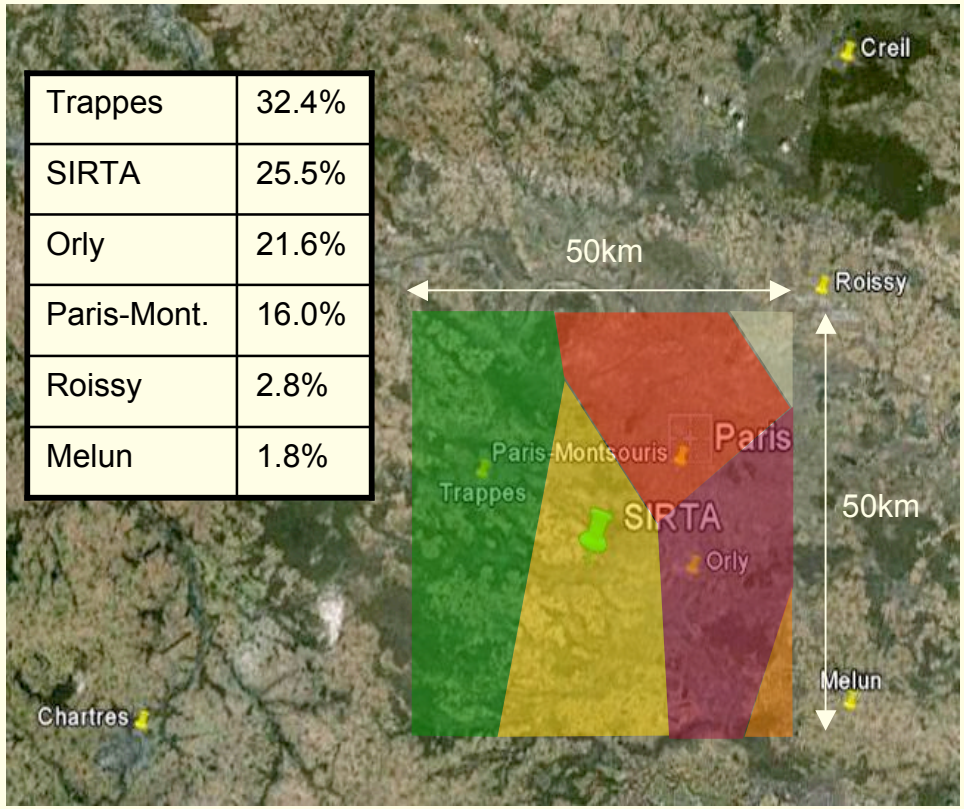
Computed from meteorological stations around the observatory

X = {x1,…xn} is a set of values for a variable V

W = {w1,…,wn} is a set of correspond weights

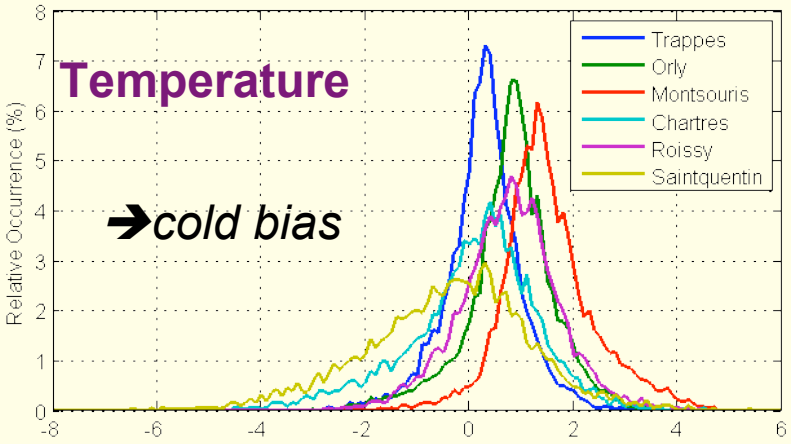
➔ In the data file, the estimated value is the site one, and the spatial variability is a weighted standard deviation

Trappes	32.4%
SIRTA	25.5%
Orly	21.6%
Paris-Mont.	16.0%
Roissy	2.8%
Melun	1.8%

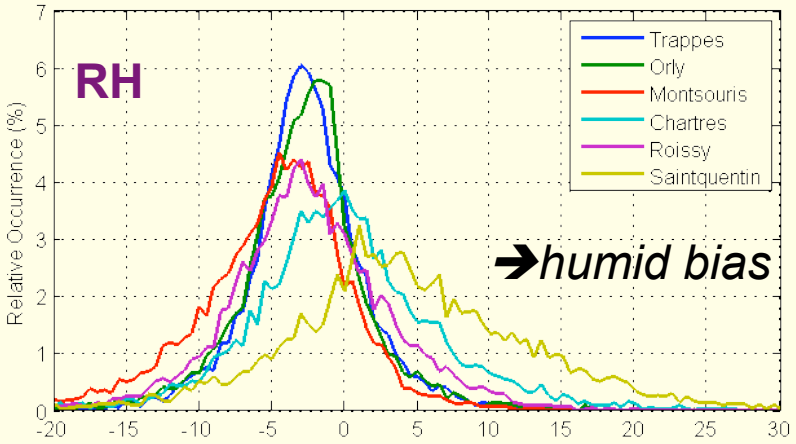


A. Campoy & J. C. Dupont

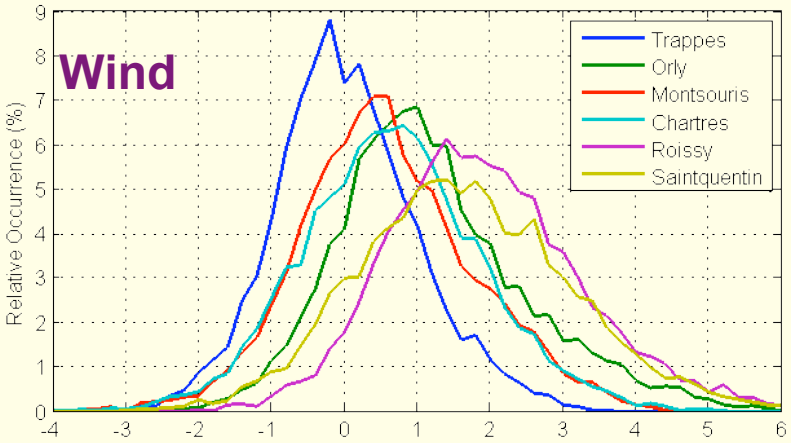
Spatial representativity of a site – ex. of SIRTA (2)



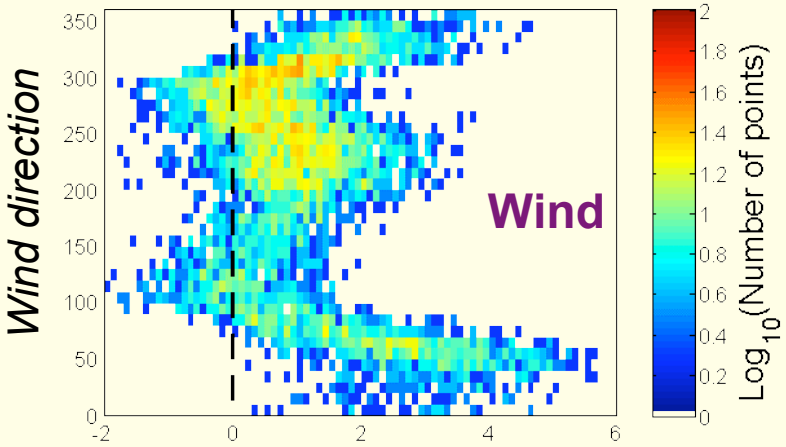
T anomaly (stations-SIRTA)



RH anomaly (stations-SIRTA)

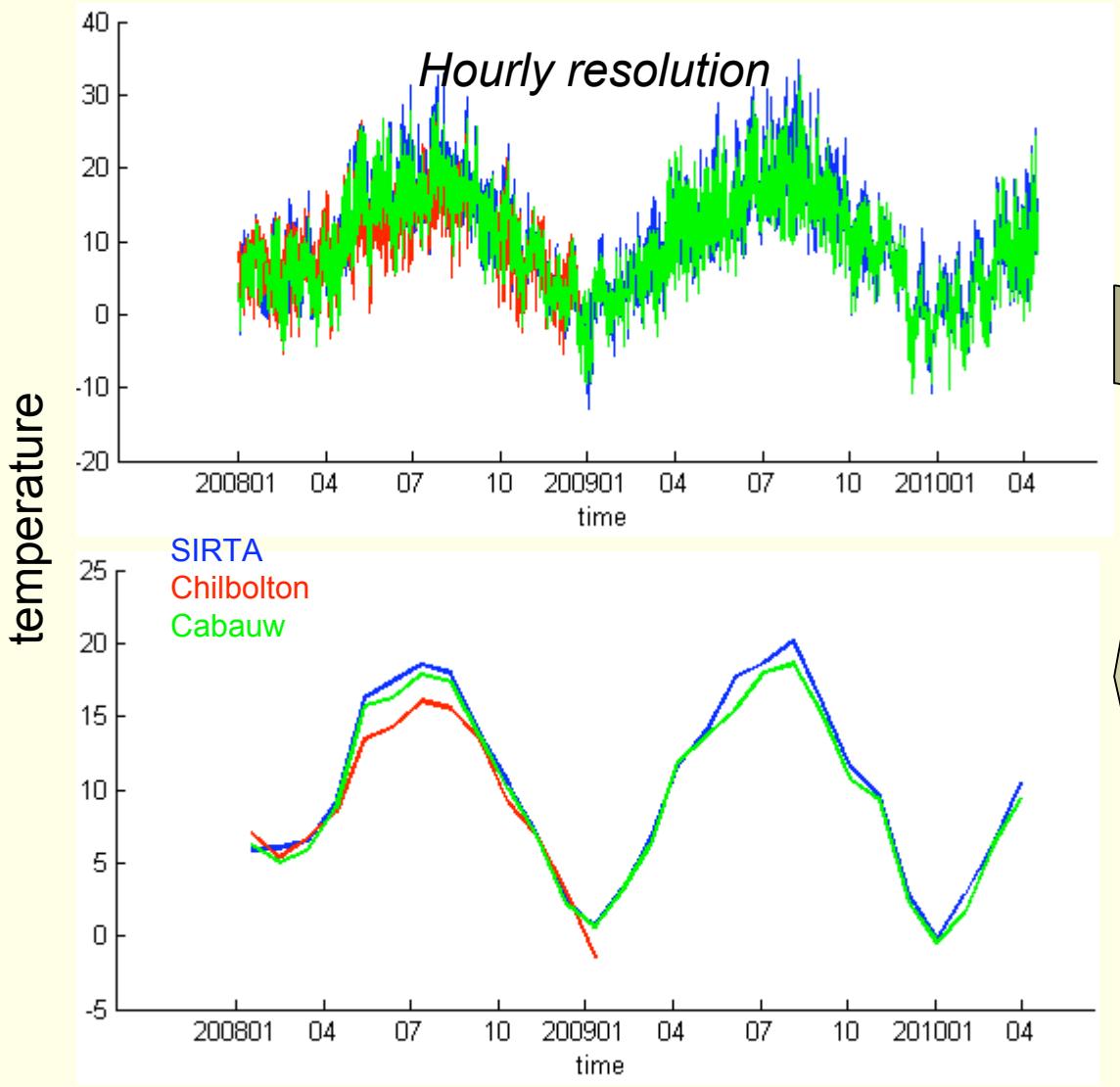


Wind speed anomaly (stations-SIRTA)



Wind speed anomaly (stations-SIRTA)

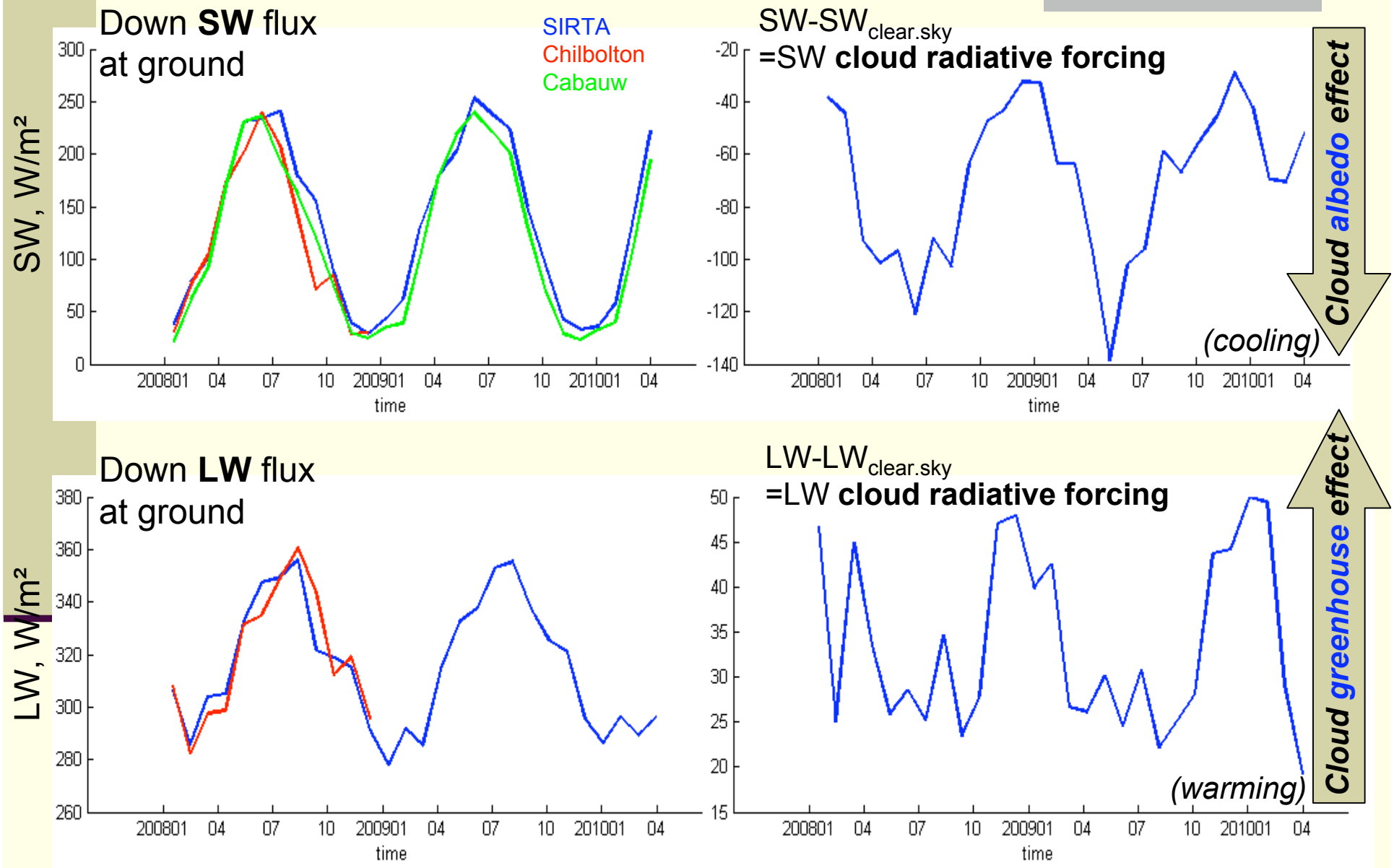
Example of file content: state variables – 2 m temperature



Different time-scale:
-small-scale processes
-Diurnal cycle
-Seasonal variations…

Monthly averaged

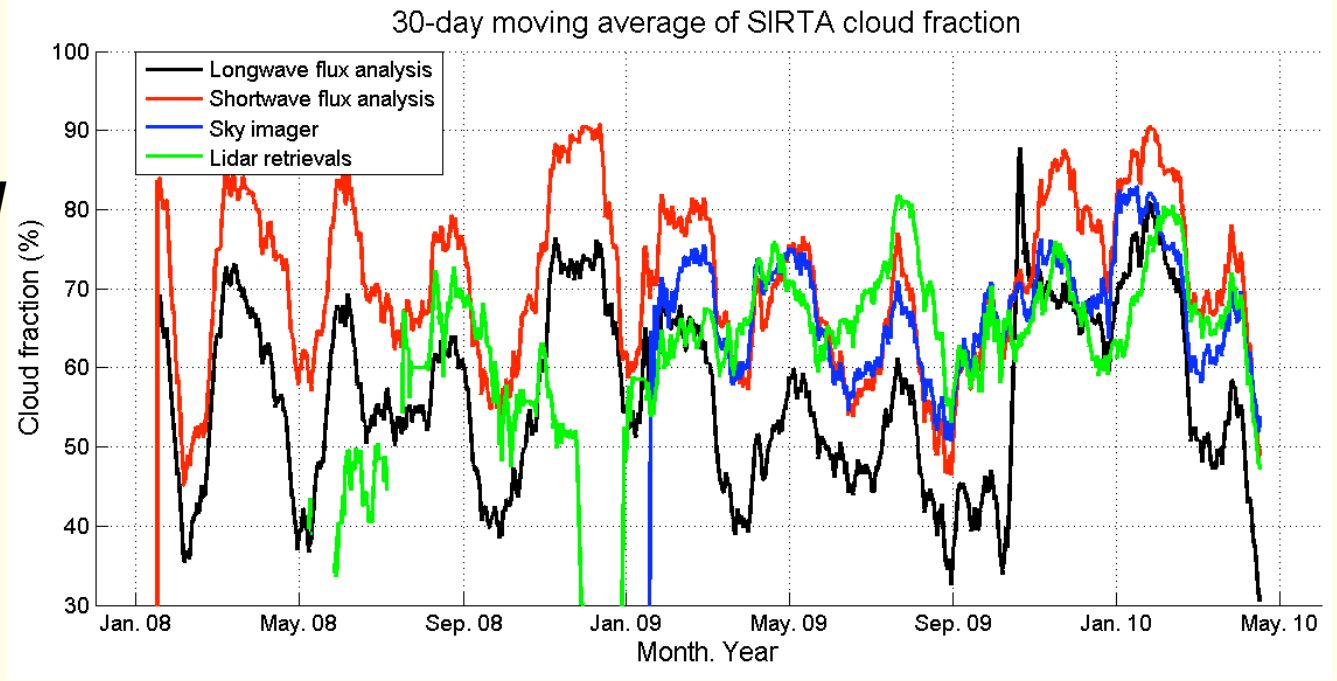
Example of file content: Radiative fluxes *(monthly)*

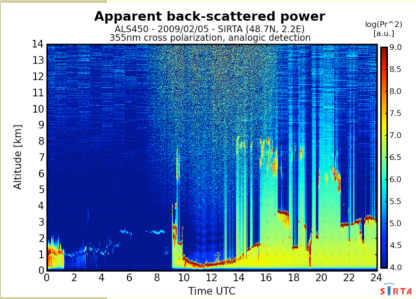


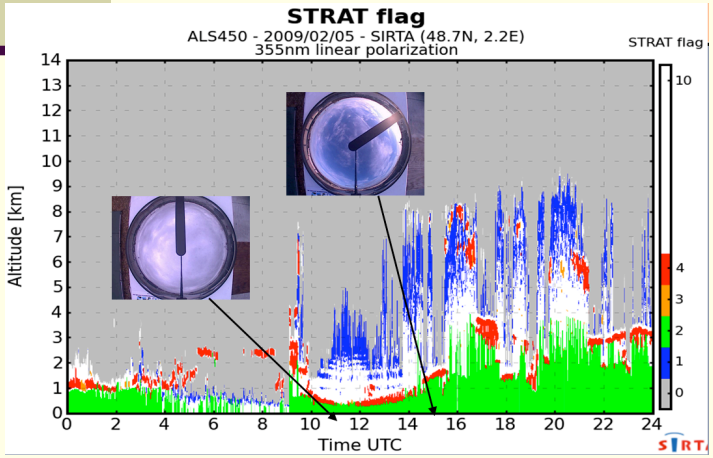
(!! Not the same scales on the figures)

Example of file content: cloud fraction retrieval

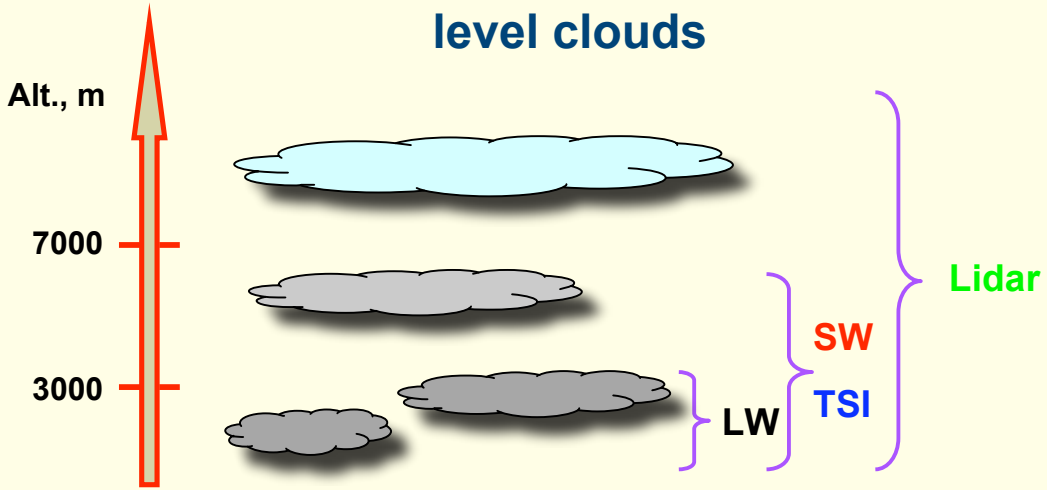
In SCTD file, but not yet in the 3 EUCLIPSE files
➔Cloudnet CF will be added in EUCLIPSE files



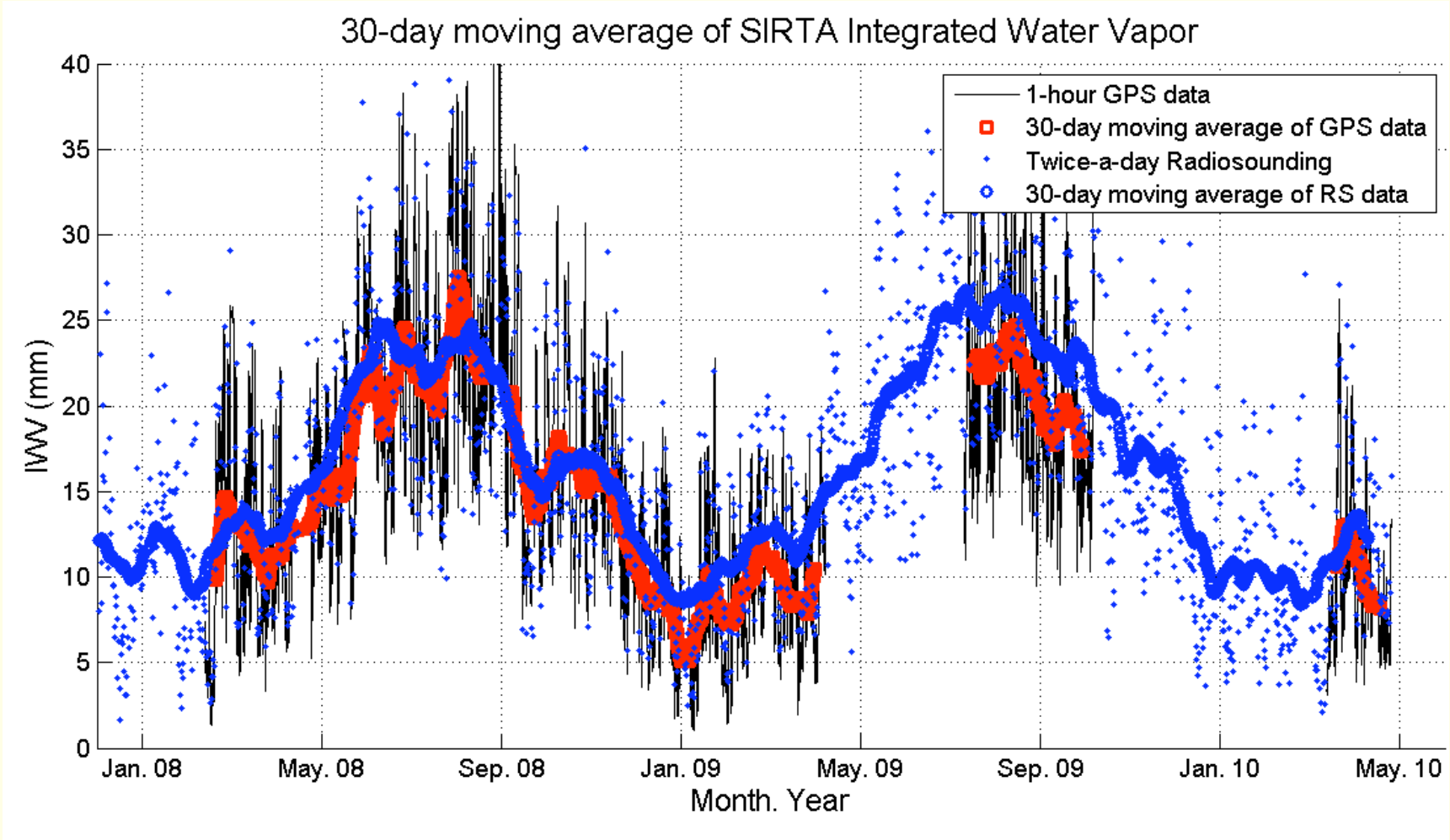




Instrument sensitivity to the different level clouds



Example of file content: water vapor retrieval, *in progress*

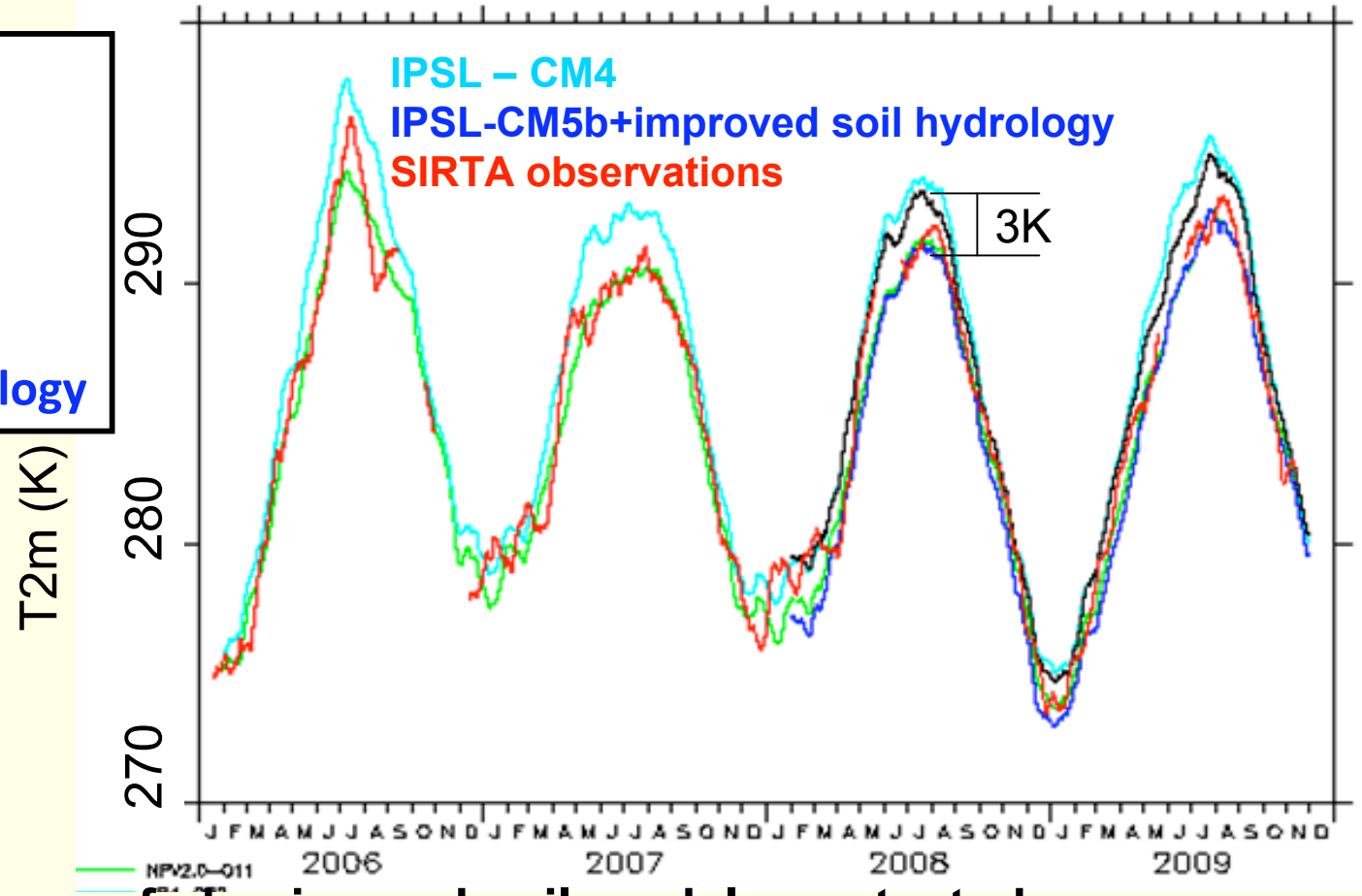


➔ **GPS Climate Water Vapor retrieval in progress.**

Application for a climate model: LMDZ evaluation (1)

- To evaluate and help to the development of the new physics of IPSL-CM5b
- To illustrate how SCM and/or Zoomed-nudged numerical experiments and instrumented site observations allow climate models to be evaluated

+ 3-D Zoomed and Nudged LMDZ model
+ New physics (BL thermals, Clouds, and Deep Convection)
+ Improved soil hydrology



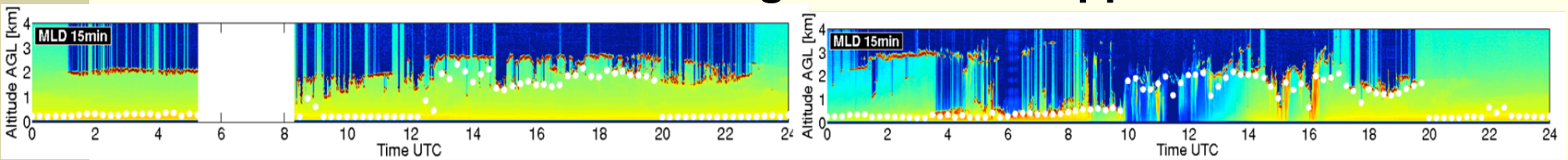
From Cheruy et al. poster:

Different combinations of physics and soil models are tested

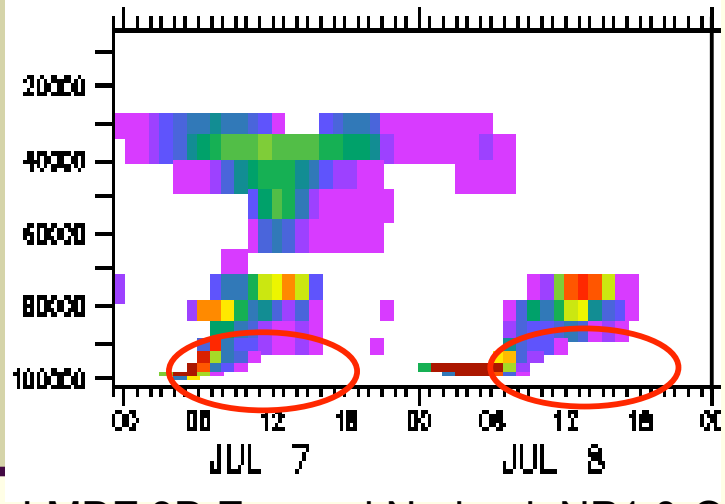
Improved seasonal cycle of temperature

Application for a climate model: LMDZ evaluation (2)

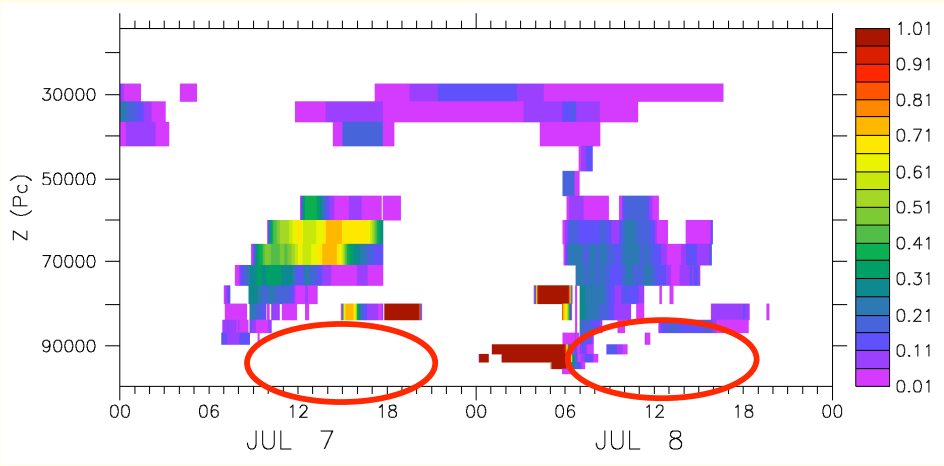
Case study **Low level clouds in summer over continental surface 3D zoomed nudged and SCM approaches**



Cloud cover



LMDZ 3D Zoomed Nudged, NP1.0-O11



LMDZ SCM, NP1.0 / RACMO forcing

Most realistic representation obtained using
- 11-layer soil model: enough evaporation, moist thermals
- Activation between shallow and deep convection better represented

- SCM forced by RACMO fluxes (latent heat fluxes underestimated, sensible heat flux overestimated)
- Underestimation of evaporation, deep convection activated instead of shallow conv°

Application for a regional model: WRF evaluation (1)

Evaluation of cloud cover simulated by WRF

-Using **CORDEX** simulations = COordinated Regional climate Downscaling EXperiment

-Configuration of the model: 28 vertical levels, forced by ERA-Interim, 2 different horizontal resolutions: **20 km** and **50 km**

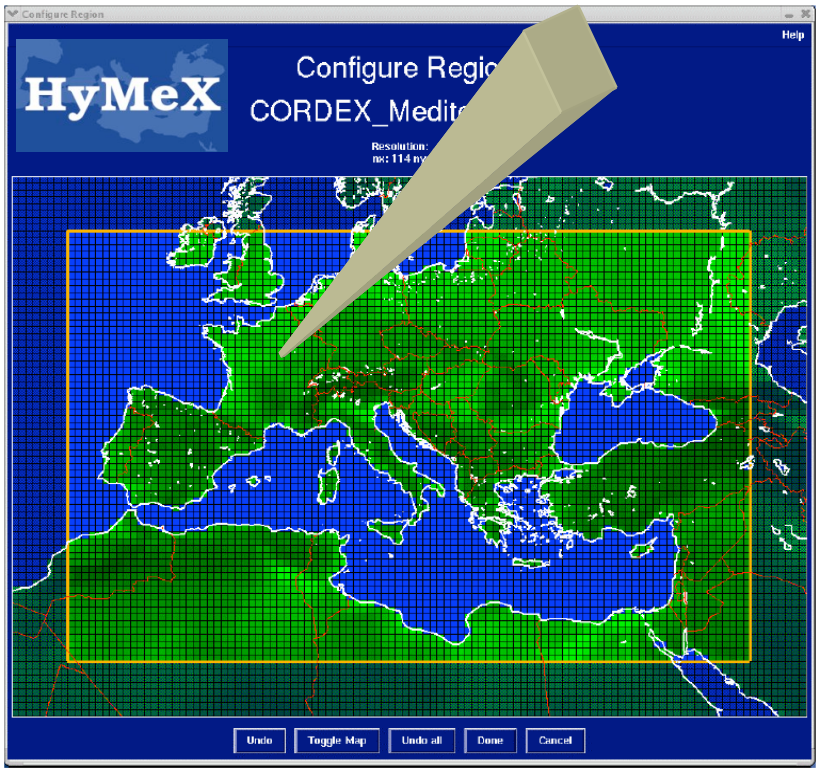
-From 1989 to 2008

➔6-years comparison (2003 – 2008)

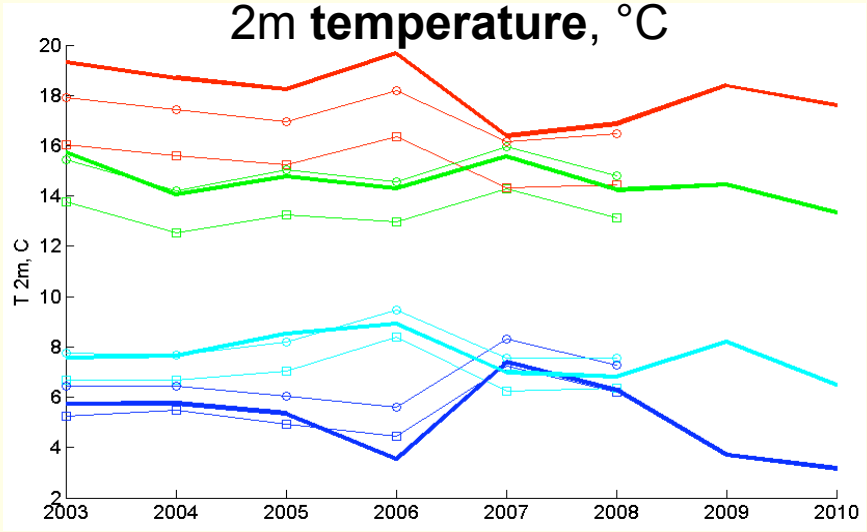
➔Extraction of the SIRTA grid-point in the CORDEX-Mediterranean region

➔Use of the SCTD file

Region 12: Mediterranean (HYMEX/MED-Cordex)



Application for a regional model: WRF evaluation (2) *preliminary*



SIRTA observations

50-km WRF simulations

20-km WRF simulations

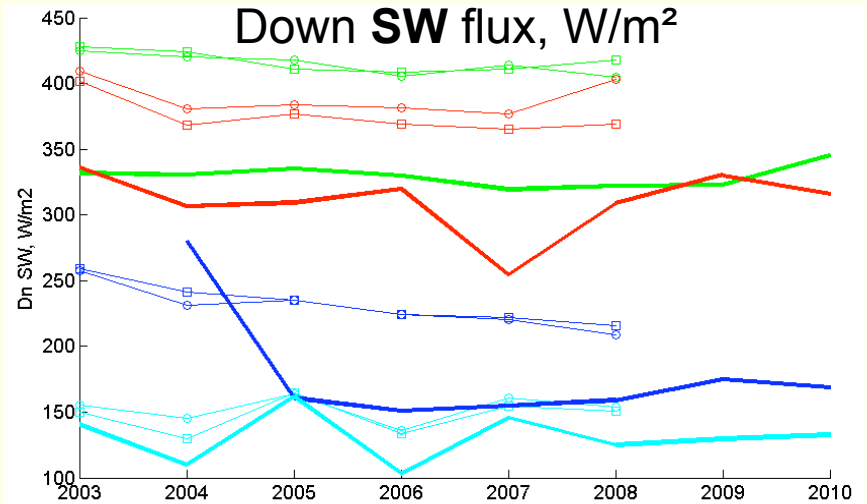
(for each color)

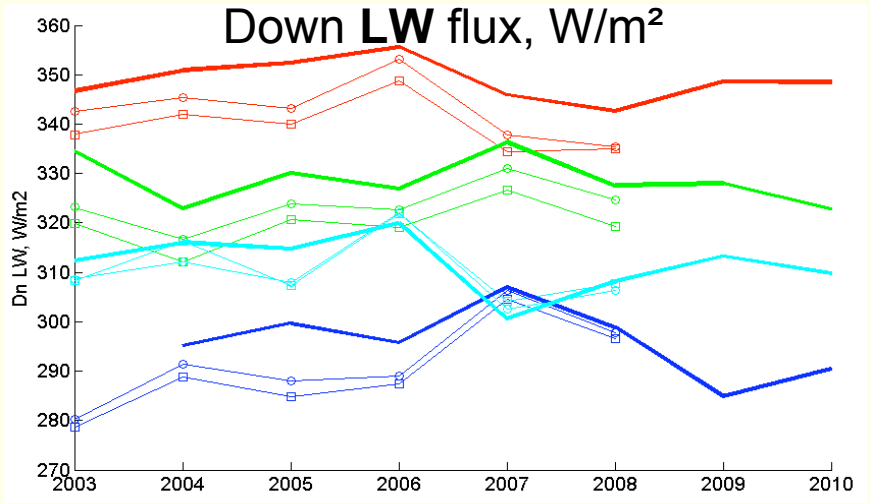
Winter

Spring

Summer

Autumn

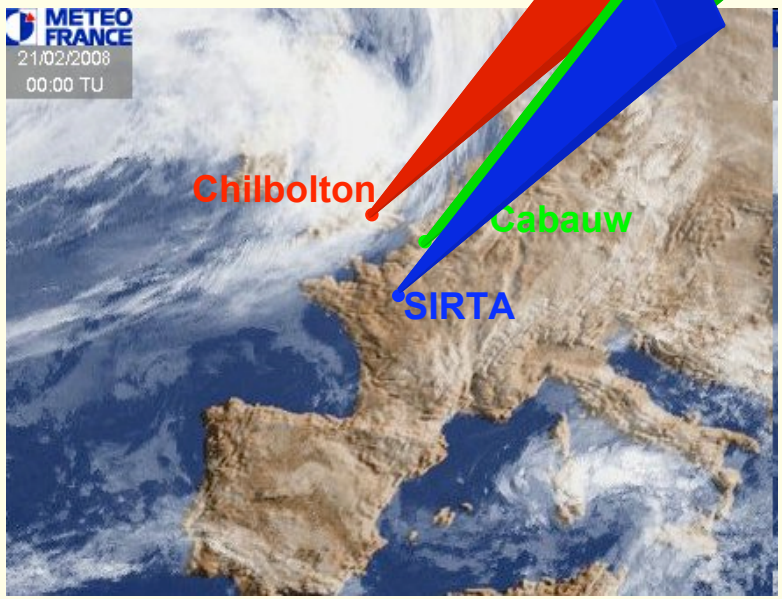




➔Significant biases for SW/LW & T, not the same for 50-km and 20-km simulations

➔Interannual variability: often well reproduced for T whatever season, only for some seasons for LW/SW

Conclusions and perspectives



Three atmospheric columns completely resolved

from ground variables, vertical profiles, TOA variables

Distribution of these 4 files on a special page in the CFMIP-obs web-site (very preliminary version, more documentation will follow)

http://climserv.ipsl.polytechnique.fr/cfmip-obs.html , click on "CLOUDNET ground"

Work to come:

-Complete the database: equivalent variables for the three site + adding water vapor, CF, TOA radiative fluxes for all sites

-**Lidar simulator**: now tested for the SIRTA/WRF comparison; using the COSP lidar simulator, with just a reverse of lidar equation, as earlier studies (Chiriaco et al. 2006); easier because only for **one profile**. Will be then distributed on the same web-page.

SIRTA cloud radiative forcing for EUCLIPSE time-period