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# Representation of Low-Level Clouds in Western Central Africa in a convection-permitting regional climate simulation

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*Dynamics, Variability and Bioclimatic Effects of Low Clouds in Western Central Africa*

<https://dyvalocca.osug.fr/>



# Introduction

In Western Equatorial Africa (WEA), low level clouds (LLC) in the dry season (June-September) extremely important for the Forest.

Analyses of ground observations, satellites and ERA5 reanalyses in the DYVALOCCA project show:

- Cloudy days on the windward side of the low mountains range but strong afternoon clearing on the leeward side (Aellig et al. 2022, EGU, AS 1.10).
- “Cloudy” days favored by cold sea surface temperature (SSTs) over the near Atlantic Ocean and a warm El Niño. (Moron et al. 2022, submitted in JoC).
- Large deficiencies of CMIP6 in simulating LLC in WEA (Camberlin et al., 2022, submitted to Climate Dynamics), likely due to the parametrization of convection (Lucas-Picher, 2021).

CP4-Africa is a convection-permitting regional climate model (CPRCM), run in Africa in 1997-2006 (Stratton et al. 2018) but **no studies done on LCC in WEA.**

**Are low-level-clouds in WEA well represented in the CP4-Africa convection-permitting regional climate model?**



West Equatorial Africa (Raffael Aellig, 2022)

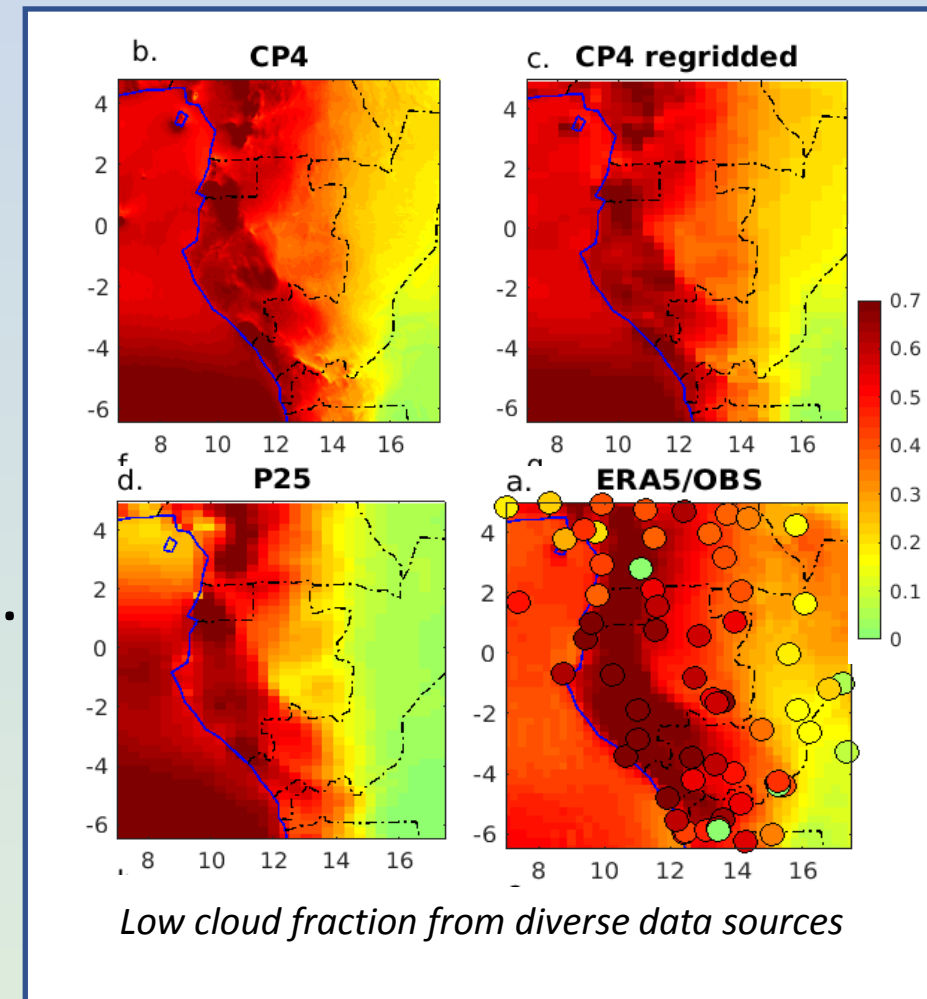
# Data and Methods

## DATA: Low cloud cover from diverse sources:

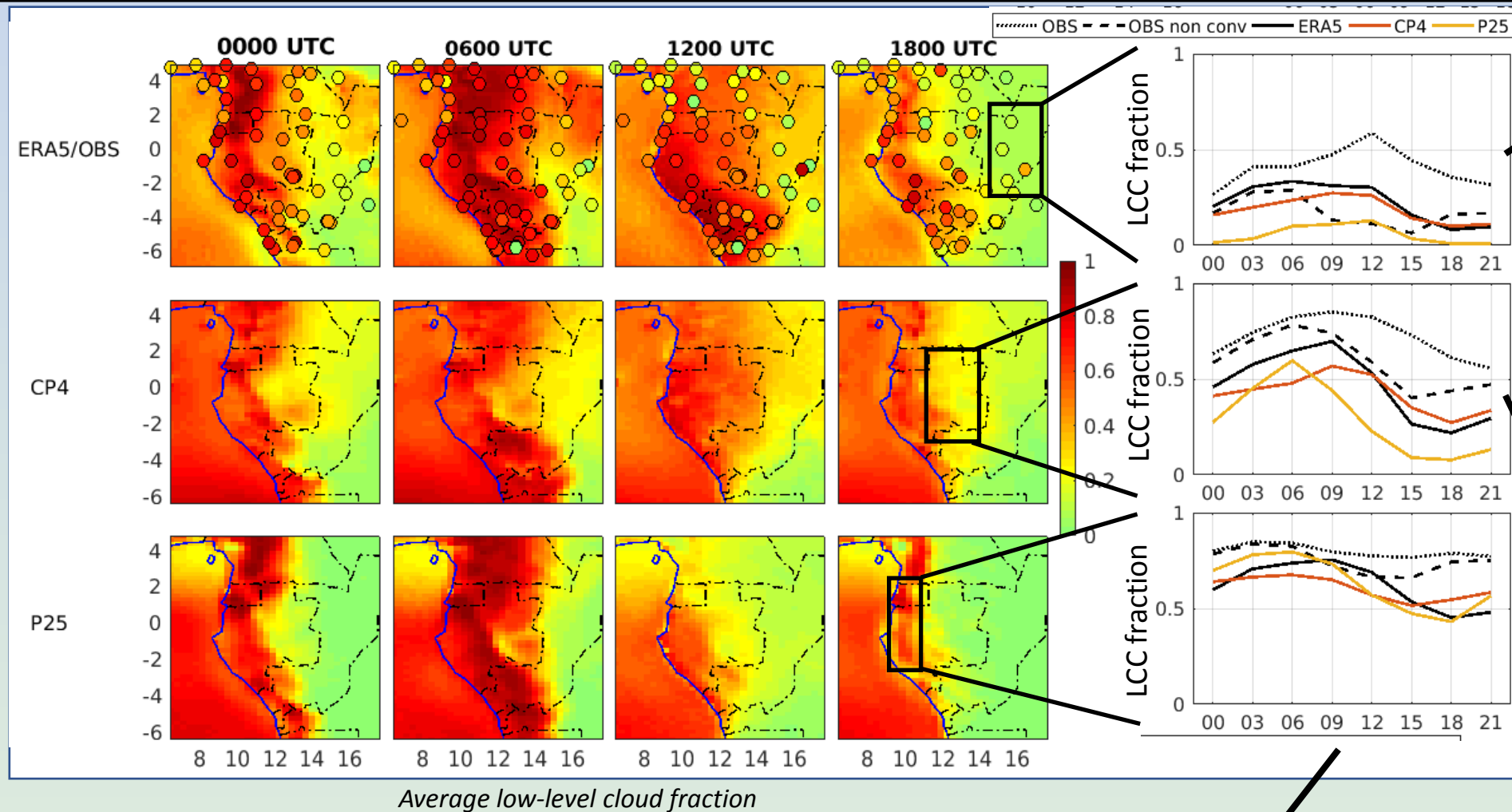
- **CP4 Africa (1997-2006):** (4km horizontal res. and reggrided to 25km) forced with N512L85 global model run in **1988-2010** and **daily sea surface temperature** (SST, Reynolds 1988)
- **P25-Africa (1997-2006):** (25km resolution) Regional climate model with **same resolution and settings as the global model** (convection parametrized). Aerosols and soil surface similar as CP4.
- **Concatenated low level clouds in situ observations (1971-2019).**
- **Low cloud cover from ERA5 reanalyses data (1979-2019).**

## METHOD: Comparison of LLC dataset in term of:

- (1) The spatial variability of the diurnal cycle
- (2) The temporal variability of these diurnal cycles (Diurnal types identified from in situ observations (points) using k-means algorithm).



# Diurnal change of low level clouds



## In NE Republic of Congo:

- All products fail to recreate **OBS** diurnal cycle (convective clouds counted as LCC in **ERA5** and **CP4**?)
- **CP4** improves **P25** negative bias

## In Eastern Gabon:

- Better representation of diurnal cycle in **all models**
- **CP4** improves **P25** negative bias
- **CP4** still underestimate LCC at night

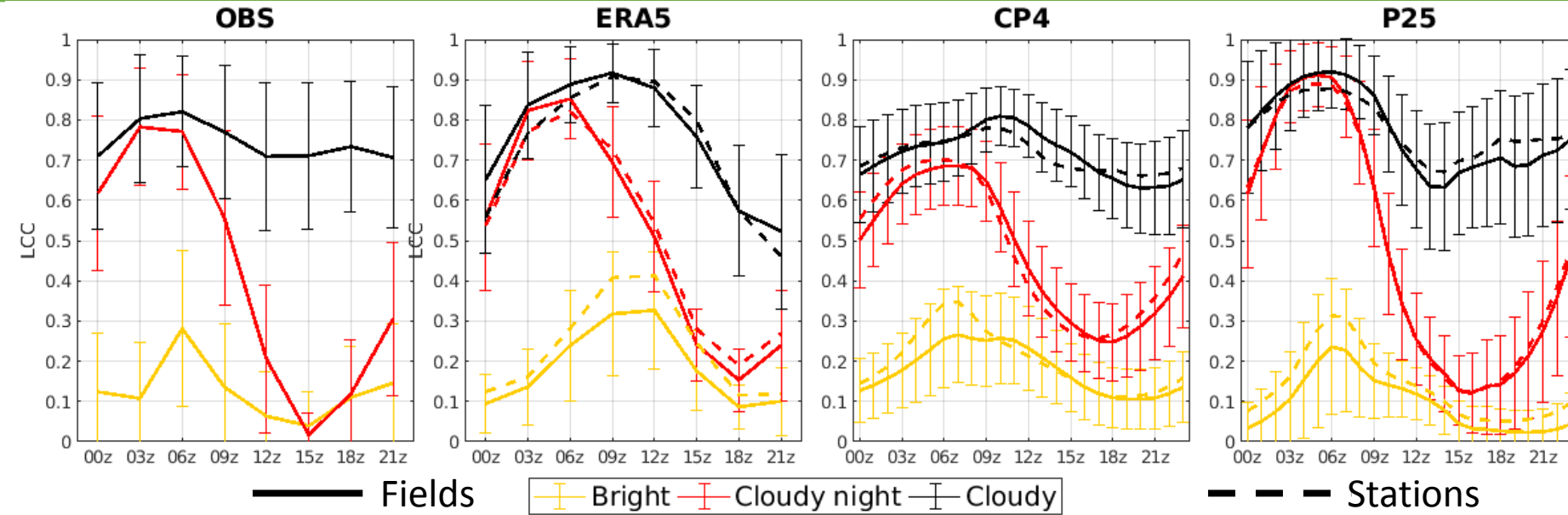
## Is CP4 improving representation of LCC?

**Less underestimation of Low cloud cover in the east**  
**BUT the diurnal cycle is still wrong (convective clouds?) and not enough amplitude in the west (too low night clouds)**

## Coastal Gabon:

- **CP4** does not improve the overall **P25** negative bias
- **CP4** underestimate the diurnal amplitude
- **P25** still overestimate the diurnal amplitude

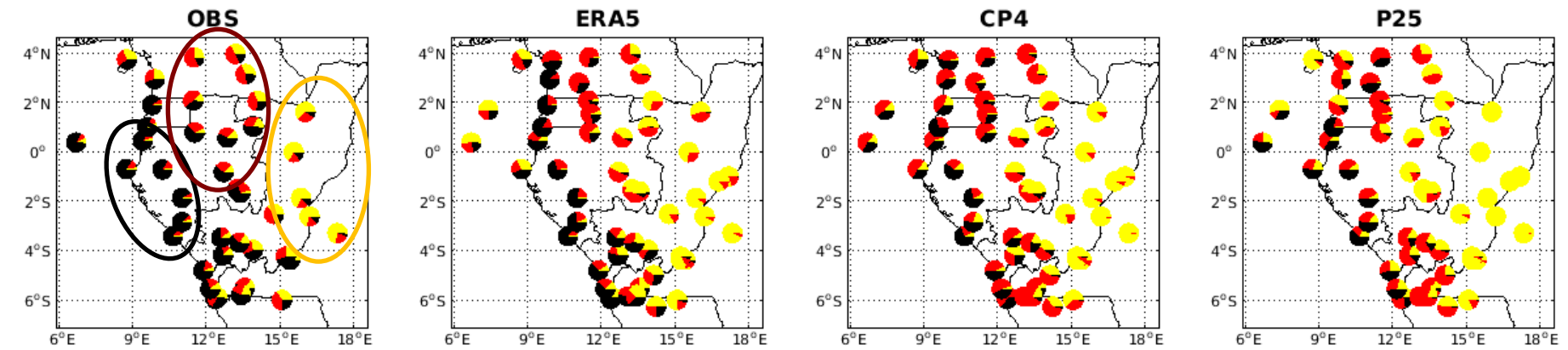
# Diurnal types of low level clouds



The amplitude of diurnal types is underestimated in CP4, overestimated in P25

In the East: **Bright type** more hegemonic in all products and mainly in P25

In coastal Gabon: **Cloudy** stays dominant but **cloudy night** is also present

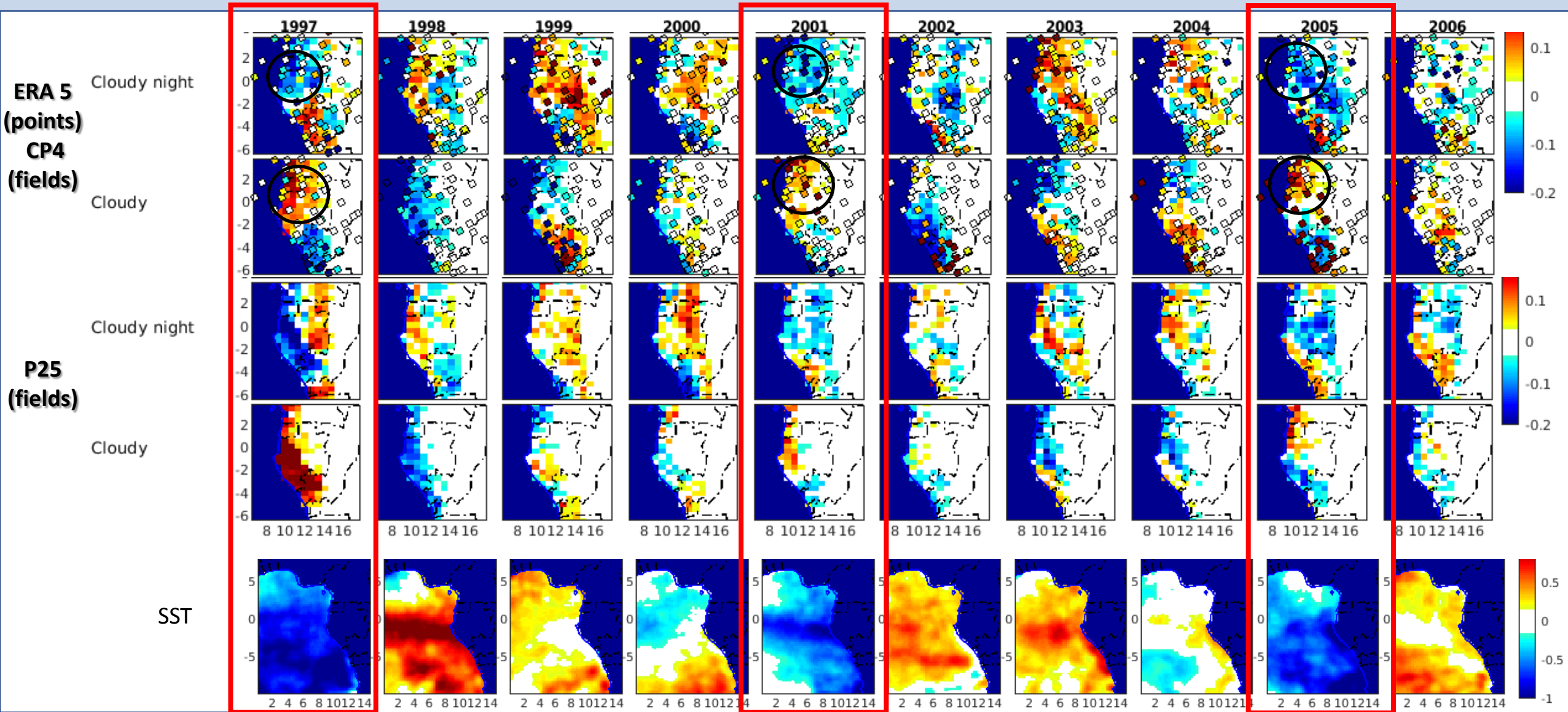


Diurnal types calculated from OBS

- In the NE RC Type 'Bright' dominant,
- In Eastern Gabon mix between Type 'Cloudy night' and 'Cloudy'
- In coastal Gabon Cloudy is dominant

Main differences is between OBS and ERA5/CP4/P25  
(more in my online presentation)

# Interannual evolution of Diurnal types occurrences



Low SST in the Atlantic ocean decrease (increase) the number of cloudy night (cloudy) types in Gabon (Ex. 1997, 2001, 2005). Signal very strong in 1997 in P25 (El Nino?)

# Conclusion

- The **low-level clouds** in **West Equatorial Africa** in June-september (1997-2006) from the **convection permitting** model **CP4 Africa** shows:

✓ A **reduction of the underestimation** of low-level clouds seen in P25 in the east (due to P25 simulating full LCC **OR** no LCC).

✗ But a Diurnal cycle of low-level clouds still **not matching well the ground observations**: mainly in the **North-east** part of the region:

- **Not enough low level clouds at night** (difficulties simulating full cloudy skies in CP4)
- **Too much clouds during the day** in the **North-east** part of the region likely due to **cumuliform clouds**.

The **apparent improvement of CP4 from P25** is more **due to a more realistic diurnal cycle of convection** than a real improvement in the representation of stratiform clouds.

- For **future research: Medium/high-level clouds** and **other variables** (temperature, wind, pressure, humidity...) should be investigated... and more on interannual variability!





# Thank you!

(Full presentation available online)

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