

climate change initiative

→ CLIMATE MODELLING USER GROUP

ESMValTool Progress Report

A. Lauer, R. King, L. Bock and the ESMValTool development team





Aim of task 4

Exploit ESA CCI and CCI+ data in the context of Earth system model (ESM) evaluation with the Earth System Model Evaluation Tool.

- Enhance ESMValTool with additional diagnostics and performance metrics for the evaluation of models with ESA CCI and CCI+ data
- Implementing new CCI datasets and corresponding diagnostics into ESMValTool
- Update existing datasets (where needed)
- Explore possibilities to take advantage of the uncertainty information provided with the CCI datasets for model evaluation



WP4.1 Implementation/update of CCI datasets



aerosol
cci

update to Swansea ATSR (v4.33) and SLSTR / 3A (v1.12) OR ensemble (ATSR v3.0 and SLSTR / 3A v2.2) v6.1



permafrost
cci

implement MODISLST_CRYOGRID-AREA4_PP-fv03.0



For optional WP



biomass
cci

implement L4-AGB-MERGED-100m-2018-fv3.0



snow
cci

implement multi-sensor.multi-platform.MERGED.2-0.r1



cloud
cci

v3.0 AVHRR AM+PM
add L3U data (daily)



soil moisture
cci

update to version v8.1



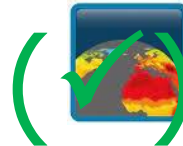
land cover
cci

update to v2.0.8



sst
cci

add daily values
update to v3.0



land surface temperature
cci

v3.00, MODIS EOS Aqua
add daily values



water vapour
cci

v3.1 TCWV-global (COMBI)
add daily values



sensible for selected time periods only





Implementation/update of CCI datasets



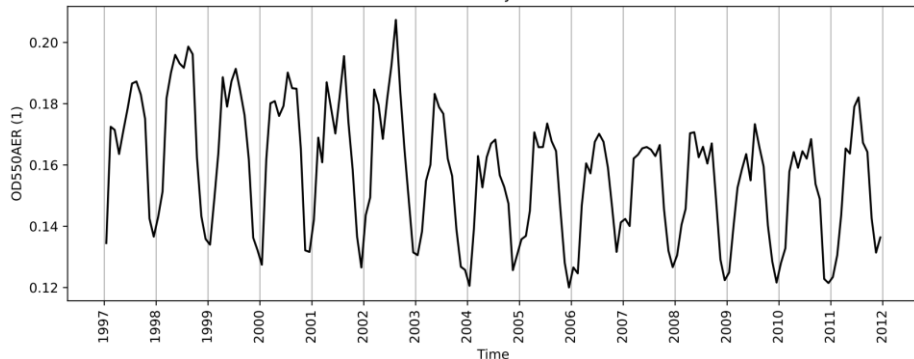
aerosol update Swansea ATSR (v4.3)

cci

Global mean aerosol optical depth (550 nm)

– monthly means (1) –

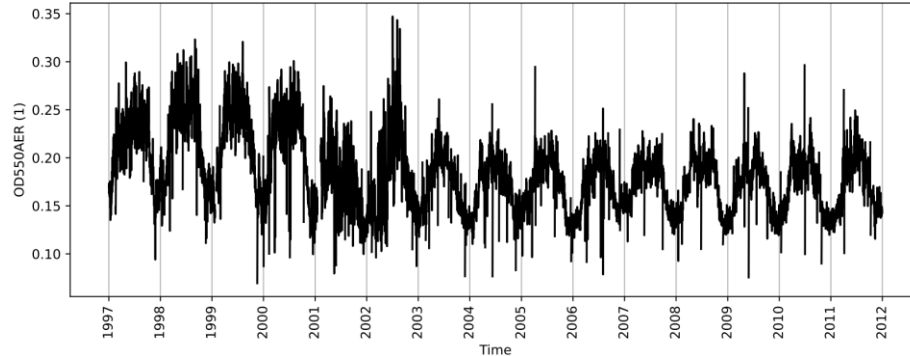
Time series of monthly mean OD550AER



Global mean aerosol optical depth (550 nm)

– daily values (1) –

Time series of monthly mean OD550AER





Implementation/update of CCI datasets

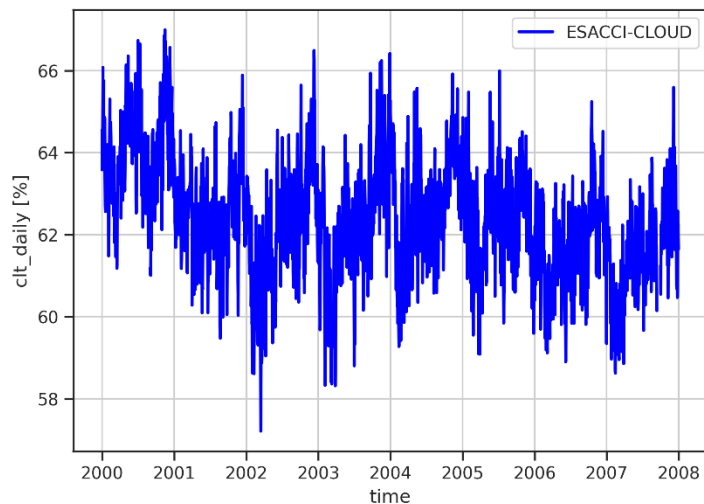


cloud
cci

v3.0 AVHRR AM+PM
add L3U data (daily)

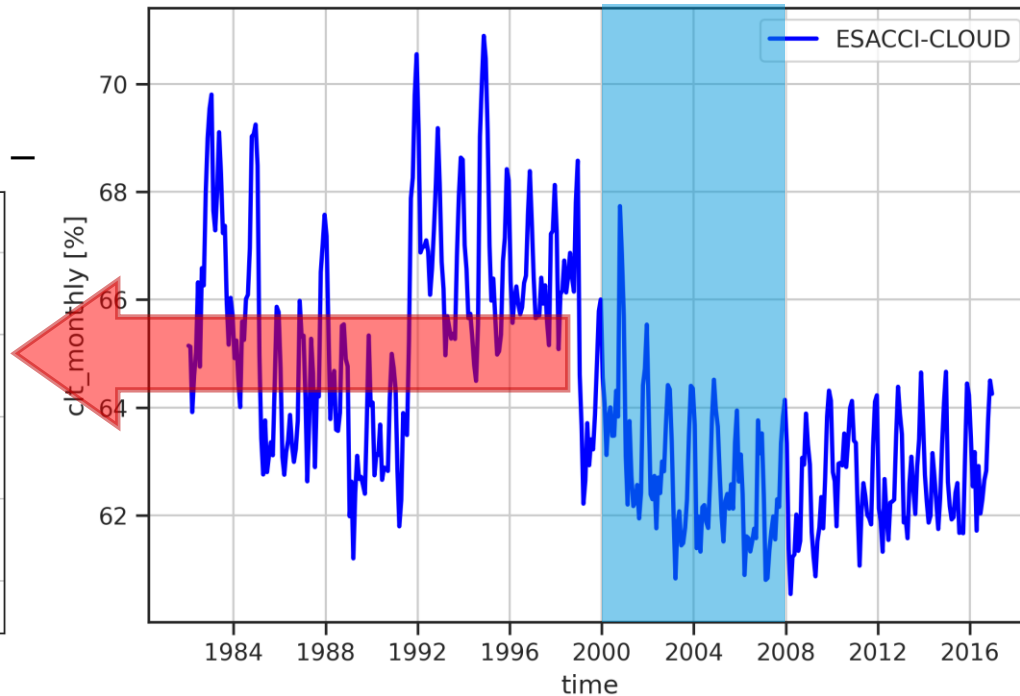
Total cloud fraction

– daily global means (AVHRR-PM) –



Total cloud fraction

– monthly global means (AVHRR AM+PM) –

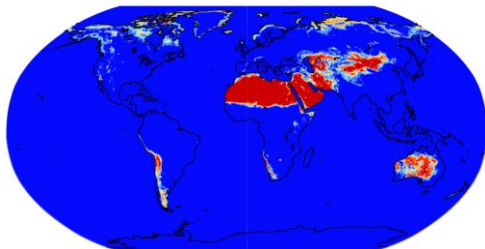




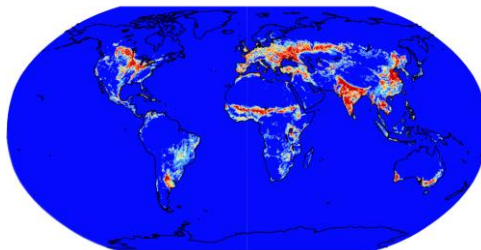
land cover **update** to v2.0.8
cci

ESA Land Cover Climate Change Initiative (Land_Cover_cci):
Global Plant Functional Types (PFT) Dataset, v2.0.8

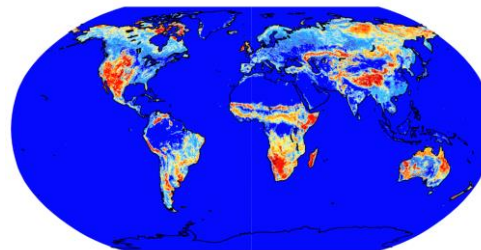
Bare soil fraction



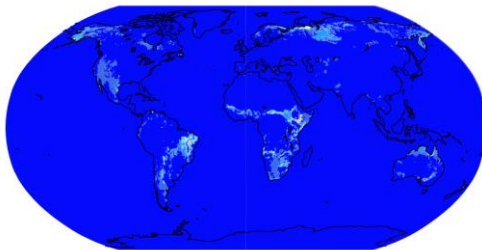
Crop fraction



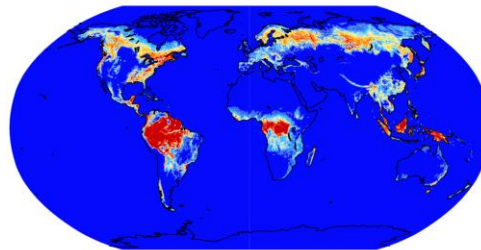
Grass fraction



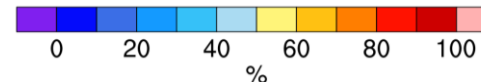
Shrub fraction



Tree fraction



PFT fraction (1996)





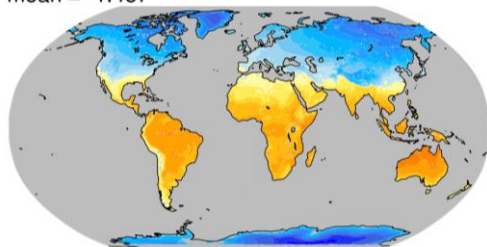
Examples land surface temperature



v3.00, MODIS EOS Aqua

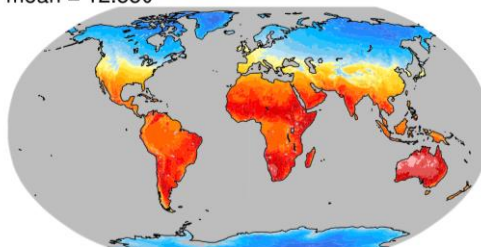
DJF night

mean = -1.487



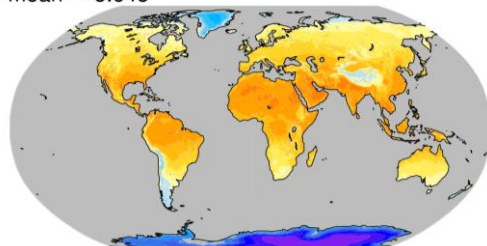
DJF day

mean = 12.880



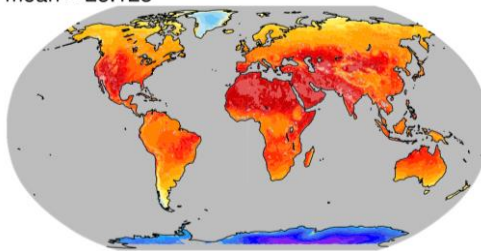
JJA night

mean = 8.645



JJA day

mean = 28.123



Land surface temperature
(seasonal average 2003-2018)



(°C)





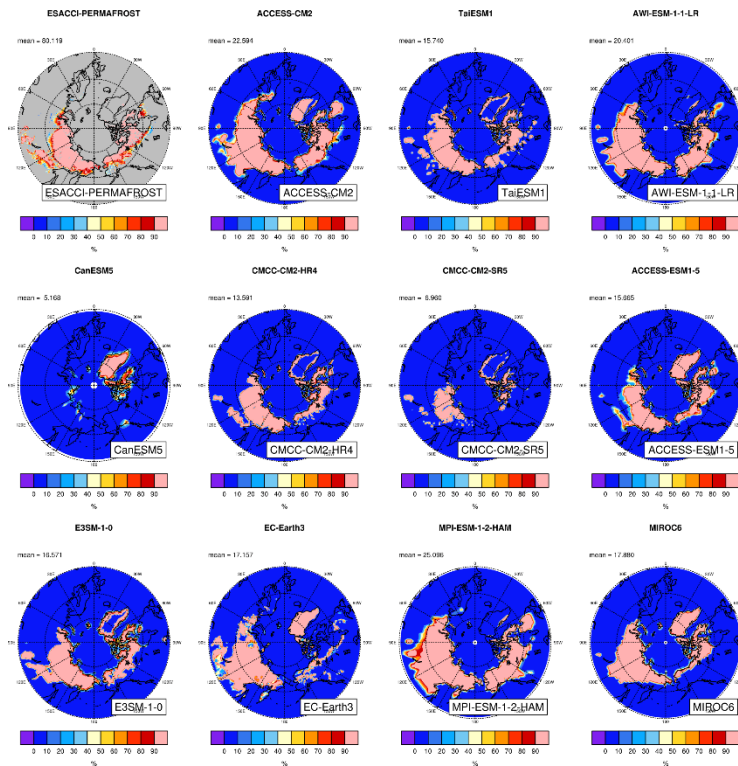
permafrost
cci

Implemented MODISLST_CRYOGRID-
AREA4_PP-fv03.0

Permafrost extent from CMIP models (Burke et al., 2020)

- 1) soil temperature in the deepest level is $< 0^{\circ}\text{C}$,
- 2) for at least 24 consecutive months, and
- 3) ice-covered part of grid cell is excluded

20-year annual average permafrost
extent from CMIP6 models compared
with ESACCI-PERMAFROST





Implementation/update of CCI datasets

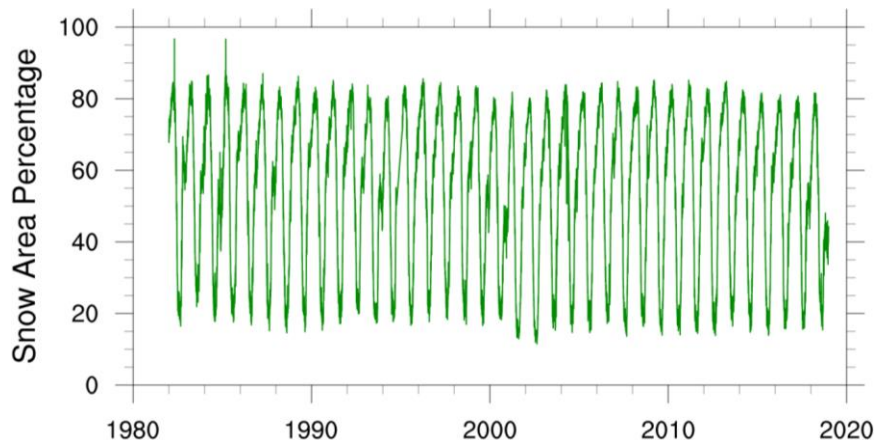


snow
cci

implemented multi-sensor.multi-
platform.MERGED.2-0.r1

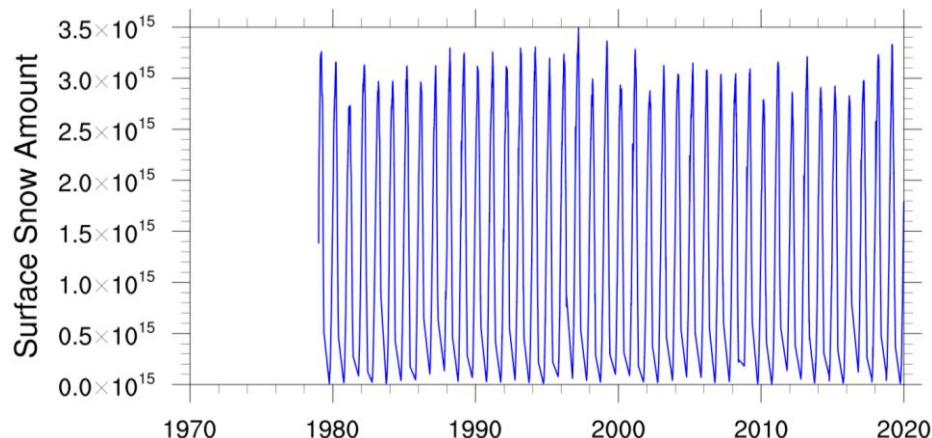
Global **mean** snow area fraction

– AVHRR (merged) daily values > 0% –



Global **sum** snow water equivalent

– daily values (SMRR-NIMBUS7, SSMI-
DMSP, SSMIS-DMSP) (10^{15} kg) –





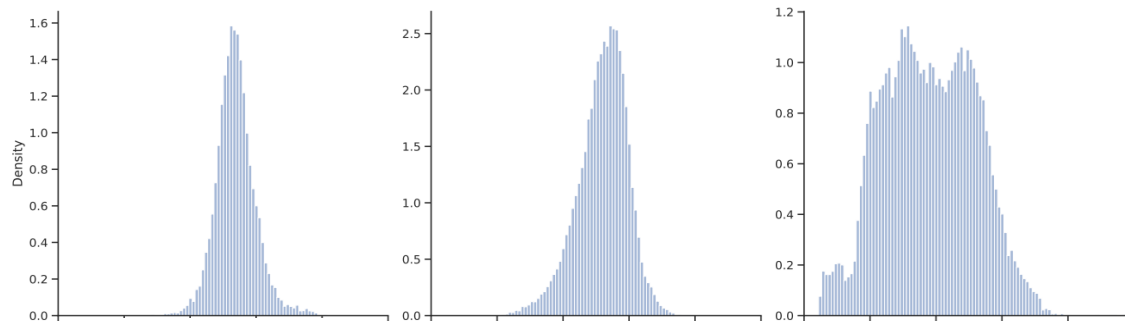
Examples soil moisture



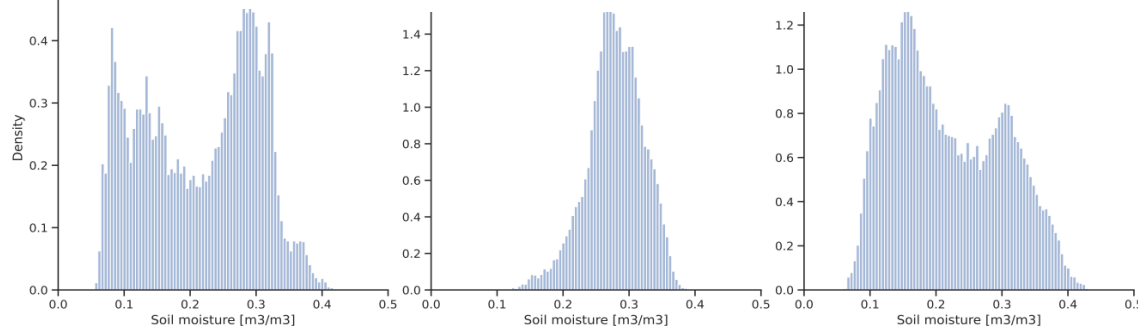
soil moisture
cci

update to version v8.1

Northern Europe West & Central Europe Mediterranean



Central Africa Eastern North America South Asia



Spatiotemporal distribution of monthly mean soil moisture from ESA CCI SOILMOISTURE in the period 1979-2022 for six IPCC AR6 regions. Each month in each grid cell in the corresponding regions is considered with equal weight.

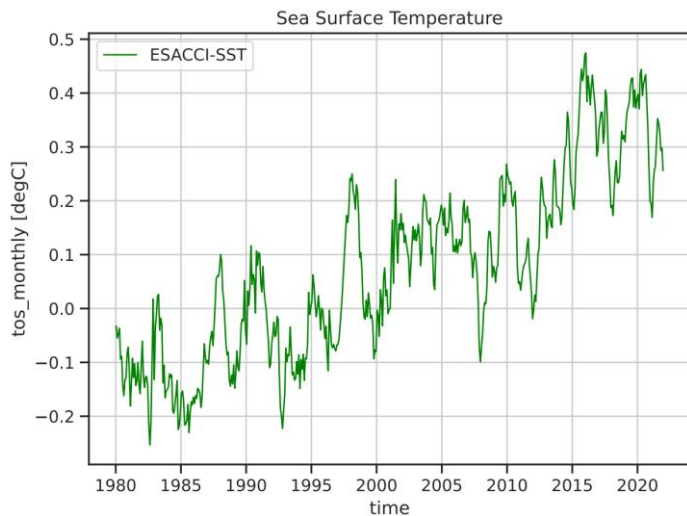




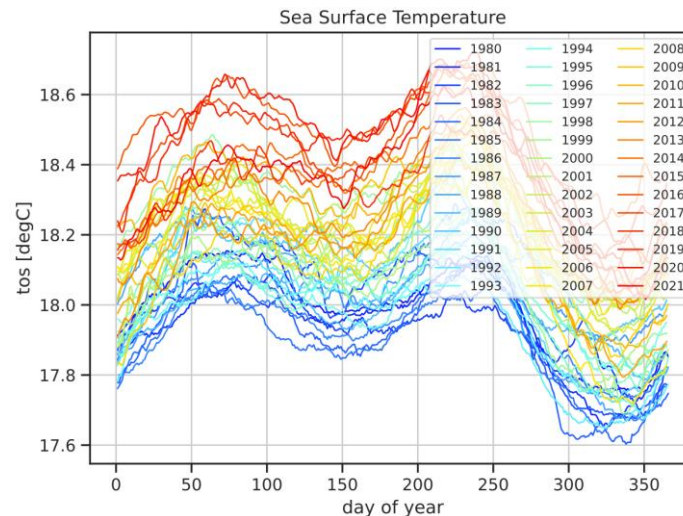
sst
cci

add daily values
update to v3.0

Global average monthly SST anomalies



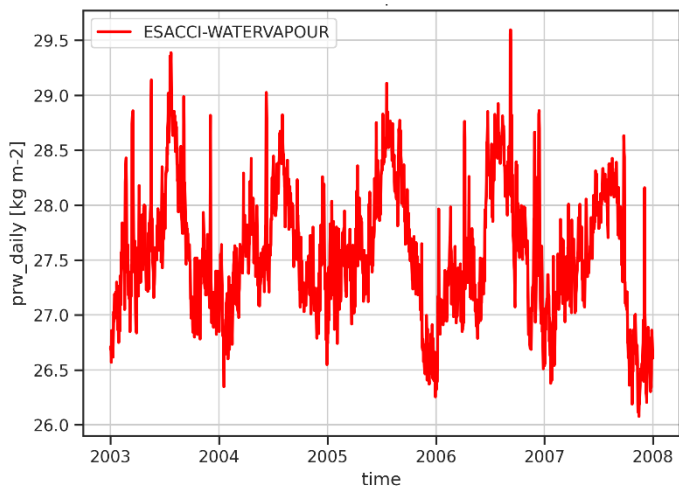
Global average daily SST



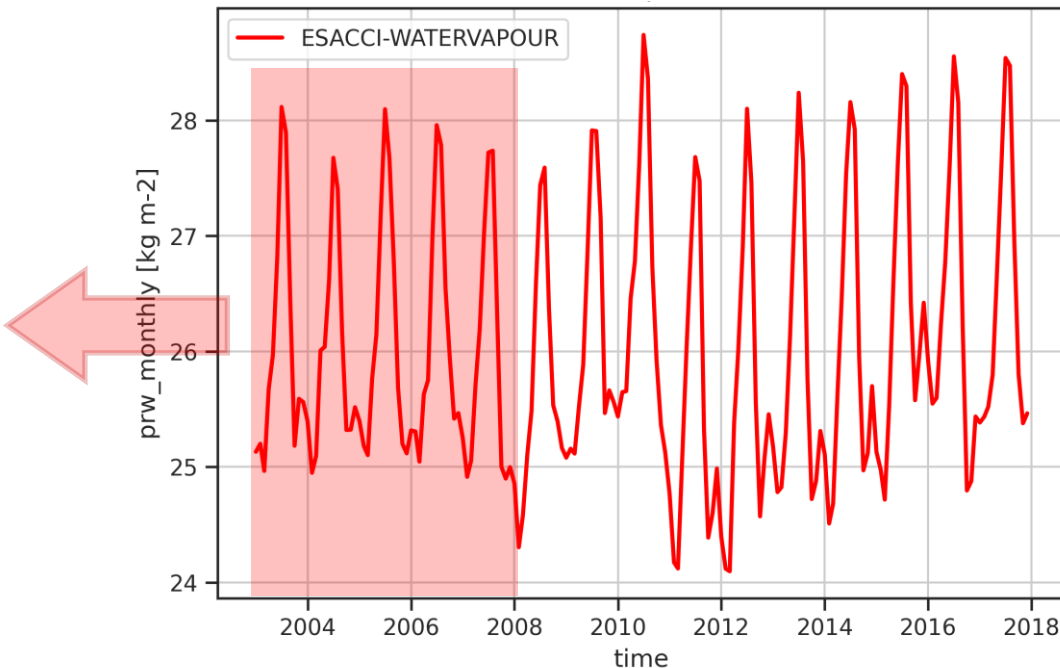


water vapour v3.1 TCWV-global (COMBI)
cci **add** daily

Water vapor path – **daily** global means –

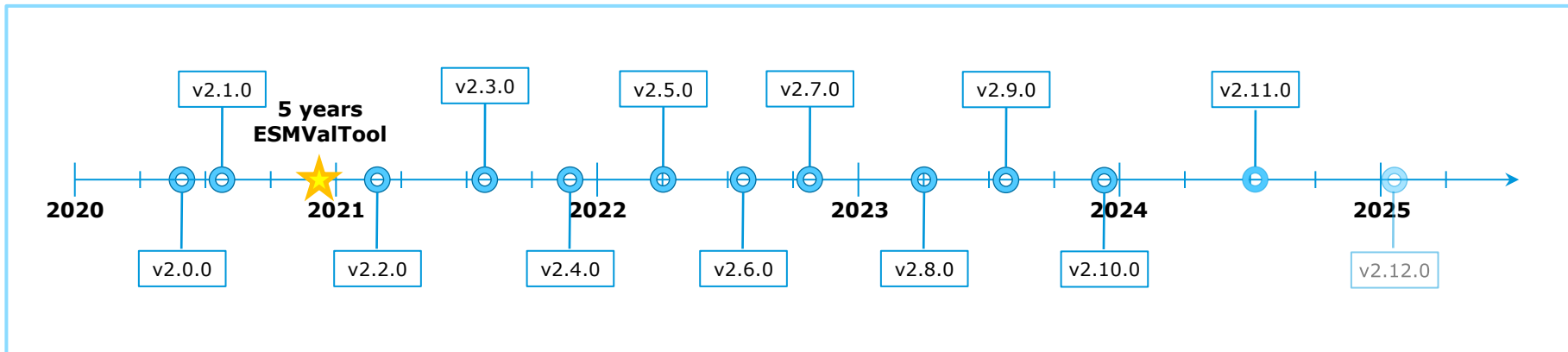


Water vapor path – **monthly** global means –





ESMValTool v2.11.0 released 4 July 2024





Highlights

- New **diagnostics**, e.g. evaluation of AOD climatologies against ground based observations from AeroNET, climate patterns from CMIP6 model
- New **preprocessing functions**, e.g. local solar time, histograms, distance metrics
- Support for new **reference datasets**, e.g. AeroNET, ANU Climate 2.0 Australian data, Australian Gridded Climate Data(AGCD) precipitation, NOAA-ERSST, NSIDC-G02202-sh sea ice fraction
- Significantly **improved performance** (better parallelization and memory management through Dask.distributed)
 - Schlund et al.: Improving climate model evaluation with ESMValTool v2.11.0 using parallel, out-of-core, and distributed computing, Geosci. Model Dev. (in preparation)



Robert King (Met Office), Axel Lauer (DLR), Claire Bulgin (University of Reading)

Aim

Demonstrate how ESMValTool can be used to propagate uncertainty information given in satellite observation products to evaluate ESM outputs, focusing on LST.



Diagnostic propagates uncertainty components across a selected region

Four components of uncertainty

1. Local correlated (atmosphere)
2. Locally correlated (surface)
3. Systematic
 - Uses the land cover class to propagate across correlated biomes
4. Random
 - Uses sampling error considering the number of available data values in the region

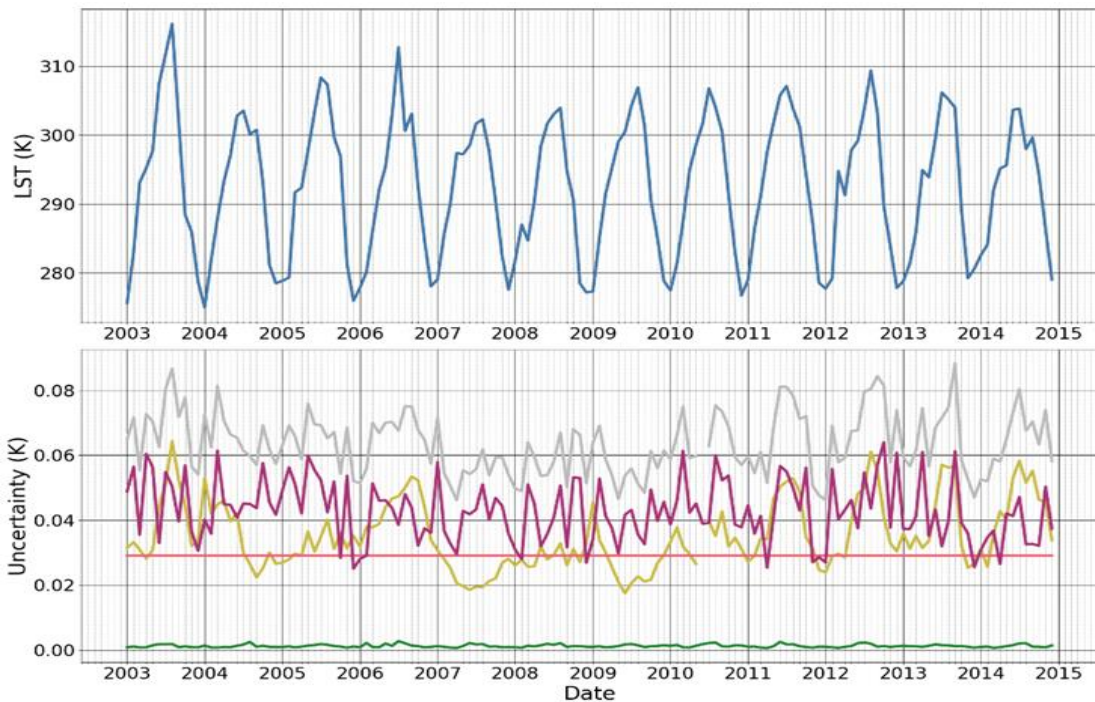


Example, region in France



MODIS Aqua (daytime)

Longitude: 2.6-3.0 E
Latitude: 46.1-47.5 N
2003-2014

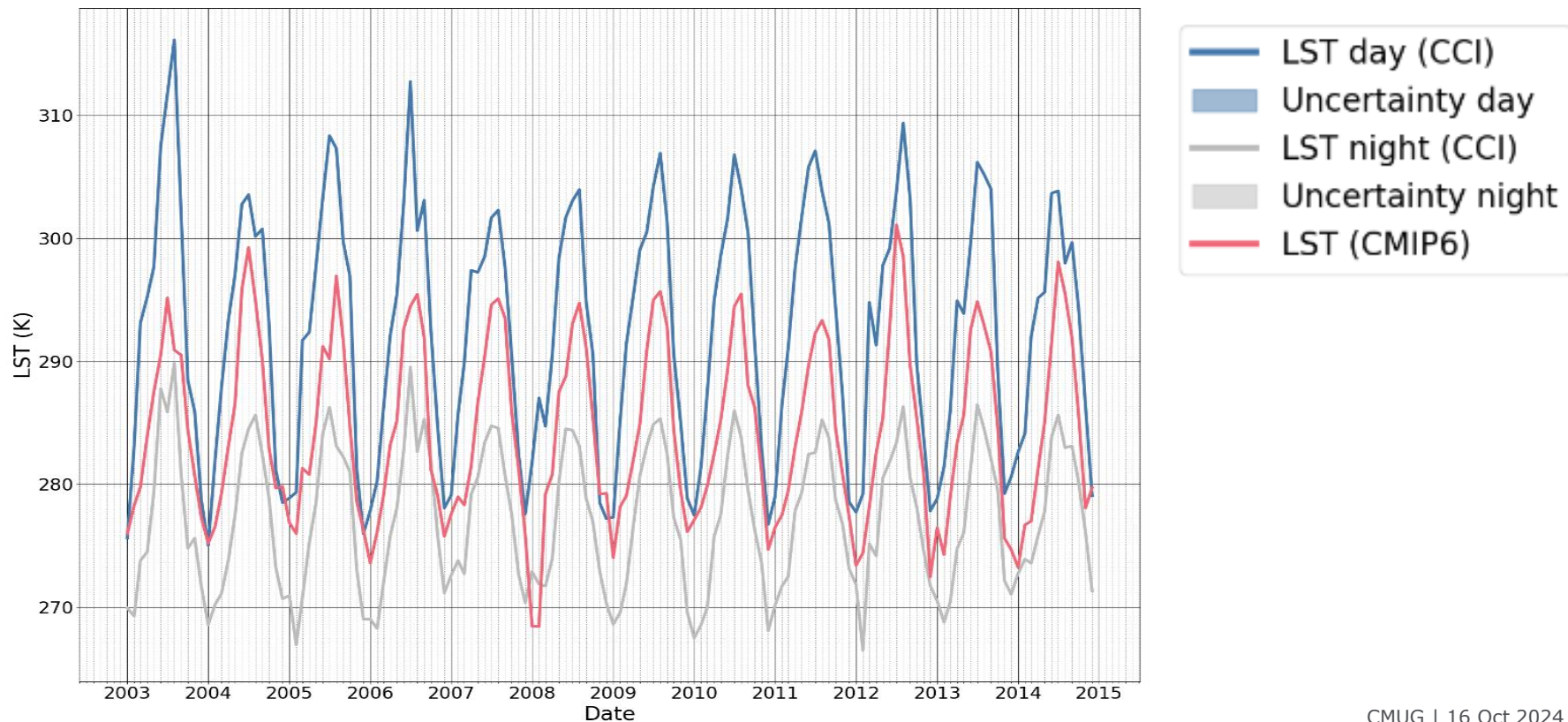


	LST with Total Uncertainty range shaded
Uncertainty Components	
	Local Atmospheric
	Local Surface
	Systematic
	Random
	Total





Example, CMIP6 model UKESM





Deliverable **D5.3.v1** (annual report on progress achieved in integrating CCI ECVs into ESMValTool and the development of associated tools and diagnostics)

→ ready to be submitted

Thank you!