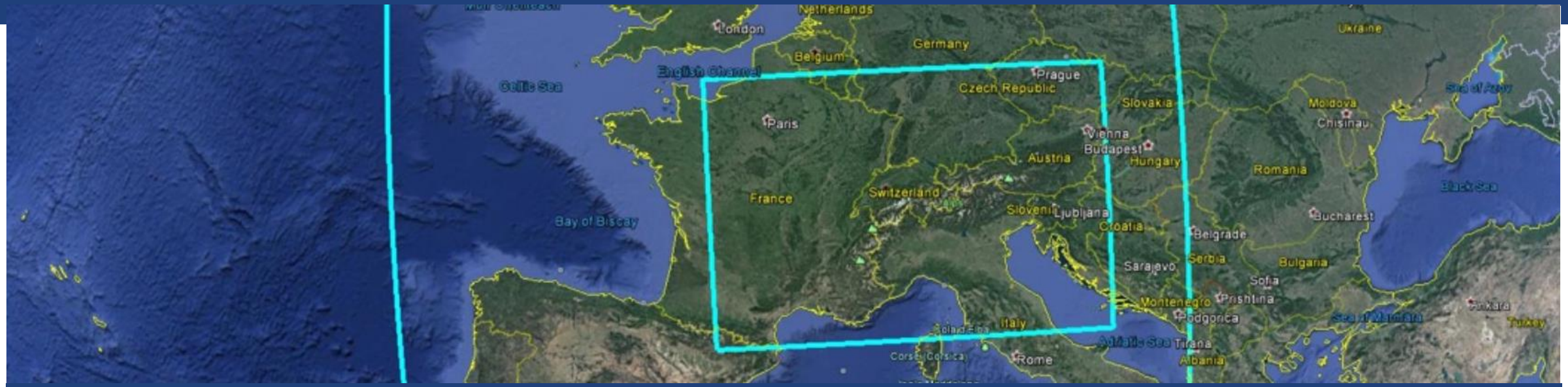
ETH zürich



Evaluation of COSMO-CLM² in weather mode

Verena Bessenbacher

Master Thesis, starting Autumn 2017 *(Master in Atmospheric and Climate Sciences, ETH Zürich)*

supervisors: Dr. Jean-Marie Bettems (MeteoSwiss),
Dr. Edouard Davin (ETHZ),
Prof. Dr. Sonia Seneviratne (ETHZ)

IAC Institute for Atmospheric and Climate Science

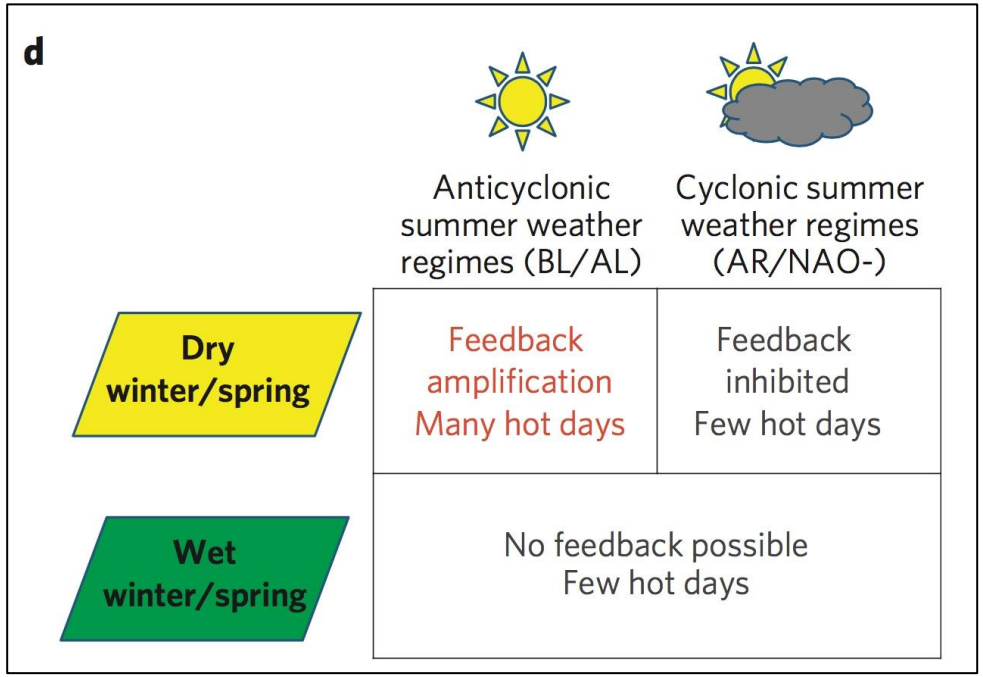
Motivation

COSMO PT: TERRA NOVA	
lead:	Yiftach Ziv
goal:	document impact of new TERRA
target areas:	Western Europe, Eastern Mediterranean, Northern part of European Russia
resolution:	6.6 km and 2.2 km
periods (Europe):	JJA 2003, JJA 2006, MAMJJA 2015
models:	TERRA/5.0, TERRA/5.05/standard, TERRA/5.05/advanced, CLM

MASTER THESIS	
team:	Verena Bessenbacher (M.Sc. student) Jean-Marie Bettems, MeteoSwiss Edouard Davin, ETHZ Sonia Seneviratne, ETHZ
goal:	**find main weaknesses of TERRA suggest improvements to TERRA**
target area:	**Western Europe**
resolution:	**6.6 km**
periods (Europe):	JJA 2003, JJA 2006, MAMJJA 2015
models:	TERRA/5.0, TERRA/5.05/standard, TERRA/5.05/advanced, CLM

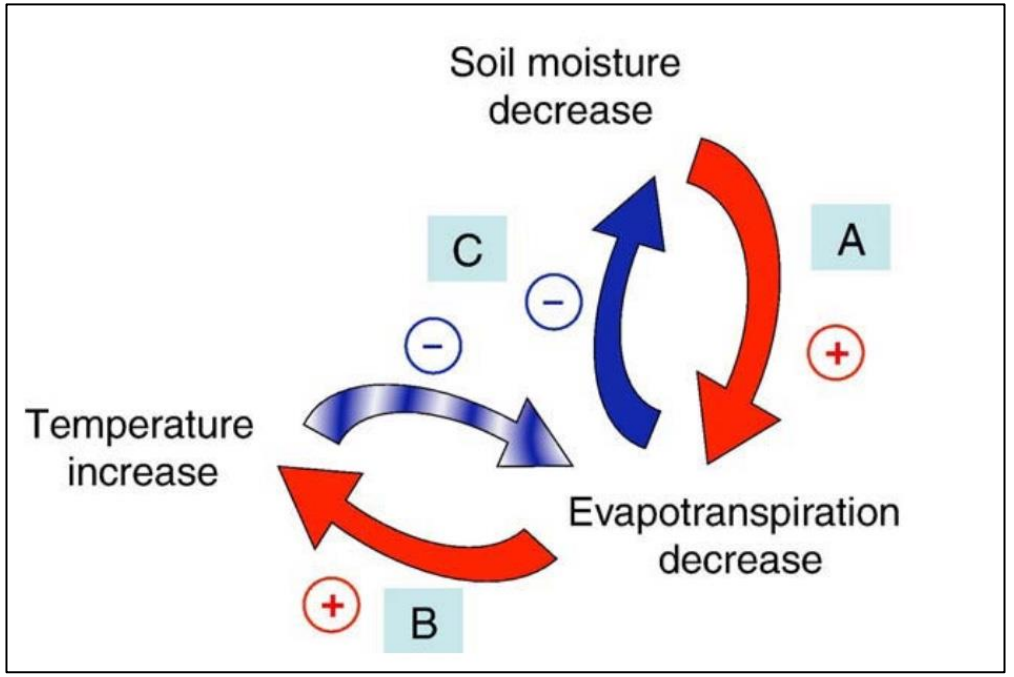
The role of the land surface in European heat extremes

Quesada et al 2012



dry soil moisture is conditional for hot summer extremes to occur…

Seneviratne et al 2010



… since soil moisture feeds back negatively on temperature by controlling ET

Starting point

LETTER

Is land surface processes representation a possible weak link in current Regional Climate Models?

Edouard L Davin[1], Eric Maisonnave[2] and Sonia I Seneviratne[1]

[1] Institute for Atmospheric and Climate Science, ETH Zurich, Zurich, Switzerland
[2] CERFACS, UMR 5318-CNRS, Toulouse, France

(...) COSMO-CLM² outperforms (…) the standard COSMO-CLM (...) in simulating sensible, latent and surface radiative fluxes as well as 2-meter temperature across different seasons and regions. (...)

*one of the most promising way forward for reducing [systematic] biases [in RCMs] is to **tackle deficiencies in modelled land-atmosphere processes**. (...) land processes play a central role in many long-standing issues affecting RCM performance.*

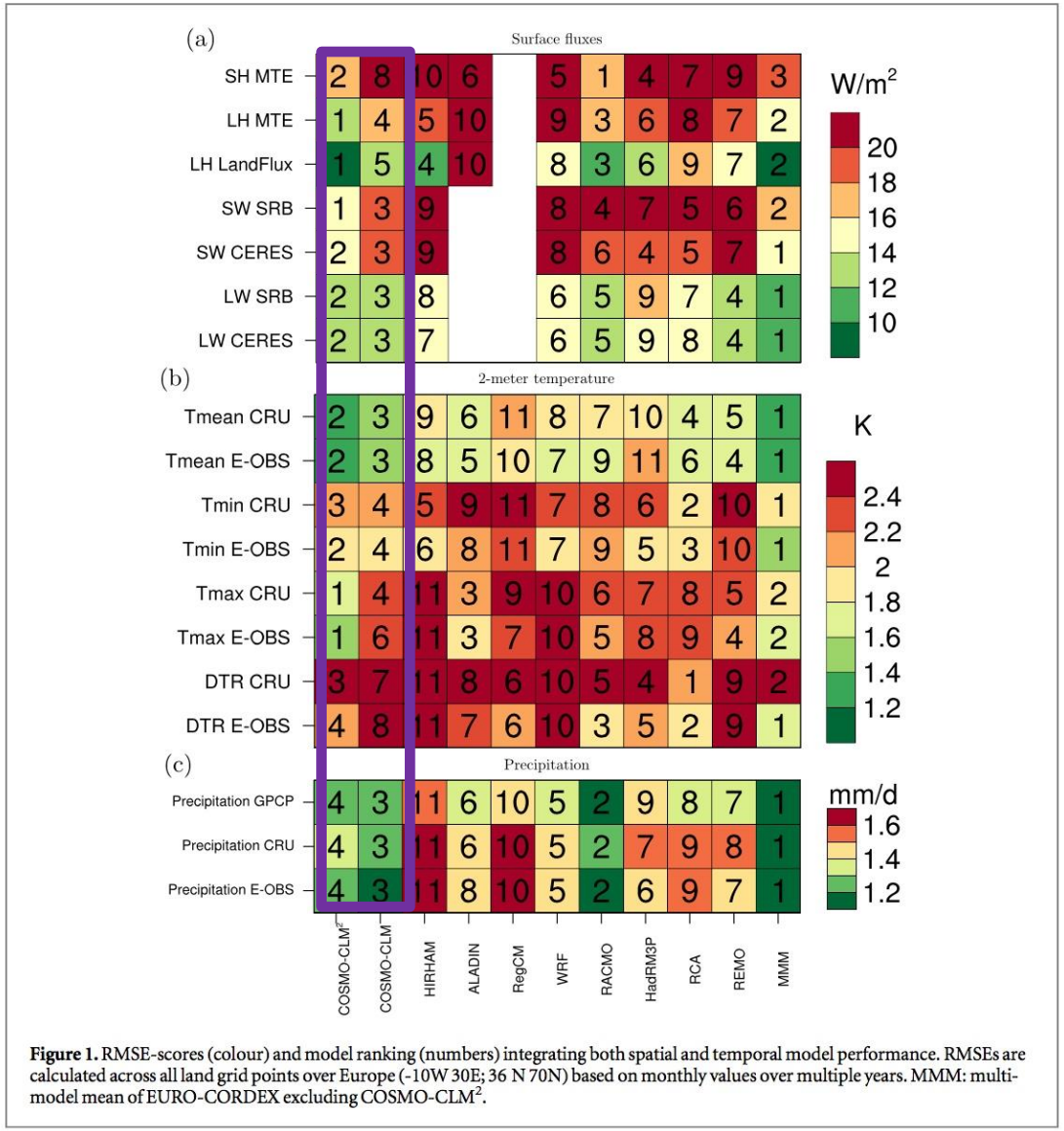


Figure 1. RMSE-scores (colour) and model ranking (numbers) integrating both spatial and temporal model performance. RMSEs are calculated across all land grid points over Europe (-10W 30E; 36 N 70N) based on monthly values over multiple years. MMM: multi-model mean of EURO-CORDEX excluding COSMO-CLM².

Davin et al 2016

COSMO-TERRA vs COSMO-CLM²

synthesized from Davin et al 2011, Doms et al 2011

	TERRA	CLM
surface heterogenity	no subgrid scale heterogenity one soil column per gridcell vegetation represented by LAI and rooting depth	tile approach vegetation represented by 16 PFTs
radiation fluxes	from grid-scale surface albedo and temperature	considering diffuse/direct, canopy(sunlit/shaded)/surface fluxes
turbulent fluxes	1-D Diagnostic 2.5 Order Closure (Mellor–Yamada) Standard Bulk-Transfer Scheme	Monin–Obukhov Similarity Theory partition into vegetation and ground fluxes
hydrology	solve Richard‘s equation only gravitational drainage 6 soil types, 7 soil layers	solve Richard‘s equation additionally: dynamic coupling between the soil column and the underlying aquifer
stomatal conductance and photosynthesis	2nd generation: empirical (depending on light, soil moisture, temperature and atmospheric humidity)	3rd generation: stomatal conductance (Collatz et al 1991) linked with photosynthesis (Farquhar 1980)
surface datasets	GLOBCOVER2009: land cover FAO: soil types	MODIS: land cover, LAI, soil color IGBP: vertical heterogenity of soil

TERRA 5.0	old physics
TERRA 5.05/standard	new ICON physics but old namelist settings
TERRA 5.05/advanced	new ICON physics with new namelist settings

Available observations

model output	FLUXNET (site)	FLUXNET MTE (gridded)	Satellite LST	SWBM dataset	LandFlux-EVAL	EOBS
kind of observation resolution time period	EddyCovariance site-dependent site-dependent	EddyCovariance upscaled 0.5° × 0.5°, monthly 1982-2007	thermal infrared from EUMETSAT 5 × 5km, hourly 1991-2015	Simple water balance model 0.5° × 0.5°, daily 1984–2013	40 sets from obs, models and reanalysis monthly 1989 – 1995 (subset – 2005)	meteorological stations 0.1° × 0.1°, daily 1950-2006
key limitation	point data	upscaling	transformation	coarse resolution	only monthly	until 2006, no fluxes
SH [W m^{-2}]	SH	SH	radiative ground temperature [K]			surface temperature (min, max, mean) [°C]
LH[W m^{-2}]	LH	LH		ET	ET	
LW [W m^{-2}]	LW	LW				
SW [W m^{-2}]	SW	SW				
Wind [ms^{-1}]	wind speed					
Precipitation [mm]	precipitation					precipitation
others	…	…		soil moisture, runoff		

standard verification scheme

priority	RA	spatial extent	time periods	observational datasets	model resolution	variables
priority	1.1	Western Europe	all	all	6.6km	meteorological variables

standard measures

for *deterministic continuous forecasts*

- bias
- MAE
- MSE/ RMSE
- lin. correlation coefficient
- lin. regression slope
- taylor diagram
- … (upon discussion)

analysis tools

availibility?

- movero from MeteoSwiss
- rdfbk from DWD
- VERSUS at ECMWF

further analysis ideas

priority	RA	spatial extent	time periods	observational datasets	model resolution	variables
priority	1.2	Western Europe	all + ref	flux data	6.6km	turbulent fluxes

advanced statistical methods, e.g. correlation analysis

priority	1.3	Western Europe	all	LST, EOBS	6.6km	T, precip

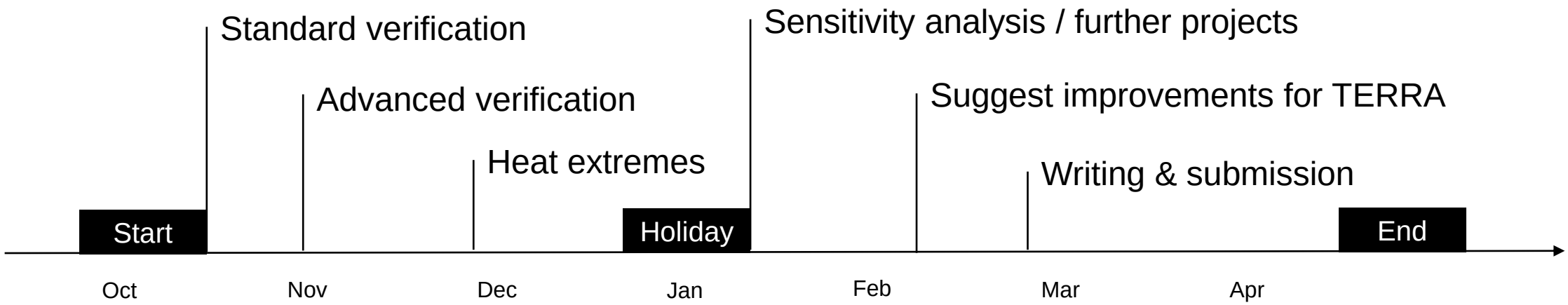
representation of ‘extremeness’ in models with
comparing different extreme event representations

other explorative methods

priority	RA	spatial extent	time periods	observational datasets	model resolution	variables
optional	extended analysis					

- sensitivity analysis: own run with different parameterizations
- coming up with my own definition of extreme events using machine learning (maybe? ☺)
- what comes up along the way …
- happy for input!

timeline

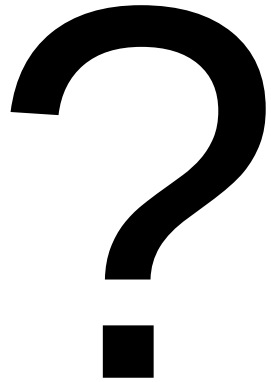

Standard verification
Advanced verification
Heat extremes
Sensitivity analysis / further projects
Suggest improvements for TERRA
Writing & submission
Start
Holiday
End
Oct
Nov
Dec
Jan
Feb
Mar
Apr

Discussion

Questions from my side

- are there any pitfalls you would like to mention?
- TERRA differences?
- is moveo/rdfbk available?
- data format issues?
- how to convert radiative temperature to sensible heat flux
- creative ideas?

Questions from your side



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