A research institute
of the ETH Domain

High-resolution climate forcing data & sensitivity experiments

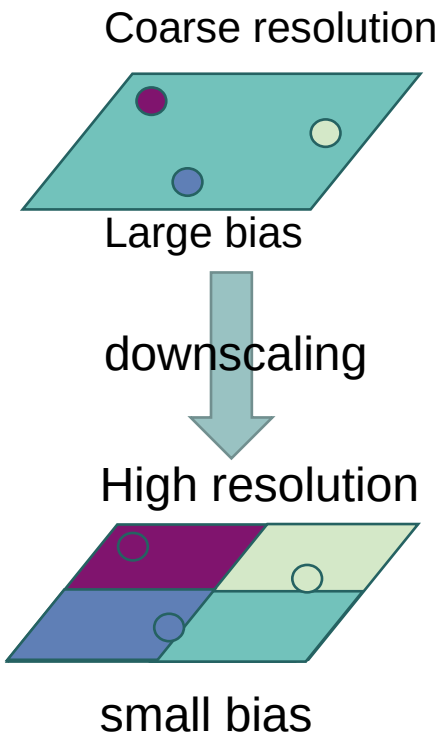
Johanna T. Malle & Dirk N. Karger
Swiss Federal Research Institute WSL
Birmensdorf, Switzerland

- **High-resolution climate forcing data**
  - What is available for ISIMIP3, and how is the performance of the high-resolution data?

- **High-resolution climate forcing sensitivity experiments (TG 1.7)**
  - Overview & first results

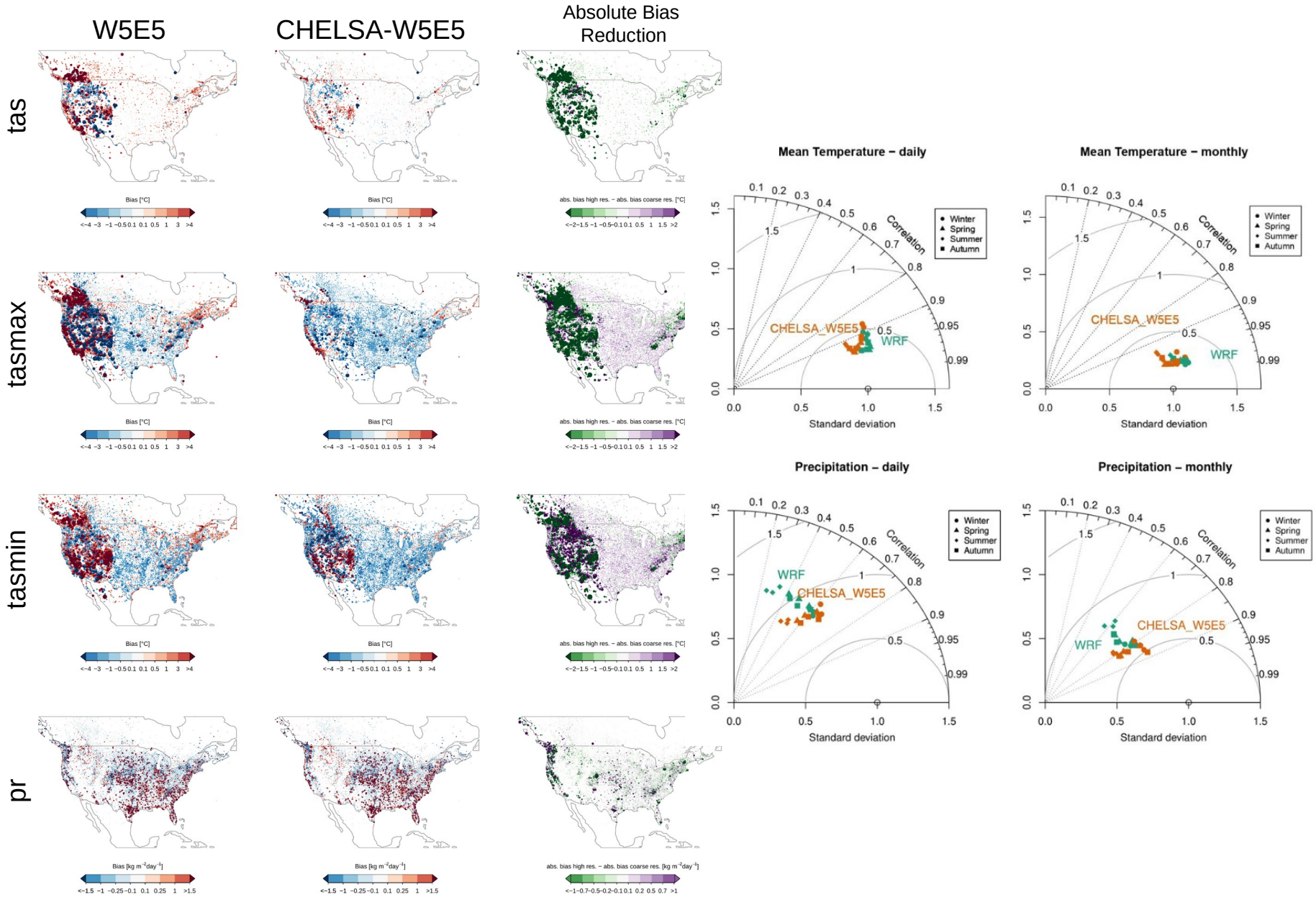
High-resolution climate forcing data

What is available for ISIMIP3?



- Daily precipitation, solar radiation, minimum/maximum/mean temperature
- 30'' / 90'' / 300'' / 1800''
- Historical period (1979 – 2016)
- Download via ISIMIP data portal (https://data.isimip.org/search/query/chelsa/)

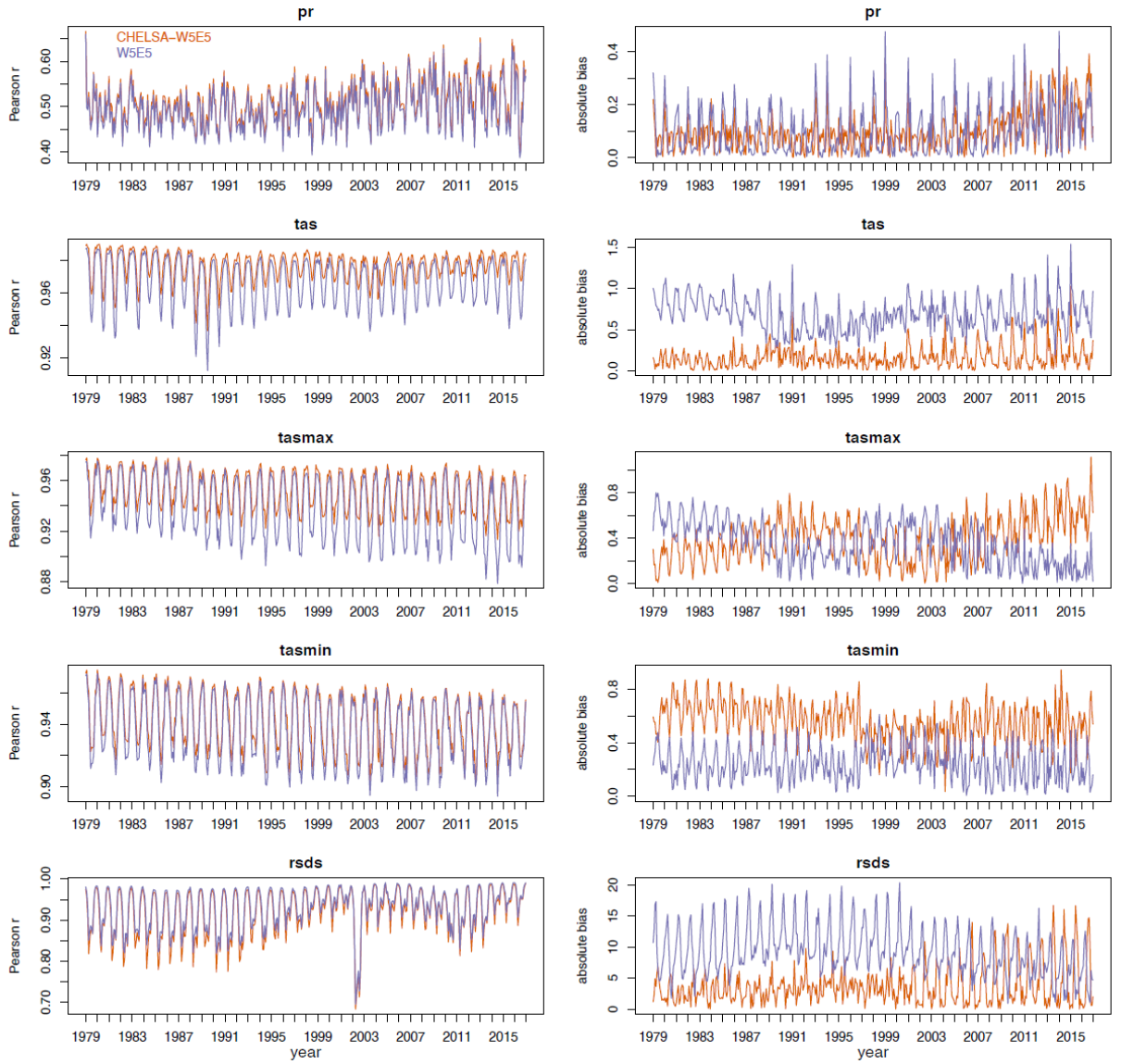
- Highest bias reduction in topographically heterogeneous terrain
- No real effect over flat terrain
- Minimum temperature downscaling not always reliable
- Similar accuracy compared to WRF



Karger, D.N., Lange, S., Hari, C., Reyer, C.O.P., Conrad, O., Zimmermann, N.E., Frieler, K. (in press) CHELSA-W5E5: Daily 1 km meteorological forcing data for climate impact studies. ***Earth System Science Data.*** https://doi.org/10.5194/essd-2022-367

Comparison with GHCN-D

- Correlation usually higher for the highres data, except for rsds
- tasmax and tasmin have various shifts in bias (stations?)
- rsds has lower bias in the highres data

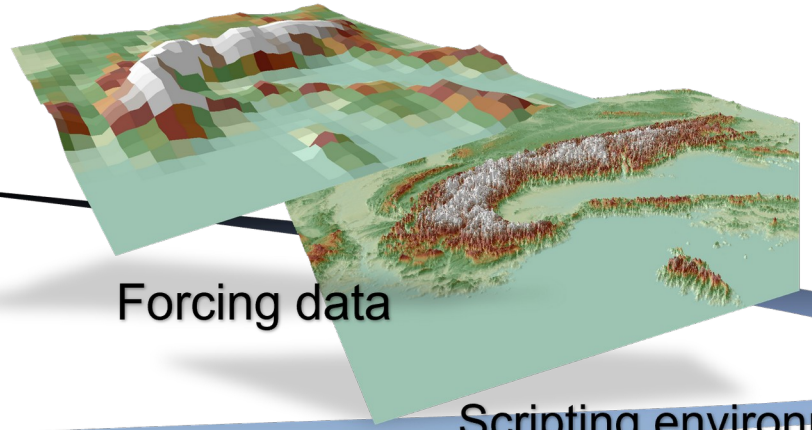


Karger, D.N., Lange, S., Hari, C., Reyer, C.O.P., Conrad, O., Zimmermann, N.E., Frieler, K. (in press) CHELSA-W5E5: Daily 1 km meteorological forcing data for climate impact studies. ***Earth System Science Data.*** https://doi.org/10.5194/essd-2022-367

High-resolution climate forcing sensitivity experiments

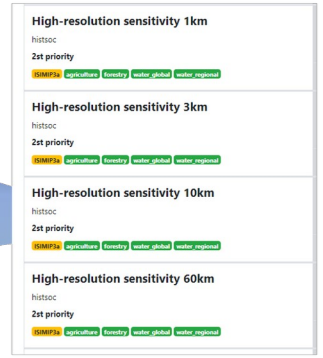
Adohris - Advantages of downscaling climate to high resolution for climate change impact studies

What are the effects of spatial scale in climate change impact models?



Forcing data

Protocol



Scripting environment for missing variables

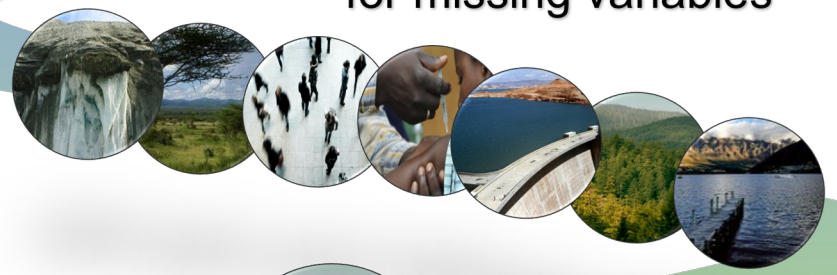
Participating models…

3D-CMCC-FEM
(Coupled Model for Carbon Cycle)
BioGeoChemical - BioPhysical Forest Ecosystem Model

GR4J

ORCHIDEE
LAND SURFACE MODEL

SWIM
Soil and Water Integrated Model



… from 7 different sectors

First results!

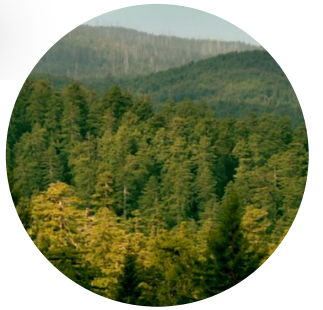
You can still join with your sector and model!

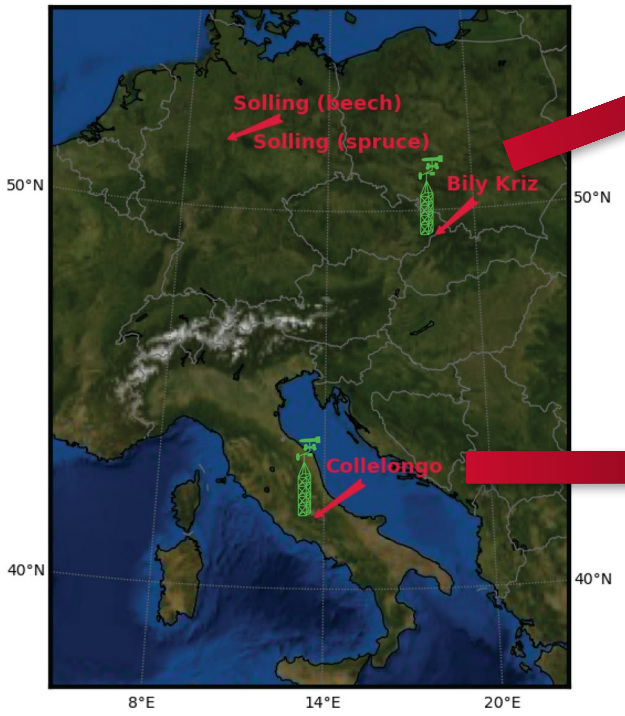
Analysis and paper writing

►Inform future ISIMIP decisions

High-resolution climate forcing sensitivity experiments

First Results





Bily Kriz

	Gross primary productivity				Actual evapotranspiration			
	60km	10km	3km	1km	60km	10km	3km	1km
4C	1.88	1.55	1.32	1.44	4.19	4.20	4.22	4.21
3pgnbw	1.48	1.25	1.22	1.20	-			
3pghydro	3.10	4.11	4.47	4.67	4.19	4.10	4.05	4.06
3D CMCC FEM	1.29	1.22	1.14	1.21	4.22	4.24	4.26	4.25
Biome-BGCMuSo 6.2	3.13	2.67	2.27	2.41	4.09	4.07	4.09	4.07
Biome-BGCMuSo 7.0	3.35	2.99	2.82	2.94	4.08	4.02	4.01	4.00
ensemble mean	2.37	2.30	**2.21**	2.31	4.15	4.13	4.13	**4.12**

norm. MSD: 2 – 4 (GPP); 4.0 – 4.1 – 4.2 (ET)

Collelongo

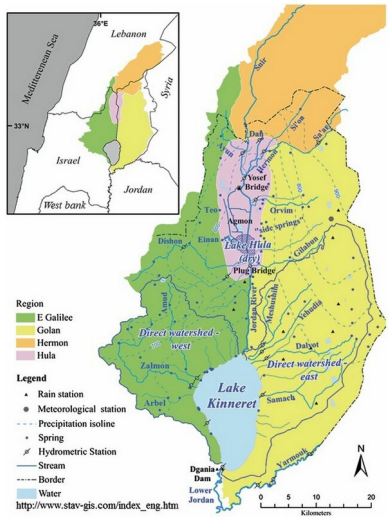
	Gross primary productivity				Actual evapotranspiration			
	60km	10km	3km	1km	60km	10km	3km	1km
4C	1.18	1.07	1.06	1.02	3.84	3.76	3.75	3.69
3pgnbw	1.64	1.40	1.53	1.30	-			
3pghydro	3.09	2.83	3.06	2.44	4.10	4.14	4.13	4.15
3D CMCC FEM	1.63	1.43	1.50	1.26	3.97	3.92	3.90	3.85
Biome-BGCMuSo 6.2	1.71	1.65	1.91	1.84	4.11	4.10	4.09	4.09
Biome-BGCMuSo 7.0	1.05	1.00	1.05	0.99	4.10	4.09	4.09	4.03
ensemble mean	1.72	1.56	1.69	**1.48**	4.02	4.00	3.99	**3.96**

norm. MSD: 1 – 2 – 3 (GPP); 3.8 – 4.0 (ET)

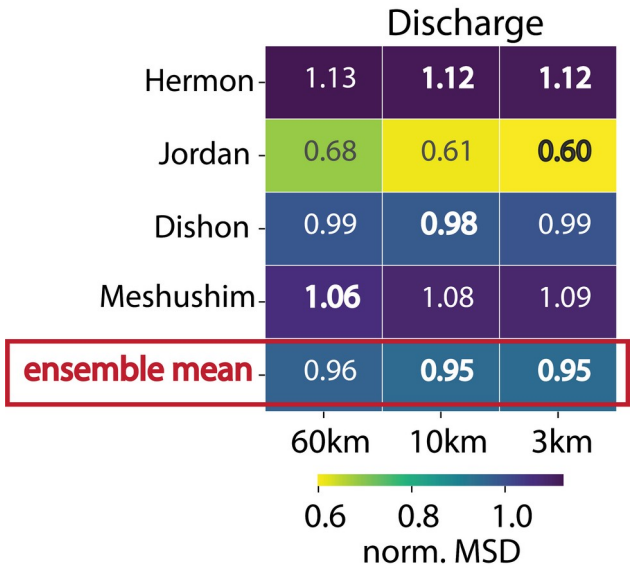
- Similar results between 3km and 1km
- Collelongo located in more complex terrain
  - larger improvement in climate forcing resolution
  - larger effects for forest impact models

High-resolution climate forcing sensitivity experiments

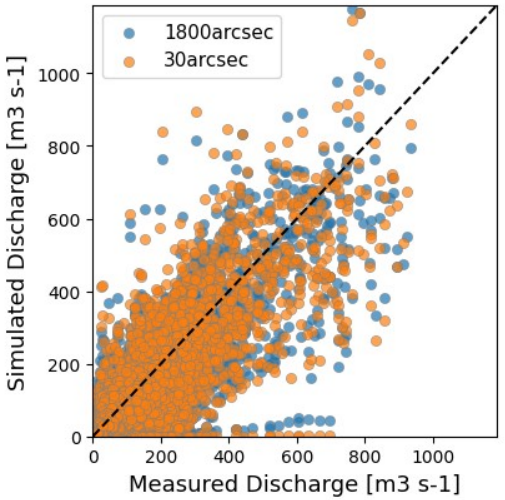
First Results



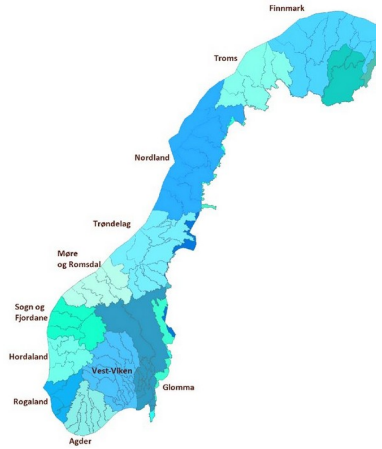
Source: Lake Kinneret – Ecology and Management, Chapter: 7, Publisher: Springer, Heidelberg, Editors: Zohary T., Sukenik A., Berman T. and, Nishri A.



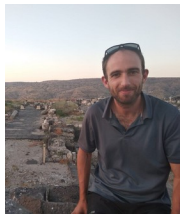
- Small improvements with resolution



	60km	1km
RMSE	10.69	10.14
MAE	4.11	3.75
MSD	0.40	0.36



Source: http://www.vannportalen.no/organisering/vannregioner/.



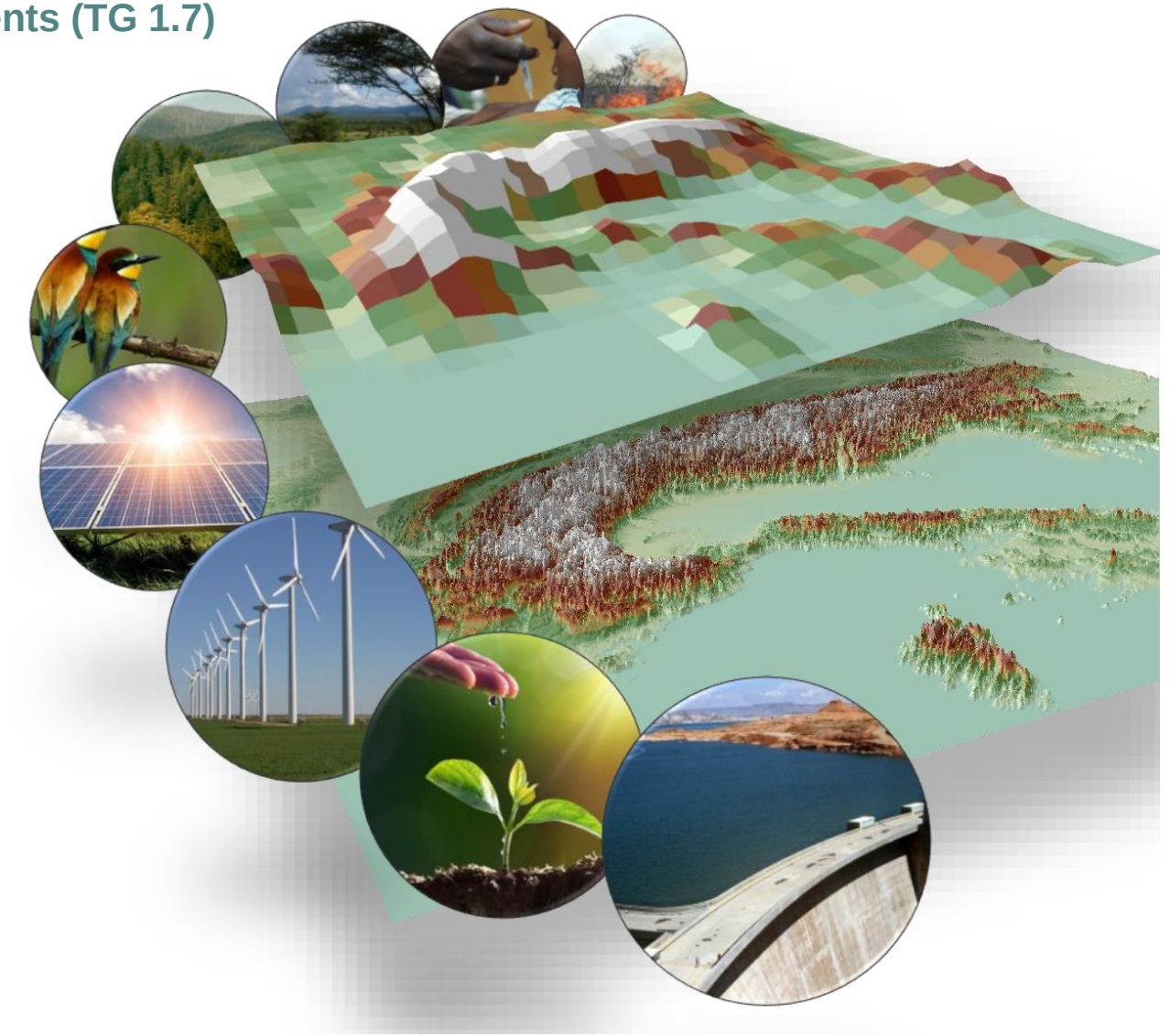
SWAT Soil & Water Assessment Tool

GR4J

Break out session this afternoon (15:30 – 17:30):
ISIMIP High resolution climate forcing data and experiments (TG 1.7)

- **High-resolution forcing data**
  - Current development status, where are we headed?
  - Additional cloud-based applications for CHELSA-ISIMIP3 data?
  - Missing variables, other high-resolution data (LUC)

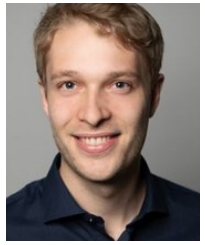
- **Overview and progress of the high-resolution sensitivity experiments (ADOHRIS project)**
  - How can I still join with my sector and model?
  - Discussions of first results
  - Paper planning



Room DP107

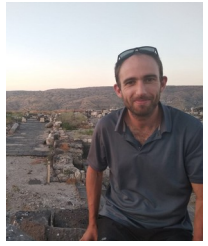
Acknowledgements

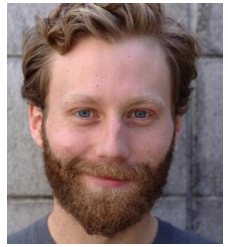
NAVIGATE
Next generation of advanced integrated assessment modelling to support climate policy making



PIK
Potsdam Institute for Climate Impact Research

WSL



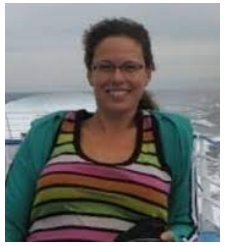


ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

Swiss National Science Foundation

biodiversa

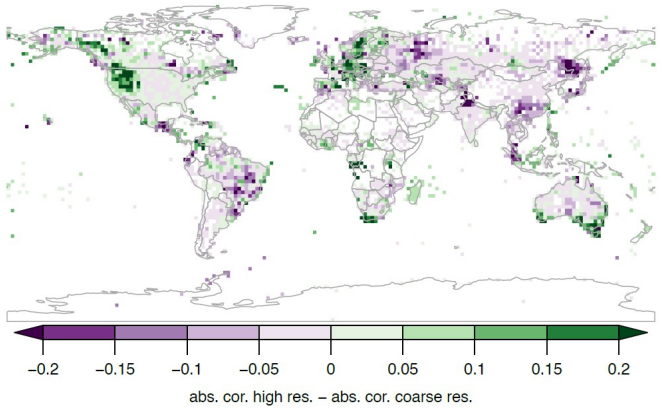
cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY



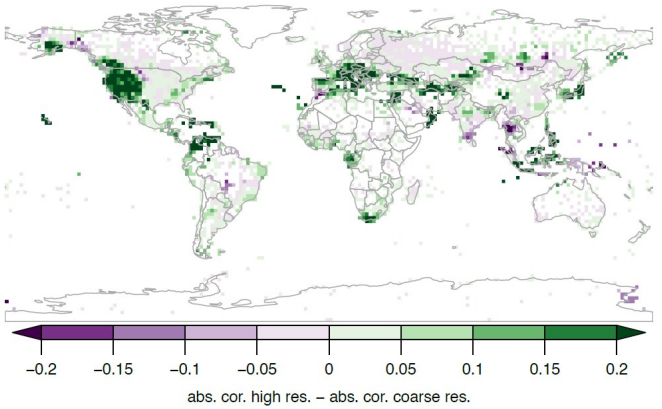
High-resolution climate forcing data

Absolute differences between coarse (W5E5 0.5°) and high-resolution (30arcsec) CHELSA data

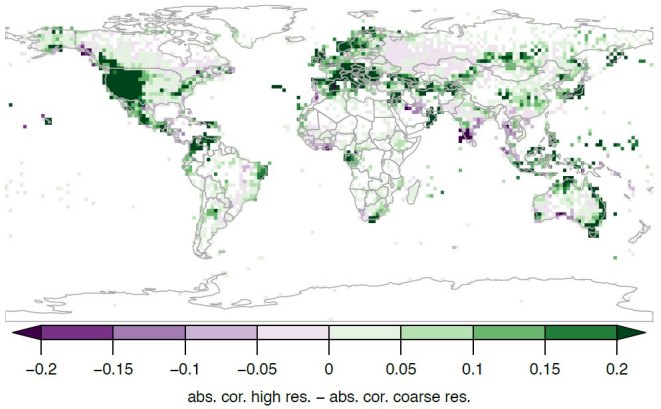
Mean Daily Precipitation



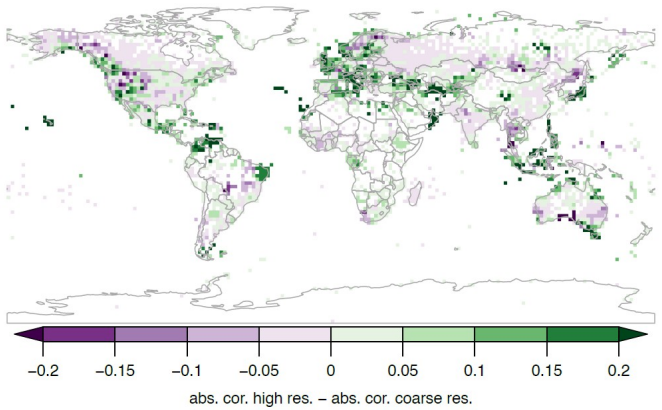
Mean Daily 2m Air−Temperature



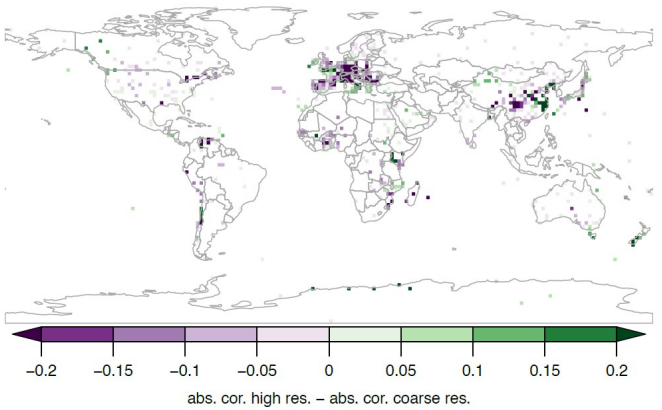
Maximum Daily 2m Air−Temperature



Minimum Daily 2m Air−Temperature

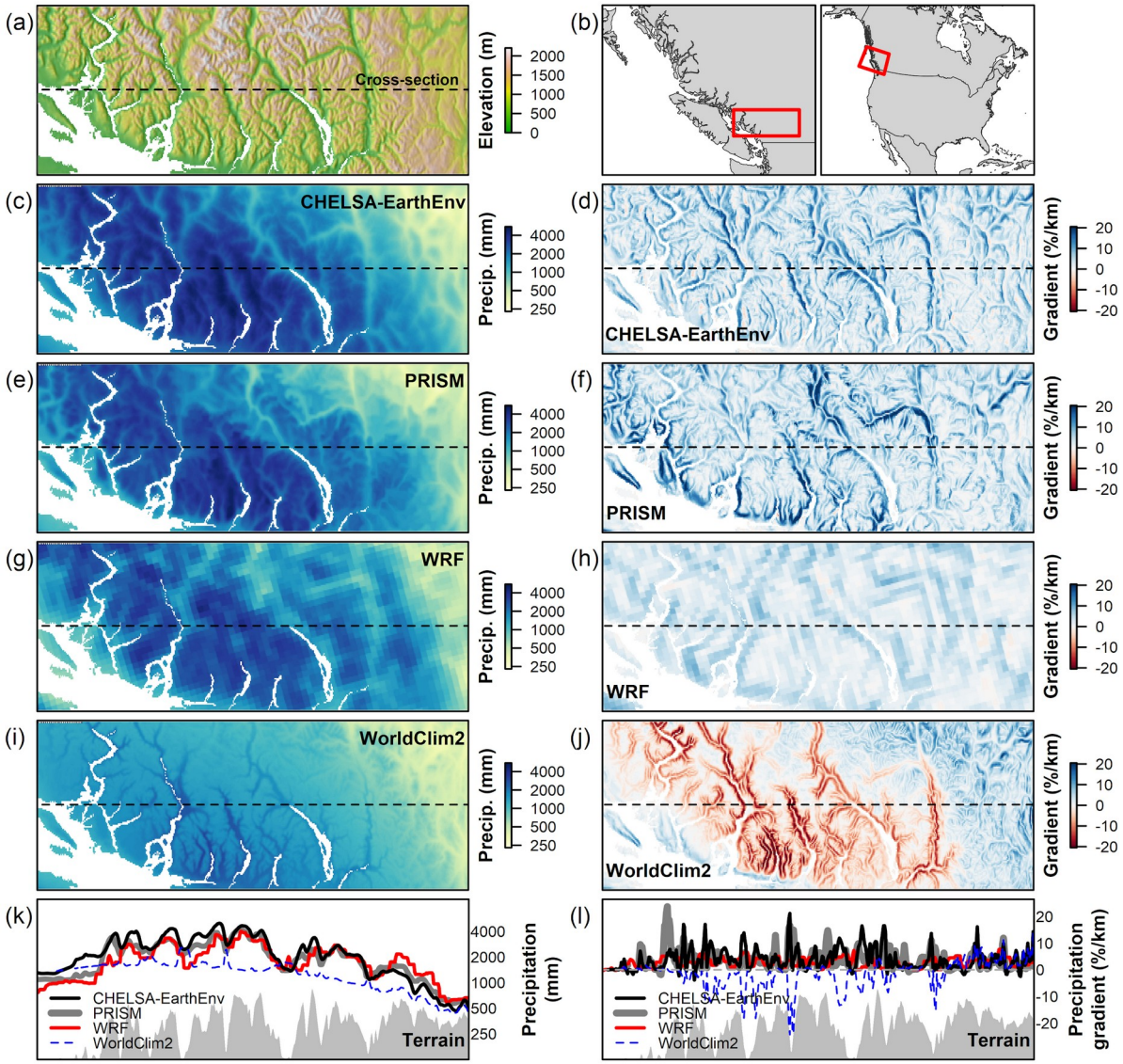


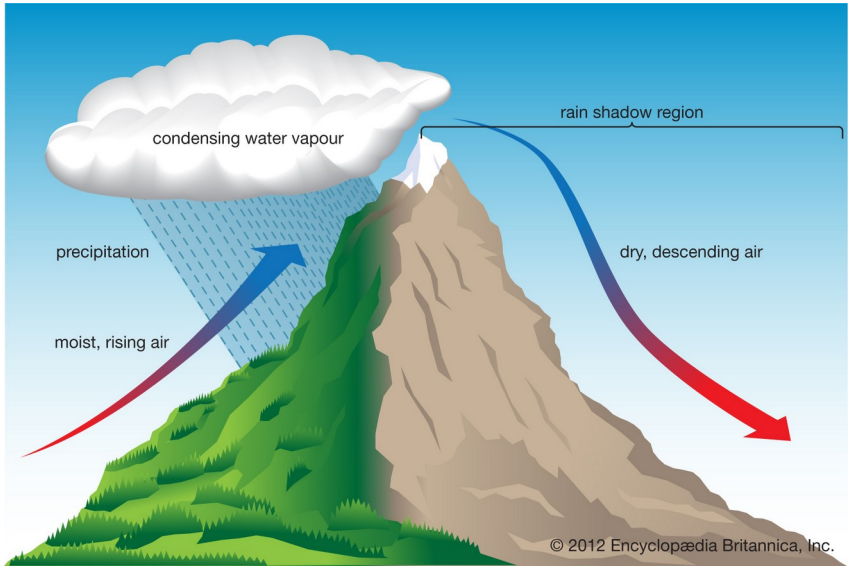
Downwelling Shortwave Solar Radiation



Karger, D.N., Lange, S., Hari, C., Reyer, C.O.P., Conrad, O., Zimmermann, N.E., Frieler, K. (in press) CHELSA-W5E5: Daily 1 km meteorological forcing data for climate impact studies. ***Earth System Science Data.*** https://doi.org/10.5194/essd-2022-367

Comparison to other high resolution products





- Better representation of orographic rain effects
- >100 x faster than a numerical model, but not a complete representation of all processes
- Avoids problems of pure statistical interpolations based on stations

Karger, D.N., Wilson, A.M., Mahony, C., Zimmermann, N.E., Jetz, W. (2021) Global daily 1km land surface precipitation based on cloud cover-informed downscaling. ***Scientific Data.*** doi.org/10.1038/s41597-021-01084-6