ERA5-Land: dedicated land surface reanalysis

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with contributions of many colleagues

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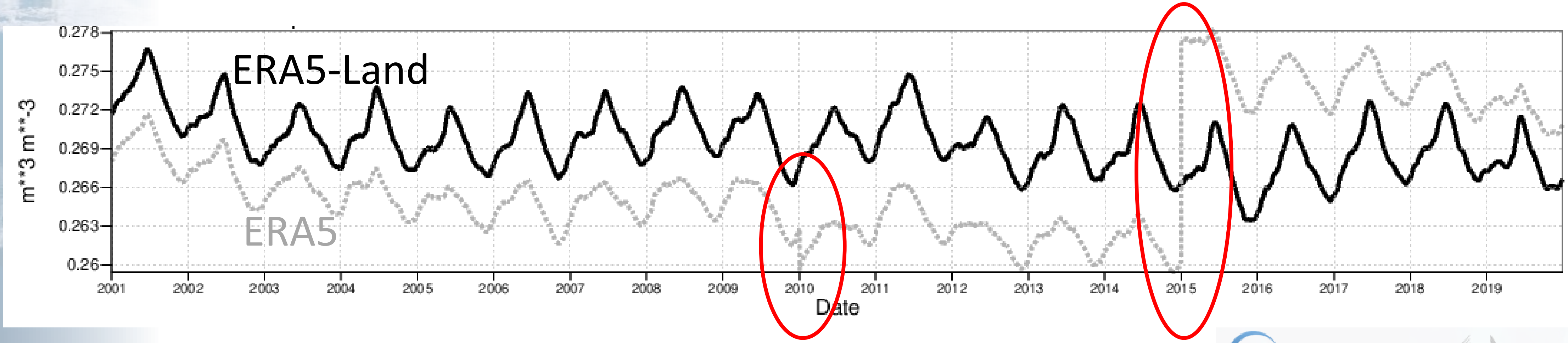
Dedicated land reanalysis - added value

Why do we need land-only reanalysis?

- Climate reanalysis does not occur very often.
- Need to bring rapid land model developments to long, consistent time series in a cost-effective way
  - Provide consistent land initial conditions to weather and climate models.
  - Support hydrological studies addressing global water resources
- Climate reanalysis often produce inconsistencies on land fields
- Provide dedicated datasets to support and encourage land applications



ERA5-Land in a simple diagram

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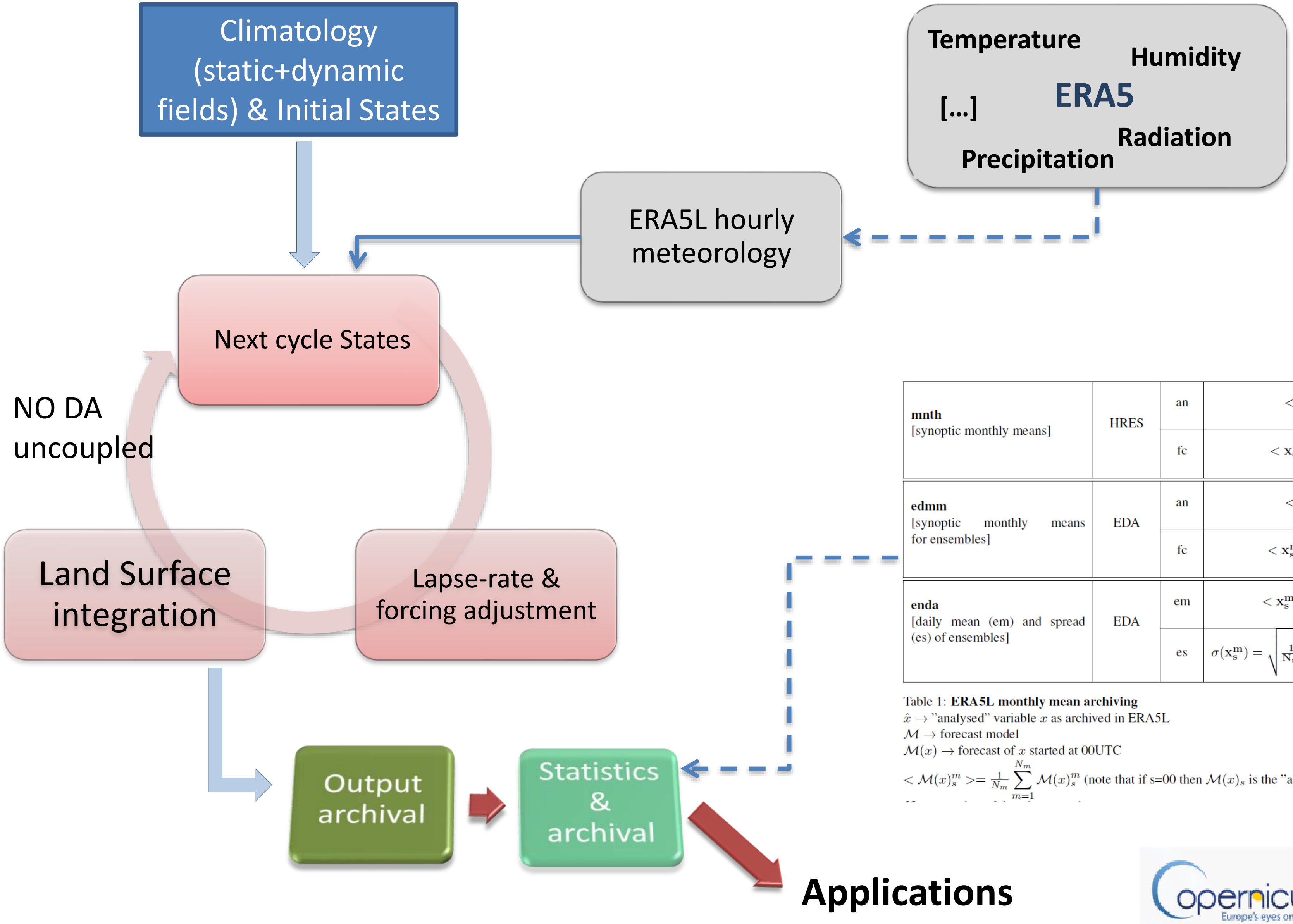

mnth [synoptic monthly means]	HRES	an	$< \hat{x}_h >= \frac{1}{N_d} \sum_{d=1}^{N_d} \hat{x}_{d,h}$
		fc	$< x_s >= \frac{1}{N_d} \sum_{d=1}^{N_d} \mathcal{M}(x)_{d,s}$
edmm [synoptic monthly means for ensembles]	EDA	an	$< \hat{x}_h^m >= \frac{1}{N_d} \sum_{d=1}^{N_d} \hat{x}_d^m$
		fc	$< x_s^m >= \frac{1}{N_d} \sum_{d=1}^{N_d} \mathcal{M}(x)_{d,s}^m$
enda [daily mean (em) and spread (es) of ensembles]	EDA	em	$< x_s^m >= \frac{1}{N_m} \sum_{m=1}^{N_m} < x_s >^m$
		es	$\sigma(x_s^m) = \sqrt{\frac{1}{N_m} \sum_{m=1}^{N_m} [\mathcal{M}(x)_s^m - < \mathcal{M}(x)_s^m >]^2}$

Table 1: **ERA5L monthly mean archiving**

$\hat{x} \rightarrow$ "analysed" variable x as archived in ERA5L

$\mathcal{M} \rightarrow$ forecast model

$\mathcal{M}(x) \rightarrow$ forecast of x started at 00UTC

$< \mathcal{M}(x)_s^m >= \frac{1}{N_m} \sum_{m=1}^{N_m} \mathcal{M}(x)_s^m$ (note that if s=00 then $\mathcal{M}(x)_s$ is the "analysis")

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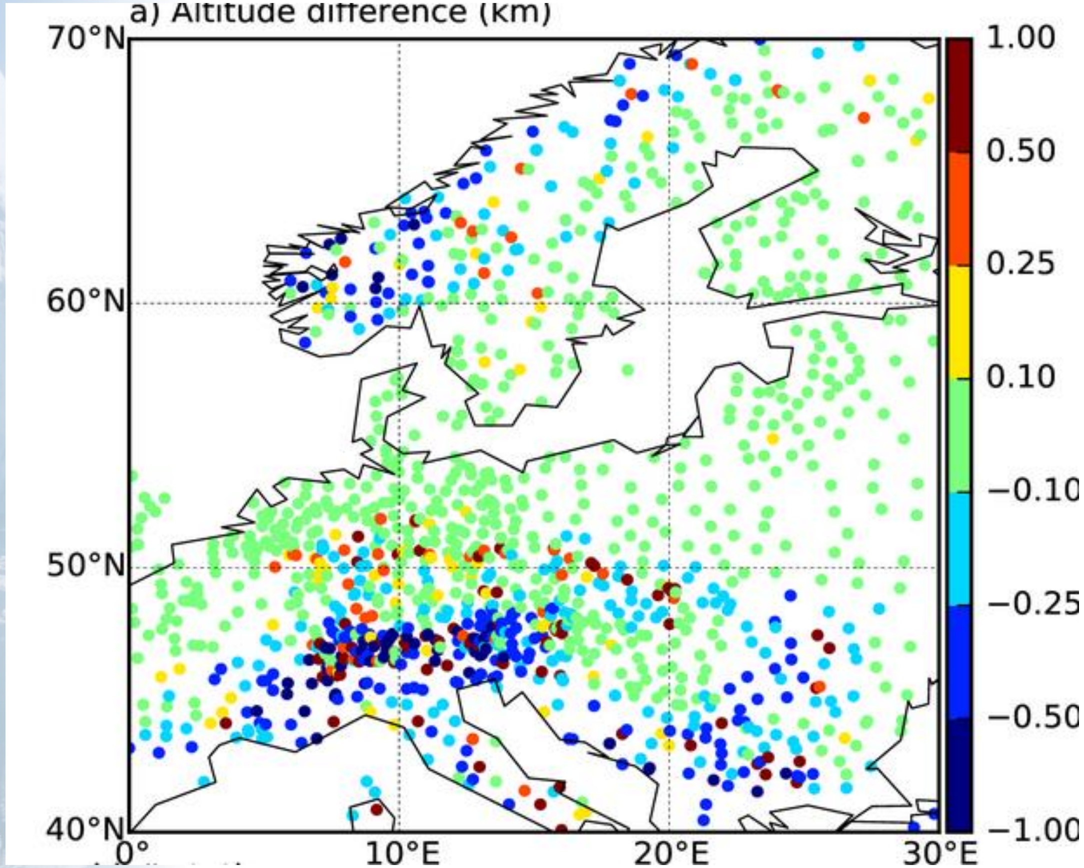
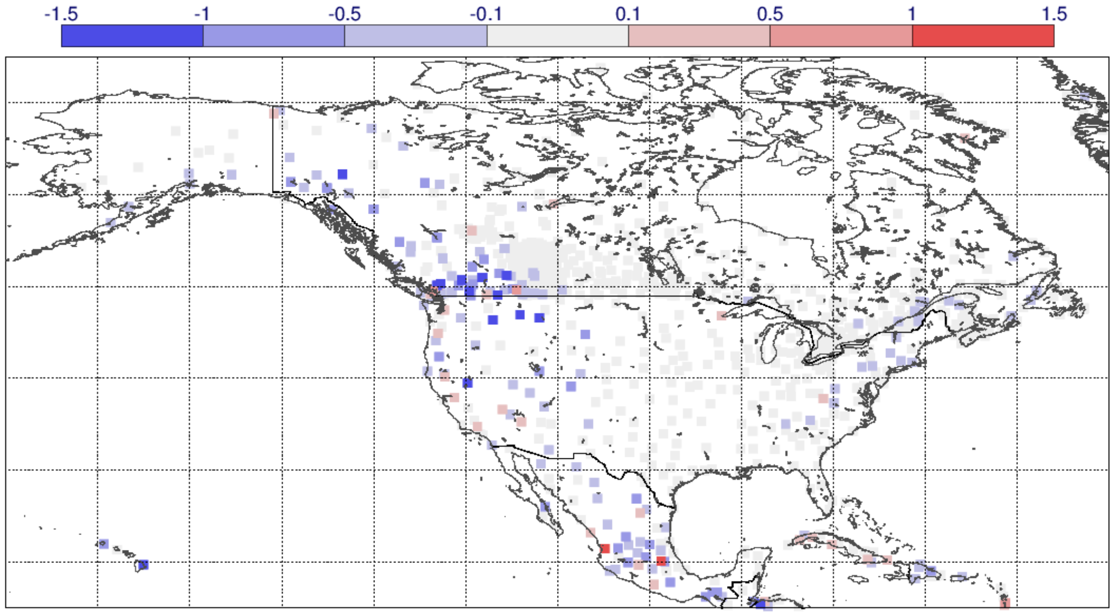
Lapse-rate adjustment

- **Correct for differences in orography due to different model resolutions.**



Δh (km)

T2m RMSE(corrected)- RMSE(no corrected) (K)



E. Dutra, J. Muñoz-Sabater, S. Boussetta, T. Komori, S. Hirahara and G. Balsamo, 2020: "Land surface downscaling of ERA5 and the role of the lapse rate correction: An application to ERA5." Earth and Space Science, https://doi.org/10.1029/2019EA000984.

ERA5-Land specs compared to…

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	ERA-Int	Era-Int/Land	ERA5	ERA5-Land
Period covered	Jan 1979 – Jul 2019	Jan 1979 – Dec 2010	Jan 1950 - NRT	Jan 1950 - NRT
Spatial resolution	~79km / 60 levels	79 km	~32 km / 137 levels	~9 km
Model version	IFS (+TESSEL)	HTESSEL cy36r4	IFS (+HTESSEL)	HTESSEL cy45r1
LDAS	cy31r1	NO	cy41r2	NO
Uncertainty estimate	-	-	Based on a 10-member 4D-Var ensemble at 62 km	Based a 10-member atmospheric forcing at 31 km (?)
Output frequency	6-hourly Analysis fields	6-hourly Analysis fields	Hourly (three-hourly for the ensemble)	Hourly (three-hourly for the ensemble)

ERA-Int/Land vs ERA5-Land inventory of fields

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Soil Temperature (4 layers)
Skin Temperature
Volumetric soil moisture (4 layers)
Snow density
Snow Water Equivalent
Snow Fall
Snow Albedo
Snow Melt
Temperature snow layer
Forecast Albedo
Surface and sub-surface runoff
Surface Latent Heat flux
Surface Sensible Heat flux
Surface net solar radiation
Surface net thermal radiation
Total Precipitation
Evaporation

2m temperature & dew point
Accumulated CO_2 (Reco, GPP, NEE)
Lakes (Bottom Temperature, Ice depth, ice Temperature, mix-layer depth, mix-layer temperature, shape factor, total layer temperature)
LAI (low/high vegetation)
Runoff
Skin reservoir content
U,V surface wind components
Surface Pressure
Snow Depth
Snow cover fraction
Snow evaporation
Canopy evaporation
Soil evaporation
Vegetation transpiration
Surface solar radiation downwards
Surface Thermal radiation downw

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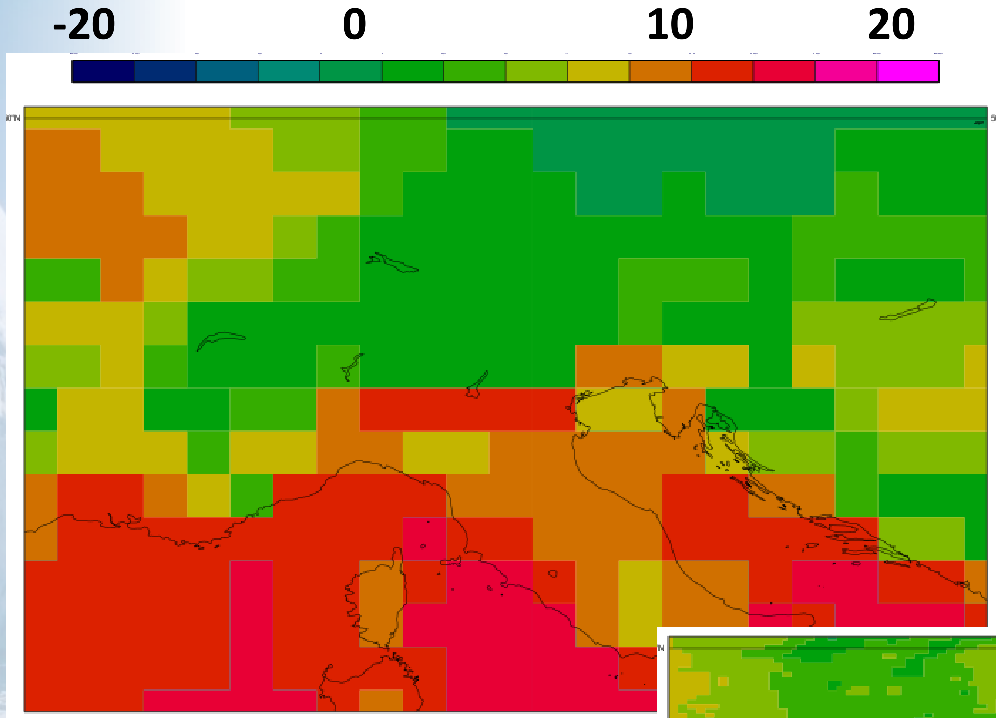
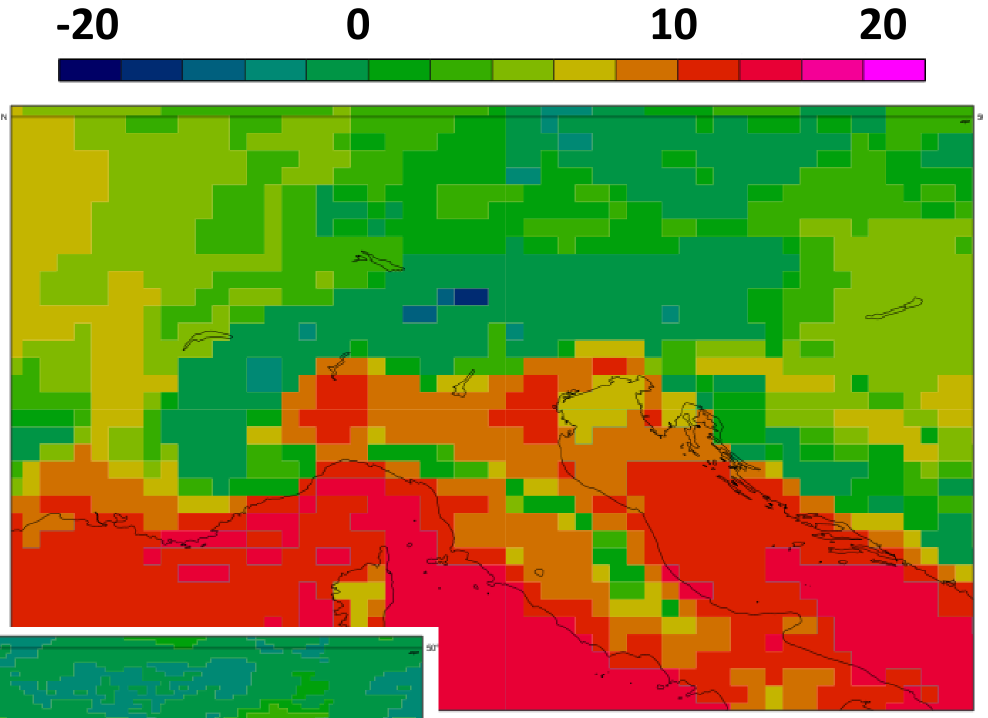
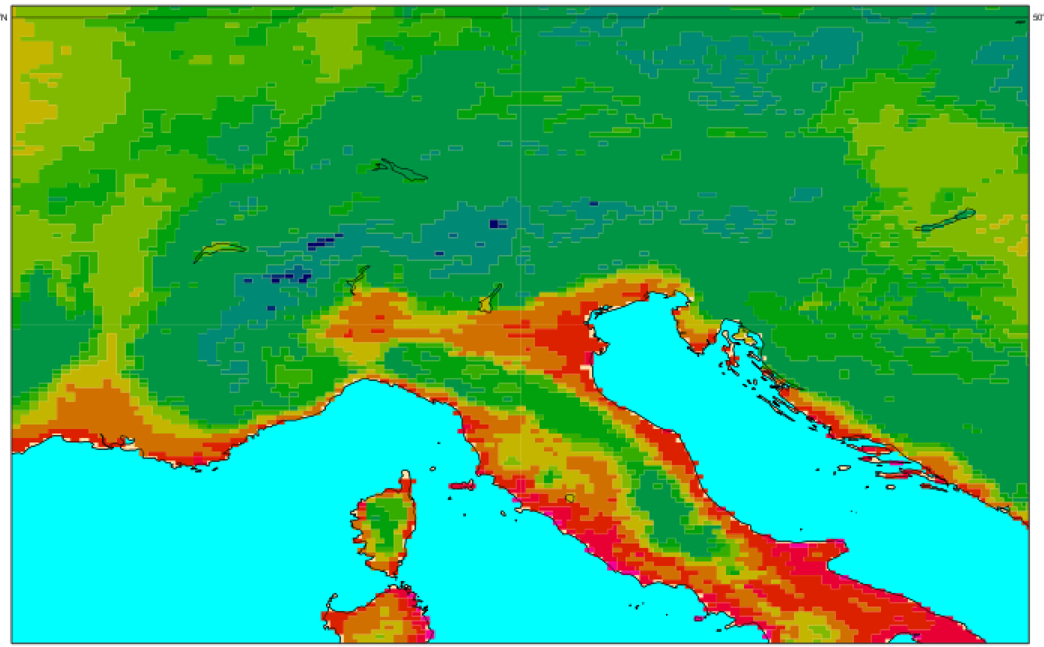
Add value of higher resolution; Soil Temperature (15 March 2010)



ERA-Interim (79 km)



ERA5 (31 km)



ERA5-Land (9 km)

Evaluation – River discharge

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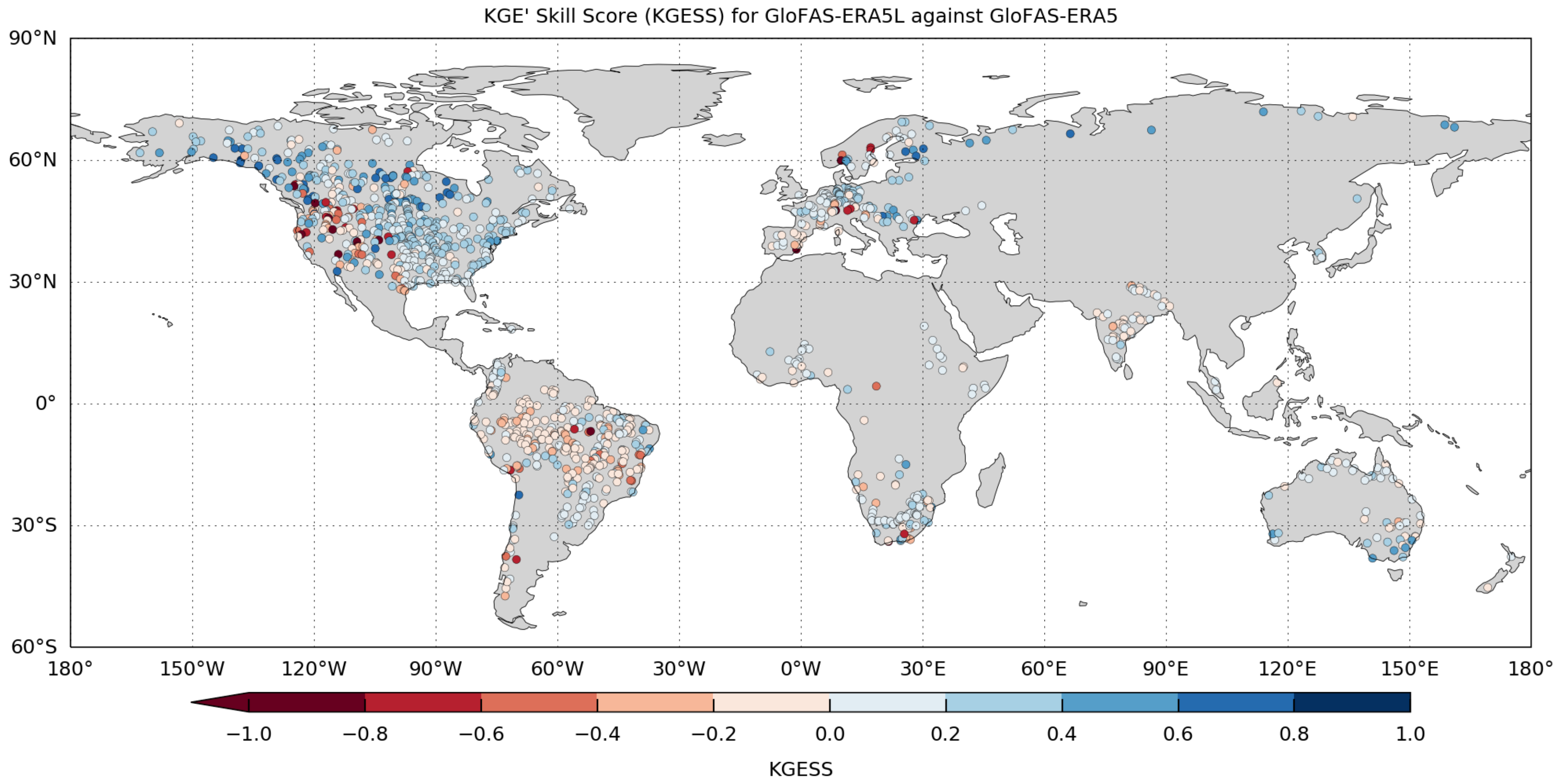

Modified Kling-Gupta Efficiency Skill Score (KGESS) for GloFAS-ERA5L river discharge reanalysis against the GloFAS-ERA5 benchmark across 1285 observation stations. Optimum value of KGESS is 1. Blue (red) dots show catchments with positive (negative) skill.

- Figure produced by S. Harrigan -

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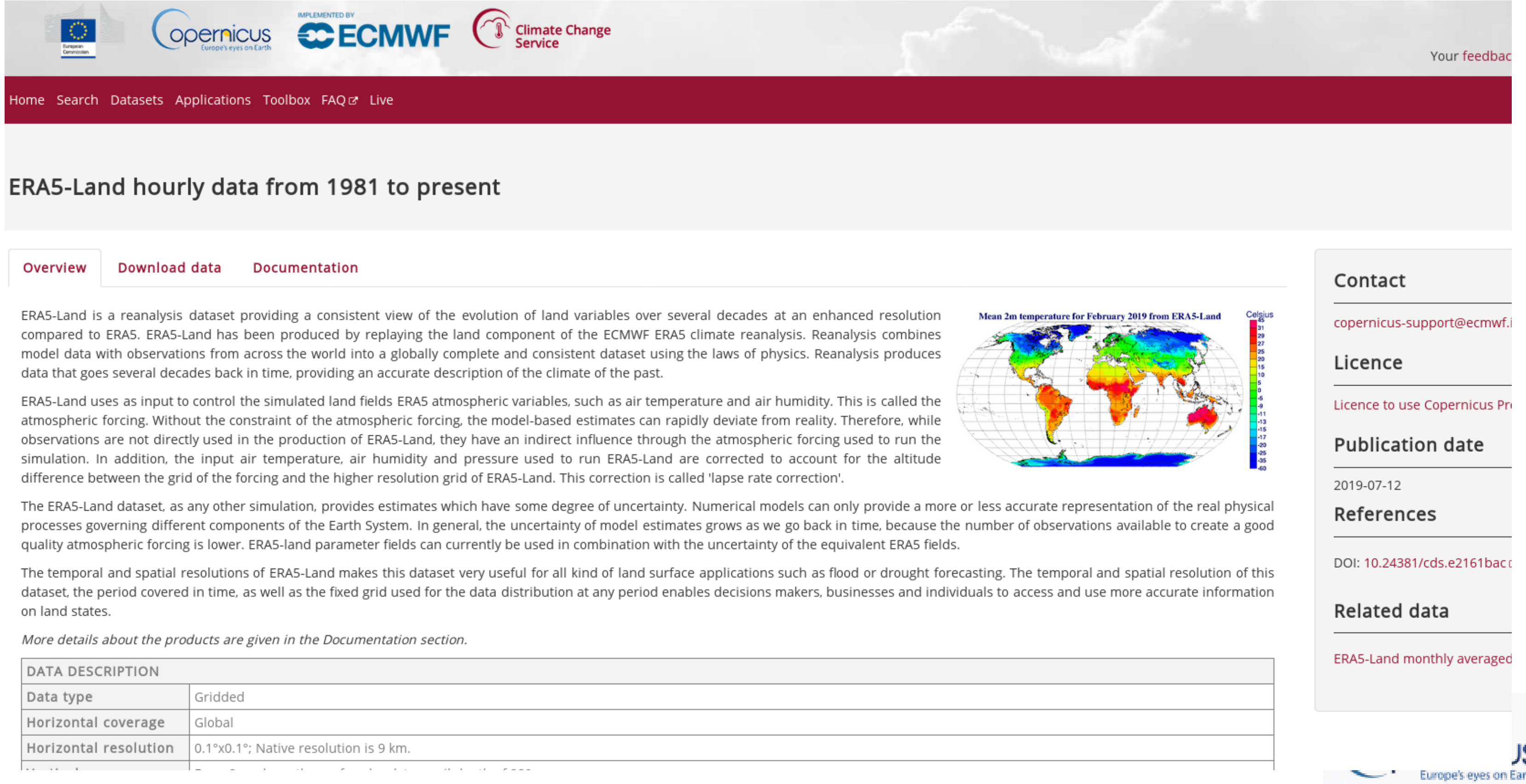
Data availability & way forward

- Available in the CDS
- 1981 to present
- Hourly and monthly fields
- 0.1° x 0.1°

Coming up:

- ERA5-LandT by Q3/Q4-2020
- 1950-1980 by Q4-2020
- Paper in preparation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ERA5-Land hourly data from 1981 to present

Overview Download data Documentation

ERA5-Land is a reanalysis dataset providing a consistent view of the evolution of land variables over several decades at an enhanced resolution compared to ERA5. ERA5-Land has been produced by replaying the land component of the ECMWF ERA5 climate reanalysis. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset using the laws of physics. Reanalysis produces data that goes several decades back in time, providing an accurate description of the climate of the past.

ERA5-Land uses as input to control the simulated land fields ERA5 atmospheric variables, such as air temperature and air humidity. This is called the atmospheric forcing. Without the constraint of the atmospheric forcing, the model-based estimates can rapidly deviate from reality. Therefore, while observations are not directly used in the production of ERA5-Land, they have an indirect influence through the atmospheric forcing used to run the simulation. In addition, the input air temperature, air humidity and pressure used to run ERA5-Land are corrected to account for the altitude difference between the grid of the forcing and the higher resolution grid of ERA5-Land. This correction is called 'lapse rate correction'.

Mean 2m temperature for February 2019 from ERA5-Land

The ERA5-Land dataset, as any other simulation, provides estimates which have some degree of uncertainty. Numerical models can only provide a more or less accurate representation of the real physical processes governing different components of the Earth System. In general, the uncertainty of model estimates grows as we go back in time, because the number of observations available to create a good quality atmospheric forcing is lower. ERA5-land parameter fields can currently be used in combination with the uncertainty of the equivalent ERA5 fields.

The temporal and spatial resolutions of ERA5-Land makes this dataset very useful for all kind of land surface applications such as flood or drought forecasting. The temporal and spatial resolution of this dataset, the period covered in time, as well as the fixed grid used for the data distribution at any period enables decisions makers, businesses and individuals to access and use more accurate information on land states.

More details about the products are given in the Documentation section.

DATA DESCRIPTION	
Data type	Gridded
Horizontal coverage	Global
Horizontal resolution	0.1°x0.1°; Native resolution is 9 km.

Contact

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Licence

Licence to use Copernicus Pr

Publication date

2019-07-12

References

DOI: 10.24381/cds.e2161bac

Related data

ERA5-Land monthly averaged

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Thank you!

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C3S: https://climate.copernicus.eu/

Climate Data Store: https://cds.climate.copernicus.eu/

ERA5-Land: https://www.ecmwf.int/en/era5-land