

METEOROLOGY FORCING

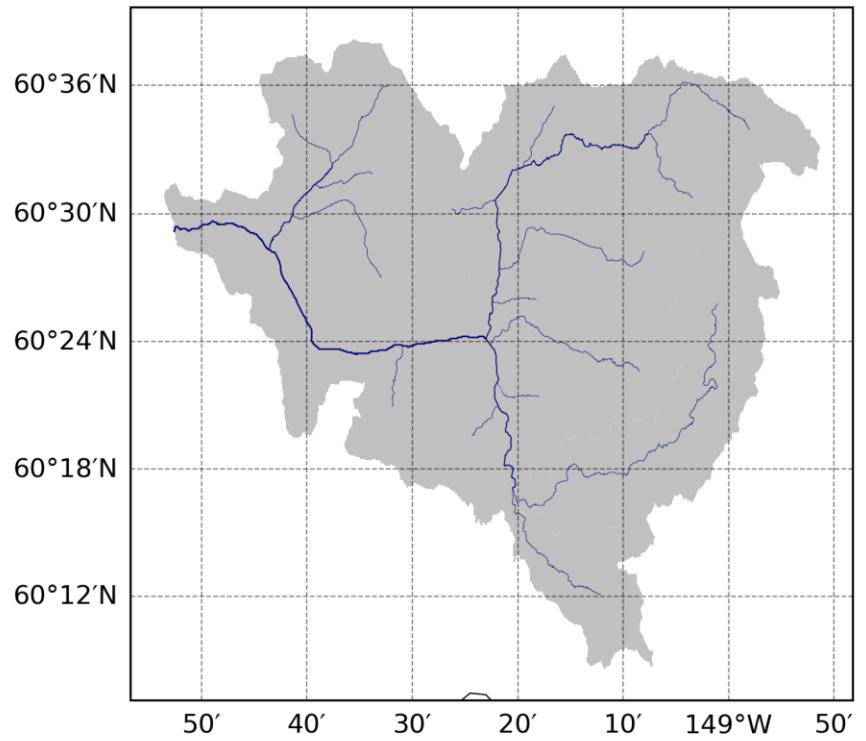
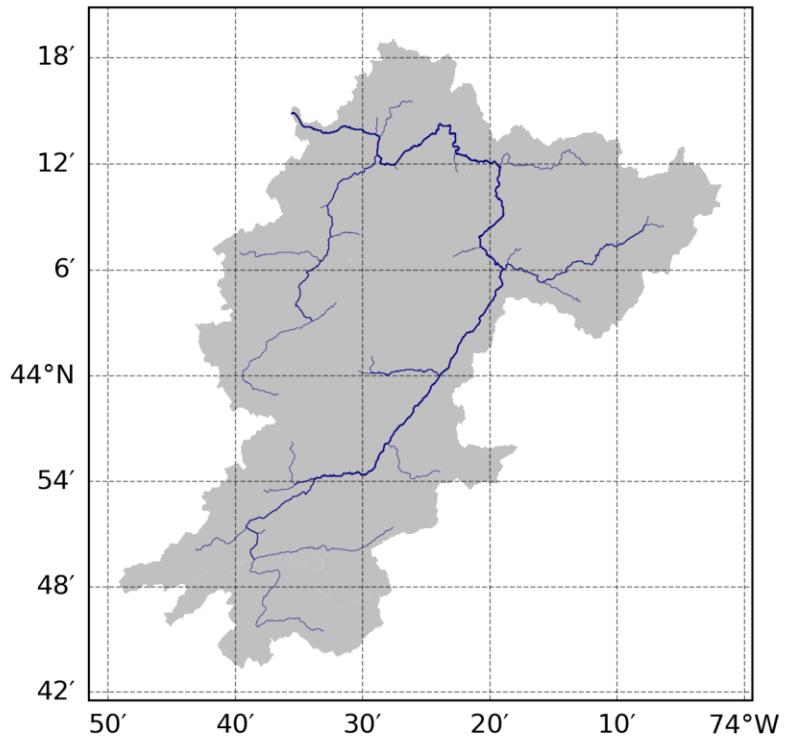
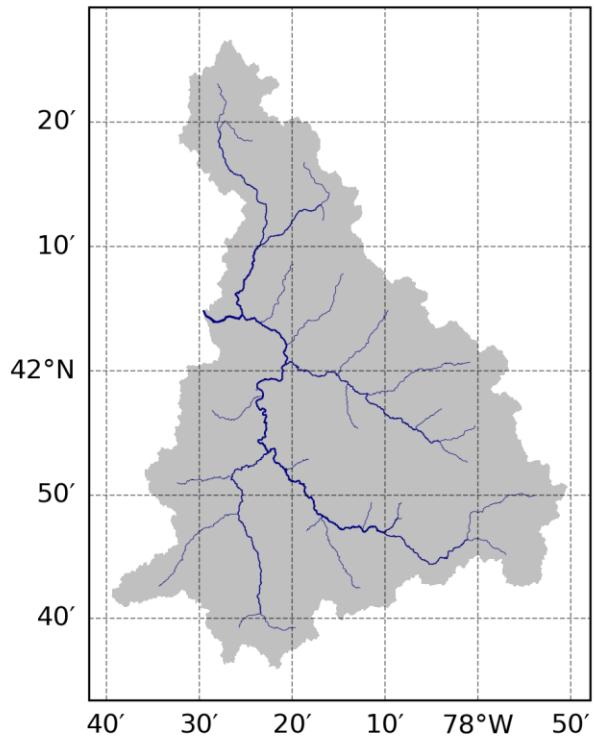
ERT 474/574

Open-Source Hydro Data Analytics

Nov 12th 2025



Basin selection!



Meteorological forcing data

- A set of **weather variables** like temperature, precipitation, humidity, wind speed, air pressure, etc., which are used as input data to drive hydrological models

Meteorological Forcings, Required in all simulations:

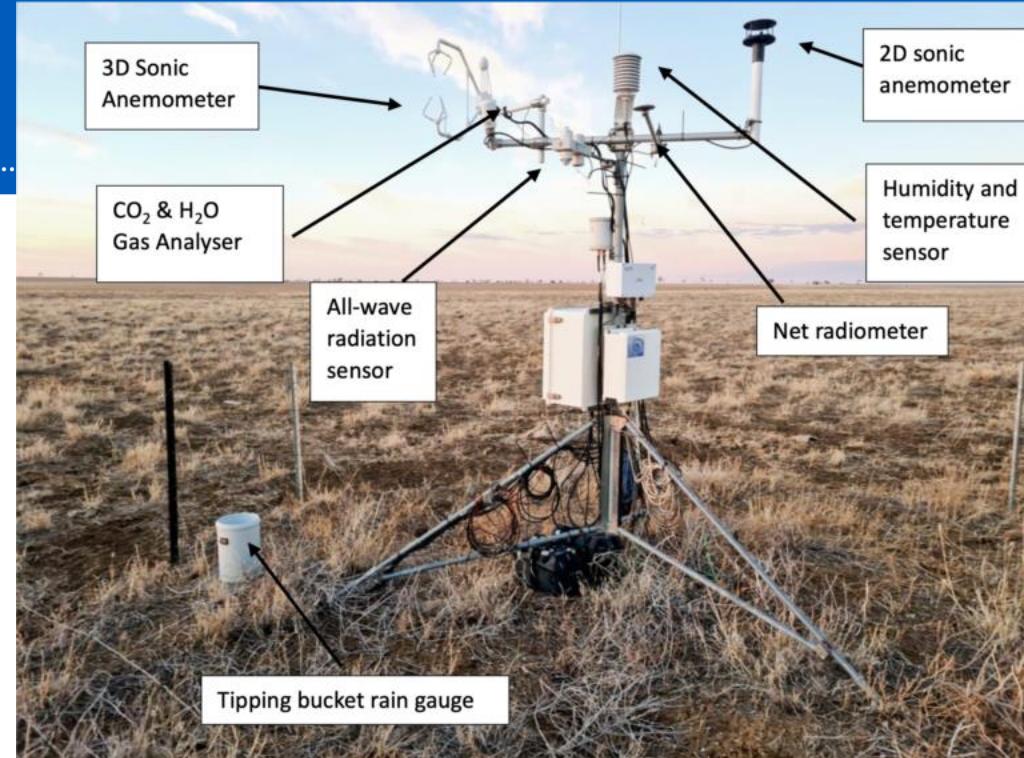
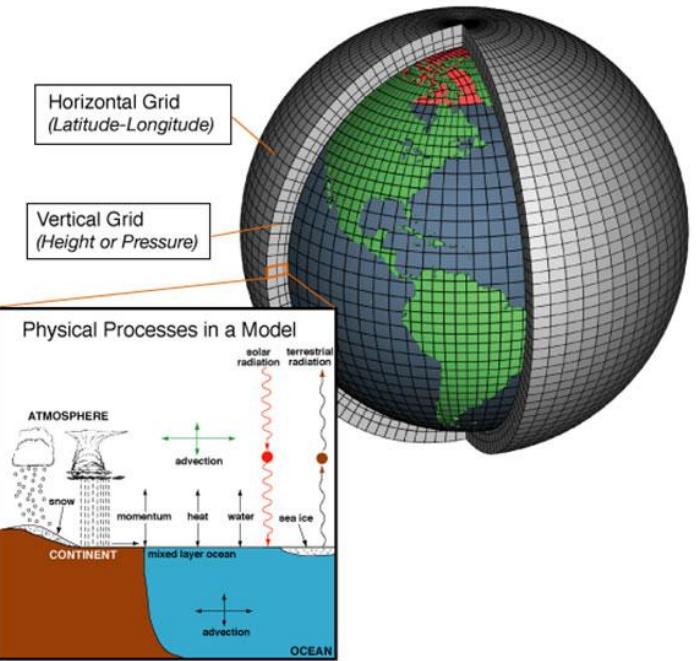
| Variable | Description | Units |
|----------|-------------------------------------|------------------|
| AIR_TEMP | Average air temperature | C |
| PREC | Total precipitation (rain and snow) | mm |
| PRESSURE | Atmospheric pressure | kPa |
| SWDOWN | Incoming shortwave radiation | W/m ² |
| LWDOWN | Incoming longwave radiation | W/m ² |
| VP | Vapor pressure | kPa |
| WIND | Wind speed | m/s |

mm/timestep

This value would be different for 3-hourly versus daily timesteps

Source of meteorological data

- Onsite observations
- Remote sensing
- Earth System Models



Ameriflux

- Ameriflux is a network of PI-managed sites measuring ecosystem CO₂, water, and energy fluxes in North, Central, and South America.
- It usually provides measurements of all necessary variables for hydrologic modeling
 - Extra quality control might be required

<https://ameriflux.lbl.gov/>



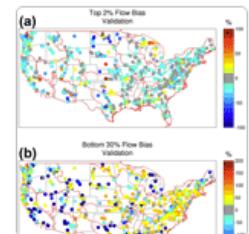
Large sample watershed-scale dataset for the contiguous U.S.

Research article | Highlight paper | CC BY

Development of a large-sample watershed-scale hydrometeorological data set for the contiguous USA: data set characteristics and assessment of regional variability in hydrologic model performance

A. J. Newman , M. P. Clark, K. Sampson, A. Wood, L. E. Hay, A. Bock, R. J. Viger, D. Blodgett, L. Brekke, J. R. Arnold, T. Hopson, and Q. Duan

14 Jan 2015



Research article | Highlight paper | CC BY

The CAMELS data set: catchment attributes and meteorology for large-sample studies

Nans Addor , Andrew J. Newman, Naoki Mizukami, and Martyn P. Clark

Abstract. We present a new data set of attributes for 671 catchments in the contiguous United States (CONUS) minimally impacted by human activities. This complements the daily time series of

20 Oct 2017



1846

Large sample watershed-scale dataset globally

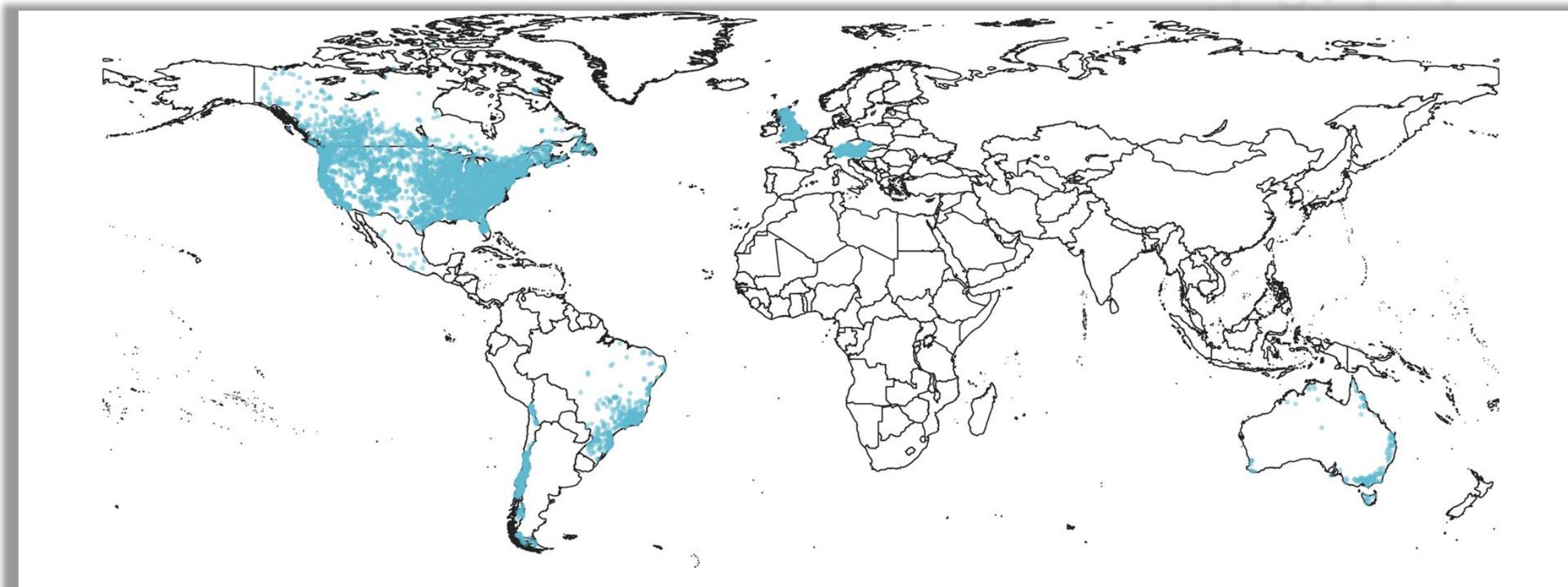
Data Descriptor | [Open access](#) | Published: 31 January 2023

Caravan - A global community dataset for large-sample hydrology

Frederik Kratzert , Grey Nearing, Nans Addor, Tyler Erickson, Martin Gauch, Oren Gilon, Lukas Gudmundsson, Avinatan Hassidim, Daniel Klotz, Sella Nevo, Guy Shalev & Yossi Matias

Scientific Data 10, Article number: 61 (2023) | [Cite this article](#)

34k Accesses | 194 Citations | 278 Altmetric | [Metrics](#)



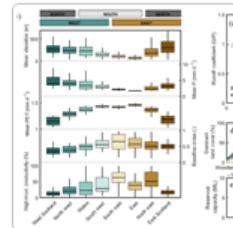
Large sample watershed-scale dataset globally

Data description paper | 

CAMELS-GB: hydrometeorological time series and landscape attributes for 671 catchments in Great Britain

Gemma Coxon , Nans Addor, John P. Bloomfield, Jim Freer, Matt Fry, Jamie Hannaford, Nicholas J. K. Howden, Rosanna Lane, Melinda Lewis, Emma L. Robinson, Thorsten Wagener, and Ross Woods

12 Oct 2020

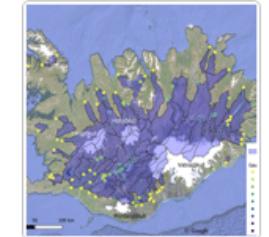


Data description paper | 

LamaH-Ice: LArge-SaMple DAta for Hydrology and Environmental Sciences for Iceland

Hordur Bragi Helgason  and Bart Nijssen

13 Jun 2024

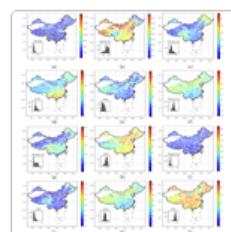


Data description paper | 

CCAM: China Catchment Attributes and Meteorology dataset

Zhen Hao ★, Jin Jin  ★, Runliang Xia, Shimin Tian, Wushuang Yang, Qixing Liu, Min Zhu, Tao Ma, Chengran Jing, and Yanning Zhang

03 Dec 2021

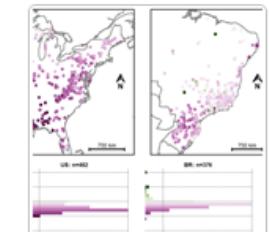


Research article | Highlight paper | 

Large-sample hydrology – a few camels or a whole caravan?

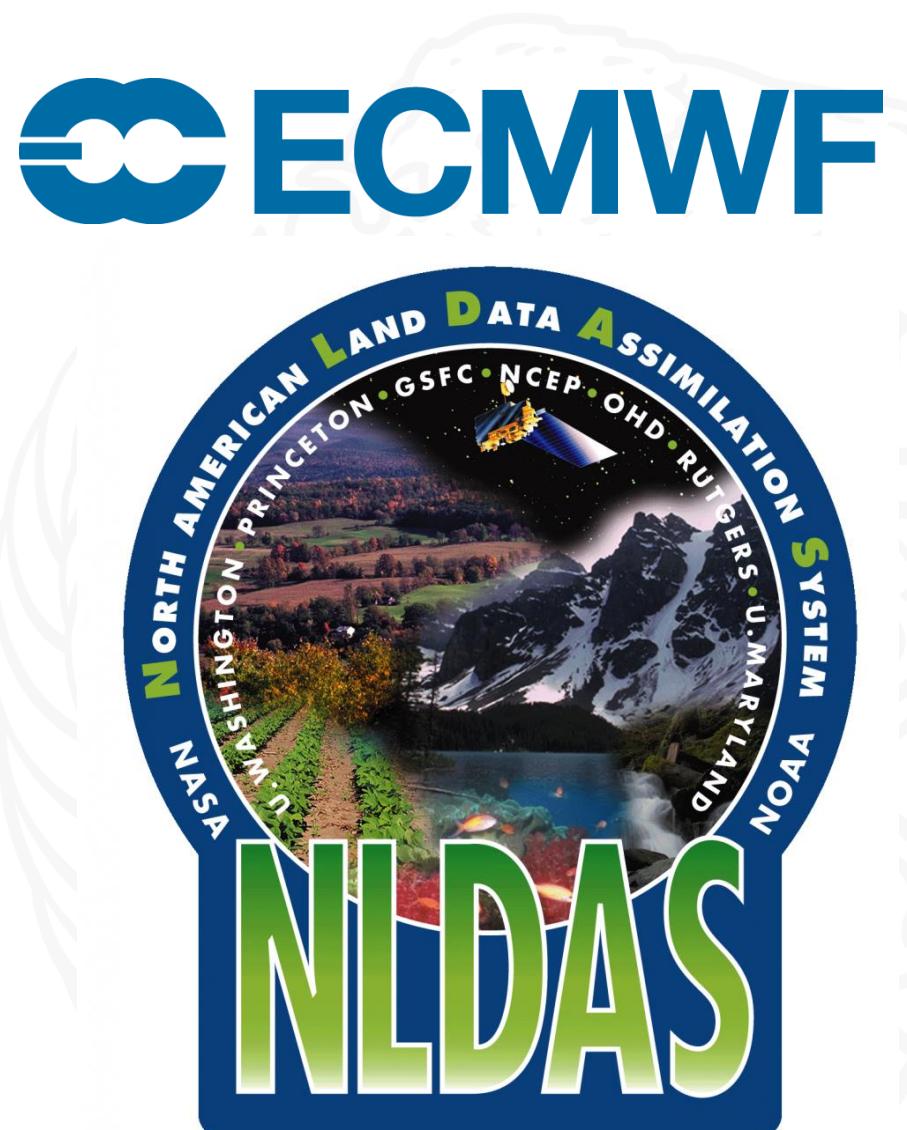
Franziska Clerc-Schwarzenbach , Giovanni Selleri, Mattia Neri, Elena Toth, Ilja van Meerveld, and Jan Seibert

12 Sep 2024



Grid-based meteorological datasets (operational)

- ERA5
 - <https://www.ecmwf.int/en/forecasts/dataset/ecmwf-reanalysis-v5>
 - ERA5 is the fifth generation ECMWF reanalysis for the global climate and weather for the past 8 decades
- GLDAS/NLDAS
 - <https://ldas.gsfc.nasa.gov/nldas>
 - North American Land Data Assimilation System (NLDAS) aims to construct quality-controlled, and spatially and temporally consistent, land-surface model (LSM) datasets from the best available observations and reanalyses to support modeling activities.



Grid-based meteorological datasets

- Daymet (<https://daymet.ornl.gov/>)
 - Daymet provides long-term, continuous, gridded estimates of daily weather and climatology variables by interpolating and extrapolating ground-based observations through statistical modeling techniques.
- GMET (<https://ncar.github.io/hydrology/models/GMET>)
 - Gridded Meteorological Ensemble Tool (GMET) allows for quantification of uncertainty for station-based gridded precipitation and temperature datasets
- gridMET (<https://www.climatologylab.org/gridmet.html>)
 - gridMET is a dataset of daily surface meteorological data covering the contiguous US from 1979-yesterday.

Compared to ERA5 and NLDAS, what are the major differences for these datasets?

Grid-based meteorological datasets

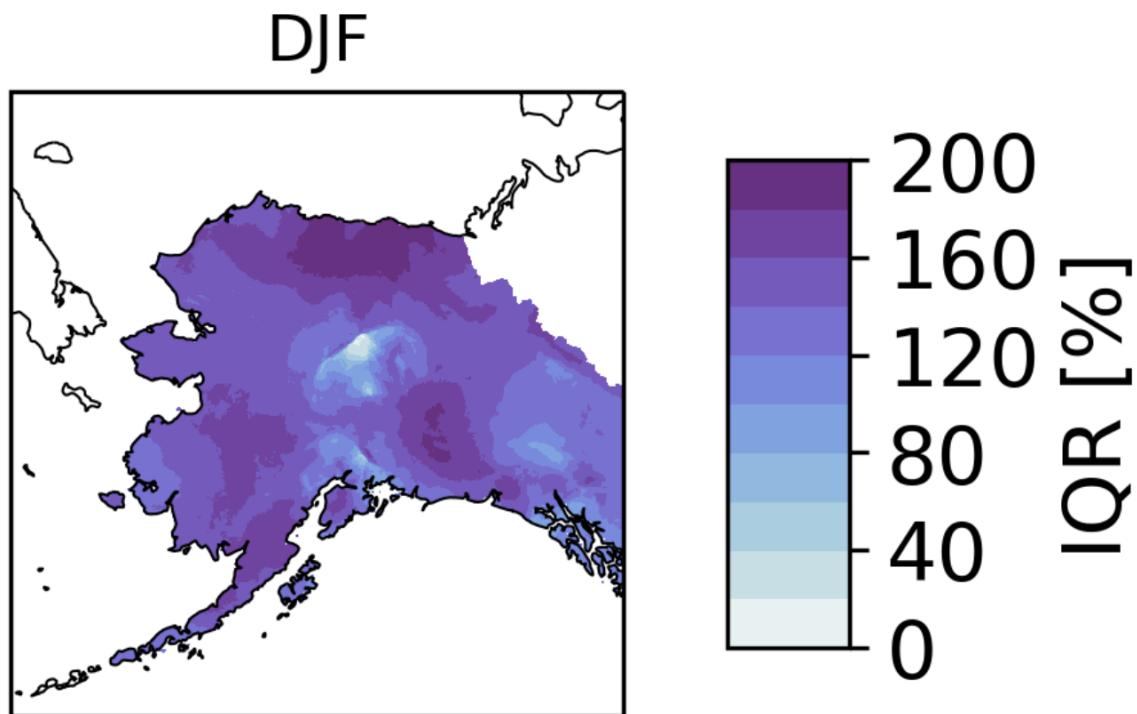
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High resolution
(1km)

Uncertainty
Quantification

Semi-operational
(Downscaled NLDAS)

Biases exist in the gridded meteorological forcings



Example: Relative Interquartile Range for GMET data in Alaska

$$IQR = \frac{P_{75\%} - P_{25\%}}{(P_{75\%} + P_{25\%})/2}$$

Biases in the met forcings are major sources for biases in the hydrologic modeling simulations!

Example: Steps to process meteorological forcings from NLDAS

- Step 1: Download the datasets
- Step 2: Concatenate the hourly files into the targeted format
- Step 3: Convert the units of the variables to the units required by the VIC model
- Step 4: If necessary, regridding the met forcing data to the targeted domain grid

Live Demo

<https://ldas.gsfc.nasa.gov/nldas>

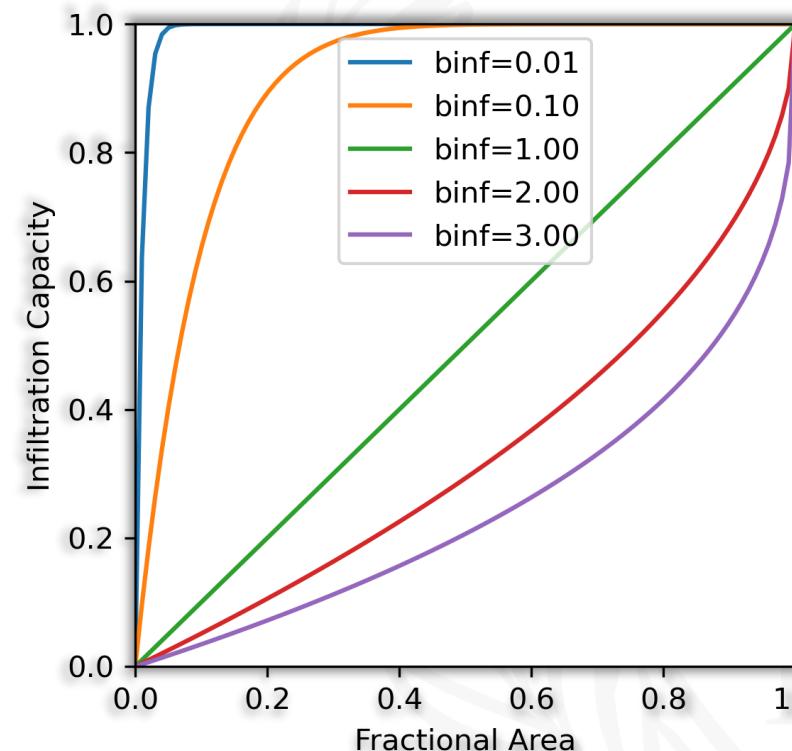
General rules when preparing meteorological forcings...

When the spatial resolutions of land surface/parameter datasets and meteorological forcing are different, it is recommended to **regrid the met forcing.**

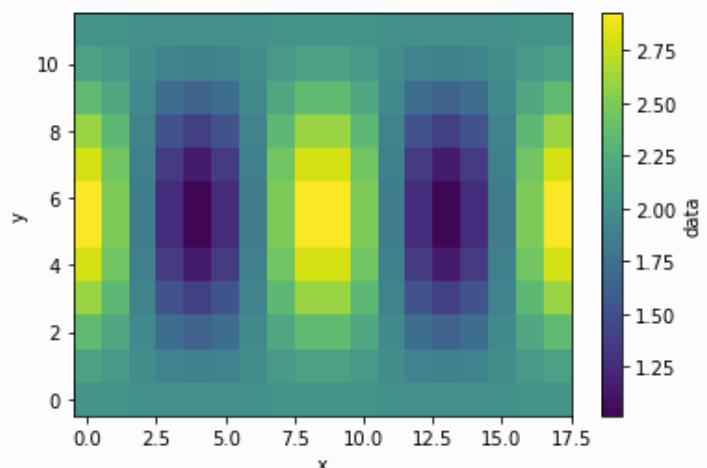


The arithmetic average works when calculating soil composition but it won't work when calculating non-linear parameters!

Question: Why don't we regrid land surface datasets?

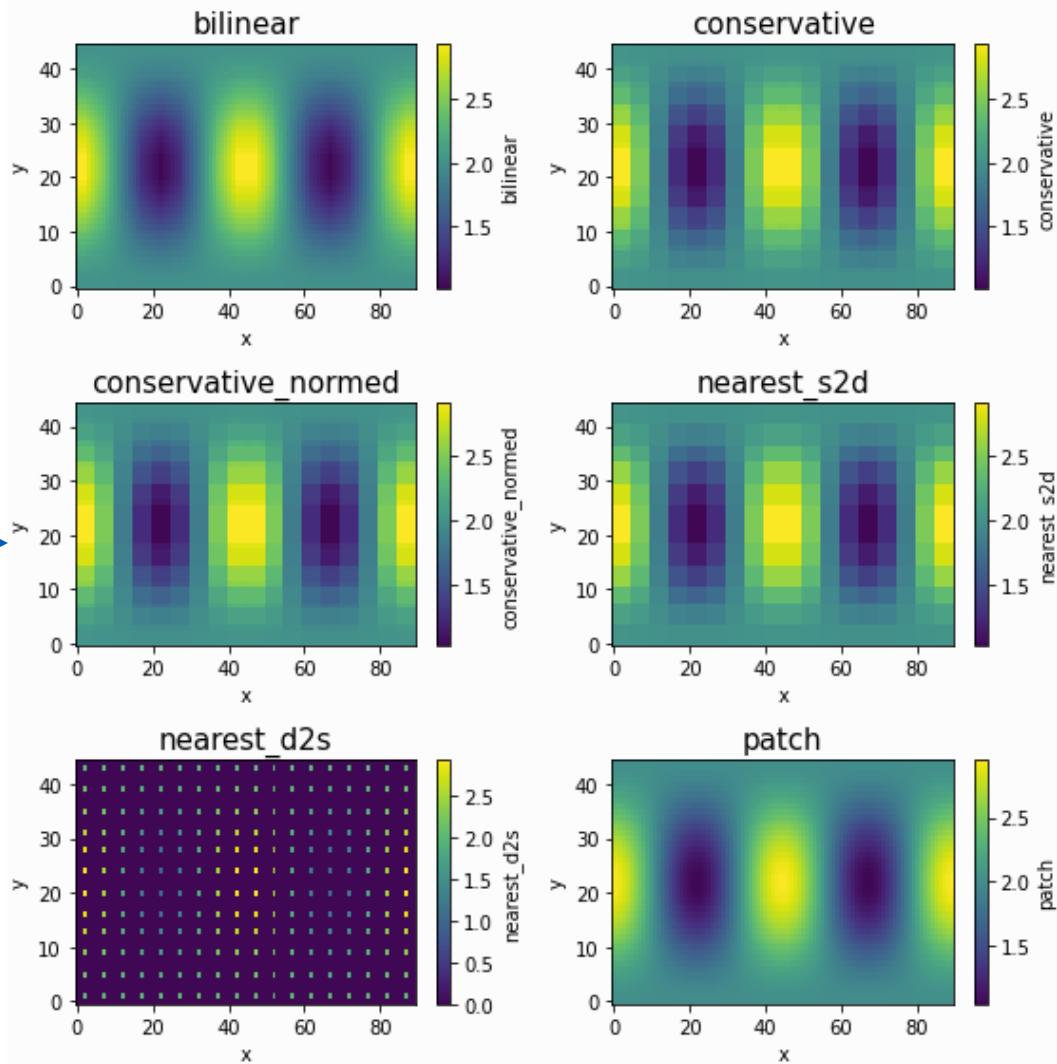


Regridding



Regrid

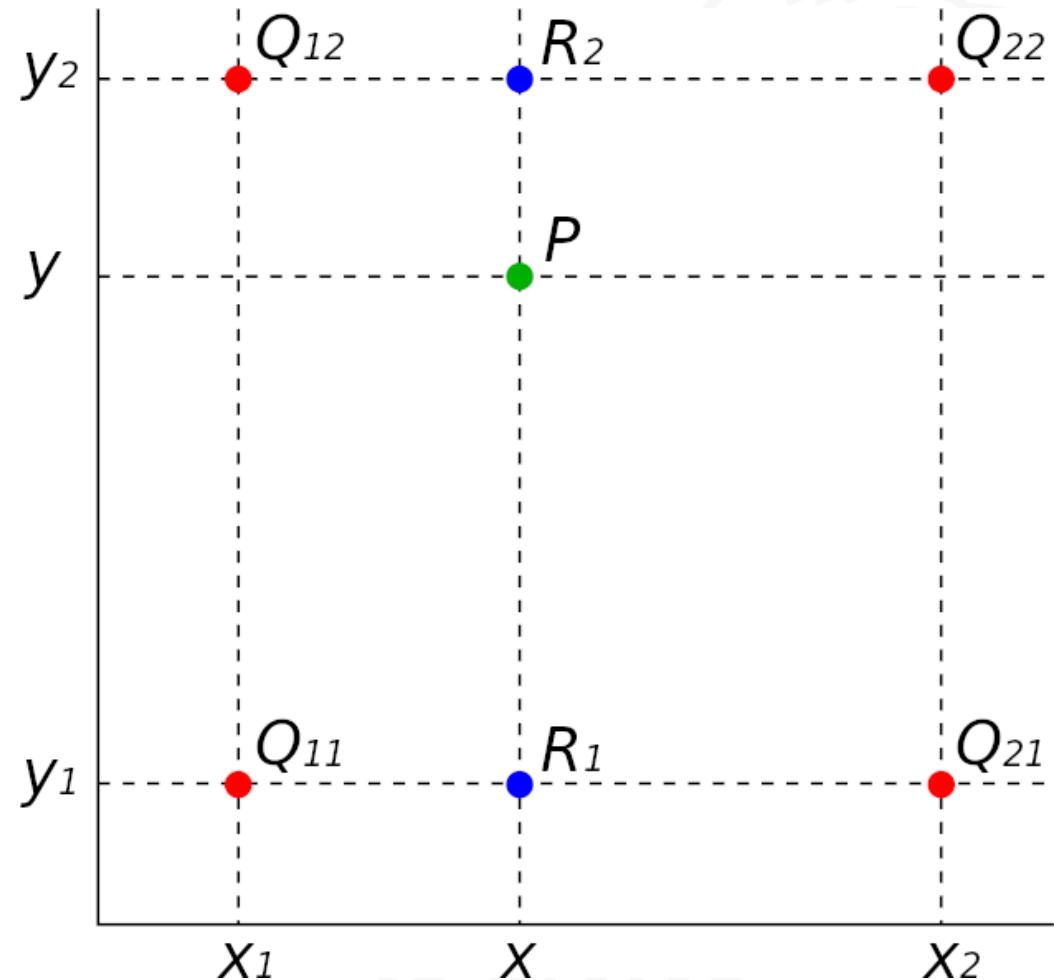
When the spatial resolution
of meteorological forcing is
different than the model
domain



Bilinear

How does bilinear (2-D) interpolation work?

Let's assume that we have defined a set of data coordinates (x_k, y_k) , where $k = 1, 2$. These coordinates define the position of the points Q_{11} , Q_{21} , Q_{12} , and Q_{22} . For any given x and y coordinates, which are located between the x_k and y_k points, by applying the bilinear interpolation technique, we can find the P point (defined by x and y).



Questions?

