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# Added value of EURO-CORDEX high-resolution downscaling over the Iberian Peninsula revisited – Part 1: Precipitation

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**Table S1. Regional models driven by the ERA-Interim reanalysis from the European Centre for Medium-Range Weather Forecasts, for the 1989-2008 period.**

| RCM | Reference | acronym |
| --- | --- | --- |
| CLMcom-CCLM4-8-17 | Keuler et al. (2016) | CCLM |
| ETH-COSMO-crCLIM-v1-1 | Pothapakula et al. (2020), Vautard et al. (2020) | ETH |
| CNRM-ALADIN53 | Colin et al. (2010), Herrmann et al. (2011) | CNRM53 |
| CNRM-ALADIN63 | Daniel et al. (2019), Nabat et al. (2020) | CNRM63 |
| DHMZ-RegCM4-2 | Giorgi et al. (2012) | DHMZ |
| DMI-HIRHAM5 | Christensen et al. (2007) | DMI |
| GERICS-REMO2015 | Remedio et al. (2019) | GERICS |
| ICTP-RegCM4-6 | Giorgi et al. (2012) | ICTP |
| IPSL-INERIS-WRF381P | Vautard et al. (2013) | IPSL |
| KNMI-RACMO22E | van Meijgaard et al. (2008) | KNMI |
| MPI-CSC-REMOO2009 | Jacob et al. (2012) | MPI |
| SMHI-RCA4 | Samuelsson et al. (2011) | SMHI |
| HadREM3-GA7-05 | Tinker et al. (2015) | MOHC |

**Table S2. EURO-CORDEX Regional models driven by the CMIP5 GCMs. Also shown the approximate spatial resolution from each GCM taken from https://portal.enes.org/data/enes-model-data/cmip5/resolution. References: (A) Keuler et al. (2016) (B) Colin et al (2010), Herrmann et al (2011), (C) Daniel et al (2019), Nabat et al (2020), (D) Christensen et al. (2007), (E) Remedio et al. (2019), (F) Vautard et al. (2013), (G) van Meijgaard et al. (2008), (H) Samuelsson et al. (2011), (I) Tinker et al. (2015), (J) Giorgi et al. (2012), (K) Jacob et al. (2012).**

| CMIP5 GCM | Variant | Resolution | RCM | Reference | Acronym |
|---|---|---|---|---|---|
| CNRM-CERFACS-CNRM-CM5 | r1i1p1 | 1.40º X 1.41º | CLMcom-CCLM4-8-17 | A | CNRM-CCLM |
| | | | CNRM-ALADIN53 | B | CNRM-CNRM53 |
| | | | CNRM-ALADIN63 | C | CNRM-CNRM63 |
| | | | DMI-HIRHAM5 | D | CNRM-DMI |
| | | | GERICS-REMO2015 | E | CNRM-GERICS |
| | | | IPSL-WRF381P | F | CNRM-IPSL |
| | | | KNMI-RACMO22E | G | CNRM-KNMI |
| | | | SMHI-RCA4 | H | CNRM-SMHI |
| ICHEC-EC-EARTH | r1i1p1 | 1.12º X 1.13º | DMI-HIRHAM5 | D | ICHEC1-DMI |
| | | | KNMI-RACMO22E | G | ICHEC1-KNMI |
| | | | SMHI-RCA4 | H | ICHEC1-SMHI |
| | r12i1p1 | | CLMcom-CCLM4-8-17 | A | ICHEC2-CCLM |
| | | | ETH-COSMO-crCLIM-v1-1 | A | ICHEC2-ETH |
| | | | DMI-HIRHAM5 | D | ICHEC2-DMI |
| | | | IPSL-WRF381P | F | ICHEC2-IPSL |
| | | | KNMI-RACMO22E | G | ICHEC2-KNMI |
| | | | MOHC- HadREM3-GA7-05 | I | ICHEC2-MOHC |
| | | | SMHI-RCA4 | H | ICHEC2-SMHI |
| IPSL-CM5A-LR | r1i1p1 | 1.89º X 3.75º | GERICS-REMO2015 | E | IPSL-GERICS |
| IPSL-CM5A-MR | r1i1p1 | 1.27º X 2.5º | IPSL-WRF381P | F | IPSL-IPSL |
| | | | KNMI-RACMO22E | G | IPSL-KNMI |
| | | | SMHI-RCA4 | H | IPSL-SMHI |
| MPI-ESM-LR | r1i1p1 | 1.87º X 1.88º | CLMcom-CCLM4-8-17 | A | MPI1-CCLM |
| | | | ETH-COSMO-crCLIM-v1-1 | A | MPI1-ETH |
| | | | CNRM-ALADIN63 | C | MPI1-CNRM63 |
| | | | DMI-HIRHAM5 | D | MPI1-DMI |
| | | | ICTP-RegCM4-6 | J | MPI1-ICTP |
| | | | KNMI-RACMO22E | G | MPI1-KNMI |
| | | | MPI-REMO2009 | K | MPI1-MPI |
| | | | SMHI-RCA4 | H | MPI1-SMHI |
| | r2i1p1 | | ETH-COSMO-crCLIM-v1-1 | A | MPI2-ETHZ |
| | | | MPI-REMO2009-MPI2-MPI | K | MPI2-MPI |
| | | | SMHI-RCA4 | H | MPI2-SMHI |
| | r3i1p1 | | ETH-COSMO-crCLIM-v1-1 | A | MPI3-ETH |
| | | | GERICS-REMO2015 | E | MPI3-GERICS |
| | | | SMHI-RCA4 | H | MPI3-SMHI |
| MOHC-HadGEM2-ES | r1i1p1 | 1.25º X 1.88º | CLMcom-CCLM4-8-17 | A | MOHC-CCLM |
| | | | ETH-COSMO-crCLIM-v1-1 | A | MOHC-ETH |
| | | | CNRM-ALADIN63 | C | MOHC-CNRM |
| | | | DMI-HIRHAM5 | D | MOHC-DMI |
| | | | ICTP-RegCM4-6 | J | MOHC-ICTP |
| | | | IPSL-WRF381P | F | MOHC-IPSL |
| | | | KNMI-RACMO22E | G | MOHC-KNMI |
| | | | MOHC- HadREM3-GA7-05 | I | MOHC-MOHC |
| | | | SMHI-RCA4 | H | MOHC-SMHI |
| NCC-NorESM1-M | r1i1p1 | 1.89º X 2.5º | ETH-COSMO-crCLIM-v1-1 | A | NCC-ETH |
| | | | DMI-HIRHAM5 | D | NCC-DMI |
| | | | GERICS-REMO2015 | E | NCC-GERICS |
| | | | IPSL-WRF381P | F | NCC-IPSL |
| | | | KNMI-RACMO22E | G | NCC-KNMI |
| | | | MOHC- HadREM3-GA7-05 | I | NCC-MOHC |
| | | | SMHI-RCA4 | H | NCC-SMHI |
| NOAA-GFDL-ESM2G | r1i1p1 | 2.02º X 2.00º | GERICS-REMO2015 | E | NOAA-GERICS |

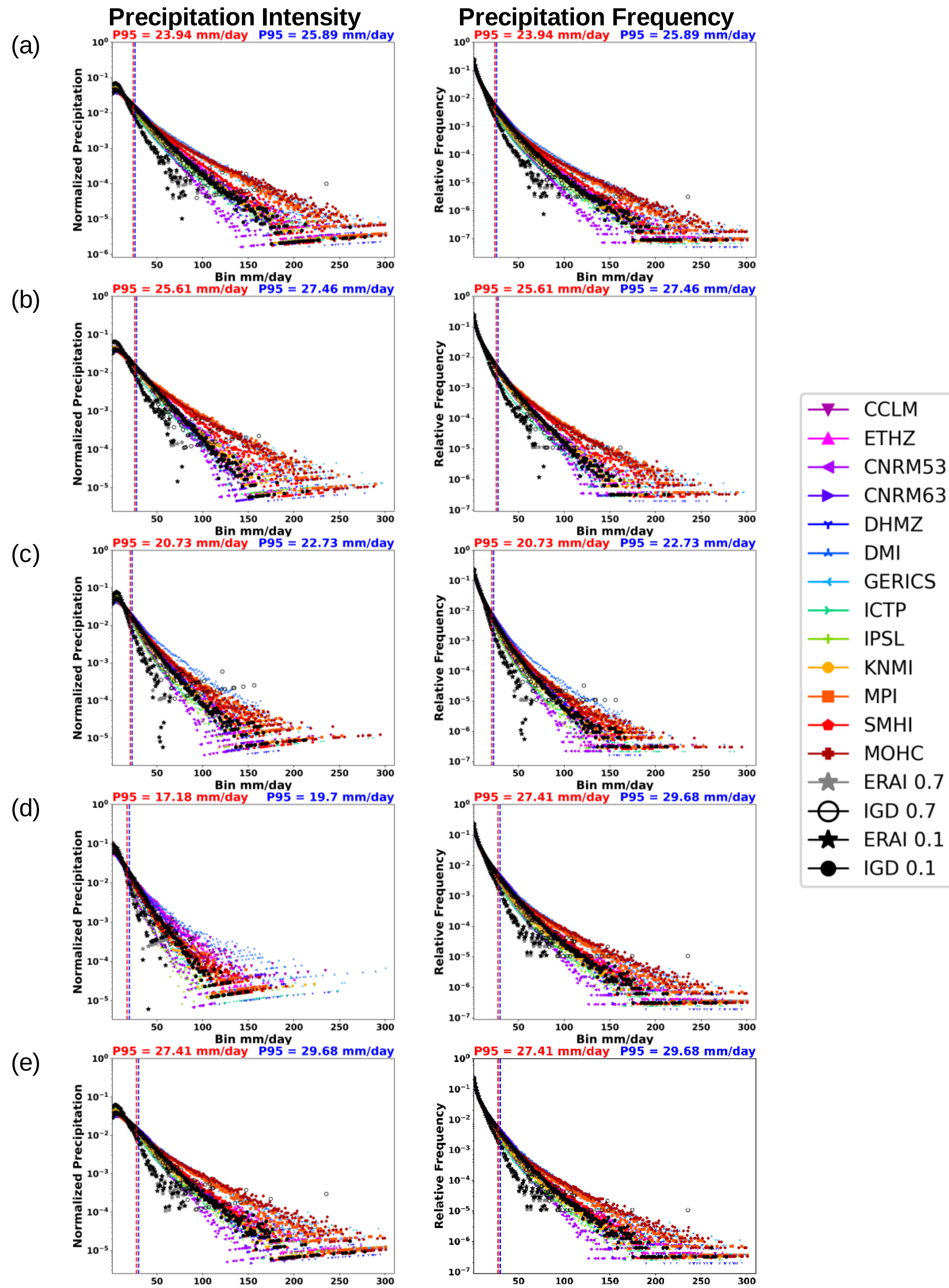


**Figure S1. Daily precipitation Intensity (left) and frequency (right) distributions taken from the hindcast EURO-CORDEX RCMs and ERA-Interim reanalysis (1989-2008) for the Iberian Peninsula. Also shown the Iberian Gridded Dataset distribution for the same domain and period. All RCM data was previously interpolated into the IGD 0.1º regular resolution. As for Era-Interim, two PDFs are shown, one for the original resolution of the low-resolution and other interpolated into the IGD resolution. The dash point and the value written refers to the 95th percentile of the observations for NGD on the original resolution (blue) and interpolated into the ERA-Interim resolution (red). The time periods are (a) Year, (b) DJF, (c) MAM, (d) JJA and (e) SON.**

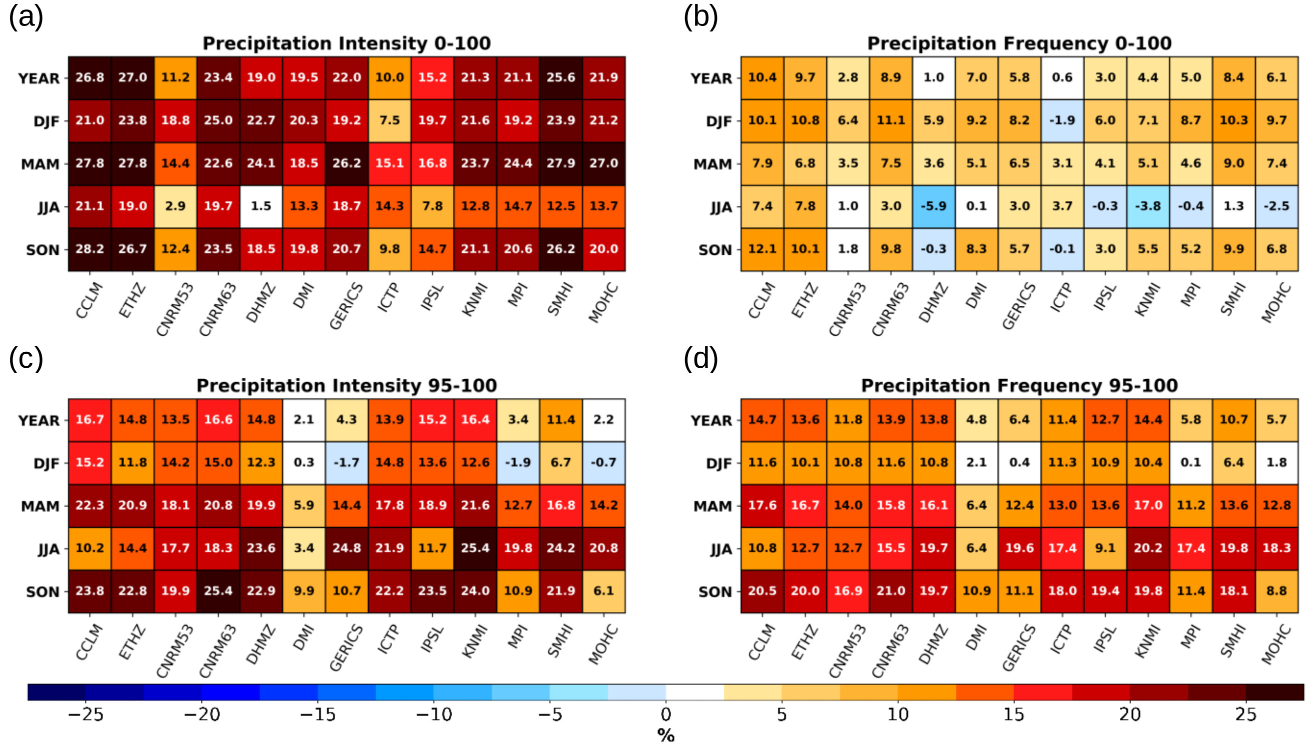


**Figure S2. Yearly and seasonal distribution added values (DAV) of the Iberian Peninsula, between the RCMs and the ERA-Interim reanalysis for the 1989-2008 period, taken from the Hindcast EURO-CORDEX simulations, with the NGD regular dataset as reference for (a) daily precipitation intensity, considering the whole PDF shown in the left panels of Figure S1, (b) daily precipitation frequency considering the whole PDF shown in the right panels of Figure S1, (c) daily precipitation intensity extremes, only considering the values above the observational 95$^{th}$ percentile shown in Figure S1 left side and (d) daily precipitation frequency extremes, only considering the values above the observational 95$^{th}$ percentile shown in the right side of Figure S1. All model data were previously interpolated to 0.1º regular resolution from the observations.**

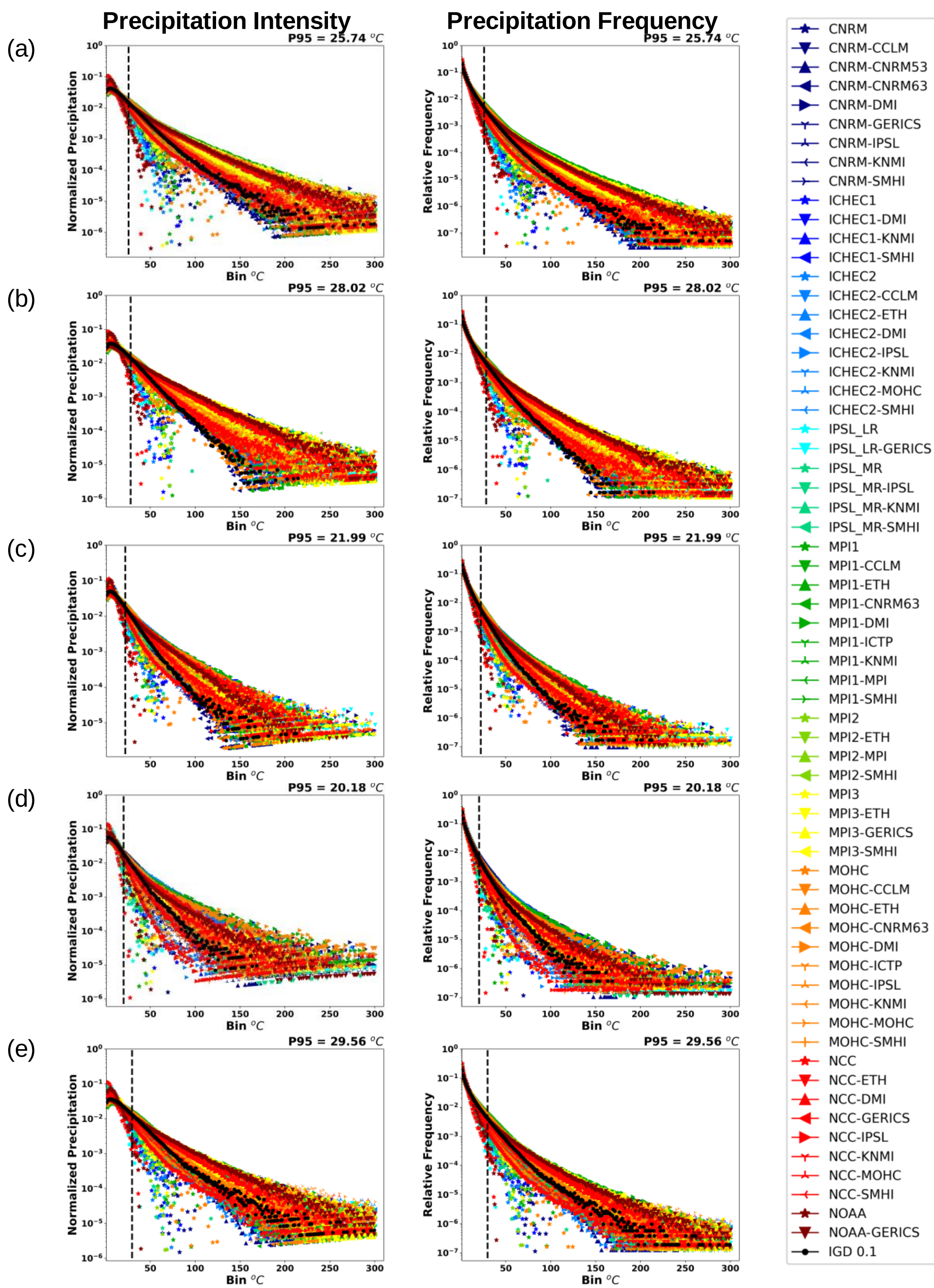


**Figure S3. Daily precipitation Intensity (left) and frequency (right) for the historical driving CMIP5 GCMs and EURO-CORDEX RCMs for the Iberian Peninsula, considering the 1971-2005 period, where all results were previously interpolated into the observational grid. The dash point and the value written refers to the 95$^{th}$ percentile of the observations. (a) Year, (b) DJF, (c) MAM, (d) JJA and (e) SON.**

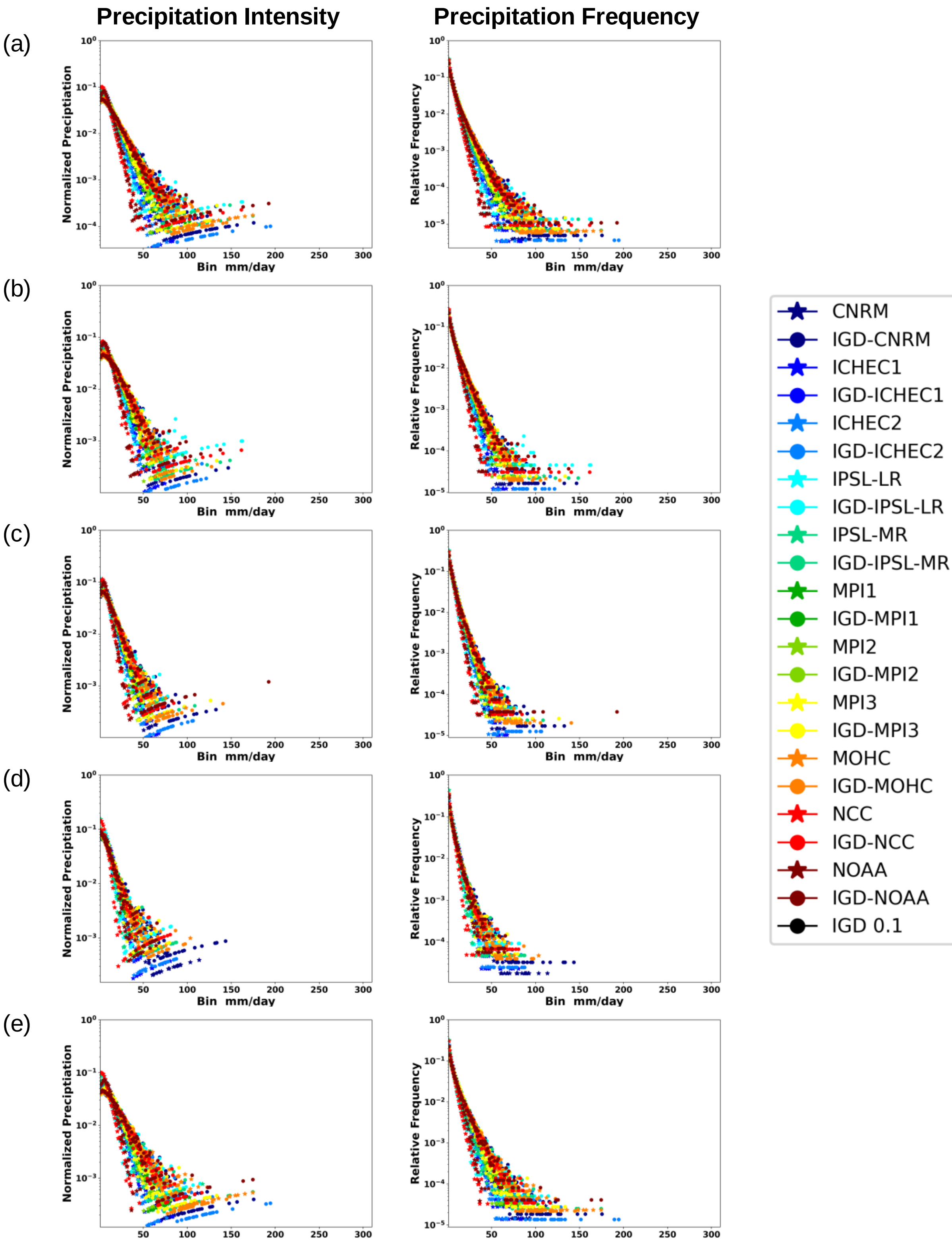


**Figure S4. Daily precipitation Intensity (left) and frequency (right) for the historical driving CMIP5 GCMs and NGD observations interpolated into each GCM resolution for the Iberian Peninsula, considering the 1971-2005 period. Also shown the PDF from the NGD observations at the original resolution. (a) Year, (b) DJF, (c) MAM, (d) JJA and (e) SON.**

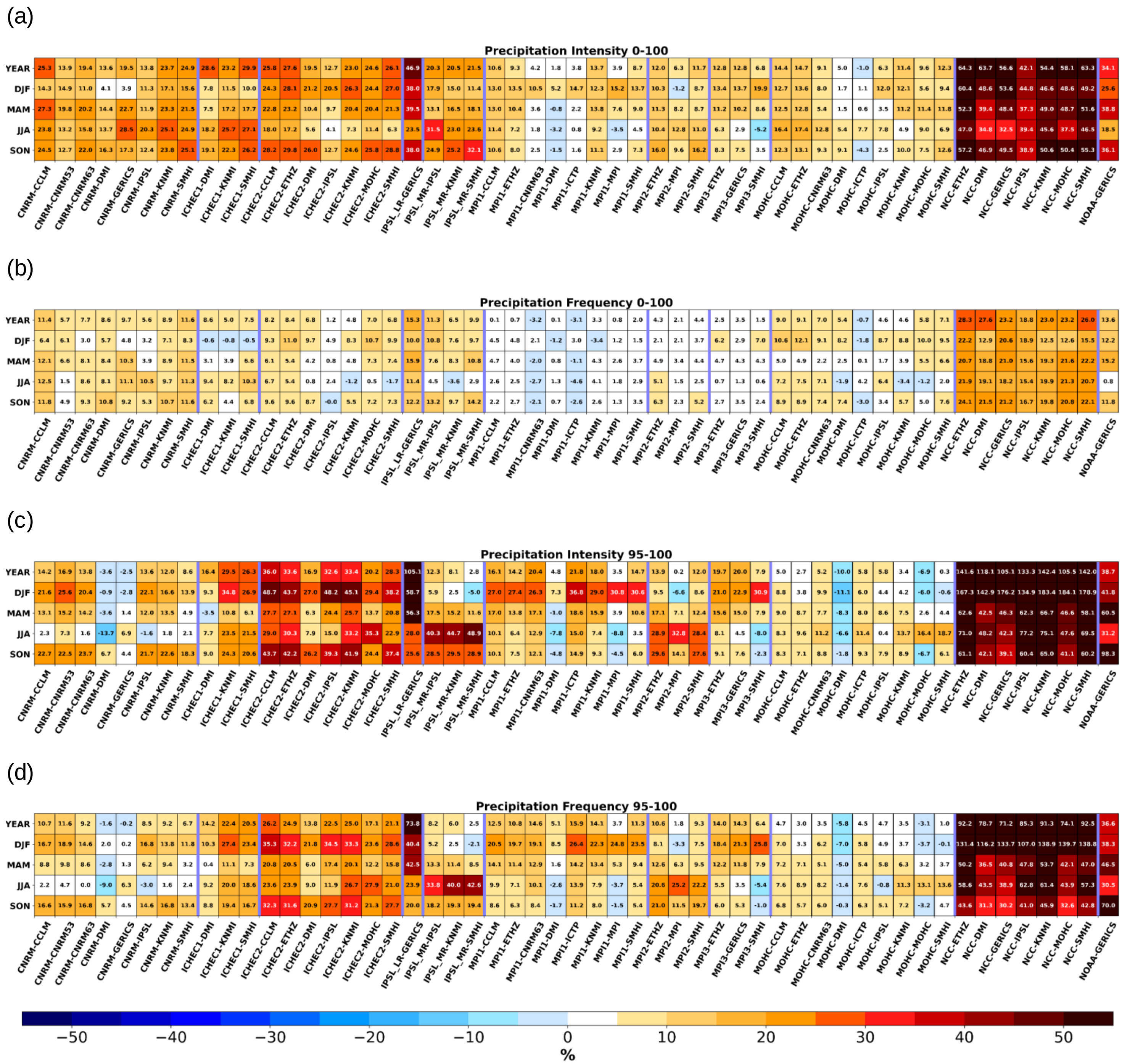


**Figure S5. Yearly and seasonal distribution added values (DAV) of the Iberian Peninsula, between the RCMs and the CMIP5 GCMs for the 1989-2008 period, taken from the Historical EURO-CORDEX simulations, with the NGD regular dataset as reference for (a) daily precipitation intensity, considering the whole PDF shown in the left panels of Figure S3, (b) daily precipitation frequency considering the whole PDF shown in the right panels of Figure S3, (c) daily precipitation intensity extremes, only considering the values above the observational 95th percentile shown in Figure S3 left side and (d) daily precipitation frequency extremes, only considering the values above the observational 95th percentile shown in the right side of Figure S1. All model data were previously interpolated to 0.1º regular resolution from the observations. The thick blue lines separate the RCMs driven by different GCM.**

## References


Christensen, O.B., Drews, M., Christensen, J.H., Dethloff, K., Ketelsen, K., Hebestadt, I. and Rinke, A.: The HIRHAM regional climate model. Version 5 (beta), 2007, https://www.dmi.dk/fileadmin/Rapporter/TR/tr06-17.pdf, last access: 29 April 2021.

Colin, J., Déqué, M., Radu, R. and Somot, S.: Sensitivity study of heavy precipitation in Limited Area Model climate simulations: influence of the size of the domain and the use of the spectral nudging technique. Tellus A: Dynamic Meteorology and Oceanography, 62, 591-604, https://doi.org/10.1111/j.1600-0870.2010.00467.x, 2010.

Daniel, M., Lemonsu, A., Déqué, M., Somot, S., Alias, A. and Masson, V.: Benefits of explicit urban parameterization in regional climate modeling to study climate and city interactions. Climate Dynamics, 52, 2745-2764, https://doi.org/10.1007/s00382-018-4289-x, 2019.

Giorgi, F., Coppola, E., Solmon, F., Mariotti, L., Sylla, M.B., Bi, X., Elguindi, N., Diro, G.T., Nair, V., Giuliani, G. and Turuncoglu, U.U.: RegCM4: model description and preliminary tests over multiple CORDEX domains. Climate Research, 52, 7-29, https://doi.org/10.3354/cr01018, 2012.

Herrmann, M., Somot, S., Calmanti, S., Dubois, C., and Sevault, F.: Representation of spatial and temporal variability of daily wind speed and of intense wind events over the Mediterranean Sea using dynamical downscaling: impact of the regional climate model configuration, Nat. Hazards Earth Syst. Sci., 11, 1983–2001, https://doi.org/10.5194/nhess-11-1983-2011, 2011.

Jacob, D., Elizalde, A., Haensler, A., Hagemann, S., Kumar, P., Podzun, R., Rechid, D., Remedio, A.R., Saeed, F., Sieck, K. and Teichmann,: C. Assessing the transferability of the regional climate model REMO to different coordinated regional climate downscaling experiment (CORDEX) regions. Atmosphere, 3, 181-199, https://doi.org/10.3390/atmos3010181, 2012.

Keuler, K., Radtke, K., Kotlarski, S., and Lüthi, D.: Regional climate change over Europe in COSMO-CLM: Influence of emission scenario and driving global model, Meteorologische Zeitschrift, 25, 121–136, https://doi.org/10.1127/metz/2016/0662, 2016.

Nabat, P., Somot, S., Cassou, C., Mallet, M., Michou, M., Bouniol, D., Decharme, B., Drugé, T., Roehrig, R., and Saint-Martin, D.: Modulation of radiative aerosols effects by atmospheric circulation over the Euro-Mediterranean region, Atmos. Chem. Phys., 20, 8315–8349, https://doi.org/10.5194/acp-20-8315-2020, 2020.

Pothapakula, P. K., Primo, C., Sørland, S., and Ahrens, B.: The synergistic impact of ENSO and IOD on the Indian Summer Monsoon Rainfall in observations and climate simulations - an information theory perspective, Earth Syst. Dynam, 11, 903–923, https://doi.org/10.5194/esd11-903-2020, 2020.

Remedio, A.R., Teichmann, C., Buntemeyer, L., Sieck, K., Weber, T., Rechid, D., Hoffmann, P., Nam, C., Kotova, L. and Jacob, D.: Evaluation of new CORDEX simulations using an updated Köppen–Trewartha climate classification. Atmosphere, 10, 726, https://doi.org/10.3390/atmos10110726, 2019.

Samuelsson, P., Jones, C.G., Will´ En, U., Ullerstig, A., Gollvik, S., Hansson, U.L.F., Jansson, E., Kjellstro¨ M, C., Nikulin, G. and Wyser, K.: The Rossby Centre Regional Climate model RCA3: model description and performance. Tellus A: Dynamic Meteorology and Oceanography, 63, 4-23, https://doi.org/10.1111/j.1600-0870.2010.00478.x, 2011.

Tinker, J., Lowe, J., Holt, J., Pardaens, A. and Wiltshire, A.: Validation of an ensemble modelling system for climate projections for the northwest European shelf seas. Progress in Oceanography, 138, 211-237, https://doi.org/10.1016/j.pocean.2015.07.002, 2015.

Vautard, R., Gobiet, A., Jacob, D., Belda, M., Colette, A., Déqué, M., Fernández, J., García-Díez, M., Goergen, K., Güttler, I. and Halenka, T.: The simulation of European heat waves from an ensemble of regional climate models within the EURO-CORDEX project. Climate Dynamics, 4, 2555-2575, https://doi.org/10.1007/s00382-013-1714-z, 2013.

Vautard, R., Kadygrov, N., Iles, C., Boberg, F., Buonomo, E., Buelow, K., Coppola, E., Corre, L., van Meijgaard, E., Nogherotto, R., Sandstad, M., Schwingshakl, C., Somot, S., Aalbers, E. E., Christensen, O., Ciarlo, J., Demory, M.-E., Giorgi, F., Jacob, D., Jones, R. G., Keuler, K., Kjellström, E., Lenderink, G., Levavasseur, G., Nikulin, G., Sillmann, J., Solidoro, C., Sørland, S., Steger, C., Teichmann, C., Warrach-Sagi, K., and Wulfmeyer, V.: Evaluation of the large EURO-CORDEX regional climate model ensemble, Journal of Geophysical Research: Atmospheres, https://doi.org/10.1029/2019JD032344, 2020.

van Meijgaard, E., Van Ulft, L.H., Van de Berg, W.J., Bosveld, F.C., Van den Hurk, B.J.J.M., Lenderink, G. and Siebesma, A.P., 2008. The KNMI regional atmospheric climate model RACMO, version 2.1 (p. 43). De Bilt, Netherlands: KNMI, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.475.9494&rep=rep1&type=pdf, last access: 29April 2021.