

Activities in Spain

[The Spanish group in 2011]

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⁴ AEMET, Madrid, Spain

⁵ iMetCam, Toledo, Spain

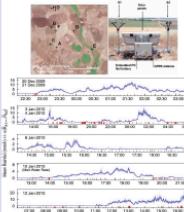
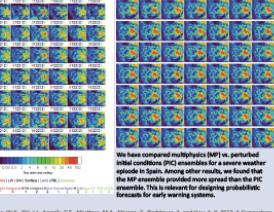
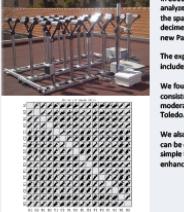
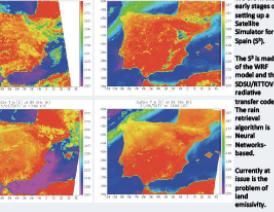
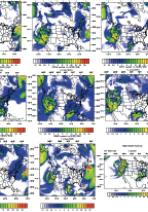
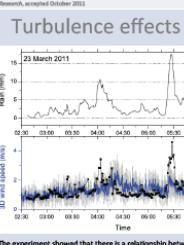
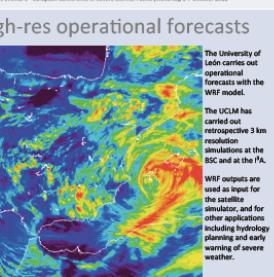
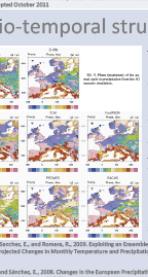
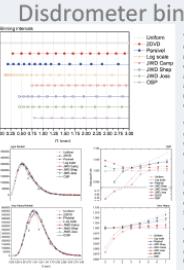
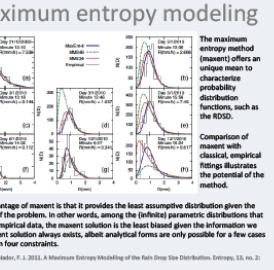
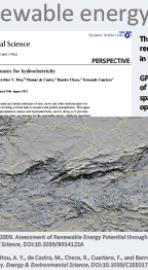
⁶ NASA Goddard Space Flight Center (GSFC) / Wallops Flight Facility, Wallops Island, VA, USA

Outline

1· RDSD estimation

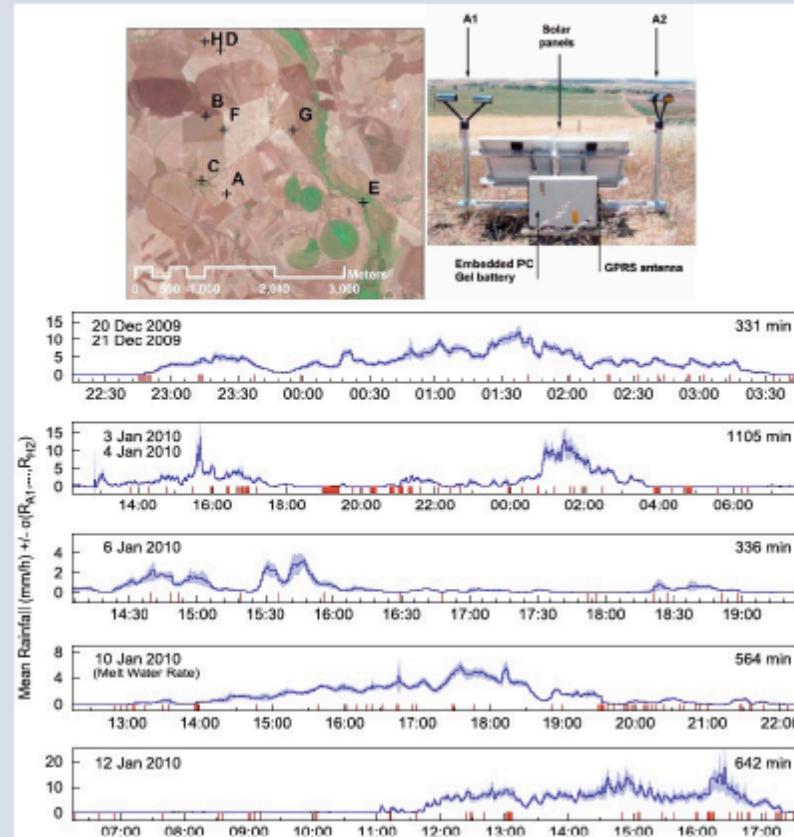
2· Modeling

3· Climate Research

RDSD estimation	Modeling	Climate Research
Medium-scale variability  <p>In 2010, we used 16 Parvelles to measure the spatial variability of the RDSD within a 0.98-size plot.</p> <p>The experiments were made in central Spain, where has a moderate rain rate, and thus within Parvelles' known limitations.</p> <p>As showed in the paper, we found a consistent pattern of OSD variability with distance, and a noticeable spread in the spread of the PR relationship within the same episode.</p> <p>Tapiador, F.J., Tan, W.-C., Shi, J.J., Angelis, C.F., Martínez, M.A., Moreno, C., Rodríguez, A., and Hoss, A.Y.: 2012, A Comparison of Parvelles and Rainbird 1000S instruments in a Severe Weather Episode in Spain, <i>Journal of Applied Meteorology and Climatology</i>, accepted October 2012.</p>	Ensembles of NWP models  <p>We have compared multiphysics (MP) vs. perturbed parameterizations (PP) ensembles for the summer episode in Spain. Among other results, we found that the MP ensemble provided more spread than the PP ensemble, which is important for providing probabilistic forecasts for early warning systems.</p> <p>Tapiador, F.J., Tan, W.-C., Shi, J.J., Angelis, C.F., Martínez, M.A., Moreno, C., Rodríguez, A., and Hoss, A.Y.: 2012, A Comparison of Parvelles and Rainbird 1000S instruments in a Severe Weather Episode in Spain, <i>Journal of Applied Meteorology and Climatology</i>, accepted October 2012.</p>	Ensembles of RCMs  <p>Ensembles of Regional Climate Models (RCMs) are required to cope with the complex topography and parameterizations such convection, turbulence, or surface processes.</p> <p>European projects as PRUDENCE and ENSEMBLES have provided projections of present and future climates using several RCMs.</p> <p>The validation of pre-climate models against observations is a more robust approach to account for known differences in the observational datasets.</p> <p>Observational databases can also assist to correct biases in models so RCMs can be used to derive climate projections and complete climatologies for a variety of applications.</p> <p>Tapiador, F.J.: 2012, A brief Estimate of the Precipitation Climate Signal in Europe using Eight Regional Models and Five Observational Datasets, <i>Journal of Climate</i>, 25, 2723-2736.</p>
Small-scale variability  <p>In 2011, we located 16(2) Parvelles to analyze the consistency of the instruments, the spatial variability of the RDSD at decimeter scale, and to cross-validate the new Parvelles instruments.</p> <p>The experiments were made in Toledo, and included some atmospheric conditions.</p> <p>We found that the Parvelles provided consistent estimates of the RDSD for moderate rainfall rates such those found in Toledo.</p> <p>We also found that the old Parvelles estimates can be corrected by a simple transfer function that accounts for the enhanced performances of the instrument.</p> <p>Tapiador, F.J., Turc, J., Petersen, W., Hoss, A.Y., García-Ortega, E., Machado, L.A.T., Angelis, C.F., Selby, P., Kidd, C., Huffines, G.L. and de Castro, M.: 2012, Global Precipitation Measurement: Methods, Datasets and Applications, <i>Atmospheric Measurement Techniques</i>, accepted October 2012.</p>	Satellite Simulator for Spain  <p>We are in the early stages of setting up a Satellite Simulator for Spain (SPS).</p> <p>The SPS is made of the SPOT-5 satellite and the SPOT-VGT radiative transfer codes. The rainfall retrieval algorithm is based on Neural Networks-based.</p> <p>Currently at the first stage of problem of land cover.</p> <p>García-Ortega, E., Tapiador, F.J., López, L., Katsaros, D., and Schröer, J.L.: 2012, A GPM simulator to Improve the NWP of severe events, 46th European Conference on Severe Storms, Pola (Malta), 27 October 2012.</p>	Model validation  <p>Satellite-derived precipitation databases are of primary importance for validating the projections made by Regional Climate Models (RCMs).</p> <p>An longer time series of precipitation available will be able to better understand model uncertainties in present climate. Thus, we are increasing our confidence on the estimates of the precipitation climate signal.</p> <p>As previously with the European ENSEMBLES and PRUDENCE projects, recent comparison of regional climate models and data have shown the potential of this research field for the PMM.</p> <p>Tapiador, F.J., Turc, J., Petersen, W., Hoss, A.Y., García-Ortega, E., Machado, L.A.T., Angelis, C.F., Selby, P., Kidd, C., Huffines, G.L. and de Castro, M.: 2012, Global Precipitation Measurement: Methods, Datasets and Applications, <i>Atmospheric Measurement Techniques</i>, accepted October 2012.</p>
Turbulence effects on the RDSD  <p>We investigated the role of turbulence on the variability of the RDSD.</p> <p>These are compared turbulence readings from a rain gauge (10 Hz sampling) with the standard deviation of the RDSD estimates from 16 Parvelles.</p> <p>The experiment showed that there is a relationship between the observed differences in the RDSD, as measured by Parvelles, and the turbulence.</p> <p>Tapiador, F.J., Turc, J., Petersen, W., Hoss, A.Y., García-Ortega, E., Machado, L.A.T., Angelis, C.F., Selby, P., Kidd, C., Huffines, G.L. and de Castro, M.: 2012, Global Precipitation Measurement: Methods, Datasets and Applications, <i>Atmospheric Measurement Techniques</i>, accepted October 2012.</p>	High-res operational forecasts  <p>The University of Toledo carried out operational forecasts with the WRF model.</p> <p>The UCLM has carried out retrospective 3 km resolution simulations at the RBC and at the PA.</p> <p>WRF outputs are used as input for the satellite simulator, and for numerical simulations including hydrology planning and early warning of severe weather.</p> <p>Tapiador, F.J., Sánchez, E., and Rosales, X.: 2010, Exploring the Ensemble of Regional Climate Models to Provide Robust Estimates of Projected Changes in Monthly Temperature and Precipitation Probability Distribution, <i>Planning, Policy & Environment</i>, 32, 254-257.</p>	Spatio-temporal structure of precip  <p>The temporal structure of precipitation is as important as the actual amount of rain for applications such as agriculture or hydroelectricity.</p> <p>Using spectral analysis, we have investigated the expected changes in the spatio-temporal cycles in Europe under the SRES-A2 climate change scenario.</p> <p>Validation of modeled precipitation with observational data is critical to assess the reliability of the predictions. Tools for this task include Probability Distribution Functions (pdfs) for spatially-aggregated data, and the semivariance structure such as the semivariogram.</p> <p>Tapiador, F.J., Sánchez, E., and Rosales, X.: 2010, Changes in the European Precipitation Characteristics (2070-2090) as Derived by Digital Regional Climate Models, <i>Journal of Climate</i>, 23, 2540-2550.</p>
Disdrometer binning effect  <p>The estimate of the size of the falling drops is quantized into a discrete number of intervals of different size, which are usually logarithm-like scaled to account for the wide spectrum of drop sizes spanning three orders of magnitude.</p> <p>We compared several binning methods with an uniform, fine-scale binning, which simulated a perfect disdrometer.</p> <p>Using Monte-Carlo sampling and several types of rainfall rates, we calculated statistics on the size and on the moments of different binning strategies.</p> <p>The results showed that non-negligible differences appear in higher moments, and that those are larger with light rainfall rates.</p> <p>Chen, R. and Tapiador, F.J.: 2011, A Maximum Entropy Modeling of the Fall Size Distribution, <i>Entropy</i>, 13, no. 21 289-315.</p>	Maximum entropy modeling  <p>The maximum entropy method (maxent) offers an alternative way to characterize probability distributions, such as the RDSD.</p> <p>Comparison of maxent with classical, empirical distributions shows the potential of the method.</p> <p>A major advantage of maxent is that it provides the least disruptive distribution given the constraints of the problem. In other words, among the (infinite) parametric distributions that fit the empirical data, the maxent solution is the least biased given the information we have about the system. In other words, about analytical forms are only possible for a few cases with less than four constraints.</p> <p>Chen, R. and Tapiador, F.J.: 2011, A Maximum Entropy Modeling of the Fall Size Distribution, <i>Entropy</i>, 13, no. 21 289-315.</p>	Renewable energy applications  <p>The applicability of PMM products for renewable energy operations is clear in the case of hydroelectric power.</p> <p>PMM will provide improved estimates of precipitation at temporal and spatial resolutions suitable for operations.</p> <p>Tapiador, F.J.: 2009, Assessment of Renewable Energy Potential through Satellite Data and Numerical Models, <i>Energy & Environmental Science</i>, 2, 1410-1419.</p> <p>Tapiador, F.J., Hoss, A.Y., de Castro, M., Chen, R., Costero, F., and Barnes, A.P.: 2011, Precipitation estimates for Hydroelectricity, <i>Energy & Environmental Science</i>, DOI:10.1039/CB003174G</p>

RDSD estimation

Medium-scale variability

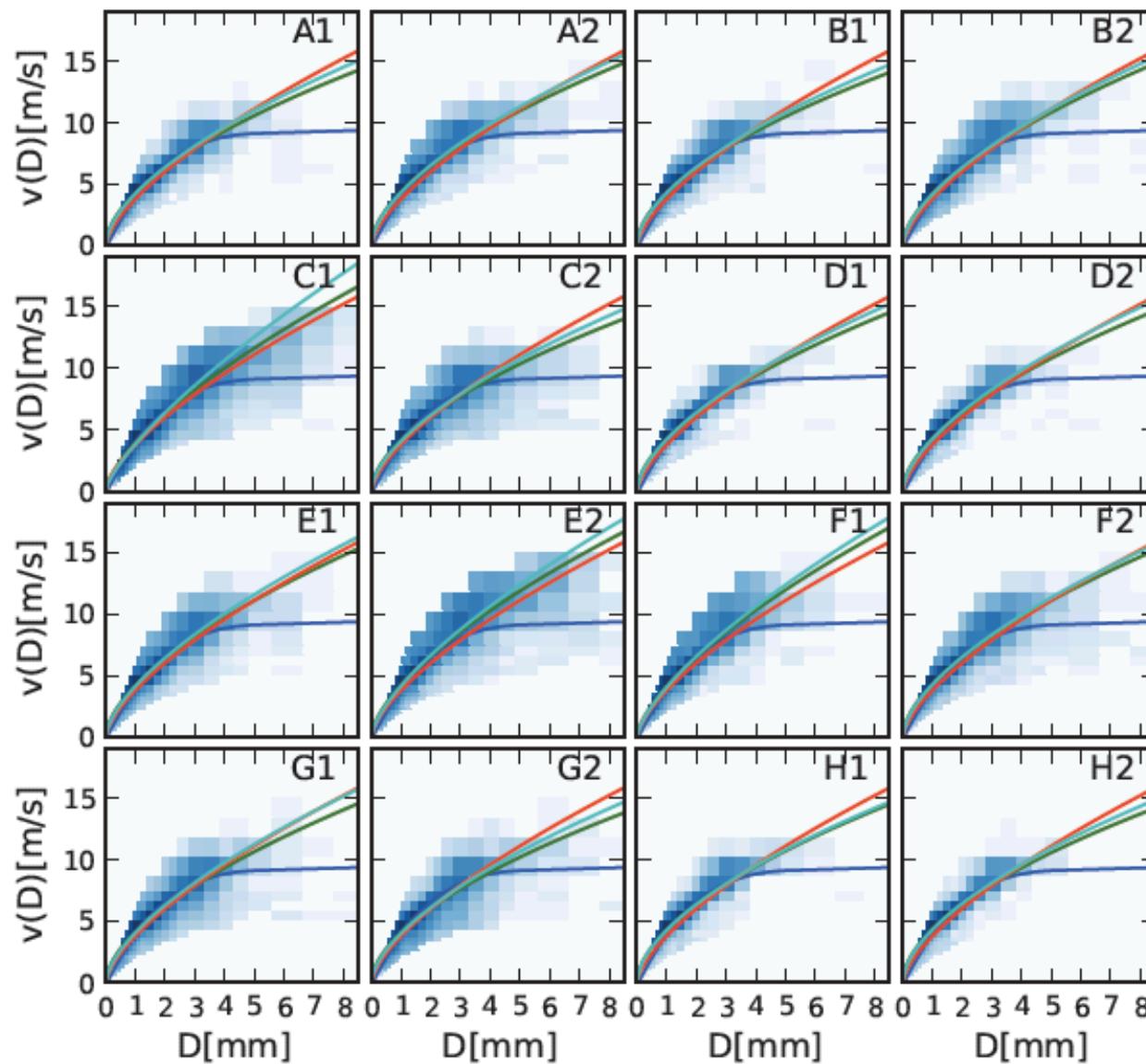


In 2010, we used 16 Parsivel disdrometers (in a dual setup to ensure consistency) to analyze the spatial variability of the RDSD within a DPR-size pixel.

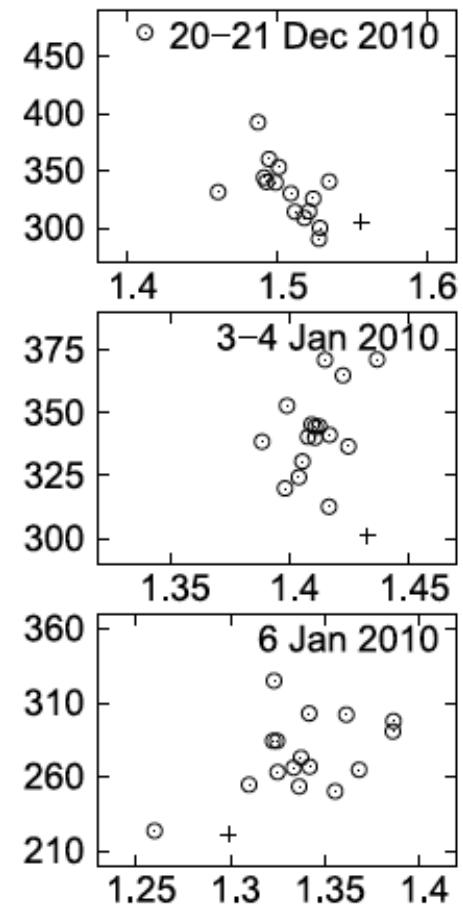
The experiments were made in central Spain, which has a semiarid climate with moderate rain rates, and thus within Parsivels' known limitations.

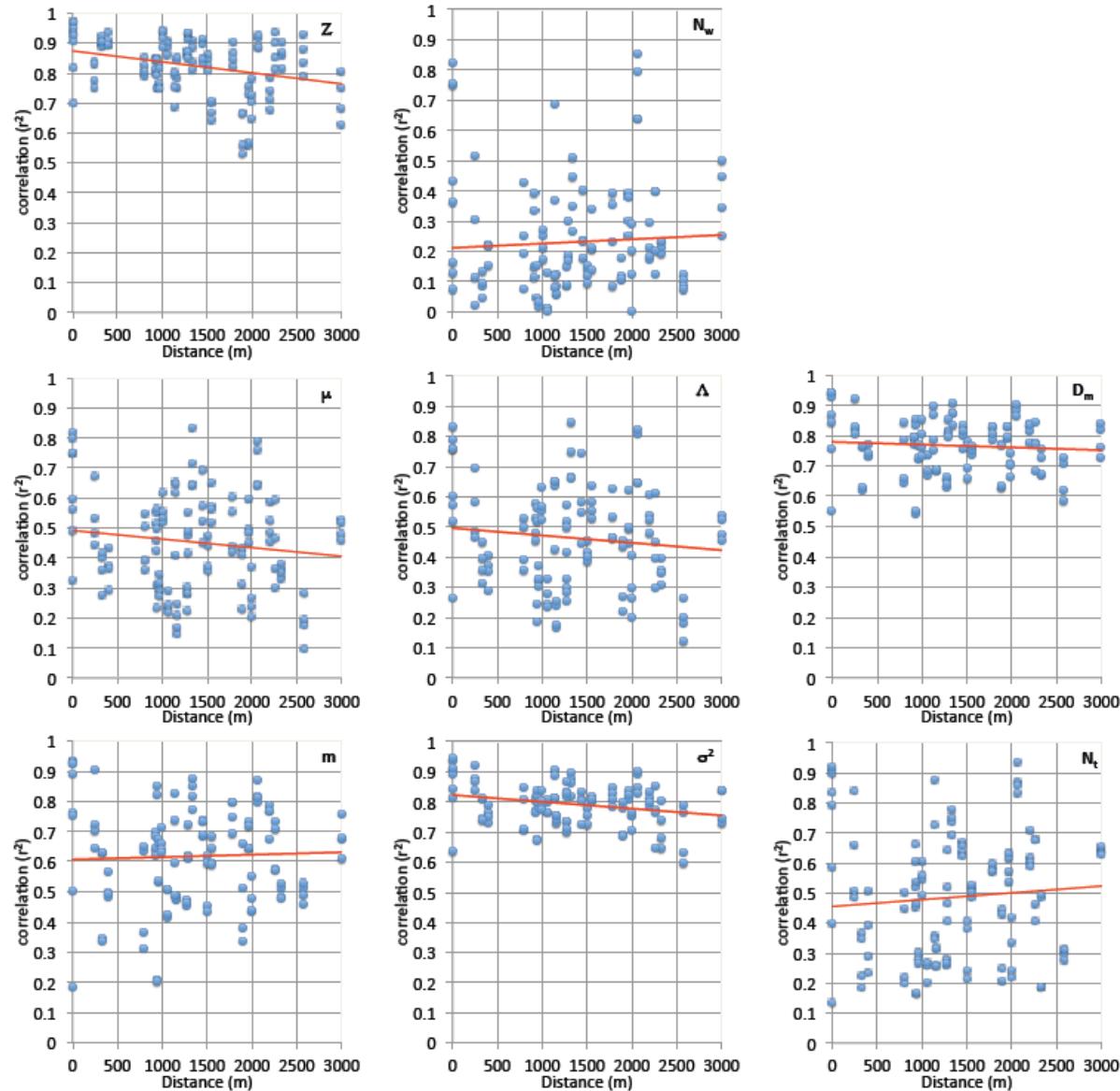
As described in the paper below, we found a consistent pattern of DSD variability with distance, and a noticeable spread in the a and b parameters of the Z/R relationship within the same episode.

Tapiador, F.J., Checa, R., and de Castro, M., 2010. An experiment to measure the spatial variability of rain drop size distribution using sixteen laser disdrometers, *Geophysical Research Letters*, 37, L16803, doi:10.1029/2010GL044120

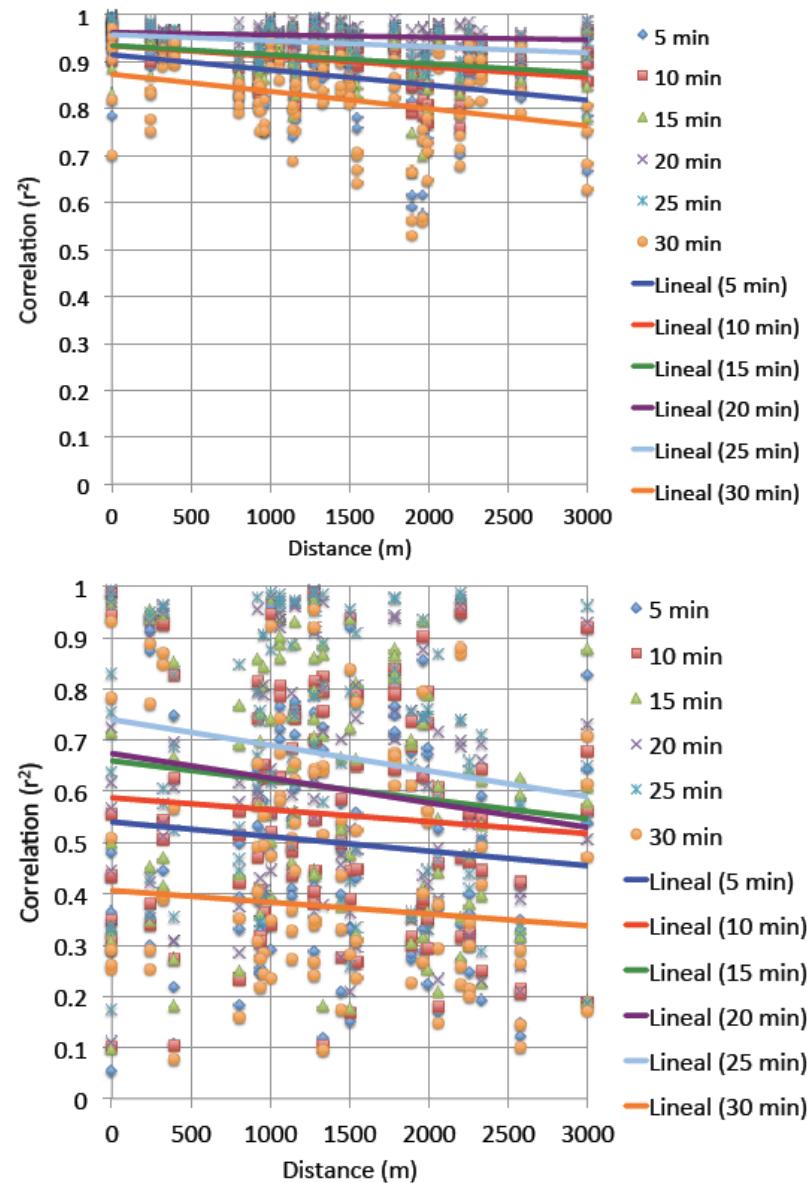
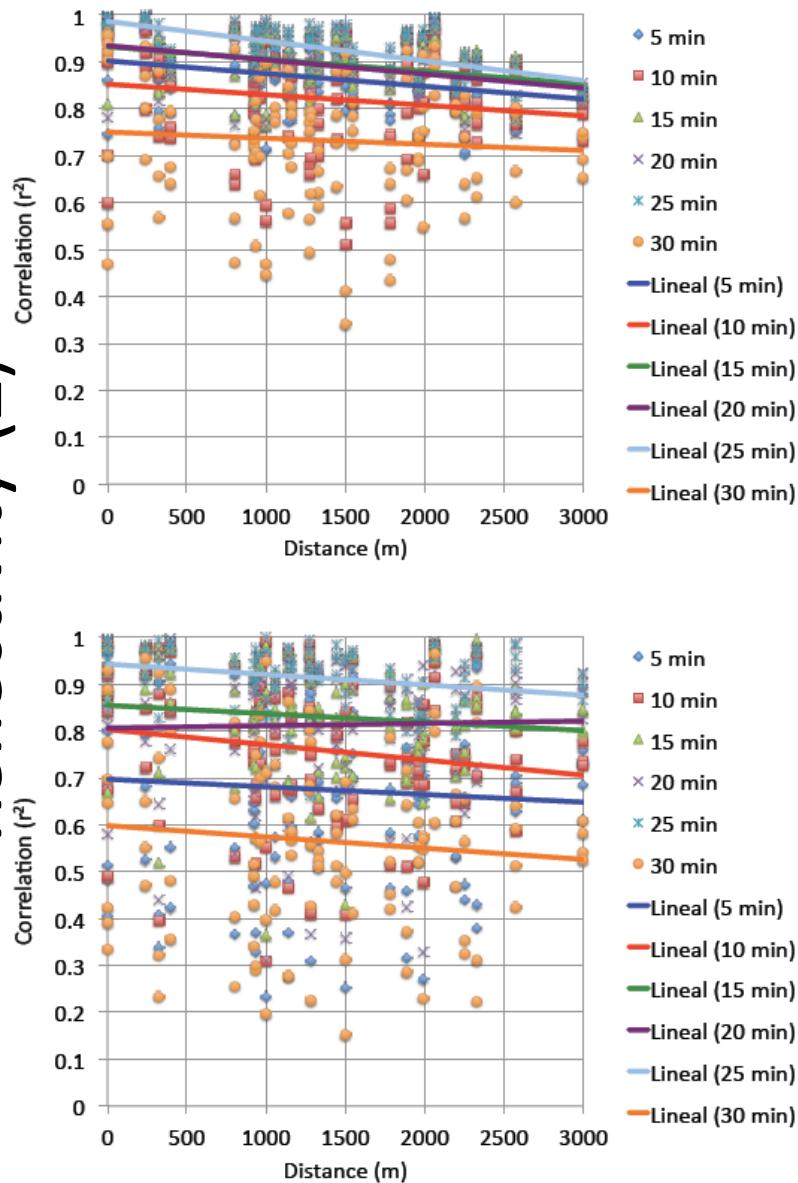


Parameter a vs b



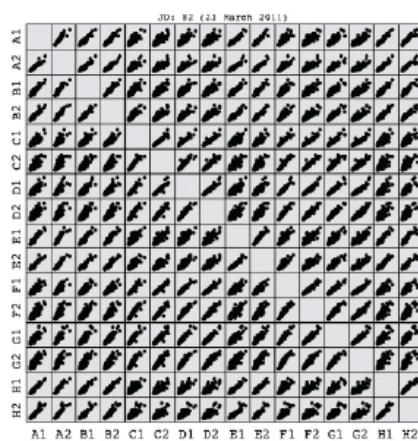


Reflectivity (Z)



RDSD estimation

Small-scale variability



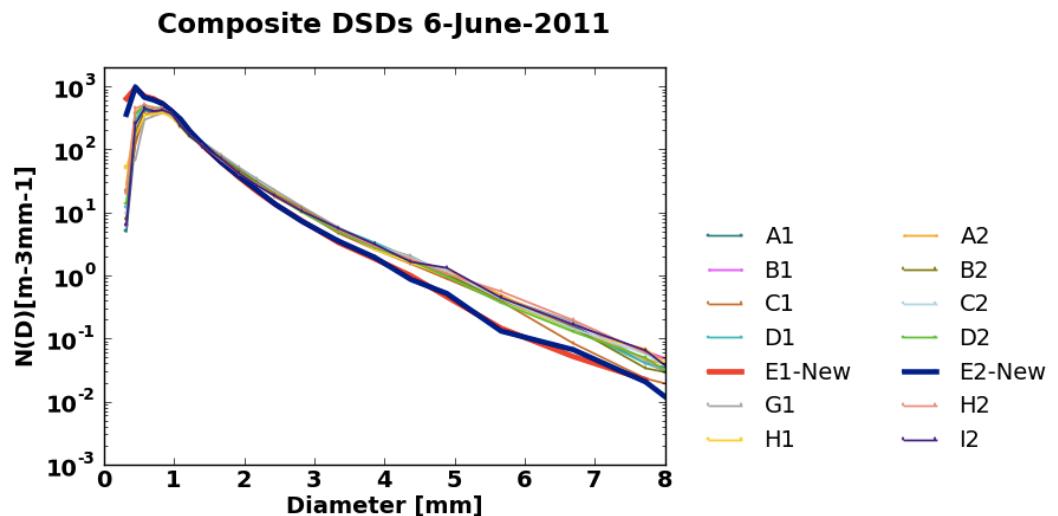
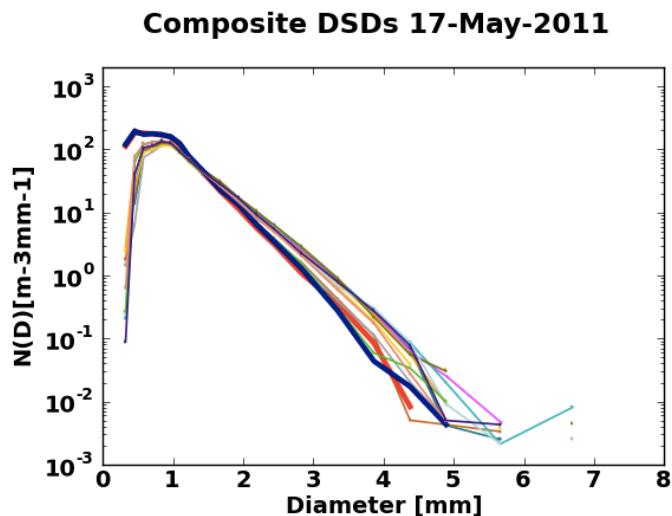
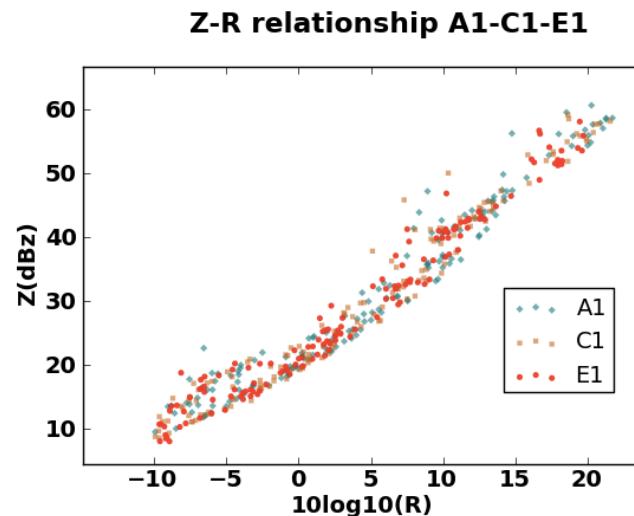
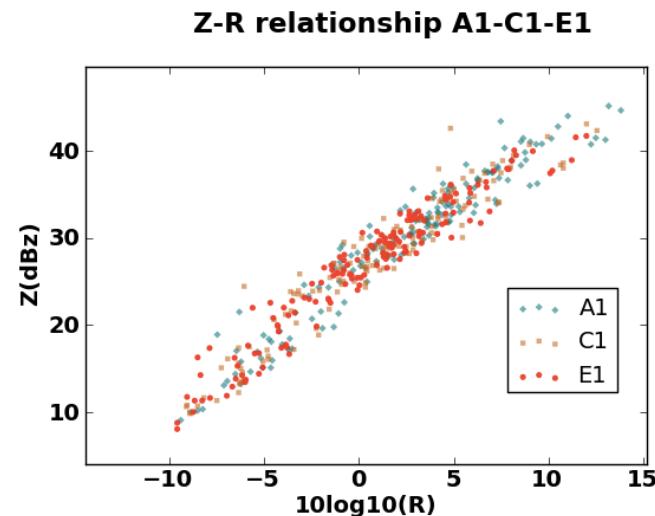
In 2011, we located 16(+2) Parsivels to analyze the consistency of the instruments, the spatial variability of the RDSD at decimeter scale, and to cross-compare the new Parsivel² instruments.

The experiments were made in Toledo, and included a sonic anemometer.

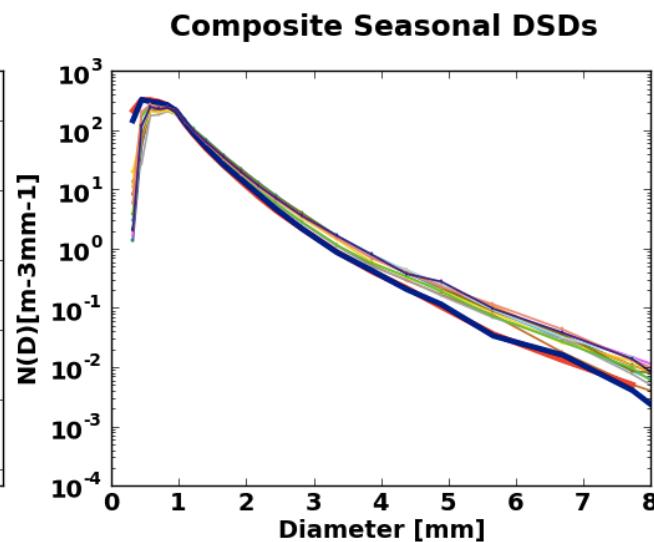
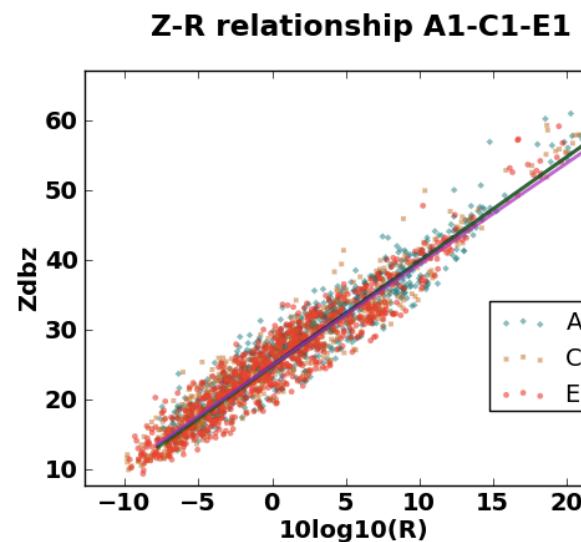
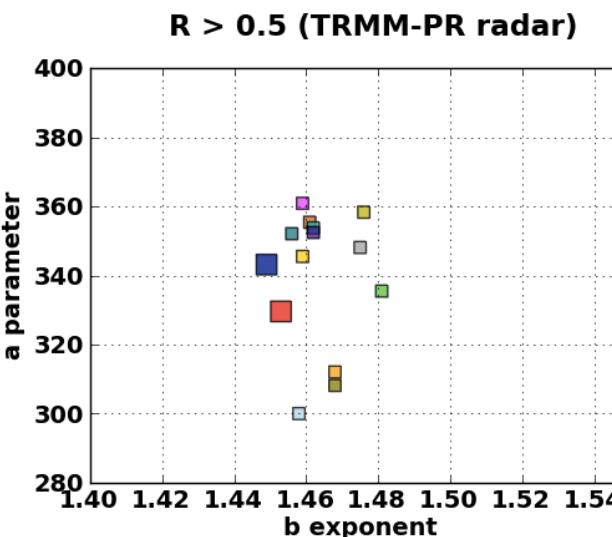
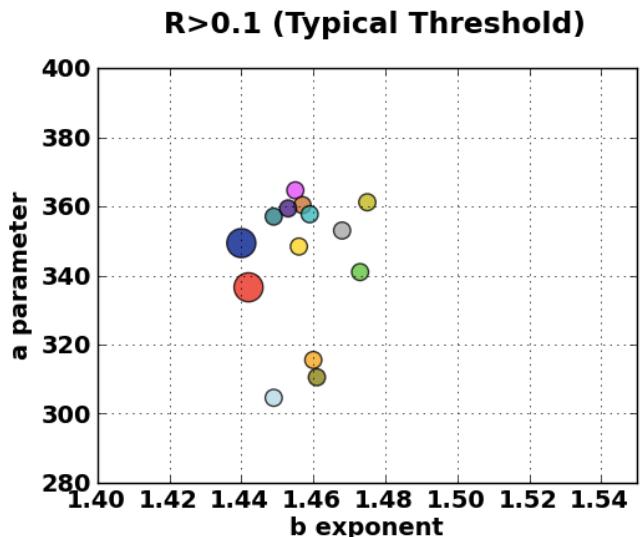
We found that the Parsivels provided consistent estimates of the RDSD for moderate rainfall rates such as those found in Toledo.

Tapiador, F.J., Turk, J., Petersen, W., Hou, A.Y., García-Ortega, E., Machado, L.A.T., Angelis, C.F., Salio, P., Kidd, C., Huffman, G.J. and de Castro, M. 2011. Global Precipitation Measurement: Methods, Datasets and Applications. *Atmospheric Research*, accepted October 2011

Parsivel 2 evaluation

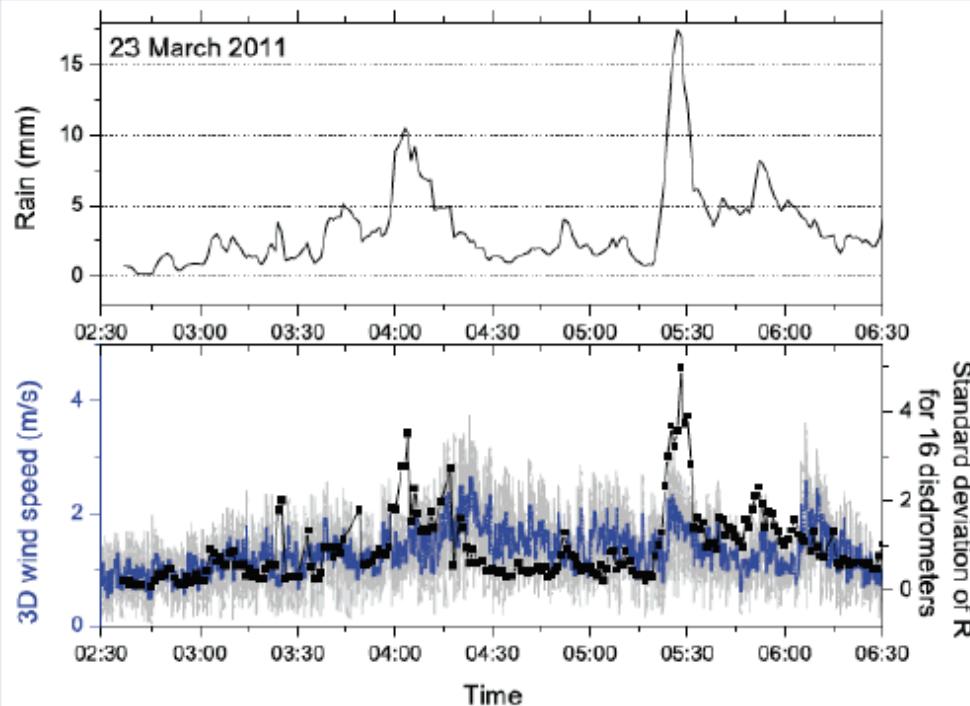


Parsivel 2 evaluation



RDSD estimation

Turbulence effects on the RDSD



We investigated the role of turbulence on the variability of the RDSD.

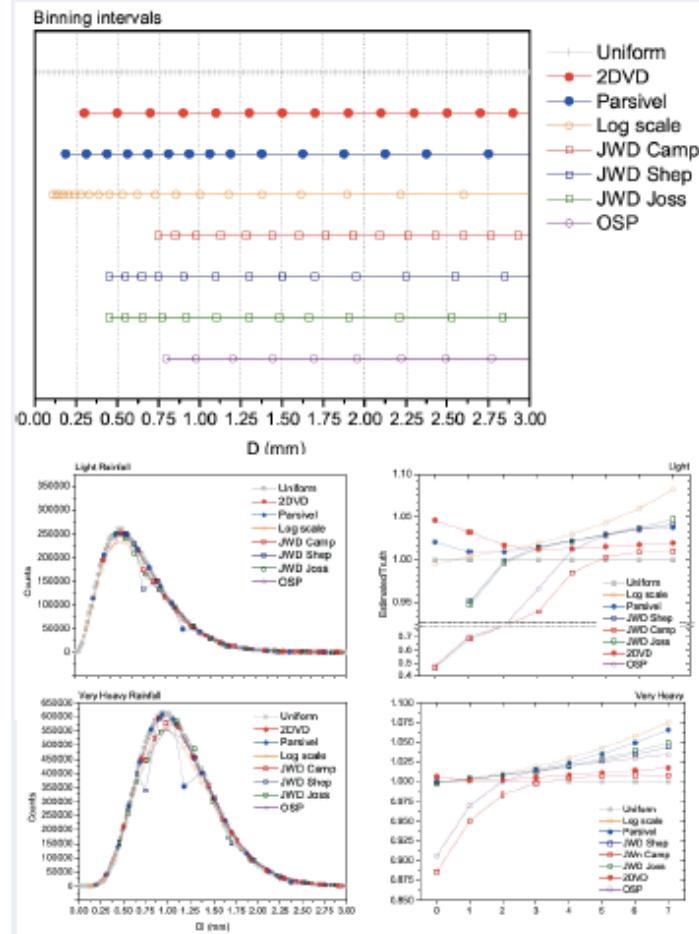
Thus, we compared turbulence readings from a sonic anemometer (10 Hz sampling) with the standard deviation of the DSD estimates from 16 Parsivels.

The experiment showed that there is a relationship between the observed differences in the RDSD, as measured by Parsivel disdrometers, and the turbulence.

Tapiador, F.J., Turk, J., Petersen, W., Hou, A.Y., García-Ortega, E., Machado, L.A.T., Angelis, C.F., Salio, P., Kidd, C., Huffman, G.J. and de Castro, M. 2011. Global Precipitation Measurement: Methods, Datasets and Applications. *Atmospheric Research*, accepted October 2011

RDSD estimation

Disdrometer binning effect



The estimates of the size of the falling drops is quantized into a discrete number of intervals of different size, or bins. The widths of the bins are usually logarithm-like scaled to account for the wide spectrum of raindrop diameters, spanning three orders of magnitude.

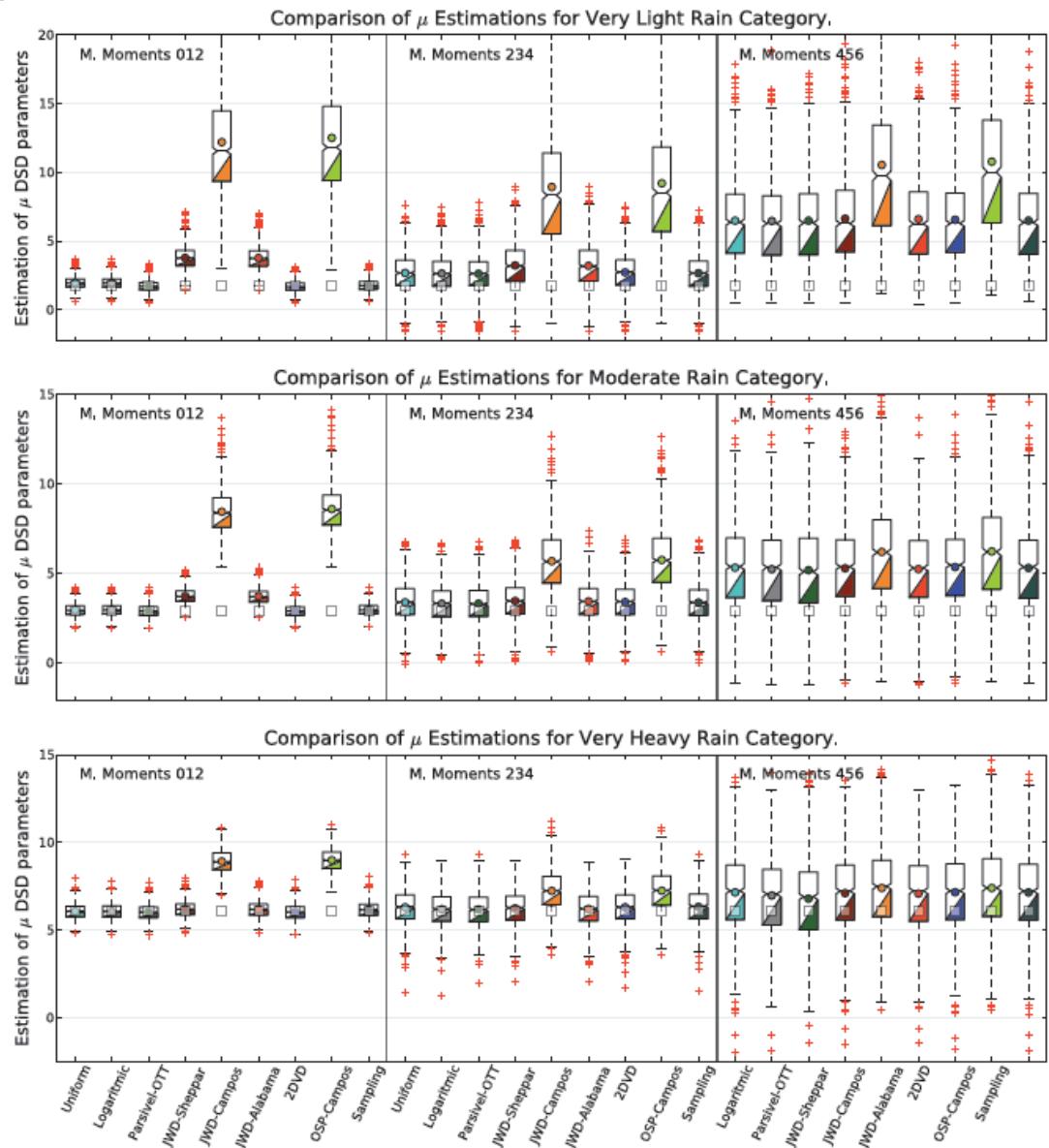
We compared several binning method with an uniform, fine-scale binning which simulated a perfect disdrometer.

Using Monte-Carlo sampling and several types of rainfall rates, we calculated the effects on the DSD and on the moments of different binning strategies.

The results showed that non-negligible differences appear in higher moments, and that those are larger with light rainfall rates.

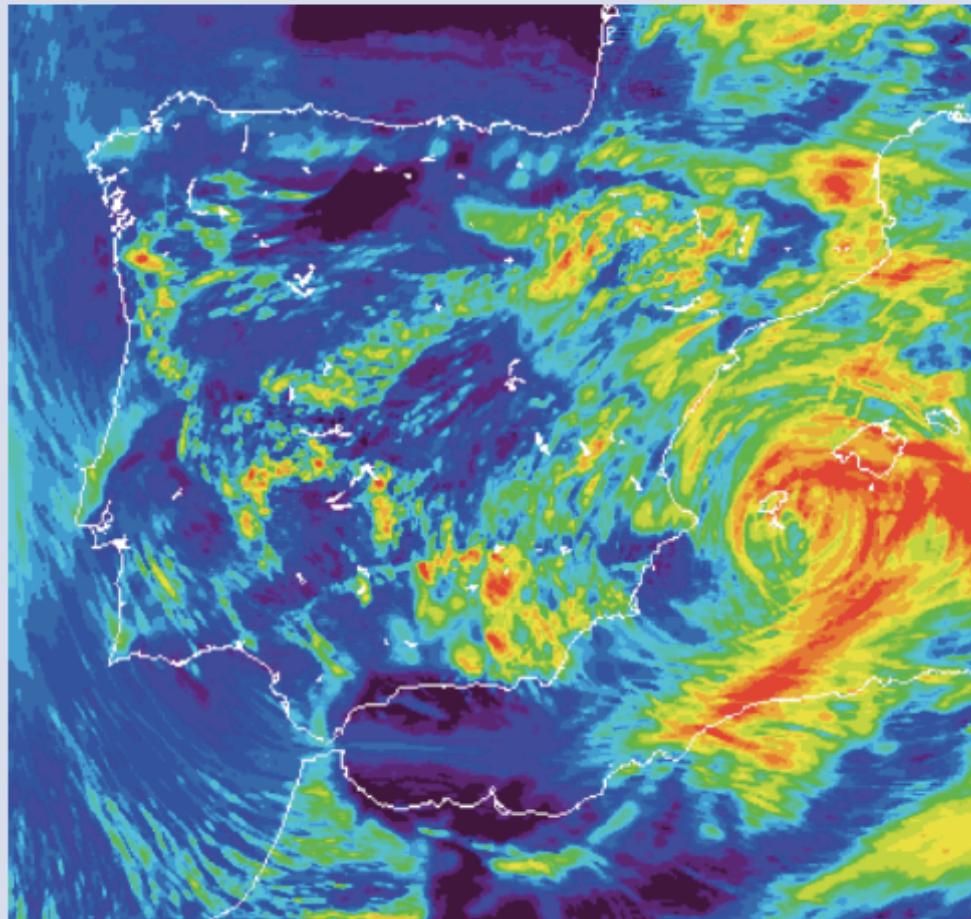
Effects on μ

Same rain
 +
 Different bin sizes
 =
 Different μ



Modeling

High-res operational forecasts



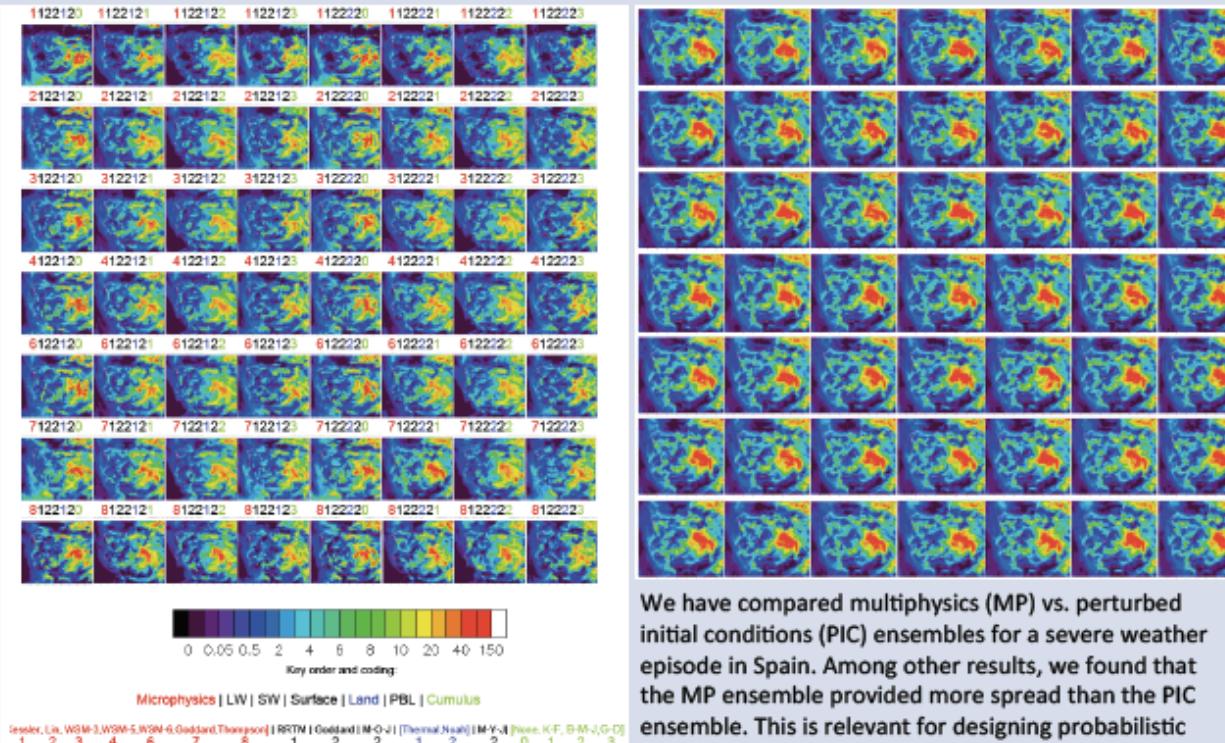
The University of León carries out operational forecasts with the WRF model.

The UCLM has carried out retrospective 3 km resolution simulations at the BSC and at the I³A.

WRF outputs are used as input for the satellite simulator, and for other applications including hydrology planning and early warning of severe weather.

Modeling

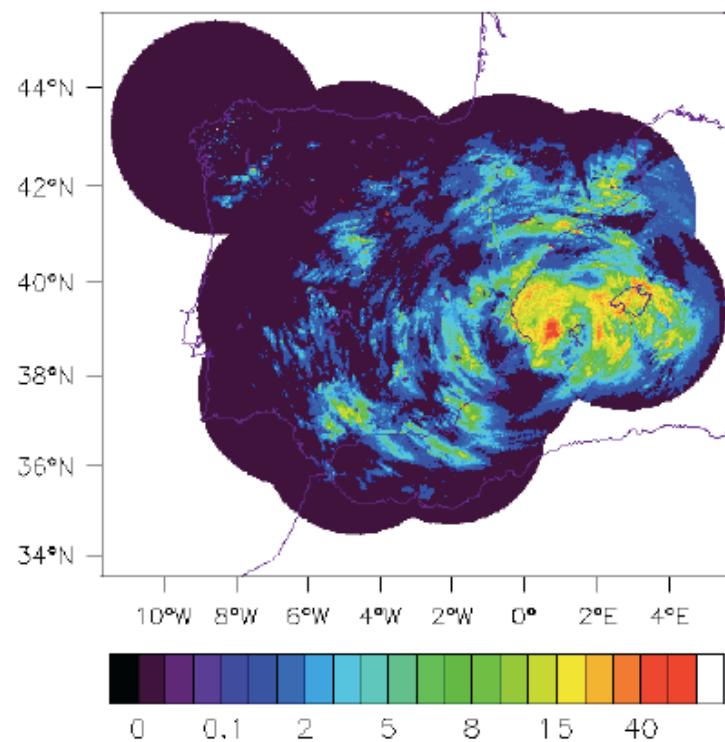
Ensembles of NWP models



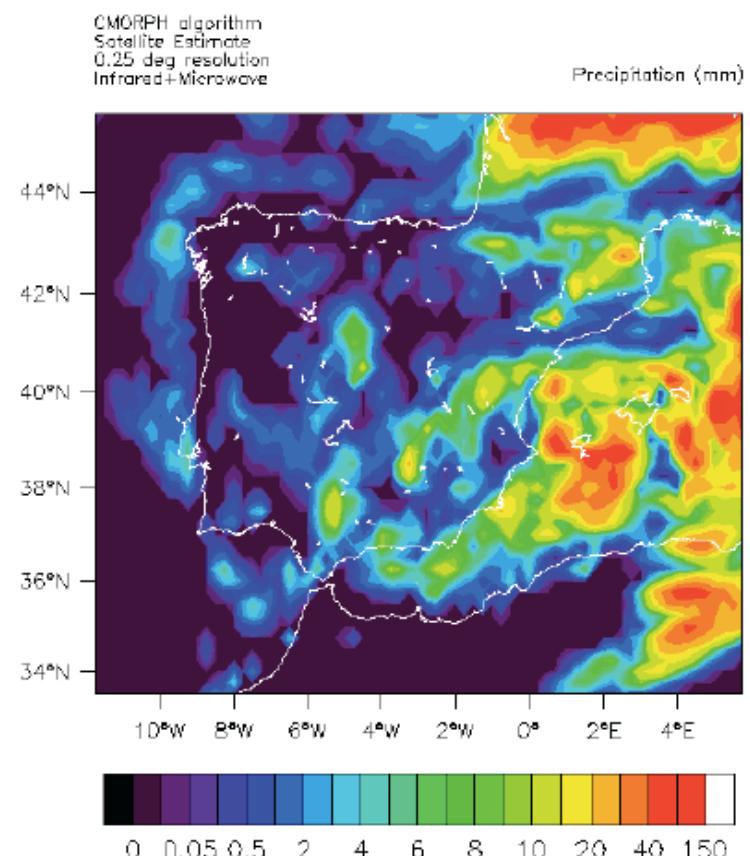
Tapiador, F.J., Tao, W-K., Shi, J.J., Angelis, C.F., Martínez, M.A., Marcos, C., Rodríguez, A. and Hou, A. Y. 2012. A Comparison of Perturbed Initial Conditions and Multiphysics Ensembles in a Severe Weather Episode in Spain. *Journal of Applied Meteorology and Climatology*, accepted October 2011

Modeling

Ground radar precipitation
(24h accum.)

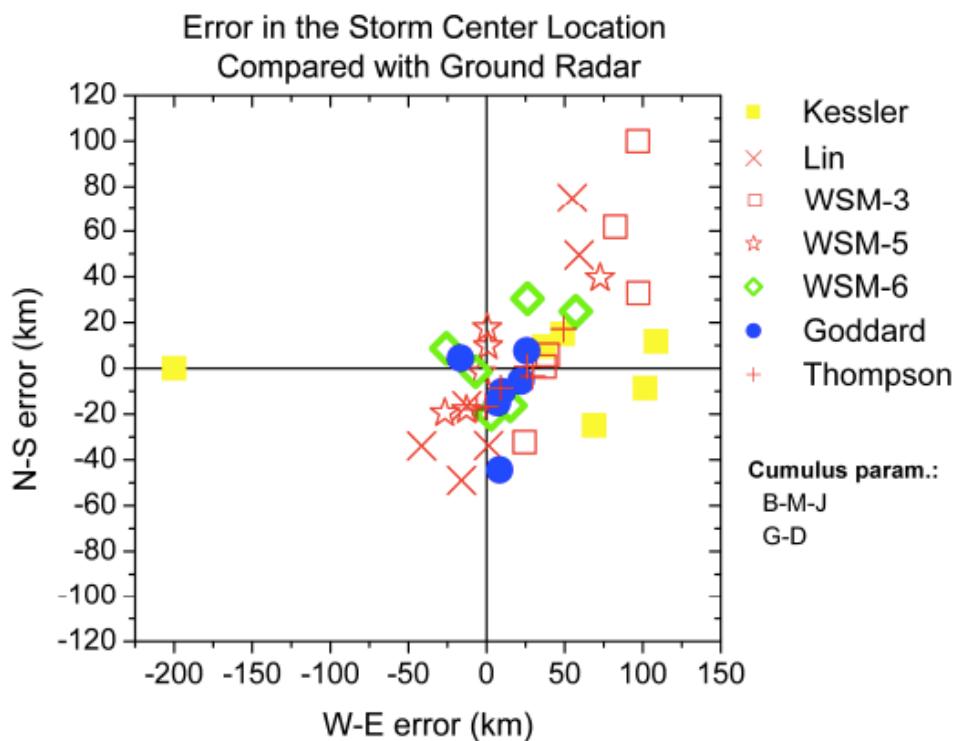


Satellite precipitation
(24h accum.)

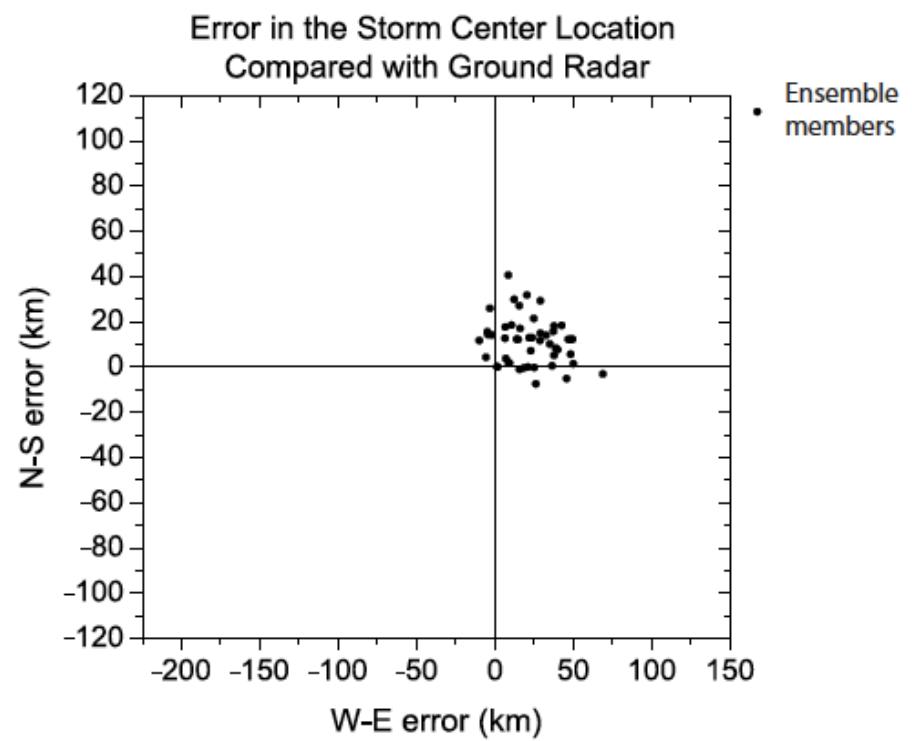


Modeling

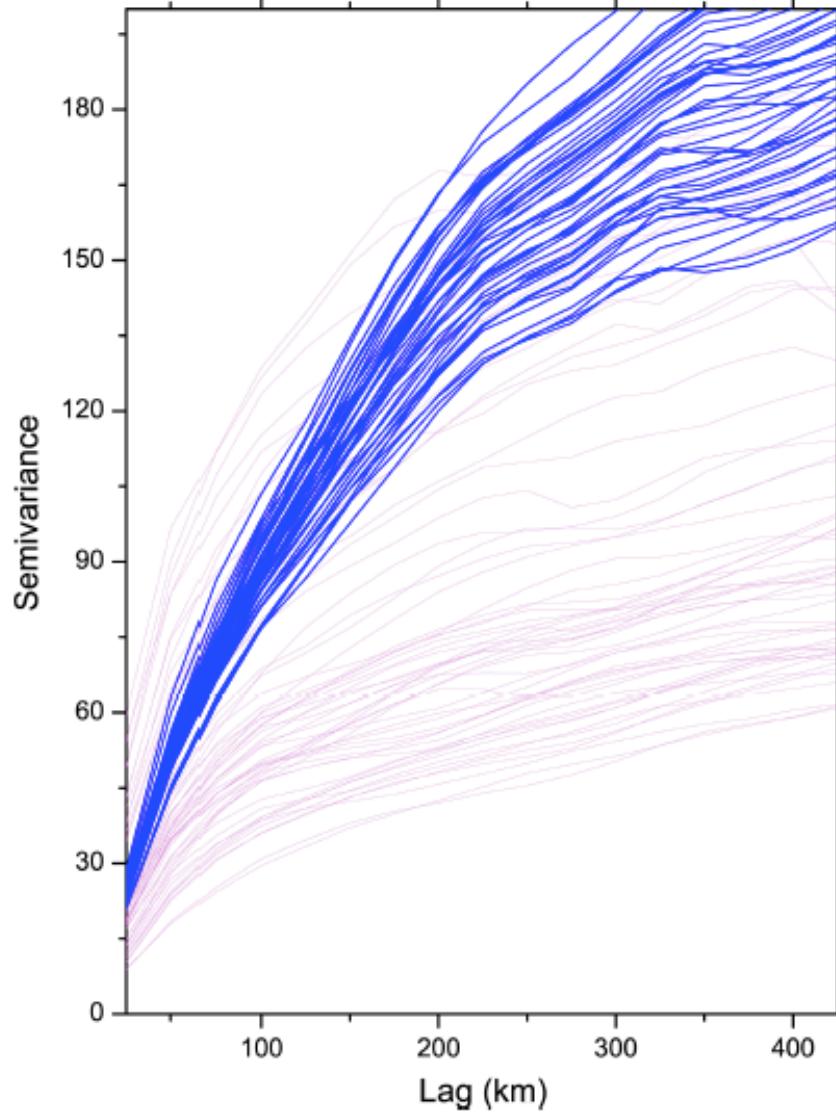
Multi-Physics (MPP)



Perturbed Initial Conditions (PIC)

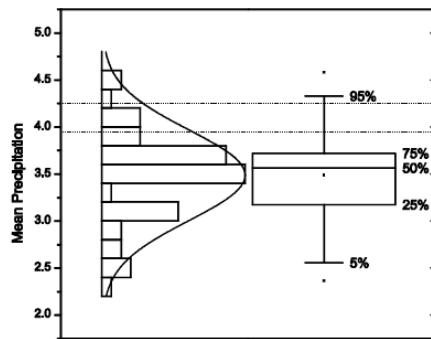


Modeling

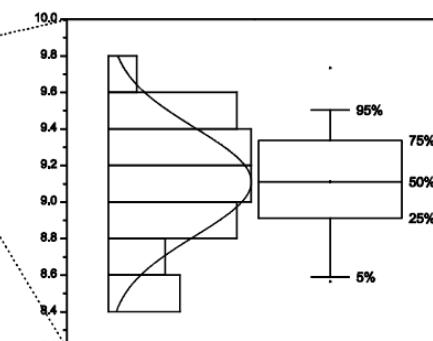
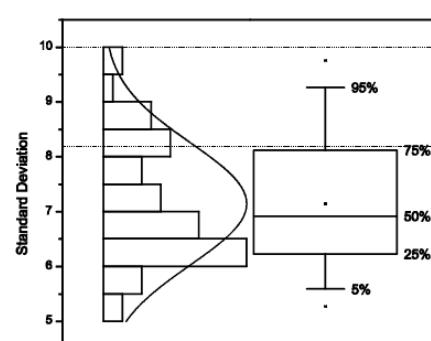
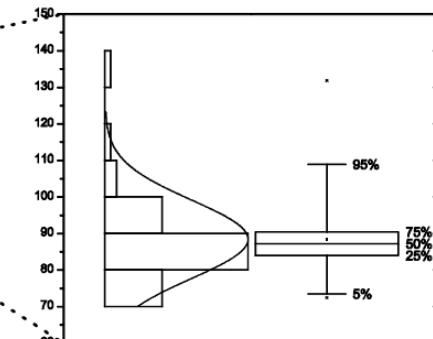
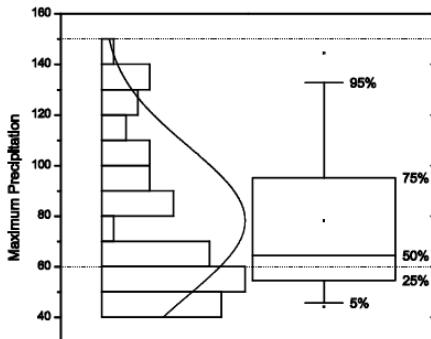
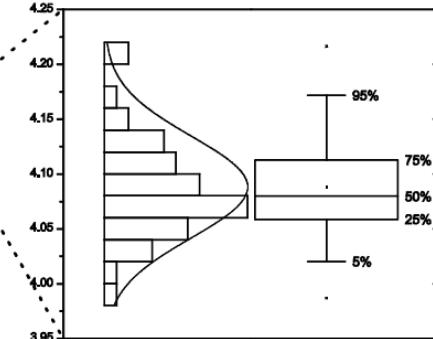


Modeling

Multi-Physics Ensemble

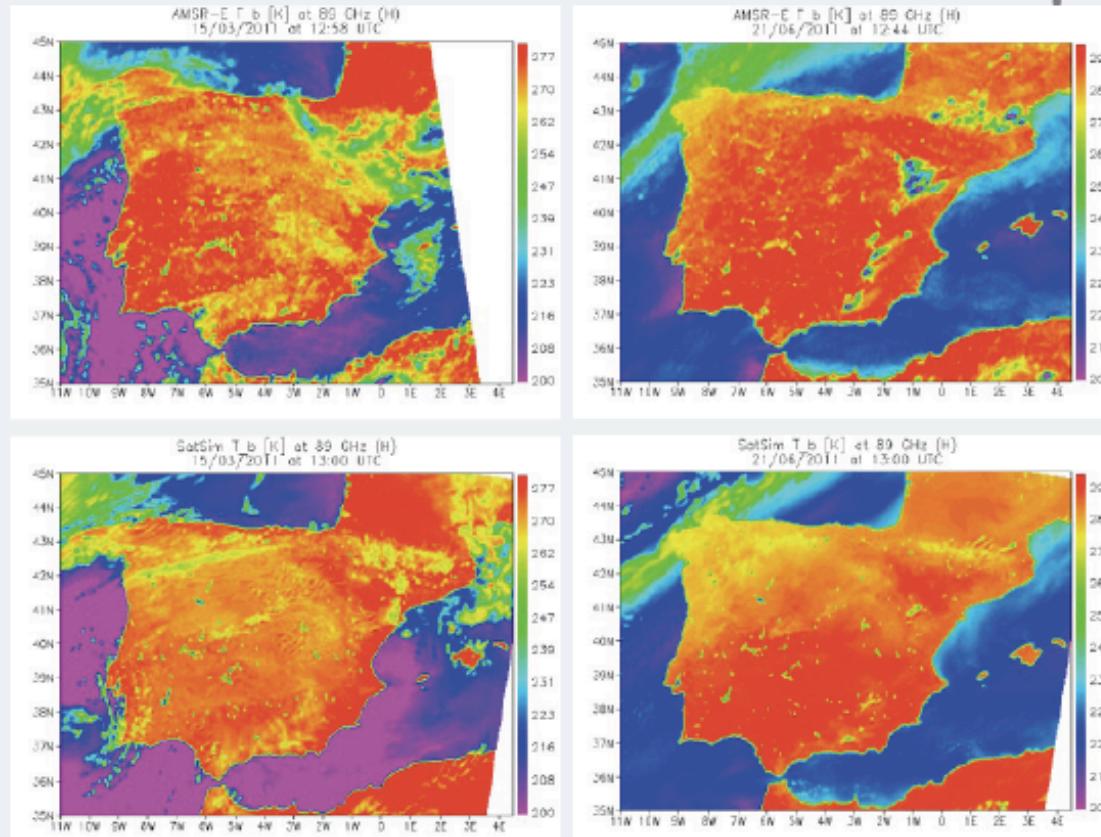


Perturbed IC Ensemble



Modeling

Satellite Simulator for Spain



We are in the early stages of setting up a Satellite Simulator for Spain (S^3).

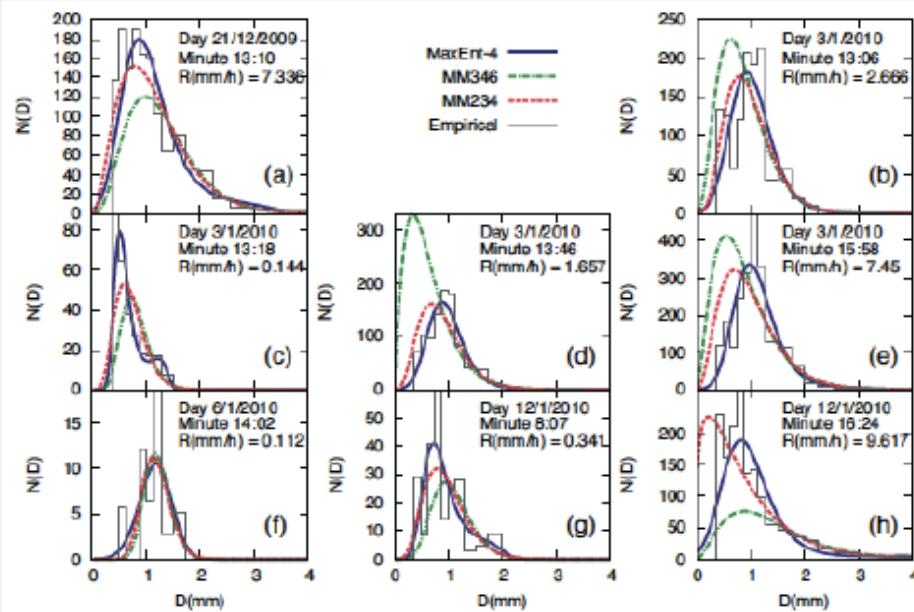
The S^3 is made of the WRF model and the SDSU/RTTOV radiative transfer codes. The rain retrieval algorithm is Neural Networks-based.

Currently at issue is the problem of land emissivity.

García-Ortega, E., Tapiador, F. J., López, L., Katsanos, D., and Sánchez, J. L. 2011. A GPM simulator to improve the NWP of severe events. 6th European Conference of Severe Storms. Palma (Mallorca), 3-7 October 2011

Modeling

Maximum entropy modeling



The maximum entropy method (maxent) offers an unique mean to characterize probability distribution functions, such as the RDSD.

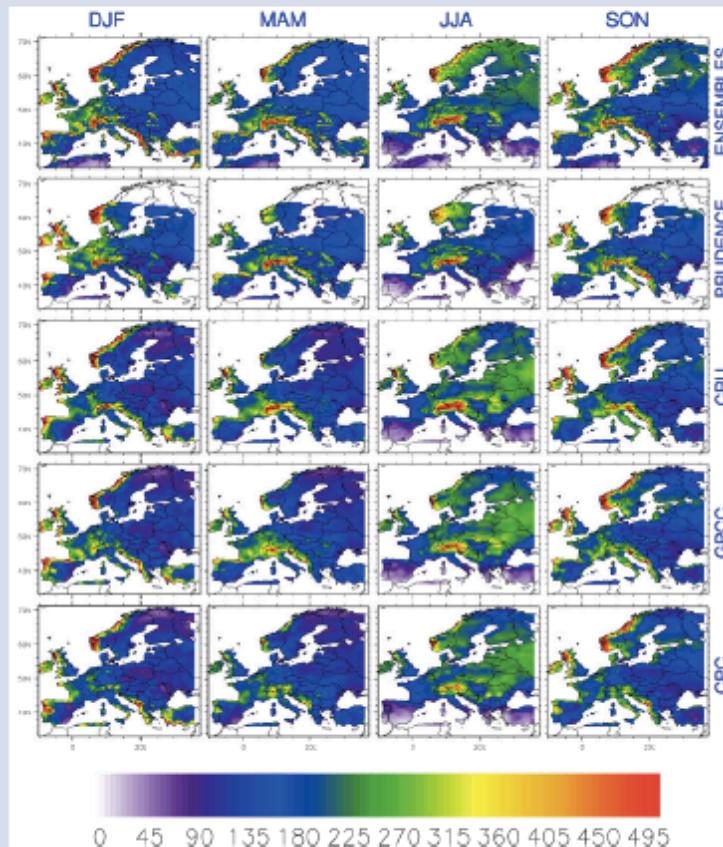
Comparison of maxent with classical, empirical fittings illustrates the potential of the method.

A major advantage of maxent is that it provides the least assumptive distribution given the constraints of the problem. In other words, among the (infinite) parametric distributions that may fit the empirical data, the maxent solution is the least biased given the information we have. A maxent solution always exists, albeit analytical forms are only possible for a few cases with less than four constraints.

Checa, R. and Tapiador, F. J. 2011. A Maximum Entropy Modelling of the Rain Drop Size Distribution. Entropy, 13, no. 2: 293-315

Climate Research

Ensembles of RCMs



Ensembles of Regional Climate Models (RCM) are required to cope with the limitations of model parameterizations such convection, turbulence, or surface processes.

European projects such as PRUDENCE and ENSEMBLES have provided projections of precipitation for present and future climates using several RCMs.

The validation of present-climate outputs also requires a multisource approach to account for known differences in the observational databases.

Observational databases can also assist to correct biases in models so RCM outputs can be used to derive better and more complete climatologies for a variety of applications.

RCMs: Dynamical downscaling tool

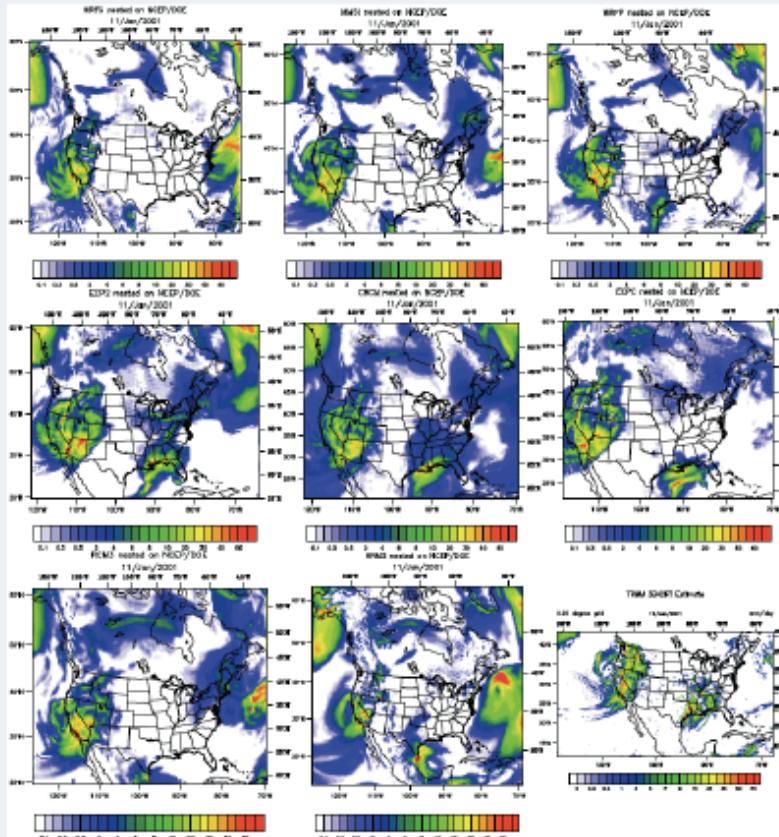
25 km res

Primary input for IPCC AR5

Tapiador, F.J., 2010. A Joint Estimate of the Precipitation Climate Signal in Europe using Eight Regional Models and Five Observational Datasets. *Journal of Climate*, 23, 7, 1719-1738.

Climate Research

Model validation



Satellite-derived precipitation databases are of primary importance for validating the projections made by Regional Climate Models (RCMs).

As longer and more precise series become available, we will be able to better understand model uncertainties in present climate. Thus, we will increase our confidence on our estimates of the precipitation climate signal.

As previously with the European ENSEMBLES and PRUDENCE projects, recent comparison of NARCCAP simulations with TRMM data have shown the potential of this research field for the PMM.

Tapiador, F.J., Turk, J., Petersen, W., Hou, A.Y., García-Ortega, E., Machado, L.A.T., Angelis, C.F., Salio, P., Kidd, C., Huffman, G.J. and de Castro, M. 2011. Global Precipitation Measurement: Methods, Datasets and Applications. *Atmospheric Research*, accepted October 2011

Climate Research

Spatio-temporal structure of precip

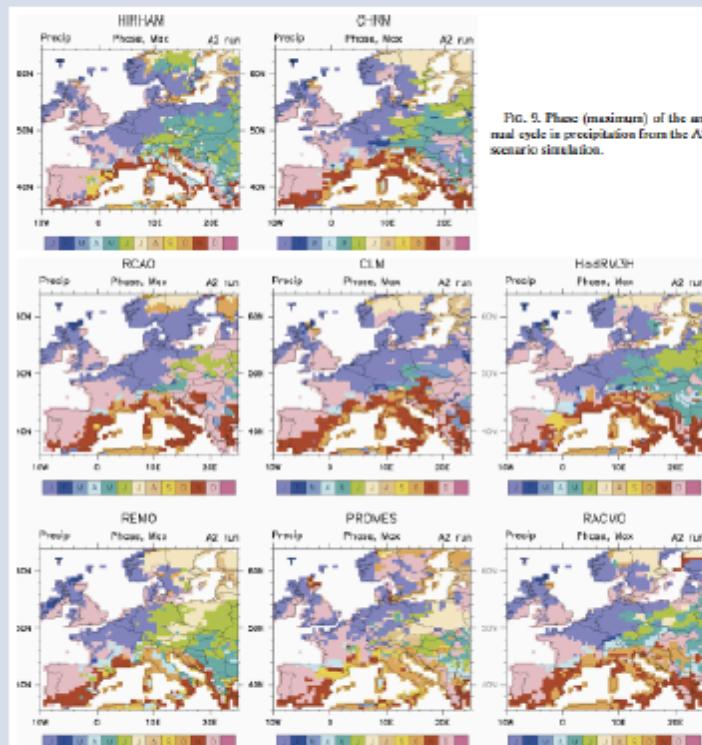


FIG. 9. Phase (maximum) of the annual cycle in precipitation from the A2 scenario simulation.

The temporal structure of precipitation is as important as the actual amount of rain for applications such as agriculture or hydroelectricity.

Using spectral analysis, we have investigated the expected changes in the precipitation cycles in Europe under the SRES-A2 climate change scenario.

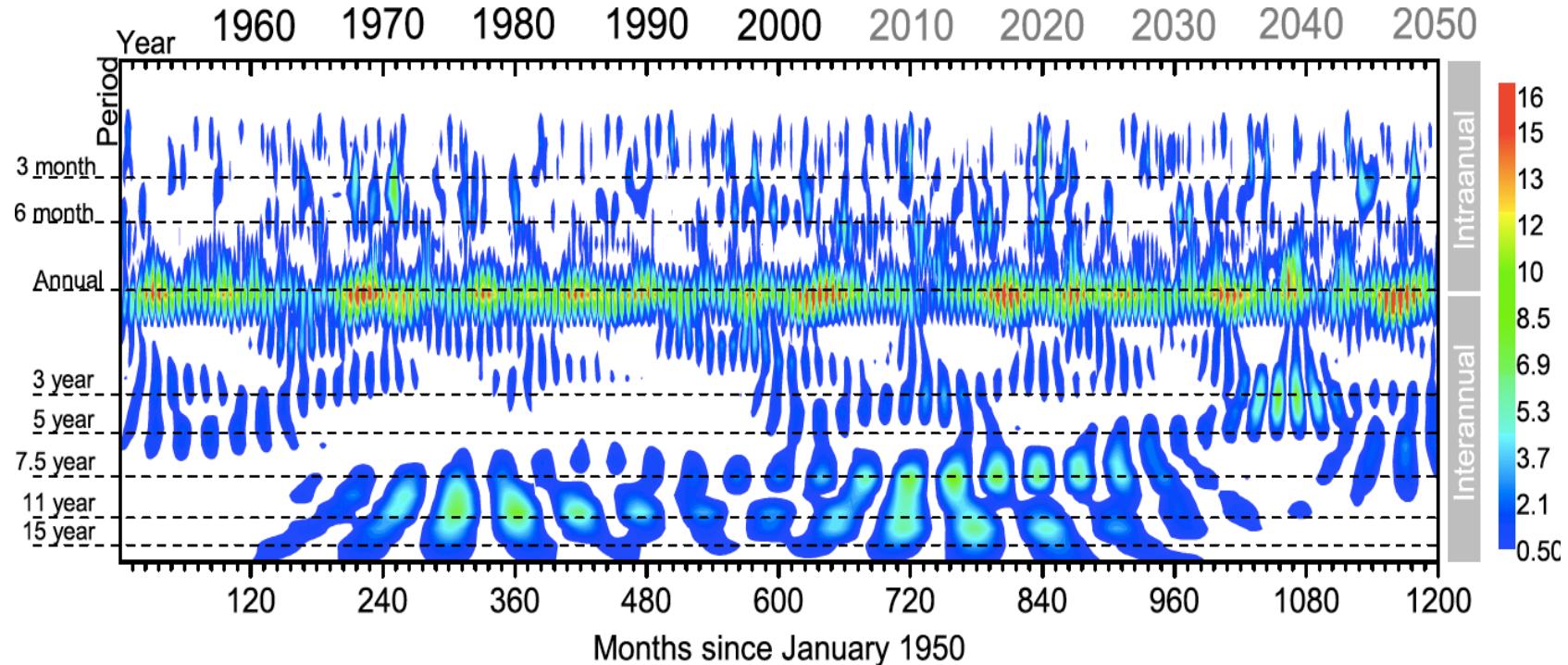
Validation of modeled precipitation with observational data is critical to ascertain the validity of the projections. Tools for this task include Probability Distribution Functions (pdfs) for spatially-aggregated data, and measures of spatial structure such as the semivariogram.

Tapiador, F.J., Sanchez, E., and Romera, R., 2009. Exploiting an Ensemble of Regional Climate Models to Provide Robust Estimates of Projected Changes in Monthly Temperature and Precipitation Probability Distribution Functions. *Tellus*, 61A, 57–71

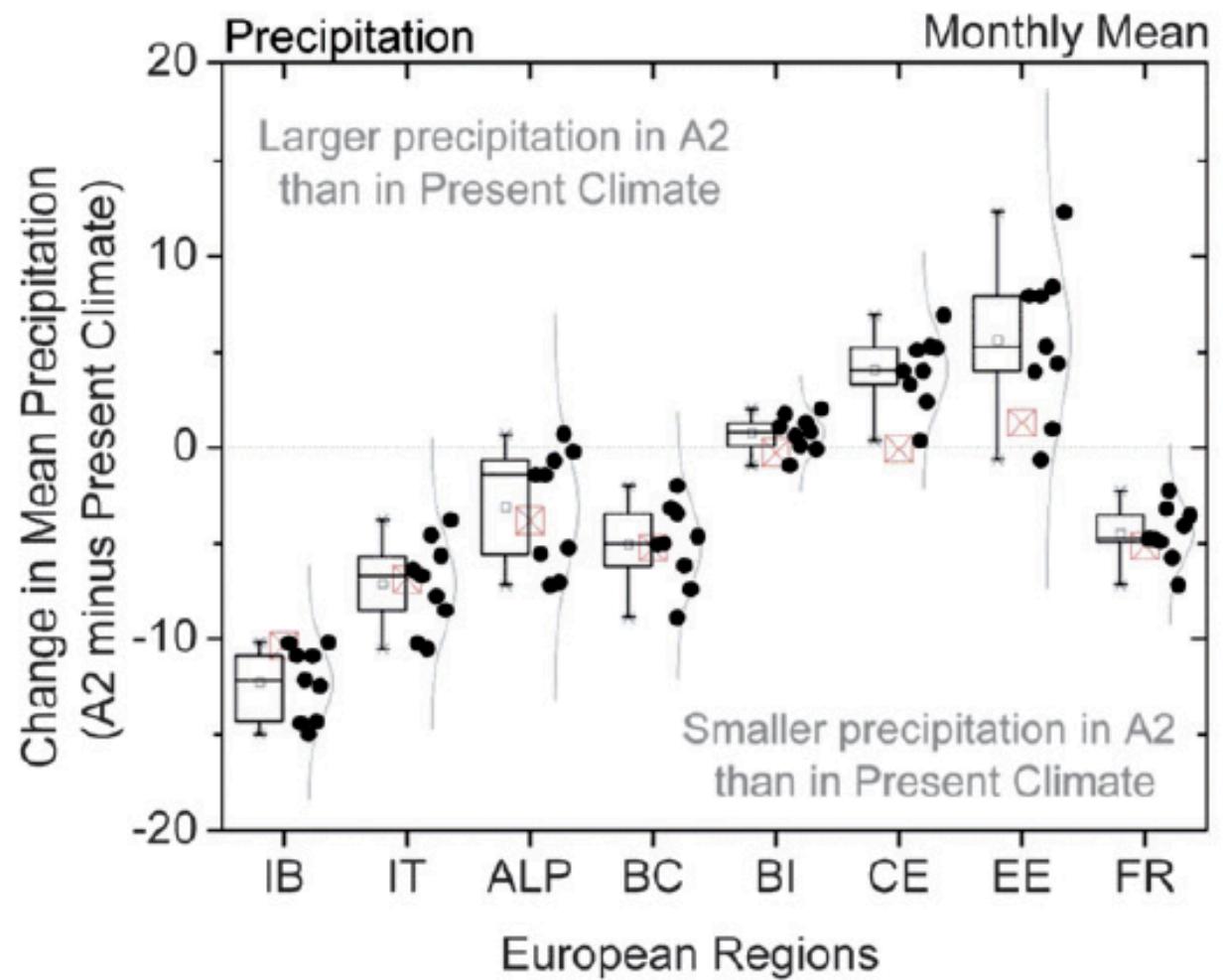
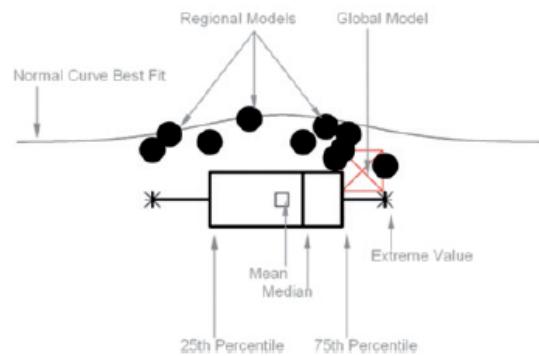
Tapiador, F.J. and Sánchez, E., 2008. Changes in the European Precipitation Climatologies (2070-2100) as Derived by Eight Regional Climate Models. *Journal of Climate*, 21, 11, 2540–2557

Climate Research

Wavelet analysis of precipitation series



Climate Research



Climate Research

Renewable energy applications

Energy &
Environmental Science

Dynamic Article Links

Cite this: DOI: 10.1039/C1EE01745D
www.rsc.org/ees

PERSPECTIVE

Precipitation estimates for hydroelectricity

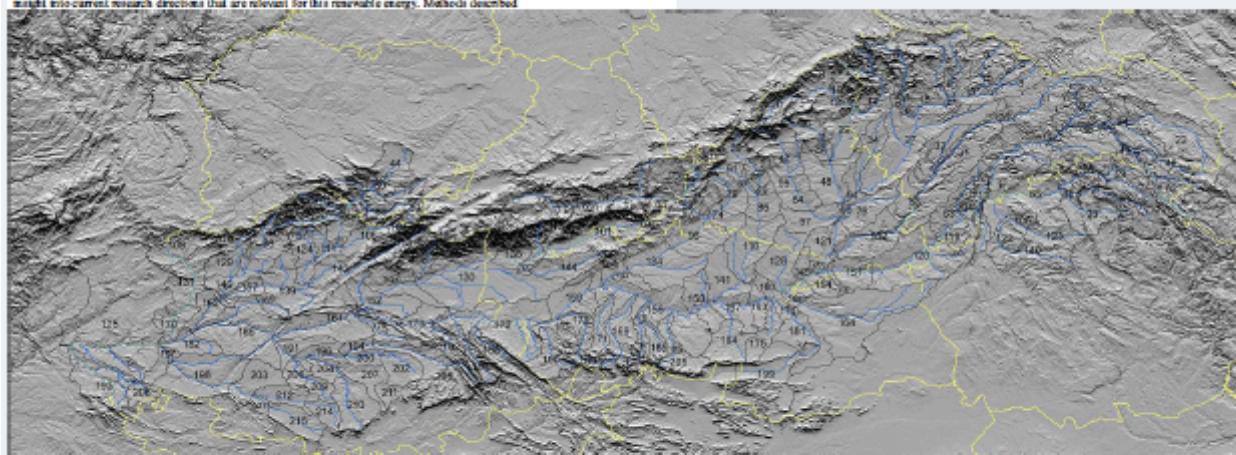
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DOI: 10.1039/C1EE01745D

Hydroelectric plants require precise and timely estimates of rain, snow and other hydroclimatic factors for operations. However, it is far from being a trivial task to measure and predict precipitation. This paper presents the linkage between precipitation science and hydroelectricity, and in doing so it provides insight into current research directions that are relevant for this renewable energy. Methods described

The applicability of PMM products for
renewable energy operations is clear
in the case of hydropower.

GPM will provide improved estimates
of precipitation at temporal and
spatial resolutions suitable for
operations.



Tapiador, F.J., 2009. Assessment of Renewable Energy Potential through Satellite Data and Numerical Models. *Energy & Environmental Science*, DOI:10.1039/B914121A

Tapiador, F.J., Hou, A. Y., de Castro, M., Checa, R., Cuartero, F., and Barros, A.P. 2011. Precipitation estimates for hydroelectricity. *Energy & Environmental Science*, DOI:10.1039/C1EE01745D

Thanks!

RDSD estimation	Modeling	Climate Research
Medium-scale variability <p>In 2010, we used 16 Parvels (in a dual setup) to cross-compare to analyse the spatial variability of the RDSD within a GPR-size plot.</p> <p>The experiments were made in central Spain, which has a central mountain chain with moderate rain rates, and thus within Parvel's known limitations.</p> <p>As shown in the paper below, we found a consistent pattern of GSD variability with distance, and a noticeable spread in the spread of the GSD relationship within the same episode.</p> <p>Tapiador, F.J., Tan, W.-C., Shi, J.J., Angelis, C.F., Martínez, M.A., Moreno, C., Rodríguez, A., and Hess, A.Y.: 2010, 'A Comparison between Parvel and GPR Measurements in a Severe Weather Episode in Spain', <i>Journal of Applied Meteorology and Climatology</i>, accepted October 2010.</p>	Ensembles of NWP models <p>We have compared multiple (MP) vs. perturbed (PP) ensembles from the same model (NCEP) over Spain. Among other results, we found that the MP ensemble provided more spread than the PP ensemble, which is important for providing probabilistic forecasts for early warning systems.</p> <p>Tapiador, F.J., Tan, W.-C., Shi, J.J., Angelis, C.F., Martínez, M.A., Moreno, C., Rodríguez, A., and Hess, A.Y.: 2010, 'A Comparison between Parvel and GPR Measurements in a Severe Weather Episode in Spain', <i>Journal of Applied Meteorology and Climatology</i>, accepted October 2010.</p>	Ensembles of RCMs <p>Ensembles of Regional Climate Models (RCMs) are required to cope with the complex topography and parameterizations such as convection, turbulence, or surface processes.</p> <p>European projects such as PRUDENCE and ENSEMBLES have provided projections of precipitation for present and future climates using several RCMs.</p> <p>The validation of pre-climate models against observations is a more robust approach to account for known differences in the observational datasets.</p> <p>Observational databases can also assist to correct biases in models so RCMs can provide a complete climatological signal for a variety of applications.</p> <p>Tapiador, F.J.: 2010, 'A brief Estimate of the Precipitation Climate Signal in Europe using Eight Regional Models and Five Observational Datasets', <i>Journal of Climate</i>, 23, 2729-2746.</p>
Small-scale variability <p>In 2011, we located 16(2) Parvels to analyse the consistency of the instruments, the spatial variability of the RDSD at decimeter scale, and to cross-compare new Parvels' instruments.</p> <p>The experiments were made in Toledo, and included some atmospheric noise.</p> <p>We found that the Parvels provided consistent estimates of the RDSD for moderate rain rates such as those found in Toledo.</p> <p>We also found that the old Parvel estimates can be corrected by applying a simple transfer function that accounts for the enhanced performances of the instrument.</p> <p>Tapiador, F.J., Turc, J., Petersen, W., Hess, A.Y., García-Ortega, E., Machado, L.A.T., Angelis, C.F., Sello, P., Kidd, C., Huffines, G.L. and de Castro, M.: 2011, 'Global Precipitation Measurement: Methods, Datasets and Applications', <i>Atmospheric Measurement Techniques</i>, accepted October 2011.</p>	Satellite Simulator for Spain <p>We are in the early stages of setting up a Satellite Simulator for Spain (SPS).</p> <p>The SPS is made of the SPOT-5 model and the SPOT-5/NOAA radiative transfer codes. The rainfall retrieval algorithm is based on Network-based.</p> <p>Currently at the initial stage of problem of land cover.</p> <p>García-Ortega, E., Tapiador, F.J., López, L., Katsaros, D., and Scherer, J.L.: 2011, 'A GPM simulator to improve the NWP of severe events', 6th European Conference on Severe Storms, Fakro (Poland), 27 October 2011.</p>	Model validation <p>Satellite-derived precipitation databases are of primary importance for validating the projections made by Regional Climate Models (RCMs).</p> <p>An long-term and precise series becomes available, will be able to better understand model uncertainties in present climate. Thus, we can increase our confidence on ensembles of the precipitation climate signal.</p> <p>As previously with the European ENSEMBLES and PRUDENCE projects, recent comparison of precipitation ensembles and data have shown the potential of this research field for the PMM.</p> <p>Tapiador, F.J., Turc, J., Petersen, W., Hess, A.Y., García-Ortega, E., Machado, L.A.T., Angelis, C.F., Sello, P., Kidd, C., Huffines, G.L. and de Castro, M.: 2011, 'Global Precipitation Measurement: Methods, Datasets and Applications', <i>Atmospheric Measurement Techniques</i>, accepted October 2011.</p>
Turbulence effects on the RDSD <p>We investigated the role of turbulence on the variability of the RDSD.</p> <p>These are compared turbulence from a rain gauge (10 Hz sampling) with the standard deviation of the RDSD estimates from 16 Parvels.</p> <p>The experiment showed that there is a relationship between the observed differences in the RDSD, as measured by Parvel disdrometers, and the turbulence.</p> <p>Tapiador, F.J., Turc, J., Petersen, W., Hess, A.Y., García-Ortega, E., Machado, L.A.T., Angelis, C.F., Sello, P., Kidd, C., Huffines, G.L. and de Castro, M.: 2011, 'Global Precipitation Measurement: Methods, Datasets and Applications', <i>Atmospheric Measurement Techniques</i>, accepted October 2011.</p>	High-res operational forecasts <p>The University of Toledo performs operational forecasts with the WRF model.</p> <p>The UCLM has carried out retrospective 3 km resolution simulations at the RCG and at the IFA.</p> <p>WRF outputs are used as input for the satellite simulator, and for numerical experiments including hydrology planning and early warning of severe weather.</p>	Spatio-temporal structure of precip <p>The temporal structure of precipitation is as important as the actual amount of rain for applications such as agriculture or hydroelectricity.</p> <p>Using spectral analysis, we have investigated the expected changes in the precipitation cycles in Europe under the SRES-A2 climate change scenario.</p> <p>Validation of modeled precipitation with observational data is critical to assess the quality of the model's interactions. Tools for this task include Probability Distribution Functions (pdfs) for spatially-aggregated data, and the spatio-temporal structure such as the semivariogram.</p> <p>Tapiador, F.J., Sánchez, E., and Rivero, X.: 2010, 'Exploring the Ensemble of Regional Climate Models to Provide Robust Estimates of Projected Changes in Monthly Temperature and Precipitation Probability Distribution', <i>Pearce, Teller, Huffines, G.L. and de Castro, M.</i>: 2011, 'Global Precipitation Measurement: Methods, Datasets and Applications', <i>Atmospheric Measurement Techniques</i>, accepted October 2011.</p>
Disdrometer binning effect <p>The estimate of the size of the falling drops is quantified into a discrete number of intervals of different size, which are usually logarithmic scaled to account for the wide spectrum of sizes spanning three orders of magnitude.</p> <p>We compared several binning methods with an uniform, fine-scale binning, which simulated a perfect disdrometer.</p> <p>Using Monte-Carlo sampling and several types of rain statistics, we calculated moments on the moments and on the moments of different binning strategies.</p> <p>The results showed that non-negligible differences appear in higher moments, and that those are larger with light rainfall rates.</p> <p>Tapiador, F.J., Turc, J., Petersen, W., Hess, A.Y., García-Ortega, E., Machado, L.A.T., Angelis, C.F., Sello, P., Kidd, C., Huffines, G.L. and de Castro, M.: 2011, 'Global Precipitation Measurement: Methods, Datasets and Applications', <i>Atmospheric Measurement Techniques</i>, accepted October 2011.</p>	Maximum entropy modeling <p>The maximum entropy method (maxent) offers an alternative way to characterize probability distributions of rainfall, such as the RDSD.</p> <p>Comparison of maxent with classical, empirical distributions emphasizes the potential of the method.</p> <p>A major advantage of maxent is that it provides the least disruptive distribution given the constraints of the problem. In other words, among the (infinite) parametric distributions that fit the empirical data, the maxent solution is the least biased given the information we have about the data. In other words, about analytical forms are only possible for a few cases with less than four constraints.</p> <p>Chen, R. and Tapiador, F.J.: 2011, 'A Maximum Entropy Modeling of the Fall Size Distribution', <i>Entropy</i>, 13, no. 21, 289-315.</p>	Renewable energy applications <p>The applicability of PMM products for renewable energy operations is clear in the case of hydroelectric power.</p> <p>PM will provide improved estimates of precipitation at temporal and spatial resolutions suitable for operations.</p> <p>Tapiador, F.J.: 2009, 'Assessment of Renewable Energy Potential through Satellite Data and Numerical Models', <i>Energy & Environmental Sciences</i>, DOI 10.1038/eneuro.2009.151.</p> <p>Tapiador, F.J., Hess, A.Y., de Castro, M., Chiva, R., Contreras, F., and Berney, A.P.: 2011, 'Precipitation estimates for Hydroelectricity, Energy & Environmental Sciences', DOI 10.1038/eneuro.2010.149.</p>

