UNIVERSIDAD DE CASTILLA-LA MANCHA

Activities in Spain
[The Spanish group in 2011]

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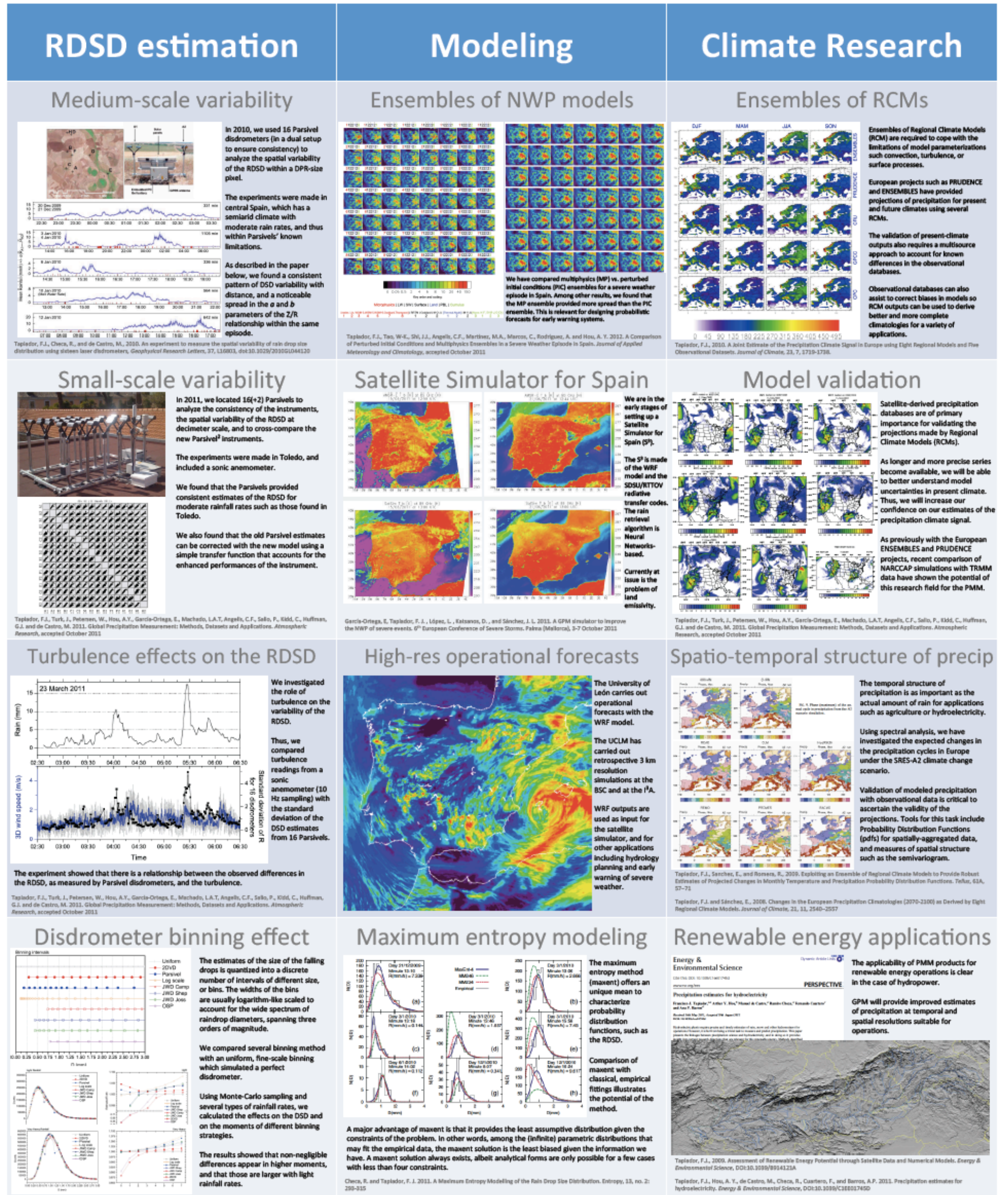
Outline

1· RDSD estimation

2· Modeling

3· Climate Research



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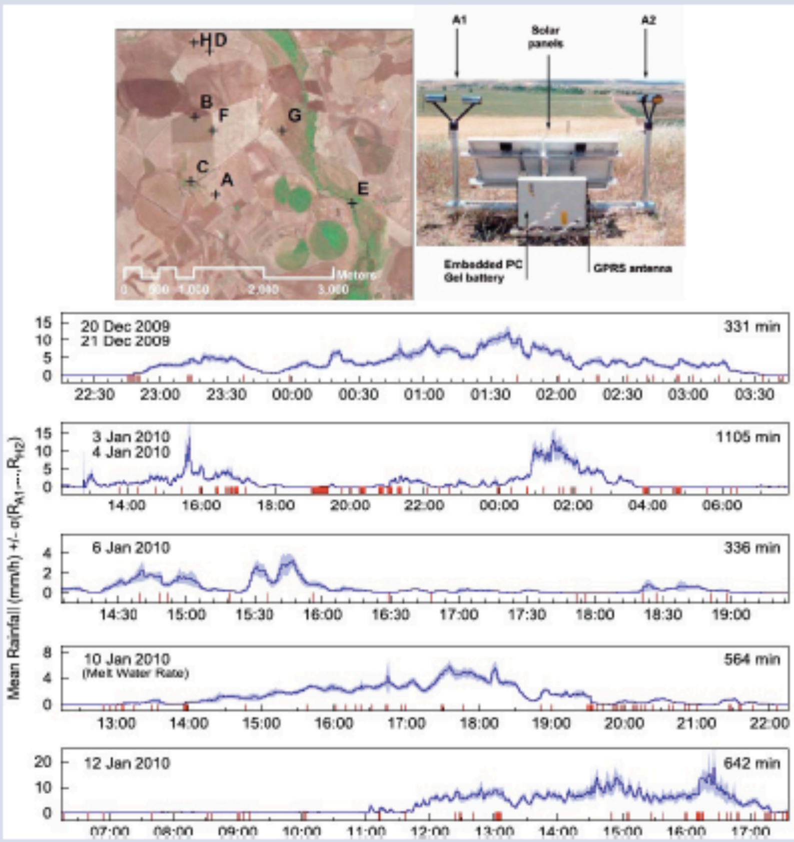
RDSD estimation

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

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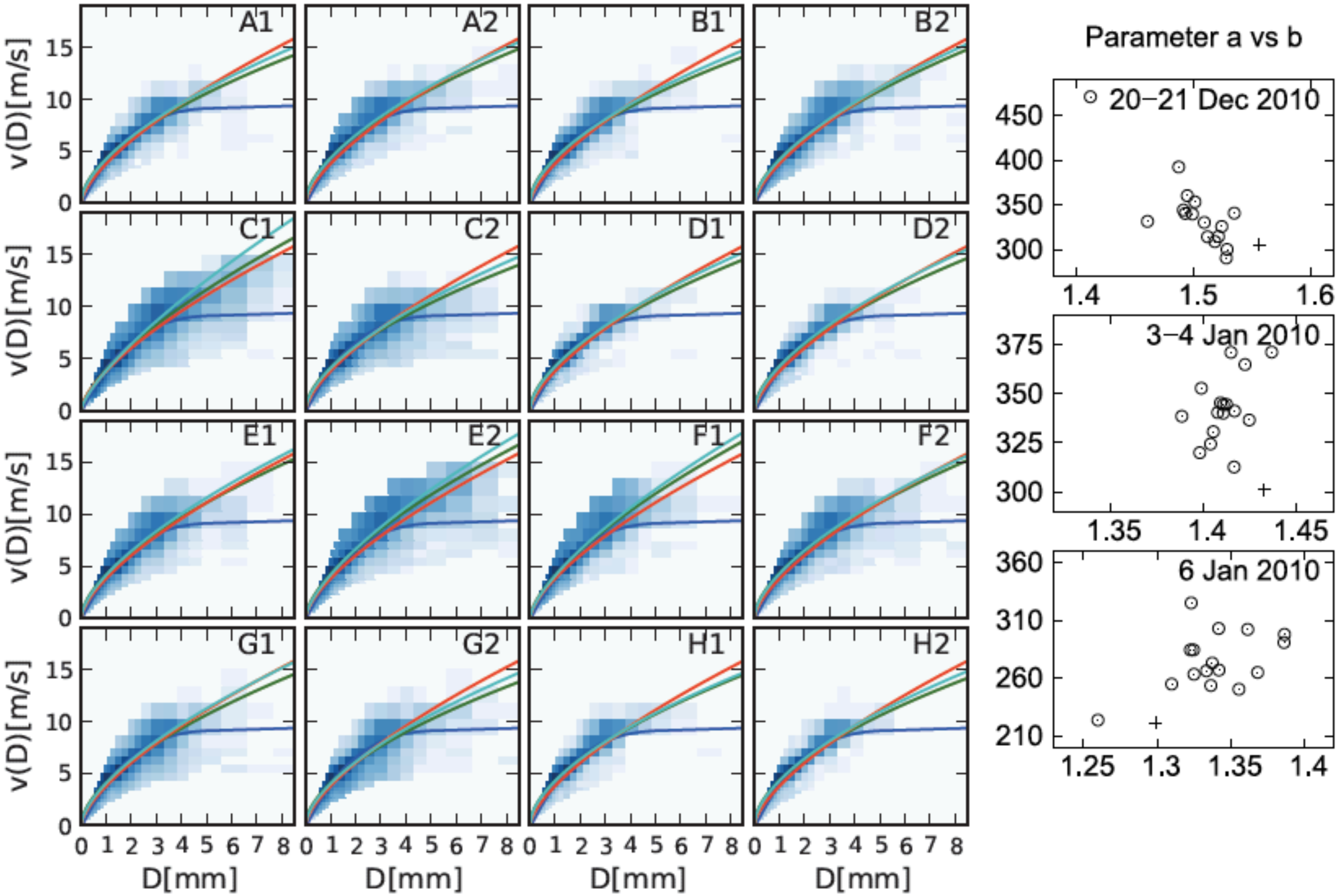

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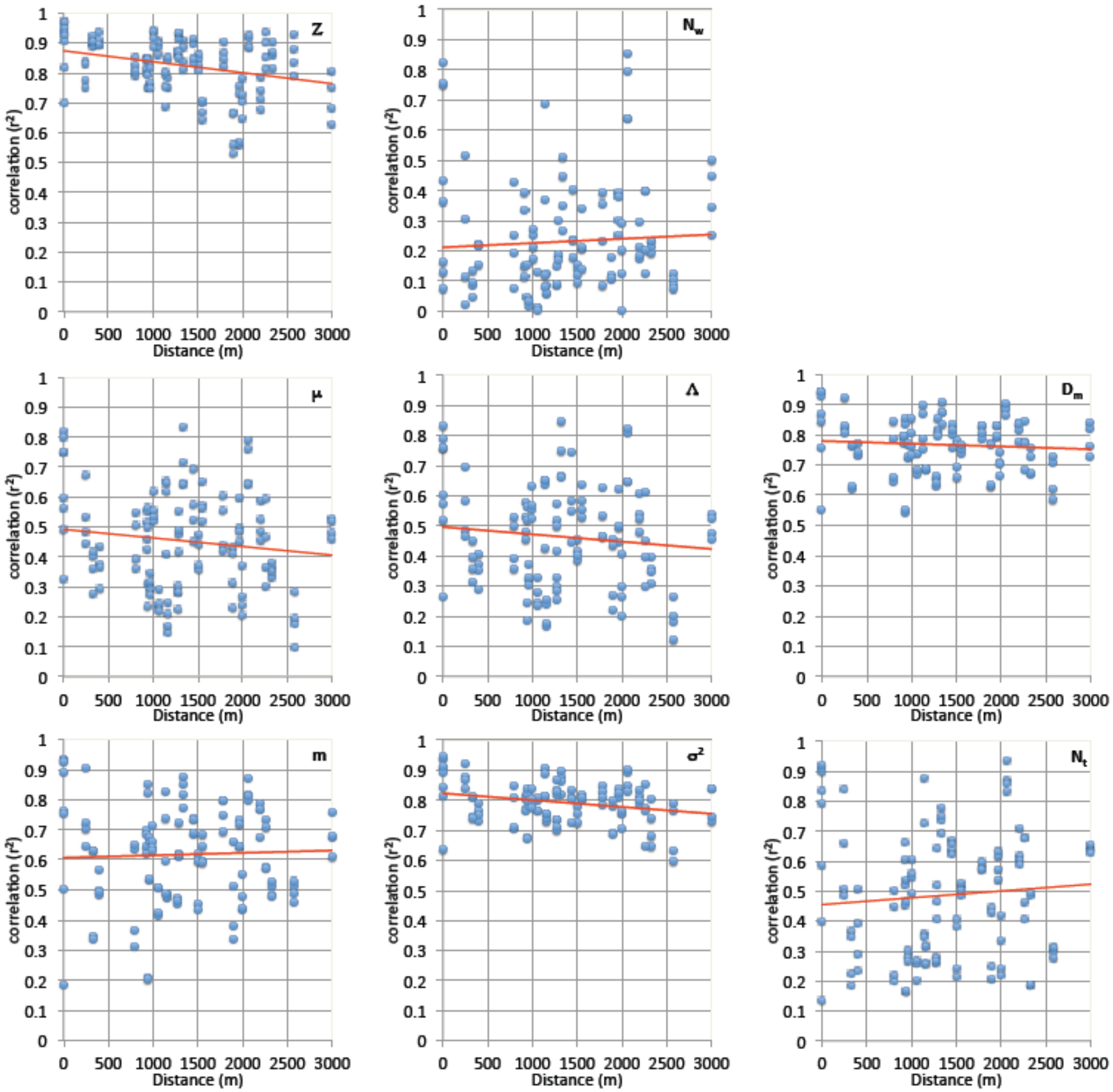

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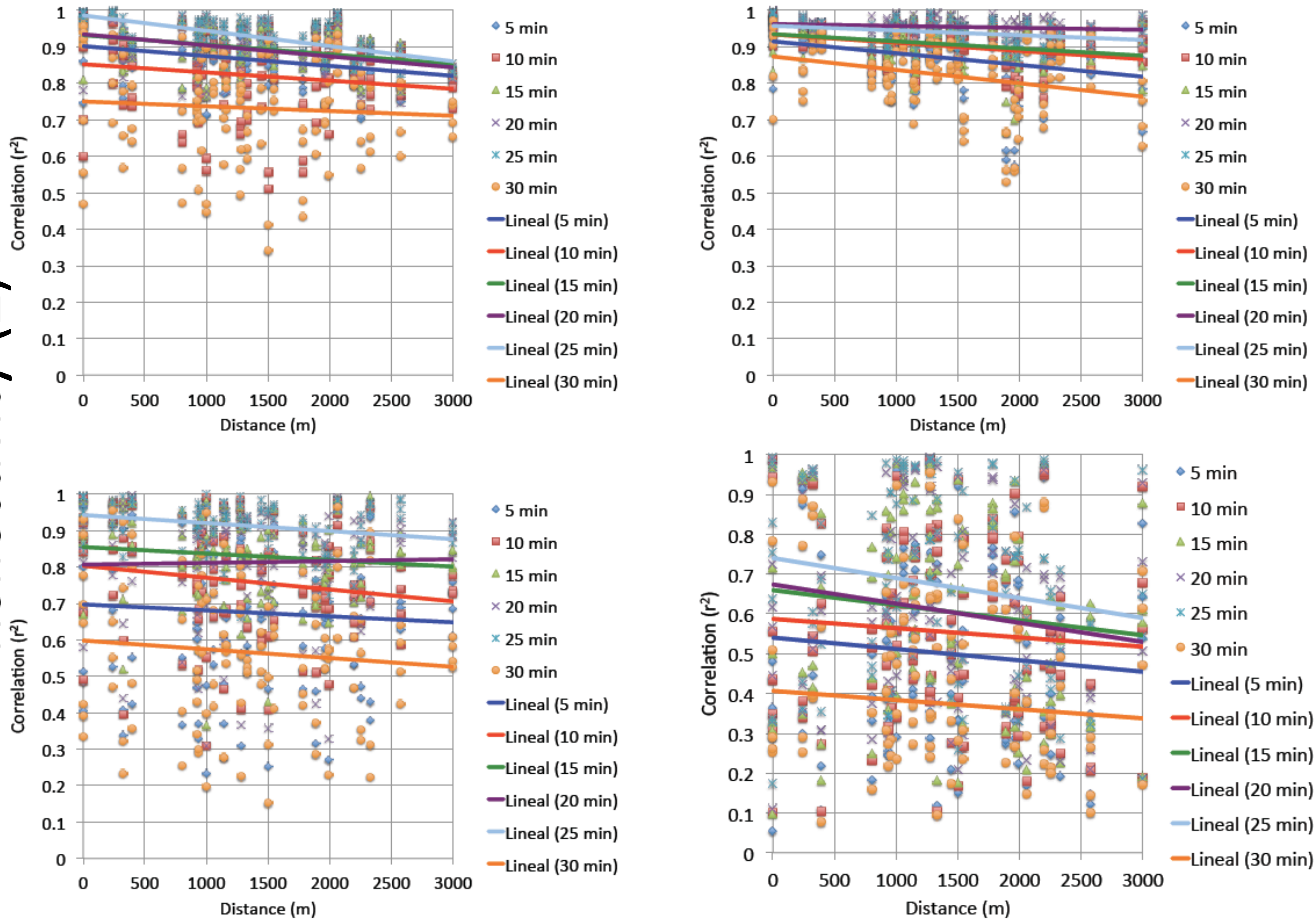
Reflectivity (Z)



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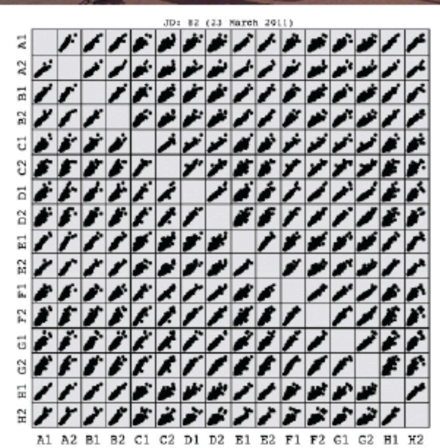
RDSD estimation

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

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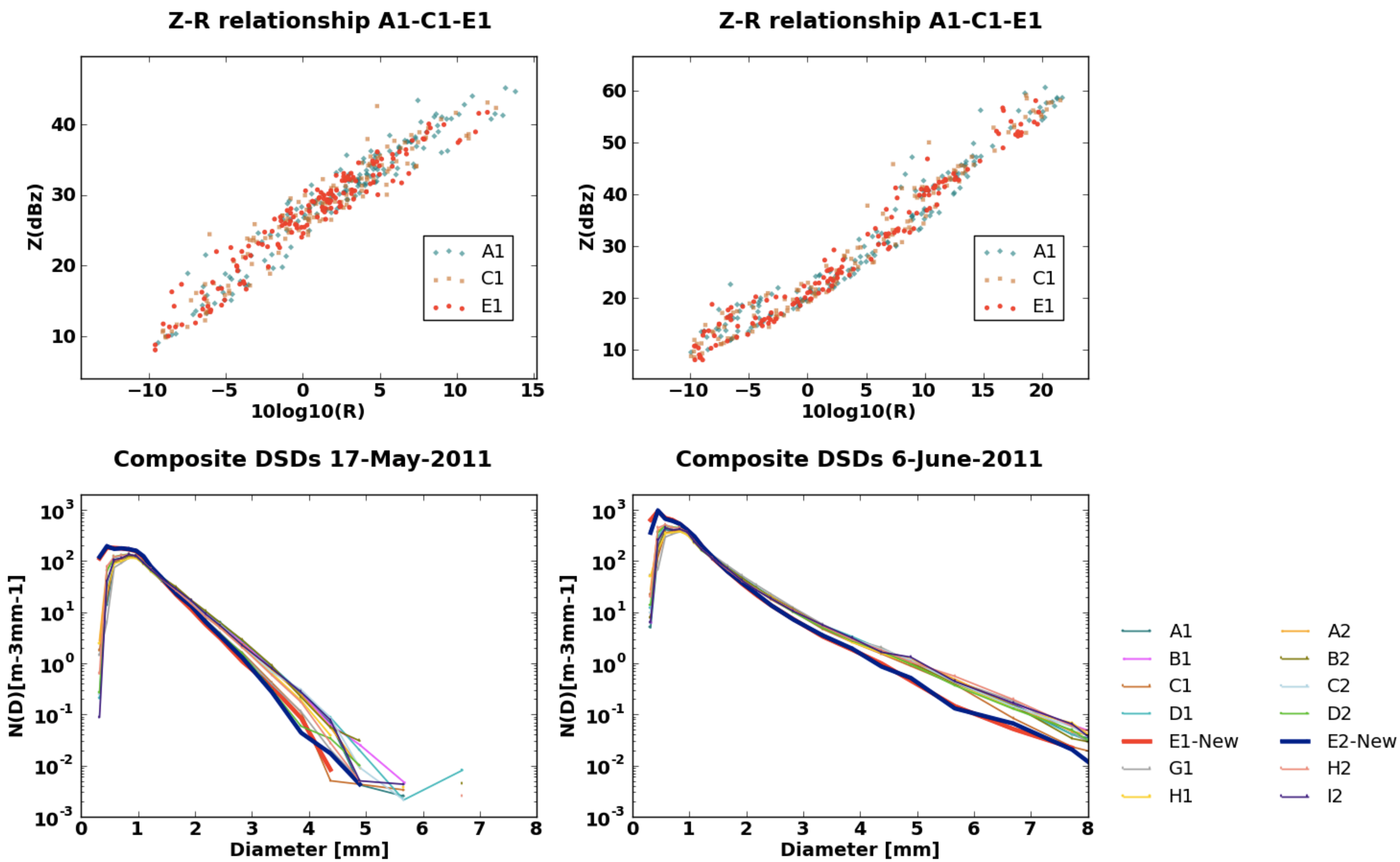
Parsivel 2 evaluation



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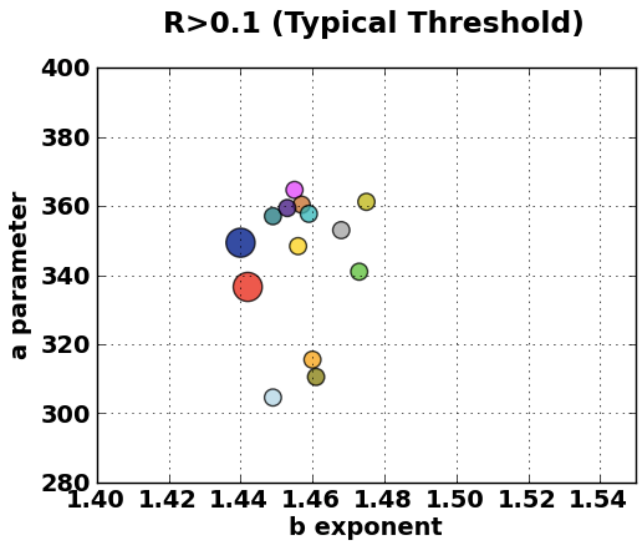
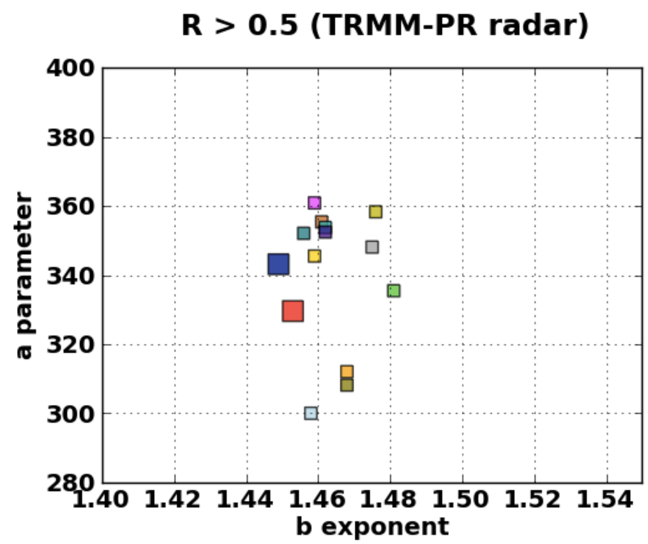
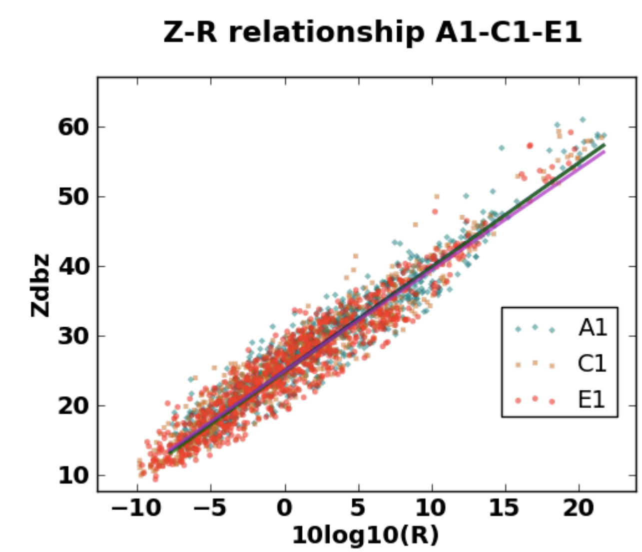
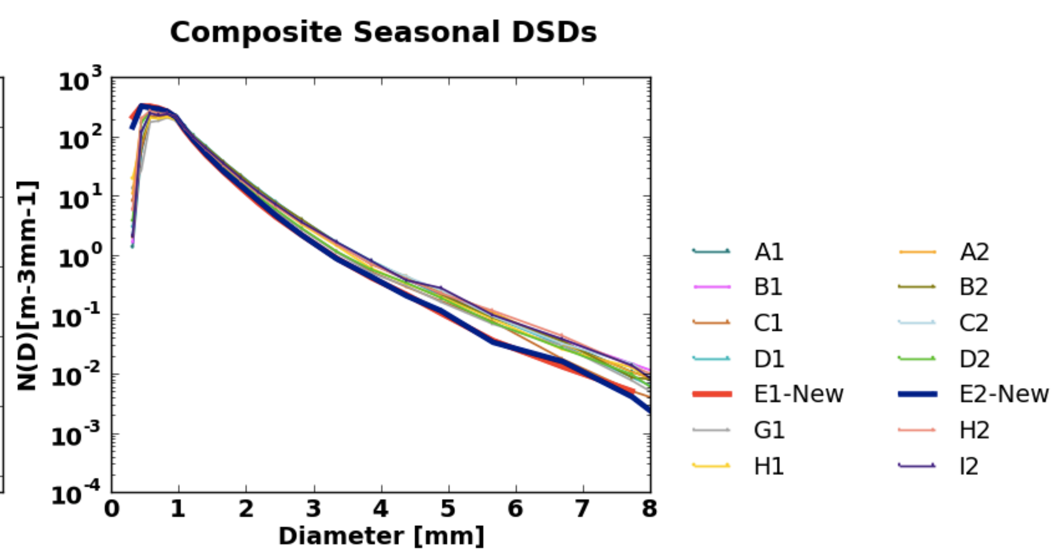
Parsivel 2 evaluation









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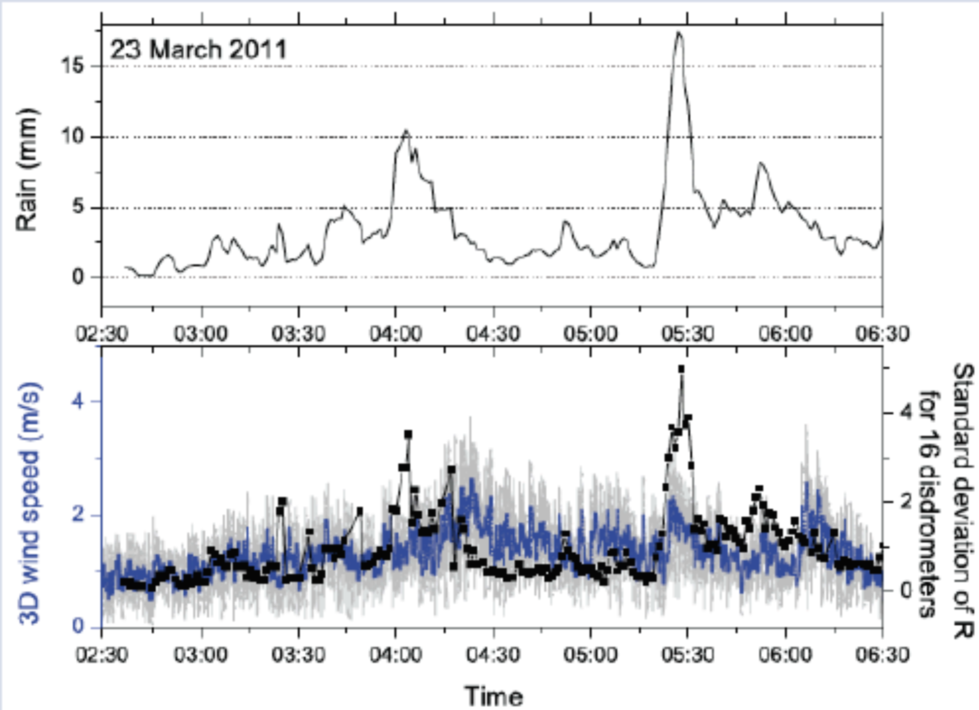
RDSD estimation

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

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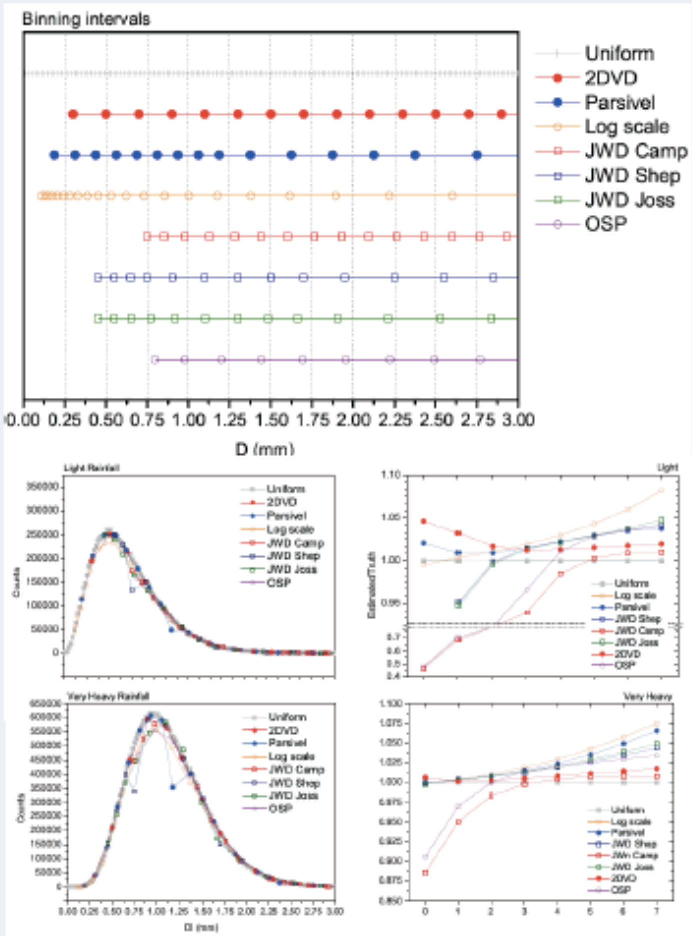
RDSD estimation

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.

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Effects on μ

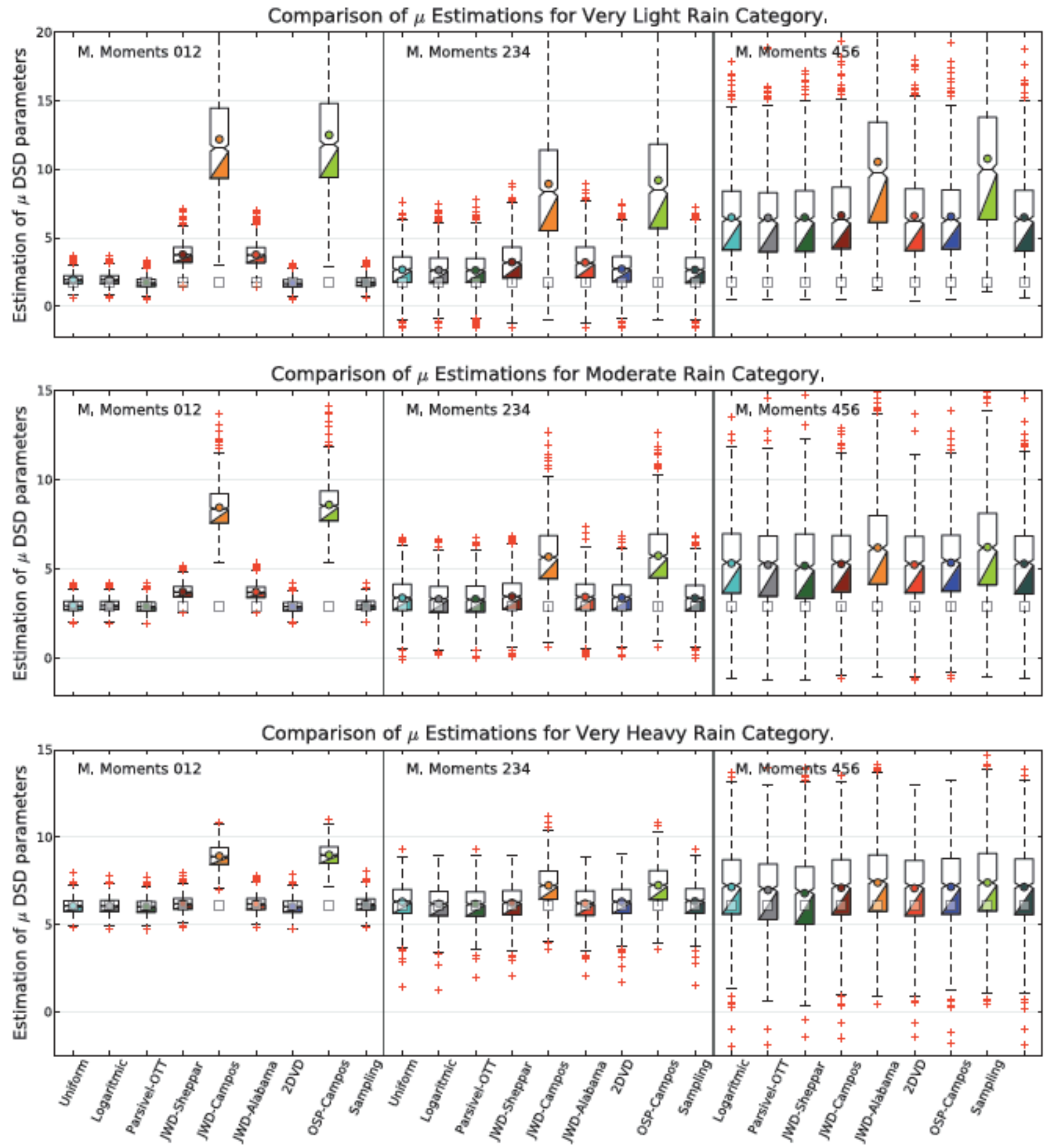
Same rain

+

Different bin sizes

=

Different μ



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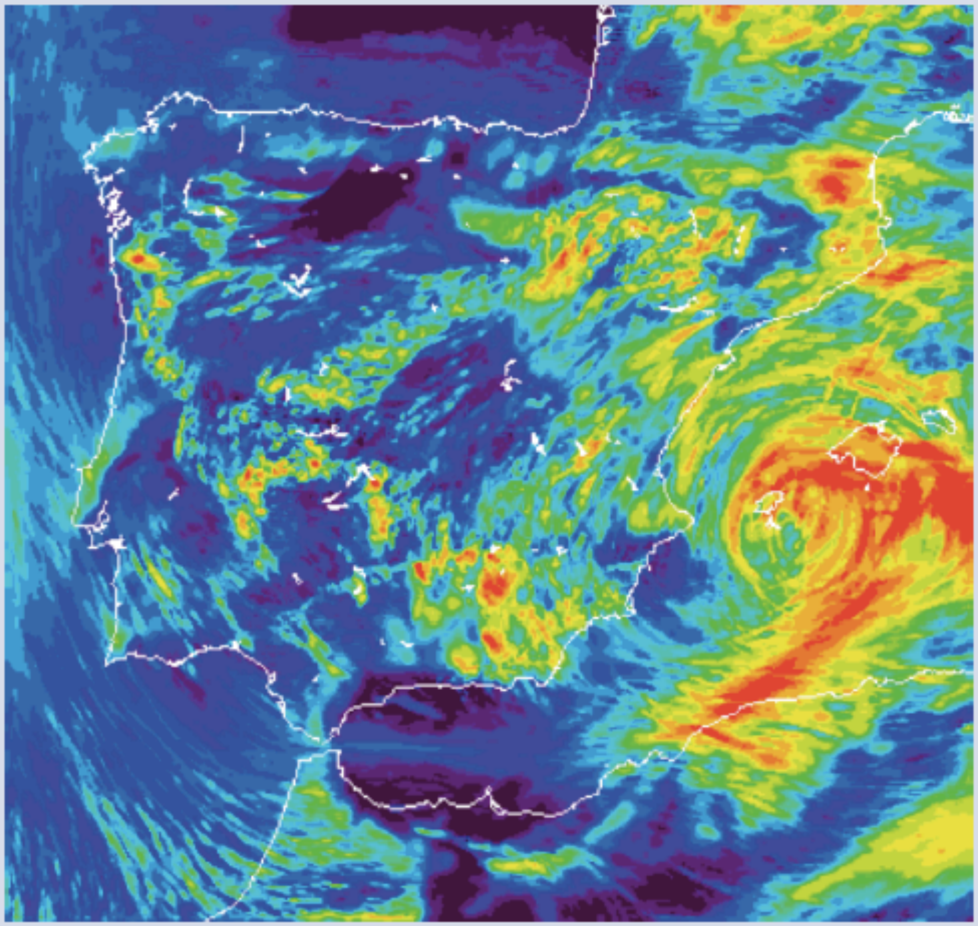
Modeling

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.

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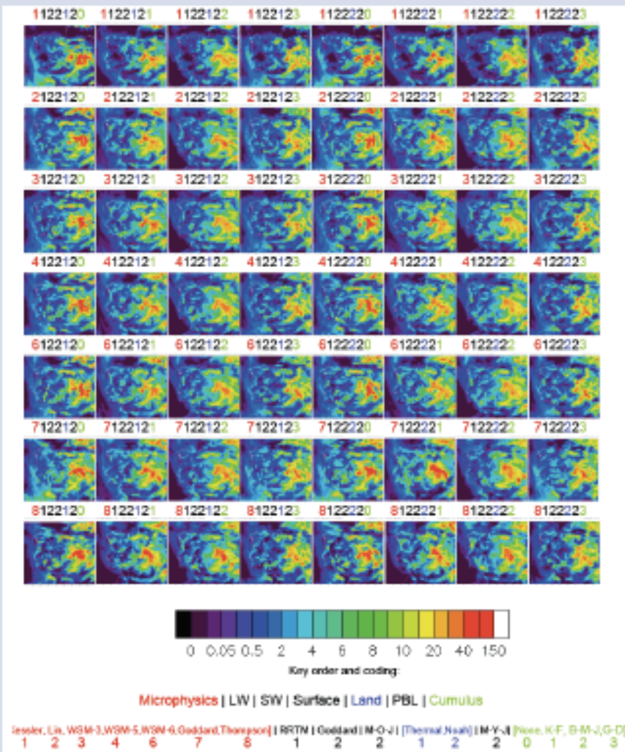
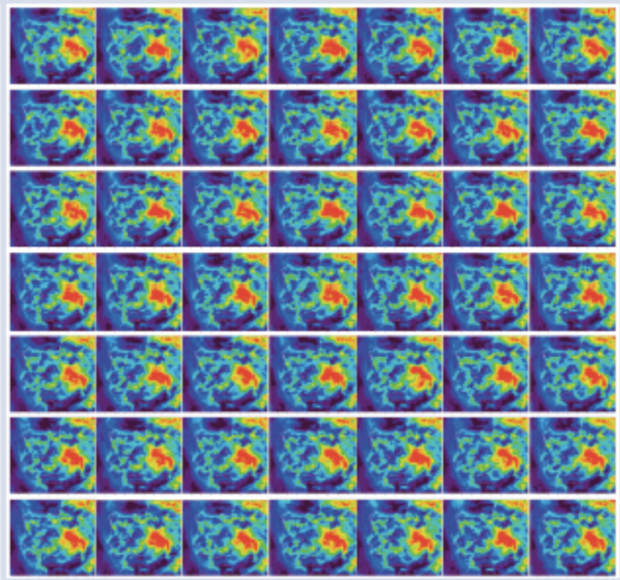
Modeling

Ensembles of NWP models





We have compared multiphysics (MP) vs. perturbed initial conditions (PIC) ensembles for a severe weather episode in Spain. Among other results, we found that the MP ensemble provided more spread than the PIC ensemble. This is relevant for designing probabilistic forecasts for early warning systems.

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

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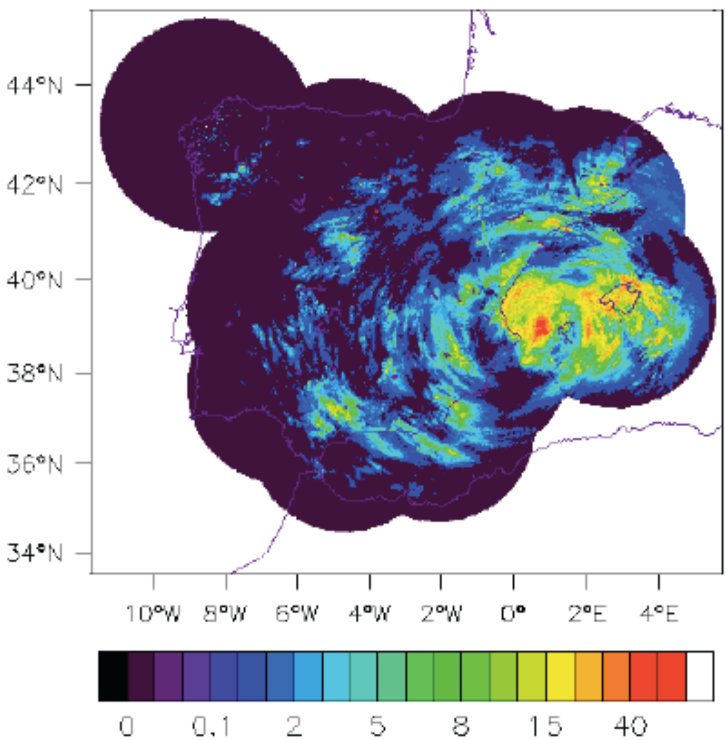
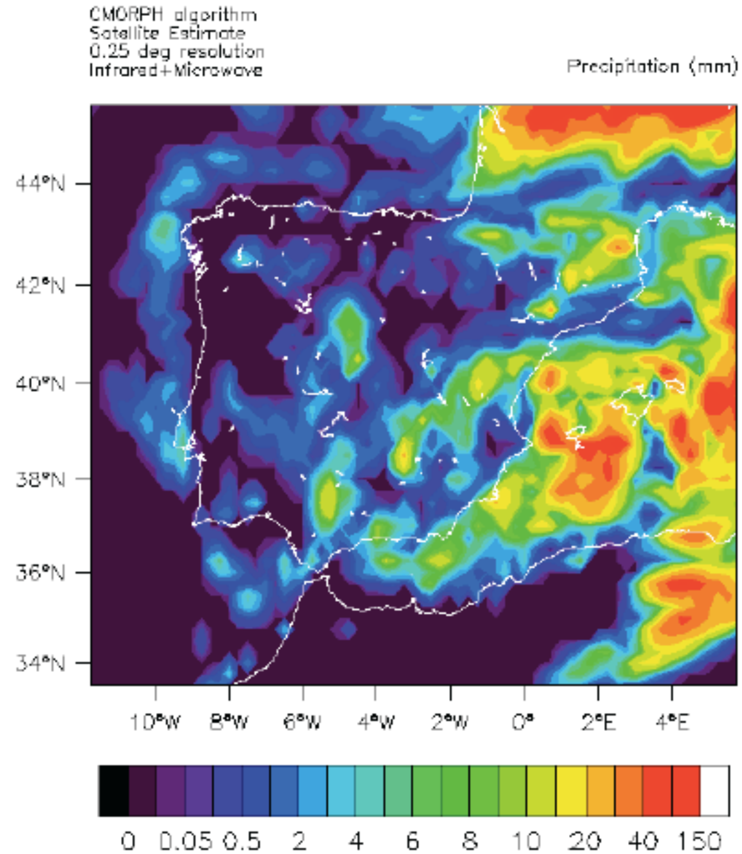
Modeling

Ground radar precipitation
(24h accum.)



Satellite precipitation
(24h accum.)



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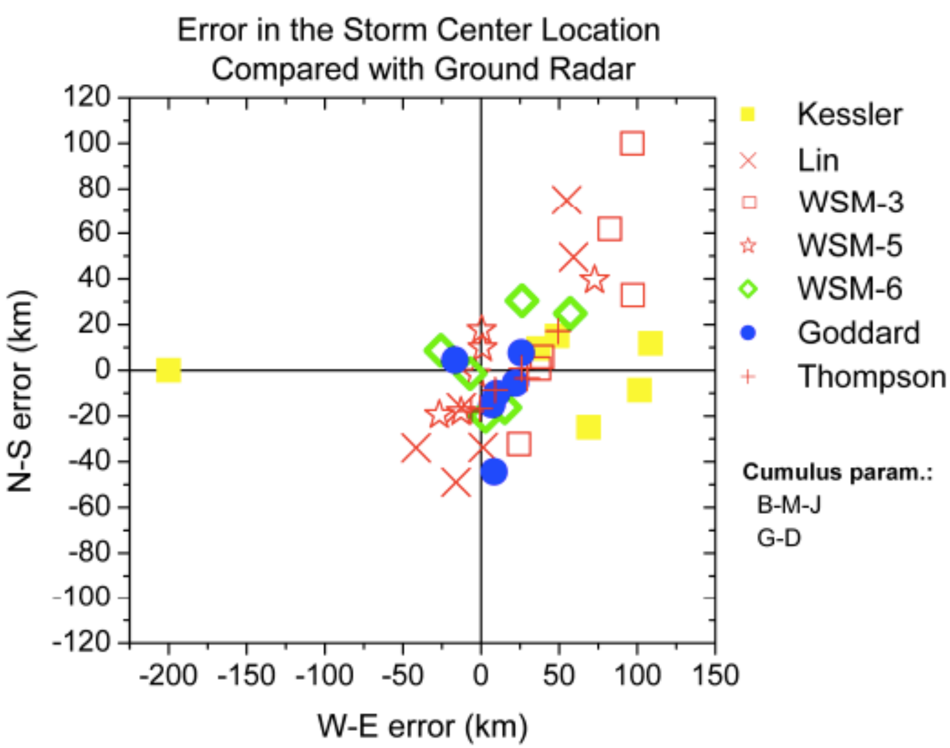
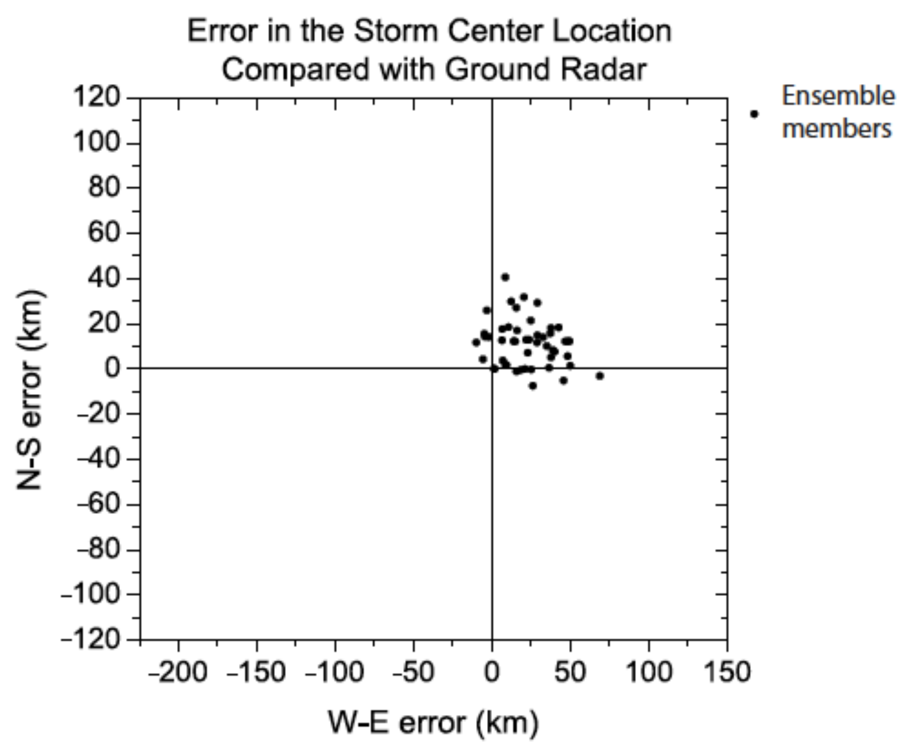
Modeling

Multi-Physics (MPP)



Perturbed Initial Conditions (PIC)



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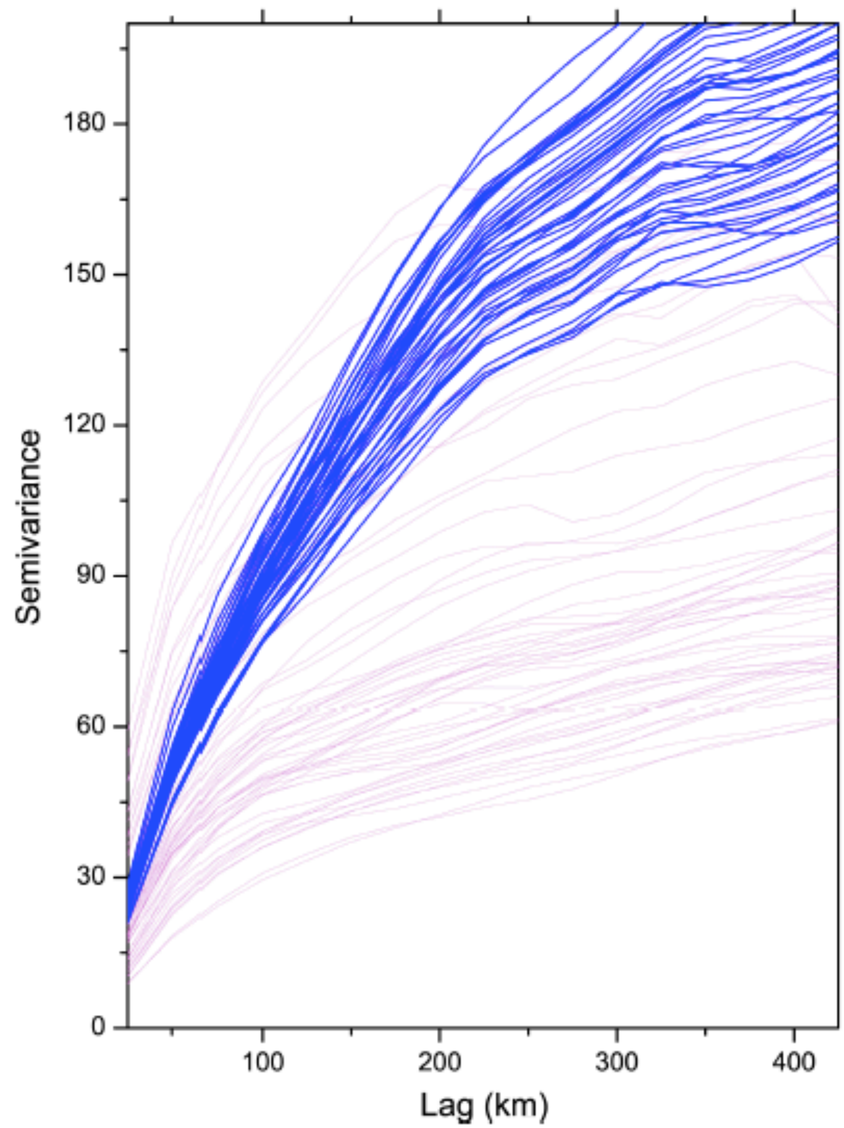

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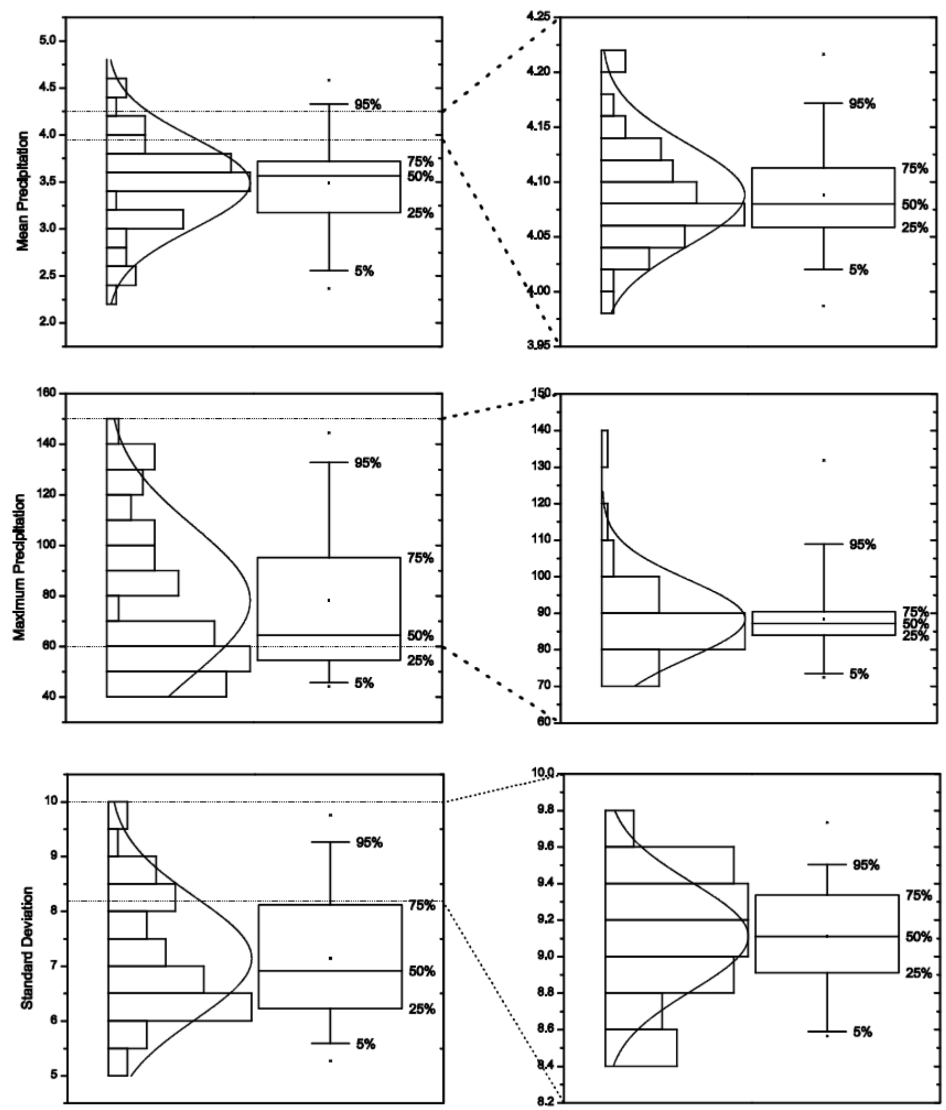
Modeling

Multi-Physics Ensemble | Perturbed IC Ensemble



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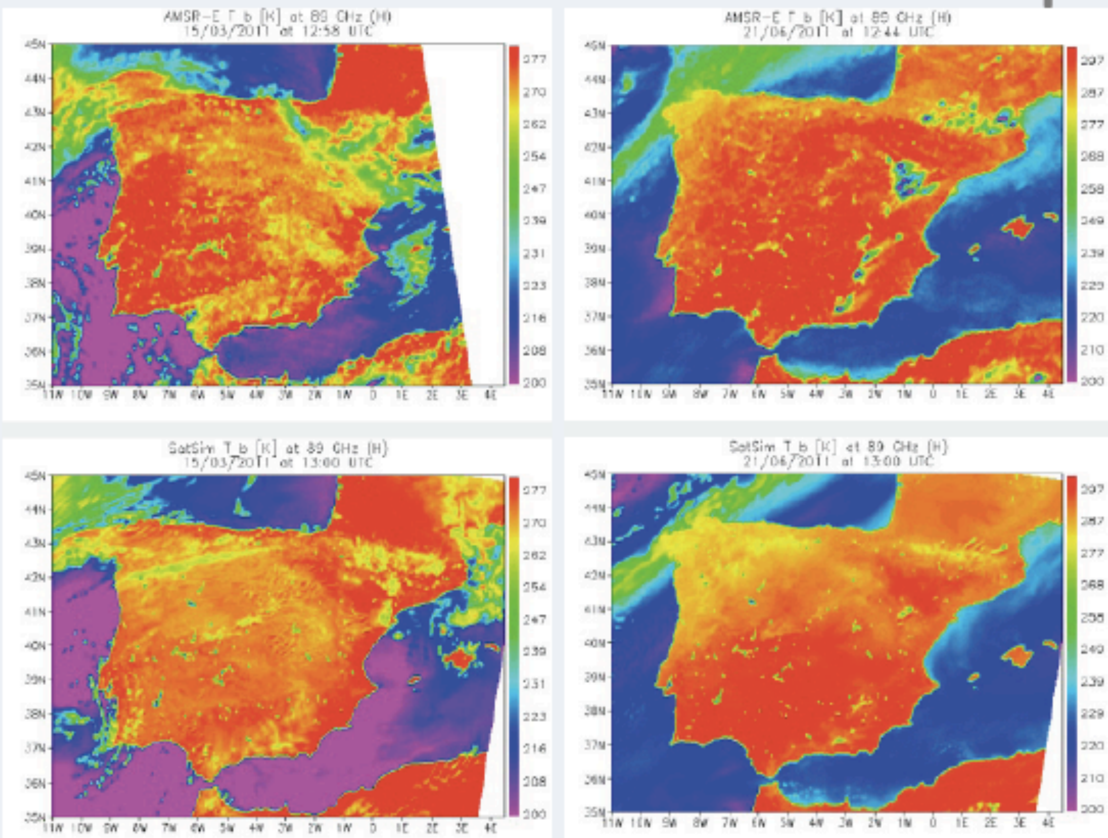
Modeling

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

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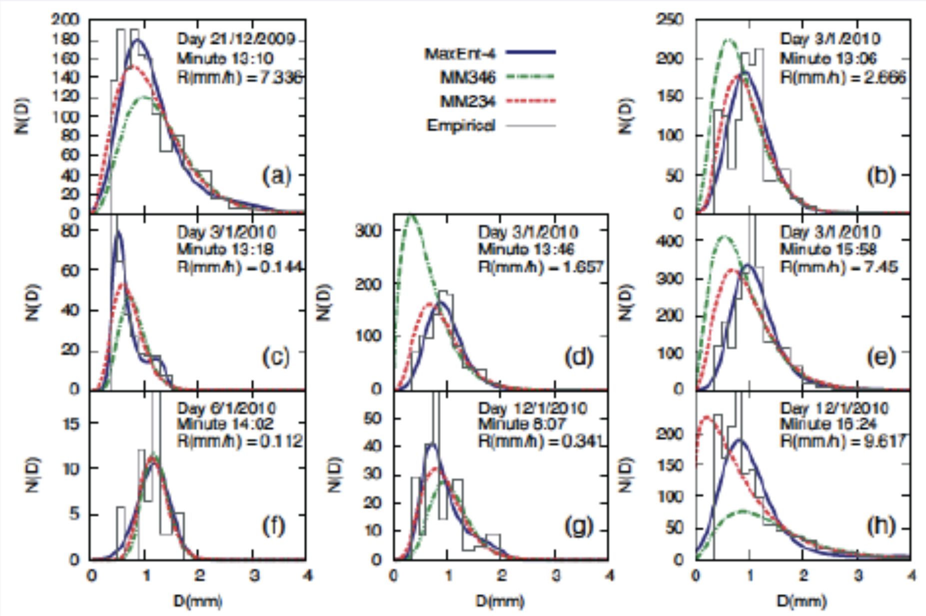
Modeling

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

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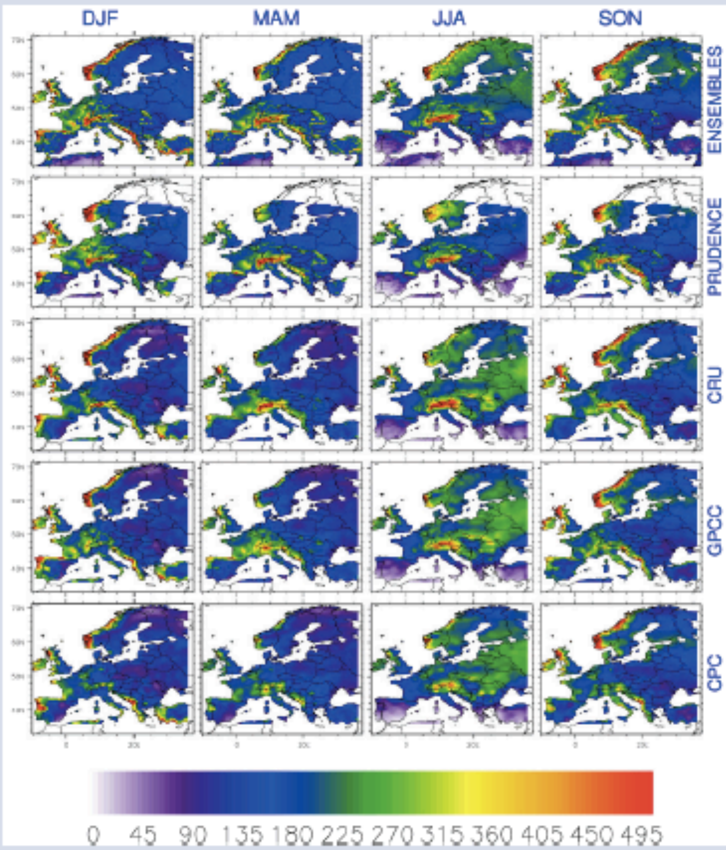
Climate Research

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.

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.

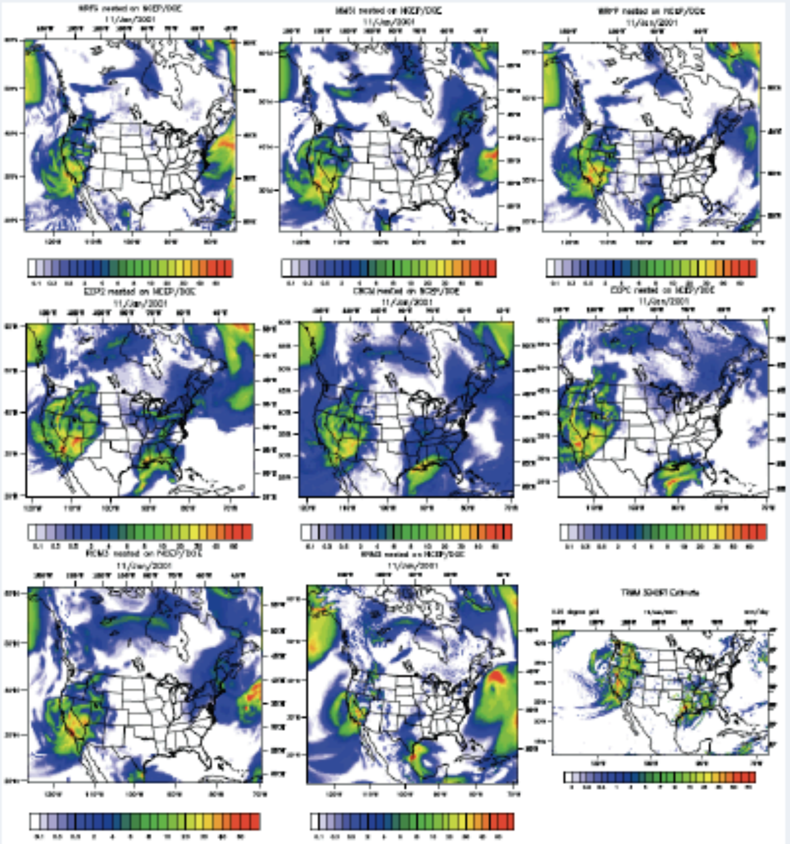
RCMs: Dynamical downscaling tool

25 km res

Primary input for IPCC AR5

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

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Climate Research

Spatio-temporal structure of precip

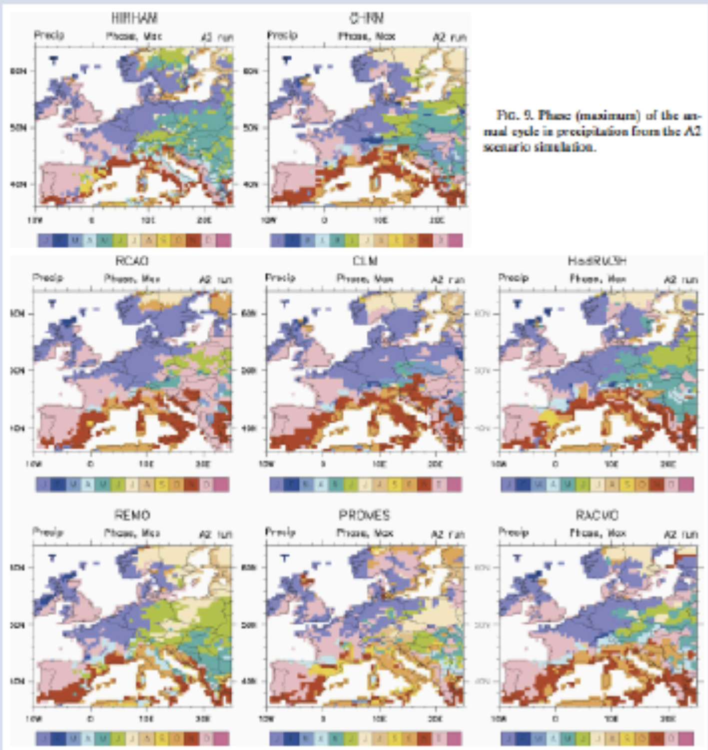

FIG. 9. Phase (maximum) of the annual cycle in precipitation from the A2 scenario simulation.

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

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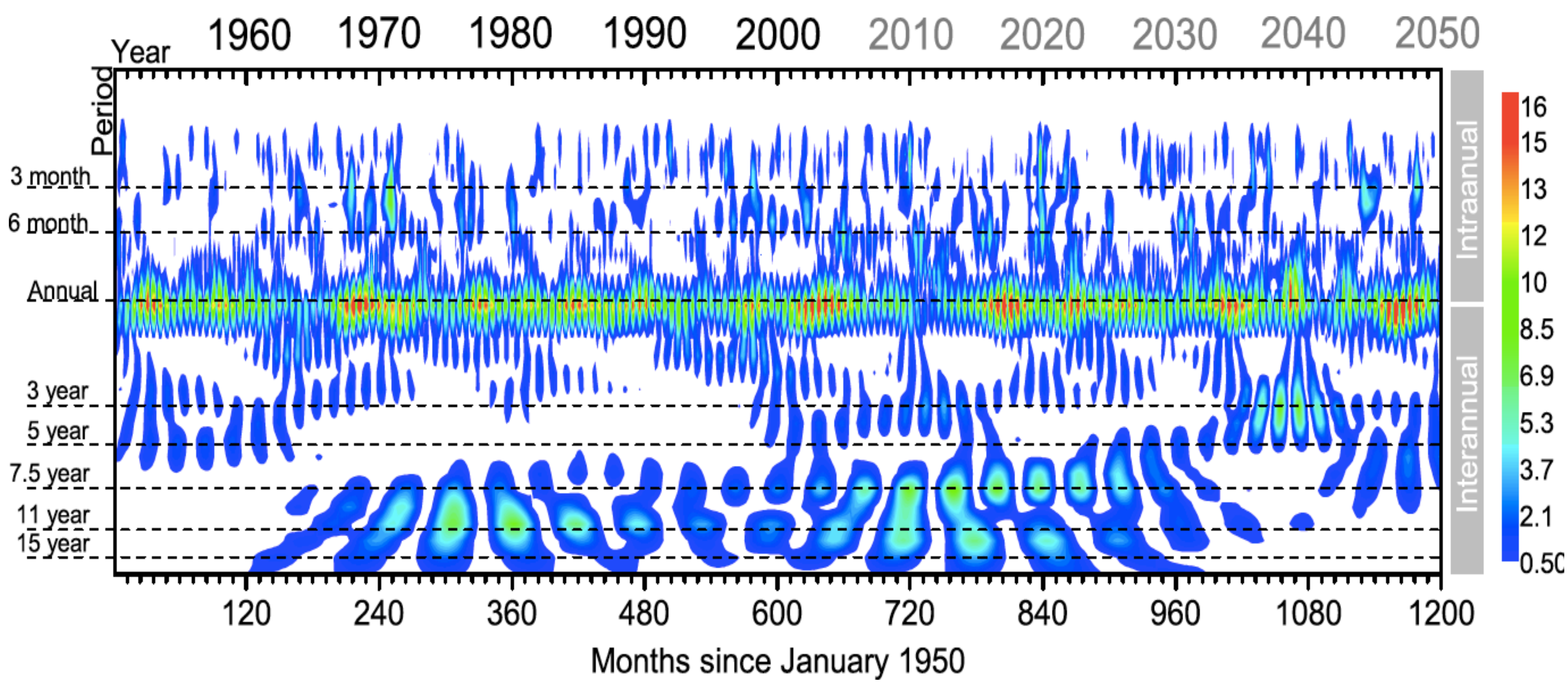
Climate Research

Wavelet analysis of precipitation series



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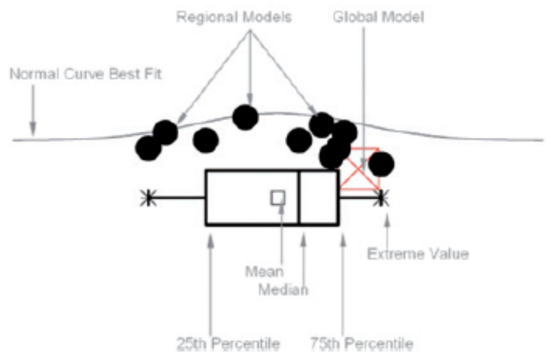

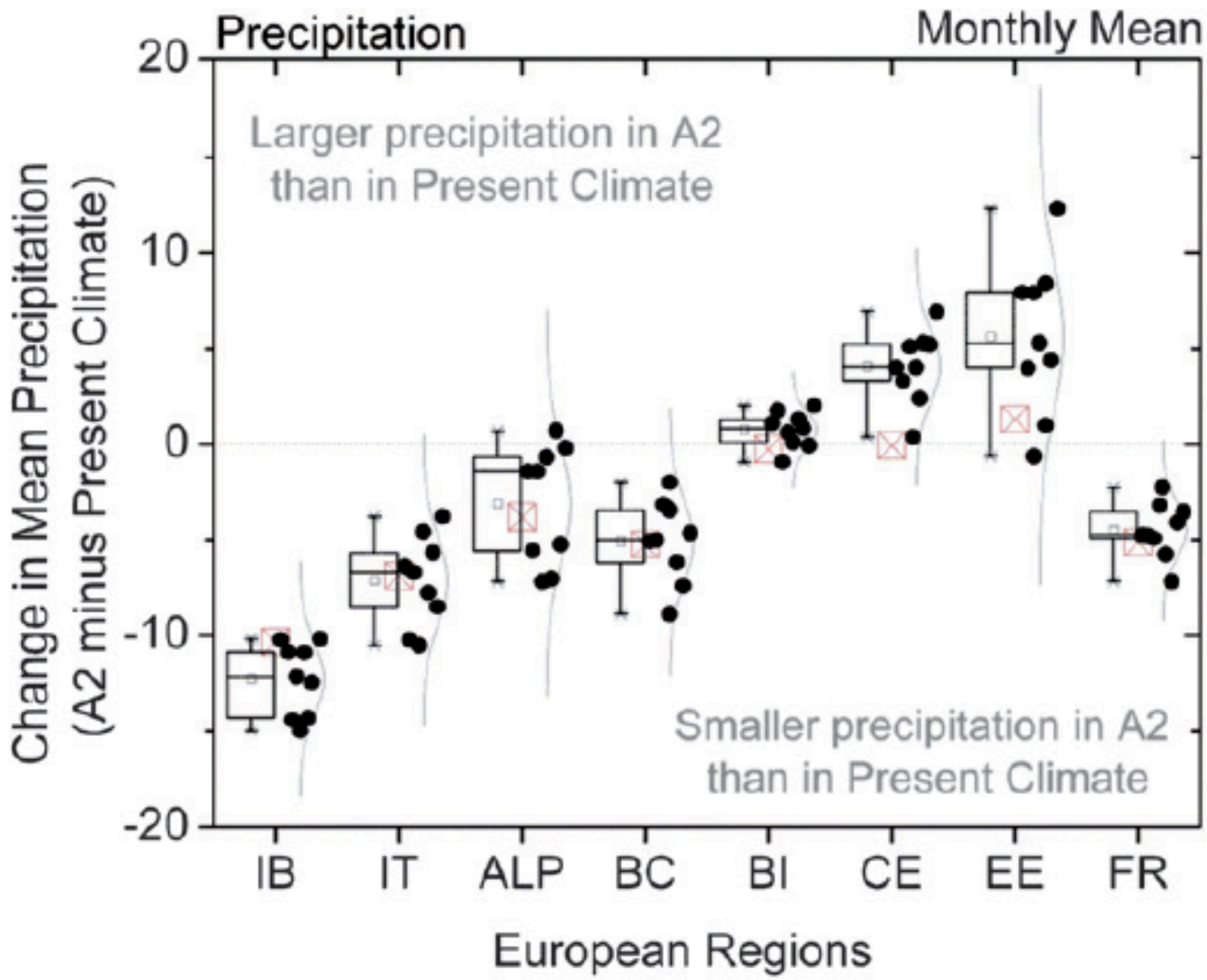

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Climate Research

Renewable energy applications

Energy &
Environmental Science

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PERSPECTIVE

Precipitation estimates for hydroelectricity

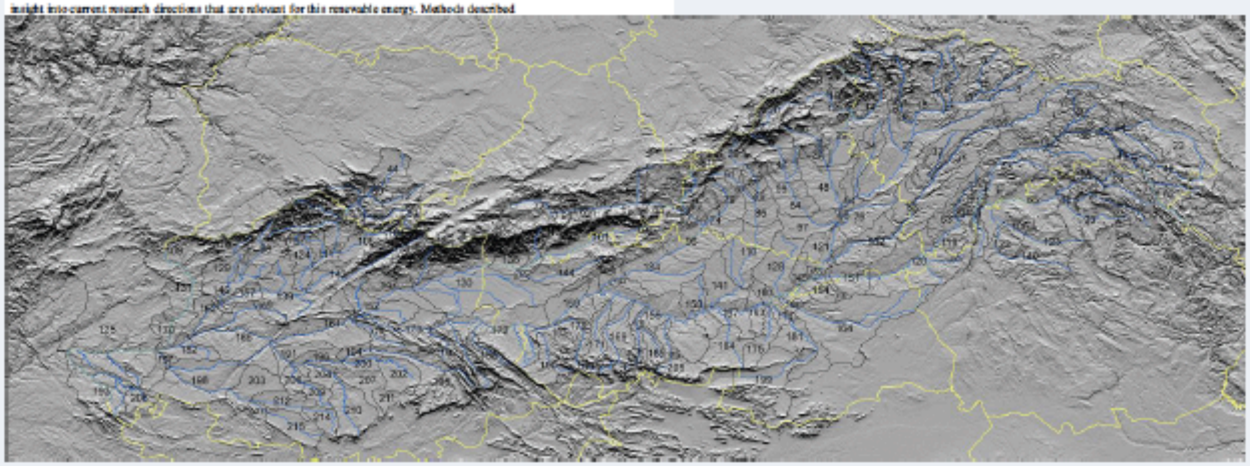
Francisco J. Tapiador,[*a] Arthur Y. Hou,[b] Manuel de Castro,[a] Ramiro Checa,[a] Fernando Cuartero[c] and Ana P. Barros[d]

Received 16th May 2011, Accepted 19th August 2011
DOI: 10.1039/c1ee01745d

Hydroelectric plants require precise and timely estimates of rain, snow and other hydrometeors for operations. However, it is far from being a trivial task to measure and predict precipitation. This paper presents the linkages 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

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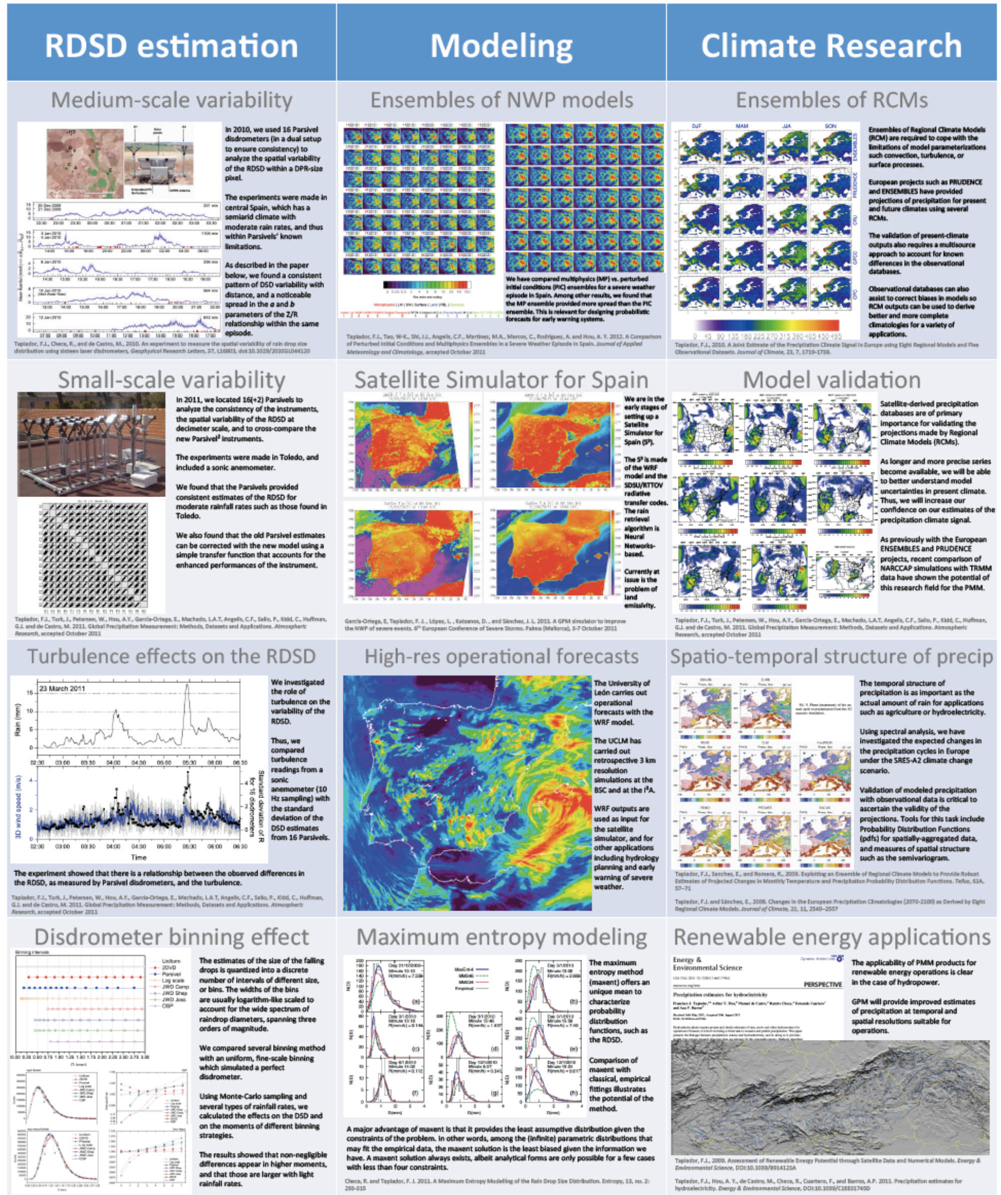
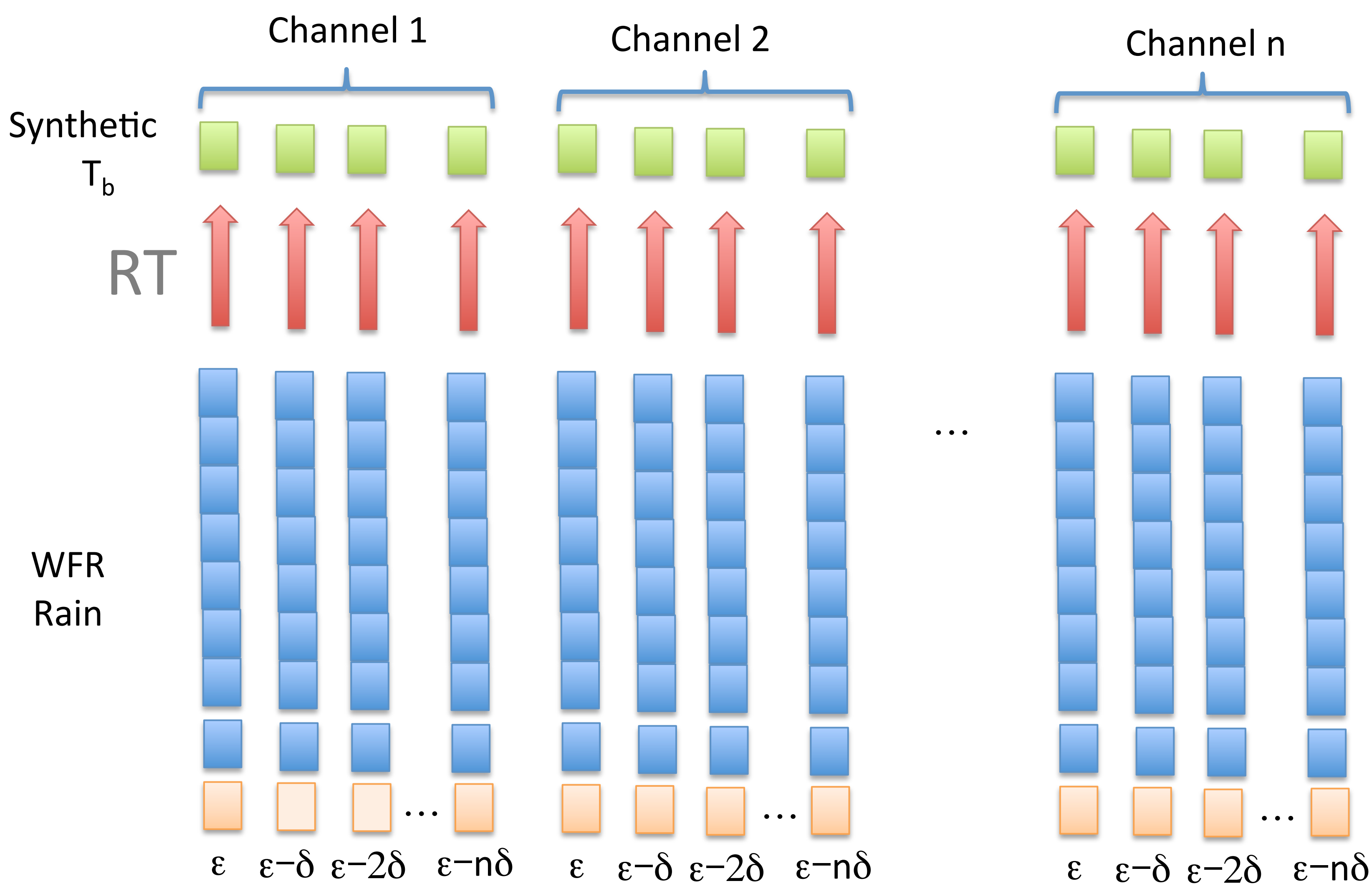
Thanks!




Channel 1
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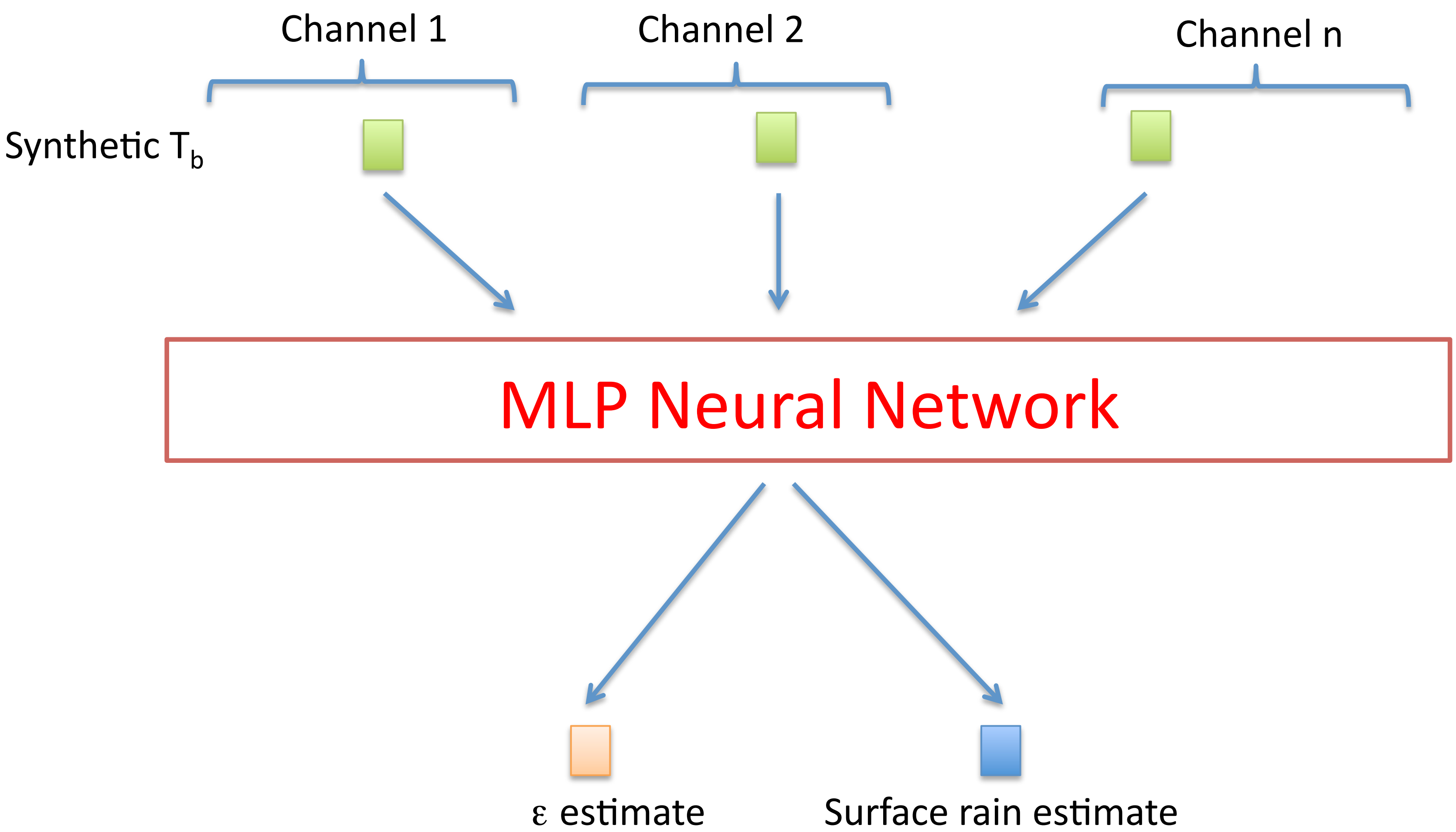
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