Design of a high resolution ensemble prediction system for Argentina

Cynthia Matsudo, Yanina García Skabar, María Eugenia Dillon, Paula Hobouchian, Juan José Ruiz, Luciano Vidal, Paola Salio

NMS - Argentina

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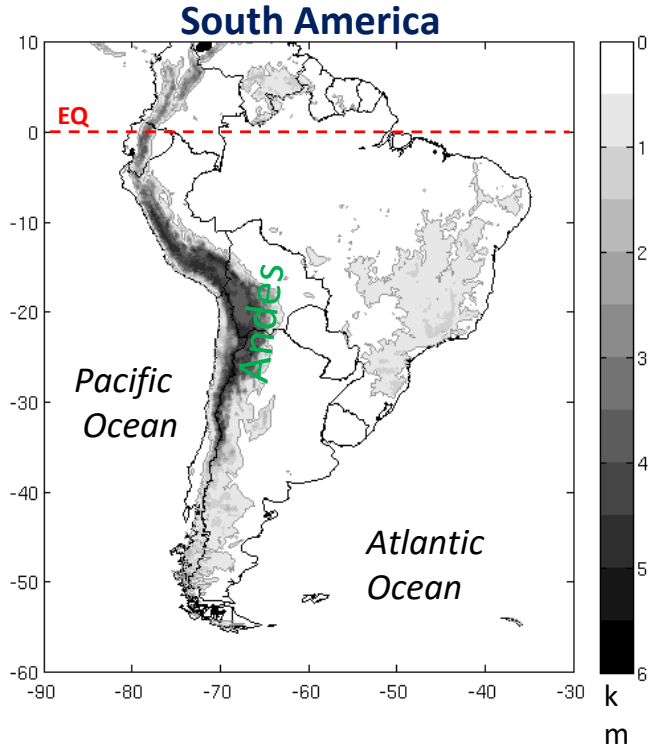
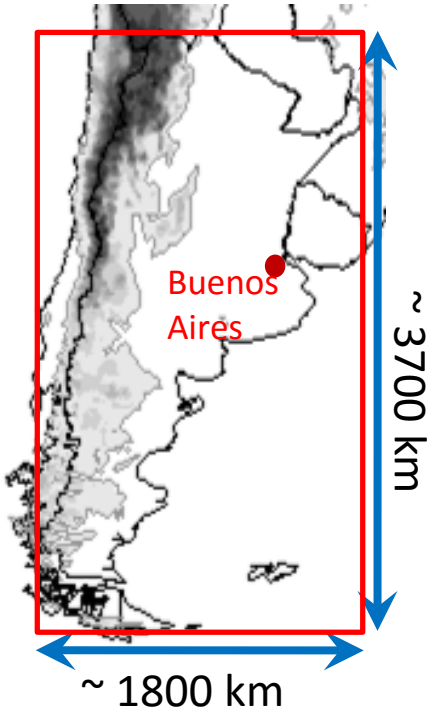
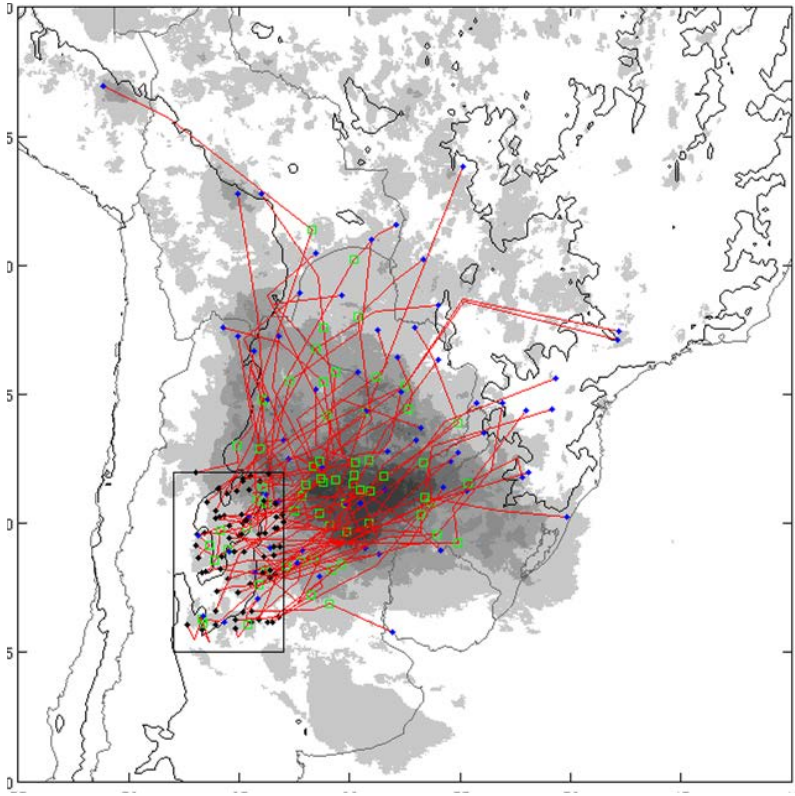
Convection in Argentina







Deep convective systems initiation location and trajectories. Courtesy of Dr. Luciano Vidal

Case study: 22-24 December 2015

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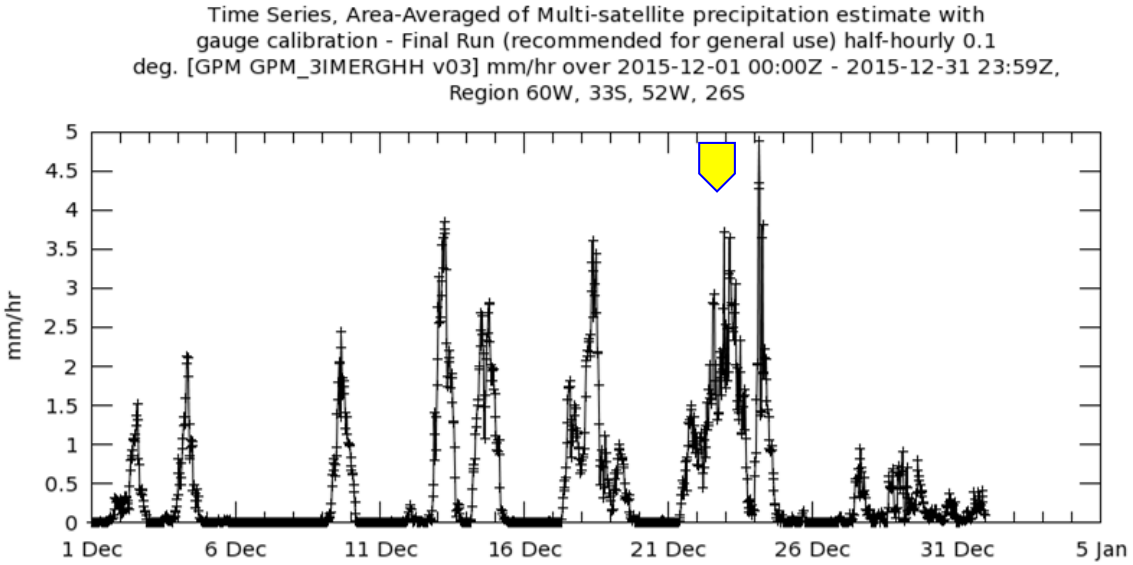
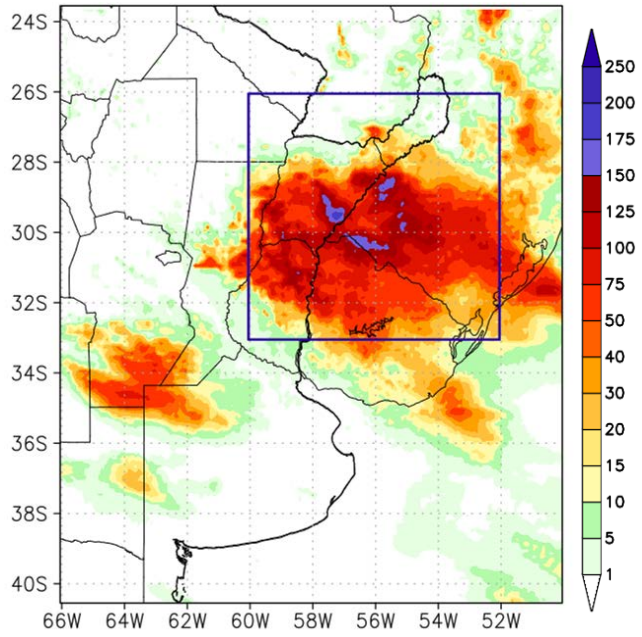
December 2015 was a very active month with several episodes of heavy rainfall over northeastern Argentina

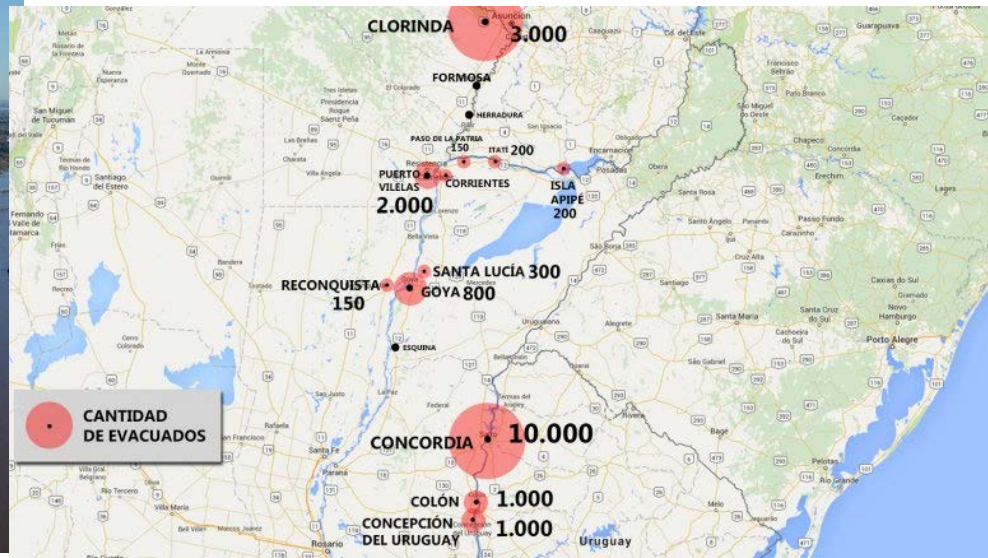




24-hr accumulated IMERG_FR precipitation estimates valid for 18 UTC 23 Dec 2015
Blue box indicates verification area

Case study: 22-24 December 2015

- Severe weather phenomena was observed associated with deep convection over NE Argentina
- Flooding from intense rainfall lead to more than 10000 evacuated people

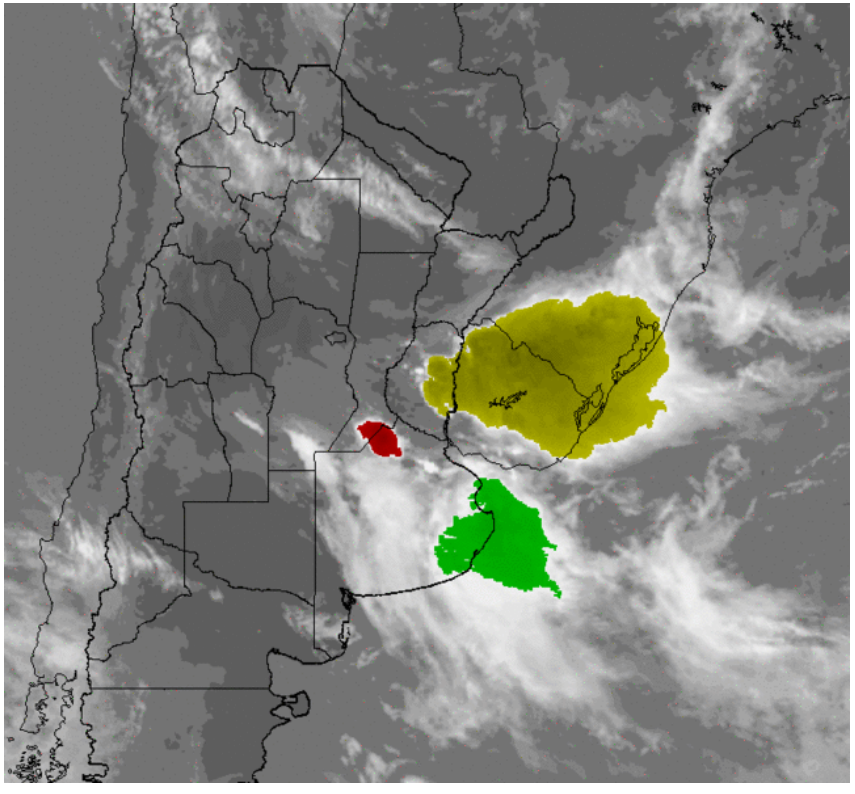


Case study: 22-24 December 2015

- A series of MCSs took place between 22nd and 24th December 2015 over central and NE Argentina. These types of MCSs is commonly observed over the region during the warm season (DJF) accounting for more than half of the rainfall amounts in the season.

- Development of deep convection was a response to the combination of a slowly advancing cold front to the north over an unstable air mass with enhanced moisture content.

Forecast and Tracking the Evolution of Cloud Clusters (ForTraCC) using GOES IR 10.7 µm imagery



Animation from 00 UTC 23 Dec to 00 UTC 24 Dec 2015.
Developed by DSA/CPTEC - Brazil

Case study: 22-24 December 2015

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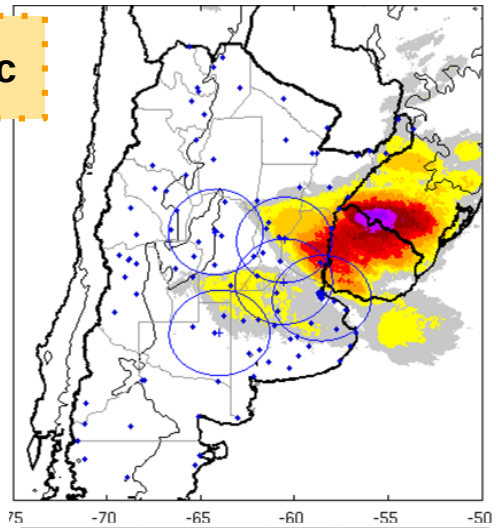
Intense lightning activity was observed associated to deep convection BT(IR)<210K

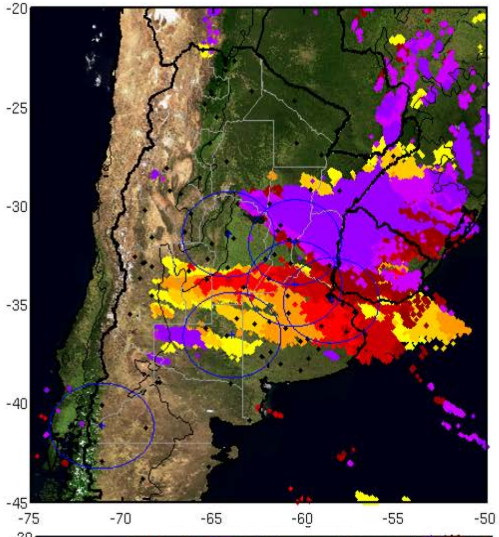
Frequency of BT(IR)<210K

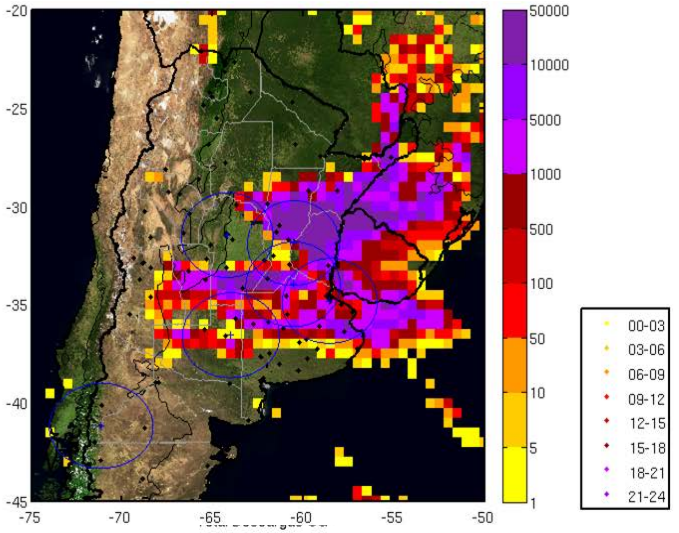
Lightning evolution

24-hr aggregated lightning discharges

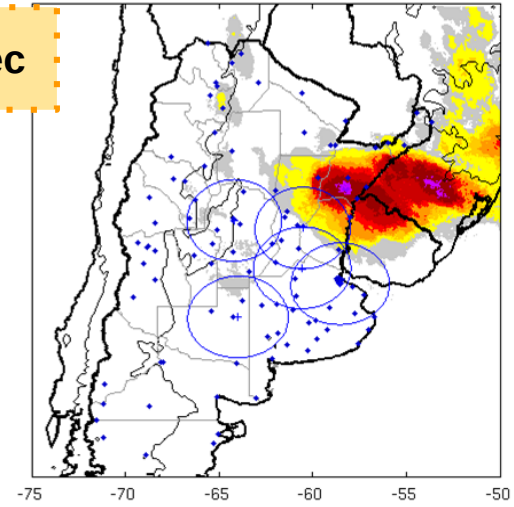
22nd Dec

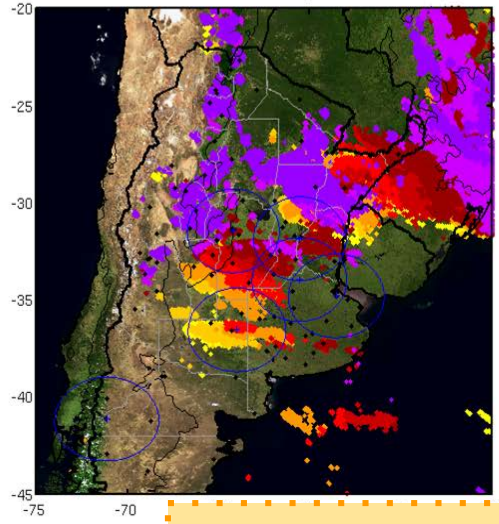


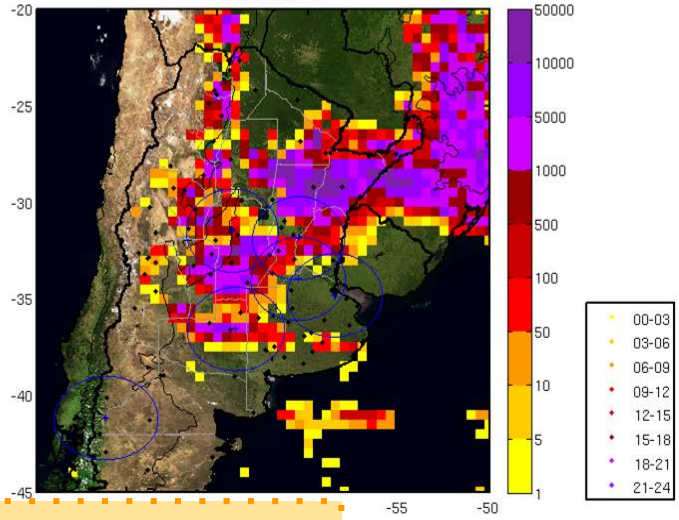


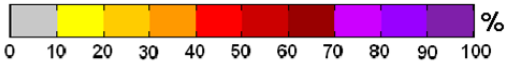


23rd Dec









Vaisala GLD360 Lightning Network

Model configuration

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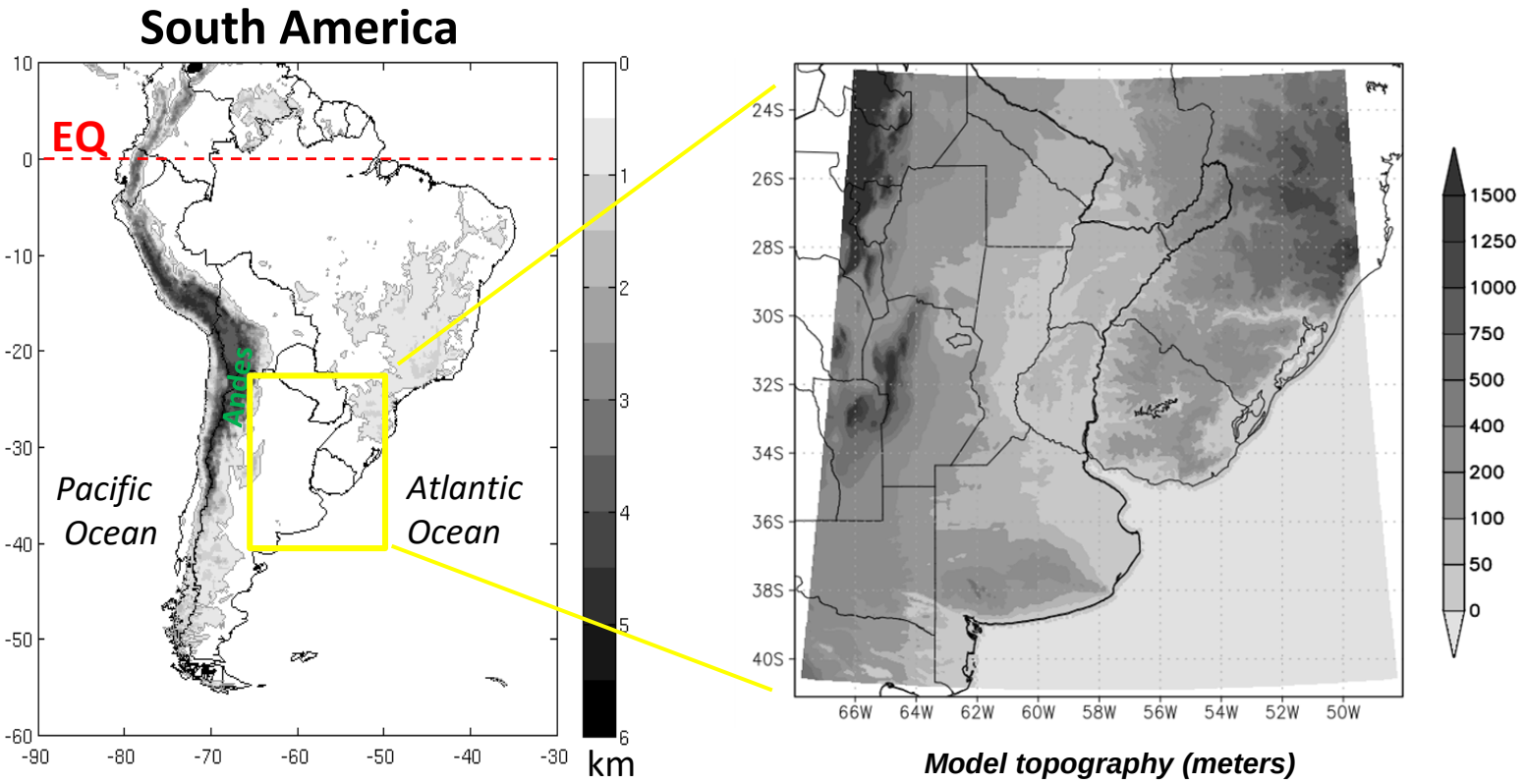
WRF-ARW

- non hydrostatic
- 4 km resolution (420x500 grid points)
- 38 sigma-p levels, top at 50 hPa
- IC/BC from GFS analysis and forecasts
- no DA



Model topography (meters)

Model configuration

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Experiments: 48hr run initialized on 12 UTC 22 December 2015

Experiments	**Name**	**ICs/BCs**	**WRF-ARW**
Deterministic	**OPER**	GFS_0.25º every 3hs	v 3.6.1
20-member ensemble	**ENS-IC**	GEFS_1º every 6hs	v 3.6.1
20-member ensemble	**ENS-MP**	GEFS_1º every 6hs	v 3.7

ENS-MP		**Microphysics scheme**			
		WDM6	Thompson	Milbrandt	NSSL2D
PBL scheme	YSU (Hong Noh and Dudhia 2006)	A (3 members)	B (3 members)	C (3 members)	D (3 members)
	MYJ (Janjic 2002)	E (2 members)	F (2 members)	G (2 members)	H (2 members)

Model configuration

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8 configurations:
4 2-mom MP
+
2 PBL schemes

ENS-MP		**Microphysics scheme**			
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Rainfall satellite estimates

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Integrated Multi-satellitE Retrievals for GPM_Final Run (IMERG_FR, NASA)

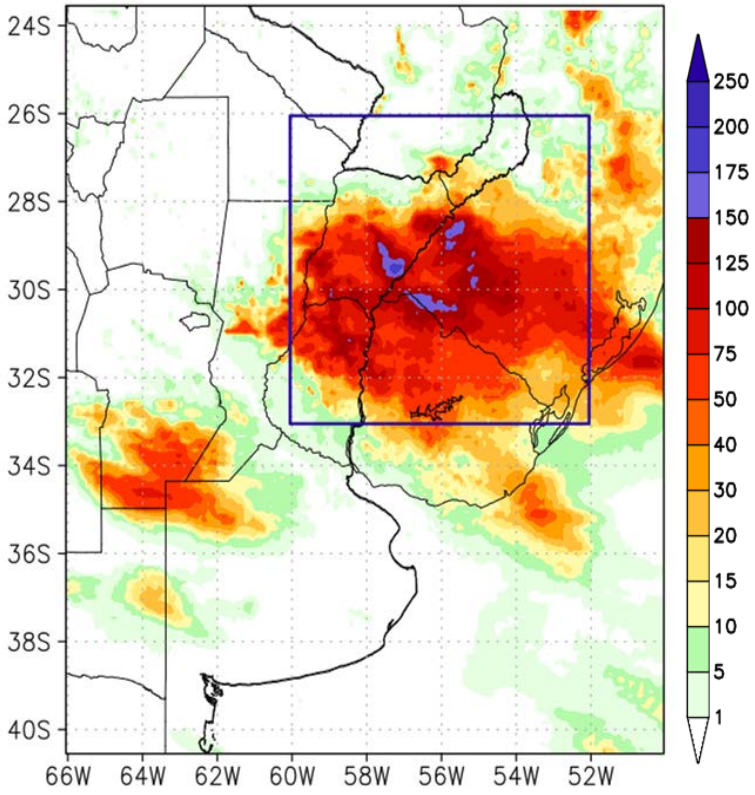
- Resolution: 0.1º - 30-min accumulation
- Type: IR+PMW+DPR+surface gauge calibration
- Huffman and Bolvin (2015)

Verification period:
24-hr from 18Z22Dec to 18Z23Dec

- Insufficient rain gauges over the region → foster the use of remote sensing information due to greater spatial and temporal coverage

- An objective evaluation of the quality of these estimates is currently under development

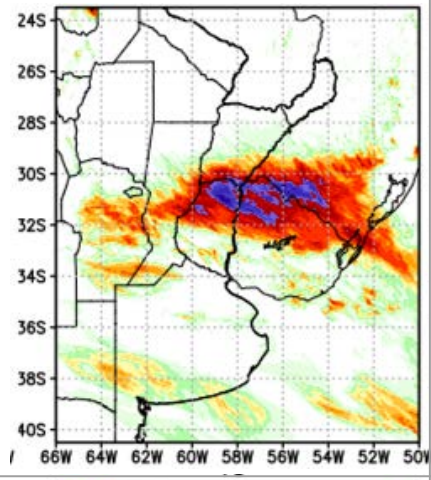
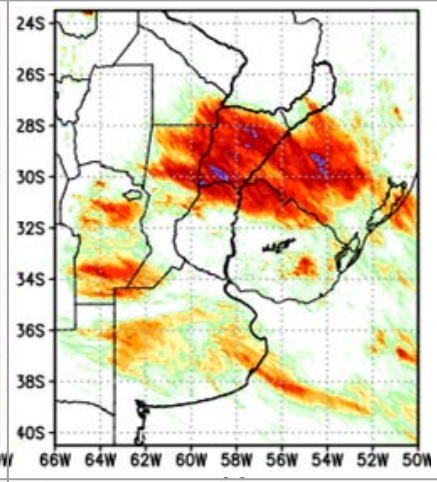
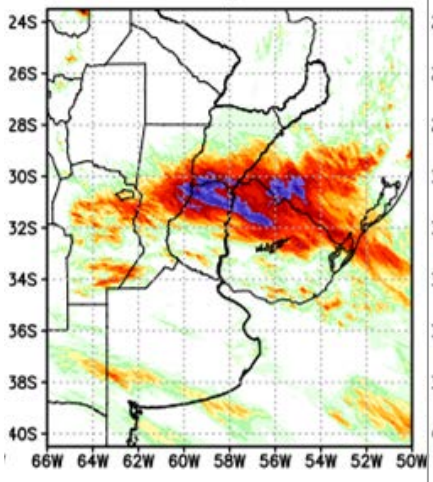
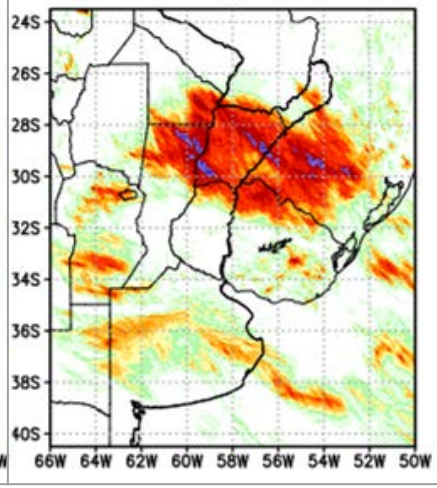
- For some case studies it was found a better performance over the region than other estimates such as 3B42V7



24-hr accumulated IMERG_FR
valid for 18UTC 23 Dec 2015
Blue box indicates verification area

Exploring results

- Members 13 of ENS-IC and ENS-MP have similar rainfall pattern. Likewise with member 14 of both ensembles
- Perturbed low resolution ICs from GEFS dominates compared to the physics parameterization schemes
- Further analysis should be made for more case studies in order to quantify this behaviour

	IC: GEFS member	
	member 13	**member 14**
ENS-IC **MP: WSM6** **PBL: YSU**		
ENS-MP **MP: WDM6** **PBL: MYJ**		

Precipitation quantitative evaluation

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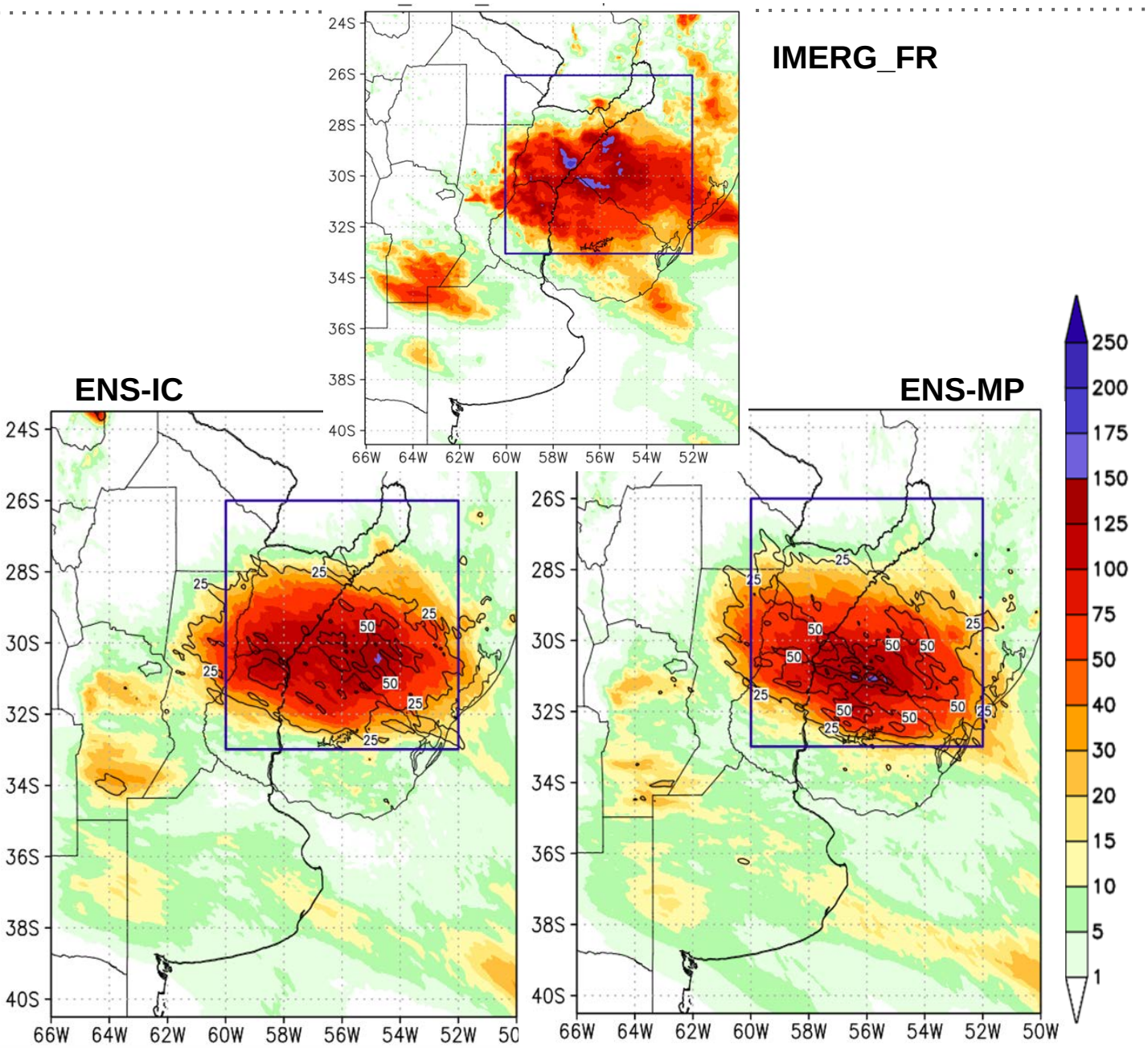
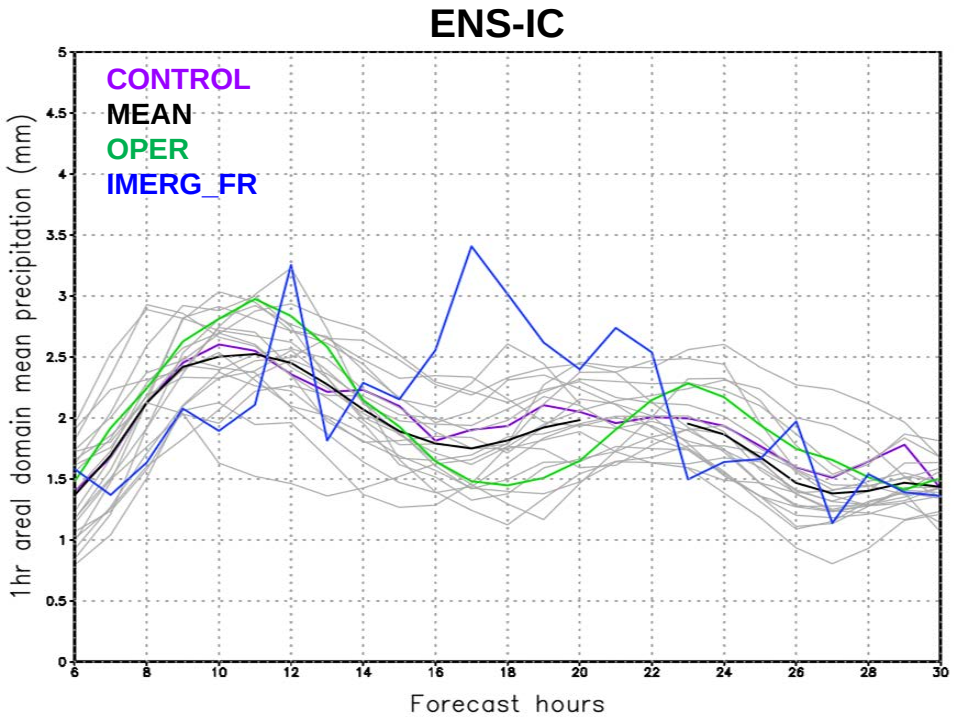
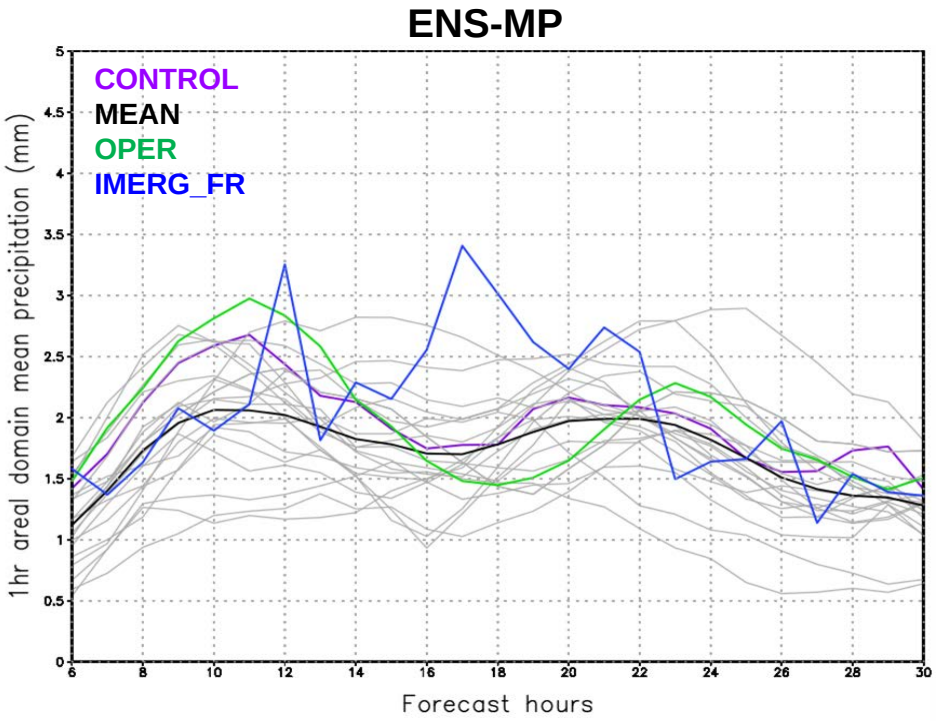
Mean (shaded) and spread (contours) values of 24-hr accumulated rainfall (mm). The forecast was initialized 12UTC 22 Dec 2015 and valid for 18UTC 23 Dec 2015.
Blue box indicates verification area.



Precipitation quantitative evaluation

- Evolution of average precipitation over the verification area shows more spread for multiphysics ensemble ENS-MP
- Deterministic OPER run initialized with high-resolution GFS captures the first maximum better than the ensemble means, though it underestimates the second maximum
- Both ensembles underestimate the values up to the 22hr lead time and the best representation is defined by the ensemble generated by ICs perturbations

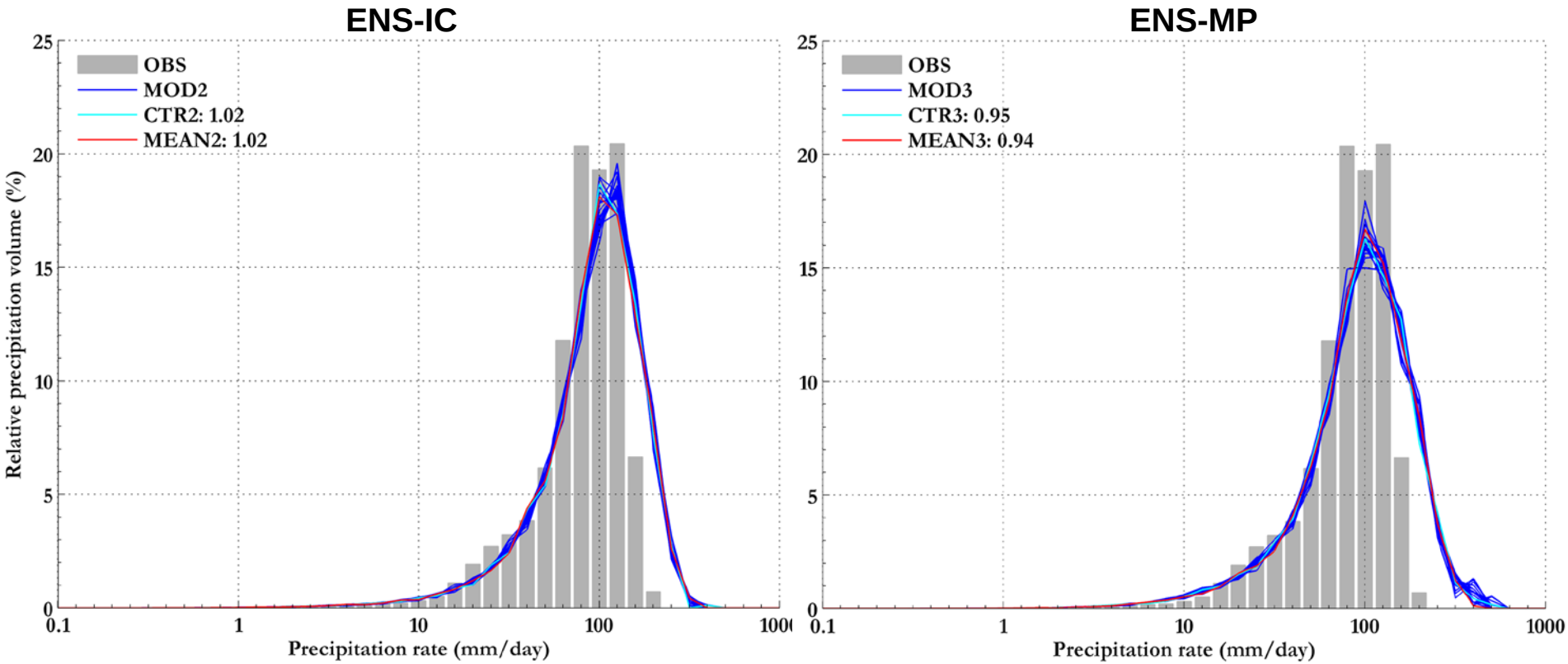




Spatially averaged precipitation rate (mm/h) for IMERG_FR, ensemble members, ensemble mean, control member and OPER experiment forecasts for verification domain.
Forecast were initialized 12UTC 22 Dec 2015.

Precipitation quantitative evaluation

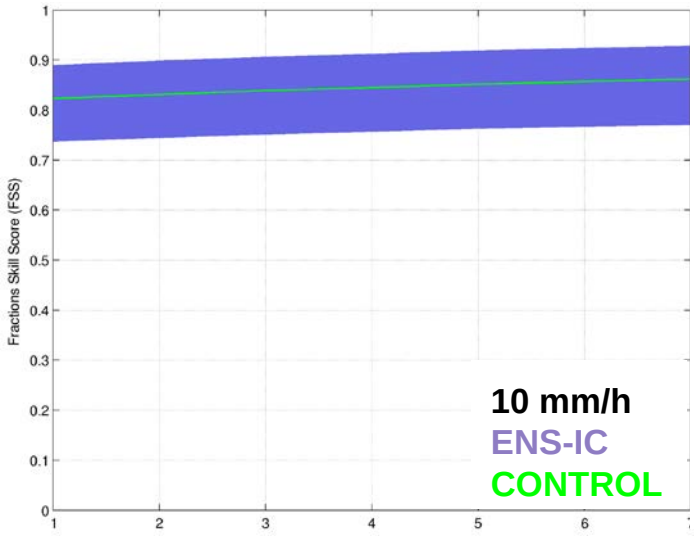
- 24hs aggregated precipitation PDF computed over the verification area shows ENS-IC distribution is closest to observation IMERG_FR.
- ENS-IC captures the frequency maximum around 100 mm/day rates better than ENS-MP
- Both ensembles overestimate the frequencies of the most intense rates

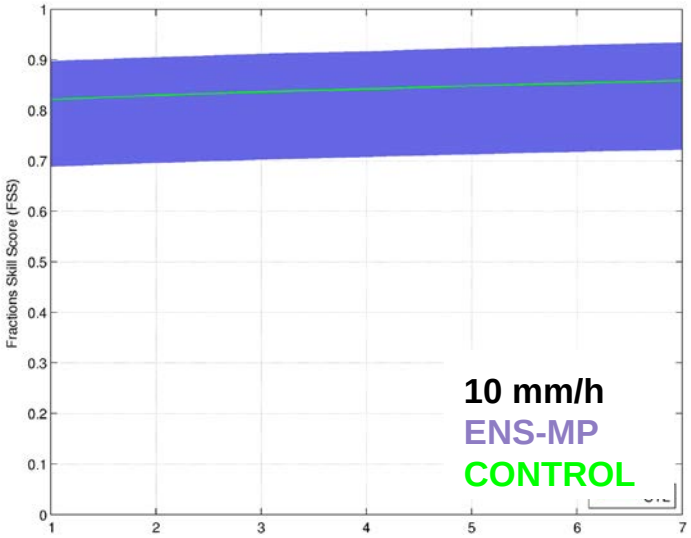


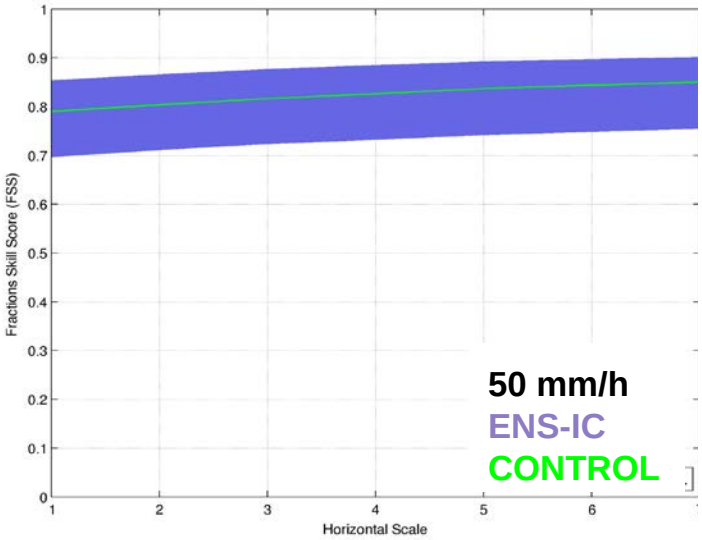
PDF of aggregated precipitation rate (mm/day) computed from 18UTC 22 Dec to 18UTC 23 Dec 2015 for the verification domain. Grey bars represent the PDF for IMERG_FR estimate

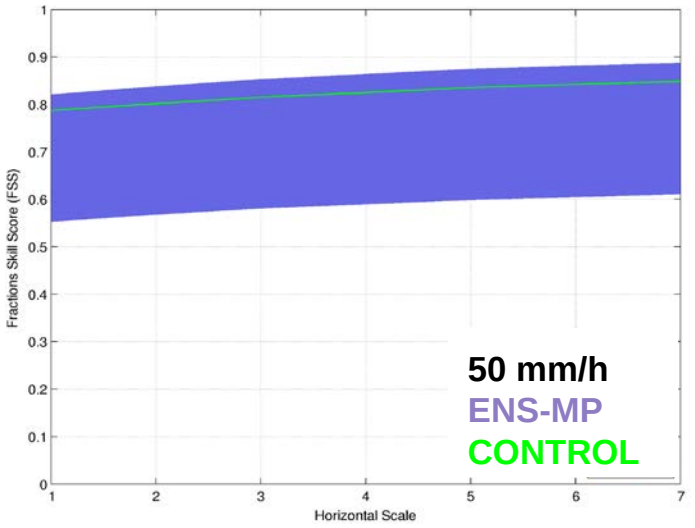
Precipitation quantitative evaluation

- As the area increases, FSS worsened at all scales revealing that ensembles have less skill at predicting heavier precipitation.
- At all thresholds, ENS-IC shows more skill than the ENS-MP.









Fractions skill score (Roberts and Lean, 2008)

$$FSS = 1 - \frac{\frac{1}{N}\sum_{N}(P_f - P_o)^2}{\frac{1}{N}\left[\sum_{N}P_f^2 + \sum_{N}P_o^2\right]}$$

Aggregated FSS computed for the 24-hr period from 18UTC 22 Dec to 18UTC 23 Dec 2015 for the verification domain for 10 and 50mm/h precipitation thresholds.

Conclusion and next steps

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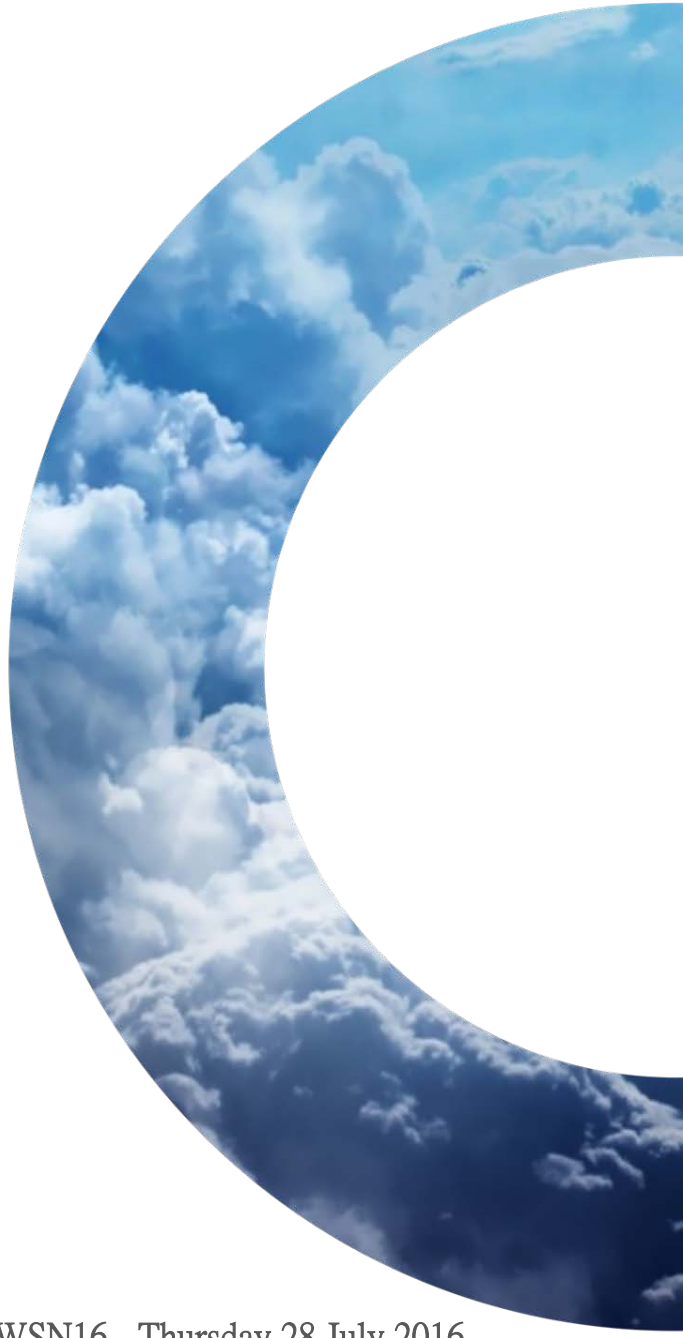
- Preliminary results for the design of a regional high resolution ensemble system was developed for Argentina and tested for a severe weather case study
- The use of perturbed ICs and different PBL and MP schemes provided more spread to the ensemble

Remains (a lot to do!) …

- Further analysis should be made of the sensitivity to different parameterizations
- More experiments should be carry out in order to evaluate a longer period of case studies during a warm season
- Objective evaluation to other variables such as reflectivity and intense surface winds associated to severe weather detection
- Extend the analysis to include other verification metrics to measure ensemble spread and sensitivity to the number of members
- To study the impact to the use of other high resolution perturbed ICs

Thank you for your attention!



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