VAREPS – M6 progress report *(January 2005)*

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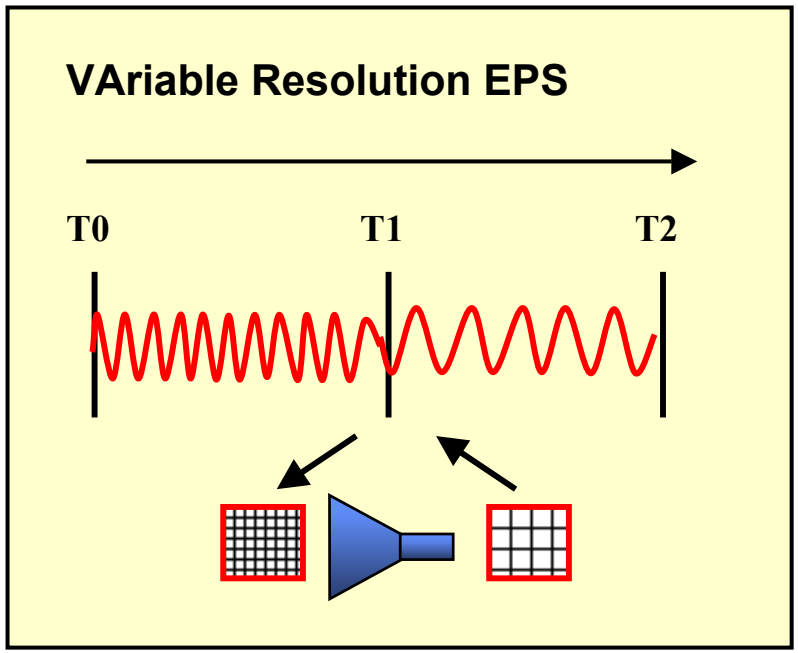


Actions identified during M5 (Sep '04)

- **CY28R3 and wave model**. Scripts needed to be modified (in collaboration with the wave group) to run VAREPS with the wave model.

- **Sensitivity experiments**. Further experiments were required to address the following issues with the most recent operational model cycle (CY28R3):
  - **Time step** - Which time steps should be used in the T_L399/T_L255 integrations? Is the proposed configuration 1800s/2700s right?
  - **Stochastic physics** - How should stochastic physics be tuned in the T_L255 integration? Should the time/spatial characteristic of the stochastic perturbation be the same in the two integrations or not?
  - **VAREPS configuration** – Which configuration should be tested for implementation?

- **MARS archiving**. A new MARS stream had to be defined to archive properly VAREPS' experiments.

Key conclusions from Q4-2004's experimentation

❖ **CY28R3 & wave model**. Scripts have been upgraded to be able to run with the wave model.

❖ **Sensitivity experiments:**

- **Time-step** – A time step of 1800s in the T_L399L40 and of 2700s in the T_L255L40 integrations could be used.
- **Stochastic physics** – The strength of stochastic physics should not be changed, since it has a limited impact on the precipitation spread reduction after truncation.
- **Next test: VAREPS with D6 truncation** – Test will start to assess whether the following configuration would cure the precipitation spread problem:

EXP-ID	MODEL A								MODEL B					
	hres	tstep	length	Stochastic physics			var-hdiff		hres	tstep	length	Stochastic physics		
				MAG	NFR	DEL						MAG	NFR	DEL
VAR7-VD6	399	1800s	d0-7	0.2	6 NST (3h)	5	d5-7		255	2700s	d7-14	0.35	4 NST (3h)	5

❖ **MARS archiving**. Technical development is still required to archive properly VAREPS' data. Work has started to upgrade VAREPS mod sets to cycle Cy29r1+.

CY28R3 experiment list

Experiment list for CY28R3. The following 51-member experiments have been run for 13 cases. Other experiments (not listed) have been performed to assess the sensitivity of the precipitation spread reduction after the truncation.

EXP-ID	MODEL A							MODEL B					
	hres	tstep	length	Stochastic physics			var-hdiff	hres	tstep	length	Stochastic physics		
				MAG	NFR	DEL					MAG	NFR	DEL
VAR7-VD4	399	1800s	d0-7	0.5	6 NST (3h)	10	d5-7	255	2700s	d7-14	0.5	6 NST (4.5h)	10
VAR7-VD5	399	1800s	d0-7	0.5	6 NST (3h)	10	d5-7	255	1800s	d7-14	0.5	6 NST (3h)	10
VAR7-VD6	399	1800s	d0-7	0.35	6 NST (3h)	10	d5-7	255	2700s	d7-14	0.35	6 NST (4.5)	10
VAR7-VD7	399	1800s	d0-7	0.2	6 NST (3h)	5	d5-7	255	2700s	d7-14	0.3	4 NST (3h)	5
TL255	399	2700s	d0-14	0.5	6 NST (4.5h)	10	-						
TL399	399	1200s	d0-14	0.5	6 NST (2h)	10	-						

Outline

- 1. Ensemble precipitation spread with CY28R3
- 2. Sources of the ensemble precipitation spread decrease
- 3. Sensitivity of ensemble precipitation spread to time step between d7-14
- 4. Sensitivity of ensemble precipitation spread to stochastic physics
- 5. Next step: test VAREPS with D6 truncation

1. Ensemble precipitation spread with CY28R3

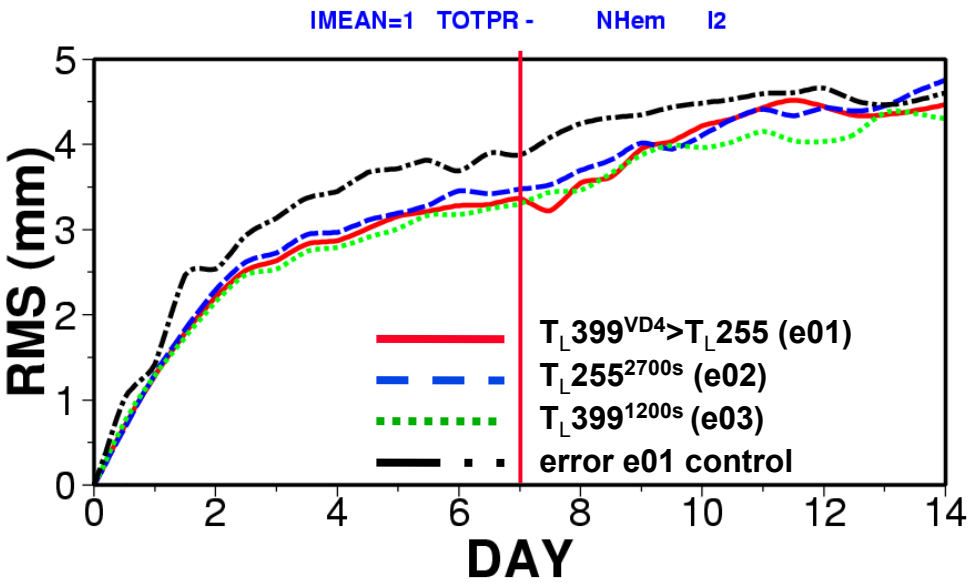
❖ **Issue** - The issue raised during M5 was whether the decrease of the ensemble precipitation spread after truncation was also detectable in model cycle CY28R3.

❖ **Conclusion** - Results obtained with 51-member ensembles for 13 cases indicate that:

- The ensemble precipitation spread reduction after the d7 truncation is still detectable (6.4% over NH, 12.2% over Tropics).
- The spread reduction has a very small impact on precipitation scores.
- Considering Z500 probabilistic scores, VAREPS performs slightly better than T_L255 beyond the d7 truncation.

1. Ensemble precipitation spread (51 members, CY28R3)

Results based on 51-member ensembles for 13 cases indicate that the ensemble spread reduction after the d7 truncation is still detectable in CY28R3, especially over the tropics (right panel).



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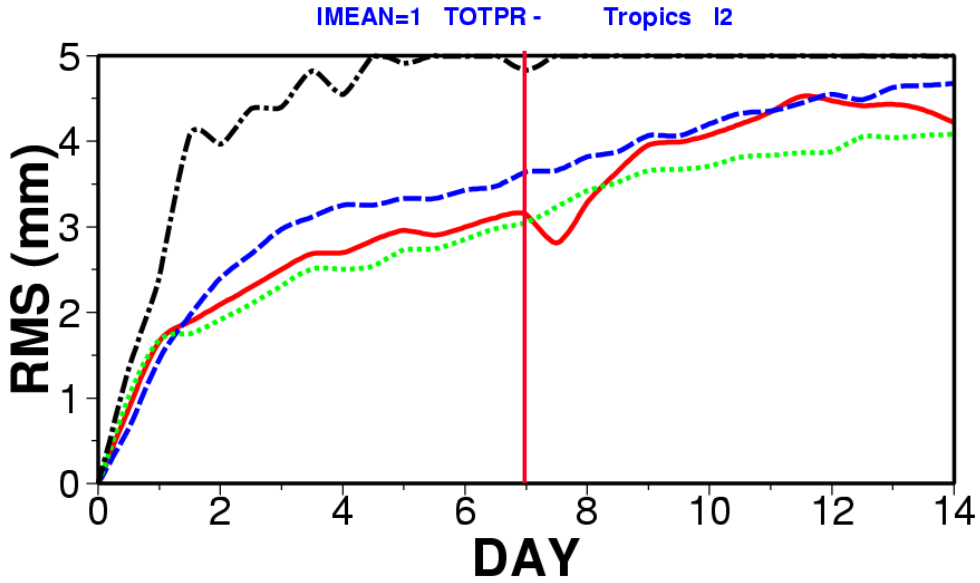
DASH BLUE: M_SP C(d) 19991201 e02G 13
DOT GREEN: M_SP C(d) 19991201 e03G 13
CH-DAS BLACK: error C(d) 19991201 e01G 13



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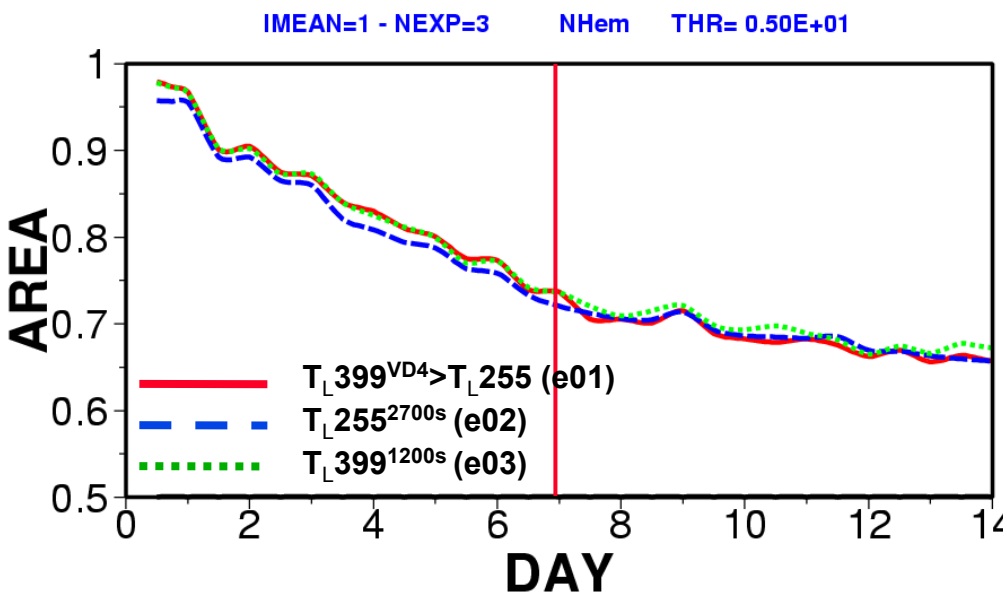
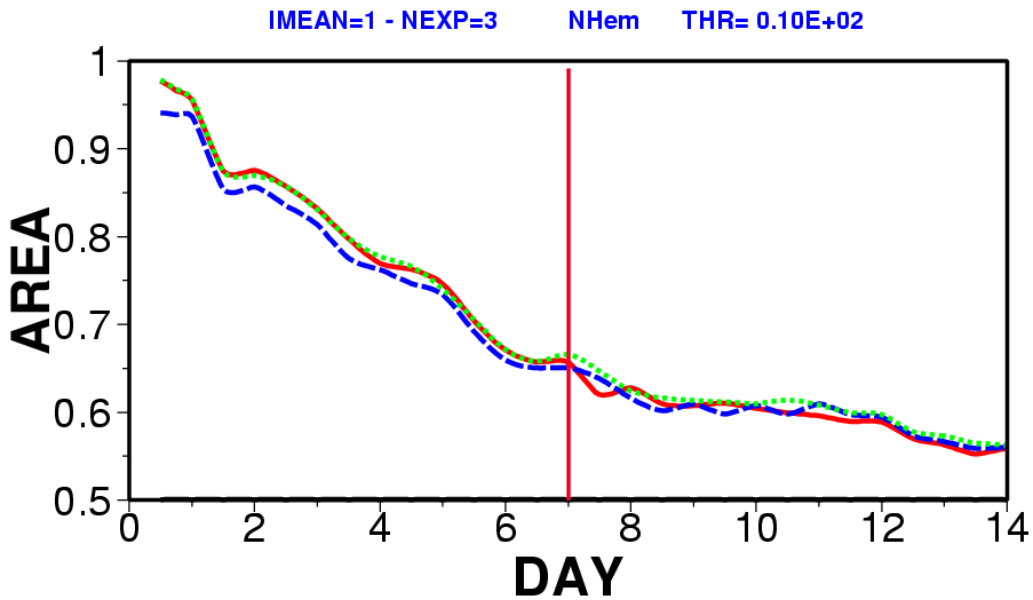
DOT GREEN: M_SP C(d) 19991201 e03G 13
CH-DAS BLACK: error C(d) 19991201 e01G 13

1. Ensemble precipitation skill scores (51m, CY28R3)

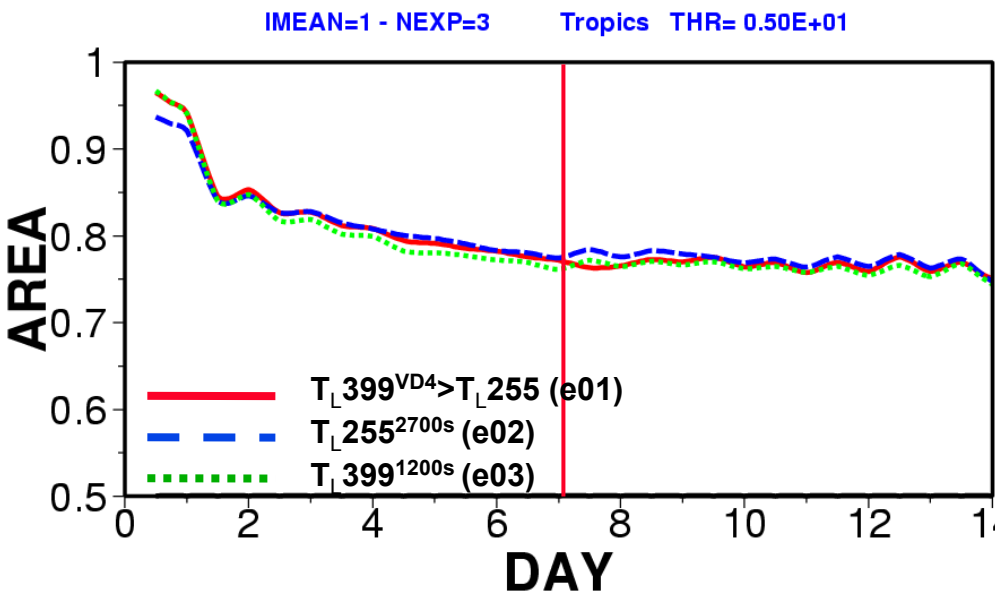
For the NH, results confirm earlier indications that precipitation skill scores are little sensitive to the spread reduction.

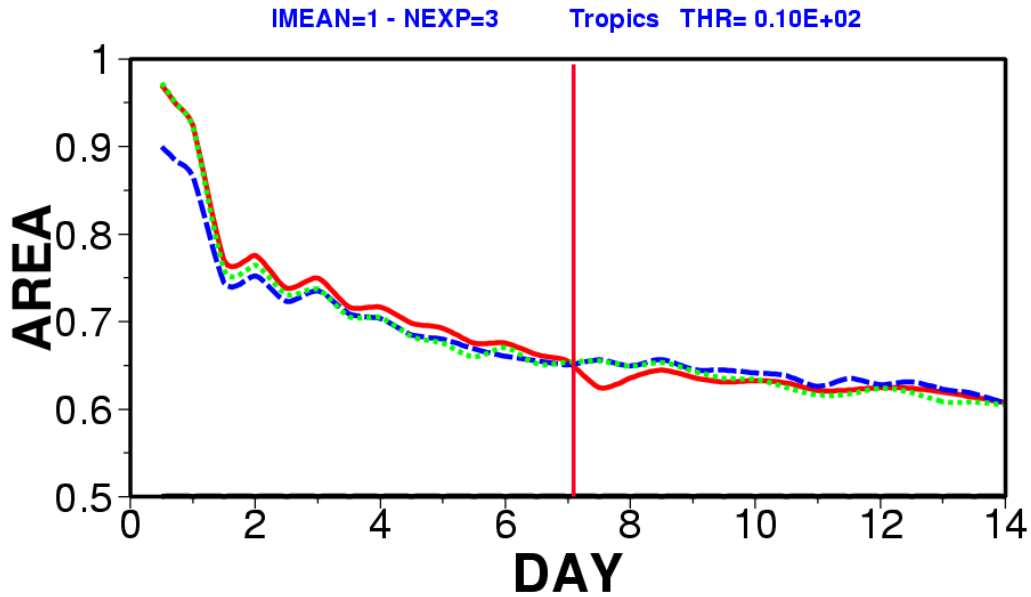




1. Ensemble precipitation skill scores (51m, CY28R3)

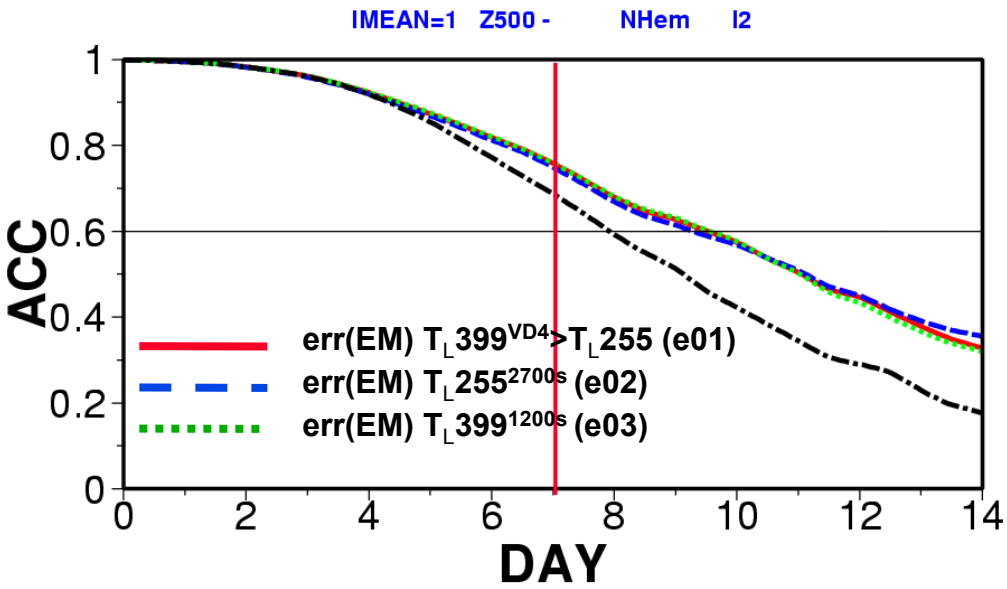
For the tropics, results confirm that the impact of the d7 spread reduction can be detected in the precipitation skill scores for high precipitation amounts (e.g. 10mm/12h, right panel).

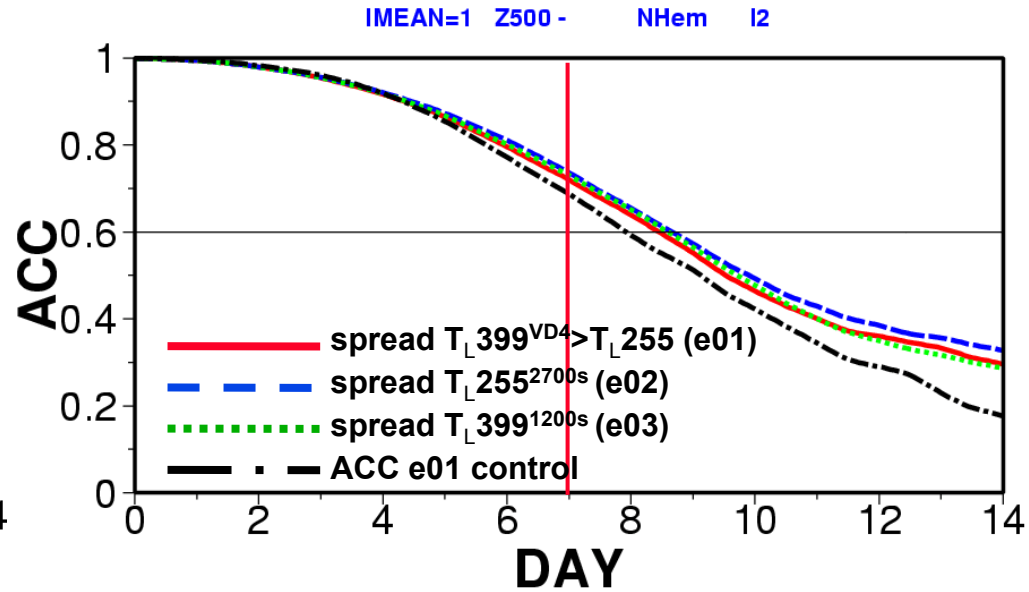




1. Z500 EM skill score and spread (51m, CY28R3)

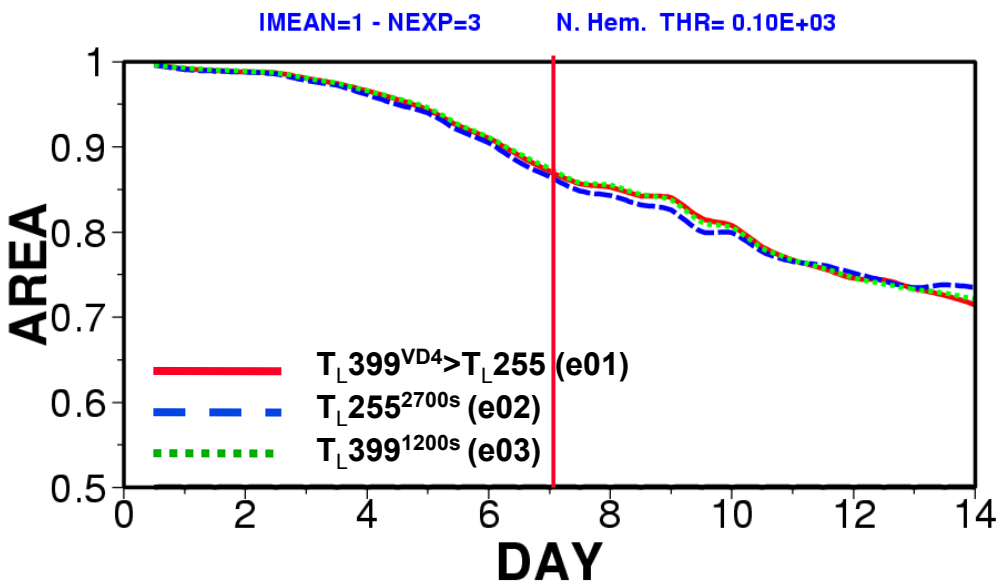
Considering Z500 hPa field over the NH, results confirm that neither the skill of the ensemble-mean forecast (left panel) nor the ensemble spread (right panel) are affected by the d7 truncation.

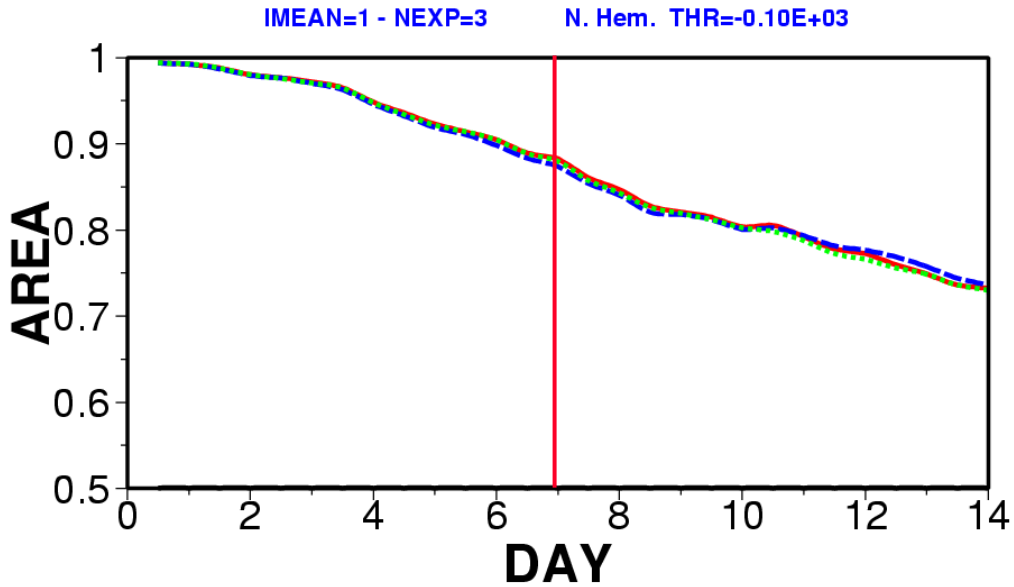




1. Z500 probabilistic scores over NH (51m, CY28R3)

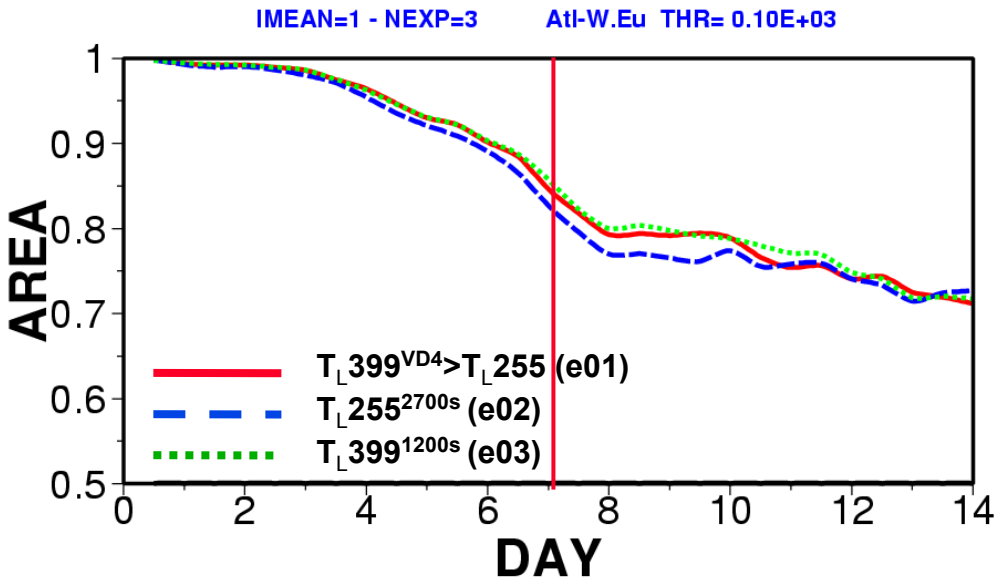
Considering probabilistic forecasts of Z500 hPa anomalies over the NH, results confirm that the VAR7^{VD4} and the T_L399 ensemble configurations are slightly better than the T_L255 configuration beyond the d7 truncation time.

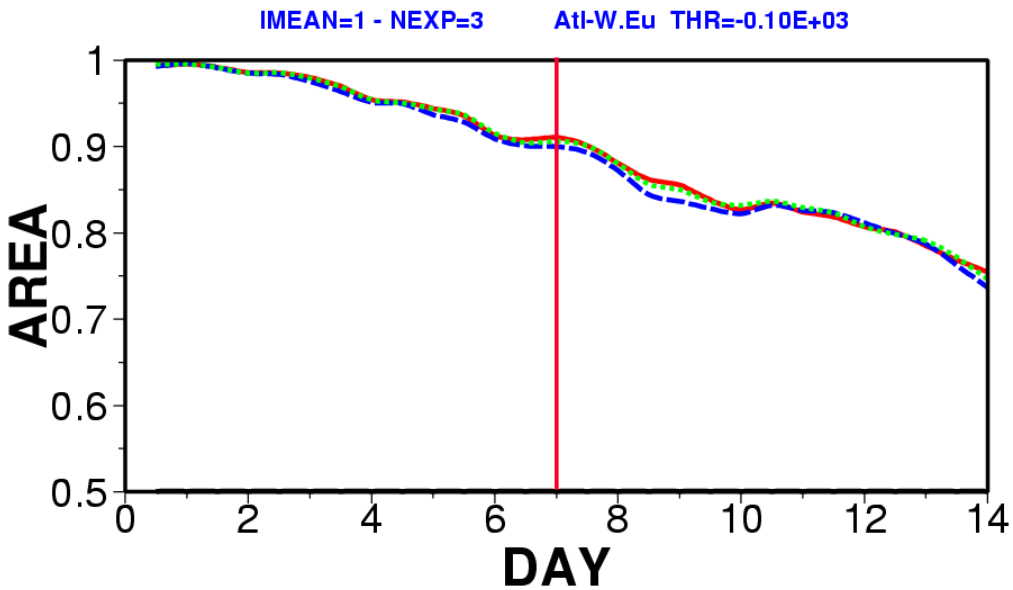




1. Z500 probabilistic scores over Atl-W Eu (51m, CY28R3)

Considering probabilistic forecasts of Z500 hPa anomalies over Atlantic-Western Europe, results confirm that the VAR7^{VD4} and the T_L399 ensemble configurations are better than the T_L255 configuration beyond the truncation time.





Outline

- 1. Ensemble precipitation spread with CY28R3
- 2. Sources of the ensemble precipitation spread reduction
- 3. Sensitivity of ensemble precipitation spread to time step between d7-14
- 4. Sensitivity of ensemble precipitation spread to stochastic physics
- 5. Next step: test VAREPS with D6 truncation

2. Sources of the precipitation spread problem

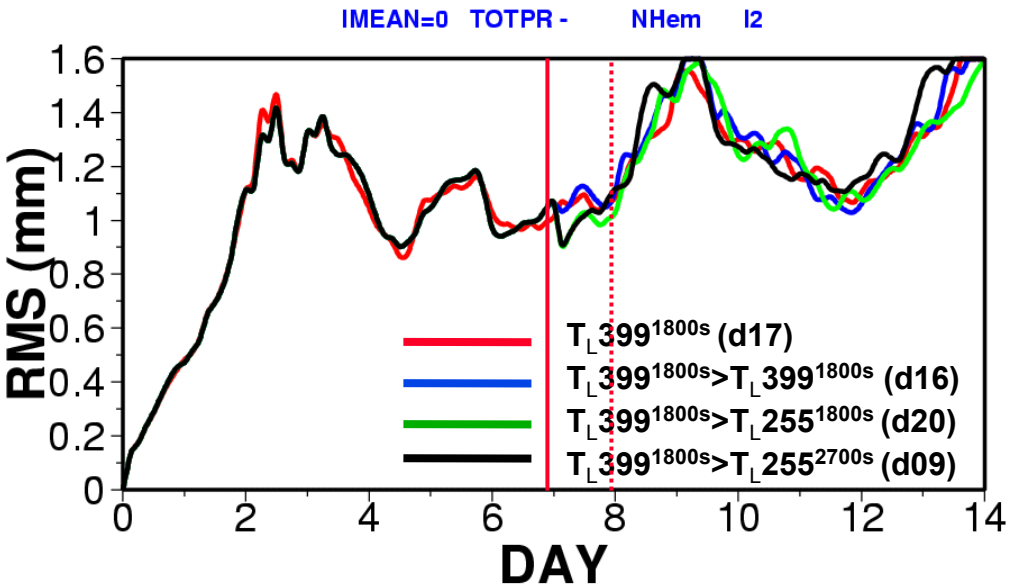
❖ **Issue** – Three issues were raised during M5: (i) whether the spread reduction was linked to a decrease in precipitation, (ii) whether the spread reduction was happening mainly during the first few time steps after the d7 truncation and (iii) whether it was mainly due to truncation.

❖ **Conclusion** - Results obtained for one case only indicate that:

- (i) The precipitation spread reduction is linked to a decrease in precipitation after the truncation.
- (ii) The spread reduction can be detected over the NH during the first 12 hours, and over the Tropics during the first 24 hours.
- (iii) The spread reduction is mainly linked to the change in forecast resolution, with a small contribution from the fact that the forecast restarts after truncation.

2. Sensitivity of precipitation spread to tstep and truncation

Experiments performed for one case (5m) with 3h accumulated precipitation indicate that the precipitation spread reduction affects the first 12 (24) hours of the T_L255 forecast over NH (TR). The spread reduction is mostly linked to the change in forecast resolution, and not to the time step or the fact that the forecast is restarted at day 7.



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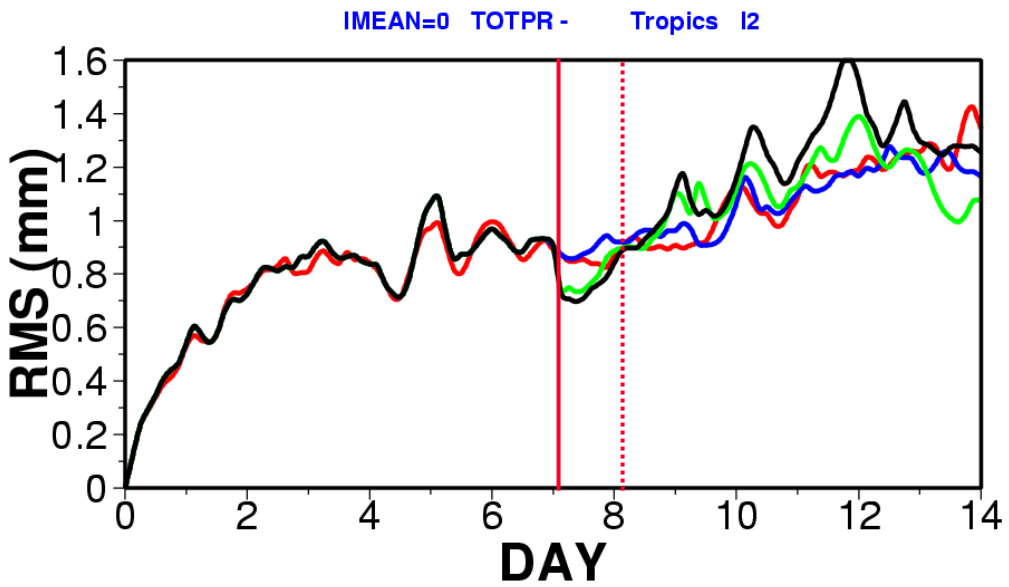
CH-DAS BLACK: M_SP C(d) 20021024 d09G 99



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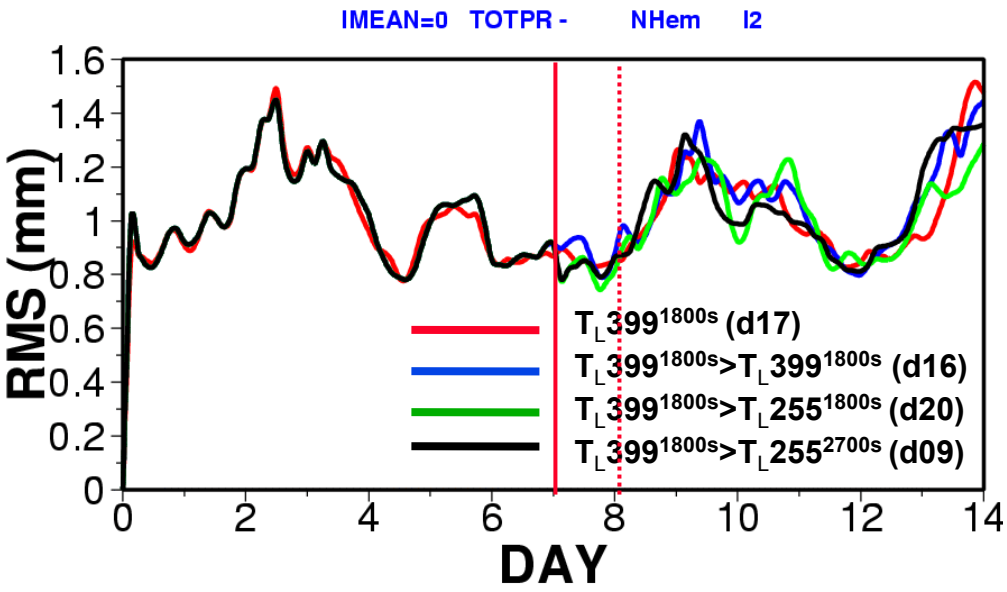
2. Sensitivity of precipitation spread to tstep and truncation

Experiments performed for one case (5m) with 3h accumulated precipitation have indicated that the precipitation spread reduction is linked to a reduction of precipitation in the TL255 forecast (NB: plots show precipitation amounts and not errors).



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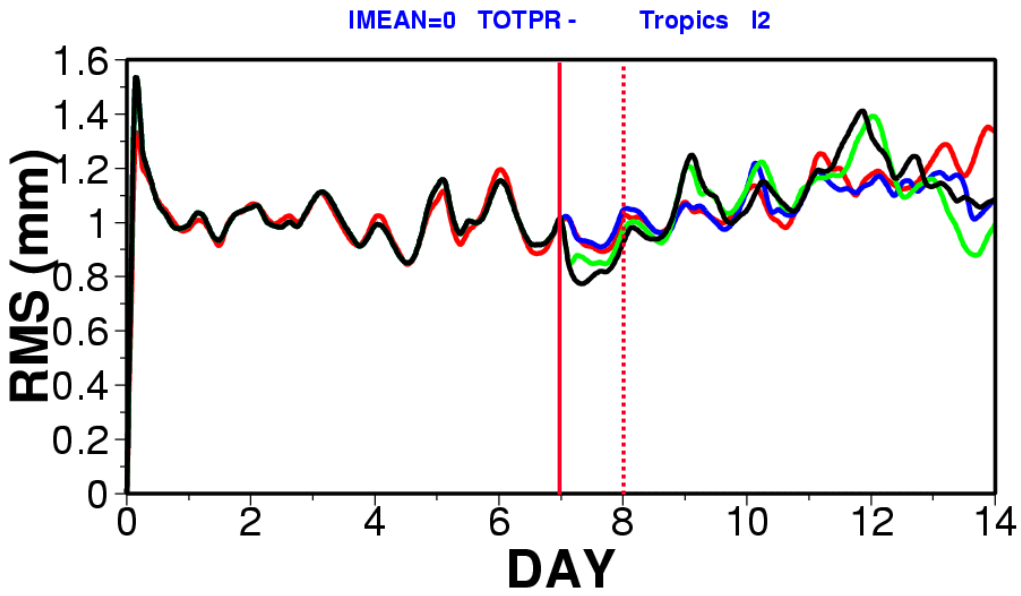

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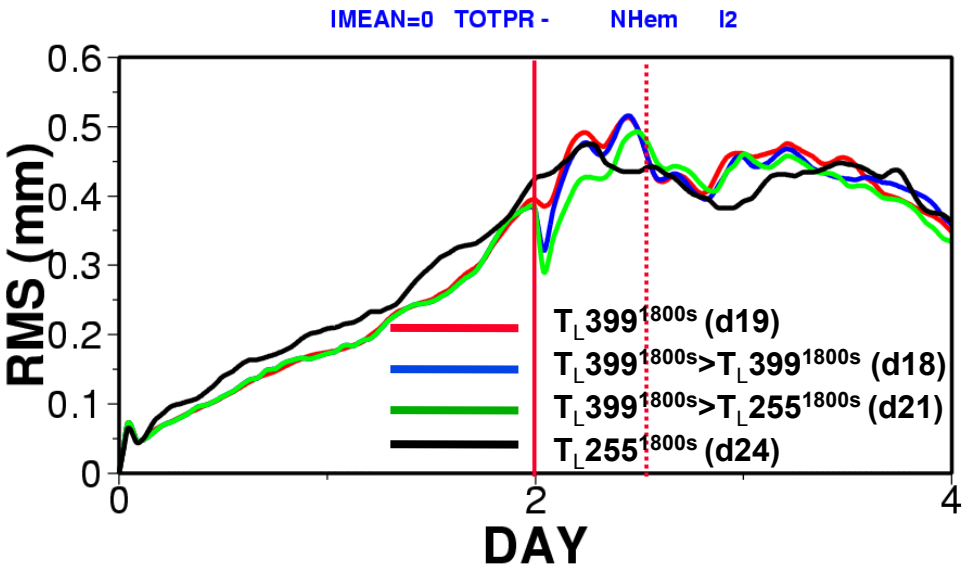
2. Sensitivity of precipitation spread to tstep and truncation

Experiments performed for one case (5m) for 4 days with 1h accumulated precipitation have confirmed that the spread reduction affects the first 12 (24) hours of T_L255 forecast over NH (TR). The spread reduction is mainly linked to the change in forecast resolution, with a small contribution from the fact that the forecast is restarted at day 2.



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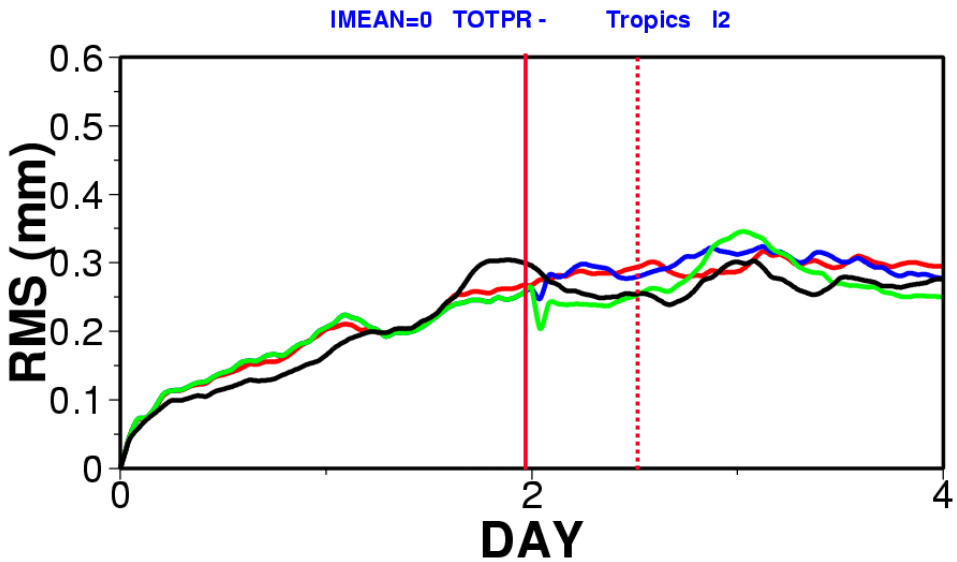

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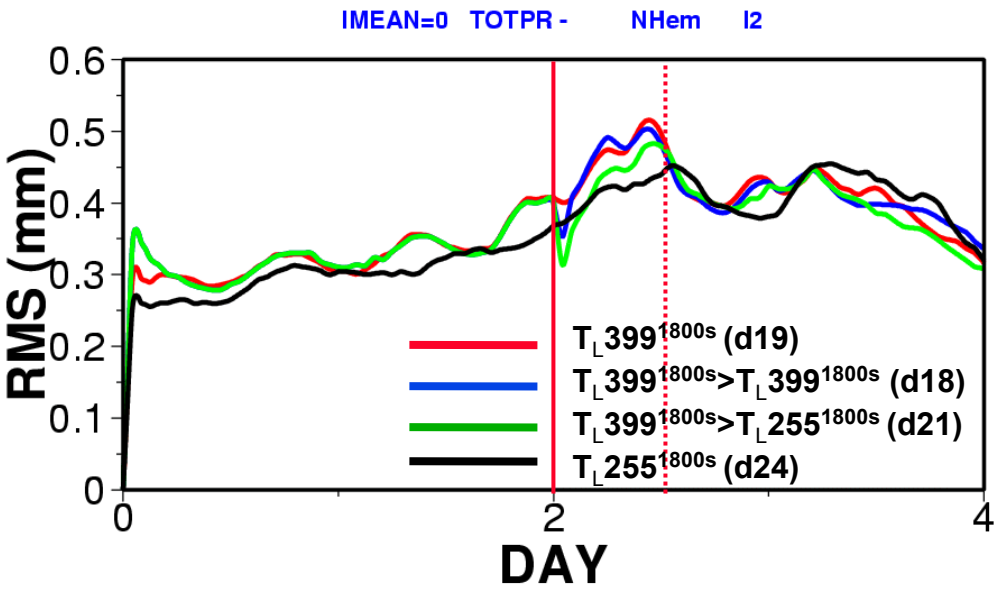
2. Sensitivity of precipitation spread to tstep and truncation

Experiments performed for one case (5m) for 4 days with 1h accumulated precipitation have indicated that the spread reduction is linked to a reduction of precipitation in the T_L255 forecast (NB: plots show precipitation amounts and not errors).



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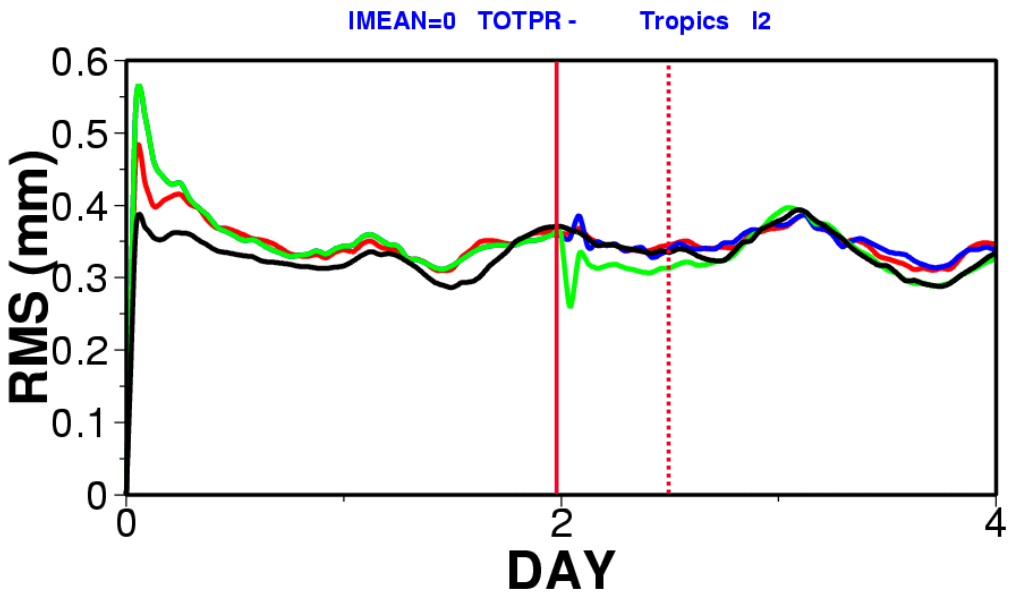

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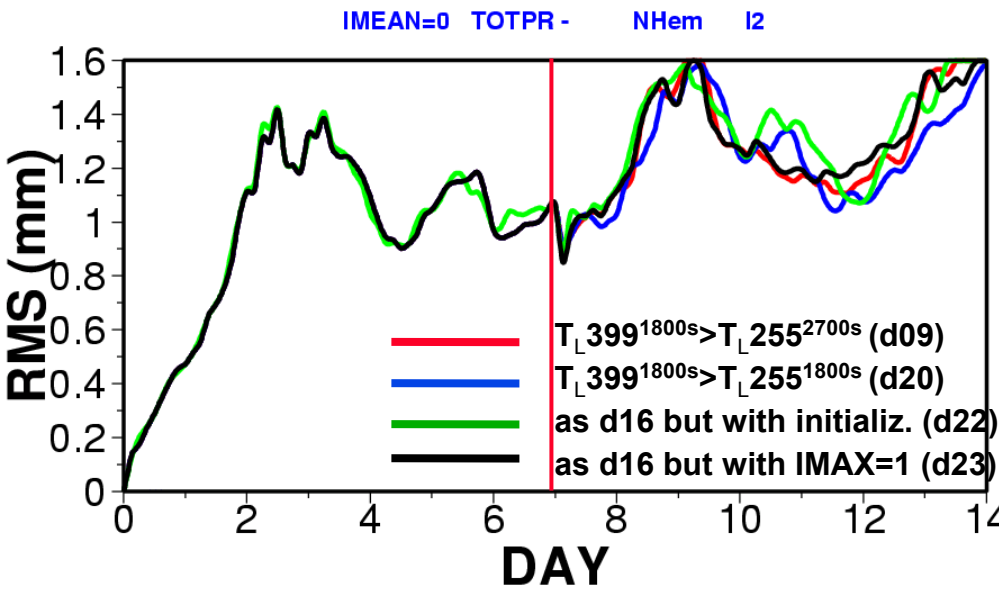
2. Sensitivity of precipitation spread to tstep and truncation

Experiments performed for one case (5m) with 3h accumulated precipitation have also indicated that the precipitation spread reduction is insensitive to initialization [d23 (NEINI=1) vs d09 (NEINI=0)] or to setting the number of iterations fro convection in the first time step to 1 (d22) instead of 3 (d09).



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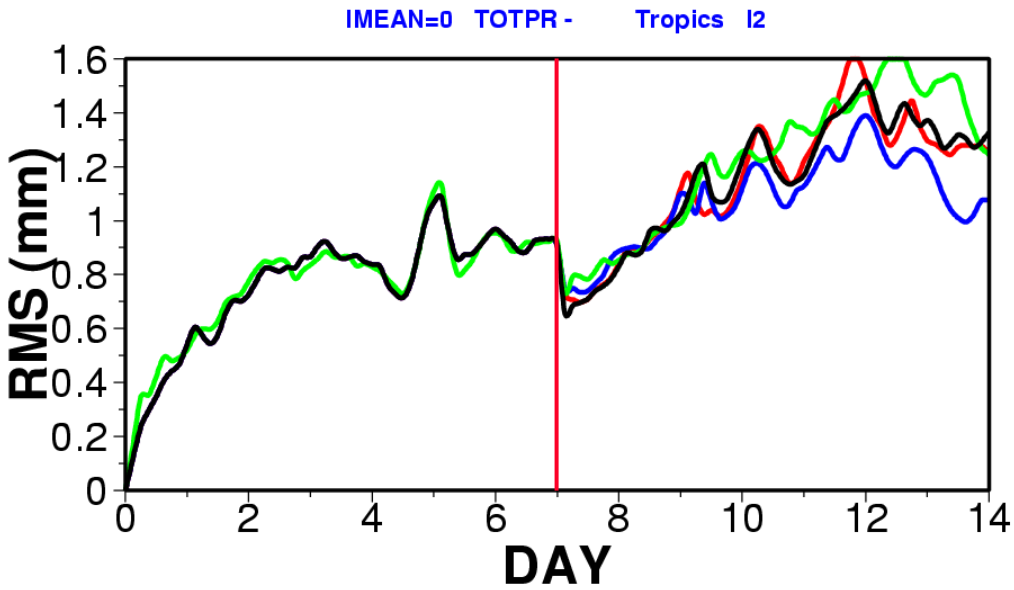

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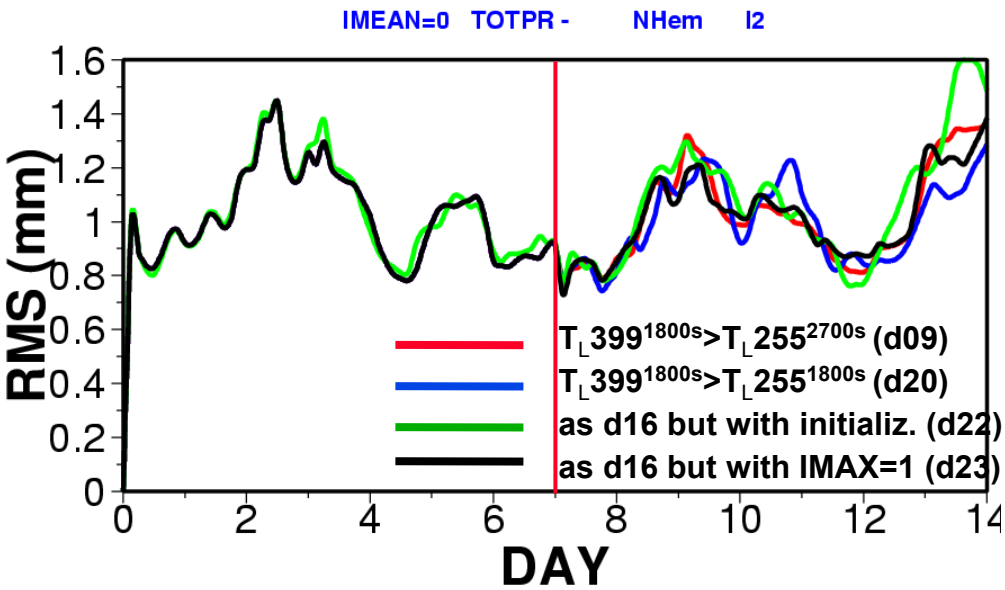

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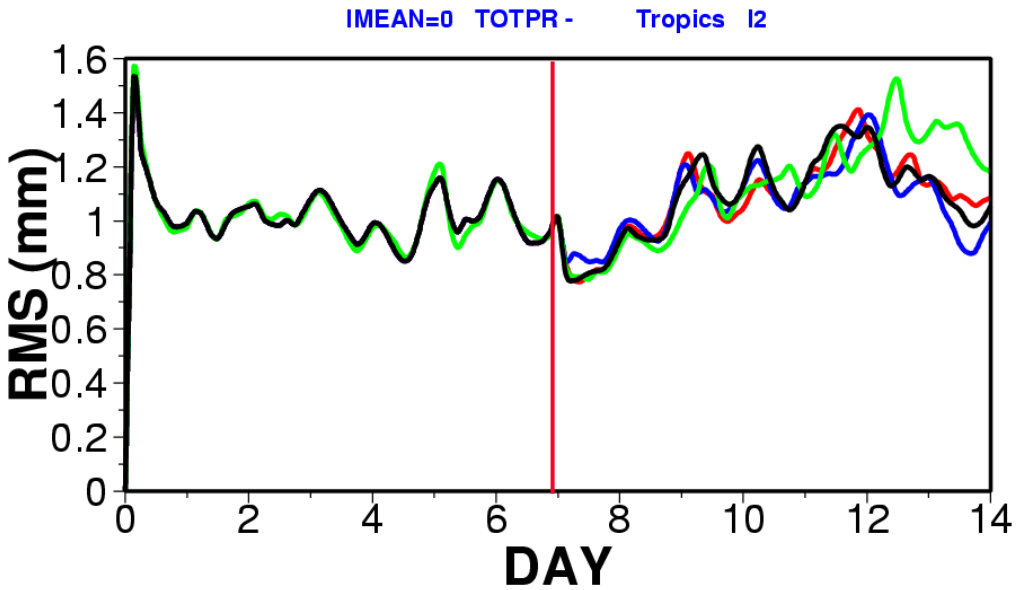

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DASH BLUE: error C(d) 20021024 d20G 99
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CH-DAS BLACK: error C(d) 20021024 d23G 99

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3. Sensitivity of precipitation spread to time step at fc d7-14

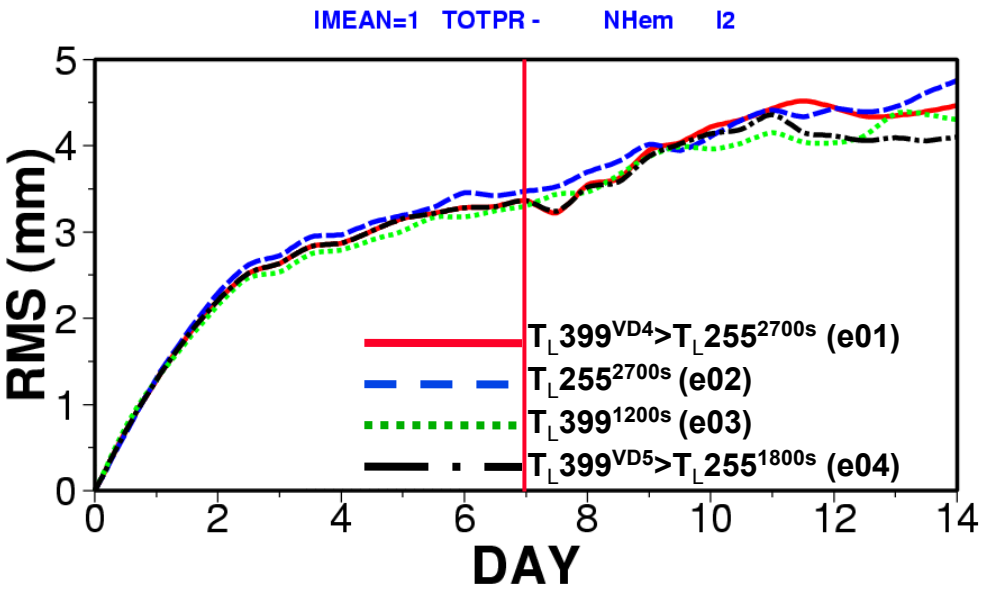
❖ **Issue** - The two issues raised at M5 were (i) whether the time step in the T_L255 d7-14 integration leg of VAREPS had any impact on precipitation spread and skill, and (ii) whether the same time step (1800s) should be used from day 0 to 14.

❖ **Conclusion** - Results obtained with 51-member ensembles run for 13 cases indicate that:

- (i) The long-term value of the precipitation spread depends on the time-step, especially over the tropics.
- (ii) The same time step should be used from day 0 to 14 for the VAREPS system to have the same precipitation spread of a T_L399(d0-14) forecast.

3. TP spread sensitivity to time step (51m, CY28R3)

Results based on 51-member ensembles for 13 cases indicates that the ensemble precipitation spread between d7-14 is still sensitive to the time step in CY28R3, especially over the tropics (right panel).



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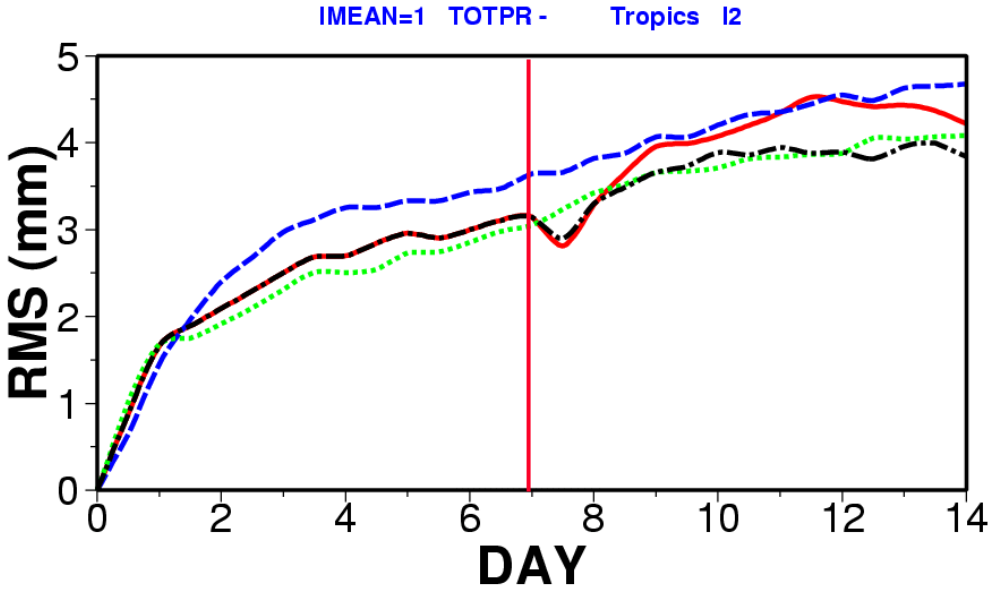
CH-DAS BLACK: M_SP C(d) 19991201 e04G 13



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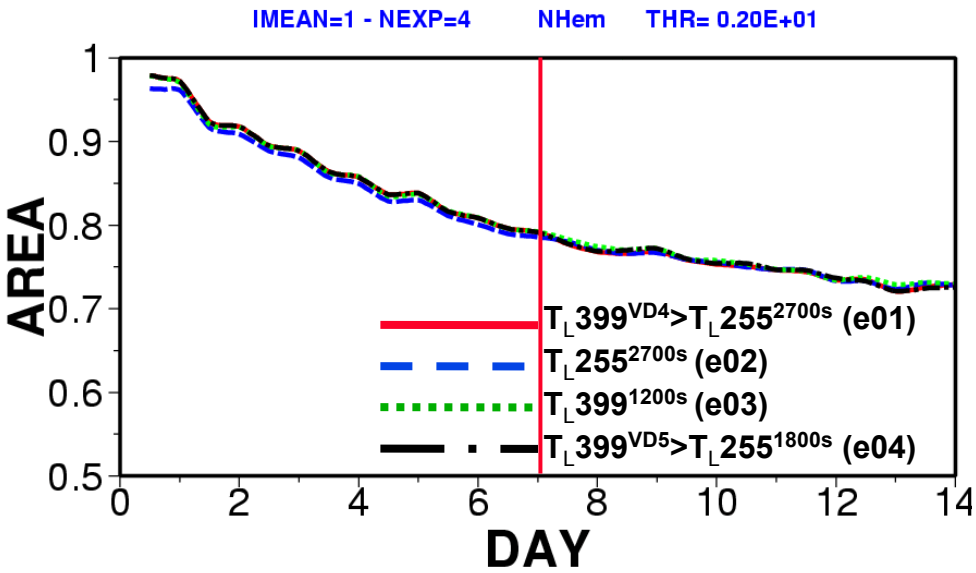
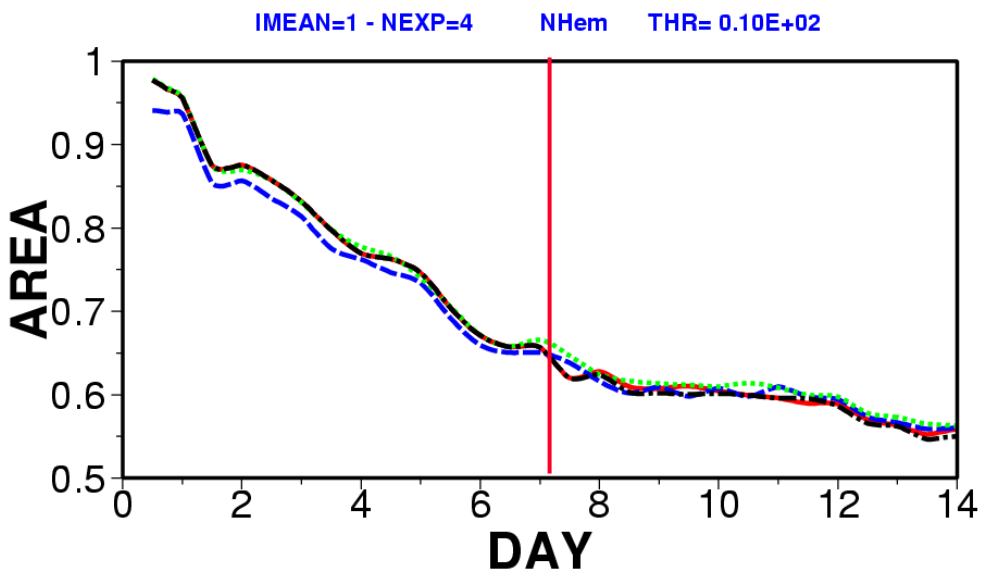
DASH BLUE: M_SP C(d) 19991201 e02G 13
DOT GREEN: M_SP C(d) 19991201 e03G 13
CH-DAS BLACK: M_SP C(d) 19991201 e04G 13

3. NH: TP skill sensitivity to time step (51m, CY28R3)

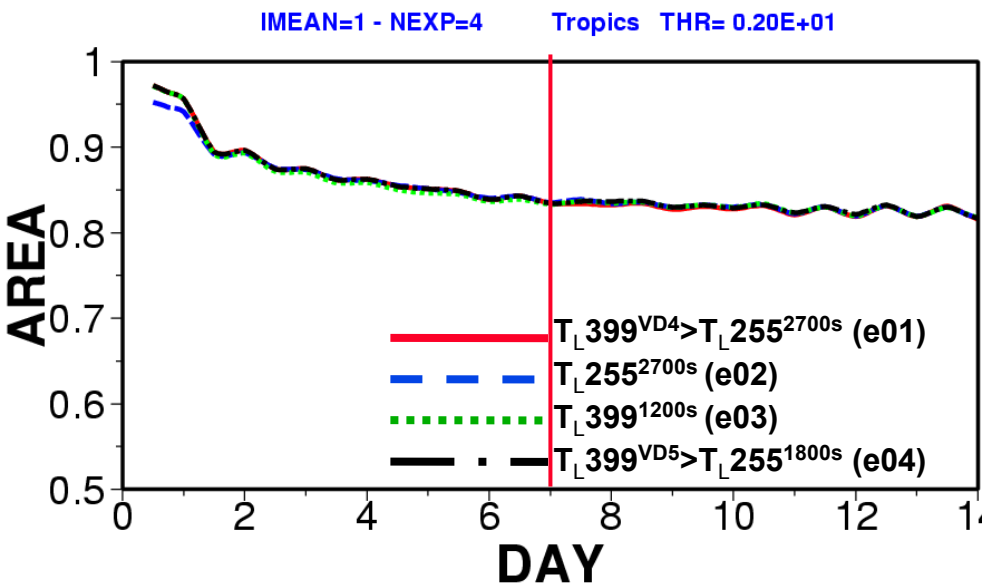
For the NH, results based on 51-member ensembles for 13 cases indicates that the skill of probabilistic precipitation scores is not sensitive to the time step.

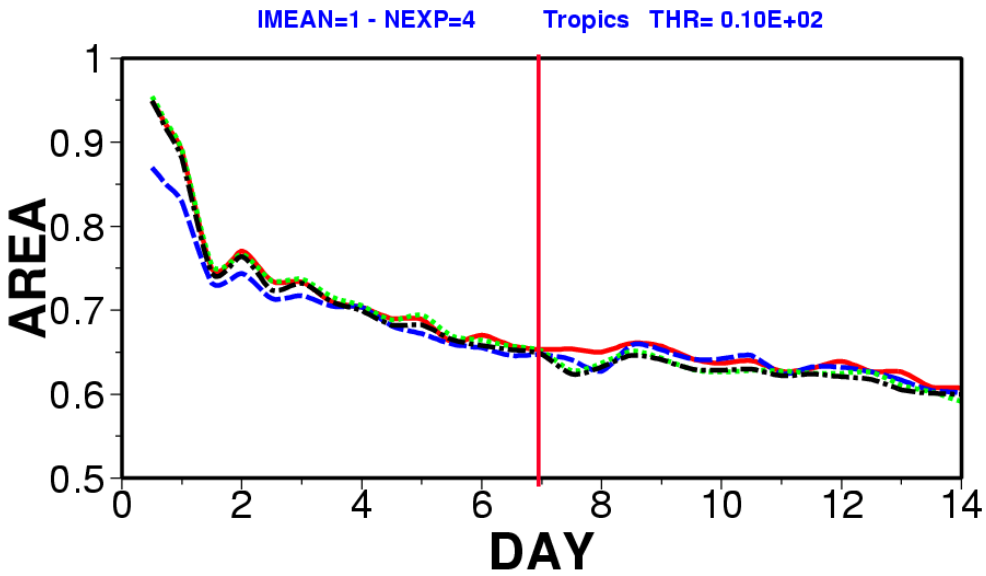




3. Tropics: TP skill sensitivity to time step (51m, CY28R3)

Also for the Tropics, results based on 51-member ensembles for 13 cases indicates that the skill of probabilistic precipitation scores is not sensitive to the time step.





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- 5. Next step: test VAREPS with D6 truncation

4. Sensitivity of precipitation spread to stochastic physics

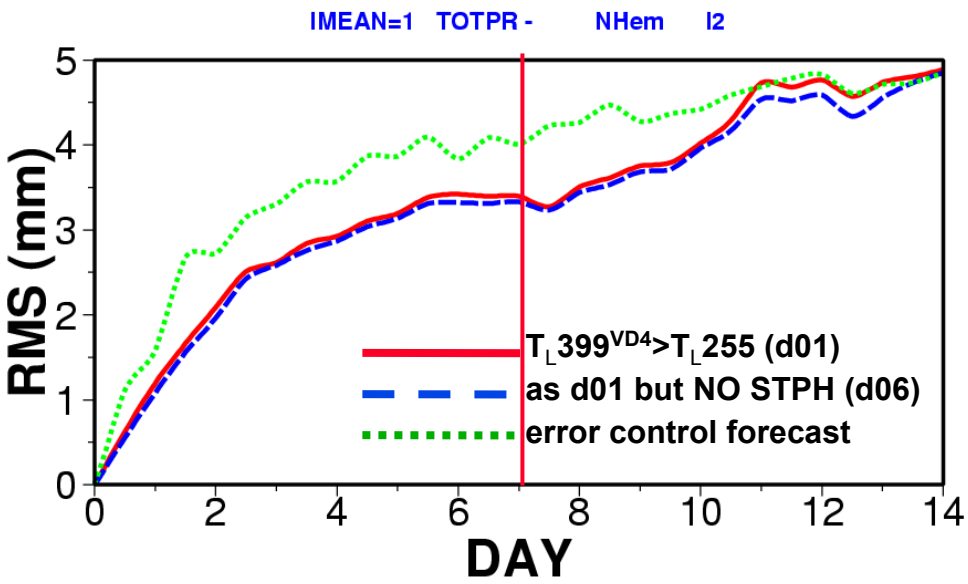
❖ **Issue** - The two key issues that were raised at M5 were (i) whether stochastic physics played any role in the precipitation spread reduction after truncation, and (ii) whether this decrease could be reduced by re-tuning stochastic physics (weakening it, and making it resolution dependent).

❖ **Conclusion** - Results indicated that:

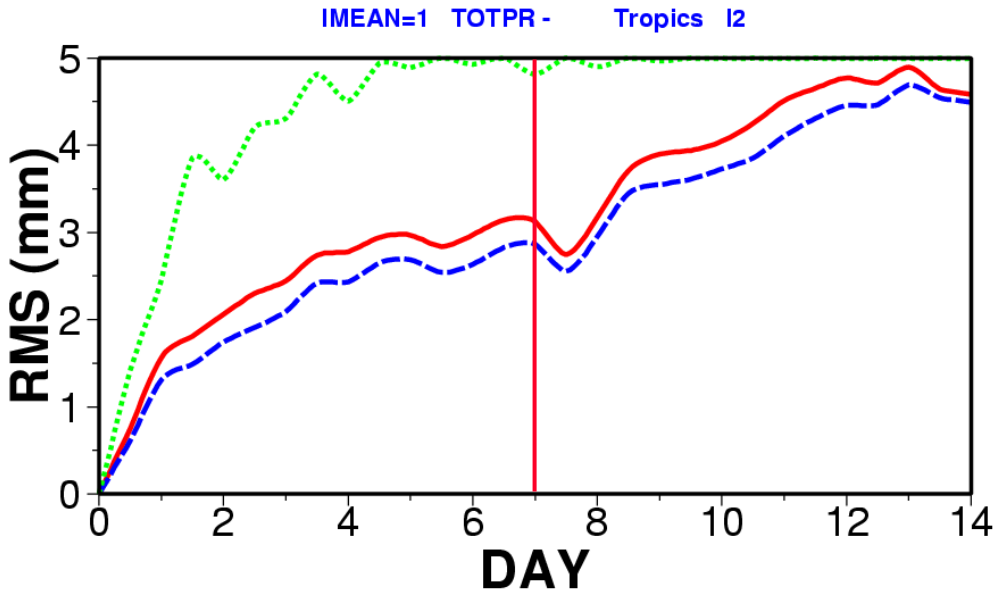
- (i) Stochastic physics plays a small role in the precipitation spread reduction, but switching off stochastic physics would deteriorate the accuracy of probabilistic precipitation prediction
- (ii) Reducing the strength of stochastic physics does not solve the precipitation spread problem after truncation time

4.1 TP spread sensitivity to stoch phys (5m, CY28R3)

Results based on 5-member ensembles for 9 cases indicate that by switching off stochastic physics, the precipitation spread sensitivity to truncation is still present but reduced, especially over the tropics (right panel).



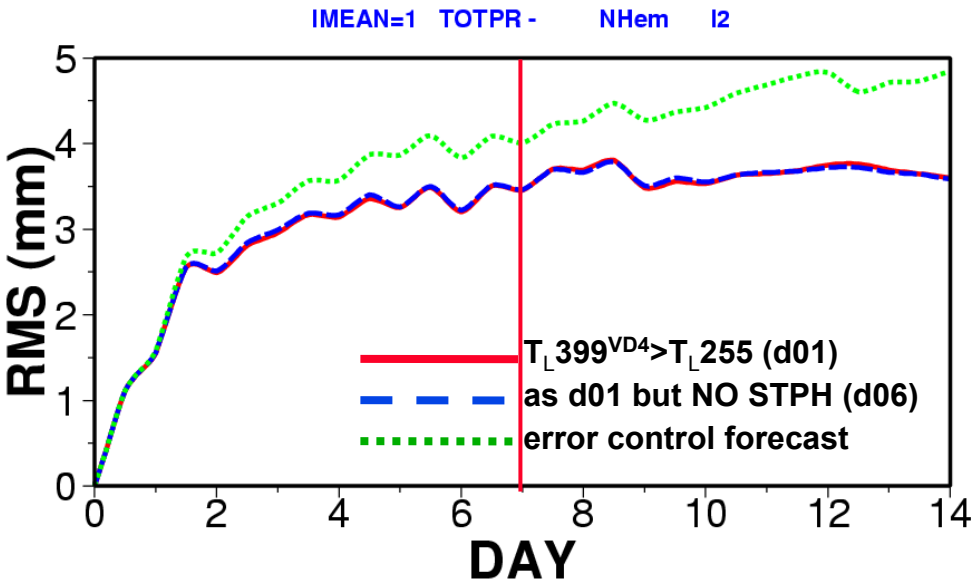
SOLID RED: M_SP C(d) 20021024 d01G 9
DASH BLUE: M_SP C(d) 20021024 d06G 9
DOT GREEN: error C(d) 20021024 d01G 9



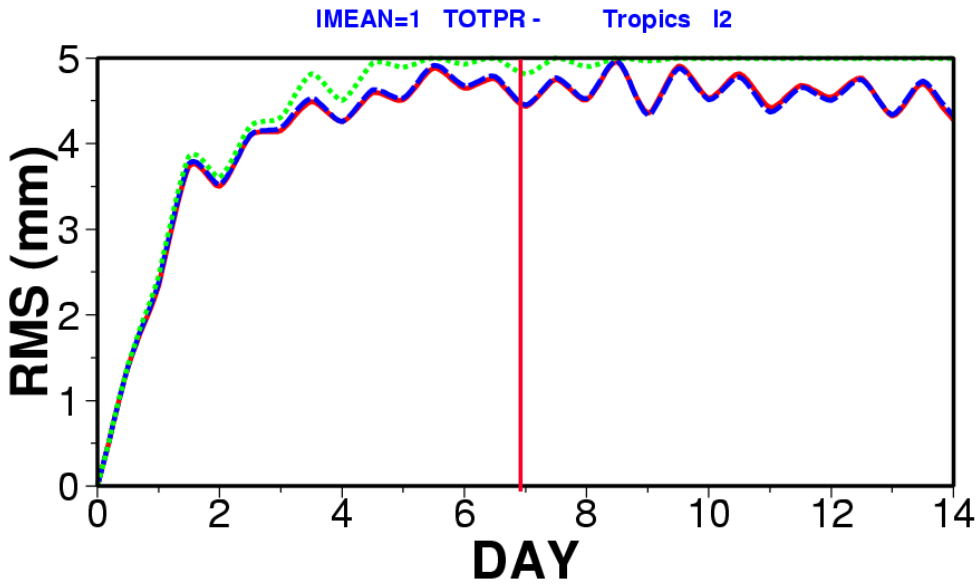
SOLID RED: M_SP C(d) 20021024 d01G 9
DASH BLUE: M_SP C(d) 20021024 d06G 9
DOT GREEN: error C(d) 20021024 d01G 9

4.1 TP spread sensitivity to stoch phys (5m, CY28R3)

Switching off stochastic physics has practically no impact on the error of the ensemble-mean forecast, even over the tropics (right panel).



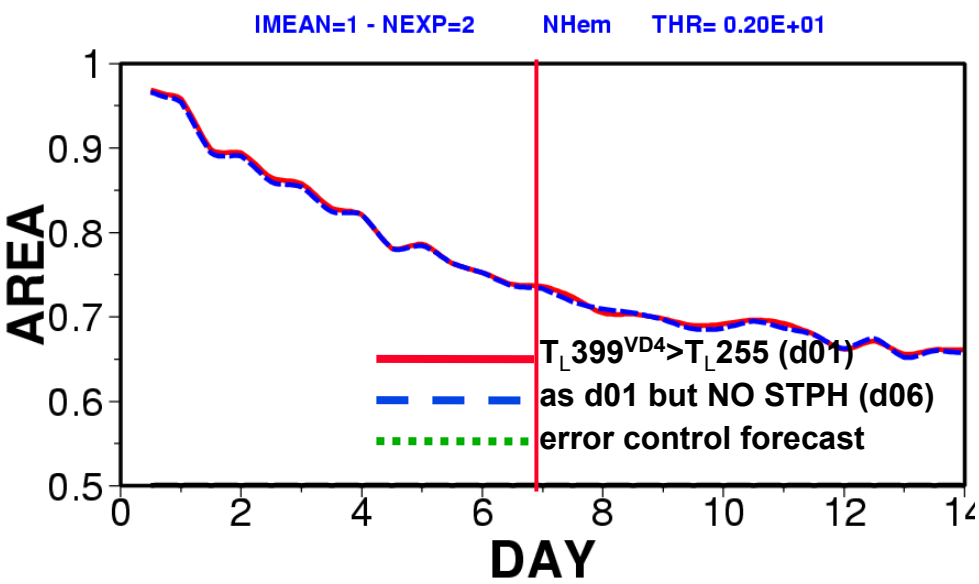
SOLID RED: error E_M 20021024 d01G 9
DASH BLUE: error E_M 20021024 d06G 9
DOT GREEN: error C(d) 20021024 d01G 9

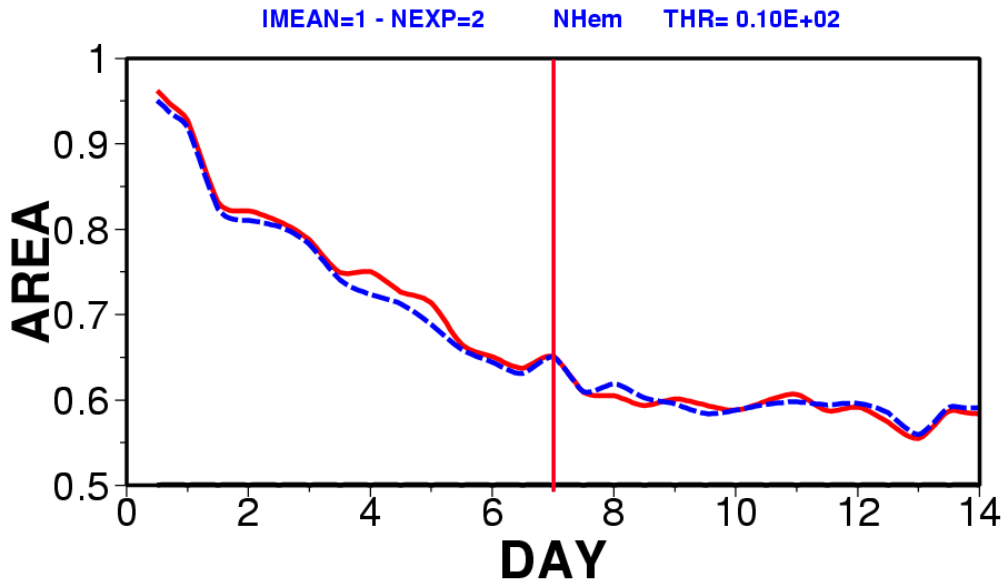


SOLID RED: error E_M 20021024 d01G 9
DASH BLUE: error E_M 20021024 d06G 9
DOT GREEN: error C(d) 20021024 d01G 9

4.1 TP spread sensitivity to stoch phys (5m, CY28R3)

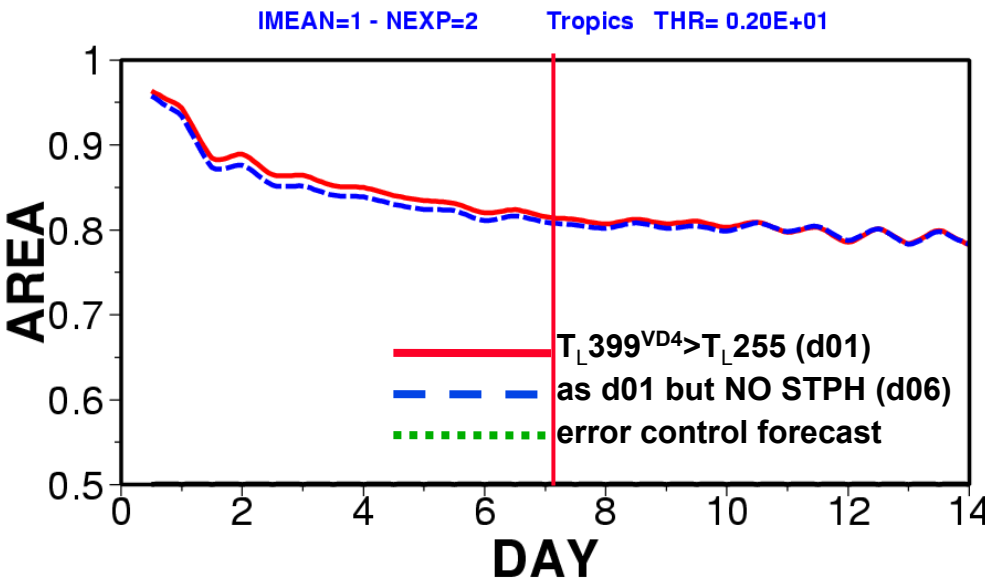
But switching off stochastic physics has a small impact on the accuracy of probabilistic forecasts over the NH measured using ROC-area, especially for high precipitation thresholds.

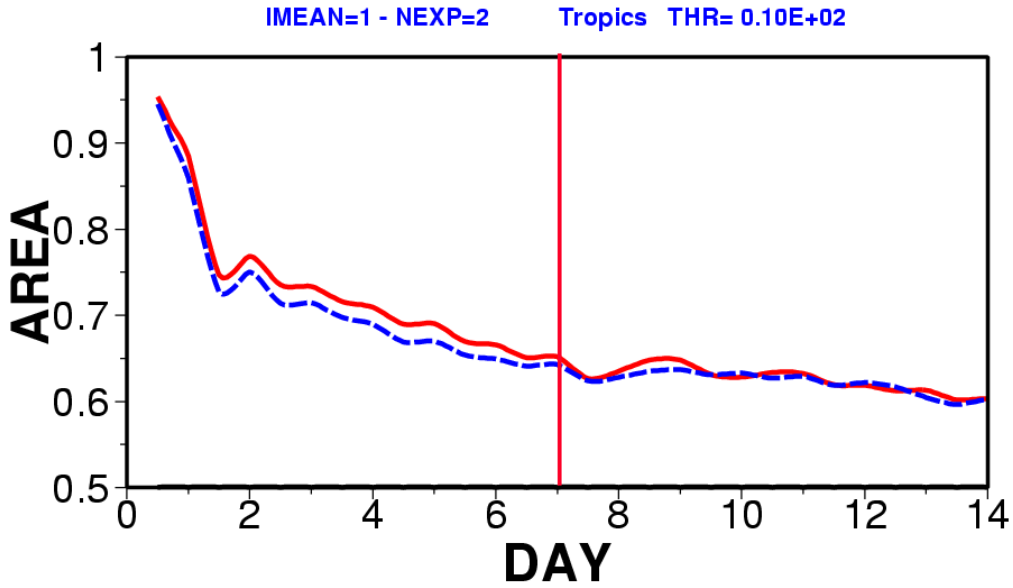




4.1 TP spread sensitivity to stoch phys (5m, CY28R3)

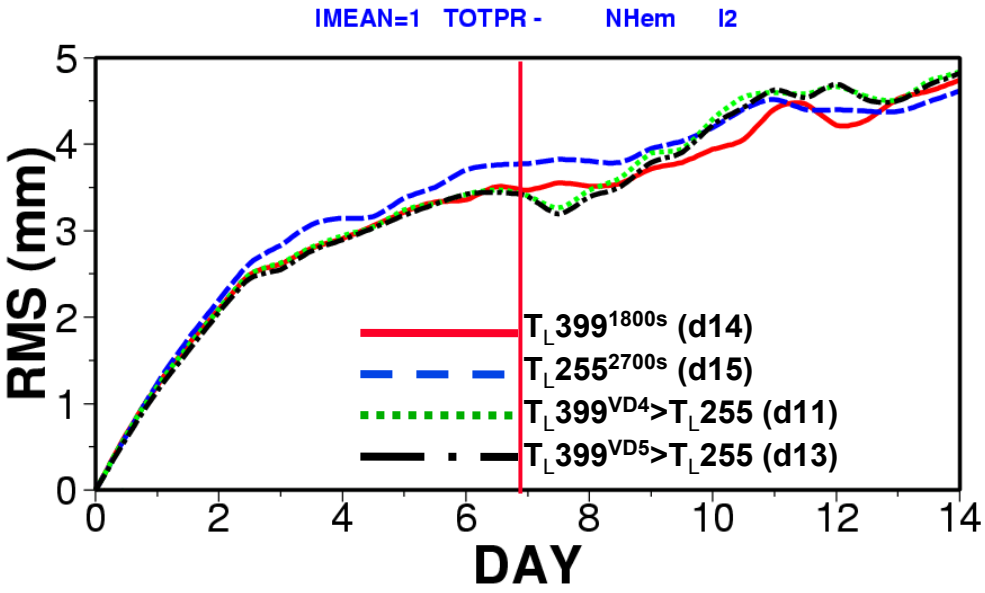
Furthermore, switching off stochastic physics has a more detectable impact over the tropics.



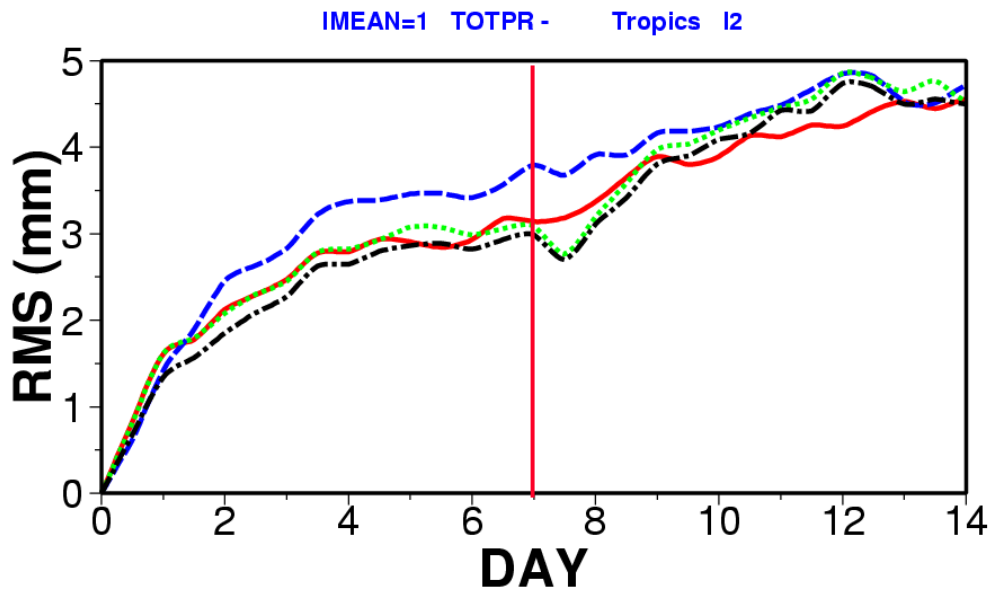


4.2 TP spread sensitivity to stoch phys (5m, CY28R3)

Results based on 5-member ensembles for 9 cases indicate that a decrease in the maximum amplitude of the stochastic physics perturbations (35% instead of 50%, black versus green curves) has a very small impact on the precipitation spread reduction at truncation time.



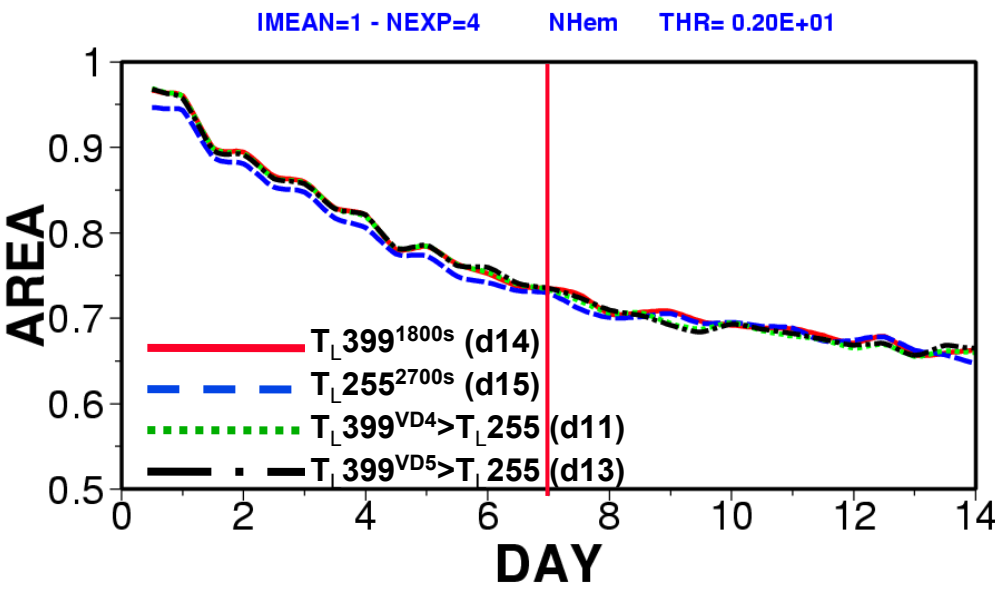
SOLID RED: M_SP C(d) 20021024 d14G 9
DASH BLUE: M_SP C(d) 20021024 d15G 9
DOT GREEN: M_SP C(d) 20021024 d11G 9
CH-DAS BLACK: M_SP C(d) 20021024 d13G 9

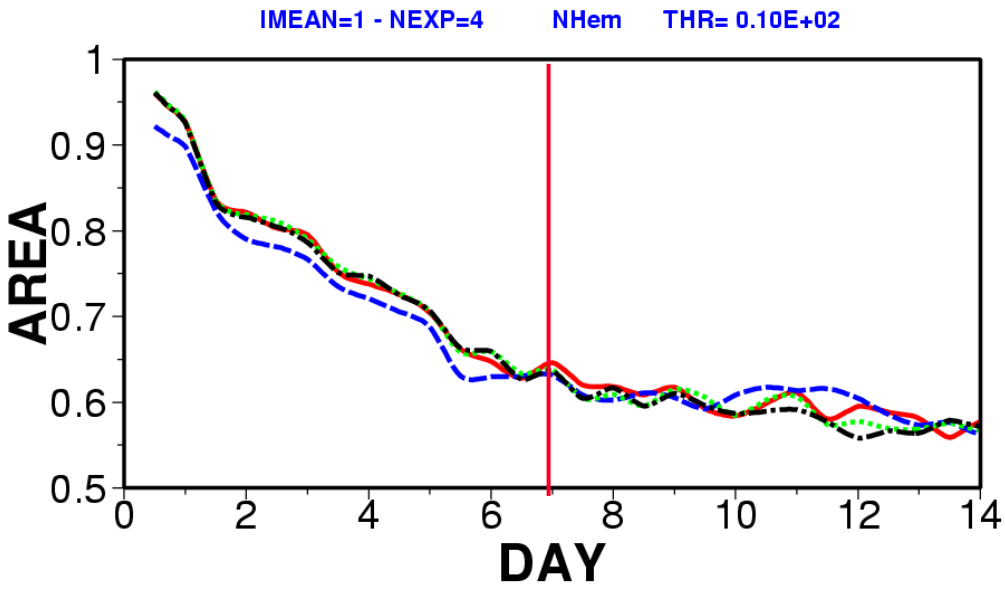


SOLID RED: M_SP C(d) 20021024 d14G 9
DASH BLUE: M_SP C(d) 20021024 d15G 9
DOT GREEN: M_SP C(d) 20021024 d11G 9
CH-DAS BLACK: M_SP C(d) 20021024 d13G 9

4.2 TP skill sensitivity to stoch phys (5m, CY28R3)

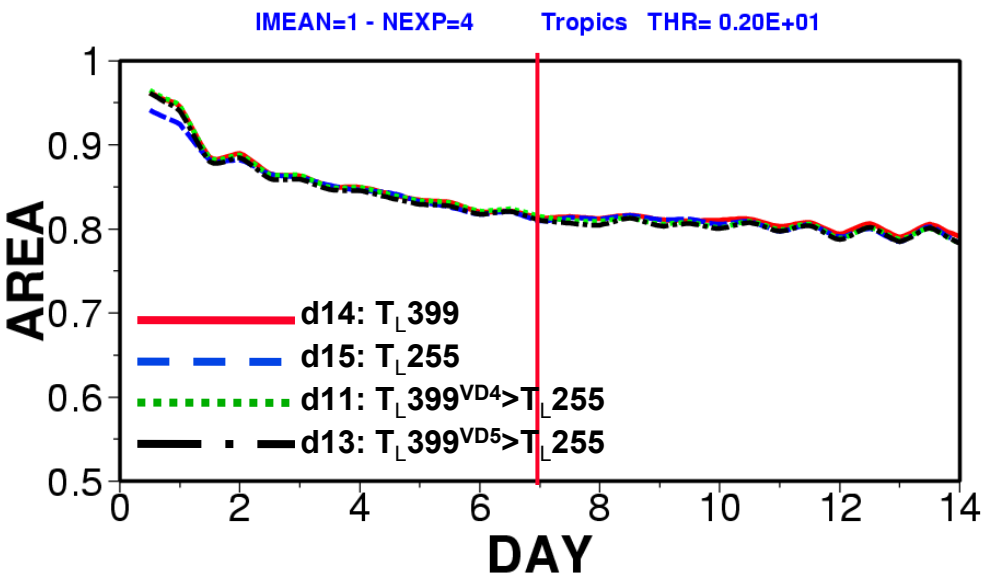
Results indicate that the accuracy of probabilistic scores for the NH is not affected by a decrease of the maximum amplitude of the stochastic physics perturbations (35% instead of 50%, black versus green curves).

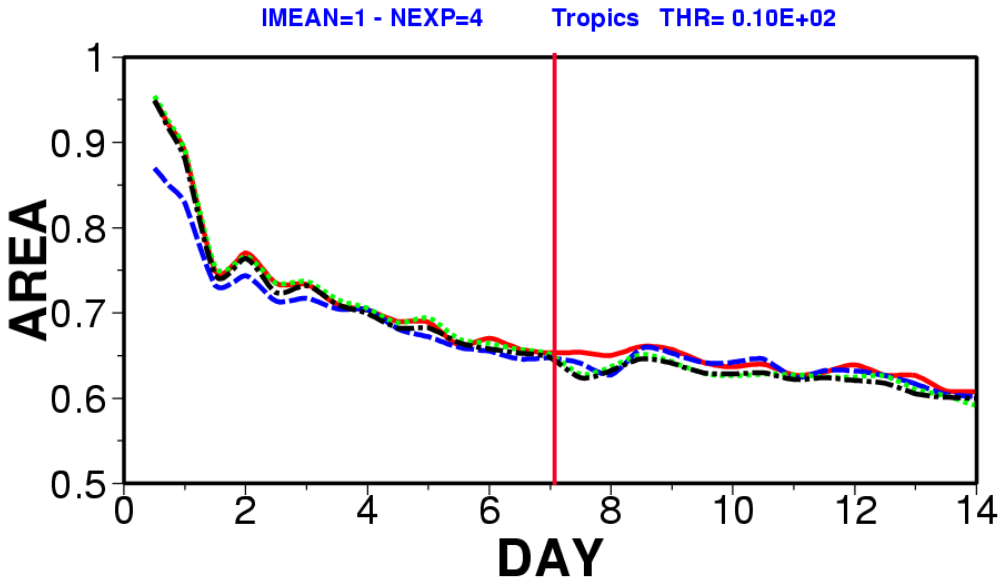




4.2 TP skill sensitivity to stoch phys (5m, CY28R3)

Results indicate that the accuracy of probabilistic scores also for the tropics is not affected by a decrease of the maximum amplitude of the stochastic physics perturbations (35% instead of 50%).





Outline

- 1. Ensemble precipitation spread with CY28R3
- 2. Sources of the ensemble precipitation spread decrease
- 3. Sensitivity of ensemble precipitation spread to time step between d7-14
- 4. Sensitivity of ensemble precipitation spread to stochastic physics
- 5. Next step: test VAREPS with D6 truncation

5. Next test: VAREPS with T_L255 starting at D6 (not D7)

The latest CY28R3 results have indicated that:

- A 2700s time step could be used in the TL255 model, but this will induce a raise in ensemble precipitation spread after truncation time
- The strength of the stochastic physics perturbations should not be reduced since it has a very limited impact on the precipitation spread reduction

The next test will be to assess whether starting the T_L255 integration at day 6 instead of day 7 (but still using the TL255 forecasts only from day 7) would cure the precipitation spread reduction (i.e. would give enough time for the T_L255 precipitation spread to adjust).