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# Fuzzy verification on Common Area 2

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### WHAT IS COMMON AREA 2









DESCRIPTION OF THE VERIFICATION

- Models verified at 0.025°: COSMO 2I, COSMO IT, COSMO PL -> D0 and D1 COSMO 2D, COSMO 1 -> D0
- Models verified at 0.045°: COSMO I5 (or COSMO 5M), COSMO GR
- Period: SON 2019, DJF 2020, MAM 2020 (not for COSMO IT)
- Scores: FSS, FAR, POD
- Methods: 1 timestep, 3 timesteps
- Cumulation: 3h



Agenzia Regionale per la Protezione Ambientale



- O: Period
- O: Score
- O: Day and timesteps
- O: Thresholds
- O: Models
- O: Spatial scales







# SON 2019







- 0.2 mm: COSMO 1 has the highest FSS at all scales, COSMO PL the lower, while the others are similar.
- 5.0 mm: COSMO PL and COSMO 1 have the highest FSS, COSMO IT and COSMO 2I the lower, CODMO D2 is in the middle.



PIEMONTE



#### SON2019 - POD at 0.2 and 5.0 mm - d0 - 1t



### Problems of COSMO PL mostly due to low POD





#### SON2019 - FSS at 0.2 and 5.0 mm - d0 - 3t Cumulation: 3h. Area: Common Area 2. -0 △ 0.2 mm 0 5.0 mm COSMO 2 COSMO IT 0.8 COSMO PL COSMO D2 COSMO 1 0.6 FSS 4. 0.2 0.0 2.8 92.4 182 8.4 25.2 47.6

Spatial scale [Km]

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## • 0.2 mm: COSMO PL has the lower skills, while the others are similar.

- 5.0 mm: COSMO PL has the highest FSS, COSMO D2 and COSMO 1 are in the middle, COSMO IT and COSMO 2I are the worst.
- Great improvement at small scales for all models if compared to 1 timestep, with the exception of COSMO 1 which already had very high score.



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#### SON2019 - POD at 0.2 and 5.0 mm - d0 - 3t



### Problems of COSMO PL mostly due to low POD, even if good FAR





- 0.2 mm: Very similar behavior.
- 5.0 mm: small difference for small spatial scales, bigger difference at bigger scales with COSMO I5 performing better.



PIEMONTE



### Better FSS for COSMO I5 at bigger scales may be due to lower FAR





- 0.2 mm: Very similar behavior.
- 5.0 mm: smaller difference for small spatial scales, bigger difference at bigger scales with COSMO I5 performing better.
- Bigger difference at 5 mm if compared to 1 timestep.





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# DJF 2020







FSS – DO - 1T – COSMO 2I, COSMO IT, COSMO PL, COSMO 1



- 0.2 mm: COSMO D2 has the highest FSS at all scales, the others are very similar. COSMO PL almost performs as good as COSMO D2 for small spatial scales but is alligned with the others for bigger scales.
- 5.0 mm: COSMO PL and COSMO D2 have the highest FSS, the others have very similar behavior up to the middle scales and then open up with COSMO 1 and COSMO 21 behaving better than COSMO IT.





DJF2020 - POD at 0.2 and 5.0 mm - d0 - 1t









FSS – DO - 3T – COSMO 2I, COSMO IT, COSMO PL, COSMO 1



- 0.2 mm: COSMO D2 has the highest FSS at all scales, the others are very similar. COSMO PL almost performs as good as COSMO D2 for small spatial scales but is alligned with the others for bigger scales.
- 5.0 mm: COSMO PL and COSMO D2 have the highest FSS. COSMO 2I is similar to COSMO D2 up to the middle scales, then gets closer to COSMO 1. COSMO IT is the worst at all scales.
- Great improvement for all the models at small scales at 0.2 mm if compared to 1 timestep. Great improvement for COSMO PL also at 5 mm.





#### DJF2020 - POD at 0.2 and 5.0 mm - d0 - 3t



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- 0.2 mm: better behavior for COSMO I5 up to the middle scales, then the two models get very close to each other.
- 5.0 mm: small difference for small spatial scales, bigger difference at bigger scales with COSMO I5 performing better.





#### DJF2020 - POD at 0.2 and 5.0 mm - d0 - 1t



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- 0.2 mm: better behavior for COSMO I5 up to the middle scales, then the two models get very close to each other.
- 5.0 mm: small difference for small scales, bigger difference at bigger scales with COSMO I5 performing better.
- Bigger improvement at small scales at 0.2 mm if compared to 1 timestep.





DJF2020 - POD at 0.2 and 5.0 mm - d0 - 3t



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# MAM 2020





- 0.2 mm: COSMO D2 and COSMO 1 have the highest performances at all scales. COSMO 2I and COSMO PL are very similar for small spatial scales, but COSMO 2I gets better at middle and bigger scales.
- 5.0 mm: COSMO 1 has the highest FSS, the others have very similar behavior at small scales and then open up at medium scales with COSMO D2 behaving better than COSMO PL and COSMO 2I.





#### MAM2020 - POD at 0.2 and 5.0 mm - d0 - 1t



driven by high FAR September the 7th 2020 A rot COSINIO ZI May be a coord 155 for COSINIO PL driven by low POD Naima Vela - 22th COSINIO General Meeting - Everywhere

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### FSS – DO - 3T – COSMO 2I, COSMO PL, COSMO 1. NO COSMO IT



- 0.2 mm: COSMO D2 and COSMO 1 have the highest performances at all scales. COSMO 2I and COSMO PL are worse and very similar for small scales, but COSMO 2I gets better at middle and bigger scales.
- 5.0 mm: COSMO 1 has the highest FSS, COSMO PL and COSMO D2 have very similar behavior and are in the middle, COSMO 2I has the worst FSS.
- Bigger improvement at small scales at 0.2 mm if compared to 1 timestep.





#### MAM2020 - POD at 0.2 and 5.0 mm - d0 - 3t







#### MAM2020 - FSS at 0.2 and 5.0 mm - d0 - 1t Cumulation: 3h. Area: Common Area 2. -0 △ 0.2 mm ○ 5.0 mm COSMO I5 COSMO GR 0.8 0.6 FSS 0.4 0.2 0.0 325 5 15 25 85 165 45

### • 0.2 mm: same behavior

• 5.0 mm: COSMO GR is performing better at all scales.





#### MAM2020 - POD at 0.2 and 5.0 mm - d0 - 1t



COSMO I5 has better POD at 5mm but this is not Better FSS for COSMO GR at 5mm may be driven by low FAR enough to beat COSMO GR in FSS





- 0.2 mm: same behavior
- 5.0 mm: COSMO GR is performing better at all scales.
- Improvement at small scales if confronted to 1 timestep only visible at 0.2 mm





#### MAM2020 - POD at 0.2 and 5.0 mm - d0 - 3t



COSMO I5 has better POD at 5mm but this is not Better FSS for COSMO GR at 5mm may be driven by low FAR enough to beat COSMO GR in FSS







## Conclusions







## Conclusions for D0 1/2 (0.025°)

- All the models have at least some improvement passing from 1 to 3 timesteps
- COSMO 1 has very good performances in SON and MAM, medium performances in DJF. Very good POD but high FAR.
- COSMO D2 is very good in DJF, average in SON and MAM. High POD, expecially at 0.2 mm/3h and at small/medium scales.
- COSMO PL has good performances at 5 mm/3h with the exception of MAM. Low FAR (good!) but also low POD (bad!).
- COSMO 2I is average at 0.2 mm/3h and often the worst at 5 mm/3h. FAR and POD with no significant trend.
- COSMO IT behaves very similarly to COSMO 2I. Sometimes worst at 5 mm/3h at large scales. (No data for MAM)





- The two models have at least some improvement passing from 1 to 3 timesteps
- FSS: very little difference between the two models at 0.2 mm. At 5 mm better behavior for COSMO GR in SON 2019 and for COSMO I5 for the other two seasons.
- FAR: Always very close to each other. Better FAR at 5 mm/3h for COSMO I5 in SON, better FAR at 5 mm/3h for COSMO GR in MAM.
- POD: very similar behavior in SON. Mixed bahavior in DJF with COSMO I5 better at small scales and COSMO GR better at bigger scales. Better POD for COSMO I5 in MAM at all scales.





## Conclusion for D1 (not shown)

- COSMO 2D and COSMO 1 are not present in the second day verification
- SON:

All the models have weaker performances for all the scores.

DJF:

COSMO PL seems to have a bigger worsening for FSS at 5 mm getting closer to (and, for bigger scales, also getting passed by) COSMO 2I and COSMO IT (both for 1 and 3 timesteps).

COSMO PL has better POD than COSMO 2I and COSMO IT at 0.2 mm. In this case only, POD for D1 is better than the one for DO.

MAM:

COSMO PL better than COSMO 2I for FSS at 0.2 mm. Almost same values as D0 for FSS and POD at this threshold.







## THANK YOU FOR YOUR ATTENTION!

### Fractions skill score

(Roberts and Lean, MWR, 2008)

- We want to know
  - How forecast skill varies with neighborhood size
  - The smallest neighborhood size that can be used to give sufficiently accurate forecasts
  - Does higher resolution NWP provide more accurate forecasts on scales of interest (e.g., river catchments)

Compare forecast fractions with observed fractions (radar) in a *probabilistic* way over different sized neighbourhoods

$$FSS = 1 - \frac{\frac{1}{N} \sum_{i=1}^{N} (P_{fcst} - P_{obs})^{2}}{\frac{1}{N} \sum_{i=1}^{N} P_{fcst}^{2} + \frac{1}{N} \sum_{i=1}^{N} P_{obs}^{2}}$$

