

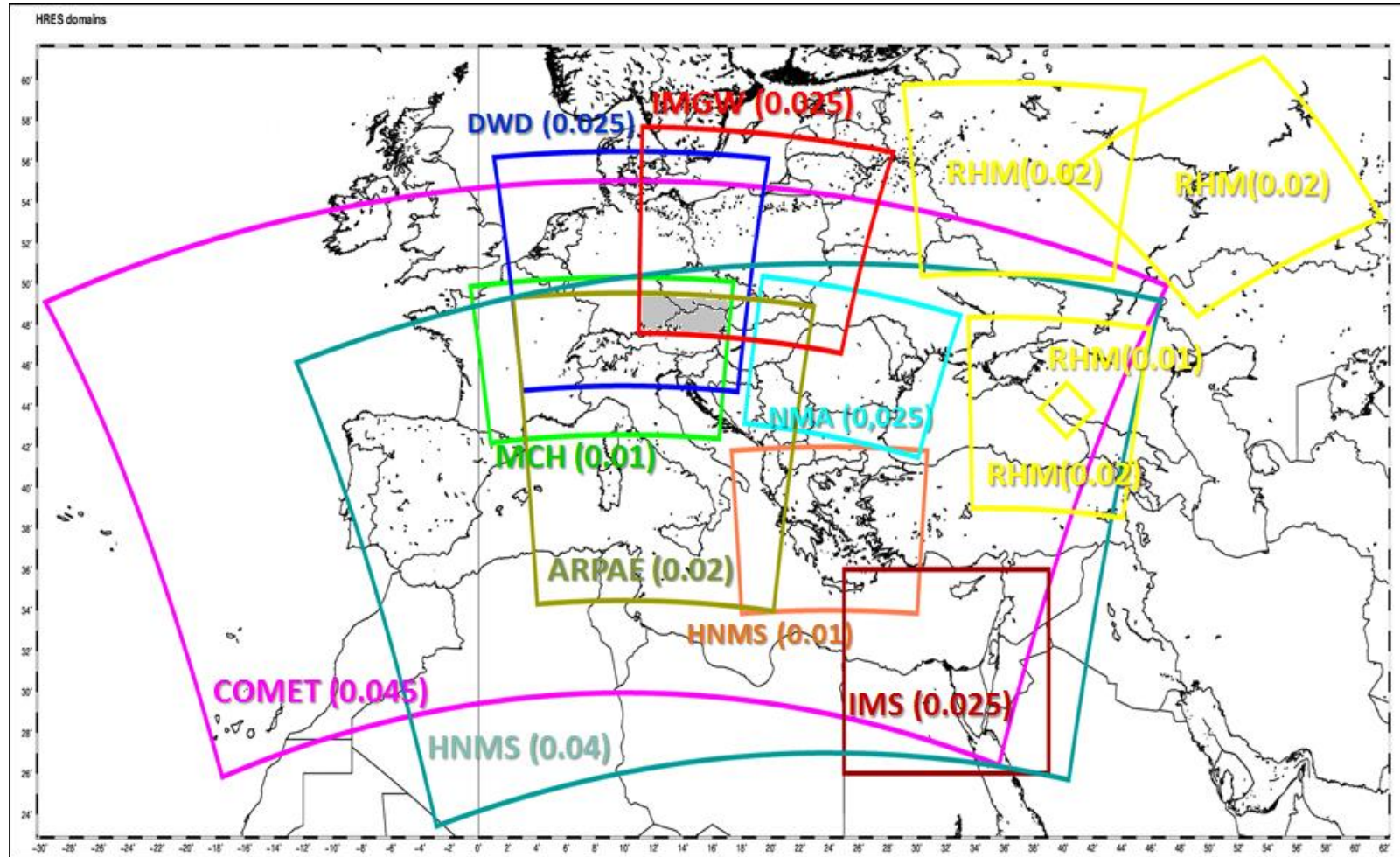


# Fuzzy verification on Common Area 2

Naima Vela



# WHAT IS COMMON AREA 2

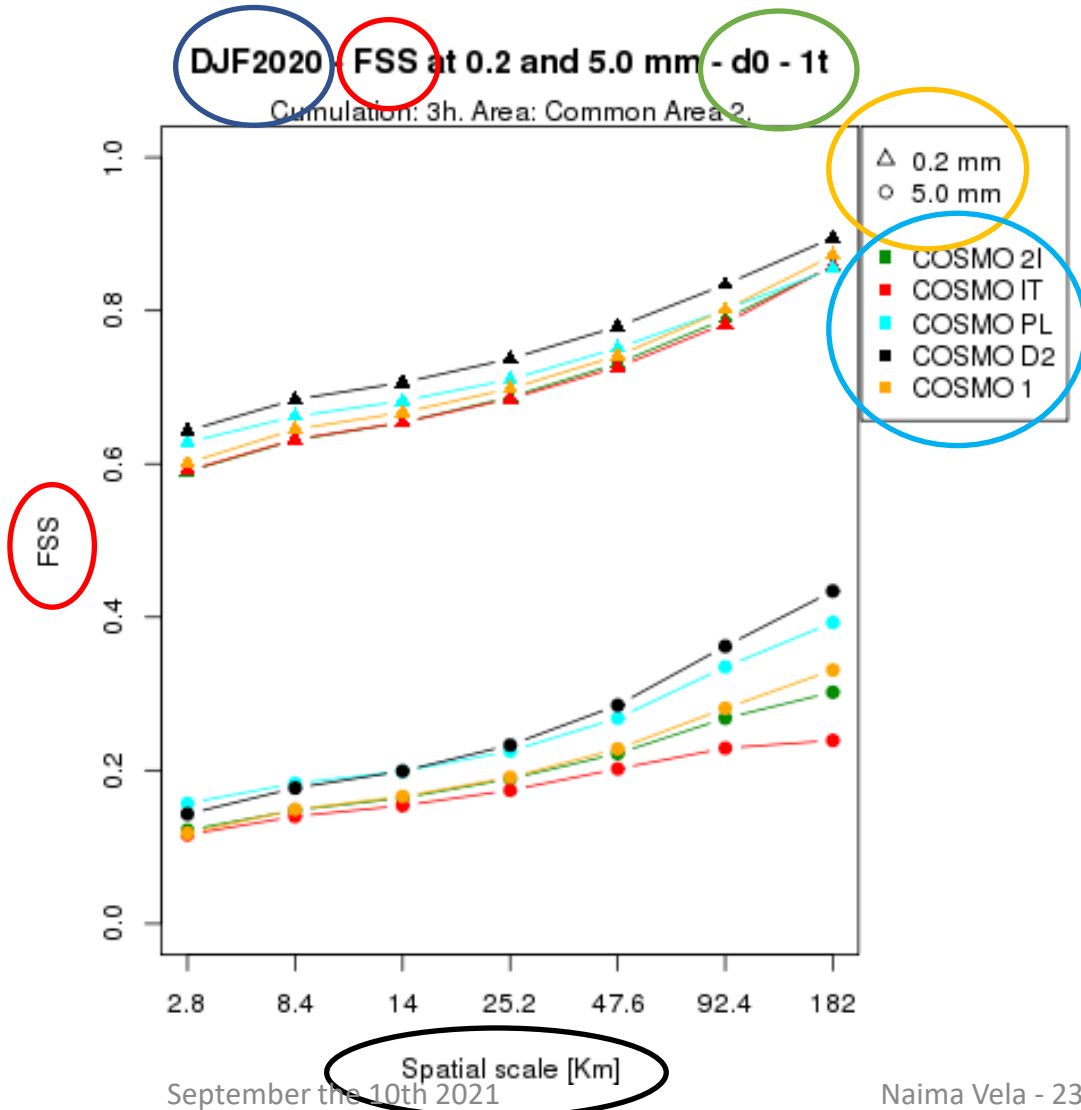


W10.963, S46.597, E17.437, N49.550

# DESCRIPTION OF THE VERIFICATION

- Models:
  - COSMO 2I, COSMO IT, COSMO PL, ICON PL, ICON IL (only MAM 2021) -> D0 and D1
  - COSMO D2 (stops SON 2020), ICON D2, COSMO 1 (stops JJA 2021), COSMO 1E (from SON2020) -> D0
  - ICON GR -> D0 and D1 (only May 2021)
- Observation: OPERA database by EUMETNET
- Resolution (forecast and observation): 0.025°, lat-lon
- Period: JJA 2020, SON 2020, DJF 2021, MAM 2021
- Scores: FSS, FAR, POD
- Methods: 1 timestep, 3 timesteps
- Cumulation: 3h

# Plot explanation

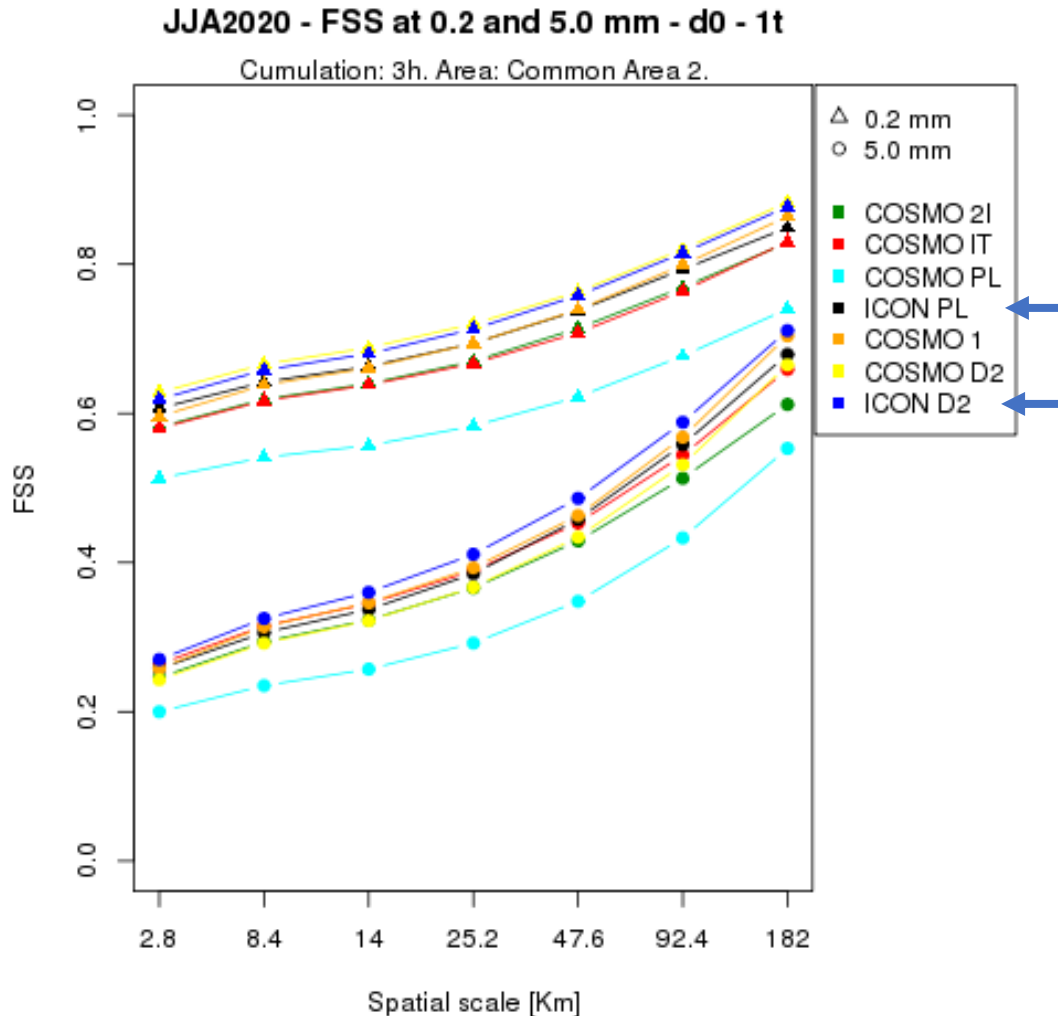


- **O**: Period
- **O**: Score
- **O**: Day and timesteps
- **O**: Thresholds
- **O**: Models
- **O**: Spatial scales



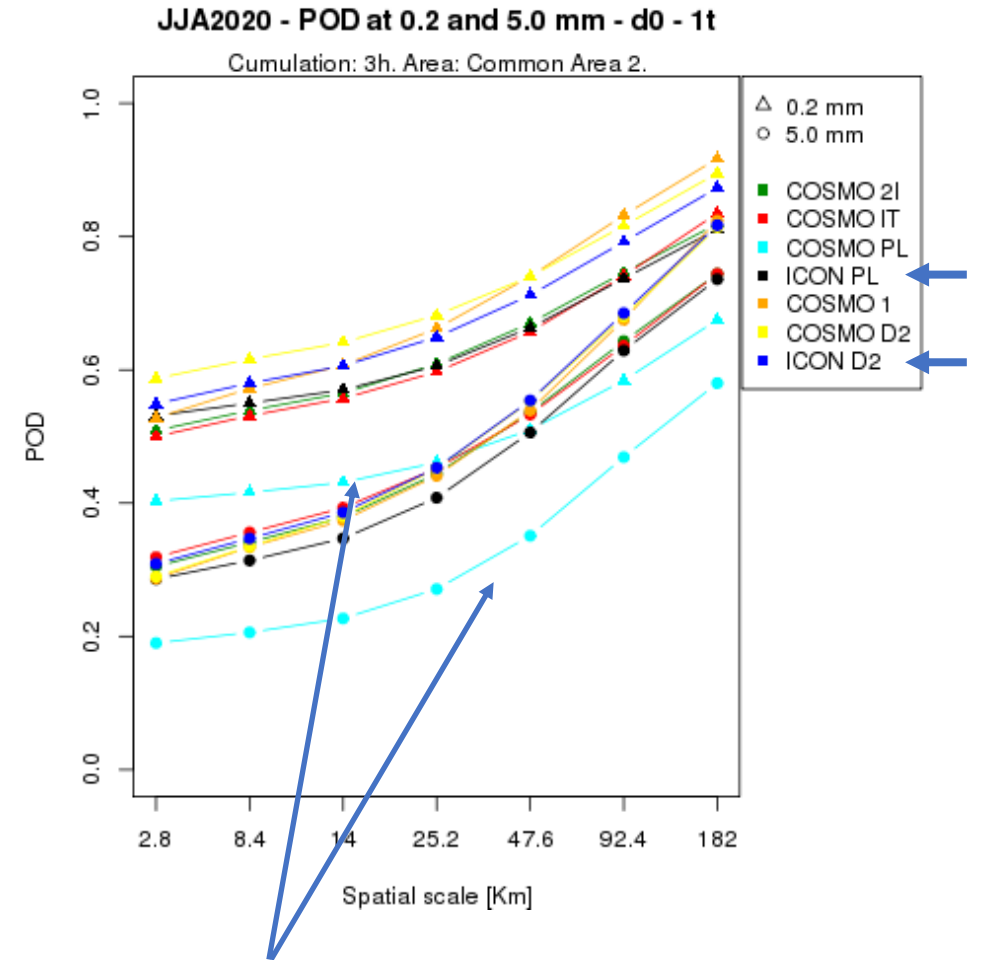
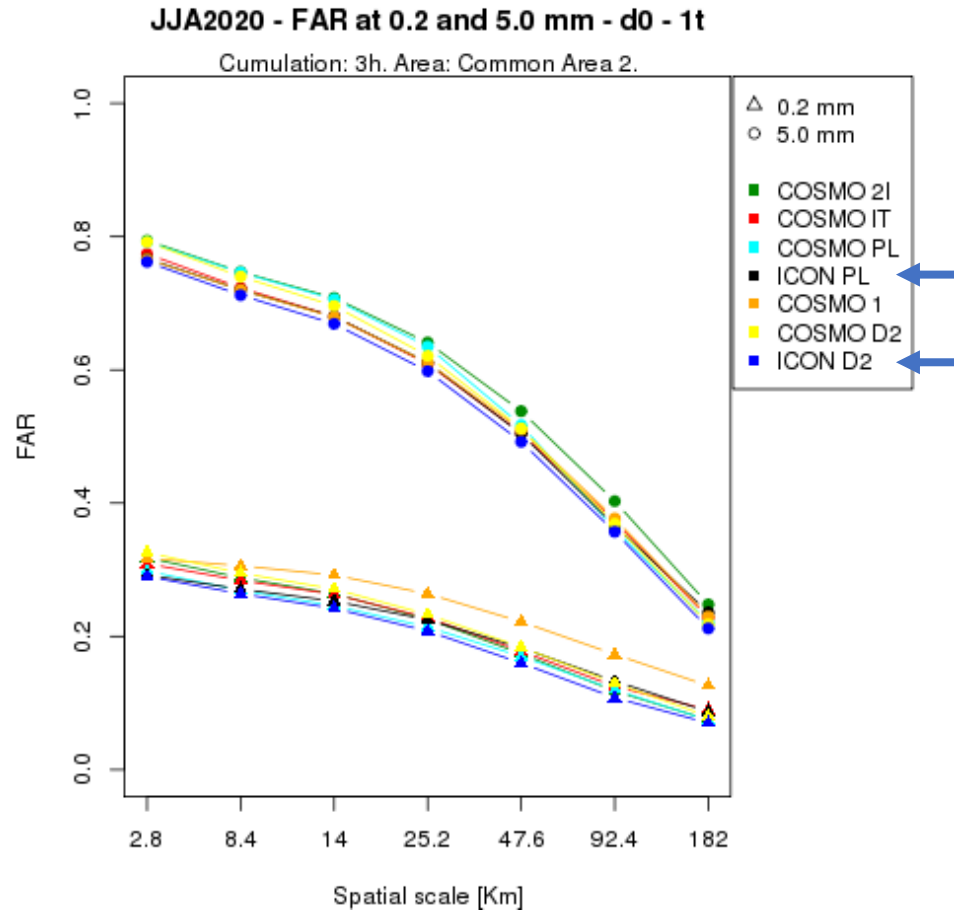
# JJA 2020

# FSS – D0 - 1T – COSMO 2I, COSMO IT, COSMO PL, ICON PL, COSMO 1, COSMO D2, ICON D2



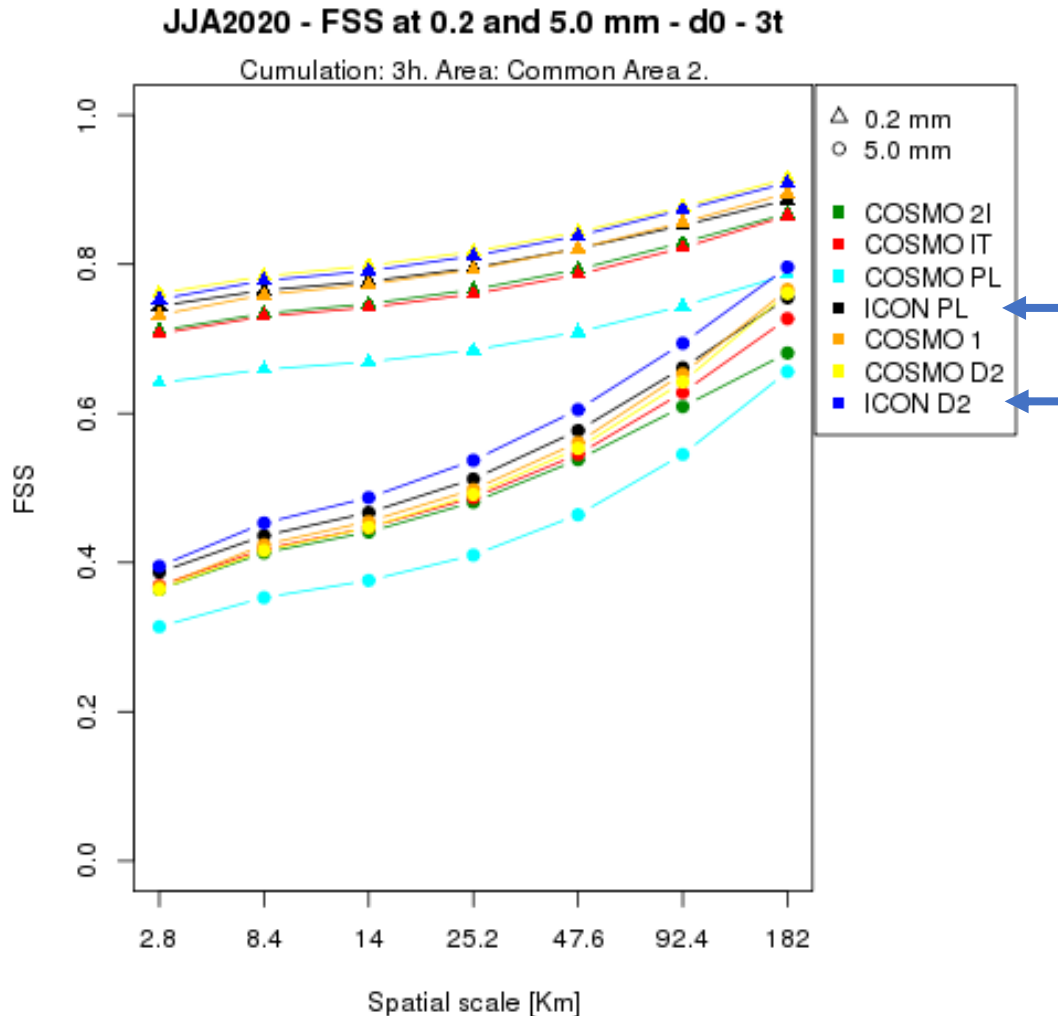
- 0.2 mm: COSMO 1, COSMO D2 and ICON D2 have the highest FSS at all scales, COSMO PL the lowest, while ICON PL and COSMO 1 are very similar and better than COSMO 2I and COSMO IT among the middle ones.
- 5.0 mm: ICON D2 has the best performance but all the models are quite close to each other except for COSMO PL which is the worst.

# FAR and POD – D0 - 1T



Problems of COSMO PL mostly due to low POD

# FSS – D0 - 3T – COSMO 2I, COSMO IT, COSMO PL, ICON PL, COSMO 1, COSMO D2, ICON D2



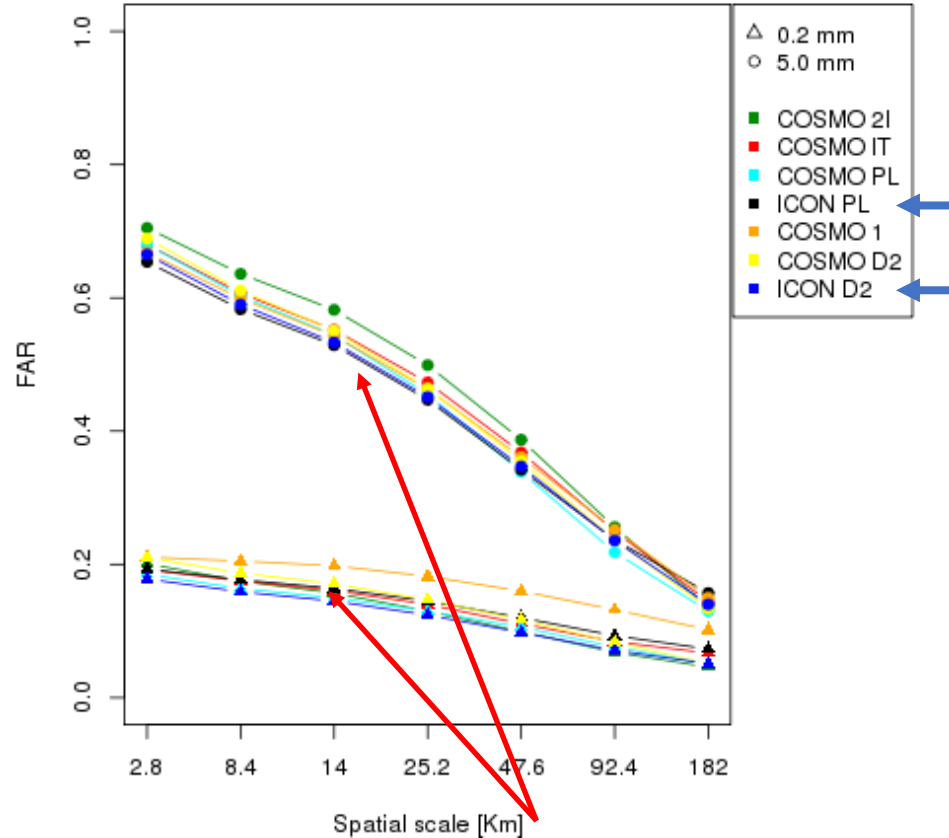
- 0.2 mm: COSMO PL has the lowest skills, COSMO D2, ICON D2, COSMO 1 and ICON PL are similar at the top. COSMO 2I and COSMO IT in the middle.
- 5.0 mm: ICON D2 has the highest FSS. The other are similar. COSMO PL is the worst.
- Great improvement at small scales for all models if compared to 1 timestep.



# FAR and POD – D0 - 3T

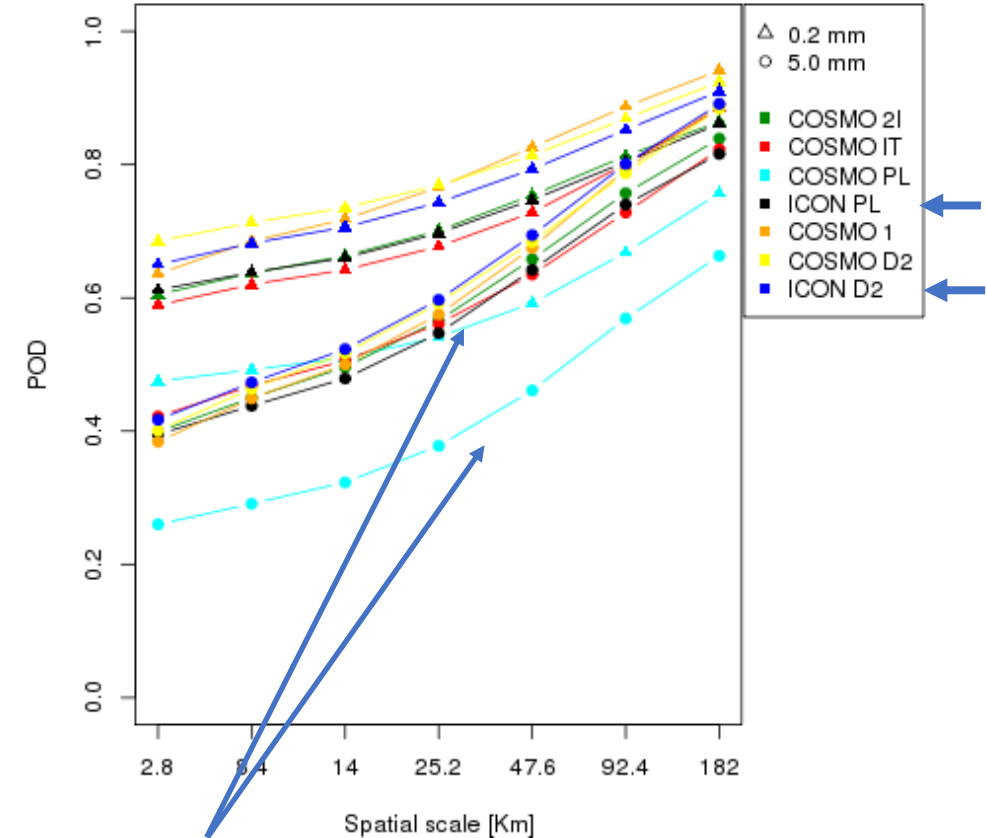
JJA2020 - FAR at 0.2 and 5.0 mm - d0 - 3t

Cumulation: 3h. Area: Common Area 2.



JJA2020 - POD at 0.2 and 5.0 mm - d0 - 3t

Cumulation: 3h. Area: Common Area 2.



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

**POD** values almost overlapping at big scales.

# Conclusions JJA 2020 (1/2)

- COSMO 2I:
  - D0: Low FSS, high FAR for 5 mm/3h, medium POD.
  - D1: Medium values.
- COSMO IT:
  - D0: Low FSS for 0.2 mm/3h, medium for 5 mm/3h. Medium FAR and POD.
  - D1: Almost identical to COSMO 2I.
- COSMO PL:
  - D0: Very low FSS and POD, medium FAR.
  - D1: Bad results for all scores.

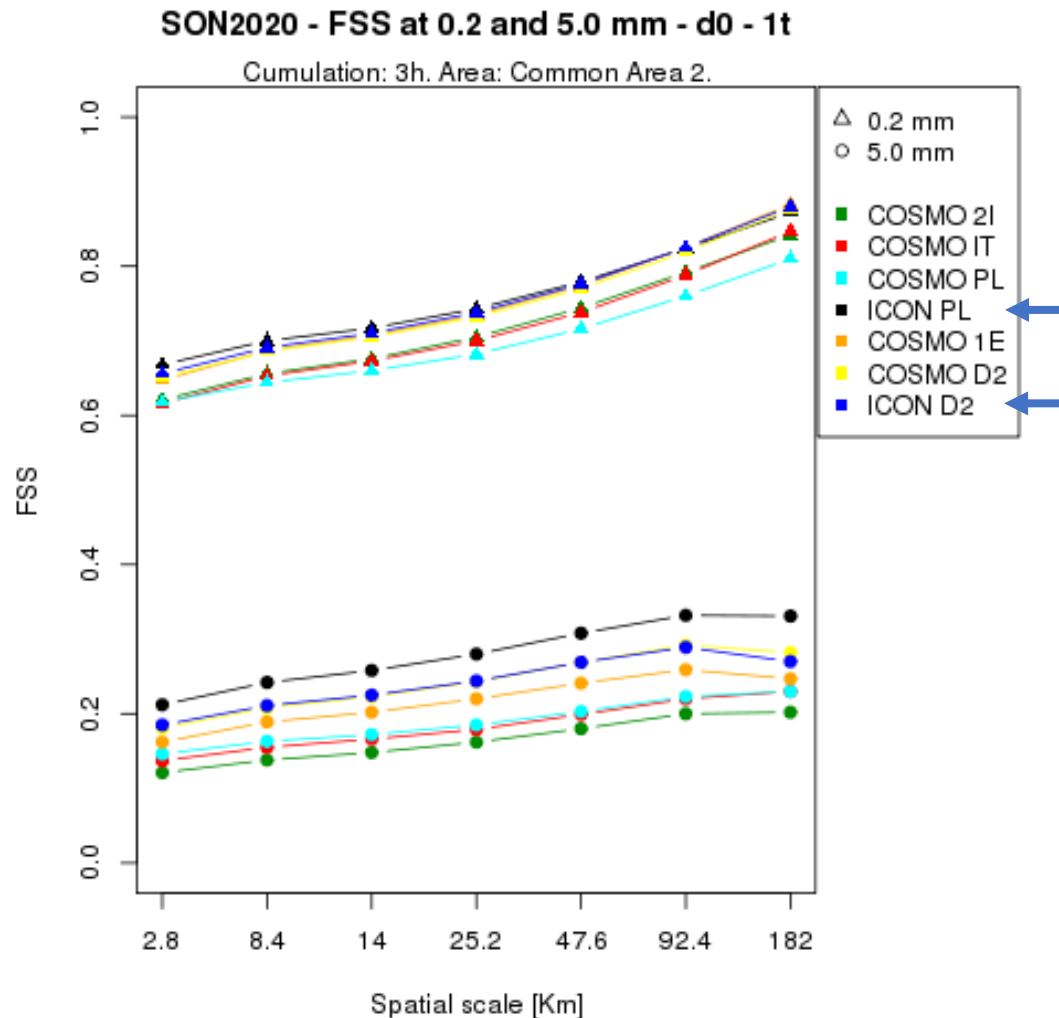
# Conclusions JJA 2020 (2/2)

- **ICON PL:**
  - D0: Medium FSS and FAR, low POD.
  - D1: High FSS for 0.2 mm/3h, medium for 5 mm/3h (gets better at bigger scales). All FAR results are very close to each other. Good POD for 0.2 mm/3h, bad POD for 5 mm/3h at small scales, better for great scales.
- **COSMO 2D:**
  - D0: Good values for all scores at 0.2 mm/3h. Medium values at 5 mm/3h.
- **ICON D2:**
  - D0: Very good results for all scores.
- **COSMO 1:**
  - D0: High POD but also high FAR at 0.2 mm, so medium FSS. Medium scores for 5 mm.



# SON 2020

# FSS – D0 - 1T – COSMO 2I, COSMO IT, COSMO PL, ICON PL, COSMO 1E, COSMO D2, ICON D2

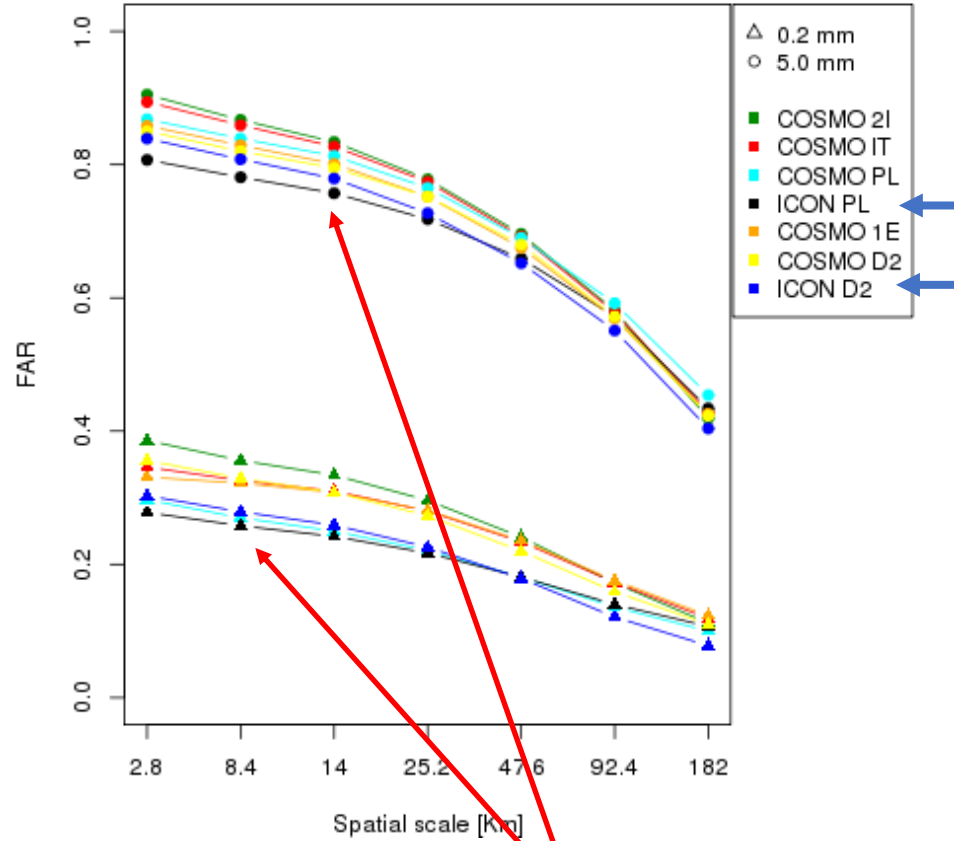


- 0.2 mm: ICON PL, ICON D2, COSMO D2 and COSMO 1E have the highest FSS at all scales, COSMO PL, COSMO IT and COSMO 2I the lower, with a little improvement for the italian models for higher scales.
- 5.0 mm: ICON PL has the best results at all scales, COSMO 2I the worst. ICON and COSMO D2 have good scores followed by COSMO 1E. COSMO PL and IT are just a little better than COSMO 2I.

# FAR and POD – D0 - 1T

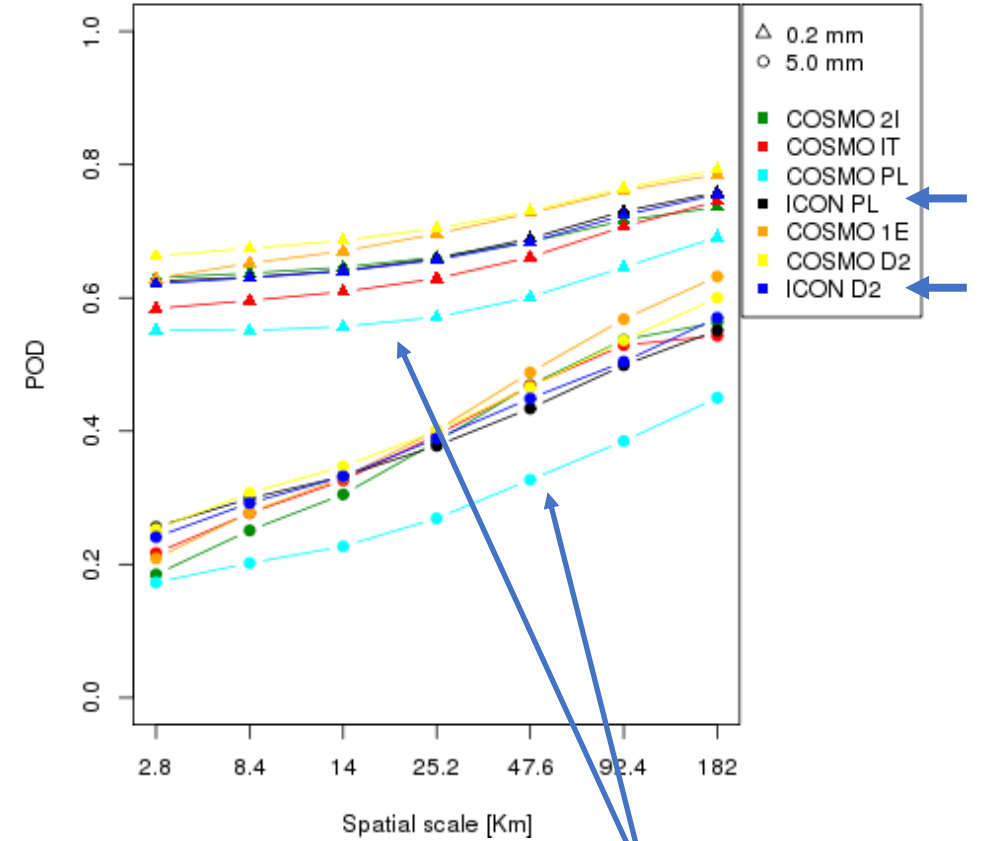
SON2020 - FAR at 0.2 and 5.0 mm - d0 - 1t

Cumulation: 3h. Area: Common Area 2.



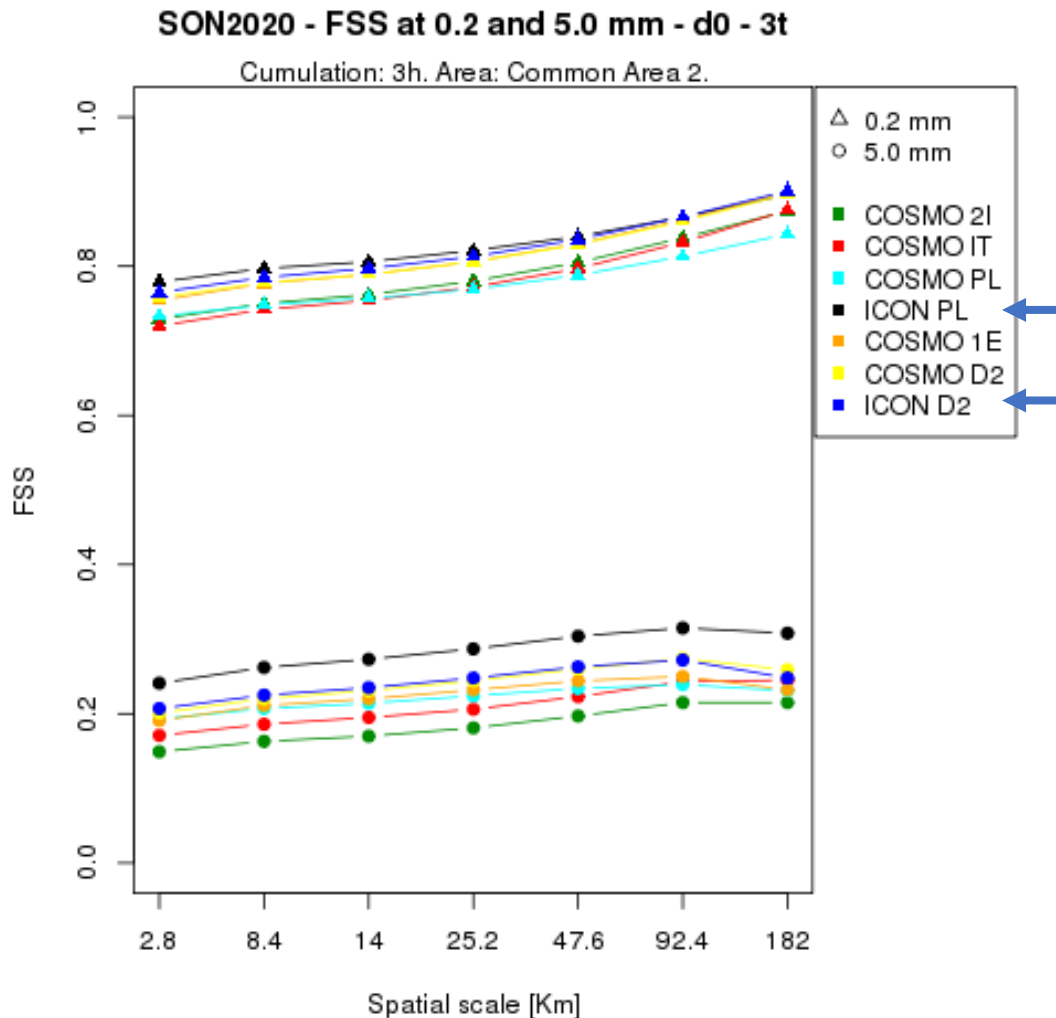
SON2020 - POD at 0.2 and 5.0 mm - d0 - 1t

Cumulation: 3h. Area: Common Area 2.



Very good **FAR** for ICON PL. COSMO PL always has the lowest **POD**

# FSS – D0 - 3T – COSMO 2I, COSMO IT, COSMO PL, ICON PL, COSMO 1E, COSMO D2, ICON D2

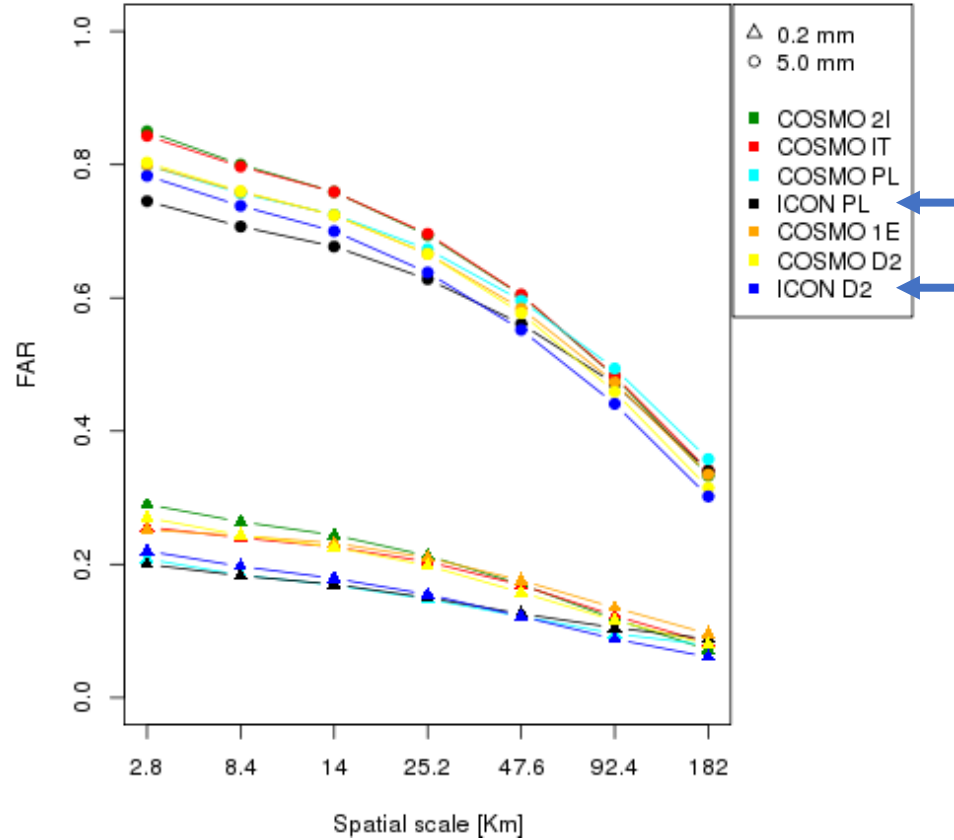


- 0.2 mm: COSMO PL has the lower skills, together with COSMO 2I and COSMO IT for smaller scales, while the others are similar.
- 5.0 mm: ICON PL has the highest FSS, COSMO 2I is the worst for all scales.
- General improvement at small scales for all models if compared to 1 timestep. This is more visible for the lower threshold.

# FAR and POD – D0 - 3T

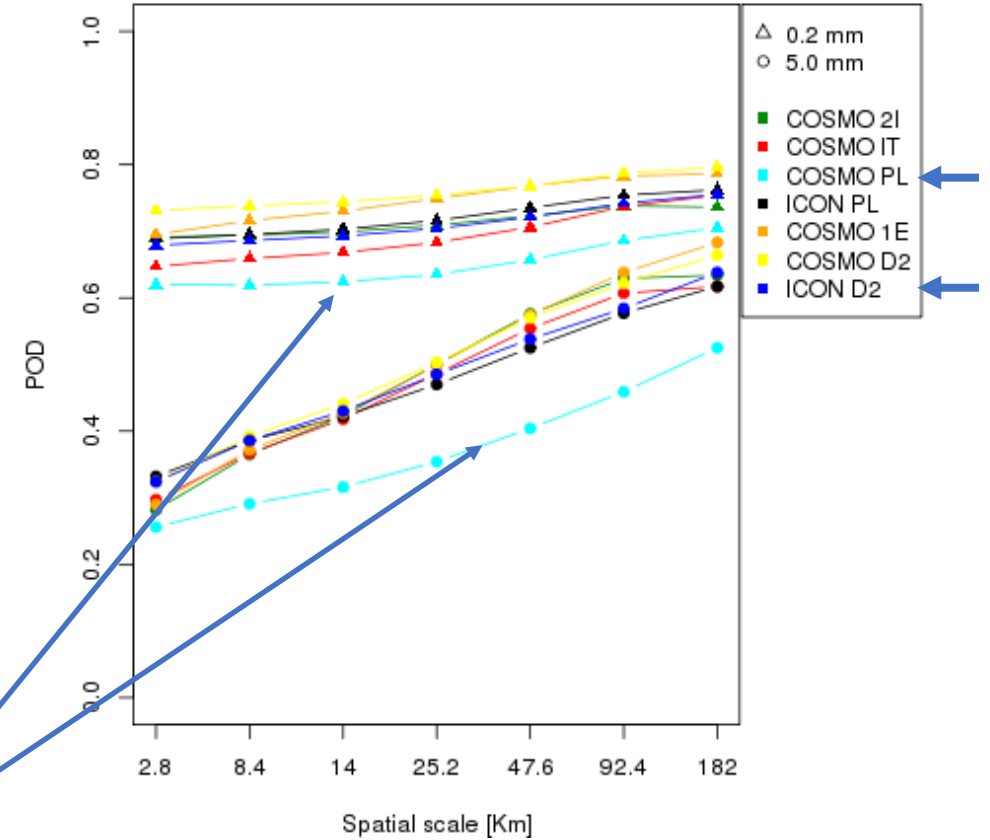
SON2020 - FAR at 0.2 and 5.0 mm - d0 - 3t

Cumulation: 3h. Area: Common Area 2.



SON2020 - POD at 0.2 and 5.0 mm - d0 - 3t

Cumulation: 3h. Area: Common Area 2.



Problems of COSMO PL mostly due to low **POD**, while **FAR** is similar to the other models.

Very good (low) **FAR** for ICON models.



# Conclusions SON 2020 (1/2)

- COSMO 2I:
  - D0: Low FSS, high FAR, medium POD.
  - D1: Medium FSS for 0.2 mm/3h, low for 5 mm/3h. Very high FAR. Medium POD for 0.2 mm/3h, medium for 5 mm/3h getting better at bigger scales.
- COSMO IT:
  - D0: Very close to COSMO 2I. Slightly better POD for bigger scales, slightly worse for smaller ones.
  - D1: Low FSS for 0.2 mm/3h, medium for 5 mm/3h. High FAR. Medium POD for 0.2 mm/3h, high for 5 mm/3h.
- COSMO PL:
  - D0: Always bad values with the exception of FAR for 0.2 mm/3h.
  - D1: Medium FSS. Low FAR. Very low POD.

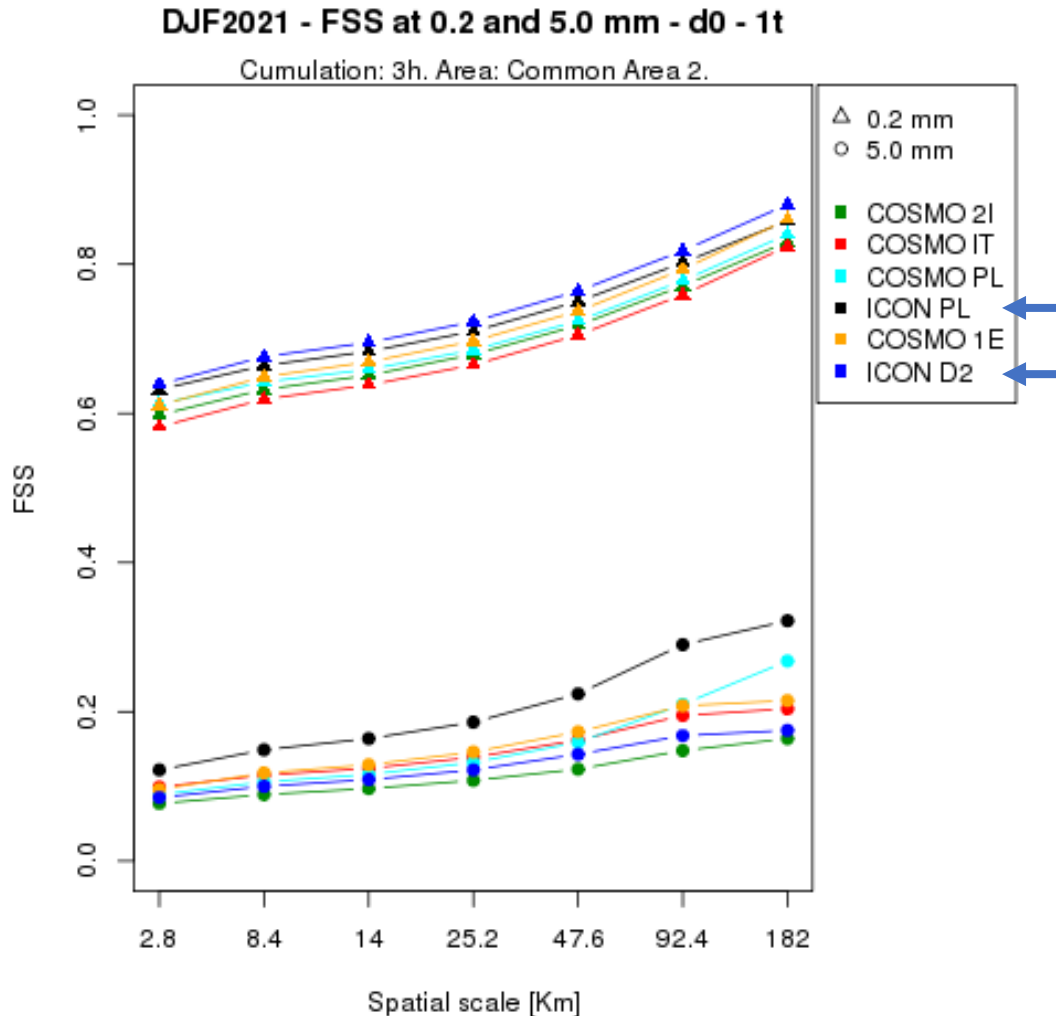
# Conclusions SON 2020 (2/2)

- **ICON PL:**
  - D0: Very high FSS and very low FAR. Medium POD.
  - D1: Good scores for FSS and FAR. High POD for 0.2 mm/3h, medium for 5 mm/3h.
- **COSMO 2D:**
  - D0: Good FSS. Great POD. Medium FAR.
- **ICON D2:**
  - D0: Very good FSS and FAR. Medium POD.
- **COSMO 1E:**
  - D0: Very good FSS for 0.2 mm/3h, medium for 5 mm/3h. Medium FAR. Good POD that gets better for bigger scales.



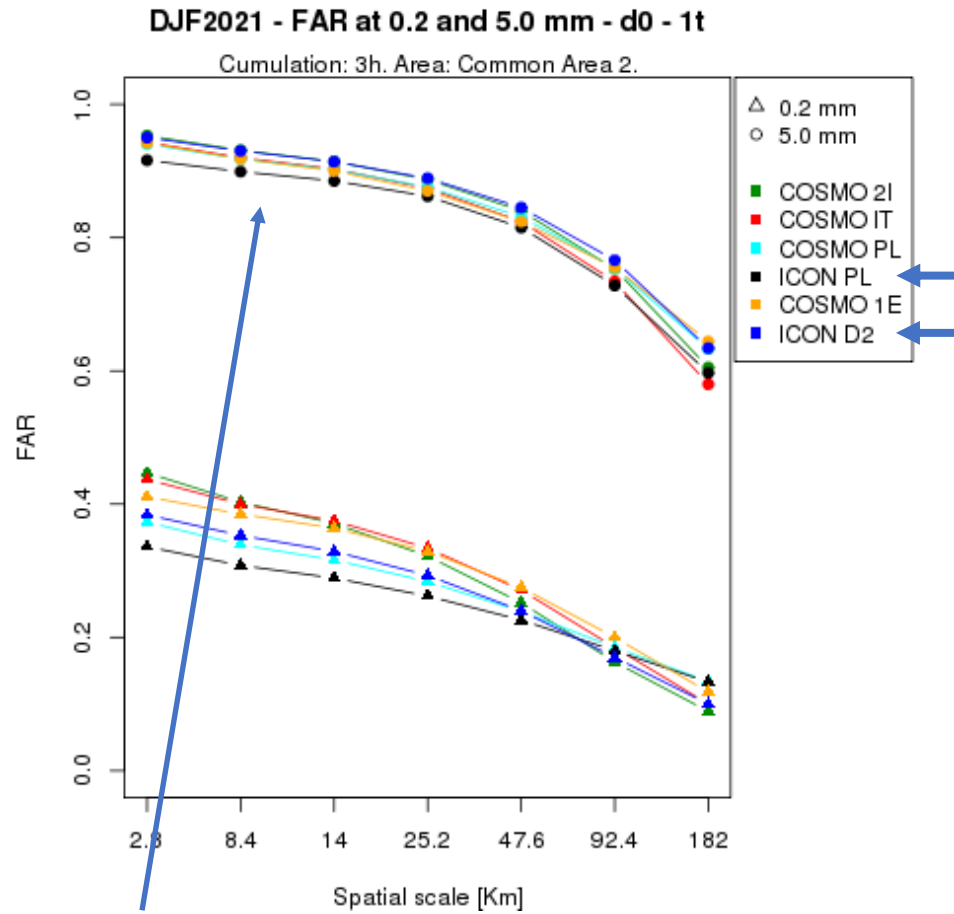
# DJF 2021

# FSS – D0 - 1T – COSMO 2I, COSMO IT, COSMO PL, ICON PL, COSMO 1E, ICON D2

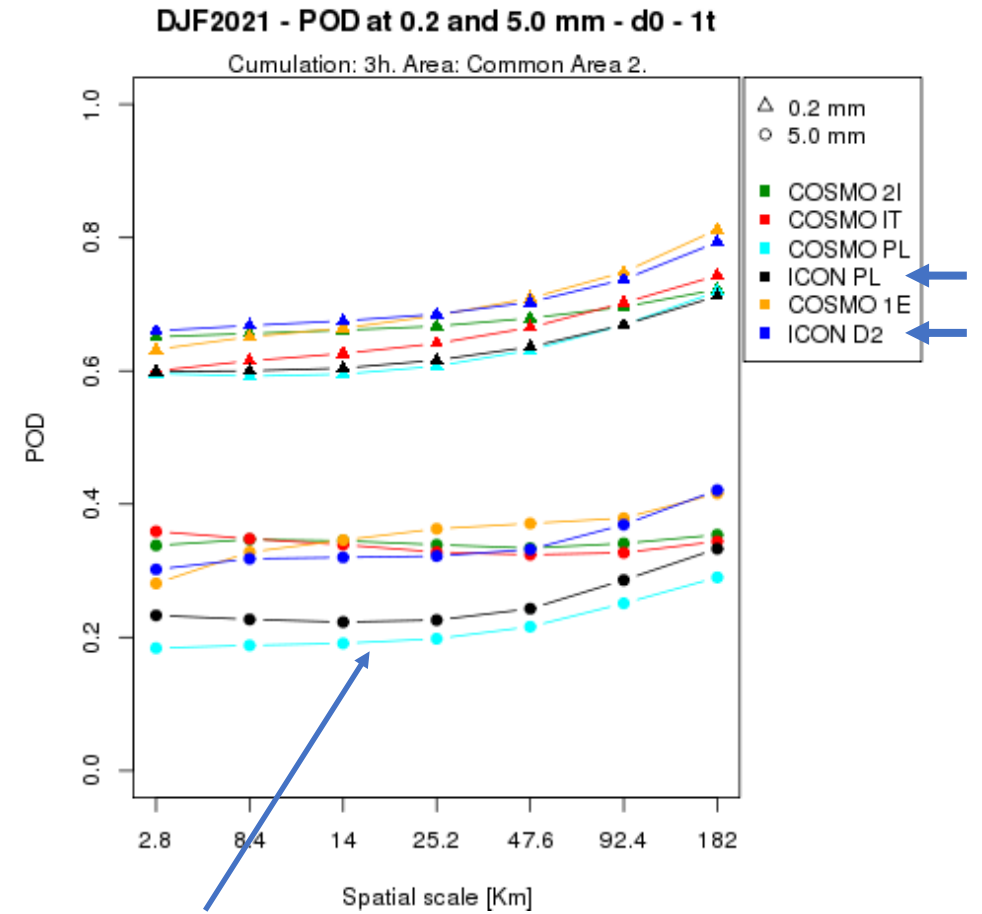


- 0.2 mm: ICON D2 has the highest FSS at all scales and COSMO IT is the worst. Better performance of COSMO PL if compared to the other seasons.
- 5.0 mm: ICON PL has the highest FSS, the others have very similar behavior up to the middle scales and then open up with COSMO PL behaving better than the others.

# FAR and POD – D0 - 1T

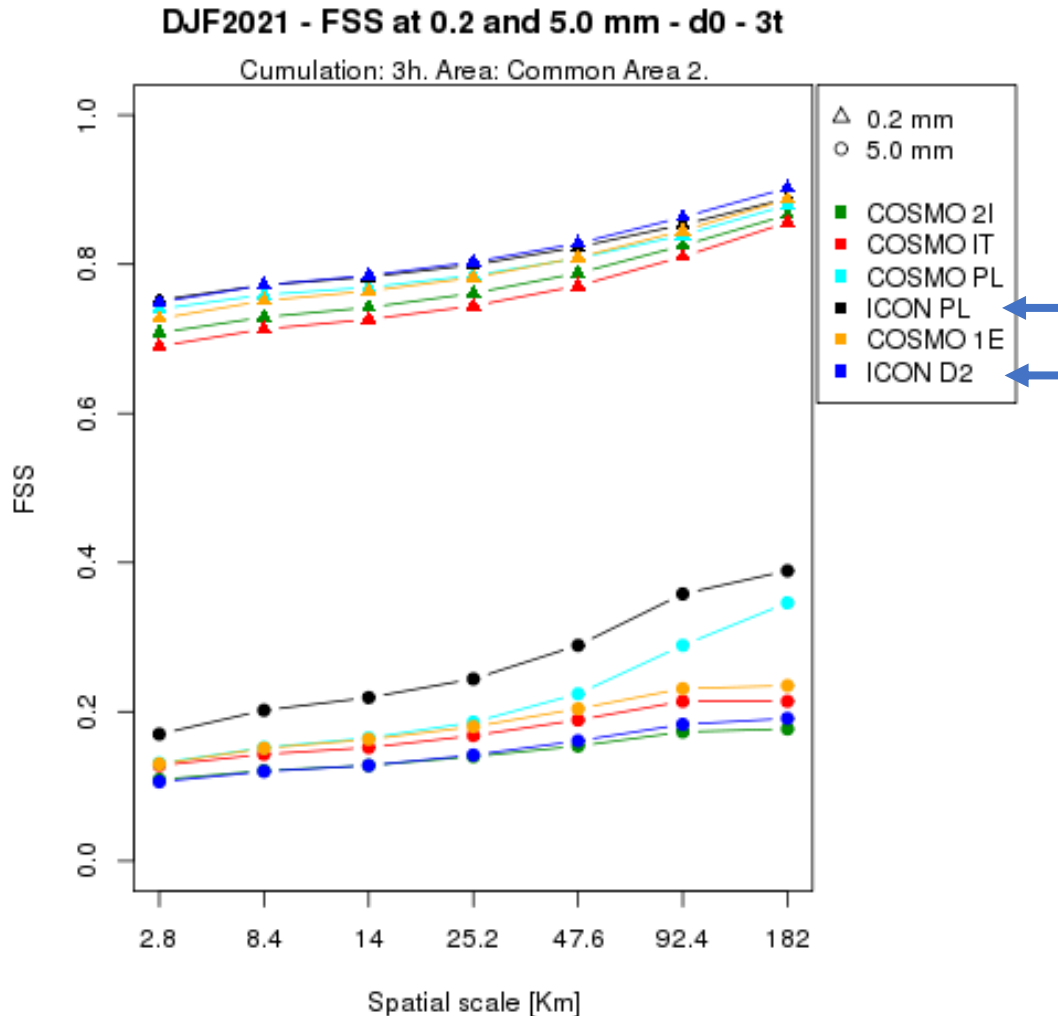


Very similar behavior for higher threshold



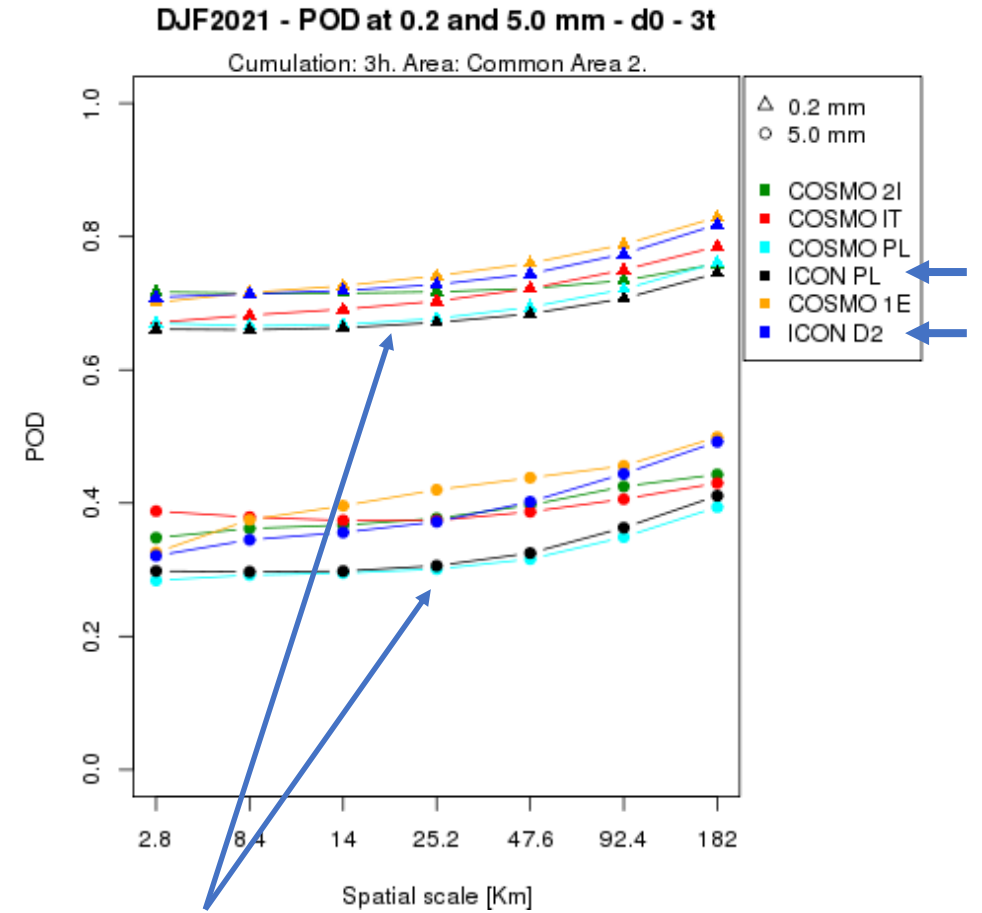
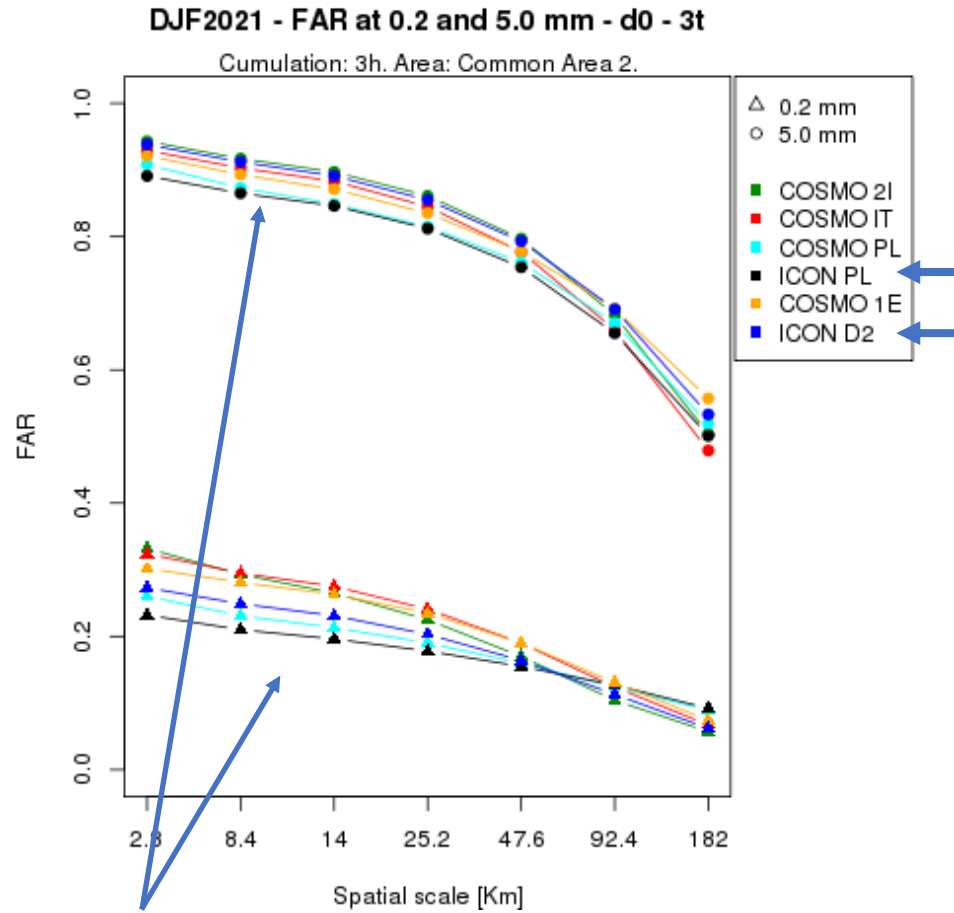
Low POD for COSMO PL (usual) and ICON PL (unusual)

# FSS – D0 - 3T – COSMO 2I, COSMO IT, COSMO PL, ICON PL, COSMO 1E, ICON D2



- 0.2 mm: ICON and COSMO PL have the highest FSS at all scales, COSMO IT the worst.
- 5.0 mm: ICON PL has the best score for all scales. COSMO PL gets better than the others at bigger scales. ICON D2 and COSMO 2I are the worst at all scales.
- Usual improvement for all the models at small scales at 0.2 mm if compared to 1 timestep. Improvement for ICON and COSMO PL also at bigger scales for 5 mm threshold.

# FAR and POD – D0 - 3T



Good FSS for COSMO and ICON  
 PL driven by low FAR

Low POD for COSMO PL (usual)  
 and ICON PL (unusual)

# Conclusions DJF 2021 (1/2)

- COSMO 2I:
  - D0: Low FSS for 0.2 mm/3h, medium for 5 mm/3h. High FAR. High POD for small scales, medium for bigger scales.
  - D1: Bad FSS and FAR. Good POD.
- COSMO IT:
  - D0: Very close to COSMO 2I with small improvement for FSS at 5 mm/3h due to better POD.
  - D1: Low FSS. High FAR that improves for bigger areas. Low POD at 0.2 mm/3h for smaller scales, improves for bigger ones. Nice POD for 5 mm/3h.
- COSMO PL:
  - D0: Medium FSS and FAR. Low POD.
  - D1: Medium FSS. Medium FAR at 0.2 mm/3h, high at 5 mm. Medium POD at 0.2 mm/3h, very low at 5 mm/3h.



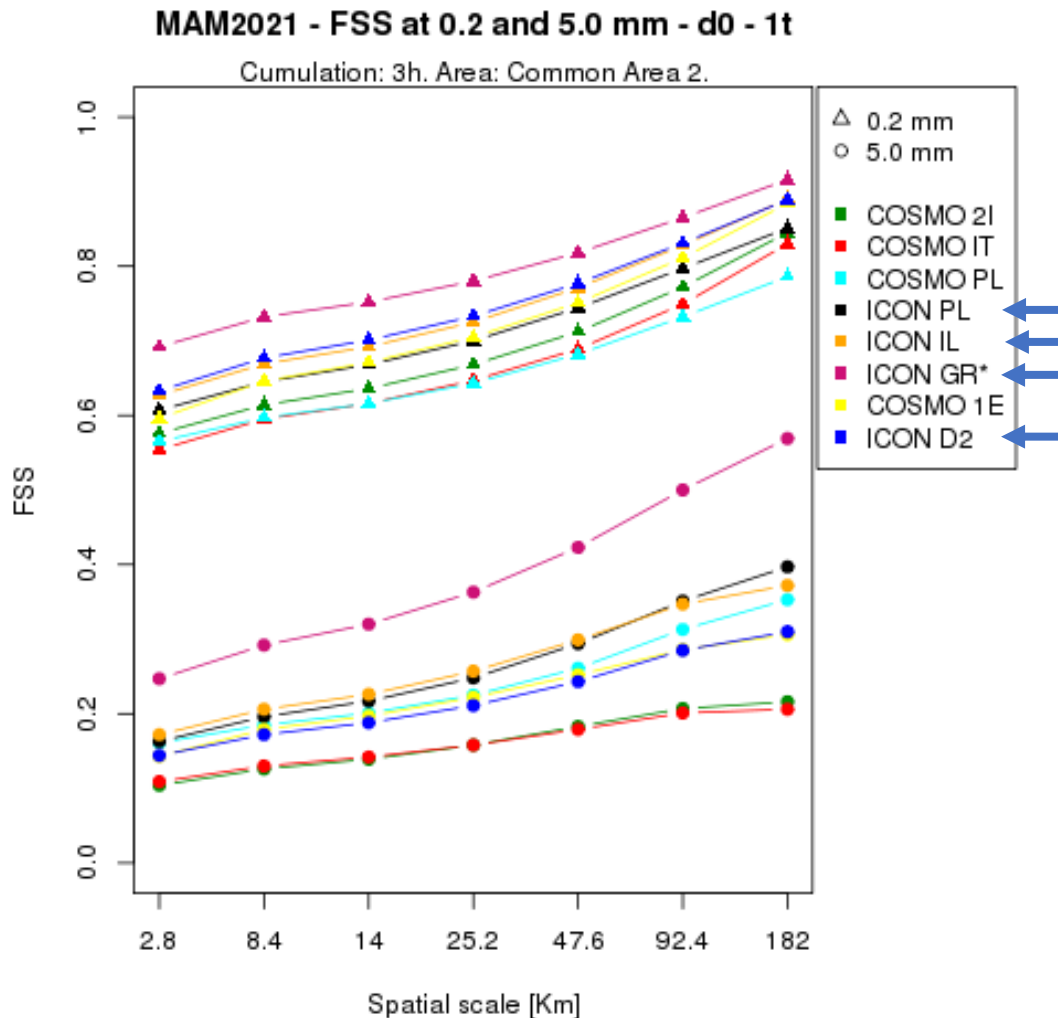
# Conclusions DJF 2021 (2/2)

- **ICON PL:**
  - D0: High FSS (very high at 5 mm/3h). Low FAR. Low POD.
  - D1: Good scores for FSS and FAR. Low POD.
- **ICON D2:**
  - D0: Good FSS at 0.2 mm/3h, low values at 5 mm/3h. High POD: High FAR at 5 mm/3h.
- **COSMO 1E:**
  - D0: Medium FSS. High FAR at 0.2 mm/3h, medium at 5 mm/3h. High POD.



# MAM 2021

FSS – D0 - 1T – COSMO 2I, COSMO IT, COSMO PL, ICON PL, COSMO 1E, ICON D2, ICON IL, ICON GR (only MAY)

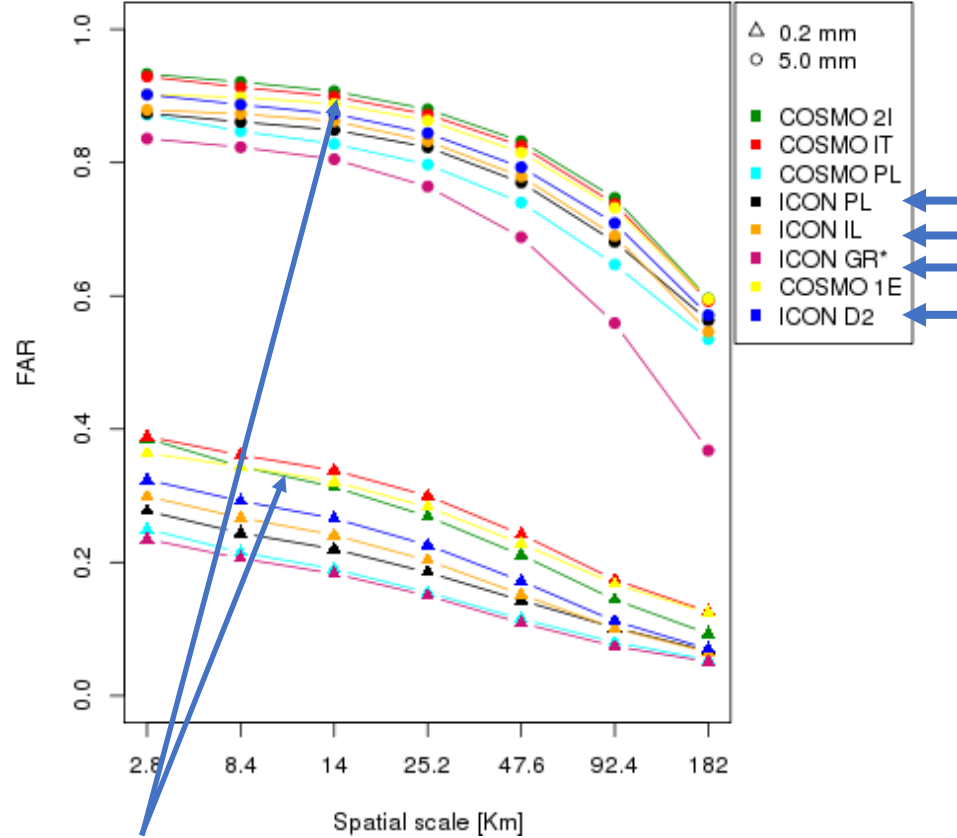


- 0.2 mm: ICON D2 and ICON IL have the highest performances at all scales. COSMO IT and COSMO PL (at the bottom) are very similar for small spatial scales, but COSMO 2I gets better at bigger scales.
- 5.0 mm: ICON IL and ICON PL have the highest FSS, COSMO 2I and COSMO IT are the worst.
- ICON GR\*: data available only for the month of May. Very promising results.

# FAR and POD – D0 - 1T

MAM2021 - FAR at 0.2 and 5.0 mm - d0 - 1t

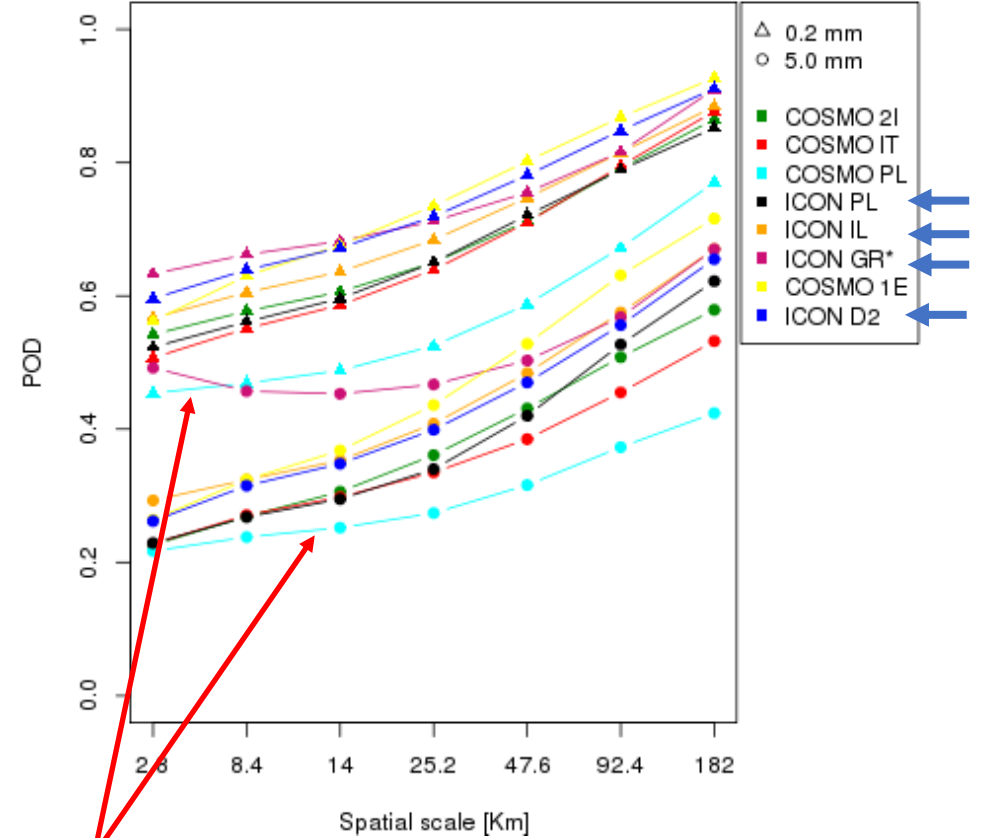
Cumulation: 3h. Area: Common Area 2.



Bad FSS for COSMO 2I and COSMO IT may be driven by high FAR. Also COSMO 1E has high FAR, but also high POD.

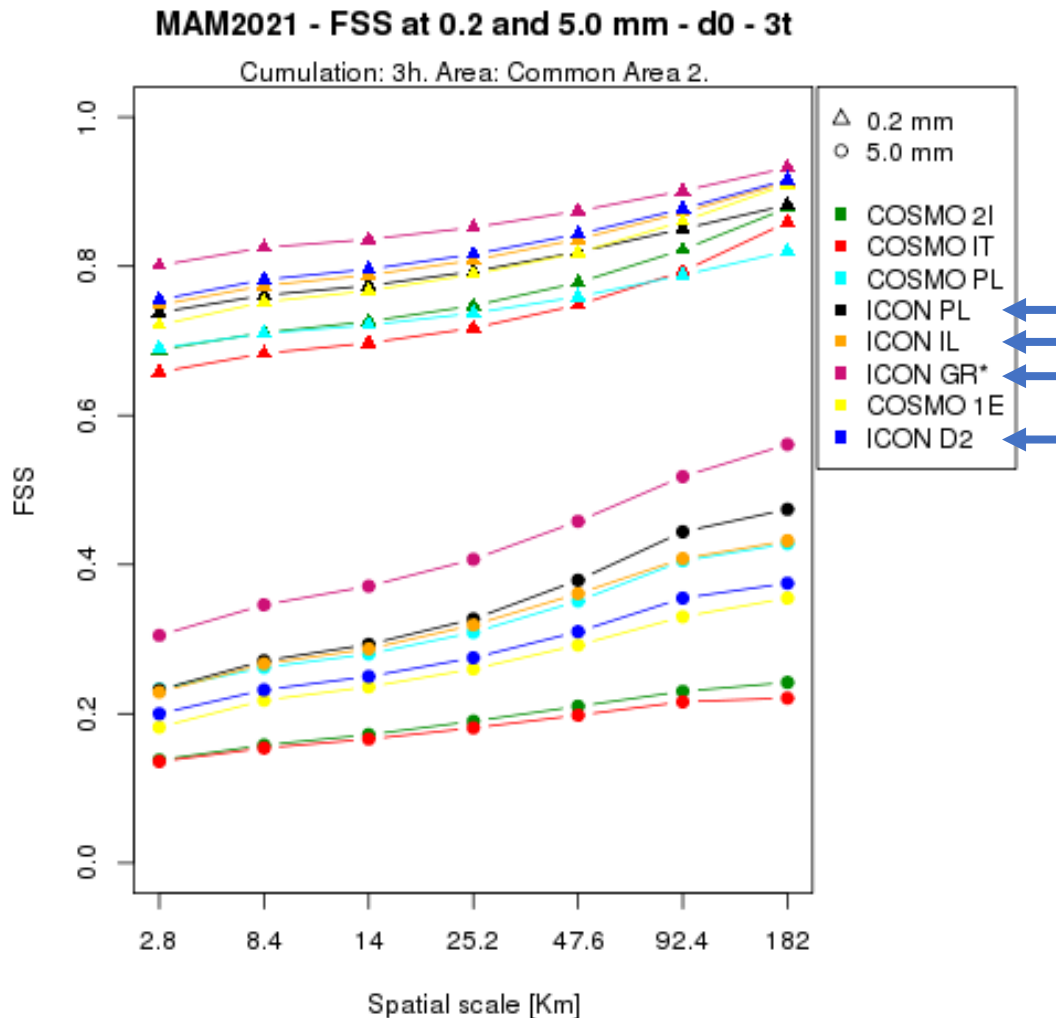
MAM2021 - POD at 0.2 and 5.0 mm - d0 - 1t

Cumulation: 3h. Area: Common Area 2.



Bad FSS of **COSMO PL** driven by low POD. Not the worst FSS because of low FAR.

# FSS – D0 - 3T – COSMO 2I, COSMO IT, COSMO PL, ICON PL, COSMO 1E, ICON D2, ICON IL, ICON GR (MAY)



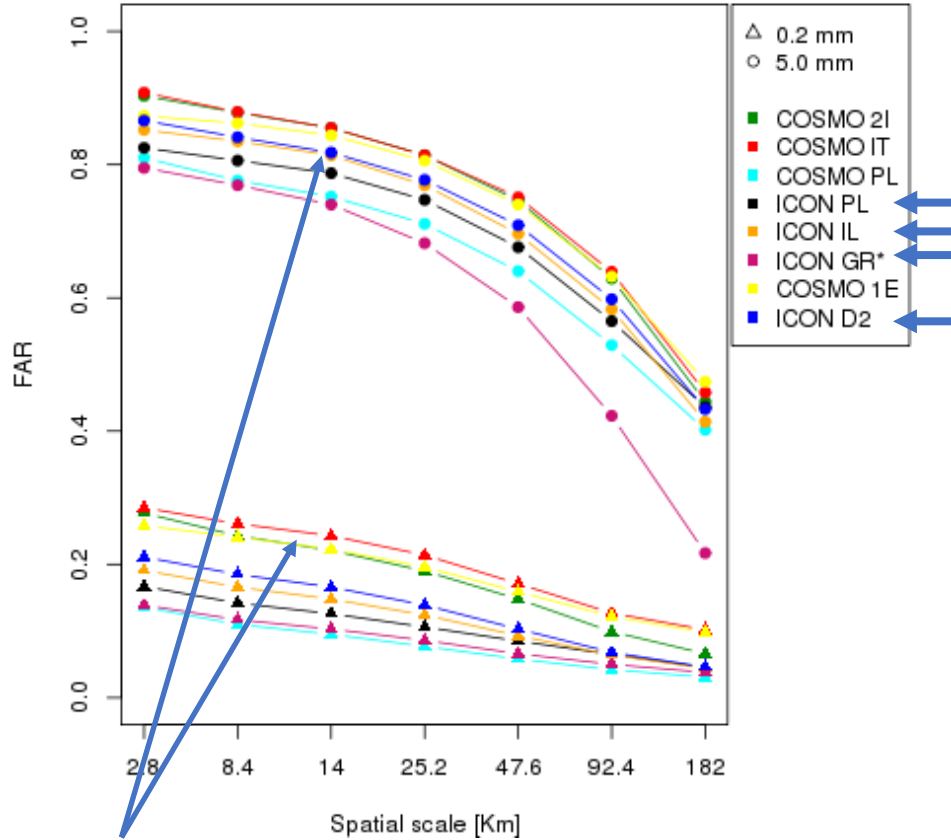
- 0.2 mm: ICON D2 and ICON IL have the highest performances at all scales. COSMO IT is the worst at small scales, COSMO PL at bigger scales.
- 5.0 mm: ICON IL and ICON PL and COSMO PL have the highest FSS at small scales. ICON PL is the best at big scales. COSMO 2I and COSMO IT are the worst at all scales.
- ICON GR: data available only for the month of May. Very promising results.
- Almost no improvement for COSMO 2I and COSMO IT from 2D to 3D at 5 mm/3h.

Very promising results for ICON GR\* both FAR and POD

# FAR and POD – D0 - 3T

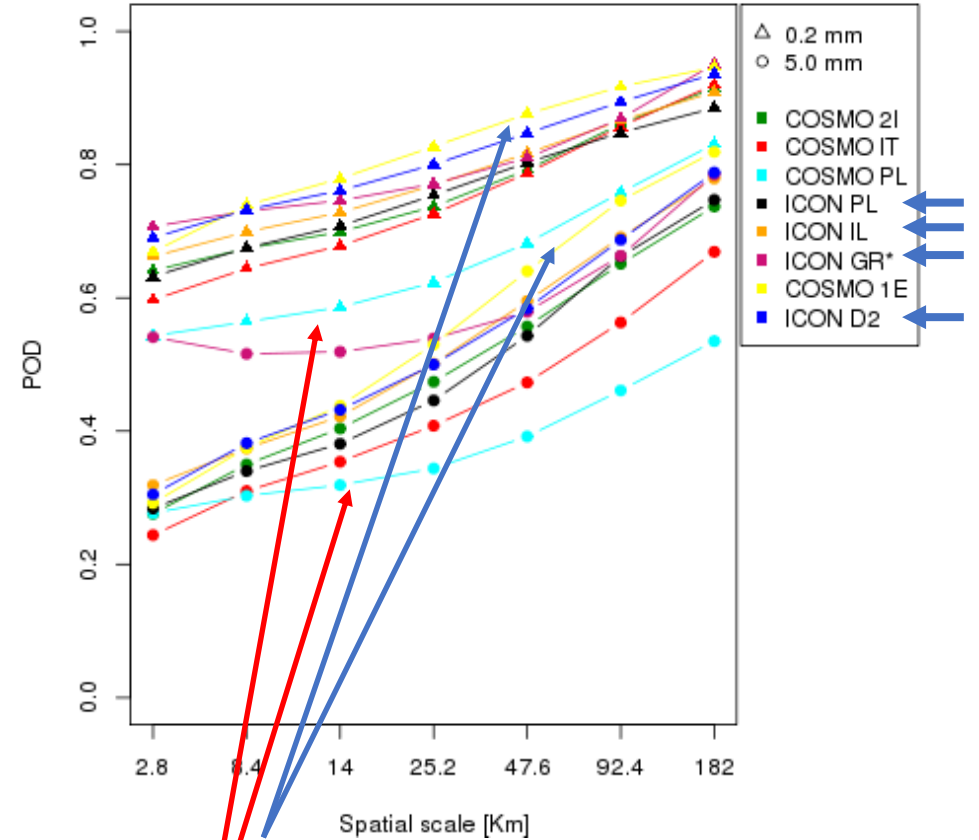
MAM2021 - FAR at 0.2 and 5.0 mm - d0 - 3t

Cumulation: 3h. Area: Common Area 2.



MAM2021 - POD at 0.2 and 5.0 mm - d0 - 3t

Cumulation: 3h. Area: Common Area 2.



Bad FSS for COSMO 2I and IT driven by high FAR. Also COSMO 1E has high FAR, but also very high POD. September the 10th 2021

Good FSS for COSMO 1E driven by high POD. The good FAR of COSMO PL compensated by terrible POD.

# Conclusions MAM 2021 (1/3)

- COSMO 2I:
  - D0: Medium-low FSS at 0.2 mm/3h, very low at 5 mm/3h. High FAR. Medium-low POD.
  - D1: Medium FSS. High FAR. Medium POD.
- COSMO IT:
  - D0: Low FSS. High FAR. Low POD.
  - D1: Low FSS. High FAR. Low POD at 0.2 mm/3h, medium at 5 mm/3h but gets worse at bigger scales.
- COSMO PL:
  - D0: Low FSS at 0.2 mm/3h, medium at 5 mm/3h. Great FAR. Terrible POD.
  - D1: Low FSS at 0.2 mm/3h, medium at 5 mm/3h. Great FAR. Terrible POD.

# Conclusions MAM 2021 (2/3)

- **ICON PL:**
  - D0: Medium FSS at 0.2 mm/3h, high at 5 mm/3h. Medium-low FAR. Low POD.
  - D1: Medium FSS at 0.2 mm/3h, high at 5 mm/3h. Medium-low FAR. Low POD.
- **ICON D2:**
  - D0: Good FSS at 0.2 mm/3h, medium at 5 mm/3h. Medium FAR. Medium-high POD.
- **COSMO 1E:**
  - D0: Medium FSS. High FAR. High POD.



# Conclusions MAM 2021 (3/3)

- **ICON IL:**
  - D0: High FSS. Medium FAR. Medium POD at 0.2 mm/3h, high at 5 mm/3h.
  - D1: High FSS. Medium FAR. High POD.
- **ICON GR (MAY):**
  - D0: Everything great.
  - D1: Everything great with the exception of POD at bigger scales.

# General conclusion

- ICON models seem to have an overall good performance over the COSMO ones
- Among the COSMO models, COSMO 1E seems to generally have better performances (like COSMO 1 used to have)
- ICON GR seems very promising (even if it has been verified only for the month of May)
- The best performance of the ICON models when compared to the COSMO ones is in spring and autumn. The values are more mixed for summer and winter.
- **FOR THE FUTURE**: feasibility study to add a review of the precipitation regime for each season to better evaluate the performance of the models.



THANK YOU FOR YOUR ATTENTION!



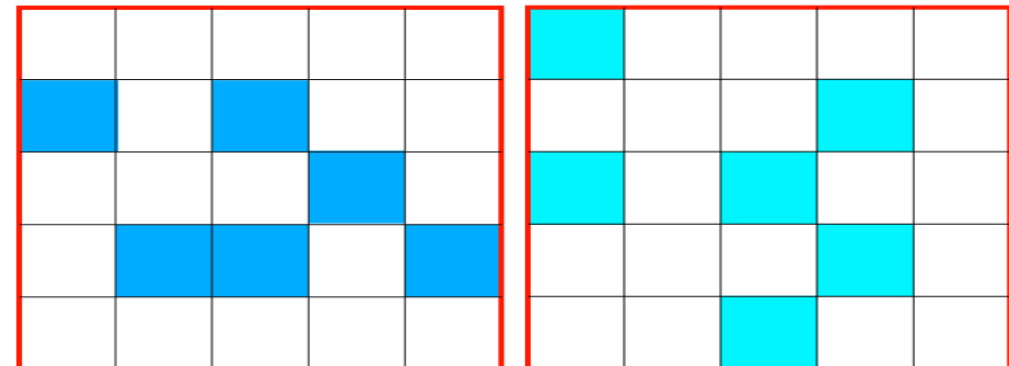
# Fractions skill score

(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

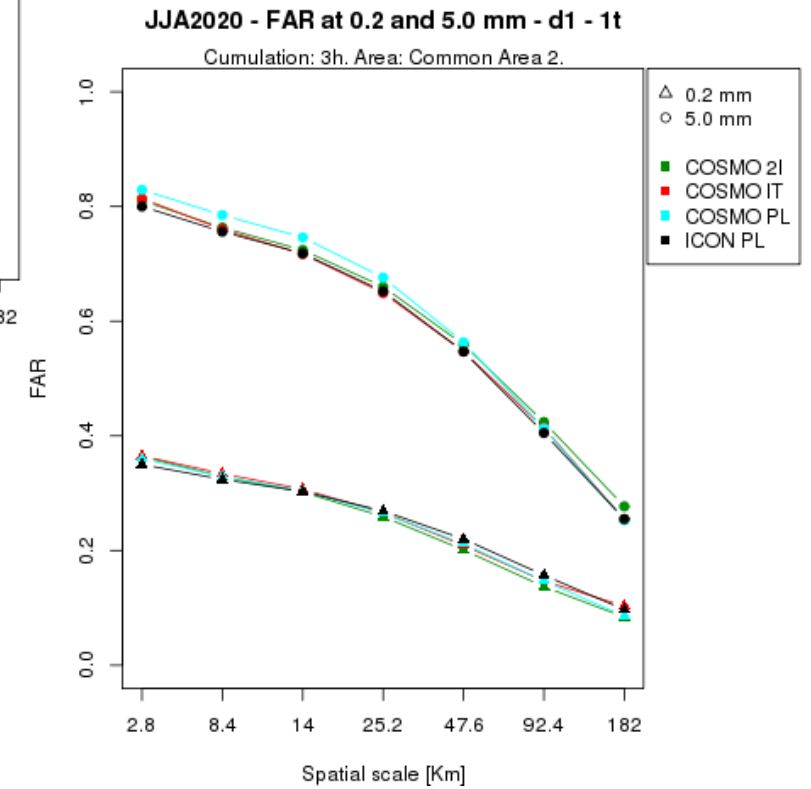
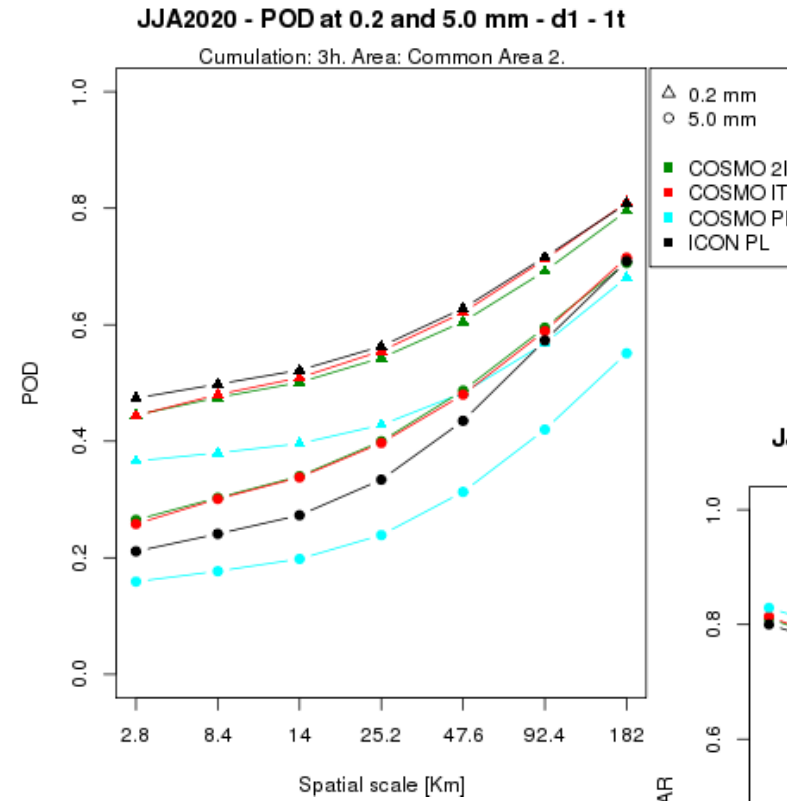
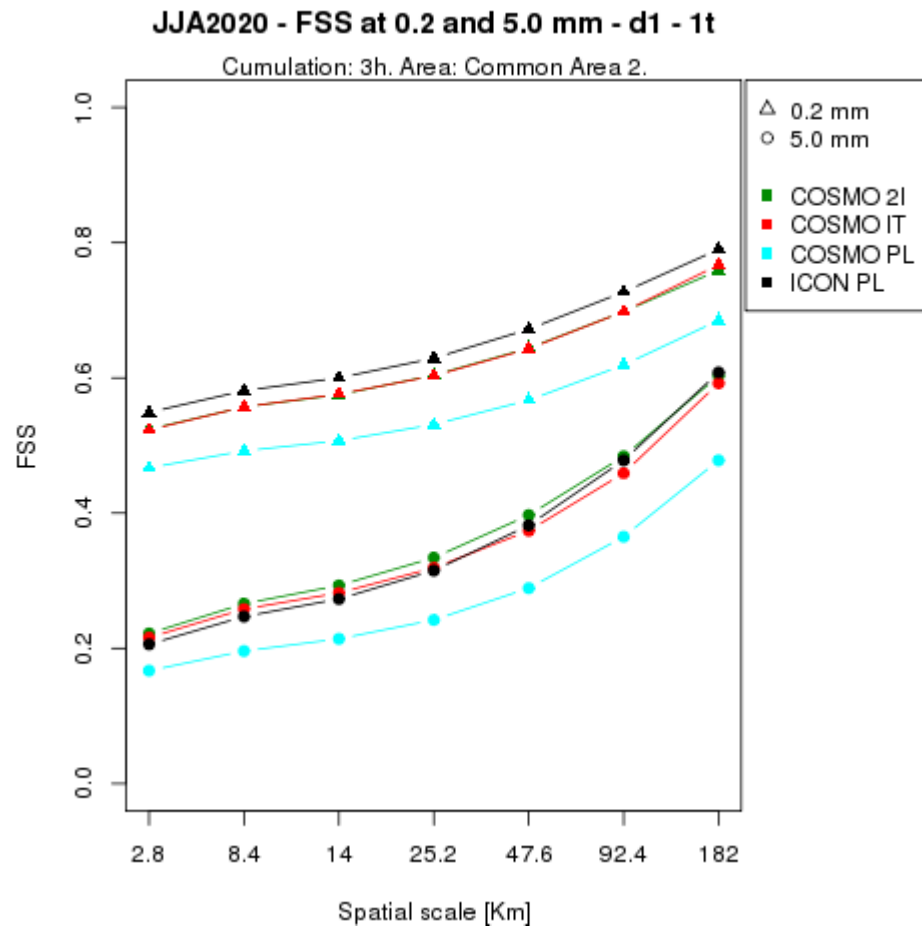
$$\text{FSS} = 1 - \frac{\frac{1}{N} \sum_{i=1}^N (P_{fcst} - P_{obs})^2}{\frac{1}{N} \sum_{i=1}^N P_{fcst}^2 + \frac{1}{N} \sum_{i=1}^N P_{obs}^2}$$



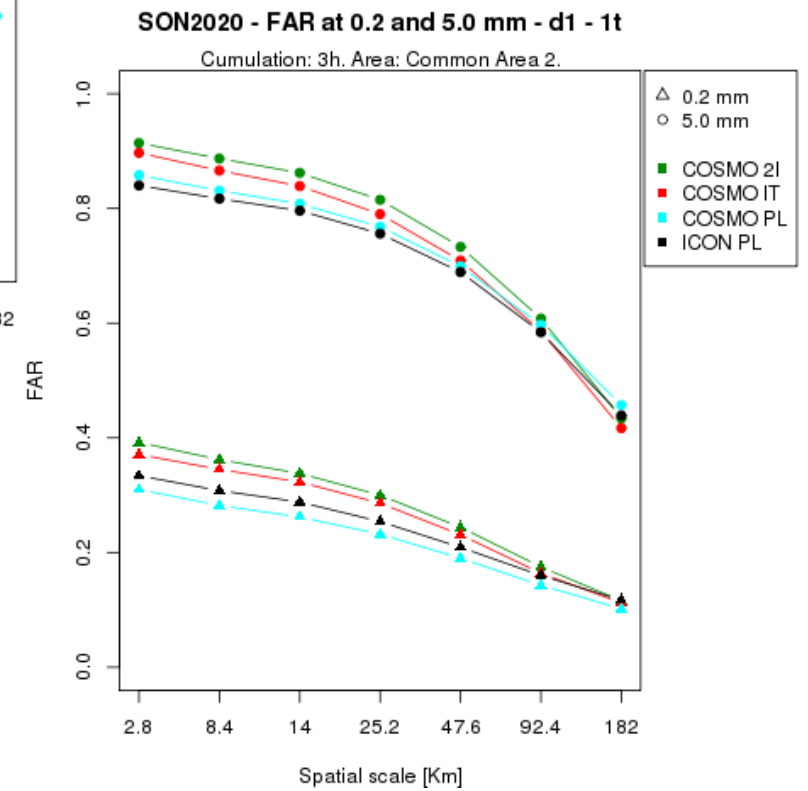
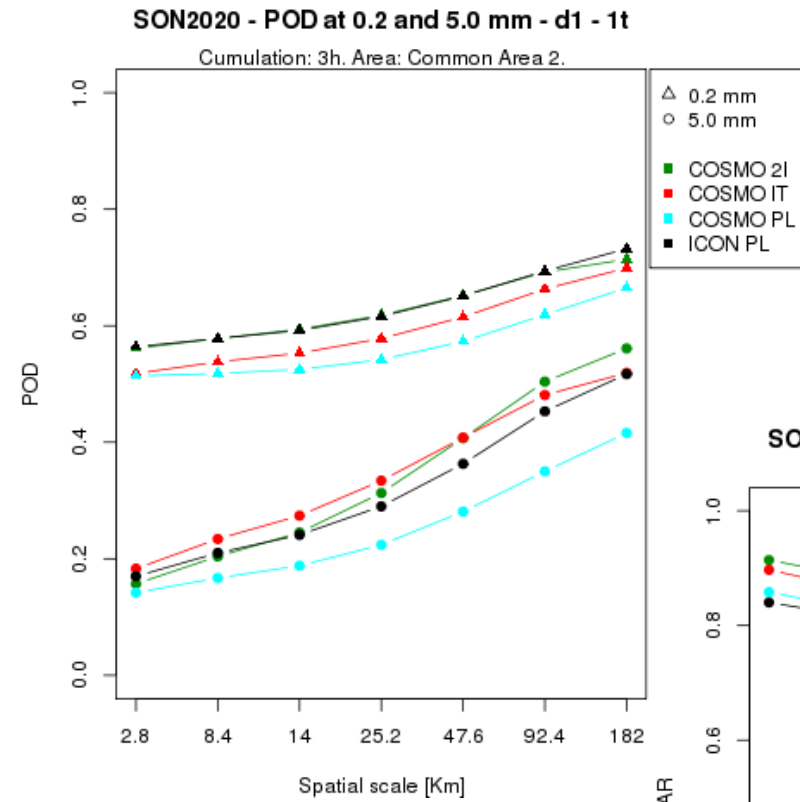
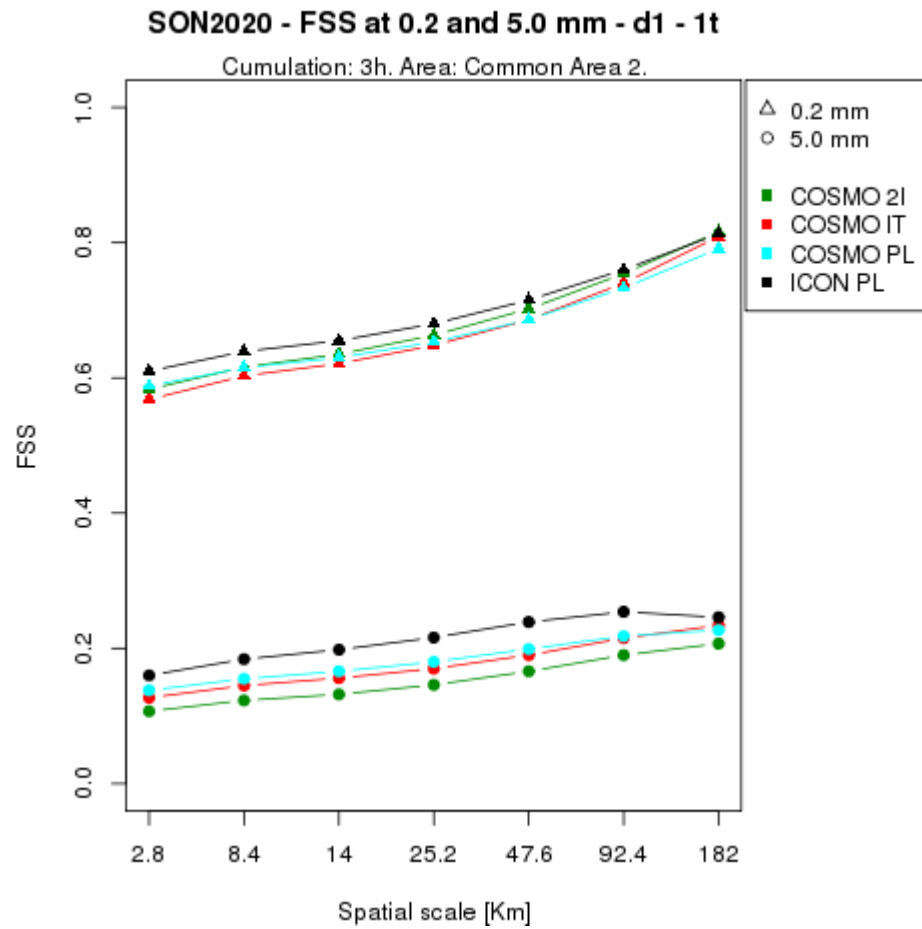
Fraction = 6/25 = 0.24  
observed

Fraction = 6/25 = 0.24  
forecast

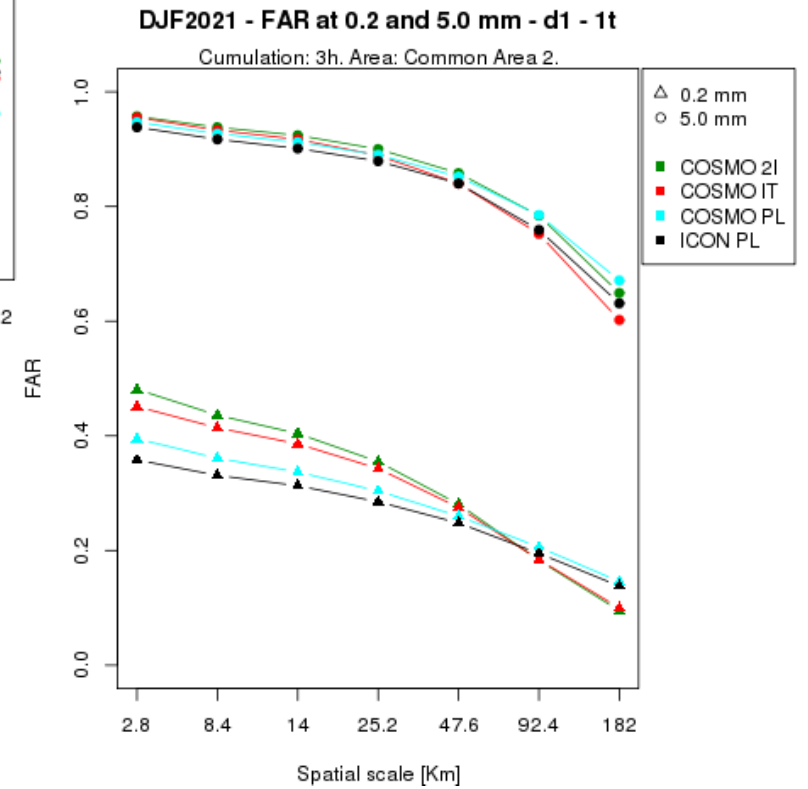
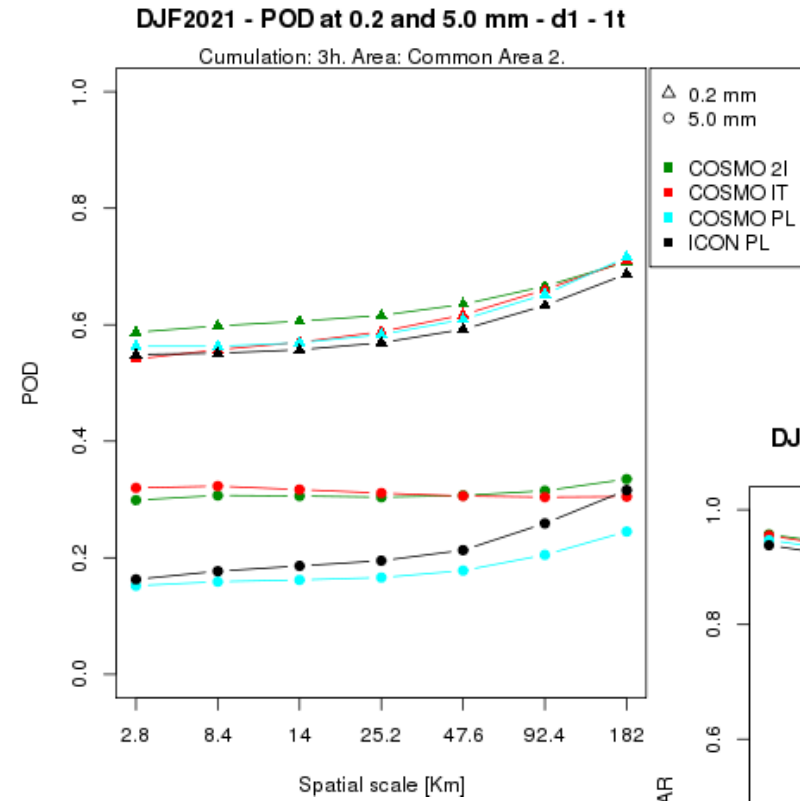
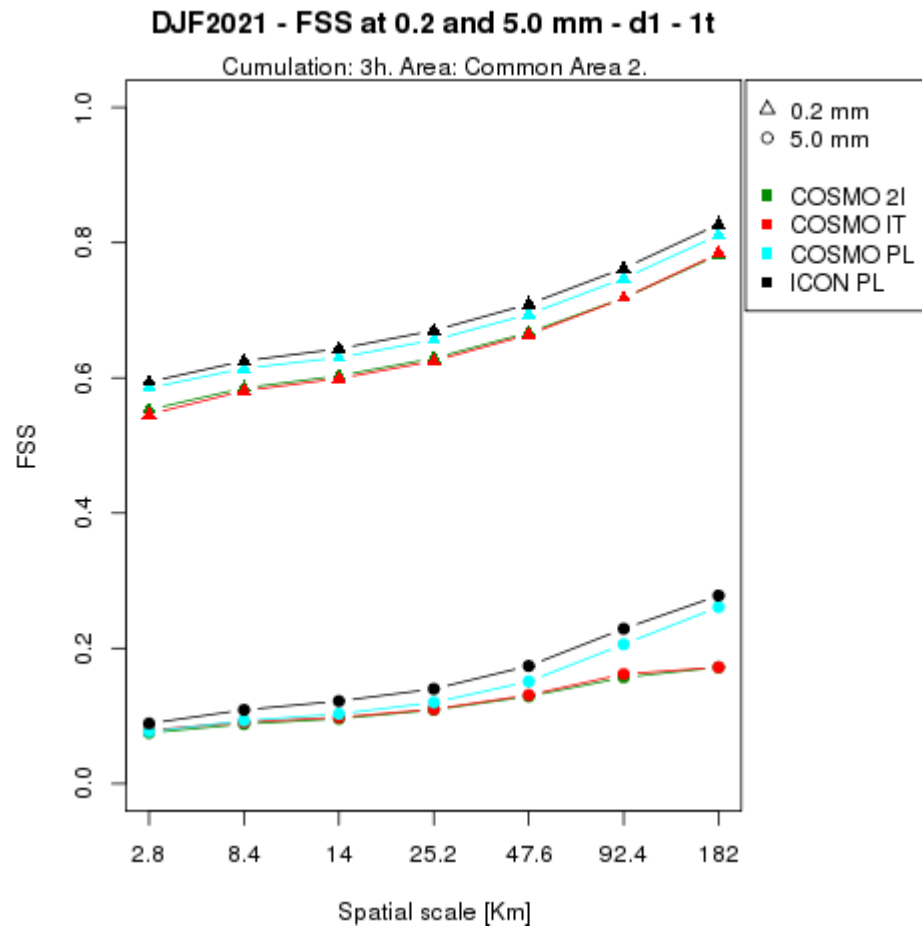
# D1 PLOTS (1T) JJA 2020



# D1 PLOTS (1T) SON 2020



# D1 PLOTS (1T) DJF 2021





# D1 PLOTS (1T) MAM 2021

