



# Fuzzy verification on Common Areas

Naima Vela



1

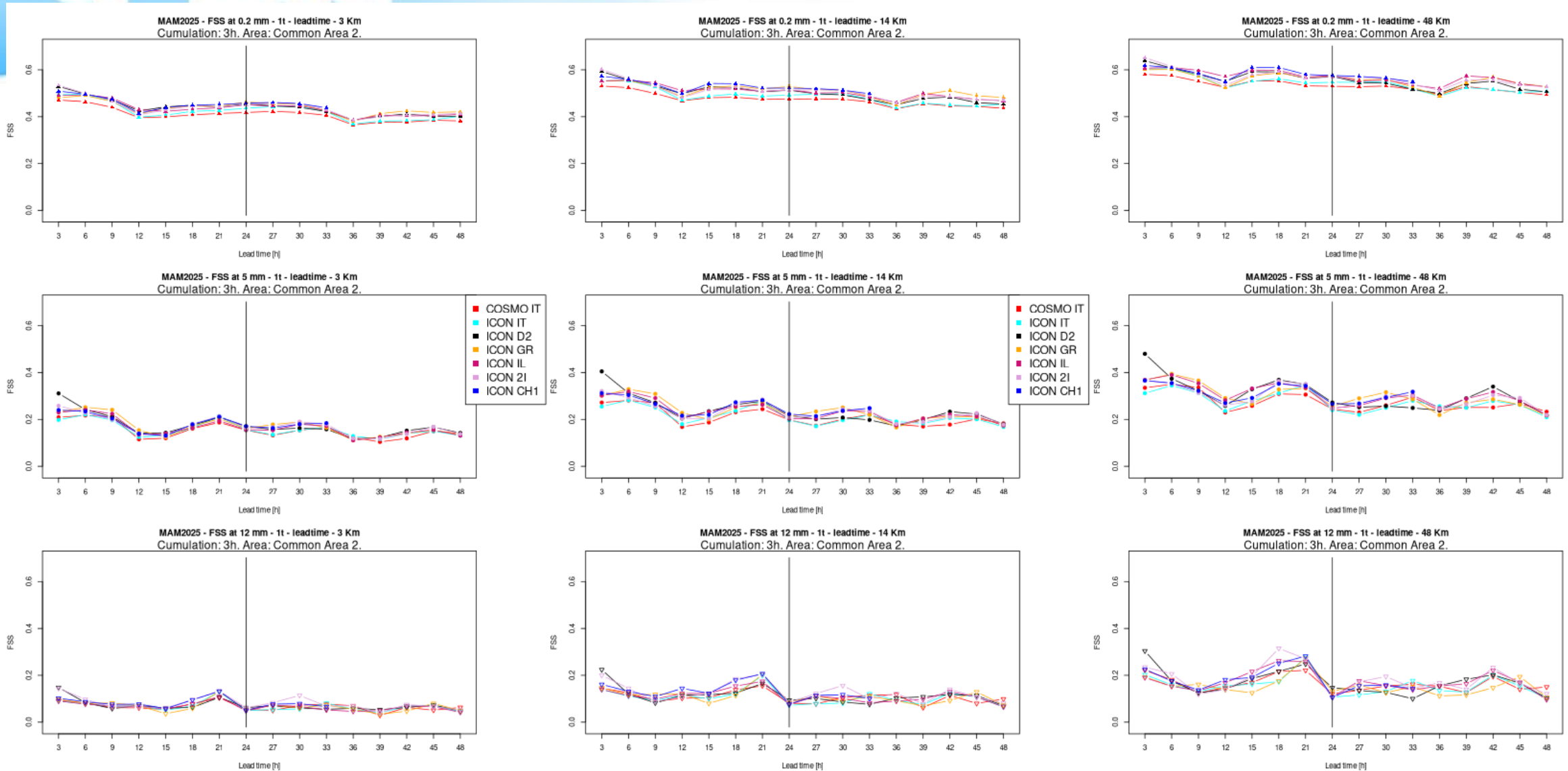
September the 1<sup>st</sup> 2025 - 27<sup>th</sup> COSMO General Meeting - Basel



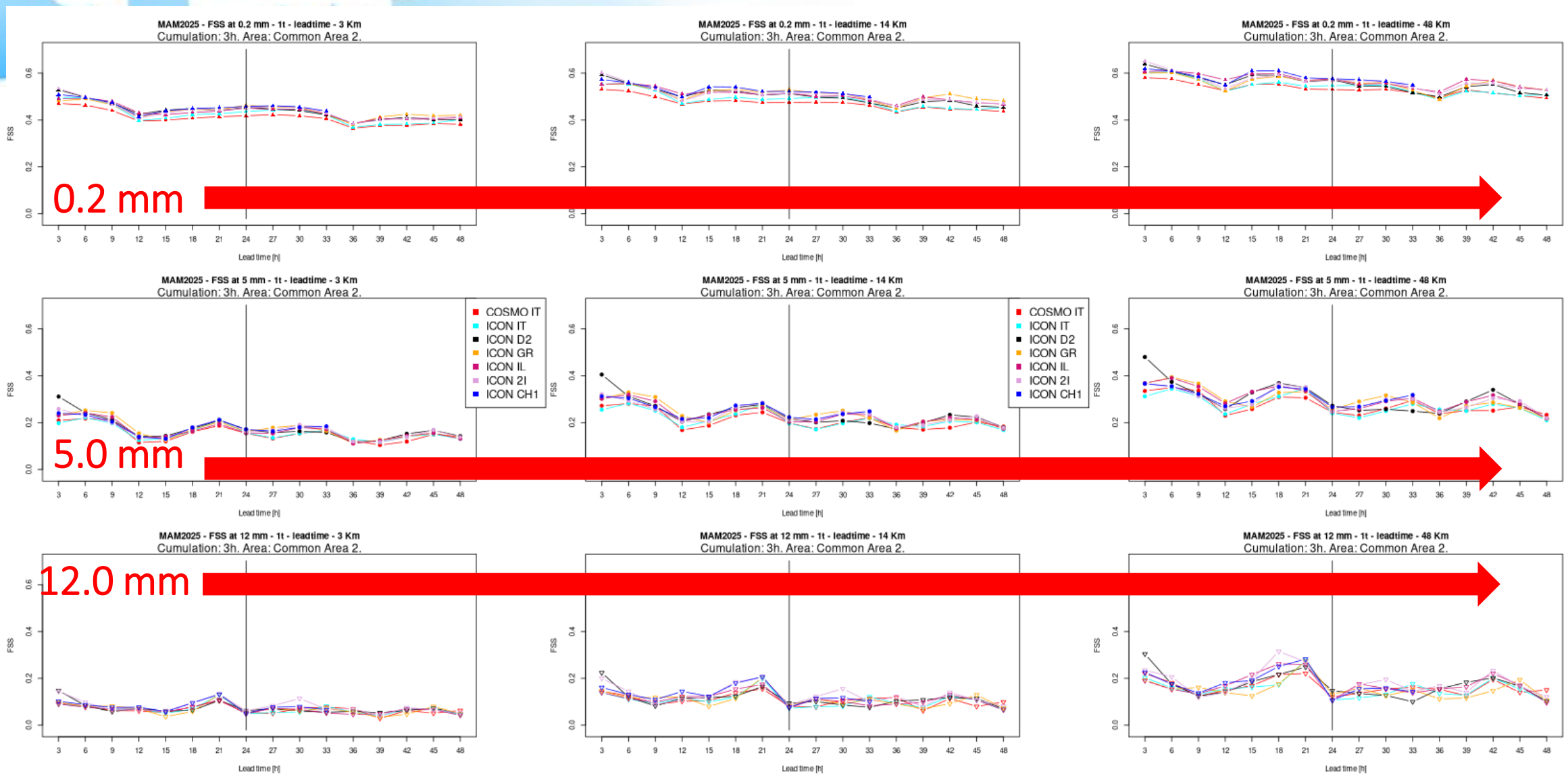
# DESCRIPTION OF THE VERIFICATION

- Models:
    - Common Area 2:
      - ICON D2, ICON CH1, ICON GR, COSMO IT, ICON IT, ICON IL, ICON 2I
    - Common Area 3:
      - ICON GR, ICON PL, COSMO CE PL, ICON IL, ICON RO
  - Observation: OPERA database by EUMETNET
  - Resolution (forecast and observation): 0.025°, lat-lon
  - Period: JJA 2024, SON 2024, DJF 2025, MAM 2025
- Scores: FSS, FBI, ETS, FAR, POD
  - Methods: 1 timestep/3 timesteps
  - D0/D1
  - Cumulation: 3h

# Fuzzy verification: new plots



# Fuzzy verification: new plots

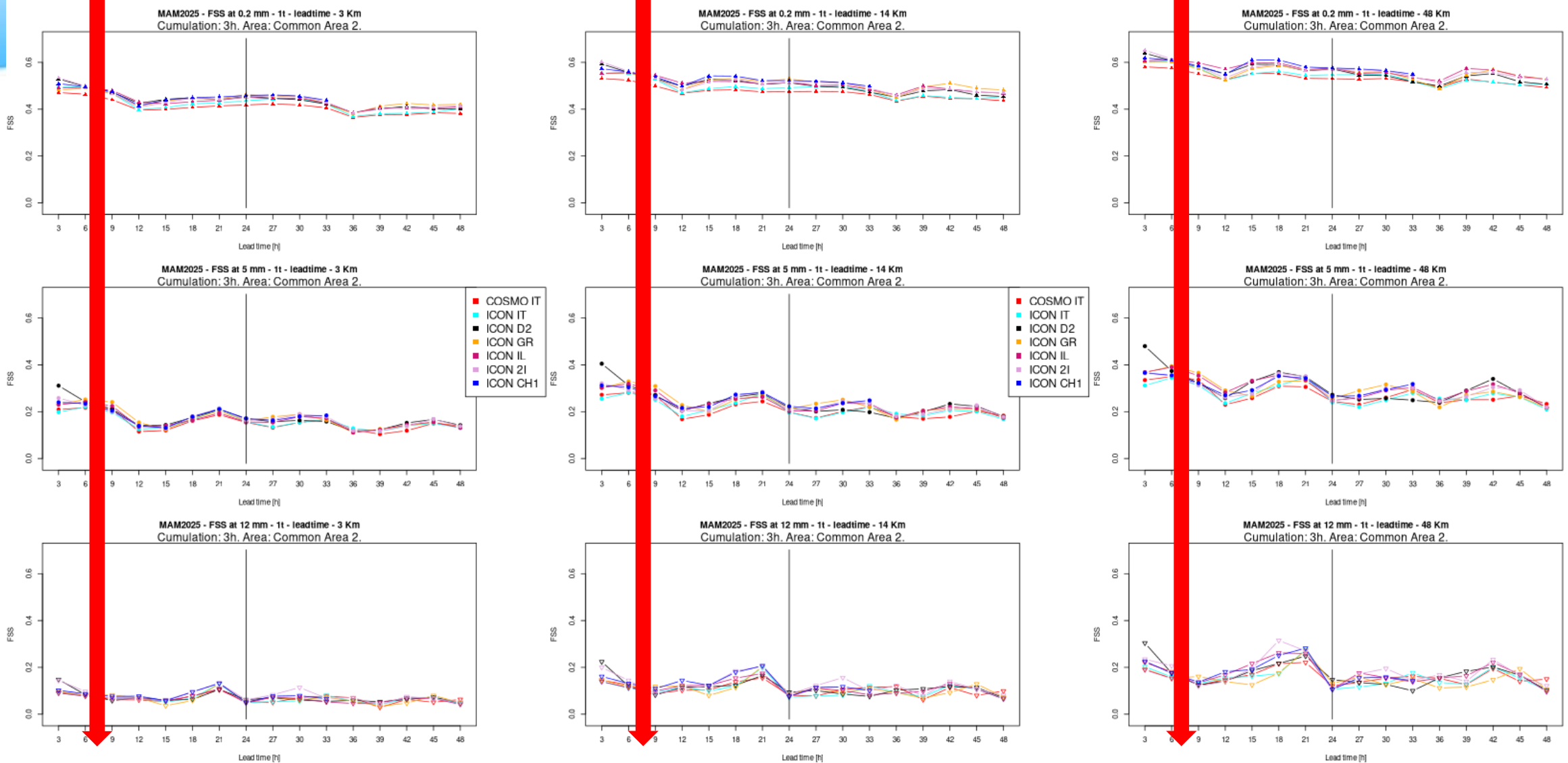


# Fuzzy verification: new plots

3 Km

14 Km

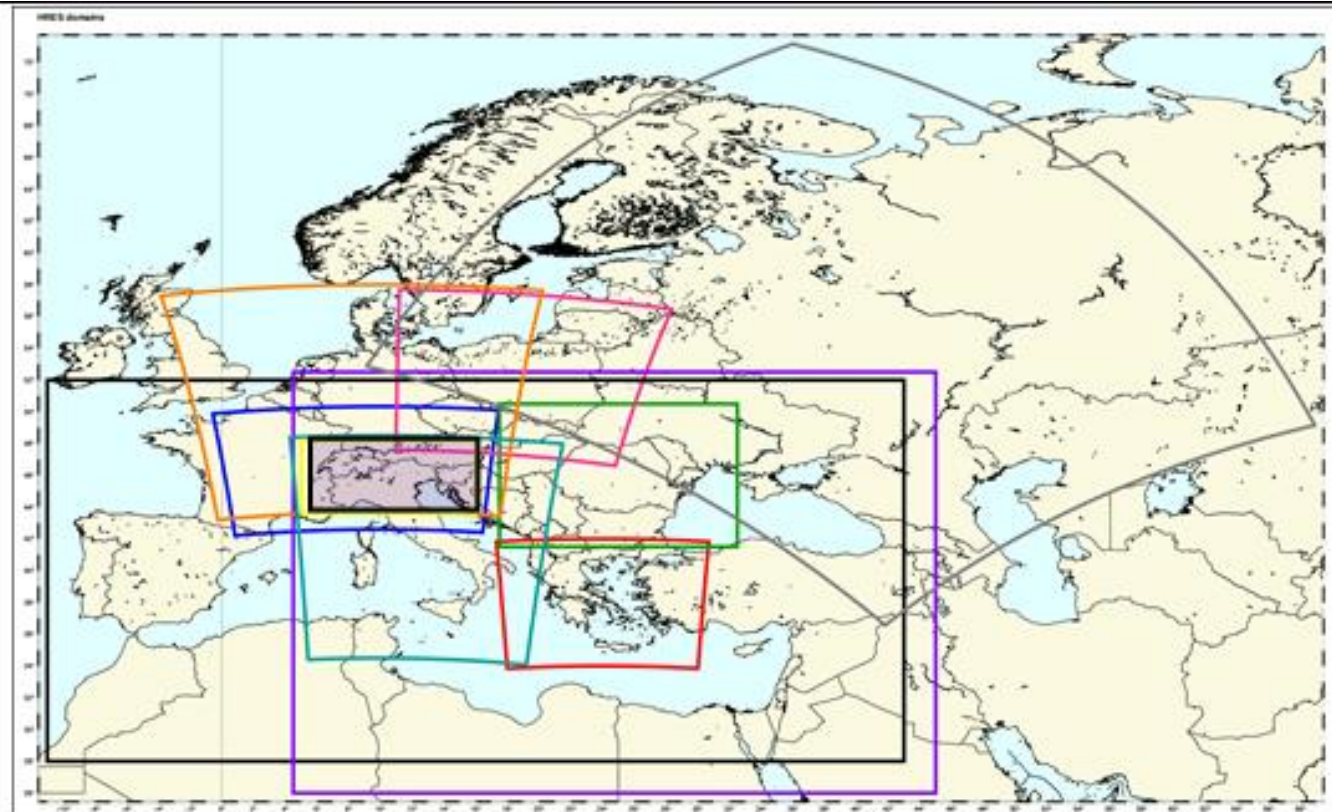
48 Km



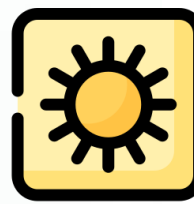
3



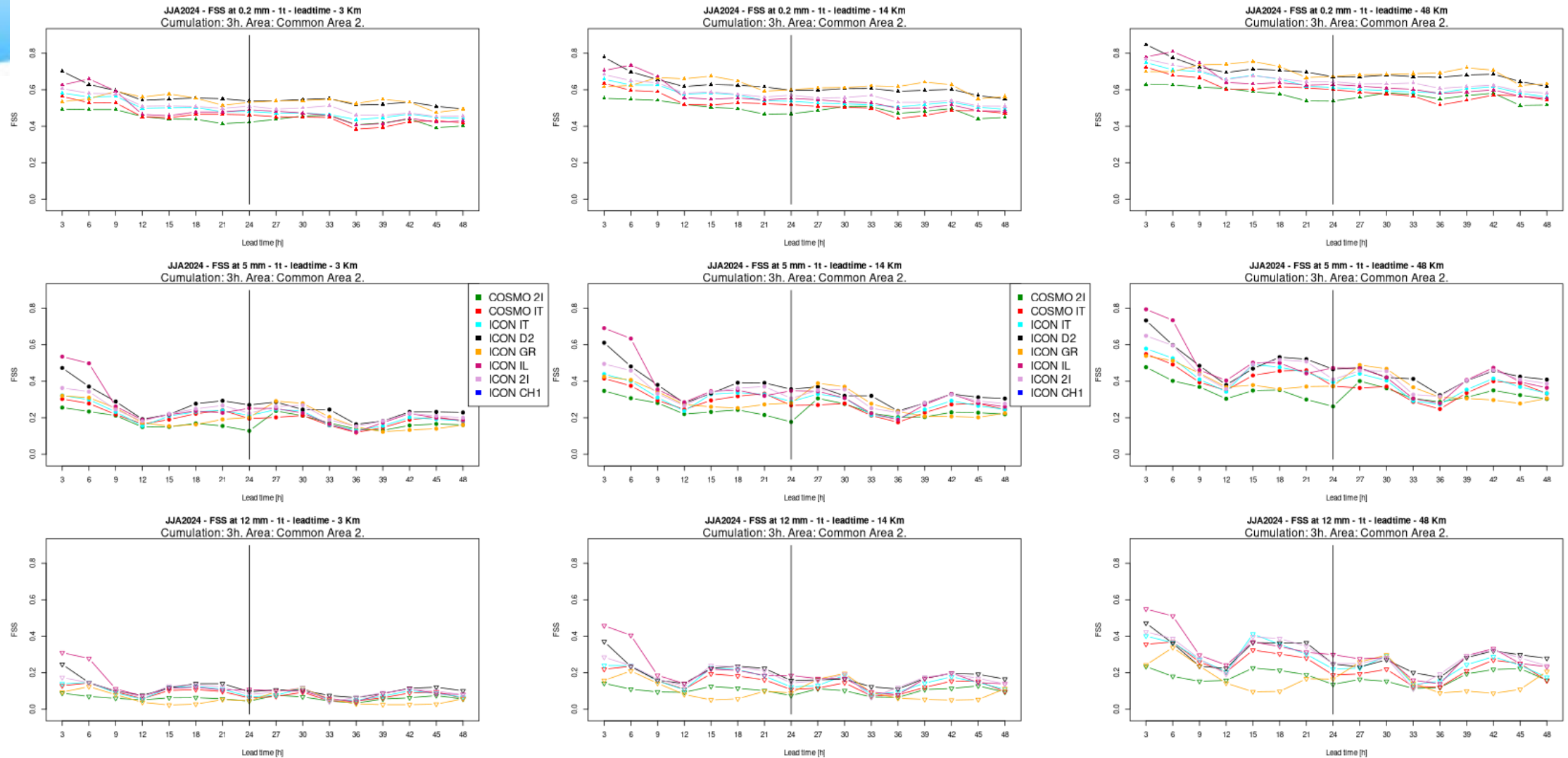
# COMMON AREA 2

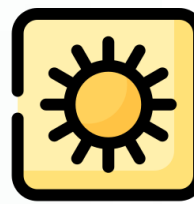


**Area: 43.5-48.2 N; 5.0-16.0 E**

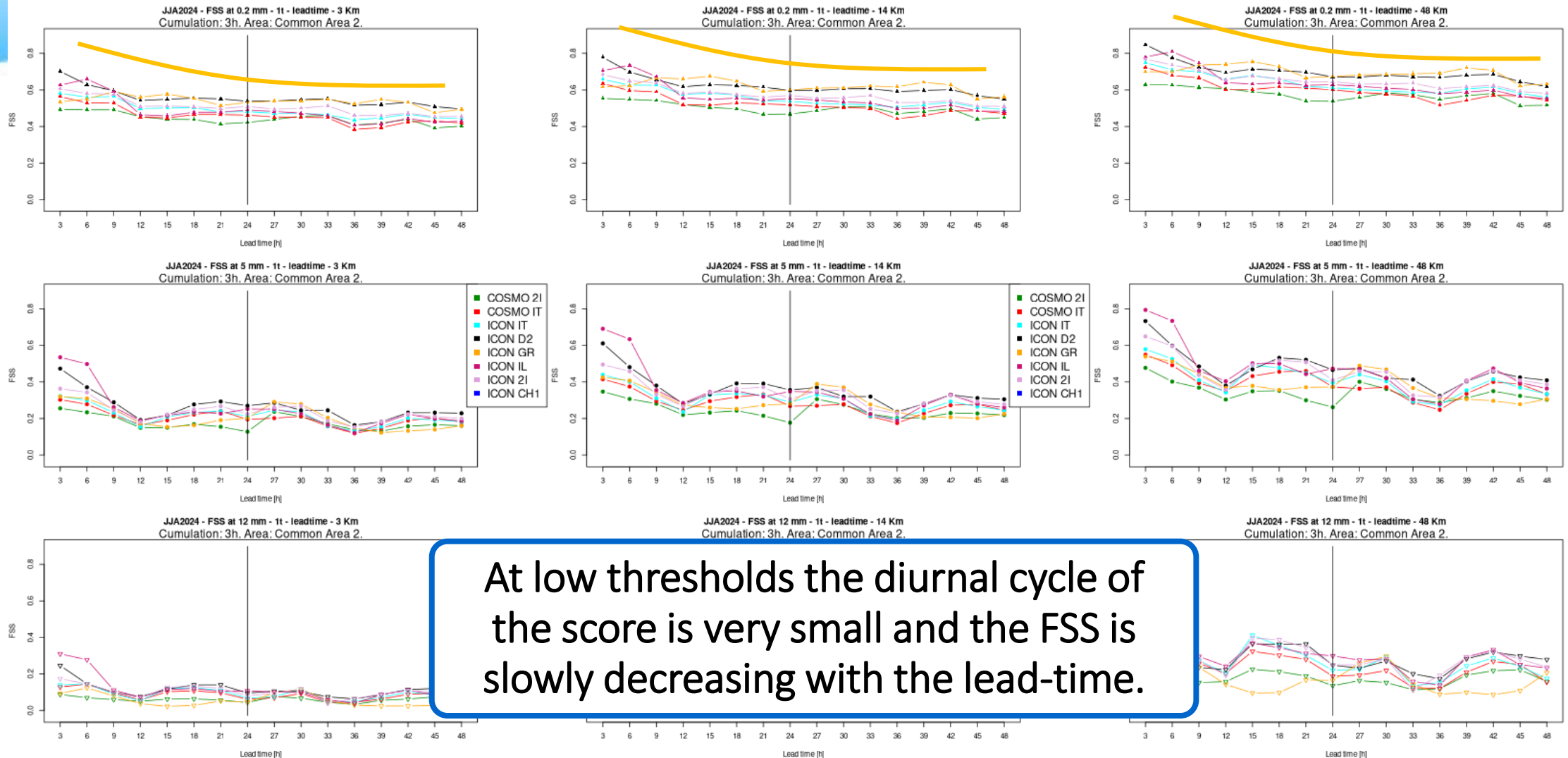


# FSS - JJA 2024 – COMMON AREA 2

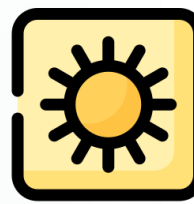




## FSS - JJA 2024 – COMMON AREA 2

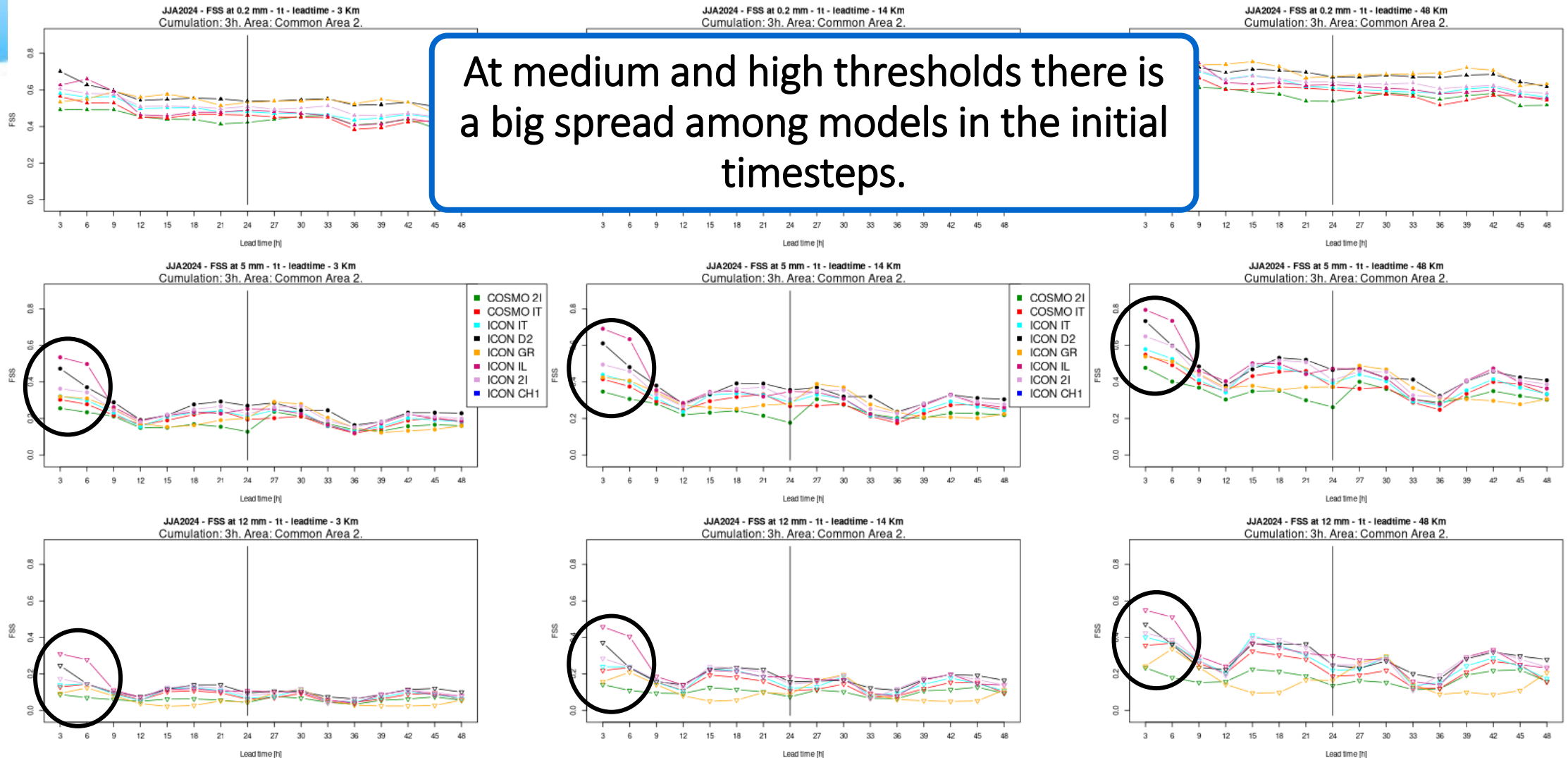


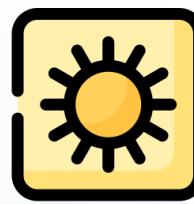




# FSS - JJA 2024 – COMMON AREA 2

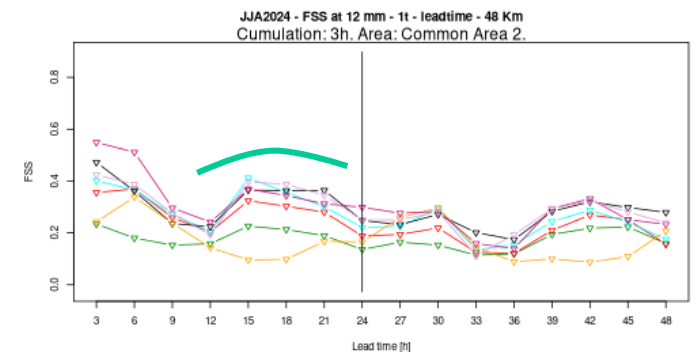
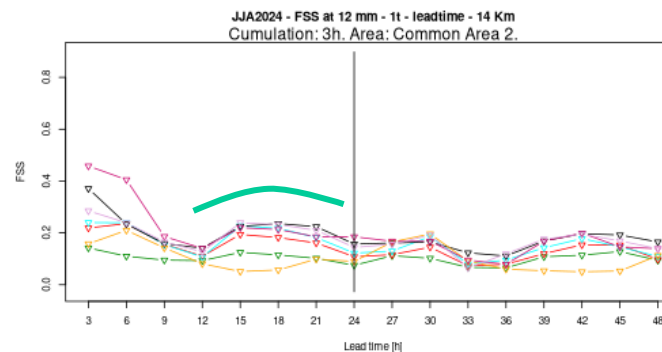
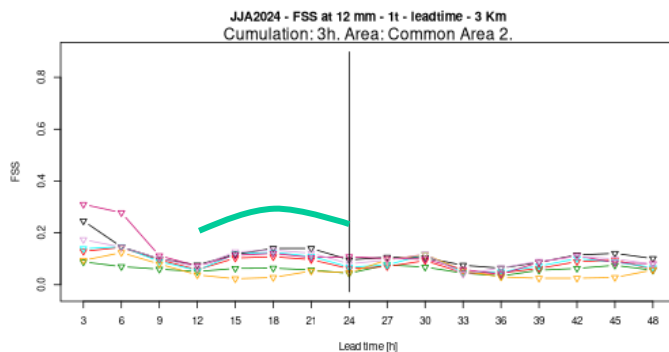
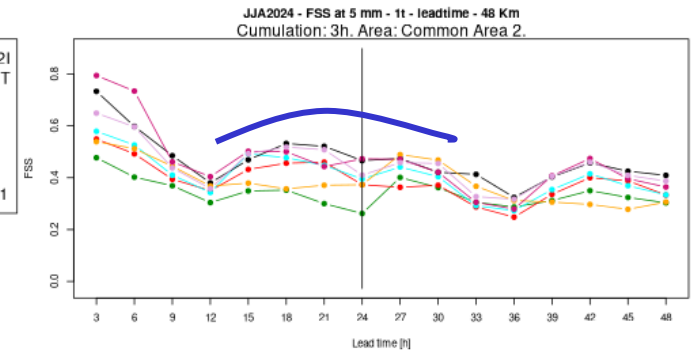
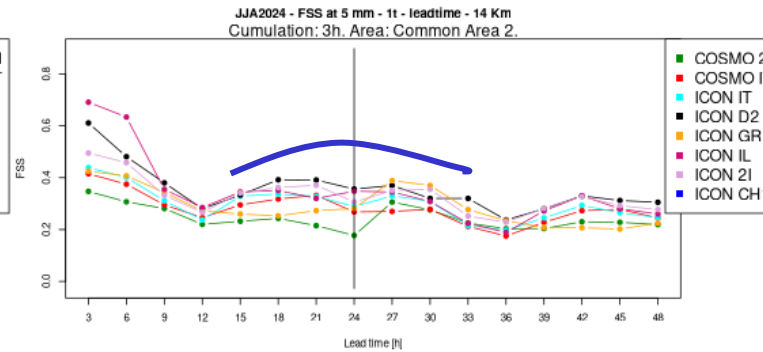
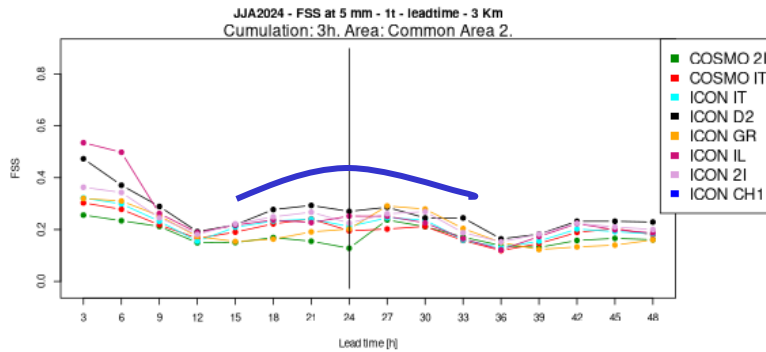
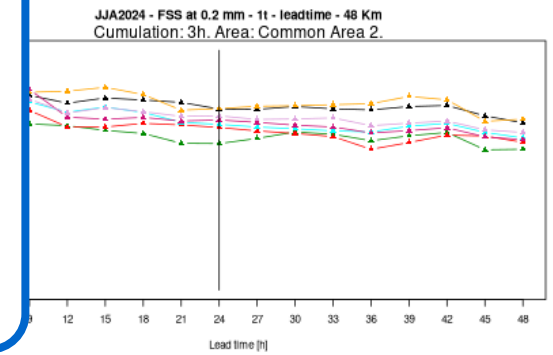
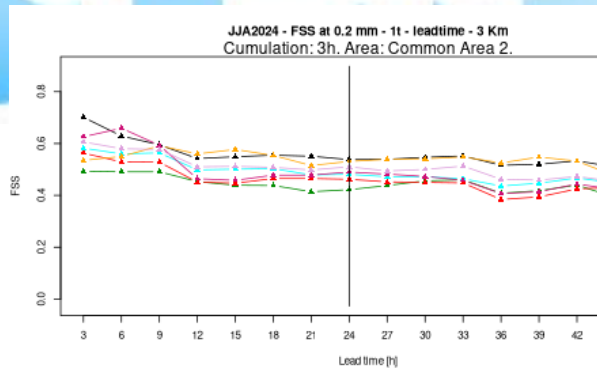
At medium and high thresholds there is a big spread among models in the initial timesteps.

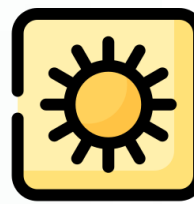




## FSS - JJA 2024 – COMMON AREA 2

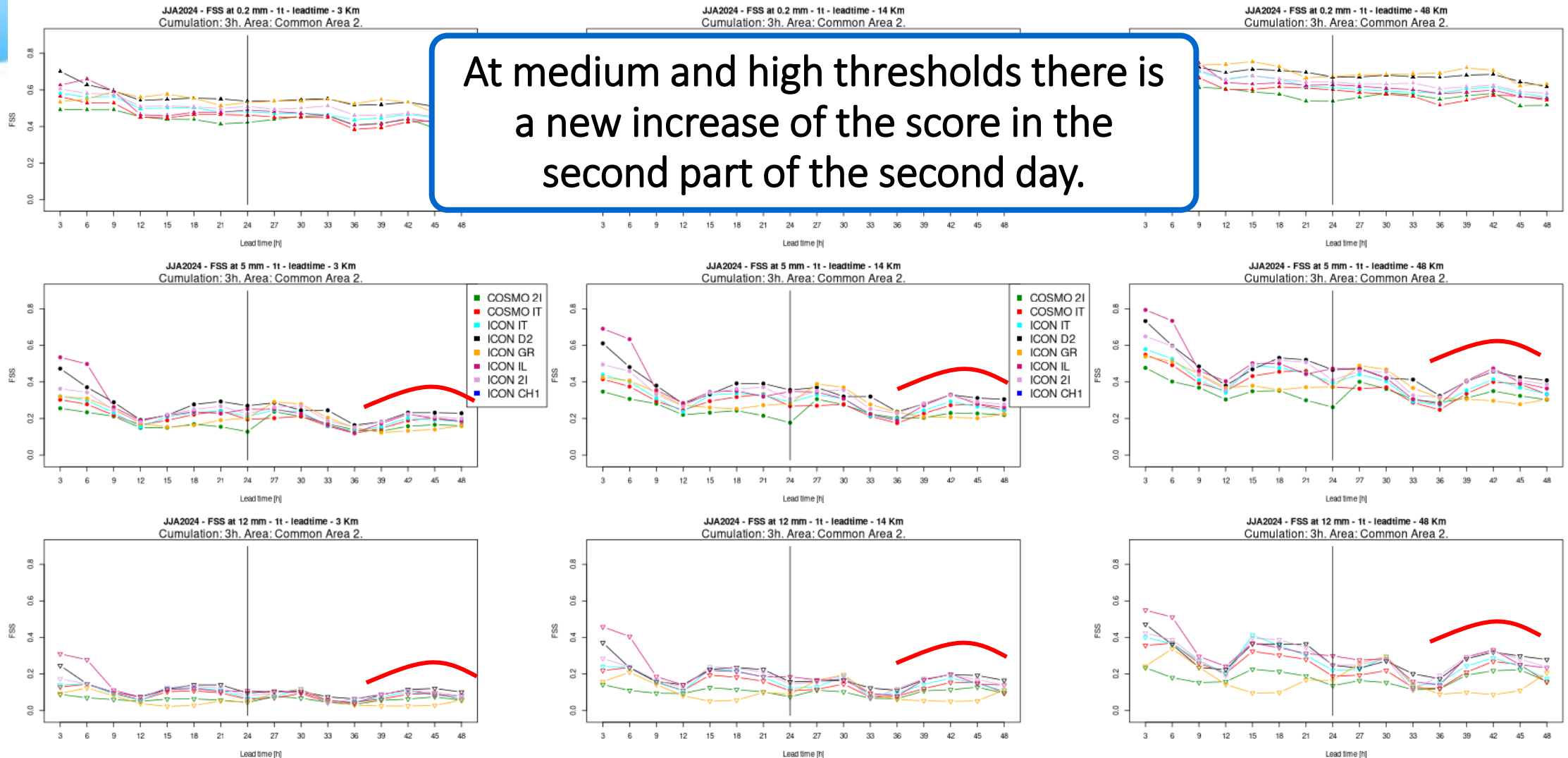
At medium thresholds there is an increase in the score during the evening of the first day lasting until the morning of the second day. At high thresholds the decrease starts earlier.

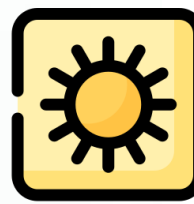




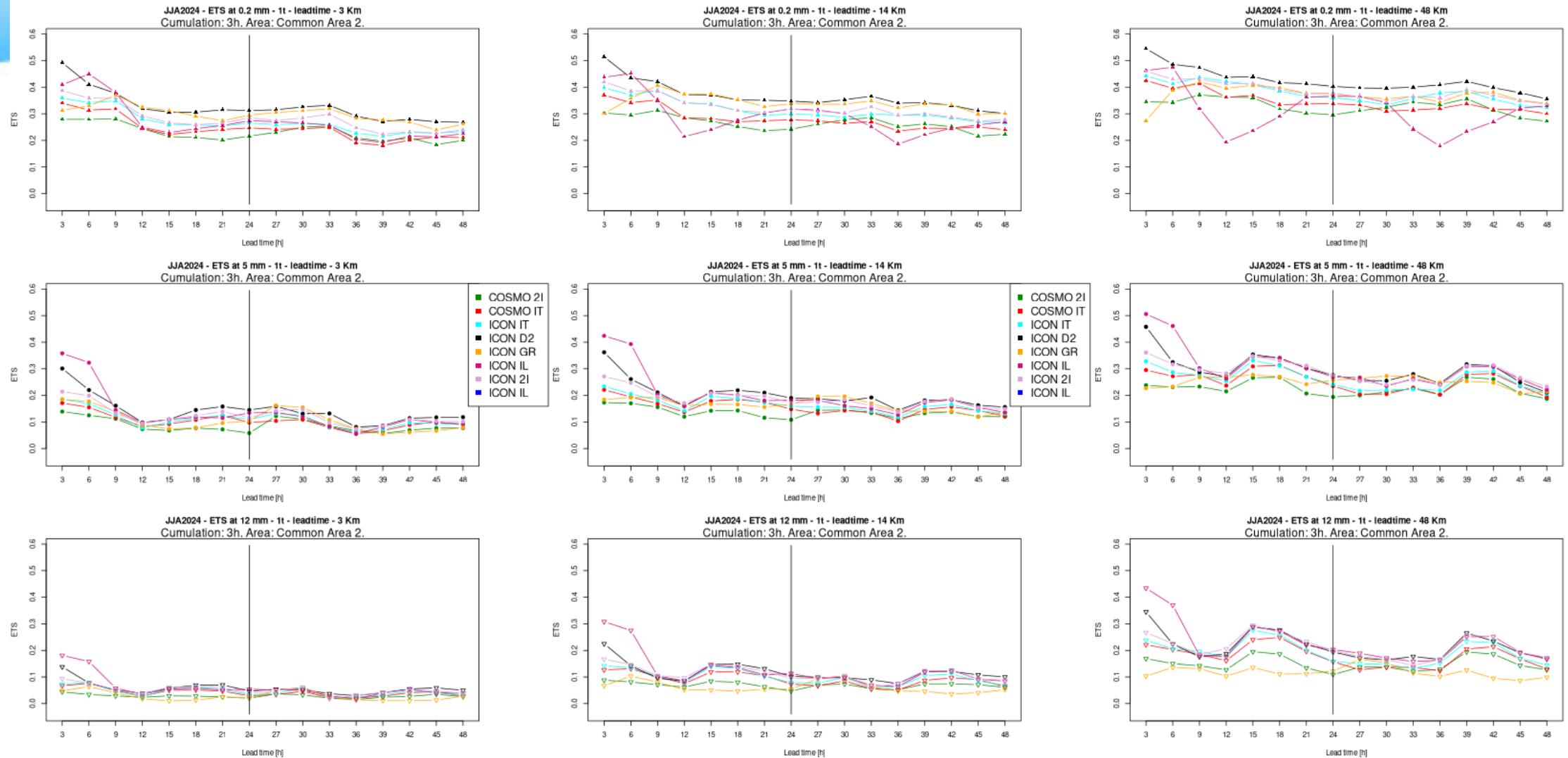
# FSS - JJA 2024 – COMMON AREA 2

At medium and high thresholds there is a new increase of the score in the second part of the second day.

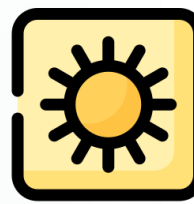




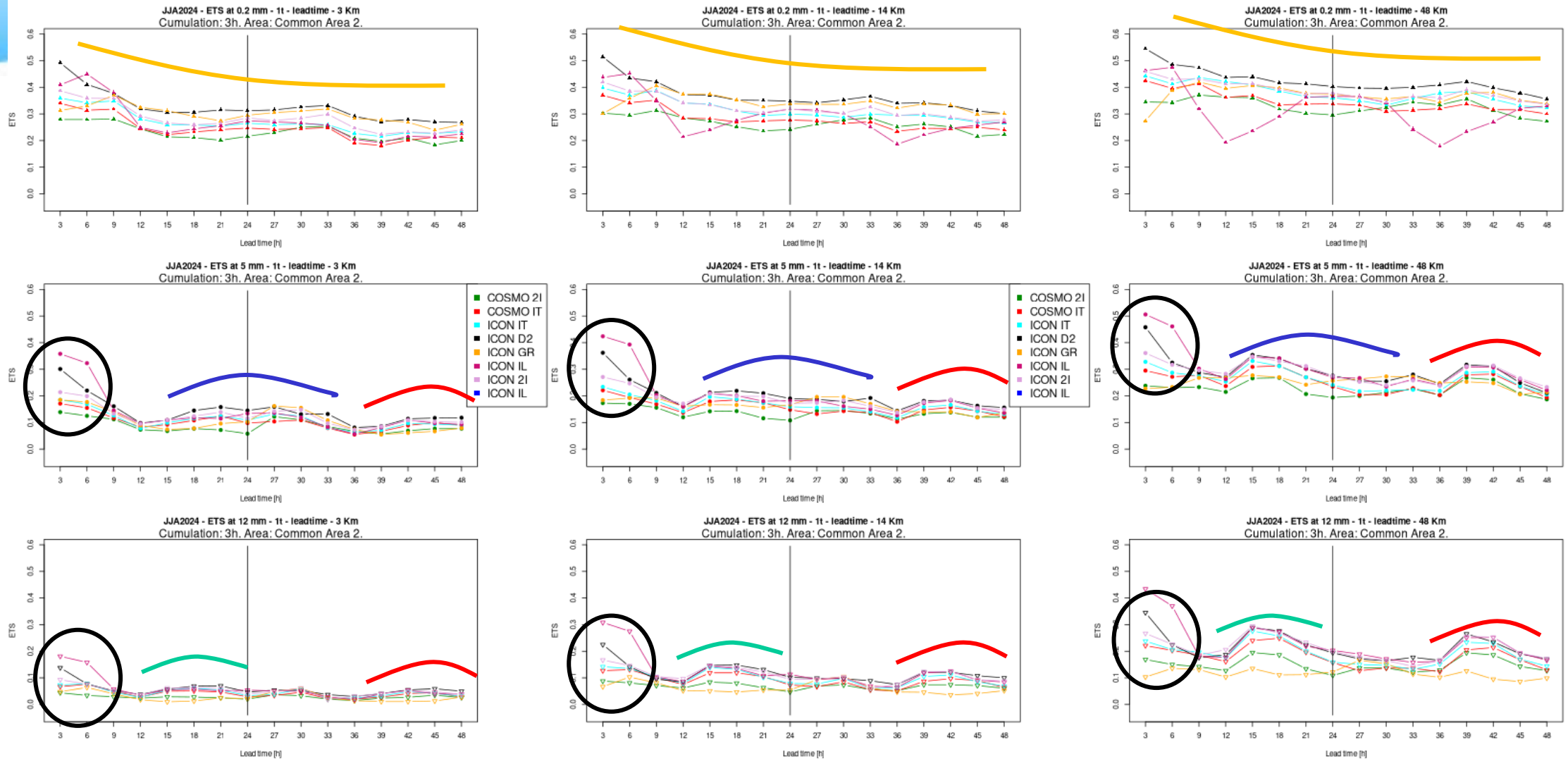
# ETS - JJA 2024 – COMMON AREA 2





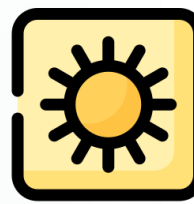


## ETS - JJA 2024 – COMMON AREA 2

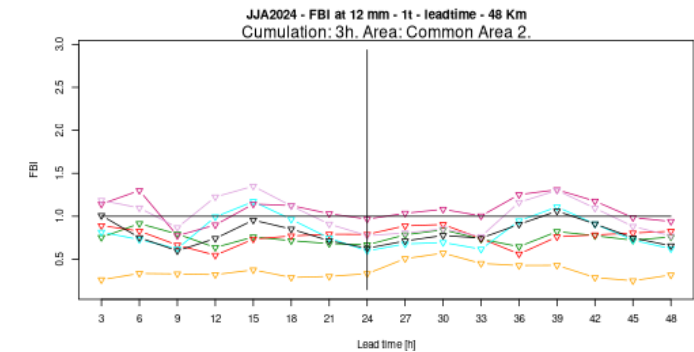
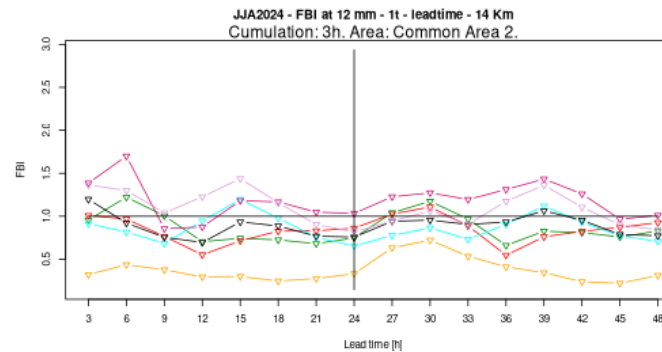
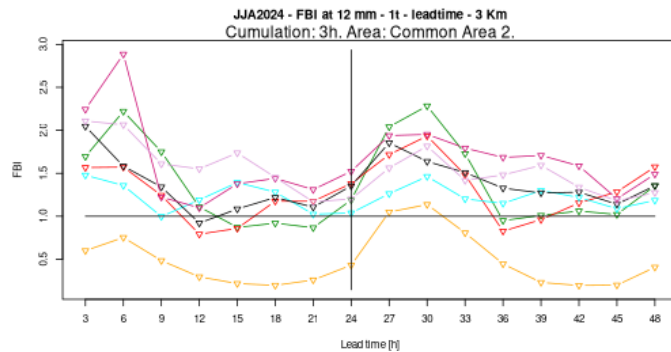
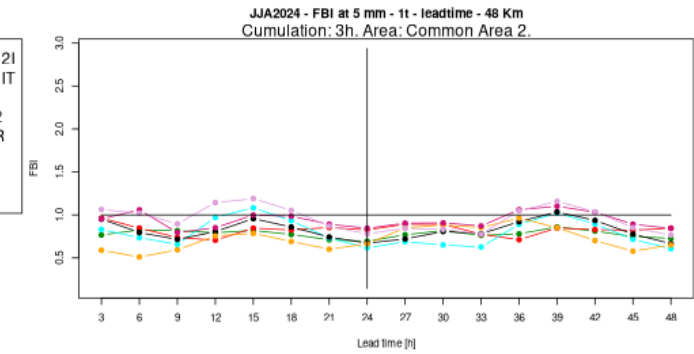
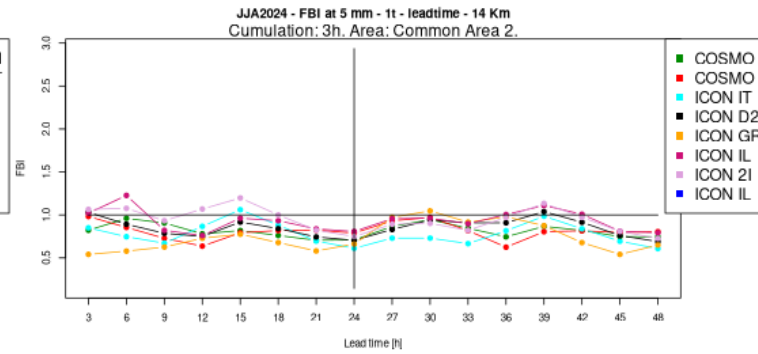
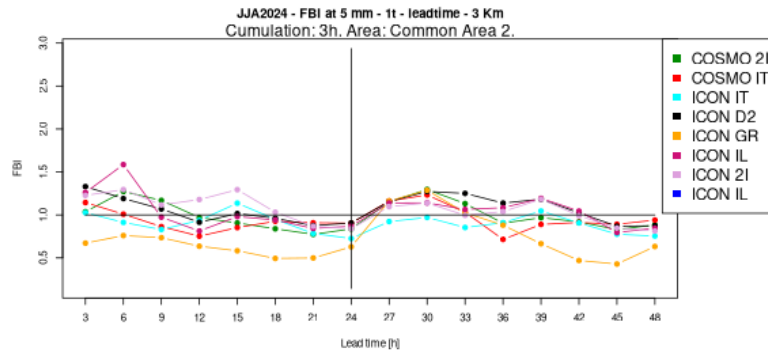
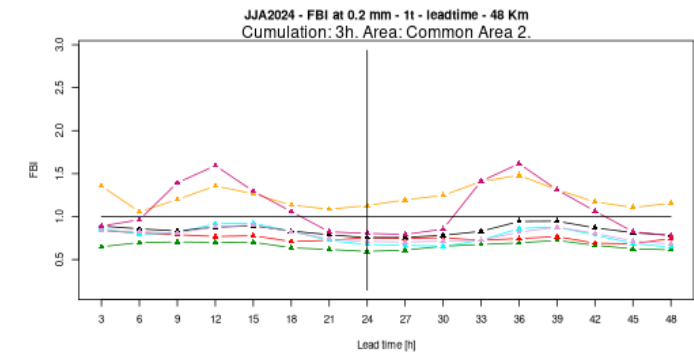
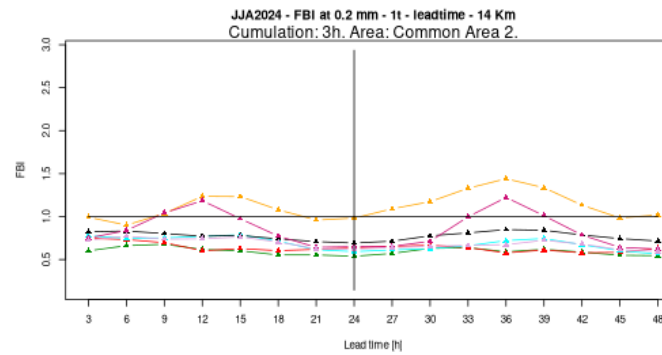
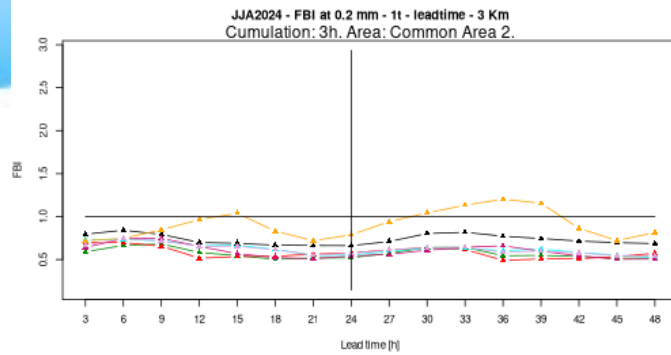


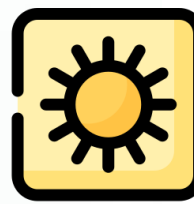
The ETS mimics many of the characteristics of the FSS.



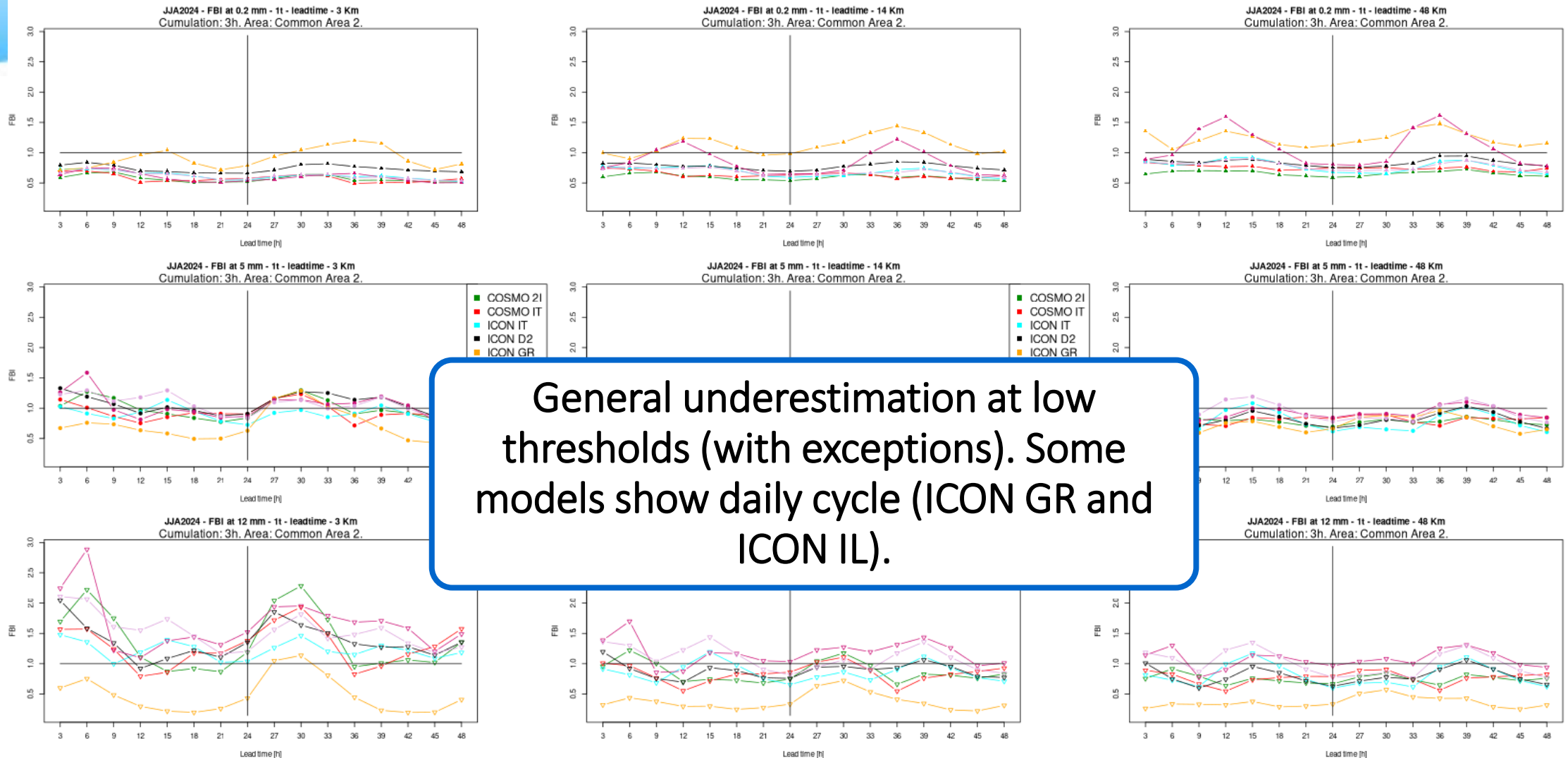


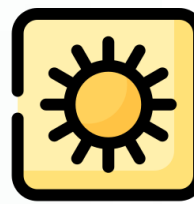
# FBI - JJA 2024 – COMMON AREA 2





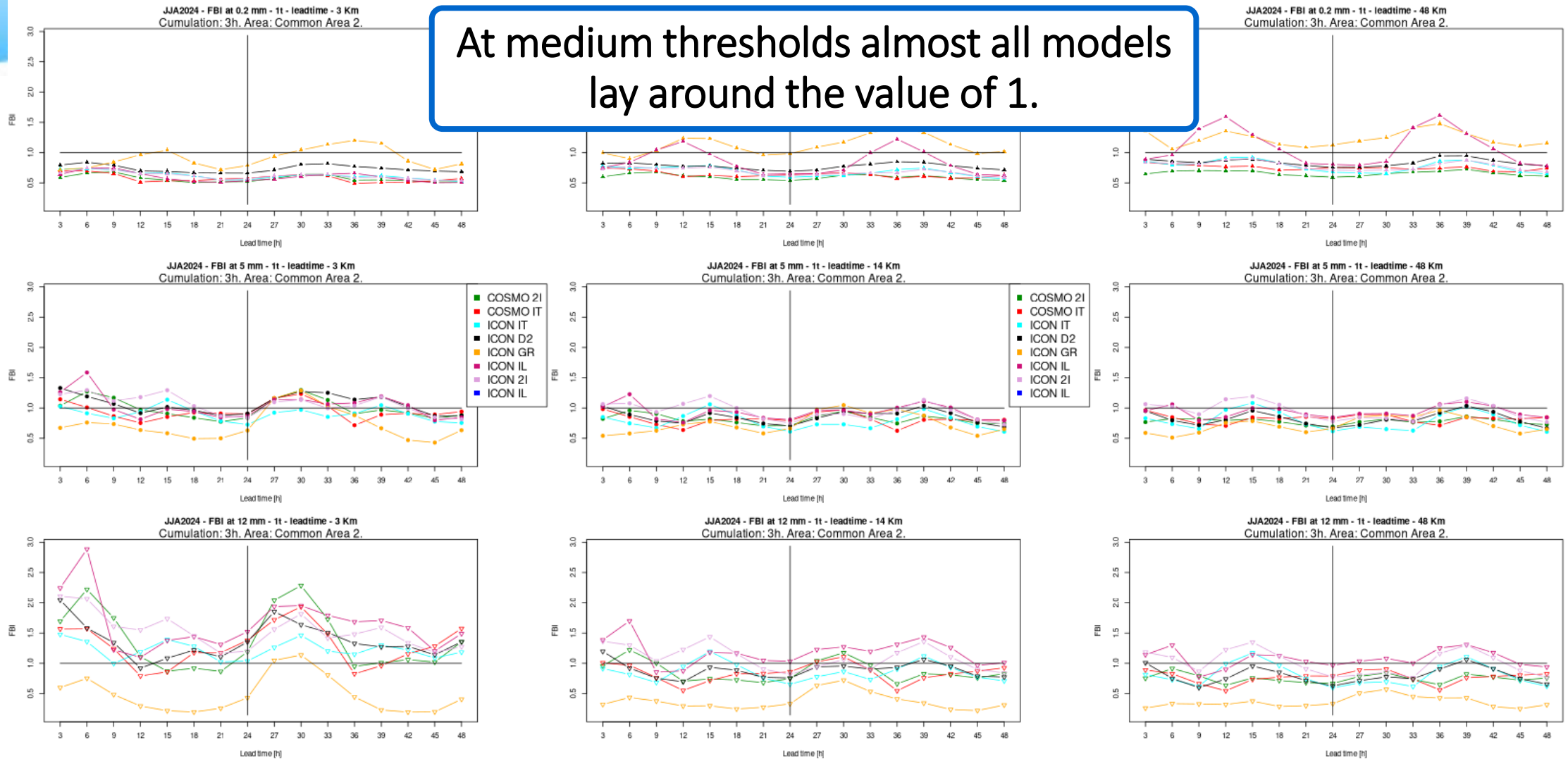
# FBI - JJA 2024 – COMMON AREA 2

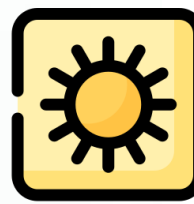




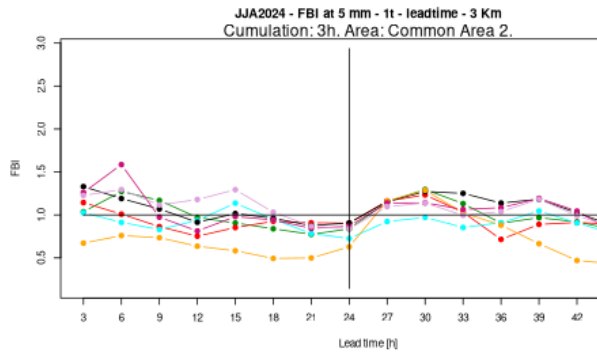
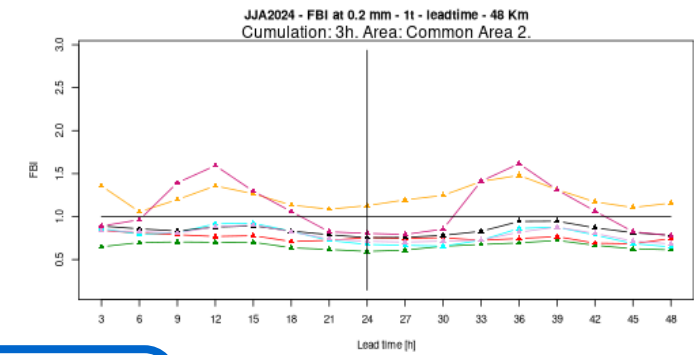
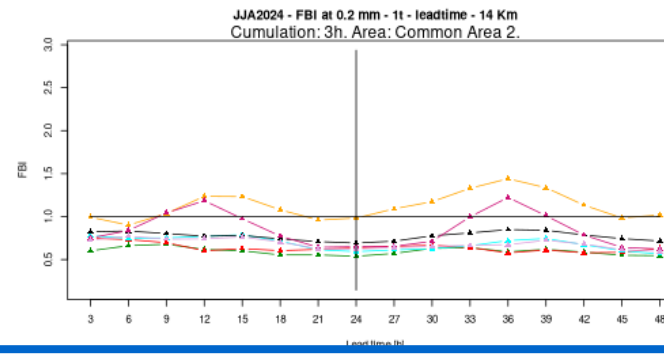
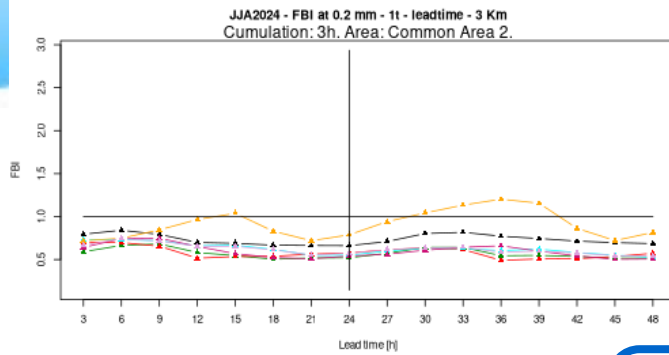
# FBI - JJA 2024 – COMMON AREA 2

At medium thresholds almost all models lay around the value of 1.

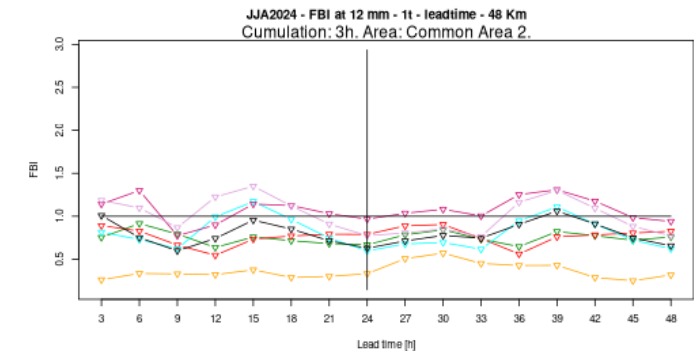
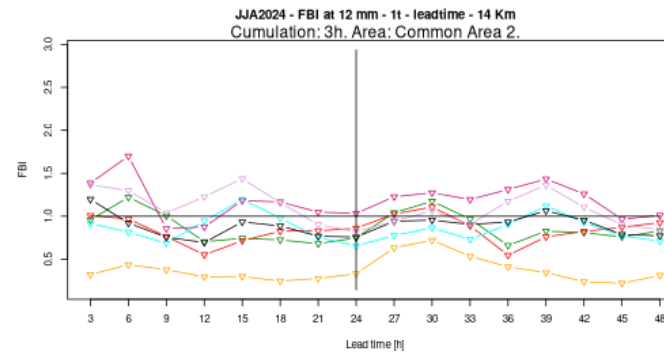
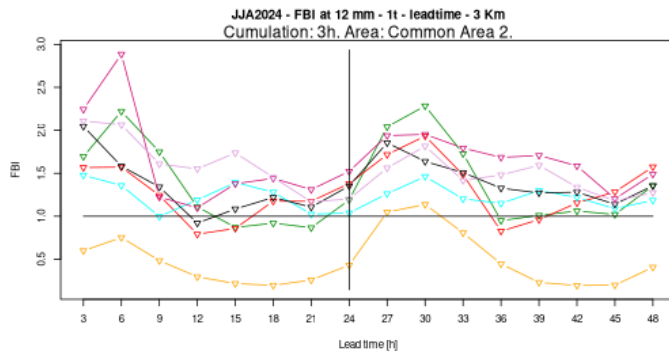
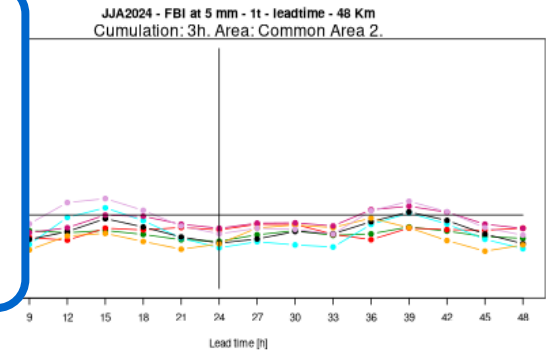




# FBI - JJA 2024 – COMMON AREA 2



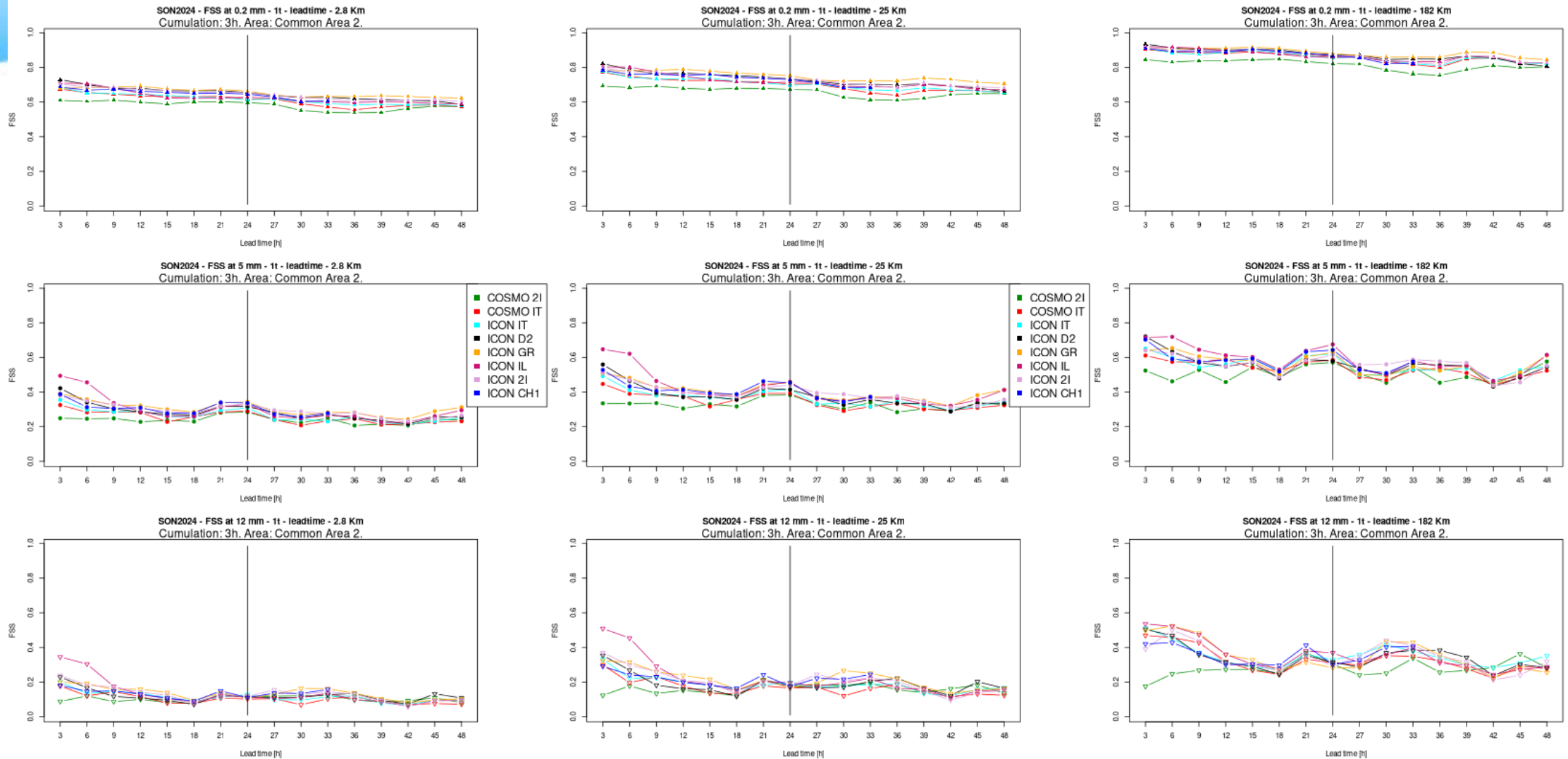
AT high thresholds there is larger overestimation at smaller scales (except for ICON GR), then the BIAS gets smaller. Great daily cycle at the smallest scale.







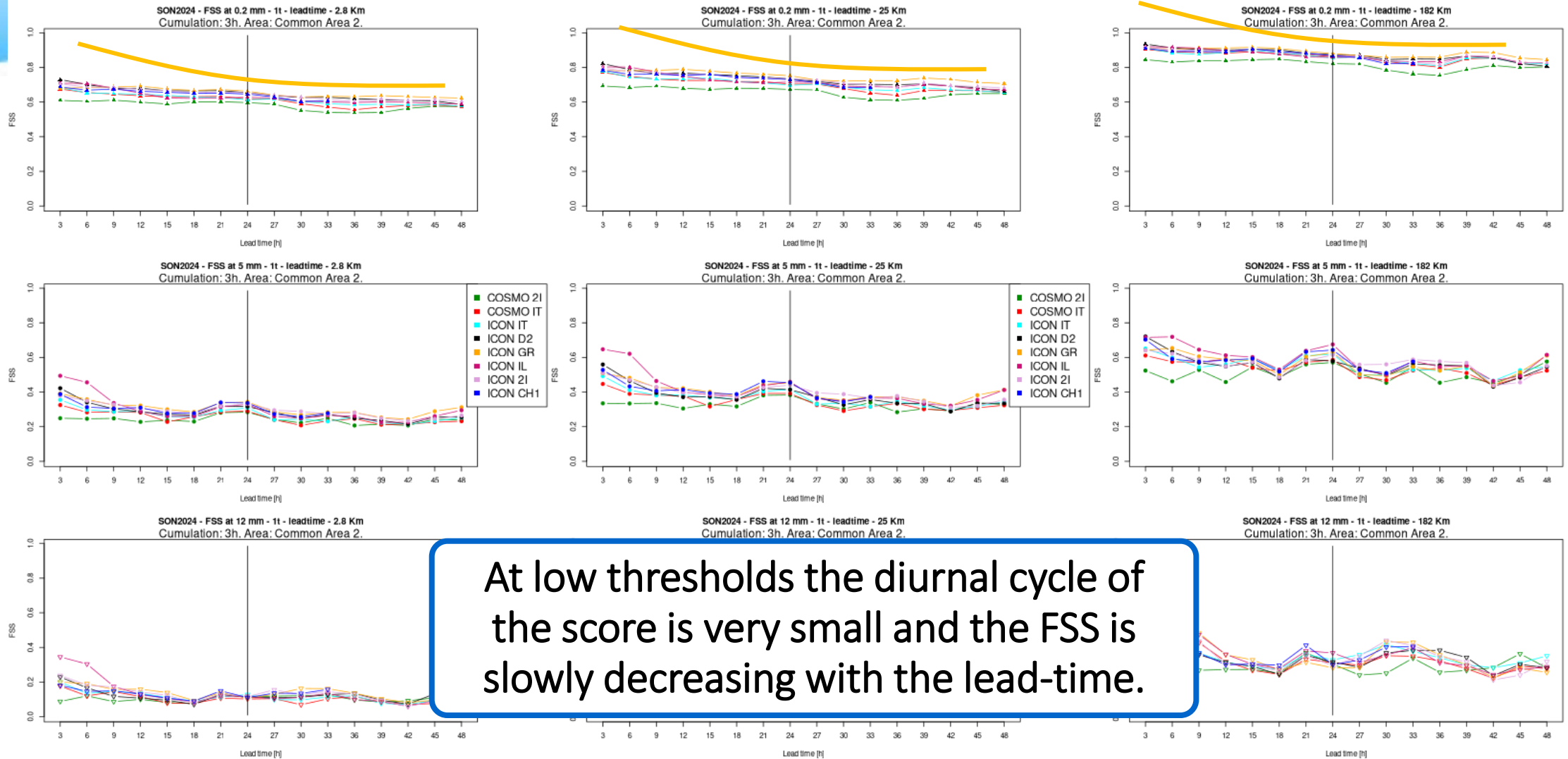
# FSS - SON 2024 – COMMON AREA 2







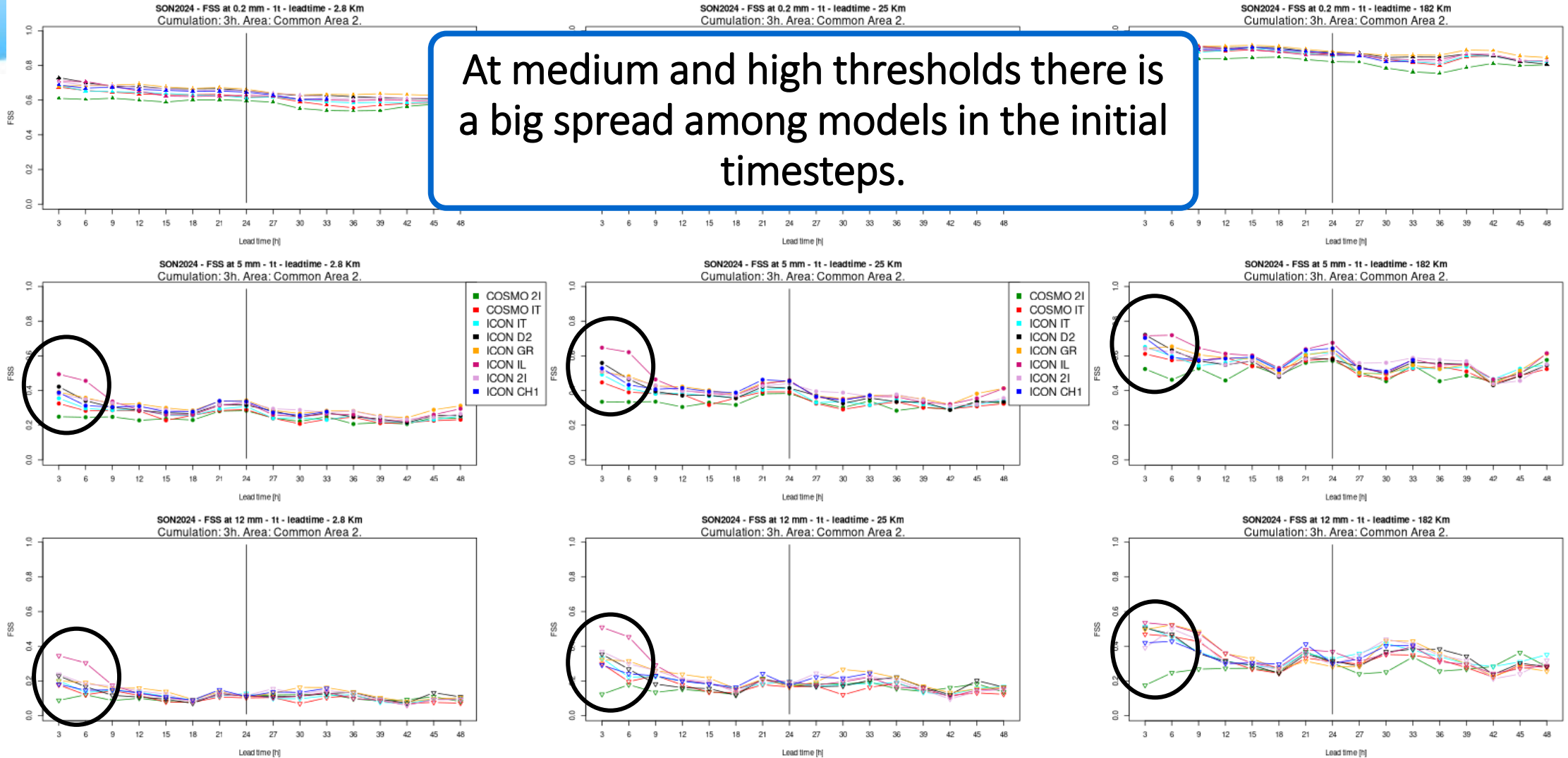
## FSS - SON 2024 – COMMON AREA 2





## FSS - SON 2024 – COMMON AREA 2

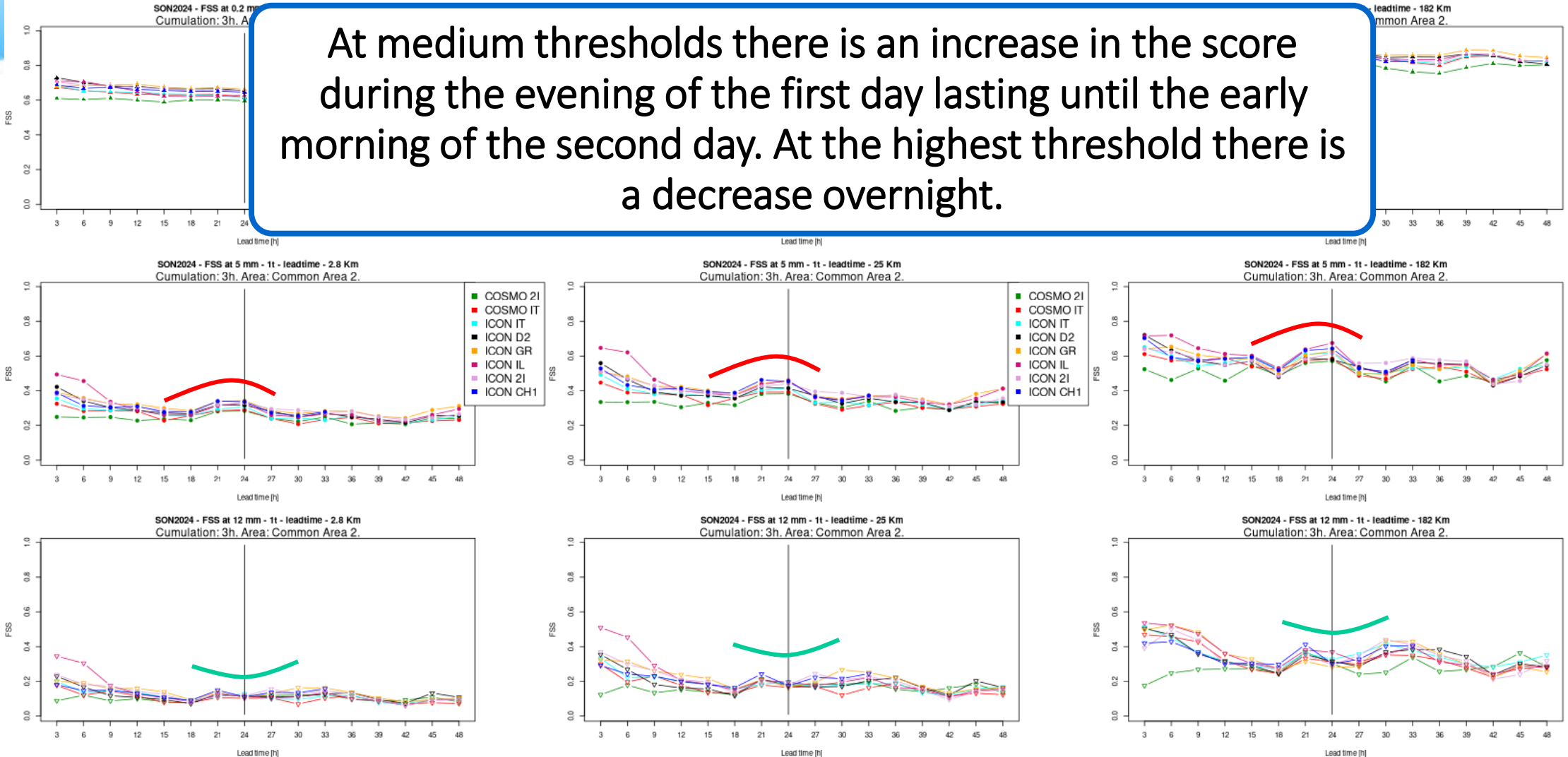
At medium and high thresholds there is a big spread among models in the initial timesteps.





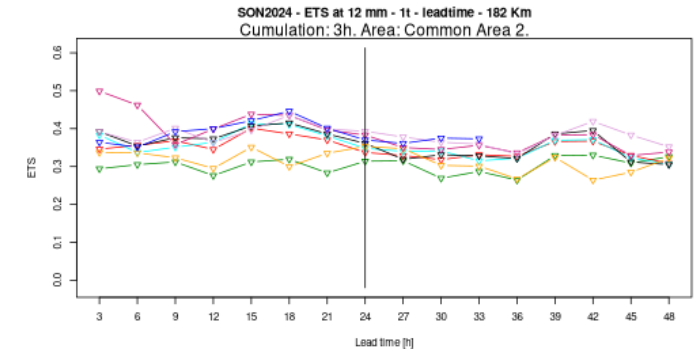
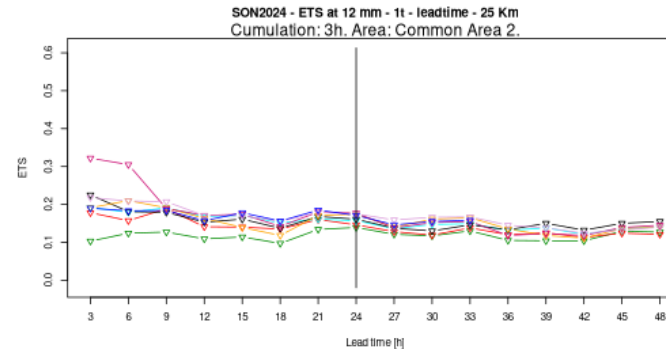
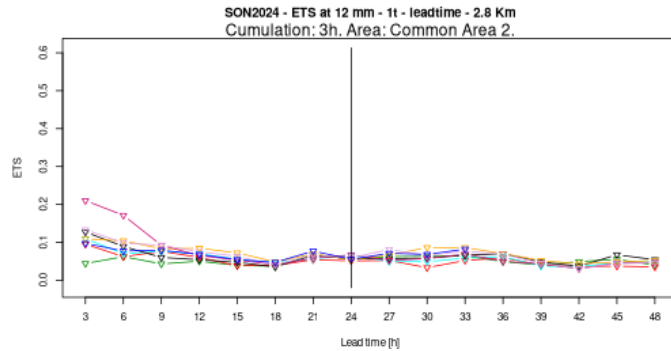
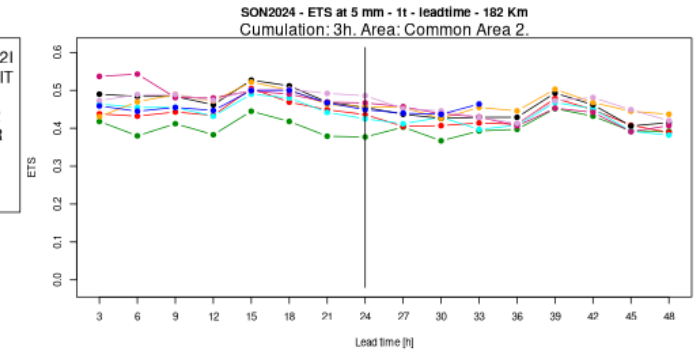
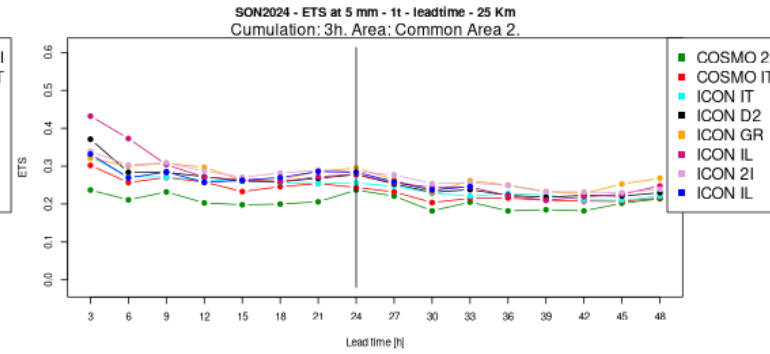
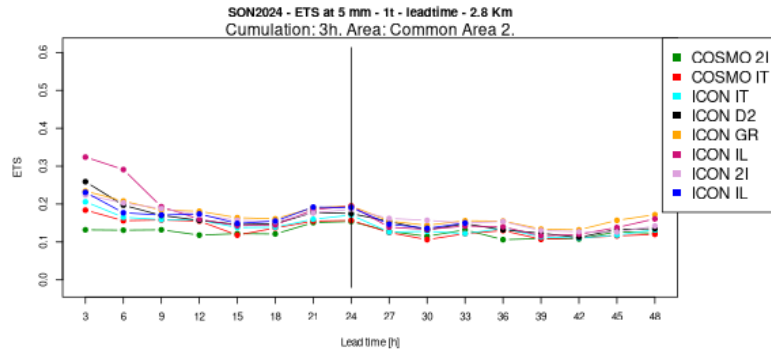
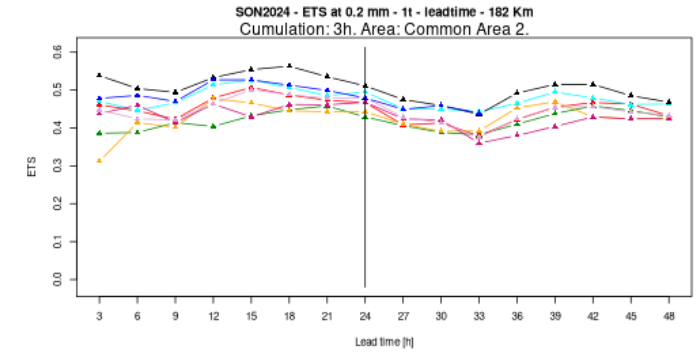
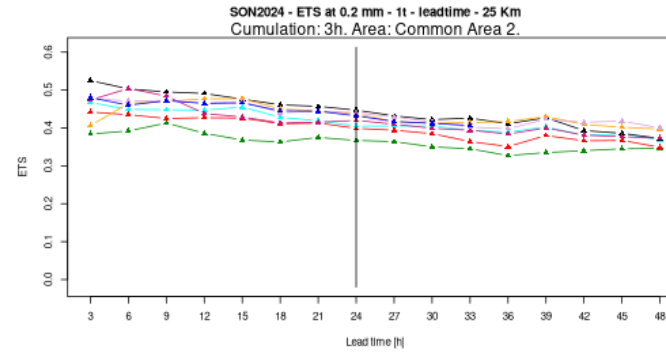
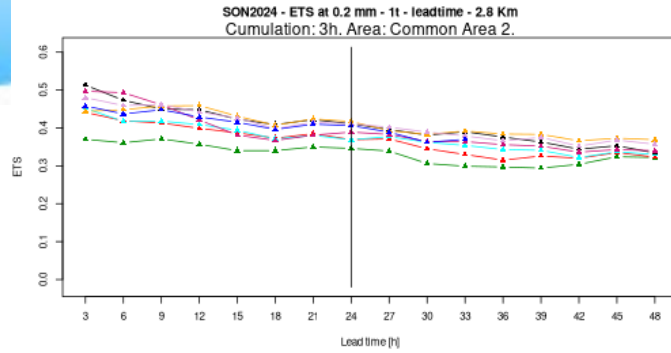
## FSS - SON 2024 – COMMON AREA 2

At medium thresholds there is an increase in the score during the evening of the first day lasting until the early morning of the second day. At the highest threshold there is a decrease overnight.





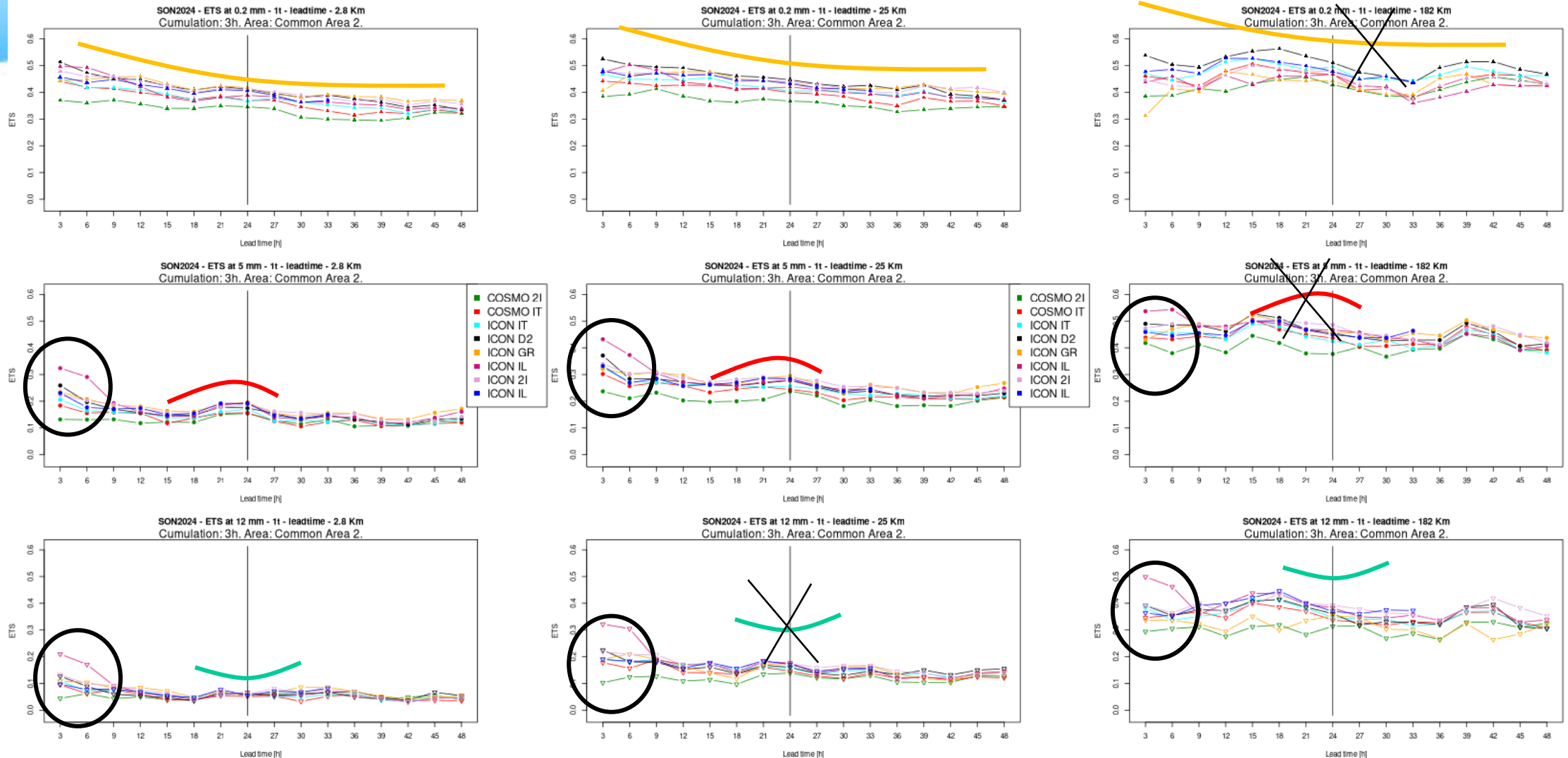
# ETS - SON 2024 – COMMON AREA 2







# ETS - SON 2024 – COMMON AREA 2

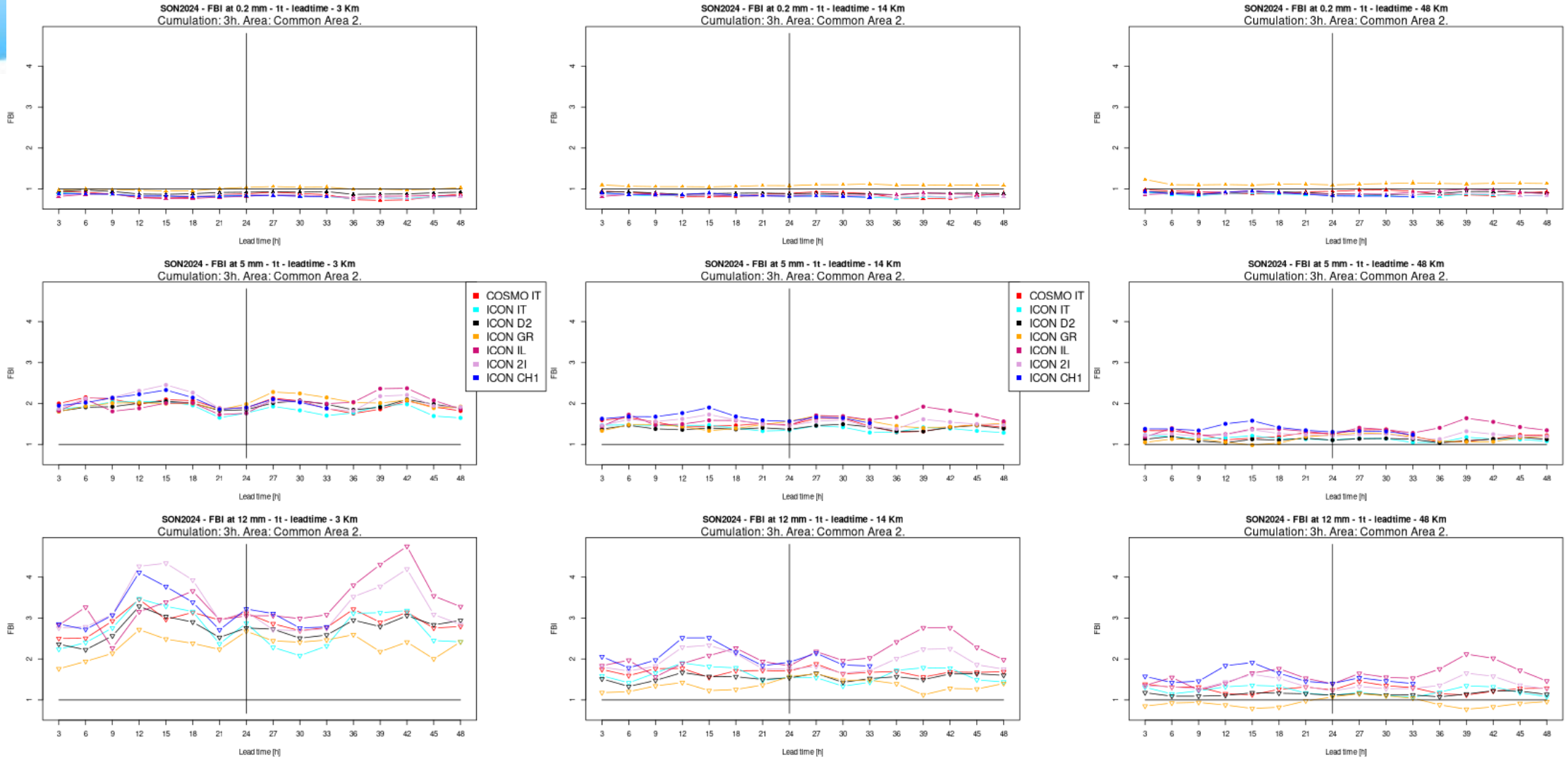


The ETS only mimics a few of the characteristics of the FSS.





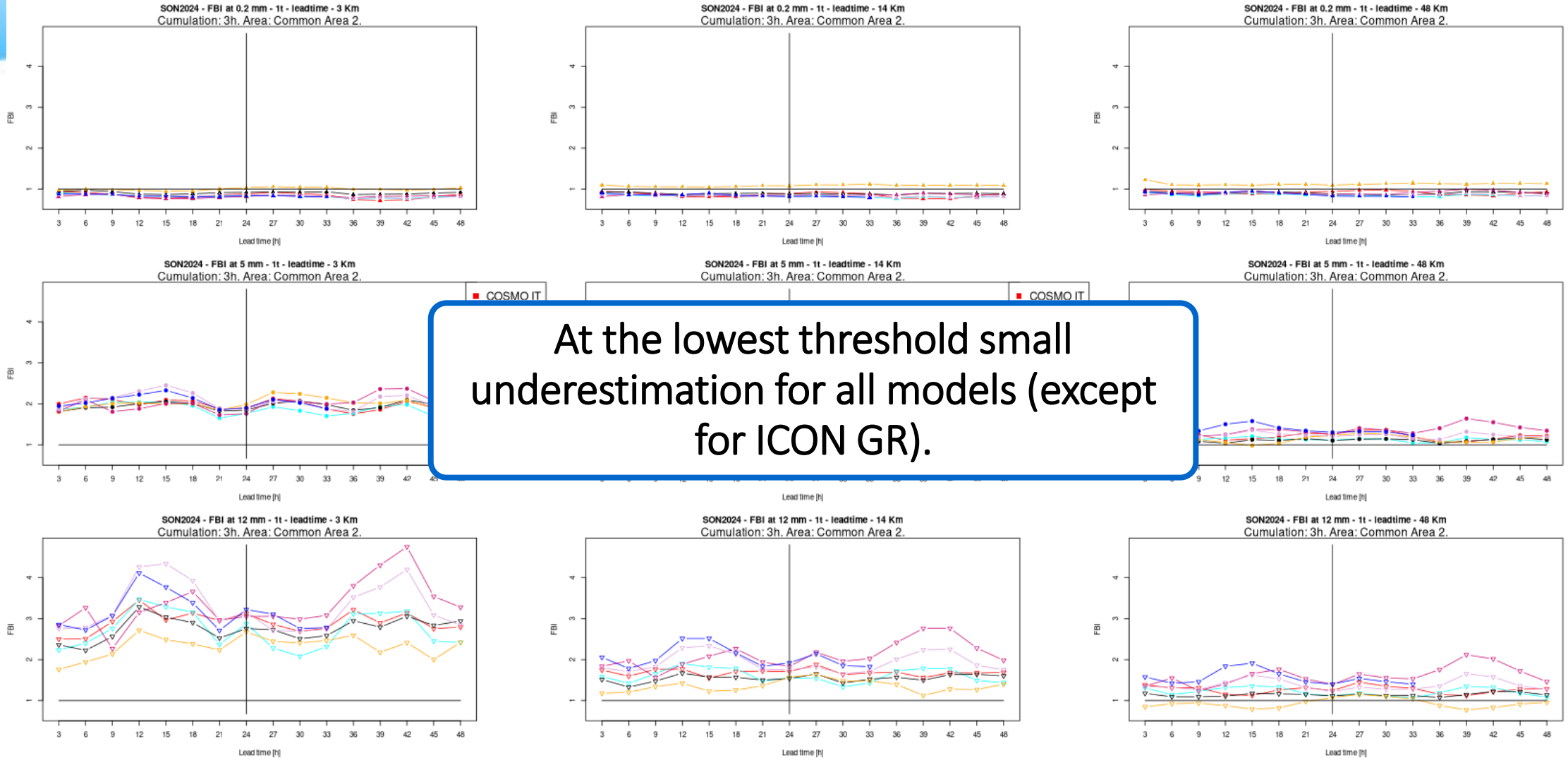
# FBI - SON 2024 – COMMON AREA 2



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## FBI - SON 2024 – COMMON AREA 2

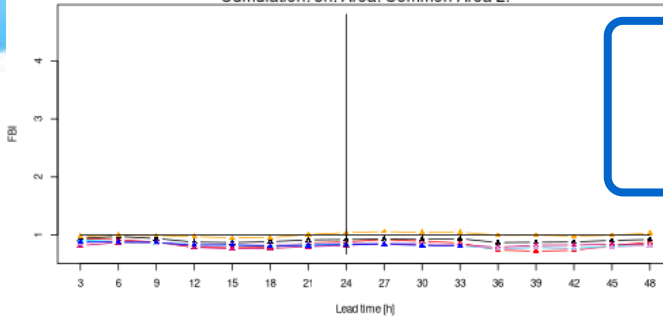




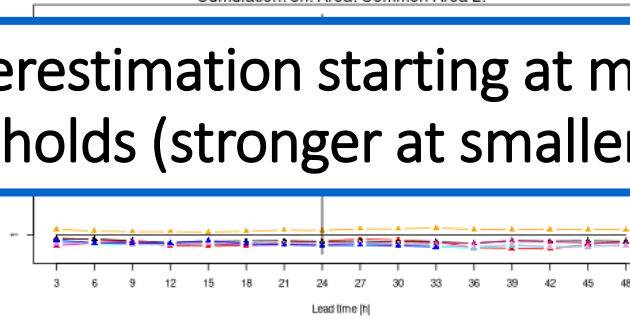
# FBI - SON 2024 – COMMON AREA 2

Overestimation starting at medium thresholds (stronger at smaller scales).

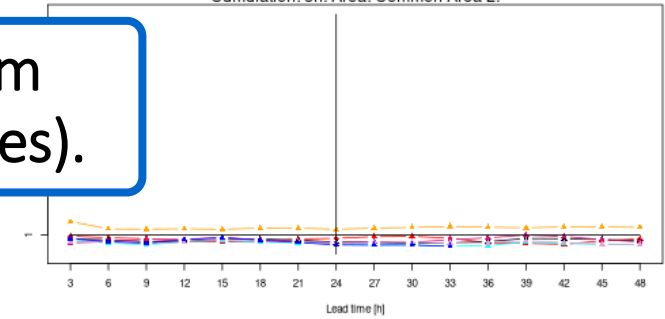
SON2024 - FBI at 0.2 mm - 1t - leadtime - 3 Km  
Cumulation: 3h. Area: Common Area 2.



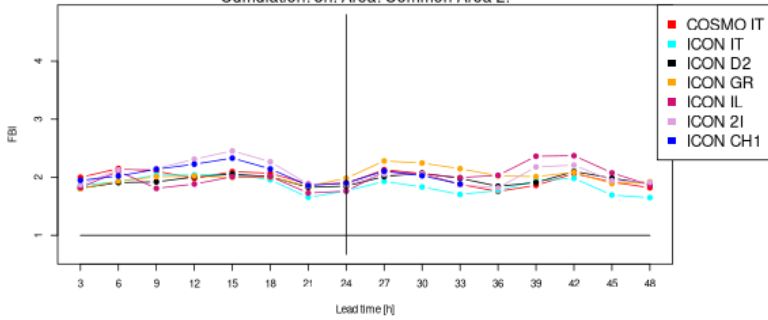
SON2024 - FBI at 0.2 mm - 1t - leadtime - 14 Km  
Cumulation: 3h. Area: Common Area 2.



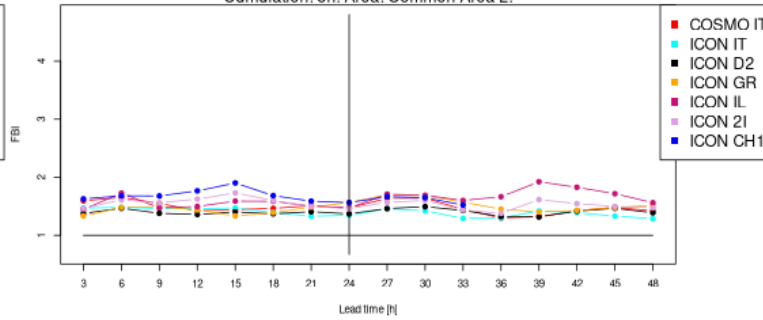
SON2024 - FBI at 0.2 mm - 1t - leadtime - 48 Km  
Cumulation: 3h. Area: Common Area 2.



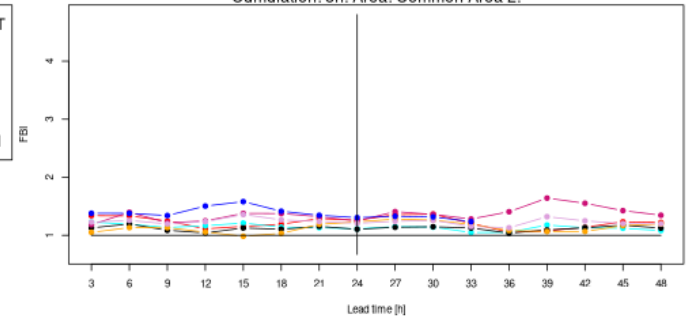
SON2024 - FBI at 5 mm - 1t - leadtime - 3 Km  
Cumulation: 3h. Area: Common Area 2.



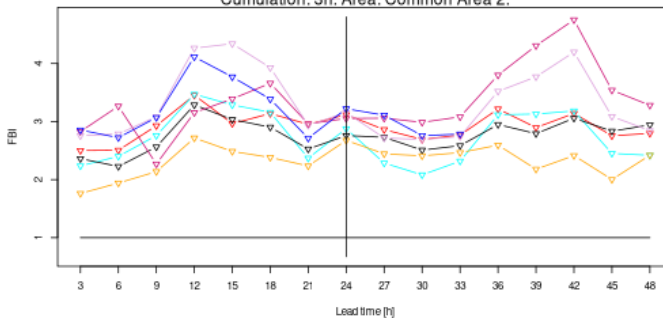
SON2024 - FBI at 5 mm - 1t - leadtime - 14 Km  
Cumulation: 3h. Area: Common Area 2.



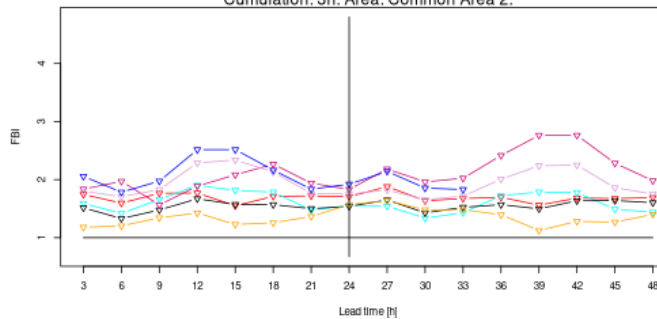
SON2024 - FBI at 5 mm - 1t - leadtime - 48 Km  
Cumulation: 3h. Area: Common Area 2.



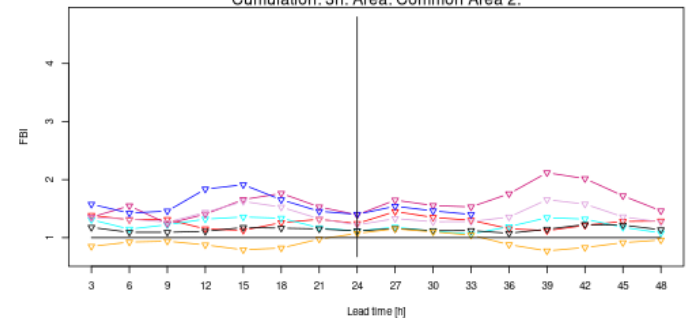
SON2024 - FBI at 12 mm - 1t - leadtime - 3 Km  
Cumulation: 3h. Area: Common Area 2.

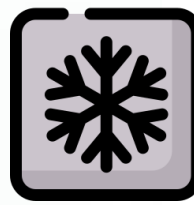


SON2024 - FBI at 12 mm - 1t - leadtime - 14 Km  
Cumulation: 3h. Area: Common Area 2.

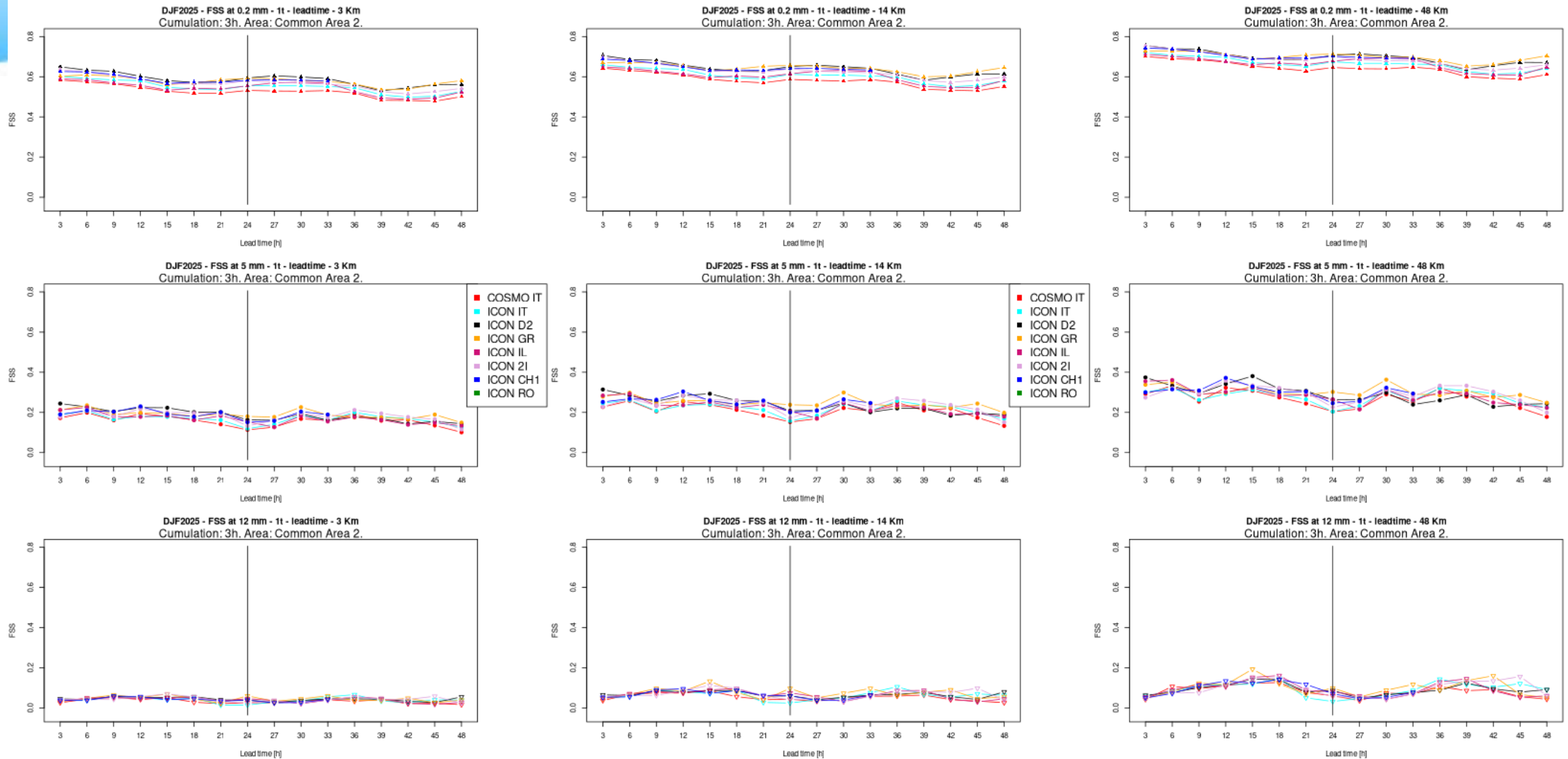


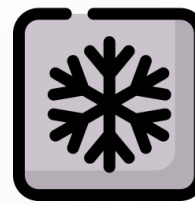
SON2024 - FBI at 12 mm - 1t - leadtime - 48 Km  
Cumulation: 3h. Area: Common Area 2.



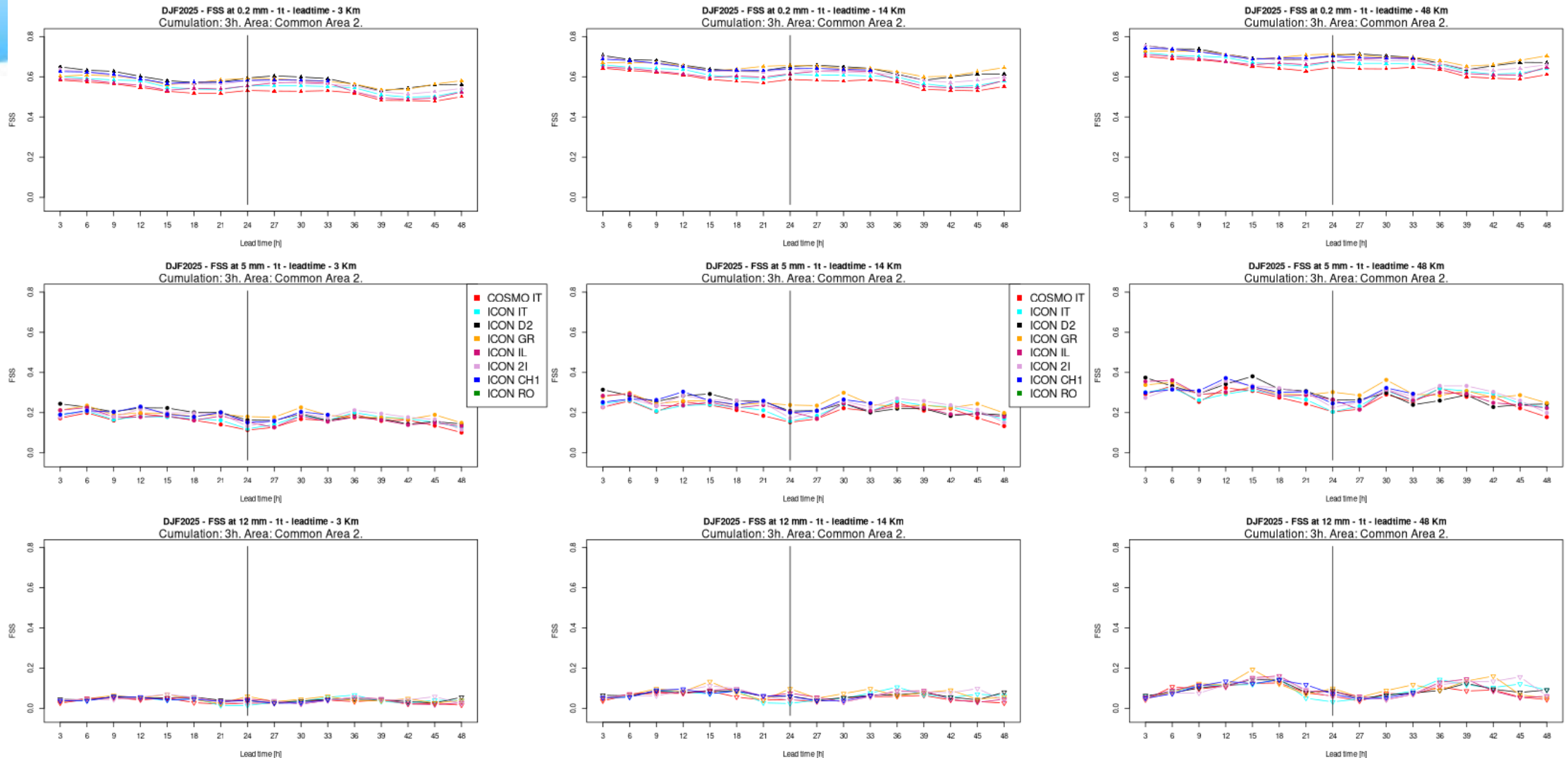


# FSS - DJF 2025 – COMMON AREA 2



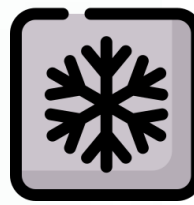


## FSS - DJF 2025 – COMMON AREA 2

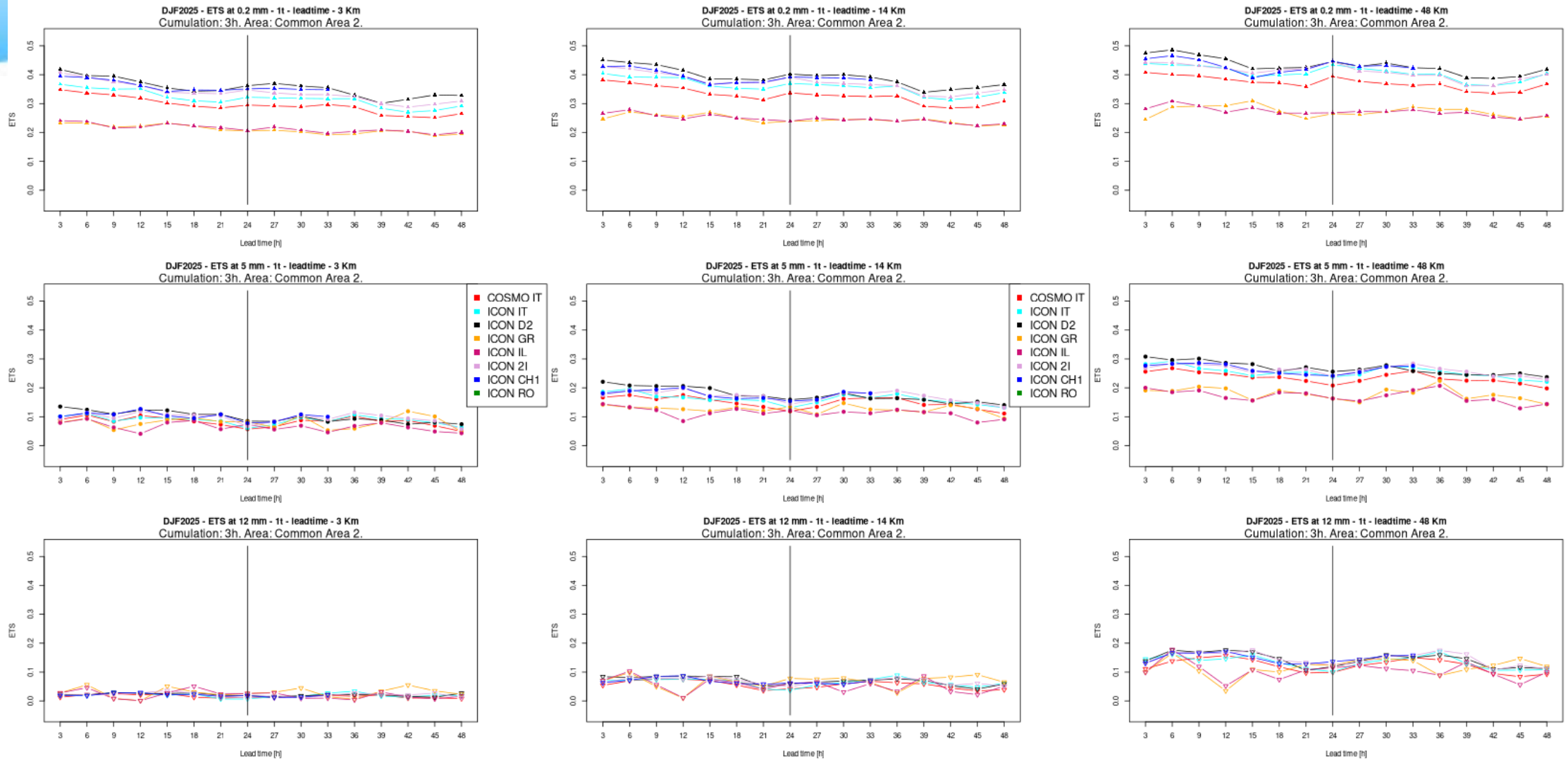


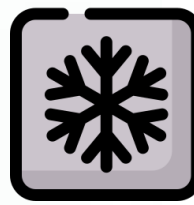
No diurnal cycle of the FSS, or very little.  
Very low scores at high thresholds and  
little increase with spatial scales.



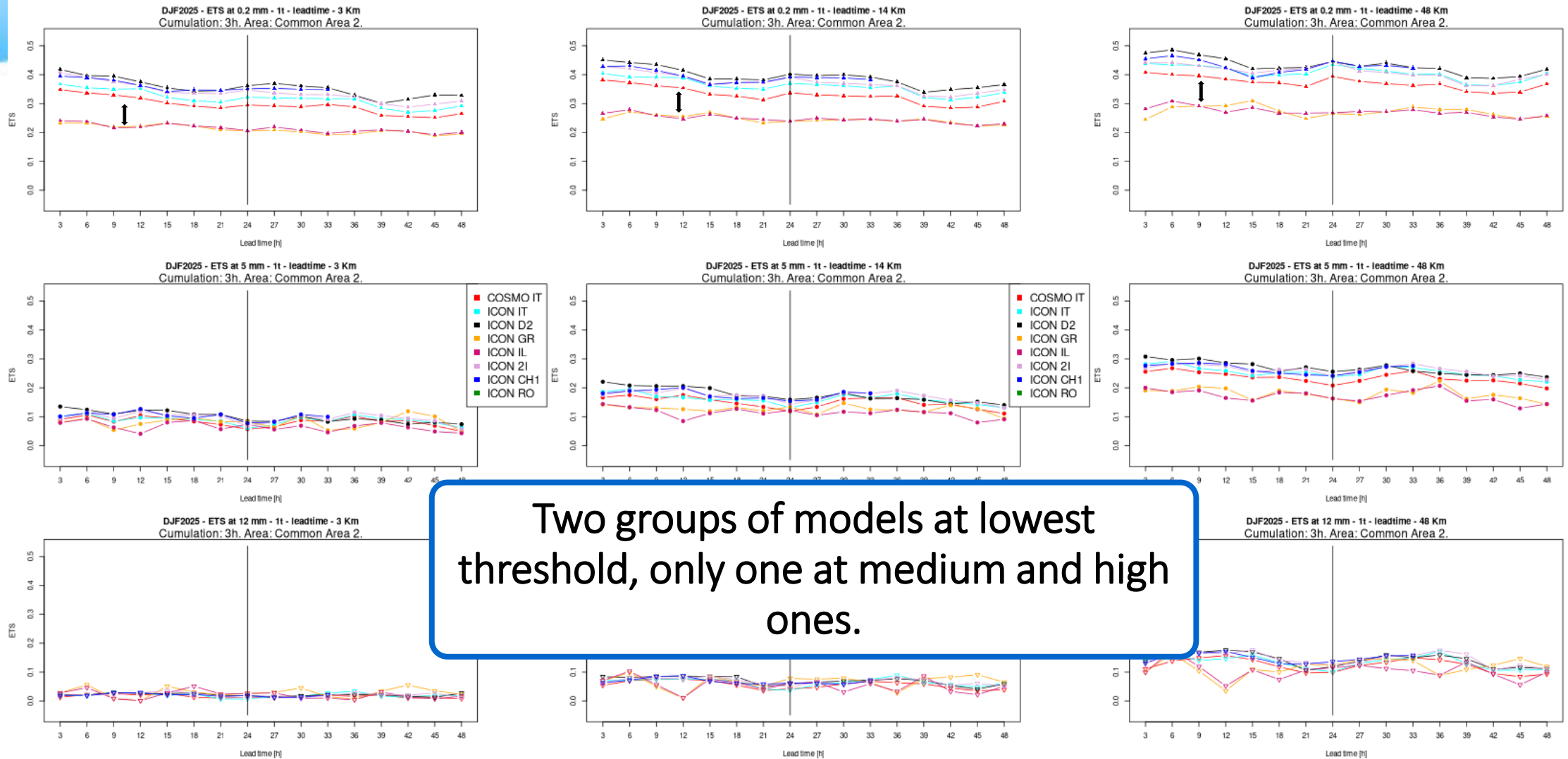


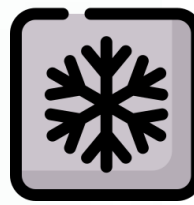
# ETS - DJF 2025 – COMMON AREA 2





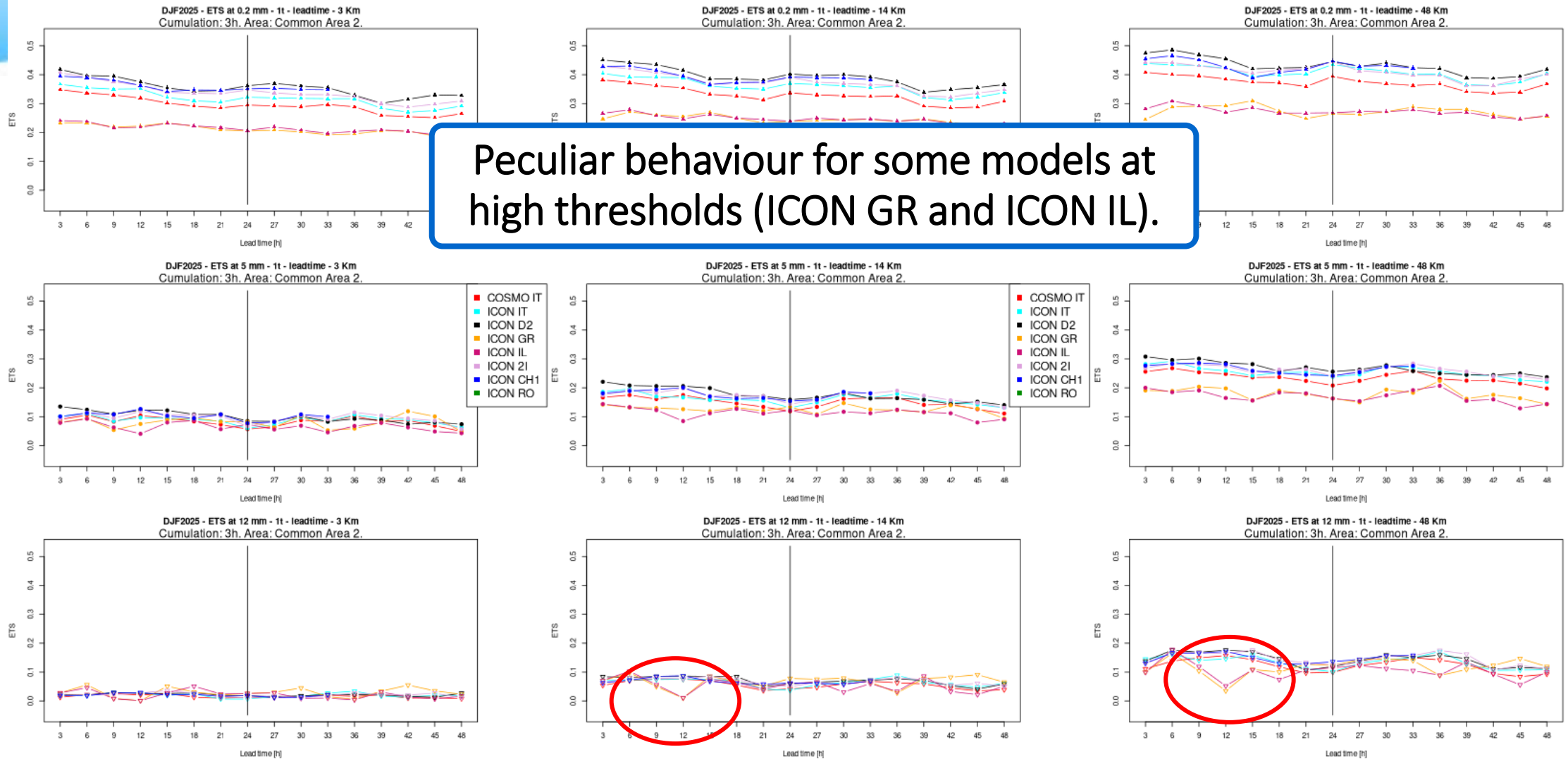
## ETS - DJF 2025 – COMMON AREA 2

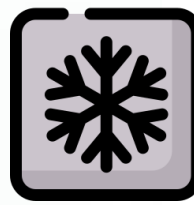




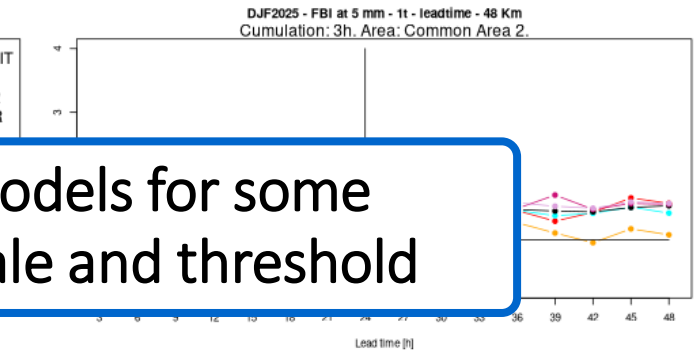
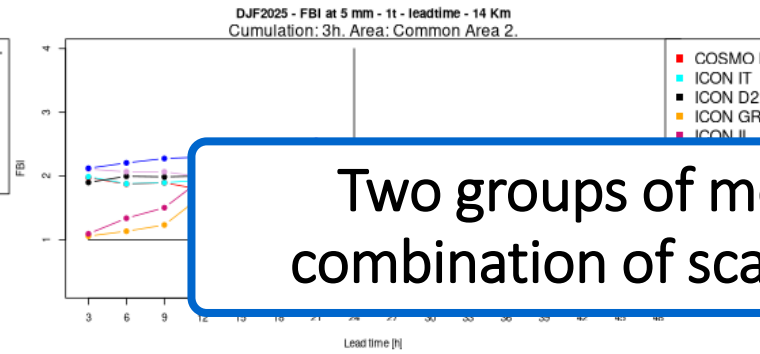
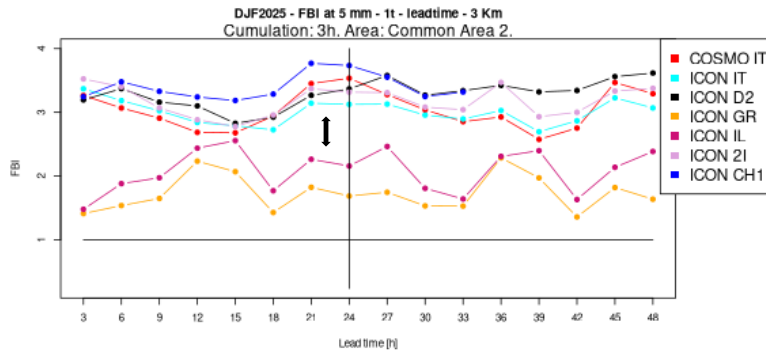
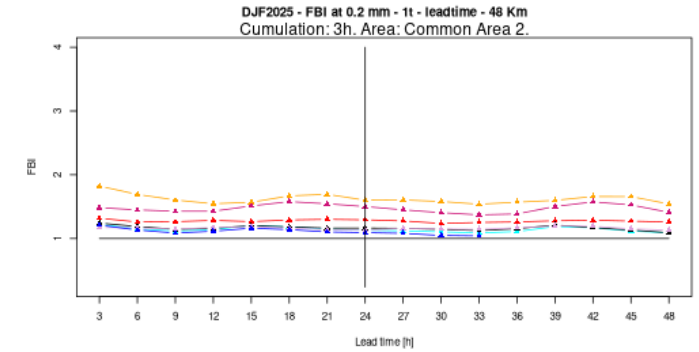
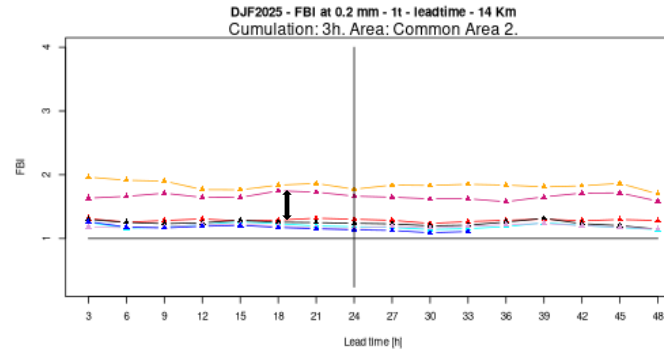
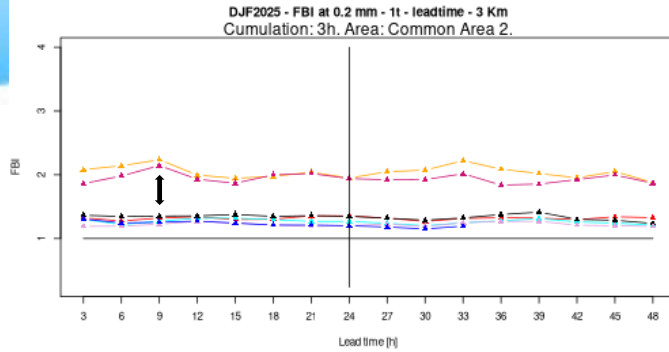
## ETS - DJF 2025 – COMMON AREA 2

Peculiar behaviour for some models at high thresholds (ICON GR and ICON IL).

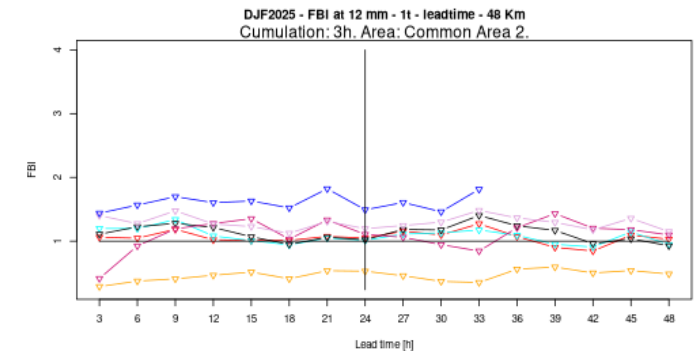
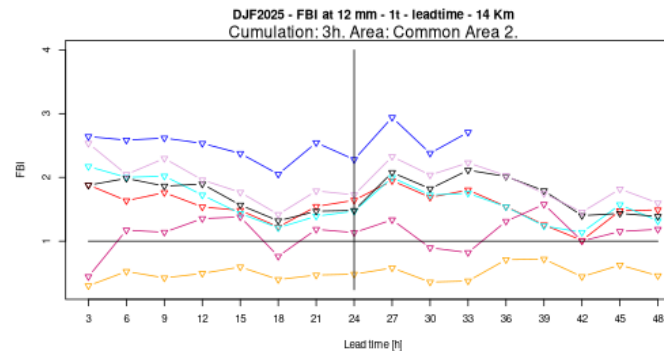
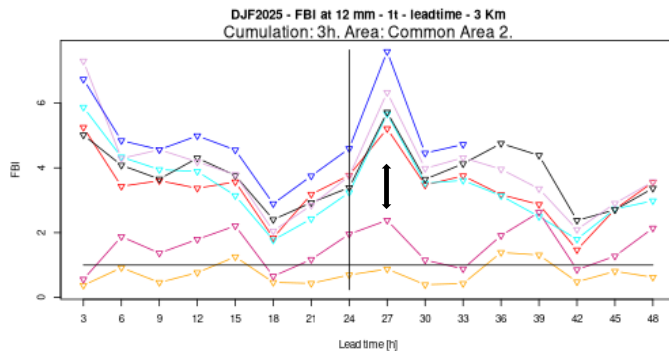


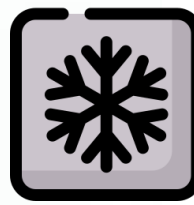


## FBI - DJF 2025 – COMMON AREA 2

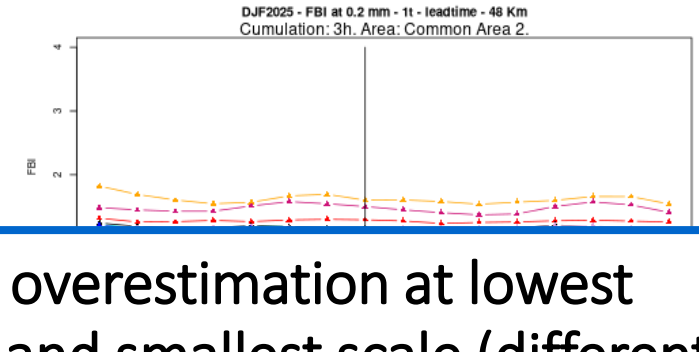
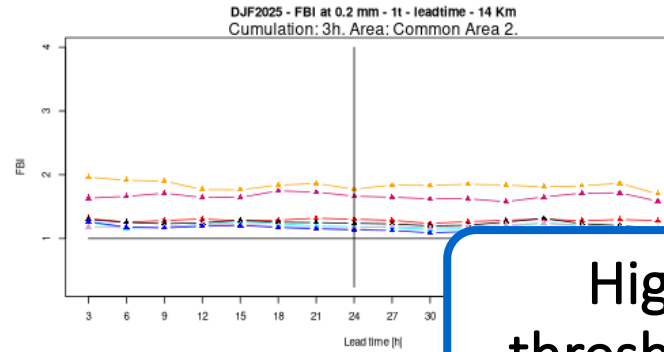
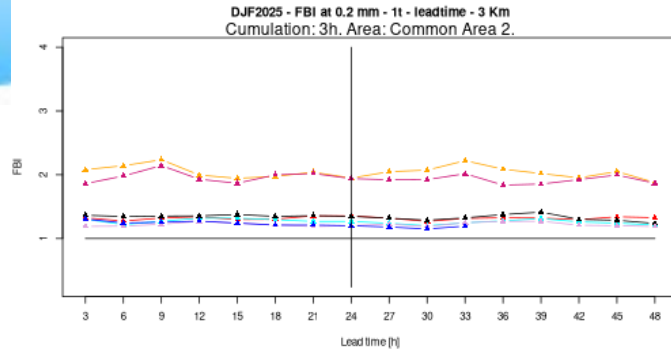


Two groups of models for some combination of scale and threshold

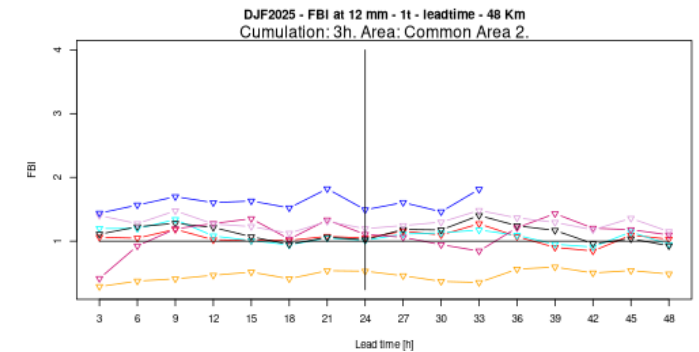
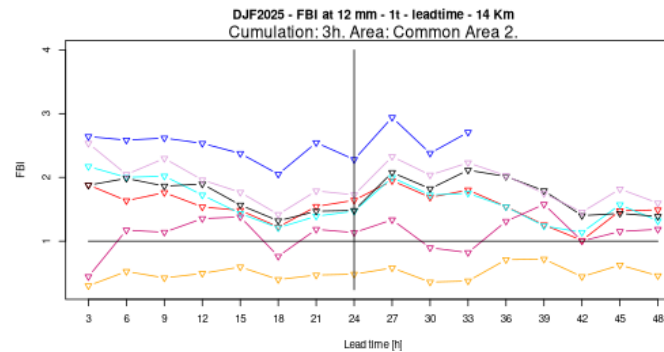
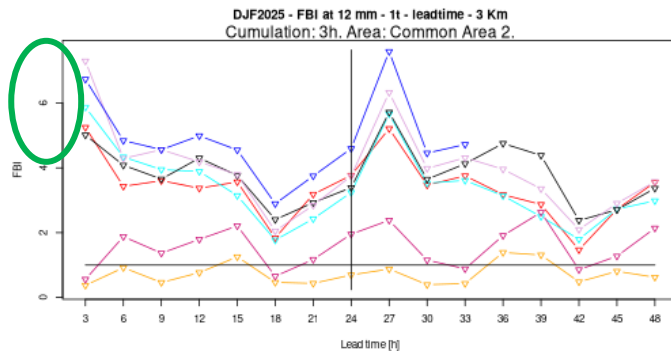
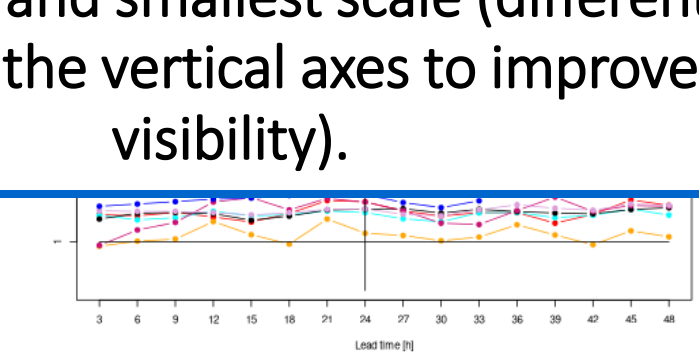
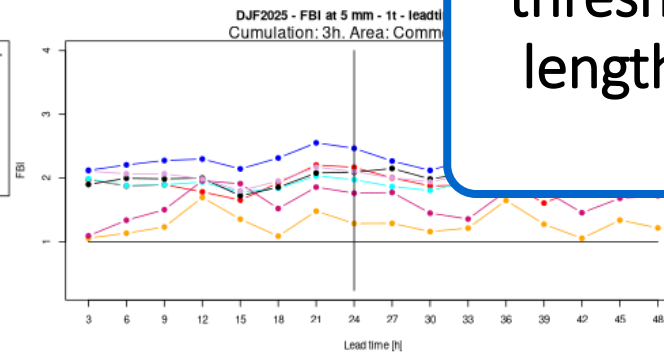
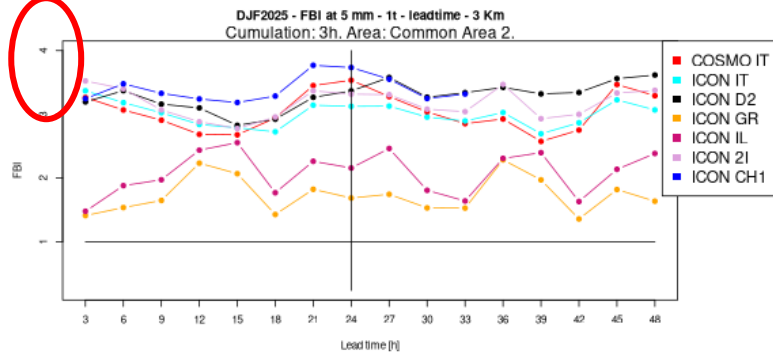




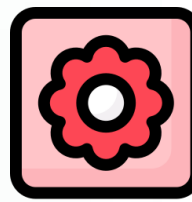
## FBI - DJF 2025 – COMMON AREA 2



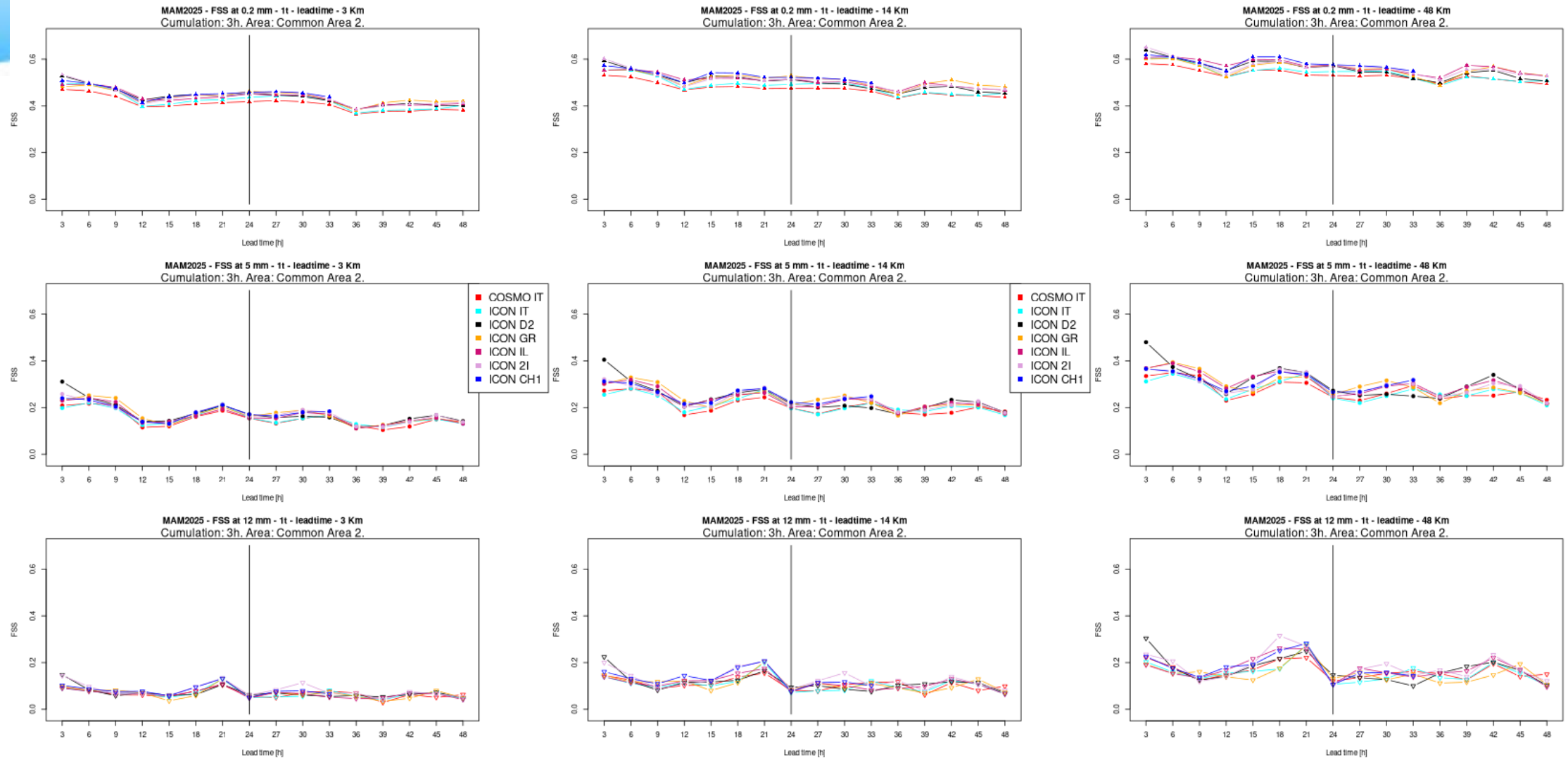
Higher overestimation at lowest threshold and smallest scale (different length of the vertical axes to improve visibility).

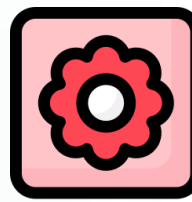




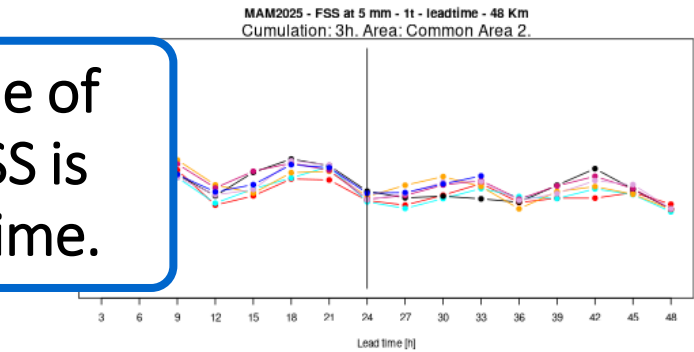
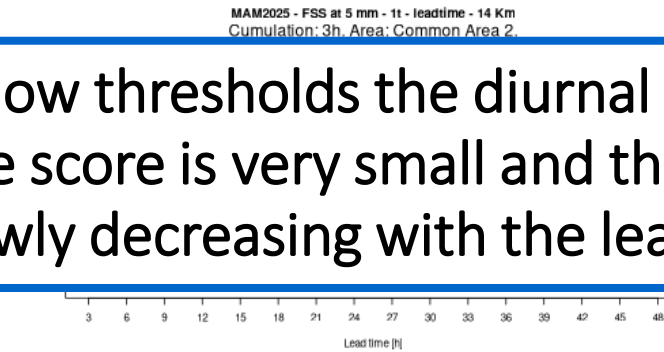
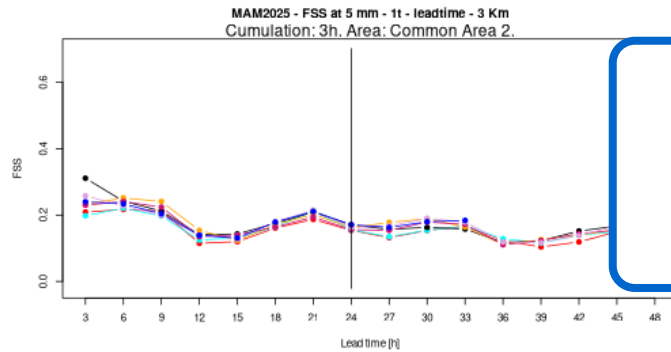
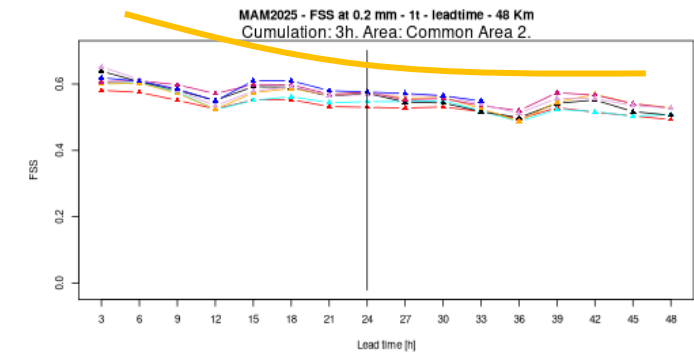
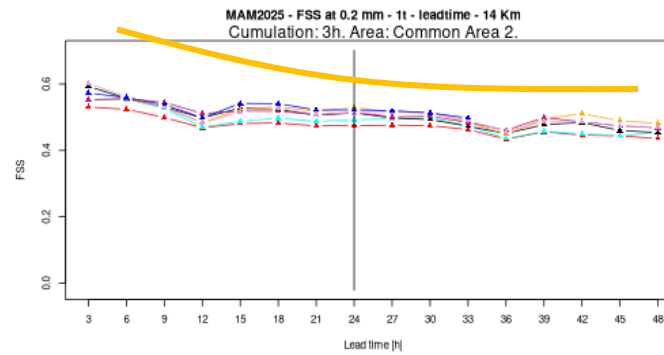
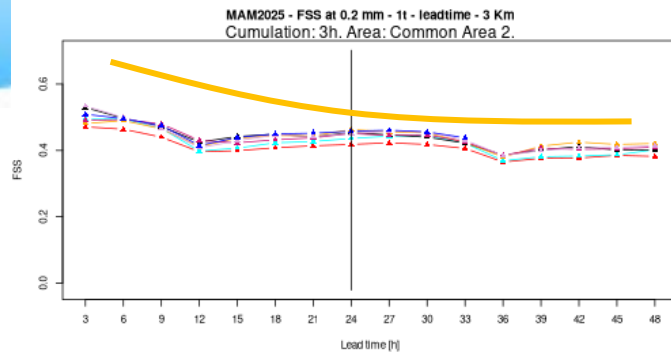


# FSS - MAM 2025 – COMMON AREA 2

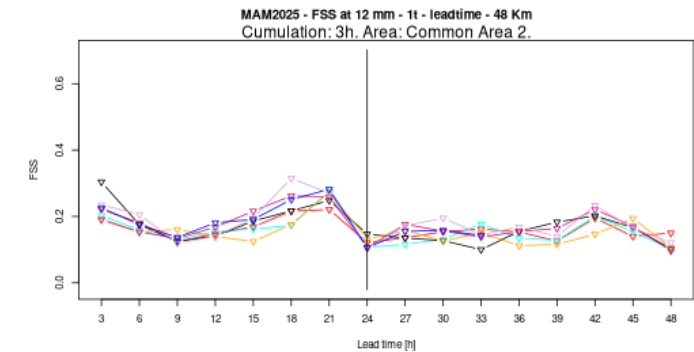
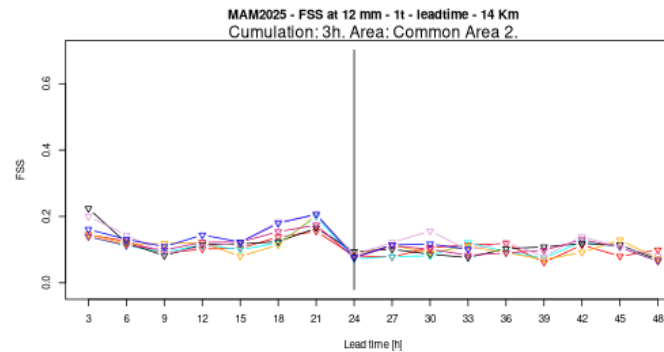
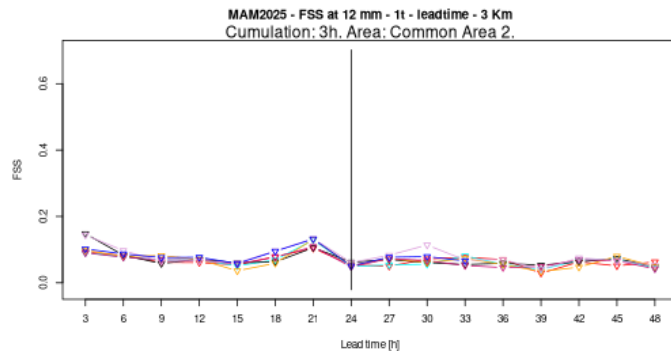


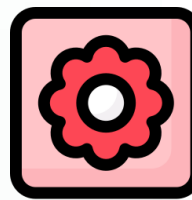


## FSS - MAM 2025 – COMMON AREA 2



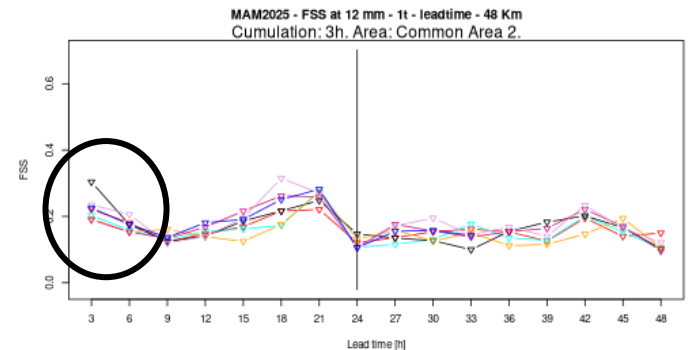
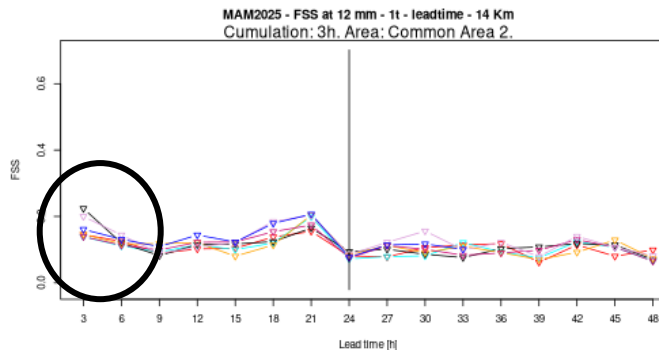
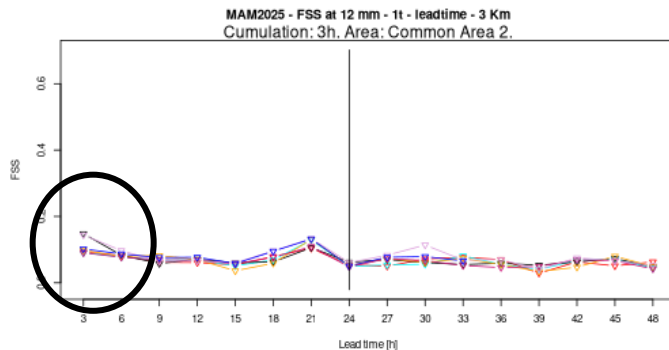
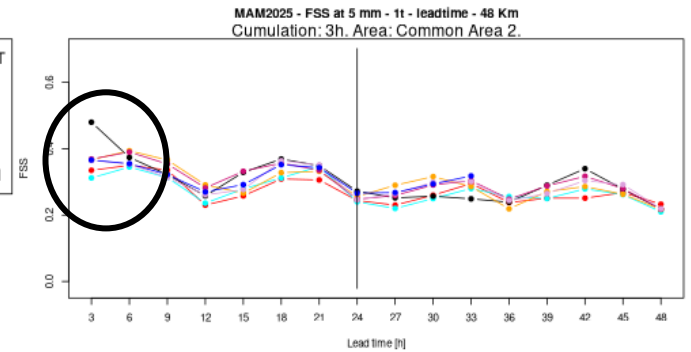
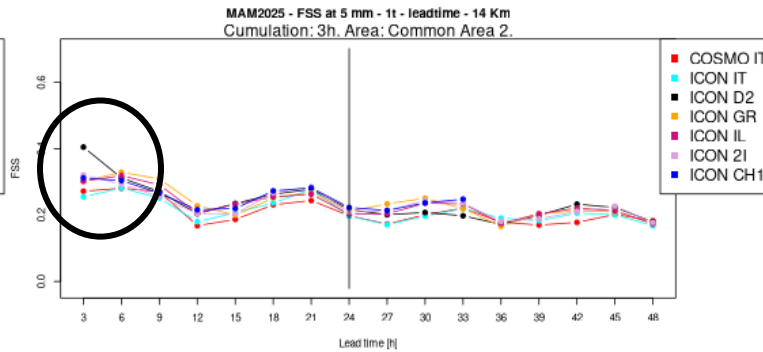
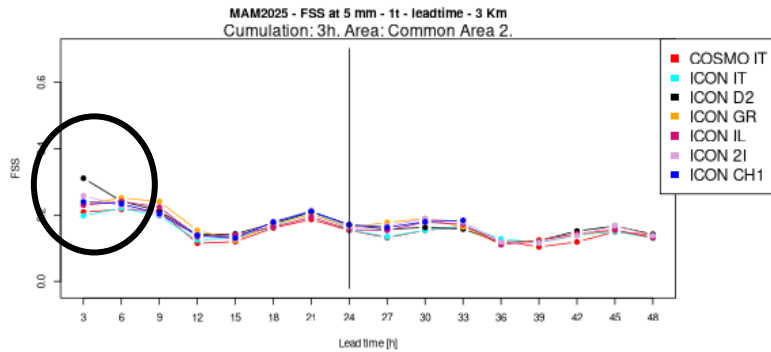
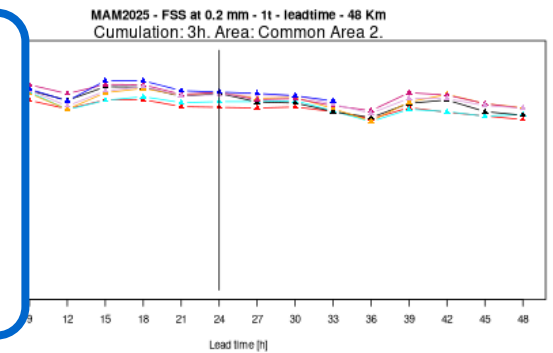
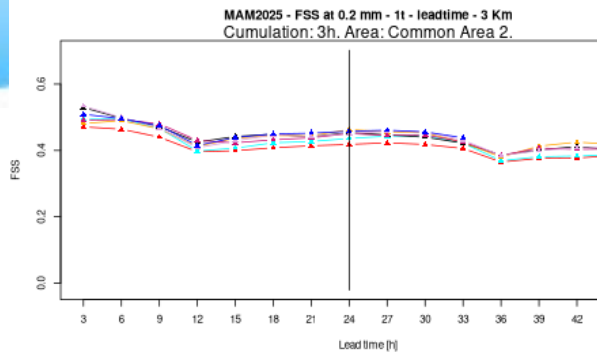
At low thresholds the diurnal cycle of the score is very small and the FSS is slowly decreasing with the lead-time.

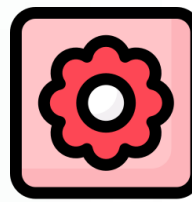




## FSS - MAM 2025 – COMMON AREA 2

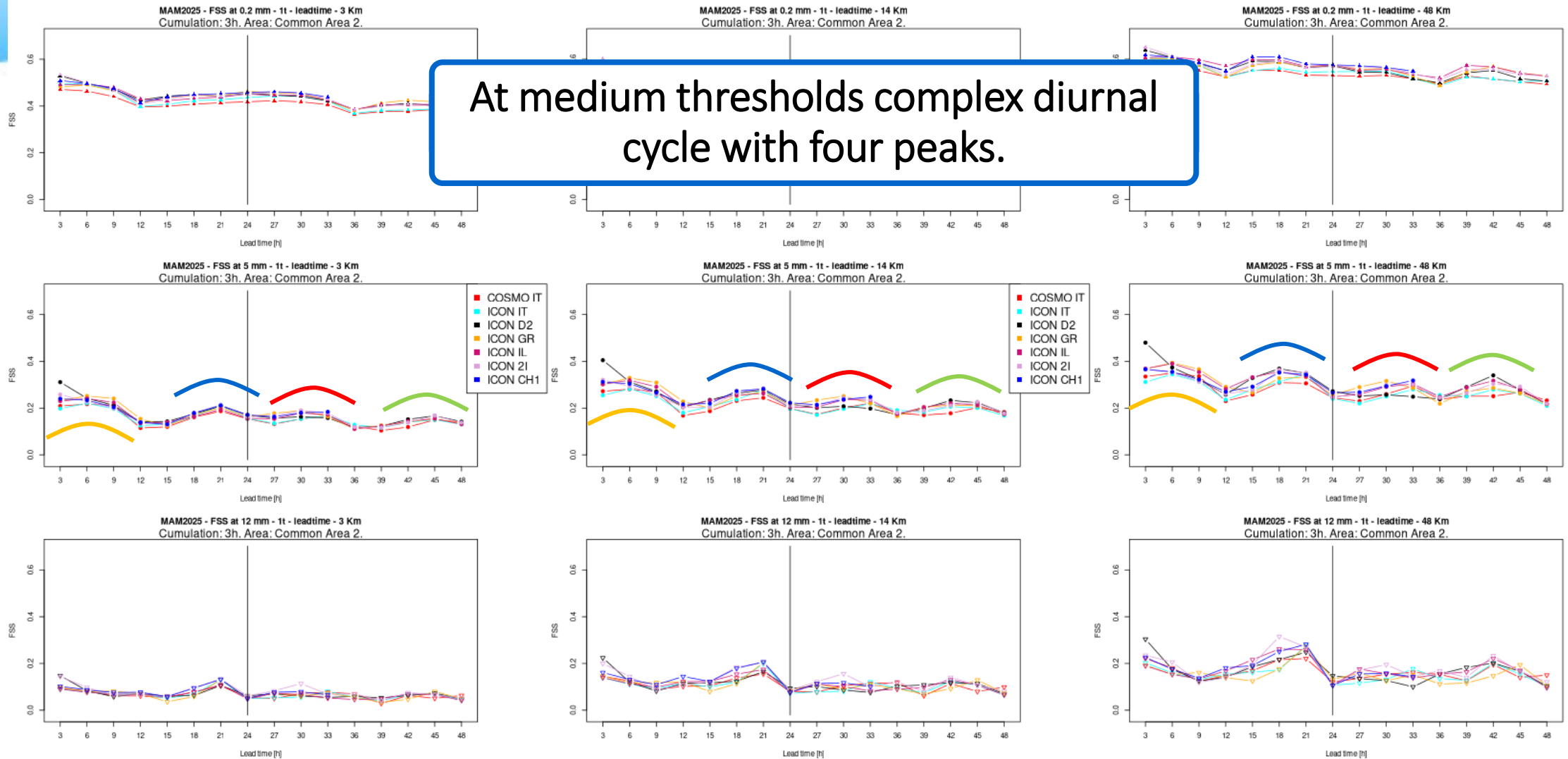
At medium and high thresholds there is a bigger spread among the models in the initial timestep (often only ICON D2, sometimes also ICON 2I).



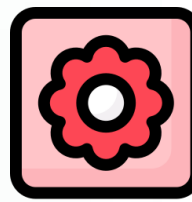


# FSS - MAM 2025 – COMMON AREA 2

At medium thresholds complex diurnal cycle with four peaks.

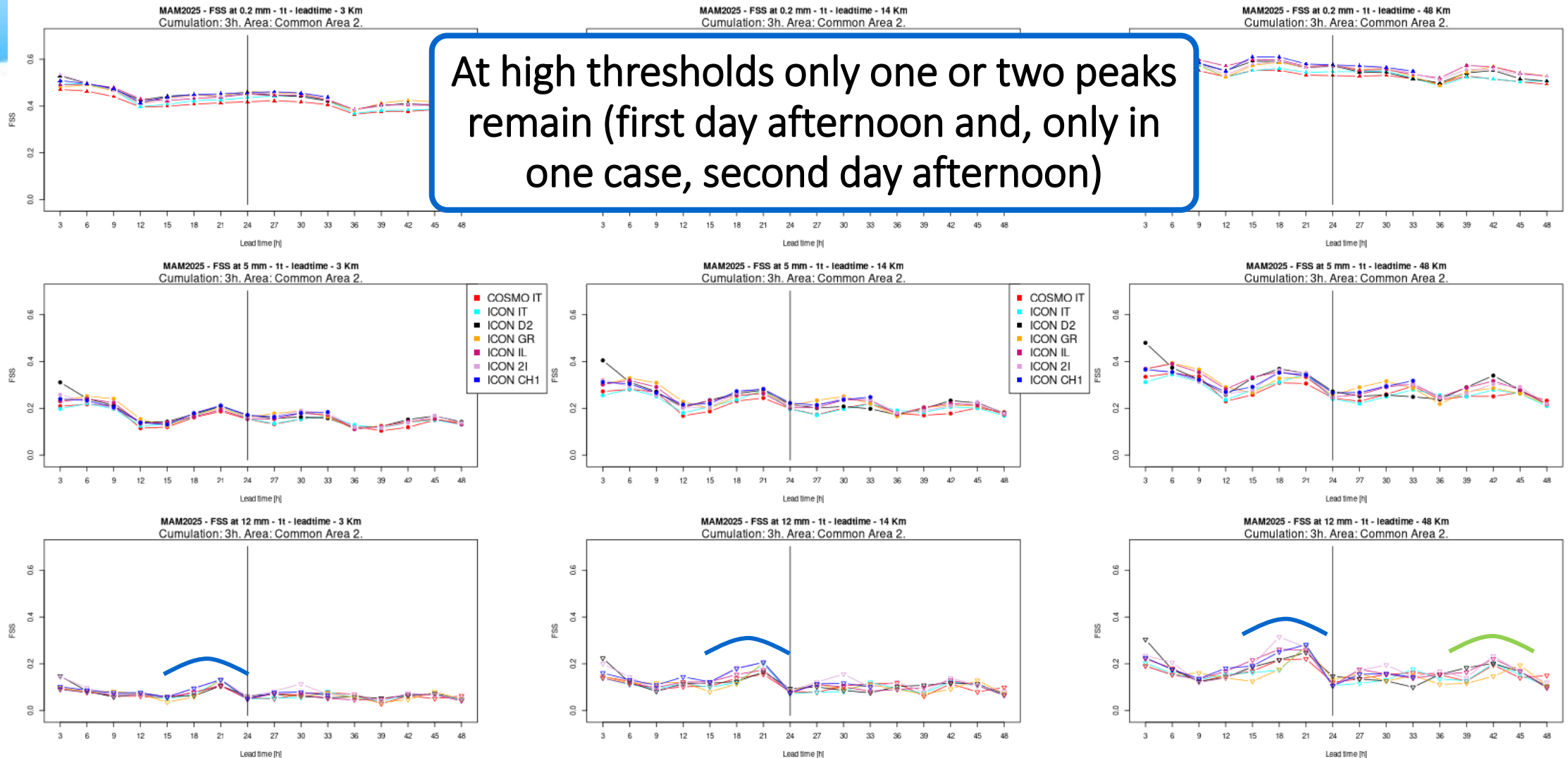


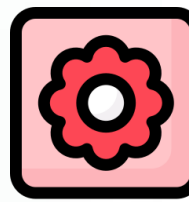




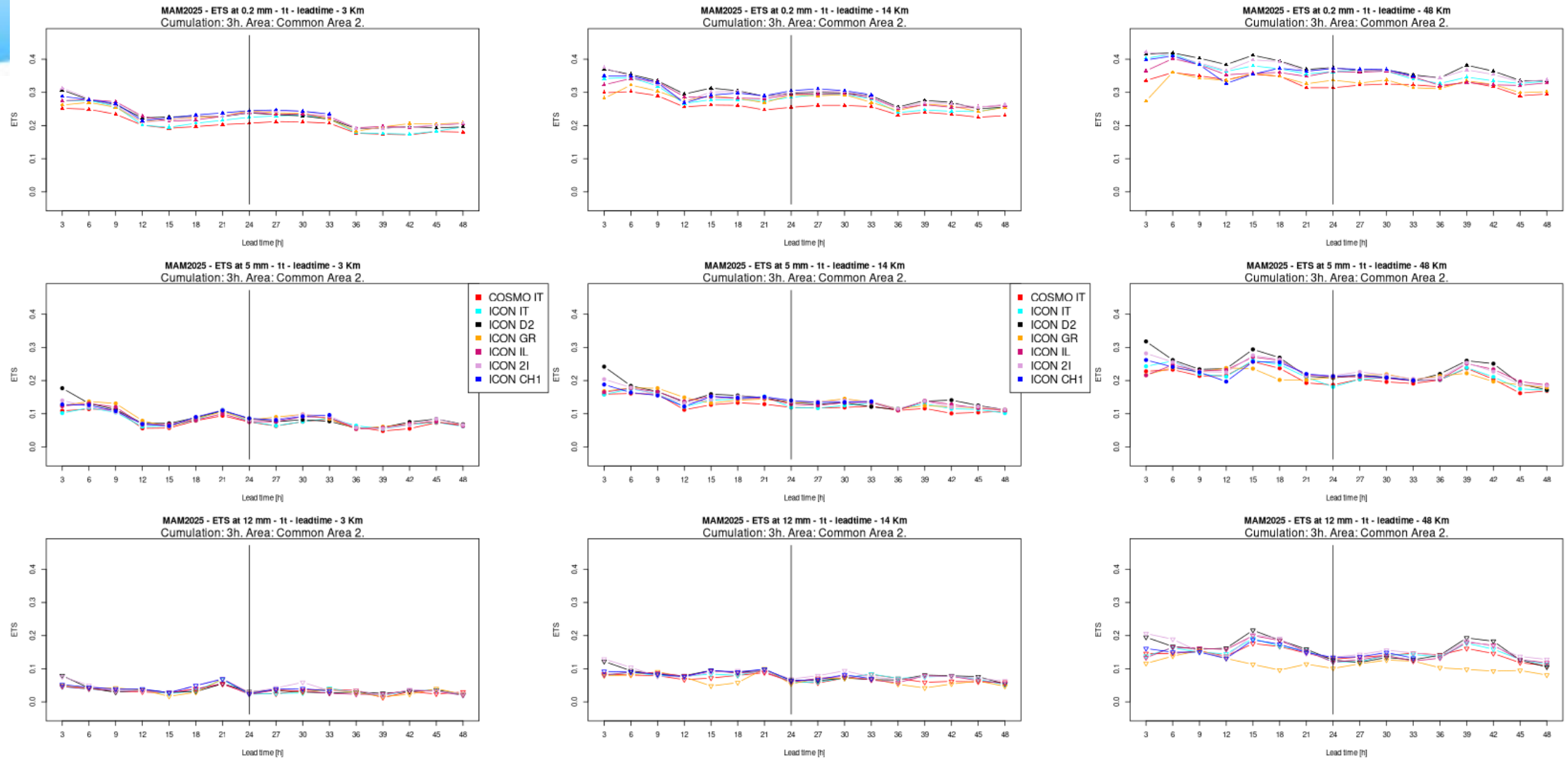
# FSS - MAM 2025 – COMMON AREA 2

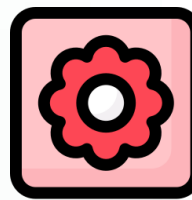
At high thresholds only one or two peaks remain (first day afternoon and, only in one case, second day afternoon)



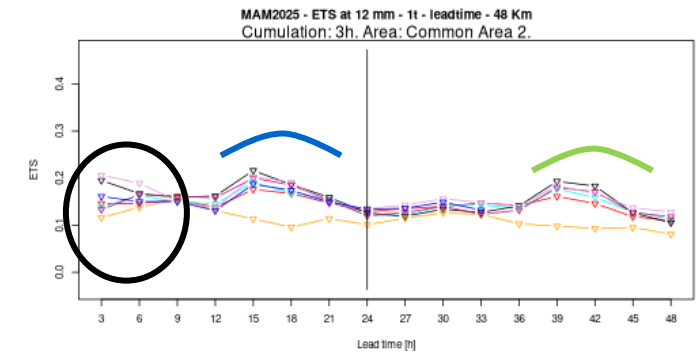
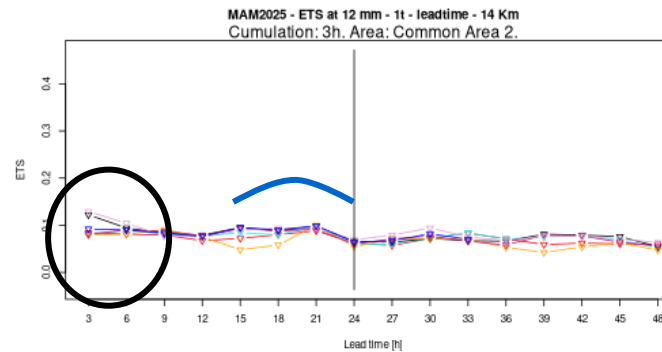
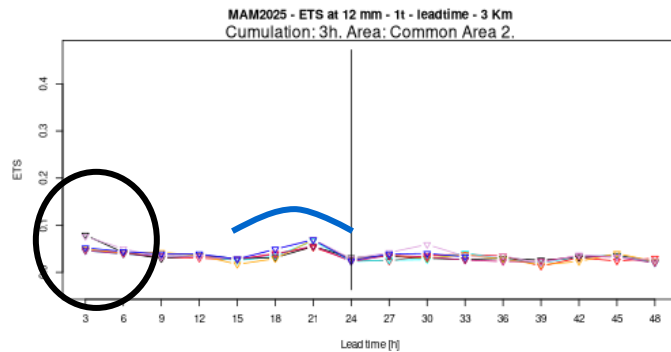
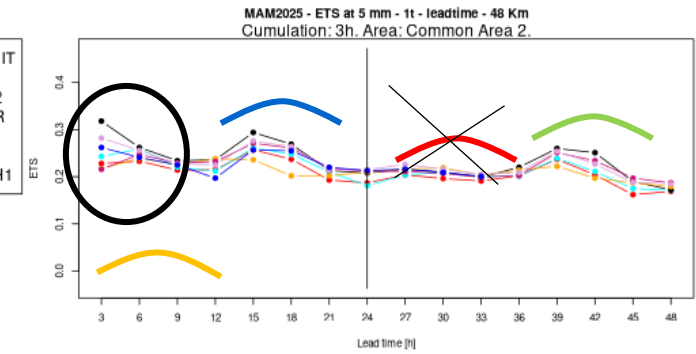
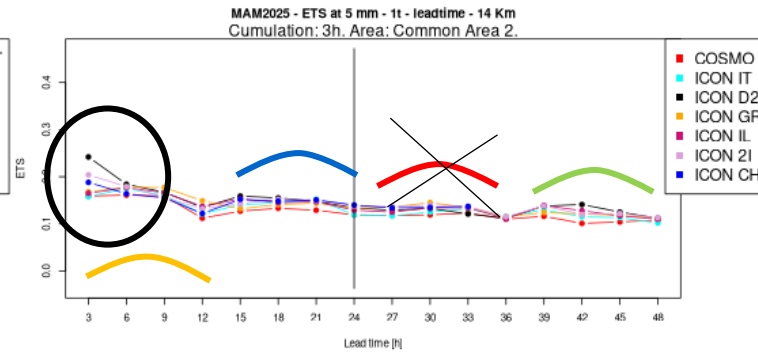
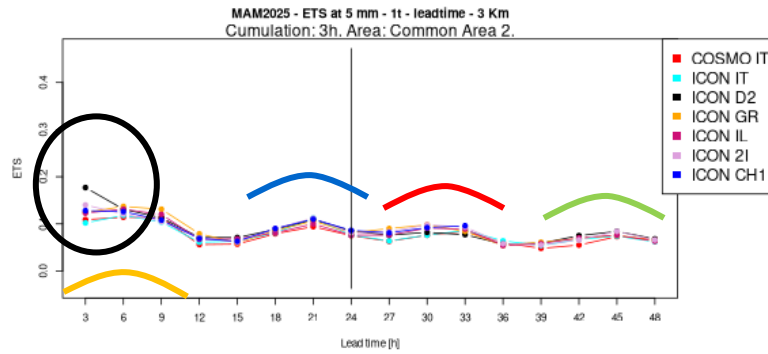
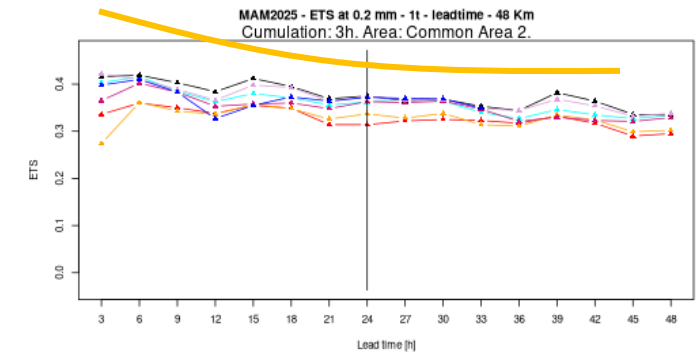
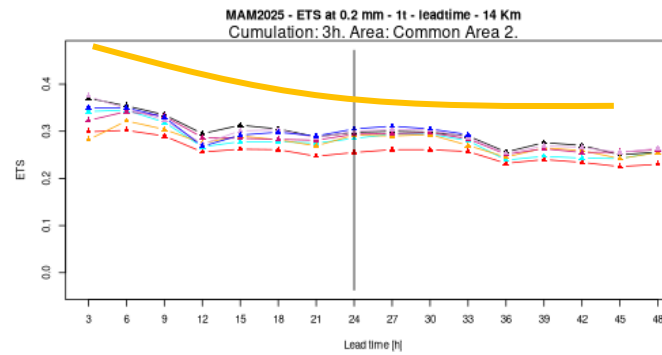
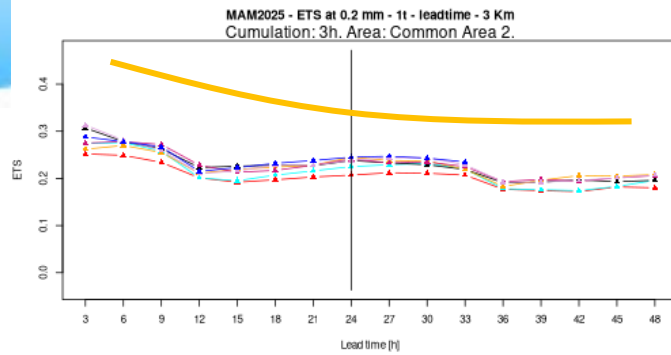


# ETS - MAM 2025 – COMMON AREA 2

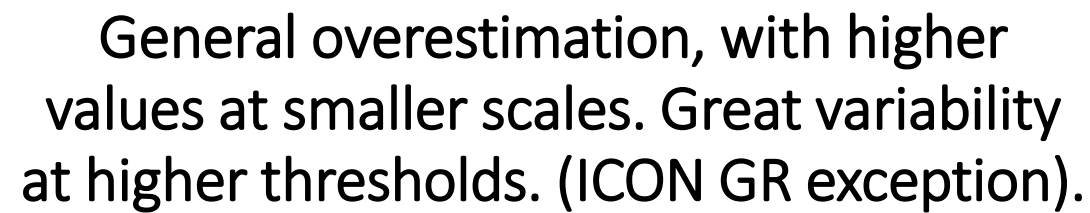




# ETS - MAM 2025 – COMMON AREA 2



The ETS mimics many of the characteristics of the FSS.





# OBSERVATIONS FOR COMMON AREA 2

## • JJA 2024:

- Weak diurnal cycle at low thresholds
- Large model spread at medium/high thresholds
- Evening increase in FSS on day 1 → morning of day 2

## • SON 2024:

- Small diurnal cycle at low thresholds
- Wide spread at initial timesteps
- Overestimation appears at medium/high thresholds

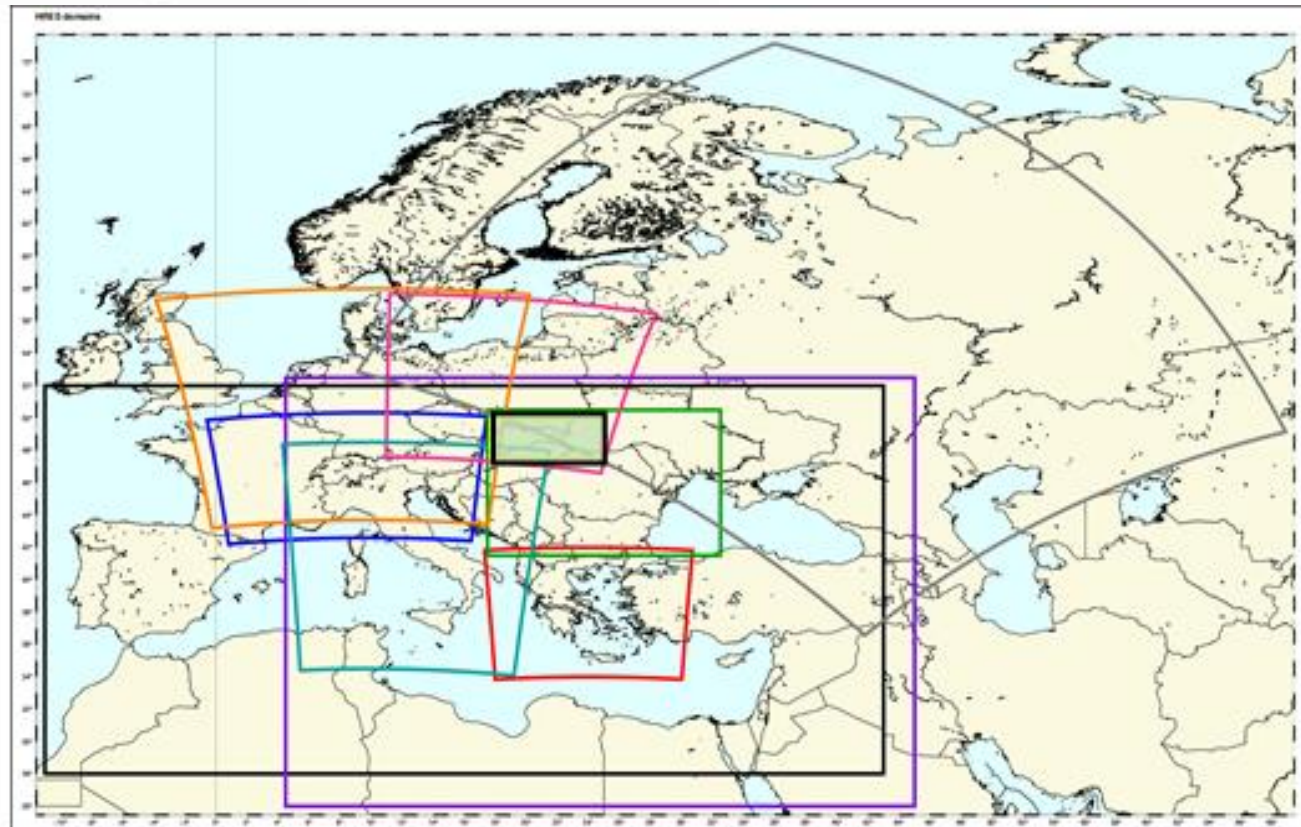
## • DJF 2025:

- Almost no diurnal cycle
- Very low FSS at high thresholds, little gain with scale
- Two model groups at low thresholds, more convergence later

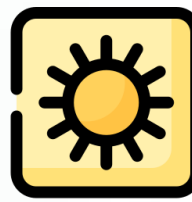
## • MAM 2025:

- Complex diurnal cycle with multiple peaks at medium thresholds
- One/two peaks at higher thresholds
- General overestimation, larger at small scales

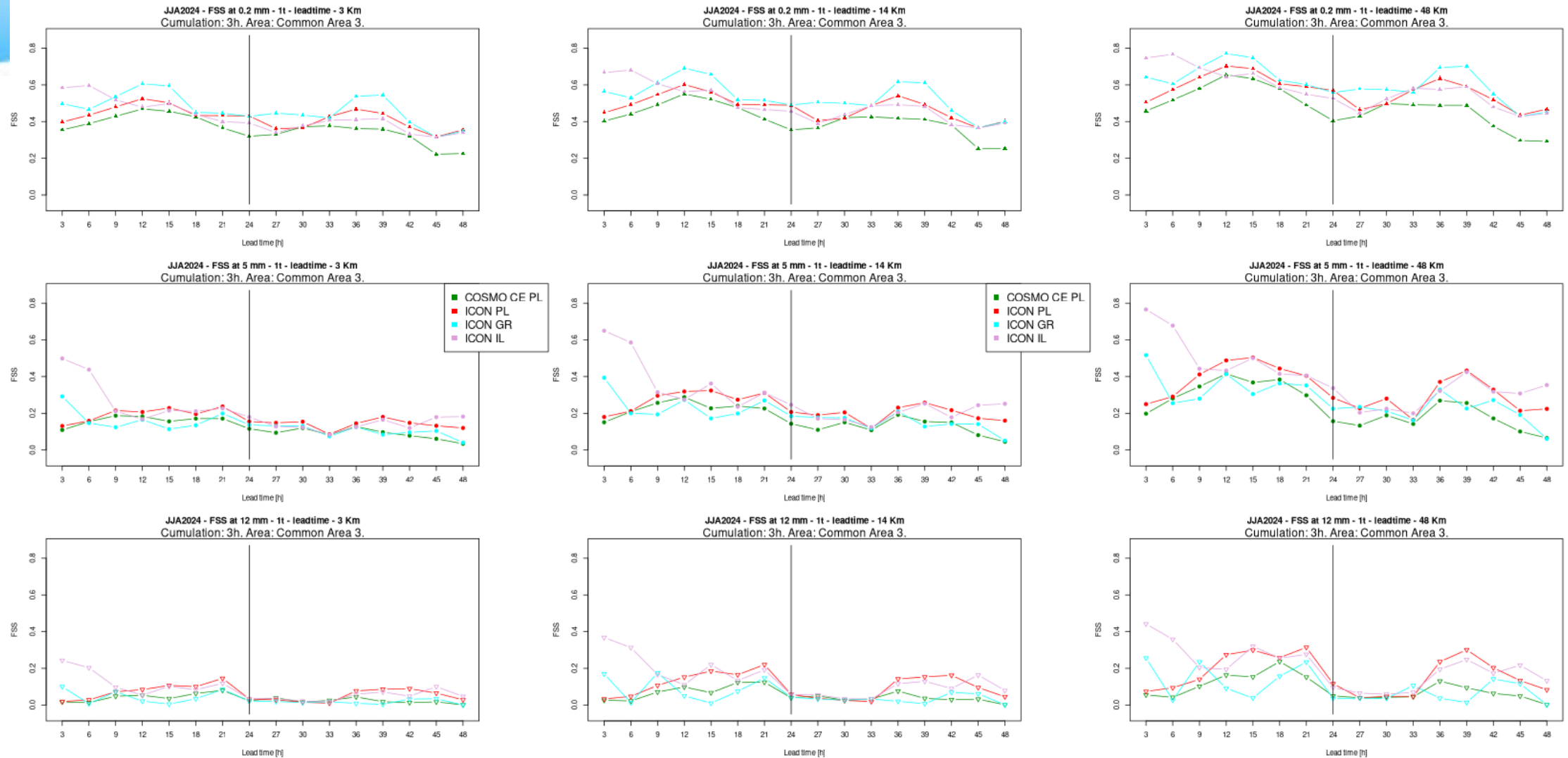
# COMMON AREA 3

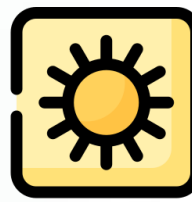


**Area: 47.5-50.0 N; 17.7-25.0 E**

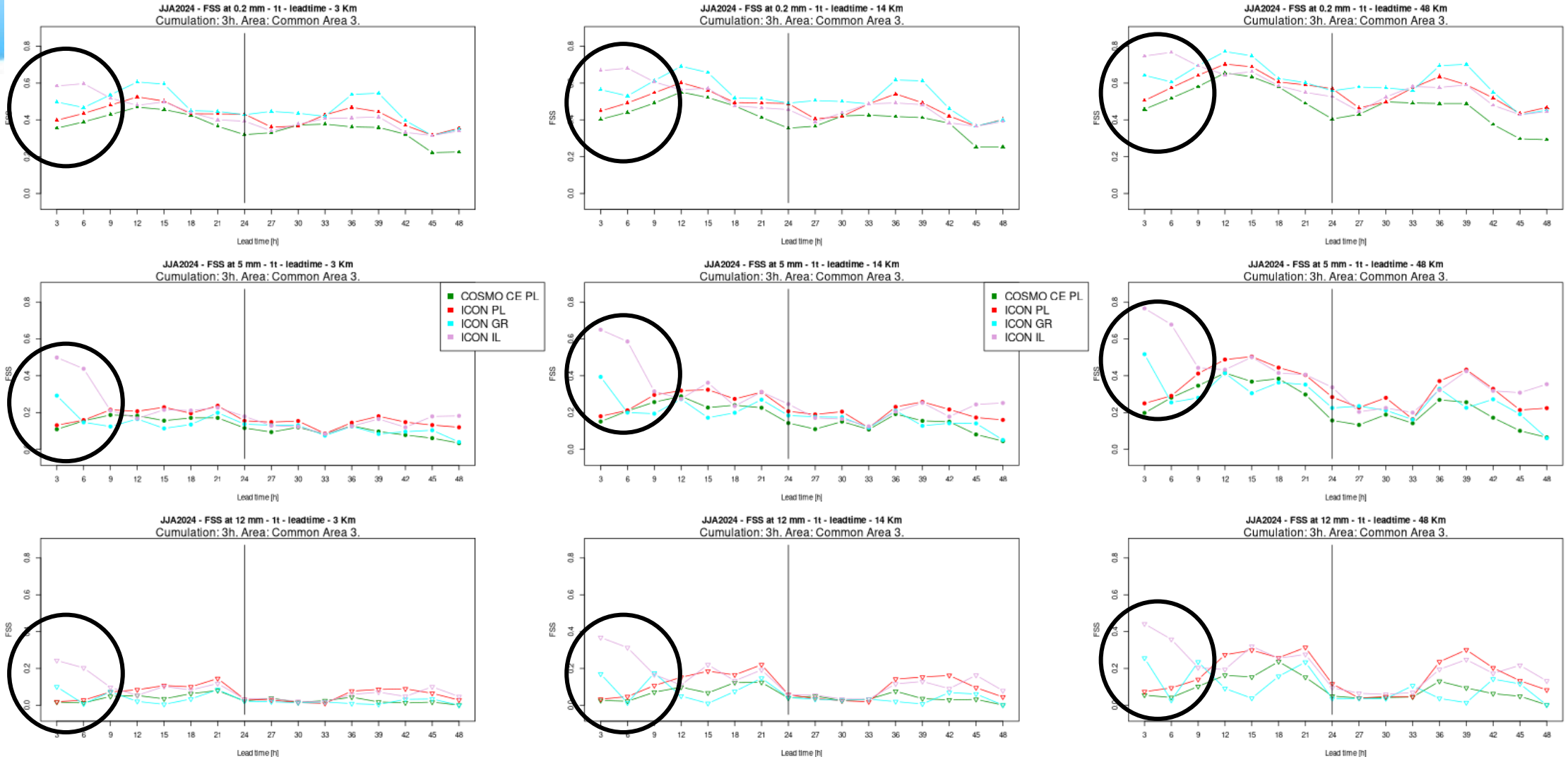


# FSS - JJA 2024 – COMMON AREA 3



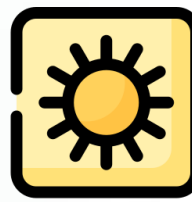


## FSS - JJA 2024 – COMMON AREA 3

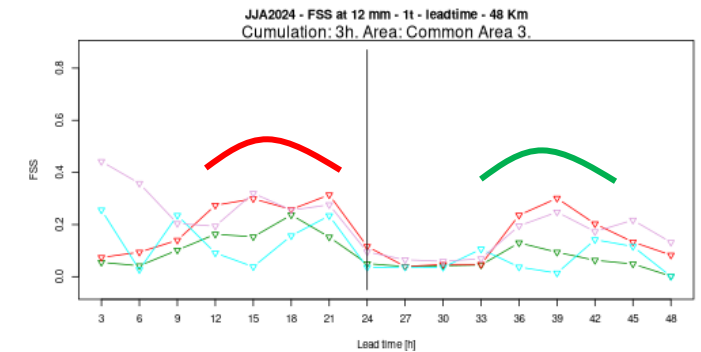
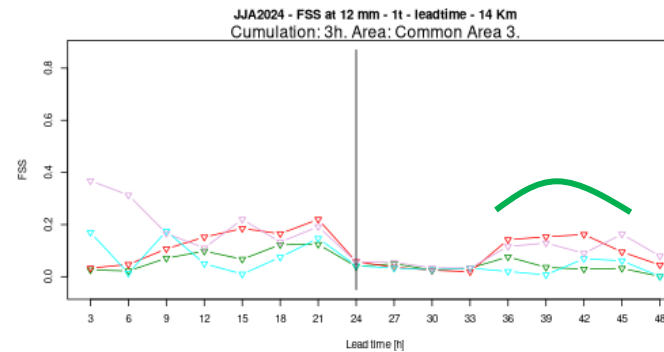
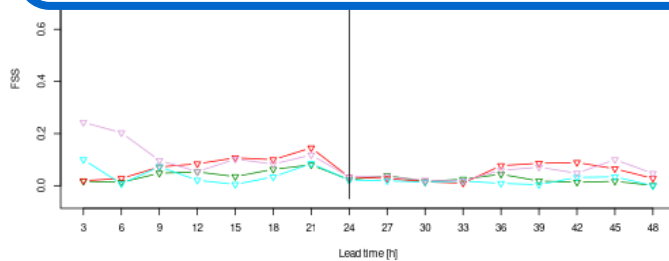
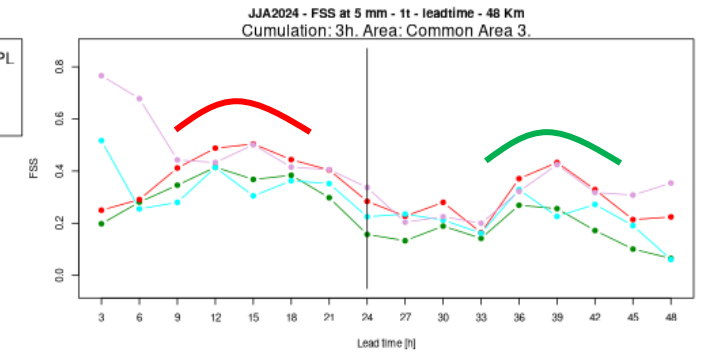
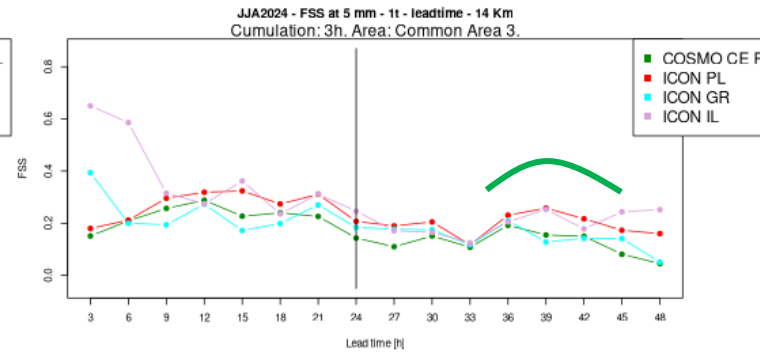
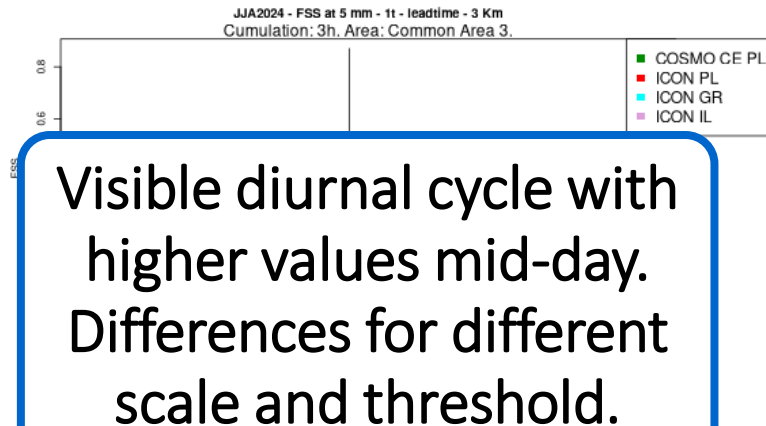
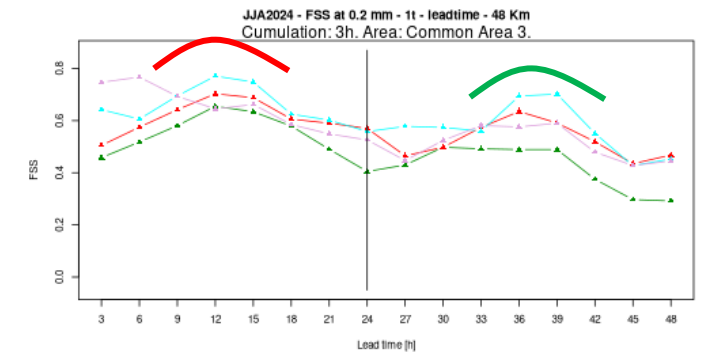
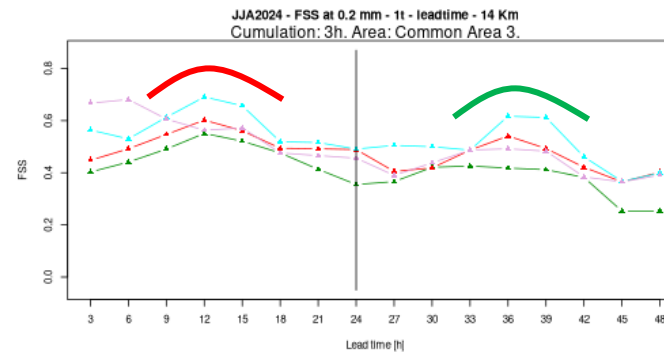
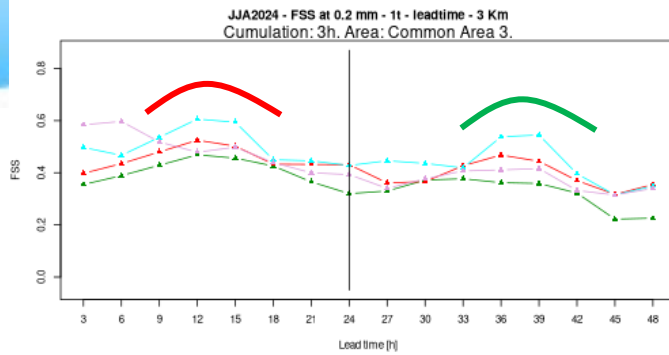


Bigger spread among the models in the initial timesteps.



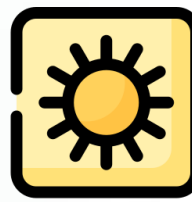


## FSS - JJA 2024 – COMMON AREA 3

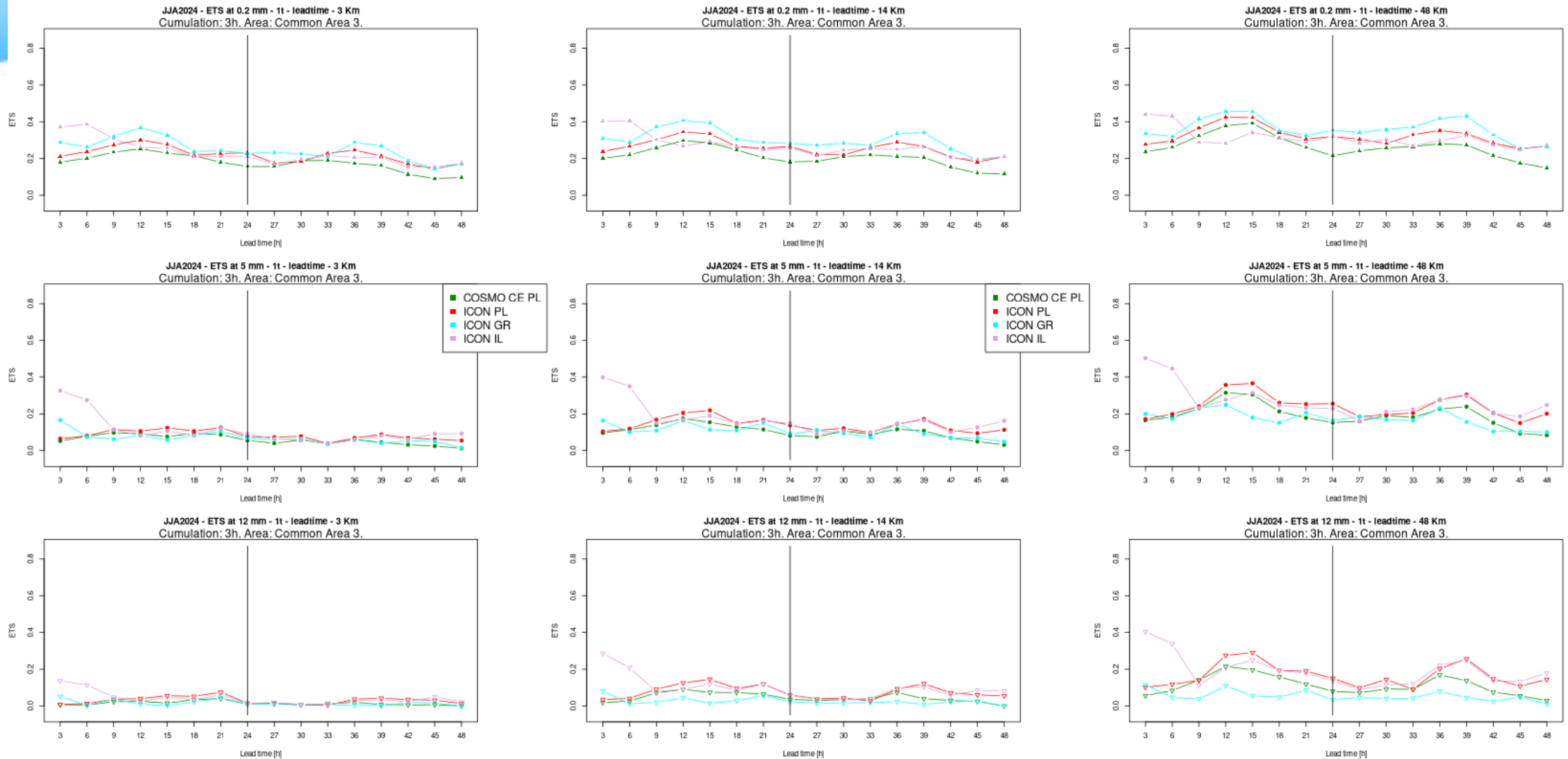


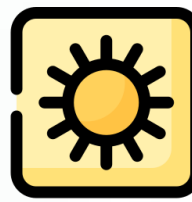
Visible diurnal cycle with higher values mid-day. Differences for different scale and threshold.



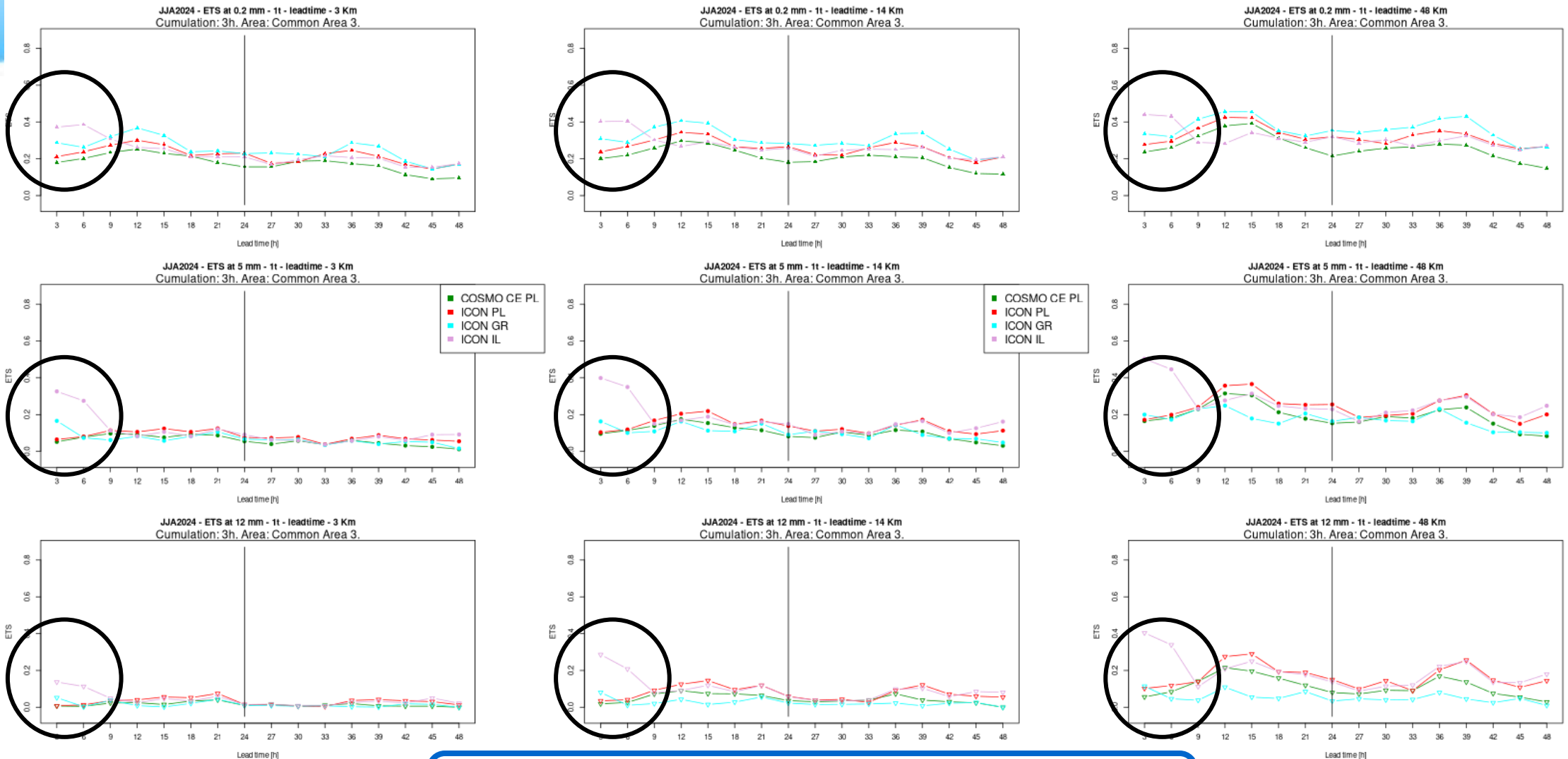


# ETS - JJA 2024 – COMMON AREA 3

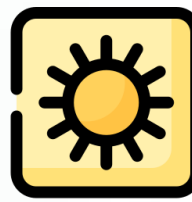




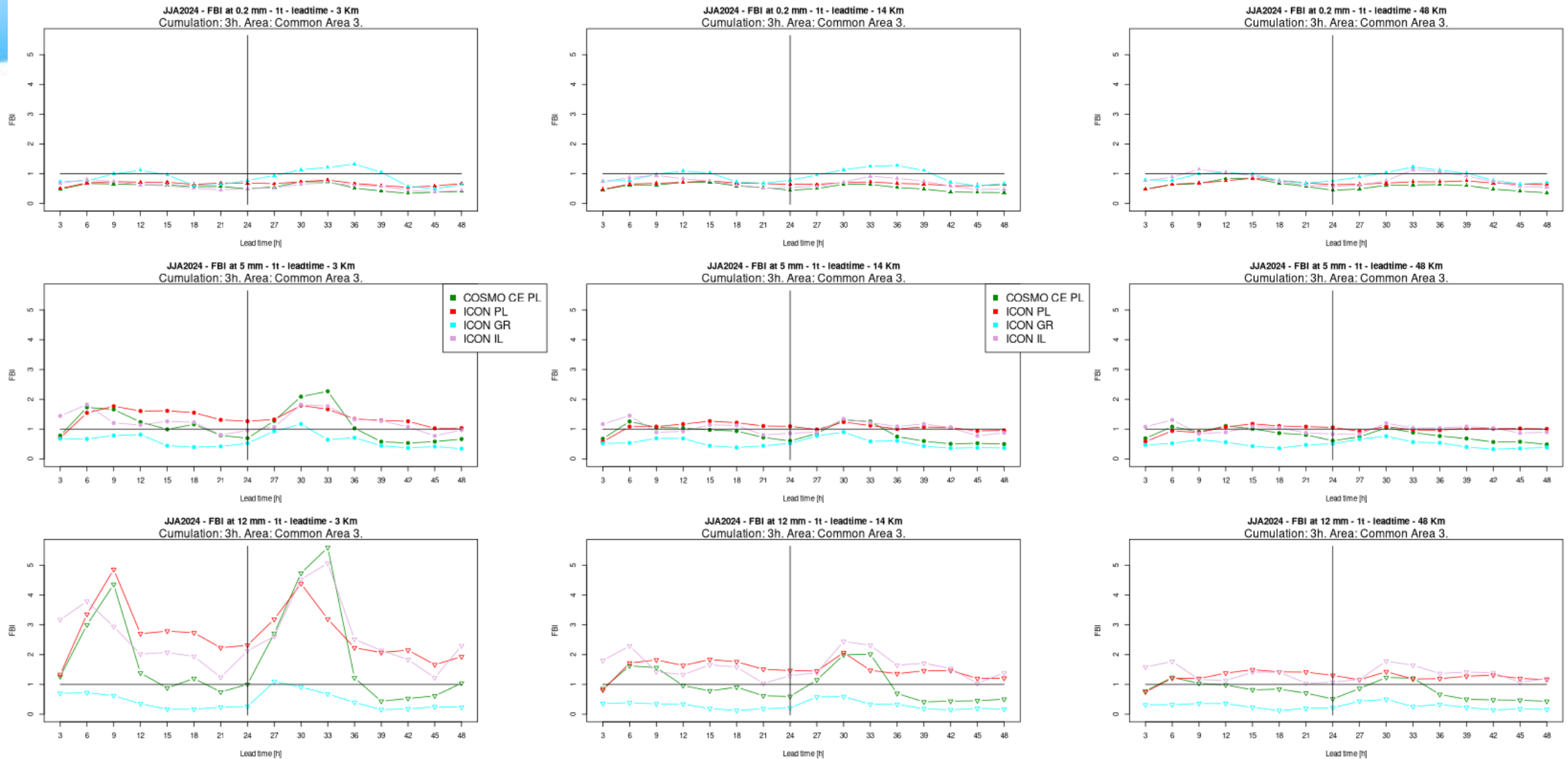
## ETS - JJA 2024 – COMMON AREA 3

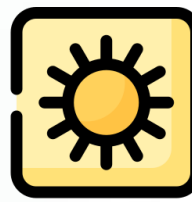


Spread also present in ETS, but mostly due to different behaviour of ICON IL.  
Less pronounced daily cycle.

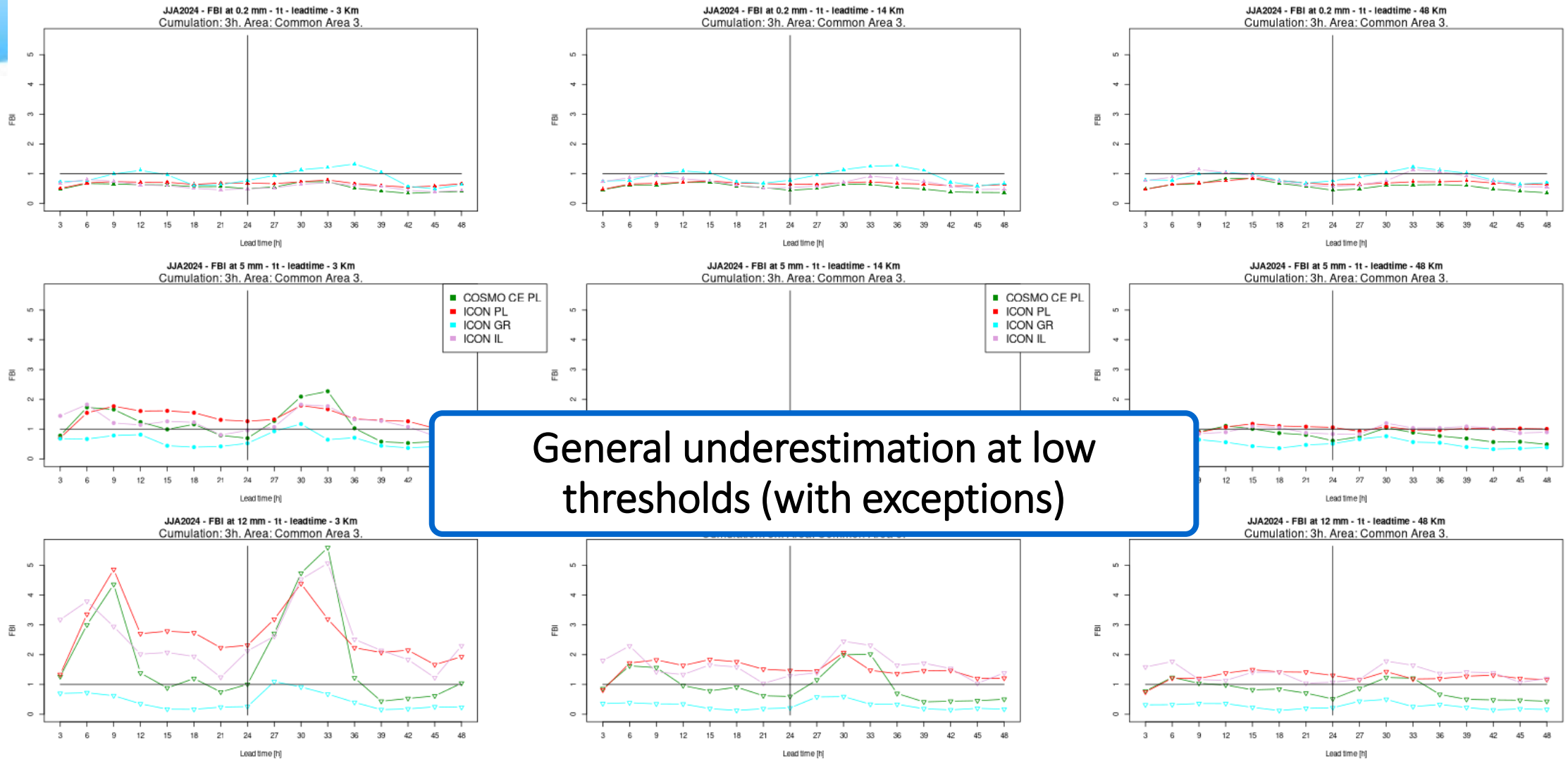


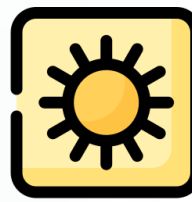
# FBI - JJA 2024 – COMMON AREA 3





# FBI - JJA 2024 – COMMON AREA 3

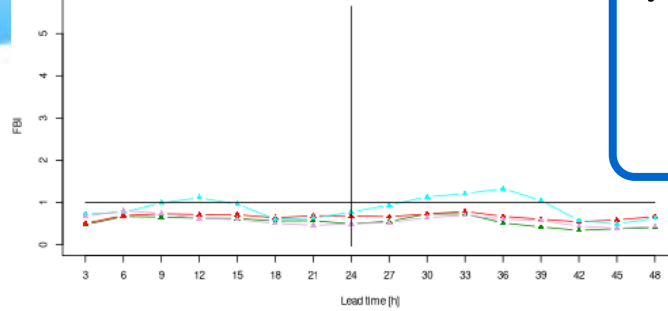




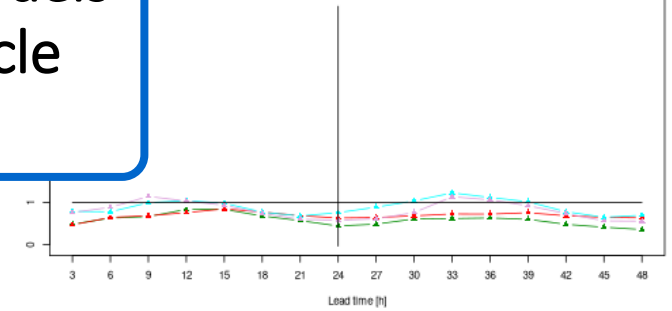
# FBI - JJA 2024 – COMMON AREA 3

At medium thresholds almost all models lay around the value of 1. Daily cycle visible at small scales.

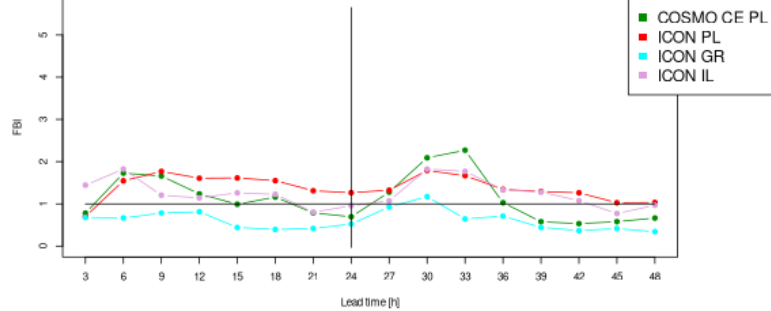
JJA2024 - FBI at 0.2 mm - 1t - leadtime - 3 Km  
Cumulation: 3h. Area: Common Area 3.



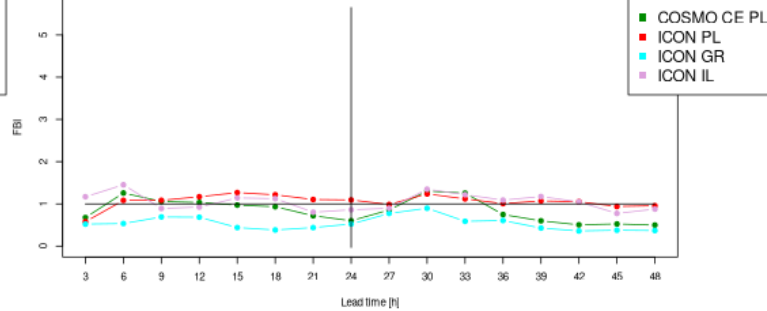
JJA2024 - FBI at 0.2 mm - 1t - leadtime - 48 Km  
Cumulation: 3h. Area: Common Area 3.



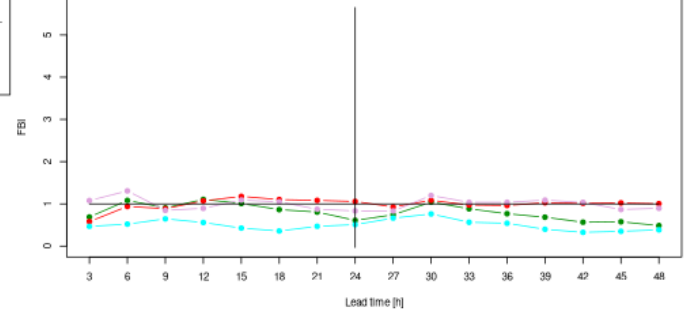
JJA2024 - FBI at 5 mm - 1t - leadtime - 3 Km  
Cumulation: 3h. Area: Common Area 3.



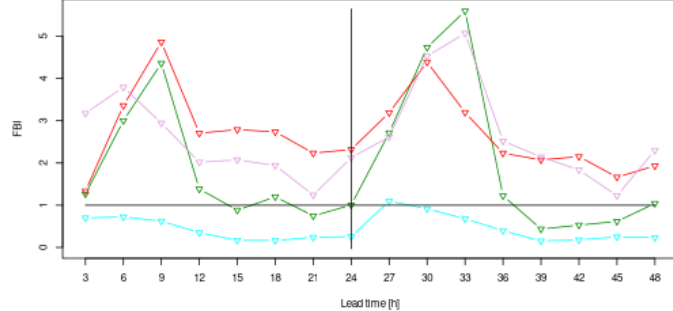
JJA2024 - FBI at 5 mm - 1t - leadtime - 14 Km  
Cumulation: 3h. Area: Common Area 3.



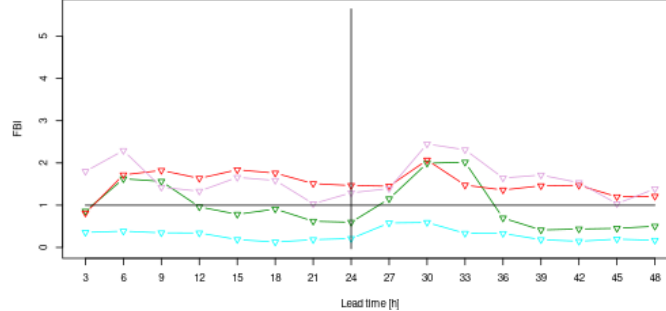
JJA2024 - FBI at 5 mm - 1t - leadtime - 48 Km  
Cumulation: 3h. Area: Common Area 3.



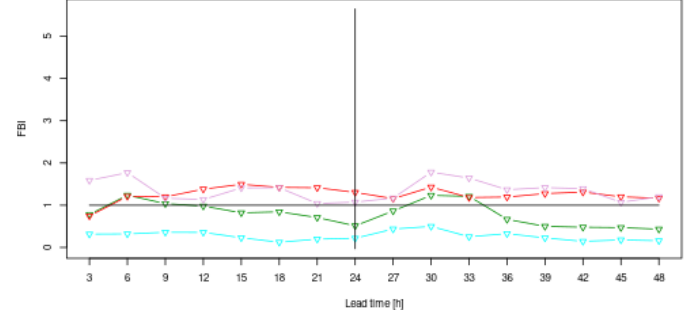
JJA2024 - FBI at 12 mm - 1t - leadtime - 3 Km  
Cumulation: 3h. Area: Common Area 3.



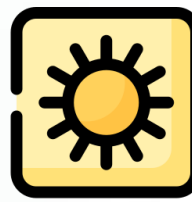
JJA2024 - FBI at 12 mm - 1t - leadtime - 14 Km  
Cumulation: 3h. Area: Common Area 3.



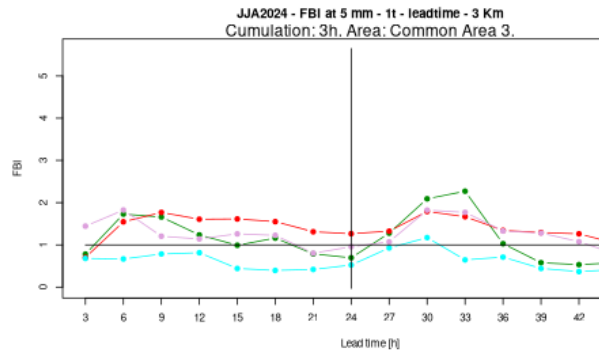
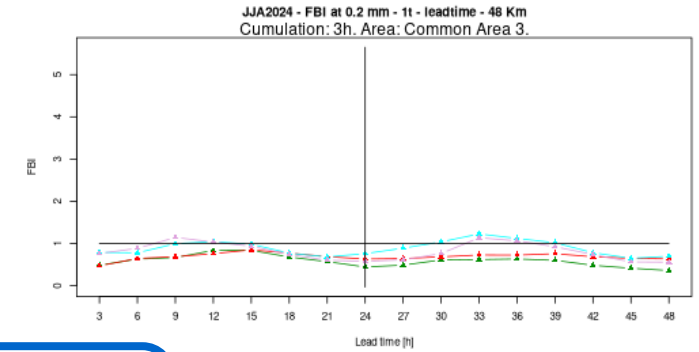
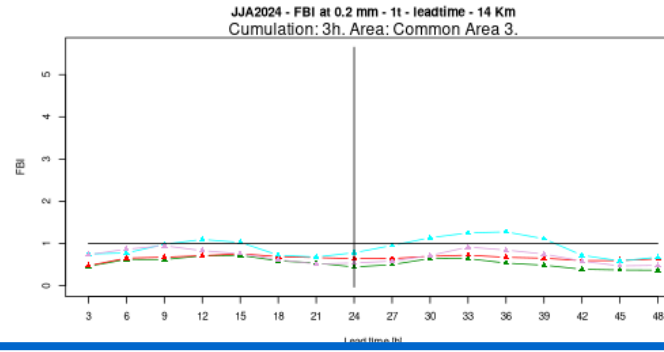
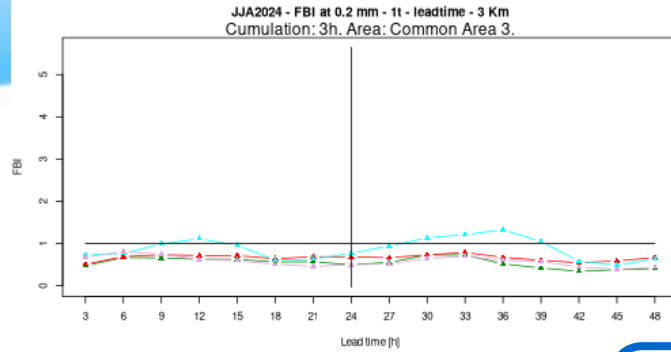
JJA2024 - FBI at 12 mm - 1t - leadtime - 48 Km  
Cumulation: 3h. Area: Common Area 3.



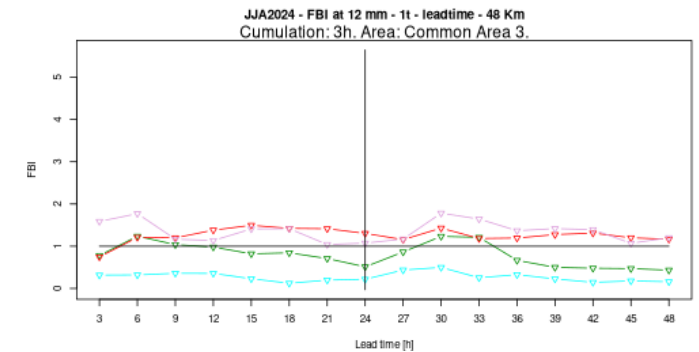
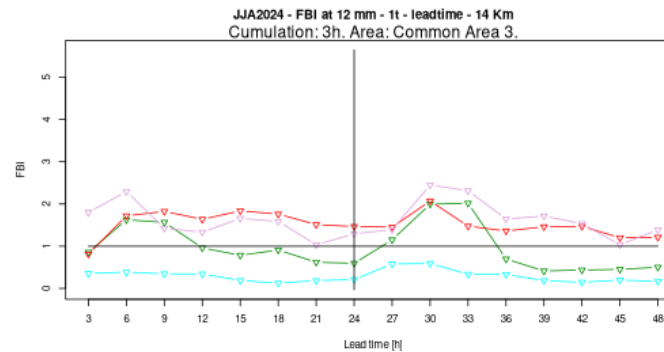
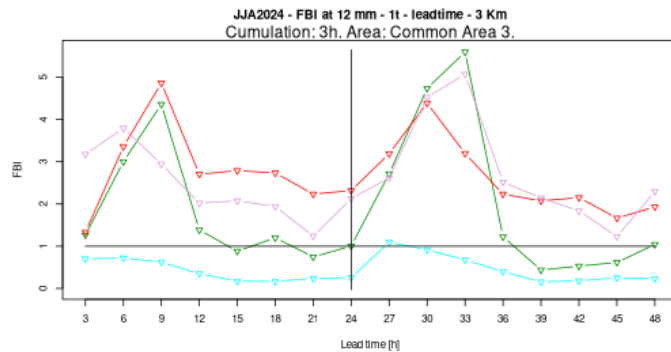
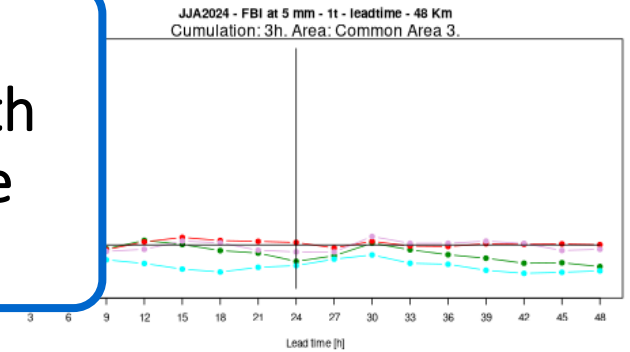




# FBI - JJA 2024 – COMMON AREA 3

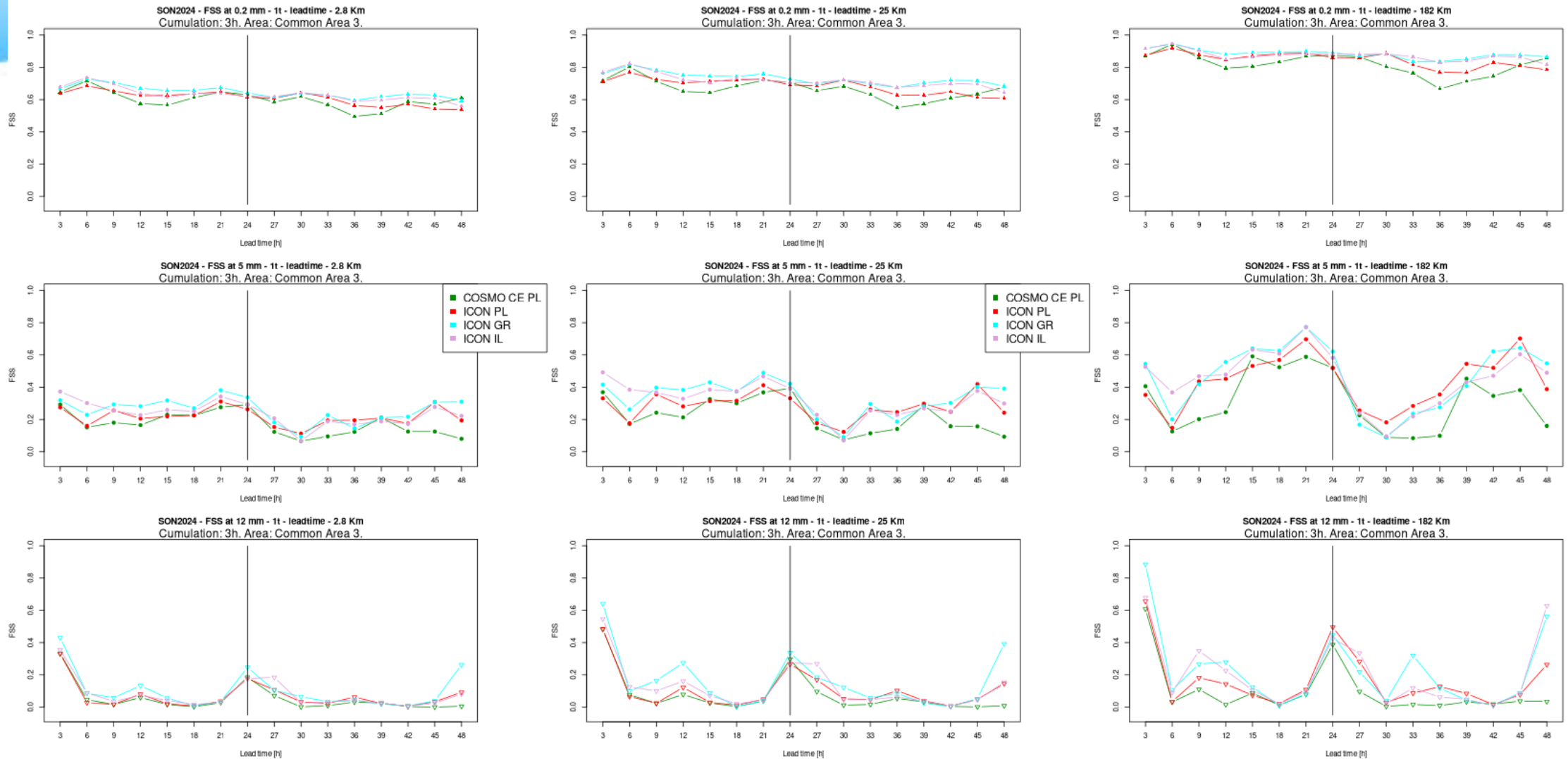


AT high thresholds there is larger overestimation at smaller scales (with the exception of ICON GR), then the BIAS gets smaller.



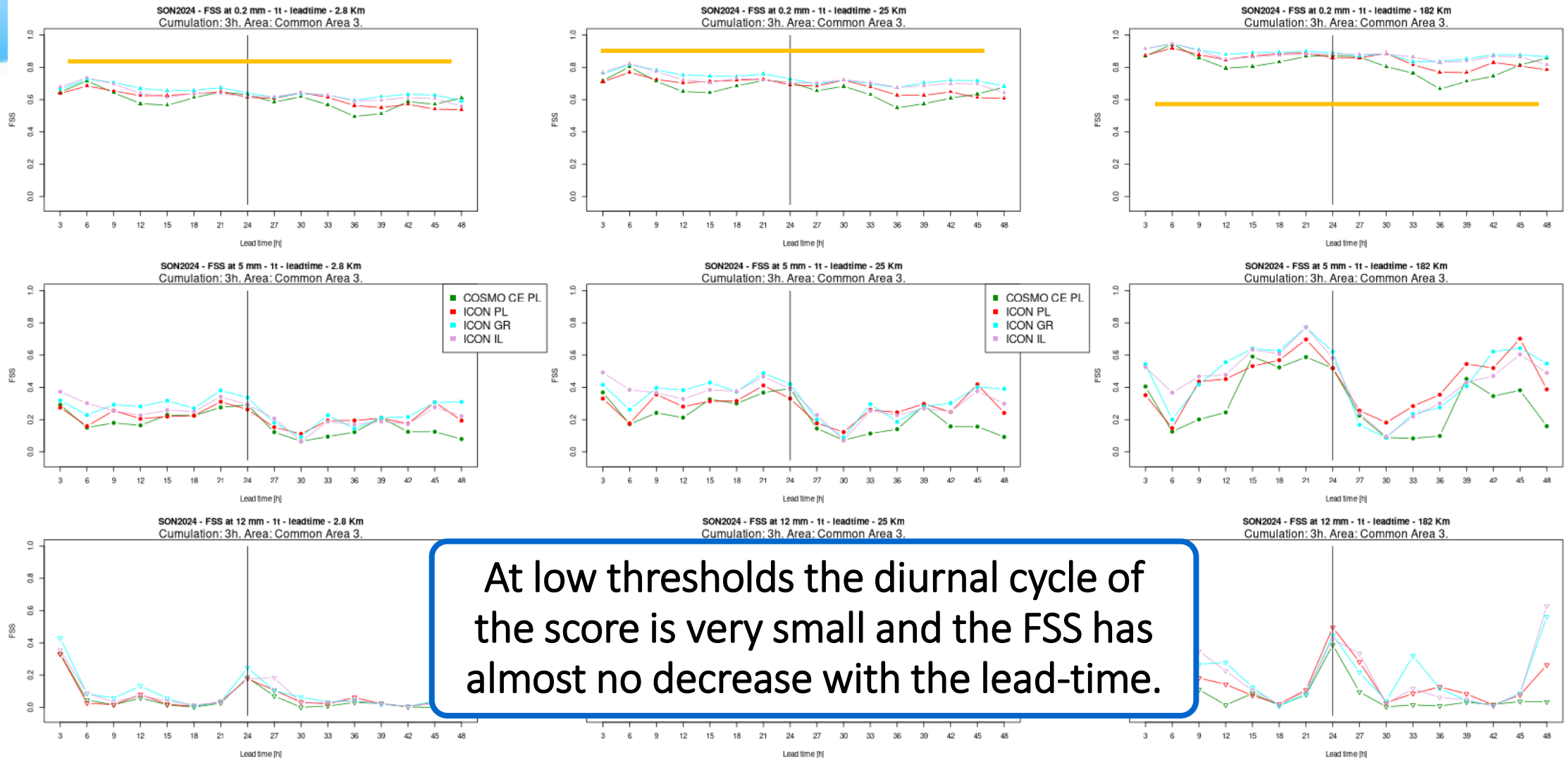


# FSS - SON 2024 – COMMON AREA 3





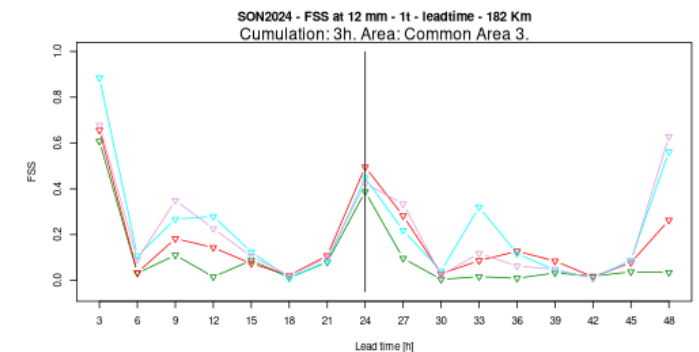
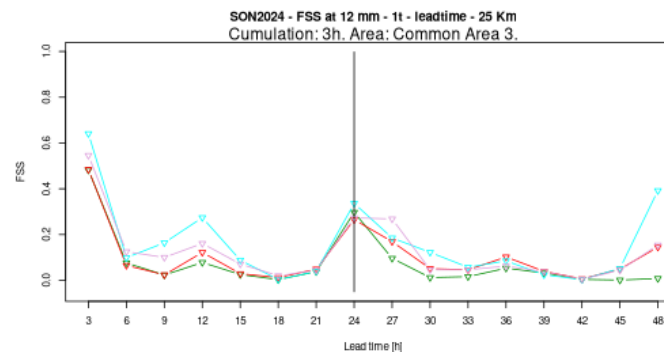
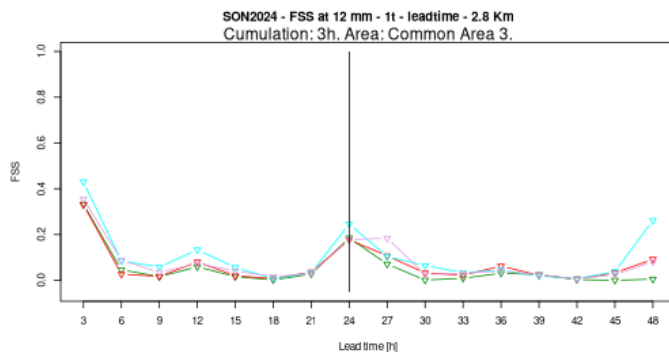
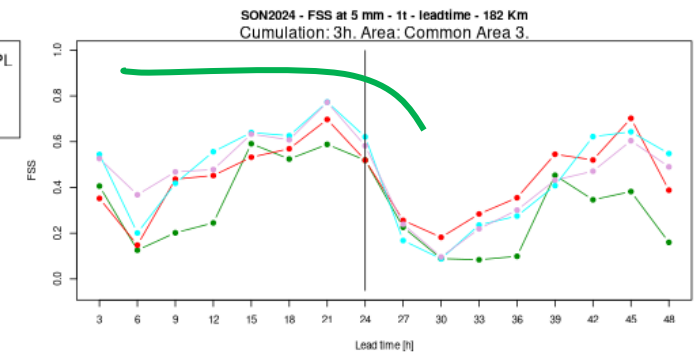
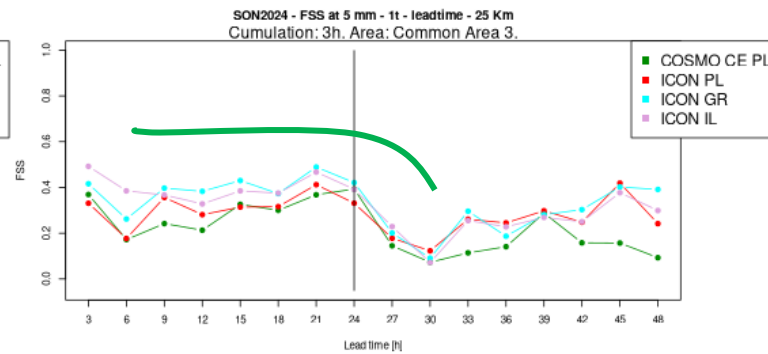
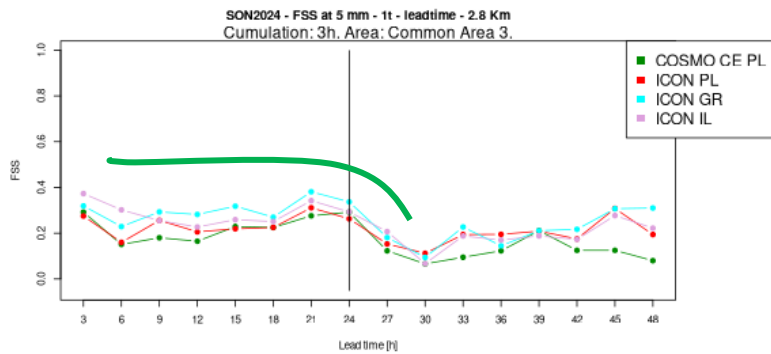
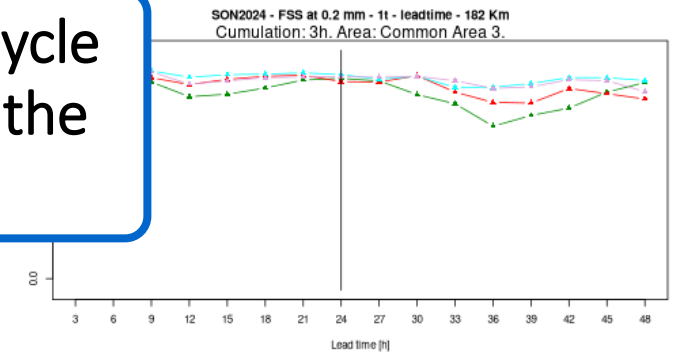
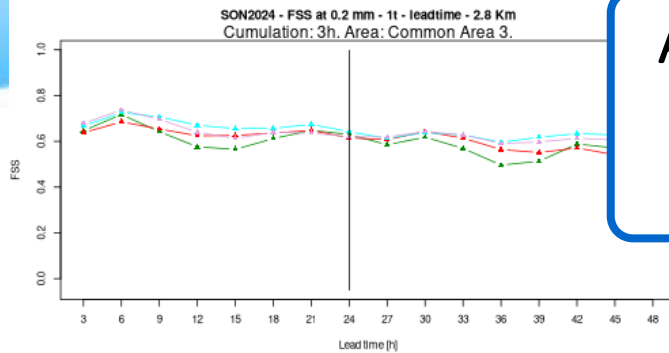
# FSS - SON 2024 – COMMON AREA 3





## FSS - SON 2024 – COMMON AREA 3

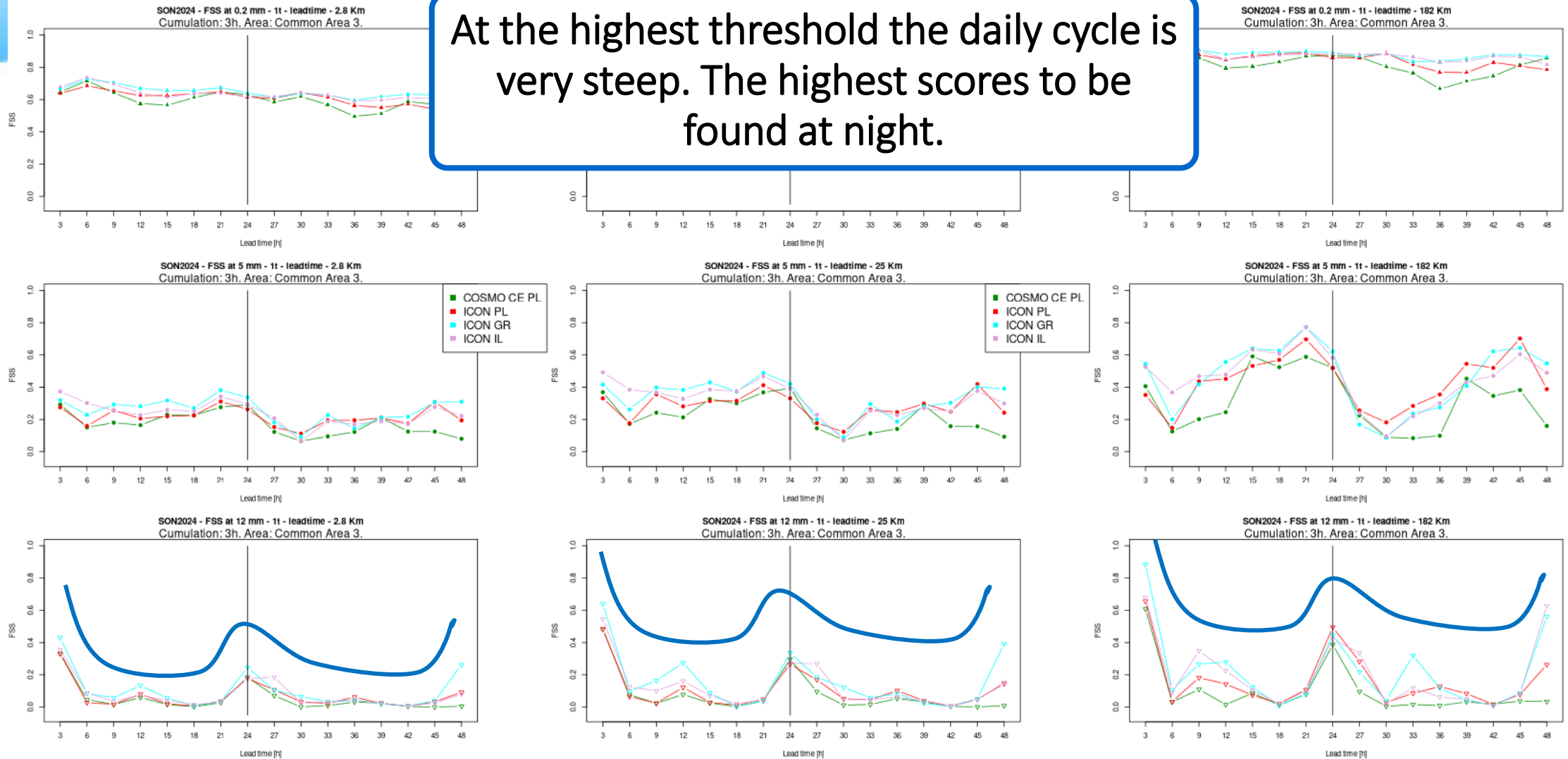
At medium thresholds the diurnal cycle of the score is less pronounced for the 1<sup>st</sup> day of forecast.





## FSS - SON 2024 – COMMON AREA 3

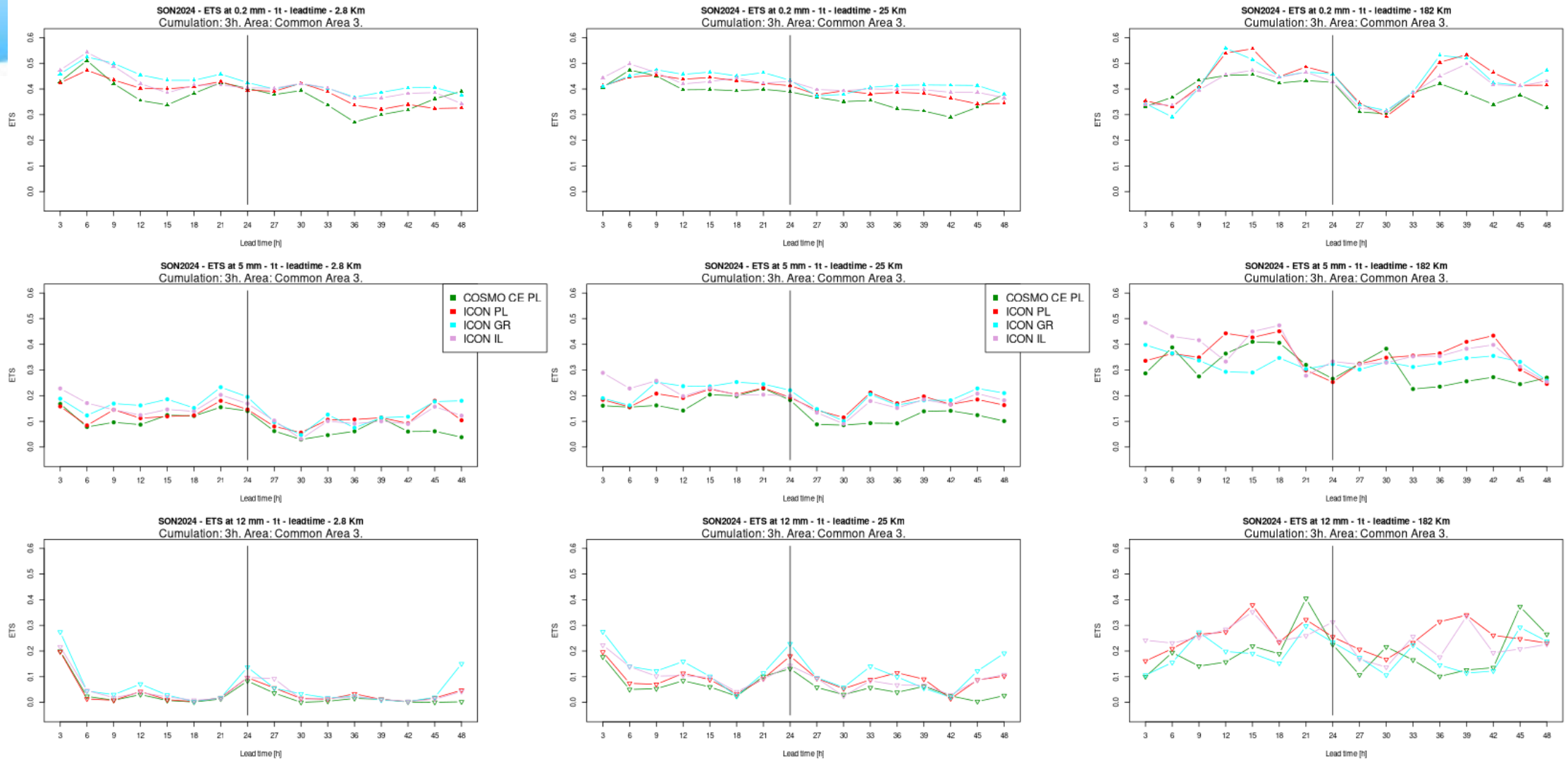
At the highest threshold the daily cycle is very steep. The highest scores to be found at night.





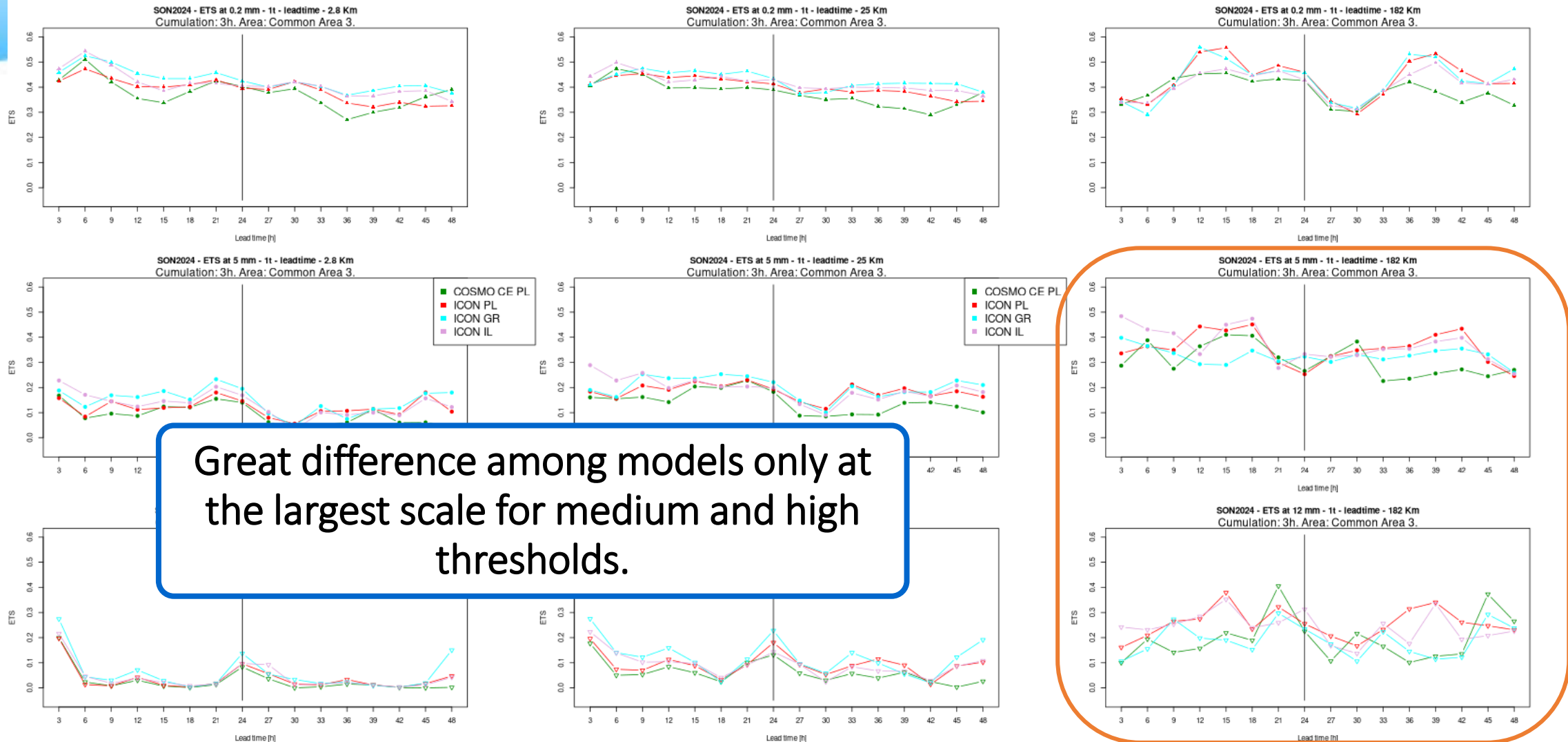


# ETS - SON 2024 – COMMON AREA 3



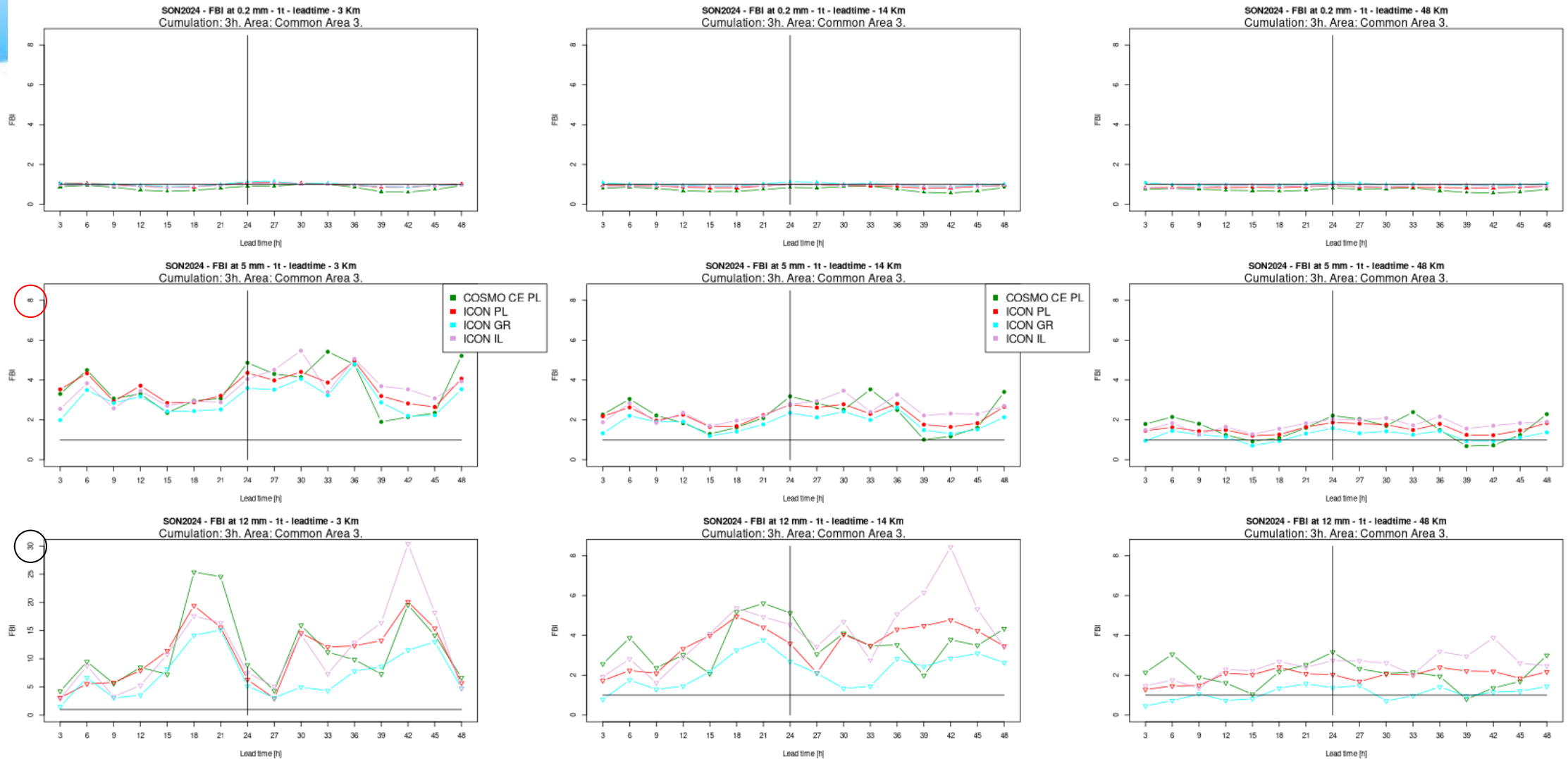


## ETS - SON 2024 – COMMON AREA 3



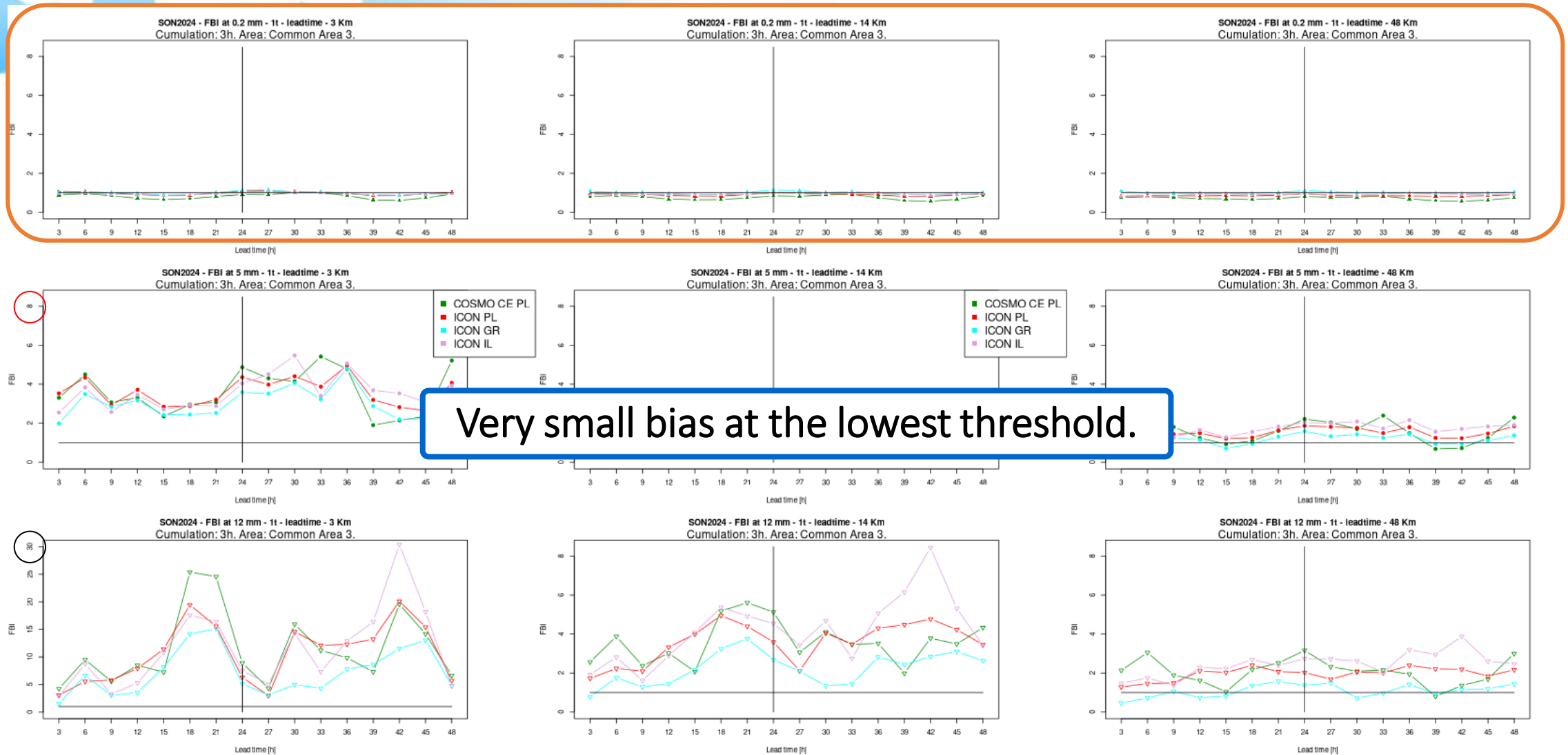


# FBI - SON 2024 – COMMON AREA 3



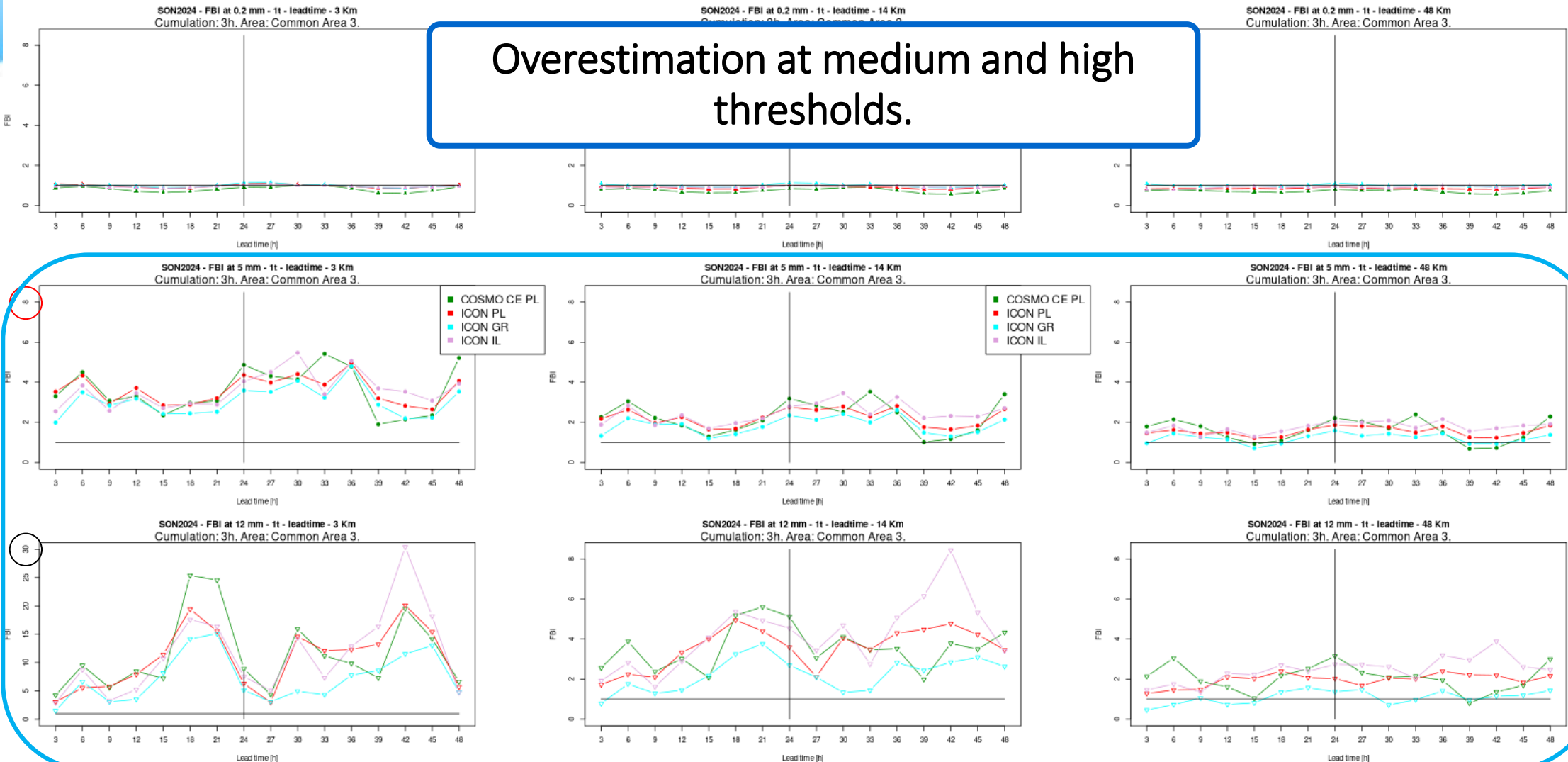


# FBI - SON 2024 – COMMON AREA 3





# FBI - SON 2024 – COMMON AREA 3



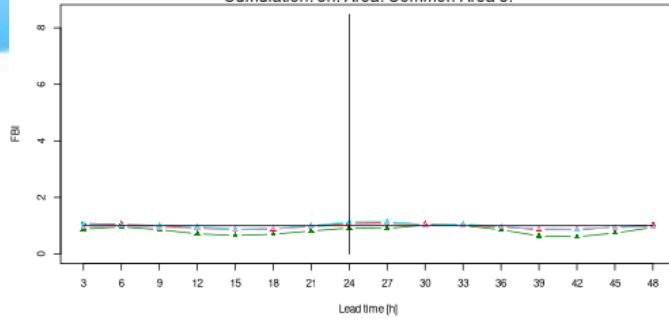
24



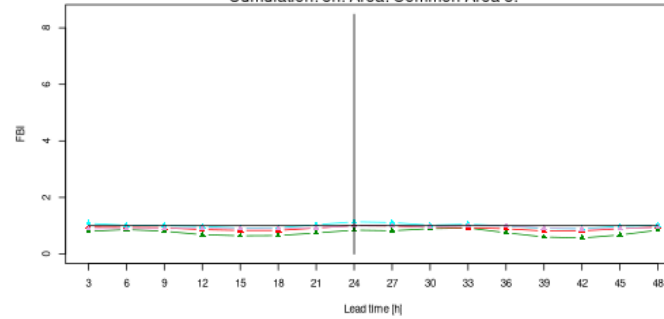


# FBI - SON 2024 – COMMON AREA 3

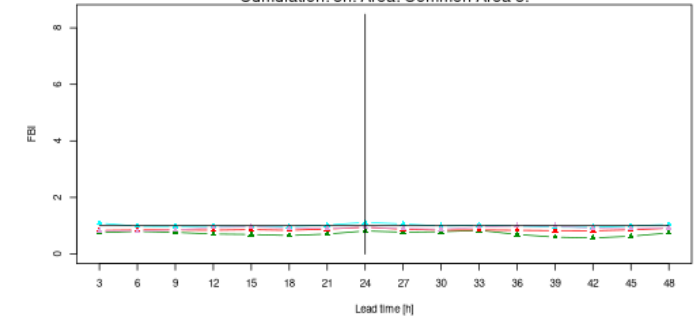
SON2024 - FBI at 0.2 mm - 1t - leadtime - 3 Km  
Cumulation: 3h. Area: Common Area 3.



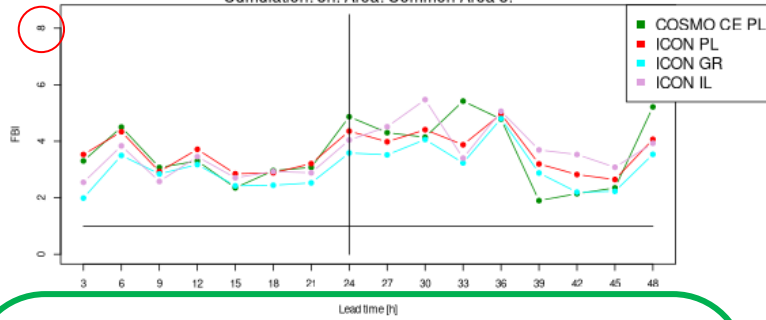
SON2024 - FBI at 0.2 mm - 1t - leadtime - 14 Km  
Cumulation: 3h. Area: Common Area 3.



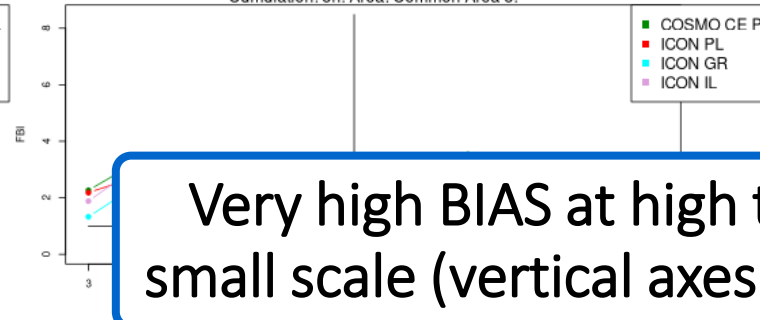
SON2024 - FBI at 0.2 mm - 1t - leadtime - 48 Km  
Cumulation: 3h. Area: Common Area 3.



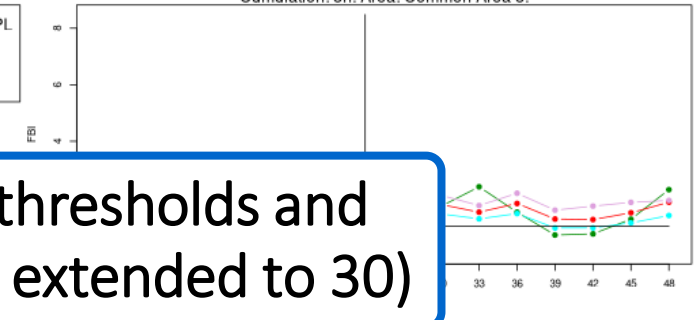
SON2024 - FBI at 5 mm - 1t - leadtime - 3 Km  
Cumulation: 3h. Area: Common Area 3.



SON2024 - FBI at 5 mm - 1t - leadtime - 14 Km  
Cumulation: 3h. Area: Common Area 3.

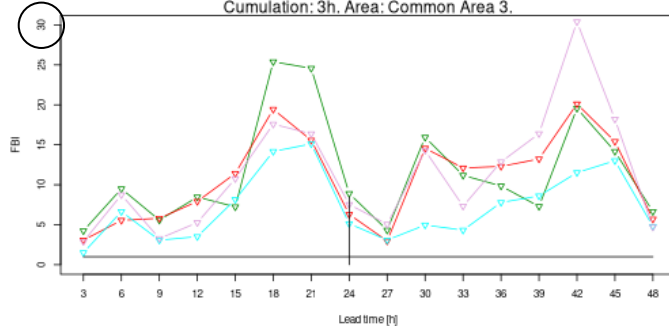


SON2024 - FBI at 5 mm - 1t - leadtime - 48 Km  
Cumulation: 3h. Area: Common Area 3.

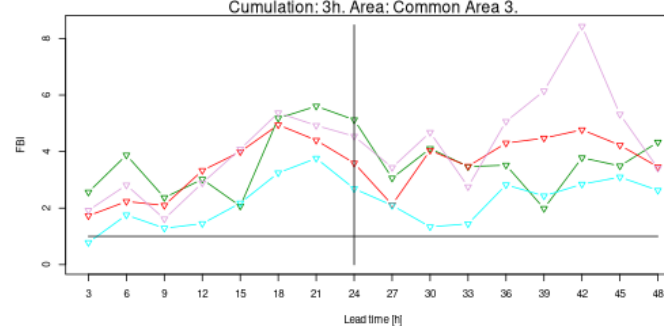


Very high BIAS at high thresholds and small scale (vertical axes extended to 30)

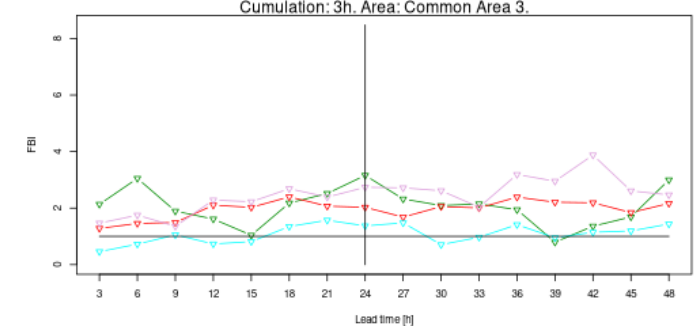
SON2024 - FBI at 12 mm - 1t - leadtime - 3 Km  
Cumulation: 3h. Area: Common Area 3.

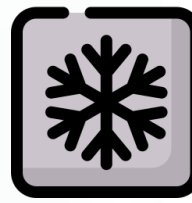


SON2024 - FBI at 12 mm - 1t - leadtime - 14 Km  
Cumulation: 3h. Area: Common Area 3.

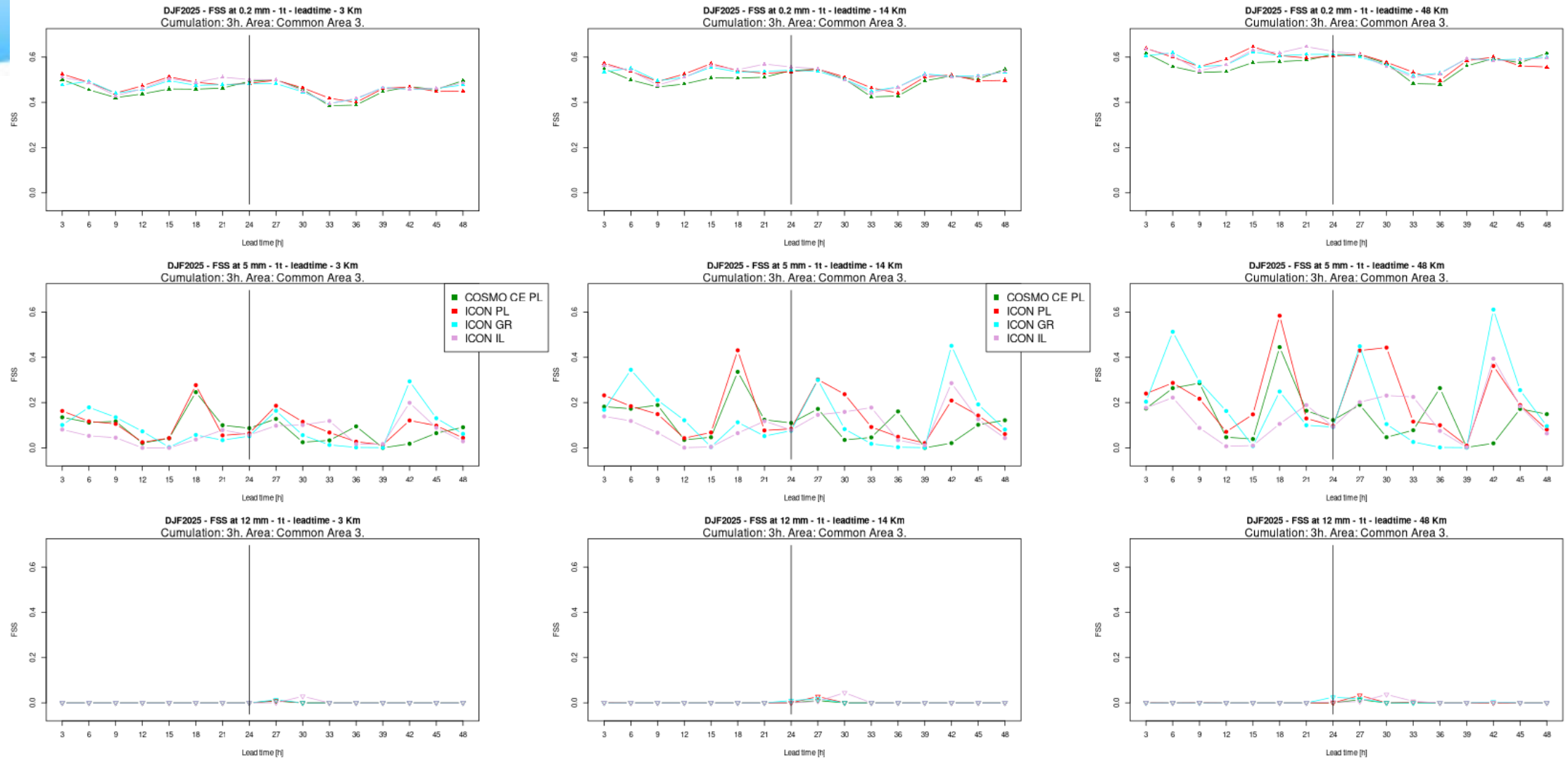


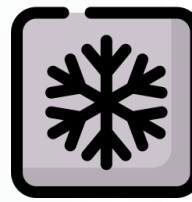
SON2024 - FBI at 12 mm - 1t - leadtime - 48 Km  
Cumulation: 3h. Area: Common Area 3.



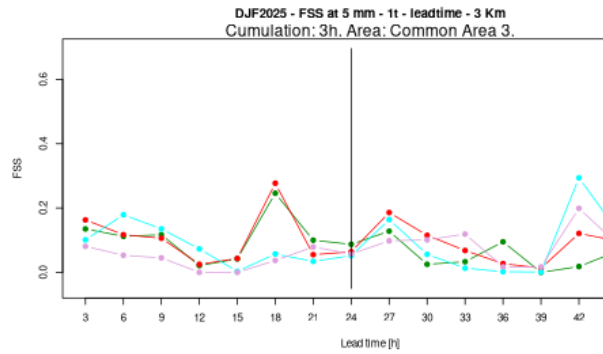
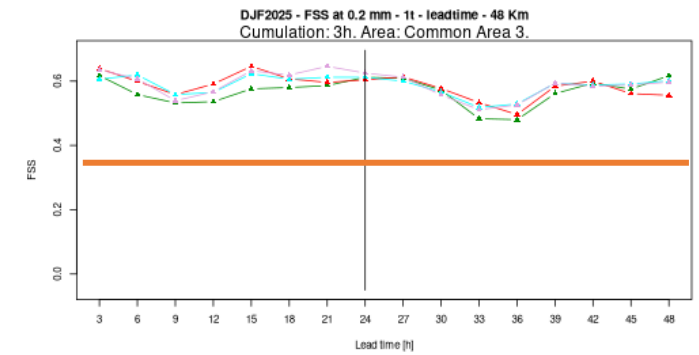
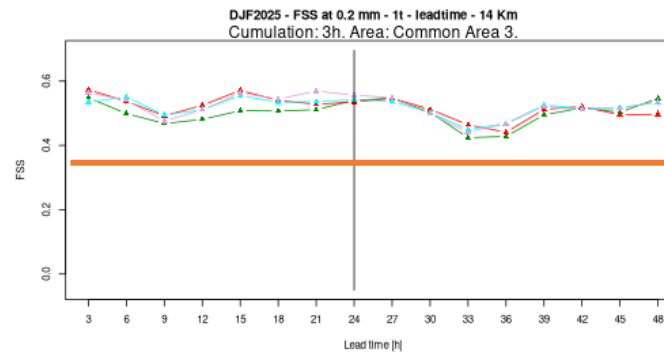
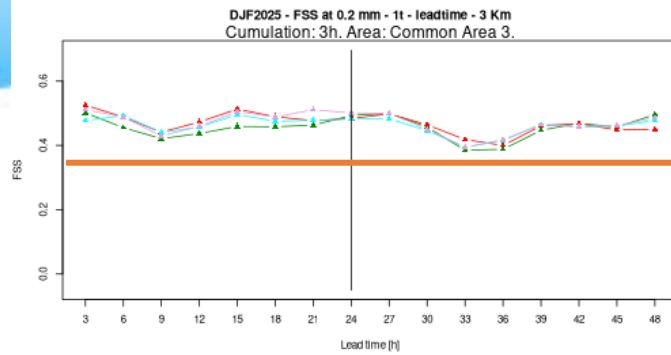


# FSS - DJF 2025 – COMMON AREA 3





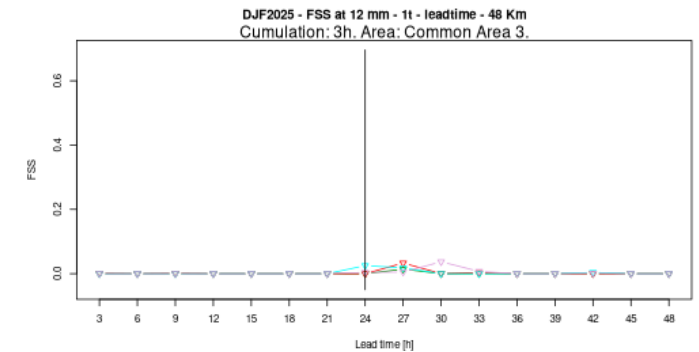
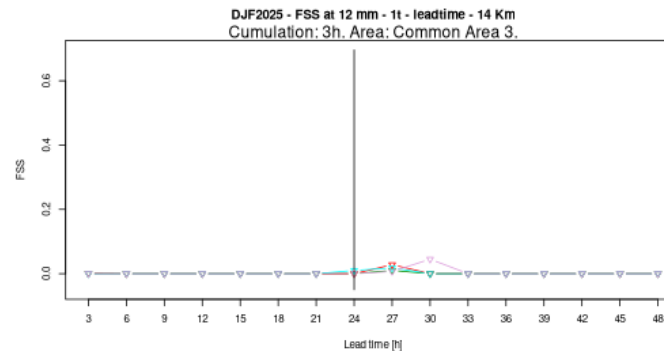
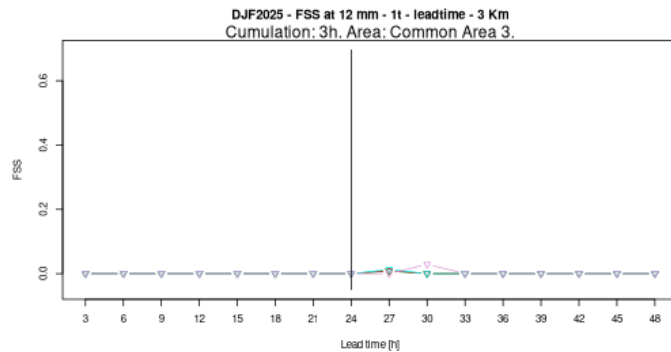
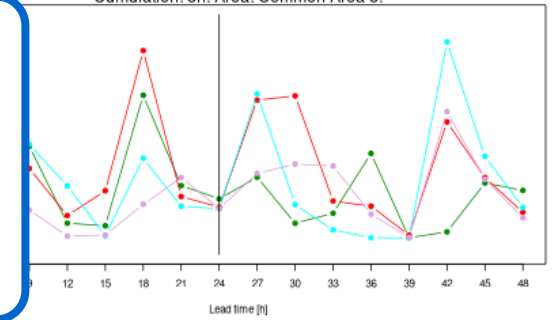
## FSS - DJF 2025 – COMMON AREA 3



Almost no degradation with leadtime at the lowest threshold. Increase of FSS with the amplitude of the spatial scale. Some daily cycle.

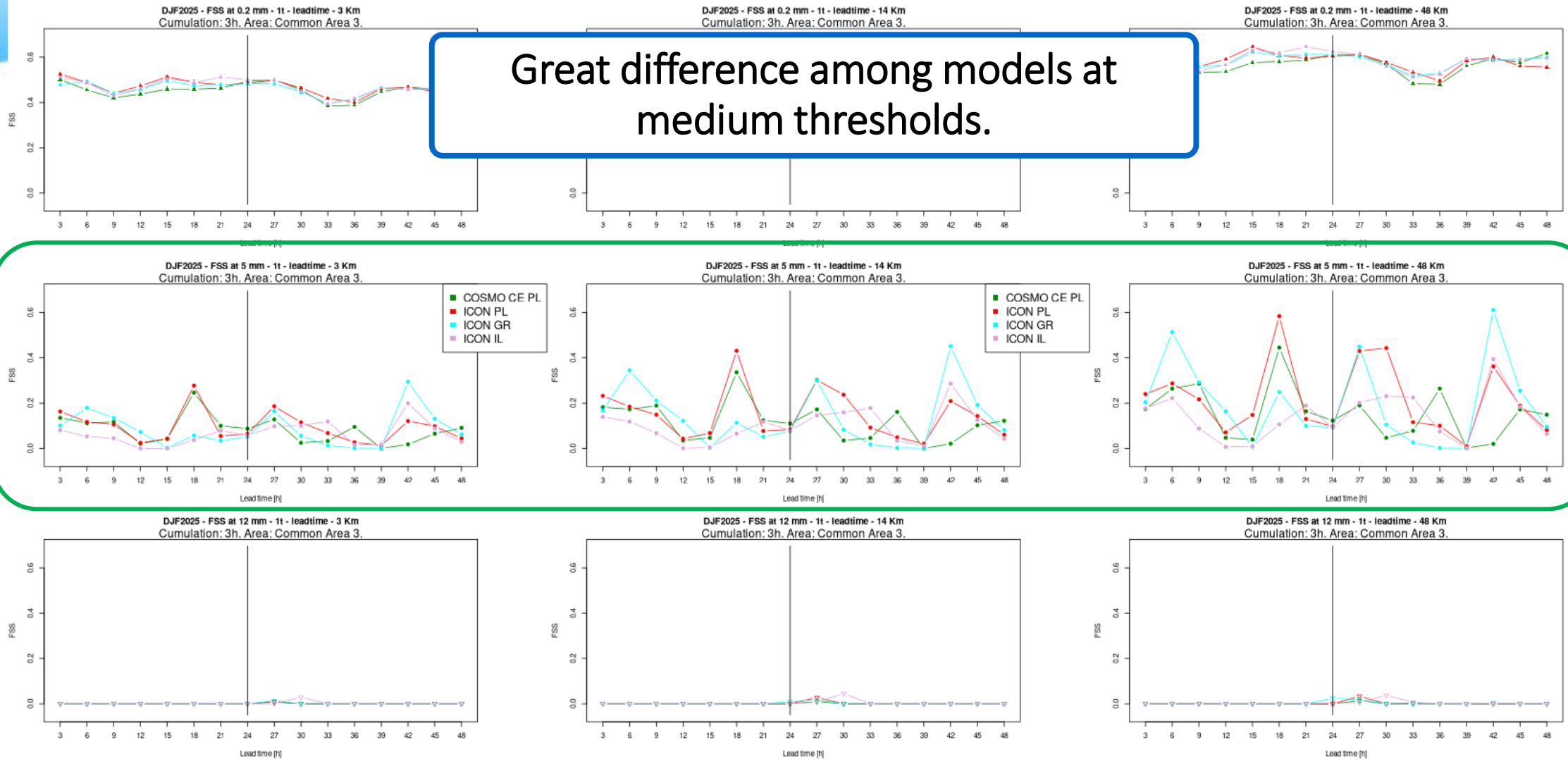
DJF2025 - FSS at 5 mm - 1t - leadtime - 14 Km  
Cumulation: 3h. Area: Common Area 3.

DJF2025 - FSS at 5 mm - 1t - leadtime - 48 Km  
Cumulation: 3h. Area: Common Area 3.



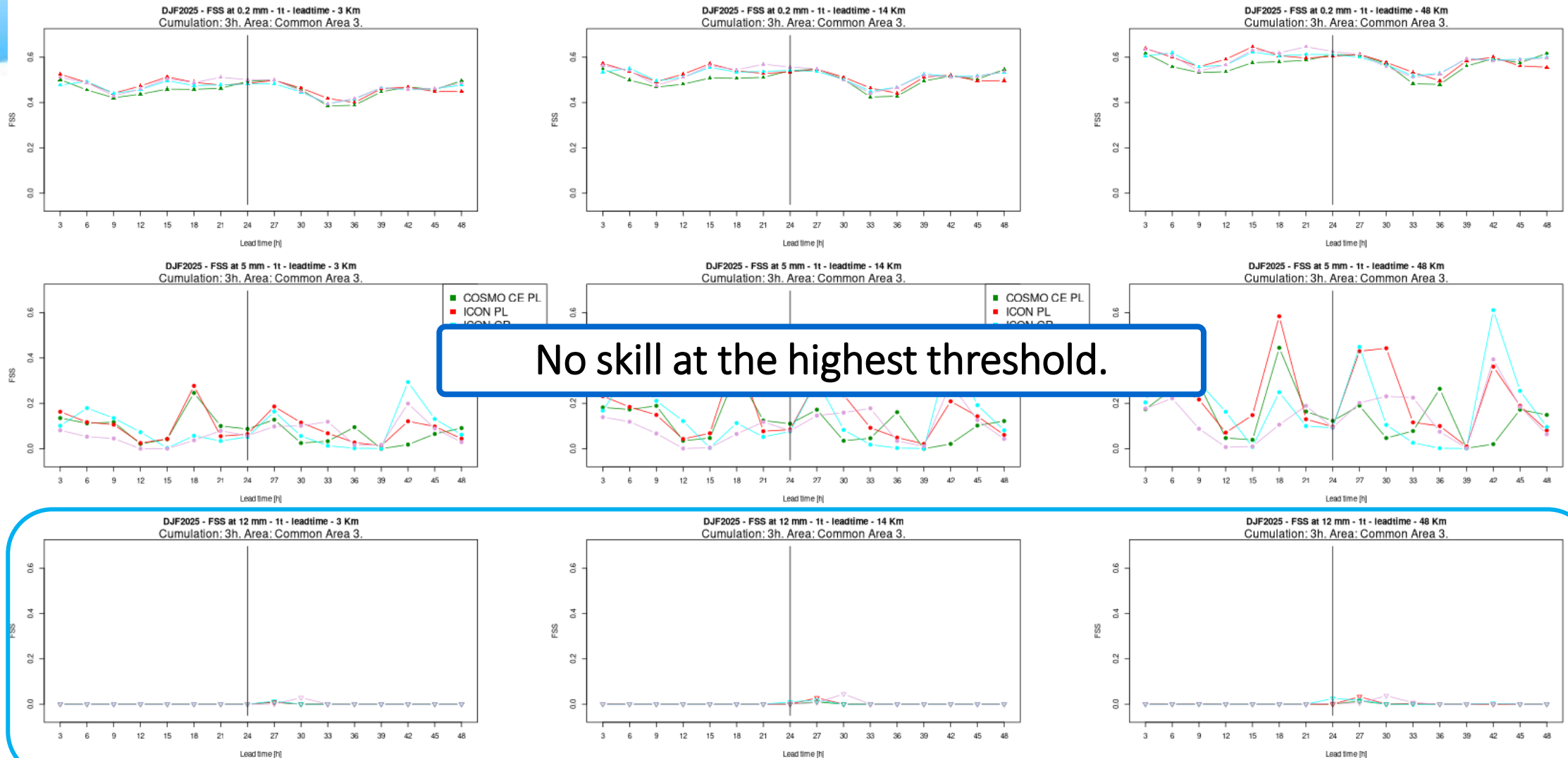


# FSS - DJF 2025 – COMMON AREA 3



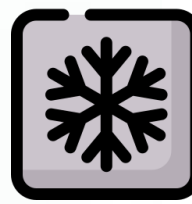


# FSS - DJF 2025 – COMMON AREA 3

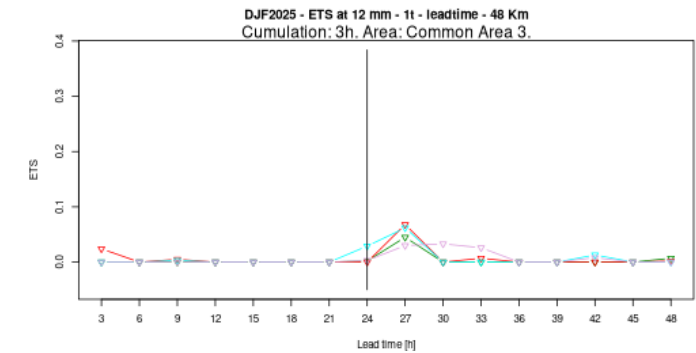
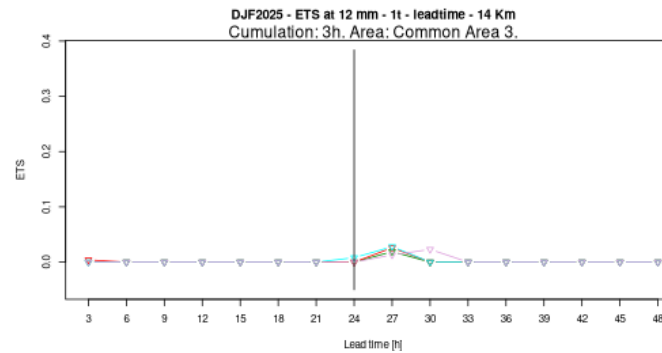
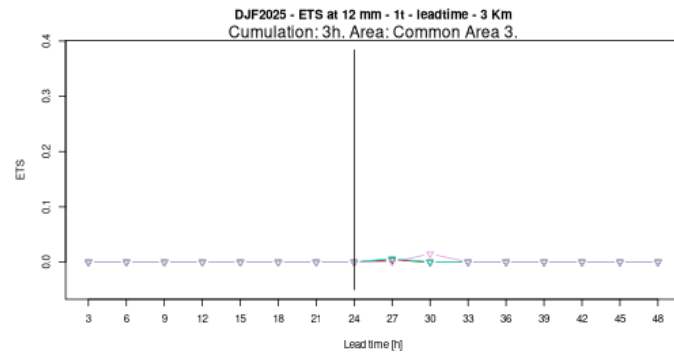
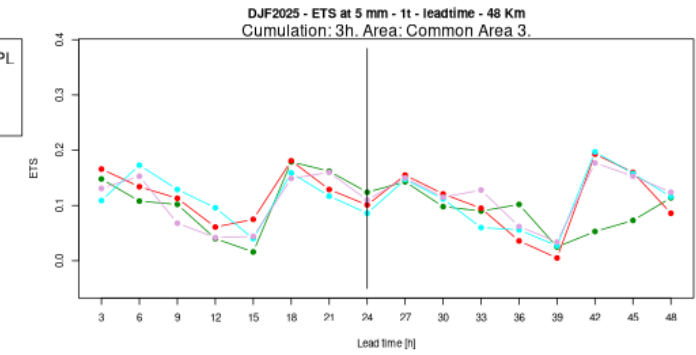
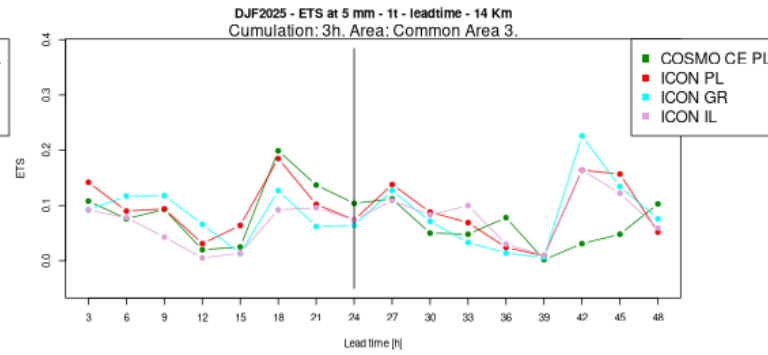
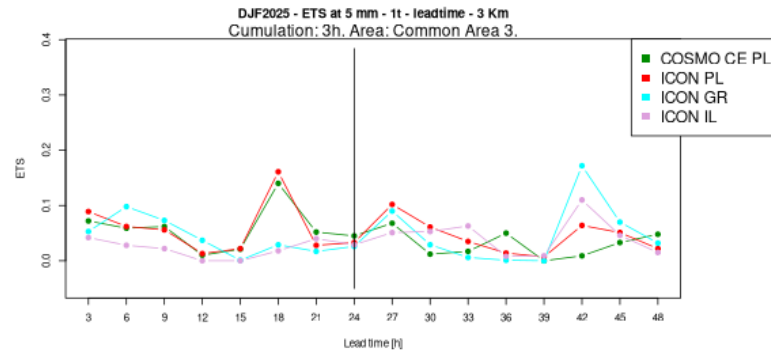
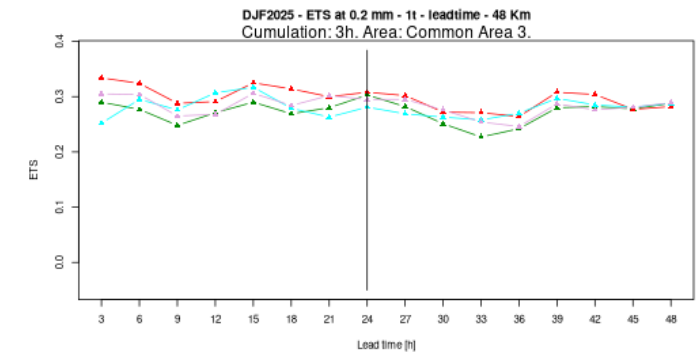
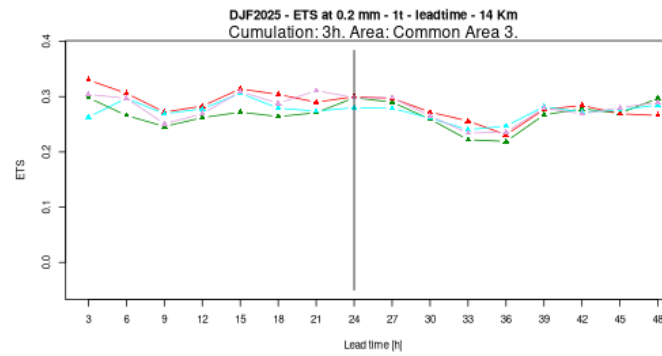
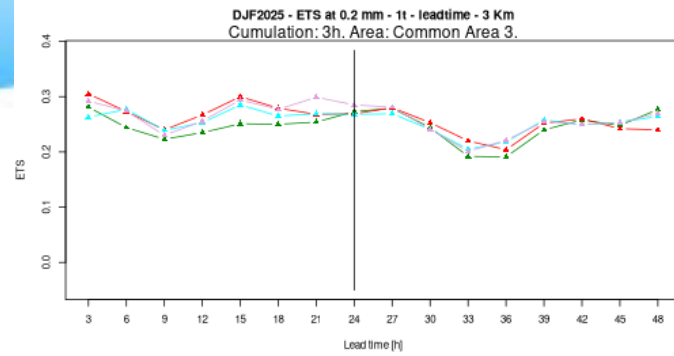


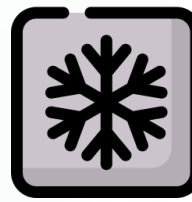
25



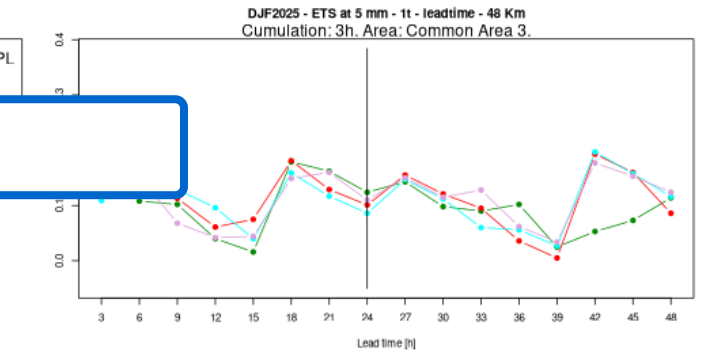
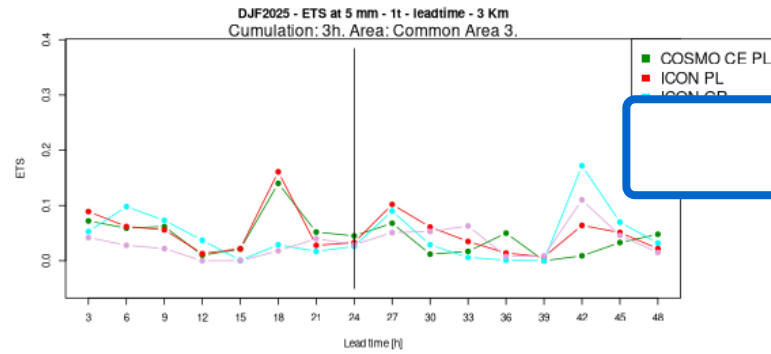
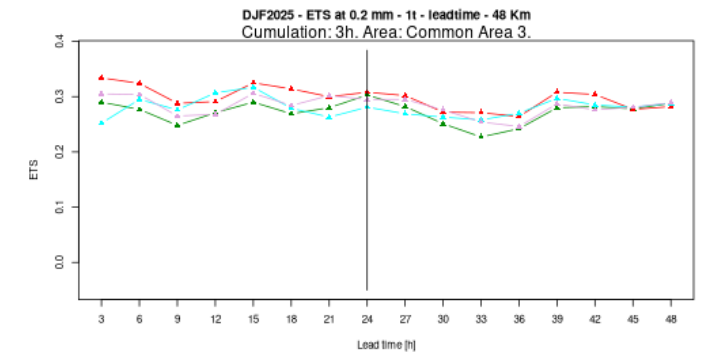
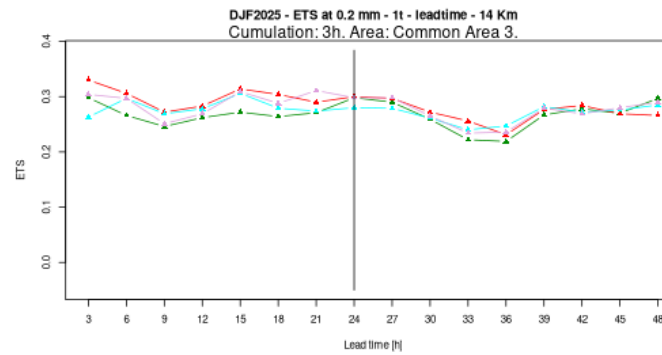
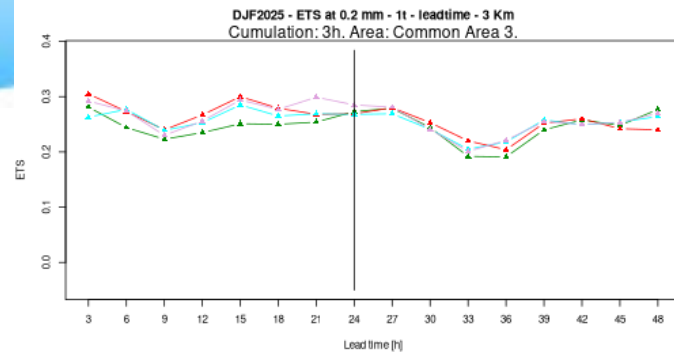


# ETS - DJF 2025 – COMMON AREA 3

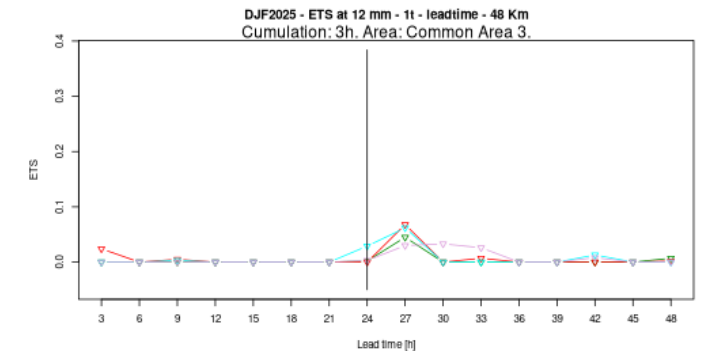
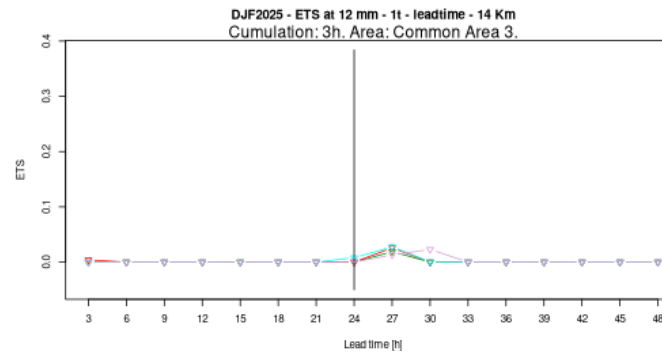
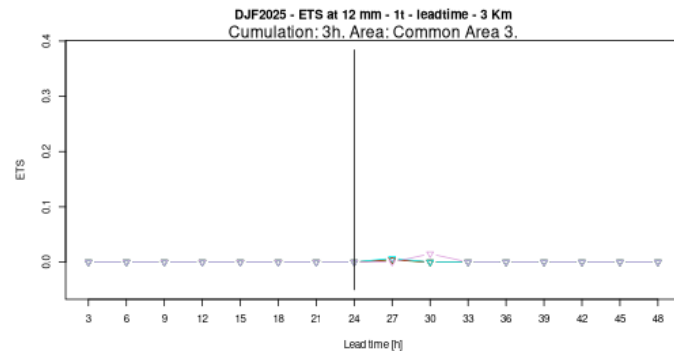


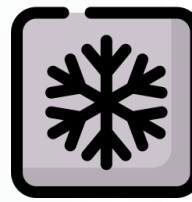


# ETS - DJF 2025 – COMMON AREA 3

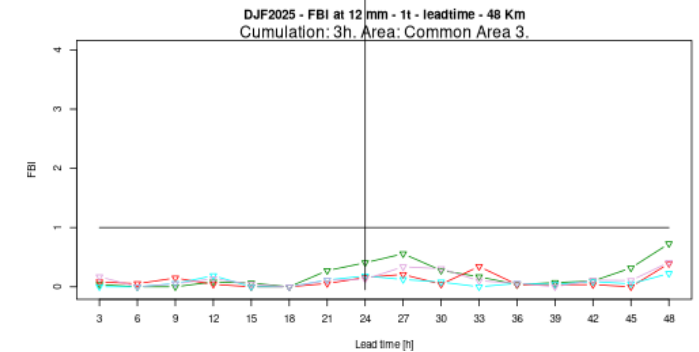
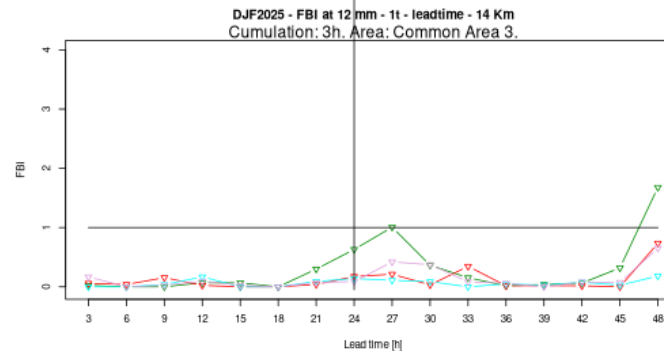
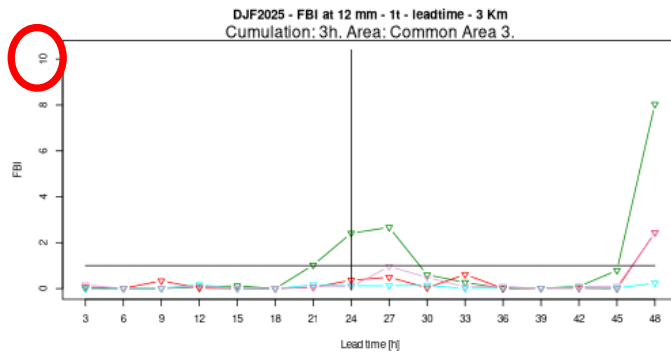
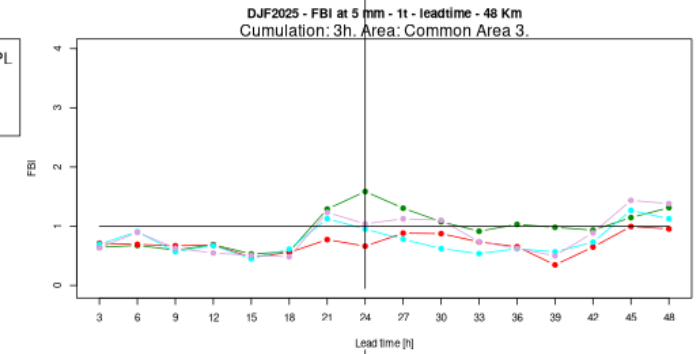
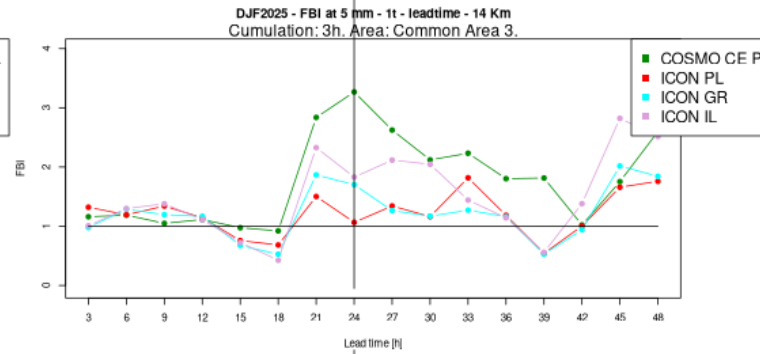
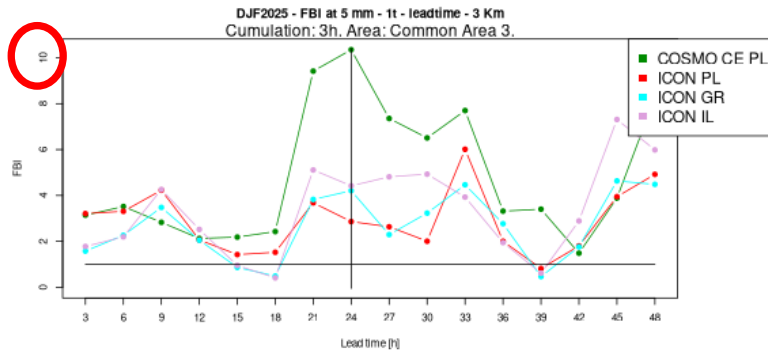
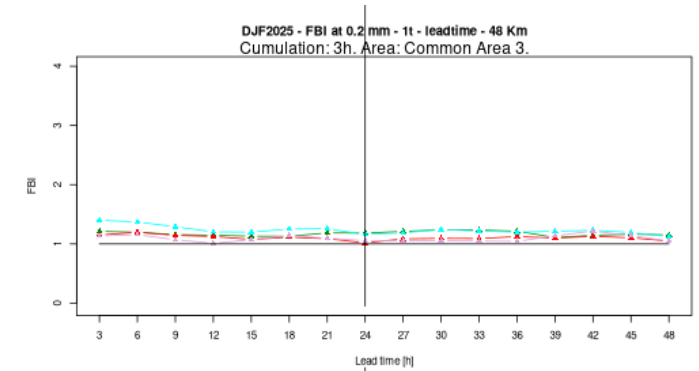
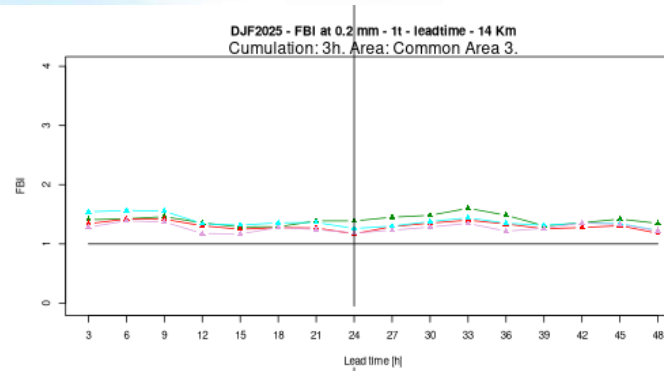
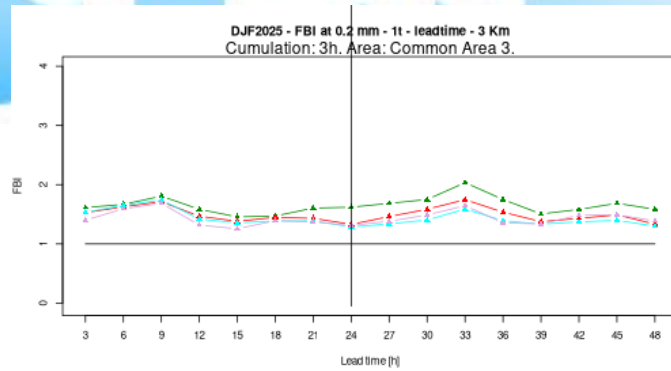


Almost exact replica of FSS.



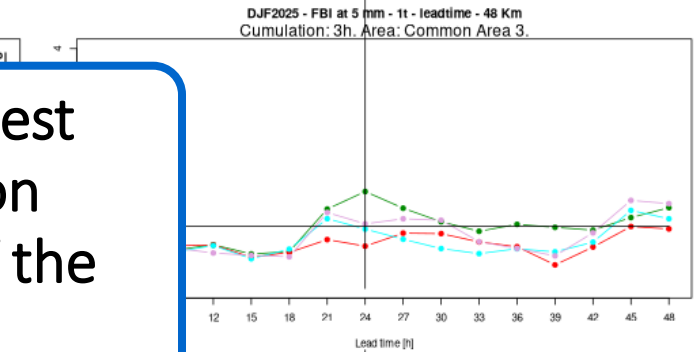
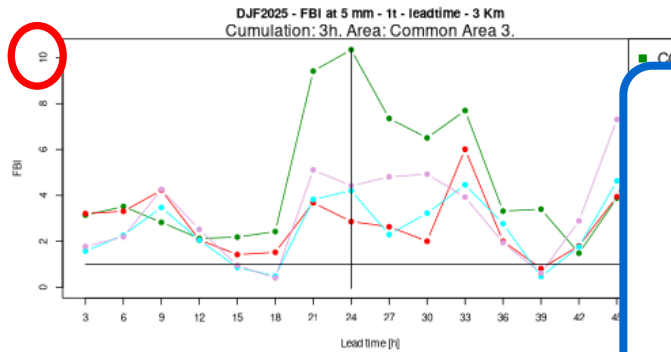
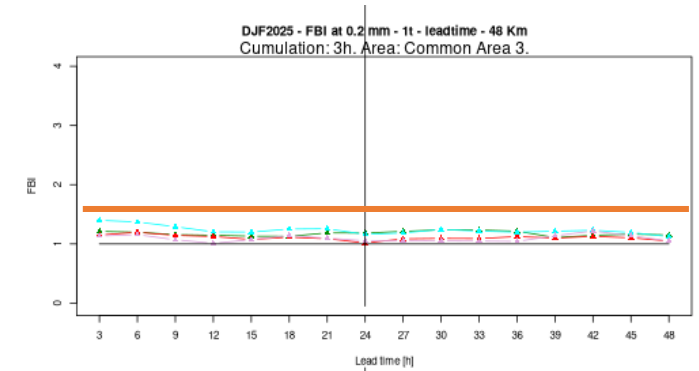
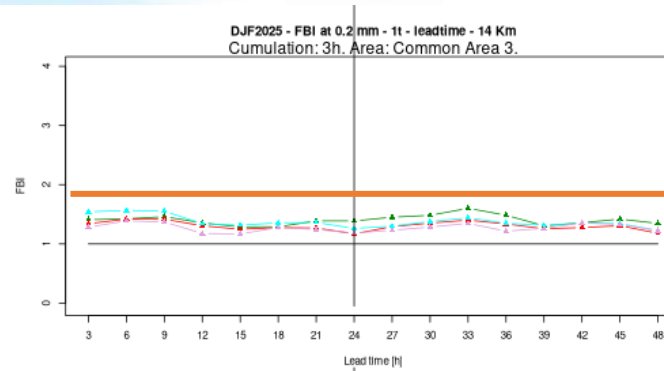
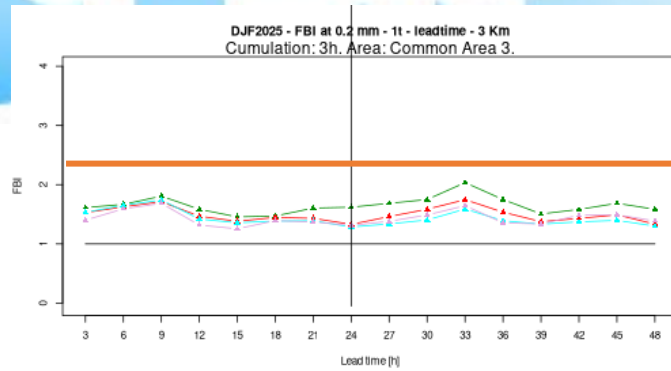


# FBI - DJF 2025 – COMMON AREA 3

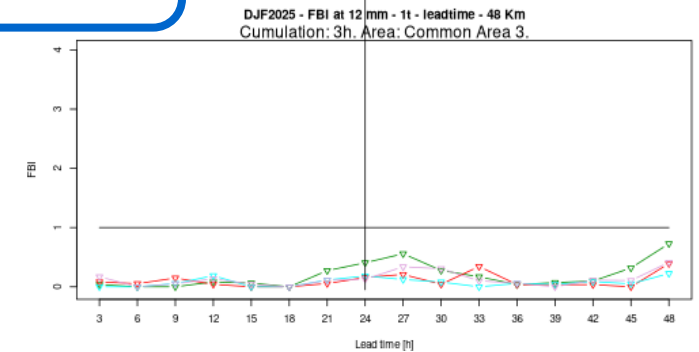
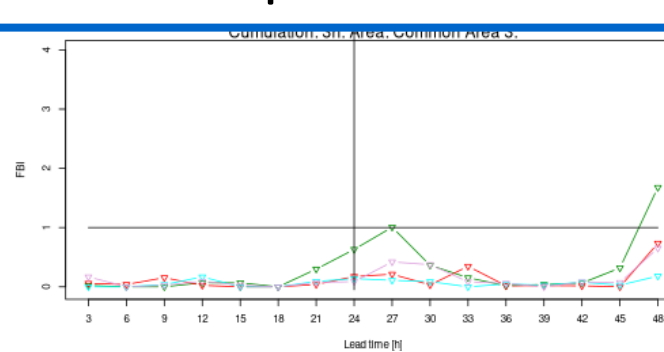
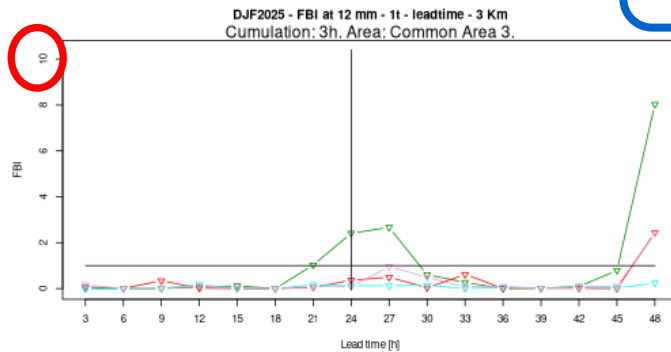




## FBI - DJF 2025 – COMMON AREA 3



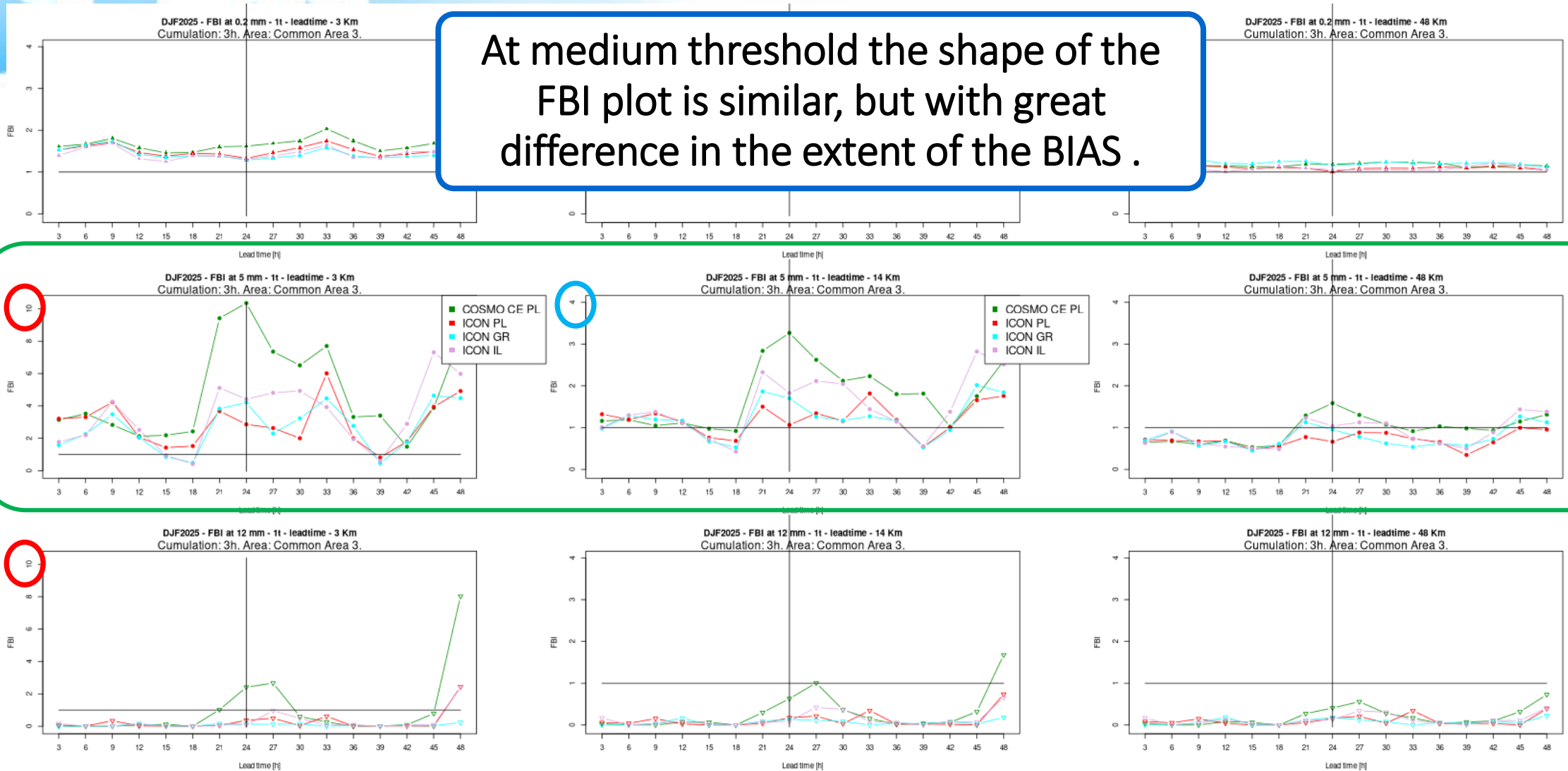
Almost no daily cycle at the lowest threshold. Small overestimation improving with the amplitude of the spatial scale.





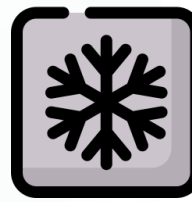
## FBI - DJF 2025 – COMMON AREA 3

At medium threshold the shape of the FBI plot is similar, but with great difference in the extent of the BIAS.

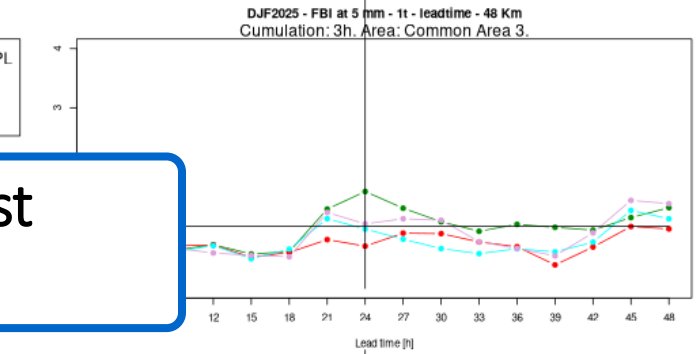
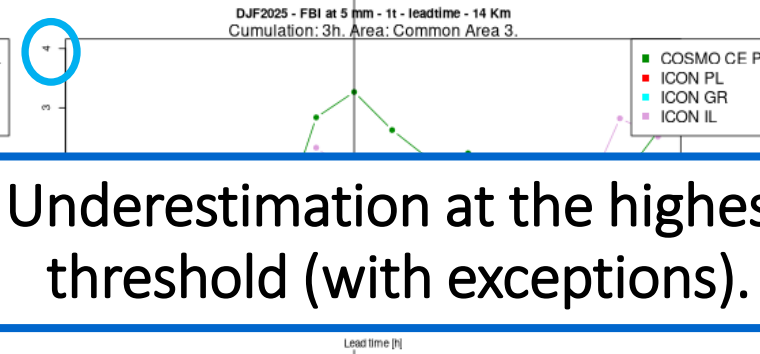
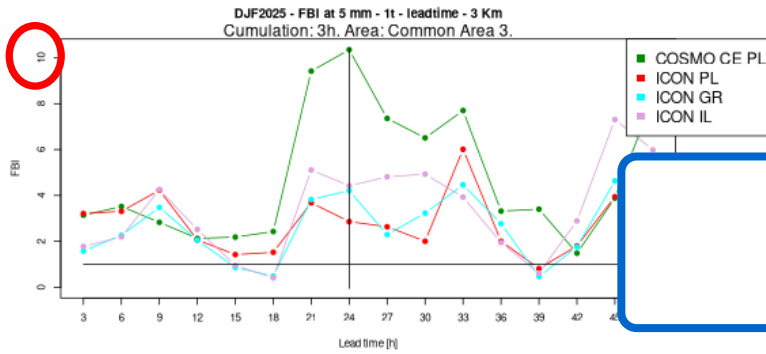
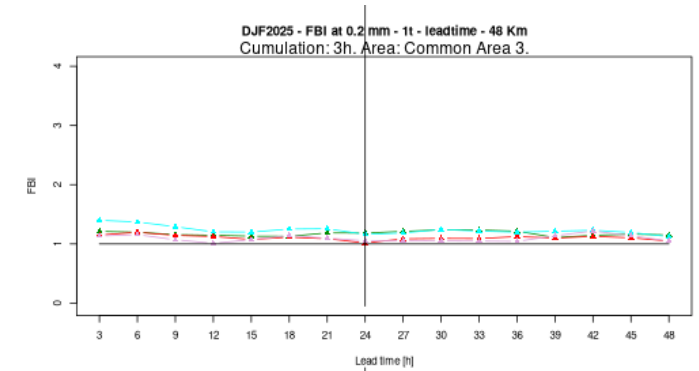
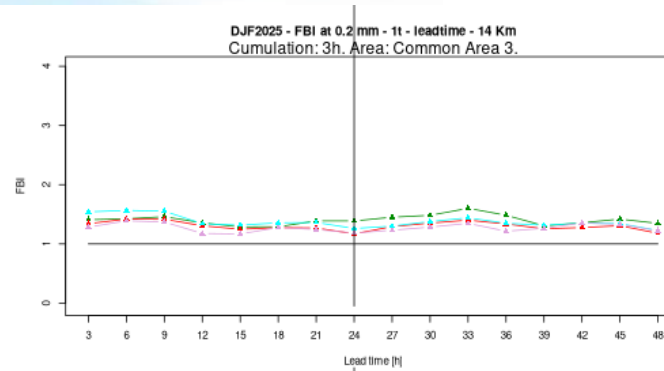
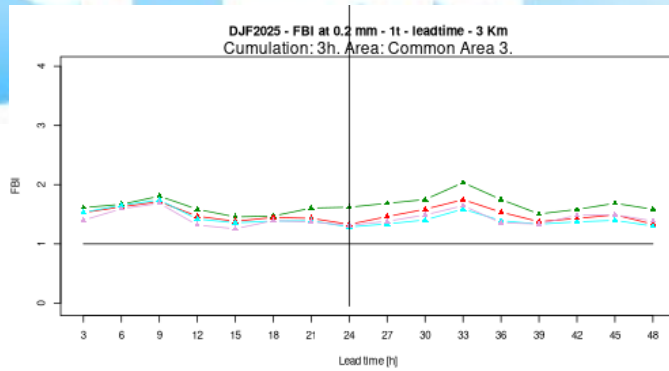


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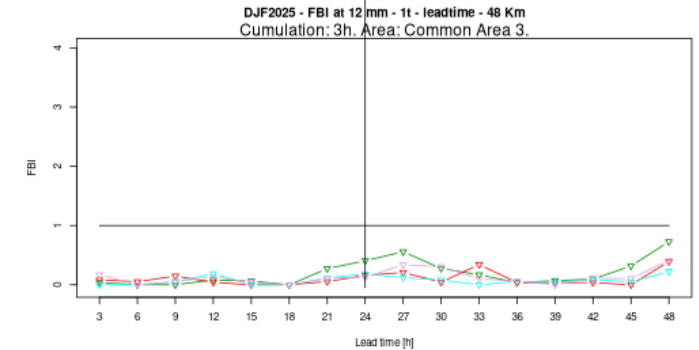
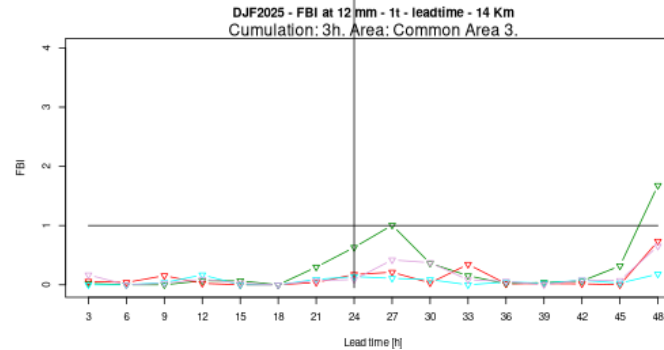
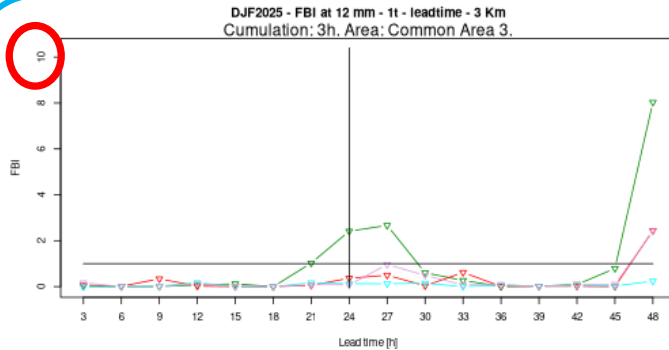


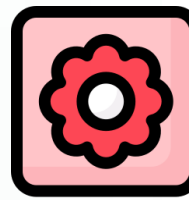


# FBI - DJF 2025 – COMMON AREA 3

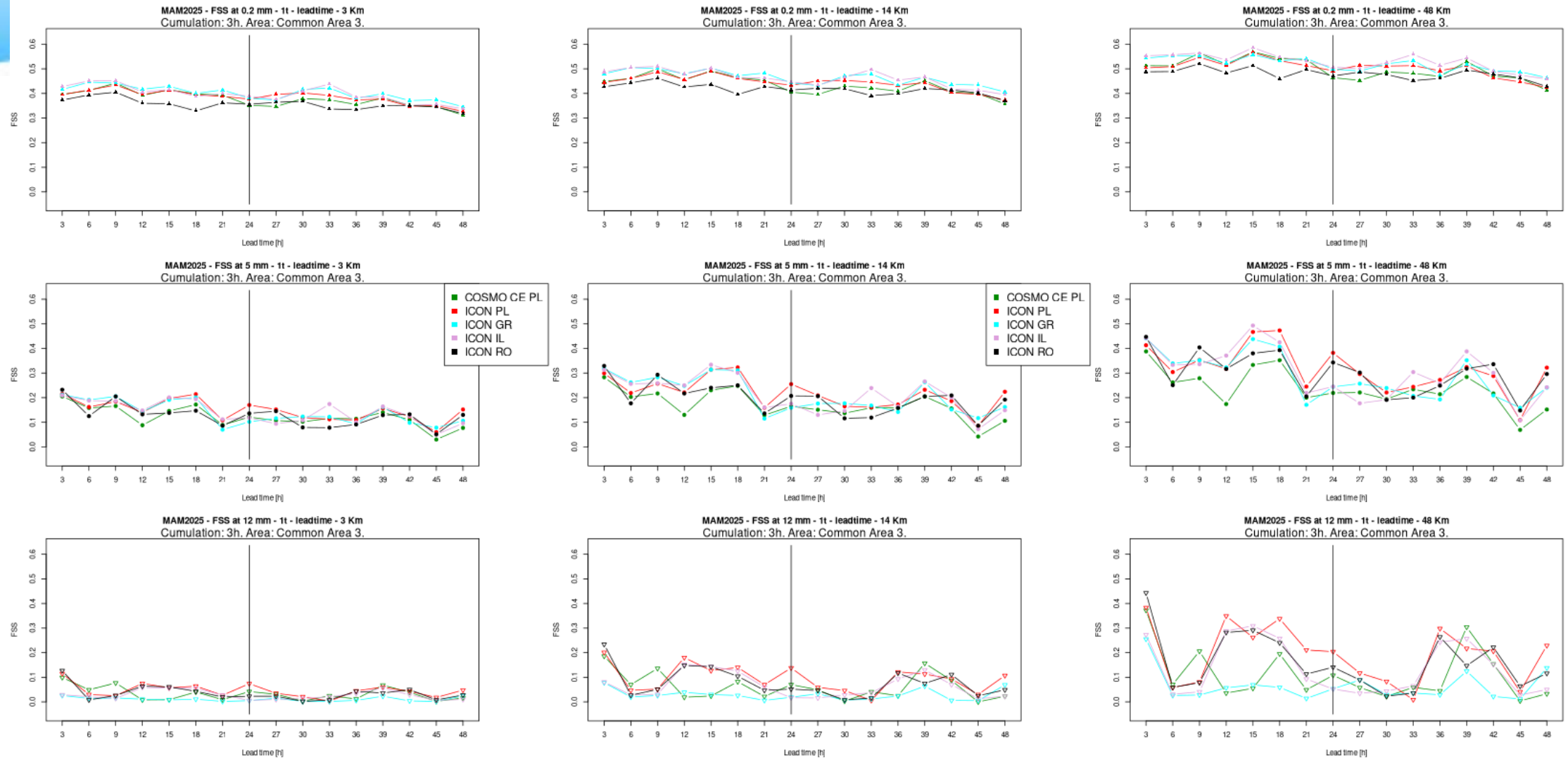


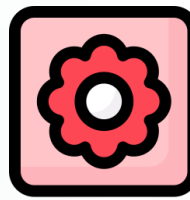
Underestimation at the highest threshold (with exceptions).



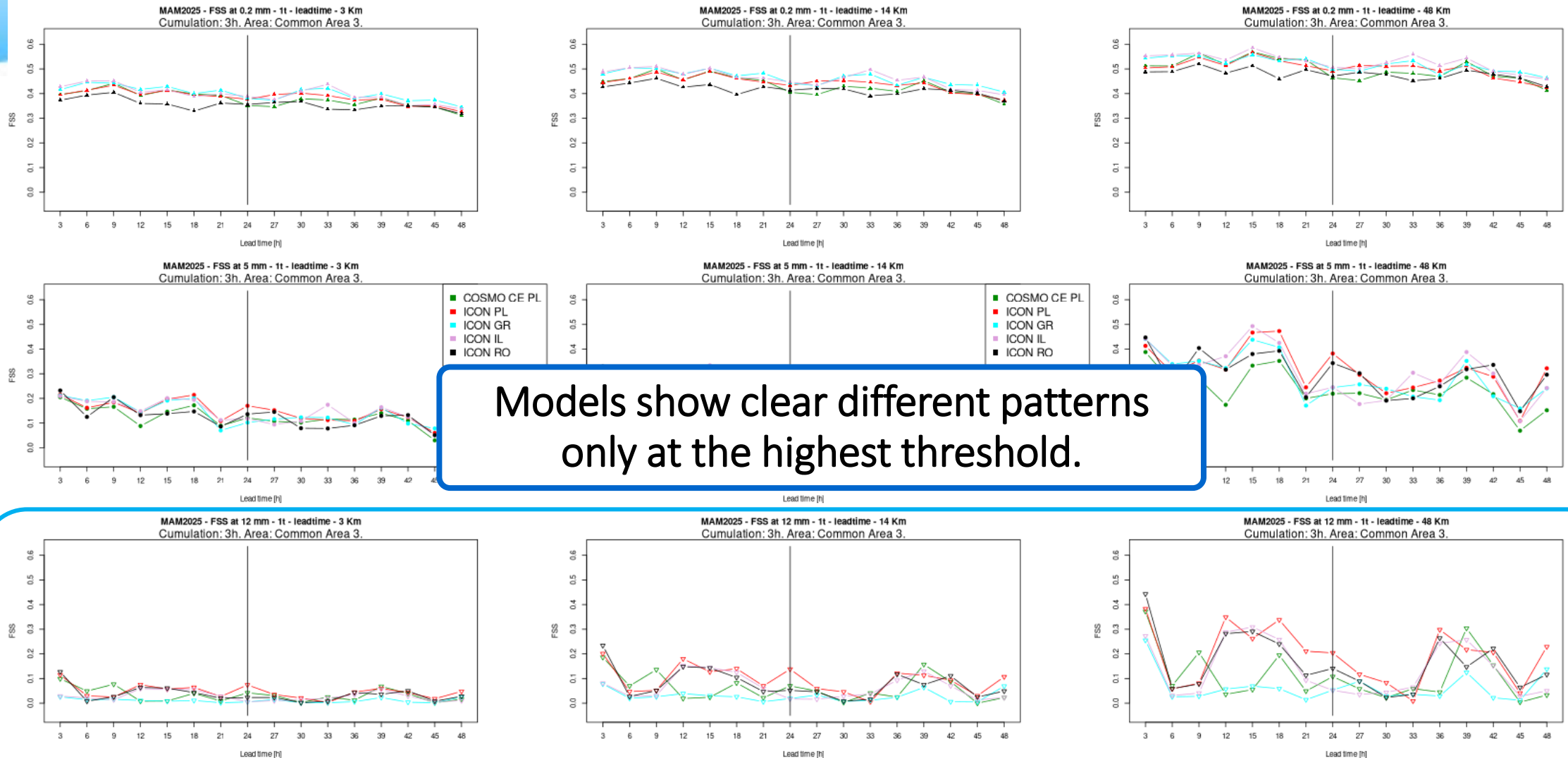


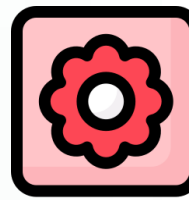
# FSS - MAM 2025 – COMMON AREA 3



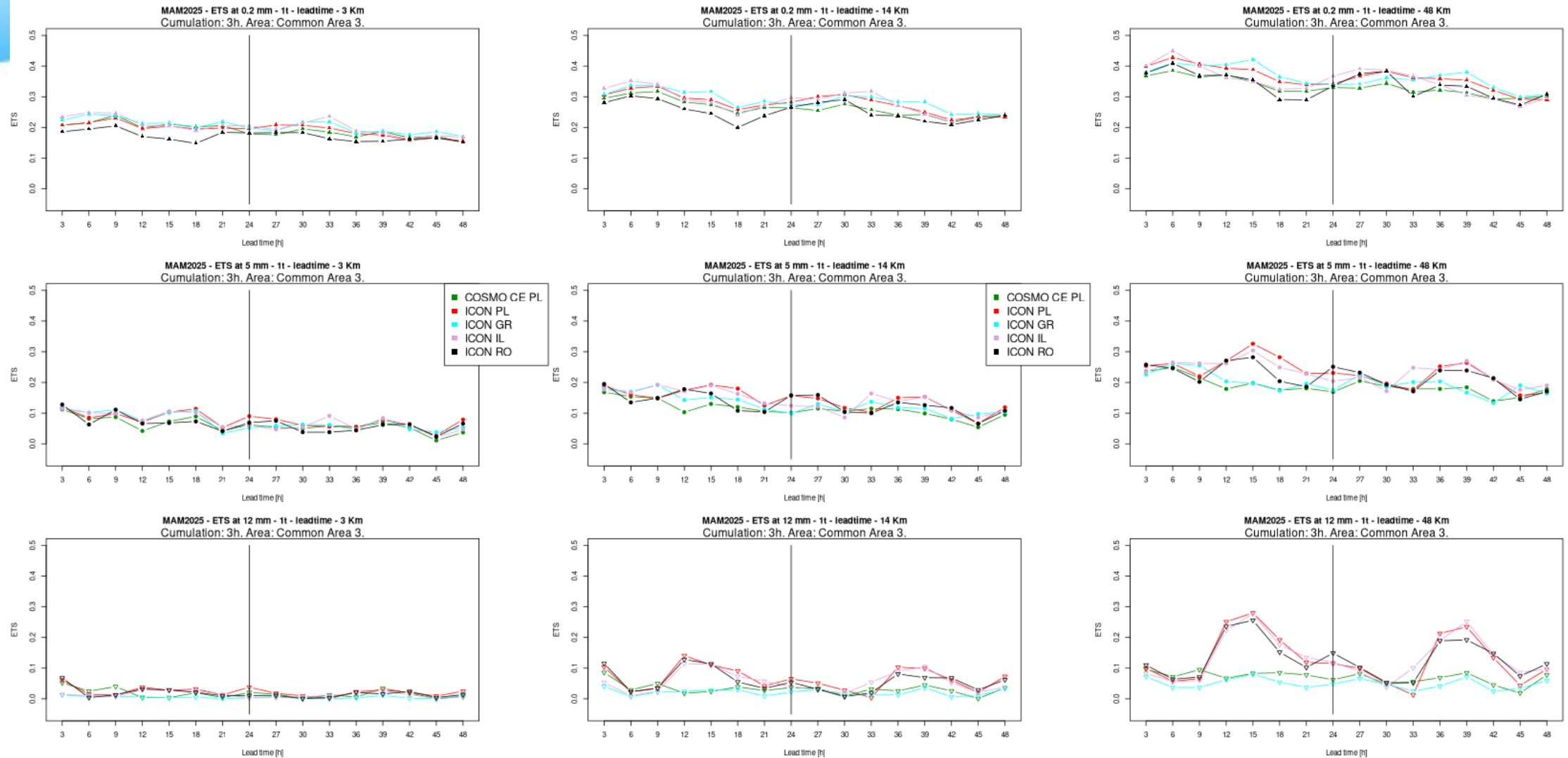


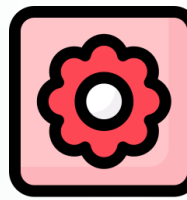
# FSS - MAM 2025 – COMMON AREA 3





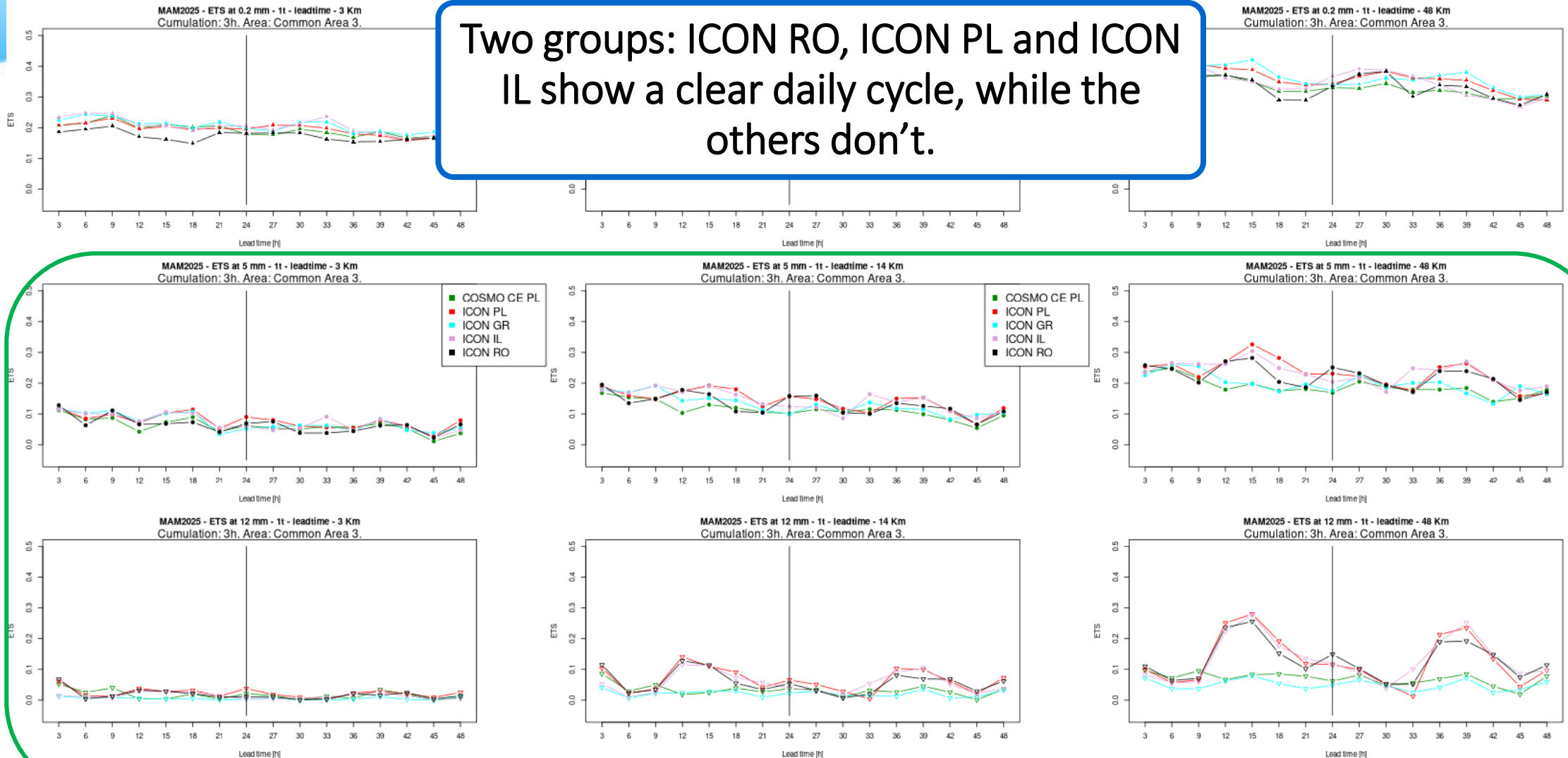
# ETS - MAM 2025 – COMMON AREA 3





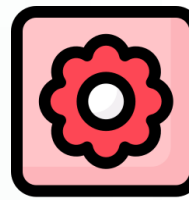
## ETS - MAM 2025 – COMMON AREA 3

Two groups: ICON RO, ICON PL and ICON IL show a clear daily cycle, while the others don't.

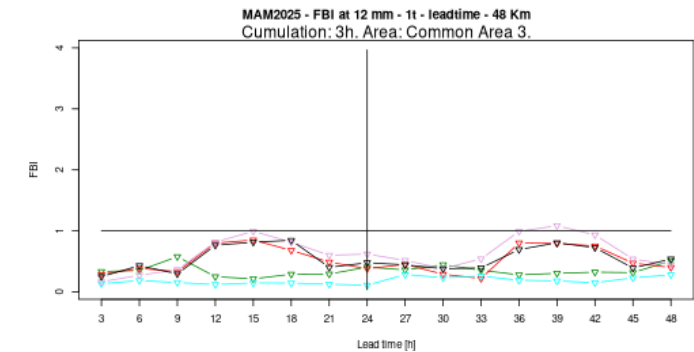
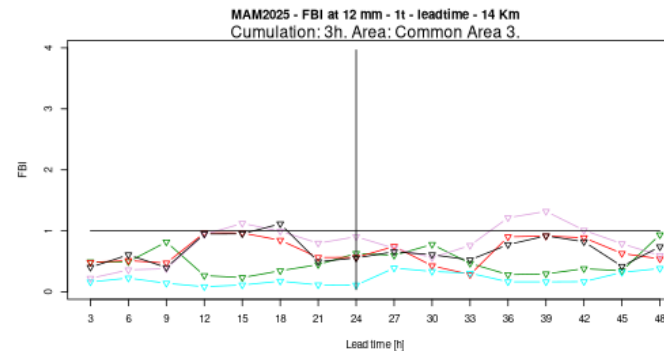
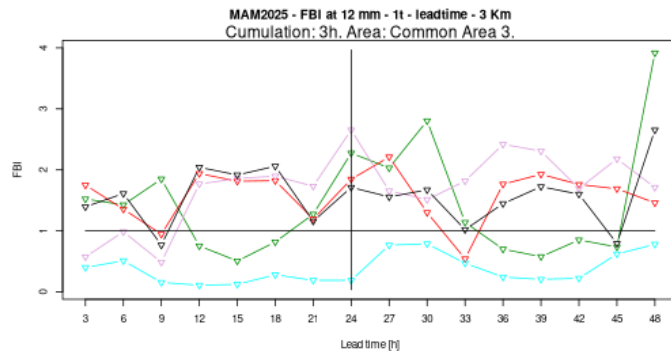
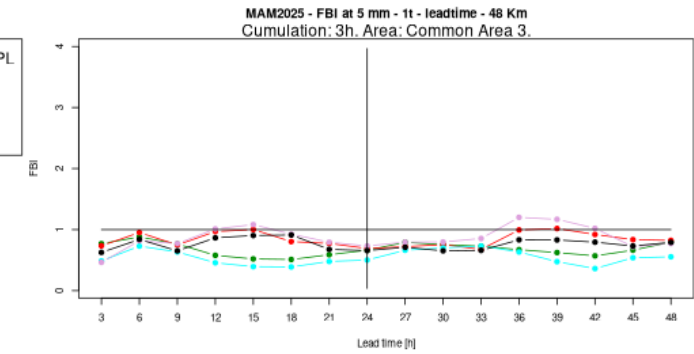
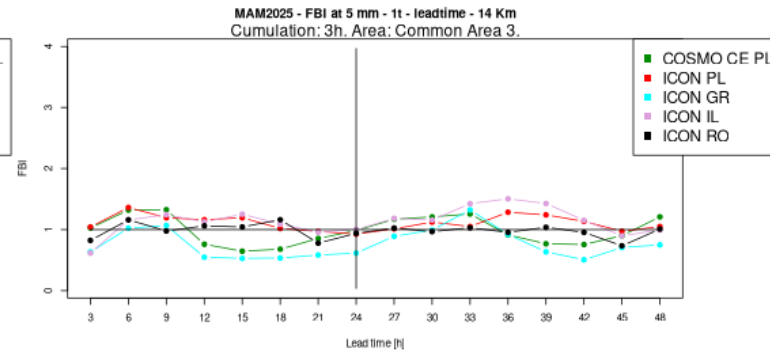
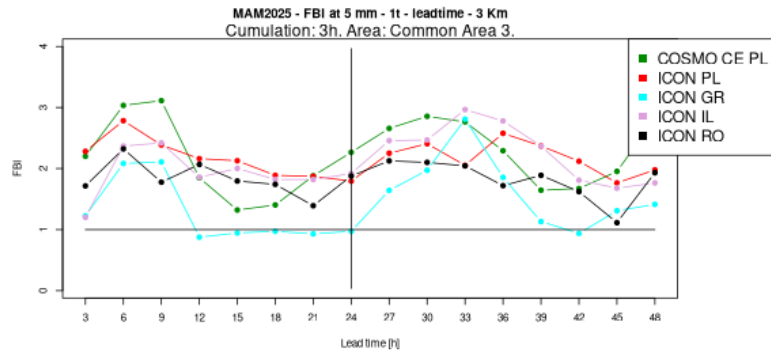
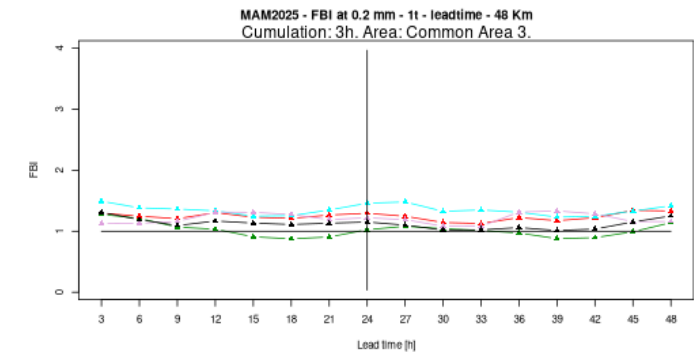
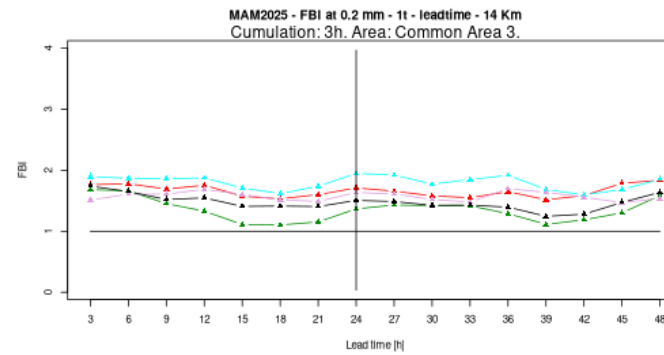
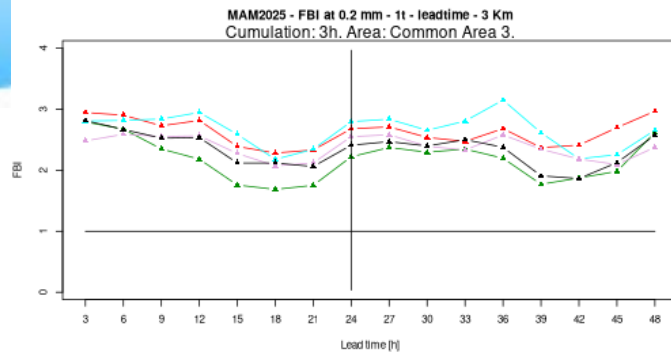


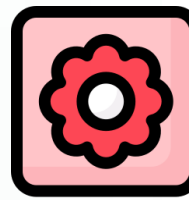
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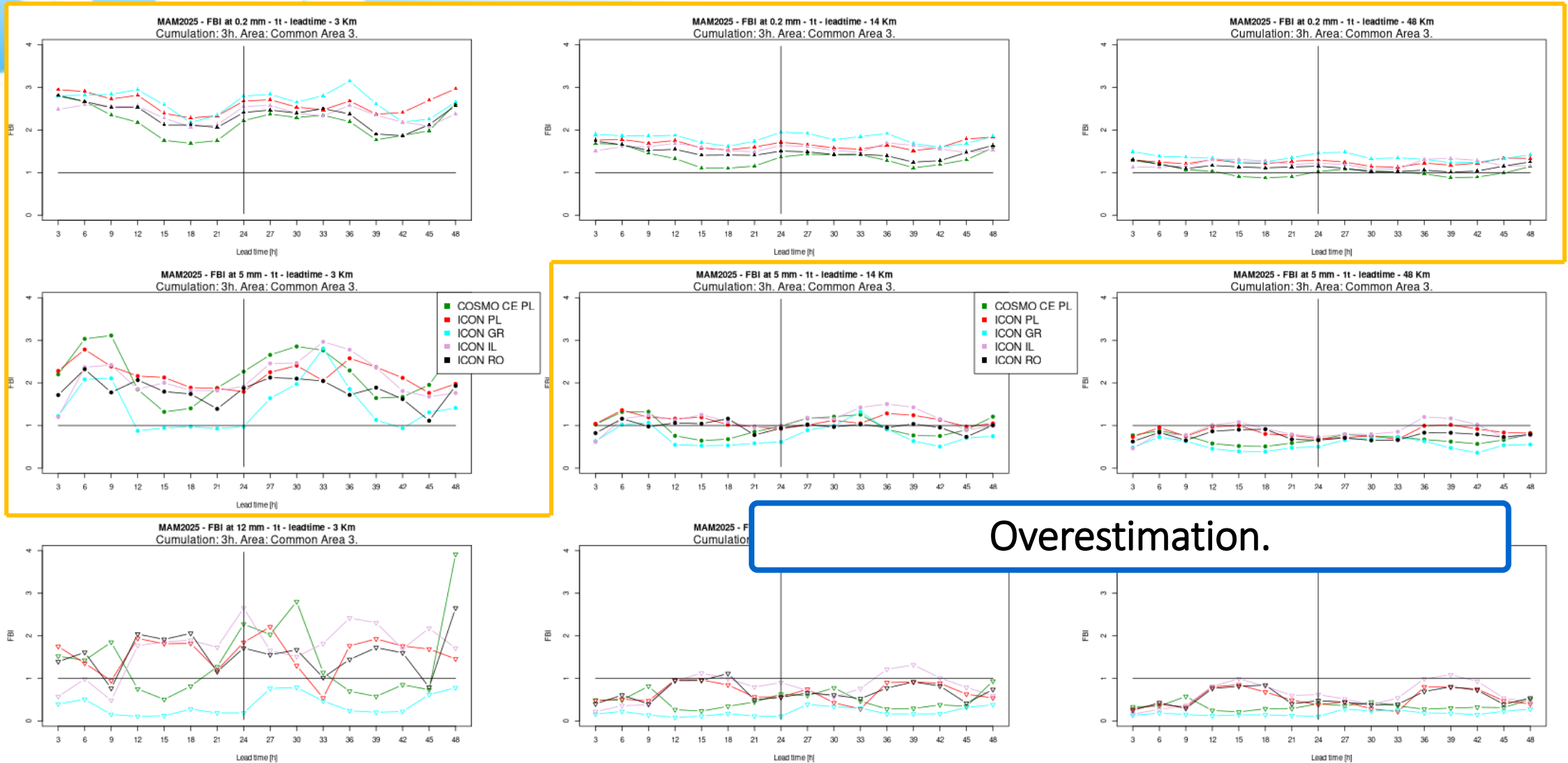


# FBI - MAM 2025 – COMMON AREA 3

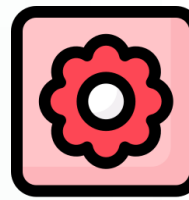




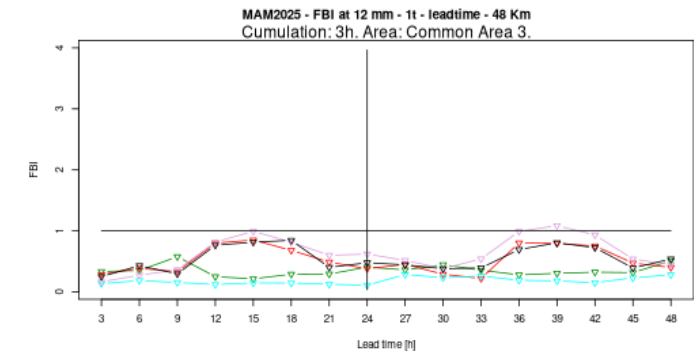
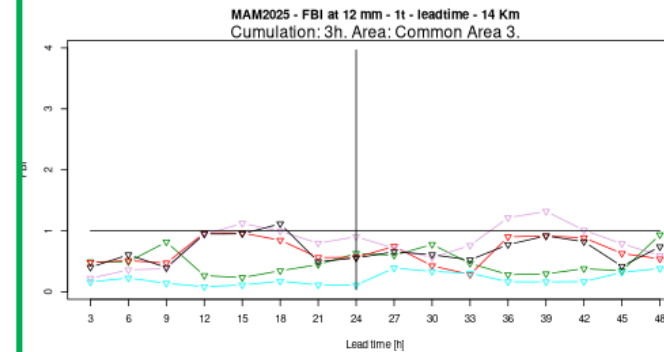
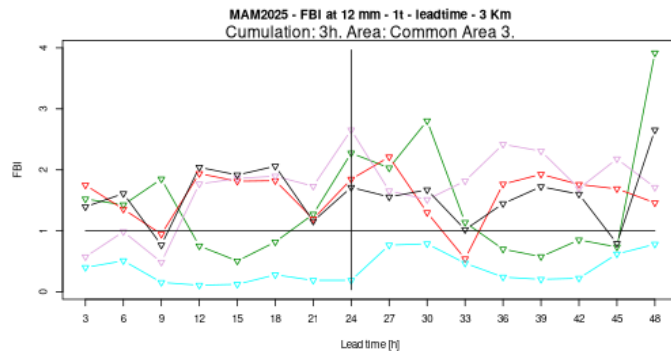
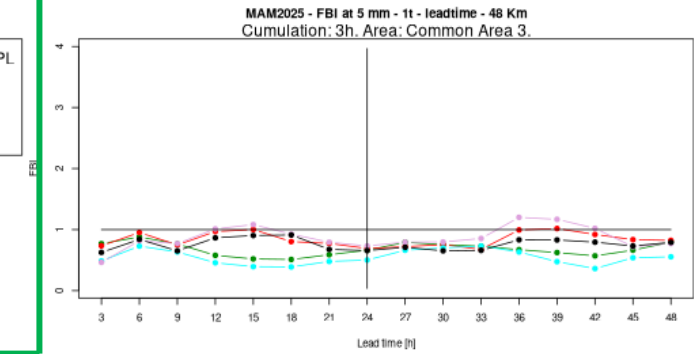
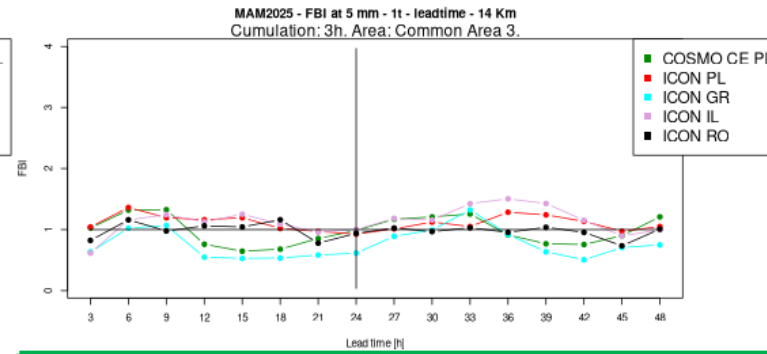
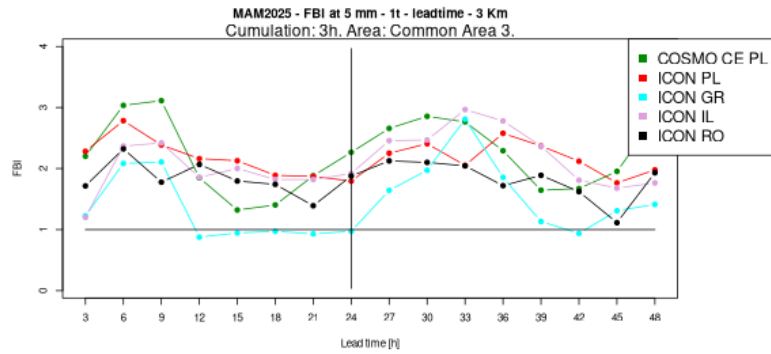
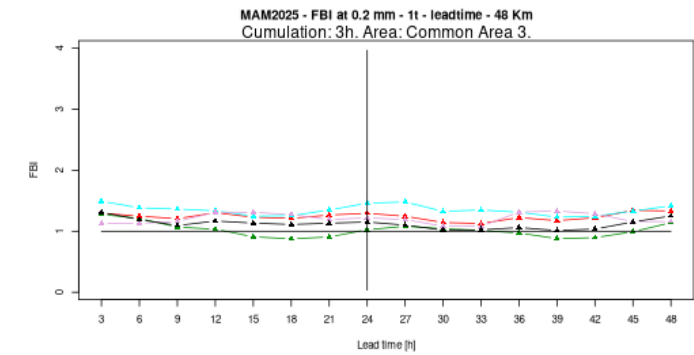
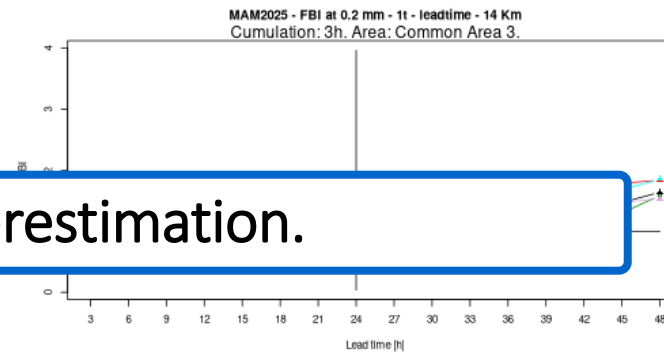
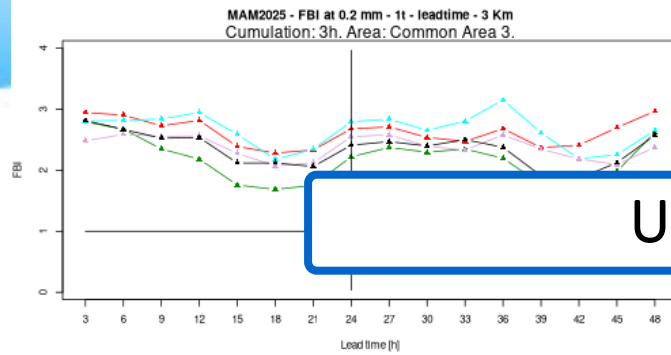
# FBI - MAM 2025 – COMMON AREA 3



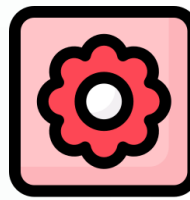
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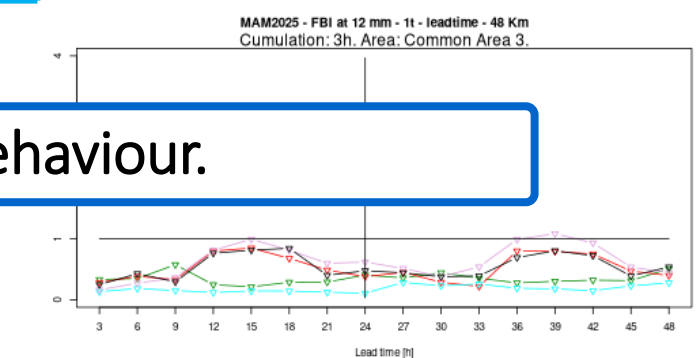
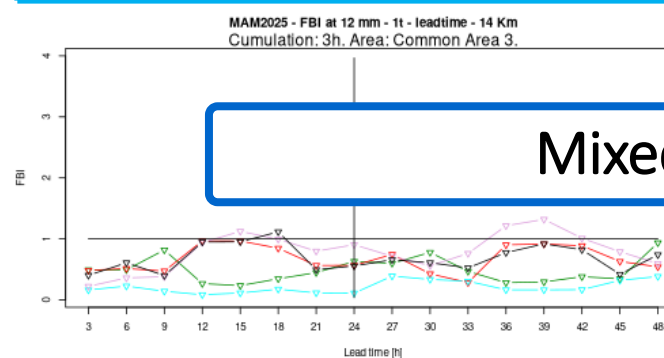
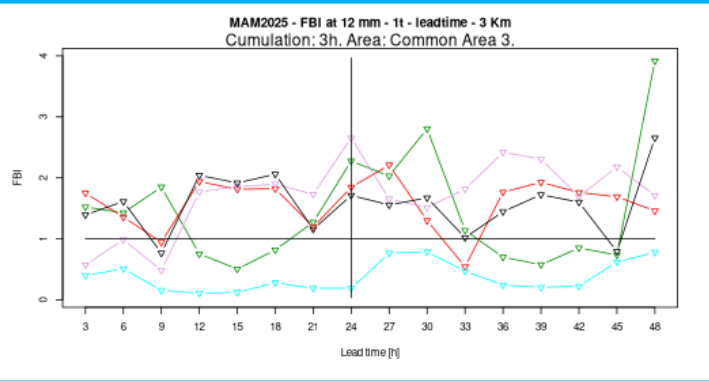
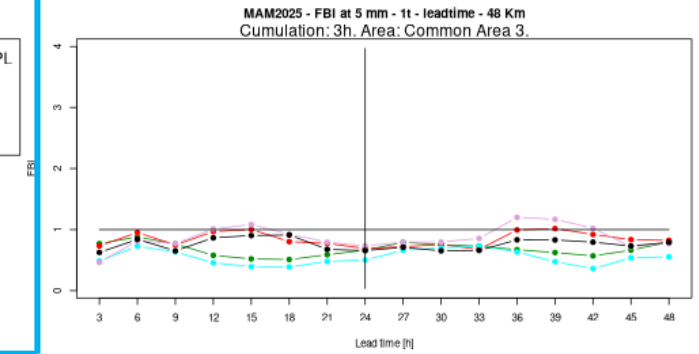
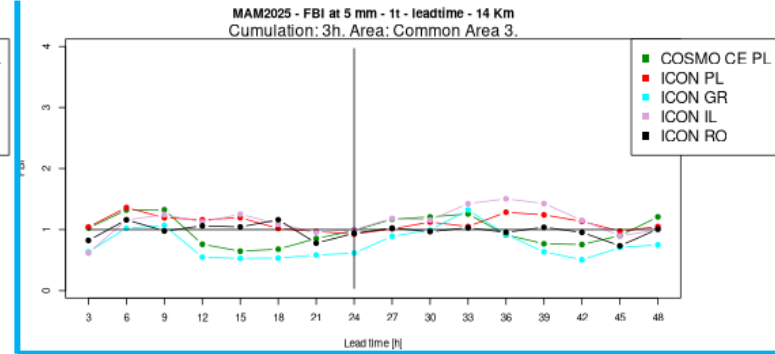
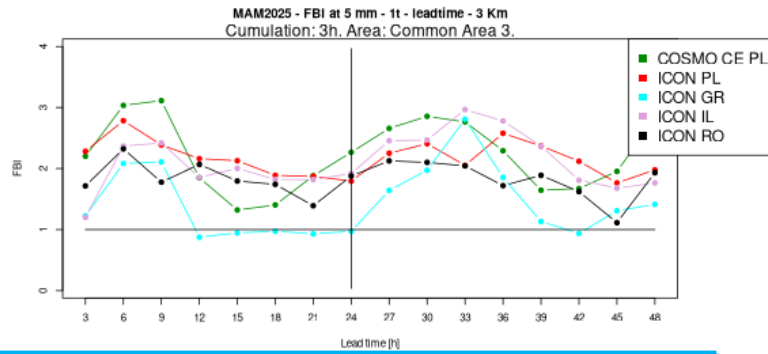
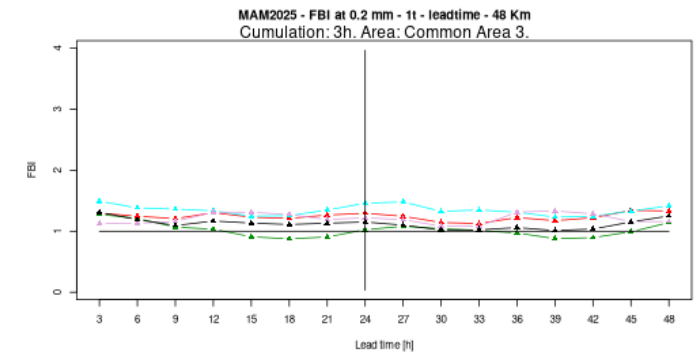
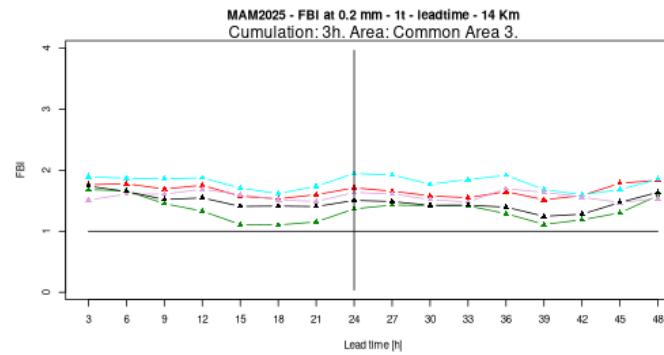
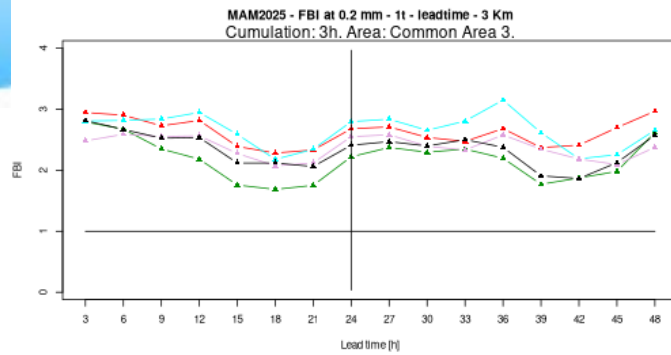
# FBI - MAM 2025 – COMMON AREA 3



Underestimation.



# FBI - MAM 2025 – COMMON AREA 3



Mixed behaviour.

# OBSERVATIONS FOR COMMON AREA 3

## •JJA 2024:

- Large model spread at first timesteps
- Clear diurnal cycle, higher FSS at mid-day
- Underestimation at low thresholds, overestimation at high thresholds / small scales

## •SON 2024:

- Almost no FSS decrease with lead time at low thresholds
- Weaker diurnal cycle at medium thresholds
- Very steep daily cycle at high thresholds, with night maxima
- Strong overestimation at medium/high thresholds, especially at small scales

## •DJF 2025:

- Stable FSS at lowest threshold, increase with larger scales
- Strong model differences at medium thresholds
- No skill at high thresholds
- ETS closely mirrors FSS
- Small overestimation at low thresholds, reduced with scale increase

## •MAM 2025:

- Weak but visible daily cycle at low thresholds
- Large inter-model differences at medium thresholds



# GENERAL CONCLUSIONS

- Good model consistency at low thresholds; larger differences at higher thresholds
- Model spread is evident especially in the first forecast timesteps and in general increases at medium-high thresholds
- BIAS: general underestimation at low thresholds, overestimation at high thresholds (and small scales)
- Diurnal cycles are more or less pronounced depending on season and threshold
- ETS partly mirrors FSS, but with seasonal differences (maybe not need to show?)
- Inter-model differences are more relevant in winter and at higher thresholds
- Some models show peculiarities (e.g. ICON GR, ICON IL)

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THANK YOU FOR YOUR ATTENTION!

If you have any more comments and questions,  
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[naima.vela@arpa.piemonte.it](mailto:naima.vela@arpa.piemonte.it)