7th International Verification Methods Workshop

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Project 4: Spatial Verification – MesoVICT-II

Q: How can two meso-scale models deal with different types of precipitation in highly complex terrain?

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Data and cases selected

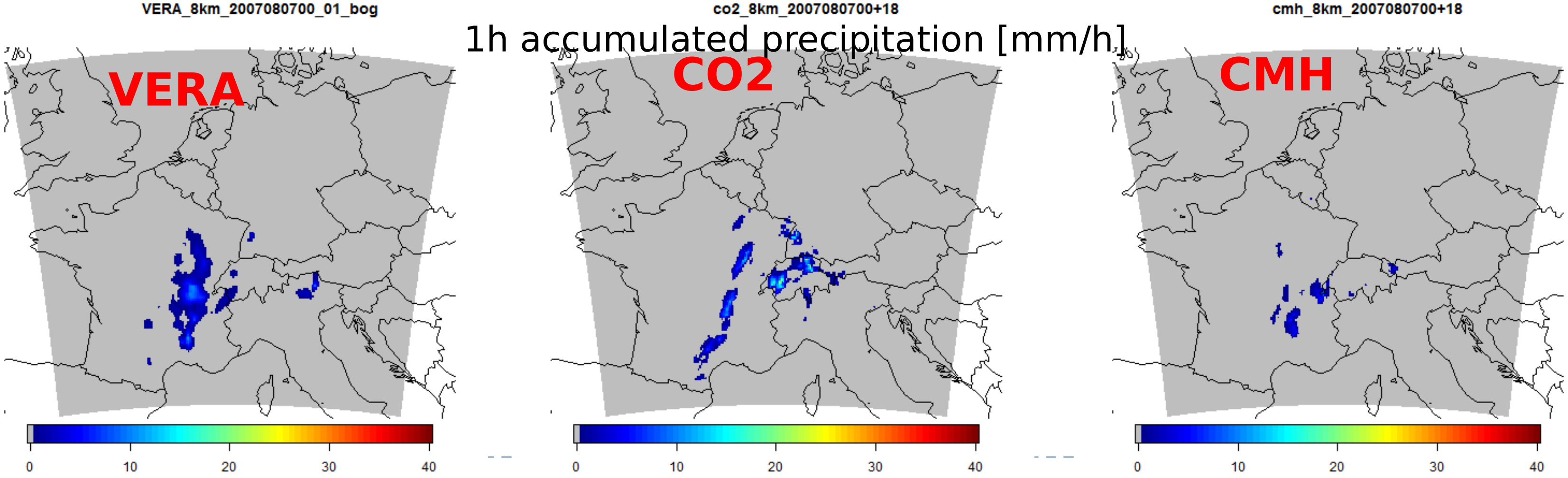
Short introduction

Data

- **NWP model data:**
  - CO2 – COSMO, 2.2 km horizontal resolution (MeteoSwiss), interpolated to VERA grid
  - CMH – CMC-GEMH, 2.5 km horizontal resolution (Environment Canada), interpolated to VERA grid
- **Observations**: verified against VERA Analysis, 8 km mesh size
- **Case Studies:**
  - MesoVICT Case 4 – convective case
  - MesoVICT Case 5 – frontal case

MesoVICT Case 4: 6-8 August 2007

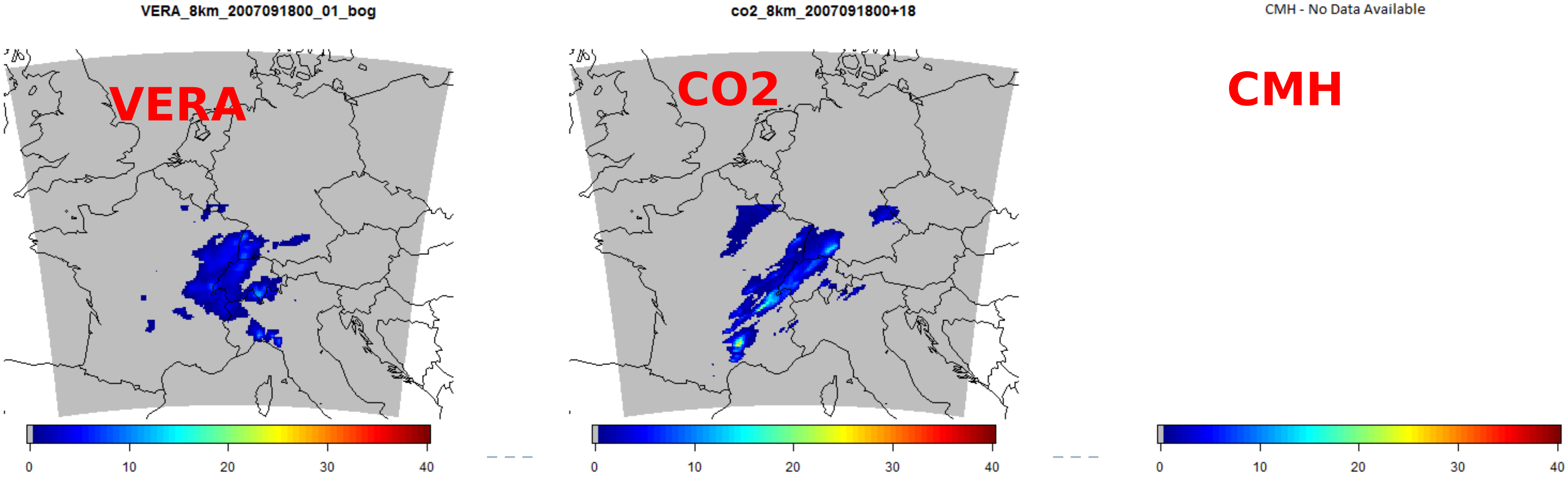
- Typical Alpine summer convection
- Strong, gusty winds observed in conjunction with the convective cells
- Squall line ahead of a cold front, moving towards the Alps from the West



MesoVICT Case 5: 18 September 2007

- Two cold fronts passing North of the Alpine region
- As cold air meets the warm air mass ahead of the fronts, strong thunderstorms are initiated East of the Alps

1h accumulated precipitation [mm/h]



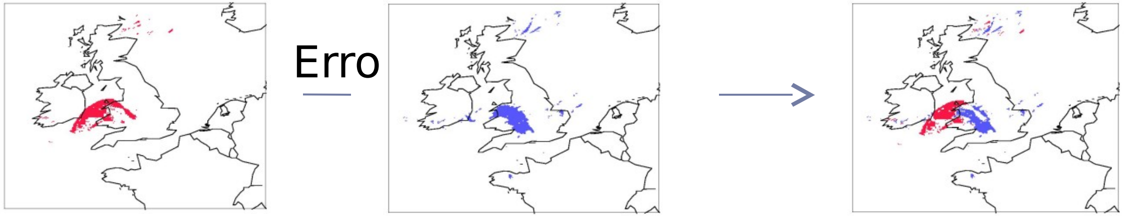
Intensity Skill Score

Intensity Skill Score (ISS)

- Robust scale-separation measure: tells us which spatial scales are well represented, depending on precipitation intensity
- Procedure:
  - Match the grids (observations vs. forecasts)
  - Define a threshold (i.e. 5 mm/h)
  - Convert data to binary fields, subtract:

(Figures from WS Presentation: Manfred Dorninger)

- Forec. – Erro

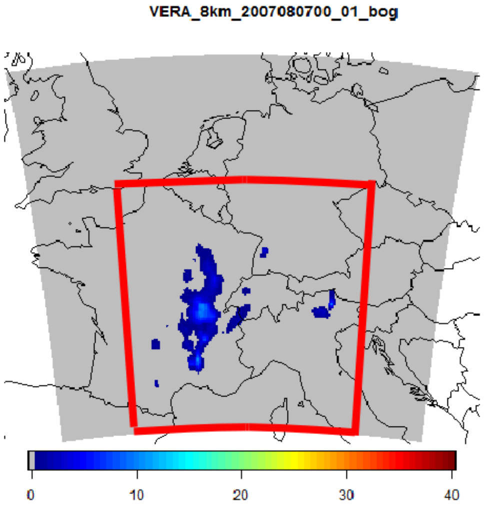


  - 2D wavelet decomposition of binary error to differentiate scales (single band spatial filter)
  - Calculate skill compared to reference forecast (random)

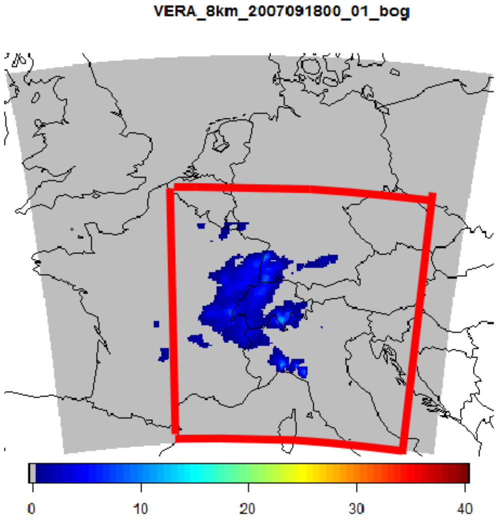
ISS: Reducing the domain

Intensity Skill Score needs quadratic 2^n domain

Case 4

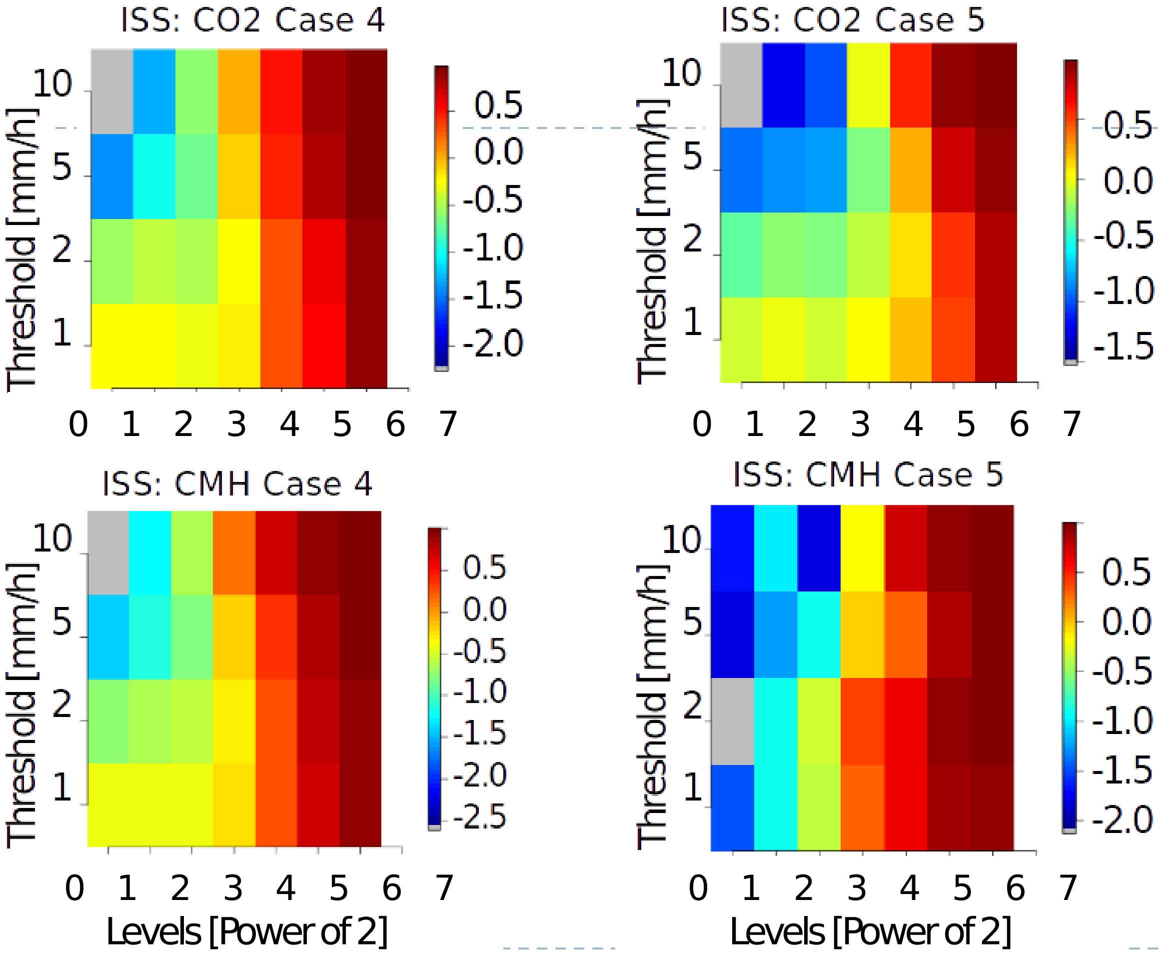


Case 5



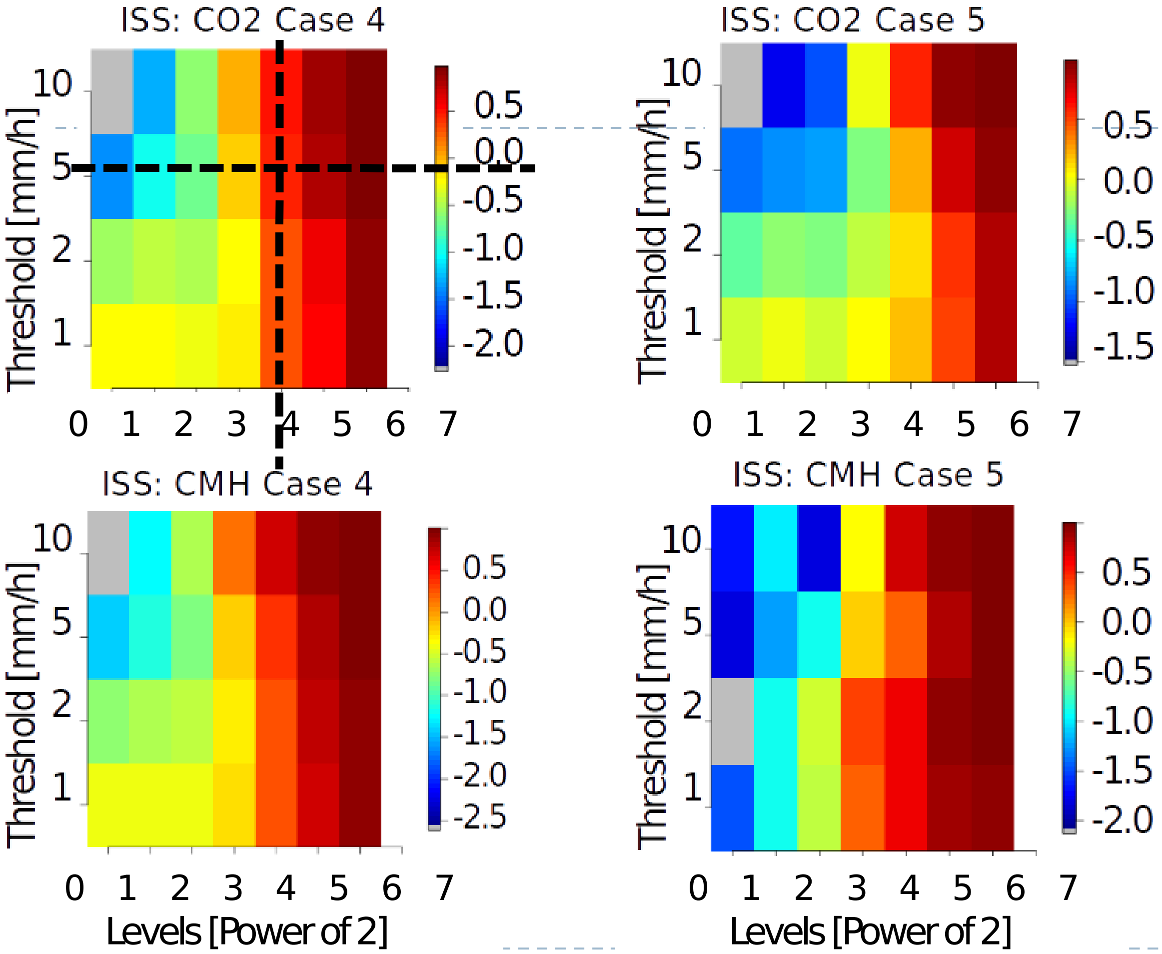
Note: smaller set of data for CMH forecast

Results



- All: skill increase with scale, more intense for higher thresholds
- Skillful scales 64-128 km, depending on a threshold
- Case 4 vs case 5: smaller scales for case 4 better resolved than for mesoscale case 5
- CO2 vs CMH:
  - Case 4 - they are very similar at low thresholds, but CMH seems to be a bit more skillful at higher thresholds (more intensive showers).
  - Case 5 - CMH shows lower skill for small (convective) scales, but higher skill for larger scales (2^3 and higher)

Results



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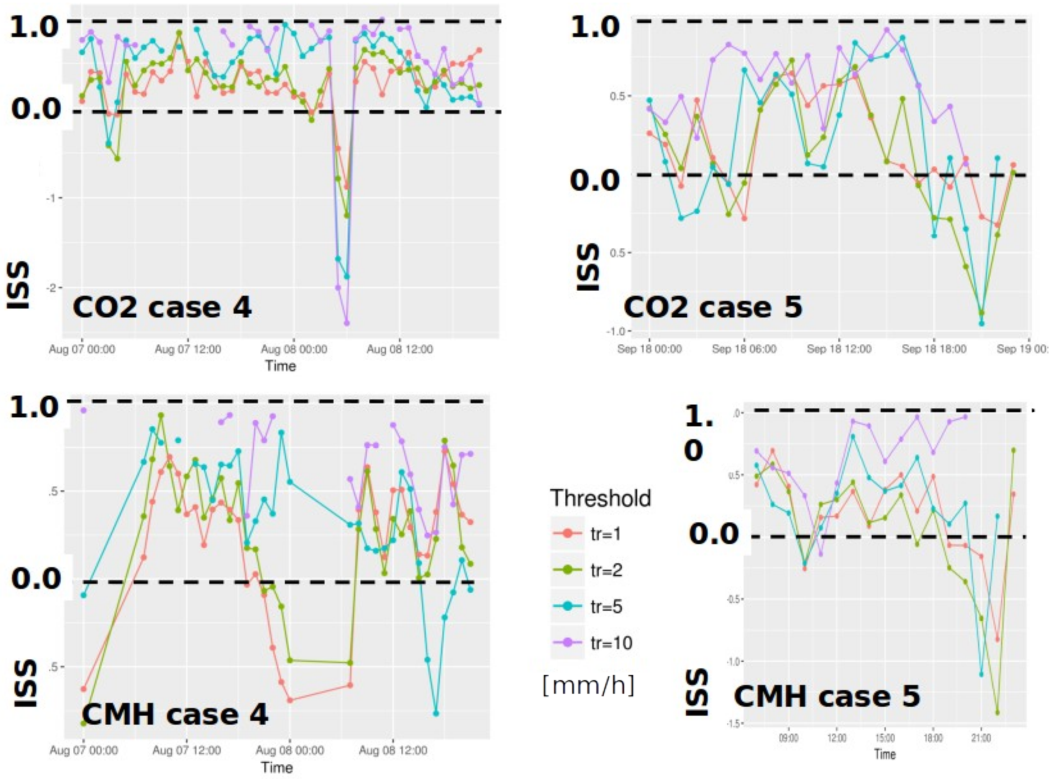
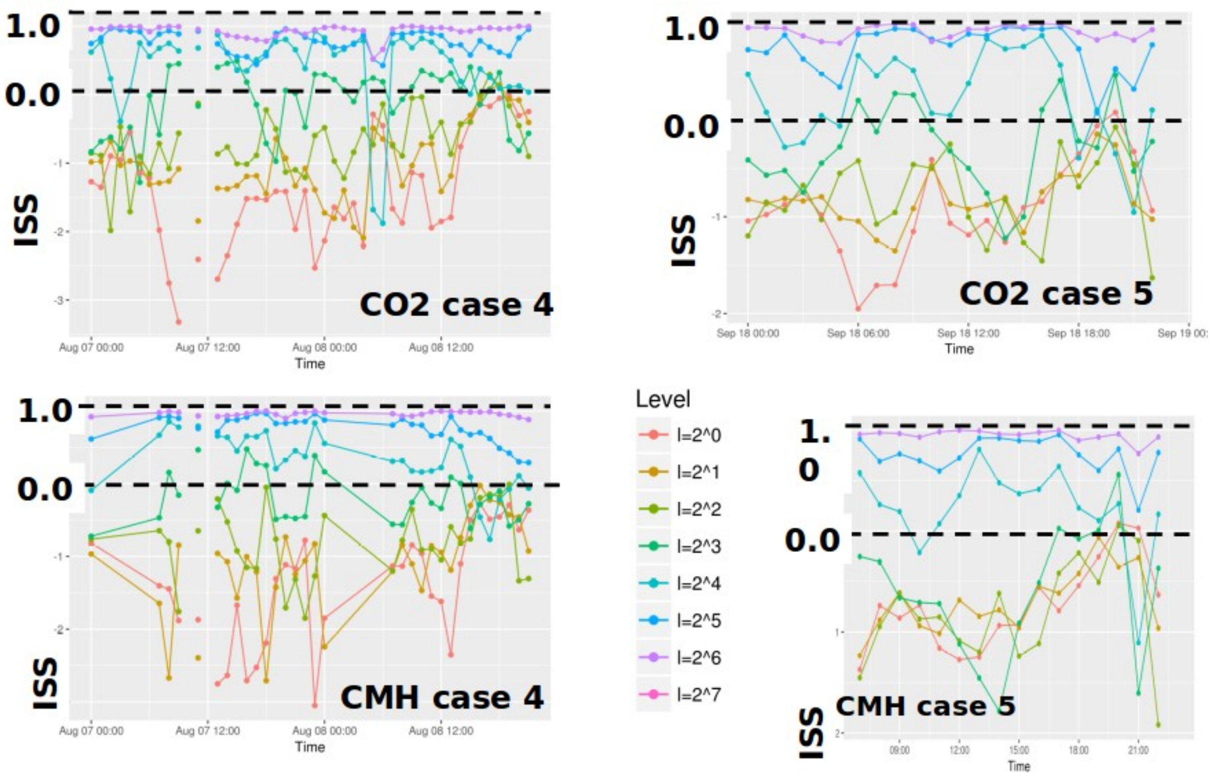
ISS - time series for a fixed level at 2^4



- For l=2^4 skill increases with threshold, due to lower base rate (Casati et. al., 2004)
- Case 4: CMH shows up to 2 minimums for low thresholds
- Case 5: Harder to compare, CMH seems a bit better at first

ISS - time series for a fixed threshold at 5 mm/h



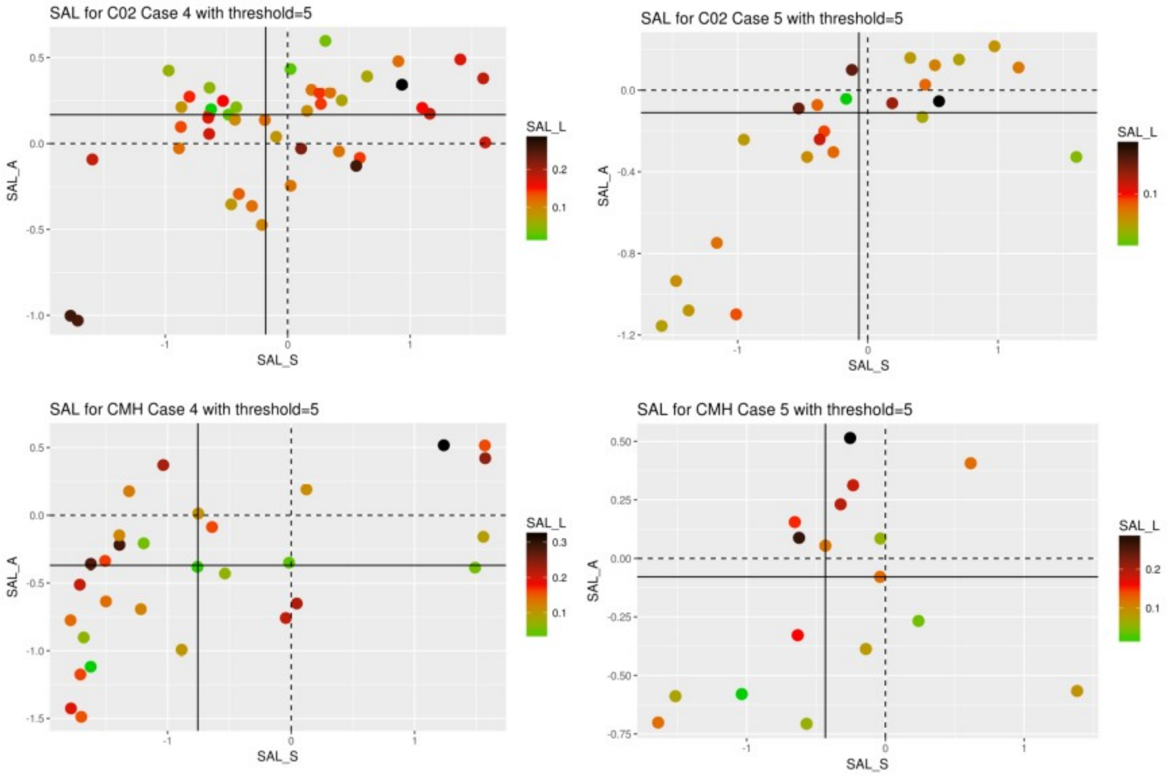
- Skill increases with the scale
- CMH separates convective scale from mesoscale more
- (Mostly) skillful scales 2^4 (128 km)
- Inconclusive influence of having smaller CMH dataset.

SAL

SAL

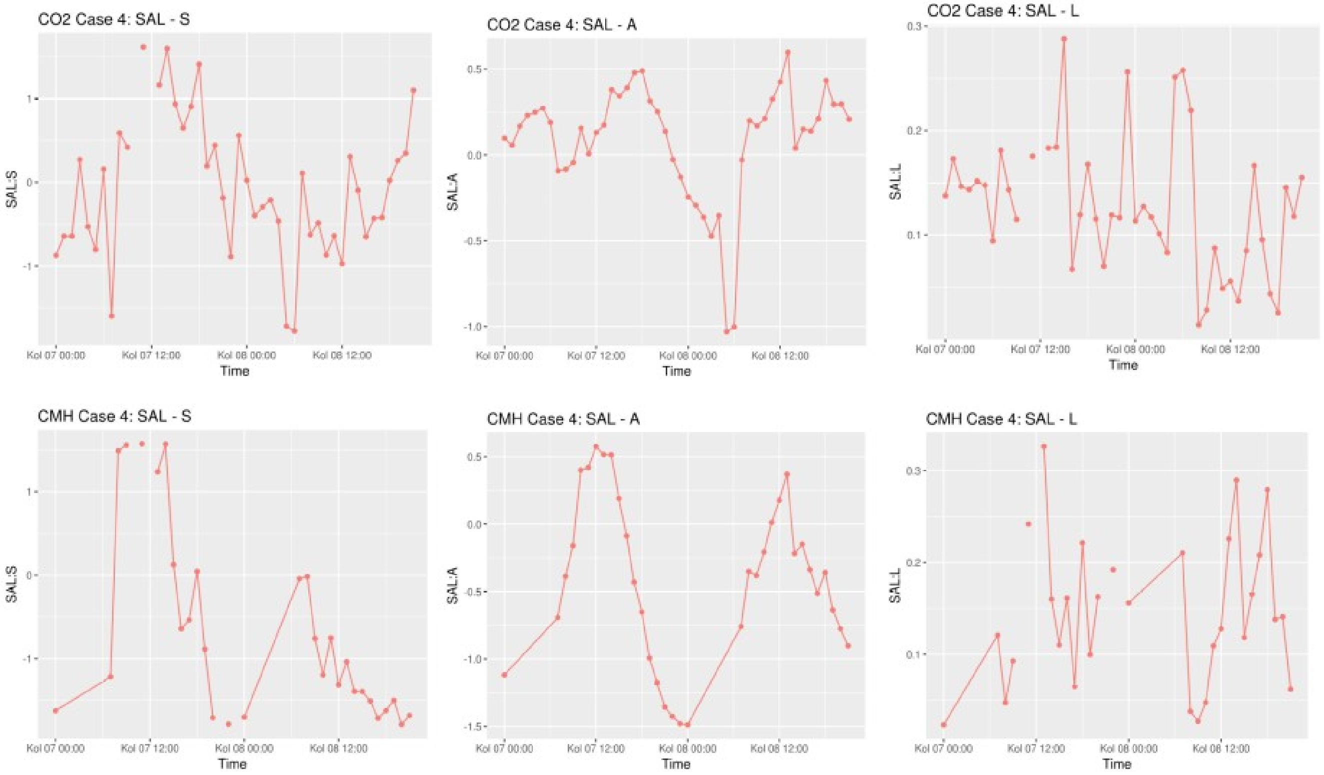
- Feature-based method
- S – precipitation objects structure error: comparison of volumes for each (scaled) object
  - S=(V(R_m*)-V(R_o*)) / 0.5*(V(R_m*)+V(R_o*)) in [-2,2]
  - i.e. small intense vs. large weak or different distribution of the same (average) intensity
- A– difference in precipitation area mean in a catchment
  - A=(D(R_m)-D(R_o))/0.5 *(D(R_m*)+D(R_o*)) in [-2,2]
  - i.e. same-size, different intensity
- L- (|r(R_m)-r(R_o)|+2|d(r_m)-d(r_o)||)/dist_(max)(area) in [0,2]
  - Distance between the centers of mass / mean distance and area-center of mass scaled displacement error of the center of mass
- IDEAL: S=A=L=0

Case 4 vs. Case 5: SAL diagrams



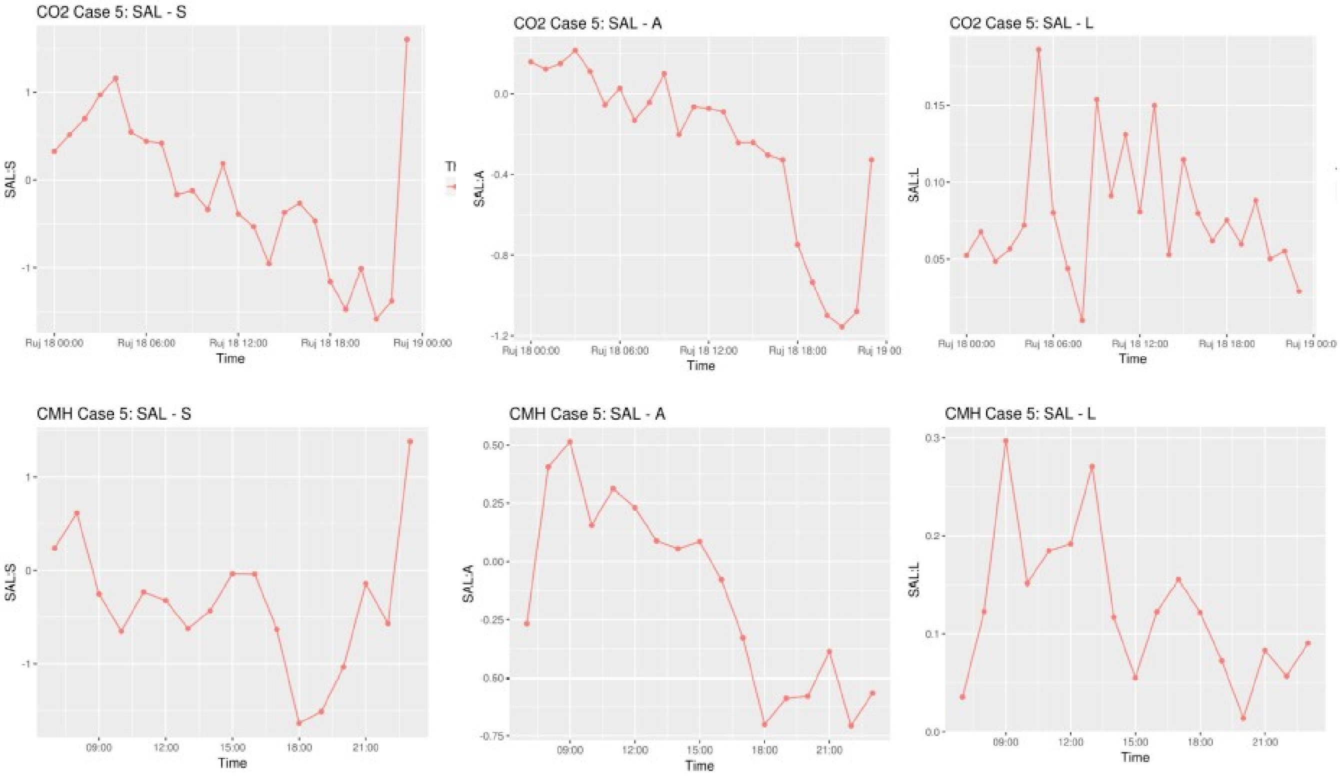
- Objects too small/peaked + underestimation of amplitude
- More for CMH
- S more negative for convective case 4
- Median value better for CO2
- Outliers

Threshold=5mm/h, Case 4 - convective



- CMH under-predicts both S and A in the beginning (spin-up)
- CMH – another minimum around 00 h
- L decreases a bit vs. time for CO2 (in average)

Threshold=5mm/h, Case 5 - frontal



- S and A from over prediction towards under prediction: structure from too intense and large/peaked to too weak and small/wide
- Dissipating the front too fast
- L lowers in time – capturing the position of an large object better

Conclusion

ISS:

- Skillful scales 64-128 km, depending on a threshold and time
- CMH seems to be a bit more skillful at higher thresholds and larger spatial scales, but shows wider skill minimum during spin-up and afterwards for low thresholds.
- CMH separates mesoscale from convective scale more

SAL:

- Objects are too small/peaked for convective case 4 (both models)
- CMH under-predicts both S and A in the beginning (spin-up) and afterwards
- Median (S,A) value is better for CO2 for these cases
- Location is better predicted with time
- Dissipation to fast

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THANK YOU FOR LISTENING!!!

SAL:S

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- S – precipitation objects structure error: comparison of volumes for each (scaled) object
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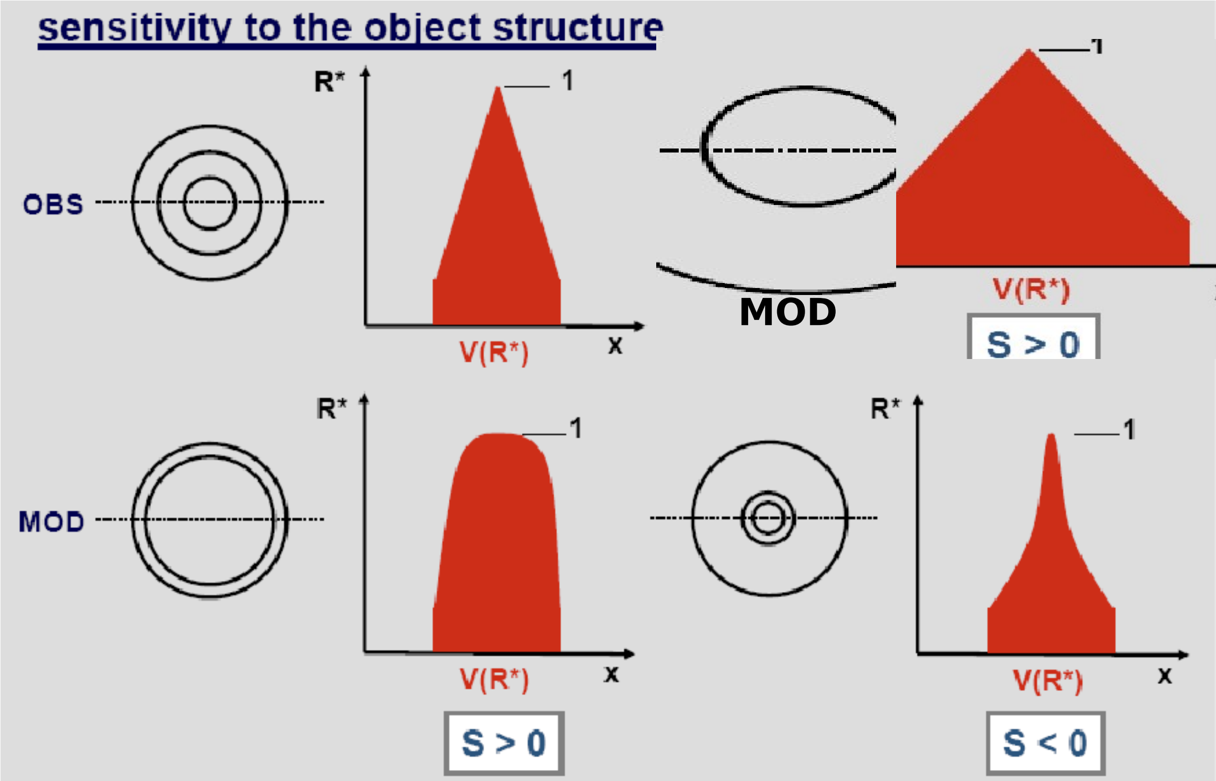
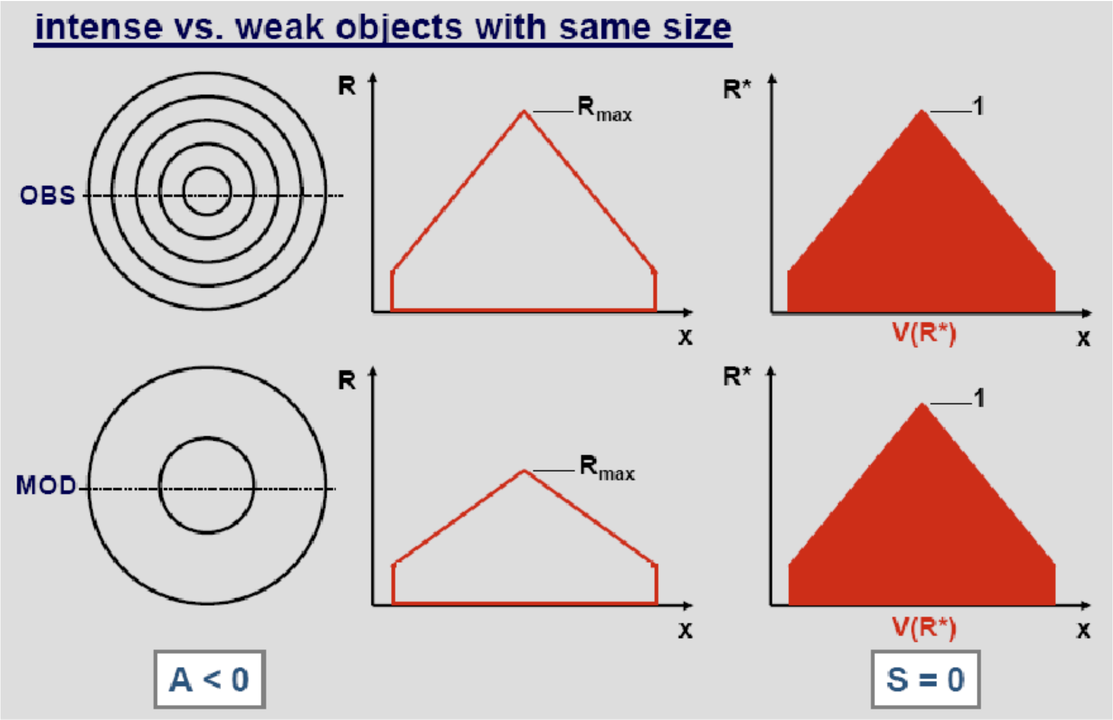
- [-2,2]



SAL: A

- A – difference in precipitation area mean within the chosen area
- A=D(R_m)-D(R_o)
- [-2,2]



SAL: L

S A L – defintion of the L-component

$L = |r(R_{mod}) - r(R_{obs})| > 0$

r(...) denotes the precipitation center of mass in the chosen area
displacement error of the center of mass