



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Verification of high-resolution precipitation forecasts by using the SAL method

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FMI

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Helsinki, Finland,
12. - 15.5.2009.



- A brief introduction to SAL.
- FMI's real-time SAL verification setup.
- What can we see from SAL?
- Diagnosing the NWP model by using SAL verification method.
- Added value of high-resolution based on Helsinki testbed data?



Structure Amplitude Location (SAL)

- **SAL** is object-based quality measure for the verification of QPFs.
- **SAL** contains three distinct components that focus on **Structure**, **Amplitude** and **Location** of the precipitation field in a specified domain.
- **S**: Model precipitation areas too large/flat or small/peaked. [-2...2]
- **A**: Difference of domain averaged precipitation. [-2...2]
- **L**: Location component = difference of mass centers of precipitation fields + averaged distance between the total mass center and individual precipitation objects. [0...2]

Wernli et al. (2008) SAL – a novel quality measure for the verification of quantitative precipitation forecasts. MWR, 136, 4470-4487.



FMI's real-time SAL verification setup

AROME 2.5km (32h2)

00,12 UTC runs +24h

No DA



Hourly 3D data:

RAIN

SNOW

GRAUPEL

CLOUD WATER

CLOUD ICE

TEMPERATURE

HUMIDITY

Radar simulator

Radar properties

Beam propagation and attenuation



FMI's real-time SAL verification setup

AROME 2.5km (32h2)
00,12 UTC runs +24h
No DA

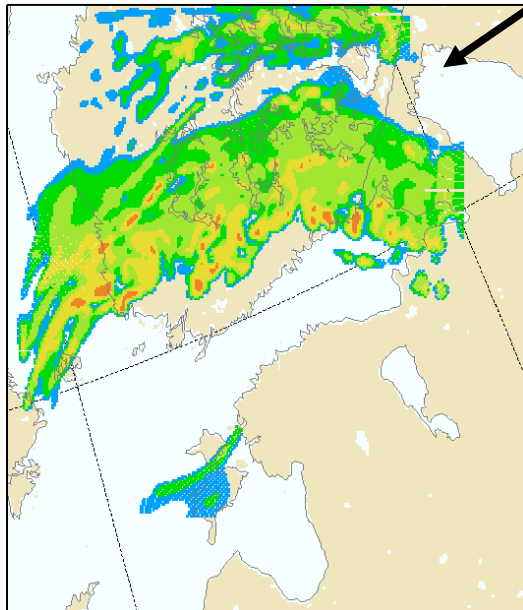
Hourly 3D data:
RAIN
SNOW
GRAUPEL
CLOUD WATER
CLOUD ICE
TEMPERATURE
HUMIDITY

Radar simulator
Radar properties

Beam propagation and attenuation

AROME dBZ

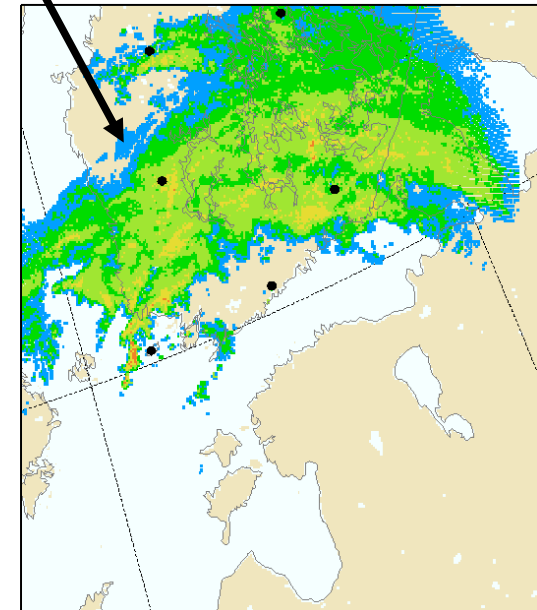
AROME 08AUG2008 00 UTC Forecast. Radar reflectivity [dBZ]
08AUG2008 10:00 UTC (aro32h2,2.5km).



Radars:VAN,IKA,ANJ,KUO,KOR,VIM

Observed dBZ in model grid

Observed radar reflectivity [dBZ].
08AUG2008 10:00 UTC.



Radars:VAN,IKA,ANJ,KUO,KOR,VIM



FMI's real-time SAL verification setup

AROME

00,12 UTC

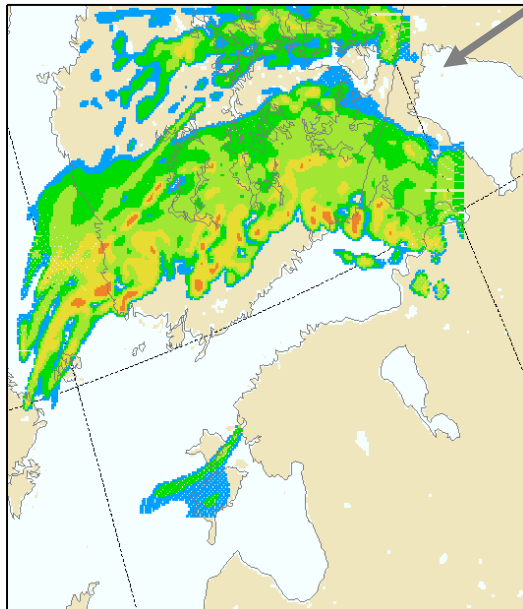
SAL verification

Fixed threshold for object detection = 16dBZ

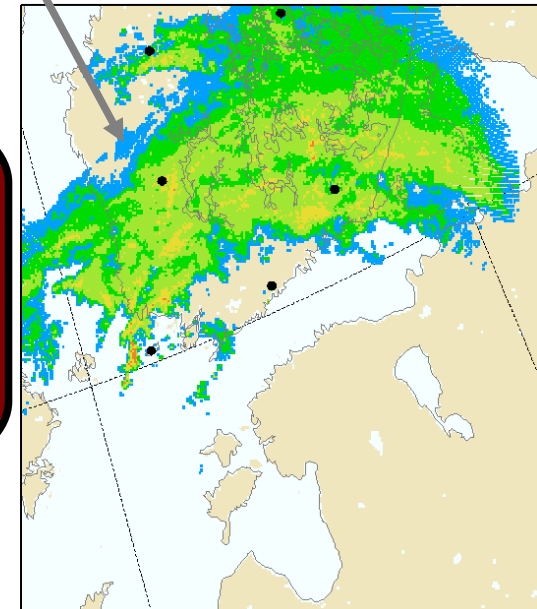
Forecast lengths 1-24h are processed, every hour.

Each SAL point is ready ~20min after obs. is available

AROME 08AUG2008 00 UTC Forecast. Radar reflectivity [dBZ]
08AUG2008 10:00 UTC (aro32h2,2.5km).



Observed radar reflectivity [dBZ].
08AUG2008 10:00 UTC.



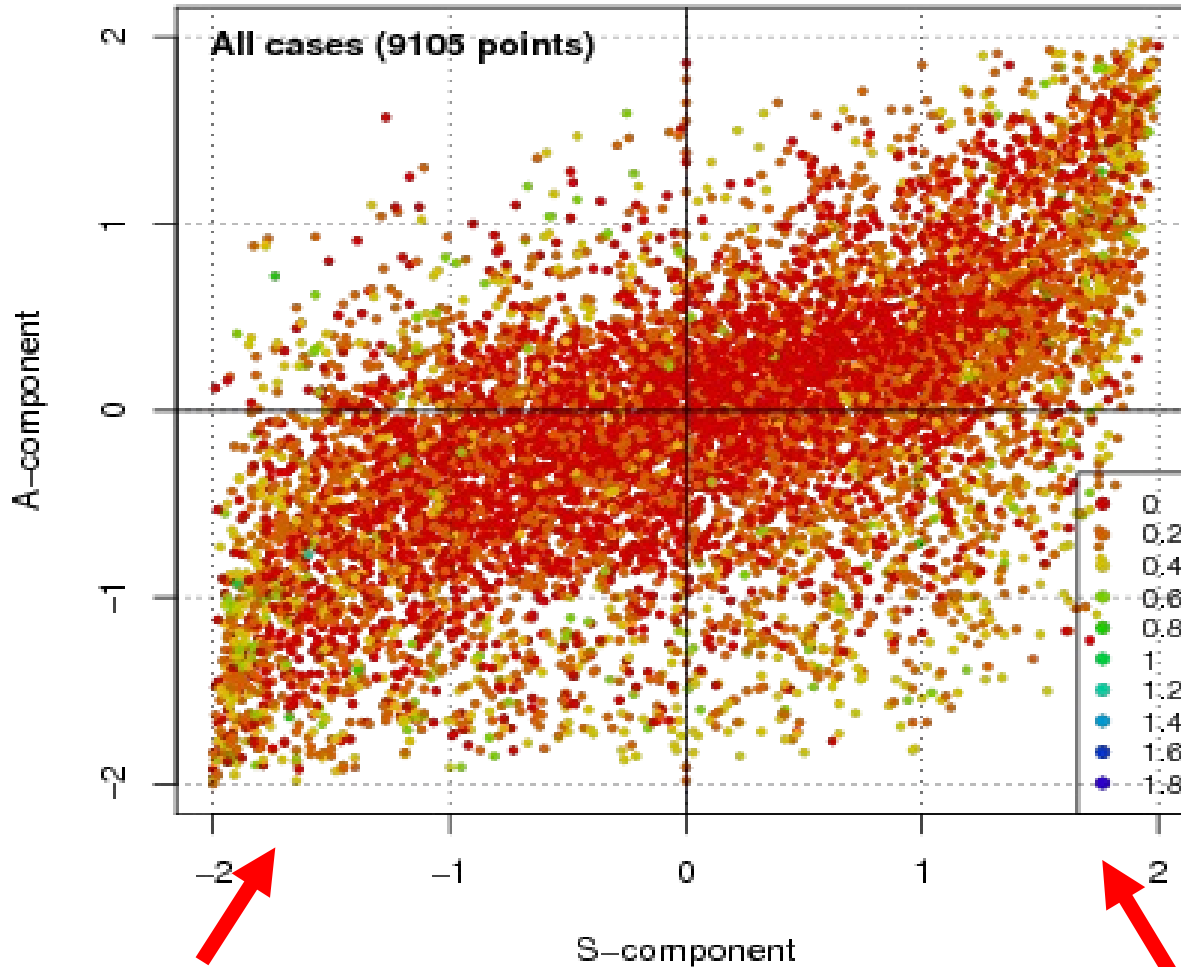
S = -0.34

A = -0.12

L = 0.07



What can we see from SAL?

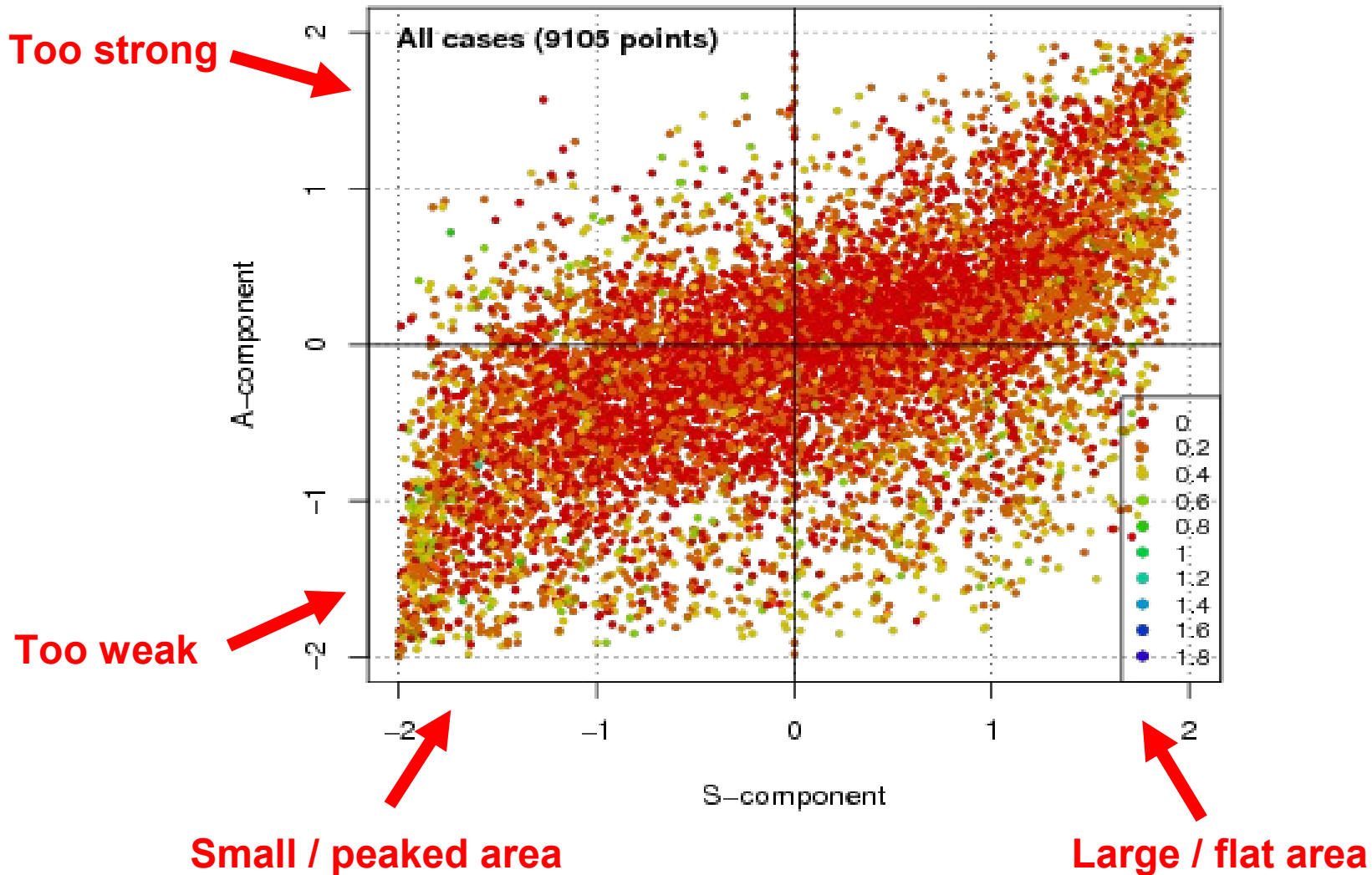


Small / peaked area

Large / flat area

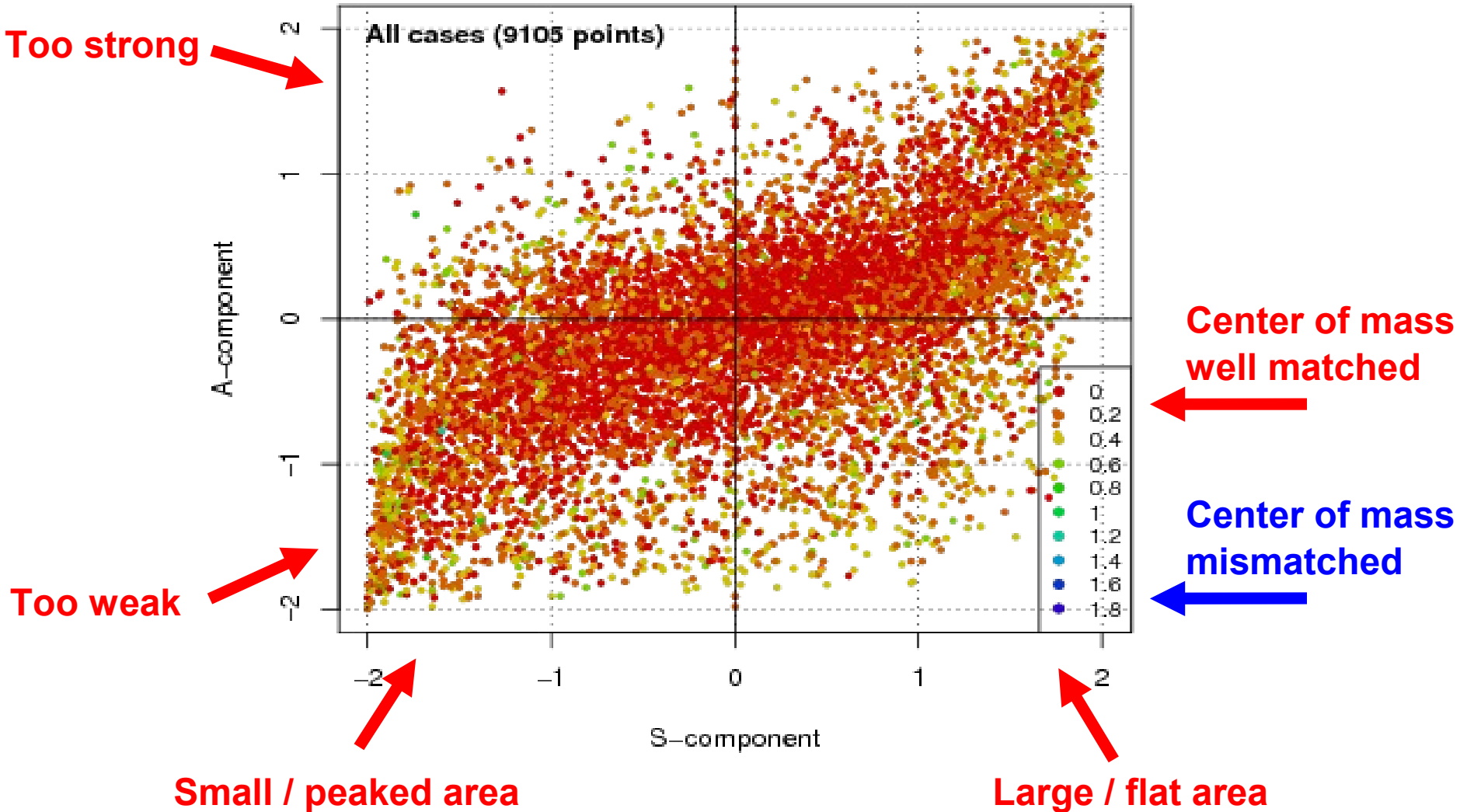


What can we see from SAL?



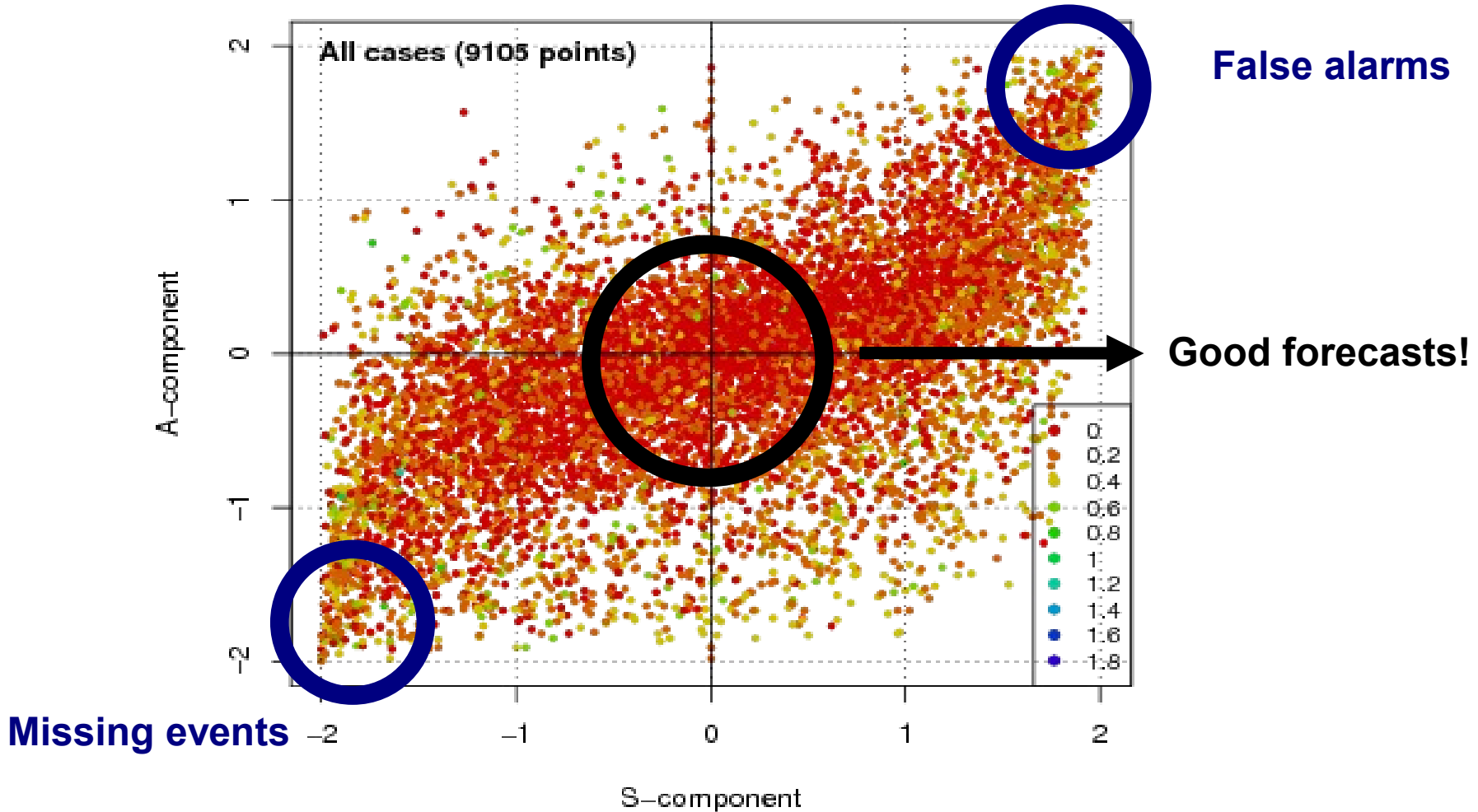


What can we see from SAL?





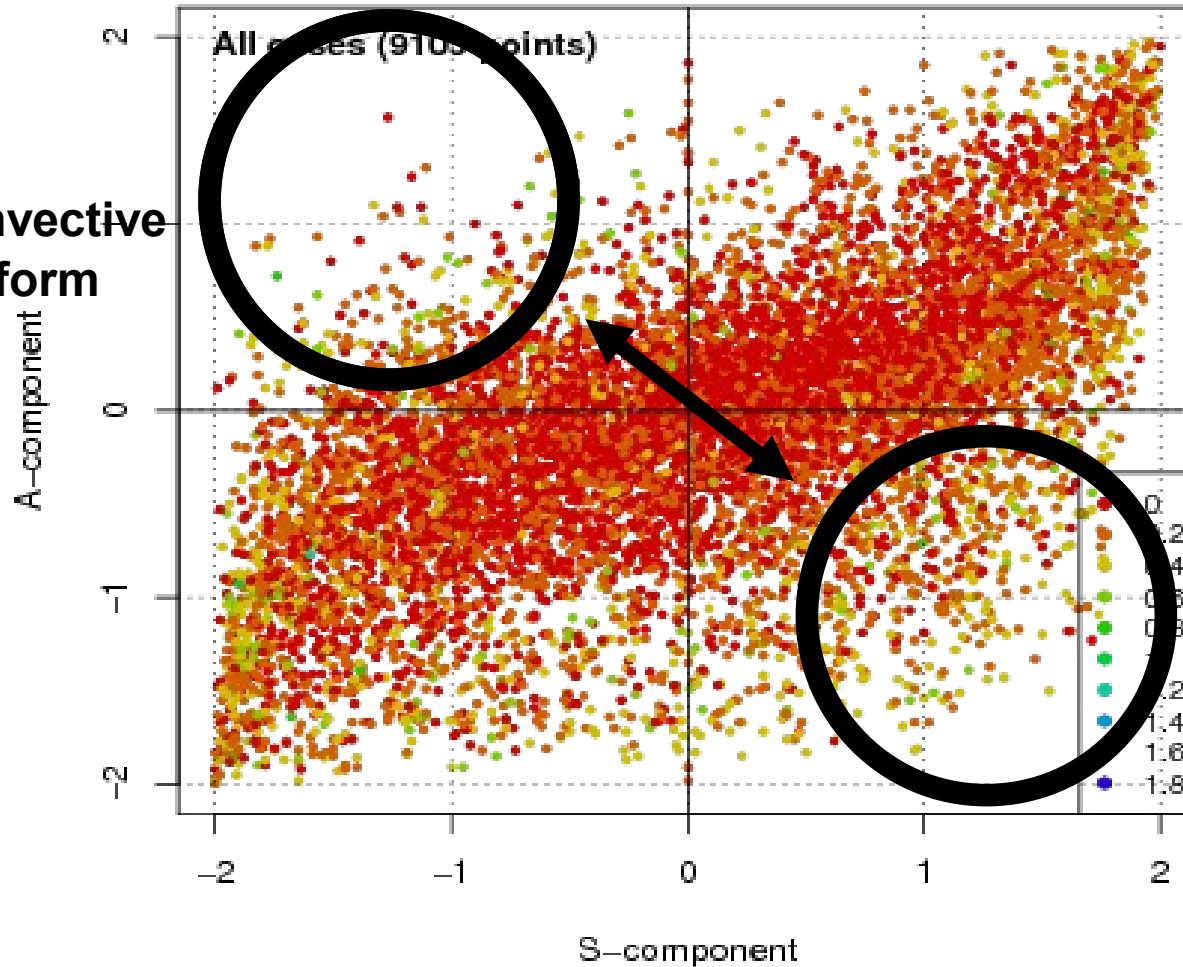
What can we see from SAL?





What can we see from SAL?

Model: convective
Obs: stratiform



Model: stratiform
Obs: convective

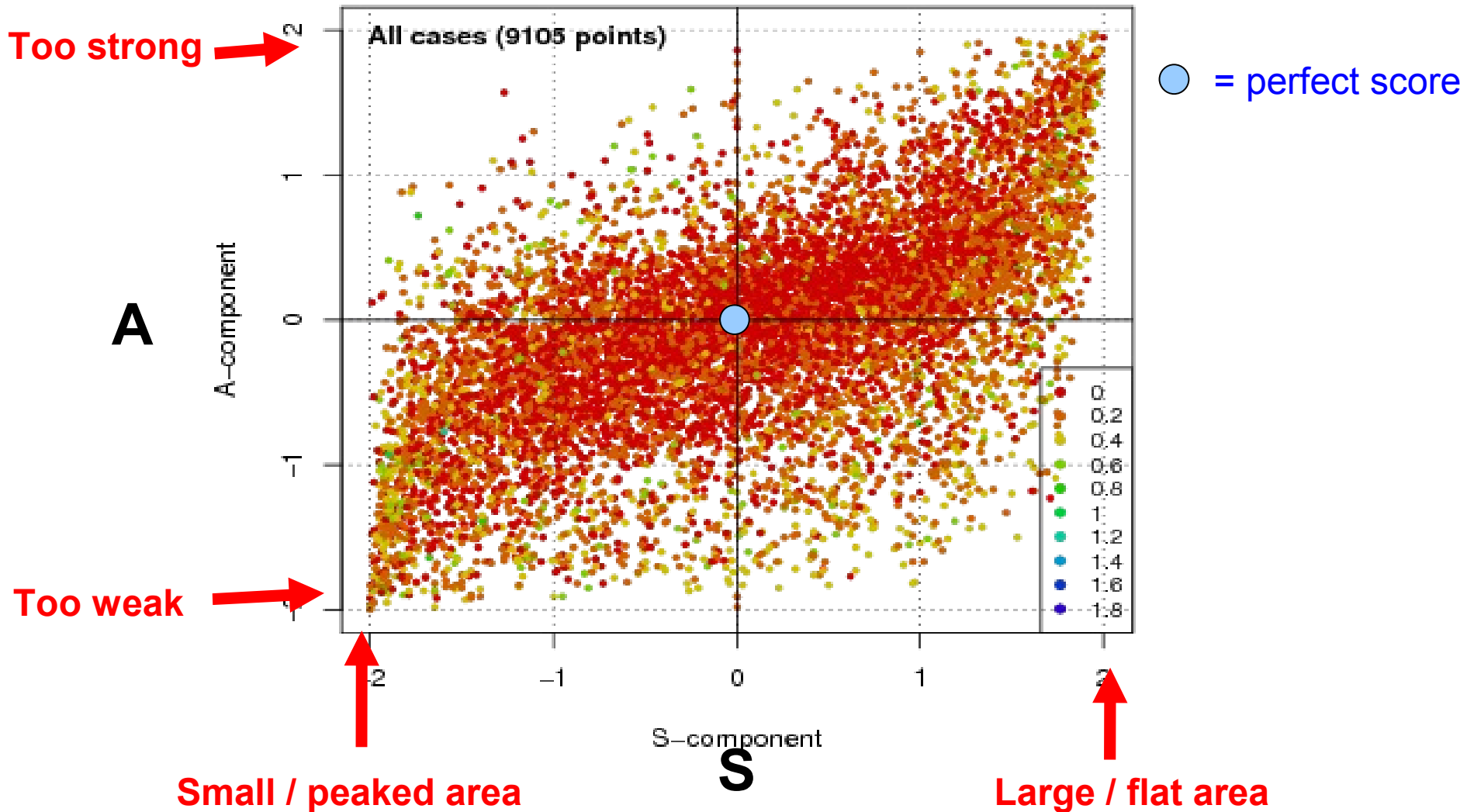


Diagnosing the NWP model by using SAL
verification method.

or

What SAL is able to tell us about the
precipitation forecasts of AROME model?

All cases Jun 2008 – Mar 2009

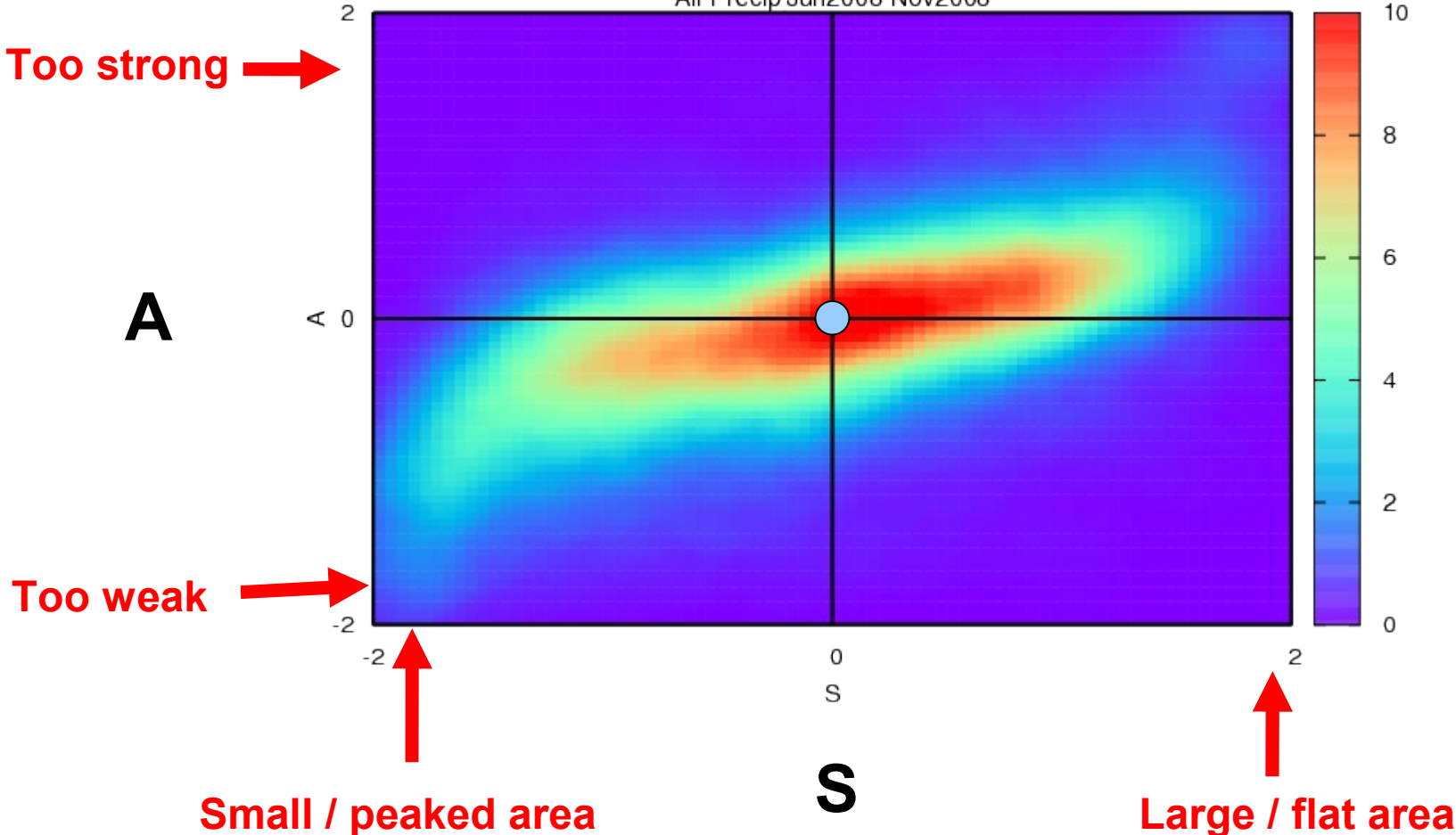




S vs. A - Precipitation cases Jun 2008 – Nov 2008

● = perfect score

Density distribution (% , N=4028) $S_{avg}=-0.07$ $A_{avg}=-0.09$ $S_{med}=-0.04$ $A_{med}=-0.06$
All-Precip Jun2008-Nov2008

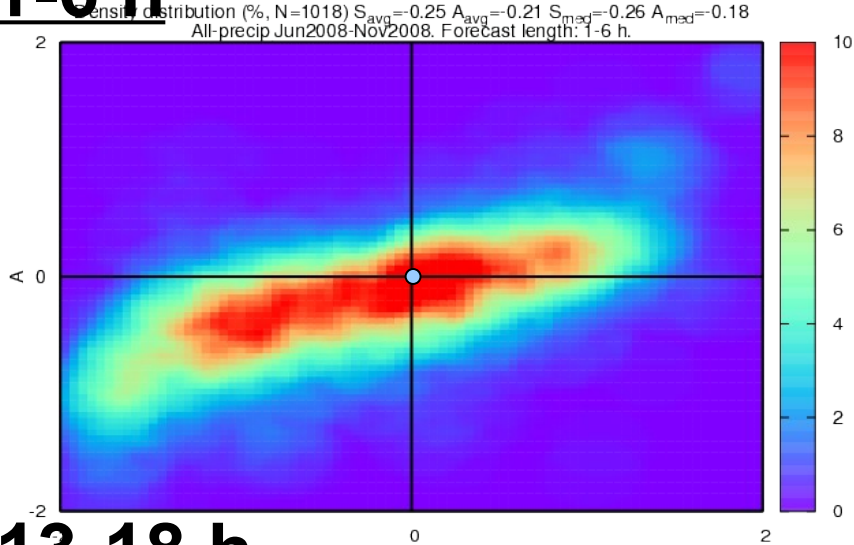




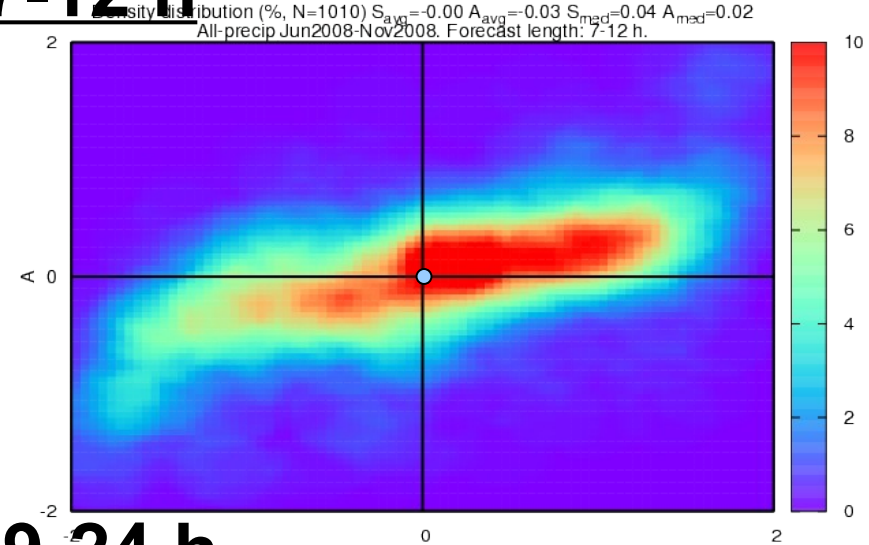
S vs. A - Time dependency

○ = perfect score

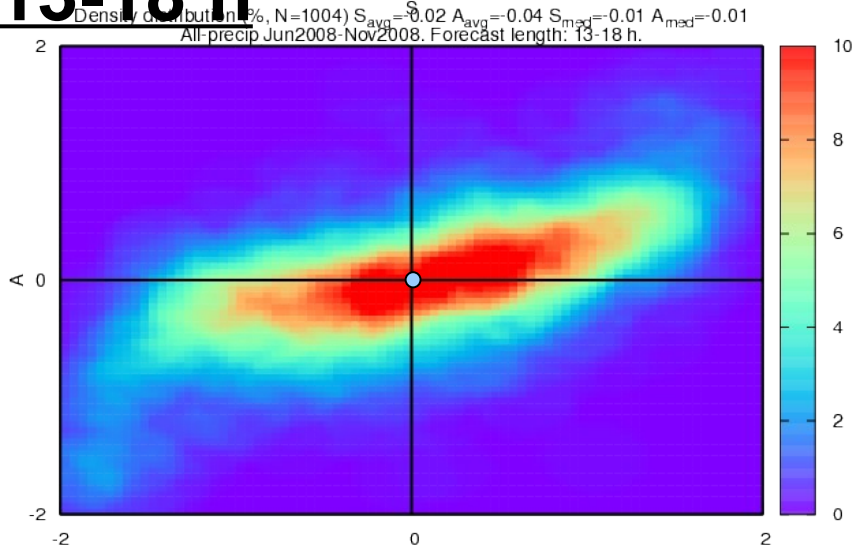
+1-6 h



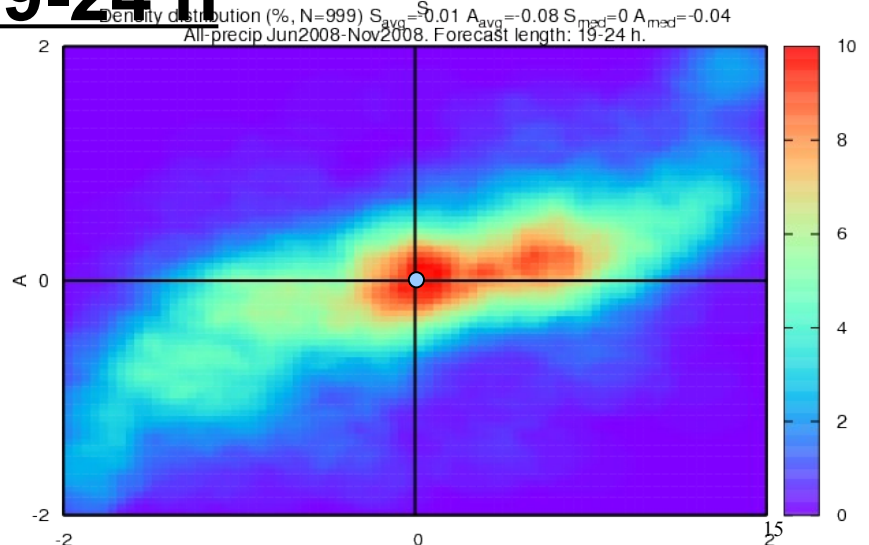
+7-12 h



+13-18 h



+19-24 h

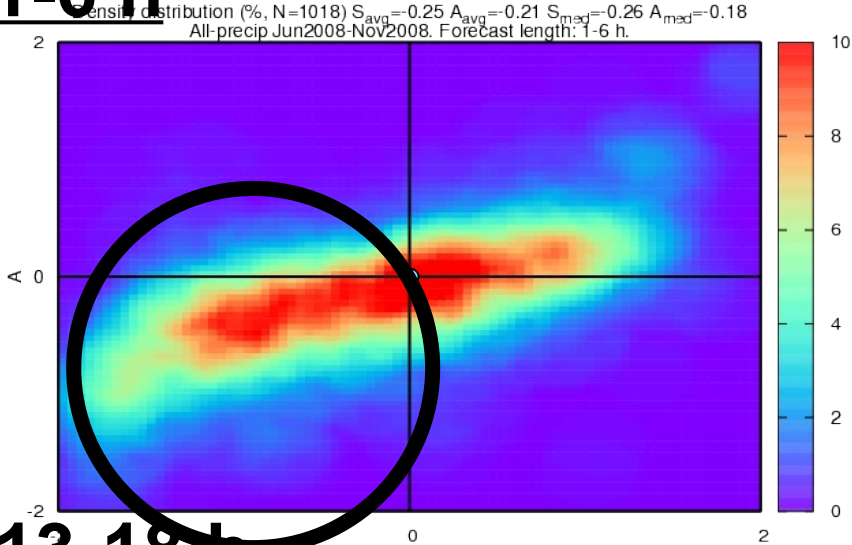




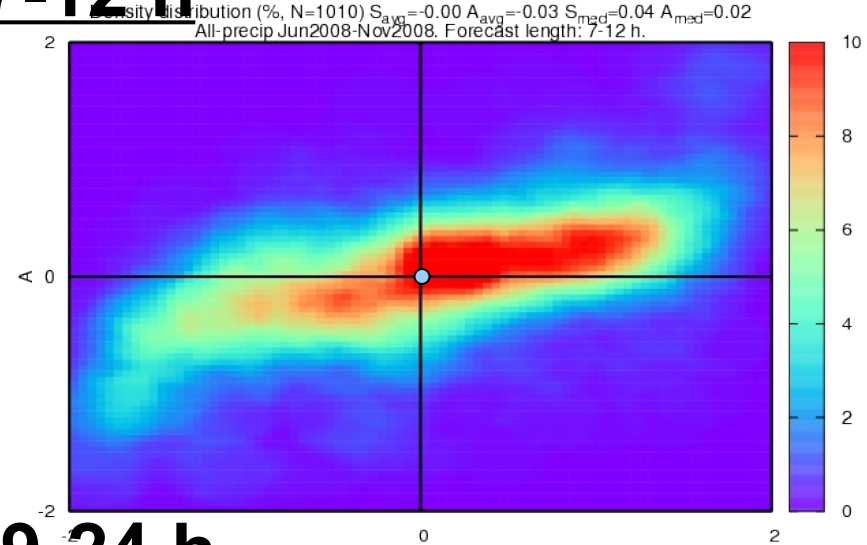
S vs. A - Time dependency

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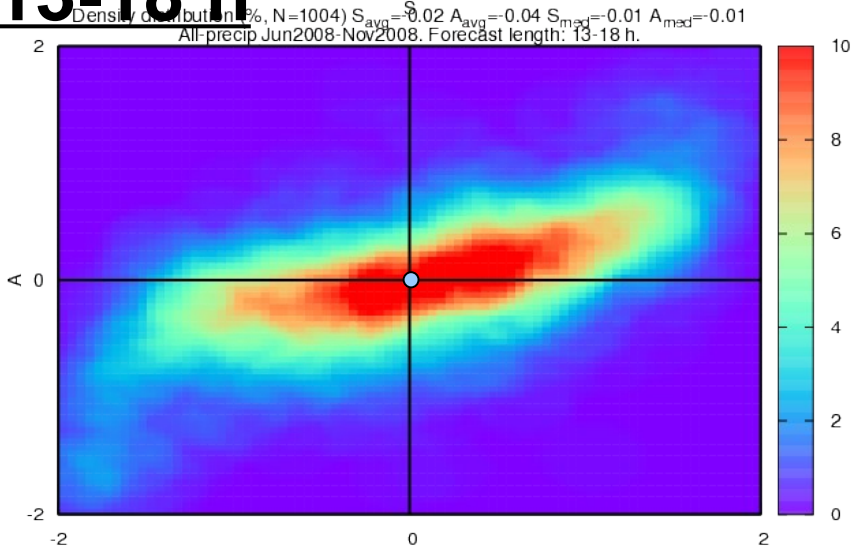
+1-6 h



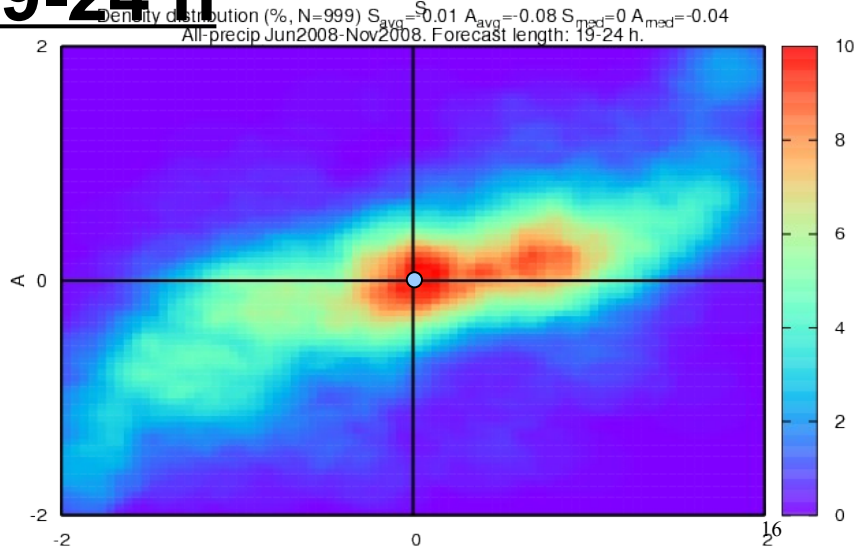
+7-12 h



+13-18 h



+19-24 h

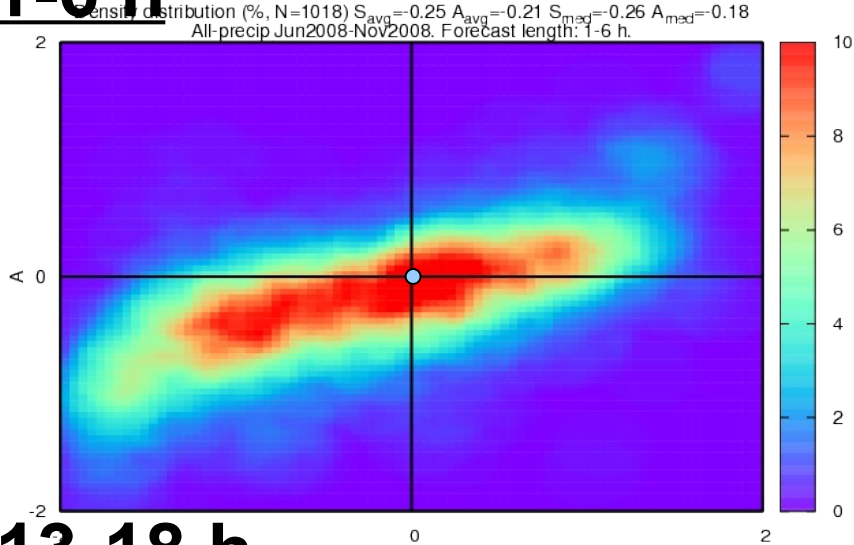




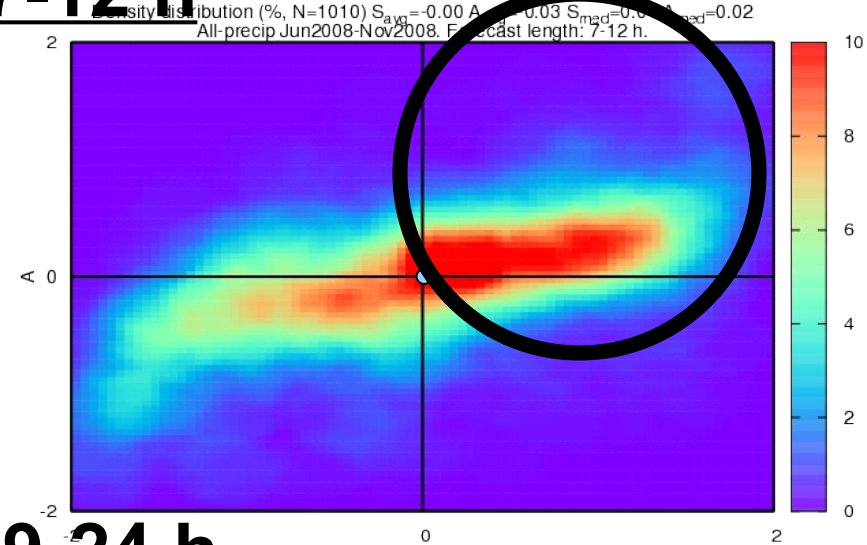
S vs. A - Time dependency

● = perfect score

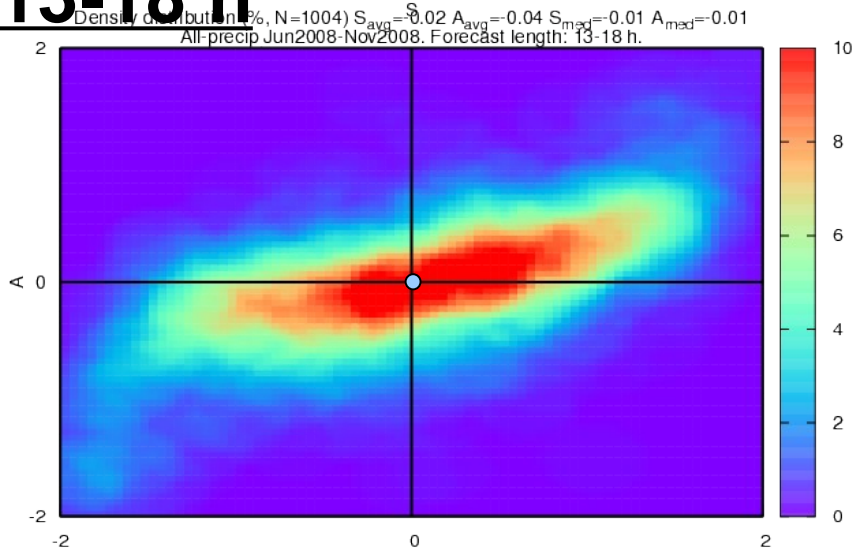
+1-6 h



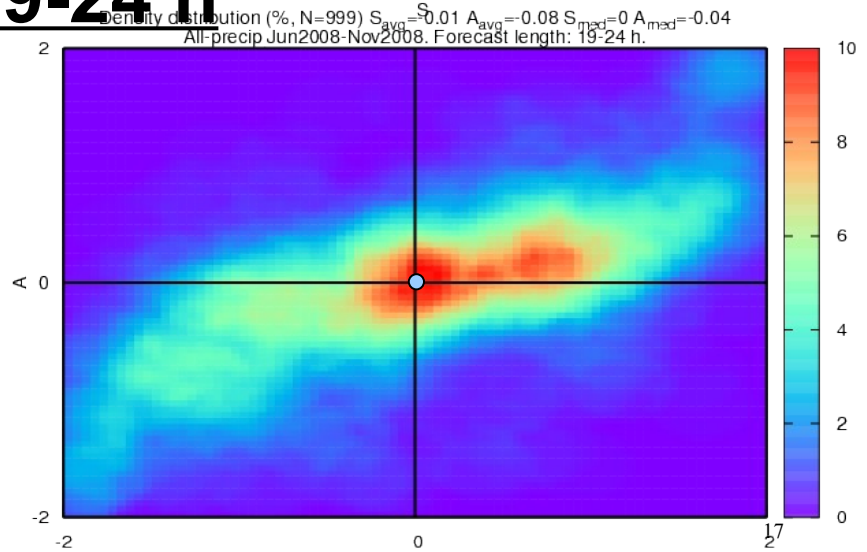
+7-12 h



+13-18 h



+19-24 h

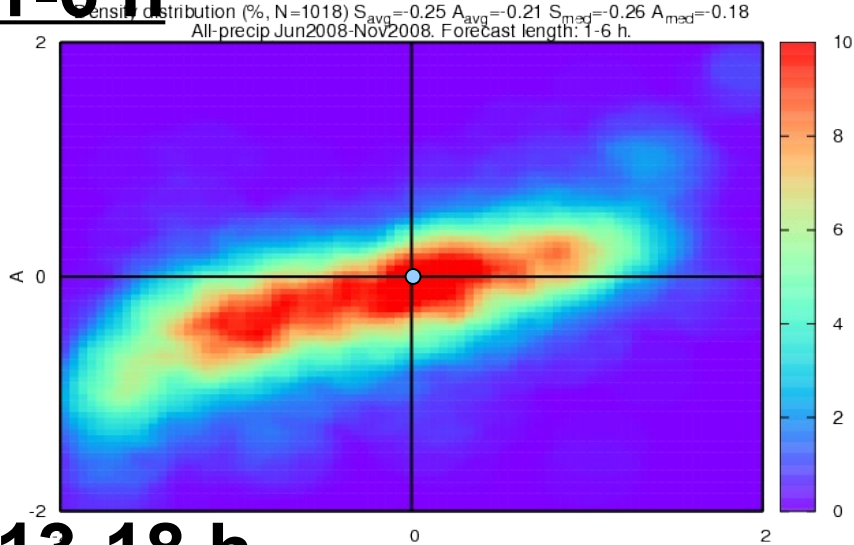




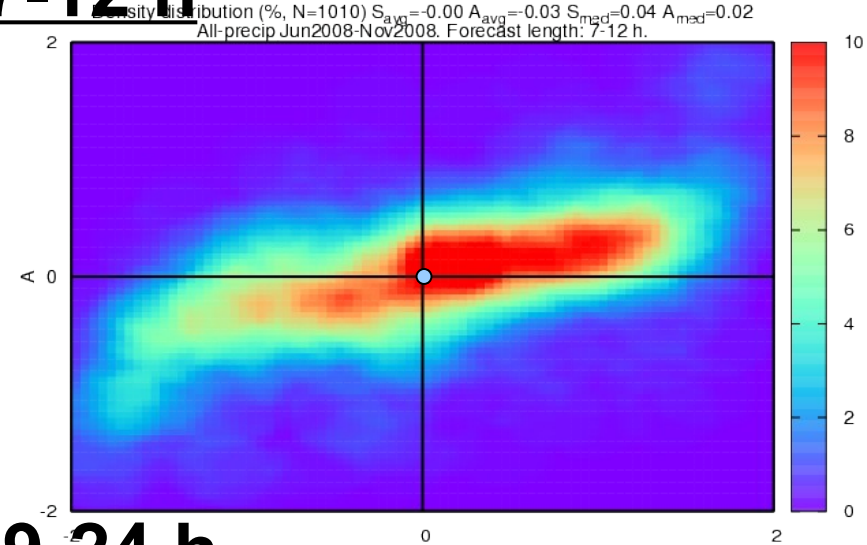
S vs. A - Time dependency

○ = perfect score

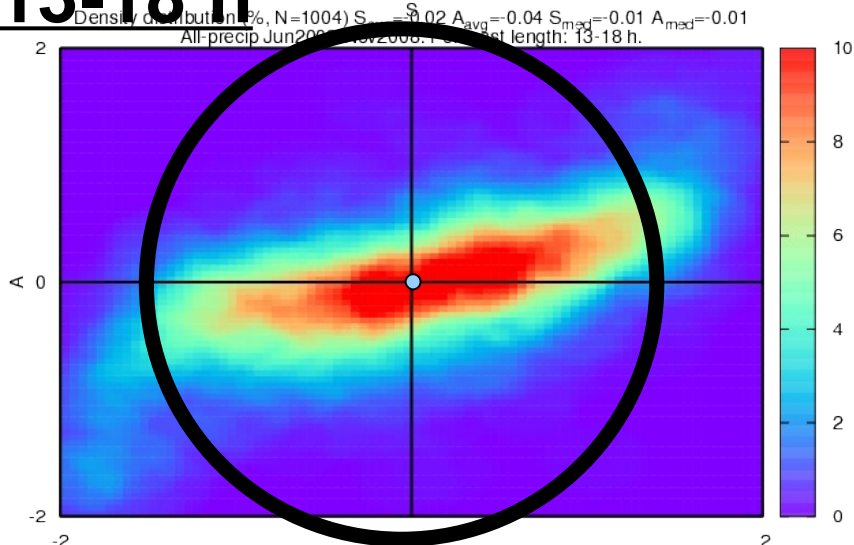
+1-6 h



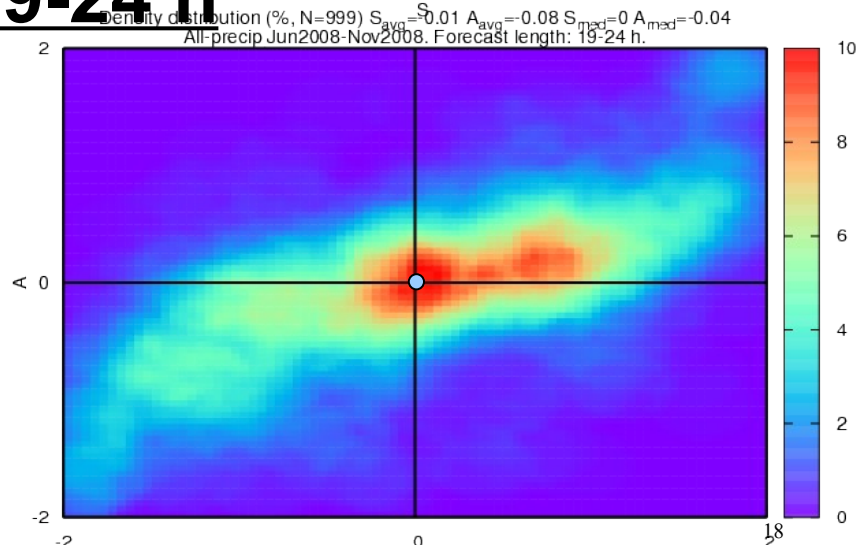
+7-12 h



+13-18 h



+19-24 h

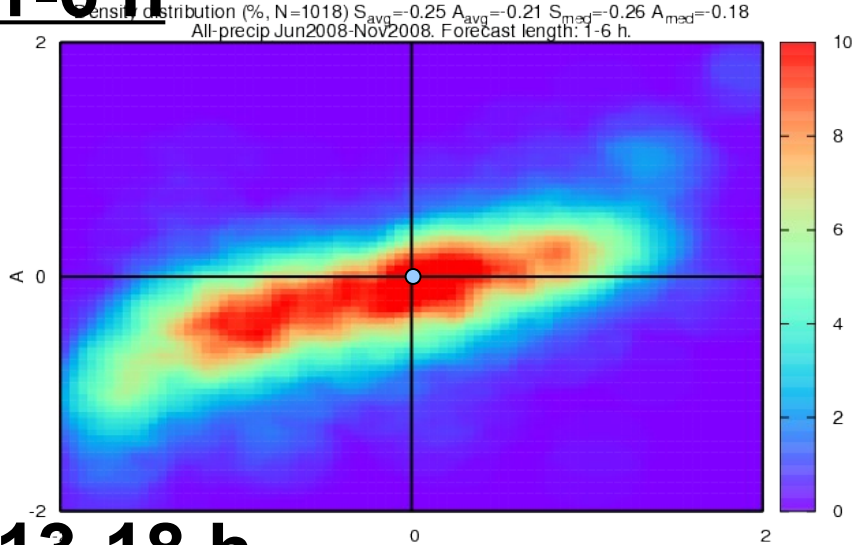




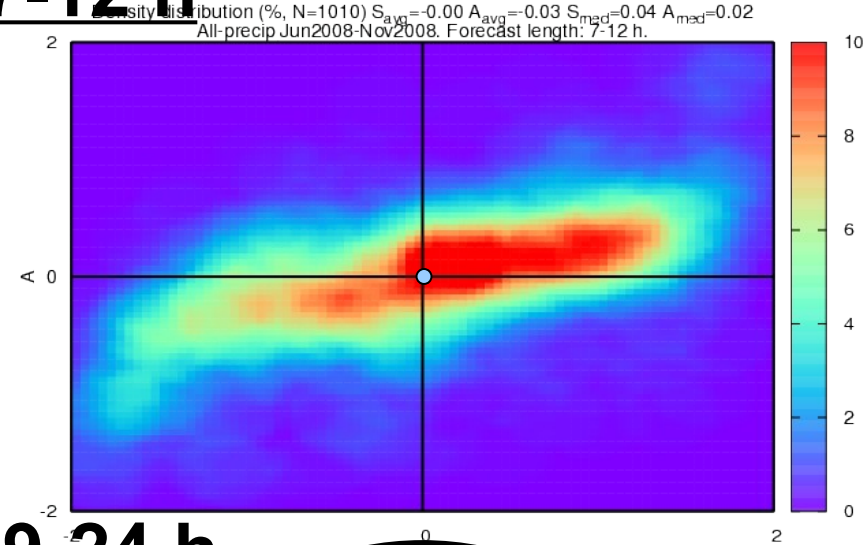
S vs. A - Time dependency

● = perfect score

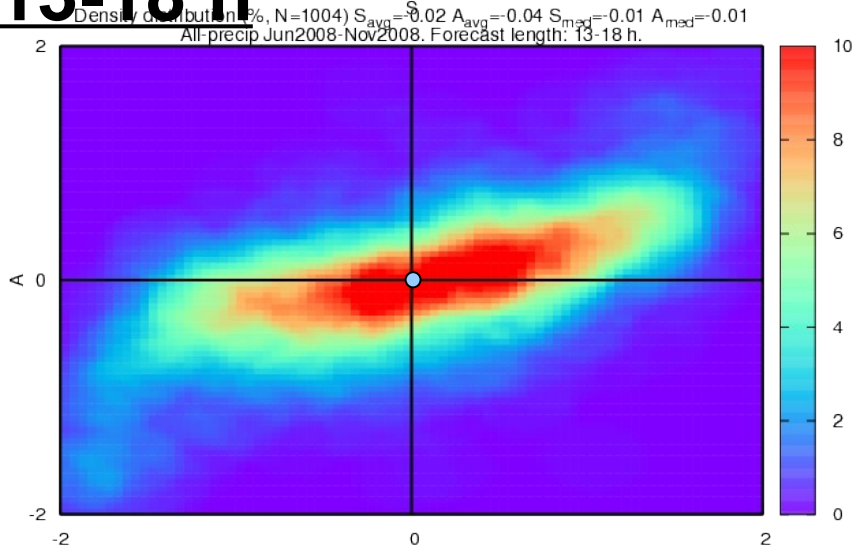
+1-6 h



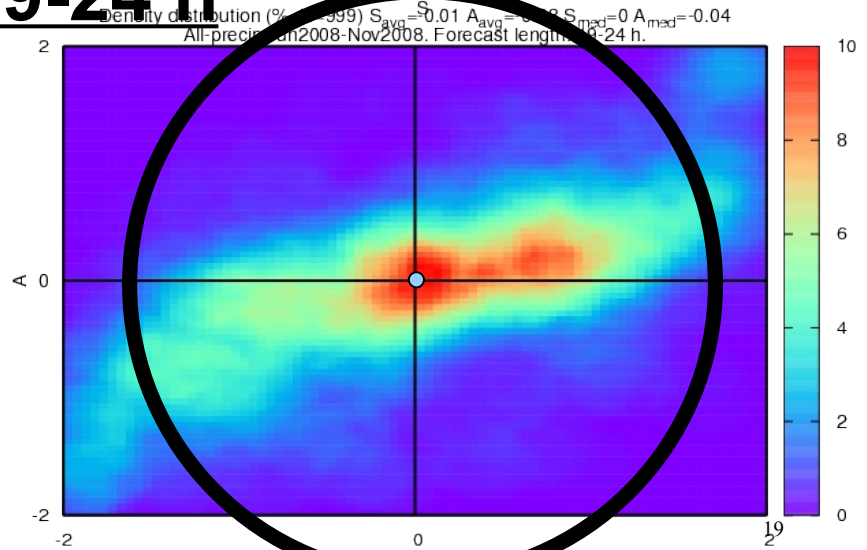
+7-12 h



+13-18 h



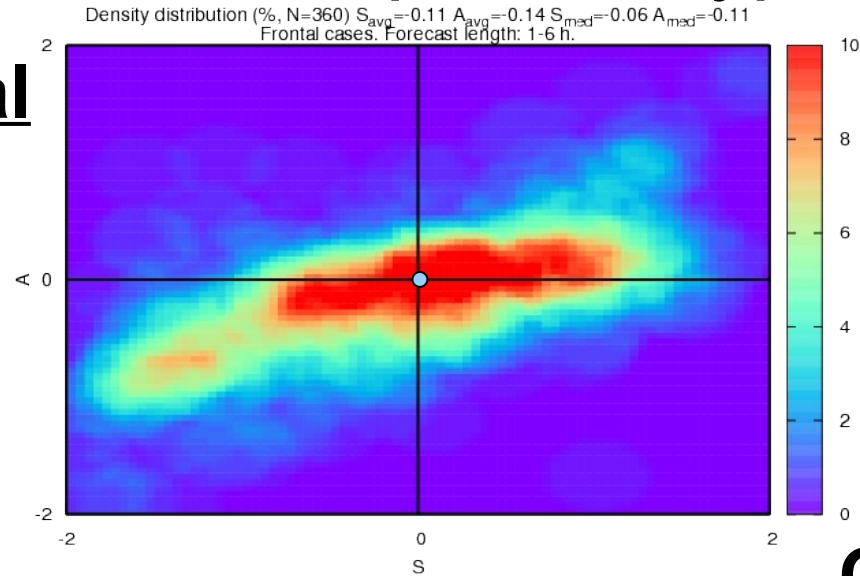
+19-24 h





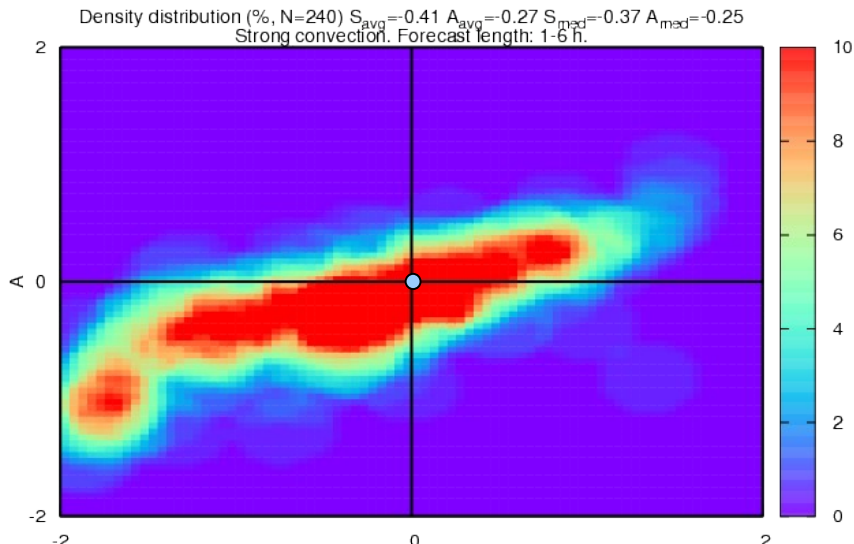
S vs. A – Precipitation type +1-6h

Frontal

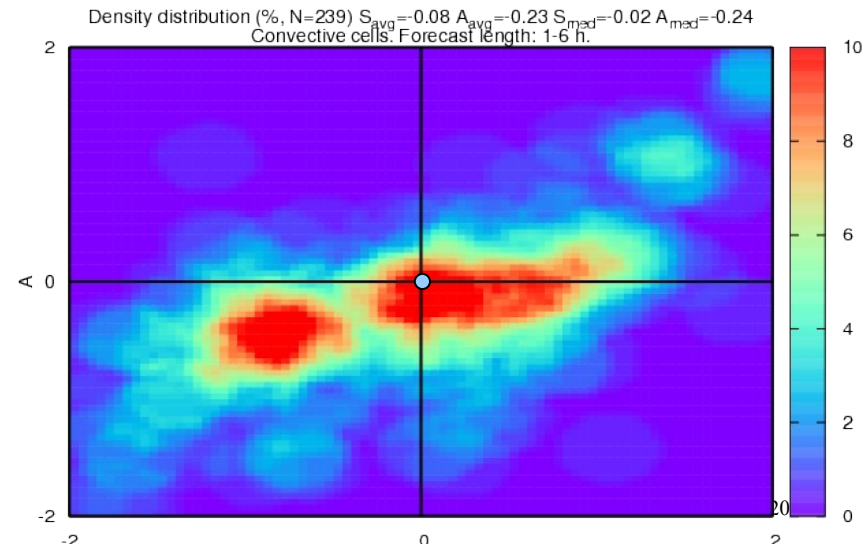


○ = perfect score

Strong conv.

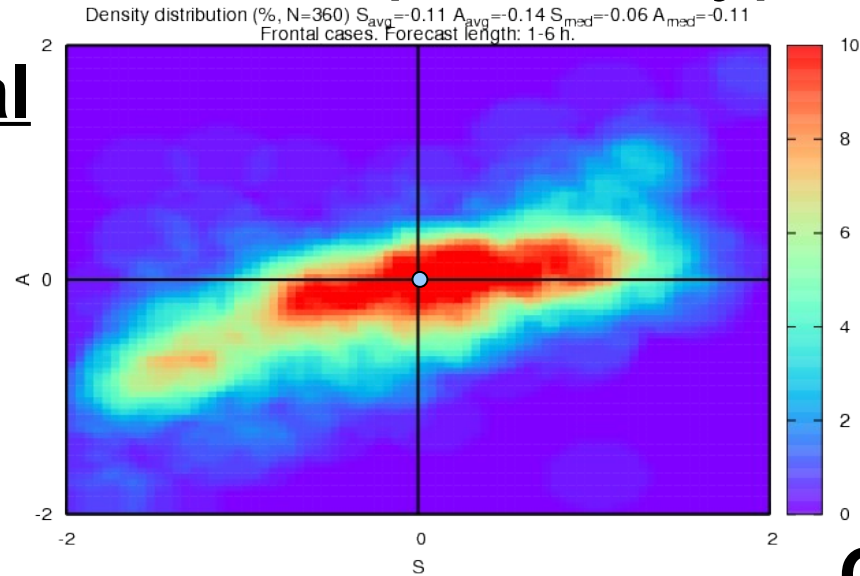


Open cell conv.



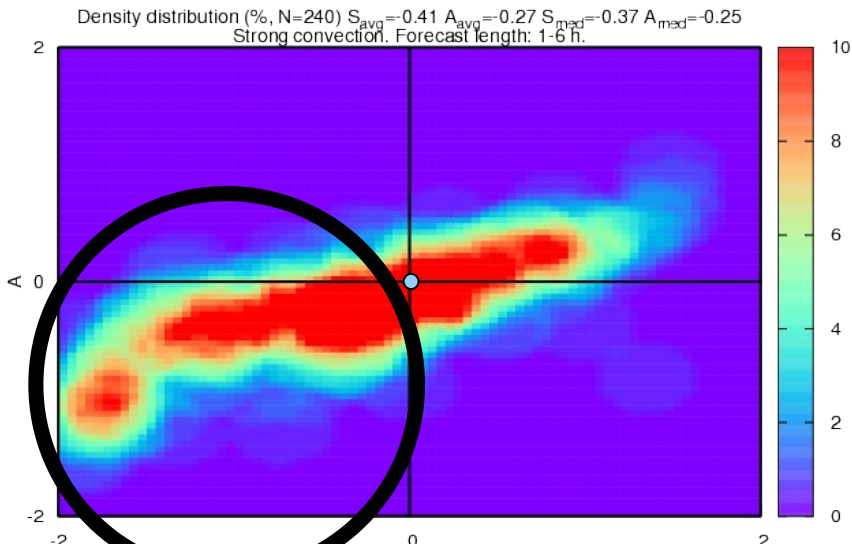
S vs. A – Precipitation type +1-6h

Frontal

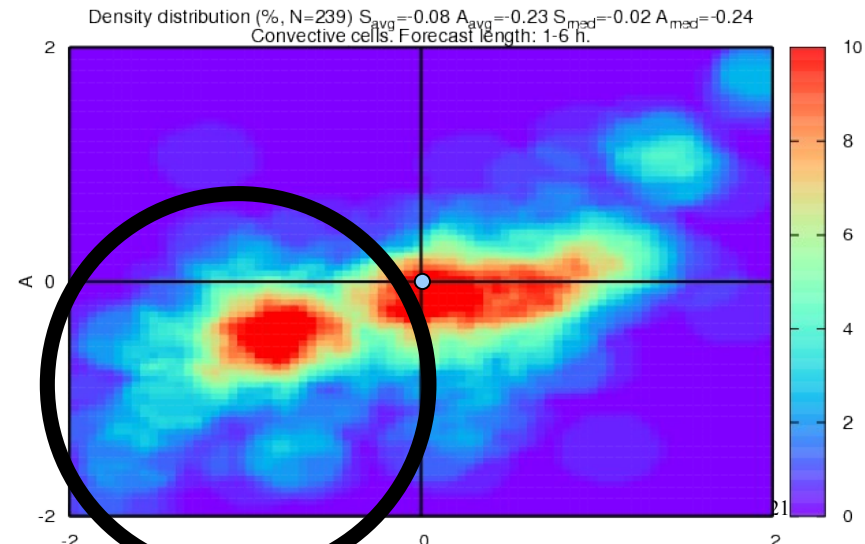


○ = perfect score

Strong conv.



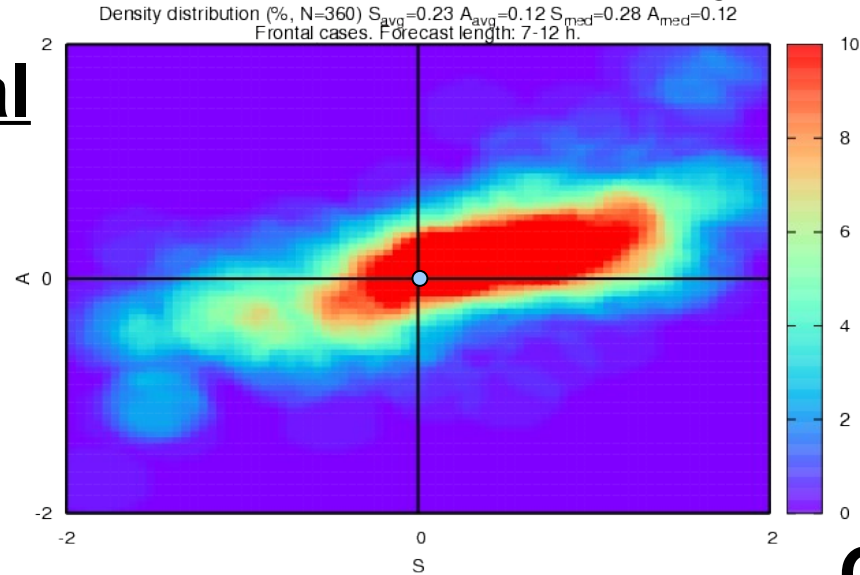
Open cell conv.



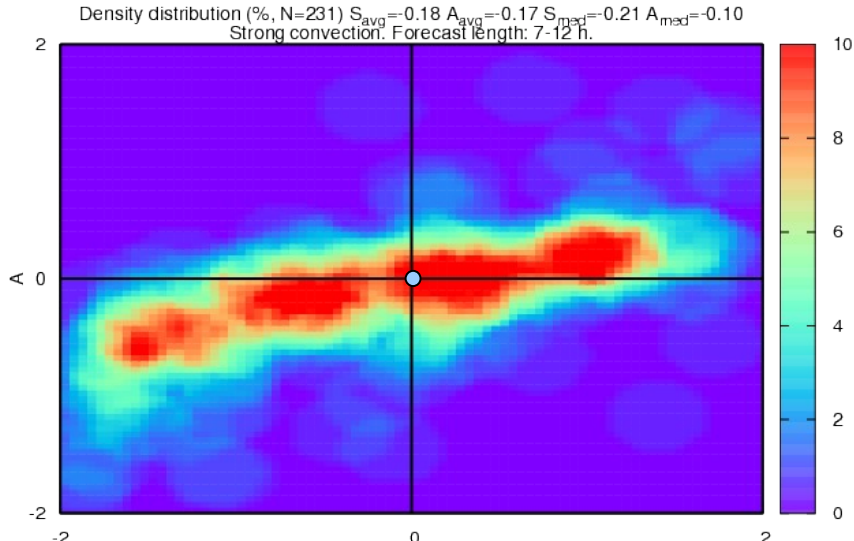


S vs. A – Precipitation type +7-12h

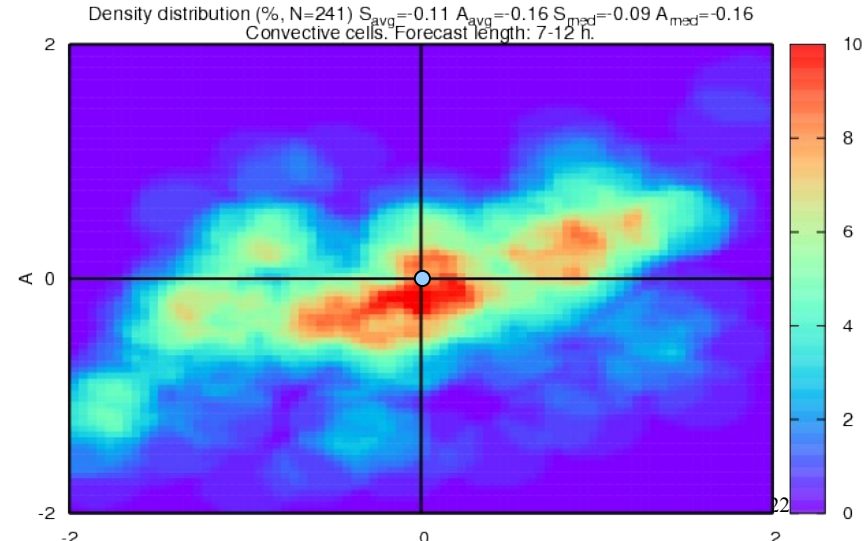
Frontal



Strong conv.



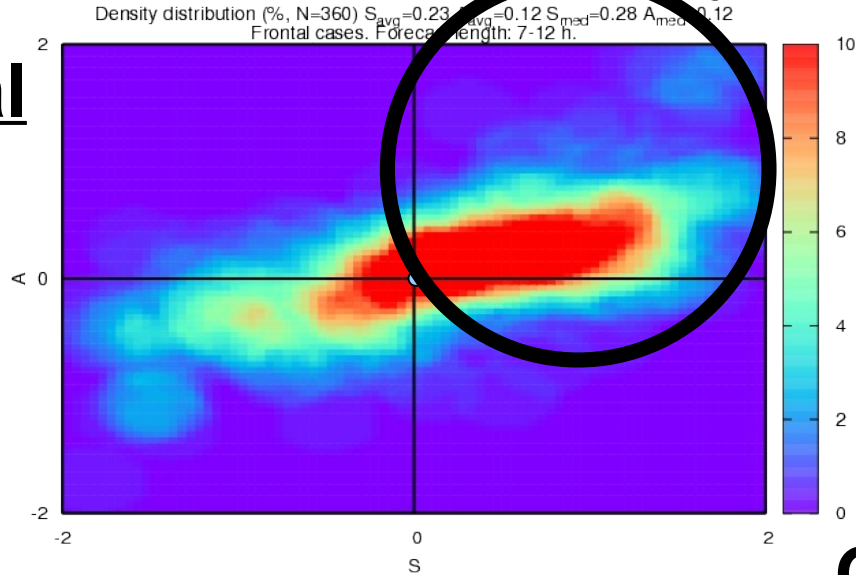
Open cell conv.





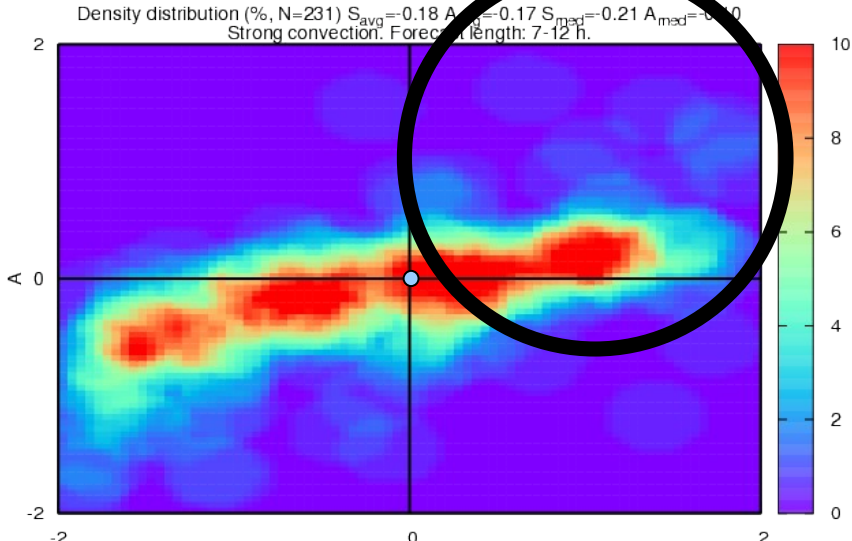
S vs. A – Precipitation type +7-12h

Frontal

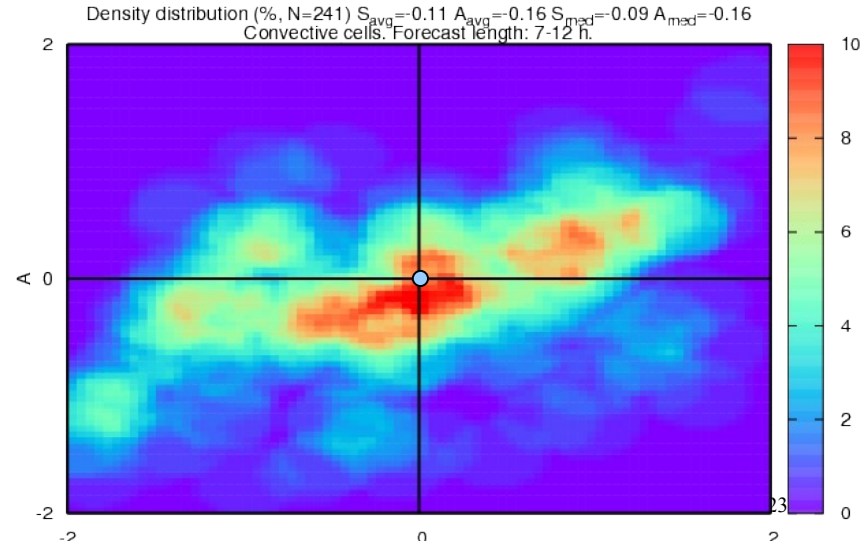


○ = perfect score

Strong conv.

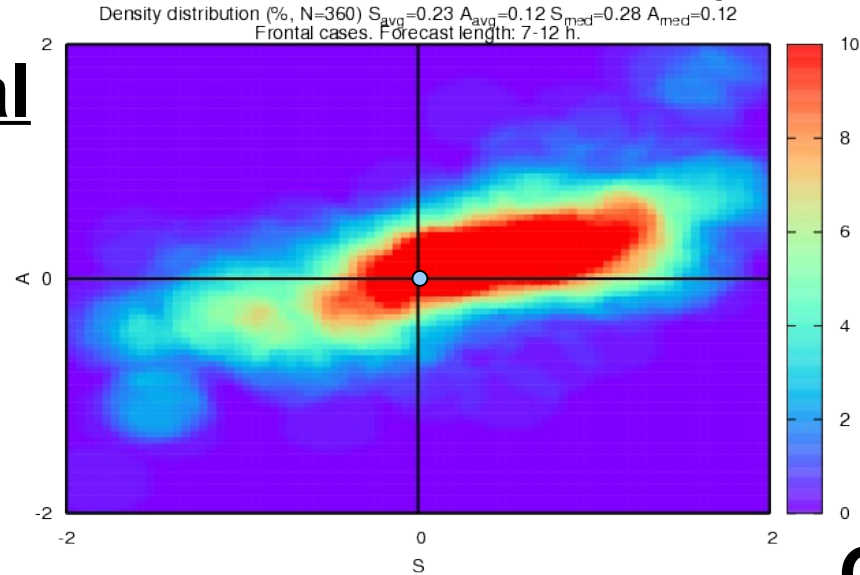


Open cell conv.



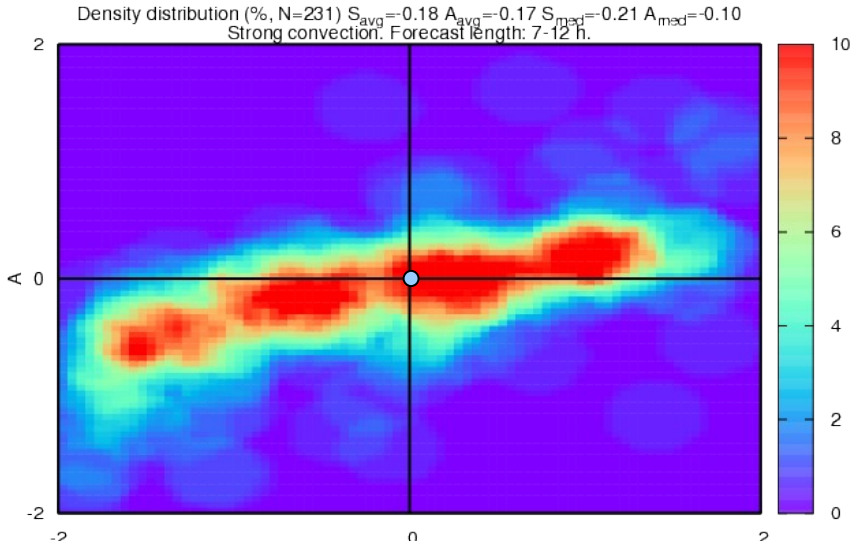
S vs. A – Precipitation type +7-12h

Frontal

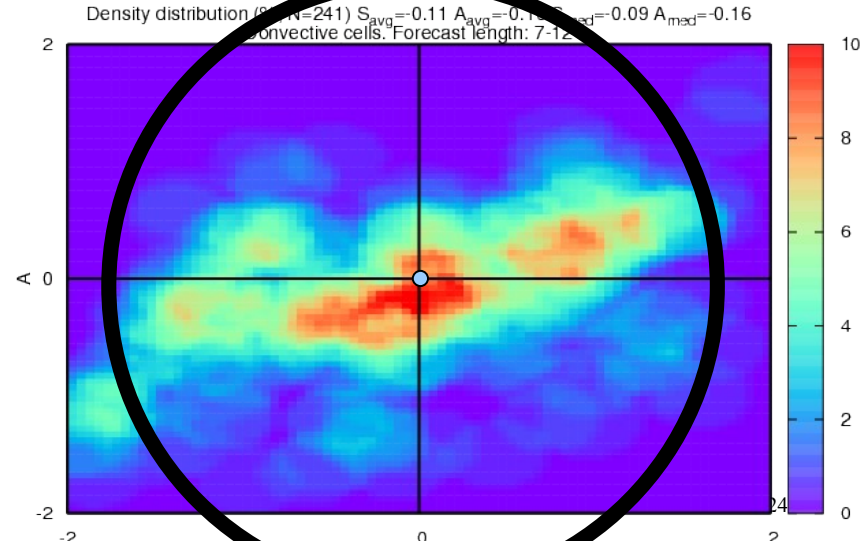


○ = perfect score

Strong conv.



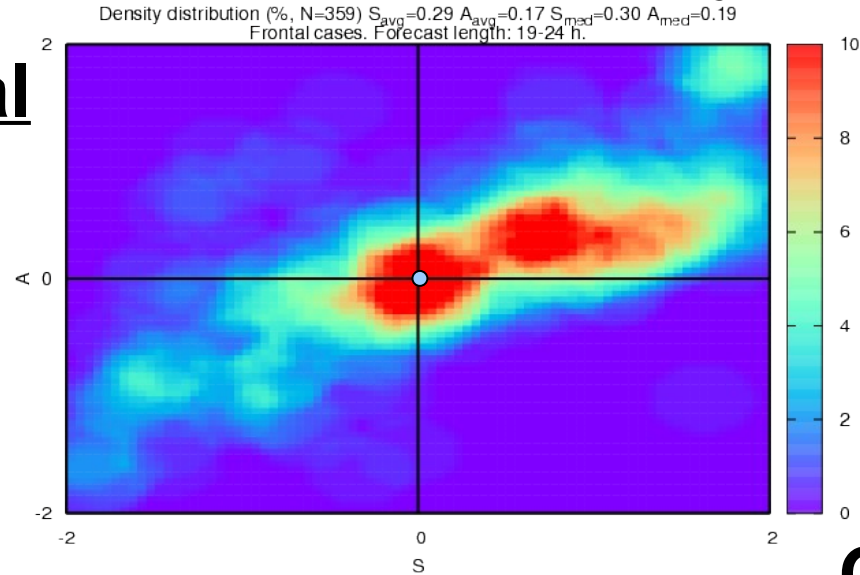
Open cell conv.





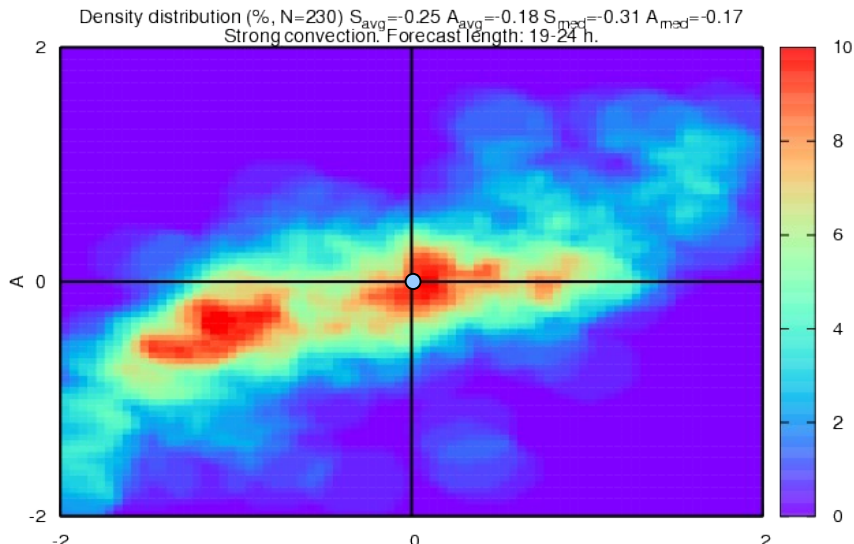
S vs. A – Precipitation type +19-24h

Frontal

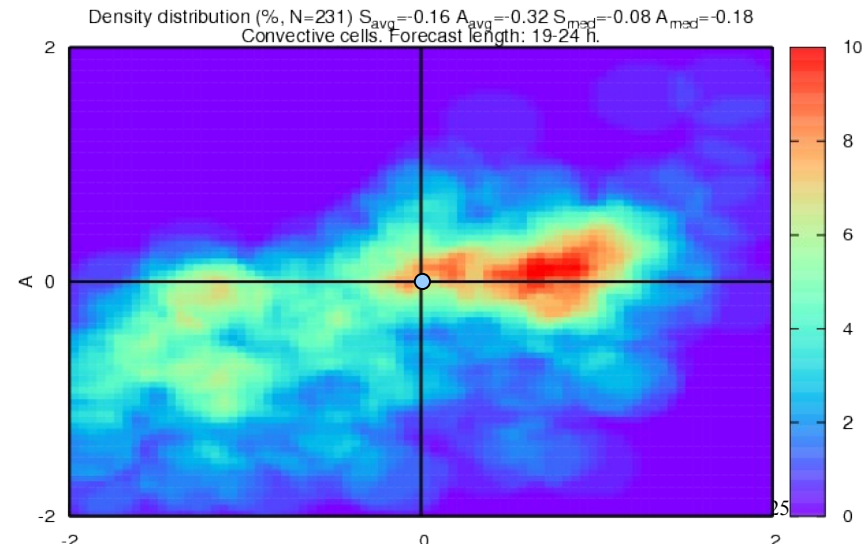


○ = perfect score

Strong conv.



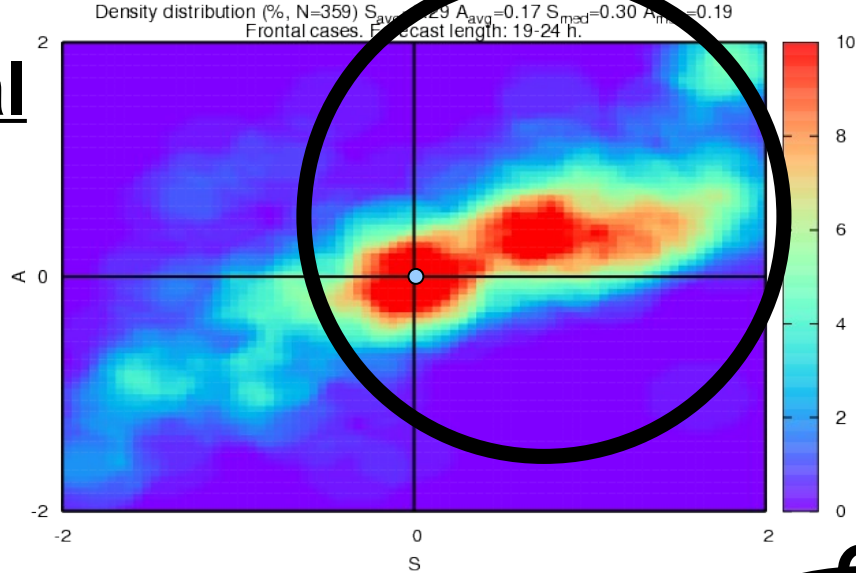
Open cell conv.





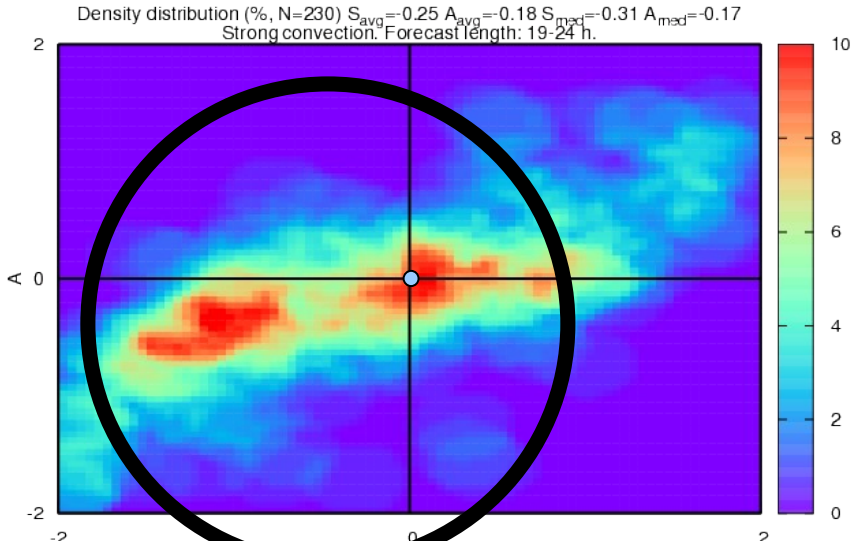
S vs. A – Precipitation type +19-24h

Frontal

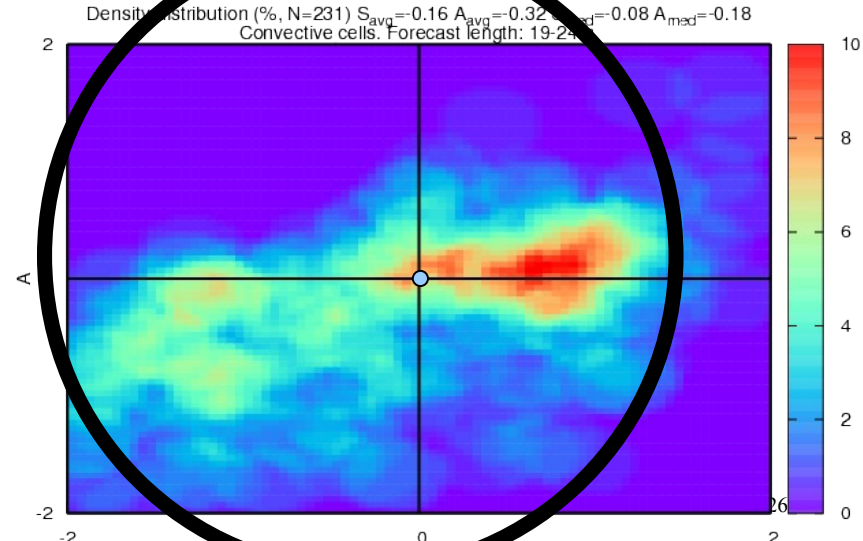


○ = perfect score

Strong conv.



Open cell conv.





How about the precipitation on the ground?

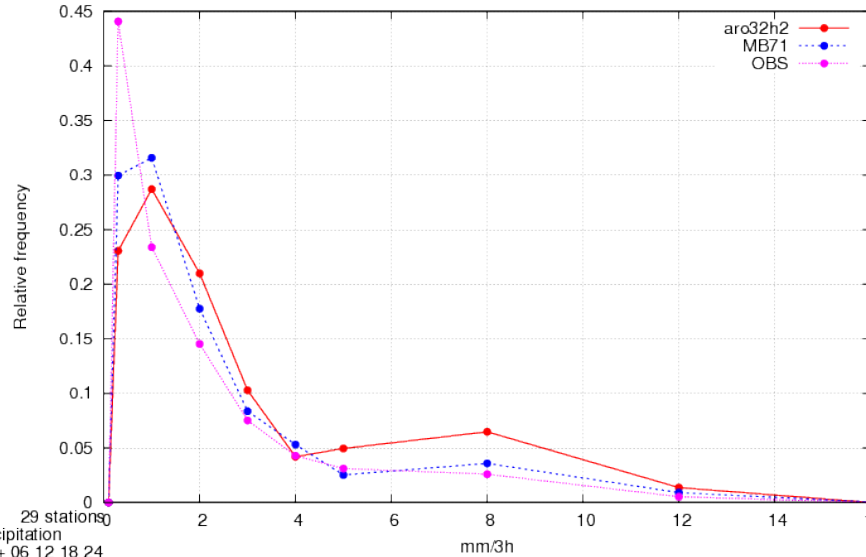
Is there any added value in AROME (2.5km)
compared to HIRLAM (7.5km)?



Frequency distribution mm/3h

Area: ALL 29 stations
 Precipitation
 At 00,12 + 06 12 18 24

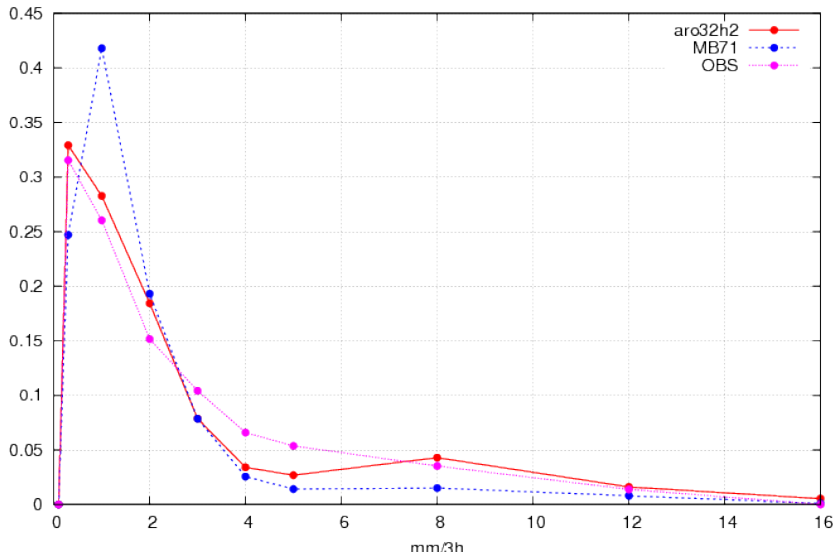
Frontal



AROME 2.5km
HIRLAM 7.5km
HTB Observations

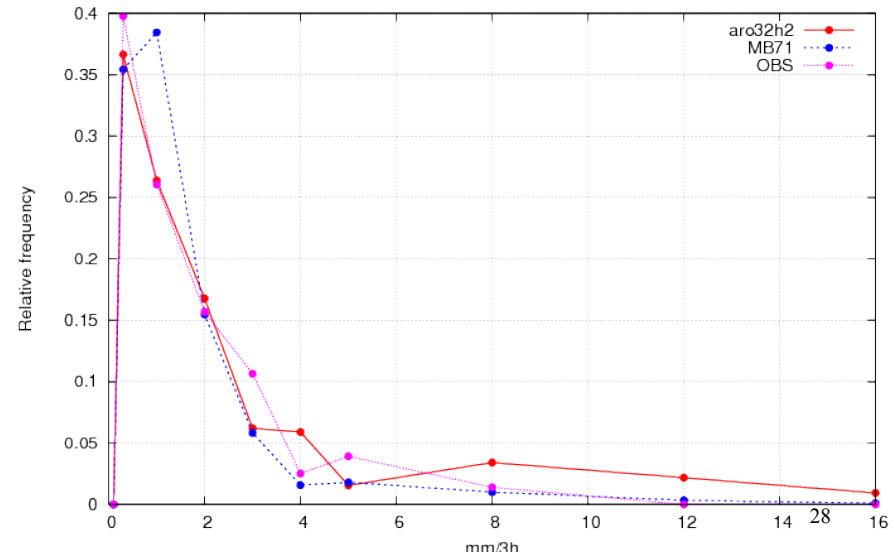
Strong conv.

Area: ALL 29 stations
 Precipitation
 At 00,12 + 06 12 18 24



Open cell conv.

Area: ALL 29 stations
 Precipitation
 At 00,12 + 06 12 18 24

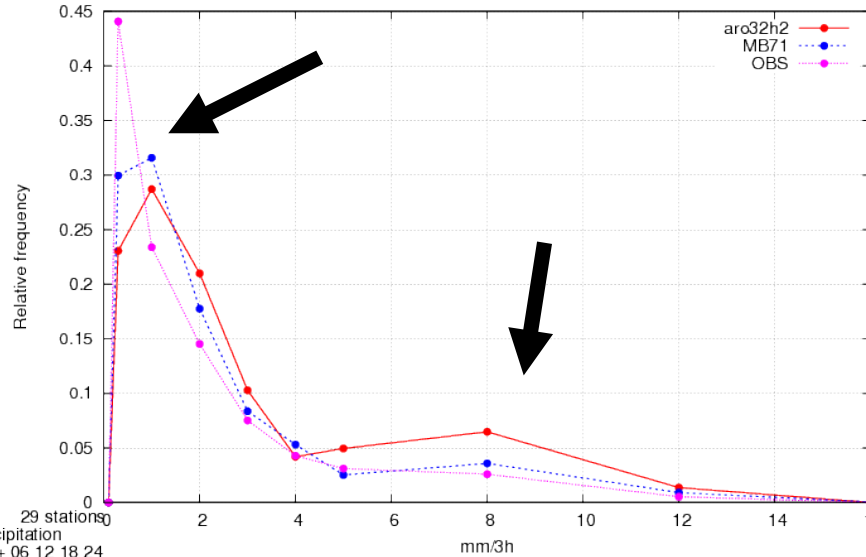




Frequency distribution mm/3h

Area: ALL 29 stations
 Precipitation
 At 00,12 + 06 12 18 24

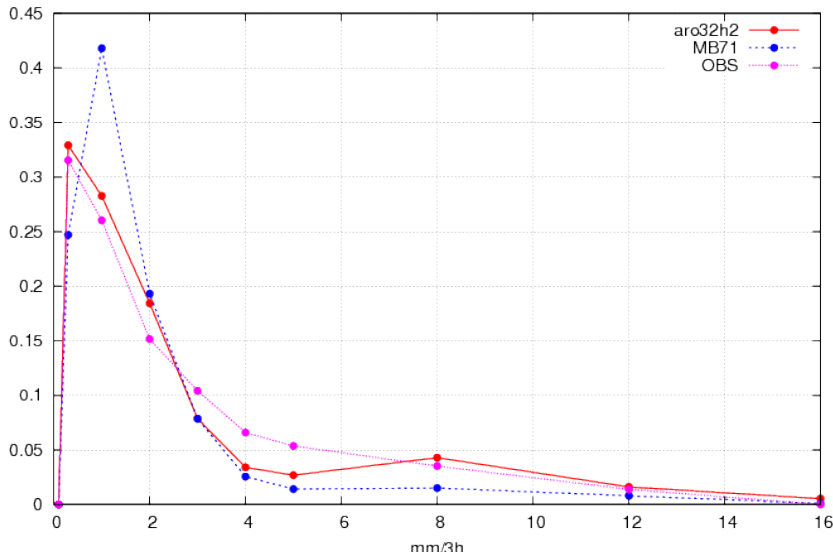
Frontal



AROME 2.5km
HIRLAM 7.5km
HTB Observations

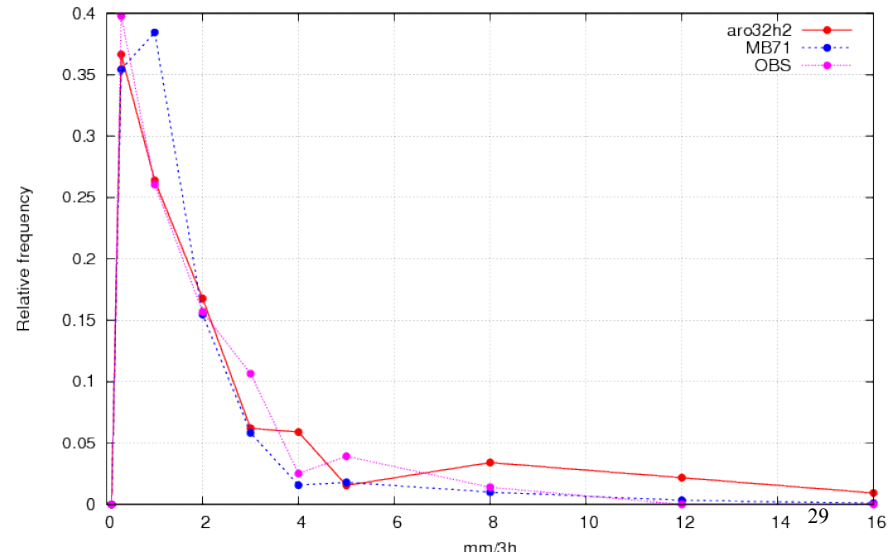
Strong conv.

Area: ALL 29 stations
 Precipitation
 At 00,12 + 06 12 18 24



Open cell conv.

Area: ALL 29 stations
 Precipitation
 At 00,12 + 06 12 18 24

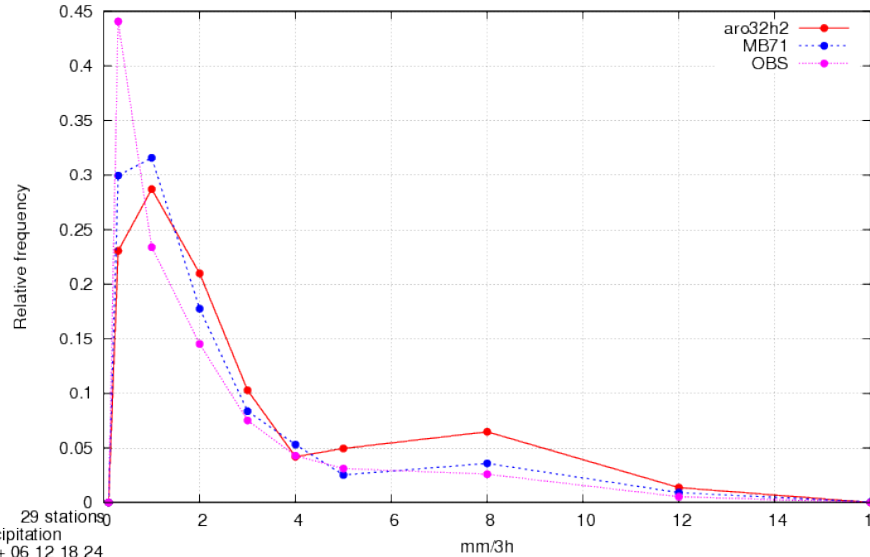




Frequency distribution mm/3h

Area: ALL 29 stations
 Precipitation
 At 00,12 + 06 12 18 24

Frontal



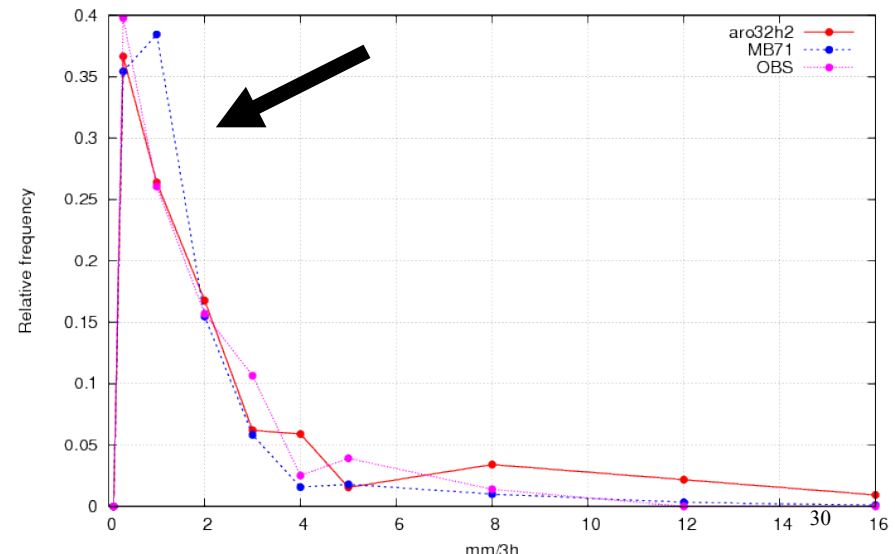
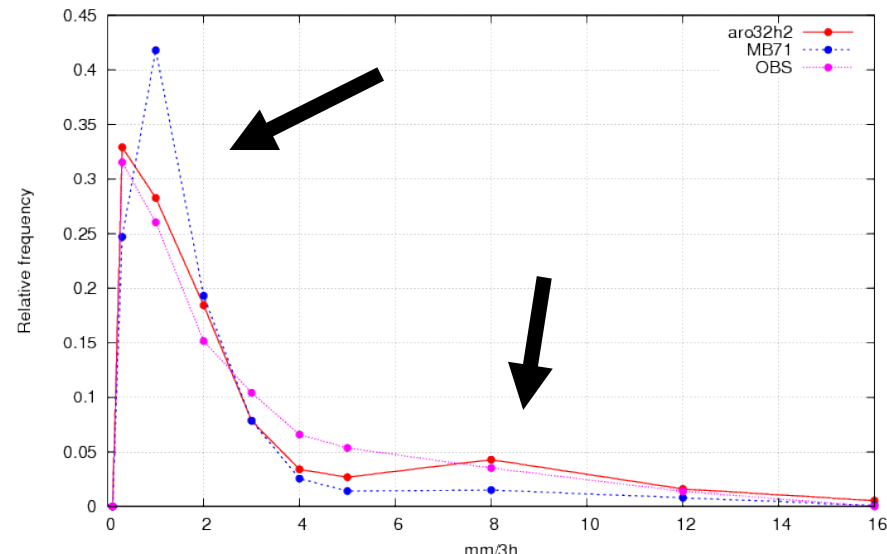
AROME 2.5km
HIRLAM 7.5km
HTB Observations

Strong conv.

Area: ALL 29 stations
 Precipitation
 At 00,12 + 06 12 18 24

Open cell conv.

Area: ALL 29 stations
 Precipitation
 At 00,12 + 06 12 18 24





Summary

- On the average, the SAL scores of AROME are very good.
- Convective cases underestimate from too small system during the first hours of the forecast.
- In the middle of the forecast frontal and strong convective cases tend to overestimate from too large system.
- In open cell cases, the distribution of SAL scores spreads as forecast length increases.
- In convective cases, high resolution AROME is able to produce more realistic frequency distribution of precipitation than coarser resolution HIRLAM.



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THANK YOU!