ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

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

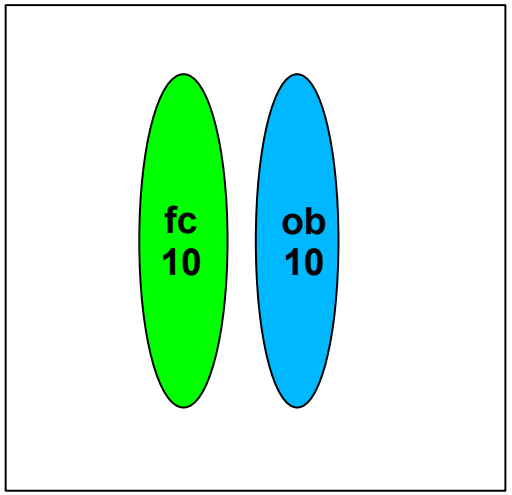
- A brief introduction to SAL.
- FMI's real-time SAL verification setup.
- What can we see from SAL?
- What SAL is able to tell us about precipitation forecasts of AROME?

Sami Niemelä
FMI

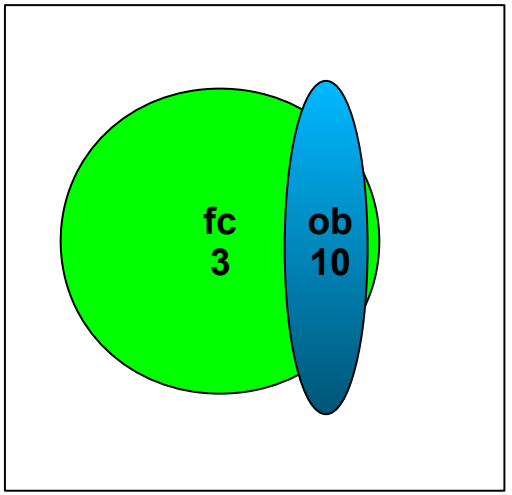
HIRLAM ASM 2009
Utrecht, The Netherlands,
12. - 15.5.2009.

Verification of precipitation

- Traditional verification methods penalize higher-resolution models.



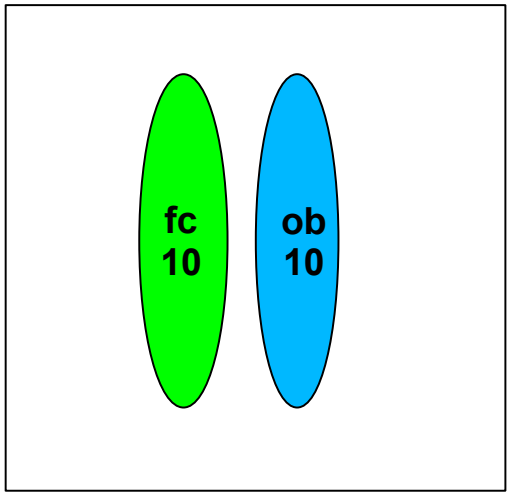
High resolution forecast
RMS ~ 4.7
POD = 0, FAR = 1, TS = 0



Low resolution forecast
RMS ~ 2.7
POD ~1, FAR ~0.7, TS ~0.3

Verification of precipitation

- Traditional verification methods penalize higher-resolution models.



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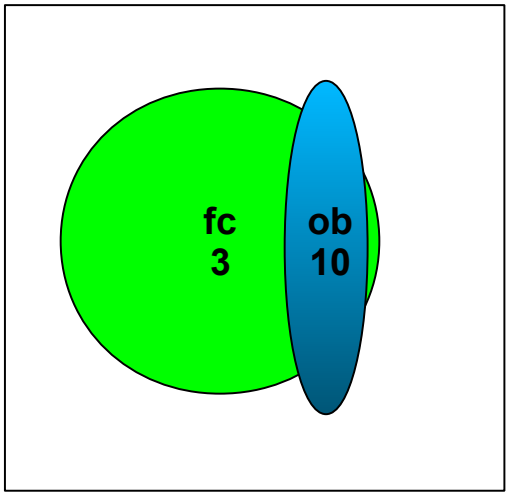

Low resolution forecast
RMS ~ 2.7
POD ~1, FAR ~0.7, TS ~0.3

→ Other methods (e.g. object based), which can capture the signal of possible additional value, are needed!

Structure Amplitude Location (SAL)

- **SAL** is object-based quality measure for the verification of QPFs.

- **SAL** contains three distinct components that focus on **S**tructure, **A**mplitude and **L**ocation 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 attennuation

FMI's real-time SAL verification setup

AROME 2.5km (32h2)

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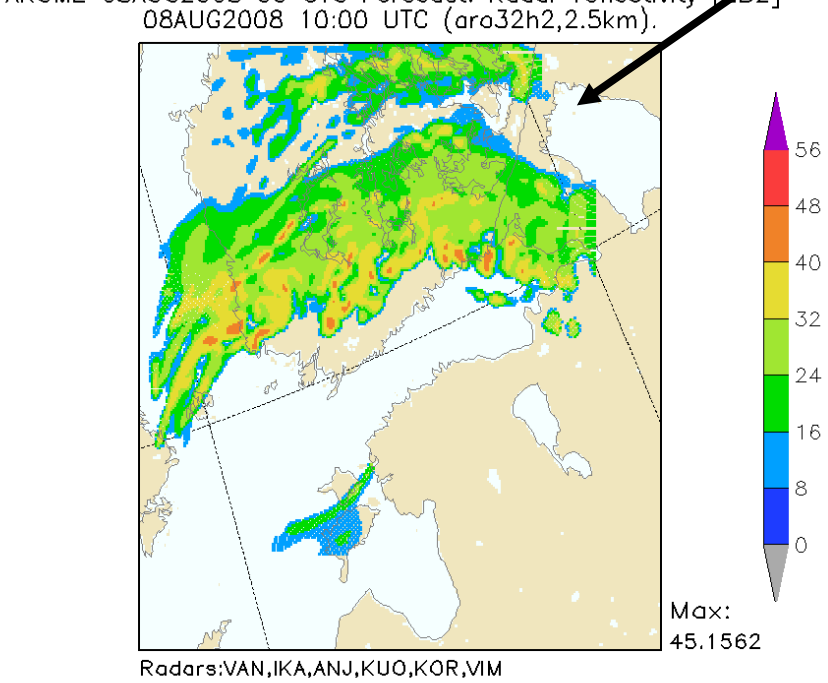
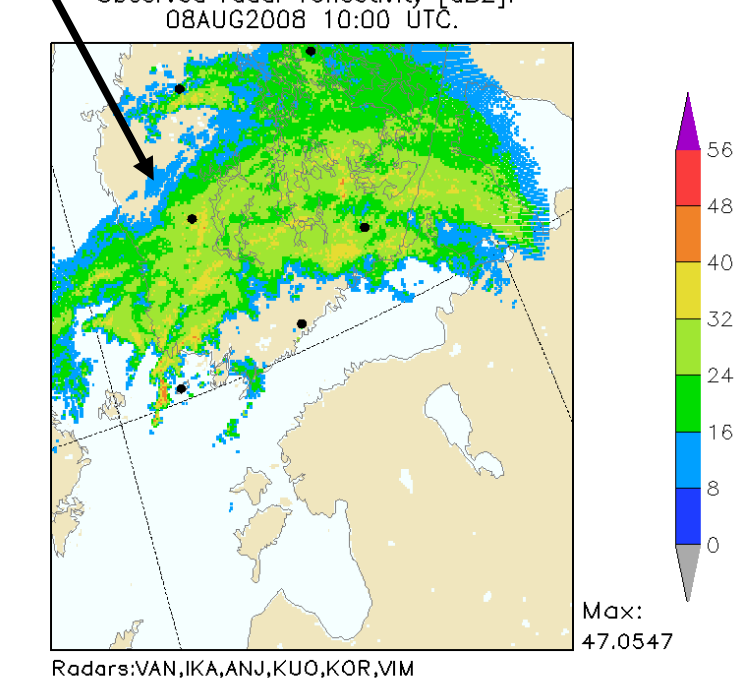
AROME dBZ



Observed dBZ in model grid



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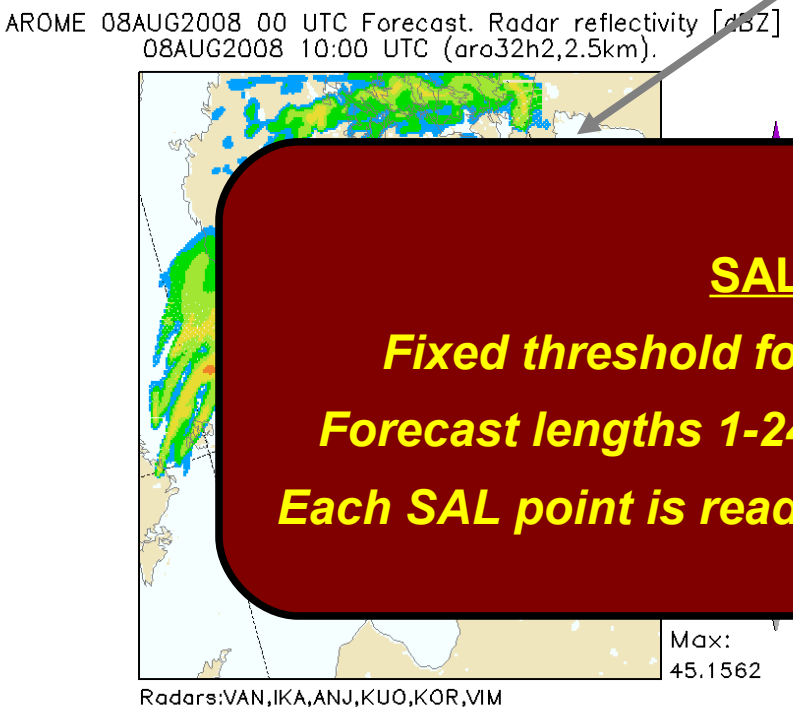

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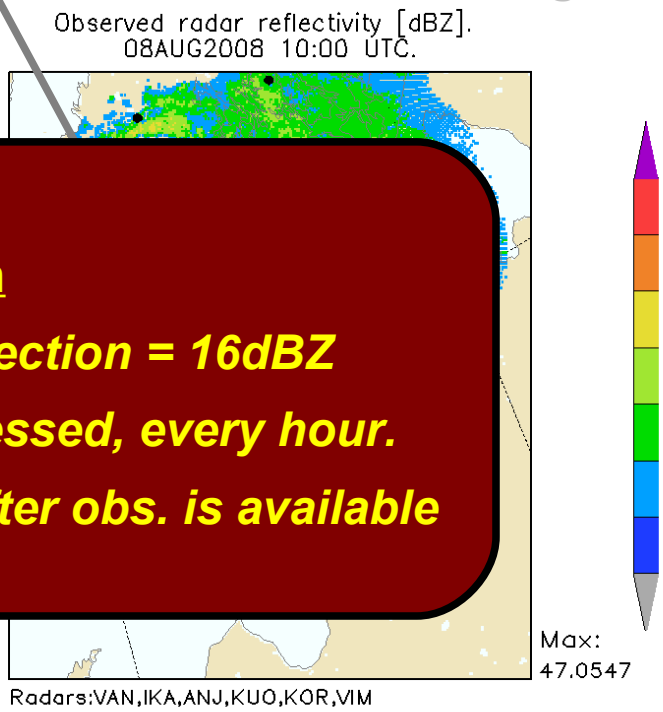


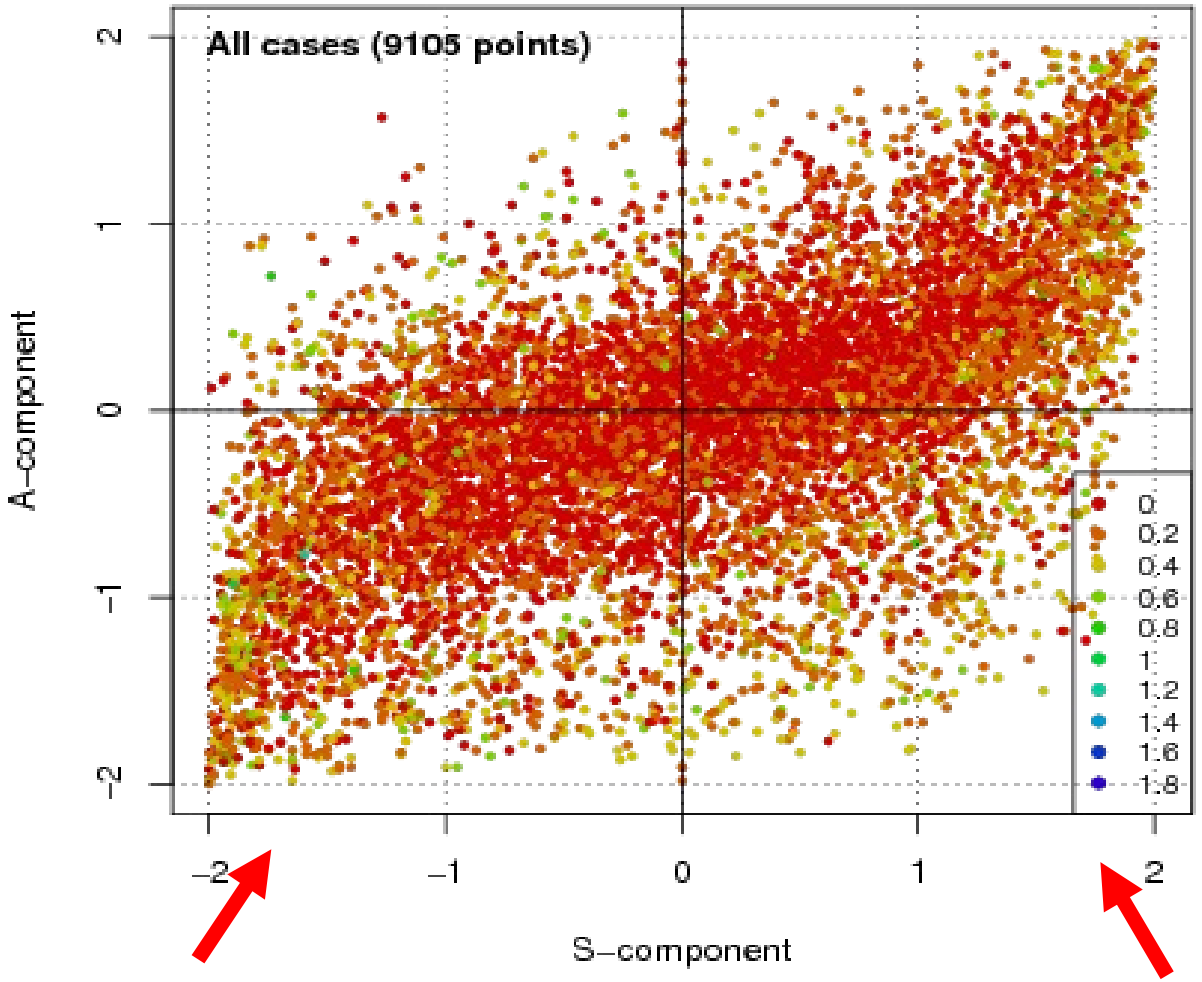
SAL verification

Fixed threshold for object detection = 16dBZ

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

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

What can we see from SAL?

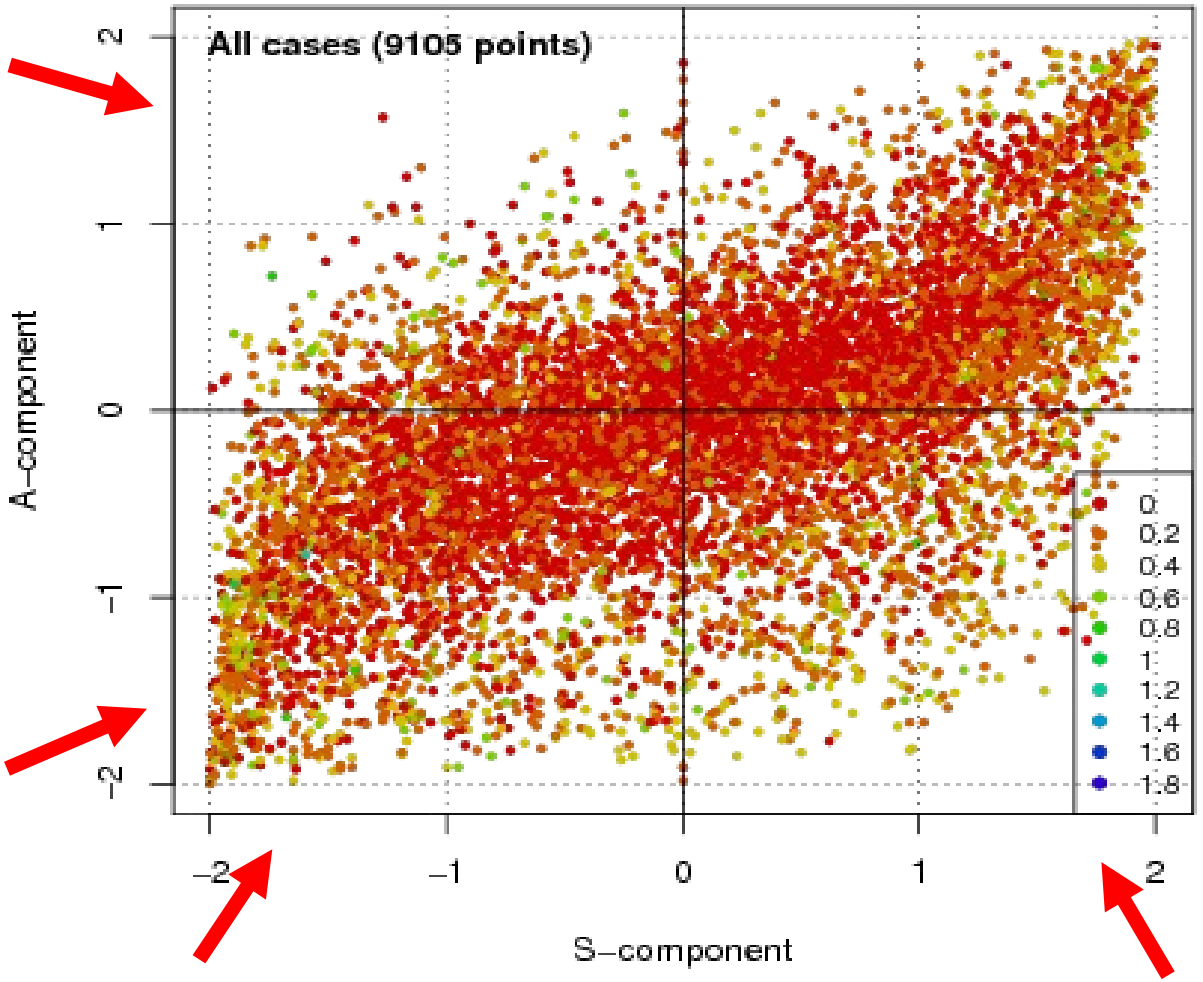


Small / peaked area

Large / flat area

What can we see from SAL?

Too strong

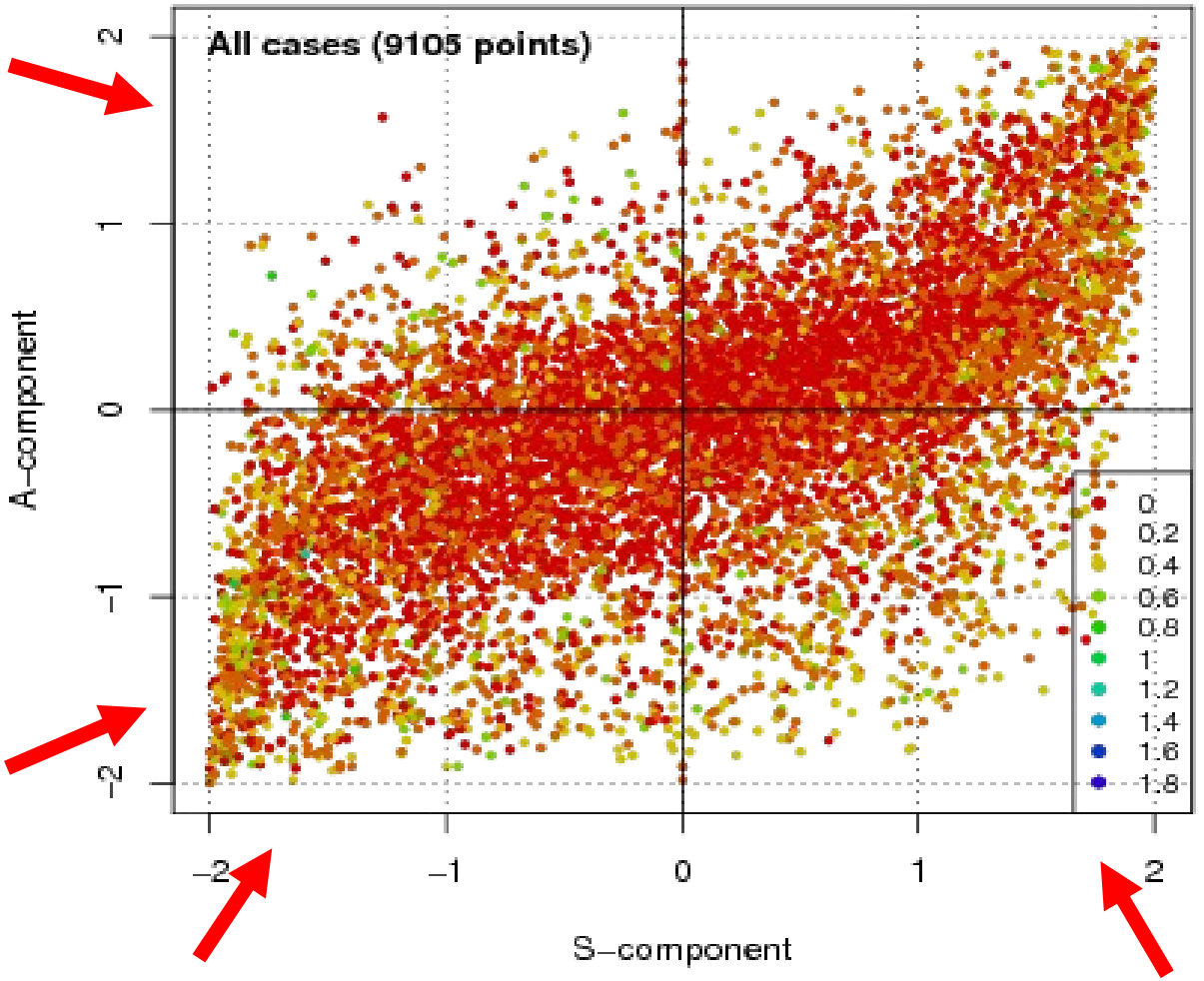


Too weak

Small / peaked area

Large / flat area

What can we see from SAL?



Too strong

Too weak

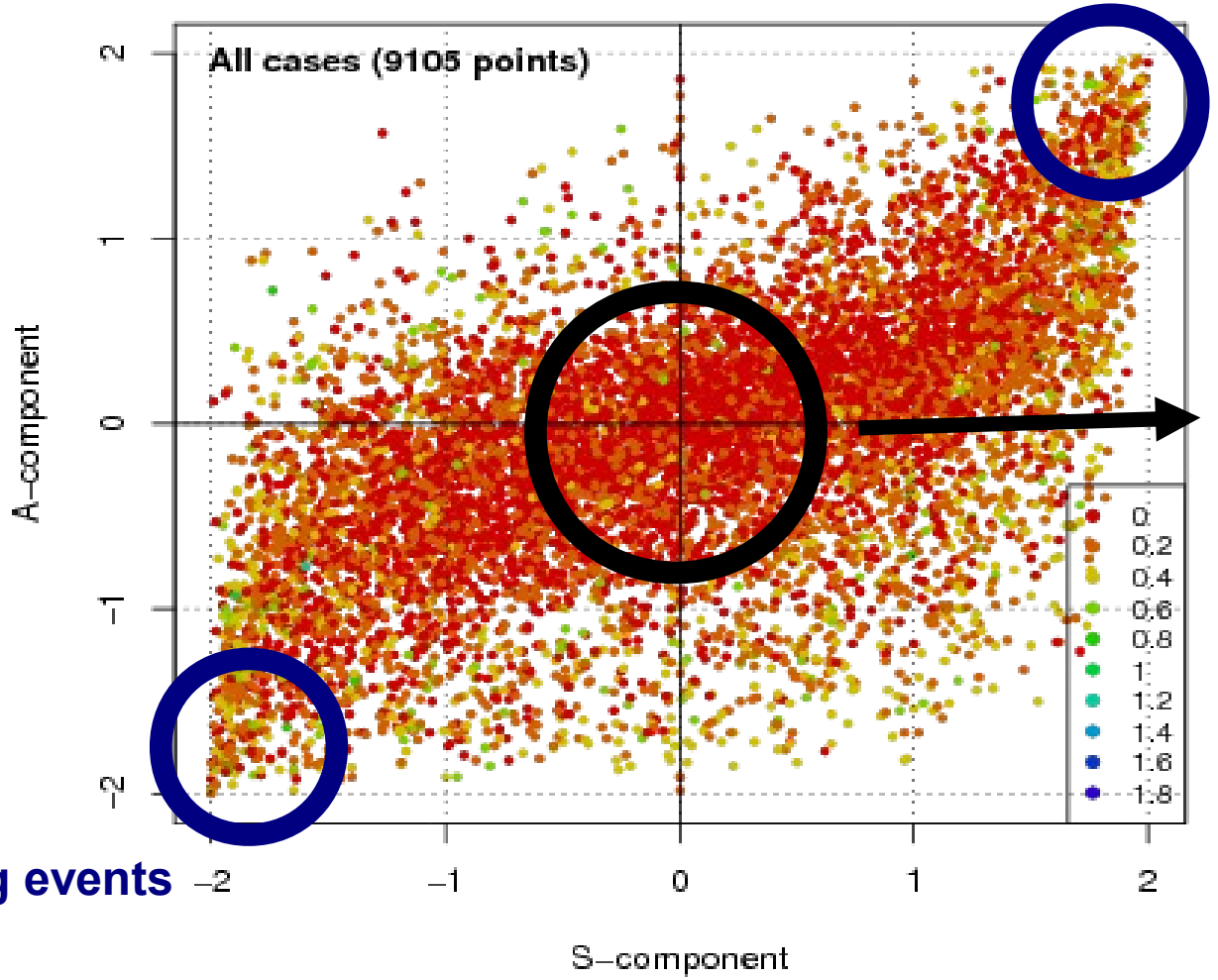
Center of mass well matched

Center of mass mismatched

Small / peaked area

Large / flat area

What can we see from SAL?



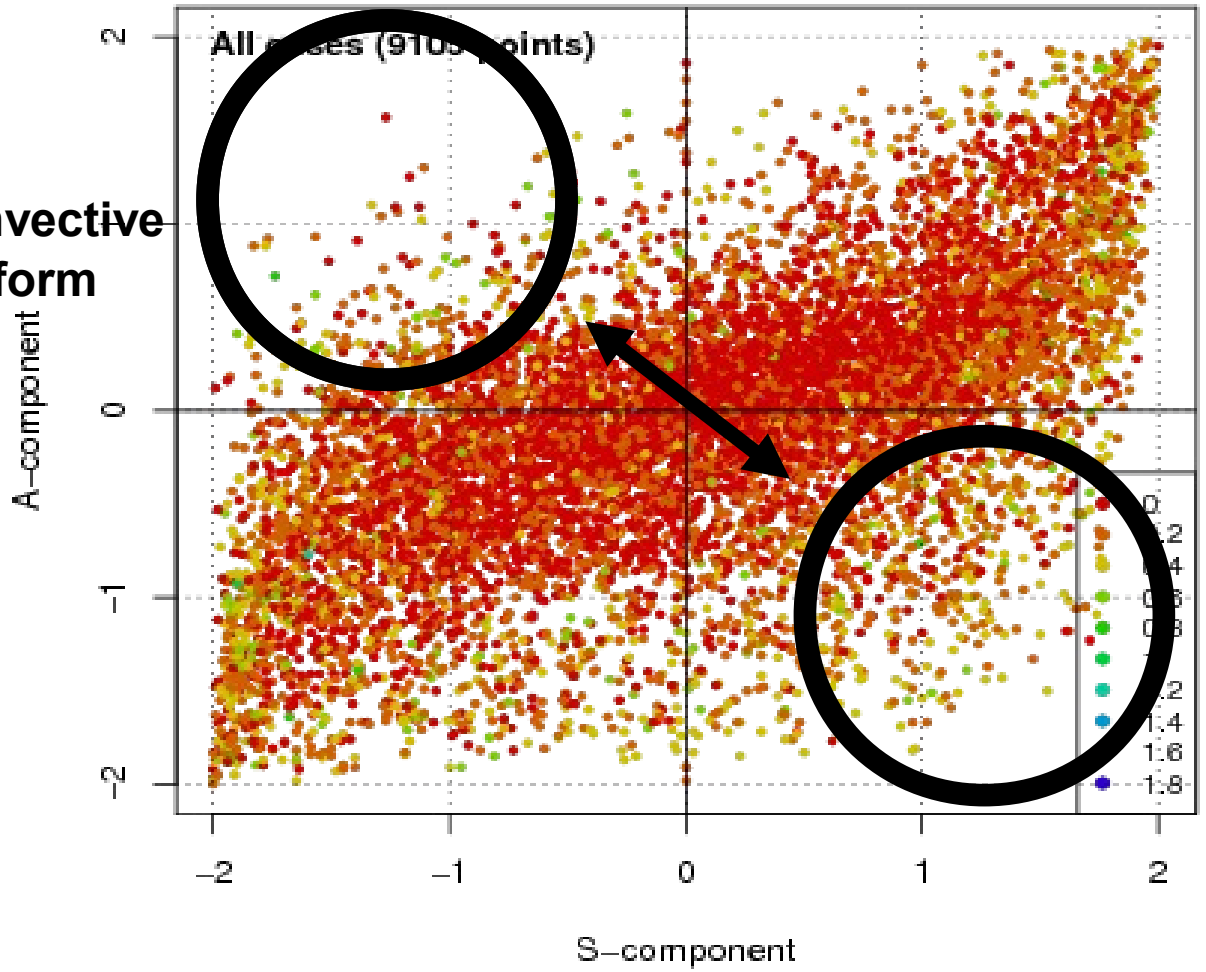
False alarms

Good forecasts!

Missing events

What can we see from SAL?

Model: convective
Obs: stratiform

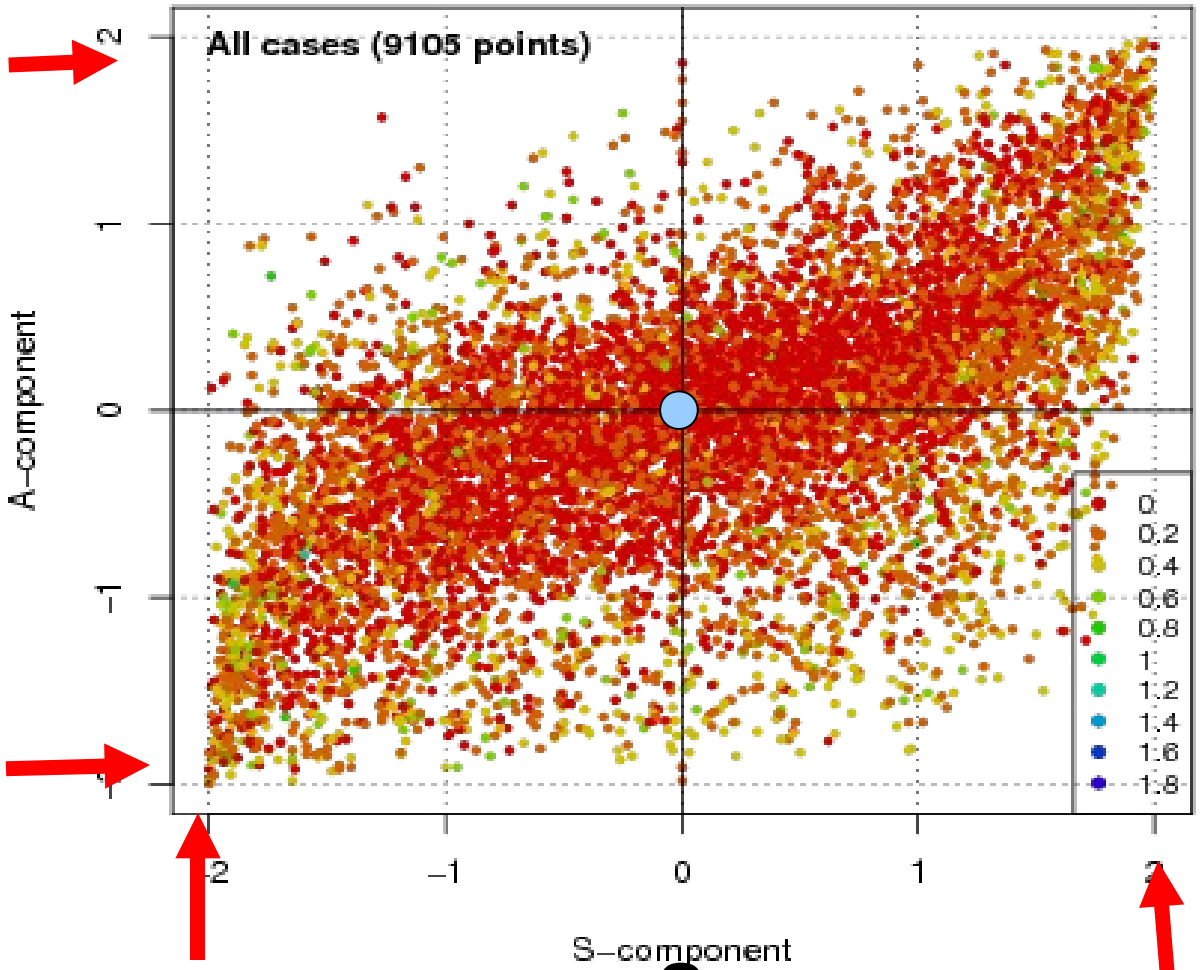


Model: stratiform
Obs: convective

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

All cases Jun 2008 – Mar 2009

Too strong



= perfect score

A

Too weak

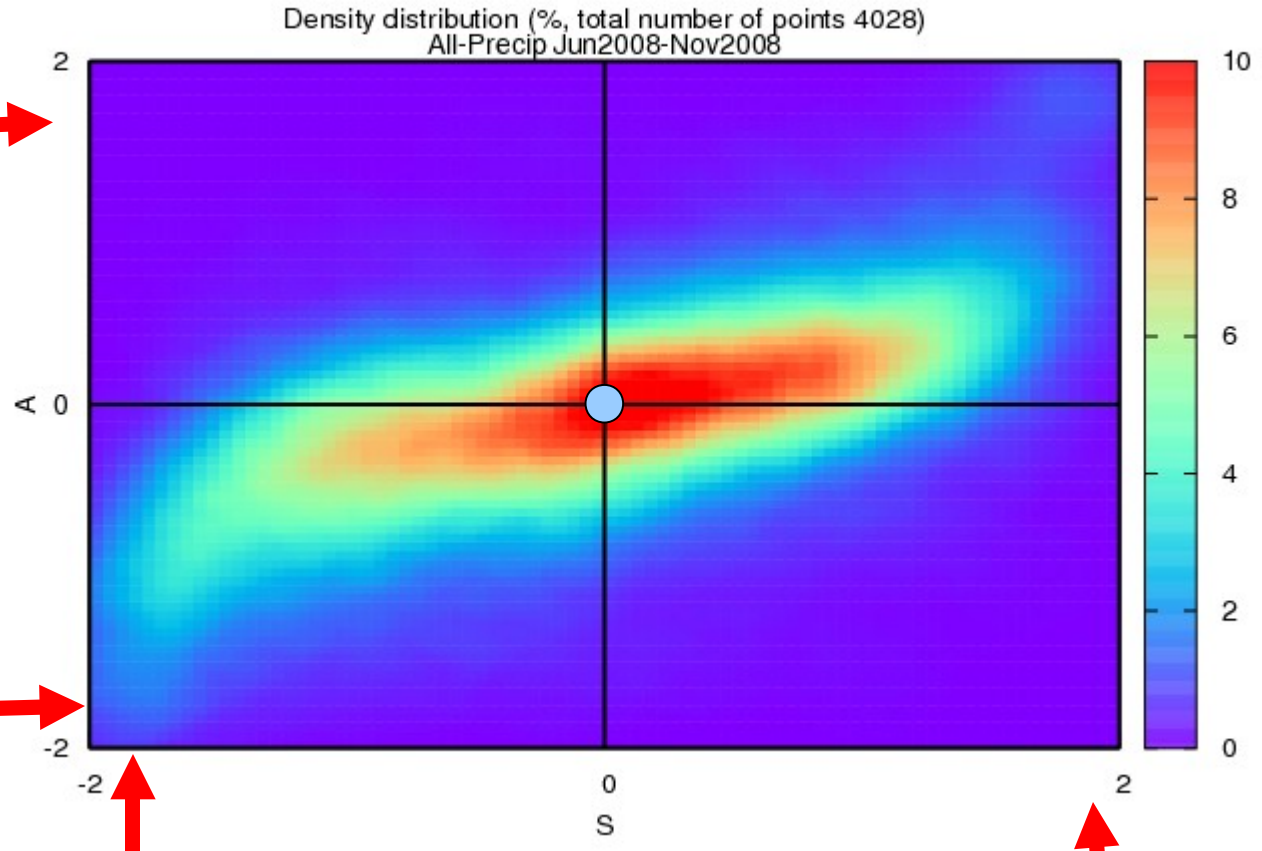
S

Small / peaked area

Large / flat area

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

= perfect score



Too strong

A

Too weak

Small / peaked area

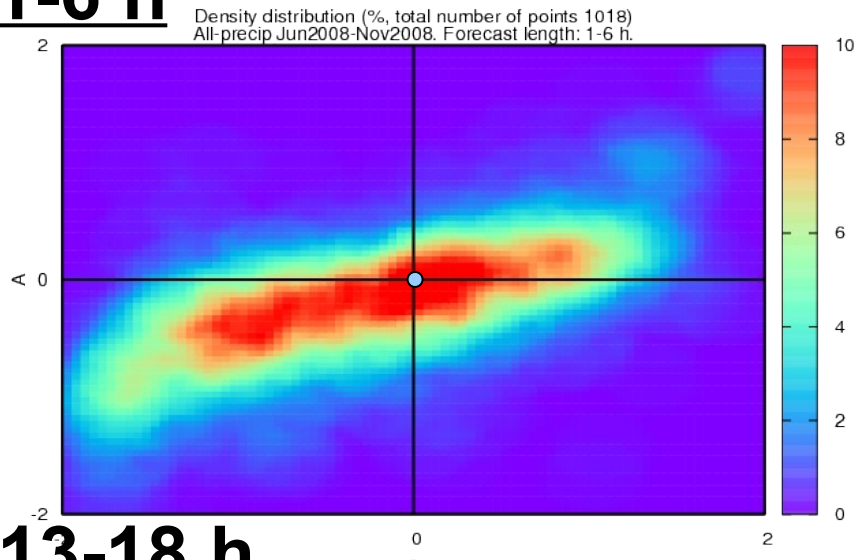
S

Large / flat area

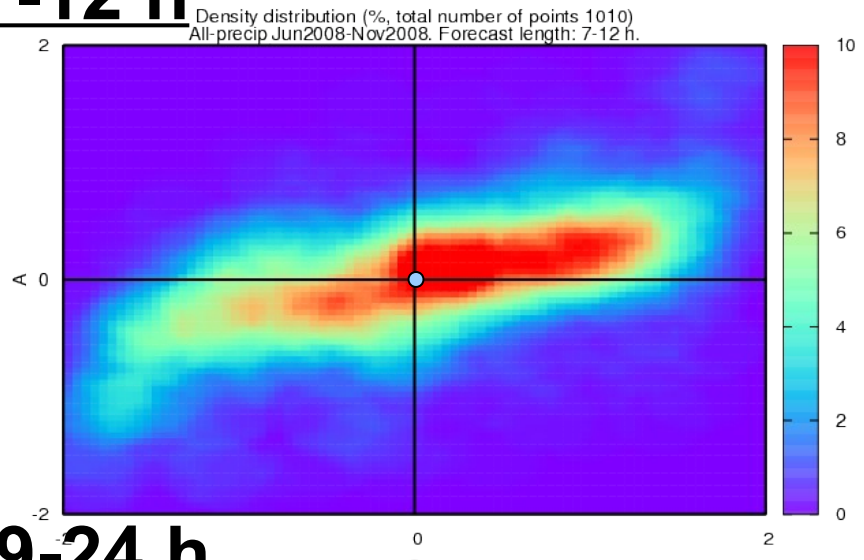
S vs. A - Time dependency

● = perfect score

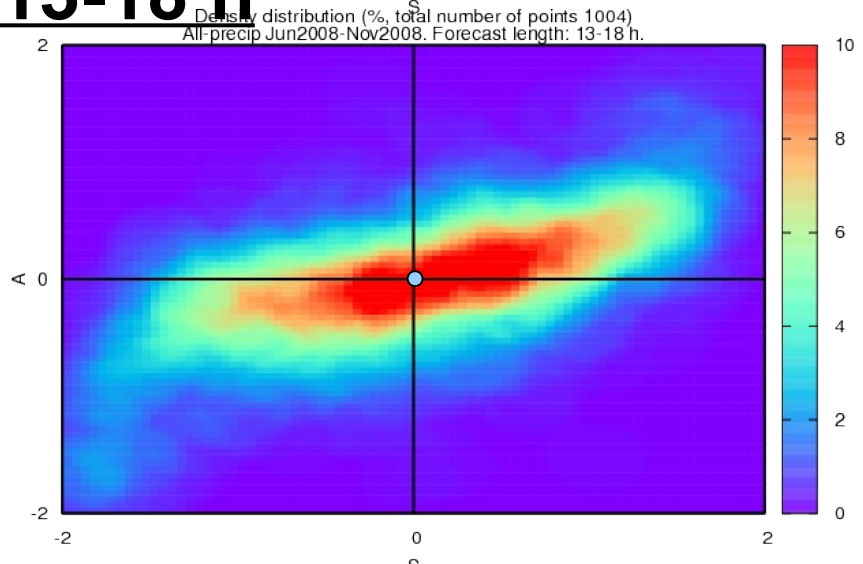
+1-6 h



+7-12 h



+13-18 h



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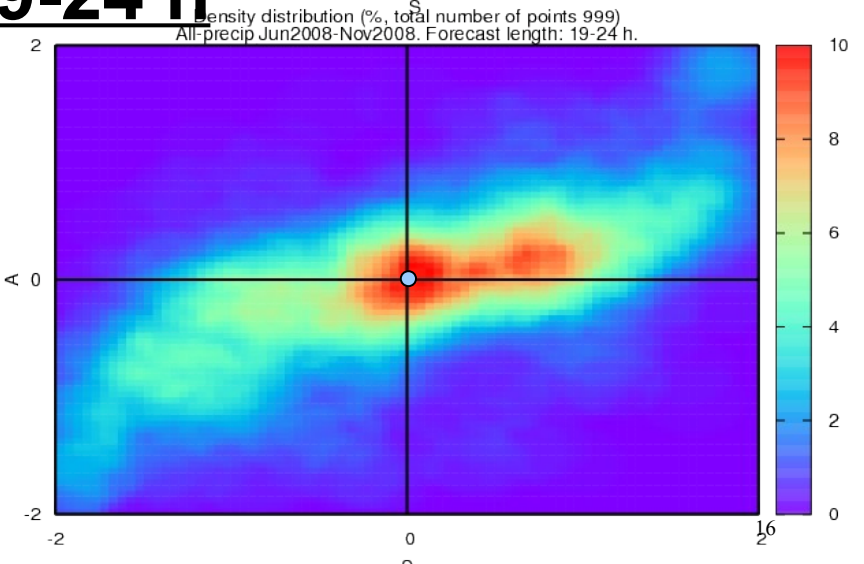

S vs. A - Time dependency

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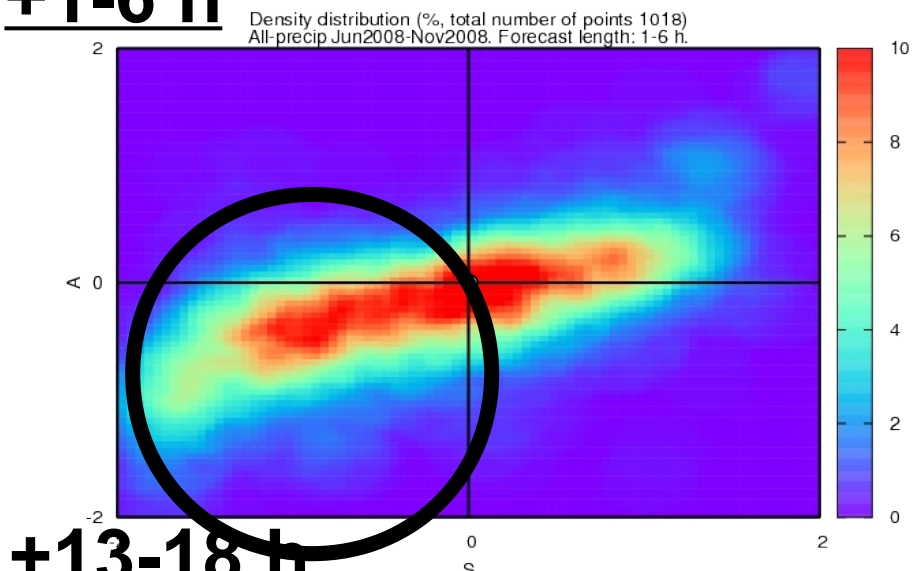

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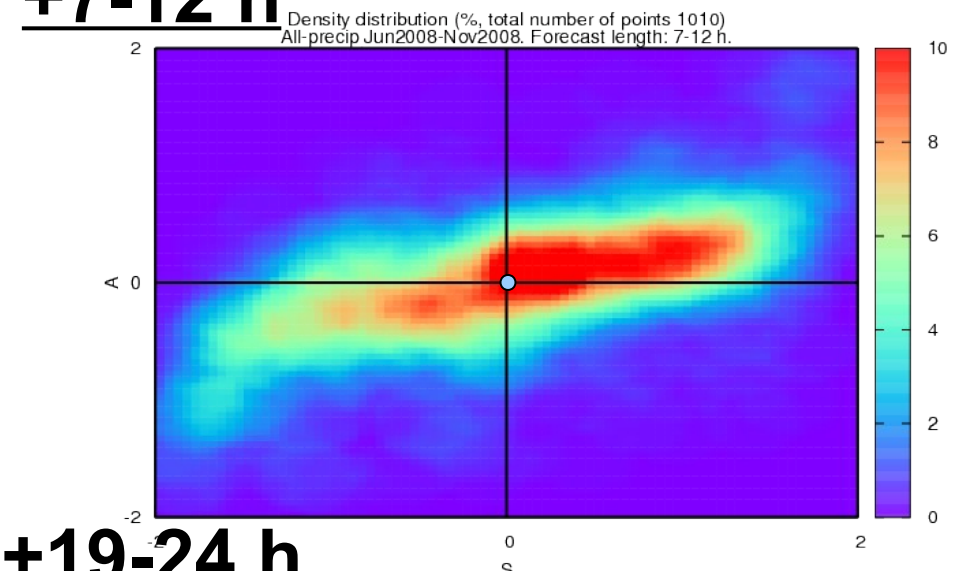

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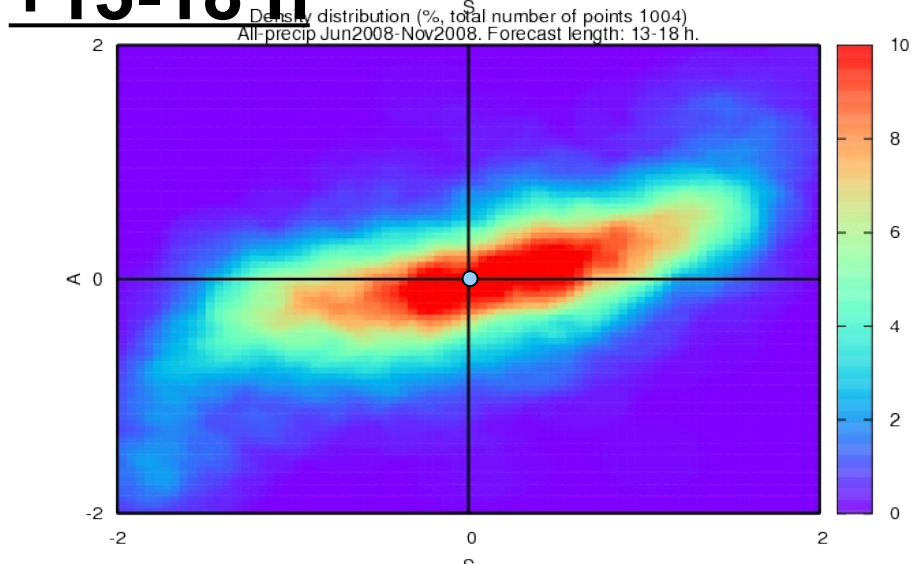

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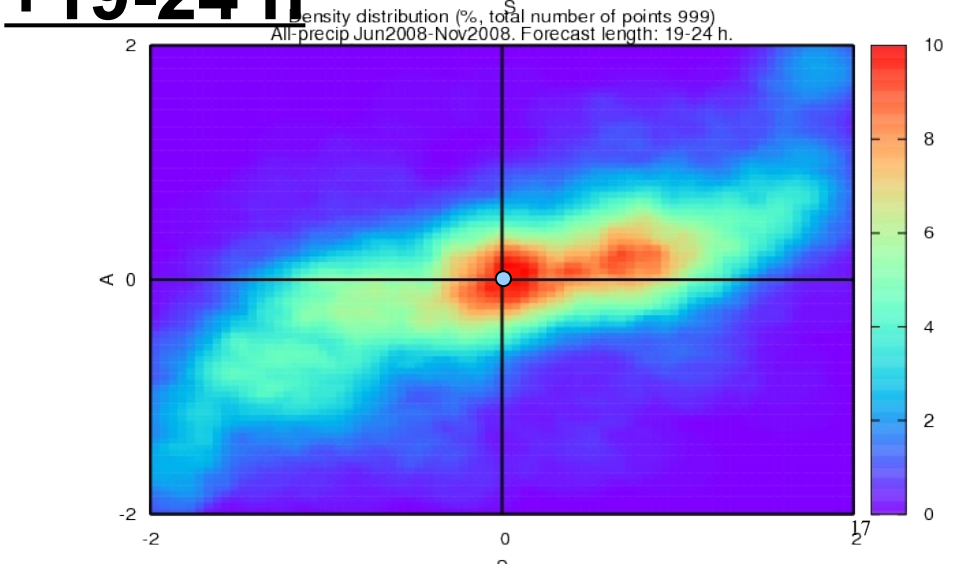

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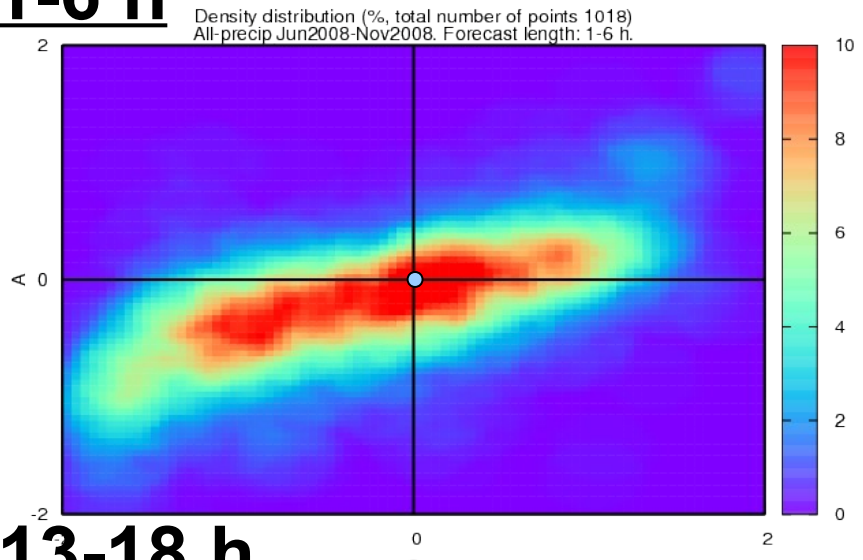

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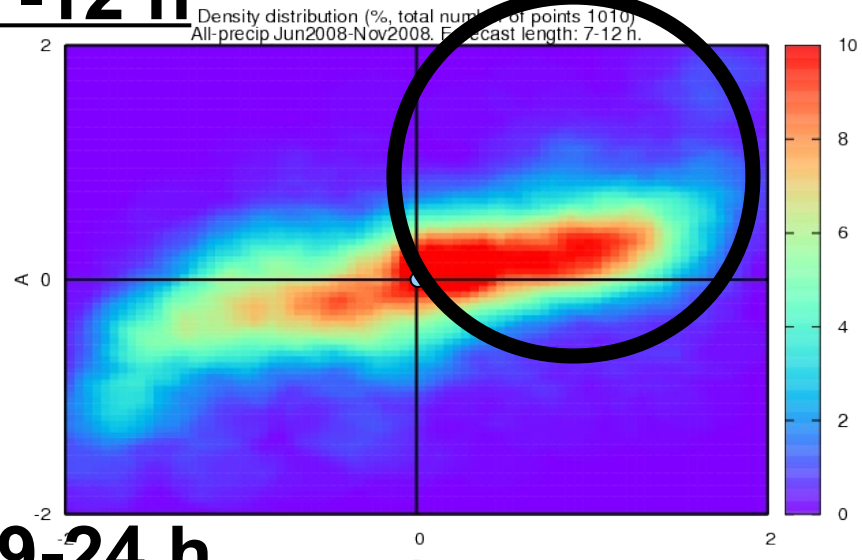

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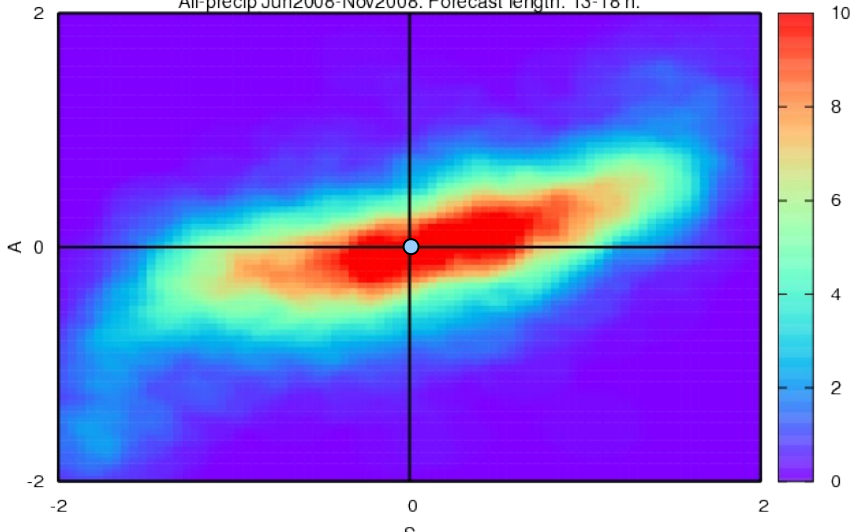

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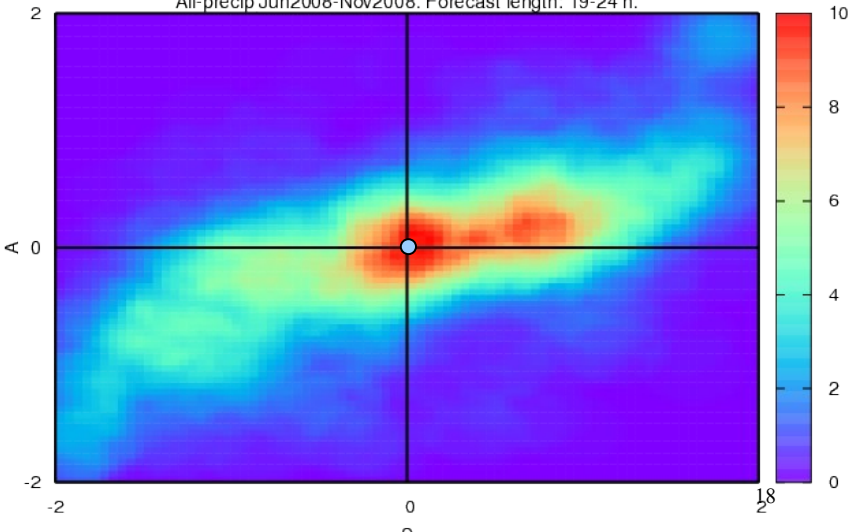

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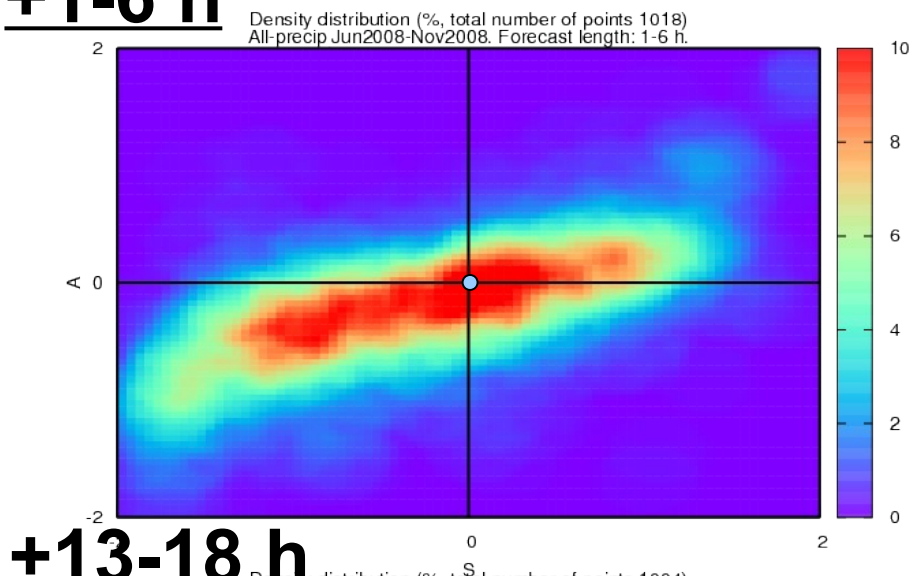

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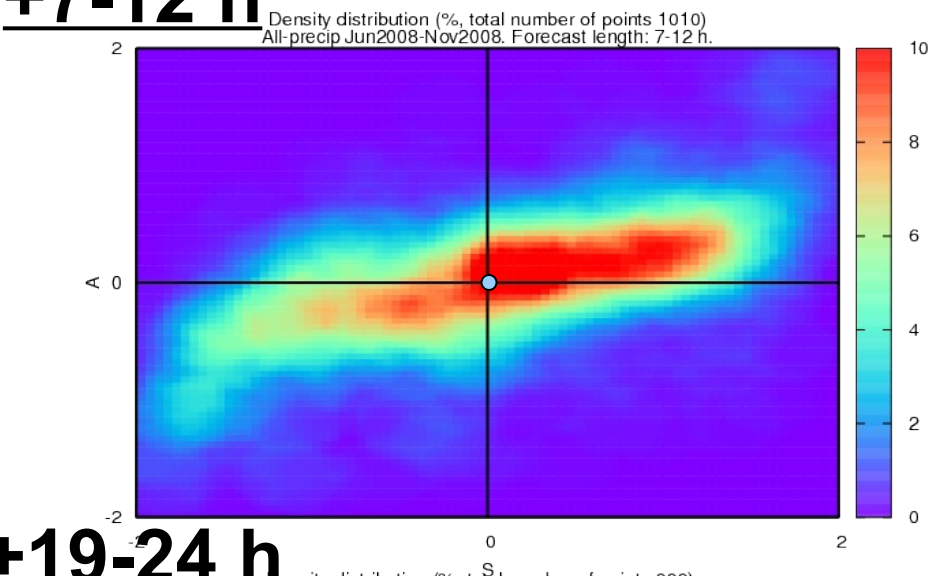

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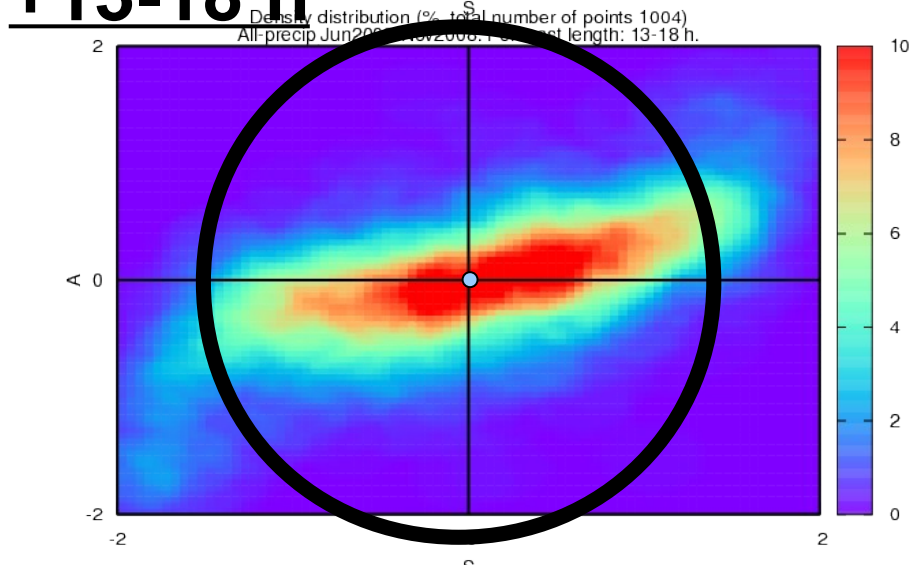

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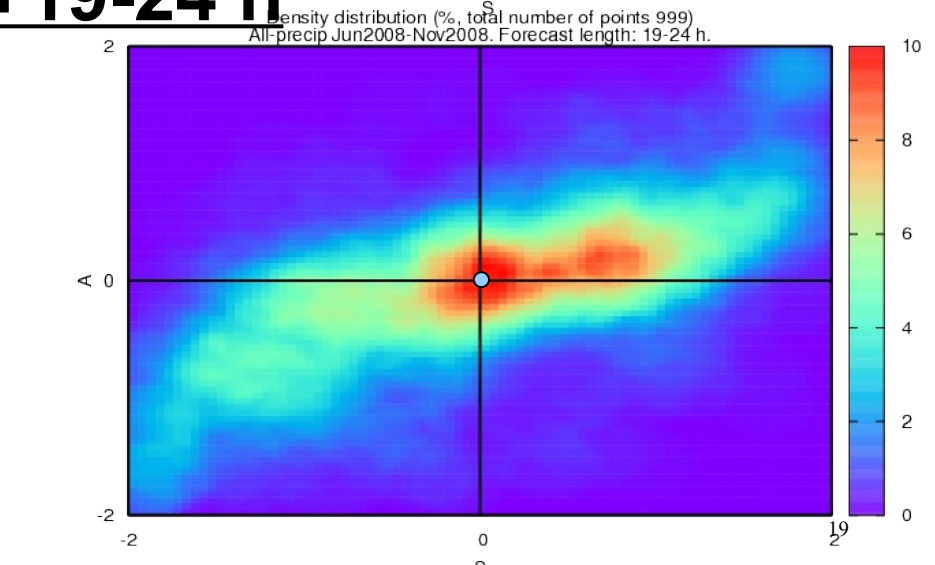

S vs. A - Time dependency

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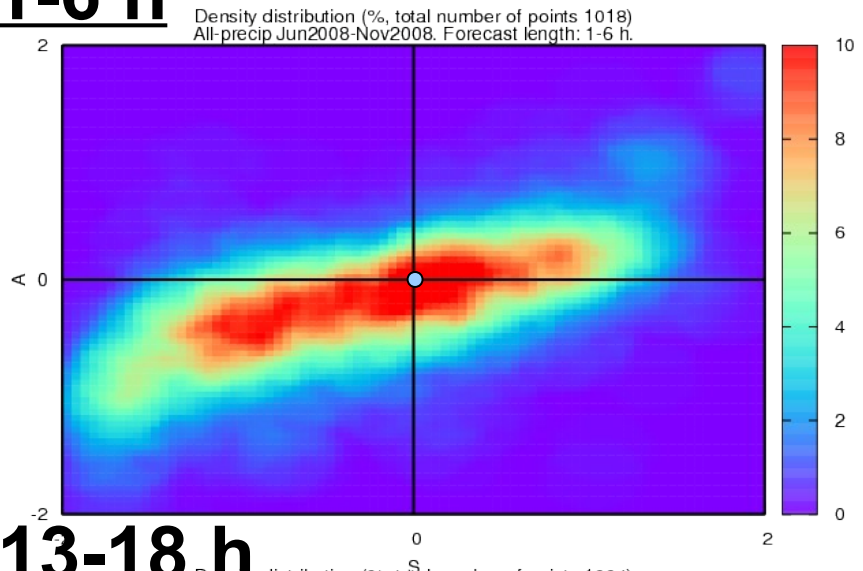

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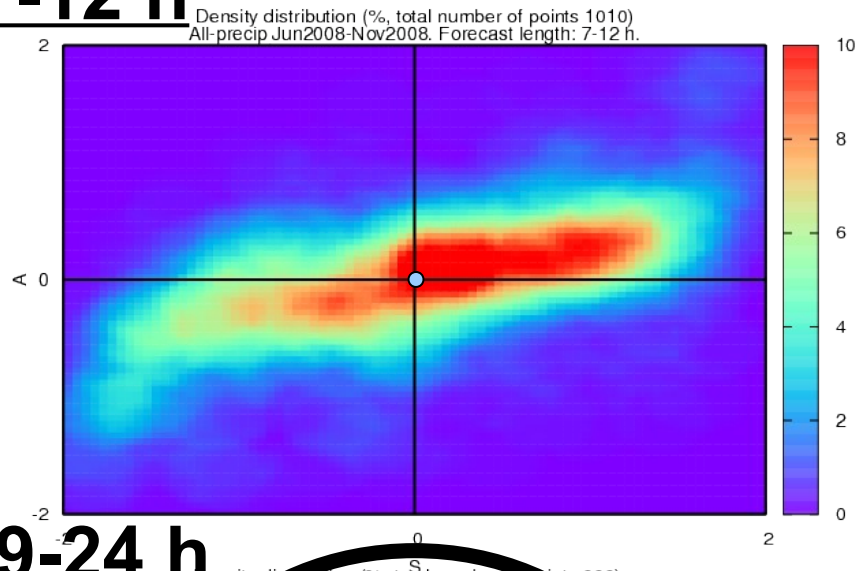

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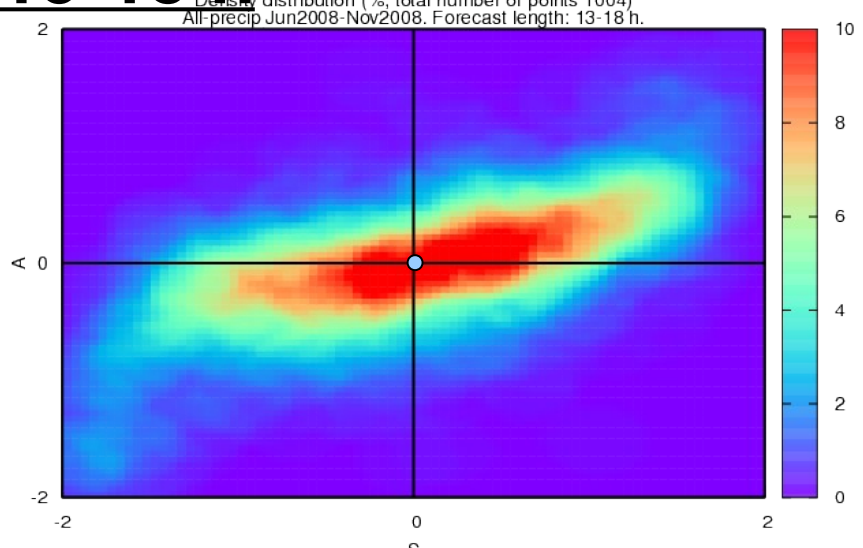

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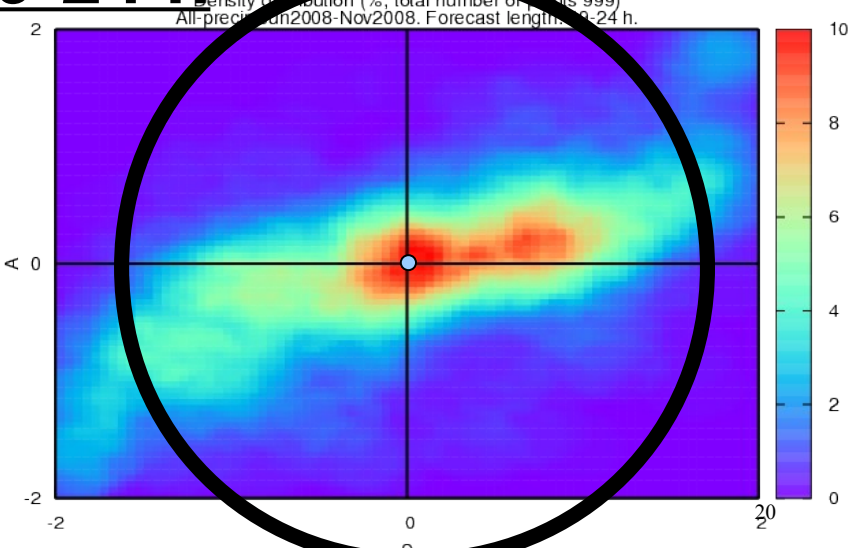
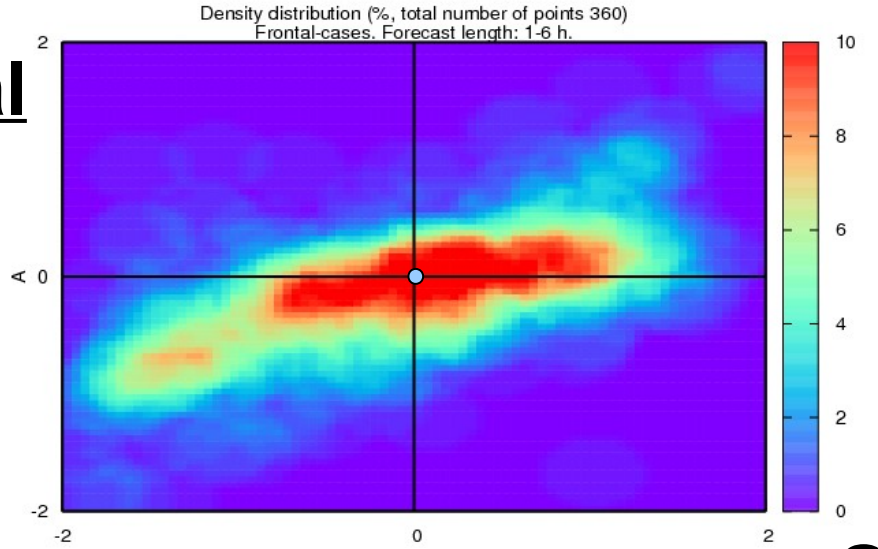


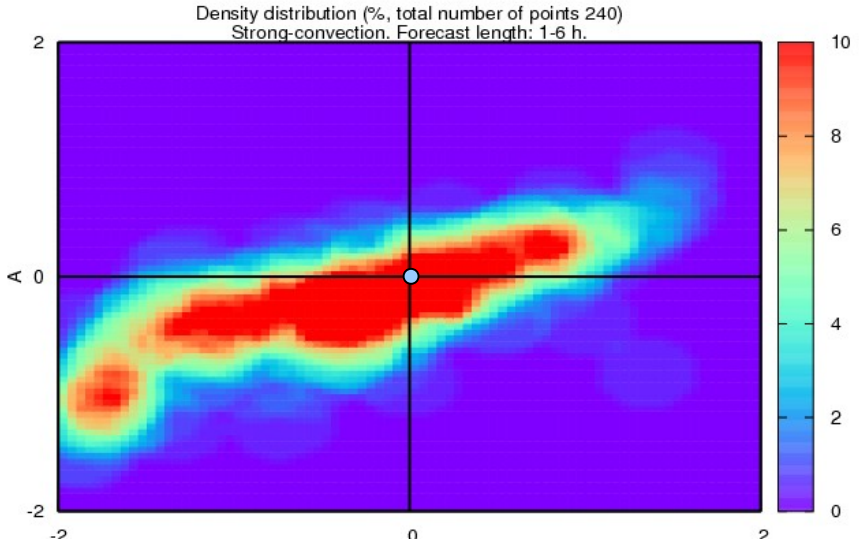
S vs. A – Precipitation type **+1-6h**

○ = perfect score

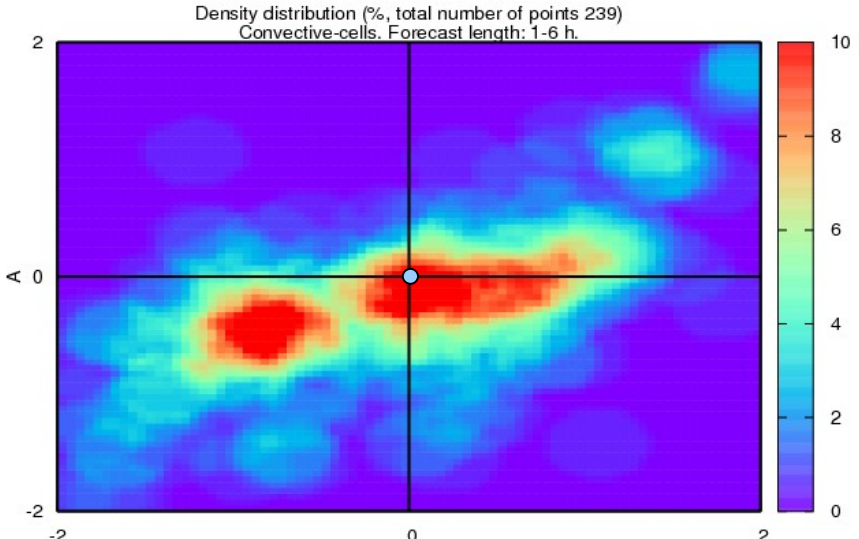
Frontal



Strong conv.



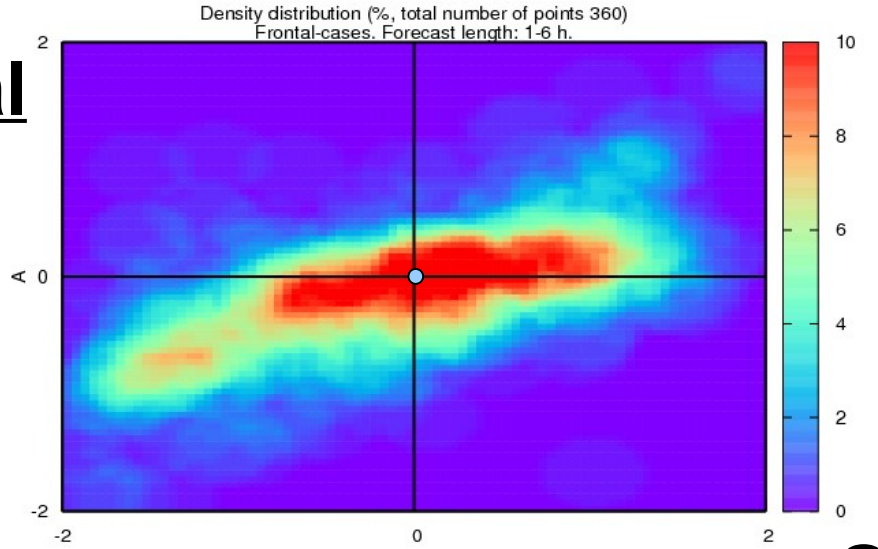
Open cell conv.



S vs. A – Precipitation type **+1-6h**

= perfect score

Frontal



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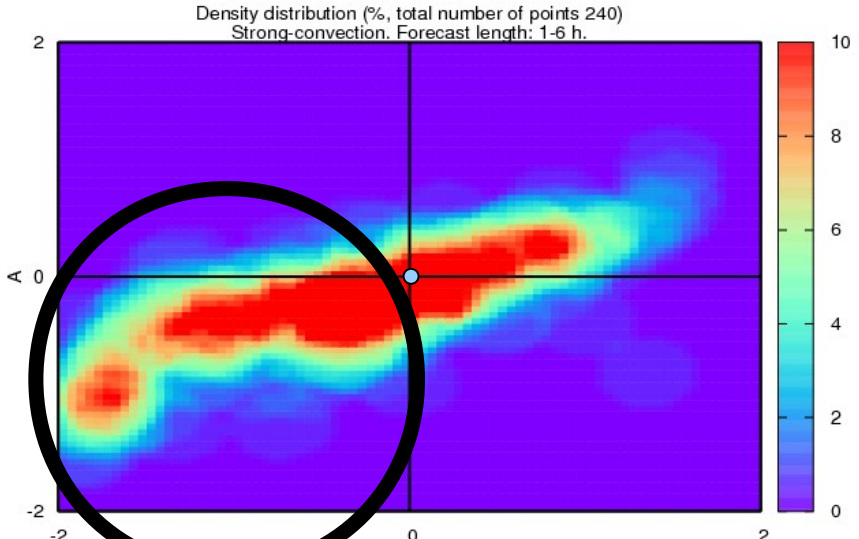

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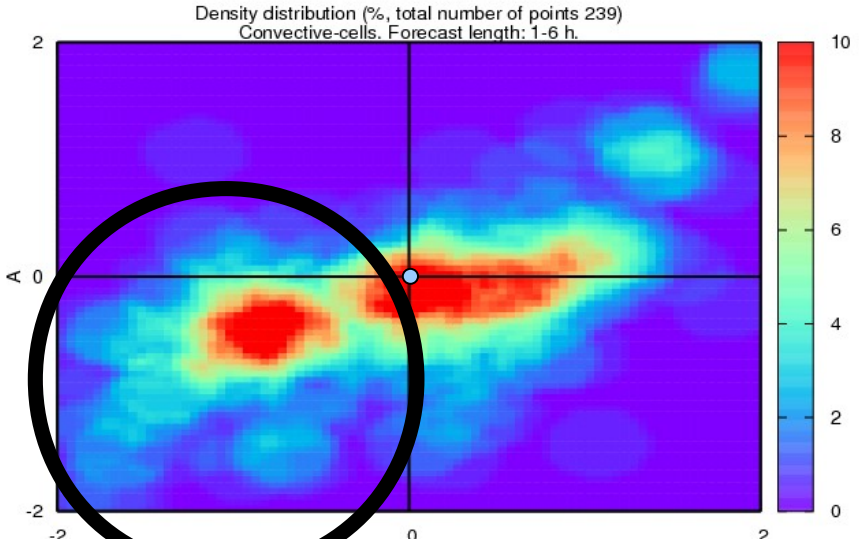
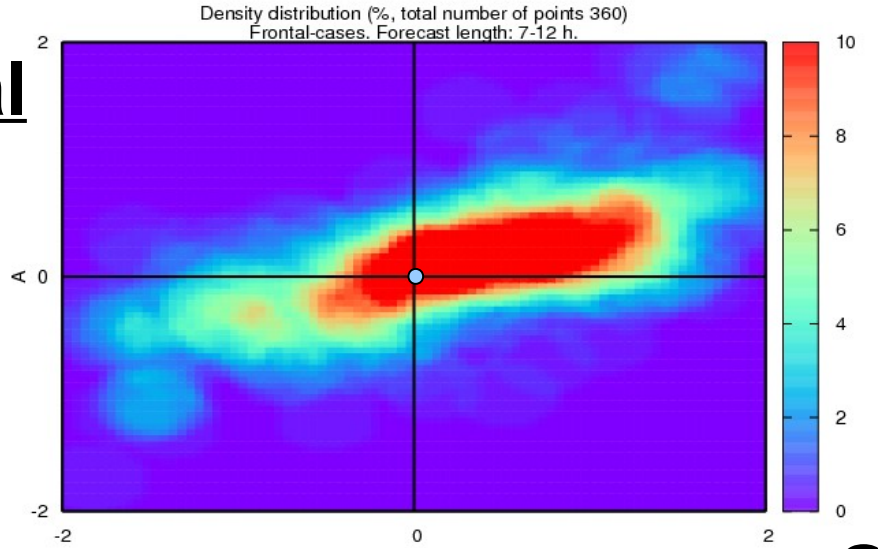


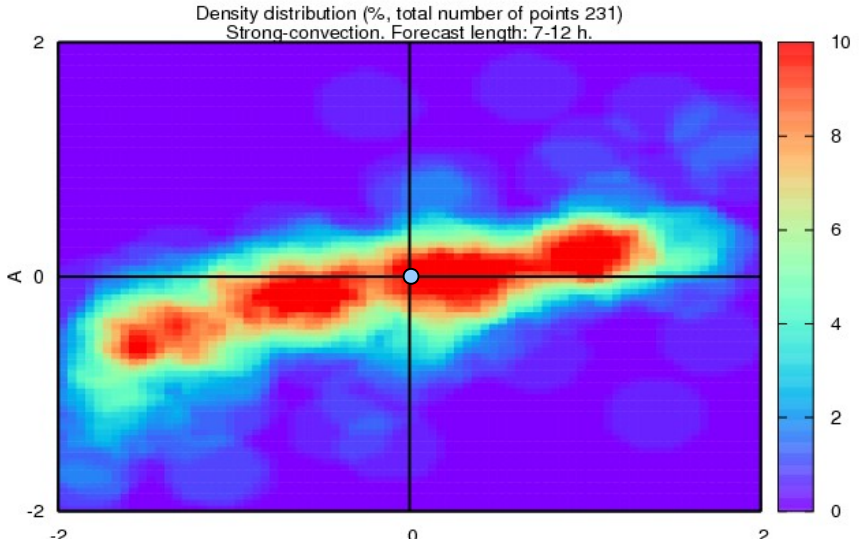
S vs. A – Precipitation type **+7-12h**

○ = perfect score

Frontal



Strong conv.



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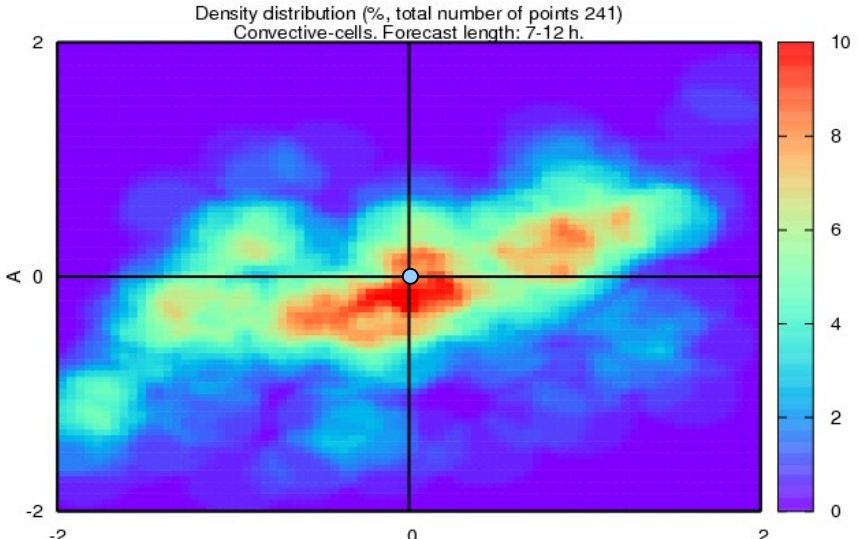

S vs. A – Precipitation type **+7-12h**

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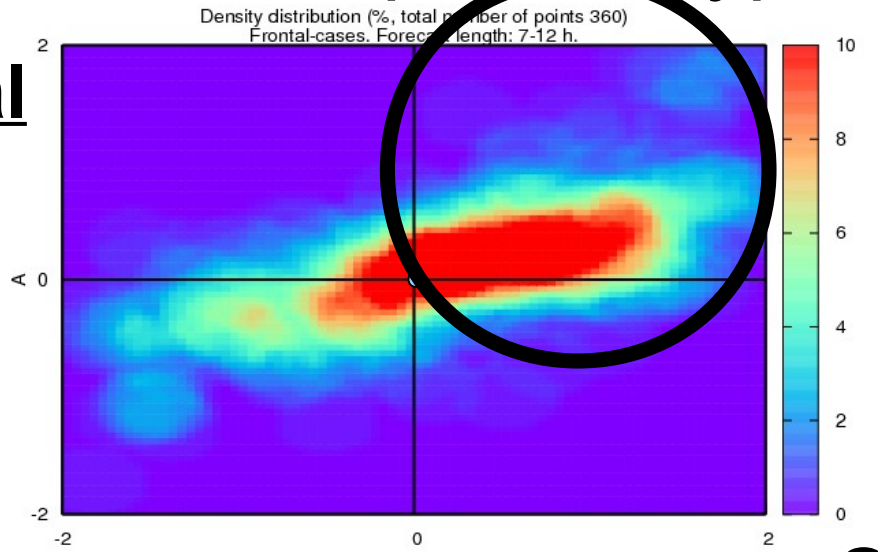
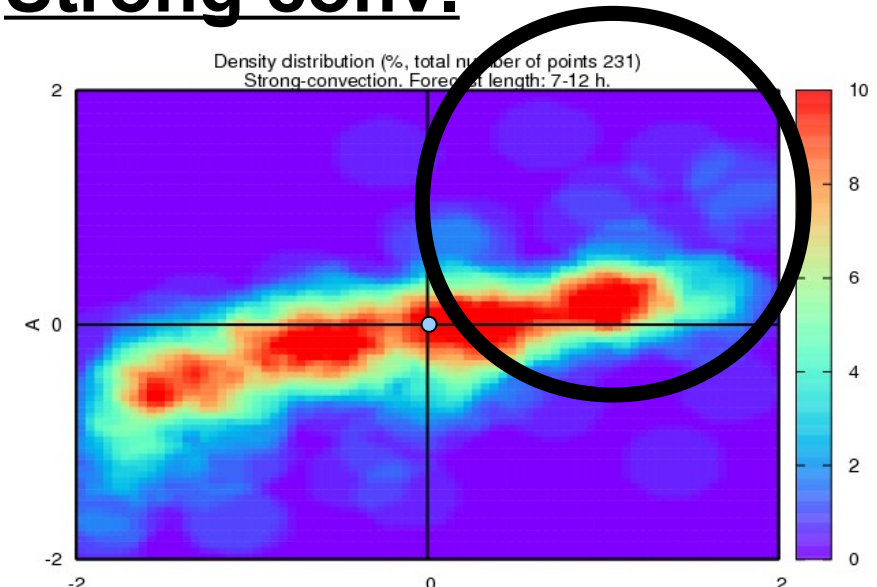
Frontal



Strong conv.



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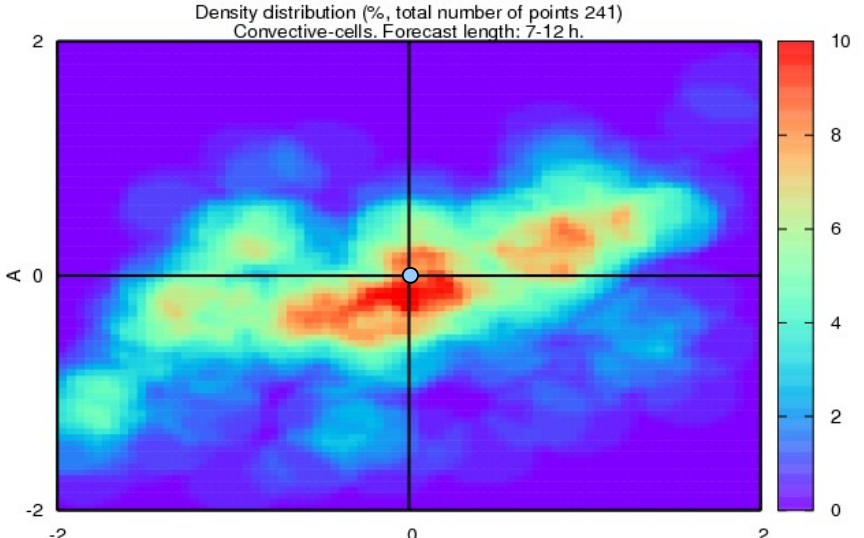
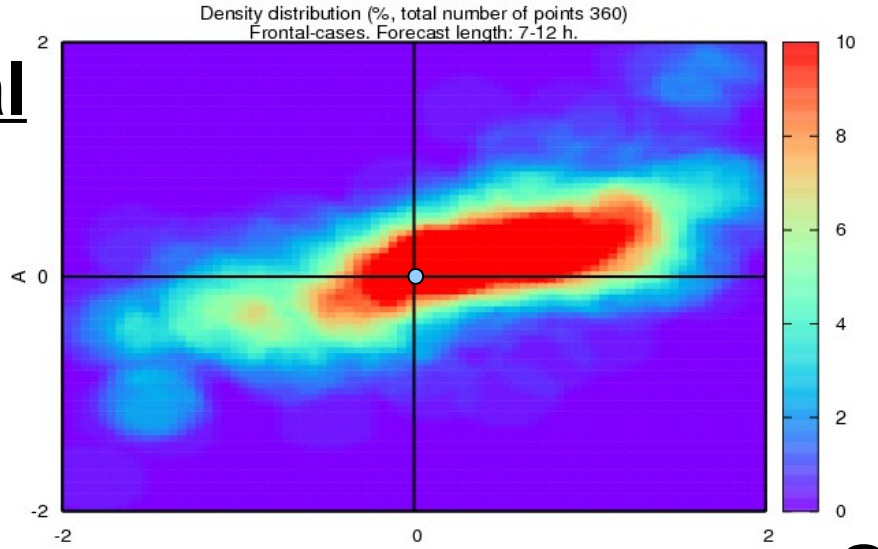


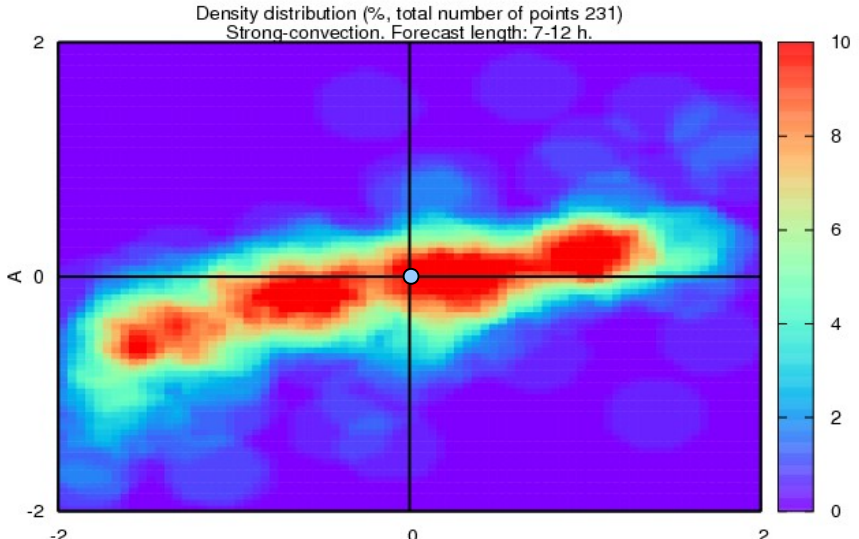
S vs. A – Precipitation type **+7-12h**

= perfect score

Frontal



Strong conv.



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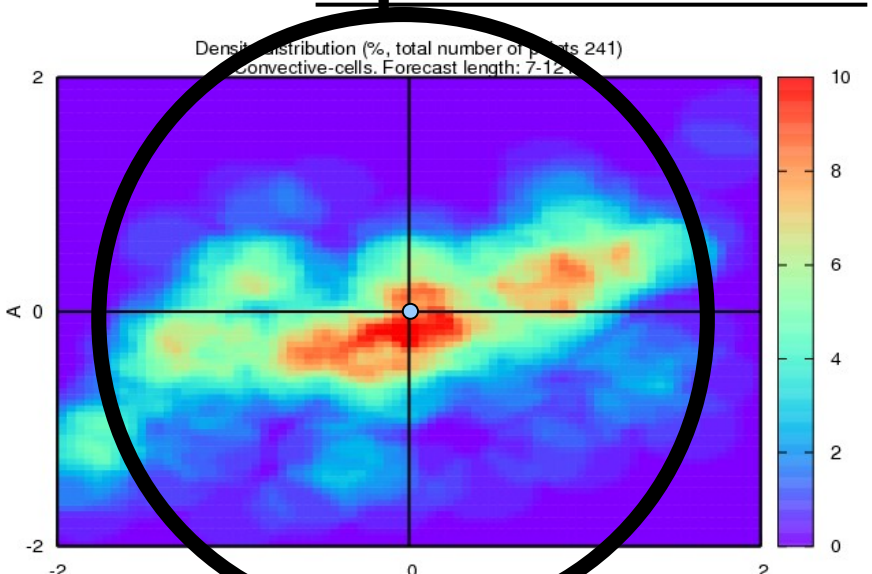
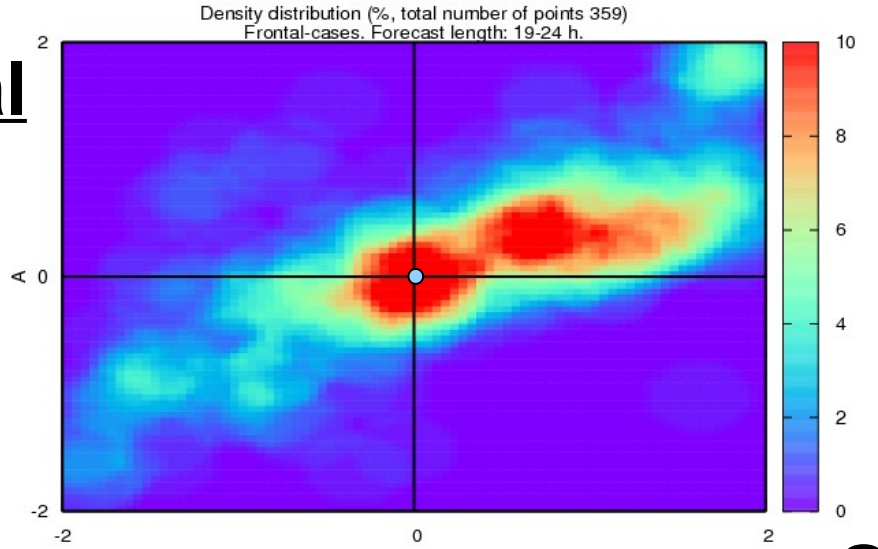


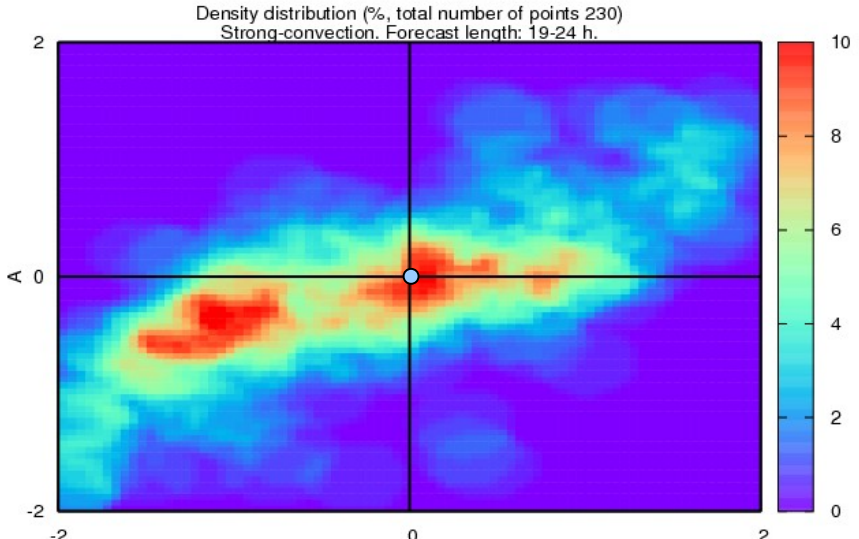
S vs. A – Precipitation type **+19-24h**

○ = perfect score

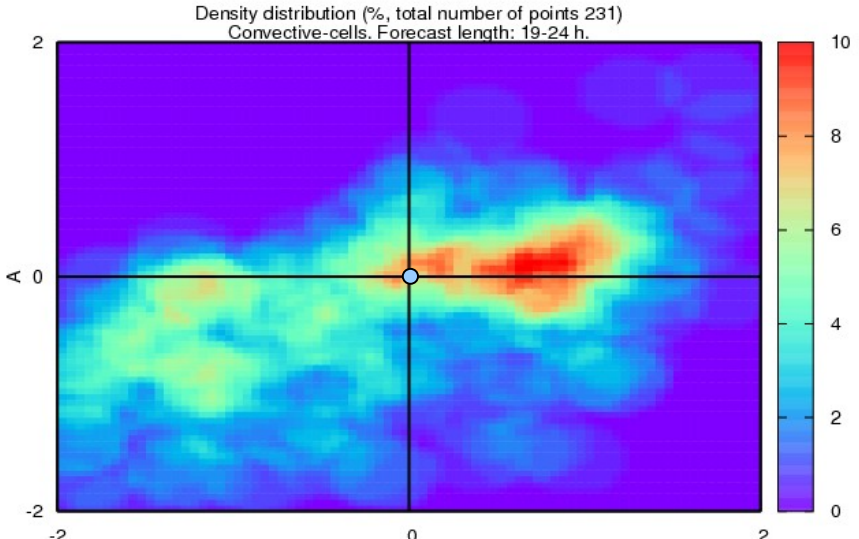
Frontal



Strong conv.



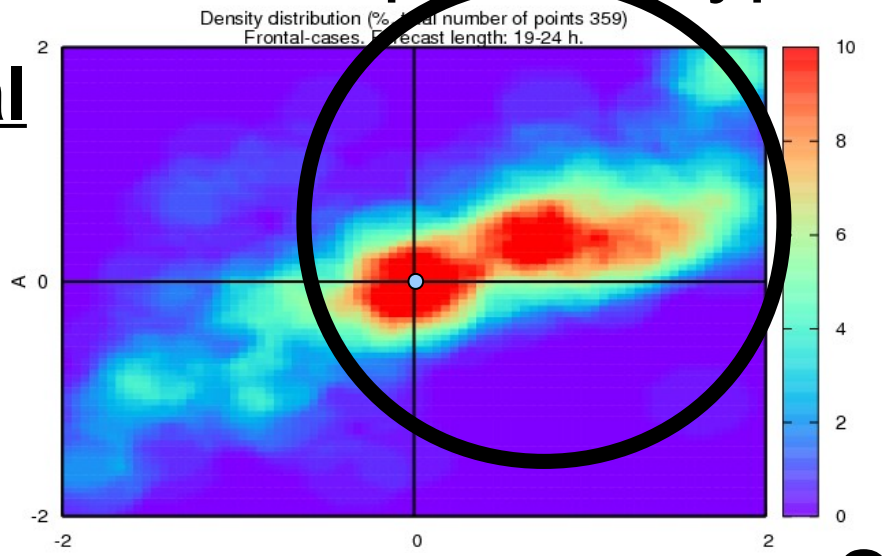
Open cell conv.



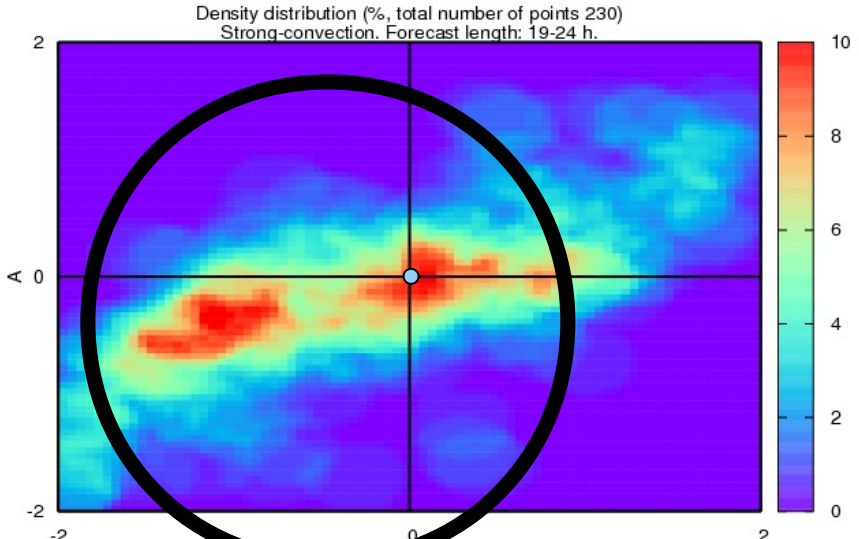
S vs. A – Precipitation type **+19-24h**

○ = perfect score

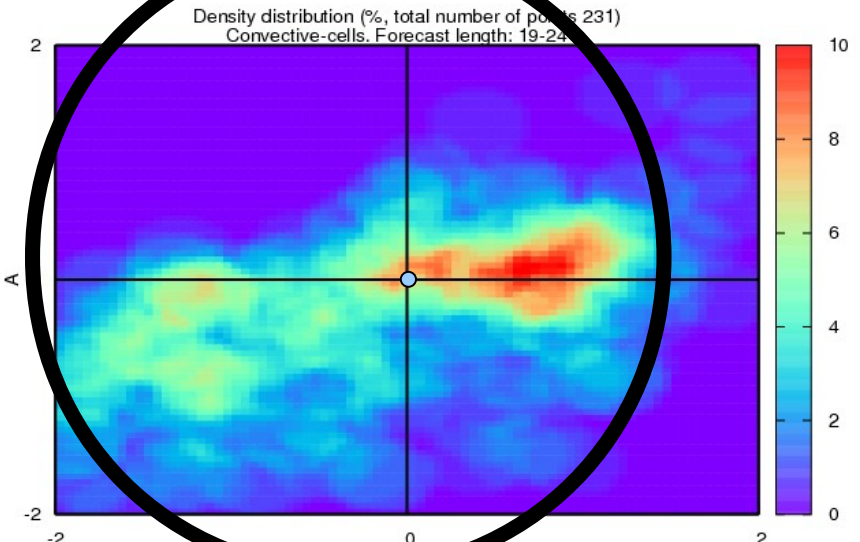
Frontal



Strong conv.



Open cell conv.



Summary

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• However, SAL can give information about the behaviour of high-resolution precipitation forecasts alone.

Summary

• SAL is a **fair method** in comparison of different resolution models! It won't penalize the higher resolution model.

• However, SAL can give information about the behaviour of high-resolution precipitation forecasts alone.

• 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.

Tools and instructions

- SAL is included in HARMONIE's **gl-package.**

- Some instructions in wiki:

https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/PostPP/gl#SAL

https://hirlam.org/trac/attachment/wiki/HarmonieSystemTraining2008/Lecture/PostppVerification/Harmonie_xtool_SAL.pdf

THANK YOU!