Recent observation usage in the AROME-France 3D-Var system

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Outline of the presentation

- Current observation usage in AROME
- New satellite observations
  - Ocean surface winds from scatterometers
  - Bending angles from GNSS-RO receivers
- Conclusions

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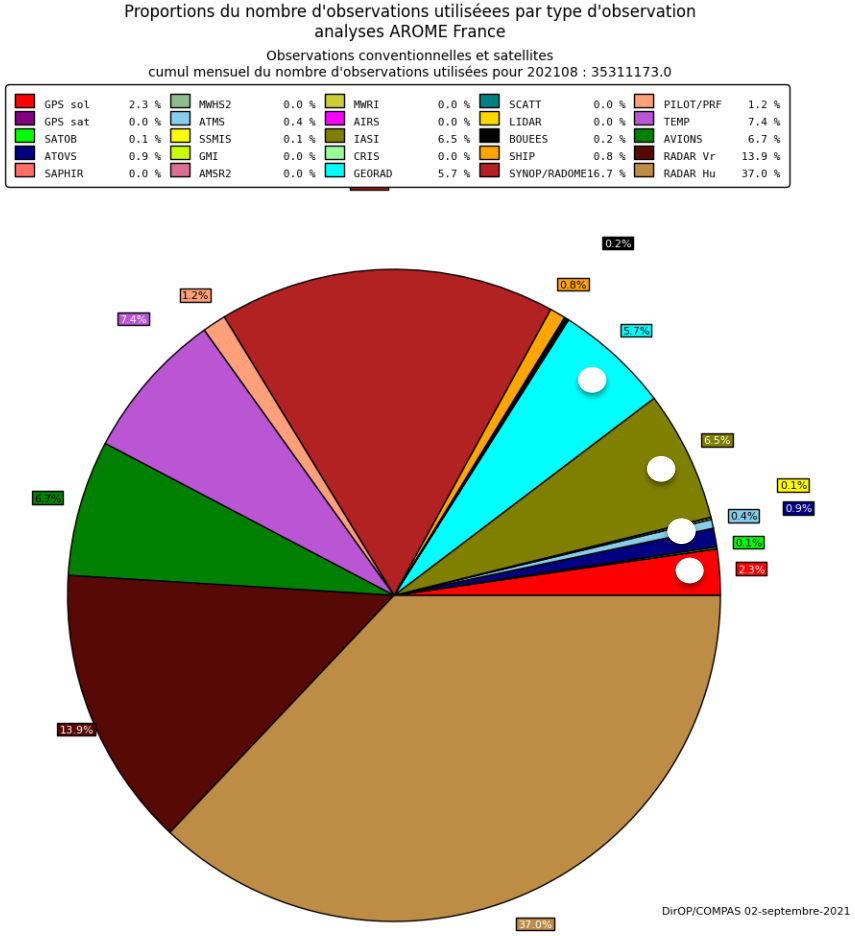
Observations assimilated in AROME



Radars Hu
Radars Vr
SYNOP
Radiosondes
Aircrafts

SEVIRI/MSG
IASI/Metop
AMSU-A/MHS
GNSS-gb

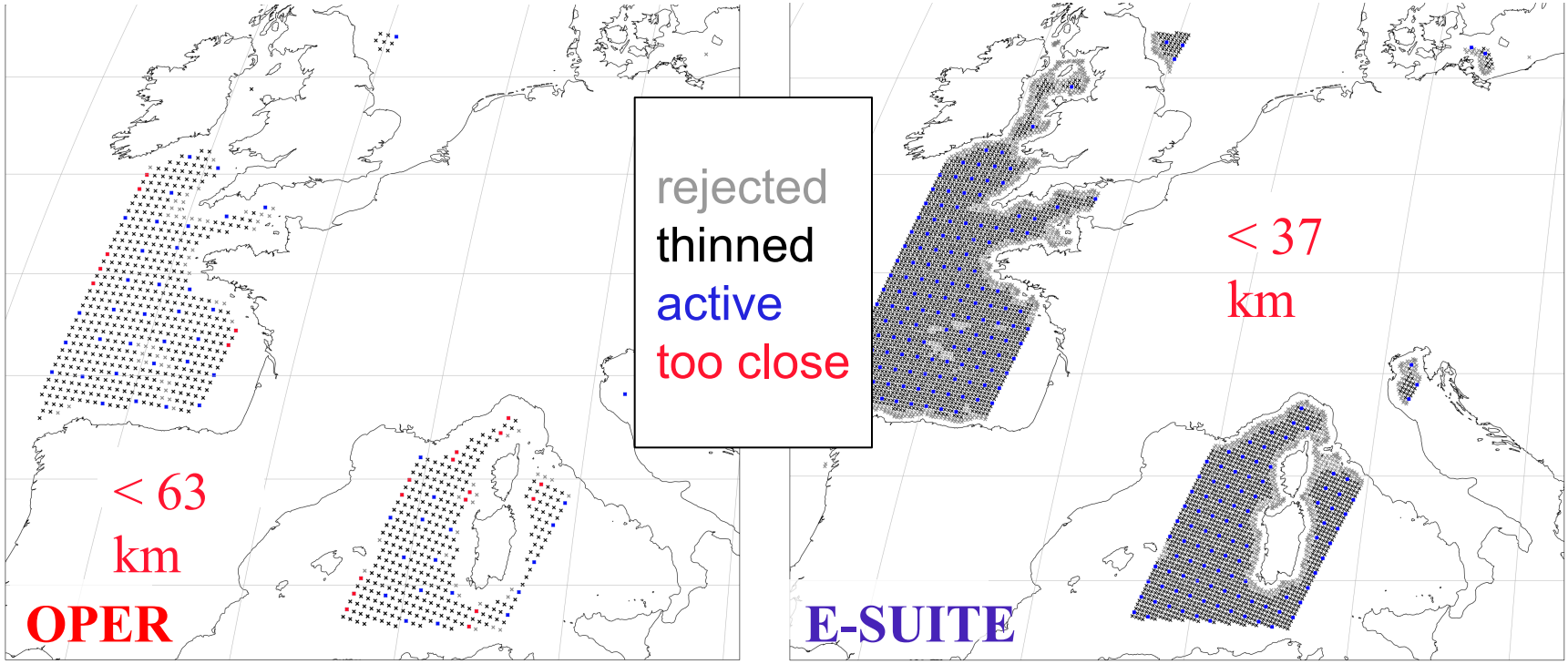
35 millions d'obs / month

- 16 % satellites

SCATT winds at high resolution (25 km)

- New thinning methodology (ARPEGE/AROME) : data selection in observation grid
- Assimilation @ 50 km (ARPEGE/AROME OPER), evolution: assimilation @ 25 km(AROME)

Ex: ASCAT-B wind selection

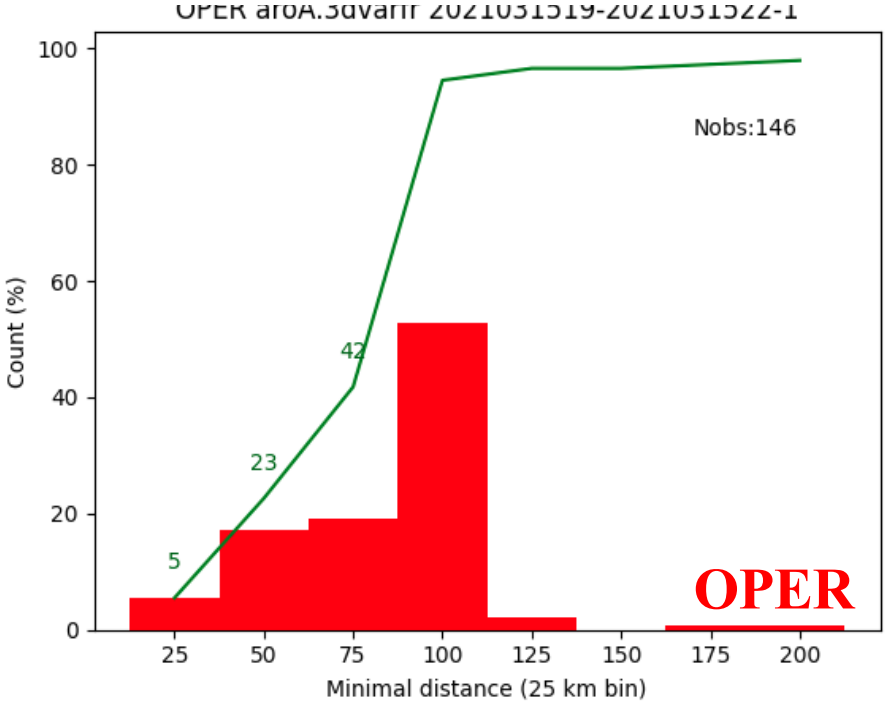


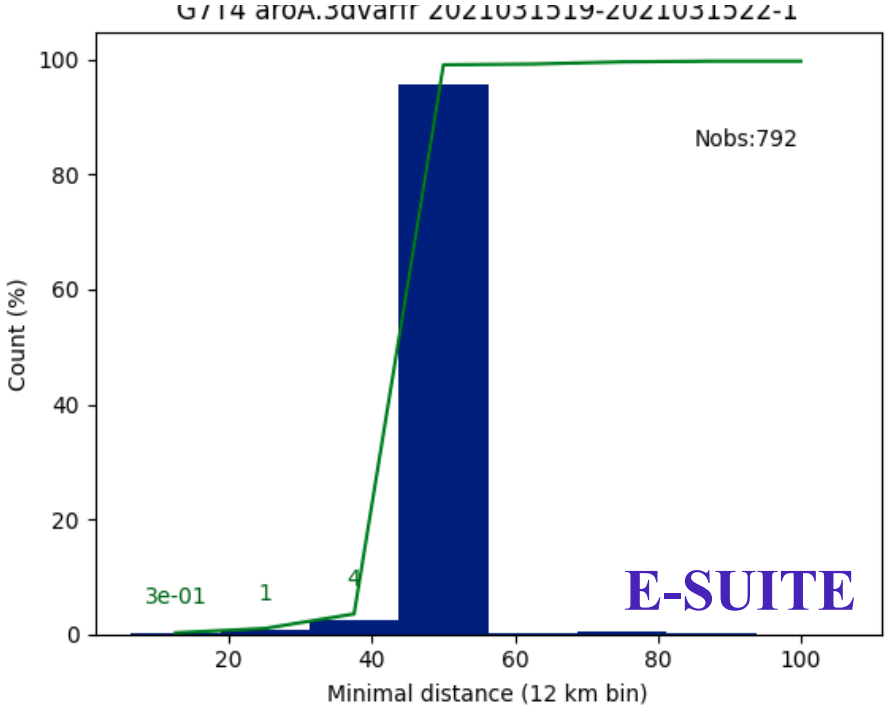
Resolution **50 km** (grid 25 km)
Thinning boxes **100 km** (oper)

Resolution **25 km** (grid 12.5 km)
Thinning grid **50 km** (e-suite)

Scatt winds at high resolution (25 km)

Ex: histogram of minimal distance between ASCAT winds



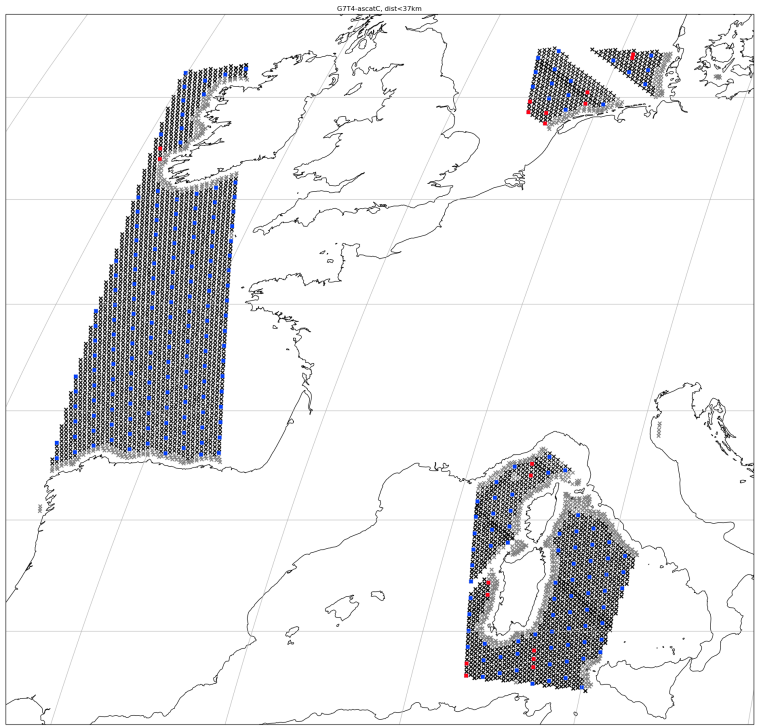


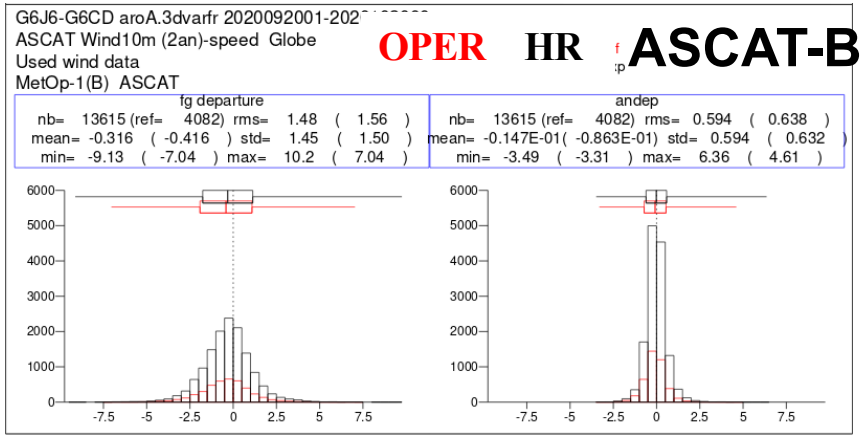
Resolution **50 km** (grid 25 km)
Thinning boxes **100 km** (oper)

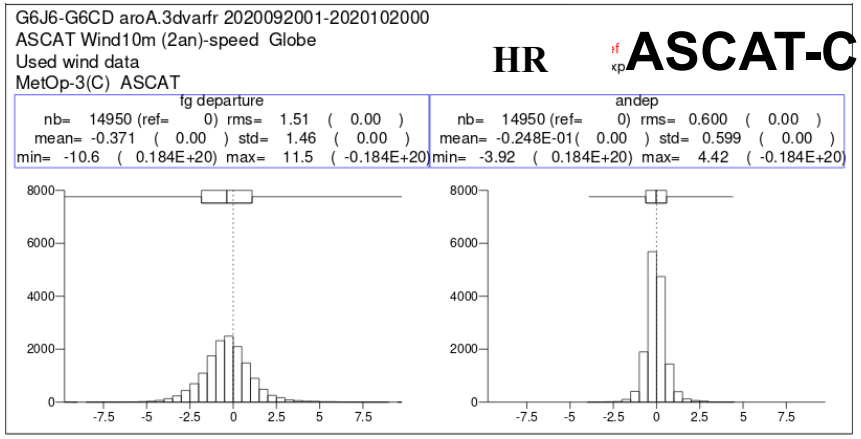
Resolution **25 km** (grid 12.5 km)
Thinning grid **50 km** (e-suite)

SCATT winds at high resolution (25 km)

- Introduction of ASCAT-C (lagged from ARPEGE)







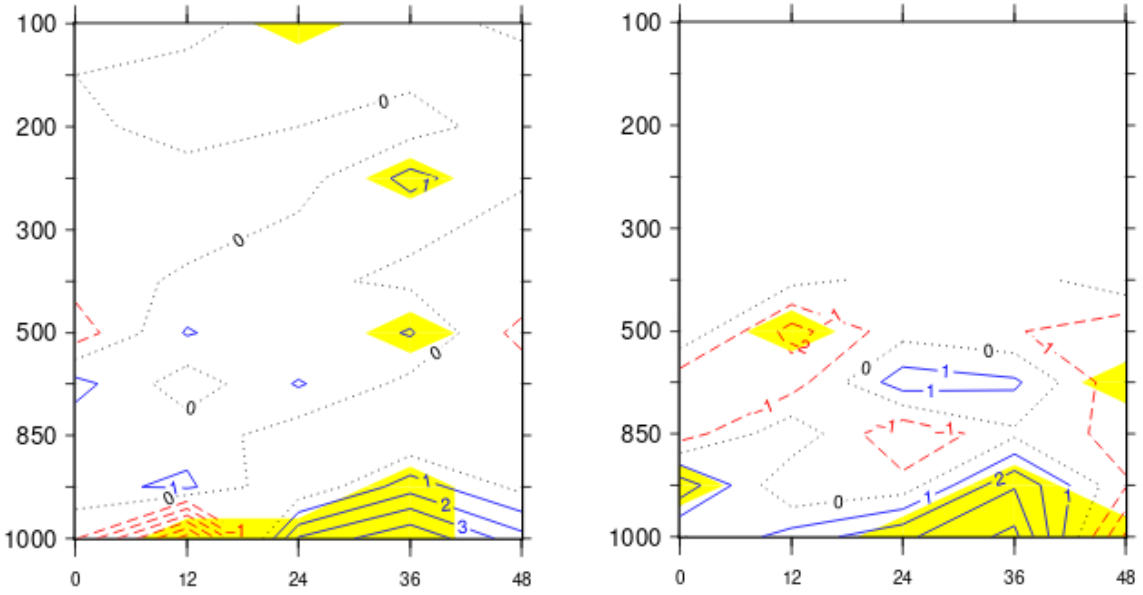
- SCATT HR + ASCAT-C ~ 4 x SCATT OPER

SCATT winds at high resolution (25 km)

- New thinning methodology (ARPEGE/AROME) : selection in observation grid
- Assimilation @ 50 km (ARPEGE/AROME OPER), evolution: winds @ 25 km (AROME)
- Assimilation of ASCAT-C (lagged from ARPEGE)

Forecast scores 12 UTC, 20/09 -> 19/10/2020 (30 days)

Normalised RMSE (REF - EXP)



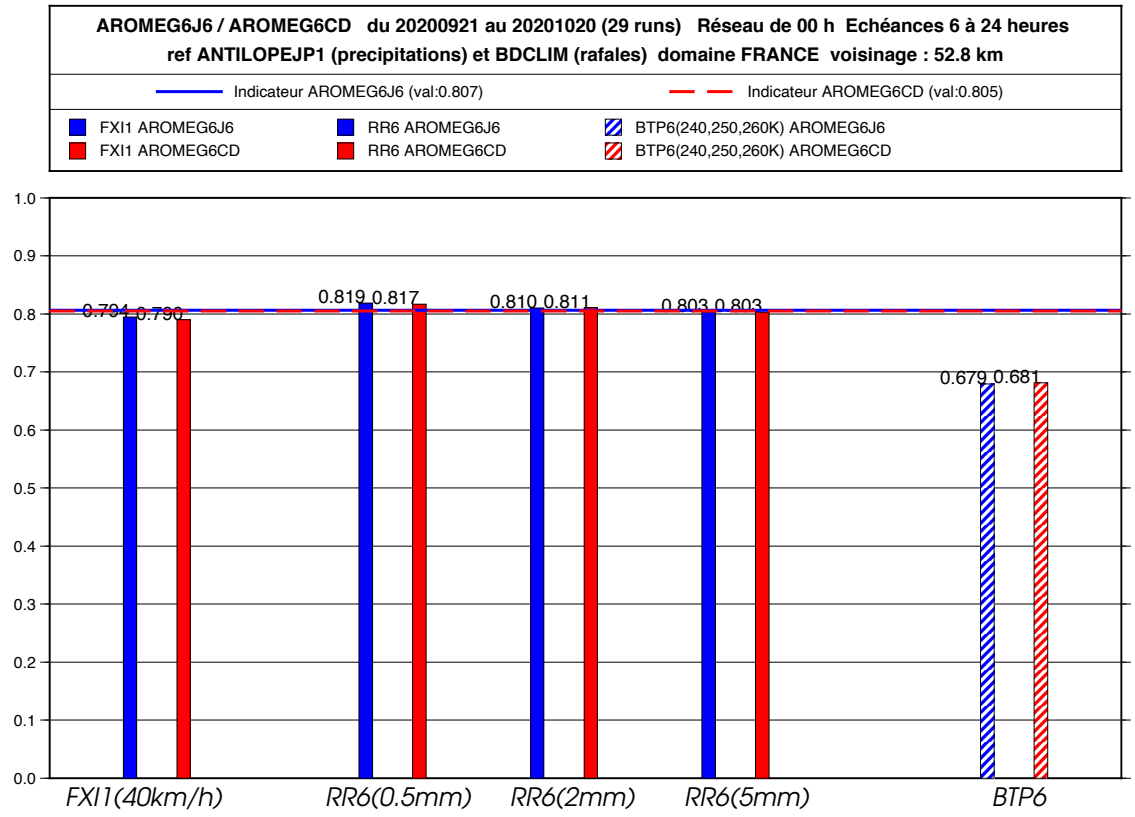
Wind **Relative humidity**

Against radiosondes
Domain: EURW1S40

significative

Météo-France NWP index (SCATT @ 25 km)

Based on wind gusts and precipitation amounts (3 thresholds)



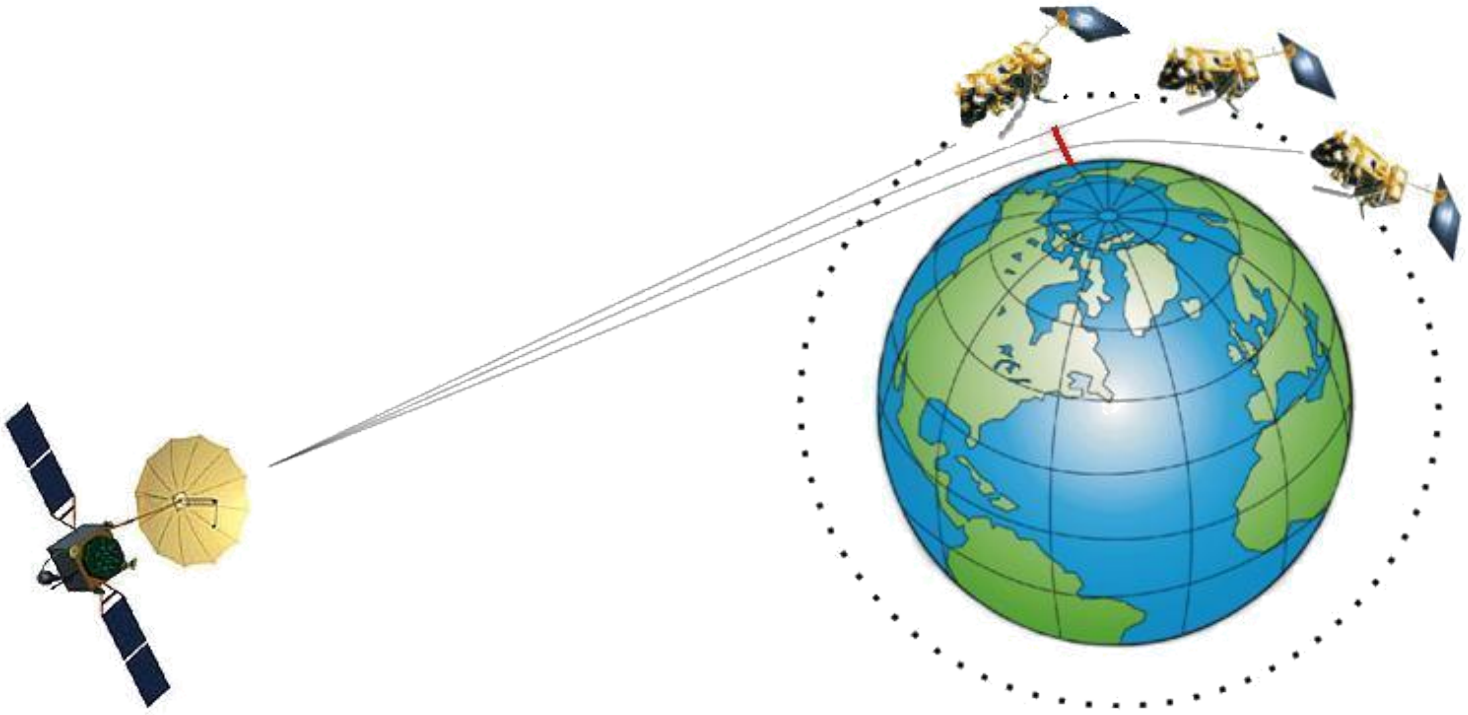
Météo-France DirOP/COMPAS
Actualisé le 22/01/2021

1 month (Oct. 2020)

REFERENCE (0,807)
EXPERIMENT (0,805)

GNSS Radio-Occultation

- GNSS radio-occultation technique based on the refraction of an electromagnetic wave between an emitting satellite (altitude: 20 000 km) and a low orbit receiving satellite (between 600 and 800 km)
- Mesurement: delay by the medium (ionosphere and atmosphere) on the received signal

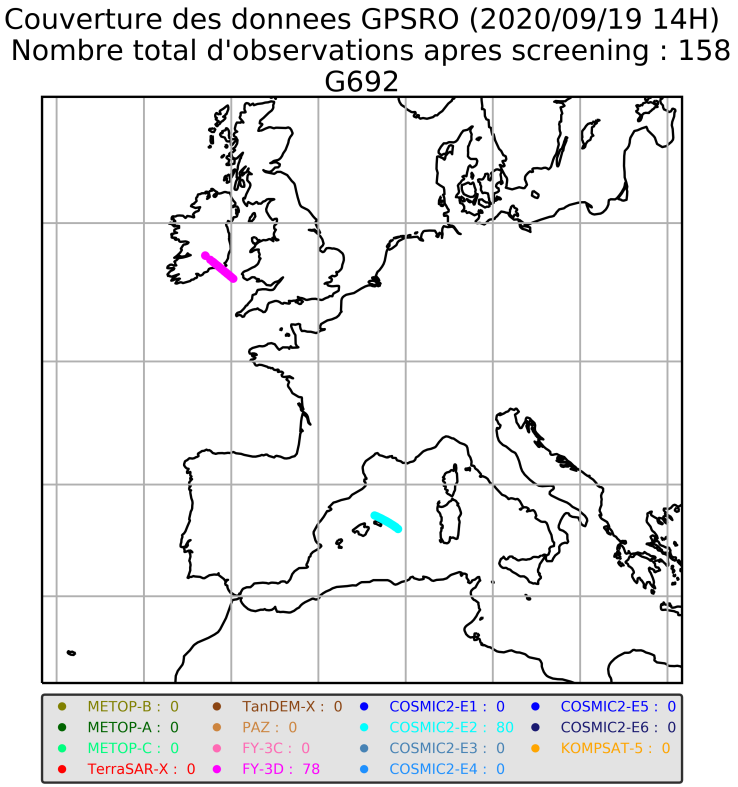


GNSS Radio-Occultation

- Assimilation of bending angles from the surface up to the AROME model top (10 hPa = 35 km)
- Retrieval of temperature profile information
- Unbiased data
- Very good vertical resolution
- GNSS-RO data are informative on temperature of mid/high troposphere and stratosphere

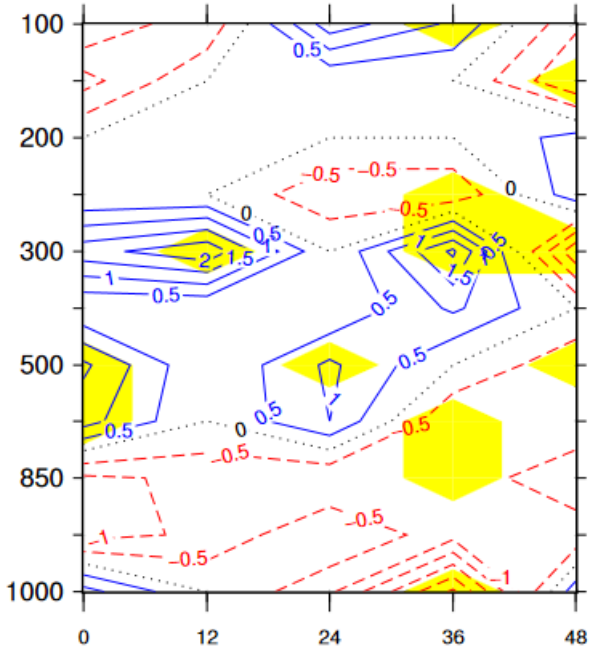
Assimilation of GNSS-RO in AROME

- Over the AROME domain, only few GNSS-RO data: before the availability of data from 6 COSMIC-2 receivers (spring 2020), data were only present ~25 à 30 % of analysis times (in average)
- Since spring 2020 with COSMIC-2 data (tropical belt up to 46° N), observations are available ~50 % of analysis times (in average)
- ~100 to 200 data / analysis



Assimilation of GNSS-RO in AROME

- Rather neutral impact on « large scale » scores, with a small positive signal on temperature
- Normalised RMSE differences against radiosondes for temperature (10/09 to 20/10/2020)



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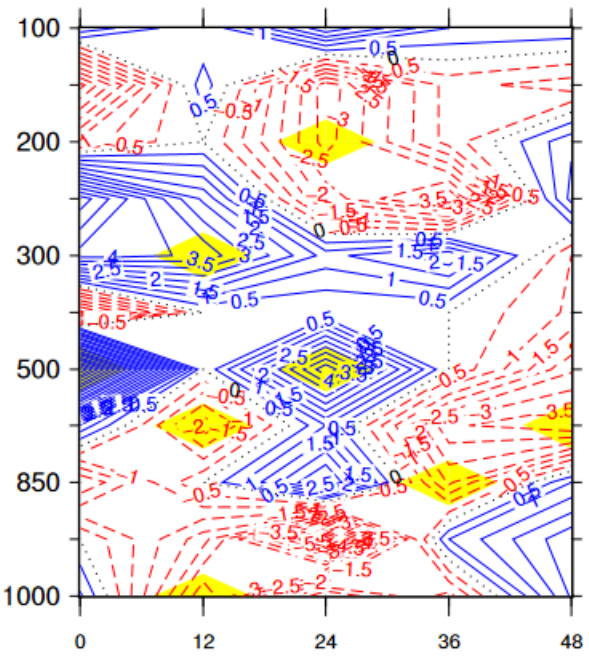


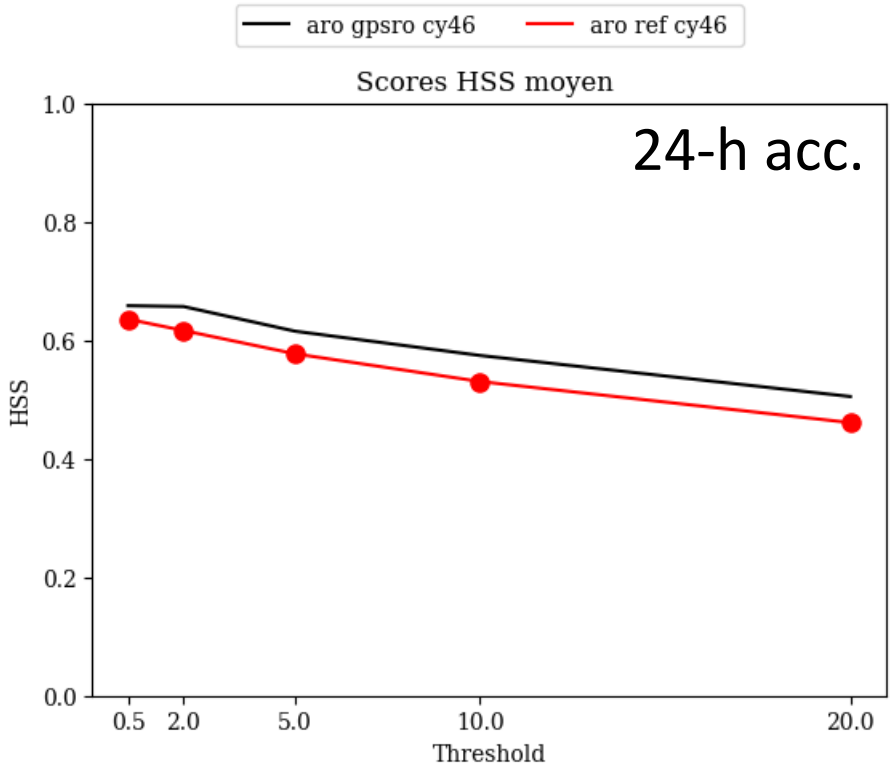
FRANCE

☺ ☹

significative

Assimilation of GNSS-RO in AROME

- Positive impact on precipitation scores, for both winter and summer periods
- Improvement of the mean HSS score for all precipitation thresholds (10/09 to 20/10/2020)

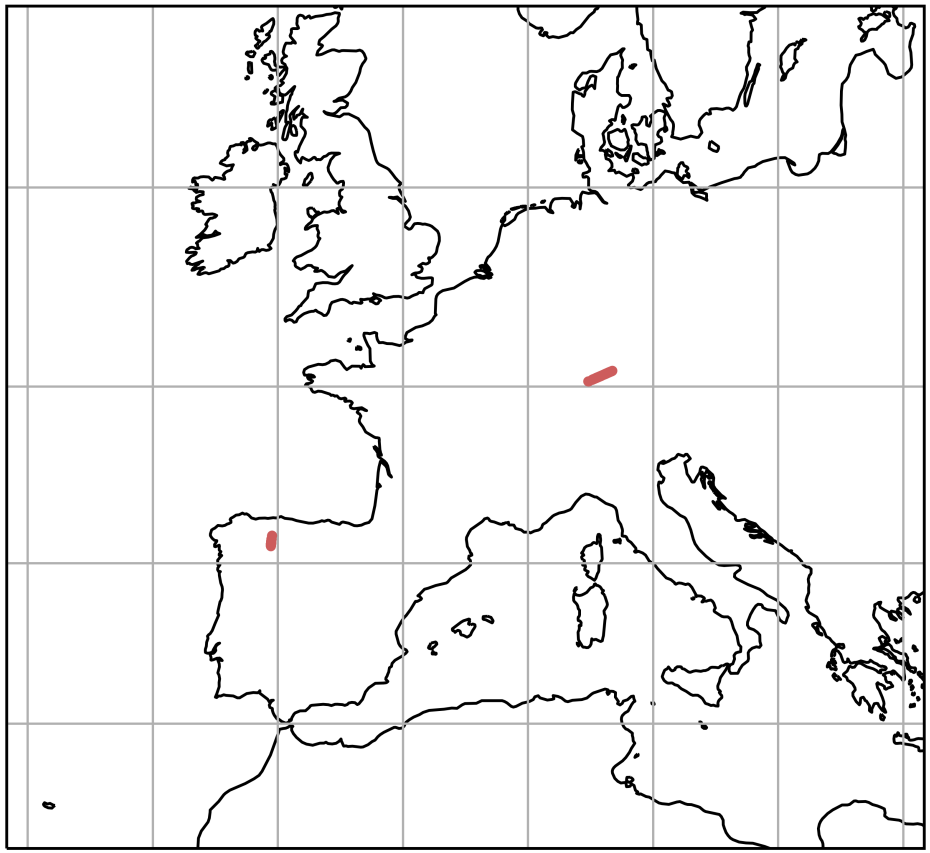


EXPERIMENT
REFERENCE

Case study: Gard 19/09/2020

- GNSS-RO assimilation in AROME (CY46T1) on a high impact weather event

Pointage des donnees GPSRO (G6DF)
Nombre d'observations apres screening reseau 20200918T1300 : 142



Case study: Gard 19/09/2020

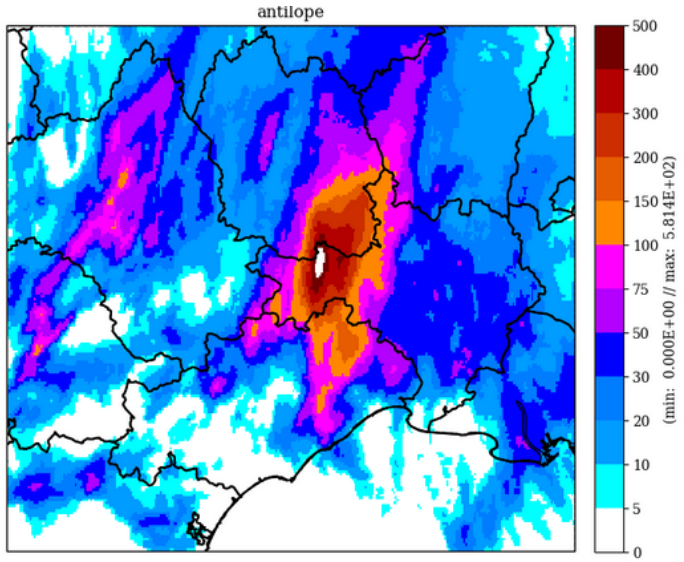
- Localised heavy Mediterranean precipitation event, not accurately forecasted by the operational AROME model
- 2 experiments with GNSS-RO data one being coupled to ARPEGE with additional quality controls on refractivity profiles.
- Sensitivity studies using « lagged ensemble » approach (P. Brousseau)
- Long-range forecasts (up to 48h) for each hourly analysis time from 18/09 à 00H to 19/09 04H from AROME with assimilation of GNSS-RO data (full coverage of 19/09).
- Examination of accumulated rainfall amounts for the 19th of September 2020

Case study: Gard 19/09/2020

- Observations : Antilope precip. analysis

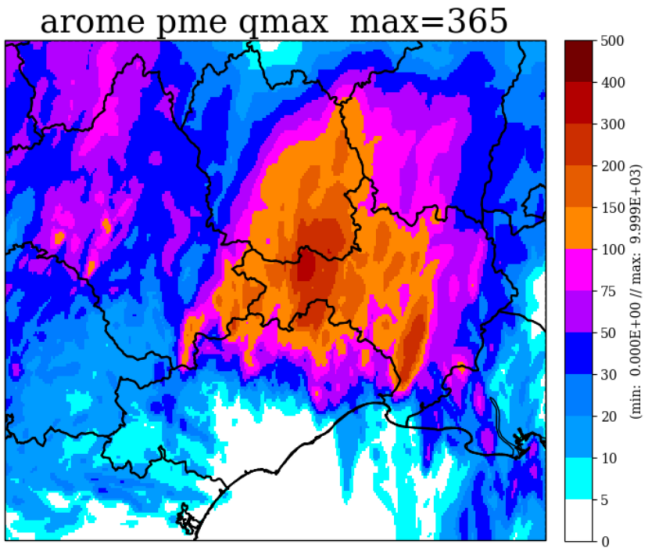
Accumulated amounts: 19/09 04h to 20/09 00h

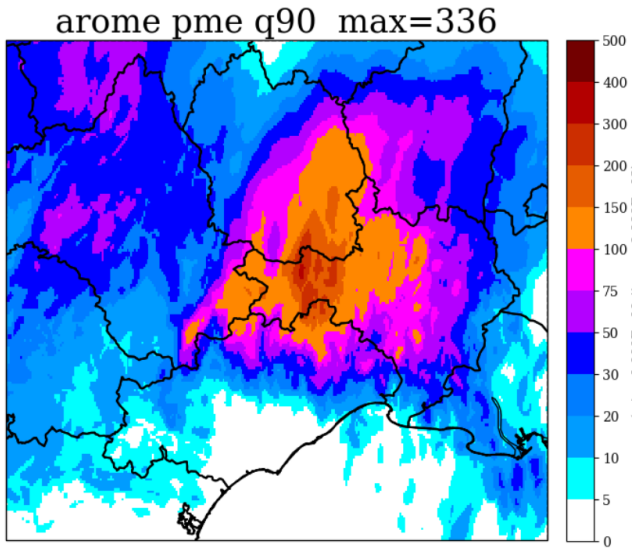
Maximum values > 500 mm



- Experiment 1 : Qmax forecast **365 mm**

Oper
342 mm





Oper
216 mm

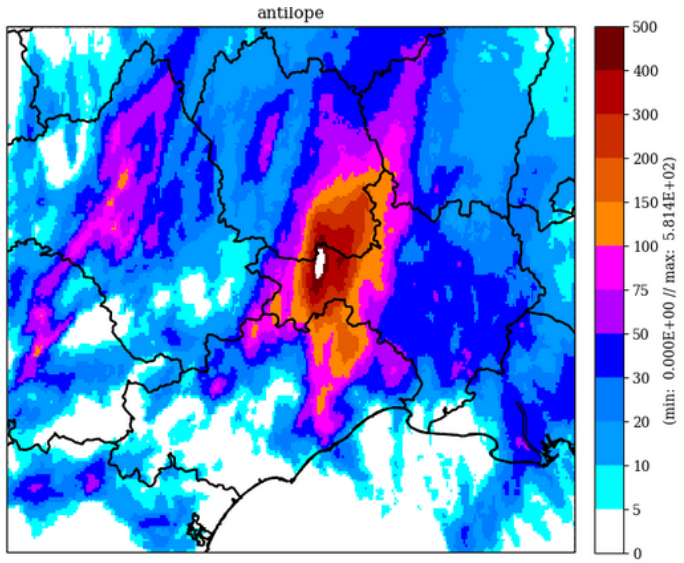
- Figures Pierre Brousseau

Case study: Gard 19/09/2020

- Observations : Antilope precip. analysis

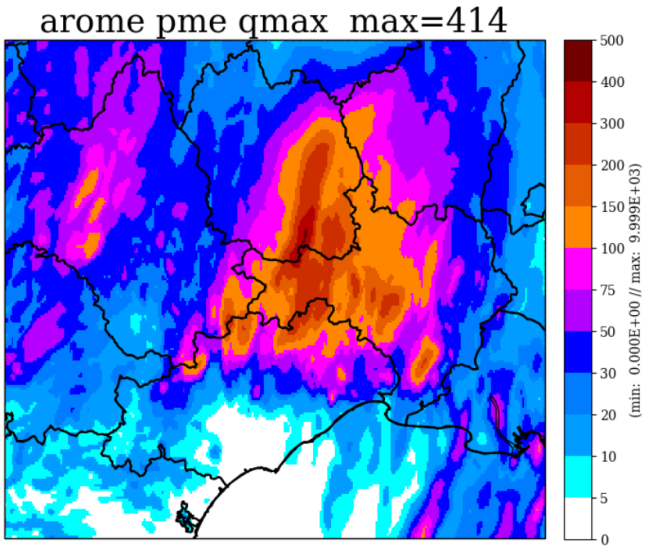
Accumulated amounts: 19/09 04h to 20/09 00h

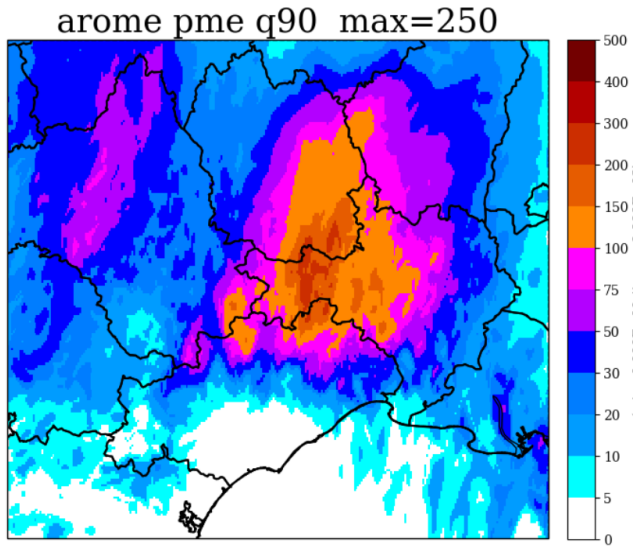
Maximum values > 500 mm



- Experiment 2 : Qmax forecast **414 mm**

Oper
342 mm





Oper
216 mm

Figures Pierre Brousseau

Conclusions

- Improvement on the assimilation of ocean surface winds from scatterometers in AROME:
  - Resolution 25 km instead of 50 km
  - Thinning @ 50 km instead of 100 km
  - New method for horizontal thinning: scanning geometry

- Assimilation GNSS-RO bending angles in AROME (so far never used operationally)

- Slight positive impacts on forecast scores
  => (SCATT = 0,2 % obs; GNSS-RO = 0,3 % obs)

- All these changes should become operational in AROME-France by mid-2022 (CY46T1)

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Thank you for your attention !