Deterministic and fuzzy verification of the cloudiness of High Resolution operational models

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Verification against satellite data

- **3 data types:**
  - ALADIN-FRANCE 0.1 ° and mass flux convection scheme
  - AROME 0.025 ° and explicit convection
  - SEVIRI METEOSAT 9

- **Verification time:**
  every 6 hours, instantaneous

**verification domain**
AROME domain with 0.1 ° grid
Simulated satellite images (SSI)

Output of the model forecasts

- *Temperature*
- *Nebulosity*
- *Specific humidity of vapor*
- *Liquid and solid water*

Two-dimensional SSI

RTTOV_CLOUD 8

AROME: explicit clouds
ALADIN: explicit + subgrid clouds

Wavelength of the Infrared channel is 10.8 micrometers
Summary

- Introduction

- Last Summer :
  - Illustrative example of SSI: 11 June 2008
  - Deterministic scores
  - Probabilistic scores
  - Comparison with QPF

- Conclusion
Simulated satellite images (SSI)  11 June 2008 18 UTC

Observation

AROME

ALADIN

Correct development of the convection

Explicit clouds

No convective subgrid clouds

213 K  273 K  313 K
BIAS

SUMMER 18 UTC
2 June – 10 September 2008

Heidke skill score

AROME superiority for high clouds

3% ~5000 events

40% ~91000 events
double-penalty and neighborhood

High resolution forecast

Low resolution forecast

Spatial tolerance

Observed field

Deterministic forecast

Probablistic forecast
Fuzzy approach

- **Brier Score (BS):**
  
  \[ BS = \frac{1}{Nobs} \sum_{k=1}^{Nobs} (p_k - o_k)^2 \]

- **Brier Skill Score (BSS):**
  
  \[ BSS = 1 - \frac{BS}{BS_{ref}} \]
  
  Ref = persistence

- **2 interesting limits:**

  1- Neighbourhood size = 0 :

  \[ BS \xrightarrow{v \to 0} HSS \]

  2- Neighborhood = simulation domain

  \[ BS \xrightarrow{v \to L} \frac{1}{N_{day}} \sum_{d=1}^{N_{day}} \alpha(d) \times (1 - BIAS(d))^2 \]

  (further details in Amodei and Stein (2009))
Neighborhood 76 Km

Brier skill score (NO)

Heidke skill score

More impact of the double penalty for high clouds in AROME
QPF verification

- Average the data and the models QPF at 0.2°x0.2°

Climatological state network

~4000 raingauges giving 24 hours accumulated rain every day
QPF verification during SUMMER 2008

2 June – 10 September 2008

24 hours accumulated rain

Known drawback of ALADIN convection scheme

We recover the same improvement of the scores for heavy rains and cold SSI due to the removal of the double penalty

Heidke skill score

Brier skill score (NO)

Thresholds (mm/day)

Difference is removed for heavy rains
Daily evolution of SSI

During the night convective clouds are likely replaced by large scale cloudy phenomena

Difficulties to forecast convective clouds
Conclusion

- SSI allow to document the forecast quality of all types of clouds.
- ALADIN and AROME under-estimate low and medium clouds.
- High-tropospheric clouds are quasi-absent in ALADIN forecasts.
- The fuzzy approach corrects the double penalty for the convection simulation for AROME but not for ALADIN.
- QPF and SSI verifications provide complementary information for convective events.
Future plans

- Define a temporal tolerance (Theis et al. 2005) to reduce the double penalty for temporal misplacement
- Perform the QPF verification for 6 hours accumulated precipitation.
- Compare both information provided by these new verifications for SSI and QPF
- Operational use of both verifications
The End
Different kind of clouds could be separated
SUMMER  
Frequency of observed and forecasted events
2 June – 10 September 2008

Total sample size $\sim 200,000$

- **Very high clouds**: $\sim 5000$ events
- **High clouds**: $\sim 13000$ events
- **Low clouds**: $\sim 91000$ events

Threshold $({}^\circ K)$
BSS SSI
every 6 hours for high clouds 240°K Neighborhood 76 Km

SUMMER 2008

AUTUMN 2008
Number of observed events

- CLOUDS
  - 23 and 26 June

- RAIN
  - 11 and 12 August

- Blue line: rain 20mm/day
- Pink line: cloud 230°C 18H
Total sample size = 91080

Threshold (°K)
12 AUGUST 2008
SEVIRI

6 UTC

12 UTC

18 UTC

24 UTC
20 November 2008 18 UTC

Autumn 2008

SSI ALADIN 10.8 micrometers

Observation

ALADIN
AUTUMN

ASSI AROME

10.8 micrometers

20 November 2008  18 UTC

21 November 2008  18 UTC

Observation

AROME
AUTUMN 18 UTC 2008

BSS 76 km

Heidke skill score