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MASCOT : an offline tool to improve surface physics in NWP

All Staff Workshop, 2 April 2025

MASCOT project

An internal project in CNRM between GMME and GMAP group at Météo France

- The objective is to move toward more complex and realistic schemes and databases for the representation of the land surfaces in NWP models ARPEGE

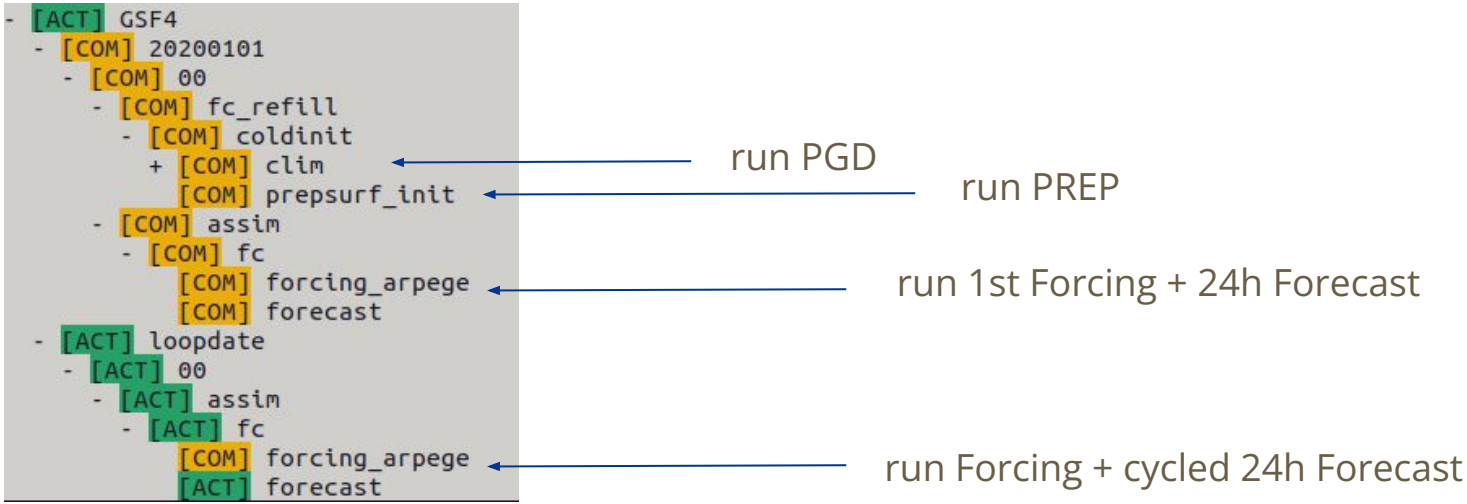
- An important step is to develop a tool to perform Offline experiment (surface forecasts without coupling with the atmosphere) as close as possible to the operational setup (I/O, compilation and running environnements). Then to test new configurations of the surface, starting with the combo : DIF/ES/3Patches and ECO-SG

- Surface assimilation is included in the offline configurations

MASCOT project

The rules are to use :

- the FA format
- the IAL code, compiled with Gmkpack, same as the operational at MF (cy48t1)
- compaction using NVGRIBSFX=123
- the operational grid of both Arome-France and Arpege setup
- the Olive software to launch the experiments



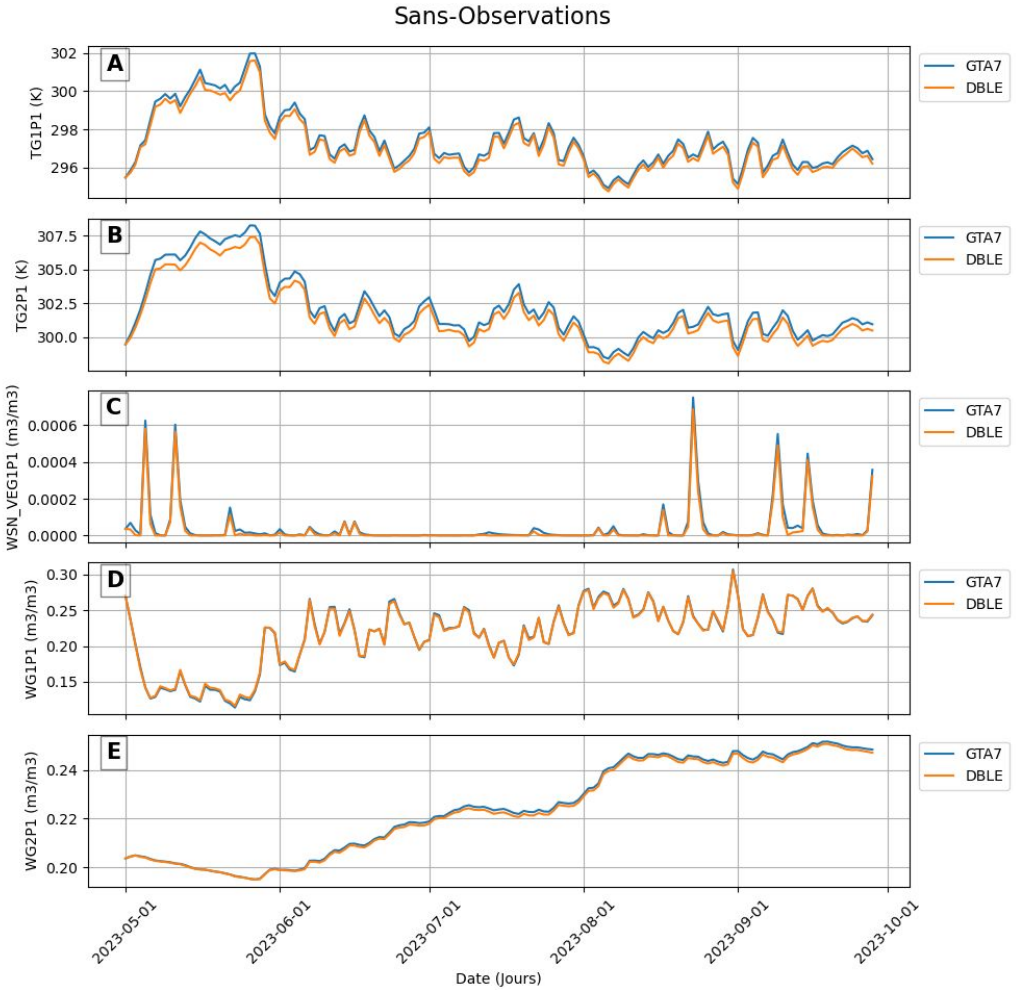
Validation of the offline tool : average over a domain in Africa containing very few observations : may to october 2023

-> domain with very few observations (limited impact of surface analysis in the operational system) : [20°E, 40°E, 5°N, 15°N]

-> the systems seems to be validated

-> differences in others domains are larger but are attributed to data assimilation

legend : OFFLINE SYTEM vs OPERATIONAL SYSTEM



Setup : main options for the NEW physics

Namelist	Option	description
CISBA	DIF 14L	soil scheme
CSNOW	ES 6L	snow scheme
NPATCH	3	max number of vegetation type on one gridcell
LSOC	T	Soil organic carbon. 2 input files from SOILGRIDS database are used (5 in a next version). 2 top layers are set to 100% of organic matter fraction
CPHOTO	AST	photosynthesis parametrization. To be evaluated with 3 patches
LMEB	F,F,F	*no working yet*
LFAKETREE	F	incrase z0 over low vegetation. Impact to be evaluated globally
CWATER / CTOWN	WATFLX / None	TEB might be activated in the next version
ECOCLIMAP-SG	T	
SAND/CLAY	soilgrids	new data base for sand and clay fractions

Technical informations

- NEW physics : 4 outputs/day, ~1.3Go/output (375 variables), 12’30”/day

- with NEW, compaction using NVGRISFX=123 is done, except for WSN field (36 fields) that are written with 52 bits.

- REF physics : 4 outputs/day, ~0.4Go/output (375 variables), 6’30”/day

T2M + Tg scores over France (120 stations)

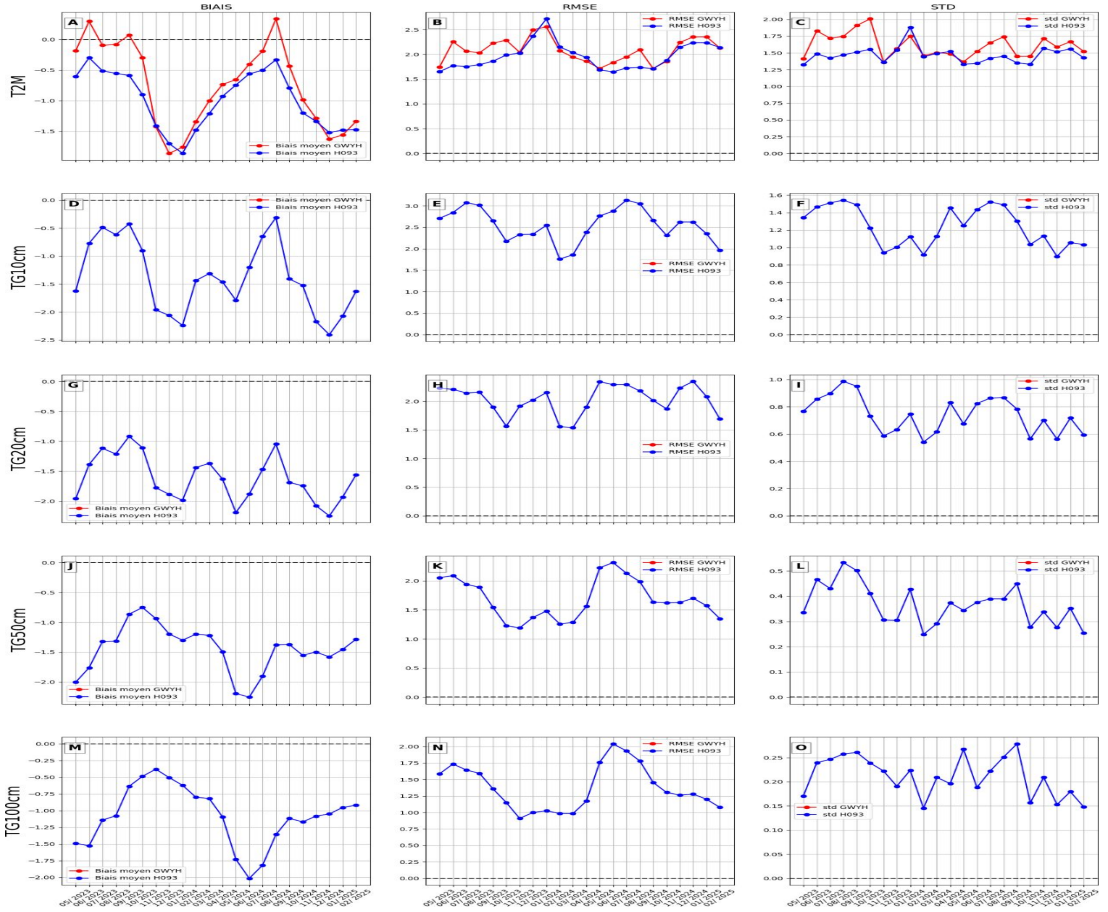
-> July 2022 to February 2025

-> initialisation from operational file (Force-restore/D95)

-> necessary spin up of ~ 6 month

-> cold bias for soil temperature for all seasons and both experiments, stronger in winter. Also for T2M, and even stronger with the NEW physics in summer

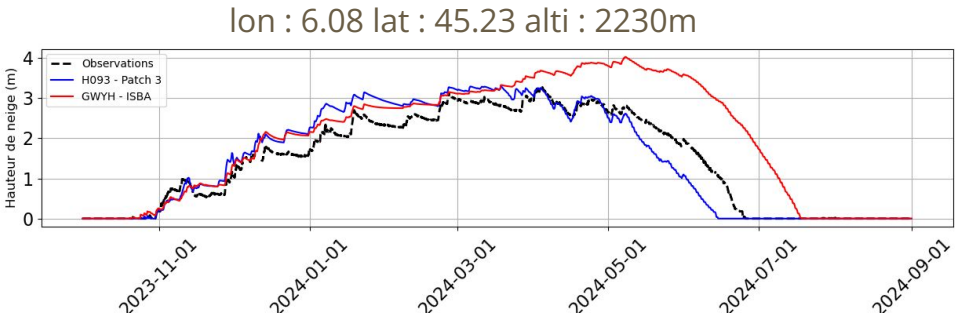
-> better scores with NEW physics than the REF for T2M

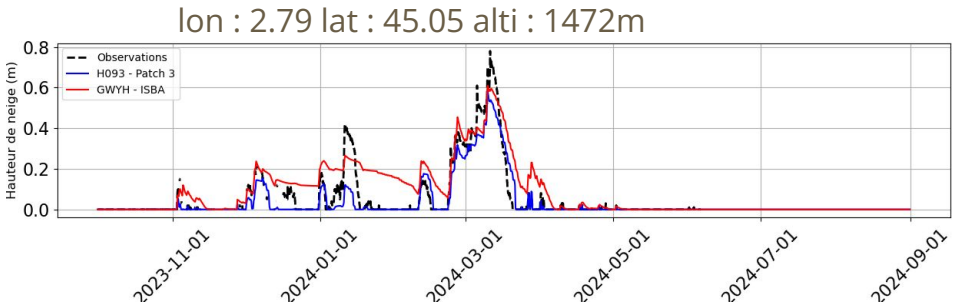


Snow scores over France

REF / NEW / Obs

- the melting period is better with NEW
- but too early
- should be improved when MEB is activated

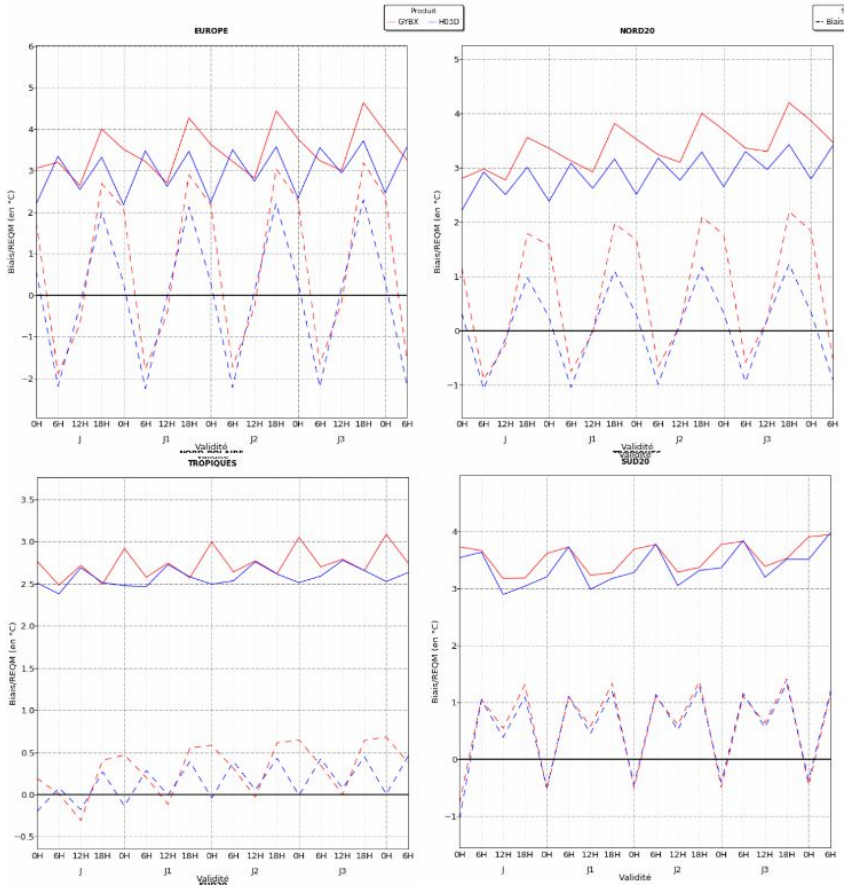




Coupled forecasts using initial condition from Offline system

Red : 102h forecast initialized from REF (offline system with operational physics)

Blue : 102h forecasts initialized from NEW (Offline system with NEW physics)



Surface analysis in the REF offline system

Surface analysis is performed every 6h as in the operational setup

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    - [ACT] 06
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        + [QUE] fc
    + [QUE] 12
    + [QUE] 18
```

Obs preprocessing

Surface analysis

Offline forecast +6h

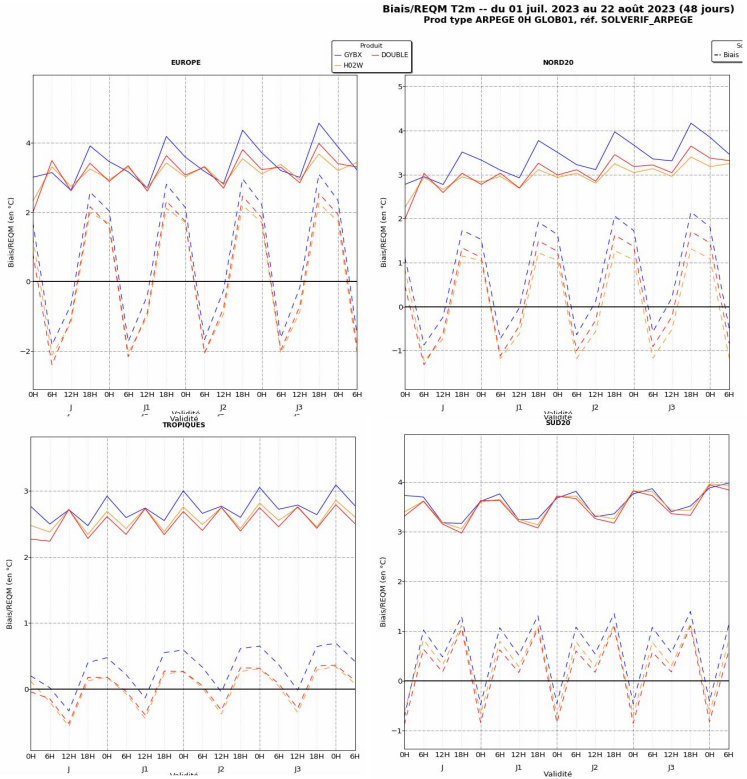
Coupled forecasts (+102 h)

Surface analysis in the REF offline system

Surface analysis is performed every 6h as in the operational setup

Scores (bias and RMSE) for 102h forecast from the operational system, intialised from the REF offline experiment without assimilation and EXP with surface assimilation

Improvement from surface data assimilation: brings **coupled forecasts** close to the operational forecasts



Surface analysis with NEW physics (ongoing work)

Analysis on 3 patches, up to 8 layers for soil temperature and 6 layers for soil moisture

- same analysis increments on the 3 patches for soil temperature
- total water content increment similar to the REF experiment on each grid cell (depending on vegetation parameters)

Conclusion

- Offline tool to run the NEW physics and evaluation
- Coupled forecasts initialised from the offline tool
- First results are promising

Issues and questions

- Still have problems with compaction of snow
- MEB on high and low vegetation does not work yet
- Should we use T2M_P3 instead of T2M for assimilation? Evaluation?

Perspectives

- Forecasts scores in upper air (vs radiosoundings and IFS analysis)
- Surface data assimilation for the NEW physics
- Full coupled experiments with the 4DVar system with the new physics

collaborations GMAP : option ARPEGE

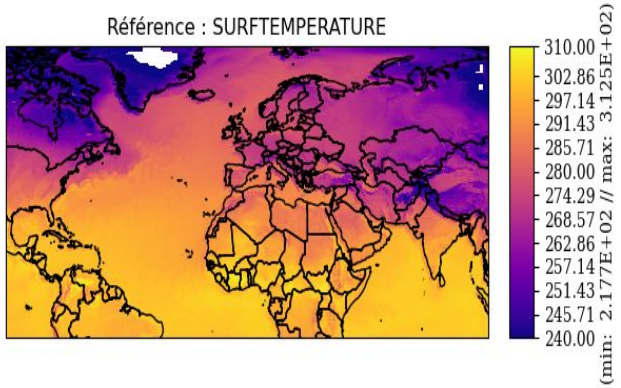
1. résoudre le problème de l'activation de SURFEX dans la traj (Yves, Etienne, Adrien, 2025)
2. adapter canari pour la nouvelle physique (Camille, début 2025)
3. passer au cy49 (Adrien, Antoine V., mi 2025)

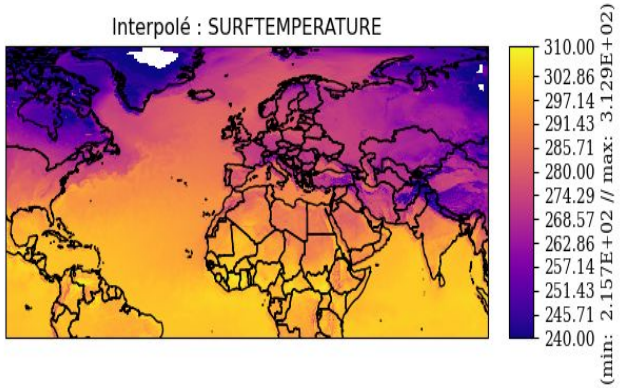
-> lancer 4dvar sur la base de la double 49 (2025)

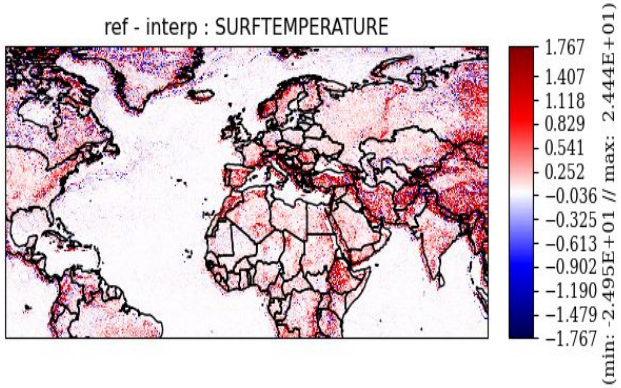
4. développer outil post-traitement (Adrien, Junior, collaboration DSM? Ingrid ?)
5. nouvelle physique dans les Arome-OM (Sophie, début 2026)
6. AEARP (Nicole, mi 2026)
7. PARP (Carole, mi 2026)

post traitement

Domaine : atourx01
Date : 2025-03-01 00:00:00







collaborations GMAP : option AROME

1. tester AD depuis arpege 4dvar ou offline (Salomé, fin 2025)
2.

Questions en suspens

1. nouvelle physique : activation de MEB, serait souhaitable en particulier pour la neige, mais encore des problèmes techniques

2. activation de TEB pour homogénéisation des systèmes. Premiers tests dans ARPEGE sont OK techniquement et neutre sur T2M

3. passage à la version 9.1 de SURFEX
4.
5. quels diagnostics pour T2M/HU2M avec les patchs ?