



The Meteo-France 48t1 e-suite - Summary of content and performance *(a complement to the « Meteo-France NWP systems » poster)*

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Tallin (remotely from Toulouse), 30th March 2023

1. Context – The present « 46t1 » o-suite

2. 48t1 AROME

3. 48t1 ARPEGE

4. Future plans

1. Context – The present 46t1 o-suite

1. Context – The present 46t1 o-suite

46t1 suite has been declared operational on 29 June 2022 :

- new ARPEGE physics (including Tiedtke-Bechtold convection scheme),
- improvements in AROME representation of convection (removal of semi-lagrangian diffusion),
- increase of resolution of ARPEGE-EPS to reach ARPEGE resolution (T1798c2.1L105),
- increase of resolution of AROME-EPS to reach AROME resolution (1.3kmL90),
- increase of resolution of AROME-overseas (and use of 32b computations),
- among many other innovations (observations for assimilation, physics, perturbations, etc)

... see ACCORD Newsletter #2

1. Context – The present 46t1 o-suite

ARPEGE :

Assimilation 4D-VAR, T1798c2.1L105

ARPEGE-EDA, 50 members, T499C1L105

Forecast 34+1 members, +102h 4times/day

AROME-France :

Assimilation 3D-VAR, 1.3kmL90

AROME-EDA, 25 members, 3,25kmL90

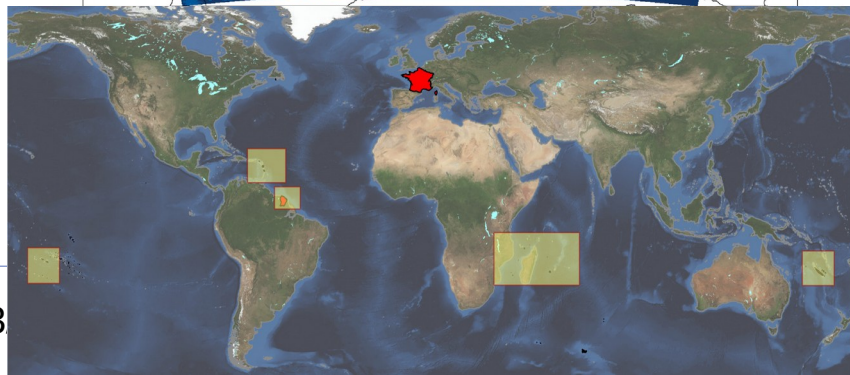
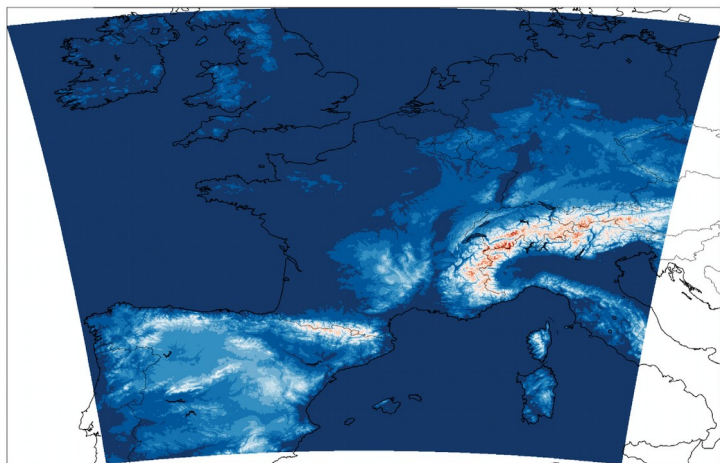
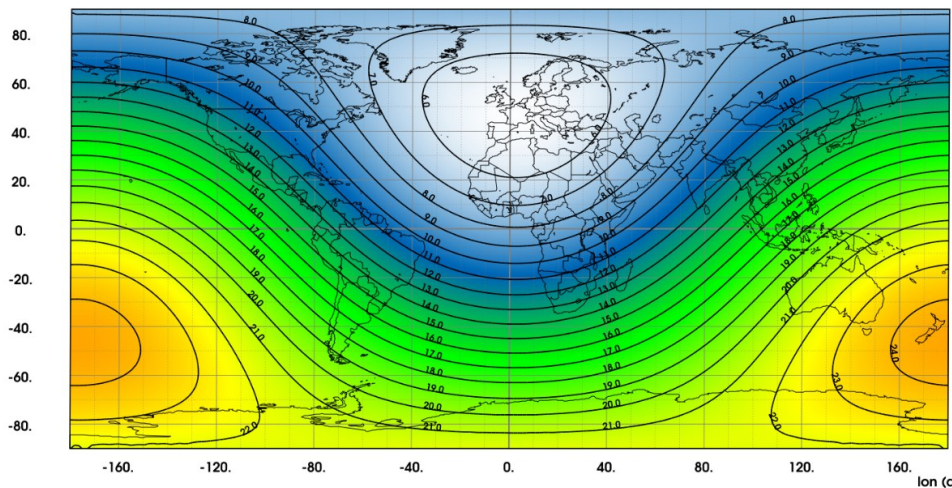
Forecast 16+1 members +51h, 4times/day

(+ deterministic runs every 3hours +
AROME-IFS + AROME-NWC)

AROME-overseas :

1.3kmL90, IFS coupling, 5 domains

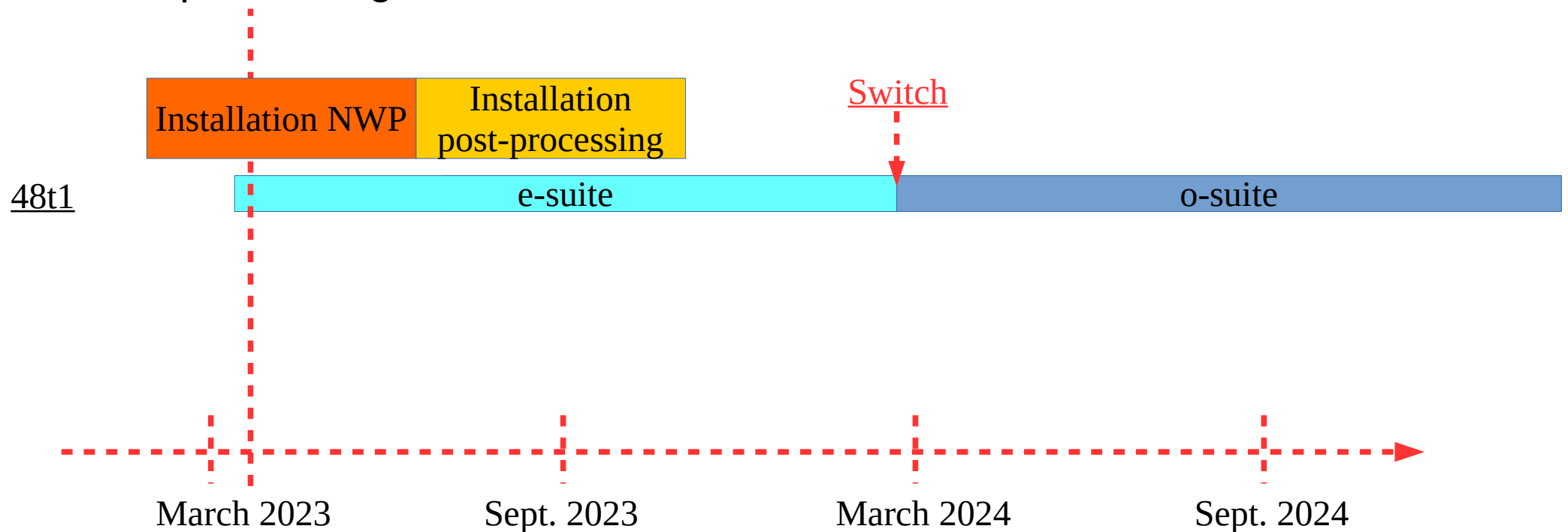
Forecast +48h (+extension for cyclones),
4times/day



1. Context – Schedule of 48t1 suite

Most components are included in the e-suite : AROME-F, AROME-EPS, ARPEGE, ARPEGE-EPS, AROME-NWC, AROME-overseas... but not all initial times for all systems,

Post-processing : calibration, automatic database « ALPHA », ...



2. 48t1 AROME

2. 48t1 AROME - Assimilation

- 3D Ensemble variational scheme « 3DEnVar », replacing 3DVAR, (*presented by V. Vogt, « Implementation of 3DEnVar with OOPS »*),
- Use of Incremental Analysis Update,
- Implementation of assimilation schemes (3DEnVar, AROME-EDA 3DVAR, AROME-NWC) under OOPS,
- AROME-EDA (used for 3DEnVar): 50 members, longer forecast term,
- Direct assimilation of microwave radiances in « all-sky » conditions (replacing assimilation of humidity after Bayesian inversion),
- Use of WIGOS reference for surface radiosonde observations,
- Assimilation of GNSS-RO data from SPIRE, GRACE-C, Sentinel-6,
- Assimilation of wind and temperature data derived from Mode-S (+900.000 wind, +500.000 temp. observations per day!) - data acquired from EMADDC,
- Assimilation of wind scatterometer HY-2B and HY-2C,
- AROME-NWC : assimilation of MeteoSat/RapidScan radiances.

2. 48t1 AROME – Surface and physics

- Surfex v8.1,
- SST from Mercator (PSY4 1/12° product, now moving to GLO12),
- Radiation : EcRad with McIca solver,
- Include the effect of solar eclipses on radiation,
- Some improvements in the turbulence scheme.

2. 48t1 AROME – Forecasts

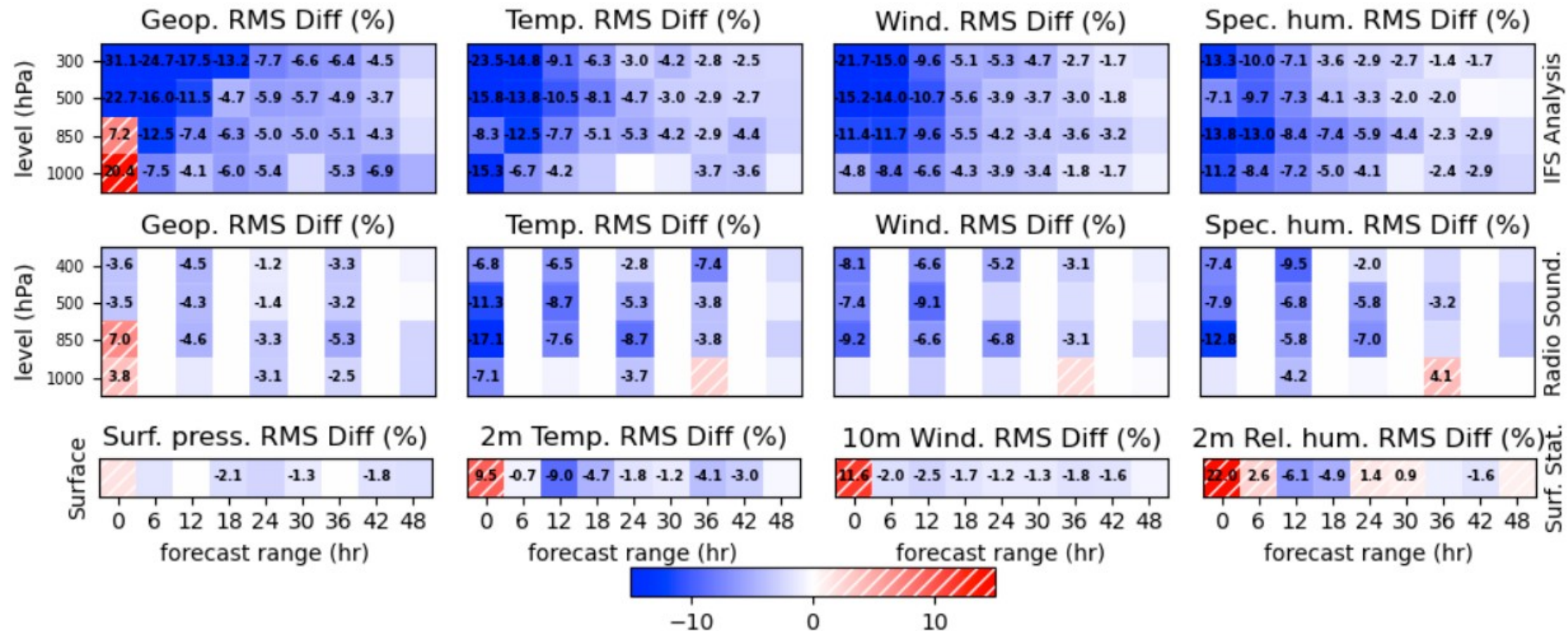
- All « production » forecasts in single precision,
- EPS : 24+1 members instead of 16+1 members,
- New user-oriented diagnostics delivered.

AROME-overseas :

- AROME-overseas system follow evolutions of AROME physics and surface (Mercator SST already included),
- AROME-EPS overseas systems have been recently installed (*presented by O. Nuissier*), a 48t1 version is included in the e-suite,

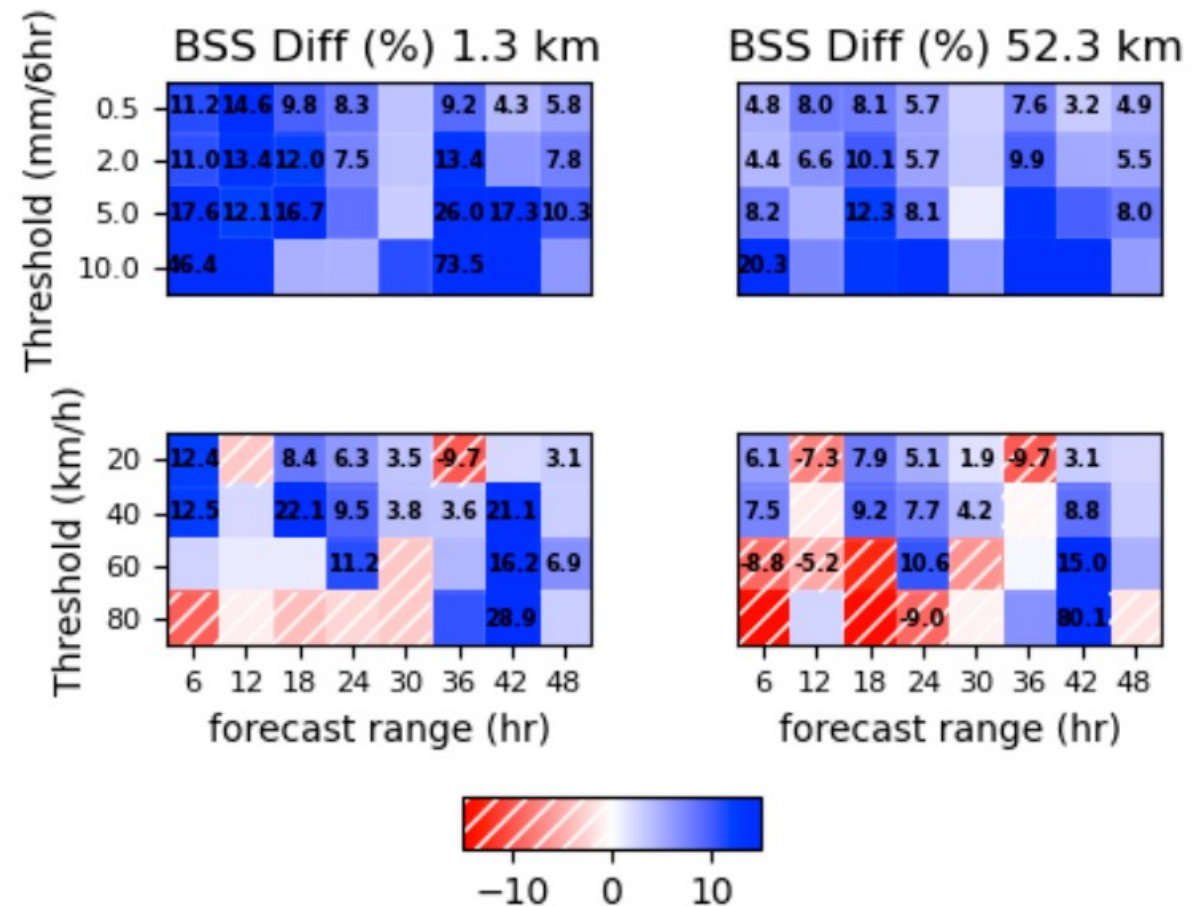
2. 48t1 AROME – Performance AROME-France

- % RMS diff, 48t1 experiment against 46t1 o-suite, 31/07/2022 → 01/10/2022,
- Verification to IFS analyses, radiosondes, surface measurements



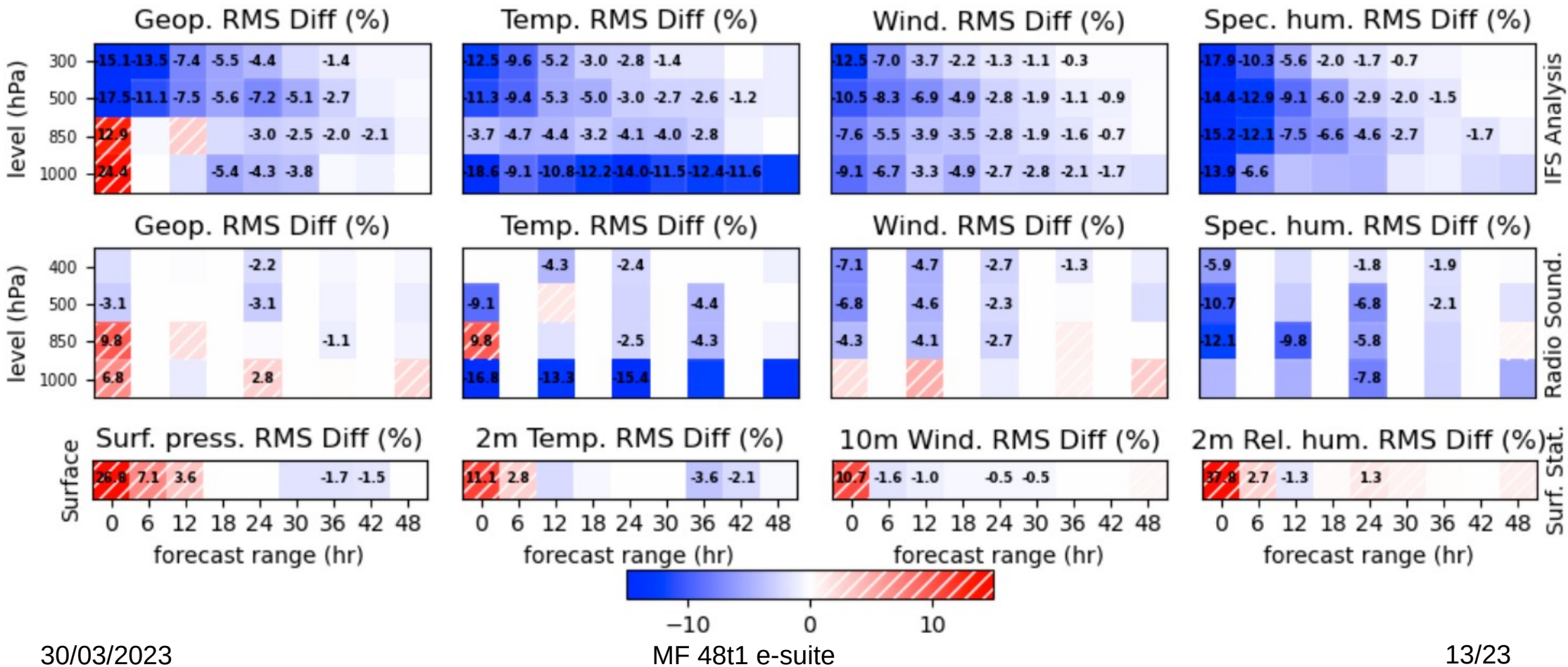
2. 48t1 AROME – Performance AROME-France

- Brier Skill Score,
- 48t1 experiment against 46t1 o-suite,
- 31/07/2022 → 01/10/2022,
- Verification surface measurements (rain accumulation and wind gusts),



2. 48t1 AROME – Performance AROME-France

- % RMS diff, 48t1 experiment against 46t1 o-suite, 01/12/2022 → 31/10/2022,
- Verification to IFS analyses, radiosondes, surface measurements



2. 48t1 AROME – Performance AROME-France

- Large improvements for all variables and at all levels,
- Very short terms : some degradation (the analyses are less close to the observations compared to 3D-Var, see *V. Vogt's presentation*),
- Larger improvements in summer than in winter,
- Many tests done on storm, fog, high precipitation events ... overall positive.

2. 48t1 AROME – Performance AROME-EPS

... integration experiments and scores on-going ...

3. 48t1 ARPEGE

2. 48t1 ARPEGE - Assimilation

- Implementation of assimilation schemes (ARPEGE, ARPEGE-EDA) under OOPS,
- Hybrid 4DVAR : 3D anisotropic covariances from ARPEGE-EDA,
- ARPEGE-EDA : addition of a control unperturbed member,
- Direct assimilation of microwave radiances in « all-sky » conditions (replacing assimilation of humidity after Bayesian inversion),
- Use of WIGOS reference for surface radiosonde observations,
- Assimilation of GNSS-RO data from SPIRE, GRACE-C, Sentinel-6,
- Variational debiasing of aircraft data,
- update of the IASI inter-channel cross-correlations errors,
- use of model (GELATO) sea-ice for assimilation of microwave radiances.

2. 48t1 ARPEGE – Physics and surface

- Update of the « Tiedtke Bechtold » deep convection scheme, some improvements (rainfall near the coastlines),
- WENO interpolations in the stratosphere (T and q),
- Radiation : EcRad with McIca solver,
- Include the effect of solar eclipses on radiation,
- Surfex v8.1,
- SST from Mercator (PSY4 1/12° product, now moving to GLO12).

Specific to ARPEGE-EPS :

- Removal of some singular vectors (over NH and SH domains),
- Adaptation of perturbation parameter ranges.

2. 48t1 ARPEGE – Performance ARPEGE

Score cards

- 48t1 experiment against 46t1 o-suite
- 05/08/2022 → 15/01/2023,
- domain Europe,
- Verification against radiosondes and IFS analyses :

	Réf.	Radiosondes	IFS analyses
	Grille	GLOB025	GLOB025
	Éch.	0H à 96H pas de 12H	0H à 102H pas de 6H
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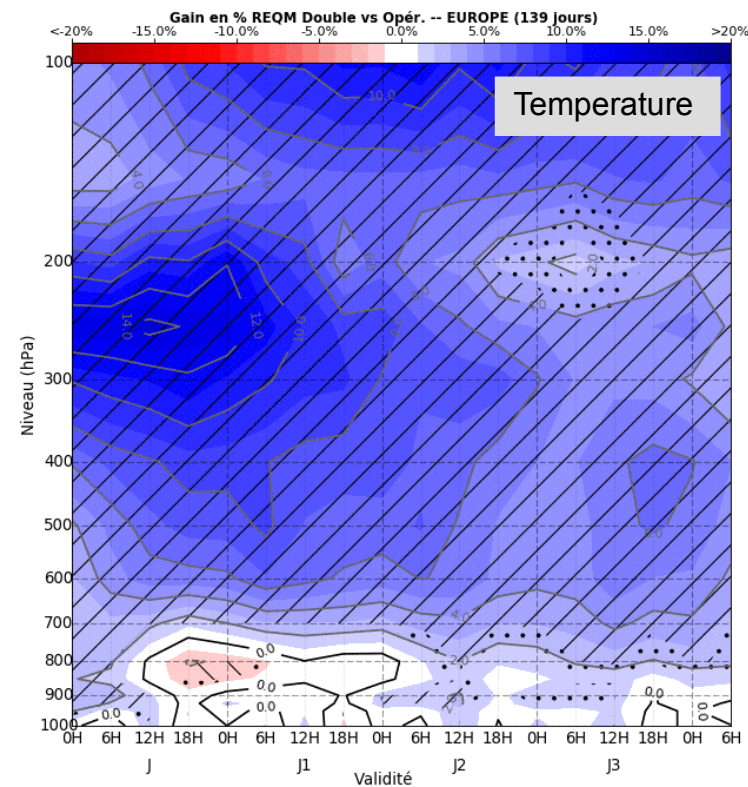
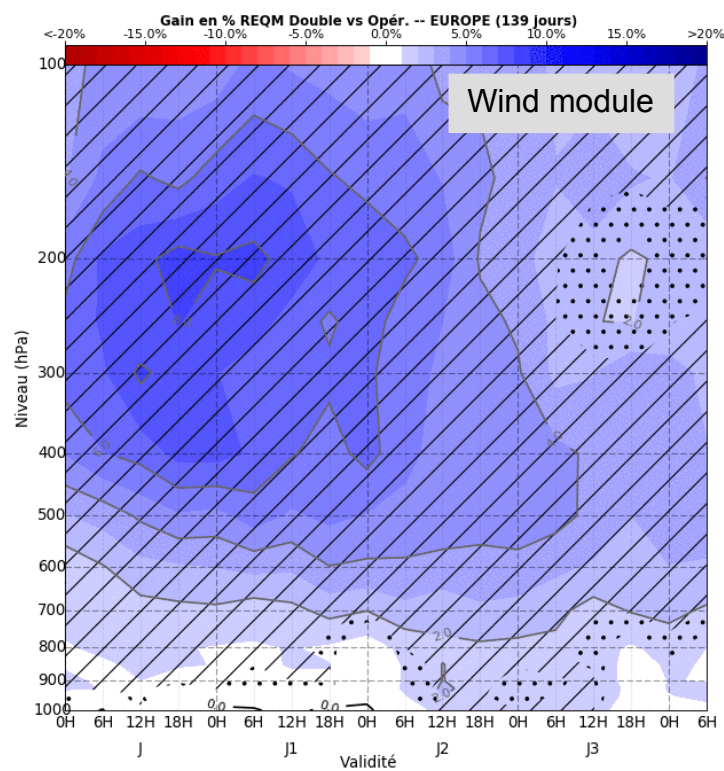
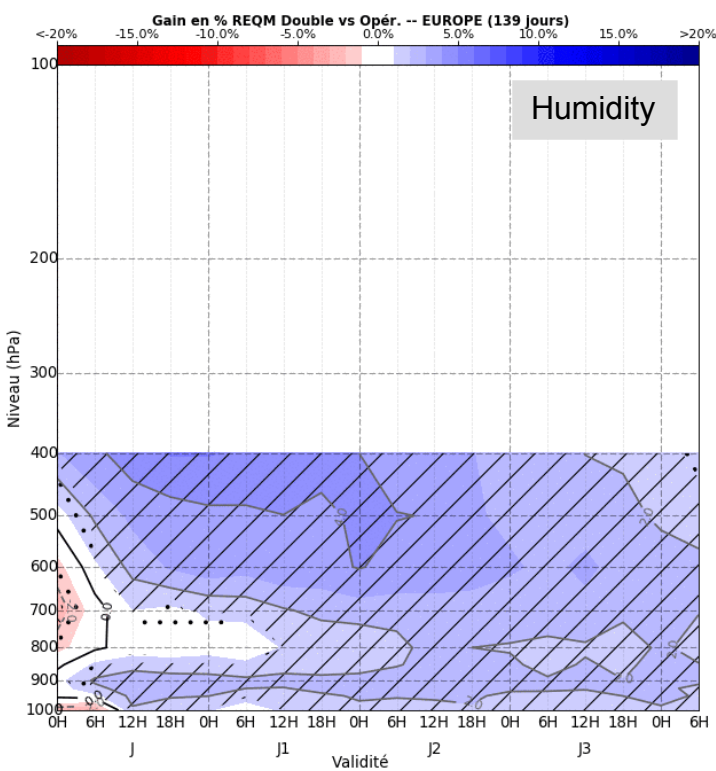
2. 48t1 ARPEGE – Performance ARPEGE

% gain in RMSE:

- 48t1 experiment against 46t1 o-suite
- 05/08/2022 → 06/02/2023,
- domain Europe,
- Verification IFS analyses

In general, positive significant improvements.

Except for temperature in the low levels (neutral or slight degradation), and humidity at short terms



4. Future plans

4. Future plans (on-going work for next e-suite or later)

- AROME 4DEnVar,
- Include hydrometeors in the AROME control variable (in order to enable direct assimilation of radar reflectivity, assimilation of MTG-I/LI),
- Improve ARPEGE 4DVAR (improve tangent-linear, revise minimization loops and resolutions, towards hybrid 4DVAR/ensemble, ...),
- Evolutions of model perturbations (parameter perturbations, SPP),
- Prepare for the assimilation of future satellites : MTG-S/IRS, Metop-SG,
- Assimilation of Mode-S in ARPEGE,
- Generalize use of single precision in forecasts,
- Surface analysis under OOPS (*presented by S. Marimbordes*),
- Include Ocean mixed layer coupling in ARPEGE and AROME-F,
- Include more complex coupling in some systems (*see AROBASE presentation*),
- ...