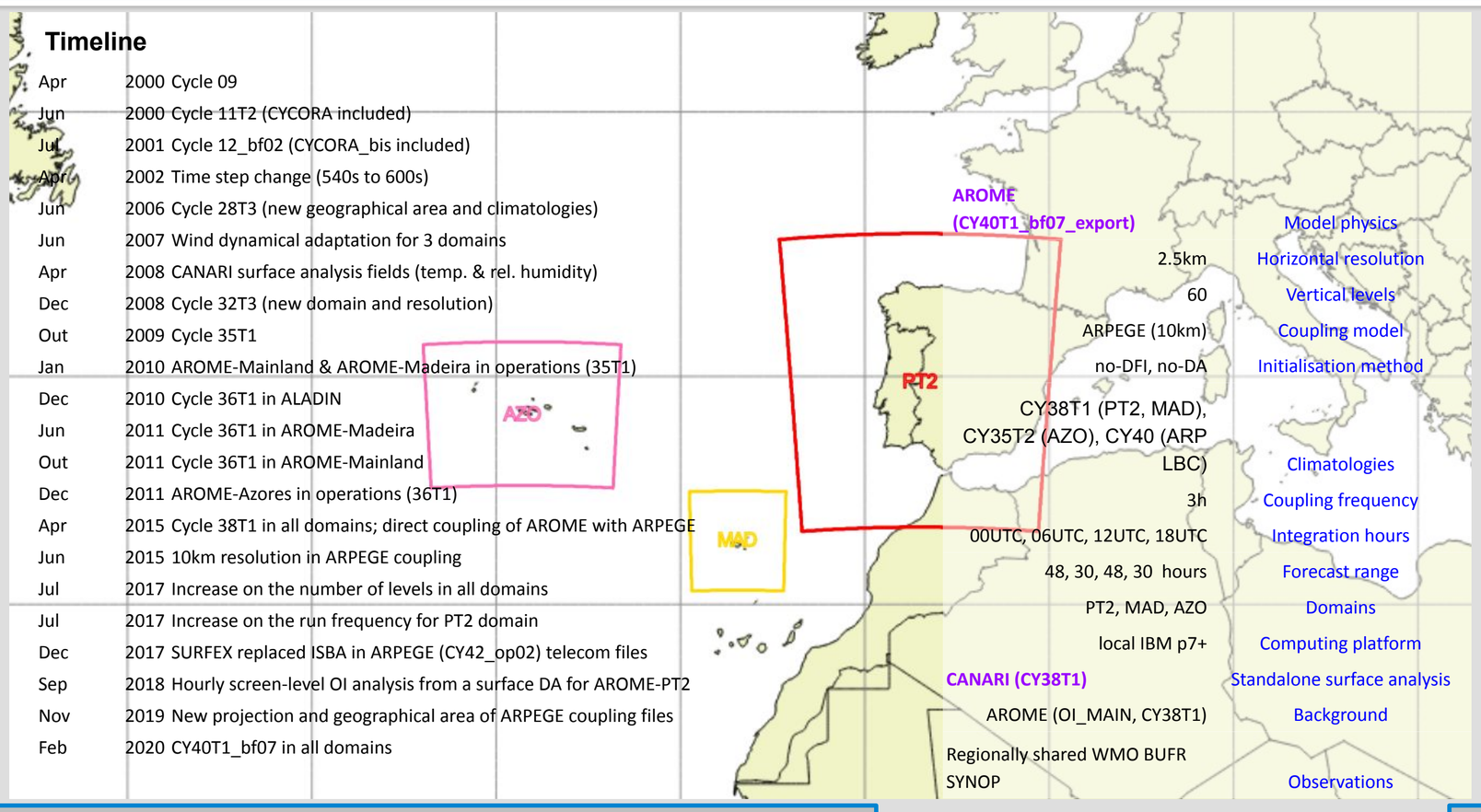
Portuguese status on SRNWP

3rd ACCORD All Staff Workshop, Tallinn, 27-31 March 2023

Timeline

Apr	2000	Cycle 09
Jun	2000	Cycle 11T2 (CYCORA included)
Jul	2001	Cycle 12_bf02 (CYCORA_bis included)
Apr	2002	Time step change (540s to 600s)
Jun	2006	Cycle 28T3 (new geographical area and climatologies)
Jun	2007	Wind dynamical adaptation for 3 domains
Apr	2008	CANARI surface analysis fields (temp. & rel. humidity)
Dec	2008	Cycle 32T3 (new domain and resolution)
Out	2009	Cycle 35T1
Jan	2010	AROME-Mainland & AROME-Madeira in operations (35T1)
Dec	2010	Cycle 36T1 in ALADIN
Jun	2011	Cycle 36T1 in AROME-Madeira
Out	2011	Cycle 36T1 in AROME-Mainland
Dec	2011	AROME-Azores in operations (36T1)
Apr	2015	Cycle 38T1 in all domains; direct coupling of AROME with ARPEGE
Jun	2015	10km resolution in ARPEGE coupling
Jul	2017	Increase on the number of levels in all domains
Jul	2017	Increase on the run frequency for PT2 domain
Dec	2017	SURFEX replaced ISBA in ARPEGE (CY42_op02) telecom files
Sep	2018	Hourly screen-level OI analysis from a surface DA for AROME-PT2
Nov	2019	New projection and geographical area of ARPEGE coupling files
Feb	2020	CY40T1_bf07 in all domains



AROME (CY40T1_bf07_export)	Model physics
2.5km	Horizontal resolution
60	Vertical levels
ARPEGE (10km)	Coupling model
no-DFI, no-DA	Initialisation method
CY38T1 (PT2, MAD), CY35T2 (AZO), CY40 (ARP LBC)	Climatologies
3h	Coupling frequency
00UTC, 06UTC, 12UTC, 18UTC	Integration hours
48, 30, 48, 30 hours	Forecast range
PT2, MAD, AZO	Domains
local IBM p7+	Computing platform
CANARI (CY38T1)	Standalone surface analysis
AROME (OI_MAIN, CY38T1)	Background
Regionally shared WMO BUFR SYNOP	Observations

The Portuguese NWP system(s)

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The actual Portuguese (SR)NWP operational system covers a wide geographical area over the North Atlantic region which includes the Iberian Peninsula and Adjacent Atlantic, and the Portuguese Archipelagos of Madeira and Azores. The system is described according to its local application: a **prognostic** component - where the integration of the AROME forecasting model is performed over the three different geographical domains of Mainland (PT2), Madeira (MAD) and Azores (AZO) as the dynamical adaptation of the global model ARPEGE which, provides the initial and lateral boundary conditions; and, a **diagnostic** component - where an hourly CANARI analysis for the PT2 domain, having as first guess a short-term AROME forecast produced by a surface data assimilation (DA) system, is produced. The system is based on a set of ecFlow scripts submitted from a front-end cluster to an HPC IBM platform (see also left middle panel).

Geographical domains of AROME model (left background illustration); timeline of main upgrades (left side of the panel); and detailed information on the operational configurations of the Portuguese (SR)NWP system (right side of the panel).

Acquisition of a new HPC

ATOS Bull Sequana X400 series

During 2022, the re-design of the Portuguese NWP system was used to prepare an ITT benchmark. In this way, a new HPC system has been acquired - an ATOS HPC Bull Sequana X430 A5 with:

- 30 computing nodes, each with 2 AMD EPYC™7763 processors with 64 cores @ 2.45 GHz and 256 RAM, in a total of 3840 cores;
- 2 login nodes, each with 1 AMD EPYC™Milan 7313 processor with 16 cores @ 3.0GHz and 128 GB RAM;
- 2 management nodes, each with 1 AMD EPYC™processor with 24 cores @ 2.8GHz and 128 GB RAM ;
- Lustre file system;
- 160 TB raw Lustre storage.

Re-design of the Portuguese (SR)NWP system

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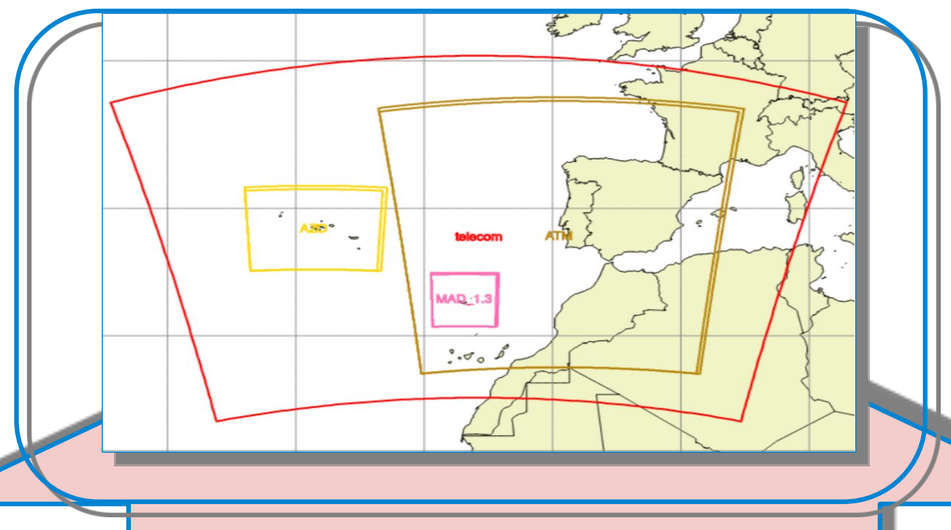
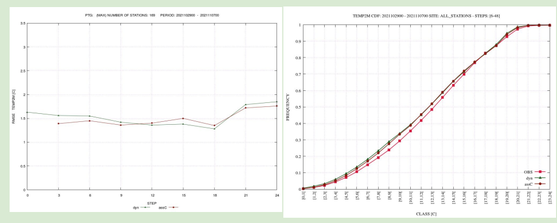
Starting in 2022, a re-design of the NWP system will occur in a four-fold process: (1) acquisition of a new HPC which has been accomplished; (2) migration (and porting to CY43T2_bf11) of the current operational system to the new HPC ATOS Bull Sequana (left panel) which has just started; (3) implementation of a new geographical configuration and model geometry on the Atlantic/Iberian domain (AROME ATM, 2.5km, 90L) that will provide the initial and lateral boundary conditions to a higher resolution version of AROME-MAD (1.3km, 90L) over the Madeira archipelago (central panel below), expected for early Summer; (4) implementation of a 3-hour cycling of the AROME combined (OI_MAIN+3D-Var) DA solution over ATM domain (central right panel).



Combined DA solution for AROME in Portugal

A combined solution of CANARI-OI_MAIN (Giard & Bazile, 2000) + 3D-Var DA is being tuned and validated on ECMWF computing platforms for AROME/PT2 and AROME/MAD (using CY43T2 and ARPEGE as coupling model): the preliminary validation of CY43T2_bf10 forecasts for AROME/PT2 initialised by surface DA has shown a slight improvement on the screen level parameters when regional SYNOP is assimilated; furthermore, the preliminary validation of CY43T2_bf10 forecasts for AROME/PT2 initialised by combined (surface+upper-air) DA has shown a neutral or slightly improvement on screen level parameters, especially the 2-metre temperature (see illustration below), when only regional GTS SYNOP data is assimilated (2-metre temperature and 2-metre relative humidity). The validation of the same solution under the assimilation of other observation types, like radiosonde profiles, AMDAR and weather radar is on-going.



Winter 9-day sampling period, 00UTC run; PT2 domain, up to 169 weather stations (after 10 days cycling)

Looking for synergies

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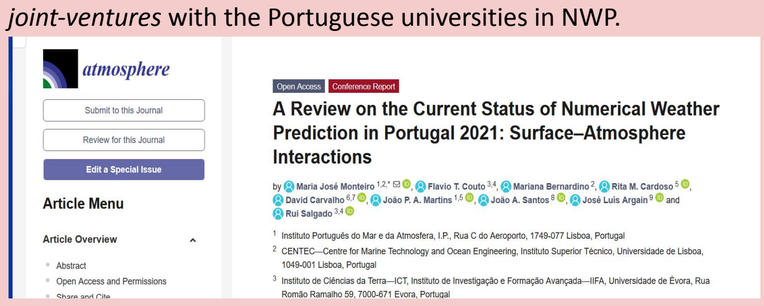
During the last year, further efforts have been put to establish *joint-ventures* with the Portuguese universities in NWP.



The workshop "Numerical Weather Prediction in Portugal, 2021", was dedicated to the surface-atmosphere interaction, gathering several Portuguese groups on NWP and also the presence of four invited speakers which are scientists from forefront European organizations: Clément Albergel (ESA), Gianpaolo Franco (ECMWF), Patrick Samuelsson (ACCORD) and Tânia Casal (ESA). As an immediate outcome, an article was published at the Atmosphere journal.

Other collaborative projects involving the Portuguese team:

. DEODE - Destination Earth On-Demand Extremes, funded by the EU

. EUMETNET A3.13 Study, on the Forecast Sensitivity Impact (FSOI) to Radiosondes

. SmokeStorm - Forecasting and Communicating Wildland Fire Smoke Effects, a project lead by University of Aveiro (PCIF/MPG/0147/2019, with grants from the Portuguese Foundation for Science and Technology

PyroC.pt - Modelling Wildfires for risk assessment and pyro-convection in Portugal

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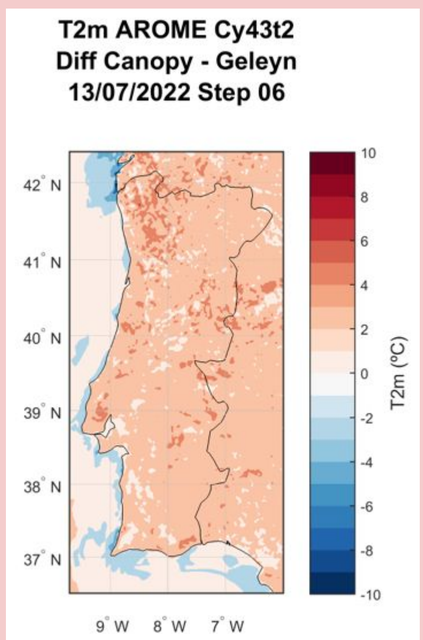
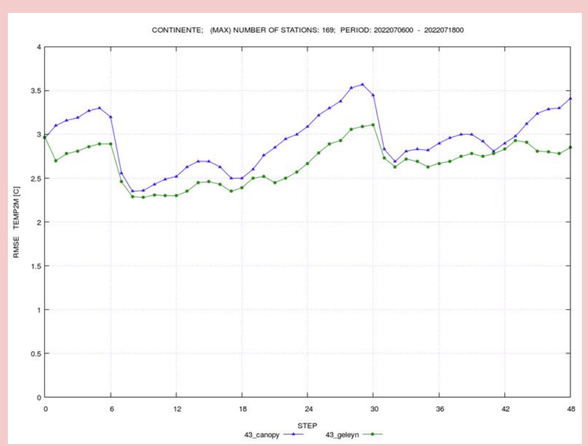
PyroC.pt - Advanced wildfire modelling for risk assessment and pyro-convection understanding in Portugal, a project from the University of Évora (PCIF/MPG/0175/2019), with grants from the Portuguese Foundation for Science and Technology is a collaborative project where the Portuguese Team is involved. In fact, Portugal is a territory prone to the ignition and propagation of wildfires. The purpose of this project is to obtain a better representation of pyro-convection in numerical modelling. The aim of the project work package M3 - First forecast using the AROME model coupled with "SURFEX - Fuel", under the responsibility of IPMA, consists on the validation of the AROME operational configuration over mainland Portugal considering the fuel state, namely live and dead fuel load, and respective moisture contents. This information is essential to produce the adequate state of the surface needed to fire-atmosphere coupled models (e.g., MesoNH/ForeFire, Filippi et al., 2009, 2018).



Wildfire propagation depends on several factors, namely favorable conditions of temperature, humidity and wind near the surface. Thus, the adequate forecast of these parameters becomes relevant in fire prevention and mitigation strategies. In the context of the PyroC.pt, the forecast of near-surface parameters in the AROME model is done using the Geleyn (1988) and CANOPY (Le Moigne, 2009) options. A validation of the forecasts was done in a very warm period in July 2022, using around 169 weather stations in mainland Portugal (see right-hand side panel). Preliminary results suggest that the forecasts of 2-metre temperature, 2-metre relative humidity and 10-metre wind speed using the CANOPY options have a higher RMSE than the ones using Geleyn (1998). Likewise, the bias is overall positive and the largest differences are detected in the nighttime period.

Spatial distribution of the difference in the 2 m temperature forecasts, when two different screen-level diagnostics are used (CANOPY and Geleyn, 1988). Data from the 00 UTC AROME-PT2 forecast on 13 july 2022, which was within a very warm period. The results show that differences can reach up to 5ºC at 06 UTC.



RMSE of the 2 m temperature from 00 UTC AROME-PT2 forecasts (dynamical adaptation). Results using data from 169 weather stations, for the period 06 Jul 2022 - 18 Jul 2022. The two diagnostics used are Geleyn (1988) - green line and CANOPY, blue line.

GELEYN, J.-F. (1988): Interpolation of wind, temperature and humidity values from model levels to the height of measurement. Tellus A, 40ª: 347-351. https://doi.org/10.1111/j.1600-0870.1988.tb00352.x; **Giard, D., & Bazile, E. (2000)**: Implementation of a new assimilation scheme for soil and surface variables in a global NWP model. Monthly Weather Review, 128, 997-1015. **Filippi, J.-B., Bosseur, F., Mari, C., Lac, C., Le Moigne, P., Cuenot, B., Veynante, D., Cariolle, D., & Balbi, J.-H. (2009):** Coupled atmosphere–wildland fire modelling. J. Adv. Model. Earth Syst. 2. https://doi.org/10.3894/JAMES.2009.1.11; **Filippi, J.-B., Bosseur, F., Mari, C., & Lac, C. (2018):** Simulation of a Large Wildfire in a Coupled Fire-Atmosphere Model. Atmosphere. 9(6), 218. https://doi.org/10.3390/atmos9060218; **Le Moigne, Patrick. (2009)**: SURFEX scientific documentation. 87. 211. https://www.researchgate.net/publication/200471711_SURFEX_scientific_documentation .

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