NWP activities at IPMA

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Operational and pre-operational Portuguese (SR)NWP systems

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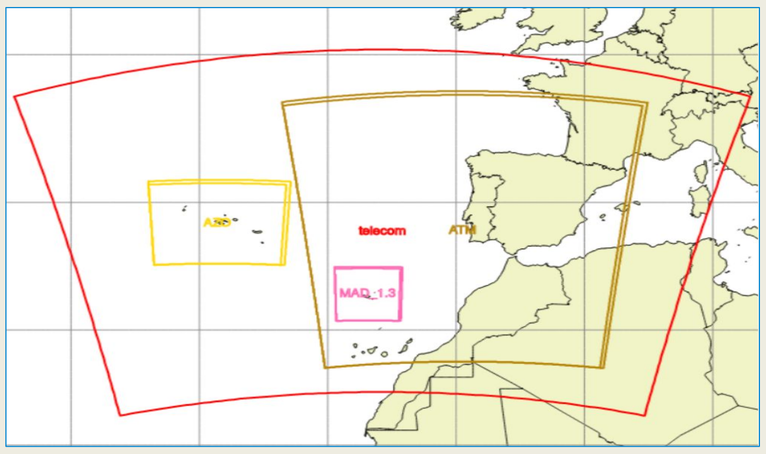
The **actual** Portuguese (SR)NWP **operational system** covers a wide geographical area over the **North Atlantic region**, including the Iberian Peninsula and the Adjacent Atlantic, as well as the Portuguese archipelagos of Madeira and the Azores. The system relies on the **AROME forecasting model** which is integrated over three different domains - Mainland (PT2, not shown), Madeira (MAD), and the Azores (AZO) - initialised by dynamical adaptation of the global ARPEGE model (10km) which provides also the lateral boundary conditions. The system is implemented on a **local ATOS machine** (top right panel) and is based on a set of ecFlow scripts as scheduling system. The model runs at **00, 06, 12, and 18 UTC**, providing hourly forecasts up to **72, 48, 72, and 48 hours**, respectively. With the recent availability of new coupling files, several upgrades have been implemented in the current model configurations: **the coupling frequency has been increased to 1 hour, the lead time has been extended, and the number of vertical levels has been increased from 60 to 90.**

Since **2023**, the **re-design of the local system** is ongoing in a **three-fold process:**

(1) the migration (and porting to CY43T2_bf11) of the actual operational system to the new HPC ATOS Bull Sequana (right top panel) entered into **operational state**. The system should be loaded under git/GitHub;
(2) the implementation of a **new geographical configuration and model geometry** on the Atlantic/Iberian domain (known as **AROME-ATM**, 2.5km, 90L) (top panel) is finished. This new model configuration will provide the initial and lateral boundary conditions to a higher resolution version of **AROME-MAD and AROME-AZO (1.3km, 90L)** over Madeira and Azores archipelagos (central panel below), and is expected for the end of the 2025;
(3) the implementation of a 3-hour cycling of the AROME combined (OI_MAIN+3D-Var) **DA solution over the ATM domai**n (central left panel below) is on-going.



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
Jan	2024	CY43T2_bf11 ported to the new local ATOS machine
Out	2024	New telecom files: new coupling frequency, lead time, vertical levels

HPC system

ATOS Bull Sequana X400 series

Operational HPC System – ATOS HPC Bull Sequana X430 A5 with:

- **30 computing nodes**, each equipped with **2 AMD EPYC™ 7763** processors (64 cores @ 2.45 GHz) and **256 GB RAM**, totaling **3,840 cores**;
- **2 login nodes**, each with **1 AMD EPYC™ Milan 7313** processor (16 cores @ 3.0 GHz) and **128 GB RAM**;
- **2 management nodes**, each with **1 AMD EPYC™ processor** (24 cores @ 2.8 GHz) and **128 GB RAM**;
- **Lustre file system**;
- **160 TB raw Lustre storage**.

DAP2024 - Git Transfer of knowledge

During **29-30 October 2024**, a training on **Git/GitHub** took place at IPMA headquarters in **Lisbon**, led by the ACCORD AL for Systems, **Daniel Santos**. This proved to be an excellent opportunity for the team: participants enjoyed the training, were enthusiastic about applying these practices and utilities to their daily work, and were trained to start contributing to ACCORD projects at any time.

DAsKIT over Portugal mainland

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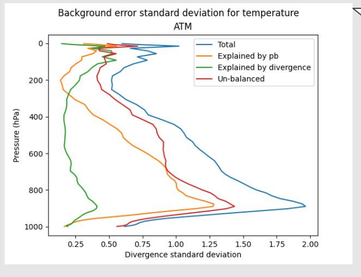
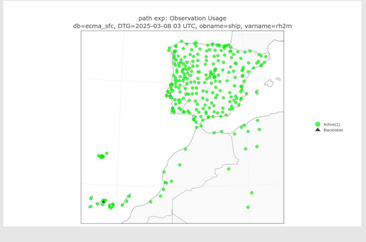
The **DAsKIT** is currently being implemented locally. A climatological **B-matrix** was generated from a two-week summer period using an ensemble technique, based on a six-member ensemble obtained through a 3-hour downscaling from **AEARP**. Diagnostics using **ACCORD** tools have just begun. Furthermore, the observation monitoring software **OBSMON** has been implemented.



Standard deviation of background error statistics on the locally computed B-matrix, obtained with AccordDaTools



Relative humidity at 2-metre, active on the local surface DAsKIT scheme, obtained with OBSMON

AROME 1.3 km over Madeira and Azores archipelagos

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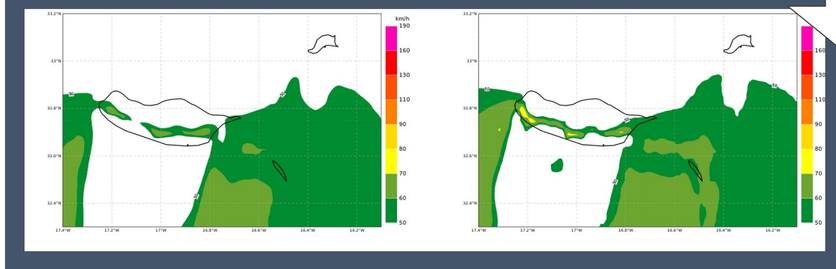
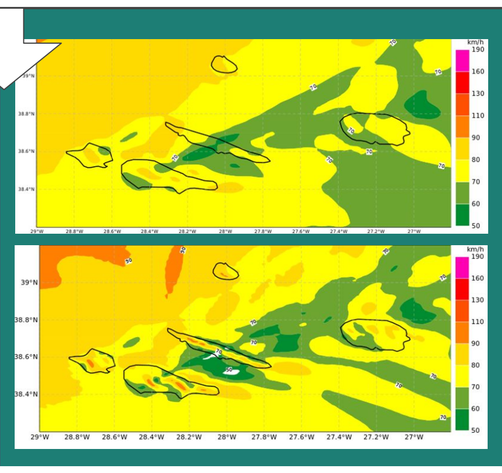
AROME is being tested at **1.3 km** resolution over the Atlantic islands of **Madeira** (left panels below) and the **Azores** (right panels below) through downscaling of **ARPEGE at 10 km resolution**, with **90 vertical levels** and **50 and 48 timesteps**, respectively.

These tests have generally shown that near-surface parameters, such as temperature and wind, benefit from the improved representation of orography when compared to AROME at **2.5 km**. For instance, at **1.3 km** resolution, the representation of **downslope winds** appears to be closely related to **orographic effects**.However, the same benefit of orography was not always observed for precipitation, for instance.



AROME-AZO **3-hour wind gust forecast (H+06)** at **2.5 km** (left) and **1.3 km** (right) horizontal resolutions for the **Madeira Archipelago**, during a **high-pressure** system located west of Madeira on **24 March 2025**.



AROME-AZO **3-hour wind gust forecast (H+39)** at **2.5 km** (top) and **1.3 km** (bottom) horizontal resolutions for the **Central Group** of the **Azores Archipelago**, during a low-pressure system influence on **16 December 2024**.

Contribution to DE_330 (ECMWF)
Impact models - Risk assessment of WildFires

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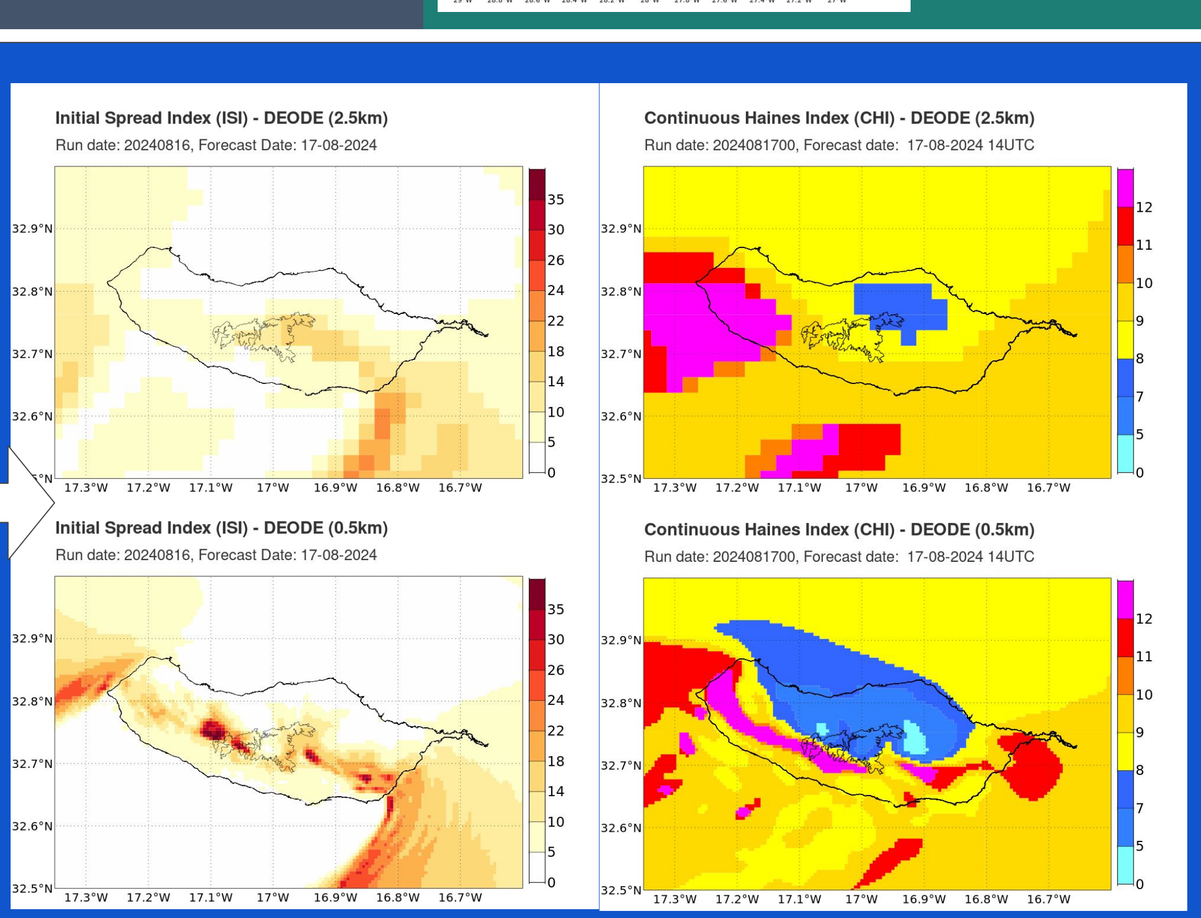
To consolidate the evidence of the added value of **sub-km** data on wildfires, four test cases have been analysed corresponding to real fire events: a) **October 2017** in the **Northern/Central Portugal**; b) **August 2022** in **Serra da Estrela**; c) **August 2024** over **Madeira Island**; and d) **September 2024** in the **Northern/Central Portugal fires**. The **sub-km simulations** were used in the **development and validation** of the products and applications now proposed by IPMA.

The **Madeira fire of August 2024** was particularly relevant due to the **island's complex terrain** and the opportunity to directly compare **DEODE simulations at 0.5 km and 2.5 km horizontal resolutions**, using the same boundary conditions. On the other cases, comparisons were made between **DEODE 0.5 km** and **IPMA's operational AROME 2.5 km** forecasts. This event was one of the **largest wildfires ever recorded in Madeira**. According to **Copernicus**, the fire consumed **5,104 ha**. Although **forest fires in Madeira are mainly driven by orography**, due to the **steep slopes (>25%)** covering the entire island, the **meteorological contribution** plays a crucial role in **planning and managing resources**, allowing for the anticipation of **fire growth characteristics**, such as **fire front intensity** and **spread rate**. The results showed **significant differences** between the **meteorological variables** relevant to fire progression in both simulations, which were clearly reflected in the **fire danger indices**. The **sub-km simulation** showed better agreement with **local reports** of observed conditions and fire behavior and was able to better capture **lower moisture conditions** at mid-level altitudes.

For the **Madeira 2024 case**, the panels show the **spread and low atmosphere stability conditions** given by the **Initial Spread Index (ISI)** (left) and the **Continuous Haines Index (CHI)** (right) for both the **2.5 km (top),** and **sub-km (0.5 km)** (bottom) resolution simulations. The final **burned area perimeter** is shown as a dark contour.



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