Ocean-Atmosphere-Wave Coupling

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27 April 2016 - ALADIN/HIRLAM strategy meeting

A shared strategy

- Many years of experience in the coupling between Climate atmospheric and ocean models (CNRM/GMGEC):

  ARPEGE-Climat and ALADIN-Climat coupled with the ocean NEMO model using the OASIS coupler

- In 2014, several simultaneous initiatives of the mesoscale atmospheric and ocean French research communities to couple atmospheric models using SURFEX (AROME, Meso-NH) with ocean (NEMO, MARS3D, SYMPHONIE) and wave (WW3, MFWAM) models

⇒ Take advantage of the climate experience to develop **a single coupling interface** for all the atmospheric models using SURFEX

⇒ Pulling efforts of the atmospheric, ocean and wave modelling communities to progress on the know-how to couple ocean-atmosphere-wave models and air-sea fluxes parameterizations

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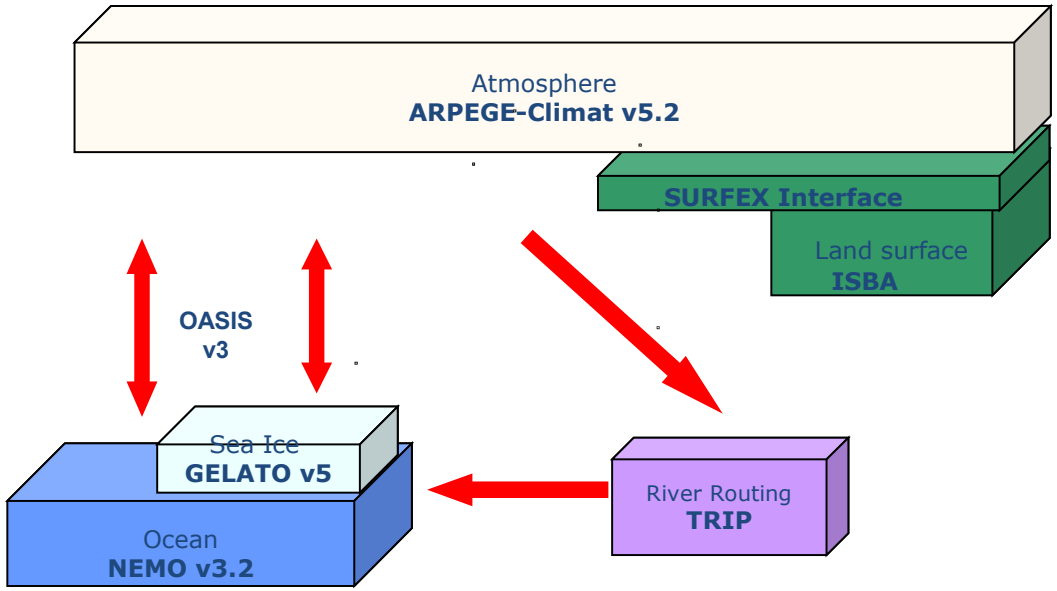
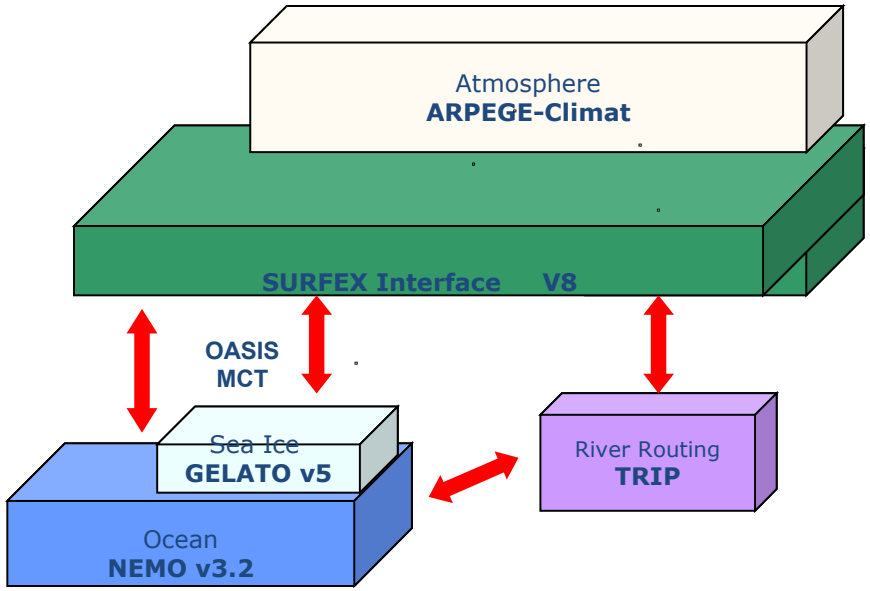
Previous coupling in ARPEGE-Climate (CNRM-CM5)



- No parallelization of the data exchanges via OASIS v3.
- The coupling with OASIS is done in ARPEGE and thus SURFEX should provide to ARPEGE the surface variables to couple (not the « SURFEX philosophy »).

The new coupling for CNRM-CM6



- use the coupler OASIS-MCT (parallel interpolations and data exchanges)
- move code modifications for OASIS-MCT call in SURFEX (as air-sea turbulent parameterizations are in SURFEX) and close to SURFEX (mse)
- enable coupling with SURFEX off-line (e.g. to evaluate each Earth system modelling component alone)

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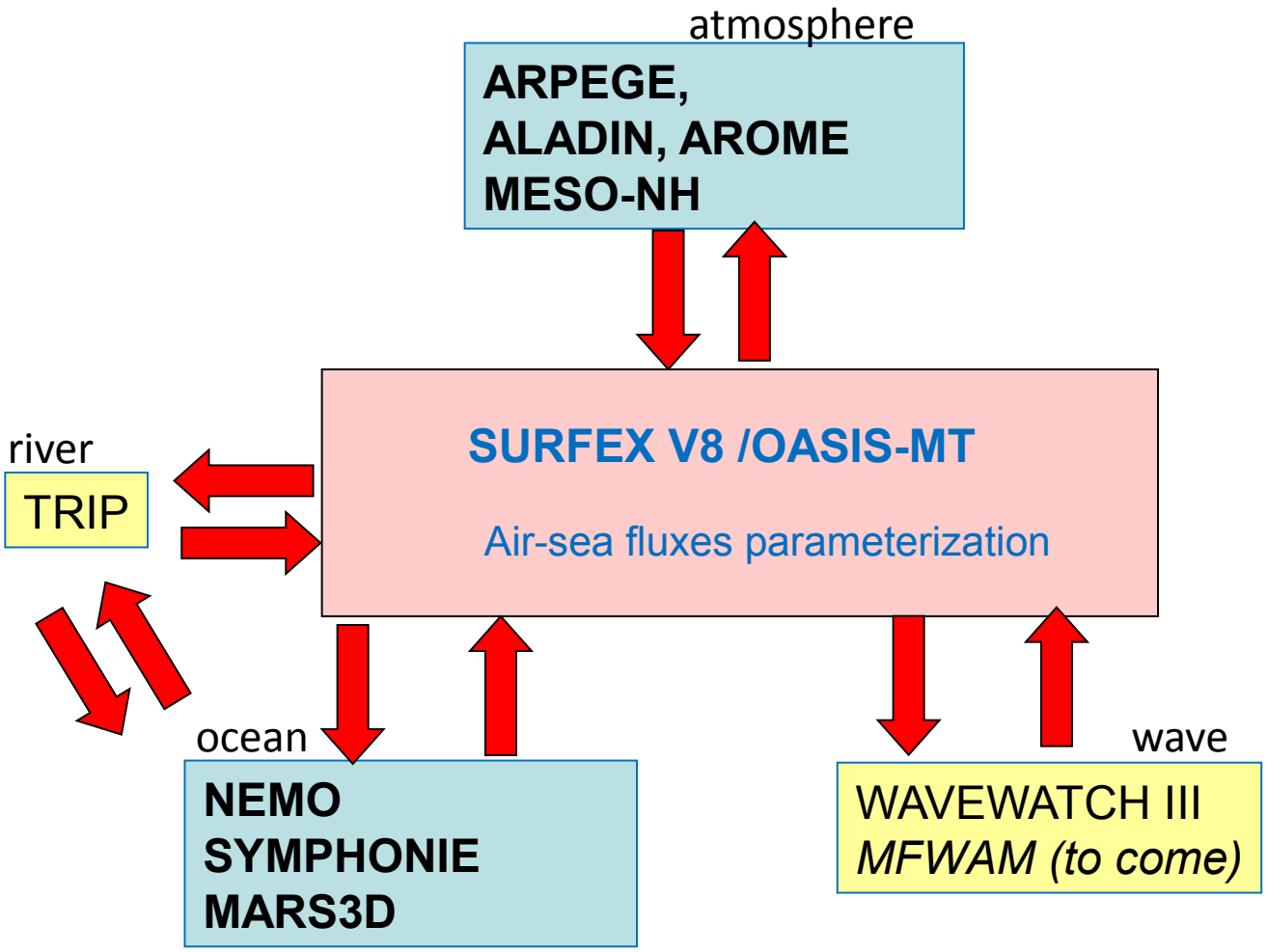
The coupled systems using SURFEX/OASIS-MCT



CNRM, Mercator Océan, LACY-CRC, LPO, IFREMER, LA

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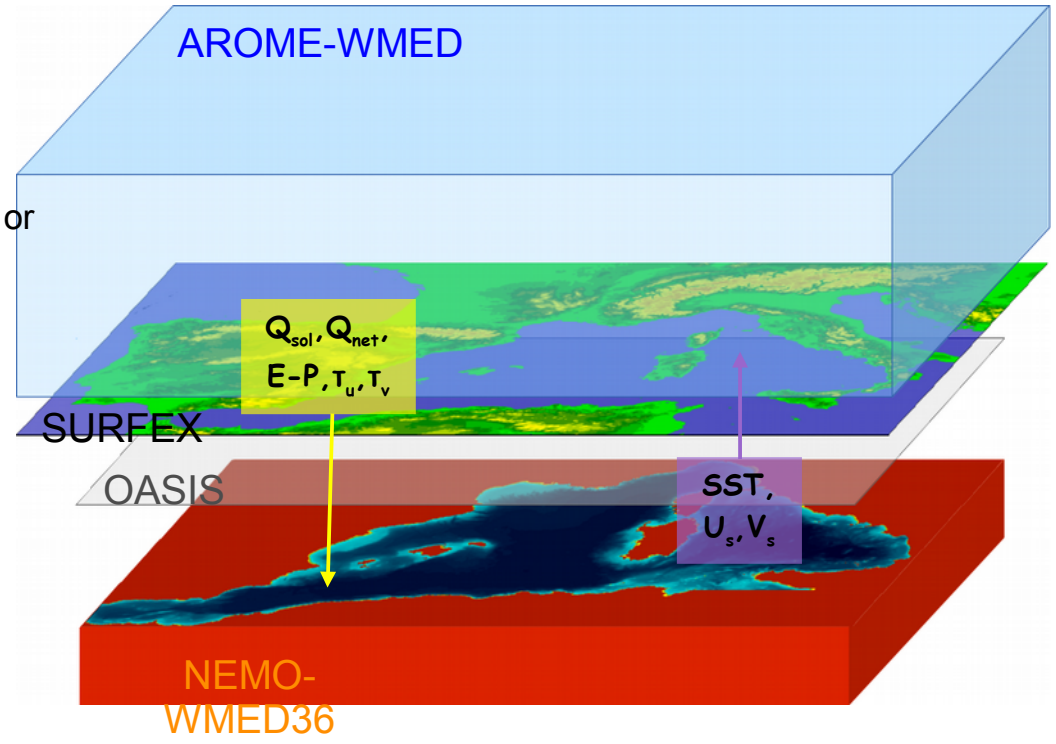
An example: AROME-NEMO coupled system

AROME-WMED (Fourrié *et al*., 2015)
Western Mediterranean domain
cy38t1 Δt=60s
Δx=2.5km - grid : 960 x 640 x 60 vertical levels

SURFEX (Masson *et al*., 2013)
v7_2 with coupling modifications
Turbulent fluxes : COARE 3.0 (Fairall *et al*., 2003) or ECUME (Belamari, 2005)

OASIS3-MCT (Valcke *et al*., 2013)
Bilinear interpolation
Coupling Frequency: 1h
Exchanged fields :
O→A : SST, U_s, V_s
A→O : Q_{net},Q_{sol}, E-P, τ_u, τ_v

NEMO-WMED36 (Lebeaupin Brossier *et al*., 2014)
code: NEMO v3_2
Δt=240s
Δx=1/36°
grid : 760 x 480 x 50 z-levels
Bathymetry : v10 Mercator-LEGOS
Climatological river run-off (Beuvier *et al*., 2010)
open radiatives frontiers



The ocean domain is included in the atmospheric domain

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An example: AROME-NEMO coupled system

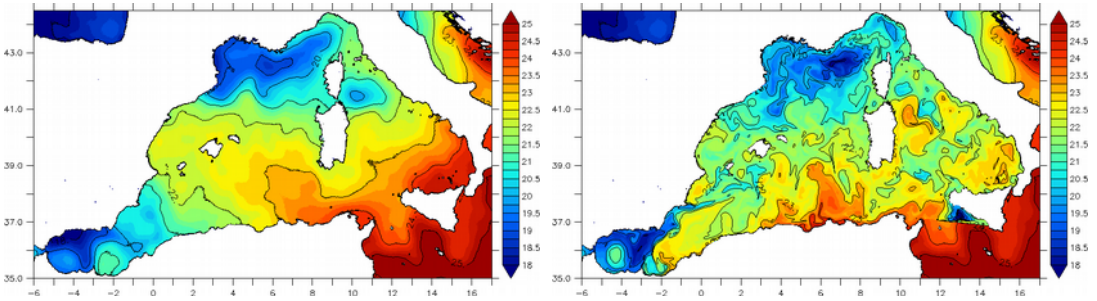
AROME only

AROME-NEMO

SST (°C)

27 Oct 2012 00UT

(20121025 T0+48h)

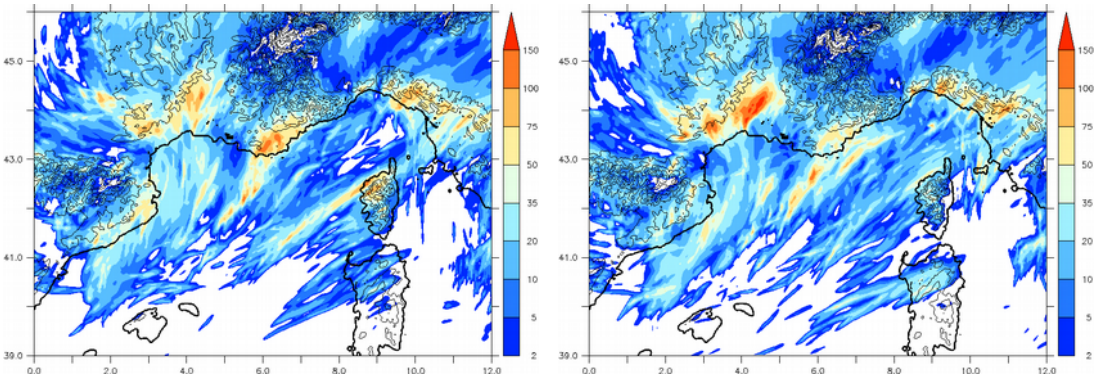


24-h Precipitation (mm)

26 Oct 00UT - 27 Oct 00UT

(20121025 +24h → +48h)

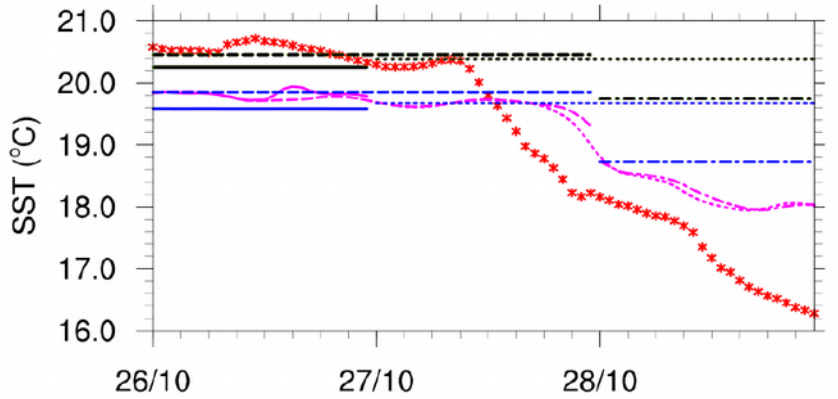
(heavy precipitation event)



SST at the Lion buoy

(Gulf of Lion)

(Mistral event on 27-28 Oct)



Obs

AROME-only

AROME-NEMO

48-h forecast starting at 00 UTC each day

Rainaud PhD, 2015

Next steps

- Short term:
  - Coupling interface with OASIS-MCT included in SURFEX V8
  - Upgrade ECUME air-sea flux parameterization in SURFEX V8 (that should decrease the too large sensible heat fluxes during strong cold wind events)

- Medium term for AROME-NEMO:
  - Initialization for operational use (some questions: more frequent data assimilation cycle for atmospheric model than for ocean model, SST initialization consistent with the ocean profiles, …)
  - Evaluation of the benefit of the air-sea coupling for short-range AROME forecast (France, overseas / tropical cyclones, Mediterranean heavy precipitation, coastal area weather)
  - Coupling with MFWAM (modification of the air-sea turbulent flux parameterizations and of the wave model to take into account the wind-waves interaction)

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A collaborative work from the Technichal Working Group

« O-A-W coupled systems using SURFEX-OASIS »:

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