Ocean-atmosphere coupling for Mediterranean heavy precipitation forecast: better river runoff and sea state modelling

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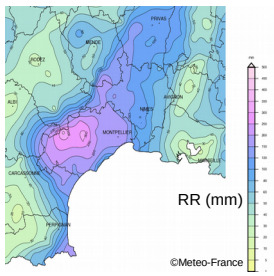
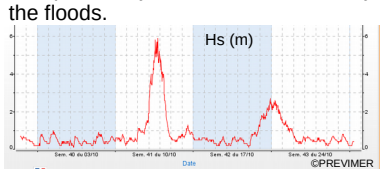
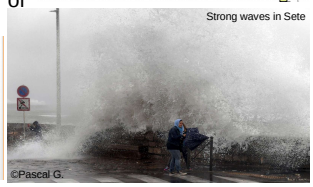
Introduction

The Western Mediterranean Sea area is frequently affected by heavy precipitation events (HPEs).
For example, in Mid-october 2016, the South-Eastern France was affected by heavy precipitation (rainfall amounts up to 350mm in 48h in the Hérault region), but also by strong easterly wind (gusts up to 130km/h in the Var region), strong waves (above 5m in the Gulf of Lion) and surge (up to 63cm recorded in Leucate), that potentially enhanced the severity of the floods.



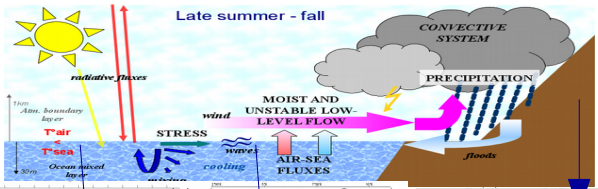


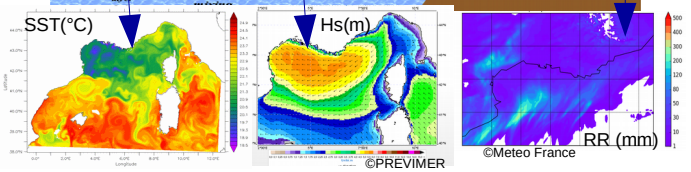


The Mediterranean Sea heat content and sea-state highly control the exchanges at the surface during HPE.

Coupled System

How to better represent the interactions between ocean – atmosphere – waves - hydrology ?
What are the impacts on the forecast of HPE?

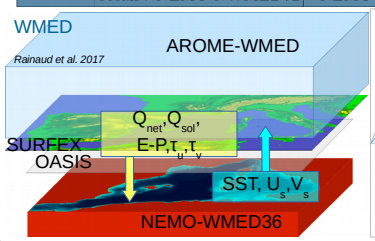


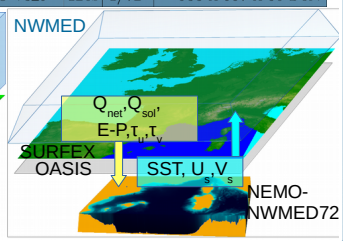


Objectives: to better represent the river inflows and to implement a coupled ocean-atmosphere-waves system at fine-scale in order to improve HPE forecast

Two configurations :

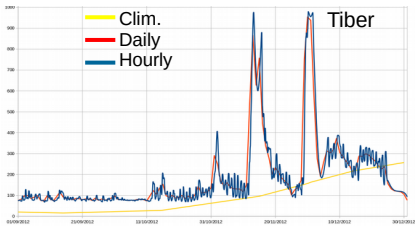
	Model	Current Version	Δt	Δx	Grid
WMED	atm : Arome-WMED	cy38t1	60s	2.5km	960 x 640 x 60 η-lev
	ocean : NEMO-WMED36	NEMO v3_2	240s	1/36°	760 x 480 x 50 z-lev
NWMED	atm : Arome France	cy41t1	50s	1.3km	1440 x 1536 x 90 η-lev
	ocean : NEMO-NWMED72	NEMO v3_6	120s	1/72°	933 x 657 x 50 z-lev

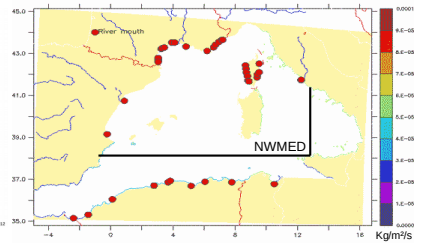




River Inflow Representation

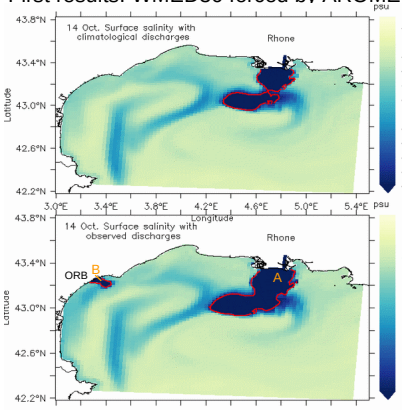
What are the impacts of the flood peaks on the ocean and in the coupled system ?

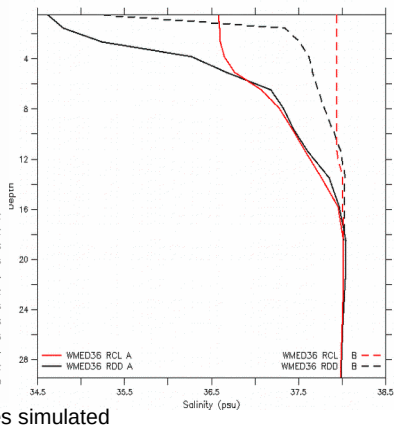




Monthly climatology *(Beuvier et al. 2012)* → daily/hourly observations during HyMeX SOP1
Few main rivers + coastal runoff → 28 observed rivers

First results: WMED36 forced by AROME-WMED fluxes, IOP13 (14-15 oct 2012)

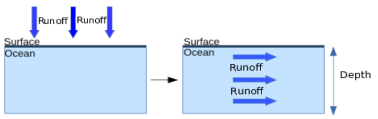




- More numerous and realistic river plumes simulated
- Significant impact locally on the ocean vertical stratification

Next steps:

- Evaluate the sensitivity of the ocean coastal circulation and local stratification to the runoff representation
- Compare to SOP1 ocean data
- Test a vertical profil of the river inflow



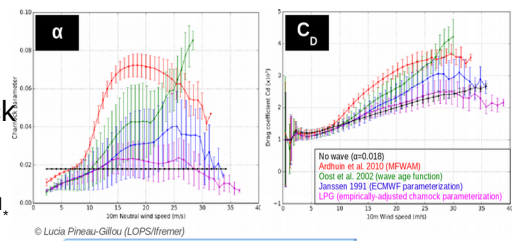
Sea-State effects and wave coupling

How the sea state will modify the turbulent fluxes during HPEs? the coupled forecast of HPEs?

Methodology:

(1) Take waves into account in the Charnock coefficient

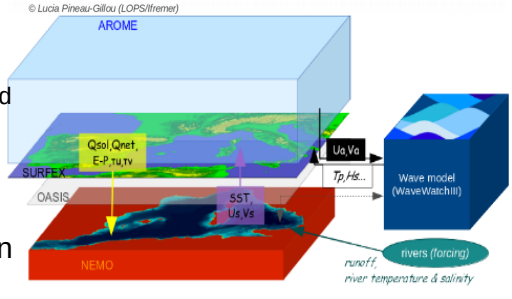
Rugosity $z_0 = \alpha_{ch} u_*^2/g + \beta\nu/u_*$
Drag coef. $C_D = K/\log(10/z_0)$



Using an adjusted parametrization more adapted to high velocity

To be compared to *Thévenot et al. 2016*

(2) Add a wave model in the coupled system



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- *Thévenot, O. et al. (2016), Influence of the sea state on Mediterranean heavy precipitation: a case-study from HyMeX SOP1, Quart. J. Roy. Meteorol. Soc., doi : 10.1002/qj.2660*
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