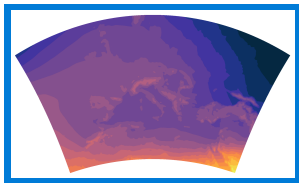


# RegIPSL : towards an IPSL Regional modelling infrastructure

Romain Pennel<sup>1</sup>, Jan Polcher<sup>1</sup>, Thomas Arsouze<sup>1,2</sup>, Karine Béranger<sup>1,4</sup>,  
Sophie Bastin<sup>3</sup>, Marc Stefanon<sup>1</sup>, Philippe Drobinski<sup>1</sup>, Lluís Fita<sup>5</sup>



*Orchidee-Dev Meeting - LSCE - March 6<sup>th</sup> 2018*

<sup>1</sup>LMD/IPSL, École Polytechnique, Palaiseau, France    <sup>2</sup>ENSTA ParisTech, Palaiseau, France    <sup>3</sup>LATMOS/IPSL, Guyancourt, France  
<sup>4</sup>IGE, Grenoble, France    <sup>5</sup>CIMA, Buenos Aires, Argentina



## The need for regional modelling capabilities at IPSL

Regional modelling capabilities are needed for :

- ▶ High resolution simulations of the Earth system.
- ▶ Moving towards convection permitting models.
- ▶ Reproducing processes in given large scale circulations.

Regional models are an ideal tool for a number of studies :

- ▶ Climate services.
- ▶ Surface/atmosphere (land & ocean) interaction studies.
- ▶ Atmospheric chemistry and air quality.
- ▶ Interactions with other communities  
(Hydrology, agronomy, air quality, energy production, ...)
- ▶ Facilitate collaborations within IPSL.

## Building an Regional Earth System Model (RESM) at IPSL

Most models of IPSL can run regionally and have been used at high resolution over limited areas, but mostly uncoupled :

- ▶ ORCHIDEE : imposed atmospheric conditions.
- ▶ NEMO : imposed surface fluxes and riverine inputs.
- ▶ CHIMERE : Flow conditions from re-analysis.

A regionally limited coupling can provide insight into processes which interact with other components. It can also feed new applications.

**The regional coupling is a sweet spot between the global ESM and the forced components.**

The technology developed at IPSL for the global model is transferable to limited area models.

We thus undertook to develop a RESM over the Mediterranean with predominantly IPSL components. The ambition is to ensure that a user of the global models can also use their regional counterpart without much further training.

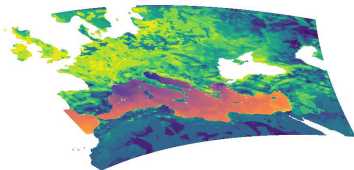
# RegIPSL-MED configuration



## OCEAN : NEMO-MED12

- ▶ NEMO v3.6 stable
- ▶  $1/12^\circ$  horizontal resolution : extraction of ORCA  $1/12^\circ$  grid
- ▶ 75 vertical levels
- ▶ Atlantic buffer zone (not coupled)
- ▶ Black sea not included

## RegIPSL-MED configuration



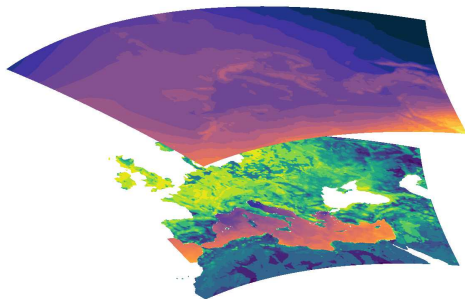
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### LAND : Orchidee

- ▶ ORCHIDEE-ROUTING Branch version 4513
- ▶ Regional routing with 36 vertices per grid box
- ▶ 200 rivers outflow to the ocean
- ▶ No interactive phenology

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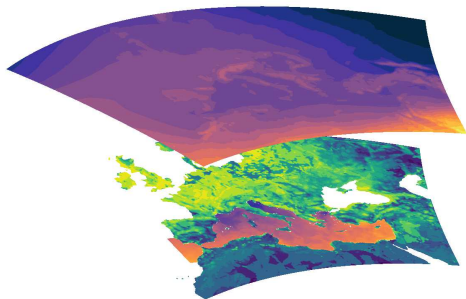
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## ATMOSPHERE : WRF

- ▶ WRF 3.7.1
- ▶ 20km resolution Lambert conformal projection
- ▶ 46 vertical levels
- ▶ Same grid as orchidee
- ▶ New T2/Q2 parametrization
- ▶ Microphysics WSM5 / PBL MYNN2.5 / spectral nudging / Tegen

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## I/O : XIOS

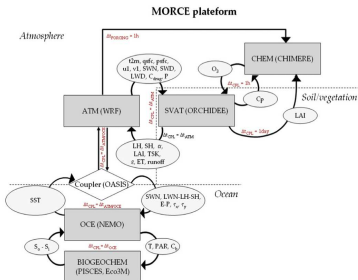
- ▶ XIOS with all 3 components (XIOS implemented into WRF)
- ▶ Standard CORDEX outputs
- ▶ Future : dr2xml ??

## Coupling : OASIS3-mct

- ▶ ≈ 40 variables exchanged
- ▶ every 60 seconds (WRF/ORCH) ; to be defined for NEMO
- ▶ Interpolation performed by oasis

# Coupled variables

## MORCE-MED/Stream I



*Drobinski et. al. 2012*

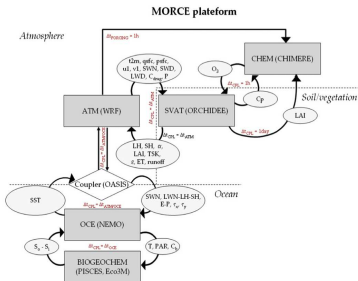
## RegIPSL-MED/Stream II

- ▶ Coupling : Not through subroutines => oasis3-mct
- ▶ 40 variables exchanged / different time step
- ▶ Estuaries directly on NEMO-MED grid
- ▶ Coastal runoff + submarin groundwater discharge interpolated on NEMO-MED grid
- ▶ The XIOS environment is used for all models.



# Coupled variables

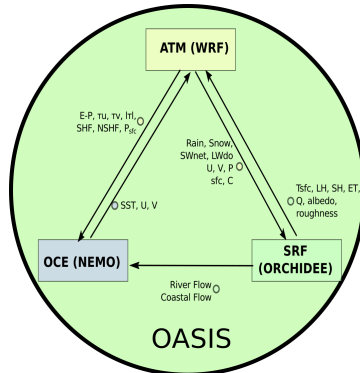
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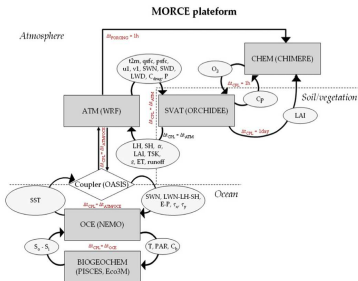
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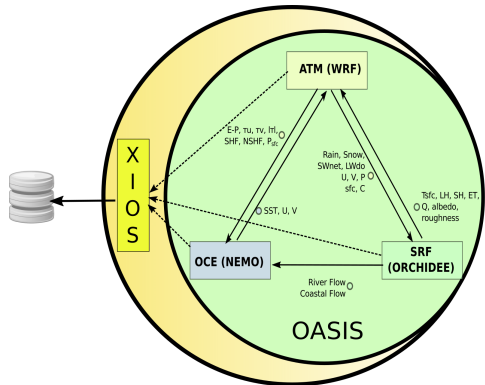
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## Development workflow

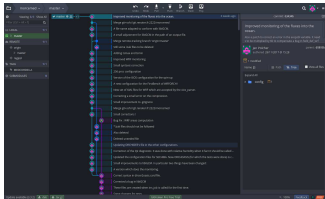
- ▶ Weekly Thursday meeting on Rendez-Vous (RENATER)
- ▶ Git versioning : central repository on SourceSup provided by RENATER  
(`git+ssh://git@git.renater.fr:2222/morcemed.git`)
- ▶ Coupled system ready to run at IDRIS, TGCC and IPSL
- ▶ Set of "plug & play" configurations :
  - ▶ ORCHIDEE off-line
  - ▶ NEMO off-line
  - ▶ WRF with original land surfaces
  - ▶ ORCHIDEE+NEMO
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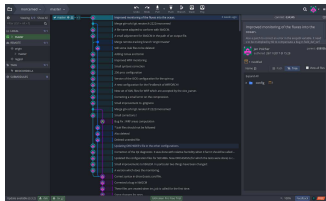
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## Production workflow

- ▶ Restart every month (trade-off between speed and wait in the queue)
- ▶ Jobs management : libGCM <http://forge.ipsl.jussieu.fr/libgcm/wiki/DocUtilisateur>
  - ▶ Limited amount of config files / independant of the machine / human readable / portable
  - ▶ Deal with transfer / copy / archive of input and output files
  - ▶ Deal with submission of jobs every month
  - ▶ Allow post-processing
  - ▶ Performance monitoring
- ▶ Simulations are monitored on the HERMES system.
- ▶ Real-time monitoring : time series and atlas (CLiMAF)

[https://prodn.idris.fr/thredds/fileServer/ipsl\\_public/rron972/RegIPSL/PROD/MEDCORDEX-A/WRFORCH/MONITORING](https://prodn.idris.fr/thredds/fileServer/ipsl_public/rron972/RegIPSL/PROD/MEDCORDEX-A/WRFORCH/MONITORING)

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HERMES Simulation Monitoring v1.3.0.2

2017-12-20T15:12:18 :: SIMULATION RESTARTED :: BOA4 is RUNNING

Simulations: Total = 9554; Filtered = 13.

Start Date: < 2 months | Acc. Project: | Machine: | Login: | Tag / Model: | Experiment: | Space: | Compute State: |

Filter by name: WRF | Sort by: Name | Asc | Page 1 of 1 | 39 pages | Previous

Acc. Project	Name	Try	Jobs (C)	Jobs (PP)	Machine	Login	Tag / Model	Experiment	Space	Output	Progress (%)	M	M
ran	TestWRFORCH	1	0 0 1 0	0 0 0 0	IDRS-ADA	mon872	regal	TestWRFORCH	PROD	--	--	--	--
ran	TestWRFORCH	6	0 0 1 0	0 0 0 0	IDRS-ADA	mon872	regal	TestWRF_PseProc	PROD	--	--	--	--
ran	WRF	1	0 0 1 0	0 1 0 2	IDRS-ADA	mon171	regal	WRF_NEW003_1D	PROD	--	--	--	--
ran	WRF	6	0 0 1 0	0 0 0 1	IDRS-ADA	mon171	regal	WRF_NEW003_3K	PROD	--	--	--	--
ran	WRF	14	0 0 1 0	0 0 0 0	IDRS-ADA	mon860	regal	FirstBench	DEVT	--	--	--	--
ran	WRFORCH	2	1 203 25 0	2 426 27 15	IDRS-ADA	mon872	regal	MEDCOORDEXA	PROD	51%	M	M	M
ran	WRFORCH	22	0 0 1 0	0 0 0 0	IDRS-ADA	mon872	regal	TestWRFORCH	PROD	--	--	--	--
ran	WRFORCH	41	0 32 0 0	0 70 1 0	IDRS-ADA	mon872	regal	FirstBench	PROD	97%	M	M	M
ran	WRFORCH	2	0 0 1 0	0 0 0 0	IDRS-ADA	mon872	regal	FirstBench	DEVT	--	--	--	--
ran	WRFORCH	10	0 7 0 0	0 4 2 7	IDRS-ADA	mon872	regal	TestWRF_PseProc	PROD	52%	M	M	M
ran	WRFORCH	3	0 0 1 0	0 0 0 0	IDRS-ADA	mon171	regal	Test_WRFORCH_LAN	PROD	--	--	--	--
ran	WRFORCH	1	0 0 1 0	0 1 0 2	IDRS-ADA	mon171	regal	Test_NewORCH	PROD	--	--	--	--
ran	WRFORCH	1	0 0 1 0	0 1 0 2	IDRS-ADA	mon171	regal	Test_WRFORCH_OLDORCH	PROD	--	--	--	--

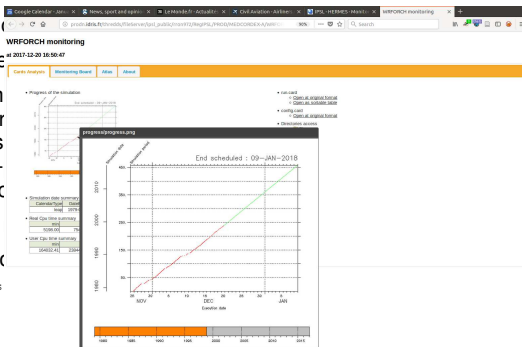
QUEUED | RUNNING | COMPLETE | LATE | ERROR | M - Monitoring | M - Inter-Monitoring

HERMES Simulation Monitoring v1.3.0.2 © 2017 IPSL

MONITORING

# Production workflow

- ▶ Restart every m
  - ▶ Jobs managem
  - ▶ Limited am
  - ▶ Deal with tr
  - ▶ Deal with s
  - ▶ Allow post-
  - ▶ Performanc
  - ▶ Simulations are
  - ▶ Real-time monit
- <https://prodn.idris>



sateur

n readable / portable

-A/WRFORCH/MONITORING



# Production workflow



▶ Restart WRFORCH monitoring  
at 2017-12-20 16:50:47

▶ Jobs n



/ portable

▶ L  
▶ C  
▶ C  
▶ A  
▶ P

▶ Simula

▶ Real-ti

https://

MONITORING

```
javascript:popupimage("images/ATM_slcWind_MED.gif")
```

# Production workflow

▶ R  
▶ Jc

Google Calendar - Jan... x News, sport and opinio... x Le Monde.fr - Actualite... x Civil Aviation - Airlines... x IPSL - HERMES - Monito... x [CLIMAF ATLAS of MED... x +

prodn.idris.fr/thredds/fileServer/ipsl\_public/rmon972/RegIPSL/PROD/MEDCORDEX-A/WRFORCH/...

90% ... Search

**Air Temperature (2m) [Celsius]**

1979 1980 1981 1982 1983 1984 1985 1986 1987 1988  
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998

Year : 1979

▶ S  
▶ R  
ht

- MAM 1979
- MAM Anomalies for1979
- JJA 1979
- JJA Anomalies for1979
- SON 1979
- SON Anomalies for1979

WRFORCH-E-OBS, Air Temperature (2m), JJA, 1979  
1979/08/31 Celsius

prodn.idris.fr/thredds/fileServer/ipsl\_public/rmon...RFORCH/MONITORING/images/tas\_seas\_JJA1979\_diff.png

table

NG

# Simulation production 2018

ERA-I: WRF-ORCHIDEE

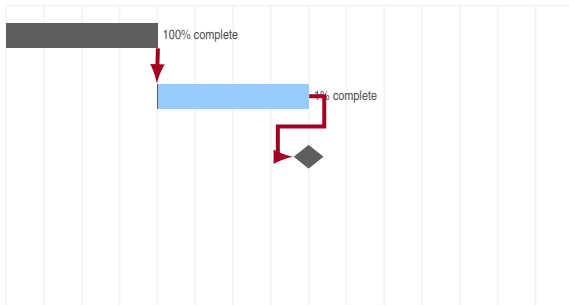


**ERA-I: WRF-ORCHIDEE**

- ▶ Hindcast 1979 - 2014
- ▶ ERA-Interim forcing

## Simulation production 2018

ERA-I: WRF-ORCHIDEE



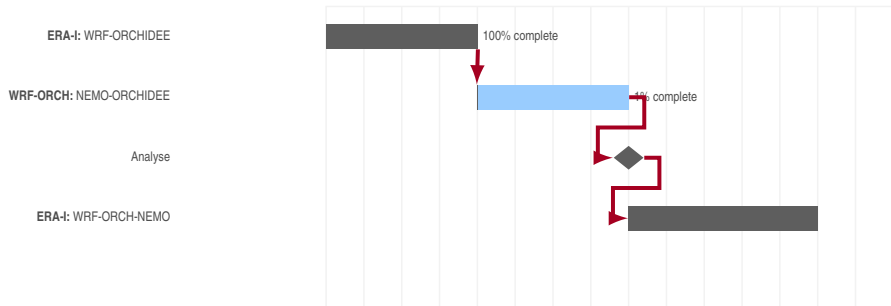
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## Simulation production 2018



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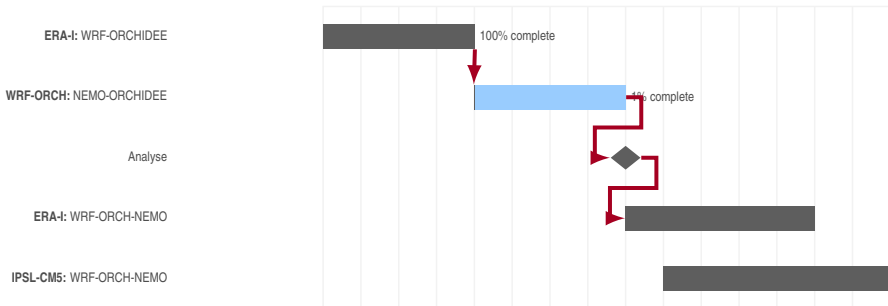
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- ▶ Hindcast 1979-2014
- ▶ Full coupling

## Simulation production 2018



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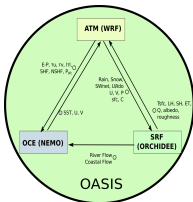
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### IPSL-CM5: WRF-NEMO-ORCHIDEE

- ▶ Historic 1971-2006 and scenario RCP 8.5 2006-2100
- ▶ IPSL CMIP-5 forcing
- ▶ Work to do on input files

## Today's status : NEMO-ORCHIDEE

- ▶ NEMO-ORCHIDEE second step towards full coupling (*first step see Jan's talk*)
- ▶ Proto atmosphere (*driver*) to test future coupling using outputs of WRF-ORCHIDEE simulation

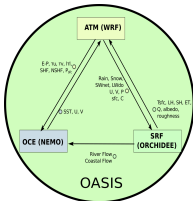


*Driver* to mimic an atmosphere :

- ▶ coastal run off and estuaries send directly from Orchidee to Nemo
- ▶ SST, U and V send to *driver*
- ▶ Net heat fluxes computed by the driver using SST from NEMO
- ▶ Wind stress computed by the driver using ocean currents

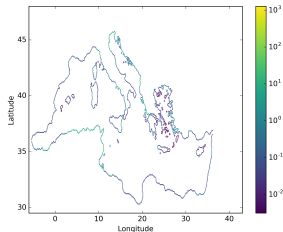
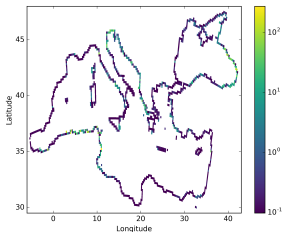
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Mapping of coastal flow between ORCHIDEE (left) and NEMO (right) grids  
resolution increase / Black Sea parametrisation



## Future projects



- ▶ CHIMERE / WRF already ready
- ▶ Needs to integrate WRF developments
- ▶ Integrate CHIMERE in the RegIPSL environment
- ▶ CHIMERE / ORCHIDEE : *work in progress*
- ▶ future : CHIMERE / PISCES

DYNAMICO



- ▶ New dynamical engine for atmosphere / LMDZ physics
- ▶ Limited area version of DYNAMICO (Idealized version next year ?)
- ▶ CHIMERE / DYNAMICO : *work in progress*

- ▶ Facilitate the preparation of configurations over other regions (South America in preparation).
- ▶ Move to higher resolution (Convection permitting over Europe).
- ▶ Use of the ERA5 re-analysis.

## Conclusion

- ▶ A first version of RegIPSL is implemented over the Mediterranean.
- ▶ As an interim solution WRF is used for the atmospheric component.
- ▶ IPSL should build-up its capacity to run its models in regional coupled configurations.
- ▶ As the same work-flows as for the global model are used, the expertise is easily transferable.
- ▶ Regional Earth System Models are an excellent tools for scientific analysis and applications.
- ▶ Users should not forget that the lateral boundary conditions of regional models are an inherent weakness for sensitivity studies.