CRESCENDO

Coordinated **R**esearch in **E**arth **S**ystems and **C**limate: **E**xperiments, k**N**owledge, **D**issemination and **O**utreach

www.crescendoproject.eu

Coordinator: Colin Jones: University of Leeds/NCAS
Project Manager : Alberto Munoz

Project start : Nov 1st 2015, Duration : 5 years

Funded under Horizon2020 Grant Agreement 641816

European Commission

CRESCENDO Objectives

- To improve the representation of key biogeochemical, biophysical and aerosol processes in European Earth System Models (ESM).

- To develop and apply an evaluation tool for benchmarking and analysis of ESMs

- To contribute to development of a new set of future emission and land-use scenarios for use by ESMs within the CMIP6 scenarioMIP

- To produce a coordinated ensemble of ESM projections, based on these scenarios and ensure this data is made available on the Earth System Grid Federation (ESGF)

- To quantify key Earth system feedbacks and their role in future Earth system change.

- To develop and apply emergent constraint methods to key Earth system feedbacks with an aim of reducing the spread in future Earth system projections.

- To coordinate a European contribution to key CMIP6 MIPs: *C4MIP, AerChemMIP, OMIP, LUMIP, LS3MIP and scenarioMIP* and make this data available through the ESGF.

- To work with the climate impacts and regional downscaling communities to ensure key ESM data produced in the project is actively and well used in these areas

- To ensure knowledge developed in the project is communicated to key stakeholder communities in an engaging and understandable form
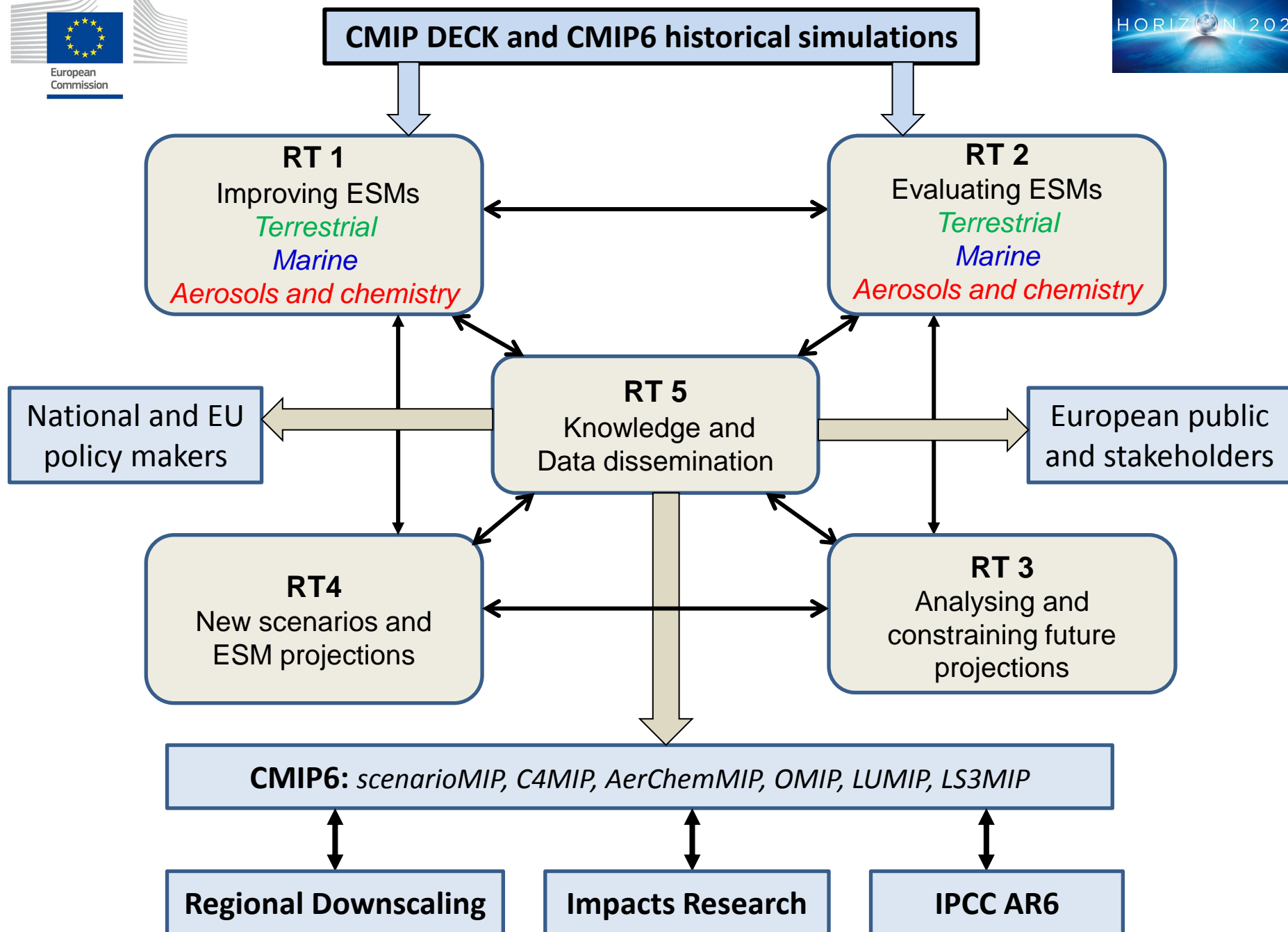
ESMs in CRESCENDO

Probable "higher" and "lower" resolution CRESCENDO ESM versions

Model	"Higher" resolution models		"Lower" resolution models	
	Atmosphere	*Ocean*	*Atmosphere*	*Ocean*
CNRM-ESM	T359	0.25°	T127	1°
CMCC-ESM	1°	0.25°	1°	1°
EC-Earth	T255	1°	T159	1°
IPSL-ESM	1.3° x 0.65°	0.25°	2.5° x 1.25°	1°
MPI-ESM	T127/T63	0.4° /1.5°	T31	3°
NorESM	0.9° x 1.25°	0.25°	1.9° x 2.5°	2°
UKESM	0.6°	0.25°	1.5°	1°

One project aim is to establish the degree of performance and future projection response traceability across different resolution versions of the same model

RT1: Improving Biogeochemical and aerosol processes in ESMs.

WP1: Terrestrial biogeochemical processes

1.1 Soil-vegetation coupled carbon-**nitrogen** processes
1.2 Wetlands and permafrost and methane emissions
1.3 Consistent treatment of Land Use and Land Cover Change in ESMs

WP2: Marine biogeochemical processes

2.1 Higher resolution ocean dynamics: impact on marine biogeochemical processes
2.2 Improved representation of organic matter cycling
2.3 External input of nutrients and emission of marine trace gases

WP3: Natural aerosol and trace gases in ESMs

3.1 Terrestrial emissions
3.2 Marine emissions
3.3 Atmospheric processing and deposition of aerosols and trace gases

Each WP includes component model (land, ocean, atmosphere) simulations targeting WP-specific process-improvements

RT1 includes CMIP6 simulations for : C4MIP, OMIP, LUMIP, LS3MIP and AerChemMIP

RT2: Process-level evaluation of ESM improvements

The RT will develop and apply targeted evaluation methods for the key processes under improvement in RT1. Where possible methods & data implemented into ESMValTool

WP4: Evaluating terrestrial processes in ESMs

4.1 Soil-vegetation coupled carbon-**nitrogen** processes

4.2 Wetlands and permafrost and methane emissions

4.3 Evaluating Land Use and Land Cover effects in ESMs

WP5: Evaluating marine processes in ESMs

5.1 Global assessment of marine biogeochemistry

5.2 Regional scale assessment of marine BGC *(links to more detailed ocean dynamics)*

5.3 Modes of variability, temporal trends and long-term drift in marine biogeochemistry

WP6: Evaluating natural aerosol and trace gases in ESMs

6.1 Evaluating new aerosol processes in ESMs

6.2 Evaluation of aerosol under pre-industrial like natural conditions ➡ Historical ERF)

6.3 Evaluation of trace gas emissions, atmospheric processing and deposition

6.4 Evaluation of atmospheric CO_2: spatial patterns, annual cycle, variability and trends

RT3: Analysing and constraining ESM projections

WP7: Benchmarking and evaluation of ESMs

7.1 Enhanced platform for routine evaluation and benchmarking ESMs
   Further develop ESMValTool to include biogeochemistry/aerosol evaluation and metrics
7.2 Maintenance, infrastructure and documentation of ESMValTool

WP8: Understanding and constraining model projections

8.1 Theoretical foundations for emergent constraints (EMC) to guide ensemble "search"
8.2 New emergent constraints on physical and biophysical feedbacks
8.3 Emergent constraints on terrestrial carbon cycle feedbacks (link to WP4)
8.4 Emergent constraints on marine carbon cycle feedbacks (link to WP5)
8.5 Emergent constraints on aerosol and trace gas feedbacks (link to WP6)
8.6 Weighting multi-model ensemble projections

WP9: Quantify aerosol/biogeochemical forcing and feedbacks

9.1 Effective Radiative Forcing (ERF) and biogeochemical coupling experiments
9.2 Feedback framework for analysis of global feedbacks
9.3 Transient experiments for regional responses to aerosol/biogeochem forcing changes

RT4: New scenarios and ESM projections

WP10: Novel climate scenarios and future projections: scenarioMIP

10.1 Populating and analysing new IAM scenarios
10.2 Development and design of new IAM scenarios
10.3 Testing new scenarios with ESMs prior to official release

WP11: Robustness of ESM performance and projection response to model resolution

11.1 CMIP DECK (and possibly CMIP6 Historical) runs using "alternative" resolution ESMs
"std" resolution CMIP-DECK runs performed external to CRESCENDO (available ~spring 2018)
11.2 Assess and document traceability between "std" and "alternative" versions (using DECK)

WP12:ESM simulations for CMIP6 scenarioMIP

12.1 A coordinated multi-model ensemble of ESM projections *(for priority scenarioMIP expts)*
12.2 Analysis of scenarioMIP projections/scenarios by multiple research communities

RT5: Knowledge and data dissemination

WP13:CRESCENDO data dissemination

13.1 Publishing key ESM data on the ESGF

13.2 Communication with impacts-research and regional downscaling communities

Ensure key simulation-data is saved for use by these communities

13.3 Develop and apply bias-correction methods for ESM data (disseminate this data)

WP14:CRESCENDO knowledge dissemination

14.1 Interaction with policymakers

14.2 Science communication training (for young researchers)

14.3 Guidance for use of ESMs data in impact research and regional downscaling

14.4 Improving public knowledge of ESM and ESM projections

14.5 Project dialogue with CMIP6

CRESCENDO simulation schedule

Timeline: Nov 2015 — Nov 2016 — Nov 2017 — Nov 2018 — Nov 2019 — Nov 2020

CMIP DECK with "std" ESMs **external** to project

CMIP DECK with "other" ESMs within project WP11

Initial scenarioMIP runs with "std" ESMs **available ~ Sept 2018/M35**

Extend scenarioMIP ensemble based on WP11 HI/LO ESM recommendations **available ~Jul-Dec 2019**

Deliverable
M38/Dec 2018
Benchmark
CMIP DECK with
ESMValTool

Milestone
M48/Oct 2019
ESM scenarioMIP
Available
on ESGF (WP14)

Deliverable
M60/Oct 2020
Report on
Weighting
of CMIP6
projections

Milestone
M45/Jul 2019
ESM scenarioMIP
Runs complete
Ready for upload
To ESGF (WP14)

Milestone
M54/Apr 2020
Apply new
Emergent
constraints to
CMIP6 runs

Milestone
M12/Oct 2016
Final delivery
of scenarios
to scenarioMIP

Milestone
M32/Jun 2018
Recommend
Use of "low"
& "high" res
ESMs in
scenarioMIP

Milestone
M52/Apr 2020
Bias-corrected
scenarioMIP data
available to
ISIMIP (WP14)

CRESCENDO simulation schedule

Timeline: Nov 2015 — Nov 2016 — Nov 2017 — Nov 2018 — Nov 2019 — Nov 2020

DECK & HIST with "std" ESMs **external** to project

Possible DECK/HIST/SSP5 run using emissions instead of concentrations
Not promised in project

DECK (and HIST?) with "other" ESMs within project WP11

Initial scenarioMIP runs with "std" ESMs

Extend scenarioMIP ensemble based on WP11 HI/LO ESM recommendations

Save simulation-data to ESGF

M36/Oct 2018 OMIP (WP2) AerChemMIP (WP3) runs Complete
Likely "std" ESM

M30/May 2018 C4MIP, LUMIP, LS3MIP runs complete: WP1
Likely "std" ESM