Next Generation Earth-system Models — NextGEMS

NextGEMS is funded through the European Union's Horizon 2020 research and innovation programme under the grant agreement No - 101003470.

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A simple project, with a few objectives

1. To develop two storm (and ocean-eddy) Earth-system Models for applications.
2. To use these to test long-standing hypotheses underpinning our understanding of climate change.
3. To build new, more integrated communities of ESM users.

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What's a storm-resolving Earth-system model?

A global coupled simulation with O(3km) horizontal resolution of the atmosphere and ocean.

Sometimes you hear people describing SR-ESMs as high-resolution climate models. That is like calling ice 'very cold water'; it's not wrong, but it misses the point.

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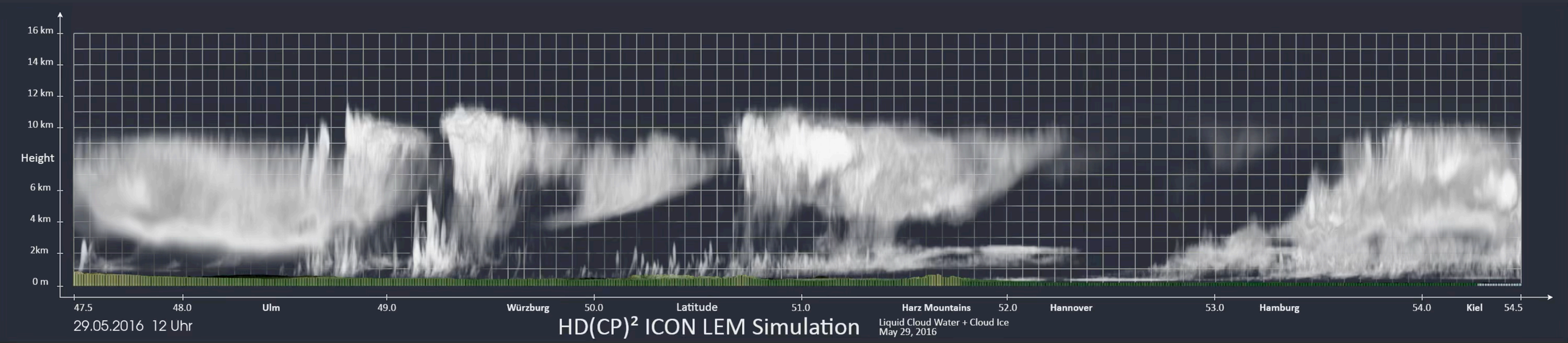
SR-ESMs resolve the main processes controlling vertical energy transport …



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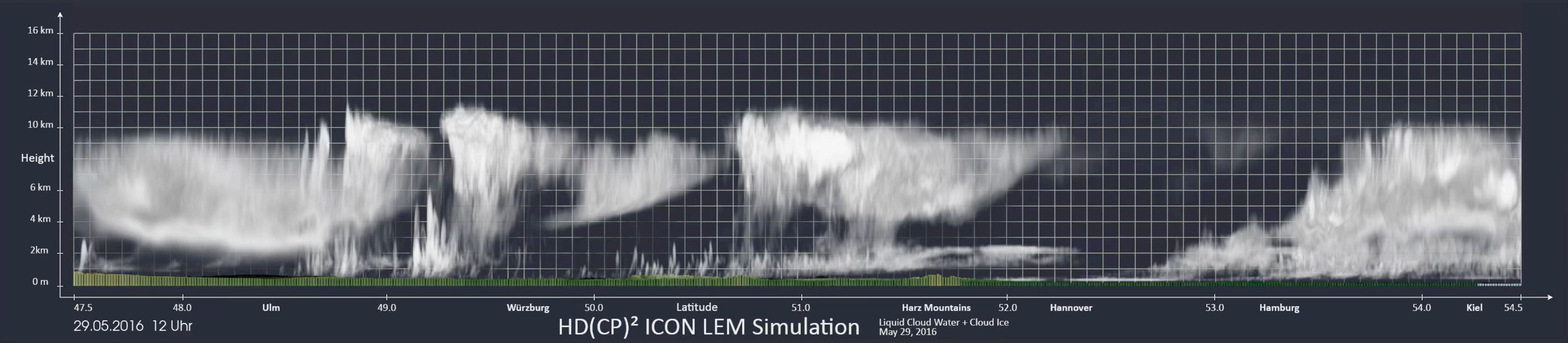
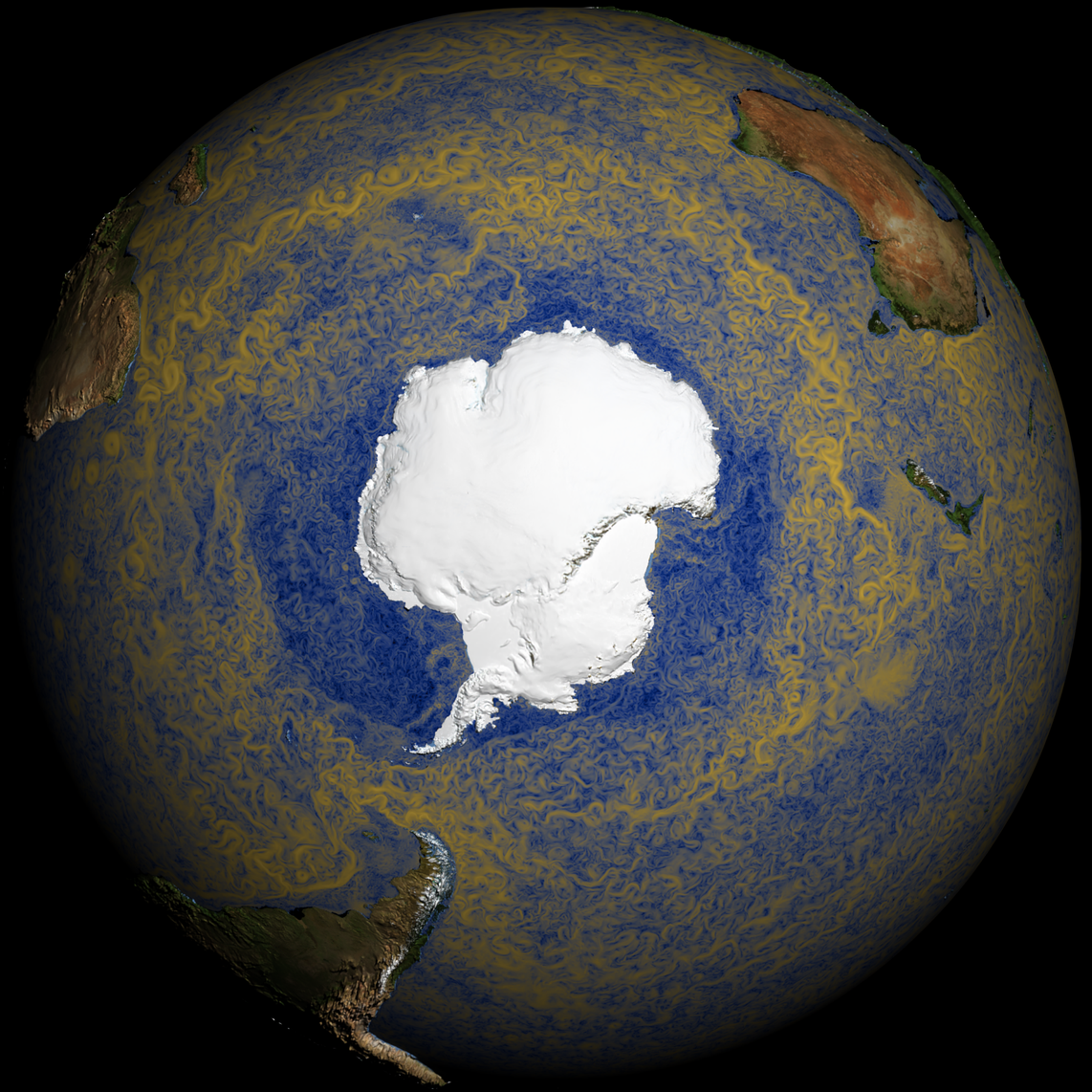


At the most fundamental level, Earth's climate arises out of the balance of vertical energy transport.

... and horizontal eddy transport through the ocean and its sea-ice



SR-ESMs are a leap to a structurally new type of models

SR-ESMs represent a leap …

1. Over some of the most ill-posed parameterization problems
2. Toward a representation of the climate-system in terms of observables (not statistics)
3. To the scales and types of events that are familiar to users

… in ways that engage industry, computational science, and informatics communities in our problems —
and allow us to begin studying slow (earth-system) physics.

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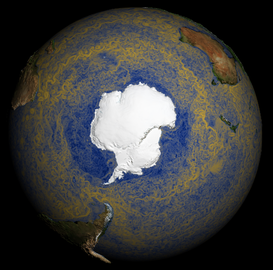
Also, into the unknown

1. exposing their information content will be a challenge.
2. they might not work.

SR-ESMs attempt to come as close to a first principles representation of the climate system as possible … the fact that it might not work is what makes NextGEMS fun.



… imagine if it doesn't work.

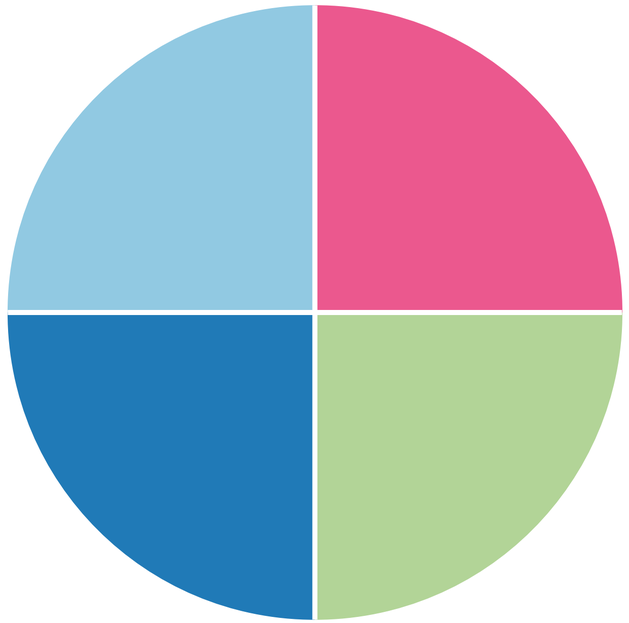
More practical matters … four main working groups

Storms & Radiation

- *TOA energy budget (O1)*
- *Simple Aerosol & Advanced Microphysics (Dev)*
- *Convective aggregation & climate sensitivity (O2)*
- *Global wind-energy potential (O3)*

Storms & Ocean

- *Surface stress and ocean state (O1)*
- *Turbulent mixing schemes (Dev)*
- *Tropical climate change/ Afr. Monsoon (O2)*
- *Fisheries (O3)*



Storms & Society

- *Video Blog (VLOG) (O3)*
- *Communication strategy (Dev)*
- *Challenge problems*
- *Stakeholder engagement*

Storms & Land

- *Surface energy budget over land (O1)*
- *Land carbon and heterogeneity (Dev)*
- *Blocking, warm and dry spells (O2)*
- *Global solar-energy potential (O3)*

Each of the 'scientific' working groups contributes to (i) model development; (ii) scientific exploitation; (iii) links to an application community; and (iv) the outreach concept.

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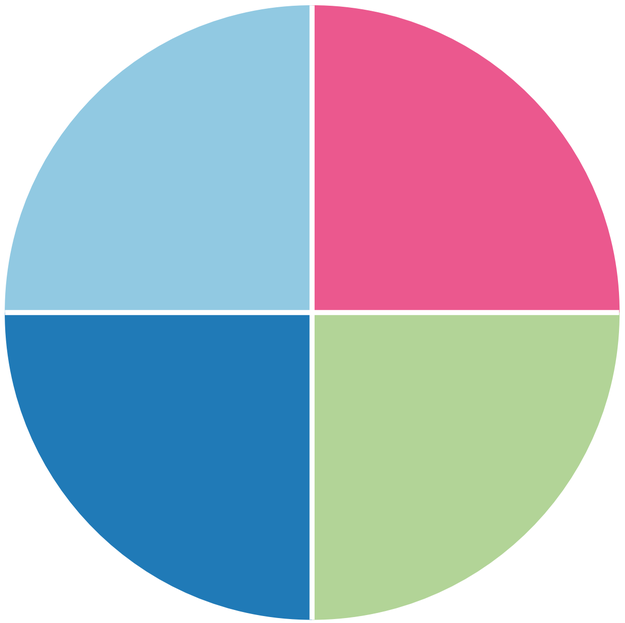
… in case you were wondering about the arithmetic

- At 5 km ICON requires about 6 kNh/sy (Atmosphere) on JUWELS-Booster, a new GPU (4xA100 NVIDIA) machine (70 PFLOPs across 1000 nodes).
- 150 kNh/sy (coupled) are needed on Mistral, an old CPU (36xBroadwell) machine (3 PFLOP across 3000 nodes).
- IFS likely has better performance.
- We recently received a PRACE allocation of 125kNh/sy on JUWESL-Booster (For the coming year); which would allow 20 (5 km) sy, or 3 (2.5 km) sy.
- LUMI will come on line during the first half of NextGEMS, and we expect a seven-fold increase in performance relative to JUWELS-Booster.



yes, output is an issue … "Without God all things are permitted" (Dostoevsky)

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NextGEMS will develop Europe's two (institutionally supported) SR-ESMs … and involve people from across Europe.

IFS-FESOM

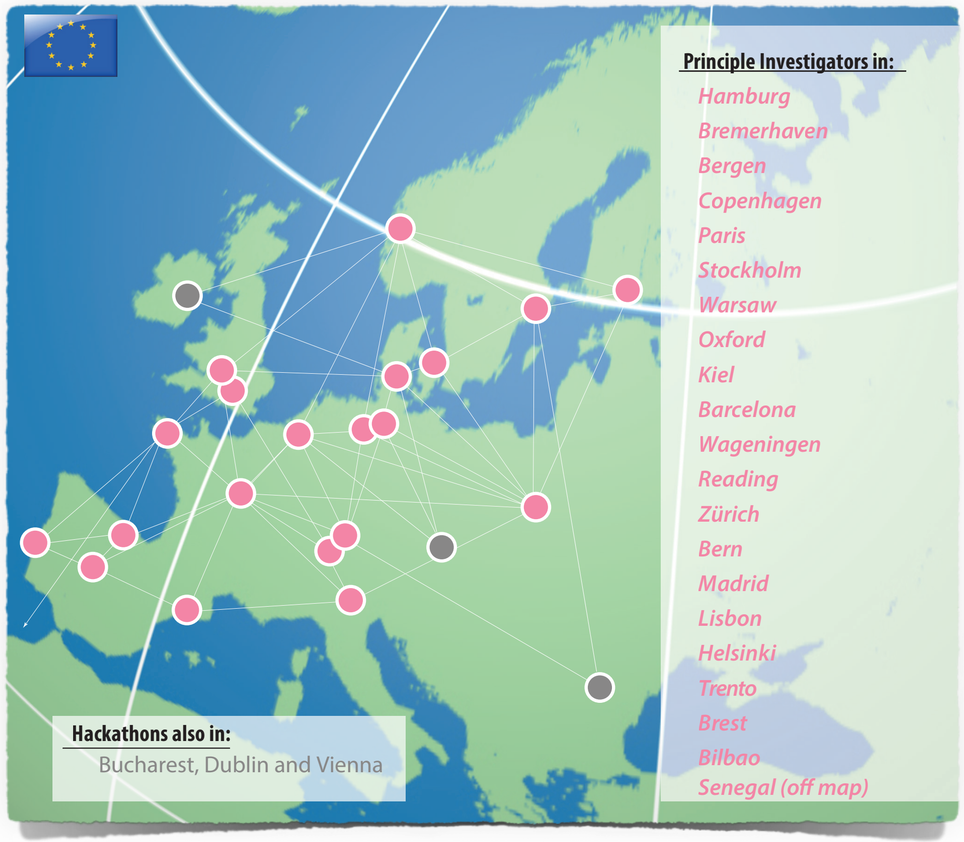
ECMWF

AWI

ICON

Max-Planck-Institut für Meteorologie

DKRZ DEUTSCHES KLIMARECHENZENTRUM



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The German Weather Service (DWD), KIT and C2SM (ETH) are co-developers of ICON and part of the ICON consortium, but not formally supporting ICON within NextGEMS

No meetings, no general assemblies … just Hackathons

First one is in Berlin in two weeks, 75 people are coming (yippee!).
Second one is in Wien (29 June) feel free to join!

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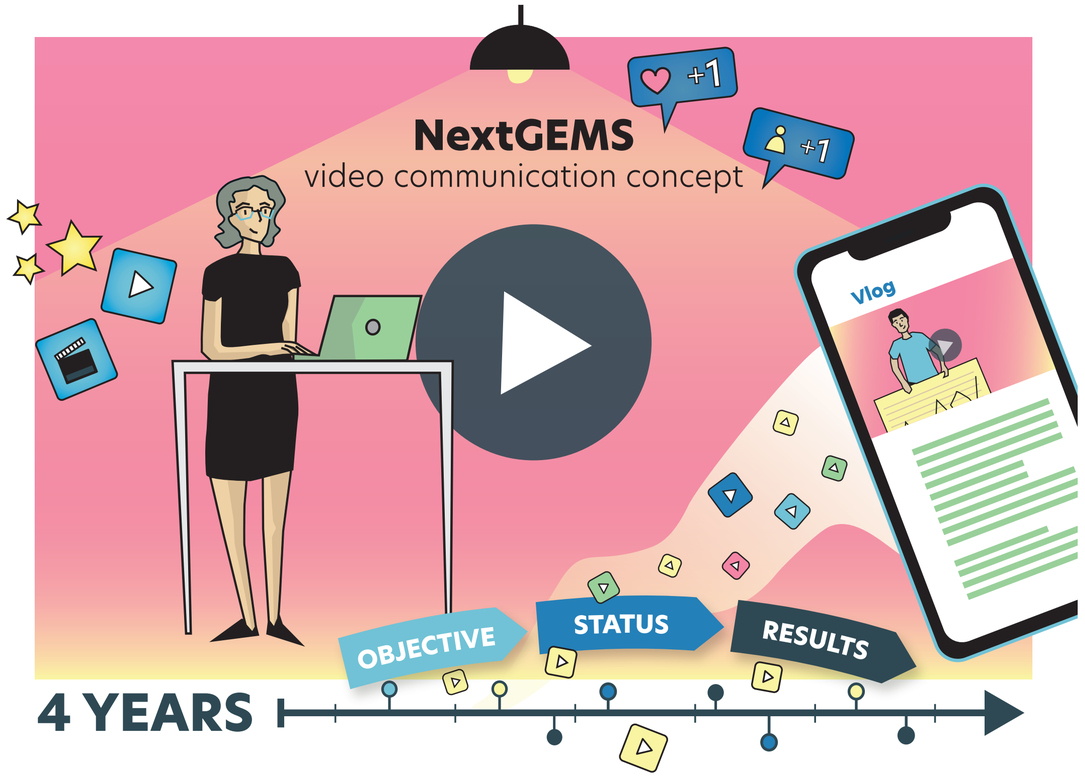
and a fun outreach/communication concept — the NextGEMS VLOG



VIDEO TYPES

NextGEMS Clip
...gives an animated overview of the project in less than 2 minutes

Research Videos
...convey content of published journals to a wider audience

Results Video
...shows technical information as accessible, impactful and accurate

Progress Videos
...give insights about the current status of the project, produced by all teams involved

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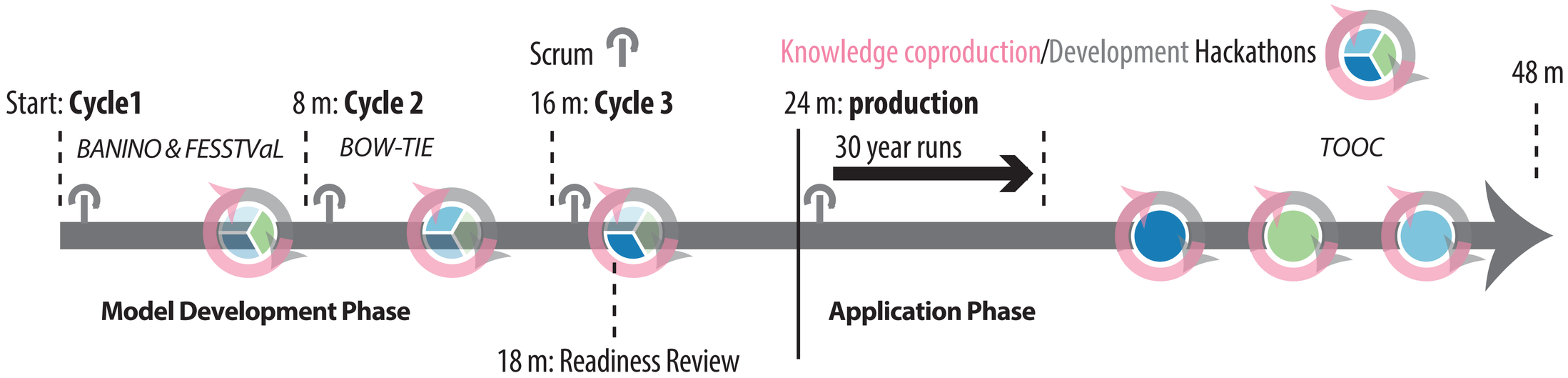
The arrow of time …



… ENES has much to contribute

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