

# Decadal climate predictions for climate services

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# Overview

A framework for decadal climate prediction

→ MiKlip project

Making skillful (and useful) predictions

„Roadmap“ for making decadal climate predictions  
part of a climate services portfolio



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# What are decadal climate predictions and how do they differ from climate projections?

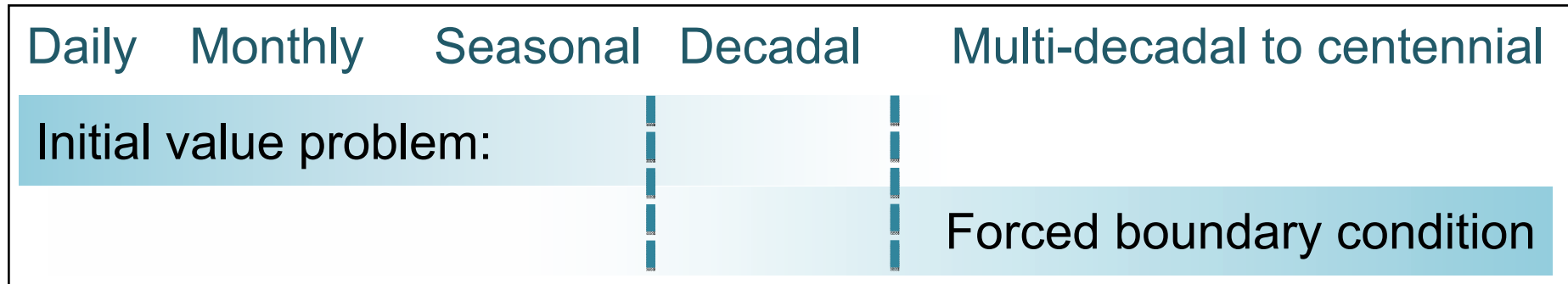
## Decadal climate predictions

- An estimate of the **actual** future evolution of climate
- Predicts anthropogenic change **and climate variability**
- Initial state based on observations of **slow climate components** (ocean, others)
- **Hindcasts** (retrospective predictions) allow to assess skill

## Climate projections

- One **potential** future evolution of climate
- Contingent on emissions scenarios
- Initial state not considered essential

# What are decadal climate predictions and how do they differ from climate projections?



# Decadal climate predictions - a candidate for climate services?

YES

- time-horizon appropriate for decision making
- indication of predictability for certain quantities
  - Atlantic hurricanes (Smith et al. 2010)
  - Arctic sea ice, heatwaves, impacts?



# Decadal climate predictions - a candidate for climate services?

YES

- time-horizon appropriate for decision making
- indication of predictability for certain quantities

## RECOMMENDATION

- develop a system for decadal climate predictions (World Summit 2009)
- “Decadal exchange“ (lead Hadley Center<sup>1</sup>)



# Decadal climate predictions - a candidate for climate services?

YES

- time-horizon appropriate for decision making
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RECOMMENDATION

- develop a system for decadal climate predictions (e.g. World Summit 2009)
- “Decadal exchange“ (lead Hadley Center)

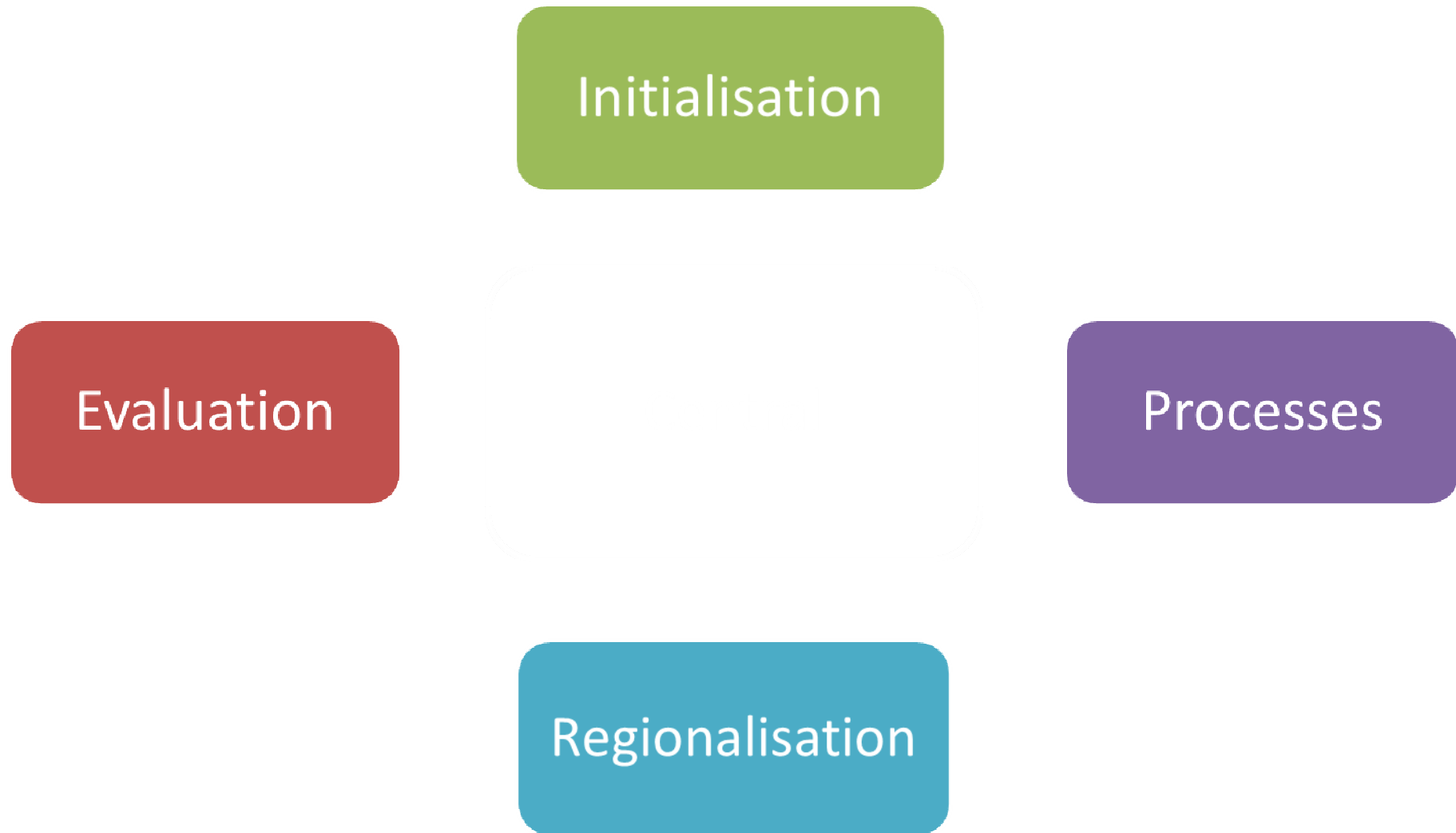
Key Question → can predictability be established?

→MiKlip project<sup>1</sup>



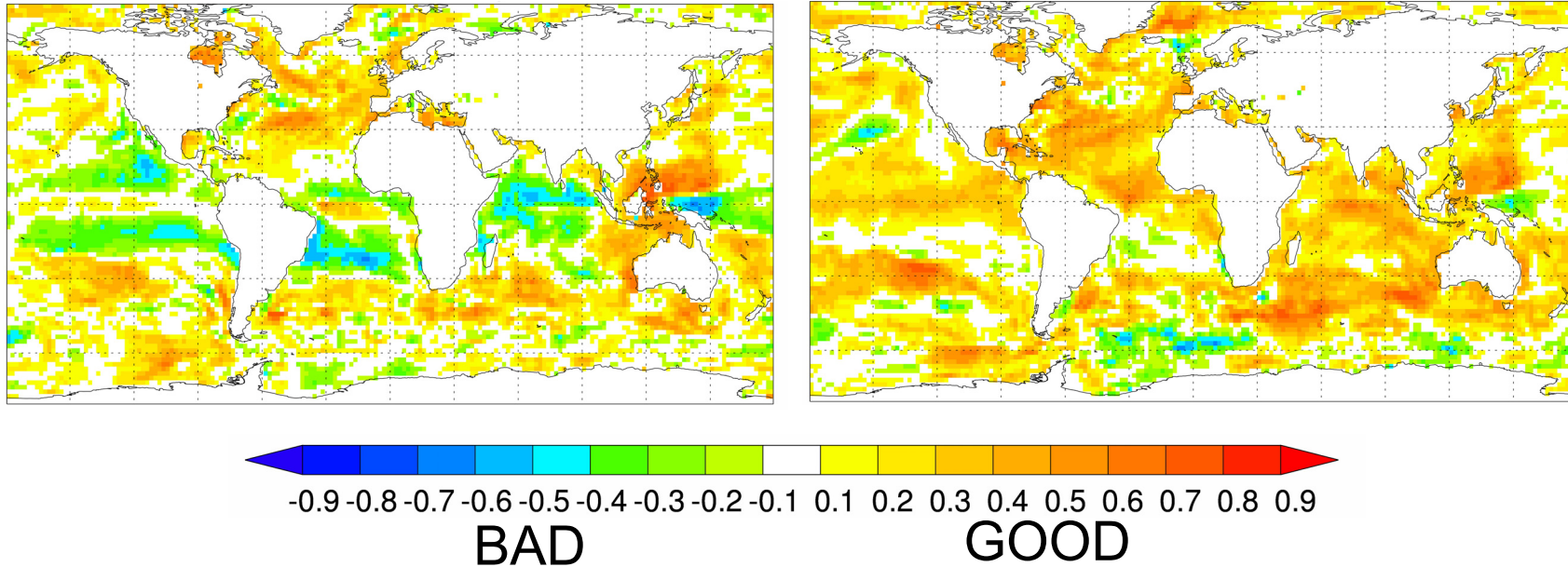


# Research challenges



# Initialisation

Correlation with HadISST for lead year 2

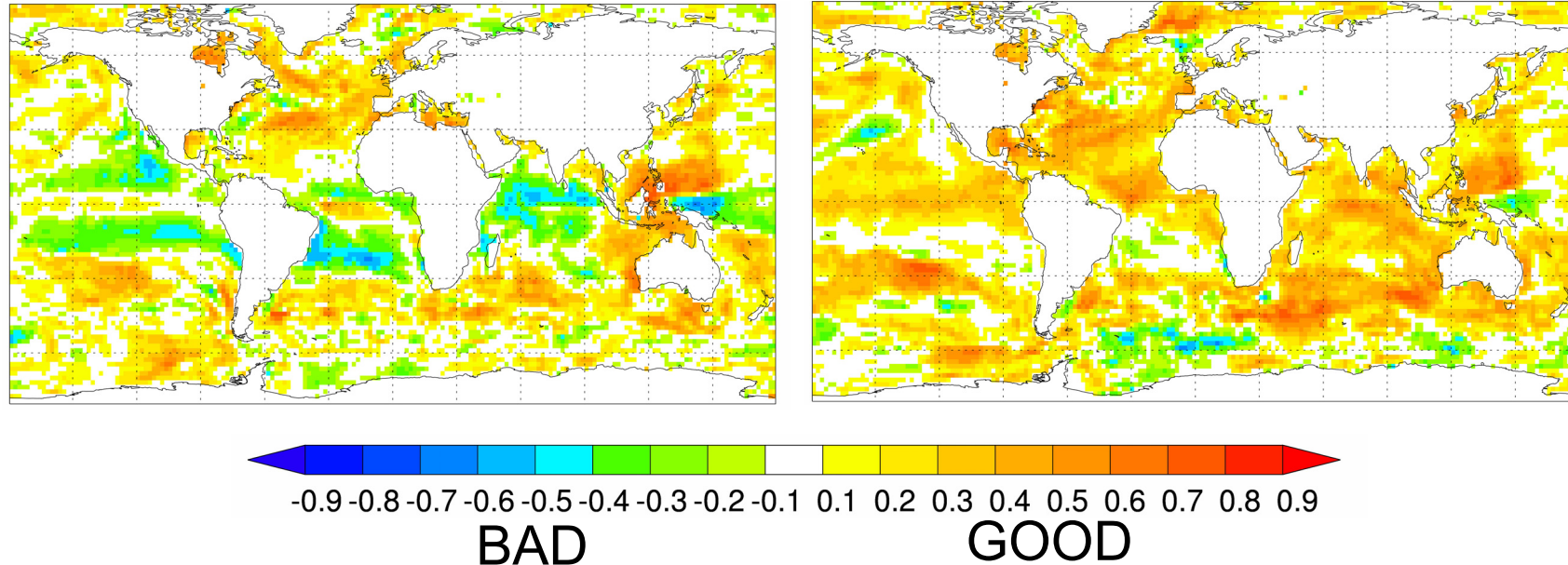


Only difference between hindcasts is the initialisation dataset  
Right panel - clear improvement over the tropics



# Initialisation

Correlation with HadISST for lead year 2



Only difference between hindcasts is the initialisation dataset  
Right panel - clear improvement over the tropics

→ Need: Initialisation techniques and state estimates

# Processes

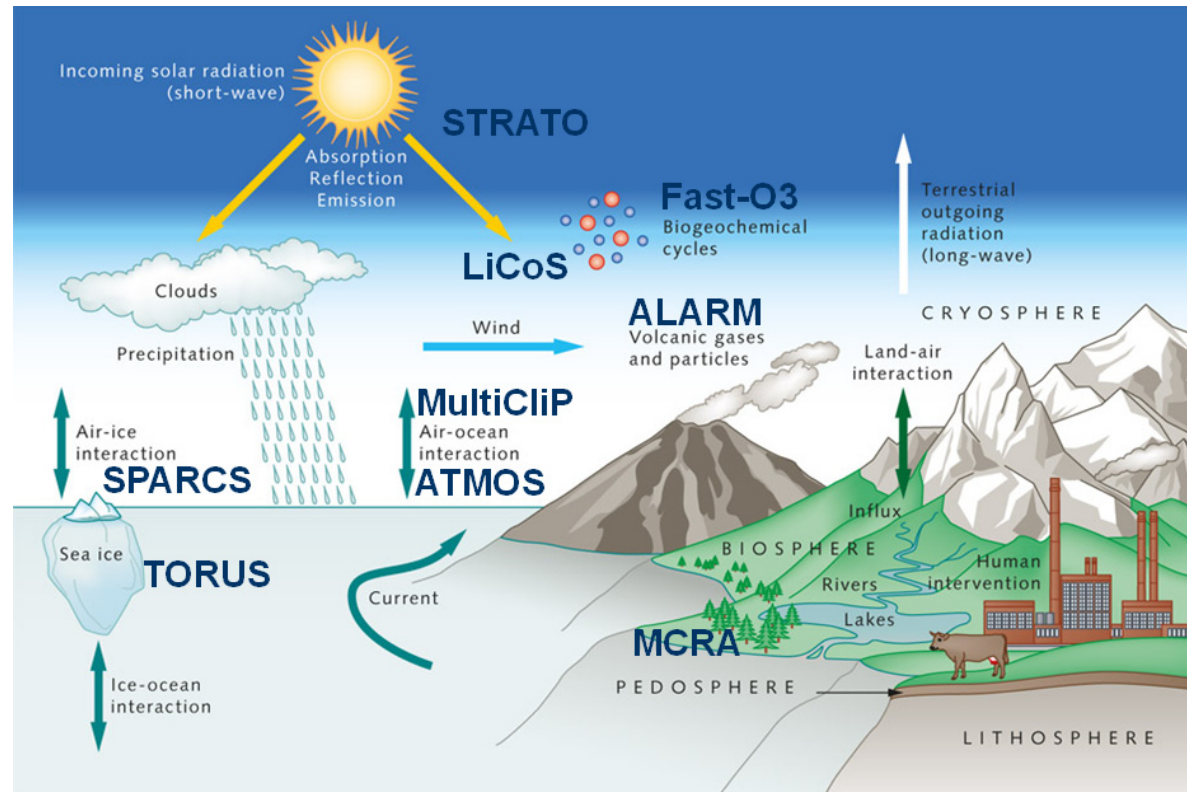
Lack of robust decadal climate variability in global models

- differences in the representation of processes e.g., AMOC
- missing processes



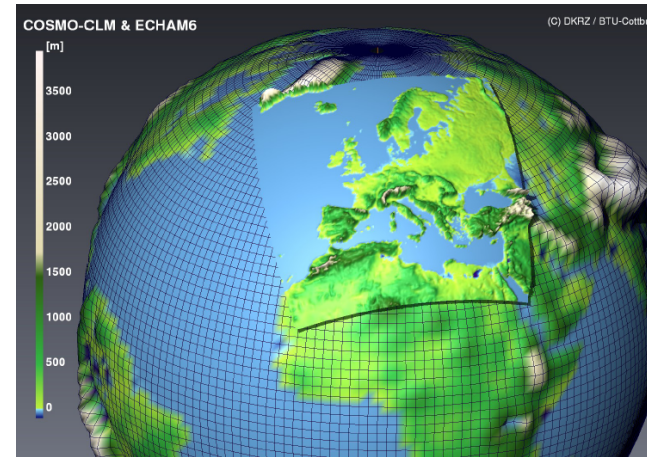
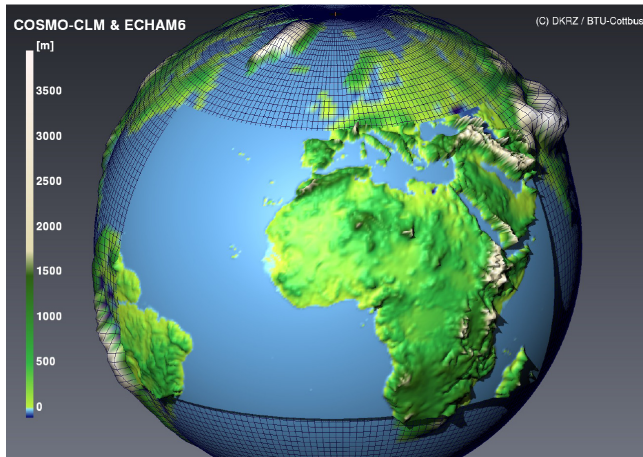
# Processes

Lack of robust decadal climate variability in global models



→ Need: increased process understanding

# Regionalisation



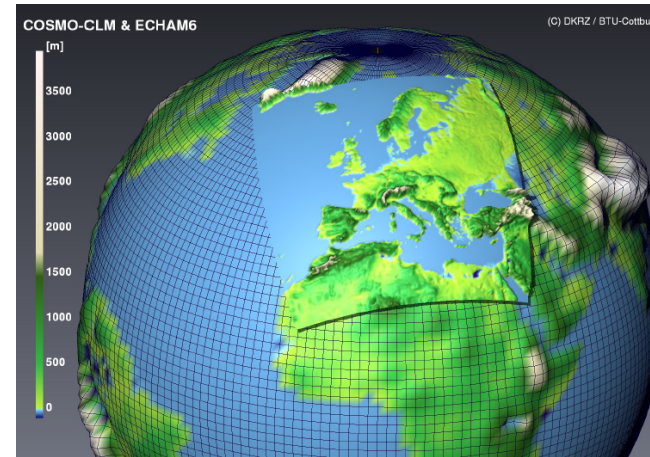
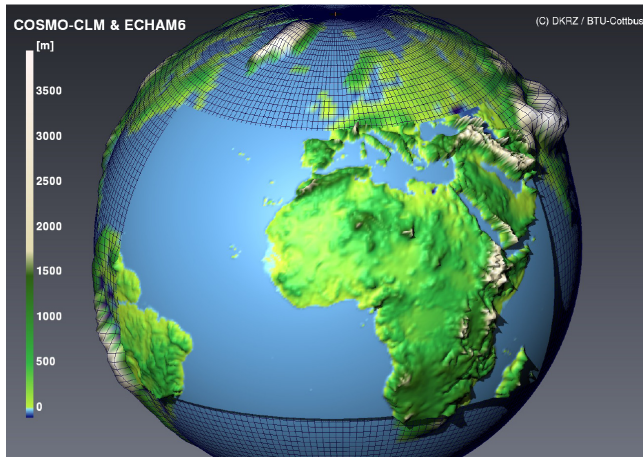
→ Increased relevance for users

But, so far:

- little focus on regional modelling + decadal climate prediction



# Regionalisation



Little regional modelling + decadal climate prediction

Need to:

- investigate key regions
- combine global and regional models



# Evaluation

How do we judge what information is of use?

- Scientific perspective:
  - Skill (statistical)
- Societal perspective
  - Usefulness /applicability for decision making





# Evaluation

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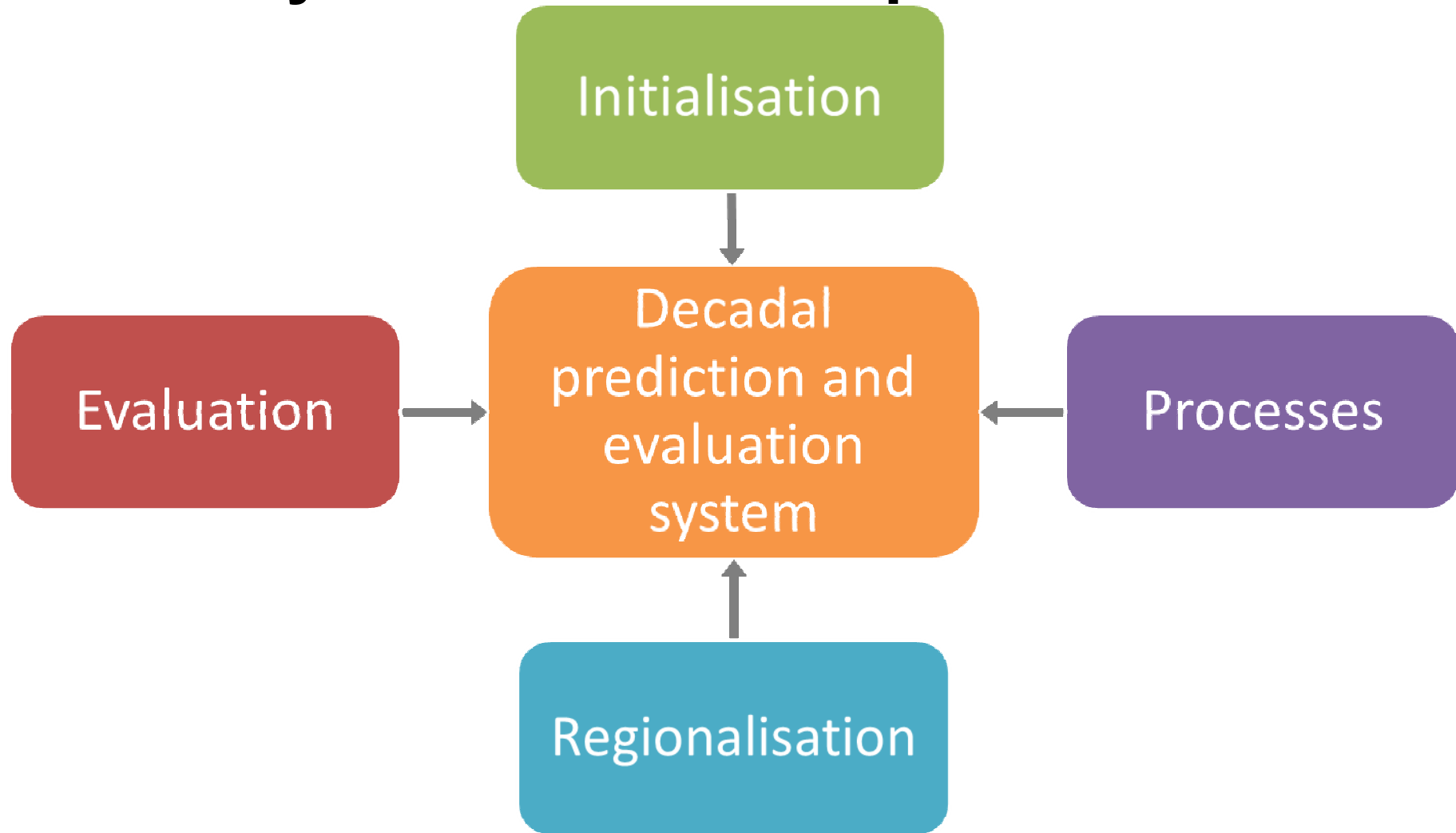
- Scientific perspective:
  - Skill (statistical)
- Societal perspective
  - Usefulness /applicability for decision making

**NEED to:**

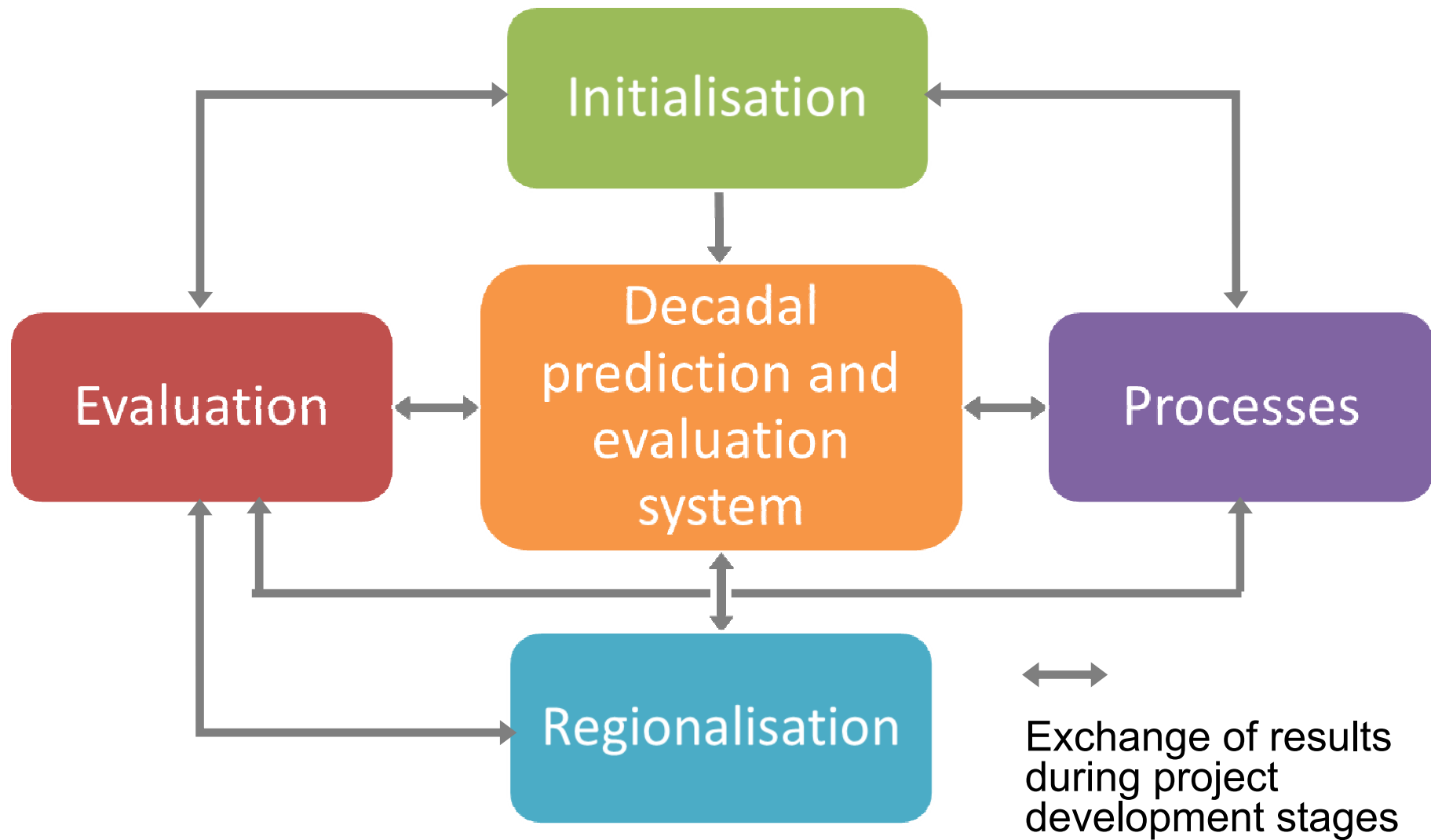
- develop tools and methods to evaluate skill of decadal predictions
- involve potential users



# Ultimate challenge: system for decadal prediction



# → MiKlip project aim



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# Current decadal prediction system

## “Baseline 0”

Global model: MPI-ESM-LR

- Historical run: CMIP5 (all forcings)
- Hindcasts: - 1961 – 2011
  - initialised yearly
  - 3 ensemble members (10 for 5<sup>th</sup> year)



# Current decadal prediction system

## “Baseline 0“

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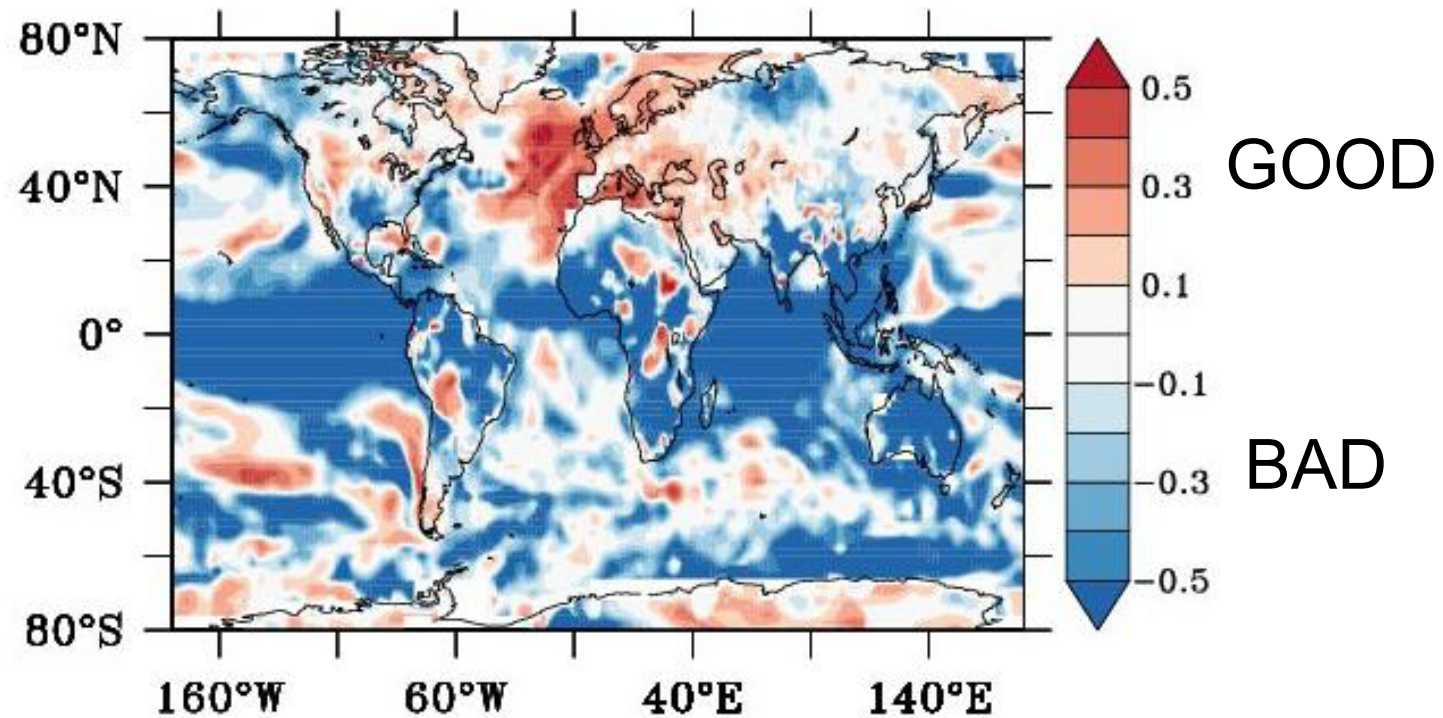
- Historical run: CMIP5 (all forcings)
- Hindcasts: - 1961 – 2011
  - initialised yearly
  - 3 ensemble members (10 for 5<sup>th</sup> year)

### Skill measure for hindcasts

- RMSE compared to
  - historical runs
  - persistence

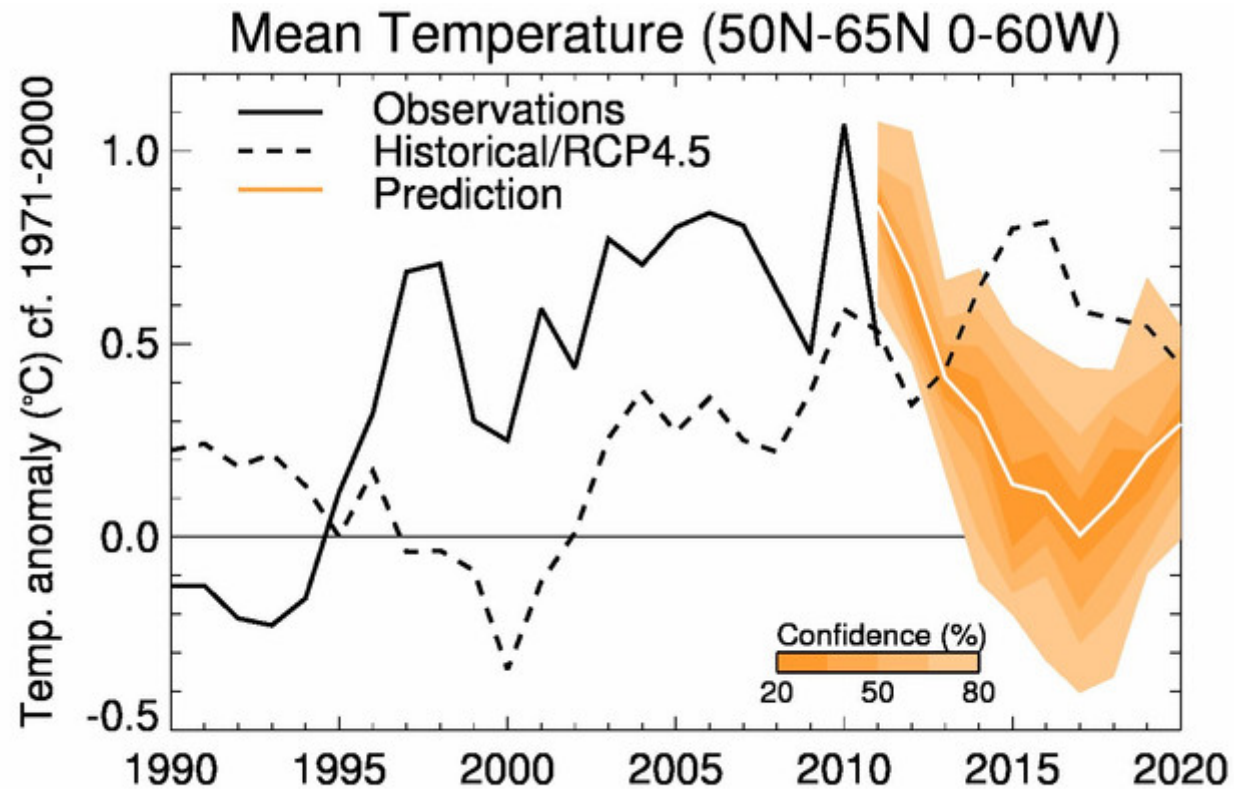


# Initialised experiments compared to historical: skill in North Atlantic, reduced skill in tropics, low skill over land



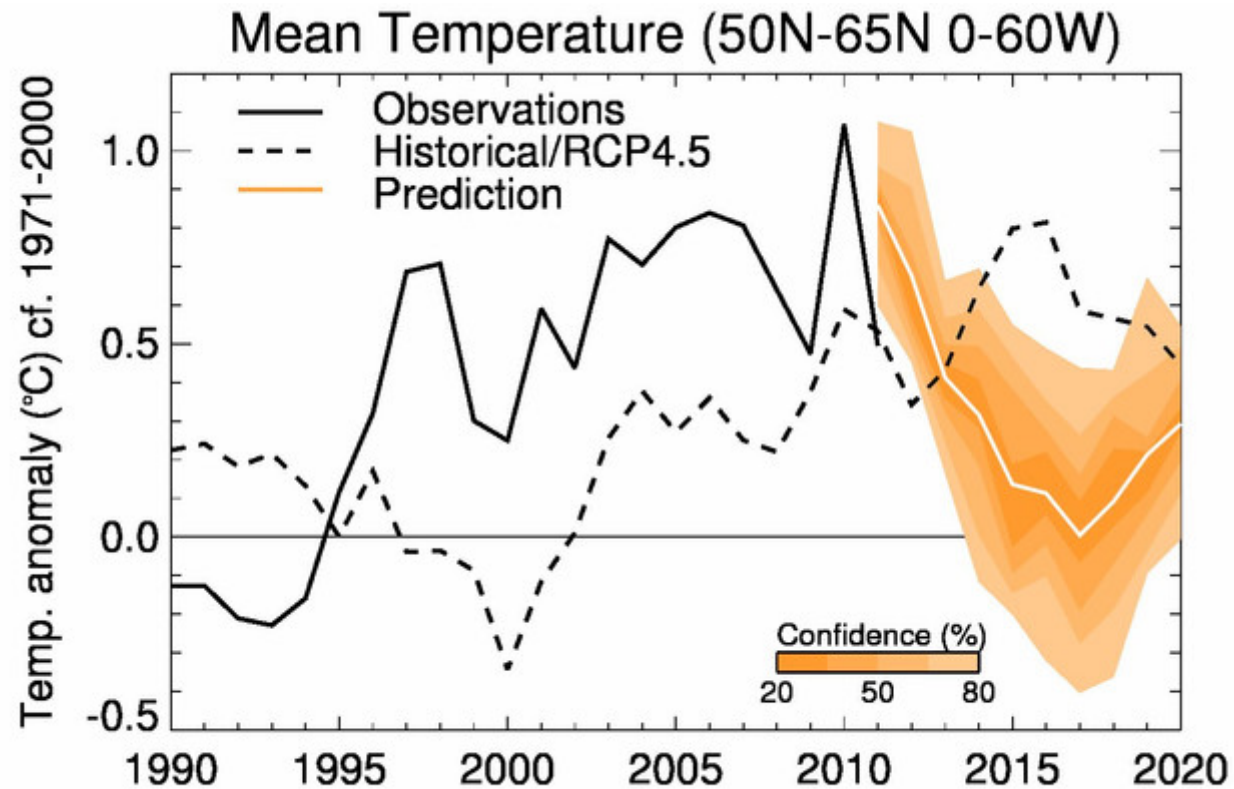
Global mean surface T – lead year 2-5  
RMSE w.r.t. HadISST & GHCN-CAMS

# Prediction of quantities with known skill + confidence in physical mechanism





# Prediction of quantities with known skill + confidence in physical mechanism

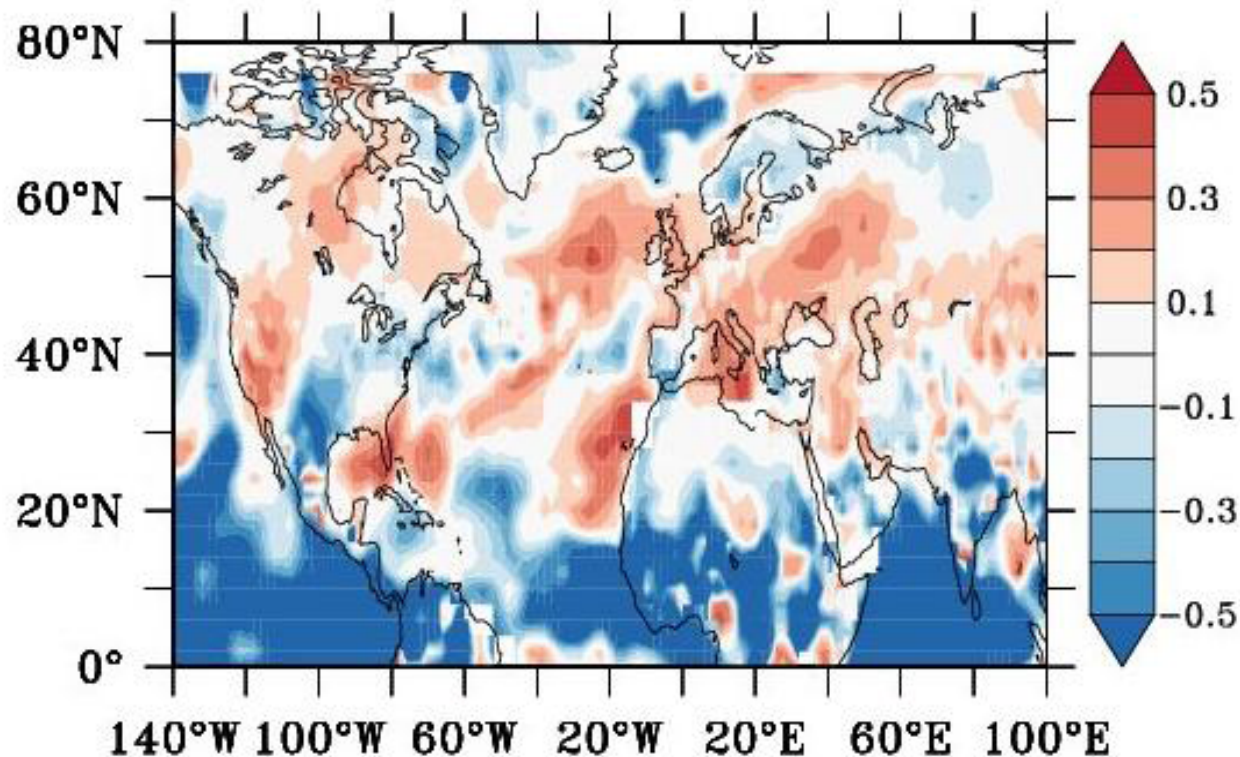


- How relevant is this information from a climate services point of view?

# Boosting skill by reduced time-interval?

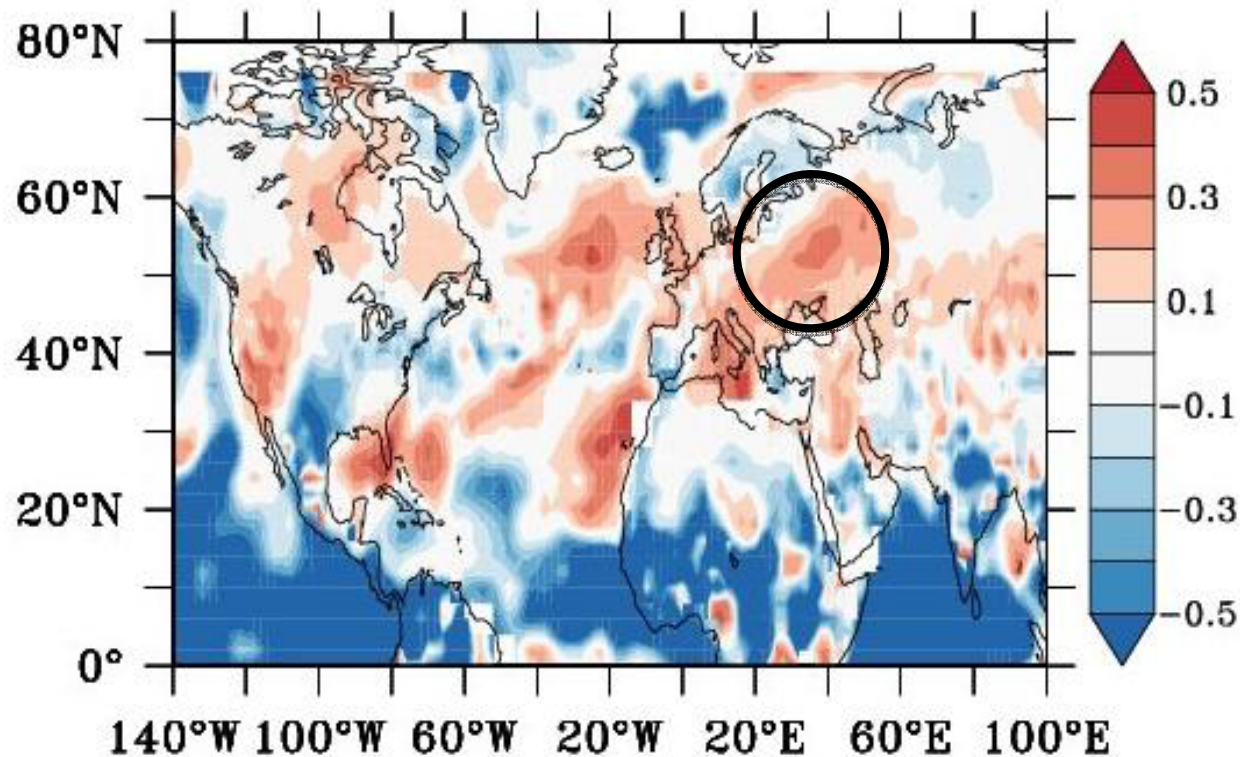
## – seasonal patterns in Europe

RMSE for Sept-Oct-Nov



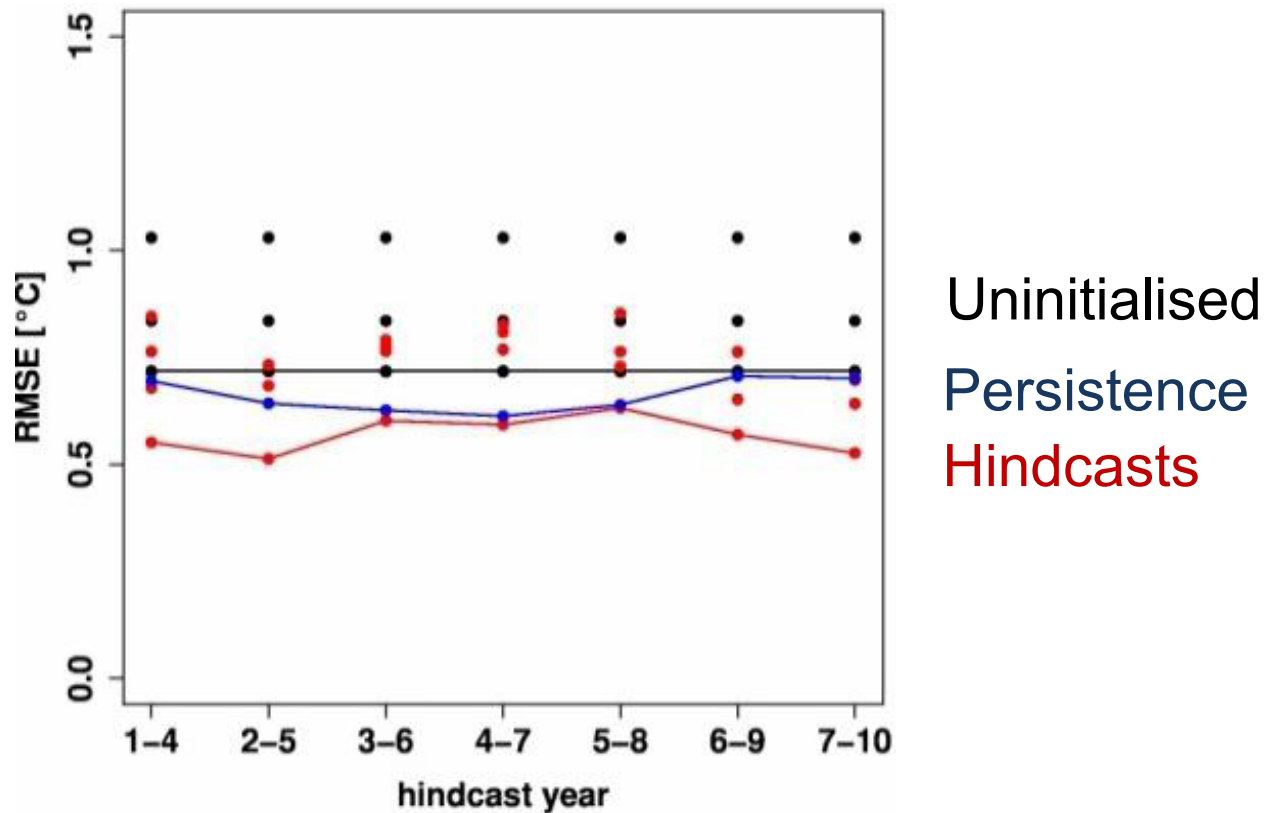
# Boosting skill by reduced time-interval? – seasonal patterns in Europe

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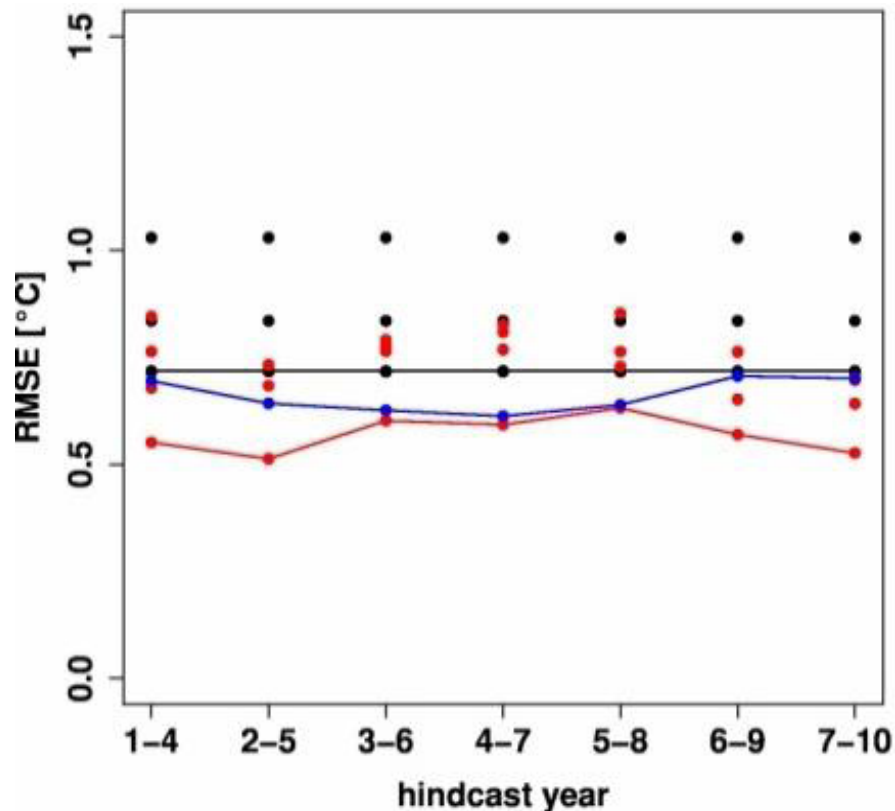
# Boosting skill by reduced time-interval? – seasonal patterns in Europe

RMSE Sept-Oct-Nov in Eastern Europe



# Boosting skill by reduced time-interval? – seasonal patterns in Europe

RMSE Sept-Oct-Nov in Eastern Europe



Uninitialised

Persistence

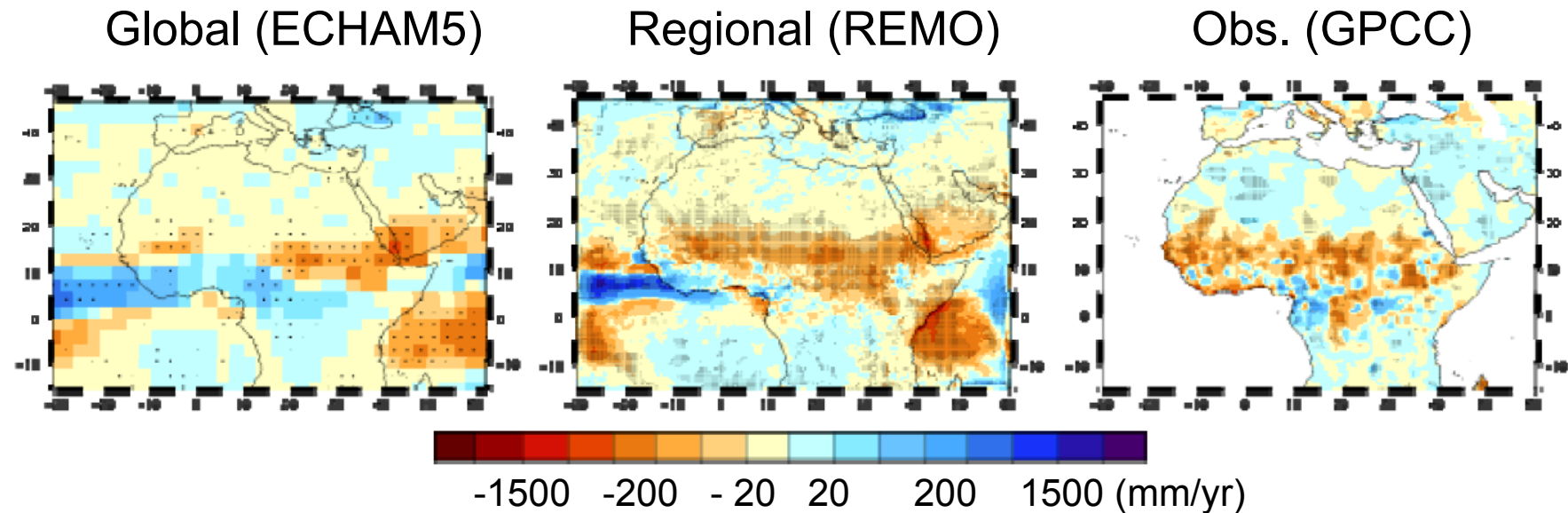
Hindcasts

RSME lower for initialised runs, but not as consistent as for annual means



# Boosting skill by regionalisation ?

## 1961-99 summer rainfall trend over N Africa



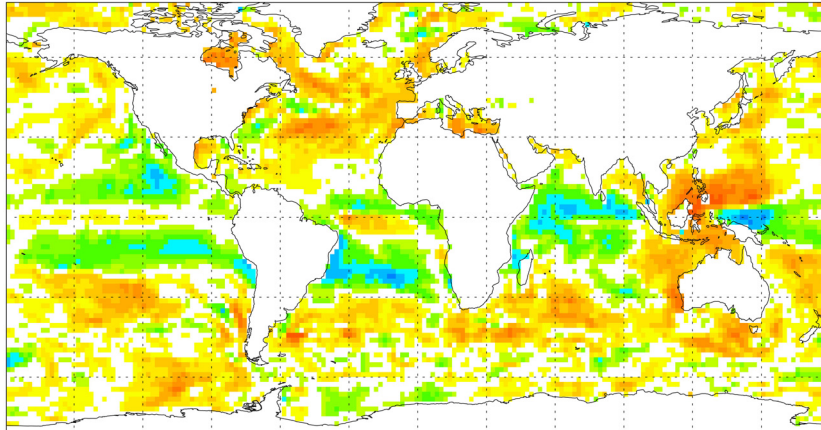
- Inter-decadal trend more realistic in regional model  
→ potential for increasing skill by using regional model  
→ contingent on global model skill in SSTs



# Updating the decadal prediction system

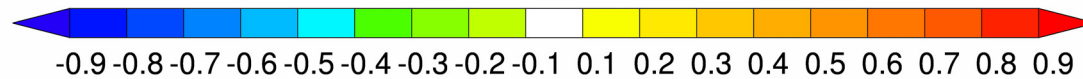
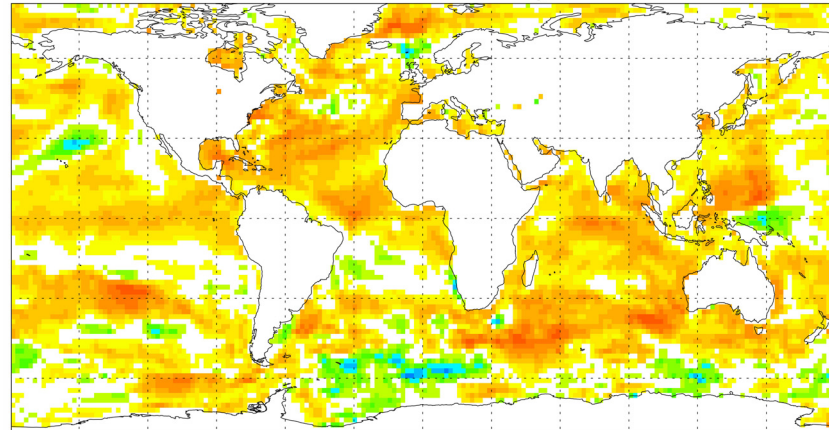
## Baseline 0

COR SST NCEPo yr2



## Baseline 1 (new initialisation)

COR SST ORAOa yr2



Baseline 0: decadal trend in Atlantic SST not captured

Baseline 1:

- Positive correlation for the whole Atlantic basin
- SSTs necessary for n. Africa might be better captured
- Highlights the need for several iterations within the project



# Skill summary

With the global model:

- robust skill for some regions (e.g. North Atlantic)
- indication of increased skill over land when considering seasons

With the regional models:

- potential for added value, if skill in the global model can be established





# Skill summary

With the global model:

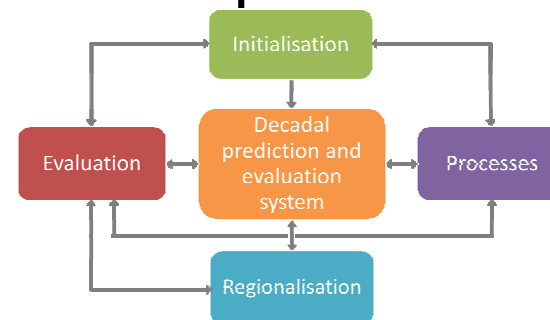
- robust skill for some regions (e.g. North Atlantic)
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With the regional models:

- potential for added value, if skill in the global model can be established

→ Promising results, but a lot of work before being able to offer a „range“ of regions/times/quantities with skill

→ Need iterations involving  
all MiKlip modules



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# Decadal climate predictions as part of a climate services portfolio

## Roadmap

### 1. Establish confidence in skill before involving users

- Framework for decadal prediction
- Improve system skill (and understanding) from a scientific perspective
- This is where MiKlip (and others) are now



# Decadal climate predictions as part of a climate services portfolio

## Roadmap

1. Establish confidence in skill before involving users

Once potential for skill has been demonstrated:

2. Involve users in particular regions/with particular quantities of interest

– e.g., useful indices, seasons, quantities



# Decadal climate predictions as part of a climate services portfolio

## Roadmap

1. Establish confidence in skill before involving users
2. Involve users in particular regions/with particular quantities of interest

When users have been involved

3. Pin-point processes, regions and evaluation tools necessary for users' needs

→improvement of skill system from a user/climate services perspective



# Decadal climate predictions as part of a climate services portfolio

## Roadmap

1. Establish confidence in skill before involving users
2. Involve users in particular regions/with particular quantities of interest
3. Pin-point processes, regions and evaluation tools necessary for users' needs
4. Provide decadal predictions for climate services



# Decadal climate predictions as part of a climate services portfolio

## Roadmap

1. Establish confidence in skill before involving users
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