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Future Climate in Northern Europe – challenges for groundwater management

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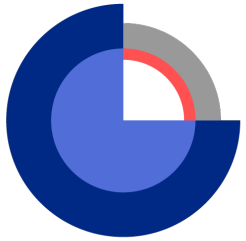


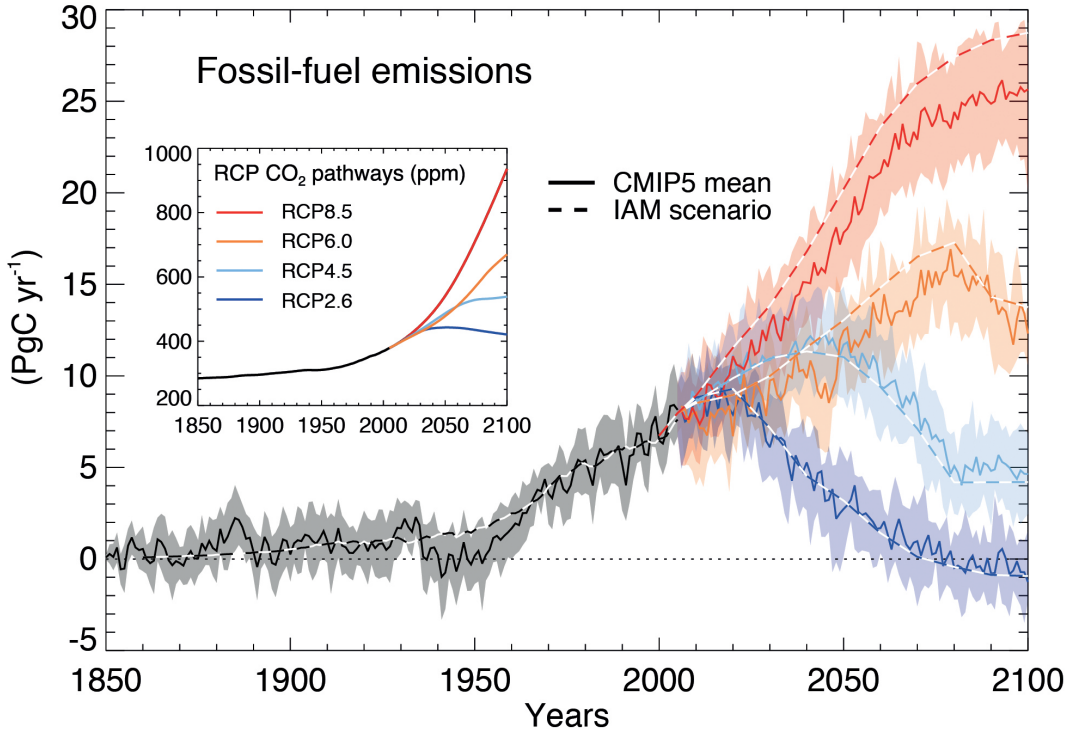
G E U S

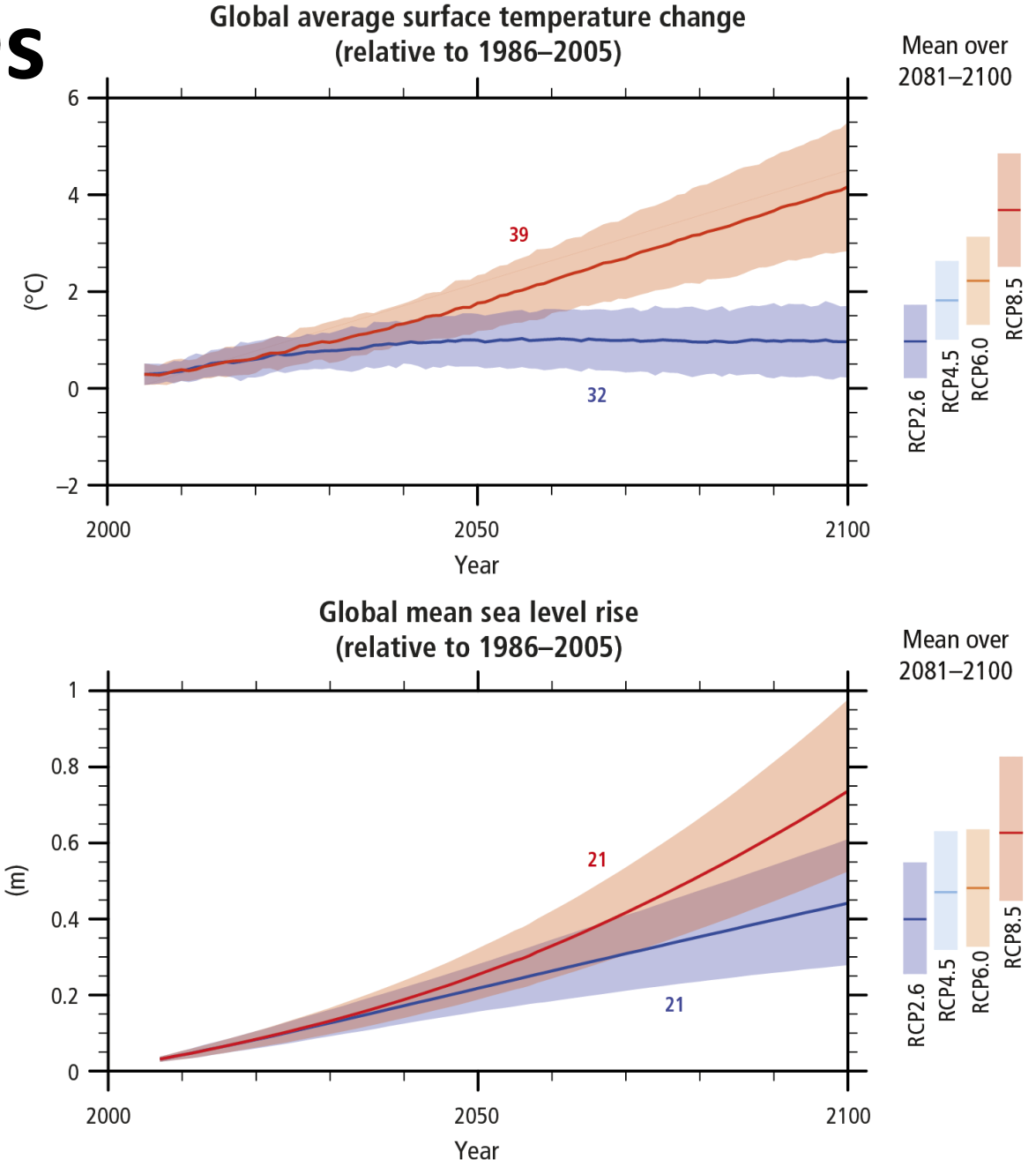
Outline

- Future climate
- Impacts on groundwater - examples related to
  - Groundwater flooding
  - Groundwater recharge
  - Groundwater quality
  - Coastal aquifers
- Uncertainties
- Key challenges for groundwater management

Future climate – projections

IPCC Emission Scenarios (RCPs)





IPCC – AR5 (2014)

Climate Change

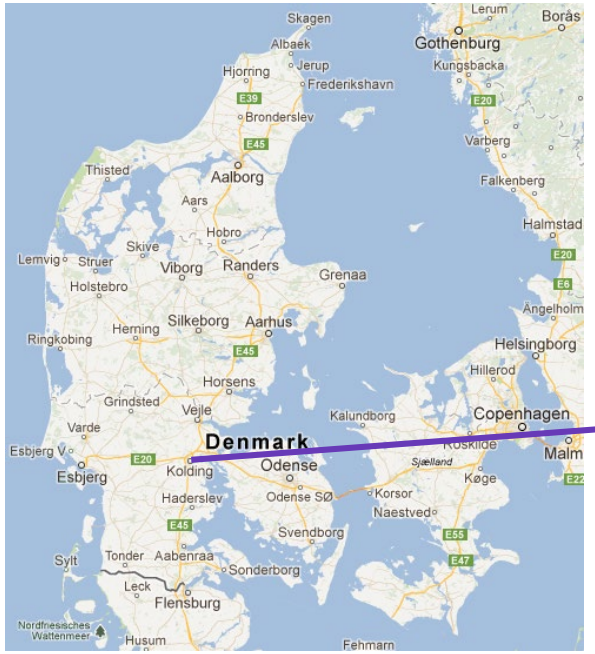
Known trends in Northern Europe

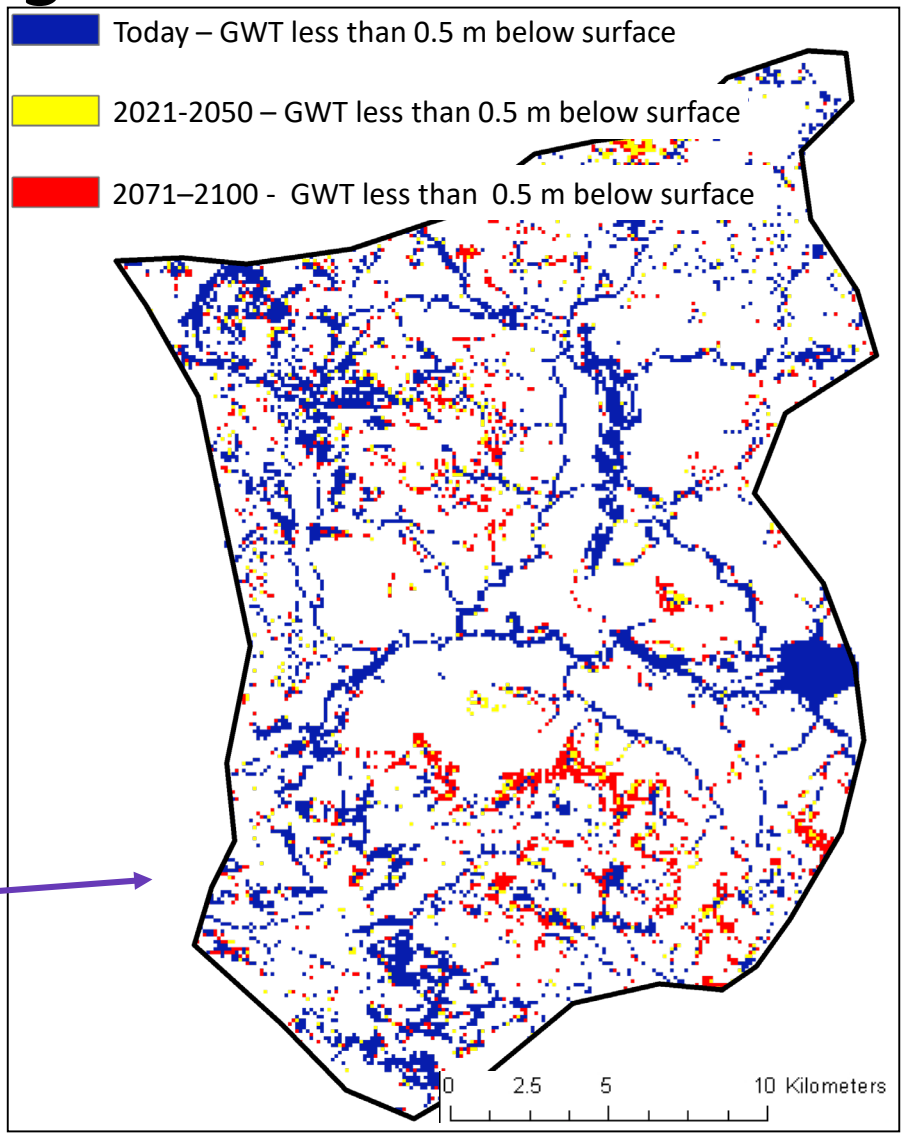
- Temperature: warmer
- Precipitation: changes in seasonal pattern
  - Relatively wetter during winter
  - Relatively dryer during summer
- Sea level: rising
- More extreme weather events (2018 as the new normal ?)
- Large uncertainty on projections

CC impacts on groundwater (Example 1/4)

Groundwater flooding

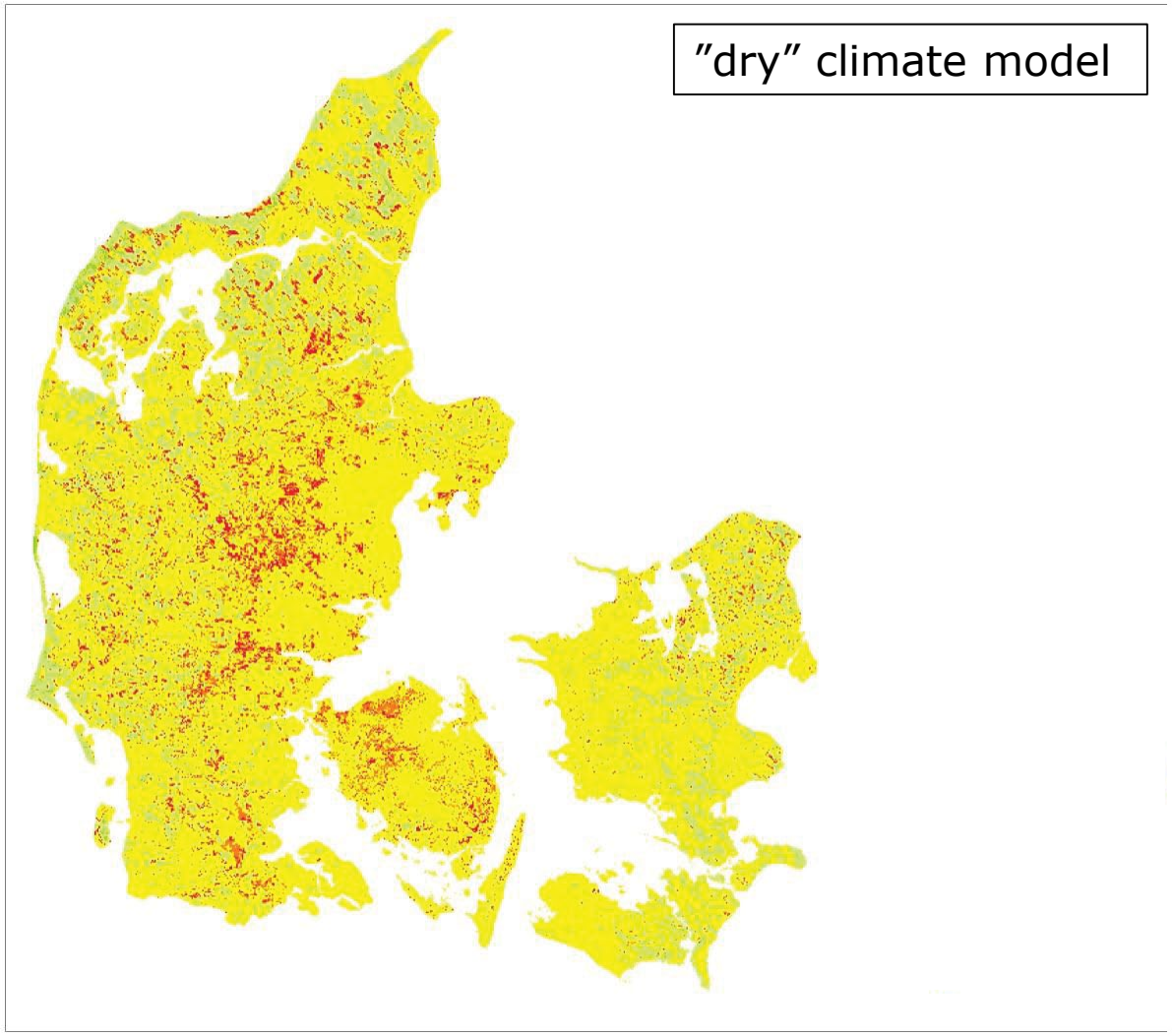
- Shallow groundwater table (phreatic surface) increases due to wetter climate
- Case from Kolding, Denmark

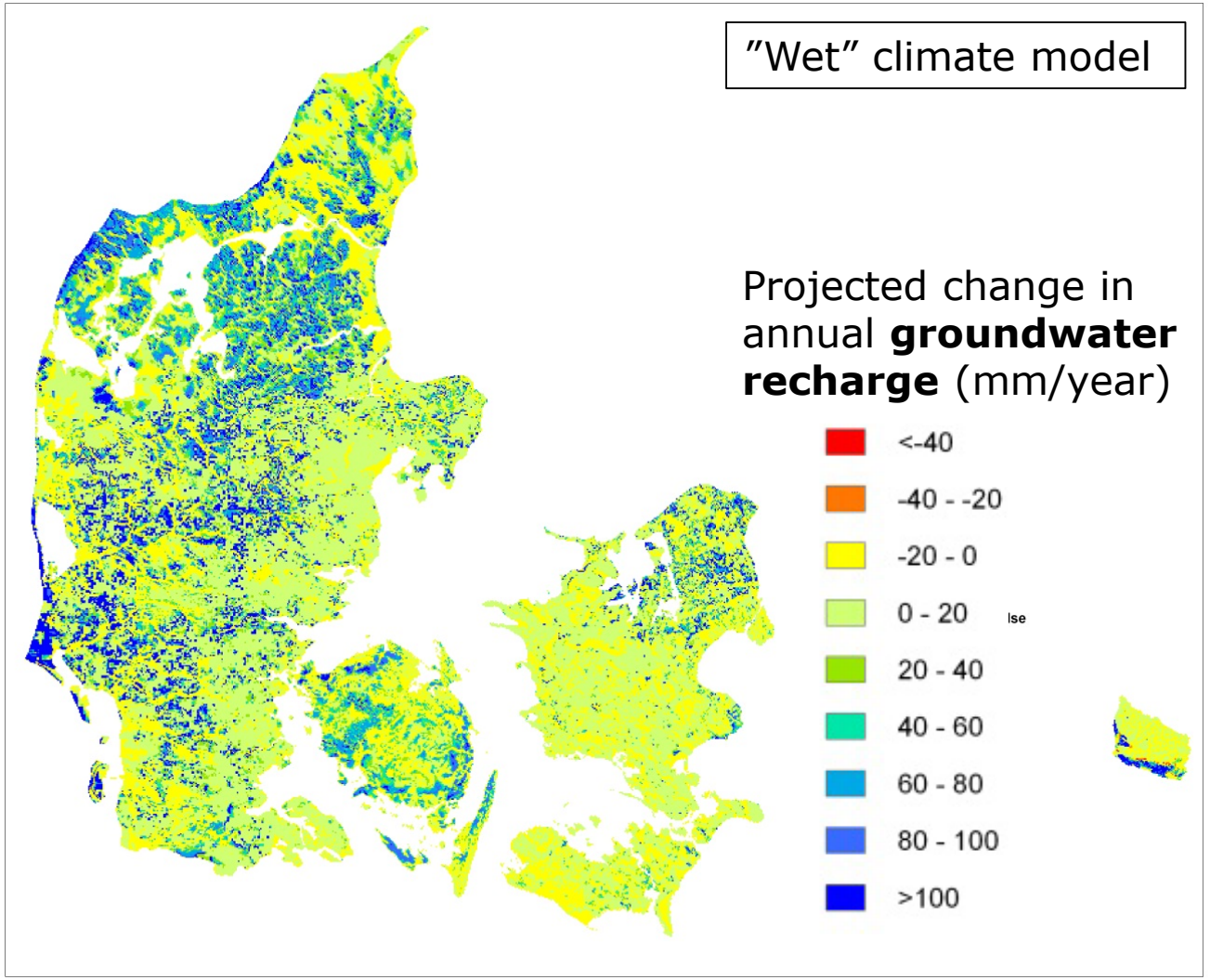




CC impacts on groundwater (Example 2/4)

Change in available groundwater [1961-90] to [2021-50]





CC impacts on groundwater (Example 3/4)

Groundwater quality

Complex situation – <u>not well studied</u>

- Increased leaching of non-point pollutants (nitrate, pesticides)
- Changes in hydrological cycle incl. groundwater flow patterns
- Transport time to deep aquifers – several decades

➔ Environmental “time bomb” (Cuthbert et al., 2019)

CC impacts on groundwater (Example 4/4)

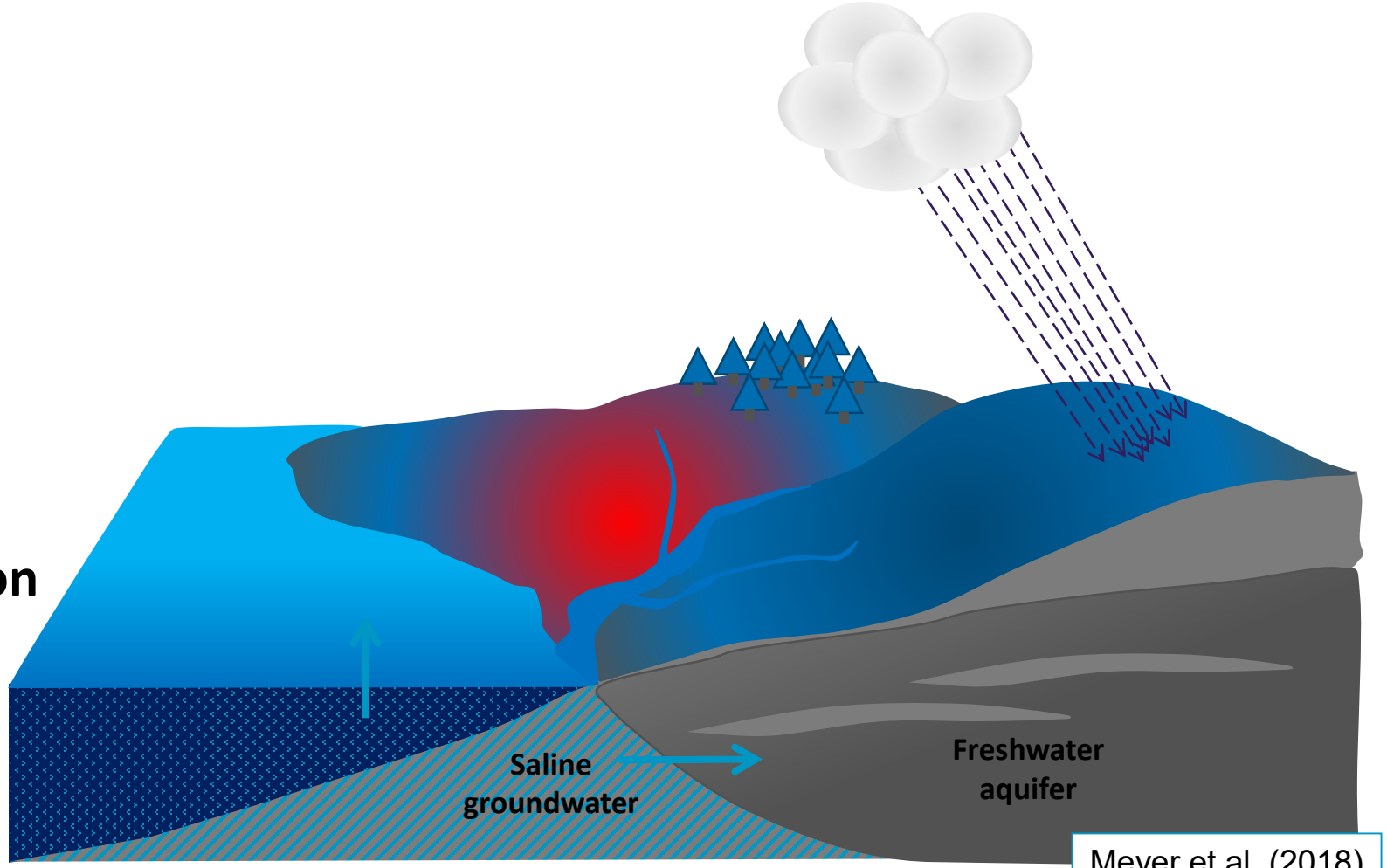
Coastal aquifers

Saline intrusion depends on e.g.

- Sea level rise
- Hydrogeology – aquifer type
  - Unconfined: everything "just" moved upwards
  - Confined: No room upwards ➔ saline intrusion
- Drainage system

How far inland can saline intrusion be for one meter sea level rise

- Unconfined aquifers: almost zero
- Confined aquifers/surface layer drained: up to 5 km

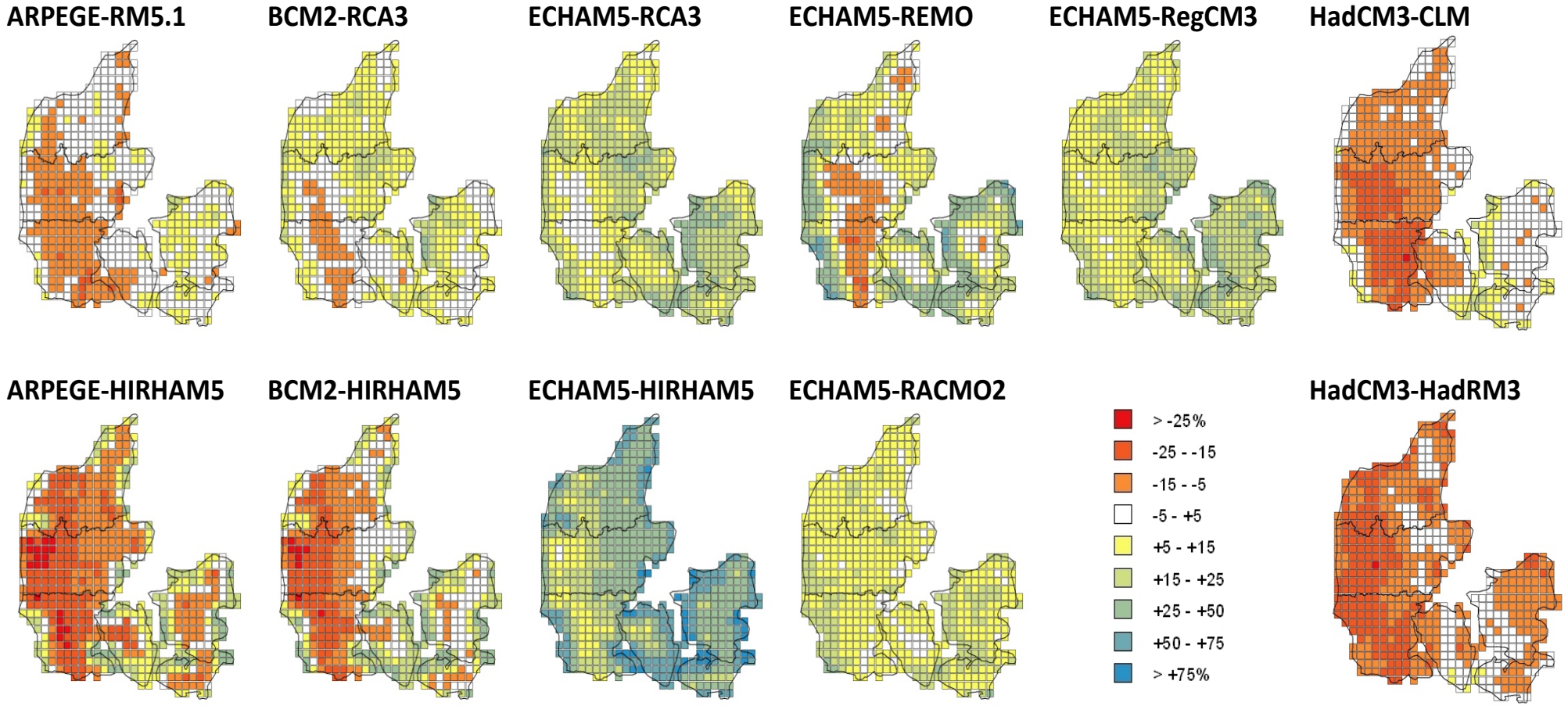


Meyer et al. (2018)

Uncertainties

Climate models have biases ➔ Bias correction

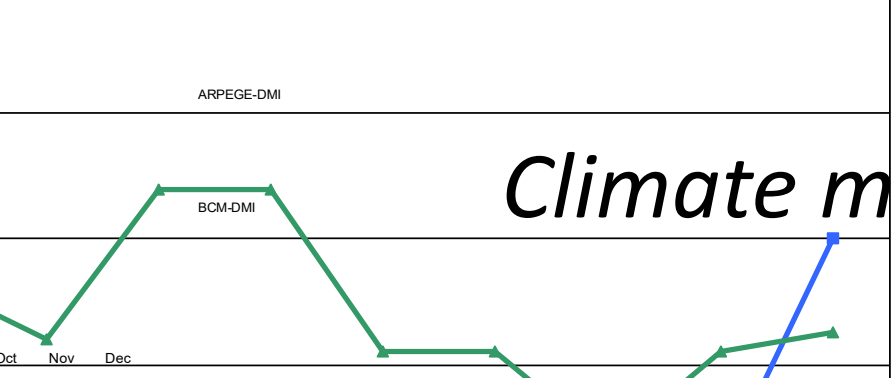
Bias
(model - observed)
on annual
precipitation for
1991-2010

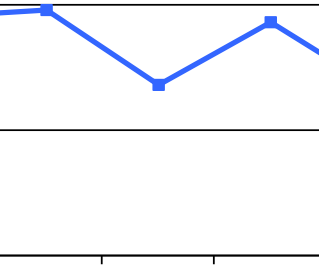


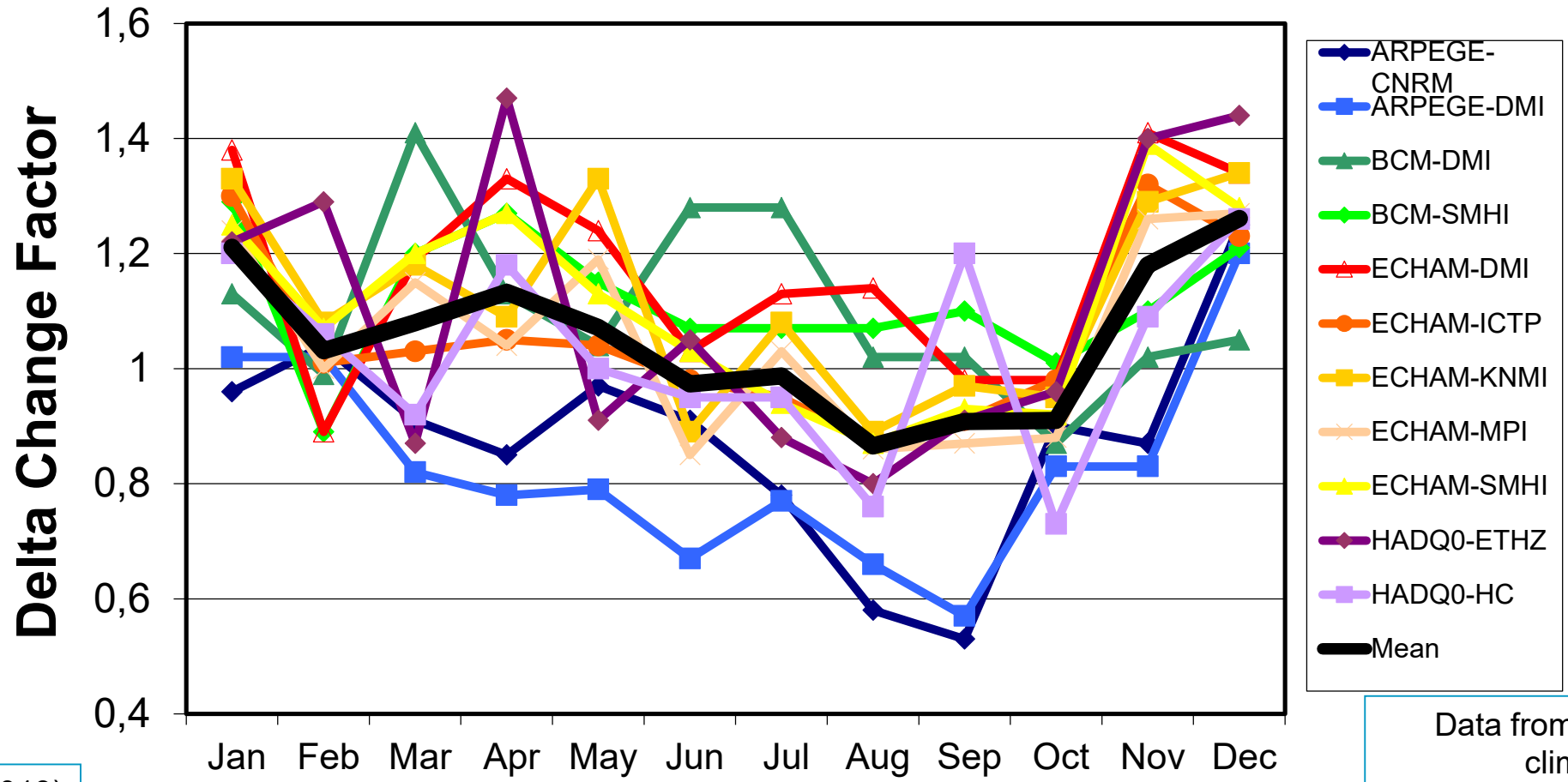
Seaby et al. (2015)

Uncertainties

Climate models have different CC signals





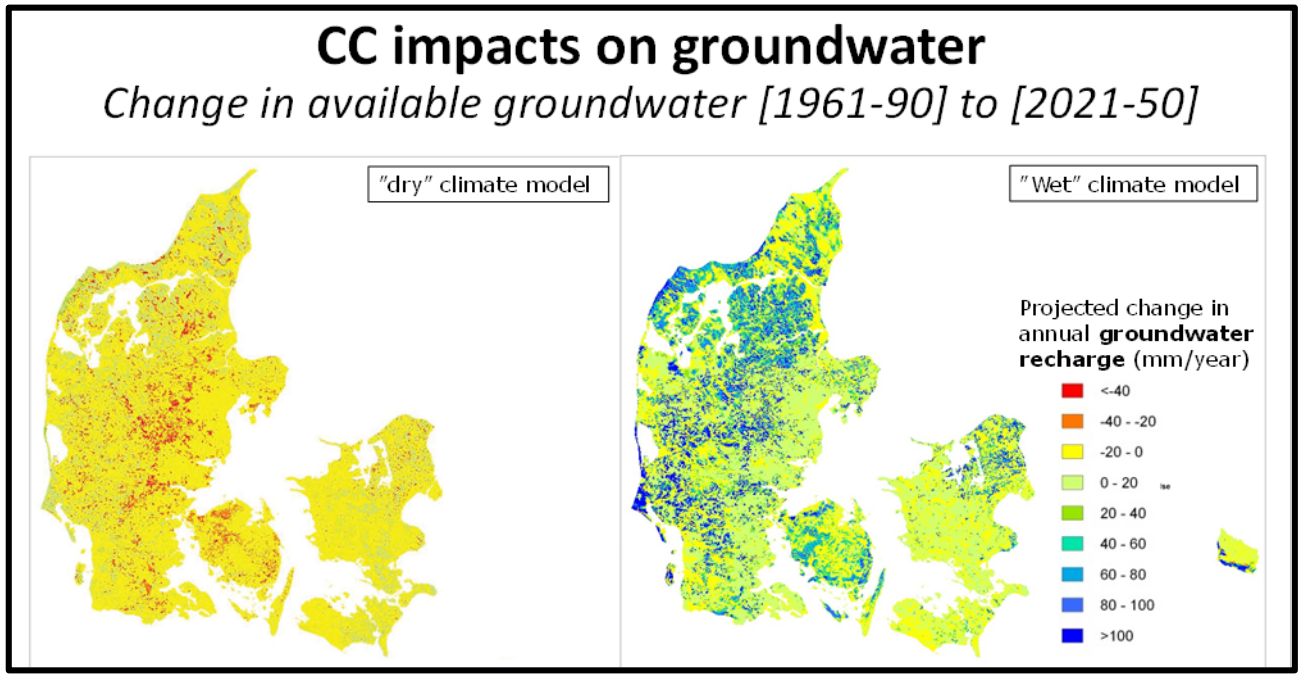


Seaby et al. (2013)

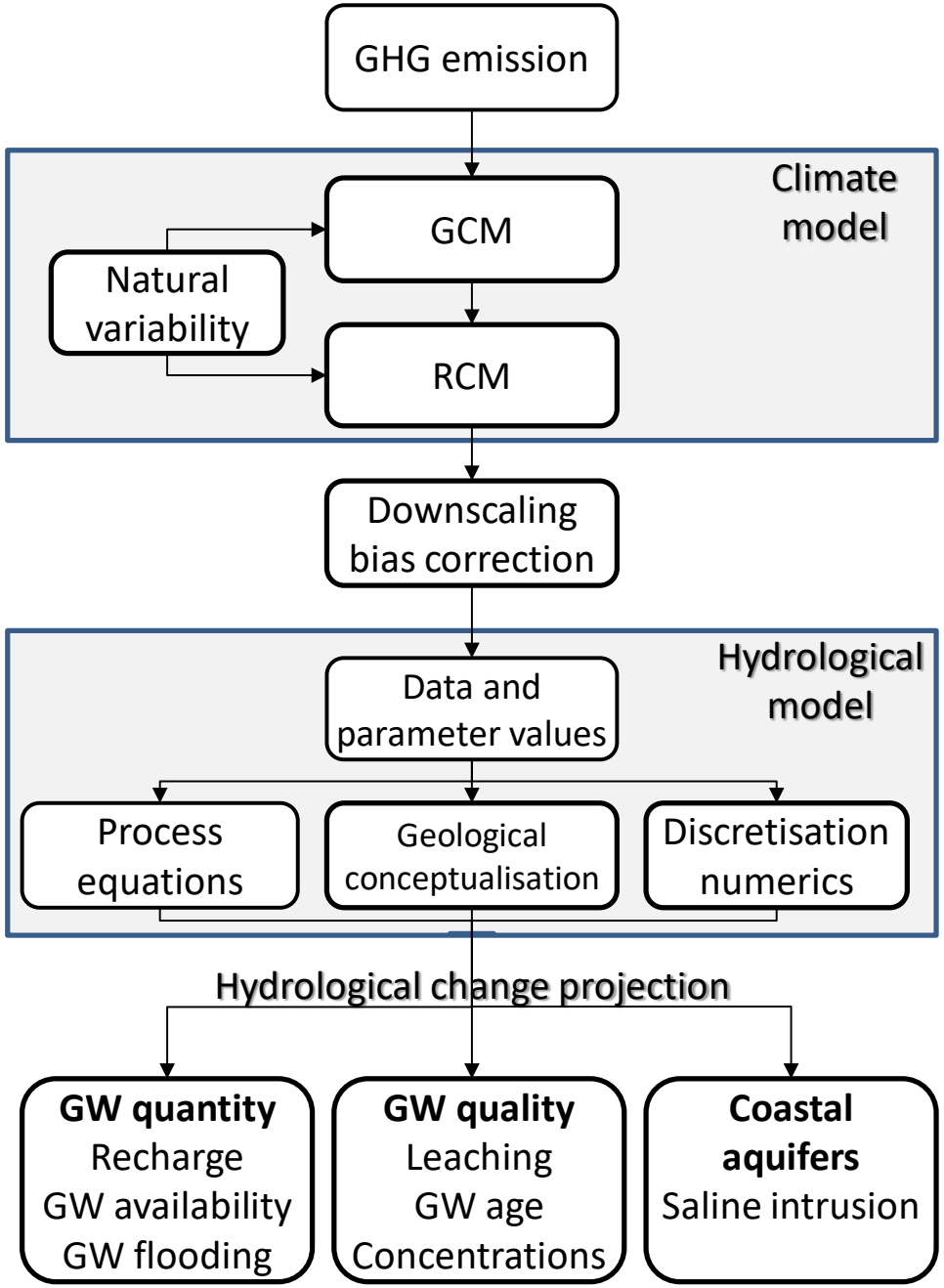
Data from 11 bias-corrected climate models in the ENSEMBLES project (A1B)

Uncertainties in climate change impact assessments

Uncertainty cascade



Refsgaard et al. (2016)



Conclusions

Key challenges for groundwater management

- Impacts, e.g.
  - Groundwater flooding
  - Groundwater recharge
  - Groundwater quality
  - Coastal aquifers
- Large uncertainties on climate impacts

➔ Uncertainties must be accounted for in water management (e.g. by adaptive management)

➔ Try to reduce uncertainties

- Improved models and data
- Discard ensemble model members with low reliability (see e.g. Climate JPI project http://aquaclew.eu/)