Comparison of statistical downscaling procedures for climate change impact assessment of water resources

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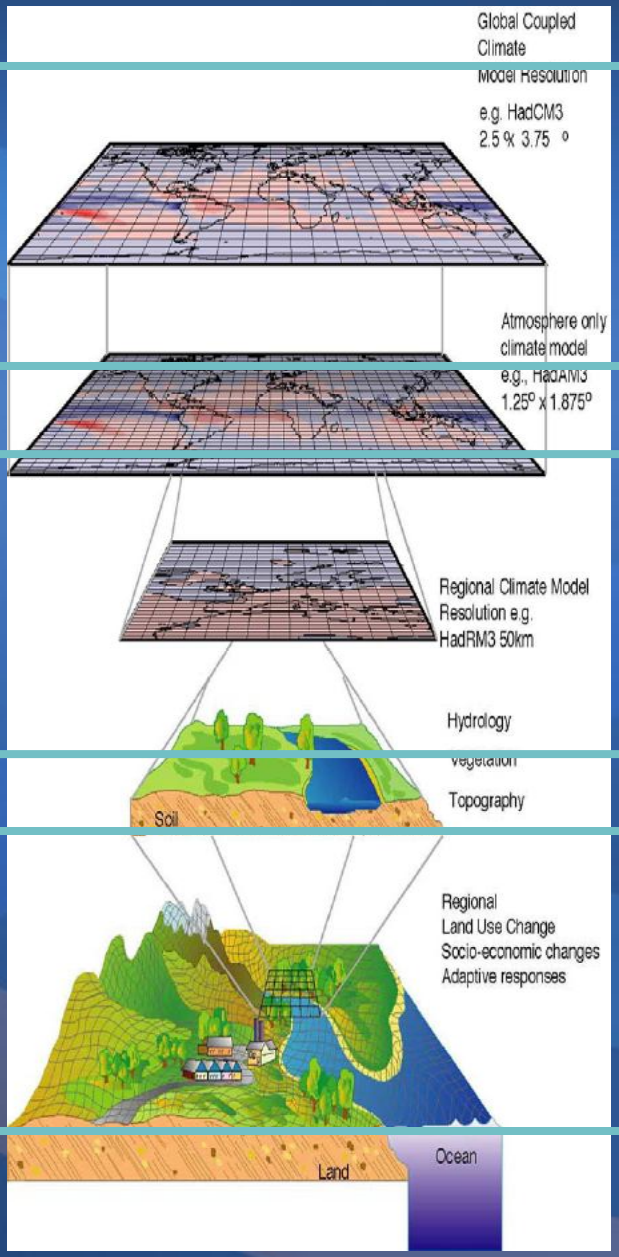
HydroPredict 2010, 20-23 September 2010, Prague, Czech Republic

Downscaling

Global climate model projections

Downscaling
- Dynamical
- Statistical

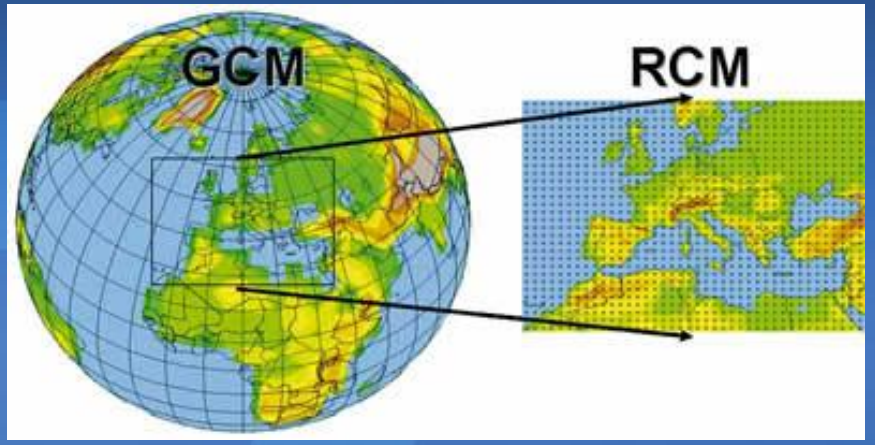
Local-scale impact assessment



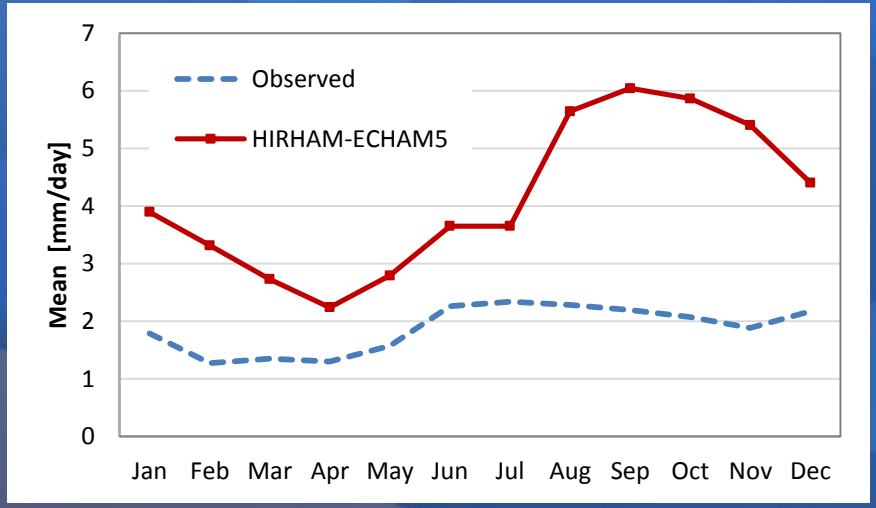
Dynamical downscaling

Regional climate model (RCM)

- Driven by GCM boundary conditions
- Higher resolution (10-50 km)
- Resolves sub-GCM grid scale forcings in a physically-based way



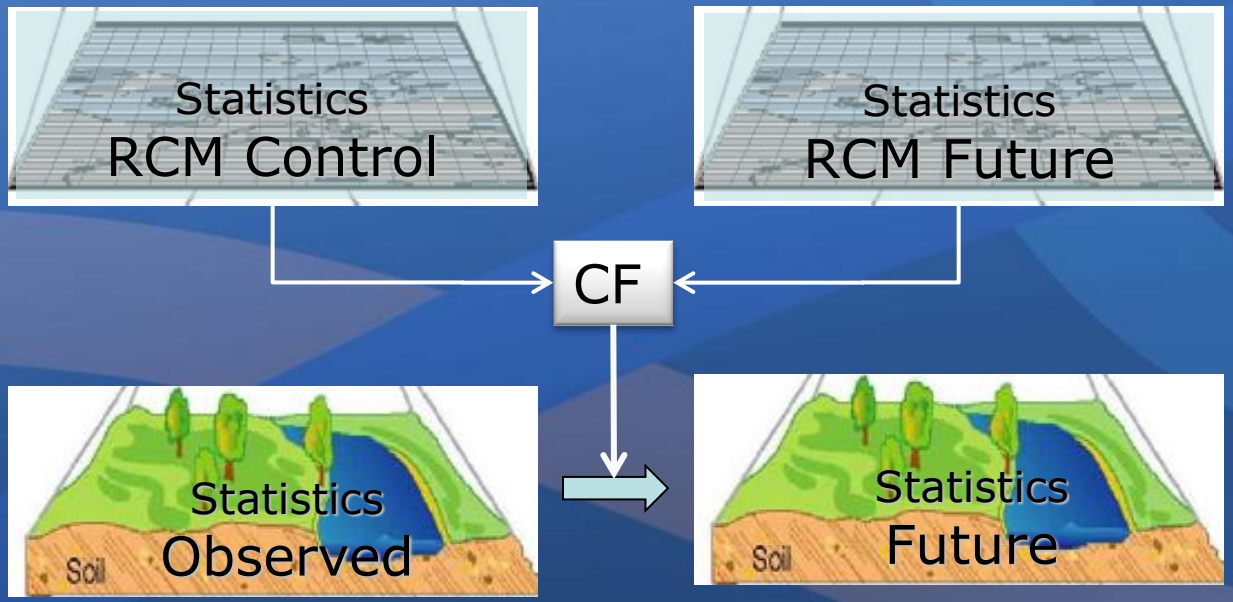
➢ **Further statistical downscaling needed**



Statistical downscaling

- Define relationship between large-scale model (GCM or RCM) and local climate

- Methods based on Change Factor Methodology:
  - Mean correction
  - Mean and variance correction
  - Weather Generators



Statistical downscaling methods

Change factors
- Mean
- Variance
- Proportion of dry days
- …

- **Mean correction (delta change)**

$$P_{fut} = a \cdot P_{obs}$$

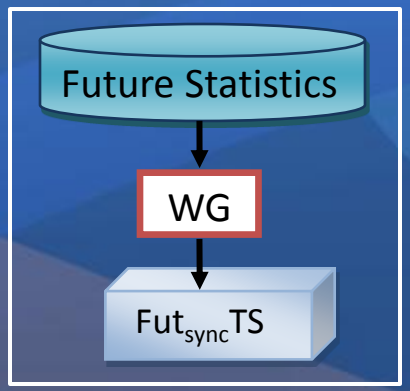
Model fitting:
-Mean

- **Mean and variance correction**

$$P_{fut} = a \cdot P_{obs}^{b}$$

Model fitting:
-Mean
-Variance

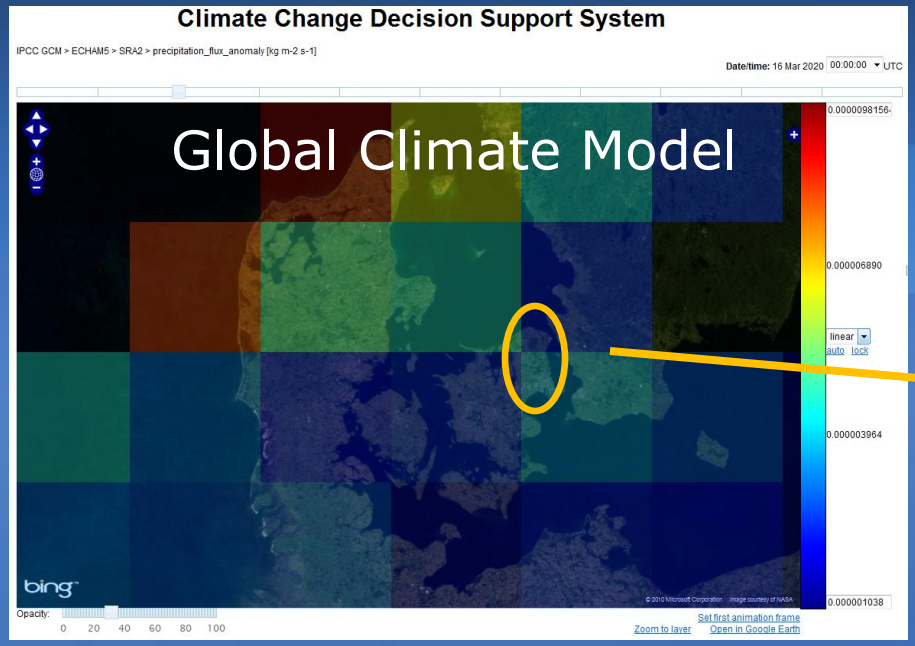
- **Weather generators**



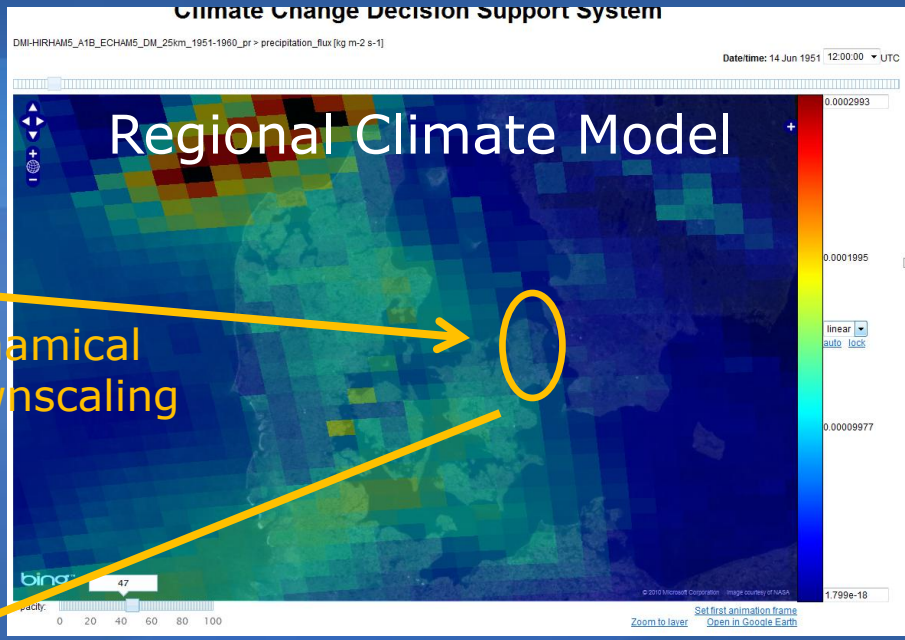
Model fitting:
-Mean
-Variance
-Skewness
-Dry-day prob.
-Autocorrelation
-Transition prob.

  - **Neyman-Scott Rectangular Pulses**
  - **Markov Chain**
  - **LARS WG**

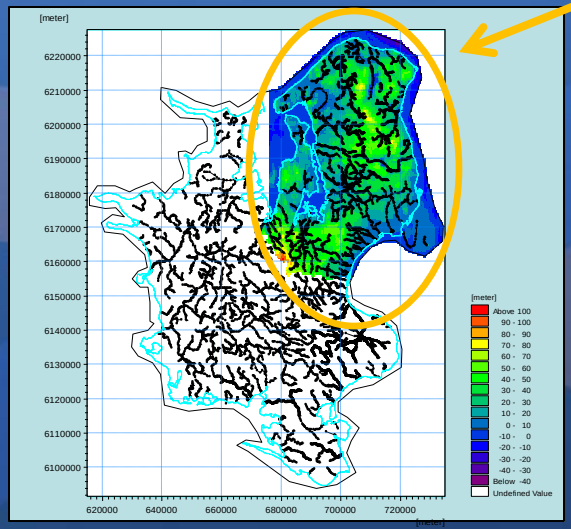
Case study – North Sealand



Dynamical downscaling



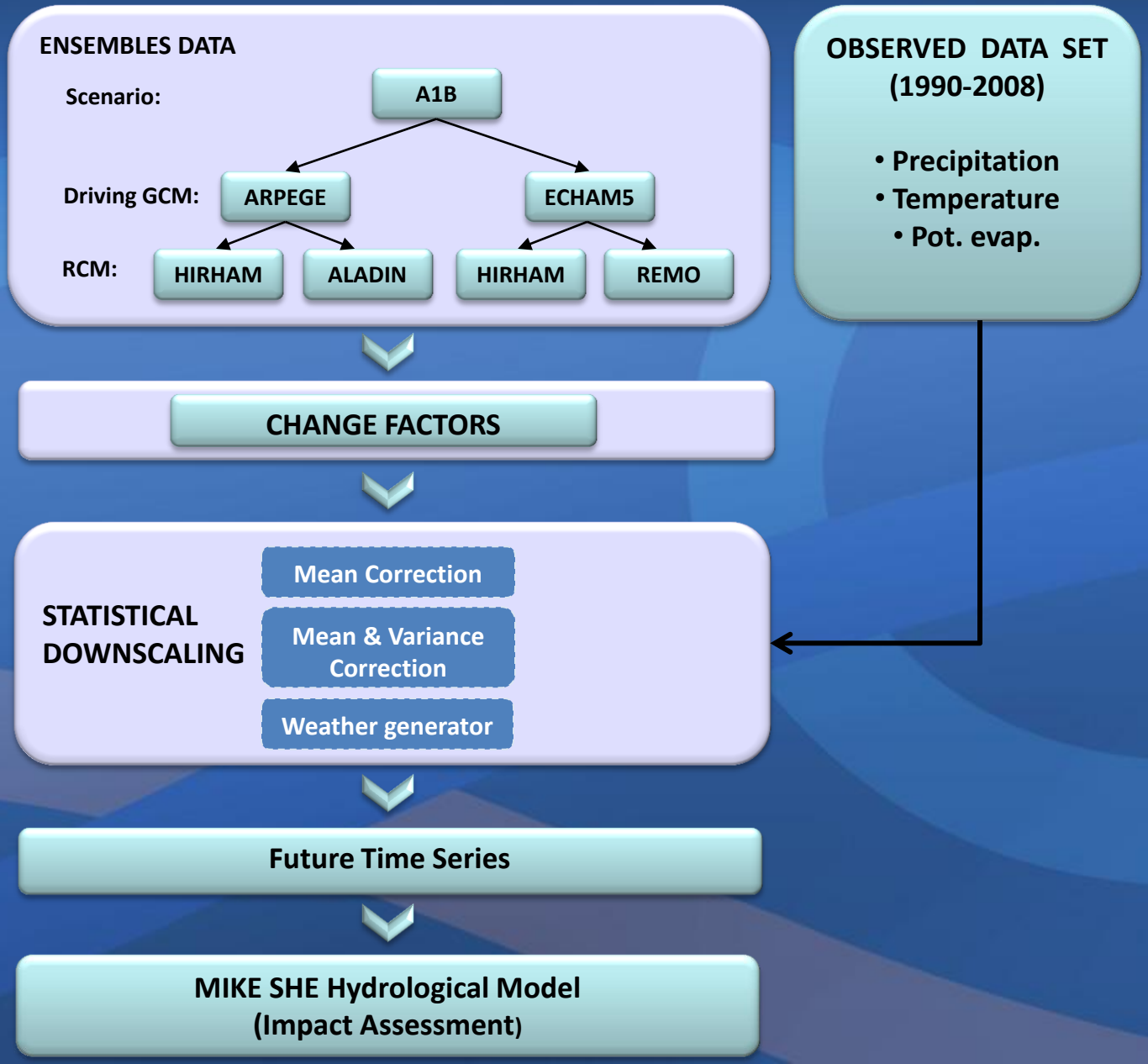
Statistical downscaling



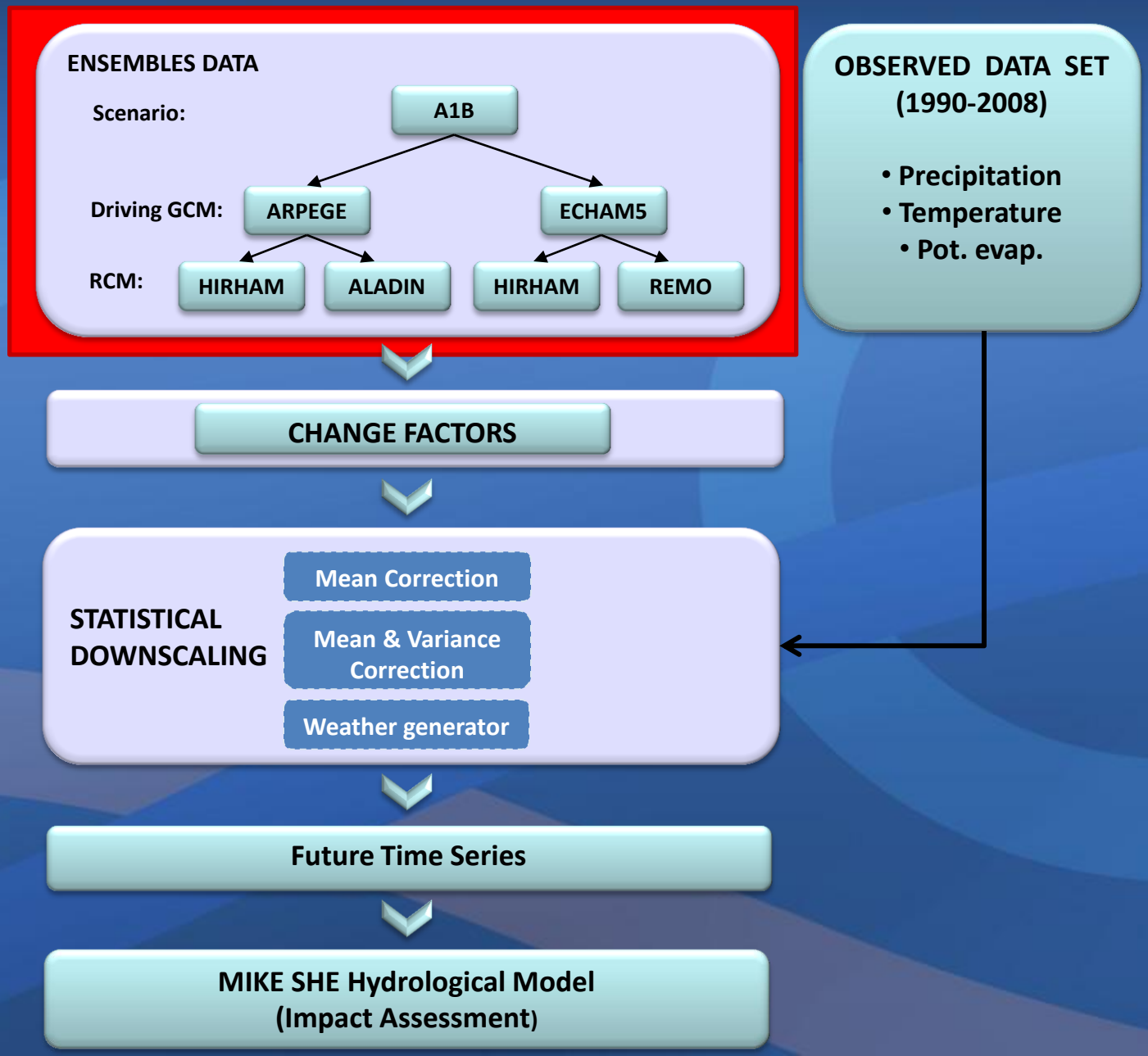
Asses climate change impacts on hydrology

North Sealand (3000 km²)

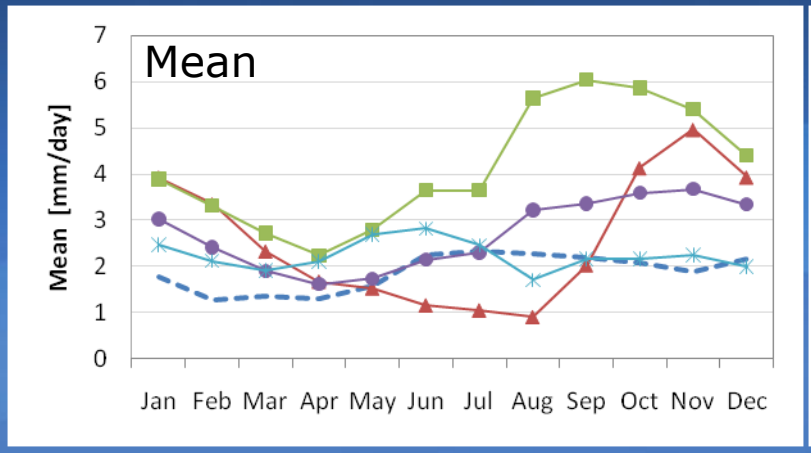
Methodology

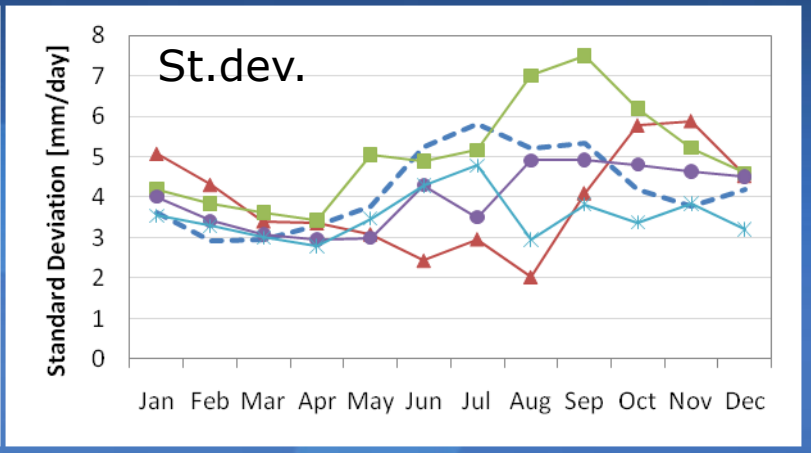


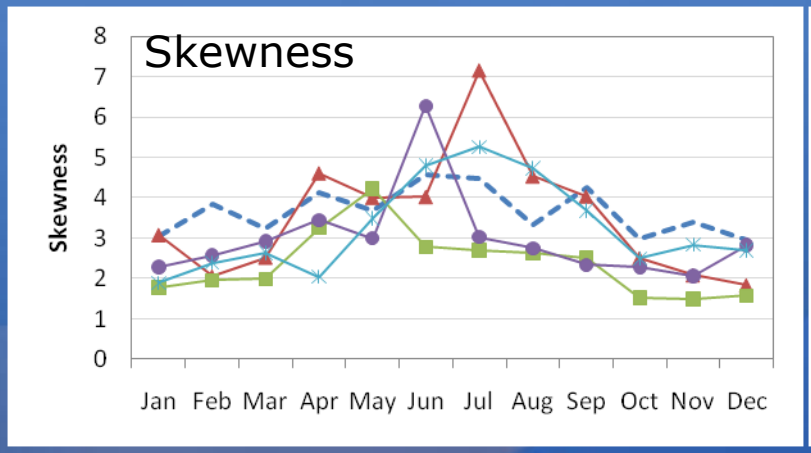
Methodology

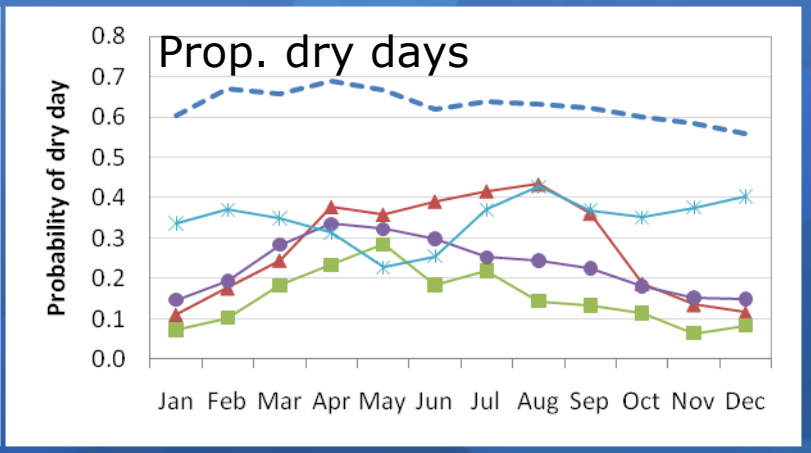


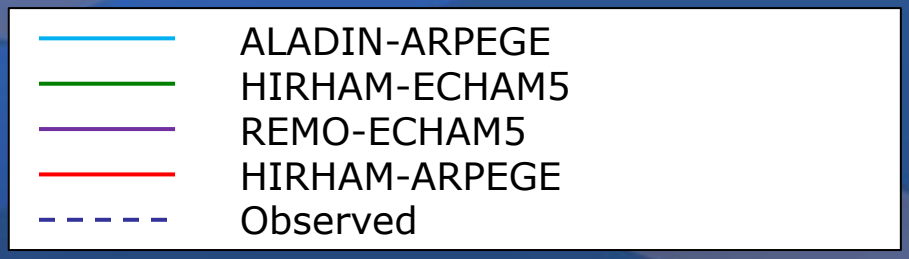
RCM compared to observations - precipitation



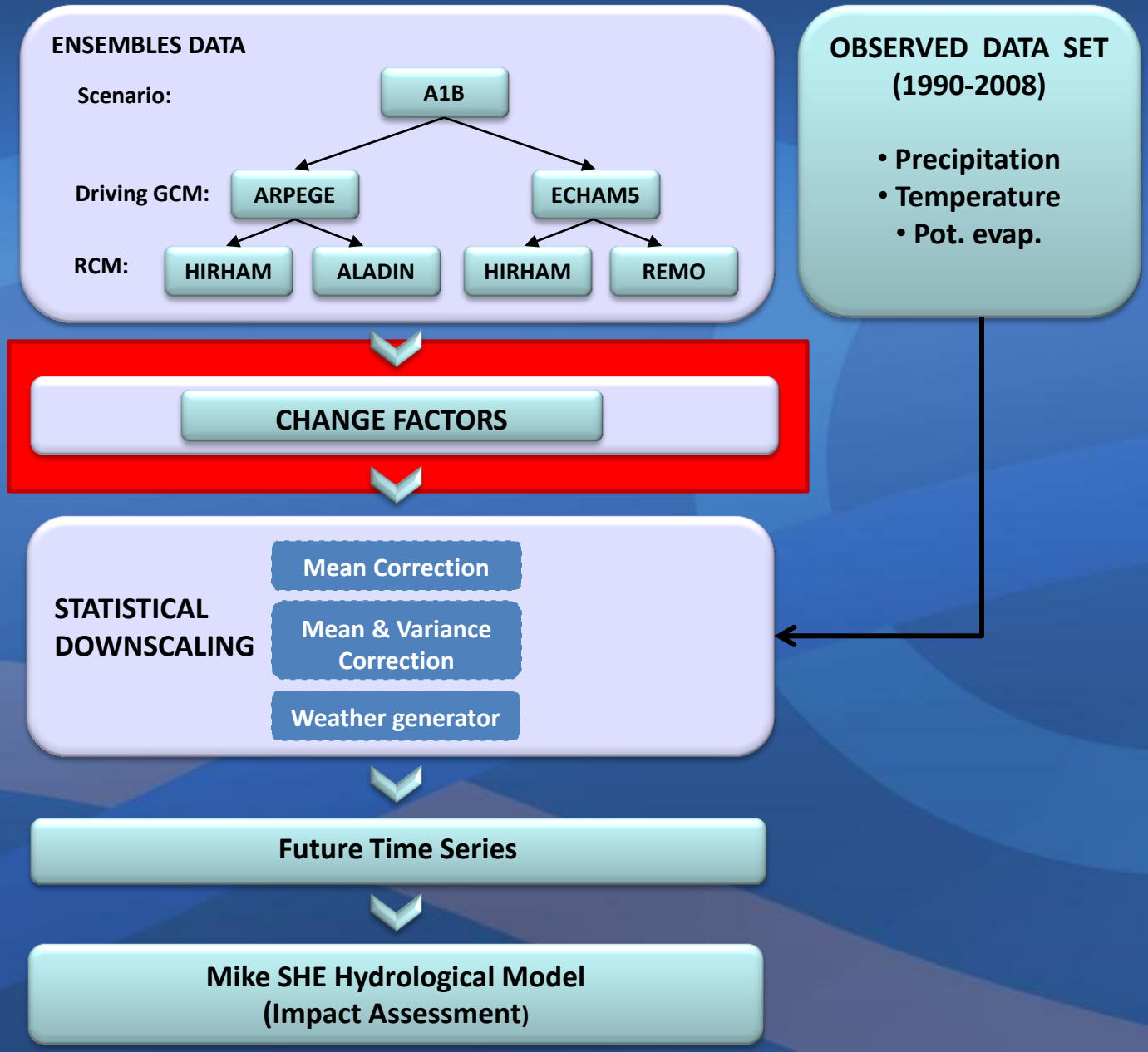




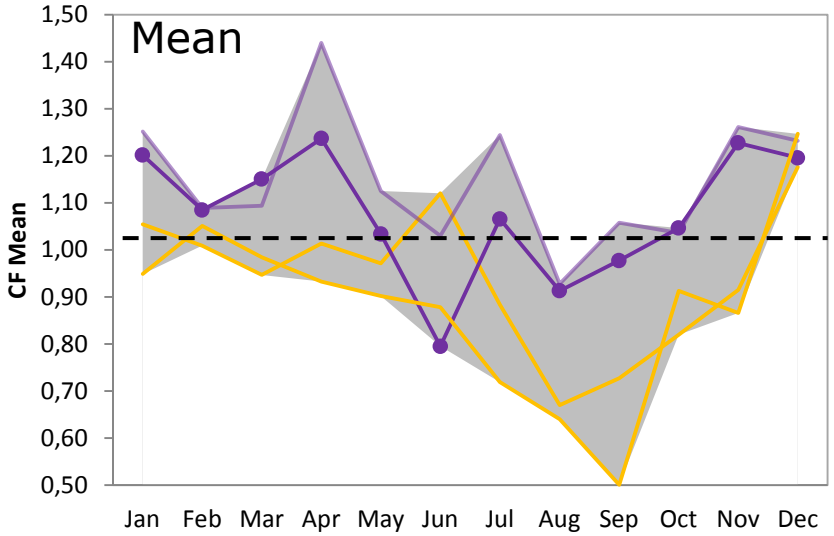


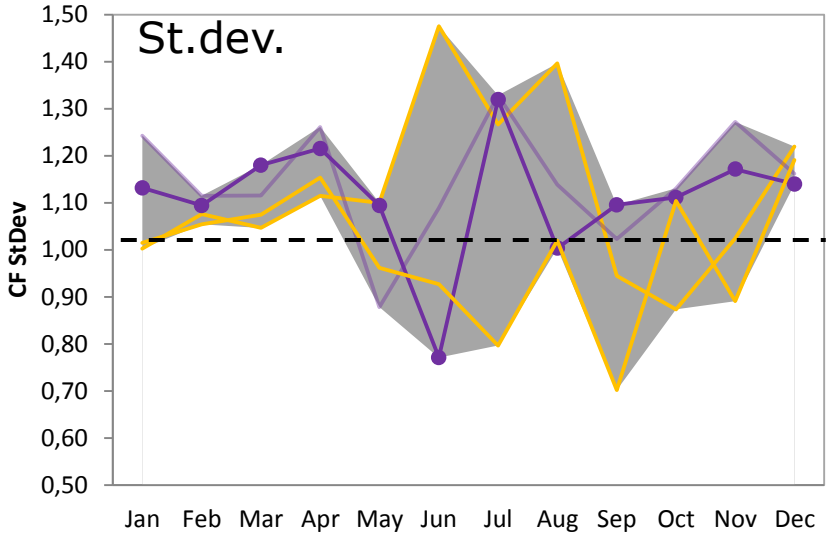


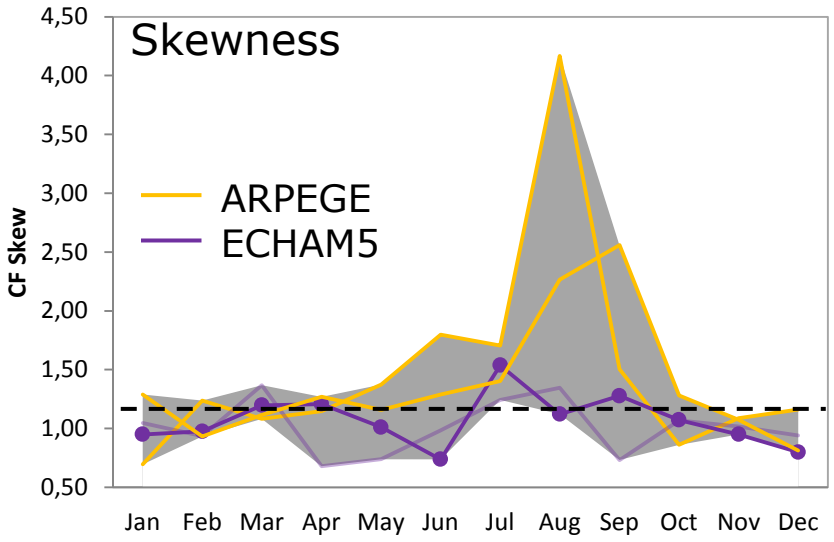
Methodology

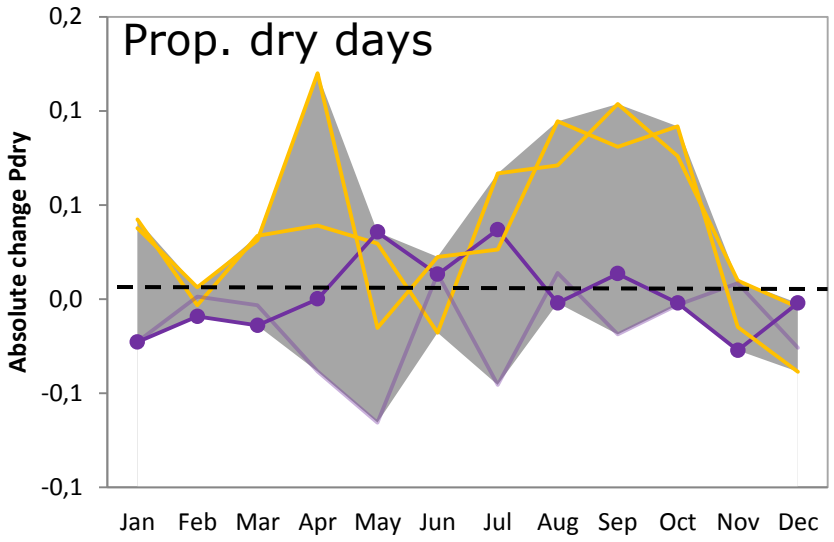


Change factors precipitation (2070-2100)









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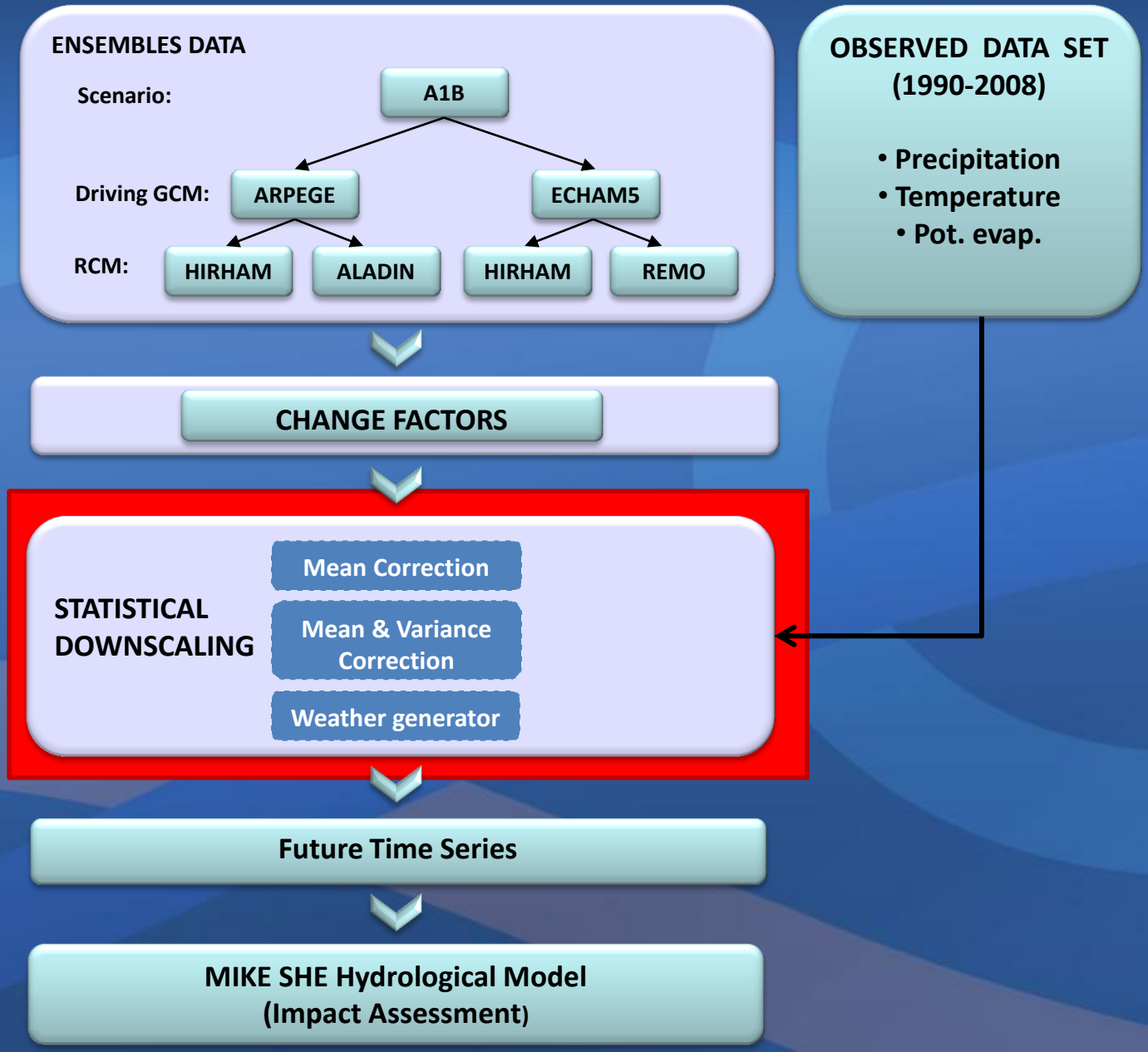
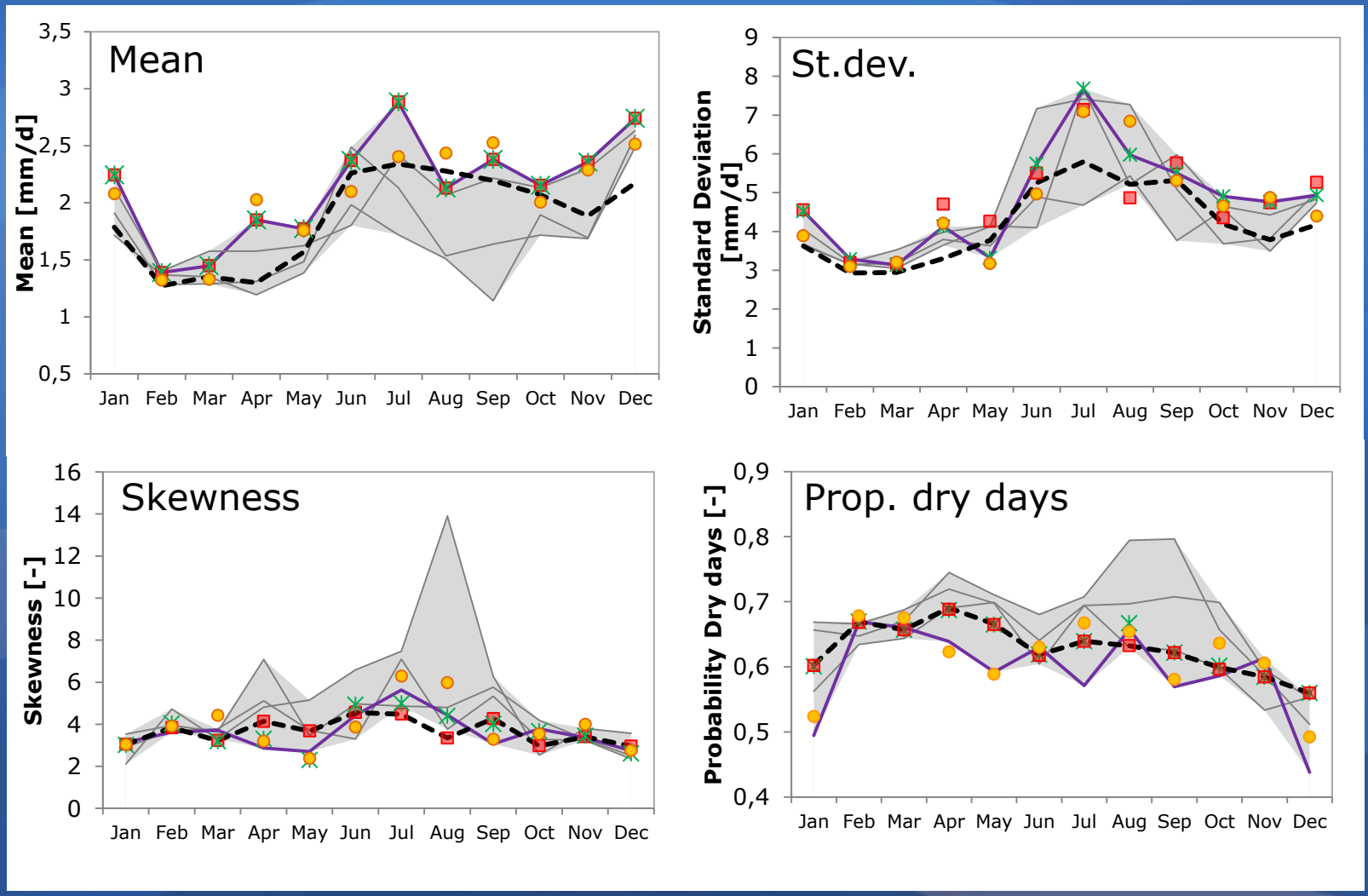


Statistical downscaling (2070-2100)



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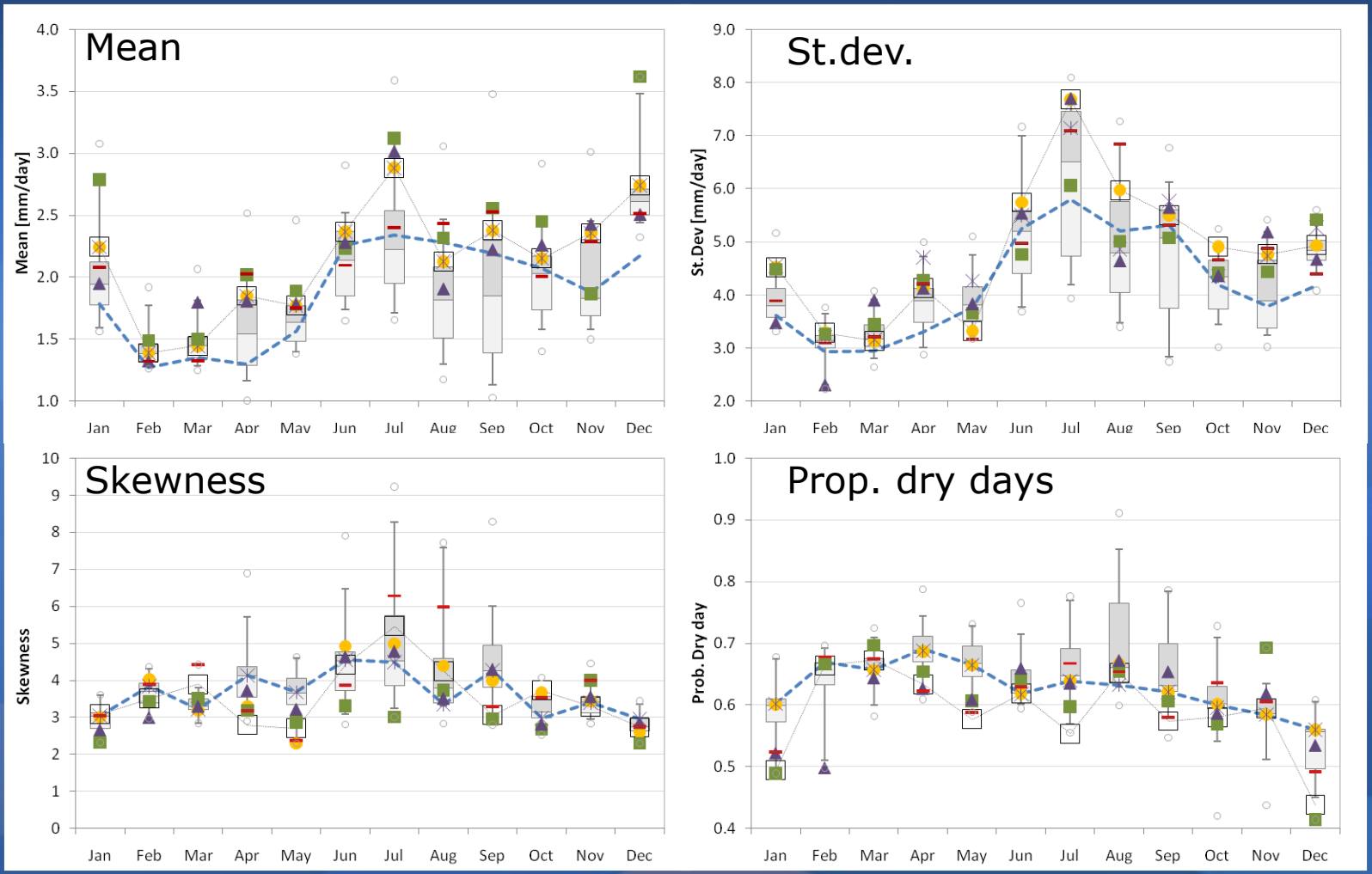
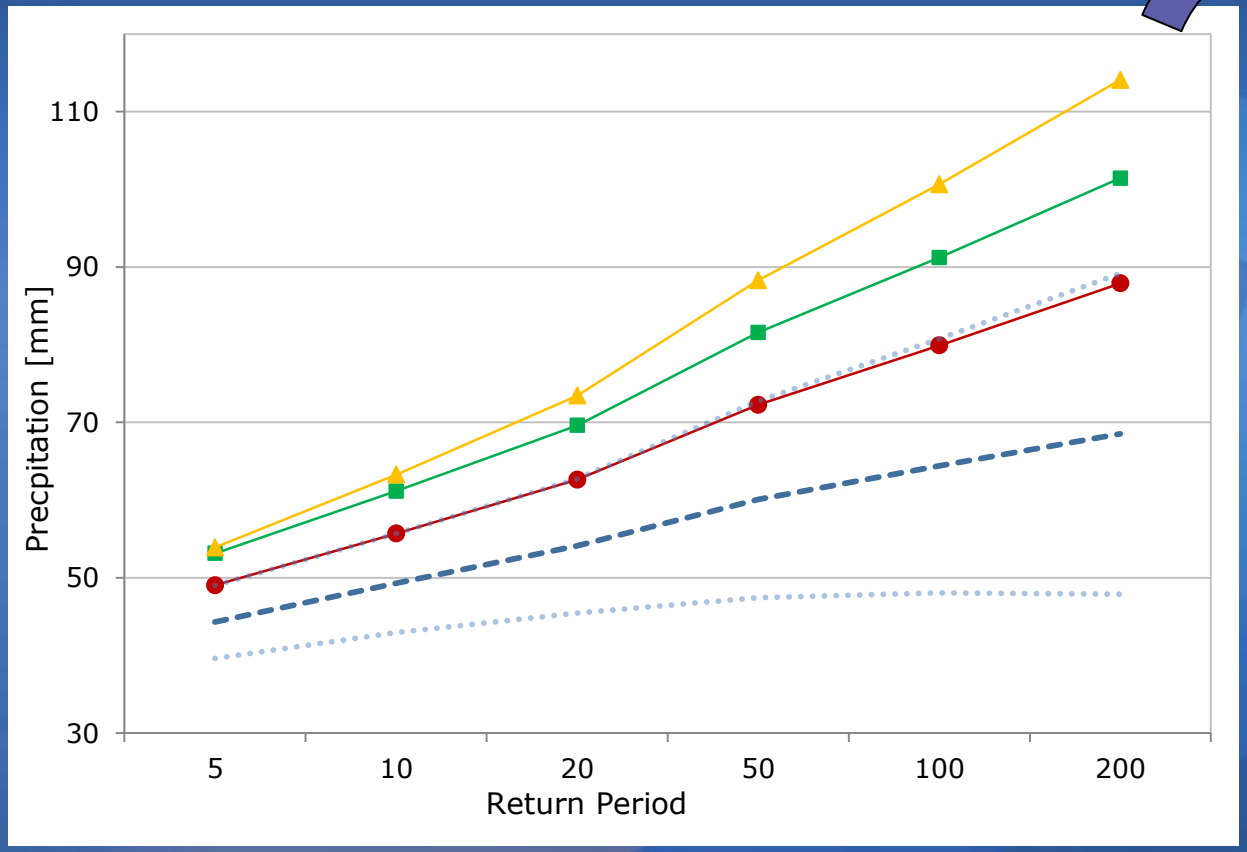


HIRHAM-ECHAM5

- Mean correction
- Mean and variance correction
- Markov chain WG
- LARS WG
- NSRP WG

Statistical downscaling - extreme events

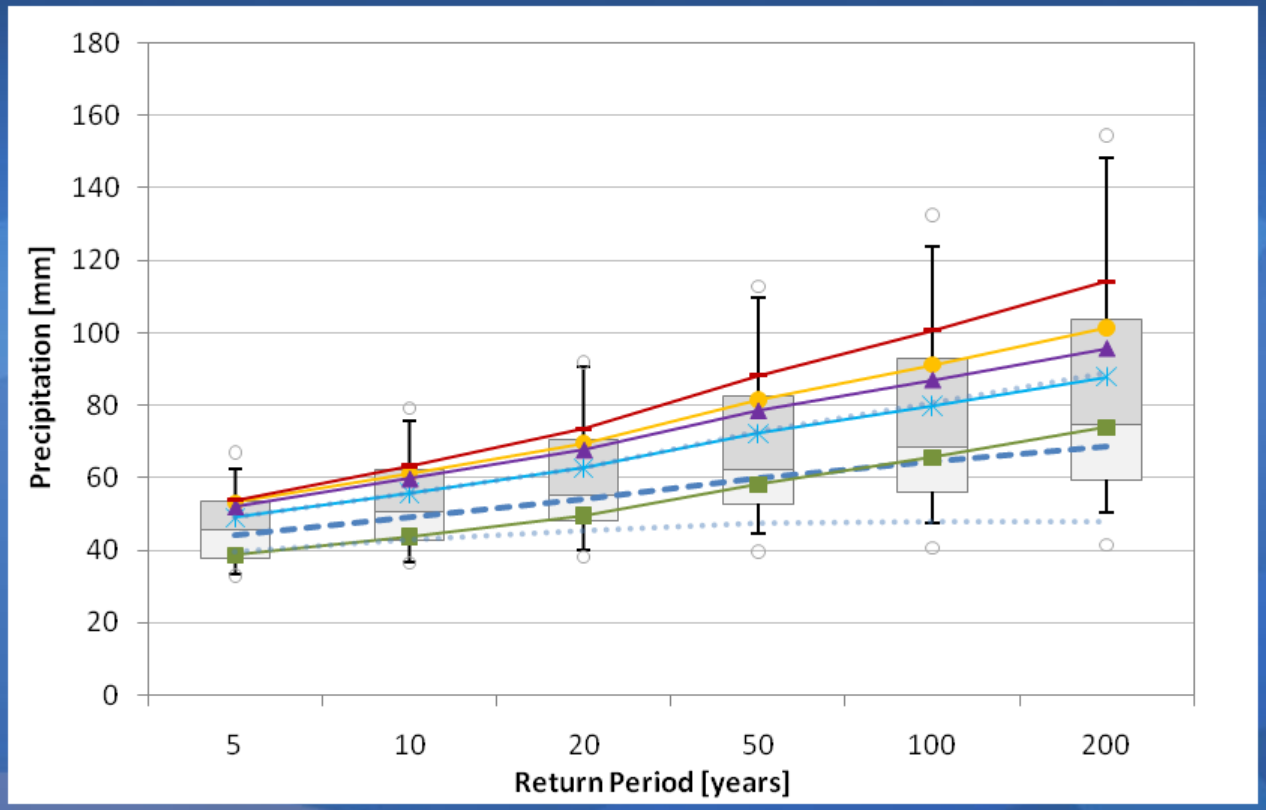


SNSRP
>
Mean and Variance Correction
>
Mean Correction

Obs
Mean correction
Mean and variance correction
SNSRP
CI-95%

HIRHAM-ECHAM5

Statistical downscaling - extreme events



HIRHAM-ECHAM5

- Mean correction
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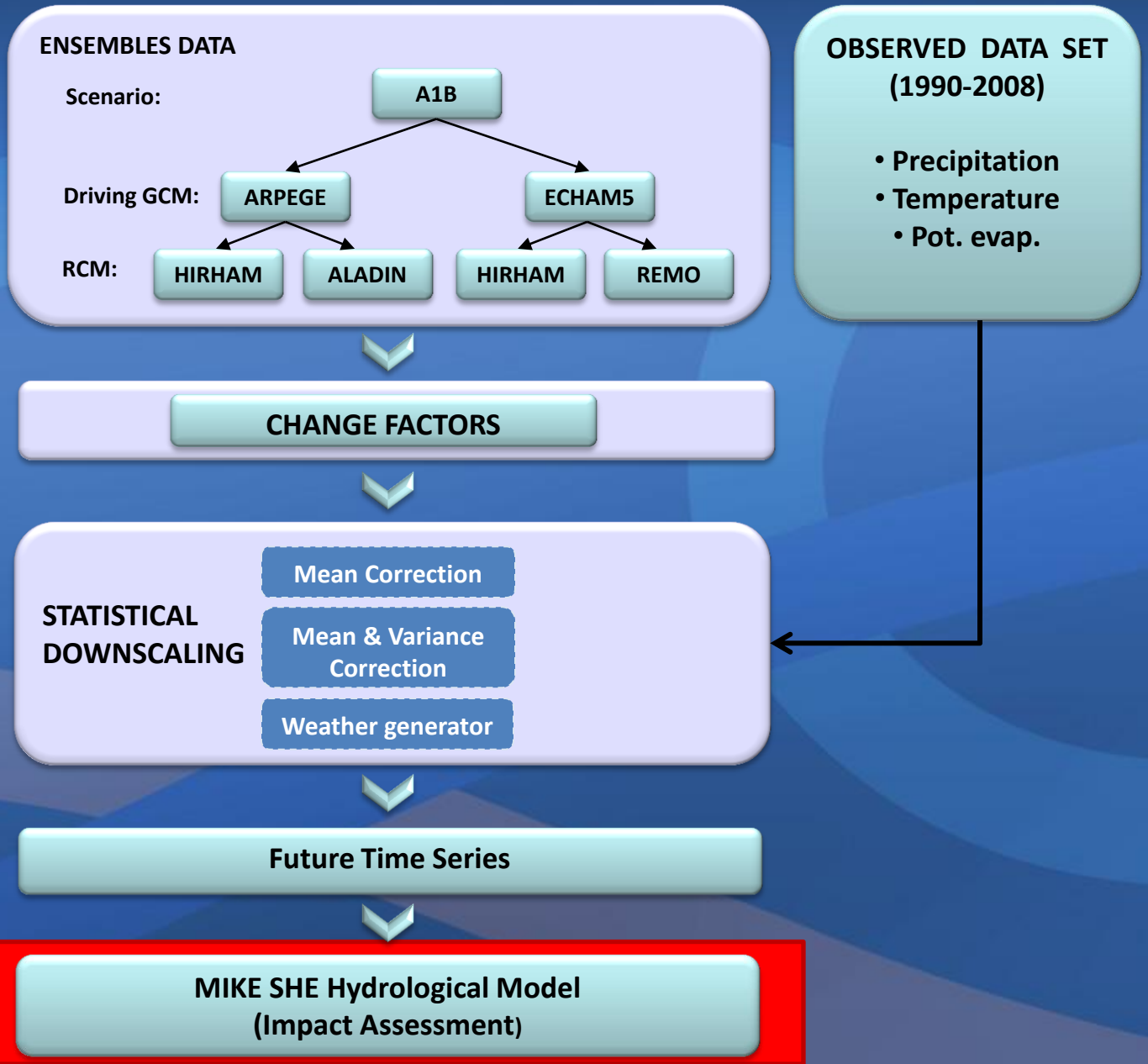
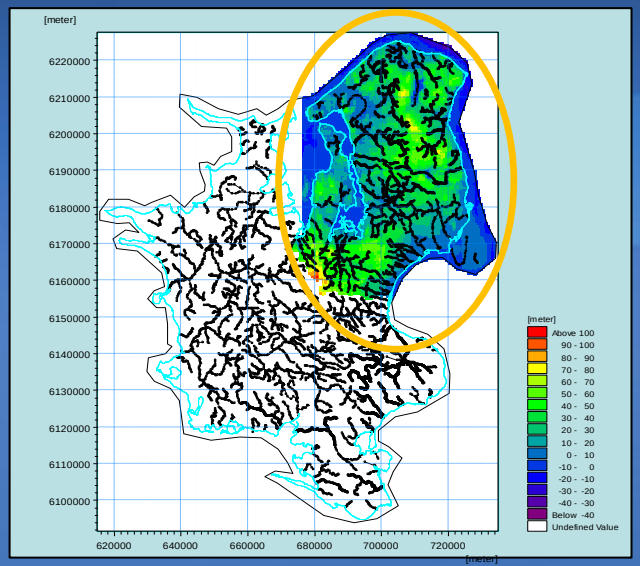
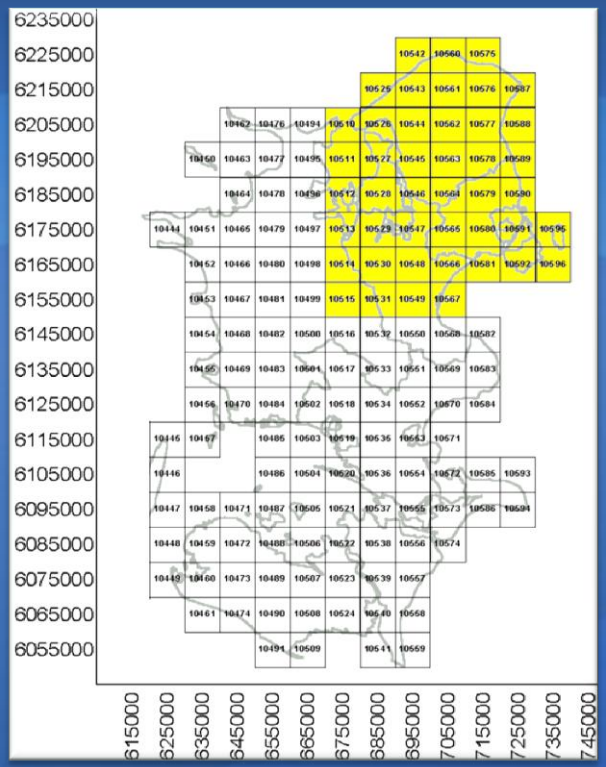
Methodology



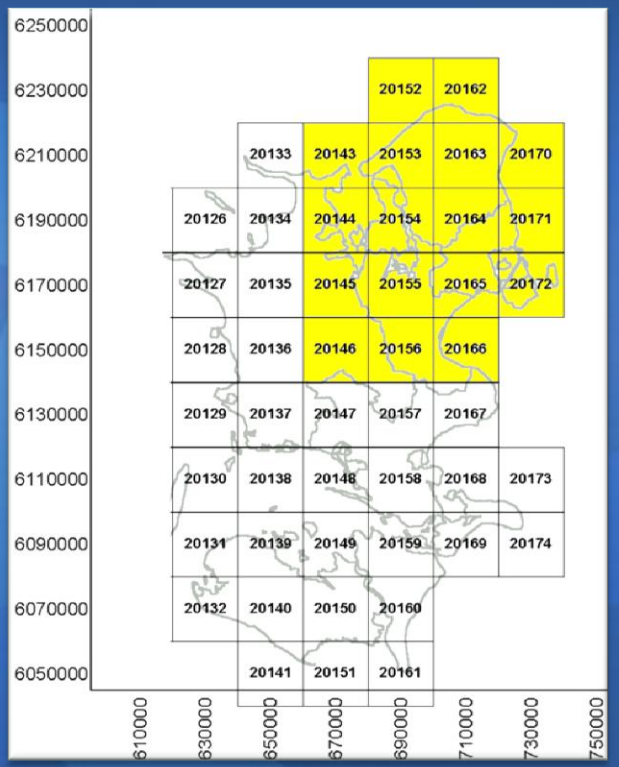
MIKE SHE model of NE Sealand



Precipitation



Temperature and Pot. Evap.



Downscaling

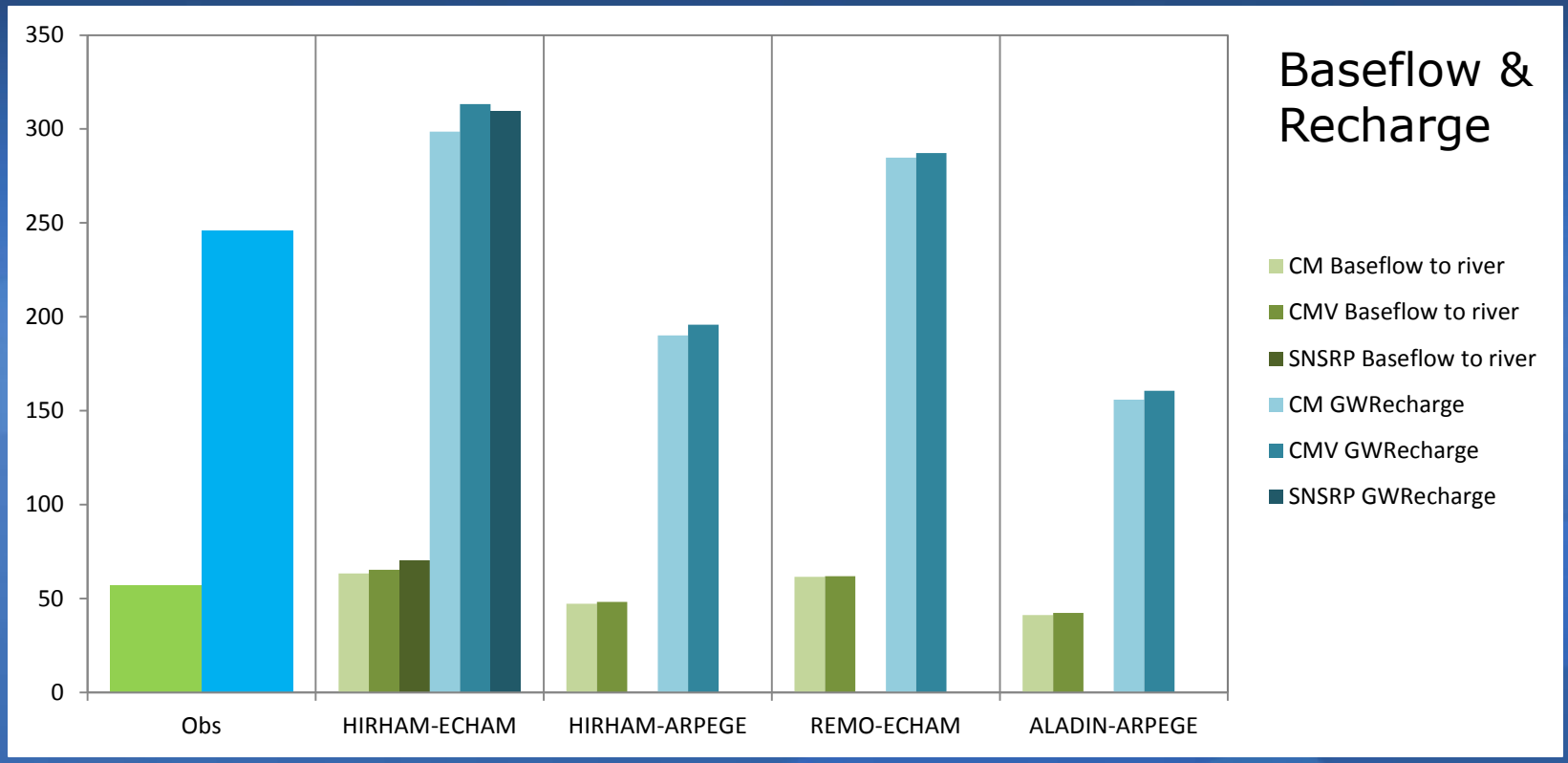
Precipitation:

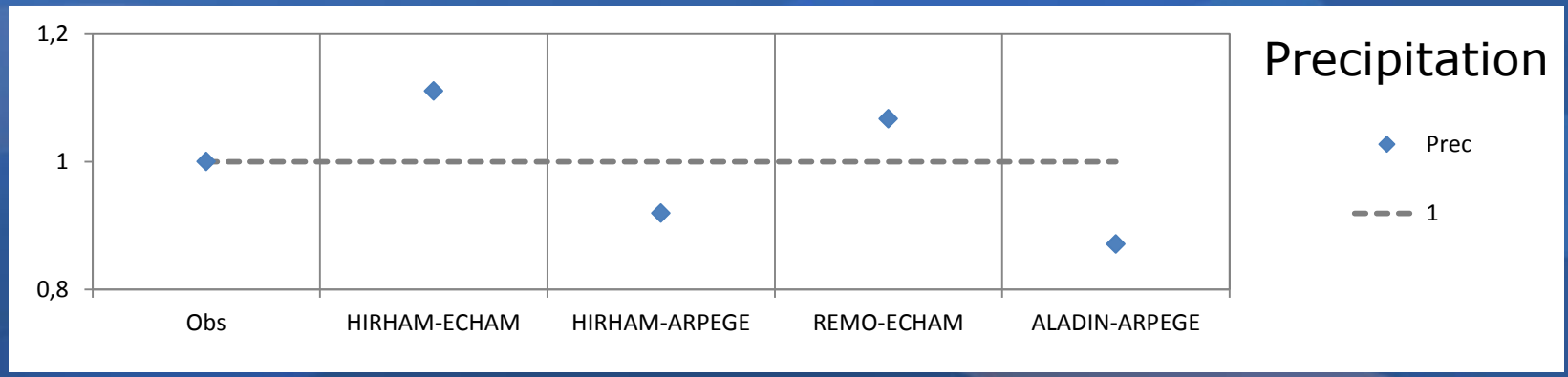
- Mean correction
- Mean and variance correction
- SNSRP weather generator

Temperature and pot. evap.

- Mean correction

MIKE SHE Results – water balance (2070-2100)

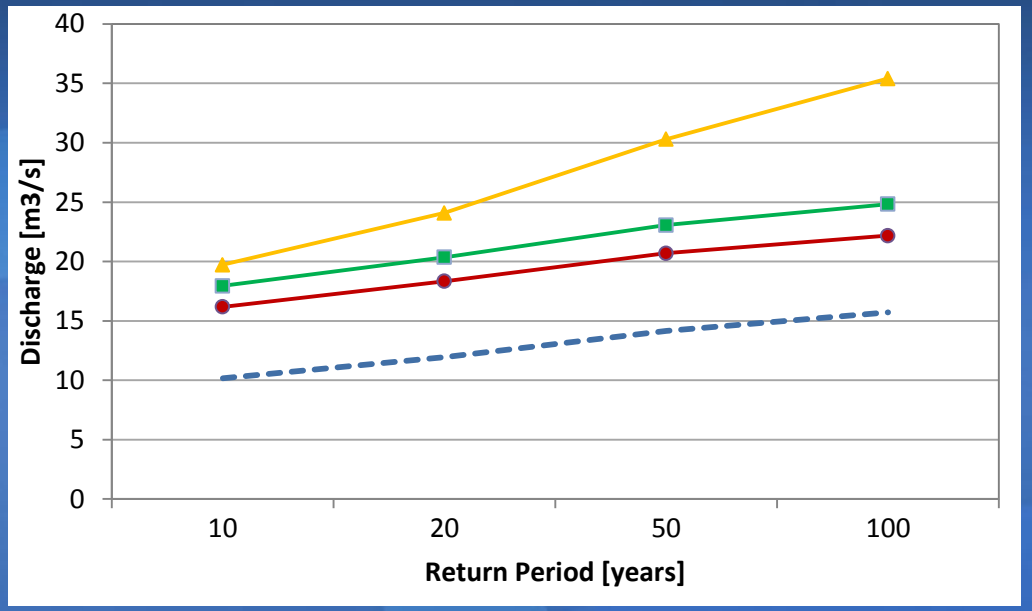




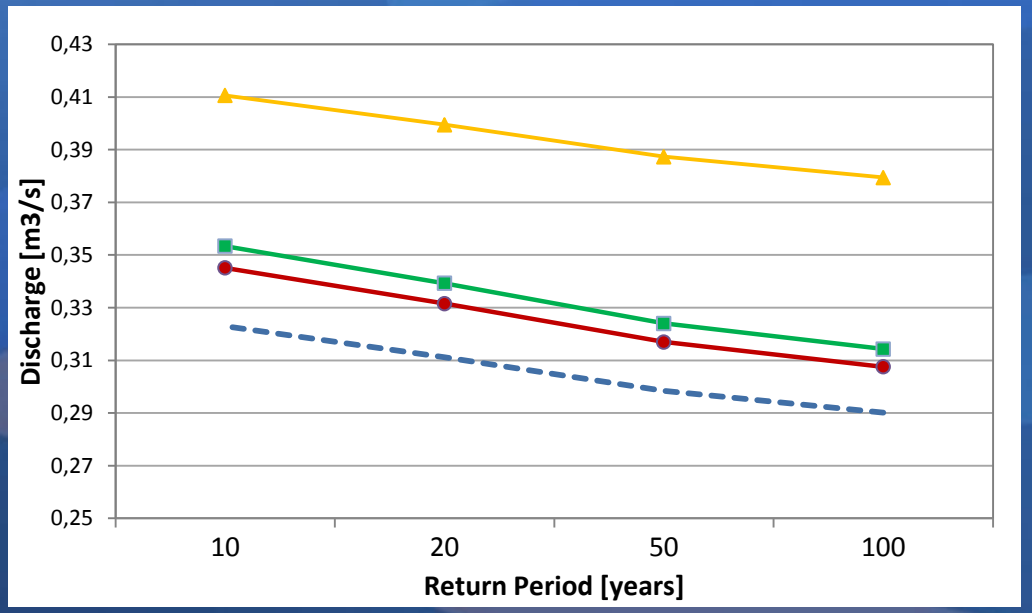
MIKE SHE Results – extremes (2070-2100)

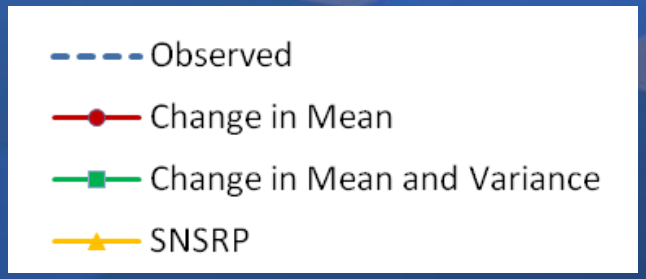
HIRHAM-ECHAM5

Annual Maximum Discharge



Annual Minimum Discharge





Concluding remarks

- Statistical downscaling required for climate change impact assessments
  - Scaling of GCM/RCM to the appropriate spatial and temporal scales
  - Statistical adjustments of GCM/RCM
- Choice of statistical downscaling procedure depends on application
  - Water balance studies -> Mean correction
  - Extreme event analysis -> Stochastic weather generators
- Assessment of uncertainties important
  - Scenario uncertainty
  - GCM/RCM uncertainty
  - Statistical downscaling uncertainty
  - Impact model uncertainty
- Probabilistic projections needed for climate change impact assessments and decisions on adaptation.

Thank you for your attention

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