Analysis of dynamically downscaled climate simulations over the Baltic Sea drainage basin

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Evaluation in present climate

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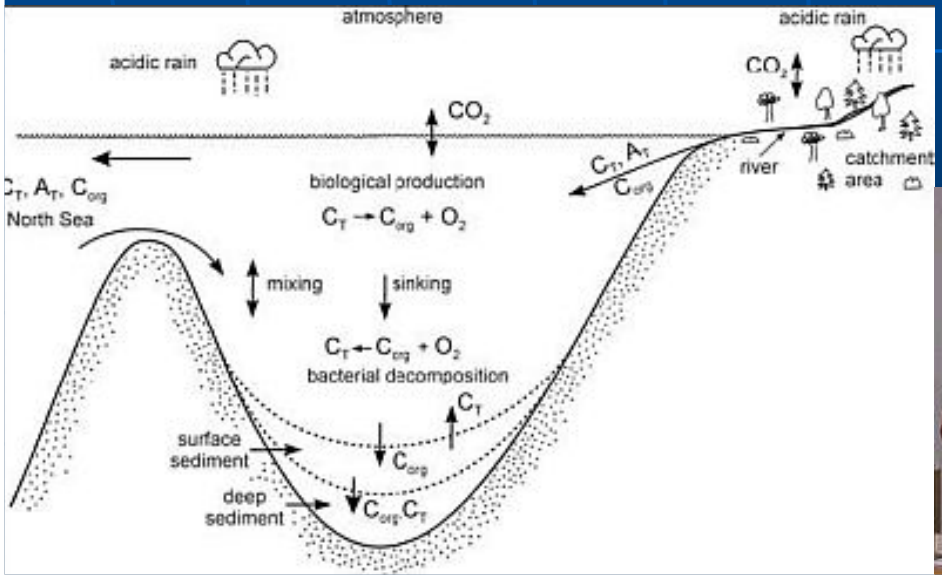
Thanks to the Rossby Centre for providing simulations

Uncertainties of scenario simulations, SMHI, 14 October 2010

BONUS+ project Baltic-C

- Aims to close the carbon budget and to predict the future biochemical and acid-base state of the Baltic Sea drainage basin in a holistic approach.
- Will develop and apply an integrated ecosystem model framework.
- (http://www.baltex-research.eu/baltic-c/index.html)



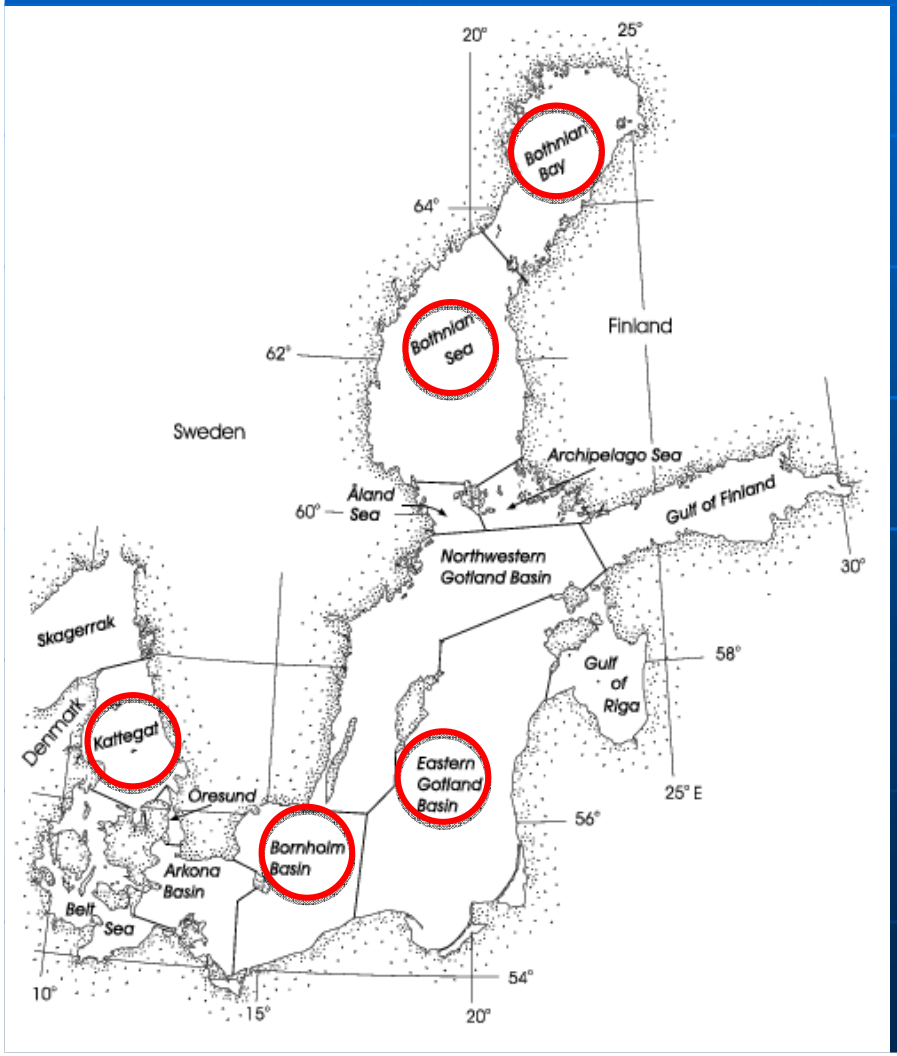
WP5. Atmospheric forcing

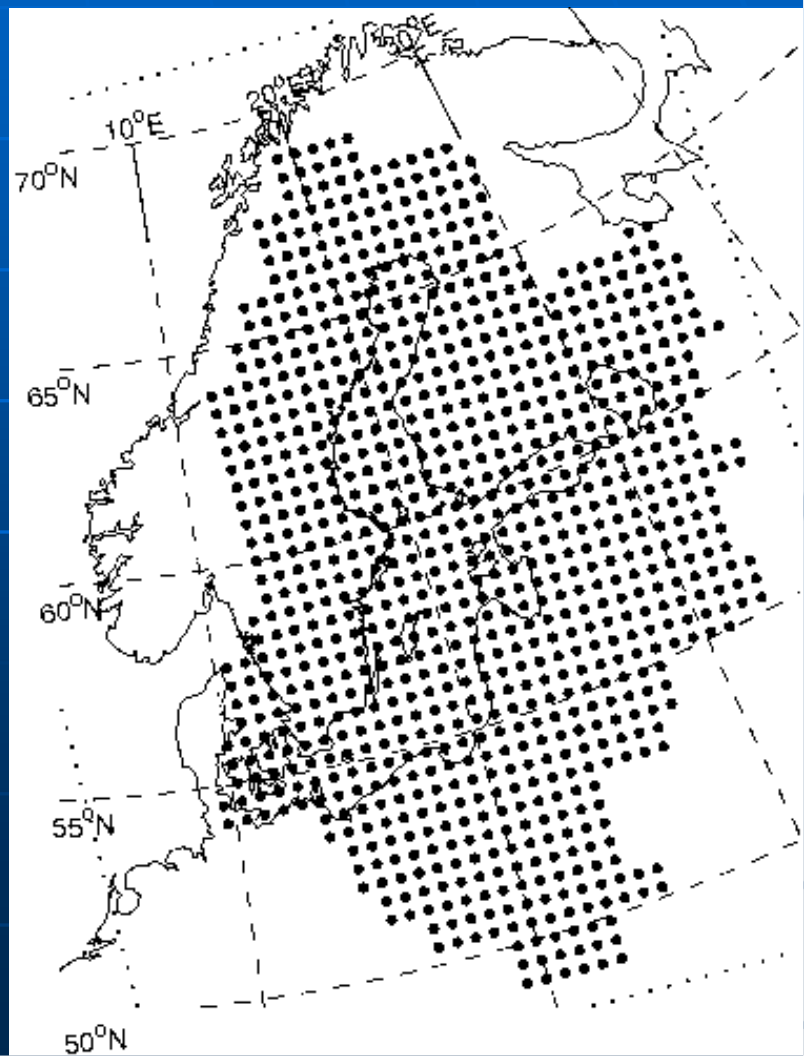
- Supply of meteorological forcing from different scenarios and models for
  - Ocean model (PROBE-Baltic) (basins)
  - Catchment model (CSIM) (grid)
  - Ecosystem model (LPJ GUESS) (grid)
- Extended work: Analyse and evaluate the input parameters
  - This talk: evaluation in present climate
    - 2-m temperature and relative humidity
    - Geostrophic wind
    - Total cloud cover
    - precipitation

Used forcings from ENSEMBLES

- Dynamically downscaled AOGCMs with RCA3 (50x50km, no ocean component
  - ECHAM5, 1.875°: A1B (3 runs), A2, B1
    - Run 1 has same initialization as for other scenarios
  - HADCM3, 2.5°x 3.75°: A1B
  - CCSM3, 1.4°: A1B
- Possible analyses
  - Performance in control period (1961–2005) compared to downscaled ERA-40.
  - Model variation: A1B (3 models)
  - Scenario variation: ECHAM5 (3 scenarios)
  - Internal variation: ECHAM5 A1B (3 different initializations)

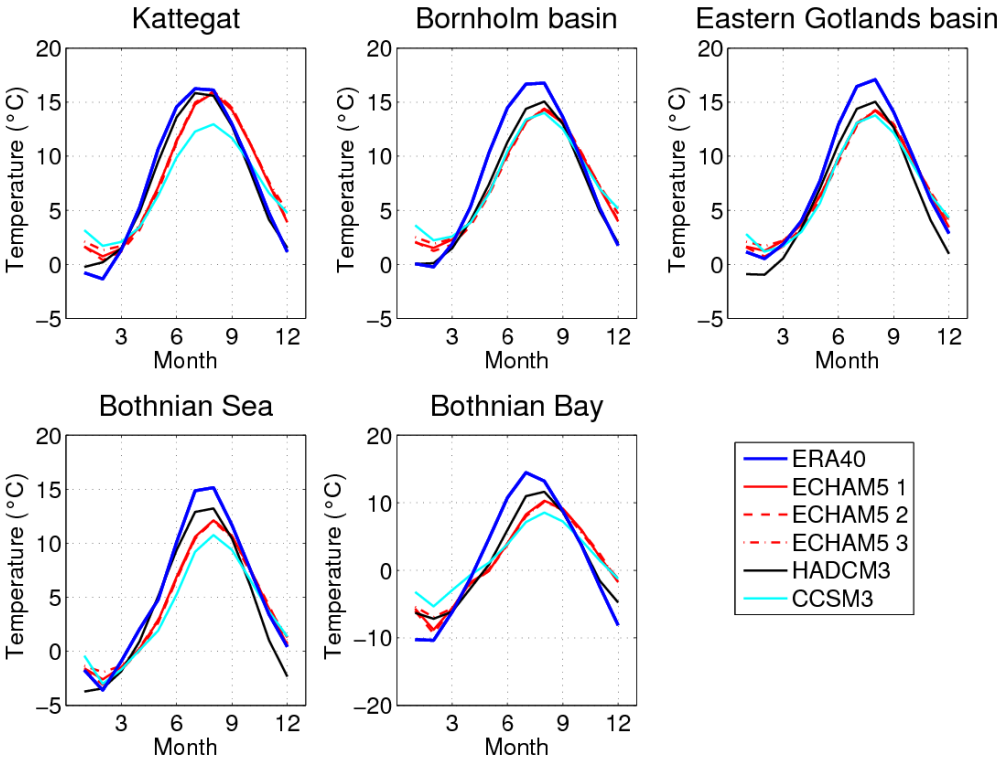
Performance in control period (1961–2005)

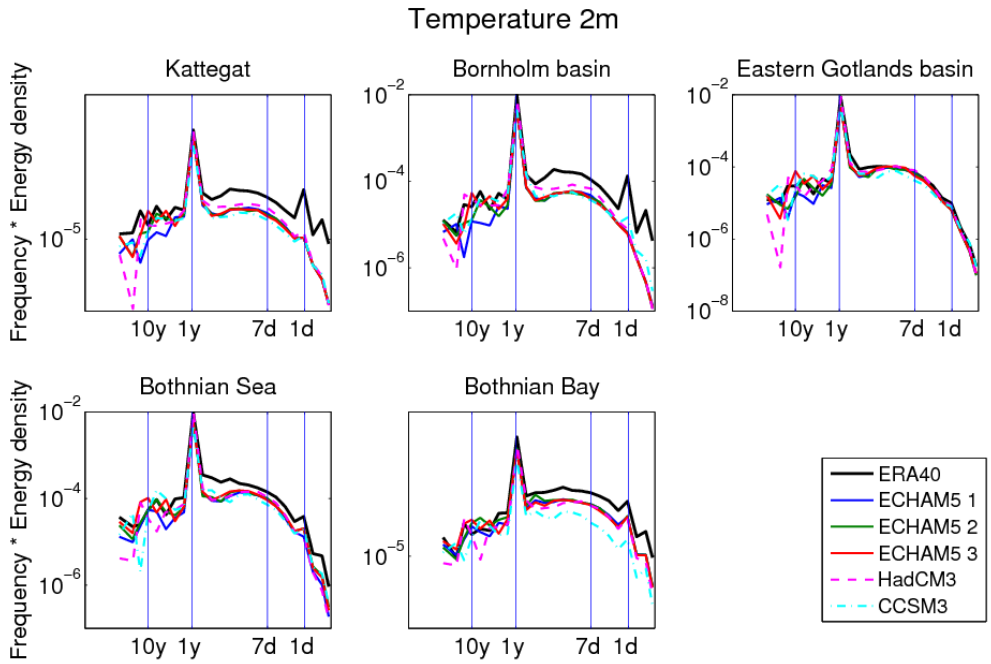


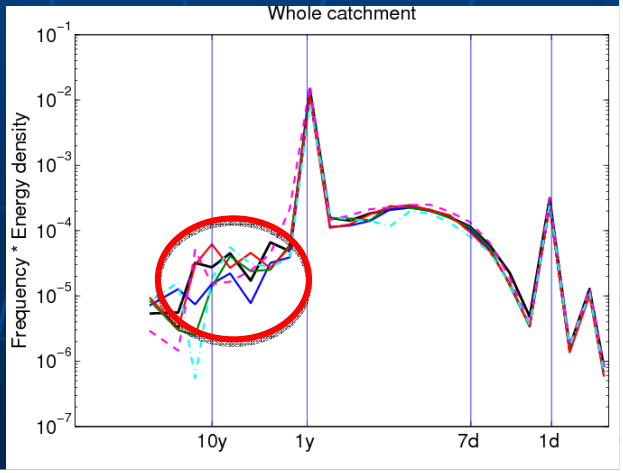


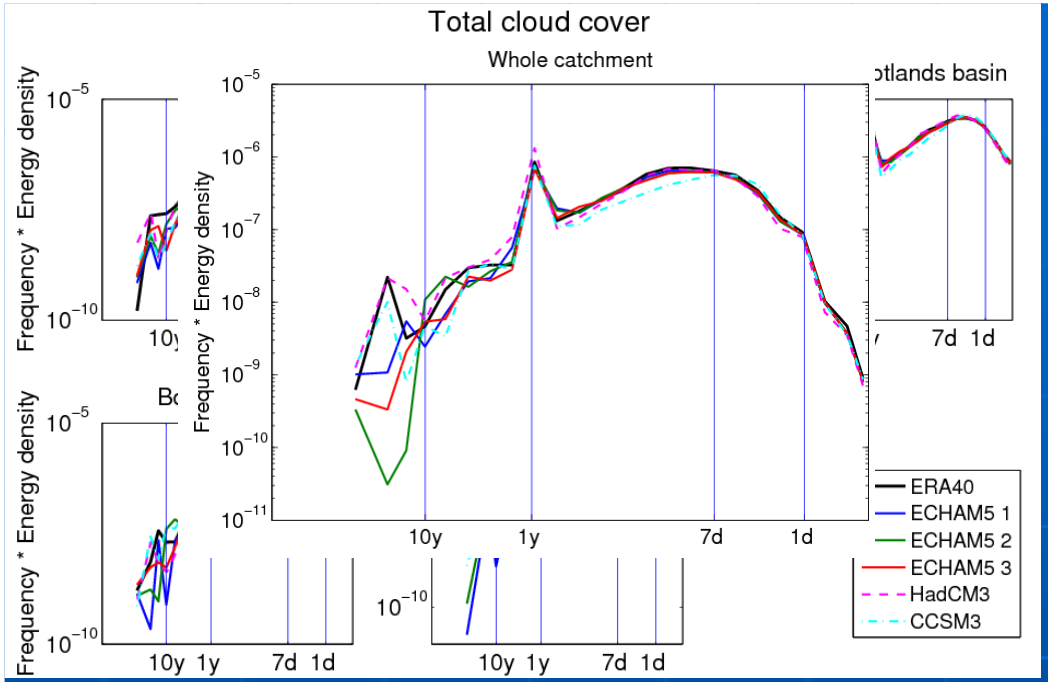
Temperature

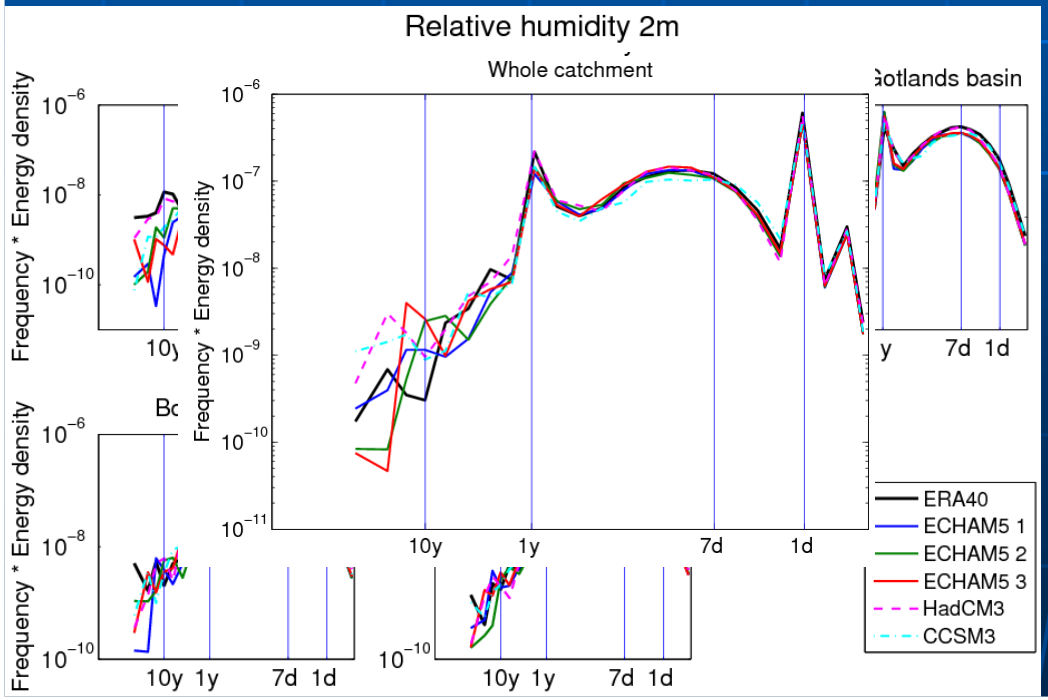
- Models are often colder than ERA-40 over the sea. (Due to lower SST, except for CCM3)
- Seasonal variability under-estimated and time lag in small basins.
- The AOGCM:s agrees on temperature variability on all scales, except CCM3 in Bothnian Bay









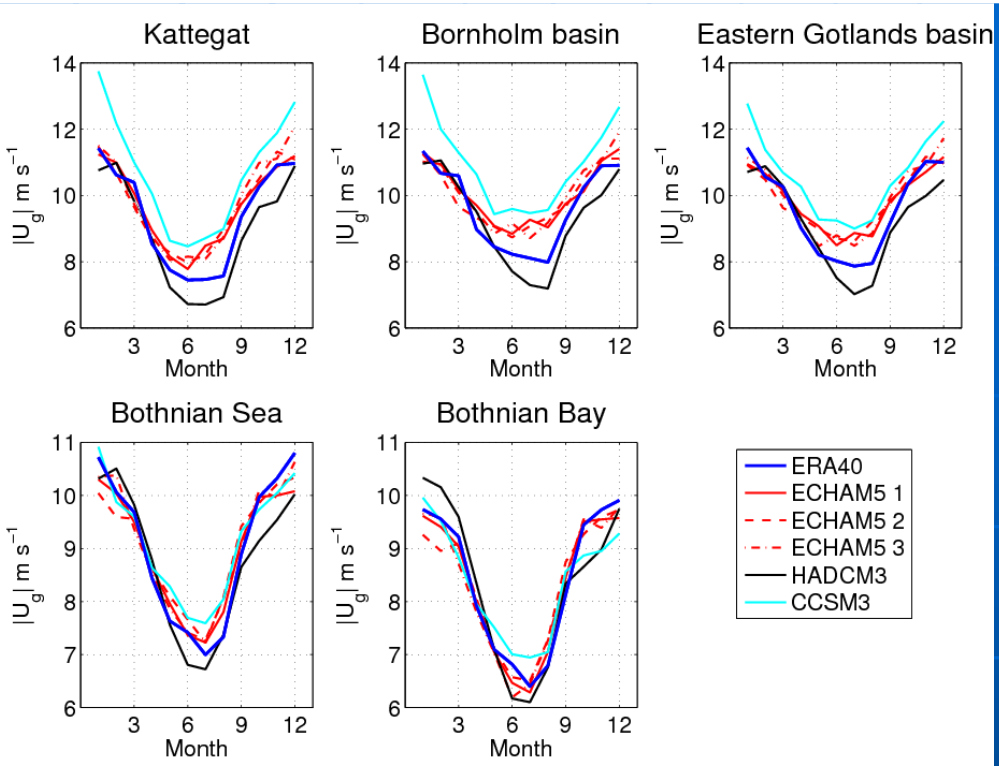


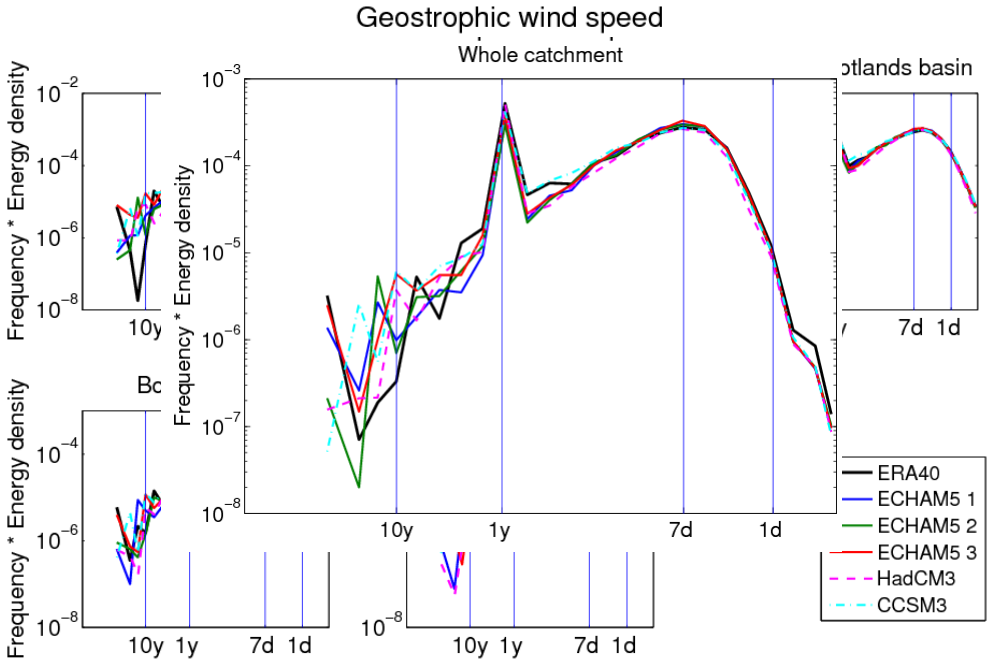
Total cloud cover

- Models over-estimate total cloudiness by 10s of %. (not seen from figure)
- But catch the variability of all scales less than a couple of years
- HadCM3 performs better in summer, but with time lag. (not shown)

Relative humidity

- Variability good at all scales. However, a stronger diurnal cycle is seen in the smaller basins, probably due to land influence





Geostrophic wind speed variations

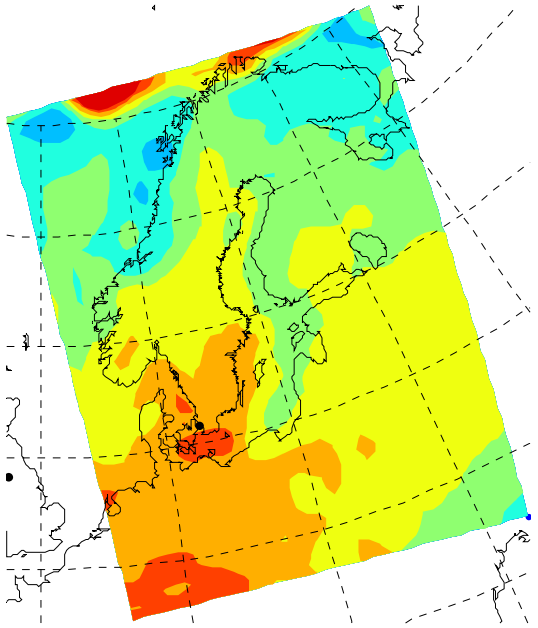
- All models except HadCM3 over-estimate the geostrophic wind, especially in the south.
- Variability is good at all scales shorter than a year

Yearly precipitation

- Problem: RCA3 increases precipitation from ERA-40.
- Models gives even higher precipitation but HadCM3 gives less in south-eastern part of the catchment.
- Seasonal differences could be important to investigate.

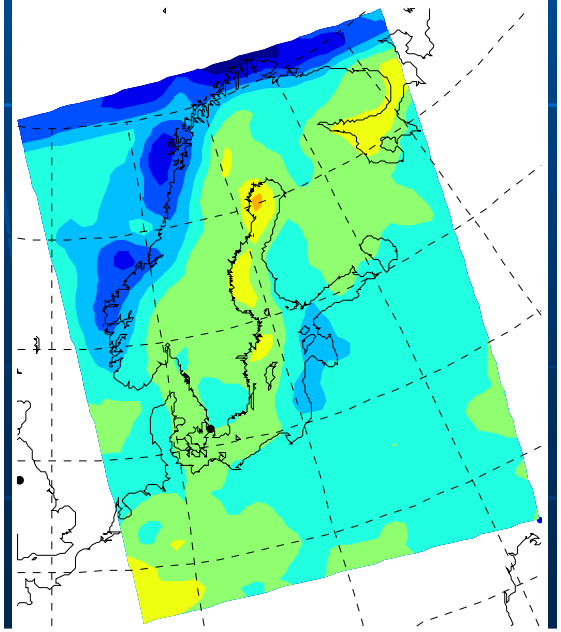
Diff in P (%)

ECHAM5 mean



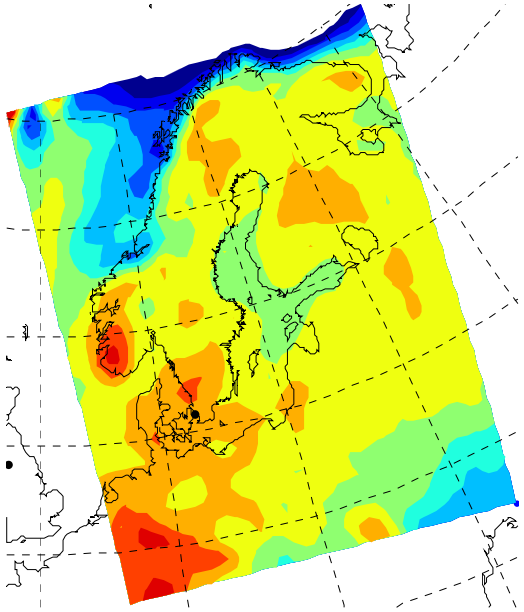
Diff in P (%)

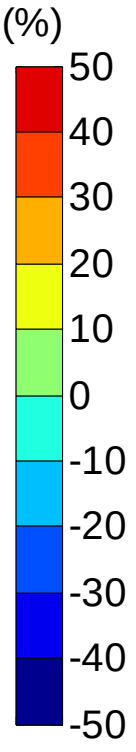
HADCM3



Diff in P (%)

CCSM3





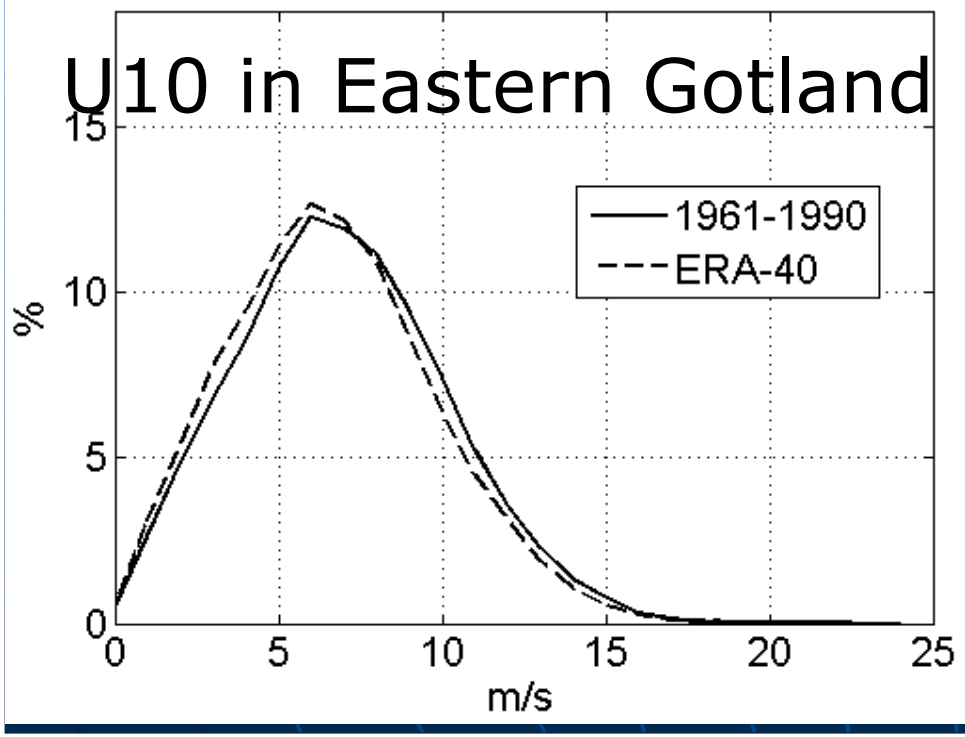
Estimation of “score”

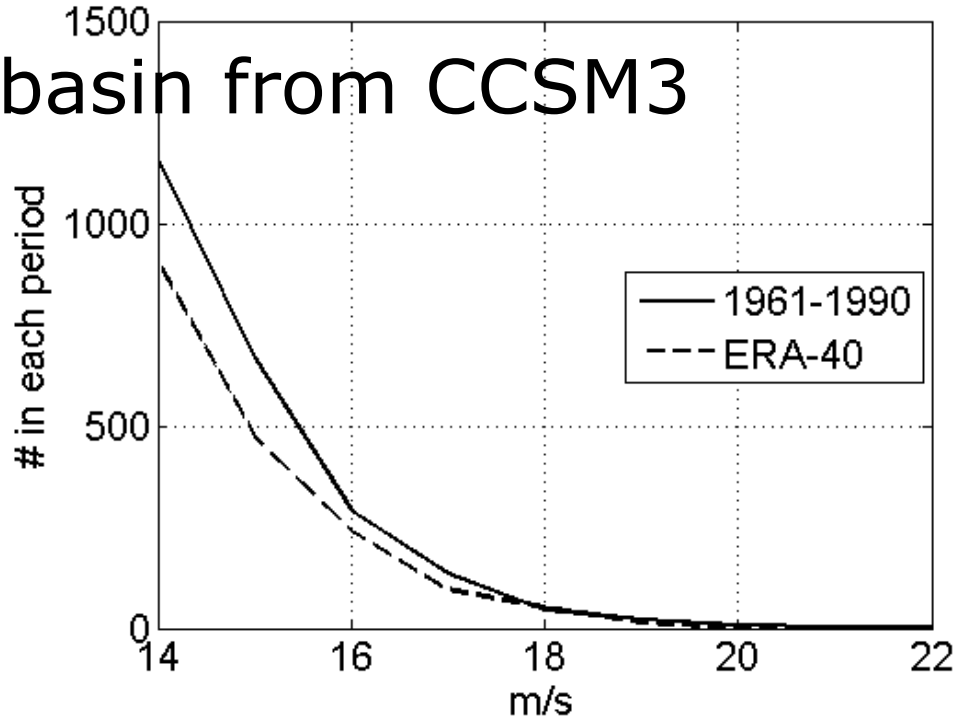
Based on the averages of 5 parameters in the catchment area

Model	T2 (n.b. in C)	Total clouds	RH2	UG (m/s)	Precipitation (mm)
ECHAM5 1	5.14 (-1%)	0.72 (+5%)	0.84 (+2%)	9.06 (+2%)	825 (+13%)
ECHAM5 2	5.02 (-3%)	0.72 (+5%)	0.84 (+2%)	9.05 (+2%)	816 (+12%)
ECHAM5 3	5.26 (+2%)	0.72 (+5%)	0.84 (+2%)	9.12 (+3%)	831 (+13%)
HadCM3	4.46 (-13%)	0.81 (+20%)	0.93 (+14%)	8.61 (-3%)	736 (+1%)
CCSM3	4.91 (-5%)	0.73 (+7%)	0.83 (+2%)	9.33 (+5%)	848 (+16%)
ERA40	**5.18**	**0.68**	**0.82**	**8.85**	**732**

Additional work

- Further analysis of the geostrophic wind can include wind distributions
- Variability in precipitation
- Look at ensemble means





Conclusions - control period

- Near surface parameters
  - Natural variability in the larger Baltic Sea basins agrees well with downscaled ERA-40 at all time scales shorter than about a year.
  - Different SSTs in AOGSMs give differences in parameters over the Baltic Sea.
  - Natural variability is good for all AOGCMs seen for the whole catchment area, though some biases.
- Other parameters have good natural variability
- ECHAM5 internal variability quite small when looking at means
- "Best" model choices, based on means for the catchment area
  - SST: ECHAM5
  - T2: ECHAM5
  - RH2: ECHAM5
  - Total cloudiness: ECHAM5 and CCM3
  - Geostrophic wind speed: ECHAM5 and HadCM3
  - Precipitation: HadCM3

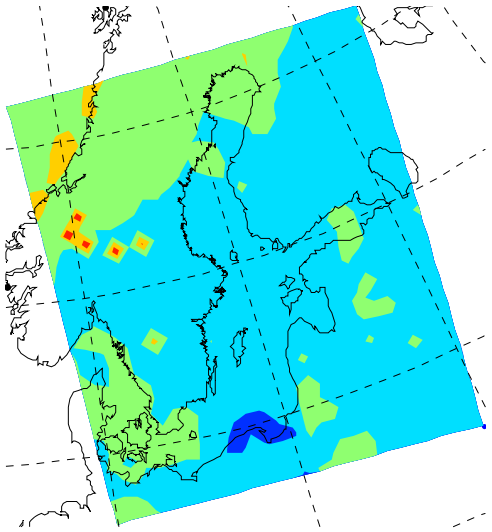
Work to be done

- Future
  - The variability in the scenarios
  - Significance in changes
  - Problems: too few members to look at true variability.
- Use
  - All scenario runs will be used as input to the carbon cycle models
  - The output from them will be analyzed and evaluated in the perspective of the present work

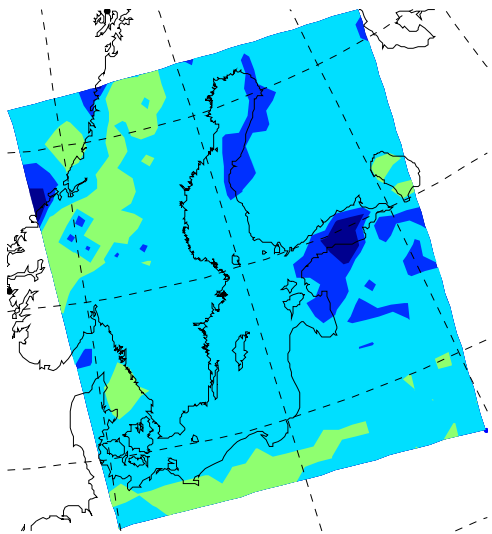
SST comparison to ERA-40

- SST is colder in ECHAM5 and HadCM3, whereas CCSM3 warmer, especially in the Gulf of Bothnia downscaled ERA-40

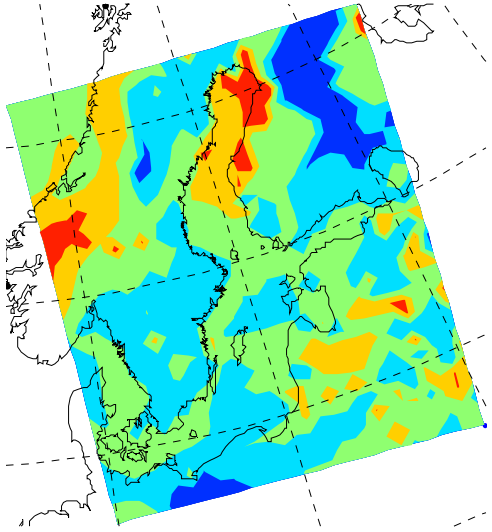
SST diff (℃) ECHAM5 A1B 1

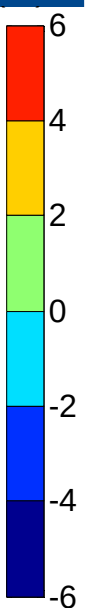


SST diff (℃) HADCM3 A1B

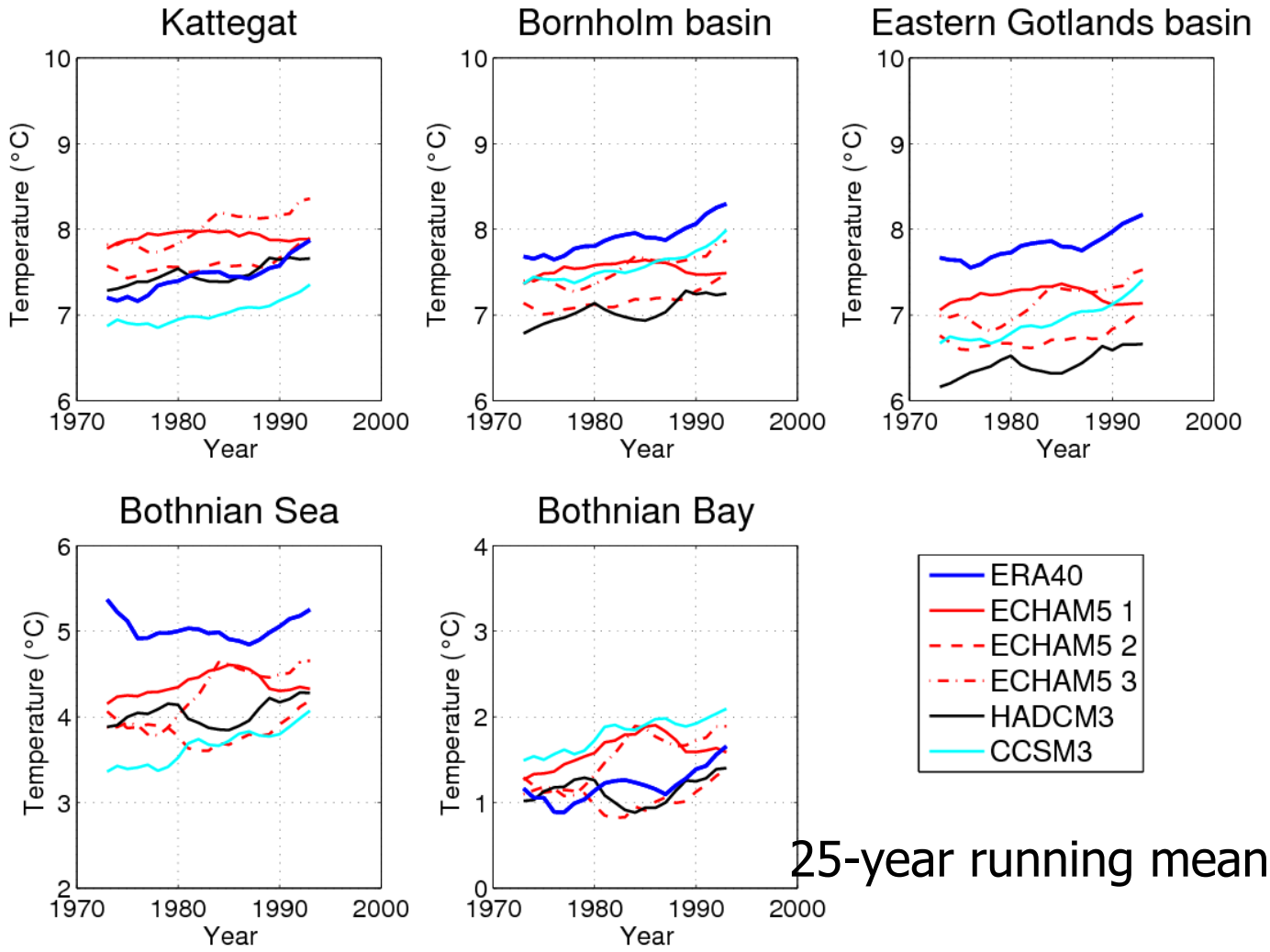


SST diff (℃) CCSM3 A1B





Tests of runs in present climate



25-year running mean

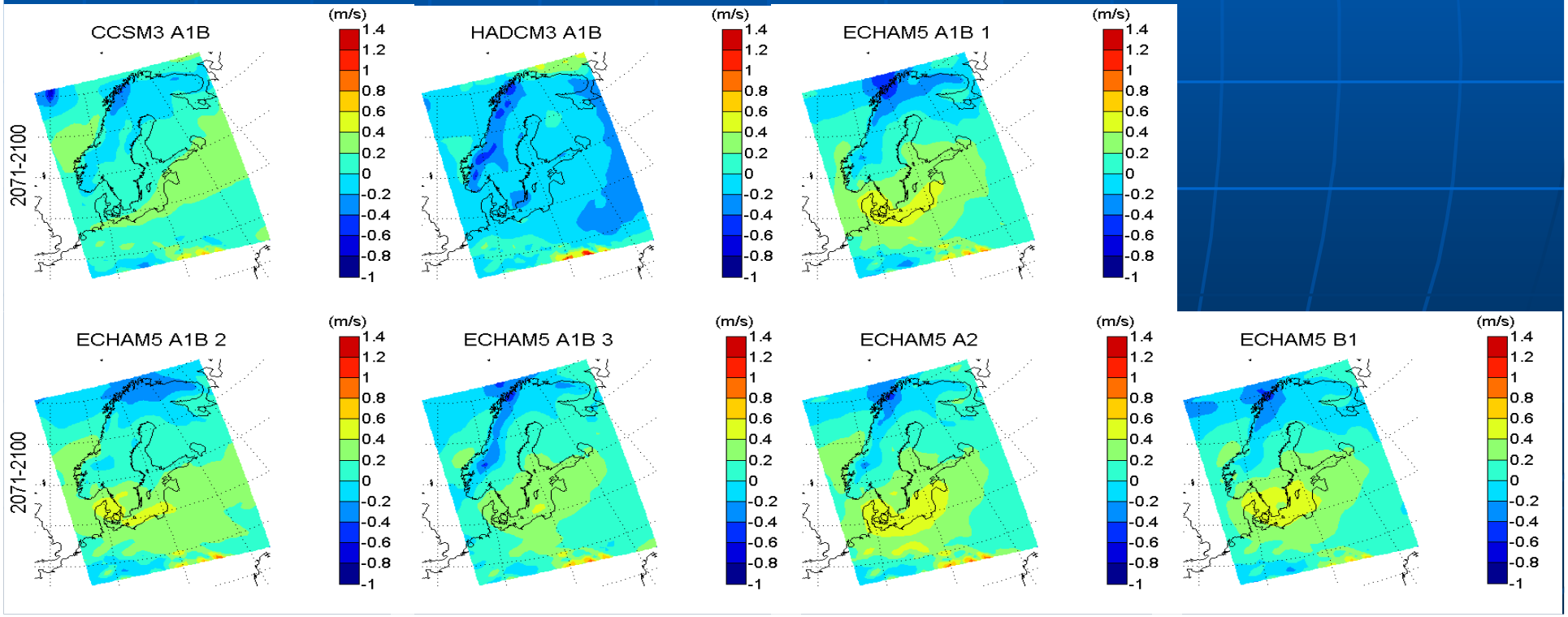
Spread within 1-2°C.

Models often colder than ERA-40.

Future scenarios

Geostrophic wind change

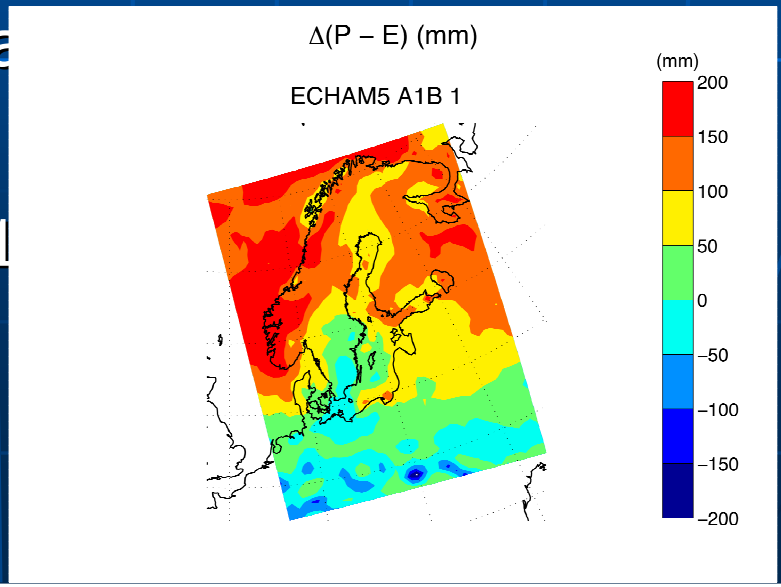
- All runs but HadCM3 give a slightly higher mean wind speed in 2071-2100 compared to 1961-1990.
- Centre of increase over southern Baltic Sea



Additional comments

- Which parameters changes significantly?

- Winds for A1B scenario in the Baltic Sea
  - Most model runs give a higher maximum speed in the period 2071-2100 compared to 1961-1990.
  - High wind speeds a
- Water balance
  - Mostly wetter 2071
    1961-1990



Climate scenarios

- Storyline A1: Rapid economic growth, population peaks in mid-century, new technologies, reduction in regional differences.
  - A1B-balance across energy sources.
- Storyline A2: Heterogeneous world, continuously increasing populations, economic developments regionally oriented.
- Storyline B1: Service and information economy, improved equity, population as in A1

Geostrophic wind

- All models except HadCM3 over-estimate the geostrophic wind, especially in the south.
- Internal variability of ECHAM 5 is small.