

## Modelling future relative sea level rise

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In collaboration with  
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### Gravitational effect

### Projections AR4

Excluding the effect of recent dynamical changes in ice sheets

### Gravitational effect

- Model includes
  - Gravitational effect
  - Rotational effect
  - Elastic deformation
- For **all** exchange of water mass
  - Land ice
  - Terrestrial exchange

(Figure from Mound & Mitrovica, 1998)

### Local Variability

**\*Climate Change variable**  
**\*Mass Change gravitational effect**

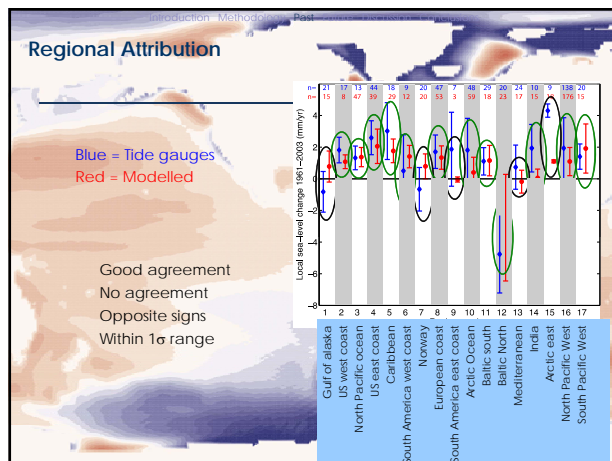
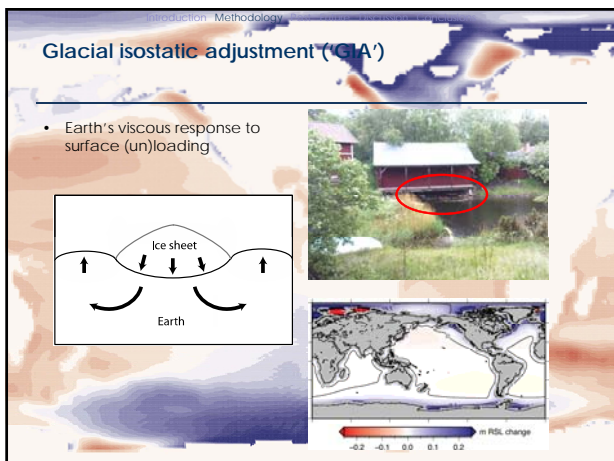
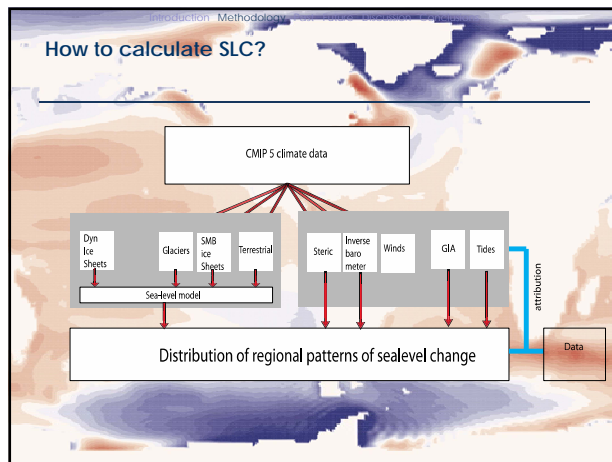
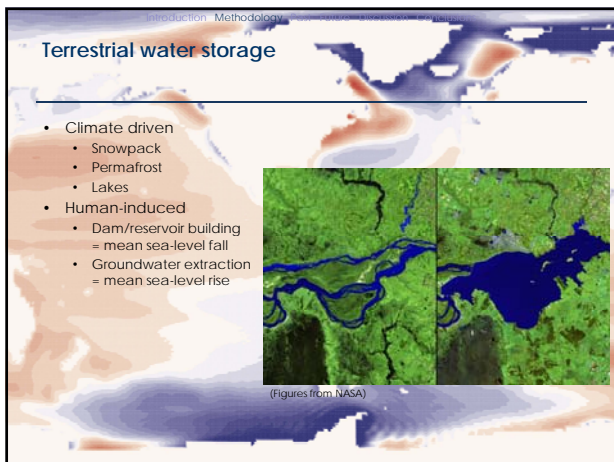
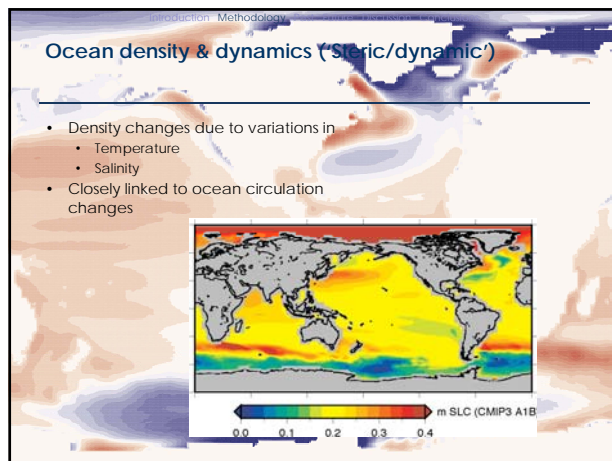
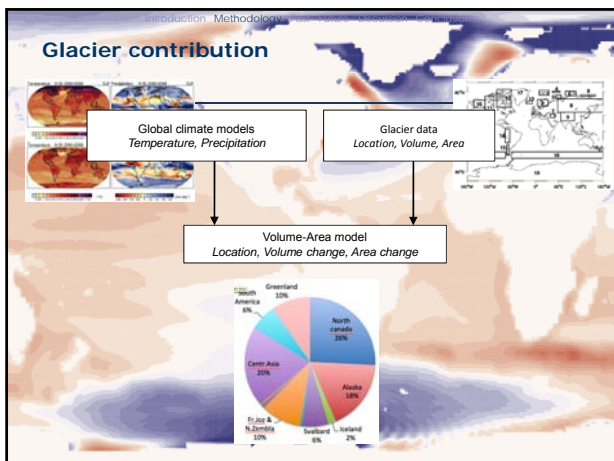
Mitrovica et al. 2000

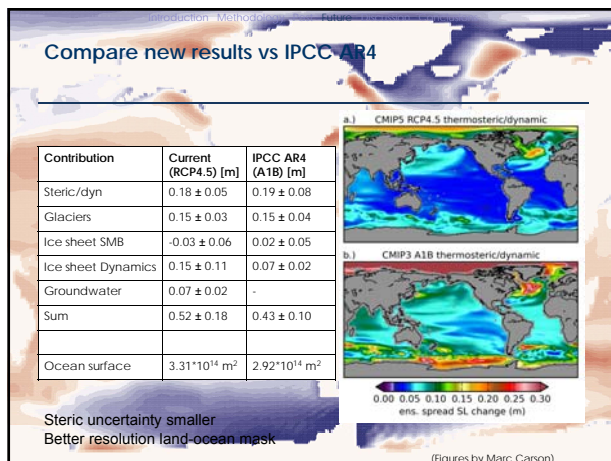
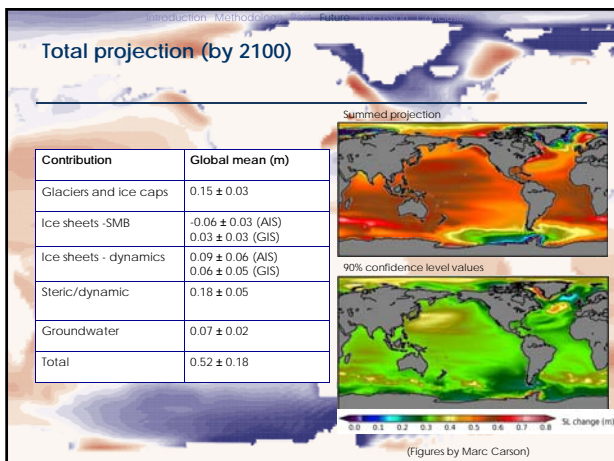
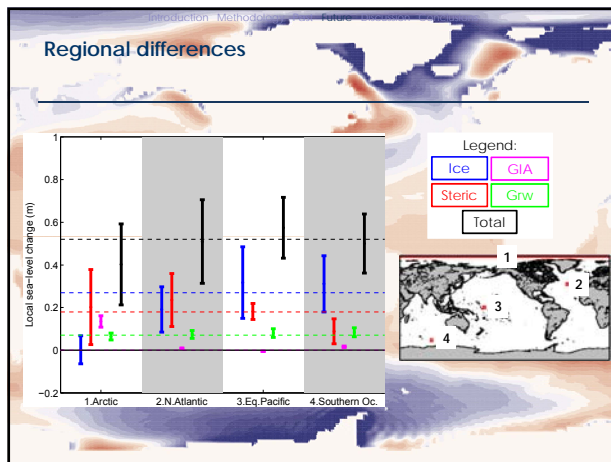
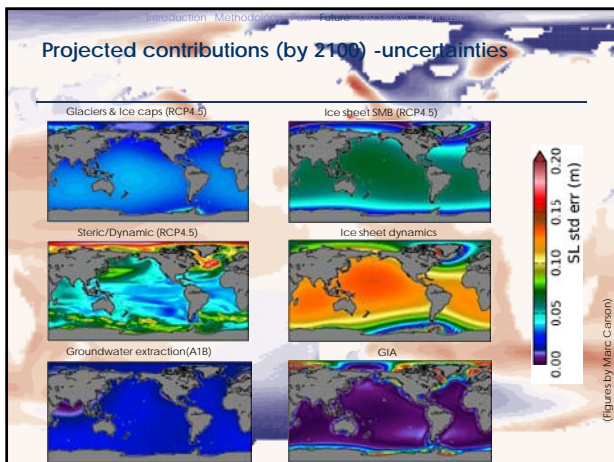
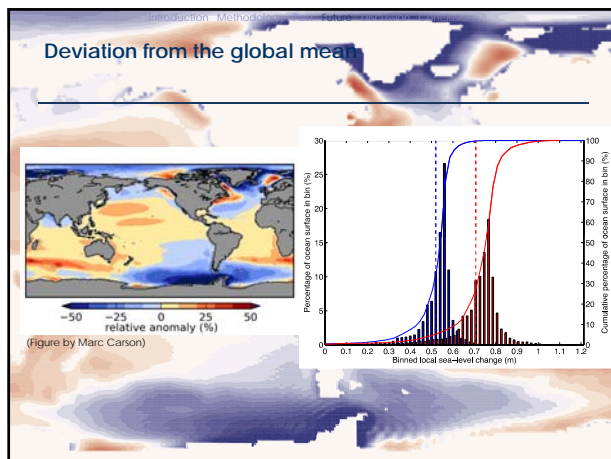
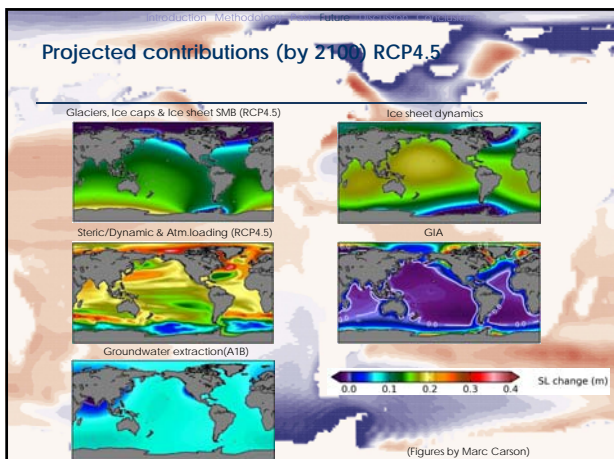
### Main contributing processes

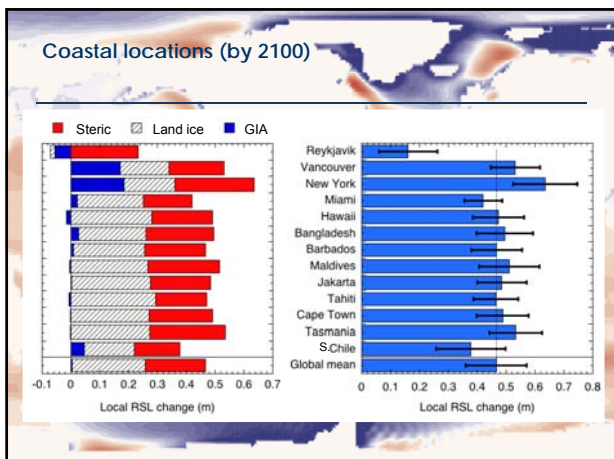
- Land ice melt (ice sheets and glaciers)
- Terrestrial water storage
- Glacial Isostatic Adjustment
- Ocean density & dynamics

Questions:

- How do these processes cause regional changes?
- Can we model this?







### Preliminary Conclusions

- Past**
  - Tide gauge observations can partly be explained by combining models & observations of the different contributions to sea-level change
  - MORE WORK NEEDS TO BE DONE ON ATTRIBUTION
- Future**
  - Combine models to show regional patterns of sea-level change
  - Each contribution can dominate sea-level change locally
  - Therefore: improving/constraining estimates of all contributions is important
  - Using most recent data & models we find local deviations of -50% to +30%

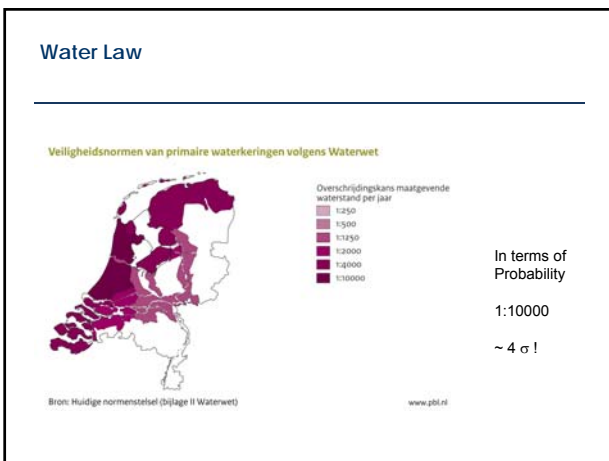
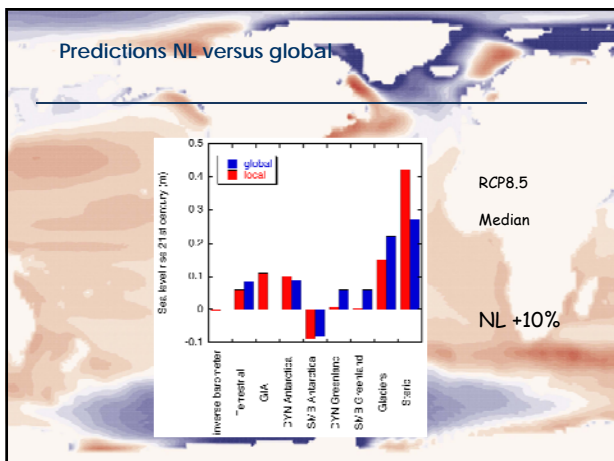
### Dutch Minister

**Dutch Moral:**

**Onder de zeespiegel**  
 Nederlanders zijn vergeten wat het betekent om onder de zeespiegel te leven, aldus Schultz. Ze vindt dat water 'een zwaar onderschat politiek onderwerp' is. 'Die ene storm in de tienduizend jaar kan juist die van morgen zijn.'

Dutch forgot what it is to live below sea level.  
 Water is an underestimated political subject.

"The single storm which may occur once every ten thousand years can be the one form tomorrow".



### Uncertainties in ice dynamical discharge

#### Deterministic approach (ICEDYN)

Gaussian distribution      IPCC AR5

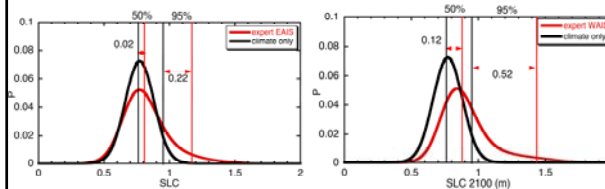
#### Stochastic scaling (ICEDYN)

Skewed distribution      Siddall et al. in prep

#### Expert assessment (SMB+ ICEDYN)

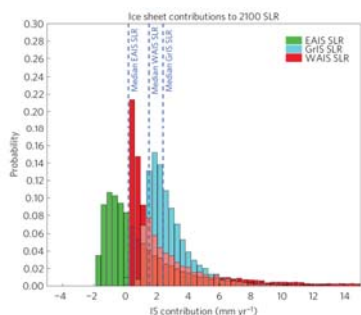
Skewed distribution      Bamber and Aspinall 2013

### Effect on ends of the frequency distributions



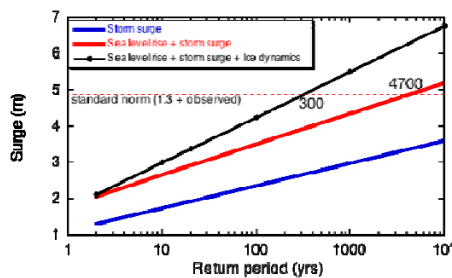
Expert assessment + CMIP5 model RCP8.5

### Ice sheet contribution probability density function

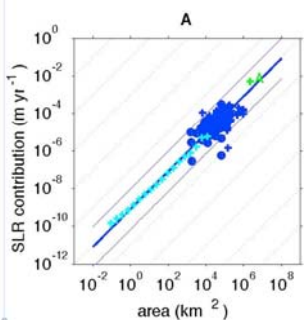


Bamber and Aspinall 2013

### Surge and return periods



### Data based (Siddall et al.)



Blue circles: GIS (Bamber et al. 2012)  
 Blue cross: Ant (Rignot et al. 2008)  
 Cyan: small glaciers (Slangen et al 2012)  
 A: WAIS at 0.5 m/100yrs

Sidall in prep.

### Provisional Conclusions

- We can calculate regional patterns
- All processes can be dominant on regional scale
- Attribution issue at regional level not satisfactory closed
- Political statements need a revision because
  - ensemble climate model results
  - skewed ice dynamical contribution
- issues for Return Period: independency of different ice sheets same forcing, different processes