

Klimatologiske Tipping Points



Den arktiske udfordring

I de arktiske egne er havens tilbagetrækning og sommerafsmeltingen af den grønlandske inlandsis i de seneste år accelereret voldsomt, mens tundraens permafrost tør op. Klimatologerne taler om forest  ende 'tipping points' - om tarskler, hvorfra klimaforandringer bliver selvst  r  kende.

I det arktiske omr  de ser man i disse   r markante klimaforandringer. St  dig store omr  de af Det Arktiske Hav, som i vinterhalvÅret er helt dækket af is, smelter i løbet af sommerm  nedene, og det slag, som dannes i løbet af vinterhalvÅret bliver st  dig tyndere. Udsigten til at Nordpolen bliver isfri i sommerm  nedene er inden for de seneste   r rykket frem fra at kunne ske i en fjern fremtid til at kunne være en realitet inden for ganske f  r. Det er et skudt i tiden, der har kommet, at tundraen, der bliver tør, taffleskes, stokken af lyset tilbage i vintersæsonen. Men n  r lyset kommer hertil, frigiver en stor del af iset ved havel og fører til øget opvarming. I de seneste   r har man kunnet konstatere en begyndende optoning af havbund og tundraerne, som har store m  ngder af metan gas indfrosset. Metan er en kraftig drivhusgas, og frigivelsen af metan gas forl  ges med CO₂, til en stor del af det sollys, som rammer Jorden, forbliver i Jordens atmosfære. P   billede herover har man antent lammer af metan gas, som har samlet sig under isen.

Det er antaget, at hvis den arktiske permafrost tør helt op, vil det føre til et op-til-10-dobbelting af atmosf  rens koncentration af metan. Klimatologerne taler i s  danne situationer om **tipping points**, hvor den klimatologiske situation fra et relativt stabilt l  per over og bliver selvecellecelerende.

En tidskorridor p   15 - 20   r

Siden begyndelsen af den industrielle   ra har der v  ret en global opvarmning p   0,7   C. Men denne opvarmning er ikke j  rv fordelt. I den arktiske region ser man allerede i dag flere st  der temperaturstigningen p   over 2   C. N  r man ved klimaforhandlingerne taler om at m  tte holdet af globale opvarmninger p   under 2   C i forhold til pr  dikningen, s  r vi det i den arktiske region svare til en opvarmning p   5   C eller mere. Det varierer m  ndigt regnet til temperaturesskellen mellem Danmark og Norditalien.

Man ser derfor i disse   r i sommerm  nedene en arktisk store afsmelting af den gr  nlandske inlandsis (se billede 1). Flere st  der langs afsmeltingen af inlandsisen har man ligeledes anlagt vandkraftsverker, som udnytter smeltevandet. I løbet af sommeren dannes der p   inlandsisen store soer af smeltevand (se 5-9), som gennem revner i isen - som gradvis bliver til store slakter (se 2-4) - lader ind under ismasserne og opbloder bunden. Dette er sandsynligvis medvirkende til, at inlandsisen kavles langt hurtigere end for blot 4   r siden.

En n  g amerikansk undersøgelse kom frem til, at den gr  nlandske inlandsis ville begynde at desublasse ved en CO₂-koncentration i atmosf  ren omkring 425 ppm. Med den nuv  rende stigning vil vi n  r det niveau i løbet af 15-20   r. Ogs  r er i dag en v  kende beklaiming for, at smeltevandet kan fore til, at store ismasser skruler ud i havet p   en gang.

Verden over ser man i disse   r g  letsjere svinde ind - i Alperne, i Andesbj  rene og i Himalaya. Mange af Asiens store floder har deres begyndelse i Himalaya-bj  rene: gletsjere Indus, Ganges, Brahmaputra, Mekong-floden, Yangtze-floden og Den Gule Flod. Gennem tiderne har gletsjere betydet, at der var rige vand i de floder, der har v  ret v  rter for landbrug og opblodet bunden. Dette er sandsynligvis medvirkende til, at inlandsisen kavles langt hurtigere end for blot 4   r siden.

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Forsiden kan vi g  rde os. Men hvis Gr  nlands inlandsis sneller, vil det føre til en hastighed på 7 m. Det vil ikke ske i morgen, og ikke i det 21.   rhundrede, men p   sigt, ifølge ledet af NASA's klimaforskningsst  relse James E. Hansen en koncentration af CO₂ p   450 ppm igennem lengre tid børne af en fuld afsmelting af alle koldens ismasser og dengang en hastighed på op omkring 75 m. Det er p   den baggrund, at klimatologerne siger, at det h  st med at vende udviklingen, og at vi ikke bare kan fortsette med at abh  nde fossile brændstoffer som nu. For hvert dr  r vi venter med at igangsætte omst  relsen til det fossile v  rterne, vil det ikke b  rlere. Reden er enkelt: vi har p   det nu, hvilket klimaforandringerne bliver sekund  rene. Hvis vi sparer og st  rre,

COP 15 i København og COP 16 i Cancun har klart vist, hvor svaret er for verdens lande at n  l enighed om de nødvendige CO₂-reduseringer til opnår, at g  r efter n  gle h『  rige l『  sninger. Dels vil man ved m  lrettet at sogn at mindsk metanudledningerne f   en hurtig effekt, da metan bliver langt korekte til i atmosf  ren end det f  rste, der m  nides at st  rre oppe p   alle koldens klimaforandringer. Hvis man ikke m  nides at halvere CO₂-emissionen i dag, tilsunders de udstukte is- og snelloader - og dermed sikre, at der igen vil blive reflekteret mere lys og varme bort fra de arktiske v  lder.



Climatological Tipping Points

In the arctic regions the withdrawal of the sea ice and the summer melting-off of the Greenland Ice Cap have accelerated tremendously the past years while the permafrost on the tundra is thawing out. Climatologists are indicating pending 'tipping points' - past these thresholds the climate changes become self-accelerating.

Lately, significant changes are seen in the arctic area. Larger parts of the **Arctic Sea**, which in the winter season are completely covered with ice, melt during the summer months, and the layer of ice that forms during the winter season is steadily thinner. The prospect of the North pole being **ice-free** in the summer months has during recent years changed from being something that might happen in a distant future, to something we could see happening within a few years.

When sunlight hits the chalky white sea ice most of the sunrays are reflected back into space. But when the rays hit the ocean, a great deal of the light seeps into the ocean and leads to **increased warming**. In the past years it has become evident that a nascent thawing of the ocean floor and tundra areas, which have large quantities of methane gas stored. Methane is a severe greenhouse gas, and the emission of methane gas like CO₂, prevents most of the sunlight that hits the Earth from leaving the Earth's atmosphere. In the pictures above to the left, pockets of methane gas have been ignited, bursting out a few under the ice.

If a significant part of the arctic permafrost thaws completely it will lead to a ten times larger methane concentration in the atmosphere. In these cases, the climatologists mention **tipping points** where the climatological situation tips over from being relatively stable to being self-accelerating.

Since the beginning of the industrial era there has been a global warming of 0,7   C. But this warming is not evenly dispersed. In the arctic region there are already temperature increases of over 2   C. When they talk at climate negotiations about keeping the global temperature increases at below 2   C compared to pre-industrial times, in the arctic region it would mean 5   C or more. This corresponds to a change of the temperature difference between Denmark and Northern Italy.

This is why an increasing melting of the **Greenland Ice Cap** (see picture 1), a number of places along the edge of the inland ice water works have even been constructed to exploit the melt water. During summertime, large lakes of melt water form on the inland ice (see 5-9) that runs through cracks in the ice - which gradually turn into huge moulins (see 2-4) - under the ice sheet and softens the bottom. This most likely contributes to the inland ice calving much quicker than a few years ago.

A recent American study reached the conclusion that the Greenland Ice Cap will begin destabilizing at a CO₂ concentration in the atmosphere of around 425 ppm. With the current increase we will reach this level in 15-20 years. And today there is a growing concern that the melt water can lead to large ice masses sloshing into the ocean at all once.

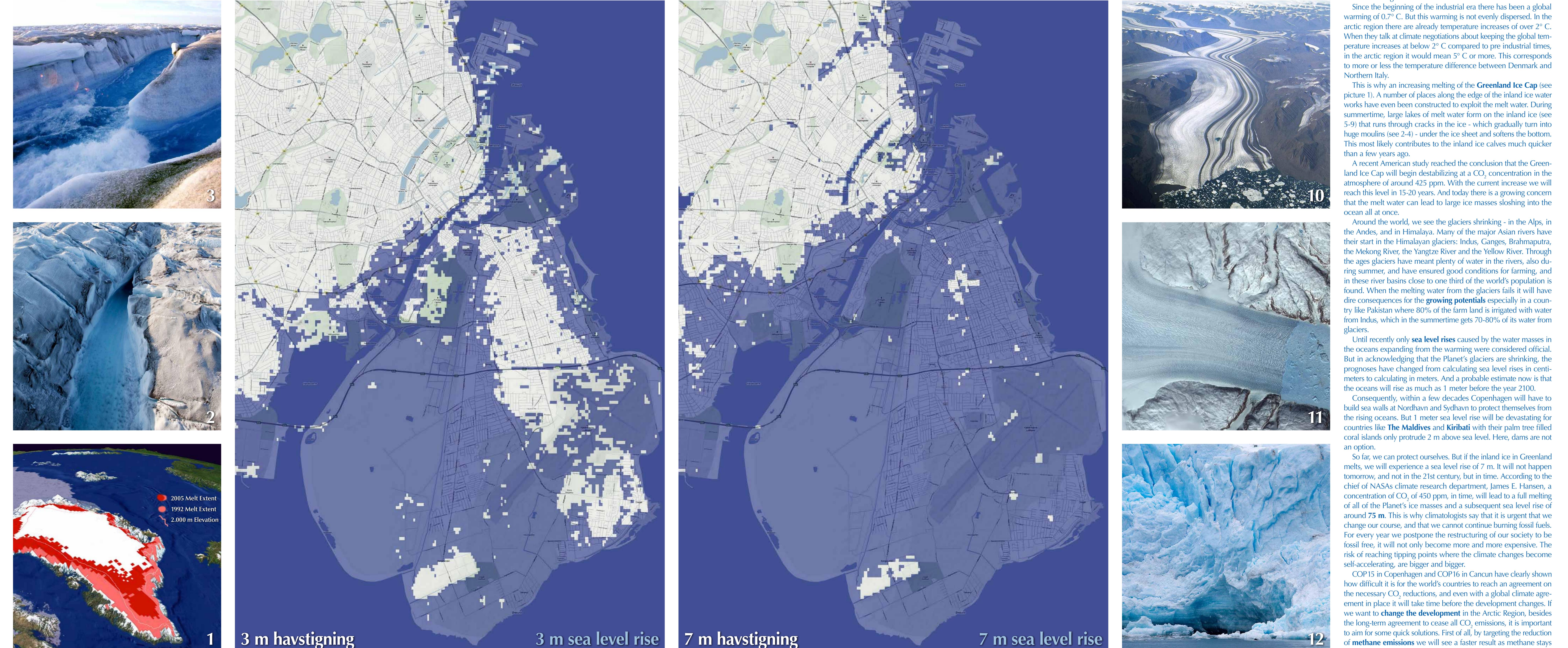
Around the world, we see the glaciers shrinking - in the Alps, in the Andes, and in Himalaya. Many of the major Asian rivers have their start in the Himalayan glaciers: Indus, Ganges, Brahmaputra, the Mekong River, the Yangtze and the Yellow River. Through the ages glaciers have meant plenty of water in the rivers, also during summer, and have enabled good conditions for farming, and in some cases, to irrigate land. To avoid that the farmlands under the ice will be lost, when the melting water from the glaciers will have dire consequences for the **growing potentials** especially in a country like Pakistan where 80% of the farm land is irrigated with water from Indus, which in the summer gets 70-80% of its water from glaciars.

Until recently only **sea level rises** caused by the water masses in the oceans expanding from the warming were considered official. But in acknowledging that the Planet's glaciers are shrinking, the prognosis has changed. Now it is not only sea level rise that centimeters to calculate matters. And a problem that may be that the oceans will rise as much as 1 meter before the year 2100.

Consequently, within a few decades Copenhagen will have to build sea walls at Nordhavn and Sydhavn to protect themselves from the rising oceans. But 1 meter sea level rise will be devastating for countries like **The Maldives** and **Kiribati** with their palm tree filled coral islands only protrude 2 m above sea level. Here, dams are not an option.

So far, we can protect ourselves. But if the inland ice in Greenland melts, we will experience a sea level rise of 7 m. It will not happen tomorrow, but it is the prediction of the climate research department, James E. Hansen. A concentration of CO₂ of 450 ppm, in time will lead to a full melting of all of the Planet's ice masses and a subsequent sea level rise of around 75 m. This is why climatologists say that it is urgent that we change our course, and that we cannot continue burning fossil fuels. For every year we postpone the restructuring of our society to be fossil free, it will not only become more and more expensive. The risk of reaching tipping points where the climate changes become self-accelerating, are bigger and bigger.

COP15 in Copenhagen and COP16 in Cancun have clearly shown how important it is to reach an agreement on the necessary CO₂ reductions, and even with a global climate agreement in place it will take time before the development changes. If we want to **change the development** in the Arctic Region, besides the long-term agreement to cease all CO₂ emissions, it is important to aim for some quick solutions. First of all, by targeting the reduction of **methane emissions** we will see a faster result as methane stays in the atmosphere for a shorter period of time than CO₂. Secondly, by putting **filters on all coal plants** in the world the quantity of coal dust in the air that darkens the ice and snow flakes could be immediately lessened, and this way more light and heat would be reflected from the Arctic spaces.



Afsmelting af Gr  nlands inlandsis

PÅ Gr  nlandskortet herover (1) angiver det lyserede omr  de, hvor der i 1992 var afsmelting i sommerm  nedene, mens det mørkeomr  de tilsammen viser, hvor der i 2005 var sommerafsmelting.

De to kort i midten viser, hvor stor en del af København, som vil st   under vand, hvis havet stiger med henholdsvis 3 meter og 7 meter.

At beskytte København mod en s  dans havstigning vil vere en natsten uoverkommelig opgave selv i et af verdens rigeste lande. Og i storst  len af verden vil man ikke kunne stille noget op. Eneste reelle l『  sning er at tage klimaforandringerne konsekvent op, inden det kommer s   langt - det vil sige lige nu.

Melting of the Greenland Ice Cap

On the map of Greenland above left (1) the pink area shows the places with melting in the summer months of 1992, and the pink and brown combined shows the summer melting in 2005.

The two maps in the middle show how much of Copenhagen will be under water if the sea level rises 3 meters and 7 meters respectively.

Protecting Copenhagen from a sea level rise like this will be an overwhelming task even for one of the world's wealthiest countries. And most of the world will be unable to do anything. The only real solution is to face the climate challenge with consistency before it gets out of hand - which is now.