United Nations
Educational, Scientific and
Cultural Organization

Organisation
des Nations Unies
pour l'éducation,
la science et la culture

International Experts Meeting

Climate Change
and Arctic Sustainable Development :
scientific, social, cultural and educational challenges

3-6 March 2009, Monaco

ABSTRACT: OCEANS, ICE AND ATMOSPHERE

Jean-Claude Gascard
University Pierre & Marie Curie, Paris,
Coordinator of the European Integrated Project DAMOCLES,
FRANCE

Unprecedented events have been reported during the past 10 years in the Arctic Ocean, mostly related to the Arctic sea-ice summer minimum extent that retreated in September 2007 far beyond previous extreme minimum records. This is the first clear evidence of a phenomenon of planetary scale importance forced by global warming mainly caused by an earth energy imbalance due to greenhouse gas concentration increasing in the atmosphere. The Earth is now absorbing 0.85 watts per square meter more energy from the sun than it is emitting into space, raising the likelihood of the acceleration of sea-ice melting, ice sheet disintegration and a rise in the sea level (Hansen et al. 2005). According to the ARCSS consortium (Overpeck et al. 2005) the Arctic system is on trajectory to a new 'super interglacial age' seasonally ice-free state.

Over the past 20 years we observed a gradual long-term warming mostly characterized by ***milder winter*** freezing seasons and ***longer summer*** melting seasons evidencing strong albedo positive feedback effects. Less ice means more sea water being exposed to solar radiation that would be absorbed and transformed into heat by the ocean melting more ice and so on… Strong positive feedback accelerates the melting of Arctic sea-ice specially due to the sharp contrast of the high albedo for sea-ice areas covered with snow (>0.8) that reflects 80% of the incoming solar radiation back into space compare with the very low albedo (0.2) of the ocean absorbing 80% of the incoming solar radiation. Although long wave and short wave downwards solar radiation agreed rather well between models and observations, one of the biggest uncertainties in Arctic climate simulations still remains albedo effects affected by cloud cover and aerosols (Arctic haze). Warming amplification in the Arctic might also be attributed partly to atmospheric circulation (Graversen et al. 2008) and oceanic circulation (Zhang et al. 1998, Polyakov et al. 2005 and Dmitrenko et al. 2008) but this is still controversial. A drastic retreat of sea-ice minimum extent in summer has inevitably profound consequences during the following fall season. Then all the heat taken up by the ocean

has to be evacuated by the atmosphere, delaying the onset of freezing and consequently the amount of sea-ice formed during the following winter. Observations taken during the past 20 years indicate that sea-ice is becoming thinner, younger, moves faster and retreats more and more in summer. Sea-ice extent, ice thickness, ice drift and age of ice are all interrelated parameters best characterising Arctic sea-ice evolution.

Surprisingly, the 2007 Arctic sea-ice event was largely unpredicted, even if extreme sea-ice conditions were observed almost every September month each year over the past 10 years (Perovich et al. 1999, 2003, Serreze et al. 2003 and Stroeve et al. 2005). Premises of an Arctic sea-ice thinning and of an Arctic ocean warming were reported nearly 20 years ago by Wadhams (1990) and Quadfasel (1991). So why was the 2007 Arctic summer sea-ice minimum extent a complete surprise if it was not an exceptional and an extraordinary event? Most of the surprise came from the fact that it happened so soon and so suddenly. 2008 was another exceptional year characterized by an extreme sea-ice retreat approaching the 2007 summer minimum record. In 2008 an exceptional replenishment of the perennial ice by first year ice did occur in contrast with 2007 when it did not happen and that compensated for an exceptional loss of perennial ice observed in 2008. How well do we understand the 2007 and 2008 sea-ice extent minimum through modelling and data analysis including retrospective analyses of long-term observational records? As predicted by all IPCC models, Arctic Sea-Ice would most likely disappear in summer in the near future. However it seems like this is going to happen much sooner than models predicted as pointed out by recent observations and data reanalysis. This is raising a critical set of issues with many important implications potentially able to speed up melting of the Greenland ice sheet, accelerating sea level rise and slowing down the world ocean conveyor belt (THC). That would also have a lot of consequences on marine and terrestrial ecosystems, on the ocean carbon sink (Bates et al. 2006) and ocean acidification. Permafrost melting could also accelerate, during rapid Arctic sea-ice loss due to an amplification of Arctic land warming 3.5 times greater than secular 21st century climate trends, as pointed out recently by Lawrence et al. (2008). This permafrost evolution would have important consequences and strong impacts on large carbon reservoirs and methane releases either in the ocean and/or on land.

Recommendations:

- Establishment of an Arctic Treaty covering scientific needs, rights and access for exploring the Arctic in exchange of a fully transparent process for all activities occurring under the Treaty.
- Greater European involvement for Arctic exploration: promotion of the Aurora Borealis European icebreaker and European full partnership to the Arctic Council.
- Establishment of an international pan-arctic coordinated scientific network of polar stations including Tiksi (Siberia), Resolute Bay & Eureka (Nunavut), Longyearbyen & Ny Alesund (Svalbard), Nuuk (Greenland) and Point Barrow (Alaska).
- Establishment of an international pan-arctic coordinated scientific network of arctic researchers gathering ALL scientists working in ALL countries contributing to Arctic research with NO exclusion. This network should elaborate and keep updated a coordinated science plan for future arctic research covering all disciplines. Scientists should elect network coordinators for any given stretch of time. This network should also elaborate an implementation plan to be discussed with national and international polar agencies. UNESCO, UNEP, the European Union and the Arctic Council could provide the funding necessary for the foundation and functioning of this international network of scientists.