A tsunami wave recorded near a glacier front

Article published in *Natural Hazards and Earth System Sciences*

Deformed sea ice near the glacier front: buckling (above) and fold (below). (Credit: Marchenko et al. 2012)

Abstract

We observed a tsunami wave near the glacier front in the Temple Fjord (Spitsbergen). Two temperature and pressure recorders were deployed on a wire from the ice approximately 300m from the glacier front. A pressure recorder was located under them on the bottom. The vertical displacement of the ice was approximately 30cm and the period of the tsunami wave was 90s. We attribute the generation of this wave to the displacement of the glacier similarly to the landslide tsunami generated by the motion of a block of rocks down the sloping bottom. The glacier motion also generated a short-period (12s) deformation wave in the ice cover. The measurements allowed us to estimate the wave number of these waves and the Young's modulus of the ice.

Reference

Marchenko, A. V., Morozov, E. G., and Muzylev, S. V. (2012): A tsunami wave recorded near a glacier front, *Nat. Hazards Earth Syst. Sci.*, 12, 415–419.

Drivers of flood risk change in residential areas

Article published in *Natural Hazards and Earth System Sciences*

Abstract

The observed increase of direct flood damage over the last decades may be caused by changes in the meteorological drivers of floods, or by changing land-use patterns and socio-economic developments. It is still widely unknown to which extent these factors will contribute to future flood risk changes.

We survey the change of flood risk in terms of expected annual damage for residential buildings in the lower part of the Mulde River basin (Vereinigte Mulde) between 1990 and 2020 in 10-yr time steps based on measurements and model projections. For this purpose we consider the complete risk chain from climate impact via hydrological and hydraulic modelling to damage and risk estimation. We analyse what drives the changes in flood risk and quantify the contributions of these drivers: flood hazard change due to climate change, land-use change and changes in building values.

We estimate flood risk and building losses based on constant values and based on effective (inflation adjusted) values separately. For constant values, estimated building losses for the most extreme inundation scenario amount to more than 360 million € for all time steps. Based on effective values, damage estimates for the same inundation scenario decrease from 478 million € in 1990 to 361 million € in 2000 and 348 million € in 2020 (maximum land-use scenario). Using constant values, flood risk is 111% (effective values: 146%) of the 2000 estimate in 1990 and 121% (effective values: 115%) of the 2000 estimate for the maximum land-use scenario in 2020. The quantification of driver contributions reveals that land-use change in the form of urban sprawl in endangered areas is the main driver of flood risk in the study area. Climate induced flood hazard change is important but not a dominant factor of risk change in the study area. With the historical exception of the economic effects in Eastern Germany following the German reunification, value developments only have minor influence on the development of flood risk.

Reference

Elmer, F. et al. (2012): Drivers of flood risk change in residential areas, *Nat. Hazards Earth Syst. Sci.*, 12, 1641–1657.

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Photo-lability of deep ocean dissolved black carbon

Article published in *Biogeosciences*

Abstract

Dissolved black carbon (DBC), defined here as condensed aromatics isolated from seawater via PPL solid phase extraction and quantified as benzenepolycarboxylic acid (BPCA) oxidation products, is a significant component of the oceanic dissolved organic carbon (DOC) pool. These condensed aromatics are widely distributed in the open ocean and appear to be tens of thousands of years old. As such DBC is regarded as highly refractory. In the current study, the photo-lability of DBC, DOC and coloured dissolved organic matter (CDOM; ultraviolet-visible absorbance) were determined over the course of a 28 day irradiation of North Atlantic Deep Water under a solar simulator. During the irradiation DBC fell from 1044±164nM-C to 55±15nM-C, a 20-fold decrease in concentration. Dissolved black carbon photo-degradation was more rapid and more extensive than for bulk CDOM and DOC. The concentration of DBC correlated with CDOM absorbance and the quality of DBC indicated by the ratios of different BPCAs correlated with CDOM absorbance spectral slope, suggesting the optical properties of CDOM may provide a proxy for both DBC concentrations and quality in natural waters. Further, the photo-lability of components of the DBC pool increased with their degree of aromatic condensation. These trends indicate that a continuum of compounds of varying photo-lability exists within the marine DOC pool. In this continuum, photo-lability scales with aromatic character, specifically the degree of condensation. Scaling the rapid photo-degradation of DBC to rates of DOC photo-mineralization for the global ocean leads to an estimated photo-chemical half-life for oceanic DBC of less than 800 years. This is more than an order of magnitude shorter than the apparent age of DBC in the ocean. Consequently, photo-degradation is posited as the primary sink for oceanic DBC and the apparent survival of DBC molecules in the oceans for millennia appears to be facilitated not by their inherent inertness but by the rate at which they are cycled through the surface ocean's photic zone.

Reference

Stubbins, A., Niggemann, J., and Dittmar, T. (2012): Photo-lability of deep ocean dissolved black carbon, *Biogeosciences*, 9, 1661–1670.

Global characteristics of the lunar tidal modulation of the equatorial electrojet derived from CHAMP observations

Article published in *Annales Geophysicae*

Abstract

It has been known since many decades that lunar tide has an influence on the strength of the equatorial electrojet (EEJ). There has, however, never been a comprehensive study of the tidal effect on a global scale. Based on the continuous magnetic field measurements by the CHAMP satellite over 10 years it is possible to investigate the various aspects of lunar effects on the EEJ. The EEJ intensity is enhanced around times when the moon is overhead or at the antipode. This effect is particularly strong around noon, shortly after new and full moon. The lunar tide manifests itself as a semi-diurnal wave that precesses through all local times within one lunar month. The largest tidal amplitudes are observed around December solstice and smallest around June solstice. The tidal wave crest lags behind the moon phase. During December this amounts to about four days while it is around two days during other times of the year. We have not found significant longitudinal variations of the lunar influence on the EEJ. When comparing the average EEJ amplitude at high solar activity with that during periods of solar minimum conditions a solar cycle dependence can be found, but the ratio between tidal amplitude and EEJ intensity stays the same. Actually, tidal signatures standout clearer during times of low solar activity. We suggest that the tidal variations are caused by a current system added to the EEJ rather than by modulating the EEJ. Gravitational forcing of the lower atmosphere by the moon and the sun is assumed to be the driver of an upward propagating tidal wave. The larger tidal amplitudes around December solstice can be related to stratospheric warming events which seem to improve the conditions for upward propagation.

The results described here have to large extent been presented as a Julius-Bartels Medal Lecture during the General Assembly 2011 of the European Geosciences Union.

Reference

Lühr, H., Siddiqui, T. A., and Maus, S. (2012): Global characteristics of the lunar tidal modulation of the equatorial electrojet derived from CHAMP observations, *Ann. Geophys.*, 30, 527–536.

On the role of ozone in long-term trends in the upper atmosphere-ionosphere system

Article published in *Annales Geophysicae*

Abstract

Origin of long-term trends in the thermosphere-ionosphere system has been discussed since the beginning of trend studies. The two most prioritized explanations have been those via long-term increase of atmospheric concentration of greenhouse gases and long-term increase of geomagnetic activity throughout the 20th century. Secular changes of the Earth's main magnetic field play an important role in trends in a limited region. Recently, Walsh and Oliver (2011) suggested that the long-term cooling of the upper thermosphere (above 200km) may be due largely to the stratospheric ozone depletion. Here, we show that the role of ozone is very important in the mesosphere and lower thermosphere but not in the upper thermosphere. The suggestion of Walsh and Oliver (2011) is based on historical (before 1988) data from Saint-Santin radar, whereas more recent data do not support their conclusion.

Reference

Laštovička, J. (2012): On the role of ozone in long-term trends in the upper atmosphere-ionosphere system, *Ann. Geophys.*, 30, 811–816.

The regulation of the air: a hypothesis

Article published in *Solid Earth*

Abstract

We propose the hypothesis that natural selection, acting on the specificity or preference for CO_2 over O_2 of the enzyme rubisco (ribulose-1,5-bisphosphate carboxylase/oxygenase), has controlled the CO_2:O_2 ratio of the atmosphere since the evolution of photosynthesis and has also sustained the Earth's greenhouse-set surface temperature. Rubisco works in partnership with the nitrogen-fixing enzyme nitrogenase to control atmospheric pressure. Together, these two enzymes control global surface temperature and indirectly the pH and oxygenation of the ocean. Thus, the co-evolution of these two enzymes may have produced clement conditions on the Earth's surface, allowing life to be sustained.

Reference

Nisbet, E. G., Fowler, C. M. R., and Nisbet, R. E. R. (2012): The regulation of the air: a hypothesis, *Solid Earth*, 3, 87–96.

Evidence of a possible turning point in solar UV-B over Canada, Europe and Japan

Article published in *Atmospheric Chemistry and Physics*

Abstract

This study examines the long-term variability of UV solar irradiances at 305nm and 325nm over selected sites in Canada, Europe and Japan. Site selection was restricted to the availability of the most complete UV spectroradiometric datasets during the period 1990–2011. The analysis includes the long-term variability of total ozone, aerosol optical depth and cloud fraction at the sites studied. The results, based on observations and modeling, suggest that over Canada, Europe and Japan the period under study can be divided into three sub-periods of scientific merit: the first period (1991–1994) is the period perturbed by the Pinatubo volcanic eruption, during which excess volcanic aerosol has enhanced the 'conventional' amplification factor of UV-B at ground level by an additional factor that depends on solar elevation. The increase of the UV-B amplification factor is the result of enhanced scattering processes caused by the injection of huge amounts of volcanic aerosols during the perturbed period. The second period (1995–2006) is characterized by a 0.14%/yr increase in total ozone and an increasing trend in spectral irradiance by 0.94%/yr at 305nm and 0.88%/yr at 325nm. That paradox was caused by the significant decline of the aerosol optical depth by more than 1%/yr (the 'brightening' effect) and the absence of any statistically significant trend in the cloud fraction. The third period (2007–2011) shows statistically significant evidence of a slowdown or even a turning point in the previously reported upward UV-B trends over Canada, Europe and Japan.

Reference

Zerefos, C. S. et al. (2012): Evidence of a possible turning point in solar UV-B over Canada, Europe and Japan, *Atmos. Chem. Phys.*, 12, 2469–2477.

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Estimating the climate significance of halogen-driven ozone loss in the tropical marine troposphere

Article published in *Atmospheric Chemistry and Physics*

Abstract

We have integrated observations of tropospheric ozone, very short-lived (VSL) halocarbons and reactive iodine and bromine species from a wide variety of tropical data sources with the global CAM-Chem chemistry-climate model and offline radiative transfer calculations to compute the contribution of halogen chemistry to ozone loss and associated radiative impact in the tropical marine troposphere. The inclusion of tropospheric halogen chemistry in CAM-Chem leads to an annually averaged depletion of around 10% (~2.5 Dobson units) of the tropical tropospheric ozone column, with largest effects in the middle to upper troposphere. This depletion contributes approximately -0.10W/m^2 to the radiative flux at the tropical tropopause. This negative flux is of similar magnitude to the ~0.33W/m^2 contribution of tropospheric ozone to present-day radiative balance as recently estimated from satellite observations. We find that the implementation of oceanic halogen sources and chemistry in climate models is an important component of the natural background ozone budget and we suggest that it needs to be considered when estimating both preindustrial ozone baseline levels and long term changes in tropospheric ozone.

Reference

Saiz-Lopez, A. et al. (2012): Estimating the climate significance of halogen-driven ozone loss in the tropical marine troposphere, *Atmos. Chem. Phys.*, 12, 3939–3949.

Revisiting Narrow Bipolar Event intracloud lightning using the FORTE satellite

Article published in *Annales Geophysicae*

Abstract

The lightning stroke called a Narrow Bipolar Event, or NBE, is an intracloud discharge responsible for significant charge redistribution. The NBE occurs within 10–20μs, and some associated process emits irregular bursts of intense radio noise, fading at shorter timescales, sporadically during the charge transfer. In previous reports, the NBE has been inferred to be quite different from other forms of lightning strokes, in two ways. First, the NBE has been inferred to be relatively dark (non-luminous) compared to other lightning strokes. Second, the NBE has been inferred to be isolated within the storm, usually not participating in flashes, but when it is in a flash, the NBE has been inferred to be the flash initiator. These two inferences have sufficiently stark implications for NBE physics that they should be subjected to further independent test, with improved statistics. We attempt such a test with both optical and radio data from the FORTE satellite, and with lightning-stroke data from the Los Alamos Sferic Array.

We show rigorously that by the metric of triggering the PDD optical photometer aboard the FORTE satellite, NBE discharges are indeed less luminous than ordinary lightning. Referred to an effective isotropic emitter at the cloud top, NBE light output is inferred to be less than ~3×10^{8}W.

To address isolation of NBEs, we first expand the pool of geolocated intracloud radio recordings, by borrowing geolocations from either the same flash's or the same storm's other recordings. In this manner we generate a pool of ~2×10^5 unique and independent FORTE intracloud radio recordings, whose slant range from the satellite can be inferred. We then use this slant range to calculate the Effective Radiated Power (ERP) at the radio source, in the passband 26–49 MHz. Stratifying the radio recordings by ERP into eight bins, from a lowest bin (<5kW) to a highest bin (>140kW), we document a trend for the radio recordings to become more isolated in time as the ERP increases. The highest ERP bin corresponds to the intracloud emissions associated with NBEs. At the highest ERP, the only significant probability of temporal neighbors is during times following the high-ERP events. In other words, when participating in a flash, the high-ERP emissions occur at the apparent flash initiation.

Reference

Jacobson, A. R. and Light, T. E. L. (2012): Revisiting 'Narrow Bipolar Event' intracloud lightning using the FORTE satellite, *Ann. Geophys.*, 30, 389–404.

Lightning in Germany during a summer thunderstorm, by Jutta Holst, distributed by EGU under a Creative Commons licence.

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