Comparison of the impacts of urban development and climate change on exposing European cities to pluvial flooding

The economic and human consequences of extreme precipitation and the related flooding of urban areas have increased rapidly over the past decades. Some of the key factors that affect the risks to urban areas include climate change, the densification of assets within cities and the general expansion of urban areas. In this paper, we examine and compare quantitatively the impact of climate change and recent urban development patterns on the exposure of four European cities to pluvial flooding. In particular, we investigate the degree to which pluvial floods of varying severity and in different geographical locations are influenced to the same extent by changes in urban land cover and climate change. We have selected the European cities of Odense, Vienna, Strasbourg and Nice for analyses to represent different climatic conditions, trends in urban development and topographical characteristics. We develop and apply a combined remote-sensing and flood-modelling approach to simulate the extent of pluvial flooding for a range of extreme precipitation events for historical (1984) and present-day (2014) urban land cover and for two climate-change scenarios (i.e. representative concentration pathways, RCP 4.5 and RCP 8.5). Changes in urban land cover are estimated using Landsat satellite imagery for the period 1984-2014. We combine the remote-sensing analyses with regionally downscaled estimates of precipitation extremes of current and expected future climate to enable 2-D overland flow simulations and flood-hazard assessments. The individual and combined impacts of urban development and climate change are quantified by examining the variations in flooding between the different simulations along with the corresponding uncertainties. In addition, two different assumptions are examined with regards to the development of the capacity of the urban drainage system in response to urban development and climate change. In the “stationary” approach, the capacity resembles present-day design, while it is updated in the “evolutionary” approach to correspond to changes in imperviousness and precipitation intensities due to urban development and climate change respectively. For all four cities, we find an increase in flood exposure corresponding to an observed absolute growth in impervious surfaces of 7-12% during the past 30 years of urban development. Similarly, we find that climate change increases exposure to pluvial flooding under both the RCP 4.5 and RCP 8.5 scenarios. The relative importance of urban development and climate change on flood exposure varies considerably between the cities. For Odense, the impact of urban development is comparable to that of climate change under an RCP 8.5 scenario (2081-2100), while for Vienna and Strasbourg it is comparable to the impacts of an RCP 4.5 scenario. For Nice, climate change dominates urban development as the primary driver of changes in exposure to flooding. The variation between geographical locations is caused by differences in soil infiltration properties, historical trends in urban development and the projected regional impacts of climate change on extreme precipitation. Developing the capacity of the urban drainage system in relation to urban development is found to be an effective adaptation measure as it fully compensates for the increase in runoff caused by additional sealed surfaces. On the other hand, updating the drainage system according to changes in precipitation intensities caused by climate change only marginally reduces flooding for the most extreme events.
New vigour involving statisticians to overcome ensemble fatigue

Climate simulation data comprise a range of different phenomena with complex and interacting processes. Yet our understanding of the climate is incomplete despite the huge volumes of data, of which only a small fraction has been explored, and many questions remain, particularly those on the character and origin of uncertainties associated with model simulations and how further modelling efforts can improve understanding. Here, we question whether climate model information could be used more effectively and how so-called 'ensembles of opportunity' should be interpreted. Statisticians can contribute substantially to designing 'smarter' ensemble experiments, improving the distillation of information from ensembles, and helping interpret the relative merits of additional simulations. Future progress may be enhanced by increasing collaborations with statisticians.
Simulation of Optimal Decision-Making Under the Impacts of Climate Change

Climate change causes transformations to the conditions of existing agricultural practices appointing farmers to continuously evaluate their agricultural strategies, e.g., towards optimising revenue. In this light, this paper presents a framework for applying Bayesian updating to simulate decision-making, reaction patterns and updating of beliefs among farmers in a developing country, when faced with the complexity of adapting agricultural systems to climate change. We apply the approach to a case study from Ghana, where farmers seek to decide on the most profitable of three agricultural systems (dryland crops, irrigated crops and livestock) by a continuous updating of beliefs relative to realised trajectories of climate (change), represented by projections of temperature and precipitation. The climate data is based on combinations of output from three global/regional climate model combinations and two future scenarios (RCP4.5 and RCP8.5) representing moderate and unsubstantial greenhouse gas reduction policies, respectively. The results indicate that the climate scenario (input) holds a significant influence on the development of beliefs, net revenues and thereby optimal farming practices. Further, despite uncertainties in the underlying net revenue functions, the study shows that when the beliefs of the farmer (decision-maker) opposes the development of the realised climate, the Bayesian methodology allows for simulating an adjustment of such beliefs, when improved information becomes available. The framework can, therefore, help facilitating the optimal choice between agricultural systems considering the influence of climate change.

General information
State: Published
Organisations: UNEP DTU Partnership, Department of Management Engineering, Systems Analysis
Authors: Møller, L. R. (Intern), Drews, M. (Intern), Larsen, M. A. D. (Intern)
Number of pages: 14
Pages: 104-117
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Management
Volume: 60
Issue number: 1
ISSN (Print): 0364-152X
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.05 SJR 0.794 SNIP 0.996
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Assessing the influence of groundwater and land surface scheme in the modelling of land surface-atmosphere feedbacks over the FIFE area in Kansas, USA

The land surface-atmosphere interaction is described differently in large scale surface schemes of regional climate models and small scale spatially distributed hydrological models. In particular, the hydrological models include the influence of shallow groundwater on evapotranspiration during dry periods where soils are depleted and groundwater is the only water supply. These mechanisms are analysed by combining a distributed hydrological model (MIKE SHE) and a regional climate model (HIRHAM) and comparing simulation results to the FIFE area observation data in Kansas, USA. The numerical experiments include five simulations. First MIKE SHE is forced by observed climate data in two versions i) with groundwater at a fixed uniform depth, and ii) with a dynamical groundwater component simulating shallow groundwater conditions in river valleys. iii) In a third simulation MIKE SHE is forced by HIRHAM simulated precipitation. The last two simulations include iv) a standard HIRHAM simulation, and v) a fully coupled HIRHAM-MIKE SHE simulation locally replacing the land surface scheme by MIKE SHE for the FIFE area, while HIRHAM in standard configuration is used for the remaining model area. The results show a clear correlation between depth to the groundwater and evapotranspiration with a distinct groundwater depth threshold at 0.5-3 m. During the dry summer period the two MIKE SHE simulations using distributed groundwater reproduced evapotranspiration better than MIKE SHE with unsaturated flow alone and the HIRHAM simulations. This indicates that including dynamic groundwater in a fully coupled climate-hydrological model may improve evapotranspiration fluxes from areas with shallow groundwater tables.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, EnviDan A/S, DHI Denmark, Danish Meteorological Institute, Geological Survey of Denmark and Greenland
Climate change impacts on groundwater hydrology – where are the main uncertainties and can they be reduced?

This paper assesses how various sources of uncertainty propagate through the uncertainty cascade from emission scenarios through climate models and hydrological models to impacts with particular focus on groundwater aspects for a number of coordinated studies in Denmark. We find results similar to surface water studies showing that climate model uncertainty dominates for projections of climate change impacts on streamflow and groundwater heads. However, we find uncertainties related to geological conceptualisation and hydrological model discretisation to be dominating for projections of well field capture zones, while the climate model uncertainty here is of minor importance. The perspectives of reducing the uncertainties on climate change impact projections related to groundwater are discussed with particular focus on the potentials for reducing climate model biases through use of fully coupled climate-hydrology models.
Impacts of urban development and climate change in exposing cities to pluvial flooding

Urban areas are characterized by very high concentrations of people and economic activities and are thus particularly vulnerable to flooding during extreme precipitation. Urban development and climate change are among the key drivers of changes in the exposure of cities to the occurrence and impacts of pluvial flooding. Cities are often dominated by large areas of impervious surfaces, that is, man-made sealed surfaces which water cannot penetrate, and increases in these – for example, as a consequence of urban development – can cause elevated run-off volumes and flood levels during precipitation. Climate change is expected to affect the intensity and frequency of extreme precipitation, with increases projected for many regions, including most parts of Europe.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, Department of Environmental Engineering, Urban Water Systems, Department of Applied Mathematics and Computer Science, Dynamical Systems
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Number of pages: 48
Publication date: 2016

Local control on precipitation in a fully coupled climate-hydrology model

The ability to simulate regional precipitation realistically by climate models is essential to understand and adapt to climate change. Due to the complexity of associated processes, particularly at unresolved temporal and spatial scales this continues to be a major challenge. As a result, climate simulations of precipitation often exhibit substantial biases that affect the reliability of future projections. Here we demonstrate how a regional climate model (RCM) coupled to a distributed hydrological catchment model that fully integrates water and energy fluxes between the subsurface, land surface, plant cover, and the atmosphere, enables a realistic representation of local precipitation. Substantial improvements in simulated precipitation dynamics on seasonal and longer time scales is seen for a simulation period of six years and can be attributed to a more complete treatment of hydrological sub-surface processes including groundwater and moisture feedback. A high degree of local influence on the atmosphere suggests that coupled climate-hydrology models have a potential for improving climate projections and the results further indicate a diminished need for bias correction in climate-hydrology impact studies.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Danish Meteorological Institute, DHI Denmark, Geological Survey of Denmark and Greenland
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Number of pages: 9
Publication date: 2016
Main Research Area: Technical/natural sciences
Methodologies for managing the Energy-Water-Food nexus at different scales

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, Department of Environmental Engineering, Urban Water Systems, Water Resources Engineering, Department of Applied Mathematics and Computer Science, Dynamical Systems
Pages: 73-82
Publication date: 2016

Host publication information
Title of host publication: DTU International Energy Report 2016: The Energy-Water-Food Nexus - from local to global aspects
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Editors: Sønderberg Petersen, L., Hvidtfeldt Larsen, H.
Chapter: 9
Main Research Area: Technical/natural sciences
Electronic versions:
DTU_INTERNATIONAL_ENERGY_REPORT_2016_2_.pdf
Publication: Commissioned - peer-review › Report chapter – Annual report year: 2016

Socio-economic Impacts—Offshore Activities/Energy
The energy sector has a strong presence in the North Sea and in the surrounding coastal areas. Commercial extraction of offshore oil and gas and related activities (exploration, transportation and distribution; pipelines; oil refining and processing) constitutes the single most important economic sector and renewable electricity generation—mainly from offshore wind—is increasing. Energy and offshore activities in the North Sea are critically vulnerable to climate change
along the full supply chain. The major vulnerabilities for offshore installations like rigs, offshore wind energy and pipelines concern wind storms and extreme wave heights, whereas on land coastal installations and transportation may also be adversely affected by flooding. Future renewable energy potentials in the North Sea are also susceptible to climate change. Whereas the hydropower potential is expected to increase, it is highly uncertain how much the future potential of other renewable energy sources such as wind, solar, terrestrial biomass, or emerging technologies like wave, tidal or marine biomass could be positively or negatively affected. Due to the different national energy supply mixes the vulnerability to climate-related impacts will vary among North Sea countries. To ensure safe and reliable future operations comprehensive and systematic risk assessments are therefore needed which account for, for example, the high integration of power systems in the region.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, Department of Wind Energy, Integration & Planning
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Number of pages: 7
Pages: 409-415
Publication date: 2016

Host publication information
Title of host publication: North Sea Region Climate Change Assessment
Publisher: Springer
ISBN (Print): 978-3-319-39743-6
ISBN (Electronic): 978-3-319-39745-0
Chapter: 14

Series: Regional climate studies
Main Research Area: Technical/natural sciences
Electronic versions:
10.1007_2F978_3_319_39745_0_14.pdf
DOIs:
10.1007/978-3-319-39745-0_14
Source: FindIt
Source-ID: 2372552432
Publication: Research - peer-review › Book chapter – Annual report year: 2017

Water consumption in the energy sector
Energy, water, and food systems are closely interlinked in the Energy-Water-Food Nexus. Water is of paramount importance for the energy sector. Fossil fuels require water for extraction, transport and processing. Thermal power plants require water for cooling, whether they use nuclear, fossil or biofuels. Hydropower is based on water in rivers or reservoirs. Feedstock production for biofuels may depend on water for irrigation. On the other hand, energy is necessary for pumping of ground- and surface water, for water treatment as well as for transport and distribution of water to end-users. The waste water is often returned to the environment after energy requiring waste water management.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, Department of Chemical and Biochemical Engineering, KT Consortium
Authors: Larsen, M. A. D. (Intern), Drews, M. (Intern), Gani, R. (Intern)
Publication date: 2016

Host publication information
Title of host publication: DTU International Energy Report 2016: The Energy-Water-Food Nexus - from local to global aspects
Publisher: Technical University of Denmark (DTU)
Chapter: 5
Main Research Area: Technical/natural sciences
Electronic versions:
DTU_INTERNATIONAL_ENERGY_REPORT_2016_reduced.pdf
Publication: Research - peer-review › Report chapter – Annual report year: 2016
A source term estimation method for a nuclear accident using atmospheric dispersion models

The objective of this study is to develop an operational source term estimation (STE) method applicable for a nuclear accident like the incident that occurred at the Fukushima Dai-ichi nuclear power station in 2011. The new STE method presented here is based on data from atmospheric dispersion models and short-range observational data around the nuclear power plants. The accuracy of this method is validated with data from a wind tunnel study that involved a tracer gas release from a scaled model experiment at Tokai Daini nuclear power station in Japan. We then use the methodology developed and validated through the effort described in this manuscript to estimate the release rate of radioactive material from the Fukushima Dai-ichi nuclear power station.

General information
State: Published
Organisations: Center for Nuclear Technologies, Radiation Physics, Department of Management Engineering, Systems Analysis, DTU Climate Centre, University of Tokyo, Japan Agency for Marine-Earth Science and Technology, Aeris, LLC
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Pages: 39-51
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Environment and Pollution
Volume: 58
Issue number: 1/2
ISSN (Print): 0957-4352
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.236 SNIP 0.243 CiteScore 0.43
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.296 SNIP 0.322 CiteScore 0.57
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.252 SNIP 0.393 CiteScore 0.49
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.184 SNIP 0.28 CiteScore 0.38
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.231 SNIP 0.293 CiteScore 0.42
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.246 SNIP 0.391 CiteScore 0.63
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.22 SNIP 0.446
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.245 SNIP 0.351
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.274 SNIP 0.427
Scopus rating (2007): SJR 0.269 SNIP 0.389
Scopus rating (2006): SJR 0.226 SNIP 0.393
Scopus rating (2005): SJR 0.214 SNIP 0.381
Scopus rating (2004): SJR 0.143 SNIP 0.217
Scopus rating (2003): SJR 0.26 SNIP 0.364
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.224 SNIP 0.404
Scopus rating (2001): SJR 0.263 SNIP 0.552
Improved Regional Climate Model Simulation of Precipitation by a Dynamical Coupling to a Hydrology Model

The complexity of precipitation processes makes it difficult for climate models to reliably simulate precipitation, particularly at sub-grid scales, where the important processes are associated with detailed land-atmosphere feedbacks like the vertical circulations driven by latent heat that affect convective precipitation systems. As a result climate model simulations let alone future projections of precipitation often exhibit substantial biases. Here we show that the dynamical coupling of a regional climate model to a detailed fully distributed hydrological model - including groundwater-, overland- and river flow as well as land surface-atmosphere fluxes of water (evapotranspiration) and energy - significantly reduces precipitation bias compared to the regional climate model alone. For a six year simulation period (2004 – 2010) covering a 2500 km2 catchment substantial improvements in the reproduction of local precipitation dynamics are seen for time scales of app. Seasonal duration and longer. We show that these results can be attributed to a more complete treatment of land surface feedbacks. The local scale effect on the atmosphere suggests that coupled high-resolution climate-hydrology models including a detailed 3D redistribution of sub- and land surface water have a significant potential for improving climate projections even diminishing the need for bias correction in climate-hydrology studies.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, Danish Meteorological Institute , DHI Denmark, Geological Survey of Denmark and Greenland
Authors: Larsen, M. A. D. (Intern), Drews, M. (Intern), Hesselbjerg Christensen, J. (Ekstern), Butts, M. B. (Ekstern), Refsgaard, J. C. (Ekstern)
Number of pages: 2
Publication date: 2015
Event: Abstract from HyMex-Baltic Earth Workshop, Rome, Italy.
Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 118077421
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

Influence of urban land cover changes and climate change for the exposure of cities to flooding during high-intensity precipitation

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, Department of Environmental Engineering, Urban Water Engineering, Technical University of Denmark
Authors: Kaspersen, P. S. (Intern), Høegh Ravn, N. (Ekstern), Arnbjerg-Nielsen, K. (Intern), Madsen, H. (Ekstern), Drews, M. (Intern)
Pages: 18-23
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: EVA : Erfaringsudveksling i vandmiljøteknikken
Volume: 28
Issue number: 1
ISSN (Print): 1901-3663
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Electronic versions:
2015_05_EVA_blad.pdf
Links:
http://evanet.dk/Pdf/Blade/2015_05_EVA_blad.pdf
Source: PublicationPreSubmission
Source-ID: 108802227
Influence of urban land cover changes and climate change for the exposure of European cities to flooding during extreme precipitation

In this paper we present a methodology suitable for investigating the relative and combined influence of urban land cover changes and climate change for the exposure of cities to pluvial flooding. A combined hydrological-hydrodynamic modelling and remote sensing approach enables the quantification of the flood risk relative to changes in imperviousness and climate change. The methodology is evaluated for the Danish city of Odense, but is easily applicable for the majority of cities within Europe, as it relies on open source data for the European continent. Results from Odense show that urban development during the past 30 years caused an increase in flood exposure that is comparable to what is expected in the RCP4.5 (+2°C) climate scenario.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, Department of Environmental Engineering, Urban Water Engineering, LNH Water, DHI Denmark
Authors: Kaspersen, P. S. (Intern), Høegh Ravn, N. (Ekstern), Arnbjerg-Nielsen, K. (Intern), Madsen, H. (Ekstern), Drews, M. (Intern)
Number of pages: 1
Publication date: 2015
Event: Poster session presented at European Climate Change Adaptation Conference 2015, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
Influence_of_urban_land.pdf

Bibliographical note
Poster no. WS.3.6.1
Source: PublicationPreSubmission
Source-ID: 117988344
Publication: Research › Poster – Annual report year: 2015

Influence of urban land cover changes and climate change for the exposure of European cities to flooding during extreme precipitation

The extent and location of impervious surfaces within urban areas due to past and present city development strongly affects the amount and velocity of run-off during high-intensity rainfall and consequently influences the exposure of cities towards flooding. The frequency and intensity of extreme rainfall are expected to increase in many places due to climate change and thus further exacerbate the risk of pluvial flooding. This paper presents a combined hydrological-hydrodynamic modelling and remote sensing approach suitable for examining the susceptibility of European cities to pluvial flooding owing to recent changes in urban land cover, under present and future climatic conditions. Estimated changes in impervious urban surfaces based on Landsat satellite imagery covering the period 1984–2014 are combined with regionally downscaled estimates of current and expected future rainfall extremes to enable 2-D overland flow simulations and flood hazard assessments. The methodology is evaluated for the Danish city of Odense. Results suggest that the past 30 years of urban development alone has increased the city’s exposure to pluvial flooding by 6% for 10-year rainfall up to 26% for 100-year rainfall. Corresponding estimates for RCP4.5 and RCP8.5 climate change scenarios (2071–2100) are in the order of 40 and 100 %, indicating that land cover changes within cities can play a central role for
the cities’ exposure to flooding and conversely also for their adaptation to a changed climate.

Influence of urban land cover changes for the exposure of European cities to flooding during high-intensity rainfall events

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, Department of Environmental Engineering, Urban Water Engineering, LNH Water, DHI Denmark
Authors: Kaspersen, P. S. (Intern), Høegh Ravn, N. (Ekstern), Ambjerg-Nielsen, K. (Intern), Madsen, H. (Ekstern), Drews, M. (Intern)
Number of pages: 1
Publication date: 2015
Event: Abstract from 26th International Union of Geodesy and Geophysics (IUGG) General Assembly 2015, Prague, Czech Republic.
Main Research Area: Technical/natural sciences
Electronic versions:
Influence_of_urban_land_cover_changes.pdf
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

Key drivers and economic consequences of high-end climate scenarios: uncertainties and risks
The consequences of high-end climate scenarios and the risks of extreme events involve a number of critical assumptions and methodological challenges related to key uncertainties in climate scenarios and modelling, impact analysis, and economics. A methodological framework for integrated analysis of extreme events and damage costs is developed and applied to a case study of urban flooding for the medium sized Danish city of Odense. Moving from our current climate to higher atmospheric greenhouse gas (GHG) concentrations including a 2°, 4°, and a high-end 6°C scenario implies that the frequency of extreme events increase beyond scaling, and in combination with economic assumptions we find a very wide range of risk estimates for urban precipitation events. A sensitivity analysis addresses 32 combinations of climate scenarios, damage cost curve approaches, and economic assumptions, including risk aversion and equity represented by discount rates. Major impacts of alternative assumptions are investigated. As a result, this study demonstrates that in terms of decision making the actual expectations concerning future climate scenarios and the economic assumptions applied are very important in determining the risks of extreme climate events and, thereby, of the level of cost-effective adaptation seen from the society’s point of view.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis
Authors: Halsnæs, K. (Intern), Kaspersen, P. S. (Intern), Drews, M. (Intern)
Pages: 85-98
Publication date: 2015
Main Research Area: Technical/natural sciences
Regional modelling of the Earth System: a summary of recent work

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre
Authors: Drews, M. (Intern), Larsen, M. A. D. (Intern)
Number of pages: 1
Publication date: 2015

Host publication information
Scalability of regional climate change in Europe for high-end scenarios

With the help of a simulation using the global circulation model (GCM) EC-Earth, downscaled over Europe with the regional model DMI-HIRHAM5 at a 25 km grid point distance, we investigated regional climate change corresponding to 6°C of global warming to investigate whether regional climate change generally scales with global temperature even for very high levels of global warming. Through a complementary analysis of CMIP5 GCM results, we estimated the time at which this temperature may be reached; this warming could be reached in the first half of the 22nd century provided that future emissions are close to the RCP8.5 emission scenario. We investigated the extent to which pattern scaling holds, i.e. the approximation that the amplitude of any climate change will be approximately proportional to the amount of global warming. We address this question through a comparison of climate change results from downscaling simulations over the same integration domain, but for different driving and regional models and scenarios, mostly from the EU ENSEMBLES project. For almost all quantities investigated, pattern scaling seemed to apply to the 6°C simulation. This indicates that the single 6°C simulation in question is not an outlier with respect to these quantities, and that conclusions based on this simulation would probably correspond to conclusions drawn from ensemble simulations of such a scenario. In the case of very extreme precipitation, the changes in the 6°C simulation are larger than would be expected from a linear behaviour. Conversely, the fact that the many model results follow a linear relationship for a large number of variables and areas confirms that the pattern scaling approximation is sound for the fields investigated, with the identified possible exceptions of high extremes of e.g. daily precipitation and maximum temperature.

General information

State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering, Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, Danish Meteorological Institute
Authors: Christensen, O. B. (Ekstern), Yang, S. (Ekstern), Boberg, F. (Ekstern), Maule, C. F. (Ekstern), Thejll, P. (Ekstern), Olesen, M. (Ekstern), Drews, M. (Intern), Sørup, H. J. D. (Intern), Christensen, J. H. (Ekstern)
Pages: 25–38
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information

Journal: Climate Research
Volume: 64
Issue number: 1
ISSN (Print): 0936-577X
Ratings:
  BFI (2017): BFI-level 1
  Web of Science (2017): Indexed Yes
  BFI (2016): BFI-level 1
  Scopus rating (2016): CiteScore 1.8 SJR 0.831 SNIP 0.68
  Web of Science (2016): Indexed yes
  BFI (2015): BFI-level 1
  Scopus rating (2015): SJR 1.107 SNIP 0.909 CiteScore 2.14
  Web of Science (2015): Indexed yes
  BFI (2014): BFI-level 1
  Scopus rating (2014): SJR 1.585 SNIP 1.35 CiteScore 2.92
  BFI (2013): BFI-level 1
  Scopus rating (2013): SJR 1.709 SNIP 1.339 CiteScore 3.22
  BFI (2012): BFI-level 1
  Scopus rating (2012): SJR 1.466 SNIP 1.087 CiteScore 2.68
  BFI (2011): BFI-level 1
  Scopus rating (2011): SJR 1.088 SNIP 1.168 CiteScore 2.44
  BFI (2010): BFI-level 1
Simple future weather files for estimating heating and cooling demand

Estimations of the future energy consumption of buildings are becoming increasingly important as a basis for energy management, energy renovation, investment planning, and for determining the feasibility of technologies and designs. Future weather scenarios, where the outdoor climate is usually represented by future weather files, are needed for estimating the future energy consumption. In many cases, however, the practitioner’s ability to conveniently provide an estimate of the future energy consumption is hindered by the lack of easily available future weather files. This is, in part, due to the difficulties associated with generating high temporal resolution (hourly) estimates of future changes in air temperature. To address this issue, we investigate if, in the absence of high-resolution data, a weather file constructed from a coarse (annual) estimate of future air temperature change can provide useful estimates of future energy demand of a building. Experimental results based on both the degree-day method and dynamic simulations suggest that this is indeed the case. Specifically, heating demand estimates were found to be within a few per cent of one another, while estimates of cooling demand were slightly more varied. This variation was primarily due to the very few hours of cooling that were required in the region examined. Errors were found to be most likely when the air temperatures were close to the heating or cooling balance points, where the energy demand was modest and even relatively large errors might thus result in only modest absolute errors in energy demand.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, Production and Service Management, Centre for Facilities Management
Authors: Cox, R. A. (Intern), Drews, M. (Intern), Rode, C. (Intern), Nielsen, S. B. (Intern)
Pages: 104-114
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication Information
Journal: Building and Environment
Volume: 83
ISSN (Print): 0360-1323
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Using Landsat Vegetation Indices to Estimate Impervious Surface Fractions for European Cities

Impervious surfaces (IS) are a key indicator of environmental quality, and mapping of urban IS is important for a wide range of applications including hydrological modelling, water management, urban and environmental planning and urban climate studies. This paper addresses the accuracy and applicability of vegetation indices (VI), from Landsat imagery, to
estimate IS fractions for European cities. The accuracy of three different measures of vegetation cover is examined for eight urban areas at different locations in Europe. The Normalized Difference Vegetation Index (NDVI) and Soil Adjusted Vegetation Index (SAVI) are converted to IS fractions using a regression modelling approach. Also, NDVI is used to estimate fractional vegetation cover (FR), and consequently IS fractions. All three indices provide fairly accurate estimates (MAEs ≈ 10%, MBE’s < 2%) of sub-pixel imperviousness, and are found to be applicable for cities with dissimilar climatic and vegetative conditions. The VI/IS relationship across cities is examined by quantifying the MAEs and MBEs between all combinations of models and urban areas. Also, regional regression models are developed by compiling data from multiple cities to examine the potential for developing and applying a single regression model to estimate IS fractions for numerous urban areas without reducing the accuracy considerably. Our findings indicate that the models can be applied broadly for multiple urban areas, and that the accuracy is reduced only marginally by applying the regional models. SAVI is identified as a superior index for the development of regional quantification models. The findings of this study highlight that IS fractions, and spatiotemporal changes therein, can be mapped by use of simple regression models based on VIs from remote sensors, and that the method presented enables simple, accurate and resource efficient quantification of IS.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, University of Copenhagen
Authors: Kaspersen, P. S. (Intern), Fensholt, R. (Ekstern), Drews, M. (Intern)
Pages: 8224-8249
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Remote Sensing
Volume: 7
ISSN (Print): 2072-4292
Ratings:
Web of Science (2017): Indexed Yes
Scopus rating (2016): CiteScore 3.56 SJR 1.31 SNIP 1.661
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 1.339 SNIP 1.691 CiteScore 3.76
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 1.28 SNIP 1.886 CiteScore 3.23
Web of Science (2014): Indexed yes
Scopus rating (2013): SJR 1.167 SNIP 1.981 CiteScore 3.01
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): SJR 0.999 SNIP 1.645 CiteScore 2.36
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.498 SNIP 1.268 CiteScore 1.3
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.315 SNIP 0.531
Original language: English
Impervious surfaces, Remote sensing, Landsat, Europe, NDVI, SAVI, Fractional vegetation cover, Regression modelling, Urban land cover change
Electronic versions:
Using_Landsat_Vegetation.pdf
DOIs:
10.3390/rs70608224
Source: PublicationPreSubmission
Source-ID: 112048227
Publication: Research - peer-review › Journal article – Annual report year: 2015

A framework for testing the ability of models to project climate change and its impacts
Models used for climate change impact projections are typically not tested for simulation beyond current climate conditions. Since we have no data truly reflecting future conditions, a key challenge in this respect is to rigorously test models using proxies of future conditions. This paper presents a validation framework and guiding principles applicable across earth science disciplines for testing the capability of models to project future climate change and its impacts. Model test schemes comprising split-sample tests, differential split-sample tests and proxy site tests are discussed in relation to their application for projections by use of single models, ensemble modelling and space-time-substitution and in relation to use of different data from historical time series, paleo data and controlled experiments. We recommend that differential-
split sample tests should be performed with best available proxy data in order to build further confidence in model projections.

**General information**

**State:** Published

**Organisations:** Department of Environmental Engineering, Urban Water Engineering, Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, Geological Survey of Denmark and Greenland, DHI Denmark, Irstea, Aarhus University, University of Waikato, Swedish Meteorological and Hydrological Institute, Katholieke Universiteit, Danish Meteorological Institute


**Number of pages:** 1

**Pages:** 271-282

**Publication date:** 2014

**Main Research Area:** Technical/natural sciences

**Publication information**

**Journal:** Climatic Change

**Volume:** 122

**Issue number:** 2-2

**ISSN (Print):** 0165-0009

**Ratings:**

- BFI (2017): BFI-level 1
- Web of Science (2017): Indexed Yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): SJR 1.883 SNIP 1.296 CiteScore 3.52
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 2.126 SNIP 1.412 CiteScore 3.67
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 2.429 SNIP 1.708 CiteScore 4.31
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 2.577 SNIP 1.852 CiteScore 4.47
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 1.941 SNIP 1.793 CiteScore 3.55
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 1.529 SNIP 1.576 CiteScore 3
- ISI indexed (2011): ISI indexed yes
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 2.056 SNIP 1.782
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 2.302 SNIP 1.75
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 2.282 SNIP 1.714
- Scopus rating (2007): SJR 1.889 SNIP 1.675
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 1.985 SNIP 1.669
- Scopus rating (2005): SJR 2.134 SNIP 1.46
- Scopus rating (2004): SJR 1.727 SNIP 1.619
A model validation framework for climate change projection and impact assessment

Models used for projection of climate change and its impacts are usually not validated for simulation of future climate conditions. This is a serious deficiency that introduces an unknown level of uncertainty in the projections. A framework and guiding principles are presented for testing models using proxies of future conditions. In general, a model that has been setup for solving a specific problem at a particular site should be tested in order to document its predictive capability and credibility. In a climate change context such tests, often referred to as model validations tests, are particularly challenging since the model is used for an unknown future with a climate that is significantly different from current conditions. Most model studies reported on projections of climate change and its impacts have not included formal model validation tests that address this issue. A model validation framework and guiding principles for testing the capabilities of models for projection of climate change and its impacts have been proposed by Refsgaard et al. (2014). This framework is based on the hierarchical test scheme for model validation developed by Klemes (1986), which distinguishes between model predictions performed under stationary (split-sample tests) or non-stationary conditions (differential split-sample test), and if the model is applied at the site where it was calibrated or at a different site (proxy site tests). This model validation scheme has been assessed in relation to use of different methods for projection of climate change (single and ensemble model projections and space-time substitution) and use of different data sources as proxy for future climate conditions (long historical records comprising non-stationarity, paleo data, and controlled experiments). The basic guiding principles state that: (i) before a model is used for climate change projections and impact assessments it must demonstrate its predictive capabilities using data that reflects the expected future climate, (ii) the validation test must be carried out using data that have not been used for model calibration, and (iii) the validation test must provide evidence on the expected accuracy of the model projections and impact assessments. The most commonly used validation test, the split-sample test, is not sufficient in a climate change context. The differential split-sample test should be applied by using adequate proxy data, reflecting future conditions. This test can be used with both single and ensemble model projections as well as with space-time substitutions. It is generally expected to be more powerful when applied to a model ensemble than to a single model. Since space-time substitutions include identification of locations with current climate similar to the expected future climate at the site in consideration, any test with this projection methodology involves elements of proxy site tests. For testing models under non-stationary conditions in a climate change context it is recommended to apply a differential split-sample test using best available proxy data that reflect the expected future conditions at the site being considered. Such proxy data may be obtained from long historical records comprising non-stationarity, paleo data, or controlled experiments. The test can be applied with different projection methods, including single and ensemble model projections and space-time substitutions.

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering, Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, Irstea, Aarhus University, University of Waikato, Geological Survey of Denmark and Greenland, DHI Denmark, Rossby Centre, University of Leuven, Danish Meteorological Institute
Number of pages: 1
Pages: 46
Publication date: 2014

Host publication information
Title of host publication: Climatic change adaptation adapting to change: from research to decision-making: Abstracts
Place of publication: Copenhagen
Main Research Area: Technical/natural sciences
Conference: 3rd Nordic International Conference on Climate Change Adaptation, Copenhagen, Denmark, 25/08/2014 - 25/08/2014
Electronic versions:
Coupled regional climate and hydrology modelling at the catchment scale

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, DHI Denmark, University of Copenhagen, Geological Survey of Denmark and Greenland, Danish Meteorological Institute
Authors: Larsen, M. A. D. (Intern), Drews, M. (Intern), Refsgaard, J. C. (Ekstern), Høgh Jensen, K. (Ekstern), Butts, M. B. (Ekstern), Christensen, J. H. (Ekstern), Christensen, O. B. (Ekstern)
Number of pages: 2
Pages: 34-35
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 3rd International Lund Regional-Scale Climate Modelling Workshop
Main Research Area: Technical/natural sciences
Conference: 3rd International Lund Regional-Scale Climate Modelling Workshop, Lund, Sweden, 16/06/2014 - 16/06/2014
Electronic versions:
21st_Century_Challenges_in_Regional_Climate_Modelling_abstract_Lund_2014.pdf
Source: PublicationPreSubmission
Source-ID: 93685111
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2014

Embedding complex hydrology in the regional climate system – Dynamic coupling across different modelling domains
To improve our understanding of the impacts of feedback between the atmosphere and the terrestrial water cycle including groundwater and to improve the integration of water resource management modelling for climate adaption we have developed a dynamically coupled climate–hydrological modelling system. The OpenMI modelling interface is used to couple a comprehensive hydrological modelling system, MIKE SHE running on personal computers, and a regional climate modelling system, HIRHAM running on a high performance computing platform. The coupled model enables two-way interaction between the atmosphere and the groundwater via the land surface and can represent the lateral movement of water in both the surface and subsurface and their interactions, not normally accounted for in climate models. Meso-scale processes are important for climate in general and rainfall in particular. Hydrological impacts are assessed at the catchment scale, the most important scale for water management. Feedback between groundwater, the land surface and the atmosphere occurs across a range of scales. Recognising this, the coupling was developed to allow dynamic exchange of water and energy at the catchment scale embedded within a larger meso-scale modelling domain. We present the coupling methodology used and describe the challenges in representing the exchanges between models and across scales. The coupled model is applied to one-way and two-way coupled simulations for a managed groundwater-dominated catchment, the Skjern River, Denmark. These coupled model simulations are evaluated against field observations and then compared with uncoupled climate and hydrological model simulations. Exploratory simulations show significant differences, particularly in the summer for precipitation and evapotranspiration the coupled model including groundwater and the RCM where groundwater is neglected. However, the resulting differences in the net precipitation and the catchment runoff in this groundwater dominated catchment were small. The need for further decadal scale simulations to understand the differences and insensitivity is highlighted. © 2014 Elsevier Ltd. All rights reserved.
Europe in a 6 degrees warmer climate

General information
State: Published
Remote sensing estimates of impervious surfaces for hydrological modelling of changes in flood risk during high-intensity rainfall events

This paper addresses the accuracy and applicability of medium resolution (MR) remote sensing estimates of impervious surfaces (IS) for urban land cover change analysis. Landsat-based vegetation indices (VI) are found to provide fairly accurate measurements of sub-pixel imperviousness for urban areas at different geographical locations within Europe, and to be applicable for cities with diverse morphologies and dissimilar climatic and vegetative conditions. Detailed data on urban land cover changes can be used to examine the diverse environmental impacts of past and present urbanisation, including the importance of such changes for the exposure of cities towards the occurrence and impacts of climate extremes like high-intensity rainfall events.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, University of Copenhagen
Authors: Kaspersen, P. S. (Intern), Fensholt, R. (Ekstern), Drews, M. (Intern)
Number of pages: 1
Remote sensing estimates of impervious surfaces for hydrological modelling of changes in flood risk during high-intensity rainfall events

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, University of Copenhagen
Authors: Kaspersen, P. S. (Intern), Fensholt, R. (Ekstern), Drews, M. (Intern)
Number of pages: 1
Publication date: 2014
Event: Abstract from IARU Sustainability Science Congress, Copehagen, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:

Abstract
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

Remote sensing estimates of impervious surfaces for pluvial flood modelling
This paper investigates the accuracy of medium resolution (MR) satellite imagery in estimating impervious surfaces for European cities at the detail required for pluvial flood modelling. Using remote sensing techniques enables precise and systematic quantification of the influence of the past 30-40 years of urban development towards the impacts of high-intensity rainfall.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis
Authors: Kaspersen, P. S. (Intern), Drews, M. (Intern)
Number of pages: 1
Publication date: 2014
Event: Abstract from 3rd Nordic International Conference on Climate Change Adaptation, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
Remote_sensing_estimates.pdf
Source: PublicationPreSubmission
Source-ID: 117988838
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

Results from a full coupling of the HIRHAM regional climate model and the MIKE SHE hydrological model for a Danish catchment
A major challenge in the emerging research field of coupling of existing regional climate models (RCMs) and hydrology/land-surface models is the computational interaction between the models. Here we present results from a full two-way coupling of the HIRHAM RCM over a 4000 km × 2800 km domain at 11 km resolution and the combined MIKE SHE-SWET hydrology and land-surface models over the 2500 km2 Skjern River catchment. A total of 26 one-year runs were performed to assess the influence of the data transfer interval (DTI) between the two models and the internal HIRHAM model variability of 10 variables. DTI frequencies between 12 and 120 min were assessed, where the computational overhead was found to increase substantially with increasing exchange frequency. In terms of hourly and daily performance statistics the coupled model simulations performed less accurately than the uncoupled simulations, whereas for longer-term cumulative precipitation the opposite was found, especially for more frequent DTI rates. Four of six output variables from HIRHAM, precipitation, relative humidity, wind speed and air temperature, showed statistically significant improvements in root-mean-square error (RMSE) by reducing the DTI. For these four variables, the HIRHAM RMSE variability corresponded to approximately half of the influence from the DTI frequency and the variability resulted in a large spread in simulated precipitation. Conversely, DTI was found to have only a limited impact on the energy fluxes and discharge simulated by MIKE SHE.
Satellite estimates of urban development for hydrological modelling

We investigate the applicability of medium resolution Landsat satellite imagery for mapping temporal changes in urban land cover in European cities for direct use in urban flood models. The overarching aim is to provide accurate and cost- and resource-efficient quantification of temporal changes in risk towards the impacts of pluvial flooding. The results show that satellite imagery may have considerable potential in this respect, and that Landsat imagery can be used to provide accurate information on recent urban development patterns.

The application of a dynamic OpenMI coupling between a regional climate model and a distributed surface water-groundwater model

To support climate adaptation measures for water resources, we have developed and evaluated a dynamic coupling between a comprehensive distributed hydrological modelling system, MIKE SHE, and a regional climate modelling system, HIRHAM. The coupled model enables two-way interaction between the atmosphere and the groundwater via the soil and land surface and can represent the lateral movement of water in both the surface and subsurface and their interactions as well as human interventions. The coupled model is applied to one-way and two-way coupled simulations for a managed groundwater-dominated catchment, the Skjern River, Denmark. The 2500 km2 catchment model is embedded in a meso-scale (4000 km x 2800 km) climate modelling domain. By using the ERA Interim reanalysis as boundary conditions the coupling performance is evaluated against measurements of both climatic and hydrological variables, including local measurements of energy fluxes. The results presented here suggest that there may be important differences in the simulated water balances for this catchment created by introducing an alternative hydrological model into the RCM.
Economic assessment of climate change adaptation options incorporating Bayesian networks: An integrated framework

**General information**
- **State:** Published
- **Organisations:** Department of Management Engineering, Systems Analysis, DTU Climate Centre, Department of Environmental Engineering, Urban Water Engineering
- **Authors:** Gregg, J. S. (Intern), Zhou, Q. (Intern), Åström, H. L. A. (Intern), Kaspersen, P. S. (Intern), Drews, M. (Intern), Halsnæs, K. (Intern), Garrè, L. (Intern), Ambjerg-Nielsen, K. (Intern)
- **Number of pages:** 14
- **Publication date:** 2013

**Publication information**
- **Media of output:** PowerPoint
- **Original language:** English
- **Main Research Area:** Technical/natural sciences
- **Electronic versions:**
  - Economic_assessment_of_climate.pdf
  - Source: dtu
  - Source-ID: u::9699
  - Publication: Research › Sound/Visual production (digital) – Annual report year: 2013

Embedding complex hydrology in the climate system - towards fully coupled climate-hydrology models

Motivated by the need to develop better tools to understand the impact of future management and climate change on water resources, we present a set of studies with the overall aim of developing a fully dynamic coupling between a comprehensive hydrological model, MIKE SHE, and a regional climate model, HIRHAM. The physics of the coupling is formulated using an energy-based SVAT (land surface) model while the numerical coupling exploits the OpenMI modelling interface. First, some investigations of the applicability of the SVAT model are presented, including our ability to characterise distributed parameters using satellite remote sensing. Secondly, field data are used to investigate the effects of model resolution and parameter scales for use in a coupled model. Finally, the development of the fully coupled climate-hydrology model is described and some of the challenges associated with coupling models for hydrological processes on sub-grid scales of the regional climate model are presented.

**General information**
- **State:** Published
- **Organisations:** Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, Department of Environmental Engineering, DHI Denmark, Danish Meteorological Institute, Geological Survey of Denmark and Greenland
- **Authors:** Butts, M. (Ekstern), Rasmussen, S. (Ekstern), Ridler, M. (Ekstern), Larsen, M. A. D. (Intern), Drews, M. (Intern), Lerer, S. M. (Intern), Overgaard, J. (Ekstern), Grooss, J. (Ekstern), Rosbjerg, D. (Intern), Christensen, J. (Ekstern), Refsgaard, J. C. (Ekstern)
- **Pages:** 133-139
- **Publication date:** 2013

**Host publication information**
- **Title of host publication:** Climate and Land Surface Changes in Hydrology. Proceedings of H01, IAHS-IAPSO-IASPEI Assembly
- **Place of publication:** Gothenburg, Sweden
- **Publisher:** IAHS Press
- **Series:** IAHS Publications Series (Red Books)
- **Number:** 359
- **ISSN:** 0144-7815
- **Main Research Area:** Technical/natural sciences
- **Source:** dtu
- **Source-ID:** n:oai:DTIC-ART:bl/391928305::32376
- **Publication:** Research - peer-review › Article in proceedings – Annual report year: 2013
The role of uncertainty in climate change adaptation strategies — A Danish water management example

We propose a generic framework to characterize climate change adaptation uncertainty according to three dimensions: level, source and nature. Our framework is different, and in this respect more comprehensive, than the present UN Intergovernmental Panel on Climate Change (IPCC) approach and could be used to address concerns that the IPCC approach is oversimplified. We have studied the role of uncertainty in climate change adaptation planning using examples from four Danish water related sectors. The dominating sources of uncertainty differ greatly among issues; most uncertainties on impacts are epistemic (reducible) by nature but uncertainties on adaptation measures are complex, with ambiguity often being added to impact uncertainties. Strategies to deal with uncertainty in climate change adaptation should reflect the nature of the uncertainty sources and how they interact with risk level and decision making: (i) epistemic uncertainties can be reduced by gaining more knowledge; (ii) uncertainties related to ambiguity can be reduced by dialogue and knowledge sharing between the different stakeholders; and (iii) aleatory uncertainty is, by its nature, non-reducible. The uncertainty cascade includes many sources and their propagation through technical and socio-economic models may add substantially to prediction uncertainties, but they may also cancel each other. Thus, even large uncertainties may have small consequences for decision making, because multiple sources of information provide sufficient knowledge to justify action in climate change adaptation.

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering, Department of Management Engineering, Systems Analysis, DTU Climate Centre, DHI Denmark, Basque Center for Climate Change, Geological Survey of Denmark and Greenland, Aarhus University, Danish Meteorological Institute, University of Copenhagen
Authors: Refsgaard, J. (Ekstern), Ambjerg-Nielsen, K. (Intern), Drews, M. (Intern), Halsnæs, K. (Intern), Jeppesen, E. (Ekstern), Madsen, H. (Ekstern), Markandya, A. (Ekstern), Olesen, J. (Ekstern), Porter, J. R. (Ekstern), Christensen, J. (Ekstern)
Pages: 337-359
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Mitigation and Adaptation Strategies for Global Change
Volume: 18
Issue number: 3
ISSN (Print): 1381-2386
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.891 SNIP 1.011 CiteScore 2.28
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.846 SNIP 1.078 CiteScore 2.2
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.023 SNIP 1.142 CiteScore 2.67
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.943 SNIP 1.244 CiteScore 2.27
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.763 SNIP 0.992 CiteScore 1.78
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.772 SNIP 0.861 CiteScore 1.63
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.73 SNIP 0.856
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.92 SNIP 0.906
BFI (2008): BFI-level 1
Using satellite imagery to assess the influence of recent urban development on the impacts of extreme rainfall

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Department of Environmental Engineering, Urban Water Engineering, DHI Denmark
Authors: Kaspersen, P. S. (Intern), Drews, M. (Intern), Arnbjerg-Nielsen, K. (Intern), Madsen, H. (Ekstern)
Number of pages: 2
Publication date: 2013
Event: Abstract from International Conference on Flood Resilience: Experiences in Asia and Europe, Exeter, United Kingdom.
Main Research Area: Technical/natural sciences
Remote sensing, Urban Development, Pluvial Flooding, Spatial Impact Assessment, Hydrological Modelling
Electronic versions:
USING_SATELLITE_IMAGERY_.pdf
Source: dtu
Source-ID: u::9644
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2013

We investigate the applicability of medium resolution Landsat satellite imagery for mapping temporal changes in urban land cover for direct use in urban flood models. The overarching aim is to provide accurate and cost- and resource-efficient quantification of temporal changes in risk towards the impacts of pluvial flooding. Initial results show that satellite imagery may have considerable potential in this respect.
Analyses of possible changes in intense and extreme wind speeds over northern Europe under climate change scenarios

Dynamical downscaling of ECHAM5 using HIRHAM5 and RCA3 for a northern European domain focused on Scandinavia indicates sustained extreme wind speeds with long recurrence intervals (50 years) and intense winds are not likely to evolve out of the historical envelope of variability until the end of C21st. Even then, significant changes are indicated only in the SW of the domain and across the central Baltic Sea where there is some evidence for relatively small magnitude increases in the 50 year return period wind speed (of up to 15%). There are marked differences in results based on the two Regional Climate Models. Additionally, internal (inherent) variability and initial conditions exert a strong impact on projected wind climates throughout the twenty-first century. Simulations of wind gusts by one of the RCMs (RCA3) indicate some evidence for increased magnitudes (of up to +10%) in the southwest of the domain and across the central Baltic Sea by the end of the current century. As in prior downscaling of ECHAM4, dynamical downscaling of ECHAM5 indicates a tendency towards increased energy density and thus wind power generation potential over the course of the C21st. However, caution should be used in interpreting this inference given the high degree of wind climate projection spread that derives from the specific AOGCM and RCM used in the downscaling.

General information
State: Published
Organisations: Meteorology, Wind Energy Division, Risø National Laboratory for Sustainable Energy, Wind Energy Systems, Systems Analysis Division, Danish Meteorological Institute, Rossby Centre
Authors: Pryor, S. (Intern), Barthelmie, R. J. (Intern), Clausen, N. (Intern), Drews, M. (Intern), MacKellar, N. (Ekstern), Kjellström, E. (Ekstern)
Pages: 189-208
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Climate Dynamics
Volume: 38
Issue number: 1-2
ISSN (Print): 0930-7575
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 3.019 SNIP 1.339 CiteScore 4.03
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 3.48 SNIP 1.302 CiteScore 3.86
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.501 SNIP 1.421 CiteScore 4.07
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 3.585 SNIP 1.59 CiteScore 4.35
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.265 SNIP 1.558 CiteScore 3.76
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.009 SNIP 1.537 CiteScore 3.74
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 3.248 SNIP 1.514
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.9 SNIP 1.616
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.962 SNIP 1.635
Scopus rating (2007): SJR 3.646 SNIP 1.471
Climate scenarios

General information
State: Published
Organisations: Danish Meteorological Institute, Swedish Meteorological and Hydrological Institute, University of Helsinki, Norwegian Meteorological Institute, University of Iceland, Icelandic Meteorological Office, Finnish Meteorological Institute, Voeikov Main Geophysical Observatory
Pages: 35-65
Publication date: 2012

Host publication information
Title of host publication: Climate Change and Energy Systems: Impacts, Risks and Adaptation in the Nordic and Baltic countries
Publisher: Nordic Council of Ministers
Editors: Thorsteinsson, T., Björnsson, H.
ISBN (Print): 978-92-893-2190-7
Series: TemaNord
Number: 502
ISSN: 0908-6692
Main Research Area: Technical/natural sciences
Electronic versions:
Climate_Change_and_Energy_Systems.pdf
Publication: Research - peer-review › Book chapter – Annual report year: 2013

Methodological framework, analytical tool and database for the assessment of climate change impacts, adaptation and vulnerability in Denmark
This report was prepared at the request of and funded by the Coordination Unit for Research in Climate Change Adaptation (KFT). The report is a milestone of the project titled "Udvikling af metodisk ramme for dansk analytisk værktøj og database over klimasårbarhed og klimatilpasning", funded by KFT. The project is one of seven initiatives proposed by KFT for 2012. The methodology report includes definitions of major concepts, an outline of an analytical structure, a presentation of models and their applicability, and the results of case studies. The work presented in this report draws on intensive research collaboration with several Danish universities and Centres of Excellence, including DMI, GEUS, DHI, Aarhus University, Copenhagen University, and DTU. Work carried out by our research partners has been co-funded by a number of different sponsors, including KFT and the Danish Strategic Research Council. The flood hazard maps presented in this report constitute the first preliminary results of on-going methodological and analysis development in mapping potential impacts in relation to flooding from extreme precipitation in the city of Aarhus. For all purposes the Aarhus flood maps presented in this report should be considered work-in-progress. The analysis was conducted by DHI as part of the DSF project Centre for Regional Change of the Earth System (CRES).
Spatial-Scale Characteristics of Precipitation Simulated by Regional Climate Models and the Implications for Hydrological Modeling

Precipitation simulated by regional climate models (RCMs) is generally biased with respect to observations, especially at the local scale of a few tens of kilometers. This study investigates how well two different RCMs are able to reproduce the spatial correlation patterns of observed summer precipitation for the central United States. On local scales, gridded precipitation observations and simulated precipitation are compared for the period of the 1987 First International Satellite Land Surface Climatological Project Field Experiment (FIFE) campaign. The results show that spatial correlation length scales on the order of 130 km are found in both observed data and RCM simulations. When simulations and observations are aggregated to different grid sizes, the pattern correlation significantly decreases when the aggregation length is less than roughly 100 km. Furthermore, the intermodel standard deviation between simulations with different domains or resolutions increases for aggregation lengths below ~130 km. Below this length scale there is a high level of randomness in the precise location of precipitation events. Conversely, spatial correlation values increase above this length scale, reflecting larger predictive certainty of the RCMs at larger scales. The findings on aggregated grid scales are shown to be largely independent of the underlying RCMs grid resolutions but not of the overall size of RCM domain. With regard to hydrological modeling applications, these findings indicate that precipitation extracted from the present RCM simulations at a catchment scale below the intermodel standard deviation length cannot be expected to accurately match observations.
Wind power

General information
State: Published
Organisations: Wind Energy Systems, Department of Wind Energy, Meteorology, Department of Management Engineering, Systems Analysis, DTU Climate Centre
Authors: Clausen, N. (Intern), Larsén, X. G. (Intern), Pryor, S. (Intern), Drews, M. (Intern)
Pages: 147-160
Publication date: 2012

Host publication information
Title of host publication: Climate Change and Energy Systems: Impacts, Risks and Adaptation in the Nordic and Baltic countries
Publisher: Nordic Council of Ministers
Editors: Thorsteinsson, T., Björnsson, H.
ISBN (Print): 978-92-893-2190-7

Series: TemaNord
Number: 502
ISSN: 0908-6692
Main Research Area: Technical/natural sciences
Electronic versions:
Fremtidige nedbørsændringer i Danmark: En oversigt over den aktuelle viden i sommeren 2011

The adaptation to a changing future climate, e.g. with more extreme precipitation events, presents a major challenge for society. Without proper handling of larger water flows, it is probable that an increase in the strength and frequency of extreme precipitation events in Denmark will lead to more frequent floodings within both urban and rural areas, causing serious societal and economic damage.

Expected change in precipitation patterns will furthermore lead to more frequent and longer dry periods in summer and increased amounts of precipitation in winter. Global observations of precipitation for the last 100 years show general geographical patterns in the change of total precipitation. Local and regional temporal variations are generally so large, however, that it is not possible to attribute such changes to anthropogenic climate change. This report provides a brief review of current knowledge with respect to observed and expected future precipitation change in Denmark, based on Danish as well as international studies since 2007. Both observations and model calculations are considered.

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy, Systems Analysis Division
Authors: Drews, M. (Intern), Boberg, F. (Ekstern), Cappelen, J. (Ekstern), Bøssing Christensen, O. (Ekstern), Hesselbjerg Christensen, J. (Ekstern), Lundholm, S. C. (Ekstern), Olesen, M. (Ekstern)
Number of pages: 17
Publication date: 2011

Publication information
Publisher: Danmarks Meteorologiske Institut
ISBN (Electronic): 978-87-7478-599-6
Original language: Danish
Number: 11-03
ISSN: 1398-490X
Main Research Area: Technical/natural sciences
Electronic versions:
Fremtidige_nedbør_sændringer.pdf
Links:
http://www.dmi.dk/dmi/dkc11-03

Bibliographical note
Denne rapport er udarbejdet på foranledning af og finansieret af Koordinationsenheden for forskning i klimatilpasning (KFT)
Source: dtu
Source-ID: u::6806
Publication: Research › Report – Annual report year: 2011

Erfaringer og perspektiver – DialoK-møder med forskningsmiljøerne 2009

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy, Systems Analysis Division
Authors: Villholth, K. G. (Ekstern), Andersen, B. (Ekstern), Drews, M. (Intern), Kaee, B. C. (Ekstern), Nellemann, V. (Ekstern), van der Blij, L. (Ekstern), Binnerup, S. (Ekstern), Strand, I. F. (Ekstern), Moseholm, L. (Ekstern)
Number of pages: 26
Publication date: 2010

Publication information
Publisher: Koordineringsenhed for forskning i klimatilpasning KFT
ISBN (Print): 978-87-993234-1-8
Original language: Danish
Main Research Area: Technical/natural sciences
Electronic versions:
DialoK.pdf
Links:
High-throughput screening of Erwinia chrysanthemi pectin methylesterase variants using carbohydrate microarrays

Pectin methylesterases (PMEs) catalyse the removal of methyl esters from the homogalacturonan (HG) backbone domain of pectin, a ubiquitous polysaccharide in plant cell walls. The degree of methyl esterification (DE) impacts upon the functional properties of HG within cell walls and plants produce numerous PMEs that act upon HG in muro. Many microbial plant pathogens also produce PMEs, the activity of which renders HG more susceptible to cleavage by pectin lyase and polygalacturonase enzymes and hence aids cell wall degradation. We have developed a novel microarray-based approach to investigate the activity of a series of variant enzymes based on the PME from the important pathogen Erwinia chrysanthemi. A library of 99 E. chrysanthemi PME mutants was created in which seven amino acids were altered by various different substitutions. Each mutant PME was incubated with a highly methyl esterified lime pectin substrate and, after digestion the enzyme/substrate mixtures were printed as microarrays. The loss of activity that resulted from certain mutations was detected by probing arrays with a mAb (JIM7) that preferentially binds to HG with a relatively high DE. Active PMEs therefore resulted in diminished JIM7 binding to the lime pectin substrate, whereas inactive PMEs did not. Our findings demonstrate the feasibility of our approach for rapidly testing the effects on PME activity of substituting a wide variety of amino acids at different positions.

General information
State: Published
Organisations: Department of Systems Biology, Department of Informatics and Mathematical Modeling, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Authors: Øbro, J. (Ekstern), Sørensen, I. (Ekstern), Derkx, P. (Ekstern), Madsen, C. T. (Ekstern), Drews, M. (Intern), Willer, M. (Ekstern), Mikkelsen, J. D. (Intern), Willats, W. G. (Ekstern)
Pages: 1861-1868
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Proteomics
Volume: 9
Issue number: 7
ISSN (Print): 1615-9853
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.85 SJR 1.492 SNIP 0.89
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.464 SNIP 0.978 CiteScore 3.7
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.436 SNIP 0.981 CiteScore 3.73
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.48 SNIP 0.985 CiteScore 3.88
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.489 SNIP 1.099 CiteScore 4.1
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.677 SNIP 1.182 CiteScore 4.49
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.494 SNIP 1.127
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.496 SNIP 1.122
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.573 SNIP 1.126
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.84 SNIP 1.201
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.968 SNIP 1.287
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.921 SNIP 1.392
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.803 SNIP 1.341
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.952 SNIP 1.193
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.214 SNIP 1.004
Web of Science (2002): Indexed yes
Original language: English
Erwinia chrysanthemi, Pectin methylesterase, Carbohydrate microarray
DOIs:
10.1002/pmic.200800349
Source: orbit
Source-ID: 243154
Publication: Research - peer-review › Journal article – Annual report year: 2009

Klimatilpasning – 5 centrale forskningstemaer

General information
State: Published
Organisations: Energy Systems Analysis, Risø National Laboratory for Sustainable Energy
Authors: Andersen, B. (Ekstern), Binnerup, S. (Ekstern), van der Bijl, L. (Ekstern), Villholth, K. G. (Ekstern), Drews, M. (Intern), Strand, I. F. (Ekstern), Henrichs, T. (Ekstern), Larsen, N. (Ekstern), Timmermann, T. (Ekstern), Moseholm, L. (Ekstern)
Number of pages: 34
Publication date: 2009

Publication information
Publisher: Koordineringsenhed for forskning i klimatilpasning KFT
ISBN (Print): 978-87-993234-0-1
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
Klimatilpasning.pdf
Links:
Source: dtu
Source-ID: u:6808
Publication: Research › Report – Annual report year: 2009

Regional climate change for Greenland and surrounding seas.: Part I: Atmosphere and land surface

General information
State: Published
Organisations: Danish Meteorological Institute
Authors: Stendel, M. (Ekstern), Hesselbjerg Christensen, J. (Ekstern), Aðalgeirsdóttir, G. (Ekstern), Kliem, N. (Ekstern), Drews, M. (Intern)
Number of pages: 26
Publication date: 2007
Source term assessment from off-site gamma radiation measurements

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy, Radiation Research Division, Radiation Physics
Authors: Lauritzen, B. (Intern), Drews, M. (Intern)
Pages: 659-661
Publication date: 2007

Host publication information
Title of host publication: Air pollution modeling and its application 17
Place of publication: New York
Publisher: Springer
Editors: Borrego, C., Norman, A.
ISBN (Print): 0-387-28255-6
Series: NATO Challenges of Modern Society series
Main Research Area: Technical/natural sciences
Conference: 28th NATO/CCMS international Technical Meeting on Air pollution Modelling and its Application, Leipzig, Germany, 15/05/2006 - 15/05/2006
Source: orbit
Source-ID: 216044
Publication: Research - peer-review › Article in proceedings – Annual report year: 2007

The HIRHAM Regional Climate Model. Version 5 (beta)
This report describes version 5(β) of the HIRHAM regional climate model. The report is in two parts. The first part discusses the structure and main features of the upgraded version of the model system, while the second part offers a short tutorial on how to install and run the code, e.g. on NEC SX6.

General information
State: Published
Organisations: Danish Meteorological Institute, Technical University of Denmark, Alfred Wegener Institute for Polar and Marine Research
Authors: Bøssing Christensen, O. (Ekstern), Drews, M. (Intern), Hesselbjerg Christensen, J. (Ekstern), Dethloff, K. (Ekstern), Ketelsen, K. (Ekstern), Hebestadt, I. (Ekstern), Rinke, A. (Ekstern)
Number of pages: 22
Publication date: 2007

Publication information
Publisher: Danish Climate Centre, Danish Meteorological Institute
Original language: English
Number: 06-17
ISSN: 0906-897X
Main Research Area: Technical/natural sciences
Electronic versions:
Analysis of a Kalman filter based method for on-line estimation of atmospheric dispersion parameters using radiation monitoring data

A Kalman filter method is discussed for on-line estimation of radioactive release and atmospheric dispersion from a time series of off-site radiation monitoring data. The method is based on a state space approach, where a stochastic system equation describes the dynamics of the plume model parameters, and the observables are linked to the state variables through a static measurement equation. The method is analysed for three simple state space models using experimental data obtained at a nuclear research reactor. Compared to direct measurements of the atmospheric dispersion, the Kalman filter estimates are found to agree well with the measured parameters, provided that the radiation measurements are spread out in the cross-wind direction. For less optimal detector placement it proves difficult to distinguish variations in the source term and plume height; yet the Kalman filter yields consistent parameter estimates with large associated uncertainties. Improved source term assessment results, when independent estimates of the plume height can be used. Perspectives for using the method in the context of nuclear emergency management are discussed, and possible extensions to the present modelling scheme are outlined, to account for realistic accident scenarios.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Drews, M. (Intern), Lauritzen, B. (Ekstern), Madsen, H. (Intern)
Pages: 75-89
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Radiation Protection Dosimetry
Volume: 113
Issue number: 1
ISSN (Print): 0144-8420
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.86 SJR 0.444 SNIP 0.727
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.466 SNIP 0.832 CiteScore 0.82
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.517 SNIP 0.913 CiteScore 0.89
Extended Kalman filter analysis of short-range atmospheric dispersion of radionuclides

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy
Authors: Lauritzen, B. (Intern), Drews, M. (Intern)
Pages: 149-151
Publication date: 2005

Host publication information
Title of host publication: Proceedings
Place of publication: Ioannina
Publisher: University of Ioannina, Department of Physics
Editors: Skouloudis, A., Kassomenos, P., Bartzis, J.
New small angle X-ray scattering facility at Risø National Laboratory

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy
Authors: Andreasen, J. (Intern), Breiby, D. (Intern), Drews, M. (Intern), Nielsen, M. (Intern)
Publication date: 2005
Event: Abstract from Workshop on small-angle scattering (SAS) on biomacromolecules in solution, København (DK), 1-2 Dec, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 308569
Publication: Research › Article in proceedings – Annual report year: 2005

Source term estimation from off-site radiation monitoring data

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy
Authors: Lauritzen, B. (Intern), Drews, M. (Intern)
Pages: 75-78
Publication date: 2005
Host publication information
Title of host publication: Proceedings
Place of publication: Stockholm
Publisher:Statens strålskyddsinstitut
Series: SSI Rapport 2005:15
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 308409
Publication: Research › Conference abstract for conference – Annual report year: 2005

Structural order of self-assembled liquid crystalline solution processable semiconductors (poster)

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy
Publication date: 2005
Event: Poster session presented at 35. Danske kristallografmøde; DANSYNC's 7. Årsmøde, Sandbjerg, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 308520
Publication: Research › Poster – Annual report year: 2005

WAXS simulations

General information
An introduction to data assimilation modelling using an extended Kalman filter on an atmospheric release of radioactive material

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy
Authors: Drews, M. (Intern)
Pages: 285-296
Publication date: 2004

Host publication information
Title of host publication: 25. Symposium i anvendt statistik
Place of publication: København
Publisher: Den Kgl. Veterinær- og Landbohøjskole
Editor: Kærgaard, N.
Main Research Area: Technical/natural sciences
Conference: Symposium, København (DK), 27-29 Jan, 01/01/2003
Source: orbit
Source-ID: 307237
Publication: Research › Article in proceedings – Annual report year: 2004

Experimental evaluation of gamma fluence-rate predictions from Argon-41 releases to the atmosphere over a nuclear research reactor site
An experimental study of radionuclide dispersion in the atmosphere has been conducted at the BR1 research reactor in Mol, Belgium. Artificially generated aerosols ('white smoke') were mixed with the routine releases of Ar-41 in the reactor's 60-m tall venting stack. The detailed plume geometry was measured with remote sensing (Lidar) of the aerosol plumes while surface radiation levels were measured under the plume using gamma detectors at downwind distances of up to 1500 in from the release point. A database was built with simultaneous measurements of plume geometry and radiation field from Ar-41 decay, together with in-situ measurements of meteorological parameters. The joint tracer/radiation experimental dataset has been subsequently used to evaluate the accuracy of predictions of dispersion parameters and gamma fluence rates obtained by the atmospheric dispersion and dose rate model RIMPUFF.

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy
Pages: 161-168
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Radiation Protection Dosimetry
Volume: 108
Issue number: 2
ISSN (Print): 0144-8420
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.86 SJR 0.444 SNIP 0.727
BFI (2015): BFI-level 1
Kalman filtration of radiation monitoring data from atmospheric dispersion of radioactive materials

A Kalman filter method using off-site radiation monitoring data is proposed as a tool for on-line estimation of the source term for short-range atmospheric dispersion of radioactive materials. The method is based on the Gaussian plume model, in which the plume parameters including the source term exhibit a ‘random walk’ process. The embedded parameters of the Kalman filter are determined through maximum-likelihood estimation making the filter essentially free of external parameters. The method is tested using both real and simulated radiation monitoring data. For simulated data, the method is shown to retrieve the embedded parameters employed in generating the data and to reconstruct the plume model parameters, including the source term. When tested against experimental radiation monitoring data the method is found accurately to uncover the known source term.

General information
State: Published
State space model analysis of a radionuclide atmospheric dispersion experiment

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy
Authors: Lauritzen, B. (Intern), Drews, M. (Intern), Madsen, H. (Ekstern)
Number of pages: 8
Publication date: 2004

Host publication information
Title of host publication: Workshop program and abstracts
Main Research Area: Technical/natural sciences
Conference: Data assimilation and recursive estimation (DARE 2004), Venice (IT), 20-21 Sep, 01/01/2004
Source: orbit
Source-ID: 307148
Publication: Research › Conference abstract in proceedings – Annual report year: 2004

Atmospheric dispersion of argon-41 from anuclear research reactor: measurement and modeling of plume geometry and gamma radiation field

An atmospheric dispersion experiment was conducted using a visible tracer along with the routine release of argon-41 from the BR1 research reactor in Mol, Belgium. Simultaneous measurements of plume geometry and radiation fields for argon-41 decay were performed as well as measurements of the argon-41 source term and the meteorological parameters. Good overall agreement is found between measurement data and model results using the mesoscale atmospheric dispersion and dose rate model RIMPUFF.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Department of Electrical Engineering, Technical University of Denmark
Pages: 47-54
Publication date: 2003
Main Research Area: Technical/natural sciences

Publication Information
Journal: International Journal of Environment and Pollution
Volume: 20
Issue number: 6
ISSN (Print): 0957-4352
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.236 SNIP 0.243 CiteScore 0.43
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.296 SNIP 0.322 CiteScore 0.57
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.252 SNIP 0.393 CiteScore 0.49
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.184 SNIP 0.28 CiteScore 0.38
ISI indexed (2013): ISI indexed yes
Atmospheric dispersion of argon-41 from a nuclear research reactor: Measurement and modelling of plume geometry and gamma radiation field

**General information**

**State:** Published  
**Organisations:** Risø National Laboratory for Sustainable Energy  
**Authors:** Lauritzen, B. (Intern), Astrup, P. (Intern), Drews, M. (Intern), Jørgensen, H. (Ekstern), Mikkelsen, T. (Intern), Thykier-Nielsen, S. (Ekstern), Aage, H. (Ekstern), Korsbech, U. (Ekstern), Bargholz, K. (Ekstern), Rojas-Palma, C. (Ekstern), Ammel, R. V. (Ekstern)

**Pages:** 47-54  
**Publication date:** 2003  
**Main Research Area:** Technical/natural sciences

**Publication information**

**Journal:** International Journal of Environment and Pollution  
**Volume:** 20  
**ISSN (Print):** 0957-4352  
**Ratings:**

- **BFI (2017):** BFI-level 1  
- **Web of Science (2017):** Indexed Yes  
- **BFI (2016):** BFI-level 1  
- **Scopus rating (2016):** SJR 0.236 SNIP 0.243 CiteScore 0.43  
- **BFI (2015):** BFI-level 1  
- **Scopus rating (2015):** SJR 0.296 SNIP 0.322 CiteScore 0.57  
- **Web of Science (2015):** Indexed Yes  
- **BFI (2014):** BFI-level 1
Gaussian plume model analysis of atmospheric dispersion measurements of radioactive releases from the BR1 research reactor in Mol, Belgium

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy
Authors: Drews, M. (Intern), Lauritzen, B. (Intern)
Pages: 418-423
Publication date: 2003

Host publication information
Title of host publication: Proceedings
Place of publication: Helsinki
Publisher: STUK
Editor: Paile, W.
ISBN (Print): 951-681-6

Series: STUK-A-195
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 305658
Publication: Research › Article in proceedings – Annual report year: 2003
Measurements of plume geometry and argon-41 radiation field at the BR1 reactor in Mol, Belgium

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy
Number of pages: 42
Publication date: 2002

Publication information
ISBN (Print): 87-7893-109-6
Original language: English
Series: NKS-55
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 304179
Publication: Research › Report – Annual report year: 2002

Projects:

Coastal Hazard Risk Reduction and Management
Department of Management Engineering
Systems Analysis
National Space Institute
Geodesy
Agency for Data Supply and Efficiency (SDFE)
Danish Coastal Authority
Danish Meteorological Institute
DHI
Skive Kommune
Ringkøbing-Skjern Kommune
Aabenraa Kommune
Helmholtz-Zentrum Geesthacht
Smith Innovation
Period: 01/11/2017 → 30/10/2020
Number of participants: 4
Acronym: COHERENT
Project participant:
Larsen, Morten Andreas Dahl (Intern)
Drews, Martin (Intern)
Sørensen, Carlo Sass (Intern)
Project Manager, academic:
Halsnæs, Kirsten (Intern)

Financing sources
Source: Public research council
Name of research programme: Innovation Fund Denmark
Web address: https://innovationsfonden.dk/en
Amount: 10,000,000.00 Danish Kroner
Year of approval: 2017
Project
OASIS+ / Open access catastrophe modelling driving adaptation to enable resilience in an uncertain future

Department of Management Engineering
Systems Analysis
DTU Climate Centre
Period: 01/01/2016 → …
Number of participants: 3
Project participant:
Larsen, Morten Andreas Dahl (Intern)
Halsnæs, Kirsten (Intern)
Drews, Martin (Intern)

Role of technologies in an Energy Efficient Economy – Model-based analysis of policy measures and transformation pathways to a sustainable energy system

Department of Management Engineering
Systems Analysis
DTU Climate Centre
Period: 01/01/2016 → 01/07/2019
Number of participants: 4
Acronym: REEEM
Project participant:
Larsen, Morten Andreas Dahl (Intern)
Karlsson, Kenneth Bernard (Intern)
Drews, Martin (Intern)
Balyk, Olexandr (Intern)

Coastal flooding hazards due to storm surges and subsidence

National Space Institute
Period: 01/03/2014 → 30/09/2017
Number of participants: 7
Phd Student:
Sørensen, Carlo Sass (Intern)
Supervisor:
Jensen, Jürgen (Ekstern)
Drews, Martin (Intern)
Main Supervisor:
Knudsen, Per (Intern)
Examiner:
Drews, Martin (Intern)
Hansen, Anja Skjoldborg (Ekstern)
Sannino, Gianmaria (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Industrial PhD

Relations
Activities:
Contribution to Trap Danmark
Kick off Coast to Coast Climate Challenge
Deformation monitoring in Denmark – Danish initiatives
Press / Media items:
Kortlægning af jordbevægelser skal målrette klimatilpasningen
Når vandet kommer
City Development, Urban Systems and the Impacts of Climate Extremes

Department of Management Engineering
Period: 15/12/2012 → 19/01/2017
Number of participants: 7
Phd Student: Kaspersen, Per Skougaard (Intern)
Supervisor: Ambjerg-Nielsen, Karsten (Intern)
Madsen, Henrik (Intern)
Main Supervisor: Drews, Martin (Intern)
Examiner: Münster, Marie (Intern)
Kreibich, Heidi (Ekstern)
Sandholt, Inge (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut/centerfinansieret
Project: PhD

Improved representation of renewable energy sources in integrated assessment modelling of energy and climate change policies

Department of Management Engineering
Period: 01/02/2010 → 03/12/2014
Number of participants: 6
Phd Student: Balyk, Olexandr (Intern)
Supervisor: Schröder, Sascha Thorsten (Intern)
Main Supervisor: Karlsson, Kenneth Bernard (Intern)
Examiner: Drews, Martin (Intern)
Espegren, Kari Aamodt (Ekstern)
Ravn, Hans V. (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut/centerfinansieret
Project: PhD

HYdrological Modelling for Assessing Climate Change Impacts at differeNT Scales

HYdrological Modelling for Assessing Climate Change Impacts at differeNT Scales (HYACINTS) has developed new methodologies and tools for assessing climate change impacts on water resources at different spatial scales. The main project components were:

Coupling of DMI's regional climate model HIRHAM and DHI's hydrological modelling system MIKE SHE and conversion of GEUS' national water resources model to run in the coupled system aiming at reducing simulation uncertainty.
Development of methodologies for using a spatially refined model grid in parts of a model domain where more detailed descriptions of hydrogeological conditions are required. An SME project on digital geological modelling was associated to this component.
Development of methodologies for estimating precipitation and evapotranspiration from satellite data, particularly aimed at application in data poor regions in the world
Assessment of uncertainty propagation in the calculation chain (emission scenarios→global climate models→regional climate models→downscaling/bias correction methods→hydrological models→hydrological change) and identification dominating sources of uncertainty in projections of climate change impacts on water resources.
Department of Management Engineering

Systems Analysis

DTU Climate Centre
Period: 01/01/2008 → 31/12/2013
Number of participants: 2
Acronym: HYACINTS
Project participant:
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Drews, Martin (Intern)

Data assimilation in atmosphere dispersion of radioactive material

Department of Informatics and Mathematical Modeling
Period: 01/10/2000 → 18/03/2005
Number of participants: 6
Phd Student:
Drews, Martin (Intern)
Supervisor:
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Main Supervisor:
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Examiner:
Poulsen, Niels Kjølstad (Intern)
Finck, Robert R. (Ekstern)
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Financing sources
Source: Internal funding (public)
Name of research programme: Risø (Løn)
Project: PhD