

effzett

FORSCHUNGSZENTRUM JÜLICH'S MAGAZINE

Offprint
from effzett
issue 3/15

Jülich researcher
Martin Riese investigates
climate processes in the
stratosphere.

A climate of change?

The facts are on the table – now it's the politicians' turn

GLIMMERS OF HOPE

What keeps climate
researchers going

ACT!

What is done
with the insights

THE IPCC REPORT

What's in it
and who writes it

Glimmers of hope



Every few years, everything we know about climate change is laid bare. But what use have the five reports published by the IPCC been so far? Not much, it seems. This November will see the 21st United Nations Climate Change Conference take place in Paris. It could end just like most of its 20 predecessors: without any profound measures for climate protection. So does compiling these reports even make sense? Absolutely, say Jülich climate researchers.



The findings are beyond dispute: glaciers are melting, permafrost soil thawing, sea levels rising. To sum up the results of the Intergovernmental Panel on Climate Change (IPCC): our climate is changing. “It is virtually certain that globally the troposphere has warmed since the mid-20th century,” states the latest IPCC report from 2013/2014. But for the first time, the researchers went one step further: in their view, the facts allow no other conclusion than that the exceptionally fast warming since the beginning of the 20th century is not simply a climate “slip”, but that it’s “extremely likely” that human influence is the dominant cause.

“The report summarizes the findings of global climate research. The latest edition is the most comprehensive collection to date,” says climate researcher Prof. Andreas Wahner. “Compared to the fourth report from 2007, the results are based on more than twice as many climate models and a much larger number of simulations.” Wahner is an expert for the lower area of the atmosphere, which is directly above the Earth’s surface, and is known as the troposphere. He has been working at Forschungszentrum Jülich since 1988 – the same year that the IPCC was founded. Two years later, the first IPCC report was published. “During the 1980s, changes in the climate became more apparent, but politicians needed an objective source of information on the causes and potential consequences,” Wahner recalls.

“In the reports, the knowledge of the day is compiled. They represent the basis for political action,” adds Wahner’s colleague Prof. Martin Riese, climate researcher for the next highest level of the atmosphere, the stratosphere. “They reveal options for action and their possible consequences – but it’s policy makers who have to decide,” Riese stresses. The fact that the international community can act quickly as a result of research findings is demonstrated by one prominent example:

the ozone hole. Especially in the atmosphere above the Antarctic, researchers had observed a pronounced thinning of the ozone layer since the mid-1980s. Chlorofluorocarbons (CFCs) were responsible for this. Since 1987, the Montreal Protocol and its follow-up protocols have almost eliminated the use of CFCs. New data and simulations – including some from Martin Riese's institute – verify a declining trend in the destruction of ozone in certain layers of the atmosphere, although the ozone hole is so far unchanged.



FEWER CFCs – SMALLER GREENHOUSE

“Without the Montreal Protocol and the tightening of measures, the ozone layer would be much thinner today from the tropics right to the polar regions,” says Riese. “In addition, banning CFCs reduced the greenhouse effect caused by humanity.” He and his team are involved as authors and reviewers in the report on the ozone layer situation, which the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) publish every four years. “However, CFCs were a comparatively simple problem for politics,” adds Riese. “It was about only one group of substances, and ultimately only a few companies were affected by the ban.” In the case of carbon dioxide, the problem is far more complex. For a long time, primarily the industrialized countries bore the responsibility, from major corporations down to individual consumers. That picture has changed of late: apart from the USA, newly industrialized countries such as China or India are now among the major polluters, causing large-scale CO₂ emissions. But to counter global warming, the emission of all greenhouse gases must be considerably lowered. “This includes more than just CO₂: other greenhouse gases such as methane or nitrous oxide also contribute to the effect,” says Andreas Wahner.

Compelling all nations to reduce their emissions by means of laws appears almost impossible. Therefore, even the “small” successes of the climate reports provide glimmers of hope: without the knowledge of the first IPCC report from 1990, for example, the United Nations' Framework Convention on Climate Change in Rio in 1992 would not have taken place. It's an agreement obligating all partners to regularly publish facts on current greenhouse gas emissions. The follow-up report from 1995 provided the scientific basis for the negotiations for the 1997 Kyoto Protocol. It stipulates binding limits for the emission of greenhouse gases in industrialized countries and entered into force in 2005. The emissions trading scheme in the European Union is also based on it.

Raising awareness is another objective of the reports, says Wahner. According to him, it's the only way for political decisions that must be sustained over several government terms to be generally accepted. A good example for this is the 2020 climate target in Germany, which aims to reduce the emission of greenhouse gases by 40 % compared to 1990.

But the report is also important to research itself. “It shows us where we're at, where there are gaps to be bridged – and where we have to correct ourselves,” says Prof. Astrid Kiendler-Scharr, expert for aerosols. These are tiny particles in the air which play an important role for the chemistry of the atmosphere and for the climate system. The influence of clouds and these aerosols is one of those gaps, and it's currently being bridged. “Both aspects are still great unknowns in climate models,” stresses Kiendler-Scharr. The formation of aerosols and their role in climatic processes are complex issues. “Together with my team, I'm working on better understanding the details. That is one precondition to, for example, better estimate how rising temperatures affect these processes,” says the researcher. In her view, global field observations and laboratory experiments are needed to create the basis for improved models.

There are already new basic principles for improved models of the self-cleansing ability of the atmosphere. Measurement campaigns conducted by Wahner and Kiendler-Scharr using the Zeppelin NT provided new data in the past few years. They show that the conventional concepts must be corrected – and, therefore, so do the models.



EVER MORE PRECISE PROGNoses

“It's decisive that we understand the scientific basis of climate and of climate change. This will allow our simulations to become better and better – and our prognoses more and more precise,” Kiendler-Scharr is convinced. Prognoses which show, among other things, what might happen if humanity simply carries on as before, unchecked. But they also show that it's possible to limit global warming to two degrees Celsius compared to the pre-industrial age. An ambitious aim, which can only be reached by reducing greenhouse gas emissions radically – but also a glimmer of hope. To what extent has the awareness of the dangers of climate change among politicians been raised? This will be shown by the Climate Change Conference in Paris in late November and the decisions taken there. But whatever politics decides – research must go on. “We are as yet far from understanding all processes in the climate system. The IPCC report shows the scientific community the direction in which research must be steered,” says Andreas Wahner.



↑ Prof. Astrid Kiendler-Scharr, director at the Institute of Energy and Climate Research – Troposphere (IEK-8)

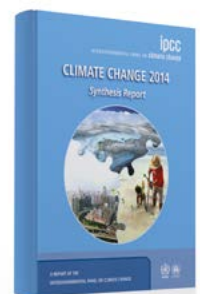
↑ Prof. Martin Riese, director at the Institute of Energy and Climate Research – Stratosphere (IEK-7)

↑ Prof. Andreas Wahner, director at the Institute of Energy and Climate Research – Troposphere (IEK-8)

Research – learn – act!

Jülich researchers have been involved in the IPCC reporting marathon right from the start. They are reviewers or authors and furnish hard facts and figures. In 2014 alone, more than 220 scientific publications from the fields of atmosphere, geoscience, and plant research were published from inside Jülich's laboratories. Each on its own represents progress: with each publication, other scientists worldwide learn something new. Often, it's a little piece of the puzzle of climatic processes, but sometimes it's a big deal, ending up in *Science* or *Nature* – or in the IPCC's reports.

Researching and learning is one side of the coin. Acting is the other. Jülich scientists consider it as their duty to directly talk to politicians and people responsible, to inform them, and thus encourage them to act. This happens in the laboratories and during the measurement campaigns of Forschungszentrum Jülich, as well as in direct talks in Germany and throughout the world. In concrete terms, it has led to buses finally being introduced in Bad Homburg which vent less fine dust and nitrogen oxides into the air. At several industry locations in China, the air pollution was reduced considerably with the aid of Jülich measuring techniques and intensive advising of local actors by a Jülich research team. "Our research has the greatest impact when we offer solutions and these are then immediately implemented," stresses Prof. Andreas Wahner. The researchers agree, however, that in complex structures, such as the atmosphere and politics, there is usually no single solution for all requirements. "In addition to the emissions, there are also economic components to be considered by politics," Prof. Astrid Kiendler-Scharr points out. She is therefore all the more delighted when she meets politicians or journalists who can handle scientific issues which can't be explained in two sentences.

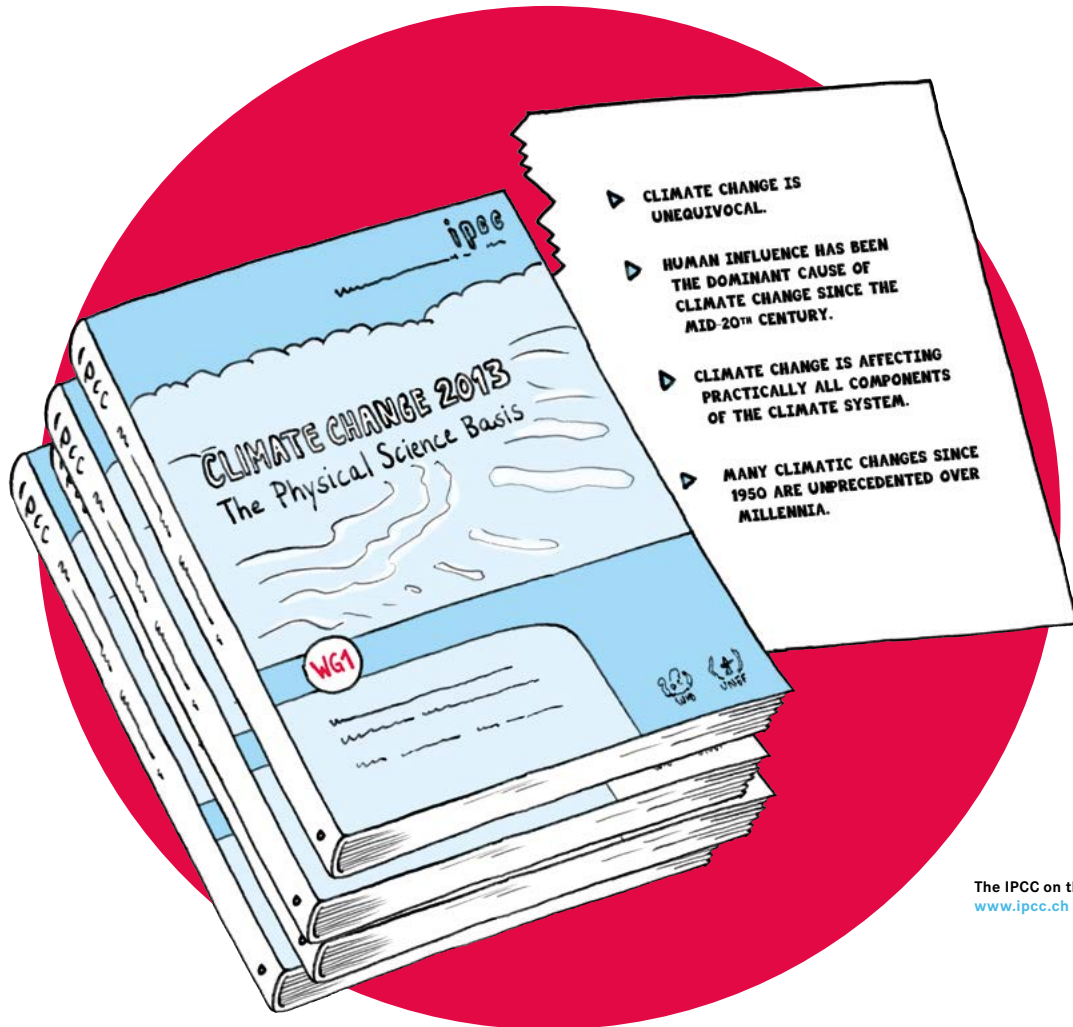


168

pages is the length of the summary of the 5th climate report from 2013/2014.

The current report on the world's climate

What's in it and who writes it



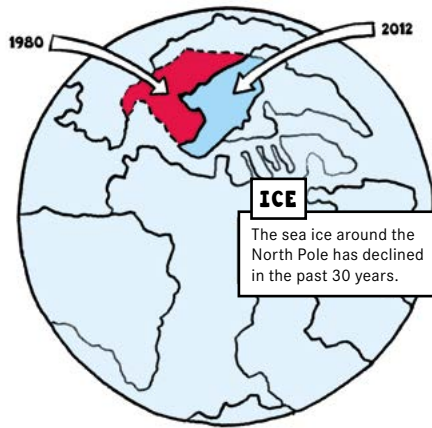
The IPCC on the Internet:
www.ipcc.ch

The World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) set up the Intergovernmental Panel on Climate Change (IPCC) in 1988. Hundreds of scientists from all over the world have since contributed to the five Assessment Reports as authors or reviewers. Among them are the two Jülich researchers Dr. Martina Krämer and Dr. Rolf Müller, who worked on the latest report from 2013 and 2014.

The IPCC currently has 195 member states. The scientists and the Chairs work in an honorary capacity, while the rest of the IPCC is financed mainly by the industrialized countries. On

the IPCC's behalf, experts from all over the world compile scientific, technical, and socioeconomic knowledge on our climate. As many as 830 lead authors worked on the latest IPCC report, among them 40 from Germany. The report is divided into three sections: the first part looks at the physical science basis of climate change. The second part is concerned with the consequences of climate change on ecosystems, economy, and health, and the third part outlines political and technological measures which could mitigate climate change.

Summaries of roughly 30 pages for each part provide policy-makers with the means to make science-based deci-



In North America and Europe, severe precipitation events have become more frequent and more intensive.

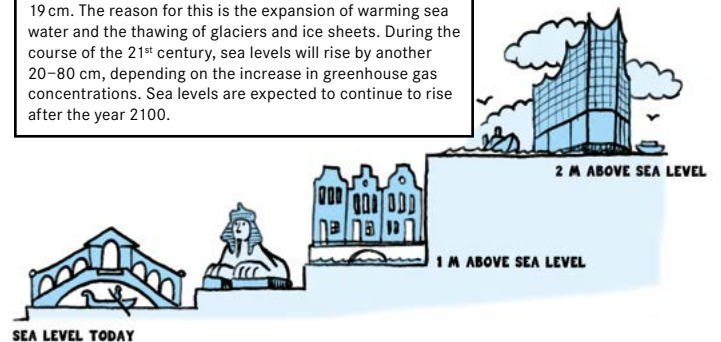
PRECIPITATION

Between 1951 and 2010, the amount of precipitation in the mid-latitudes of the northern hemisphere increased. Progressing global warming will amplify the difference between wet and dry regions.

The number of hot days and nights has risen on a global scale.

SEA LEVEL

Between 1901 and 2010, the mean global sea level rose by 19 cm. The reason for this is the expansion of warming sea water and the thawing of glaciers and ice sheets. During the course of the 21st century, sea levels will rise by another 20–80 cm, depending on the increase in greenhouse gas concentrations. Sea levels are expected to continue to rise after the year 2100.

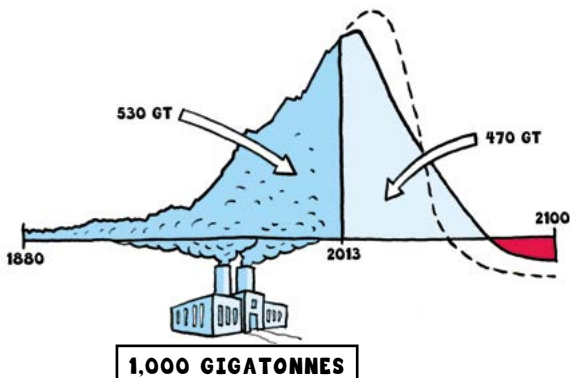
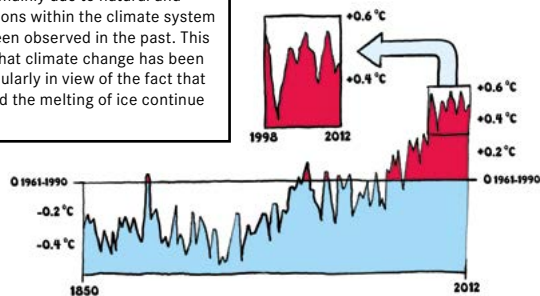


+0.3 °C SINCE 1970

The temperature of the world's oceans has risen considerably since approximately 1970. They have absorbed more than 90% of the energy that has remained within the Earth's system due to the additional greenhouse effect. The oceans also absorb a large part of the CO₂ emissions caused by humans. This has led to their water becoming more acidic.

TEMPERATURE

For the past 15 years, the surface temperature has remained at a high level. Such short-term phenomena are mainly due to natural and internal fluctuations within the climate system and have also been observed in the past. This does not mean that climate change has been mitigated, particularly in view of the fact that sea-level rise and the melting of ice continue unabated.



For the first time, the internationally recognized two-degree limit has been linked to a concrete threshold for greenhouse gas emissions: in order to stay below the two-degree limit with a probability of 66%, greenhouse gas emissions may not exceed the equivalent of approximately 1,000 gigatonnes of carbon. So far, just over half of that amount has already been released by human activities.

sions. These summaries are approved sentence by sentence by government representatives and scientists during several days of negotiations. The statements contained in them must be comprehensive and understandable. The scientists have the right to veto formulations if they do not correspond to the content of the report. The government representatives must subsequently approve the summaries and the entire report, acknowledging the scientific content of the IPCC report.

Climate change – Jülich expertise

Stratosphere

- Climate-relevant processes in the atmosphere
- Interactions between ozone and climate
- Water vapour and ice clouds
- Remote sensing of the atmosphere
- Development of measuring instruments

Prof. Dr. Martin Riese

Director at the Institute of Energy and Climate Research,
Stratosphere (IEK-7)
Email: m.riese@fz-juelich.de
Tel: +49 2461 61-2065

Troposphere

- Air quality/air pollution
- Chemistry of the atmosphere
- Particle formation/atmospheric aerosols
- Degradation of trace gases/self-purification of the atmosphere
- Anthropogenic and biogenic emissions
- Global long-term measurements of atmospheric trace substances
- Chemical weather forecasts/reactive greenhouse gases/modelling of chemical and transport processes
- Detection techniques for atmospheric, reactive trace substances

Prof. Dr. Andreas Wahner

Director at the Institute of Energy and Climate Research,
Troposphere (IEK-8)
Email: a.wahner@fz-juelich.de
Tel: +49 2461 61-4692

Prof. Dr. Astrid Kiendler-Scharr

Director at the Institute of Energy and Climate Research,
Troposphere (IEK-8)
Email: a.kiendler-scharr@fz-juelich.de
Tel: +49 2461 61-4185

Agrosphere

- Impact of climate change on soils and ecosystem services
- Examination of the impact on material cycles and exchange processes between soil, plants, and the atmosphere
- Modelling of water, energy, and material cycles as well as their interactions as part of climate change and changing land use

Prof. Dr. Harry Vereecken

Director at the Institute of Bio- and Geosciences,
Agrosphere (IBG-3)
Email: h.vereecken@fz-juelich.de
Tel: +49 2461 61-4570

Plant Sciences

- Adapting plants to climate change
- Photosynthesis, growth, and quality of plants in view of future CO₂ concentrations
- Quantification and modelling of root structures and function under variable soil and climate conditions
- Carbon fluxes in plants and exudation in soils
- Influence of increased CO₂ on carbon fluxes and nutrient budget of crop plants
- Aircraft- and satellite-borne remote sensing of photosynthesis and stress in plants and vegetation

Prof. Dr. Ulrich Schurr

Director at the Institute of Bio- and Geosciences,
Plant Sciences (IBG-2)
Email: u.schurr@fz-juelich.de
Tel: +49 2461 61-3073

Prof. Dr. Michelle Watt

Director at the Institute of Bio- and Geosciences,
Plant Sciences (IBG-2)
Email: m.watt@fz-juelich.de
Tel: +49 2461 61-9112

Prof. Dr. Uwe Rascher

Head of the research field Photosynthesis and Remote Sensing
Email: u.rascher@fz-juelich.de
Tel: +49 2461 61-2638

Energy Technologies and Systems

- Technical and economic options
- Perception and acceptance of measures
- Governance of systems

Prof. Jürgen-Friedrich Hake

Director at the Institute of Energy and Climate Research,
Systems Analysis and Technology Evaluation (IEK-STE)
Email: iek-ste-sekretariat@fz-juelich.de
Tel: + 49 2461 61-6363

Publication details

effzett offprint of Forschungszentrum Jülich's magazine

Published by: Forschungszentrum Jülich GmbH, 52425 Jülich, Germany

Conception and editorial work: Annette Stettien, Dr. Barbara Schunk, Christian Hohlfeld, Dr. Anne Rother (responsible under German Press Law)

Authors: Brigitte Stahl-Busse, Erhard Zeiss, texts first appeared in: *effzett* 3/15, Forschungszentrum Jülich's magazine

Translation: Language Services, Forschungszentrum Jülich

Graphics and layout: SeitenPlan GmbH, Corporate Publishing Dortmund

Images: Forschungszentrum Jülich/Sascha Kreklau (1, 2, 5 top).

© German Climate Consortium, Klimafakten.de/illustrations: Climate Media Factory, (6-7 [infographics])

Contact: Corporate Communications, tel: +49 2461 61-4661, fax: +49 2461 61-4666, email: info@fz-juelich.de

Printed by: Forschungszentrum Jülich GmbH

Print run: 500