What is happening in the climate system?

What are the risks?

What can be done?

Courtesy: Jean-Pascal van Ypersele, IPCC Vice-Chair
Headlines of the IPCC WGI 5th Assessment Report

- Warming is unequivocal. Many observed changes are unprecedented on timescales of decades or millennia.

- Human influence on climate is clear.

- Climate will continue to change in future.

- Limiting future climate change will require substantial and sustained reductions in emissions.
New findings since the Fourth Assessment Report

- Increased certainty of a human influence on climate
- Improved observations & models and increased understanding of many components of the climate system
- New emission scenarios and projections of climate change beyond 2100 to 2300
- Sea level rise projections include ice-sheet dynamical changes
- Estimates of the total allowable global emissions in order to limit temperature rise to e.g. 2°C above pre-industrial
Global mean surface temperatures increased by 0.89°C between 1901 and 2012

Globally averaged surface temperatures

IPCC (2013) Figure SPM.1
Almost the entire globe warmed between 1901 and 2012

Observed change in surface temperature 1901–2012

°C over period

IPCC (2013) Figure SPM.1
Arctic summer sea ice extent has decreased

IPCC (2013) Figure SPM.3
Global mean sea level increased by 0.19 m between 1901 and 2010.

1901-2010: 1.7 mm/yr
1993-2010: 3.2 mm/yr

IPCC (2013) Figure SPM.3
Multiple lines of robust and compelling evidence support the conclusion that many aspects of the climate system have changed.
### Regional Observed Changes in Climate Indices

<table>
<thead>
<tr>
<th>Region</th>
<th>Warm Days (e.g., TX90p)</th>
<th>Cold Days (e.g., TX10p)</th>
<th>Warm Nights (e.g., TN90p, TR)</th>
<th>Cold Nights/Frosts (e.g., TN10p, FD)</th>
<th>Heat Waves / Warm Spells</th>
<th>Extreme Precipitation (e.g., RX1day, R95p, R99p)</th>
<th>Dryness (e.g., CDD) / Drought</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Africa and Middle East</strong></td>
<td>Low to medium confidence: limited data in many regions but increases in most regions assessed</td>
<td>Low to medium confidence: limited data in many regions but increases in most regions assessed</td>
<td>Medium confidence: decrease North Africa and Middle East</td>
<td>Medium confidence: decrease North Africa and Middle East</td>
<td>Low confidence: insufficient evidence (lack of literature)</td>
<td>Low confidence: increase in North Africa and Middle East and southern Africa</td>
<td>Medium confidence: increase in North Africa and Middle East and southern Africa, although 1970s Sahel drought dominates the trend</td>
</tr>
<tr>
<td></td>
<td>Medium confidence: increase North Africa and Middle East</td>
<td>Medium confidence: decrease North Africa and Middle East</td>
<td>Medium confidence: increase North Africa and Middle East</td>
<td>Medium confidence: increase North Africa and Middle East</td>
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</tr>
<tr>
<td></td>
<td>High confidence: Likely increase southern Africa</td>
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<td>High confidence: Likely increase southern Africa</td>
<td>High confidence: Likely decrease southern Africa</td>
<td>Low confidence: insufficient evidence and spatially varying trends</td>
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</tr>
</tbody>
</table>
How large is the projected change in surface temperature compared with internal variability?

RCP 2.6

RCP 8.5

Change in average surface temperature (1986–2005 to 2081–2100)

IPCC (2013) Figure SPM.8

Box 12.1: Methods to Quantify Model Agreement in Maps

Stippling indicates regions with large changes and high model agreement

Hatching indicates regions with small changes or low model agreement
## Climate extremes: more hot and fewer cold extremes

<table>
<thead>
<tr>
<th>Phenomenon and direction of trend</th>
<th>Assessment that changes occurred (typically since 1950 unless otherwise indicated)</th>
<th>Assessment of a human contribution to observed changes</th>
<th>Likelihood of further changes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Early 21st century</td>
<td>Late 21st century</td>
</tr>
<tr>
<td></td>
<td><img src="image.png" alt="Image" /></td>
<td><img src="image.png" alt="Image" /></td>
<td><img src="image.png" alt="Image" /></td>
</tr>
<tr>
<td>Warmer and/or fewer cold days and nights over most land areas</td>
<td>Very likely (2.6.1)</td>
<td>Very likely (10.6.1)</td>
<td>Likely (11.3.2)</td>
</tr>
<tr>
<td></td>
<td>Very likely</td>
<td>Likely</td>
<td>Virtually certain (12.4.3)</td>
</tr>
<tr>
<td>Warmer and/or more frequent hot days and nights over most land areas</td>
<td>Very likely (2.6.1)</td>
<td>Very likely (10.6.1)</td>
<td>Likely (11.3.2)</td>
</tr>
<tr>
<td></td>
<td>Very likely</td>
<td>Likely (nights only)</td>
<td>Virtually certain (12.4.3)</td>
</tr>
<tr>
<td>Warm spells/heat waves. Frequency and/or duration increases over most land areas</td>
<td>Medium confidence on a global scale</td>
<td>Likely (a)</td>
<td>Not formally assessed (b)</td>
</tr>
<tr>
<td></td>
<td>Likely in large parts of Europe, Asia and Australia</td>
<td>(2.6.1)</td>
<td>Very likely (12.4.3)</td>
</tr>
<tr>
<td></td>
<td>Medium confidence in many (but not all) regions</td>
<td>Not formally assessed</td>
<td>Very likely</td>
</tr>
<tr>
<td></td>
<td>Likely</td>
<td>(10.6.2)</td>
<td></td>
</tr>
<tr>
<td>Heavy precipitation events. Increase in the frequency, intensity, and/or amount of heavy precipitation</td>
<td>Likely more land areas with increases than decreases</td>
<td>Medium confidence</td>
<td>Likely over many land areas</td>
</tr>
<tr>
<td></td>
<td>Very likely in central North America</td>
<td>(2.6.2)</td>
<td>More likely than not</td>
</tr>
<tr>
<td></td>
<td>Likely more land areas with increases than decreases</td>
<td>(7.6.5, 10.6.1)</td>
<td>Likely over many areas</td>
</tr>
<tr>
<td></td>
<td>Likely over most land areas</td>
<td>(11.3.2)</td>
<td>Very likely</td>
</tr>
<tr>
<td>Increases in intensity and/or duration of drought</td>
<td>Low confidence on a global scale</td>
<td>Low confidence (f)</td>
<td>Likely (medium confidence) on a regional to global scale (g)</td>
</tr>
<tr>
<td></td>
<td>Likely changes in some regions (c)</td>
<td>(2.6.2)</td>
<td>(10.6.1)</td>
</tr>
<tr>
<td></td>
<td>Medium confidence in some regions</td>
<td>Low confidence (e)</td>
<td>(11.3.2)</td>
</tr>
<tr>
<td></td>
<td>Likely in many regions, since 1970 (d)</td>
<td>More likely than not</td>
<td>Medium confidence in some regions</td>
</tr>
<tr>
<td></td>
<td>Likely (e)</td>
<td>Likely (d)</td>
<td>Likely</td>
</tr>
<tr>
<td>Increases in intense tropical cyclone activity</td>
<td>Low confidence in long term (centennial) changes</td>
<td>Low confidence (h)</td>
<td>More likely than not (i)</td>
</tr>
<tr>
<td></td>
<td>Virtually certain in North Atlantic since 1970</td>
<td>(2.6.3)</td>
<td>(10.6.1)</td>
</tr>
<tr>
<td></td>
<td>Low confidence</td>
<td>Low confidence (l)</td>
<td>(11.3.2)</td>
</tr>
<tr>
<td></td>
<td>Likely (in some regions, since 1970)</td>
<td>More likely than not</td>
<td>Medium confidence in some regions</td>
</tr>
<tr>
<td></td>
<td>Low confidence</td>
<td>Likely (l)</td>
<td>Likely</td>
</tr>
<tr>
<td></td>
<td>(2.6.3)</td>
<td>(3.7.5)</td>
<td></td>
</tr>
<tr>
<td>Increased incidence and/or magnitude of extreme high sea level</td>
<td>Likely (since 1970)</td>
<td>Likely (j)</td>
<td>Not assessed</td>
</tr>
<tr>
<td></td>
<td>Likely (late 20th century)</td>
<td>Likely (j)</td>
<td>Very likely (k)</td>
</tr>
<tr>
<td></td>
<td>Likely</td>
<td>More likely than not (j)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Likely</td>
<td>Likely (l)</td>
<td></td>
</tr>
</tbody>
</table>

IPCC (2013) Table SPM.1
More hot and fewer cold days and nights as global temperatures increase

IPCC (2013) Figure 12.13
The contrast between wet and dry regions and wet and dry seasons will increase* with some regional exceptions.

*Stippling: changes are "large" compared with internal variability (greater than two standard deviations of internal variability), and at least 90% of models agree on sign of change.

IPCC (2013) Figure SPM.8

RCP2.6

Change in average precipitation (1986–2005 to 2081–2100)

RCP8.5

IPCC AR5 Working Group I
Climate Change 2013: The Physical Science Basis
The rate of sea level rise is very likely to increase.
Annex I: Atlas of Global and Regional Climate Projections
Supplementary Material RCP2.6
Examples of reworking the atlas using data provided
Coordinated Regional Downscaling Experiment

- Sponsored by the World Climate Research Programme
  - http://wcrp-cordex.ipsl.jussieu.fr/
- Coordinate high-resolution regional climate modeling
  - unified protocols, experiments, format, variables, etc.
- Provide a set of high-resolution Regional Climate Scenarios for the majority of land-regions of the globe
- Make these data sets available and useable to the impact and adaptation communities
- 14 CORDEX Domains defined (South-East Asia is latest)
Establishment of IPOC at SMHI, Sweden

The CORDEX International Project Office Established at SMHI 23.10.2014

SMHI has been chosen as the host of the new International Project Office for Regional Climate Modelling, more specifically for CORDEX. The Office will support the development of climate models and projections of future climate, facilitate cooperation among countries in regions, and promote knowledge exchange and capacity building with particular focus on developing countries... read more
CORDEX Phase I experiment design

Model Evaluation Framework

Climate Projection Framework

Multiple regions (Initial focus on Africa)
50 km grid spacing

ERA-Interim LBC
1989-2007

RCP4.5, RCP8.5
1951-2100 or 1980-2050

Decadal predictions

Multiple AOGCMs

Regional Analysis
Regional Databanks

AMIP like

CMIP like

50 km grid spacing
• “Added-value” of downscaling compared to global models: target higher resolution (25km or finer), systematic comparisons
• Flagship Pilot Studies (FPS), high resolution (few km) regional climate simulations in selected regions with good observational records
• Room for innovative science:
  – multiple (possibly 2-way) coupled nests
  – Earth-System downscaling approach (coupling with ocean, land, cryosphere, etc)
• Promote systematic use of ESGF within CORDEX
• ...

• (see CORDEX 2013 conf final report for further details)
Climate Change 2013: The Physical Science Basis
Working Group I contribution to the IPCC Fifth Assessment Report

Further Information
www.climatechange2013.org