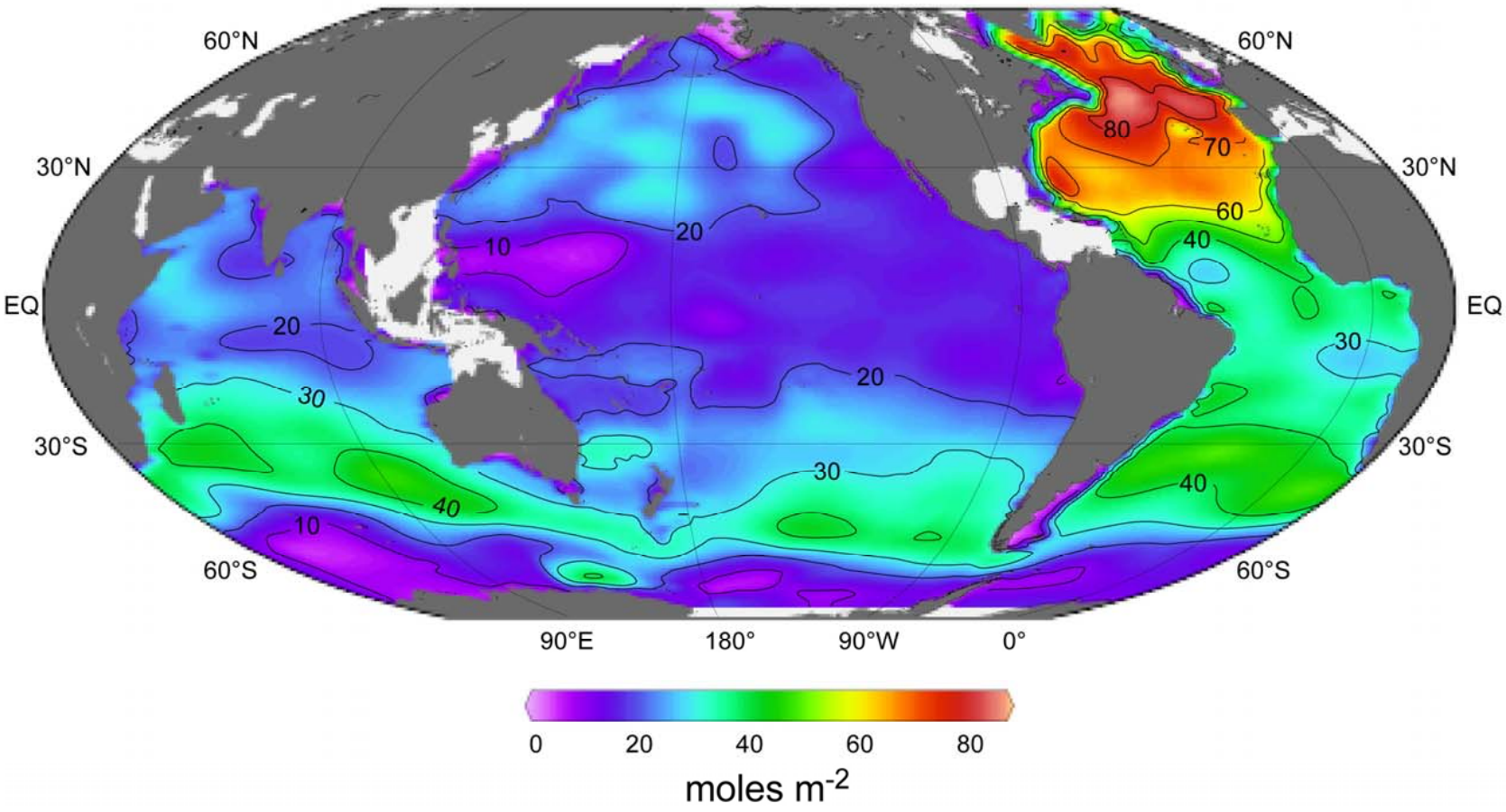
Anthropogenic CO_2 in the oceans



Sabine, C.L., Feely, R.A., Gruber, N., Key, R.M., Lee, K., Bullister, J.L., Wanninkhof, R., Wong, C.S., Wallace, D.W.R., Tilbrook, B., 2004. The oceanic sink for anthropogenic CO2. Science 305, 367-370

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Changing ocean pH

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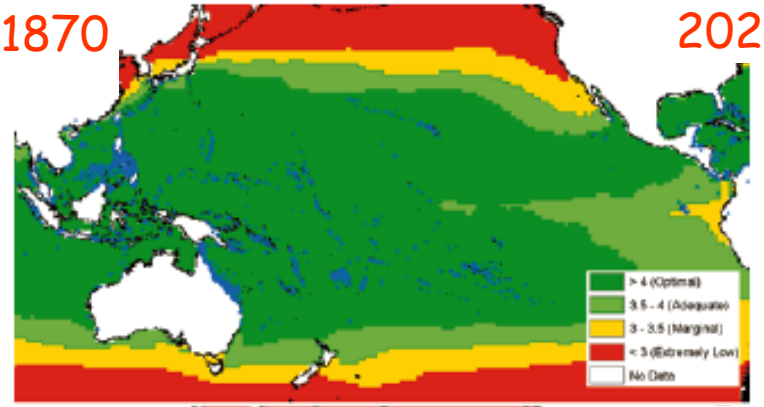
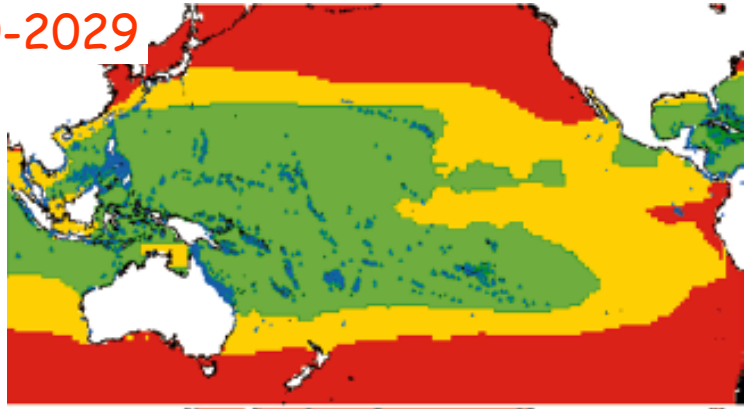
pCO_2 = 280 ppmv

1870

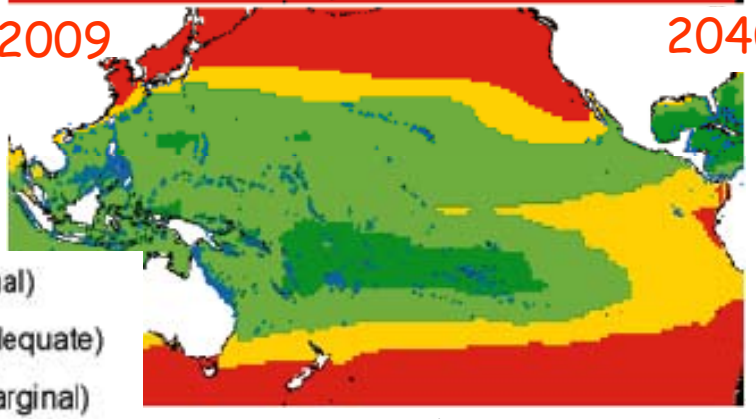


pCO_2 = 415 ppmv

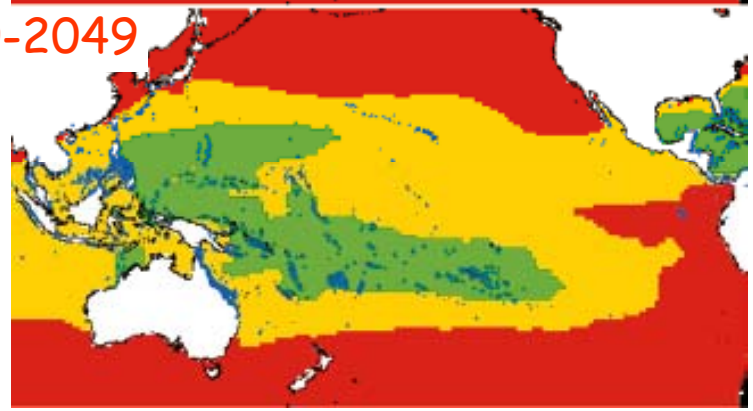
2020-2029



2000-2009



2040-2049



> 4 (Optimal)
3.5 - 4 (Adequate)
3 - 3.5 (Marginal)
< 3 (Extremely Low)
No Data

pCO_2 = 375 ppmv

pCO_2 = 465 ppmv

Guinotte et al., Coral Reefs 22, 551-558, 2003

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Geo-engineering: can we undo ocean acidification by adding limestone ($CaCO_3$)?

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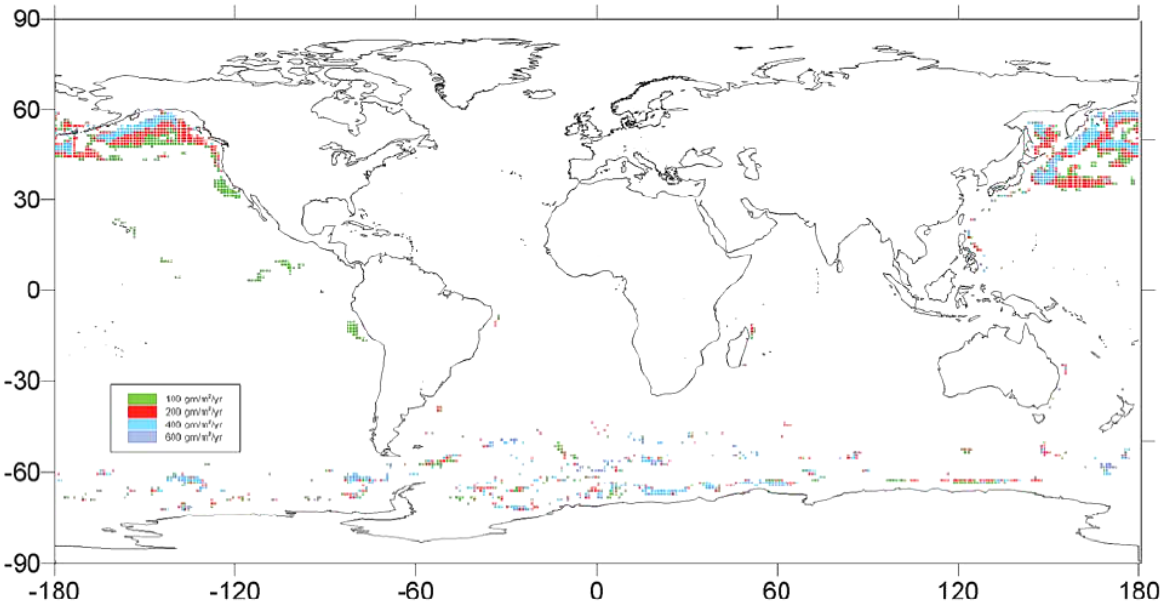
$$CO_{2(gas)} + H_2O_{(liquid)} \rightarrow H_2CO_{3(aq)}$$

$$H_2CO_{3(aq)} \rightarrow H^+ + HCO_3^-$$

$$HCO_3^- \rightarrow H^+ + CO_3^{2-}$$

$$CaCO_3 + CO_2 + H_2O \rightarrow Ca^{2+} + 2HCO_3^-$$



Distribution of limestone that maximizes the total CO_2 absorption, subject to a total application rate of 4 Gt a^{-1}.

Harvey, L. D. D. (2008), Mitigating the atmospheric CO2 increase and ocean acidification by adding limestone powder to upwelling regions, J. Geophys. Res., 113, C04028, doi:10.1029/2007JC004373.

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Impact of geoengineering schemes on global hydrology

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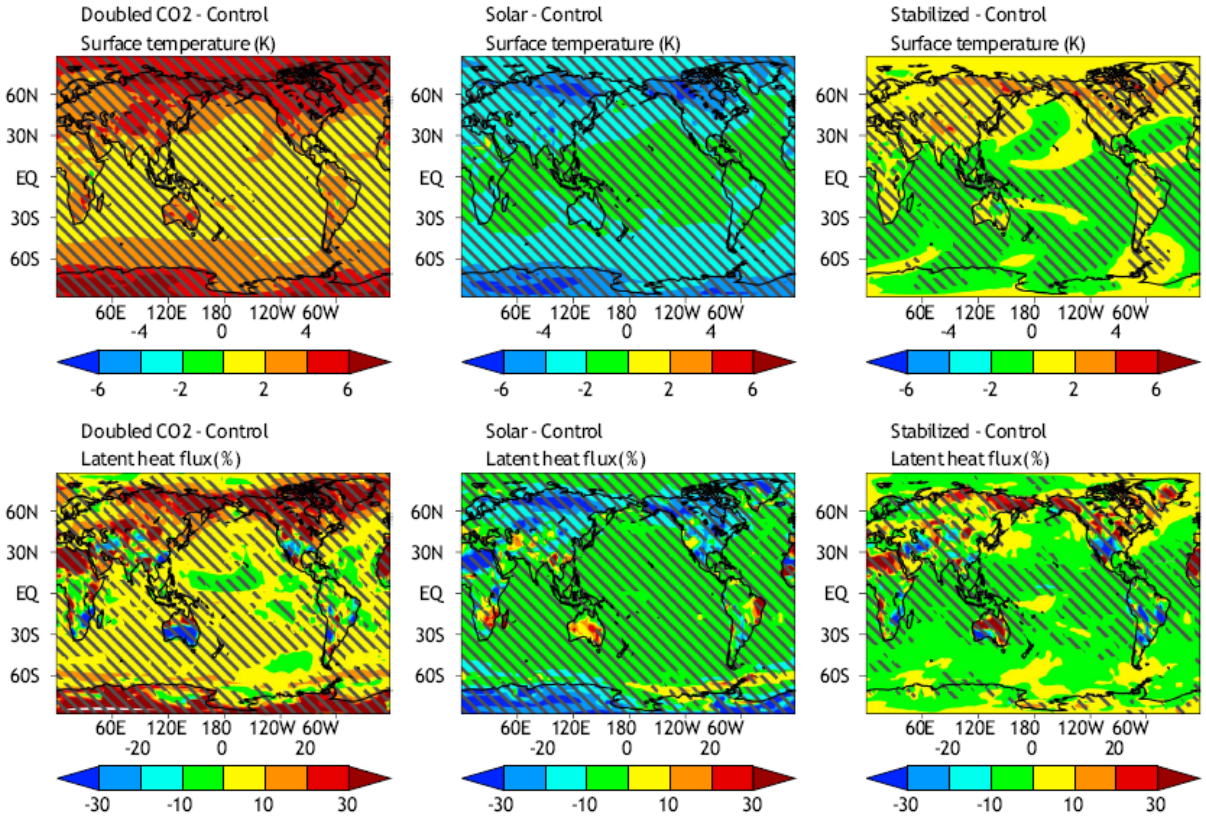

Bala, G., et al. 2008. Impact of geoengineering schemes on the global hydrological cycle. PNAS 105, 7664-7669.

The hydrological cycle is more sensitive to temperature adjustment by changes in insolation than by changes in greenhouse gases. This implies that an alteration in solar forcing might offset temperature changes or hydrological changes from greenhouse warming, but could not cancel both at once.

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GEC and Human Health
(New ESSP Project)

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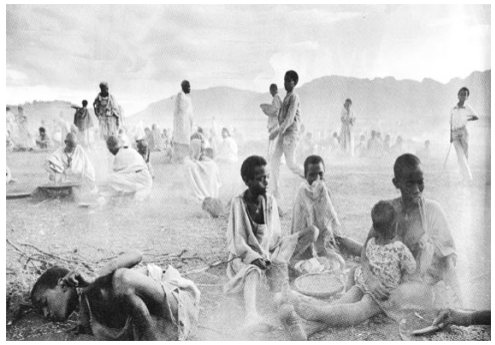
Goals:



1. Identify and quantify health risks posed by Global Environmental Change, now and in the reasonably foreseeable future.
2. Describe spatial (geographic, inter-population) and temporal differences in health risks, to better understand vulnerabilities and, therefore, intervention priorities.

3. Develop adaptation strategies to reduce health risks, assess their cost-effectiveness and communicate results.
4. Foster research training, to boost networked international research capacity in Global Environmental Change and Human Health.

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Current Health Burden (deaths) due to Climate Change

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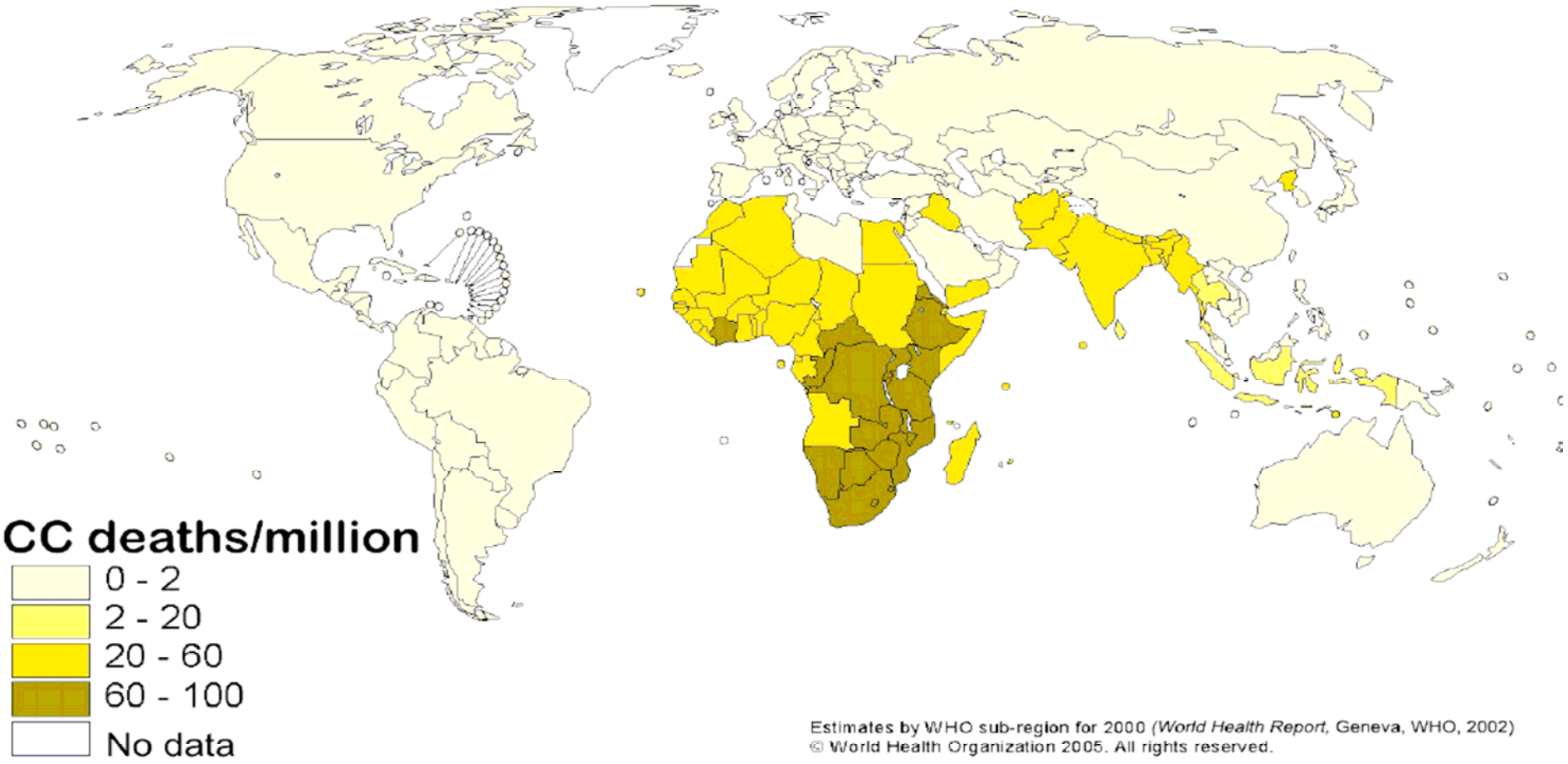

Estimates by WHO sub-region for 2000 (*World Health Report*, Geneva, WHO, 2002)

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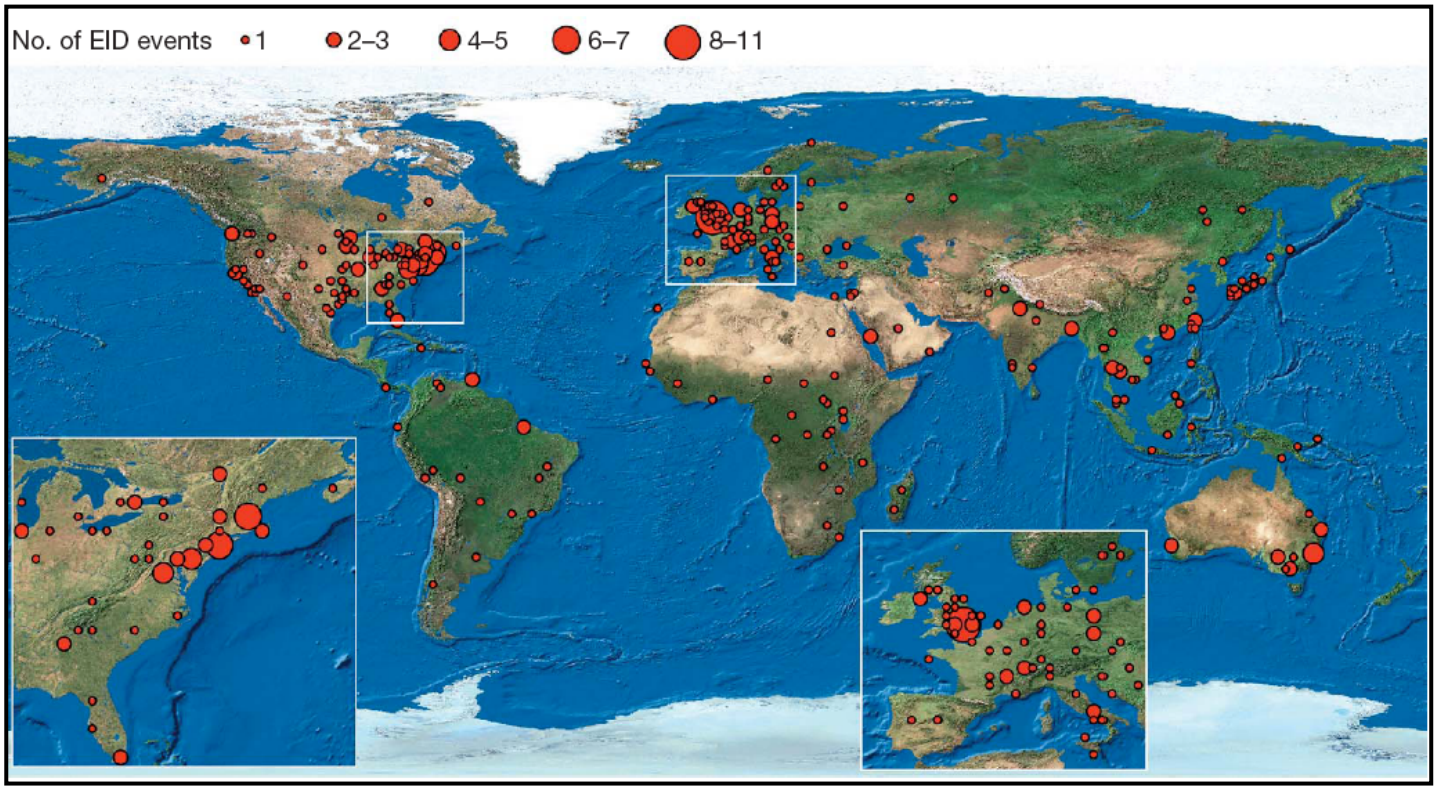
Emerging infectious diseases 1940-2004



Jones, K.Eet al. 2008. Global trends in emerging infectious diseases. Nature 451, 990-993.

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Cartogram: Greenhouse gases Emissions

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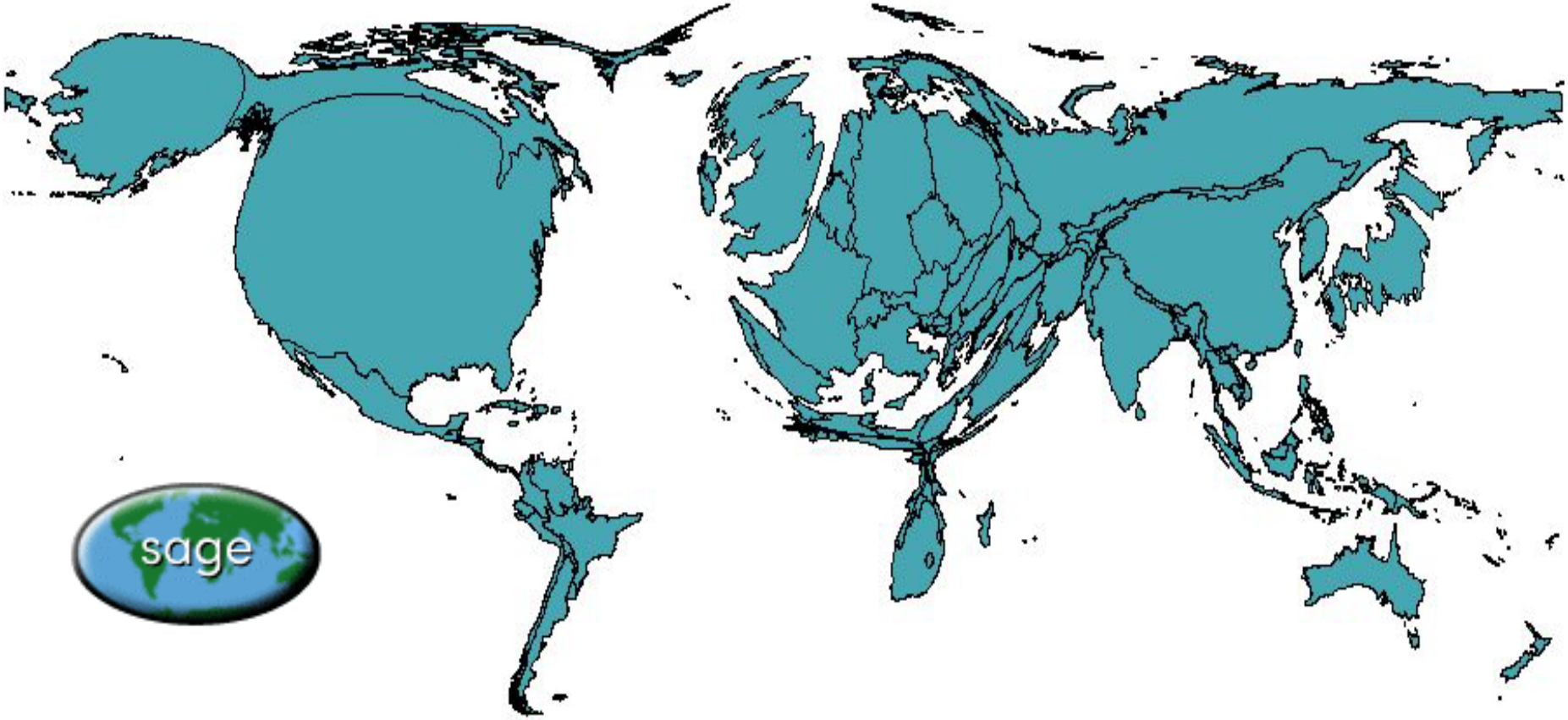

Countries scaled according to cumulative emissions in billion tonnes carbon equivalent in 2002. (Patz, Gibbs, et al, 2007)

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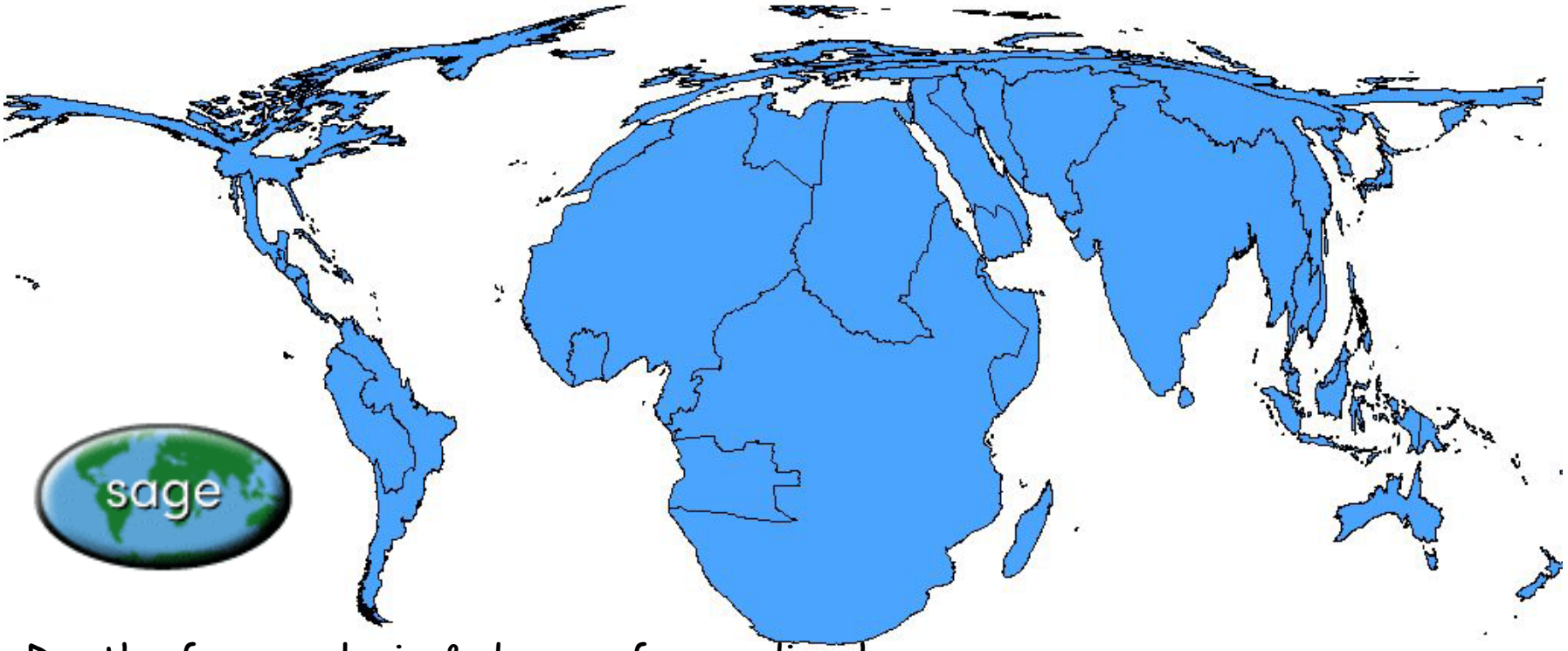
Cartogram: Health impacts of climate change

Earth System Science Partnership



Deaths from malaria & dengue fever, diarrhoea, malnutrition, flooding and (OECD countries) heatwaves

WHO regions scaled according to estimated mortality (per million people) in the year 2000, attributable to the climate change that occurred from 1970s to 2000 (Patz, Gibbs, et al, 2007)

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More reasons for concern since 2001 (IPCC TAR)

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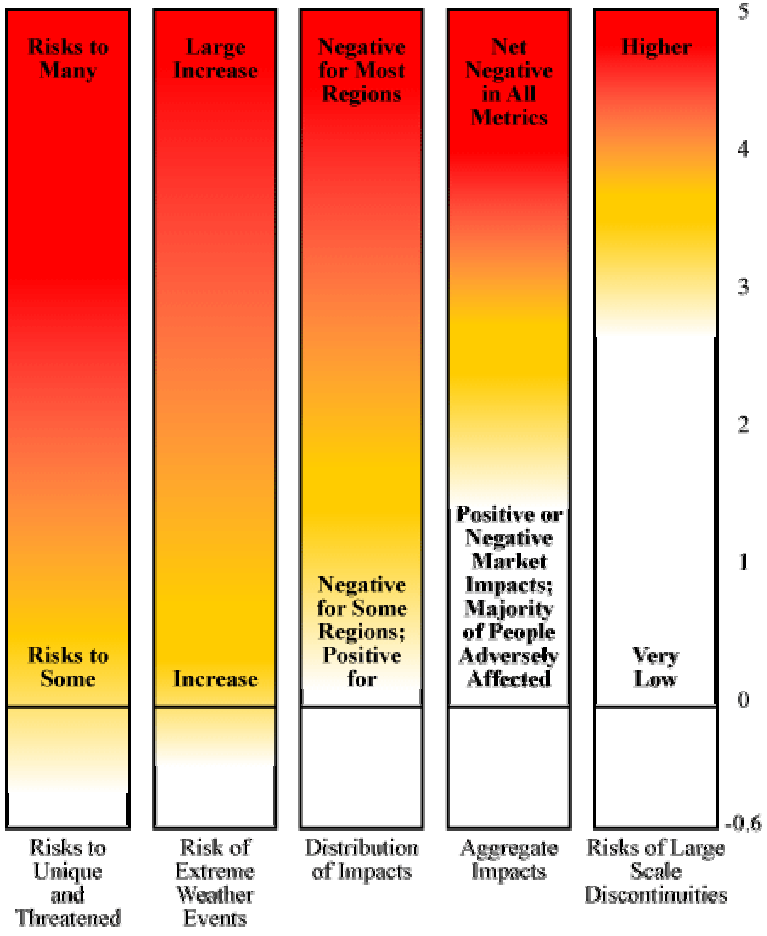
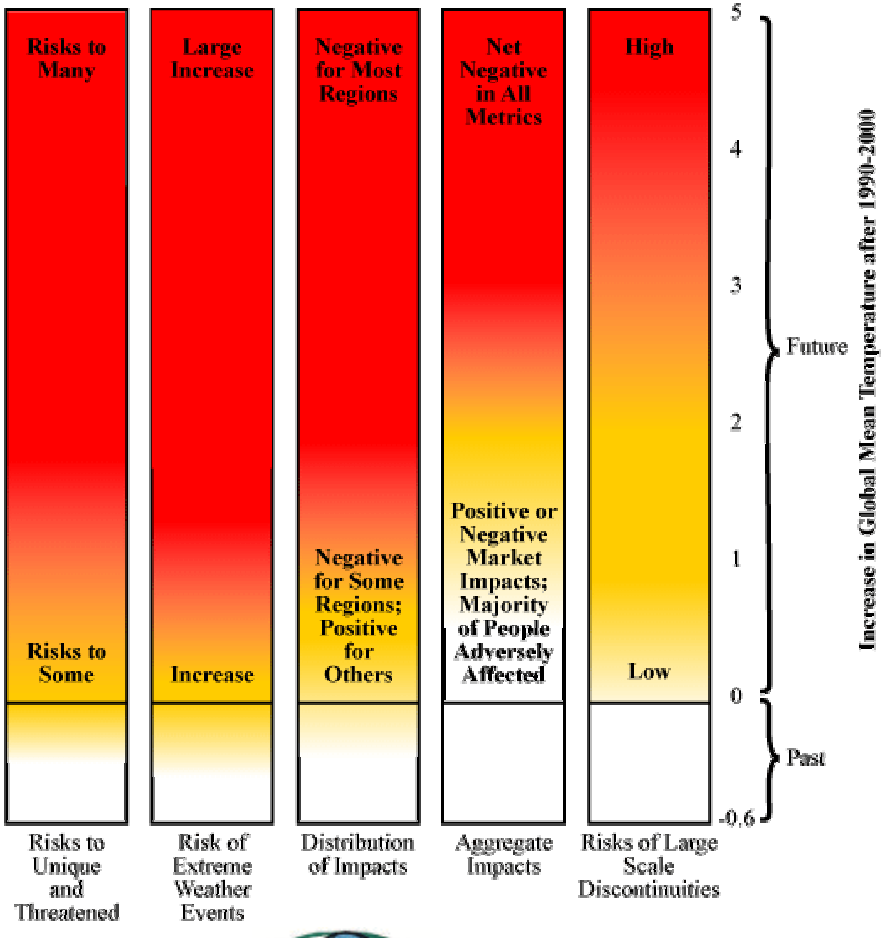
Schneider, S. et al., 2008 PNAS in press

IPCC TAR



Redrawn with data from IPCC AR4



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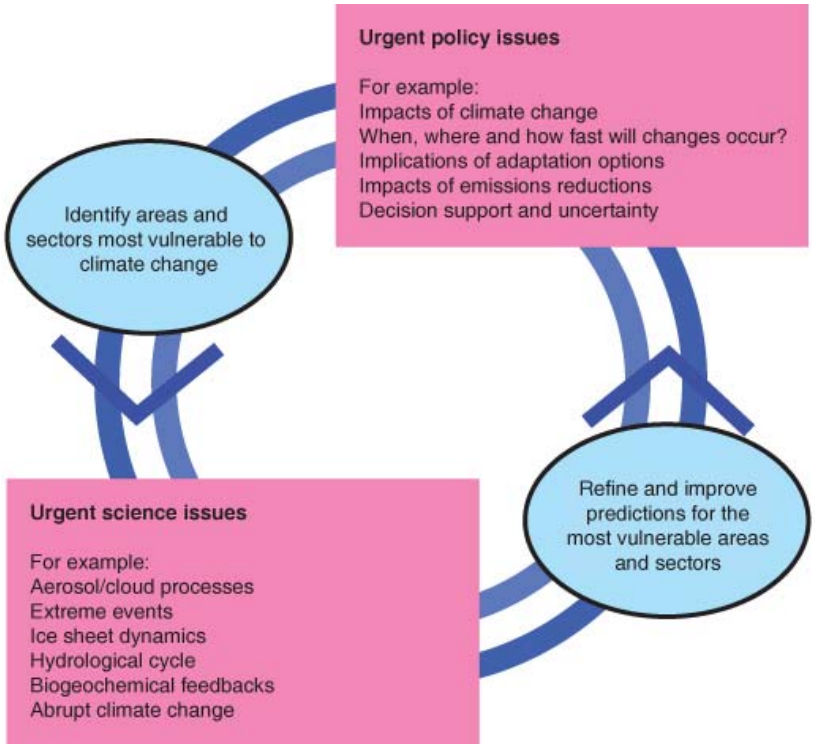
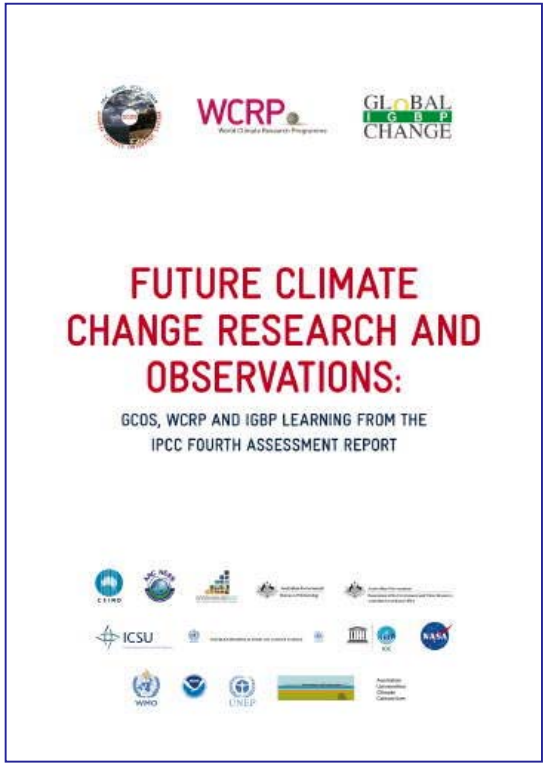
Developing the research agenda
Lessons learnt from IPCC AR4





Frame Science around Impacts, Adaptation, Mitigation:
a Risk Management Framework

WCRP& IGBP & GCOS organized Workshop in Sydney, Australia, Oct. 2007

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A innovative improved approach on defining vulnerabilities

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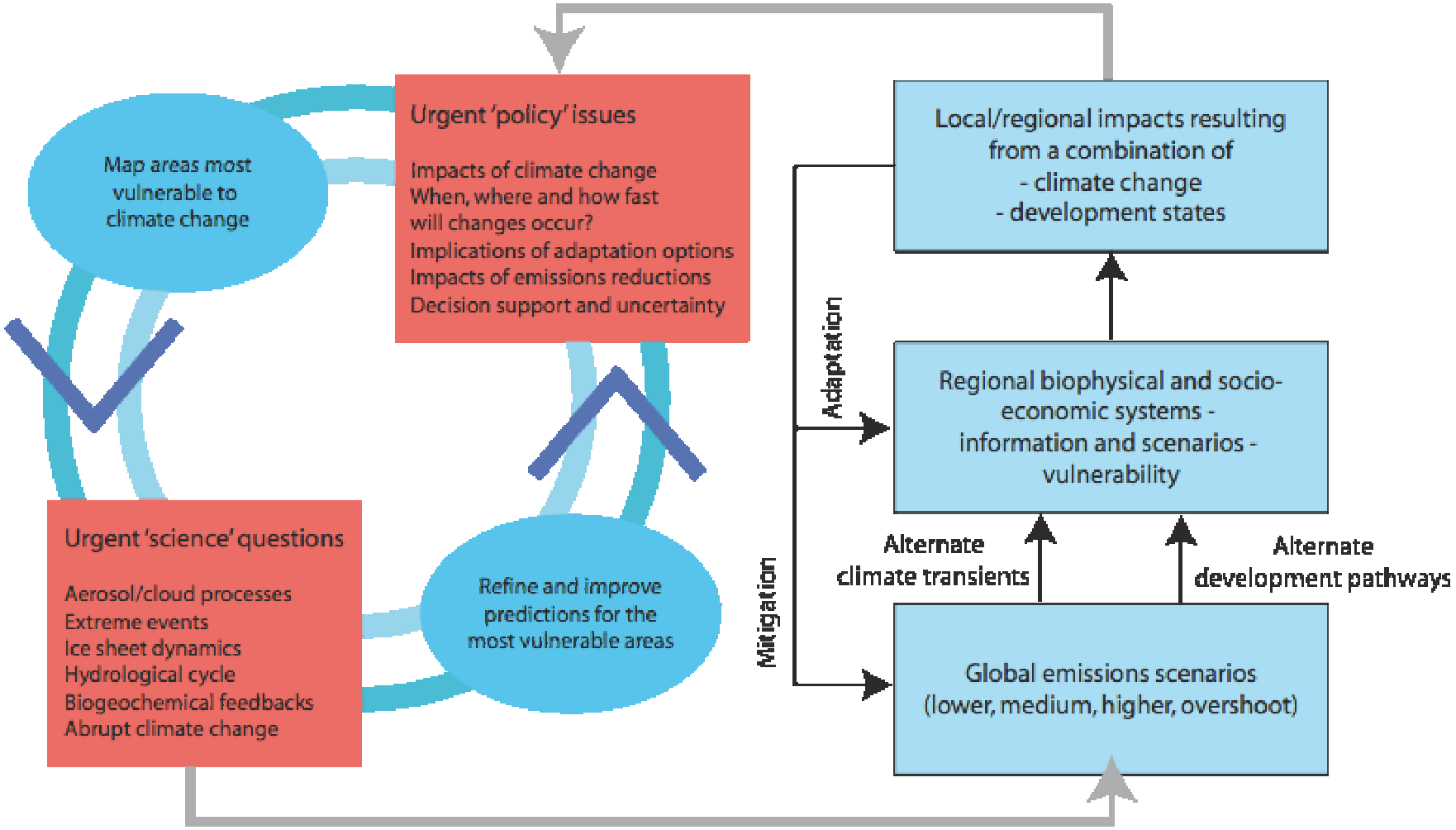

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ESSP: integrative science to support decision making

- We will continue to do innovative and integrative earth system science to understand the earth's system behavior and facilitate sustainable management and create the necessary capacity to advance and apply this scientific understanding
- We will contribute to the Millennium Assessment-follow-up and IMoSEB, the regional and global biodiversity assessments for the CBD
- We will contribute to national communications, adaptation planning and the Nairobi Action Plan
- We will contribute to the next IPCC assessments and national communications & adaptation planning
- We will get stronger involved with the urgently needed science-policy dialogue with policy makers, the private sectors and public NGOs

To achieve all this we need your support!

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