Комментарии к докладу Елисеева Алексея Викторовича «Глобальный цикл CO_2»

Гинзбург В.А.

- В ОД5 МГЭИК сказано, что «атмосферная концентрация CO_2 в атмосфере увеличилась в среднем на 2.0± 0.1 промилле год–1 в течение 2002-2011 гг.
- По данным NOAA скорость роста содержания CO2 за 10 лет с 2000 по 2009 гг. составляла 1.9±0.1 ppm, за последние 10 лет (с 2007 года) – 2.2±0.09 ppm, за последние 5 лет - 2.6±0.09 ppm, а за последние 2 года – 3.0±0.09 ppm.

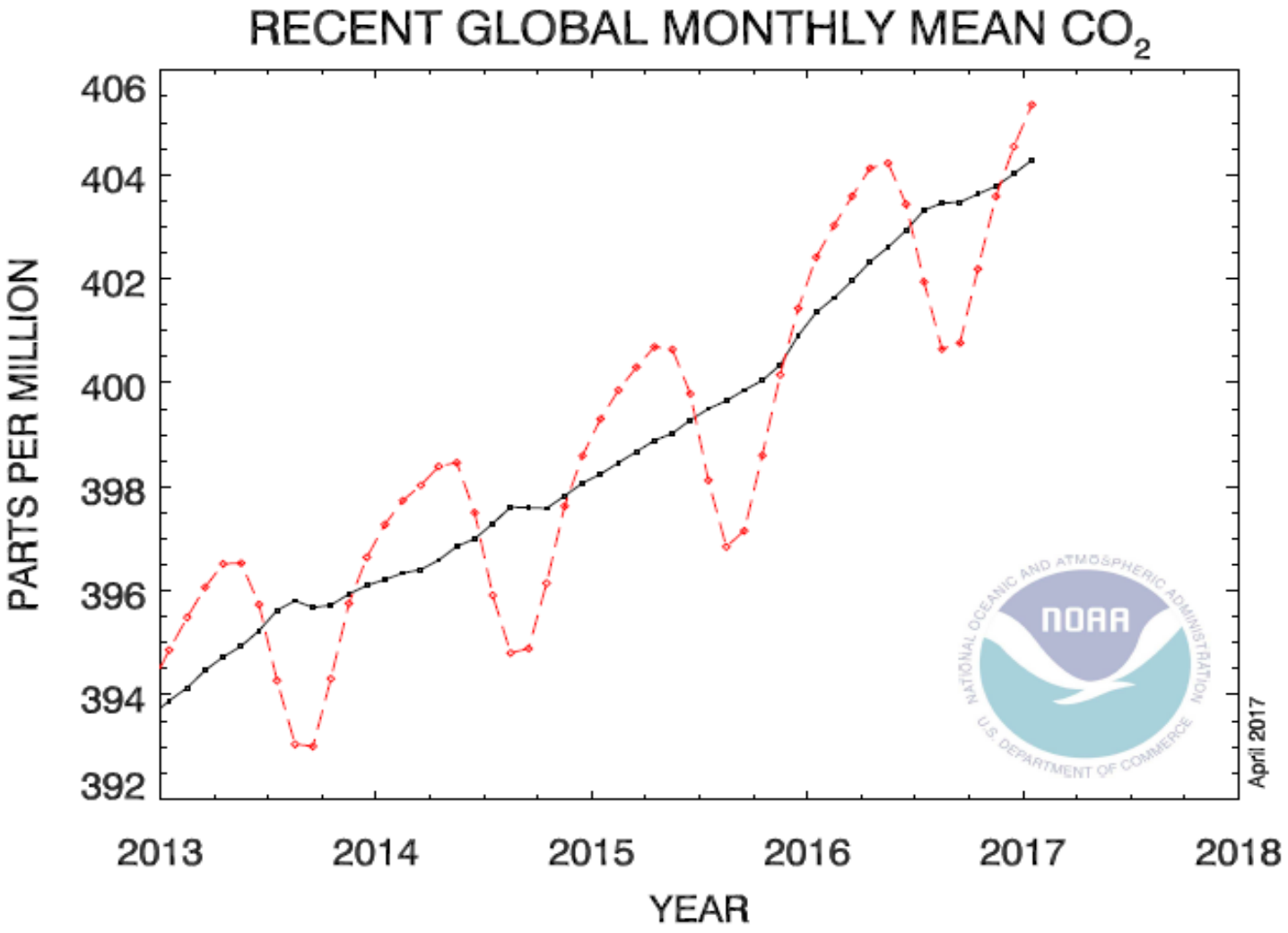
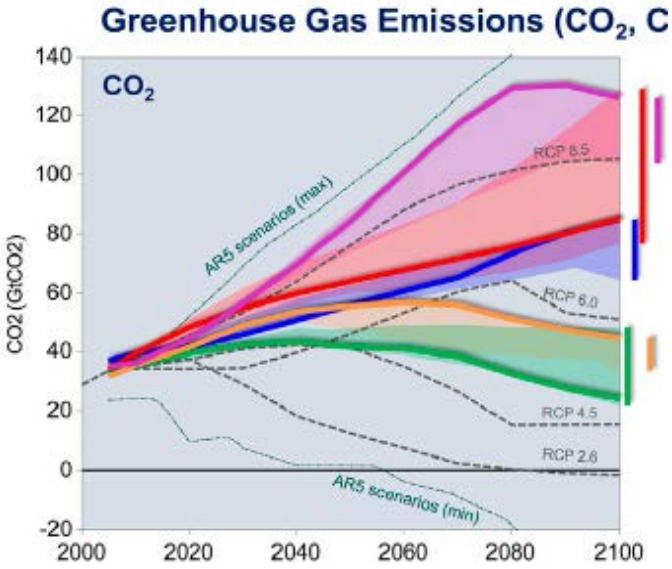

RECENT GLOBAL MONTHLY MEAN CO_2
PARTS PER MILLION
406
404
402
400
398
396
394
392
2013
2014
2015
2016
2017
2018
YEAR
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
April 2017

Table 2
Summary of SSP narratives.

SSP1	Sustainability – Taking the Green Road (Low challenges to mitigation and adaptation) *The world shifts gradually, but pervasively, toward a more sustainable path, emphasizing more inclusive development that respects perceived environmental boundaries. Management of the global commons slowly improves, educational and health investments accelerate the demographic transition, and the emphasis on economic growth shifts toward a broader emphasis on human well-being. Driven by an increasing commitment to achieving development goals, inequality is reduced both across and within countries. Consumption is oriented toward low material growth and lower resource and energy intensity.*
SSP2	Middle of the Road (Medium challenges to mitigation and adaptation) *The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns. Development and income growth proceeds unevenly, with some countries making relatively good progress while others fall short of expectations. Global and national institutions work toward but make slow progress in achieving sustainable development goals. Environmental systems experience degradation, although there are some improvements and overall the intensity of resource and energy use declines. Global population growth is moderate and levels off in the second half of the century. Income inequality persists or improves only slowly and challenges to reducing vulnerability to societal and environmental changes remain.*
SSP3	Regional Rivalry – A Rocky Road (High challenges to mitigation and adaptation) *A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to increasingly focus on domestic or, at most, regional issues. Policies shift over time to become increasingly oriented toward national and regional security issues. Countries focus on achieving energy and food security goals within their own regions at the expense of broader-based development. Investments in education and technological development decline. Economic development is slow, consumption is material-intensive, and inequalities persist or worsen over time. Population growth is low in industrialized and high in developing countries. A low international priority for addressing environmental concerns leads to strong environmental degradation in some regions.*
SSP4	Inequality – A Road Divided (Low challenges to mitigation, high challenges to adaptation) *Highly unequal investments in human capital, combined with increasing disparities in economic opportunity and political power, lead to increasing inequalities and stratification both across and within countries. Over time, a gap widens between an internationally-connected society that contributes to knowledge- and capital-intensive sectors of the global economy, and a fragmented collection of lower-income, poorly educated societies that work in a labor intensive, low-tech economy. Social cohesion degrades and conflict and unrest become increasingly common. Technology development is high in the high-tech economy and sectors. The globally connected energy sector diversifies, with investments in both carbon-intensive fuels like coal and unconventional oil, but also low-carbon energy sources. Environmental policies focus on local issues around middle and high income areas.*
SSP5	Fossil-fueled Development – Taking the Highway (High challenges to mitigation, low challenges to adaptation) *This world places increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. Global markets are increasingly integrated. There are also strong investments in health, education, and institutions to enhance human and social capital. At the same time, the push for economic and social development is coupled with the exploitation of abundant fossil fuel resources and the adoption of resource and energy intensive lifestyles around the world. All these factors lead to rapid growth of the global economy, while global population peaks and declines in the 21st century. Local environmental problems like air pollution are successfully managed. There is faith in the ability to effectively manage social and ecological systems, including by geo-engineering if necessary.*



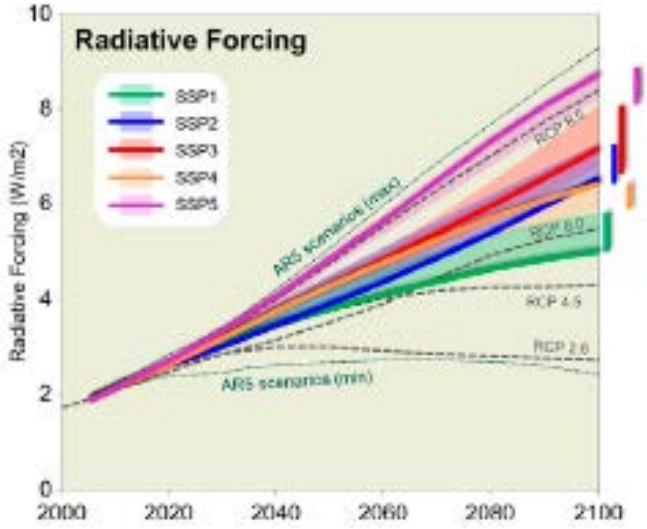


Table 3
Summary of Shared Climate Policy Assumptions (SPAs) for mitigation. All SPAs foresee a period with moderate and regionally fragmented action until 2020, but differ in the development of mitigation policies thereafter (see Section 6 and Appendix B of the Supplementary material for further details and definitions).

Policy stringency in the near term and the timing of regional participation	Coverage of land use emissions
SSP1, SSP4 Early accession with global collaboration as of 2020	*SSP1, SSP5* Effective coverage (at the level of emissions control in the energy and industrial sectors)
SSP2, SSP5 Some delays in establishing global action with regions transitioning to global cooperation between 2020–2040	*SSP2, SSP4* Intermediately effective coverage (limited REDD*, but effective coverage of agricultural emissions)
SSP3 Late accession – higher income regions join global regime between 2020–2040, while lower income regions follow between 2030 and 2050	*SSP3* Very limited coverage (implementation failures and high transaction costs)

* REDD: Reducing Emissions from Deforestation and forest Degradation.

Table 3.1: Overview of pathway characteristics for two global temperature targets. A detailed overview of scenario names is provided in Annex A.1. available online. Source: UNEP (2015) and additional calculations.

1.5°C (>50% in 2100)	Pathways limiting warming to below 1.5°C by 2100 with >50% probability Limited action until 2020 and cost-optimal mitigation afterwards				
Number of available scenarios: 6; Number of contributing modelling frameworks: 2 Year of global annual emissions becoming net zero† for: Kyoto greenhouse gases (GHGs): (2060-2080); total CO_2 (including land use, land-use change and forestry (LULUCF)): (2045-2050); CO_2 from energy and industry: (2045-2055)					
	Annual emissions of global total GHGs [$GtCO_2e$/year]				
Year	*2020*	*2025*	*2030*	*2050*	*2100*
median*	56	47	39	8	-5
range and spread**	53(-/-)56	46(-/-)48	37(-/-)40	4(-/-)14	-5(-/-)-3
	CO_2 carbon budgets [global total cumulative CO_2 emissions in $GtCO_2$]				
Time period	*2015-2030*	*2030-2050*	*2050-2075*	*2075-2100*	*2015-2100*
median*	552	236	-199	-353	217
range and spread**	503(-/-)567	178(-/-)259	-146(-/-)-277	-288(-/-)-372	71(-/-)383
2°C (>66% in 2100)	**Pathways limiting warming to below 2°C by 2100 with >66% probability Limited action until 2020 and cost-optimal mitigation afterwards**				
Number of available scenarios: 10; Number of contributing modelling frameworks: 4 Year of global annual emissions becoming net zero† for: Kyoto-GHGs: 2085 (2080-2090); total CO_2 (including LULUCF): 2070 (2060-2075); CO_2 from energy and industry: 2070 (2060-2075)					
	Annual emissions of global total GHGs [$GtCO_2e$/year]				
Year	*2020*	*2025*	*2030*	*2050*	*2100*
median*	52	48	42	23	-3
range and spread**	49(49/53)55	44(46/50)53	29(31/44)44	17(18/27)29	-11 (-9/-1)0
	CO_2 carbon budgets [global total cumulative CO_2 emissions in $GtCO_2$]				
Time period	*2015-2030*	*2030-2050*	*2050-2075*	*2075-2100*	*2015-2100*
median*	533	362	70	-288	553
range and spread**	481(499/582)572	242(258/431)447	-97(-52/175)187	-120(-146/-327)-342	483(490/934)988

* Rounded to the nearest 1 $GtCO_2e$/year

** Rounded to the nearest 1 $GtCO_2e$/year. Format: minimum value (20th percentile/80th percentile) maximum value – no percentiles are provided if less than 10 scenarios are available.

† Rounded to nearest 5 years. Format: median (20th percentile – 80th percentile); (minimum – maximum) if less than 10 scenarios are available.

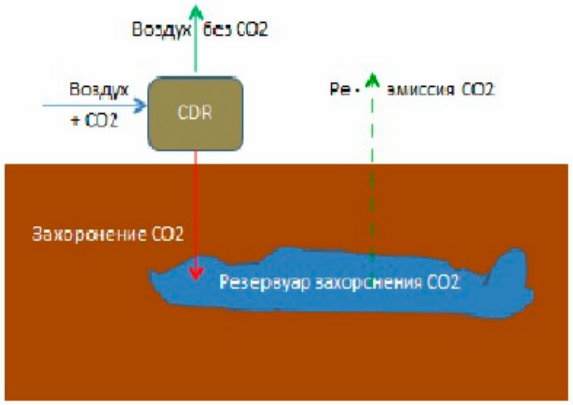


Рисунок 3 – Принципиальная схема методов CDR с захоронением CO_2 и ре-эмиссией из резервуара захоронения

Таблица 8 – Относительный вклад различных методов в суммарное ежегодное поглощение CO_2 в 2050, 2100, 2200 и 2300 годах (%) и величина кумулятивного поглощения CO_2 (Гт и ppmv).

Раздел	Метод	Годы			
		2050	2100	2200	2300
5.1	Консервация углерода в виде древесного угля	9	21	15	14
5.2	Производство биоэнергии с захватом и захоронением CO_2	2	14	15	15
5.3	Прямой захват CO_2 из атмосферы	0	12	44	45
5.4	Внесение химических поглотителей в почвы	12	15	9	9
5.5	Электрохимическое поглощение CO_2	0	1	1	1
5.6	Внесение химических поглотителей в океан	0	2	3	3
5.7	Внесение в океан питательных веществ	27	15	4	3
5.8	Культивирование микро– и макро-водорослей	0	0	2	2
5.9	Интенсификация вертикальных перемещений воды в океане	0	1	3	4
5.10	Восстановление лесов и создание новых лесопосадок	17	10	2	1
5.11	Захоронение биомассы в глубинных слоях океана	0	0	0	0
5.12	Захоронение биомассы в анаэробных условиях на суше	0	0	0	0
5.13	Совершенствование способов землепользования	20	3	0	0
5.14	Восстановление торфяников	0	0	0	0
5.15	Расширенное использование дерева в строительстве	8	4	1	1
5.16	Изъятие CO_2 из морской воды с получением жидкого топлива	0	0	0	0
5.17	Производство магний-силикатного цемента	3	3	1	1
Общее кумулятивное поглощение CO_2, Гт		**87**	**668**	**6328**	**12246**
Величина снижения глобальной концентрации CO_2, ppmv		**11**	**84**	**790**	**1530**

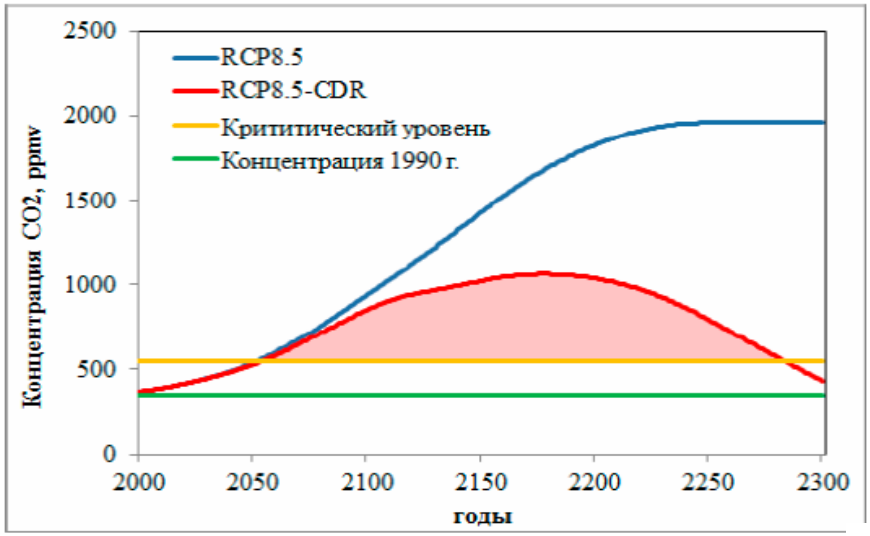


Рисунок 20 – Изменение концентрации (ppmv) CO_2 при реализации RCP8.5 (синяя кривая) и при использовании совокупности методов CDR в сочетании с RCP8.5 (красная кривая), концентрация CO_2 550 ppmv (желтая прямая), концентрация CO_2 354 ppmv 1990 года (зеленая прямая). Розовым цветом окрашена зона превышения условно приемлемой концентрации CO_2.

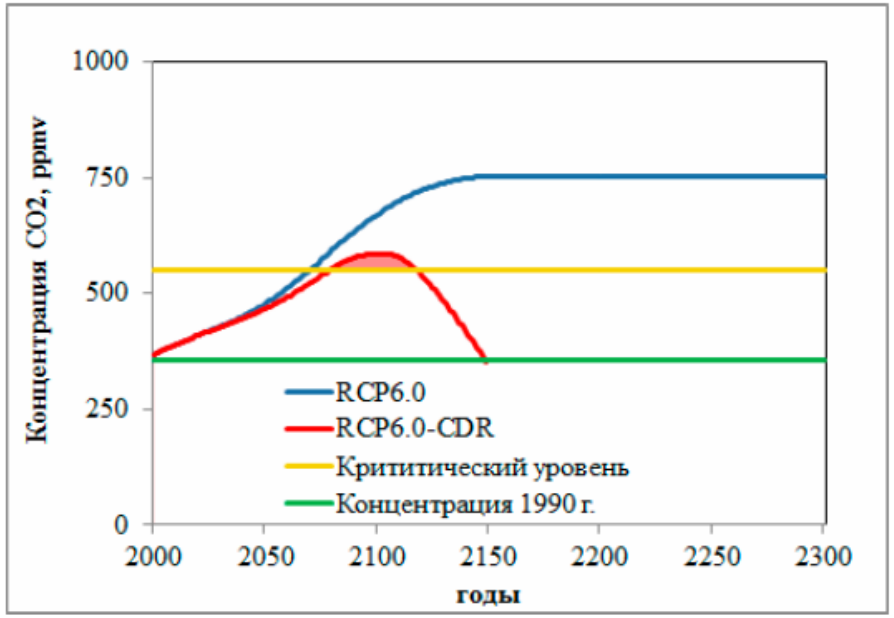


Рисунок 21 – Изменение концентрации CO_2 (ppmv) при реализации RCP6.0 (синяя кривая) и при использовании совокупности методов CDR в сочетании с RCP6.0 (красная кривая), концентрация CO_2 550 ppmv (желтая прямая), концентрация CO_2 354 ppmv 1990 года (зеленая прямая). Розовым цветом окрашена зона превышения условно приемлемой концентрации CO_2.