IPCC Visual Style Guide
for Authors

IPCC WGI Technical Support Unit

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Working Group I (WGI) - The Physical Science Basis

An IPCC Visual Style Guide
for
the Authors

Creating engaging, user-friendly and understandable data visualisations to convey complex scientific information is a core part of the IPCC's commitment to making scientific knowledge about climate change more accessible to wider audiences.

This document provides guidelines to Authors on preparing data visualisations for all IPCC reports under the Sixth Assessment Cycle (AR6). More than just recommendations, this document contains additional guidance that supports your outreach activities after the report approval. It is an updated version of the IPCC's visual style guide from AR5, adapted to include recommendations from cognitive scientists[1] and information designers[2] on creating compelling data visualisations while retaining all aspects of scientific integrity. The guidelines have been widely inspired by research led by Dr Jordan Harold from the University of East Anglia and the Tyndall Centre for Climate Change Research[3,4,5]. The research was supported by the Norwegian Environment Agency and the High-End cLimate Impacts and eXtremes (HELIX Climate) project. This guide also contains general formatting rules and principles that will ensure your figures are consistent with IPCC style and appropriate for use in print and online.

As much as possible, IPCC Authors should aim to apply this style guide from the beginning of their design process. Not only will this keep a consistent and harmonized visual style across the AR6 reports but also help you create visualisations where your readers can clearly understand the message that you want communicated from your data.

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[1] University of East Anglia and Tyndall Centre for Climate Change Research, https://tyndall.ac.uk/datavisuals

[2] InfoDesignLab, an information design firm specialised on visualising science https://infodesignlab.com/

[3] Harold, J., Lorenzoni, I., Coventry, K.R., & Minns, A. (2017). Enhancing the accessibility of climate change data visuals: Recommendations to the IPCC and guidance for researchers. Report published by the Tyndall Centre for Climate Change Research, Norwich, UK.

[4] Harold, J., Lorenzoni, I., Shipley, T. F., & Coventry, K. R. (2016). Cognitive and psychological science insights to improve climate change data visualization. Nature Climate Change, 6, 1080-1089.

[5] http://guidance.climatesciencecognition.com/

AT A GLANCE - What this guide covers

The **M.A.D.E** principle of good visual design

The basic elements of good visual design are encapsulated by the **M.A.D.E** principle - **M**essage, **A**udience, **D**esign, **E**valuation. Developed from cognitive and psychological evidence, these four elements are essential to keep in mind when visualizing complex scientific data.

Message ———• Does the visual communicate a clear message?

A udience ———• Is the visual appropriate for the intended audience(s)?

D esign ———• Does the visual use evidence-based design principles?

E valuation ——• Has the visual been tested with the audience(s)?

Before you begin...

Ask yourself three questions

• What message do I want to convey?

• Who is my audience and what is my audience's prior knowledge?

• What information is essential to communicate the message to my audience in a rigorous, transparent and exhaustive way?

Your narrative in words - A useful exercise is to write down, as concisely as you can, the main message you want your readers to take away from your figure, and refer back to this throughout the design process. Ideally, test prototypes or different versions with your target audience at different stages. Check if the messages they take away from it match what you intended - and use this feedback to improve your figure. You should expect to make several iterations during the design process.
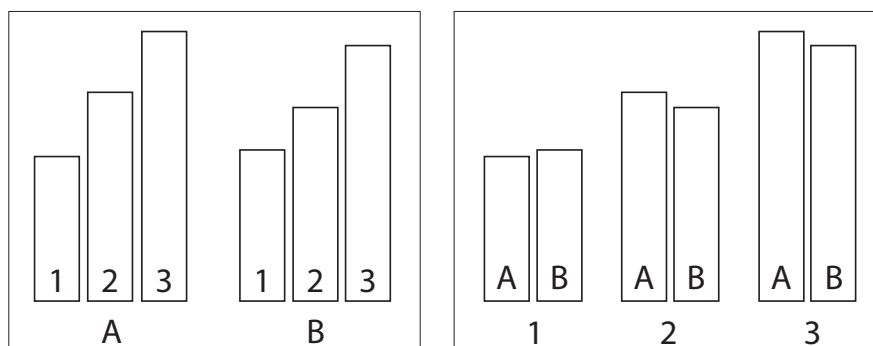
The left and right-hand visuals illustrated above show the same data in different layouts. If, for example, your main message is that there are subtle differences between A and B in the data then the right-hand visual conveys this message more clearly than the left-hand visual

Adapted from Harold et al., 2017

WHO ARE THE IPCC'S AUDIENCES?

The primary target audiences of IPCC are governments and policy-makers.

Broader audiences are the United Nations, IPCC observer organizations, the scientific community, educators, non-governmental organizations (NGOs), the business and finance sector and the wider public.

Keep in mind that each individual has their own

- Level of existing knowledge
- Way of thinking
- Landmarks in terms of graphics
- Information needs

The IPCC's audience is global and we should be careful of cultural differences in interpreting some elements of visual design. If you use icons for example, be extra mindful and ask yourself if they are representative for the majority of the population. Always show your icons with text to avoid any misunderstanding.

Wheat and tractors are common agriculture icons. However, they are not common practice worldwide and are therefore not suitable for the IPCC.

STEP 1 - Choosing your data visualisations

Where possible, choose a visual format that your audience is familiar with. This will help them grasp how the data are structured and move quickly to the main message[6,7].

If you use an unfamiliar data format, consider helping the reader by building up information and/or guiding them through. Could you use multiple panels? Is there a logical order in which they should view the information? A well-designed figure is recognized by the clarity of its message and readability. Avoid any features that might confuse and distort a reader's interpretation.

Before | After (information sequentially built up)
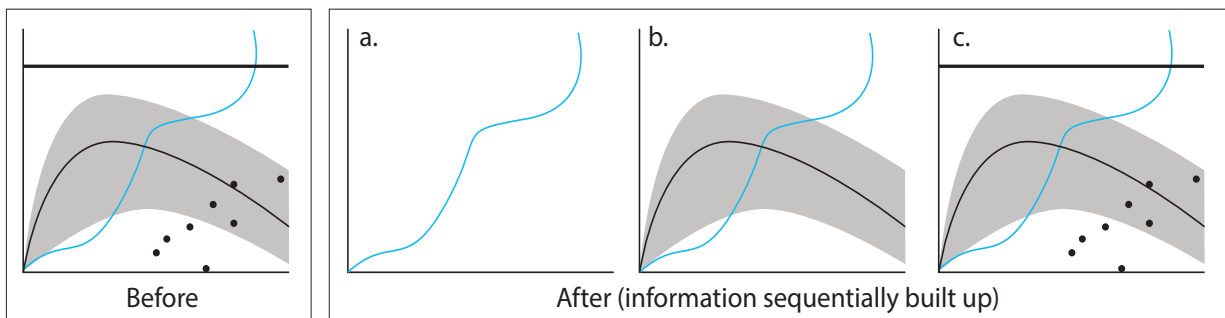
Grouping information into visual chunks can support readers in making relevant inferences about the data.

Adapted from Harold et al., 2017

Also, keep in mind that a reader's comprehension can be influenced by widely-accepted visual metaphors and by their observations of the physical world. Consider these examples:

 Up tends to be associated with good, down with bad.
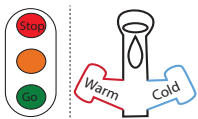
 Colours often come with intuitive perceptions (see Step 2, page 6)

 Vertical arrangement can give a stronger sense of positive/negative. Horizontal bars may work better for variables that have a horizontal element (i.e. distance).
N.B: In some situations however, horizontal bars can be preferable to vertical bars, to enable text labels to be legible and appear as horizontal text.

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[6] Zacks, J., Levy, E., Tversky, B., & Schiano, D. (2002). Graphs in print. In Anderson, M., Meyer, B., & Olivier, P. (Eds). Diagrammatic Representation and Reasoning (pp. 187-206). London, Springer

[7] Gołębiowska, I. (2015). Legend layouts for thematic maps: A case study integrating usability metrics with the thinking aloud method. The Cartographic Journal, 52(1), 28-40

STEP 2 - Which colours to use

Use of colour can be very effective for adding clarity or emphasis to a figure. However, colour should always be used with care. An overly colourful graph can hinder a reader's comprehension and lead to unintended interpretations.
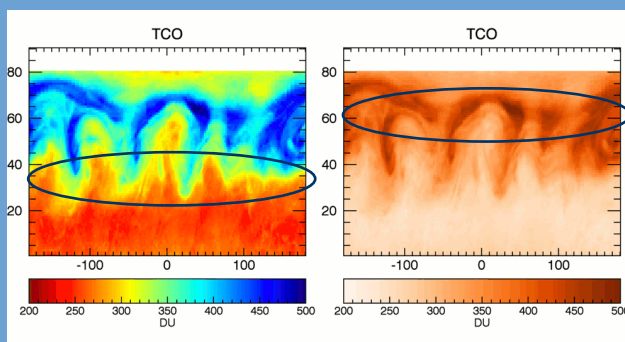
A few points to bear in mind

- Question your choices: What is the purpose of using this colour in this specific place or for this data? Does it enhance your message? For more on this, see the discussion on the use of the rainbow scale (Box #endrainbow on page 6-7).

- Be aware of specific cultural interpretations as well as common perceptions. Red tends to infer warmth, danger or a "stop" signal while blue is associated with cold and water. Green tends to be associated with nature and "go" signal while yellow-brown tones can be associated with dryness. A darker colour tends to indicate "more" of a quantity. Although exceptions to these tendencies can be found across different cultures.

- When it comes to seeing colours, some colours are percieved differently by people. Colour blindness also known as colour vision deficiency, is the decreased ability to see colour or differences in colour.

- Colours displayed on your screen may not be preserved when printed or photocopying (see page 11 and 12).

#ENDRAINBOW

Even with effective colour cues, your figure can be rendered illegible to colour blind readers through a poor choice of colour scale.

The most commonly used « rainbow» colour scale is a good example of misleading data visualisation and should be avoided for the following reasons:

- **A percieved gradient that does not match the underlying data**

https://www.climate-lab-book.ac.uk/2016/why-rainbow-colour-scales-can-be-misleading/
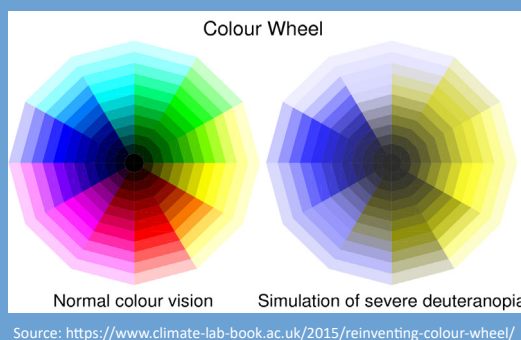Figure by Sean Davis

Sharp colour changes (i.e. red/yellow/green/blue) create apparent boundaries that are not necessarily present in the data.
Because yellow is the brightest colour of the palette, it will stand out and create the illusion of a front where there is none and minimize the actual front.

An unsuitable palette for colour blind vision

Rainbow colours when together are not easily distinguished by colour blind readers (i.e. red/green, magenta/turquoise) and may lead to distorted perceptions of the data and altered meaning.
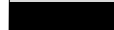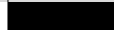
Colour Wheel

Normal colour vision   Simulation of severe deuteranopia

Source: https://www.climate-lab-book.ac.uk/2015/reinventing-colour-wheel/

For standard formats (e.g. line graphs, maps) and for visualisation of the Representative Concentration Pathways (RCPs), please follow the IPCC's colour palettes below. These colour guides have been developed to be accessible for readers with common forms of colour blindness. Online tools[8] can help you check what your graphic will look like to someone who is colour blind. We aim for a consistent colour coding within each report and across reports.
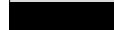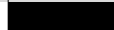
Line charts

For line graphs, please use the colours below in the order in which they appear. The order can be skipped if your variable matches the culturally accepted perception of one of the colour below (i.e. «blue» for water masses, «green» for biomass, see Step 1 on page 5). This selection is adapted for accessibility from the IPCC Visual Identity Guidelines[9], which also contains guidance on fonts, photography and use of the IPCC logo to ensure consistency of the IPCC brand across internal and external communications.

Shading	R	G	B	C	M	Y	K
	128	128	128	49	39	38	20
	91	174	178	65	12	32	0
	204	174	113	20	28	60	6
	191	191	191	0	0	0	25
	67	147	195	72	30	10	1
	223	237	195	17	0	31	0

1 colour	R	G	B	C	M	Y	K
	0	0	0	91	79	62	97

2 colours	R	G	B	C	M	Y	K
	0	0	0	91	79	62	97
	112	160	205	60	28	6	0

3 colours	R	G	B	C	M	Y	K
	0	0	0	91	79	62	97
	112	160	205	60	28	6	0
	196	121	0	19	55	100	9

4 colours	R	G	B	C	M	Y	K
	0	0	0	91	79	62	97
	112	160	205	60	28	6	0
	196	121	0	19	55	100	9
	178	178	178	0	0	0	30

5 colours	R	G	B	C	M	Y	K
	0	0	0	91	79	62	97
	112	160	205	60	28	6	0
	196	121	0	19	55	100	9
	178	178	178	0	0	0	30
	0	52	102	100	82	35	21

6 colours	R	G	B	C	M	Y	K
	0	0	0	91	79	62	97
	112	160	205	60	28	6	0
	196	121	0	19	55	100	9
	178	178	178	0	0	0	30
	0	52	102	100	82	35	21
	0	79	0	89	42	100	45

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[8] Color Oracle https://colororacle.org/
[9] IPCC Visual Identity Guidelines https://wg1.ipcc.ch/SR/documents/ipcc_visual-identity_guidelines.pdf

Maps

To represent diverging data, such as temperature change, it is best to use two contrasting hues, where white is the central value and an increase in colour darkness indicates a more positive/ negative value. Please note that multi-hue sequences in general will not render properly in black and white photocopy or print. Also, sequences do not exceed 11 colours since further divisions within the scheme lead to a set of adjacent colours that are hard to distinguish from each other[10].

For any other variables, coordinating choices with your co-authors on common styles and colours will help a reader navigate seamlessly through your chapter. Alternatively, contact the TSU for advice.

- Representative Concentration Pathways (RCPs) -

RCP	Line	R	G	B	C	M	Y	K	Shading	R	G	B	C	M	Y	K
8.5		153	0	2	25	100	100	26		252	209	197	0	24	20	0
6.0		196	121	0	19	55	100	9		204	174	113	20	28	60	6
4.5		112	160	205	60	28	6	0		146	197	222	47	10	9	0
2.6		0	52	102	100	82	35	21		67	147	195	72	30	10	1

- Temperature -

5 colours	R	G	B	C	M	Y	K
	202	0	32	13	100	91	4
	244	165	130	0	44	49	0
	247	247	247	4	3	3	0
	146	197	222	47	10	9	0
	5	113	176	87	48	7	0

6 colours	R	G	B	C	M	Y	K
	178	24	43	21	99	80	13
	239	138	98	1	56	62	0
	253	219	199	0	19	22	0
	209	229	240	25	2	6	0
	103	169	207	61	20	10	0
	33	102	172	87	56	3	0

7 colours	R	G	B	C	M	Y	K
	178	24	43	21	99	80	13
	239	138	98	1	56	62	0
	253	219	199	0	19	22	0
	247	247	247	4	3	3	0
	209	229	240	25	2	6	0
	103	169	207	61	20	10	0
	33	102	172	87	56	3	0

8 colours	R	G	B	C	M	Y	K
	178	24	43	21	99	80	13
	214	96	77	13	73	62	2
	244	165	130	0	44	49	0
	253	219	199	0	19	22	0
	209	229	240	25	2	6	0
	146	197	222	47	10	9	0
	67	147	195	72	30	10	1
	33	102	172	87	56	3	0

9 colours	R	G	B	C	M	Y	K
	178	24	43	21	99	80	13
	214	96	77	13	73	62	2
	244	165	130	0	44	49	0
	253	219	199	0	19	22	0
	247	247	247	4	3	3	0
	209	229	240	25	2	6	0
	146	197	222	47	10	9	0
	67	147	195	72	30	10	1
	33	102	172	87	56	3	0

10 colours	R	G	B	C	M	Y	K
	103	0	31	34	100	66	54
	178	24	43	21	99	80	13
	214	96	77	13	73	62	2
	244	165	130	0	44	49	0
	253	219	199	0	19	22	0
	209	229	240	25	2	6	0
	146	197	222	47	10	9	0
	67	147	195	72	30	10	1
	33	102	172	87	56	3	0
	5	48	97	100	84	37	24

11 colours	R	G	B	C	M	Y	K
	103	0	31	34	100	66	54
	178	24	43	21	99	80	13
	214	96	77	13	73	62	2
	244	165	130	0	44	49	0
	253	219	199	0	19	22	0
	247	247	247	4	3	3	0
	209	229	240	25	2	6	0
	146	197	222	47	10	9	0
	67	147	195	72	30	10	1
	33	102	172	87	56	3	0
	5	48	97	100	84	37	24

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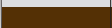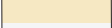
[10]Mark Harrower & Cynthia A. Brewer (2003) ColorBrewer.org: An Online Tool for Selecting Colour Schemes for Maps, The Cartographic Journal, 40:1, 27-37, DOI: 10.1179/000870403235002042

- Precipitation -

5 colours	R	G	B	C	M	Y	K		6 colours	R	G	B	C	M	Y	K		7 colours	R	G	B	C	M	Y	K
	166	97	26	25	80	98	19			140	81	10	31	64	100	33			140	81	10	31	64	100	33
	223	194	125	14	22	58	2			216	179	101	16	28	67	4			216	179	101	16	28	67	4
	245	245	245	5	4	4	0			246	232	195	5	8	29	0			246	232	195	5	8	29	0
	128	205	193	53	0	31	0			199	234	229	26	0	14	0			245	245	245	5	4	4	0
	1	133	113	84	24	61	8			90	180	172	64	6	38	0			199	234	229	26	0	14	0
										1	102	94	88	34	59	28			90	180	172	64	6	38	0
																			1	102	94	88	34	59	28

8 colours	R	G	B	C	M	Y	K		9 colours	R	G	B	C	M	Y	K		10 colours	R	G	B	C	M	Y	K
	140	81	10	31	64	100	33			140	81	10	31	64	100	33			84	48	5	43	68	92	64
	191	129	45	21	50	89	11			191	129	45	21	50	89	11			140	81	10	31	64	100	33
	223	194	125	14	22	58	2			223	194	125	14	22	58	2			191	129	45	21	50	89	11
	246	232	195	5	8	29	0			246	232	195	5	8	29	0			223	194	125	14	22	58	2
	199	234	229	26	0	14	0			245	245	245	5	4	4	0			246	232	195	5	8	29	0
	128	205	193	53	0	31	0			199	234	229	26	0	14	0			199	234	229	26	0	14	0
	53	151	143	76	19	47	3			128	205	193	53	0	31	0			128	205	193	53	0	31	0
	1	102	94	88	34	59	28			53	151	143	76	19	47	3			53	151	143	76	19	47	3
										1	102	94	88	34	59	28			1	102	94	88	34	59	28
																			0	60	48	93	46	73	60

11 colours	R	G	B	C	M	Y	K
	84	48	5	43	68	92	64
	140	81	10	31	64	100	33
	191	129	45	21	50	89	11
	223	194	125	14	22	58	2
	246	232	195	5	8	29	0
	245	245	245	5	4	4	0
	199	234	229	26	0	14	0
	128	205	193	53	0	31	0
	53	151	143	76	19	47	3
	1	102	94	88	34	59	28
	0	60	48	93	46	73	60

a)

b)
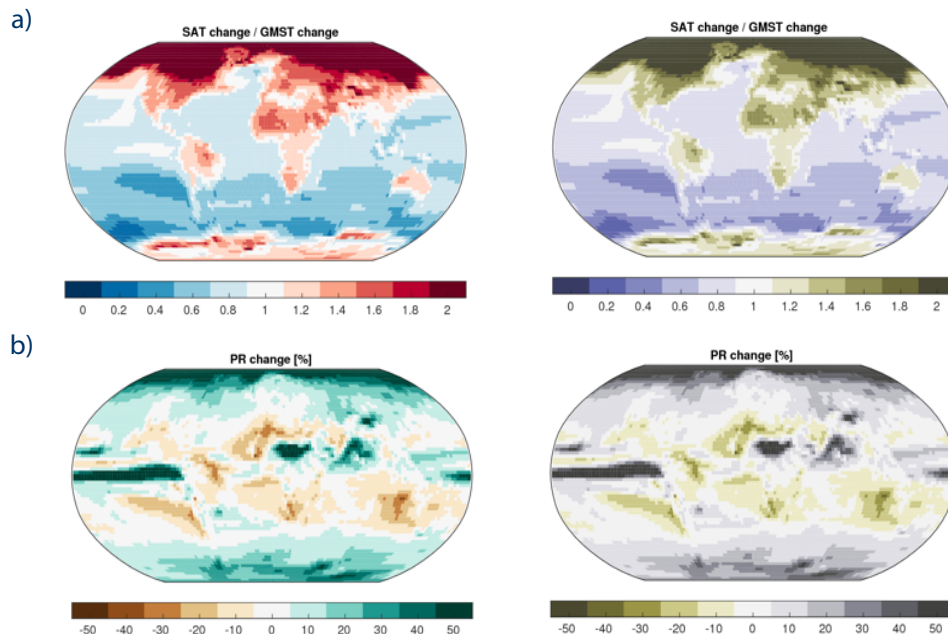
The images on the left are examples of (a) temperature and (b) precipitation maps using the IPCC colour palette. The images on the right are how a severely (deuteranope) colour blind person would see them.

Non-diverging data

When your data is not divergent and you want to order your data from low to high, use the following hue sequential schemes with a gradient effect from light (i.e. low values) to dark (i.e. high values) colours. This accessible colour selection is in line with the IPCC Visual Identity Guidelines but, please note that, when using more than 5 colours, contrasts will not render properly in black/white printing.

When applicable, chose the colour that intuitively represents the most your variable (e.g. blue for «water», green for «biomass», red for «temperature»). If you decide to use more than one colour scheme in your figure, do not use blue/purple or green/red together as this combination is not distinguishable for colour blind vision.

Single-hue sequential schemes:

3 colours	R	G	B	C	M	Y	K	4 colours	R	G	B	C	M	Y	K	5 colours	R	G	B	C	M	Y	K
	222	235	247	15	4	1	0		239	243	255	7	4	0	0		239	243	255	7	4	0	0
	158	202	225	42	9	8	0		189	215	231	30	8	7	0		189	215	231	30	8	7	0
	49	130	189	78	40	6	0		107	174	214	60	18	7	0		107	174	214	60	18	7	0
									33	113	181	84	49	2	0		49	130	189	78	40	6	0
																	8	81	156	97	69	5	0

3 colours	R	G	B	C	M	Y	K	4 colours	R	G	B	C	M	Y	K	5 colours	R	G	B	C	M	Y	K
	239	237	245	7	7	2	0		242	240	247	6	6	1	0		242	240	247	6	6	1	0
	188	189	220	31	25	3	0		203	201	226	23	21	3	0		203	201	226	23	21	3	0
	117	107	177	63	61	0	0		158	154	200	44	40	3	0		158	154	200	44	40	3	0
									106	81	163	70	74	0	0		117	107	177	63	61	0	0
																	84	39	143	84	95	0	0
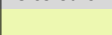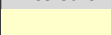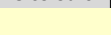
3 colours	R	G	B	C	M	Y	K	4 colours	R	G	B	C	M	Y	K	5 colours	R	G	B	C	M	Y	K
	254	224	210	0	17	17	0		254	229	217	0	14	14	0		254	229	217	0	14	14	0
	252	146	116	0	54	52	0		252	174	145	0	41	71	0		252	174	145	0	41	71	0
	222	45	38	4	92	88	0		251	106	74	0	70	68	0		251	106	74	0	70	68	0
									203	24	29	13	99	95	3		222	45	38	4	92	88	0
																	165	15	21	23	100	98	19
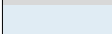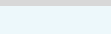
3 colours	R	G	B	C	M	Y	K	4 colours	R	G	B	C	M	Y	K	5 colours	R	G	B	C	M	Y	K
	229	245	224	13	0	17	0		237	248	233	10	0	13	0		237	248	233	10	0	13	0
	161	217	155	43	0	50	0		186	228	179	33	0	39	0		186	228	179	33	0	39	0
	49	163	84	77	6	84	0		116	196	118	58	0	67	0		116	196	118	58	0	67	0
									35	139	69	90	31	100	21		49	163	84	77	6	84	0
																	0	109	44	90	32	93	25
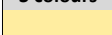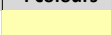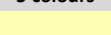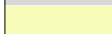
If you wish to have a more striking contrast between the different colour classes, please use the following multi-hue sequential schemes based on the same colours in the previous palette.

Multi-hue sequential schemes:

3 colours	R	G	B	C	M	Y	K	4 colours	R	G	B	C	M	Y	K	5 colours	R	G	B	C	M	Y	K
	237	248	177	12	0	40	0		255	255	204	3	0	27	0		255	255	204	3	0	27	0
	127	205	187	53	0	34	0		161	218	180	42	0	38	0		161	218	180	42	0	38	0
	44	127	184	80	41	8	0		65	182	196	68	3	25	0		65	182	196	68	3	25	0
									34	94	168	89	62	2	0		44	127	184	80	41	8	0
																	37	52	148	99	87	1	0

3 colours	R	G	B	C	M	Y	K	4 colours	R	G	B	C	M	Y	K	5 colours	R	G	B	C	M	Y	K
	224	236	244	15	4	3	0		237	248	251	9	0	2	0		237	248	251	9	0	2	0
	158	188	218	43	19	7	0		179	205	227	34	12	7	0		179	205	227	34	12	7	0
	136	86	167	63	61	0	0		140	150	198	51	39	4	0		140	150	198	51	39	4	0
									136	65	157	59	83	0	0		136	86	167	57	74	0	0
																	129	15	124	62	100	6	1

3 colours	R	G	B	C	M	Y	K	4 colours	R	G	B	C	M	Y	K	5 colours	R	G	B	C	M	Y	K
	254	237	160	1	5	47	0		255	255	178	4	0	39	0		255	255	178	4	0	39	0
	254	178	76	0	36	75	0		254	204	92	0	22	71	0		254	204	92	0	22	71	0
	240	59	32	0	86	88	0		253	141	60	0	55	78	0		253	141	60	0	55	78	0
									227	26	28	0	97	93	0		240	59	32	0	86	88	0
																	189	0	38	18	100	84	8

3 colours	R	G	B	C	M	Y	K	4 colours	R	G	B	C	M	Y	K	5 colours	R	G	B	C	M	Y	K
	247	252	185	7	0	36	0		255	255	204	3	0	27	0		255	255	204	3	0	27	0
	173	221	142	39	0	56	0		194	230	153	31	0	51	0		194	230	153	31	0	51	0
	49	163	84	77	6	84	0		120	198	121	57	0	66	0		120	198	121	57	0	66	0
									35	132	67	83	23	91	8		49	163	84	77	6	84	0
																	0	104	55	90	32	93	25

If you are dealing with qualitative data, using contrasting colours allows to clearly separate the different categories. We suggest you to use the same colour schemes as proposed for line charts on page 7 as they are accessible for colour blind vision and black/white printing.

Choose the right colour mode

The colours you see on your computer monitor and in a printed image are based on two different colour mixing systems. Digital devices create colours with the RGB (Red Green Blue) method while professional printers apply mostly the CMYK (Cyan Magenta Yellow Black) system. RGB mode covers a wider colour range than CMYK, which results in tone and brightness differences between the printed version of a figure and its digital rendering on screen.

RGB
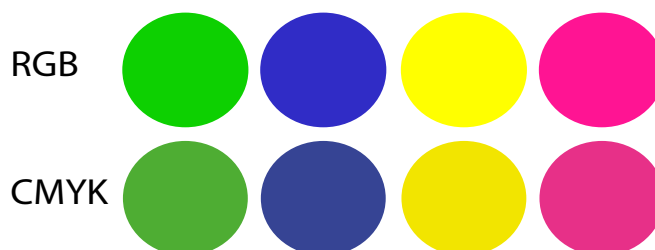
CMYK

N.B: when printed, this figure displays no difference between both colour modes as the printer automatically converts RGB into CMYK. To see the difference, please check on screen the PDF file of the Visual Style Guide.

As a rule of thumb, figures to be displayed on screens (web, Powerpoint) should be formatted in RGB. Those intended for printing should be formatted in CMYK. Modern printers can convert RGB files into CMYK automatically but some colour accuracy will be lost during the printing.

For IPCC purposes and if supported by your software, please design and submit your figures to the TSU in CMYK format, with an additional version converted into RGB (Step 11 on page 20). If you are working with black and grey shades only, you can save your figure in Greyscale mode. Prior the submission of the Second Order Draft, the TSU will provide you with specific guidance for formatting your figures accordingly.

STEP 3 - Formatting text and axes

For IPCC purposes, please use sans serif fonts (Arial, preferably) for any text within graphics. Avoid bold, italic or underlined text. Except for Y-axis title, avoid rotating text through 90°, wherever possible[11]. In general, use 9 pt font size for text on smaller figures and 11 pt font size for larger figures.

Please keep axes black and use a line thickness of 0.5 pt. All axes should be clearly labelled with the quantity being represented, including its unit in parenthesis (not square brackets) e.g., Temperature Anomaly (°C). If your title contains chemical formulae, use majuscules and subscript numbers (i.e. CH_4) and specify the chemical name first (see Step 5 on page 14). For powers (i.e. m^3), use superscript numbers.

The X and Y axes should have a neat intersection and cover the full range of values. If your Y axis goes below zero, place a horizontal dotted line on the chart to indicate the zero level.

If your figure is composed of several graphics, ask yourself if any of the axes are redundant and if they could be combined to facilitate comparison between the variables. If the Y-axes cannot be combined, try to keep the same scale, where possible. Consider dual axis charts only when comparing two data sets with different measures.
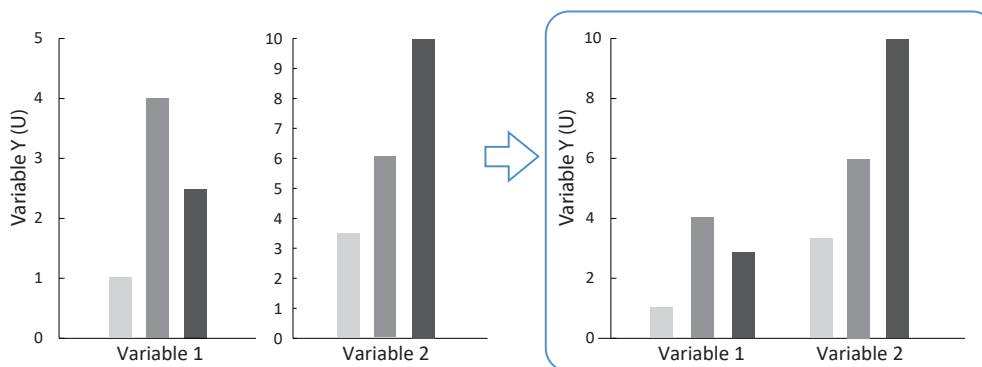
Combining two charts into one facilitates the comparision between variables and unclutters the figure. Note, however, that in this specific example, small differences in variable 1 are then harder to detect. The choice of your design comes always down to the message you want to convey.

[11] Evergreen, S. D. H. (2014). Presenting Data Effectively: Communicating Your Findings for Maximum Impact. London, Sage.

Using tick marks can facilitate a reader's understanding. However, too many can be distracting. Use major tick marks for linear scales and add minor ones for logarithmic scales.

Adding a grid can help relate the data to the axis tick marks and compare absolute values. However, use grids only when they facilitate your audience ability to grasp your message. In this respect, use transparency or dotted lines, depending on the density of your data. Also, chose a transparent background for the plane and do not frame the graph.

STEP 4 - Legends and colour bars

A reader will typically look back and forth continuously between the data and the legend to make sense of a graphic. Integrating annotations and labels in the graphic rather than putting them in a separate legend can help a reader match up information with the relevant part of the visual (Step 5 on page 14)[12]. But it is important not to make the visual too busy. Include only annotations that are essential to communicate your message and avoid 'visual clutter' that may impair understanding. If adding annotations brings too much unnecessary complexity, use a legend.
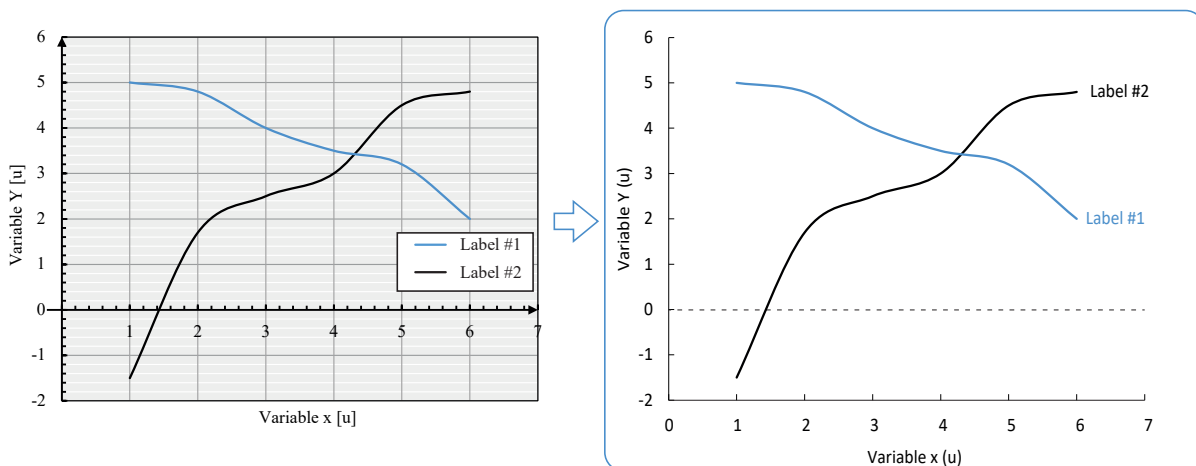
If using a legend or colour bar, locate it clearly on the figure and use a bounding box (0.5 line thickness, black) to distinguish it from surrounding elements. If there is sufficient white space within a plot area, move the legend/colour bar there rather than using additional space below or to the side of the figure. This will liberate space that you can use for the graph itself.

Please ensure colour bars are an appropriate size and that all relevant units are given. Any colours on a map that are not in the colour bar should be explained in the caption or the figure itself (e.g. grey shading, stippling, white areas). To choose which colour to use, please refer to Step 2 on page 6.

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[12] Tufte, E. R. (2006) Beautiful Evidence. Cheshire, Connecticut, Graphics Press.

STEP 5 - Using labels and annotations

Try to avoid jargon when labelling figures, wherever possible[13]. Avoiding unfamiliar acronyms and abbreviations and using lay terms in place of technical jargon as far as possible will help make your figure accessible for different audiences.

Where a technical term is used, try to explain its meaning in the visual rather than assume readers will know where to look it up. Spell out an acronym on first use and give the shortened version in brackets. After that, use the abbreviated form only.
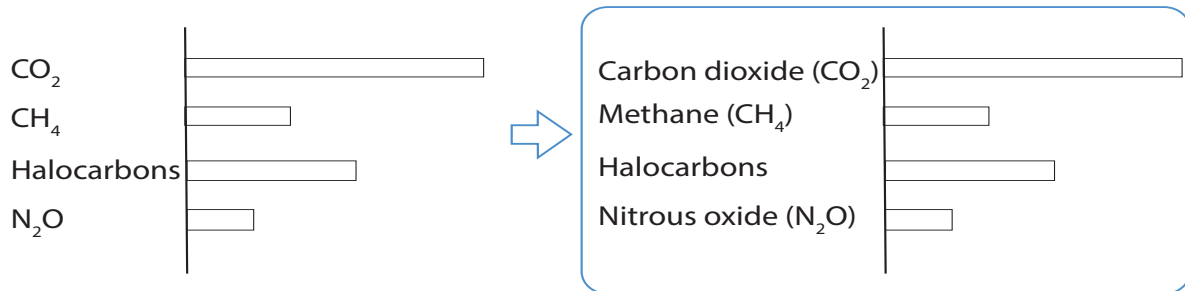
Unfamiliar acronyms and abbreviations can alienate readers, because they require the reader to locate and interpret their meaning.

Adapted from Harold et al., 2017

Annotations are short text labels embedded directly in a graphic to add clarity, lead a reader through different sequential elements or highlight a specific aspect of your key message. Always place annotations close to the element of interest to avoid splitting a reader's attention.

STEP 6 - Enhancing with visual cues

Following a few simple cognitive and perceptual design techniques can help direct readers' visual attention in a way that enhances their understanding of the data and of the message you are trying to convey. Using contrasting colours or sizes can highlight were a reader should focus their attention (i.e. bright or dark colour for the most salient information and soft colour for the rest)[14]. Visually link connected information by grouping data together or using the same colour for an annotation and the data it refers to (Step 4 on page 13). Arrows can also help direct visual attention.

When using any such cues, think about the 'visual hierarchy' of your figure. Which elements do you want a reader to see first (see Step 1 on page 5 - building up the information)? Which features should be kept in the background as supporting elements? You do not want the reader to be distracted from your key message. For this reason, you could also consider using a different line thickness (i.e. dotted or thinner) or transparency level compared to your data.

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[13] Hales, A. H., Williams, K. D., & Rector, J. (2017). Alienating the audience: How abbreviations hamper scientific communication. Association for Psychological Science Observer, 30(2), 22-24.

[14] Kosslyn, S. M. (1989). Understanding charts and graphs. Applied Cognitive Psychology, 3(3), 185-225

The production rate of **A** is the highest among the tested group.
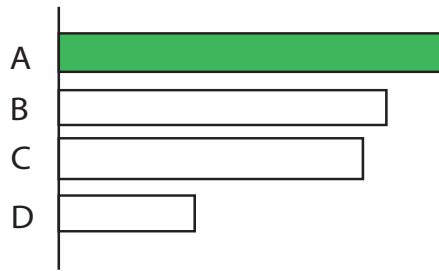
Contrast in colour can direct reader's visual attention. Matching elements, e.g. text and data, enables readers to easily associate them.

Adapted from Harold et al., 2017

REPRESENTING UNCERTAINTY AND CONFIDENCE

It it is important to convey uncertainty and confidence in your visual as this is often an inherent part of the outcome of your assessment. Think carefully about different ways to do this - and preferably test them out on your target audience. There is no one-size-fits-all rule and different formats will be appropriate in different contexts. You could use error bars, a shaded range or hatching, for example. Consider whether adding short text labels could help a reader understand how uncertainties should be interpreted.

Five visual representations of uncertainty/confidence
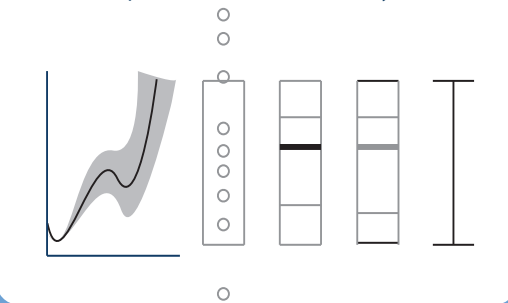
There is no single 'correct' way to represent uncertainties in data. Be aware, however, that different representations may affect interpretation differently in different audiences.

Harold et al., 2017
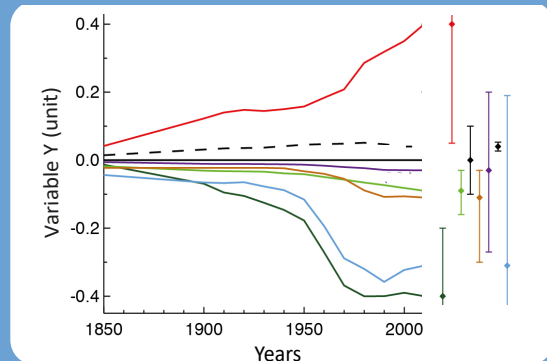
Adapted from Figure 8.8, WGI AR5.

Representing uncertainty outside of the x/y plane can unclutter the graphic and present all information in a clear way.

STEP 7 - Create a caption

Captions should be as concise as possible, explaining only what is needed to understand the graphic (e.g., lines, symbols, shading, colours, etc.) As with many scientific journals, we recommend captions of 250 words or less, where possible. Make sure that the caption starts right after the figure on the same page. Ideally, it should fit fully on this same page.

Captions should be able to act as a standalone explanation of a figure, giving the reader the information they need to understand the message. They should not just be a technical description that leaves the reader to make sense of the information for themselves. Neither should they provide extensive scientific interpretation, which is usually better placed in the main text. The caption should however include the sources of the underlying data.
You can think of the first sentence of the caption as an overarching title of the figure. Consider which elements could be integrated into the figure itself, to help a reader match up information with the relevant part of the visual (Steps 4 on page 13 and Step 5 on page 14).

Where multiple data sources are used, consider putting them in a table with their acronyms in the main text and referring to the table in the figure caption. Any references cited in figure captions should be included in the reference list of the chapter.

DESIGNING SPM GRAPHICS

The Summary for Policymakers (SPM) is a distillation of the most policy-relevant findings from an IPCC report, and is often the highest-profile and most-read part. More so than the graphics in the underlying chapters, those in the SPM will need to be easily understood and convey a core message concisely and engagingly.

Think carefully about your audience.

Engaging with a user is a powerful technique to dive into the needs of your audience. Rather than constructing a fictitious profile in your head of an average person representing your audience, get in touch with one or two people that could potentially belong to this audience, interview them and understand their needs in relation to the information you have to communicate.

Identify the peak of your story.

Building on from the 'visual hierarchy' of your figure, as discussed in Step 6 on page 14, think carefully about your core message, the peak of your visual journey, that you should be able to summarize in no more than one sentence. Once this peak is set, consider what information is essential to understand the core message and build the visual elements around this to support your readers' understanding.

Headings, subheadings, annotations, arrangement of the visual elements on the page, colour and visual cues can direct the visual attention and provide explanation when readers need it.

Figure heading

Descriptive figure heading
Sub-heading to highlight the main message

Line A
Line B

Y (unit)

Legend
Line A
Line B

X (unit)

Y (unit)

X (unit)
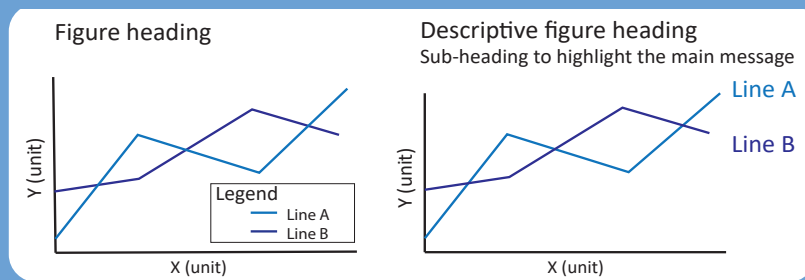
When a visual and associated text are separated, visual attention is split. Readers need to exert more cognitive effort and the risk of comprehension difficulties increases.

Adapted from Harold et al., 2017

How things are perceived visually affects how things are understood.

You should be aware that the way you organize or group different elements on a page or computer screen carries meaning and is an important visual affect. The Gestalt Principles of Visual Perceptions[15] can help identify which elements in your visualisation are necessary and which might be noise.

STEP 8 - Testing on your audience

Ideally, test early versions of your figure on your target audience. If that is not possible, test it with people who have a similar level of prior knowledge to your audience. Avoid testing successive versions on the same person. It is better to get a fresh perspective each time.

A simple way to test your graphic is to ask people what they think is the main message and see if their interpretations match what you intended. More rigorous testing, such as eye-tracking, can help diagnose the reasons for comprehension problems, but these are unlikely to be necessary in most cases. Contact the TSU for more information about audience testing.

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[15] https://uxcheat.com/visual-ui-design/gestalt-principles/

1. Plan your visual using the guidance

2. Create your visual

Iterative design cycle

3. Test your visual
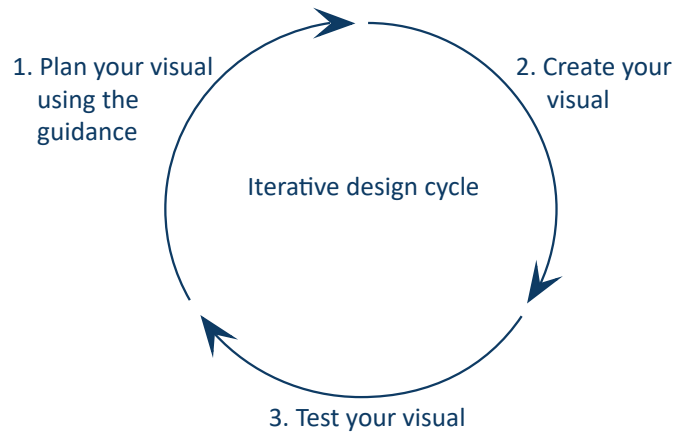
Peoples' intuitions of what constitutes an effective design for a visual don't always match what people find easiest to understand.

Adapted from Harold et al., 2017

STEP 9 - Size, positioning and numbering

For IPCC purposes, please design figures to display in either single-column (9 cm) or double-column (18 cm) width and avoid making them wider than double-column or taller than 25 cm. When resizing figures, ensure all information remains legible and that font sizes and line thicknesses do not fall below the minimum requirement of 9 pt and 0.5 pt, respectively.

Figures should be numbered consecutively, using the chapter number as a prefix (e.g., "Figure 5.1", "Figure 5.2", …). For figures in boxes or part of an FAQ, please include the Box/FAQ number and restart the figure numbering from 1 (e.g. "Box 5.1, Figure 1"; "FAQ 5.1, Figure 1").

Multiple panels should always be labelled "(a)", "(b)", "(c)" (e.g., "Figure 5.2a", "Figure 5.2b"…). Remember to refer to them this way within the caption too. As long as it does not interfere with your data, place the label at the upper left corner of each panel. Think where the reader's eyes will naturally go and order the panels accordingly.

Anticipate what makes logical sense to your reader and organize your panels accordingly.
This can be checked during user testing.
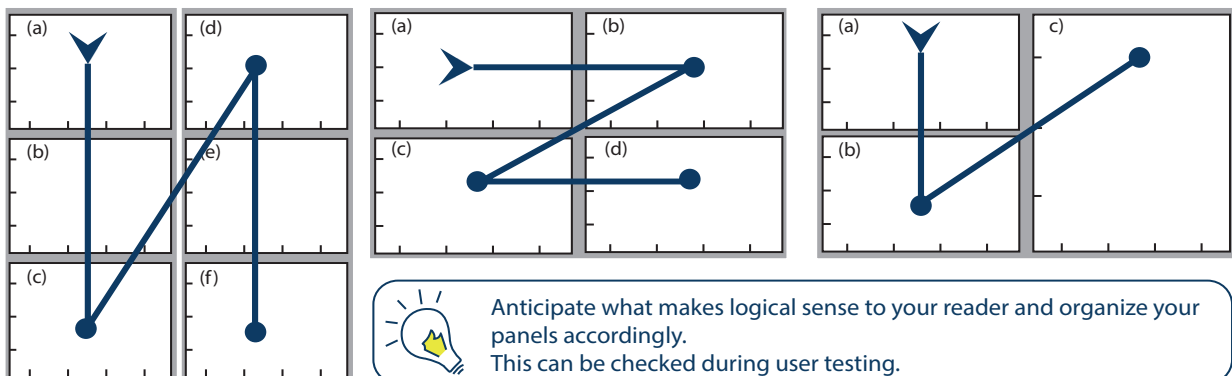
In general, drawing your own graphics that match your text is preferable to reproducing figures from published articles. In cases where you do use somebody else's figure, please ensure you obtain copyright permission from the copyright holder or the adapted or reproduced figure and send it to the relevant TSU. Failing to obtain the correct copyright permission could result in plagerism and even prosecution.

Where possible, try to obtain graphics files (.eps) from the authors of the original publication. Please do not extract the figures from the article using the print screen key or the snapshot tool on Adobe as this will result in poor quality raster files. If you have a vector editor such as Adobe Illustrator or Inkscape (an open access, free software), you can extract the graphics in vector format, provided it was embedded as such in the original pdf article. If these options are not possible, it is usually best to recreate the graphics yourself or contact the relevant TSU for advice.

STEP 10 - Metadata

What lies behind your figure and how it was created is not necessarily obvious to your audience when reading the report. The provision of metadata and data management can help enhance transparency on how your figure was generated, and can facilitate the reproducibility and accessibility to the figure and data.

For your adapted, redrawn or original figures, we therefore ask Authors to supply in a spread sheet distributed by the TSU the following information

- Contact information of the responsible author

- Software used to generate the figure

- Design software used to edit the figure

- How was the figure adapted from the original

- Citation (if adapted or redrawn figure)

- Origin of the data set(s) used

The information will be stored in an online resource manager and will be available on the IPCC website. Please submit the information for the Second Order Draft. We however recommend you to start gathering this information from the start.

STEP 11 - File formats and submitting your figures

For IPCC purposes, please generate standard 2-D plots, contour plots, bar charts, etc. as an encapsulated postscript (EPS) or PDF files using the original graphics/ visualisation software (e.g., MATLAB, Python, R, IDL, GrADS, etc). For schematics and illustrations, please use a vector-based drawing program such as Adobe Illustrator, Adobe InDesign or Corel Draw and save in EPS format. If you don't have access to any of the paid software, you can use Inkscape[16], a free graphics editor. Avoid creating graphics with raster-based software designed for pixel images, such as Adobe Photoshop and Microsoft Paint, unless absolutely necessary.

If you are designing a figure that displays both photos and schematics together, please make sure the photo is embedded in your vector design as a TIFF format with a minimum resolution of 350 pixels per inch (ppi). The photo should not be vectorized. Saving such figures as PDF will ensure both raster and vector objects are retained. Where it is necessary to create a fixed size pixel image, please save it at resolution of at least 350 pixels per inch.

For all drafts (First Order Draft, Second Order Draft, Final Government Distribution), place easily readable versions of each figure in a Word document and submit it separately to the chapter text. Since Word does not read EPS files, embed the figures as JPG with an acceptable resolution to avoid large file size. The figure file should be ordered as the figures appear in the chapter, with one figure per page and the caption immediately below.

For the Final Government Distribution of an IPCC report, the TSU will require figures submitted individually as EPS (for vector-only graphics) or PDF (for raster/vector figures) format. Please make sure all files are in CMYK mode. The TSU will also require versions of the figures for publishing online. Please export your EPS and PDF figures (RGB mode) into JPG format with a resolution of 140ppi and upload these figures separately. It is very important to have the figure in its intended size (see Step 9 on page 18) before setting the resolution and saving the file.

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[16] https://inkscape.org/en/

THE ABC OF IMAGE FILE FORMATS

There are two main types of image files:
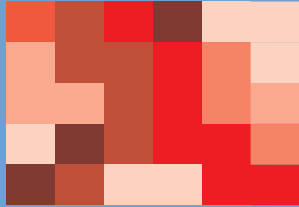
Raster (or Bitmap) figures, in which the visual information is encoded in a grid of pixels, where each pixel is a colour. The higher the amount of pixels, the sharper the image. A scanned figure or a photo taken with a digital camera will be automatically saved as a raster image.
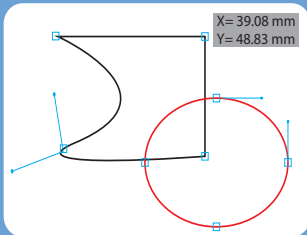
Vector figures, in which the visual information is encoded in a series of vectors describing shapes and colours and is therefore mathematical by nature. A vector image can be converted into raster without losing visual information. This is not the case when vectorizing a raster image.

Both file types have their strengths and weaknesses. Good quality raster graphic files are generally larger than their vector counterpart and cannot be modified or edited.

In addition, raster files are affected by resolution, as opposed to vector images. This means that when rescaling the original can result in a jagged or pixelated image. Vector format, on the other hand, is not suitable for complex images such as high-resolution photographs, where preserving the colour information is crucial.

Because vector images are composed of lines and shapes, in which color and placement are calculated by mathematical formulas, they can be sized, scaled and modified repeatedly without losing sharpness. They are therefore ideal format for illustrations, graphs and line art.
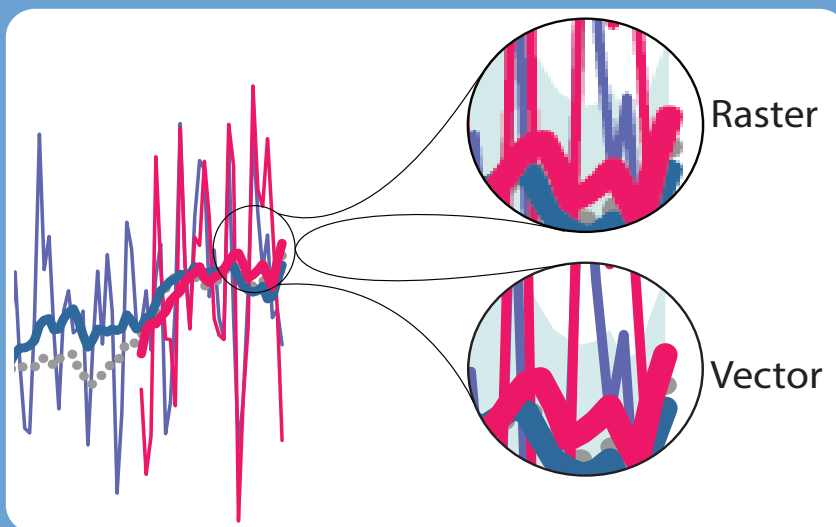
Graphic adapted from IPCC AR5 Chapter 3

WHAT NEXT? Animate and present your figures

Using your figures in a presentation

Avoid transferring a figure exactly as it appears on paper into your presentation slides. The way the audience interacts with it will be different: the figure will be bigger on screen but the audience has less time to look at it, and there is no option to zoom in.

Think about modifying your figure for a presentation as follow

- Simplify the design to emphasize the key message.

- Remove any details that are not necessary to understand your message.

- Avoid too many annotations (your voice will do the work) and use design features that is easy to refer to (e.g. the dashed line, the yellow circle)

- Make the graphic elements (lines, fonts, dashes) thicker and larger so that your audience can see them from a distance.

- Guide your audience through your graph by using simple animations in your slides.
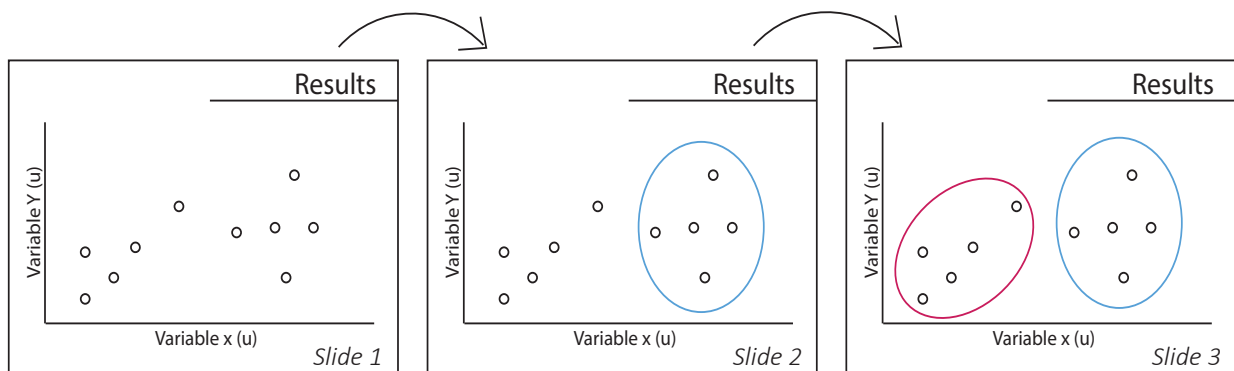
Creating animations

For presentations and online use, animating your figure or making it interactive can enhance the message you are trying to convey. In other cases, however, it might impair a reader's understanding. Ask yourself whether creating an animated or interactive visual will strengthen your message or whether a series of carefully crafted static visuals might be more effective[17].

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[17] Tversky, B., Morrison, J. B., & Betrancourt, M. (2002). Animation: Can it facilitate? International Journal of Human-Computer Studies, 57(4), 247-262

If you do choose to produce an animation, aim to give the reader control over playback (stop/ start) and the speed of animation[18], and use an intuitive or familiar interface. If your animation is not controllable by the user, keep the length to a few seconds.

Small multiples (sequences of static visuals) may work better than animations
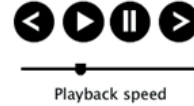
Provide users controls for animation

Animated visuals can be difficult to comprehend if they are too complex or move too quickly for the reader, because information can be difficult to accurately perceive.

Animations tend to work better with a narration than with written text. Using an embedded audio file of a recorded voice alongside animated graphs during presentations can be effective. Consider adding cues to signal where the audience's attention should be focused.

Do not over-complicate. It is better to animate a few elements in a subtle way. Presentation softwares usually have simple animation tools to guide your audience through your graphics and build up the information. Just as for static graphics, consider testing early prototypes of your animations and refining them based on the feedback.

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[18] Betrancourt, M. (2005). The animation and interactivity principles in multimedia learning. In Mayer, R. E. (Ed.) The Cambridge Handbook of Multimedia Learning (pp. 287–296). Cambridge, Cambridge University Press

Summary flowchart

Is this your own figure?

- **No** — Obtain copyright proof for TSU / Ask the authors for the EPS file
- **Yes**

CREATE
- Apply the M.A.D.E principle
- Create your figure in its intended size for the report
- Use the RGB/CMYK colour palettes provided in this style guide
- Check additional colour choices are suitable for colourblindness
- Use plain sans-serif fonts (e.g., 'Arial' rather than 'Times New Roman')
- Avoid bold, italic or underlined text
- Use font size 9 pt for small figures and 11 pt for large figures
- Axis line thickness is 0.5 pt
- Check your labels, annotations and axis title

Does your figure contain a photo?

- **Yes** — Embed the photo in your vector design as a TIFF, resolution of 350 ppi as a minimum
- **No** — Is it for print or for web?

Print

SAVE
- Set your colour space to CMYK
- Set your figure size to 9 cm or 18 cm wide and max. 25 cm long
- Resolution (for raster only): 350 ppi

Web
- Set your colour space to RGB   For animated figures
- Resolution: 140 ppi

Metadata spread sheet

SUBMIT

FOD[19]
- JPG at acceptable resolution

SOD[20]
- JPG at acceptable resolution

FGD[21]
- EPS for vector figures
- PDF for raster/vector figures
- PDF for raster figures (350 ppi)
- JPG at acceptable resolution

JPG (140 ppi/RGB mode)   mp4 (HD)

[19] First Order Draft, [20] Second Order Draft, [21] Final Government Distribution