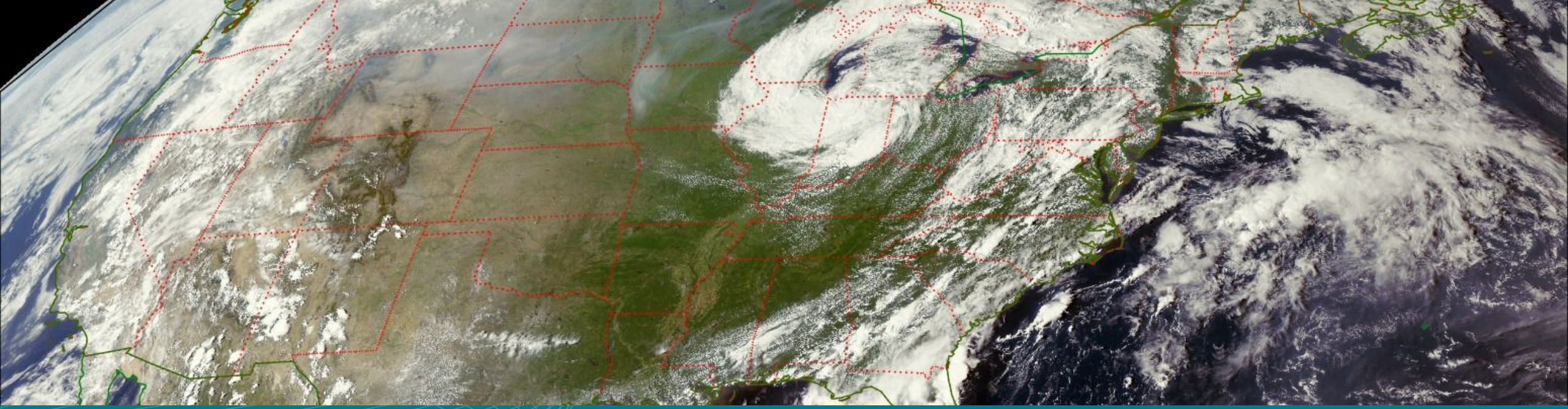


Meteorology Webinar

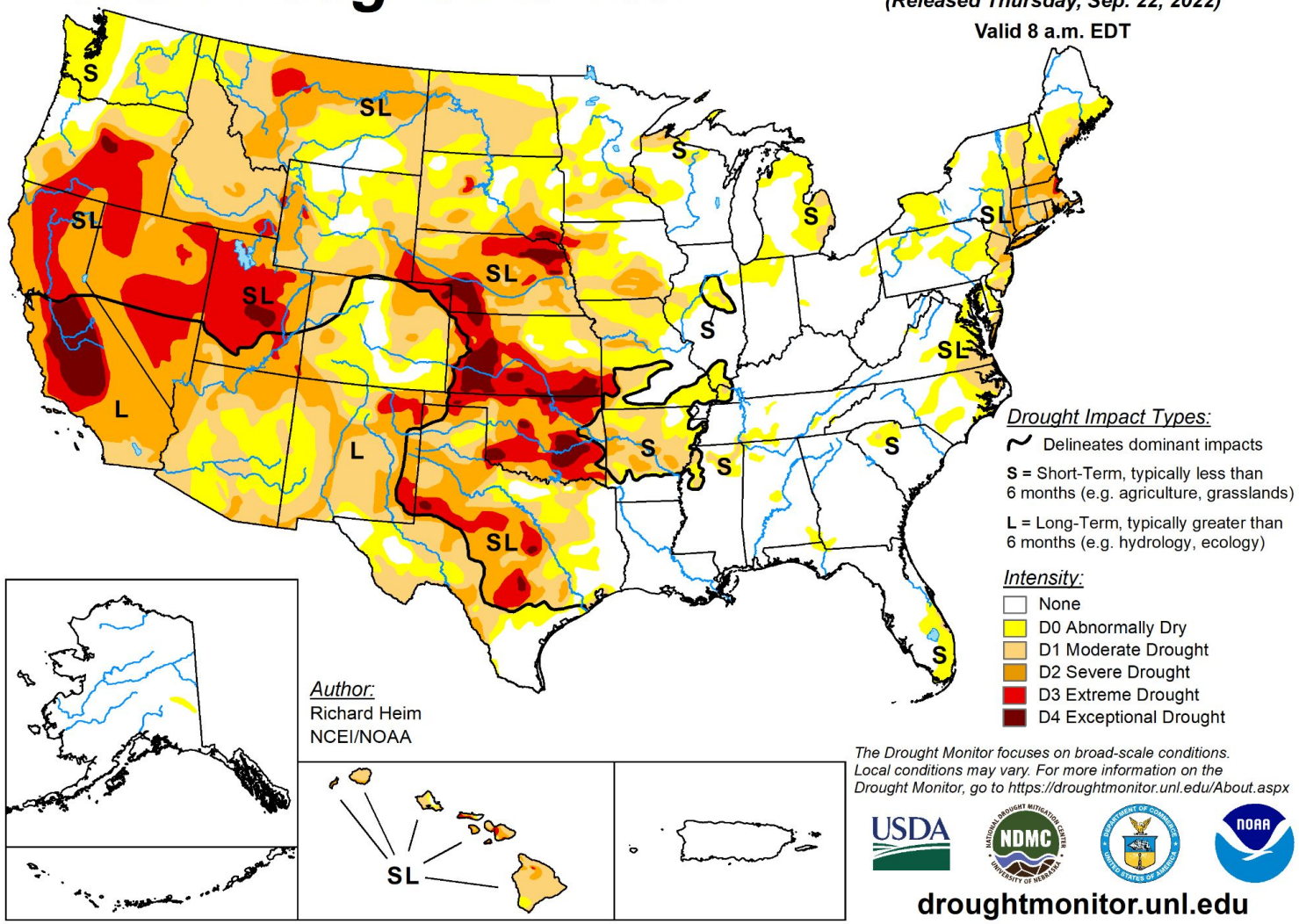
Kari Strenfel, Meteorologist, September 28th 2022

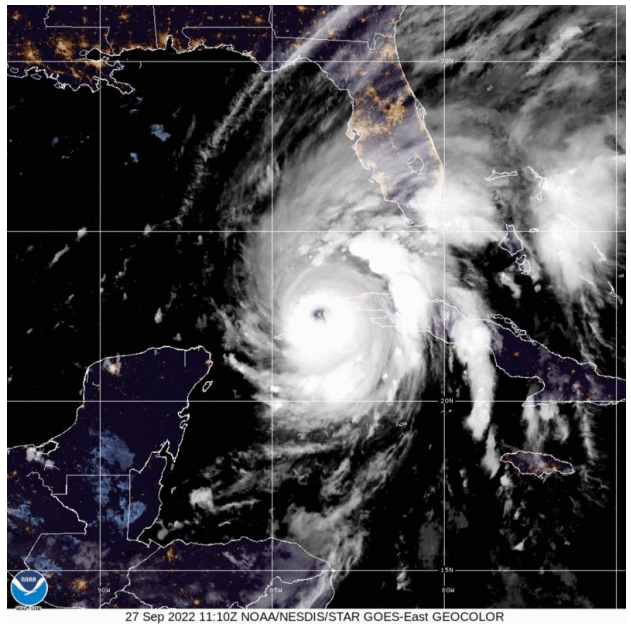
Hydro International

Agenda

1. Weather vs. Climate
2. Weather Forecast Models: Process and Accuracy
3. Climate Models
4. Latest findings in IPCC Report: Intergovernmental Panel on Climate Change
5. What does this mean for stormwater planning?

Weather vs. Climate





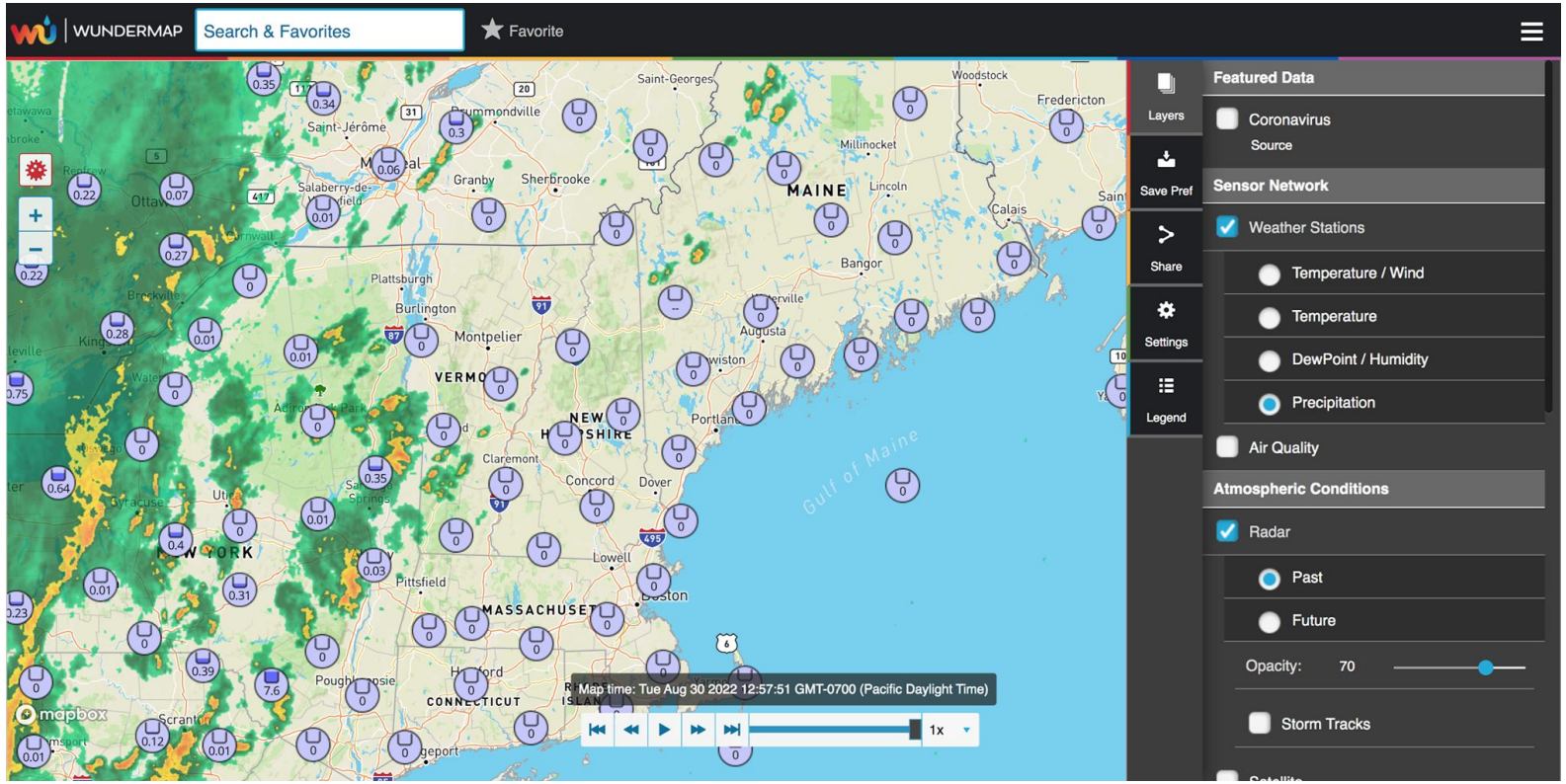
Weather Underground

Hydro International

Personal Weather Stations range from $150-$320, with wireless and wifi options:

AcuRite Weather Stations

Ambient Weather Stations



Why are meteorologists always wrong?

Hydro International

Model Analyses and Guidance

Back | **Model Guidance** | Home

To view images, select a Model Area and Model Type [Reset Selection(s)]

Model Type				
GFS	NAM	HRRR	SREF	GFS-WAVE
GEFS-SPAG	NAM-HIRES	HRW-FV3	HREF	ESTOFS
GEFS-MEAN-SPRD	FIREWX	HRW-ARW	NBM	ICE-DRIFT
NAEFS	RAP	HRW-ARW2	SREF-CLUSTER	STORM-TRACKS
PANELS				

Model Area		
NAMER	CONUS	AFRICA
ATL-PAC	ATLANTIC	CONUS-A
EUROPE	GOM	GUAM
NE-COAST	NORTH-CAL	NORTH-P
SAMER	SE-COAST	SOUTH-C
US-NW	US-SAMOA	US-SC
WEST-ATL	WEST-GOA	WEST-GC

Model Analyses and Guidance

Back | **HRRR** | Home

Continental United States

Page Help

Cycles –

09/02/2022 19UTC
09/02/2022 18UTC
09/02/2022 17UTC
09/02/2022 16UTC
09/02/2022 15UTC
09/02/2022 14UTC
09/02/2022 13UTC
09/02/2022 12UTC
09/02/2022 11UTC
09/02/2022 10UTC
09/02/2022 09UTC
09/02/2022 08UTC
09/02/2022 07UTC
09/02/2022 06UTC
09/02/2022 05UTC
09/02/2022 04UTC

Precipitation –

precip_p01	precip_ptot	precip_rate	snow_total	sim_radar_1km	sim_radar_comp
sim_radar_max					

Surface-Layer –

1000_500_thick	1000_850_thick	850_700_thick	850_temp_mslp_precip	helicity_1km	helicity_3km
max_updraft_hlcy	accu_max_updraft_hlcy	10m_wnd	10m_maxwnd	2m_temp_10m_wnd	2m_dewp_10m_wnd
10m_wnd_sfc_gust	sfc_cape_cin	best_cape_cin	lightning	echo_top	ceiling
vis					

Upper Air –

250_wnd	300_wnd	500_vort_ht	500_temp_ht	700_rh_ht	850_temp_ht
925_temp_wnd					

Four Panel –

500_vort_ht, 1000_500_thick,
700_rh_ht, 850_temp_ht

What's New | User's Guide | Frequently Asked Questions | Product Description Document

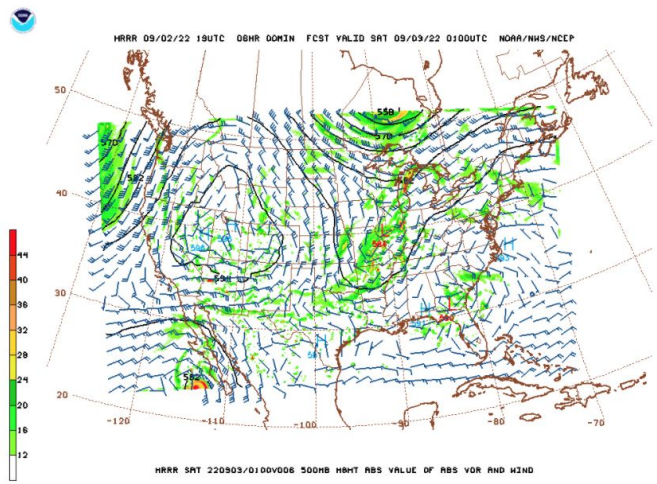
MAG v3.19.0 College Park, MD

Weather Forecast Models

Hydro International

Stop	< Prev	Next >	|< First	Last >|	Slower	Faster	Reset	7 of 19

hrrr_conus_00600_500_vort_ht



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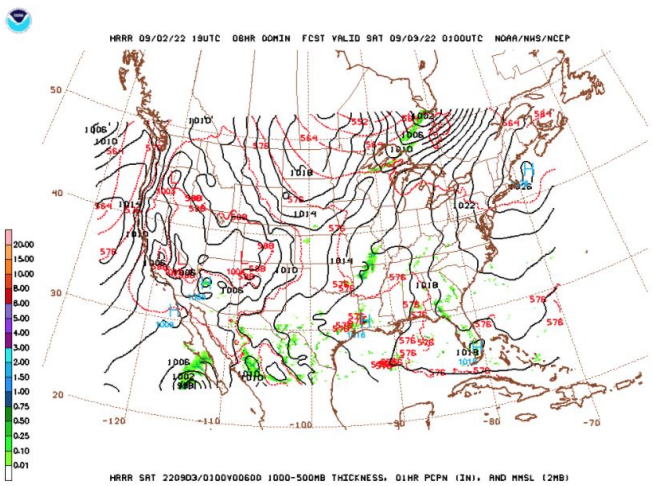

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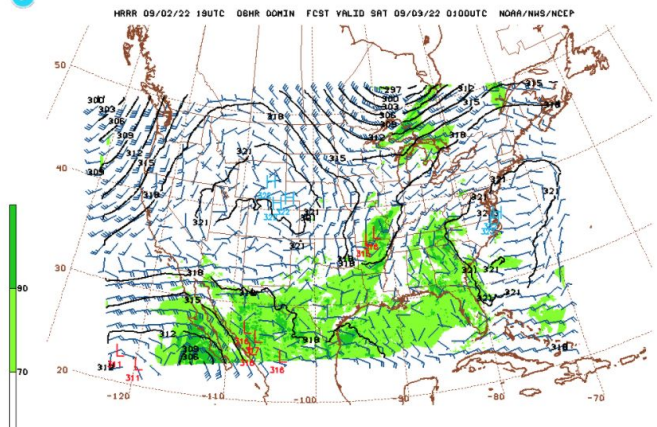

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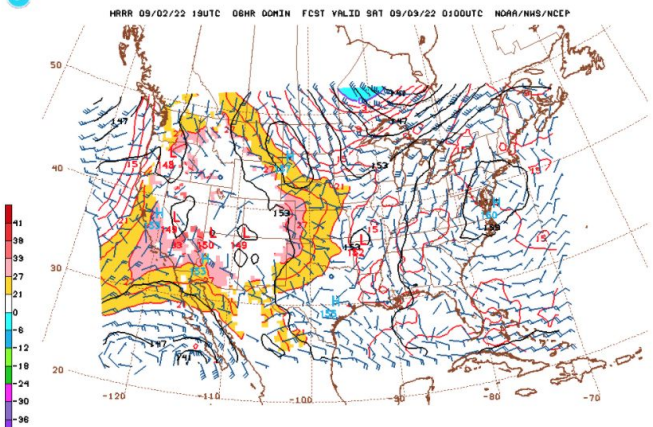
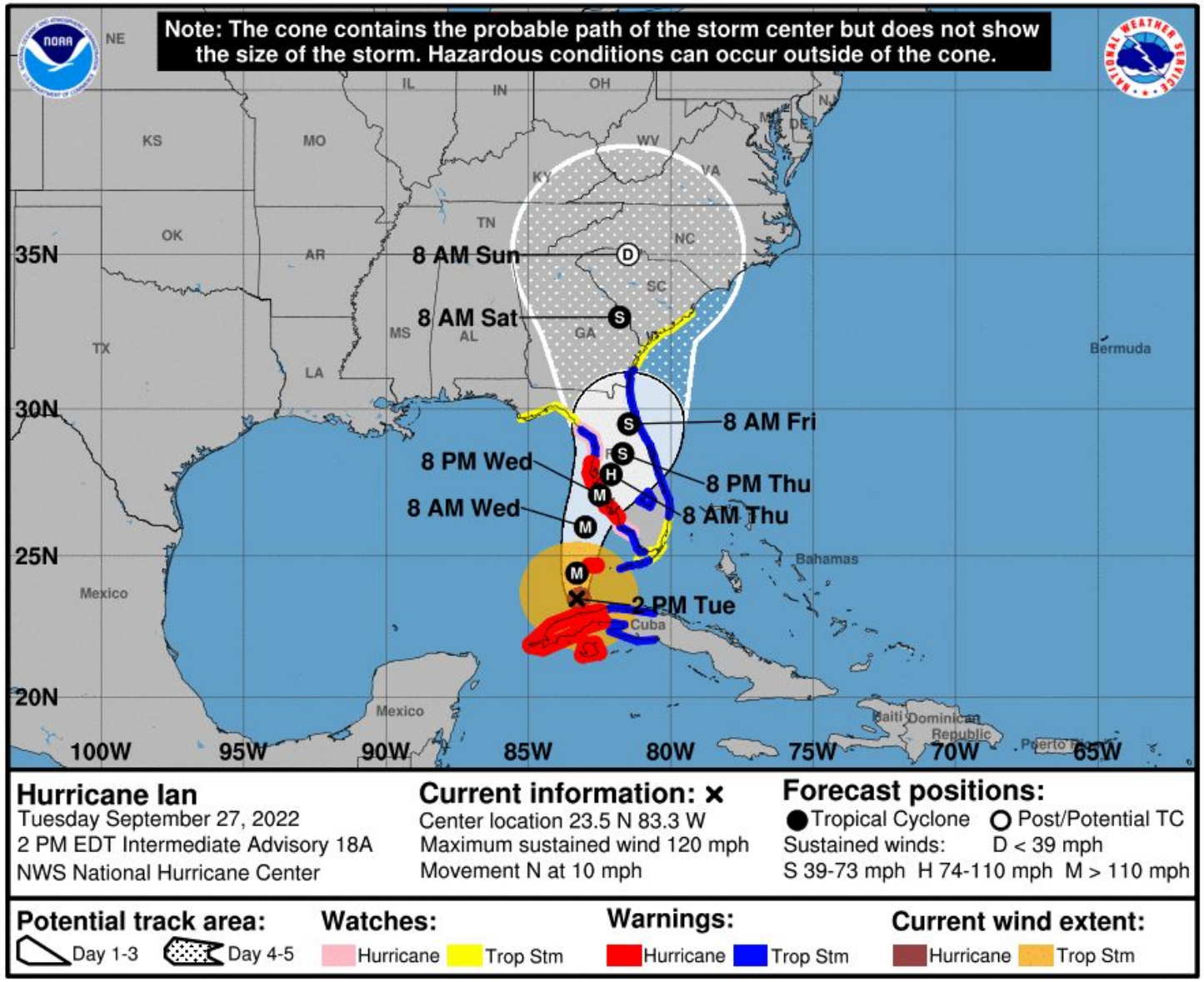
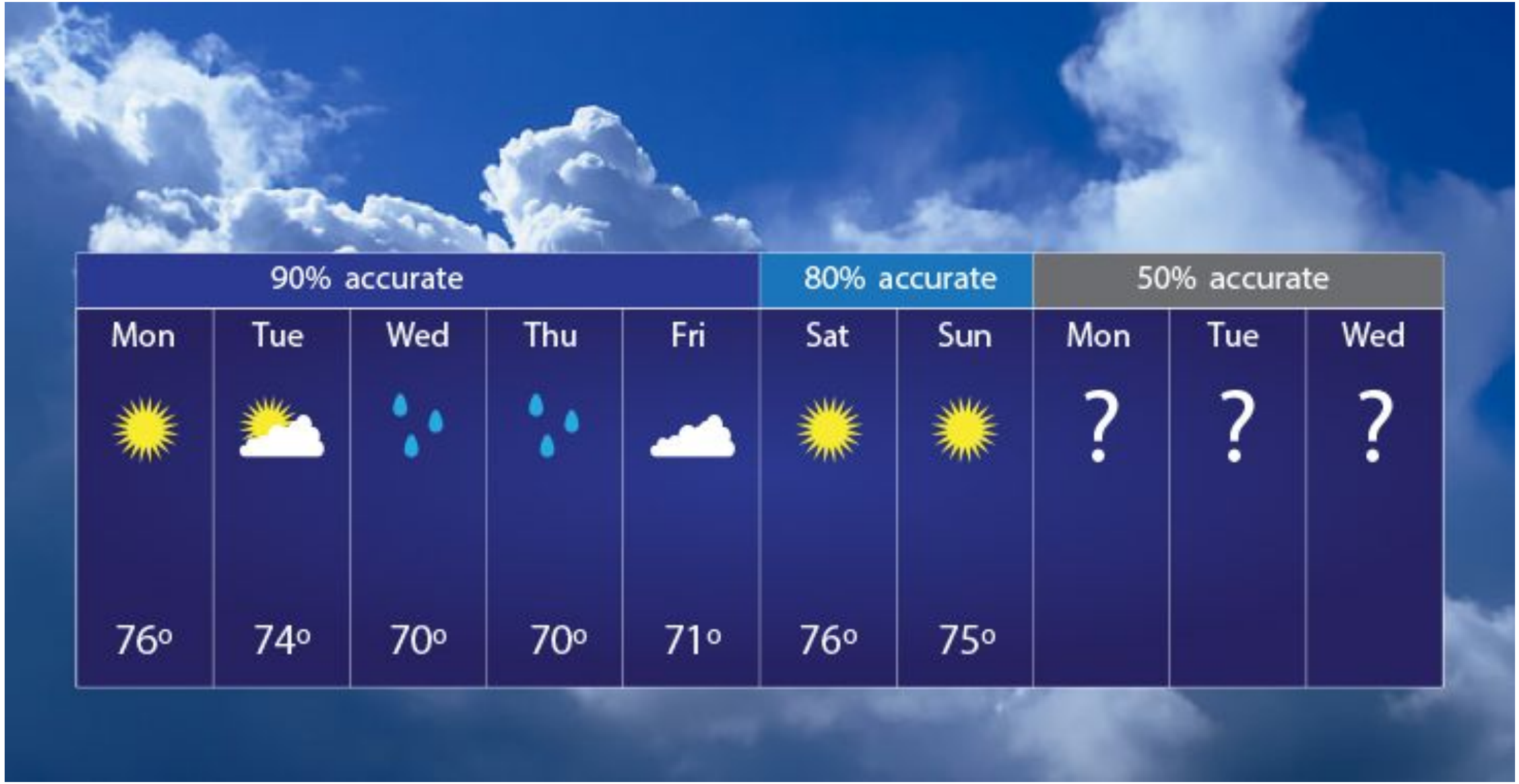


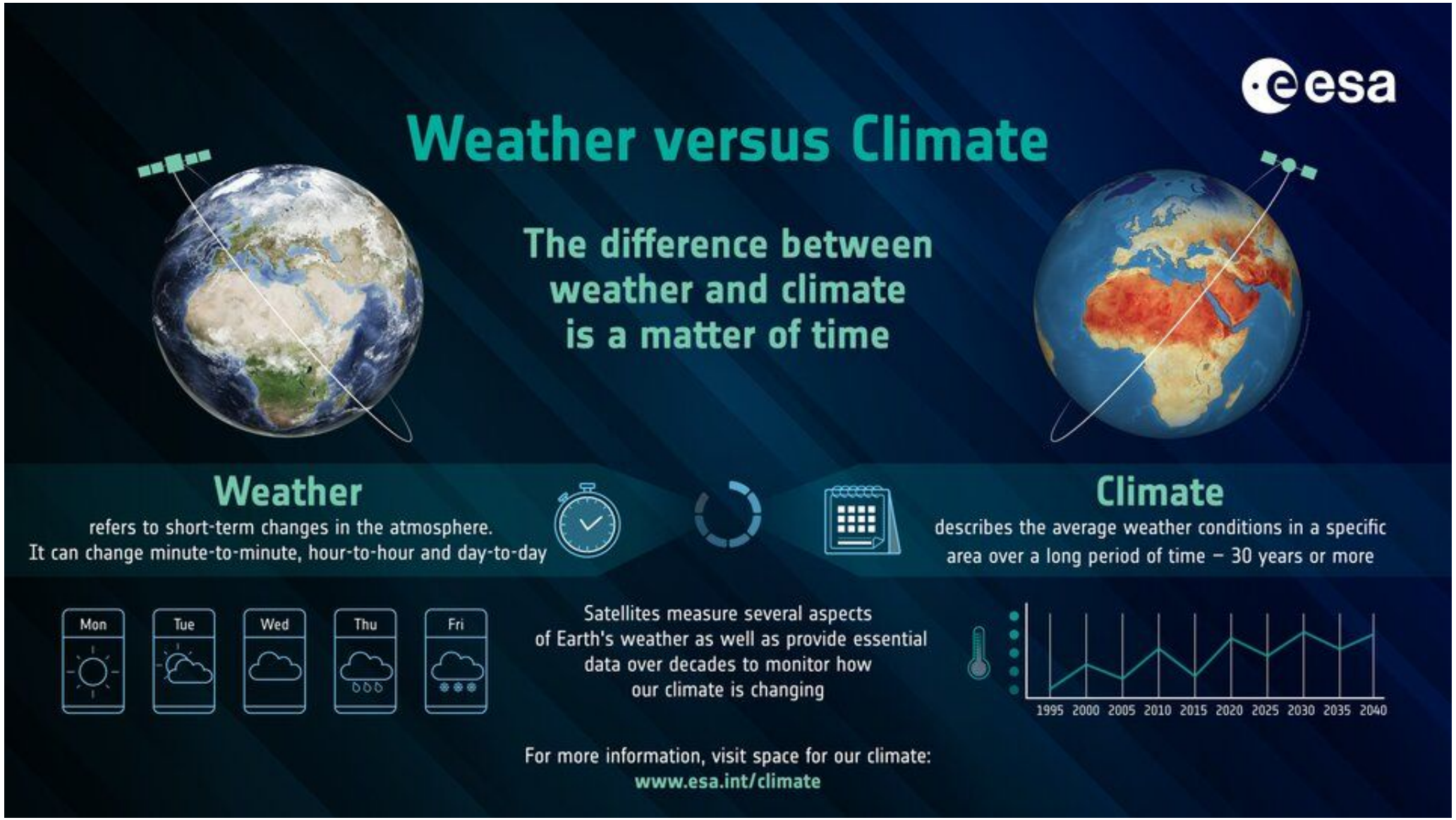
Weather Forecast Models



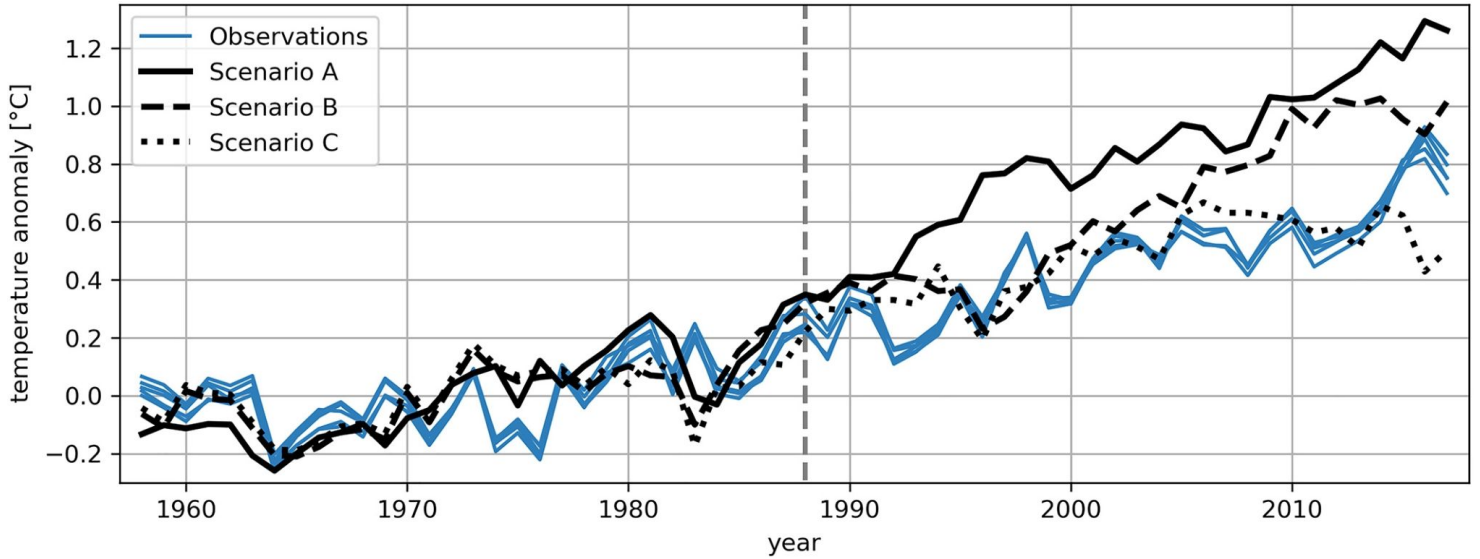
Accuracy of Weather Forecast Models

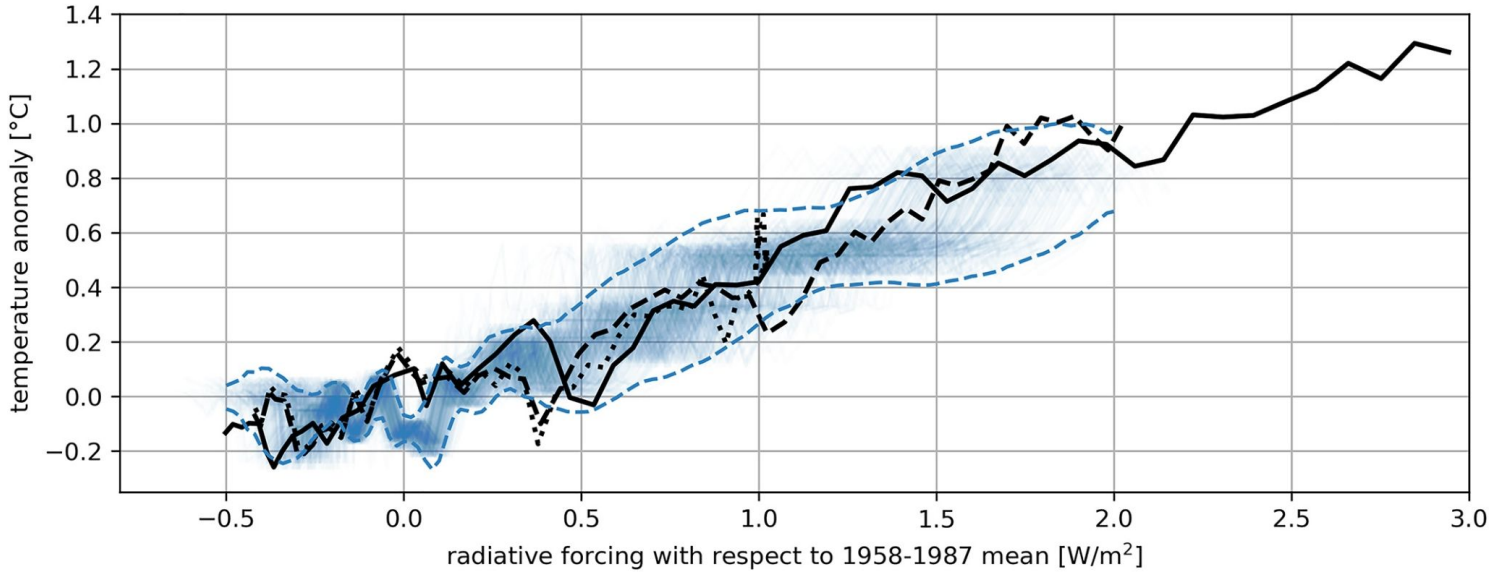


Weather vs. Climate



Climate Model Predictions vs. Actuals





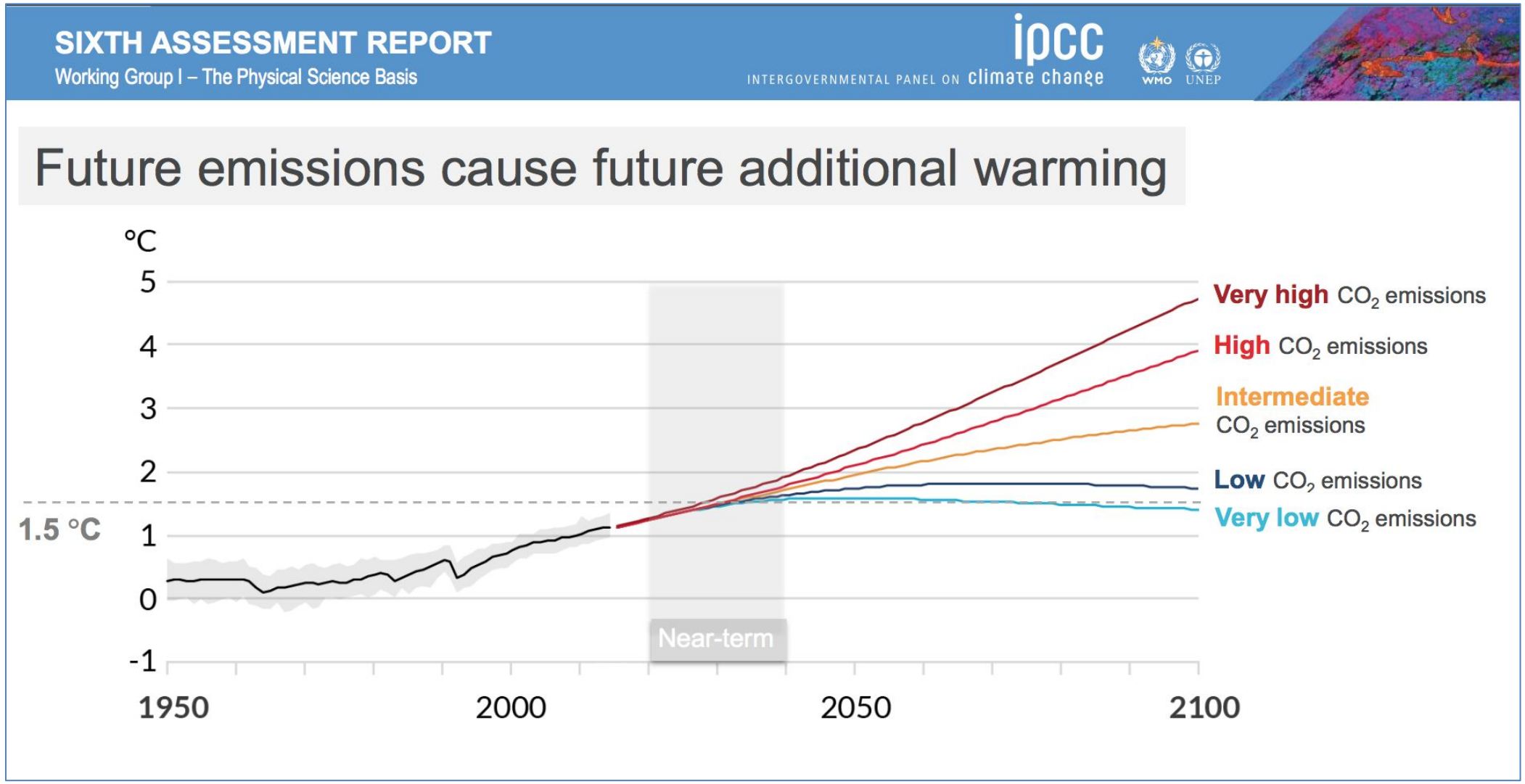
30-year Climatology

Recurrence intervals and probabilities of occurrences

Recurrence interval, years	Annual exceedance probability, percent
2	50
5	20
10	10
25	4
50	2
100	1
200	0.5
500	0.2

"100-year floods can happen 2 years in a row"
Statistical techniques, through a process called frequency analysis, are used to estimate the probability of the occurrence of a given **precipitation** event.

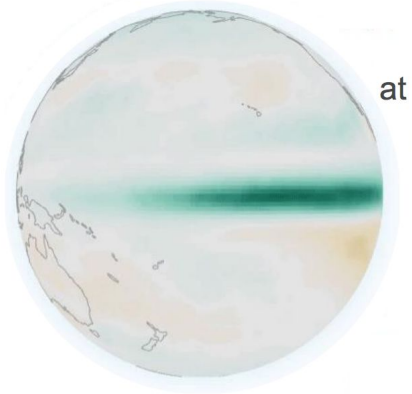
Latest IPCC Report



Latest IPCC Report

SIXTH ASSESSMENT REPORT
Working Group I – The Physical Science Basis

With every additional amount of global warming, changes get larger.

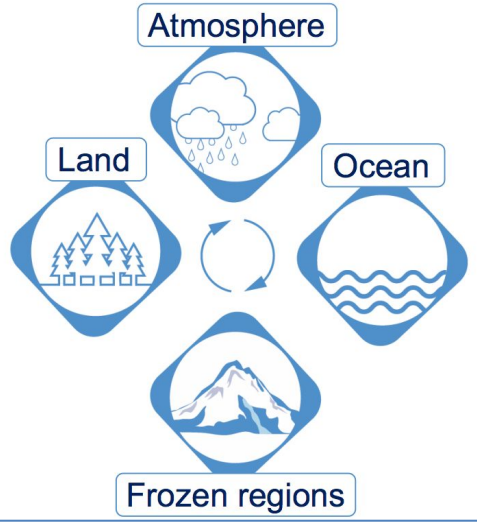


at 1.5°C
at 2°C

Extreme rainfall intensifies by 7% for each additional 1°C

SIXTH ASSESSMENT REPORT
Working Group I – The Physical Science Basis

Changes to the Water cycle



With warmer temperature

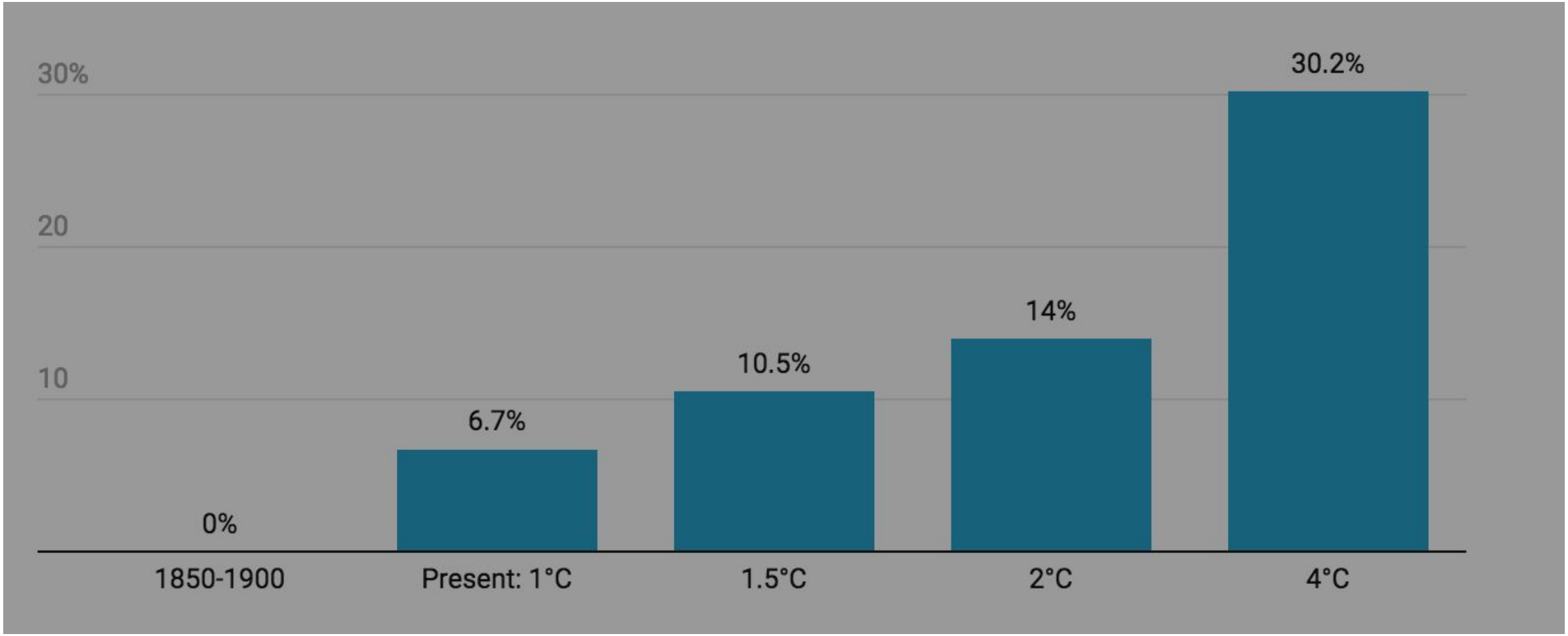
- Atmosphere can hold more water
- More and faster evaporation
- Heavier precipitation

7% more water vapor for each 1°C of warming

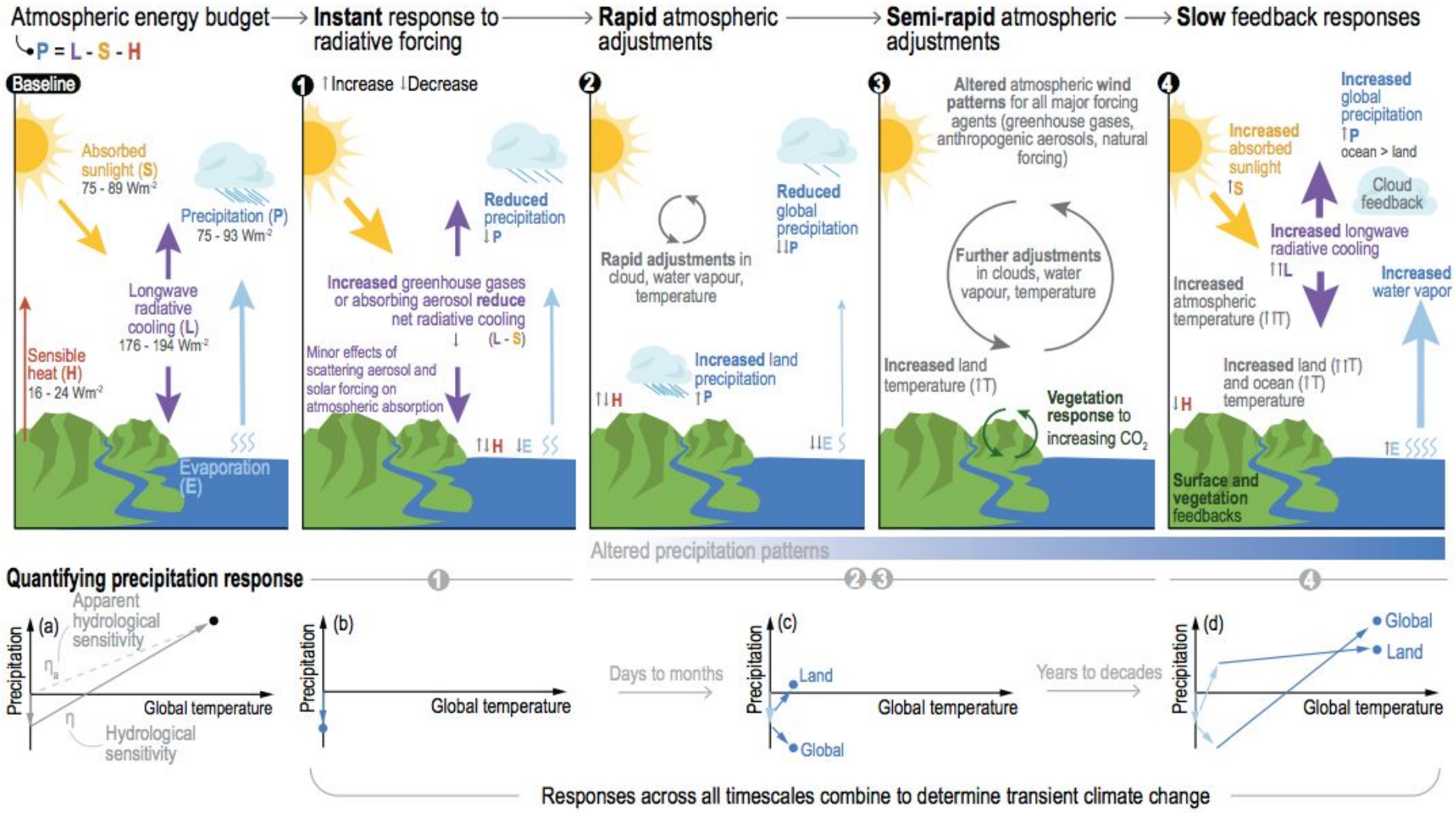
(Effects seen regionally)
Heavier rainfall and **more intense rainfall events**, makes wet seasons and events wetter.

Increased temperatures allow for **reduced snowpack**, intensifying dry seasons and **droughts**.

Impacts on the Hydrologic Cycle

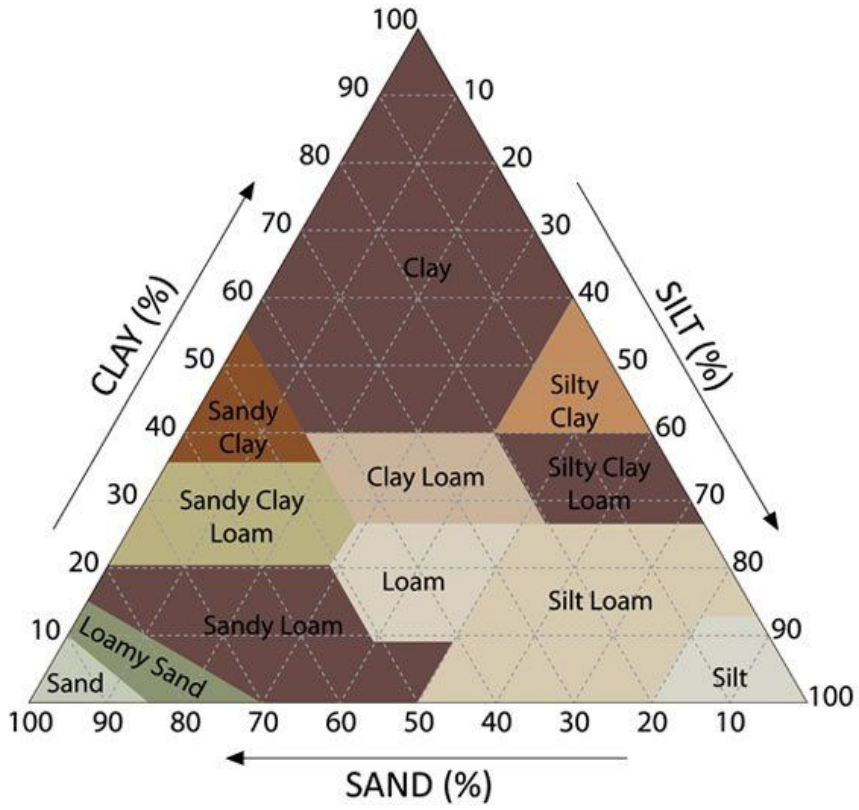


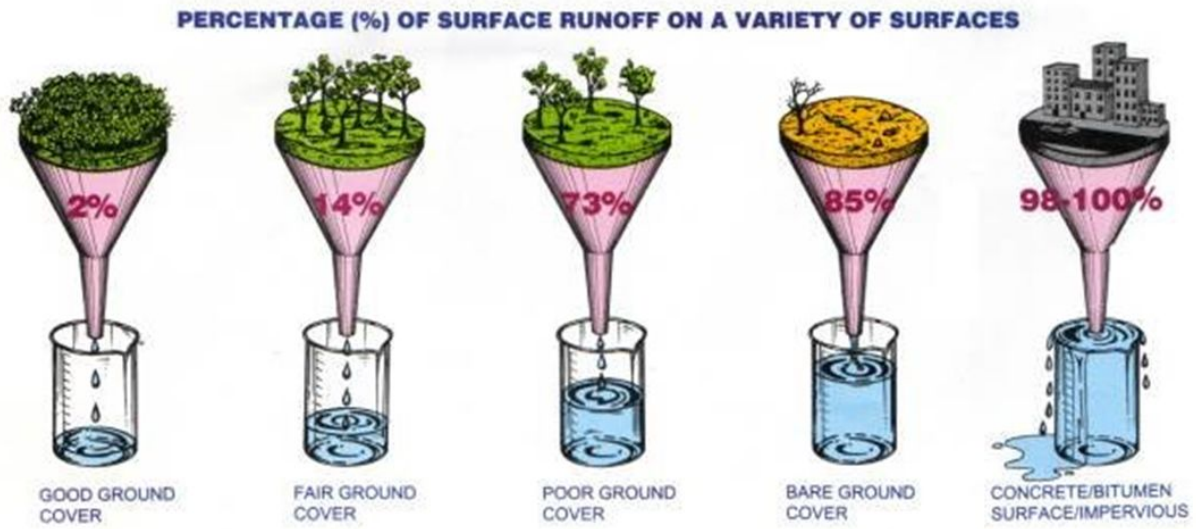
Impacts on the Hydrologic Cycle



Soil Types and Permeability

While we know we need to consider different soil and surface land use types, we also need consider the storm history. What happens if the soil is still saturated from the previous rain event?





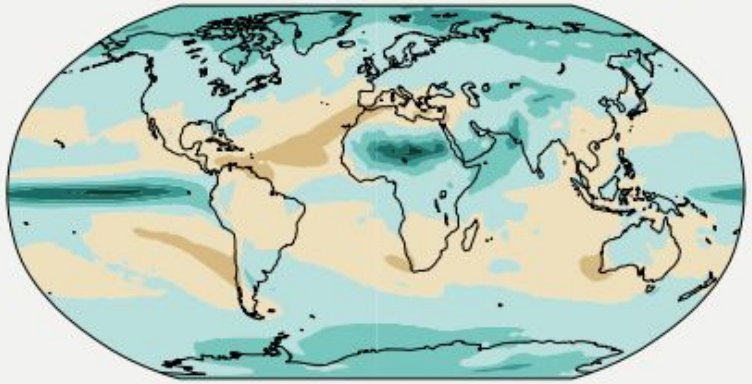
Impacts on the Hydrologic Cycle

Hydro International

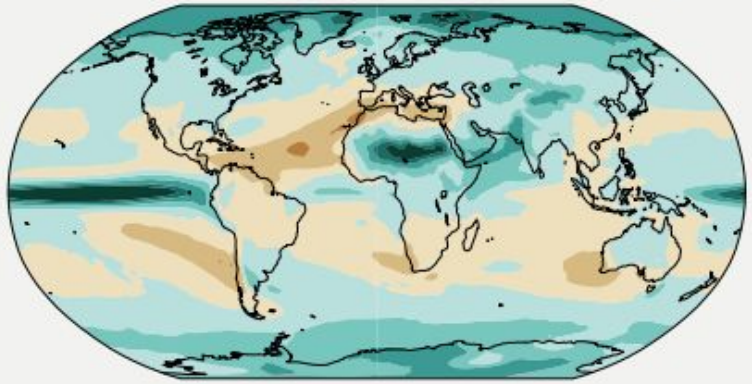
(c) Annual mean precipitation change (%) relative to 1850–1900

Precipitation is projected to increase over high latitudes, the equatorial Pacific and parts of the monsoon regions, but decrease over parts of the subtropics and in limited areas of the tropics.

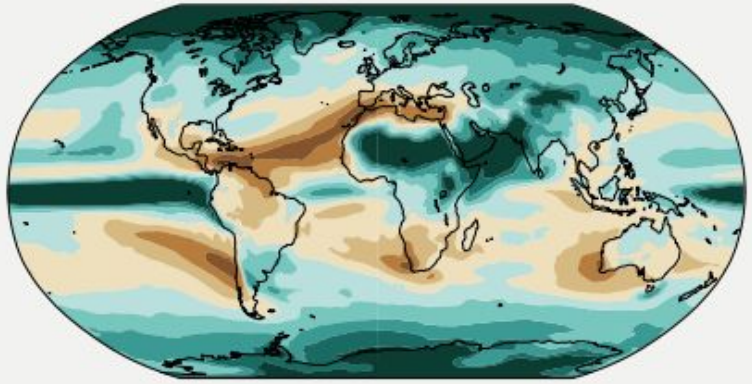
Simulated change at **1.5°C** global warming



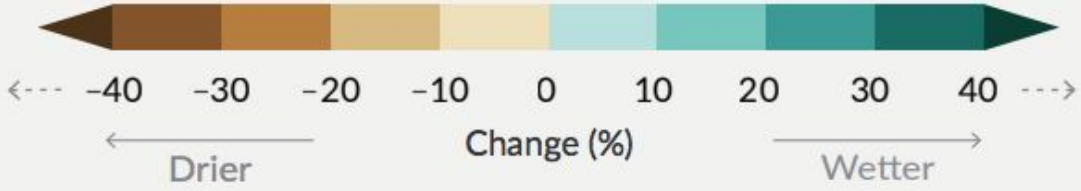
Simulated change at **2°C** global warming



Simulated change at **4°C** global warming



Relatively small absolute changes may appear as large % changes in regions with dry baseline conditions.



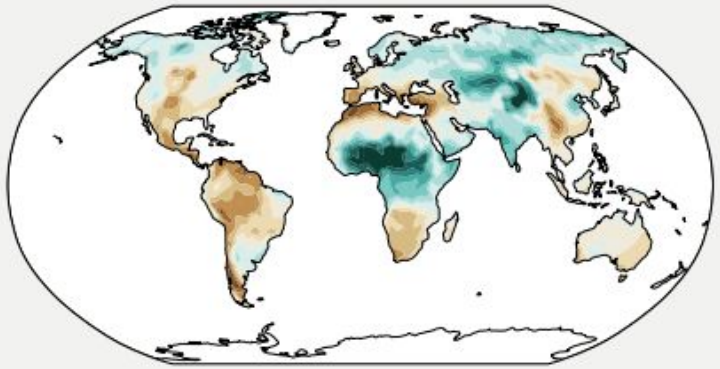
Impacts on the Hydrologic Cycle

Hydro International

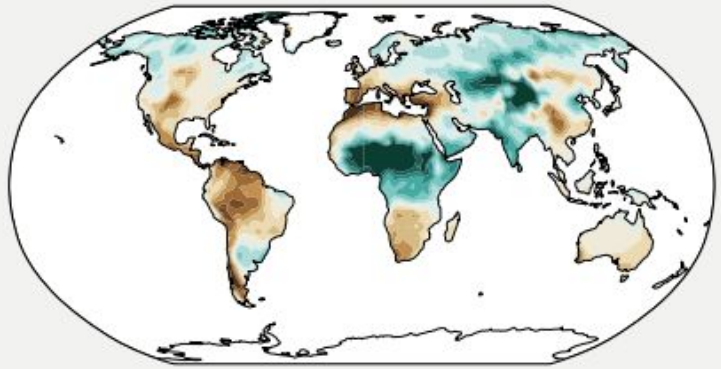
(d) Annual mean total column soil moisture change (standard deviation)

Across warming levels, changes in soil moisture largely follow changes in precipitation but also show some differences due to the influence of evapotranspiration.

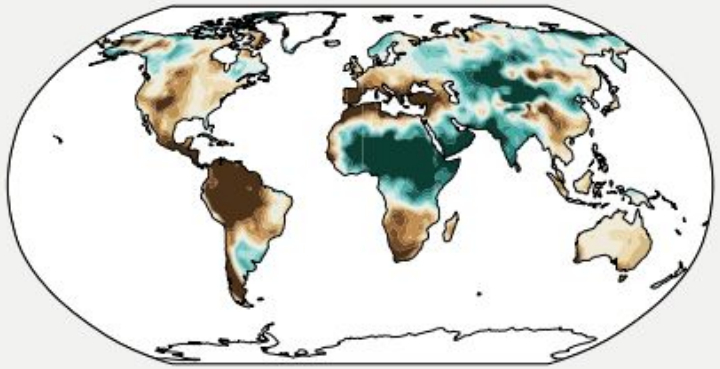
Simulated change at **1.5°C** global warming



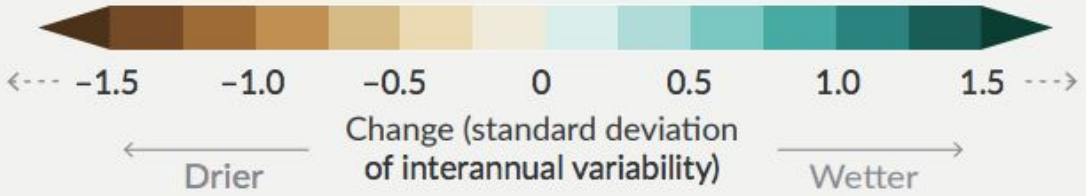
Simulated change at **2°C** global warming



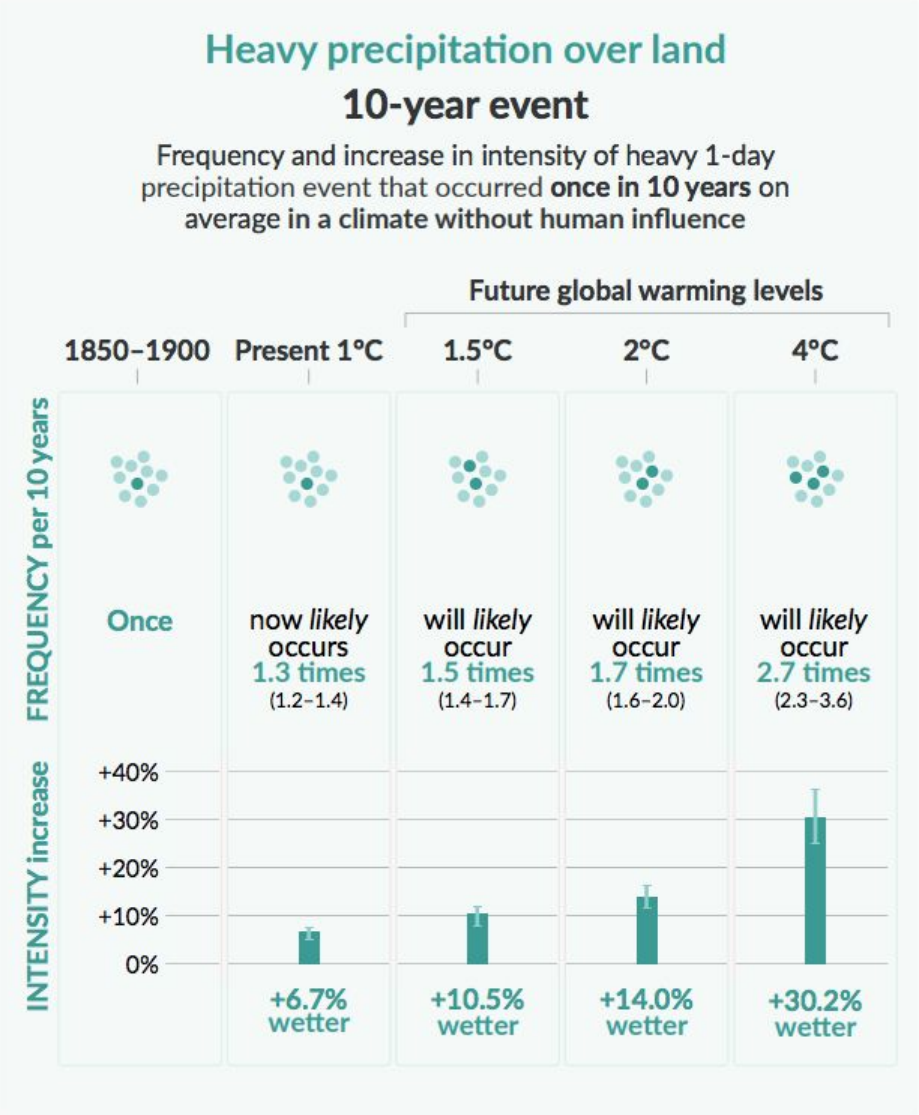
Simulated change at **4°C** global warming

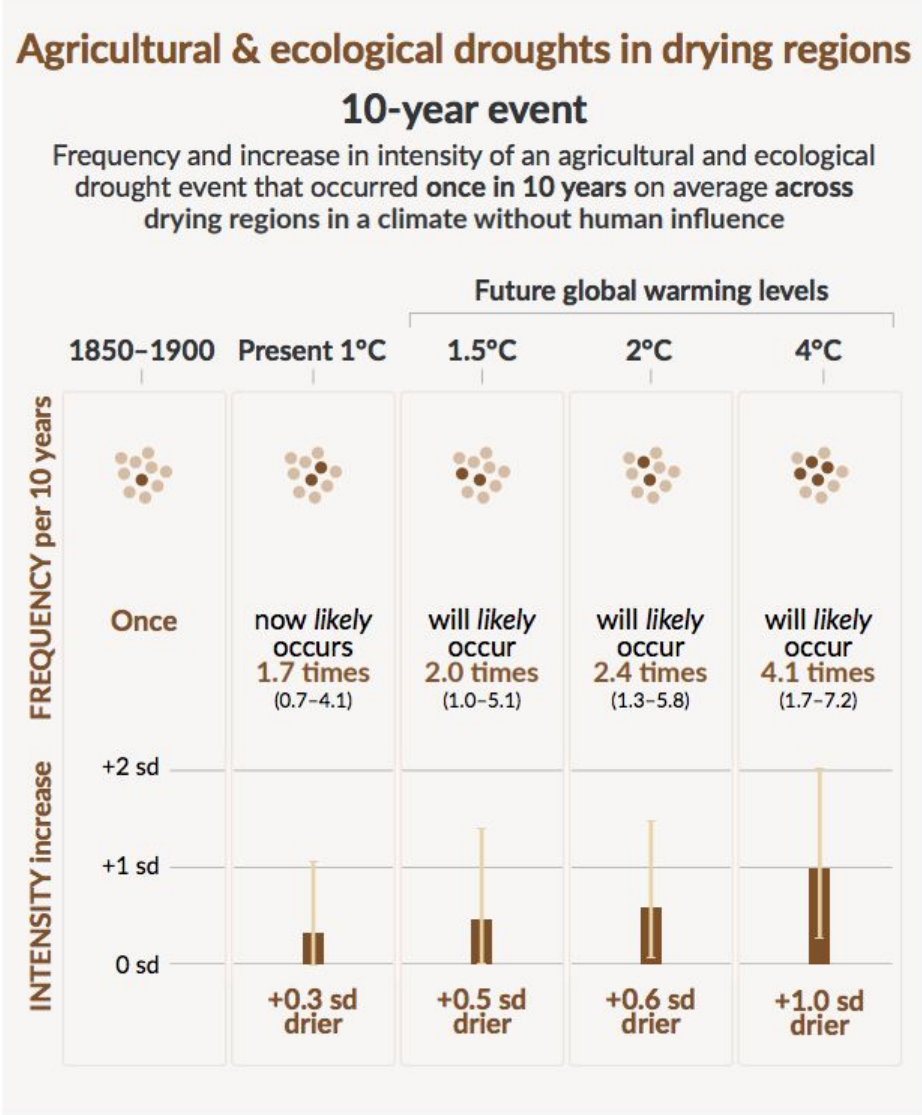


Relatively small absolute changes may appear large when expressed in units of standard deviation in dry regions with little interannual variability in baseline conditions.



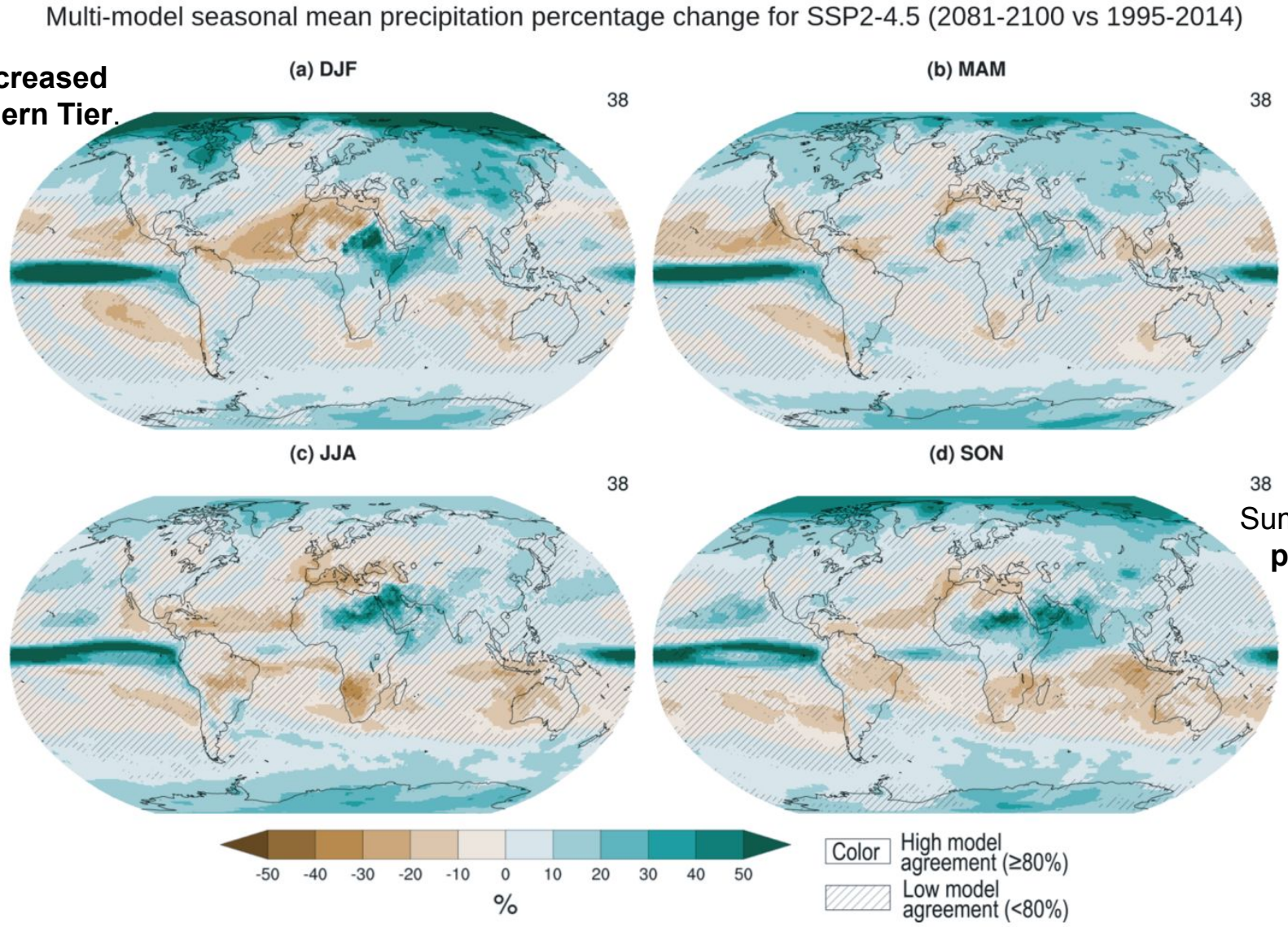
Impacts on the Hydrologic Cycle





Impacts on the Hydrologic Cycle: Seasonal Precipitation

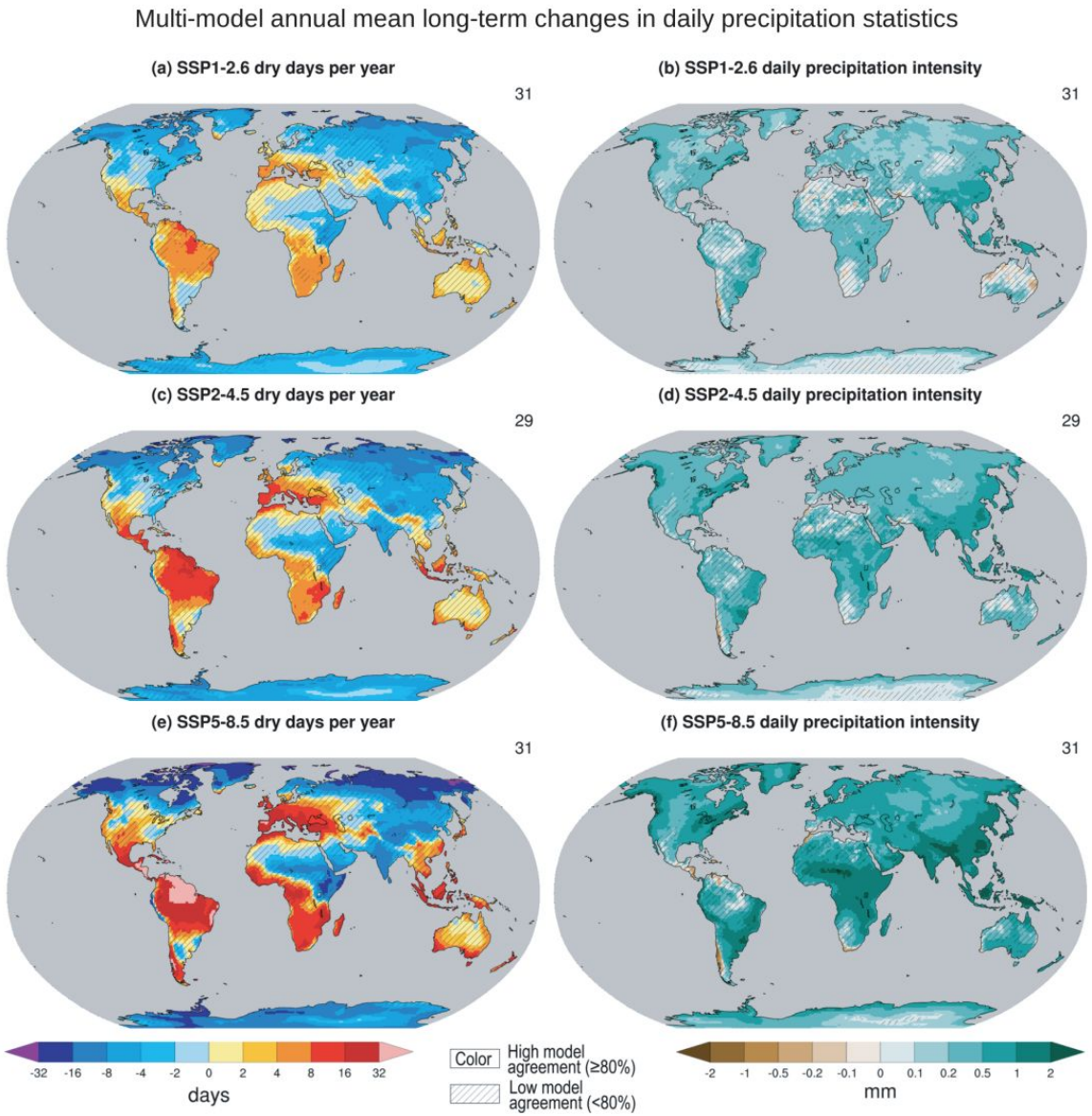
Winter and Spring show **increased precipitation** for the **Northern Tier**.



Summer and Fall show **increased precipitation** for the Southeast.

Impacts on the Hydrologic Cycle: Daily Precipitation

Number of **dry days** per year **increases** for the South and Southwest.



Daily **precipitation intensity** **increases** for the East and Northeast.

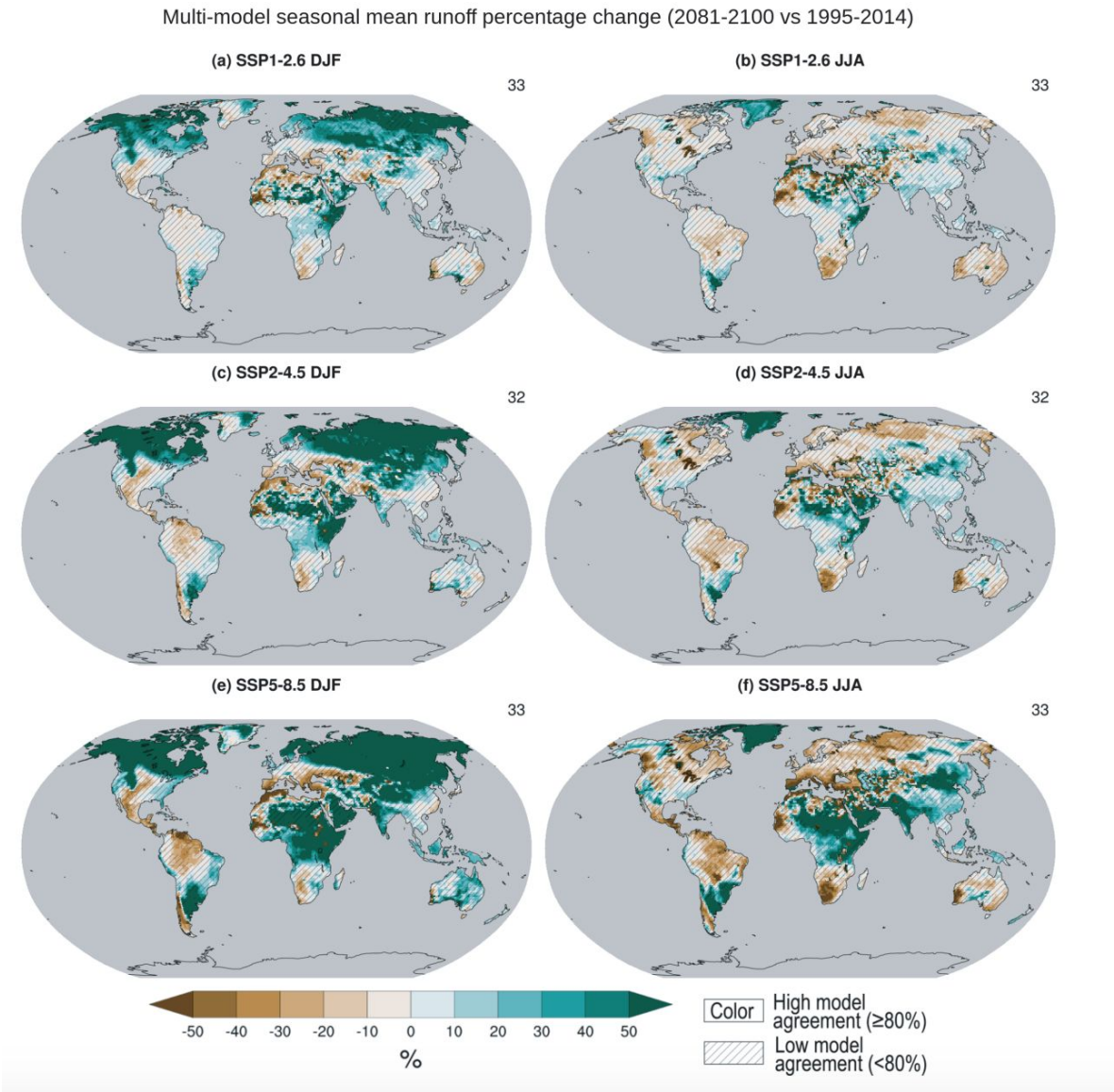
Impacts on the Hydrologic Cycle: Runoff

North America Report

Intensified droughts and **earlier runoff from diminished snowpack** will increase water scarcity during the summer peak water demand period especially in regions with extensive irrigated agriculture, leading to economic losses and increased pressures on limited groundwater as a substitute for diminished surface water supplies (medium to high confidence).

Coastal, riverine, and urban flooding affecting communities and ecosystems will become a dominant risk to urban centres (high confidence), displacing people, compromising economic activity, disrupting transportation and trade infrastructure.

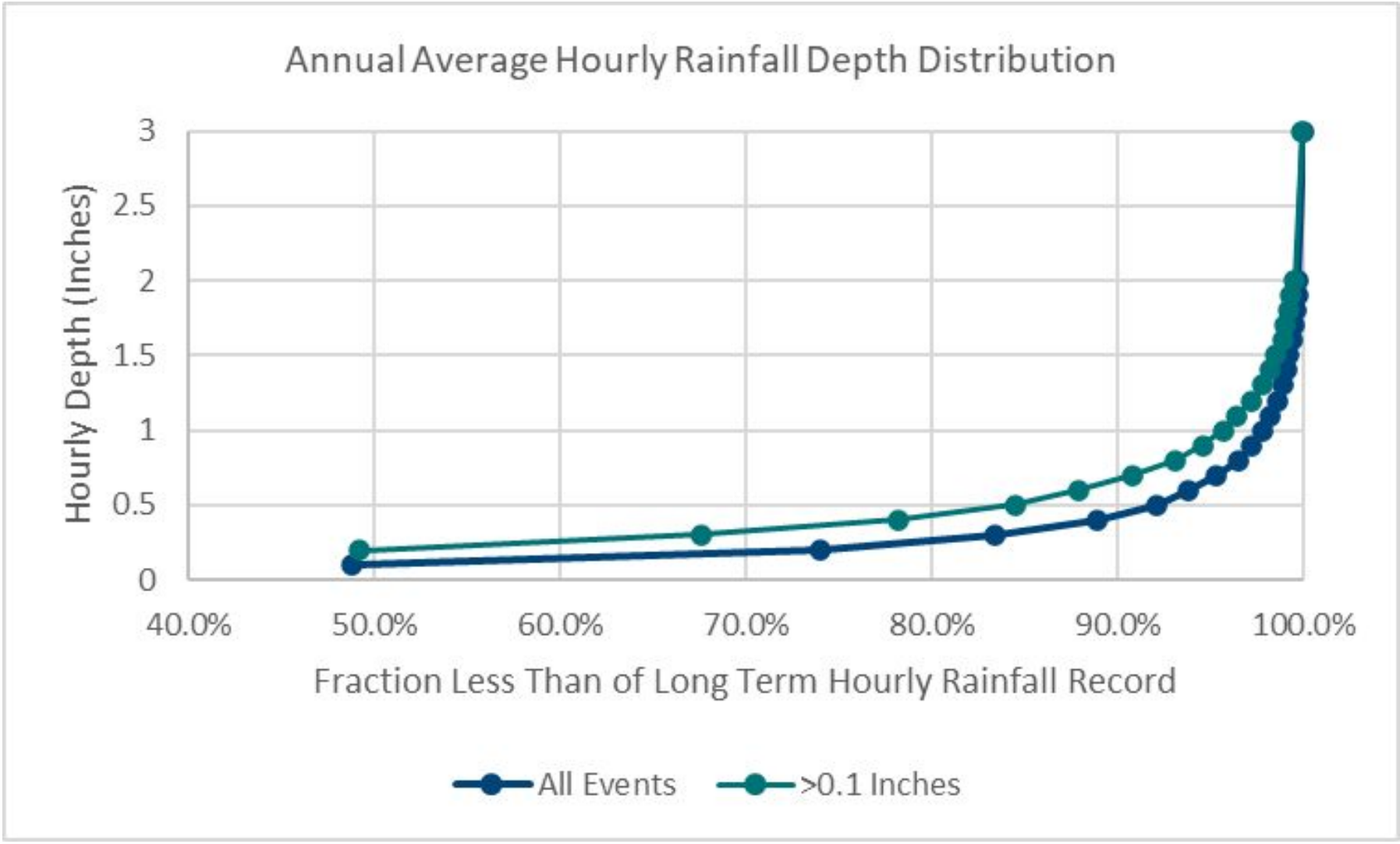
In the Northern Hemisphere, **runoff increases during winter since more precipitation falls as rain than snow** and decreases in the summer as less snow is available to contribute to runoff during the warm season. (medium confidence)



Small Storm Hydrology

Hydro International

Frequent small storms that account for the majority of the pollutant load



Rainfall - Runoff - Pollutants - Water Quality

Hydro International

Green Infrastructure

Manufactured Treatment Systems

Regional Ponds

These operate on certain design assumptions about the behavior of runoff & pollutants during a storm event.

2. Water Quality Volume (WQv)

The WQv criteria is focused on the capture and treatment of runoff from the most commonly occurring storm events. Statewide, approximately 90% of rainfall events on an annual basis are less than or equal a depth of 1.25 inches. The vast majority of runoff from a site will be captured and treated through installation of BMPs that are sized to address these most common, small storms. A 80% reduction in TSS can typically be expected from practices that address 90% of annual rainfall events.

This is a **volumetric standard**, calculated using the "Short cut method" (Schueler, 1987):

Runoff - Are we missing the mark?

Hydro International

Common Models

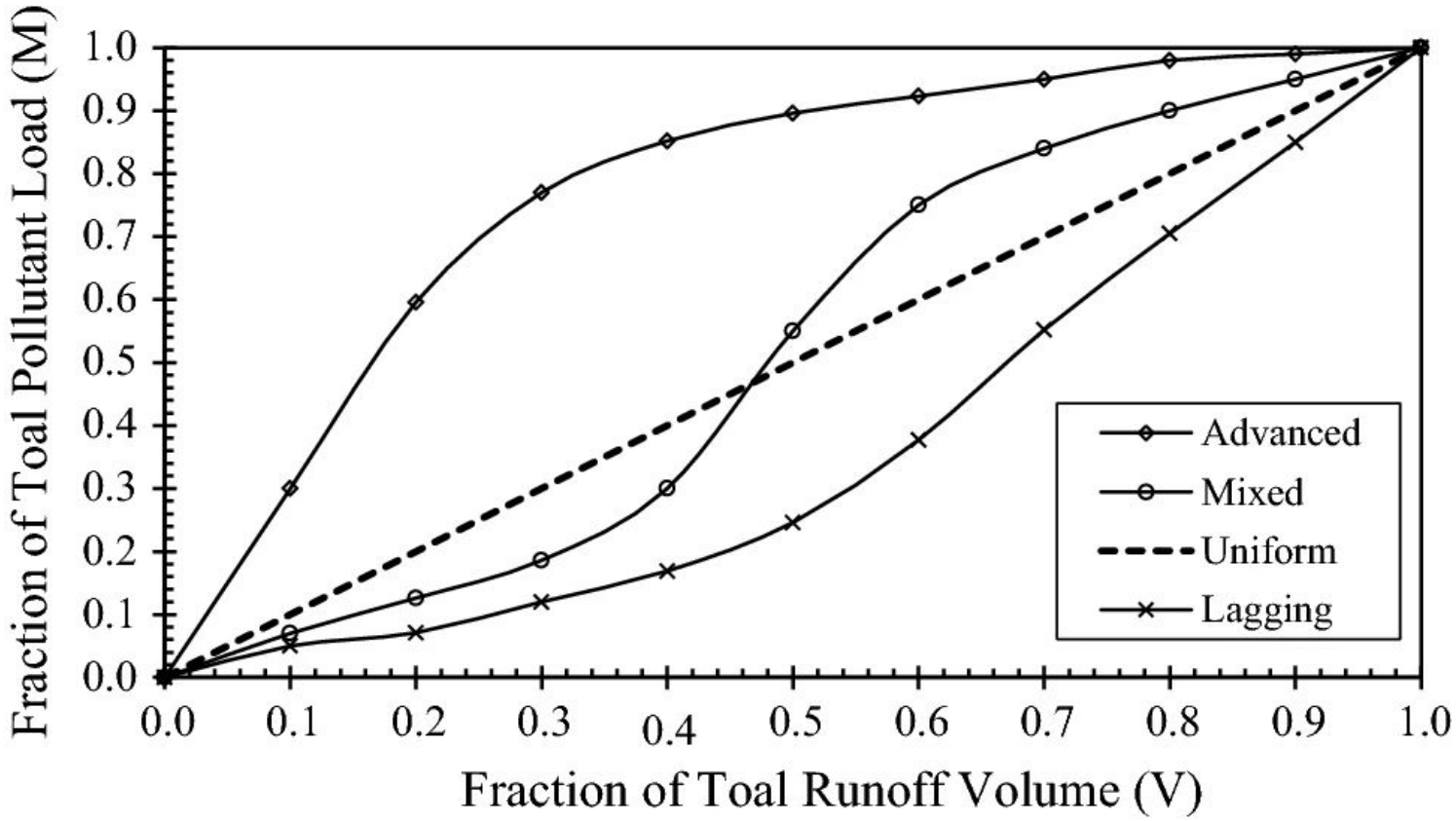
- SCS TR-55 (No suitable for small storms, drainage model)
- Rational Method

Small Source Areas & Short Duration Rainfall Events

- Initial Abstractions
- Infiltration Losses
- Highly Sensitive to C, CN, & R_v values

First Flush

The initial runoff of a rainstorm event that typically carried a more concentrated pollutant load than the later part of the runoff from a rain event



Mamun, A.A., Shams, S. & Nuruzzaman, M. Review on uncertainty of the first-flush phenomenon in diffuse pollution control. *Appl Water Sci* 10, 53 (2020). https://doi.org/10.1007/s13201-019-1127-1

Hydro International

Rainfall Distribution Weighted Removal Model - Is it appropriate?

Rainfall Data		Influent Flow Calcs	
Average Intensity	Distribution	Runoff Rate	Runoff SLR
(in/hr)	(%)	(cfs)	(gpm/ft2)
0.04	69.20%	0.04	1.38
0.14	15.87%	0.14	4.85
0.25	5.34%	0.24	8.65
0.34	3.40%	0.33	11.77
0.45	1.88%	0.44	15.58
0.55	1.08%	0.53	19.04
0.65	0.71%	0.63	22.50
0.74	0.40%	0.72	25.62
0.85	0.36%	0.82	29.42
0.94	0.35%	0.91	32.54
1.05	0.21%	1.02	36.35
1.14	0.21%	1.11	39.46
1.25	0.16%	1.21	43.27
1.33	0.12%	1.29	46.04
1.45	0.12%	1.41	50.19
1.54	0.06%	1.49	53.31
1.65	0.05%	1.60	57.11
1.75	0.05%	1.70	60.58
1.85	0.08%	1.79	64.04
1.94	0.05%	1.88	67.15

All This and More!

Hydro International

ASTM International Collaboration Area

Current Collaboration Area: 79393 - WK82815 - Practice for Determini...

79393 - WK82815 - Practice for Determining Annual Rainfall Weighting Factors for Use in Sizing Stormwater Control Measures

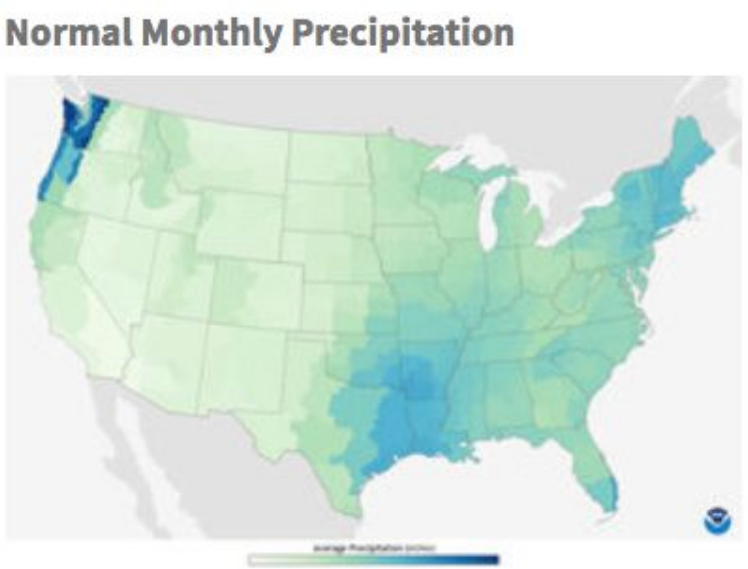
Collaboration Area | Drafts | Polls | Discussions | Files

Overview | Members | History

WK82815 - Practice for Determining Annual Rainfall Weighting Factors for Use in Sizing Stormwater Control Measures

WorkItem Creation Date: 07/18/2022
Ballot Target Date: 07/2023
Work Item Status: Draft Under Development
Status: Draft Under Development

30-year averages by month – U.S.



How much rain and snow usually fall this month?

Updated every 10 years, climate.gov offers maps for monthly and seasonal precipitation and temperature “normals”. Climatological “normals” are data averaged over 30 years.

*Note: these maps display “normals” from 1981-2010 and have not been updated to 2020.

Resources

- WATER CYCLE REPORT:
  - https://www.ipcc.ch/report/ar6/wg1/downloads/report/ipcc_ar6_wgi_chapter08.pdf
- FACT SHEET INTRODUCTION:
  - https://www.ipcc.ch/report/ar6/wg2/about/factsheets/
- FACT SHEET (REGIONAL): NORTH AMERICA AND CENTRAL AMERICA
  - https://www.ipcc.ch/report/ar6/wg2/downloads/outreach/IPCC_AR6_WGII_FactSheet_NorthAmerica.pdf
- FACT SHEET URBAN AREAS:
  - https://www.ipcc.ch/report/ar6/wg2/downloads/outreach/IPCC_AR6_WGII_FactSheet_HumanSettlements.pdf
- FAQS: WATER CYCLE AND FLOODING:
  - https://www.ipcc.ch/report/ar6/wg1/downloads/faqs/IPCC_AR6_WGI_FAQ_Chapter_08.pdf
  - FAQs general: https://www.ipcc.ch/report/ar6/wg1/resources/frequently-asked-questions/
  - Weather and Climate Extreme Events FAQs: https://www.ipcc.ch/report/ar6/wg1/downloads/faqs/IPCC_AR6_WGI_FAQ_Chapter_11.pdf

Glossary

- **100 year storms:** The term "100-year flood" is used in an attempt to simplify the definition of a flood that statistically has a 1-percent chance of occurring in any given year. Likewise, the term "**100-year storm**" is used to define a rainfall event that statistically has this same 1-percent chance of occurring.
- Instead of the term "100-year flood" a **hydrologist** would rather describe this extreme hydrologic event as a flood having a 100-year **recurrence interval**.

  https://www.usgs.gov/special-topics/water-science-school/science/100-year-flood

  https://www.youtube.com/watch?v=eackimrt0pc

- GPCP: Global Precipitation Climatology Project
- QGAG: the volume of precipitation (calculated by weight) accumulated in measuring bucket as recorded at the station for the 15 minute period ending at the time specified for DATE above given in hundredths of inches or tenths of millimeters depending on user's specification of standard or metric units.
- QPCP: the amount of precipitation recorded at the station for the 15 minute period ending at the time specified for date above given in hundredths of inches or tenths of millimeters depending on user's specification of standard or metric units.

  https://climatedataguide.ucar.edu/climate-data/gpcp-daily-global-precipitation-climatology-project

  https://psl.noaa.gov/data/gridded/data.gpcp.html