Jet Propulsion Laboratory
California Institute of Technology

Projections of Climate Change Effects on Atmospheric Rivers and Their Landfalls

A Global Perspective

V. Espinoza[1], D. Waliser[2,3], B. Guan[2,4], D. Lavers[5]

[1]Sonny Astani Civil & Environmental Engineering Dept, USC, Los Angeles, CA

[2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA

[3]Center for Western Weather and Water Extremes, UCSD, San Diego, CA

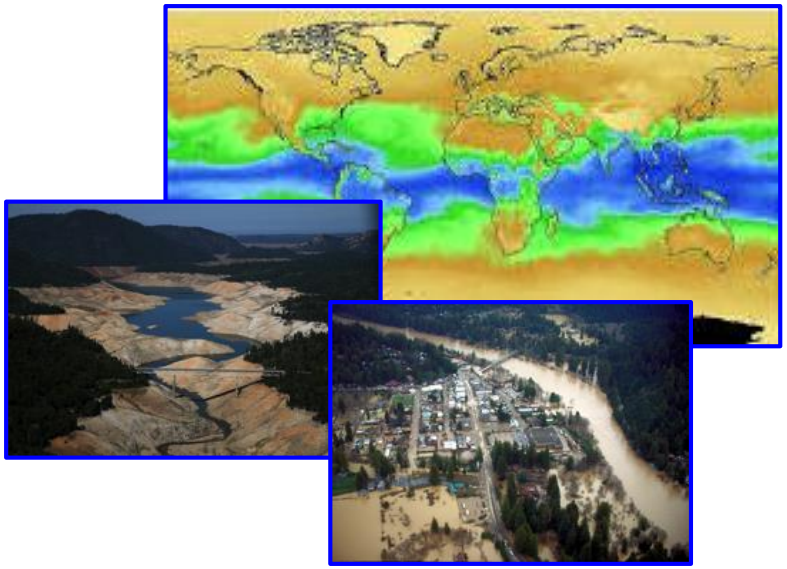
[4]Joint Institute for Regional Earth System Science and Engineering, UCLA, Los Angeles, CA

[5]European Centre for Medium-Range Weather Forecasts, Reading, UK

International Atmospheric River Conference
La Jolla, CA
August 8-11, 2016

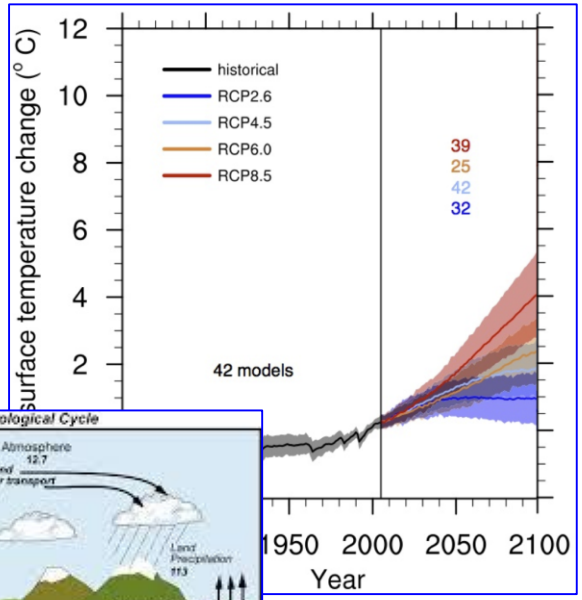
Atmospheric Rivers Affects

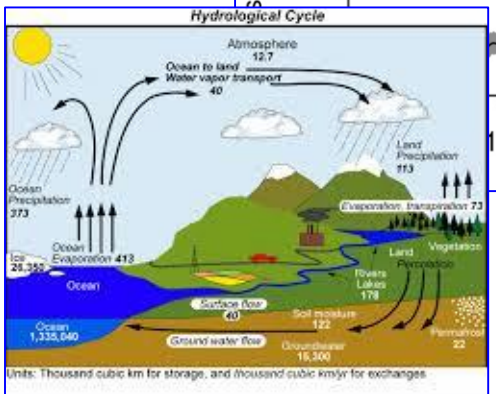
- Global Climate
- Water Availability
- Extreme Precipitation and Floods



Projections of Global Warming Indicate Significant Changes to:

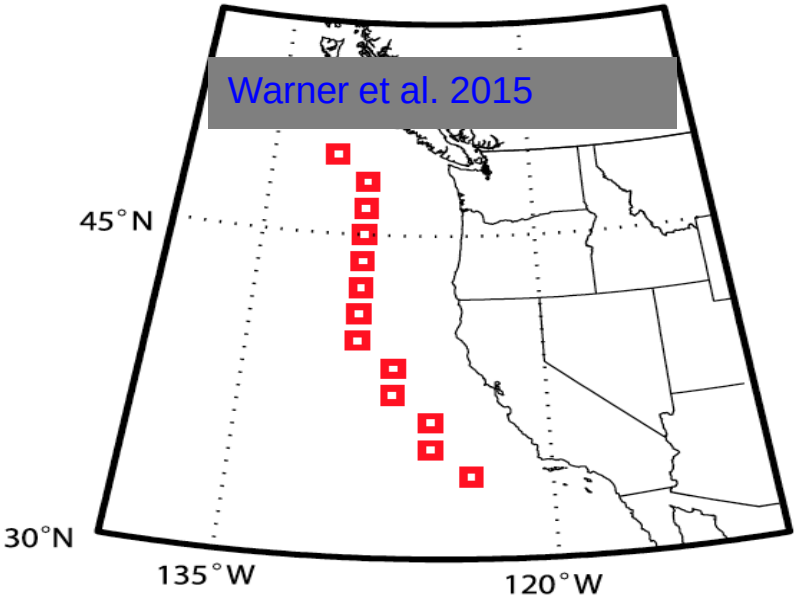
- Global Water Cycle
- Global Energy Cycle
- Atmosphere/Ocean Circulation
- Extreme Events
- Etc.





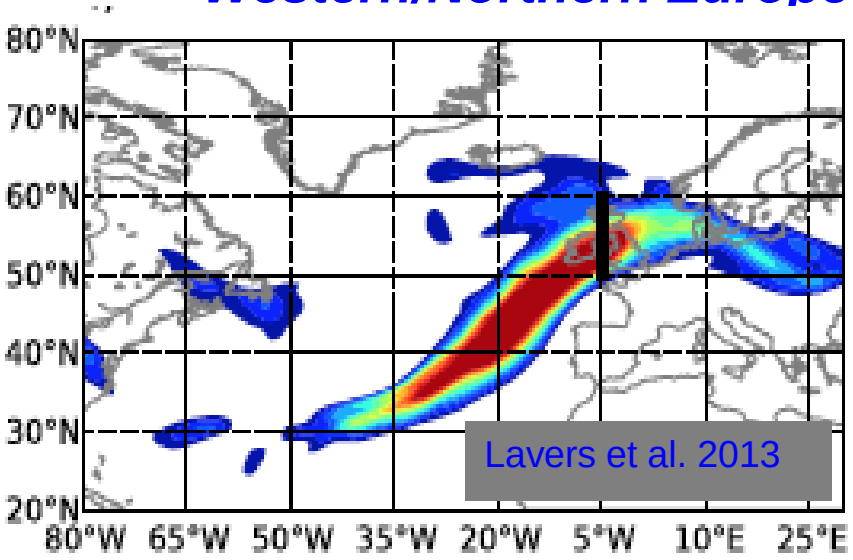
Climate Projection Studies Of Atmospheric Rivers To Date Have Mainly Focused On Two Regions

West Coast of N. America



Dettinger (2011), Payne and Magnusdottir (2015), Warner et al. (2015), Gao et al. (2015), Radić et al. (2015) Hagos et al. (2016),

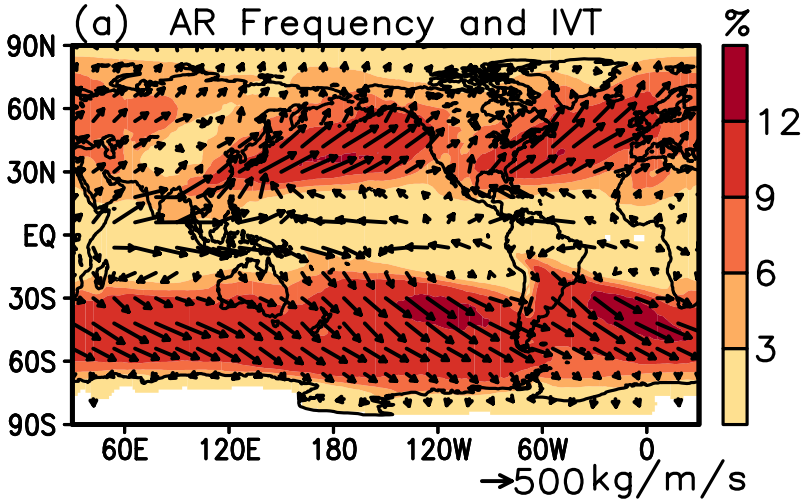
Western/Northern Europe

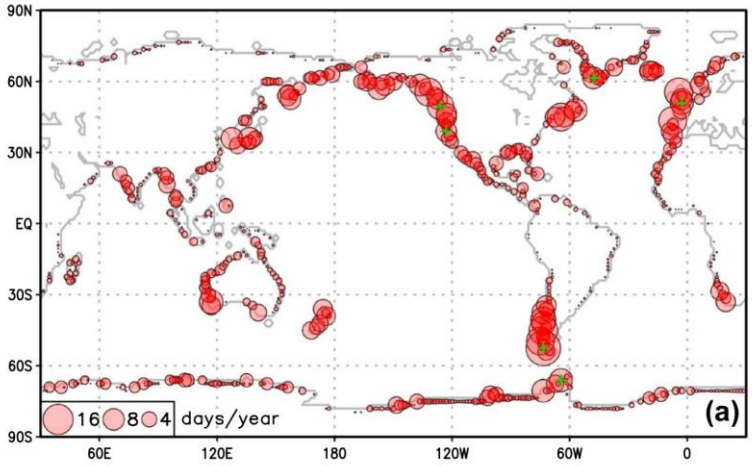


Lavers et al. (2013), Gao et al. (2015)

The Impacts Of Climate Change On "Atmospheric Rivers" Across The Globe Has Yet To Be Examined

Using a Global Perspective, We Examine The Impacts Of Global Change On



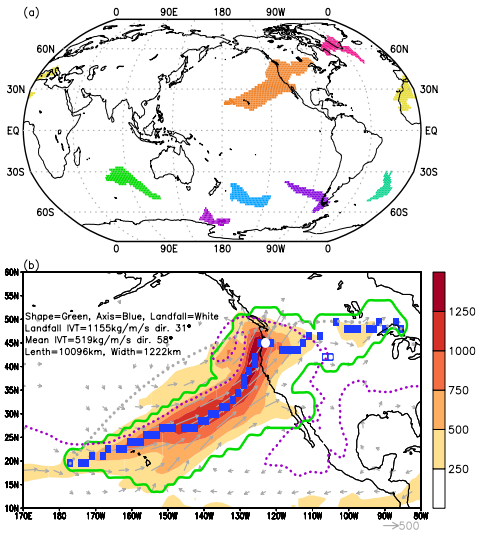


Guan & Waliser (2015)

Atmospheric River Frequency & Intensity

Atmospheric River Landfall Occurrences

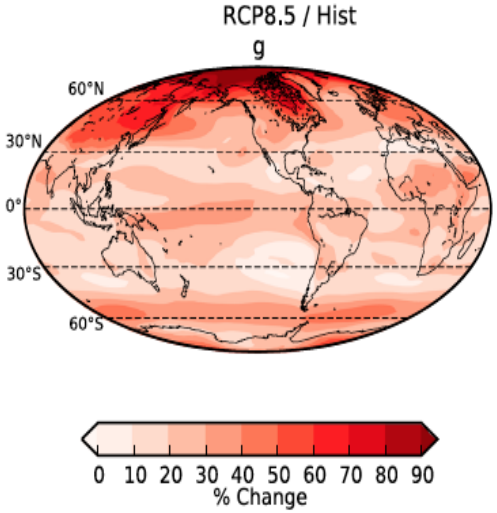
Approach



Guan & Waliser (2015)

Global Detection Algorithm

Identifies ARs, frequency, transports and landfalls



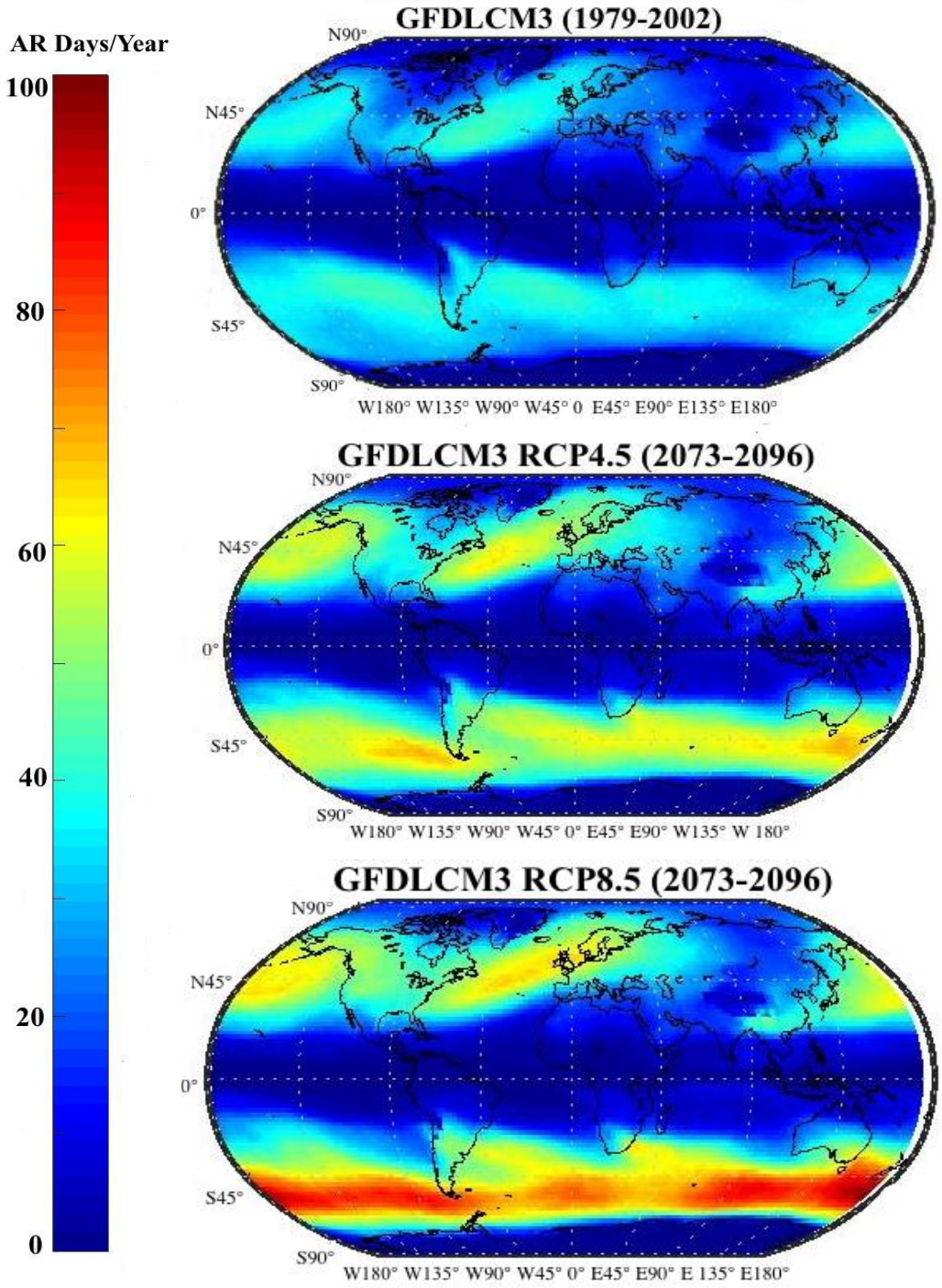
Lavers et al. (2015)

CMIP5 Analysis of IVT Climate Changes for 21 CMIP5 Models

IVT increases by 30–40% in the North Pacific and North Atlantic storm tracks for RCP8.5

Global Evaluation of Climate Change Impacts on ARs

?



Example Result for GFDL CM3 GCM

(Annual Means)

North Pacific Ocean

Historical: ~40 AR Days/Yr

RCP4.5: ~60 AR Days/Yr

RCP8.5: ~70 AR Days/Yr

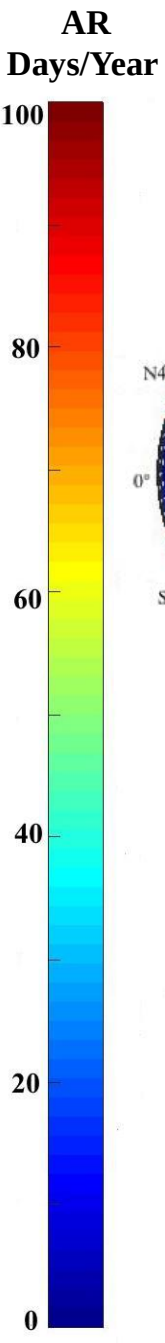
Southern Ocean

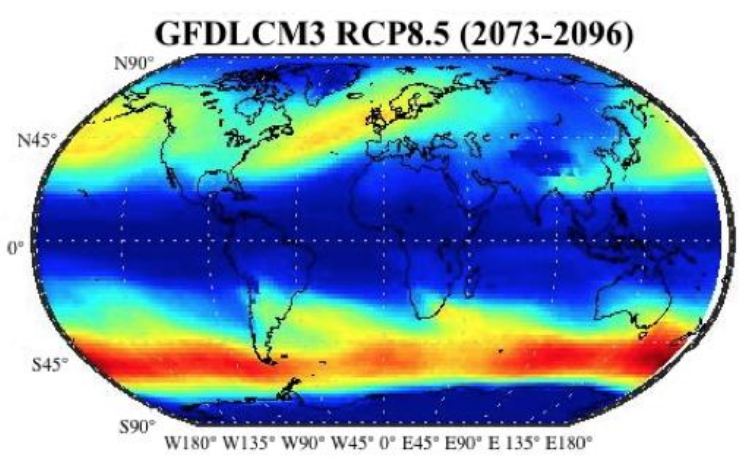
Historical: ~40 AR Days/Yr

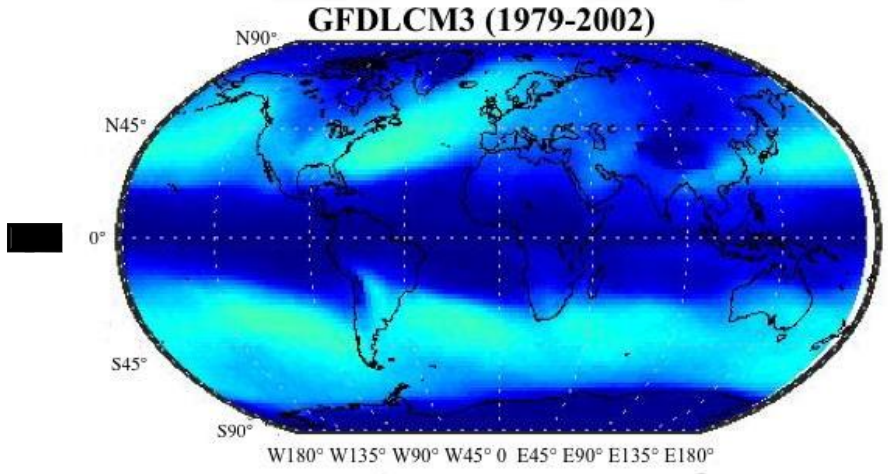
RCP4.5: ~65 AR Days/Yr

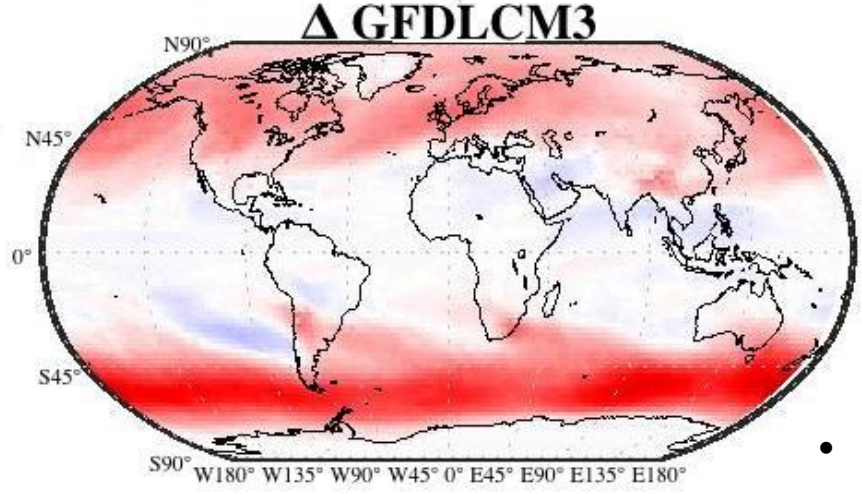
RCP8.5: ~85 AR Days/Yr

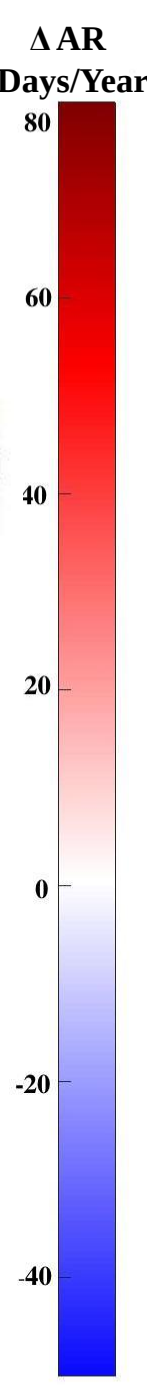
Example Result for GFDL CM3 GCM
(Annual Means)





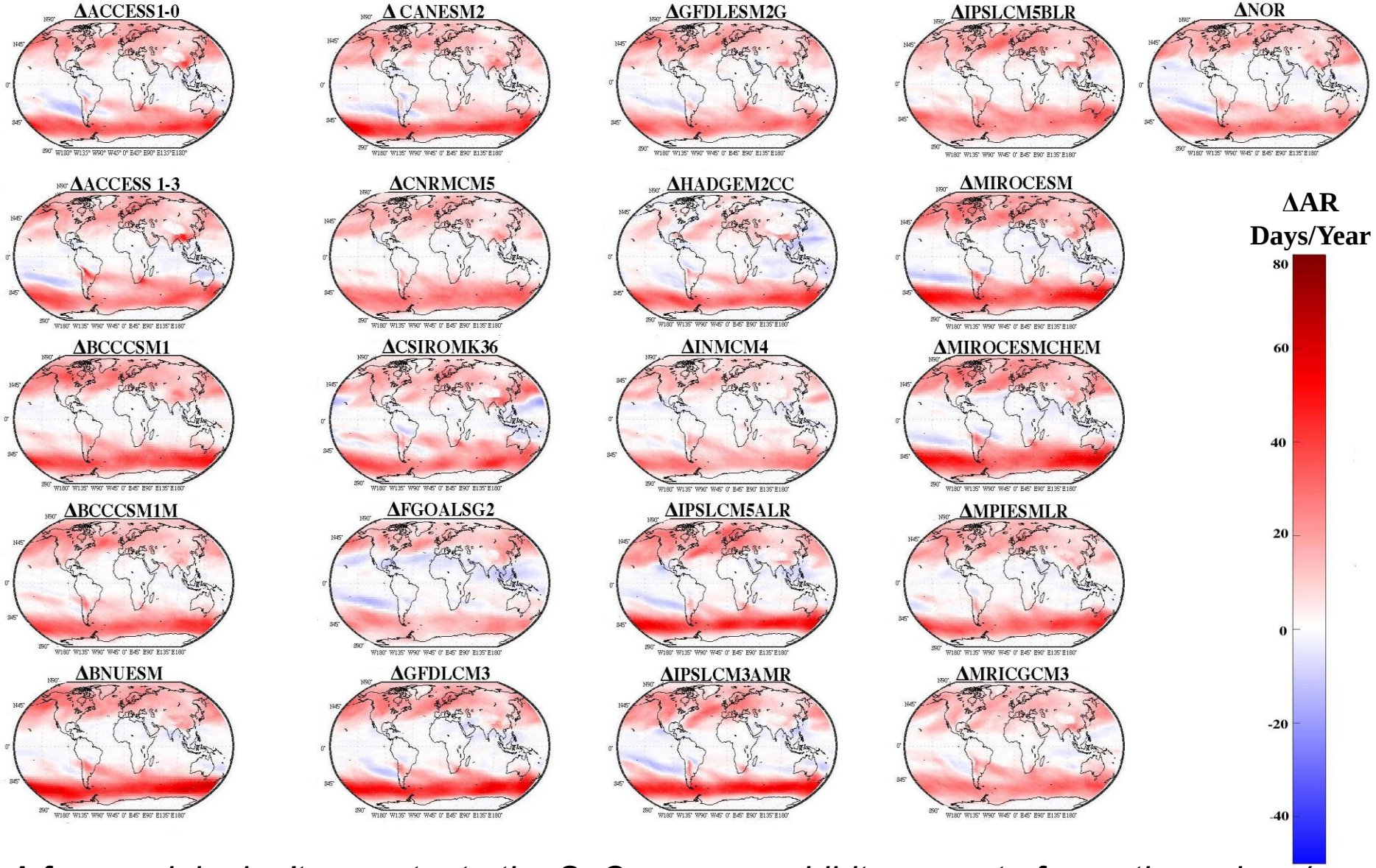






- Extra-tropics Increase
- S. Ocean Increases Most
- A Few Regions Decrease

Atmospheric River Frequency: RCP8.5 – Historical



A few models don't accentuate the S. Ocean, or exhibit as great of negative values/areas.

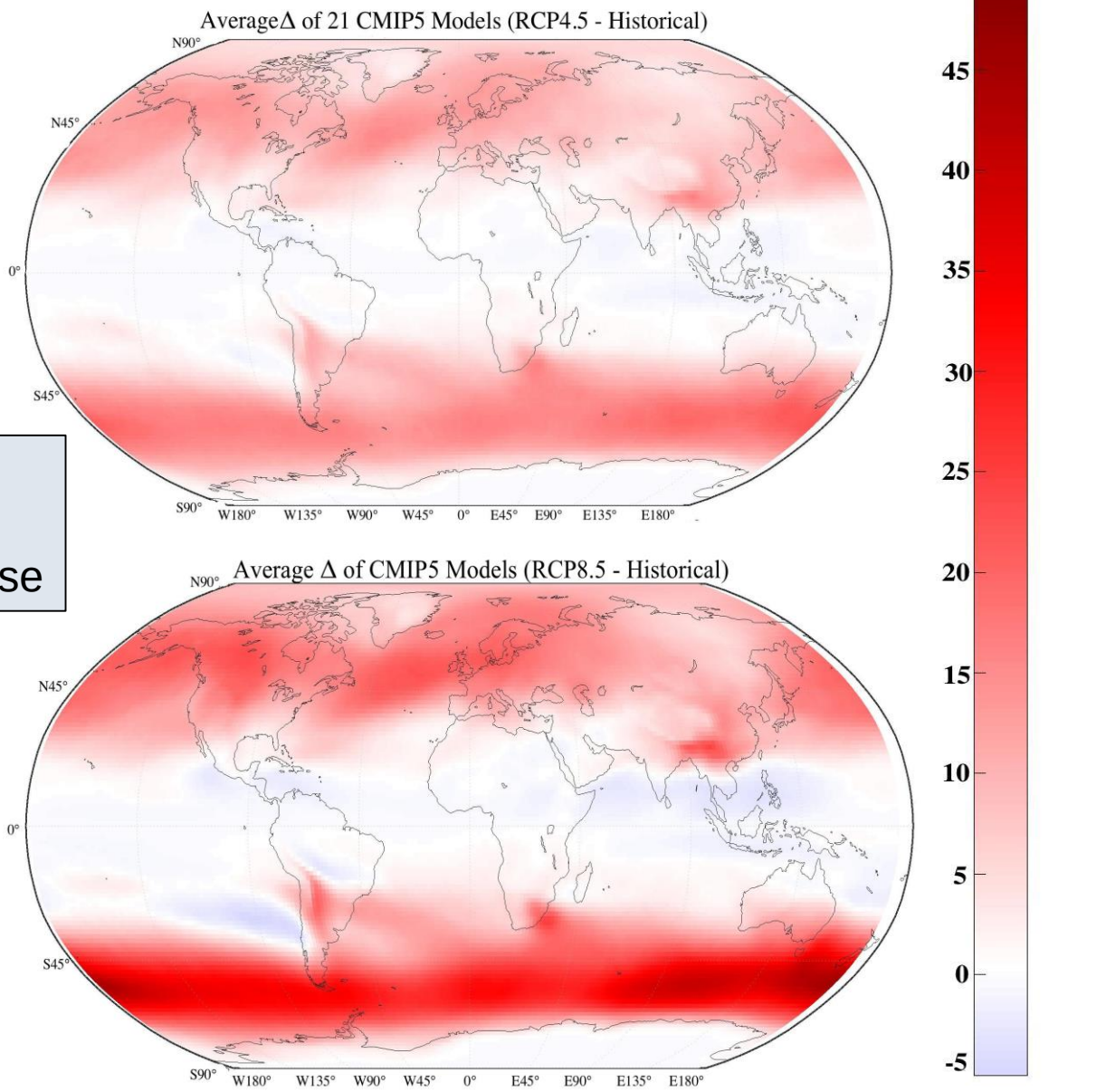
Atmospheric River Frequency Changes

Multi-Model Means

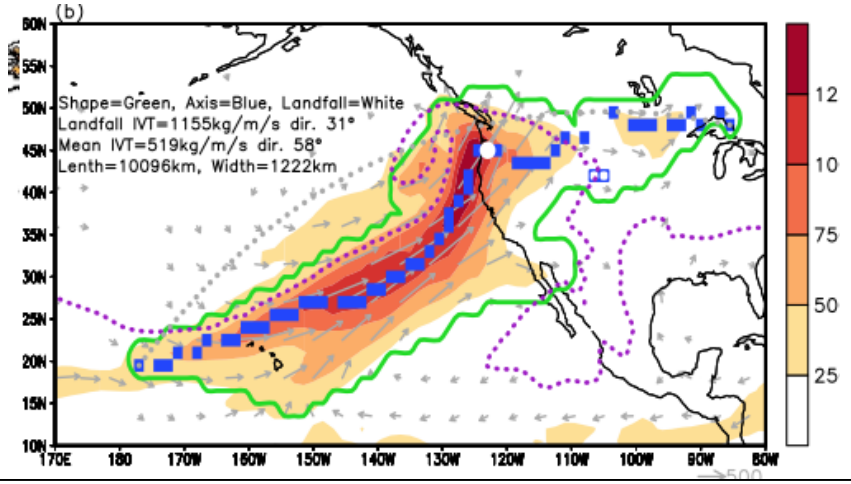
RCP4.5 - Historical

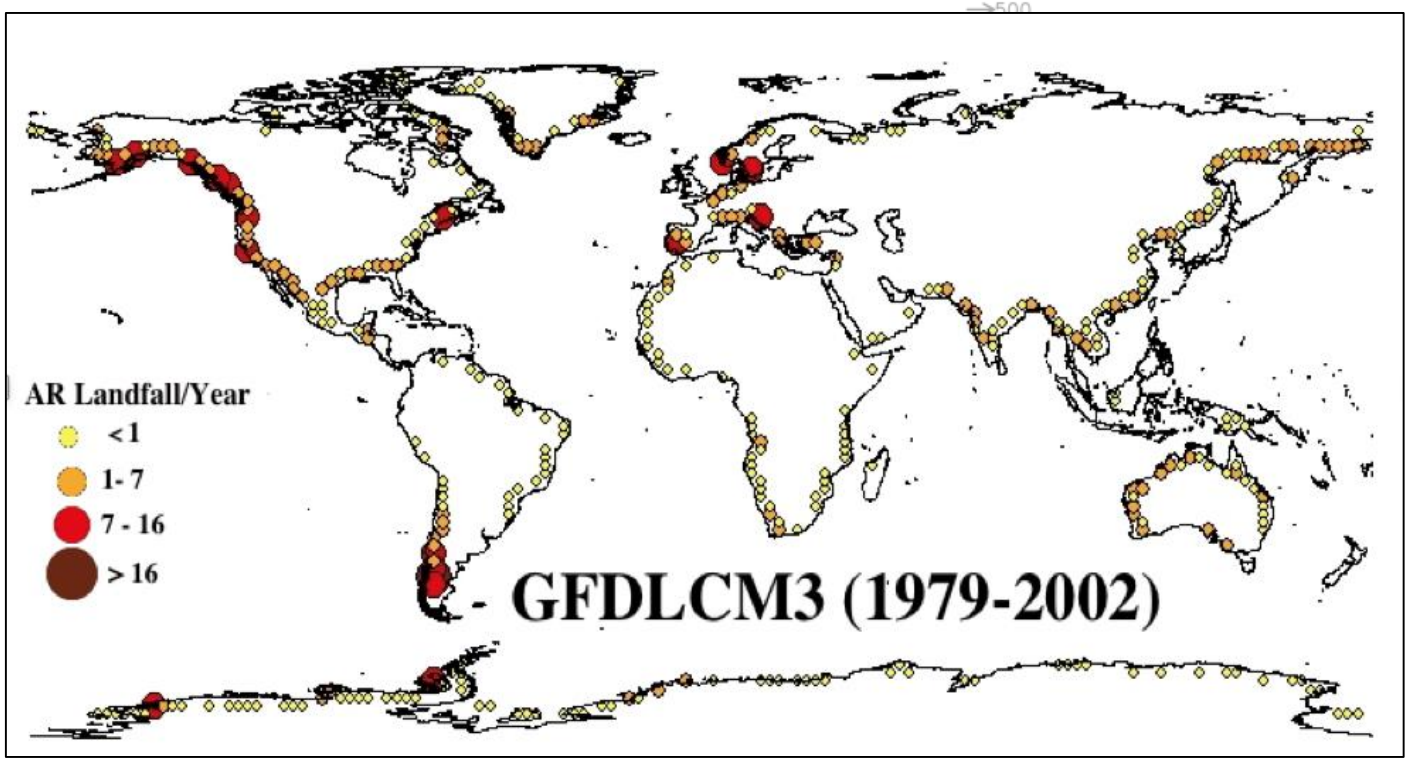
- Extra-tropics Increase
- S. Ocean Increases Most
- Tropics/S. America Decrease

RCP8.5 - Historical



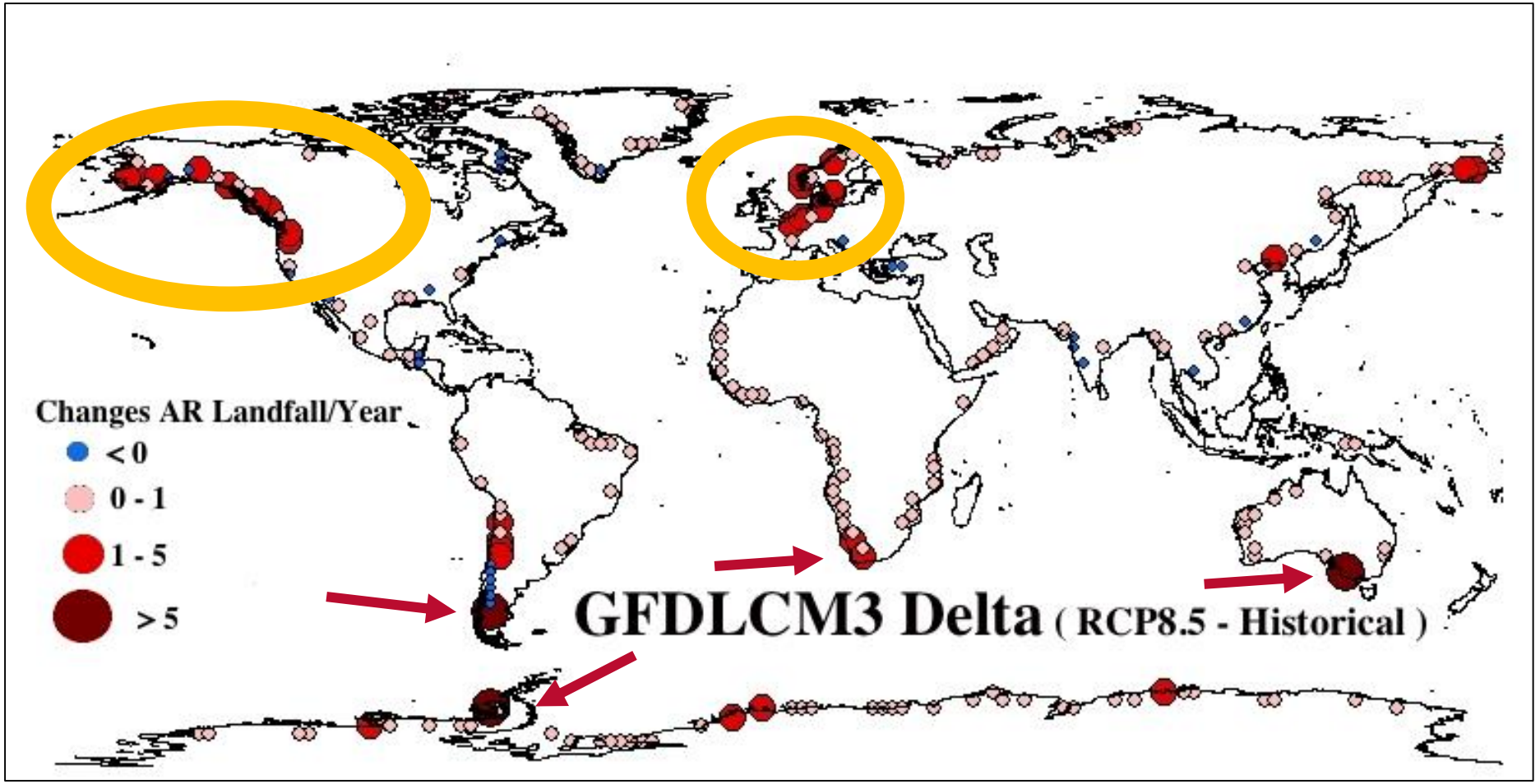
Global AR Landfall/Year Defined By AR Detection Algorithm





Landfall/Year Changes for GFDL CM3 GCM

(Annual Means)



Summary

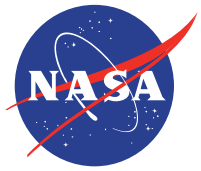
AR global detection algorithm applied to 21 CMIP5 model simulations to quantify global changes in AR frequency and landfalls in RCP4.5 and RCP8.5 global change projections.

- Largest projected increases in AR conditions over mid-latitudes (+20-30 days/year, +50%), with greatest increases over the southern ocean (+30-45 days/year; +100%), with the latter likely due to both thermodynamic and dynamic effects.
- Zero to small decreases in AR conditions (-5 days/year; -10%) in some tropical/subtropical areas (e.g. west of S. America).
- Preliminary examination of changes in landfalling ARs for the GFDL CM3 model show sizable % increases (~30-50% or more) in regions where AR events are common (e.g. western N. America, S. South America).

Future Work

- Complete AR landfall analysis
- Quantify changes in AR IVT values

Thank you!



Jet Propulsion Laboratory
California Institute of Technology

---

jpl.nasa.gov

espinoza.vicky@jpl.nasa.gov