Global Precipitation Part I: Trends & Projections

Bulletin Synopsis *April 2015*

Observations of Global Precipitation

Observations suggest that there has been an increase in globally averaged precipitation on land over the last century. This is based on several global datasets that show a statistically significant increase since 1900. However, the datasets do not agree on *how much* it has increased.

Future Global Precipitation

Total – Models project a gradual increase in total global precipitation over the 21st century – warmer temperatures drive more evaporation and the increase in water vapor leads to more precipitation. Regional variability will generally take the form of a wet-get-wetter, dry-get-drier pattern.

Timing – The contrast between the wet and dry season is likely to increase in most places as temperatures warm. In both mid- and high-latitude regions the expected increase is larger for winter than summer. However, this increase in average winter precipitation will occur at the same time that increasing temperatures contract the length of the snow season.

Intensity – Warmer temperatures allow the air to hold more water vapor when it is saturated, which will increase the intensity of individual precipitation events. As a result, the probability of heavy precipitation is projected to increase, and the effect will be stronger with increased warming.

Uncertainty of Precipitation Projections

We have a high level of confidence in estimates of future temperature because those projections are based on basic physical principles and significant model consensus, but precipitation is much more uncertain. And, as with temperature, the uncertainty grows as we scale down – from estimates of change in the global average to regional projections. There is less agreement among global climate models regarding the direction and magnitude of precipitation change, especially in certain regions.

There are a number of reasons for this uncertainty, including:

1. The small spatial scales of precipitation dynamics (e.g. cloud microphysics)
   The scale of these processes is much smaller than the resolution of global climate models, so those dynamics cannot be simulated from first principles, instead they must be described using parameterization, which introduces some room for error.
2. A large degree of spatial variability from one location to the next
   More data coverage is necessary to accurately capture precipitation trends. In contrast, the temperature at one location is closely related to the temperature nearby, so fewer data points can be used to estimate a large area.
3. The indirect relationship between greenhouse gases and precipitation change
   Greenhouse gases influence the climate by changing the amount of heat, which changes atmospheric pressure, which leads to changes in rainfall. Since this influence is several steps removed, it is more complex to simulate how GHG changes will affect precipitation.

Drought: A Closer Look

Generally, drought implies a moisture deficit relative to some previous norm. More specifically there are three types of drought: meteorological, hydrological, and soil moisture. Of these, soil moisture drought is perhaps the most relevant for forests because it is closely tied to plant water availability.

Soil moisture drought is driven by reduced precipitation and/or increased evapotranspiration. Soil characteristics, rooting depth, vegetation, an on-going lack of precipitation, and previous soil moisture and groundwater conditions play a role in determining this type of drought risk. Despite recent model improvements, there are only a handful of locations where we can currently be confident about how soil moisture will change in the future and those locations are all projected to become drier.

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