Global evaluation of trends in wetting and drying over wet and dry regions

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Background

- Definition of Drought : Drought is a recurring extreme climate event over land characterized by below-normal precipitation over a period of months to years. Drought is defined as a dry spell relative to its local normal condition[Aiguo Dai,2010].

- Three types of drought[Wilhite DA,2000]:

  Meteorological drought

  Agricultural drought

  Hydrological drought

Background

- Drought is a major natural hazard that can have devastating impacts on regional agriculture, water resources and the environment.

- More intense and longer droughts have been observed.

Background

Hot topic

- A concept that dry regions dry out further, whereas wet regions become wetter(DDWW) as the climate warms[Chou,C et al., 2009; Liu, C et al., 2010].
- Contradicting results : Aridity changes over land have not followed a simple intensification of existing patterns[Greve et al.,2014].

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Global assessment of trends in wetting and drying over land

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Data & Materials

1.Precipitation:

Global Precipitation Climatology Project(GPCP) daily rainfall dataset 1998-2013;

Climatic Research Unit(CRU),1948-2012

2. Potential evapotranspiration:

CRU, 1948-2012

3. Sc_PDSI_pm :

National Center for Atmospheric Research. 1948-2012

4.Volumetric soil water

European Centre for Medium-Range Weather Forecasts(ECMWF) ERA-20C，monthly dataset, 1948-2010

5.SPEI(multi-time scale)：

DIGITAL.CSIC Conjuntos de datos SPEIbase v.2.3. 1948-2012

Data & Materials

- Methods:

1. Regions are classified by Aridity Index(AI), as arid (*E*p/*P* > 0.65), transitional(<=0.2*E*p/*P*<=*0.65*) or humid (*E*p/*P* < 0.2)[UNEP, 1997]over the 1948–1968.
2. We use PDSI, SPEI3, soil moisture, SPEI12 to represent meteorological drought, agricultural drought, hydrological drought, respectively.
3. The trends are computed using a least square fit. The trend significance is further tested by the two-tailed test.

Results

1. Investigating the DDWW paradigm

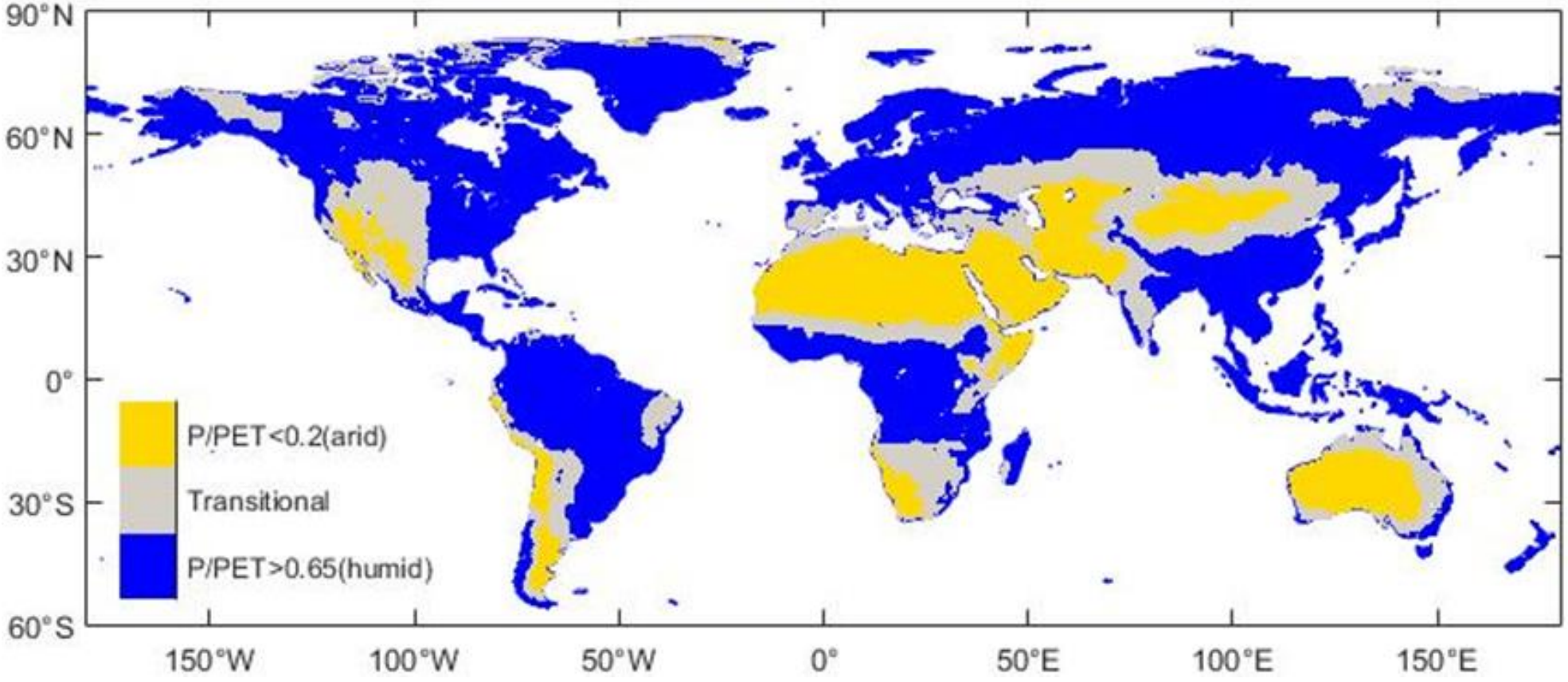


Fig 1 Distribution of arid (orange) and humid (blue) areas within the period from 1948 to 1968

1. Investigating the DDWW paradigm

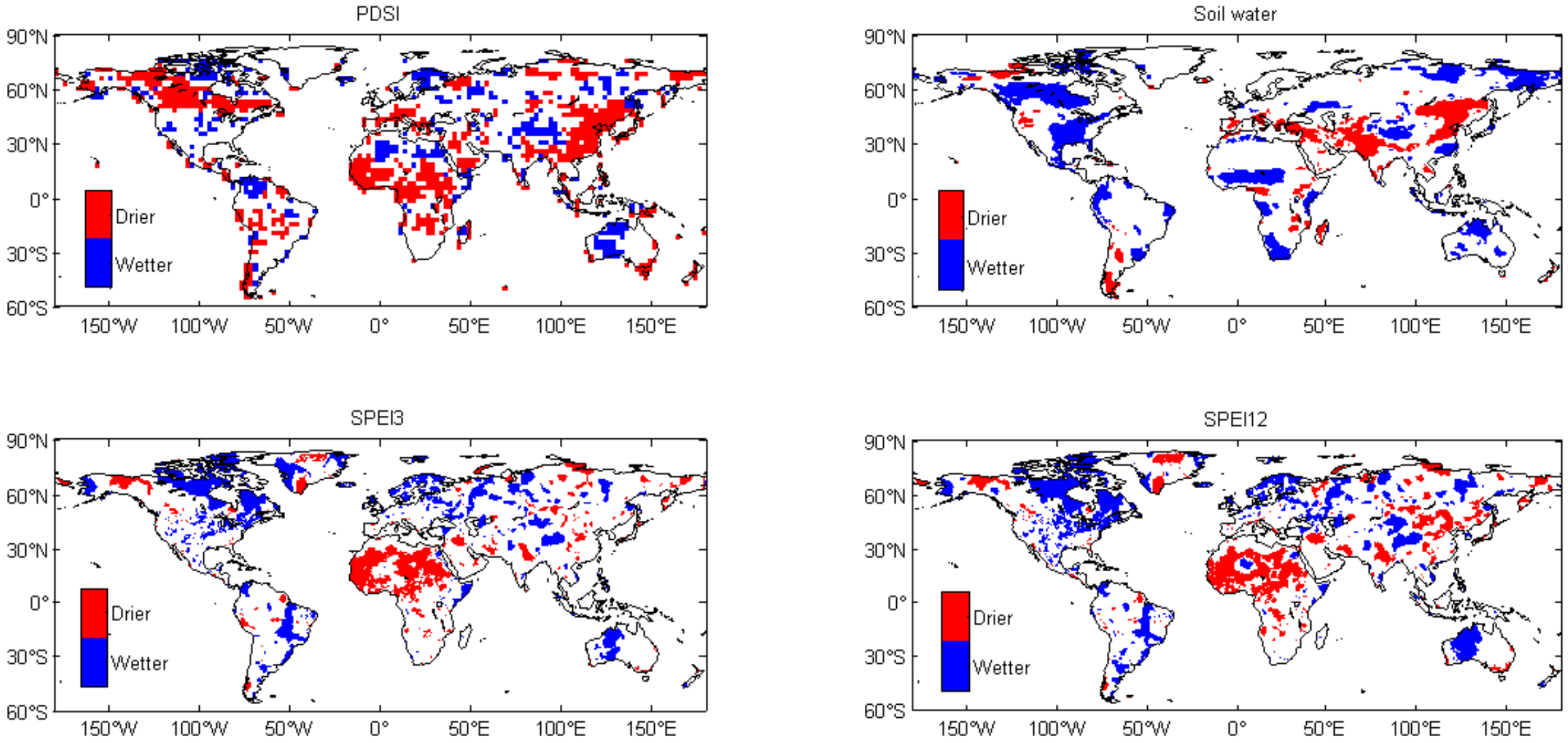


Figure 2 Annual drought trend defined by PDSI, soil water, SPEI3, and SPEI12, respectively

1. Investigating the DDWW paradigm

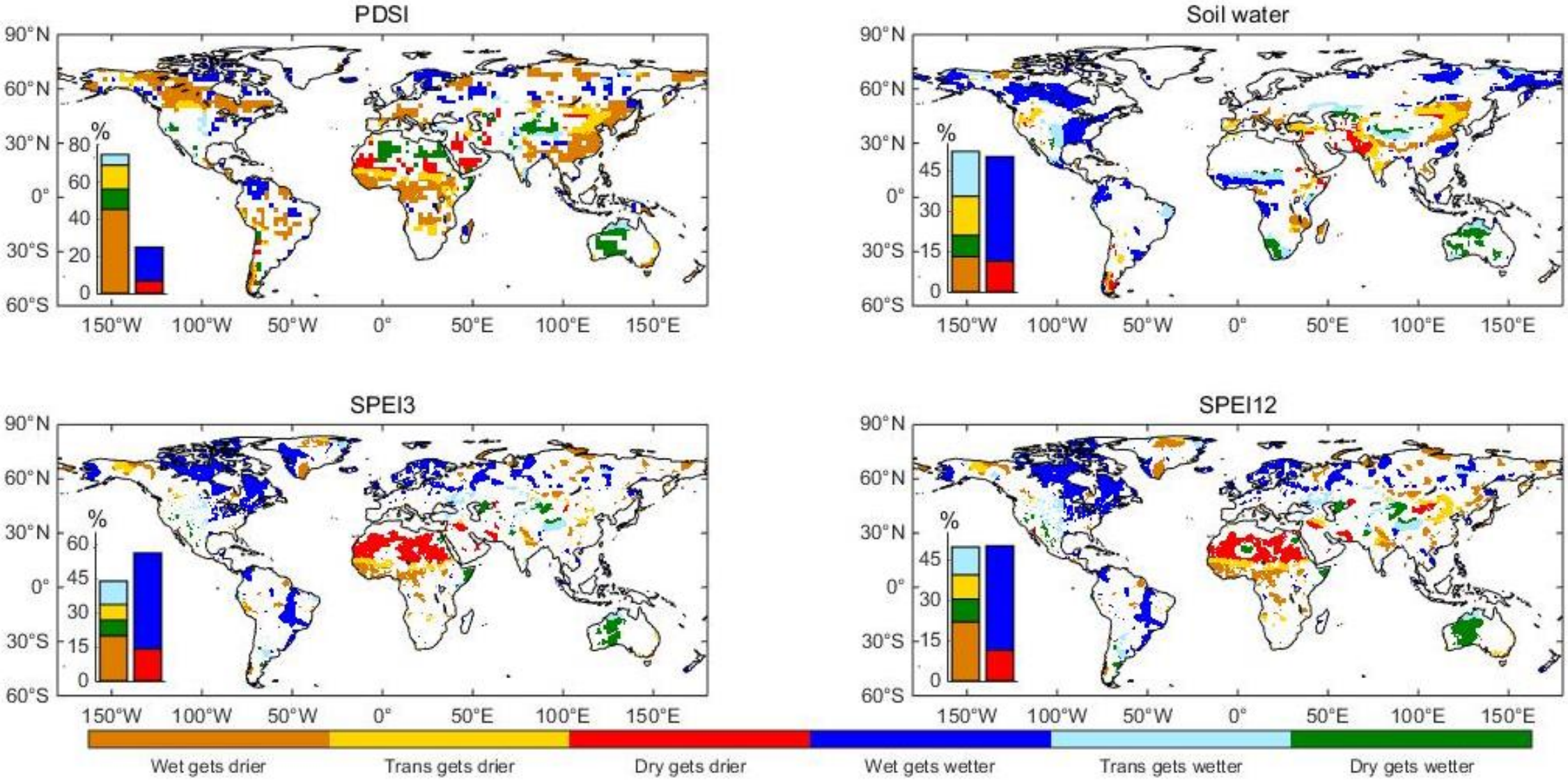
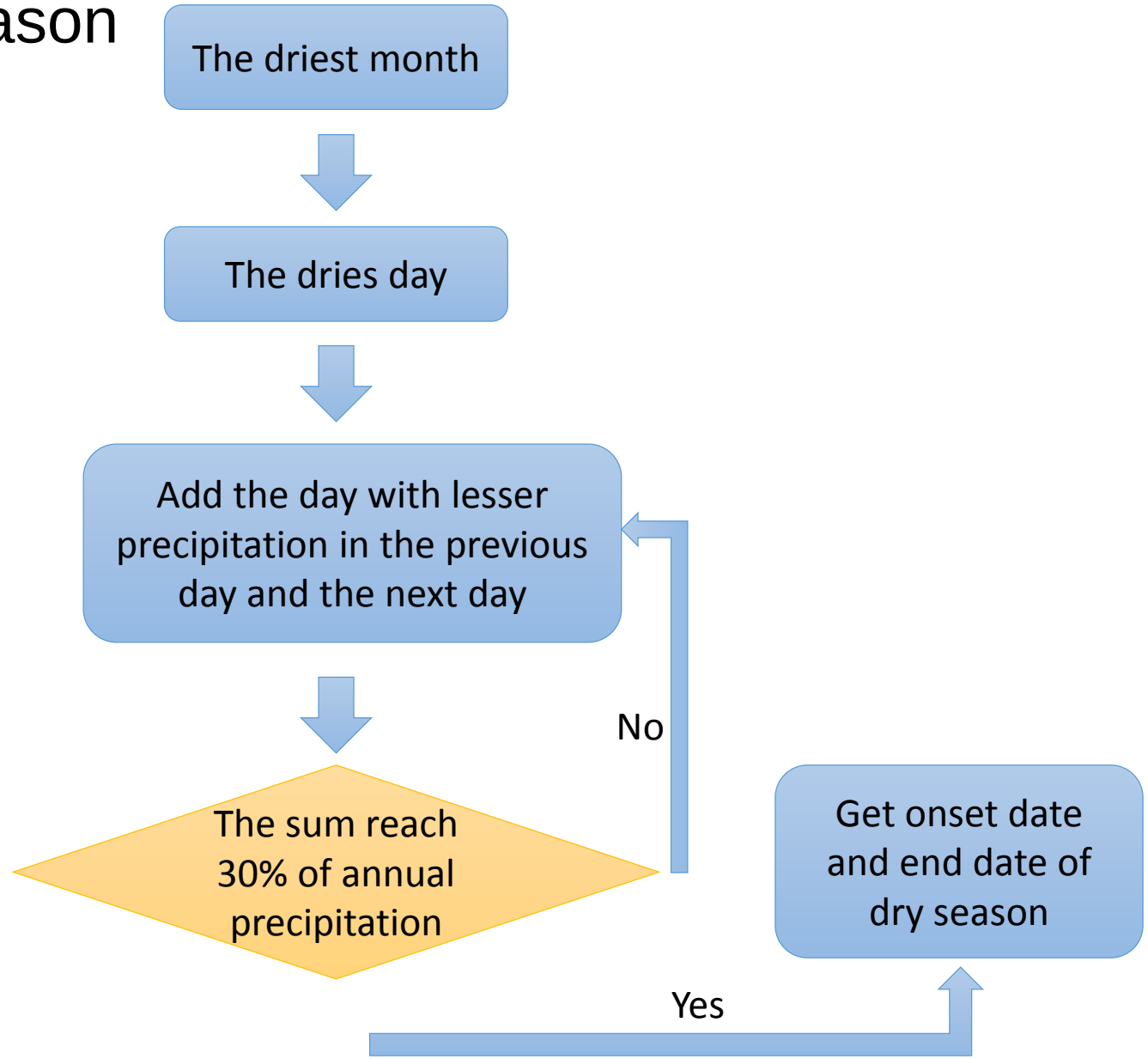


Figure 3 Evaluation of the 'dry gets drier, wet gets wetter' paradigm based on annual drought trend defined by PDSI, soil water, SPEI3, and SPEI12, respectively

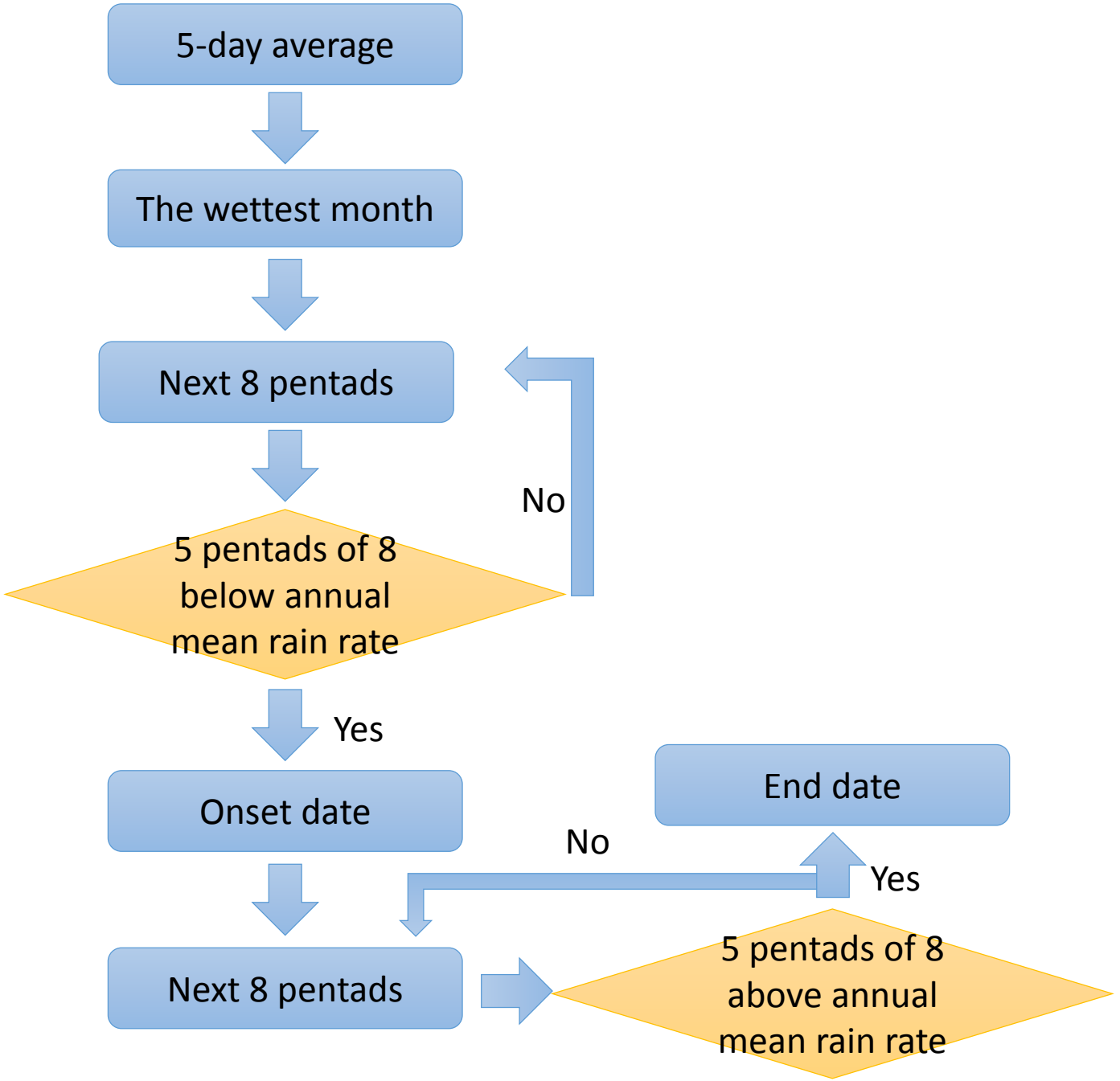
2. DDWW paradigm in dry season

We define dry season as :

(a)Continuous days in each year with precipitation less than 30% of multiyear averaged annual precipitation [Staver et al., 2011]



(b)The dry season end date is determined by the first date when the pentad mean rain rate changes from below to above a threshold, and vice versa for the dry season onset. [Li WH et al., 2004].



2. DDWW paradigm in dry season

- The main difference occurs in DSE date

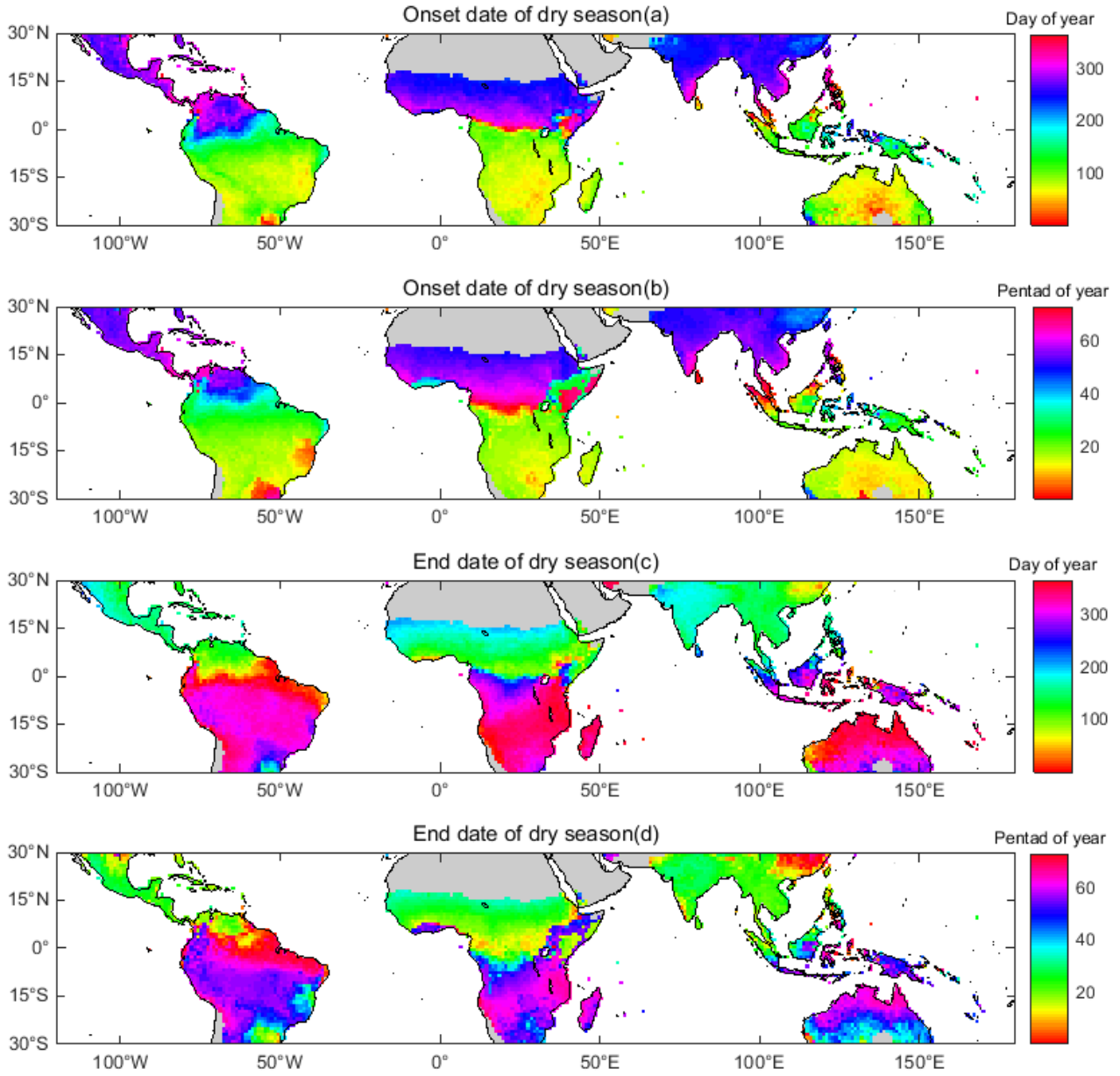


Fig 4. Spatial distributions of the onset date and end date of the dry season calculated by (a), (c)method 1 and (b), (d)method 2

2. DDWW paradigm in dry season (Further work)

- Choose or propose a widely applicable way to define rainy and dry season, and evaluate DDWW paradigm at seasonal scale.

- Evaluate how drought changes temporally and spatially in arid and humid region during rainy and dry season.

Conclusion & Discussion

- At annual scale, simplifying statements such as the DDWW paradigm for assessments on historical dryness changes on land can not fully account for the complexity of the underlying system.

- The definition by days can be more generally applicable; the definition by pentads can captures the rapid transition in rainfall regime associated with the DSE and DSA.

- Change of dry season length can be also a indicator of seasonal and annual drought condition.

Thanks for your attention and valuable comments!

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