



Global Atmospheric River Depicted from Satellite and NWP Reanalysis, and Their Connection to Weather and Climate Phenomenon

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Outline

1. Basic equations to describe water vapor transport
2. Spatial and temporal display of Global Atmospheric Rivers
3. Humidity along an atmospheric river
4. Verification using rain and lightning
5. AR climatology and ENSO signals
6. On going research

Basic Equations

$$\frac{\partial w}{\partial t} + \nabla \cdot \frac{1}{g} \int_{p_0}^0 \vec{v} q dp = E - P$$

$$w = \frac{1}{g} \int_{p_0}^0 q dp$$

w – total precipitable water

t – time

g – acceleration due to gravity

p, p₀ – pressure, surface pressure

v – wind vector

q – atmospheric humidity

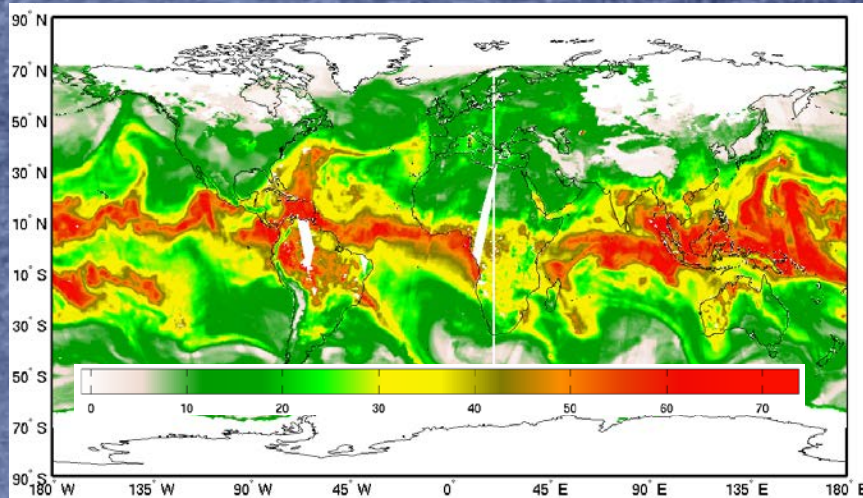
E – surface evaporation rate

P – surface precipitation rate

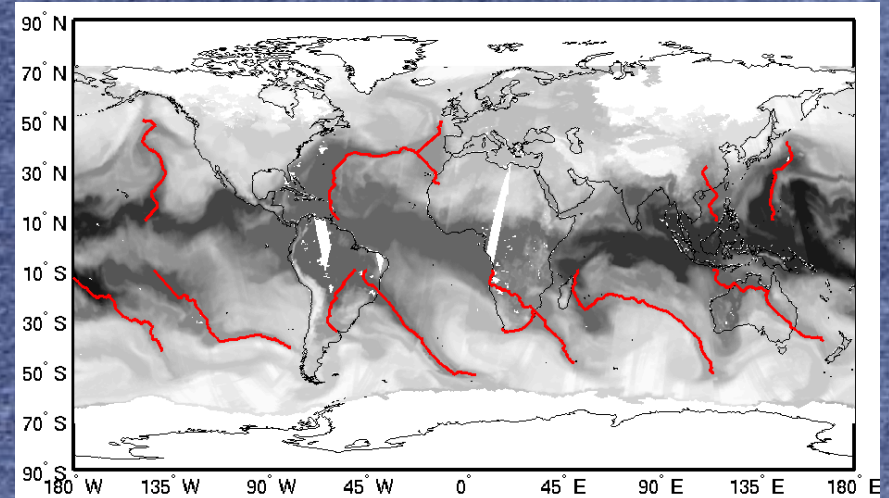
Atmospheric Rivers – Introduction

- ARs may be extracted from TPW (total precipitable water), from observation or NWP.
- ARs are connected to prolonged flooding events, e.g., “The Pineapple Express” in the U.S.
- ARs may be connected to climate signals as ENSO, MJO, etc.
- ARs have broad impact on agriculture, health, tourism, water resources, etc.

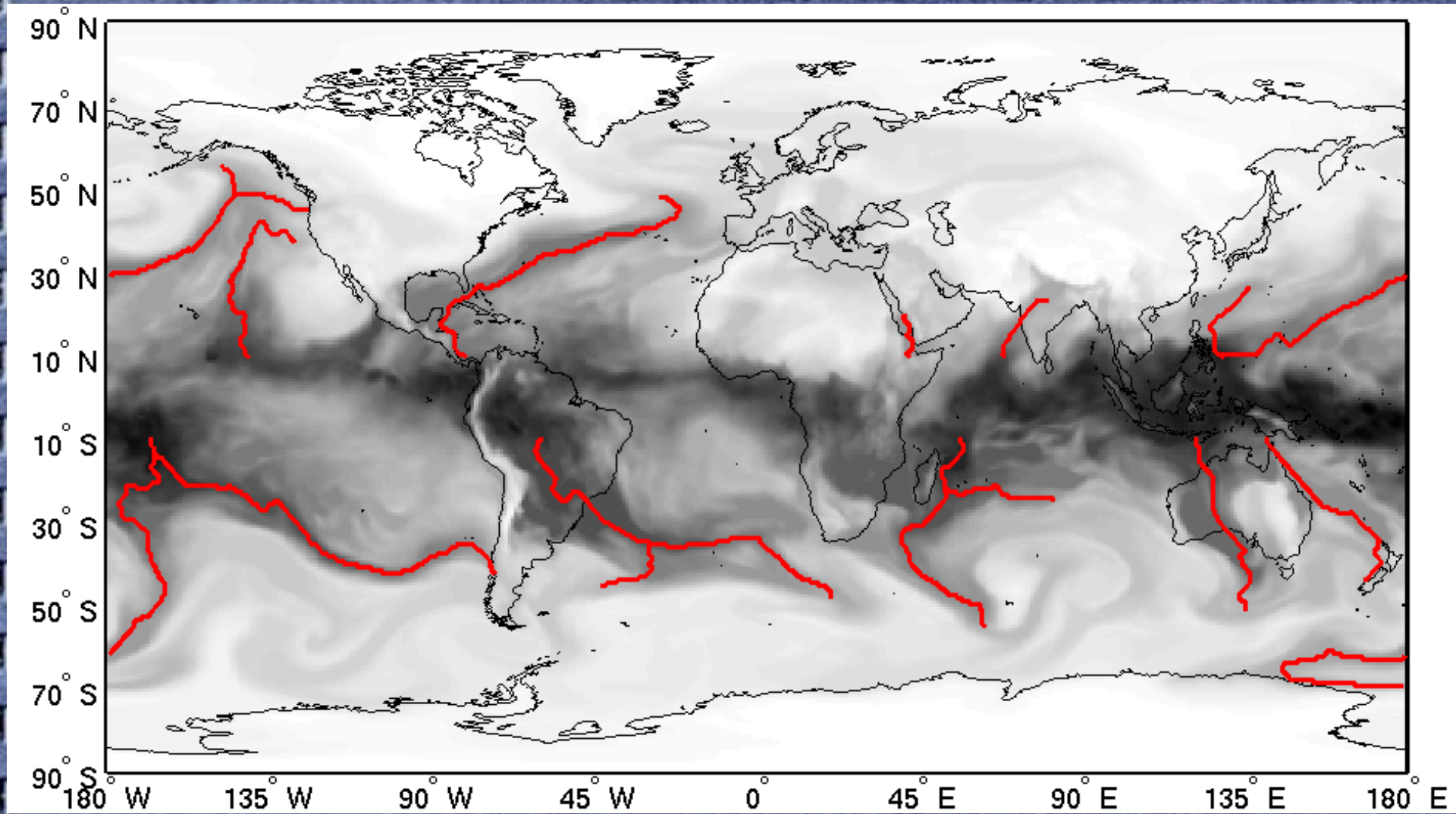
Blended TPW from November 9, 2014



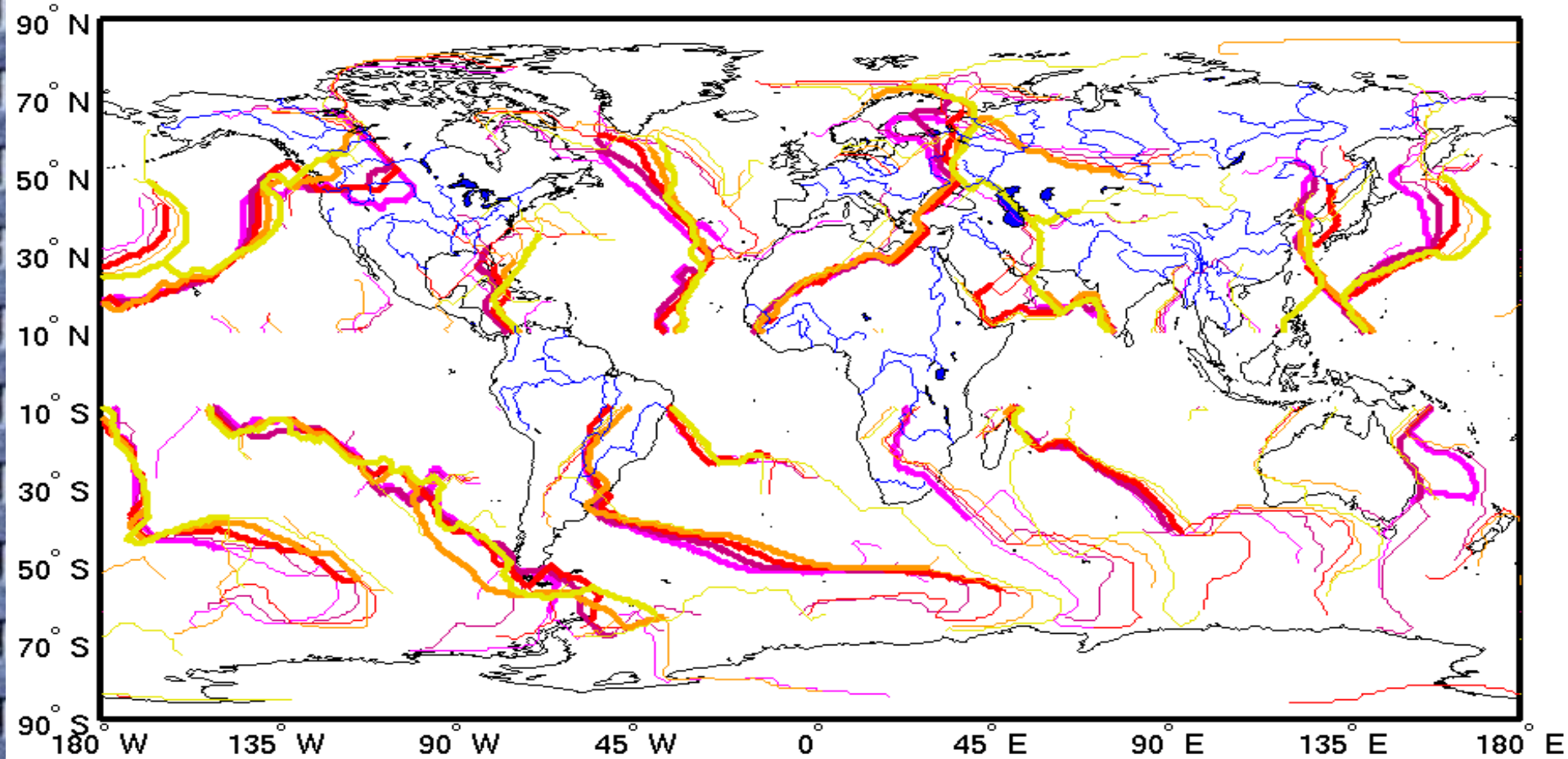
AR Detected from November 9, 2014



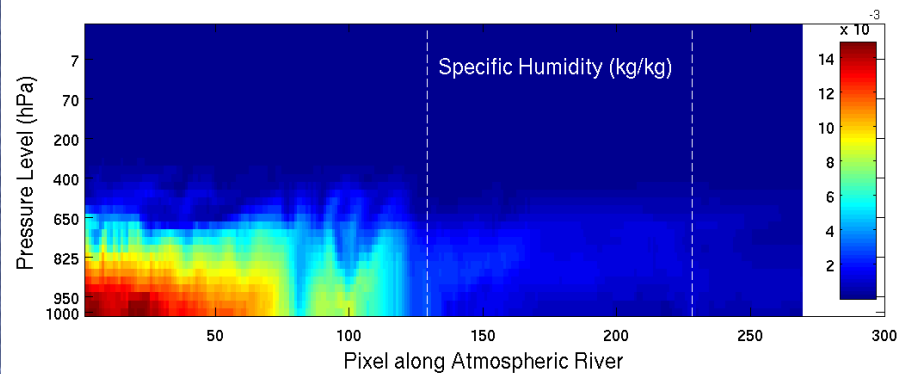
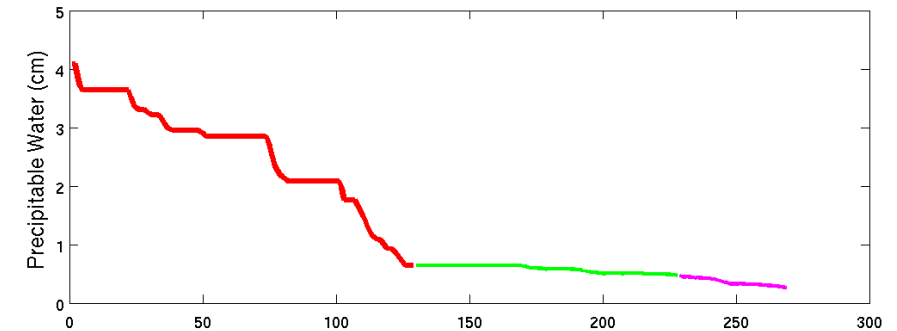
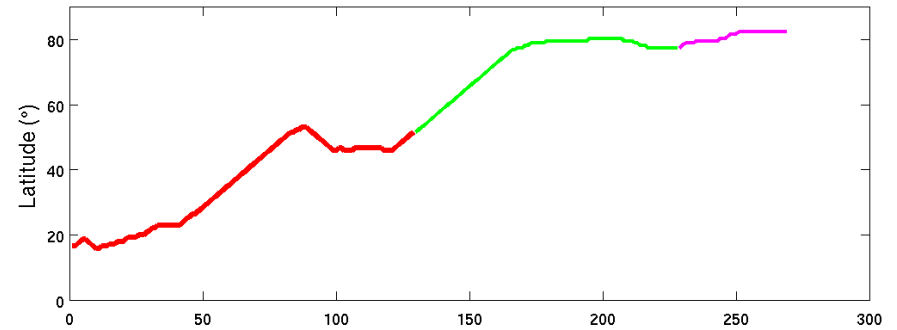
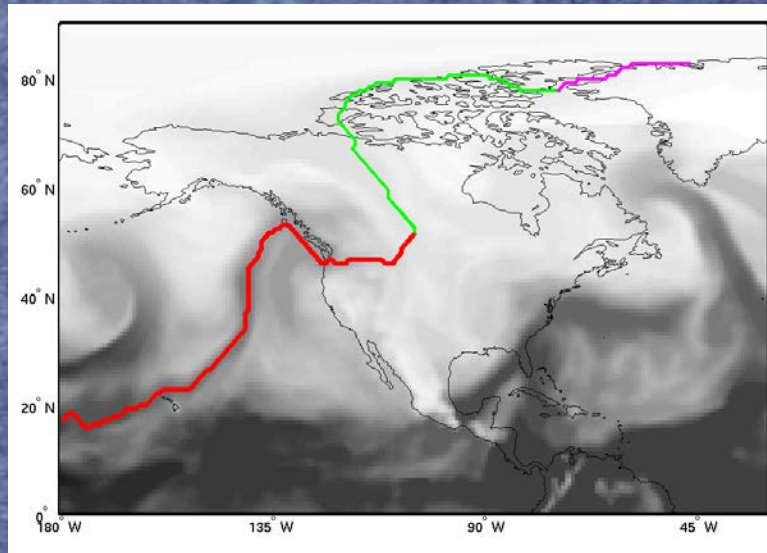
Global AR for Dec 31, 18:00 UTC, 2013



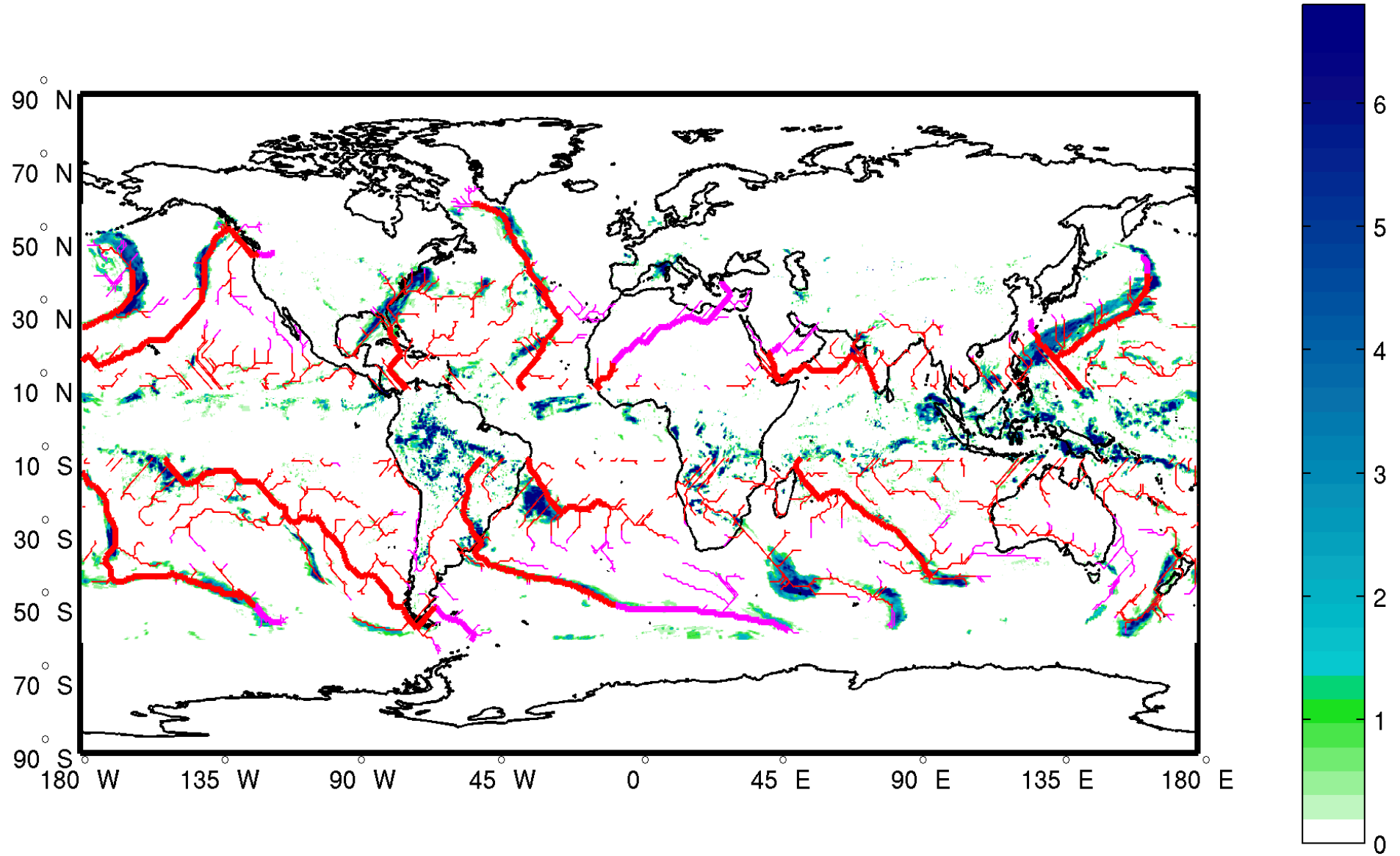
Five Consecutive 6-hourly AR, Centered at Nov 30, 18:00 UTC, 2008



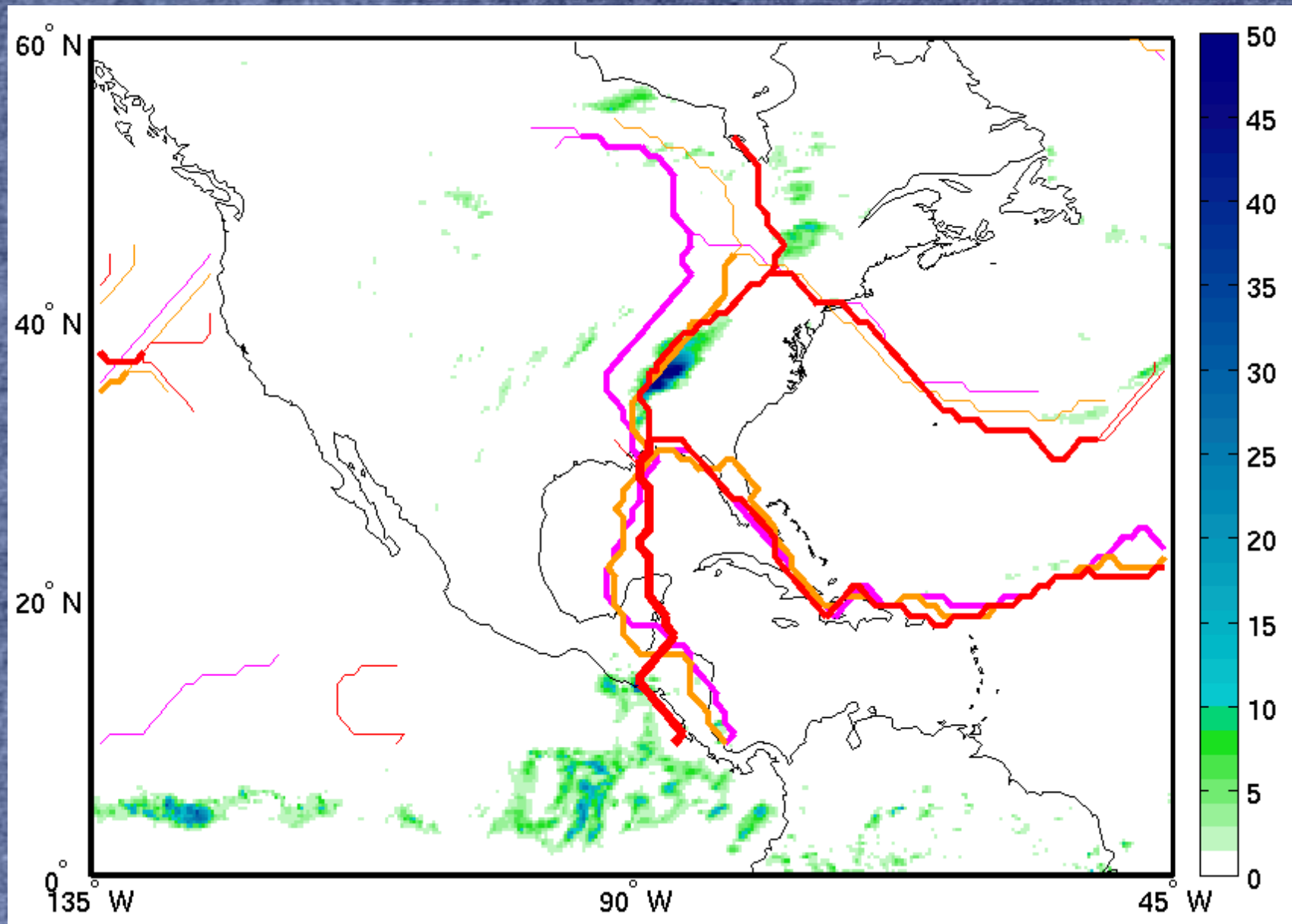
Humidity along an AR



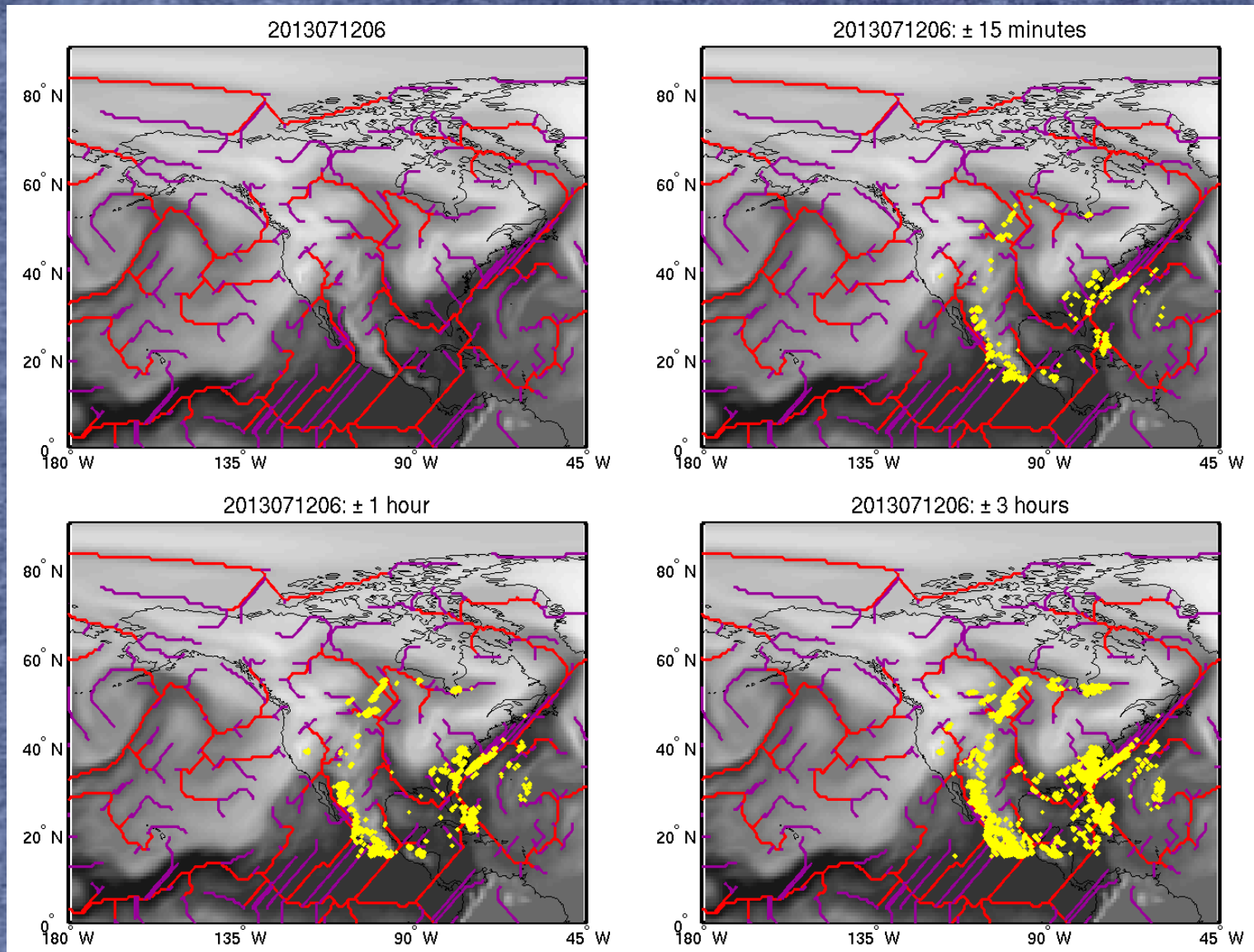
AR (TPW > 2 cm) and Rain (CMORPH) on Nov 30, 18:00 UTC, 2008



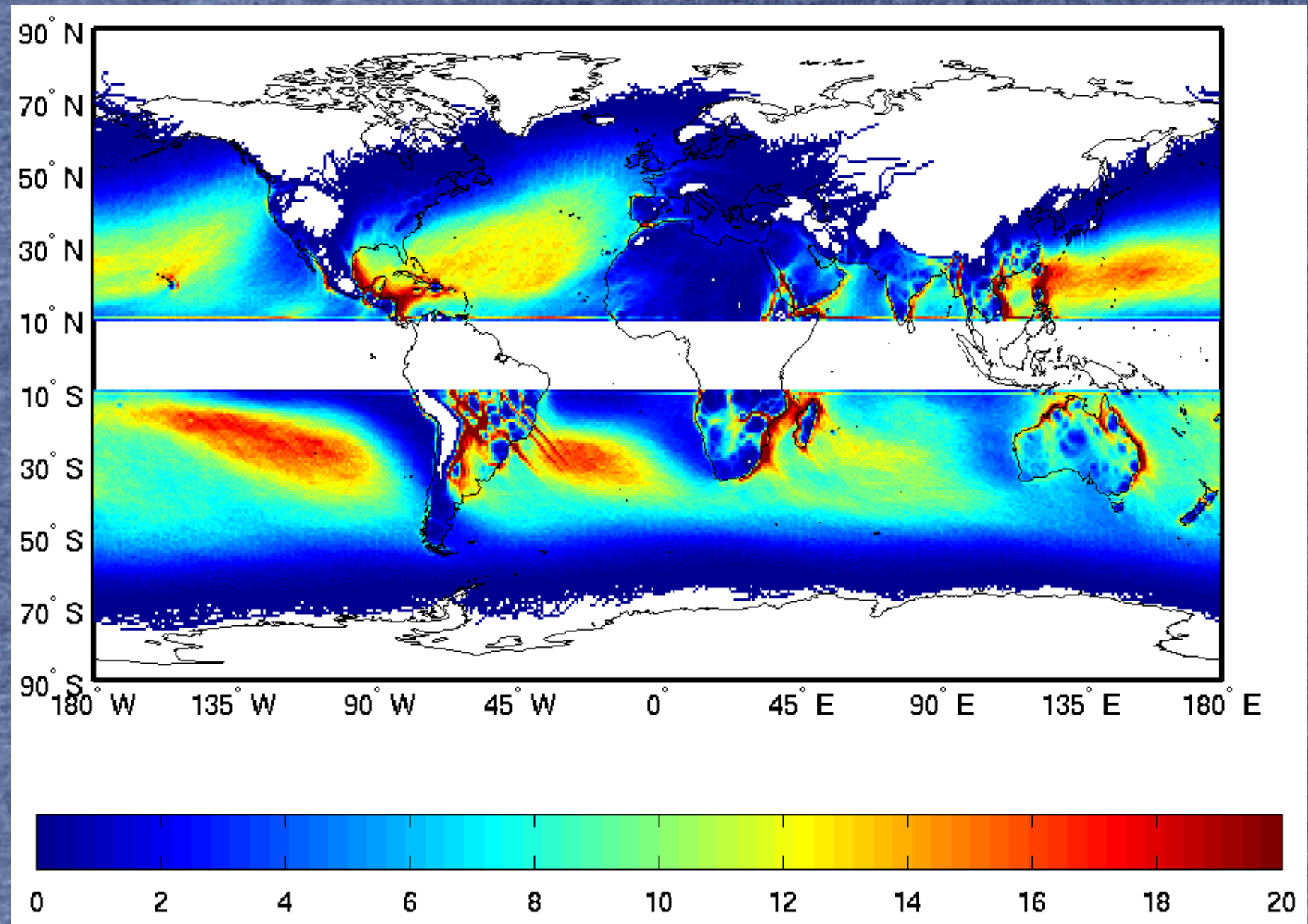
AR and Extreme Rain at Nashville, 2010



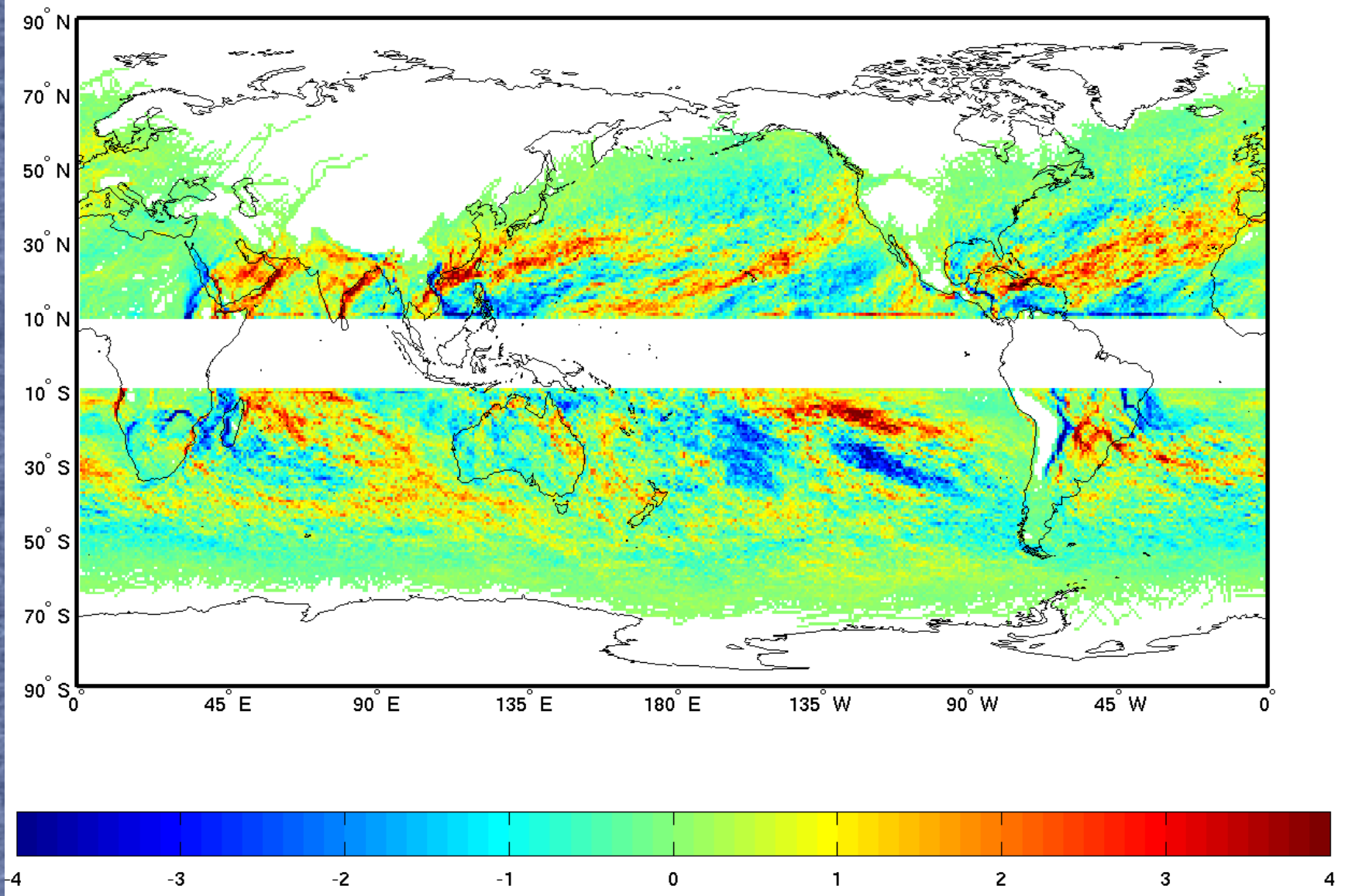
AR and Lightning



AR Climatology in NDJF from 1979 to 2014



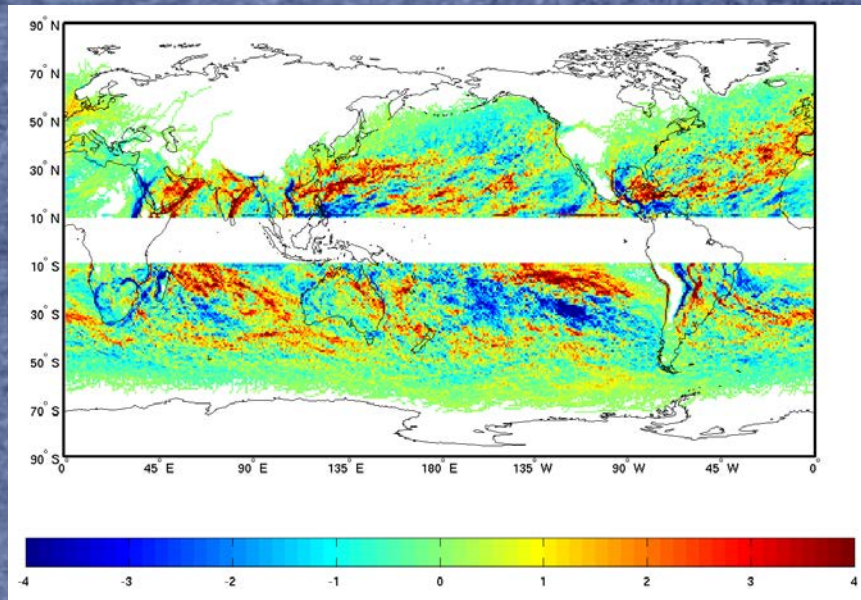
AR Climatology Anomaly to Capture ENSO Signals



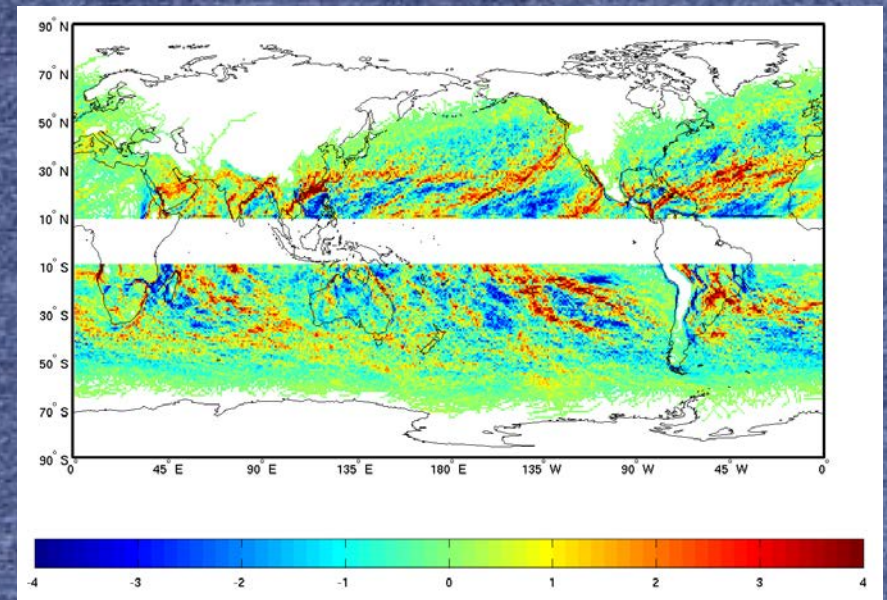
The eastern and central Pacific El Niño events during DJFM

Eastern El Niño	Central El Niño
1982/1983, 1986/1987, 1997/1998, 2006/2007	1994/1995, 2002/2003, 2004/2005, 2009/2010

Eastern El Niño



Central El Niño



On Going ...

1. Comparison with current AR publications
2. Go deeper into weather related phenomenon
3. Go deeper into climate related phenomenon, as MJO, high latitude
4. Etc