

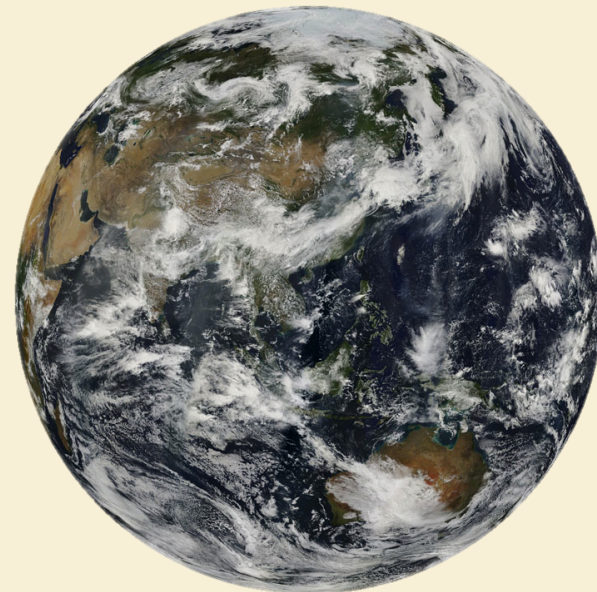
# Climate Data Records: A MODIS Perspective

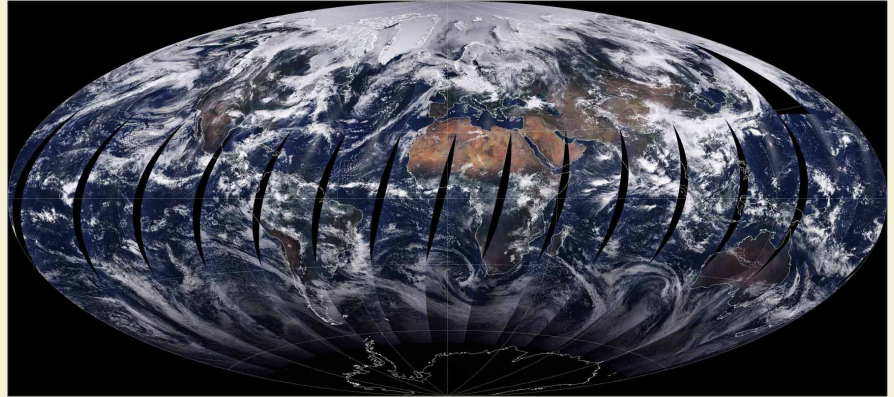
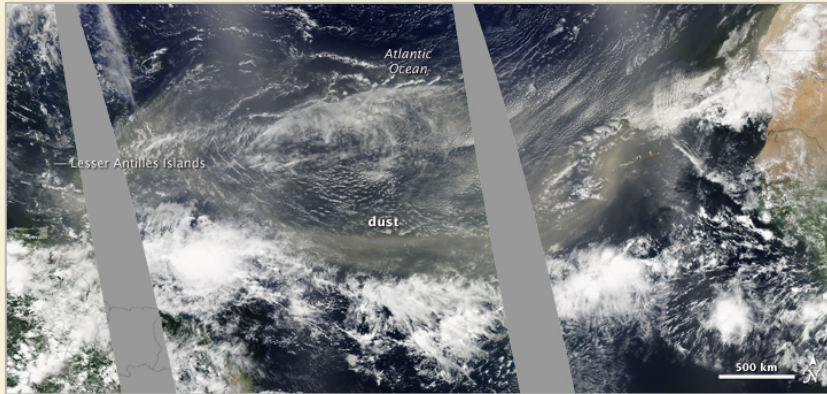
S. Platnick<sup>1</sup>, N. Amarasinghe<sup>2</sup>, and the MODIS Atmosphere Team

<sup>1</sup> NASA GSFC, <sup>2</sup> SSAI

Workshop on *Observations &  
Modeling of Aerosol/Cloud Properties  
for Climate Studies*

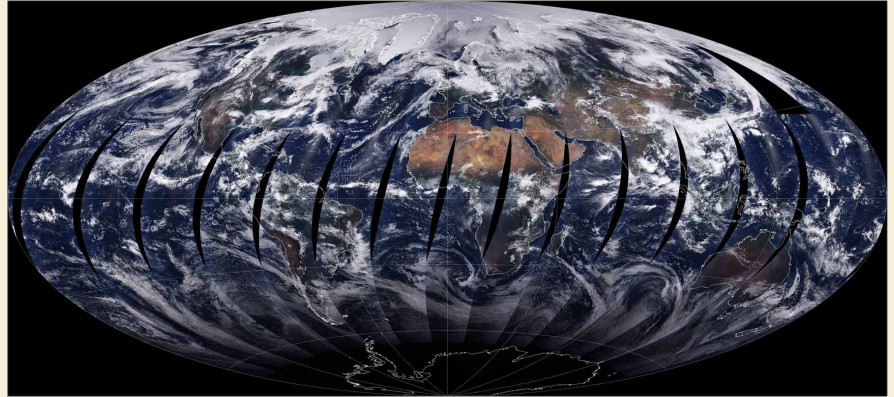
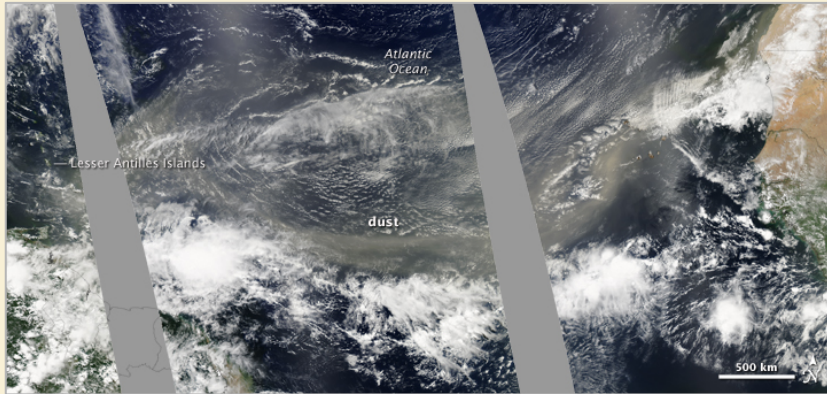
Paris, 12-14 Sept 2011





## Outline:

- ▼ Global Analyses
  - ▶ Trends
  - ▶ ENSO Correlations
- ▶ Some Lessons-Learned



## Outline:

### ▼ Global Analyses

#### ▼ Trends

- ▶ Time-to-Detection vs. grid size
- ▶ Example trends, instrument artifacts
- ▶ ENSO Correlations
- ▶ Some Lessons-Learned

# Motivation

- Trends

- For observed MODIS temporal variability on regional scales, what is the expected “time to detection” for a given trend?
- Consistency between Terra and Aqua MODIS? Lack of consistency traced to instrument differences? Statistically significant regional trends found?

- Sensitivity of retrievals to interannual (low frequency) climate variability, e.g., ENSO

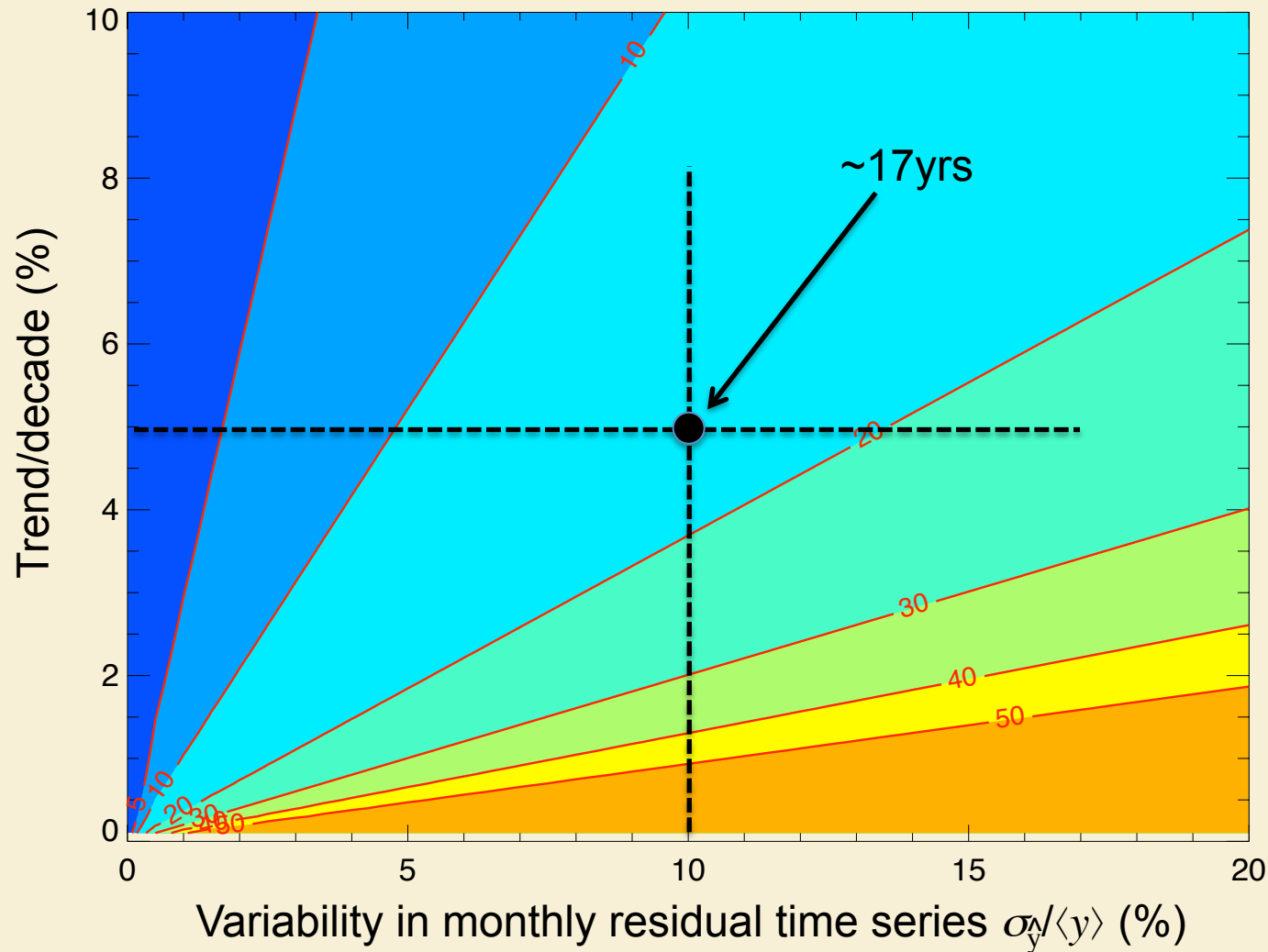
- Correlation of atmosphere properties to ENSO useful for climate model evaluation (e.g., GFDL AM3 cloud fields)
- To what extent can ENSO responses alias into trend observations?

- Datasets and Analysis

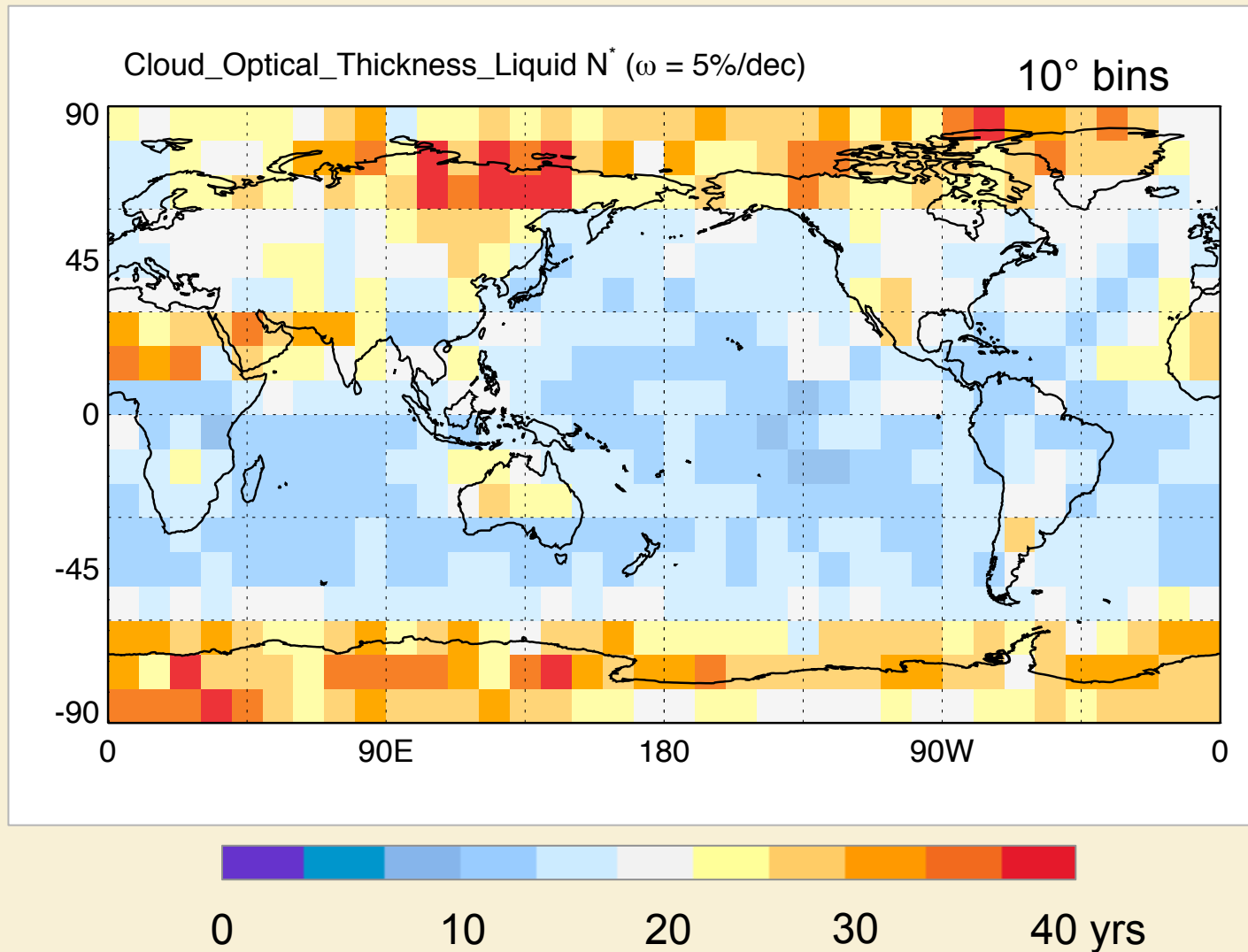
- Monthly mean anomalies derived from archived MODIS Atmosphere Team Terra and Aqua monthly Level-3 aggregations
- Analyses for various equal-angle grids, from 1° (native Level-3 resolution) to regional and zonal
- All analysis includes effects of data set temporal correlations (“order 1” autocorrelation for trend calculations)

## Number of Years Required to Detect a Trend

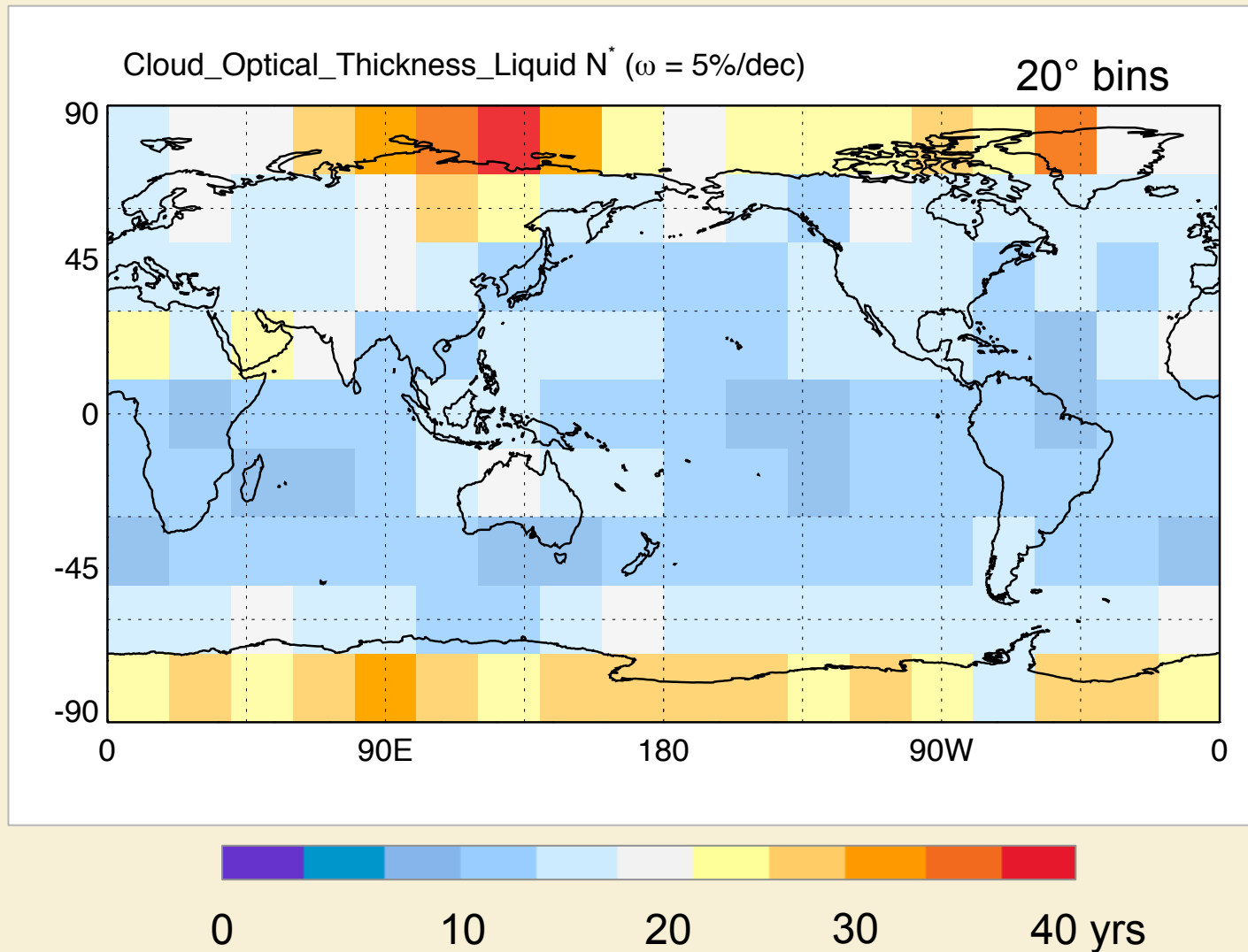
(90% prob. of detecting a trend to a 0.05 statistical level, no autocorrelation:  
Tiao et al., 1990; Weatherhead et al., 1998)



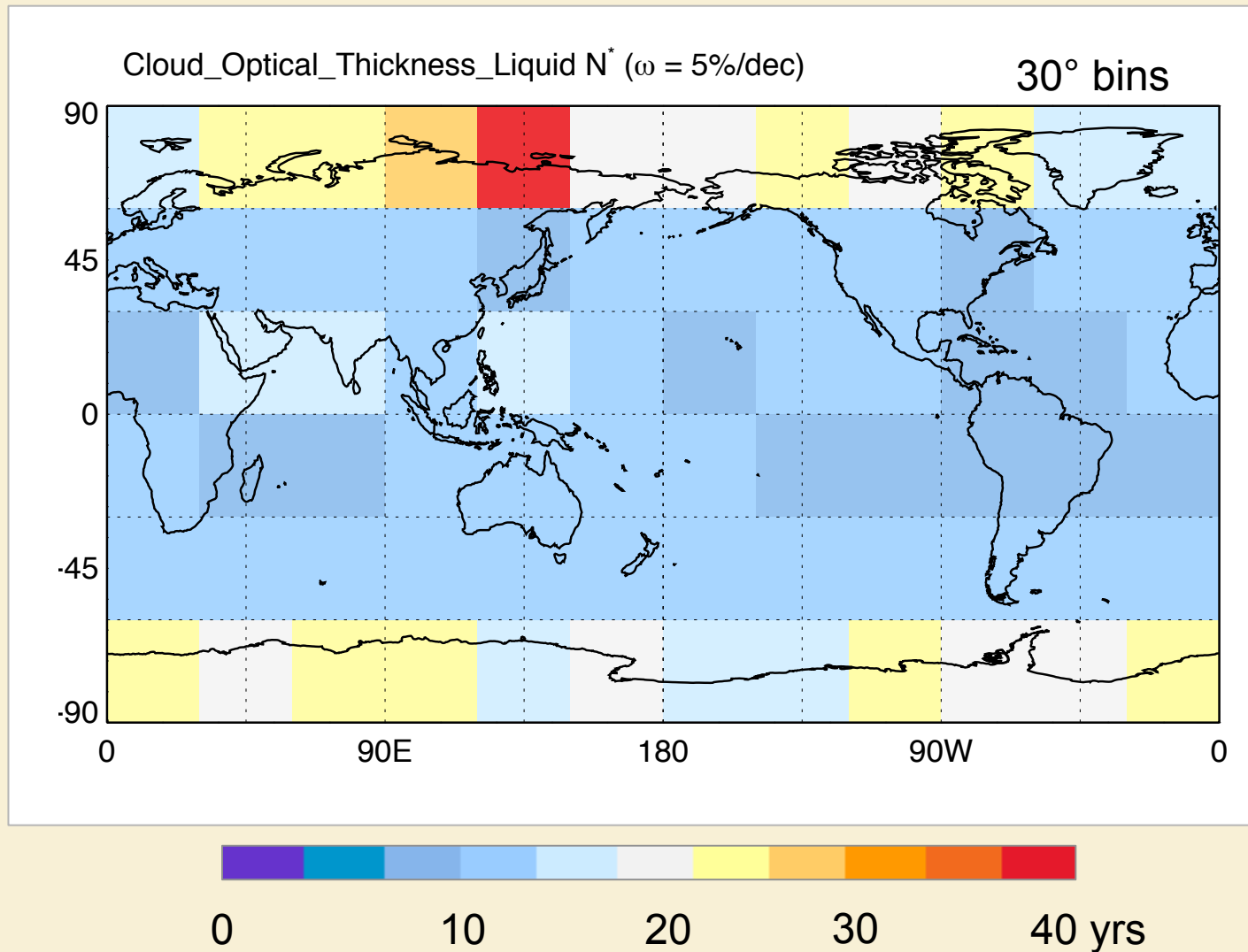
# Time Required for Detection of 5%/decade Trend (90% prob. of detecting a 0.05 statistical significance, from 10 yr monthly anomaly variability w/autocorrelation correction)



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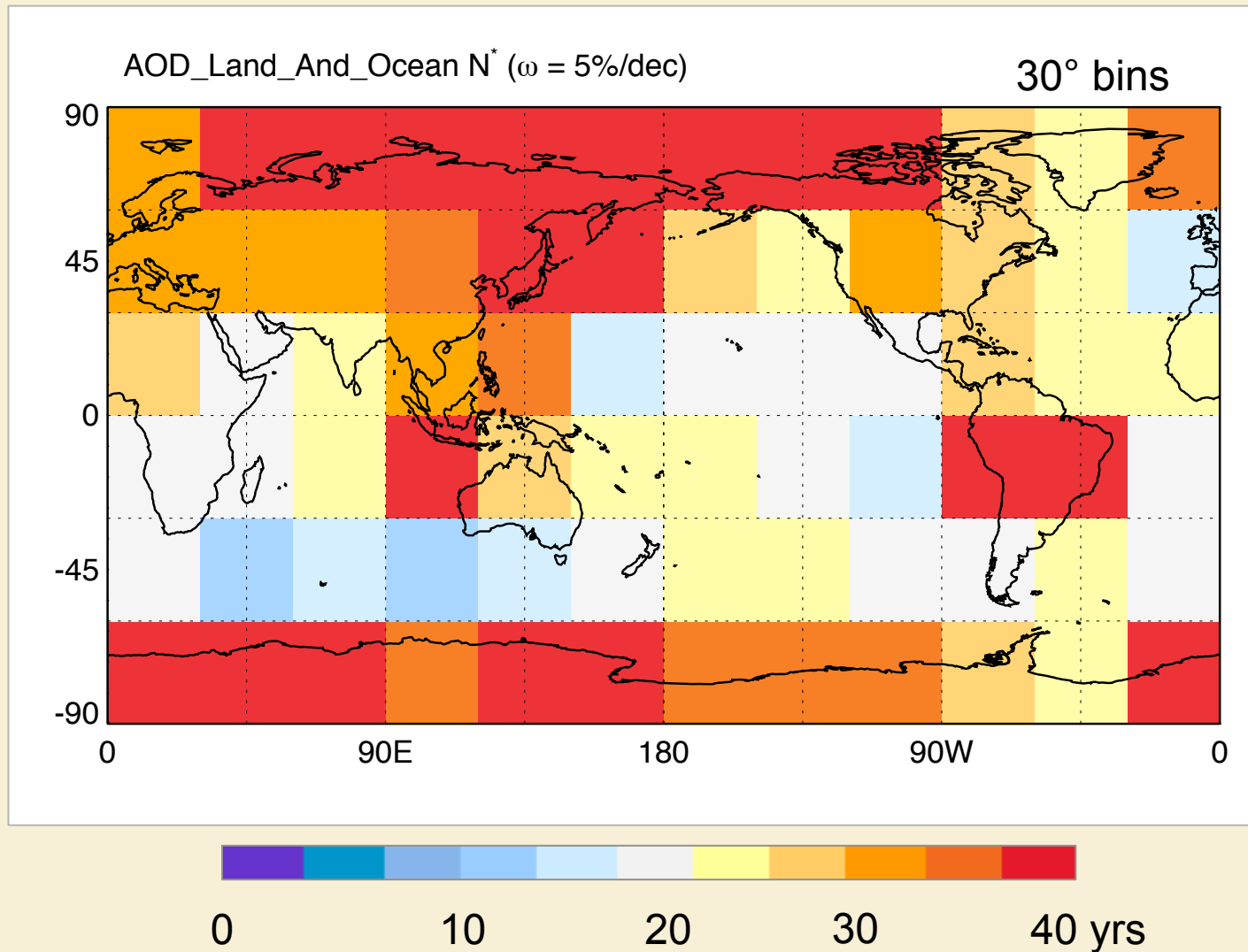


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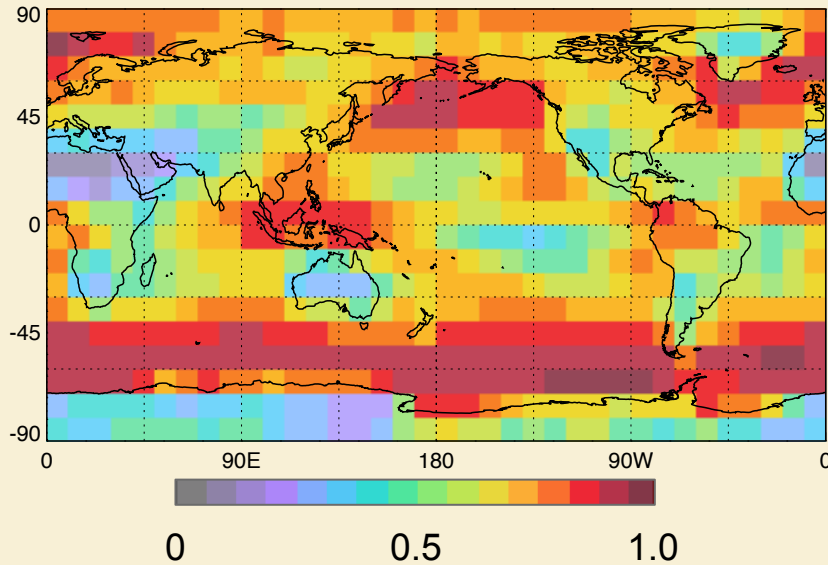




# Time Required for Detection of 5%/decade Trend (90% prob. of detecting a 0.05 statistical significance, from 10 yr monthly anomaly variability w/autocorrelation correction)



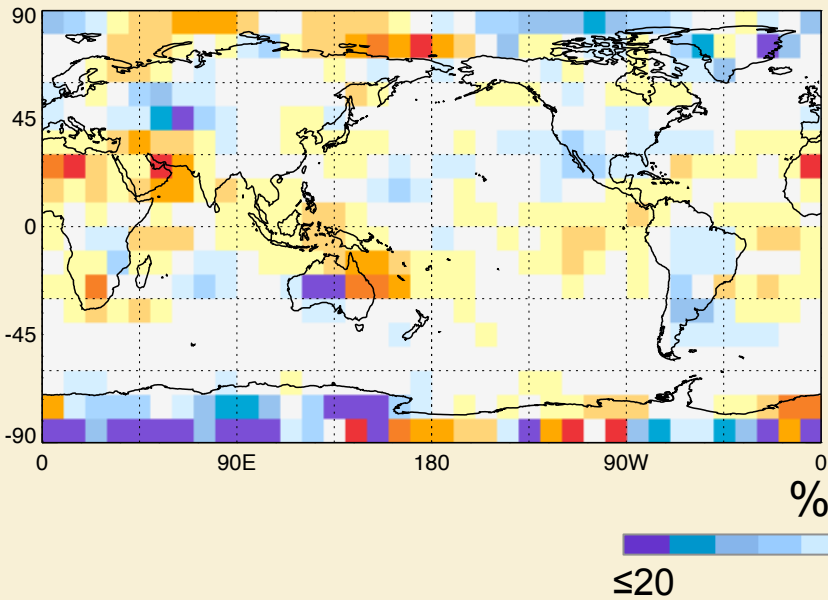
## Annual Mean Fraction (July 2000 – June 2001)



Cloud Fraction from MODIS mask, Terra (10° binning, daytime observations only)

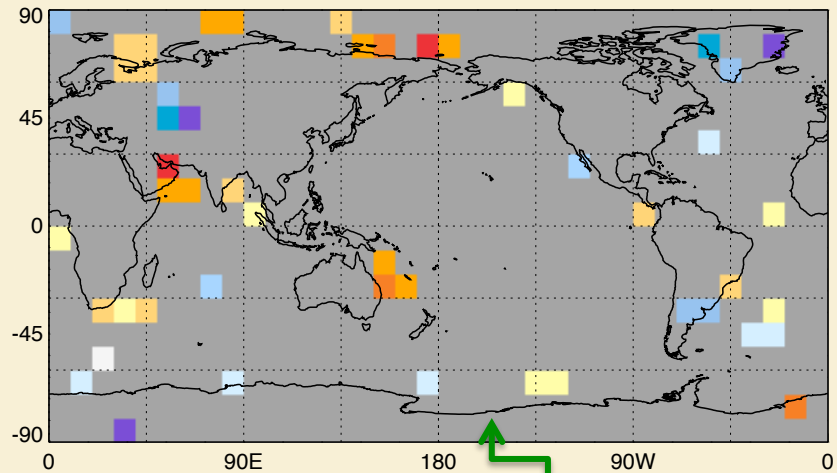
## Cloud Fraction Trends

(monthly anomalies, July 2000 – June 2010)



## Trends Masked by Significance Level $\leq 0.05$

(w/autocorrelation correction in  $t$ -test)

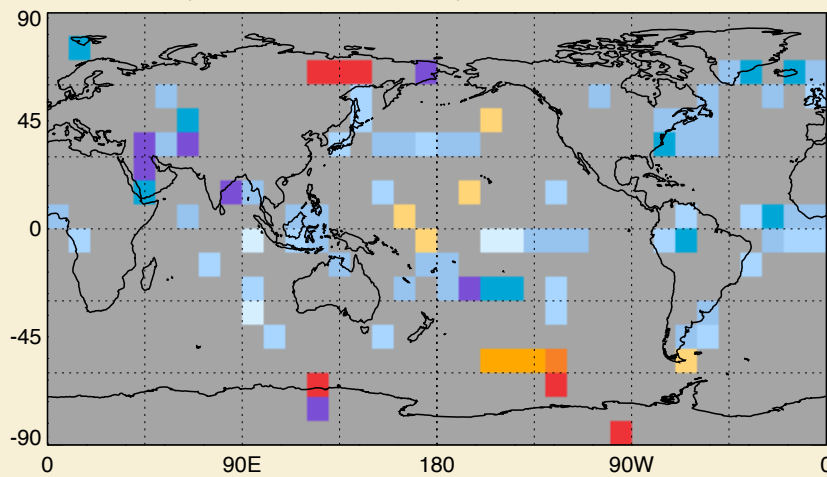


~8% of grid boxes

# MODIS Cloud Optical Thickness Trends, Aqua vs. Terra (water clouds, 10° binning)

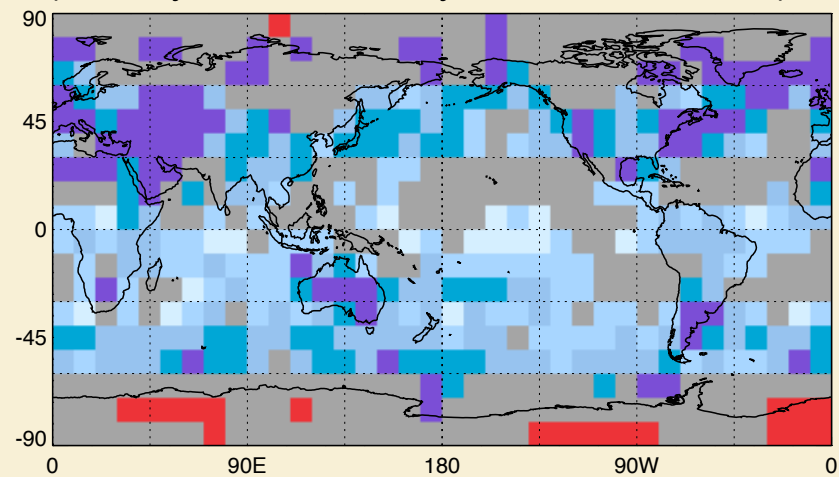
Aqua

(monthly anomalies, July 2002 – June 2010)

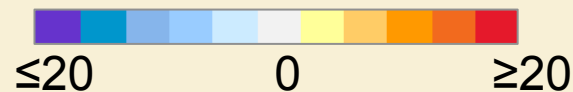


Terra

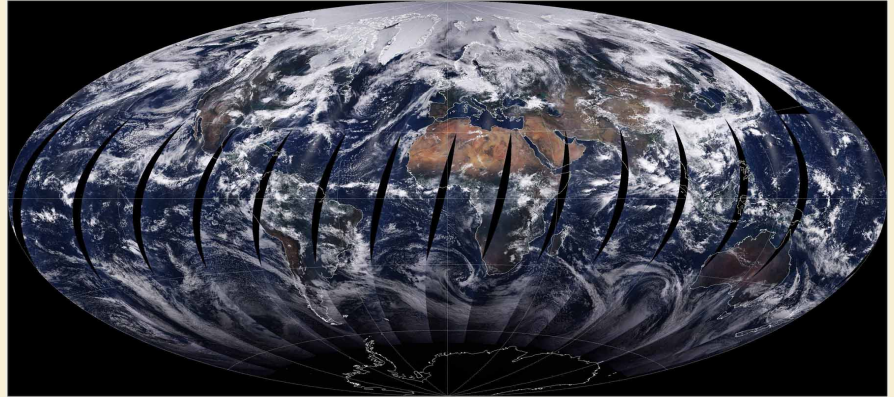
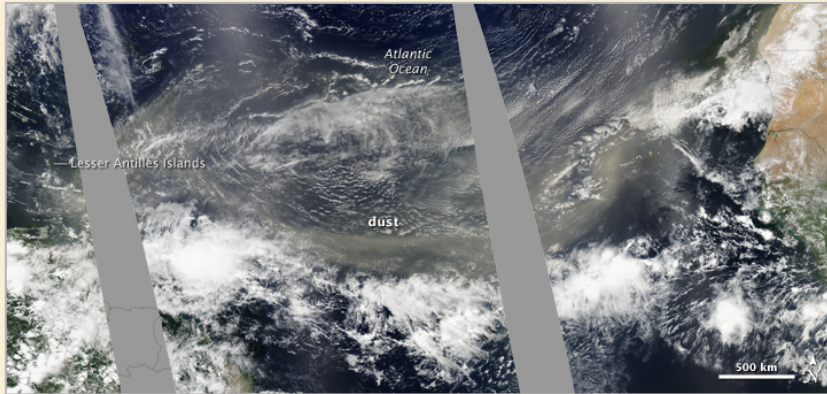
(monthly anomalies, July 2000 – June 2010)



%/decade



Trends Masked by Significance Level  $\leq 0.05$   
(w/autocorrelation correction in *t*-test)

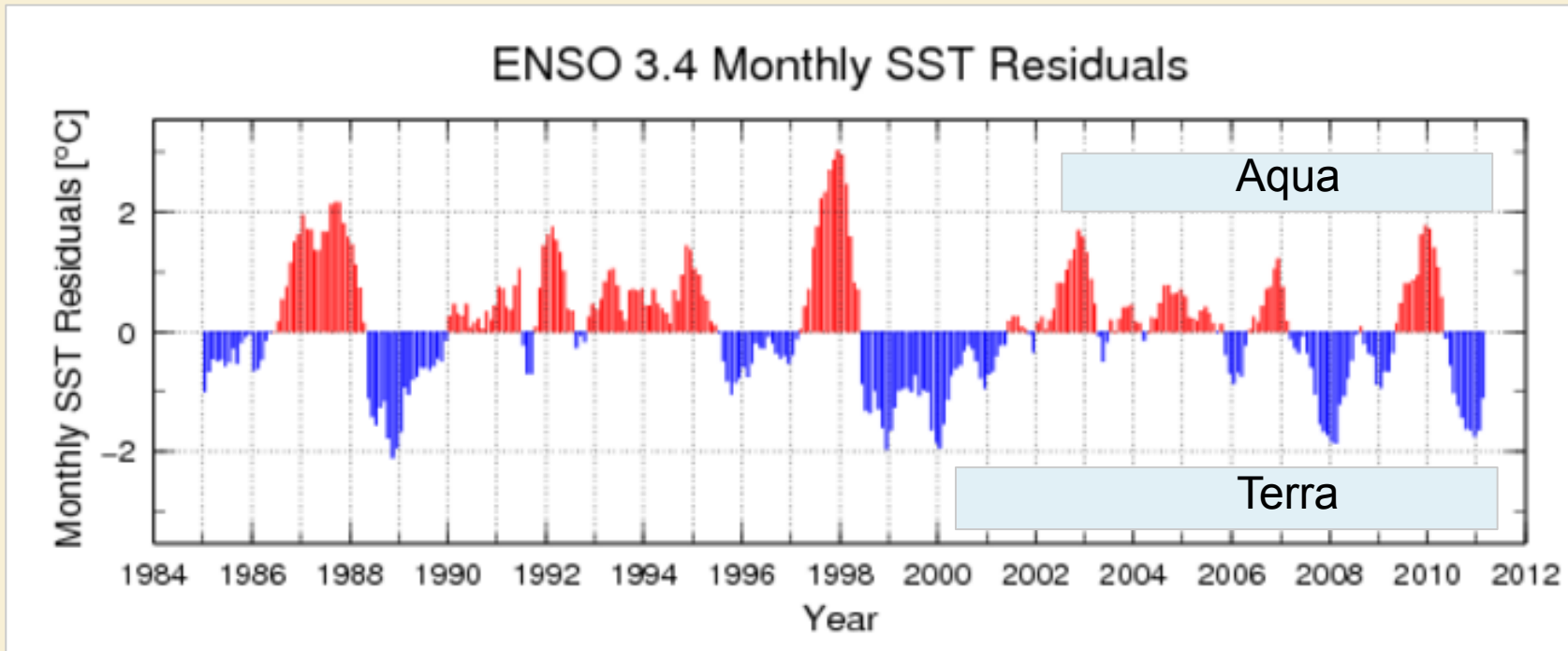


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- ▼ Global Analyses
  - ▶ Trends
  - ▼ ENSO Correlations
    - ▶ Aliasing into trends?
- ▶ Some Lessons-Learned

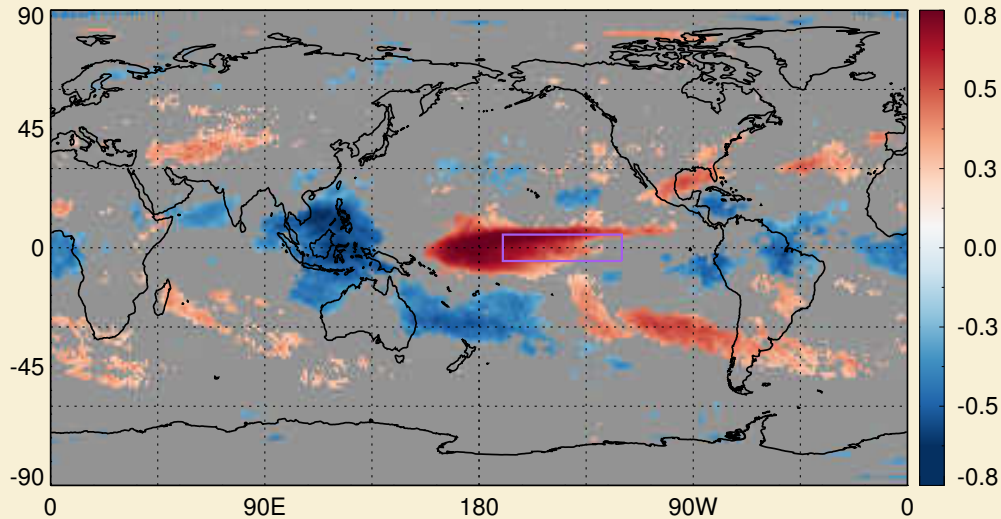
## ENSO3.4 SST Anomaly Index

(avg. temperature in a box in east-central equatorial Pacific)

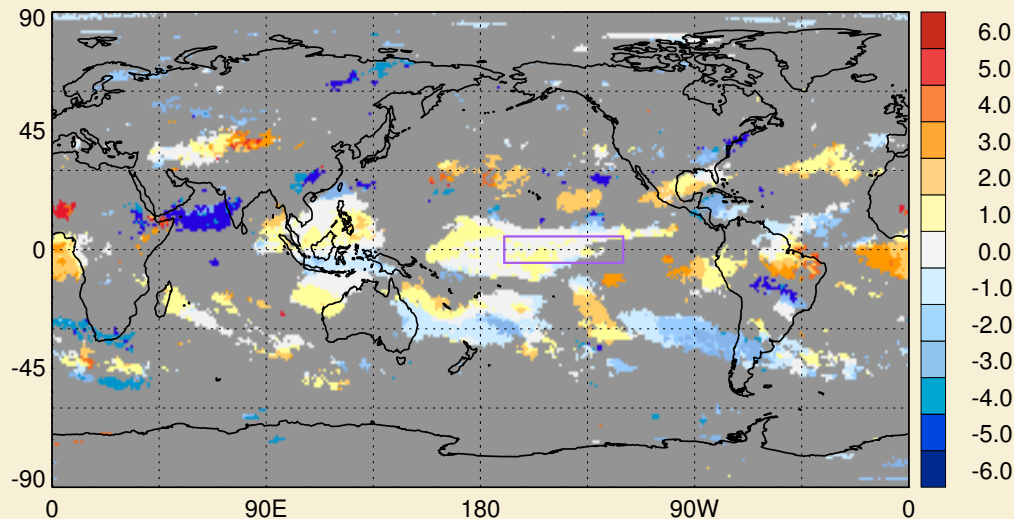


# Example ENSO3.4 vs. MODIS Monthly Anomaly Correlation 1° bins, masked by 1% statistical sig., July 2002–Jan 2011

## High Cloud Amount Correlation



High Cloud Amount

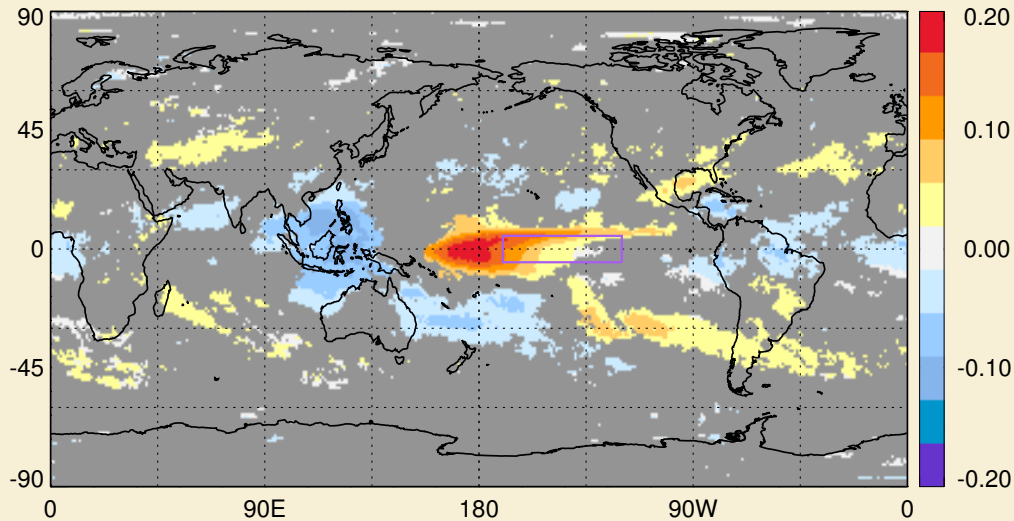


Lag (months)  
Modified *Chen et al.*, 2007

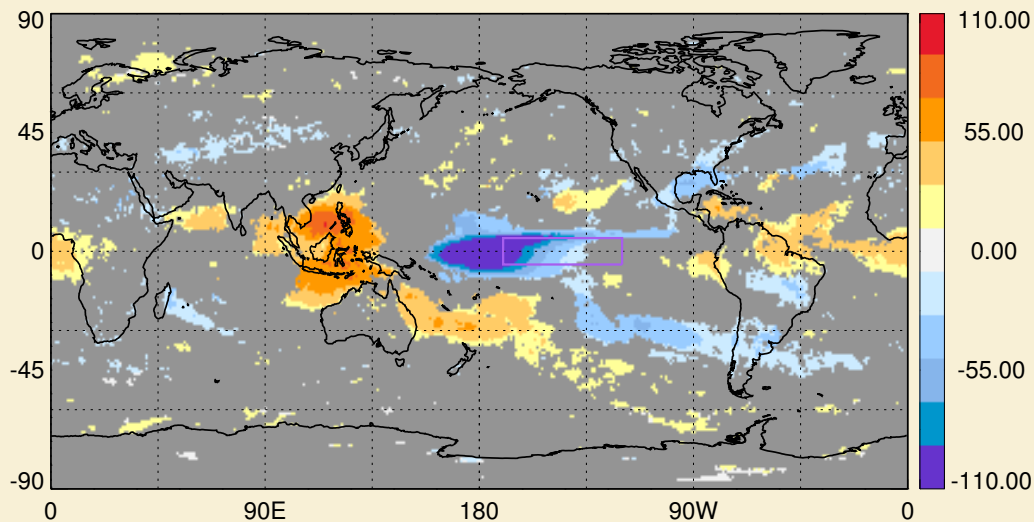
[red => cloud response lags  
E3.4 index; blue => cloud  
response precedes index]

# Example ENSO3.4 vs. MODIS Monthly Anomaly Correlation 1° bins, masked by 1% statistical sig., July 2002–Jan 2011

## High Cloud Amount and Pressure: Derived Regression Slopes



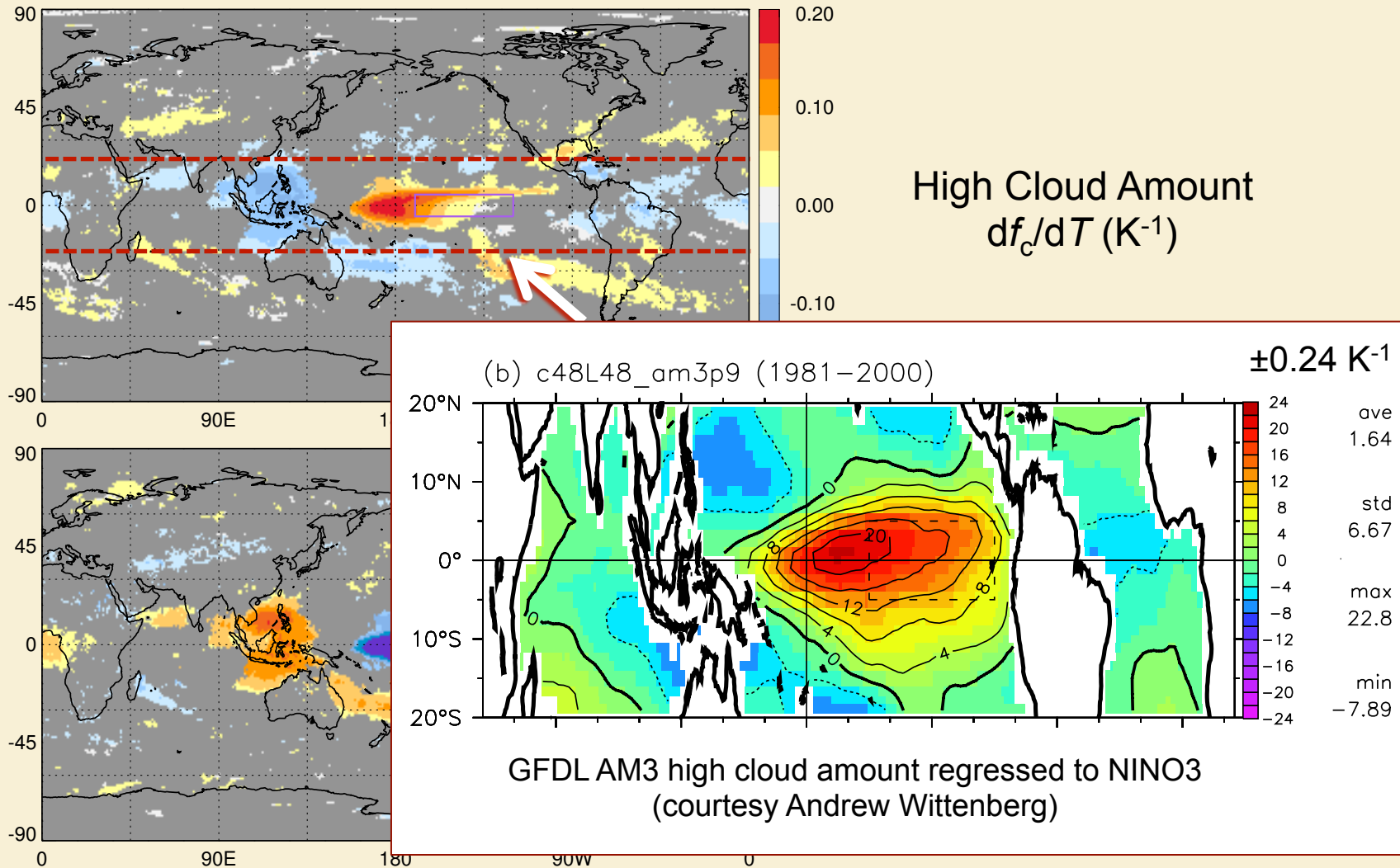
High Cloud Amount  
 $df_c/dT$  ( $K^{-1}$ )



Cloud-top Pressure  
 $dp_c/dT$  ( $hPa-K^{-1}$ )

# Example ENSO3.4 vs. MODIS Monthly Anomaly Correlation 1° bins, masked by 1% statistical sig., July 2002–Jan 2011

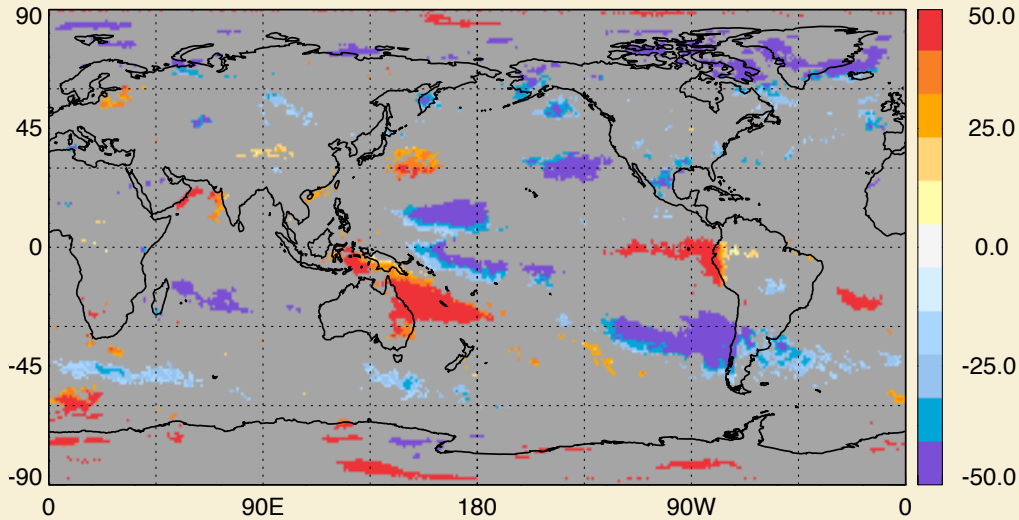
## High Cloud Amount and Pressure: Derived Regression Slopes



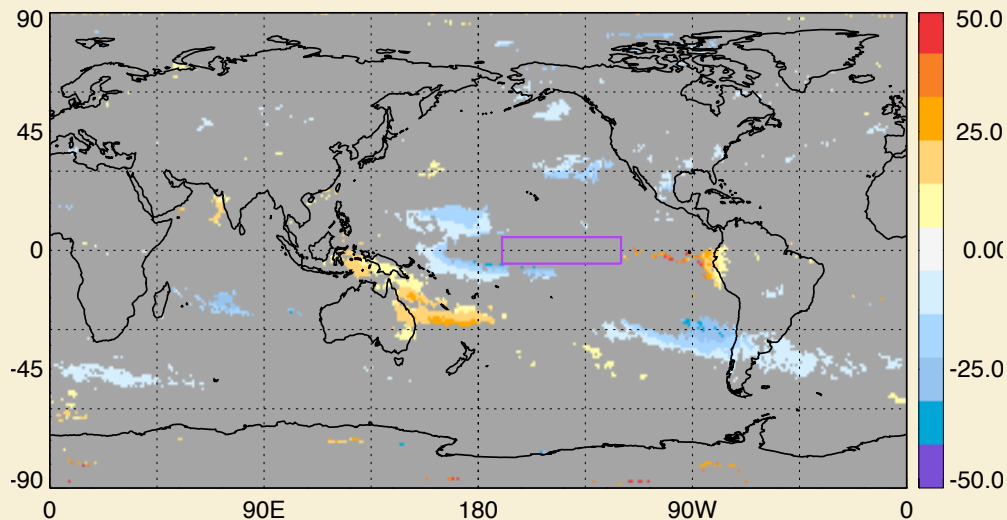


Example ENSO3.4 Component of MODIS Trend (from Monthly Anomalies)  
Aqua, 1° bins, July 2002–Jun 2010

## High Cloud Amount



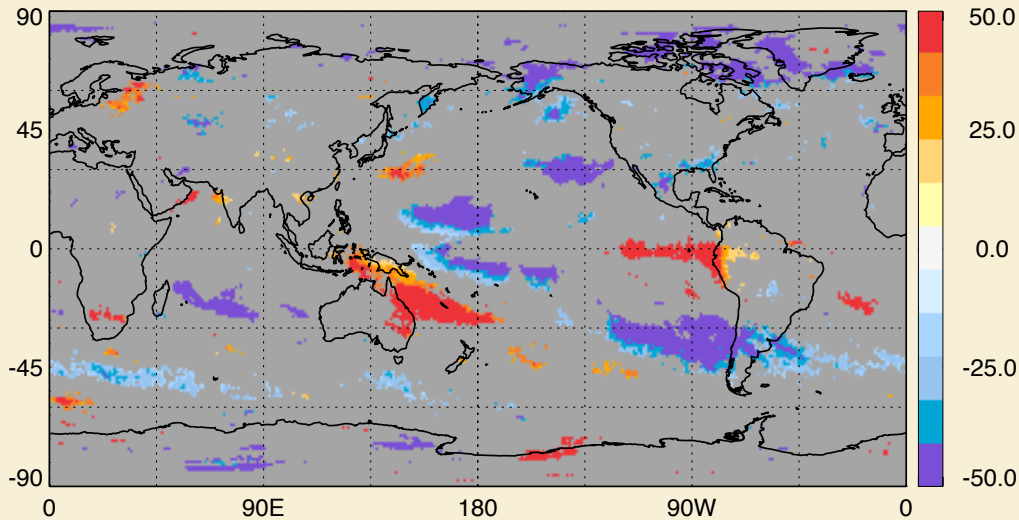
MODIS Aqua Trend (%/dec)  
July 2002–Jun 2010  
(masked by stat. sig.  $< 0.05$ )



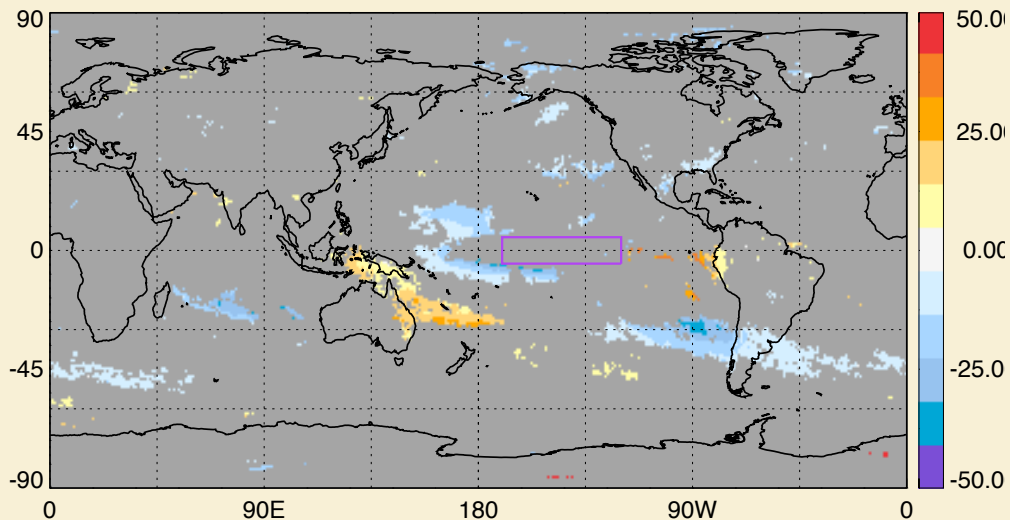
ENSO component of trend  
derived from correlation  
regression slope  
(masked by trend & ENSO3.4  
correlation sig.  $< 0.05$ )

Example ENSO3.4 Component of MODIS Trend (from Monthly Anomalies)  
Terra, 1° bins, July 2002–Jun 2010

## High Cloud Amount



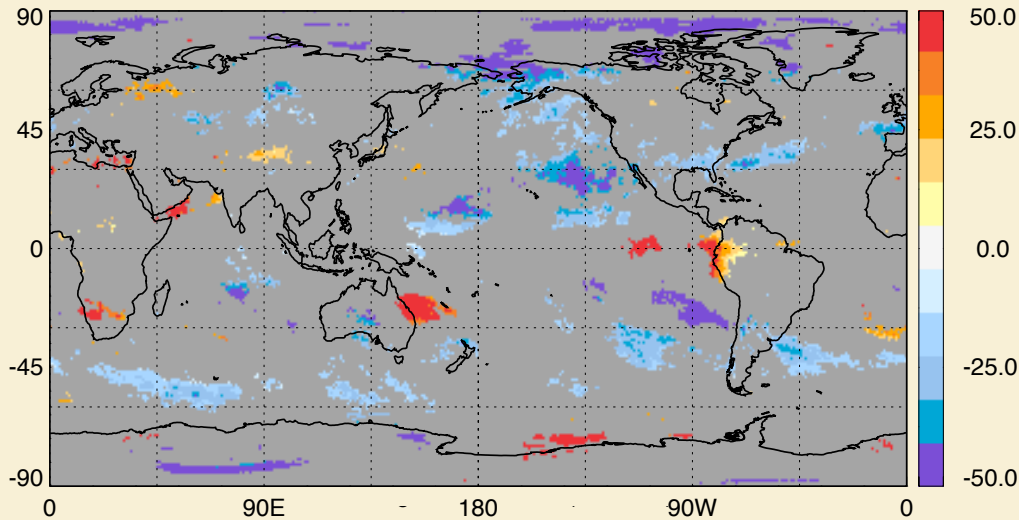
MODIS Terra Trend (%/dec)  
July 2002–Jun 2010  
(masked by stat. sig. <0.05)



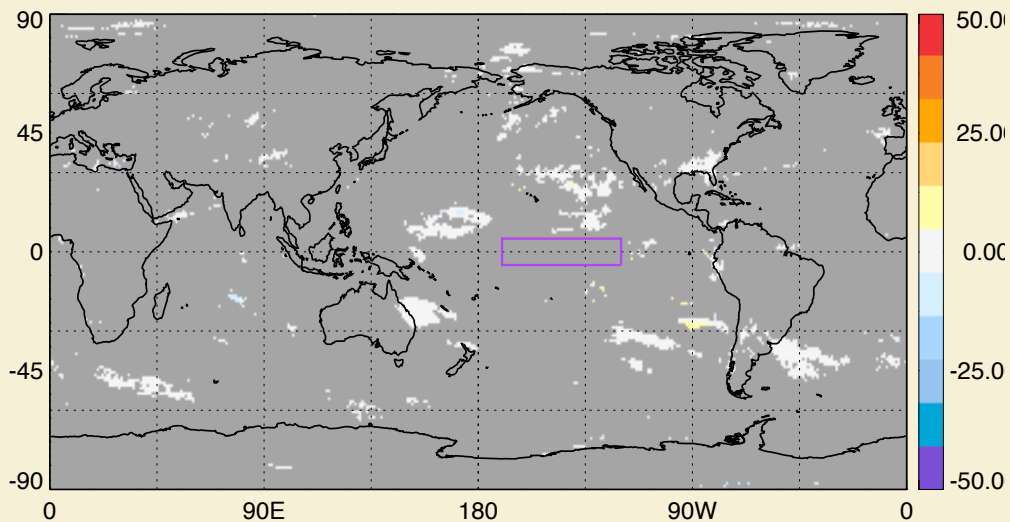
ENSO component of trend  
derived from correlation  
regression slope  
(masked by trend & ENSO3.4  
correlation sig. < 0.05)

Example ENSO3.4 Component of MODIS Trend (from Monthly Anomalies)  
Terra, 1° bins, July 2000–Jun 2010

## High Cloud Amount



MODIS Terra Trend (%/dec)  
July 2000–Jun 2010  
(masked by stat. sig. <0.05)

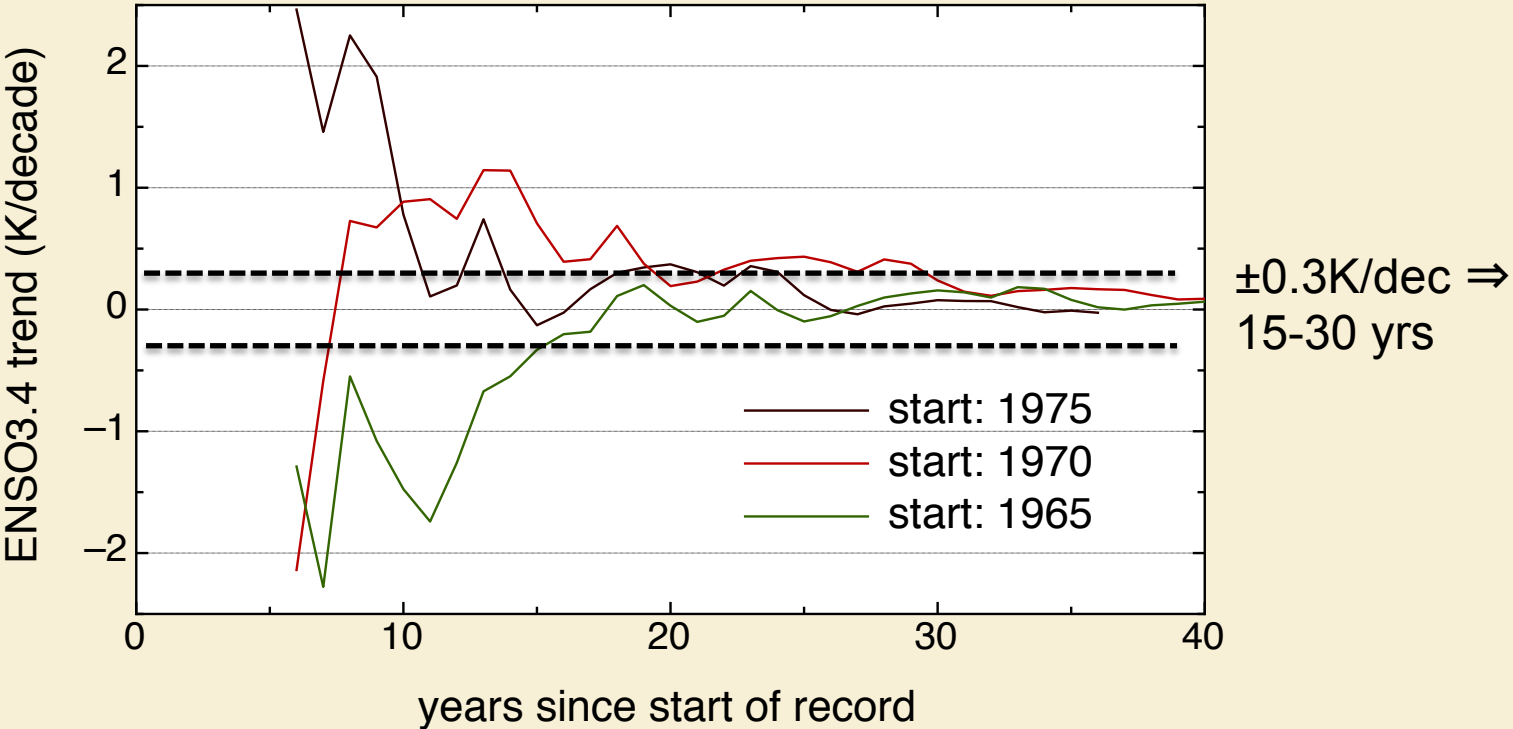


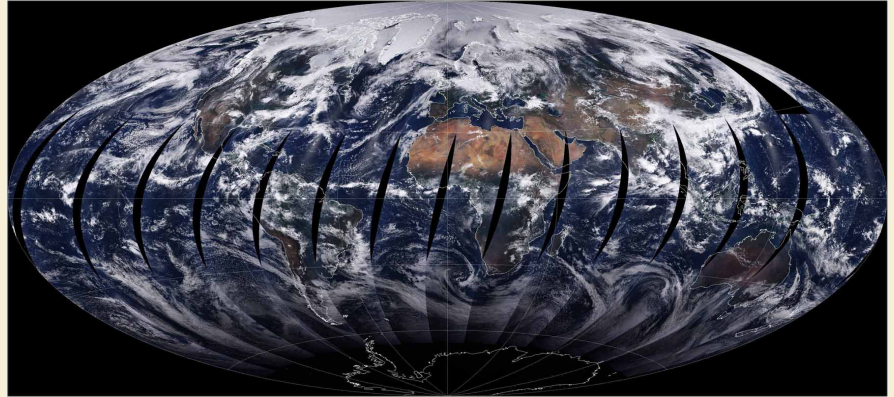
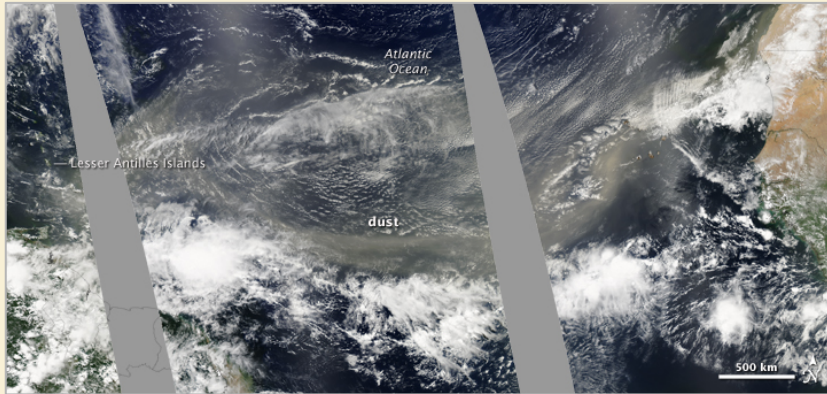
ENSO component of trend  
derived from correlation  
regression slope  
(masked by trend & ENSO3.4  
correlation sig. < 0.05)

# ENSO3.4 Aliasing Into Trends

Number of years for ENSO trend to decay to less than some value?

cumulative by year from January in given year up to 2010

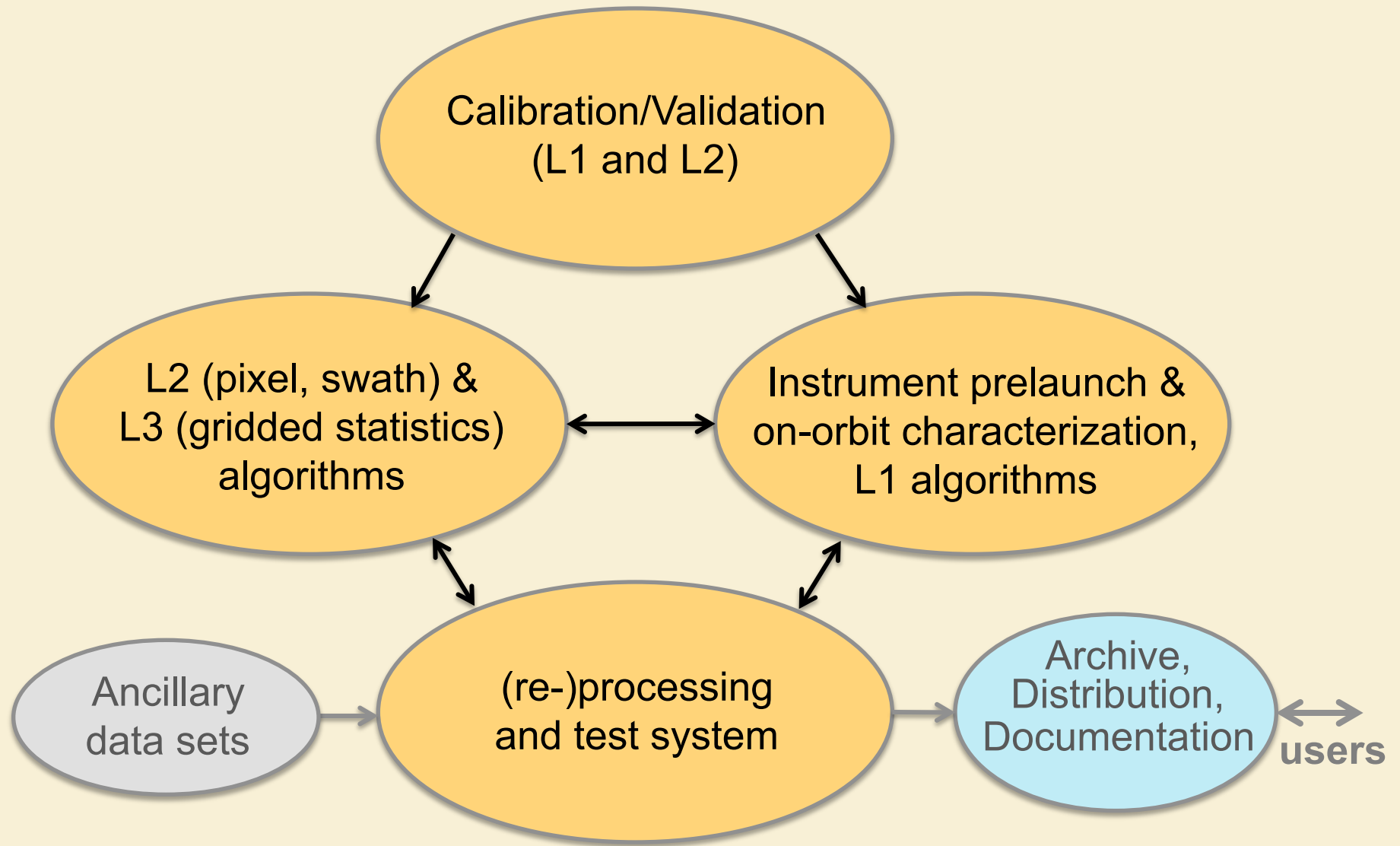




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# A Coordinated System/Infrastructure of Elements is Required for Production and Sustainability of Climate Records



Thank you!