Cross-assessment of ECV's for global climate variability study SMHI

Evaluate Pacific Ocean-Atmosphere interactions, El Niño Southern Oscillation (ENSO) patterns in observations and models

Observations:
CCI: SST, clouds (CLT), sea level, ocean colour (Aerosols)
Other: SST, clouds, water vapour, radiation, precipitation...

Climate Models: HadGEM2, IPSL-CM5, CNRM-CM5, EC-Earth2
**AMIP Atmosphere only simulations 1979-2008**
**CMIP: Atmosphere Ocean Coupled, 1982-2012**

Investigate known relationships, climate indices, e.g. Niño3.4 SST timesseries correlation with global rainfall, cloudiness

Aim to derive new metrics/ observational constraints from multiple ECV's to evaluate climate models
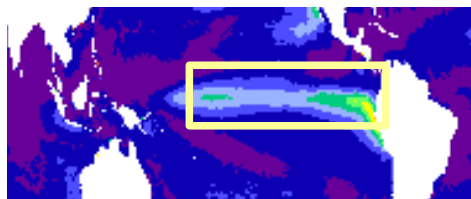
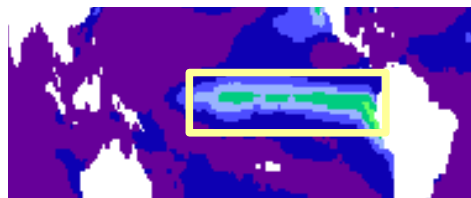# Comparing CCI Indices [mean 5S/5N, lon 100E-280E]. Bottom standard deviation.
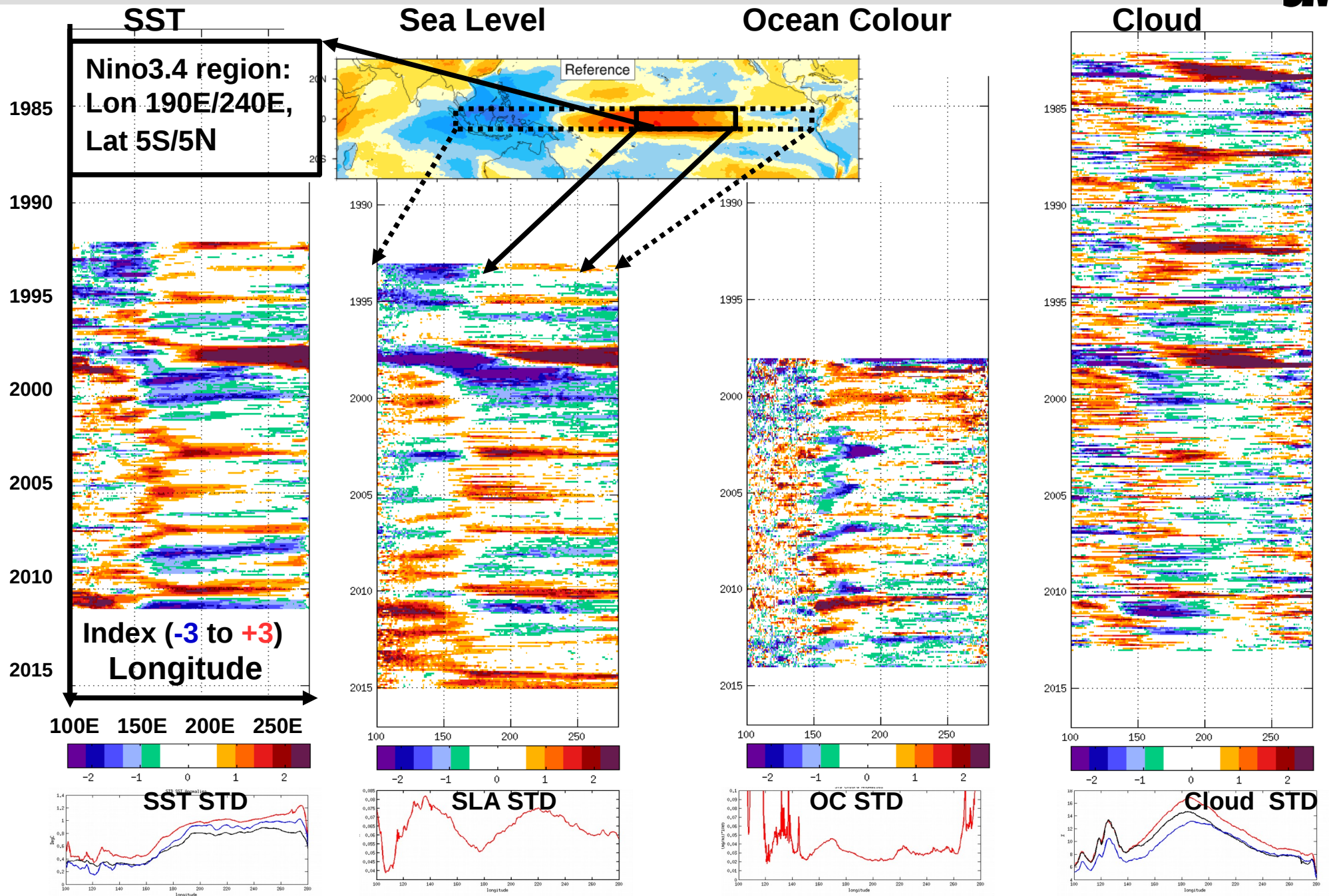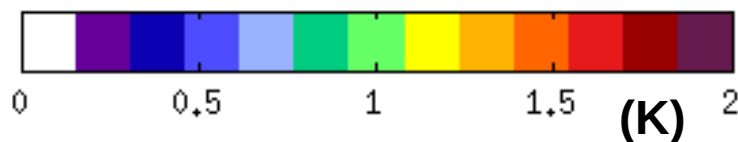
SST CCI MEAN 1992-2015
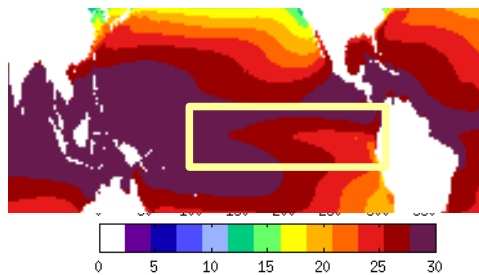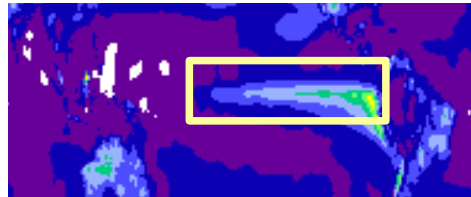
Cloud CCI MEAN 1982-2014
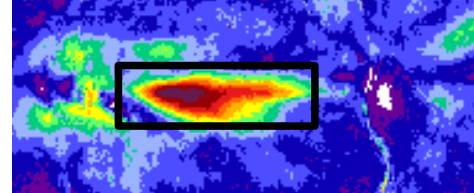
CCI SST STD as expected, similar to other observations maxima for cold tounge region. Higher values off SA coast – higher resolution
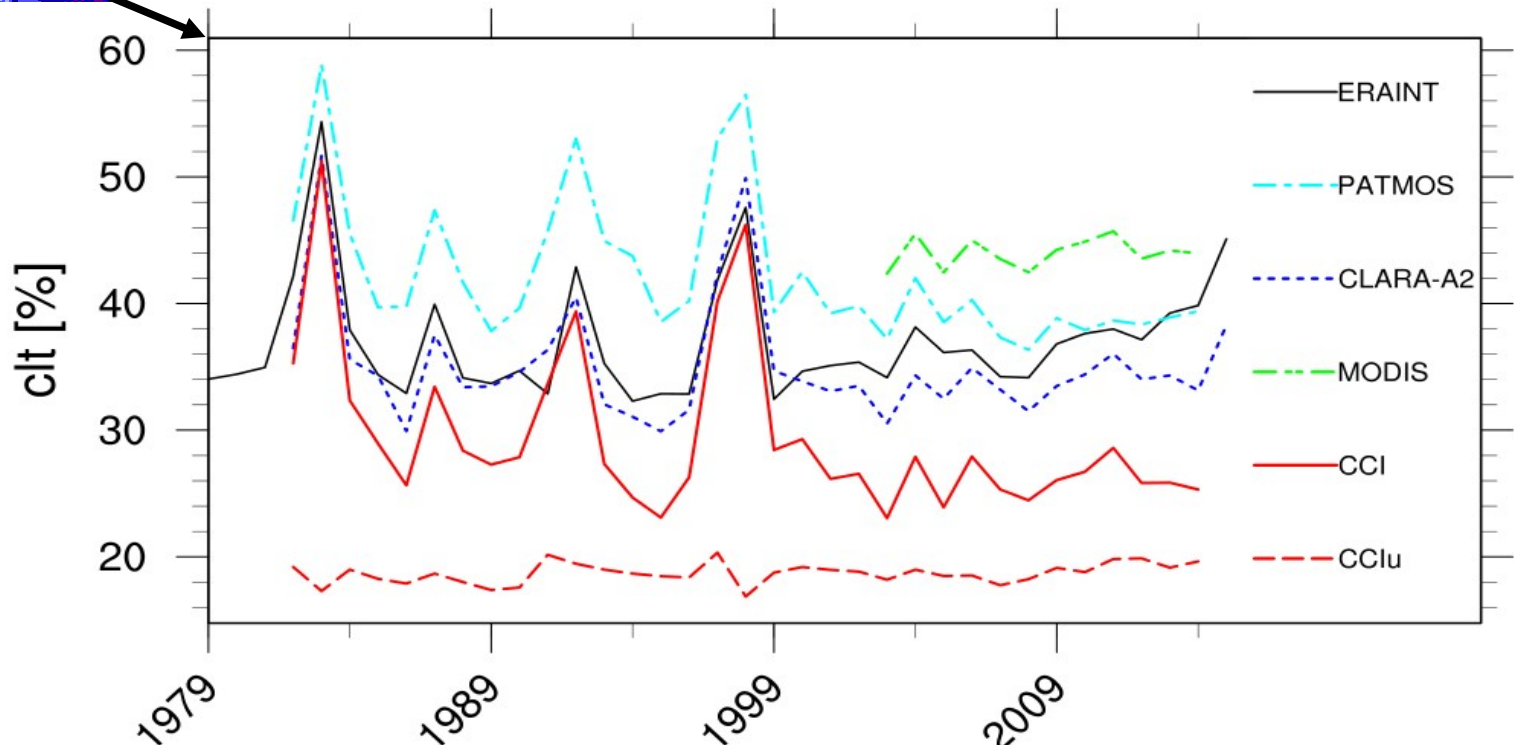
CCI STD 1992-2015

CCI STD 1982-2014

CCI SST STD as maxima west of cold tounge reg.

HadISST STD 1982-2014

CLARA-A2 STD 1982-2014

CCI higher max than other sat datasets

ERAI STD 1982-2014

ERAI STD 1982-2014

(K)

(%)

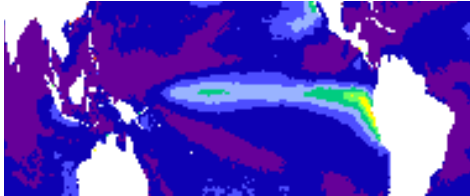# CCI Cloud variability larger over Pacific Ocean than other sat datasets
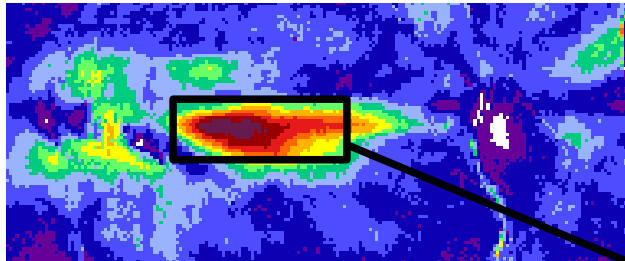
Cloud ANNUAL mean timeseries:
Southern Nino3.4 region:
Lon 190E/240E, Lat 0S/5N
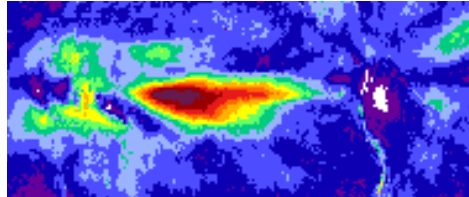

* CCI CLT during Nina periods 5-10% lower than other satellite datasets
  Why....? Underestimation of low clouds?
* MODIS – too short record

![SMHI]

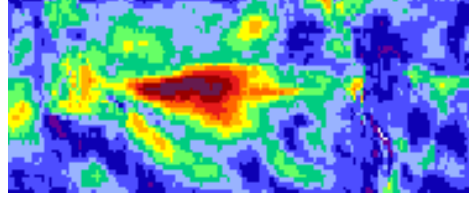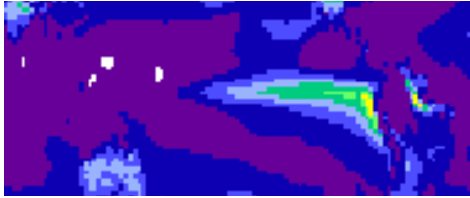# Comparing Atmosphere only AMIP model interannual variability
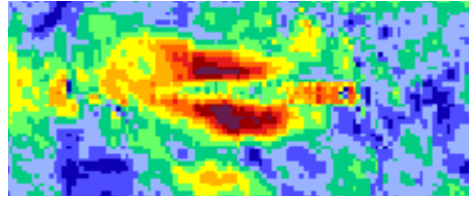

SST STD CCI

Cloud STD CCI

HadGEM2 AMIP

HadGEM2 AMIP
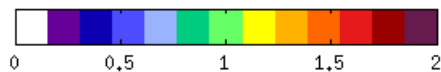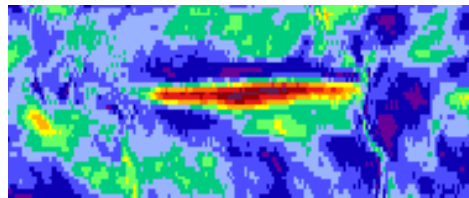
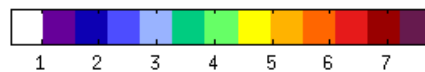**IPSL-CM5 AMIP**

IPSL-CM5 AMIP

CNRM-CM5 AMIP
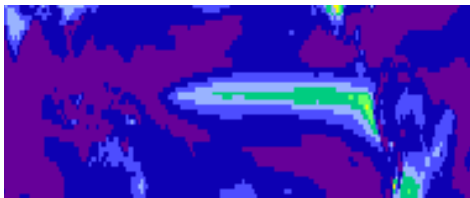
CNRM-CM5 AMIP

(0-2K)

(0-8%)

The AMIP simulations capture the maxima in cloud variability over mid Pacific. Some models double structure, others narrow maxima
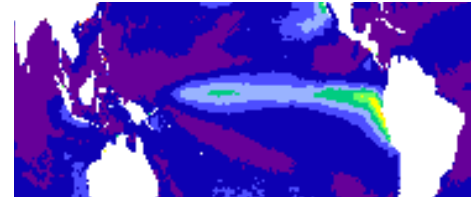
Comparing Atmosphere-Ocean Coupled CMIP model interannual variability
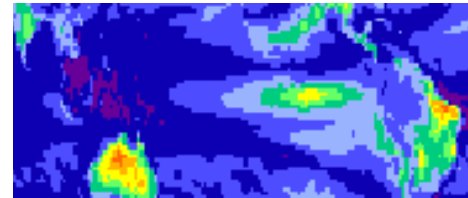
The CMIP simulations

SST STD less strong and not distinct cold tounge structure

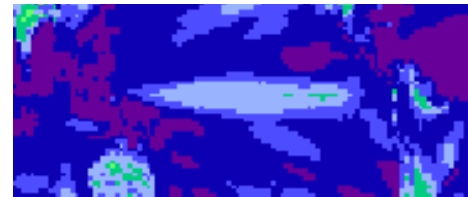**CLT STD as strong but not as confined as observed. Models double structure**
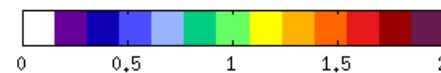

SST STD CCI   **Cloud STD CCI**
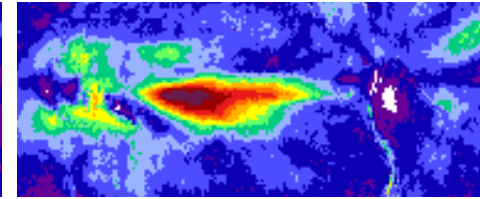
HadGEM2 CMIP   **HadGEM2 CMIP**

IPSL-CM5 CMIP   **IPSL-CM5 CMIP**
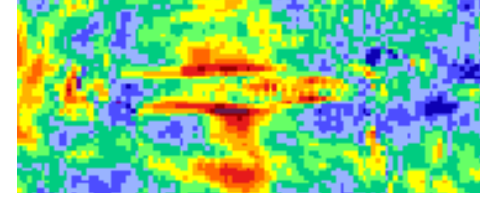
CNRM-CM5 CMIP   **CNRM-CM5 CMIP**
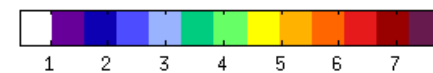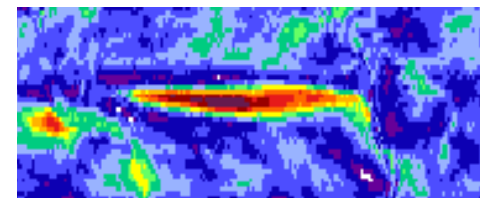
(0-2K)   **(0-8%)**

Derive new metrics/ observational constraints from multiple ECV's to evaluate climate models

Constraints

CLT NinoX

SST Nino34
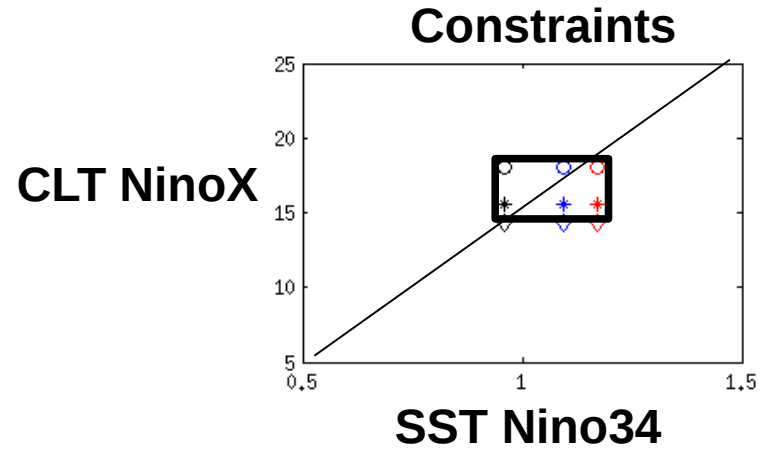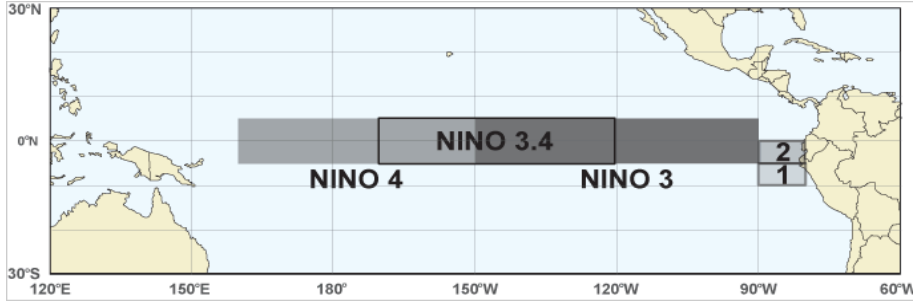
CCI SST
HadISST
EC-Earth SST 1870-1900,1982-2012, 2070-2100

CCI, CLARA, PATMOS Cloud CLT
ERAI CLT
EC-Earth CLT 1870-1900, 1982-2012, 2070-2100

Nino34

SST STD

Longitude (100E-280E)

NinoX

CLT STD

Longitude (100E-280E)
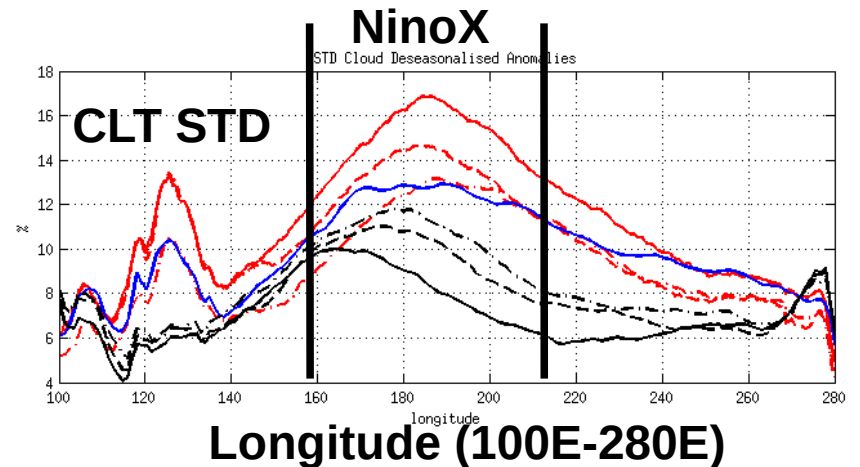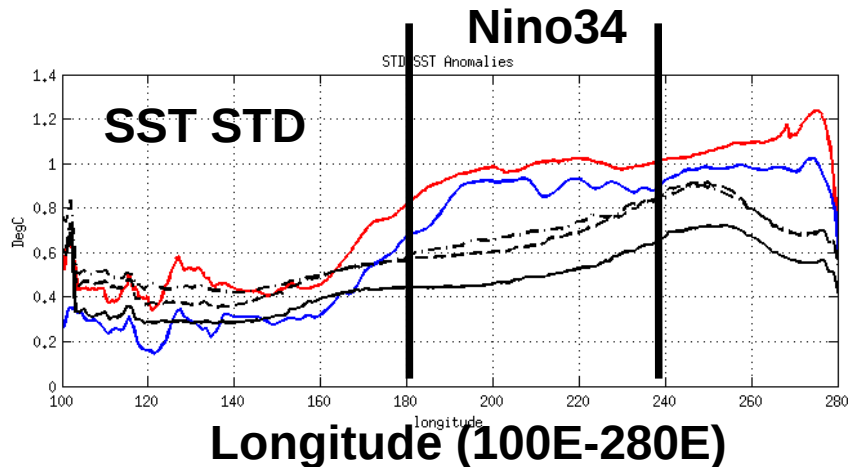
Normalised Anomalies HadISST vs CCI and CLARA CLT for different regions

Variability analysis to check CCI ECV's – stability and consistency

Compare same ECV from different satellite datasets

Compare different CCI retrievals for same ECV
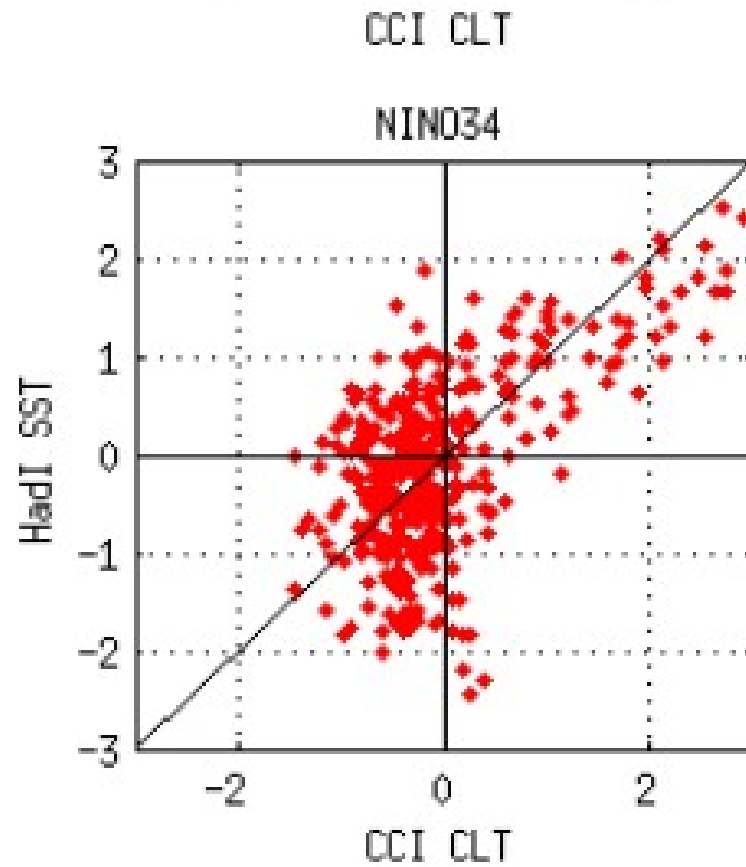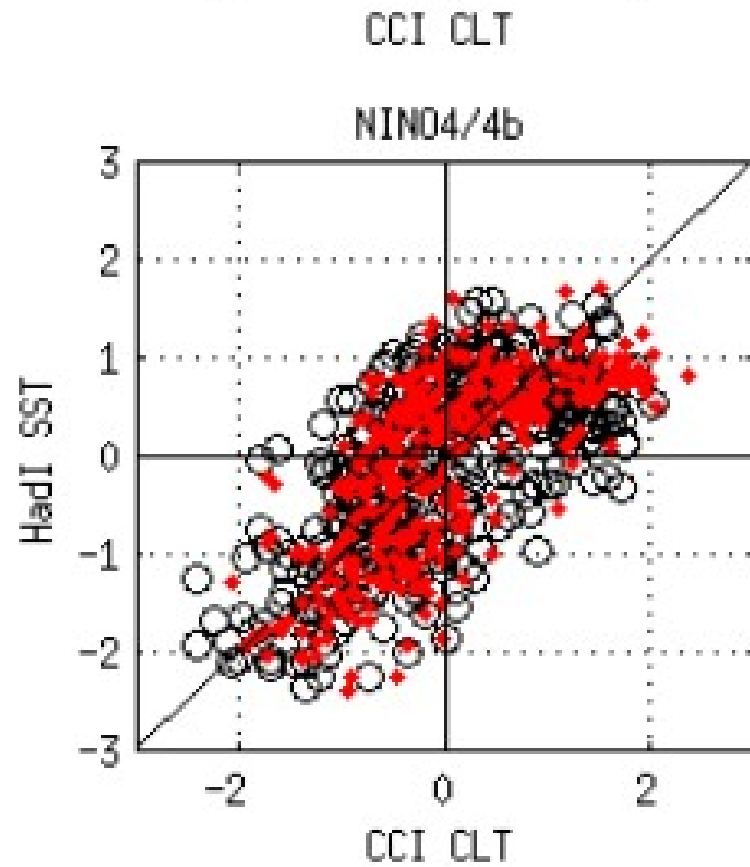
Compare to climate model AMIP simulations
Models have problems/biases but no jumps due to changes in satellite, drift, or data assimilation (ERA-Interim) and can show long term variability

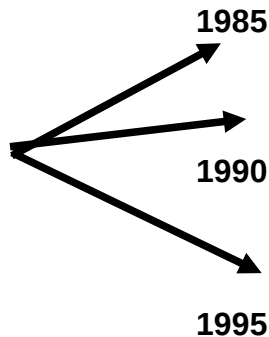**Compare to climate model CMIP simulations**
Long term variability

Consistency between different cloud data sets
Variability analysis reveal instrument problems

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Liquid Water Path (LWP)
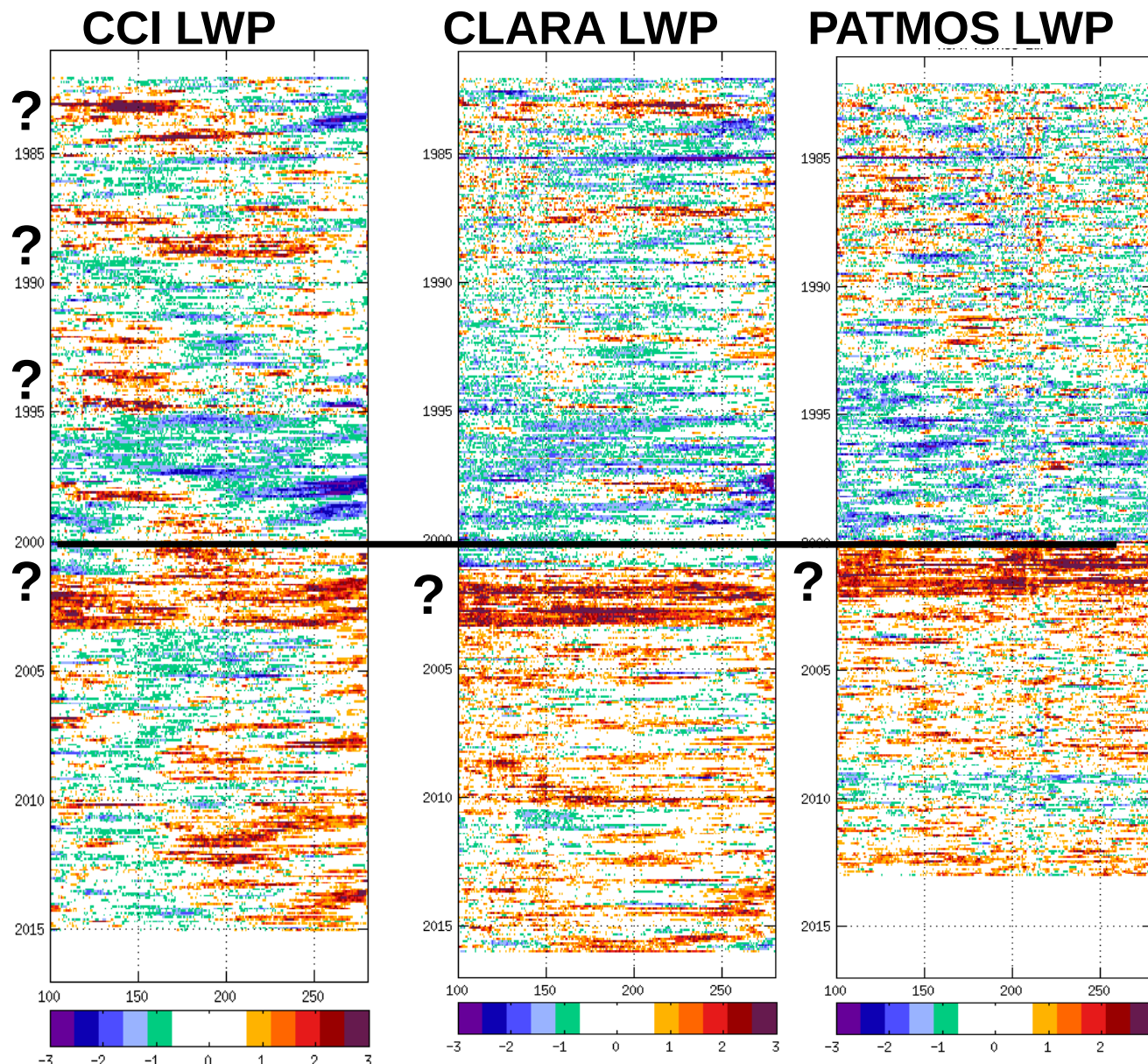Hovmöller Pacific Indices:
Mean 5S/5N, lon 100E-280E

CCI LWP   **CLARA LWP**   **PATMOS LWP**
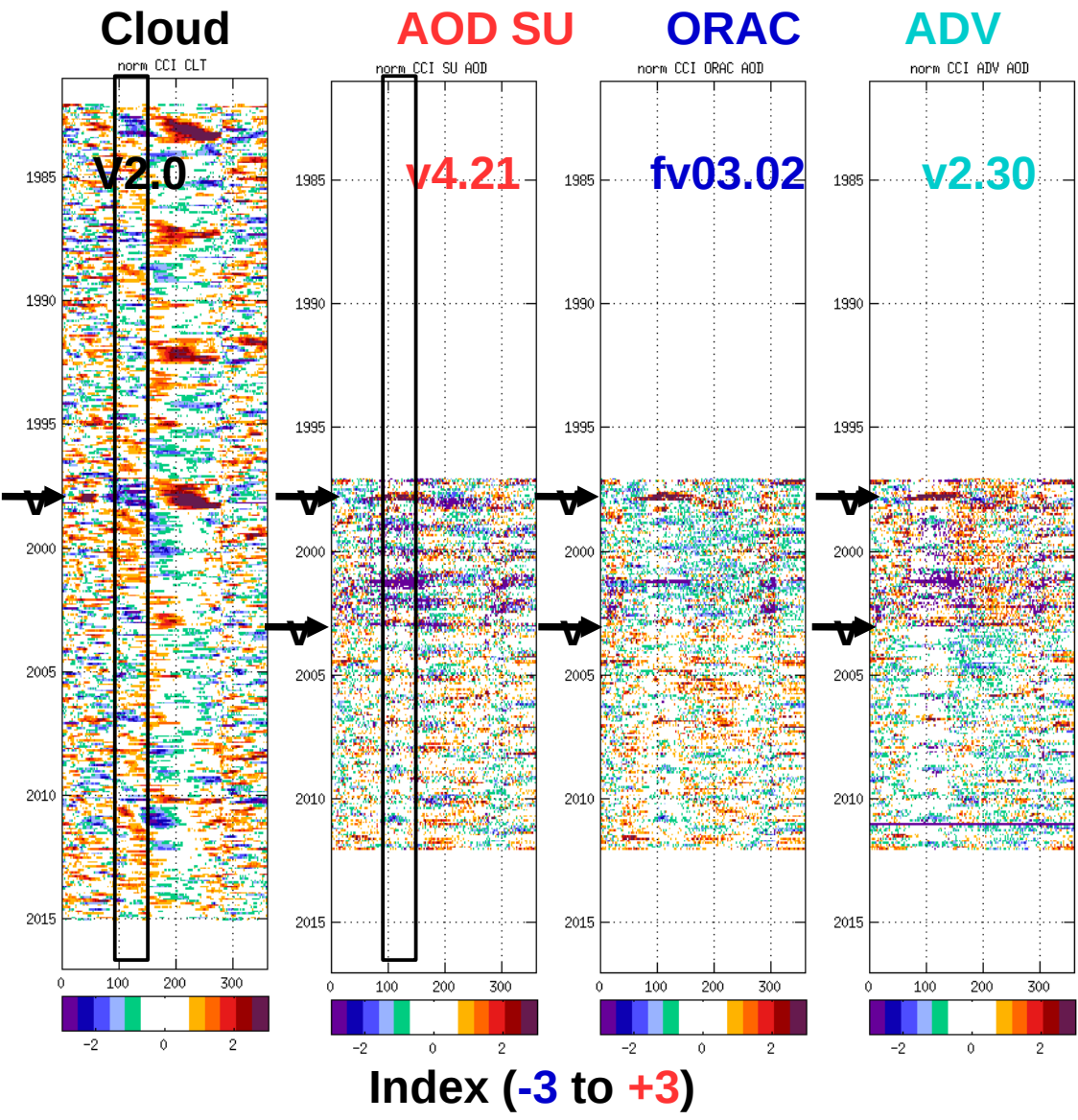
NIR Channel issues

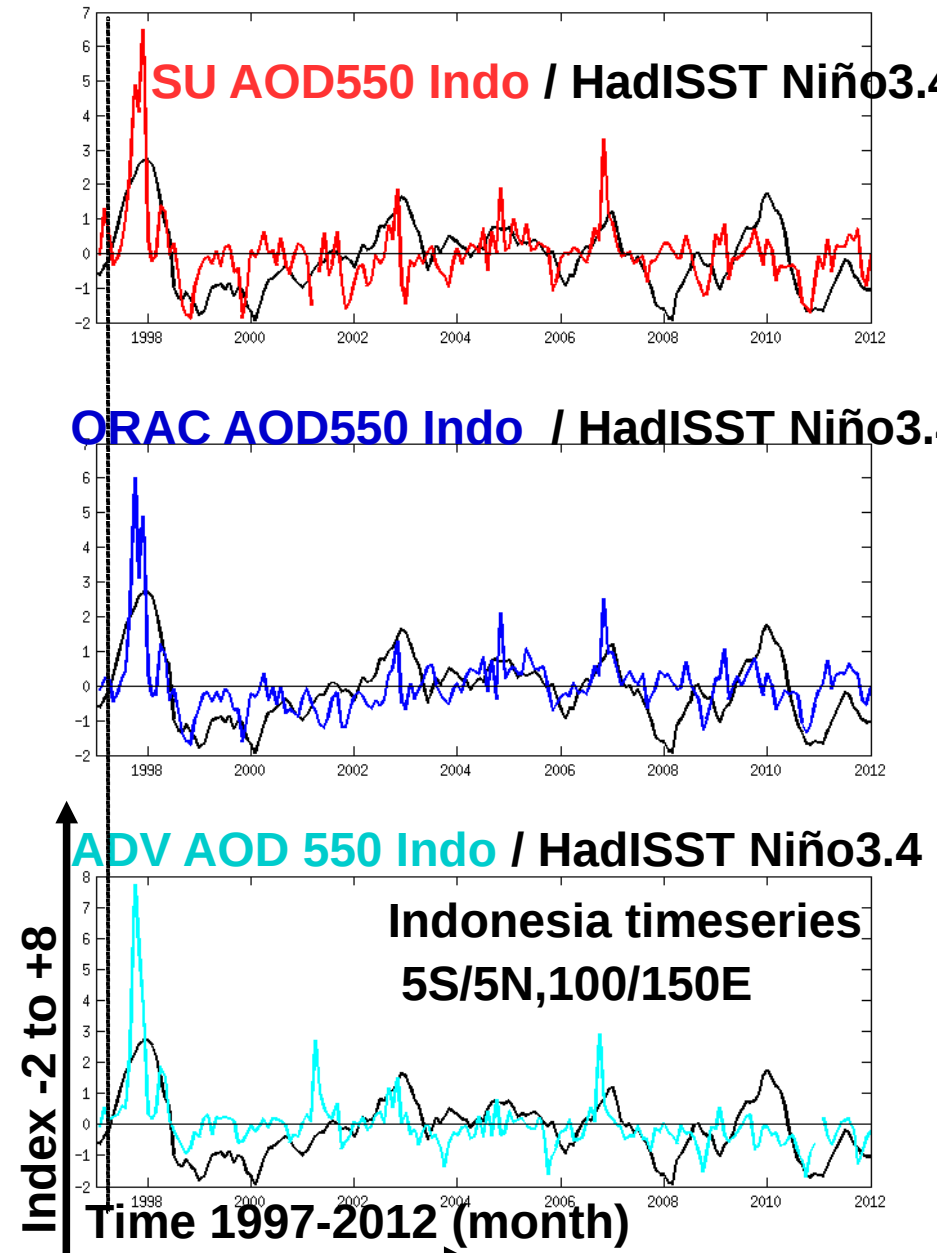**NOAA scanning motor problems**

Variability analysis reveal instrument problems

Consistency between different Aerosols retrievals (AOD index)
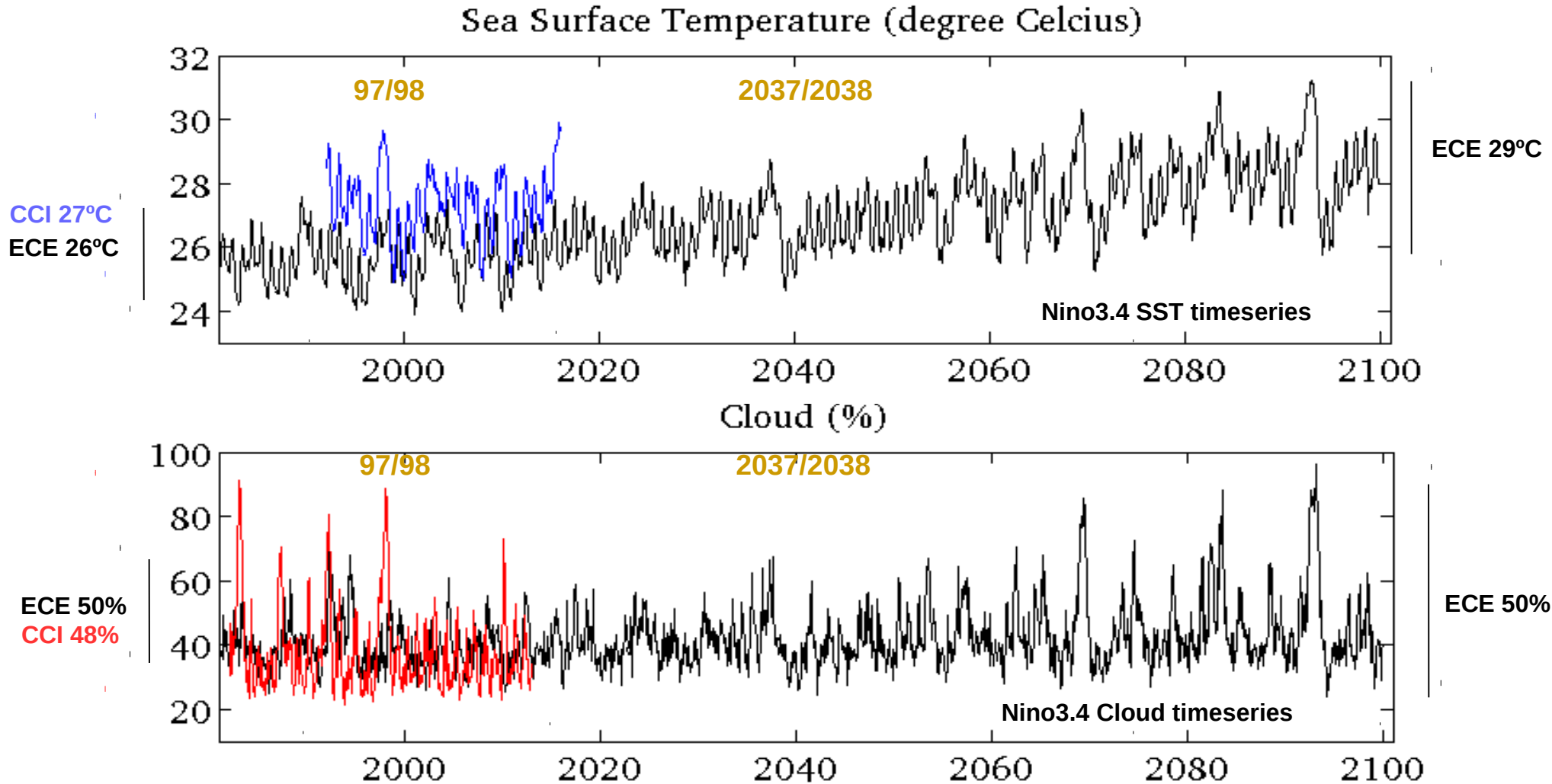## -Jump between ATSR2/AATSR +Similar ENSO signal over Indonesia

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Cloud — norm CCI CLT — V2.0

AOD SU — norm CCI SU AOD — v4.21

ORAC — norm CCI ORAC AOD — fv03.02

ADV — norm CCI ADV AOD — v2.30

Index (-3 to +3)

SU AOD550 Indo / HadISST Niño3.4

ORAC AOD550 Indo / HadISST Niño3.

ADV AOD 550 Indo / HadISST Niño3.4

Indonesia timeseries
5S/5N,100/150E

Index -2 to +8

Time 1997-2012 (month)

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CMIP5 model EC-Earth RCP8.5 CMIP5 simulation cf to CCI SST and Clouds
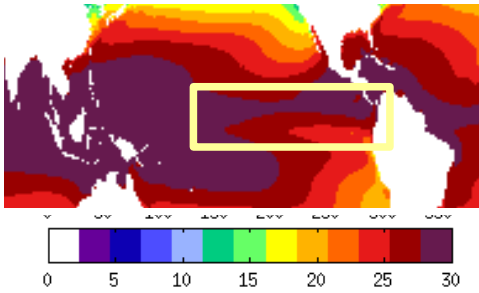**EC-Earth simulates El Niño/La Niña and plateaus.**
For present day: colder and cloudier and less variability than CCI variables.
Towards end of century warmer and higher variability for SST and cloudiness
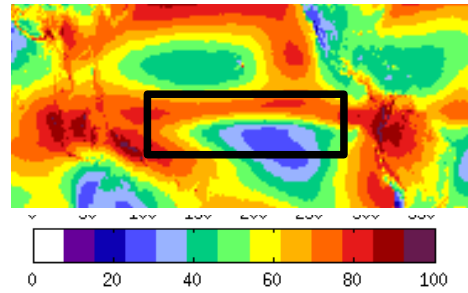

Sea Surface Temperature (degree Celcius)

97/98   2037/2038

ECE 29°C

CCI 27°C
ECE 26°C

Nino3.4 SST timeseries

Cloud (%)

97/98   2037/2038

ECE 50%
CCI 48%

ECE 50%

Nino3.4 Cloud timeseries

Changes in CMIP model mean and interannual variability [2070,2100]-[1982-2012]

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CCI SST MEAN **CCI CLT MEAN** **CCI SST STD** **CCI CLT STD**
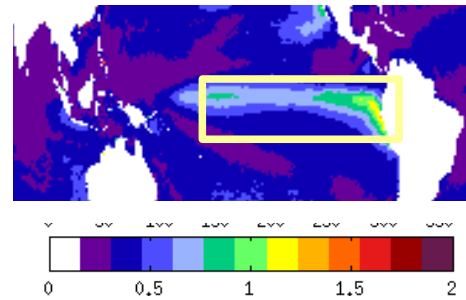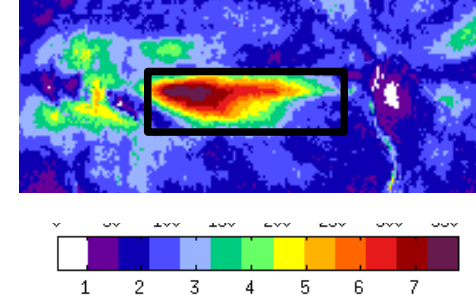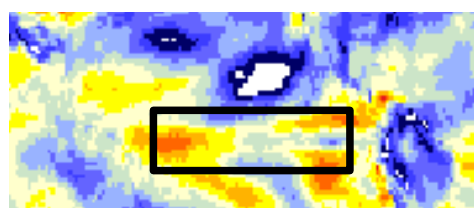
HadGEM2 SST Trend **HadGEM2 CLT Trend** **HadGEM2 SST Trend** **HadGEM2 CLT Trend**
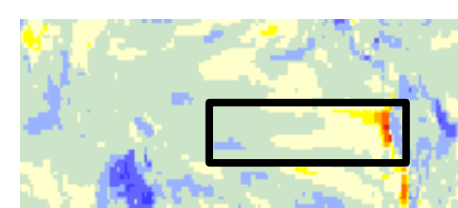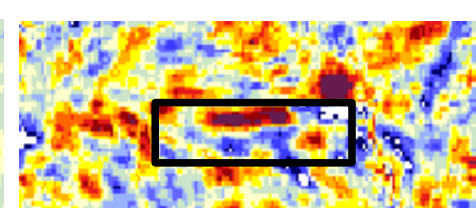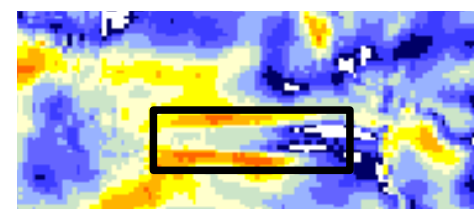
IPSL-CM5 SST Trend **IPSL-CM5 CLT Trend** **IPSL-CM5 SST Trend** **IPSL-CM5 CLT Trend**
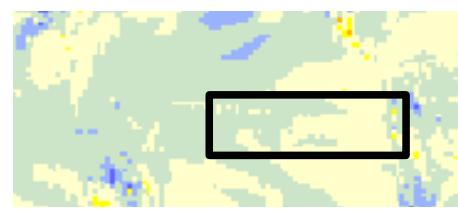
CNRMCM5 SST Trend **CNRMCM5 CLT Trend** **CNRMCM5 SST Trend** **CNRMCM5 CLT Trend**

(K) (%) (K) (%)