Comparison between TRMM-TMI microwave land surface emissivity maps derived from JRA-25 and ERA-Interim

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Introduction

- Tropical Rainfall Measuring Mission (TRMM) satellite could bring the long term data. Therefore, trend analysis can be performed.
- To study on correlation between trends of precipitation characteristics and land surface microwave emissivity with land surface information reveals the interaction of land surface and precipitation.

→

- We made monthly averaged data with grid size of 0.2 degree for 15 yrs (Jan.1998-Dec.2012), and estimated the trend by fitting with sine curve plus linear function at each grid, and then, made maps of their trends.
- The correlation of them is studied.

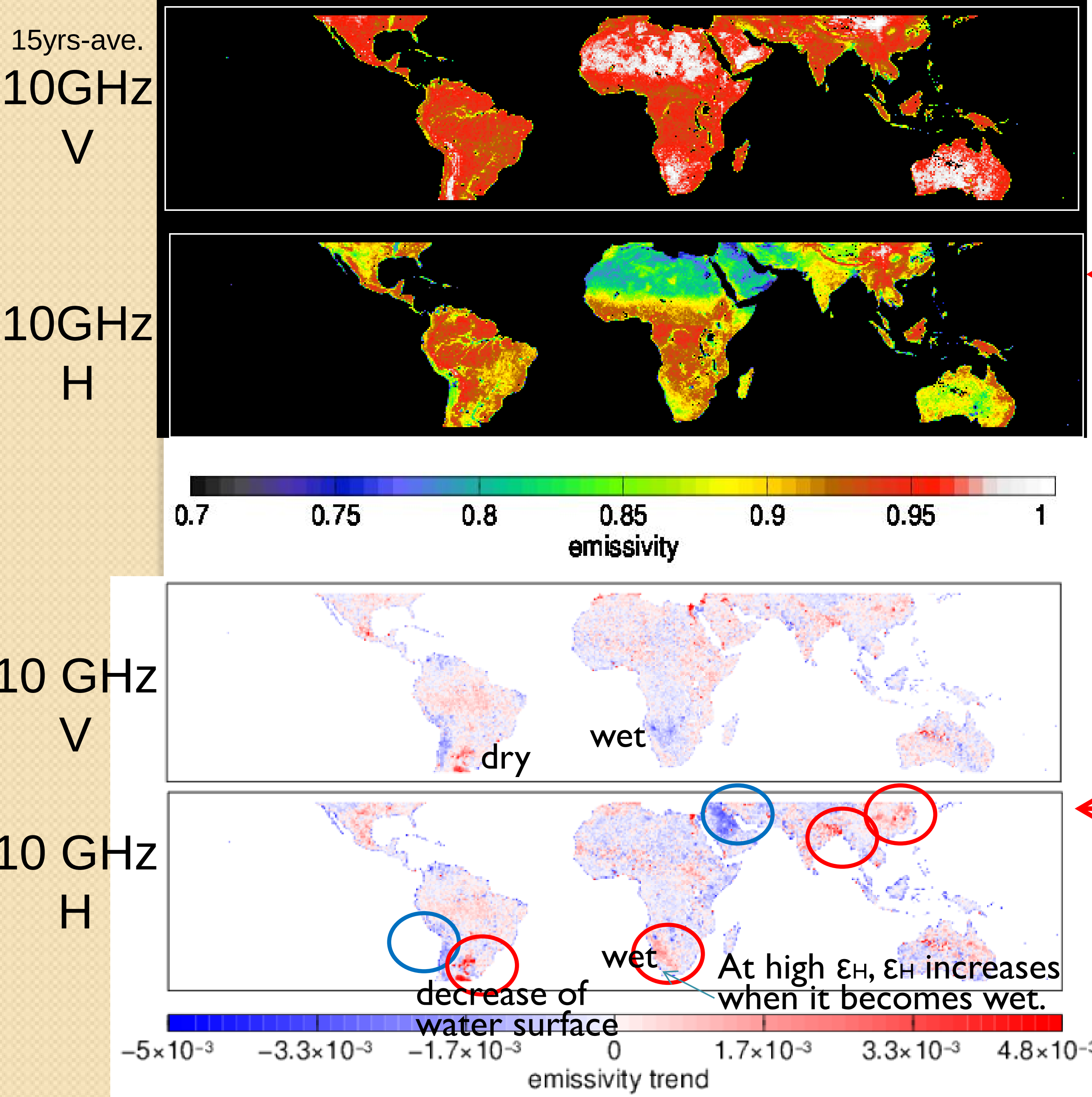
Introduction of emissivity

- Our instantaneous no-rainy-land emissivity database has been made in order to improve an algorithm for land precipitation retrieval.
- 9 emissivities were calculated from TMI 9-ch brightness temperatures under no-rain condition defined by PR and reanalysis-data's atmospheric information and topographic data, using a following equation (Prigent et al. 2006),

$$\varepsilon_p = \frac{\mathrm{Tb}_p - T_{\mathrm{atm}}^{\uparrow} - T_{\mathrm{atm}}^{\downarrow} e^{-\tau(0,H)/\mu}}{e^{-\tau(0,H)/\mu}\left(T_{\mathrm{surf}} - T_{\mathrm{atm}}^{\downarrow}\right)}$$

- As reanalysis data, JRA25 and ERA-Interim are used for two sets of database, respectively. First, results of JRA25 case are shown.

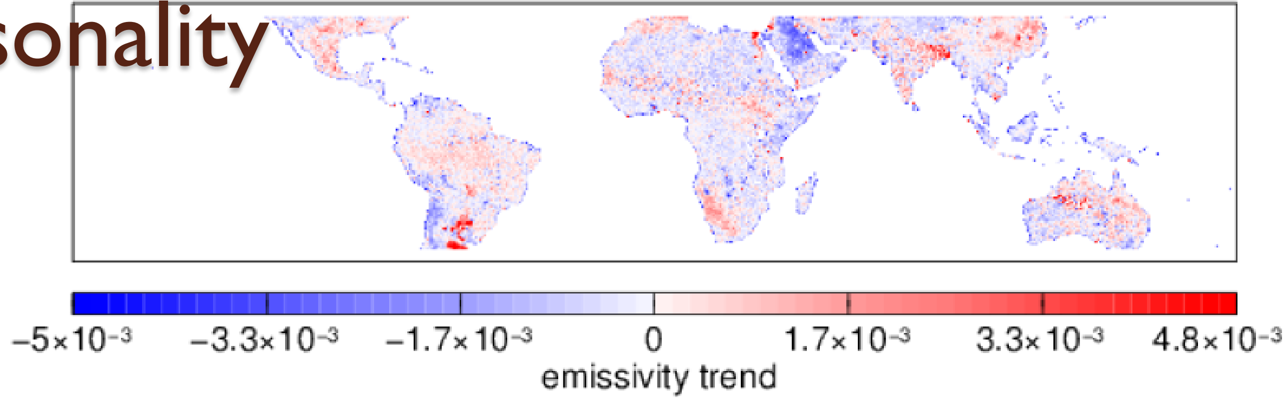
Results of Emissivity



emissivity of horizontal wave：high at tropical forest and low at dessert and coast of ocean and river basin.

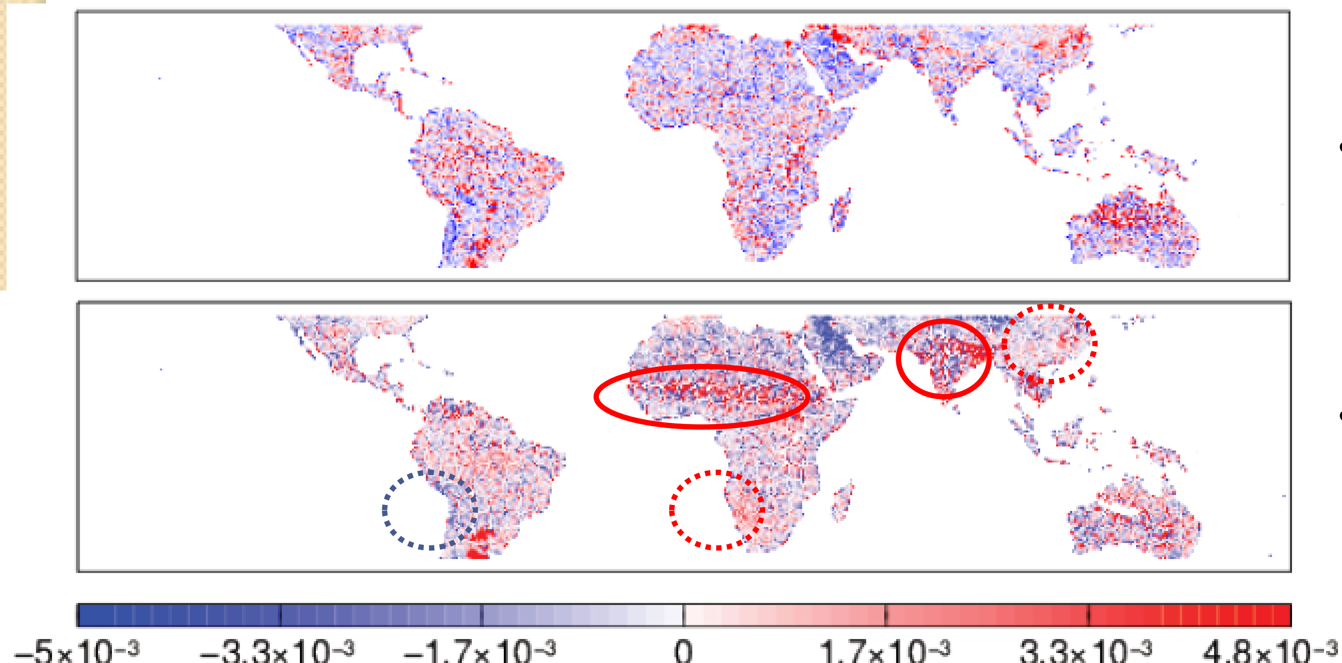
trend of horizontal wave：low emissivity region has decrease trend (northeast side at Arabian Peninsula and Andes(dry?). Increase trend is seen at Namibia (vegetation?) and Argentina, Bangladesh, China (dry & decrease of water surface?).

Seasonality



emissivity trend
10 GHz-H
(15yrs−all data)

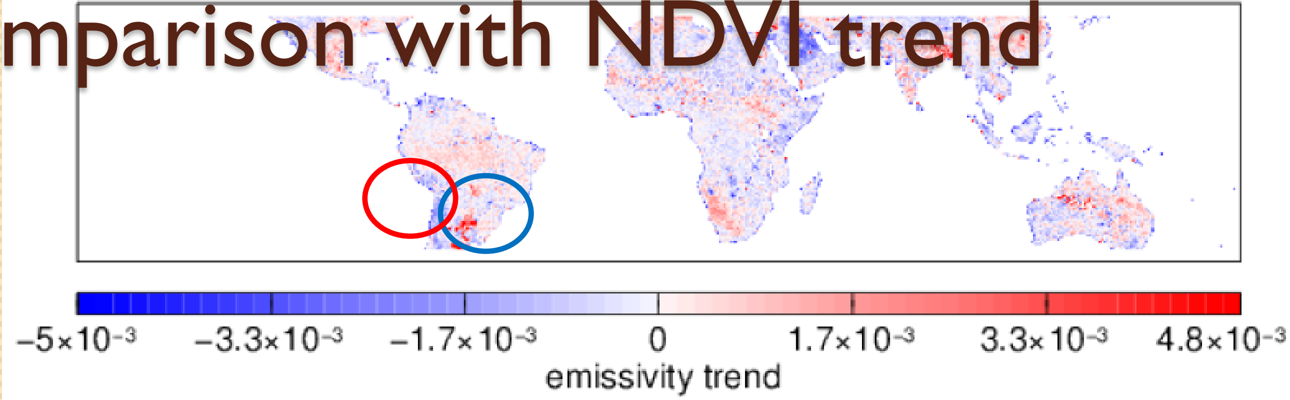
July: decrease trend at the Andes is small, and increase trends at Namibia or China is small,
but increase trend at Bangladesh or south edges of the Sahara are large.
Seasonal variations are seen.



January

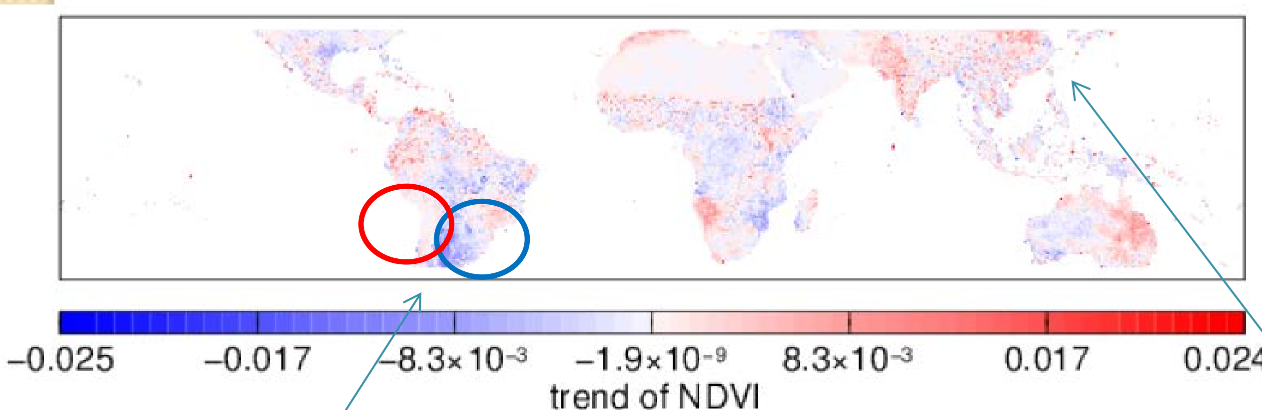
July

Comparison with NDVI trend



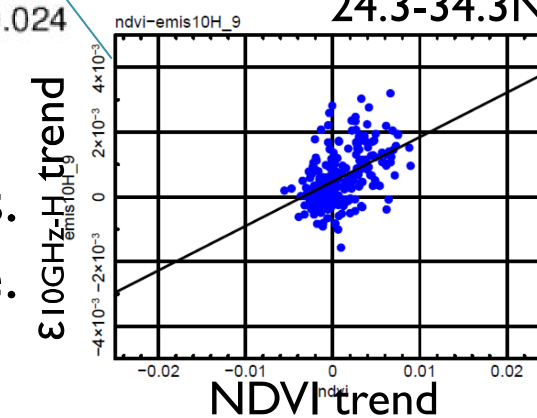
emissivity trend
10 GHz-H
(15yrs all data)

MODIS Normalized Difference Vegetation Index



NDVI (all data)
(band2 – band1)/(band2+band1)

East China 117.1-118.1E
24.3-34.3N



positive correlation

At the Andes, emissivity decreases & NDVI increases.
At Argentina, emissivity increases & NDVI decrease.
negative correlation

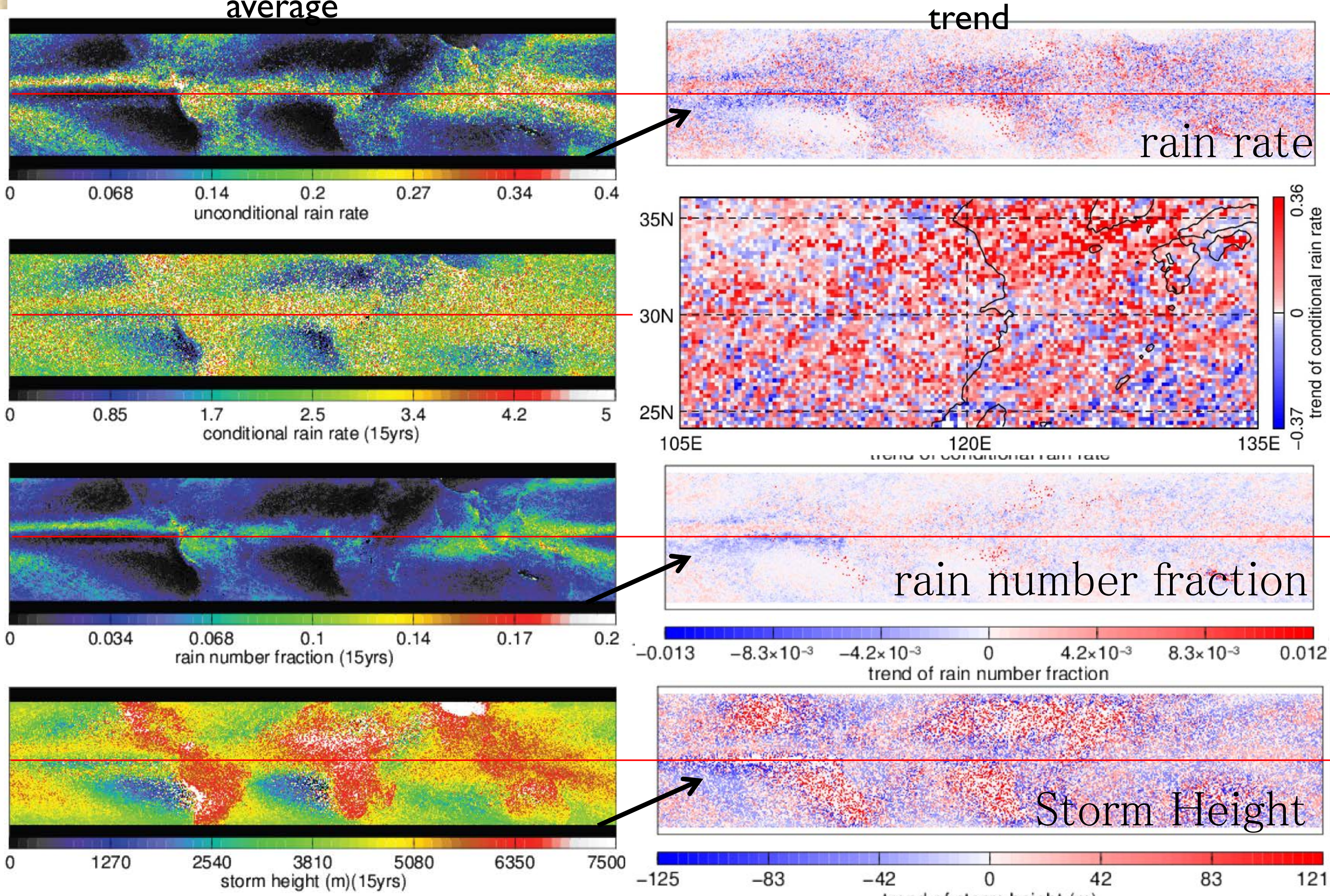
The correlation depends on each area.

Results of Rain Characteristics

At ITCZ, convection is largely strengthened. At the south area, it is largely weakened and at the north area, it is slightly weakened (it is consistent with CloudSat's CLWP).
Intensity of rain rate is strengthened over the northeast side of China and the East China see.

ITCZ
RR↑
f_{No}↑
SH↑

around ITCZ
RR↓
f_{No} ↓
SH↓



Results of Correlations between their trends

East China: 117.1-118.1E,24.3-34.3N has many emissivity-increase pixels.

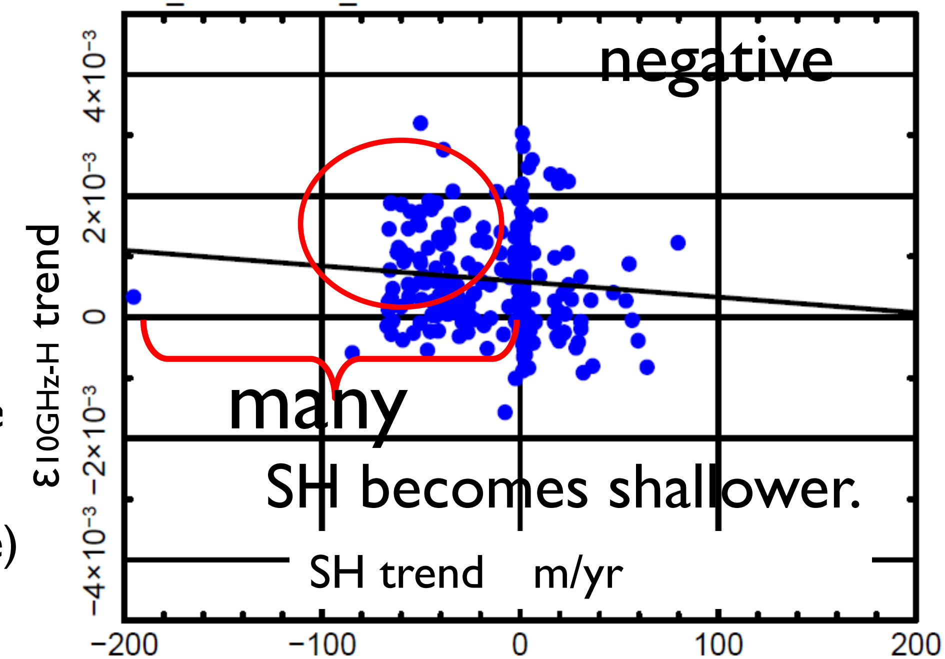
Focused on area with increase of ε,

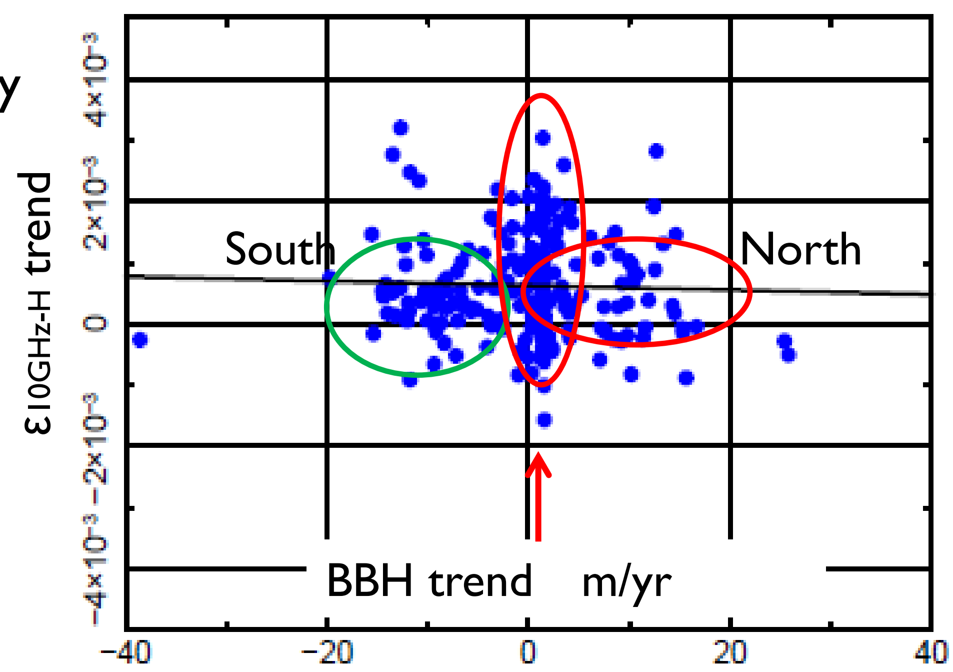
- SH decrease=weak convection
- south side: BBH decrease=FL decrease～Ts decrease=cooling effect→sensible heat decrease→shallow convection
- north side: BBH increase(Ts increase)

(hereafter, no figures)

- Increase of No. or fraction of rain rate of convective rain, strengthening of rain intensity at many regions (due to increased dust?).

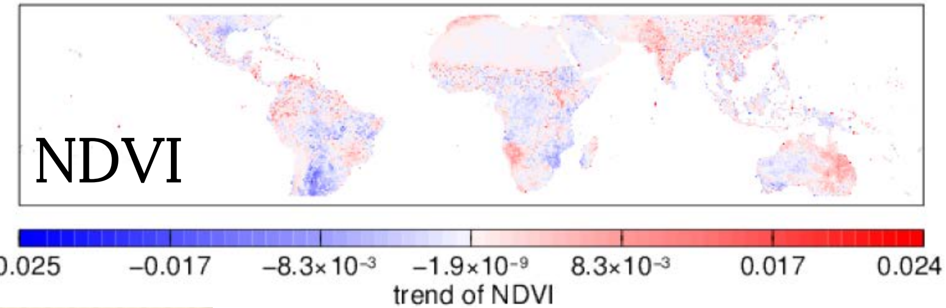
Decrease(increase) of rain No. frequency, small decrease(increase) of rain-rate at north(south), ⇒North side indicates decrease of water surface area induced water vapor decrease, and frequency of rain decreased, thus, Ts increases. South side indicates increase of water vapor owing to vegetation makes abundant rain from shallow convective rain system.



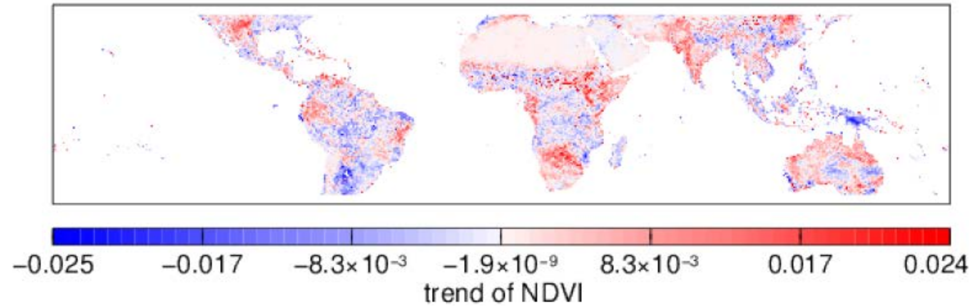


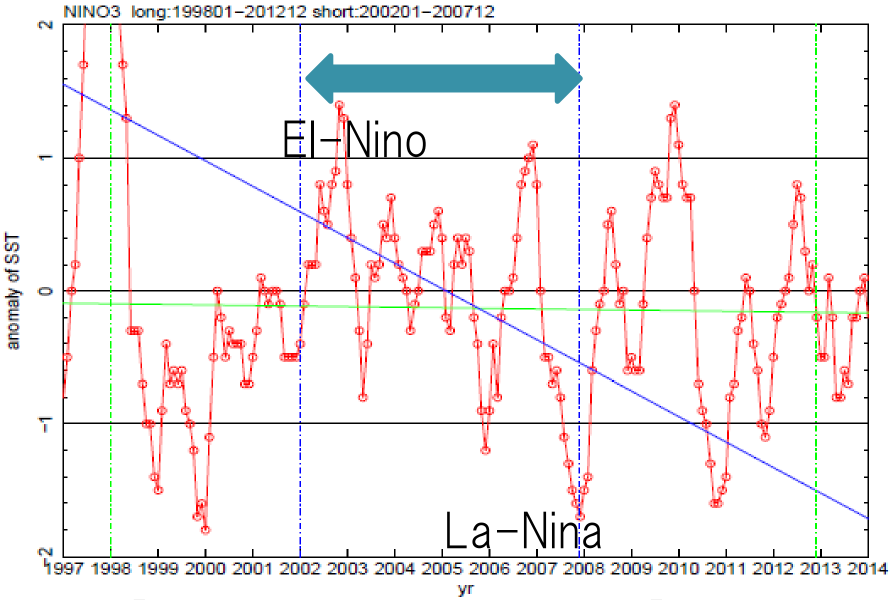
Difference of term: effects of ENSO

1998–2012 all data(15yrs)



2002–2007(6yrs):TRMM stable

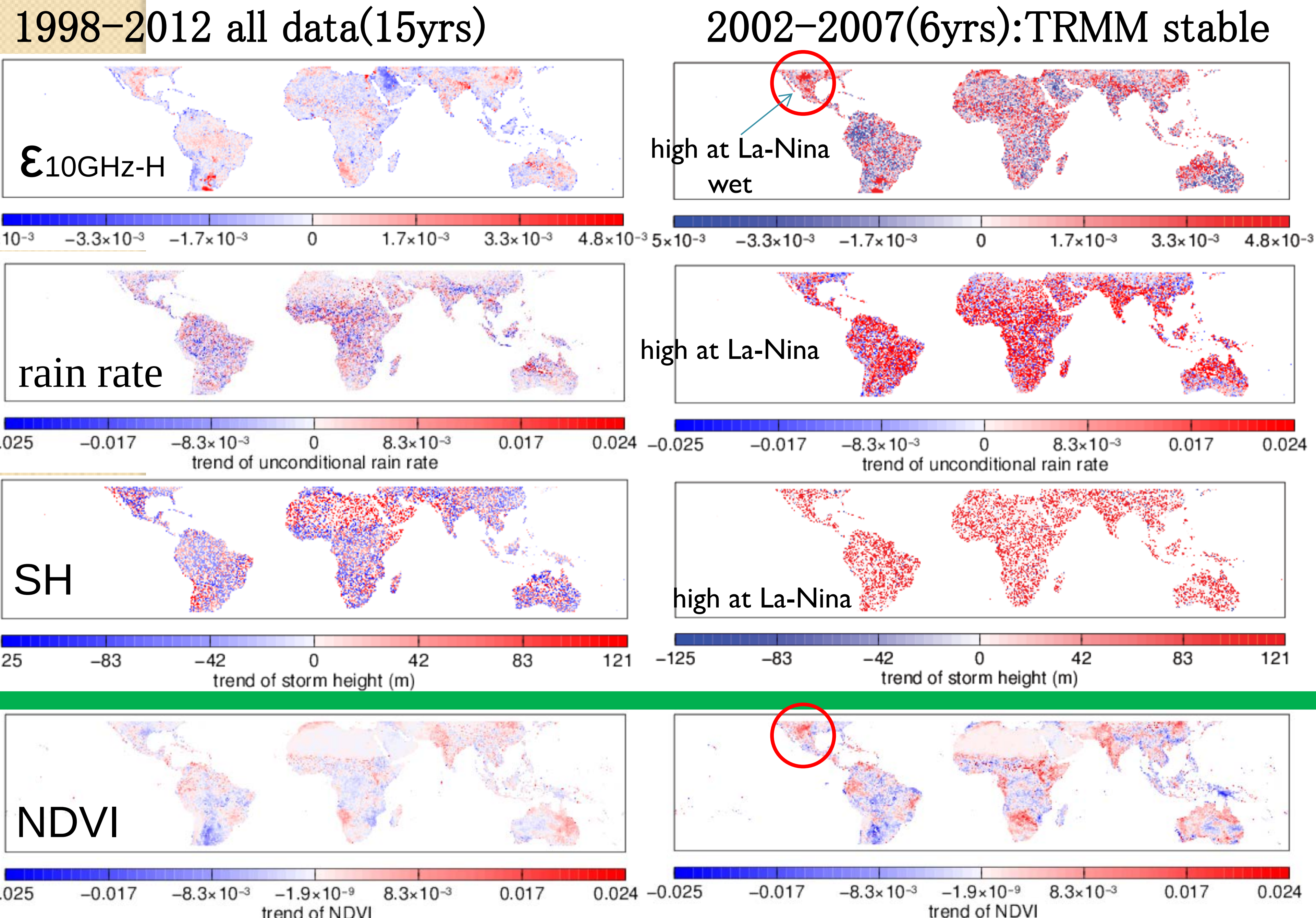




The first of 2002–2007(6yrs) shows El–Nino, and the late shows La–Nina. Therefore, deviation of trend is large.

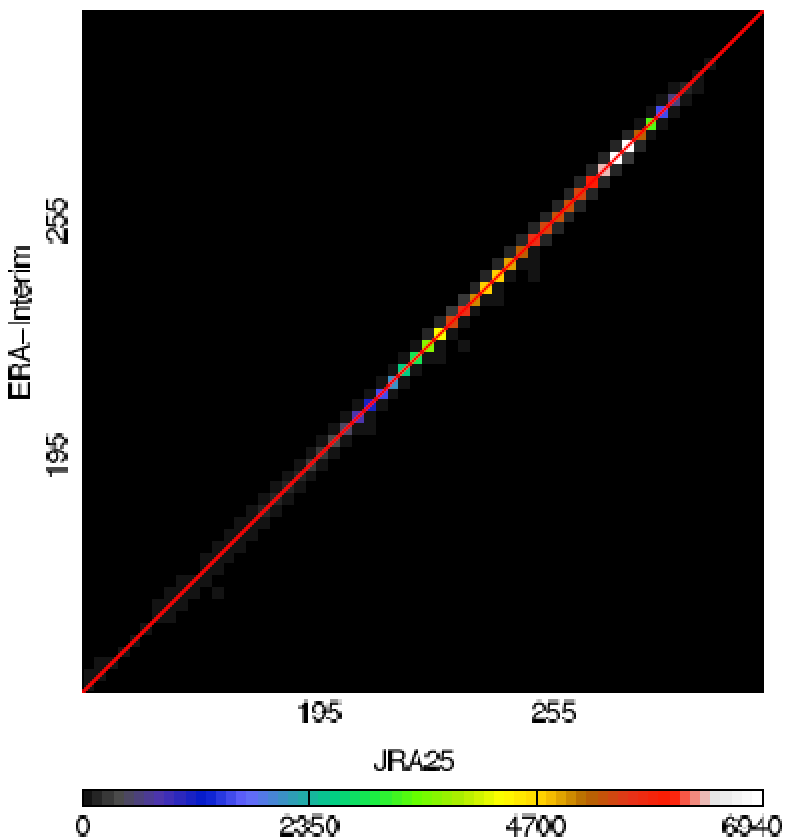
On the precipitation characteristics or emissivity, short term results show the change induced by El-Nino/La-Nina. We assume that long term trends are caused by natural phenomena of global warming.

Difference of term: effects of ENSO

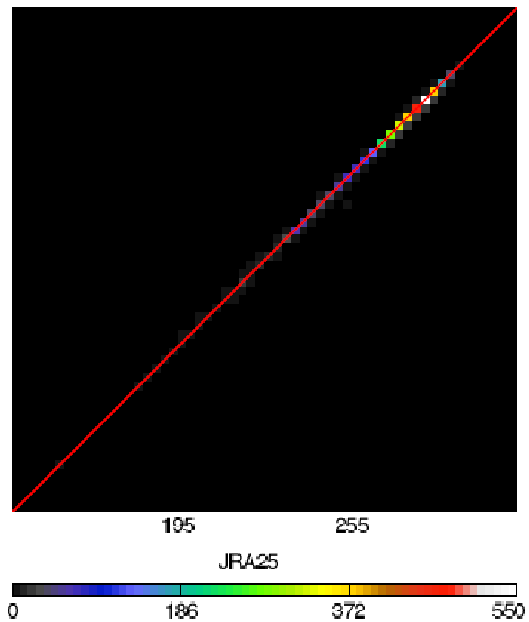


Comparison of emissivity x Ts between Era-Interim and JRA25/JCDAS

200301 10GHz-H histogram of all data



10LT



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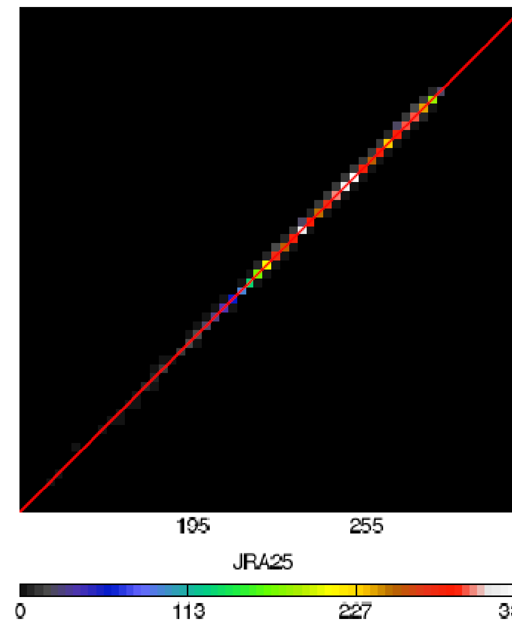


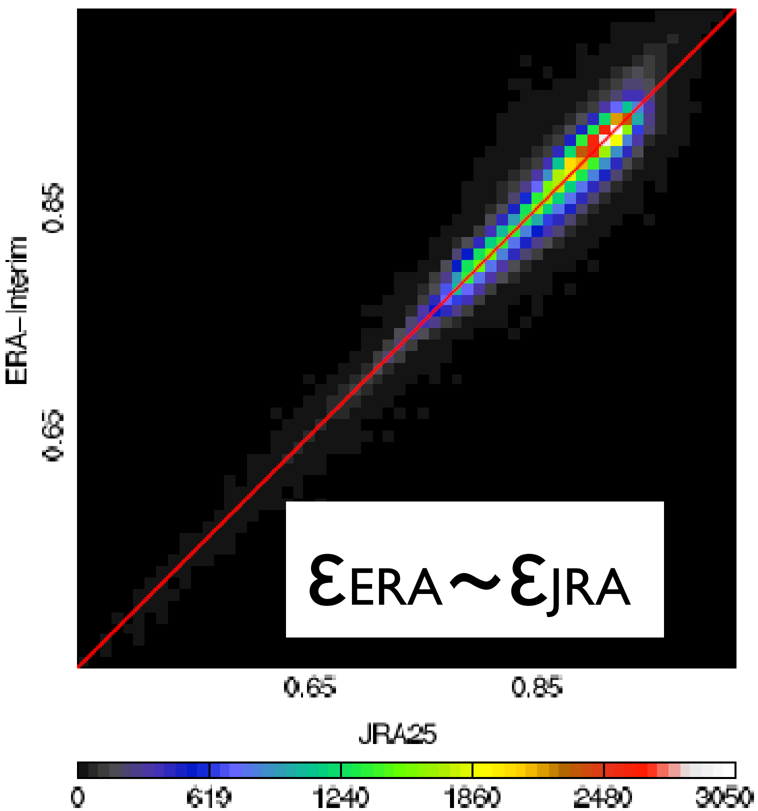
$T_s\varepsilon_{ERA} \sim T_s\varepsilon_{JRA}$ $T_s\varepsilon_{ERA} \sim T_s\varepsilon_{JRA}$

$T_s\varepsilon_{ERA} \sim T_s\varepsilon_{JRA}$

Not only all time result but also each time data show they are similar.

Comparison of emissivity between Era-Interim and JRA25/JCDAS

200301 10GHz-H histogram of all data



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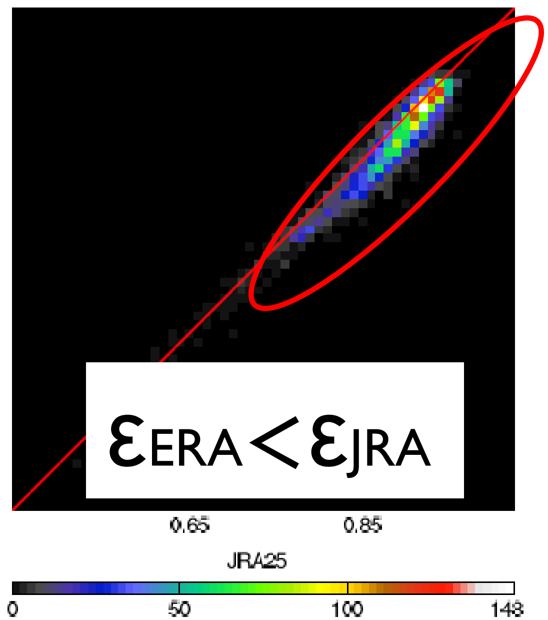

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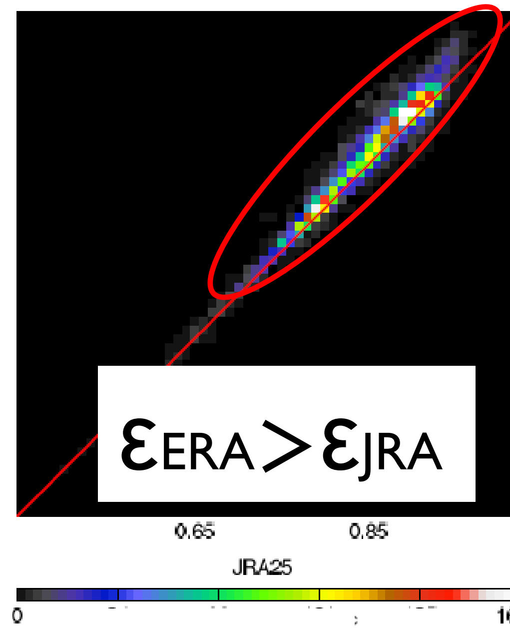
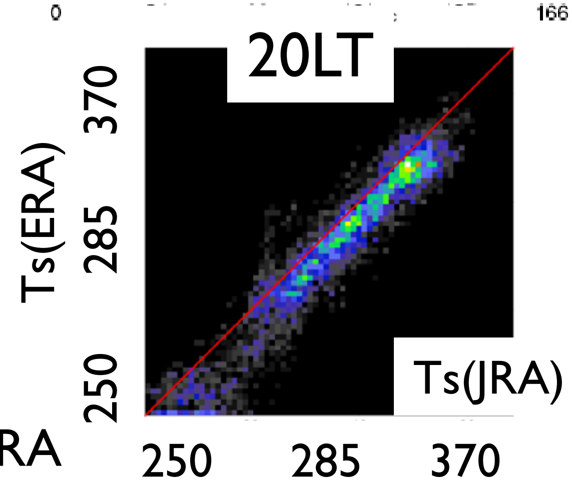


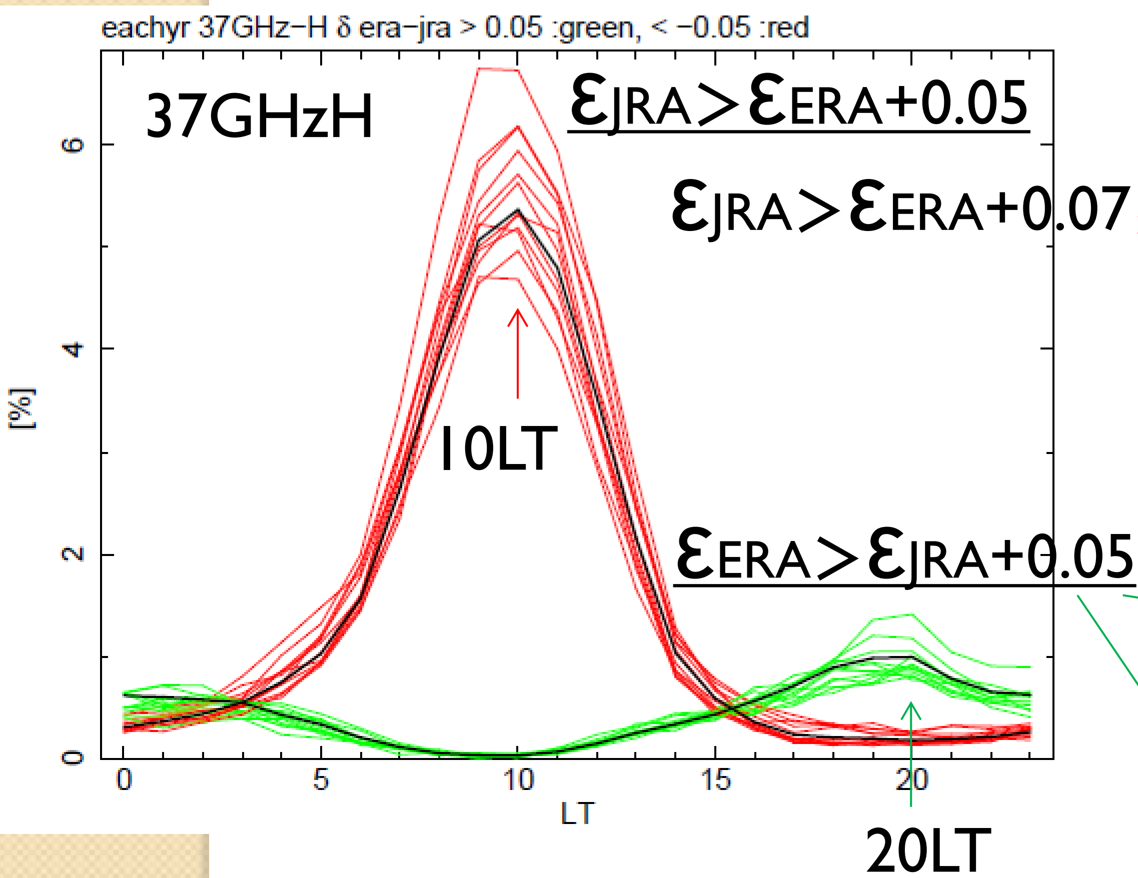


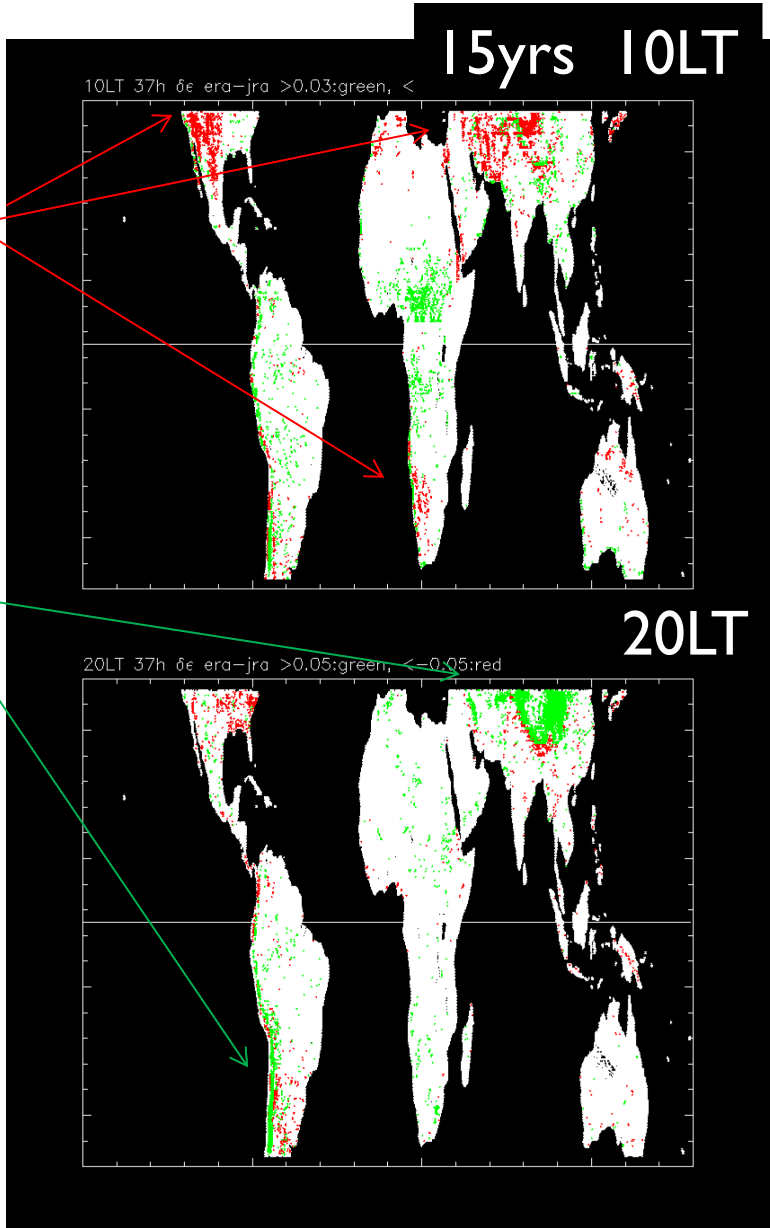
All time result shows they are similar, but on each time, they are different.

→the difference is due to Ts.

$T_{ERA} < T_{JRA}$

Dependence of Δemissivity between Era-Interim and JRA25/JCDAS on Local Time



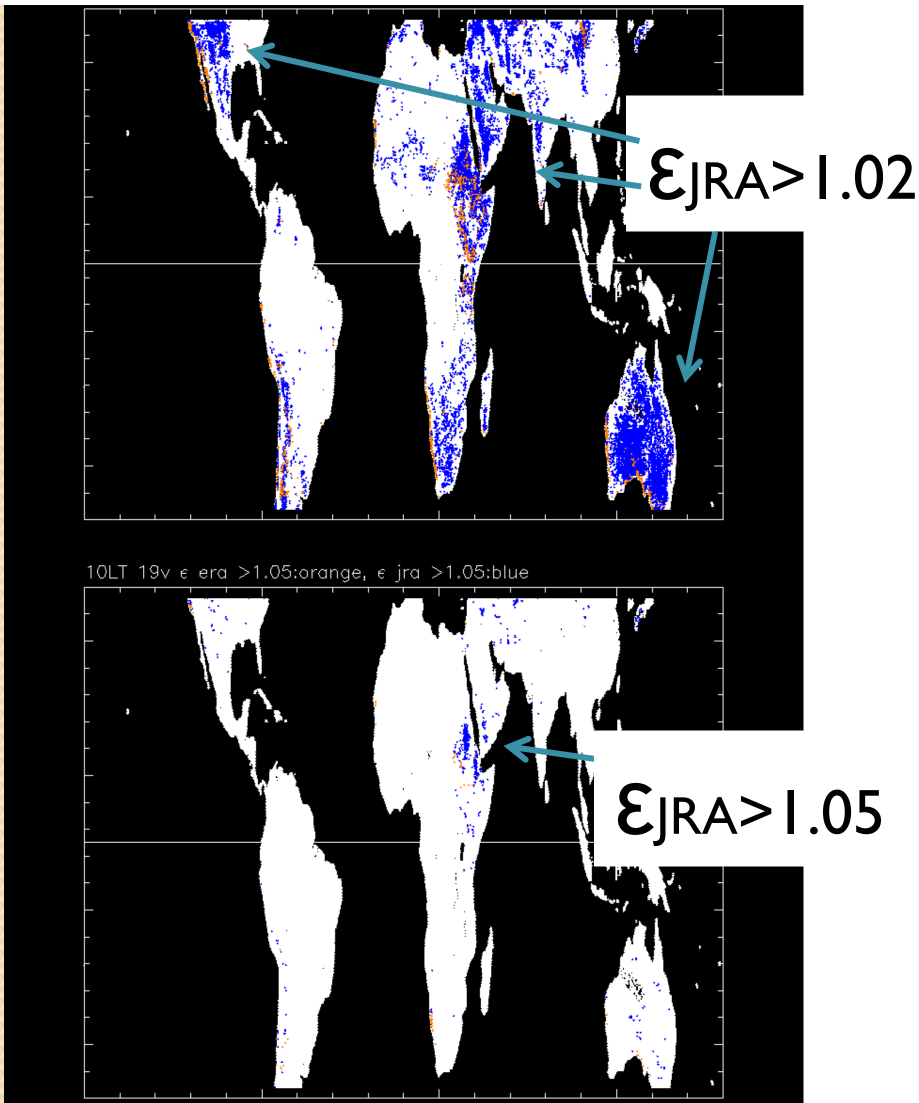


black line ：the average

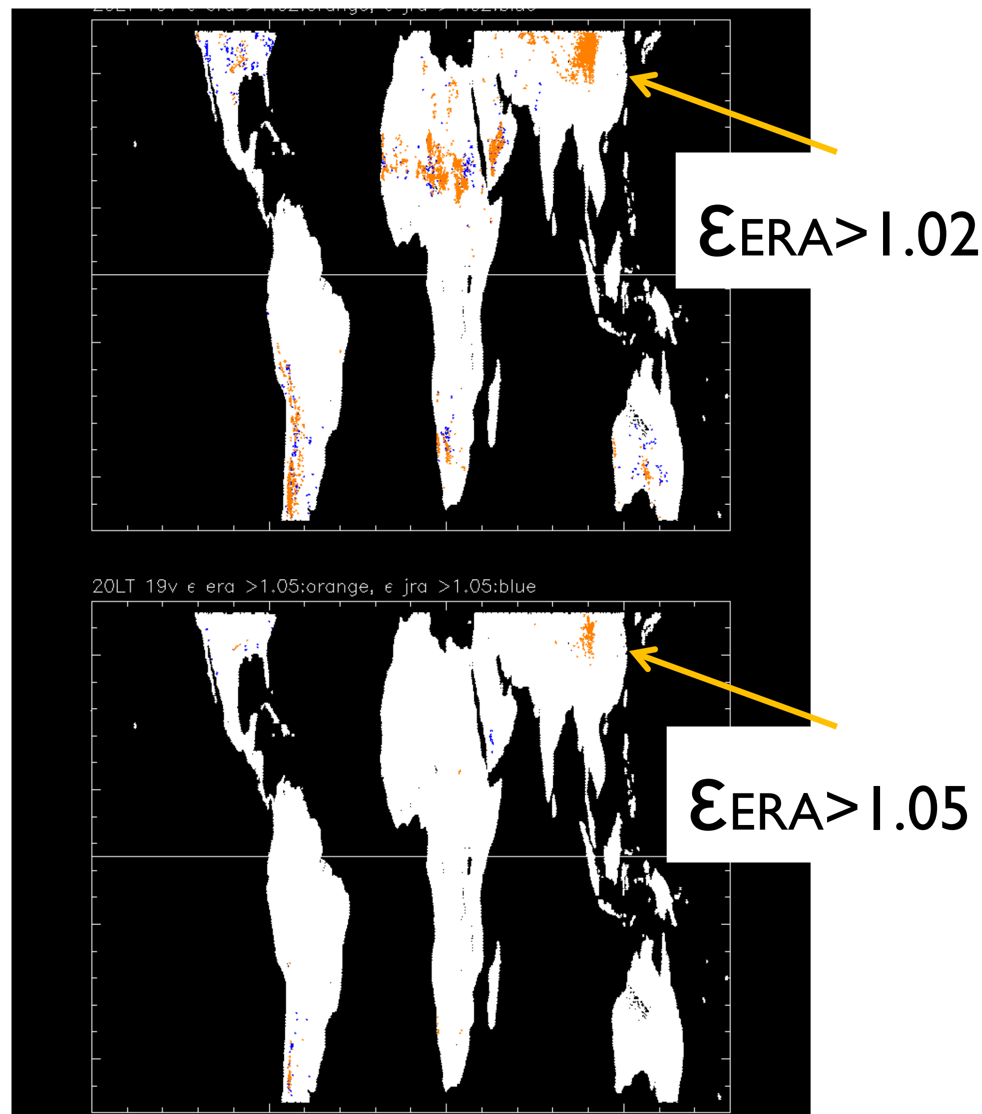
other line ：the each year

Regions of 19GHz-V emissivities with over unity (underestimation of Ts)

10LT



20LT



Conclusions

- Trend of 1998~2012(15 yrs) was studied with resolution of 0.2 deg.
- Trend of precipitation characteristics
  - Strengthening of ITCZ convection, strengthening of rain intensity over from Northeast of China and the East China sea, etc. are shown.
- Trend of emissivity (10 GHz results are shown here.)
  - clear regionality is seen depending on NDVI and seasonality is clearly seen.
- Comparison of trends over East China
  - increases of No. of convective rain and of shallower rain, and a strengthening of rain intensity are obtained.
  - North China has increase-ε region due to decrease of water surface area, where No. of rain decreases, BBH becomes higher (Ts increases.)
  - South China has increase-ε region due to vegetation, where No. of rain increases, BBH becomes lower (Ts decreases, sensible heat decreases.)

  - North：water vapor decreases, and rain rate decreases (thus, water surface area decreases).
  - South：water vapor increases, and No. of rain increases and intensity becomes strong, and thus, rain rate increases.
- 6yrs-short term trend indicates the El-Nino/La-Nina effect.
- ε from JRA25/ERA-Interim is affected by underestimation of Ts.

In future

Now, emissivity map from GPM/GMI has been made with the same method.
Emissivity of higher latitude or higher frequency can be investigated.

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Thank you.