The CM SAF CLARA-A3 Climate Data Record – TOA Radiation

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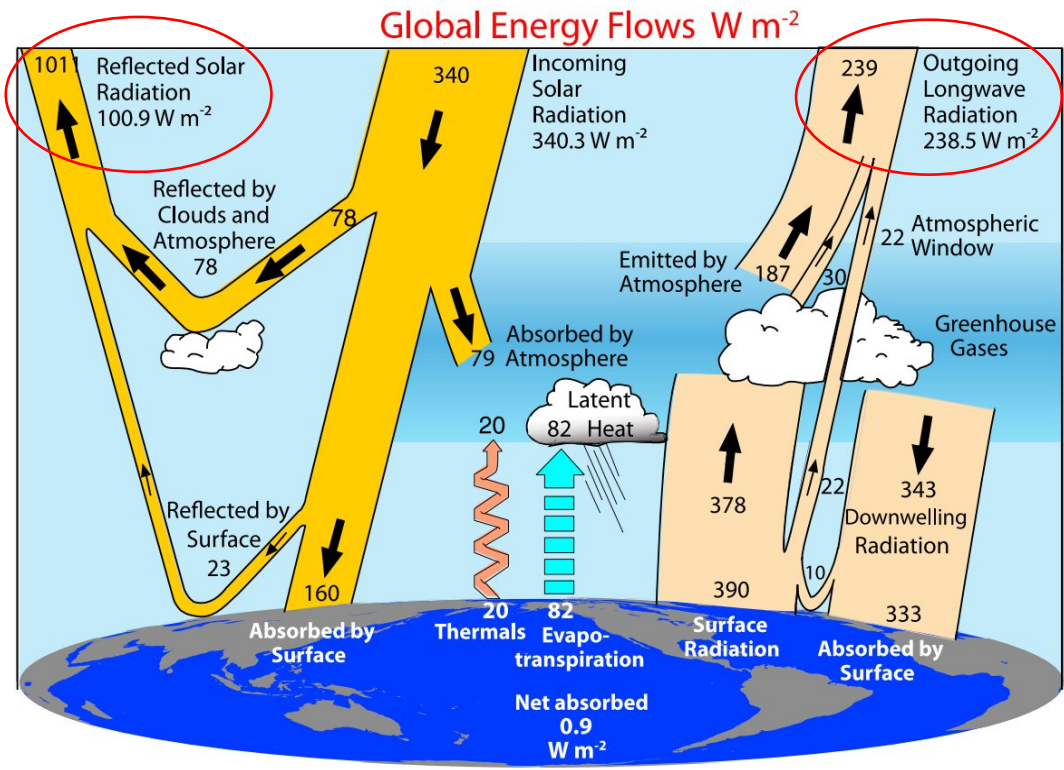
1. Introduction

- At the Top-Of-Atmosphere (TOA), the following radiative fluxes are defined: the Incoming Solar Radiation (ISR), the **Reflected Solar Flux (RSF)** and the **Outgoing Longwave Radiation (OLR)**.
- These three components of the Earth Radiation Budget (ERB) are the driver of the climate on our planet. In the frame of climate monitoring, the continuous monitoring of these fluxes is of prime importance to understand climate variability and change. **The nature of these quantities, which are defined at TOA, makes the use of satellite observations especially useful.**



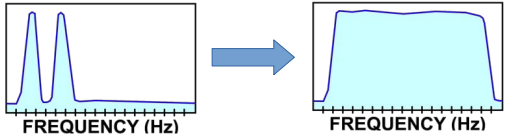
1. Introduction

- Added value of the CLARA-A3 TOA RSF and OLR products with respect to the currently existing state-of-the-art data records from CERES (Loeb et al.,2018):
  - (1) a prolongation back in time to the late 1970s (*CERES 2000-2020*)
  - (2) increasing the spatial resolution to 0.25°x0.25° (*CERES 1°x1°*)
  - (3) their synergy and compatibility with other CLARA-A3 products.

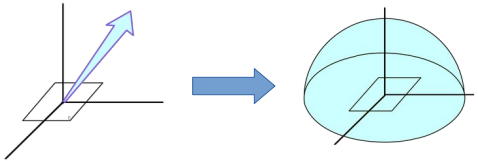
- Note that it is the first time that these TOA flux products are included in the portfolio, so we cannot compare CLARA-A3 with CLARA-A2.

Simplified version of processing chain:

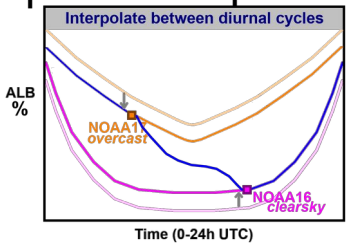
- Starting point : Reflectances (RSF) or brightness temperatures (OLR) in 2 narrowband channels from AVHRR instrument
- Narrowband-to-broadband conversion (using empirical regressions) :



- Directional-to-hemispherical conversion (using Angular Dependency Models):



- Instantaneous-to-dailymean conversion (using temporal interpolation models):



2. Overview of the products

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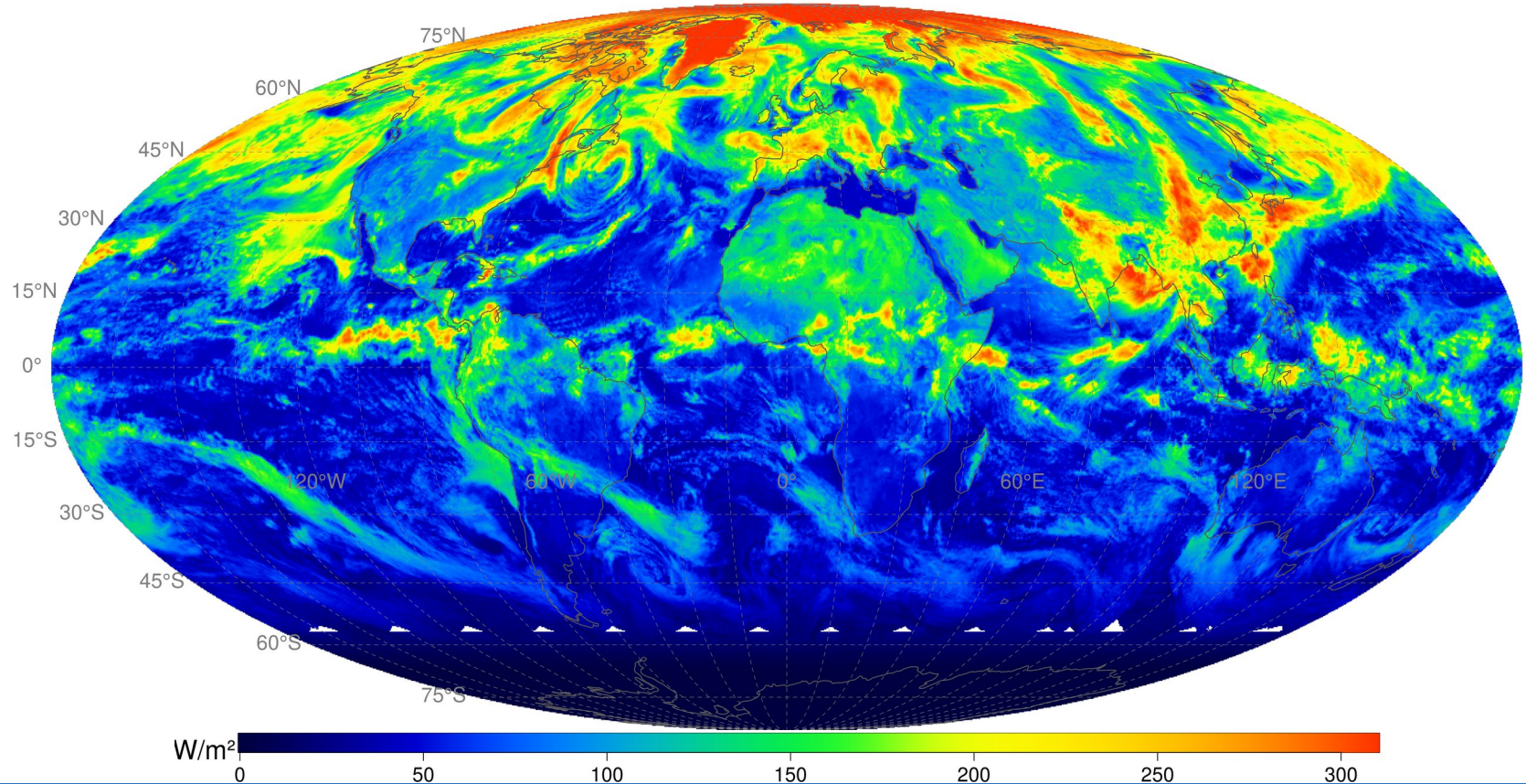
- Example: daily mean RSF (15/6/2008)



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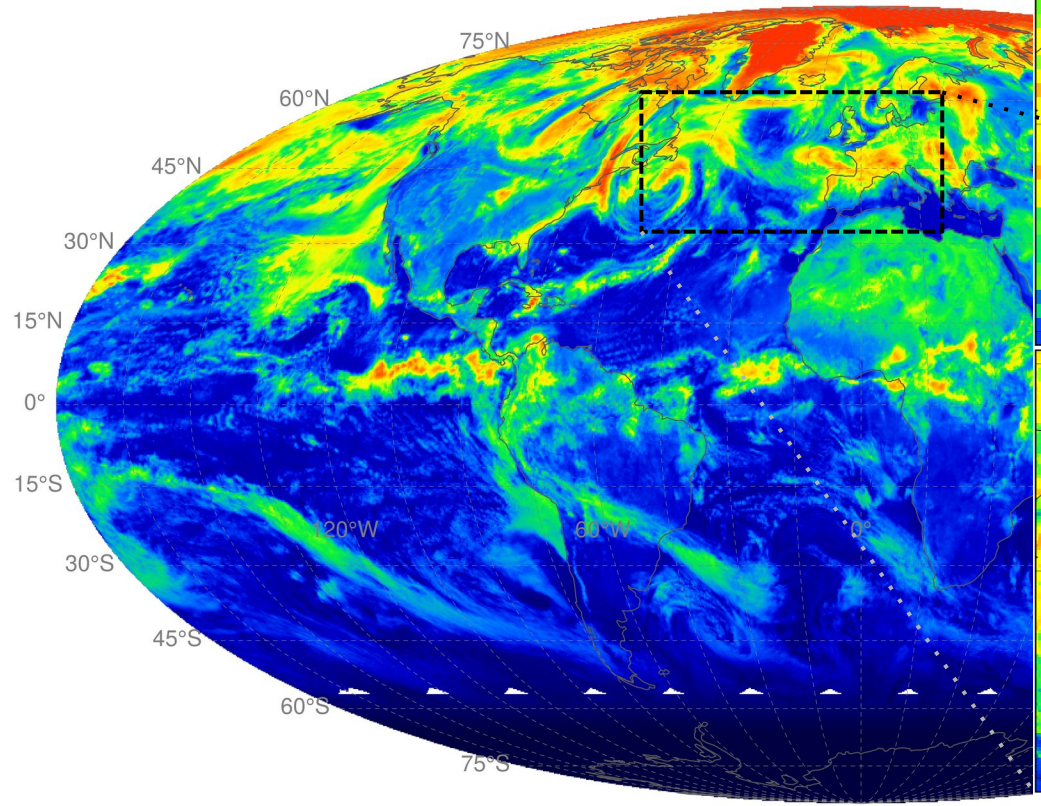

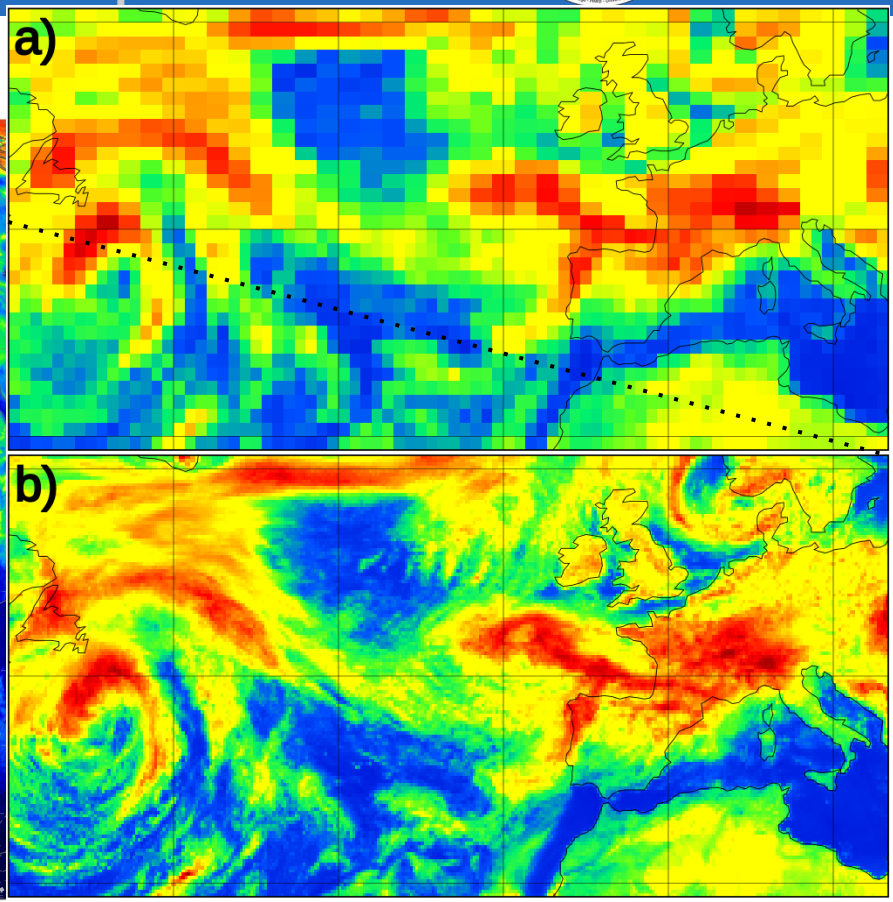

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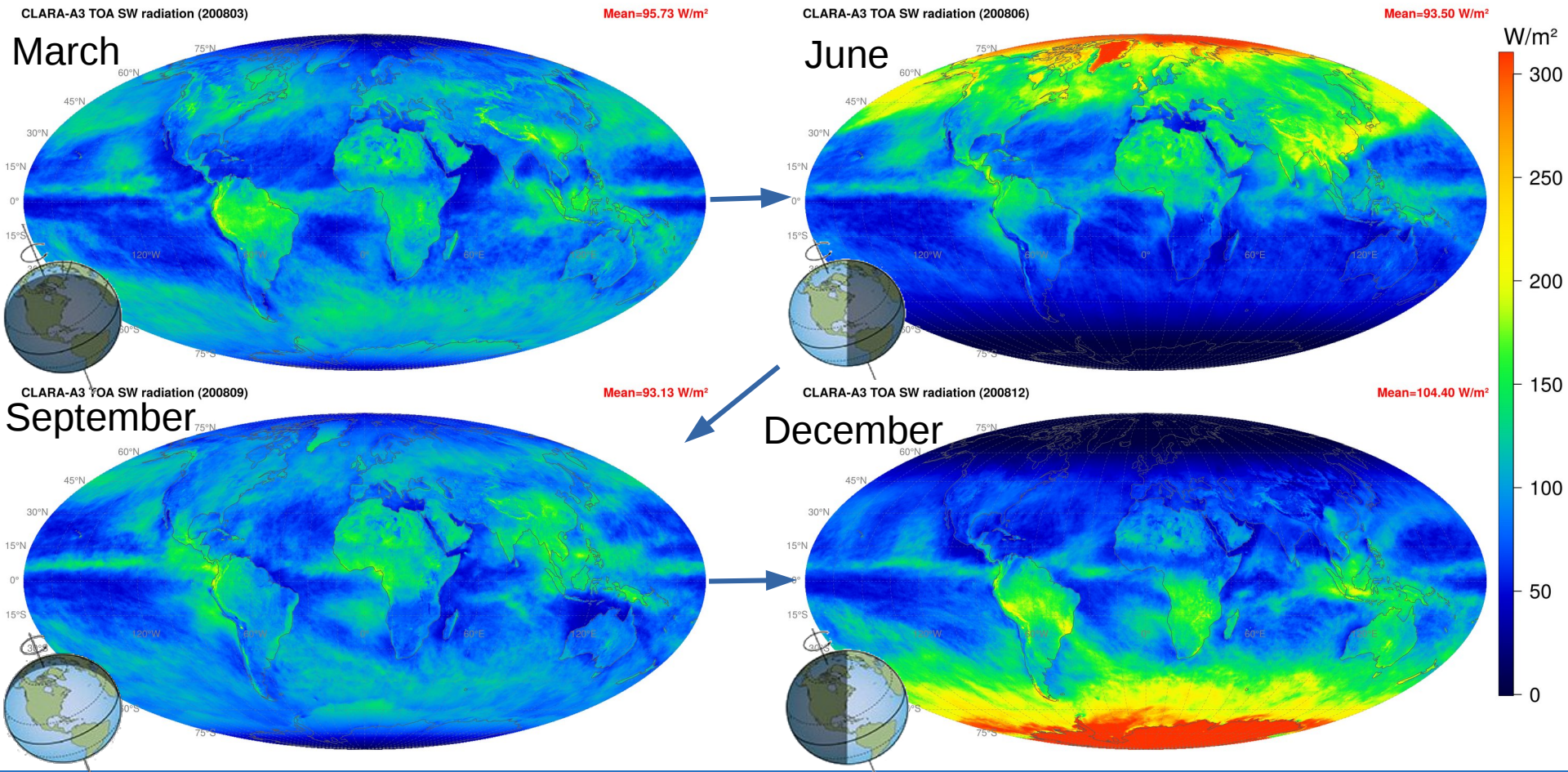
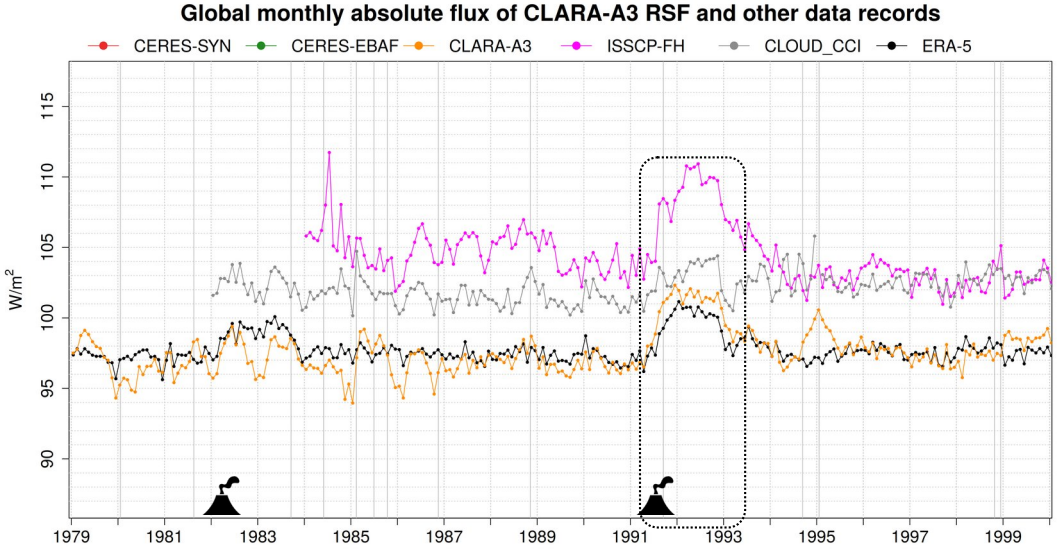


- **Global** Monthly Mean RSF:



- Deseasonalized

Major volcanic events

Trends (W/m²/dec):

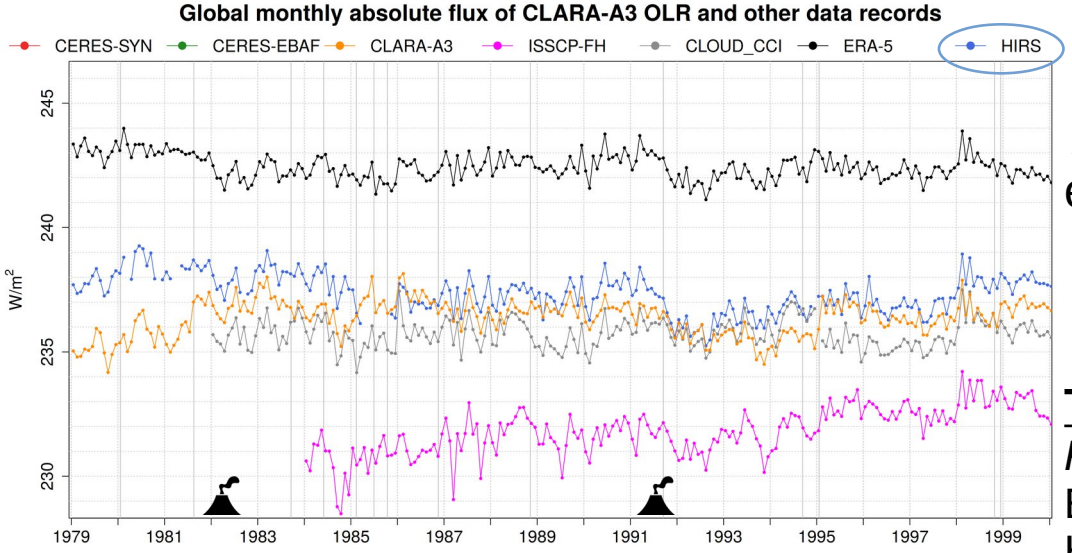
Full series:

ERA5:	-0.0769
CLARA-A3:	-0.2318

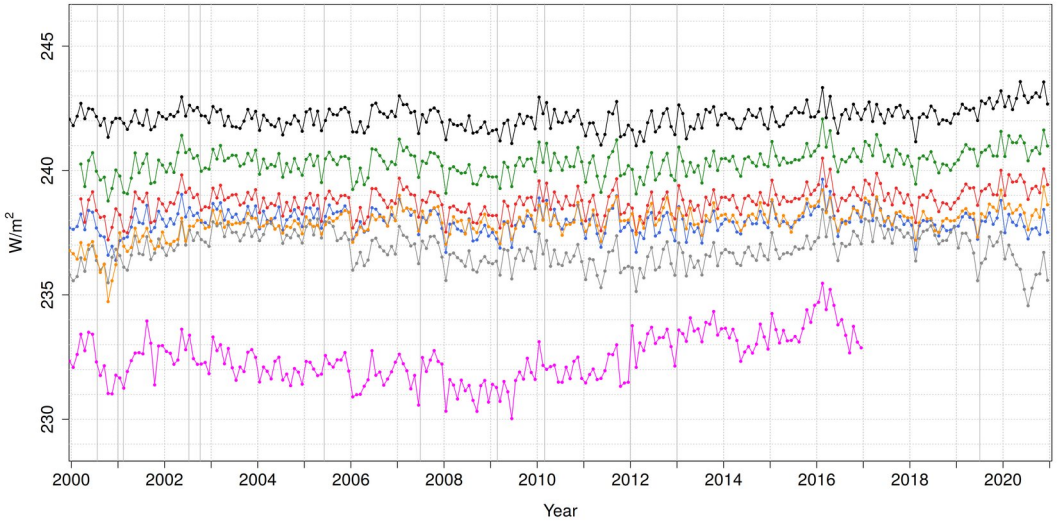
Since 2000:

ERA5:	-0.2024
CLARA-A3:	-0.9645
CERESSYN:	-0.6451
CERESEBAF:	-0.7023

- **Global** Monthly Mean OLR:



- Deseasonalized



Major volcanic events

Trends (W/m²/dec):

Full series:

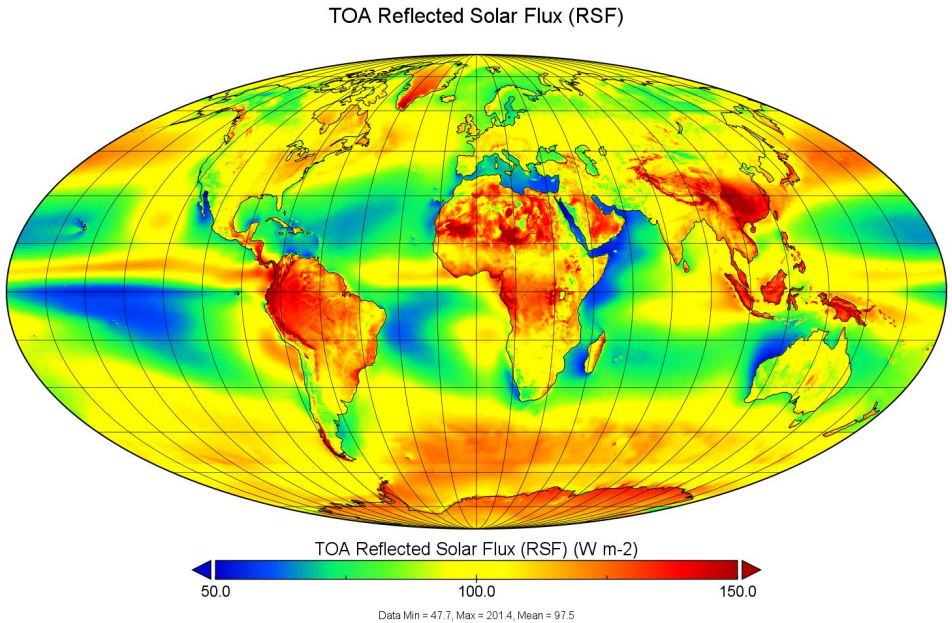
ERA5:	-0.1125
HIRS:	+0.1461
CLARA-A3:	+0.6321

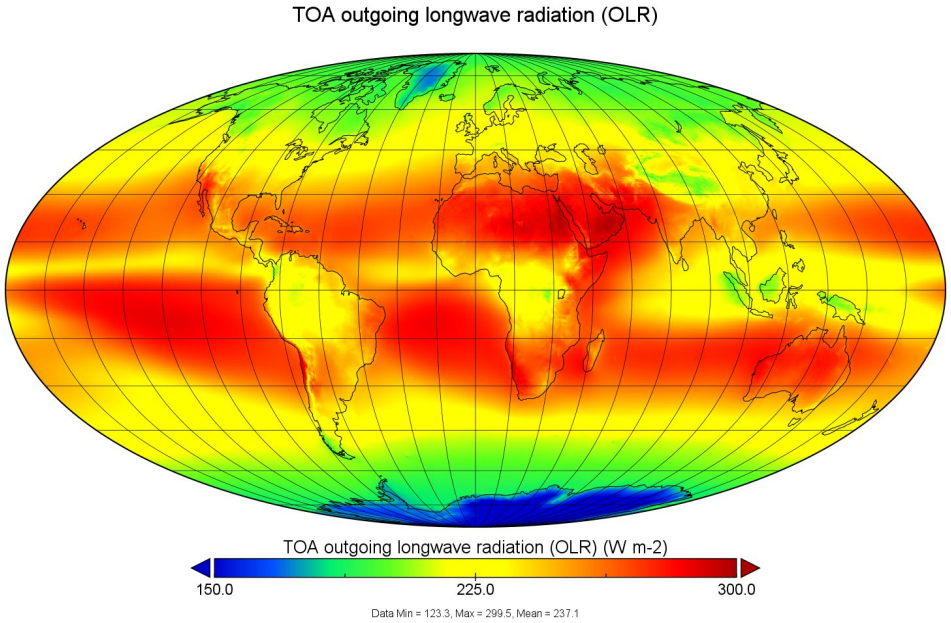
Since 2000:

ERA5:	+0.2295
HIRS:	-0.0679
CLARA-A3:	+0.3800
CERESSYN:	+0.2825
CERESEBAF:	+0.2839

2. Overview of the products

- Long-term average TOA fluxes (1979-2020) from CLARA-A3:





3. Some spatio-temporal insights in the data record

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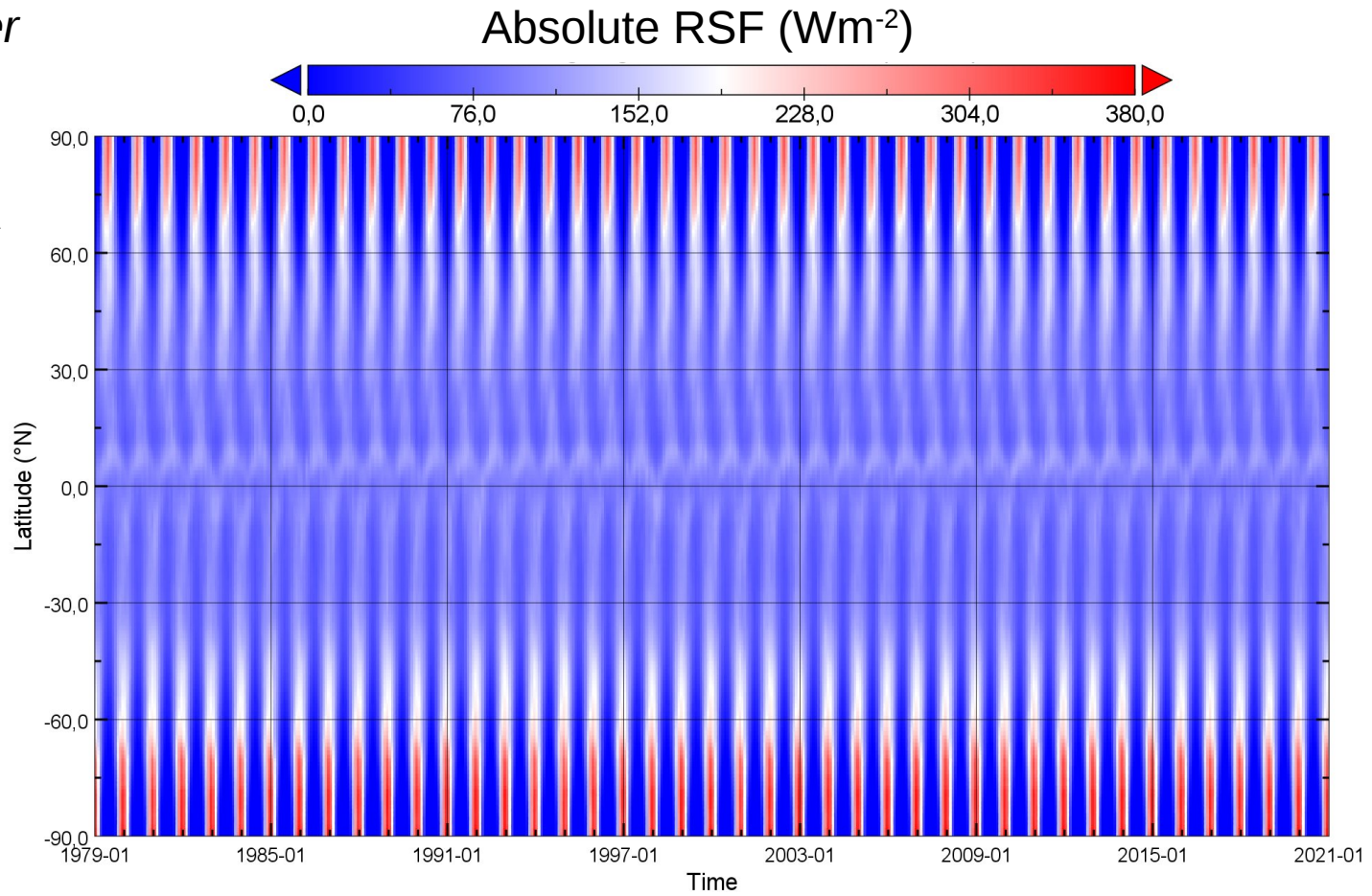
Hovmöller diagram: time vs zonal averages



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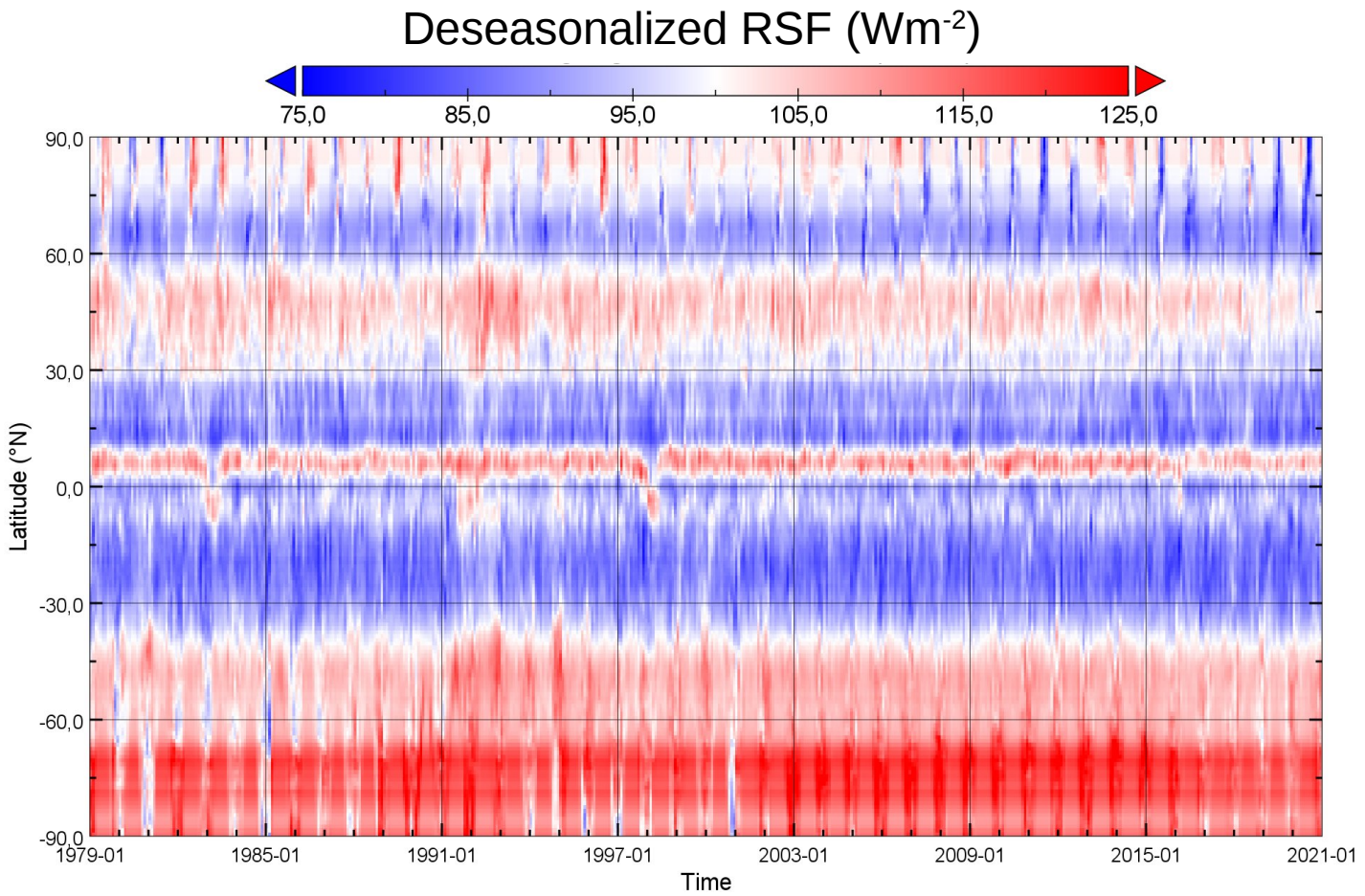

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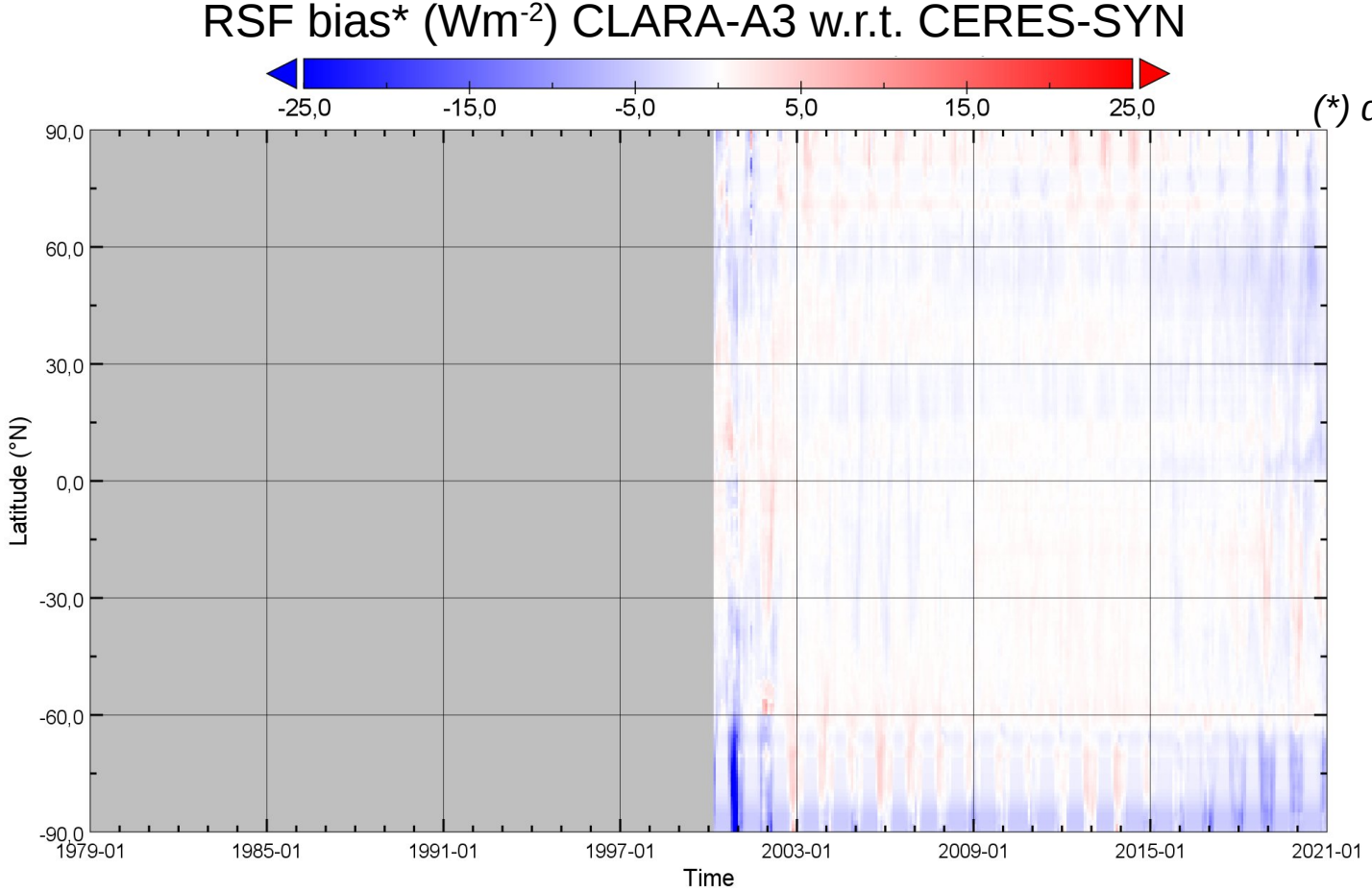

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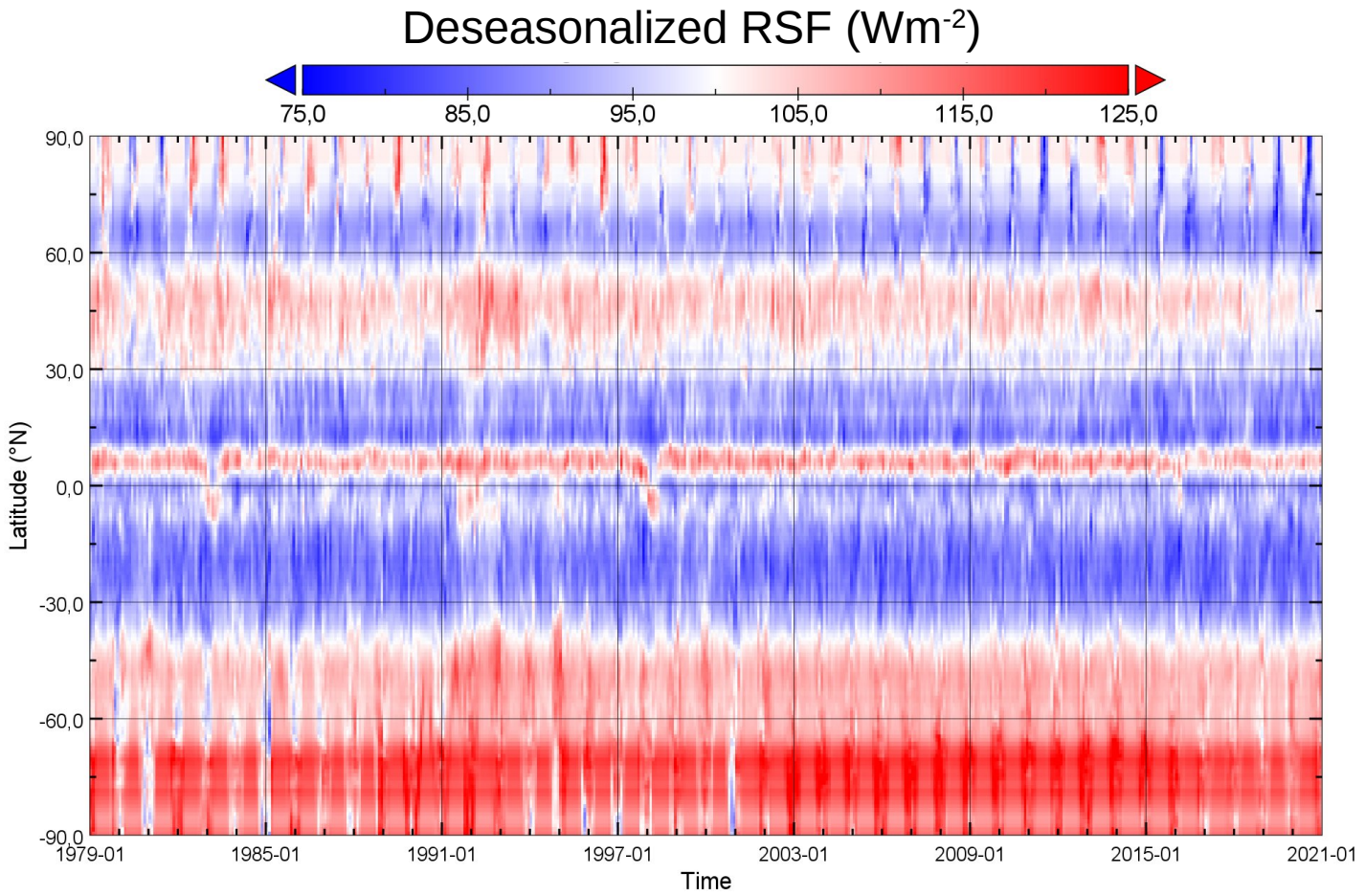

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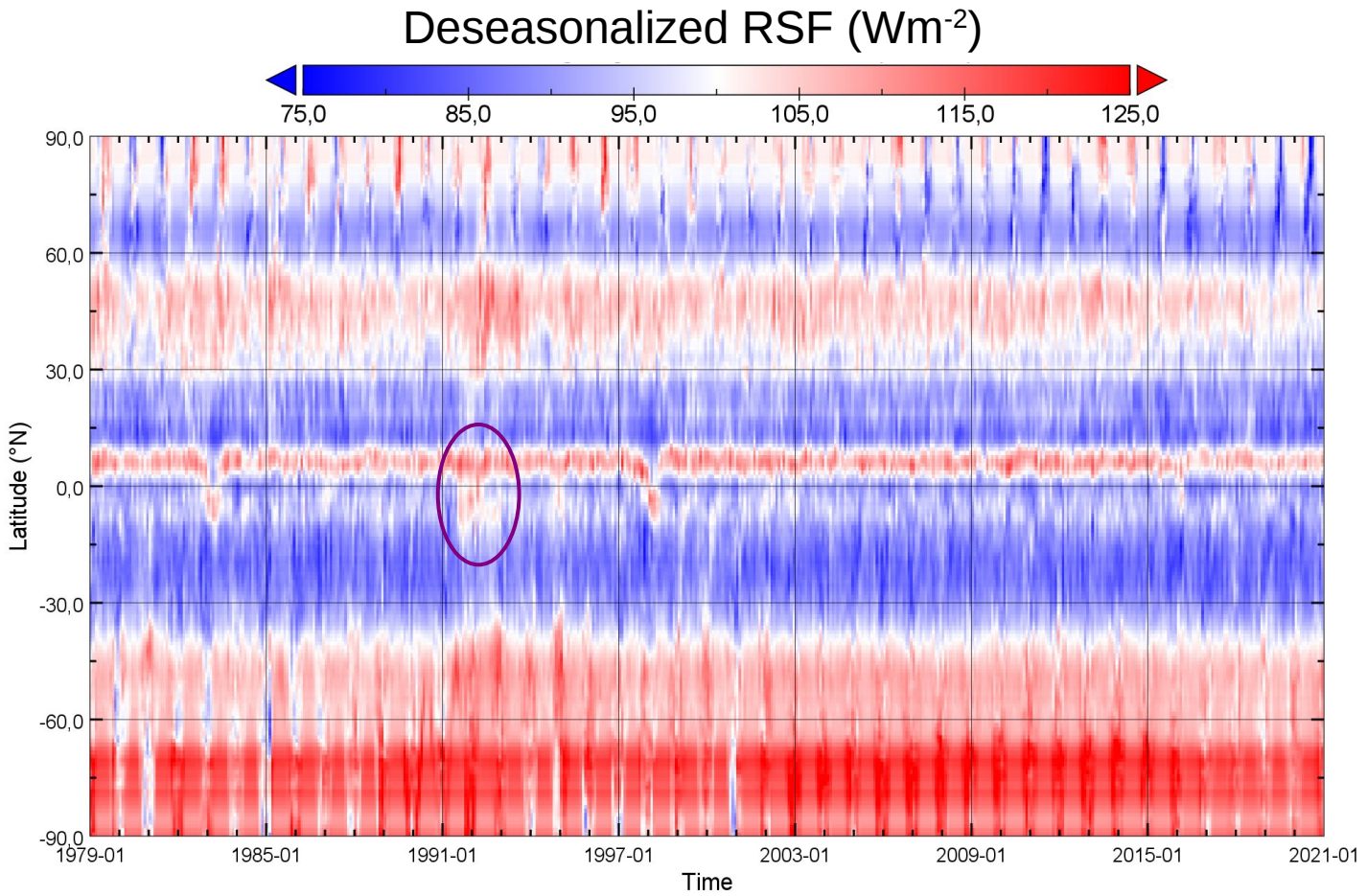
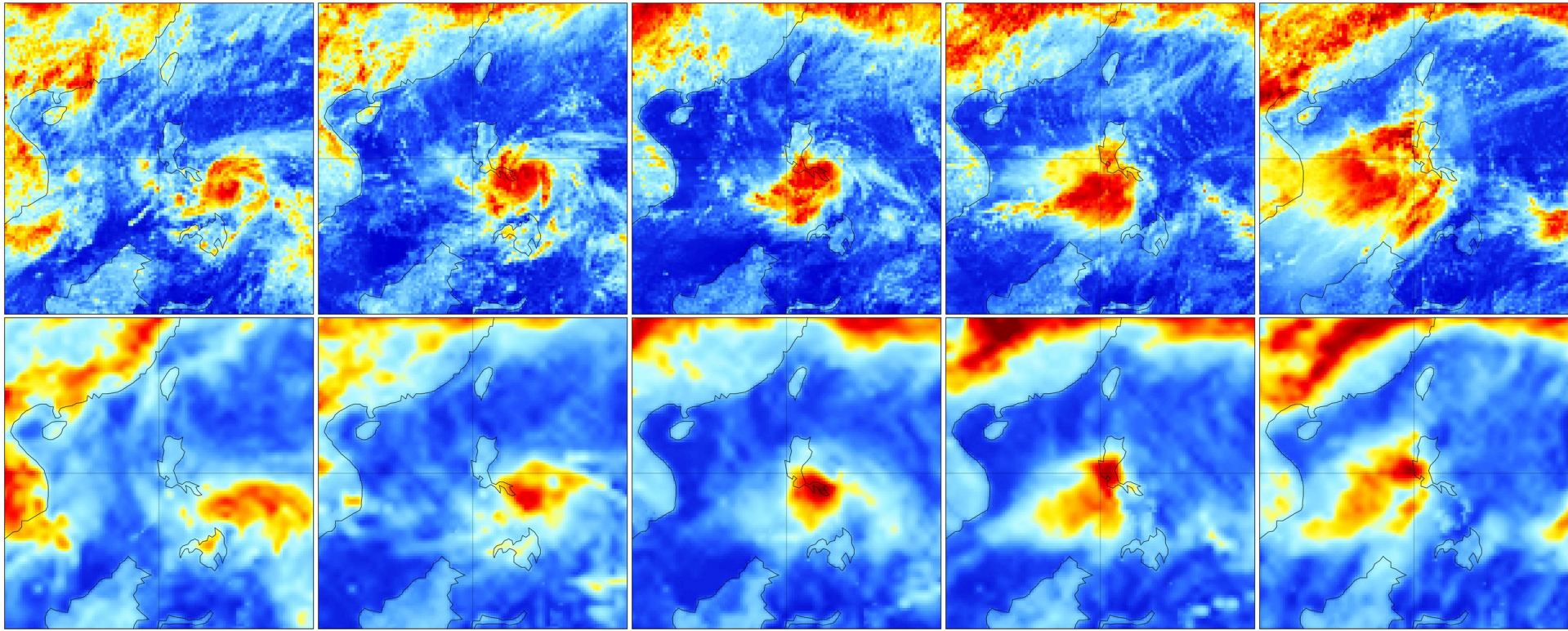


3. Some spatiotemporal insights

Typhoon Yunya + Pinatubo eruption: Daily mean **RSF** (W/m²) from CLARA-A3 (top) and ERA5 (bottom)

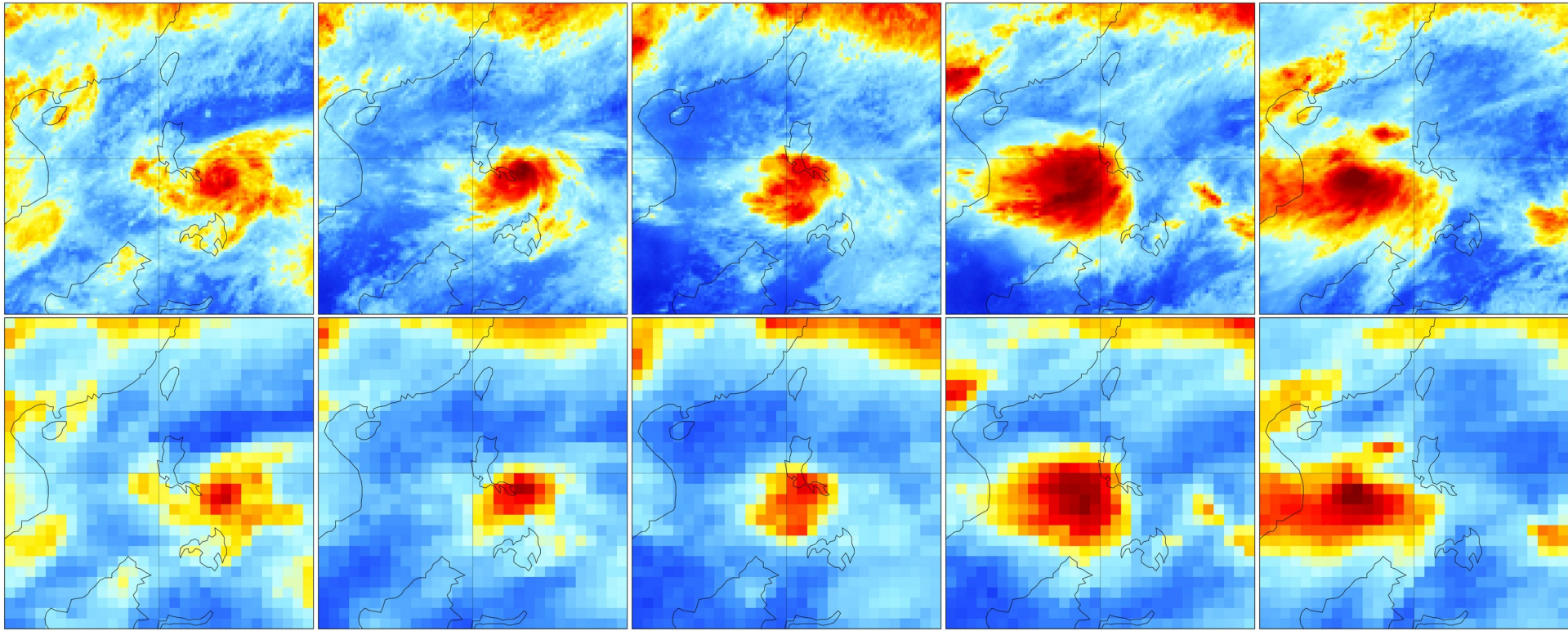


12-06-1991 **13**-06-1991 **14**-06-1991 **15**-06-1991 **16**-06-1991

30,0 90,0 150,0 210,0 270,0 330,0

3. Some spatiotemporal insights

Typhoon Yunya + Pinatubo eruption: Daily mean **OLR** (W/m²) from CLARA-A3 (top) and HIRS* (bottom)



12-06-1991 **13**-06-1991 **14**-06-1991 **15**-06-1991 **16**-06-1991

(*) NOAA HIRS OLR v01r02

100,0 140,0 180,0 220,0 260,0 300,0

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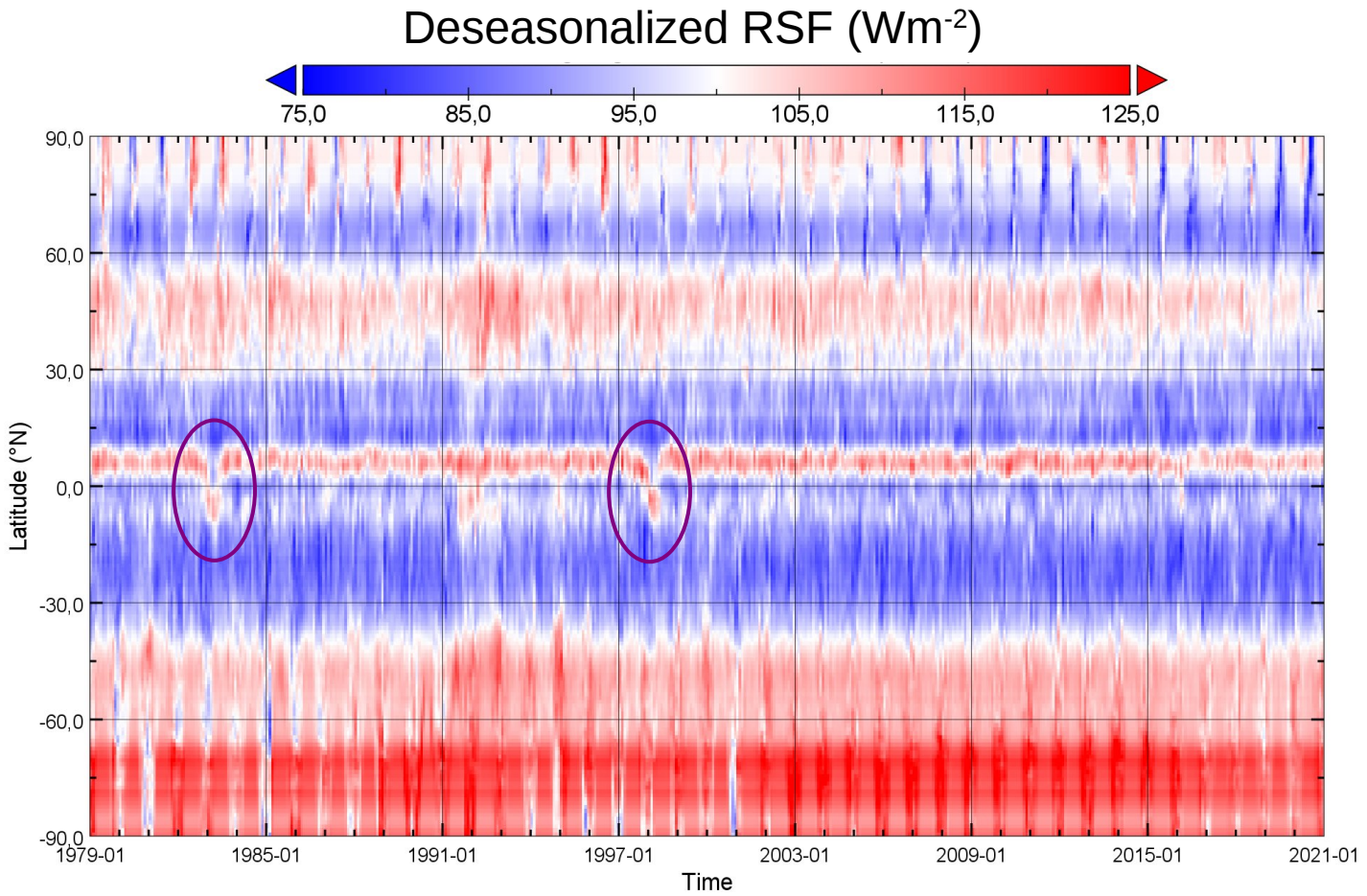
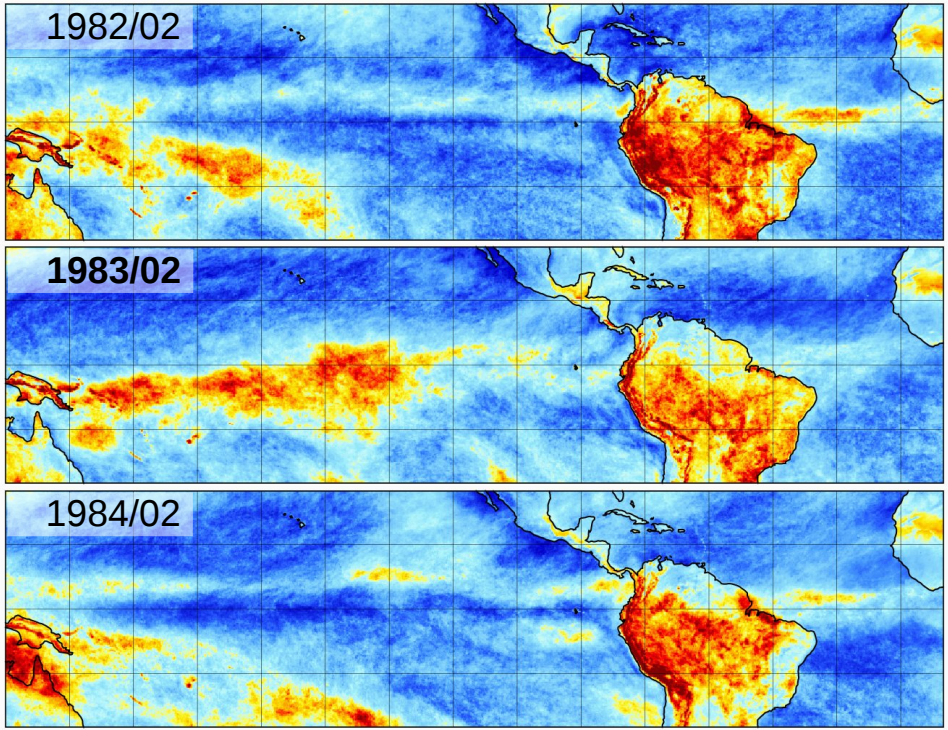


3. Some spatiotemporal insights

"For the 1983 and 1998 El Niño's, warm equatorial SSTs (>27 °C) persisted from November to June, and these warm SSTs replaced the climatic cold tongue. Accompanying the disappearance of the cold tongue during March-April, the northern ITCZ and southern ITCZ migrated to each other." (Chen et al., 2021*).

(*) Chen, Y., Yan, L., Li, G., Xu, J., Long, J., & Zheng, S. (2021). Contrasting Impacts of Three Extreme El Niños on Double ITCZs over the Eastern Pacific Ocean. Atmosphere, 12(4), 424.



Monthly mean RSF (W/m²) from CLARA-A3

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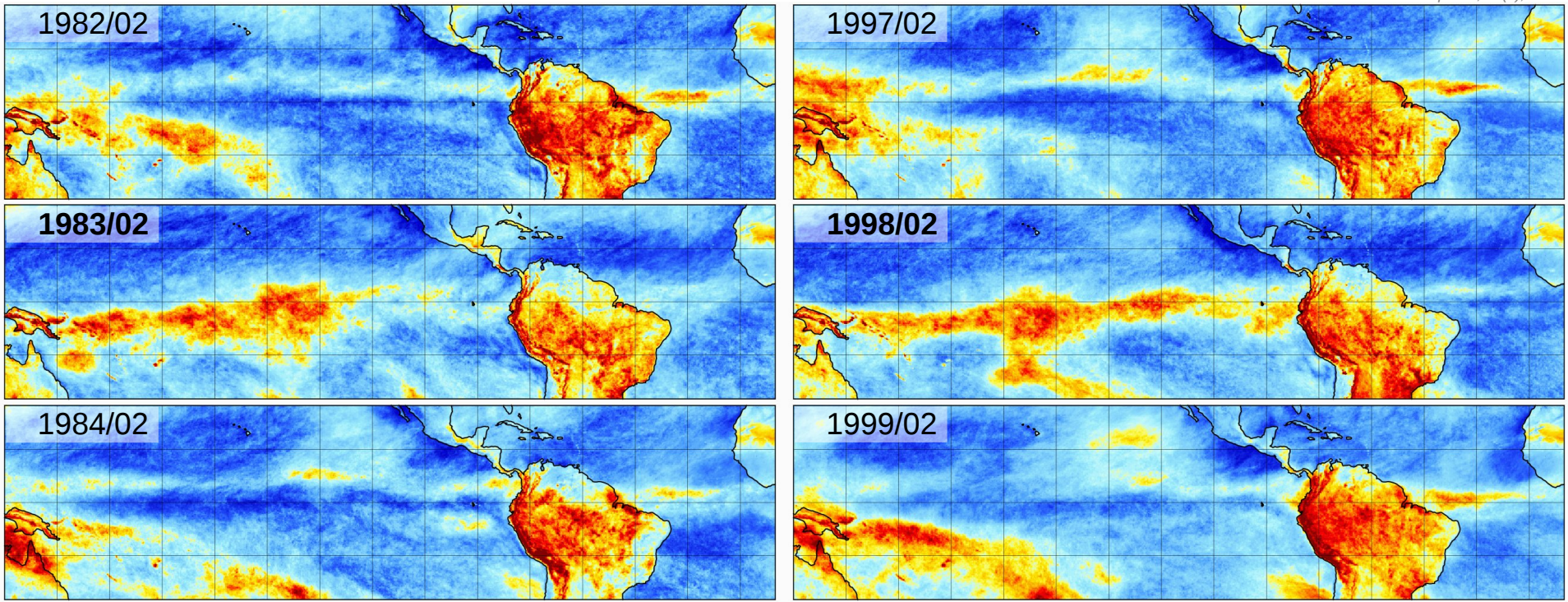

Monthly mean RSF (W/m²) from CLARA-A3

40,0 72,0 104,0 136,0 168,0 200,0

4. Trend analysis

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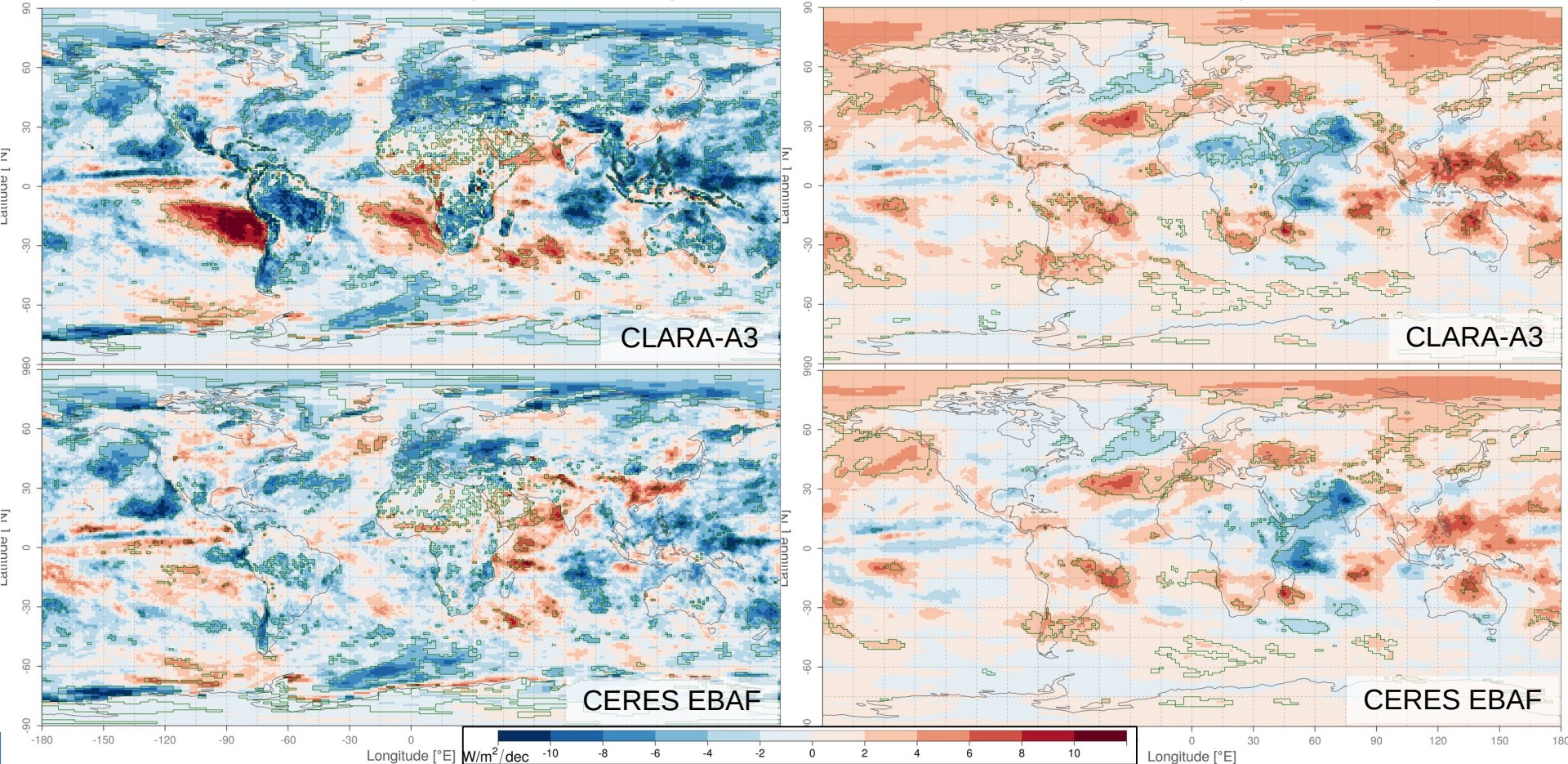
RSF trend 2000-2020 (W/m²/decade)

OLR trend 2000-2020 (W/m²/decade)



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RSF trend 2000-2020 (W/m²/decade)

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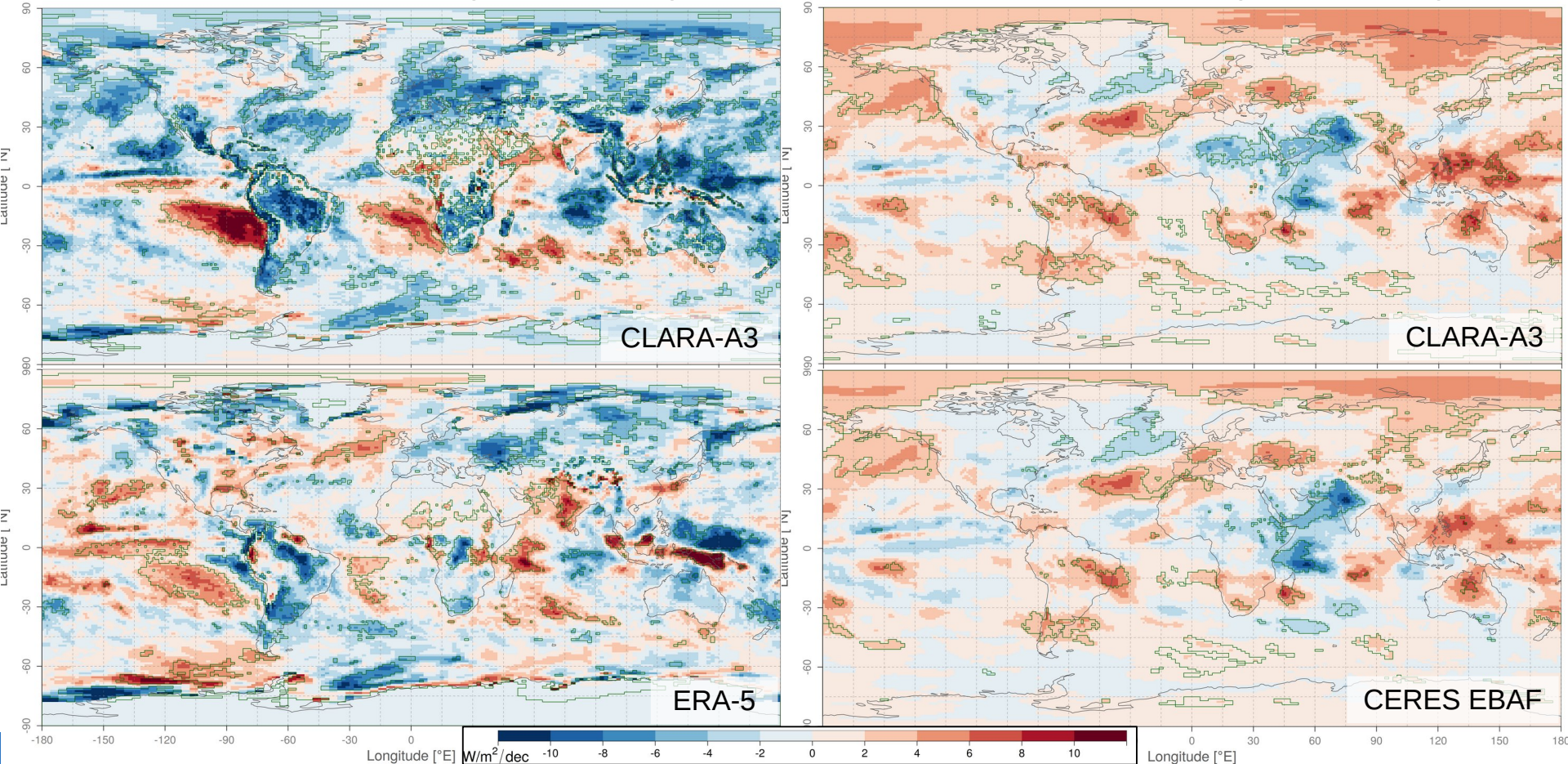

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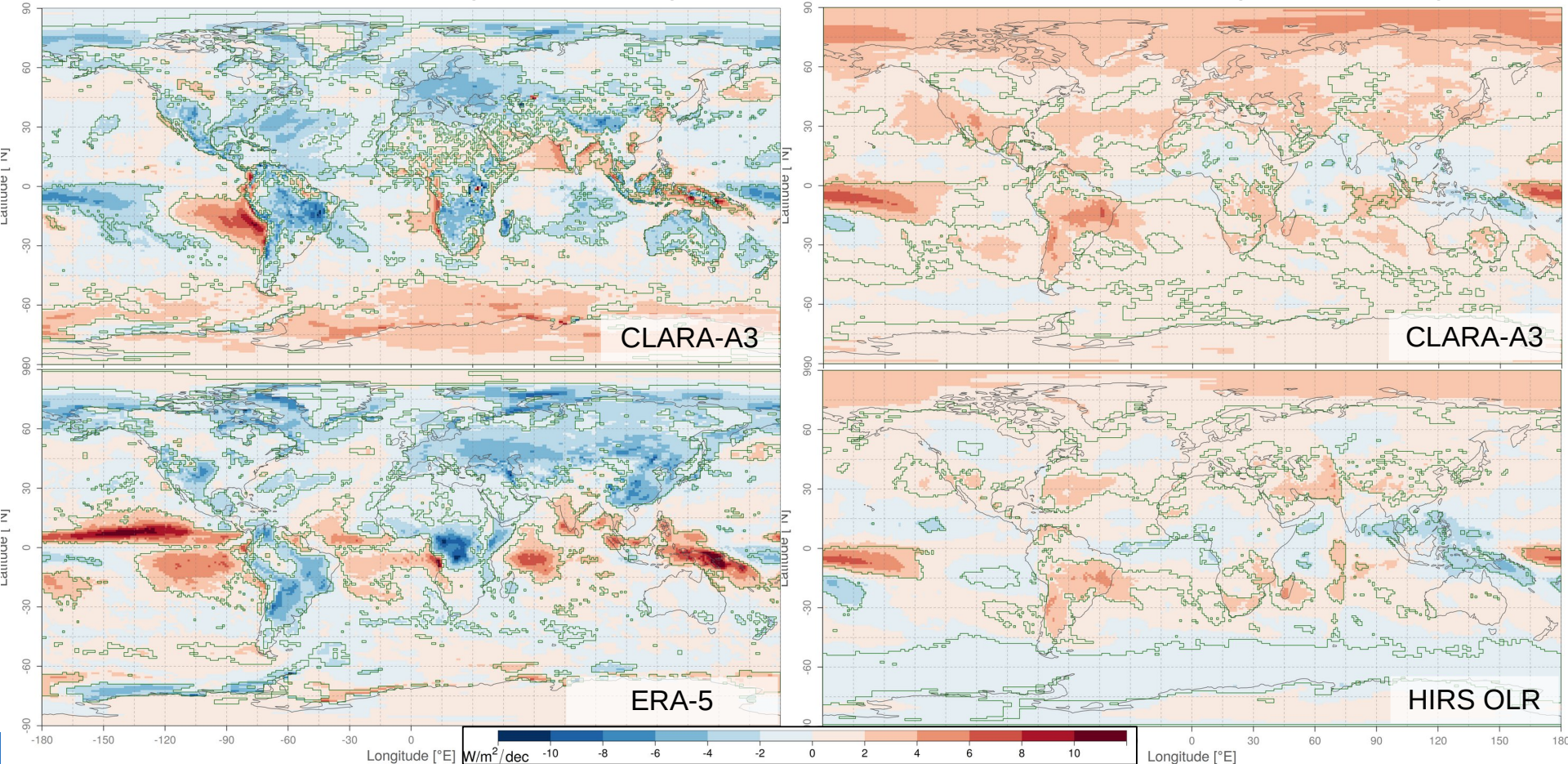

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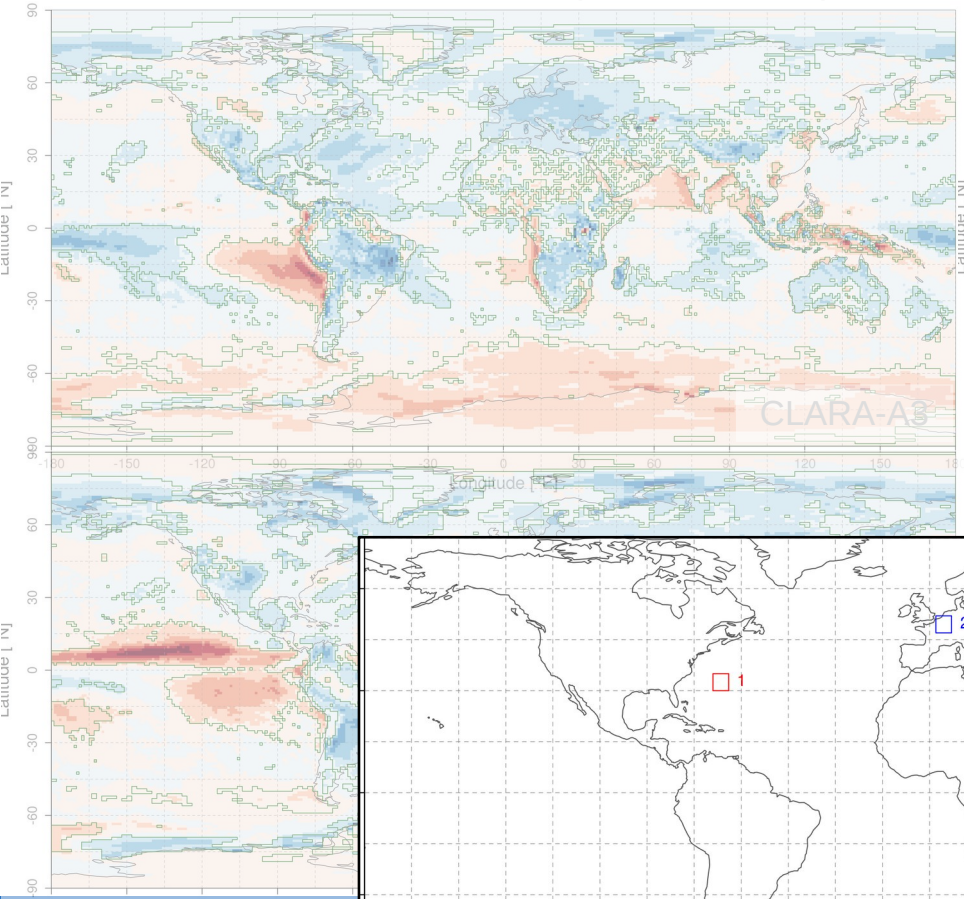
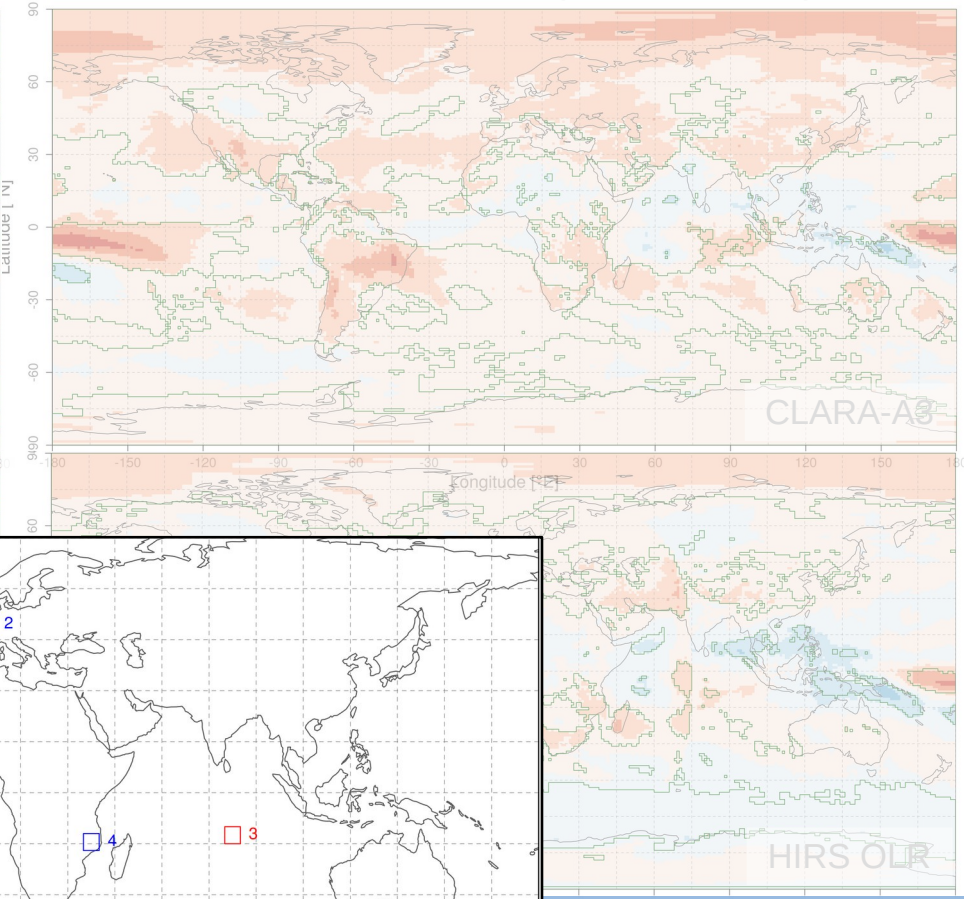
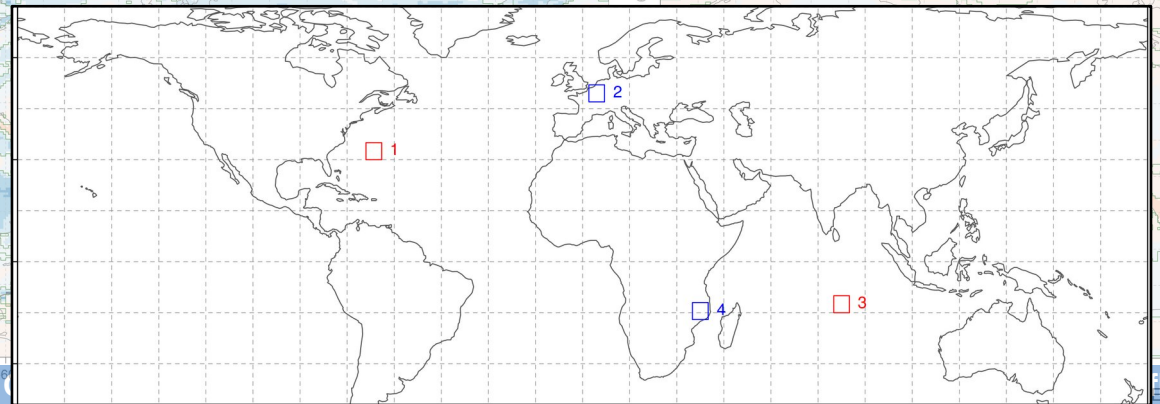
RSF trend 1979-2020 (W/m²/decade)



OLR trend 1979-2020 (W/m²/decade)





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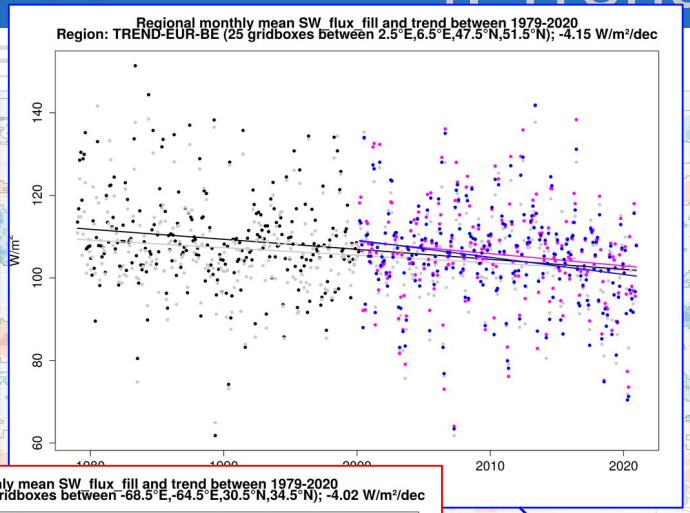

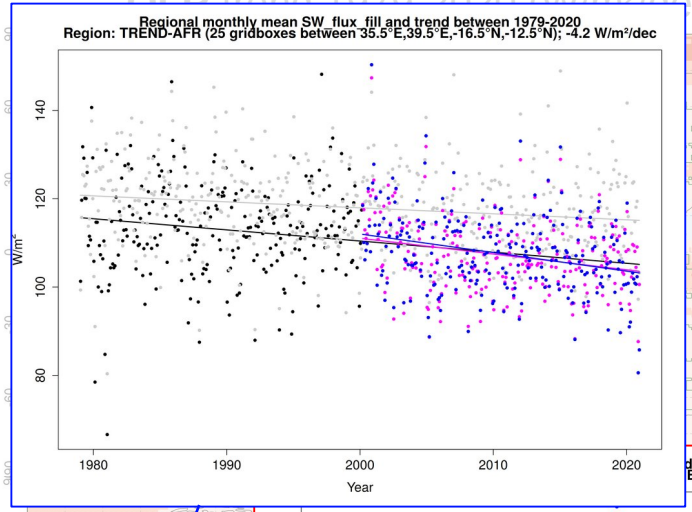

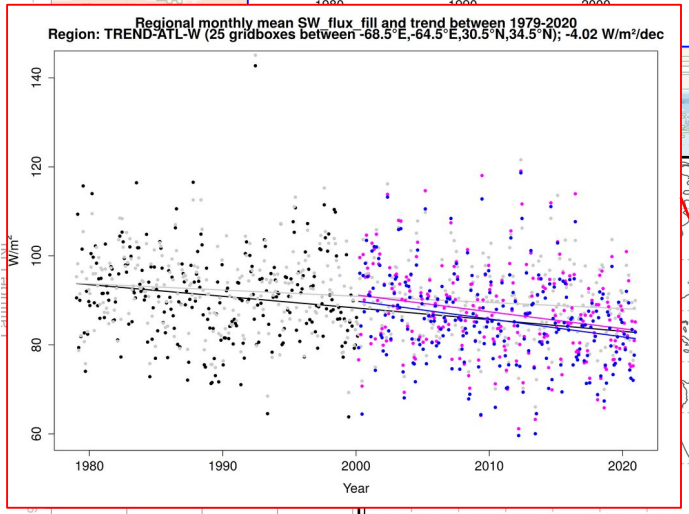

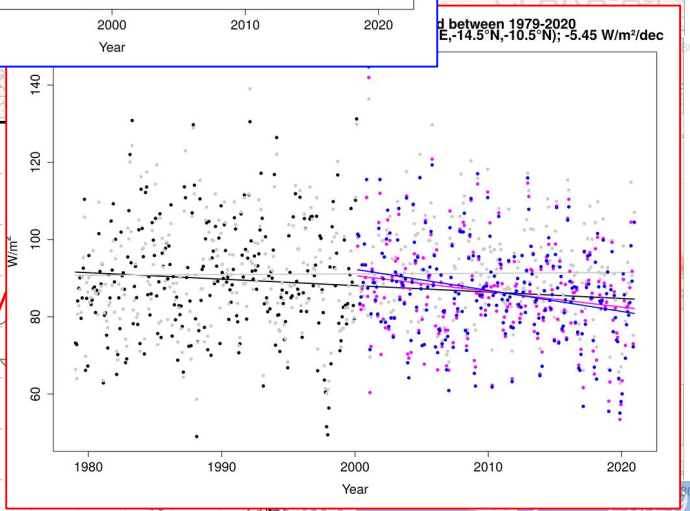

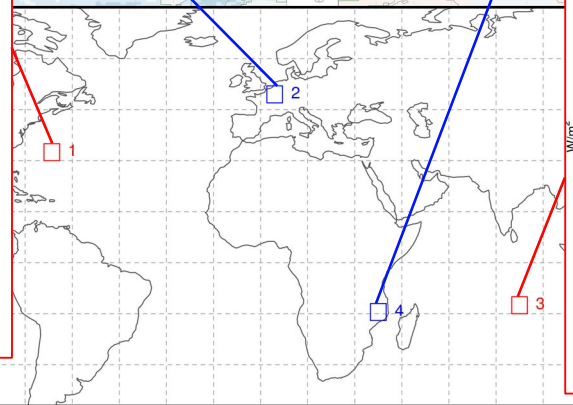

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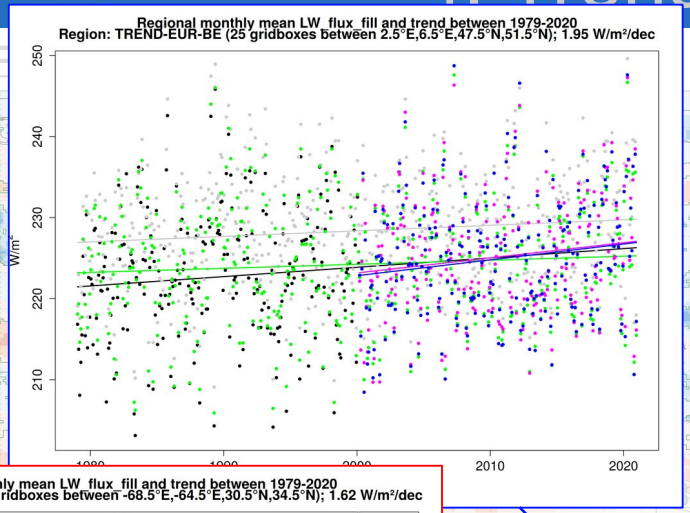

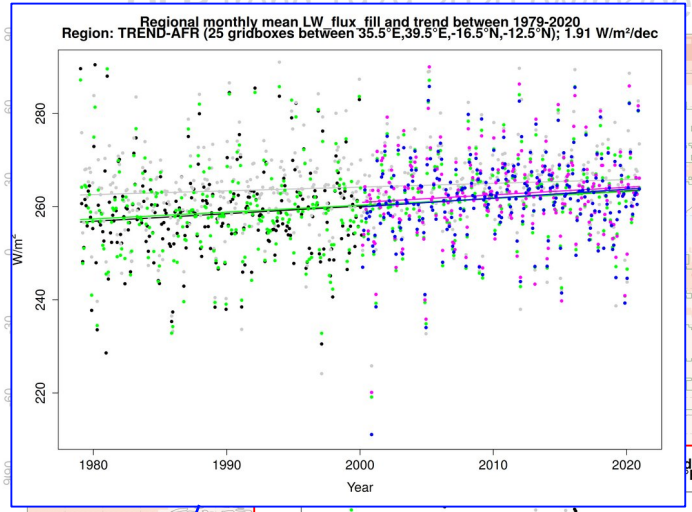

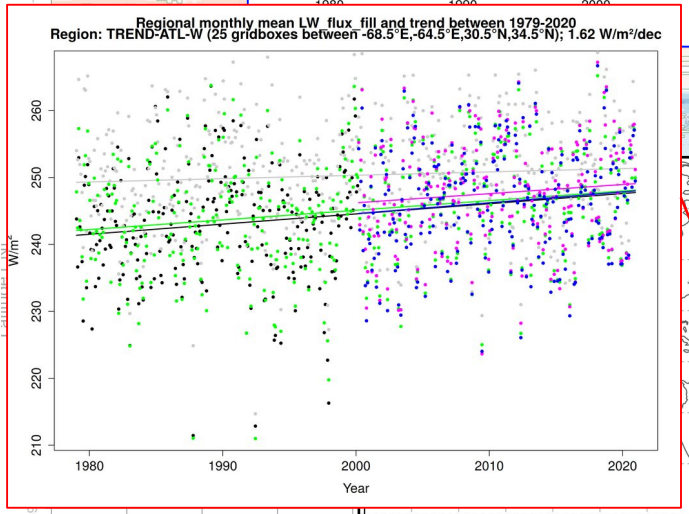

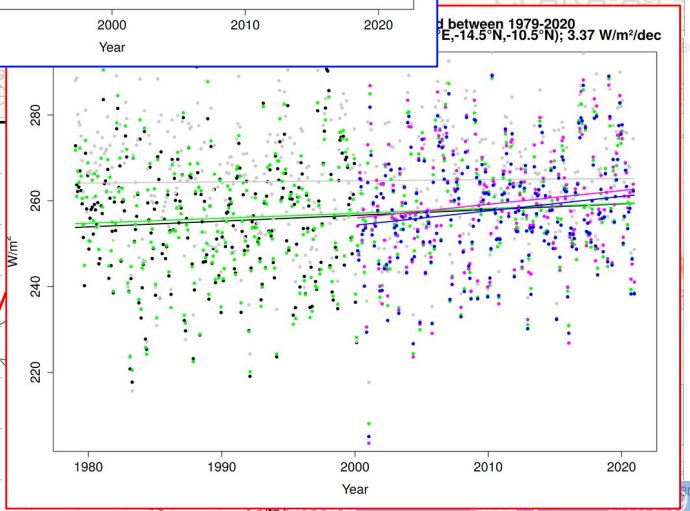

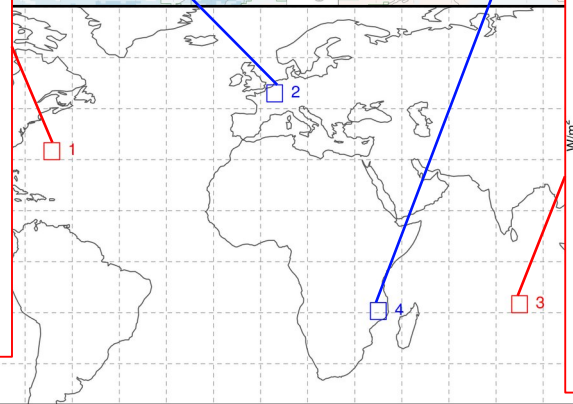

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Thanks for your attention!

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RSS Remote Sensing from Space group