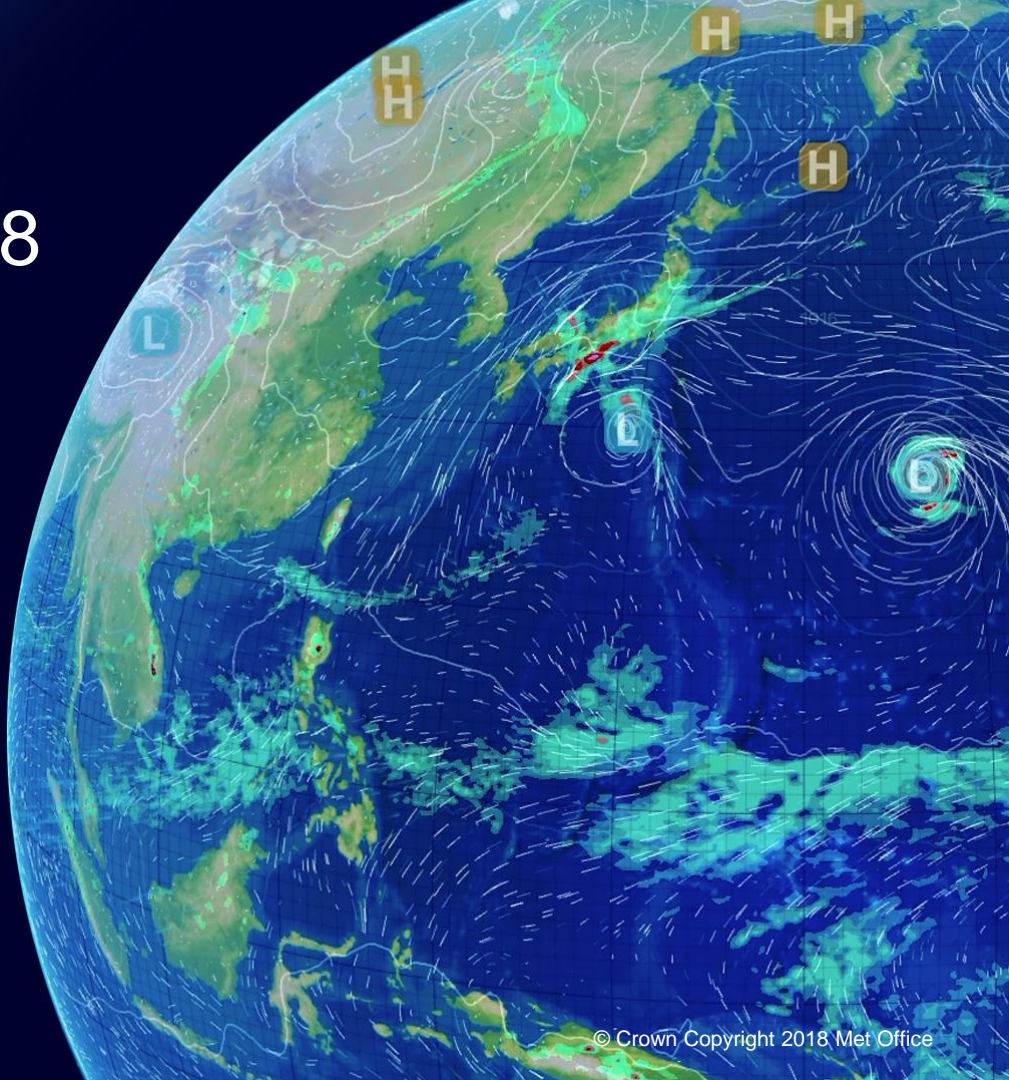


Trends from 1979 to 2018 in the WFDE5 and WFDEI data sets

Graham P. Weedon Jan 2021

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Met Office WFD surface meteorological forcing data sets

Processing: identical for all 0.5° x 0.5° grid boxes: elevation correction, monthly adjustment to CRU observations (and GPCC precip totals). SWdown includes corrections for cloud cover and stratospheric & tropospheric aerosol loading.

<i>Name</i>	<i>Range</i>	<i>Reanalysis</i>	<i>Time step</i>
WATCH Forcing Data	1901-2001	ERA-40	3 hours
WFDEI	1979-2018	ERA-Interim	3 hours
WFDE5*	1979-2018	ERA-5	1 hour
	*vn2 1979-2019		

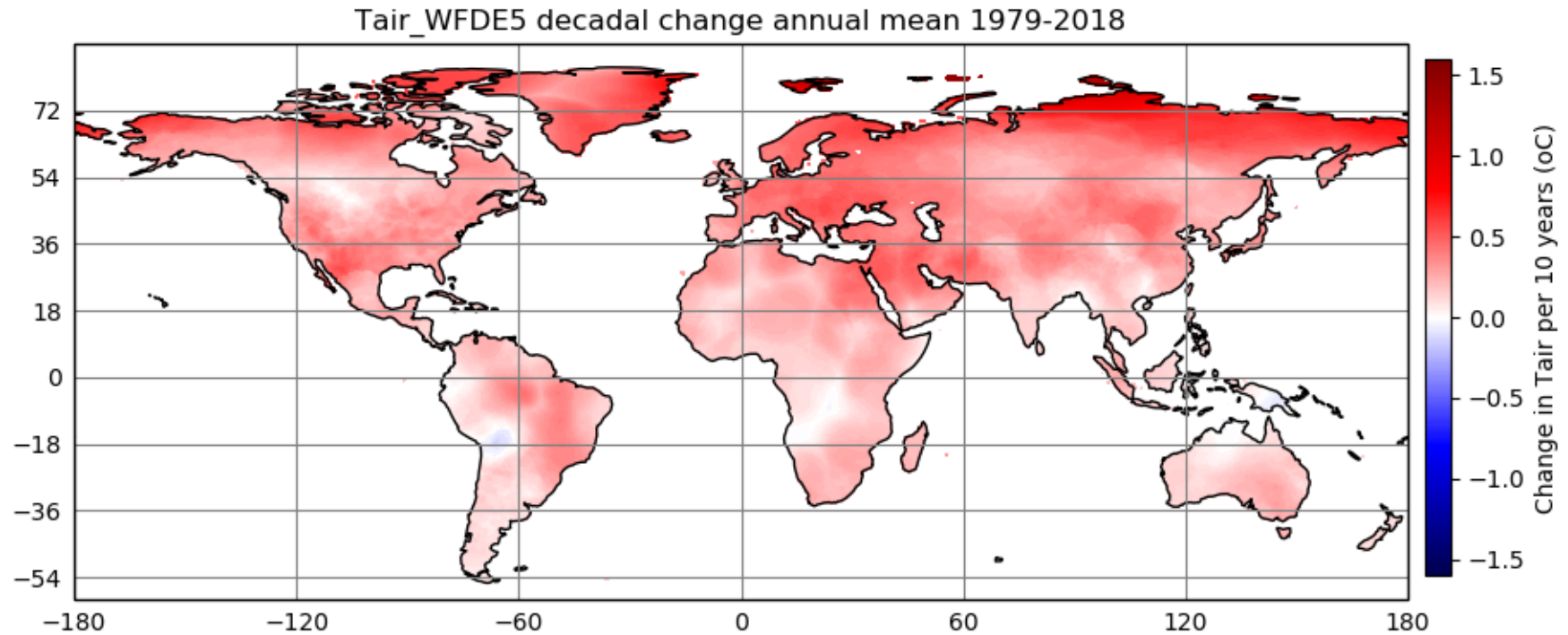
WFD documentation: Weedon et al. 2011 *JHM* doi: 10.1175/2011JHM1369.1

WFDEI documentation: Weedon et al. 2014 *WRR* doi: 10.1002/2014WR015638

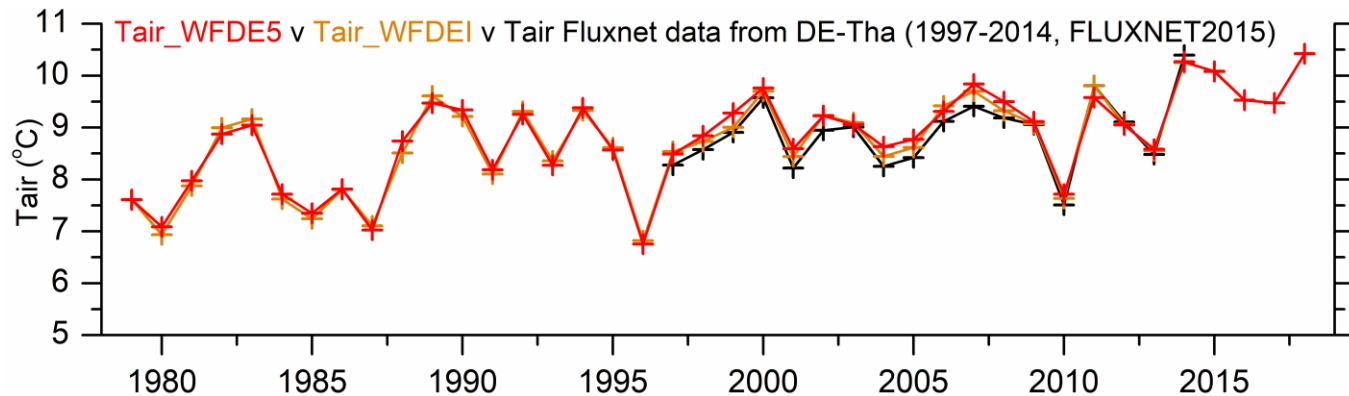
WFDE5 documentation: Cucchi et al. 2020 *Earth Syst. Sci. Data* doi: 10.5194/essd-12-2097-2020

Trends in annual means 1979-2018

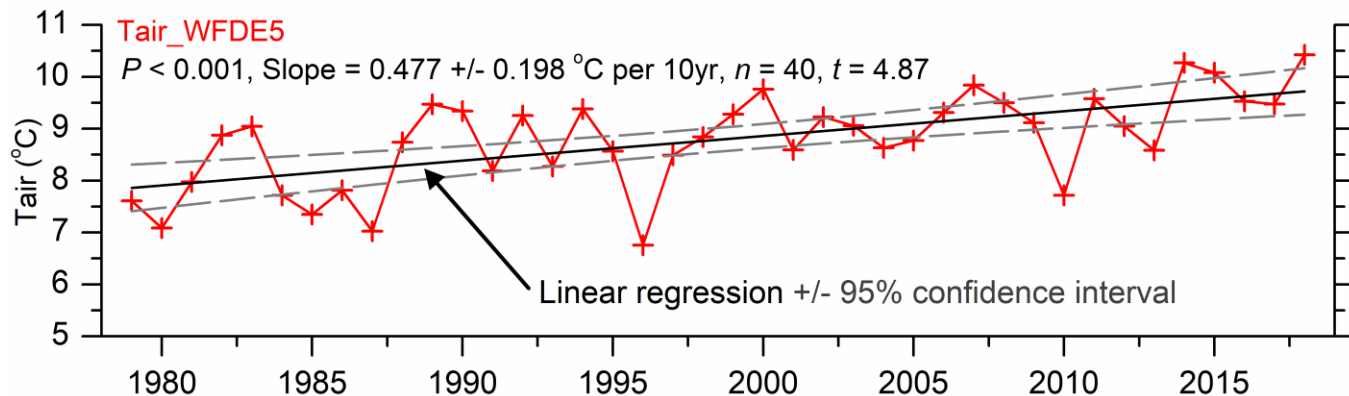
Met Office Average decadal change in annual mean Tair_WFDE5



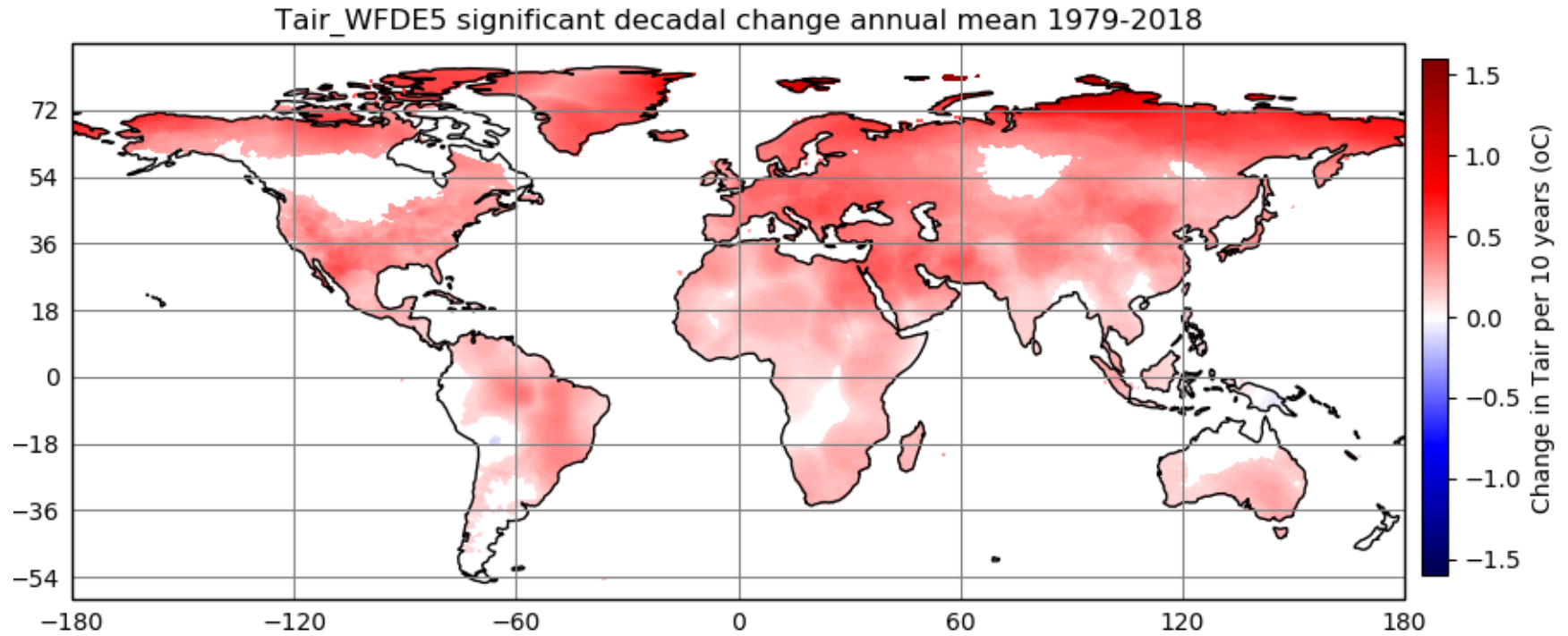
Met Office Tair_WFDE5 annual mean at grid box containing the Tharandt Fluxnet site



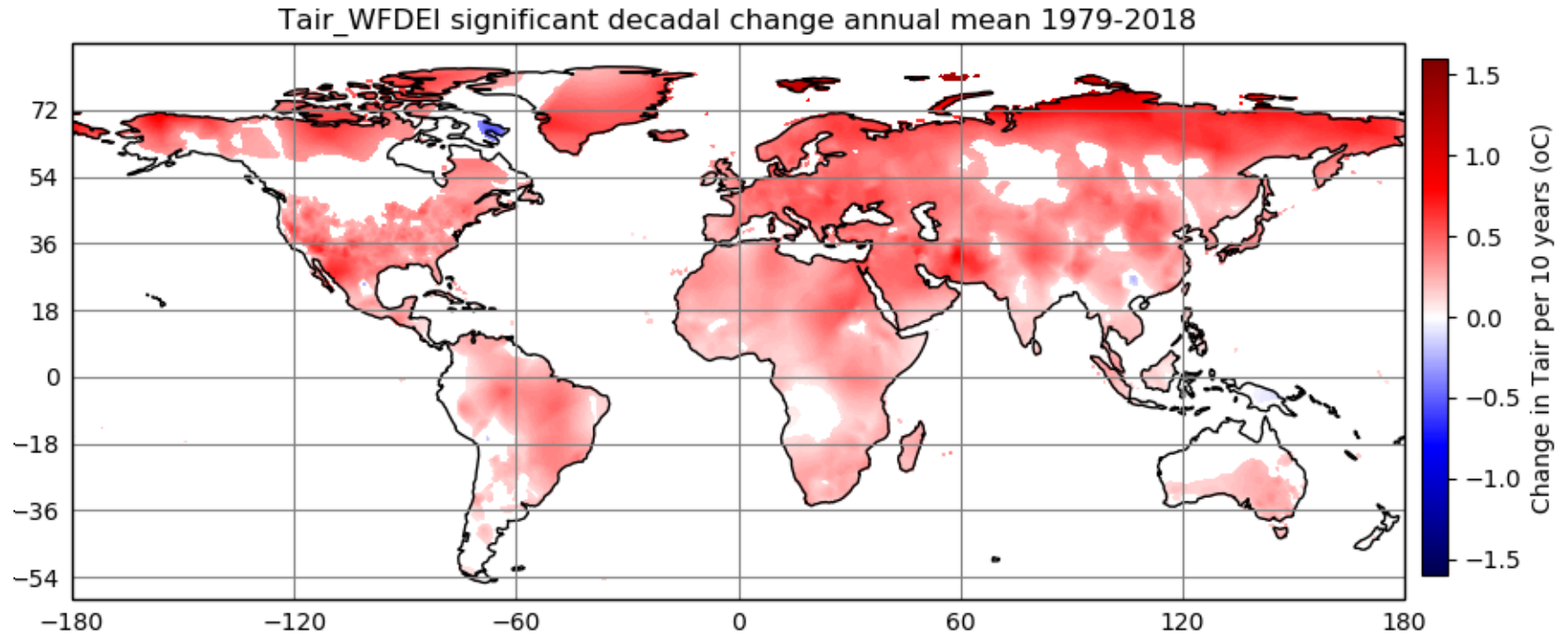
Tharandt, Germany:
50.96 °N, 13.57 °E

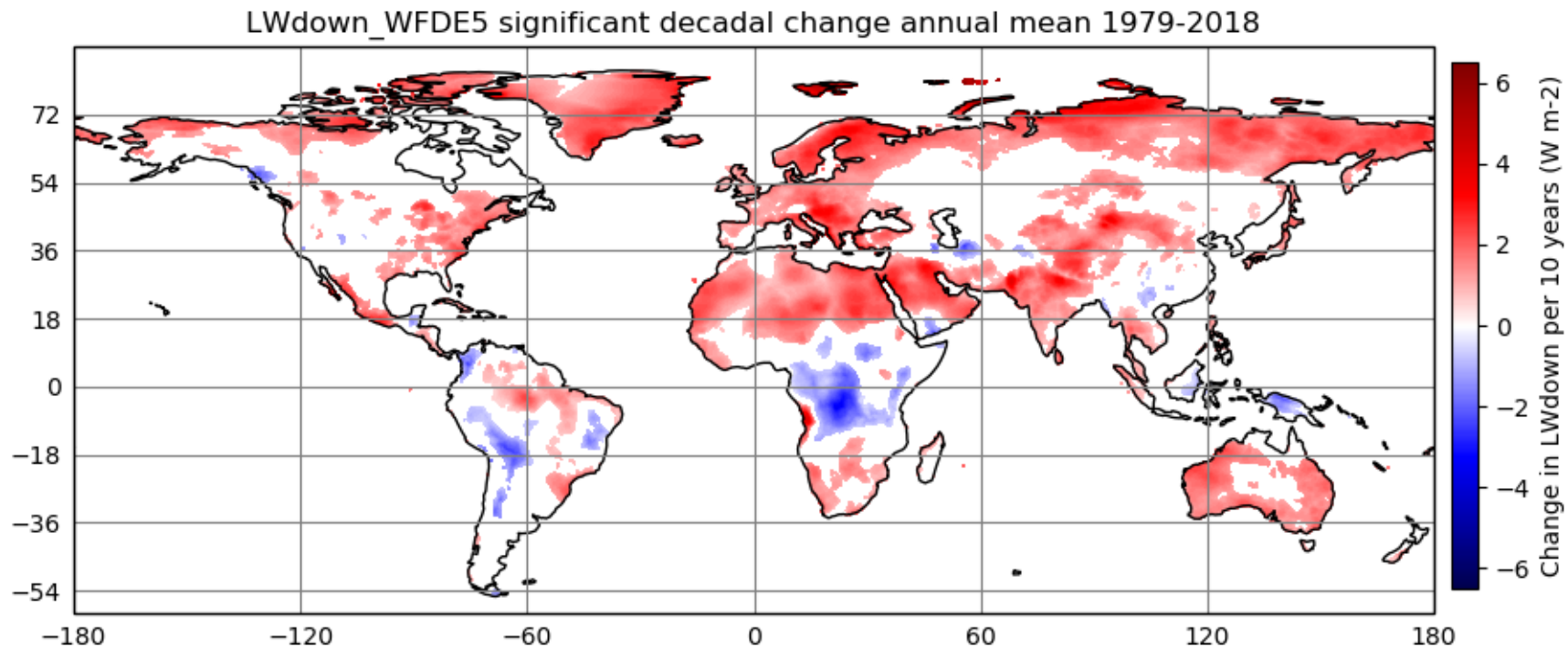


Met Office Average sig. ($P < 0.05$) decadal change in annual mean Tair_WFDE5



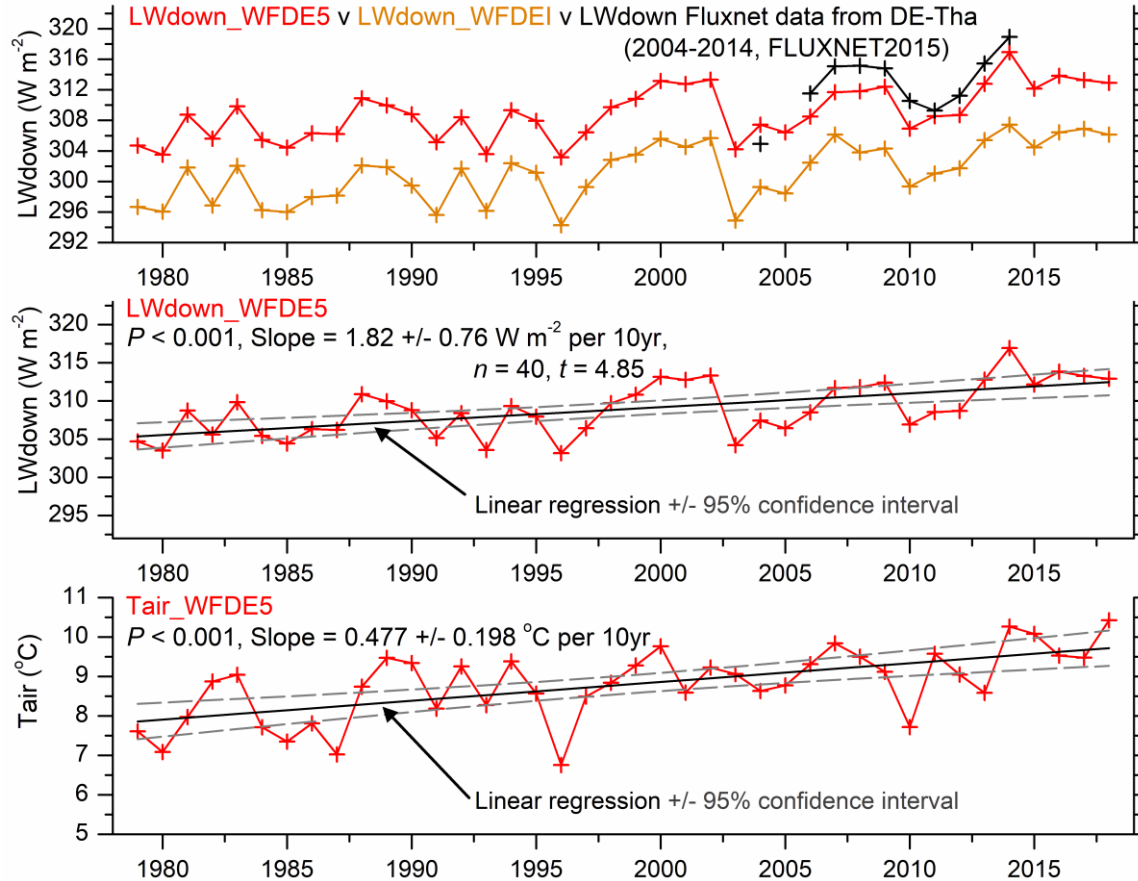
Met Office Average sig. ($P < 0.05$) decadal change in annual mean **Tair_WFDEI**





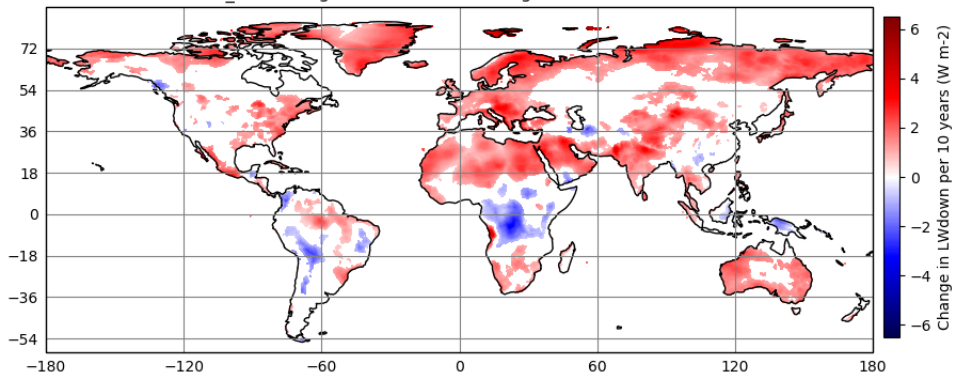
Met Office LWdown_WFDE5 annual mean at grid box containing Tharandt Fluxnet site

Tharandt, Germany:
50.96 °N, 13.57 °E

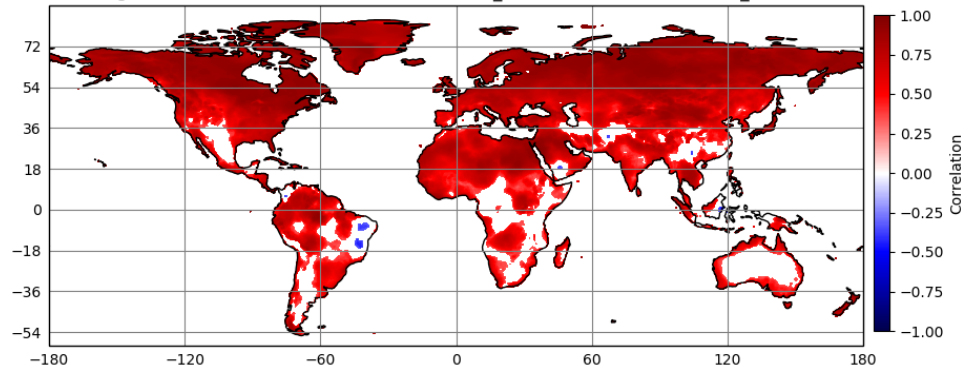


Average significant decadal change

LWdown_WFDE5 significant decadal change annual mean 1979-2018

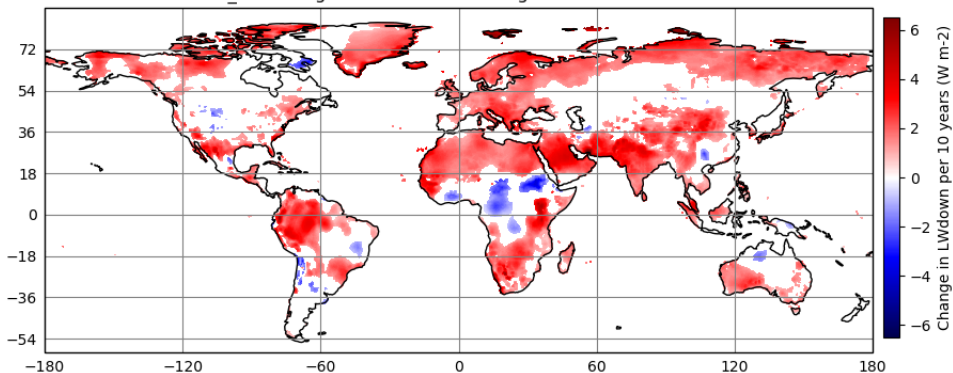
Significant correlation v
annual mean Tair_WFDE5

Significant correlation annual mean LWdown_WFDE5 v annual mean Tair_WFDE5

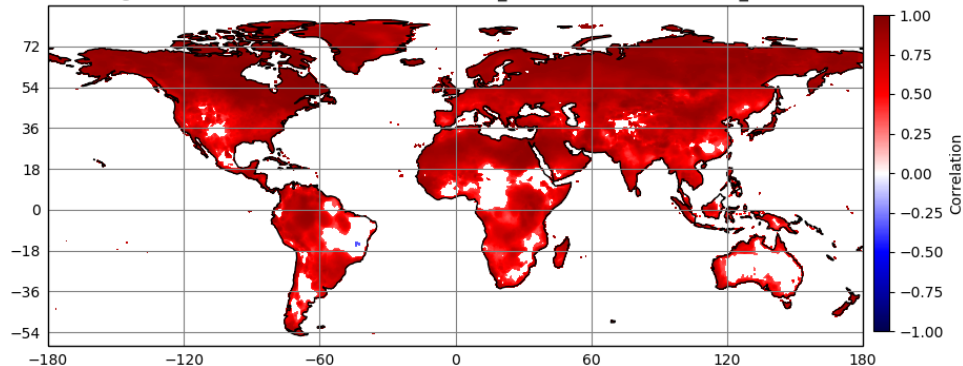


Average significant decadal change

LWdown_WFDEI significant decadal change annual mean 1979-2018

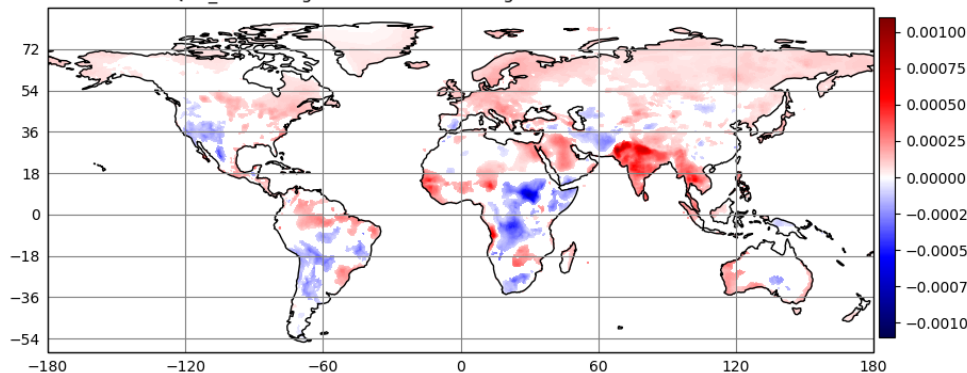
Significant correlation v
annual mean Tair_WFDEI

Significant correlation annual mean LWdown_WFDEI v annual mean Tair_WFDEI



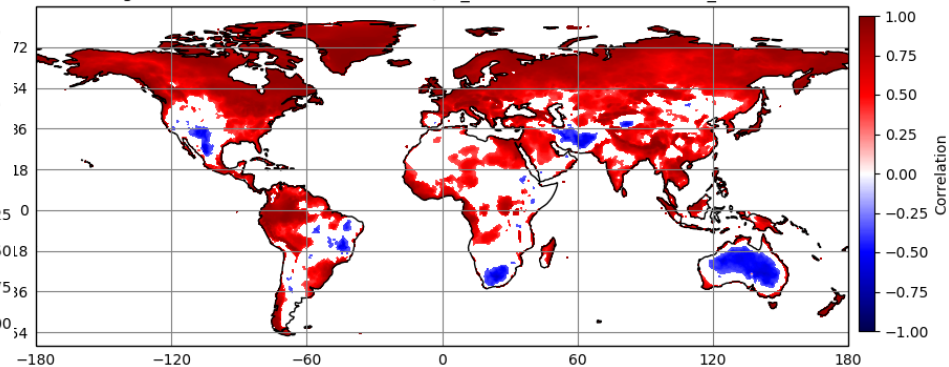
Average significant decadal change

Qair_WFDE5 significant decadal change annual mean 1979-2018



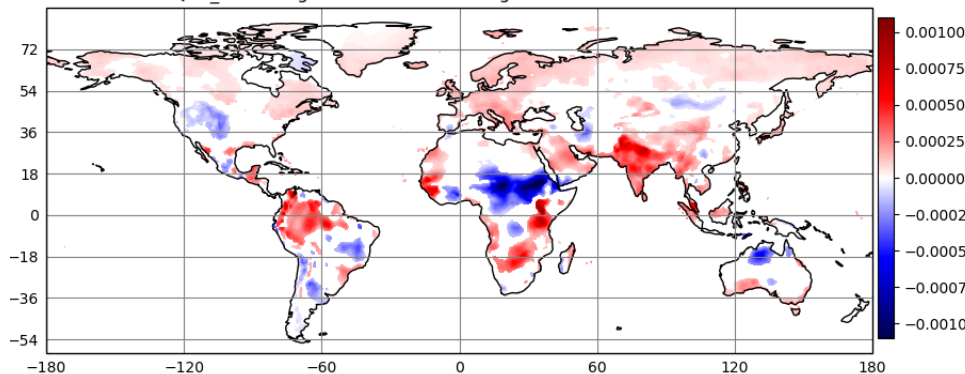
Significant correlation v annual mean Tair_WFDE5

Significant correlation annual mean Qair_WFDE5 v annual mean Tair_WFDE5



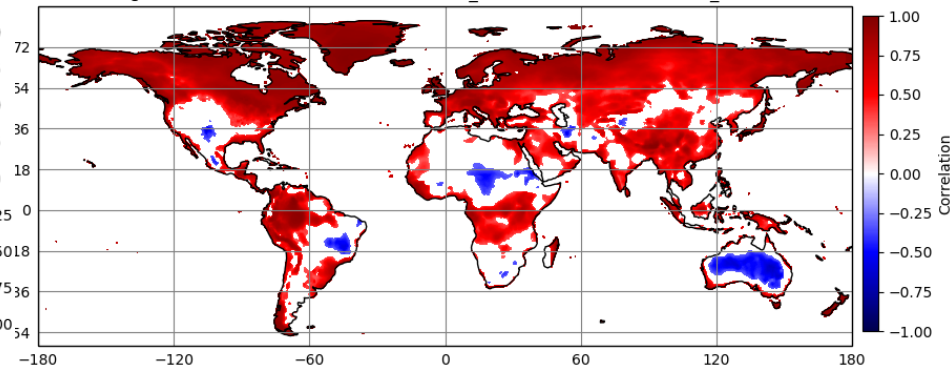
Average significant decadal change

Qair_WFDEI significant decadal change annual mean 1979-2018

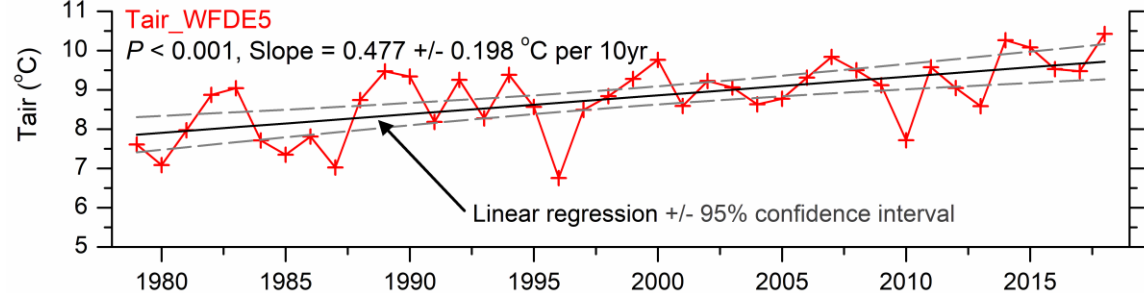
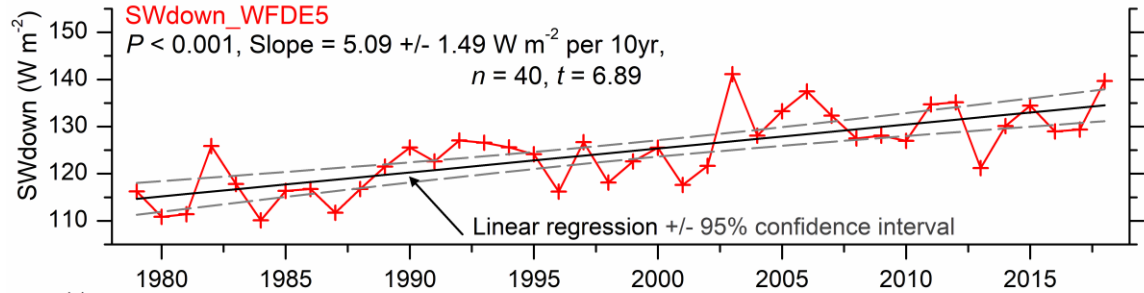
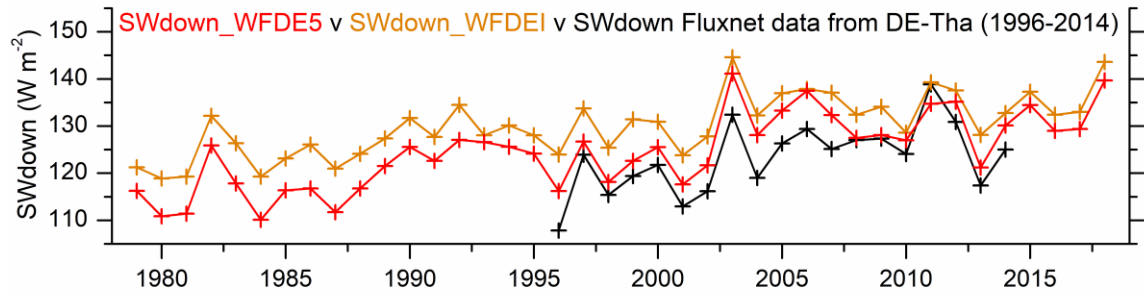


Significant correlation v annual mean Tair_WFDEI

Significant correlation annual mean Qair_WFDEI v annual mean Tair_WFDEI



Met Office SWdown_WFDE5 annual mean at grid box containing Tharandt Fluxnet site



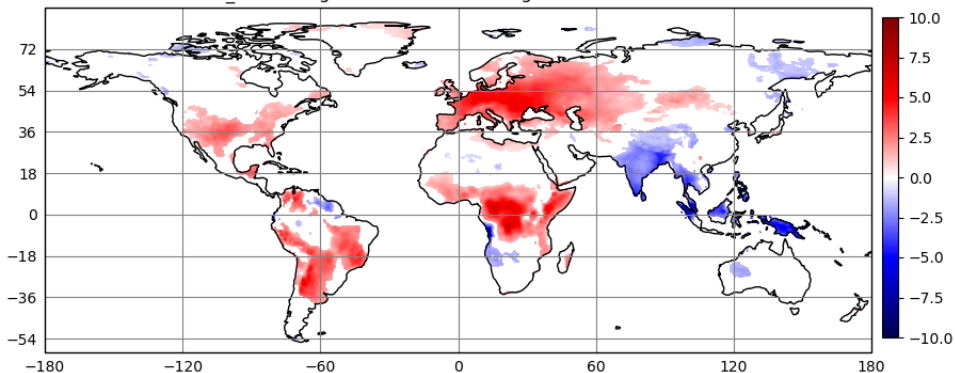
Average SWdown_WFDE5 increase in Europe due to legislation leading to decreased atmospheric pollution (regional brightening)

Spurious correlation

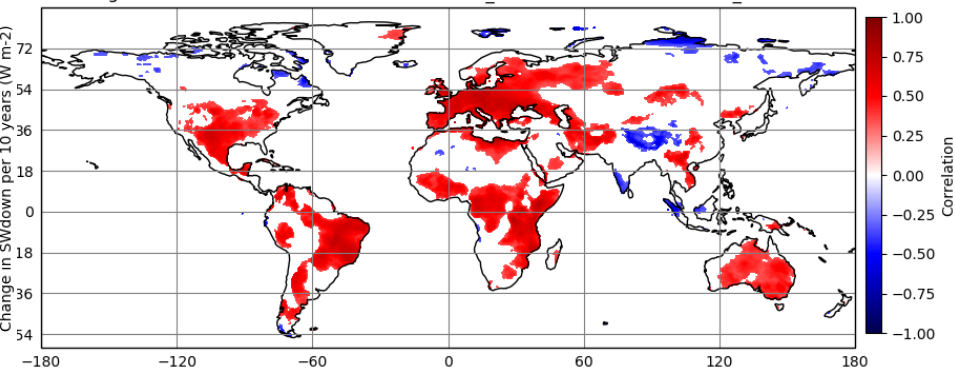
Average Tair_WFDE5 increase due to increased atmospheric CO_2 (global warming)

Average significant decadal change

SWdown_WFDE5 significant decadal change annual mean 1979-2018

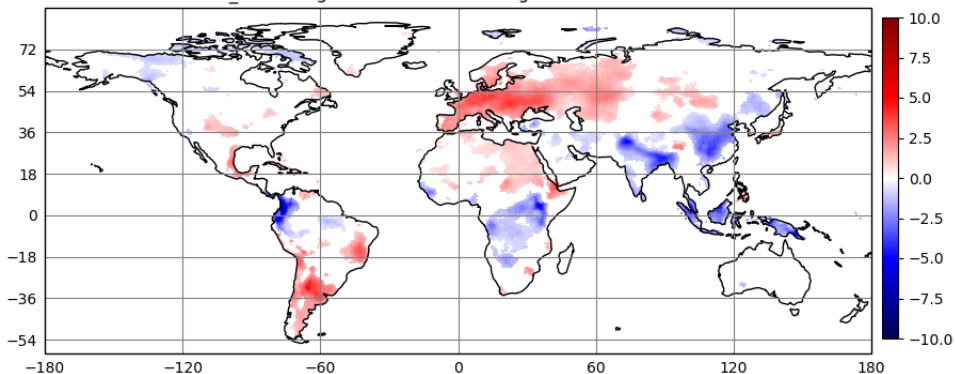
Significant correlation v
annual mean Tair_WFDE5

Significant correlation annual mean SWdown_WFDE5 v annual mean Tair_WFDE5

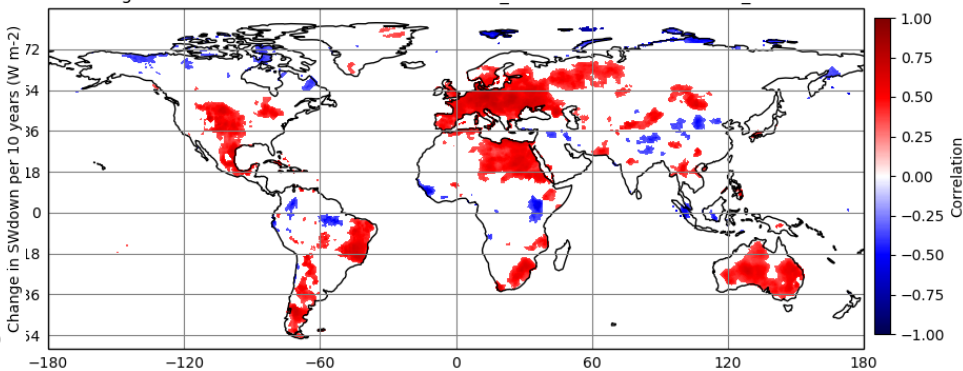


Average significant decadal change

SWdown_WFDEI significant decadal change annual mean 1979-2018

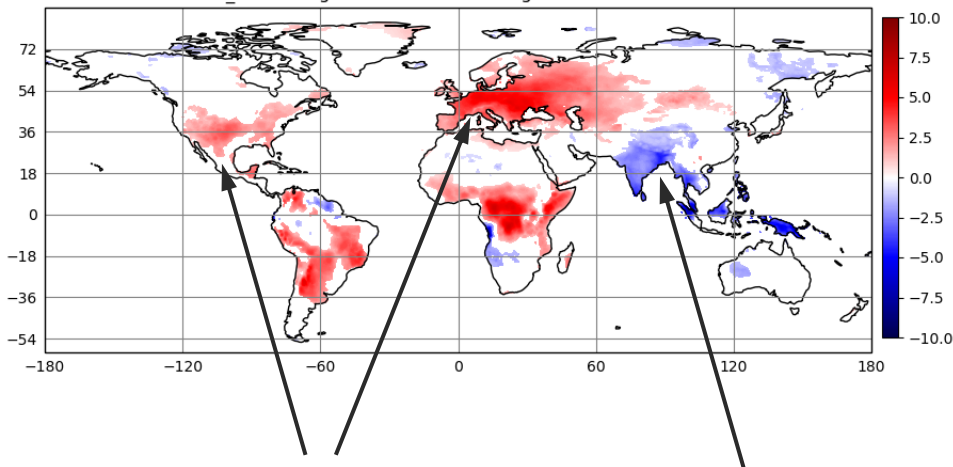
Significant correlation v
annual mean Tair_WFDEI

Significant correlation annual mean SWdown_WFDEI v annual mean Tair_WFDEI



Average significant decadal change

SWdown_WFDE5 significant decadal change annual mean 1979-2018

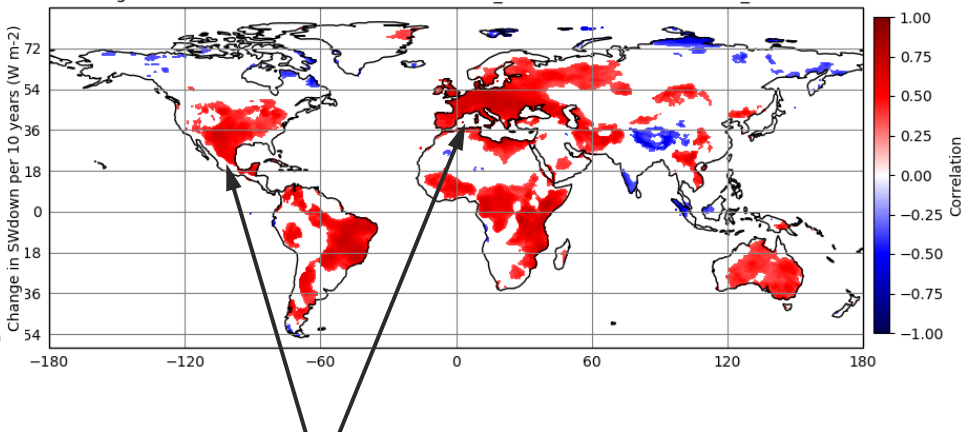


Regional brightening due to reduced aerosol loading

Regional dimming due to increased aerosol loading

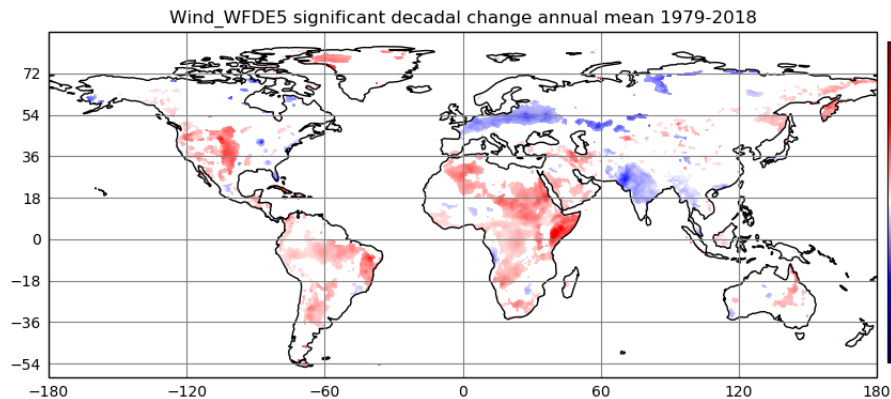
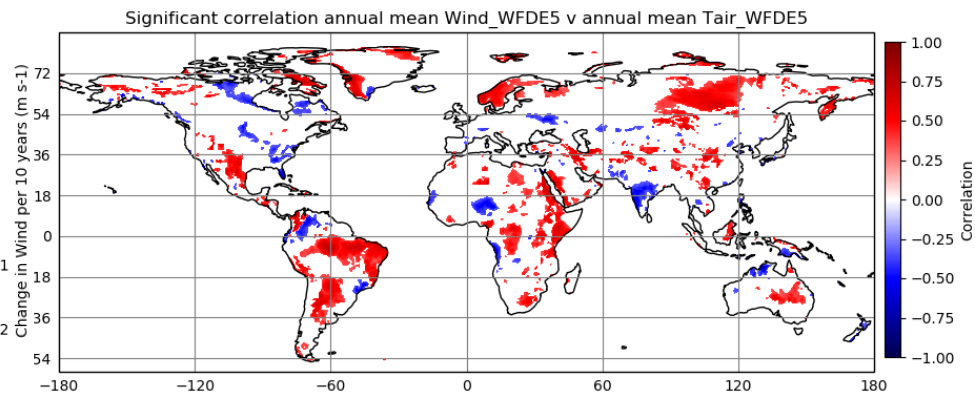
Significant correlation v annual mean Tair_WFDE5

Significant correlation annual mean SWdown_WFDE5 v annual mean Tair_WFDE5



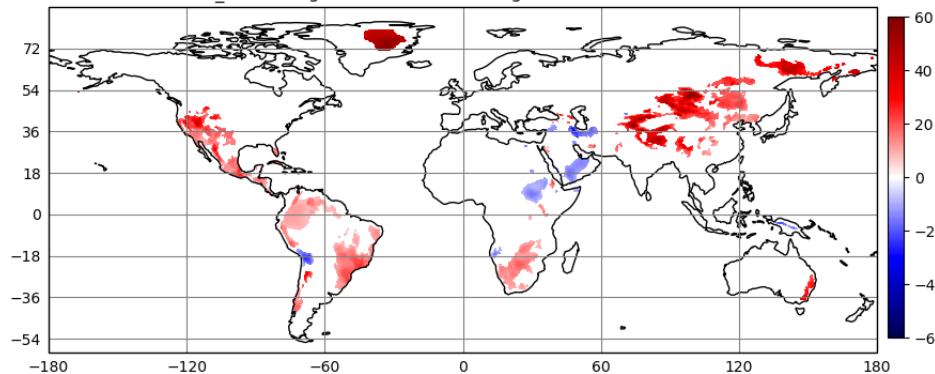
Spurious correlation of mean annual SWdown_WFDE5 with mean annual Tair_WFDE5

Average significant decadal change

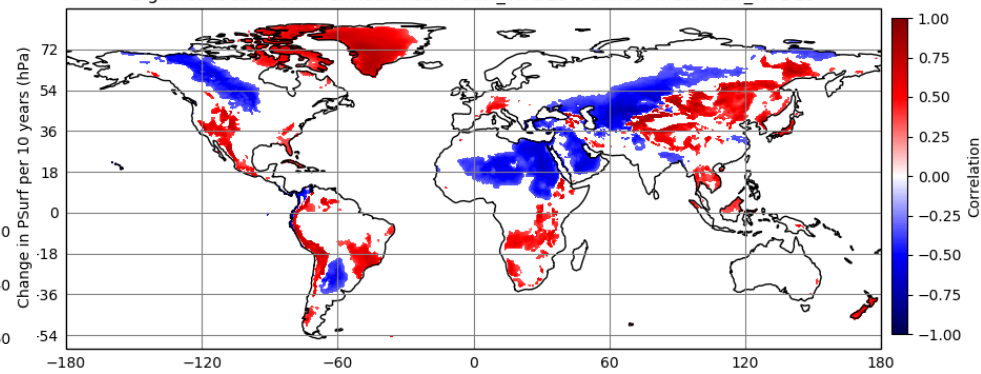
Significant correlation v
annual mean Tair_WFDE5

Average significant decadal change

PSurf_WFDE5 significant decadal change annual mean 1979-2018

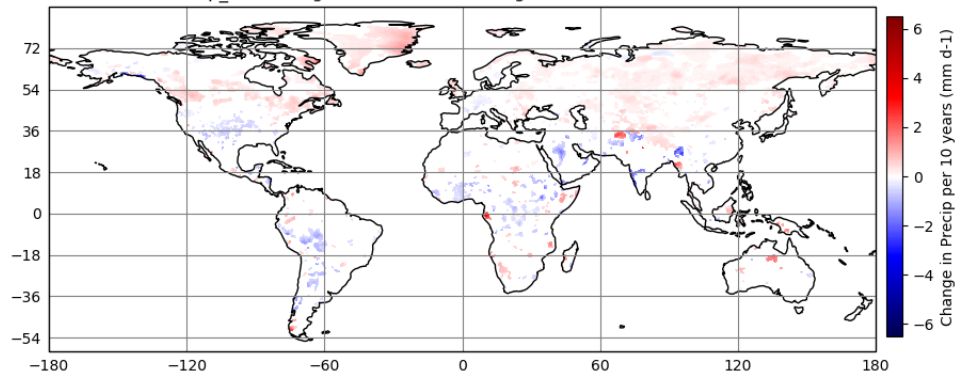
Significant correlation v
annual mean Tair_WFDE5

Significant correlation annual mean PSurf_WFDE5 v annual mean Tair_WFDE5

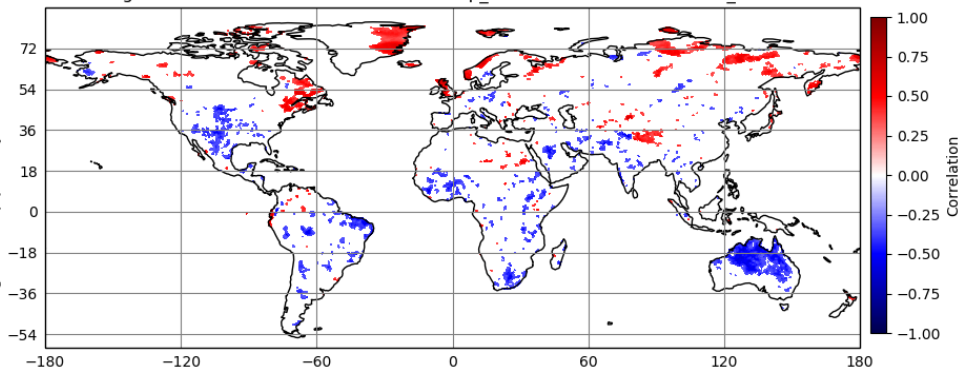


Average significant decadal change

Precip_WFDE5 significant decadal change annual mean 1979-2018

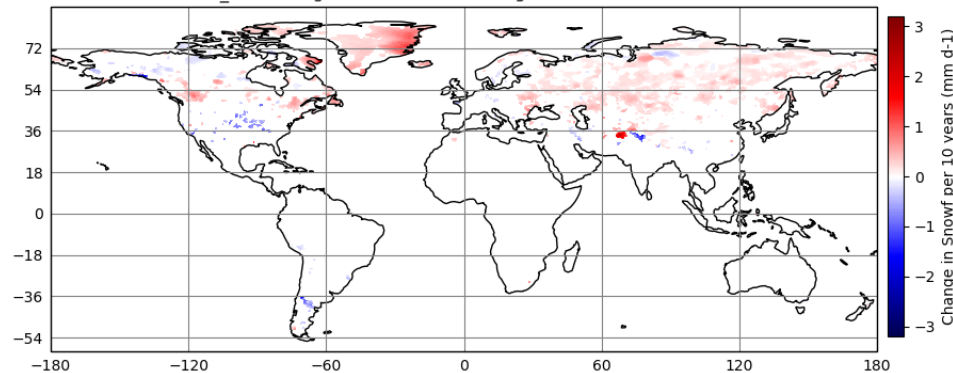
Significant correlation v
annual mean Tair_WFDE5

Significant correlation annual mean Precip_WFDE5 v annual mean Tair_WFDE5

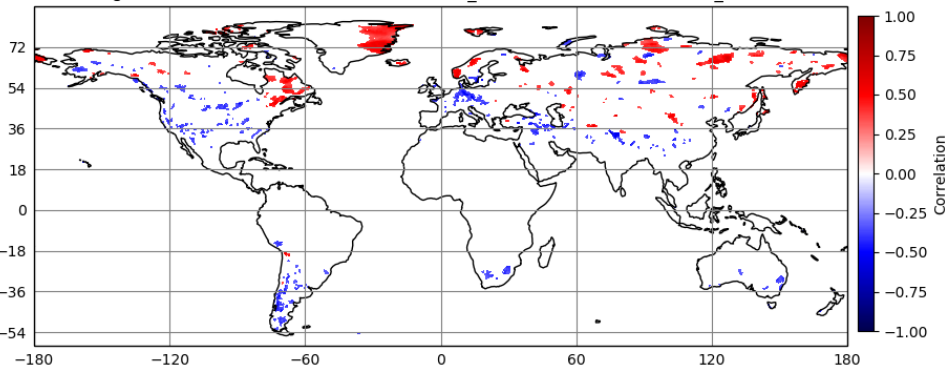


Average significant decadal change

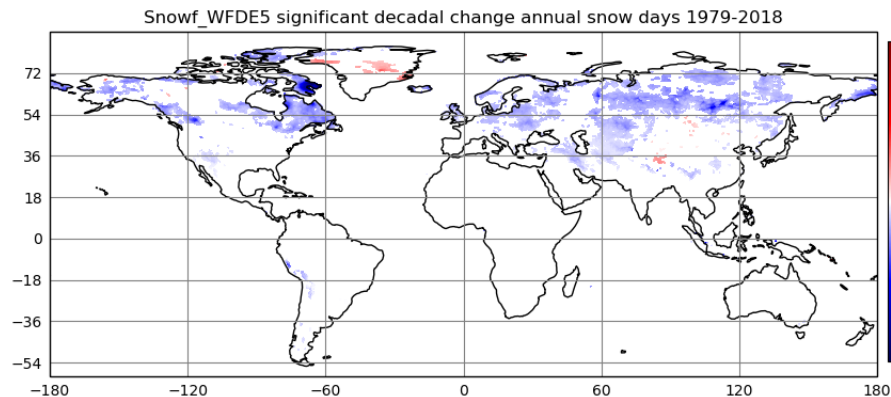
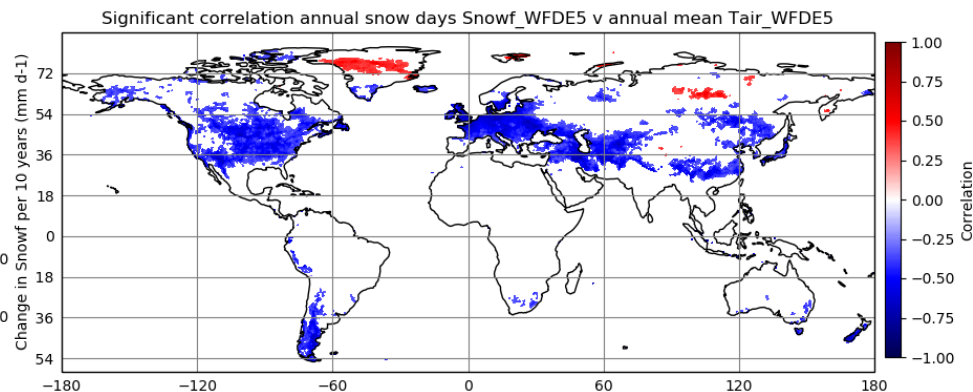
Snowf_WFDE5 significant decadal change annual mean 1979-2018

Significant correlation v
annual mean Tair_WFDE5

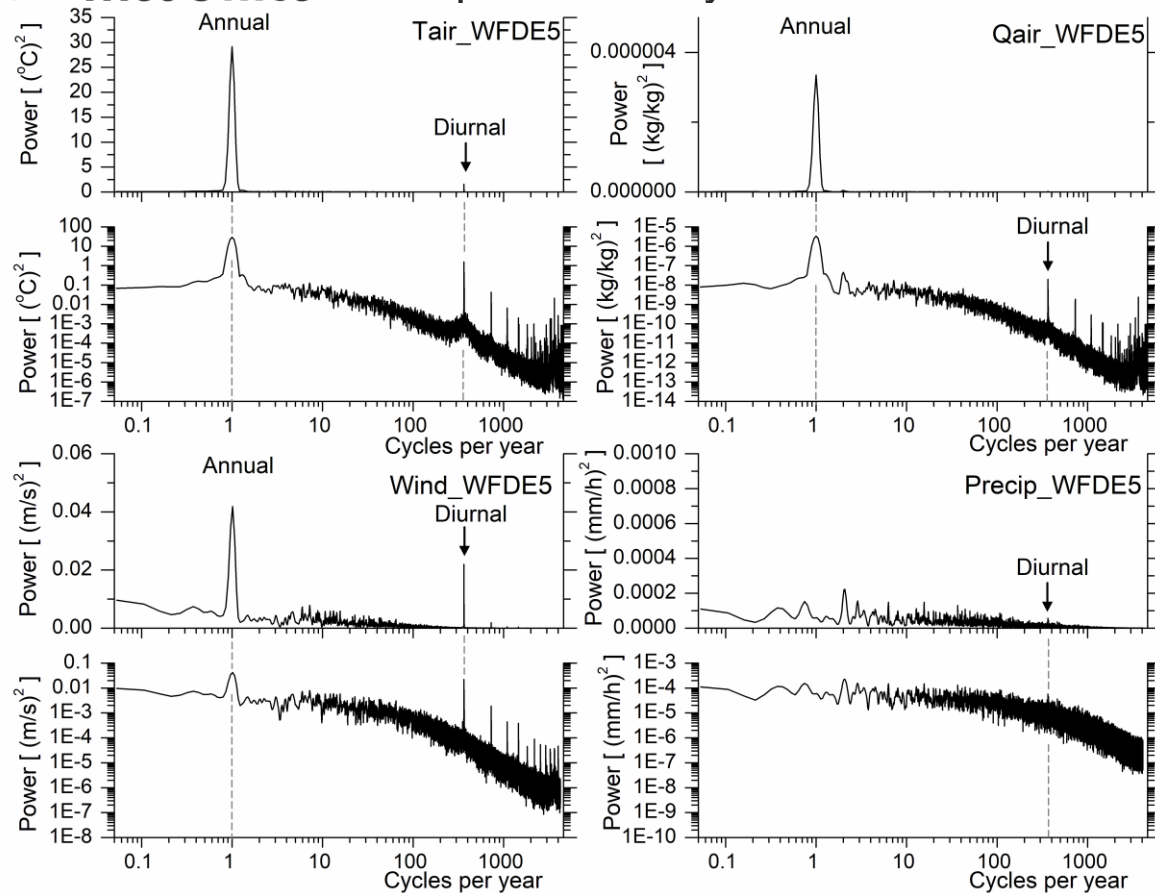
Significant correlation annual mean Snowf_WFDE5 v annual mean Tair_WFDE5



Average significant decadal change

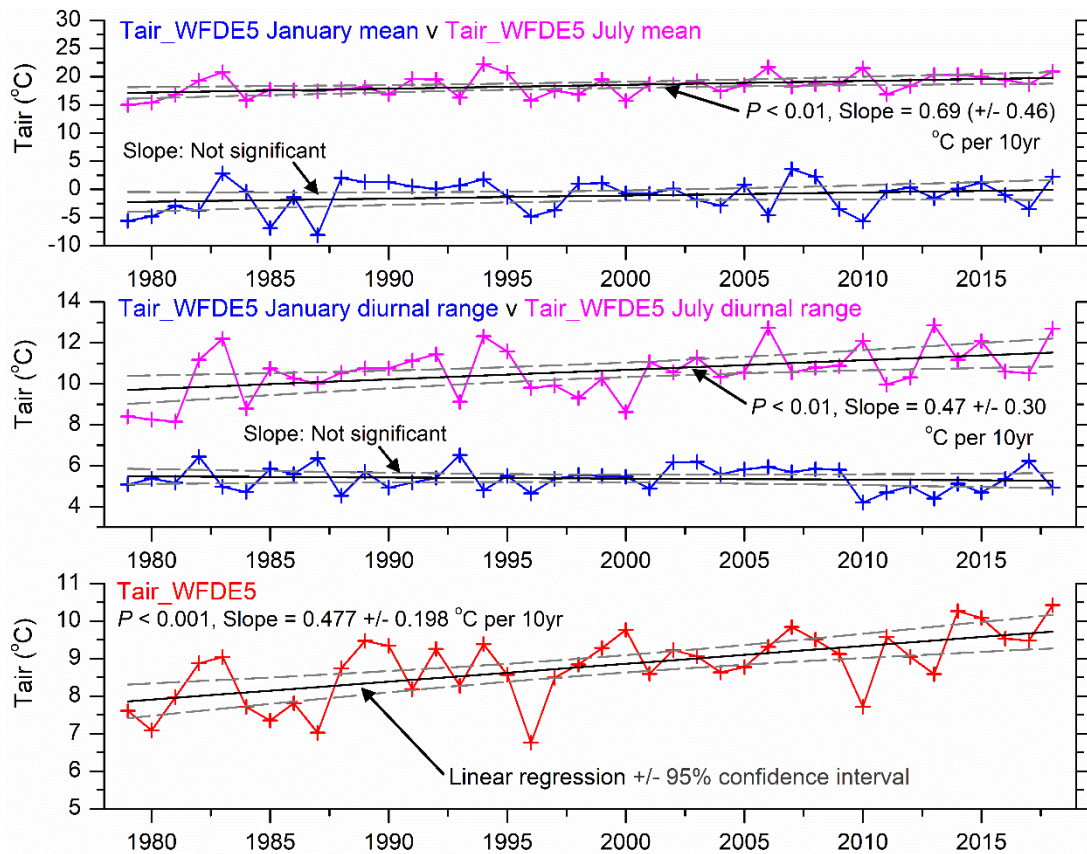
Significant correlation v
annual mean Tair_WFDE5

Trends in variability 1979-2018



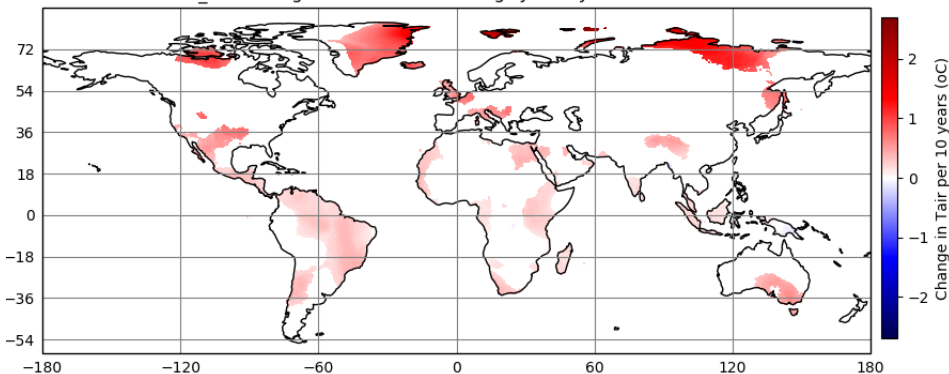
Most variables (i.e. excluding Rainf and Snowf) have most variance concentrated at annual and diurnal scales.

Met Office Tair_WFDE5 Jan & Jul mean, Jan & Jul diurnal range, Tharandt grid box

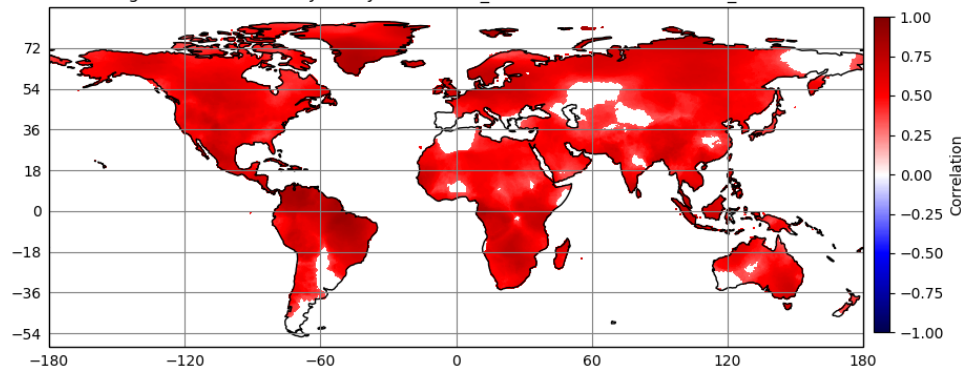


Average significant decadal change

Tair_WFDE5 significant decadal change January mean 1979-2018

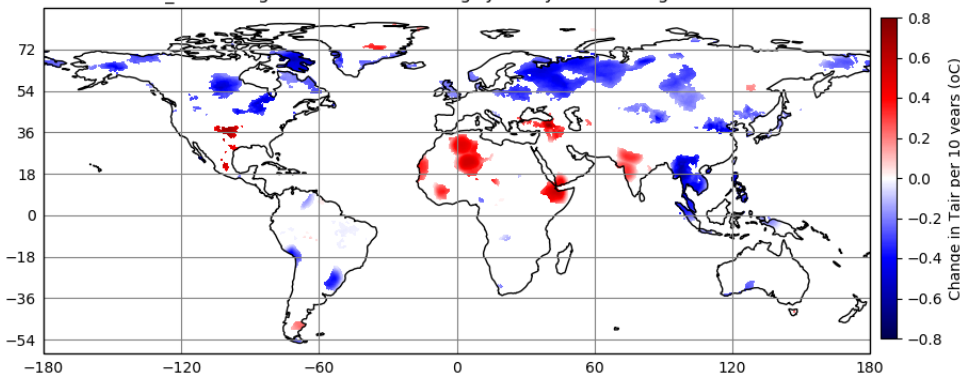
Significant correlation v
annual mean Tair_WFDE5

Significant correlation January means Tair_WFDE5 v annual mean Tair_WFDE5



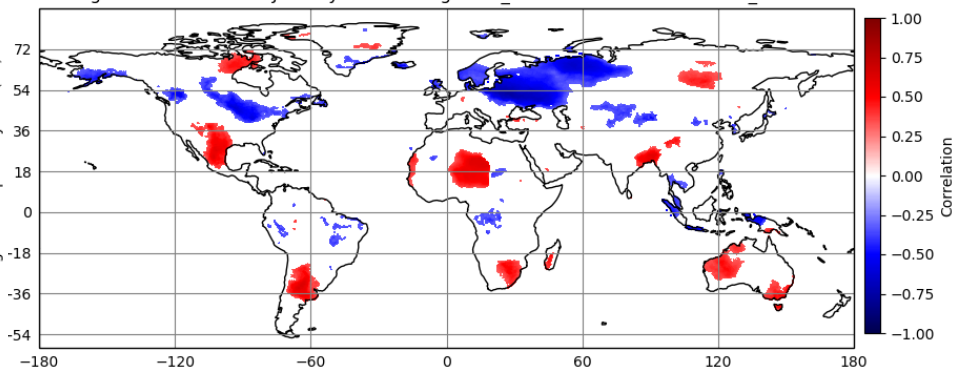
Average significant decadal change

Tair_WFDE5 significant decadal change January diurnal range 1979-2018



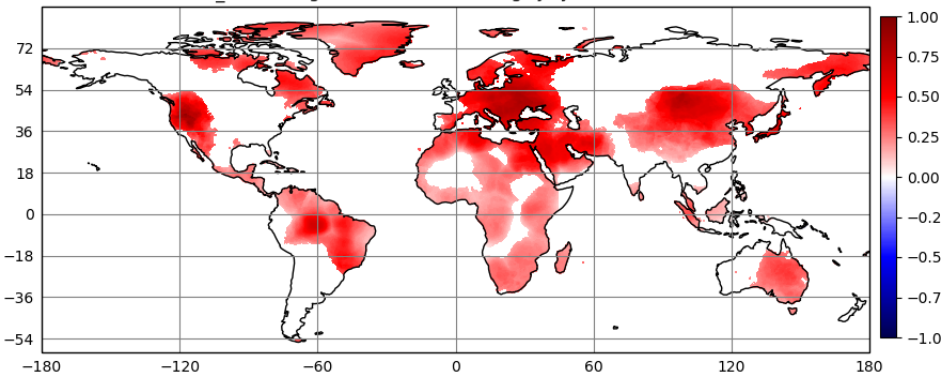
Significant correlation v annual mean Tair_WFDE5

Significant correlation January diurnal range Tair_WFDE5 v annual mean Tair_WFDE5

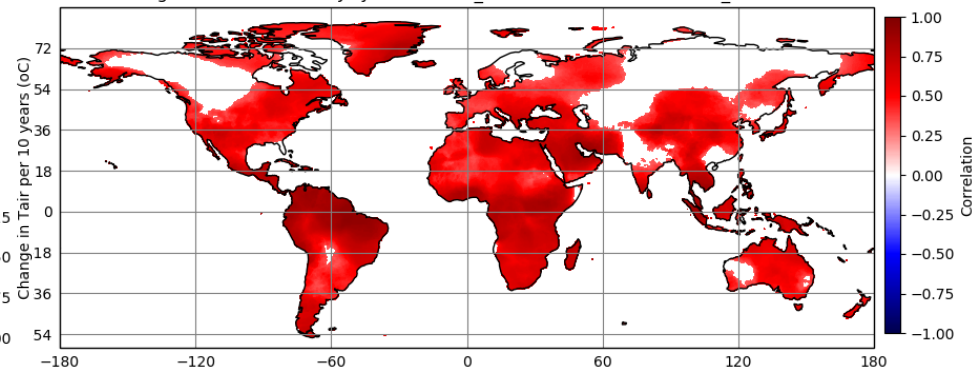


Average significant decadal change

Tair_WFDE5 significant decadal change July mean 1979-2018

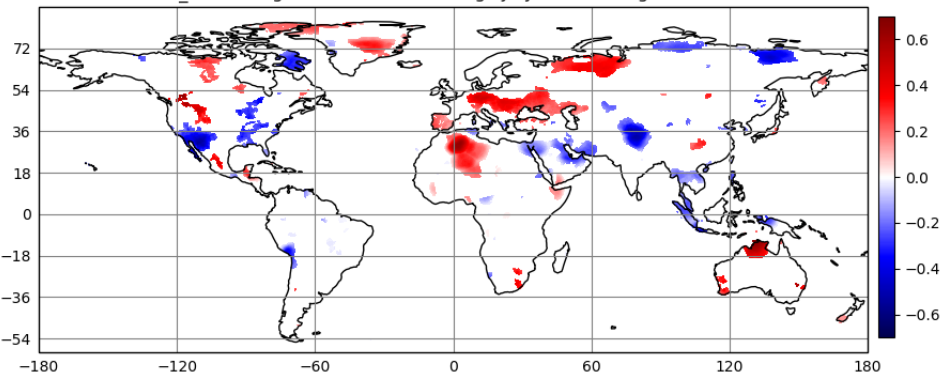
Significant correlation v
annual mean Tair_WFDE5

Significant correlation July means Tair_WFDE5 v annual mean Tair_WFDE5

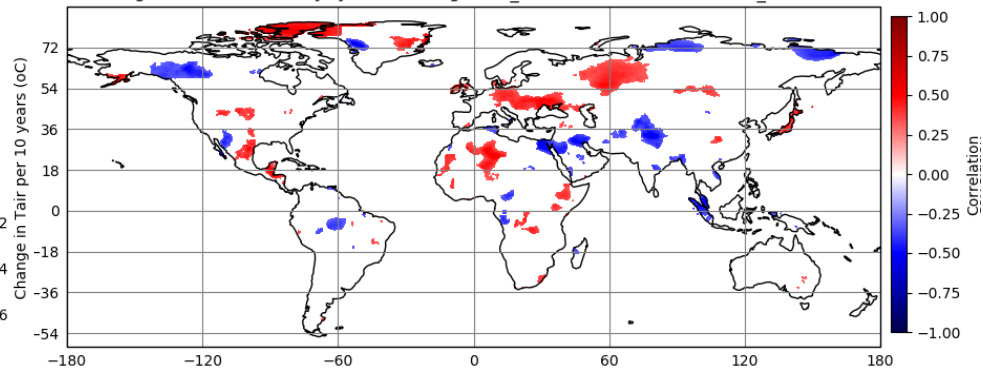


Average significant decadal change

Tair_WFDE5 significant decadal change July diurnal range 1979-2018

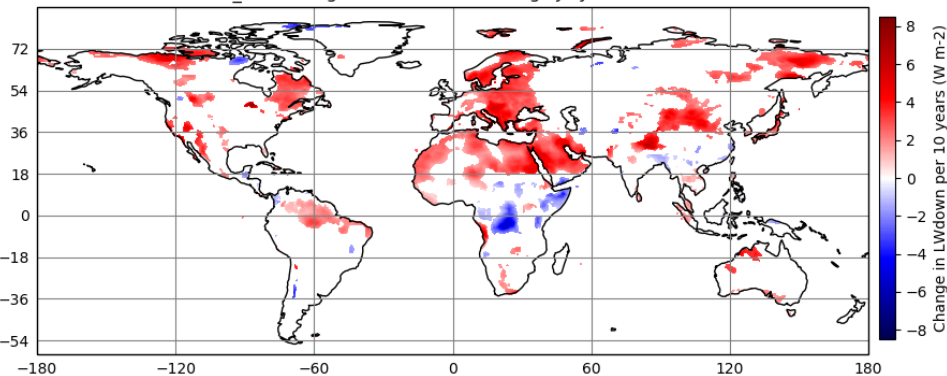
Significant correlation v
annual mean Tair_WFDE5

Significant correlation July diurnal range Tair_WFDE5 v annual mean Tair_WFDE5

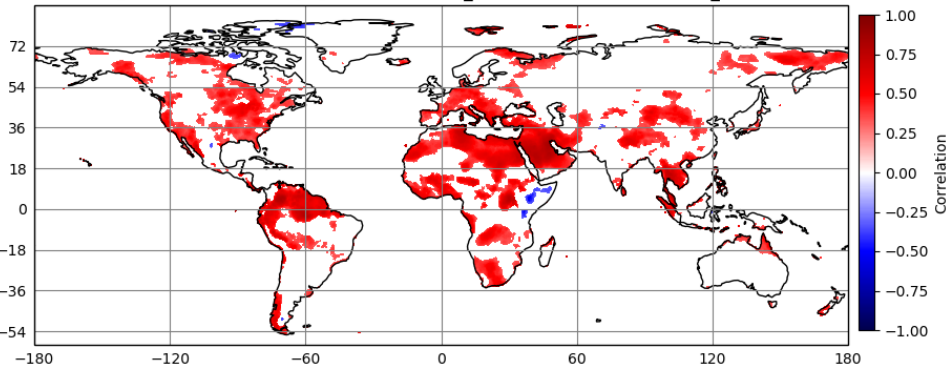


Average significant decadal change

LWdown_WFDE5 significant decadal change July mean 1979-2018

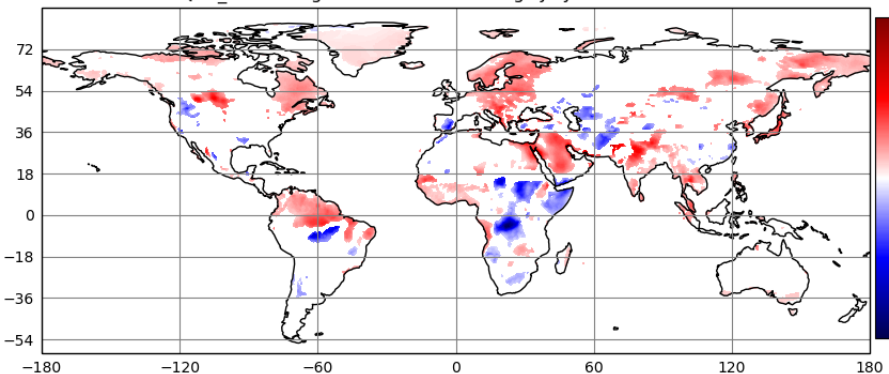
Significant correlation v
annual mean Tair_WFDE5

Significant correlation July mean LWdown_WFDE5 v annual mean Tair_WFDE5

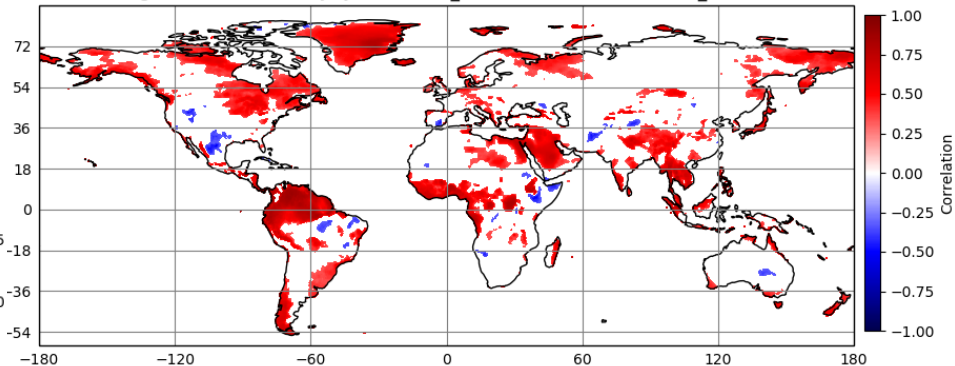


Average significant decadal change

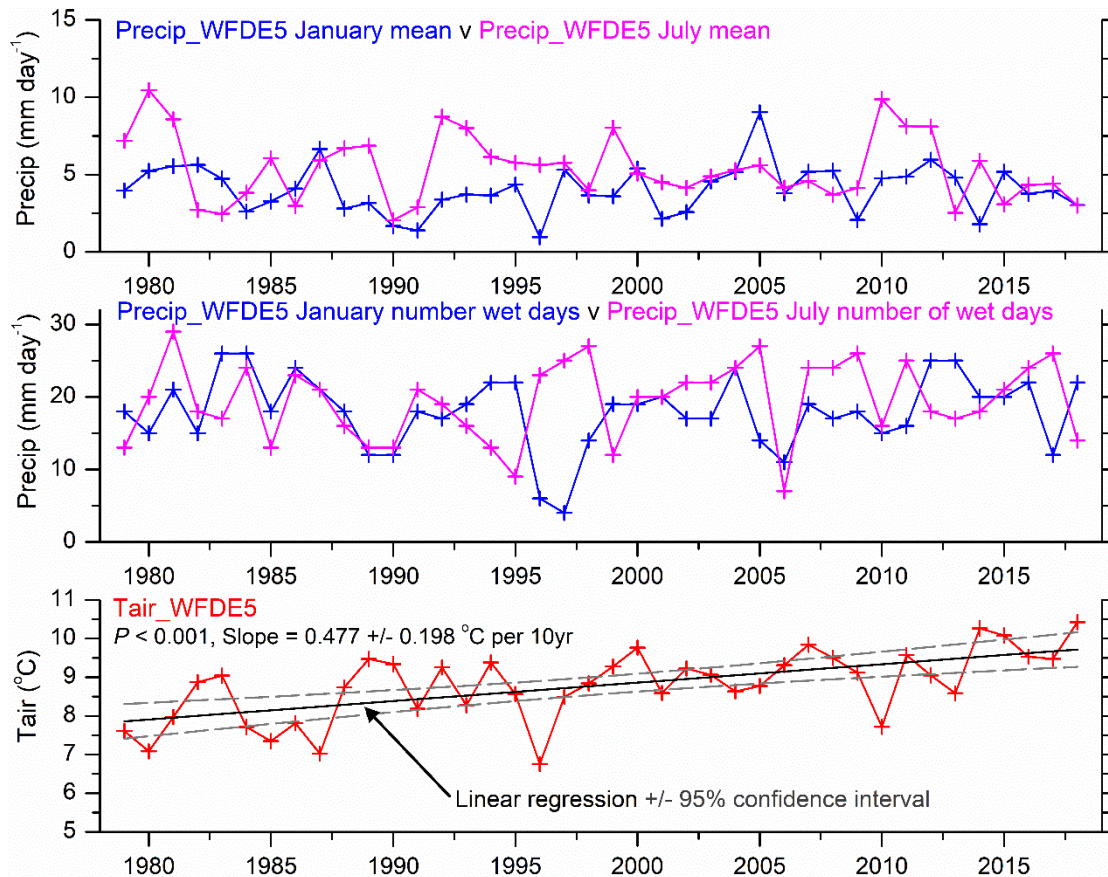
Qair_WFDE5 significant decadal change July mean 1979-2018

Significant correlation v
annual mean Tair_WFDE5

Significant correlation July mean Qair_WFDE5 v annual mean Tair_WFDE5

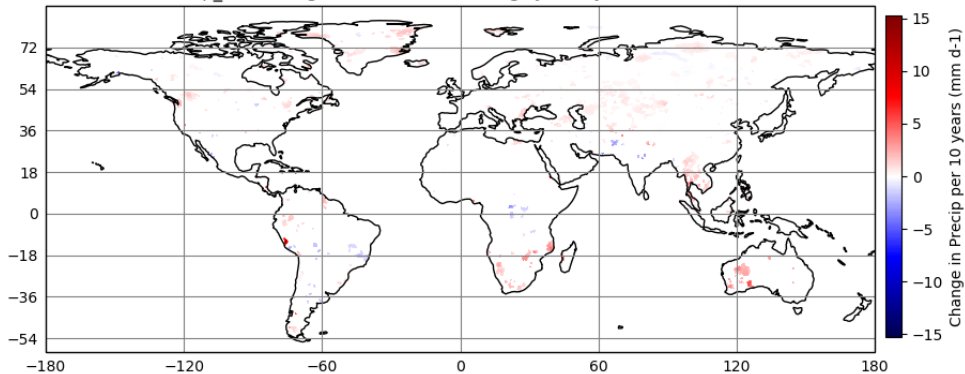


Met Office Precip_WFDE5 Jan & Jul mean, Jan & Jul no. wet days, Tharandt grid box

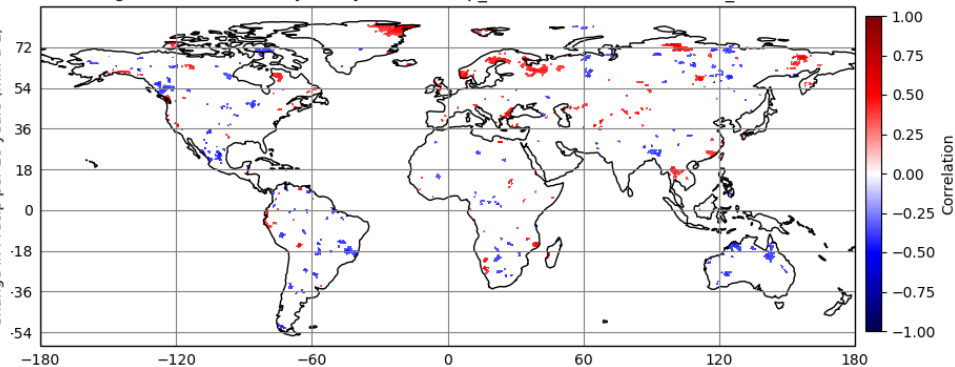


Average significant decadal change

Precip_WFDE5 significant decadal change January mean 1979-2018

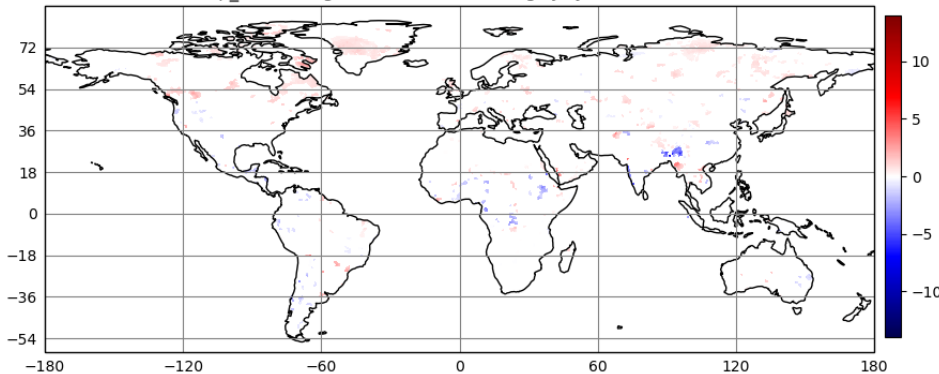
Significant correlation v
annual mean Tair_WFDE5

Significant correlation January mean Precip_WFDE5 v annual mean Tair_WFDE5

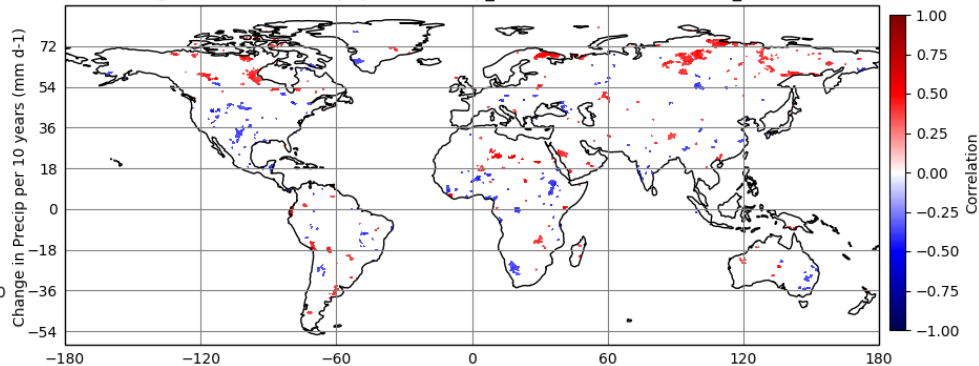


Average significant decadal change

Precip_WFDE5 significant decadal change July mean 1979-2018

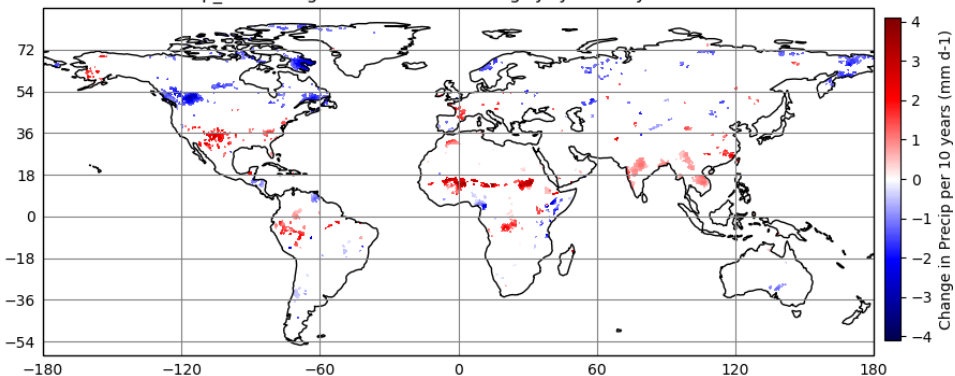
Significant correlation v
annual mean Tair_WFDE5

Significant correlation July mean Precip_WFDE5 v annual mean Tair_WFDE5

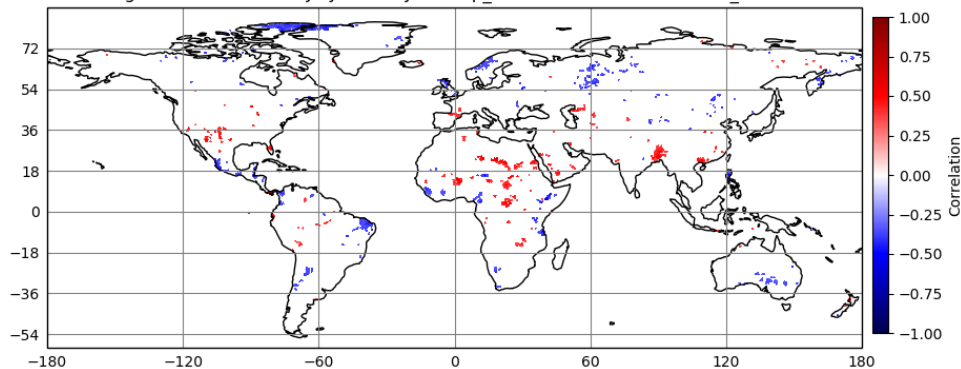


Average significant decadal change

Precip_WFDE5 significant decadal change July wet days 1979-2018

Significant correlation v
annual mean Tair_WFDE5

Significant correlation July wet days Precip_WFDE5 v annual mean Tair_WFDE5



Caveats:

- 1) Analysis for linear trends.
- 2) Significance of trends and correlations excluded allowance for lag-1 autocorrelation.
- 3) Significance of trends and correlations excluded allowance for spatial correlation.

Conclusions:

- 1) Trends and correlations with mean annual air temperature in WFDEI and WFDE5 are broadly the same.
- 2) Widespread increases in annual mean for **Tair**, **LWdown**, **Qair** plus decreases in numbers of annual **snow days** in northern hemisphere are correlated with increasing mean annual air temperature. Annual mean **PSurf**, **Wind**, **Rainf** & **Snowf** have patchy regional coherent trends and correlations. In N. America and Europe **SWdown** regional increases are regionally correlated *spuriously* with increasing mean annual Tair.
- 3) July trends and correlations for means are sometimes regionally spatially coherent. Very patchy results for trends and correlations of January means and also for January and July diurnal ranges across variables. Not regional coherent patterns for January & July wet days.