Land-atmosphere coupling during compound extreme heat and drought events in the LUCAS experiment

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INSTITUTO DOM LUIZ

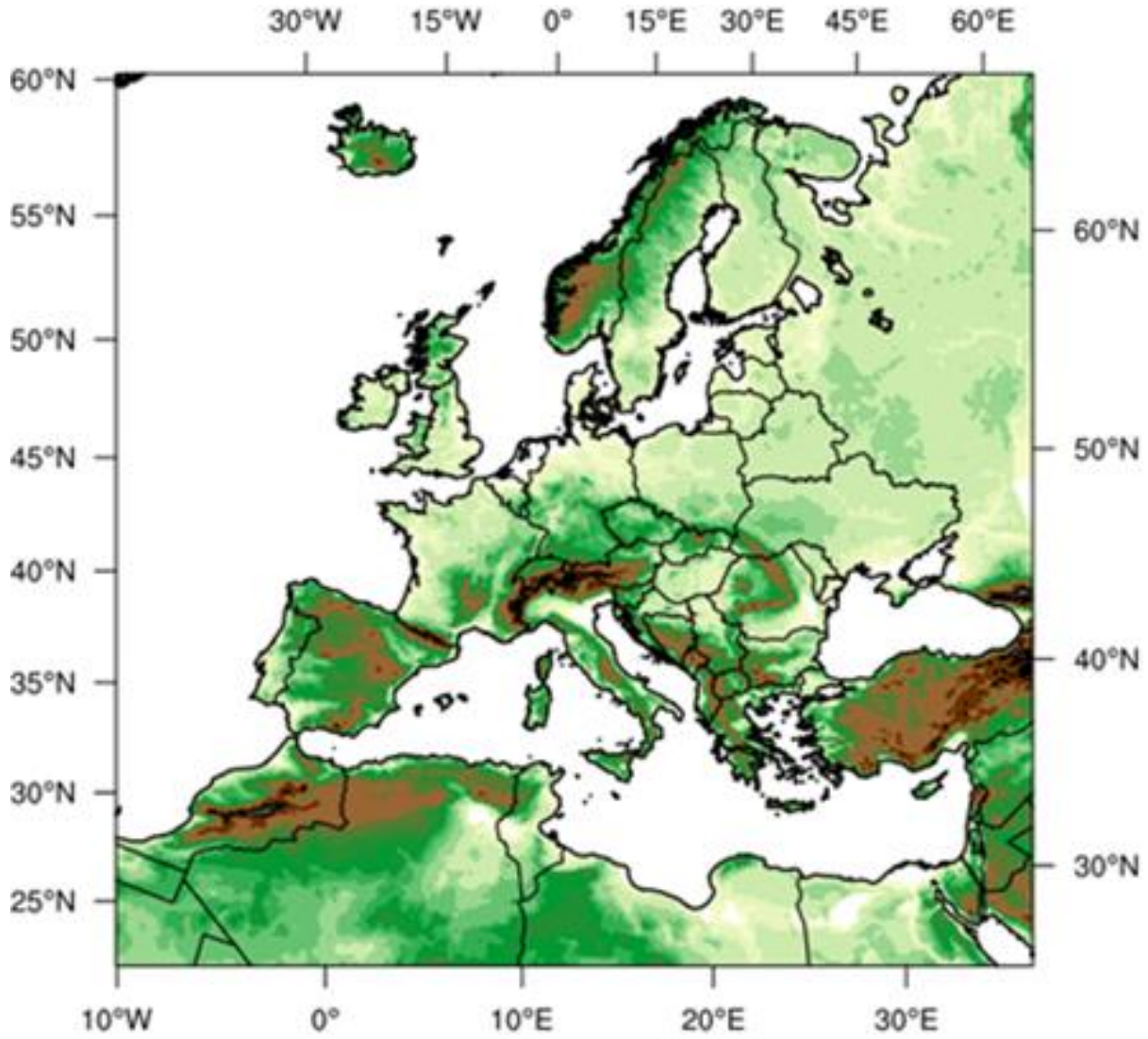
LUCAS

WCRP CORDEX FLAGSHIP PILOT STUDIES

Ciências ULisboa

RCM simulations

- EURO-CORDEX domain at 0.44^{o} (~ 50km) resolution
- ERA-Interim forcing
- 3 Land Use experiments
  - Current vegetation (CORINE)
  - Trees replaced by grassland (GRASS)
  - Grasses and shrubs replaced by trees (FOREST)
- 11 European research institutes



• Daily Maximum Temperature magnitude (MT):

$$MT(Tx_d) = \begin{cases} \dfrac{Tx_d - P_{25}}{P_{75} - P_{25}} & if\ Tx_d > P_{25} \\ 0 & if\ Tx_d \leq P_{25} \end{cases}$$

P_{75} daily percentile centred on a 91 day window

P_{25} daily percentile centred on a 91 day window

• Daily Latent Heat Flux Magnitude (MH):

$$MH(hfls_d) = \begin{cases} \dfrac{hfls_d - P_{h75}}{P_{h75} - P_{h25}} & if\ hfls_d < P_{h75} \\ 0 & if\ hfls_d \geq P_{h75} \end{cases}$$

$Tasmax > P_d$ daily percentile centred on a 31 day window

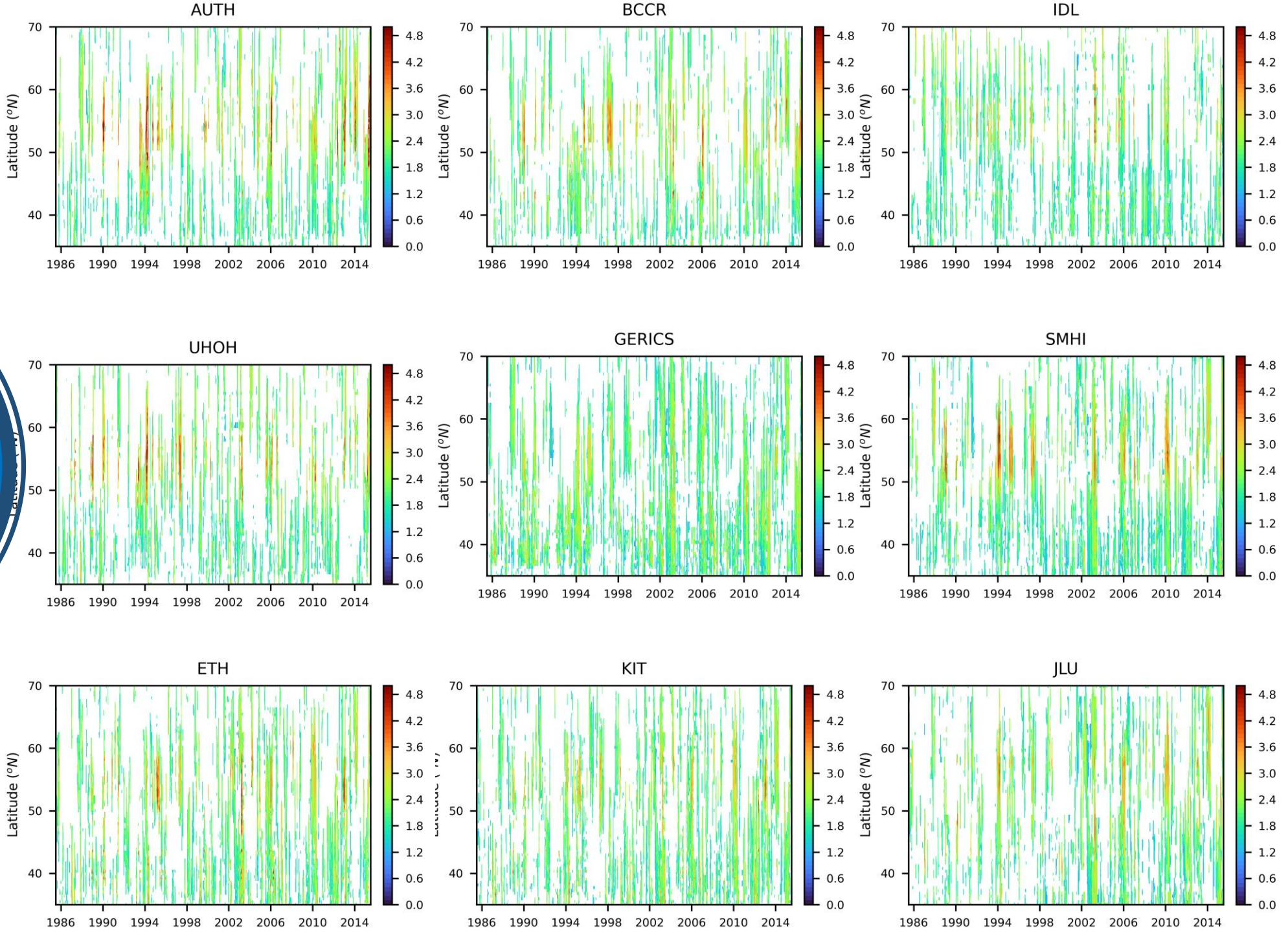
Heat Wave:

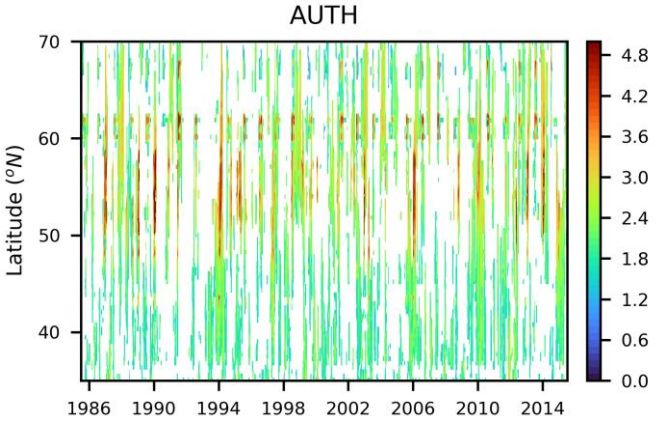
Tasmax > P90 for at least 5 consecutive days

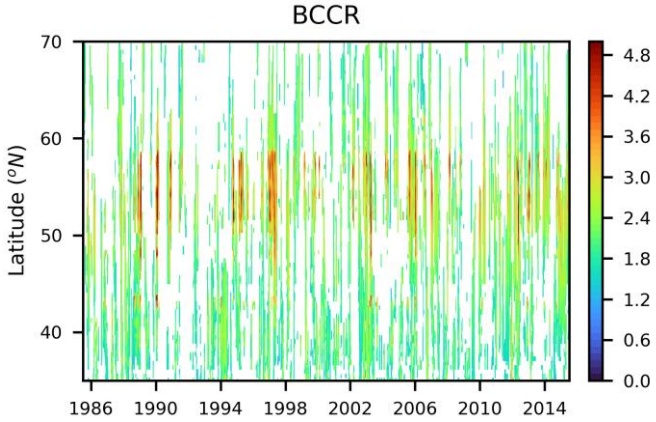
• Latent Heat Flux-Temperature Coupling Magnitude (LETCM):

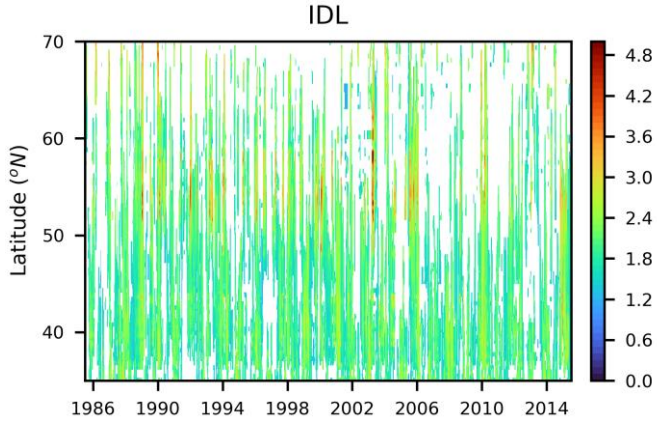
$$LETCM = \sum MT(Tx_d) * MH(hfls_d)$$

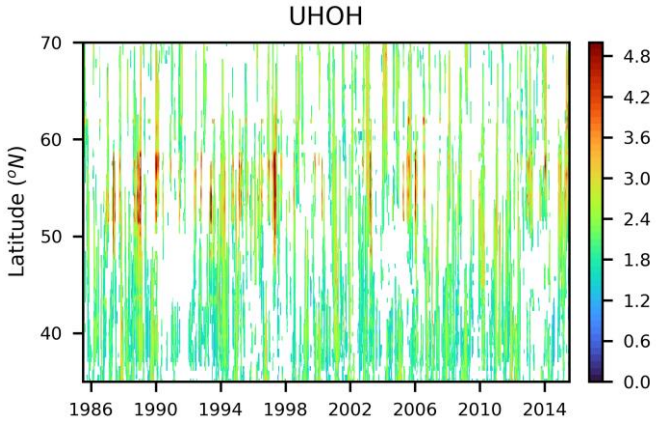
Magnitude of Heat Wave Events 1986-2015

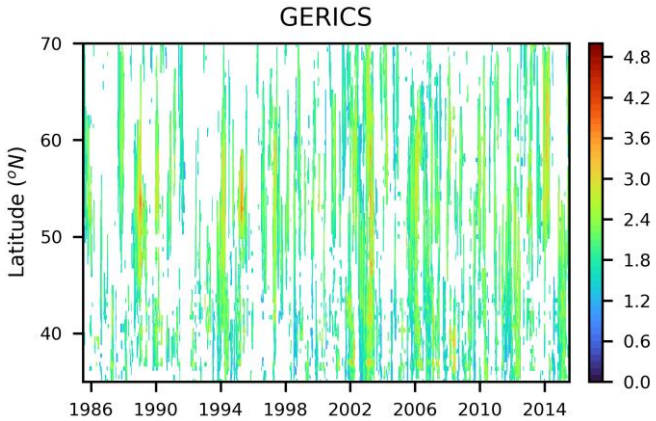


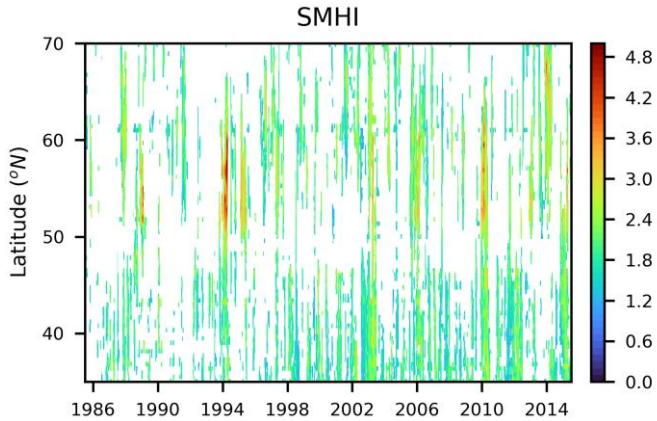


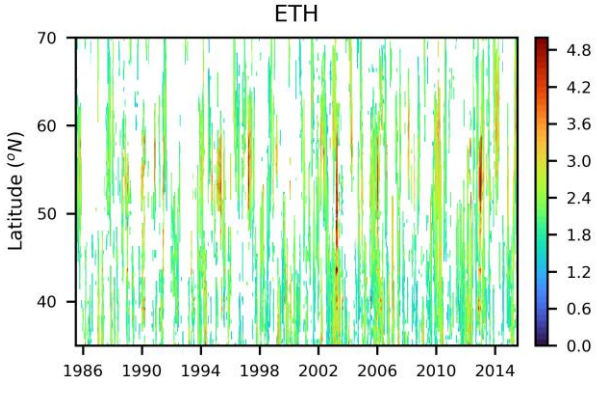


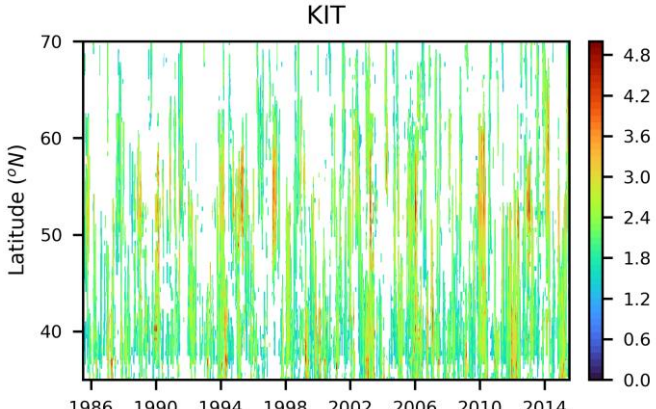


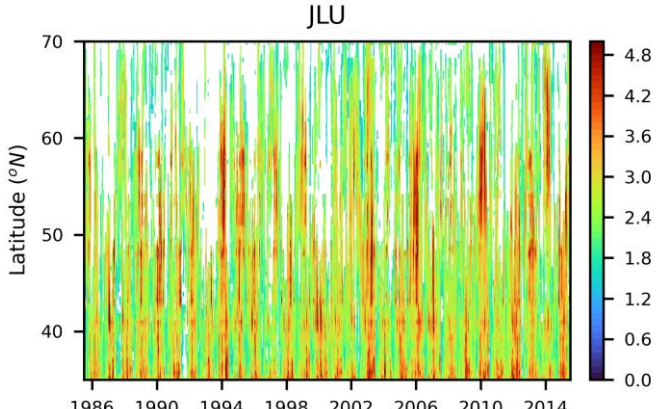




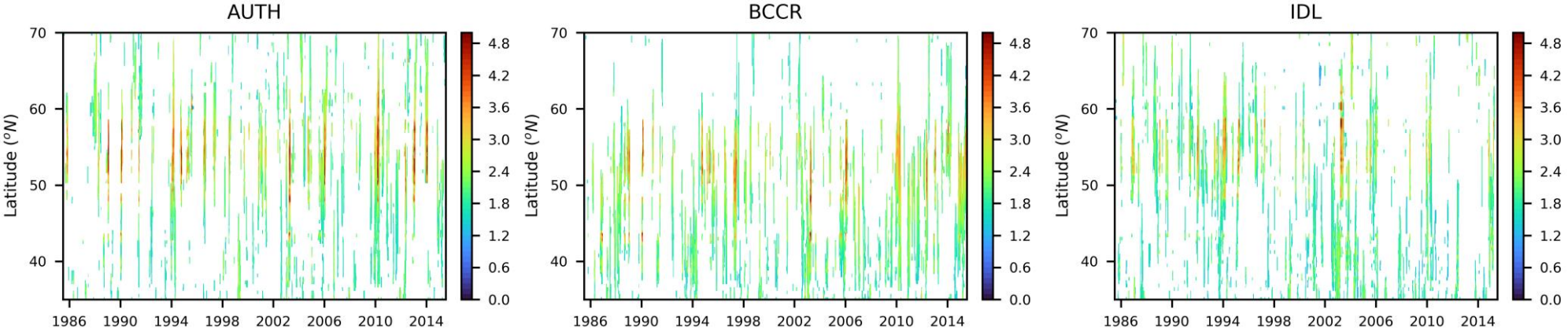


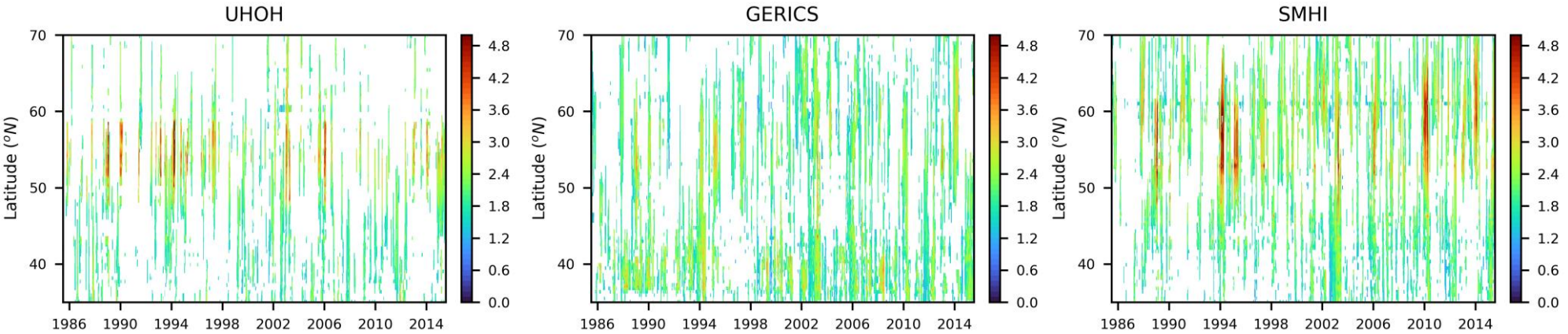


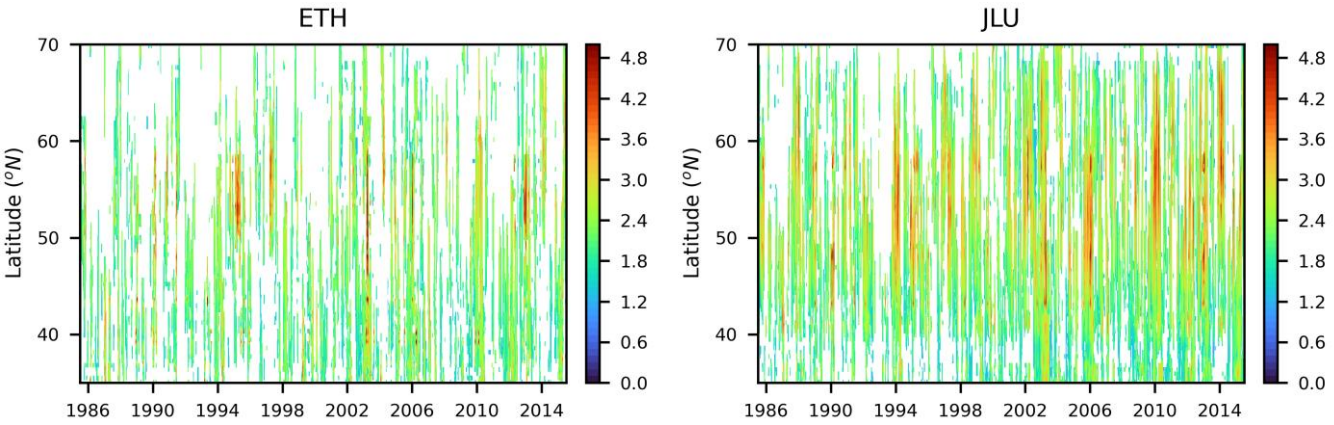




Magnitude of Heat Wave Events 1986-2015 Forest

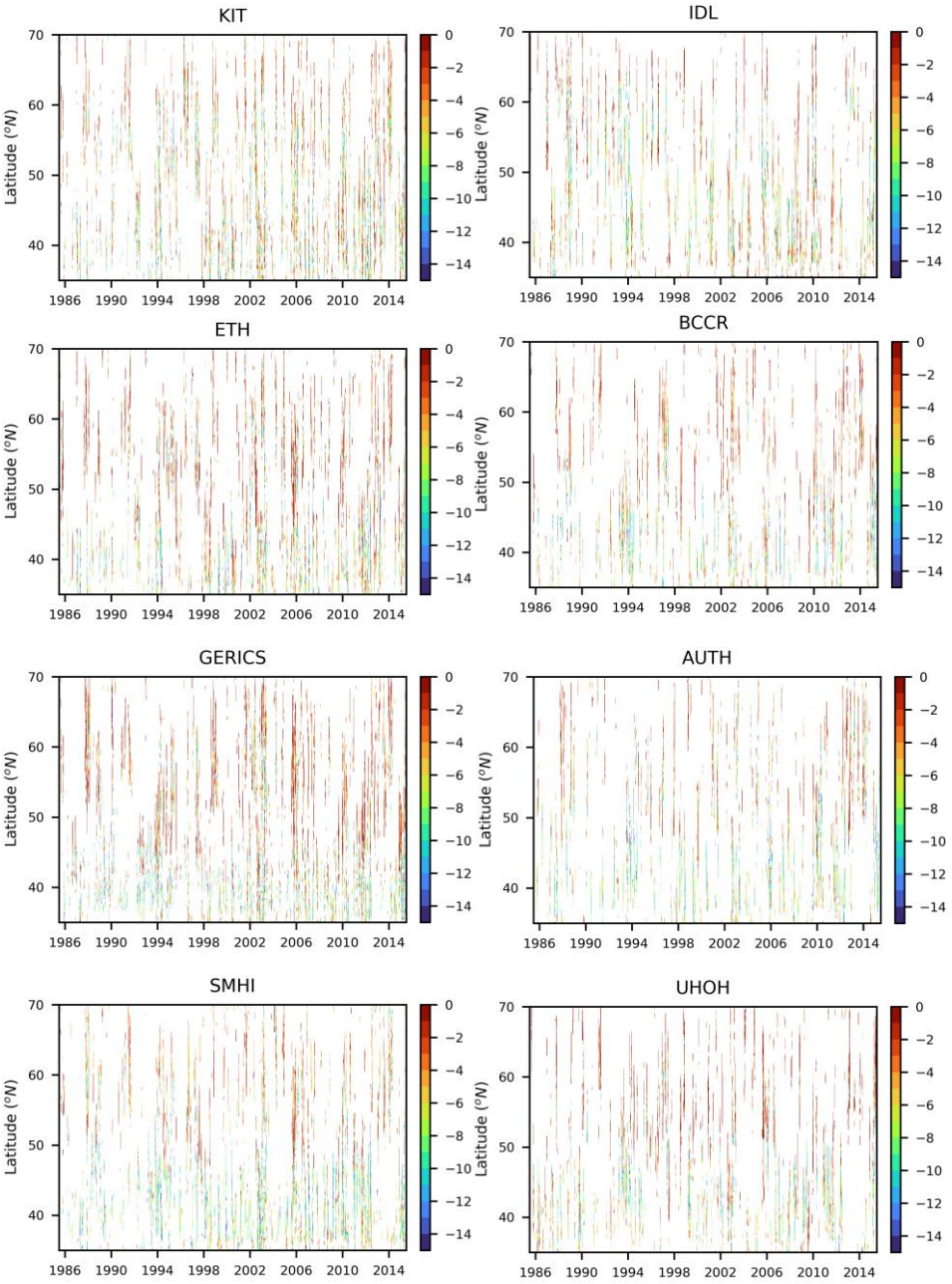






Magnitude of Heat Wave Events 1986-2015 Grass

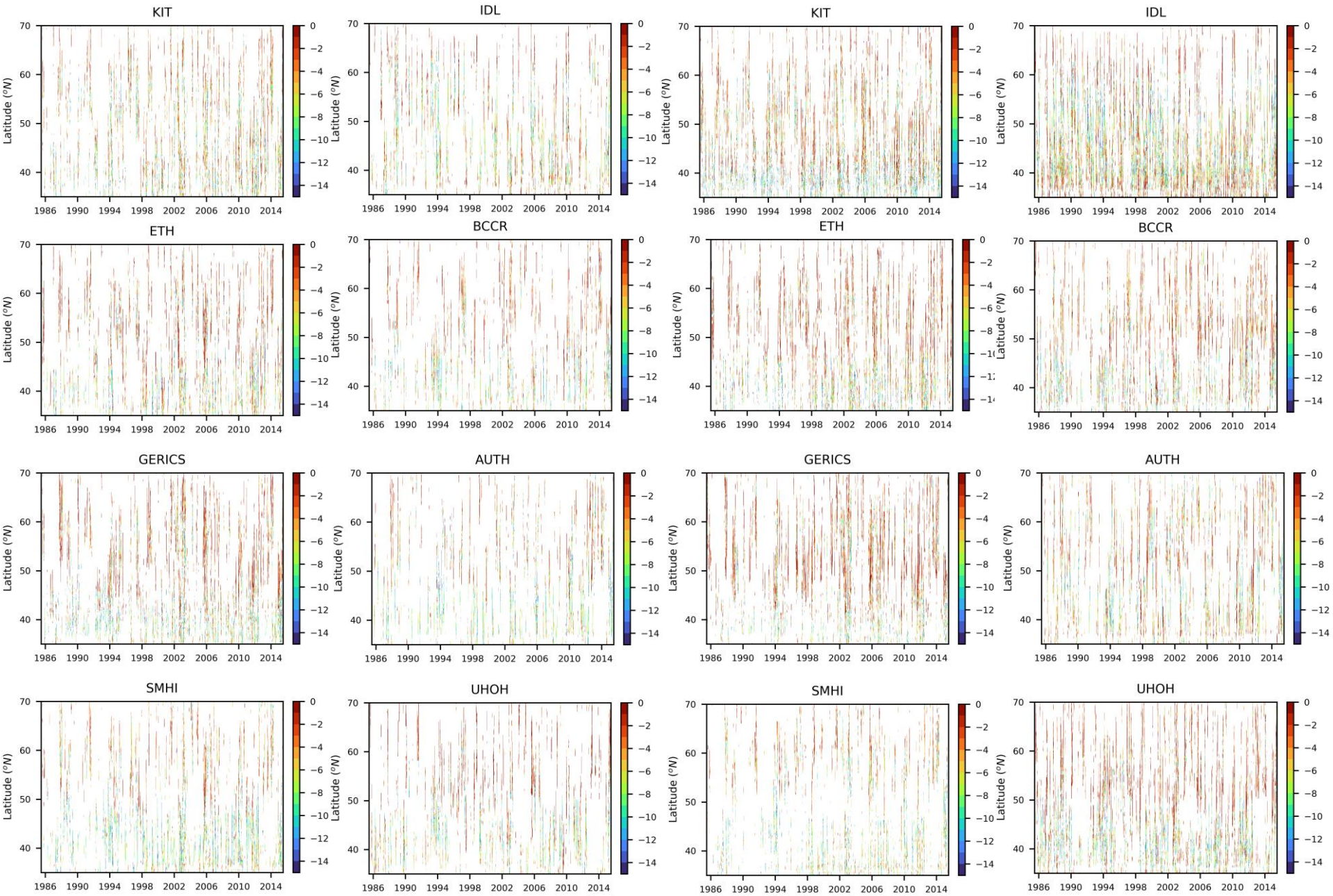
Corine



LETCM

Corine

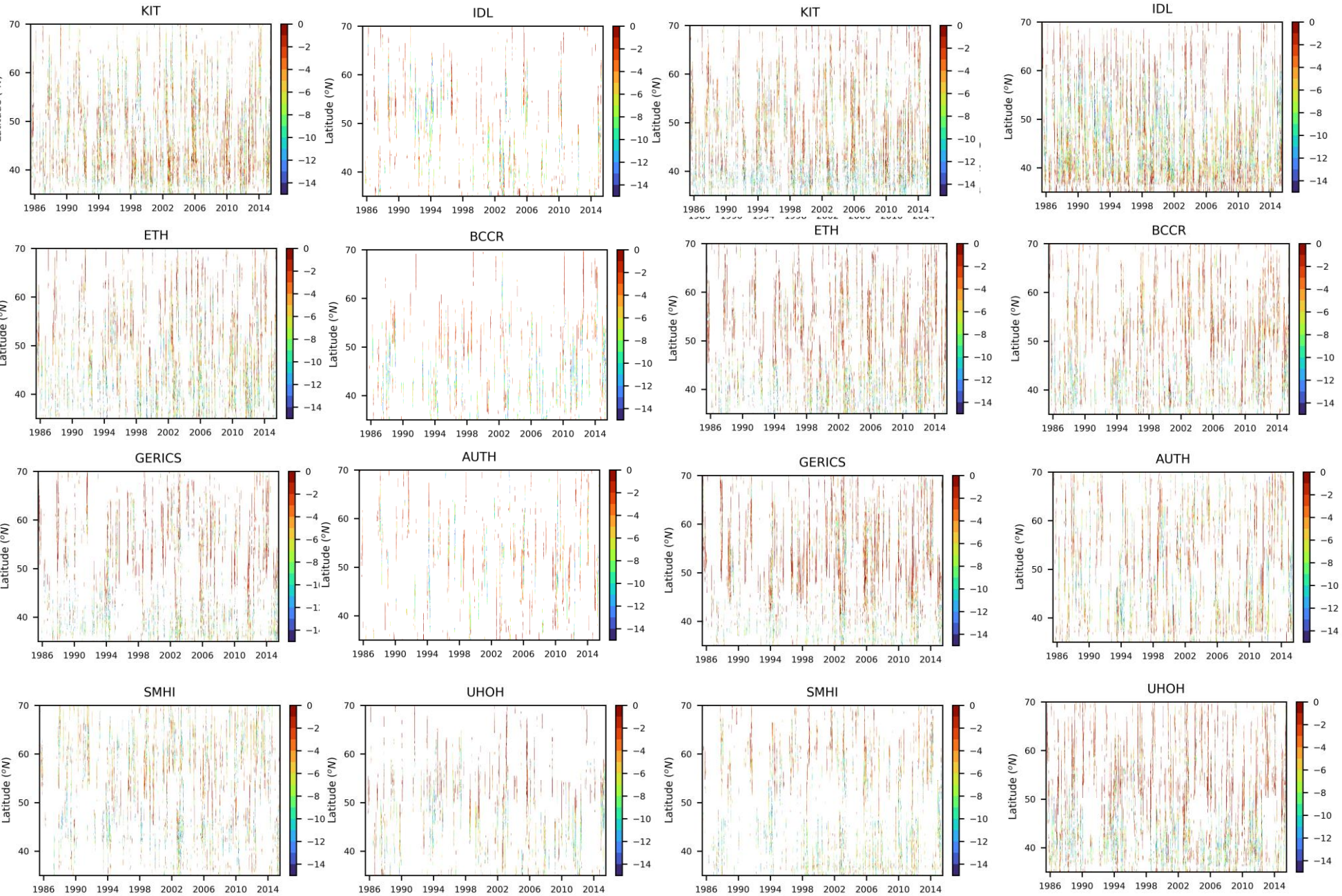
Forest



LETCM

Grass

Forest



LETCM

- **Daily Drought Magnitude (DR):**

$$DR(pr_{30d}) = \begin{cases} \dfrac{pr_{30d} - P_{h75}}{P_{h75} - P_{h25}} & if\ pr_{30d} < P_{h75} \\ 0 & if\ pr_{30d} \geq P_{h75} \end{cases}$$

P_{75} daily percentile centred on a 91 day window

P_{25} daily percentile centred on a 91 day window

$pr_{30d} < P_d$ daily percentile centred on a 31 day window

- **Compound Magnitude (CM)**

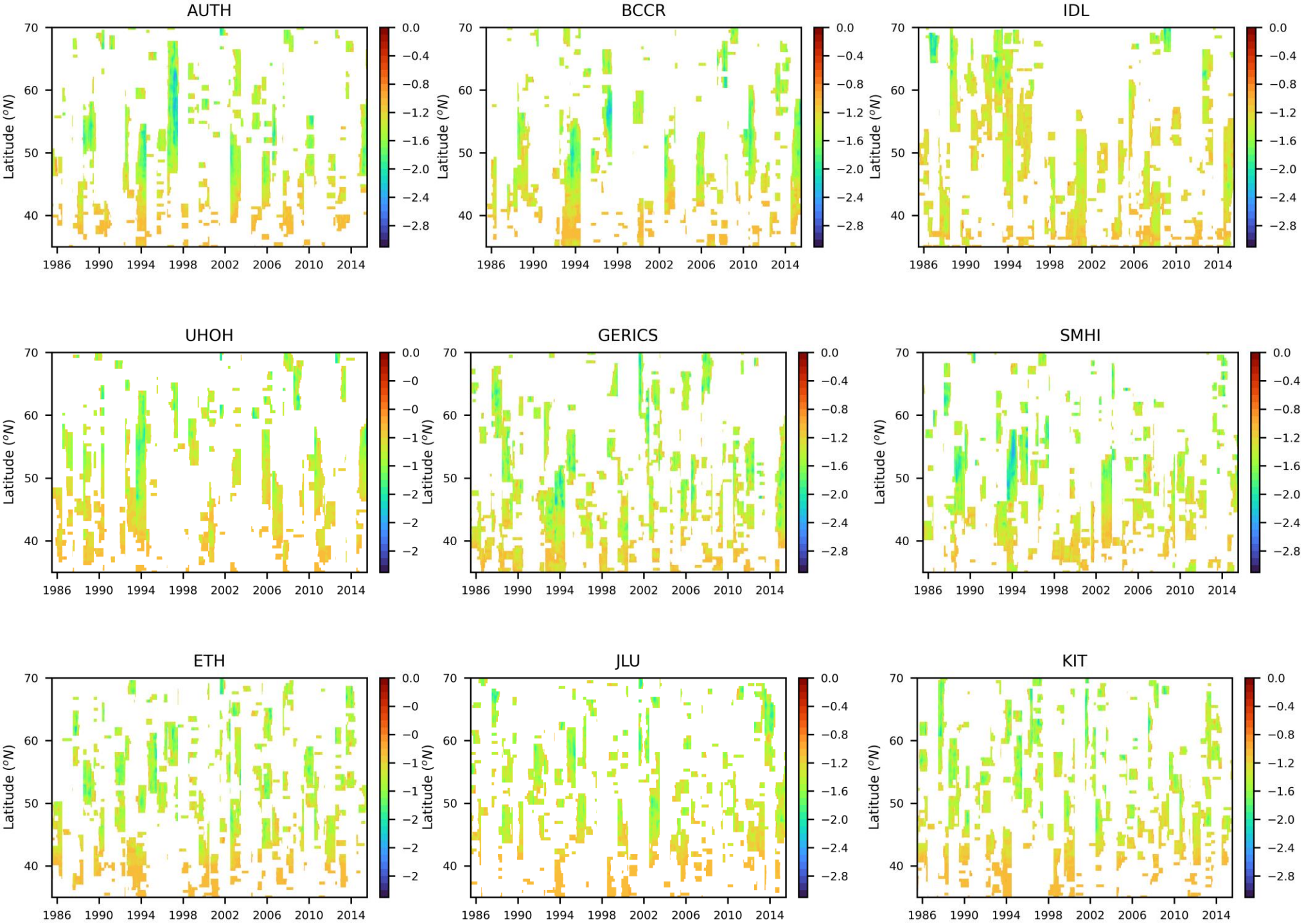
$$CM = \sum MT(Tx_d) * DR(pr_{30d})$$

Heat Wave:

Tasmax > P90 for at least 5 consecutive days

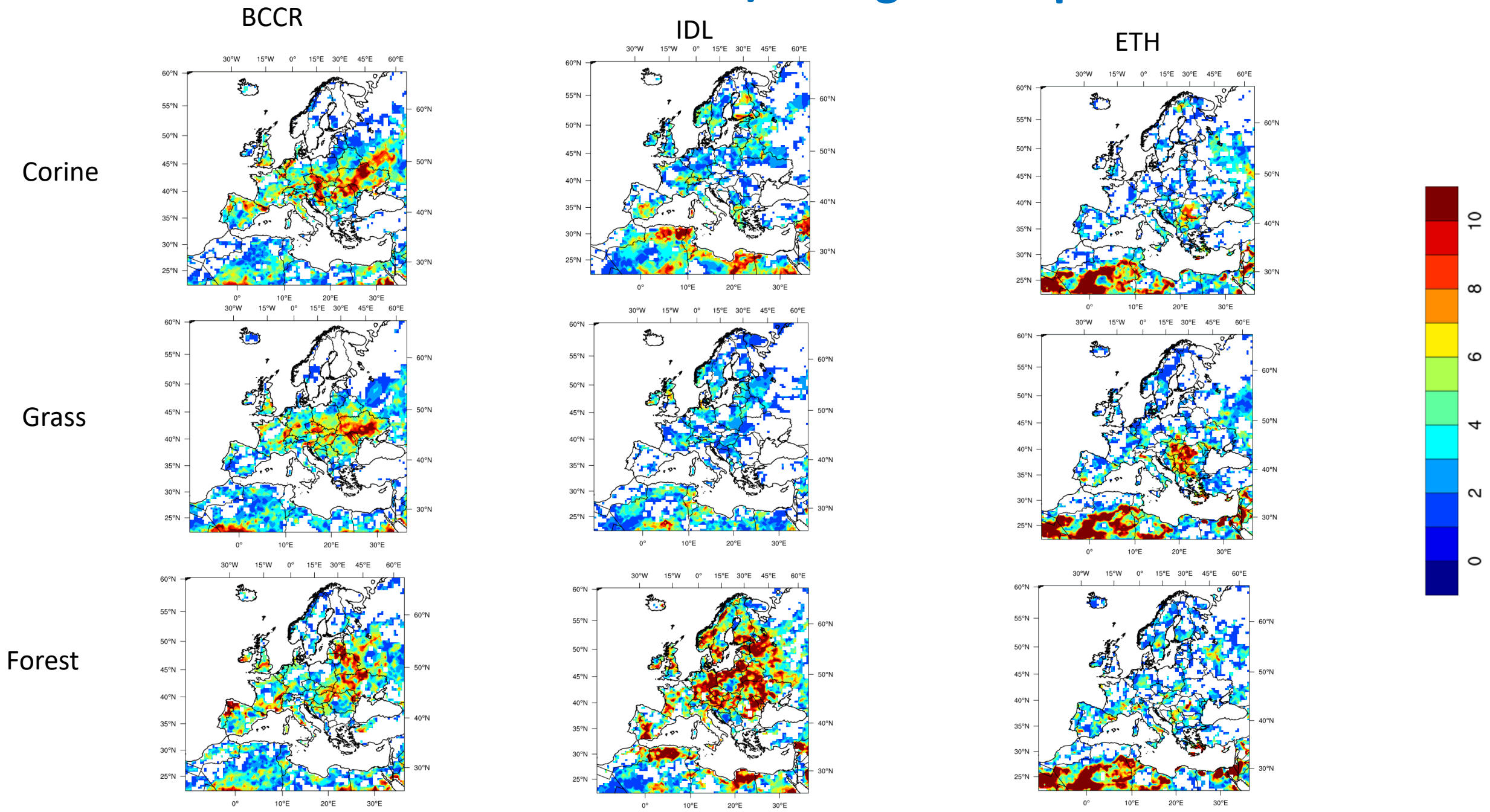
Drought:

Accumulated precipitation for30 days < P20 for at least 90 days



Magnitude of Drought Events 1986-2015

Number of Heat Wave/Drought Compound Events



Length of Heat Wave/Drought Compound Events

BCCR

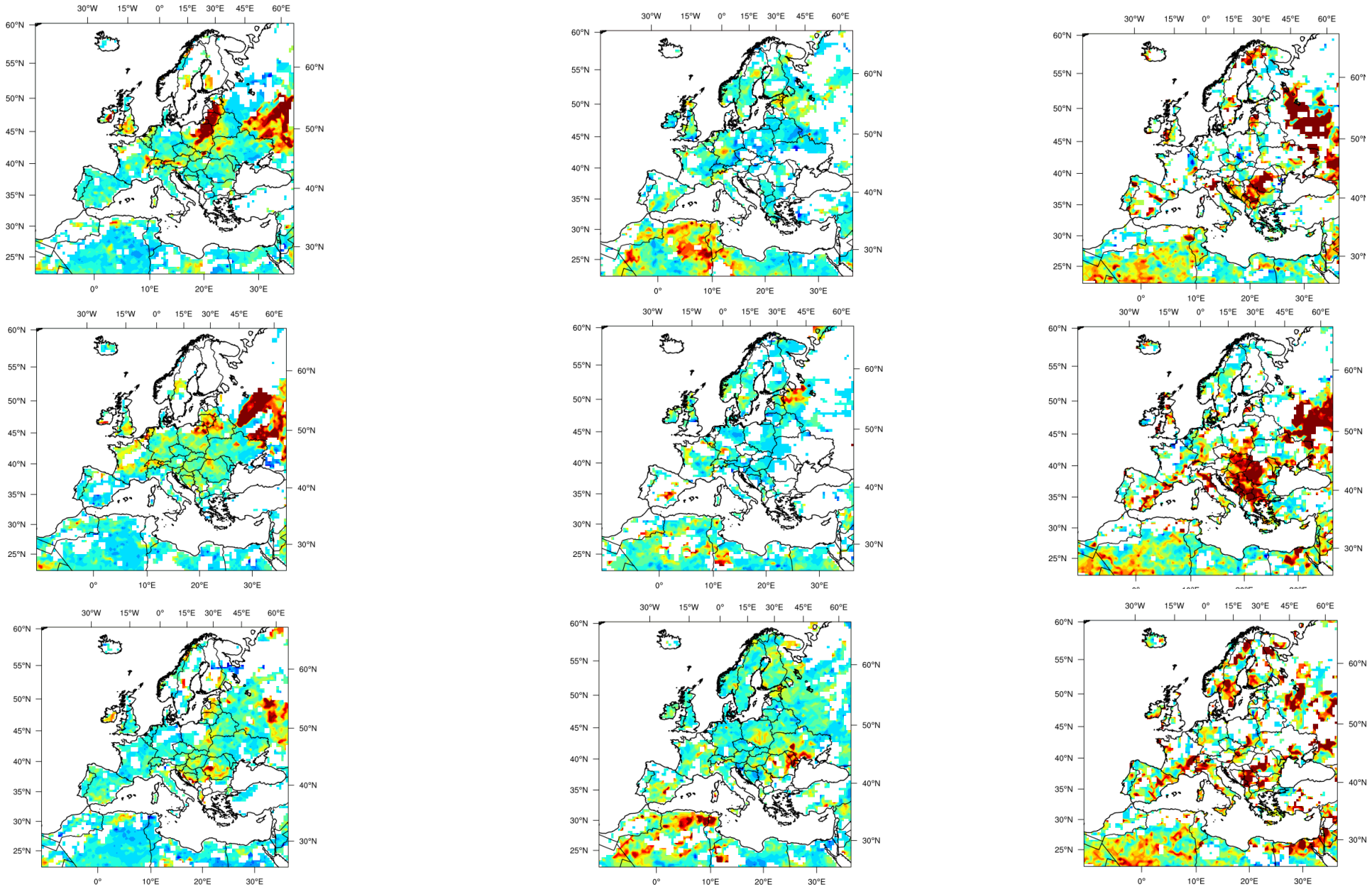
IDL

ETH

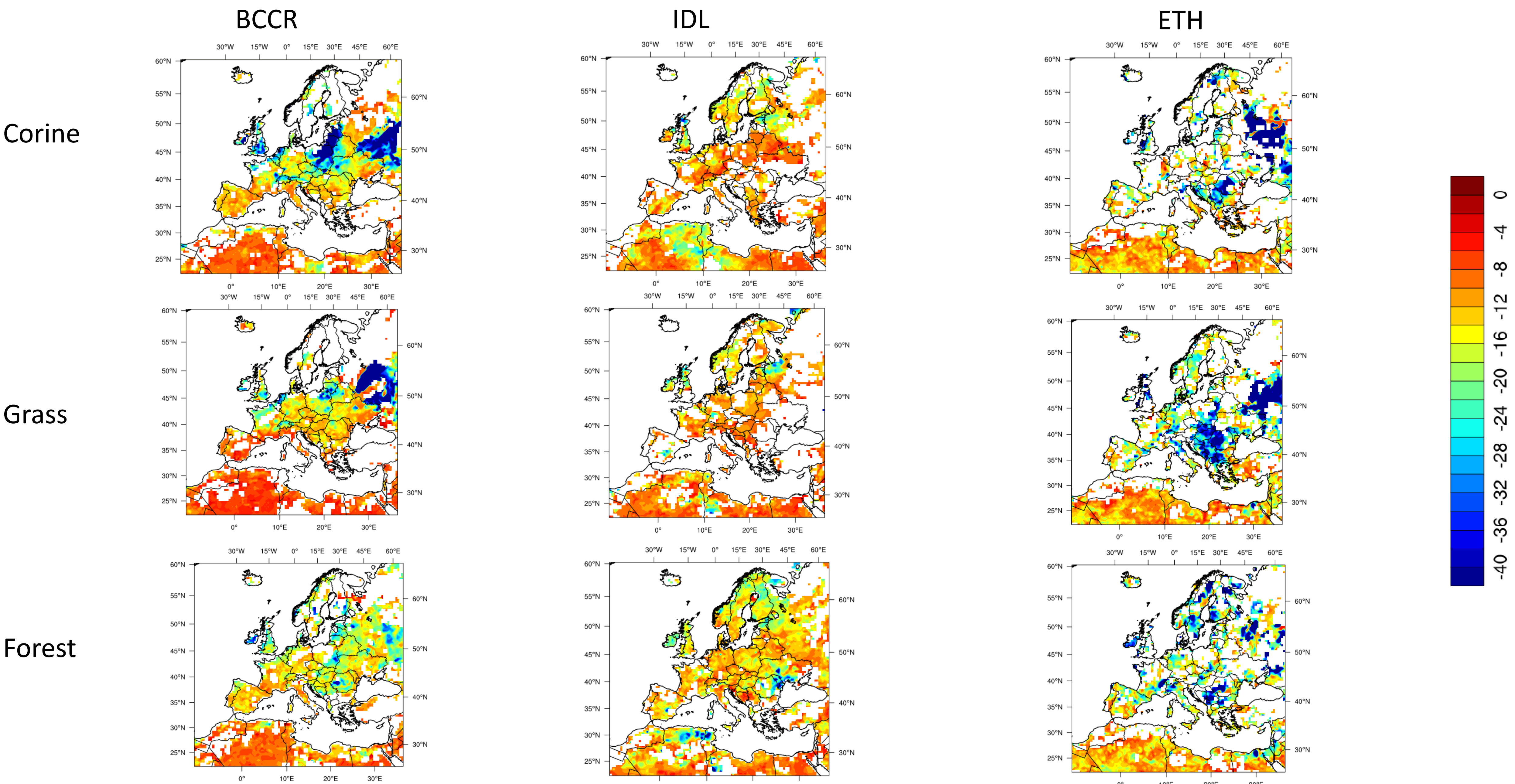
Corine

Grass

Forest



Amplitude of Heat Wave/Drought Compound Events



Conclusions

- The new extreme heat and latent heat metric highlights positive temperature extremes associated to reduced evaporation
- The new compound heat and drought metric considers the positive temperature extremes and negative accumulated precipitation extremes
- Both metrics allow the detection of events that are extreme for energy and water cycle
- The number, amplitude and spatial distribution of compound extreme heat and evaporation/drought is highly model dependant
- The impact of afforestation or deforestation is not consistent across models