

## MOSES

### A novel observing system for highly dynamic events

Ute Weber, Claudia Schütze & MOSES Team



## MOSES – Modular Observation Solutions for Earth Systems

- new observing system / research infrastructure
- designed to investigate the interactions of short-term **events** and long-term **trends** across Earth compartments

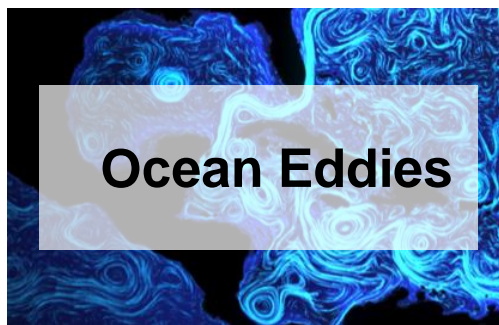
## Organisation und Implementation

- measures energy, water, nutrient and GHG states and fluxes
- Investment 30 Mio. € / Implementation Phase 2017 – 2021 ► Operation Phase 2022
- developed by 9 Helmholtz Centers in the research field “Earth and Environment”
- Coordination: Helmholtz Centre for Environmental Research (UFZ)
- Information: [moses-helmholtz.de](https://moses-helmholtz.de), campaign blog: <https://blogs.helmholtz.de/moses/>



- **Scientific Question**
- **Observing System**
- **Observation & Evaluation**
- **Timeline & Organisation**

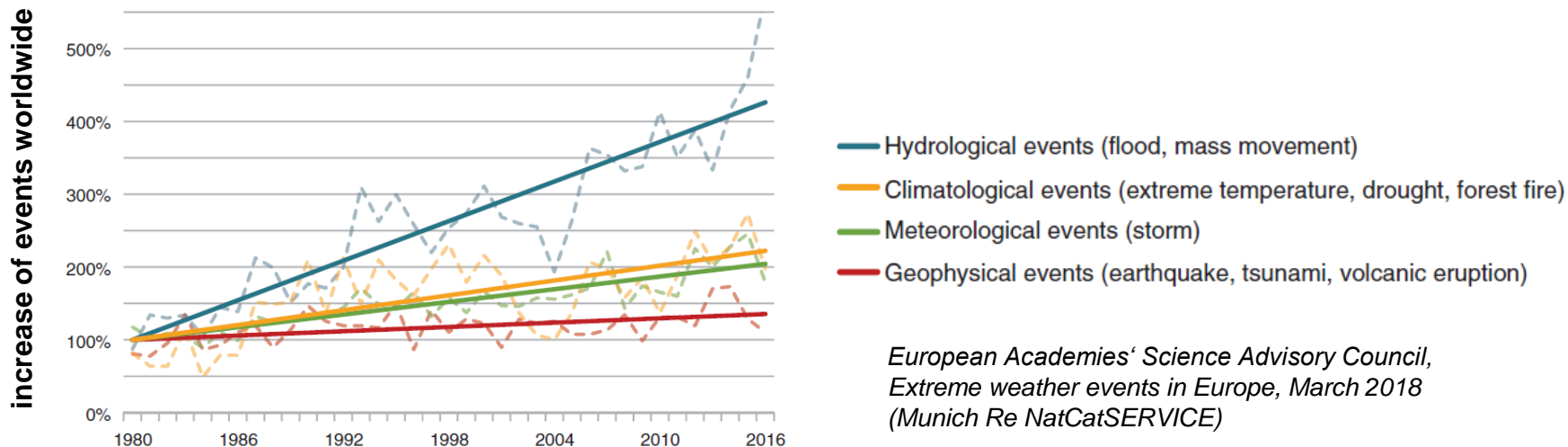
# Why Events ?



**1. Events have the potential for long-term environmental changes**

➤ **To what extent ?**

# Why Events ?



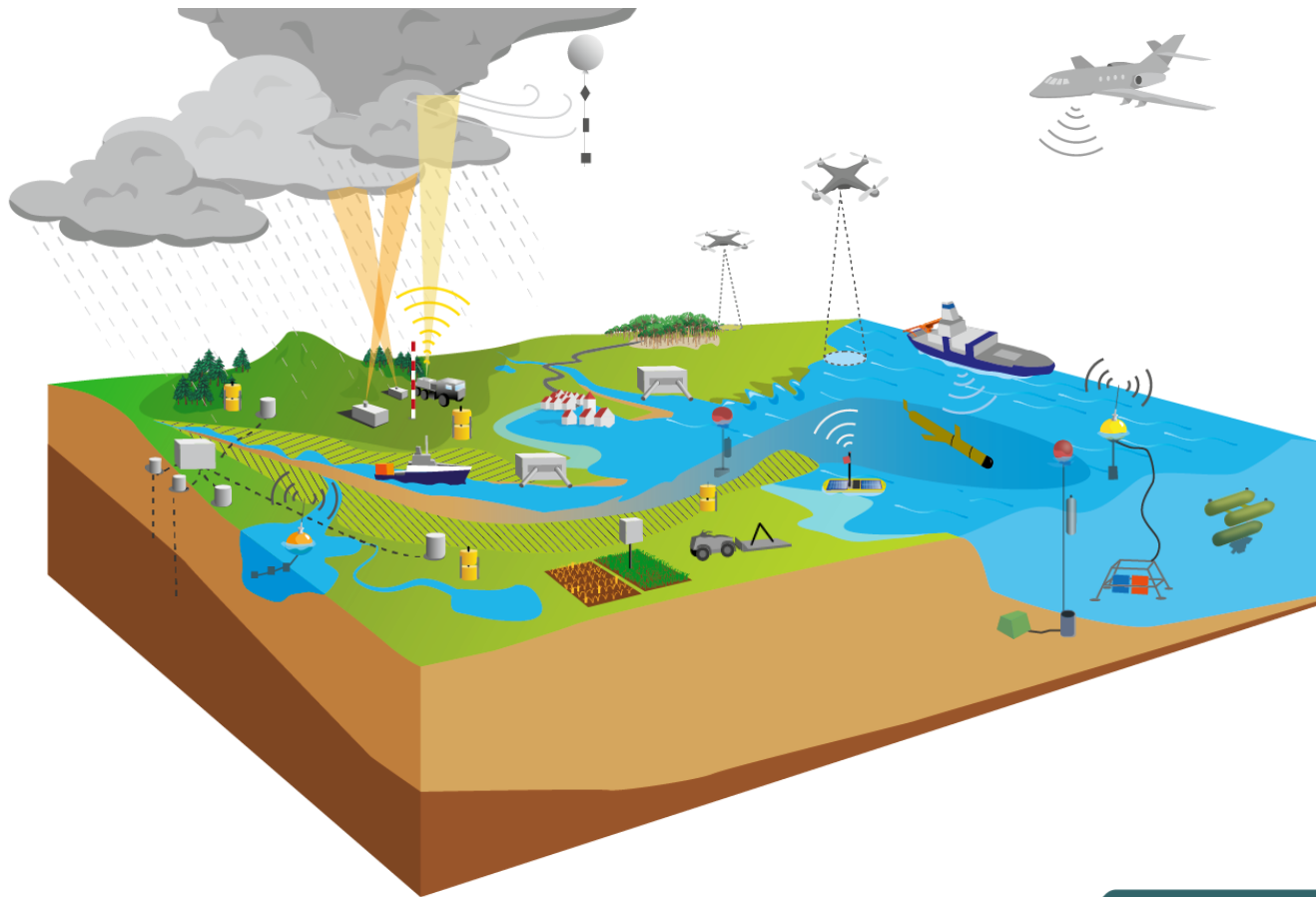
## 2. Events are likely to appear more frequently / intense in the future

### ➤ What are their long-term impacts?



- **Scientific Question**
- **Observing System**
- **Observation & Evaluation**
- **Timeline & Organisation**

# Mobile and Modular Observing System



## Requirements

- mobile + modular
- system-oriented
- multi-parameter sensor systems

## Technical Innovation

- new developments
- miniaturization
- automation



MOSES Module	Consortium	Heat Waves	Hydrologic Extremes	Ocean Eddies	Thaw Events Permafrost
Autonomous Vehicles	GEOMAR, HZG		X	X	X
Fixed Point Observatories	AWI, GEOMAR, HZG		X	X	X
Coastal and Marine Mobile Systems	AWI, GEOMAR, HZG		X	X	X
Permafrost Thaw and Subsidence	AWI, GFZ	X	X		X
Flow and Sediment Dynamics	AWI, GFZ, UFZ	X	X		X
Biota	AWI, HMGU, UFZ, KIT, FZJ	X	X		
Water Balance	GFZ, FZJ, UFZ	X	X		X
Soil and Water Quality	HMGU, UFZ	X	X		
Land-Atmosphere Fluxes	KIT, FZJ, UFZ, GFZ	X	X		X
Atmospheric Dynamics	FZJ, KIT	X	X	(X)	
Atmospheric Chemistry	FZJ, KIT	X	X		X

DLR: airborne TANDEM-L-like System (operational ~2020)

**mobile gravimeters** groundwater  
**cosmic ray rover** soil moisture  
**mobile flux-towers** GHG + energy fluxes  
**isotope-stations** isotope signatures of GHG + H<sub>2</sub>O  
**mobile lidar** aerosols, wind, turbulence,  
boundary layer properties  
**mobile radar** rain, wind, cloud properties  
**drones (planes)** GHG, O<sub>3</sub>, VOC, NO<sub>x</sub>, aerosols,  
thermal, multispectral  
**mini balloons** H<sub>2</sub>O, aerosols, O<sub>3</sub>, radiosonde,  
GHG



# Technical Innovation

## Land-Atmosphere Fluxes

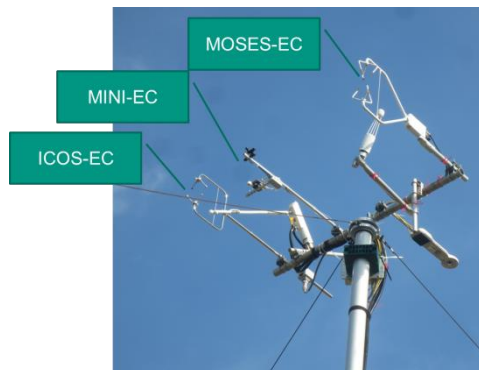
### Mobile Isotope Stations $\text{CO}_2$ / $\text{H}_2\text{O}$



high resolution isotope measurements

- GHG-assessment
- identification of sources

### MoLEAF Tower incl. Mini-EC System

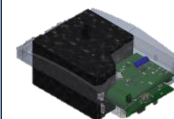


MOSES flux-system in accordance with ICOS system

- perspective: Mini-EC on drones

### Air Quality Drone additional Sensors

fine dust



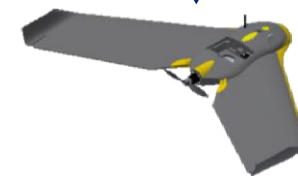
ozone



trace gases  
 $\text{NO}$ ,  $\text{NO}_2$ ,  $\text{CO}$ ,  $\text{O}_3$



VOC  
(offline, to be developed)





- Scientific Question
- Observing System
- **Observation & Evaluation**
- Timeline & Organisation

heat waves & droughts  
hydrological extremes  
rapid permafrost thaw  
ocean eddies

**event-driven observation campaigns**  
along „event chains“



integration of event data into long-term / large-scale reference systems

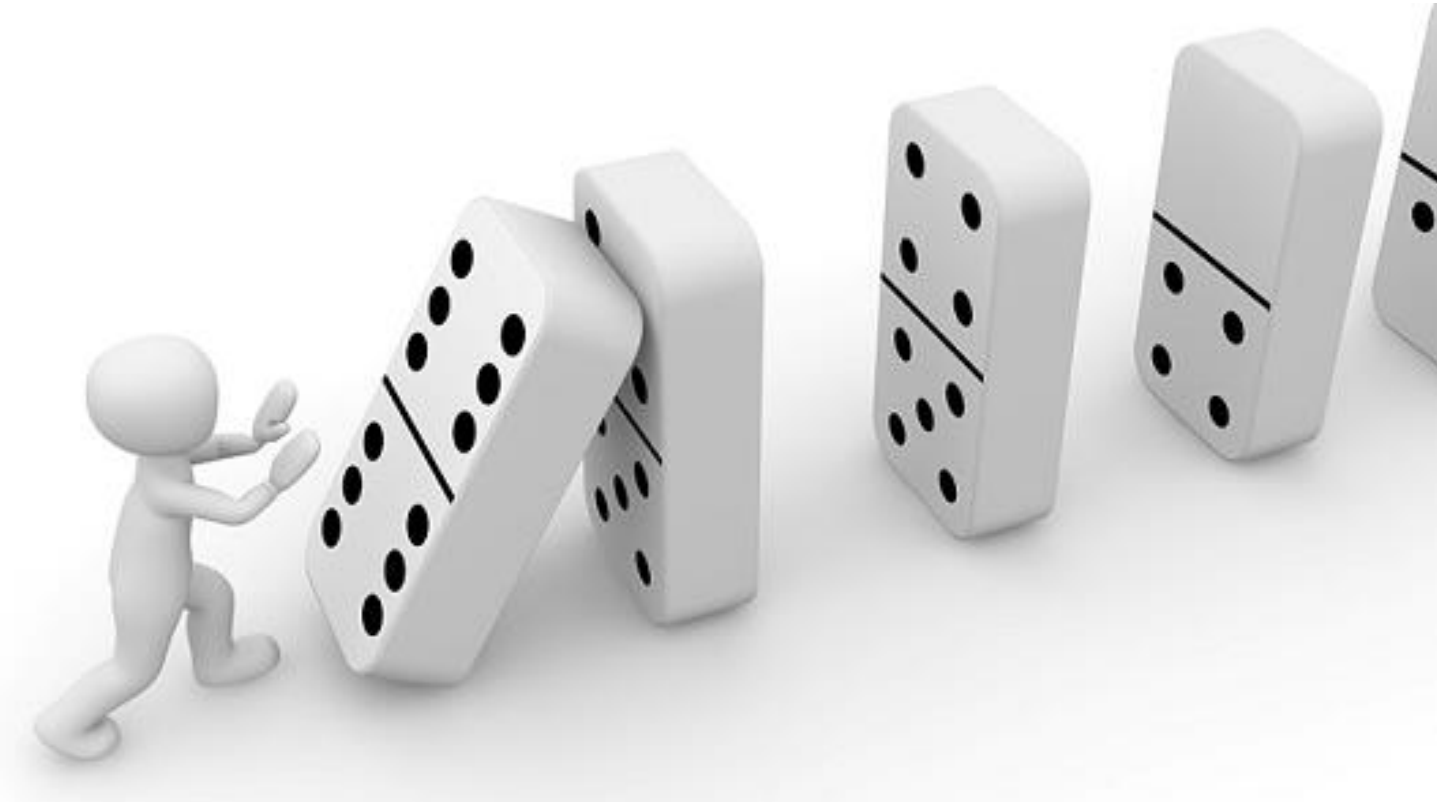
 **national and international monitoring programmes / satellite data**

## MOSES requires long-term / large scale reference systems

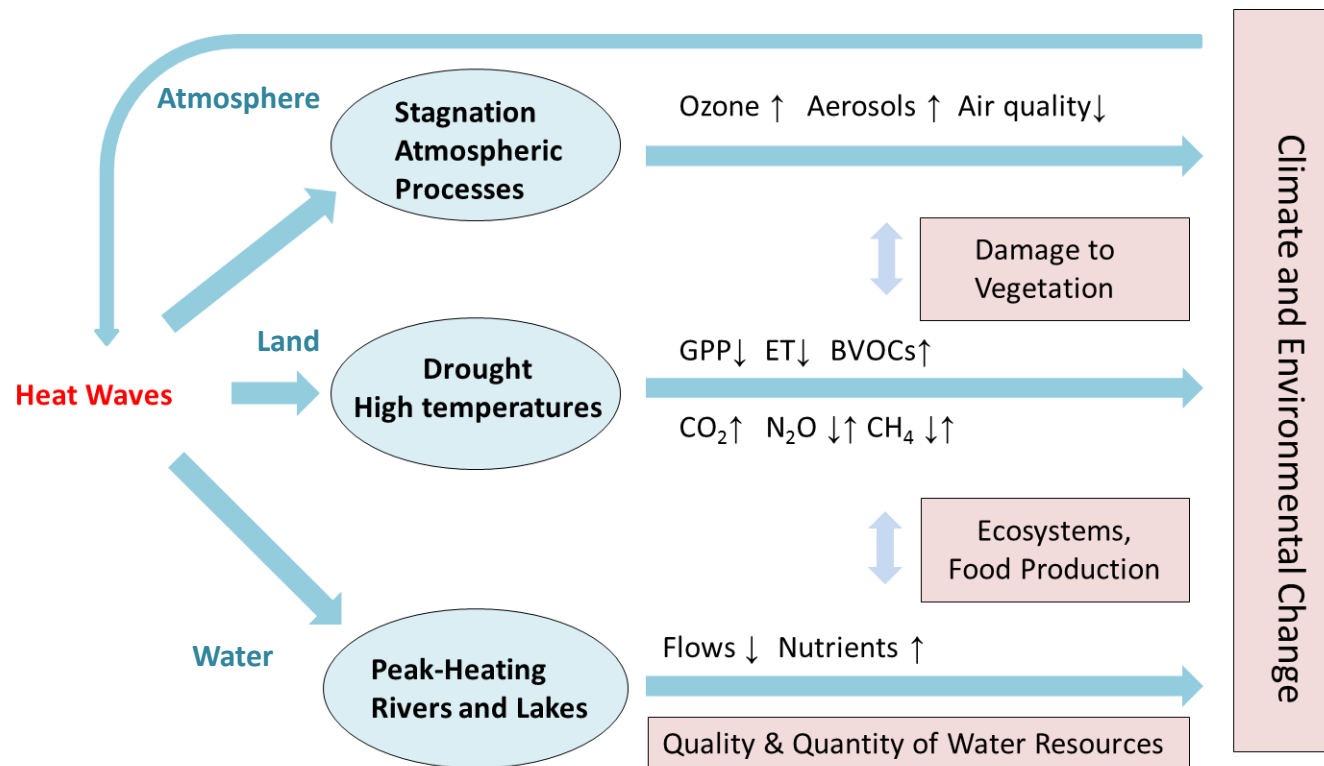
- **Helmholtz Observatories**  
TERENO, COSYNA, Kapverden, Lena Delta,  
→ sites for MOSES test campaigns
- **National and International Environmental Monitoring Programmes**  
ICOS, LTER, WWRP, EuroGOOS, ...
- **Satellite Missions**  
MODIS, EnMAP, Sentinels, Grace-FO, ...



# Observation along Event Chains



# Observation along Event Chains





- **Scientific Question**
- **Observing System**
- **Observation & Evaluation**
- **Timeline & Organisation**



# Implementation 2017 - 2021: Test Campaigns

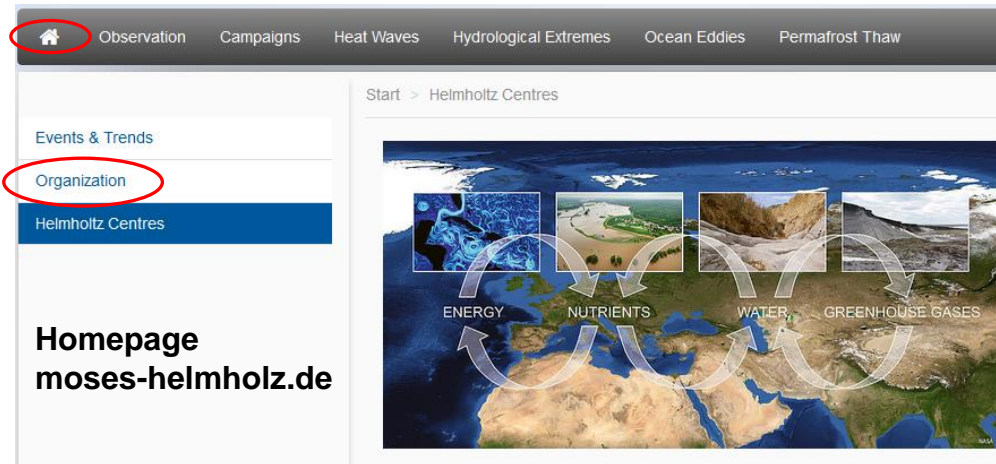


➤ cooperation with national / (international) partners from research and practise

Event	Date	Test Campaign
Heat & Droughts	7/2018 5/2019	TERENO Eifel: atmosphere chemistry, soil moisture, land-atmosphere fluxes ✓ ScaleX, TERENO Ammer: atmosphere chemistry and dynamics, vegetation stress, land-atmosphere fluxes, soil moisture
Hydrological Extremes	4/2019 4-9/2019 2020	Erzgebirge, Müglitztal: heavy rain and flood generation Elbe estuary: water quality Elbe catchment and estuary: dominant processes during high and low flows
Permafrost	8/2018	Mackenzie Delta: GHG emissions, thermokarsts ✓
Ocean Eddies	2019/20	Cape Verde: low oxygen eddies

... there are more test campaigns to come

# Organisation



## Project Coordination

Dr. Ute Weber, UFZ

## Implementation Office

Dr. Claudia Schütze, UFZ

## Data Management

Dr. Dorit Kerschke, GFZ

## MOSES Team

## MOSES Steering Committee

Prof. Philipp Fischer, AWI

Prof. Irena Hajsek, DLR

Prof. Harry Vereecken, FZJ

Prof. Jens Greinert, GEOMAR

Prof. Bruno Merz, GFZ

Prof. Jörg Schnitzler, HMGU

Prof. Burkard Baschek, HZG

Prof. Hans-Peter Schmid, KIT

Prof. Peter Dietrich, UFZ

## Coordination Event Workgroups

### Heat Waves and Droughts

Prof. Astrid Kiendler-Scharr, Prof. Nicolas Brüggemann, FZJ

### Hydrological Extremes

Prof. Dietrich Borchardt, UFZ, Prof. Philipp Fischer, AWI

### Ocean Eddies

Prof. Burkard Baschek, HZG

### Abrupt Permafrost Thaw

PD Dr. Julia Boike, AWI

# Aims for Operation Phase from 2022



- **Operational Observing System**  
for event-driven observation campaigns
    - ▶ including ad hoc operation for heat & droughts, hydrological extremes
  - **Access Procedure to the Sensor Systems**  
based on scientific quality
  - **MOSES data portal**  
internal and external access
- Poster Friday 8:30–10:15 Hall X1 Board X1.53



- **implementation phase from 2017 until 2021, mainly via the test campaigns in cooperation with partners from research and practice**

# Thank you for Attention



First MOSES Test Campaign: Heat & Drought, July 2018 TERENO Eifel

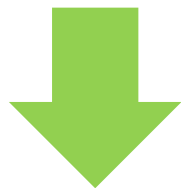
## Acknowledgements

- Helmholtz Association for funding
- involved centers for their support
- all who participate

**in case someone wants to know**

## 1. Conception and Planning

- **MOSES Campaign:** Concept and operational plan are developed bottom up by a HGF consortium + partners
- **Steering committee or ...panel:** checks quality and feasibility, assigns time frame



elaborated + approved  
MOSES campaign

## 2. Operation

- **Ocean Eddies and Permafrost:** reliable time frame, find hot spot
  - **Heatwaves and Hydrologic Extremes:** place and time uncertain  
ad hoc operation based on elaborated and approved campaign,  
MOSES modules and personnel are available at short notice
  - **1-2 MOSES campaigns per year**
- } weeks - months

## 3. Coordinated use of MOSES modules should be possible during idle times

# Observation: Heat Wave Campaign

