



PAGES Focus 3: Global Earth-System Dynamics



- How do large-scale changes in the Earth System affect regional climatic and environmental conditions?
- How have regions or Earth System components interacted to produce climate and environmental variations on a global scale?
- What are the causes and thresholds of rapid transitions, in particular on timescales that are relevant to society? How reversible are these changes?

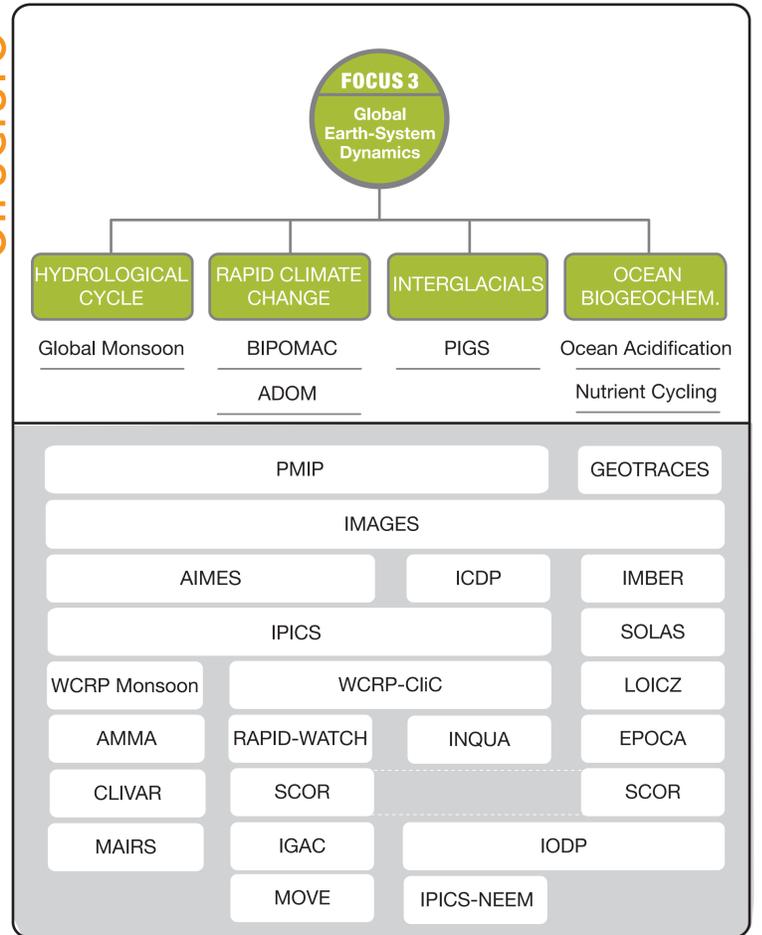
Aims

Focus 3 looks at large-scale interactions between components of the Earth System (atmosphere, biosphere, cryosphere, hydrosphere) and the links between regional- and global-scale changes. It hosts activities to synthesize records at a global scale, acting as an umbrella for the regional studies of Focus 2 on Regional Climate Dynamics and as a link to the forcings addressed in Focus 1 on Climate Forcings. Working Groups address global-scale abrupt and gradual Earth System changes and their underlying processes, including their response to changes in forcings, internal feedbacks and teleconnections.

Rationale

The past provides numerous examples in which changes in forcing at the global scale have occurred, and others where a redistribution of climate patterns appears to have occurred in the absence of global-scale forcing, either because of a change in the spatial and seasonal pattern of forcing, or because of internal changes in the system. We can use the past to diagnose the patterns of change that occur under different scenarios. More specifically, by investigating how changes in different components of the Earth System and different regions were related in the past, we can test and improve the process understanding required for predictive models. Additionally, we can investigate whether the system has exhibited rapid changes, and possibly threshold behavior.

Structure



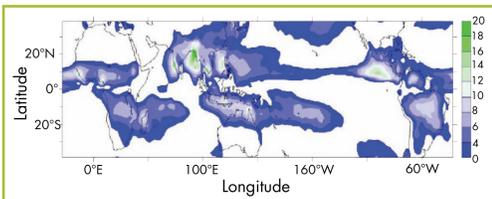
Structure of Focus 3. Top: Focus Themes (green boxes) with the corresponding Working Groups below. Bottom: Overlap with external programs (white boxes).

Activities & Goals

Goals by Theme:

HYDROLOGICAL CYCLE

- To unravel the mechanisms causing variations in both the global and regional monsoon systems.
- To identify and understand teleconnections between global- and regional-scale monsoon variations and other components of the climate system.
- To disentangle the processes leading to shifts in the position and strength of the Intertropical Convergence Zone at interdecadal to millennial timescales.



Observed difference between summer and winter precipitation (mm/day) showing the monsoon domains. Based on modern precipitation climatology of Xie and Arkin (1997).

OCEAN BIOGEOCHEM.

- To compile proxy evidence for past global changes in the oceanic nitrogen and iron cycles during rapid climate transitions, and to unravel the mechanisms causing the variations.
- To quantify the response of marine organisms and ecosystems to acidification and their feedback on atmospheric CO₂ using paleoceanographic records of historical acidification, as well as examples from high-CO₂ worlds in Earth history.
- To compile proxy data on marine productivity at glacial-interglacial and shorter timescales to assess the overall efficiency of the marine biological pump under different climatic boundary conditions.

RAPID CLIMATE CHANGE

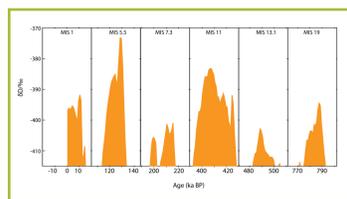
- To combine well-dated records of centennial- to millennial-scale oceanographic and climatic change during the Holocene, the last glacial period and previous interglacials, using both bipolar and global comparisons of data with rigorous quality and age control.

- To characterize the rate of abrupt changes and their temporal relation to the underlying forcings and feedback processes.

- To use data compilations to assess hypotheses on the drivers and effects of past Meridional Overturning Circulation (MOC) changes in order to inform assessments of the possibility of such changes in the future and of their potential impacts.

INTERGLACIALS

- To combine well-dated records of multiple glacial cycles over at least the ice core era (800 ka), with the particular goal of understanding the spatial pattern and temporal trends within interglacials.
- To constrain the extent of changes in sea level and ice-sheet extent in past interglacials.
- To determine the variability at multi-annual to millennial timescales within warmer interglacials of the last 800 ka.



Evolution of Antarctic temperature (represented by deuterium content) across a selection of interglacials. Data are shown as 1ka averages, based on Jouzel et al. (2007).

Implementation

Many activities defined within the Hydrological Cycle Theme are carried out within the **Global Monsoon Working Group (WG)** in cooperation with international, modern climatological programs. The Global Monsoon WG includes both data producers and modelers, and integrates across all the regional monsoon systems, as well as across past and present timescales. Within the Rapid Climate Change Theme, the **Bipolar Climate Machinery (BIPOMAC) WG** aims to facilitate better understanding of the ocean-atmosphere-ice related processes in the Southern and the Northern Hemisphere that trigger, amplify and propagate climate change in polar regions. The **Past Atmospheric Dynamics (ADOM) WG**, which addresses atmospheric dynamics using eolian deposits and modeling, will also provide a major contribution towards the Theme goals, as will the **Past Interglacials (PIGS) WG**, by addressing whether abrupt events like the 8.2 ka event also occurred during previous interglacials. The PIGS WG leads the implementation of scientific activities for the Interglacials Theme. Furthermore, formation of an intercomparison project on past interglacial ice sheet modeling will be encouraged. Along the way, collection and archiving of well-dated and highly resolved records is envisioned and should eventually lead to spatial reconstructions of past interglacials. **Marine Nutrient Cycling** and **Ocean Acidification WGs** will pursue the goals within the Paleo-Perspective on Ocean Biogeochemistry Theme, with the involvement and collaboration of other international marine programs.