

# **NORTHERN AFRICA —**

**PAST, PRESENT, AND FUTURE CLIMATE CHANGES**

**Workshop of the Excellence Cluster CliSAP  
and the Max Planck Institute for Meteorology  
at KlimaCampus Hamburg**

**on 7 - 9 February 2011**

A workshop of the Excellence Cluster CliSAP  
(Integrated Climate System Analysis and Prediction, DFG EXC 177)  
and the Max Planck Institute for Meteorology at KlimaCampus  
Hamburg on 7 - 9 February 2011

## Scientific Organizing Committee

Martin Claussen (Hamburg)

Victor Brovkin (Hamburg)

Philipp Hoelzmann (Berlin)

Zhengyu Liu (Madison, WI)

Jörg Völkel (München)

## Layout & Design & Druck

Norbert P. Noreiks (MPI-M, Hamburg)

Photo: Philipp Hoelzmann (FU Berlin)

Klimaneutraler Druck: flyeralarm GmbH, Würzburg

## Workshop Dinner

The workshop dinner is scheduled for **Tuesday 8 February 2011**  
at 19:00 h at the Germania Rowing Club, Alsterufer 21 (phone:  
+49-40-418035). The Germania Rowing Club is nicely located with  
a view over the lake Außenalster. Walking distance from the Geo-

matikum is about 20 minutes. When you reach the square across  
the street from Dammtor railway station (Theodor Heuss Platz),  
head East crossing the street Moorweide and then using the small  
street Alsterterrassen until you reach the Alster lake. Then turn  
left and after 200 m you will reach the Germania Rowing Club.

The closest stations for public transport are Dammtor and  
Stephansplatz. From Geomatikum you can take bus no. 4 to  
Dammtor (direction Hauptbahnhof/ZOB or Marco-Polo-Terrassen  
or Rathausmarkt), leaving every 10 minutes just from the subway  
station Schlump, Gustav-Falke-Straße.

## Workshop Office

Barbara Zinecker | E-mail: [barbara.zinecker@zmaw.de](mailto:barbara.zinecker@zmaw.de)

Tel: +49-40-41173-226 | Fax: +49-40-41173-350

## WLAN access

WLAN is available in the ZMAW building. You have to connect to  
the wireless network of the University of Hamburg with the SSID  
„GUEST“. Please find more information in the User Manual for Uni-  
versity of Hamburg Wireless Network „GUEST“ in your workshop  
folder.

# NORTHERN AFRICA – PAST, PRESENT, AND FUTURE CLIMATE CHANGES

“Will greenhouse green the Sahara?” This question posed by Nicole Petit-Maire some 20 years ago (Petit-Maire, Episodes, 1990) refers to the apparent correlation between global temperature and Northern African vegetation change. During the early and mid-Holocene, Northern Africa was, at least regionally, warmer and more humid than today, and during glacials, deserts covered a larger area.

Thus it seems plausible to assume that Northern Africa could become greener again if anthropogenic greenhouse gas-induced warming continues to increase. Although it has been disputed whether the so-called mid-Holocene climate optimum is a direct analogue for future greenhouse gas-induced climate change in Northern Africa, current recovery of vegetation in the Sahel is sometimes, at least in some media, interpreted as “greenhouse gas greening”.

Science, as summarized in the latest IPCC report, reveals an ambiguous picture with the exception for the Mediterranean region, where all models indicate dryer climate. Hence, today the classical question is still open. The current workshop attends to critically revisit the scientific challenge by reviewing and discussing the following questions:

## 1. How green was Northern Africa in the early and mid-Holocene?

The extent of vegetation coverage of Northern Africa during the mid-Holocene wet phase is still not fully known. Areal reconstructions differ, so do model simulations. Was the Sahara more or less uniformly covered by diffuse vegetation with trees along lakes and rivers?

Or did contracted vegetation prevail in large oases being surrounded by desert? Is the vegetation-atmosphere interaction the dominant, positive feedback as previously assumed?

## 2. How fast did Northern Africa change?

Model studies indicate the possibility of multiple states of the atmosphere-vegetation system in Northern Africa and the possibility of an, in comparison with orbital forcing, abrupt retreat in the early Holocene, or even in the Bølling/Allerød, and abrupt expansion of the Sahara. However, different types of transition are realized in the models ranging from single abrupt transition, apparently smooth transition and a flickering in a bi-stable or mono-stable regime. Dynamics in the Western and the Eastern part of the Sahara seem to differ.

Evidence to falsify models is sparse. A number of marine records indicate a fast change in humidity proxies and dust trans-

port. Terrestrial records point at a sequence of dry and wet spells around the mid-Holocene. What do we know about the onset of the wet phase in Northern Africa?

### 3. How could Northern Africa change in the future?

According to the latest IPCC report, estimates on possible precipitation changes in Northern Africa vary. The standard deviation among various model estimates is larger than the ensemble climate change signal – except for the region around the Mediterranean (see Fig. 10.9 in IPCC AR4, 2007). Therefore, it is not at all obvious whether greenhouse gas-induced climate warming will lead to more or less rainfall.

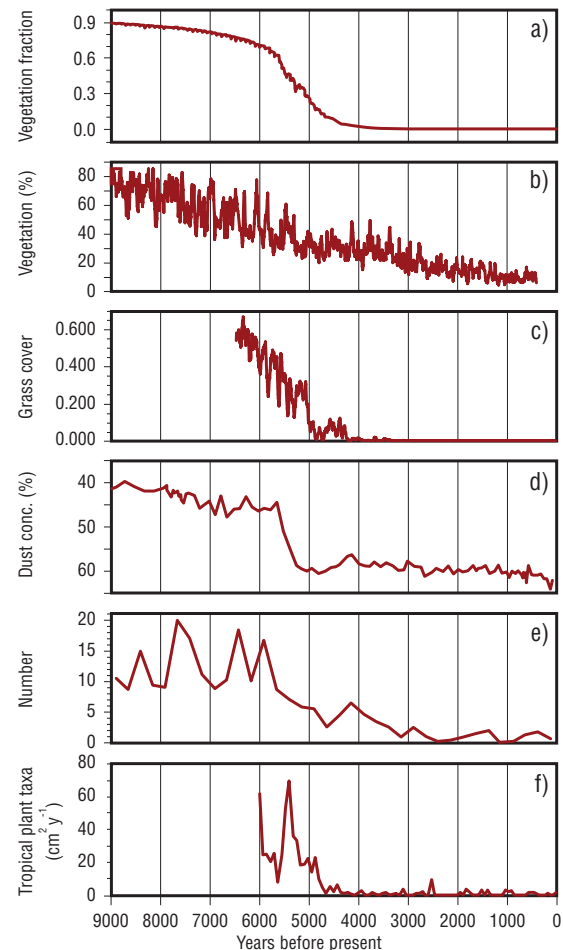
Models which include atmosphere-vegetation interaction indicate that this interaction might amplify any signal, i.e., by producing a stronger greening or a stronger desert expansion. What are the newest estimates? Would falsification of models by use of palaeoclimatic reconstruction help improve estimates of potential future changes? Can current greening as observed from satellites already be interpreted as response to greenhouse gas increase? Or does decadal variability in Sahelian rainfall conceal any detection of a signal?

### Scope of the workshop

This is the first of (at least) two workshops on Northern African climate change. In the first workshop, we would like to focus on the dynamics of the natural climate system and on lessons learnt from palaeoclimate modelling and palaeoclimatology. A second workshop will focus on humans and human interaction with Northern African climate.

A desirable outcome of the workshop would be a comprehensive discussion being presented in a review paper or a series of papers, perhaps even a special issue in some of the open-access journals. The paper(s) should summarize the spectrum of data and of our conceptual and model-based interpretation of data. Where do we agree, and where do we disagree?

Fig. 1: Transient development of vegetation fraction and climate in the Sahara. (a) Simulated changes in vegetation fraction on average over the entire Sahara by Claussen and Gayler (1997). (b) Simulated changes in vegetation fraction in the Western Sahara/Sahel region (14°W to 3°E, 17°N to 28°N) by Renssen et al. (2003). (c) Simulated changes in grass cover in the Eastern Sahara (11°E to 34°E, 18°N to 23°N) by Liu et al. (2007). (d) Reconstructed dust concentration in North Atlantic marine sediment (at approximately 20.8°N, 18.5°W) by deMenocal et al. (2000). (e) Number of <sup>14</sup>C dates in the Sahara east of 11°E by Pachur (1999). (f) Reconstructed change in tropical plant taxa from Lake Yoa (at approximately 19°N, 20.3°E) by Kröpelin et al. (2008). This figure is taken from Claussen (2009).



## References

- Claussen, M., 2009: Late Quaternary vegetation – climate feedbacks. *Clim. Past*, **5**, 203-216.
- Claussen, M. and Gayler, V., 1999: The greening of Sahara during the mid-Holocene: Results of an interactive atmosphere - biome model. *Global Ecology and Biogeography Letters*, **6**, 369-377.
- Kröpelin, S., Verschuren, D., Lézine, A.-M., Eggermont, H., Cocquyt, C., Francus, P., Cazet, J.-P., Fagot, M., Russell, J.M., Darius, F., Conley, D.J., Schuster, M., von Suchodoletz, H., and Engstrom, D.R., 2008: Climate-driven ecosystem succession in the Sahara: The past 6000 years. *Science*, **30**, 765-768.
- Liu, Z., Wang, Y., Gallimore, R., Gasse, F., Johnson, T., deMenocal, P., Adkins, J., Notaro, M., Prentice, I.C., Kutzbach, J.E., Jacob, R., Behling, P., Wang, L., and Ong, E., 2007: Simulating the transient evolution and abrupt change of Northern Africa Atmosphere-Ocean-Terrestrial Ecosystem in the Holocene. *Quaternary Science Review*, **26**, 1818-1837.
- deMenocal, P.B., Ortiz, J., Guilderson, T., Adkins, J., Sarnthein, M., Baker, L., and Yarusinski, M., 2000: Abrupt onset and termination of the African Humid Period: Rapid climate response to gradual insolation forcing. *Quaternary Science Review*, **19**, 347-361.
- Pachur, H.-J., 1999: Paläo-Environment und Drainagesysteme der Ostsahara im Spätpleistozän und Holozän. In: Nordost-Afrika: Strukturen und Ressourcen; Ergebnisse aus dem Sonderforschungsbereich "Geowissenschaftliche Probleme in Ariden und Semiariden Gebieten": (Eds. Klitzsch, E. and Thorweihe, U.), 366-455, Wiley - VCH, Weinheim.
- Petit-Maire, N., 1990: Will greenhouse green the Sahara? *Episodes*, **13** (2), 103-107.
- Renssen, H., Brovkin, V., Fichefet, T., and Goosse, H., 2003: Holocene climate instability during the termination of the African Humid Period. *Geophys. Res. Lett.*, **30** (4), 1184.

## Workshop Agenda

Presentation format:

15 min presentation and 5 min brief questions

### Monday 7 February 2011

13:00 – 13:15 Welcome and Introduction to the Workshop

#### *Question 1: How green was Northern Africa in the mid-Holocene?*

13:20 – 13:40 Anne-Marie Lézine (LSCE, Paris) et al.

**Sahara and Sahel vulnerability, lessons from the past: Holocene pollen and hydrological data**

13:40 – 14:00 Stefan Kröpelin (U Köln)

**Discrepancies between marine and terrestrial data on Holocene climate change in the Sahara and the so-called „African Humid Period“**

14:00 – 14:20 Philipp Hoelzmann (FU Berlin)

**Ideality and reality: The dilemma of palaeohydrological and palaeoenvironmental data bases for the Sahara**

14:20 – 14:40 Hans-Joachim Pachur (FU Berlin)

**Palaeohydrology of the Eastern Sahara - a CO<sub>2</sub>-sink at 6 ka**

14:40 – 15:00 Brief Discussion

15:00 – 15:30 Coffee Break

15:30 – 15:50 Stefan Mulitza (MARUM, Bremen)

**Mid- to late Holocene history of West African precipitation, vegetation and dust production**

15:50 – 16:10 Matthias Prange (MARUM, Bremen)

**African Humid Period: Mid-Holocene versus earlier interglacials**

16:10 – 16:30 Anne Dallmeyer, Freja Vamborg

(MPI-M, Hamburg)

**Green Sahara as simulated in the ECHAM-N models**

16:30 – 16:50 Jim Russell (Brown, Rhode Island)

**Synchronous and asynchronous monsoon variations in Northern and Equatorial Africa**

16:50 – 17:10 Brief Discussion

17:15

Ice Breaker

Presentation format:

15 min presentation and 5 min brief questions

## Tuesday 8 February 2011

### *Question 1: How green was Northern Africa in the mid-Holocene? (Cont.)*

- 09:00 – 09:20 Lydie Dupont (MARUM, Bremen)  
**Green, greener, greenest? The Sahara in Middle Pleistocene and Late Pliocene**
- 09:20 – 09:40 Uli Salzmann (Northumbria, Newcastle)  
**Shifting savannas and collapsing forests: A Holocene and Pliocene view from the South**
- 09:40 – 10:00 Jörg Völkel (TU München)  
**Megafloods and landscape change during OIS 3 in the Sinai Mts., Egypt**

10:00 – 10:30 **Coffee Break**

10:30 – 12:00 Discussion (chair: Martin Claussen)

12:00 – 13:30 **Lunch**

### *Question 2: How fast did Northern Africa Change?*

- 13:30 – 14:00 Peter deMenocal (LDEO, Columbia)  
**Marine sediment records of the African Humid Period: Timing and Rates of Climate Transitions**
- 14:00 – 14:20 Dirk Verschuren (U Gent)  
**Abrupt or gradual: the archive and proxy do matter**

14:20 – 14:40 Zhengyu Liu (U Wisconsin)  
**Abrupt change and vegetation feedback in N Africa climate-ecosystem: A combined paleo- and present perspective**

14:40 – 15:00 Hans Renssen (VU Amsterdam)  
**Simulation of the Holocene climate evolution: The termination of the African Humid Period**

15:00 – 15:30 **Coffee Break**

15:30 – 15:50 Sebastian Bathiany (SICSS, Hamburg)  
**Implications of climate variability for a vegetation collapse at the end of the African Humid Period**

15:50 – 16:10 Bette Otto-Bliesner (NCAR)  
**Onset of the wet phase in North Africa: orbital, carbon dioxide and meltwater effects**

16:10 – 16:30 Sharon Nicholson (Florida State U)  
**Non-linearities in the environmental system over West Africa and implications for abrupt change**

16:30 – 18:00 Discussion (chair: Zhengyu Liu)

19:00 **Dinner “Der Hamburger und Germania Ruder Club”**  
*Follow the directions on page 2 „Workshop Dinner”*

Presentation format:  
15 min presentation and 5 min brief questions

### **Wednesday 9 February 2011**

#### ***Question 3: How could Northern Africa change in the future?***

09:00 – 09:20 Martin Claussen (UHH/MPI-M, Hamburg)

**The future of North Africa as simulated in the  
CLIMBER Model**

09:20 – 09:40 John Hughes (UK MetOffice, Reading)

**The future of North Africa as simulated in the Hadley  
Center Model**

09:40 – 10:00 Sam Levis (NCAR)

**21<sup>st</sup> century climate and vegetation simulated for  
N. Africa by the CCSM4/CESM1**

**10:00 – 10:30 Coffee Break**

10:30 – 10:50 Victor Brovkin (MPI-M, Hamburg)

**The future of North Africa as simulated  
in the MPI-ESM**

10:50 – 11:10 Kerry Cook (U Texas)

**Future Climate of Northern Africa: Regional  
Prediction and the Evaluation of Confidence**

11:10 – 11:30 Heiko Paeth (U Würzburg)

**Man-made land-cover changes as a driver for future  
climate change in Africa**

11:30 – 11:40 Jonathan Seaquist (Lund)

**Sahel greening patterns derived from Earth  
observation data**

11:30 – 12:40 Discussion (chair: Victor Brovkin)

12:40 – 13:00 Final Remarks

## Participants

Bathiany, Sebastian (U Hamburg, MPI-M)

*sebastian.bathiany@zmaw.de*

Brovkin, Victor (MPI-M)

*victor.brovkin@zmaw.de*

Brücher, Tim (MPI-M)

*tim.bruecher@zmaw.de*

Claussen, Martin (U Hamburg, MPI-M)

*martin.claussen@zmaw.de*

Cook, Kerry H. (U Texas, Austin)

*kc@jsge.utexas.edu*

Cubasch, Ulrich (FU-Berlin)

*cubasch@zedat.fu-berlin.de*

deMenocal, Peter B. (LDEO, Columbia)

*peter@ldeo.columbia.edu*

Dallmeyer, Anne (MPI-M)

*anne.dallmeyer@zmaw.de*

Dupont, Lydie (U Bremen)

*dupont@uni-bremen.de*

Fink, Andreas (U Köln)

*fink@meteo.uni-koeln.de*

Fraedrich, Klaus (U Hamburg)

*klaus.fraedrich@zmaw.de*

Gasse, Françoise (CEREGE, CNRS, Aix-en-Provence)

*gasse@cerege.fr*

Gayler, Veronika (MPI-M)

*veronika.gayler@zmaw.de*

Hagemann, Stefan (MPI-M)

*stefan.hagemann@zmaw.de*

Hänsler, Andreas (MPI-M)

*andreas.haensler@zmaw.de*

Heine, Klaus (U Regensburg)

*klaus.heine@geographie.uni-regensburg.de*

Hoelzmann, Philipp (FU Berlin)  
*phoe@zedat.fu-berlin.de*

Holzwarth, Ulrike (MARUM, Bremen)  
*holzwarth@uni-bremen.de*

Hughes, John (UK Met. Office)  
*john.hughes@metoffice.gov.uk*

Kleinen, Thomas (MPI-M)  
*thomas.kleinen@zmaw.de*

Körper, Janina (FU Berlin)  
*janina.koerper@met.fu-berlin.de*

Kröpelin, Stefan (U Cologne)  
*s.kroe@uni-koeln.de*

Levis, Sam (NCAR, Boulder)  
*slevis@ucar.edu*

Lezine, Anne-Marie (CNRS)  
*anne-marie.lezine@lsce.ipsl.fr*

Löw, Alexander (MPI-M, CliSAP)  
*alexander.loew@zmaw.de*

Marmer, Elina (CliSAP Guest)  
*elina.marmer@gmx.de*

Mulitza, Stefan (MARUM, Bremen)  
*smulitza@uni-bremen.de*

Nicholson, Sharon (FSU)  
*snicholson@fsu.edu*

Otto-Bliesner, Bette (NCAR, Boulder)  
*ottobli@ucar.edu*

Pachur, Hans-Joachim (FU Berlin)  
*pachurp@zedat.fu-berlin.de*

Paeth, Heiko (U Wuerzburg)  
*heiko.paeth@mail.uni-wuerzburg.de*

Prange, Matthias (MARUM, Bremen)  
*mprange@palmod.uni-bremen.de*

## Participants (Cont.)

Raddatz, Thomas (MPI-M)

*thomas.raddatz@zmaw.de*

Reick, Christian (MPI-M)

*christian.reick@zmaw.de*

Renssen, Hans (VU Amsterdam)

*hans.rensen@falw.vu.nl*

Russell, Jim (U Providence)

*james\_russell@brown.edu*

Salzmann, Ulrich (U Newcastle upon Tyne)

*ulrich.salzmann@northumbria.ac.uk*

Scheffran, Jürgen (U Hamburg)

*juergen.scheffran@zmaw.de*

Schilling, Janpeter (U Hamburg)

*janpeter.schilling@zmaw.de*

Schmiedl, Gerhard (U Hamburg)

*gerhard.schmiedl@uni-hamburg.de*

Schulz, Michael (MARUM, Bremen)

*mschulz@marum.de*

Seaquist, Jonathan (U Lund)

*Jonathan.Seaquist@nateko.lu.se*

Street-Perrott, Alayne (Swansea U)

*alayne@perrott3.freemove.co.uk*

Vamborg, Freja (MPI-M)

*freja.vamborg@zmaw.de*

Verschuren, Dirk (U Gent)

*Dirk.Verschuren@ugent.be*

Völkel, Jörg (TU München)

*jvoelkel@wzw.tum.de*

Zhengyu, Liu (U Wisconsin Madison)

*zliu3@wisc.edu*

## Accommodation

|                      |                      |                        |                      |
|----------------------|----------------------|------------------------|----------------------|
| Cook, Kerry H.       | <b>Mercure Hotel</b> | Renssen, Hans          | <b>Mercure Hotel</b> |
| deMenocal, Peter B.  | <b>Mercure Hotel</b> | Russell, Jim           | <b>Mercure Hotel</b> |
| Dupont, Lydie        | <b>Mercure Hotel</b> | Salzmann, Ulrich       | <b>YoHo Hotel</b>    |
| Fink, Andreas        | <b>YoHo Hotel</b>    | Schulz, Michael        | <b>Mercure Hotel</b> |
| Gasse, Francoise     | <b>YoHo Hotel</b>    | Seaquist, Jonathan     | <b>Mercure Hotel</b> |
| Heine, Klaus         | <b>YoHo Hotel</b>    | Street-Perrott, Alayne | <b>Mercure Hotel</b> |
| Hoelzmann, Philipp   | <b>Mercure Hotel</b> | Verschuren, Dirk       | <b>Mercure Hotel</b> |
| Hughes, John         | <b>Mercure Hotel</b> | Völkel, Jörg           | <b>Mercure Hotel</b> |
| Körper, Janina       | <b>YoHo Hotel</b>    | Zhengyu, Liu           | <b>Mercure Hotel</b> |
| Kröpelin, Stefan     | <b>YoHo Hotel</b>    |                        |                      |
| Levis, Sam           | <b>Mercure Hotel</b> |                        |                      |
| Lezine, Anne-Marie   | <b>Mercure Hotel</b> |                        |                      |
| Mulitza, Stefan      | <b>Mercure Hotel</b> |                        |                      |
| Nicholson, Sharon    | <b>Mercure Hotel</b> |                        |                      |
| Otto-Bliesner, Bette | <b>Mercure Hotel</b> |                        |                      |
| Paeth, Heiko         | <b>Mercure Hotel</b> |                        |                      |
| Pachur, Hans-Joachim | <b>Mercure Hotel</b> |                        |                      |
| Prange, Matthias     | <b>Mercure Hotel</b> |                        |                      |

# HOW TO GET TO THE WORKSHOP

(ZMAW Building, Bundesstraße 53)

## Public Transport

Hamburg buses and undergrounds are operated by HVV. All tickets you buy are valid for buses and undergrounds. An underground map to direct you to MPI-M can be found at the next two pages.

## From Hamburg Airport

Please take the S-Bahn S1 (signed Ohlsdorf) to Ohlsdorf station where you get off to enter the blue underground line no. U1, signed Ohlstedt/Großhansdorf. Please exit at Kellinghusenstrasse, change to the yellow line no. U3 on the same platform, signed Wandsbek-Gartenstadt, and get off at Schlump underground station.

Travel time for the alternative route is about 5 minutes more, but only requires one change of trains: Take the S-Bahn S1 signed Ohlsdorf as far as Barmbek station (please note: at Ohlsdorf two coaches will be coupled, but you can remain seated). At Barmbek please change to the yellow underground line U3 signed Wandsbek-Gartenstadt via Kellinghusenstrasse and exit at Schlump underground station.

## Taxi from the Airport

Cost is approx. 17-23 EUR. Transfer time: 30-50 minutes, depending on traffic density.

## By Train

### Public Transport

Arriving by train at the central railway station (Hauptbahnhof Hbf), take the HVV underground U2, red line, (tickets from machines in the station entrance hall). Enter trains signed Niendorf-Nord/Niendorf-Markt. Get off at Schlump underground station.

Alternatively, check if your train continues to Dammtor (Bahnhof) Station. If so, this station is the better choice for reaching MPI-M: Take bus No. 4 in front of Dammtor station, signed Wildacker, and exit at bus station Bundesstrasse. From there, turn towards the high-rise building, Geomatikum, on the left-hand side of which MPI-M is located.

### Taxi from the Central Railway Station

Cost is approx. 10 EUR. Transfer time: 15-25 minutes, depending on traffic density.



# Max-Planck-Institut für Meteorologie

**The Young Hotel  
YOHO**  
Moorkamp 5  
20357 Hamburg  
Tel.: 040-28 41 91 0

**Station  
Christuskirche**  
U

**Station  
Schlump**  
U

## Pavillon

**Bundesstraße 55:**  
**Max Planck Institute for Meteorology**  
• The Land in the Earth System  
University of Hamburg  
• Sustainability and Global Change  
Deutsches Klimarechenzentrum (DKRZ)

## CliSAP-Office

**Grindelberg 5:**  
University of Hamburg  
• Exzellenzcluster Integrated  
Climate System Analysis  
and Prediction (CliSAP)

## Geomatikum

**Bundesstraße 55:**  
**Max Planck Institute for Meteorology**  
• The Land in the Earth System  
University of Hamburg  
• Meteorological Institute

## MPI-M Main Building

ZMAW – Centre for Marine and  
Atmospheric Sciences  
**Bundesstraße 53:**  
**Max Planck Institute for Meteorology**  
• The Atmosphere in the Earth System  
• The Ocean in the Earth System  
Tel.: 040-411 73 - 249  
University of Hamburg  
• Institute of Oceanography

## DKRZ

**Bundesstraße 45a:**  
Deutsches Klimarechenzentrum  
(DKRZ)  
Climate Service Center  
(CSC)

**Sternschanzenpark**

**Station Sternschanze**  
S U

**Hotel Mercure  
an der Messe**  
Schröderstiftstr. 3  
20146 Hamburg  
Tel.: 040-450 69-2931 / -0

**Planten un Blumen**

**University of Hamburg**  
Edmund-Siemers-Allee 1

**Dammtor Bahnhof**  
S DB

Public Transport:

 Bus Lines 4, 5, 15, 181

 Underground Station **Schlump**: Lines U2 + U3

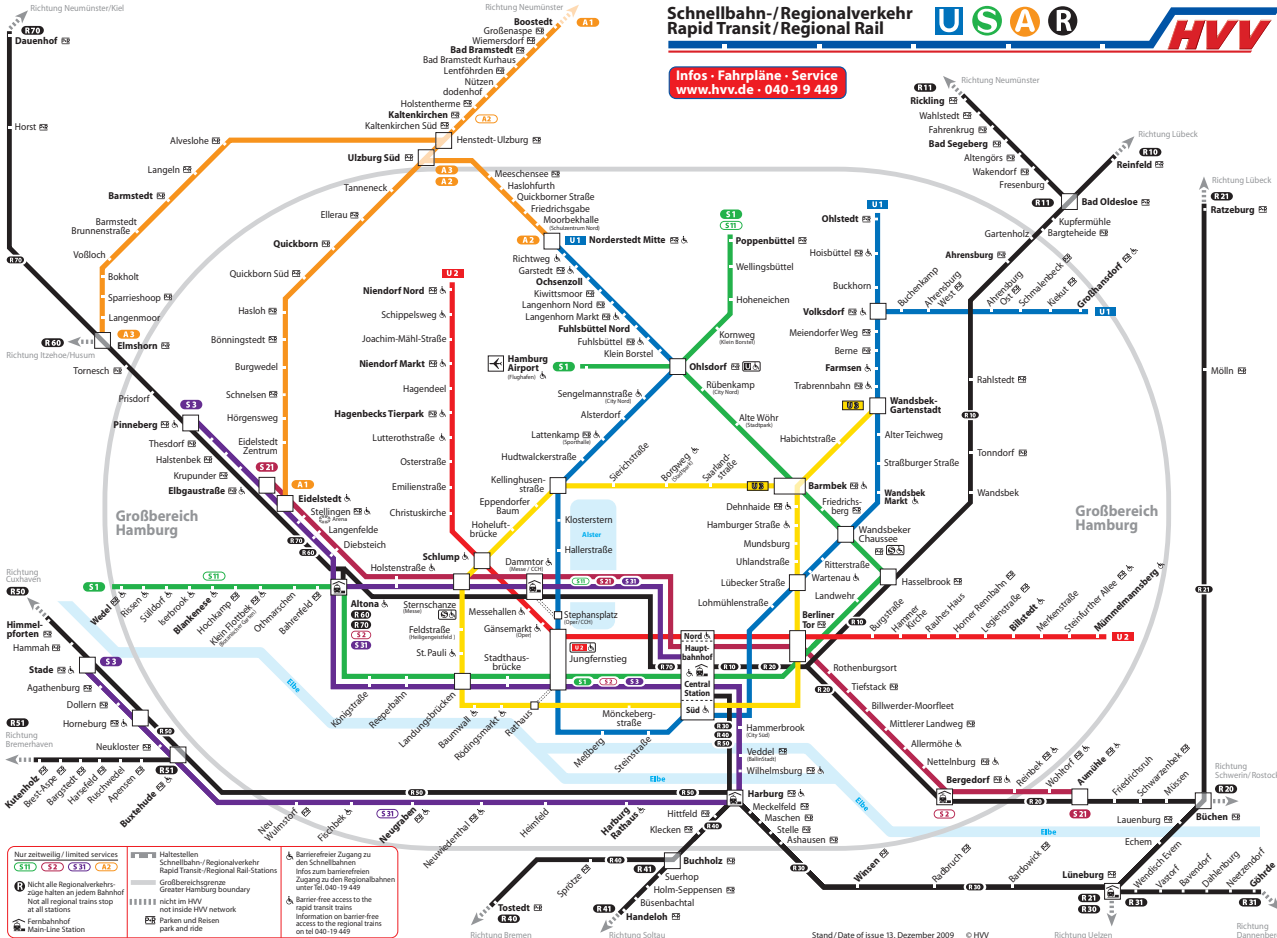
  Railway Station **Dammtor**: S-Bahn and Train

# Schnellbahn-/Regionalverkehr Rapid Transit/Regional Rail



**HVV**

Infos · Fahrpläne · Service  
[www.hvv.de](http://www.hvv.de) · 040-19 449



Source: HVV