

**UČNI NAČRT PREDMETA / COURSE SYLLABUS**

**Predmet:** PODNEBNE SPREMEMBE  
**Course title:** CLIMATE CHANGE

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Okoljske in regionalne študije, doktorski študij 3. stopnje	skupni	1	1,2
Environmental and Regional Studies, doctoral study 3 <sup>rd</sup> level	common	1	1,2

**Vrsta predmeta / Course type**

Izbirni / Elective

**Univerzitetna koda predmeta / University course code:**

DI014

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
30		20		10	120	6

**Nosilec predmeta / Lecturer:**

Doc. dr. Matija Zorn  
(ostali izvajalci: doc. dr. Mateja Ferk, dr. Matej Lipar)

**Jeziki /  
Languages:**

**Predavanja / Lectures:  
Vaje / Tutorial:**

slovenščina, angleščina / Slovene, English

slovenščina, angleščina / Slovene, English

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Končana druga bolonjska stopnja ustrezne smeri ali univerzitetni študij VII stopnje.

**Prerequisite:**

Finished second Bologna level in the appropriate field or University degree VII.

**Vsebina:**

**1. Komponenti podnebja**

1.1. Sevanje (elektromagnetni spekter, sončna energija)  
1.2. Učinek tople grede  
1.3. Zemeljsko energetska ravnovesje in spreminjanje sončnega sevanja  
1.4. Kroženje zraka v atmosferi  
1.5. Kroženje oceanov / tokovi  
1.6. Interakcije atmosfera-ocean (Severno-atlantski oscilacijski indeks, El Niño, La Niña, Dipol Indijskega oceana)

**Content (Syllabus outline):**

**1. Climate components**

1.1. Radiation (electromagnetic spectrum, solar energy)  
1.2. Greenhouse effect  
1.3. Earth's Energy Balance & Variation in Sun's Radiation  
1.4. Atmospheric Circulation  
1.5. Ocean Circulation / currents  
1.6. Atmosphere-Ocean interactions (North Atlantic Oscillation, El Niño, La Niña, Indian Ocean Dipole)

## **2. Zapisi o preteklih podnebnih spremembah**

- 2.1. Instrumentalne meritve
- 2.2. Zgodovinski zapisi
- 2.3. Proxy meritve (izotopi kisika, dodatne informacije iz ledeniških vrtin, siga/stalagmiti, drevesne letnice, trosi in cvetni prah, korale, nihanje morske gladine)

## **3. Zgodovina atmosfere**

- 3.1. Zemljina zgodnja atmosfera
- 3.2. Veliki dogodek oksidacije

## **4. Zgodovina preteklih podnebnih sprememb**

- 4.1. Proterozoik
- 4.2. Paleozoik
- 4.3. Mezozoik
- 4.4. Kenozoik
- 4.5. Kvartar
- 4.6. Zadnja ledena doba
- 4.7. Holocen
  - 4.7.1. Saharske podnebne spremembe
  - 4.7.2. Evropska spremenljivost podnebja
- 4.8. Ogrevanje 20. - 21. stoletja

## **5. Vzroki za podnebne spremembe**

- 5.1. Tektonika
- 5.2. Milankovičevi cikli
- 5.3. Vulkanizem
- 5.4. Bolidi
- 5.5. Sončne pege
- 5.6. Sestava ozračja
  - 5.6.1. Metan
  - 5.6.2. CO<sub>2</sub>

## **6. Skeptiki/zanikalci/racionalisti**

- 6.1. Lažne novice
- 6.2. Znanstveniki
- 6.3. Kolumnisti
- 6.4. Organizacije, Clexit skupina
- 6.5. Nikalne izjave in dejstva

## **7. Podnebne prilagoditve**

- 7.1. Geoinženiring - velike rešitve
  - 7.1.1. Tehnike upravljanja sončnega sevanja
  - 7.1.2. Tehnike zmanjševanja CO<sub>2</sub> v atmosferi
- 7.2. Globalni podnebni protokoli
  - 7.2.1. Pogajanja o podnebnih spremembah
  - 7.2.2. Montrealski sporazum
  - 7.2.3. Kjotski protokol
- 7.3. Lokalne (slovenske) organizacije

## **2. Records of past climate change**

- 2.1. Instrumental measurements
- 2.2. Historical records
- 2.3. Proxy measurements (oxygen isotopes, additional information from ice cores, speleothems/stalagmites, tree rings, spores and pollen, corals, sea level changes)

## **3. History of atmosphere**

- 3.1. Earth's early atmosphere
- 3.2. Great Oxidation Event

## **4. History of past climate change**

- 4.1. Proterozoic
- 4.2. Palaeozoic
- 4.3. Mesozoic
- 4.4. Cainozoic
- 4.5. Quaternary
- 4.6. Last glacial/interglacial cycle
- 4.7. Holocene
  - 4.7.1. Saharan climate change
  - 4.7.2. European variability
- 4.8. 20th – 21st century warming

## **5. Causes of climate change**

- 5.1. Tectonics
- 5.2. Milankovic cycles
- 5.3. Volcanism
- 5.4. Bolides
- 5.5. Sunspots
- 5.6. Composition of the atmosphere
  - 5.6.1. Methane
  - 5.6.2. CO<sub>2</sub>

## **6. Climate sceptics/deniers/rationalists**

- 6.1. Fake news
- 6.2. Scientists
- 6.3. Columnists
- 6.4. Sceptic organisations, Clexit Coalition
- 6.5. Denial statements versus facts

## **7. Climate adaptations**

- 7.1. Geoengineering – Big solutions
  - 7.1.1. Solar radiation management techniques
  - 7.1.2. Techniques to reduce CO<sub>2</sub> in the atmosphere
- 7.2. Global climate protocols
  - 7.2.1. Climate change negotiations
  - 7.2.2. Montreal Protocol
  - 7.2.3. Kyoto Protocol
- 7.3. Local (Slovenian) climate organisations

7.4. Prilagajanje podnebnim spremembam – strategije Sektorja za okolje in podnebne spremembe, Ministrstvo za okolje in prostor  
7.5. Podnebje v primerjavi z okoljem

### **8. Zmagovalci in poraženci**

8.1. Pozitivne/negativne posledice večjega deleža CO<sub>2</sub>

8.2. Pozitivne/negativne posledice višjih temperatur

8.3. Pozitivne/negativne posledice sprememb količine padavin

7.4. Climate change adaptations – strategies of the Ministry of the Environment and Spatial Planning

7.5. Climate versus environment

### **8. Winners and losers**

8.1. Positive/negative effects of greater CO<sub>2</sub> levels

8.2. Positive/negative effects of higher temperatures

8.3. Positive/negative effects of change in rainfall amount

#### **Temeljni literatura in viri / Readings:**

- Castillo, F., Wehner, M., Stone, D.: 2021. Extreme Events and Climate Change: A Multidisciplinary Approach. Wiley, 256 p.
- Letcher, T. (Ed.): 2021. Climate Change: Observed Impacts on Planet Earth, Third Edition. Elsevier, 750 p.
- Letcher, T. (Ed.): 2021. The Impacts of Climate Change. Elsevier, 420 p.
- Singh, S., Singh, P., Rangabhashiyam, S., Srivastava, K. K.: 2021. Global Climate Change. Elsevier, 370 p.
- Komac, B., Pavšek, M., and Topole, M.: 2020. Climate and Weather of Slovenia. In: The Geography of Slovenia, Perko, D., Ciglič, R., and Zorn, M. (Eds.), Springer. Pp. 71-90.
- Fletcher, C.: 2018. Climate Change: What The Science Tells Us, 2nd Edition. Wiley, 352 p.
- Thomas, J. A., Williams, M., Zalasiewicz, J.: 2020. The Anthropocene: A Multidisciplinary Approach. Wiley, 288 p.
- Anderson, D., Maasch, K., Sandweiss, D. (Eds.): 2007. Climate Change and Cultural Dynamics: A Global Perspective on Mid-Holocene Transitions. Elsevier, 602 p.
- Sperling, D., Cannon, J.: 2006. Driving Climate Change. Elsevier, 312 p.
- Issar, A. S.: 2003. Climate Changes during the Holocene and their Impact on Hydrological Systems. Cambridge University Press, 127 p.

#### **Cilji in kompetence:**

Cilj predmeta je zagotoviti osnovo za razumevanje fizičnih zemeljskih procesov in procesov v vesolju, ki vodijo podnebne spremembe v različnih časovnih okvirih. To je nadgrajeno s podajo glavnih klimatskih sprememb tekom zemeljske zgodovine, vključno z metodami in proksiji podnebnih sprememb.

S to podlago bodo pridobljene kompetence spoznanja da čeprav je vzpostavljeno vse večje znanstveno soglasje o obstoju trenutnih podnebnih sprememb, zapletenost in negotovost znanosti omogoča vzpon podnebnim skeptikom in lažnim novicam, da izpodbijajo znanstvene ugotovitve. Končni cilj tečaja je predstaviti podnebne

#### **Objectives and competences:**

The course aims at providing the basis for understanding the physical Earth and space processes which govern climate variations on different timescales. This is supplemented by the introduction of the overall climatic changes throughout the Earth's history, including the methods and proxies of climate change. These bases will provide the awareness that although a growing scientific consensus of climate change has become established, the complexities and uncertainties of the science provide opportunities for climate sceptics to challenge the findings. The final objective of the course is to present climatic adaptations and proposed consequences of climate change.

prilagoditve in predlagane posledice podnebnih sprememb.



**Predvideni študijski rezultati:**

- Razumevanje fizikalnih osnov v naravni, ki ustvarjajo podnebje, vključno s sevanjem, učinkom tople grede, ozračjem in oceanom.
- Razumevanje metod raziskovanja podnebnih sprememb in proksijev, ki nakazujejo te spremembe.
- Razumevanje splošnih podnebnih sprememb skozi zemeljsko zgodovino in naravne spremenljivosti podnebja zaradi različnih vzrokov ter posledično problematično dokazovanje signalov antropogenega globalnega segrevanja nad ozadjem hrupa naravnih signalov.
- Sposobnost opazovanja dolgoročnih in kratkoročnih podnebnih sprememb v lokalnem, regionalnem in svetovnem merilu.
- Odražanje splošne perspektive vzrokov in posledic podnebnih sprememb in posledično sposobnosti razprave o skepticizmu podnebnih sprememb.
- Znanje o dejavnostih (in protokolih) za preprečevanje podnebnih sprememb oziroma prilagajanje njihovim spremembam, ter kakšne so napovedane kratkoročne in dolgoročne posledice za človeštvo.

**Intended learning outcomes:**

- Understanding of the physical basis of the natural climatic forcings, including radiation, greenhouse effect, atmospheres and ocean.
- Understanding methods of climate change research and proxies that indicate the changes.
- Understanding overall climatic changes throughout the Earth's history and natural variability in the Earth's climate due to various causes, and consequently demonstrating an awareness of the difficulties involved in the detection of any unusual global warming signal above the background noise of attributing (in whole or in part) any such signal to human activity.
- Ability to observe long- and short-term climatic changes on a local, regional and global scale.
- Reflecting the overall perspective of causes and consequences of climate change, and consequently the ability to discuss scepticism of climate change.
- Summarising activities (and protocols) taken to prevent climate change or to adapt to its changes, and what are the predicted short-term and long-term consequences to the human population.

**Metode poučevanja in učenja:**

- Predavanje,
- e-učenje,
- vaje,
- terensko delo/ekskurzija

**Learning and teaching methods:**

- Lectures,
- online learning,
- practicals,
- field work/excursion

**Načini ocenjevanja:**

- Ustni izpit
- vaje

Delež (v %) /  
Weight (in %)

**Assessment:**

- Oral exam
- Practicals

	80	
	20	

**Reference nosilca / Lecturer's references:**

1. Carey, A. E., **ZORN, M.**, Tičar, J., Lipar, M., Komac, B., Welch, S. A., Smith, D. F., Lyons, W. B. 2019: Glaciochemistry of cave ice: Paradana and Snežna Caves, Slovenia. *Geosciences* 9-2, str. 1–12. DOI: 10.3390/geosciences9020094
2. Ferik, M., Gabrovec, M., Komac, B., **ZORN, M.**, Stepišnik, U. 2017: Pleistocene glaciation in Mediterranean Slovenia. *Special Publication of the Geological Society London* 433, str. 179–191. DOI: 10.1144/SP433.2
3. Gabrovec, M., Hrvatin, M., Komac, B., Ortar, J., Pavšek, M., Topole, M., Triglav Čekada, M., **ZORN, M.** 2014: Triglavski ledenik. Ljubljana: Založba ZRC. DOI: 10.3986/9789610503644
4. Gabrovec, M., Ortar, J., Pavšek, M., **ZORN, M.**, Triglav Čekada, M. 2013: The Triglav glacier between the years 1999 and 2012. *Acta geographica Slovenica* 53-2, str. 257–293. DOI: 10.3986/AGS53202
5. Gavrilov, M. B., Marković, S. B., Janc, N., Nikolić, M., Valjarević, A., Komac, B., **ZORN, M.**, Punišić, M., Bačević, N. 2018: Assessing average annual air temperature trends using the Mann-Kendall test in Kosovo. *Acta geographica Slovenica* 58-1, str. 7–25. DOI: 10.3986/AGS.1309
6. Hrvatin, M., **ZORN, M.** 2017: Trendi pretokov rek v slovenskih Alpah med letoma 1961 in 2010. *Geografski vestnik* 89-2, str. 9–35. DOI: 10.3986/GV89201
7. Hrvatin, M., **ZORN, M.** 2017: Trendi temperatur in padavin ter trendi pretokov rek v Idrijskem hribovju. *Geografski vestnik* 89-1, str. 9–44. DOI: 10.3986/GV89101
8. Marković, S. B., Ruman, A., Gavrilov, M. B., Stevens, T., **ZORN, M.**, Komac, B., Perko, D. 2014: Modeling of the Aral and Caspian seas drying out influence to climate and environmental changes. *Acta geographica Slovenica* 54-1, str. 143–161. DOI: 10.3986/AGS54304
9. Peña-Angulo, D., **ZORN, M.**, et al. 2020: Relationship of weather types on the seasonal and spatial variability of rainfall, runoff, and sediment yield in the Western Mediterranean Basin. *Atmosphere* 11-6, str. 1–20. DOI: 10.3390/atmos11060609
10. Peña-Angulo, D., **ZORN, M.**, et al. Spatial variability of the relationships of runoff and sediment yield with weather types throughout the Mediterranean basin. *Journal of Hydrology* 571, str. 390–405. DOI: 10.1016/j.jhydrol.2019.01.059
11. Tošić, I., **ZORN, M.**, Ortar, J., Unkašević, M., Gavrilov, M. B., Marković, S. B. 2016: Annual and seasonal variability of precipitation and temperatures in Slovenia from 1961 to 2011. *Atmospheric Research* 168, str. 220–233. DOI: 10.1016/j.atmosres.2015.09.014