

# Respiratory adaptation to climate in Upper Palaeolithic modern humans: the case of Sungir and Mladeč.

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## Supplementary Information

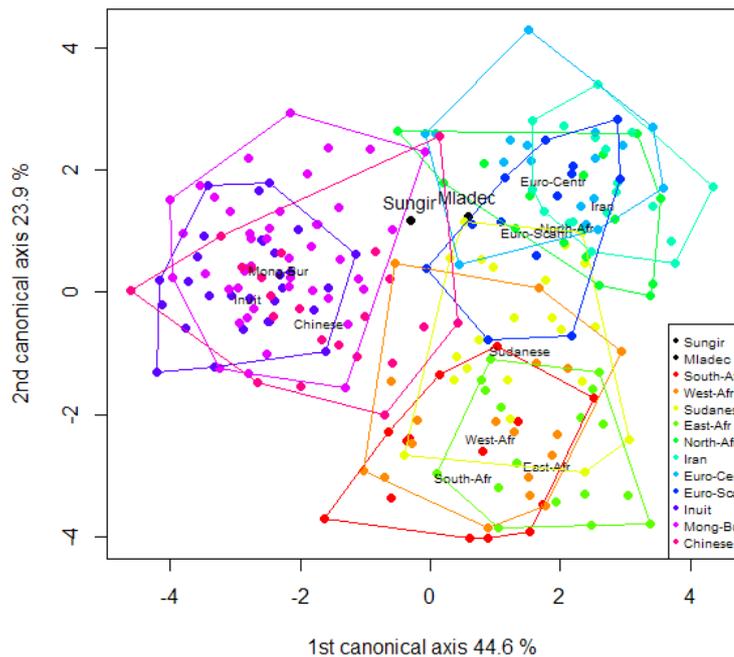
### Reduced Rank Regression of the Shape of the Mid-Face

**Table S1. Squared singular values in the analysis of the 61 internal and external mid-facial landmarks.**

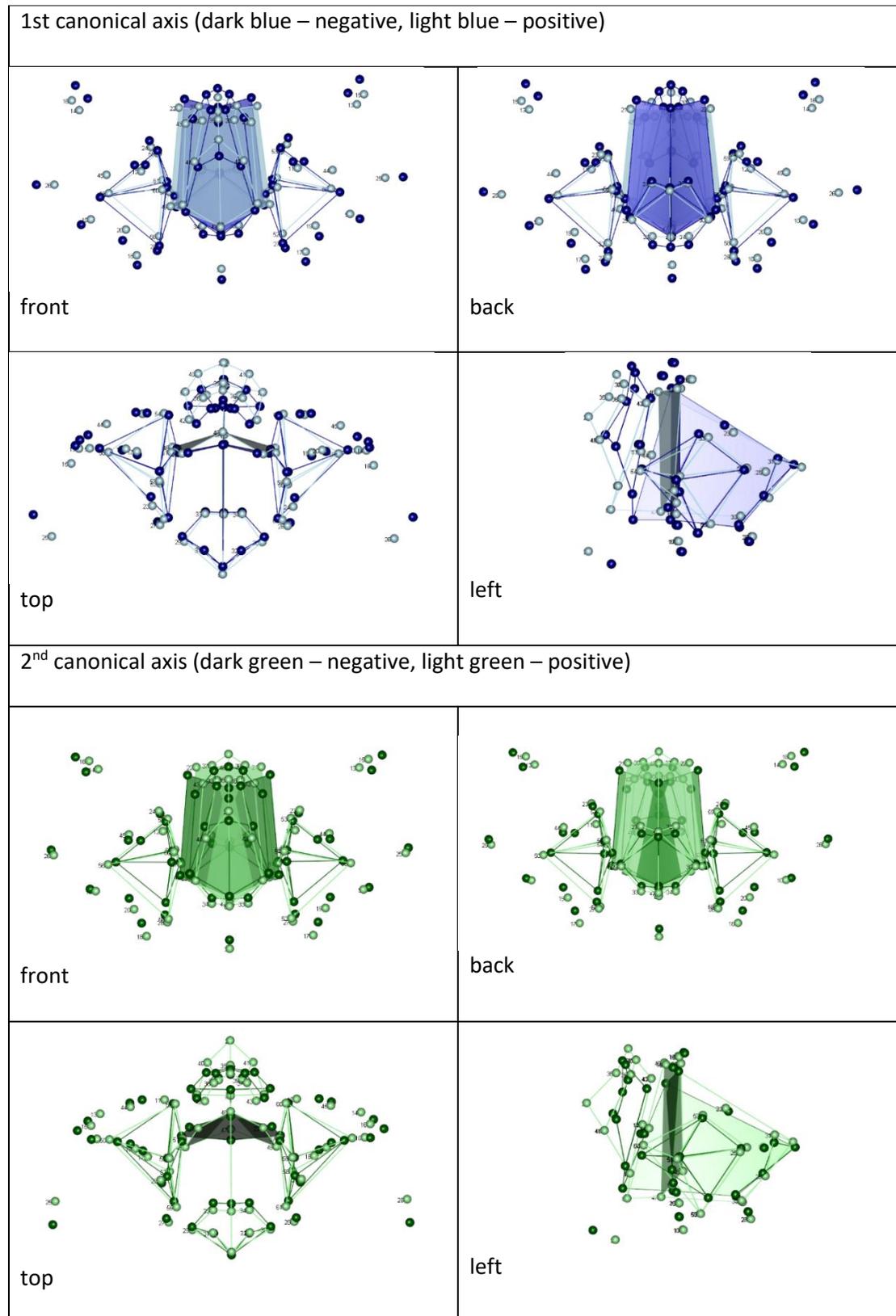
dimension	Squared singular values	percent of squares
1	0.00547	73.19799
2	0.00154	20.58751
3	0.00042	5.670704
4	0.00004	0.543789

### CVA of facial and internal facial landmarks

**Figure S1. CVA analysis of 61 internal and external mid-facial landmarks.** CVA has been performed on 13 PCs (1 smaller than the smallest group), which describe 71% of variation. Correct (jack-knifed) classification is obtained in 67.8% of the cases.



**Figure S2. CVA analysis of 61 internal and external mid-facial landmarks: shape associated with the first two canonical axes.**



## Regression of the centroid size onto climate variables

**Table S2. Regression of the centroid sizes on the standardized climate variables.**

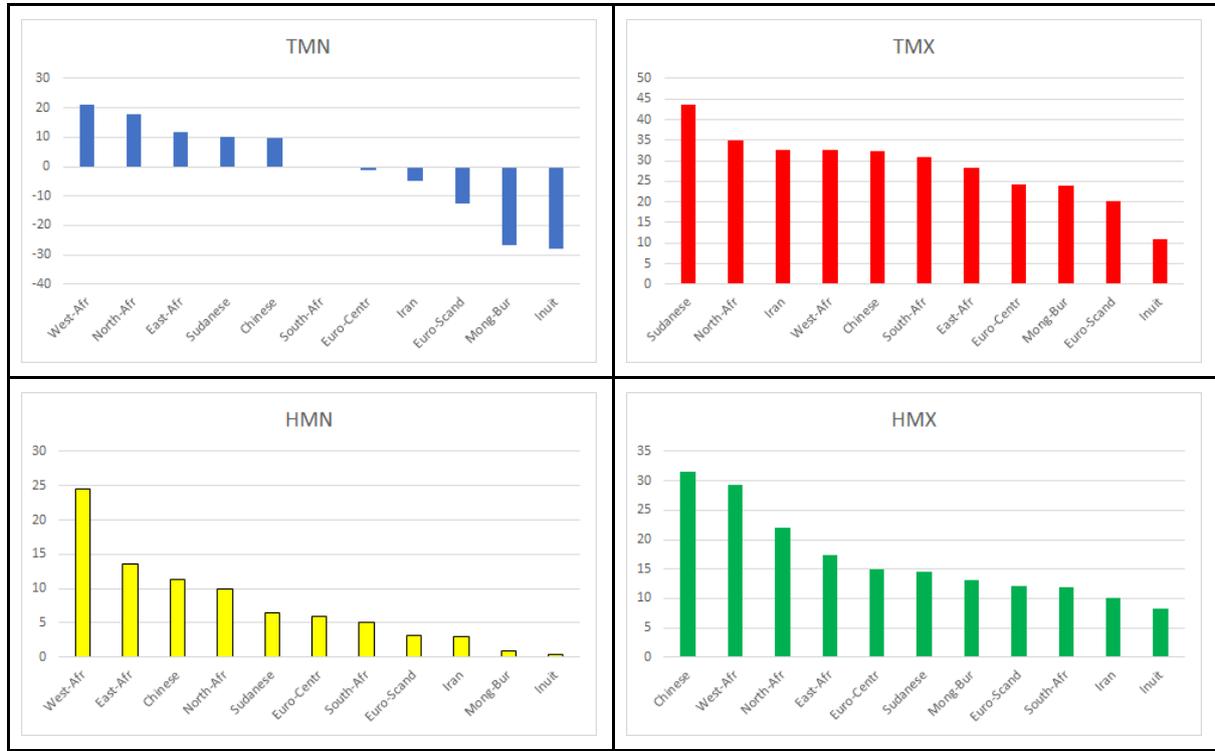
landmark configuration	Absolute CS						
	intercept	coefficients				R <sup>2</sup>	p-value
		TMN	TMX	HMN	HMX		
face	219.85*	<b>-7.644*</b>	-0.0098	<i>4.8687**</i>	1.62219	0.8208	0.01992
external nose	67.465	-2.9407	-0.0169	0.21861	1.92941	0.586	0.1957
internal nose	82.608	-2.5008	0.9582	-0.1601	1.2465	0.419	0.4427
choanae	39.874	-1.7761	0.3278	-0.5941	1.5989	0.5769	0.2068
sinuses	101.17	-1.9282	0.8812	-1.4272	2.0448	0.2926	0.6647
landmark configuration	Relative CS						
	intercept	coefficients				R <sup>2</sup>	p-value
		TMN	TMX	HMN	HMX		
face	n/a	n/a	n/a	n/a	n/a	n/a	n/a
external nose	0.3072	<b>0.0004</b>	-0.0001	-0.0121	0.00842	0.5237	0.2778
internal nose	0.37551	<b>-0.002</b>	0.00509	-0.0063	0.00136	0.5538	0.2364
choanae	0.18058	<b>-0.002</b>	0.00161	-0.0068	0.0054	0.394	0.4856
sinuses	0.45989	<b>0.0013</b>	0.0083	-0.0132	0.00558	0.6564	0.1205

\*bold means significance at 0.05 level

\*\*italic means significance at 0.1 level

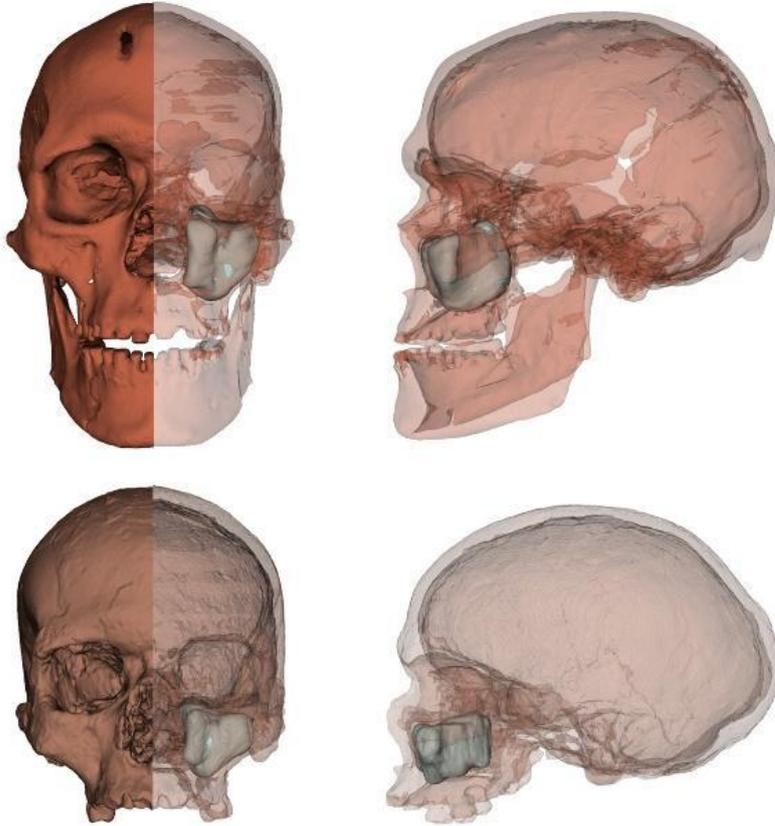
## Distribution of groups in accordance with the climate variables

**Figure S3. Distribution of groups in accordance with the climate variables.**



## Material and Methods: Supplementary Information

**Figure S4.** Internal Views of Sungir (top) & Mladeč (bottom). The left maxillary sinus is segmented and highlighted in grey in each skull.



**Table S3.** Landmarks utilized in the current study, along with the cranial region they are assigned to: face, external nose, internal nose, or choanal region. Abbreviations correspond to Figure 5.

Landmark Name (abr.)	Region	Description
<i>Prosthion (pr)</i>	Face	Midline, most anterior point on maxillary alveolar process
<i>Zygomaxillare anterior (zma)</i>	Face	Paired points on inferior/anterior zygomaticomaxillary suture
<i>Zygoorbitale (zmo)</i>	Face	Paired points on superior zygomaticomaxillary suture at inferior orbital rim
<i>Frontomolare orbitale (fmo)</i>	Face	Paired points on the frontomalar suture along medial surface of lateral orbital rim

<b><i>Frontomalare temporale (fmt)</i></b>	Face	Paired points on the frontomalar suture along lateral surface of lateral orbital rim
<b><i>Alveolare (alv)</i></b>	Face	Paired points on most lateral external alveolar process
<b><i>Maximum maxillary curvature (mmc)</i></b>	Face	Paired points on the maximum curvature between upper alveolar process and zygomaxillary suture (Lahr, 1992)
<b><i>Maxillary tuberosity superior (mts)</i></b>	Face	Paired points at most superior aspect of posterior maxillary body, typically at/near constriction of the inferior orbital fissure
<b><i>Zygotemporal inferior (zti)</i></b>	Face	Paired points at the inferior aspect of zygotemporal suture
<b><i>Maxillary tuberosity inferior (mti)</i></b>	Face	Paired points at the most posterior aspects of the maxillary tuberosity, at the alveolar process
<b><i>Dacryon (dk)</i></b>	Face	Paired points at the apex of the lacrimal fossa, adapted from
<b><i>Orbitale (or)</i></b>	Face	Paired points at the most inferior point of each inferior orbital rim
<b><i>Nasion (na)</i></b>	Ext Nose	Midline point on fronto-nasal suture
<b><i>Rhinion (rhi)</i></b>	Ext Nose	Midline point at inferior end of nasals
<b><i>Alare (al)</i></b>	Ext Nose	Paired points on the most lateral aspects of the anterior nasal piriform aperture
<b><i>Nasospinale (ns)*</i></b>	Ext & Int Nose	Midline point on floor of the piriform nasal aperture (adapted from Martin, 1928)
<b><i>Superior Ethmoid (seb)*</i></b>	Ext & Int Nose	Paired points along the frontal-ethmoidal suture on the medial orbital wall, as when taking superior ethmoidal breadth (Following Franciscus, 1995)
<b><i>Sellion (s)</i></b>	Ext Nose	Midline point of deepest curvature between nasion and rhinion; also known as subnasion
<b><i>Nasomaxillary frontale (nmf)</i></b>	Ext Nose	Paired points at junction of the frontonasal and nasomaxillary sutures
<b><i>Nasomaxillary minimum (nmw)</i></b>	Ext Nose	Paired points on nasomaxillary suture, as when taking minimum (simotic) nasal breadth
<b><i>Nasomaxillary inferior (nmi)</i></b>	Ext Nose	Paired points at the most inferior aspect of the nasomaxillary suture, where it meets the piriform aperture

<b><i>Ethmoidale (e)</i></b>	Int Nose	Midline point at junction of ethmoid and frontal bones on nasal roof, as when taking maximum internal nasal height with the <i>nasal floor (nf)</i> (Butaric, 2015)
<b><i>Nasal floor (nf)</i></b>	Int Nose	Midline point on nasal floor directly below ethmoidale, as when taking maximum internal nasal height with <i>ethmoidale (e)</i> (Butaric, 2015)
<b><i>Inferior nasal meatus (inf)</i></b>	Int Nose	Paired points at the lateral aspects of the inferior nasal meatus, as when taking maximum internal nasal breadth (Butaric, 2015)
<b><i>Staphylion (sta)*</i></b>	Int Nose & Choanae	Midline point on hard palate, crossed by tangent line across curves of posterior palatal margin
<b><i>Hormion (ho)*</i></b>	Int Nose & Choanae	Midline point where vomer intersects the sphenoid
<b><i>Choanal/posterior alare (clb)</i></b>	Choanae	Paired points on most lateral aspects of choanal aperture, on medial surface of medial pterygoids; as when taking maximum choanal breadth
<b><i>Choanal superior (cls)</i></b>	Choanae	Paired points on superior aspect of sphenoid, as when taking choanal height; also known as choanal apex or roof
<b><i>Choanal inferior (cli)</i></b>	Choanae	Paired points on the posterior edge of palate, as when taking choanal height; also known as choanal base or floor
<b><i>Lateral maxillary sinus (msl)</i></b>	Sinus	Paired points on most lateral aspects (apex) of each maxillary sinus
<b><i>Medial maxillary sinus (msm)</i></b>	Sinus	Paired points on each medial maxillary sinus wall; as when taking sinus breadth from the apex, parallel to Frankfort plane
<b><i>Superior maxillary sinus (mss)</i></b>	Sinus	Paired points on each maxillary sinus roof; as when taking maximum sinus height perpendicular to Frankfort plane
<b><i>Inferior maxillary sinus (msi)</i></b>	Sinus	Paired points on each maxillary sinus floor; as when taking maximum sinus height perpendicular to Frankfort plane
<b><i>Anterior maxillary sinus (msa)</i></b>	Sinus	Paired points on each maxillary sinus anterior wall; as when taking maximum sinus length/depth parallel to Frankfort plane
<b><i>Posterior maxillary sinus (msp)</i></b>	Sinus	Paired points on each maxillary sinus posterior wall; as when taking maximum sinus length/depth parallel to Frankfort plane

\* indicates a landmark that was used in more than one morphological region