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ABSTRACT BOOK – WEDNESDAY, MAY 17

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Oral Presentation Abstracts

WEDNESDAY, MAY 17

Morning Parallel Sessions [10:30-12:00] **VENTANA ROOMS A, B, C**

Plant Biometeorology 2 **VENTANA A**

Mark D Schwartz	Development of New Continental-Scale Spring Phenology Models The seasonal timing, or phenology, of many North American plant species is in flux with accelerating environmental change. The influence of factors such as temperature and precipitation on plant growth, as weather patterns change from spring to summer, vary from place-to-place, month-to-month, and for different plants species. An improved understanding of these relationships revealed by this research will support development of more accurate and diverse models of spring plant growth stages. These models may then be able to predict which trees and shrubs will be favored in different regions with future environmental change, to the benefit of many types of societal planning. Further, the project will implement national-scale, long-lead forecasts for new measures representing the spring season, which will also be relevant for annual agricultural, horticultural, and forestry management planning. We have produced significant first leaf-out and first bloom regression models for 18 species. Among all species the median Mean Absolute Error value for bloom models was 8.11 days (range of 4.85 to 13.24 days) and was 9.39 days for leaf models (range of 5.79 to 24.06 days). Likewise, the median Mean Bias Error value for bloom models was -1.28 days (range of -2.82 to +2.47 days) and was -2.42 days for leaf models (range of -1.75 to +14.85 days). The best models were all thermal time-type (the simplest form). These initial models yielded promising results with typical mean absolute errors around 8-9 days. The outputs also show the typical spatial pattern of the phenological events with them occurring earlier in the south and later in the north. This work demonstrates that simple regression models can produce surprisingly accurate predictions at continental scales. We will continue to investigate the importance of spatial distributions on phenological model development, to show the potential utility of creating spatially dependent phenological models.
Surendra Ranpal	Biotic and abiotic effects on pollen production of birch assessed in International Phenological Gardens of Europe The network of the International Phenological Gardens (IPG) and their cloned plant species allow analysing phenological responses to climate change while excluding genetic variations. In addition to phenological studies, this specific feature of common genetic background can be used to examine other plant traits such as pollen production. According to recent literature, plants in warmer environments mostly produce more pollen. However, the relationship between temperature and pollen production is not satisfactorily understood yet. In this study, we sampled catkins prior to anthesis from 46 individuals of downy birch (Betula pubescens EHRH.) in the period from 2019 to 2021 (38 IPGs and 11 European countries). Pollen production was assessed using a mixed

	sample from each tree resulting in more than 400 microscope slides, which were analyzed for their birch pollen quantities. Meteorological data were obtained from the E-OBS dataset (0.1° regular grid); pollution data (O3 and NOx) were downloaded from Sentinel-5P. Most of the trees were characterized by a diverse pollen production at catkin level with maximum values of 7×10^6 pollen grains (average 2×10^6 pollen grains). We found significant and positive correlation of pollen production per catkin with preceding annual temperature (rs = 0.52, p < 0.001). Partial regression analyses revealed that other variables such as altitude and air pollution were also significantly associated to pollen production, but the importance of these factors differed across years. Infections with Cherry leaf roll virus were not related to pollen production. However, we observed that a higher pollen production was linked to higher allergenicity values. Our findings from the DFG project pollenPALS (655850) indicate that global warming can exert an influence on pollen production of birch and therefore on human health. Establishing a long-term monitoring of pollen production would be highly desirable for investigating confounding masting effects.
Claudia-Helena Giraldo-Escobar	Integrating Eucalyptus into the Plant Phenology Ontology Phenological studies in Australia are limited compared to the number conducted in the temperate northern hemisphere. One of the most iconic Australian plant taxa is the hyper-diverse genus Eucalyptus, which contains over 700 native species. Despite several floral development studies on this taxon, phenological traits and stages are not easily compatible with other flora. Structures like the operculum, which consists of fused petals that cover the anthers before dehiscing, may confuse some people as to whether the reproductive structure under study is a bud or a flower. Similarly, Eucalyptus scientists diverge in defining when the study organ ceases to be a flower and becomes a fruit or when the fruit is ripe. The eucalypt-specific terminology is therefore unique and complex. Having clear, compatible, and accessible definitions of reproductive structures will provide a consistent methodology that should allow for cross-study comparisons and modeling. In this study, six terms from the Plant Phenology Ontology (PPO) or related ontologies were matched to eucalypt-specific terms, and four new terms are proposed for inclusion in the PPO. For example, a swelling flower bud would be defined as a flower bud that is in the bud swell stage. In Eucalyptus, this structure is known as an umbel bud or bud. They are green and swollen until they reach the species-specific maturity size. The inclusion of this term is significant because flower buds in Eucalyptus can remain in this stage for years, so distinguishing them from bursting inflorescence buds —another suggested term— and unopened flowers would indicate phenologically critical development stages, such as the meristem transition or blooming readiness. These stages are likely to be triggered by environmental cues; therefore, they can be quantified and potentially used to build models that can predict flowering times under climate variability and change.
Theresa Crimmins	Volunteer-contributed observations of flowering show potential for characterizing airborne pollen concentrations Characterizing airborne pollen concentrations is crucial for supporting allergy and asthma management, however, pollen monitoring is labor intensive and, in the United States, is currently spatially limited. The USA National Phenology Network (USA-NPN) engages thousands of volunteer observers across the country in documenting the developmental and reproductive status of plants on an approximately weekly basis. The reports of flower and pollen cone status contributed to the USA-NPN's observation

	platform, Nature's Notebook, have the potential to help address this geographic gap in pollen monitoring by providing critical real-time, spatially explicit information. To assess the potential of flowering observations to support characterization of airborne pollen concentrations, we compared daily pollen counts from 36 National Allergy Bureau (NAB) certified stations in the U.S. with observations of flowering and pollen cone status collected within 200km of each NAB station in each year, 2009-2021, for 15 common tree taxa using Spearman's correlations (ρ). Of 350 comparisons, 58% of correlations were significant ($p < 0.05$). Comparisons could be made at the largest numbers of sites for maple (Acer) and oak (Quercus). Oak demonstrated a comparatively high proportion of tests with a significant strong agreement, with a median ρ of 0.49. Walnut (Juglans) demonstrated the strongest overall coherence between the two datasets, with a median ρ of 0.79, though comparisons were made at only a small number of sites. We found that for particular taxa, volunteer-contributed flowering status observations demonstrate promise to indicate seasonal patterns in airborne pollen concentrations. The quantity of observations, and therefore, their utility for supporting pollen alerts, could be substantially increased through a formal observation campaign led by the USA-NPN.
Franck Koman	Agricultural Water Use and Climate Change: What Consequences for Land Resources For more than 30 years, the entire planet, and West Africa in particular, has had to deal with a phenomenon of climate disruption that is unprecedented. Considered as a threat to biological diversity and agricultural practices, climate change is causing paradoxical situations wherever it occurs. We have drought and desertification, the disappearance of animal and plant species, the disappearance of sources of water supply, the reduction of plant cover, the rise in sea levels and floods and storms. In Ivory Coast, this climate change is manifested by repeated rains and high water levels in some regions, where agriculture is heavily practiced. On the other hand, in some regions, climate change affects the availability of water resources in the short, medium and long term. In this context, the modalities of agricultural water use have an impact not only on the balance between the different resources of water, soil, biodiversity and landscape. Indeed, climate change has an impact on land, the main element of agriculture. Agriculture occupies an important place in terms of professional activities. Unfortunately, this activity is highly dependent on rainfall. Despite the IPCC reports, the COP 21, climate protests and other mobilizations to mitigate the effects of climate change, the change is not up to everyone's expectations. Thus, the objective of this study is to identify the perceptions of climate change by farmers and to analyze the consequences of climate change at the agricultural level. After analysis of field experiences and interviews conducted with farmers and other stakeholders, and data observed within communities in the outlying areas of the district of Abidjan, it emerges that climate change is a perceptible reality for farmers. Similarly, it affects the yields of agricultural activities. In addition, the results show a negative evolution of yields.

Human Biometeorology 4 - including presentation of Tromp Award	VENTANA B
Loic Gillerot TROMP AWARD RECIPIENT	Forest structure and composition alleviate human thermal stress Current climate change aggravates human health hazards posed by heat stress. Forests can locally mitigate this by acting as strong thermal buffers, yet potential mediation by forest ecological characteristics remains underexplored. We report over 14 months of hourly microclimate data from 131 forest plots across four European countries and compare these to open-field controls using physiologically equivalent temperature (PET) to reflect human thermal perception. Forests slightly tempered cold extremes, but the strongest buffering occurred under very hot conditions (PET >35°C), where forests reduced strong to extreme heat stress day occurrence by 84.1%. Mature forests cooled the microclimate by 12.1 to 14.5°C PET under, respectively, strong and extreme heat stress conditions. Even young plantations reduced those conditions by 10°C PET. Forest structure strongly modulated the buffering capacity, which was enhanced by increasing stand density, canopy height and canopy closure. Tree species composition had a more modest yet significant influence: that is, strongly shade-casting, small-leaved evergreen species amplified cooling. Tree diversity had little direct influences, though indirect effects through stand structure remain possible. Forests in general, both young and mature, are thus strong thermal stress reducers, but their cooling potential can be even further amplified, given targeted (urban) forest management that considers these new insights.
Oleh Skrynyk	CERRA-Thermal: A European gridded dataset of human thermal indices The thermal indices are widely used for various climate-health applications in human biometeorology. The study aims to investigate the thermal environment at the pan-European scale. The main objective was to compute and create a gridded dataset of the Mean Radiant Temperature (MRT) and Universal Thermal Climate Index (UTCI) using the Copernicus European Regional ReAnalysis (CERRA). The created reanalysis dataset of thermal indices is expected to be accessible to the general public at the CERRA's current availability: from September 1984, 3 hours temporal and 5.5 km x 5.5 km spatial resolution. For this purpose, the recently published thermofeel library in python was applied. It computes MRT based on the European Centre for Medium-Range Weather Forecasts' numerical weather prediction radiation variables: surface solar radiation downwards, surface net solar radiation, total sky direct solar radiation at the surface, surface thermal radiation downwards, surface net thermal radiation, cosine of solar zenith angle. The cosine of the solar zenith angle is instantaneous (for each UTC hour). However, it could also be integrated over forecast steps. For UTCI: 2m temperature, MRT, wind speed at 10m above the ground, and relative humidity were applied through polynomial approximation called operational procedure. This dataset will profit from numerous applications in biometeorology, sports, social and health care, agriculture, and construction. Since the data has a high spatial resolution, it creates opportunities for thermal environment applications over elevated locations and mountains.
Pablo Fernandez de Arroyabe	Atmosphere electricity and human biometeorology: challenges and preliminary outcomes Atmospheric electric fields (AEF) interacts with living organisms as many other meteorological factors do it, such as air temperature and humidity or atmospheric pressure. There are few studies considering this fact from a biometeorological point of view. The study of the interaction of AEF and magnetic ones (such as the Schumann Resonance, SR with living organism and specifically with human beings is a great challenge for biometeorology. This was a relevant topic for founders of the Int. Society of Biometeorology. Researcher from Working Group IV in the COST Action 15211 (Electronet) have worked on this topic for four years and some preliminary

	results have been obtained. Atmospheric nanoparticles were measured in Santander city (Spain) considering their electric charge using an electrometer ELPI+ device from DEKATI company. Nanoparticles properties have become a fundamental measurement to classify air masses affecting the city elect. Measurements have also been used to create new hypothesis on how atmospheric particulate matter (PM) bellow 2.5 can be deposited in the human respiratory tract considering electric charge of these nanoparticles a fundamental property in this process. The confirmation of this hypothesis in labs can have an extraordinary relevance for the study of respiratory diseases
Stevan Savic	The 'network of networks' concept for better data usability and assessment of microclimate conditions – the FAIRNESS Action In October 2021, the European Cooperation in Science and Technology (COST) has awarded four years (2021-2025) of funding to the "FAIR network of micrometeorological measurement" (FAIRNESS). Actions will be supported to increase readiness, support knowledge exchange and foster a strong background for future research and innovation focused on micrometeorological measurements and applications, as well as improving data access through establishing the first Pan-European Micrometeorological network. To contribute to the further micrometeorological monitoring and assessments, the technical information, web links and contact of responsible person for each rural or urban network are collected, as a first step of the FAIRNESS Action. Initially limited to FAIRNESS participants, a 'network of networks' will be the starting point of future FAIR-enhancement of micrometeorological data. For this purpose, a Micromet_KSP (micrometeorological knowledge share platform) will be designed to help data owners to improve the Findability, Accessibility, Interoperability, and Reusability of their data. The Micromet_KSP will be integrated with the ZENODO repository and the FAIRNESS webpage. Currently, the Pan-European Micrometeorological network includes 52 (rural or urban) networks from 20 countries and it is available on the following link: https://www.fairness-ca20108.eu/working-group-1/. Information on how participate with providing information about created network or would like to share datasets through the Micromet_KSP, please contact one of the working group leaders on the following link: https://www.cost.eu/actions/CA20108/#tabs+Name:Working%20Groups%20and%20Membership.
Niels Döscher	Bioclimate Analog Cities - Identification of climate analog regions based on bioclimatic indices derived from CORDEX data In this study, we investigate how the approach of climate analog cities can be combined with bioclimatological concepts. Based on EURO-CORDEX climate projection data, we calculate future bioclimatic indices for a region with a dense urban structure and compare these finding to the current bioclimate of other regions across Europe with similar urban development. If the future bioclimatological situation of the first region is similar to the current situation in a second region, we conclude urban areas located in these two regions as possible bioclimate analog cities. To compare the actual bioclimate within these urban environments, we are looking at the statistical relationship between the regional background climate provided by the projections and the urban microclimate to account for a possible bias. The objective is to improve the popular approach of comparing climate analog cities by defining the central term "similar climate" with the help of well-known and established bioclimatic indices. In this way a perspective on human wellbeing and health related questions is added to the method while future studies using the same indices can have a higher comparability. Additionally, we assume that more realistic analogs can be found by including the actual urban climate of possible twin cities in the analysis rather than using climate projection data only. It is expected that our method can help to find real world examples of a possible bioclimatological future of a given city, which might support decision makers to initiate appropriate mitigation and adaptation strategies against the impacts of climate change.

Animal Biometeorology 1	**VENTANA C**
Sheila Tavares Nascimento	Artificial shading alternatives for dairy cows In tropical regions artificial shading must be provided for grazing animals mainly when trees are not available. Therefore the aim of this work was to evaluate the microclimate from a shading structure for grazing Holstein cows based on the combination between black polypropylene and heat-reflective aluminized nets. The results were compared to the microclimate from trees (Handroanthus albus) and an area directly exposed to the sun. The shading structure was erected at 2 m high with measures of 4 m wide by 4 m long with a difference of 15 cm in height between the nets, with the heat-reflective net as a cover and the black polypropylene as the second layer, with the use of the light-colored material on the external surface and the dark colored on the internal one. The shading structure were analyzed for 20 days in a paddock at the Iguatemi Farm from the State University of Maringá, Brazil, where the dry-bulb, wet-bulb, black globe temperatures, the shortwave radiation and wind speed were collected for the micrometeorological characterization from 8:00 am to 4:00 pm. The mean radiant temperature, radiant heat load, and black globe temperature and humidity index (BGHI) were calculated. The data were analyzed with aid of the statistical analysis system. The nets association structure showed the lowest averages for the mean radiant temperature and the radiant thermal load (P<0.05; 27.7ºC and 465 W m-2, respectively). The air temperature and BGHI were similar between the trees and the nets association (26º and 26.3ºC; 76 and 75, respectively) and lower (P<0.05) compared to the unshading area (27.9ºC and 82). The artificial shading proved to be as efficient as the tree in promoting thermal comfort for dairy cows.
Vinicius Fonseca	Shading plus sprinkler as alternative to mitigate heat stress of dairy goats in an equatorial semi-arid environment Little has been investigated about evaporative cooling system for dairy goats raised in hot and dry environment. This study aimed at testing the impact of shading plus sprinkler on thermoregulation and productive performance of dairy goats. Twenty-four lactating Saanen and Alpine crossbred goats (50.64 ± 5.91 kg body weight; milk yield = 1.90 ± 0.48; and with 43.13 ± 8.59 of days on milking) were randomly assigned into three treatments for evaluations along sixty continuous days, from October to December, 2020, in an experimental farm of Brazil (Latitude 7ºS). The treatments were: T1 = shade-cloth, 50% of solar blockage; T2 = Shade - 100% (roof structure with clay tile) plus sprinkler; and T3 = only shade - 100%). Goats in T2 were sprayed with water using a hand-held pump, from 09:00 to 16:00, every two hours (1.2 L of water animal-1 day-1). Goats experienced as much as 1000 W m-2 of solar radiation, and air temperature above 40 ºC. At times of high radiant heat load (from 09:00 to 2:00h), goats in T2 had hair-coat surface temperature lowered (P = 0.0001) by 4.5 ºC, skin temperature by 1 ºC, rectal temperature by 0.3 ºC, and respiratory rate by 30 breath min-1, when compared with goats in pens with shade only (T1 and T3). Overall, goats in T1 and T3 experienced more than five hours with respiratory rate (RR) above 60 breath min-1 (i.e., heat stress threshold). Goats in T2 maintained RR below this threshold. They also had milk yield incremented (P = 0.0001) by 350 g animal-1 day-1. Under circumstances of equatorial semi-arid environment, shading plus sprinkler is the most effective way to mitigate heat stress of lactating dairy goats.
Angela Lees	Evaluating the heat load alleviation strategies of sheep feedlots in the Middle East

	For the development of alleviation strategies, the current heat load abatement practices must be evaluated. This study aimed to evaluate the effectiveness of alleviation strategies in commercial sheep feedlots. Two Middle East feedlots were enrolled into the current study: Feedlot 1, was located in a hot and dry region; and Feedlot 2, was located in a hot and humid region. Shade structures were used at Feedlot 1 and Feedlot 2 and pen microclimates were evaluated. Feedlot 1 shade was composed of i) solid metal roof and shadecloth (PEN A) or ii) shadecloth (PEN B) structures. Pen wetting was also used. Feedlot 2 shade consisted of i) single shadecloth (PEN C) or ii) double-layered shadecloth (PEN D). Provision of shadecloth decreased pen surface temperatures by 15°C in PEN A and 14°C in PEN B (P=0.0005). The solid metal roof shade structure within PEN A reduced pen surface temperatures by approximately 19°C (P=0.0067). Pen wetting further reduced pen surface temperatures under the shadecloth structures within PEN A and PEN B by 16°C and 15°C under the solid metal roof (P=0.0050). At Feedlot 2, pen surface temperatures were numerically lower (≈6.7 °C) within PEN D, however there were not enough data points (n=22) to validate the difference. Temperature humidity index (THI) was calculated based on the equation provided by Marai et al. (2007), maximum THI ≥32.3 on all days. THI stress categories were used to determine accumulated heat load (AHL). Accumulated heat load was a greater concern at Feedlot 1 (PEN A, maximum 287.1; PEN B, maximum 96.5) than Feedlot 2 (PEN A, maximum 113.1; PEN B, maximum 54.1), where AHL≥50 is considered as sever heat stress and AHL≥100 are extreme conditions. These results highlight that shade, is an important heat load alleviation tool for sheep feedlots in the Middle East.
John Gaughan	Investigation of new approaches to cooling cows experiencing increased heat load Few studies have investigated cooling options for cows that are largely pasture based or managed on a feedpad. One hundred and twenty lactating Holstein-Friesian dairy cows were used in a 90d study undertaken during summer. Two treatments using 60 cows/treatment and two pens/treatment were imposed: (i) Control (CON): Spray + fans while in dairy holding yard only, plus shade and fans at the feedpad, and (ii) Strategic Cooling (COL): Spray + fans in the dairy holding yard + windsock array cooling during milking + spray on exit from dairy + shade + fans at feed pad (turned off at night) + feed pad loafing area windsock at night. All cooling strategies were implemented when THI≥ 75 during the day. Cows were fitted with feed activity collars, and rumen temperature (RT) and activity was obtained at 10-min intervals via RFDS boluses that were orally inserted into the rumen. Individual panting score (PS), mean panting scores (MPS), cow activity (eating, drinking, ruminating), cow posture (lying or standing) and cow location (shade, sun, feedpad, paddock) was obtained at approximately 0430h, 0930h, 1530h and 2030h daily. Individual daily milk yields were collected. There was a 2.05 kg·cow-1·day-1 milk advantage for the COL group compared with CON (P<0.0001). There were treatment effects for both RT and MPS (P=0.0060). Rumen temperature was lower for the COL cows compared with CON (P<0.0001). The MPS for the COL cows was lower than for CON cows at 0.68±0.02 and 0.75±0.02 units respectively (P=0.0060). There were treatment differences for min d-1 cows spent eating at 183.75±2.34 min and 159.31±2.20 min respectively for COL and CON (P<0.0001). During an 8-d heat wave, the COL cows had a mean RT of 39.57±0.03oC compared with 40.07±0.03oC for the CON cows. The COL cows had a +3.6kg/d advantage in MY following the heat wave.
Tomilola Ayo Arilekolasi	Dietary manipulations using Cajanus cajan for improved ruminant production in a climate-resilient environment

	Ruminant animals contribute significantly to global warming through emission of methane gases which have direct and indirect impact on the well-being of all living organism. One of the farmers' friendly approach to mitigating the effect and ensuring production in an eco-friendly environment (climate-smart production) is through dietary manipulations. Hence, this study harnessed the potentials of a multipurpose leguminous plant – pigeon pea (Cajanus cajan), by evaluating the in vitro digestibility and methane gas production of a total mixed ration made from Cajanus cajan forage. The C. cajan forage were harvested from cultivated/artificial pasture on two different fertilizer application (unfertilized - control, poultry manure and urea) and the harvested forage were later subjected to three different drying methods (air-drying, sun drying and solar drying) to make hay. Thereafter, the C. cajan hays were milled and incorporated at 50% inclusion with other convectional feed ingredients to make total mixed ration and thereafter pelletized. Suitability of the hay, nutrient profile, in vitro digestibility, methane gas production, short chain fatty acids were evaluated using standard procedures. From results, application of poultry manure at 30kg/Ha had significant improvement on the foliage production and protein content of the forage. Solar drying method (solar cabinet) aided the greenish colouration of leaves, had better nutrient profiles compared to other treatments and in vitro gas production showed a drastic reduction in methane production. Thus, increased degradability, dry matter content. The tannin content of 8.47% of the solar dried poultry manure fertilized C. cajan based diet was effectively utilized in the reduction of methane production and it's recommended for improved ruminant production in a climate-smart environment.

Early Afternoon Parallel Sessions [1:30-3:00] VENTANA ROOMS A, B, C

Plant Biometeorology 3 VENTANA A

Tanja Cegnar	Effective communication of agrometeorological services The workshop Effective communication of agrometeorological services took place at the EMS2022. As climate science becomes increasingly sophisticated and exponentially important, how do meteorologists align their communications to optimize value delivery to the primary sector? It is not enough to provide a service, it is also important to communicate it in such a way that the users are empowered to take advantage of the information provided. We are supposedly living through a communications revolution, and the means for disseminating information have certainly increased and multiplied. But are we communicating more effectively? Our health and well-being are inextricably linked to our natural environment. So much, in fact, that the WHO has called climate change "the single biggest health threat facing humanity." There is also great pressure on the agriculatural sector to reduce GHG emissions and reduce fertilizers use while producing more food. The change in climate could have considerable consequences for agriculture, not only due to the direct changes in conditions for crops (milder winters, more drought, increase in CO2-concentration and the like) but also because of indirect effects such as new diseases, pests and plagues, a demand for different crops (e.g. bio-fuels) and the risks of business management (yield consistency). It is paramount that the sector and the authorities anticipate the risks and opportunities (of adaptation). Effective science education and communication of agrometeorological knowledge and skill is crucial. For example: Slovenian agrometeorological service is bringing a wide range of information to the customers in the

	agricultural sector on a national level. In parallel, it supports drought watch on the regional level of SEE in the frame of Drought Management Center. At a time when new sources of data and modern communications are available Drought Watch, Droughtmeter, and Agrometeorological forecast were introduced.
Liang Liang	Calibrating Spring Index Model for More Geographically Accurate and Locally Relevant Predictions Phenological models are useful for tracking and predicting climate change impact on the timing of plant life cycle events. The widely used Spring Index (SI) models developed using cloned plant phenology have offered a standard reference to spring weather patterns that lead to onset of spring season. In this study, a climate calibration method is introduced to customize SI first leaf model to fit locally adapted plant populations for native and naturalized species, therefore expanding the utility of SI model structure for spring onset predictions across species and locations. Multi-year (2009-2021) phenological data for common lilac (Syringa Vulgaris) and red maple (Acer rubrum) in the eastern U.S. from the USA-National Phenology Network (USA-NPN) supported delineating the climate adaptation patterns and subsequent calibration of the SI first leaf model. The approach removed typical geographic biases from using a uniform SI model (i.e., without considering the effect of local adaptation) and yielded lower prediction errors (e.g., from 30 to 16 days of RMSE for red maple). Although the SI was originally designed to serve as a general bioclimatic indicator that is independent of underlying plant heterogeneity, the findings from this research suggest that climate-calibrated SI models can be fitted for specific species and populations to achieve more geographically accurate and locally relevant predictions of spring onset in a broad geographic region. The approach can be applied to any species with adequate spatial distribution of observational data, therefore is potentially useful for supporting the pheno-forecast effort of the USA-NPN.
Frank-Michael Chmielewski	A physiological model for cherry blossom Predicting the onset of fruit tree blossom under changed climate conditions is of great importance for agriculture and horticulture. Models used for this purpose should be as far as possible physiologically based. Pure optimised phenology models carry the risk of unrealistic predictions due to a misinterpretation or an oversimplification of metabolic processes in plants. On the basis of multi-year observational, analytic and experimental data from the sweet cherry orchard at Berlin-Dahlem (Germany) it was possible to show that during ecodormancy - time between endodormancy release (t1) and beginning of ontogenetic development (t1*) - the bud's temperature response is not comparable with the forcing effectiveness after beginning of ontogenetic development. The reason is that during ecodormancy the forcing effectiveness of cherries is depressed by the phytohormone abscisic acid (ABA). Thus, on the basis of our physiological findings we developed and tested a 3-phase phenology model for the sweet cherry cultivar Summit which considered the chilling requirement of 'Summit' during endodormancy (Phase 1), the accumulation of heat during ecodormancy, which was weighted by the bud's ABA content (Phase 2), and finally the heat accumulation in GDH between t1* and cherry blossom (Phase 3). The results showed that the ABA-related weighting of heat during ecodormancy significantly increased the model performance, compared with a model without the consideration of the bud's ABA content. This emphasizes that the ignorance or misinterpretation of the ecodormancy phase in phenology models can have substantial consequences for the estimation of the species and cultivar specific chilling and forcing requirement. References: Chmielewski, F.-M.; Götz, K.-P. Metabolites in Cherry Buds to Detect Winter Dormancy. Metabolites 2022, 12, 247.

	https://doi.org/10.3390/metabo12030247 Chmielewski, F.-M.; Götz, K.-P. ABA and Not Chilling Reduces Heat Requirement to Force Cherry Blossom after Endodormancy Release. Plants 2022, 11, 2044. https://doi.org/10.3390/plants11152044
Georgia Kahlenberg	Influence of meteorology on airborne Hymenoscyphus fraxineus spore concentrations Ash dieback, caused by the fungus Hymenoscyphus fraxineus, is severely affecting forest ecosystems. Knowledge on the influence of meteorological parameters on fungal spore concentration might give insights into the possible impact of climate change on the infection pressure. We used a 7-day volumetric spore trap installed at a semi-urban location at 10 m a.g.l. in Eichstätt, Germany, to gather data on spore concentration for a period of four years (2018 to 2021). In 2020, we installed an additional trap to record spore concentrations in a floodplain forest where infection pressure was assumed to be extraordinary high due to a higher abundance of ash trees and severely affected individuals. To obtain meteorological data, we installed weather stations at both sites. We analysed spore season characteristics and assessed the influence of temperature, humidity, precipitation and wind on daily and bi-hourly spore concentrations. We found a large variation between the sites and years regarding season length and season intensity. At Eichstätt, the annual spore integral (ASIn) varied widely between approx. 1,500 and more than 20,000 spores*day/m^3. The length of the spore season based on the 5-95 % method varied between 6 and 10 weeks. Peak values were always registered in July and the highest peak values were recorded in 2021 (approx. 1,500 spores/m^3). Bivariate correlation analyses indicated that spore concentration was positively correlated with precipitation and humidity. Bi-hourly values were related to wind direction and ash tree abundance. Both meteorology and ash tree abundance seem to have an influence on the spore concentration of Hymenoscyphus fraxineus. Further analyses will provide additional information on influential factors. Keywords: Hymenoscyphus fraxineus, fungal spores, ash dieback, Fraxinus excelsior.
Simrat Singh	Biometeorological influence on the phenology of Yellow Bells (Tecoma stans L.) and implications on reproductive success Seasonal variation in temperature and precipitation distinctly affected the reproductive phenology of Tecoma stans – a versatile drought tolerant yellow flowering shrub used for landscape beautification. A two-year study (2020-2022) was undertaken in the plains of north west India to assess variation in the vegetative and reproductive phenology of T. stans under subtropical climatic conditions, with mean annual air temperature range of 6.9-37.7oC and precipitation of 70.0 mm. Findings revealed ‘phenotypic plasticity’ in the leaf length and leaf morphology. The leaf length ranged 10-20 cm with an emergence of single, trifoliate and compound leaf pairs on a single branch. Leaf primordia unfolded earlier, taking 7-8 days with greater leaf area during summers and relatively steady (10-12 days) leaf unfolding was observed, coupled with intense dentations at the leaf margins during winters. The flower induction in T. stans has been linked to photoperiod, being a quantitative long day plant with profuse flowering during mid spring till late autumn. The reproductive success was recorded very low (20.7%) during hot summer months resulting in considerably lower pod production and subsequent seed yield which can be attributed to pollen degeneration at higher temperature during April to June (37.6 oC) recorded during our period of investigation that limits the availability of pollinators as well. Air temperature exceeding 34oC accompanying a prolong rainfall deficit period results in pollen sterility and improper fertilization. Inflorescence in form of raceme panicles opening in an acropetal pattern seems as an adaptable character in T. stans facilitating longer time (47-50 days) for the cross-pollination events to occur favoring greater chances of reproductive success essential for species perpetuation.

	Phenological studies can help researchers build crop specific models to predict the crop growth and yields that are likely to vary with erratic weather patterns anticipated due to climate change.
Lumnesh Swaroop Kumar Joseph (VIRTUAL)	Climate change: future levels of elevated CO2, warming and drought will change phenology of mountain grasslands Mountain grasslands provide a plethora of ecosystem services from conservation to livestock industry and tourism, and have high recreational value. Global change currently causes significant phenological shifts, including the advancement of spring leaf emergence and the postponement of autumnal leaf senescence. While the individual effects of elevated CO2, climate warming and drought events on grassland phenology have been studied to some degree, our understanding of the interactive effects of these global change drivers is still limited. Here we show that future climate conditions lead to strong phenological shifts. Using a multifactorial global change experiment, we tested the individual and combined effects of elevated CO2 (eCO2; +300 ppm), warming (eT; +3°C) and severe summer droughts on canopy- and species-level phenology. The results demonstrate that warming, both individually and when combined with elevated CO2, lead to early leaf emergence, whereas summer droughts, both under natural conditions and when combined with warming and elevated CO2, advance leaf senescence. Overall, our findings reveal distinct, non-additive effects of interacting global change drivers on the phenology of mountain grasslands, and show that phenological shifts are pivotal indicators of climate change. These results pave the way for further studies to understand the relationship between phenological shifts with other ecosystem processes including primary productivity and biogeochemical cycles.

Animal Biometeorology 2	**VENTANA B**
Nicola Lacetera	Creation of a first Italian climate database for the national livestock sector use: the case of Livestock Environment Opendata Project The Livestock Environmental Open-data Project (LEO) is a platform for livestock data supported by the Italian Minister of Agriculture and implemented by the Italian Livestock Breeders Association (AIA). The goal of the LEO project is to create an innovative database for the conservation and management of new livestock information capable of acquiring, integrating, validating and making available, through automated procedures, data from different sources and of different types (i.e., climatic, environmental, health, animal-based, farm-based, etc.) The climatic database is populated by 690 meteorological stations located throughout the country and belonging to public institutions (air force and regional agrometeorological services). Procedures have been implemented for downloading and organizing daily and hourly data from 2018 to date relating to the main meteorological variables: maximum and minimum air temperature, maximum and minimum relative humidity and precipitation. Starting from these data, climatic and bioclimatic indices of interest for livestock were calculated and made available on the database. The calculation of the Gaussen-Bagnouls climatic index has been implemented monthly. This index relates the temperature and rainfall and expresses the risk of aridity. The Temperature Humidity Index (THI), a bioclimatic index that combines air temperature and relative humidity and is widely used to assess the risk of heat stress, is calculated on a daily scale. Finally, the calculation of the bioclimatic index THI-LOAD that measures the thermal balance of animals

	as the time spent above or below critical thresholds of THI is implemented. The climatic database currently contains 8,904,127 and 2,676,349 daily and hourly values, respectively. Users can download the data from the Leo portal (https://opendata.leo-italy.eu/portale/home) and use them to obtain statistics or to research topics. This system will make available to operators in the sector and the farm advisory system in agriculture a series of helpful information to improve national livestock system.
Angela Lees	The behavioural benefits of providing feedlot cattle with shelter structures during a temperate Australian Summer Heat stress is an issue in tropical and sub-tropical production systems, however information from temperate environments is limited. This study evaluated the influence of two shade types on panting score and behavioural responses of feedlot cattle in a temperate environment, during a southern hemisphere summer. A total of 720 Bos taurus heifers were inducted as two cohorts (n=360) 28 days apart. There were three treatments with six pens per treatment; 1) unshaded; 2) shaded: via 80% solar block shadecloth; and 3) waterproof: via waterproof polyethylene material. Observational data activity (feeding, drinking, or ruminating), posture, shade utilisation and panting score were obtained four times daily (0800h; 1100h; 1300h; and 1500h) over 104d for Cohort 1 and 109d for Cohort 2. Observational data were converted to a proportion of animals utilising shade; standing; lying; ruminating; drinking or feeding within each pen for each observation. These data were then modelled using a repeated measures linear mixed effects model. Shade utilisation was variable throughout the study, however increased between 0800h and 1300h, regardless of treatment. Maximum shade utilisation occurred at 1300h for both shaded (44.7±1.71%) and waterproof (58.7±1.72%) treatments. There was a 12.1% increase in shade utilisation regardless of treatment as heat load increased from cool (HLI≤70) to very hot (HLI≥86). Mean panting score increased by 0.78, 0.67 and 0.61 units between 0800h and 1500h observations for the unshaded, shaded and waterproof treatments. Cattle in the waterproof treatment had lower mean panting scores across each HLI stress category (P≤0.05). These results provide further affirmation that providing shade to feedlot cattle is important for expression of behavioural responses to support thermoregulation as evidenced by reduced mean panting score. These results are particularly important given the mild climatic conditions experienced throughout the study, overall supporting the provision of shade for feedlot cattle regardless of climatic region.
Vinicius Fonseca	Modelling evaporative water loss in goats Direct measurements of evaporative water loss (EWL) in animals require knowledge about the temperature and wetness of the animal's cutaneous surface and upper respiratory tract, which in turn, are challenging to be obtained under field. On the other hand, some physiological and meteorological measures can be used to indirectly estimate EWL in animals. We performed parallel measurements of body temperatures, cutaneous (CEWL) and respiratory (REWL) evaporative water loss in order to derive predictive models of EWL in goats. Five castrated male indigenous goats (Capra hircus) aged 3-4 years and weighing between 30

	and 35 kg were randomly assessed from 09:00 to 12:00h, exposed and not exposed to simulated solar radiation provided by heat lamps (Power = 400W), along twenty consecutive days. Goats were fed twice a day and water was freely available. The least-square linear regression was used to predict CEWL and REWL based on the following independent variables: air temperature (Ta, ºC), mean radiant temperature (TRM, ºC), expired air temperature (TEXP, ºC), skin temperature (TSKIN, ºC), subcutaneous (TSUB, ºC), and intraperitoneal temperature (TINT, ºC). Over the study period, goats experienced Ta ranging from 24 to 42 ºC, TRM from 24 to 54 Cº, and water vapor pressure between 0.8 and 1.6 kPa. The REWL oscillated between 3.5 and 57 g h-1 m-2, and the CEWL from 3 to 140 g h-1 m-2. The REWL was better predicted by Ta (R2 = 0.80) and TRM (R2 = 0.67). The skin (R2 = 0.80) and subcutaneous temperature (R2 = 0.74) well predicted the CEWL. In conclusion, this study provides simple linear models to predict evaporative water loss in goats kept under circumstances of hot and dry environment. Moreover, body temperatures obtained with implantable biologgers can well predict the EWL in free-ranging animals.
Silpa Mullakkalparambil Velayudhan (VIRTUAL)	Assessing The Influence of Heat Stress on Caprine Skin: Unravelling The Impact of Epigenetic Alteration Due to Heat Stress at The Functional Level A study was conducted to assess the skin-based heat stress response in two indigenous goat breeds, black coated Kanni Aadu goats and white coated Kodi Aadu goats, using climate chambers. The experiment was conducted on 24 does that were divided into 4 experimental groups: KAC (Kanni Aadu Control; 26°C; n=6), KAH (Kanni Aadu Heat Stress; 37-40°C; n=6), KOC (Kodi Aadu Control; 26°C; n=6) and KOH (Kodi Aadu Heat Stress; 37-40°C; n=6) for a total duration of 45 days. The temperature humidity index, skin surface temperature and impact of DNA methylation at the functional level were assessed using weather variables, infra-red thermal imager and bisulfite sequencing. The animals housed in the control chambers (KAC and KOC) had a comfortable afternoon THI of 69.42 ± 0.05 and KAH and KOH were subjected to severely high THI of 94.76 ± 0.45. Alteration in the surface temperature (eye, forehead, flank, back and front leg) was recorded with significantly higher temperature recorded in KAH and KOH goats when compared to KAC and KOC. Likewise, the DNA methylation profile also revealed a significant alteration at the epigenetic level. When assessing the impact of the differentially methylated genes (DEGs) at the functional level, substantial alterations were observed in the metabolism, cell signaling and immune response pathways. This study was a first-time attempt to assess the impact of heat stress on DNA methylation profile in goats. Though the skin tissue of both the goat breeds revealed a significant impact due to heat stress, the severity of stress was relative higher in the black coated Kanni Aadu goats than the white coated Kodi Aadu goats. This thereby highlights the adaptive differences exhibited by the two indigenous goat breeds.

Human Health and Epidemiology 4	**VENTANA C**
Robert Davis	Associations between Synoptic Weather Types and Self-Reported Sinus Symptoms

	Little research has been conducted on the relationship between weather conditions and sinonasal symptoms. The purpose of this study is to examine linkages between weather and patient-reported symptoms during clinic visits at the University of Virginia Medical Center in Charlottesville, Virginia, U.S.A. At the time of each visit, rhinology clinic patients complete the Sino-Nasal Outcome Test (SNOT-22), a 22-question survey using a 6-point Likert scale regarding commonly reported symptoms. Daily mean scores from SNOT-22 surveys taken from January, 2010 through March, 2020 serve as the dependent variable. Daily meteorological data for the same time period were acquired from the Charlottesville-Albemarle County Airport observation station. These data were used to identify the synoptic weather type for each day using the Spatial Synoptic Classification (SSC), a nominal, multivariate method that characterizes six primary synoptic types and a transition category. Preliminary analysis found associations between high SNOT-22 scores (22-question sum ≥ 50) and both dry, polar (DP) and transition (TR) air masses. Using these categories, odds ratios were computed based on SNOT-22 scores above/below 50 and the presence/absence of DP or TR synoptic types. Analyses were conducted from the day of the clinic visit through a 3-day lag. Based on 1145 SNOT-22 surveys, the odds of recording a score ≥ 50 were twice as high on DP/TR days compared to all other weather situations (OR = 2.0 [1.4, 2.8]). Similar results were found for patients suffering from chronic rhinitis (OR=1.8 [1.2, 2.9]) or chronic sinusitis (OR=1.8 [1.2, 2.9]). Odds ratios tended to weaken with lag, indicating that weather impacts are acute. These results suggest that cold and/or dry weather conditions exacerbate sino-nasal symptoms. As transition air masses frequently represent frontal passages, changing weather conditions often include the onset of DP conditions or high wind speeds that can increase airborne particulate matter concentrations.
Andreas Matzarakis	Weather Sensitivity Surveys in Germany Scientifically based data on the prevalence of weather-associated complaints and symptoms as well as impairment of well-being have been obtained from population surveys on weather sensitivity in Germany since the 1950s. This analysis focuses on the findings from the representative population survey of 2021 and relates the results to the surveys of 2013 and 2001. The “Institut für Demoskopie Allensbach”, on behalf of the German Meteorological Service, interviewed a representative sample of 1080 German citizens. Based on respondents’ self-assessment, the proportion of individuals who said the weather had an impact on their health was 46% in 2021, compared to 50% in 2013 and 54% in 2001. Elderly and chronically ill individuals are more likely to suffer from weather sensitivity than the average population. Women are more affected than men. The most common complaints of weather sensitivity are headaches/migraines, exhaustion/general fatigue, limited activities, and abnormal fatigue. The decrease in the proportion of weather-sensitive humans may be related to greater health awareness and improved health care. Preventive measures, such as going outdoors and dosed exposure of the body to different weather, as well as avoiding other stresses, can train the body’s ability to regulate itself and help to make it less susceptible to weather sensitivity.
Eduardo Kruger	Feasibility of using ERA5-HEAT UTCI data as a proxy for missing field data in outdoor thermal comfort surveys and in the context of hospital admissions for respiratory diseases Scrutinizing existing relationships between weather variables and human response is the main goal of human biometeorology. We analyze thermal perception assessed by outdoor thermal comfort (OTC) surveys and hospital admission (HA) entries for respiratory

	diseases against thermal stress data as given by the Universal Thermal Climate Index (UTCI), retrieved from the ERA5-HEAT, a downloadable reanalysis dataset providing hourly grids of UTCI records at 28 × 28 km spatial resolution from 1940 to date. We evaluate the feasibility of using ERA5-HEAT data as: 1) a proxy for field measurements carried out concurrently alongside questionnaire surveys with pedestrians; 2) surrogate and complementary data to trivial ambient temperature data with different lag times versus HA entries due to respiratory diseases. The datasets comprise of 1,640 thermal sensation votes (TSV) for various urban morphologies and exposures in subtropical Curitiba, Brazil, and of daily HA data for the elderly in 2018 (total records 9,055) and 2020 (total records 5,508) in six Brazilian locations with differing climates (i.e. before and during the first year of the COVID-19 pandemic). Comparisons between correlations found for air temperature and TSV/HA have been drawn for the UTCI, assuming that the index represents better the thermal environment. Results show that reanalysis UTCI data are reasonable surrogates for missing field data in OTC studies involving questionnaire surveys. Concerning health data, predicted daily mean UTCI either improved the strength of the correlations or lead to similar trends as observed in the daily mean air temperature. Results are meaningful, considering that ground-based observations are collected at location-specific stations whereas reanalysis data have a comparatively coarser spatial resolution, sometimes not fully matching the evaluated location.
Luis B. Lecha Estela (VIRTUAL)	Impacts of extreme meteor-tropic effects on daily excess mortality in Cuba As extreme meteor-tropic effects there are considered the known dangerous weather phenomena such as hurricanes, tornadoes, storm surges, floods and intense winter cyclones, plus the incidence of heat or cold waves and the occurrence of abrupt weather changes. They are increasing frequency and intensity in Cuba since the beginning of XXI Century, being a significant source of massive and diverse health crisis, including deaths. More than 82 % of the days with excess mortality higher than 20 individuals was related with the occurrence of extreme meteor-tropic effects, and they have the same magnitude observed during catastrophic accidents or in the period of Covid-19 epidemic in Cuba. A clear seasonal difference between the genesis of extreme meteor-tropic effects and the characteristics of daily excess mortality was observed. The impact of extreme meteor-tropic effects on daily excess mortality in Cuba is higher than expected, with a fast increase since the years 2009-2010.