Preparing to teach AS/A-level Environmental Science

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Contents

Structure of the course

Structure of the course – AS and A-level

The living environment

- Conditions for life on Earth
- Conservation of biodiversity
- Life processes in the biosphere and conservation planning

The physical environment

- The atmosphere
- The hydrosphere
- Mineral resources
- Biogeochemical cycles
- Soils

Structure of the course – A-level only

Energy resources

Evaluation of new extraction/harnessing technologies relating to:

- fossil fuels
- nuclear power – fission and fusion
- renewable energy technologies
- new energy storage systems
- new energy conservation technologies
- vehicle design for use and end of life
- building design.

Structure of the course – A-level only

Pollution

- The properties of pollutants
- How environmental features affect pollution events
- Strategies to control pollutants based on their properties and features of the environment

Biological resources

- Agriculture
- Aquatic food production systems
- Forest resources

Sustainability

- Dynamic equilibria
- Energy
- Material cycles
- The Circular Economy

Changes to the specification

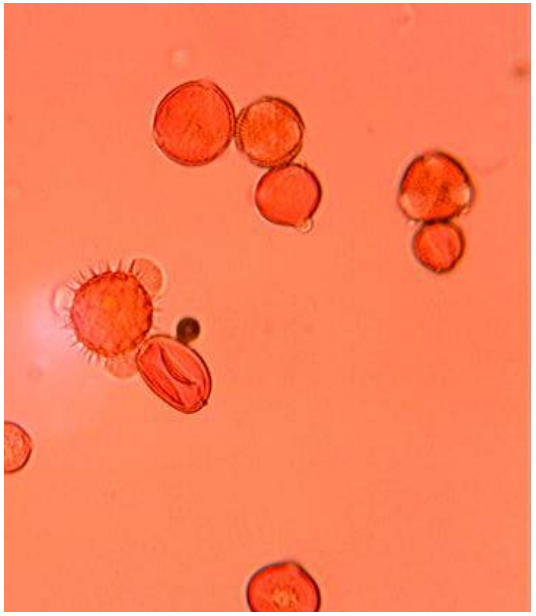
Specification changes/new emphasis

- Significant changes from Environmental Studies.
- Detailed guide to changes in our summary of changes document.
- There is a new emphasis in the specification to reflect:
  - the tentative nature of scientific knowledge
  - how environmental information is gained
  - how research fills gaps in knowledge.

The following slides illustrate a number of these changes.

Conditions for life on Earth

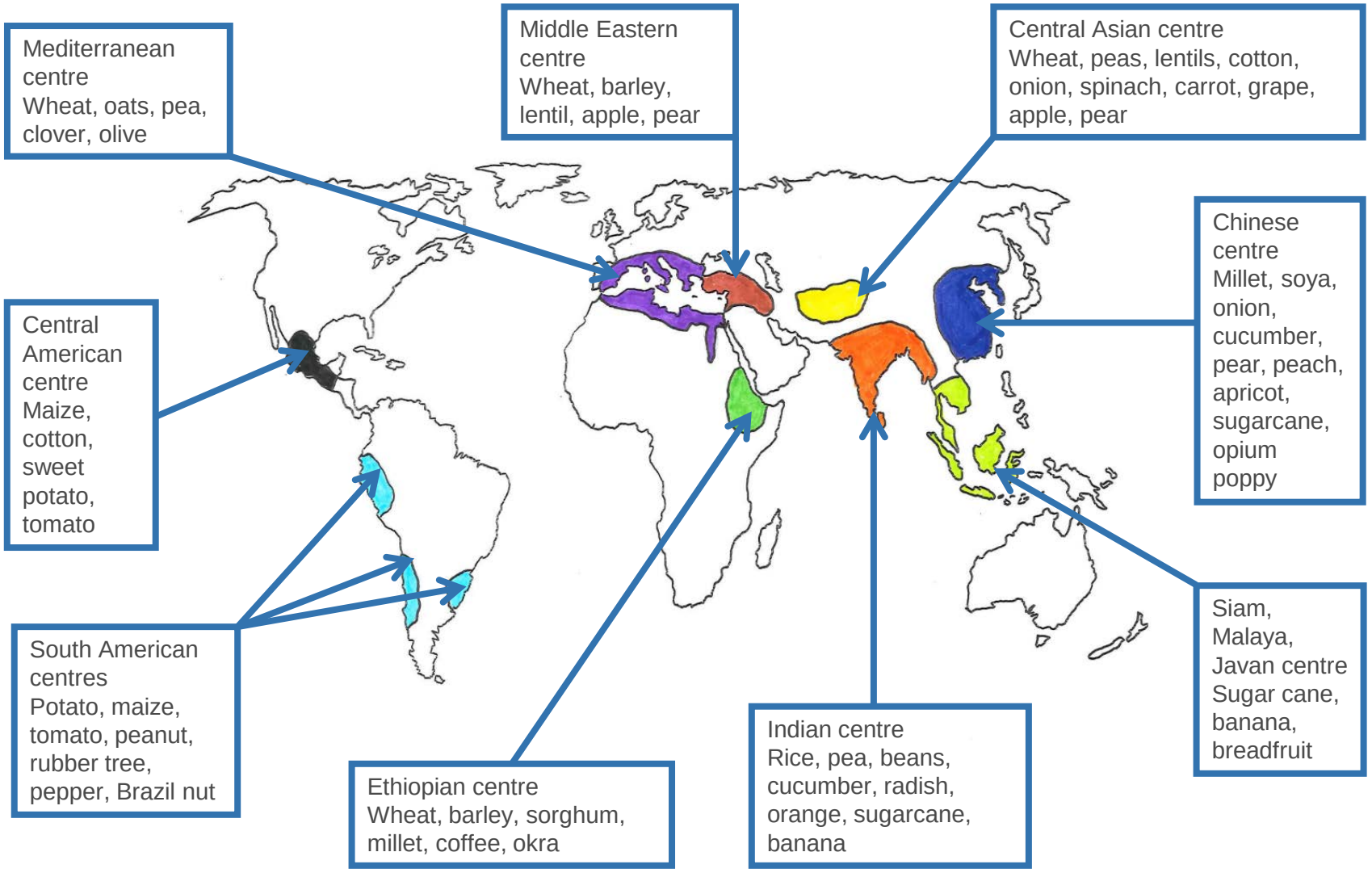
How historical conditions for life were monitored in the past and how these methods have developed over time.



Biomimetics

youtube.com/watch?v=V8Nu94khHoo

Vavilov centres of origin and crops that were found there



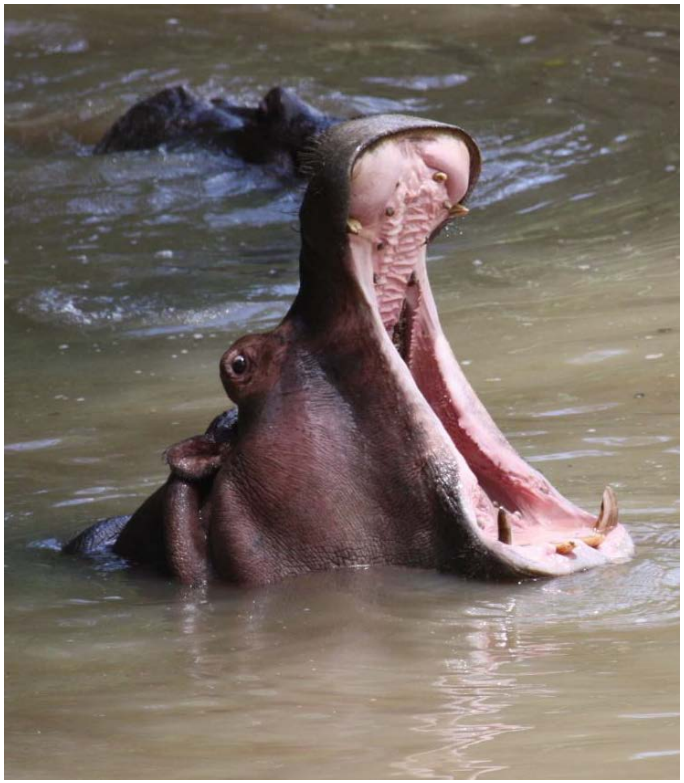
IUCN criteria

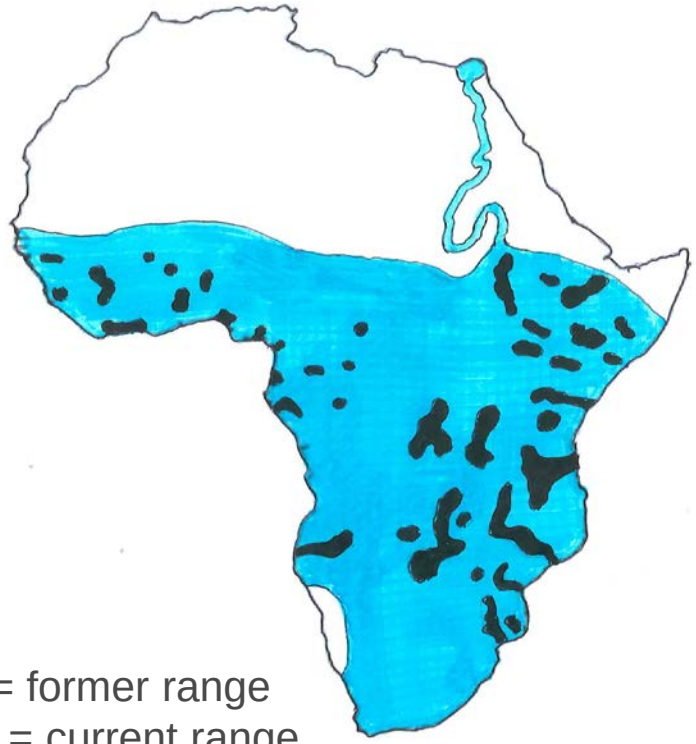
- Evolutionary uniqueness
- Endemic species
- Keystone species
- Flagship species
- Threats to survival
- Population dispersal

s3.amazonaws.com/iucnredlist-newcms/staging/public/attachments/3097/redlist_cats_crit_en.pdf

Hippopotamus

IUCN status = Vulnerable





blue = former range
black = current range

Giraffe sub-species

IUCN conservation status = LC (least concern)

Common name	Latin name	Population in the wild	Population in captivity
Giraffe	Giraffa camelopardalis	52,600	1,144

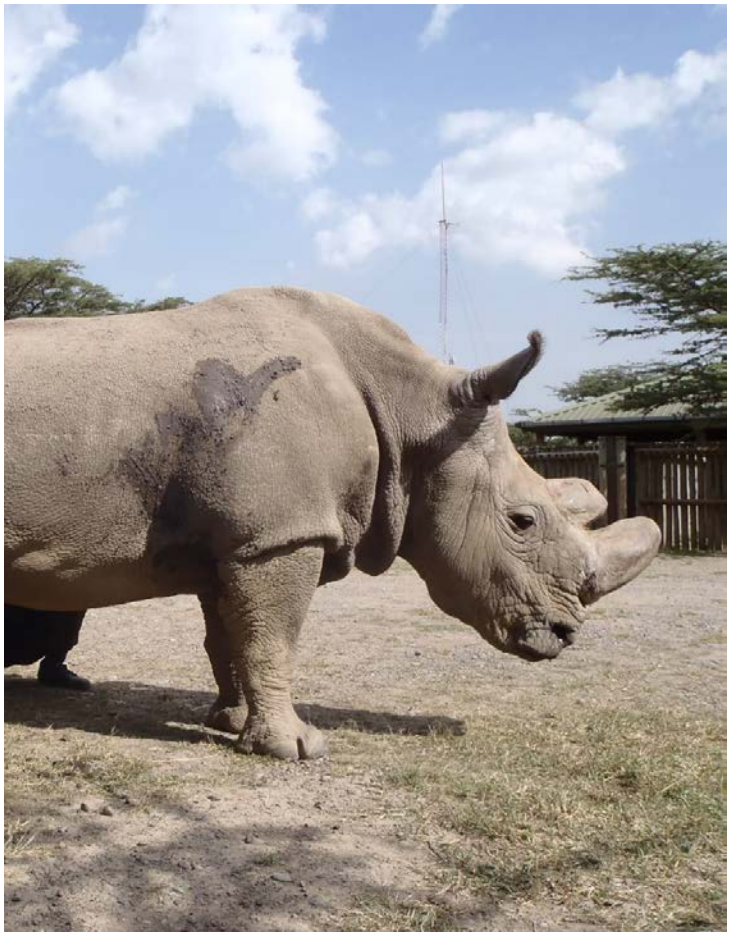
Giraffe sub-species

Common name	Latin name	Population in the wild	Population in captivity
Species			
Giraffe	Giraffa camelopardalis	52,600	1,144
Sub-species			
Angolan giraffe	G.c. angolensis	20,000	20
Kordofan giraffe	G.c. antiquorum	3,000	65
Nubian giraffe	G.c. camelopardalis	250	14
S African giraffe	G.c. giraffa	12,000	45
W African giraffe	G.c. peralta	230	0
Reticulated giraffe	G.c. reticulata	5,000	450
Rothschild's giraffe	G.c. rothschildi	670	450
Thorncroft's giraffe	G.c. thorncrofti	1,500	0
Masai giraffe	G.c. tippelskirchi	40,000	100

Waldrapp Ibis/Northern Bald Ibis

IUCN status: critically endangered

In vitro fertilisation



Embryo transfer

Bongo

Eland

Embryo transfer

Sand cat

Designated protected areas

Students should understand the different ways in which designated areas protect species and habitats by restricting activities and establishing management plans.

Global map of protected areas

protectedplanet.net

Deep water coral reefs, oceanic islands and mangroves

Data: degrees of certainty - IPCC reports

- The degree of certainty in each key finding of the assessment is based on the type, amount, quality and consistency of evidence (eg data, mechanistic understanding, theory, models, expert judgment) and the degree of agreement.
- The summary terms for evidence are: limited, medium or robust.
- For agreement, they are low, medium or high.
- Levels of confidence include five qualifiers: very low, low, medium, high and very high and are typeset in italics eg medium confidence.

Data: degrees of certainty - IPCC reports

The likelihood, or probability, of some well-defined outcome having occurred or occurring in the future can be described quantitatively through the following terms:

- virtually certain, 99-100% probability
- extremely likely, 95-100%
- very likely, 90-100%
- likely, 66-100%
- more likely than not, >50-100%
- about as likely as not, 33-66%; unlikely, 0-33%
- very unlikely, 0-10%
- extremely unlikely, 0-5%; and exceptionally unlikely, 0-1%

ipcc.ch/report/ar5/syr/

Changes in atmospheric CO2

CO2
co2.earth

Global data
earth.nullschool.net

CCS
co2stored.co.uk/home/about

Mineral resources

What would life be like without:

- Indium?
- Neodymium?

Metals used in modern cars

As vehicles become more sophisticated, the use of rare earth metals increases.

General use
- Body – iron and aluminium
- Wiring - copper

Catalytic converter
- Platinum
- Palladium
- Rhodium
- Cerium
- Zirconium
- Lanthanum

Glass and mirror polishing
Cerium

LCD screen
- Europium
- Yttrium
- Cerium

Battery
- Nickel
- Lanthanum
- Cerium

Electronic sensors
Yttrium

Diesel fuel additive
- Cerium
- Lanthanum

Electric motors and generator
- Neodymium
- Praesodymium
- Dysprosium
- Terbium

AQA

Future supply problems

- Geological processes – Lasky's principle
- Improved exploratory techniques
- Improved extraction techniques

Marine mineral resources

dsm.gsd.spc.int/images/pdf_files/dsm_brochures/DSM_Brochure3.pdf

Energy

The development of society

- How energy has shaped the development of society
- How the properties of energy resources have affected this development

Future challenges

- Developing new resources to satisfy demand
- Developing new infrastructure to use new resources

Solar power

Noor 1

power-technology.com/projects/noor-ouarzazate-solar-complex/

Ourzazate

google.co.uk/maps/@31.0203167,-6.8603305,10410m/data=!3m1!1e3

Seville

google.co.uk/maps/@37.4391529,-6.24921,11968m/data=!3m1!1e3

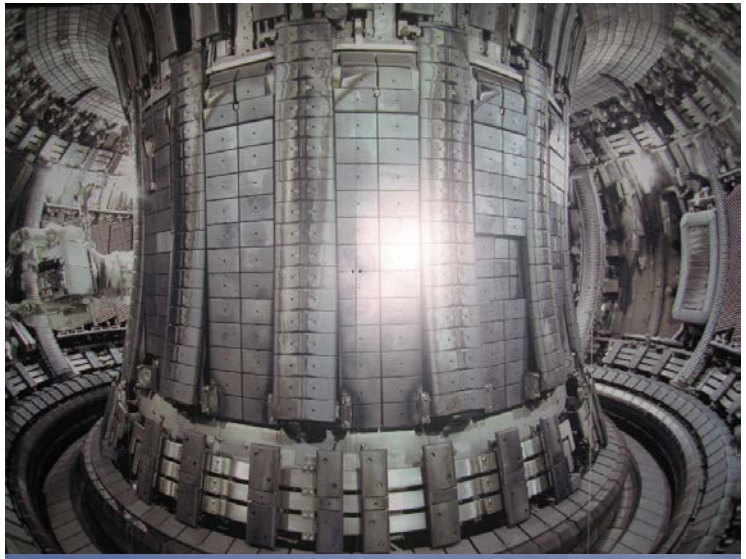
Nuclear power

Fission

- Improved uranium extraction technologies
- Plutonium reactors
- Thorium reactors

Fusion

- Toroidal reactors
- Laser fusion



Wave power

wavenet.cefas.co.uk/Map

VAWTs

Improved designs

Offshore windfarms

thecrownestate.co.uk/energy-minerals-and-infrastructure/offshore-wind-energy/offshore-wind-electricity-map

Tidal power

The national grid

BM reports
bmreports.com/bmrs/?q=eds/main

Gridwatch
gridwatch.templar.co.uk

An approach to pollution: predict or react?

The ‘Agatha Christie’ approach

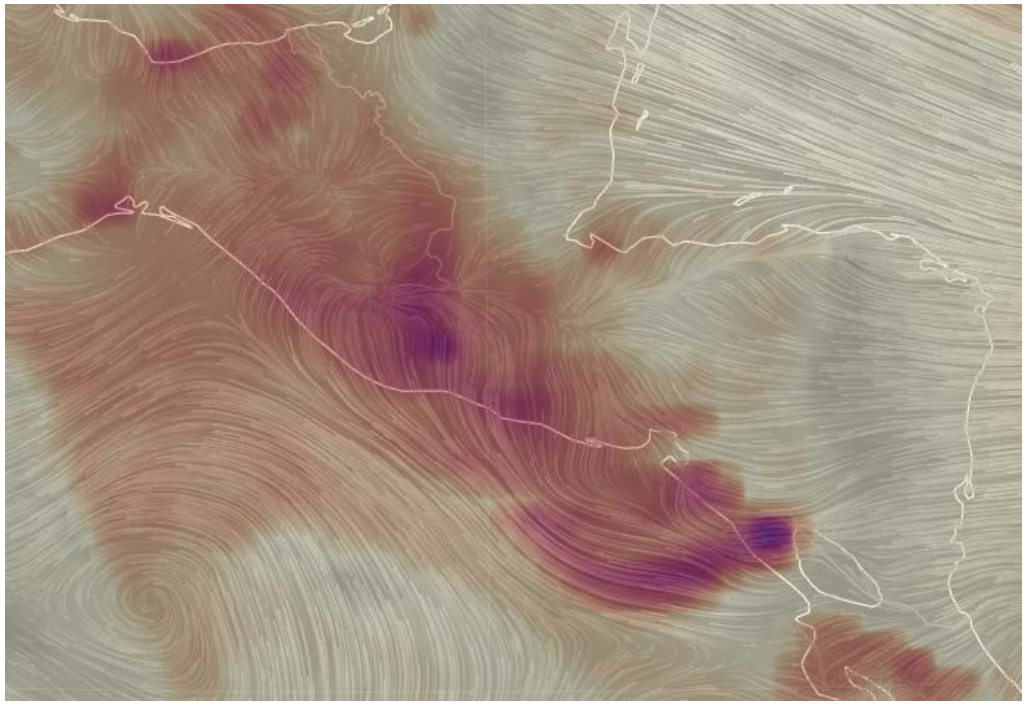
- Ozone depletion
- DDT and birds of prey
- Acid rain

Who are the current ‘suspects?’

Pollutant pathways

Air quality standards
ec.europa.eu/environment/air/quality/standards.htm

Nullschool
earth.nullschool.net



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How environmental features affect the severity of pollution

Noise pollution

Noise pollution

Airport noise control database
boeing.com/commercial/noise/list.page

Aircraft in flight
flightradar24.com/50.7,6.64/5

Heathrow airport
webtrak5.bksv.com/lhr4

Road noise
extrium.co.uk/noiseviewer.html

Concorde
youtube.com/watch?v=AMCupanPgf8

Sustainability

Industrial symbiosis
Kalundborg
symbiosis.dk/en
symbiosis.dk/diagram

The Circular Economy
ellenmacarthurfoundation.org/circular-economy

Living Planet Report
wwf.panda.org/about_our_earth/all_publications/lpr_2016

Topics that have been reduced/deleted

- Conservation in the UK – legislative details.
- Land use and land use conflicts.
- No overlap of GCSE knowledge.
- Some progression from GCSE themes, for example carbon cycle.
- Builds on assumed knowledge from GCSE section 8, Appendix C.

Assessment

Assessment

Practical skills

- No coursework.
- No required list of specific practical activities.
- Centres will be required to sign a declaration statement confirming students had the opportunity to carry out the practical skills and do a minimum of two or four days of fieldwork.

Exams

- AS
- A-level
- Question types
  - short answer
  - comprehension
  - data analysis
  - extended prose
- Maths skills

AS assessment at a glance

Paper 1	Weighting	Content
• written paper • 120 marks • 3 hours	100%	• The living environment • The physical environment • Research methods

Students are required to answer a combination of multiple choice, short answer and extended writing questions.

Students will be expected to draw on knowledge and understanding of the entire course of study to show a deeper understanding of the relationship between topics.

A-level assessment at a glance

Paper 1	Weighting	Content
• written paper • 120 marks • 3 hours	50%	• The physical environment • Energy resources • Pollution • Research methods
Paper 2	**Weighting**	**Content**
• written paper • 120 marks • 3 hours	50%	• The living environment • Biological resources • Sustainability • Research methods

In both papers:

- students are required to answer a combination of multiple choice, short answer and extended writing questions
- students will be expected to draw on knowledge and understanding of the entire course of study to show a deeper understanding of the relationship between topics.

Assessment objectives

Assessment objective		AS	A-level
AO1	Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures, including in relation to natural processes/systems and environmental issues	35-40%	30-35%
AO2	Apply knowledge and understanding of scientific ideas, processes, techniques and procedures, including in relation to natural processes/systems and environmental issues	40-45%	40-45%
AO3	Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to environmental issues, to make judgements and draw conclusions	20-25%	25-30%

Assessment objective weighting by paper (A-level)

AO	Component weightings		Overall weighting approx %
	Paper 1	Paper 2	
AO1	17-19	14-16	30-35
AO2	19-21	20-22	40-45
AO3	11-13	13-15	25-30
Overall weight of component	50%	50%	100%

The AS has one written paper only, therefore the component weighting will be the same as the overall AO weighting.

Extended prose

- 9 mark questions on AS and A-level
- 25 mark questions on A-level only

- Similar general approach to answering these type of questions:
  - principle/issue being described/explained/discussed
  - development point: why is it the right answer?
  - technical details/terminology/examples used to add detail

- Timing
- New generic mark schemes

9 mark extended prose question

08.5 Evaluate the extent to which recycling used materials affects the environmental impact of using mineral resources.

Advantages

- less waste for disposal
- less space required for landfill
- no toxic leachate produced
- less demand for virgin materials
- less atmospheric pollution from extracting virgin materials
- lower habitat impacts of mineral extraction/processing
- reduced energy use for extraction/ processing

Disadvantages

- difficulties with material separation
- identification difficulties
- restricted uses of recycled alloys/mixtures
- increased transport costs of collection
- higher handling costs of small quantities
- toxic wastes produced by processing of some materials
- supply can't match growth in demand – need for virgin materials
- need for consumer cooperation
- use of linked examples to illustrate points

9 mark extended prose question

11.3 Discuss how poor soil management methods used on farmland may cause environmental problems in other areas.

Poor management

- Ploughing/drainage
- Compaction by machinery/trampling
- Reduced addition of organic matter
- Desertification
- Desertification
- Ploughing vulnerable soils

Soil erosion impacts

- Increased atmospheric particulates
- Reduced land stability
- Reduced agricultural productivity

Other justified issues

Level of response mark scheme

Level	Marks	Descriptor
3	7 – 9	A comprehensive response to the question, with the focus sustained. A conclusion is presented in a logical and coherent way, fully supported by relevant judgements. A wide range of knowledge and understanding of natural processes/systems is applied. The answer clearly identifies relationships between environmental issues. Relevant environmental terminology is used consistently and accurately throughout, with no more than minor omissions and errors.
2	4 – 6	A response to the question which is focussed in parts but lacking appropriate depth. A conclusion may be present, supported by some judgements, but it is likely not all will be relevant. A range of knowledge and understanding of natural processes/systems is shown. There is an attempt to apply this to the question, but there may be a few inconsistencies, errors and/or omissions. The answer attempts to identify relationships between environmental issues, with some success. Environmental terminology is used, but not always consistently.
1	1-3	A response to the question which is unbalanced and lacking focus. It is likely to consist of fragmented points that are unrelated. A conclusion may be stated, but it is not supported by any judgments and is likely to be irrelevant. A limited range of knowledge and understanding of natural processes/systems is shown. There is an attempt to apply this to the question, but there are fundamental errors and/or omissions. The answer may attempt to identify relationship between environmental issues, but is rarely successful. Limited environmental terminology is used, and a lack of understanding is evident.
	0	Nothing written worthy of credit.

Command words

Calculate	A numerical answer is required, using the values provided.
Compare	Weigh up the significant aspects of more than one issue.
Describe	Give a factual description eg of a graph or process.
Discuss	Outline the conflicting arguments for and against a specific position.
Estimate	A numerical answer is required, using values, some of which involve judgement eg values read from a graph.
Evaluate	Present a statement that includes an assessment of the significance or magnitude of an issue.
Explain	Give an account that shows understanding of why an issue occurs.
Give	A name or brief statement is required.
How	Don't use, except in conjunction with describe, explain etc.
Identify	Select an appropriate name or technical term.
Name	Give a suitable named example.
Outline	Give a brief description, including the main issues.
Select	Choose an appropriate name or technical term eg from a given list.
State	Give a name or technical term.
Suggest	Give a plausible answer based on subject knowledge that could be correct, eg where an unfamiliar context is involved.
Use example(s) to...	Credit will be given for the use of correct examples, in addition to marks for the other commands in the question.
What	A factual answer is required to show knowledge rather than understanding , eg a name or term.
Why	Requires an explanation.

Practical skills and research methods

Practical skills requirements

- Assessment of the knowledge and understanding of the practical skills in the AS and A-level specification remains 100% direct assessment via the written papers.
- At least 15% of the overall assessment of AS and A-level Environmental Science will assess knowledge, skills and understanding in relation to practical work (see Working Scientifically).
- Opportunities for practical skills development will be signposted throughout the specification and will equip students with the essential practical skills that they will need to progress to HE courses in Science.

Practical skills requirements and research methods

Students must be given the opportunity to carry out investigative/practical activities which enable them to develop the required practical skills:

- independent thinking
- use and application of scientific methods and practices
- numeracy and the application of mathematical concepts in a practical concept
- using instruments and equipment.

Students need to have an understanding of:

- all scientific methodologies
- all sampling techniques
- required knowledge of methodologies and sampling techniques is outlined in the subject content section of the specifications **Research methods**.

Where practical skills appear in the specification

- 3.7 Research methods
  - 3.7.1 Scientific methodologies
  - 3.7.2 Sampling techniques
    - 3.7.2.1 Standard environmental techniques
    - 3.7.2.2 Fieldwork and laboratory activities
    - 3.7.2.3 Specialist techniques

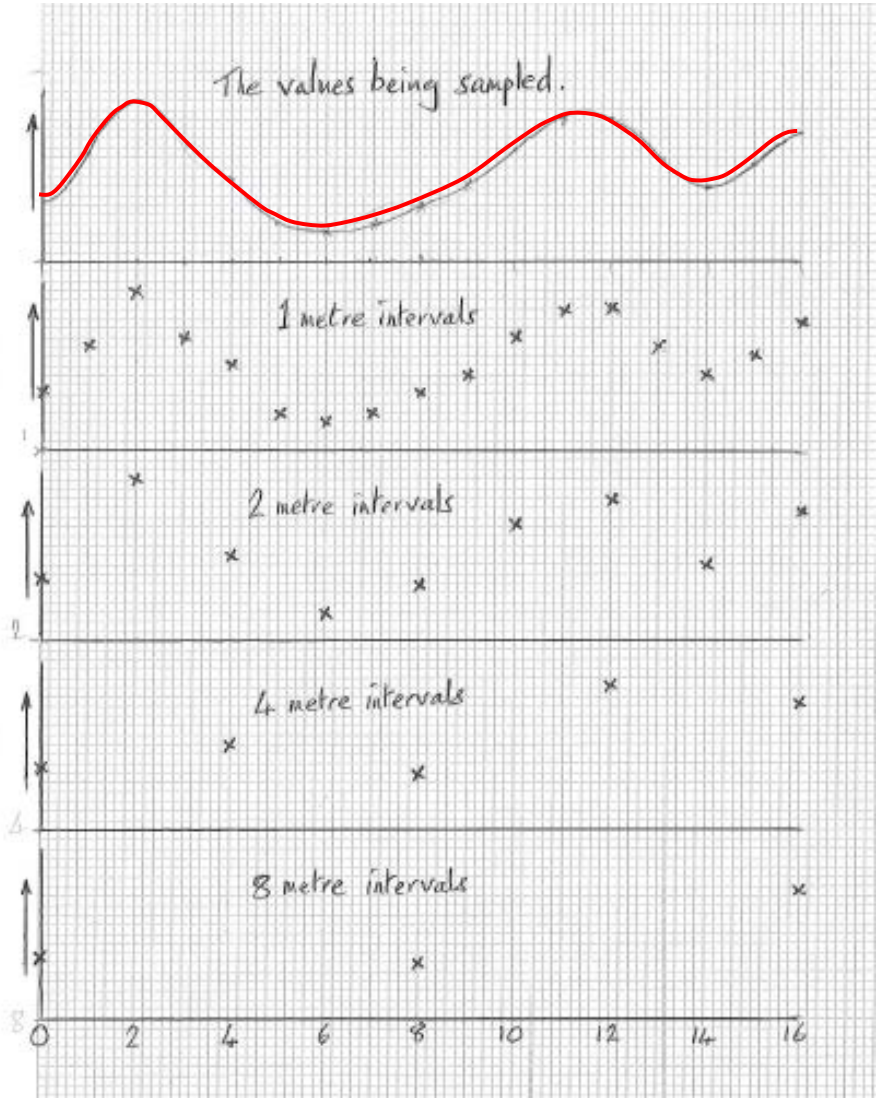
- 6 Appendix A: Working scientifically
  - 6.1 Practical skills
    - Table 2. Independent thinking
    - Table 3. Use and application of scientific methods and practices
    - Table 4. Numeracy and the application of mathematical concepts
    - Table 5. Instruments and equipment

Where practical skills appear in the specification

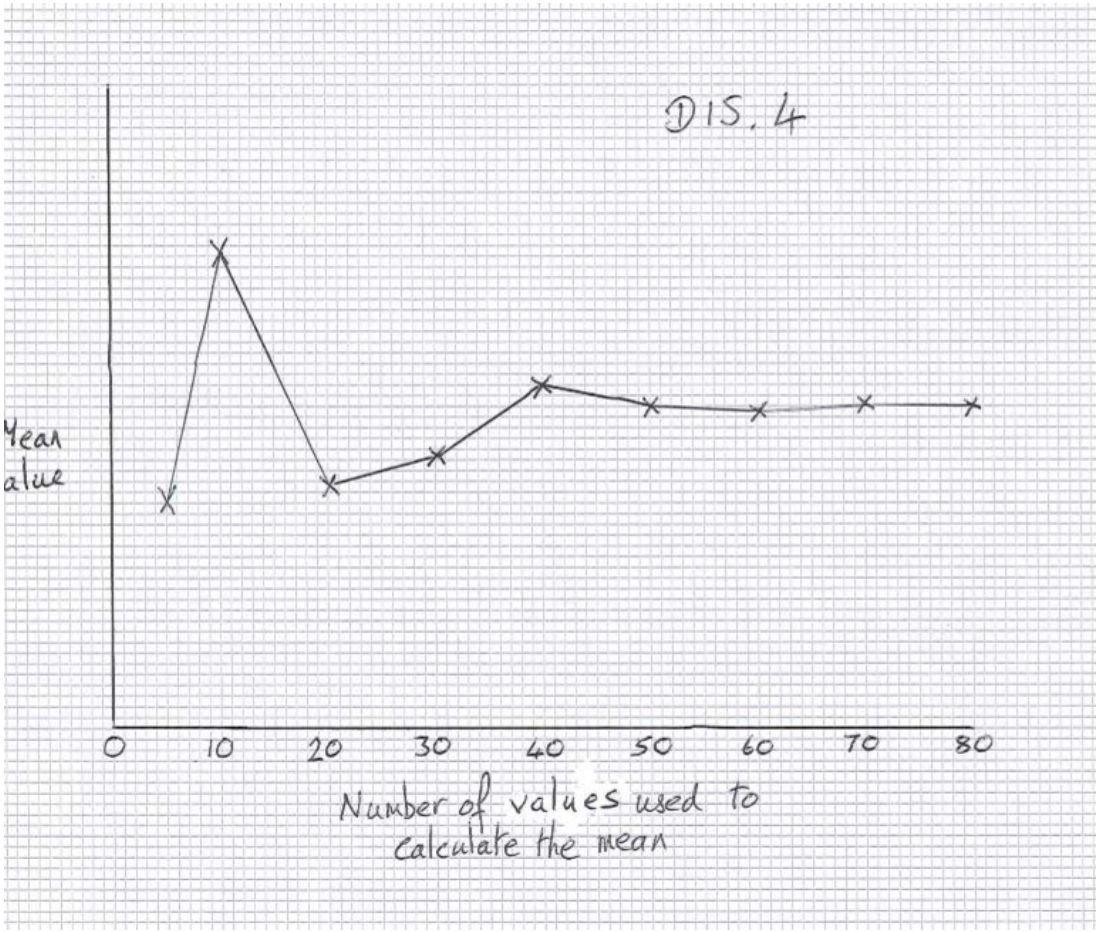
- 6.3 Methodologies
  - Me 1. Sample location – random sampling
  - Me 2. Sample location – systematic sampling
  - Me 3. Number of samples
  - Me 4. Sample size
  - Me 5. Sample timing
  - Me 6. Standard deviation. Stats tests.

AS Methodologies 1 to 3 only.

What is the best sampling interval to provide representative results?



How many samples are needed to provide reliable results?



Application of practical skills and research methods

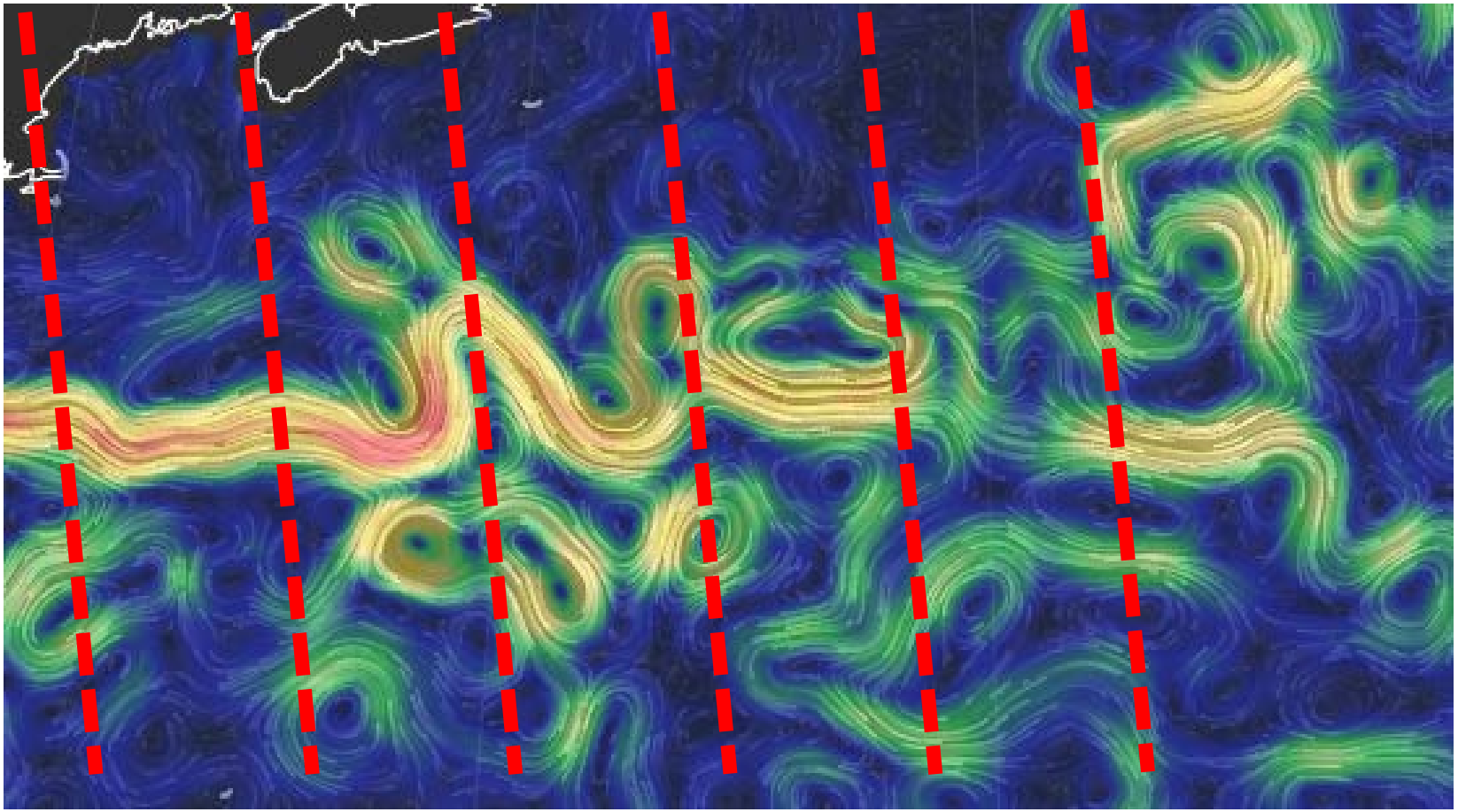
Putting a single figure on variable data.

How fast is the Gulf Stream?

earth.nullschool.net

Application of practical skills and research methods

The Gulf Stream



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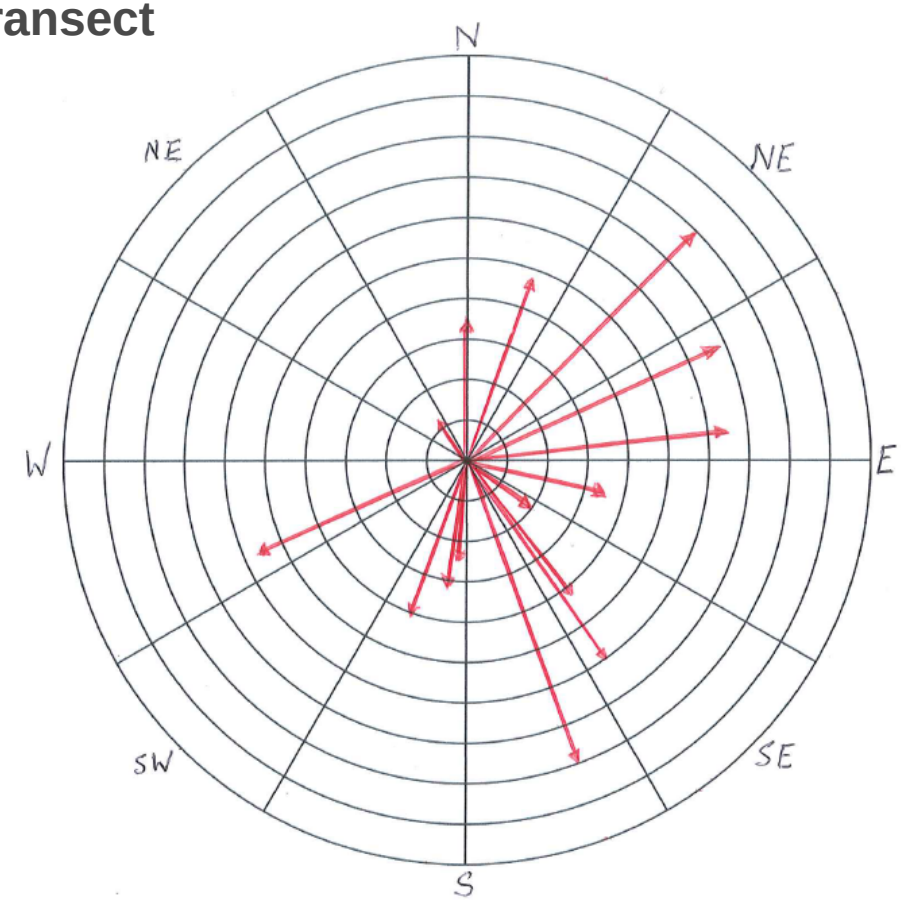
Application of practical skills and research methods

Gulf Stream currents along one transect

- Current direction and velocity along a transect across the Gulf Stream
- One ring = 0.1 ms -1



6.4 Sampling techniques

- ST 1. Measurement of abiotic factors
- ST 2. The use of quadrats
- ST 3. Measurement of edaphic factors
- ST 4. Animal taxa on/in soil
- ST 5. Animal taxa on foliage/flying
- ST 6. Aquatic biota

Guidance on research methods/practical skills

These **do not** involve extra content. These provide guidance on the approach/emphasis required and suggest suitable activities.

6.5 Scientific principles

- 6.5.1 Use theories, models and ideas
- 6.5.2 Use knowledge and understanding
- 6.5.3 Use of ICT
- 6.5.4 Undertake experimental and investigative activities
- 6.5.5 Analyse and interpret quantitative and qualitative data
- 6.5.6 Evaluate methodology, evidence and data
- 6.5.7 Scientific knowledge develops over time
- 6.5.8 Appropriate terminology
- 6.5.9 Consider applications and implications of environmental science
- 6.5.10 Ethical issues
- 6.5.11 The role of the scientific community in validating new knowledge
- 6.5.12 How society uses science to inform decision making

Opportunities for skills development and independent thinking

- Mathematical skills
- Practical skills
- Methodologies
- Sampling techniques

Guidance on possible activities at the end of each topic.

Key research questions

- What is the hypothesis you want to test?
- What?
- How?

Sampling techniques

- Where?
- How many?
- How big?
- When?
- Analysis

Methodologies

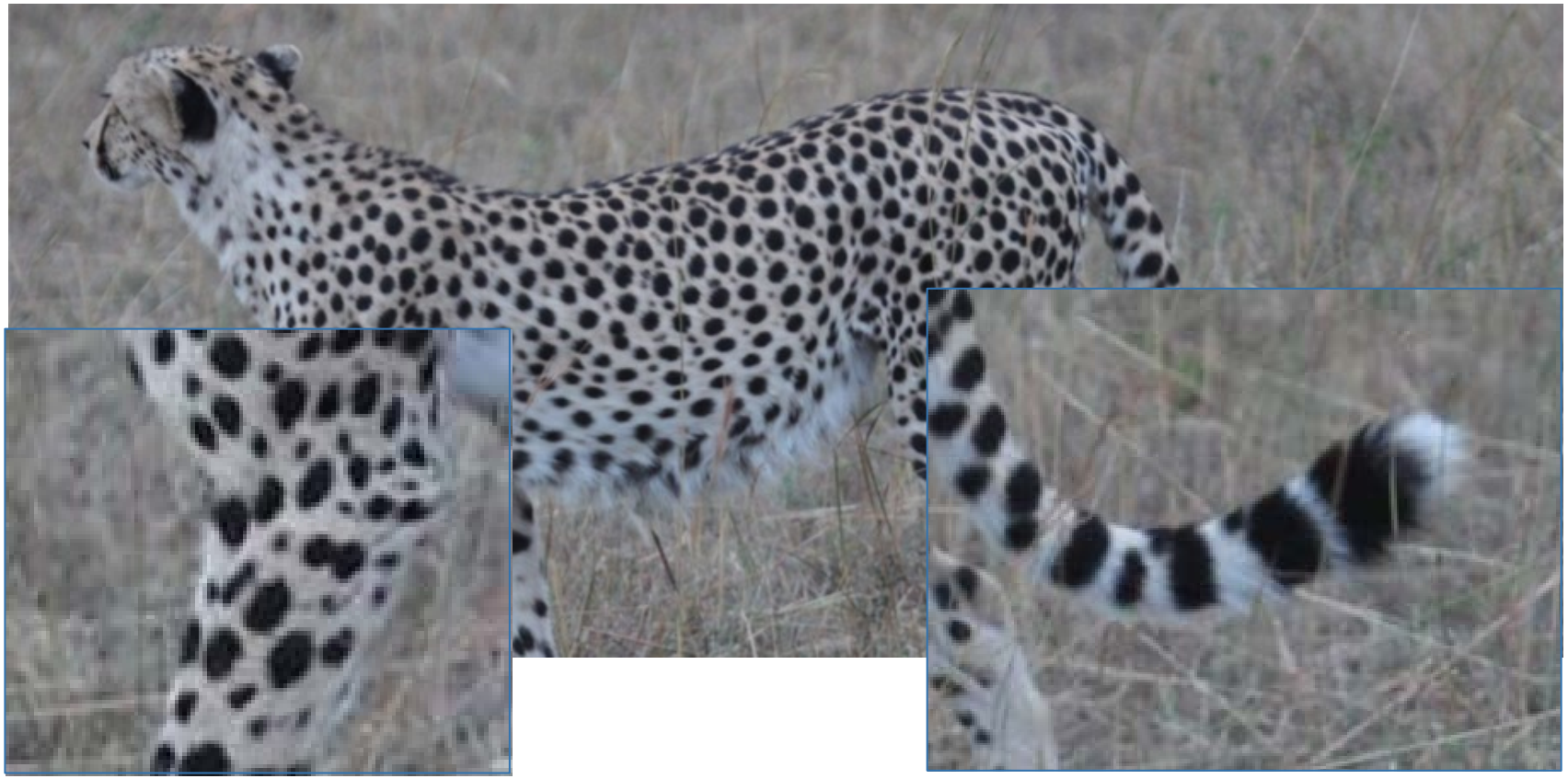
Specialist techniques

- No first hand experience required.
- An opportunity to link with any topic.
- An opportunity to develop research skills.

The following slides illustrate examples of where specialist techniques can be used.

Image databases

marameru.org/eng/project/cheetah-identification



Radio tracking

Tracking wildlife

ocearch.org

Radio tracking/data recorders

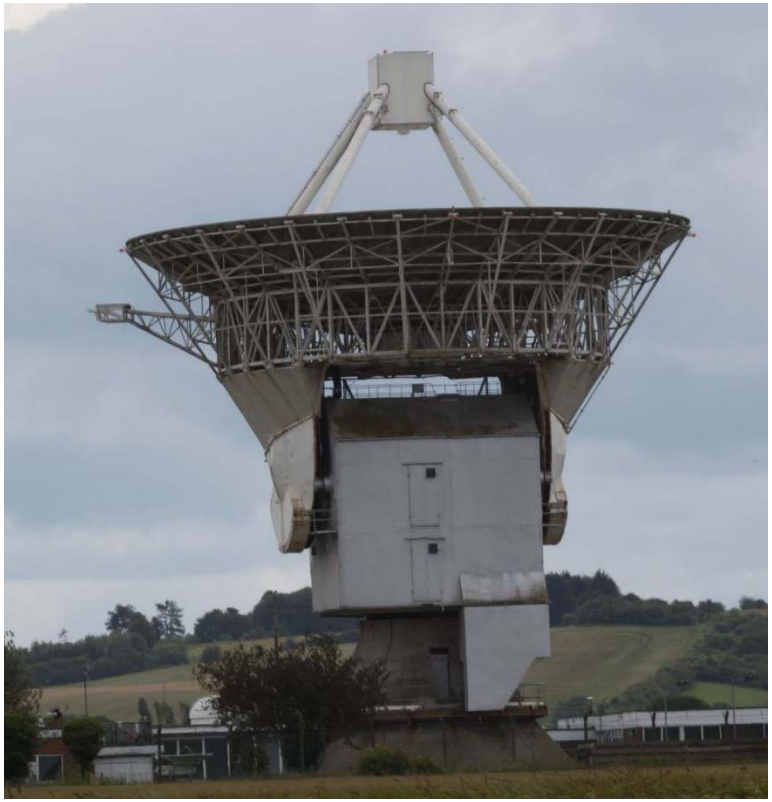
Data collection

Argo

argo.ucsd.edu/Marine_Atlas.html

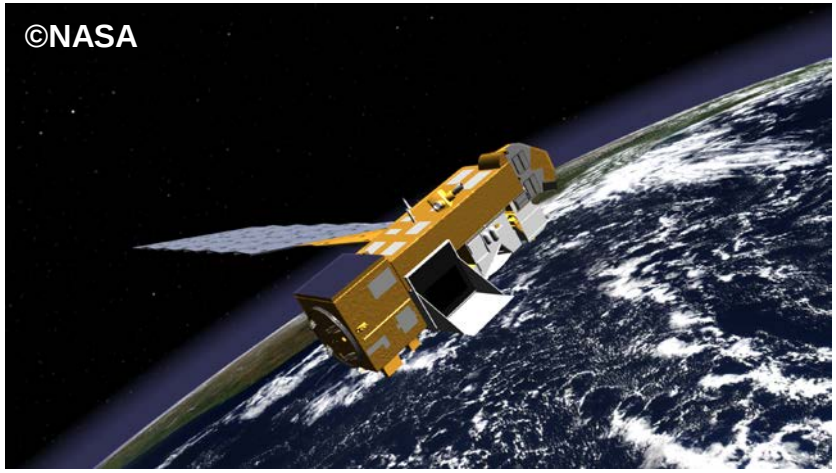
- Download and install Google Earth at earth.google.com
- Launch the application
- Click on: argo.jcommops.org/argo.kml

Remote sensing



Chilbolton Observatory

Air quality monitoring



Aura

6 Earth-observing instruments: the Atmospheric Infrared Sounder (AIRS), the Advanced Microwave Sounding Unit (AMSU), the Humidity Sounder for Brazil (HSB), the Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) Moderate Resolution Imaging Spectroradiometer (MODIS).

Clouds and the Earth's Radiant Energy System (CERES).

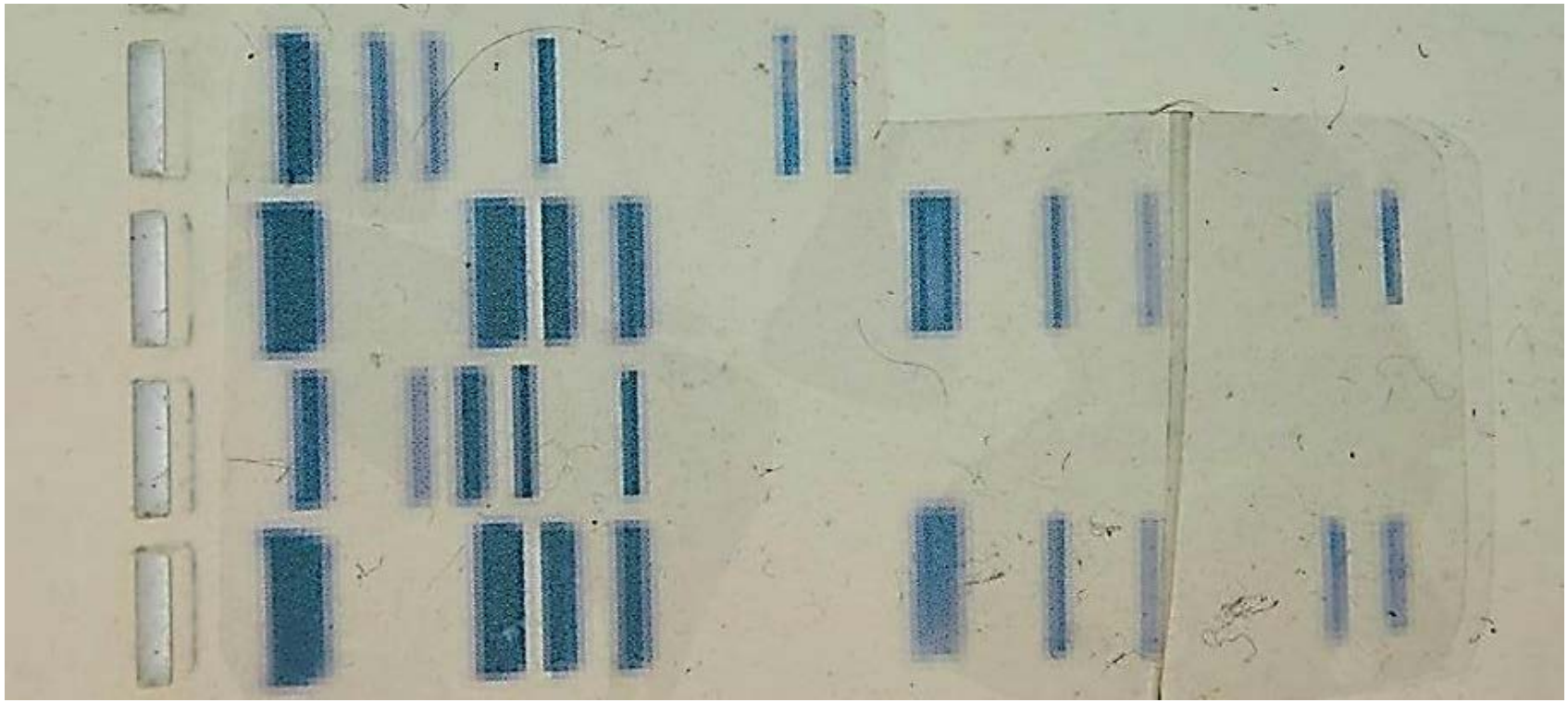
Satellites

N2Yo.com

n2yo.com/?s=27391

DNA analysis

freshwaterhabitats.org.uk/projects/edna/edna



Diet analysis

Maths skills requirements

- At least 10% of the overall assessment of AS and A-level Environmental Science will assess mathematical and statistical skills.

- These skills will be applied in the context of environmental science and will be at least the standard of higher tier GCSE mathematics.

Resources

Resources

Online resources:

- AS: aqa.org.uk/subjects/science/as-and-a-level/environmental-science-7446
- A-level: aqa.org.uk/subjects/science/as-and-a-level/environmental-science-7447

- Summaries of changes
- Schemes of work
- Subject specific vocabulary
- Practical guidance
- Student exemplars
- Textbook

Get in touch

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alevelscience@aqa.org.uk
01483 477 756

Events
events@aqa.org.uk
0161 696 5994

AQA website
aqa.org.uk

Thank you