National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

NERC SCIENCE OF THE ENVIRONMENT

NERC National Centre for Earth Observation

John Remedios

Director of NCEO

www.nceo.ac.uk

@NCEOscience

EO science for a changing planet

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NCEO

NCEO is a NERC **Research** Centre

Vision: "Transformational EO science *capability* to meet Earth System challenges"

Raison d'etre:

- Long-term science and facilities
- Support for UK EO and environmental sciences community (NERC)
- Interface: research community to space agencies, government, industry

Capabilities:

- Critical observations of Earth System change
- Evaluation of models
- Innovative data assimilation into models.
- Instrument and data facilities

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NCEO Science

NCEO has broad science interests across EO and environmental data:

Understanding long-term changes in the Earth system: climate data; carbon cycle; energy cycle including radiation and rainfall; atmosphere composition including climate-chemistry.

Merging data for realistic predictions: theory of data assimilation; ocean biology; terrestrial carbon exchanges; gas emission estimates.

Earth Observation for forests and vegetation: forest structure, biomass, fires, radiative temperature.

Understanding and monitoring hazards in the Earth system: fires, air quality, algal blooms

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EO Data Facilities

EO data – getting it and using it

- CEDA-EO (STFC RAL)
- Academic CEMS (STFC RAL)
- NEODAAS (PML, Dundee)

Centre for Environmental Data Archival
SCIENCE AND TECHNOLOGY FACILITIES COUNCIL
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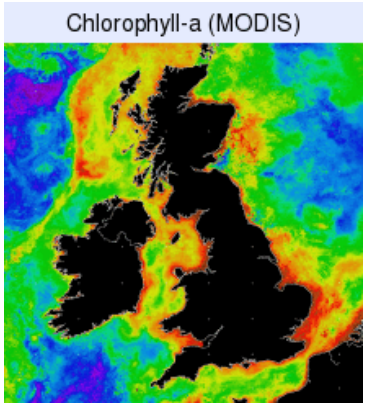
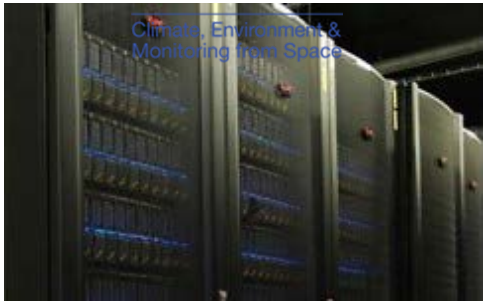
NEODAAS

CEMS





jasmin

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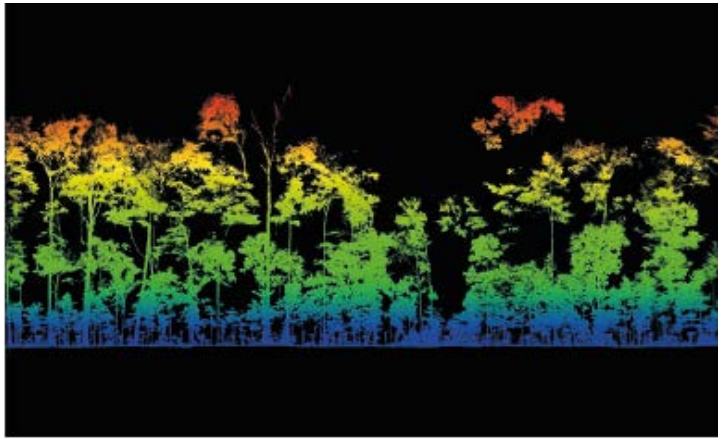
EO Instruments

- Instrument facility: FSF (Edinburgh)
- NCEO instruments: field, lab and aircraft
- EO Radiative Transfer: Land and atmospheric models, surface and atmosphere spectroscopy



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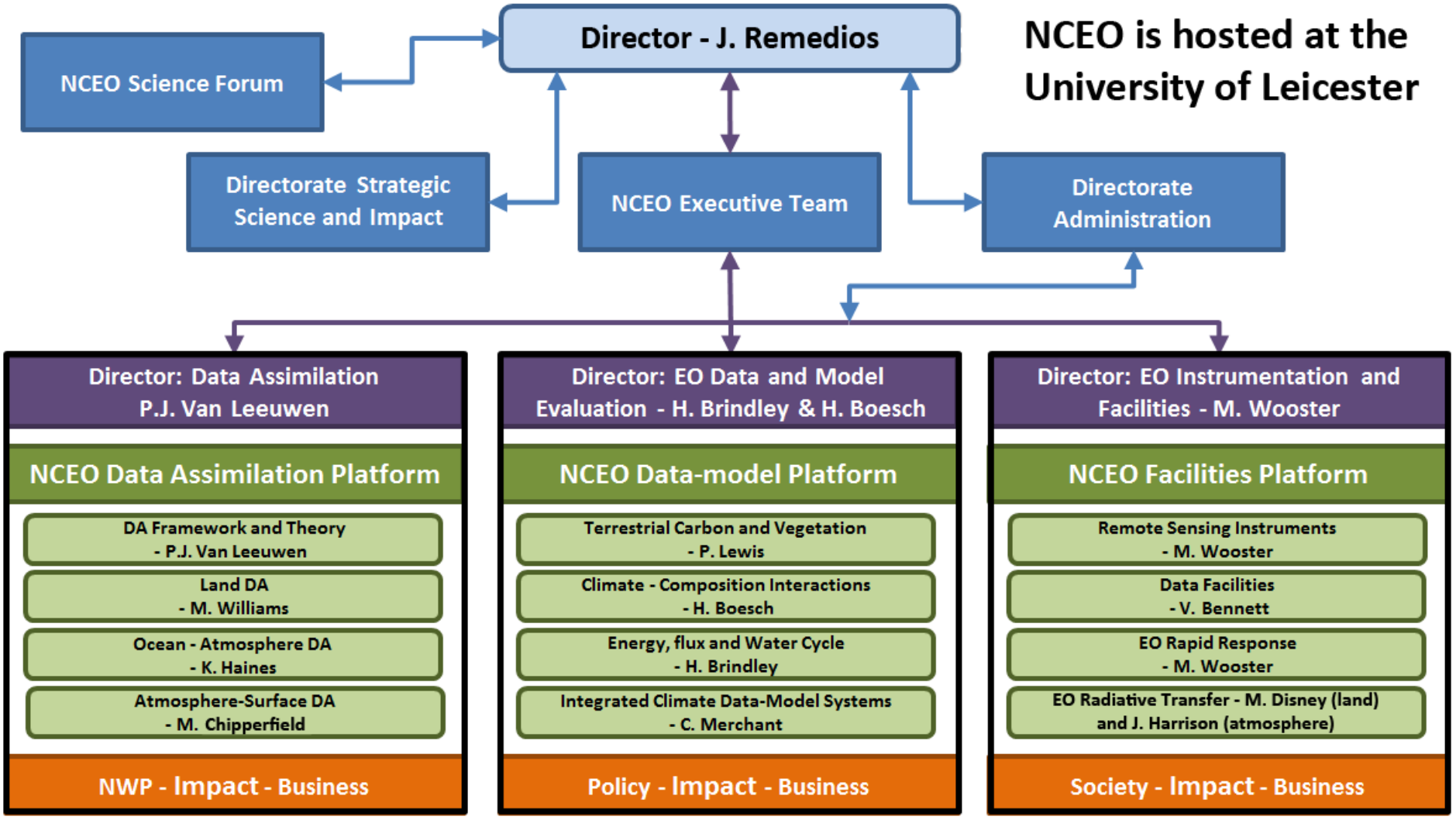
NCEO Structure



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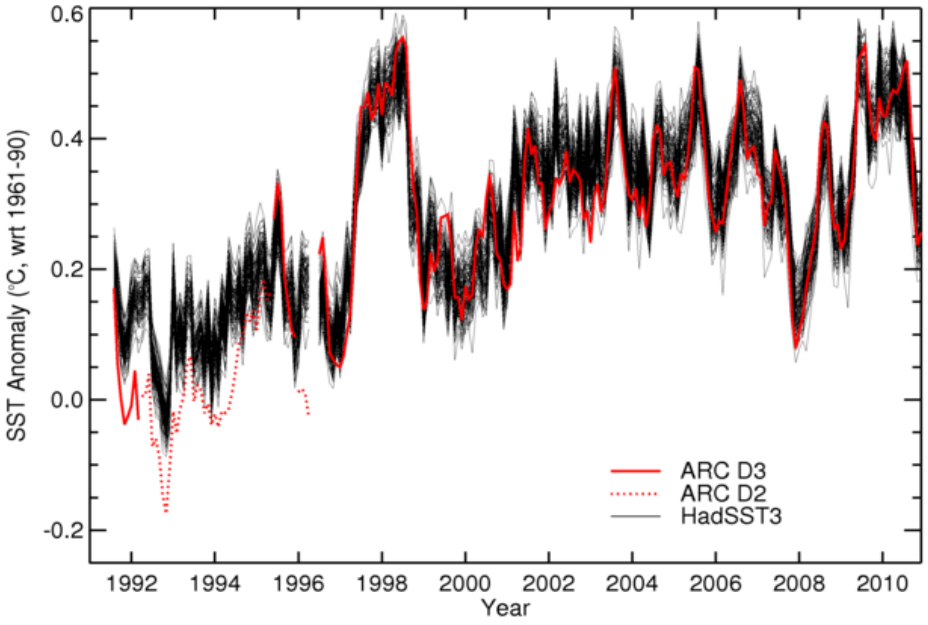
Climate: Regions in transition

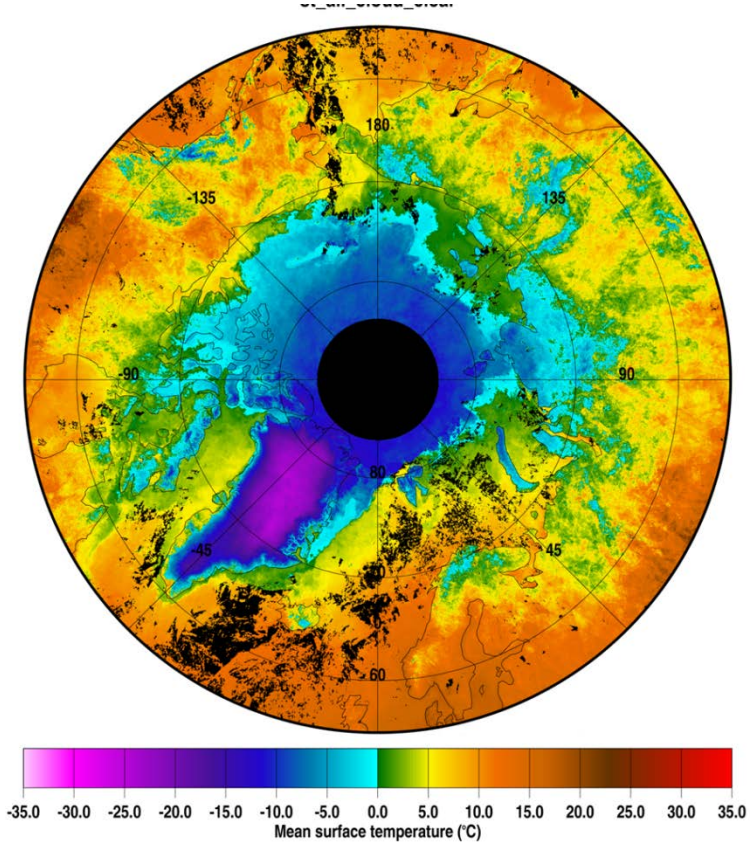
IPCC SST



Climate SST Anomalies
C. Merchant Reading) et al, JGR, 2012

Very low uncertainties < 0.02 K

Arctic monthly mean surface temperature ; Sept 2006
K. Veal, D. Ghent Leicester



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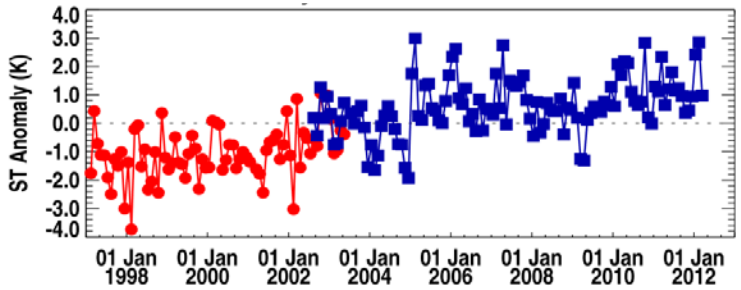
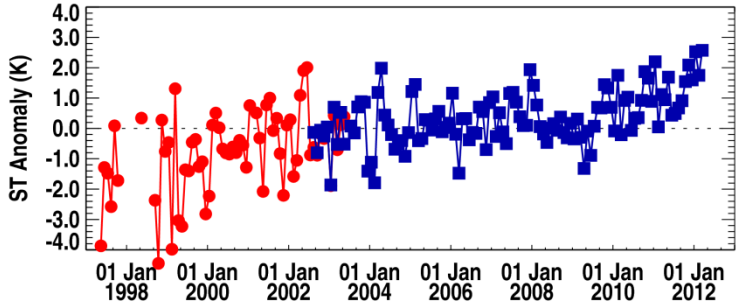
Time series of monthly mean ST anomaly for region above 65 °N

All surface

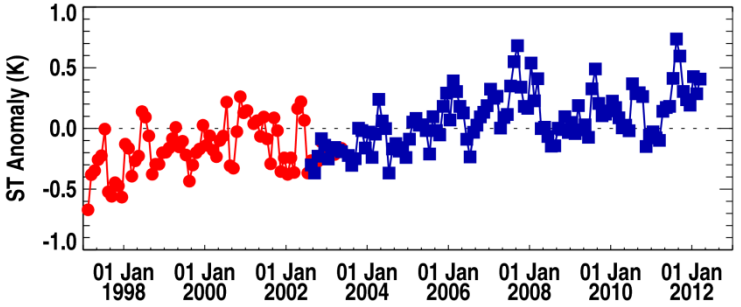


Anomalies calculated relative to climatology for 1998 to 2011

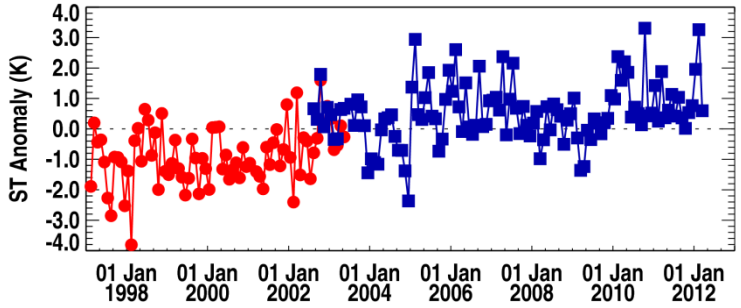
Open land



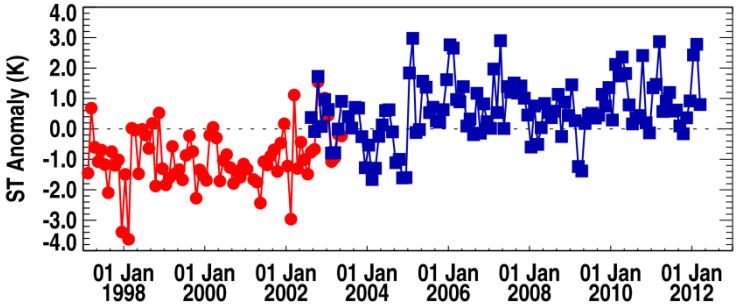
Open ocean



Land-ice



Sea-ice



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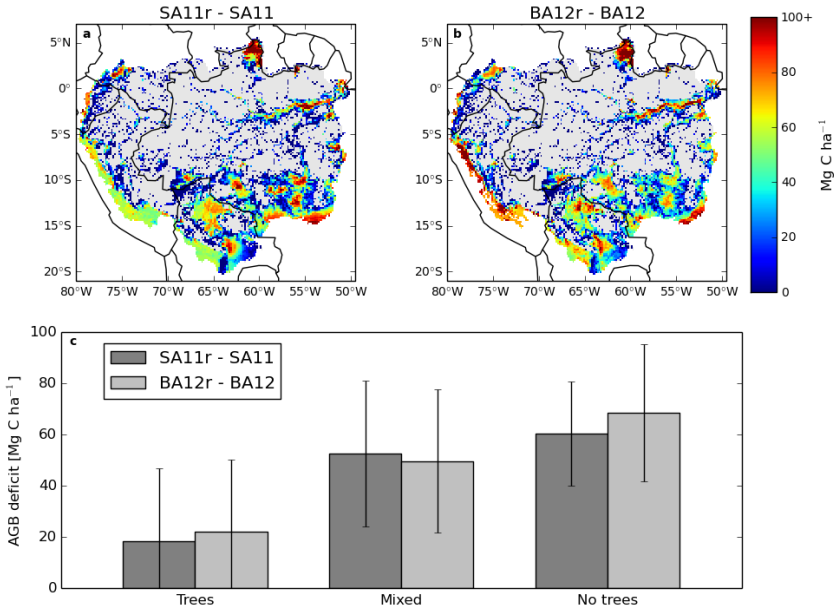
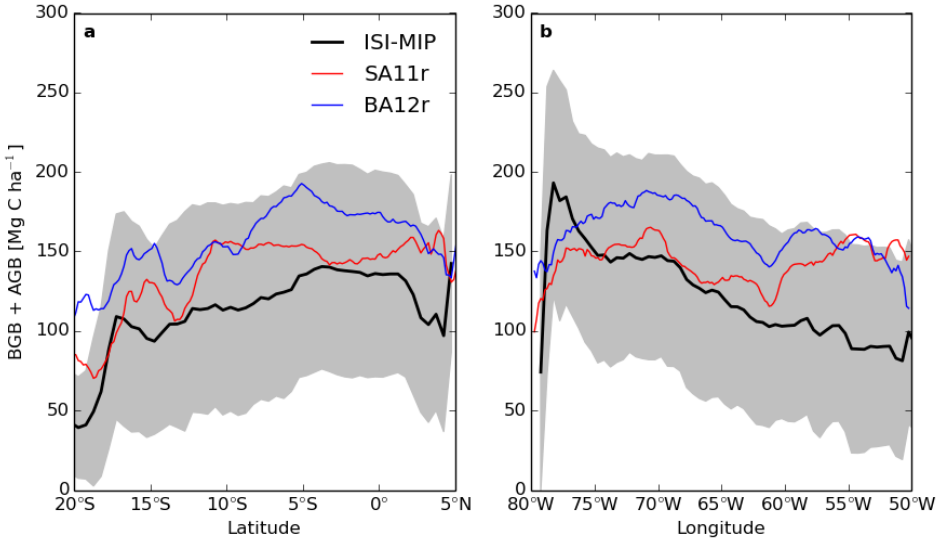
Amazon biomass reconstructions

Estimated biomass loss using Saatchi (Sa) and Baccini (Ba) biomass maps



Estimated biomass losses are consistent with current land cover classifications

Comparison of our undisturbed biomass estimates with those from global vegetation models (ISI-MIP)



Exbrayat & Williams (2015), GRL.

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Some pointers for future: science

Fundamental science with impact

- Long-time series of data
- Culmination of determined analysis
- Calibration and uncertainty analysis
- Synergistic:
  - Models
  - Other satellite data
  - In situ data
- BIG COMPUTING!!

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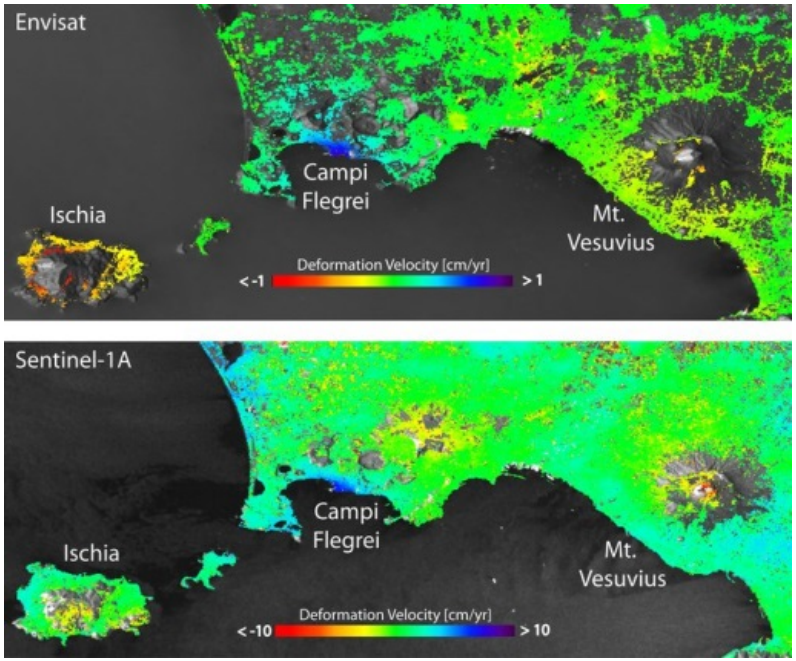
UK EO Science Programme II

- **Operational missions inspired by science research:**
  - **Copernicus Sentinel satellites**, largely heritage in Envisat.
  - **Eumetsat Metop and MSG/MTG** meteorological satellites
  - ***Long-term "serendipity"*** through multi-agency investments.



- Greenhouses gases: SCIAMACHY (ESA), GOSAT (JAXA), OCO-2 (NASA)
- Co-operative missions: GPM (NASA) and Passive microwave instruments

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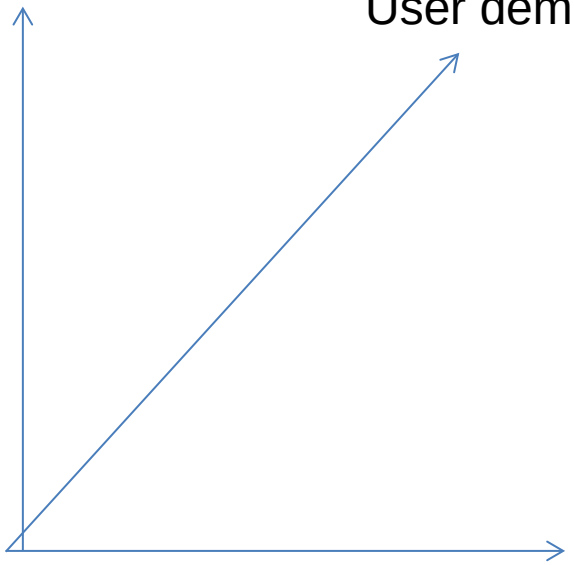
Operational is fun!



INNOVATION

NEW SCIENCE APPROACHES

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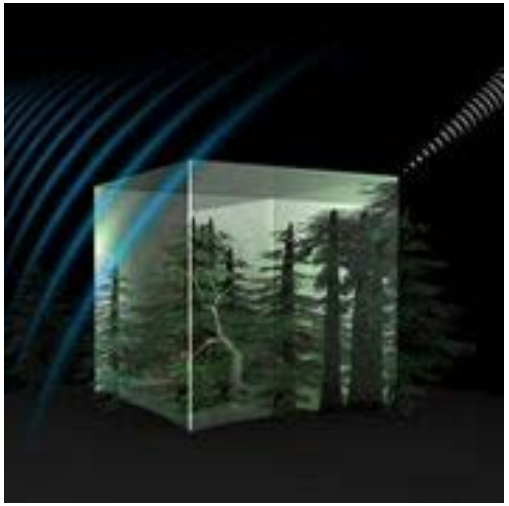
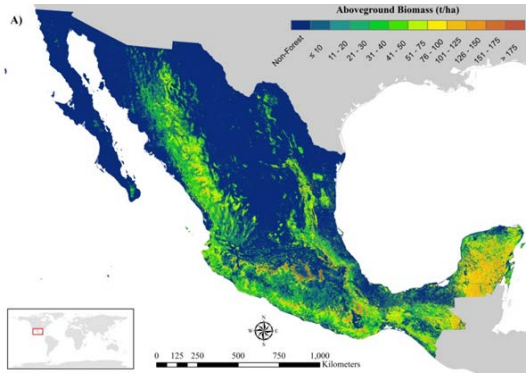
UK EO Space Science Programme

- **ESA missions (EOEP), e.g. Cryosat, SMOS, GOCE**
  - Current missions, e.g. , Cryosat, SMOS, GOCE
  - Future missions include ADM-Aeolus, EarthCare, Biomass





  - EE-8 FLEX
  - EE-9 call open

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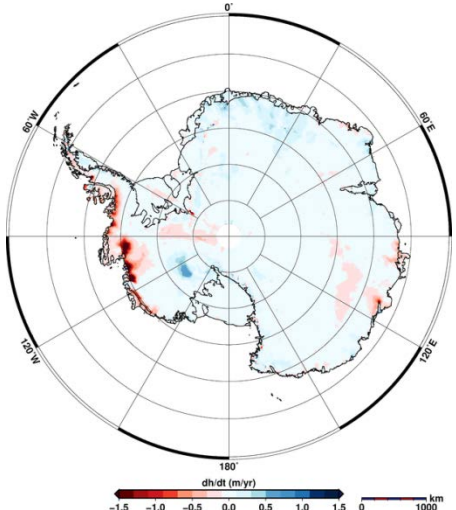
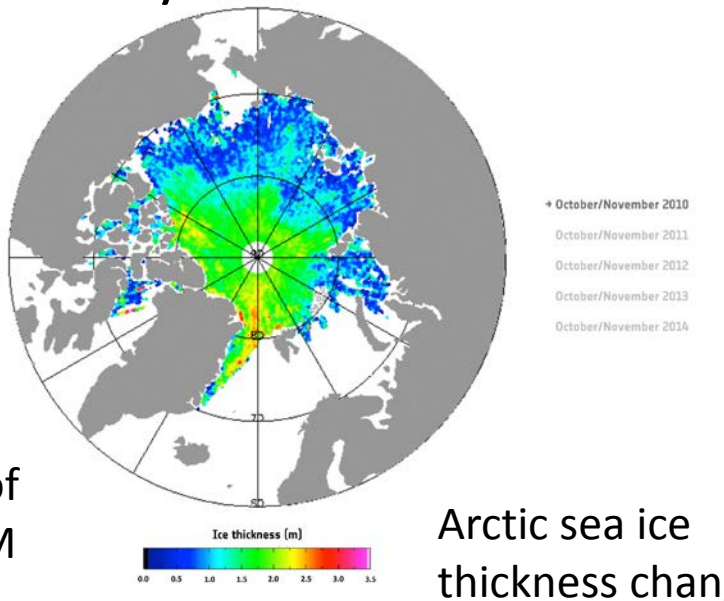
CRYOSAT

- Launched in 2010
- SIRAL Altimeter and DORIS
- Sea-ice thickness, ice sheet change, sea surface topography
- Led by UK CPOM

Antarctic ice sheet change



Images courtesy of ESA/CPOM



Arctic sea ice thickness change

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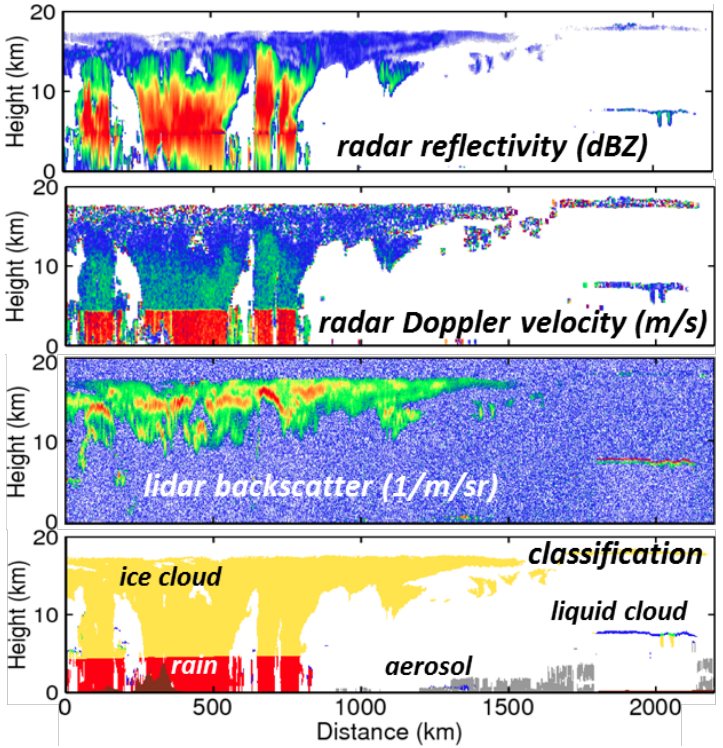
EarthCARE – Earth Clouds, Aerosols and Radiation

European Budget: €800M
P.I.: Illingworth (Reading)
Prime contractor: Airbus, UK
Cloud radar: Japan
Lidar: France
Spectral Imager: UK
Broadband Radiometer: UK

NCEO+Reading are developing synergy retrievals for clouds, precipitation and aerosols (Illingworth, Chiu, Hogan, Allan); Doppler velocity, multiple scattering (Battaglia).



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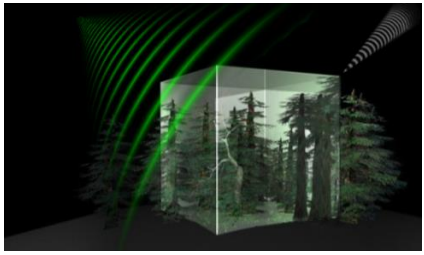
BIOMASS mission (P.I. S. Quegan, Sheffield)

BIOMASS uses a radar whose P-band wavelength, 70 cm, is the longest possible from space:

- to penetrate the canopy in all forest biomes
- to interact with woody vegetation elements



BIOMASS will map forest biomass, height and change with unprecedented accuracy

Forest biomass and forest height:

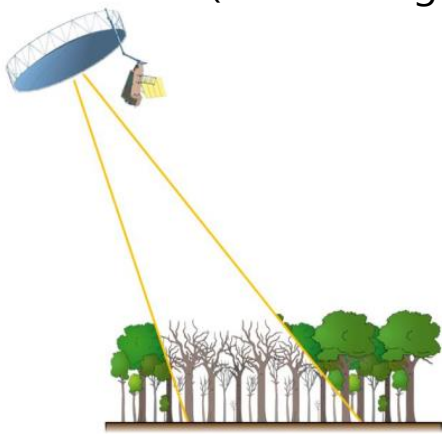
- global
- 200 m scale
- every 6 months for 4 years
- 20% uncertainty in biomass
- 20-30% accuracy in height

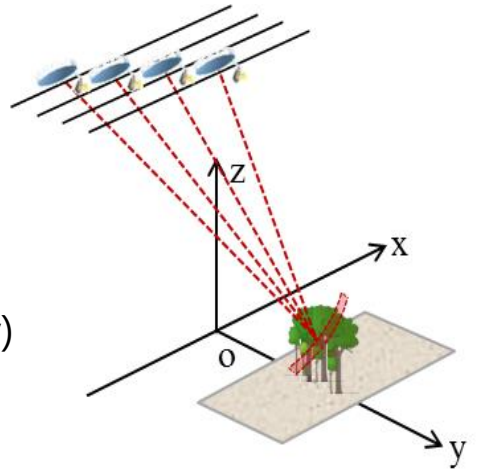
Disturbances:

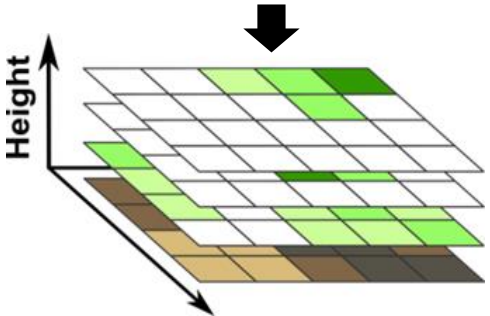
- global
- 50 m scale

esa

TomoSAR
(SAR Tomography)







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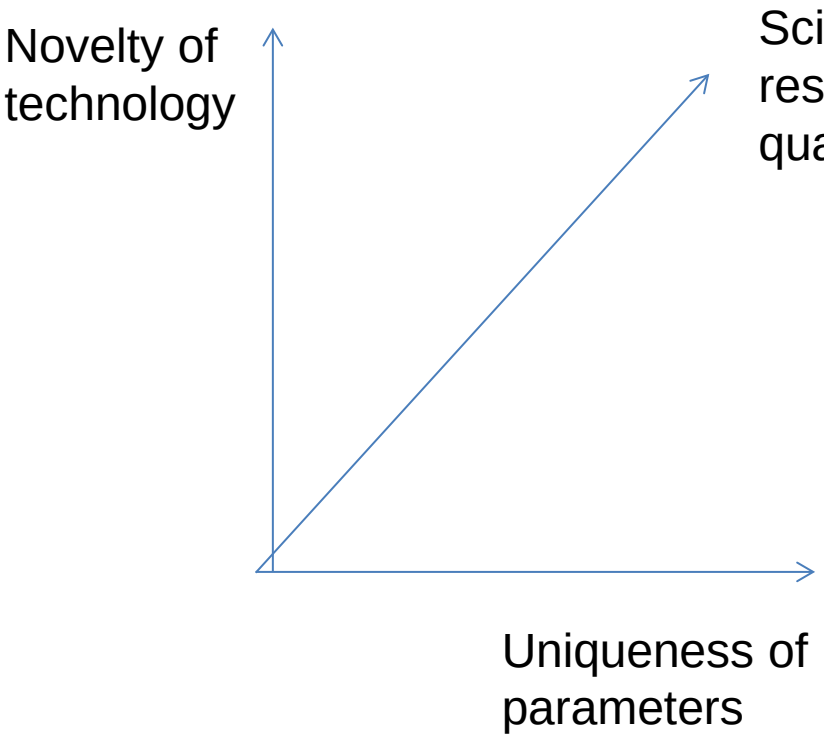
Game changers!



Leading science

Super-users

Research to Operational

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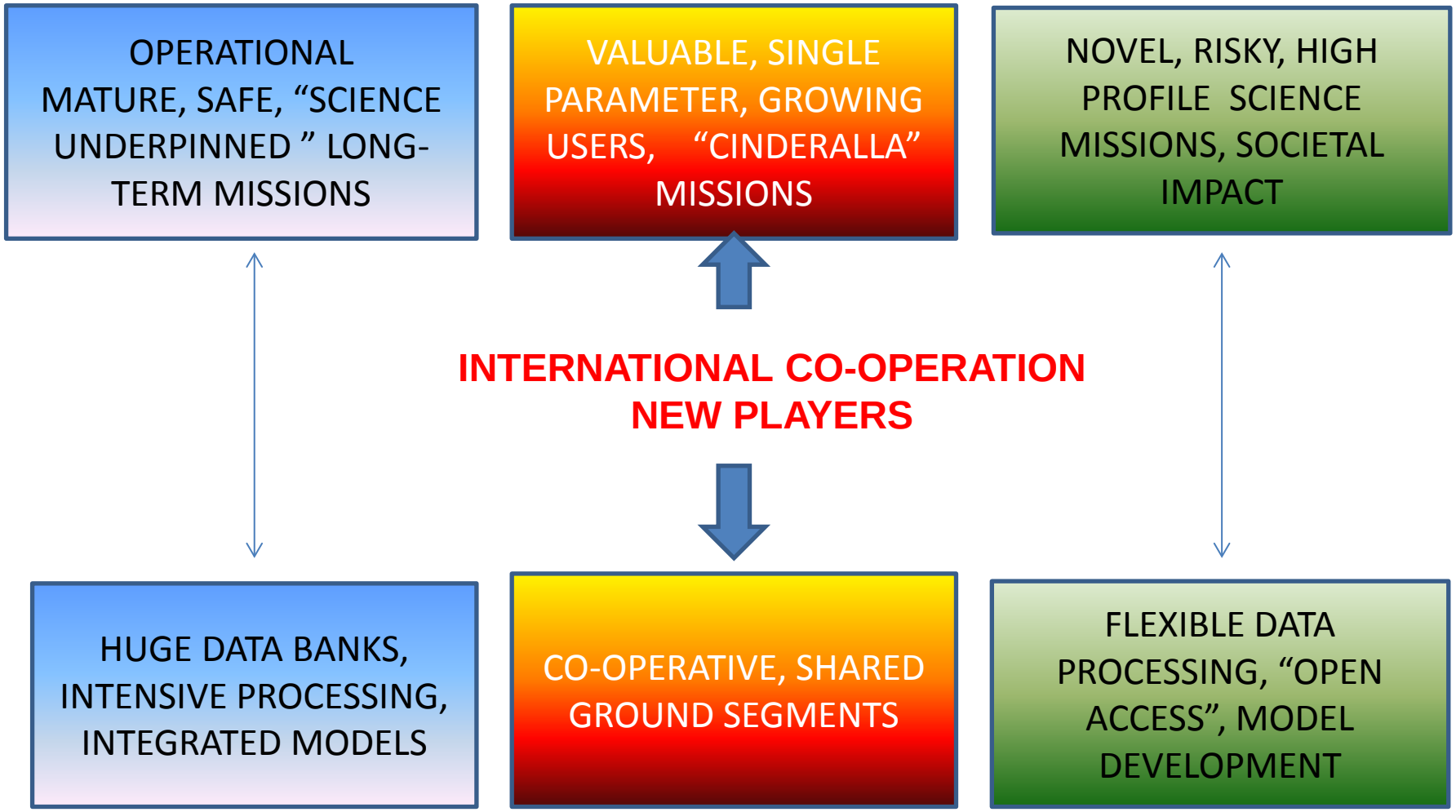
Next decades for SCIENTIFIC EO



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International: Science to Programmes

- **Global Climate Observing System**
  - Land surface temperature as an ECV
  - EO data for climate model evaluation.
- **ESA Climate Change Initiative**
  - UK leadership of SST, ocean colour etc; CCI data portal
  - CCI+ programme
- **Copernicus Climate Service**
- **GEO Group on Earth Observations**
  - 2 UK people on GEO Programme Board
  - Global Forests Observation Initiative.; Data sharing
- **CEOS Committee on Earth Observation Satellites**