NERC National Centre for Earth Observation

John Remedios
Director of NCEO

www.nceo.ac.uk
@NCEOscience

EO science for a changing planet
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
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
EO Data Facilities

EO data – getting it and using it

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

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

NCEO Science Forum

Director - J. Remedios

Directorate Strategic Science and Impact

NCEO Executive Team

Directorate Administration

NCEO is hosted at the University of Leicester

Director: Data Assimilation
P.J. Van Leeuwen

NCEO Data Assimilation Platform

- DA Framework and Theory
  - P.J. Van Leeuwen
- Land DA
  - M. Williams
- Ocean - Atmosphere DA
  - K. Haines
- Atmosphere-Surface DA
  - M. Chipperfield

NWP - Impact - Business

Director: EO Data and Model Evaluation
H. Brindley & H. Boesch

NCEO Data-model Platform

- Terrestrial Carbon and Vegetation
  - P. Lewis
- Climate - Composition Interactions
  - H. Boesch
- Energy, flux and Water Cycle
  - H. Brindley
- Integrated Climate Data-Model Systems
  - C. Merchant

Policy - Impact - Business

Director: EO Instrumentation and Facilities
M. Wooster

NCEO Facilities Platform

- Remote Sensing Instruments
  - M. Wooster
- Data Facilities
  - V. Bennett
- EO Rapid Response
  - M. Wooster
- EO Radiative Transfer
  - M. Disney (land) and J. Harrison (atmosphere)

Society - Impact - Business
Climate: Regions in transition

IPCC SST

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

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

Very low uncertainties < 0.02 K
Time series of monthly mean ST anomaly for region above 65 °N

- All surface
- Open land
- Land-ice
- Sea-ice

Anomalies calculated relative to climatology for 1998 to 2011
Amazon biomass reconstructions

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

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

Estimated biomass losses are consistent with current land cover classifications

Exbrayat & Williams (2015), GRL.
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!!
• 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
Operational is fun!

Secure technology

User demand

Maturity of products

INNOVATION

NEW SCIENCE APPROACHES
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
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
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).
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
Game changers!

Novelty of technology

Scientific research quality

Uniqueness of parameters

Leading science

Super-users

Research to Operational
Next decades for SCIENTIFIC EO

OPERATIONAL
MATURE, SAFE, “SCIENCE
UNDERPINNED” LONG-
TERM MISSIONS

VALUABLE, SINGLE
PARAMETER, GROWING
USERS, “CINDERALLA”
MISSIONS

NOVEL, RISKY, HIGH
PROFILE SCIENCE
MISSIONS, SOCIETAL
IMPACT

INTERNATIONAL CO-OPERATION
NEW PLAYERS

HUGE DATA BANKS,
INTENSIVE PROCESSING,
INTEGRATED MODELS

CO-OPERATIVE, SHARED
GROUND SEGMENTS

FLEXIBLE DATA
PROCESSING, “OPEN
ACCESS”, MODEL
DEVELOPMENT
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**