Novel Earth Observation products to characterise Wetland Extent and Methane Dynamics: The ESA ALANIS-Methane Project

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Contents

• Background
• ALANIS Methane
• Initial results
• Future activities

Acknowledgements

• European Space Agency
• iLEAPS
Background

- CH$_4$ second most important greenhouse gas after CO$_2$
- Wetlands are largest natural source but there are large uncertainties
- CH$_4$ wetland emissions by diffusion across the soil or water interface, by ebullition (bubbling), and by plant-mediated transport
- Key parameters for land surface and climate modelling:
  - wetland extent
  - temperature
  - soil carbon

Source: http://www.riceweb.org/research/Res.issmethane.htm
ALANIS Methane

Linking Earth Observation and Land Surface Modelling

2007

2008

JULES (CEH)

Column CH₄

(Bremen)

Radiation

Precipitation

Evaporation

Heat

CO₂

Methane

Momentum

Photosynthesis

Interception

Snow

Heat transfer

Water transfer

Respiration

Wetland Extent (Estellus)

Snowmelt (Vienna)
ALANIS Methane:
Key EO Datasets

1. **Wetland Extent**
   - Need to capture the rapid spring inundation, implying 10-day timescale
   - Include all wetland and lake areas (may require aggregation of small features)
   - Use as driving dataset or constraint

2. **Freeze/thaw**
   - 1-10-day timescale
   - Used to validate soil thermodynamics

3. **Snow melt**
   - 1-10 day timescale needed to capture the spring melt event
   - Use for evaluation

4. **Atmospheric column CH$_4$**
   - Assessment of methane wetland emissions against atmospheric measurements

5. Land Cover (input)

6. Leaf Area Index (input)

7. Land surface temperature
Integrated science for our changing world
www.ceh.ac.uk

ALANIS Methane
Focus on Northern Eurasia, 2007-2008

Test Site #1: Western Siberia (N)
- Subarctic-Arctic
- continuous to discontinuous permafrost
- hotspot of lake change

Test Site #2: Western Siberia (S)
- Boreal
- Ob river floodplains
- sporadic to discontinuous permafrost
- extensive peatlands

Test Site #3: Lower Lena River floodplain and delta
- Subarctic to High Arctic lowlands
- key region for understanding the basic processes of the dynamic and development of permafrost in the Siberian Arctic
- upstream basin with flood plains
- extensive delta area with several terraces
Regional Wetlands Extent and Dynamics

- **Existing product**
  - Use satellite data at different wavelengths (ERS scatterometer, SSM/I, AVHRR)
  - Global coverage with spatial resolution compatible with climate studies

- **Several publications** [Prigent et al., GRL, 2001; JGR, 2007; Papa et al., JGR, 2010]

- **Adjustments in methodology**
  - Use MetOP ASCAT scatterometer data
  - Higher temporal resolution (10 days from monthly)
  - Initial dataset for July 2007 to June 2008
Local Wetlands Extent and Dynamics

- New product based on ENVISAT ASAR Wide Swath
- Classification of open water surfaces, 10-day updates for maps of wetland dynamics
- Implementation with NEST
- Cross-comparison with the regional wetland product

June 2007

September 2007

See also poster
Snowmelt and Ground freeze/thaw

• New product based on resampled level 1b Metop ASCAT
• Algorithm development based on ECMWF ERA-Interim soil temperature
• Post-processing to identify day of year
  • Begin of thaw
  • End of thaw
  • Refreeze

See also poster
Sciamachy Column Methane

- Existing product for 2003-2005
- Dataset extended (to 2009) and retrieval algorithm adapted to address inter alia loss of key detector pixels
- Better coverage for boreal region
Land surface modelling with Joint UK Land Earth Simulator

- **Process-based model**
- **Gedney et al [2003, 2004]** parameterisations of large-scale hydrology and wetland biogeochemistry
- **Use in 3 configurations:**
  a. Point/Offline
  b. Gridded/Offline
  c. Coupled into atmospheric chemistry model
- **Aims:**
  • Validation of JULES
  • Improve emission estimates

$$F_{wCH4} = k_{CH4} * f_w * C_s * Q_{10} (T_{soil}/(T_{soil}-T_0))^{10}$$

- $F_{wCH4} =$ methane flux from wetlands
- $k_{CH4} =$ scaling factor
- $f_w =$ wetland fraction
- $C_s =$ “substrate”: fixed soil carbon content
- $Q_{10} =$ temperature sensitivity

http://www.jchmr.org/jules/
Website and Data Dissemination

ALANIS Methane

Background
Objectives
Structure
Collaborating Institutes
Funding Agencies
Project Documents
Members Login
Links
Contact Us

ALANIS Methane is a research project to produce and use a suite of relevant earth observation (EO) derived information to validate and improve one of the next generation land-surface models and thus reduce current uncertainties in wetland-related CH₄ emissions.

ALANIS Methane Participants

Centre for Ecology & Hydrology
IPF, Vienna University of Technology
Estellus
IPF, University of Bremen
UK Met Office

ALANIS Methane Stakeholders

European Space Agency
Integrated Land Ecosystem Atmosphere Processes Study (ILEAPS)

http://www.alanis-methane.info
Future Work

• On going validation of EO target products
• Development, application and evaluation of JULES in different configurations
• Dissemination of EO datasets
• Workshop and promotion of project
• Roadmap for product exploitation
• Ongoing interaction with iLEAPS community

• Benchmarking of wetlands in land surface models (GEWEX-GLISS)
Summary

- Wetlands are the largest natural source of methane but the emission estimates have large uncertainties
- ALANIS methane project described
- Focus on the boreal region of Northern Eurasia
- Novel EO products being developed relevant for land surface modelling
- Future activities summarised
Related presentations and posters


- **Water body delineation from active microwave satellite data for improved modelling of methane emissions at high latitudes in the framework of the ESA project ALANIS** by Stefan Schlaffer, Daniel Sabel, Christoph Paulik, Annett Bartsch, and Wolfgang Wagner [Geophysical Research Abstracts, 13, EGU2011-10566, 2011]

- **Surface status information from scatterometer data for improved climate modelling at high latitudes** by Christoph Paulik, Vahid Naeimi, Annett Bartsch, Stefan Schlaffer, Wolfgang Wagner, Kirsten Elger, and Birgit Heim [Geophysical Research Abstracts, 13, EGU2011-7238, 2011]