Analysis of OLR in short timescales over Africa

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Outline:

• Motivation
• Data product & method
• Different Modes of Variability
• Diurnal timescale
• Semi diurnal
• Longer timescale variability
• Summary
Motivation

- Characterise short term OLR variability
- Identify different cycles
- Investigate shorter cycles using GERB
- Understand the climate processes associated with the cycles
- Gain better understanding of African meteorology
Data product & method

- GERB LW flux product (L2 ARG)
- Fourier Analysis
  - Latitude -50:50, longitude -50:50
  - Over 2006/01,07
- Principal Component Analysis
  - Latitude -30:30, longitude -30:40
  - 2006/01,07, averaged
Modes of variability

- Averaged ‘zonally’
- Along the ITCZ
- Small diurnal, large part of ocean
- Peaks in high cycle length, i.e 3 & 5, further investigation
  - Outside ITCZ
  - High diurnal cycle strength, region along Sahara
  - Relatively weak in longer cycle lengths
Modes of variability

- Averaged 'zonally'
- Along the ITCZ
- Small (semi)diurnal, large part of ocean
- Peaks in high cycle length, i.e. 3 & 5, caused by AEWs

- Relatively weak in longer cycle lengths

[2006 Jan] FT power spectrum lat(0, 5)

$\frac{1}{2}$ day 1 day 2 3

(Wm$^{-2}$)

[2006 Jan] FT power spectrum lat(10, 15)

(Wm$^{-2}$)

cycle length (days)
Diurnal timescale analysis

- PC analysis – 2006/07/01-30
- PC1 - surface heat response
- PC2 - clouds associated with ITCZ
- Comer et al. 2007
Diurnal timescale analysis

- **EOF** – 2006/07/01-30
- **EOF1** – dominant signal over land
- **EOF2** – most of the strong signals along ITCZ
Diurnal timescale analysis

- First order PCs over different surface types
- Desert OLR peaks before vegetation
- Ocean has a different heating cycle
Diurnal timescale analysis

- 2\textsuperscript{nd} order PC
- Inversely related to cloud cycle
- Different peak times with surface type
- Similar phase lag between veg. and desert
Diurnal timescale analysis

• Desert EOF 2 (2006/01)
  – 0 to low magnitude in most regions
  – Some positive signal
  – Region out of ITCZ

• Vegetation EOF 2 (2006/01)
  – Strong EOF 2 signal occurs where EOF 1 is weak
  – Suggests different overall diurnal cycle along ITCZ
Semi-diurnal cycle

- Modelling OLR using only incoming solar radiation and surface
- Average albedo
- 7 surface categories:
  - Heat capacities
  - Effective surface depth
- All ISR is absorbed by the surface
- Surface radiates as a black body
- 15 minutes time step
Semi-diurnal cycle

- Modelled OLR is only dependent on ISR and heat capacity
- Absolute magnitude between modelled and DATA is large
- The peaks are roughly in phase
- Vegetation more difficult to model

2006/07 Desert OLR cycle

2006/07 Vegetation OLR cycle
Semi-diurnal cycle

- Modelled OLR is only dependent on ISR and heat capacity
- Absolute magnitude between modelled and DATA is large
- The peaks are roughly in phase
- Vegetation more difficult to model
Semi-diurnal cycle

- Fourier power spectrum (Desert – avoid ITCZ)
- Both modelled and simulated OLR showed diurnal and semi-diurnal peaks
- Relatively magnitudes are similar
Modes of variability

- Averaged ‘zonally’
- Along the ITCZ
- Small diurnal, large part of ocean
- Peaks in high cycle length, i.e 3 & 5, further investigation
  - Outside ITCZ
  - High diurnal cycle strength, region along Sahara
  - Relatively weak in longer cycle lengths

[2006 Jan] FT power spectrum lat(0, 5)
[2006 Jan] FT power spectrum lat(10, 15)
Fourier power map

- Power of 2-3 days cycle length
- Found over ITCZ & mid latitude
- Strongest signal found in ITCZ
- 2-3 days convective variability
2 days filter

• Niger (15N, 5E)
• Low pass filter
• 2 -4 days cycle in this region
• Amplitude varies over 1 month
• Time scale of wave changes, might need to use another technique
2 days filter

- Sahara desert (25N, 20E)
- Almost no variation beyond 1 day cycle
- Suggests a fairly consistent diurnal cycle over the month
Summary

• Semi-diurnal & diurnal cycle strongest over land
• Modelled OLR using surface properties & ISR
• Semi-diurnal could be explained by heat capacity of surface, in terms of fourier power
• 2-3 days cycle possibly caused by convective variability
• Peaks in high cycle length, i.e. 3 & 5
• AEWs
• Longer cycles were observed in low pass OLR over central Africa
End
Background - GERB

- Geostationary satellite
- Broadband instrument (0.32-100 μm)
- 2 channels:
  - Total
  - SW measured through quartz filter
- High temporal resolution (17 minutes)
- 2 products:
  - SW : 0.32-4.0 μm
  - LW : 4.0-100 μm (by subtraction)
Modes of variability

- Averaged ‘zonally’
- Three surface types
- Strongest mode is diurnal variation
- Larger amplitude over land
Semi-diurnal