Soil Moisture Time Series from Active Radar in Support of Runoff Monitoring on varying scales

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Source: ENVISAT ASAR GM
Soil Moisture Time Series for Runoff Monitoring

1) Scatterometer – regional to global scale (25-50km)
   - Soil moisture derivation method
   - Validation example
   - Soil moisture – river runoff relationship in subtropics and high latitudes

2) ScanSAR – local to continental scale (150m – 1km)
   - ESA Tiger Innovator project SHARE
   - Validation example
   - Local scale – soil saturation and runoff
   - Soil moisture – river runoff relationship in subtropics

3) Possible benefits of joint soil moisture – altimeter analyses
The TU Wien Method

Selected publications:

Method
Wagner et al. 1999 (IEEE TGRS)
Bartalis et al. 2007 (GRL)

Validation
Vischel et al. 2007 (HESS)
Ceballos et al. 2005 (Hydr. Processes)
Wagner et al. 2003 (JGR)
Verstraeten et al. 2006 (RSE)

Application
Scipal et al. 2005 (HESS)
Parajka et al. 2006 (HESS)
Zhao et al. 2006 (AAS)

Product Comparison
Crow & Zhan 2006 (IEEE GRSL)
Pellerain et al. 2006 (GRL)
Product Examples – Profile Soil Moisture (SWI)

SWI 1992-2000 monthly means

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Floods in South Africa 1995/96

Contrary to the season 1994/95 in the season 1995/96, a progression of Atlantic lows led to a series of storms, bringing heavy rainfall to the area. According to USAID, the excessive rainfalls resulted in floods and consequently in damage to crops and property in the South African areas of Northern Transval and Eastern Cape Provinces and in Mozambique.
Drought conditions South Africa 2007

- Metop ASCAT
- Deviations based on ERS time series (1992-2000)
- 21-31 March
- Bartalis et al. 2007
River runoff comparison

River runoff is a point measurement integrating information on the hydrologic status of an entire catchment

Basin Water Index (Scipal et al. 2005)

\[ BWI = \frac{\sum_{i=1}^{N} SWI_i}{N} \]

Example: Zambezi River

Temporal offset & basin size

Runoff & BWI

Offset 2 months

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Soil moisture and runoff in regions with seasonal snow cover

夏季仅

10天偏移
20天偏移

Bartsch et al. 2007

\[ y = 12,922 \ln(x) - 51,551 \]
\[ R^2 = 0.5398 \]

\[ y = 10,375 \ln(x) - 36,374 \]
\[ R^2 = 0.8327 \]
Snowmelt & runoff

Snowmelt (diurnal thaw/refreeze) from Ku-Band Seawinds QuikScat

Lena

MacKenzie

Snow free area
Thaw Area
River runoff

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Transfer of approach to SAR

Scatterometer
Soil moisture approach
Regional to Global

25-50 km

ENVISAT ASAR WS
Soil moisture & scaling
Local to Regional

150 m

ENVISAT ASAR GM
Soil moisture & scaling
Local to Continental

1000 m
SHARE

Soil Moisture for Hydrometeorologic Applications in the SADC region

AOI: Africa below the Equator

- ENVISAT ASAR GM 1km experimental surface soil moisture
- Scaling layer for interpretation of 50 km product at 1km

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www.ipf.tuwien.ac.at/radar/share
Ground data ENVISAT ASAR GM

heat dissipation sensors

Oklahoma Mesonet

relation between monthly means of FWI (fractional water index) and GM surface soil moisture for station “OKEM”

Pathe et al. 2007

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Saturated soil (surface) – runoff generation

Percentage catchment area with saturated soil conditions

Wilge River Basin, South Africa (Upper Vaal)

Sabel et al. 2007

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ScanSAR surface soil moisture – Okavango river runoff

Offset 3 months

\[ R^2 \text{ (exp) } = 0.956 \]

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Information from soil moisture - Summary

- Local scale: saturation ➞ runoff generation
- Basin scale: delay ➞ runoff prediction
- ENVISAT ASAR Global Mode: local to continental applications
- ERS/METOP ASCAT scatterometer: regional to global scale in Near Real Time
Outlook: Soil moisture & river runoff from altimeter

- Determination of delay in ungauged basins

- Soil moisture provides information from
  - where the water is actually coming from &
  - where it goes

- Complements altimeter measurements

Soil moisture from ENVISAT ASAR GM
Okavango River & Delta

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