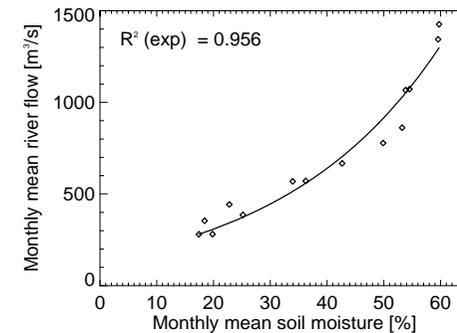
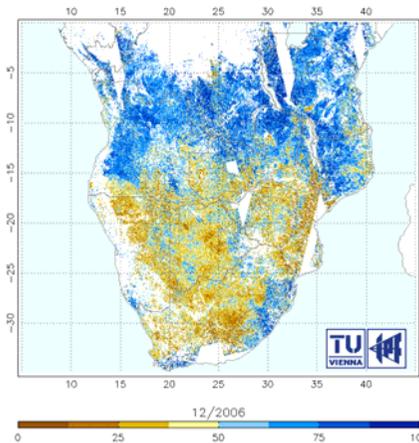


# Soil Moisture Time Series from Active Radar in Support of Runoff Monitoring on varying scales

*Bartsch, A.; Pathe, C.; Sabel, D.; Wagner, W.; Doubkova, M.*

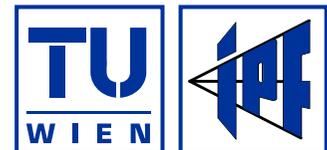
**FWF**  
Der Wissenschaftsfonds.



Source: ENVISAT ASAR GM

2nd Space for Hydrology Workshop  
Geneva, 12-14 November 2007

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# 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)

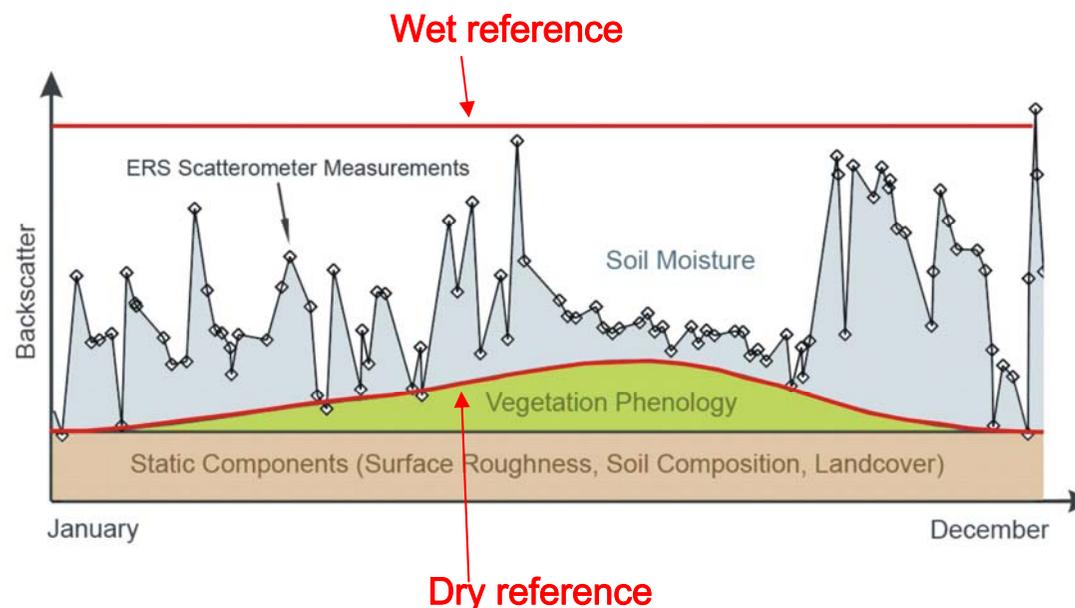
### Application

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

### Product Comparison

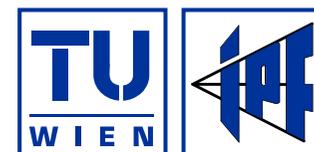
Crow & Zhan 2006 (IEEE GRSL)  
Pellerain et al. 2006 (GRL)

## Time series for a single location (C-band)



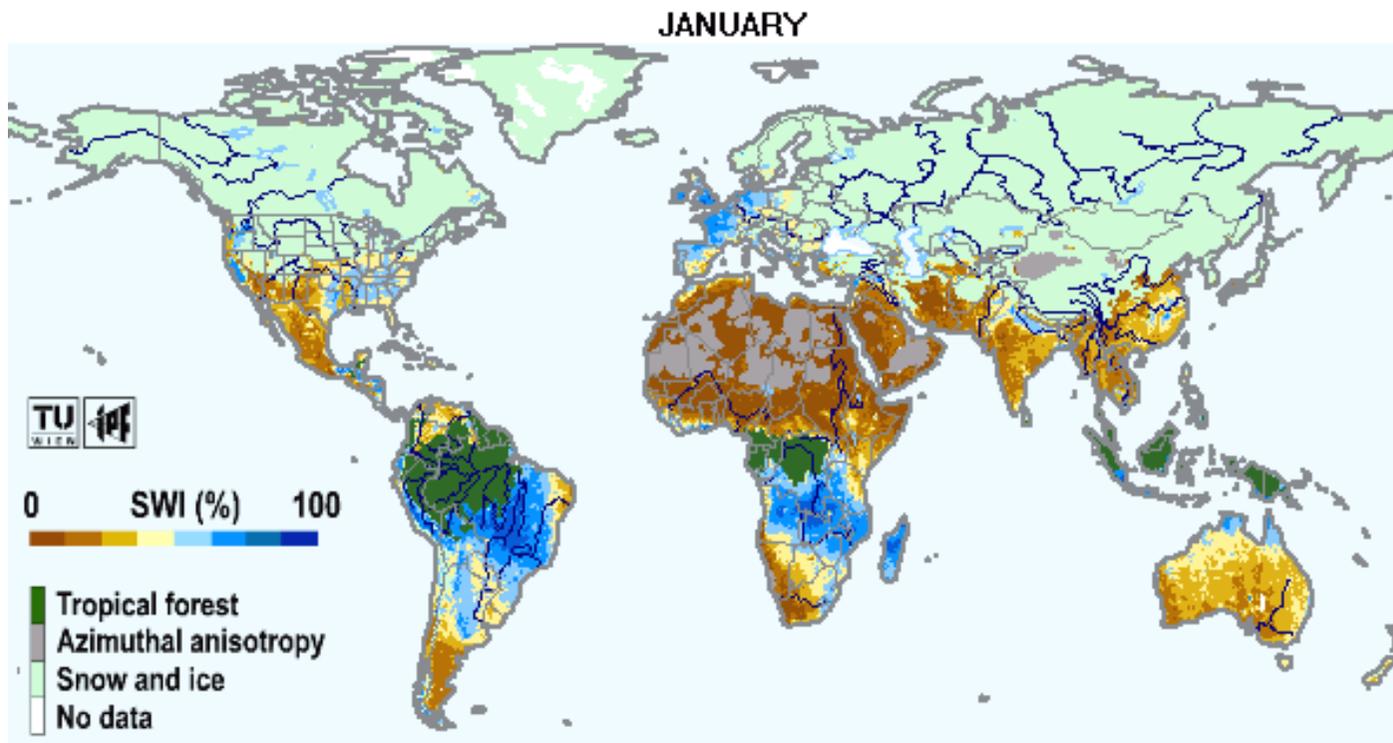
Level 2: Surface Soil Moisture  
Level 3: Profile Soil Moisture (SWI)

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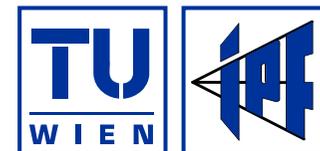
# Product Examples – Profile Soil Moisture (SWI)

SWI 1992-2000 monthly means



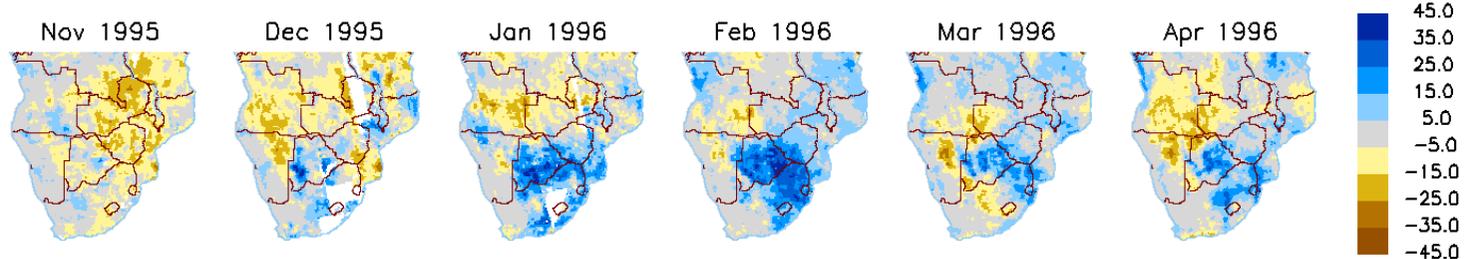
ab@ipf.tuwien.ac.at

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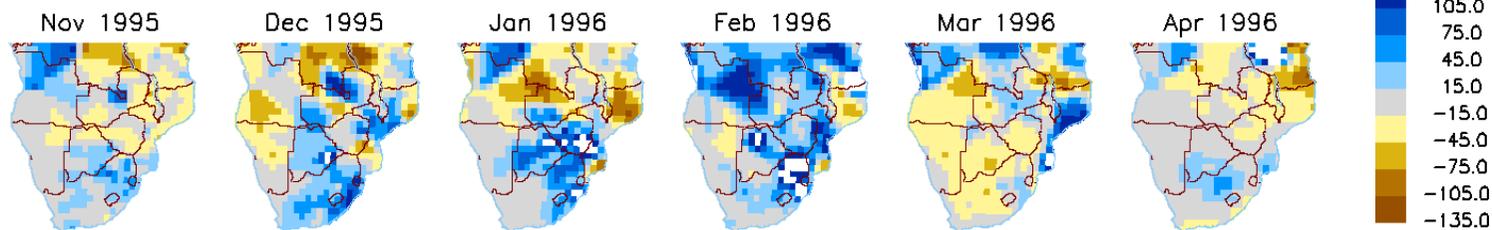


# Floods in South Africa 1995/96

## SWI Deviation from Normal(92-00)



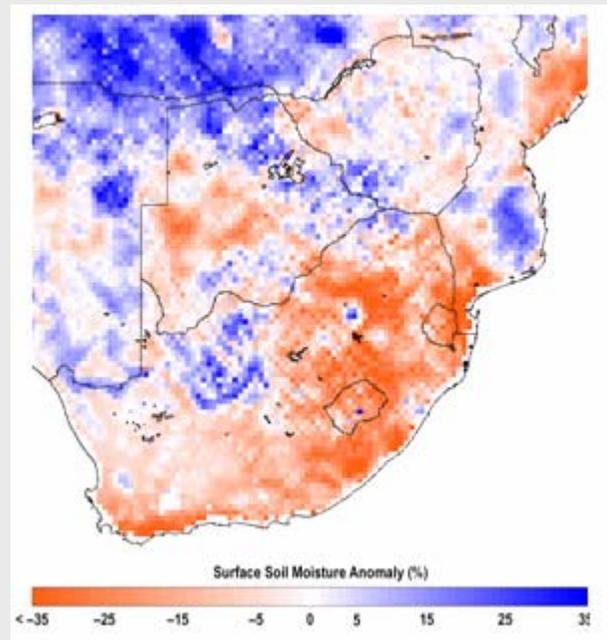
## Precipitation Deviation from Normal(92-00)



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

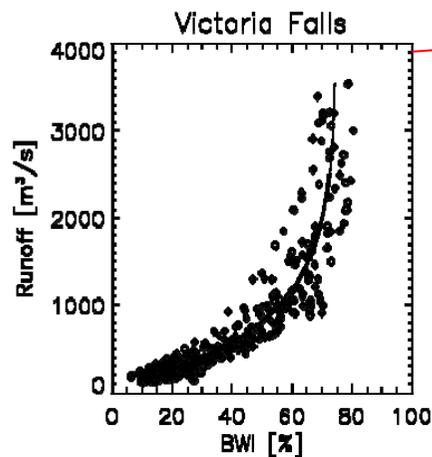
Example: Zambezi River

Temporal offset & basin size

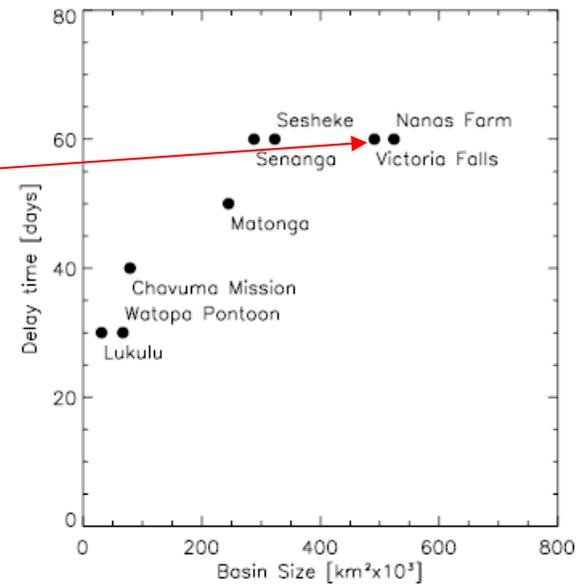
Basin Water Index  
(Scipal et al. 2005)

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

Runoff & BWI



Offset 2 months



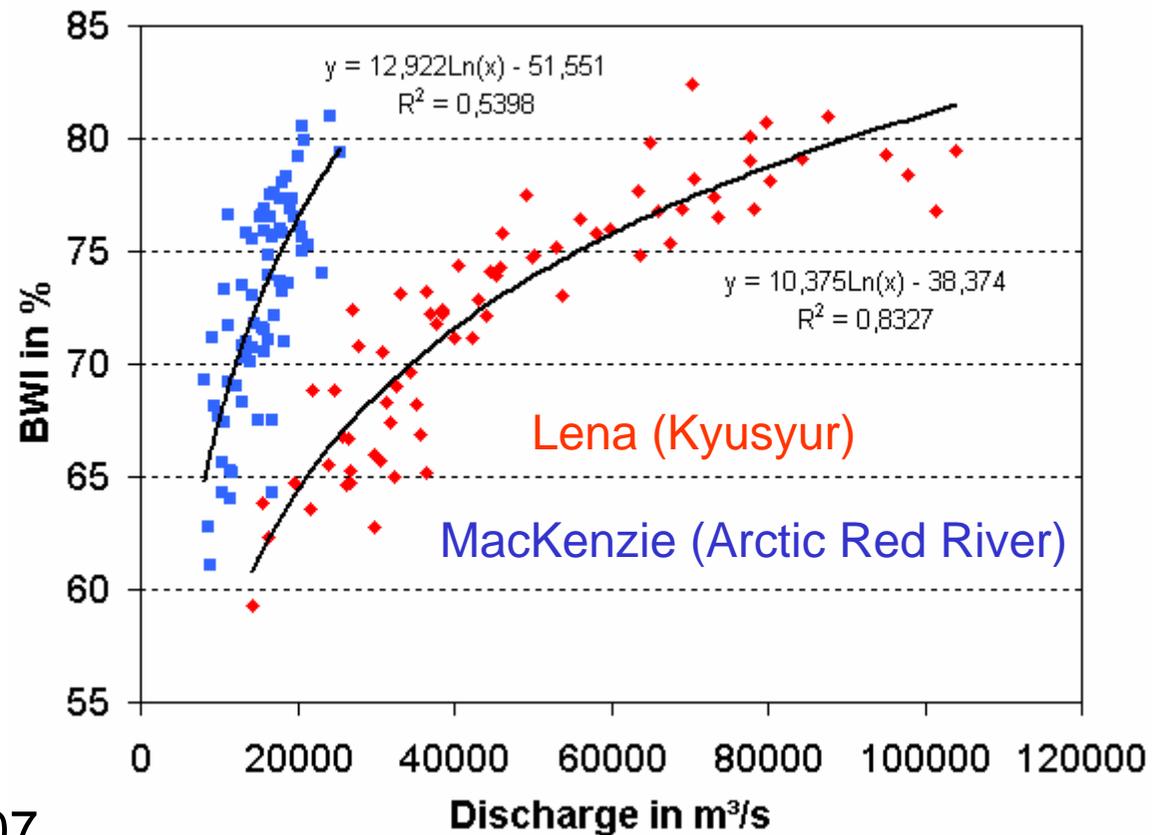
# Soil moisture and runoff in regions with seasonal snow cover

June - August, 1993-2000

Summer only

10 day offset

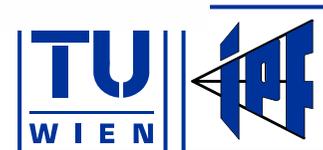
20 day offset



Bartsch et al. 2007

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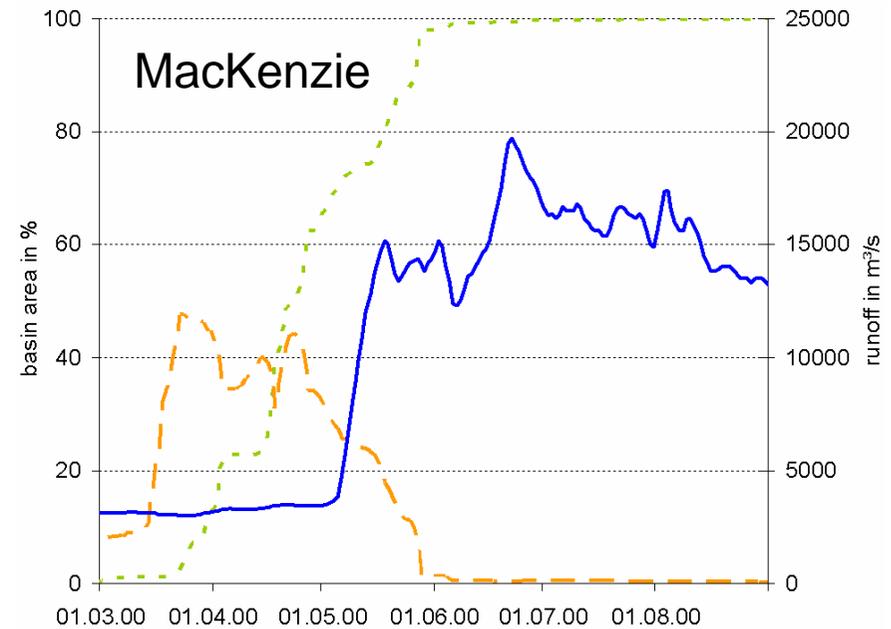
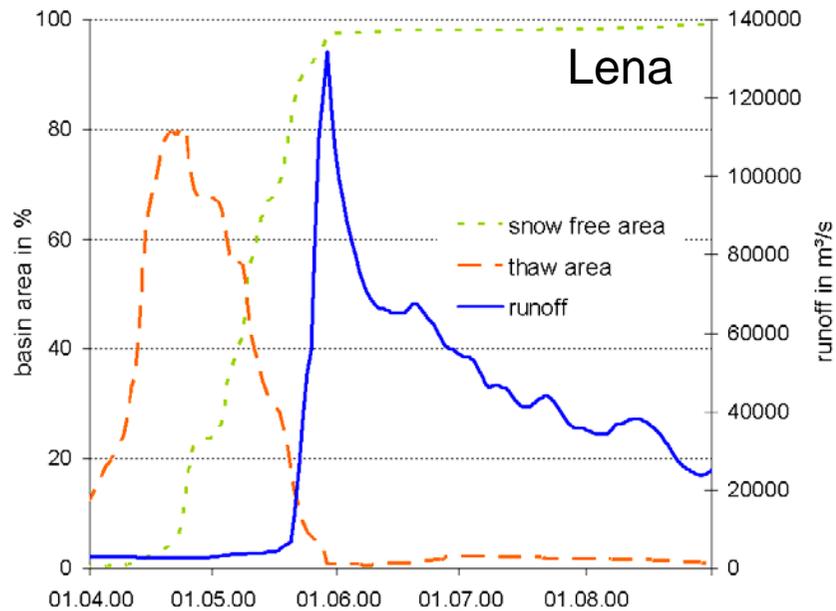
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# Snowmelt & runoff

Bartsch et al. 2007

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



Snow free area

Thaw Area

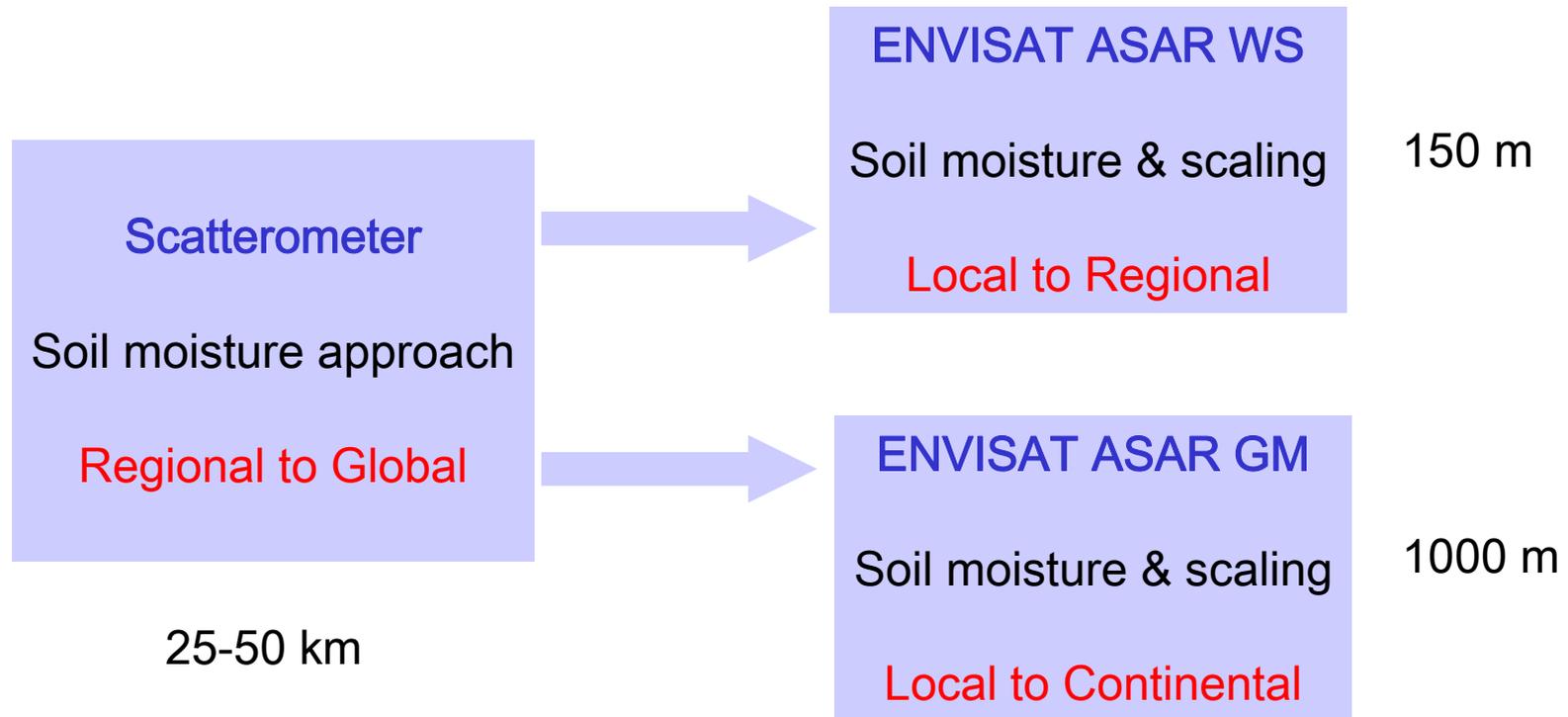
River runoff

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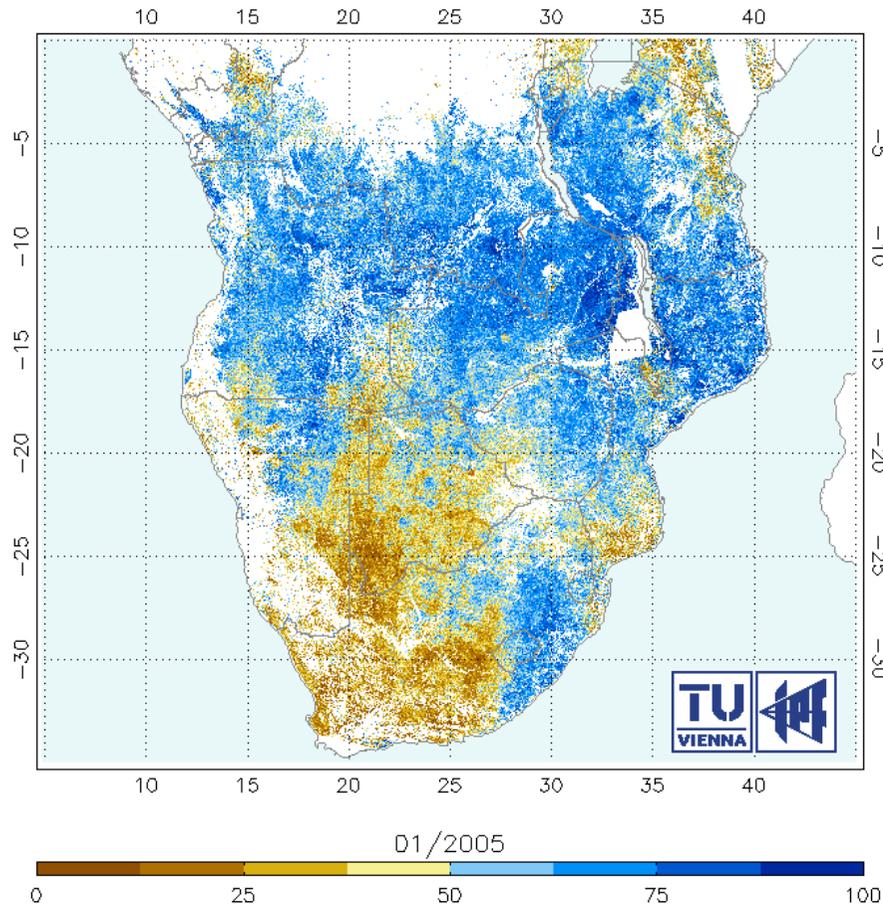


# Transfer of approach to SAR



# SHARE

Soil Moisture for Hydrometeorologic Applications  
in the SADC region



## SHARE

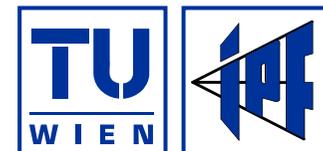


AOI: Africa below the Equator

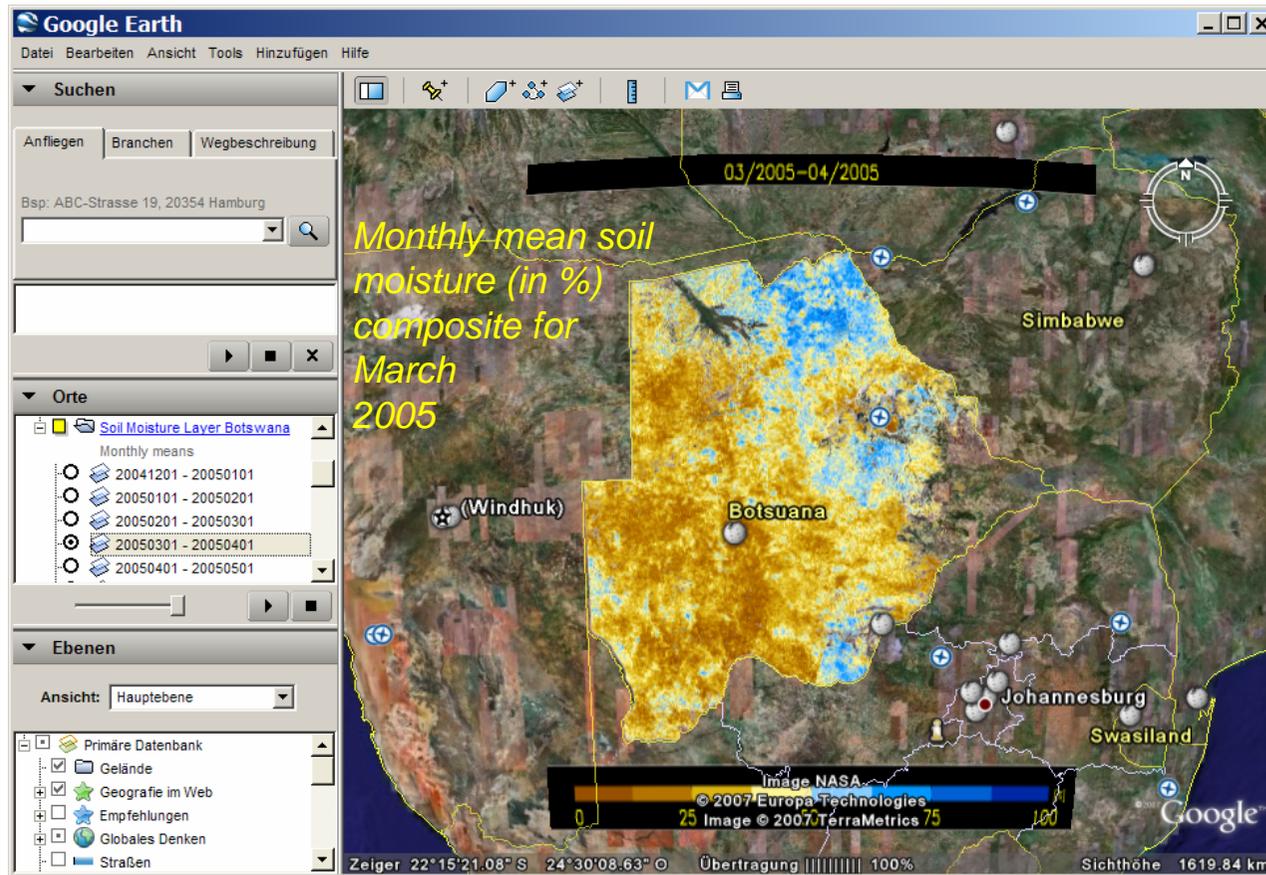
- ✓ ENVISAT ASAR GM 1km experimental surface soil moisture
- ✓ Scaling layer for interpretation of 50 km product at 1km

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[www.ipf.tuwien.ac.at/radar/share](http://www.ipf.tuwien.ac.at/radar/share)

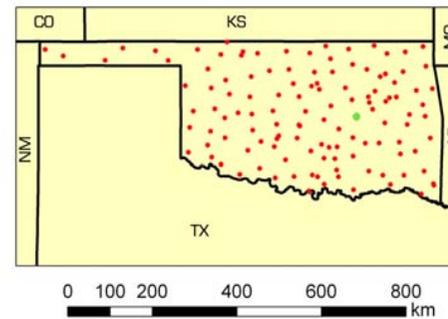
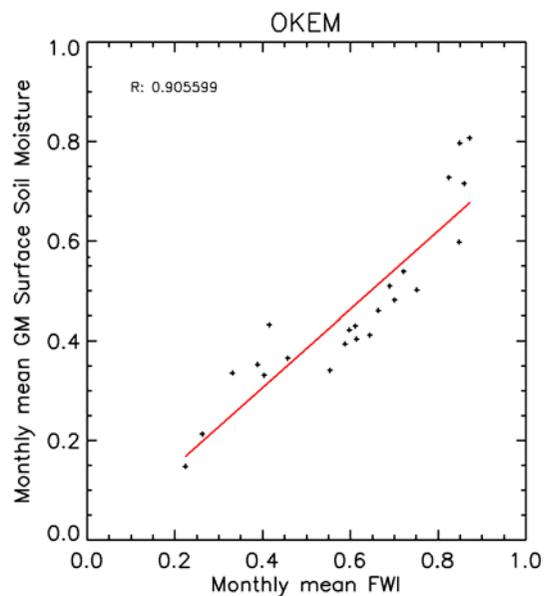


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## Ground data ENVISAT ASAR GM

heat dissipation sensors



**Oklahoma  
Mesonet**

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

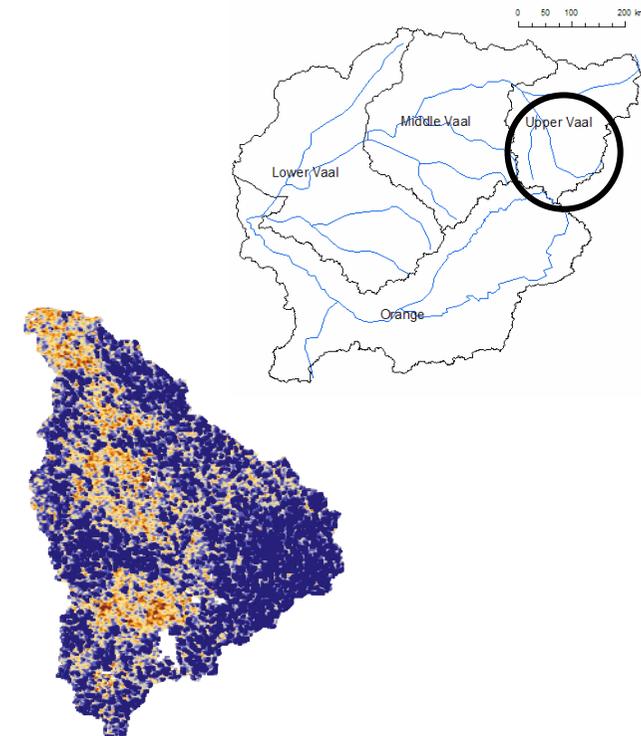
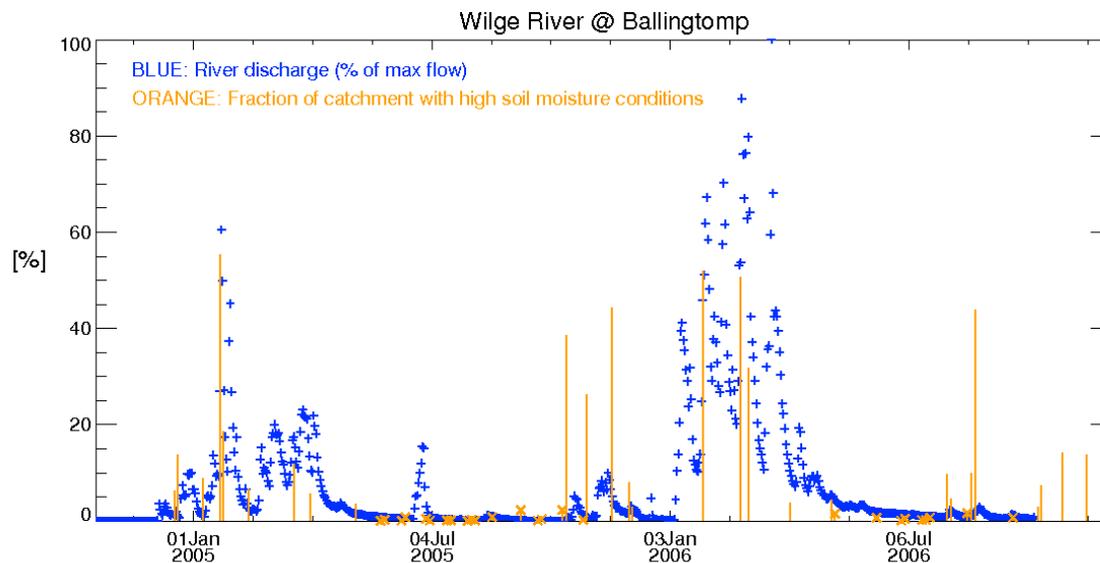
Pathe et al. 2007

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## Saturated soil (surface) – runoff generation

Wilge River Basin, South Africa  
(Upper Vaal)

### Percentage catchment area with saturated soil conditions

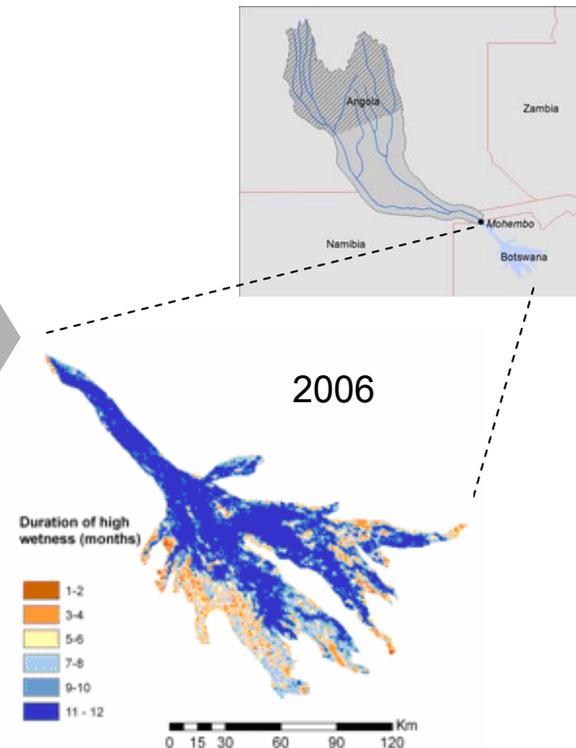
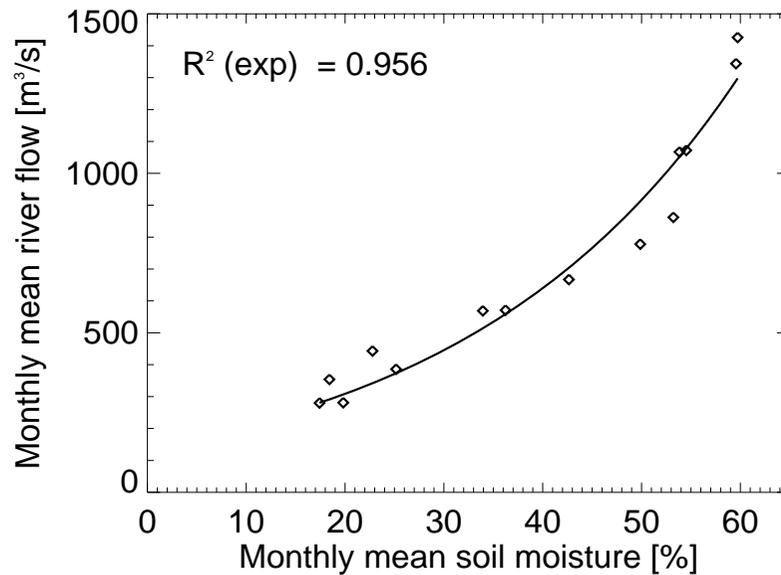


Sabel et al. 2007

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## ScanSAR surface soil moisture – Okavango river runoff

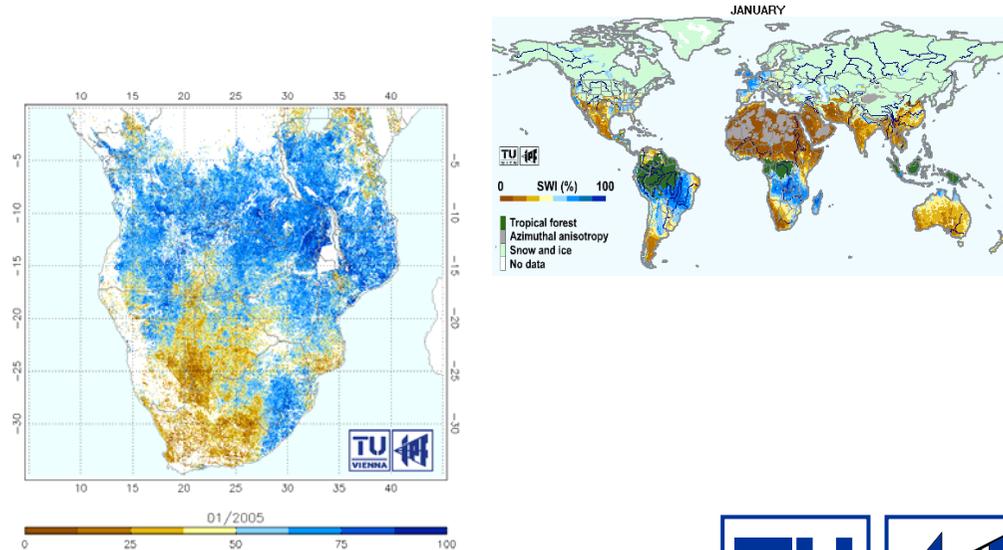
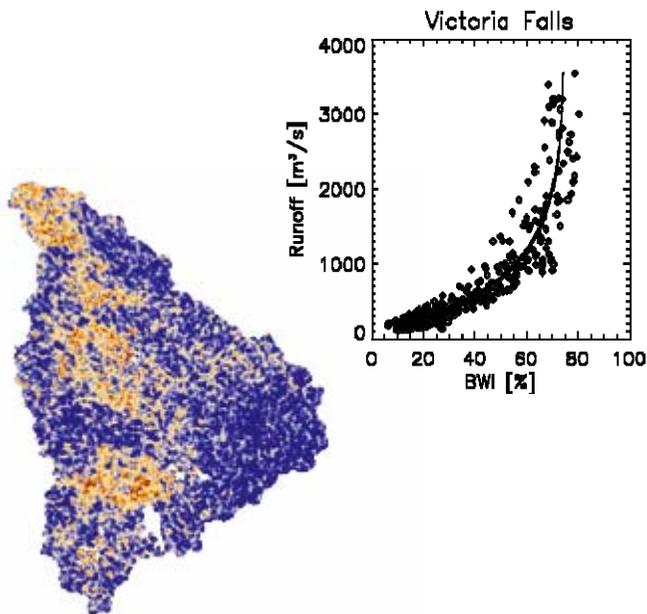


Offset 3 months

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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**



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# 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

