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Vulnerability of the Tanzanian hydropower production to extreme weather events

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Introduction

- Energy sources in Tanzania are solar, wind, biogas, coal reserves, natural gas, hydropower, biofuel, wood fuel, and geothermal power
- The most exploited is wood fuel because it is both cheap and accessible to the majority in rural and urban areas
- Petroleum, hydropower and coal are the major source of commercial energy in the country
- fuel-wood and charcoal from both natural forest and plantations, accounts for 93 per cent of total energy consumption
- Tanzania depends mainly on rainfall to recharge the hydropower plants which are the major source of electricity.

Introduction cont ...

- The spatiotemporal variability of rainfall over Tanzania and its impacts on hydropower production is investigated
- Extremely dry years are defined as those whose rainfall per day is more than 1 and 0.5 mm below average for OND and MAM respectively
- Extremely wet years are defined as those whose rainfall per day is more than 1 and 0.5 mm above average for OND and MAM respectively
- Monthly means of rainfall (mm/day) from combined satellite/station data given at 2.5 degree latitude by 2.5 degree longitude from January 1979 to June 2009 were used

Introduction cont ...

- Data were obtained from the Global Precipitation Climatology Project (GPCP), provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at http://www.esrl.noaa.gov/psd/
- River basins that are used for hydropower production are the Pangani and Ruaha Basins
- Nyumba ya Mungu, Hale and Pangani hydropower plants are in the Pangani River Basin
- Mtera, Kihansi and Kidatu hydropower plants are in the Ruaha River Basin
- Pangani river originates from Mount Meru and Kilimanjaro and flows into the Indian Ocean
- The Ruaha tributaries originates from southern highlands and flows into the Indian Ocean

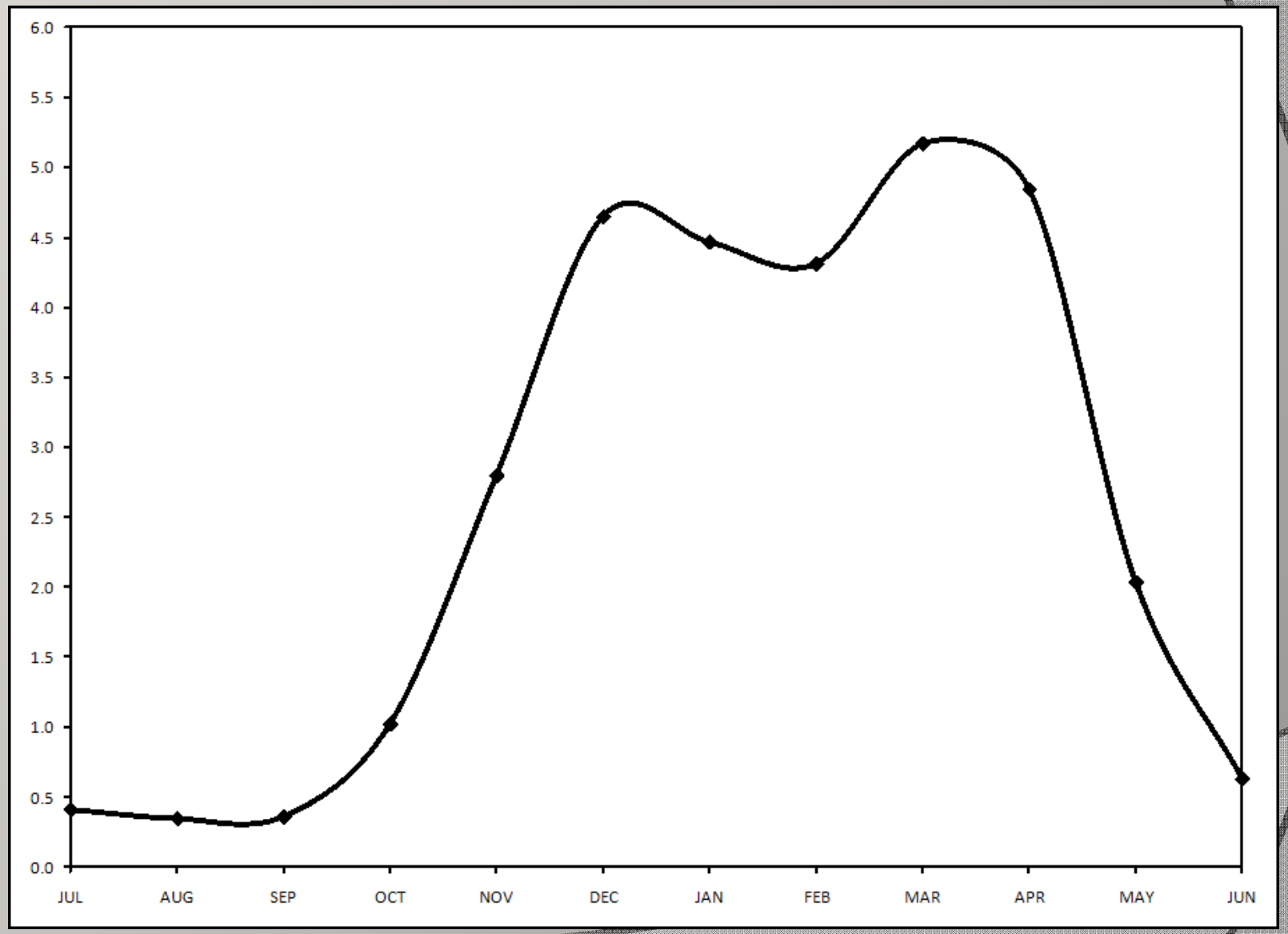
Spatiotemporal distribution of rainfall

- Northeastern and northern Tanzania have two rainfall seasons, OND and MAM
- Southern and western Tanzania have one rainfall season, October to May
- Extremely dry years during OND and October to May from 1979 to 2008 were 1987, 1993, 1995, 1996, 1998, 2003 and 2005
- Extremely dry years during MAM from 1979 to 2009 were 2000, 2001, 2003, 2005, 2007, and 2009
- Extremely wet years during OND and October to May from 1979 to 2008 were 1982, 1986, 1997 and 2006
- Extremely wet years during MAM from 1979 to 2009 were 1979, 1986, 1989, 1990, 1999 and 2006

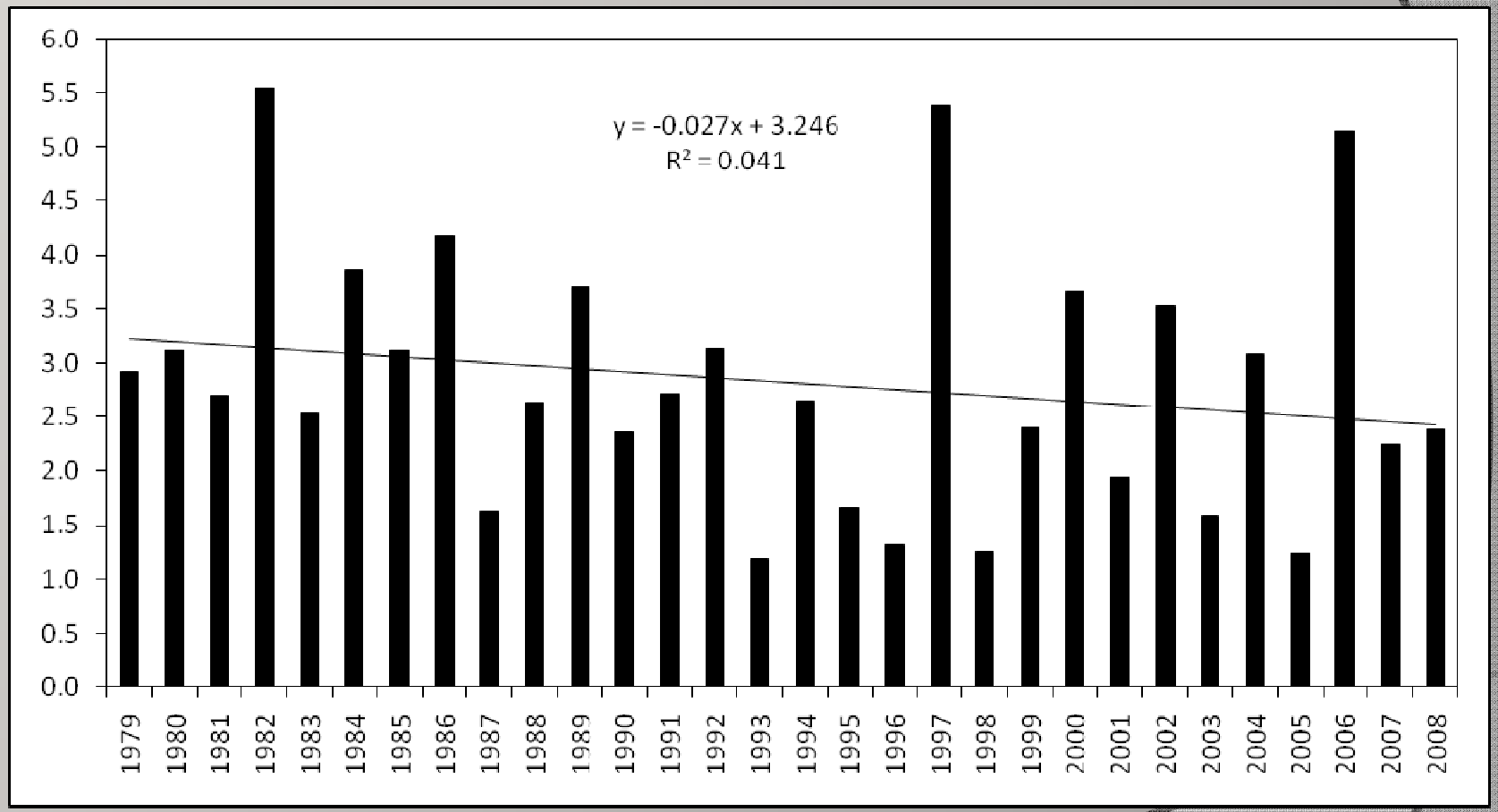
Spatiotemporal distribution of rainfall cont ...

- There is a general decrease of the amount of annual rainfall
- The frequency of below average rainfall is generally going up
- It is also evident that the severity of extreme weather events like dry and wet spells is intensifying
- The ENSO episodes impacts are also becoming more evident and severe
- The predictability of seasonal weather patterns is becoming more challenging

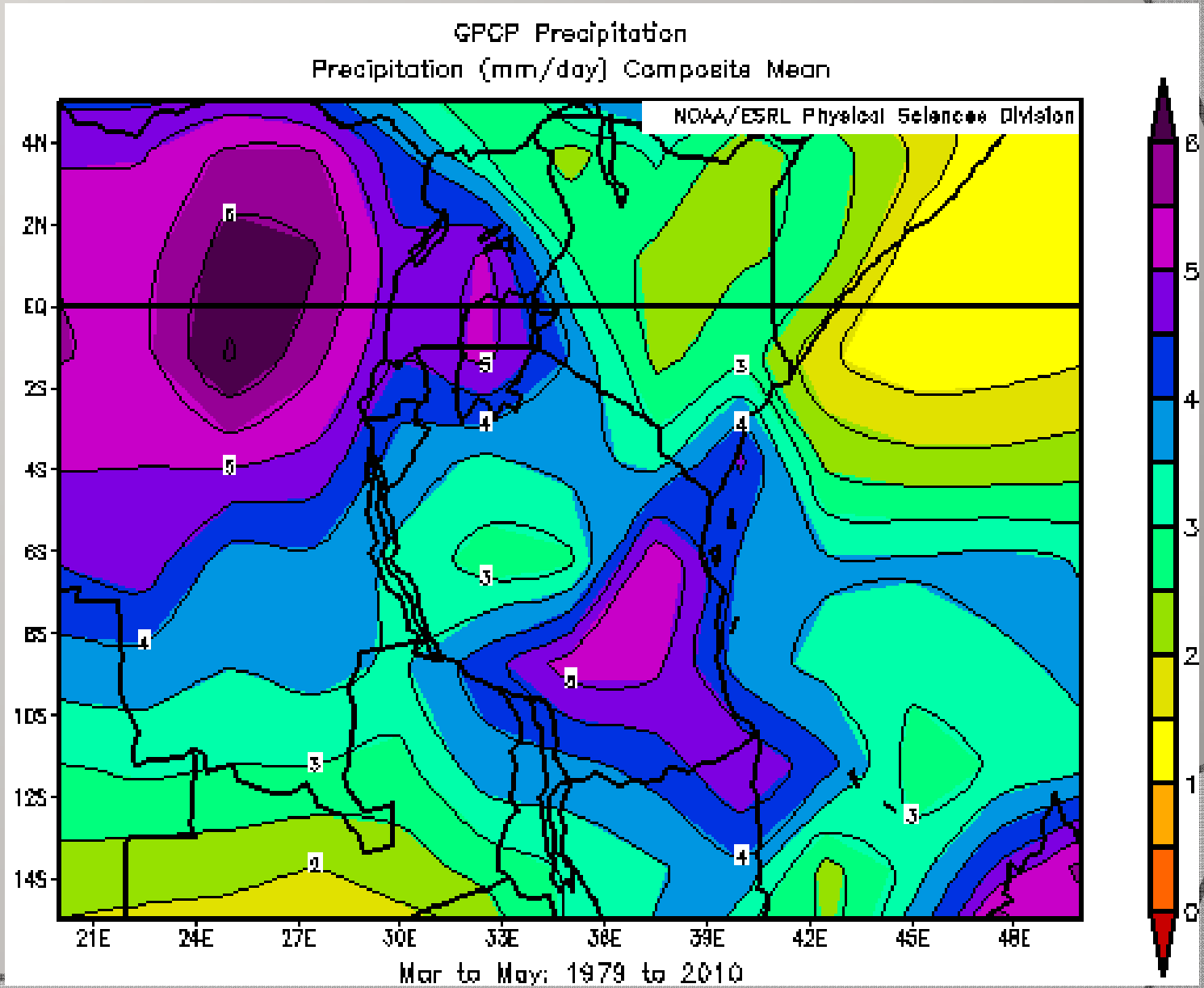
Annual rainfall cycle over Tanzania for 1979 - 2008



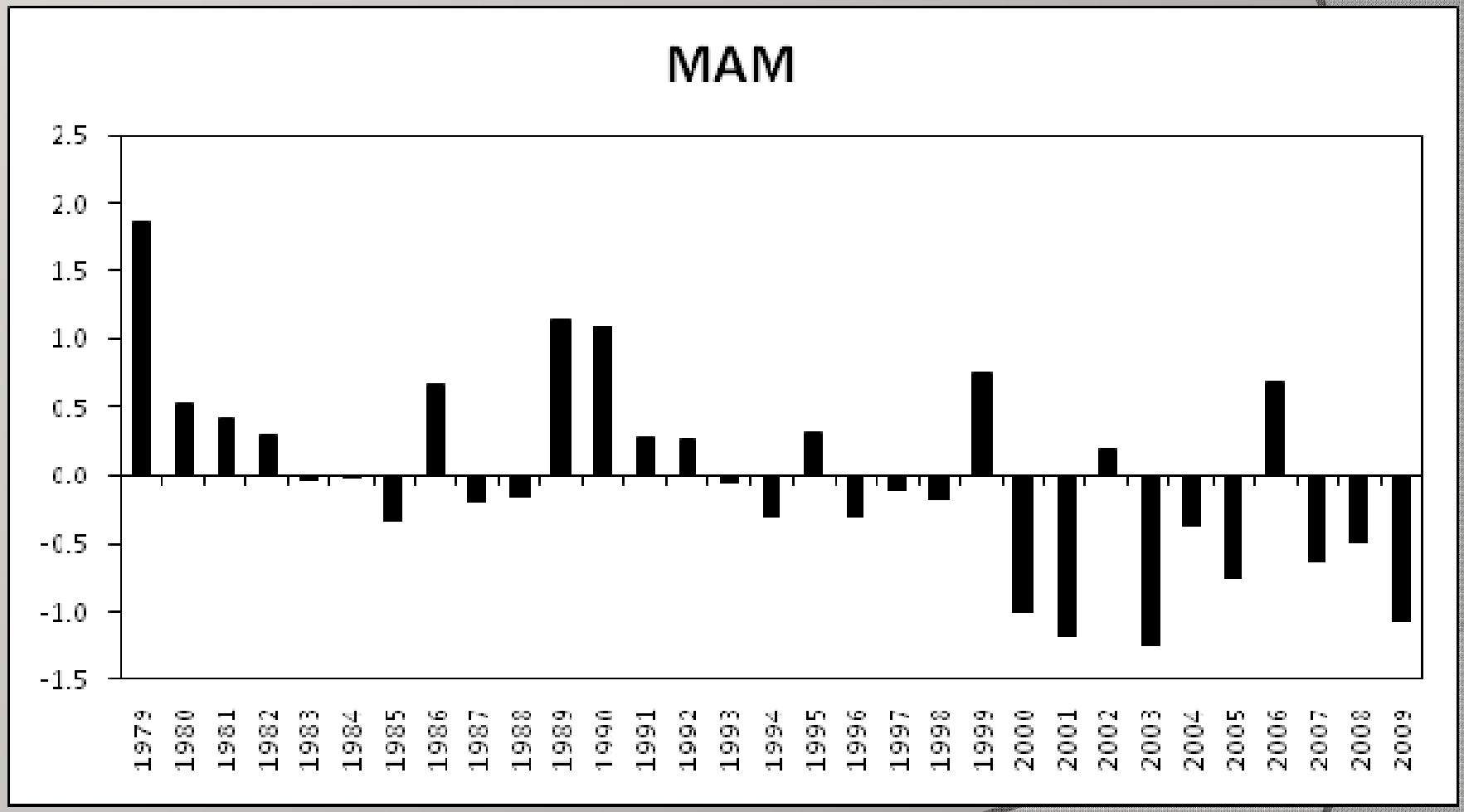
October – May rainfall trend over Tanzania from 1979 - 2008



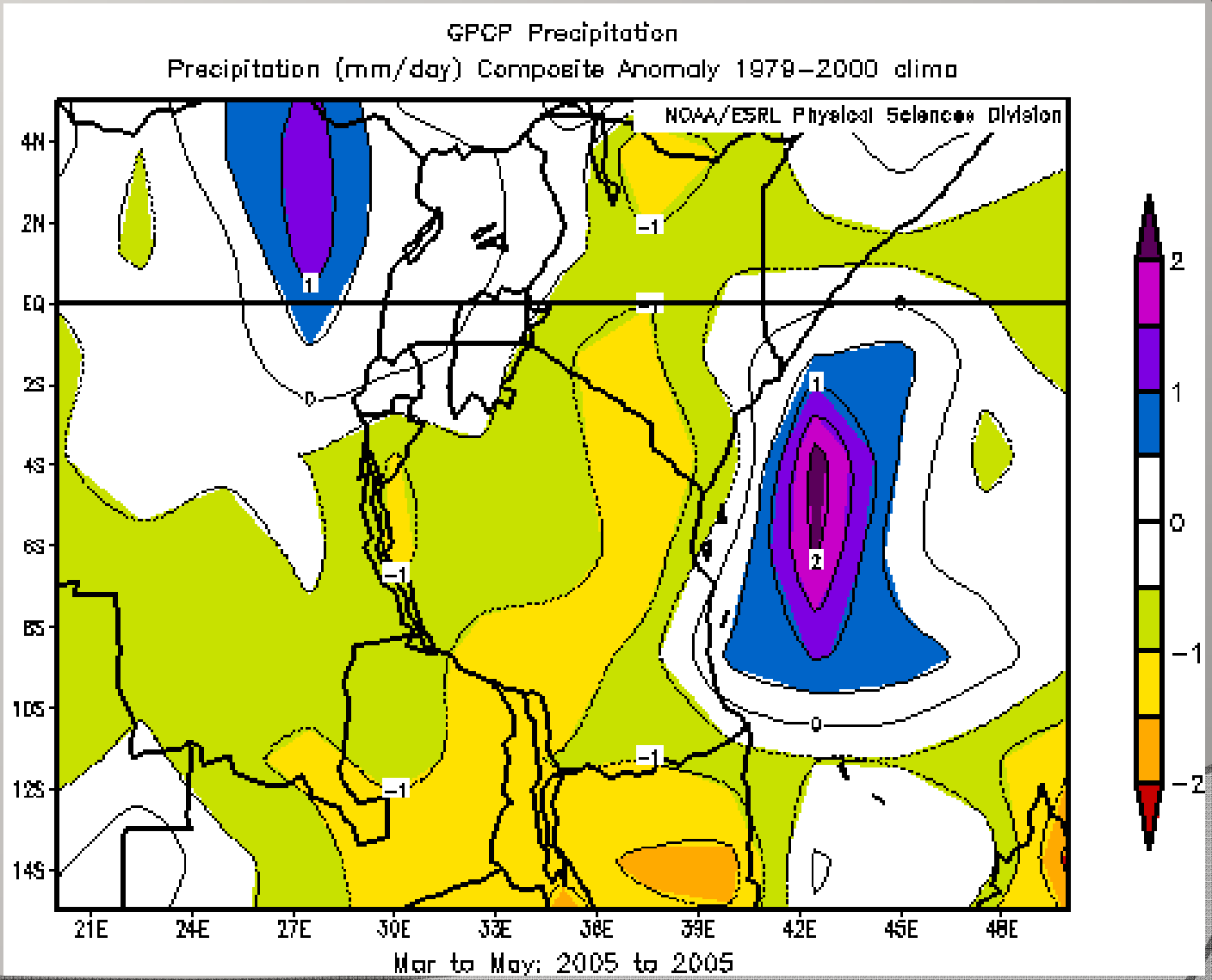
Spatial distribution of rainfall (MAM) 1979 -2009



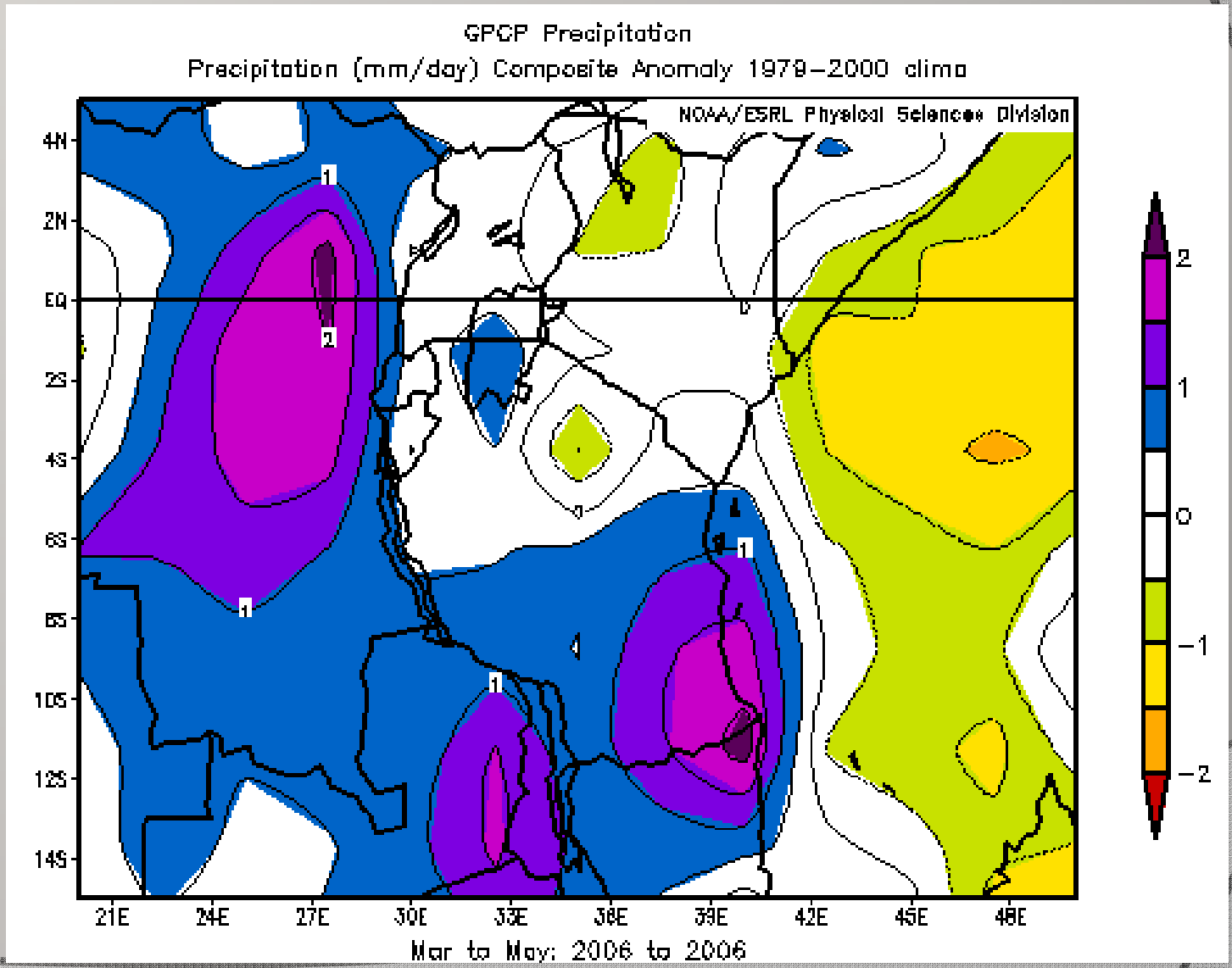
Temporal variability of rainfall (MAM) 1979 -2009



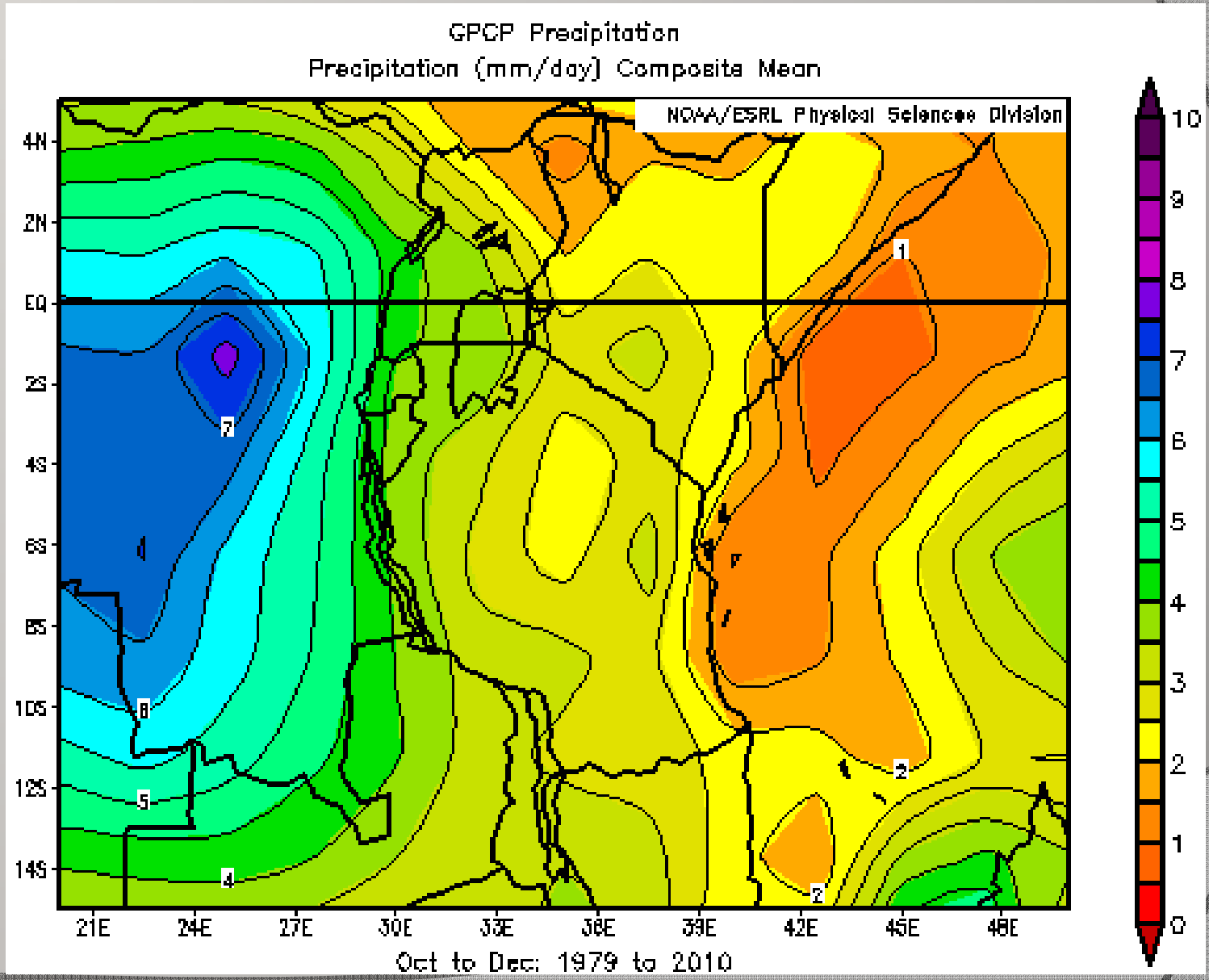
Spatial distribution of rainfall anomalies– MAM/2005



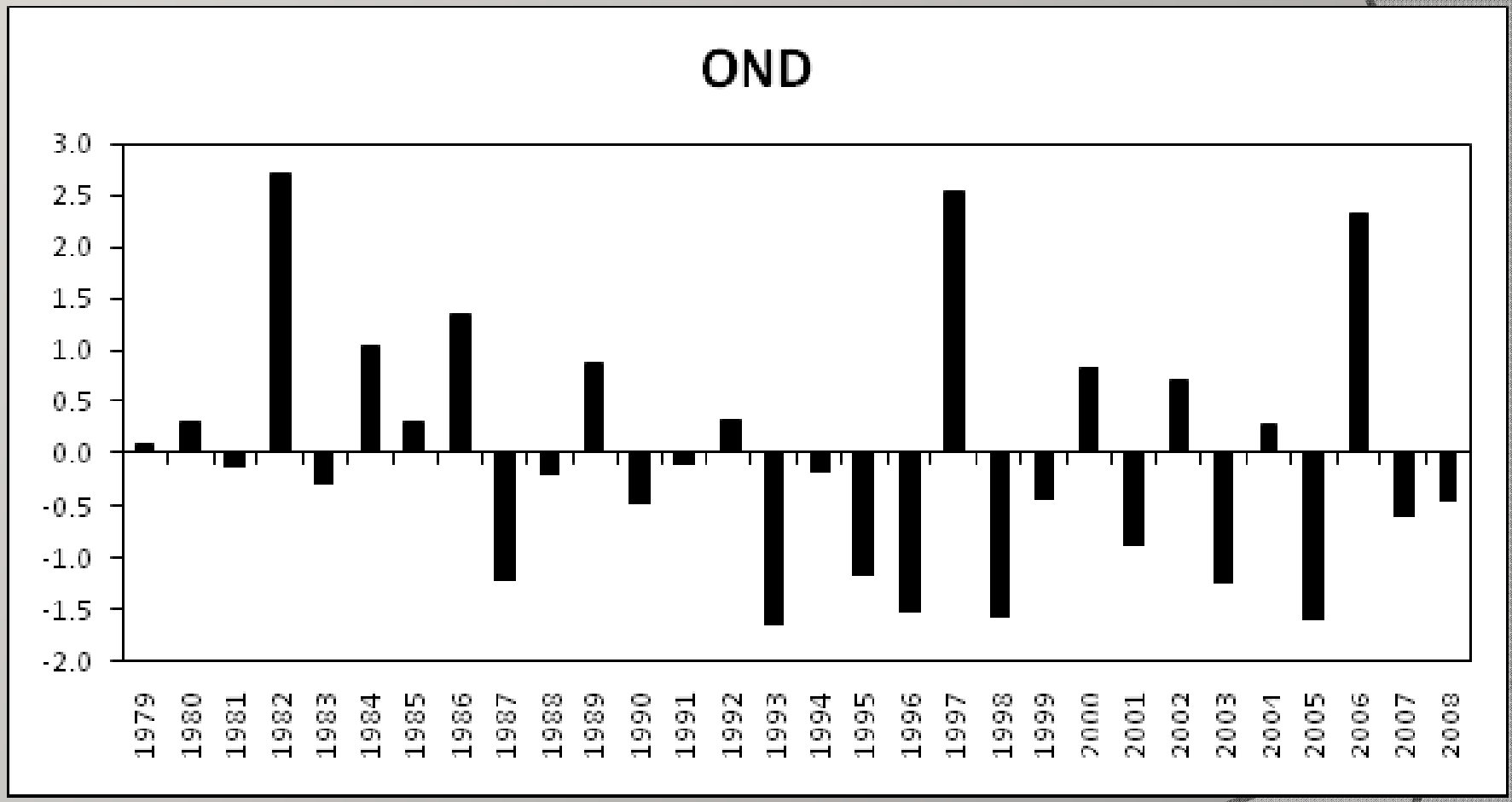
Spatial distribution of rainfall anomalies– MAM/2006



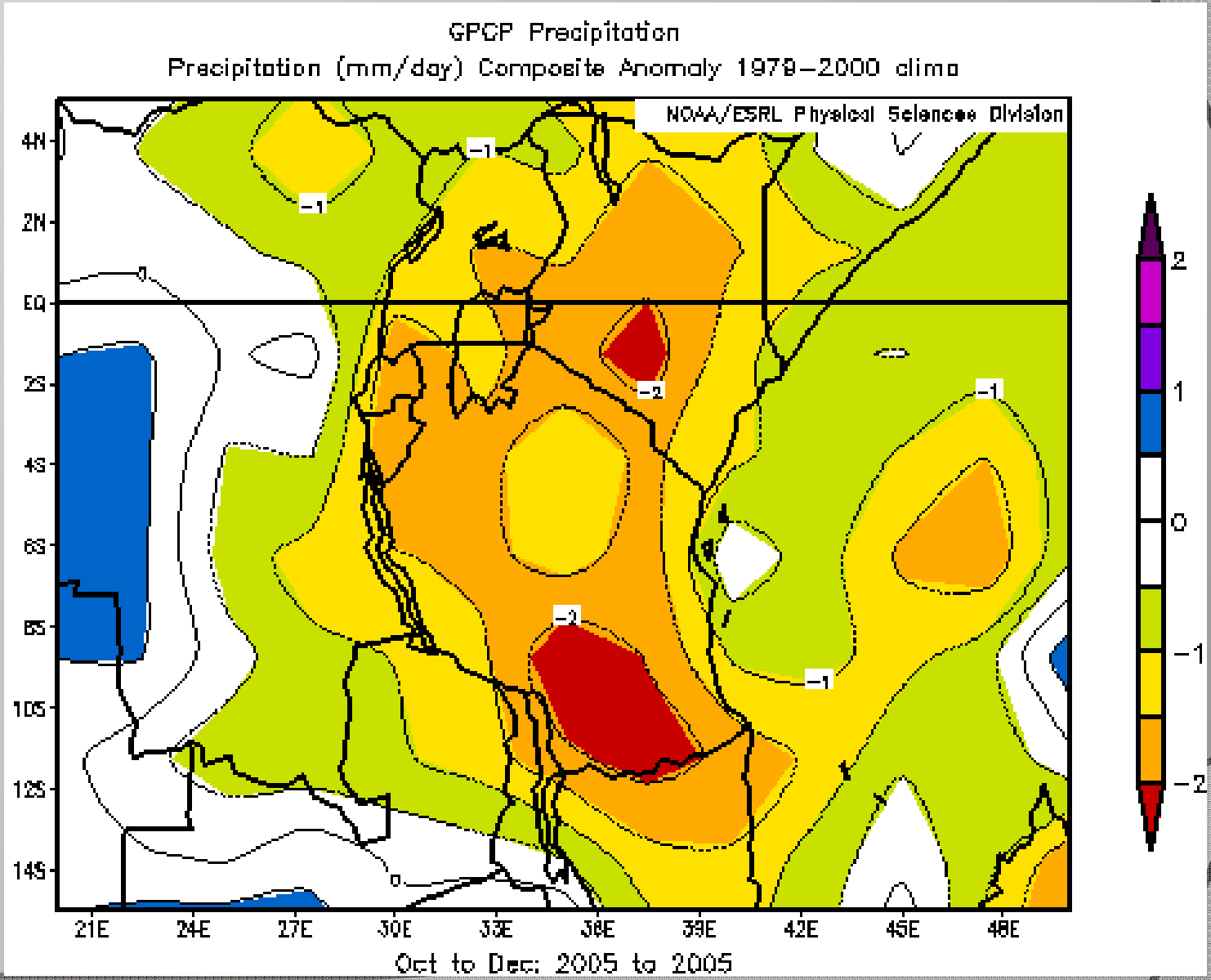
Spatial distribution of rainfall (OND) 1979 -2008



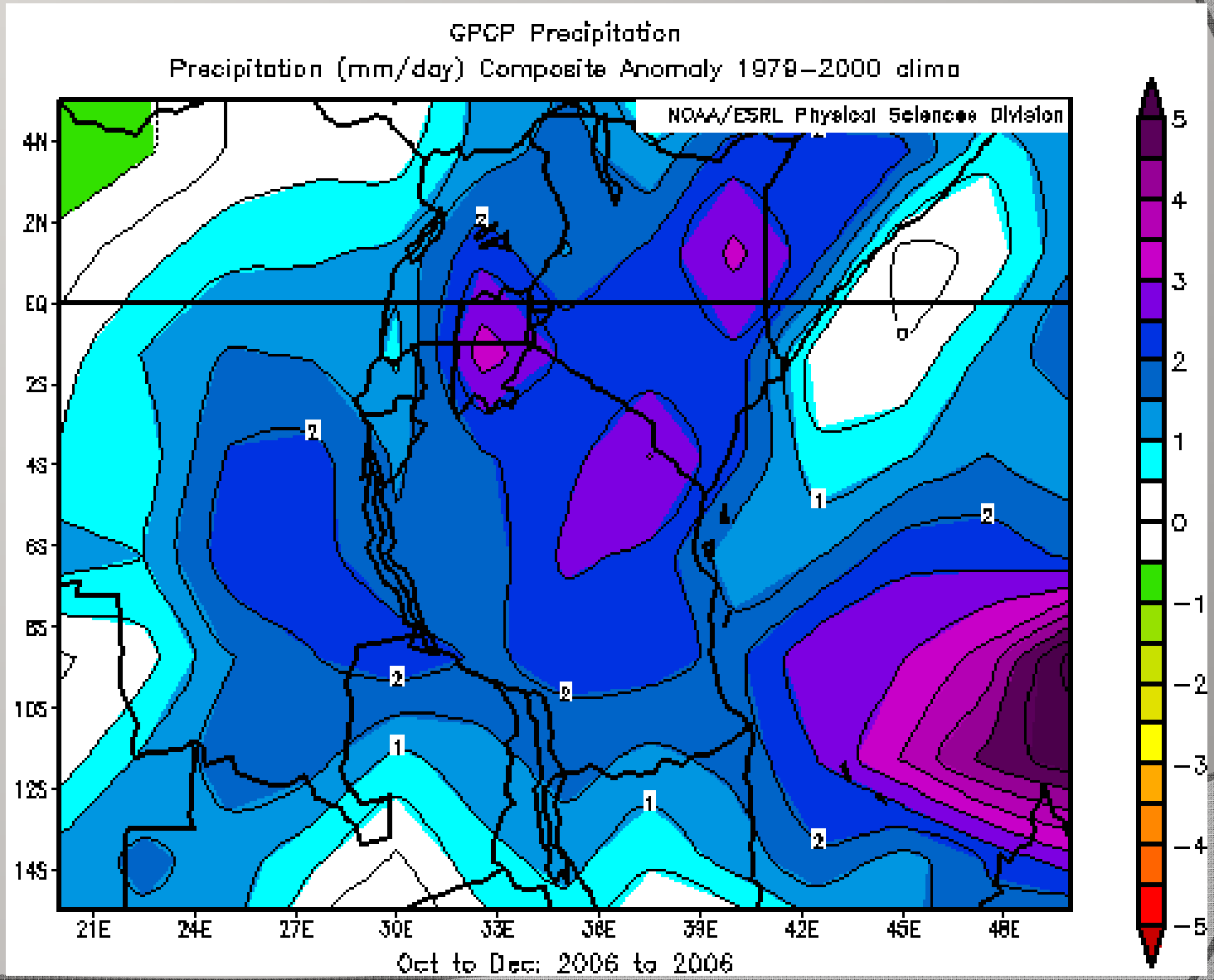
Temporal variability of rainfall (OND) 1979-2008



Spatial distribution of rainfall anomalies– OND/2005



Spatial distribution of rainfall anomalies– OND/2006



Hydropower production

- Tanzania installed Hydropower generation capacity is about 561 MW
- Ruaha Basin is the major source of hydropower, producing about 82% of the total hydropower generation
- Mtera hydropower station generates 80MW
- Kidatu has power generating capacity of 204MW
- Kihansi has a power generating capacity of 180MW, likely to increase to 300MW in the future.
- The Pangani river basin has three power generation plants at Nyumba ya Mungu (8MW), Hale (21MW) and New Pangani Falls (68MW)

Vulnerability of the hydropower production to rainfall variability

- Due to drought, the highest water levels in most of the hydropower stations have progressively been declining in recent years
- Mtera Dam

2003	2004	2005	2006
695.8m	690.5m	689.5m	688m

- Nyumba ya Mungu Dam

2003	2004	2005	2006
686.2m	683.8m	683m	680m

- These affected hydropower production

Vulnerability of the hydropower production to rainfall variability cont …

- In February, 2006 load shedding started in Tanzania due to insufficient hydropower generation into the national grid to meet the country`s maximum demand
- While the country's demand stood at about 540 MW, the contribution by hydropower plants was as low as 140 MW (from the installed capacity of 561 MW)
- In March, 2006 TANESCO announced that drought has affected all the six hydropower stations
- The six stations was then yielding a paltry 50 megawatts, which necessitated the day-long power shedding
- Floods during wet years lead to erosion on the highlands leading to siltation of the dams

Conclusions and recommendations

- Use thermal power, natural gas and coal in Kinyerezi, on the outskirts of Dar es Salaam, and Kiwira coal mines to generate 500 MW that would completely end power outages.
- Set up small hydropower plants that are environment friendly, like the Kinko one in Lushoto area, producing 27 kW
- Popularise the adoption of solar panels for the rural majority left out of the national power grid
- Use biogas from animal waste
- Invest in wind energy to generate electricity
- Engage in Interconnector Power project
- Suspend tax on imported generators and related equipment during power rationing episodes

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