Understanding conditions over Lake Victoria:
A WMO initiative

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Lake Workshop

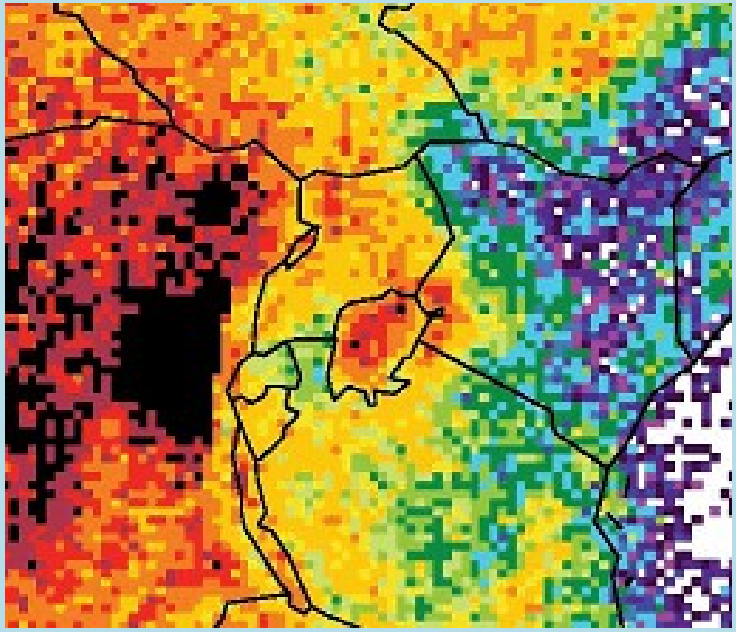
18-20 September, Helsinki

Outline:

- The problem and the proposed WMO approach
- What is happening over the lake?
- An “understanding project” on Lake Victoria

The problem

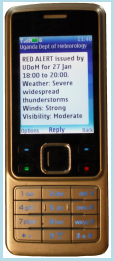
- Frequent severe thunderstorms over the lake, mostly at night
  - 200,000 fishermen active
  - 5000 deaths / year? Many presumed weather-related
  - Local weather/lake conditions/casualty information poorly known from observations
  - National weather services (NMS) in surrounding countries: little experience with warning services for severe weather
- NMS's requested WMO assistance
- Gaps:
  - Observations/Technology
  - Understanding (Nocturnal thunderstorms)
  - Knowledge/Capacity
  - Concept of Operations for Warnings
  - Warning services to the lake community
- Satellite, lightning and NWP based nowcasting / forecasting systems needed



The approach proposed by WMO

A three-pronged strategy:

1. Do the best you can with what you already have: Set up basic operational warning service in the NMS's involved, using available or easily accessible means and technology
   - In-situ observations, satellite observations, lightning networks
   - UK MetOffice 4km NWP model for Africa
   - Kenya weather service acting as regional center supplying alerts to surrounding NMS's
   - NMS's providing warnings via mobile telephone network



2. In-depth study of available RS observations/model data
3. Initiate a research project to enhance our understanding of the complex dynamics and thunderstorm evolution over the lake

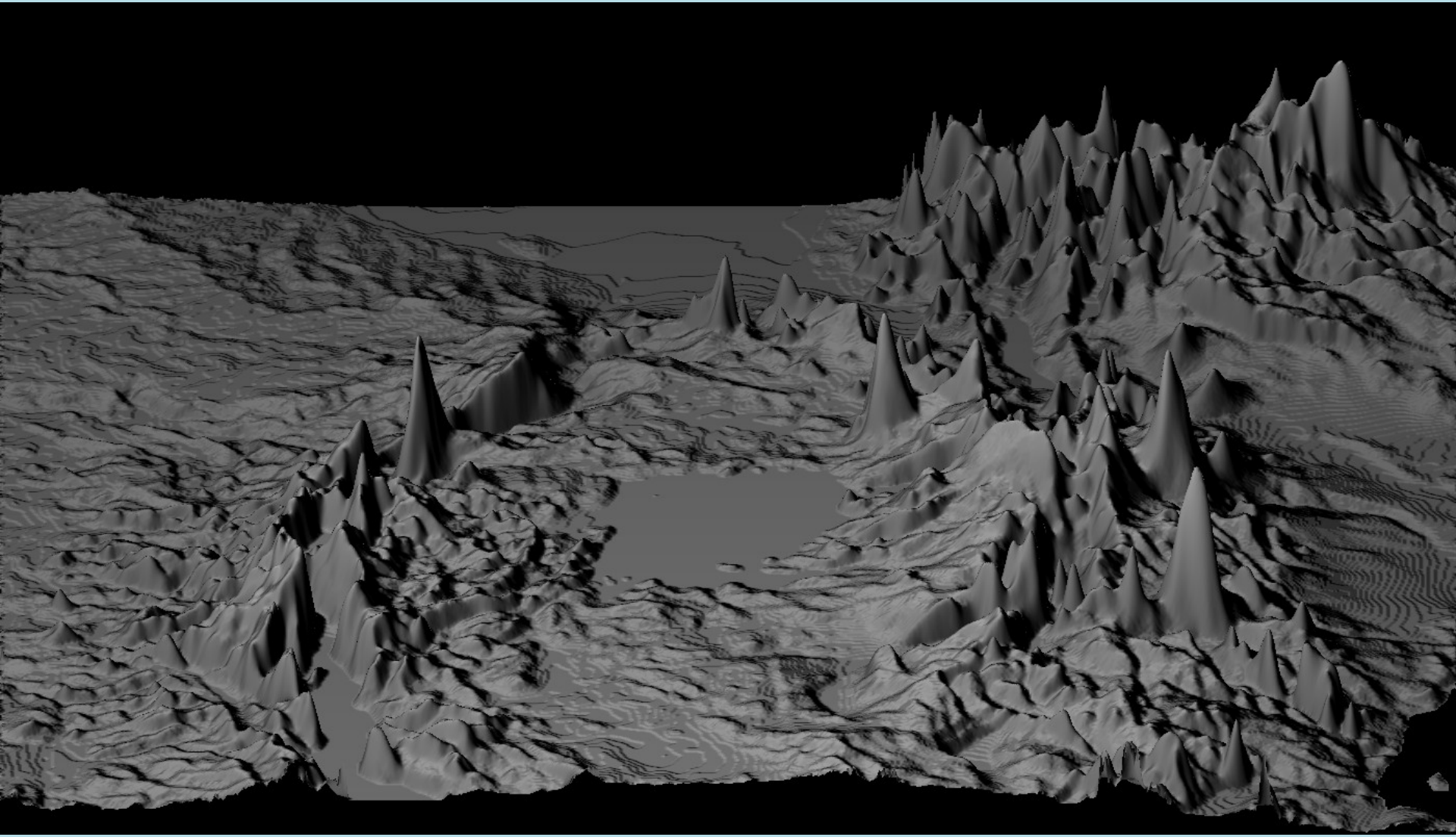
Lake Victoria “understanding” project

“WMO Executive Council (EC) recommended that a World Weather Research Programme (WWRP) project be considered for the Lake Victoria Watershed that would include a test-bed for field campaigns to collect data for research to understand the dynamics over the lake in order to reduce disaster from water spouts, waves, and wind gusts that affect both lake transport and fishermen who rely on the lake for their livelihoods. “

Preliminary investigations by:

Jim Wilson, Marianne Koenig, Steve Goodman

The Lake Victoria environment: topography



Satellite observations climatology: TRMM

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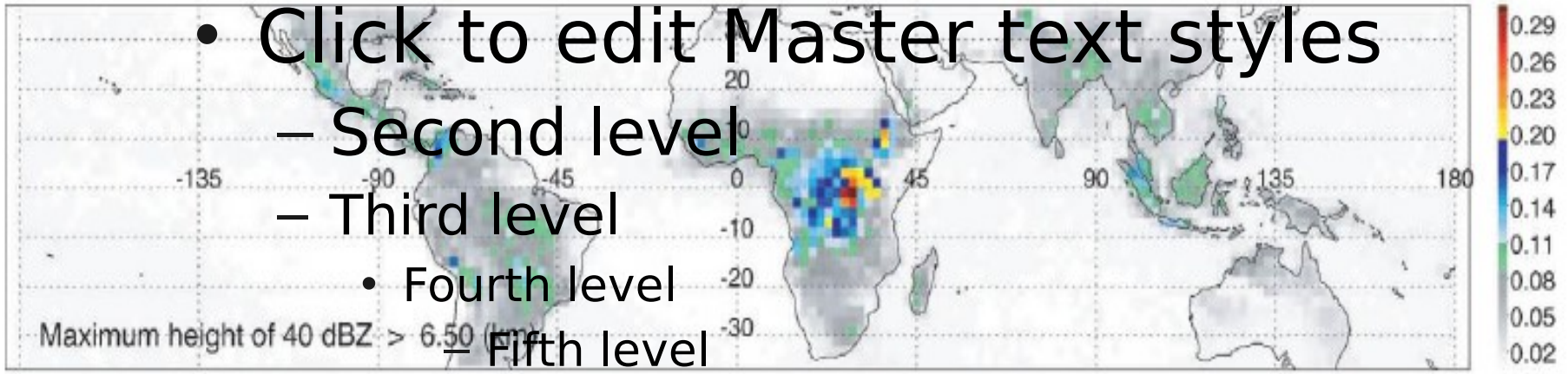


Fig. 3: Frequency of 40 dBZ echoes occurring higher than 6.5 km observed by the TRMM satellite. (From Zipser et al. 2006)

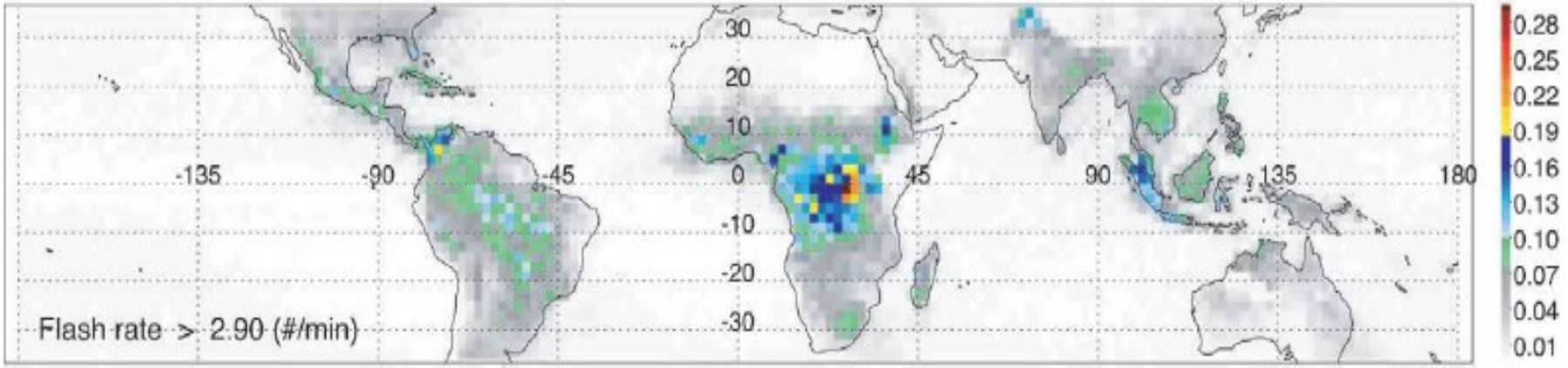
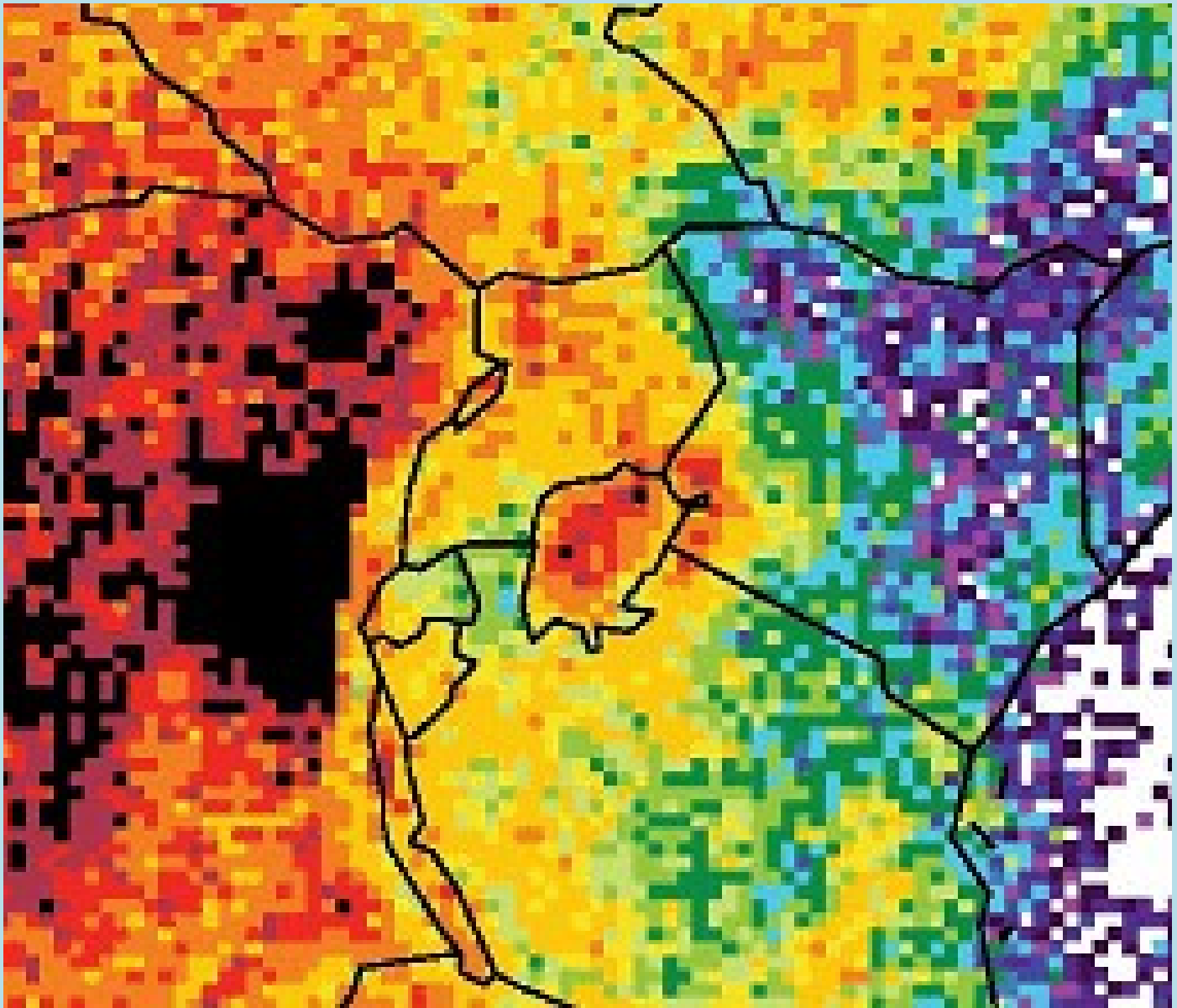
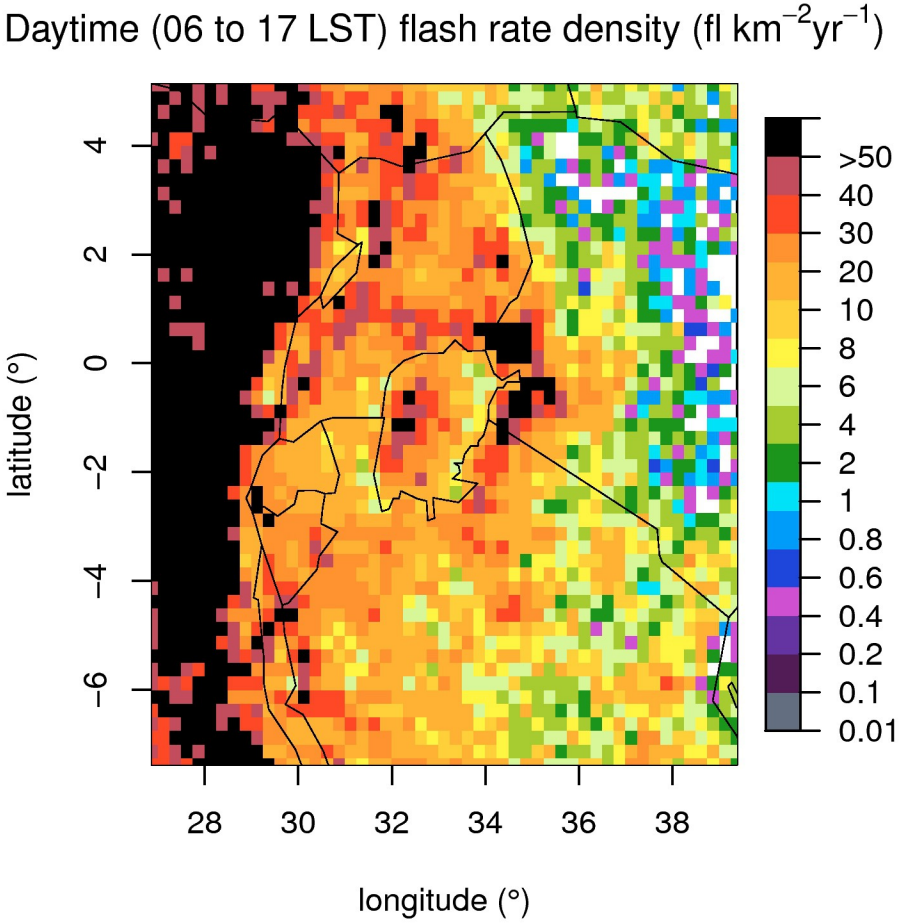


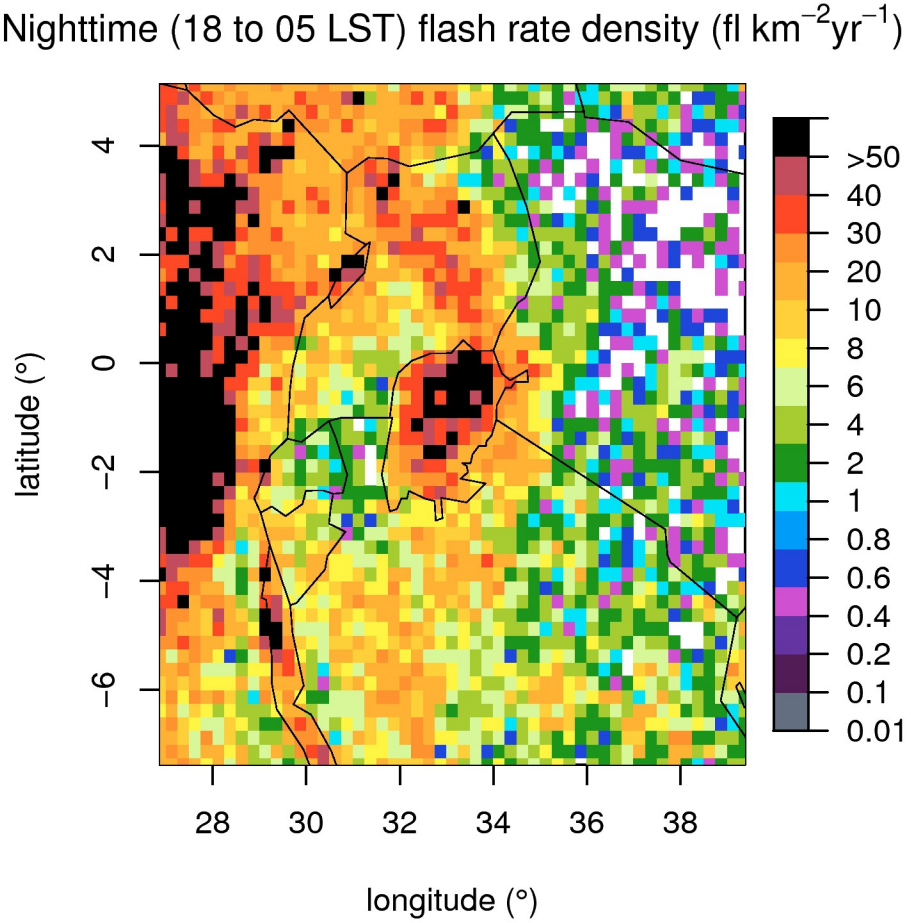
Fig. 4: Global distribution of lightning strikes observed by the TRMM satellite. (From Zipser et al. 2006)

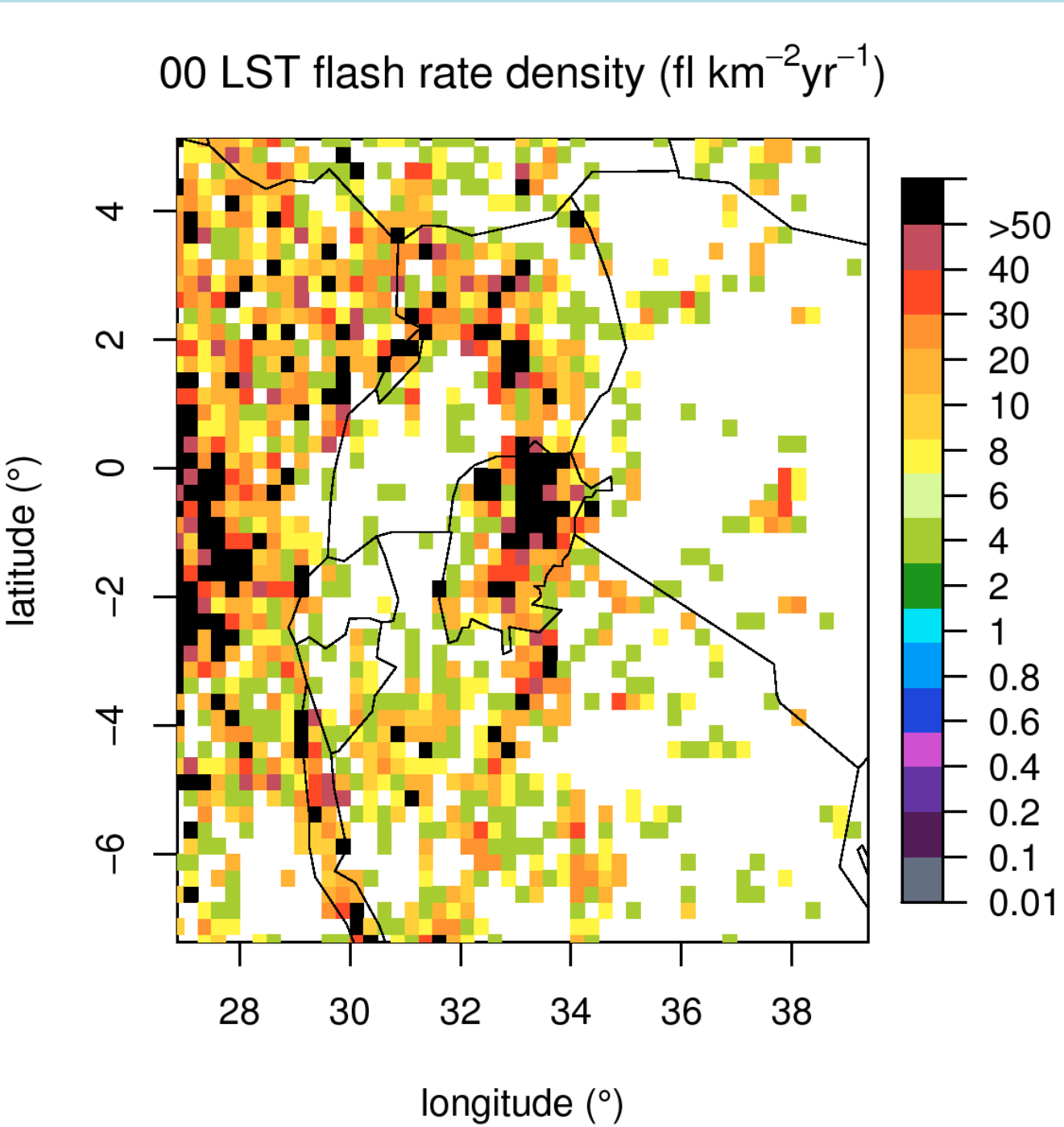
Satellite observations climatology: MSG CI product



Diurnal cycle: TRMM






00 LST flash rate density (fl km^{-2}yr^{-1})
latitude (°)
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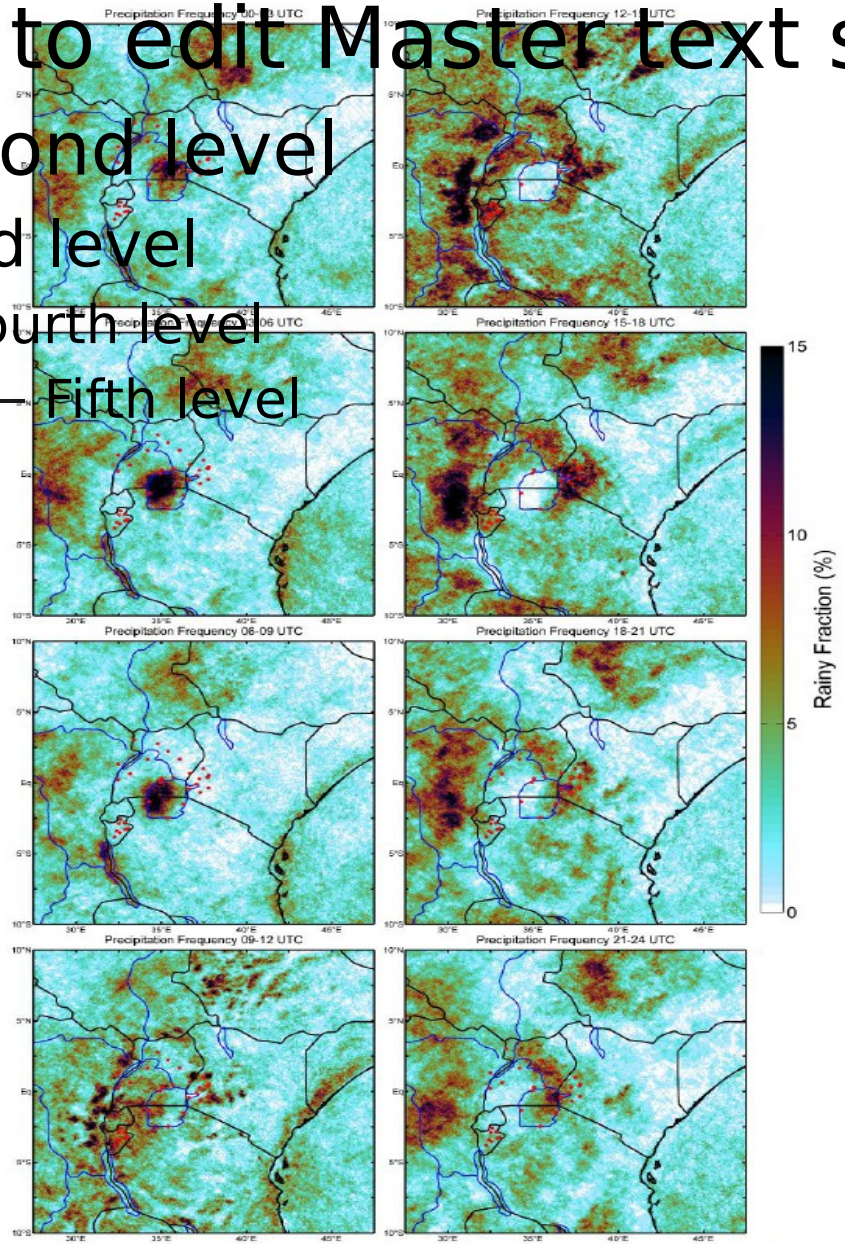
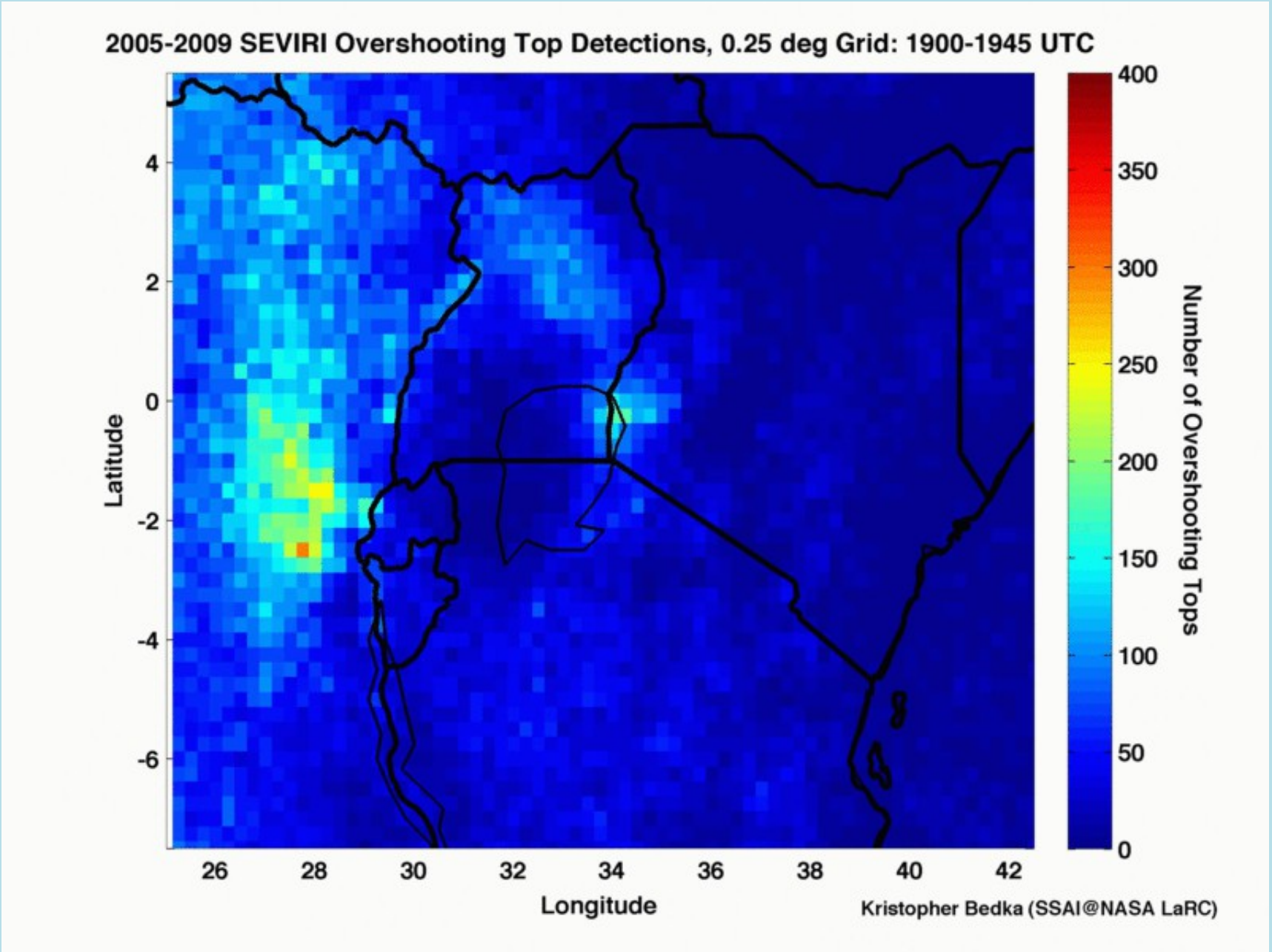
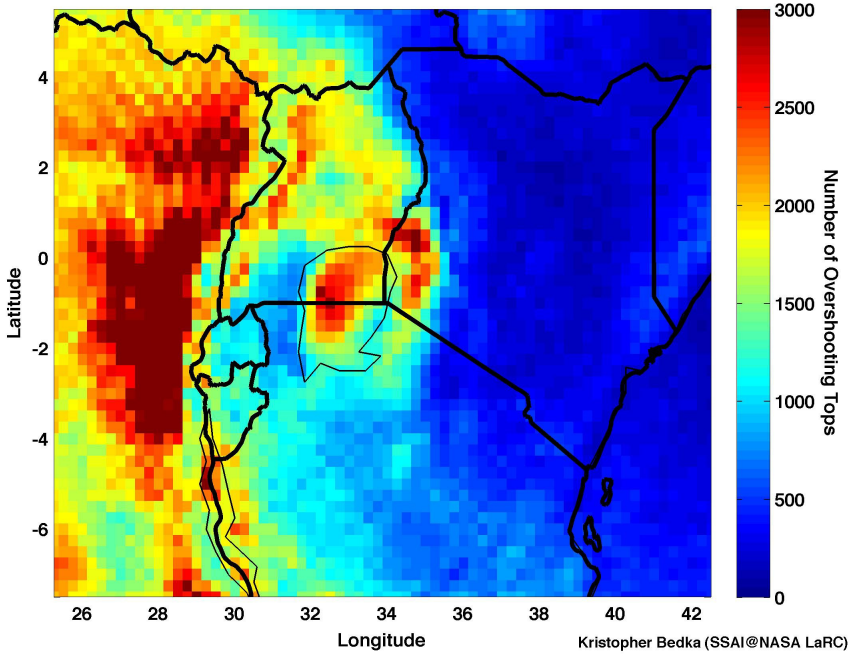


Fig. 1: The distribution of precipitation frequency in three-hour time blocks across the diurnal cycle. The frequency plots are overlaid on a map of the surface observation sites in the East African countries.

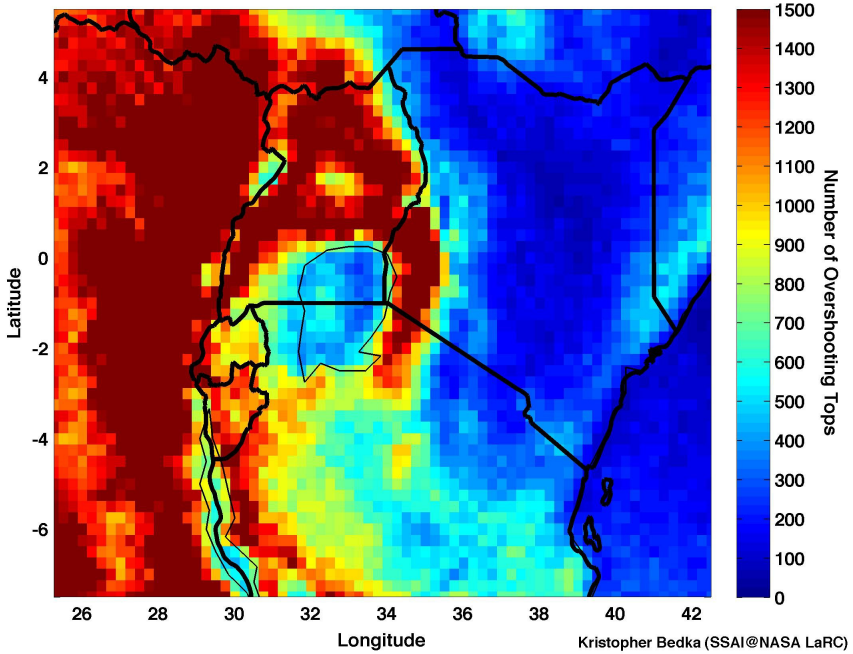
5-Year Overshooting Top Detection Database Using 15-Min SEVIRI Imagery



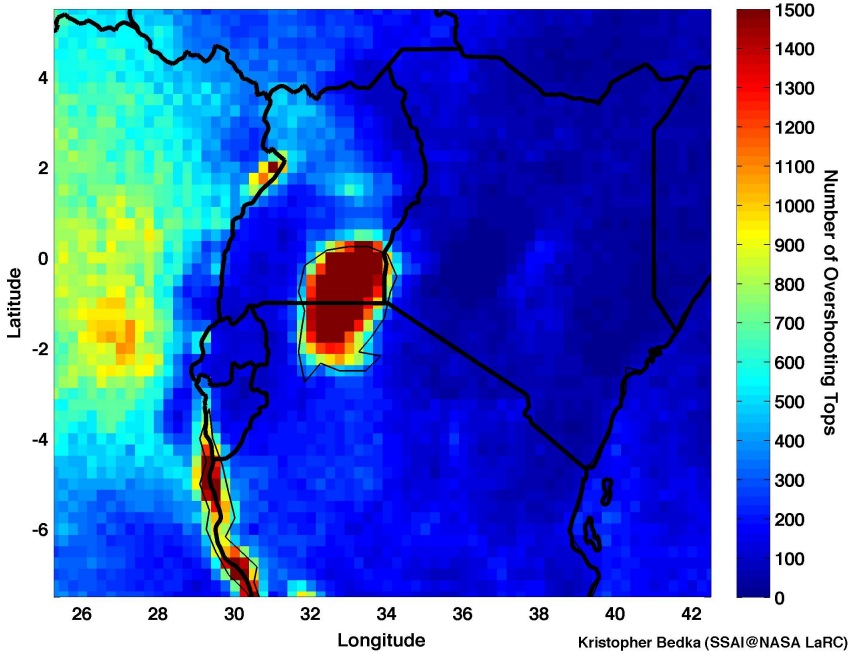
2005-2009 SEVIRI Overshooting Top Detections, 0.25 deg Grid: Total



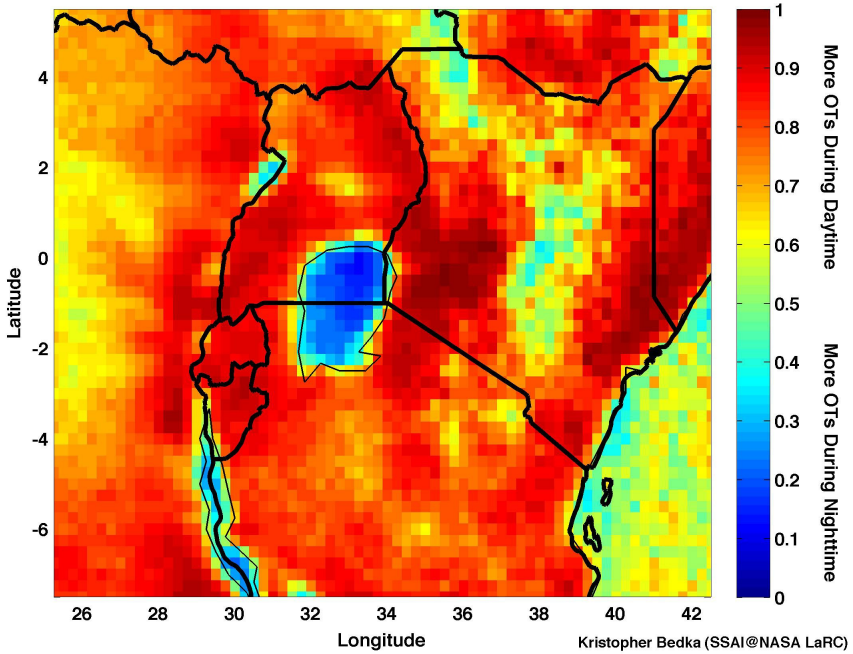
2005-2009 SEVIRI Overshooting Top Detections, 0.25 deg Grid: 9 AM - 9 PM



April-September 2004-2009 Gridded Overshooting Top Detections: 9 PM to 9 AM



2005-2009 SEVIRI Overshooting Top Detections, 0.25 deg Grid: Diurnal Behavior



Night-Time Convection over Lake Victoria

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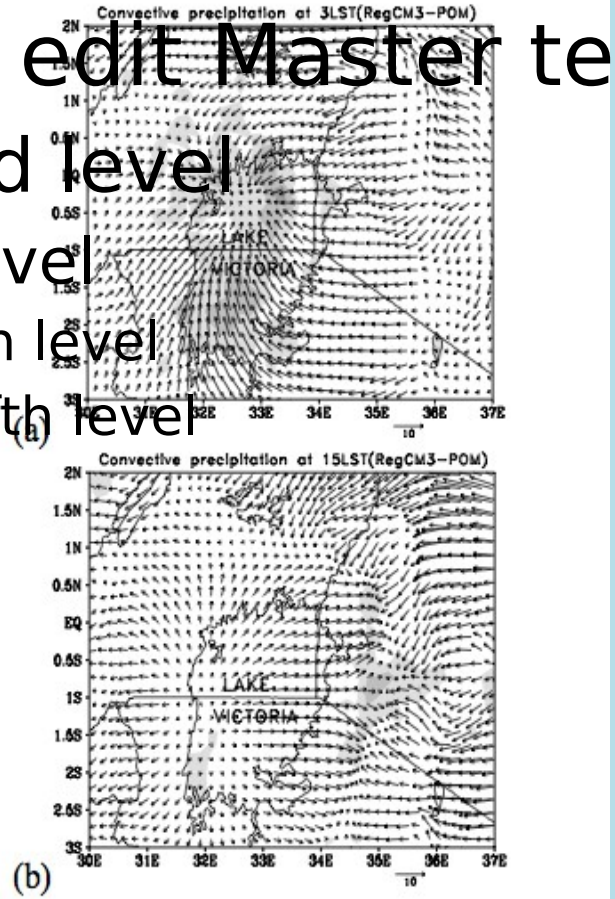
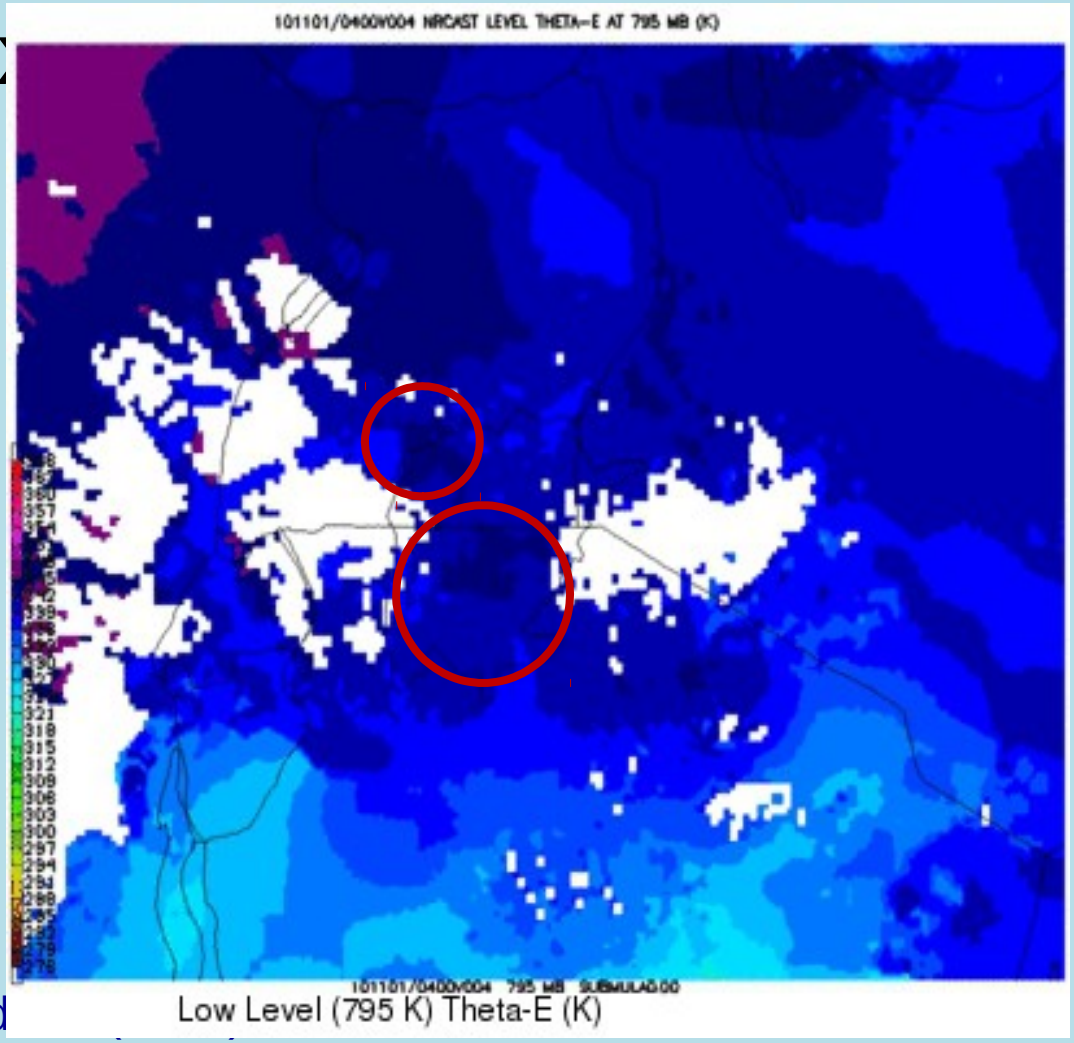
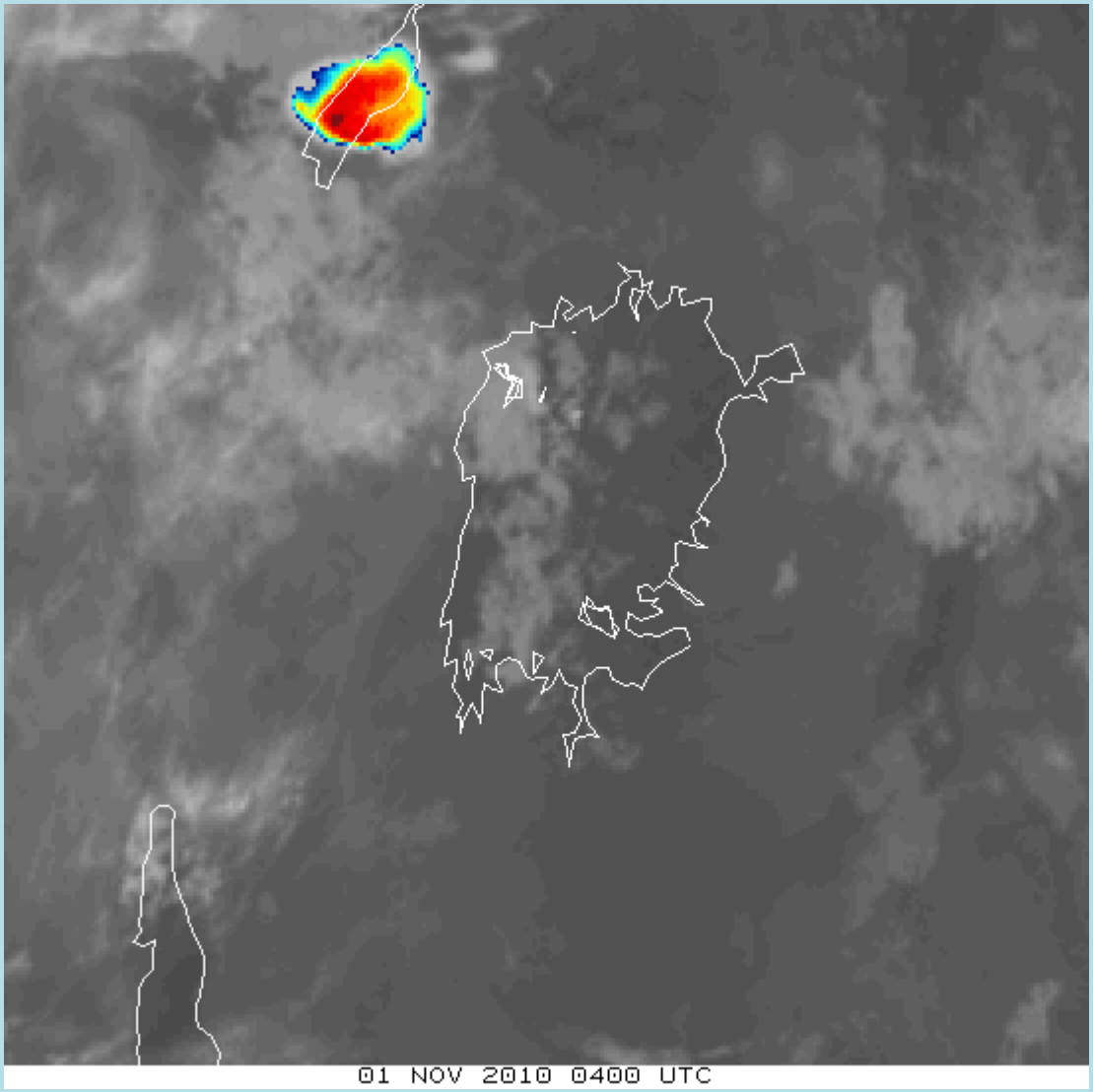


Figure 3: Overlay of 850hPa mean flow on convective precipitation over the Lake Basin (a) 3 LST (b) 15 LST



Low Level (795 K) Theta-E (K)

Anyah, Semazzi and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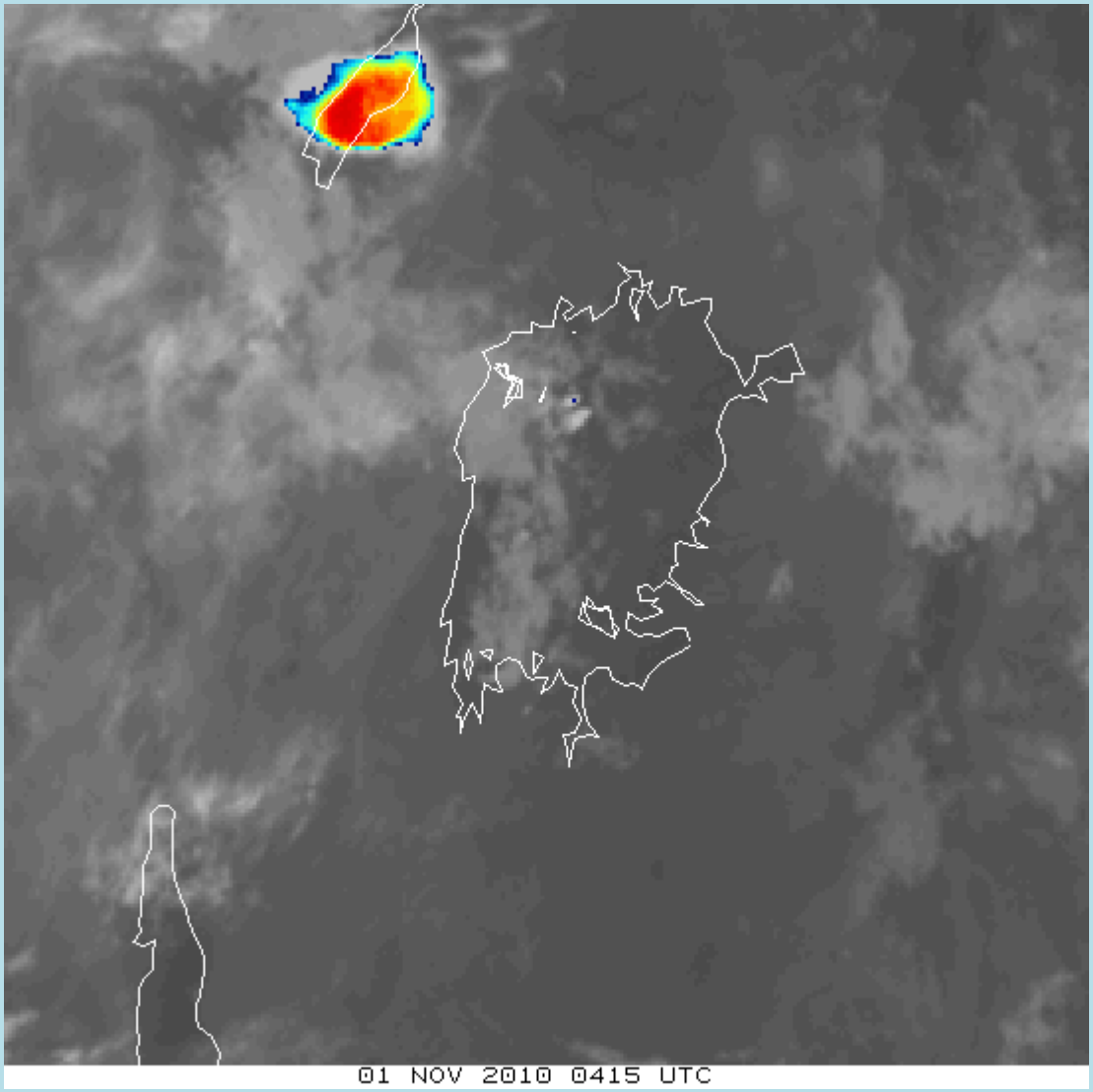
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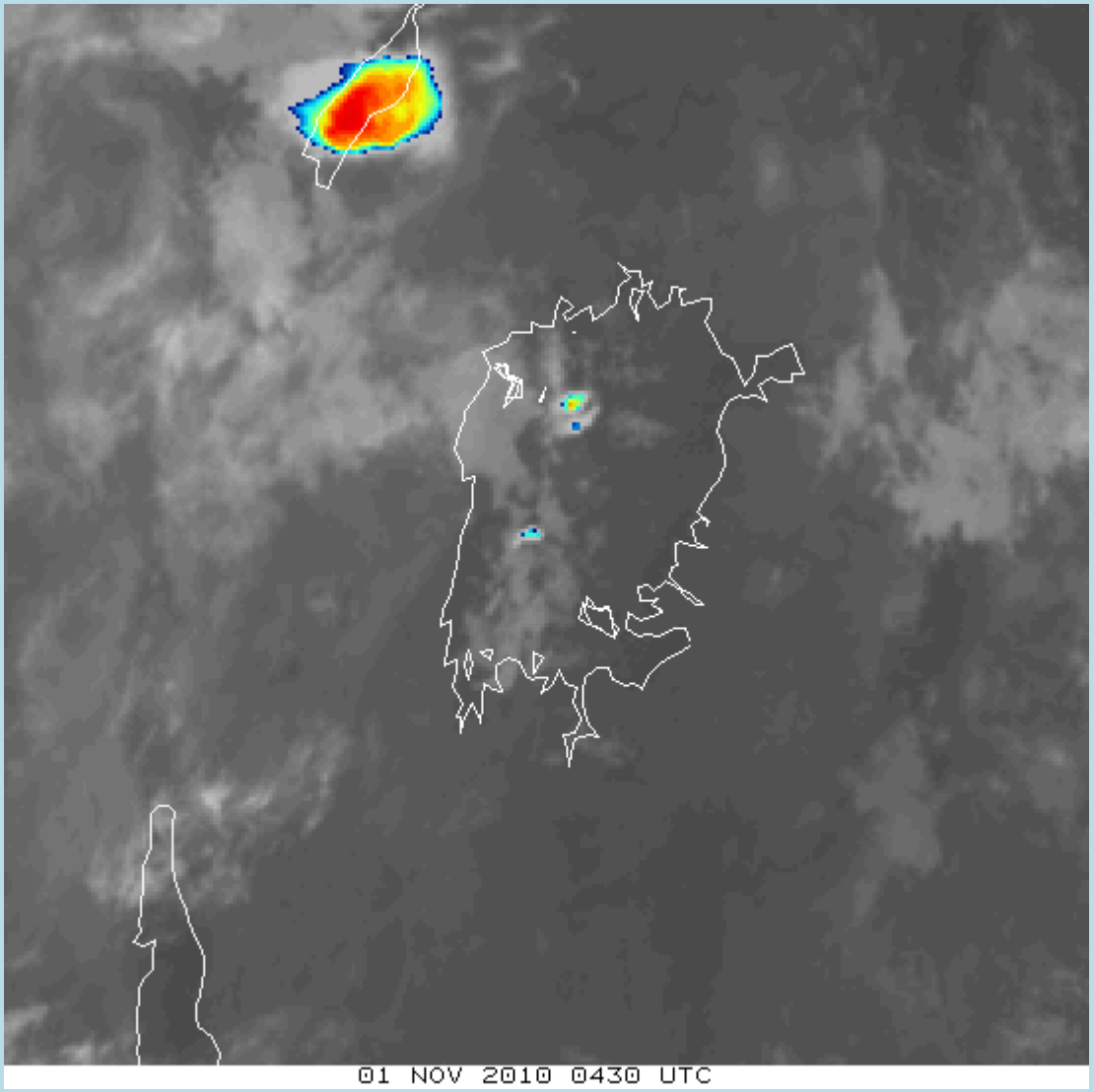
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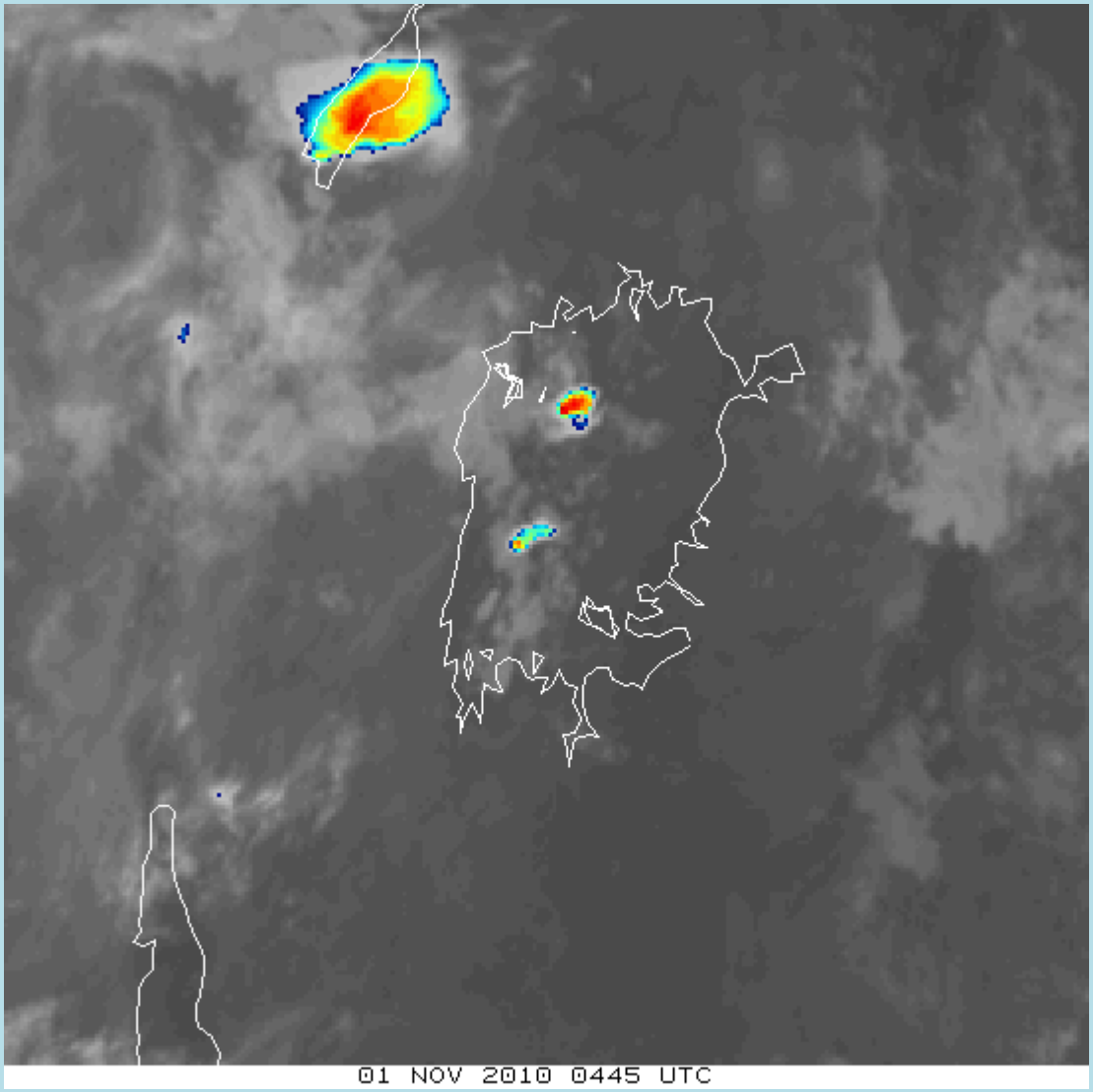
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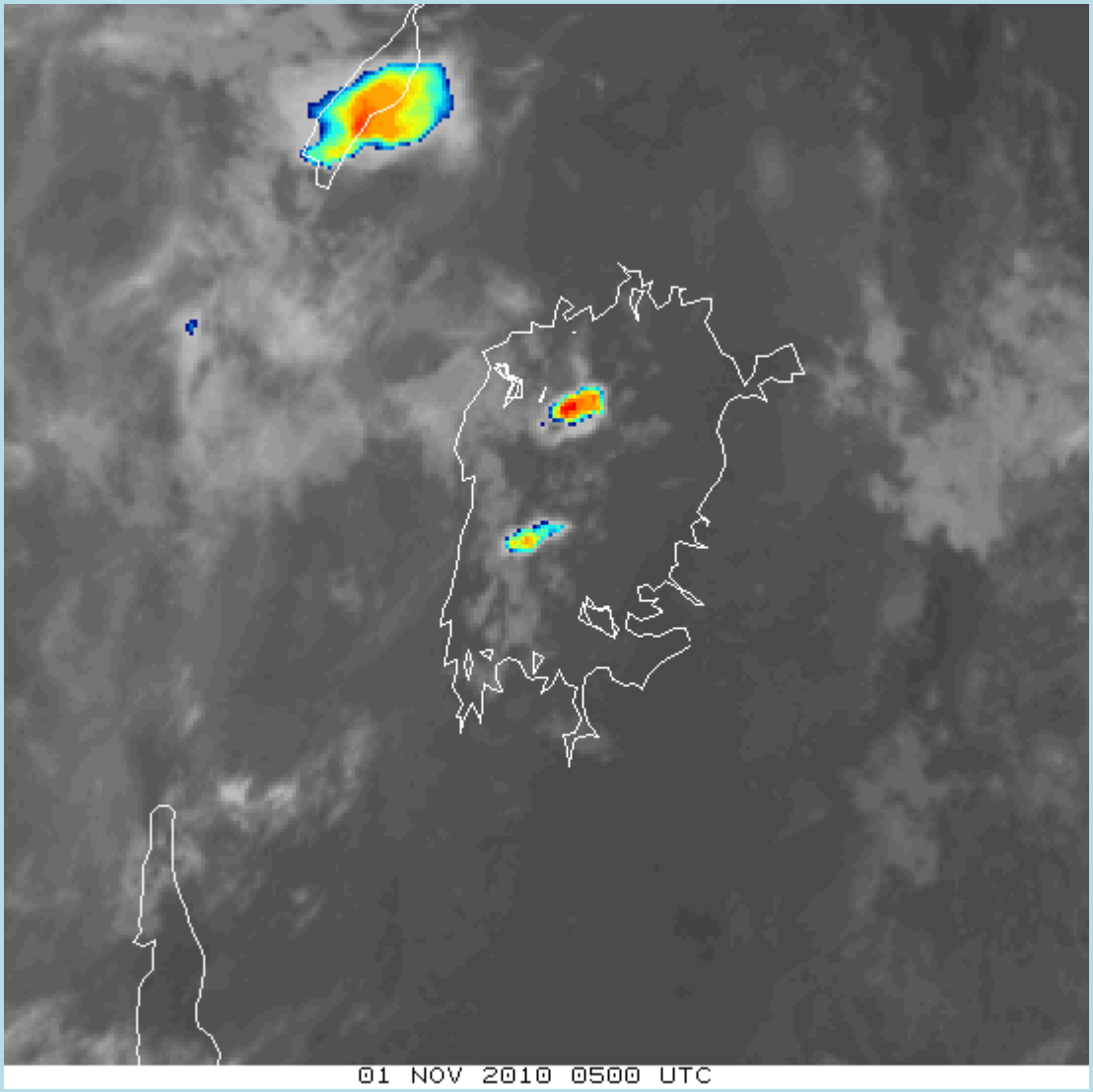
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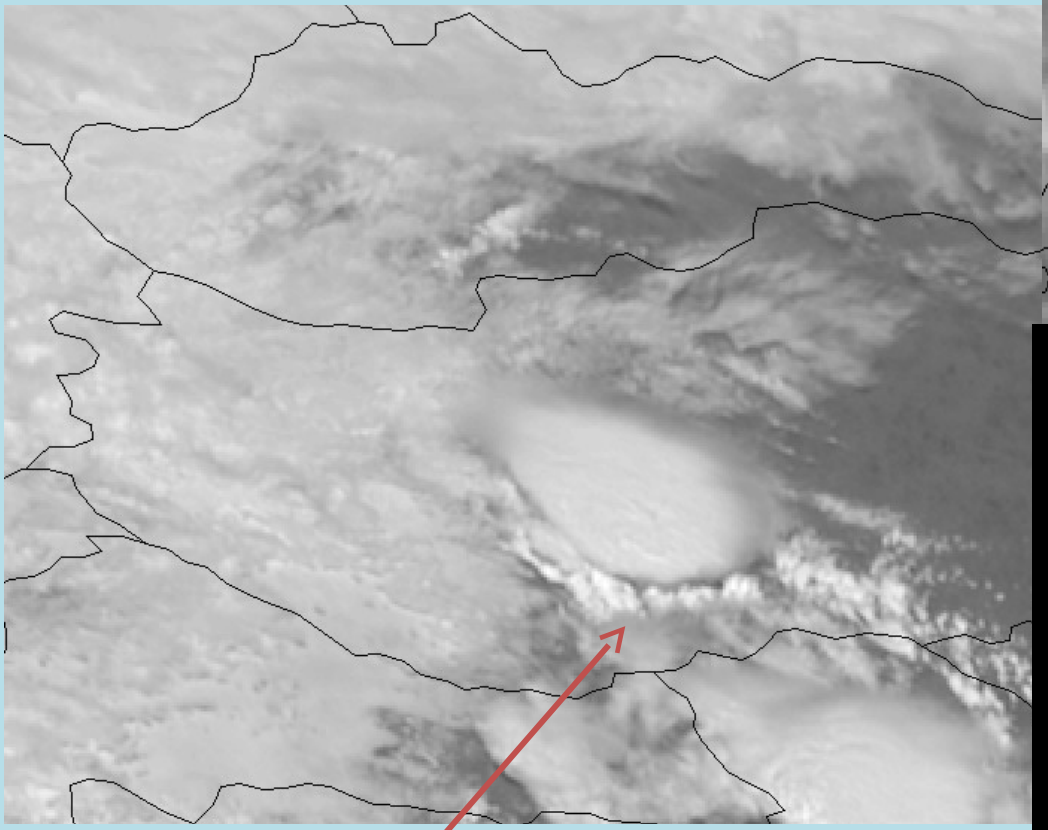
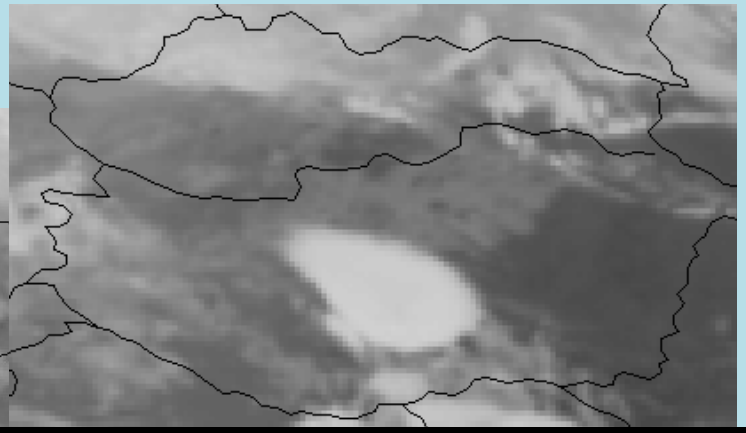
Snapshot HRV 1200 UTC





NEW

Low Level Towering Cu, “Feeding” Cell

Diagnosis Technique

- Right-moving storm
- Well developed cold ring shape (*)
- Long living (> 10 hours)
- Explosive Growth
- Continuous Development of new Cells/Overshooting Tops
- Low level features (Towering Cu, Feeder Clouds)

Interpretation of (atmospheric) findings so far

- Little large scale dynamics present (equatorial). Diurnal behaviour of convection is triggered by local land-lake breeze effect: in day time winds are onshore, during night offshore.
- This circulation interacts with the easterly trade winds: during day, onshore flow converges with trade winds on east side of lake, leading to enhanced convection and precipitation on the eastern shore. On the west side of lake, the flow diverges and convection is reduced.
- During the night, this pattern is reversed. Stronger convective triggering occurs on the western part of the lake.
- Resulting thunderstorms on the lake during the night are small scale and develop explosively => difficult to detect by local fishermen in time to escape them
- Occurence: quite frequent!

NB: This basic picture seems ok, but much is still unknown. In particular, the role of the lake itself other than its effect on lake breeze has not been considered yet!

Elements of an “understanding project”

Routine operations:

- In-situ observations
- Rapid scan satellite d
- Radar??
- Lightning
- UM Africa model (4kr

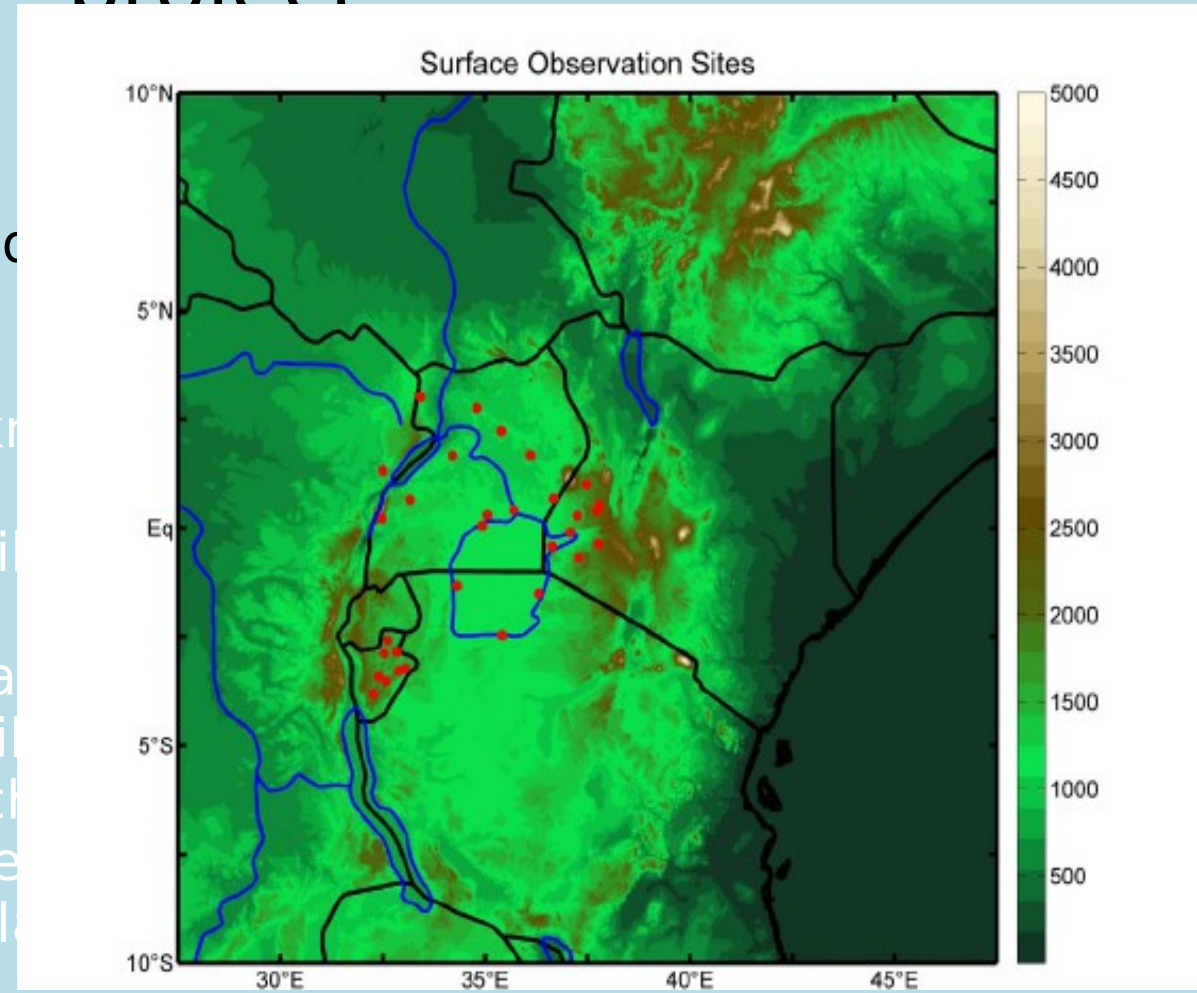
Field campaign:

- Boundary layer profi
  lidar, X-band radar,
  in-situ obs around a

Deeper studies on avail
from obs/model arch

Collect local knowledge
risks/losses on the l

Lake observations and modelling??



Elements of an “understanding project”

Routine operations:

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- Radar??
- Lightning
- UM Africa model (4km?)

Field campaign:

- Boundary layer profiling
  lidar, X-band radar,
  in-situ obs around and
- Deeper studies on availabl
  from obs/model archive
- Collect local knowledge on actua
  risks/losses on the lake

Lake observations and modelling??

Elements of an “understanding project”

Routine operations:

- In-situ observations
- Rapid scan satellite data
- Radar??
- Lightning network
- UM Africa model (4km?)

Deeper studies on available clima
from obs/model archives

Field campaign:

- Boundary layer profiling,
lidar, X-band radar,
in-situ obs around and on lake

Collect/assess local knowledge on actual
risks/losses on the lake

Lake observations and lake modelling??

Needed:

- ✓ Funding:
  - World Bank?
  - Government Norway?
  - …?
  - WMO secretariat is quite optimistic about funding opportunities. What we need is a good plan!

- ✓ Participants in the planning, field campaign and research!!

Questions to lake experts community

- How relevant could lake processes be in this matter? What processes are relevant and should be captured in a research project?
- What observations on the lake would be needed to further our understanding? Which of these are available already?
- What contribution could lake modelling give to our understanding? What kind of lake models (level of complexity) would be useful?
- Interest of lake research community to participate??