Novel conception of short-term earthquake forecast based on Lithosphere-Atmosphere-Ionosphere Coupling (LAIC) model

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1. LAIC model schematic presentation
2. The nature of the thermal anomalies
3. Connection with Global Electric Circuit and Ionosphere
4. Validation scheme
5. Conclusions
Faults activation – permeability changes
Gas discharges including radon emanation
Air ionization by $\alpha$-particles – product of radon decay
Ions hydration – formation of aerosol size particles
Air temperature growth
Latent heat release
Humidity drop
Jet-streams
Air pressure drop
Earthquake clouds formation
Convective ions uplift, charge separation, drift in anomalous EF
Ions hydration – formation of aerosol size particles
Air ionization by $\alpha$-particles – product of radon decay
Faults activation – permeability changes
Gas discharges including radon emanation

Schematic presentation of the LAIC model

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What are criteria to explain the thermal anomalies morphology?

- Mechanism should be connected with the processes of water evaporation and condensation (anomalous latent heat fluxes are observed)
- Extremely high energy effectiveness producing the effects of meteorological scale
- Air humidity drop should be explained
- The process is very dynamic in space and time
- Does not depend on land or ocean epicenter position
Anomalous latent heat flux

Kashmir, 08 Oct. 2005 M 7.6

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<table>
<thead>
<tr>
<th>Param</th>
<th>Magnitude</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_Q$</td>
<td>$4.3 \times 10^{18} \text{ J} - 5.5 \times 10^{17} \text{ J}$</td>
<td>M ~ 9.3 earthquake, and 8.7, respectively</td>
</tr>
<tr>
<td>$E_{\text{LH}}$</td>
<td>$3.1 \times 10^{19} - 8 \times 10^{18} \text{ J}$</td>
<td>Latent heat anomalies of ~ 80 Wm$^{-2}$ persisting for 5 days, over six, 200 km x 200 km grids; and ~ 100 Wm$^{-2}$ persisting for 10 days, over nine, 200 km x 200 km grids, respectively for the 8.7 and 9.3 associated anomalies, respectively</td>
</tr>
<tr>
<td>$E_{\text{TS}}$</td>
<td>$&lt; 1.5 \times 10^{17} - 5 \times 10^{17} \text{ J}$</td>
<td>KE of tsunami for 30-100 km$^3$ displaced water (probably an upper limit)</td>
</tr>
<tr>
<td>$E_M$</td>
<td>$&lt; 5 \times 10^{19} \text{ J}$</td>
<td>From yield strength &amp; molecular binding forces involved in rupture of land</td>
</tr>
<tr>
<td>$\delta E_R$</td>
<td>$6 \times 10^{18} \text{ J}$</td>
<td>From change of rotational energy of the Earth</td>
</tr>
</tbody>
</table>

Kafatos et al., 2007
Humidity drop

Colima, Mexico
21 Jan 2003

Kashmir, Pakistan
08 Oct 2005

Wenchuan, China
12 May 2008

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Genzano et al., 2007

Gujarat, India
26 Jan 2001
OLR in open ocean (Tonga island 2008-2009)

M7.1- 19 Oct, 2008;  
1-4 Oct 2008

M6.3 – 22 Oct, 2008;  
5-8 Oct 2008

M7.9 19 Mar.2009  
1-18 Mar 2009
What can produce meteorological effects?

Svensmark, 1998

Fig. 1. Variation of low-altitude cloud cover, cosmic rays, and total solar irradiance between 1984 and 1994. The cosmic ray intensity is from Huancazo observatory, Hawaii. [Adapted from (4)].
What processes connected with ionization and condensation can produce thermal anomalies?

Latent heat

Positive small ion
Mobility 1.4 cm²/Vs

Negative small ion
Mobility 1.9 cm²/Vs

Approx 1 μs

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Radiative pollution – emergencies at Three-Mile island (1979) and Chernobyl (1986) atomic electric power plants.
**Tectonic faults - the channels of gas migration**

Volume radon activity along the pass crossing the tectonic fault.

Spivak, 2008

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What particle size we observe before earthquakes?
Final selection

1. Tectonic heat flow
2. Thermal waters
3. Greenhouse gases
4. Positive holes
5. Ionization by radon as one of the degassing components

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Validation: false alarms – support for our model and mechanism selection

Spivak, 2008  Tides and radon emanation

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– confirmation of their seismo-electric nature

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What about ionosphere?

$M=7.3$, New Guinea Islands, $\Delta f_0 F_2$
16.07.1980, Intercosmos-19

M9.3 Sumatra, electron temperature
26.12.2004, DMSP satellite
Global electric circuit and EM coupling with the ionosphere

The Global Electric Circuit

Voltage gradient from surface to ionosphere:

200,000 – 500,000 V or 100-140 V/m

Fair weather current return:

1,000-1,500 A or 3 x 10^{-12} A m^{-2}
Increased conductivity

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2 hours after the seismic shock

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Technology testing areas

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Conclusions

- Further LAIC model perfection to obtain quantitative correspondence, inclusion of new elements (jet streams, etc.)
- Intensification of the field works to “catch” the key factors of atmospheric chemistry, atmospheric electricity and atmospheric thermodynamics
- Real-time validation – the next step of technology development
- After real-time validation (in case of success) it could be distributed for practical application in short-term earthquake prediction