ANNEX C

NATIONAL REPORTS AVAILABLE TO THE MEETING

Argentina  
Armenia  
Australia  
Azerbaijan  
Belarus  
Belgium  
Burkina Faso  
Cambodia  
Canada  
Chile  
China  
Colombia  
Comoros  
Cook Islands  
Cote d'Ivoire  
Cuba  
Czech Republic  
Democratic Republic of Congo  
Denmark  
Egypt  
Estonia  
European Union  
Finland  
Gambia  
Germany  
Indonesia  
Iraq  
Japan  
Kenya  
Kyrgyzstan  
Madagascar  
Nepal  
Netherlands  
Norway  
Poland  
Republic of Kazakhstan  
Russian Federation  
Samoa  
South Africa  
Sweden  
Switzerland  
Togo  
Turkey  
Turkmenistan  
United Kingdom  
United States  
Uzbekistan  
Vietnam  
Zimbabwe
ARGENTINA - National Report


The frequent overpass of the Antarctic Ozone Hole each spring, the extreme UV radiation levels over the northwestern Andean Plateau and their effects put the territory of the Argentine Republic at a strategic situation for atmospheric ozone and solar UV radiation studies. Major issues related to the accomplishment of the 7th ORM recommendations during the period 2008-2011 are:

- Research within Argentine institutions in these subjects is at present significant. There is a strong political decision to sustain the investigations, as many of the research projects are economically supported directly by the Argentine State. Argentine private institutions participate also with increasing interest and support in these research fields.

- Support for collaboration with international projects was also strengthened with both logistic and scientific support, including monitoring and modeling of ozone, UV radiation and related parameters along the National territory and principally in the Argentine Antarctic stations.

- The Regional Calibration Center at the Argentine National Weather Service accomplished the scheduled tasks with the 2010 intercomparisons of South-American Dobson instruments, UV-Biometers and surface ozone instruments.

- New sophisticated equipment has been incorporated by several Argentine institutions (e.g. spectroradiometers), including instrumentation developed in Argentina (e.g. LIDAR).

- The efforts to maintain the monitoring networks are being fruitful. Several databases are reaching an extension of decades, allowing for an estimation of the climatological behavior of measured parameters.

- Satellite databases have been often used in many studies over the region.

- Data for international archiving are being sent currently to the corresponding databases.

- The extent of the springtime Antarctic Ozone Hole each year is still very significant and concerning for the region. Its pass over the continent several times within the period 2008-2011 emphasizes the need to closely follow its monitoring and study.

- The prevention of sunburning-related skin diseases and skin cancer for the population is taken as a subject of Public Health with annual diffusion campaigns. In November 2010, the Argentine Dermatological Society carried out the XVII National Campaign for the prevention of the skin cancer.

- There is an increasing trend to study the ozone-climate interactions within the frame of the Global Climate Change.

The present report is an update of the activities in Argentina and spans the period 2008-2011.

1. MONITORING

The following are the detailed measurement activities at the principal monitoring institutions and its contact address:
- Argentine National Weather Service (SMN)

Contact: MSc. Gerardo Carbajal Benítez
Servicio Meteorológico Nacional. Av. de los Constituyentes 3454, C1427BLS, Ciudad Autónoma de Buenos Aires. Phone: 54-11-51676767 int. 18306. Email: gcarbajal@smn.gov.ar.

<table>
<thead>
<tr>
<th>Station</th>
<th>Location</th>
<th>Total O₃ Column</th>
<th>Surface O₃</th>
<th>Vertical O₃ Profile</th>
<th>Broadband Surface UV irradiance</th>
</tr>
</thead>
<tbody>
<tr>
<td>La Quiaca</td>
<td>22.11ºS, 65.57ºW, 3459m. a.s.l.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Pilar</td>
<td>31.66ºS, 63.88ºW, 338 m. a.s.l.</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mendoza</td>
<td>32.88ºS, 68.87ºW, 704m. a.s.l.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rosario</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>34.61ºS, 58.41ºW, 25m. a.s.l.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Comodoro Rivadavia</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>San Julián</td>
<td>49.32ºS, 67.75ºW, 62m. a.s.l.</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ushuaia</td>
<td>54.80ºS, 68.27ºW, 14m. a.s.l.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Marambio</td>
<td>64.23ºS, 56.72ºW, 300m. a.s.l.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

SMN is the WMO South-American Regional Calibration Center for Dobson Spectrophotometers and for UV-Biometers.

Projects in collaboration with: World Meteorological Organization, Finnish Meteorological Institute, Instituto Nacional de Meteorología (INM, Spain), Instituto Nacional de Tecnología Aeroespacial (INTA, Spain), Argentine Antarctic Institute.

- Argentine Antarctic Institute

Contact: Ing. Eduardo Calviño, Téc. Héctor A. Ochoa

<table>
<thead>
<tr>
<th>Station</th>
<th>Location</th>
<th>Total O₃ Column</th>
<th>Surface O₃</th>
<th>NO₂ (DOAS)</th>
<th>O₃ Profile</th>
<th>UV</th>
<th>LIDAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marambio</td>
<td>64.23ºS, 56.72ºW, 300m. a.s.l.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>San Martin</td>
<td>68.13ºS, 67.13ºW, 40m. a.s.l.</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgrano II</td>
<td>77.86ºS, 34.62ºW, 250m. a.s.l.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Projects in collaboration with: Servicio Meteorológico Nacional (Argentina), Instituto de Física Atmosférica de Roma (IFAR, Italia), Instituto Nacional de Técnica Aeroespacial (INTA, España), el Instituto Nacional de Meteorología (INM, España), Instituto Meteorológico Finlandés (IMF, Finlandia), Observatorio Solar y de Ozono del Instituto Hidrometeorológico de la República Checa.
### Argentine National Institute of Genetics and Molecular Biology (INGEBI) - Capital Federal

**Contact:** Ing. Susana B. Diaz
**Instituto de Investigaciones en Ingeniería Genética y Biología Molecular (INGEBI). Obligado 2490, Capital Federal, Argentina. Phone: 54-11-47832871 int. 14. Email: rqdiaz@criba.edu.ar.

<table>
<thead>
<tr>
<th>Station</th>
<th>Location</th>
<th>Instrument (Narrowband UV and PAR surface irradiances)</th>
<th>Last Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Salvador de Jujuy</td>
<td>24.17°S, 65.02°W, 1300m. a.s.l.</td>
<td>GUV-511</td>
<td>Next April 2011</td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>34.58°S, 58.47°W, Sea level</td>
<td>GUV-511</td>
<td>2011</td>
</tr>
<tr>
<td>San Carlos de Bariloche</td>
<td>41.01°S, 71.42°W, 700 m. a.s.l.</td>
<td>GUV-511</td>
<td>2011</td>
</tr>
<tr>
<td>Trelew</td>
<td>43.25°S, 65.31°W, Sea level</td>
<td>GUV-511</td>
<td>2011</td>
</tr>
<tr>
<td>Ushuaia</td>
<td>54.83°S, 68.30°W, Sea level</td>
<td>GUV-511</td>
<td>Next Oct. 2011</td>
</tr>
</tbody>
</table>

Projects in collaboration with: National Science Foundation (NSF, USA), Centro Austral de Investigaciones Científicas (CADIC, Argentina), Dirección Nacional de Antártico (DNA, Argentina) y Dirección Nacional de Meteorología (INM, Spain), Instituto Nacional de Tecnología Aeroespacial (INTA, Spain), Programa Nacional para Investigaciones Antárticas (PNRA, Italy).

### Austral Center for Scientific Research (CADIC) - Tierra del Fuego

**Contact:** Ing. Susana B. Diaz
**Instituto de Investigaciones en Ingeniería Genética y Biología Molecular (INGEBI). Obligado 2490, Capital Federal, Argentina. Phone: 54-11-47832871 int. 14. Email: rqdiaz@criba.edu.ar.

<table>
<thead>
<tr>
<th>Station</th>
<th>Location</th>
<th>Measured Parameters</th>
<th>Instrument</th>
<th>Last Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ushuaia</td>
<td>54.83°S, 68.30°W, Sea level</td>
<td>Spectral solar irradiance (range: 280-620 nm)</td>
<td>SUV-100 spectroradiometer</td>
<td>2008 (every 15 days with secondary lamps)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total O$_3$ Column, NO$_x$</td>
<td>EVA 4</td>
<td>2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Narrowband UV and PAR solar irradiance</td>
<td>GUV-511</td>
<td>2008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Narrowband UV and PAR solar irradiance</td>
<td>NILU-UV</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total O$_3$ Column Spectral solar irradiance (range: 280-325 nm)</td>
<td>Brewer MKIV spectroradiometer</td>
<td>2010</td>
</tr>
</tbody>
</table>

Projects in collaboration with: National Science Foundation (NSF, USA), Instituto de Investigaciones en Ingeniería Genética y Biología Molecular (INGEBI, Argentina), Dirección Nacional de Antártico (DNA, Argentina) y Dirección Nacional de Meteorología (INM, Spain), Instituto Nacional de Tecnología Aeroespacial (INTA, Spain), Programa Nacional para Investigaciones Antárticas (PNRA, Italy).
- Photo-Biological Station “Playa Union” - Chubut

Contact: Dr. Walter Helbling

Estación de Fotobiología Playa Unión. Casilla de Correos N°15 (9103). Rawson, Chubut, Argentina. Phone: 54-2965-498019. Email: whelbling@efpu.org.ar, efpu@efpu.org.ar

<table>
<thead>
<tr>
<th>Station</th>
<th>Location</th>
<th>Measured Parameters</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Playa Union</td>
<td>43.30°S, 65.03°W, 10m. a.s.l.</td>
<td>Surface broadband UVB, UVA and PAR solar irradiance</td>
<td>ELDONET surface spectrometer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resolution: 1nm. Range: 190-1100 nm</td>
<td>Ocean Optics spectroradiometer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Underwater broadband UVB, UVA and PAR solar irradiance</td>
<td>ELDONET submersible spectrometer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Underwater solar irradiance</td>
<td>Ocean Optics submersible radiometer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Weather station</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Laboratory equipment for biological-sample analysis</td>
<td></td>
</tr>
</tbody>
</table>

Projects in collaboration with: Universidad de Concepción (Chile), Universidade de Sao Paulo, Fundação Universidade Federal do Rio Grande e Instituto Nacional de Pesquisas Espaciais (Brasil), CONICET, Estación de Fotobiología Playa Unión, Instituto Nacional de Investigación y Desarrollo Pesquero (Argentina), University of South Florida (USA), Centro de Procesamiento de Imágenes y Fundación La Salle (Venezuela), Interamerican Institute for Global Change Research (IAI), National Natural Science Foundation of China.

- Center for Laser Research and its Applications, CEILAP (CITEDEF-CONICET)

Contact: Dr. Eduardo J. Quel

CEILAP, Juan B. de La Salle 4397. B1603ALO - Villa Martelli, Buenos Aires. Argentina. Phone: 54-11-4709-8217. E-mail: equel@citefa.gov.ar

<table>
<thead>
<tr>
<th>Station</th>
<th>Location</th>
<th>Instrument Measurement</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rio Gallegos</td>
<td>51.60°S, 69.32°W, 15m. a.s.l.</td>
<td>DIAL LIDAR: Ozone profile between 15-45 km</td>
<td>CEILAP/Argentina</td>
</tr>
<tr>
<td></td>
<td></td>
<td>YES UVB-1: UV erythemal irradiance</td>
<td>CEILAP/Argentina</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SAOZ UV-Vis. Spectrometer: Ozone and NO2 total column</td>
<td>SAOZ Network/France</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pyranometer: Total solar radiation</td>
<td>CEILAP/Argentina</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GUV 541: Spectral bands at 305, 313, 320, 340 and 380 nm</td>
<td>CEILAP/Argentina</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brewer Spectrophotometer S/N 124: Total ozone, NO2 a nd spectral UV every 0.5 nm</td>
<td>INPE/Brasil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Milimetric waves radiometer: Upper stratospheric-mesospheric ozone profiles between 35 and 80 km</td>
<td>Nagoya University/Japan</td>
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</tbody>
</table>

Projects in collaboration with: Network for the Detection of Atmospheric Composition Change (NDACC/NOAA), Laboratorio de Ozono y Radiación Ultravioleta de la Universidad de Magallanes, Punta Arenas - Chile, Japan International Cooperation Agency.
- Institute of Physics of Rosario

Contact: Dr. Rubén Piacentini
Grupo de Radiación Solar – IFIR (CONICET/UNR). 27 de febrero 210bis, 2000, Rosario. Argentina. Phone: 54-341-4472824 int. 30. E-mail: ruben.piacentini@gmail.com

<table>
<thead>
<tr>
<th>Station</th>
<th>Location</th>
<th>Measured Parameters</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosario</td>
<td>32.96ºS, 60.62ºW, 25m. a.s.l.</td>
<td>UV erythemal irradiance</td>
<td>YES UVB-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total solar irradiance</td>
<td>Kipp &amp; Zonen CM5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Broadband Total UV</td>
<td>Kahl TUVR</td>
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<tr>
<td></td>
<td></td>
<td>Broadband UVB</td>
<td>EKO UVB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Broadband UVA</td>
<td>EKO UVA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface air quality</td>
<td>CO, NOx and O₃</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface aerosols size</td>
<td>0.25-30 μm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Portable single monocromator spectroradiometer with optical fiber</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Automatic weather station</td>
<td></td>
</tr>
</tbody>
</table>

Projects in collaboration with: CEILAP (Argentina), Universidad Federal de Pernambuco (Brasil), Japan International Cooperation Agency.

- Institute for Physical-Chemical Investigations – National University of Córdoba

Contact: Dra. Beatriz M. Toselli
Departamento de Físico Química – INFIQC. Facultad de Ciencias Químicas, Universidad Nacional de Córdoba. Ciudad Universitaria, 5000 Córdoba. Argentina. Email: tosellib@fcq.unc.edu.ar

<table>
<thead>
<tr>
<th>Station</th>
<th>Location</th>
<th>Measured Parameters</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Córdoba</td>
<td>31.40ºS, 64.18ºW, 470m. a.s.l.</td>
<td>UV erythemal irradiance</td>
<td>YES UVB-1 (2)</td>
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<tr>
<td></td>
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<td>Total solar irradiance</td>
<td>YES TSP-700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spectroradiometer</td>
<td>Ocean Optics USB-4000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aerosols with size &lt;10 μm and &lt;2.5 μm</td>
<td>SKC Deployable particulate sampler</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aerosols size distribution</td>
<td>SIOUTAS-SKC</td>
</tr>
</tbody>
</table>

- Institute of Ecology “Fundación Miguel Lillo” - Tucumán

Contact: Dr. Juan A. González, Dr. Fernando Eduardo Prado
Instituto de Ecología - Fundacion Miguel Lillo. Miguel Lillo 251, 4000, Tucumán, Argentina. E-mail: lirios@cgcet.org.ar, fepra@csnat.unt.edu.ar

<table>
<thead>
<tr>
<th>Location</th>
<th>Measured Parameters</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Miguel de</td>
<td>26.83ºS, 65.22ºW, 400m. a.s.l.</td>
<td>UVB irradiance</td>
</tr>
</tbody>
</table>
Projects in collaboration with: other Argentine institutions.

- Institute of the Bio-diversity and the Environment (INIBIOMA) - Rio Negro

**Contact:** Dra. María Gabriela Perotti, Dra. María C. Diéguez, Dra. A. Patricia Pérez
INIBIOMA-Centro regional Universitario Bariloche. Universidad Nacional del Comahue. Quintral 1250, 8400 Bariloche, Argentina. Phone: 54-2944-428505. Email: perottigaby@yahoo.com, dieguezmc@gmail.com, perezfotolab@gmail.com

<table>
<thead>
<tr>
<th>Location</th>
<th>Measured Parameters</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Carlos de Bariloche</td>
<td>Narrowband UV channels</td>
<td>GUV 500</td>
</tr>
<tr>
<td></td>
<td>Underwater broadband UV irradiance</td>
<td>Ocean Optics submersible spectrometer</td>
</tr>
</tbody>
</table>

During 2011 a new equipment will be installed:
- Automatic weather station
- $\text{CO}_2$ monitoring instrument
- Aerosols monitoring instrument
- Atmospheric Mercury monitoring instrument

Projects in collaboration with: other Argentine institutions, BBVA Foundation (Spain), European Union Program “Global mercury observation system”.

2. REGIONAL CALIBRATION ACTIVITIES

Three calibration activities of the South-American WMO Network instruments have taken place during 2010 at the Regional Calibration Center for South America - Buenos Aires Central Station of the Argentine National Weather Service. In September 2010 it was developed the IV Regional Intercomparison of surface ozone measurement instruments. In November 2010 it were realized the calibrations of both the Dobson ozone spectrometers and the UV erythemal solar irradiance instruments (UV-Biometers).

The World Meteorological Organization (WMO) Secretariat and the Argentine National Weather Service with close cooperation and assistance of the USA National Oceanic and Atmospheric Administration’s Climate Monitoring and Diagnostics Laboratory (NOAA/CMDL) coordinate Dobson calibrations.

The World Meteorological Organization (WMO) Secretariat and the Argentine National Weather Service with close cooperation and assistance of the Physikalisch-Meteorologisches Observatorium Davos, World Radiation Center, coordinate UV-Biometers calibration. The Solar Light 501A reference radiometer from PMOD/WRC was used as reference instrument for this intercomparison.

3. THEORY AND MODELING

- Program for the Study of Atmospheric Processes Related to the Global Change (PEPACG UCA/CONICET) – Capital Federal

**Contact:** Dr. Pablo O. Canziani
PEPACG is the principal research Group where modeling of the physical-chemical properties of the atmosphere, as well as climatological studies of the coupled troposphere-stratosphere system are carried out. Particularly, PEPACG study the dynamics and climatology of the coupled system Troposphere-Stratosphere over the Southern Hemisphere, included the ozone layer and solar UV radiation. PEPACG is cooperating with University of Reading (U.K.) in the development and application of an adaptive grid Chemistry Transport Model, called Adaptive Mesh Refinement or AMR-CTM, which is currently a 2-D model whose resolution adapts locally in order to better solve the evolving stratospheric features. Also included in this work is an interaction with Max-Planck Institut fur Atmospheric Chemie, University of Mainz, in order to install in the AMR-CTM the MECCA-MESSY Chemistry module. Work includes the development of a 2-D and 3-D trajectory code. Areas of study in the period 2008-2011 included: - Dynamic Climatology of the Tropopause over Argentina. - Sudden climate perturbations in the Southern Hemisphere’s troposphere and stratosphere. - Cirrus, Tropopause and interchanges troposphere-stratosphere over Argentina.

Modeling of UV radiative transfer in the atmosphere is still limited to 1-D codes using principally the Discrete Ordinates algorithm with semi-spherical correction in the direct component, which is useful for cases of homogeneous-layers composition of the atmosphere.

4. DISSEMINATION OF RESULTS

Data Reporting

The SMN sends total ozone measurements as well as the ozonesonde data routinely to the WOUDC. The database is currently being transformed to the required CSV format. Surface ozone retrievals are submitted to the corresponding center in Japan.

Information to the public

The SMN continues providing a daily national UV Index forecast map for clear and cloudy conditions both in its web page (http://www.smn.gov.ar) as well as to the massive diffusion media. All mentioned institutions often provide information to the media. During the ozone hole season SMN, CADIC and PEPACG send to the media frequent reports describing the ozone hole evolution, using satellite retrievals and ground-based information.

In turn, over 50 plenary conferences within congress and other open to the public were given in the different specialties in the period 2008-2011.

Each November, the Argentine Dermatological Society carries out the National Campaign for prevention of the skin cancer.
5. HIGHLIGHTED RESULTS 2008-2011

- Austral Spring Stratospheric and Tropospheric Circulation Interannual Variability [Agosta and Canziani, 2010]

Figure 2: a) October mean TOC 1979-2005 climatology (contours interval: 5DU). Composite residual TOC maps for upper (b) and lower (c) VarMax index quartiles (contour interval 10DU).

- Increased UV radiation at Southern Sub-polar Latitudes in the period 1997–2005 [Pazmiño et al., 2008]

Fig. 6. (1) Number of vortex occurrences (VO), (2) TOC differences and (3) UVI changes for September (a), October (b) and November (c) months over the 1997–2005 period. Latitude band 50°S–60°S is emphasized. Only data corresponding to reflectivity values lower than 27.5%, 22.5% and 12.5%, respectively, are considered.
- Small total O3 columns and high UV radiation over the southern tip of South America during the 2009 Antarctic O3 hole season [de Laat et al., 2010]

Figure 3. Time series of daily average (left) UVI values and (right) MSR total O3 columns (in DU) for the period 1 September – 1 January. The shaded areas indicate the occurrence intervals of total O3 columns and UVI values for 1979–2008 for the latitude band 52°–56°S. Occurrence intervals are calculated on a daily basis, and intervals are shown for 66%, 95% and 99% as well as the minimum and maximum MSR values. The numbers indicate the percentage of total O3 columns or UVI values that fall within this range. The red/yellow bars represent the 2009 values for the area 52°–56° S, 77°–65° W (see Figures 1 and 2). Mean values are indicated by the black dots, the 2σ root-mean-square of O3 and UVI values within the area are shown by the yellow bars, and the minimum and maximum range within the area are indicated by the red bars.

- UVR exposure for biological systems along a latitudinal gradient [Vernet et al., 2009]

<table>
<thead>
<tr>
<th>Site</th>
<th>a) DNA</th>
<th>b) Phytoplankton</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean +/- Standard Deviation</td>
<td>Mean +/- Dev</td>
</tr>
<tr>
<td>Site</td>
<td>Positive Anomalies</td>
<td>Negative Anomalies</td>
</tr>
<tr>
<td>Jujuy</td>
<td>0.155 +/- 0.137</td>
<td>-0.138 +/- 0.115</td>
</tr>
<tr>
<td>Buenos Aires</td>
<td>0.098 +/- 0.094</td>
<td>-0.087 +/- 0.100</td>
</tr>
<tr>
<td>Santiago</td>
<td>0.059 +/- 0.055</td>
<td>-0.061 +/- 0.086</td>
</tr>
<tr>
<td>Valdivia</td>
<td>0.072 +/- 0.076</td>
<td>-0.061 +/- 0.083</td>
</tr>
<tr>
<td>Bariloche</td>
<td>0.070 +/- 0.078</td>
<td>-0.059 +/- 0.081</td>
</tr>
<tr>
<td>Trelew</td>
<td>0.063 +/- 0.069</td>
<td>-0.057 +/- 0.077</td>
</tr>
<tr>
<td>Punta Arenas</td>
<td>0.043 +/- 0.065</td>
<td>-0.027 +/- 0.034</td>
</tr>
<tr>
<td>Ushuaia</td>
<td>0.043 +/- 0.065</td>
<td>-0.028 +/- 0.034</td>
</tr>
</tbody>
</table>

Table 7. Statistics of the positive and negative UVR anomalies (1995-2002), a) for DNA and b) for phytoplankton photosynthesis-weighted irradiances.
- Remote sensing of stratospheric $O_3$ and $NO_2$ using a portable and compact DOAS spectrometer [Raponi et al., 2011]

Figure 2. NO$_2$ VCD variability at Marambio Antarctic Station during (a) the sunrise and (b) the sunset.

Figure 3. O$_3$ VCD variability at Marambio Station, during (a) the sunrise and (b) the sunset.

- Effect of clouds on surface UV-B and total solar irradiance at Córdoba, Argentina [López et al., 2009]

Fig. 5. Modified Cloud Modification Factors (CMFm) as a function of wavelength for cirrus and cumulus. In the stratocumulus case the CMF was calculated.
- Leaves of Citrus aurantifolia’s sensibility to solar UV-B radiation [Ibáñez et al., 2008]

Fig. 2. Changes in the level of photosynthetic pigments in prior-developed and post-developed leaves of C. aurantifolia grown with and without solar UVR. (a) Chlorophyll a; (b) chlorophyll b; (c) total chlorophyll; and (d) carotenoids. Data correspond to the mean of two independent experiments carried out during 2005 and 2006 year. Each bar represents the mean (±SD) of four replicates. Columns within a grouping marked by a different letter are significantly different at P<= 0.05.

- UVR-induced photoinhibition of summer marine phytoplankton communities from Patagonia [Villafañe et al., 2008]

Fig. 7. Output from the multiple linear regression models as compared to the data obtained for the assimilation numbers for the PAR treatment in IC (lg chl a)-1 h-1 (a), and for UVR inhibition (b). The thin lines and symbols are the experimental data while the thick lines are the modeled data; the broken lines represent the 95% limit. The vertical bars in each panel are the residuals from the models.
6. RELEVANT SCIENTIFIC PAPERS 2008-2011


Agosta E.A. and Canziani, P.O., Interannual variations in the Zonal Field of the subpolar latitudes Total Ozone Column during the Austral Spring. Geocacta, accepted 2010.


Lakkis S.G., P.O. Canziani, A comparative analysis of the temperature behavior and multiple tropopause events derived from GPS, radiosonde and reanalysis datasets over Argentina, as an example of Southern mid latitudes. Revista de Climatología, 9, 1-14. 2009.

Pazmiño Andrea, Godin-Beekmann Sophie, Lucchini Eduardo, Piacantini Rubén, Quel Eduardo and Hauchecorne Alain. Increased UV radiation due to polar ozone chemical depletion and vortex occurrences at southern sub-polar latitudes in the period [1997-2005]. Atmospheric Chemistry and Physics, 8, 5339-5352. 2008.


7. FUTURE PLANS

In view that the main problems concerning the ozone depletion and its consequences will affect particularly the Argentine territory and its neighborhood for many years, future research activities will be a continuation and extension of current investigations. Then, future plans and recommendations are basically similar to those of the ORM-2008. Among the principal subjects:

- Evolution of the total ozone column over the region. Trends of ozone and UV levels. Dynamics, chemistry and inter-annual variation of the Antarctic ozone hole.
- Study of the influence of the near vortex and ozone hole incursions over Patagonia
- Study the relationship between tropospheric and stratospheric dynamic and climatic behavior and the links with ozone change.
- Ozone and climate change interactions.
- The chemistry and dynamics of stratosphere-troposphere exchange.
- Cirrus clouds, the tropopause, and ozone.
- Effects of the UV radiation on the human health in the region. Biological effects of the UV radiation, especially on crops in the region.
- Studies of solar radiation and its components and biological effects in Antarctic Peninsula.
8. NEEDS AND RECOMMENDATIONS

- Antarctica and the Southern Cone of South-America must be still for many years considered the most critical region in the world related to ozone depletion and its consequences.

- The Antarctic Ozone Hole must be continuously monitored by all means for many years. Permanent ground-based and satellite-based instruments are an essential complement for this task.

- The current monitoring networks must be maintained in qualified operation. One main problem faced by Argentina, related to monitoring and research activities, has been the lack of adequate support to maintain such activities over time. This is particularly relevant since at this stage the ozone layer seems to be reaching the peak state of its depletion and sensitive monitoring and important research is necessary to determine the future evolution and the start of the possible recovery ozone layer and ozone hole.

- There is growing evidence that the ozone layer is both acting in response to current climate variability and change as well as affecting climate over the Southern Hemisphere. Such coupled studies are an important component of understanding needed to assess climate variability and climate change processes. Hence it is important to strength all atmospheric measurements relevant to both processes. This also requires a strong support in capacity building at the technician and research levels to continue both with monitoring and relevant research as proposed by SPARC-WCRP and its links with the various WCRP initiatives.

- The Argentine National Weather Service, main national institution for atmospheric monitoring, is still undergoing a mayor restructuring and requires support for its new strategies, in particular monitoring and calibration aspects, and replacement of obsolete and obsolescent equipment and facilities. It also requires including new monitoring activities to provide relevant information for both these topics, including long-term monitoring.

- It is essential that research activities be enhanced regionally and globally in the double-pronged aspect of ozone depletion and change within the framework of Climate Change due to the many joint aspects and couplings that are now starting to be known. Hence it is essential to sustain national and international projects regarding these as relevant issues.

- Until the recovery of the ozone layer does not become evident and sustained in time and as long as the international scientific community does not have a clear and fully developed picture of the linkages between the ozone layer, the stratosphere and the troposphere, within the scope of climate change and variability such research must be supported, nationally, regionally and internationally.

This report was prepared by Dr. Eduardo Luccini and Dr. Pablo Canziani, based on the infrastructure, activities and achievements of the Argentine institutions and research groups involved in Vienna-Convention-related monitoring and research activities. We gratefully acknowledge all the experts and institutions that provided the information to elaborate this Report.

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ARMENIA

OBSERVATIONAL ACTIVITIES

Column measurements of ozone and other gases/variables relevant to ozone loss.

The GAW regional station #410 Amberd carries out the measurements of total ozone. The station is equipped by Dobson spectrophotometer D-044 (Fig. 1).

The begun in 1990 measurements of total ozone on the local network ozone-observing station Arabkir in city Yerevan are continued. The station is equipped by filter ozonometer M-124.

The results of carried out in Armenia during 1991-2010 measurements of total ozone are presented on Fig. 2.

Figure 1. GAW regional station #410 Amberd.

Figure 2. Dynamics of changes of total ozone in Armenia during 1991-2010.

Profile measurements of ozone and other gases/variables relevant to ozone loss - not made.

UV measurements - not made.

Calibration activities - the calibration of Dobson spectrophotometer D-044 in European RDCC in Hohenpeissenberg was executed in 2010.

RESULTS FROM OBSERVATIONS AND ANALYSIS

The results of measurements total ozone at Dobson-station Amberd showed, that after 1999 the general tendency to its decrease to a level 1993-94 was observed.

The study of connection between changes of total ozone and the morbidity of population by skin cancer begun in [1] is continued.
According to results and recommendations of DQ Workshop (Feb. 2001, Hradec Kralove, Czech Republic) is undertaken the reanalysis of Total Ozone data set for 2005-2010.

**THEORY, MODELLING, AND OTHER RESEARCH**

Using the climatic parameters of seasonal changes of total ozone above Armenia, carried out during 1990-2006, solar extraterrestrial spectrum in the wavelength range from 280nm to 400nm, coefficients of UV absorption by ozone, and the electronic map of surface with horizontal step of 300 m, is constructed the computer model of solar radiation transfer in atmosphere and of its distribution on the territory according to parameters of relief and albedo of surface.

In particular, are defined the climatic parameters of distributions of the hourly, daily, monthly and annual sums of UVR (also separately for UV-A and UV-B,C), UV Indexes and the times in order to receive of 1 MED (for 4 skin types) in various regions of country in various time of day, using erythemal CIE spectra of McKinlay and Diffey and Practical Guide “Global Solar UV Index”.

According to the recommendations of 7ORM the following researches are carried out.

- The results of last researches of influence of radiation on human health, begun in [1], will be published in this year.
- The processing of results of total ozone measurements, executed in 1990-1998 in different regions of Armenia is undertaken. The received data will be published this year.
- The comparative analysis of modern results of total ozone measurement at stations “Arabkir” (ozonemeter M-124) and "Amberd" (Dobson spectrophotometer) with the purpose to find correction of algorithm of calibration of filter-ozonometers connected with aging of filters.
- As a result of participation in Dobson Quality Workshop (February, 2011, SOO CHMI, Chech Republic) both received estimations and recommendations the recalculation of some data on measurement ozone at station "Amberd" is undertaken.

**DISSEMINATION OF RESULTS**

**Data reporting**

Monthly results of measurements of total ozone at station Amberd are regularly submitted in the WOUDC.

On the basis of results of measurements of total ozone at stations Amberd and Arabkir is continued the creation of local computer bank.

Are studied the climatic resources of different components of balance of UV solar radiation and with their decomposition on separate standard spectral intervals: UV, UV-A, UV-BC radiation, - in all regions of territory of Armenia.

**Information to the public**

Using the forecasts of total ozone distribution above northern hemisphere from WMO/GAW ozone mapping program and forecasts of cloudiness with use of the model of solar irradiation are developed the daily maps of forecasts of distribution of UV Indexes on the territory of Armenia. The forecasts of UV indexes for mostly inhabited areas of Armenia, calculated according to "UV Index for Public“ (COST-713 Action UVB Forecasting) on the base of daily maps of UV Indexex, are included in the weather forecasts for dissemination to the public via mass media.

**Relevant scientific papers**


PROJECTS AND COLLABORATION

Execution of Dobson program is being implemented in scientific and methodical collaboration with DWD (Germany) and SOO CHMI (Czech Republic).

At the station Amberd is being created the first level station for EMEP for measurements of concentrations of pollution in precipitations and of solid particles in air, also of SO$_2$, NO$_X$ and surface ozone O$_3$.

The model of solar (in particular, UV) irradiation was developed for implementation of national project "Estimation of resources of solar radiation on the territory of Armenia" (2005-2007).

FUTURE PLANS

The results of modeling of a climatic regime of UV irradiation are used for development of results begun in [1] research of vulnerability of health of the village and urban population to increase of ultraviolet radiation and the influence on vulnerability of height of location in all regions of territory of Armenia. The research is based on long-term statistics on morbidity of the population of Armenia by skin cancer and on results of total ozone measurements.

NEEDS AND RECOMMENDATIONS

The capacities of weather station Amberd allow performing of national and international projects on monitoring of solar radiation, investigations of vertical distribution of ozone with balloon sondes, lidar observations, aerosol transfer and transboundary air pollution in region of South Caucasus.

The recommendation: it is necessary periodically to organize DQ Workshops.

Need: it is necessary for ozone-experts from developing countries enabling of short-term practice in leading scientific centres of the world for improving of their scientific and technical potential.
AUSTRALIA

1. OBSERVATIONAL ACTIVITIES

1.1 Column measurements of ozone and other gases/variables relevant to ozone loss.

The Australian Government’s Bureau of Meteorology (BoM) has primary responsibility for monitoring total column ozone.

- The BoM Dobson network consists of stations located at Brisbane, Darwin, Macquarie Island, Melbourne, and Perth (Perth is operated in conjunction with NOAA). Brisbane, Macquarie Island and Melbourne have records stretching back to 1957.

A number of universities also undertake some total ozone monitoring:

- A Brewer spectrophotometer operated by the University of Tasmania (operating costs financed by the BoM).
- Two Mk IV Brewer spectrophotometers operated by the Queensland University of Technology.
- Remote sensing FTIR operated by the University of Wollongong (the measurements are made as part of the Network for the Detection of Atmospheric Composition Change, NDACC).

Measurements of ozone depleting substances (CFCs, HCFCs, halons, methyl bromide, carbon tetrachloride and methyl chloroform) are made by GC-ECD and GC-MS techniques at Cape Grim, Tasmania, and Aspendale, Victoria by CSIRO and BoM.

1.2 Profile measurements of ozone and other gases/variables relevant to ozone loss

Regular ozonesonde measurements are taken by the BoM at:

- Macquarie Island (weekly flights since 1994)
- Melbourne (weekly flights, with a program having operated from various locations around Melbourne since 1965).
- Davis station, Antarctica, in conjunction with the Australian Antarctic Division (AAD), since 2003. Flights are currently weekly for the whole year. In conjunction with these ozonesonde flights, the AAD operates a Rayleigh/Mie/Raman lidar at Davis to measure temperature and aerosol loading in the stratosphere.

1.3 UV measurements

1.3.1 Broadband measurements

The Australian Radiation and Nuclear Safety Agency (ARPANSA) has maintained a network of UV detectors in capital cities around Australia since 1989. In 1996 the instruments were changed over to Solar Light UVB 501 broadband biometers. Kingston, Tasmania was added in 2007 and more recently Canberra was added as a new site (December 2010). Biometers have also been collecting data at Macquarie Island since 2001 and the Australian Antarctic stations Mawson, since 2002, and both Davis and Casey since 1996. The sites in Antarctica are currently being upgraded with new biometers. The biometers are intercompared at Yallambie before placement in the field. Spectral measurements with traceable calibrations at Antarctic mainland stations commenced in 2010 at Davis and Mawson. In 2011 a Bentham spectral system was installed at Davis for at least two summers with the aim of providing a longer duration series of calibrated spectral measurements, with the aim to subsequently extend this to both Mawson and Casey as well.
The Queensland University of Technology uses Solar Light 501 UV biometers in Brisbane to provide a live UV Index update to the public, as well as operating a national network of Yankee UVB pyranometers, located in Brisbane, Townsville, Canberra and Hobart.

### 1.3.2 Narrowband filter instruments

N/A

### 1.3.3 Spectroradiometers

The BoM owns and operates two NIWA-designed spectroradiometers at Alice Springs and Melbourne.

A UV spectroradiometer generated data at Cape Grim between 1999 and 2006. A repaired spectrometer is awaiting site works for redeployment and a replacement system has been developed at BoM and is undergoing field testing.

ARPANSA currently uses a Bentham spectroradiometer based at the Melbourne site to simultaneously measure solar UVR and transfer a traceable calibration to the biometers before installation. This instrument commenced measurements in December 2008 and has been operating continuously since then.

### 1.4 Calibration activities

The BoM holds the RA V Dobson standard and operates the Regional Dobson Calibration Centre (RDCC) for Australia. The regional standard Dobson is inter-compared regularly with the world standard Dobson. ARPANSA meets the WMO's instrument specifications and characterization as a health advisory agency that provides the daily UV levels. CSIRO/BoM ODS measurements employ calibration standards supplied by the Scripps Institution for Oceanography (USA) and the data are regular compared to data collected at Cape Grim by NOAA (USA), U. East Anglia (UK) and NIES (Japan).

An Australian Dobson expert attended the WMO Dobson Data Quality Workshop recently held in Hradec Kralove, Czech Republic.

### 2. RESULTS FROM OBSERVATIONS AND ANALYSIS

Ozonesonde and Dobson data from the Bureau network are available through the WOUDC and are frequently used for purposes such as satellite calibrations and trend analysis.


Analyses of ozonesonde data from Davis station (Antarctica) are used in the following areas;

• Near real-time analyses of ozone in the Southern Hemisphere winter (WMO Antarctic Ozone Bulletins; see http://www.wmo.ch/pages/prog/arep/gaw/ozone/index.html)
• Satellite and instrument validation (e.g. Dupuy et al., 2008).

Existing UVR measurements have had difficulties in detecting any increase in UVR due to the natural variability in solar UVR at the earth's surface (Peter Gies et al., 2004).

ODS data collected at Cape Grim have been used in recent international assessments of climate change (IPCC 2007) and ozone depletion (WMO 2011), and are reported biennially in Baseline (Krummel et al., 2007). The data have been used in the Commonwealth Government State of the Environment Report (Beer et al., 2006).

3. THEORY, MODELLING, AND OTHER RESEARCH

Using the UK Chemistry and Aerosols (UKCA) model within the Australian Community Climate and Earth-Simulation System (ACCESS) framework, researchers at the University of Melbourne and CSIRO, along with collaborators at the New Zealand National Institute of Water and Atmospheric Research (NIWA) are developing the capability of a fully coupled atmosphere-chemistry (and eventually ocean) model. The model will be used to simulate the stratospheric ozone layer chemistry and dynamics with the goal of a better understanding of the impacts of the development and recovery of the Antarctic Ozone Hole on the climate of the southern hemisphere.

Recently Arblaster, Meehl and Karoly (Arblaster et al. 2011) have studied the impact of ozone depletion and recovery on southern hemisphere climate.

With the implementation of the ACCESS modelling system, an Ozone and UV forecast (ACCESS-O3+UV) system has been developed to predict the ozone field within the ACCESS framework. The assimilation and forecast system provides extended ozone forecast from 3d variational (3dVAR) assimilation of ATOVS radiances and a modified version of the ACCESS-NWP unified model (UM) (Lemus-Deschamps et al. 2008). The UV and ozone forecast system http://www.bom.gov.au/uv/index.shtml is under continuous development.

Satellite and surface measurements have been used to investigate ozone and UV changes over Australia and skin cancer incidence (Lemus-Deschamps and Makin, 2011; Makin and Lemus-Deschamps, 2011).

Studies of the Antarctic Ozone Hole in recent years have been made in Tully et al. (2008, 2011). Recent analysis by Salby et al. (2011) reports the strong control of inter-annual variability in the size of the Antarctic Ozone Hole by stratospheric dynamics, and the recent unambiguous sign of ozone recovery.

Work by Innis and Klekociuk (2006) and Alexander et al. (2011) has quantified the effects of planetary waves and orographic gravity waves, respectively, on the formation of Polar Stratospheric Clouds.
4. DISSEMINATION OF RESULTS

4.1 Data reporting

Ozonesonde and Dobson data from all Bureau of Meteorology stations are archived at the World Ozone and UV Data Centre (WOUDC).

Measurements of column amounts from the FTIR system at Wollongong are reported via the Network for Detection of Atmospheric Composition Change (NDACC) database (see http://www.ndsc.ncep.noaa.gov/data/), as are spectral UV data from Alice Springs.

4.2 Information to the public

A UV forecast is issued daily by the Bureau of Meteorology. The UV forecast is important because approximately 380,000 Australians still get skin cancer every year. The UV forecast is released to the public by the Bureau of Meteorology regional office in each state and it is provided to the media as part of the weather report (Deschamps et al., 2006). It is also available at http://www.bom.gov.au/uv/index.shtml, and it is extensively used in Australia’s SunSmart promotional and educational campaigns.

ARPANSA provide measured real-time UV levels which are updated every minute. A plot of the UV levels for Australian sites is available on the ARPANSA web site at http://www.arpansa.gov.au/uvindex/realtime/index.cfm. Historical UV index data since 2004 is also available on the ARPANSA web site at http://www.arpansa.gov.au/uvindex/monthly/ausmonthlyindex.htm.

The Queensland University of Technology’s Aus Sun Research Lab maintains a website giving five-minute updates of the UV Index in Brisbane:
http://www.uv.hlth.qut.edu.au/community/uvindex.jsp

Ozone analyses and forecasts are used by a number of groups to issue statements on the development of the ozone hole each year.

4.3 Relevant scientific papers


5. PROJECTS AND COLLABORATION

Information on Australian activities related to ozone and UV is shared through the *Australian Ozone Science Group*, co-ordinated by the Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPC), which has led to increased co-operation between agencies and institutions.

The Bureau of Meteorology has ongoing collaboration projects with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) on UV Index validation against surface measurements and with SunSmart (Cancer Council Australia) on the use of the UV Index to promote sun protection; and

The BoM/AAD ozonesonde and AAD lidar measurements at Davis station in Antarctica have contributed to the International Polar Year cluster project ORACLE-O3, and the CONCORDIASI and MATCH campaigns.

A number of Australian scientists contributed as lead-authors, co-authors, contributors or reviewers of the 2010 Scientific Assessment of Ozone Depletion, supported by DSEWPC.

6. FUTURE PLANS

- Total column FTIR measurements of ozone and related trace gases at Davis station are currently being validated by the AAD.
- A low-cost UV spectroradiometer is also being developed by the BoM and is currently being field-tested.

7. NEEDS AND RECOMMENDATIONS

Continued provision and development of international data archival facilities (e.g. WOUDC) and instrument calibration standards and inter-comparisons (e.g. through NDACC and WMO).
AZERBAIJAN

Azerbaijan Republic ratified Vienna Convention on Protection of Ozone Layer, Montreal Protocol; London, Montreal and Copenhagen amendments to Montreal Protocol. The Project of “Implementation of National Program to recover and recycle refrigerating agents” was prepared with direct support of UNEP and UNDP. GEF ratified the project in 1998 in order to give a support. As a result of its implementation ozone depleting substances were reduced by 307.4 tones (32% of consumption in 1996 year). Realization of these project finished in 2002. Project consist of a few components like investments into exploitation and using of refrigeration equipment sector, fire safety activities, after realization of this project reconstructions works have been made in the companies producing home and industrial refrigeration installations. The Ministry of Agriculture reported to the Climate change and Ozone Center of National Hydrometeorological department that methyl bromide is not being imported into Azerbaijan since 1997. As a results of project import of CFC and halons was suspended in January 2006. Besides, legal documents were formulated concerning taxes on imports of ODS and licensing systems to monitor and control of ODS import and the ban on imports of equipment which uses ODS.

Systematic observations of general ozone concentrations in upper layers of atmosphere in Azerbaijan began in January of 1995, where ozonometer (of Russian production) was used in meteorological station of Baku (the capital of Azerbaijan). The results of observations were monthly reported to Main Geophysical Observatory of Russian Federation.

In 1997 the equipment broke and needed fixing. Because of absence of financing it was not possible to send the equipment to Russia for repair. At this moment the observations of ozone layer are not conducted in Azerbaijan.

Unfortunately the absence of financial resources of Government doesn’t let to conduct these works fully. We need financial support to restart continuous observations of ozone layer in Azerbaijan.