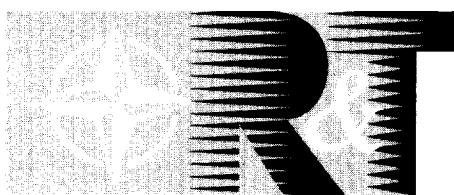


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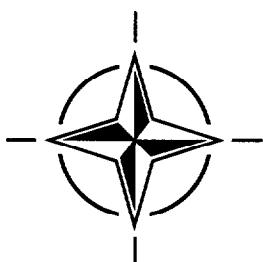
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RTO MEETING PROCEEDINGS 1

**E-O Propagation, Signature and System
Performance Under Adverse
Meteorological Conditions Considering
Out-of-Area Operations**

(La propagation, la signature et les performances des systèmes optroniques dans des conditions météorologiques défavorables, compte tenu des opérations hors zone)

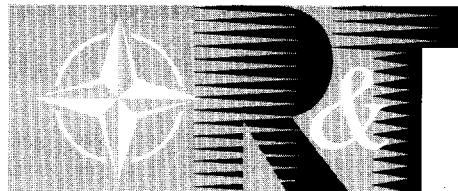
Papers presented at the Sensors & Electronics Technology Panel Symposium held at the Italian Air Force Academy, Naples, Italy, 16-19 March 1998.



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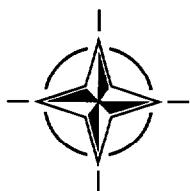
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The Research and Technology Organization (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote cooperative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective coordination with other NATO bodies involved in R&T activities.

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The total spectrum of R&T activities is covered by 6 Panels, dealing with:

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- SCI Systems Concepts and Integration
- SET Sensors and Electronics Technology
- IST Information Systems Technology
- AVT Applied Vehicle Technology
- HFM Human Factors and Medicine

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E-O Propagation, Signature and System Performance Under Adverse Meteorological Conditions Considering Out-of-Area Operations

(RTO MP-1)

Executive Summary

If a system, for example a sighting system, which operates in the electro-optic wavebands is considered, large amounts of time are devoted to the design and modification of the detectors and emitters. Furthermore, the science behind the operation of these devices is understood. This understanding and the mathematical processing of their signals facilitate the improvement and development of system characteristics. For example, different operational wavelengths can be used for improved detector suitability, filters can be added to remove unwanted energies, and automatic detection algorithms can be incorporated.

However, in an operational situation, between the emitter (for example a target) and the detector there is a layer of intervening atmosphere. Within reason this layer of atmosphere cannot be modified, yet the atmosphere has as much effect on system performance as any other aspect of the total system.

The operational performance of an electro-optic system will vary under different meteorological or weather conditions, and adverse weather conditions in particular will affect and degrade system performance. Similarly the weather varies in different geographical areas and deployment zones, and the implication of this is that an electro-optic system that operates with a certain level of performance in one location will operate at a different level of performance in a different location. Issues such as these were the subject matter of the symposium.

The value and relevance of the meeting was demonstrated during the presentation of the invited introductory paper, "The reconnaissance, search and target acquisition cycle; lessons learned", by B. Gen. G. Marani. Aspects of the presentation detailed an analysis of operational data that indicated that a significant number of missions in the region of the Adriatic failed or had to be aborted due to weather-related phenomena. Presenters during the technical visit to NATO AIRSOUTH reinforced these findings.

The symposium comprised four sessions, in which 34 papers were presented.

- Modelling
- EOPACE (Electro-optical Propagation Assessment on Coastal Environments)
- System performance
- Sensing.

The modelling session concentrated on the development and applications of computer codes. In particular, codes, such as MODTRAN, which are associated with the prediction of atmospheric transmission and radiance codes were discussed. However, measurement and comparison programmes that used atmospheric prediction codes were also presented.

Results from the EOPACE project demonstrated the importance and effect of aerosols in the near-surface coastal environment, and their implications for system operation in this layer of the atmosphere. EOPACE also demonstrated the synergistic ability of different Nations to work together for a common goal. It could be clearly seen that the results from the project would eventually be able to support the improvement of the models presented in the first session of the symposium.

The system modelling session suffered from an unprecedented number of cancelled papers. However, the remaining papers demonstrated techniques that could be employed to mitigate the effect of adverse weather conditions. The effect of battlefield contamination was also addressed.

The session on sensing produced a selection of presentations on satellite and ground based sensing projects. Projects were described which produced valuable results that could be used to improve and supplement modelling activities, whereas other projects were concentrating on military operational issues.

The symposium should be considered a great success and contained presentations that covered fundamental atmospheric research to the operational performance of systems related to propagation phenomena. Many of the operational problems that are associated with system operation in adverse meteorological conditions were also addressed and possible solutions were presented.

The meeting produced a clear understanding that propagation related issues will directly effect the ultimate operational performance of electro-optical systems and therefore cannot be separated from other aspects of system specification, design, and performance evaluation life cycle.

La propagation, la signature et les performances des systèmes optroniques dans des conditions météorologiques défavorables, compte tenu des opérations hors zone

(RTO-MP-1)

Synthèse

Pour tout système fonctionnant dans les gammes d'onde électromagnétiques, comme les systèmes de visée par exemple, il faut beaucoup de temps pour concevoir et modifier les émetteurs et les détecteurs. Pourtant, les sciences qui régissent le fonctionnement de ces dispositifs sont parfaitement maîtrisées. Cette maîtrise, associée au traitement mathématique de leurs signaux, facilite l'amélioration et le développement des caractéristiques systèmes.

À titre d'exemple, pour optimiser la conception des détecteurs, des gammes d'onde opérationnelles différentes peuvent être utilisées; des filtres peuvent être ajoutés pour éliminer d'éventuelles énergies parasites, et des algorithmes de détection automatique peuvent être incorporés.

Cependant, en situation opérationnelle, il existe une couche intermédiaire de l'atmosphère entre l'émetteur (par exemple une cible) et le détecteur. Cette couche ne peut-être modifiée que dans des limites très raisonnables et pourtant l'atmosphère exerce autant d'effet sur les performances des systèmes que tout autre élément du système global.

Les performances opérationnelles d'un système électro-optique varient selon les conditions météorologiques, et le mauvais temps, en particulier, a pour effet de dégrader les performances des systèmes. De la même façon, les conditions météorologiques varient en fonction du lieu géographique et de la zone de déploiement, ce qui signifie qu'un système électro-optique avec des performances données sur un site aura des performances différentes sur un autre site. Le symposium s'est donné pour objectif d'examiner des questions de cet ordre.

L'intérêt et la pertinence de la réunion ont été démontrés lors de la présentation de l'exposé liminaire sur "Le cycle de reconnaissance, recherche et acquisition de la cible - enseignements à tirer", qui a été préparée par le Général de brigade G. MARANI. Parmi d'autres aspects, l'exposé a fourni une analyse de données opérationnelles indiquant qu'un certain nombre de missions réalisées en Adriatique avaient échouées, soit été annulées à cause de phénomènes météorologiques. Les présentations données à l'occasion de la visite du commandement AFSOUTH/OTAN ont confirmé ces conclusions.

Le symposium a été organisé en quatre sessions, avec un total de 34 présentations.

- modélisation
- EOPACE (évaluation de la propagation électro-optique dans un environnement côtier)
- performances systèmes
- détection

La session sur la modélisation a été axée sur le développement et la mise en œuvre de codes machine tels que MODTRAN, qui sont associés à la prévision de la transmission atmosphérique, ainsi que sur les codes de luminance énergétique. Cependant, des programmes de mesure et de comparaison faisant appel à des codes de prévision atmosphérique ont également été présentés.

Les résultats obtenus du projet EOPACE ont démontré l'importance et les effets des aérosols dans l'environnement côtier proche de la surface de la mer et les conséquences en ce qui concerne l'exploitation des systèmes dans cette couche atmosphérique. Le projet EOPACE a également témoigné de la capacité synergétique des différents pays œuvrant ensemble pour un objectif commun. Il est apparu très clairement que les résultats du projet pourraient à terme servir à améliorer les modèles présentés lors de la première session du symposium.

La session sur la modélisation a été pénalisée par un grand nombre de présentations annulées au dernier moment. Cependant, les communications présentées ont mis en évidence des techniques permettant d'atténuer les effets du mauvais temps et la dégradation des conditions visuelles sur le champ de bataille.

La session sur la détection a été caractérisée par une série de présentations sur des projets de détection au sol et par satellite. Certains projets donnent des résultats pouvant servir à améliorer et à compléter les activités de modélisation, tandis que d'autres concernent plus particulièrement des questions militaires opérationnelles.

Le symposium a obtenu un succès incontestable. Des domaines variés, allant de la recherche atmosphérique fondamentale aux performances opérationnelles des systèmes relatifs aux phénomènes de propagation ont été couverts. De nombreux problèmes opérationnels associés à l'exploitation de systèmes dans des conditions météorologiques défavorables ont été examinés et des solutions présentées.

Il a permis de clairement prendre conscience que la programmation a une influence directe sur les performances opérationnelles des systèmes électro-optiques et que, par conséquent, elle doit être prise en compte dans les spécifications techniques dans la phase de conception et dans le cycle d'évaluation des performances.

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Theme

During “favourable” weather conditions the operational performance of the majority of the UV, visible, and IR Wave weapon systems that are used by NATO forces is nominally equivalent to the performance that is achieved by most opposing forces. However, the most important factor in weapon systems design is very often not the final performance of a system but the performance differential between the system and the threat. In the presence of adverse weather conditions, for example, rain, fog, snow, and cloud, the performance of systems will be degraded but it may be possible, by way of an improved understanding of adverse weather conditions, that a performance differential can be achieved. It is reported that the success of Desert Storm was, in part, achieved by the differential superiority of the coalition forces.

Historically, both the threat and the location of the next conflict were “assumed”, and systems were optimised accordingly. However, the concept of modern Rapid Reaction Forces troops may now be deployed in any location, including desert, arid, and polar regions. In these regions, systems that were once optimised for use in temperate locations may now prove to be sub-optimal.

The ability to maintain weapon system performance during adverse weather conditions is essential. A small improvement in performance may yield a significant advance under such conditions. It is of considerable importance to NATO that the full impact of out-of-area operations on electro-optic system performance be addressed.

The following topics are appropriate for consideration:

- Theoretical and practical aspects of atmospheric propagation under adverse conditions
- Out-of-area operations, variations in weather conditions and propagation phenomena
- System optimisation techniques for out-of-area applications
- Modelling techniques
- Measurement programmes, including existing collaborations
- Applications of dual use technologies for adverse conditions (military/commercial).

Thème

Avec des conditions météorologiques favorables, les performances opérationnelles de la plupart des systèmes d’armes UV, visibles et IR mise en œuvre par les forces de l’OTAN sont en principe équivalentes à celles de la majorité des forces d’opposition. Cependant, les performances définitives d’un système d’armes ne sont pas toujours considérées comme l’élément le plus important lors de sa conception; une attention particulière est souvent accordée au différentiel de performances entre le système et la menace.

En présence de conditions météorologiques défavorables, par exemple pluie, brouillard, neige ou nuages, les performances des systèmes sont dégradées, mais un différentiel de performances peut néanmoins être obtenu grâce à une meilleure appréhension de ces conditions météorologiques. Les rapports indiquent que la réussite des opérations “Tempête de Désert” est en partie due à la supériorité différentielle des forces de la coalition.

En réalité le type de menace et la situation géographique du conflit avaient été “présumés” et les systèmes optimisés en conséquence. Cependant, conformément au concept de la force d’intervention rapide, des troupes peuvent, dorénavant, être déployées partout, y compris dans des régions désertiques, arides ou polaires. Il se pourrait alors que les systèmes optimisés pour les régions tempérées s’avèrent moins performants.

La capacité de maintien des performances d’un système d’armes dans des conditions météorologiques défavorables est vitale. Toute amélioration opérationnelle peut produire des avantages non négligeables dans de telles conditions. Il est d’une importance considérable pour l’OTAN que la véritable incidence des opérations hors zone sur les performances des systèmes optroniques soit prise en compte.

Les sujets suivants doivent être examinés:

- les aspects théoriques et pratiques de la propagation atmosphérique dans des conditions météorologiques défavorables
- les opérations hors zone et la variation des conditions météorologiques et des phénomènes de propagation
- les techniques d’optimisation de systèmes pour d’applications hors zone
- les techniques de modélisation
- les programmes de contrôle, y compris les projets collaboratifs en cours
- l’application des technologies duales (militaires/commerciales) en cas de conditions défavorables

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