Meteorology in the Next GANP/ASBU Update



CAeM-16 Side event - 26 July 2018

University of Exeter, Exeter, United Kingdom

WMO OMM

World Meteorological Organization Organisation météorologique mondiale

What is the GANP ?

What does ASBU mean ?

Any meteorology in there ?



The Global Air Navigation Plan

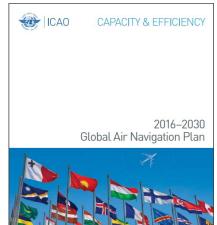
ICAO's 15-year Plan Addressing Global Air Navigation

- The Global Air Navigation Plan (GANP) is a means to help achieve a global interoperable air navigation system for all users for all phases of flight, which meets agreed safety levels, provides optimum economic operations, is environmentally sustainable and meets national security requirements.
- A <u>reference</u> for ICAO, States, manufacturers and other organizations to develop the necessary technology, standards and procedures.
- A rolling, 15-year strategic methodology which leverages existing technologies and anticipates future developments based on State/industry agreed operational objectives.



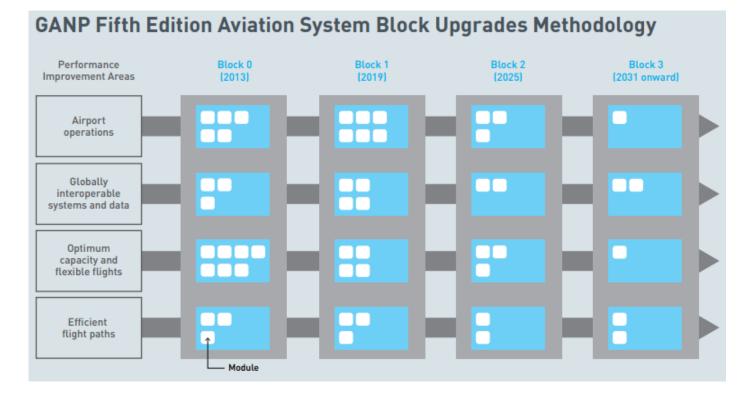
The Global Air Navigation Plan

- Long-term vision to ensure continuity and harmonization with ICAO, States and industry modernization programs.
- Objective is to increase capacity and improve efficiency of the global civil aviation system whilst improving or at least maintaining safety
- Methodology based on Block Upgrades, organized in nonoverlapping six-year time increments starting in 2013 and continuing through 2035 and beyond.
- Triannual revision cycle, with major updates every six years, One major in 2019





Aviation System Block Upgrades (ASBU)



Refer to the target availability timelines for a group of operational improvements i.e. technologies and procedures organized into unique Modules This block upgrade and module-based methodology would allow Member States to <u>only consider and adopt the Modules appropriate to their operational needs.</u>



Aviation System Block Upgrades (ASBU)

Key concepts in developing the draft 2019 version of the GANP :

ASBU Block: a six year timeframe whose starting date defines a deadline for an element to be available for implementation.

ASBU Thread: key feature area of the air navigation system that needs improvement in order to achieve the vision outlined in the Global ATM Operational Concept (GATMOC).

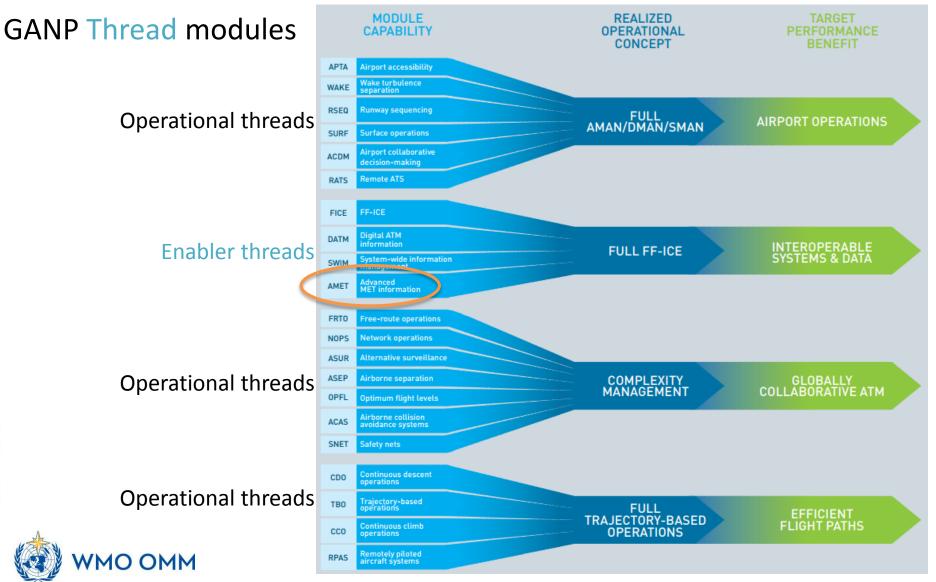
ASBU Element: a specific change in operations designed to improve the performance of the air navigation system under specified operational conditions. **ASBU Module:** a group of elements from a thread that, according to the enablers' roadmap, will be available for implementation within the defined deadline established by the ASBU Block.

ASBU Enabler: component (standards, procedures, training, technology, etc) required to implement an element.

=> Operational threads, Enabler threads and Network/Infrastructure threads



Aviation System Block Upgrades (ASBU)



From the ICAO ASBU Panel Project Team work:

- Meteorology is an **Enabler** for the majority of the other Threads.
- Challenge is to ensure that **all the other ASBU threads** and related modules are <u>able to fully articulate the requirements they have for MET</u> <u>information in the future</u>.
- This means looking at the **MET information required**, rather than existing products.
- Information includes phenomenon/parameter and data characteristics such as severity, accumulation, intensity, probability of occurrence, confidence/ uncertainty of forecasts and reliability, etc.
- Evolution of AMET thread and modules is driven by the transition to the SWIM environment and by the need for more interoperability allowing integration of MET information in ATM systems



AMET Block 0:

Global, regional and local meteorological information to support flexible airspace management, improved situational awareness, collaborative decision-making and dynamically optimized flight trajectory planning.

AMET Block 1:

Meteorological information supporting automated decision process or aids, involving meteorological information, meteorological information translation, ATM impact conversion and ATM decision support.



AMET Block 2:

Integrated meteorological information in support of enhanced operational ground and air decision-making processes, particularly in the planning phase and near-term.

AMET Block 3:

Integrated meteorological information in support of enhanced operational ground and air decision-making processes, for all flight phases and corresponding air traffic management operations.

AMET Block 4:

Integrated meteorological information supporting both air and ground decision making for all phases of flight and ATM operation, especially for implementing immediate weather mitigation strategies.



AMET – METEOROLOGICAL INFORMATION

TEMPLATE TABLE 1: Thread overview

	AMET	METEOROLOG	BICAL INFORMATION							
PART 1	CONCEPT OF	OPERATIONS OF	THE THREAD BY BLOCK							
	BBB	Meteorological info	Meteorological information provided to support operational efficiency and safety.							
	Block 0	· · ·	Slobal, regional and local meteorological information to support flexible airspace management, improved situational awareness, collaborative decision-making and dynamically optimized flight trajectory planning.							
	Block 1	Meteorological information supporting automated decision process or aids, involving meteorological information, neteorological information translation, ATM impact conversion and ATM decision support.								
	Block 2		ntegrated meteorological information in support of enhanced operational ground and air decision-making processes, particularly in the planning phase and near-term.							
	Block 3	-	logical information in support of enhanced operational ground and air decision-making ight phases and corresponding air traffic management operations.							
	Block 4		logical information supporting both air and ground decision making for all phases of flight and specially for implementing immediate weather mitigation strategies.							
	Block	Element ID	Title							
	Block 0	AMET-B0/1	Meteorological observations products							
	Block 0	AMET-B0/2	Meteorological forecast and warning products							
	Block 0	AMET-B0/3	Climatological and historical meteorological products							
	Block 0	AMET-B0/4	Dissemination of meteorological products							
	Block 1	AMET-B1/1	Meteorological observations information							
	Block 1	AMET-B1/2	Meteorological forecast and warning information							
	Block 1	AMET-B1/3	Climatological and historical meteorological information							
	Block 1	AMET-B1/4	Dissemination of meteorological information							
5	Block 2	AMET-B2/1	Meteorological observations information							
PART	Block 2	AMET-B2/2	Meteorological forecast and warning information							
•	Block 2	AMET-B2/3	Climatological and historical meteorological information							
	Block 2	AMET-B2/4	Meteorological information service in SWIM							
	Block 3	AMET-B3/1	Meteorological observations information							
	Block 3	AMET-B3/2	Meteorological forecast and warning information							
	Block 3	AMET-B3/3	Climatological and historical meteorological information							
	Block 3	AMET-B3/4	Meteorological information service in SWIM							
	Block 4	AMET-B4/1	Meteorological observations information							
	Block 4	AMET-B4/2	Meteorological forecast and warning information							
	Block 4	AMET-B4/3	Climatological and historical meteorological information							
	Block 4	AMET-B4/4	Meteorological information service in SWIM							

Meteorology in 2019 GANP/ASBU



AMET-B1/2	METEOROLOGICAL FORECAST AND WARNING INFORMATION	1			sholds					
	Meteorological forecast and warning information in support of automated decision processes or aids and	1		Format (TAC, Gridded, Graphical, IWXXM)						
Main purpose	performance based requirements,, involving meteorological information, meteorological information			Data quality flag Runway identification or location identifier Effect for a statement of a supervision or instance of the supervision						
main purpose	translation, ATM impact conversion and ATM decision support.									
		11			ation (expos	on aviation systems (i.e. communications, navigation & surveillance systems)				
New capabilities	Commencement of change from product-centric to data-centric information. Commencement of space weather and sulphur dioxide (SO2) services. Enhanced hazardous weather services. First steps in the				anen lenter	arc _y				
Newcapaonite	provision of probabilistic information derived from ensemble prediction systems.									rom the meteorological
		41						ased on user	defined thresho	olds. Meteorological
	Meteorological forecasts and warnings will begin to transition from traditional alphanumeric code (IAC) form to data-centric into majorite better support the common understanding on the various operational constraints,			information	n to be used	to assess impa	ict.			
	capabilities and needs. The following SWIM-compliant forecast parameters and phenomena will begin to be			Verification	n of quality (accuracy) of for	ecastoarameters	An increase	duse nerforma	nce measures(via
	made available to users and will include:						indices) of foreca			noo modaanoo (via
	 Wind speed and direction (aerodrome) including gusts and operationally significant wind shifts 				task by use		Yes			
	Air temperature and dew point temperature (aerodrome)			-		ormation by user				
	Upperlevel:		Human Factors		vequipment		Yes			
	o Wind (speed and direction), including departure to Top of Climb (TOC) and then Top of Descent				level of aut		Yes			
	(TOD) to landing				pendencies			ASBU ele	ement	
	 Air temperature and dew point temperature or equivalent (i.e. humidity), including height of freezing 		Dependencies and	Evolution		ID	Title			
	level and lower tropospheric temperature inversions		relations	X	Treatment	AMET-B0/2		(4-
	Flight level and temperature of tropopause		Ciduona	~			Meteorological			
	Geopotential altitude for flight levels				Х	AMET-B1/1	Meteorological	observations	information (op	erational requirement)
	Pressure (aerodrome) (i.e. QNH, QFE) Visit Tay (conditional and conditional and conditational and conditional and conditionand conditional and condit					Flig	ght phases			- Turn-around
	Visibility (aerodrome), Runway visual range (RVR)		Operations	Taxi	i-out	Departure	En-route	Arrival	Taxi-in	TumParound
	Cloud type (of operational significance) Cloud coverage, bases, tops and layers)	X	Х	Х	Х	Х	Х
	Cloud coverage, bases, tops and layers Thunderstorms, Lightning, Convection (TCU & CB)							Та	ctical	
	Precipitation (ie. drizzle, rain, freezing rain, snow, hail)			ATM pl	lanning	Strategical	Pre-tactical			Post operations
	 Precipitation (ie. dnzzie, rain, ireezing rain, snow, naii) Weather (ie. dust storm, sand storm, funnel cloud, squall, smoke, haze, mist, foq) 		Planning layers					Pre ops	During ops	
,	 Icing (airframe and engine),)	X	Х	Х	Х	Х	
	Liquid Water Content, Iced Water Content		Enablers							
		11 P	· · · · · · · · · · · · · · · · · · ·							
	Turbulence, Mountain waves, Wind shear		Category	Туре		Description/E	xamples			Stakeholder(s)
		11 H	Category Regulatory					e for Internati	onal Air	Stakeholder(s)
	Turbulence, Mountain waves, Wind shear				nex		xamples eorological Servic	e for Internati	onal Air	Stakeholder(s)
Description	Turbulence, Mountain waves, Wind shear Fronts		Regulatory			Annex 3 - Mete Navigation				Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash 		Regulatory	Anr	nex	Annex 3 - Mete Navigation WMO No.49 V Documents No	eorological Servic ol II - Technical R o. 2, Volume II – N	egulations - B	asic	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO2) and other hazardous gases 		Regulatory	Anr	nex Regulation	Annex 3 - Meter Navigation WMO No.49 V Documents No International A	eorological Servic ol II - Technical R o. 2, Volume II – N ir Navigation	egulations - E leteorological	asic Service for	Stakeholder(s)
Description	Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO2) and other hazardous gases Sea temperature, state and wave height (seaports)		Regulatory	Anr Technical I	nex Regulation	Annex 3 - Meter Navigation WMO No.49 V Documents No International A WMO No.49 V	eorological Servic ol II - Technical R o. 2, Volume II – N ir Navigation ol IV - Technical F	egulations - E leteorological Regulations - I	asic Service for Basic	Stakeholder(s)
Description	Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO2) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events		Regulatory	Anr Technical I	nex Regulation	Annex 3 - Meter Navigation WMO No.49 V Documents No International A WMO No.49 V	eorological Servic ol II - Technical R o. 2, Volume II – N ir Navigation	egulations - E leteorological Regulations - I	asic Service for Basic	Stakeholder(s)
Description	Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO2) and other hazardous gases Sea temperature, state and wave height (seaports)		Regulatory	Anr Technical I Technical I	nex Regulation Regulation	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No Procedures for	eorological Servic ol II - Technical R D. 2, Volume II – N ir Navigation ol IV - Technical F D. 2, Volume IV – (r Air Navigation Si	egulations - B leteorological Regulations - I Quality Man a ervices – Met	asic Service for Basic gement	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood 		Regulatory	Anr Technical I Technical I	nex Regulation Regulation NS	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No Procedures for (PANS-MET) –	eorological Servic ol II - Technical R D. 2, Volume II – N ir Navigation ol IV - Technical F D. 2, Volume IV – (r Air Navigation So being developed	egulations - E leteorological Regulations - I Quality Mana ervices – Metr I	asic Service for Basic gement eorology	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: 		Regulatory	Anr Technicall Technicall PA	nex Regulation Regulation NS	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No Procedures for (PANS-MET) – Doc. 4444 - Pri	eorological Servic ol II - Technical R , 2, Volume II – N ir Navigation ol IV - Technical F , 2, Volume IV – (r Air Navigation S being developed ocedures for Air N	egulations - E leteorological Regulations - I Quality Mana ervices – Met J Javigation Se	asic Service for Basic gement eorology	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO2) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) 		Regulatory Provisions	Anr Technical I Technical I PA PA	nex Regulation Regulation NS	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No Procedures for (PANS-MET) – Doc. 4444 - Pm Traffic Manage	eorological Servic ol II - Technical R b. 2, Volume II – N ir Navigation ol IV - Technical f b. 2, Volume IV – (r Air Navigation So being developed ocedures for Air N ement (PANS-ATI	egulations - E leteorological Regulations - I Quality Mana ervices - Met d lavigation Se M)	Basic IService for Basic gement eorology rvices – Air	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement 		Regulatory Provisions Operational	Anr Technical I Technical I PA PA	nex Regulation Regulation NS	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Procedures for (PANS-MET) – Doc. 4444 - Pn Traffic Manage WMO No.306	eorological Servic ol II - Technical R , 2, Volume II – N ir Navigation ol IV - Technical F , 2, Volume IV – (Air Navigation S being developed ocedures for Air N ement (PANS-ATI - Manual on Code	egulations - B leteorological Quality Mana ervices – Met J lavigation Se M) ss – Internatio	Basic IService for Basic gement eorology rvices – Air nal Codes	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SOs) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) 	14	Regulatory Provisions	Ann Technicall Technicall PA PA Mar	nex Regulation Regulation INS INS nual	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Procedures for (PANS-MET)- Doc. 4444 - Pn Traffic Manage WMO No.306 WMO No.732	eorological Servic ol II - Technical R , 2, Volume II – N ir Navigation ol IV - Technical F o. 2, Volume IV – (r Air Navigation Si- being developed ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic	egulations - B leteorological Quality Mana ervices – Met J lavigation Se M) ss – Internatio	Basic IService for Basic gement eorology rvices – Air nal Codes	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) 		Regulatory Provisions Operational	Ann Technicall Technicall PA PA Mar	nex Regulation Regulation NS	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Procedures for (PANS-MET) – Doc. 4444 - Pn Traffic Manage WMO No.306	eorological Servic ol II - Technical R . 2, Volume II – N ir Navigation ol IV - Technical F o. 2, Volume IV – (r Air Navigation Si- being developed ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic	egulations - B leteorological Quality Mana ervices – Met J lavigation Se M) ss – Internatio	Basic IService for Basic gement eorology rvices – Air nal Codes	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) Geo Location (2D/3D/4D context, point, line or polyhedron) Movement 		Regulatory Provisions Operational	Ann Technicall Technicall PA PA Mar	nex Regulation Regulation INS INS Inual Iance	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Procedures for (PANS-MET)- Doc. 4444 - Pn Traffic Manage WMO No.306 WMO No.732 Offices Serving	eorological Servic ol II - Technical R . 2, Volume II – N ir Navigation ol IV - Technical F o. 2, Volume IV – (r Air Navigation Si- being developed ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic	egulations - E leteorological Quality Mana ervices – Met J lavigation Se M) es – Internatio es for Meteon	lasic Service for Basic gement eorology rvices – Air nal Codes ological	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO2) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) Geo Location (2D/3D/4D context, point, line or polyhedron) Movement 		Regulatory Provisions Operational	Anr Technical I Technical I PA PA Mar Guid	nex Regulation Regulation INS INS Inual Iance	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No (PANS-MET)- Doc. 4444 - Pn Traffic Manage WMO No.306 WMO No.732 Offices Serving WMO No.782	eorological Servic ol II - Technical R , 2, Volume II – N ir Navigation ol IV - Technical F o. 2, Volume IV – (r Air Navigation Si- being developed ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic g Aviation	egulations - E leteorological Quality Mana, ervices - Met J lavigation Se M) as - Internatio es for Meteon ports and Fore	lasic Service for Basic gement eorology rvices – Air nal Codes ological casts	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) Geo Location (2D/3D/4D context, point, line or polyhedron) Movement Severity, Accumulation, Intensity 		Regulatory Provisions Operational	Anr Technical I Technical I PA PA Mar Guid Hand	nex Regulation Regulation INS INS Inual Iance	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No Procedures foi (PANS-MET) – Doc. 4444 - Pm Traffic Manage WMO No.306 WMO No.732 Offices Serving WMO No.782 WMO No.1001 System for the	eorological Servic ol II - Technical R 2, Volume II – N ir Navigation ol IV - Technical F 0, 2, Volume IV – (r Air Navigation Se being developes being developes ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic g Aviation – Aerodrome Rep I - Guide to the Q Provision of Mete	egulations - E leteorological Quality Mana ervices - Met J lavigation Se M) es - Internatio es for Meteor worts and Fore uality Manage	lasic Service for Basic gement eorology rvices – Air nal Codes ological costs ement	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) Geo Location (2D/3D/4D context, point, line or polyhedron) Movement Severity, Accumulation, Intensity Range (Max. – Min.) 		Regulatory Provisions Operational	Anr Technical I Technical I PA PA Mar Guid Hand	nex Regulation Regulation INS INS INS Inual Ilance	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No Procedures for (PANS-MET) – Doc. 4444 - Pn Traffic Manage WMO No.306 WMO No.732 Offices Serving WMO No.782 WMO No.1001	eorological Servic ol II - Technical R 2, Volume II – N ir Navigation ol IV - Technical F 0, 2, Volume IV – (r Air Navigation Se being developes being developes ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic g Aviation – Aerodrome Rep I - Guide to the Q Provision of Mete	egulations - E leteorological Quality Mana ervices - Met J lavigation Se M) es - Internatio es for Meteor worts and Fore uality Manage	lasic Service for Basic gement eorology rvices – Air nal Codes ological costs ement	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) Geo Location (2D/3D/4D context, point, line or polyhedron) Movement Severity, Accumulation, Intensity Range (Max. – Min.) Variations 		Regulatory Provisions Operational	Anr Technical I Technical I PA PA Mar Guid Guid	nex Regulation Regulation INS INS INS Inual Iance Ibook	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No Procedures for (PANS-444 - Pm Traffic Manage WMO No.302 WMO No.732 WMO No.782 WMO No.782 WMO No.782 WMO No.1000	eorological Servic ol II - Technical R b. 2, Volume II - N ir Navigation ol IV - Technical I b. 2, Volume IV - (r Air Navigation Si being developed ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic g Aviation - Aerodrome Rep I - Guide to the Q Provision of Meta ir Navigation 0 - Guide to the Im	egulations - E leteorological Quality Mana, ervices - Met J lavigation Se M) es - Internatio es for Meteoro orts and Fore uality Manage eorological Se	lasic Service for Basic gement eorology rvices – Air nal Codes ological ccasts ement rvice for of a Quality	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) Geo Location (2D/3D/4D context, point, line or polyhedron) Movement Severity, Accumulation, Intensity Range (Max. – Min.) Variations Probability of occurrence Confidence/Uncertainty of forecast Reliability 		Regulatory Provisions Operational	Anr Technical I Technical I PA PA Mar Guid Guid	nex Regulation Regulation INS INS INS Inual Ilance	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No Procedures for (PANS-MET) – Doc. 4444 - Pn Traffic Manage WMO No.306 WMO No.306 WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 WMO No.732 WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 MMO No.732 Offices Serving WMO No.732 MMO No.732	eorological Servic ol II - Technical R , 2, Volume II – N ir Navigation ol IV - Technical F , 2, Volume IV – (r Air Navigation Si being developed ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic g Aviation – Aerodrome Rep 1 - Guide to the Q Provision of Mett in Navigation) - Guide to the Im System for Nation	egulations - E leteorological Quality Mana, ervices - Met J lavigation Se M) es - Internatio es for Meteoro orts and Fore uality Manage eorological Se	lasic Service for Basic gement eorology rvices – Air nal Codes ological ccasts ement rvice for of a Quality	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) Geo Location (2D/3D/4D context, point, line or polyhedron) Movement Severity, Accumulation, Intensity Range (Max. – Min.) Variations Probability of occurrence Confidence/Uncertainty of forecast 		Regulatory Provisions Operational	Anr Technical I Technical I PA PA Mar Guid Hand Guid	nex Regulation Regulation INS INS INS Inual Iance Iance	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Procedures for (PANS-MET) – Doc. 4444 - Pn Traffic Manage WMO No.306 WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 Hydro No.1100 Management S Hydrological S	eorological Servic ol II - Technical R , 2, Volume II – N ir Navigation ol IV - Technical F , 2, Volume IV – (r Air Navigation Sr being developed ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic g Aviation – Aerodrome Rep Provision of Mett ir Navigation) - Guide to the Im System for Nation ervices	egulations - E leteorological Quality Mana, envices – Met Javigation Se M) as – Internatio es for Meteoro orts and Fore uality Manage eorological Se plementation al Meteorolog	lasic Service for Basic gement eorology rvices – Air nal Codes ological casts ment rvice for of a Qualty ical and	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) Geo Location (2D/3D/4D context, point, line or polyhedron) Movement Severity, Accumulation, Intensity Range (Max. – Min.) Variations Probability of occurrence Confidence/Uncertainty of forecast Reliability Data sample period Auto 		Regulatory Provisions Operational	Anr Technical I Technical I PA PA Mar Guid Hand Guid	nex Regulation Regulation INS INS INS Inual Iance Ibook	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Procedures for (PANS-MET) – Doc. 4444 - Pn Traffic Manage WMO No.306 WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 Hydro No.1100 Management S Hydrological S	eorological Servic ol II - Technical R , 2, Volume II – N ir Navigation ol IV - Technical F , 2, Volume IV – (r Air Navigation Si being developed ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic g Aviation – Aerodrome Rep 1 - Guide to the Q Provision of Mett in Navigation) - Guide to the Im System for Nation	egulations - E leteorological Quality Mana, envices – Met Javigation Se M) as – Internatio es for Meteoro orts and Fore uality Manage eorological Se plementation al Meteorolog	lasic Service for Basic gement eorology rvices – Air nal Codes ological casts ment rvice for of a Qualty ical and	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) Geo Location (2D/3D/4D context, point, line or polyhedron) Movement Severity, Accumulation, Intensity Range (Max. – Min.) Variations Probability of occurrence Confidence/Uncertainty of forecast Reliability Data sample period Auto Change indicator/period 		Regulatory Provisions Operational	Anr Technical I Technical I PA PA Mar Guid Guid Guid	nex Regulation Regulation INS INS INS Ilance Ilance Iance Iance Inual Inual	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No Procedures for (PANS-MET)- Doc. 4444 - Pn Traffic Manage WMO No.306 WMO No.306 WMO No.732 Offices Serving WMO No.748 Offices Serving WMO No.748 O	eorological Servic ol II - Technical R , 2, Volume II – N ir Navigation ol IV - Technical F , 2, Volume IV – (r Air Navigation Sr being developed ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic g Aviation – Aerodrome Rep Provision of Mett ir Navigation) - Guide to the Im System for Nation ervices	egulations - E leteorological Regulations - I Quality Mana, envices - Met lavigation Se M) as - Internatio es for Meteoro orts and Fore uality Manage eorological Se uplementation al Meteorolog	lasic Service for Basic gement eorology rvices – Air nal Codes ological icasts ment ervice for of a Qualty ical and mosphere	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) Geo Location (2D/3D/4D context, point, line or polyhedron) Movement Severity, Accumulation, Intensity Range (Max. – Min.) Variations Probability of occurrence Confidence/Uncertainty of forecast Reliability Data sample period Auto Change indicator/period Amendment / Correction 		Regulatory Provisions Operational	Anr Technical I Technical I PA PA Mar Guid Guid Guid	nex Regulation Regulation INS INS INS Inual Iance Iance	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No Procedures for (PANS-444 - Pm Traffic Manage WMO No.306 WMO No.732 Offices Serving WMO No.782 WMO No.782 WMO No.782 WMO No.782 WMO No.7100 Management S Hydrological S Doc.7488 – M	eorological Servic ol II - Technical R b. 2, Volume II – N ir Navigation ol IV - Technical F b. 2, Volume IV – (r Air Navigation Si being developed ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic g Aviation - Aerodrome Rep I - Guide to the Q Provision of Metr ir Navigation D - Guide to the Im System for Nation ervices anual of the ICAC	egulations - E leteorological Regulations - I Quality Mana, envices - Met lavigation Se M) as - Internatio es for Meteoro orts and Fore uality Manage eorological Se uplementation al Meteorolog	lasic Service for Basic gement eorology rvices – Air nal Codes ological icasts ment ervice for of a Qualty ical and mosphere	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) Geo Location (2D/3D/4D context, point, line or polyhedron) Movement Severity, Accumulation, Intensity Range (Max. – Min.) Variations Probability of occurrence Confidence/Uncertainty of forecast Reliability Data sample period Auto Change indicator/period Amendment / Correction Operational Status 		Regulatory Provisions Operational	Anr Technical I Technical I PA PA Mar Guid Guid Guid Mar Mar	nex Regulation Regulation INS INS INS INS INS INS INS INS INS INS	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No Procedures foi (PANS-MET)- Doc. 4444 - Pn Traffic Manage WMO No.306 WMO No.306 WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 Doc. 7488 - M Doc. 8896 - Me Practice Doc. 9691 - Me	eorological Servic ol II - Technical R . 2, Volume II – N ir Navigation ol IV - Technical F o. 2, Volume II – N ir Navigation Si - Deing developed ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic g Aviation - Aerodrome Rep I - Guide to the Q Provision of Meta ir Navigation D - Guide to the Im System for Nation D - Guide to the Im System for Nation anual of the ICAC anual of Aeronaut	egulations - E leteorological Quality Mana ervices - Met lavigation Se M) es - Internatio es for Meteoro worts and Fore uality Manage eorological Se plementation al Meteorolog O Standard At ical Meteorolog	lasic Service for Basic gement eorology rvices – Air nal Codes ological casts ement rvice for of a Qualty ical and mosphere ogical	Stakeholder(s)
Description	 Turbulence, Mountain waves, Wind shear Fronts Radioactive clouds, Toxic chemicals Tropical cyclones Volcanic ash Sulphur dioxide (SO₂) and other hazardous gases Sea temperature, state and wave height (seaports) Space weather events Tsunami, Flood Characteristics of the meteorological information include: Time (ie. issue time, validity, commencement/cessation, lead time) Units of measurement Resolution (temporal & spatial) Geo Location (2D/3D/4D context, point, line or polyhedron) Movement Severity, Accumulation, Intensity Range (Max. – Min.) Variations Probability of occurrence Confidence/Uncertainty of forecast Reliability Data sample period Auto Change indicator/period Amendment / Correction 		Regulatory Provisions Operational	Anr Technical I Technical I PA PA Mar Guid Guid Guid Mar Mar	nex Regulation Regulation INS INS INS Ilance Ilance Iance Iance Inual Inual	Annex 3 - Mete Navigation WMO No.49 V Documents No International A WMO No.49 V Documents No Procedures foi (PANS-MET)- Doc. 4444 - Pn Traffic Manage WMO No.306 WMO No.306 WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 Offices Serving WMO No.732 Doc. 7488 - M Doc. 8896 - Me Practice Doc. 9691 - Me	eorological Servic ol II - Technical R , 2, Volume II – N ir Navigation ol IV - Technical F , 2, Volume IV – (r Air Navigation Si- being developed ocedures for Air N ement (PANS-ATI - Manual on Code - Guide to Practic g Aviation – Aerodrome Rep I - Guide to the Q Provision of Meter ir Navigation D - Guide to the Q Provision of Meter ir Navigation - Guide to the Q Provision of Meter ir Navigation D - Guide to the CA System for Nation ervices anual of the ICAC anual of Aeronaut	egulations - E leteorological Quality Mana ervices - Met lavigation Se M) es - Internatio es for Meteoro worts and Fore uality Manage eorological Se plementation al Meteorolog O Standard At ical Meteorolog	lasic Service for Basic gement eorology rvices – Air nal Codes ological casts ement rvice for of a Qualty ical and mosphere ogical	Stakeholder(s)

PART 3

	AMET-B1/4	DISSEMIN	ATION OF	METEOROLOG	GICAL INFORMA	TION				
	Main purpose	Dissemination of meteorological information in support of automated decision process or aids, involving meteorological information, meteorological information translation, A 1 minute conversion and ATM decision support								
	New capabilitie ,	Meteorological information in ICAO Meteorological Information Exchange Model (IWXXM) form starts to replace traditional alphanumeric code (TAC) products. Human-readable products will start to be derived from the IWXXM information (rather than the other way around). The introduction of web services allows for progressive replacement of fixed line dissemination systems.								
	Description	 This element represents the dissemination of meteorological products using a variety of formats, including Tailored products (human-readable) Impact-translated products Gridded Graphical (PNG and BUFR to be phased out) ICAO Meteorological Information Exchange Model (IWXXM) format Traditional alphanumeric code (TAC) – being phased out Dissemination means include aeronautical fixed service (ie. AMHS) and via secure internet services (ie. WIFS/SADIS). Commencement of SWIM-compliant web service capability to access the exact meteorological information required by users (in terms of geographical coverage, resolution etc). 								
	Human Factors	Processing Use of new Change in	equipment level of auto	ormation by user t? omation?	Yes ? Yes Yes Yes					
3			pendencies			ASBU ele	ement			
PART		Evolution	Relation	ID	Title					
•		X		_	Dissemination of meteorological products Meteorological observations information (operational requirement)					
			x x	AMET-B1/1 AMET-B1/2	Mataomiani			erational requirement) ation (operational		
	Dependencies and		Х	COMS-B1/1	PBCS approve airspace	d CPDLC (FA	NS 1/A+) for do	omestic and procedural		
	relations		Х	COMS-B1/2	PBSC approved ADS-C (FANS 1/A+) for procedural airspace					
			Х		SATVOICE (incl. routine communications) for procedural airspace					
			Х	COMI-B1/1						
			Х	COMI-B1/2		· · ·				
			Х	COMI-B1/3						
			Х	DAIM-B1/1	-	-		ata and information		
			Х	DAIM-B1/2	sets	ital Aeronauti	cal Information	Publication (AIP) data		
					ht phases			- Turn-around	1	
	Operations	Taxi		Departure	En-route	Arrival	Taxi-in		1	
		Х		Х	Х	X	Х	Х		
	Planning layers	ATM planning		Strategical	Pre-tactical	Ta Pre ops	ctical During ops	Post operations	1	
		Х		Х	X X X			Х	I	
	Enablers								I	
_	Category	Туре		Description/Examples Stakeholder(s)						
PART 4	Regulatory Provisions	Ann	iex	Annex 3 - Meteorological Service for International Air Navigation					1	
		Technical Regulation WMO No.49 Vol II - Technical Regulations Basic Documents No. 2, Volume II - Meteorological Service for						1		

		International Air Navigation	
	Technical Regulation	WMO No.49 Vol IV - Technical Regulations - Basic Documents No. 2, Volume IV – Quality Management	
	PANS	Procedures for Air Navigation Services – Meteorology (PANS-MET) – being developed	
	Annex	Annex 10 - Aeronautical Telecommunications	
	Annex	Annex 15 - Aeronautical Information Services	
Operational Procedures	Manual	Doc. 8896 - Manual of Aeronautical Meteorological Practice	
	Manual	Doc. 9377 – Manual on the Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services	
	Guidance	Doc. 9855 - Guidelines on the use of the Public Internet for Aeronautical Applications	
	Manual	Doc. 9880 - Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI Standards and Protocols	
	Manual	Doc. 9896 – Manual on the Aeronautical Telecommunication Network (ATN) using Internet Protocol Suite (IPS) Standards and Protocol	
	Manual	Doc. 10003 - Manual on the Digital Exchange of Aeronautical Meteorological Information	
	Manual	Doc. 10039 - Manual on System Wide Information Management (SWIM) Concept	
	Guidance	WMO No.731 - Guide to Meteorological Observing and Information Distribution Systems for Aviation Weather Services	
	Guidance	ICAO Guidelines for the Implementation of OPMET Data Exchange using IWXXM	
	Guidance	Regional OPMET Interface Control Documents	
	Guidance	Regional OPMET Bulletin Exchange Handbooks	
Airborne System capability			
Ground system			
infrastructure			
Training			
Information Exchange Model	ICAO Meteorological I	n formation Exchange Model (IWXXM)	
Other			

SWIM and IWXXM ... don't be afraid to dive into IWXXM! With good advice from WMO and ICAO experts.

IWXXM = model ; built on XML schemes WMO CBS TT-AvXML

From the ICAO ASBU Panel Project Team work:

- Meteorology is an **Enabler** for the majority of the other Threads.
- \Rightarrow Dependencies between threads and/or elements:
- what relations AMET has with other threads,
- what are the elements in other threads the AMET modules depend on, and
- what are the AMET elements that modules in other threads depend on.



	AMET-B1/4	DISSEMINATION OF METEOROLOGICAL INFORMATION									
	Main purpose	Dissemination of meteorological information in support of automated decision process or aids, involving meteorological information, meteorological information translation, ATM impact conversion and ATM decision support.									
	Newcapabilities	Meteorological information in ICAO Meteorological Information Exchange Model (IWXXM) form starts to replace traditional alphanumeric code (TAC) products. Human-readable products will start to be derived from the IWXXM information (rather than the other way around). The introduction of web services allows for progressive replacement of fixed line dissemination systems.									
	Description	This element represents the dissemination of meteorological products using a variety of formats, including: Tailored products (human-readable) Impact-translated products Gridded Graphical (PNG and BUFR to be phased out) ICAO Meteorological Information Exchange Model (IWXXM) format Traditional alphanumeric code (TAC) – being phased out Dissemination means include aeronautical fixed service (ie. AMHS) and via secure internet services (ie. WIFS/SADIS). Commencement of SWIM-compliant web service capability to access the exact meteorological									
			task by use		ofgeographical Yes	coverage, res	olution etc).				
	Human Factors	-	-	rr ormation by user							
	Human Factors	-	, vequipment		Yes						
		-	level of aut		Yes						
,			pendencies			ACOU of	ement				
		Evolution	Relation	1	Title						
-		Х		AMET-B0/4	Dissemination of	-					
			X	AMET-B1/1	-			(operational requirement)			
			Х	AMET-B1/2	Meteorological requirement)	forecastand	warninginfo	ormation (operational			
	Dependencies and		х	COMS-B1/1	airspace						
	relations		Х	COMS-B1/2	PBSC approve	d ADS-C (FAI	NS 1/A+) for	r procedural airspace			
			Х	COMS-B1/3	SATVOICE (inc	l. routine con	nmunications	s) for procedural airspace			
			Х	COMI-B1/1	VHF Data Link	(VDL) Mode 2	Mulit-Frequ	uency			
			Х	COMI-B1/2	SATCOM Class	B (SB-S) Vo	ice and Data	a			
			Х	COMI-B1/3	Commercial link	s for non-saf	ety critical				
			Х	DAIM-B1/1	Provision of qu	ality-assured	aeronautica	al data and information			
			х	DAIM-B1/2		ital Aeronauti	cal Informat	ton Publication (AIP) data			
				Elia	sets ht phases						
	Operations	Tavi	out	Departure	En-mute	Arrival	raxi-in	Turn-around			
	Operations		(X	X	X	Х	X			
			-				ctical				
	Planning layers	ATM planning		Strategical	Pre-tactical	Pre ops During op		Post operations			
		X		Х	Х	X	X	X			
Enablers											
	Category	Туре		Description/E	Stakeholder(s)						
	Regulatory Provisions		nex	Annex 3 - Meteorological Service for International Air Navigation							
-		Technical	Regulation WMO No.49 Vol II - Technical Regulations Basic Documents No. 2, Volume II – Meteorological Service for								

Г		International Air Navigation	
1	Technical Regulation	WMO No.49 Vol IV - Technical Regulations - Basic Documents No. 2, Volume IV - Quality Management	
	PANS	Procedures for Air Navigation Services – Meteorology (PANS-MET) – being developed	
	Annex	Annex 10 - Aeronautical Telecommunications	
	Annex	Annex 15 - Aeronautical Information Services	
Operational Procedures	Manual	Doc. 8896 - Manual of Aeronautical Meteorological Practice	
	Manual	Doc. 9377 – Manual on the Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services	
	Guidance	Doc. 9855 - Guidelines on the use of the Public Internet for Aeronautical Applications	
	Manual	Doc. 9880 - Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI Standards and Protocols	
	Manual	Doc. 9896 – Manual on the Aeronautical Telecommunication Network (ATN) using Internet Protocol Suite (IPS) Standards and Protocol	
	Manual	Doc. 10003 - Manual on the Digital Exchange of Aeronautical Meteorological Information	
	Manual	Doc. 10039 - Manual on System Wide Information Management (SWIM) Concept	
	Guidance	WMO No.731 – Guide to Meteorological Observing and Information Distribution Systems for Aviation Weather Services	
	Guidance	ICAO Guidelines for the Implementation of OPMET Data Exchange using IWXXM	
	Guidance	Regional OPMET Interface Control Documents	
	Guidance	Regional OPMET Bulletin Exchange Handbooks	
Airborne System capability			
Ground system infrastructure			
Initiastructure			
Training			
-	CAO Meteorological I	nformation Exchange Model (IWXXM)	
Other			

ICAO GANP web portal

https://www4.icao.int/ganpportal/

- Where to find the most relevant information related to the GANP;
- It provides elements and threads overview including AMET elements:

MO OMM

https://www4.icao.int/ganpportal/ASBU

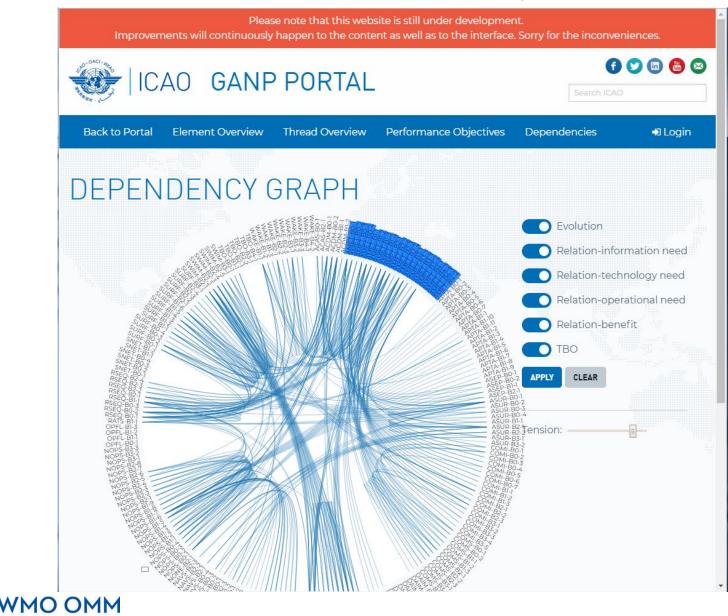
• And a graphics of dependencies.

<image><image><image><text><text><text><text><text>

THE GLOBAL AIR NAVIGATION PLAN

The Global Air Navigation Plan (Doc 9750) is the ICAO's highest air navigation strategic document and the plan to drive the evolution of the global air navigation system, in line with the Global Air Traffic Management Operational Concept (GATMOC, Doc 9854) and the Manual on Air Traffic Management System Requirements (Doc 9882). It also supports planning for local and regional implementation.

ICAO GANP web portal



ICAO GANP/ASBU more information

Also presented at WMO Aeronautical Meteorology Scientific Conference, in Toulouse, France in November 2017:

- AeM Series, 02. Proceedings of the 2017 WMO Aeronautical Meteorology Scientific Conference

- https://library.wmo.int/doc_num.php?explnum_id=4339



WEATHER CLIMATE WATER TEMPS CLIMAT EAU





WMO OMM

World Meteorological Organization Organisation météorologique mondiale