China's Eagle Strike-8 Anti-Ship Cruise Missiles

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Cold Wars 2013

Admiralty Trilogy Seminar

Outline

- Designation Confusion Aplenty
- Recognition Features
- YJ-8: China's *Flying Fish*
  - Reverse Engineered Exocet
  - Independent Development
- YJ-8A: Folding Wing Variant
- YJ-81: Air-Launched Variant
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- C802 – A Means to an End
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- YJ-8 Family Untangled
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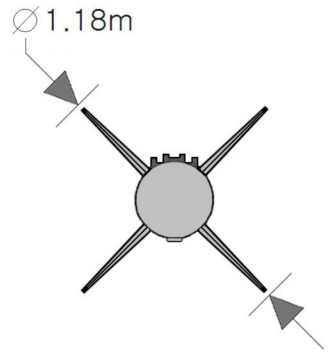
YJ-8A Launch

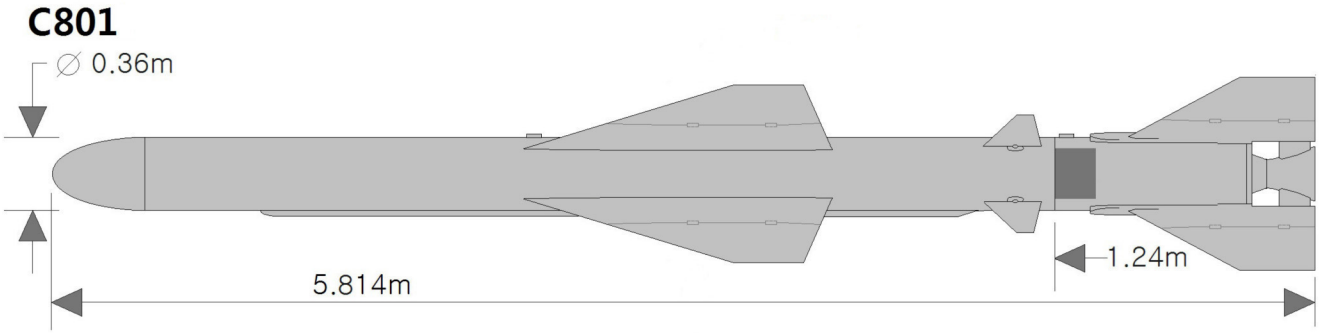
Designation Confusion

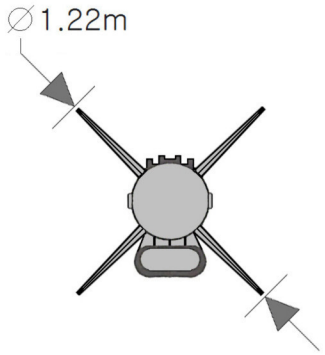
PLAN Designation	Export Designation	Accuracy
YJ-1	C801	✗
YJ-12	C801A	✗
YJ-2	C802	✗
YJ-21	C802A	✗
YJ-8	C801	✓
YJ-8A	C801A	✗
YJ-81	C801A	✗
YJ-8K	C801K	✗
YJ-8Q	C801Q	✗
YJ-82	C802	✗
YJ-82K	C802K	✗
YJ-83	C803	✗
YJ-83K	C803K	✗

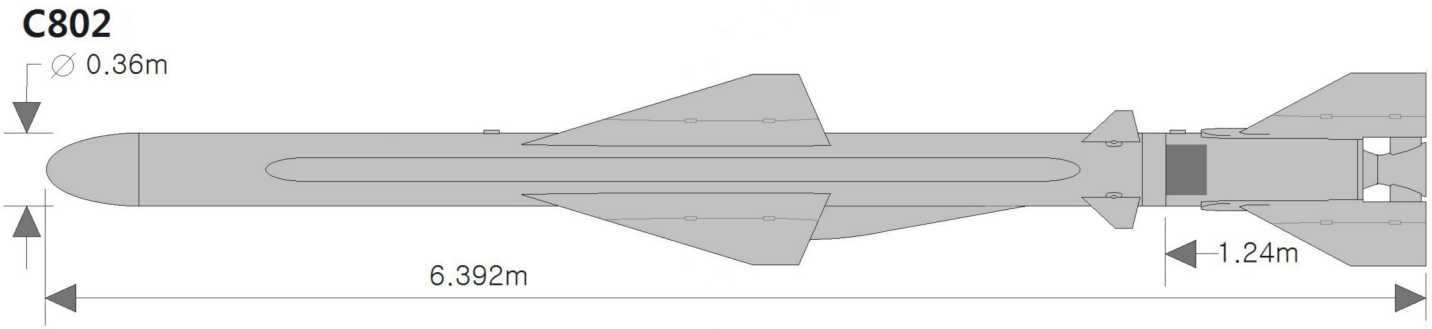
- Myriad of designations for the YJ-8 family in the open press
  - Ying Ji-8 means Eagle Strike-8
- The vast majority are incorrect
- Summarized popular list in table
  - Only one correct designation pair
  - Single red entry represents an incorrect designation
  - Two red entries indicate either both designations are incorrect for the YJ-8 family or an incorrect linkage is made between the two designations
- Clearing the confusion is essential to understanding the missile's identity, and who uses it
  - PLAN missiles are YJ-8 series
  - Export missiles are C800 series

Recognition Features









- Three significant recognition features
  - C802 has a longer fuselage aft of the wings to accommodate the TRI-60 turbojet
  - C802 also has a scoop inlet for the turbojet, C801 doesn't as it is rocket propelled
  - C802 has two external flank cable runs, C801 has only one on the missile's underbelly

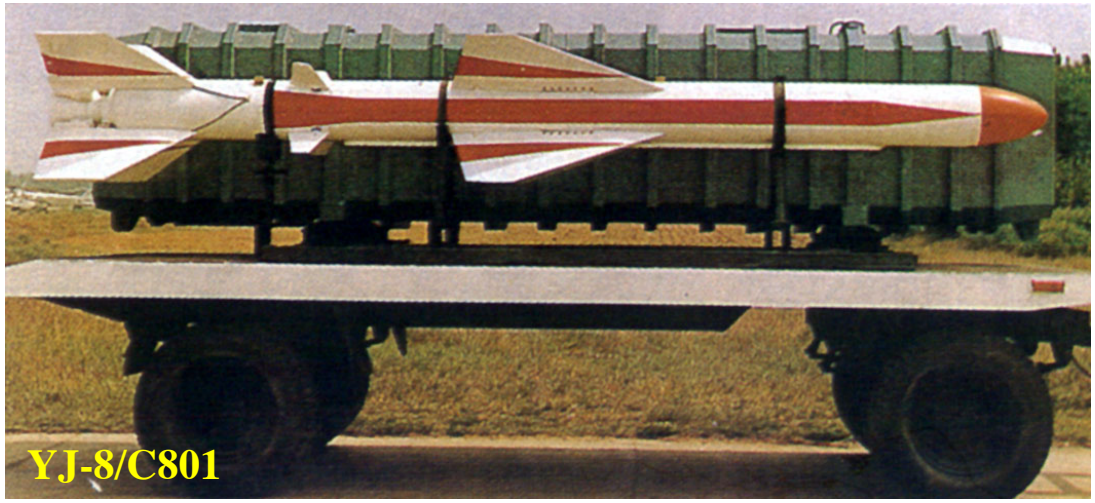
YJ-8: China's *Flying Fish*

YJ-8 being loaded on the
Type 033G Mod Romeo SSG

- Radical departure from the liquid fueled rocket P-15 (SS-N-2) based missiles
  - Development began in September 1976, however, solid rocket work began mid-1960s
  - Flight testing completed by 1985
  - Reached Initial Operational Capability (IOC) in 1987

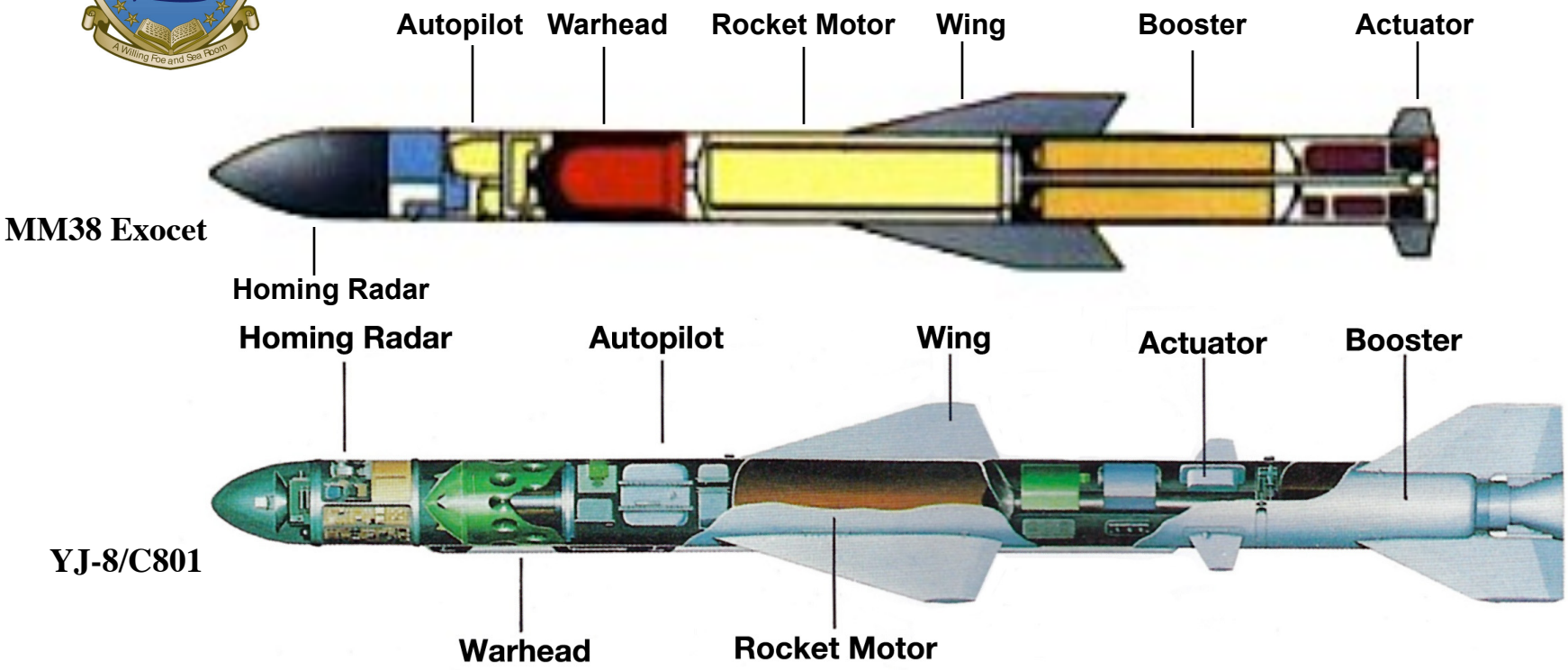
China Reverse Engineers The Exocet

- Origins of the YJ-8 are somewhat mysterious
- Several defense analysts argue the YJ-8 is a reverse engineered Exocet
  - Overall configuration similarity
  - Use of an externally ribbed launch container
- Didn't help that many Chinese articles called their missile the "Flying Fish"
  - Exocet is French for flying fish


YJ-8/C801


MM38 Exocet

Similar Requirements Yield Similar Results



- Other defense analysts believe the YJ-8 is the logical result of a missile that has similar requirements to the MM38 Exocet
  - Point to differences in overall size: YJ-8 is slightly larger, both in length and diameter
  - Significant disparity in rocket motor design
    - Exocet has booster and sustainer housed within the fuselage
    - YJ-8 has an internal sustainer, but a separate and jettisonable booster

Independent Development Hard To Support

- PRC weapon systems development strategy has relied heavily on the acquisition of foreign systems
- Reverse engineering is an acknowledged method of reducing technological risk, as well as saving time and money
  - Select systems and technologies that are known to work
  - Greatly shortens the research phase, jumpstarts the development process
  - A logical approach for a country that has to close a significant gap in military capabilities quickly and with limited resources
  - Does not require the indigenous system to be an exact copy
- China could have done all the R&D itself, but it would have taken longer, cost more, and had a higher risk of failure
- China's leadership appears to have made the choice to acquire foreign systems or technology, study them thoroughly, then build their own
  - Enabled PRC to get advanced systems faster and at a lower cost

Is the YJ-8 China's Exocet?

- YJ-8 design was at the very least heavily influenced by the MM38, if not an outright *modified* copy – it is not an exact duplicate
- Operational characteristics are a better indicator of the degree of influence than physical observables or component arrangement
  - Range is identical at 42 km
  - Speed is very similar (Exocet: Mach 0.93, YJ-8: Mach 0.90)
  - Warhead is identical at 165 kg
  - Very similar flight profile, both are sea skimmers (Exocet: 2.5 – 8 m, YJ-8: 5 or 7 m)
    - Exocet was the world's first sea skimming missile with an advanced radar altimeter
    - For China to replicate this ability in about seven years implies access to proven technology
    - A Western industrial country in the 1970s would have had difficulties meeting this goal
- An article in the Chinese Shipborne Weapons journal implies their engineers had access to Exocet technology
  - Exocet flight control gave Chinese experts "great inspiration"
  - Suggests China had a missile, flight control components, and/or detailed schematics

YJ-1 Designation

- Early Western reporting on the YJ-8 referred to it as the YJ-1, supposedly linking it to the export C801 designation
- The YJ-1 designation for the YJ-8 missile is incorrect
  - PLAN designation for an unsuccessful supersonic ship and aircraft launched ASCM
  - Export designation is C101

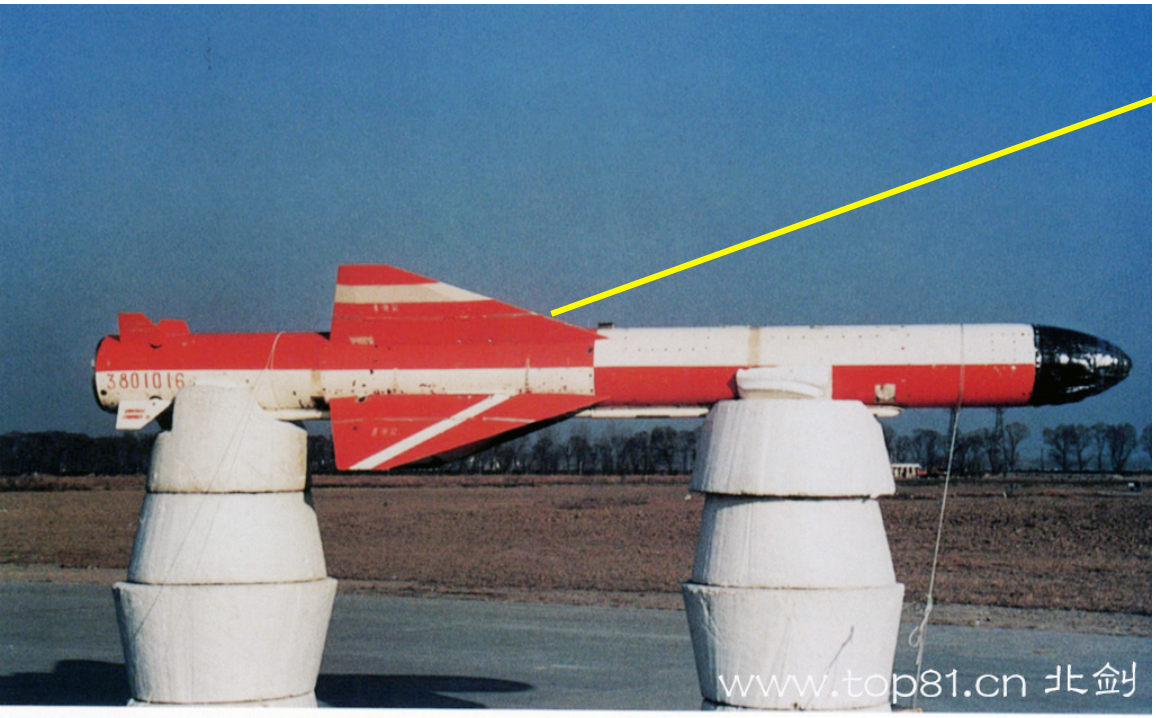
Limited Deployment

***Wuhu*, Jianghu III (Type 053HT) frigate**

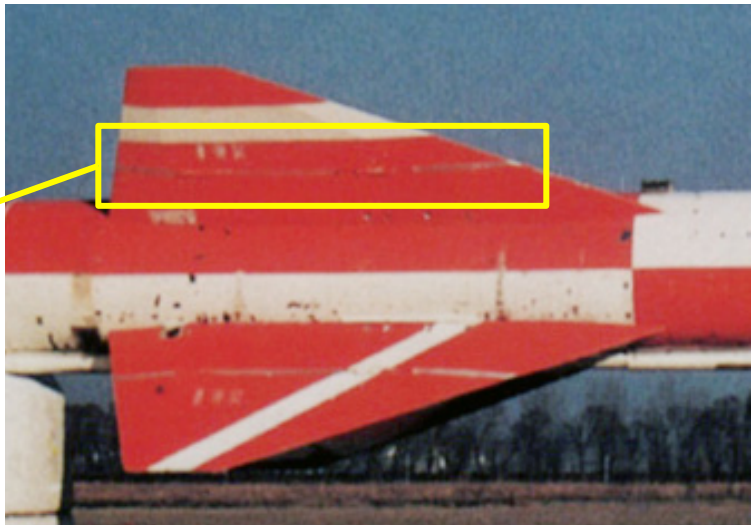
Mod Romeo (Type 033G) submarine

- YJ-8 reached IOC in 1987
- Deployed on only three platforms in the PLAN
  - Two Type 053HT Jianghu III frigates
    - *Huangshi* (535)
    - *Wuhu* (536)
  - Single Type 033G Mod Romeo submarine
- Limited export as well
  - Thailand's four Type 053HT Jianghu III frigates
  - Yemen's three Type 021 Hounan guided missile patrol boats

YJ-8A: Folding Wing Variant



YJ－8A 导弹隐身技术测试

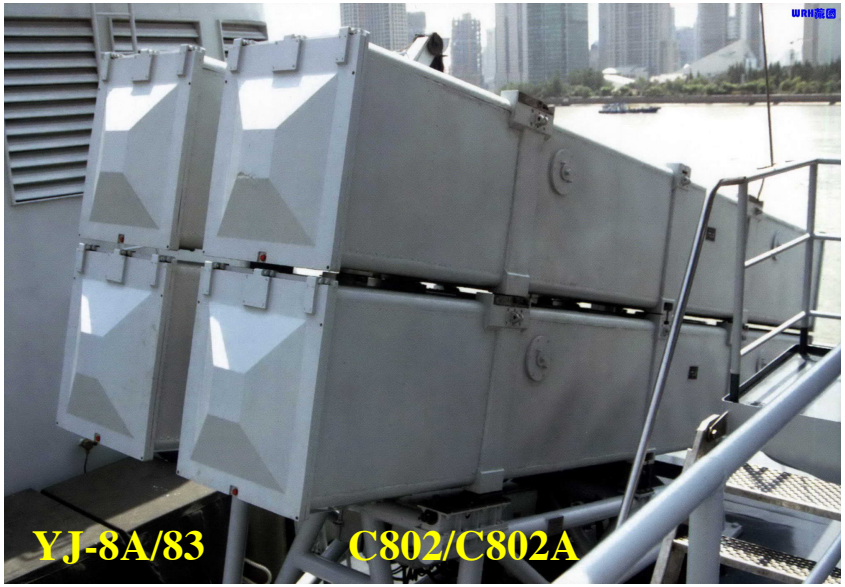


- YJ-8A appeared very quickly after the YJ-8 entered service, reaching IOC in 1992 or 1993
- Only visible physical difference was the folding wings and booster fins

YJ-8A: Why the Change?

- No reason has been given for the very limited deployment of the original fixed-wing YJ-8 missile
  - No reports of technical problems or dissatisfaction with the YJ-8's performance
  - Historical accounts of the YJ-8 development indicate flight tests were quite successful
- YJ-8A stored in a smaller, non-ribbed launch canister
  - Same canister could be used by C802 and YJ-83 missiles
- YJ-8A was reported in Western press as having a longer range, 70 – 90 km
  - Assumed missile was reversed engineered MM40 with folding wings (70 km)
  - YJ-8A dimensionally the same as the fixed wing YJ-8, MM40 is 0.6 m longer than MM38
  - Concluded increased range due to a more energetic solid rocket fuel
- Original YJ-8 rocket motor took 8 years to develop and test
  - Initial R&D took 10 – 12 years before YJ-8 solid rocket motor work even began
  - To suggest China could develop an entirely new fuel and field it in 7 years strains credibility to the breaking point – would be difficult for a more advanced Western country
  - *China had already decided on an air breather solution to achieve greater range*

Launcher Configurations



YJ-12, YJ-81, C801A Designations

- The designations YJ-12, YJ-81, and C801A were often used in the Western press to describe an “extended range” C801 – all three are inaccurate
- YJ-12 is linked to the original YJ-1, repeatedly described as a supersonic missile - first picture appeared in January 2013, more like YJ-91 than YJ-8
- YJ-81 is a valid designation, but it is for the air-launched variant of the YJ-8
- C801A designation never seen on CPMIEC arms show brochures and displays

C801: One Export Designator, Two Missiles

- Both the fixed wing YJ-8 and the folding wing YJ-8A have been advertised as the export C801 missile
  - Folding-wing C801 shown at arms shows throughout the 1990s and up to 2003
- All CPMIEC advertised performance characteristics, including range, is the same between the two versions

YJ-81: Air-Launched Variant

- PLAN had a keen desire for an air-launched version of the YJ-8
  - Short aft section, no inlet scoop, single underbelly cable run = solid rocket variant
  - Near simultaneous development with ship-launched version
  - Flight testing began in mid-1980s, IOC in 1989
- YJ-8K designator is incorrect, a good try by a knowledgeable outside source
  - "K" reportedly means "Kongjun" or air force, denotes an aircraft weapon in this case
- Export variant is the C801K

YJ-8: Submarine-Launched Variant

- PLAN strongly desired to develop a submarine launched missile
  - Styx-based missiles too big, volatile liquid fuel too dangerous
  - Small solid rocket-fueled YJ-8 was just what the PLAN was looking for
- Modified Romeo Type 033G submarine delivered in 1983
  - Began firing trials in 1985, launch system appears to have functioned adequately
- One fatal flaw – submarine had to surface to fire
  - Vulnerable to detection and attack before it could get all its missiles off

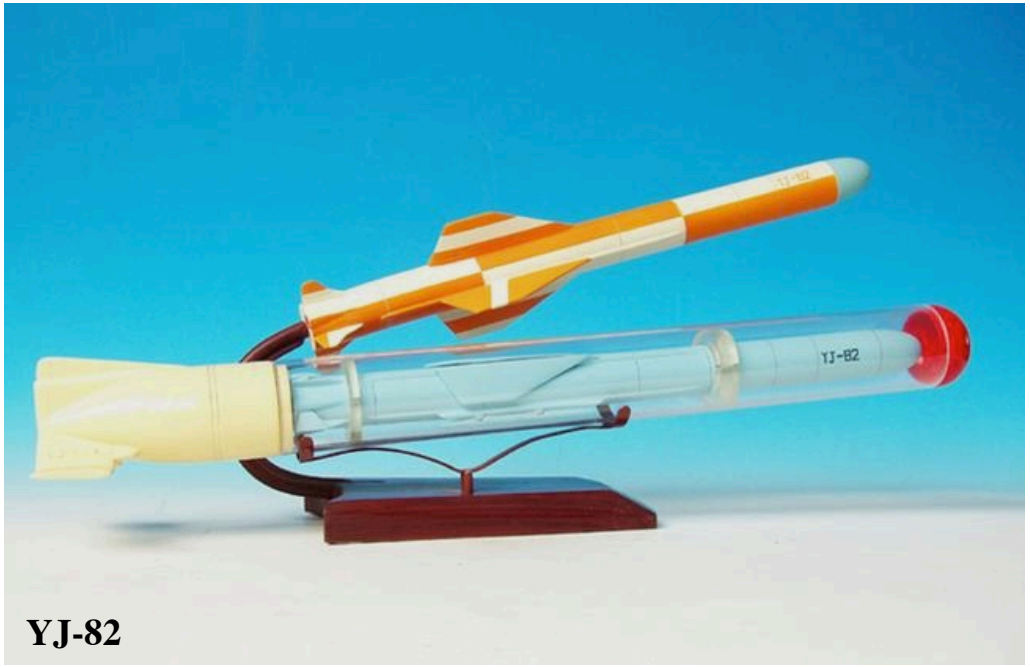
Torpedo Tube Launched Options

UGM-84 Harpoon

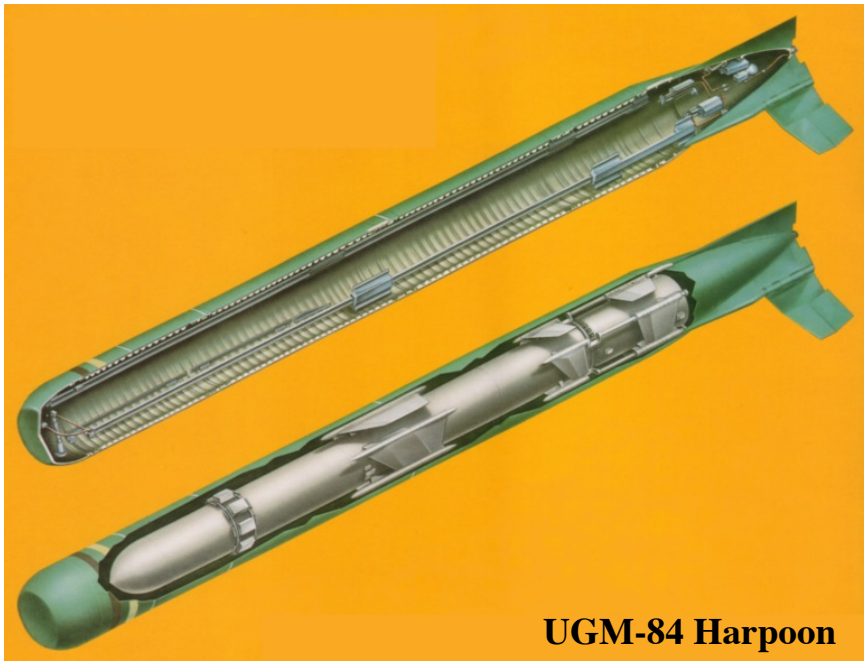
SM-39 Exocet

- PLAN chose a torpedo tube launch approach over external tubes
  - Alleviated many complicated submarine design issues, but limited their options
- Only two torpedo tube launched ASCMs in the 1980s
  - French SM39 – Powered capsule boosted missile in to the air before launch
  - U.S. Harpoon – Buoyant, unpowered capsule, missile launched after canister broaches

Harpoon Canister Knockoff



YJ-82



UGM-84 Harpoon

- At the 2004 Zhuhai Airshow China exposition – CPMIEC displayed an image of the YJ-82 and what appeared to be an identical copy of the U.S. submarine-launched Harpoon canister
- Harpoon canister is 6.1 meters long, Chinese model scale is very similar
  - Harpoon missile is 4.635 m long with booster
  - YJ-82 missile is 4.574 m long without booster

Harpoon Canister Knockoff

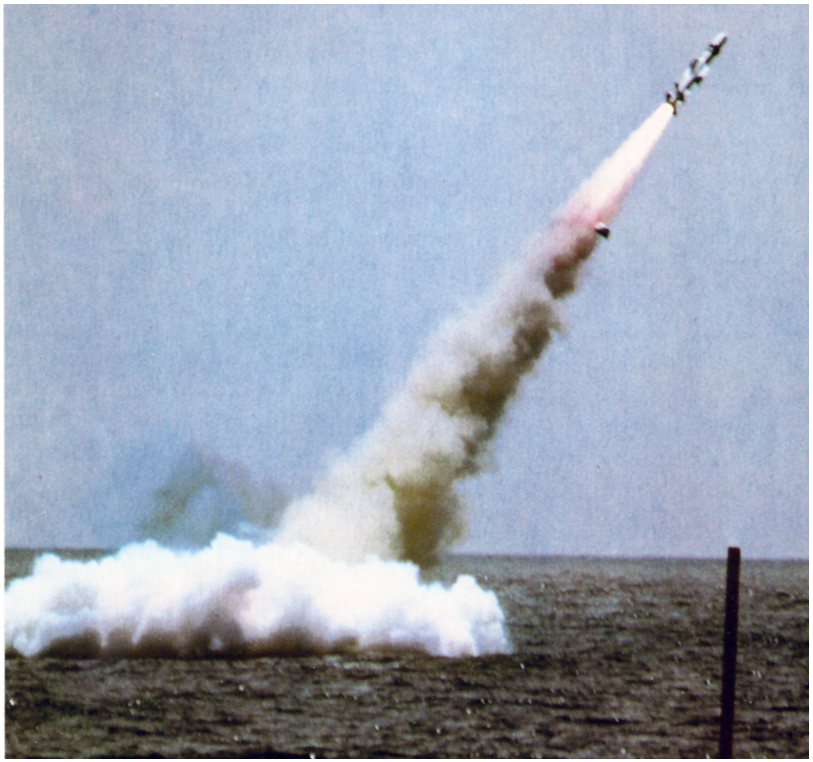
UGM-84 Harpoon Canister

YJ-82 Canister

- Pakistan was the most likely source of submarine launched Harpoon technology transferred to China
  - *Agosta* and *Daphne* class subs modified to be Harpoon capable in 1984 – 1986
  - Growing relationship due to India concerns
  - One can easily envision a quid pro quo for Chinese technical assistance in the ballistic missile and nuclear programs

Harpoon/YJ-82 Test Firings

YJ-82



UGM-84 Harpoon

- First test shot in 1997 from Song Hull 1, reportedly didn't go well
- Multiple test launch photos show YJ-82 doesn't have a booster
  - With sustainer performing both functions, range will be shorter than 42 km

YJ-82: Submarine-Launched Variant

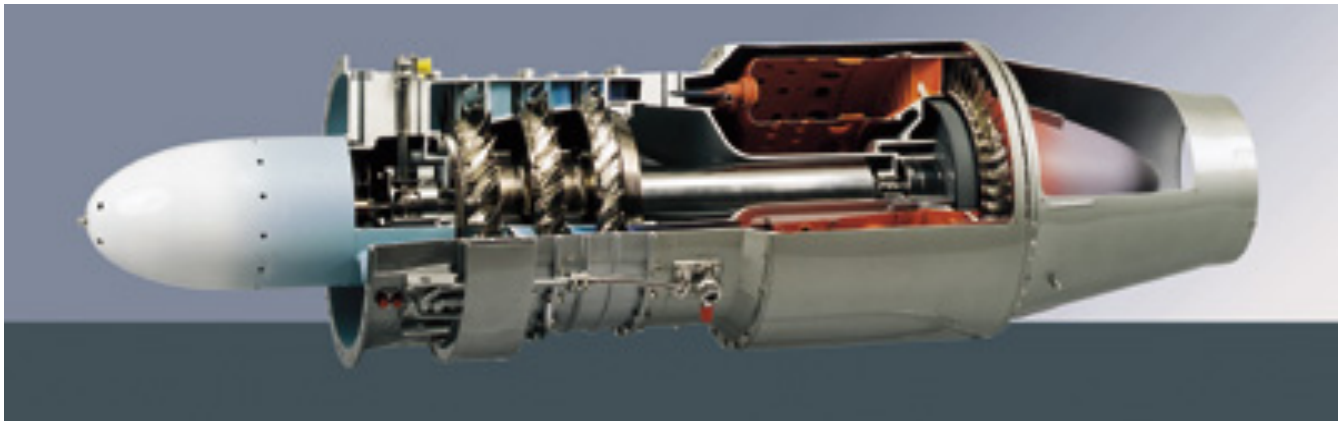
- Short section aft, no inlet scoop, no flank cable runs = solid rocket version
  - Missile model shows single underbelly cable run
- *Conclusively proves YJ-82 is not the indigenous version of the C802*
  - Radically different propulsion plants, very different launch platforms
- YJ-8Q designation also in error, a good try by a knowledgeable outside source
  - "Q" reportedly means "Qian" or submarine, denotes a submarine weapon in this case
- Export variant is the C801Q

C802: A Means to an End

CPIEMC C802 Display Model

- Even as the YJ-8 was undergoing flight tests, the Chinese knew they wanted to extend the missile's range
  - Decided on an air breather solution, not another solid rocket motor
- The C802 has the extended section aft of the wings, the scoop inlet, and the flank cable runs indicating this is a turbojet propelled missile
- Export weapon only, never adopted by the PLAN
- A means to provide funding to pay for the missile they wanted, the YJ-83

Solution to Extended Range



TRI 60-2 Turbojet Engine

- China contacted Microturbo SA in France during the mid-1980s
  - Microturbo SA delivered the first shipment of TRI 60-2 turbojets in 1987
    - Recall the YJ-8 reached IOC in the very same year
  - Three shipments of 50 engines were made between 1987 and 1996
  - Soon after the 1987 shipment, China began a reverse engineering program to produce the engines indigenously
  - In the meantime, China could sell missiles with the French supplied turbojets
- The TRI 60-2 turbojet has a maximum rated speed between Mach 0.7 and 0.9
- Increased the C802's range to 120 km, nearly three times that of the YJ-8
- Warhead, navigation, and radar homing subsystems remained essentially unchanged – CPMIEC brochures claim some additional ECCM features

Iran: The First Big Customer

C802

C802K

- By 1990 - Iran was negotiating with China to purchase 200 missiles
  - About 100 each of C801 and C802 ASCMs
  - Ship, coastal, and air launched versions
- First evidence the C802 had reached IOC was in late November 1995, when a C802 was launched during Iran's Saeqa-4 exercise

YJ-8A: PLAN's Initial Mainstay

- There is no evidence the PLAN ever adopted the C802
  - YJ-8A was the primary ASCM during the 1990s and early 2000s
- China didn't become proficient at producing the TRI 60-2 until 1996-97
  - Rarely accepts a weapon into wide scale use unless they can build it

YJ-2, YJ-82, YJ-82K Designations

- YJ-2 is also an early 1990s creation often used by the Western press
  - Assumes a relationship between YJ-2 and C802 that is incorrect
  - No photographic evidence of a missile with the YJ-2 designation
- YJ-82 designation has already been discussed
- YJ-82K is an incorrect designation for the air launched version of this missile, the correct designation is C802K

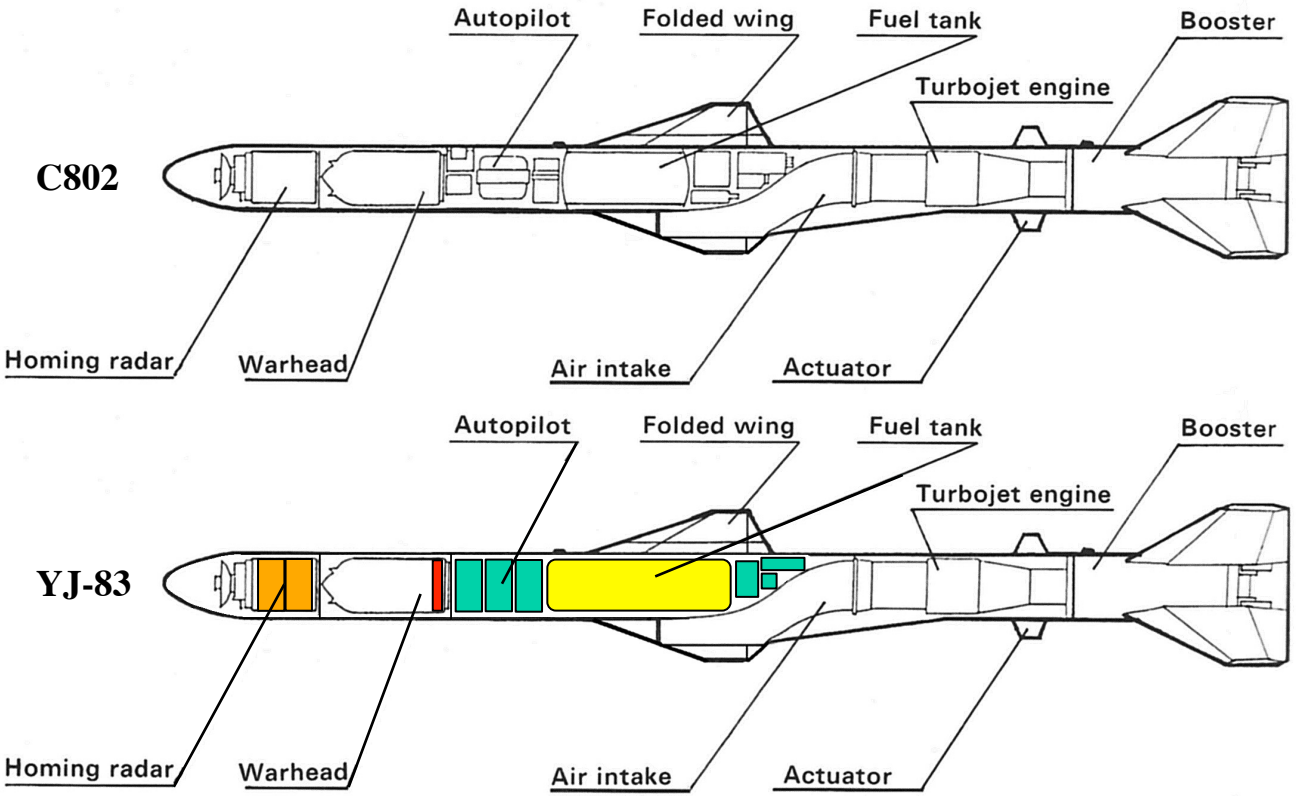
YJ-83: PLAN's Main ASCM

- The YJ-83 showed up on the scene without any advance warning
  - No actual missiles seen at the National Day Military Parade in Beijing in Oct 1999
  - Only the ship-based launch canisters on the back of a flat bed truck were shown
  - Mockup display missiles wouldn't be seen for a number of years
    - Note the YJ designation on the parade missiles, not C802 or C803
- Wild claims about the missile's performance began showing up on Internet blog sites soon thereafter – supersonic, GPS, data links

YJ-83: PLAN's Main ASCM

- The development of the YJ-83 is somewhat blurred
  - Closely linked to the C802 as they share a common propulsion system
- Final design was probably frozen in 1994 after the Chinese were confident the C802 would fly properly
- YJ-83 passed quickly through flight testing, likely reached IOC in 1998
- The TRI 60-2 turbojet essentially defines the YJ-83's size and form
  - Photos of C802, YJ-83, C802A show they are virtually the same length

Differences Between C802 and YJ-83

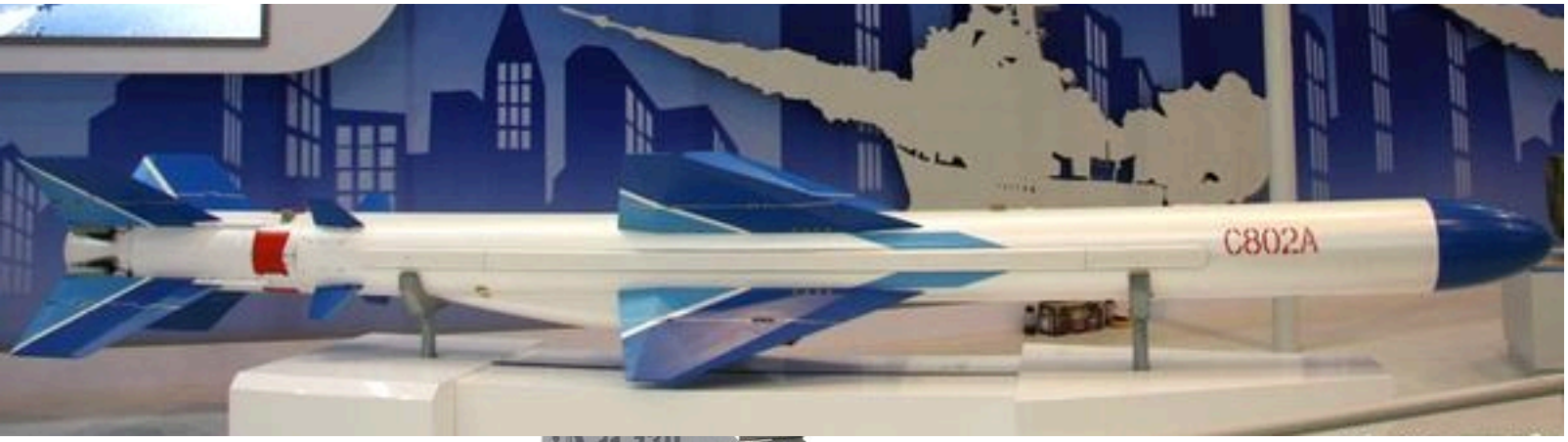


- With propulsion plant, warhead set, electronics only other area for improvement
  - YJ-8/8A used hybrid computers for navigation, autopilot, and radar seeker
    - Mixture of digital and analog components, only radar altimeter was fully digital (direct Exocet influence)
  - Inertial reference unit (IRU) used small bulky mechanical gyros and accelerometers
- Replaced electronics with digital microprocessors and a compact strap down IRU
  - Space available for more fuel, increases the range to 180 km, and a larger 190 kg warhead

YJ-83K: Air-Launched Variant

- YJ-83K is the longer ranged (220 – 250 km) air-launched variant
  - Can be carried by small tactical aircraft (JH-7), as well as large bombers (H-6)
  - Photos of missiles without cable runs are dummy training units
- Submarine launched version, YJ-83Q, has not been seen nor is it likely it ever will be
  - YJ-83 is about 0.5 m longer than YJ-8, and YJ-83 requires a booster to get airborne
  - Canister would be on the order of 8+ m long, and wouldn't fit in Chinese torpedo tubes
    - Indigenous Chinese submarine designs have torpedo tubes with lengths on the order of 7.1 m

C802A and C802AK Export Missiles



- The export variant of the YJ-83 is the C802A – ***NOT*** *the C803*
  - Based on the flawed assumption that YJ-81 = C801, YJ-82 = C802, therefore, YJ-83 = C803
  - Export model of the YJ-83K is the C802AK
- C802A wasn't displayed until the DSEi 2005 arms show in London, England
  - Seven-year delay likely due to production limitations and the need to replace YJ-8As

Does a C803 Missile Exist?

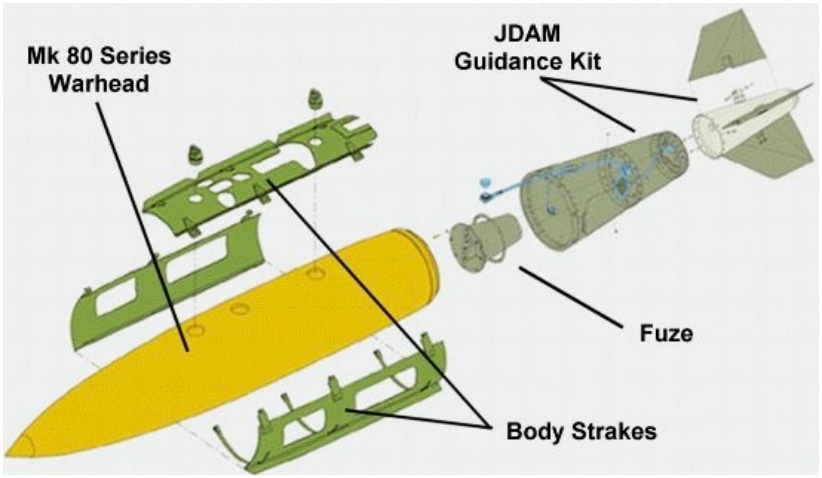
- Since about 2002, the "C803" designation has worked its way into just about every Western naval systems reference book and article
  - Yet in over 10 years of reporting, there is no formal evidence to support its existence
  - No CPMIEC brochure, placard, model or display has ever been seen with the "C803" designator
- Zhuhai Airshow China 2010 and 2012 expos displayed numerous anti-ship missiles – the C803 was conspicuous by its absence

Is the YJ-83 Supersonic?

- The YJ-83 is most definitely a subsonic missile
  - TRI 60-2 has a maximum rated speed between Mach 0.7 and 0.9
  - Supersonic drag is heavily influenced by the shape of the missile's nose cap
    - YJ-83 has a low fineness ratio, drag coefficient about twice that of a sharper nose
  - Turbojet scoop inlet is a fixed geometry inlet - all missiles with this inlet design are subsonic (C802, C602, and C705) and the inlet lacks an upper diverter to isolate it from shockwave interactions

Does the YJ-83 have GPS?

U.S. JDAM GPS Guided Bomb



C602 ASCM

- The first GPS-directed ordnance is the U.S. Joint Direct Attack Munition
  - Began flight testing in 1996, reached IOC in 1998, first used in early 1999
- An in depth Chinese paper in 1995 acknowledged the benefits of GPS
  - China didn't possess the technical capability in the mid-1990s to employ GPS in munitions
    - R&D on ring laser gyroscopes on going, had to purchase GPS receivers from other countries
  - Concerns about the accuracy of the signal, i.e. Selected Availability
- YJ-83 reached IOC in 1998 as well, including a GPS feature makes little sense
- C802A brochure makes no reference to a GPS function, C602 brochure does

Does the YJ-83 have a Data Link?

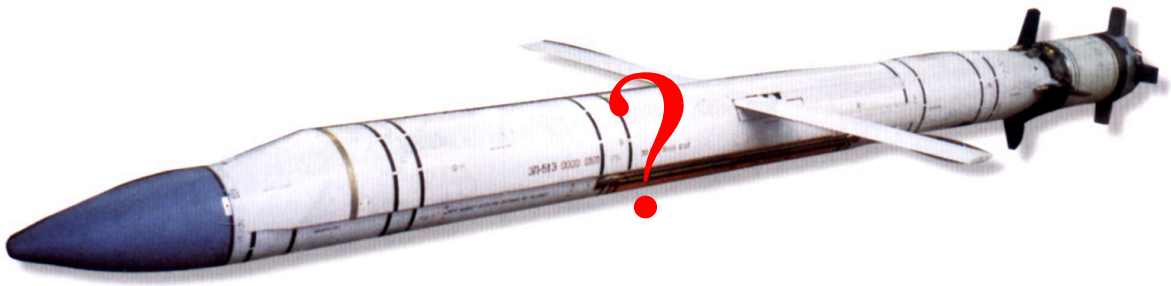
AKD-88 EO Variant

CM-802AKG

- Before the late 1990s, some Soviet ASCMs and the Otomat had a limited data link
  - U.S. and Israel would field full two-way data links in their Harpoon upgrades in early 2000s
- C802A brochure doesn't mention a data link – quite the opposite, "fire and forget"
  - 2010 brochure mentions ability to use four attack paths with three waypoints for the first time
- Some YJ-83 based missiles do have data links, all ground attack weapons
  - AKD-88 first seen in 2006, CM-802AKG in 2010: 8 – 12 years after the YJ-83 entered service

Is There Another Missile?

- Can't ignore the repeated claims in Western press and on Chinese Navy blogs
  - Begs the question: "Is there another missile with these performance features?"
- US DoD 2010/2011 annual report to Congress mentions an advanced ASCM in development and testing, CH-SS-NX-13, to be fired from Chinese submarines
  - Most likely a torpedo tube fired weapon
  - Some evidence also suggests the weapon could be launched from a ship's vertical launcher
- Shift in flight profile from all supersonic to subsonic cruise, supersonic attack
  - Reduces the field of possible options to one – Russia's 3M54 Novator Alpha
- Recent Chinese blog discussions have suggested a new missile with the designation YJ-18 is the Chinese version of the Russian Club
- A program start date around 2000 is consistent with the YJ-83 claims



The YJ-8 Family Untangled

PLAN Designation	Export Designation	IOC	Launch Platform	Length (m)	Weight (kg)	Maximum Range (km)	Speed (Mach)	Cruise Altitude (m)	Terminal Altitude (m)
YJ-8	C801	1987	Surf/Coast	5.814	815	42	0.90	20	5 or 7
YJ-8A	C801	1992-93	Surf/Coast	5.814	815	42	0.90	20	5 or 7
YJ-81	C801K	1989	Air	4.65	610	50	0.90	20	5 or 7
YJ-82	C801Q	2003 est	Sub	4.57	610 est	30-34 est	0.90	20	5 or 7
	C802	1994-95	Surf/Coast	6.392	715	120	0.80-0.90	20 or 30	5 or 7
	C802K	1997 est	Air	5.15	510 est	150-160 est	0.80-0.90	20 or 30	5 or 7
YJ-83	C802A	1998	Surf/Coast	6.383	800	180	0.80-0.90	20	5 or 7
YJ-83K	C802AK	2002	Air	5.14	595 est	225 - 250	0.80-0.90	20	5 or 7

- A lot of confusion has been proliferated in published works and on blog sites
  - The YJ-8 family is particularly a tangled up mess, the table above presents a clearer picture
  - Likely not some disinformation program, just a lot of information that has been misunderstood
- If the YJ-8 is China's Exocet, then the YJ-83 is China's Harpoon Block 1C
  - Evolutionary weapon, not a quantum leap
  - A good solid ASCM that is supported by a targeting system that can conduct OTH attacks
- Detailed three-part article posted on Defense Media Network
  - URL Part 1: http://www.defensemedianetwork.com/stories/chinas-eagle-strike-eight-anti-ship-cruise-missiles-designation-confusion-and-the-family-members-from-yj-8-to-yj-8a/

Questions?